METR 360 LAB BOOK

FALL, 2018

NAME _____

Fall, 2018: Weather Analysis and Forecasting I (METR 360)

Lectures: 1-1:50 p.m. Monday, Wednesday, Friday in S309. Labs: 2-4:50 p.m. Wednesday in S309
Instructor: Dr. Jerome Blechman, 311B Sci I, campus phone: 3322, Jerome.Blechman@oneonta.edu
Office hours: Monday, Wednesday, 10-10:50, Thursday 1-1:50

Text: Lab workbook (available first class period)
Good references (not required): An Introduction to Dynamic Meteorology by James R. Holton; Mid-Latitude Weather Systems by T.N. Carlson; Synoptic-Dynamic Meteorology in Midlatitudes by Howard B. Bluestein

Learning Outcomes:

- Students will apply principles of atmospheric synoptic and dynamic meteorology to the prediction of states of the atmosphere on time scales up to two weeks into the future
- Students will demonstrate their ability to communicate scientific and technical information effectively through appropriate oral, visual and written presentation.
- Students will demonstrate their ability to apply scientific reasoning, technology and collaborative skills to solve real world problems in the Earth and Atmospheric Sciences

Emergency Evacuation/Shelter-in-Place Procedures
In the event of an emergency evacuation (i.e. fire or other emergency), classes meeting in Science I are directed to reassemble at **Chase Gymnasium** so that all persons can be accounted for. Complete details of the College's emergency evacuation, shelter-in-place, and other emergency procedures can be found at www.oneonta.edu/security.

ADA (Americans With Disabilities Act) Statement
All individuals who are diagnosed with a disability are protected under the Americans with Disabilities Act, and Section 504 of the Rehabilitation Act of 1973. As such, you may be entitled to certain accommodations within this class. If you are diagnosed with a disability, please make an appointment to meet with Student Disability Services (SDS), 209 Alumni Hall, ext. 2137. All students with the necessary supporting documentation will be provided appropriate accommodations as determined by the SDS Office. It is your responsibility to contact SDS and provide the professor with your accommodation plan before a test. More information can be found at http://www.oneonta.edu/development/sds/

Student responsibilities and my expectations for you
You, the student, are responsible for *earning* your grade in this class. I don't "give out" grades.
In addition, I expect you to know and follow the student responsibilities established in the College Code of Student Conduct: http://www.oneonta.edu/communitystandards/code-of-student-conduct.asp I will follow the code as well whenever it applies to faculty.

Grading: Two exams: 20% each (total=40%, see schedule); Lab assignments: 30% Forecasting Contest: 10% (details to be announced), Final exam (cumulative): 20% (The Final Exam will be on Dec 17 at 11 a.m)

Grading Scale:	93-100% = A	90-92% = A-	87-89% = B+	83-86% = B
	80-82% = B-	77-79% = C+	73-76% = C	70-72% = C-
	67-69% = D+	63-66% = D	60-62% = D-	0-59% = E

First Assignment: Read the short story "Profession" by Isaac Asimov. A web link is provided here (http://www.abelard.org/asimov.php) and a pdf version on the course homepage (http://employees.oneonta.edu/blechmjb/JBpages/METR360top18.html).
Think about it and be prepared to discuss how the concepts in this story could relate to this course and to our own profession as meteorologists. There are also more general philosophical implications. We will discuss this on Monday Aug 27. Please be ready.

Lecture Topics (note: on any day with interesting weather, lecture may be pre-empted for a map discussion)

1. Norwegian model review	5. Air masses (damming, lake effect)	9. Potential vorticity
2. Fronts	6. NCEP guidance products	10. Cyclogenesis
3. Stability	7. Waves in the westerlies	11. Jet streams
4. Upper air	8. Vertical motion	
EXAM (Oct 3)	EXAM (Nov 14)	FINAL EXAM (Dec 17)
		(The Final exam is cumulative)

Lab Topics

Aug 29	Surface map analysis review (Map 2 graded)
Sep 5	Synoptic code (Graded)
Sep 12	Radiosonde release Analyze plotted maps* (Graded)
	* after maps are returned on Friday
Sep 19	Upper air code and Sounding plotting (Graded)
Sep 26	Upper air maps I (Graded),
Oct 3	**Exam 1**
Oct 10	Upper air maps II (Graded)
Oct 17	Numerical Guidance (Graded)
Oct 24	METAR code (Graded)
Oct 31	Lake Effect snow forecasting (Graded)
Nov 7	Forecast teams (Not Graded)
Nov 14	**Exam 2**
Nov 28	IDV nor'easters (Graded)
Dec 5	Forecast teams (Not graded)

Notes:

1. As standard equipment for all labs, you will need the lab workbook, a calculator, colored pens and pencils, a regular pencil with eraser, a plotting pen, and a ruler. For colored pens, get some inexpensive felt tips. At a minimum, you will need black, blue, red and green. Also, get red, blue and green pencils for shading maps. You will need a fine-tipped black plotting pen (felt-tip is fine).

2. Since we have no formal text, you must attend all labs and lectures. You should only miss a class or lab for a good reason. Sickness is a good reason. Softball practice is not. If you feel you must be absent or late, ask me first (whenever possible).

3. There will be no lab exam. The grades given for labs will be averaged and will count 30% toward the course grade. Labs are a major part of the course. Read the lab write-ups in the lab book before each lab. Graded labs must be turned in Monday following the lab, unless a different due date is announced during the laboratory period. If you are sick and miss the lab period, you must make up the assignment as soon as possible.

4. Everyone will enter the WxChallenge forecasting contest (forecasting is worth 10% of your grade). The entry fee is $5.00 for the year. You just pay me and I will pay the Contest for everyone. Read the rules at http://www.wxchallenge.com/info/rules.php You will need a six-character identifier. Mine is blechm. Yours can be anything such as kissme, Mickey, or SoGood (keep it clean). It can be your name, like Lovell or StacyB. It can be someone else's name, like AJudge or Smith7. Notice that they are case-sensitive. You will type this identifier many times. Make it something you can type easily and remember, too. You also need a nine-character password. You can use any combination of 9 letters and numbers.

Surface Map Analysis Review

Many of the labs this semester will involve plotting and analysis of weather data in different forms from different perspectives. The form most of you recognize is the analyzed surface map. You should have done this at least once in METR 110, so the basics will not be repeated here. However, now that you are advanced meteorology majors, you will be expected to be able to produce a smooth, readable analysis and therefore we will practice analyzing maps.

Some of you may be thinking that a computer plotter can draw a map and that this is a waste of time. You will think that about many of this semester's labs. It is, however, important to learn how analysis and plotting are done, so when, not if the computer breaks down or does something you think looks strange, you know the mechanics of the analysis and plotting processes.

Your 28 September map will be returned Friday in class with comments to help you improve your analysis technique. Your analysis of the 00Z Surface Obs map on page 7 will be graded.

Lab Assignment:

1. Analyze the map for 28 September in lab and turn it in before you leave. Remember to write your name on all maps to be turned in. On Friday you get this one back with comments but no grade. Use the comments to do a better job on the second map.
Do the following analysis:

a) Draw isobars in black every 4 mb, including the 1000 mb isobar (label them 92, 96, 00, etc.)
b) Draw isotherms in red every 10°F (label them 60, 70, 80, etc.)
c) Put in centers of High and Low pressure (H and L). Remember that winds must be cyclonic around the "L" and anticyclonic around the "H".
d) Draw in the fronts, if any exist. This will be tough. Give it a try.

Color conventions for meteorological analyses are summarized on the next page.

2. After you get back the 28 September map, analyze the map on page 7 (00Z Surface Obs), to be turned in next week in lab. Do a, b, c, and d from above. This one will be graded.

Remember - always draw isopleths lightly in pencil first, then ink over.

Review of the station model (where to look for pressure, temperature, precip, etc.):

TT-> temperature, T_dT_d -> dew point, PPP -> pressure, ww -> weather, ddff -> wind direction and speed. For this example: Temperature = 68°F, dew point = 66°F, pressure = 1006.5 mb, pressure dropped 1.0 mb in past 3 hours, current weather = thunderstorm, wind from 170° at 10 knots, sky obscured, rainfall = 0.61" in past 3 hours, past weather = rain. Note: not all reports have all this information.

Color and contouring Conventions for Synoptic Analyses

Surface (MSL) maps

Isobars - solid black felt tip pen (4 mb intervals, centered at 1000 mb.).

Isotherms - solid red felt tip pen (intervals of 5°C, centered on 10°C or 10°F, centered on 50°F).

Fronts - red felt tip pen for warm, cold for blue, purple for occluded.

Isallobars - lightly dashed red lines for falls, blue for rises.

Areas of continuous precipitation - shade lightly with green pencil. Outline shaded green area with heavier green line. Add a few weather symbols in heavier green (inside) showing type of precipitation.

Areas of showery precipitation - outline with heavy green line. Add weather symbols inside.

850 mb and 700 mb charts

Contours in solid black felt tip pen (60 m intervals centered on 1500 m for 850, 3000 m for 700).

Isotherms in red felt tip pen (5° intervals, centered on 0°C).

Shade areas where T-TD $\leq$ 5°C.

500 mb chart

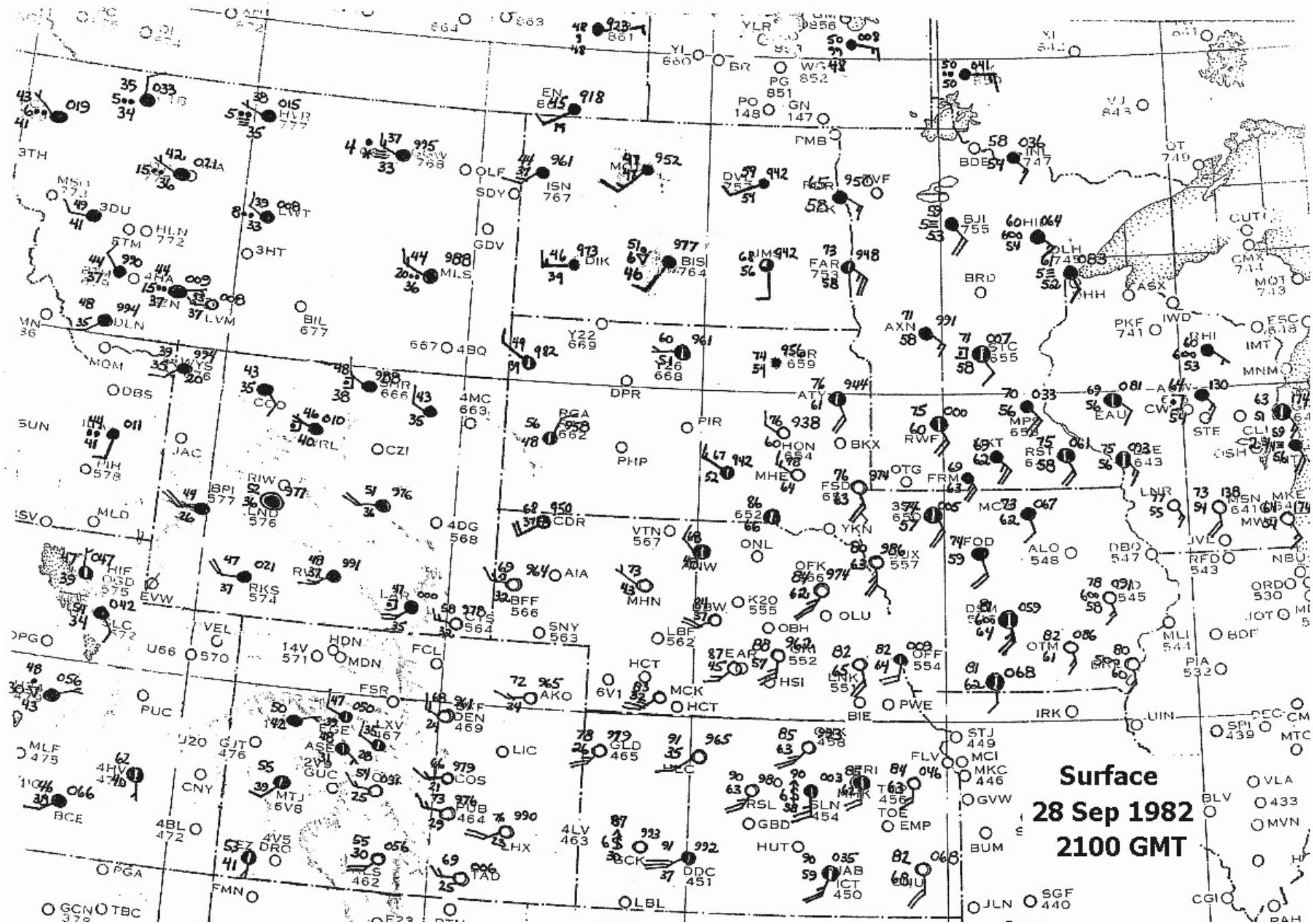
Contours in solid black felt tip pen (60 m intervals centered on 5400 m).

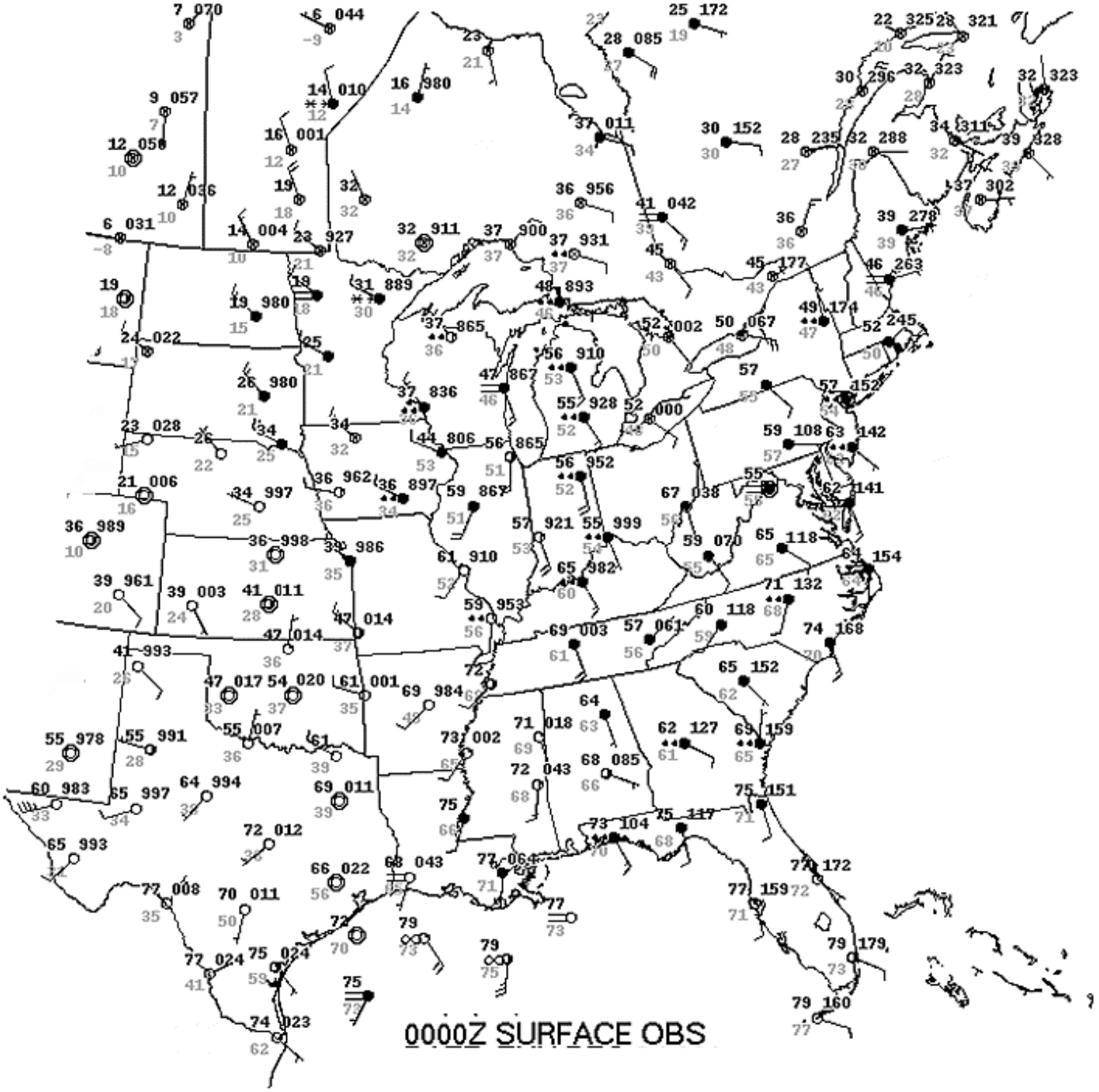
Isotherms in red felt tip pen (5° intervals, centered on -20°C).

300 mb, 250 mb, and 200 mb charts

Contours in solid black felt tip pen (120 m intervals centered on 9000 mb for 300 mb and 12000 m for 200 mb).

Isotachs in dashed light blue (20 kt intervals centered on 70 kts). Shade alternate 20 kt intervals.


Surface
28 Sep 1982
2100 GMT


0000Z SURFACE OBS

The Synoptic Code

There are two types of code used to transmit surface weather data from Weather Forecast Offices (WFO's) to the National Center for Environmental Prediction (NCEP, the Weather Service's main office). The most commonly used code is known as METAR Code, but this code is a shorthand type, designed to send out an abbreviated weather message every hour, mainly for pilots. It will be the subject of a later lab.

The code used by the Weather Service to send out synoptic type data is known as the **Synoptic Code**. It is the code used by first-order stations to report their observations every three hours for the weather maps at 00Z, 03Z, 06Z, etc. Today's lab uses only Part 1 of the code. The complete code book can be found at http://www.ofcm.gov/publications/fmh/allfmh2.htm (specifically, Handbook No. 2, at http://www.ofcm.gov/publications/fmh/FMH2/FCM-H2-1988.pdf).

The Synoptic code is a message consisting almost entirely of numbers. This message contains an extraordinary amount of weather information. Deciphering the code is what today's lab is all about. Here is a sample line of code:

72518 SM 11212 82313 10165 20159 39923 40027 57022 69961 75154 8662/

You should notice that after the first three groups of five, each group starts with an identification number, **1**0165 **2**0159 **3**9923, etc. This is so you can rapidly decode the message. Use the identifiers with the symbolic form shown below. The code SM just indicates synoptic code and may be omitted on many reports.

Decoded observation: Albany, N.Y., precipitation included, measured at a manned (not automatic) station, base of the lowest cloud is 100-199 meters above ground, visibility 1.2 km (3/4 mile), sky completely overcast, wind from 230° at 13 knots, temperature 16.5°C, dew point 15.9°C, station pressure 992.3 millibars, sea level pressure 1002.7 mb, pressure has fallen 2.2 mb in the last three hours, precipitation = 0.6 millimeters and it began less than 1 hour ago, current weather is slight continuous drizzle, most significant past weather is drizzle, secondary past weather is fog.

As you can see, the Synoptic Code is a very efficient way to get an entire paragraph of data into one line. There could be much more additional information, but we will concentrate on the first section which ends with the cloud group, as above.

You do not have to memorize this code. That is why we have reference tables, like this lab and the Federal Meteorological Handbook (again, at http://www.ofcm.gov/publications/fmh/allfmh2.htm). Also there are computer programs to decode it. As we discussed, you are studying the code so that you understand it and that when the computer makes an error, you won't be helpless.

IMPORTANT - Note that whenever possible, the coded information is in metric units. The U.S. is alone in its persistent usage of English units. Even the English don't use them anymore. We will use a lot of metric units in this course.

The symbolic form of the message follows. You should compare this to the explanations and examples on the following pages:

IIiii $i_R i_x$hVV Nddff $1s_nTTT$ $2s_nT_dT_dT_d$ $3P_oP_oP_oP_o$ 4PPPP 5appp $6RRRt_r$ $7wwW_1W_2$

Depending on the weather, not all of the groups are reported at each synoptic observation. For example, if no precipitation occurs, the group $6RRRt_r$ may be omitted.

In addition, on the first working day of each month, the 18Z SM will contain monthly mean and record breaking data.

EXPLANATION OF SYNOPTIC CODE GROUPS

Identification System (IIiii)

This group contains the WMO identification number of the station. The first two digits (II) represent the region (U.S.=72). The last three digits represent the station code.

Cloud height- Visibility group ($i_R i_x$hVV)

The first identifier (i_R) is the indicator for inclusion or omission of precipitation data. There are 3 possible code figures:

Code Figure	Group $6RRRt_R$ is:
1	Included
3	Omitted (PRECIP=0)
4	Omitted (PRECIP amt not available)

If any precipitation falls (including a trace) during the 6 hour time interval between messages, code figure 1 will be used.

The second identifier (i_x) indicates the type of station operation (manned or automatic) and indicates the inclusion of present or past weather data. There are 6 possible code figure, however the first three are most common:

Code Figure	Type of Station	Group $7wwW_1W_2$ is:
1	Manned	Included
2	Manned	Omitted (no significant phenomenon to report)
3	Manned	Omitted (Data not available)

Code figures 4 through 6 repeat the above for automatic stations. Code figure 2 is used if the present and past weather both only describe characteristic changes in the state of the sky. Code figure 1 is used (and therefore $7wwW_1W_2$) is included) if any atmospheric meteors were observed during the previous 6 hours.

The third figure (h) reports the height above ground of the base of the lowest cloud seen. Check the following table for an interpretation of the code figures:

CODE FIGURE	HEIGHT IN FEET	HEIGHT IN METERS
0	0-149	0-49
1	150-299	50-99
2	300-599	100-199
3	600-999	200-299

4	1000-1999	300-599
5	2000-3499	600-999
6	3500-4999	1000-1499
7	5000-6499	1500-1999
8	6500-7999	2000-2499
9	8000 or higher or no clouds	2500 or higher or no clouds

VV is the coded form of the horizontal visibility at the surface. Table 3 is a complete chart of reportable visibilities and their associated code figures.

Examples of Group $i_R i_x$hVV

32866 No precip group in report (amount is zero).
Manned station with no significant weather group
Lowest cloud base 2000-2500 meters (6500-8000 ft)
Visibility 16 kilometers (10 miles)

46/// No precipitation group in report (not available)
Auto. station with no weather group (not observed)
No cloud height reported
No visibility reported

Sky-cover – Wind Group (Nddff)

Sky covers amounts (N) are evaluated in terms of the fraction of celestial dome (entire sky area above the local horizon) covered by all types of clouds. The amounts are recorded in tenths and reported in accordance with Table 2. **Note:** currently, amounts recorded in eighths (octas). When an observer at the surface is unable to evaluate the sky cover due to atmospherics obstructions to vision such as fog, smoke, haze, precipitation, or any other phenomena other than clouds, an obstruction is reported by code figure 9.

Wind direction (dd) is defined as the direction from which the surface wind is blowing. Wind directions are made over a one minute average except for multiple registers, when a 5 minute average is used. The direction is determined with reference to true north and expressed to the nearest tens of degrees on the 01-36 scale. For example, a wind blowing from the north (360º) toward the south (180º) is called a north wind and code figure 36 is reported. When the air has no perceptible motion (calm), code figure 00 is reported. If neither an instrumental nor estimated direction is obtained, solidi (//) shall be reported for dd to indicate missing data.

Wind speed ff is determined to the nearest knot. As far as possible, the average wind speed observations are not made during a peak or lull in gusty winds or squalls. In general, observed wind speeds are a one minute average. When the air is calm, code figure 00 is reported. In the range 01-99 knots, inclusive, the speed is coded directly for ff. In the 100-199 knot range, the speed minus 100 is reported, along with a special revision to the direction (dd). In this range, 50 is added to the code figure normally reported for dd. Thus a 125 knot north wind is reported 8625 (i.e. dd is 36 (north) + 50 = 86, and ff is 125 -100 = 25, so coded it is 8625.

Other examples: 90000 Sky totally obscured, wind calm.
01506 Sky clear or partially obscured, wind SE at 6 knots.

Temperature Groups ($1s_nTTT$ and $2s_nT_dT_dT_{d)}$

The character "1" identifies the air temperature group. The character s_n gives the sign of the temperature.

Code Figure	
0	Temperature positive or zero
1	Temperature negative

The characters TTT give the temperature of the air in tenths of Celsius degrees. $T_dT_dT_d$ gives the dew point temperature to nearest tenth degree Celsius.

Example: 10036 21036 Air temperature is +3.6ºC
Dew point temperature is -3.6ºC

Pressure Groups ($3P_oP_oP_oP_o$ 4PPPP 5appp)

"3" is the code figure for the station pressure group. This is a non-reduced pressure corrected for instrument error. The pressure given to the nearest tenth of a millibar (e.g. 975.3mb is coded 39753; 1003.3 mb is coded 30033).

"4" is the code figure for surface pressure reduced to sea level given to the nearest tenth of a millibar.

The third group (5appp) is the three-hour pressure tendency and pressure change group. The characteristics of the pressure tendency, "a", are described in Table 5.

The last three characteristics, ppp, are the actual change in the pressure (but with no decimal) during the 3 hours ending at the actual time of observation.

EXAMPLES OF PRESSURE GROUPS

39548 40176 54000	Station pressure = 954.8mb
	Sea-level pressure = 1017.6mb
	3 hour pressure tendency is steady
	Pressure is the same now as 3 hours ago
39658 49984 57084	Station pressure = 965.8mb
	Sea-level pressure = 998.4mb
	Pressure falling steadily past 3 hours
	Pressure has fallen 8.4mb past 3 hours

Precipitation Group ($6RRRt_R$)

"6" is the identifier for the precipitation group. RRR is the total six hour amount of liquid precipitation and water equivalent of solid precipitation. The precipitation is recorded in millimeters and is coded as in Table 4.

t_R is the time precipitation began or ended as described in the following:

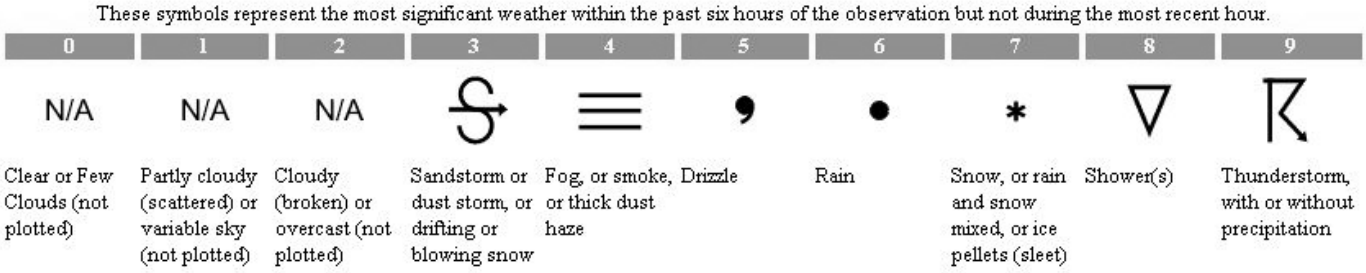
CODE FIGURE	TIME BEGAN OR ENDED	CODE FIGURE	TIME BEGAN OR ENDED
0	No precipitation	6	5-6 hrs ago
1	less than l hr ago	7	6-12 hrs ago
2	1-2 hrs ago	8	More than 12 hrs ago
3	2-3 hrs ago		
4	3-4 hrs ago	9	Unknown
5	4-5 hrs ago		

Past and Current Weather Group ($7wwW_1W_2$)

"7" is the group identifier. ww is weather occurring at the observation time and is shown in Table 1.

The last two characters in the group (W_1W_2) are used together to show the past weather. W_1 is the most significant past weather during the appropriate 6 hour period while W_2 is the second most significant. The figure on the next page shows how to decode the past weather group:

Past Weather Symbols



Cloud Group ($8N_hC_LC_MC_H$)

This group is rarely used on modern maps but it may appear in synoptic code data.

The fraction of the celestial dome covered by all the C_L (or C_M) clouds present is given as N_h. When low clouds (C_L) are present, the value reported for N_h represents the total amount of all types of C_L clouds present regardless of the number of C_L types that may coexist at the time of the observation.

When no C_L clouds are present and middle clouds (C_M) are present, the value reported for N_h represents the total amount of all C_M clouds present. High cloud types (C_H) are never reported for N_h. Code figure 0 is reported for N_h when there are no clouds of C_L or C_M types and celestial dome is not obscured. If the celestial dome is obscured, code figure 9 is reported. N_h is coded using the same procedure as for coding N, presented in Table 2. Code figure 1 is thus reported when up to and including 1/10 of the sky is covered by all types if low clouds. The fraction of the celestial dome covered by the clouds which is reported for N_h however, may never exceed the value reported for N in the Nddiff group. If, due to either an obscuration or an intervening cover (usually more than 9/10) of a lower altitude cloud type, the cloud type cannot be determined, a solidus (/) is reported.

The code figures for the characters $C_LC_MC_H$ are given in Table 2. For example, 86521 would indicate that ¾ of the sky is covered by stratocumulus type low clouds, with the remaining of the sky covered by altostratus type middle clouds and cirrus type high clouds.

Generally, synoptic maps plotted and transmitted by NCEP's Weather Prediction Center, or WPC, do not include cloud symbols so this group is unfortunately ignored. WPC maps can be found at http://www.wpc.ncep.noaa.gov/html/sfc2.shtml

Table 1

WW PRESENT WEATHER (Descriptions Abridged from W. M. O. Code)

WW	0	1	2	3	4	5	6	7	8	9
00	Cloud development NOT observed or NOT observable during past hour	Clouds generally dissolving or becoming less developed during past hour	State of sky on the whole unchanged during past hour	Clouds generally forming or developing during past hour	Visibility reduced by smoke	Haze	Widespread dust in suspension in the air, NOT raised by wind, at time of observation	Dust or sand raised by wind, at time of observation	Well developed dust devil(s) within past hour	Dust storm or sand storm within sight of or at station during past hour
10	Light fog	Patches of shallow fog at station, NOT deeper than 6 feet on land	More or less continuous shallow fog at station, NOT deeper than 6 feet on land	Lightning visible, no thunder heard	Precipitation within sight, but NOT reaching the ground	Precipitation within sight, reaching the ground, but distant from station	Precipitation within sight, reaching the ground, near to but NOT at station	Thunder heard, but no precipitation at the station	Squall(s) within sight during past hour	Funnel cloud(s) within sight during past hour
20	Drizzle (NOT freezing and NOT falling as showers) during past hour, but NOT at time of observation	Rain (NOT freezing and NOT falling as showers) during past hour, but NOT at time of observation	Snow (NOT falling as showers) during past hour, but NOT at time of observation	Rain and snow (NOT falling as showers) during past hour, but NOT at time of observation	Freezing drizzle or freezing rain (NOT falling as showers) during past hour, but NOT at time of observation	Showers of rain during past hour, but NOT at time of observation	Showers of snow, or of rain and snow, during past hour, but NOT at time of observation	Showers of hail, or of hail and rain, during past hour, but NOT at time of observation	Fog during past hour, but NOT at time of observation	Thunderstorm (with or without precipitation) during past hour, but NOT at time of obs.
30	Slight or moderate dust storm or sand storm, has decreased during past hour	Slight or moderate dust storm or sand storm, no appreciable change during past hour	Slight or moderate dust storm or sand storm, has increased during past hour	Severe dust storm or sand storm, has decreased during past hour	Severe dust storm or sand storm, no appreciable change during past hour	Severe dust storm or sand storm, has increased during past hour	Slight or moderate drifting snow, generally low	Heavy drifting snow, generally low	Slight or moderate drifting snow, generally high	Heavy drifting snow, generally high
40	Fog at distance at time of observation, but NOT at station during past hour	Fog in patches	Fog, sky discernible, has become thinner during past hour	Fog, sky NOT discernible, has become thinner during past hour	Fog, sky discernible, no appreciable change during past hour	Fog, sky NOT discernible, no appreciable change during past hour	Fog, sky discernible, has begun or become thicker during past hour	Fog, sky NOT discernible, has begun or become thicker during past hour	Fog, depositing rime, sky discernible	Fog, depositing rime, sky NOT discernible
50	Intermittent drizzle (NOT freezing) slight at time of observation	Continuous drizzle (NOT freezing) slight at time of observation	Intermittent drizzle (NOT freezing) moderate at time of observation	Continuous drizzle (NOT freezing), moderate at time of observation	Intermittent drizzle (NOT freezing), thick at time of observation	Continuous drizzle (NOT freezing), thick at time of observation	Slight freezing drizzle	Moderate or thick freezing drizzle	Drizzle and rain, slight	Drizzle and rain, moderate or heavy
60	Intermittent rain (NOT freezing), slight at time of observation	Continuous rain (NOT freezing), slight at time of observation	Intermittent rain (NOT freezing) moderate at time of obs.	Continuous rain (NOT freezing), moderate at time of observation	Intermittent rain (NOT freezing), heavy at time of observation	Continuous rain (NOT freezing), heavy at time of observation	Slight freezing rain	Moderate or heavy freezing rain	Rain or drizzle and snow, slight	Rain or drizzle and snow, moderate or heavy
70	Intermittent fall of snowflakes, slight at time of observation	Continuous fall of snowflakes, slight at time of observation	Intermittent fall of snowflakes, moderate at time of observation	Continuous fall of snowflakes, moderate at time of observation	Intermittent fall of snowflakes, heavy at time of observation	Continuous fall of snowflakes, heavy at time of observation	Ice needles (with or without fog)	Granular snow (with or without fog)	Isolated starlike snow crystals (with or without fog)	Ice pellets (sleet, U. S. definition)
80	Slight rain shower(s)	Moderate or heavy rain shower(s)	Violent rain shower(s)	Slight shower(s) of rain and snow mixed	Moderate or heavy shower(s) of rain and snow mixed	Slight snow shower(s)	Moderate or heavy snow shower(s)	Slight shower(s) of soft or small hail with or without rain, or rain and snow mixed	Moderate or heavy shower(s) of soft or small hail with or without rain, or rain and snow mixed	Slight shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder
90	Moderate or heavy shower(s) of hail, with or without rain or rain and snow mixed, not associated with thunder	Slight rain at time of observation; thunderstorm during past hour, but NOT at time of observation	Moderate or heavy rain at time of observation; thunderstorm during past hour, but NOT at time of observation	Slight snow or rain and snow mixed or hail at time of observation; thunderstorm during past hour, but not at time of observation	Moderate or heavy snow, or rain and snow mixed or hail at time of observation; thunderstorm during past hour, but NOT at time of obs.	Slight or moderate thunderstorm without hail, but with rain and/or snow at time of obs.	Slight or moderate thunderstorm, with hail at time of observation	Heavy thunderstorm, without hail, but with rain and/or snow at time of observation	Thunderstorm combined with dust storm or sand storm at time of obs.	Heavy thunderstorm with hail at time of observation

CLOUD ABBREVIATION		C_L	DESCRIPTION (Abridged From W.M.O. Code)		C_M	DESCRIPTION (Abridged From W.M.O. Code)		C_H	DESCRIPTION (3) (Abridged From W.M.O. Code)
St or Fs-Stratus or Fractostratus	1		Cu of fair weather, little vertical development and seemingly flattened	1		Thin As (most of cloud layer semi-transparent)	1		Filaments of Ci, or "mares tails," scattered and not increasing
Ci-Cirrus	2		Cu of considerable development, generally towering, with or without other Cu or Sc bases all at same level	2		Thick As, greater part sufficiently dense to hide sun (or moon), or Ns	2		Dense Ci in patches or twisted sheaves, usually not increasing, sometimes like remains of Cb; or towers or tufts
Cs-Cirrostratus	3		Cb with tops lacking clear-cut outlines, but distinctly not cirriform or anvil-shaped; with or without Cu, Sc, or St	3		Thin Ac, mostly semi-transparent; cloud elements not changing much and at a single level	3		Dense Ci, often anvil-shaped, derived from or associated with Cb
Cc-Cirrocumulus	4		Sc formed by spreading out of Cu; Cu often present also	4		Thin Ac in patches; cloud elements continually changing and/or occurring at more than one level	4		Ci, often hook-shaped, gradually spreading over the sky and usually thickening as a whole
Ac-Altocumulus As-Altostratus	5		Sc not formed by spreading out of Cu	5		Thin Ac in bands or in a layer gradually spreading over sky and usually thickening as a whole	5		Ci and Cs, often in converging bands, or Cs alone; generally overspreading and growing denser; the continuous layer not reaching 45° altitude
Sc-Stratocumulus	6		St or Fs or both, but no Fs of bad weather	6		Ac formed by the spreading out of Cu	6		Ci and Cs, often in converging bands, or Cs alone; generally overspreading and growing denser; the continuous layer exceeding 45° altitude
Ns-Nimbostratus	7		Fs and/or Fc of bad weather (scud)	7		Double-layered Ac, or a thick layer of Ac, not increasing; or Ac with As and/or Ns	7		Veil of Cs covering the entire sky
Cu or Fc-Cumulus or Fractocumulus	8		Cu and Sc (not formed by spreading out of Cu) with bases at different levels	8		Ac in the form of Cu-shaped tufts or Ac with turrets	8		Cs not increasing and not covering entire sky
Cb-Cumulonimbus	9		Cb having a clearly fibrous (cirriform) top, often anvil-shaped, with or without Cu, Sc, St, or scud	9		Ac of a chaotic sky, usually at different levels; patches of dense Ci are usually present also	9		Cc alone or Cc with some Ci or Cs, but the Cc being the main cirriform cloud

R_t	TIME OF PRECIPITATION (4)	h	HEIGHT IN FEET (Rounded Off)	HEIGHT IN METERS (5) (Approximate)
0	No Precipitation	0	0 - 149	0 - 49
1	Less than 1 hour ago	1	150 - 299	50 - 99
2	1 to 2 hours ago	2	300 - 599	100 - 199
3	2 to 3 hours ago	3	600 - 999	200 - 299
4	3 to 4 hours ago	4	1,000 - 1,999	300 - 599
5	4 to 5 hours ago	5	2,000 - 3,499	600 - 999
6	5 to 6 hours ago	6	3,500 - 4,999	1,000 - 1,499
7	6 to 12 hours ago	7	5,000 - 6,499	1,500 - 1,999
8	More than 12 hours ago	8	6,500 - 7,999	2,000 - 2,499
9	Unknown	9	At or above 8,000, or no clouds	At or above 2,500, or no clouds

N	SKY COVERAGE (6) (Total Amount)
	No clouds
	1/8
	2/8
	3/8
	4/8
	5/8
	6/8
	7/8
	Completely overcast
	Sky obscured

N_h	SKY COVERAGE (7) (Low And/Or Middle Clouds)
0	No clouds
1	Less than one-tenth or one-tenth
2	Two-tenths or three-tenths
3	Four-tenths
4	Five-tenths
5	Six-tenths
6	Seven-tenths or eight-tenths
7	Nine-tenths or overcast with openings
8	Completely overcast
9	Sky obscured

Symbol VV=Horizontal Visibility

Code Figure	Statute Mile	Code Figure	Statute Mile	Code Figure	Statute Mile
00	under 1/16	65	9 3/4	83	28 1/4
		66	10	84	31 1/4
01 to 50	1/16 to 3 1/16 (* Divide code by 16)	67	10 1/4	85	34 1/2
		68	11 1/4	86	37 1/2
		69	11 3/4	87	40 3/4
		70	12 1/2	88	43 3/4
		71	13 1/4	89	over 43 3/4
51-55	not used	72	13 3/4		
		73	14 3/4	90	under 1/32
56	3 1/4	74	15	91	1/32
57	4 1/4	75	15 1/2	92	1/4
58	5	76	16 1/4	93	1/16
59	5 1/2	77	16 3/4	94	1/8
60	6 1/4	78	17 1/2	95	1 1/4
61	6 3/4	79	18 1/4	96	2 1/2
62	7 1/2	80	18 3/4	97	6 1/4
63	8 1/4	81	21 1/4	98	12 1/2
64	8 3/4	82	25	99	31 1/4 or more

NOTES:
(1) The values given are discrete values (i.e., not ranges). If the observed visibility is between two of the reportable distances as given in the table, the code figure of the lower reportable distance shall be reported.
(2) Only the code figures 00-89 shall be used in reports from land stations.
(3) In reporting visibility at sea the decade 90-99 shall be used.

Table 2

Table 3 - Horizontal visibility at the surface (VV)

Code Figure	Statute Miles	Kilometers	Code Figure	Statute Miles	Kilometers
00	<1/16	<0.1	40	2 1/2	4.0
01	1/16	0.1	44	2 3/4	4.4
02	1/8	0.2	48	3.0	4.8
03	3/16	0.3	57	4.0	7
04	¼	0.4	58	5.0	8
05	5/16	0.5	60	6.0	10
06	3/8	0.6	61	7.0	11
08	½	0.8	63	8.0	13
10	5/8	1.0	65	9.0	15
12	¾	1.2	66	10.0	16
14	7/8	1.4	68	11.0	18
16	1.0	1.6	69	12.0	19
18	1 1/8	1.8	71	13.0	21
20	1 ¼	2.0	73	14.0	23
22	1 3/8	2.2	74	15.0	24
24	1 ½	2.4	81	20.0	35
26	1 5/8	2.6	82	25.0	40
28	1 ¾	2.8	84	30.0	50
30	1 7/8	3.0	85	35.0	55
32	2.0	3.2	87	40.0	65
36	2 ¼	3.6	89	>40.0	>70

Table 4 - Precipitation Amount

RRR - Amount of precipitation which has fallen during the period preceding the time of observation, as indicated by t_R

Code Figure	Amount Millimeters	Code Figure	Amount Millimeters
000	Not used	990	Trace
001	1	991	0.1
002	2	992	0.2
003	3	993	0.3
004	4	994	0.4
005	5	995	0.5
etc.		996	0.6
		997	0.7
988	988	998	0.8
989	989 mm or more	999	0.9

Table 5: Pressure tendency (“a” in the 5appp group)

Pressure higher than three hours ago	**0**		Rising, the falling
	1		Rising, then steady; or rising, then rising more slowly
	2		Rising steadily, or unsteadily
	3		Falling or steady, then rising; or rising, then rising more quickly
Pressure the same as three hours ago	4		Steady, same as 3 hours ago
	5		Falling, then rising, same or lower than 3 hours ago
Pressure lower than three hours ago	**6**		Falling, then steady; or falling, then falling more slowly
	7		Falling steadily, or unsteadily
	8		Steady or rising, then falling; or falling, then falling more quickly

Lab Assignment (due next Wednesday)

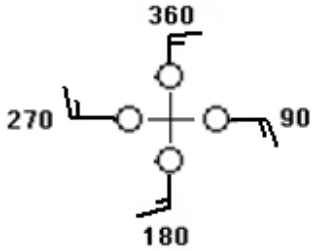
On a U.S. base map, plot the synoptic code on the following pages, starting with Key West and ending with Seattle.

NOTES:
(1) Plot a few in pencil until you feel comfortable with station plotting. Then ink over the first few and proceed in ink. Use a plotting pen.

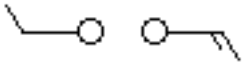
(2) Plot small enough that you don't overlap data from neighboring stations. However, plot large enough so I can easily read your numbers. You should draw a station circle over the small circle on the base map.

(3) Be neat. After you plot all the stations, you must analyze the maps for isobars, Highs, Lows, and fronts. It will be graded for accuracy of plotting and isoplething.

The following parameters must be plotted (decode unless otherwise specified):



sky cover (N), wind direction (dd), Note convention at right -------->

wind speed (ff) (Round to nearest 5 knots. Plot calm as  . Note the barbs or feathers are always to the left of the shaft  if you are facing the way the wind is going), temperature (TT) rounded to the nearest degree, dew point (T_d) rounded to the nearest degree, coded sea level pressure (PPP), pressure tendency with no decimal (appp), present weather symbol (ww), and precipitation in millimeters with the decimal if 0.1-0.9 (see note 4), but not time ($RRRt_R$).

↑
No

For precipitation, note that codes 991-999 are 0.1 – 0.9 millimeters. Plot the decimal. For codes 1-989, plot the whole number. Example: 60231 is plotted as 23 (the "1" is t_R. Ignore it). 990 is Trace. Plot "T".

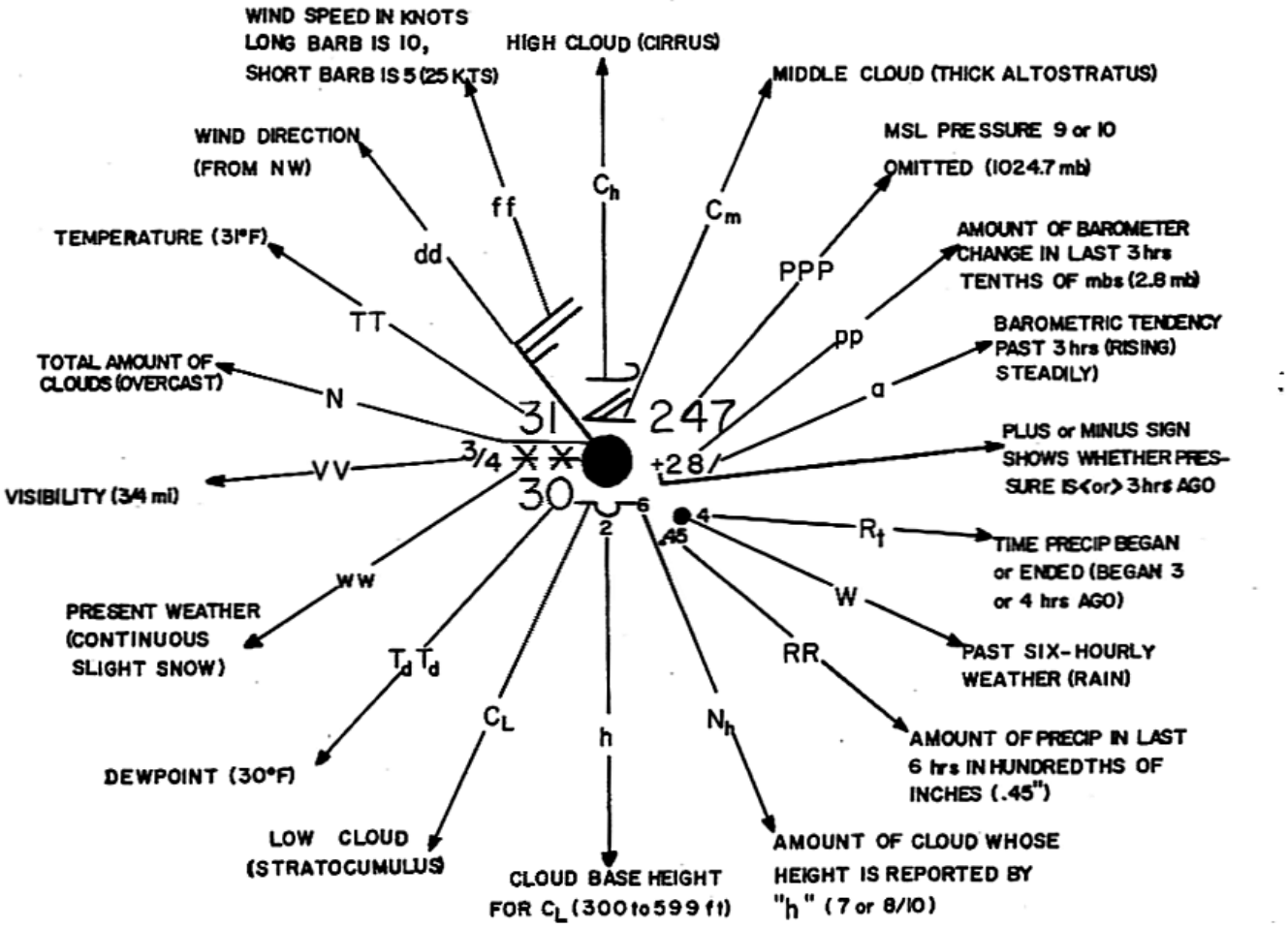
If a group is missing or slashes (///), plot "M" for missing. Exception: If the precipitation (6xxxx) or present weather (7xx//) groups are missing, just leave those areas blank.

Station 72203 is on the base map as PBI (in Florida). 72332 is TUP, plotted at 330 in Mississippi, 72371 is plotted at PGA in Arizona. 72304 is plotted at HAT in North Carolina. 72402 is plotted at

WAL, in coastal Virginia. 72672 is plotted at RIW in Wyoming. Latitude and Longitude are provided.

After you plot all the stations, turn it in next Wednesday.

Use the Station Model to plot (not all fields are to be plotted):



Data from 00Z February 6, 2010

72201, Key West, Key West International Airport | 24-33-13N | 081-45-13W | 1 m
201002052353 AAXX 06004 72201 11428 82716 10228 20217 30105 40110 53005 60031 765// =

72202, Miami, Miami International Airport | 25-47-26N | 080-18-59W | 3 m
201002052353 AAXX 06004 72202 12566 81710 10244 20217 30088 40096 58015 69901=

72203, West Palm Beach, Palm Beach International Airport | 26-41-05N | 080-05-58W | 5 m
201002052353 AAXX 06004 72203 12666 61711 10244 20200 30077 40082 56014 69951=

72205, Orlando, Orlando International Airport | 28-25-02N | 081-19-30W | 29 m
201002052353 AAXX 06004 72205 11366 82214 10194 20178 30029 40064 55003 60131 761// =

72206, Jacksonville, Jacksonville International Airport | 30-29-40N | 081-41-36W | 9 m
201002052356 AAXX 06004 72206 12466 62411 10189 20167 30018 40028 53001 60141=

72207, Savannah, Savannah International Airport | 32-07-08N | 081-12-08W | 15 m
201002052353 AAXX 06004 72207 11261 82706 10172 20161 39990 40005 56012 60201 761//=

72208, Charleston, Charleston Air Force Base | 32-53-56N | 080-02-26W | 14 m
201002052356 AAXX 06004 72208 11448 82214 10178 20167 39984 49998 55029 60241 761//=

72211, Tampa, Tampa International Airport | 27-57-41N | 082-32-25W | 8 m
201002052353 AAXX 06004 72211 12366 62209 10183 20172 30068 40082 53006 60161=

72212, Cross City, Cross City Airport | 29-33-00N | 083-06-19W | 12 m
201002052353 AAXX 06004 72212 15/// /2613 10167 20150 30046 40061 53009 60141=

72214, Tallahassee, Tallahassee Regional Airport | 30-23-35N | 084-21-12W | 24 m
201002052353 AAXX 06004 72214 12566 62617 10161 20122 30035 40052 53007 60021=

72217, Macon, Middle Georgia Regional Airport | 32-41-16N | 083-39-16W | 107 m
201002052353 AAXX 06004 72217 11132 83204 10083 20078 39901 40030 53006 60031 710//=

72218, Augusta, Bush Field | 33-21-52N | 081-57-48W | 44 m
201002052353 AAXX 06004 72218 31232 83504 10067 20056 39968 40019 50017 763//=

72219, Atlanta, Hartsfield - Jackson Atlanta International Airport | 33-38-25N | 084-25-37W | 313 m
201002052352 AAXX 06004 72219 11208 81103 10039 20039 39657 40034 51006 60041 751//=

72223, Mobile, Mobile Regional Airport | 30-41-18N | 088-14-44W | 66 m
201002052356 AAXX 06004 72223 32566 62604 10122 20083 30001 40078 51011=

72226, Montgomery, Dannelly Field | 32-18-01N | 086-24-22W | 67 m
201002052353 AAXX 06004 72226 12466 82405 10106 20089 39982 40055 51016 69931=

72231, New Orleans, New Orleans International Airport | 29-59-34N | 090-15-03W | 1 m
201002052353 AAXX 06004 72231 32461 82811 10122 20078 30095 40103 53010=

72234, Meridian, Key Field | 32-20-17N | 088-44-52W | 90 m
201002052358 AAXX 06004 72234 12466 82707 10089 20067 39968 40074 51011 69901=

72235, Jackson, Jackson International Airport | 32-19-11N | 090-04-39W | 105 m
201002052354 AAXX 06004 72235 31332 82604 10078 20072 39978 40085 51010 710//=

72240, Lake Charles, Lake Charles Regional Airport | 30-07-34N | 093-13-24W | 5 m
201002052353 AAXX 06004 72240 32966 03104 10117 20061 30111 40124 53003=

72243, Houston, Houston Intercontinental Airport | 29-59-33N | 095-21-50W | 29 m
201002052353 AAXX 06004 72243 32566 43110 10117 20067 30092 40137 53011=

72248, Shreveport, Shreveport Regional Airport | 32-26-49N | 093-49-27W | 78 m
201002052356 AAXX 06004 72248 32666 22705 10083 20039 30009 40106 51006=

72250, Brownsville, Brownsville / South Padre Island Int'l Airport | 25-54-51N | 097-25-23W | 7 m
201002052353 AAXX 06004 72250 32966 01306 10178 20144 30132 40138 53002=

72251, Corpus Christi, Corpus Christi International Airport | 27-46-23N | 097-30-46W | 13 m
201002052351 AAXX 06004 72251 32966 00906 10167 20128 30112 40132 55003=

72254, Austin City, Austin Camp Mabry | 30-19N | 097-46W | 200 m
201002052351 AAXX 06004 72254 35966 03303 10133 20072 39913 40140 53001=

72255, Victoria, Victoria Regional Airport | 28-51-45N | 096-55-47W | 35 m
201002052351 AAXX 06004 72255 32966 00208 10144 20100 30098 40136 53003=

72256, Waco, Waco Regional Airport | 31-37-02N | 097-13-40W | 157 m
201002052351 AAXX 06004 72256 32966 02505 10122 20078 39952 40129 56002=

72259, Dallas / Fort Worth, Dallas / Fort Worth Int'l Airport | 32-53-49N | 097-01-19W | 183 m
201002052353 AAXX 06004 72259 32966 03010 10133 20033 39911 40118 53003=

72261, Del Rio, Del Rio International Airport | 29-22-29N | 100-55-25W | 304 m
201002052353 AAXX 06004 72261 35966 03405 10222 20061 39751 40112 55003=

72263, San Angelo, Mathis Field | 31-21-05N | 100-29-38W | 584 m
201002052351 AAXX 06004 72263 32966 00000 10133 20050 39466 40146 55001=

72265, Midland, Midland International Airport | 31-56-52N | 102-12-31W | 875 m
201002052353 AAXX 06004 72265 32966 03004 10161 20000 39137 40125 56003=

72266, Abilene, Abilene Regional Airport | 32-24-37N | 099-40-54W | 545 m
201002052352 AAXX 06004 72266 32966 03203 10117 20022 39503 40141 53002=

72267, Lubbock, Lubbock International Airport | 33-40-03N | 101-49-17W | 1000 m
201002052353 AAXX 06004 72267 32966 42405 10122 20006 39002 40127 55001=

72268, Roswell, Roswell Industrial Air Center Airport | 33-18-29N | 104-30-28W | 1118 m
201002052351 AAXX 06004 72268 32966 01805 10139 20017 38868 40112=

72270, El Paso, El Paso International Airport | 31-48-40N | 106-22-33W | 1206 m
201002052351 AAXX 06004 72270 32966 62309 10150 20006 38798 40126 56009=

72274, Tucson, Tucson International Airport | 32-07-53N | 110-57-19W | 805 m
201002052353 AAXX 06004 72274 32966 00104 10189 20022 39257 40147 56010=

72278, Phoenix, Phoenix Sky Harbor International Airport | 33-26-03N | 112-03-04W | 345 m
201002052351 AAXX 06004 72278 32766 62006 10194 20050 39754 40145 58010=

72290, San Diego, San Diego International-Lindbergh Field | 32-44-01N | 117-10-59W | 4 m
201002052351 AAXX 06004 72290 32566 81910 10156 20089 30161 40175 58003=

72295, Los Angeles, Los Angeles International Airport | 33-56-17N | 118-23-20W | 38 m
201002052353 AAXX 06004 72295 11328 81110 10128 20111 30103 40157 55006 60111 761//=

72302, Wilmington, NC. | 34-16N | 077-54W | 10 m
201002052353 AAXX 06004 72302 17340 81519 10156 20139 3//// 40017 58057 60101 763//=

72304, Cape Hatteras | 35-16N 075-33W | 2 m
201002052351 AAXX 06004 72304 11212 81115 10144 20089 30074 40076 56054 6//// 763// =

72306, Raleigh / Durham, Raleigh-Durham International Airport | 35-52-14N | 078-47-11W | 133 m
201002052351 AAXX 06004 72306 11356 80818 10044 20028 39869 40024 58069 60171 761//=

72308, Norfolk, Norfolk International Airport | 36-54-13N | 076-11-31W | 8 m
201002052351 AAXX 06004 72308 11459 81018 10039 20028 30088 40105 58059 60081 761//=

72309, Cherry Point, Marine Corps Air Station | 34-53-52N | 076-52-51 | 8 m
201002052351 AAXX 06004 72309 11201 81015 10139 20128 30039 40040 57050 6//// 765//=

72310, Columbia, Columbia Metropolitan Airport | 33-56-31N | 081-07-05W | 71 m
201002052356 AAXX 06004 72310 11156 80000 10072 20000 39913 40001 56019 60181 705//=

72314, Charlotte, Charlotte / Douglas International Airport | 35-12-48N | 080-56-55W | 228 m
201002052352 AAXX 06004 72314 11132 80212 10028 20017 39747 40010 56043 60111 761//=

72315, Asheville, Asheville Regional Airport | 35-25-55N | 082-32-15W | 660 m
201002052354 AAXX 06004 72315 11358 80000 10006 20006 39238 40015 58010 60101 763//=

72317, Greensboro, Piedmont Triad International Airport | 36-05-51N | 079-56-37W | 282 m
201002052354 AAXX 06004 72317 11159 80309 10006 20000 39710 40037 55056 60141 761//=

72323, Huntsville, Huntsville International / Jones Field | 34-38-37N | 086-47-08W | 192 m
201002052353 AAXX 06004 72323 12466 82605 10083 20072 39805 40029 51012 60021=

72324, Chattanooga, Lovell Field | 35-02-00N | 085-12-00W | 207 m
201002052353 AAXX 06004 72324 11348 81906 10056 20044 39772 40021 51002 60041 751//=

72326, Knoxville, McGhee Tyson Airport | 35-49-05N | 083-59-09W | 299 m
201002052353 AAXX 06004 72326 11248 82405 10061 20056 39649 40006 51002 60101 765//=

72327, Nashville, Nashville International Airport | 36-07-08N | 086-41-21W | 182 m
201002052353 AAXX 06004 72327 11459 82606 10067 20056 39766 40012 53006 60021 710//=

72329, London, London-Corbin Airport | 37-05N | 084-04W | 369 m
201002052353 AAXX 06004 72329 112// 81305 10050 20044 39760 49995 56009 6//// 761//=

72332, Tupelo, Tupelo Regional Airport | 34-16-05N | 088-46-12W | 106 m
201002052353 AAXX 06004 72332 17359 82807 10067 20050 39929 40054 53017 69901 710//=

72334, Memphis, Memphis International Airport | 35-03-40N | 089-59-06W | 101 m
201002052353 AAXX 06004 72334 11216 82710 10056 20039 39958 40061 53012 69931 761//=

72344, Fort Smith, Fort Smith Regional Airport | 35-20-01N | 094-21-54W | 142 m
201002052353 AAXX 06004 72344 32666 83009 10067 20017 39934 40101 53012=

72351, Wichita Falls, Sheppard Air Force Base | 33-58-43N | 098-29-34W | 309 m
201002052352 AAXX 06004 72351 32966 03209 10106 20017 39770 40134 53009=

72353, Oklahoma City, Will Rogers World Airport | 35-23-19N | 097-36-01W | 394 m
201002052352 AAXX 06004 72353 32666 63416 10067 20006 39669 40133 53026=

72363, Amarillo, Amarillo International Airport | 35-13-12N | 101-43-02W | 1099 m
201002052353 AAXX 06004 72363 32966 00106 10028 21022 38901 40163 53009=

72365, Albuquerque, Albuquerque International Airport | 35-02-30N | 106-36-53W | 1631 m
201002052356 AAXX 06004 72365 32966 62904 10094 21028 38359 40144 56005=

72370, Kingman, Kingman Airport | 35-15-28N | 113-55-59W | 1050 m
201002052351 AAXX 06004 72370 17666 80605 10089 20061 38983 40137 53001 69951 761//=

72371, Page, Page Municipal Airport | 36-55-14N | 111-26-53W | 1314 m
201002052353 AAXX 06004 72371 35/66 /0000 10083 21011 38684 40183 5////=

72376, Flagstaff | 35-08-15N | 111-40-12W | 2135 m
201002052356 AAXX 06004 72376 11459 82506 10022 20000 37859 40165 54000 69901 771//=

72384, Bakersfield, Meadows Field Airport | 35-26-01N | 119-03-24W | 155 m
201002052354 AAXX 06004 72384 12866 61706 10161 20083 39935 40113 56014 69951=

72386, Las Vegas, McCarran International Airport | 36-04-44N | 115-09-19W | 663 m
201002052356 AAXX 06004 72386 32766 61607 10144 20044 39388 40123 56007=

72389, Fresno, Fresno Air Terminal | 36-46-48N | 119-43-10W | 101 m
201002052353 AAXX 06004 72389 11561 81208 10139 20111 30004 40125 58002 69981 761//=

72401, Richmond, Richmond International Airport | 37-30-40N | 077-19-24W | 51 m
201002052354 AAXX 06004 72401 11248 80915 10011 21006 30038 40105 58061 60101 761//=

72402, Wallops Island, Wallops Flight Facility Airport | 37-56-26N | 075-27-47W | 12 m
201002052354 AAXX 06004 72402 17012 80912 10006 21006 30138 40153 56041 60061 771//=

72403, Washington DC, Washington-Dulles International Airport | 38-56-05N | 077-26-51W | 95 m
201002052352 AAXX 06004 72403 11204 80610 10000 21011 30030 40144 58039 60091 775//=

72406, Baltimore, Baltimore-Washington International Airport | 39-10-00N | 076-41-00W | 44 m
201002052354 AAXX 06004 72406 11208 80612 11006 21006 30091 40163 56033 60061 773//=

72407, Atlantic City, Atlantic City International Airport | 39-27-53N | 074-35-12W | 23 m
201002052354 AAXX 06004 72407 11559 80707 10017 21039 30144 40186 56028 69901 771//=

72408, Philadelphia, Philadelphia International Airport | 39-52-06N | 075-13-52W | 6 m
201002052354 AAXX 06004 72408 11558 80507 10006 21028 30164 40185 56028 69901 771//=

72411, Roanoke, Roanoke Regional Airport | 37-19-01N | 079-58-27W | 358 m
201002052354 AAXX 06004 72411 11224 81106 10000 21011 39645 40079 56025 60091 779//=

72414, Charleston, Yeager Airport | 38-22-46N | 081-35-29W | 299 m
201002052354 AAXX 06004 72414 11232 80708 10028 20017 39657 40024 56037 60161 763//=

72417, Elkins, Elkins-Randolph County-Jennings Randolph Field | 38-53-07N | 079-51-10W | 605 m
201002052351 AAXX 06004 72417 17532 8//04 10000 21033 39342 40063 56024 60101 771//=

72421, Covington / Cincinnati, Northern Kentucky Int'l Airport | 39-02-35N | 084-40-18W | 273 m
201002052352 AAXX 06004 72421 11208 80513 10006 20000 39694 40013 56017 60061 771//=

72422, Lexington, Blue Grass Airport | 38-02-27N | 084-36-21W | 298 m
201002052354 AAXX 06004 72422 11256 80000 10044 20044 39642 49996 55014 60071 761//=

72423, Louisville, Standiford Field | 38-10-38N | 085-43-47W | 151 m
201002052356 AAXX 06004 72423 11361 83606 10028 20022 39831 40005 56012 60111 761//=

72428, Columbus, Port Columbus International Airport | 39-59-42N | 082-52-35W | 248 m
201002052351 AAXX 06004 72428 11316 80613 10006 20006 39749 40047 56025 60061 771//=

72429, Dayton, Cox Dayton International Airport | 39-54-22N | 084-13-07W | 307 m
201002052356 AAXX 06004 72429 11212 80517 10000 21011 39679 40047 56018 60051 771//=

72432, Evansville, Evansville Regional Airport | 38-02-35N | 087-31-13W | 127 m
201002052354 AAXX 06004 72432 11264 83606 10017 20011 39878 40019 58004 60051 761//=

72434, St. Louis, Lambert-St. Louis International Airport | 38-45-09N | 090-22-25W | 184 m
201002052351 AAXX 06004 72434 11316 80209 10011 20000 39861 40071 53005 60051 771//=

72438, Indianapolis, Indianapolis International Airport | 39-43-30N | 086-16-55W | 243 m
201002052354 AAXX 06004 72438 11320 80421 10000 21011 39745 40037 56011 60051 771//=

72440, Springfield, Springfield Regional Airport | 37-14-23N | 093-23-23W | 386 m
201002052352 AAXX 06004 72440 11340 83110 10000 21017 39624 40089 53014 69931 771//=

72445, Columbia, Columbia Regional Airport | 38-49-01N | 092-13-06W | 271 m
201002052354 AAXX 06004 72445 11228 80109 10006 21006 39764 40090 53016 60041 771//=

72446, Kansas City, Kansas City International Airport | 39-17-50N | 094-43-50W | 312 m
201002052353 AAXX 06004 72446 11312 83610 10011 21006 39740 40127 53021 69981 771//=

72450, Wichita, Wichita Mid-Continent Airport | 37-38-50N | 097-25-46W | 406 m
201002052353 AAXX 06004 72450 12466 83412 10022 21006 39654 40145 51024 69901=

72451, Dodge City, Dodge City Regional Airport | 37-46-22N | 099-58-11W | 790 m
201002052352 AAXX 06004 72451 35464 83613 10006 21022 39235 40167 53018=

72458, Concordia, Blosser Municipal Airport | 39-33-05N | 097-39-02W | 453 m
201002052355 AAXX 06004 72458 37448 83510 11006 21033 39626 40166 53020 704//=

72462, Alamosa, San Luis Valley Regional Airport | 37-26-20N | 105-51-41W | 2297 m
201002052352 AAXX 06004 72462 35966 03106 11017 21083 37669 40208 56004=

72464, Pueblo, Pueblo Memorial Airport | 38-17-24N | 104-29-54W | 1440 m
201002052353 AAXX 06004 72464 32966 01408 10056 21050 38544 40158 53018=

72465, Goodland, Renner Field | 39-22-03N | 101-41-35W | 1114 m
201002052353 AAXX 06004 72465 35566 83611 10000 21044 38878 40170 53008=

72469, Denver, Denver International Airport | 39-49-58N | 104-39-27W | 1655 m
201002052353 AAXX 06004 72469 32866 41007 10028 21078 38305 40133 53007=

72476, Grand Junction, Walker Field | 39-08-02N | 108-32-19W | 1481 m
201002052353 AAXX 06004 72476 35964 63205 10000 21033 38534 40196 58001=

72486, Ely, Ely Airport | 39-17-42N | 114-50-43W | 1907 m
201002052353 AAXX 06004 72486 35666 81511 10022 21017 38048 40131 55001=

72488, Reno, Reno Tahoe International Airport | 39-29-02N | 119-46-16W | 1345 m
201002052355 AAXX 06004 72488 32766 42013 10122 21167 38585 40074 56010=

72494, San Francisco, San Francisco International Airport | 37-37-11N | 122-21-53W | 3 m
201002052356 AAXX 06004 72494 32566 82015 10150 20100 30077 40106 55004=

72503, New York, La Guardia Airport | 40-46-45N | 073-52-48W | 6 m
201002052351 AAXX 06004 72503 32966 80705 10017 21078 30179 40191 57019=

72507, Providence, Theodore Francis Green State Airport | 41-43-26N | 071-25-41W | 16 m
201002052351 AAXX 06004 72507 32966 83604 10006 21106 30170 40191 58013=

72508, Windsor Locks, Bradley International Airport | 41-56-17N | 072-40-57W | 53 m
201002052351 AAXX 06004 72508 32966 80000 11006 21089 30120 40194 56012=

72509, Boston, Logan International Airport | 42-21-38N | 071-00-38W | 6 m
201002052354 AAXX 06004 72509 32766 83309 10000 21122 30185 40191 58006=

72513, Wilkes-Barre-Scranton, Wilkes-Barre / Scranton Int'l Airport |41-20-20N |075-43-36W |293m
201002052354 AAXX 06004 72513 32966 80000 11017 21078 39830 40182 56023=

72514, Williamsport, Williamsport Regional Airport | 41-14-30N | 076-55-15W | 161 m
201002052354 AAXX 06004 72514 32866 80000 10000 21083 39979 40182 56026=

72515, Binghamton, Binghamton Regional Airport | 42-12-28N | 075-58-53W | 496 m
201002052353 AAXX 06004 72515 32566 80405 11033 21078 39593 40197 56018=

72518, Albany, Albany International Airport | 42-44-53N | 073-48-06W | 87 m
201002052351 AAXX 06004 72518 32666 80209 11022 21106 30092 40202 57016=

72519, Syracuse, Syracuse Hancock International Airport | 43-06-33N | 076-06-12W | 128 m
201002052354 AAXX 06004 72519 32966 83606 11044 21106 30057 40211 55016=

72520, Pittsburgh, Pittsburgh International Airport | 40-30-14N | 080-15-59W | 366 m
201002052351 AAXX 06004 72520 11204 80713 10000 21011 39664 40104 56032 60061 775//=

72524, Cleveland, Cleveland-Hopkins International Airport | 41-24-18N | 081-51-10W | 241 m
201002052351 AAXX 06004 72524 11316 80416 11006 21022 39841 40129 56020 60031 771//=

72528, Buffalo, Greater Buffalo International Airport | 42-56-27N | 078-44-09W | 220 m
201002052354 AAXX 06004 72528 32466 80713 11039 21067 39921 40203 55012=

72530, Chicago, Chicago-O'Hare International Airport | 41-58-47N | 087-54-16W | 203 m
201002052351 AAXX 06004 72530 11562 80518 10006 21039 39897 40142 55004 69951 771//=

72532, Peoria, Greater Peoria Regional Airport | 40-40-03N | 089-41-02W | 201 m
201002052354 AAXX 06004 72532 11420 80312 10006 21017 39865 40114 53003 60011 771//=

72533, Fort Wayne, Fort Wayne International Airport | 40-58-42N | 085-11-43W | 248 m
201002052354 AAXX 06004 72533 11312 80424 11017 21033 39794 40096 56010 60011 771//=

72537, Detroit, Detroit Metropolitan Wayne County Airport | 42-13-53N | 083-19-51W | 194 m
201002052353 AAXX 06004 72537 11532 80516 10000 21039 39913 40150 58008 69901 771//=

72546, Des Moines, Des Moines International Airport | 41-32-16N | 093-39-58W | 291 m
201002052354 AAXX 06004 72546 11532 80508 10006 21033 39802 40162 53014 69951 771//=

72547, Dubuque, Dubuque Regional Airport | 42-23-52N | 090-42-13W | 328 m
201002052353 AAXX 06004 72547 11456 80415 11011 21028 39766 40165 51004 69901 771//=

72550, Omaha, Eppley Airfield | 41-18-37N | 095-53-57W | 299 m
201002052352 AAXX 06004 72550 11432 83608 11006 21022 39792 40172 53021 69931 710//=

72556, Norfolk, Stefan Memorial Airport | 41-58-50N | 097-26-13W | 479 m
201002052356 AAXX 06004 72556 37424 80208 11017 21039 39615 40186 53017 710//=

72562, North Platte, North Platte Regional Airport | 41-07-19N | 100-40-06W | 846 m
201002052353 AAXX 06004 72562 35466 80108 11006 21033 39177 40179 51010=

72564, Cheyenne, Cheyenne Airport | 41-09-28N | 104-48-25W | 1876 m
201002052353 AAXX 06004 72564 32866 43307 10033 21078 38075 40139 53011=

72567, Valentine, Miller Field | 42-51-31N | 100-33-05W | 789 m
201002052352 AAXX 06004 72567 37220 83504 11028 21039 39255 40197 51012 710//=

72569, Casper, Natrona County International Airport | 42-53-51N | 106-28-23W | 1630 m
201002052353 AAXX 06004 72569 32866 62005 10017 21078 38319 40143 52003=

72571, Craig, Craig-Moffat Airport | 40-29-36N | 107-31-25W | 1888 m
201002052353 AAXX 06004 72571 17559 82503 10000 21050 38081 40209 53006 69901 771//=

72572, Salt Lake City, Salt Lake City International Airport | 40-46-41N | 111-58-10W | 1288 m
201002052353 AAXX 06004 72572 12666 62007 10072 20006 38688 40139 57005 69931=

72578, Pocatello, Pocatello Regional Airport | 42-55-13N | 112-34-16W | 1356 m
201002052353 AAXX 06004 72578 11556 80204 10011 20000 38608 40159 51005 69901 710//=

72583, Winnemucca, Winnemucca Municipal Airport | 40-54-07N | 117-48-26W | 1311 m
201002052356 AAXX 06004 72583 35766 23610 10083 20011 38633 40101 56007=

72591, Red Bluff, Red Bluff Municipal Airport | 40-09-02N | 122-15-08W | 106 m
201002052354 AAXX 06004 72591 35766 81608 10128 20094 39984 40106 56016=

72594, Eureka | 40-48N | 124-10W | 13 m
201002052353 AAXX 06004 72594 35966 01909 10150 20033 30029 40054 56021=

72597, Medford, Rogue Valley International Airport | 42-22-52N | 122-52-20W | 405 m
201002052353 AAXX 06004 72597 32966 01510 10144 20011 39593 40057 56011=

72606, Portland, Portland International Jetport | 43-38-32N | 070-18-16W | 22 m
201002052351 AAXX 06004 72606 12966 03306 11039 21172 30171 40189 54000 69901=

72617, Burlington, Burlington International Airport | 44-28-05N | 073-09-01W | 101 m
201002052354 AAXX 06004 72617 32966 00106 11078 21161 30090 40224 56009=

72635, Grand Rapids, Gerald R. Ford International Airport | 42-52-51N | 085-31-22W | 242 m
201002052353 AAXX 06004 72635 32462 80522 11006 21044 39874 40168 58003=

72638, Houghton Lake, Roscommon County Airport | 44-21-04N | 084-40-27W | 350 m
201002052353 AAXX 06004 72638 17464 80613 11044 21083 39783 40216 58002 69901 771//=

72641, Madison, Dane County Regional-Truax Field | 43-08-26N | 089-20-43W | 262 m
201002052353 AAXX 06004 72641 11459 80313 10000 21022 39858 40178 55004 69901 710//=

72645, Green Bay, Austin Straubel International Airport | 44-28-46N | 088-08-12W | 211 m
201002052353 AAXX 06004 72645 12566 80415 11028 21061 39964 40219 51001 69901=

72654, Huron, Huron Regional Airport | 44-23-17N | 098-13-42W | 392 m
201002052355 AAXX 06004 72654 17728 80706 11006 21028 39734 40213 53009 69901 771//=

72658, Minneapolis, Minneapolis-St. Paul International Airport | 44-52-59N | 093-13-44W | 256 m
201002052353 AAXX 06004 72658 11548 80308 10000 21028 39897 40222 53008 69901 771//=

72662, Rapid City, Rapid City Regional Airport | 44-02-44N | 103-03-14W | 976 m
201002052352 AAXX 06004 72662 32666 83403 11056 21089 39053 40214 53006=

72666, Sheridan, Sheridan County Airport | 44-46-10N | 106-58-08W | 1225 m
201002052353 AAXX 06004 72666 35966 40103 11028 21044 38772 40175 51003=

72672, Riverton, Riverton Regional Airport | 43-03-43N | 108-26-47W | 1684 m
201002052353 AAXX 06004 72672 35966 00000 11033 21072 38275 40165 57001=

72677, Billings, Billings Logan International Airport | 45-48-25N | 108-32-32W | 1112 m
201002052353 AAXX 06004 72677 32166 80605 11028 21039 38891 40171 53001=

72681, Boise, Boise Air Terminal | 43-34-00N | 116-14-26W | 871 m
201002052353 AAXX 06004 72681 12966 01709 10100 20033 39115 40125 53004 69901=

72683, Burns, Burns Municipal Airport | 43-35-42N | 118-57-23W | 1263 m
201002052353 AAXX 06004 72683 35966 00506 10039 20000 38679 40113 56003=

72688, Pendleton, Eastern Oregon Regional At Pendleton Airport | 45-41-54N | 118-50-03W | 455 m
201002052353 AAXX 06004 72688 12966 00000 10117 20044 39564 40097 56003 69981=

72693, Eugene, Mahlon Sweet Field | 44-08-00N | 123-12-52W | 111 m
201002052354 AAXX 06004 72693 32566 60000 10156 20039 39918 40054 55009=

72698, Portland, Portland International Airport | 45-35-27N | 122-36-01W | 8 m
201002052353 AAXX 06004 72698 32766 61209 10117 20056 30062 40071 56009=

72712, Caribou, Caribou Municipal Airport | 46-52-02N | 068-00-48W | 191 m
201002052354 AAXX 06004 72712 35766 63214 11139 21194 39931 40180 50009=

72745, Duluth, Duluth International Airport | 46-50-34N | 092-13-34W | 435 m
201002052355 AAXX 06004 72745 12466 80817 11050 21078 39721 40262 51006 69901=

72747, International Falls, Falls International Airport | 48-33-43N | 093-23-52W | 361 m
201002052355 AAXX 06004 72747 35966 20703 11072 21111 39828 40283 53004=

72753, Fargo, Hector International Airport | 46-55-31N | 096-48-40W | 274 m
201002052353 AAXX 06004 72753 17528 80503 11006 21022 39896 40240 53008 69951 771//=

72764, Bismarck, Bismarck Municipal Airport | 46-46-57N | 100-45-26W | 511 m
201002052352 AAXX 06004 72764 11308 80804 11017 21028 39610 40230 53008 60011 771//=

72767, Williston, Sloulin Field International Airport | 48-10-26N | 103-38-12W | 604 m
201002052352 AAXX 06004 72767 11540 80804 11061 21078 39516 40233 53003 60011 771//=

72772, Helena, Helena Regional Airport | 46-36-20N | 111-57-49W | 1180 m
201002052353 AAXX 06004 72772 11748 60000 11033 21050 38776 40186 51003 69901 710//=

72777, Havre, Havre City-County Airport | 48-32-34N | 109-45-48W | 789 m
201002052353 AAXX 06004 72777 17128 80000 11100 21117 39243 40205 58001 69901 710//=

72785, Spokane, Spokane International Airport | 47-37-17N | 117-31-40W | 723 m
201002052353 AAXX 06004 72785 11112 80507 10028 20022 39257 40123 53007 60011 761//=

72793, Seattle, Seattle-Tacoma International Airport | 47-26-41N | 122-18-49W | 130 m
201002052353 AAXX 06004 72793 12766 61306 10144 20033 39922 40089 55004 69901=

Radiosonde release

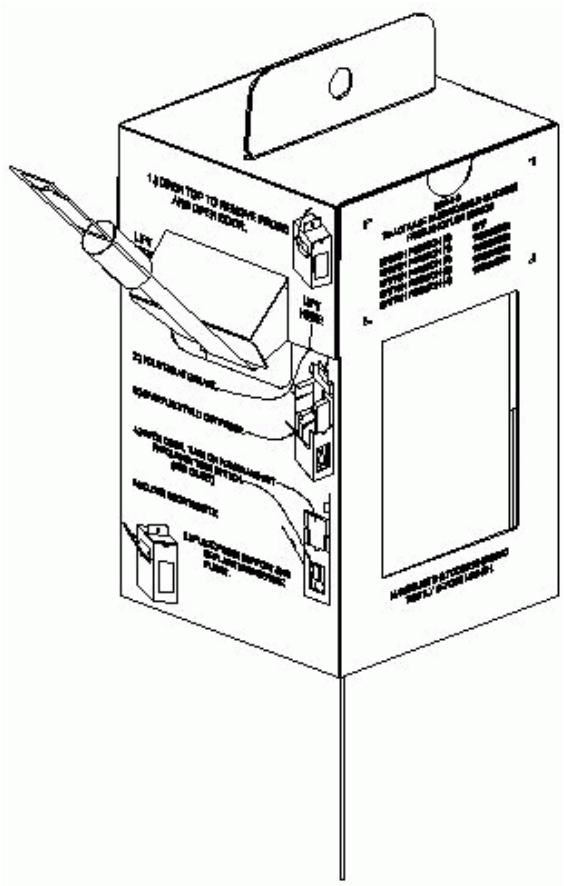
To obtain upper air winds, temperature, and dew point, we will set up and launch a radiosonde balloon with a functioning radiosonde package. These are not standard NWS radiosondes, but our InterMet-3150 system will give us a realistic taste of how it is done by the professionals. If you become a NWS student intern, perhaps you will get to launch one of their radiosondes as well.

The full radiosonde setup includes a balloon, parachute, the radiosonde itself, a receiver for the sounding data being transmitted from the radiosonde, a decoder to change radio signals into binary data, and a computer program to interpret the data. We will need to set up the entire system, although parts of it have been initialized prior to this lab. For example, the software has been installed and its parameters initialized.

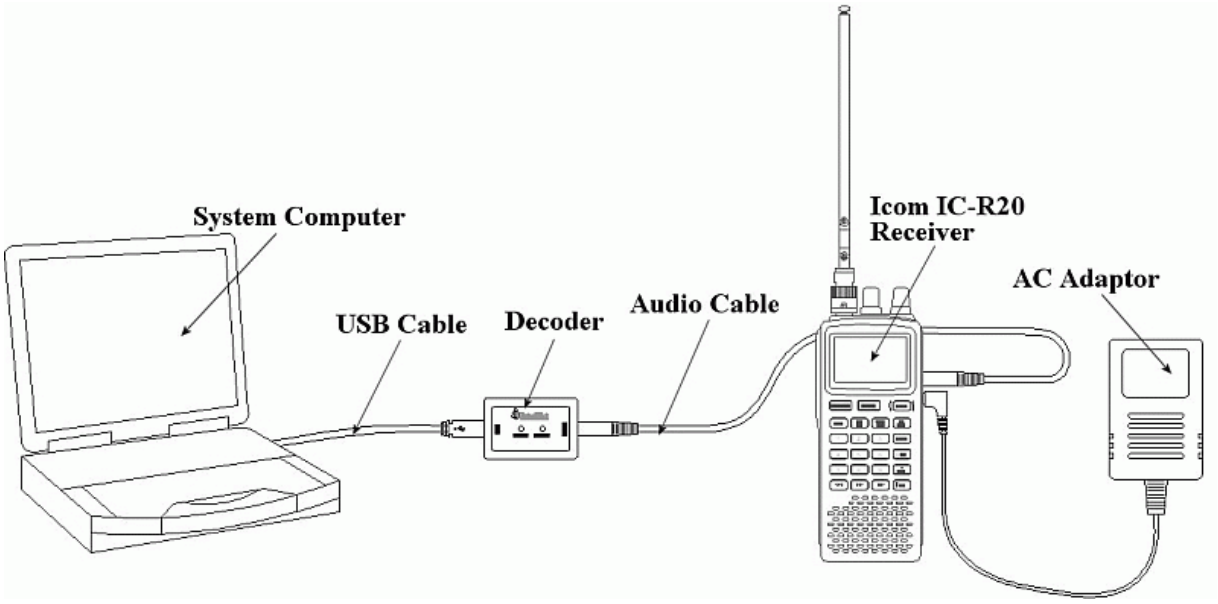
The computer we will use is a Panasonic "Toughbook" which, as its name implies, is a special laptop that can function while outdoors in the elements. We will perform this operation even during inclement weather since that's when you need the data the most! If, however, there is a thunderstorm or winds greater than Tropical Storm strength, i.e., 40 mph, we will not go out on the roof today.

Note that you cannot release radiosondes without a meteorology professor being present. Do not invite your friends, either unless they are meteorology students. This is a meteorology-only activity.

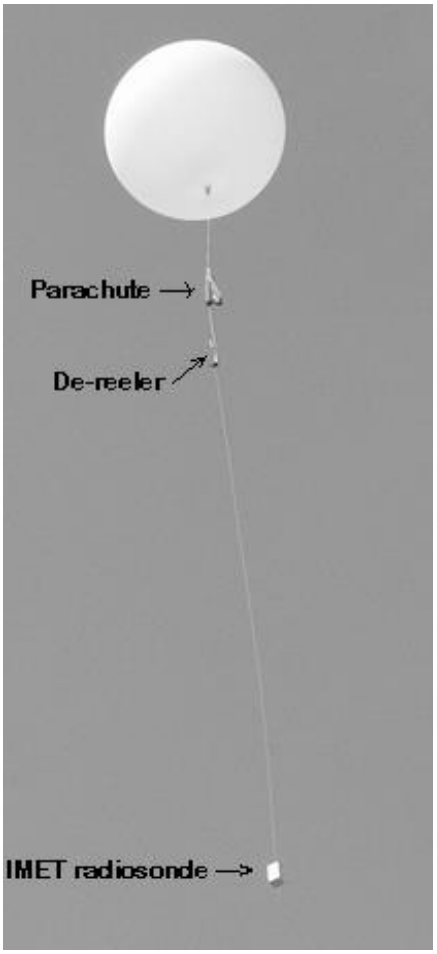
InterMet portable radiosondes are small, disposable packages, about 5 inches high (plus the antenna which is on the bottom):



The ground station, consisting of the receiver, decoder, and Toughbook (System Computer) looks like this:



The "weather balloon" will be inflated with helium until it rises at a rate of 5 m s^{-1}. We have an inflation kit to do that. Then a parachute will be attached to bring the device down safely, a small "de-reeler" to pay out the string, and finally, the radiosonde instrument itself:


Parachute
De-reeler
IMET radiosonde

Here's the launch sequence:

1. Your professor will connect the receiver, decoder, and Toughbook.

2. One student in the class will complete the pre-flight baseline data entry. This means checking the station pressure in hPa, also known as mb. This is not sea-level pressure – get station pressure directly from the mercury barometer in the meteorology lab. Also, baseline data includes Temperature in °C, humidity in %, wind direction in °, and wind speed in knots.

3. A student will start the iMetOS software (it's the blue icon on the desktop) and enter the preflight conditions.

4. Two students will set up the radiosonde. They will also activate the receiver and tune to the radiosonde. Verify that a strong signal is being received.

5. The class will cooperate to inflate the balloon and set up the Flight Train (balloon, parachute, de-reeler, and radiosonde).

6. When everything is ready and it is verified that the iMetOS software is receiving data, the balloon will be launched. Take pictures!

If all goes well, it may be a while before the balloon bursts and parachutes back to Earth. Once that occurs, the data recording is terminated in the software. Upper level data will be downloaded from the Toughbook and made available on the course homepage.

You are to plot today's Oneonta soundings of temperature and dew point on a Skew T Log P diagram to be supplied. This will <u>not</u> be graded but next week's lab will also involve plotting soundings. I will correct your mistakes for today's plot so you will know what to do next week. **I strongly suggest you do this in the next two days, even though it is due Sept 19. On Friday, Sept 12 I will return your graded, plotted maps. By next Wednesday Sept 19 you will do a standard analysis of your plotted map:**

a) Draw isobars in black every 4 mb, including the 1000 mb isobar (label it 00)
b) Put in centers of High and Low pressure (blue H and red L). Remember that winds must be <u>cyclonic</u> around the "L" and <u>anticyclonic</u> around the "H".
c) Draw in the fronts, if any exist. Use the proper symbols.

Here is how you plot the Skew T Lop P diagram:

Today's data will be made available on the course webpage once the instrument stops sending or when it reaches a sufficiently high elevation. Plot these in black ink. Use dots for the plotted temperatures and x's for dew points. Make them big enough to see, about 1 mm diameter.

Connect the temperature observations with straight red lines and the dew point observations with straight green lines. Use ink, not pencil.

Draw wind flags in black ink on the right side of each chart on one of the vertical axes with circles.

For all winds, put the wind barbs on the correct side.

Upper Air Code (soundings)

1. Introduction

Observations of the atmosphere above the surface are made with the help of radiosondes like the one we launched last week. Radiosonde observations or RAOBS are released from some 70 U.S. stations and from hundreds of special stations throughout the world. Signals from the rising radiosonde allow plotting of temperature, pressure and relative humidity. In addition, the balloons are tracked as they rise, giving information about wind velocity and direction. When the observations include wind data they may be called Rawinsondes (RAWIN).

The radiosonde stations report their data at 00Z and 12Z, by World Meteorological Organization (WMO) convention. The transmission of the data is usually made approximately two hours after the observation is begun, i.e., about 02Z and 14Z. On request, additional RAOB observations may be made at 06Z and/or 18Z. The National Weather Service (NWS) posts the radiosonde data in coded form. One convenient site with raw data is http://weather.rap.ucar.edu/upper/Current.rawins

Each coded RAOB report is divided into several reporting sections, each section being transmitted separately. The first transmission is identified by the group TTAA. This transmission consists of data at specified levels called mandatory levels. These are the surface, 1000 mb, 925 mb, 850 mb, 700 mb, 500 mb, 300 mb, 250 mb, 200 mb, 150 mb, 100 mb, the tropopause and the level of maximum wind. You always get these levels.

The second transmission contains data at nonstandard levels. These are called significant levels. A significant level can be any pressure where something of meteorological interest happens, such as the beginning of an inversion. The radiosonde operator decides which levels to report as significant, within guidelines published by the NWS. This transmission is identified by the group TTBB.

Wind data are transmitted after the significant data and this is identified by the group PPBB. Late transmissions contain data above 100 mb and are identified by the groups TTCC and TTDD for mandatory and significant levels, followed by PPDD wind data.

2. The form of the TTAA code (mandatory levels)

The TTAA transmission always starts with three groups to identify the station and date:

TTAA YYGGI_d IIiii

Following the three initial groups will be a number of data groups, clustered in threes. These clusters will always start with a two-number identifier for each mandatory level. The form is as follows:

99$P_oP_oP_o$	$T_oT_oT_{ao}D_oD_o$	$d_od_of_of_of$	(Surface data)
00hhh	TTT$_a$DD	ddfff	(1000 mb)
92hhh	TTT$_a$DD	ddfff	(925 mb)
85hhh	TTT$_a$DD	ddfff	(850 mb)
70hhh	TTT$_a$DD	ddfff	(700 mb)

50hhh	TTT_aDD	ddfff	(500 mb)
40hhh	TTT_aDD	ddfff	(400 mb)
30hhh	TTT_aDD	ddfff	(300 mb)
25hhh	TTT_aDD	ddfff	(250 mb)
20hhh	TTT_aDD	ddfff	(200 mb)
15hhh	TTT_aDD	ddfff	(150 mb)
10hhh	TTT_aDD	ddfff	(100 mb)
$88P_tP_tP_t$	$T_tT_tT_{at}$ D_tD_t	$d_td_tf_tf_tf_t$	(Tropopause data)
$77P_mP_mP_m$	$d_md_mf_mf_mf_m$	$4v_bv_bv_av_a$	(Max wind data)

66 is sometimes used instead of 77 as the maximum wind identifier

For translating parameters such as TTT and DD, refer to the "definition of symbols" in part 5.

Example (translation follows):
72520 TTAA 68121 72520 99981 09013 04008 00196 ///// ///// 85543 08471 03014 70132 04075 30021 50580 11368 28037 40747 23364 27043 30951 38959 26558 20216 593// 25560 15399 589// 27056 10651 625// 26539 88202 597// 25560 77279 26064=

Decoded mandatory levels for station 72520 (Pittsburgh): 12Z observation on the 18th of the month, wind in knots, last group = 100 mb. Surface data -> pressure = 981 mb, temperature = 9.0°C, dew point depression =1.3°C (actual dew point = 7.7°C), wind at 8 knots from 40E. No 1000 mb level. Other levels are:

Level	Height (m)	Temperature (°C)	Dew point depression (°C)	Wind speed + Direction
850 mb	1543	8.4	21	14 kts from 30°
700 mb	3132	4.0	25	21 kts from 300°
500 mb	5800	-11.3	30	37 kts from 280°
400 mb	7470	-23.3	14	43 kts from 270°
300 mb	9510	-38.9	9	58 kts from 265°
200 mb	12160	-59.3	no dew point	60 kts from 255°
150 mb	13990	-58.9	no dew point	56 kts from 270°
100 mb	16510	-62.5	no dew point	39 kts from 265°
Trop=202 mb		-59.7	no dew point ------->	60 kts from 255°
max wind at 279 mb ---------->				64 kts from 260°

3. The form of the TTBB code (significant levels)

The TTBB transmission always starts with three groups which are very similar to those of the TTAA part:

TTBB YYGG/ IIiii

Following the three initial groups will be a number of data groups as in the TTAA code. Unlike the TTAA's, the TTBB's consist of two-group clusters. The clusters always start with a numerical identifier, like 11, 22, 33, etc. The form is as follows:

00$P_oP_oP_o$	$T_oT_oT_oD_oD_o$	(Surface data)
11PPP	TTT_aDD	
22PPP	TTT_aDD	
33PPP	TTT_aDD	(significant level data)
44PPP	TTT_aDD	
.....	....., etc.	

Note that PPP means pressure <u>in whole millibars</u> at the significant levels.

Example:
UJUS1 061200 GRB TTBB 5612/ 72645 00985 17830 11978 16415 22920 16257 33850 13270 44627 04565 55582 06377 66500 12375 77425 21325 88400 23568 99320 35356 11189 619// 22124 603// 33100 615//

Decoded significant levels for station 72645 (Green Bay, WI): 12Z observation on the 6th of the month, wind in knots. Surface data -> pressure = 985 mb, temperature = 17.8°C, dew point depression = 3.0°C. First significant level = 978 mb, temperature = 16.4°C, dew point depression = 1.5°C. Second significant level = 920 mb, temperature = 16.2°C, dew point depression = 7°C, etc. Other levels are listed:

Level (mb)	Temp (°C)	Dew point depression (°C)
850	13.2	20
627	-4.5	15
582	-6.3	27
500	-12.3	25
425	-21.3	2.5
400	-23.5	18
320	-35.3	6
189	-61.9	no dewpoint
124	-60.3	no dewpoint
100	-61.5	no dewpoint

Note that mandatory levels (from TTAA) like 850 mb and 500 mb may also be significant levels (in TTBB), but not all mandatory levels will be included. It depends on the operator.

4. The form of the PPBB group

The PPBB transmission also starts with a three-group identification cluster:

PPBB YYGGa_4 IIiii
(a_4 - indicator for type of equipment used. 0 is Rawinsonde)

Unlike the first two types, in the PPBB part the clusters consist of two, three or four groups. The initial group in the cluster is the most important and is ALWAYS indicated by a leading "9". The rest of the initial group tells you what altitudes the winds are. The other groups give the actual wind data. The form is:

9$t_n u_1 u_2 u_3$ ddfff ddfff ddfff

The ddfff symbols are the same as in the TTAA and TTBB parts. The most confusion arises from the altitude indicator group. Again, it will always be identified by the leading 9. The next symbol, t_n, gives the digit of the altitude in ten-thousands. For example, if the altitude of the observation is

10000 feet, t_n = 1. If the altitude is 20000 feet, t_n = 2, etc.

To get more than just increments of 10000 feet, we use the u's. These give the digit of the altitude in thousands. For convenience, consider only u_1. Suppose t_n = 1 and u_1 = 2. The indicated altitude is 12,000 feet. If t_n = 0 and u_1 = 3, this indicates 3000 feet (0 ten-thousands and 3 thousands).

The u_1 altitude is the height of the wind of the <u>first</u> ddfff group immediately following the 9-altitude indicator group. Similarly, u_2 applies to the <u>second</u> dfff group after the 9-group and u_3 applies to the <u>third</u> ddfff group after the 9-group. The t_n refers to all three groups. For example (next page):

```
   ↑--------->|3000' wind|
90345          24036          25548          27030
   ↓--------------------------->|4000' wind|   |5000' wind|
    ↓-----------------------------------------------------↑
```

At 3000, 4000, 5000 feet the wind is 240E at 36 kts, 255E at 48 kts and 270E at 30 kts.

IMPORTANT - There may NOT be three groups after the 9-group. For example,

929// 24624

Here the altitude is 29000 feet with a wind of 124 kts from 245°. Note that the next thousand foot level would be 30000 feet, which must go in the next cluster because the tens indicator, t_n for the 929// cluster is 2. The next cluster would follow immediately. Its initial group might be something like 93024. Remember also the ddfff convention when the wind goes over 100 kts or m/s add 1 to the third digit, making it 1 or 6.

5. Definition of Symbols

TTAA (mandatory levels) – message identifier stating that the following data are for the standard isobaric surfaces up to 100 mb (hPa). These standard levels are as follows: the surface, 1000 mb, 850 mb, 700 mb, 500 mb, 400 mb, 300 mb, 200 mb, 150 mb, and 100 mb.

yy – day of the month in Greenwich and the wind speed indicator (either knots or m/s). The day of the month is indicated with the code figures 01-31. When the wind speed is given in knots, 50 is added to the day of the month, but if the wind speed is given in m/s, the date is coded directly. For example, 53 – third day of the month with wind speed in knots. 03 – third day of the month with wind speed in m/s.

gg – actual time of observation to the nearest whole hour in GMT. This is usually 00Z or 12Z but soundings can also occur at 06Z and/or 18Z.

I_d – indicator of the last standard isobaric level for which the wind group is included in the TTAA and TTCC groups. I_d is usually 1 which means the last level is 100 mb.

99 – indicator that surface data follow. The subscript "o" on any symbol in the following description

indicates that the value is for the surface, i.e., T_o means surface temperature.

$P_oP_oP_o$ – surface (station) pressure not corrected to sea level in while millibars (mb) with only the hundreds, tens, and units digits given. For example, 981 → 981 mb; 015 → 1015 mb.

TTTa - observed temperature and approximate tenths value (T_a). TT reported in while degrees Celsius at the specified pressure level. Incorporated in the figure T_a is the information as to the sign of the temperature (+ or -). If the reported value of T_a is even, the temperature is positive and if odd, the temperature is negative.

DD – dew point depression. The difference between the temperature and the dew point temperature. When the depression is 5° or less, the units and tenths digits of the depression in degrees Celsius are reported. When the depression is greater than 5°, 50 is added to the tens and units digits. Thus, 65 would be the code for a depression of 15°, while 49 would be the code for a depression of 4.9°. Codes 51-55 are not used (1° would be reported as 10, rather than 51 for example). A code of 50 means a 5° depression.

dd(f) – the true direction in tens of degrees of the observed direction rounded to the nearest 5° from which the wind is blowing at the specific level (see ff).

(f)ff – wind speed in knots or m/s, depending on the the indicator yy. The first digit of this group is incorporated into the direction group and will always be reported as either 5 or 0 unless the speed is in excess of 99 knots (or m/s) in which case 1 will be added to the first digit of this group and it will therefore be reported as a "1" or a "6". For example, 35610 would indicate a north wind of 110 knots.

The next series of levels is reported in groups of three for the standard isobaric surfaces with the first two digits indicating the level for which the following information is given (00 – 1000 mb level, 85 – 850 mb level, etc.)

hhh – geopotential altitude of the standard isobaric surfaces given in geopotential meters. Only certain digits of the entire height is given. Which digits are reported depends on the surface.

88 – indicator for the tropopause data.

77 – indicator for the data of the maximum wind. The maximum wind group will only be reported if the wind speed is in excess of 60 knots.

** NOTE: Be aware that when upper level winds are missing, the wind group may be omitted. In that case, the group which follows should not be mistaken for a wind group. Instead it will be the next level height indicator group, starting with 85, 70, 50, etc. This can be misleading if the 300 mb group is missing since the next indicator is 25 (250 mb) and that can look like a wind direction.

TTBB (significant levels) – This message is coded substantially the same as the TTAA type, except that the wind group is eliminated and information as to the altitude of the pressure surface is also absent. Note that the indicators 11, 22, 33, 44, etc. are used to mark successive significant levels. When there are more than 9 significant levels, the numbers 11 to 99 are repeated until all the levels are given. PPBB follows TTBB with wind data.

Lab Assignment (due next Wednesday)

1. Translate the upper air data shown after these instructions for stations 72305 (MHX), 72403 (IAD), 72520 (PIT), 72518 (ALB), and 72747 (INL). Make five tables, one for each station. It can be done in Excel (MS Office), CALC (Open Office) or Numbers (Apple). Lay them out as follows:

Station:
Pressure (mb) Temperature (°C) Dew Point (°C) Wind (degrees, knots)

a) It is easiest to do the TTAA's (mandatory levels) first, then the TTBB's (significant levels). You will probably find your first copies are messy or out of order after adding significant levels between the mandatory levels. So copy it over neatly or sort if it is digital. Put the PPBB winds into a separate table.

b) Remember the reports give dew point depressions. Convert them to the actual dew points.

2. On a set of 5 thermodynamic diagrams, plot the radiosonde data from your tables in black ink. Use dots for the plotted temperatures and x's for dew points. Make them big enough to see, about 1 mm diameter.

a) Connect the temperature observations with straight red lines and the dew point observations with straight green lines. Use ink, not pencil.

b) Plot TTAA winds in black ink on the right side of each chart on one of the vertical axes with circles. Place a wind flag for each observation in the PPBB part on the axis marked ICAO Standard Atmosphere Altitude. For all winds, put the wind barbs on the correct, left side. Be sure to plot the tropopause wind and the max wind.

Turn in all five thermodynamic diagrams **and** the printed data tables. Put your name on all sheets.

```
USUS42 KMHX 060000

72305 TTAA  56001 72305 99005 13600 11509 00053 13201 13013 92710
11806 16054 85414 08406 17049 70001 01606 22555 50565 11523 25066
40733 22139 24573 30939 34556 24601 25064 45557 24106 20209 56358
24634 15389 62359 26098 10636 68959 26073 88999 77193 25136=

72305 TTBB  56000 72305 00005 13600 11946 12606 22820 06806 33758
04006 44721 03206 55653 01306 66650 00705 77641 02106 88479 13326
99380 24742 11375 24541 22347 27147 33315 31756 44240 48157 55208
55558 66194 57358 77179 57559 88160 61759 99153 61959 11141 63759
22138 63359 33130 65159 44124 65359 55122 63559 66119 63359 77107
67959 88105 67559=

72305  PPBB 56000 72305 90012 11509 15543 16054 90345 16053 16550
16552 90678 18548 20047 20544 909// 21551 91024 22555 23062 23065
9167/ 23555 24054 92057 25066 24580 23577 93016 24599 24606 24107
94067 25136 26098 25608 9501/ 26572 26064=

72403 TTAA  56001 72403 99006 00104 06504 00133 00520 07507 92753
01904 10525 85423 03906 12518 70954 07509 18025 50556 13719 25055
40722 24743 25080 30925 38350 24089 25047 47357 24613 20191 59357
24663 15370 57559 26601 10625 63363 27566 88183 61757 25153 77200
24663=

72403 TTBB  56000 72403 00006 00104 11005 00328 22991 01111 33953
02909 44930 01904 55852 03906 66838 02303 77812 03704 88799 03103
99742 05105 11695 07709 22674 07505 33637 09109 44580 08704 55523
11511 66430 20732 77420 21943 88312 38156 11268 44556 22238 49757
33206 58357 44193 60557 55183 61757 66170 61358 77162 62158 88158
58958 99153 57159 11147 58359 22143 55960 33138 54961 44126 57762
55116 58363 66110 59763=

72403 PPBB  56000 72403 90012 06504 08515 09528 90345 10526 11020
14518 90678 18030 17535 17022 909// 16521 91024 19031 20056 22076
9168/ 23067 24555 92058 24564 24585 24069 93049 24088 24603 24663
94368 25638 26590 26566 950// 26075=

72518 TTAA  56001 72518 99009 01157 00000 00160 02158 31003 92774
07350 34016 85426 12536 34518 70925 10373 31036 50546 24756 28552
40707 31940 27075 30906 42747 27125 25028 48343 26171 20171 59338
26679 15355 53176 29078 10614 605// 27566 88200 59338 26679 88166
58175 29089 77215 26181=

72518 TTBB  56006 72518 00009 01157 11852 12534 22840 11957 33831
09977 44806 09777 55743 08175 66578 17577 77563 17377 88501 24757
99482 23728 11363 35743 22345 35541 33294 43347 44270 45745 55200
```

59338 66194 57750 77191 53957 88186 50577 99166 58175 11154 53176
22133 54376 33130 53176 44116 56775 55100 605//=

72518 PPBB 56006 72518 90012 00000 31012 32514 90346 34516 35013
32528 90789 31532 31035 31035 91246 30543 30045 29549 92025 27564
27568 26592 9279/ 26110 27122 93025 27130 26661 26176 9379/ 26181
26676 9438/ 29088 28065 9502/ 27560 27065=

72520 TTAA 56001 72520 99967 00000 08007 00090 ///// ///// 92714
02306 09533 85387 01103 11533 70921 05903 15019 50550 16119 22037
40715 26541 22559 30916 40156 23111 25040 46757 22143 20183 58557
22650 15364 59759 24590 10620 59162 27555 88203 58957 22651 77206
22651=

72520 TTBB 56000 72520 00967 00000 11955 00303 22906 03105 33889
02905 44881 01303 55866 00703 66769 03703 77717 06707 88689 05903
99611 11710 11552 15120 22545 15119 33535 14110 44523 14312 55467
17923 66341 35556 77304 40356 88288 40756 99282 39956 11278 40156
22249 46958 33216 55757 44203 58957 55193 59357 66181 57758 77172
58159 88168 57159 99157 59159 11146 59760 22143 56760 33139 56960
44137 56160 55123 57561 66119 56962 77109 59962 88107 59762 99105
60562=

72520 PPBB 56000 72520 90023 08007 09027 12043 90456 12038 11531
13527 90789 13024 11527 12023 91024 18020 17031 20044 9168/ 20029
22542 92015 22550 22554 23058 9268/ 23556 23075 93018 23110 22635
22651 943// 24593 950// 26577=

72747 TTAA 56001 72747 99983 06156 07004 00224 ///// ///// 92832
08549 11019 85490 07964 10515 70984 13358 33509 50548 273// 30012
40706 381// 29022 30897 529// 28539 25012 605// 28042 20154 519//
28028 15342 495// 29022 10605 533// 30022 88259 601// 27544 77999=

72747 TTBB 56000 72747 00983 06156 11970 06356 22925 08549 33922
08345 44914 07561 55909 06962 66877 06965 77855 07968 88851 07964
99827 09160 11823 09159 22819 08761 33817 08765 44809 08766 55796
08962 66794 08959 77792 08959 88764 10956 99753 11143 11728 12756
22698 13358 33692 13160 44687 13560 55683 13956 66676 13756 77666
13964 88654 14173 99615 16774 11596 18575 22589 19367 33555 22563
44543 239// 55408 371// 66332 489// 77304 525// 88259 601// 99248
605// 11244 589// 22240 587// 33237 571// 44234 573// 55229 553//
66212 521// 77186 515// 88167 491// 99149 493// 11132 509// 22127
503// 33119 523// 44107 529// 55103 539//=

72747 PPBB 56000 72747 90023 07004 09015 11521 90467 10016 10010
06514 9089/ 03508 00503 91124 33516 34012 34012 91569 34512 31006
29514 92024 29516 30519 29022 9258/ 29027 29530 93026 28040 28045
28525 950// 28525=

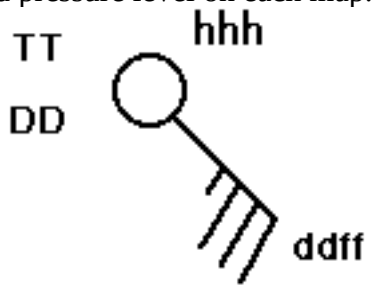
Upper Air Maps (Analysis I)

This will be a detailed upper air analysis, starting from RAOB data transmissions. Since the TTAA's give the mandatory upper air levels, we could, on any given day, draw our own upper air maps from that data. Suppose the network breaks down? It's certainly possible, even likely at least once or twice a month. How would you get upper air maps? It is important not to be too dependent on computers to analyze data and draw maps. After these next two labs, you should be pretty good at plotting and analyzing from RAOB data.

We will start this week with two upper tropospheric maps and finish next week with two lower tropospheric maps.

Lab Assignment (due next Wednesday. Remember, exam 1 is next week):

1. On an upper air base map, plot the data for 300 mb and 500 mb from TTAA's. Use the stations on the pages following this one. Write your name, the date, time, and pressure level on each map.



Upper air data is plotted on a simplified station model ——>

Here TT is temperature in °C, DD is dew point depression (not dew point itself) in °C and hhh is the height of the pressure surface, as coded for the TTAA. Refer to the Definition of Symbols in lab 4. Plot the height digits as coded on your maps without translation.

Notes: Some stations have changed since your upper air base maps were designed. If the stations or their locations have changed, such as 72231 changing to 72230, that is noted just above the TTAA data.

DD and TT must be rounded to whole °C for the map. If 0.5°C, round to 1°C, if -0.5°C, round to -1°C.

2. Analyze the 500 mb map. Do the standard analysis:

a) height contours every 6 decameters, in black. Include a 540 line. For example plot 528, 534, 540, 546, etc.

Try to make your height contours follow the wind directions. Label all contours and isopleths. Do not analyze where you have no data. Make all contours and isopleths smooth. If you have a closed contour, it must have a center, either "L" or "H".

b) isotherms every 5°C in red dashed lines. Include a -10°C isotherm.

3. Analyze the 300 mb map. Do this analysis:

a) height contours every 12 decameters, in black. Include a 900 line. For example, 888, 900, 912, 924, etc.

b) isotachs (lines of constant wind speed) in dashed blue lines, every 20 knots, starting at 30, i.e, 30, 50, 70, 90, etc. Also, at 70 knots and higher, shade lightly in blue.

4. Compare your upper air maps to the surface map. Comment on what you see, meteorologically. (Extra)

```
72201 TTAA  56001 72201 99008 25436 18009 00086 25231 ///// 92769
20835 21535 85495 15211 23539 70119 08060 25541 50581 07769 23067
40751 18166 23578 30960 32545 24080 25086 42549 24072 20233 51758
23596 15415 62958 24579 10657 74757 26053 88999 77177 24099 40826=

TTBB  56000 72201 00008 25436 11978 24650 22815 12610 33742 09212
44718 08231 55707 08860 66656 04456 77638 05068 88593 00675 99547
05156 11540 05508 22535 05910 33529 05365 44527 05368 55500 07769
66479 10361 77473 10766 88443 14368 99439 14757 11434 15323 22422
16711 33414 17311 44410 17166 55400 18166 66379 21756 77373 21534
88355 23540 99220 50556 11204 50957 22155 62558 33100 74757 31313
05102 82302=

72202 56001 TTAA  99009 25250 15006 00087 24434 16512 92766 20223
21536 85492 15223 23540 70113 07266 24543 50580 07598 24074 40750
18594 24079 30959 32150 24071 25085 43157 24074 20232 51960 24593
15413 64960 24596 10655 73759 26061 88999 77181 24596 41601 31313
58708 82303=

72202 TTBB  56000 72202 00009 25250 11977 22415 22939 20209 33929
20619 44856 15827 55819 12808 66761 09401 77743 08809 88733 08633
99732 08656 11714 07662 22679 06678 33671 05876 44665 05068 55661
04661 66652 03457 77639 02259 88637 02260 99633 02274 11628 01867
22622 01698 33600 01082 44580 00193 55562 02379 66556 02968 77554
03359 88540 04961 99534 05163 11531 04980 22530 05193 33491 08597
44490 08580 55487 08397 66440 14595 77438 14793 88435 14760 99434
14759 11428 15165 22425 15565 33424 15594 44418 15995 55394 20188
66392 20169 77391 19958 88390 19747 99387 19333 11380 20341 22351
24724 33326 27747 44302 31750 55282 35757 66221 49757 77208 51759
88197 52160 99174 58360 11166 59560 22150 64960 33139 64960 44127
69160 55116 70560 66108 72159 77106 71959=

72206 TTAA  56001 72206 99002 19412 26505 00027 19411 24011 92695
15416 25042 85407 11600 23536 70008 00664 23542 50566 11173 24085
40735 19547 22612 30943 33956 21597 25068 44150 21609 20214 53960
23629 15395 61163 24611 10643 68162 25557 88999 77190 23629 43117
31313 58708 82317=

72206 TTBB  56000 72206 00002 19412 11911 14417 22875 12000 33841
11400 44767 07404 55757 06219 66744 05614 77738 05200 88722 03801
99720 03607 11718 03438 22713 02658 33711 02261 44701 00864 55683
00669 66657 00265 77649 00068 88633 01569 99615 03164 11608 03567
22599 03773 33595 03799 44565 03999 55563 04396 66554 05565 77553
05762 88551 05956 99545 06540 11527 07925 22523 08356 33518 08957
44513 09562 55503 10765 66497 11388 77482 12396 88465 14795 99444
14981 11442 15168 22439 15362 33430 16359 44424 16736 55421 16935
66416 17356 77392 20540 88385 21324 99375 22549 11371 23159 22365
24160 33351 25559 44343 26546 55329 28343 66292 35357 77266 40557
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88249 44350 99225 50357 11220 50557 22207 53359 33180 56762 44160
60563 55141 61763 66122 66362 77117 66362 88116 64763 99111 63163
11109 63363=

72208 TTAA  56001 72208 99999 18010 21013 00009 ///// ///// 92676
16638 22049 85390 11209 21552 70990 02808 23047 50565 09922 23062
40734 20737 23074 30940 35156 23093 25065 45358 23109 20210 55358
23636 15390 61762 25116 10639 67764 24569 88158 62161 25125 88103
68763 24562 77187 24637=

72208 TTBB  56000 72208 00999 18010 11997 17610 22966 16005 33958
17008 44941 17836 55915 15835 66884 13210 77748 06009 88707 02806
99699 02809 11694 03034 22679 02456 33645 00750 44638 00257 55633
00757 66619 00758 77562 07337 88543 08316 99534 08306 11519 08308
22496 10330 33480 12331 44460 13736 55426 17932 66309 34356 77284
37556 88219 53758 99208 53558 11196 56558 22158 62161 33146 61762
44137 62562 55136 62162 66135 59563 77134 58963 88125 59164 99116
62565 11103 68763 22102 67564=

Plot at 211
72210 TTAA  56001 72210 99006 19205 19506 00068 18802 21513 92735
15400 24032 85450 11800 25539 70055 04826 25554 50573 10559 24077
40742 19519 23595 30950 33358 22598 25075 43186 22092 20222 53383
24115 15403 62580 25107 10648 68978 25042 88999 77159 24616=

72210 TTBB  56000 72210 00006 19205 11979 17600 22811 10200 33801
09203 44787 07458 55766 07858 66745 06660 77724 06256 88715 05457
99709 05443 11699 04824 22676 02802 33605 01302 44531 07511 55499
10760 66488 11556 77469 12757 88459 13537 99447 14722 11439 14712
22432 15119 33406 18919 44394 19519 55386 21321 66385 21934 77380
22357 88377 22957 99356 25557 11333 29350 22326 28742 33317 30357
44311 31156 55291 35161 66277 38161 77273 38965 88270 39387 99219
50184 11207 51783 22177 58981 33169 59781 44165 59381 55158 61181
66154 61181 77144 64780 88133 67379 99127 66179 11118 69178 22116
68779 33113 65979 44110 65579=

72214 TTAA  56001 72214 99998 17631 26510 00038 ///// ///// 92698
11603 25526 85406 10456 25539 70996 00871 26035 50562 14595 25081
40729 20393 22125 30937 34189 22123 25062 43186 22134 20210 50584
23127 15393 59181 24110 10643 65575 25059 88999 77232 22635=

TTBB  56000 72214 00998 17631 11992 16830 22934 12205 33905 10205
44897 12236 55892 12650 66837 10258 77822 09259 88809 08258 99772
05858 11767 05858 22764 05862 33757 05261 44739 04265 55736 04471
66732 04272 77679 01368 88660 02975 99652 03199 11629 03799 22512
14795 33462 15195 44433 18994 55425 19594 66415 18994 77375 22593
88355 26191 99347 24992 11290 36388 22265 39787 33235 45785 44198
50784 55176 55782 66148 59181 77139 62380 88135 61581 99127 63578
11122 63777 22119 64975 33115 64376 44113 62378 55108 62180=
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Plot at 219
72215 TTAA 56001 72215 99974 06009 00000 00031 ///// ///// 92669
06003 25022 85362 04801 26038 70931 00763 24040 50552 19194 24551
40716 26191 23088 30921 35388 21132 25046 41786 22132 20195 48984
22622 15381 54782 24586 10635 63180 26068 88999 77262 21637=

72215 TTBB 56000 72215 00974 06009 11964 04617 22948 04005 33932
05602 44906 07004 55857 04202 66843 06002 77820 05207 88769 02016
99748 00448 11734 00057 22732 00158 33730 00364 44729 00565 55718
00967 66707 00563 77692 01163 88676 01959 99664 03159 11641 05921
22628 07142 33610 09511 44605 09721 55602 09750 66599 10157 77588
11149 88585 11356 99578 11568 11559 13562 22517 18957 33516 18957
44514 18766 55511 18579 66506 18594 77499 19394 88493 18394 99427
24992 11406 25592 22373 28791 33349 28791 44287 37188 55269 39587
66261 39787 77229 45585 88187 50984 99167 52983 11158 55382 22154
54383 33151 55182 44142 54183 55134 55782 66125 59581 77119 60981
88103 63780=

Plot at 72228
72230 TTAA 56001 72230 99984 08817 28009 00039 ///// ///// 92681
05404 27022 85370 03811 29036 70930 01760 27042 50553 175// 27548
40716 291// 27561 30915 399// 24072 25039 407// 23098 20190 451//
23097 15378 531// 24082 10634 627// 24560 88318 421// 26063 77218
23104=

72230 TTBB 56000 72230 00984 08817 11971 07814 22913 04805 33867
03005 44858 04008 55820 02436 66753 00336 77709 01957 88702 01760
99694 01759 11655 05357 22631 07758 33627 07760 44625 07566 55623
07392 66618 07198 77586 10196 88578 10975 99574 11195 11568 11177
22555 11596 33552 117// 44523 153// 55417 281// 66410 279// 77396
295// 88318 421// 99307 411// 11301 399// 22293 401// 33288 385//
44281 397// 55271 393// 66259 411// 77249 405// 88239 423// 99221
439// 11212 433// 22196 461// 33193 457// 44180 485// 55168 499//
66163 511// 77160 509// 88155 523// 99144 539// 11127 579// 22122
565// 33113 581// 44110 593//=

Plot at 231
72233 TTAA 56001 72233 99008 12435 26008 00076 11434 27016 92722
06408 29021 85416 06043 27531 70993 00869 28037 50562 15983 28049
40726 28591 27557 30924 44572 26056 25047 41583 24587 20197 45978
24597 15385 54368 25590 10640 63963 26564 88305 44572 26554 77161
25603=

TTBB 56000 72233 00008 12435 11980 10030 22907 05405 33893 07208
44883 07034 55868 06442 66843 05840 77833 05625 88824 05833 99822
06250 11814 06458 22749 02059 33738 01860 44736 02063 55731 02264
66728 02269 77725 02269 88691 00070 99663 00395 11478 18986 22414
26391 33356 36381 44305 44572 55293 44772 66287 42775 77273 43176
88261 42180 99257 42579 11253 41382 22227 43581 33216 43582 44187
46976 55168 51170 66163 52169 77158 52169 88143 56166 99140 55567
11132 56166 22113 60564 33110 60564=

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72240 TTAA  56001 72240 99011 11850 32010 00093 11258 31513 92738
05215 30519 85428 06259 31536 70011 01275 29038 50564 16162 28052
40728 28763 27560 30926 46563 28567 25048 43968 26062 20197 44572
26582 15386 54567 26103 10640 63764 28066 88297 46963 28566 77149
26603=

72240 TTBB  56000 72240 00011 11850 11005 11659 22923 05013 33895
03413 44879 04023 55873 05041 66857 06257 77840 06662 88812 06866
99793 06467 11785 06472 22765 06276 33706 01474 44676 00675 55622
03173 66523 13966 77511 14965 88504 15562 99446 22367 11424 25164
22297 46963 33286 47163 44276 43964 55235 44169 66205 45372 77202
44372 88190 46771 99173 48770 11164 51369 22160 51369 33152 54367
44142 55167 55135 57766 66134 57366 77128 57966 88113 62164 99110
62364=

72248 TTAA  56001 99000 10656 29505 00089 10456 28008 92732 04636
29520 85417 05064 32041 70972 04772 30043 50558 17368 28564 40721
29367 29070 30919 47765 28072 25040 46965 28560 20187 47166 26576
15376 51365 27067 10632 62562 27058 88292 48964 27573 88104 62562
27072 77170 27583 40918 77281 27579=

TTBB  56000 72248 00000 10656 11970 08257 22885 01416 33866 01833
44855 04661 55850 05064 66774 01070 77747 01769 88674 06972 99662
07173 11633 03377 22622 03977 33585 07770 44502 17168 55460 20169
66292 48964 77276 49364 88268 46365 99265 45965 11254 47365 22244
47165 33233 48765 44224 49365 55222 48365 66212 48365 77206 47166
88182 47566 99174 48965 11168 48166 22154 51165 33149 51365 44138
54964 55135 54364 66123 55164 77104 62562=

Plot at FWH (Dallas-Ft Worth, next to 259)
72249 TTAA  56001 72249 99989 14060 31011 00105 ///// ///// 92756
08659 31016 85448 04266 33030 70001 05377 31542 50560 17766 30051
40724 29172 29559 30922 47369 29066 25041 49968 28571 20189 47972
29063 15376 53769 28091 10632 63765 27565 88270 52966 28067 77148
28091=

72249 TTBB  56000 72249 00989 14060 11982 13463 22908 07458 33906
07260 44895 06459 55885 05860 66872 05665 77854 04266 88828 04069
99806 02465 11763 01567 22724 03175 33690 05979 44663 05596 55652
02599 66642 02979 77515 16567 88469 20365 99432 24172 11363 34977
22301 47169 33270 52966 44266 52766 55259 50167 66249 50168 77247
47369 88244 46370 99228 44972 11215 47172 22194 48372 33188 49771
44183 49372 55171 51570 66162 51970 77158 50971 88150 53769 99141
54369 11135 56168 22134 56168 33132 55168 44130 55168 55116 60166
66108 60366=

72250 TTAA  56001 72250 99012 20050 13508 00113 17038 11508 92777
14244 27006 85484 08629 31515 70090 040// 29525 50574 135// 28041
40740 27376 27052 30941 349// 27070 25068 373// 28069 20220 463//
27066 15405 58769 27071 10652 71163 29070 88322 39173 27557 77309
27077=
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72250 TTBB  56000 72250 00012 20050 11003 17441 22992 16427 33978
17029 44946 15641 55863 09221 66844 08436 77836 09860 88832 10669
99829 11071 11827 12099 22824 128// 33808 126// 44718 048// 55601
027// 66558 075// 77546 077// 88494 143// 99438 209// 11419 24183
22388 29371 33367 31779 44331 38775 55322 39173 66307 34183 77300
34988 88299 351// 99287 339// 11264 365// 22247 375// 33209 439//
44184 507// 55175 52776 66159 57171 77132 62567 88118 67164 99114
67364 11111 68764 22107 68764=

72251 TTAA  56001 72251 99011 19256 00000 00108 17856 29501 92769
14259 30020 85476 09870 30525 70071 03676 29037 50571 15177 27550
40736 27764 27558 30935 45565 27058 25060 38772 28578 20211 45171
28067 15398 55966 26071 10647 70562 28073 88298 45965 27059 77115
26581=

72251 TTBB  56000 72251 00011 19256 11002 18056 22958 14444 33928
14459 44882 11059 55854 10269 66819 08676 77795 08686 88756 07487
99667 01874 11615 03373 22565 07371 33540 10569 44524 12177 55500
15377 66463 18574 77445 21172 88435 22765 99421 24963 11369 31967
22298 45965 33292 44765 44289 41766 55276 39968 66270 38169 77263
37570 88257 37971 99219 42572 11208 42972 22186 49169 33181 49369
44170 52967 55163 54367 66159 53767 77115 66163 88109 66163=

72261 TTAA  56001 72261 99975 23069 31010 00098 ///// ///// 92770
18470 31016 85485 11664 29517 70072 01666 30033 50569 13771 29033
40734 27765 26537 30933 45762 28542 25056 391// 28582 20207 453//
29081 15394 571// 28062 10644 691// 27564 88297 46361 28542 77191
28585=

72261 TTBB  56000 72261 00975 23069 11936 19470 22925 18470 33870
13465 44773 04458 55725 02869 66710 02465 77685 00267 88650 03563
99634 04765 11626 05373 22619 05592 33609 05795 44562 09972 55553
10768 66547 11562 77536 12764 88529 12764 99527 12758 11525 12958
22511 12968 33497 13972 44387 29965 55372 32559 66339 38362 77297
46361 88288 45962 99283 43163 11272 43167 22262 39780 33259 39786
44254 389// 55237 397// 66211 443// 77188 473// 88176 515// 99170
523// 11162 545// 22155 555// 33145 589// 44128 623// 55124 621//
66121 631// 77116 627// 88110 653//=

72265 TTAA  56001 72265 99914 16668 29007 00113 ///// ///// 92770
///// ///// 85479 10065 30512 70054 01575 31532 50567 15763 30535
40731 28565 29035 30929 46765 28537 25048 46766 28071 20198 45782
29092 15385 55972 28069 10636 67165 27057 88279 51364 28539 77202
29093 40713 77135 27089=

TTBB  56000 72265 00914 16668 11897 14470 22873 12268 33763 02060
44725 00666 55709 00967 66700 01575 77692 02170 88685 02162 99650
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66420 26363 77361 34770 88279 51364 99262 51164 11250 46566 22239
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88158 53575 99141 58970 11125 60369 22112 64766 33110 64766=

72274 TTAA  56001 72274 99929 18267 00000 00127 ///// ///// 92790
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28108 15386 57368 28101 10636 66964 27072 88295 47957 26544 77207
28612=

72274 TTBB  56000 72274 00929 18267 11916 16266 22889 13865 33758
02057 44742 01257 55740 01659 66739 01863 77736 02876 88720 03092
99621 05985 11582 09972 22569 11369 33560 11778 44525 14979 55517
15770 66506 17370 77498 18564 88468 23160 99458 24356 11451 25358
22433 27956 33420 27541 44401 29350 55295 47957 66284 46759 77281
45560 88278 45760 99273 44162 11263 43365 22256 44366 33239 43770
44234 44770 55232 43571 66225 43573 77205 47773 88190 49573 99177
52371 11173 52970 22171 52371 33148 57768 44145 58367 55139 57168
66118 64365 77112 64965 88110 64365=

Plot at 309
72305 TTAA  56001 72305 99005 13600 11509 00053 13201 13013 92710
11806 16054 85414 08406 17049 70001 01606 22555 50565 11523 25066
40733 22139 24573 30939 34556 24601 25064 45557 24106 20209 56358
24634 15389 62359 26098 10636 68959 26073 88999 77193 25136=

TTBB  56000 72305 00005 13600 11946 12606 22820 06806 33758 04006
44721 03206 55653 01306 66650 00705 77641 02106 88479 13326 99380
24742 11375 24541 22347 27147 33315 31756 44240 48157 55208 55558
66194 57358 77179 57559 88160 61759 99153 61959 11141 63759 22138
63359 33130 65159 44124 65359 55122 63559 66119 63359 77107 67959
88105 67559=

72317 TTAA  56001 72317 99970 01010 06021 00033 ///// ///// 92659
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40724 22548 21573 30929 37957 22590 25052 46359 23111 20196 58159
23648 15376 57967 25614 10631 637// 26066 88190 60359 23654 77193
23655=

TTBB  56000 72317 00970 01010 11943 01107 22886 02104 33869 00204
44862 03804 55854 06805 66837 08205 77818 08004 88791 06004 99754
04848 11720 03656 22651 01943 33634 03525 44628 02519 55609 05513
66574 08118 77543 08518 88515 10948 99489 12134 11375 26356 22310
36356 33252 45959 44204 58159 55197 58159 66190 60359 77176 60761
88160 59964 99155 58366 11150 58167 22147 56170 33143 56571 44136
54981 55135 55182 66109 623//=

72327 TTAA  56001 99980 06603 26505 00010 ///// ///// 92648 03208
28022 85328 00905 28015 70872 04506 27036 50545 20769 23537 40707
313// 25057 30904 425// 24062 25028 425// 23072 20177 459// 23078
15367 511// 24079 10626 613// 25566 88305 435// 23561 77191 22588=
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72327 TTBB 56000 72327 00980 06603 11975 06203 22888 01007 33822
02305 44809 00903 55794 01103 66759 02703 77740 02302 88690 05305
99660 06105 11628 08717 22616 09956 33581 12756 44572 13963 55545
15960 66532 17364 77502 20569 88479 22372 99474 22765 11470 23167
22463 23761 33454 24361 44437 26966 55435 27172 66328 415// 77305
435// 88293 413// 99281 433// 11272 423// 22268 433// 33258 417//
44250 425// 55236 415// 66217 451// 77204 455// 88190 477// 99184
477// 11181 467// 22173 487// 33167 487// 44160 509// 55158 499//
66151 511// 77148 505// 88145 515// 99138 511// 11132 531// 22127
537// 33122 551// 44116 551// 55109 587//=

72340 TTAA 56001 72340 99987 06423 27510 00065 ///// ///// 92700
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40704 313// 28088 30902 425// 28090 25025 439// 26561 20174 459//
26574 15364 503// 26550 10624 603// 25046 88291 433// 28085 88100
603// 25046 77380 28108 43410 77188 27079=

TTBB 56000 72340 00987 06423 11981 06023 22930 02011 33831 04705
44825 02707 55822 02525 66816 02749 77808 03356 88762 06157 99733
07560 11682 09164 22672 08975 33642 10997 44611 13793 55606 14373
66595 15175 77550 20393 88513 24391 99509 24974 11498 25766 22486
26765 33484 26366 44483 25788 55478 251// 66466 253// 77414 309//
88397 313// 99325 407// 11291 433// 22286 425// 33262 423// 44226
463// 55220 455// 66208 465// 77196 449// 88186 463// 99176 461//
11172 453// 22154 501// 33144 513// 44138 511// 55126 535// 66125
531// 77116 561// 88111 563// 99104 595//=

72363 TTAA 56001 72363 99890 04656 32504 00147 ///// ///// 92782
///// ///// 85467 03261 30010 70023 02366 31525 50561 19756 33545
40724 29564 29053 30922 47161 29561 25039 55960 29062 20184 48366
28576 15373 54371 28579 10628 62767 27556 88255 56760 29563 77149
28579 42122 77213 28579=

72363 TTBB 56000 72363 00890 04656 11880 04261 22811 02262 33792
01265 44754 01162 55740 00767 66726 00766 77695 02766 88659 06561
99653 06361 11624 08960 22599 09761 33503 19756 44484 18957 55458
22357 66449 23158 77440 23562 88426 25565 99384 32364 11364 35365
22346 38360 33255 56760 44251 56560 55247 53961 66244 54561 77239
53361 88232 53961 99223 50362 11219 49563 22211 50363 33206 48764
44200 48366 55196 47367 66193 47767 77182 46770 88172 48173 99158
52572 11150 54371 22144 54771 33134 57569 44129 56770 55116 60168
66113 58569 77110 58369=

72365 TTAA 56001 72365 99836 09461 25004 00132 ///// ///// 92785
///// ///// 85484 ///// ///// 70055 02559 28518 50564 19335 28551
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28080 15375 54165 26578 10628 64163 26033 88252 57157 27544 77189
28086=

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72365 TTBB  56000 72365 00836 09461 11829 08064 22823 07263 33762
01458 44723 00959 55692 03358 66677 04560 77665 05358 88634 06777
99610 08976 11599 09566 22594 10158 33588 10759 44586 10765 55582
10969 66541 15965 77534 16562 88530 16759 99528 16956 11523 17345
22516 18135 33512 18548 44508 18940 55495 19935 66485 19349 77454
23147 88445 23550 99441 23558 11379 32560 22355 36757 33252 57157
44250 55357 55246 54757 66231 56158 77228 55358 88220 50959 99194
48962 11180 50363 22161 51765 33159 51365 44150 54165 55146 53965
66135 57564 77131 57764 88126 60164 99114 61163 11109 63163 22106
62363=

Plot at 374.  Do NOT plot at 376 in New Mexico.
72376 TTAA  56001 72376 99782 03229 19504 00158 ///// ///// 92808
///// ///// 85503 ///// ///// 70063 05112 23012 50565 19138 27029
40727 31558 25537 30923 48159 25058 25042 50163 27551 20187 50781
27084 15373 55182 27596 10627 62780 25553 88279 52359 26052 88114
62780 26567 77158 27106=

72376 TTBB  56000 72376 00782 03229 11776 02659 22763 01456 33701
05112 44633 08109 55547 14331 66486 20739 77429 27757 88279 52359
99273 51559 11257 52161 22249 49963 33245 49964 44236 51966 55230
51567 66219 52370 77203 50379 88168 50984 99142 57182 11136 56982
22129 59581 33118 60781 44114 62780 55112 62580 66110 60381 77104
61980 88102 61780=

Plot at 394
72393 TTAA  56001 99000 15245 14017 00103 ///// ///// 92756 09614
16517 85454 04618 20010 70017 00088 23021 50561 21570 24540 40721
34759 25050 30916 46175 23569 25036 48780 25583 20184 47379 26608
15372 53374 26108 10627 61370 25066 88276 49172 25569 77167 26118=

TTBB  5600/ 72393 00000 15245 11991 13612 22964 11416 33862 05402
44850 04618 55843 04025 66833 03632 77811 03009 88800 03041 99793
02637 11765 00115 22749 01705 33746 01911 44745 01913 55742 00364
66741 00270 77740 00475 88732 01086 99728 01088 11709 00492 22699
00187 33692 00585 44452 27768 55435 30360 66424 31557 77379 36567
88378 36567 99341 42757 11339 43158 22322 44567 33307 46373 44301
45975 55276 49172 66268 46575 77248 48979 88237 47377 99204 46380
11174 49377 22157 52974 33152 52374 44135 57572 55123 57772 66113
61370 77110 61571=

Plot at NKZ in the Delmarva peninsula
72402 TTAA  56001 72402 99016 00209 06020 00140 00105 07518 92765
00707 10525 85440 00907 16033 70984 03906 22031 50560 14117 25077
40726 24937 25069 30930 36950 25098 25054 46348 25626 20197 59146
25153 15376 58158 26610 10629 66172 27577 88170 62950 26141 77196
25156=
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72402 TTBB  56006 72402 00016 00209 11920 00907 22799 00908 33736
04306 44706 03706 55544 10110 66386 26739 77305 35950 88202 58946
99170 63150 11150 57958 22133 57963 33119 59973 44100 66172=

Plot at NYG in eastern Virginia
72403  TTAA 56001 72403 99006 00104 06504 00133 00520 07507 92753
01904 10525 85423 03906 12518 70954 07509 18025 50556 13719 25055
40722 24743 25080 30925 38350 24089 25047 47357 24613 20191 59357
24663 15370 57559 26601 10625 63363 27566 88183 61757 25153 77200
24663=

72403 TTBB  56000 72403 00006 00104 11005 00328 22991 01111 33953
02909 44930 01904 55852 03906 66838 02303 77812 03704 88799 03103
99742 05105 11695 07709 22674 07505 33637 09109 44580 08704 55523
11511 66430 20732 77420 21943 88312 38156 11268 44556 22238 49757
33206 58357 44193 60557 55183 61757 66170 61358 77162 62158 88158
58958 99153 57159 11147 58359 22143 55960 33138 54961 44126 57762
55116 58363 66110 59763=

Plot at ILN in southwest Ohio
72426 TTAA  56001 72426 99964 00406 07016 00027 ///// ///// 92653
01306 07540 85326 01905 13531 70868 05505 18005 50546 17741 21552
40710 27749 18555 30909 439// 21059 25031 465// 20608 20177 513//
22092 15363 517// 24069 10620 613// 26056 88212 51983 21611 77214
21612=

72426 TTBB  56000 72426 00964 00406 11922 01506 22883 02106 33848
01905 44834 00905 55772 02105 66650 08306 77609 07705 88595 08305
99565 11112 11556 12736 22536 14947 33510 17348 44484 18530 55441
22537 66393 28750 77321 41358 88306 43376 99296 44586 11281 45785
22273 44386 33258 46385 44244 46985 55212 51983 66206 51184 77194
51184 88181 53383 99171 53383 11166 54583 22162 53583 33157 54183
44153 51783 55143 53383 66140 53183 77136 54383 88131 52983 99127
53183 11121 55982 22117 56382 33103 61181=

Lincoln, IL.  Plot at 439
74560 TTAA  56001 74560 99987 00613 04519 00074 ///// ///// 92696
03307 05546 85366 03505 08543 70886 09312 05029 50543 20927 06018
40705 32742 08502 30900 495// 14018 25019 505// 23023 20166 471//
26037 15356 487// 24536 10617 563// 26043 88284 523// 15020 88115
553// 25541 77999=

74560 TTBB  56000 74560 00987 00613 11923 03507 22900 02705 33792
04906 44508 20126 55436 27937 66310 47757 77300 49557 88284 523//
99278 525// 11267 501// 22257 511// 33247 501// 44238 507// 55227
477// 66216 475// 77211 461// 88201 475// 99196 463// 11189 461//
22181 477// 33171 465// 44166 477// 55155 475// 66143 503// 77138
501// 88127 519// 99115 553// 11107 553// 22105 545//
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72440 TTAA  56001 72440 99962 00203 31011 00077 ///// ///// 92703
02310 31024 85370 04910 30528 70889 09720 31518 50540 27391 36009
40697 37762 08024 30894 407// 29533 25018 427// 29039 20168 437//
27044 15358 485// 28050 10619 591// 26029 88374 39187 06516 77999=

72440 TTBB  56000 72440 00962 00203 11956 00316 22889 04110 33841
05110 44821 04707 55793 06109 66775 05709 77726 07509 88713 08721
99676 11315 11668 12518 22661 13563 33658 13765 44616 16974 55565
20973 66540 23570 77509 26791 88483 28788 99477 28966 11472 28768
22459 29959 33454 30557 44441 32150 55432 33358 66400 37963 77392
37787 88374 39187 99363 38587 11341 39387 22328 40787 33320 40387
44313 41387 55306 40587 66282 42186 77238 42586 88222 44586 99210
42786 11204 43786 22198 43586 33192 44786 44172 46785 55157 49584
66149 48584 77139 49384 88134 51184 99119 54383 11114 56182 22106
57182=

72451 TTAA  56001 72451 99923 01021 36013 00141 ///// ///// 92769
///// ///// 85442 04709 35025 70965 06361 33044 50553 19977 33558
40715 30766 ///// 30912 47761 ///// 25030 55560 30080 20176 48363
30059 15365 51164 29557 10624 57362 29047 88252 56559 30580 77241
30081=

72451 TTBB  56000 72451 00923 01021 11850 04709 22775 06157 33728
04761 44680 06364 55632 10180 66587 12571 77537 16581 88400 30766
99252 56559 11234 48962 22223 50762 33191 47563 44100 57362=

72456 TTAA  56001 72456 99981 00611 34507 00111 ///// ///// 92734
03307 36021 85400 04505 02522 70918 07542 03521 50546 24158 36024
40704 37778 02513 30897 483// 34022 25017 473// 32038 20164 461//
29542 15355 497// 28041 10615 58381 26527 88304 49584 34523 77999=

72456 TTBB  56000 72456 00981 00611 11933 02908 22885 04907 33837
04305 44811 05506 55779 05905 66725 09308 77713 07911 88699 07544
99685 08350 11647 10134 22608 13557 33563 17750 44558 18356 55523
21756 66497 24558 77448 30760 88443 31564 99427 33772 11384 40181
22332 47585 33304 49584 44294 47185 55278 49384 66272 49584 77267
48384 88251 47185 99240 48384 11235 47185 22210 48384 33200 46185
44195 46385 55192 45585 66186 46585 77183 45985 88176 47585 99159
48184 11152 49984 22151 49584 33145 50384 44141 49384 55137 50784
66135 49784 77118 55182 88112 54982 99110 55782=


72469 TTAA  56001 72469 99833 07067 11507 00114 ///// ///// 92759
///// ///// 85448 ///// ///// 70006 04162 28525 50557 20950 30026
40719 30973 31026 30916 491// 30041 25033 553// 31030 20175 531//
29045 15361 519// 28550 10620 569// 28539 88234 579// 28033 77159
28066=

72469 TTBB  56000 72469 00833 07067 11819 05269 22802 03468 33736
02962 44728 02362 55709 03362 66637 09358 77613 11356 88576 14343
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99556 15556 11515 19942 22477 22548 33474 21550 44470 21358 55418
28370 66400 30973 77379 34769 88359 38159 99340 41556 11300 49157
22279 535// 33275 531// 44265 549// 55260 543// 66234 579// 77226
575// 88224 555// 99218 535// 11214 539// 22209 529// 33192 529//
44179 551// 55168 535// 66166 519// 77161 527// 88159 513// 99158
511// 11151 517// 22137 557// 33129 571// 44128 569// 55127 553//
66125 535// 77122 523// 88104 573// 99102 563//=

72476 TTAA 56001 72476 99851 02457 29004 00180 ///// ///// 92810
///// ///// 85486 02457 29001 70031 05956 25011 50559 19348 28522
40721 32160 27036 30917 49559 25542 25034 55560 28042 20177 52562
28055 15363 52764 27067 10620 61563 25535 88231 57560 28041 77153
27068 43124 77213 26064=

72476 TTBB 56000 72476 00851 02457 11826 01260 22806 00460 33801
00458 44790 00550 55768 02342 66755 02738 77751 02750 88736 03756
99715 05133 11711 05140 22685 07556 33633 10750 44617 11558 55610
12157 66605 12343 77562 15914 88523 19315 99519 19516 11515 18317
22511 18326 33500 19348 44480 21350 55459 23941 66426 28359 77404
31560 88352 40160 99291 51160 11277 53160 22267 53160 33245 56560
44231 57560 55225 56960 66219 53960 77213 53561 88208 54361 99205
53161 11190 51562 22176 53163 33171 51963 44156 51764 55136 55764
66129 56364 77123 56764 88120 55764 99118 54365 11110 57164=

Plot at 488
72489 TTAA 56001 72489 99841 11673 17509 00063 ///// ///// 92723
///// ///// 85430 ///// ///// 70999 05161 22509 50554 24770 24537
40712 38356 23543 30904 51559 24554 25021 54759 24064 20166 46962
25048 15354 51763 24051 10614 58762 24540 88248 55159 24066 77234
24574 41421 77164 25062=

72489 TTBB 56000 72489 00841 11673 11831 08674 22770 02472 33739
00968 44732 01764 55696 05561 66690 06361 77689 06363 88687 06559
99686 06759 11685 06764 22684 06761 33681 07164 44666 08761 55649
10365 66639 11563 77631 11165 88592 14568 99571 17166 11563 17767
22560 17973 33555 18365 44521 21968 55493 25571 66429 34564 77420
35557 88404 38156 99371 41559 11342 46959 22320 50159 33306 50559
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53760 11222 52160 22219 49760 33211 47361 44202 46562 55196 46962
66181 50763 77173 51363 88166 53562 99161 51763 11157 51163 22151
51763 33145 51164 44140 52163 55138 50764 66133 50964 77129 51764
88120 55363 99105 56763=

72493 TTAA 56001 99010 16250 26504 00087 14850 23506 92741 09015
22508 85435 03635 18011 70982 06173 20524 50554 24562 22032 40713
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23547 77193 25582=
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49184 77175 49184 88172 48184 99166 49584 11162 49384 22146 53183
33140 53983 44132 53983 55129 51983 66124 53383 77118 52783 88110
56582 99107 56782=

This is Upton. Plot just north of the "A" in LGA.
72501 TTAA 56001 72501 99018 01156 00000 00158 00558 29504 92776
05756 34509 85440 043// 31022 70955 079// 29524 50550 20122 28057
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72501 TTBB 56000 72501 00018 01156 11008 00057 22979 01760 33920
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72518 TTAA 56001 72518 99009 01157 00000 00160 02158 31003 92774
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72520 TTBB 56000 72520 00967 00000 11955 00303 22906 03105 33889
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Plot at 553
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72562 TTAA  56001 72562 99917 00514 35508 00154 ///// ///// 92782
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72562 TTBB  56000 72562 00917 00514 11913 01115 22881 03711 33870
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72572 TTBB 56000 72572 00869 06449 11850 05258 22784 00523 33772
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72582 TTAA 56001 72582 99836 03021 18010 00128 ///// ///// 92772
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72582 TTBB 56000 72582 00836 03021 11821 01219 22763 02111 33592
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50159 66299 50161 77293 49162 88265 54163 99243 56363 11237 55963
22236 54164 33234 53764 44225 53565 55222 51366 66218 50768 77215
49370 88199 51779 99196 50783 11195 50783 22190 505// 33186 487//
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66103 563// 77102 553//=

72597 TTAA 56001 72597 99960 15063 13510 00051 ///// ///// 92706
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40707 38172 21031 30897 55360 24038 25012 59360 24537 20154 49365
23542 15342 48375 23043 10606 55177 22519 88268 61359 24547 77999=

TTBB 56000 72597 00960 15063 11951 13866 22894 08862 33826 03059
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66562 18568 77526 22762 88505 25366 99490 25982 11475 27187 22407
36975 33347 46960 44268 61359 55261 59560 66247 59360 77241 60360
88234 59560 99232 58160 11225 56561 22222 56761 33213 52362 44207
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Plot at 606
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29652 15347 52760 28567 10604 57960 28564 88173 56159 30094 88108
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22403 34182 33394 33377 44379 33577 55341 38960 66325 39358 77298
43157 88279 43357 99262 44757 11235 50358 22232 49758 33227 50358
44219 49158 55211 51358 66205 50959 77198 53159 88191 52759 99180
54359 11173 56159 22168 55359 33166 53359 44163 52359 55158 52159
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Gaylord, MI. Draw a station circle at 45°N, 85°W

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72634 TTAA  56001 72634 99967 04928 08007 00183 ///// ///// 92796
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72634 TTBB  56000 72634 00967 04928 11876 11910 22873 11717 33871
11356 44870 11162 55868 10765 66859 08566 77839 07363 88796 09761
99785 09762 11764 10159 22750 10562 33732 09567 44710 10767 55675
11168 66652 12367 77610 15967 88565 19165 99544 20960 11527 21961
22485 26556 33466 28348 44446 29957 55427 32359 66381 37956 77373
37159 88360 38961 99317 46961 11287 50559 22259 56559 33251 55559
44247 54160 55236 54560 66230 53361 77217 52962 88214 52162 99209
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66156 51370 77154 50770 88149 52170 99141 53370 11134 52172 22127
52772 33120 54771 44110 54572=

72645 TTAA  56001 72645 99996 02927 03513 00176 ///// ///// 92790
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66695 10970 77692 10967 88686 10776 99682 10773 11666 11974 22658
12567 33647 13166 44634 13568 55618 15360 66607 16563 77603 16762
88598 17167 99594 17562 11587 17763 22584 17975 33579 18363 44570
18957 55560 19550 66510 23556 77476 27156 88462 28539 99431 32344
11409 34556 22396 35760 33388 36369 44374 37180 55274 55766 66249
60564 77242 55765 88239 55966 99234 54767 11227 55169 22221 53574
33216 53779 44215 537// 55209 521// 66207 493// 77204 487// 88185
497// 99181 487// 11170 497// 22166 491// 33160 505// 44148 515//
55141 509// 66131 521// 77127 517// 88119 531// 99116 525// 11110
539//=
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Minneapolis. Draw a station circle at 44.8°N, 93.5°W.

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72649 TTAA  56001 72649 99986 00339 05003 00178 ///// ///// 92798
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04510 07521 85463 04105 07014 70971 12320 07013 50549 24140 29007
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29020 15348 50184 29028 10610 54183 27522 88269 57757 28008 77999=

72649 TTBB 56000 72649 00986 00339 11983 00734 22958 02310 33909
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43356 66269 57757 77253 58357 88239 56558 99235 56959 11232 56359
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50584 88183 48784 99175 48784 11166 50184 22135 50584 33124 52783
44116 52183 55110 53383=

Aberdeen, SD. Draw a station circle north of HON at 45.5°N, 98.5°W
72659 TTAA 56001 72659 99973 00914 01006 00182 ///// ///// 92803
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29021 15346 51172 29524 10607 56372 28528 88259 59757 24516 88103
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72659 TTBB 56000 72659 00973 00914 11945 03117 22928 03712 33903
02317 44893 02719 55839 05917 66824 06508 77752 10319 88682 14315
99675 13311 11657 13714 22587 18926 33527 22112 44507 23122 55422
34149 66390 38156 77369 40548 88292 53757 99259 59757 11252 58357
22249 56757 33240 55358 44235 55559 55228 53760 66224 53960 77214
52361 88202 52563 99196 52164 11194 51164 22177 52566 33167 51168
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72662 TTAA 56001 72662 99898 04928 36004 00179 ///// ///// 92795
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30046 15351 51383 29027 10611 55982 29028 88231 58168 30554 88134
54982 28026 77365 31567=

72662 TTBB 56000 72662 00898 04928 11882 06724 22868 05918 33850
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22245 57168 33238 56569 44231 58168 55224 57768 66215 58968 77210
55970 88208 53972 99205 52774 11198 53176 22194 52179 33189 52979
44185 50784 55173 49584 66164 51184 77162 50184 88153 50384 99147
52183 11141 52783 22134 54982 33132 53583 44126 54183 55124 53583
66110 54583=

Plot at 576
72672 TTAA 56001 99824 03140 04002 00155 ///// ///// 92781 /////
///// 85452 ///// ///// 70988 05358 27514 50555 22727 27532 40716
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15355 53765 28522 10615 56166 27037 88263 57560 26032 77999=
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44795 03556 55790 02556 66788 02158 77773 02160 88767 01358 99762

00958 11754 01561 22724 04160 33689 05558 44654 08550 55631 09950
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88251 55760 99233 58360 11228 58360 22224 57561 33218 53961 44207
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11173 50764 22166 48765 33162 49165 44151 53565 55142 55165 66136
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72681 TTAA 56001 72681 99912 10257 04506 00105 ///// ///// 92753
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72681 TTBB 56000 72681 00912 10257 11905 08456 22866 04827 33828
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72694 TTBB 56000 72694 00999 17263 11991 15063 22947 11261 33880
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08146 66662 11129 77654 11730 88641 12556 99637 12950 11631 13557
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49968 33141 48569 44129 50170 55120 48372 66106 49175=

72712 TTAA 56001 99994 13156 32010 00142 ///// ///// 92730 17750
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TTBB 56000 72712 00994 13156 11984 13558 22850 23127 33839 23525
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28028 15342 495// 29022 10605 533// 30022 88259 601// 27544 77999=

72747 TTBB 56000 72747 00983 06156 11970 06356 22925 08550 33922
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08962 66794 08959 77792 08959 88764 10956 99753 11143 11728 12756
22698 13358 33692 13160 44687 13560 55683 13956 66676 13756 77666
13964 88654 14173 99615 16774 11596 18575 22589 19367 33555 22563
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66212 521// 77186 515// 88167 491// 99149 493// 11132 509// 22127
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TTBB 56000 72764 00960 01508 11957 02108 22935 03307 33835 07309
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22508 26561 33485 29567 44463 32565 55447 34771 66440 35188 77406
38387 88387 38787 99371 40187 11274 53583 22260 53383 33247 55182
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66172 50584 77157 50784 88148 52383 99146 51583 11142 51983 22131
51384 33123 51983 44117 53783 55110 53983 66107 55182 77103 53583=

Plot at 775
72776 TTAA 56001 72776 99884 10115 09003 00174 ///// ///// 92781
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Plot at 785
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72786 TTBB  56000 72786 00927 02800 11890 00602 22867 00801 33827
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99508 25958 11496 27563 22493 27564 33492 27591 44465 29390 55419
35188 66400 37767 77396 37963 88392 38569 99386 38971 11346 45563
22295 54362 33273 56363 44262 55165 55230 56368 66220 58168 77215
56969 88212 55371 99206 54773 11203 53376 22197 53183 33187 521//
44186 511// 55177 511// 66176 501// 77170 497// 88167 485// 99159
499// 11155 491// 22142 521// 33126 533// 44120 523// 55115 531//
66110 513// 77105 513//=

Plot at 798
72797 TTAA  56001 72797 99000 10028 16008 00054 ///// ///// 92697
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40700 39962 21535 30889 55962 24044 25004 59161 19030 20147 50773
17020 15335 46585 20030 10601 49584 21513 88274 59760 21530 77999
31313 58708 82302 51515 10164 00004 10194 16530 18038=

72797 TTBB  56000 72797 00000 10028 11996 09628 22938 06009 33851
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45785 11133 48184 22129 48184 33112 51583 44110 50584 55102 50784
31313 58708 82302 41414 85500=
```

Upper Air Maps (Analysis II)

This week we will continue working on upper air analysis with the 700 mb and 850 mb maps of the same case. As you may have guessed, these are the upper air maps for the surface map you analyzed in lab 3.

You should look over your surface and upper air maps when you are done, noting the meteorological features. Review the Norwegian cyclone model from class notes. This case is a good example of intense cyclone activity at all levels in the troposphere.

Lab Assignment (due next Wednesday):

1. On an upper air base map, plot the data for 700 mb and 850 mb from TTAA's as you did last week. Use the same RAOB transmissions, pp 40-58.

2. Analyze the 700 mb map. Do the standard analysis:

a) height contours every 30 gpm in black. Include a 300 line (3000 gpm). Note that the "hhh" in the RAOB data for 700 mb gives the height minus 3000 meters. Plot the transmitted numbers (024, not 302; 940, not 294). The contours on the 700 mb map, however, look like this: ...294, 297, 300, 303, 306, etc. If you have a closed contour, it must have a center, either "L" or "H".

b) isotherms every 5°C in red dashed lines. Include a 0°C isotherm.

3. Analyze the 850 mb map. Do the standard analysis:

a) height contours every 30 gpm in black. Include a 150 line (1500 gpm). Note that the "hhh" in the RAOB data for 850 mb gives the height minus 1000 meters, i.e., 1482 gpm is transmitted in hhh as 482, not 148. Plot the transmitted numbers (such as 430, not 143; 524, not 152). The contours on the 850 mb map, however, look like this: ... 147, 150, 153, 156, etc. If you have a closed contour, it must have a center, either "L" or "H".

b) isotherms every 5°C in red dashed lines. Include a 10°C isotherm.

4. Compare the 700 mb and 850 mb maps to each other and to the 300 mb and 500 mb maps from the last graded lab. Also, remember the surface map from lab 3 is this case. Write a meteorological discussion, describing the important aspects of this case. Start with the surface, e.g., the location and central pressure of the surface low, where noteworthy weather was reported, etc. Then relate the features you analyzed on the upper air maps to those surface features. Your discussion should be no longer than a single page.

Numerical Guidance Exercise

Assignment (Due next Wednesday):

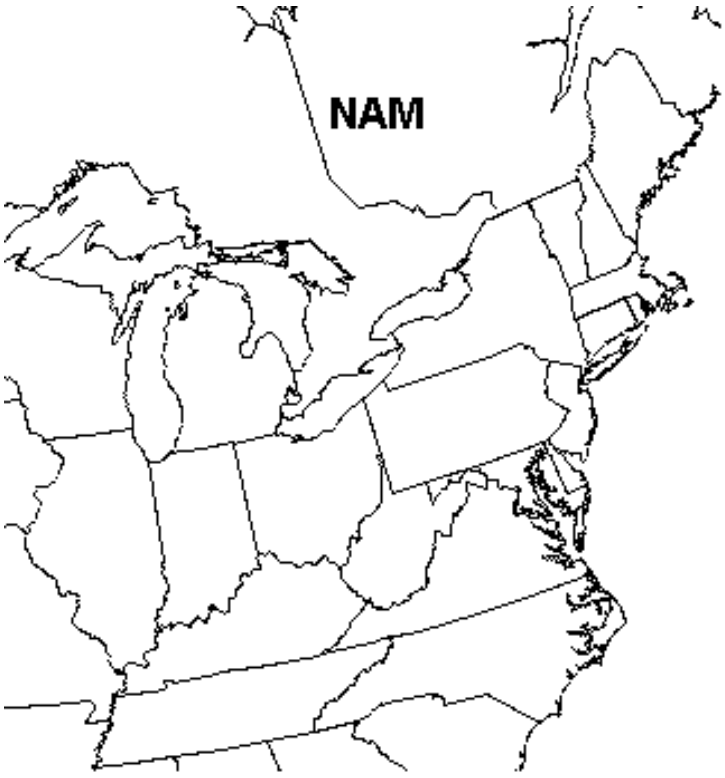
On the next three pages you have been given NAM and GFS-based MOS forecasts and NAM Direct Model Output from the model run initialized at 12Z on June 12, 2009. Based solely upon this information, you are to complete the blank tables given below. Write in the predicted values requested from the source shown (GFS MOS, NAM MOS or NAM direct model output) and the parameter name (TMP, P06, CLD, etc.) Be sure to include the proper units in your answers. An example is done for you (00Z forecast temperature)

36 Hour Forecast (00Z June 14)	Prediction	Parameter Name	Source
Surface Temperature	66°F	TMP	NAM MOS
Surface Temperature			GFS MOS
Surface Dew Point			NAM MOS
Surface Dew Point			GFS MOS
Surface Wind (speed and direction)			NAM MOS
Surface Wind (speed and direction)			GFS MOS
850 mb wind (speed and direction)			NAM Direct
850 mb wind (speed and direction)			GFS Direct
1000-500 mb thickness			NAM Direct
1000-500 mb thickness			GFS Direct
700 mb Vertical Velocity			NAM Direct
700 mb Vertical Velocity			GFS Direct
Total precipitation 12Z June 12 to 12Z June 14			NAM Direct
Total precipitation 12Z June 12 to 12Z June 14			GFS Direct

Answer the following questions about the DIRECT and MOS data on a separate sheet:

1. Your answers to part one should have shown the 48 hour total precipitation predicted by the NAM model to be different from the total precipitation in the first 48 hours of the GFS model. Give three reasons from any parts of the numerical guidance in this lab which can physically explain the differences in the forecasts. The word "physically" in that assignment means you can't use the probability of precipitation which is higher in the NAM forecast. That doesn't physically explain why the model forecasts more or less precipitation; it just describes the chances, given the physics. (For physics, think about what causes precipitation).

2. What would the forecasted surface maps look like for the NAM and for the GFS at 00Z on June 14? These can be and probably are different from each other. On the blank base maps below, draw two simple maps of fronts, Highs, Lows, and air masses, based on the guidance you have for each model:



3. This is a June forecast so thunderstorms are a possibility. What is the maximum probability for any thunderstorm in each model? What day and 6-hour time period did each model pick for their maximum probability? Finally, for each model, find three forecast elements (other than probability) that are favorable for thunderstorms.

4. From the guidance and observations alone, try to devise a reasonable meteorological explanation for the differences in the NAM and GFS forecasts. In other words, what happened in the real atmosphere that the models forecast differently? Was a frontal passage forecast to happen earlier? Was it forecast to be later? Maybe the front washed out? This is an essential part of forecasting, doing post-event analysis with the eventual aim of improving the models. You don't need to explain why the model was wrong or fix it but you must identify what the model tried to do.

Here is your guidance:

```
KBGM   NAM MOS GUIDANCE    6/12/2009  1200 UTC
DT /JUNE 12/JUNE 13                 /JUNE 14                 /JUNE 15
HR   18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 06 12
N/X                    56          75          55          65    52
TMP  70 69 66 63 60 58 60 69 72 72 66 61 58 57 56 58 61 62 60 55 55
DPT  59 58 58 57 55 54 55 55 54 55 57 58 57 55 54 53 52 51 51 48 49
CLD  OV BK BK SC CL BK BK SC BK OV OV OV OV OV OV OV OV OV OV BK OV
WDR  33 34 34 34 35 36 06 12 20 20 17 26 25 28 28 31 31 32 33 29 31
WSP  08 08 06 04 04 03 03 05 05 06 04 06 06 05 05 08 09 10 07 04 06
P06        15     3     4     6    41    68    52    53    27 13  7
P12                     6          67          81          58    18
Q06         0     0     0     0     1     3     1     1     0  0  0
Q12                     0          1           3           1     0
T06     18/ 6  2/ 2  2/ 0  4/ 6 37/16 35/ 9  4/ 2  7/ 4 15/12  2/ 0
T12           18/10        4/ 6       57/17       10/ 4    23/12
CIG   3  7  8  8  8  8  8  8  8  6  6  2  3  2  2  2  6  6  7  7  4
VIS   7  7  7  7  7  7  7  7  7  7  5  5  5  6  5  7  7  7  7  7  7
OBV  BR  N  N  N  N  N  N  N  N  N BR BR BR BR BR BR  N  N  N  N  N

KBGM   GFS MOS GUIDANCE    6/12/2009  1200 UTC
DT /JUNE 12/JUNE 13                 /JUNE 14                 /JUNE 15
HR   18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 06 12
N/X                    57          71          52          69    52
TMP  73 72 67 63 60 58 59 66 68 66 62 58 55 53 54 61 66 67 63 56 56
DPT  59 58 58 56 55 54 55 57 57 56 56 54 52 51 52 52 51 50 50 51 52
CLD  BK SC FW CL CL FW BK BK OV OV OV OV OV OV OV OV BK OV BK CL SC
WDR  35 34 34 36 35 36 01 05 32 35 36 35 33 30 30 34 34 34 36 27 21
WSP  09 07 06 05 04 04 03 04 05 05 05 04 04 04 05 06 08 07 05 03 03
P06        12     4     7    21    71    62    46    26    13 11 11
P12                    10          71          64          29    17
Q06         0     0     0     0     2     2     1     0     0  0  0
Q12                     0          2           2           0     0
T06     15/ 6  6/ 0  3/ 0 10/ 0 34/ 7 21/ 0  5/ 0  4/ 0 10/ 8  3/ 0
T12           15/ 6       12/ 0       44/ 7        7/ 0    12/ 8
CIG   6  7  8  8  8  8  6  6  6  6  6  6  5  4  3  6  6  7  8  8  8
VIS   7  7  7  7  7  7  5  7  7  5  5  5  5  5  5  7  7  7  7  7  7
OBV   N  N  N  N  N  N BR  N  N  N BR BR BR BR BR  N  N  N  N  N  N
```

NAM grid interpolations (Direct Model output)

```
Station: KBGM    Lat: 42.22  Lon: -75.98  Elev: 490  Closest grid pt: 21.3 km.
Initialization Time: 09-06-12 1200 UTC
PARAMETER/TIME      000    006    012    018    024    030    036    042    048
------------------ ------ ------ ------ ------ ------ ------ ------ ------ ------
  DAY / HOUR       12/12  12/18  13/00  13/06  13/12  13/18  14/00  14/06  14/12
------------------ ------ ------ ------ ------ ------ ------ ------ ------ ------
TEMPS
  2 M (F)             62     67     68     58     62     75     67     59     56
  850 MB (C)          13     12     13     12     11     12     12     10      7
  700 MB (C)           5      4      4      3      2      1      2      1      0
  500 MB (C)         -11    -10    -12    -13    -13    -13    -13    -14    -15
  1000-500 THCK      565    565    565    563    561    563    563    559    556

MOISTURE
  2 M DEW POINT (F)    61     63     62     54     58     59     63     58     55
  850 MB DP(C)/RH   13/99  10/89   7/66   5/62   4/59   8/79  11/93   9/92   7/99
  700 MB DP(C)/RH    3/87  -1/68  -5/51  -8/43  -6/58  -3/76   1/92   1/98  -1/91
  500 MB DP(C)/RH  -17/63 -25/28 -24/38 -24/40 -21/51 -17/73 -13/99 -18/73 -38/12
  PRCPABLE WTR (IN)  1.52   1.19   1.01   0.84   0.88   1.09   1.41   1.25   1.00
  CONV PRECIP (IN)          0.04   0.01   0.00   0.00   0.00   0.10   0.29   0.02
  TOTAL PRECIP (IN)         0.05   0.01   0.00   0.00   0.00   0.10   0.55   0.11
```

PARAMETER/TIME	000	006	012	018	024	030	036	042	048
DAY / HOUR	12/12	12/18	13/00	13/06	13/12	13/18	14/00	14/06	14/12
WIND DD/FFF (Kts)									
10 M	33/008	35/009	35/006	34/003	06/002	15/004	16/001	27/004	29/005
850 MB	35/014	02/019	02/012	34/006	32/002	17/006	19/012	26/018	32/013
700 MB	28/017	33/013	29/014	28/020	29/016	25/018	22/016	25/030	27/031
500 MB	26/029	27/032	29/026	27/018	25/025	25/031	24/034	25/032	26/038
250 MB	24/052	25/058	25/048	27/039	26/053	25/046	25/040	24/043	27/052
PRESS/HEIGHTS									
MSL PRESSURE	1007.0	1008.1	1010.3	1013.3	1014.3	1012.2	1011.1	1011.0	1012.2
850 MB HGT	144	145	148	149	150	150	148	146	146
700 MB HGT	305	306	308	308	309	309	308	305	304
500 MB HGT	571	572	573	574	574	573	572	569	566
250 MB HGT	1065	1065	1065	1064	1064	1065	1062	1056	1051
VERTICAL VEL (uB/S)									
850 MB	-7	-1	-9	1	-13	22	55	60	2
700 MB	-1	0	-7	-12	0	22	73	107	12
500 MB	3	2	5	-16	4	5	39	5	3
CONVECTION PARAMS									
LIFT INX SFC	2	2	-1	3	4	0	-2	2	4
LIFT INX 4LYR	-1	2	-1	2	4	0	-2	1	3
CAPE SFC	12	68	303	0	11	109	933	73	21

GFS grid interpolations (Direct Model output)

Station: KBGM Lat: 42.22 Lon: -75.98 Elev: 490 Closest grid pt: 21.3 km.
Initialization Time: 09-06-12 1200 UTC

PARAMETER/TIME	000	006	012	018	024	030	036	042	048	054	060	066	072
DAY / HOUR	12/12	12/18	13/00	13/06	13/12	13/18	14/00	14/06	14/12	14/18	15/00	15/06	15/12
TEMPS													
SFC (2 M) (F)	62	75	67	54	60	73	59	54	52	67	61	45	57
850 MB (C)	13	12	12	11	11	12	11	10	8	8	9	9	8
700 MB (C)	4	4	4	3	2	2	1	1	0	-1	-1	-1	-3
500 MB (C)	-11	-11	-12	-12	-13	-13	-14	-15	-16	-18	-18	-19	-21
1000-500 THCK	565	566	565	563	561	562	560	558	556	555	555	554	551
MOISTURE													
30 M AVG RH	99	66	72	87	89	64	90	100	97	62	64	72	76
850 MB DP/RH	11/87	11/91	9/80	7/75	7/77	10/87	10/93	9/96	7/98	6/88	5/77	2/63	3/71
700 MB DP/RH	3/96	0/72	-3/60	-2/70	-4/69	-2/74	0/90	-1/87	-3/80	-5/73	-8/62	-15/32	-11/54
500 MB DP/RH	-16/66	-22/40	-25/33	-26/30	-23/42	-16/79	-19/68	-17/84	-39/11	-36/18	-30/37	-31/33	-22/94
TOTAL PRECIP (IN)	0.01	0.01	0.00	0.00	0.04	0.26	0.09	0.07	0.02	0.01	0.00	0.00	
WIND DD/FFF (Kts)													
30 M AVG	32/010	35/013	36/015	01/010	02/004	02/003	02/009	34/011	34/014	02/014	02/011	33/004	27/002
850 MB	01/012	00/014	01/013	01/006	06/003	35/002	16/004	28/005	02/013	02/017	01/011	35/009	00/006
700 MB	30/013	33/012	30/012	27/017	27/013	24/013	25/019	25/014	29/012	35/014	36/013	32/011	34/012
500 MB	27/027	27/028	28/024	26/018	25/026	23/037	26/035	27/026	27/032	28/027	32/025	29/017	28/020
250 MB	25/050	25/057	25/052	27/046	25/048	25/052	26/053	25/058	27/058	27/049	30/053	29/054	29/076
VERTICAL VEL (uB/S)													
850 MB	-10	1	-28	1	64	20	30	14	6	-8	-7	14	
700 MB	-1	-3	-34	12	73	22	19	-8	-24	-2	-15	11	
500 MB	0	2	-19	8	15	20	1	9	-23	-25	10	22	
OTHER													
TROP PRES (MB)	205	204	206	211	200	209	219	221	236	250	236	226	218
MSL PRES (MB)	1007	1008	1010	1013	1014	1013	1013	1013	1014	1014	1015	1016	1017
500 MB HGT (DM)	571	573	574	574	573	573	571	568	567	567	568	567	566
500 MB ABS VORT	15.7	12.7	7.4	7.1	9.5	5.5	13.1	19.3	13.5	19.4	9.4	10.1	13.3

Observations for BINGHAMTON BROOME, NY (BGM)
Location: 42.22N 75.98W 0 meters

STN	TIME DD/HHMM	PMSL hPa	ALTM inHg	TMP F	DEW F	RH %	DIR deg	SPD kt	GUS kt	VIS mile	CLOUDS			Weather	MIN F	MAX F	PCP in
BGM	14/1353	1016.7	30.04	64	50	60	40	5	10.0	CLR							
BGM	14/1253	1017.0	30.04	61	53	75	330	4	10.0	CLR							
BGM	14/1153	1016.6	30.03	59	52	77	0	0	10.0	CLR					53	59	
BGM	14/1053	1015.9	30.01	55	51	86	10	4	10.0	CLR							
BGM	14/0953	1015.5	29.99	53	51	93	20	4	10.0	CLR							
BGM	14/0853	1014.9	29.98	56	49	77	30	4	10.0	SCT040	BKN100						
BGM	14/0753	1014.4	29.97	56	50	80	350	3	10.0	BKN040							
BGM	14/0653	1014.2	29.97	57	50	77	340	6	10.0	FEW100	SCT120						
BGM	14/0553	1014.7	29.99	57	50	77	330	5	10.0	OVC100					56	61	
BGM	14/0453	1015.2	30.00	56	52	87	300	4	10.0	OVC100							
BGM	14/0353	1015.0	29.99	57	53	87	350	6	10.0	BKN110							
BGM	14/0253	1015.3	30.00	59	53	81	30	4	10.0	BKN049	OVC060						
BGM	14/0153	1015.4	30.00	59	54	83	30	5	10.0	SCT043	BKN065	OVC110					
BGM	14/0053	1014.8	29.98	60	56	86	20	5	10.0	BKN060	OVC085						
BGM	13/2353	1014.6	29.98	61	56	83	30	7	10.0	FEW007	OVC060				61	75	0.00
BGM	13/2253	1013.9	29.95	62	59	90	20	9	10.0	BKN007	OVC075						
BGM	13/2153	1013.7	29.95	63	57	81	360	12	10.0	BKN080	BKN100			R-			
BGM	13/2053	1013.4	29.94	66	56	70	350	14	10.0	OVC090							
BGM	13/1953	1012.8	29.93	73	54	51	360	7	10.0	SCT055	SCT065	BKN100					
BGM	13/1853	1012.7	29.93	74	53	48	0	0	10.0	FEW100							
BGM	13/1753	1013.5	29.95	72	55	55	270	6	10.0	BKN090					62	74	
BGM	13/1653	1014.1	29.97	72	55	55		3	10.0	FEW041	SCT055	BKN070					
BGM	13/1553	1014.3	29.97	70	55	59	0	0	10.0	FEW075							
BGM	13/1453	1014.8	29.99	67	56	68	0	0	10.0	OVC075							
BGM	13/1353	1015.0	29.99	65	56	73	60	4	10.0	OVC070							
BGM	13/1253	1014.7	29.98	65	56	73	50	4	10.0	CLR							
BGM	13/1153	1014.4	29.97	62	54	75	20	4	10.0	CLR					56	62	
BGM	13/1053	1014.2	29.97	59	54	83	40	4	10.0	FEW065							
BGM	13/0953	1014.1	29.96	56	53	90	30	5	10.0	CLR							
BGM	13/0853	1014.1	29.96	56	54	93	0	0	9.0	CLR							
BGM	13/0753	1013.5	29.95	57	54	89	0	0	10.0	CLR							
BGM	13/0653	1013.4	29.94	58	54	87	20	3	10.0	CLR							
BGM	13/0553	1013.3	29.94	59	54	83	360	4	10.0	CLR					59	68	
BGM	13/0453	1013.1	29.94	60	55	83	360	5	10.0	CLR							
BGM	13/0353	1012.8	29.93	62	55	78	350	6	10.0	CLR							
BGM	13/0253	1012.6	29.93	63	55	75	330	5	10.0	CLR							
BGM	13/0153	1012.7	29.93	64	55	73	340	5	10.0	CLR							
BGM	13/0053	1011.9	29.90	65	55	70	360	7	10.0	CLR							
BGM	12/2353	1011.5	29.89	67	58	73	330	5	10.0	CLR					67	72	
BGM	12/2253	1011.5	29.89	69	58	68	340	8	10.0	CLR							
BGM	12/2153	1010.8	29.87	71	59	66	320	9	10.0	FEW047	BKN060	BKN075					
BGM	12/2053	1010.4	29.86	71	59	66	310	7	10.0	FEW026	SCT044						
BGM	12/1953	1010.2	29.86	70	61	73	340	6	10.0	BKN018	BKN029	OVC042					
BGM	12/1853	1010.0	29.85	68	61	78	310	7	10.0	SCT016	BKN023	OVC070					
BGM	12/1753	1009.9	29.84	68	60	76	340	9	10.0	BKN017	BKN028	OVC044			62	71	

Description of the GFS MOS MAV Alphanumeric Message

The short-range GFS-Based MOS MAV guidance is generated from 0000, 0600, 1200, and 1800 UTC model output from NCEP's Global Forecast System(GFS). This guidance is valid for stations in the United States, Puerto Rico, and the U.S. Virgin Islands.

Forecast elements are valid from 6 to 72 hours in advance.

Sample Message

```
KDEN   GFS MOS GUIDANCE    3/04/2010  1200 UTC
DT /MAR   4/MAR   5                /MAR   6                /MAR   7
HR   18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 06 12
N/X                    27          53          28          51    24
TMP  48 52 51 40 35 32 30 35 47 50 48 40 38 35 32 36 45 48 45 31 27
DPT  25 25 27 29 29 27 25 25 21 17 18 20 21 21 20 21 21 22 22 23 21
CLD  BK SC SC SC SC OV OV OV BK BK BK SC BK SC SC SC SC SC SC SC SC
WDR  19 14 13 16 20 20 25 25 28 28 28 22 23 23 22 21 12 10 10 17 21
WSP  05 12 11 08 08 07 07 07 08 10 11 08 08 07 07 07 07 10 10 08 07
P06         1     6    14    20    14    25     8     4     2  3  2
P12                    15          27          26          4     3
Q06         0     0     0     0     0     0     0     0     0  0  0
Q12                    0           0           0           0     0
T06      5/11  1/ 2  0/ 1  1/ 2  8/ 3  1/ 1  0/ 0  0/ 0  2/ 8  0/ 0
T12            7/11        1/ 2        8/ 4        0/ 1     2/ 8
POZ   1  1  3  2  2  7  8  3  4  2  3  0  3  3  4  6  3  1  2  0  3
POS  27 16 18 24 28 65 74 72 31 20 37 57 94 87 95 65 41 18 28 50 91
TYP   R  R  R  R  R  S  S  S  R  R  R  S  S  S  S  S  R  R  R  R  S
SNW                    0                       0                 0
CIG   8  8  8  8  8  8  8  7  8  8  7  8  8  8  8  8  8  8  8  8  8
VIS   7  7  7  7  7  7  7  1  7  7  7  7  7  7  7  7  7  7  7  7  7
OBV   N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N  N
```

* *DT * = The day of the month, denoted by the standard three or four letter abbreviation
* *HR * = Hour of the day in UTC time. This is the hour at which the forecast is valid, or if the forecast is valid for a period, the end of the forecast period.
* *N/X* = nighttime minimum/daytime maximum surface temperatures.
* *TMP* = surface temperature valid at that hour.
* *DPT* = surface dewpoint valid at that hour.
* *CLD* = forecast categories of total sky cover valid at that hour.
* *WDR* = forecasts of the 10-meter wind direction at the hour, given in tens of degrees.
* *WSP* = forecasts of the 10-meter wind speed at the hour, given in knots.
* *P06* = probability of precipitation (PoP) during a 6-h period ending at that time.
* *P12* = PoP during a 12-h period ending at that time.
* *Q06* = quantitative precipitation forecast (QPF) category for liquid equivalent precipitation amount during a 6-h period ending at that time.
* *Q12* = QPF category for liquid equivalent precipitation amount during a 12-h period ending at the indicated time.

* *SNW* = snowfall categorical forecasts during a 24-h period ending at the indicated time.
* *T06* = probability of thunderstorms/conditional probability of severe thunderstorms during the 6-hr period ending at the indicated time.
* *T12* = probability of thunderstorms/conditional probability of severe thunderstorms during the 12-hr period ending at the indicated time.
* *POZ* = conditional probability of freezing pcp occurring at the hour.
* *POS* = conditional probability of snow occurring at the hour.
* *TYP* = conditional precipitation type at the hour.
* *CIG* = ceiling height categorical forecasts at the hour.
* *VIS* = visibility categorical forecasts at the hour.
* *OBV* = obstruction to vision categorical forecasts at the hour.

Definitions of Categorical Elements

MAV Ceiling Height Categories

1	< 200 feet
2	200 - 400 feet
3	500 - 900 feet
4	1000 - 1900 feet
5	2000 - 3000 feet
6	3100 - 6500 feet
7	6600 - 12,000 feet
8	> 12,000 feet or unlimited ceiling

MAV Visibility (VIS) Categories

1	< 1/2 miles
2	1/2 - < 1 miles
3	1 - < 2 miles
4	2 - < 3 miles
5	3 - 5 miles
6	6 miles
7	> 6 miles

MAV QPF Categories

0	no precipitation
1	0.01 to 0.09 inches
2	0.10 to 0.24 inches
3	0.25 to 0.49 inches
4	0.50 to 0.99 inches
5	1.00 to 1.99 inches
6	2.00 inches or greater

MAV Cloud (CLD) Categories

CL	clear
FW	few > 0 to 2 octas
SC	scattered > 2 to 4 octas
BK	broken > 4 to < 8 octas
OV	overcast

MAV Obstruction to Vision (OBV) Categories

N	none of the following
HZ	haze, smoke, dust
BR	mist (fog with visibility >= 5/8 mile)
FG	fog or ground fog (visibility < 5/8 mile)
BL	blowing dust, sand, snow

MAV Snow Fall Amount Categories

0	no snow or a trace expected
1	> a trace to < 2 inches
2	2 to < 4 inches
4	4 to < 6 inches
6	6 to < 8 inches
8	>= 8 inches

MAV Precipitation Type (TYP) Categories

S	pure snow or snow grains
Z	freezing rain/drizzle, ice pellets, or anything mixed with freezing precip
R	pure rain/drizzle or rain mixed with snow

Description of the NAM MOS Alphanumeric Message

The NAM-Based MOS guidance is generated from 0000 UTC and 1200 UTC model output from the Environmental Modeling Center's NAM Model. This guidance is valid for stations in the Continental United States, Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands. Forecast elements are valid from 6 to 72 hours in advance.

Sample Message

KDCA NAM MOS GUIDANCE 1/24/2008 1200 UTC

DT	/JAN		24/JAN			25					/JAN		26						/JAN		27	
HR	18	21	00	03	06	09	12	15	18	21	00	03	06	09	12	15	18	21	00	06	12	
N/X							15				24				20				30		28	
TMP	36	35	30	24	21	18	16	21	23	22	23	21	20	21	22	24	27	29	29	29	30	
DPT	14	9	3	0	-2	-4	-3	-3	-2	2	8	12	15	17	19	22	24	25	25	24	21	
CLD	CL	CL	FW	FW	SC	SC	BK	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	OV	BK	FW	
WDR	34	33	34	35	34	36	36	06	14	08	05	04	02	02	03	05	05	06	03	35	34	
WSP	07	14	14	11	10	10	08	03	02	05	07	11	11	12	10	07	04	04	07	11	10	
P06			0		0		0		0		55		76		60		34		36	13	9	
P12							0				58				86				48		25	
Q06			0		0		0		0		1		1		1		0		1		0	
Q12							0				1				2				1		0	
T06		0/	0	0/	9	0/	1	1/	0	3/	0	0/	0	0/	1	0/	0	3/	0	0/	0	
T12				1/	9			1/	1			3/	0			1/	1		1/	0		
SNW							0								6						0	
CIG	6	8	8	8	8	7	7	7	7	4	4	3	2	3	3	2	2	1	1	2	8	
VIS	7	7	4	5	5	5	6	7	7	7	7	7	7	7	7	7	7	7	7	6	5	
OBV	N	N	BR	BR	BR	BR	N	N	N	N	N	N	N	N	N	N	N	N	N	HZ	BR	

* *DT* = The day of the month, denoted by the standard three or four letter abbreviation
* *HR * = Hour of the day in UTC time. This is the hour at which the forecast is valid, or if the forecast is valid for a period, the end of the forecast period.
* *N/X* = nighttime minimum/daytime maximum surface temperatures.
* *TMP* = surface temperature valid at that hour.
* *DPT* = surface dewpoint valid at that hour.
* *CLD* = forecast categories of total sky cover valid at that hour.
* *WDR* = forecasts of the 10-meter wind direction at the hour, given in tens of degrees.
* *WSP* = forecasts of the 10-meter wind speed at the hour, given in knots.
* *P06* = probability of precipitation (PoP) during a 6-h period ending at that time.
* *P12* = PoP during a 12-h period ending at that time.
* *Q06* = quantitative precipitation forecast (QPF) category for liquid equivalent precipitation amount during a 6-h period ending at that time.
* *Q12* = QPF category for liquid equivalent precipitation amount during a 12-h period ending at the indicated time.
* *T06* = probability of thunderstorms/conditional probability of severe thunderstorms during the 6-hr period ending at the indicated time.
* *T12* = probability of thunderstorms/conditional probability of severe thunderstorms during the 12-hr period ending at the indicated time.

* *SNW* = snow fall categorical forecasts during a 24-h period ending at the indicated time.
* *CIG* = ceiling height categorical forecasts at the hour.
* *VIS* = visibility categorical forecasts at the hour.
* *OBV* = obstruction to vision categorical forecasts at the hour.

Definitions of Categorical Elements

QPF Categories

0	no precipitation
1	0.01 to 0.09 inches
2	0.10 to 0.24 inches
3	0.25 to 0.49 inches
4	0.50 to 0.99 inches
5	1.00 to 1.99 inches
6	2.00 inches or greater

Cloud (CLD) Categories

CL	clear
FW	> 0 to 2 octas of total sky cover
SC	> 2 to 4 octas of total sky cover
BK	> 4 to < 8 octas of total sky cover
OV	8 octas of total sky cover or totally obscured

Snow Fall Amount Categories

0	no snow or a trace expected
1	> a trace to < 2 inches
2	2 to < 4 inches
4	4 to < 6 inches
6	6 to < 8 inches
8	>= 8 inches

MAV Obstruction to Vision (OBV) Categories

N	none of the following
HZ	haze, smoke, dust
BR	mist (fog with visibility >= 5/8 mile)
FG	fog or ground fog (visibility < 5/8 mile)
BL	blowing dust, sand, snow

Visibility (VIS) Categories

1	< 1/2 miles
2	1/2 - < 1 miles
3	1 - < 2 miles
4	2 - < 3 miles
5	3 - 5 miles
6	6 miles
7	> 6 miles

Ceiling Height (CIG) Categories

1	< 200 feet
2	200 - 400 feet
3	500 - 900 feet
4	1000 - 1900 feet
5	2000 - 3000 feet
6	3100 - 6500 feet
7	6600 - 12,000 feet
8	> 12,000 feet

Hourly Surface Observations Code (METAR)

1. Introduction

In lab 2 we learned how weather data is transmitted using the synoptic code. This code, while very complete, is not the one used routinely by most meteorologists. The most commonly available weather observations are taken every hour at both FAA and Weather Service stations. Sometimes they are called **hourlies**. Hourlies are transmitted to NCEP and are available from many weather data sources such as the University of Wyoming (http://weather.uwyo.edu/surface/meteorogram/) or the Aviation Weather Center (http://www.aviationweather.gov/metar).

These readings are taken in addition to the Weather Service's synoptic observations (lab 2). With the inclusion of the FAA stations, a very dense network of surface reports is obtained every hour, giving information of primary interest to aviation. This information is also useful to the meteorologist for making more detailed and timely surface weather analysis. Hourlies are transmitted in a somewhat simpler form than synoptic code. The code used is called METAR (Meteorological Aviation Routine) code. This is an internationally recognized standard. It was adopted by NCEP on July 1, 1996 in order to be consistent with international standards for weather reporting. Everyone uses METAR.

In this lab we will plot from code and analyze a map. You do not have to memorize METAR code. Use the following pages to help you translate it. The full reference for METAR code is http://www.ofcm.gov/publications/fmh/FMH1/FMH1.pdf

2. METAR code - translation key and explanation of groups

The following is the format of a line of code:

METAR NNNN DDTTTT (AUTO) (COR or CCA) DDFFFGnnKT VVVV Rnna/vBBBB X SSSHHHCC tt/dd Qpppp RMK text =

EXPLANATION OF CODE GROUPS:

METAR - OPTIONAL, may be given at beginning of message (SPECI for Special Report)

NNNN - 4 letter ICAO location indicator; for example: KALB for Albany, NY

DDTTTT - Date and Time of observation followed by Z (Zulu)

AUTO - included if METAR is from an automatic, e.g. ASOS station, otherwise omitted.

COR - correction to observation (CCA for Canada)

DD - Wind direction in tens of degrees, VRB means variable; if direction varies 60 degrees or more, variability is appended, e.g. 180V260

FFF - Wind speed in knots (KT), meters per second, or kilometers per hour

Gnn - Wind gusts in knots (KT), meters per second, or kilometers per hour, omitted if wind is steady

VVVV - Visibility in meters (statute miles for the U.S.)

R - Runway information for pilots, often omitted. Be careful not to confuse R with RA (rain)

nn - Two digit runway designator
a - Left (L), right (R), or center (C) runway as needed

v - M (lower) or P (higher) indicates that Runway Visual Range (RVR) value is either lower or higher than the RVR reportable values.

BBBB - Runway visual range in meters (feet for the U.S.) Range value may be followed by a trend (D - down, U - up, N - no change, V - variable) for non-U.S. stations

X - Weather and/or obstruction to visibility

SSS - Cloud cover - SKC (sky clear) or CLR (clear below 12,000 feet for automatic stations), FEW (1-2 octas), SCT (3-4 octas), BKN (5-7 octas), or OVC (8 octas).

HHH - 3-digit cloud height in hundreds of feet; obscured sky given as VV (vertical visibility), height in hundreds of feet; unknown height reported as ///; more than one layer may be reported

CC - Cloud type, given if either TCU (towering cumulus) or CB (cumulonimbus) are present

tt - Temperature in degrees Celsius (including U.S.)

dd - Dew point in degrees Celsius (including U.S.)

Q - Indicator for altimeter setting in hecto Pascals

A - Indicator for altimeter setting in hundreths of inches (U.S. only)

pppp - Altimeter setting

RMK - Remarks consisting of recent operationally significant weather as well as additive and automated maintenance data (mainly used in the U.S. and Canada). IMPORTANT: The sea level pressure (SLP) will always be in the remarks. SLP is given in millibars and tenths, i.e., SLP098 -> 1009.8 mb.

= or $ denotes end of report

QUALIFIERS - Intensity/Proximity:

- Light (no sign) Moderate + Heavy
VC - in Vicinity (within 8000 meters but not at airport)

Descriptor
MI - Shallow BC - Patches DR - Drifting TS - Thunderstorm
BL - Blowing SH - Shower FZ - Freezing PR - Partial

WEATHER PHENOMENA (X):

Precipitation:
DZ - Drizzle RA - Rain SN - Snow SG - Snow grains IC - Ice crystals PL - Ice pellets
GR - Hail GS - Small hail/snow pellets UP - Unknown (automatic station only)

Obscuration:
BR - Mist FG - Fog FU - Smoke VA - Volcanic ash
SA - Sand HZ - Haze BY - Blowing spray DU - Widespread Dust

Other:
SQ - Squall SS - Sandstorm DS - Duststorm PO - Dust devils
FC - Funnel cloud(s)/tornado/waterspout

Remarks - one or more remarks may appear after the code RMK in the following order:
Volcanic eruption
Tornadic activity (B/E_(hh)mm_LOC/DIR_(MOV)
Type of automated station (AO1, AO2)
Peak Wind (PK_WND_dddff(f)/(hh)mm)
Wind Shift (WSHFT_(hh)mm_FROPA)
Tower Visibility (TWR_VIS_vvvvv)
Surface Visibility (SFC_VIS_vvvvv)
Variable Prevailing Visibility (VIS_vvvvv_[LOC]
Sector Visibility (VIS_[DIR]_vvvvv)
Visibility at second location (VIS_vvvvv_[LOC]
Lightning ([FREQ]_LTG[type]_[LOC]
Begin/End Pcpn (w'w'B(hh)mmE(hh)mm)
Begin/End Thunderstorm (TSB(hh)mmE(hh)mm
Thunderstorm location (TS_LOC_(MOV_DIR)
Hailstone size (GR_[size]
Virga (VIRGA_(DIR)
Variable Ceiling Height (CIG_hhhVhhh)
Obscurations (w'w'_[NNN](hhh)

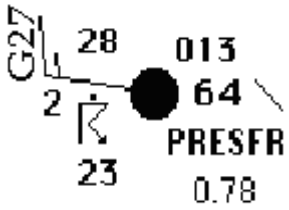
Variable Sky Condition (NNN(hhh)_V_NNN
Significant Cloud Types
Ceiling Height at 2nd Location (CIG_hhh_[LOC]
Pressure Rising/Falling Rapidly (PRESRR,PRESFR)
Sea-level Pressure (SLPppp or SLPNO)
Aircraft mishap (ACFT MSHP)
No SPECI reports taken (NOSPECI)
Snow increasing rapidly (SNINCR_[inches-hr/inches on ground]
Other significant information, e.g. LAST
Hourly Precipitation Amount in hundreths of inches (Prrrr)
3- and 6-hour precipitation amount (6RRRR)
24-hour precipitation amount (7RRRR)
Snow depth on the ground in inches (4/sss)
Water equivalent of snow on ground (933RRR)
Cloud Types (8/ClCmCh)
Duration of sunshine in minutes (98mmm)
Hourly temperature and dew point in tenths degrees C (SnTTTSnDDD)
6-hour maximum temperature in tenths degrees C (1SnTTT)
6-hour minimum temperature in tenths degrees C (2SnTTT)
24-hour max/min temperature in tenths degrees C (4SnTTTSnTTT)
3-hour pressure tendency (5appp)
Sensor status indicators (RVRNO, PWINO, PNO, FZRANO, TSNO, VISNO_LOC, CHINO_LOC
Maintenance check indicator: $

EXAMPLE:

METAR KDAL 101855Z 28013G27KT 2SM TSRA OVC010CB 28/23 A2993 RMK SLP013 PRESFR 60078 57064

METAR observation from Dallas, Texas. Date and Time of observation is 1855 Zulu on the 10th day of the month. Wind is from 280 degrees at 13 knots with a gust to 27 knots. Visibility is 2 statute miles. Current weather is a thunderstorm with moderate rain. Sky is overcast with a cloud height of 1000 feet. The temperature is 28°C. The dew point is 23°C. Altimeter setting is 29.93 inches of Mercury. The sea level pressure is 1001.3 mb, falling rapidly. The pressure has fallen 6.4 mb in the last three hours. For the last 3 (or 6) hours 0.78" of rain has fallen.

The sample report from Dallas shown on the previous page would be plotted as follows:



3. ASSIGNMENT (due next Wednesday)

I. On the following pages you will find METAR code from October 30, 2012. On a blank base map, plot all stations listed by decoding the METAR reports. Use the standard plotting model (lab 2). Plot the wind speed and direction, visibility, present weather, sky coverage, temperature, dew point, sea level pressure, pressure change, precipitation and PRESFR or PRESRR if they are observed.

Notes: Sky cover is plotted with these symbols:

If you have two sky indicators, use the most cloudy one (e.g., if BKN and OVC, plot OVC). If you have no sky indicators, plot missing as shown in the last station circle. Plot visibility just the way it is shown: 2 1/2 means plot 2 1/2, not 2.5 and be careful to get it all (2 1/2, not 1/2.)

Plot the steady wind with the standard flags. Plot the gusts as Gxx at the end of the wind flag.

The present weather symbols can be found in Table 1 in Lab 1. If you have two weather indicators, plot only the first one. Do not plot cloud height or runway information.

Plot temperature and dew point in Celsius degrees. Sea level pressure is found in the remarks (RMK) section. The only other remarks you plot are the 3 or 6 hour precipitation amount (6RRRR, e.g.,

60198 -> 1.98 inches of rain, plot as 1.98), the pressure tendency (5appp, e.g., 57012 -> 12 \) and PRESFR/PRESRR (pressure falling or rising rapidly).

II. Do the following analyses:

a) Draw isobars in black every 4 mb, including the 1000 mb isobar (labeled 00).

b) Draw isotherms in red every 5°C, including the 10°C isotherm.

c) Put in centers of High and Low pressure (H and L).

III. Answer the following: This is "Superstorm" Sandy from October 30, 2012. Sandy had both tropical and extratropical characteristics. Briefly describe three surface characteristics of Sandy that were likely to be from her tropical origins. Then describe two surface characteristics of Sandy that were definitely extratropical. All of the characteristics you name must be evident from the map you just plotted and analyzed. Use specific station examples to provide evidence for your answers.

METARS to Plot:

Vermont

KBTV 300254Z 08021G31KT 10SM -RA FEW041 BKN050 OVC065 18/11 A2932 RMK AO2 PK WND 10031/0248 DZE17RAB25 SLP929 P0000 60000 T01830111 56027
KMPV 300330Z AUTO 07006KT 2 1/2SM +RA BR FEW013 BKN027 OVC033 13/13 A2938
KRUT 300335Z 10018G24KT 9SM BKN026 OVC032 16/13 A2923 RMK AO1 P0009
K614 300354Z AUTO 14/12 A2940 RMK AO1 PRESRR SLP951 P0003 T01440122

New Hampshire

KAFE 300252Z AUTO 10015G27KT 4SM -RA OVC008 17/14 A2927 RMK AO2 PK WND 12027/0226 CIG 005V011 SLP915 P0010 60138 T01670139 51015
KBML 300317Z AUTO 10017G28KT 3SM RA OVC033 14/12 A2950 RMK AO2 PK WND 12028/0316 P0007
KLCI 300335Z AUTO 08014G26KT 8SM BKN014 OVC019 14/12 A2937 RMK AO1 P0017
KLEB 300253Z AUTO 10007G23KT 3SM -RA FEW018 OVC034 16/13 A2930 RMK AO2 PK WND 06029/0218 SLP915 P0013 60021 T01560128 55009
KMWN 300354Z 11076G102KT 0SM +RA FG VV000 05/05 RMK PK WND 100111/0250
KPSM 300251Z AUTO 10021G37KT 4SM RA BR BKN008 OVC013 16/14 A2938 RMK AO2 PK WND 10041/0219 SLP945 P0034 60053 T01560139 53003

Maine

KPWM 300332Z 10024G39KT 3SM -RA BR OVC005 14/13 A2947
KAUG 300337Z AUTO 08017G28KT 3SM -RA BR SCT010 OVC015 14/13 A2956
KBGR 300253Z 08015G29KT 5SM -RA BR BKN012 OVC017 14/13 A2973 RMK AO2 PK WND 08029/0250 DZE10RAB43 SLP066 P0001 60001 T01390128 56009

Connecticut

KBDL 300251Z 13018G26KT 5SM R06/6000VP6000FT -RA SCT025 BKN033 OVC085 17/14 A2912 RMK AO2 PK WND 13035/0154 RAE04B31 SLP860 P0002 60021 T01670139 51025
KGON 300339Z AUTO 14020KT 6SM HZ FEW024 BKN030 OVC039 17/14 A2918

Massachusetts

KACK 300253Z AUTO 12014KT 4SM BR OVC027 16/15 A2928 RMK AO2 SLP917 60004 T01610150 53027 TSNO
KEWB 300253Z AUTO 11013G22KT 7SM BKN037 OVC047 18/15 A2925 RMK AO2 PK WND 11029/0200 SLP904 60016 T01780150 53023 TSNO
KBOS 300254Z 11017G27KT 3SM BR OVC005 15/14 A2931 RMK AO2 PK WND 11034/0200 SFC VIS 3 RAB10E30 SLP923 P0002 60053 T01500144 53024=
KBAF 300253Z 10009G26KT 10SM BKN037 OVC047 18/12 A2913 RMK AO2 PK WND 08026/0245 RAB0159E14B34E47 SLP864 P0000 60002 T01830122 53023
KORH 300254Z AUTO 11013G20KT 7SM -RA OVC005 16/15 A2924 RMK AO2 SLP902 P0002 60030 T01560150 53019

Rhode Island

KPVD 300251Z 12012KT 4SM -RA BR FEW014 BKN034 OVC041 17/15 A2923 RMK AO2 RAB00 SLP898 P0000 60027 T01720150 53027

New York

KJFK 300251Z 16040G46KT 5SM BR OVC017 16/13 A2889 RMK AO2 PRESRR SLP784 6//// T01560133 53089 PNO $

KISP 300304Z AUTO 15030G45KT 10SM FEW018 OVC035 15/10 A2900 RMK AO2 PK WND 15045/0303 PRESRR

KSWF 300345Z 13032G47KT 4SM -RA BR OVC035 14/11 A2901 PRESRR SLP796

KELZ ***(plot at 523)*** 300256Z AUTO 34019G33KT 6SM -RA BR BKN006 OVC011 08/06 A2900 RMK AO2 PK WND 34039/0227 SLP825 P0009 60036 T00780061 56056

KELM 300253Z AUTO 01023G42KT 10SM BKN034 OVC043 12/10 A2889 RMK AO2 PK WND 01047/0205 RAE25 SLP783 P0000 60015 T01220100 58016 $

KBGM 300346Z AUTO 07013G18KT 7SM -RA FEW014 BKN025 OVC047 13/12 A2891

KALB 300251Z 07013G24KT 10SM FEW040 SCT047 BKN060 17/14 A2909 RMK AO2 RAE09 SLP849 P0000 60004 T01720139 53003

KBUF 300345Z 35021G34KT 3SM -RA BR BKN006 OVC013 07/06 A2918

KSYR 300254Z 03016G22KT 4SM RA BR OVC027 14/13 A2904 SLP826=

KROC 300340Z 03024G41KT 3SM RA BR OVC008 11/11 A2910

KRME 300253Z AUTO 06021G32KT 10SM SCT046 BKN110 17/12 A2903 RMK AO2 PK WND 08039/0207 RAB12E32 SLP828 P0000 60000 T01720117 56023

KGFL 300253Z AUTO 04014G22KT 10SM -RA FEW049 SCT075 OVC100 15/14 A2919 RMK AO2 SLP886 P0020 60028 T01500139 55011

KART 300323Z AUTO 04026G36KT 10SM -RA SCT027 BKN060 OVC080 14/11 A2922 SLP896

KSLK 300354Z AUTO 06020G29KT 2 1/2SM -RA BR SCT012 OVC019 12/11 A2927 RMK AO2 VIS 2V3 P0000 TSNO

KMSS 300253Z AUTO 05019G34KT 10SM FEW025 SCT032 OVC041 15/10 A2939 RMK AO2 PK WND 04041/0233 SLP953 T01500100 56022

New Jersey

KMIV 300346Z AUTO 18016G34KT 150V210 4SM RA BR OVC012 09/08 A2865 RMK AO2 PK WND 16035/0318 P0007

KACY 300354Z AUTO 18026G45KT 10SM BKN017 OVC029 11/08 A2878 RMK AO2 PK WND 16050/0338 PRESRR SLP743 P0003 T01060078 TSNO

KNEL 300330Z AUTO 13026G38KT 8SM R06/5000VP6000FT -RA OVC011 11/10 A2867 RMK AO2 PK WND 13039/0317 PRESRR SLP720

KEWR 300351Z 11040G60KT 6SM -RA BR SCT015 BKN025 OVC035 14/12 A2890 RMK AO2 PRESRR SLP787 P0006 T01430124=

Pennsylvania

KPHL 300254Z 12026G34KT 3SM -RA BR BKN009 OVC015 13/12 A2837 RMK AO2 PK WND 10039/0159 PRESRR SLP608 P0007 60014 T01330122 53072 $=

KHAR 300256Z AUTO 34013G16KT 2SM +RA BR FEW014 BKN022 OVC027 12/12 A2853 RMK AO2 PK WND 33030/0202 SLP661 P0018 60030 T01220122 56010

KRDG 300254Z AUTO 08018G37KT 2 1/2SM -RA BKN014 OVC020 13/ A2839 RMK AO2 PK WND 06047/0207 SLP612 P0005 60011 T0128 53004 TSNO $

KAOO 300253Z AUTO 33025G42KT 7SM BKN019 BKN025 OVC033 06/02 A2886 RMK AO2 PK WND 33045/0224 PRESFR SLP776 P0003 60014 T00560022 56050

KJST 300254Z AUTO 29025G34KT 2SM -SN BR OVC004 01/01 A2897 RMK AO2 PK WND 30038/0221 TSE0159RAB0155E44SNE0155B44 PRESFR SLP824 P0014 60044 T00060006 55024

KPIT 300251Z 32020G34KT 5SM RA BR OVC012 04/02 A2922 RMK AO2 PK WND 32039/0210 SLP908 P0015 60044 T00390022 58048

KDUJ 300256Z AUTO 34019G37KT 5SM -RA BR OVC012 04/02 A2899 RMK AO2 PK WND 35039/0222 SLP824 P0003 60053 T00390022 56066

KIPT 300254Z AUTO 01008G16KT 10SM -RA FEW030 BKN038 OVC049 13/11 A2871 RMK

KAVP 300354Z 07011G28KT 8SM -RA SCT027 OVC035 13/08 A2877 RMK AO2 PK WND 06038/0258 SLP737 P0000 T01280083
KERI 300349Z AUTO 36025G37KT 2 1/2SM BR OVC010 06/04 A2928

Maryland
METAR KNHK 300352Z AUTO 21020G33KT 7SM RA BKN013 BKN020 OVC028 08/06 A2879 RMK AO2 PK WND 21036/0254 SLP750 P0013 T00830061 $
KOXB ***(plot at 595)*** 300253Z AUTO 23021G32KT 7SM -RA BKN015 OVC019 09/08 A2880 RMK AO2 PK WND 22041/0231 PRESRR SLP751 P0003 60012 T00890083 51064 TSNO
KADW 300354Z AUTO 27024G35KT 4SM R01L/4000V4500FT +RA BR BKN013 OVC021 07/06 A2866 RMK AO2 PK WND 29043/0309 SLP706
KBWI ***(plot at BAL)*** 300254Z 28029G42KT 1 3/4SM RA BR FEW025 OVC038 08/07 A2849 RMK AO2 PK WND 29052/0223 SLP649 P0019 60065 T00830067 58016=
KHGR 300315Z AUTO 07/05 A2869 RMK AO2 RAEMM P0001 PWINO $

Delaware
KDOV 300351Z AUTO 18027G40KT 3SM R01/3500V4000FT -RA BR BKN009 OVC014 08/08 A2861 RMK AO2 PK WND 17040/0343 PRESRR SLP690
KILG 300346Z AUTO 15032G40KT 2 1/2SM RA BR BKN005 BKN013 OVC020 11/10 A2845

Quebec (only selected station shown)
CYUL 300300Z 04027G40KT 15SM FEW020 BKN120 OVC210 14/10 A2947 RMK CF1AC6CI1 SLP980

Ontario (only selected stations shown)
CYTR 300300Z AUTO 01027G34KT 9SM BKN017 BKN066 BKN090 11/08 A2929 RMK SLP921=
CYYZ 300300Z 36023G38KT 5SM -RA BKN012 OVC025 03/03 A2942 RMK SF6SC2 PRESFR SLP967=
CYOW 300300Z 04019G26KT 15SM SCT032 BKN040 OVC110 15/10 A2945 RMK SC3SC3AC2 SLP974 DENSITY ALT 900FT
CYPQ 300300Z AUTO 01019G30KT 9SM BKN018 BKN023 OVC030 07/05 A2939 RMK MAX WND 02031KT AT 0235Z PRESFR SLP958

Lake Effect Snow Forecasting

Forecast models have become very accurate on the synoptic scale, although human forecasters can usually improve on their accuracy. The more difficult 21st century weather forecast challenges occur with smaller, mesoscale forecasts, mainly due to problems with model resolution and assumptions. Lake effect is a classic example of a local forecasting problem in which a synoptic situation can be well understood and forecast but the scale of the weather phenomena make individual location forecasts problematic. In this lab, we will study three cold season examples and in each case, lake effect was a significant element. After studying the synoptic maps, data, and numerical guidance, you will be asked to think about the lake effect component. To see the maps, go to the web version and click on the links.

Case 1: Classic set up over Lake Michigan

In Fall 2013, the lake effect station chosen for WxChallenge was Grand Rapids, MI (KGRR). Downwind from Lake Michigan, this city experienced light snow overnight and during the day on December 7. Click here for the radar loop. KGRR is east of the lake. The 12Z surface map showed an Arctic High west of Michigan with a pressure gradient over the lake (click here for loop). Other information and observations can be found on the 850 hPa map, 500 hPa vorticity map, and 250 hPa map, all from 12Z on December 7. The Great Lakes water temperature map from Dec 5 is also available.

For this lab you must answer questions 1-7 in a text or Word file. Start here:

1. Based on the observed and forecast conditions from the map links already given, write a discussion in the NWS format. Your discussion must describe what's happening in enough detail so that a professional meteorologist will understand both the general synoptic situation and the nuances that pertain to lake effect.

2. Based on the forecasts for 12Z December 7, both graphical (NAM 24 hour MSLP and the 24 hour surface prog) and digital for Grand Rapids in particular (NAM MOS and Grid Extracts), what is an appropriate and consistent forecast for Grand Rapids, MI from 00Z Dec 7 to 00Z Dec 8? Include all the usual elements, i.e., temperature, precipitation type, precipitation amount, wind, and sky cover.

Case 2: Buffalo lake effect " Snow Blast"

On November 18, 2014, Buffalo experienced one of the most intense lake effect squalls in history. Images of the wall of snow across Lake Erie are still iconic on the Internet:

The radar loop for this case shows a very different reaction than you saw in the Grand Rapids case and the observations show a prolonged period of measurable snowfall.

As in the first case, you must become familiar with the surface map for 00Z Nov 18, surface map loop, 850 hPa map, 500 hPa vorticity map, and 250 hPa map. You also have, as before, the Great Lakes water temperatures from Nov 15.

For this Buffalo case, the resulting lake effect squalls were very different in terms of intensity as well as structure. Here are your questions:

3. How is the synoptic setup different from the Grand Rapids case? Wherever possible, be quantitative.

4. How do these conditions work to create such a different lake effect event?

5. Was the forecast guidance (MOS in an Excel spreadsheet, and 24 hour surface prog) helpful in guiding you to the correct forecast? Why or why not?

Case 3: Syracuse 2012

In the Fall of 2012, WxChallenge chose Syracuse, NY as their northeast station. Late in the day on Nov 28, radar showed what appeared to be a long single lake effect band set up on the south shore of Lake Ontario. Observations from 12Z Nov 28 to 12Z Nov 29 featured a number of hours with S- but little accumulation which may indicate that the long shoreline band was not as strong as it looked.

You again have a surface map loop for the same times as the observations and, for 00Z Nov 29, the U.S. surface analysis, 850 hPa map, 500 hPa vorticity map, and 250 hPa map. The Great Lakes water temperatures were from Nov 29. Your MOS digital forecast was from the NAM that was initialized at 00Z Nov 28, 2012 and the 24 hour surface prog was based on the same 00Z initialization.

Please answer the following:

6. Was this pure lake effect, lake-enhanced precipitation, or not lake effect at all? Or was it something other than those choices? Justify your answer using the information given.

7. Assess the MOS guidance for this case, knowing what the observations were. Would you have made an accurate forecast using this guidance? Why or why not?

Send your text or Word file to Jerome.Blechman@oneonta.edu by next Wednesday, Nov 7, no later than 2 p.m.

Team Map Discussion

For this lab, members of the class will split into teams. Teams will be announced at the beginning of the period. Each team is to prepare a detailed map discussion and conduct it, starting at 3:45 p.m. There will be three teams: Surface, Upper Air, and Forecast. For lab 12 and next semester, the jobs will be rotated so everyone gets to do all aspects of map diagnosis and forecasting.

The responsibilities of the Surface discussion team are:

1. Get a series of surface maps, starting with the most recent U.S. surface from the WPC. Go back at least 24 hours. In your discussion, you are specifically looking for fronts, Highs, Lows, troughs, observed weather conditions like temperatures, dew points, present weather etc., and anything special that may be significant (dryline, outflow boundaries, etc.)
2. Get current radar loops for the entire U.S. and for the northeast U.S. Get a loop for our WxChallenge city too.
3. What is this morning's snow cover, if any? Find a chart. Include Canada.
4. What was the 24-hour precipitation in the U.S.?
5. This morning's minimum temperature chart and yesterday's maximum chart should be shown
6. Show the latest surface plot for the northeast U.S. Wait until after 3 p.m. to get this so it is current.

The responsibilities of the Upper Air team will be:

1. Get the following conventional upper air charts from this morning: 850 hPa, 300 hPa, 200 hPa, and 500 hPa chart with vorticity from weather.unisys.com.
2. Get the latest visible, IR, and Water Vapor satellite pictures. Get IR and Water Vapor satellite loops of at least 24 hours.
3. Show a map of 1000-500 hPa thickness. A model initialization panel will work.
4. Get and highlight sounding plots for Albany, the WxChallenge station, and a sounding from any part of the U.S. where important weather is occurring. What's important? Tornadoes, heavy rain, drought, heavy snow, severe cold or heat, etc.

The Forecast team has following responsibilities:

1. Get the 12Z NAM forecasts for the surface, 500 hPa, and 300 hPa. Do the same for the GFS.
2. Note discrepancies between the NAM and the GFS.
3. How has the NAM been doing lately? Show the forecast for today, for which you have a verification.
4. Are there any watches or warnings currently in effect anywhere in the U.S.?

5. Be prepared to discuss the 12, 24, 36, and 48 hour surface forecast as well as the Day 4,5,6 and 7 surface forecasts from WPC.

Everyone is expected to report on their responsibilities to the class. Be efficient in your presentation, as we must be done by 4:50 p.m. Know what you are going to say before you get up there. Practice using the tools – a viewing program like Irfanview, the browser, or perhaps PowerPoint for loops.

The Integrated Data Viewer – Nor'easter Study

As we are currently studying how potential vorticity conservation creates storms, this lab will focus on a powerful Nor'easter that happened in 2015. However, rather than just view the existing maps of the storm, we will also learn to use a computer tool for creating your own maps. It's from a consortium of colleges and universities called Unidata and the Open-Source software is called the Integrated Data Viewer, or IDV. The IDV is already loaded on the PC's in room 308. If you wish to download it for your own personal computer, it's free from Unidata at https://www.unidata.ucar.edu/downloads/idv/index.jsp. The IDV will work on any PC, Mac, or Linux platform. Be sure you download the correct installation file.

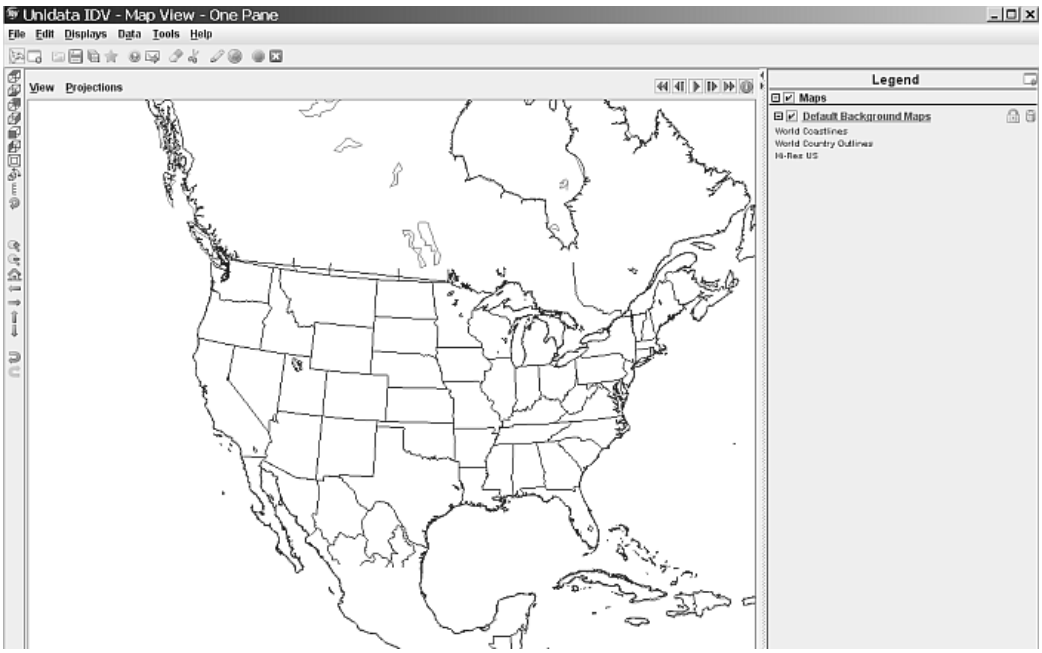
The IDV is a very useful tool for visualization of atmospheric properties and patterns. It can also be used for forecasting or research. Learning to use the IDV is, however, not simple. It has a graphical user interface but the operation is a bit different from Windows or Mac OS. I can show it to you but that certainly wouldn't give you any expertise in using the IDV. As always, practice is the key. Therefore, one of the purposes of this lab is to get your hands "dirty" and test out the IDV for yourself. The other is to use the IDV to study and answer questions about the January 27, 2015 Nor'easter.

Procedure – You will get the IDV running and use it to diagnose an archived storm as follows:

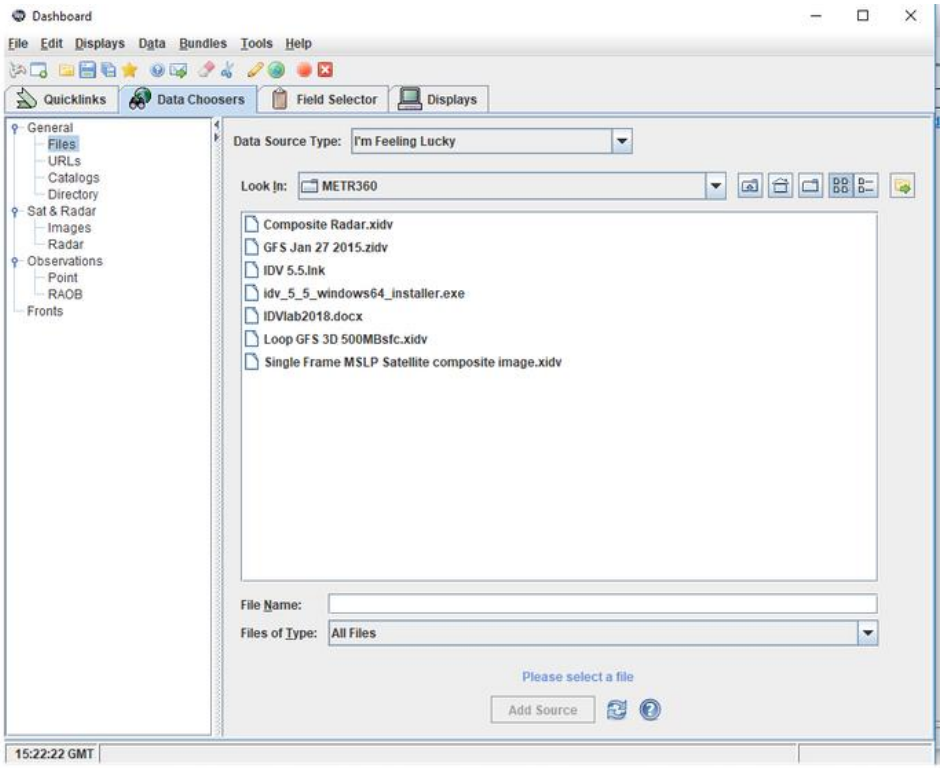
1. Go into the computer lab, room 308 and pick any computer other than the older one just inside the door, used for maps and observations only. Log on using your Oneonta username and password.

2. Quick Start

To start the IDV, double-click on the IDV 5.5 shortcut icon found in the Meteorology folder on the desktop. It will take a few seconds to initialize, then it will create two windows. These are the main operating windows that you need. One is the map view window:



The other window is called the Dashboard. Here is where you control where you get the data and how you display it:



3. Working with the IDV

In the Dashboard, click the tab marked “Data Choosers, as shown above.” That will show a number of “bundles.” A bundle is just a saved IDV set of instructions that you create, i.e., once you have set up the displays the way you want them, you can save what you see as a bundle. Bundles have the file extensions .xidv or .zidv. With the IDV, you can design and save your own bundles. You can also add to or change

any bundles that you download. If you open a bundle you see the same types of displays every time, like pressure and temperature, but each time you open the IDV it uses new, current data. So, if your bundle displays sea level pressure, you always get isobars but they will be the ones on today's map. You can decide what you want to see. Some bundles carry their own data so you could save today's maps and view them tomorrow. These are called Zipped Bundles. We'll work with one of those today, showing maps from January 2015. By the way, if you make changes to the zipped bundle, please save it using a different name so the original is maintained. I have backup copies, in case of accidents.

a. Get Started

To get familiar with the way the IDV works, in the Dashboard, click on Files then open the folder "metr360" (it might already be open - see example above) and click the bundle "Single Frame MSLP Satellite composite image.xidv". Then click the Add Source button at the bottom of the Dashboard screen. You get an Open Bundle dialog box. The top box should be checked. If it is, click the OK button. Wait a few minutes for the data to load and displays to be created.

Now look at the other window, which is called the Map View. The Single Frame MSLP Satellite composite bundle is a 2-D display of mean sea level pressure (MSLP) as colored isobars with a non-enhanced GOES-E IR image superimposed. Depending on the time of day, you may need to advance the frame to see the IR image. To do that you use the frame advance arrow (). The IDV can do much more but we will practice simple navigation using the MSLP Satellite display. Along the left margin there is a series of icons. To get the map to a view from the top and aligned with the screen, click the little Home icon (). Depending on how big a change this is, the display may reload, taking a few seconds. Clicking the + magnifier icon  makes it bigger and the – magnifier makes it smaller  . Moving the whole display must be done with the arrows  and  , not the mouse which is for 3-D. To undo any display change, use  . For practice, try zooming in and centering on New York State. By the way, the mouse wheel will also work for magnifying if you have just clicked a magnifier icon.

b. Other bundles

Go to the top of the map view screen. Under the menu headings (File, Edit, Displays, etc.), there is a series of small icons. Click the one that looks like a pair of scissors,  . All the isobars and satellite information will disappear. The scissors icon removes all displays and data sources from the dashboard. Go back to the Dashboard. Click Data Choosers. Click the bundle "Loop GFS 3D 500MBsfc.xidv" and click the Add Source button. When the Open bundle dialog box comes up, click OK and wait a bit. On the Map view screen you will see a multicolored 500 mb animation. This is a 5-day forecast from the latest GFS run. It can be animated if you click the forward arrow (). You can stop it with the pause icon,  . Advance one frame at a time with the frame advance arrow () or the arrow keys, if you have activated the frame advance.

Now, do this carefully: Put the cursor anywhere in the map itself, click AND HOLD the right mouse button, and move the mouse slowly forward while holding the button. The map will be rotated so that you can appreciate the fact that this is a 3-D 500 mb surface. By holding the right mouse button and moving the mouse, you can rotate the map view all the way around the even view it from underneath. Try moving in various ways, even while the map is looping. Notice how the yellow or orange areas are high (ridges) while the blue areas are low (troughs).

Having trouble getting it right-side up again? Click the Home icon, above the movement arrows. It might take a few seconds for the black contours to reappear. The data is all loaded but you changed the view so the IDV has to re-map them. You probably will want to zoom in ( or use the mouse wheel).

On the right side of the Map View is the Legend. Each display is shown. The 500 mb surface is obscuring the GFS precipitation forecast which is also part of this bundle. To see the precipitation, click the two boxes for Geopotential height isobaric to uncheck them. That just hides them from view. You can easily restore the displays if you check the boxes again.

Go back to the Dashboard. Click Data Choosers again. Click the bundle named "Composite Radar.xidv" and the Add Source button. This is the radar loop for the last two hours. Advance the frames until you see radar echoes. Compare them to the forecast precipitation. They won't be the same.

c. Designing your own displays. Current model forecasts

You can make 2D and 3D displays with variables of your own choosing. First, click the scissors icon. As we now know, that removes the old displays and any data sources previously loaded when you chose the bundle. The map remains. Go to the Dashboard. Click the Data Choosers tab. Now go down the menu past Files and URLs to Catalogs. Click it. The first catalog listed is Unidata Model Data.

There's a small lever icon next to each folder. Choose the Unidata Model Data and click the lever until it points down. Next, choose Forecast Model Data and click that lever. Choose the North American Model which is the NAM. Again, turn the lever down. You get a number of variations. Choose NAM CONUS 12 km from CONDUIT. That's the 12 km grid over the Continental U.S from the NAM. Click the line "Latest Collection for NAM CONUS 12km from CONDUIT" (which has no lever) then click the Add Source button.

At this point, the Dashboard switches you to the Field Selector tab automatically. Turn down the lever on the 2D grid and again on Temperature. Pick Temperature@Ground or water surface. Over on the right, you should pick a display type. Let's do Contour Plan View (find it).

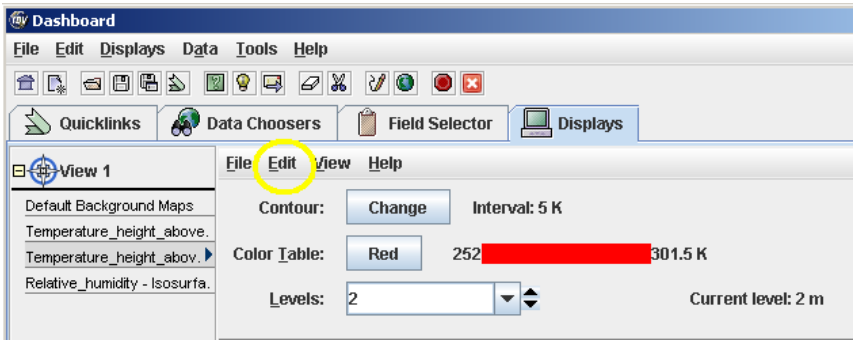
You need to choose a time or series of times or the IDV will use all available times by default. The NAM is very large model so be careful about times. The full default is 29 times from initialization. That can take a while to load. To remedy that, first click the Use Default box and make it Use Selected. For this example, click just the first time shown, probably 12:00:00Z. Click the Create Display button. The map will very quickly be colored. These are the surface temperatures at the model initialization time. Zoom in for more detail. It would be nice to see the isobars on the same map so you can relate the temperatures to the weather systems.

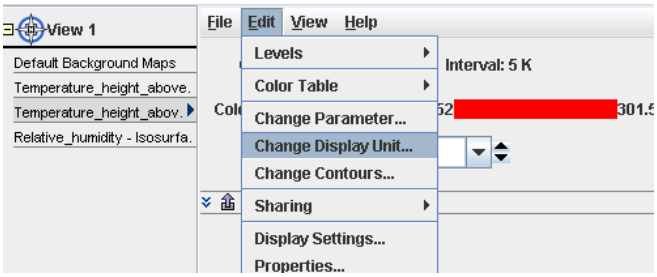
Go back to the Dashboard (that happens a lot, doesn't it? The Dashboard is your main control on what gets shown). The IDV is now showing the Display tab. Click the Field Selector tab. We're going to use the Pressure reduced to MSL @ Mean sea level. When you find it, click it. Then click what you need to create a Contour Plan View at the same 12Z time as the previous temperature display. Remember to click the Create Display button.

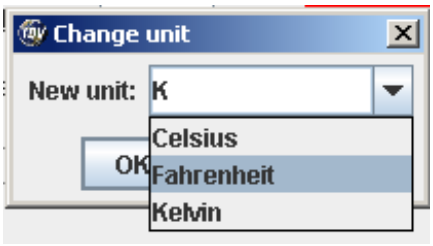
Now your map should be a mess of colored lines and very difficult to read. That's because the IDV is using the same color scheme for the isobars as it did for the isotherms. Let's change that. Click the blue Pressure Reduced to MSL title under the legend. It's a link back to the Dashboard Display. There's a button for the Color Table, in this case labeled Pressure MSL. Click it to get a list of actions and

properties. Go down to Solid at the bottom, hover over that and click the Black choice. Now you can see the isobars but they are still overwhelmed by the isotherms. Back at the Dashboard, click the button marked Contour: Change. Change the Line Width to 2 and, while we're at it, bump up the (label) frequency slider one notch to see more numbers. Click OK.

There are many ways you can customize your displays to get the most information out of them. For example, the temperatures are in Celsius degrees. To change that, go to the dashboard display view by clicking Temperature under the Legend and pull down the Edit menu next to the View line:







Choose Change Display unit and pick Fahrenheit from the menu which results. You might want to change the contour interval. The default is 9°F. You can change it with the Contour Change button menu (not shown here).

By the way, if you do the right-mouse motion again, you will see that this display is NOT 3D. It's flatter than a pancake since 2D is what you requested.

Of course, you could choose more than one time and get an animated display. If you do that, remember, it will take longer to load, especially using NAM data. You are creating displays, not loading canned displays from the Internet. Give the computer time to work. For faster loops, try the GFS or lower resolution NAM grids, like 40 km or even 80 km. And it's best not to load all 29 NAM times but you could since these semi-new PC's are pretty fast machines.

Now that you know the basics, play with it. Load other types of data and different types of displays. The IDV can do a tremendous variety of tasks and show you lots of displays. For example, how would you display a jet stream? Or a vortmax?

4. Assignment (due next Wednesday)

Clear all displays and data. Go to Data Choosers. Under the word "General" click Files. Open the folder IDVLab if it's not already open. Click GFS Jan 27 2015.zidv and click Add Source. When the

Open Bundle dialog box comes up, check the Remove box and click OK. Then another dialog box asks you if you want to write files to a temporary directory. Click OK again. We're using the GFS for fast loading. This display is only sea-level pressure and 6-hour precipitation forecast but most of the GFS is available by using the Field Selector. You should add whatever displays you need to answer the questions. This is graded:

Based on the GFS forecast, answer the following questions on a separate sheet of paper or in a text (or Word/docx) file. If you write a text file, send it to me by next Wednesday, December 5 via email (Jerome.Blechman@oneonta.edu):

1. The storm we are studying occurred on January 27, 2015. Boston's airport officially had a record 22.1" of snow from this one but places in central Massachusetts reported as much as 36". In NYC, Central Park had 9.8" and La Guardia airport reported 11.4". A trained spotter in Eastern Long Island reported as much as 30". So it was an intense storm. When and where was that surface Low forecast to be most intense by the GFS? Be specific and quantitative (use numbers!). Hint: the initial map shows a Low off the New England coast. That is not the big one. Click ahead in time.

2. You have a paper copy of the isobars, isotherms, and 1000 mb wind flags for 00Z on Jan 27, 2015. Draw in the fronts in the places consistent with those data fields. Drawing fronts is not one of the IDV's strengths so you will need to do it. Use the standard symbols and colors.

3. Add 500 hPa heights for all times. (Hint: 500 hPa is a Geopotential height. Find that using the Field Selector). When and where was the 500 hPa Low forecast to be most intense? Again, give numbers. You might find this easier if you uncheck all boxes in the Legend, except for the Geopotential Heights and Default Background Maps.

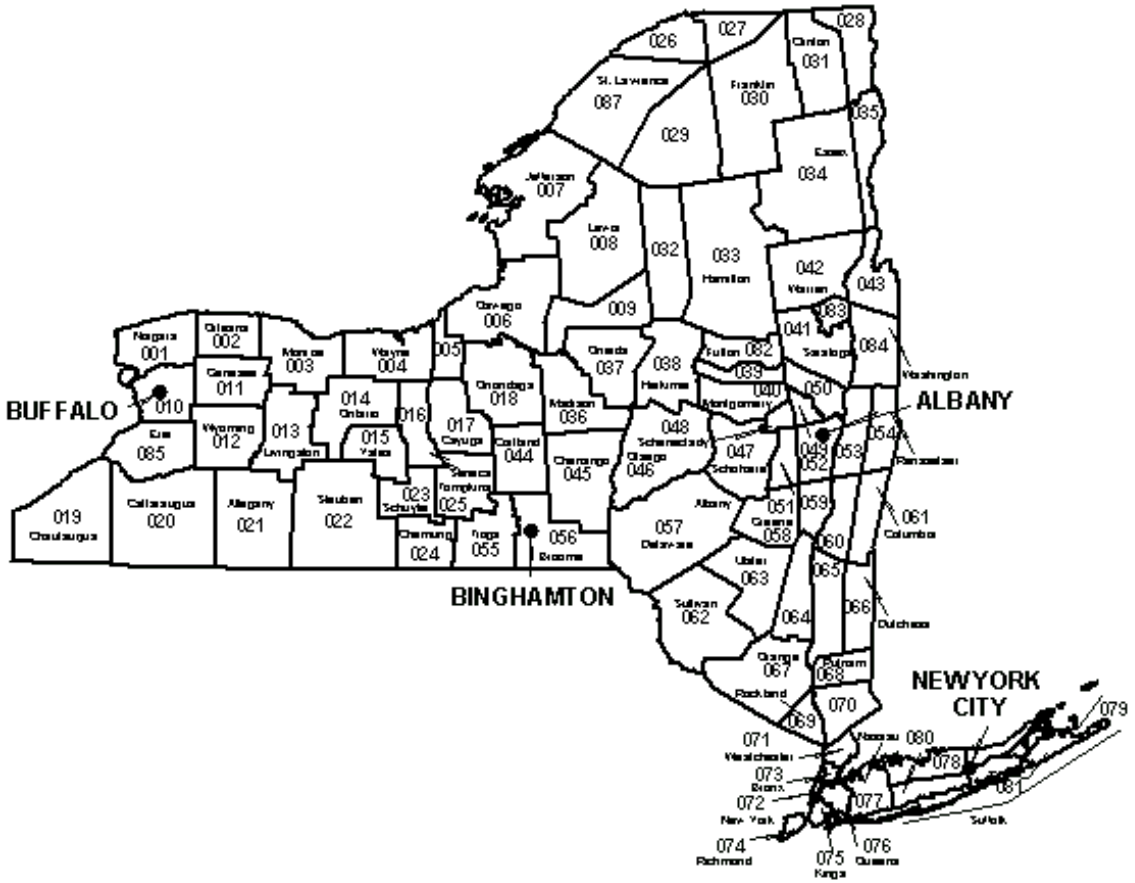
4. In the Dashboard under 3-D "Derived" True wind vectors, add wind barbs at 500 hPa. You may need to skip some winds to make it readable. What can you say about the forecast winds and waves in the northeastern quarter of the U.S. during the period from 00Z Jan 25 to 18Z Jan 27? Make at least two observations about what you see, one about wind speed and the other about what the wind direction says about the trough. Whenever possible, make them quantitative and include the date and time of your observations.

5. Add the 2D 1000-500 hPa thickness (in the Derived menu). I like to make these solid red since the default 500 mb height line color is blue. You can choose the color table as we did before. Remember you can uncheck the precipitation and put it back when you need it. Notice that the forecast thickness pattern does not match the forecast 500 hPa height pattern exactly, although it is very close in most places. At 12Z on Jan 27, the two fields differ the most over southern New England where the impacts were greatest. That is not a coincidence. How would a difference between forecast thickness and height cause the heavy snowfall? Wind barbs will help you here. Use what you learned about what causes vertical motion.

6. In cities such as Philadelphia and Atlantic City, schools were closed in advance and the governors issued states of emergency. The city officials were criticized for that early decision. Based on the sequence of maps shown by this GFS forecast made two days in advance, what would have been the proper forecast? Based solely on this GFS forecast, give a short summary of the expected synoptic situation. Then use the GFS to forecast the snowfall total for Philadelphia for January 26 and 27, 2015. Do not look up what actually fell. Your forecast must be based on the guidance you have.

Next: Appendices

NEW YORK
PUBLIC FORECAST ZONE BOUNDARIES

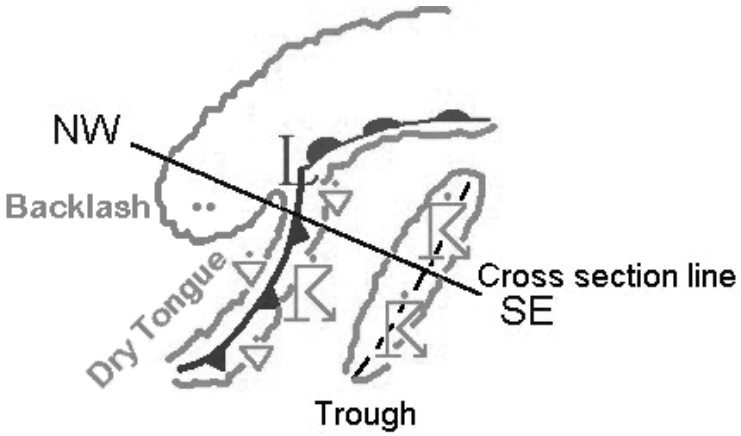


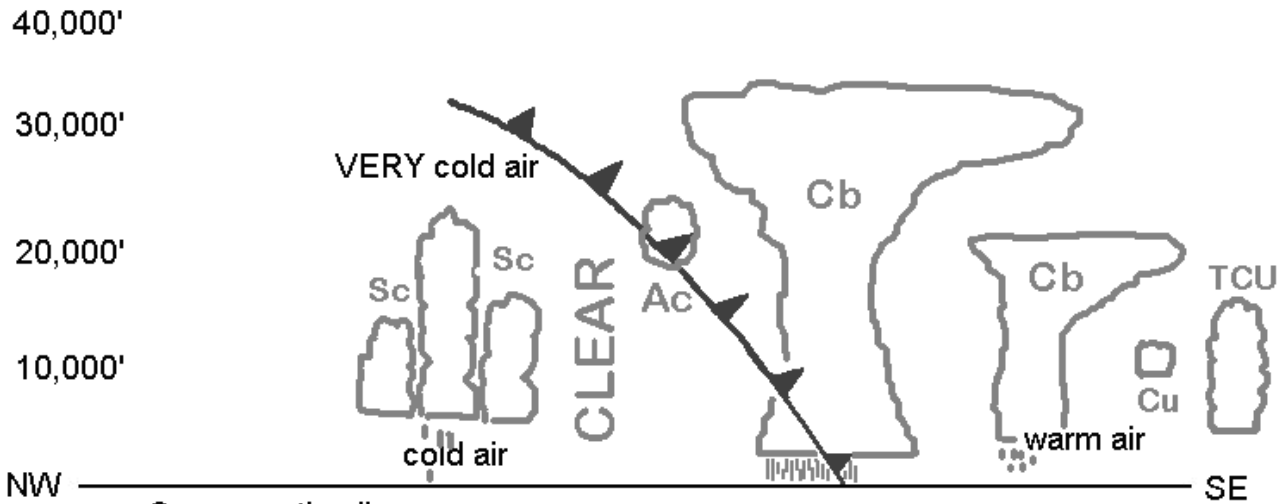
NATIONAL WEATHER SERVICE
EASTERN REGION

- Weather Forecast Office
- County Boundary
- Forecast Zone Boundary

DECEMBER 2003
MIRS GIS GROUP

Cold Front

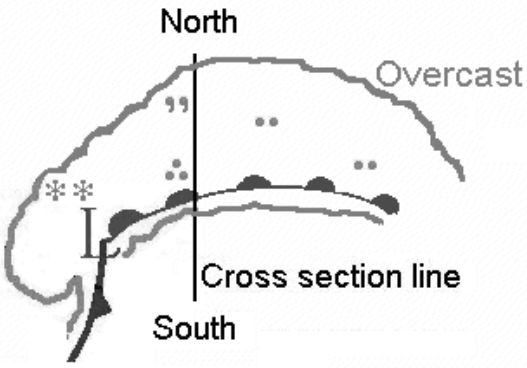


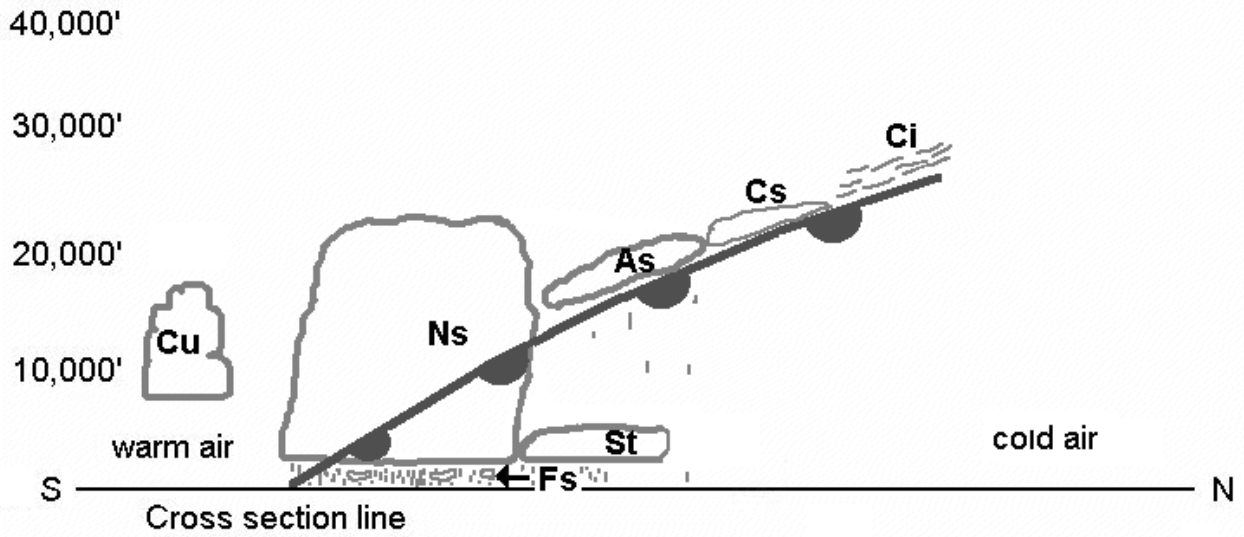


Sequence of Clouds and Weather

Time (start with 0)	7	6	5	4	3	2	1	0
Clouds	Sc	Sc	No Clouds	Ac	Cb	Cu	Cb	Cu + TCU
Weather	▽/●●				⋰		⋰	

Warm Front



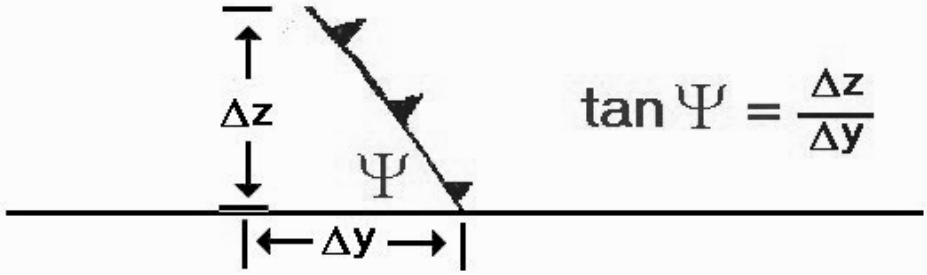


7

Sequence of Clouds and Weather

6	5	4	3	2	1	0	Time (start with 0)
Cu	Clearing	Ns/Fs	St	As	Cs	Ci	Clouds
◁		••/••	,,/••	•			Weather

FRONTAL SLOPES (MARGULES)



$$\tan\Psi = \frac{\Delta z}{\Delta y}$$

$$\tan\Psi = \frac{f\overline{T}}{g}\,\frac{\mathbb{V}_{gD} - \mathbb{V}_{gL}}{T_D - T_L}$$

where f = the Coriolis parameter $= 2\Omega\sin\Phi$

g = the acceleration of gravity ($=9.8\ m/s^2$)

$\mathbb{V}_{gD}$ = the geostrophic wind in the dense air

$\mathbb{V}_{gL}$ = the geostrophic wind in the light air

$\overline{T}$ = the overall mean temperature

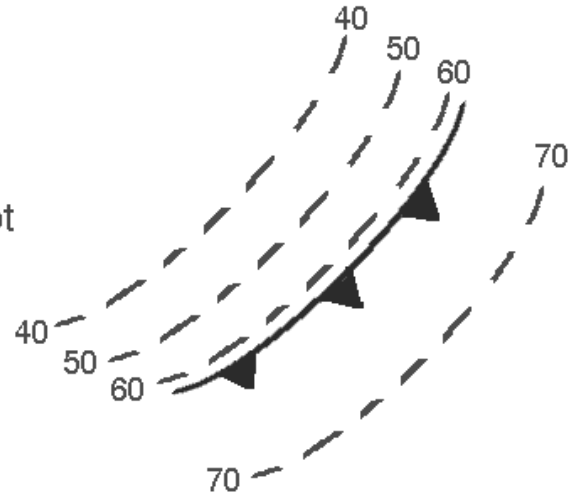
T_D = the temperature at the front in the dense air

T_L = the temperature at the front in the light air

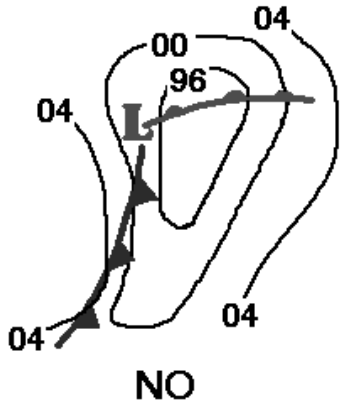
Analyzing Fronts

1. Temperature gradient

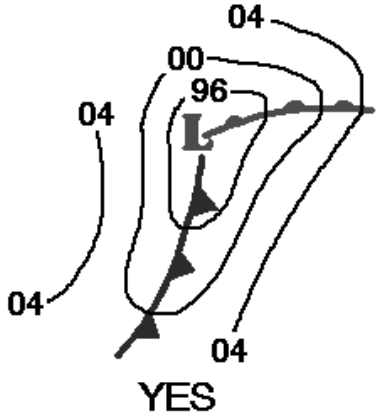
Place the front at the edge of the isotherm packing. It is not necessary to get every isotherm behind the front.



2. Use the fact that fronts always lie in troughs.

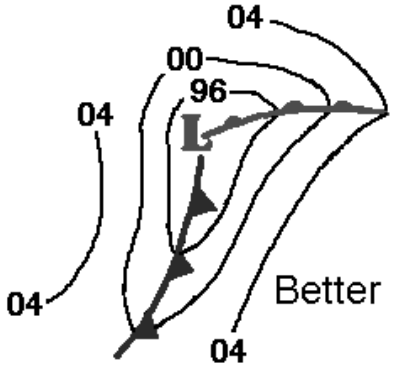


NO



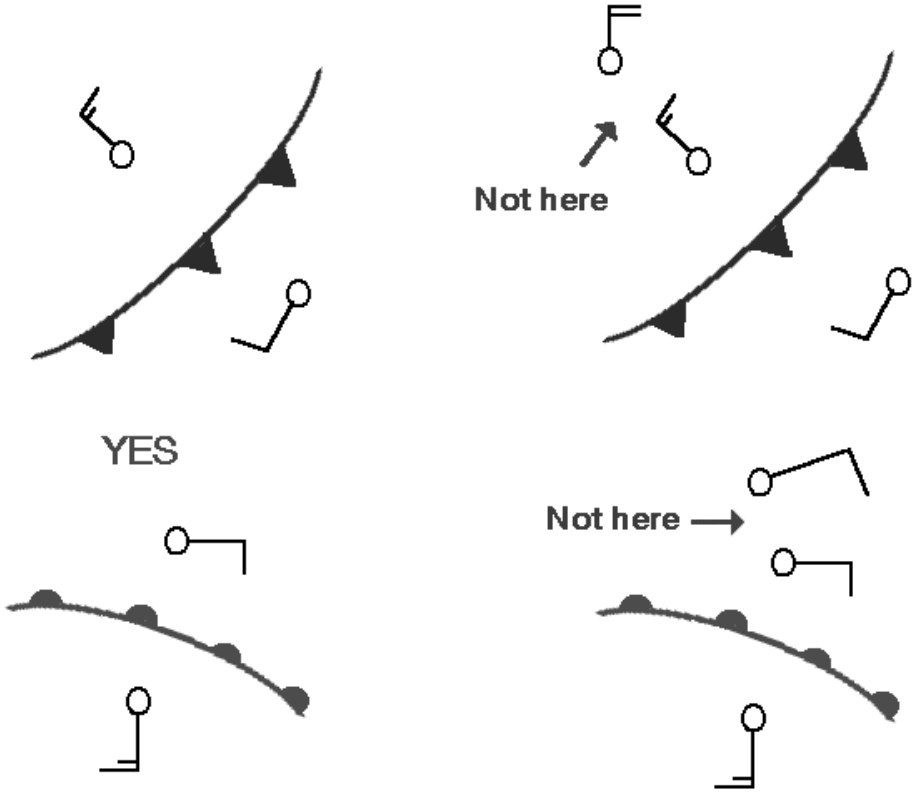
YES

After drawing the front, "kink" the isobars



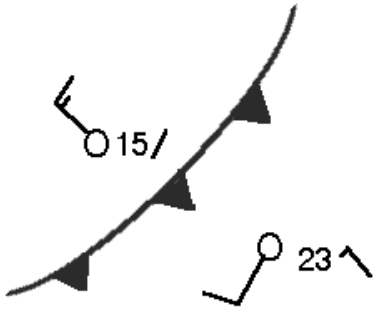
Better

3. Look for an abrupt wind shift.

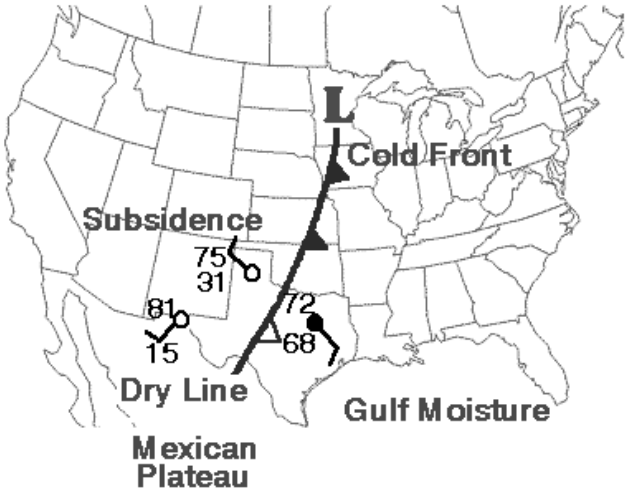


Remember, fronts always have wind convergence.

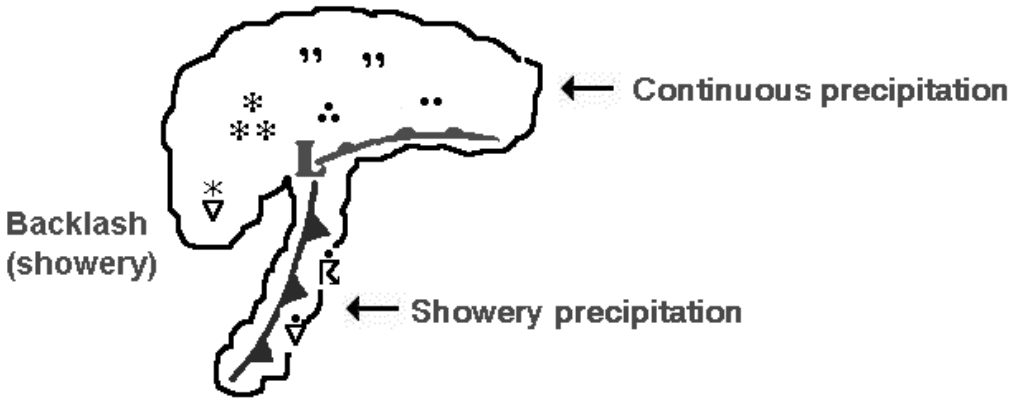
4. Since fronts are in troughs, the pressure tendency will be negative as it approaches, positive after frontal passage.



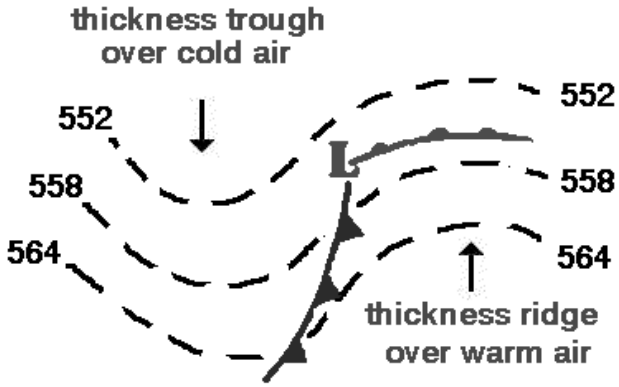
5. In the southwest and south-central U.S., look for big dew point decreases.



6. Fronts have characteristic weather and cloud types.



7. Surface temperatures may be misleading. Check the upper air thickness pattern.



Principles of Convection II: Using Hodographs

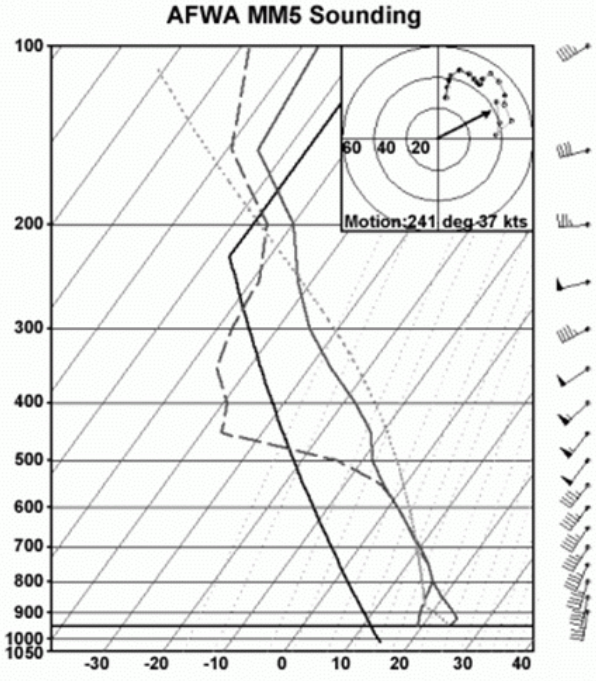
Find this tutorial at http://deved.meted.ucar.edu/mesoprim/hodograf/print.htm

1. Introduction

1.1 The Importance of Shear

The hodograph is a graphical tool that helps forecasters evaluate vertical wind shear. In a convective environment, an understanding of the vertical wind shear is tremendously important for anticipating convective storm type, where new storms may form, the likelihood of supercell storms, and even storm and storm system motion. For example, these figures show the simulated radar returns for a series of modeled storms that evolved under different vertical wind shear conditions, which are depicted by the idealized hodographs in the lower left.

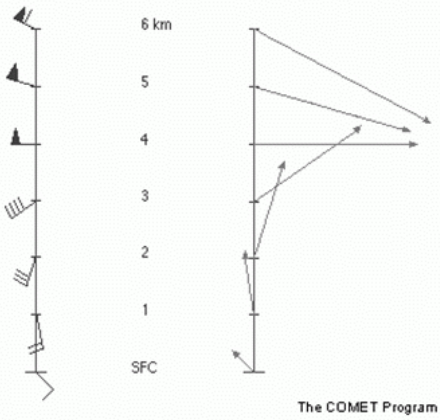
1.2 The Hodograph



AFWA The ability to anticipate possible storm structures is critical in managing your activities before and during a convective event. Having the right set of expectations for a given storm environment will make you a more efficient and accurate forecaster. The hodograph depicts the environmental wind shear, which profoundly influences storm evolution. Thus, a representative hodograph combined with a representative buoyancy profile can greatly enhance forecast skill. This figure shows an AFWA MM5 model sounding, along with the associated hodograph, downloaded from the Joint Army-Air Force Weather Information Network (JAAWIN) Website. Similar sounding/hodograph plots are available from many sources.

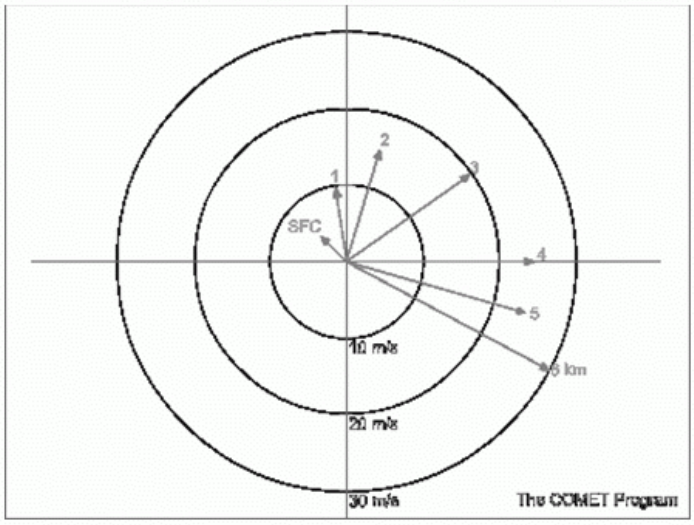
2. Plotting a Hodograph

2.1 Wind Barbs vs. Wind Vectors



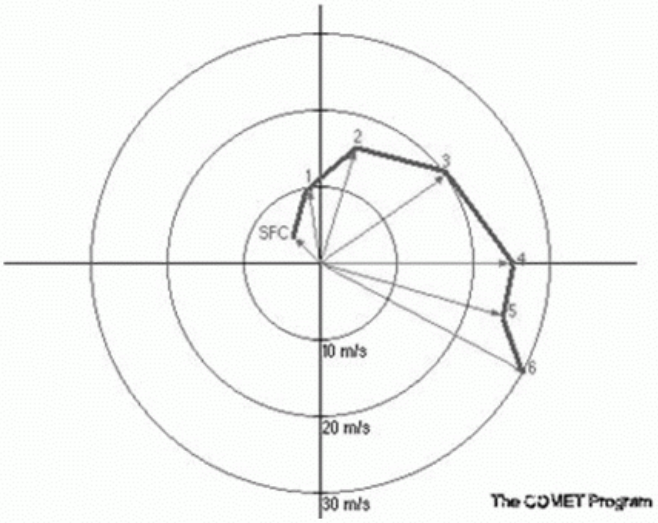
Meteorologists are all familiar with the traditional vertical wind profile from a radiosonde that uses barbed lines to indicate wind direction and speed at various levels. The hodograph communicates the same information. However, since its primary purpose is to reveal vertical wind shear, the hodograph is based on wind vectors. Unlike the wind barb, a vector indicates speed by its length rather than a combination of barbs.

2.2 The Polar Coordinate Chart



For a hodograph, wind vectors are plotted on a polar coordinate chart. The axes of the chart represent the four compass directions. All the wind vectors extend from the origin and point in the direction of the wind's movement. Since the vector length indicates speed, concentric circles drawn around the origin represent constant wind speeds. For example, this hodograph shows that both the 4- and 5-km winds are 25 m/s, although their wind directions are from the west and west-northwest, respectively.

2.3 The Hodograph



Typically, the actual wind vectors are not drawn on the hodograph, but are indicated only by their endpoints on the polar coordinate chart. The hodograph is plotted by connecting the endpoints of each of the wind vectors.