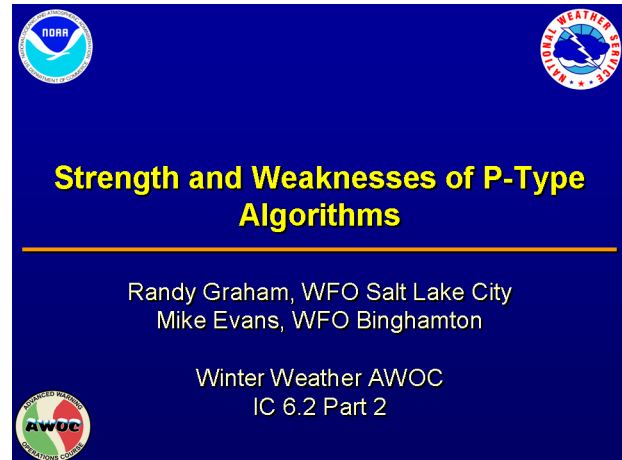

1. IC6.2 Part 2: Strength and Weaknesses of P-Type Algorithms

Instructor Notes: Welcome to IC6 lesson 2, Part 2. This lesson is about 30 slides long and will take approximately 25 minutes to complete.

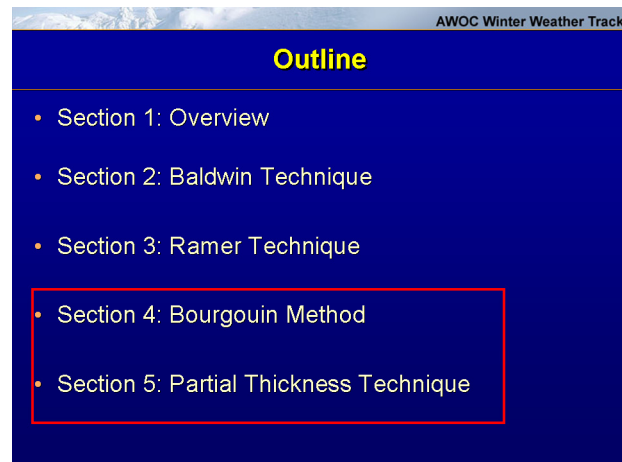
Student Notes:



2. Outline

Instructor Notes: Lesson 2 of IC 6 is divided into five sections. In Part 1 we discussed the learning and performance objectives, the utility of p-type algorithms, and then we focused on the Baldwin technique and the Ramer technique. Now, in Part 2, we will discuss the Bourgouin Method and Partial Thickness Method.

Student Notes:

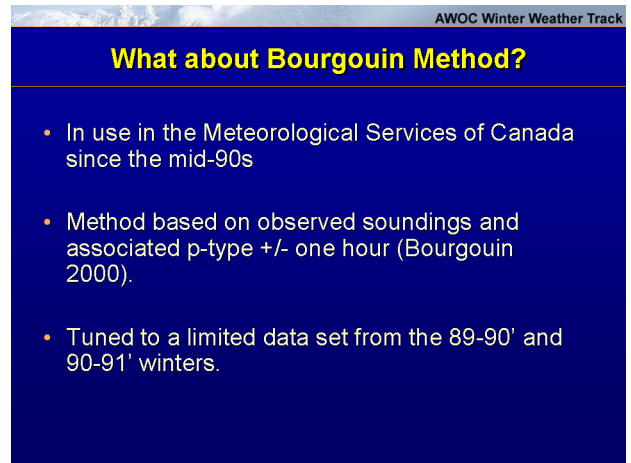


3. What about Bourgouin Method?

Instructor Notes: This method was developed by Bourgouin of the Canadian Meteorological Centre in Dorval, Quebec in the early 1990's and it has been in use in the Meteo-

rological Services of Canada since the mid 1990's. The method was developed by looking at a data set of cases in which surface precipitation observations were collocated with upper air soundings. The upper air soundings provided the vertical temperature structure needed to establish the criteria utilized in the method. RAOB drift was not accounted for and values were assumed to be above the sounding site. The precipitation had to be reported within one hour of the time that the sounding was taken and at the same location for it to be included in the data set utilized to tune the method. This criteria and the fact that the technique was tuned over only two winter seasons (1989-90 and 1990-91) resulted in a small training data set. For example, it was initially tuned to 54 cases of freezing rain versus ice pellets, 119 cases of rain versus snow, and 3-5 cases of ice pellets versus rain. The number of cases with respect to ice pellets versus rain is uncertain in that there is no information on the exact state of the hydrometeor aloft, (i.e., as it enters a surface based warm layer) so the number of cases is estimated.

Student Notes:



AWOC Winter Weather Track

What about Bourgoquin Method?

- In use in the Meteorological Services of Canada since the mid-90s
- Method based on observed soundings and associated p-type +/- one hour (Bourgoquin 2000).
- Tuned to a limited data set from the 89-90' and 90-91' winters.

4. Bourgoquin Method – the Basics

Instructor Notes: The method is built on the premise that the temperature variation of a falling hydrometeor and its resulting phase changes are predominately driven by the temperature of the environment through which the hydrometeor falls. Clearly, a hydrometeor falling through a layer with temperatures above freezing temperatures will become liquid if it resides in this layer for a sufficient time. Given this premise, the method assumes that two parameters drive p-type, the mean temperature of a layer and the residence time of the hydrometeor in this layer. The mean temperature of a given layer can be readily computed for both observed and forecast soundings. The same cannot be said of the residence time of the hydrometeor in a layer as the residence time is dependant on the depth of the layer, the terminal velocity of the hydrometeors, and the mean vertical motion. Therefore, the method assumes a constant vertical motion and terminal velocity. The assumption of a constant terminal velocity could be considered a weakness as different crystal structures have different falls speeds. However, it is not clear how significant this variation could be or how one could account for it operationally.

Student Notes:

AWOC Winter Weather Track

Bourgouin Method – the Basics

- Two parameters to assess P-type
 - Mean temperature of a layer
 - Terminal velocity of Hydrometeors
- Calculates the residence time in a layer
 - Constant vertical motion
 - Constant terminal fall speed
- This is a potential weakness as crystals have different terminal velocities

5. Bourgouin Method – the Basics

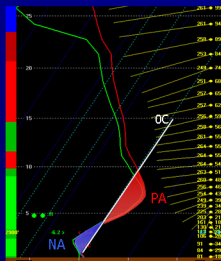
Instructor Notes: Given these concepts it is clear that one can combine the mean temperature of a layer and the height of a layer by multiplying them together which will give you a value proportional to the area covered by the layer in question. Essentially, the algorithm determines if there is sufficient energy to melt or freeze hydrometeors as they fall. A positive area is defined as the area between the 0 degree C isotherm and the environmental temperature in the above freezing layer. Conversely, a negative area is defined as the area between the 0 degree C isotherm and the environmental temperature in the below freezing layer. Positive and negative areas in a given sounding are computed, bounded by the 0 degree C isotherm and the environmental temperature curve. The precipitation type (snow, freezing rain, ice pellets, or rain) is determined by the magnitude of the positive and negative areas. In cases where two precipitation types are determined to be of equal likelihood, one or the other is chosen randomly.

Student Notes:

AWOC Winter Weather Track

Bourgouin Method – the Basics

- Calculates the energy in positive and negative areas to derive p-type
- Positive Area (PA)
 - Area between the 0°C isotherm and the environmental temperature in the above freezing layer
- Negative Area (NA)
 - Area between the 0°C isotherm and the environmental temperature in the below freezing layer



6. Bourgoquin Method – Rain vs. Snow

Instructor Notes: The most obvious forecast is when ice crystals are present and the entire profile is sub-freezing then you will have snow or the entire profile is above freezing in which case you will obviously have rain. Obviously, rain versus snow considerations get much more complex than this. When you have a surface based warm layer (or positive area) with no warm air aloft (in other words all negative area aloft) the possibilities are confined to rain, snow, or a mix of the two. To differentiate between profiles of this type the Bourgoquin method interrogates the positive area at the surface.

Student Notes:

AWOC Winter Weather Track

Bourgoquin Method – Rain vs. Snow

- Surface based PA with sub-freezing profile aloft becomes a rain vs snow decision
- Strength of the surface PA determines p-type

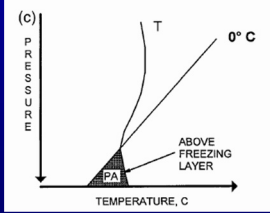
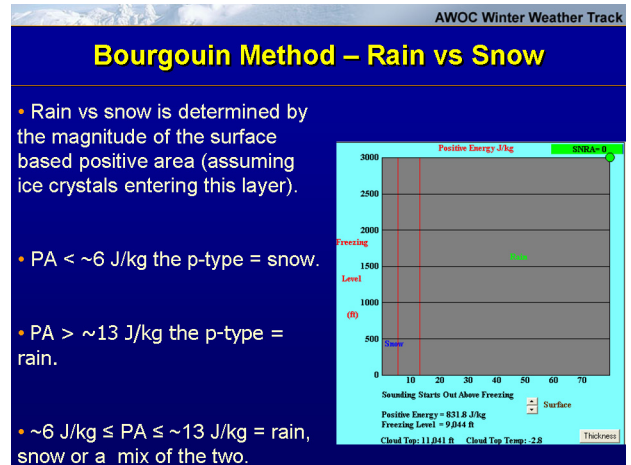


Image from Bourgoquin 2000

7. Bourgoquin Method – Rain vs. Snow

Instructor Notes: In cases such as the one we just described, the table on the right is utilized to differentiate between rain and snow. If the surface based positive area is less than roughly 5.5 J/kg it will predict snow. If the surface based positive area is greater than a little over 13 J/kg it is determined to be rain. Between these two values the method assumes a rain/snow mix. Here is an example of how the snow versus rain table looks when displayed in the Bufkit software. Note they only considered cases with small surface based positive areas (less than 20 J/kg) as surface warm layers stronger than this were associated with surface temperatures well above freezing and were clearly strong enough to completely melt any frozen hydrometeors. Also, it is important to note that the Bourgoquin method assumes ice crystals are entering the surface layer. It does not perform a check for the initial state of the hydrometeor.

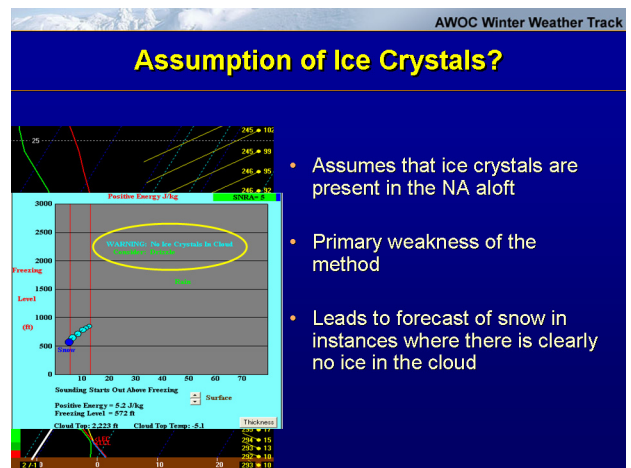
Student Notes:



8. Assumption of Ice Crystals?

Instructor Notes: The Bourgouin Method does not check the negative area aloft for saturation to ensure that the moisture is deep enough and temperature cold enough to support heterogeneous nucleation of ice crystals. This is the primary weakness of the method and one that you should keep in mind when you look at output from the Bourgouin method. Note in the example shown that the saturated layer only extends to a temperature of -4 or -5 degrees C and that the profile is very dry at temperatures of -10 degrees C and below. Clearly this is a case where it would be unlikely that we would have ice crystals present. However, the output from the Bourgouin algorithm indicates snow. Utilizing the top-down methodology you will quickly catch this, but if you were to look at the algorithm output in a vacuum you may get a forecast of snow in what turns out to be a freezing drizzle event. BUFKIT has an added check to account for this and will display a message (as seen on this slide) alerting you to the likelihood that heterogeneous nucleation may not occur in the given profile.

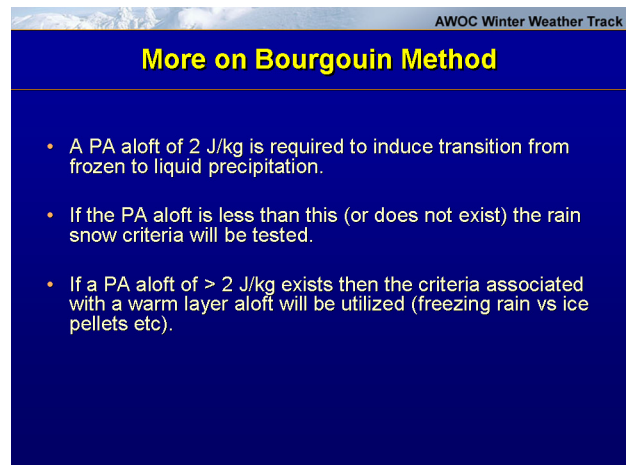
Student Notes:



9. More on Bourgoquin Method

Instructor Notes: The database utilized to tune the Bourgoquin method did not contain, or only contained a very small number of, cases of mixed snow and freezing rain or mixed snow and ice pellets, so these scenarios are not addressed by the method. Based on the soundings studied during development of the algorithm it was found that it only took a positive area of 2 J/kg to induce the transition from frozen to liquid precipitation. If the positive area aloft (if any) is less than 2 J/kg then it assumes that the ice crystals are not melted and it will look at the low levels to test the rain versus snow criteria. If there is a positive area of 2 J/kg or greater aloft then the algorithm assumes complete melting of the ice crystals and then it will look at the low level to determine if the resultant precipitation type should be freezing rain, ice pellets, or rain.

Student Notes:



AWOC Winter Weather Track

More on Bourgoquin Method

- A PA aloft of 2 J/kg is required to induce transition from frozen to liquid precipitation.
- If the PA aloft is less than this (or does not exist) the rain snow criteria will be tested.
- If a PA aloft of > 2 J/kg exists then the criteria associated with a warm layer aloft will be utilized (freezing rain vs ice pellets etc).

10. Bourgoquin Method – ZR vs. IP

Instructor Notes: This example demonstrates how the Bourgoquin method would consider a freezing rain or ice pellet case. It was found in the research that the most promising predictors of ice pellet versus freezing rain cases were the positive and negative areas in the sounding (that is a positive area above a surface based negative area). The positive area aloft would be enough to melt any frozen hydrometeors, in this example. If the hydrometeor completely melts and then falls into a sub-freezing surface layer then the question becomes is there enough negative area to completely re-freeze the hydrometeors as ice pellets or will it reach the surface as freezing rain.

Student Notes:

AWOC Winter Weather Track

Bourgouin Method – ZR vs IP

- Freezing rain vs ice pellet sounding scenario
- Positive area aloft ≥ 2 J/kg would completely melt ice crystals
- The negative area below shows the potential the potential for freezing rain or ice pellets.

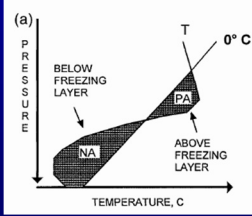


Image from Bourgouin, 2000

11. Bourgouin Method – ZR vs. IP

Instructor Notes: The Bourgouin study actually found a pretty clear delineation between freezing rain and ice pellets in scenarios such as this based on the strength of the positive area aloft and the negative area near the surface. They found that even a small positive area aloft (say, greater than 2 J/kg) will lead to freezing rain so long as the surface based negative area is relatively small (say, less than 50 J/kg). For cases with a weak positive area (left hand side of the image) it was found that a negative area greater than around 100 J/kg would lead to ice pellets while cases with stronger positive areas aloft would require a stronger negative area to completely refreeze the hydrometeors to ice pellets. The study noted that with a small positive area (2 J/kg or less), it is possible to get some snow mixed in with the freezing rain or ice pellets. However, they did not attempt to discriminate whether or not freezing rain or ice pellets would be mixed with snow. Obviously, if you have a reliable sounding near these thresholds you will likely want to forecast a mix of precipitation types. The resultant diagram shown on this image is utilized in the Bourgouin method to differentiate between ice pellets and freezing rain when you have a positive area aloft and a negative area at the surface.

Student Notes:

AWOC Winter Weather Track

Bourgouin Method – ZR vs. IP

- Clear separation between ice pellet and freezing rain cases
 - Compare PA aloft and NA at surface
- Surface NA > 75-100 J/kg (depending on the strength of the PA aloft) will result in ice pellets
 - With liquid entering layer
- Diagonal lines equate to a transition zone

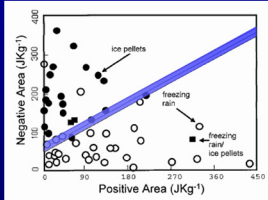
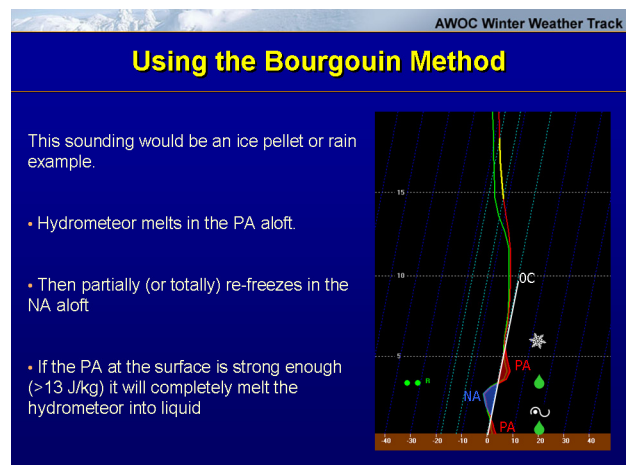


Image from Bourgouin, 2000

12. Using the Bourguoin Method

Instructor Notes: The area (or Bourguoin) method follows a theoretical hydrometeor as it falls through different temperature layers. In the sounding you will note that there are two positive areas (one at the surface and one aloft) with a negative area in between the two. To determine the p-type in a scenario such as this the method will attempt to mimic the behavior of the hydrometeor as it descends. Let's look at how the Bourguoin technique would handle a scenario such as this. The method assumes that the hydrometeors start off as ice crystals, so the first question is whether the positive area aloft is sufficient to melt the ice crystals. As the crystal enters the positive area aloft the method would assume complete melting as this positive area is greater than 2 J/kg. So, as it exits the positive area aloft the method would treat hydrometeors as being in liquid form. It would then check to determine if the negative area is strong enough to completely re-freeze the hydrometeors by looking at the strength of the positive area aloft and the negative area beneath it. If the negative area is less than 75-100 J/kg it will treat the hydrometeors as liquid as they exit the bottom of the negative area. Then as the hydrometeors enter the surface based positive layer, in this case, the method will determine the resultant precipitation type as rain.

Student Notes:

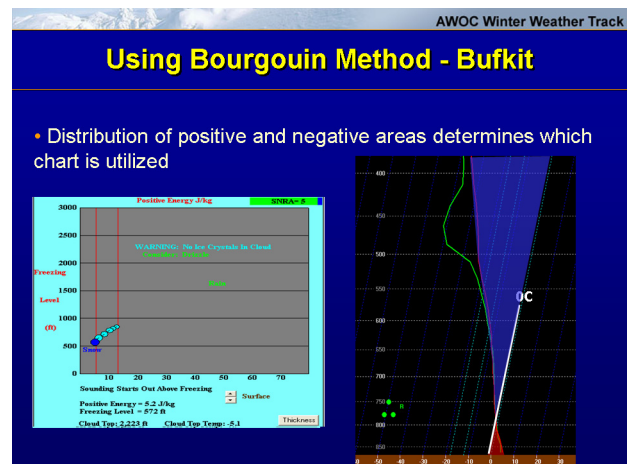


13. Using Bourguoin Method - BUFKIT

Instructor Notes: Keep in mind that the appearance of the Bourguoin charts will change depending on the vertical temperature profile. Depending on the vertical distribution of the positive and negative areas different charts are utilized to assess the resultant p-type. In this first example, we have two positive areas adjacent to an elevated negative area. The Bourguoin method treats this as a sleet versus rain decision and utilizes the chart shown on the left. In this next example, we have a positive area aloft and a negative area at the surface. This is treated as a freezing rain versus sleet scenario. Finally, in this last example we have a negative area aloft and a positive area at the surface. This is a rain versus snow decision and the Bourguoin method utilizes the chart displayed on the left. Keep in mind that as you step through time the vertical profile will change. As the

vertical profile changes the distribution of the positive and negative areas will change as well which may result in different Bourgoiu charts being utilized for different time periods in the forecast time frame of concern. The best place to view the output from the Bourgoiu technique is in the BUFKIT software. In BUFKIT the Bourgoiu output can be displayed for any model sounding. As you step through the hourly or three hourly soundings, with the Bourgoiu technique toggled on, the appropriate chart will display based on the distribution of the positive and negative areas in the profile.

Student Notes:



14. Bourgoiu Technique: Strengths and Weaknesses

Instructor Notes: The Bourgoiu technique has several strengths. First, it was developed based on observed soundings and the precipitation type associated with those soundings. It can also be applied to any region or model output. The technique also has a high POD for freezing rain cases. There are also several weaknesses to the method. Foremost of these is the assumption that ice crystals are present. The assumption that heterogeneous nucleation has occurred can easily lead to precipitation type forecast failures. Another weakness is that it does not account for dry layers. This has the same effect as what was discussed with the Ramer technique in that hydrometeors are not allowed to sublime. This is compounded by the methodology's use of the temperature as opposed to the wet-bulb temperature. By utilizing the temperature and ignoring dry layers the technique does not appropriately consider sublimation or evaporation and the associated wet-bulb cooling as hydrometeors fall through an unsaturated layer. Finally, the technique assumes a constant terminal velocity of hydrometeors. Hydrometeors have different terminal velocities based on their size and shape and this impacts the residence time of a hydrometeor in a given layer.

Student Notes:

AWOC Winter Weather Track

Bourgouin Technique: Strengths and Weaknesses

<u>Strengths</u>	<u>Weaknesses</u>
<ul style="list-style-type: none"> Based on observed soundings and associated precipitation types Can be applied to any region or model output High POD for freezing rain cases 	<ul style="list-style-type: none"> Assumes heterogeneous nucleation Does not account for dry layers Uses T instead of Tw Assumes consistent terminal velocity of hydrometeors

15. Quiz Break 1

Instructor Notes: Time for a short Quiz Break. Assume that you have precipitation associated with this sounding. Which of the Bourgouin technique's weaknesses would come into play with this profile? When you are ready to see the answer click 'Next' to advance to the next slide.

Student Notes:

AWOC Winter Weather Track

Quiz Break 1

Assume that you have precipitation associated with this sounding. Which of the Bourgouin technique's weaknesses would come into play with this profile?

- A. Inability to assess dry layers
- B. Assumption of a constant terminal velocity
- C. Assumption of heterogeneous nucleation
- D. Use of T instead of Tw

Advance to next slide for answer

16. Quiz Break 1

Instructor Notes: The correct answer is C. Given that the profile is saturated to only -5 degrees C the Bourgouin technique's assumption that ice crystals are present would come into play in this example. The Bourgouin would assume that ice crystals are present and since there is no positive area in the sounding it would forecast a precipitation type of snow. Since the sounding is only saturated to around -5 degrees C it is unlikely that ice crystals are present in this cloud layer and the most likely precipitation type would actually be freezing rain.

Student Notes:

AWOC Winter Weather Track

Quiz Break 1

- Assume that you have precipitation associated with this sounding. Which of the Bourgooin technique's weaknesses would come into play with this profile?

- A. Inability to assess dry layers
- B. Assumption of a constant terminal velocity
- C. Assumption of heterogeneous nucleation
- D. Use of T instead of Tw

17. What About the Partial Thickness Technique?

Instructor Notes: The partial thickness method was developed prior to widespread access to gridded data and BUFR soundings. Essentially, the method assesses layer thickness values to interrogate warm and cold wedges aloft and at the surface. While the technique is not as detailed as more rigorous sounding analysis methods such as the top-down methodology it can be useful in plan view mode as it may assist the forecaster in the identification of areas that require more thorough inspection. This methodology is also useful in later time periods when you are looking to get handle on the potential range in the precipitation type and not as confident in the details of the vertical profile.

Student Notes:

AWOC Winter Weather Track

What About the Partial Thickness Technique?

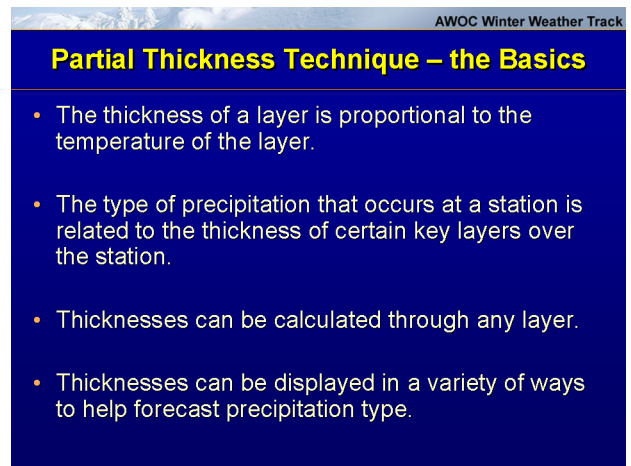
- Developed prior to widespread access to gridded data and BUFR soundings (Keeter and Cline 1991)
- Correlates layer thickness with warm/cold wedges aloft and surface warm/cold layers
- Can be useful in a plan view mode to help you focus on trouble spots
- Also useful in later time periods when you just need to get an idea for the potential range in the p-type

18. Partial Thickness Technique – the Basics

Instructor Notes: Forecasters have been using thickness to forecast precipitation type for many years. However, recent advances in computing power have allowed forecasters and researchers to develop and apply some new approaches to this technique. Thickness techniques are based on the fact that the thickness of a layer, defined by 2 constant pressure levels, is proportional to the temperature of the layer, with lower thicknesses

corresponding to lower temperatures. Previous research has shown that reliable precipitation type thresholds for thicknesses can be determined for a given station. For example, it was determined many years ago that snow was favored over rain at many locations when the 1000-500 mb thickness is below 540 dm. Similar thresholds have been determined at many locations for smaller layers, such as 1000 to 850 mb and the 850 to 700 mb. The term “Partial” in Partial Thickness refers to the fact that these layers comprise only part of the traditional 1000 to 500 mb layer. Modern computing power now allows forecasters to easily compute observed and model forecast thicknesses for a variety of layers, and allows forecasters to combine and display combinations of various thicknesses in a variety of ways in order to visualize the horizontal and vertical temperature profile in an effort to forecast precipitation type.

Student Notes:



AWOC Winter Weather Track

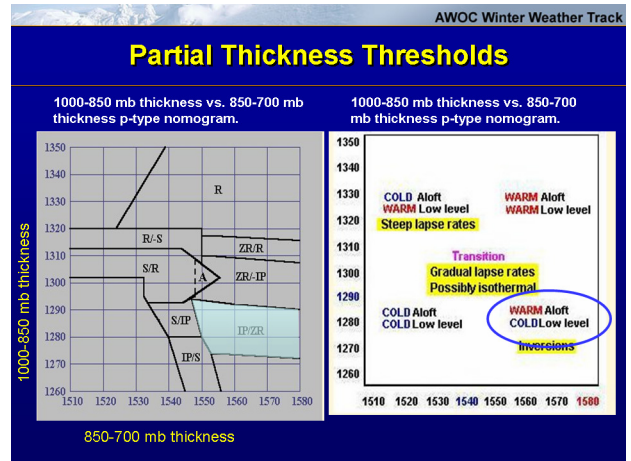
Partial Thickness Technique – the Basics

- The thickness of a layer is proportional to the temperature of the layer.
- The type of precipitation that occurs at a station is related to the thickness of certain key layers over the station.
- Thicknesses can be calculated through any layer.
- Thicknesses can be displayed in a variety of ways to help forecast precipitation type.

19. Partial Thickness Thresholds

Instructor Notes: The thickness thresholds indicated by the nomograms shown on this slide were developed for Greensboro, North Carolina. Research in the Carolinas indicate that these thresholds work well at locations with elevations ranging from sea-level to around 1500 feet above sea-level. Note that the forecast technique suggested by these nomograms involves combining low-level thickness with mid-level thickness to derive precipitation type. For example, a small 1000-850 mb thickness in combination with a large 850-700 mb thickness (the lower-right portion of the nomogram) implies cold air at low levels, with warmer air aloft, and the likelihood of freezing precipitation.

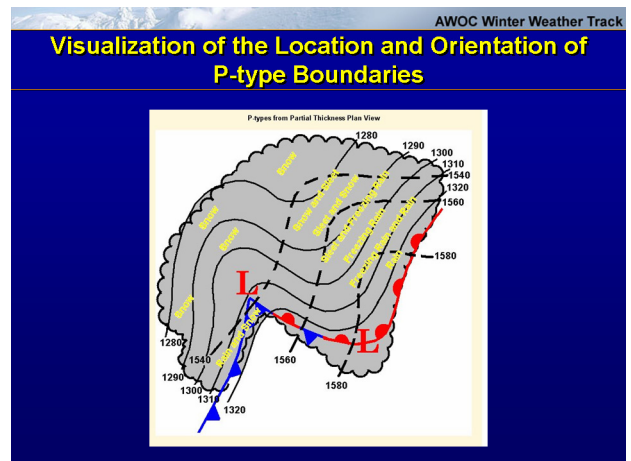
Student Notes:



20. Visualization of the Location and Orientation of P-type Boundaries

Instructor Notes: One advantage of utilizing the partial thickness method in the forecast process is the increased ability to visualize the location and movement of precipitation type boundaries across wide areas in plan view. In the example shown on this slide, the plot of partial thickness values would help the forecaster visualize the likely location of precipitation type boundaries in a complex situation. The forecaster would then be able to further refine his or her forecast by performing a high resolution sounding analysis at a few key locations utilizing a more rigorous methodology such as the top-down method. In addition, viewing this type of display in a time-lapse mode would also allow forecasters to visualize the evolution of the atmospheric thermal environment; for example, the advance or retreat of cold air at low or midlevels.

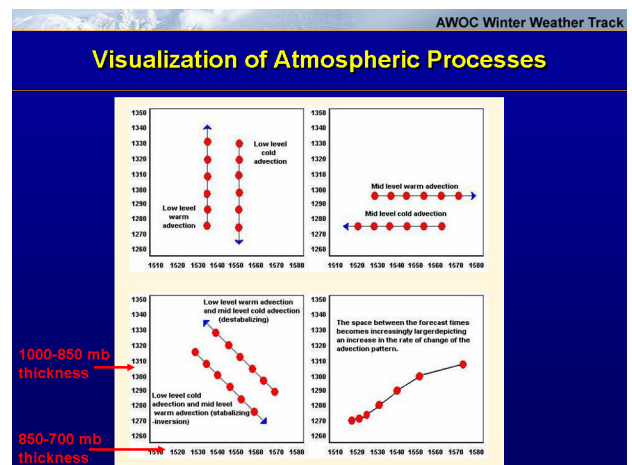
Student Notes:



21. Visualization of Atmospheric Processes

Instructor Notes: Another application of partial thickness is shown on this slide. Viewing the time-evolution of partial thickness values at a particular site can give the forecaster insight into what kind of atmospheric processes are at work. For example, in the graph at the upper left, low-level temperature advection, in the absence of mid-level temperature advection, is indicated when the low-level thickness is changing, but the mid-level thickness remains constant. The graph at the upper right shows the opposite condition; mid-level temperature advections are indicated with an absence of low-level temperature advection, when the mid-level thickness values change while the low-level thickness values remain constant. The 2 graphs at the bottom of this slide show the response of the thickness values in sample situations for various combinations of lower and mid-level temperature advection.

Student Notes:



22. Partial Thickness Technique: Strengths and Weaknesses

Instructor Notes: In summary, the use of partial thickness to forecast precipitation type has both strengths and weaknesses. The first strength is that partial thickness values are derived from fields, specifically height fields, that are well-forecast by the models. In contrast, sounding interrogation techniques sometimes rely on accurate model forecasts of shallow warm layers, and subtle boundary layer temperature structures, that may not be as well-forecast. Another strength is that partial thicknesses can be displayed in ways that help the forecaster visualize the location and movement of precipitation type boundaries, and to visualize the atmospheric processes that are affecting the vertical profile. The primary weakness of the partial thickness technique is that it does not take advantage of the full vertical resolution of the model. For example, the NAM model currently has a vertical resolution of 60 layers, with the majority of those layers located below 500 mb. Partial thickness techniques only involve the diagnosis of a very limited number of those layers (typically 2), and may sometimes miss important details in the forecast verti-

cal structure of the atmosphere, especially in situations where very shallow layers of warm or cold air are present. For example, rain can sometimes occur at stations near large, unfrozen bodies of water when partial thickness values are below typical rain/snow thresholds, if a shallow, mild layer of maritime air is present near the surface. Another weakness of partial thickness is that threshold values can vary by station, depending on the geographic characteristics of the station. For example, locations at higher elevations tend to have higher rain/snow thresholds of partial thickness. Forecasters should also keep in mind that microphysical processes are not accounted for in any partial thickness technique. For example, the partial thickness technique may erroneously predict snow in situations where the entire sounding is below freezing, yet the moist layer does not extend into a layer where the temperature is below -10 degrees C and therefore the profile is not likely to support heterogeneous nucleation. Because of these weaknesses, it is not recommended that partial thickness forecasting techniques be used alone to forecast precipitation type. If you choose to utilize the partial thickness technique it may be best to utilize partial thicknesses for plan view visualization, and visualization of atmospheric processes, and then utilize more through sounding interrogation to account for shallow warm and cold layers, as well as for microphysical considerations.

Student Notes:

AWOC Winter Weather Track

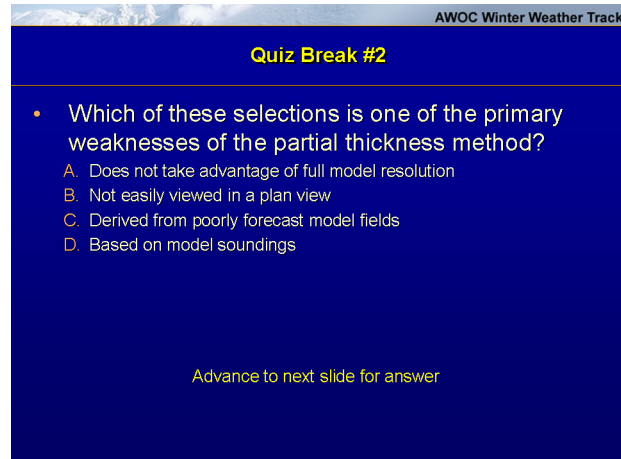
Partial Thickness Technique: Strengths and Weaknesses

<u>Advantages</u>	<u>Disadvantages</u>
<ul style="list-style-type: none"> • Values derived from fields that are well-forecast by the models • Plan view displays allow for a quick assessment • Examination of temporal trends allows forecasters to visualize key processes 	<ul style="list-style-type: none"> • Not taking advantage of the full vertical resolution of the model • Threshold values vary by station depending on geographic characteristics • Microphysics not considered

23. Quiz Break #2

Instructor Notes: Time for a short quiz break. Which of these selections is one of the primary weaknesses of the partial thickness method? Click 'next' to advance to the next slide.

Student Notes:



AWOC Winter Weather Track

Quiz Break #2

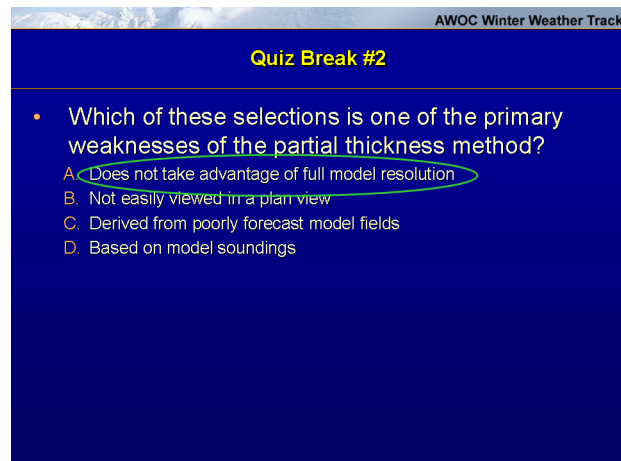
- Which of these selections is one of the primary weaknesses of the partial thickness method?
 - A. Does not take advantage of full model resolution
 - B. Not easily viewed in a plan view
 - C. Derived from poorly forecast model fields
 - D. Based on model soundings

Advance to next slide for answer

24. Quiz Break #2

Instructor Notes: The correct answer is A. One of the weaknesses of the partial thickness technique is that it does not take advantage of the full vertical resolution of current numerical models.

Student Notes:



AWOC Winter Weather Track

Quiz Break #2

- Which of these selections is one of the primary weaknesses of the partial thickness method?
 - A. Does not take advantage of full model resolution
 - B. Not easily viewed in a plan view
 - C. Derived from poorly forecast model fields
 - D. Based on model soundings

25. Summary: Strengths and Weaknesses of Algorithms

Instructor Notes: One key aspect to take away from this presentation is that all p-type algorithms have individual strengths and weaknesses. The best way to determine precipitation type is to utilize your own knowledge of the environment and potential model errors while applying the top-down methodology. However, p-type algorithms can assist you in the process of making the determination of p-type, particularly when you are looking at many points and time periods. The Baldwin method is widely available and is easy to understand and visualize why it is producing a given precipitation type. Another strength is its use of the wet-bulb temperature to determine precipitation type. The pri-

major weakness of the Baldwin method is with how it handles deep isothermal layers near the surface with temperatures between 0 degrees C and -4 degrees C. If these layers are sufficiently deep the Baldwin method will produce a forecast of rain or freezing rain it what is ultimately a snow sounding. The Ramer method may be the strongest algorithm statistically speaking. Another strength is its use of the wet-bulb temperature in a top-down process to determine precipitation type. It may be a more robust algorithm than the others, but it is correspondingly more difficult to understand how it arrived at a given precipitation type. While it is not as visually appealing as the others the primary weakness of the method is its inability to assess dry layers. The Bourgoin method again is easy to understand and has very useful charts to help visualize why it is producing a given precipitation type. The method is based on precipitation types associated with actual observed soundings which is a strength. However, the Bourgoin method does not check the initial state of the hydrometeor and, as a result, will assume ice crystals are present in some situations where heterogeneous nucleation has not been achieved. Another significant weakness is the use of T instead of Tw. Partial thickness concepts are particularly useful in plan views and for visualization of the potential distribution of precipitation. The methodology itself may not be as detailed as the others, but it readily lends itself assessing a larger area without requiring us as forecasters to look at a multitude of point soundings. Significant weaknesses of partial thickness techniques are that they do not consider microphysical concepts and do not take advantage of the details available in high resolution model data.

Student Notes:

AWOC Winter Weather Track

Summary: Strengths and Weaknesses of Algorithms

- **Baldwin**
 - Easy to understand; utilizes Tw
 - Problem with deep isothermal layers warmer than -4C near the surface
- **Ramer**
 - May be strongest statistically speaking, utilizes Tw
 - More difficult to understand; does not account for dry layers
- **Bourgoin**
 - Easy to visualize, based on observed soundings
 - Does not check state of initial hydrometeor; uses T instead of Tw
- **Partial thickness**
 - Good in plan views and for visualization
 - Do not consider microphysics, do not take advantage of high resolution model data

26. Availability of Different Techniques

Instructor Notes: Here is a brief review on the availability of the different algorithms. The Baldwin technique is available for the NAM BUFR data in BUFKIT and the NAM precipitation type selections in the AWIPS browser. It is also available on the EMC web site which shows an ensemble of precipitation type algorithm output. The Ramer technique is available for the GFS BUFR data in BUFKIT and is also available with the LAPS precipitation type display in AWIPS. The Ramer output is also displayed on the EMC web site alongside the Baldwin technique output. The Bourgoin method output can be displayed for any BUFR data output in BUFKIT. However, it is not available in AWIPS at this

time. Output from the partial thickness method can be displayed for any BUFR output in BUFKIT. It is also available in AWIPS as a local add-on to the Volume Browser selections.

Student Notes:

AWOC Winter Weather Track

Availability of Different Techniques

- **P-Type Ensemble**
 - WRF p-type in AWIPS and in Bufkit and GFS p-type in AWIPS
 - Baldwin, Revised Baldwin, Ramer, Bourgoiun, WRF microphysics
- **Baldwin**
 - Part of dominant p-type ensemble for WRF (AWIPS and Bufkit) and GFS in AWIPS
 - EMC website (http://www.emc.ncep.noaa.gov/mmb/precip_type/)
- **Ramer**
 - GFS BUFR data in Bufkit
 - Part of dominant p-type ensemble for WRF (AWIPS and Bufkit) and GFS in AWIPS
 - EMC website (as listed above)
- **Bourgoiun**
 - Available for any model in Bufkit
 - Part of dominant p-type ensemble for WRF (AWIPS and Bufkit) and GFS in AWIPS
- **Partial thickness**
 - Available for any model in Bufkit
 - Local add-on precipitation type icons in AWIPS

27. Interactive Quiz

Instructor Notes: Take a few moments to complete this interactive quiz.

Student Notes:

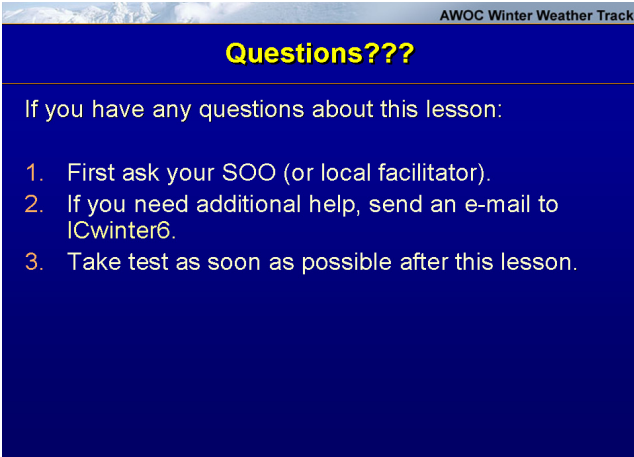
AWOC Winter Weather Track

Articulate Quizmaker Quiz Placeholder - IC 6 Lesson 2 Part 2 Quiz Question

28. Questions???

Instructor Notes: After going through this lesson if you have any questions, first ask your SOO, or local AWOC winter track facilitator. Your SOO or local facilitator should be able to help answer many questions. If you need additional info from what your SOO provided, send an E-mail to the address on the slide. This address sends the message to all the instructors involved with this IC. Our answer will be CC'd to your SOO so that they can answer any similar questions that come up in the future. We may also consider the question and answer for our FAQ page. Thanks for your time and good luck on the exam!

Student Notes:



AWOC Winter Weather Track

Questions???

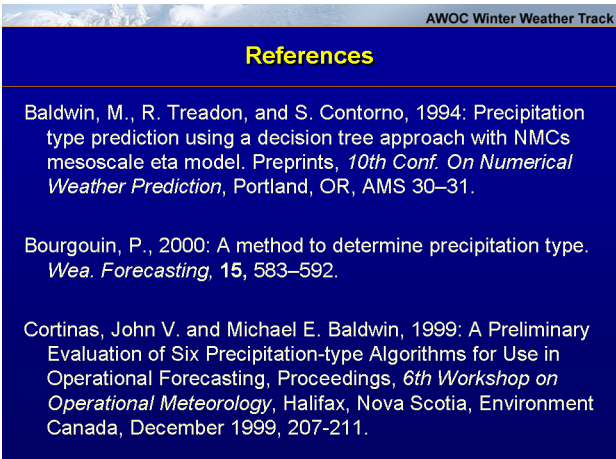
If you have any questions about this lesson:

1. First ask your SOO (or local facilitator).
2. If you need additional help, send an e-mail to ICwinter6.
3. Take test as soon as possible after this lesson.

29. References

Instructor Notes: References

Student Notes:



AWOC Winter Weather Track

References

Baldwin, M., R. Treadon, and S. Contorno, 1994: Precipitation type prediction using a decision tree approach with NMCs mesoscale eta model. Preprints, *10th Conf. On Numerical Weather Prediction*, Portland, OR, AMS 30–31.


Bourgouin, P., 2000: A method to determine precipitation type. *Wea. Forecasting*, **15**, 583–592.

Cortinas, John V. and Michael E. Baldwin, 1999: A Preliminary Evaluation of Six Precipitation-type Algorithms for Use in Operational Forecasting, Proceedings, *6th Workshop on Operational Meteorology*, Halifax, Nova Scotia, Environment Canada, December 1999, 207-211.

30. References

Instructor Notes: Additional references

Student Notes:



References

Keeter, K., and J. Cline, 1991: The objective use of observed and forecast thickness values to predict precipitation type in North Carolina, *Wea. Forecasting*, 6, 456–469.

Ramer, J., 1993: An empirical technique for diagnosing precipitation type from model output. Preprints, *5th International Conf. On Aviation Weather Systems*, Vienna, VA, AMS, 227–230.

UCAR MetEd web page “Winter Microphysics Topics” and “Topics in Precipitation Type Forecasting” available at <http://meted.ucar.edu>