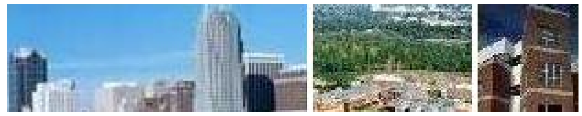
Event Summary
National Weather Service, Raleigh NC



January 25, 2000 Winter Storm

Note that this is a PDF version of the event summary and that some links, media or resources may not be avaiable in this format.

Event Headlines

...A powerful winter storm dropped record amounts of snow over central North Carolina...
...The all time single storm snow accumulation record for Raleigh-Durham was set with this storm when the airport received 20.3 inches of snow...
...The storm was not well forecast by numerical weather models...
...Over 100,000 homes were without power and many schools and business closed for several days...

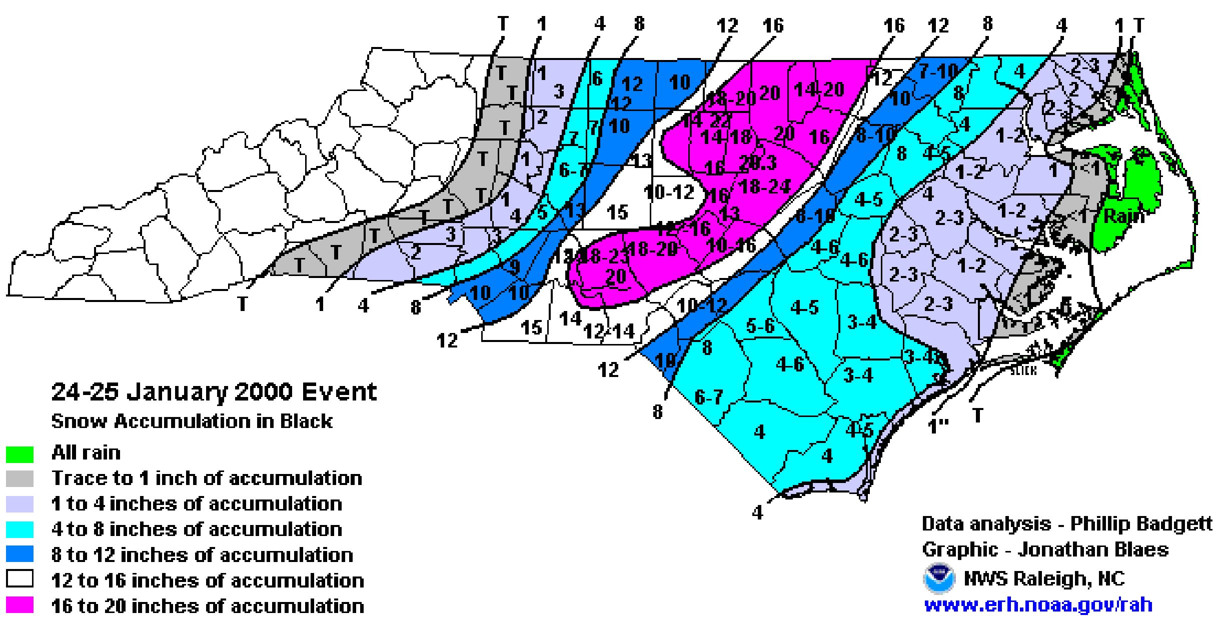
Objectives

...Summarize the January 25, 2000 snowstorm...
...Discussion of the model error in forecasting this storm...

Event Summary

This storm was the third of four storm systems to impact central North Carolina during a two week period featuring an active winter storm pattern that featured a deep trough over the eastern U.S. during the last two weeks of January, 2000. Winter storms impacted North Carolina on January 18, 2000; January 23, 2000; January 25, 2000 and January 30, 2000. The January 25, 2000 storm was preceded by a generally weak storm that dropped up to an inch of snow and some freezing rain across the North Carolina Peidmont on January 23. As this storm moved off the Mid-Atlantic coast, a second low pressure system developed over Florida on the morning of the 24th. This storms system rapidly strengthened late in the day. Snow began falling during the afternoon and evening on January 24, as the storm moved north along the North carolina coast, dropping well over 10 inches of snow throughout central North Caorlina in 24 hours. The heaviest snowfall amounts of 15 or more inches occurred from Anson County northeast through Wake County and continuing into Virginia. Areas both east and west of this line received 5 to 10 inches. Locations near the coast, such as Wilmington, even received up to 5 inches of snow. This storm received a great deal of media attention including a news story on CNN.

Snow Accumulation Map



Synoptic Overview

As the Janurary 23 surface low and upper-level jet began to lift northeast away from North Carolina, a second short-wave trough was digging southeastward into the gulf states region. At 00Z on the 24th, a large area of precipitation stretched from the North Carolina coast through northern Florida. At around 06Z, an area of convection developed along the Gulf Coast over Louisiana and Southern Mississippi. By 12Z, the upper-level short-wave had begun to amplify and become negtively tilted, and a low pressure system formed over northern Florida.

As the deepening upper-level wave drew cold air southward, precipitation began falling into the relatively dry air airmass over the state, and surface temperatures fell to below freezing across much of the area. The upper-level support, coupled with a pre-existing baroclinic zone draped across the southeast, caused the surface low to strengthen off the South Carolina coast. As the area of new convection moved across the Southeast, it rapidly merged with the developing low pressure, creating an "instant occlusion" of the storm, which lead to rapid cyclogenesis. Heavy snow began began to fall just after midnight in the Raleigh-Durham area on the 25th (see surface observations above below). The low pressure system would eventaully deepen to around 986mb and move up the Atlantic seaboard, spreading snow across much of the Mid-Atlantic and New England by 06Z on the 26th.

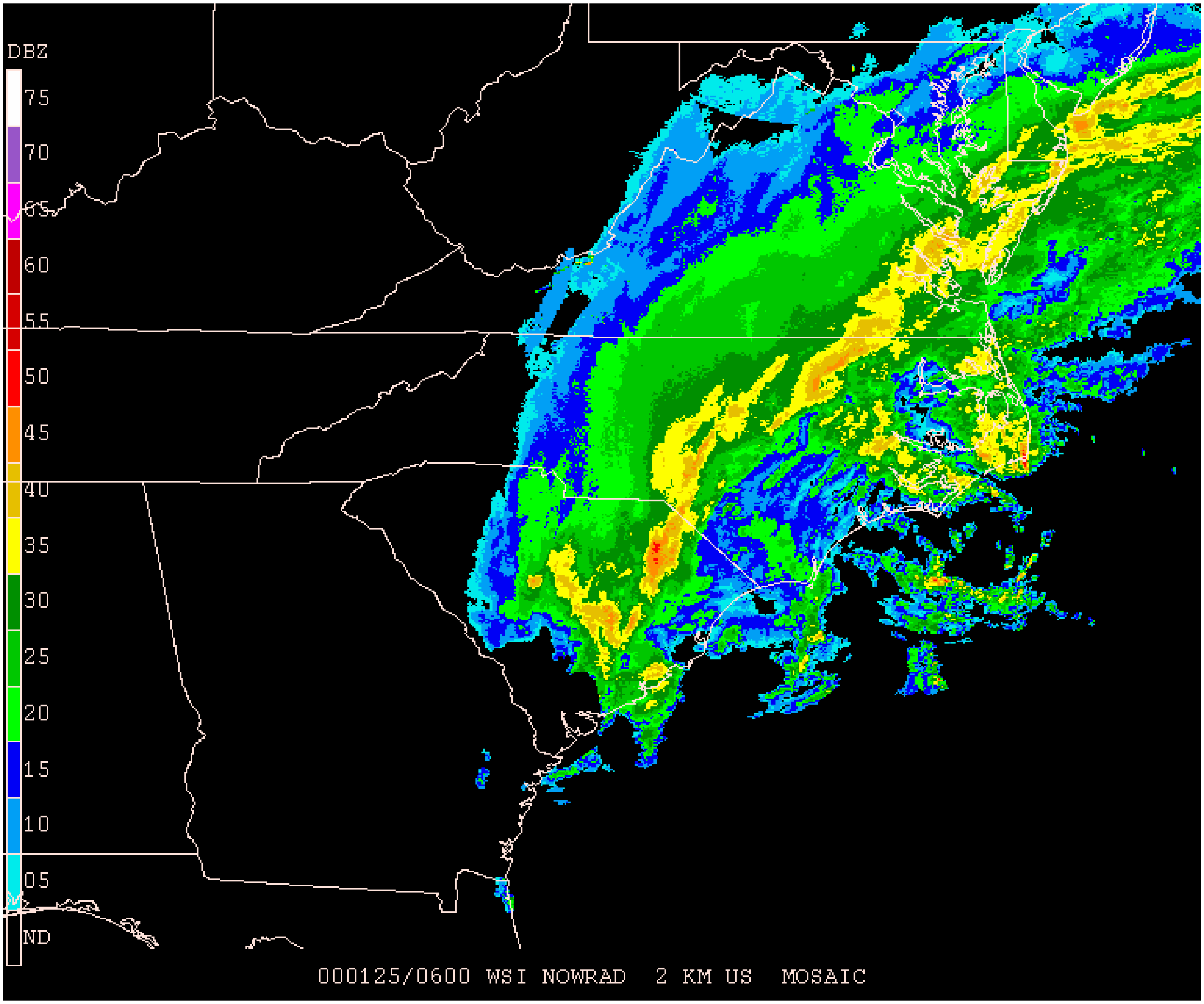
Surface Observations at Raleigh-Durham (KRDU)

The intensity of the snowfall, combined with the accumulation and strong winds, caused thousands of business and residents to be without power for several days. Observations from the Raleigh Durham International show six out of seven consectutive hours reporting heavy snow (*Note: 11Z Observation unavailable):

KRDU 250551Z 01016G27KT 1/4SM +SN FZFG SCT002 BKN006 OVC011 M02/M02 A2954
KRDU 250651Z 36012G19KT 310V030 1/4SM +SN FZFG OVC002 M02/M02 A2955
KRDU 250751Z 01013G25KT 1/4SM +SN FZFG OVC002 M02/M03 A2953
KRDU 250851Z 36009G19KT 330V040 M1/4SM +SN FZFG SCT002 OVC008 M03/M03 A2951
KRDU 250951Z 36013G29KT 310V030 M1/4SM +SN FZFG SCT002 OVC008 M02/M03 A2950
KRDU 251151Z 35010G21KT 310V050 1SM -SN BR SCT002 OVC009 M02/M03 A2952
KRDU 251251Z 34012G20KT 300V360 1/4SM +SN FZFG SCT002 BKN009 OVC014 M02/M03 A2952

Radar Observations

Heavy precitation can be seen in the regional radar reflectivty image from 06Z (100 AM) on January 25 below. A band of high radar reflectivity indicative of heavy precipiation is shown stretching across North Carolina. As the storm system intensified and moved up the coast the band evolved and rotated but it generally remained over central North Carolina resulting in the significant accumulations. A **radar loop from 00Z January 24 (700 PM January 23) through 11Z January 26 (600 AM January 26)** shows the evolution of the storm system including the initial storm on January 23, the development of precipation across the Gulf Coast states resulting from an intense upper level jet, to the rapid deepening of the primary storm on January 24 and 25, 2000.



Objective 2: Model Error

As forcasters scrambled to adjust forecasts to reflect the unfolding snowstorm, there was little time to analyze the full reason why the forecast had gone bad. In the wake of the storm, many were left wondering how nearly two feet of snow could have fallen in less than 24 hours with very little warning. Was there something that could have been analyzed ahead of time that would have lead to questioning of model precipitation forecasts? Or was there a physical mechanism that was misunderstood, or missed by the models? Below is a brief summary of a couple of the forecast errors and research topics that arose from this case.

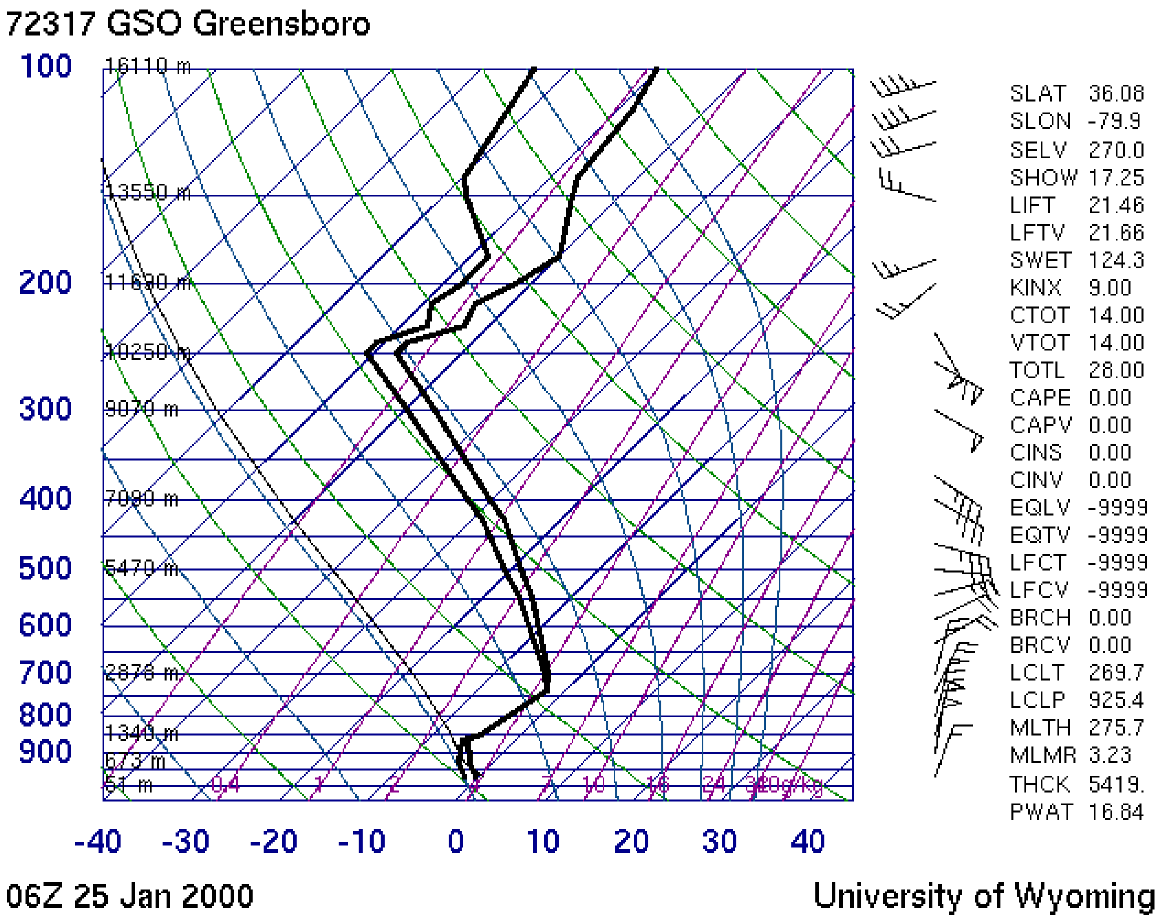
"Inscipient Precipitation"

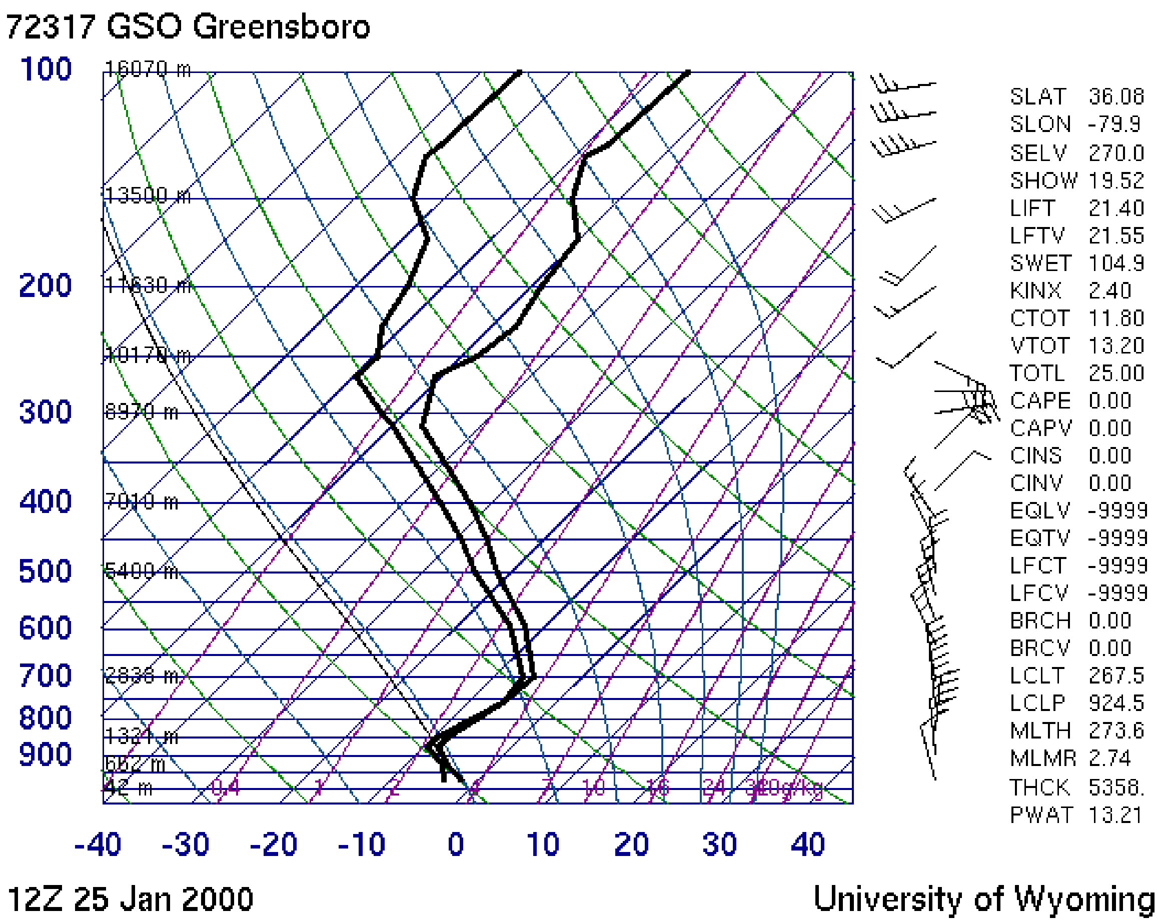
The precipitation that developed and intensified along the Gulf Coast was not captured by forecast models until well into the event. This lead to errors in precipitation forecasts all along the East Coast. Many forecasters were lead to believe that the heaviest precipitation would remain off-shore as the low track along the coast. The 24/00Z Eta model run shows the heaviest precipitation along and off the Carolina coasts. However, as previously discussed, the heaviest precipitation fell mainly in the form of snow and a couple hundred miles inland. The combination of poor model initialization, and the interaction of unforecast convection and the coastal low pressure system leading to rapid development, were part of the forecast problem.

Model Error/Latent-heating Feedback

Not only did the unforecast precipitation cause errors in the quanititative precipitation forecasts, but errors in temperature forecasts also became problematic. From the ETA model for 12Z January 25, 24 hour model thickness forecasts were 60 decameters too high, as observations showed a strong pocket of cold air over the Carolinas. While it is diffcult to speculate whether the model temperature forecasts would have been correct had the unforecast precipitation not occurred, it is evident that a physical response to the precipitation enhanced the forecast error.

Based on quasi-geostrophic (QG) theory, height rises (falls) occur above (below) a mid-level latent heating maximum, due to changes in the density of the air above and below. This response also creates a low-level maximum in cyclonic potential vorticity (PV), as low-level static stability is increased. The effects of the induced cyclonic PV max are manifest in wave amplification and enhanced rotation around the PV center. The PV max induced by the convection over the Southeast enhanced easterly flow downstream, creating stronger westward moisture advection over the Carolinas from off the Atlantic (Brennan and Lackmann 2005), thereby extending the heavy snowfall further inland. The combination of increased moisture advection, enhanced dynamics, and a deep subfreezing column of air see GSO soundings below), created an environment that was primed for intense winter weather.





Conclusion

The "Blizzard of 2000" was one of the most powerful on record across North Carolina. It was also one of the most poorly forecast. Many lessons have been learned from this event, including the importance of human analysis of the impending weather situation and awareness of upstream conditions. It is vital to compare model forecasts with observations, not only over the regional area, but also well upstream, in order to validate the model forecast for use. Another useful outcome of the storm has been the research on the role of latent heat release on the surrounding environment. The enhanced circulation around an area of positive PV where latent heating is strong was found to be instumental in supplying high ammounts of moisture to the forecast area. This knowledge can help forecasters in the furture to recognize this feedback, thus improving precipitation forecasts and situational awareness.

Case Study Team

Barrett Smith

References

Brennan, M. J., and G. M. Lackmann, 2005: The influence of inscipient latent heat release on the precipitation distribution of the 24-25 January 2000 U.S. East Caost cyclone.*Mon. Wea. Rev.*, **133,** 1913-1937.

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