Collaboration & Research Success:
NOAA/National Weather Service and North Carolina State University

Presented by:
Gail Hartfield
NOAA/NWS Raleigh, NC

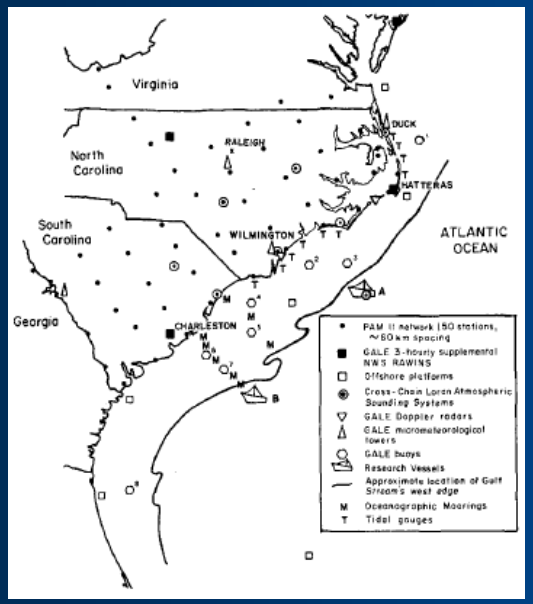
NWS-NCSU Collaborations: A long and storied road

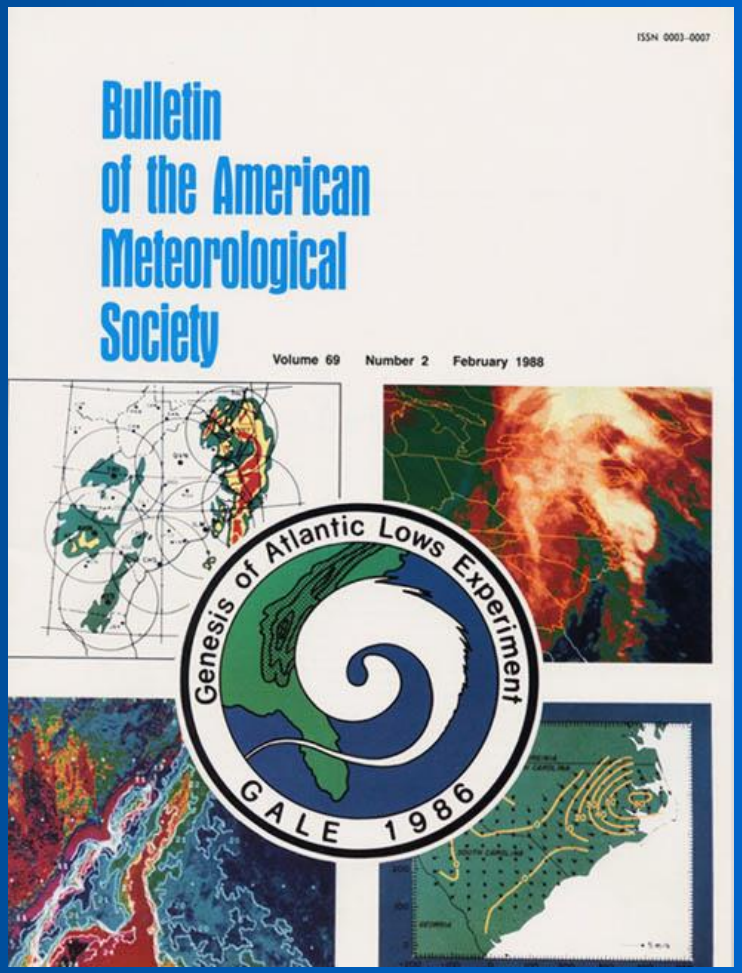
- 1970s:
  - John McClain (NWS) & Walter Saucier (NCSU)
  - Student internships
  - American Meteorological Society meetings, NCSU seminars
  - Forecast aids: winter precipitation type study, topography of flash flood

1Lt Walter J. Saucier
18th Weather Squadron
Commander

NWS-NCSU Collaborations: A long and storied road

- 1980s:
  - The GALE Project, studying the development of Atlantic storms





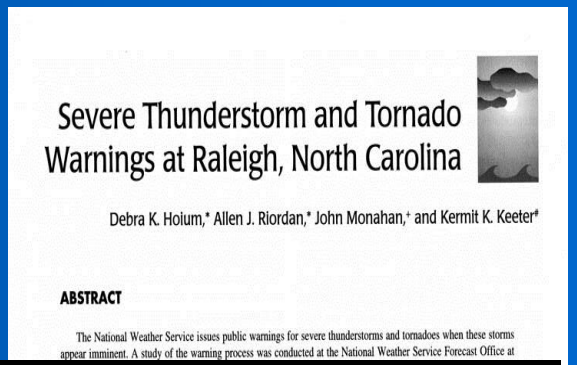
NWS-NCSU Collaborations: A long and storied road

- 1990s:
  - The Southeast Consortium on Severe Thunderstorms and Tornadoes
    - Included intensive study of the Nov. 28, 1988 Raleigh F4 tornado →
    - Paradigm for tornado outbreaks in the Carolinas/mid-Atlantic was developed
    - Conceptual models adopted by operational forecasters; computer-based tools for detection of tornado outbreaks later created

Photos courtesy of WRAL-TV

NWS-NCSU Collaborations: A long and storied road

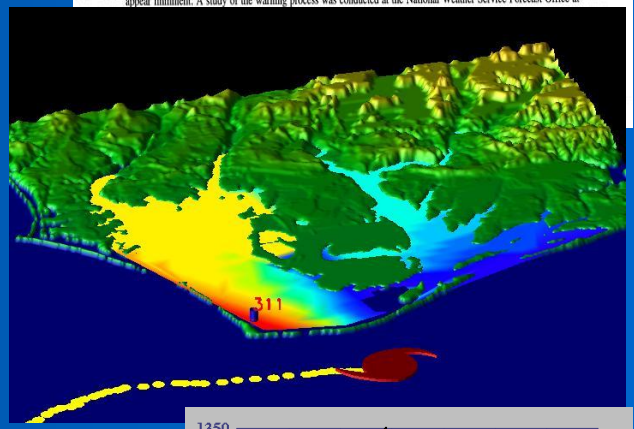
- 1990s:
  - Joint Severe Weather Collaboration
    - 38 students participated
    - 78 events, covering 277 hours
    - Warning decision process thoroughly analyzed
    - Benefited both students and NWS
  - Coastal flood model
  - Algorithm for determining winter precipitation type
  - Assessment of coastal cyclone intensification rates & development of forecast index

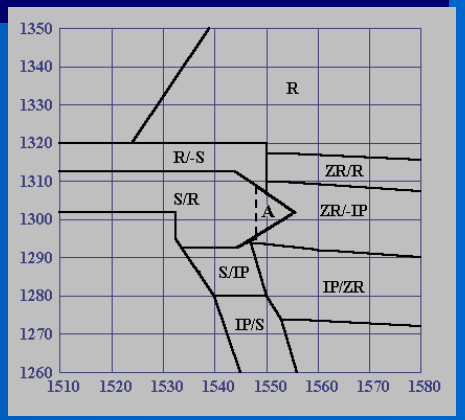

Severe Thunderstorm and Tornado Warnings at Raleigh, North Carolina

Debra K. Hoium,* Allen J. Riordan,* John Monahan,+ and Kermit K. Keeter#

ABSTRACT

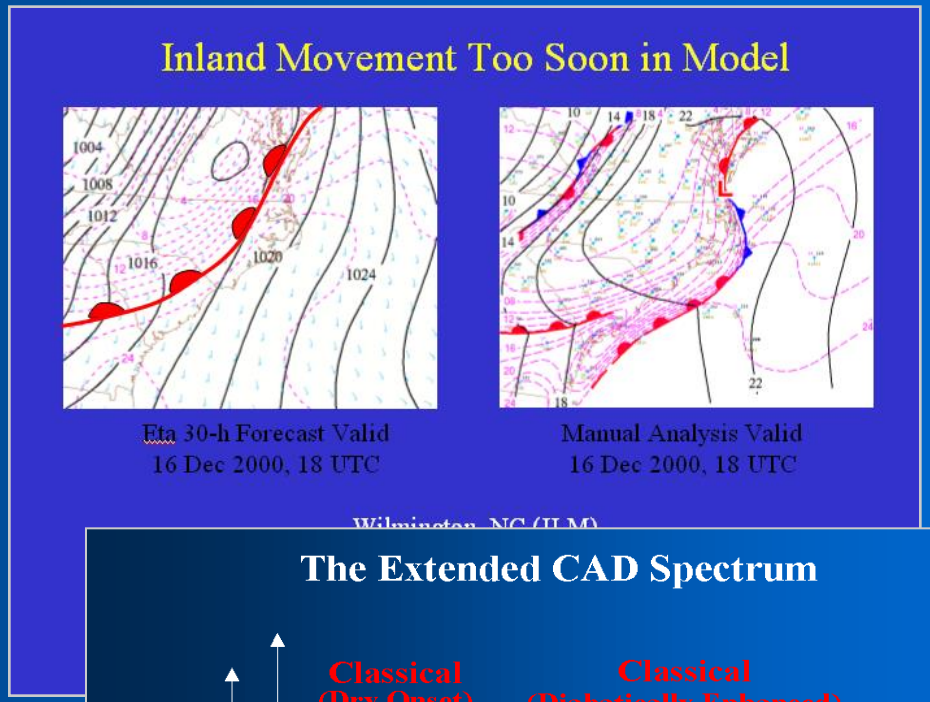
The National Weather Service issues public warnings for severe thunderstorms and tornadoes when these storms appear imminent. A study of the warning process was conducted at the National Weather Service Forecast Office at

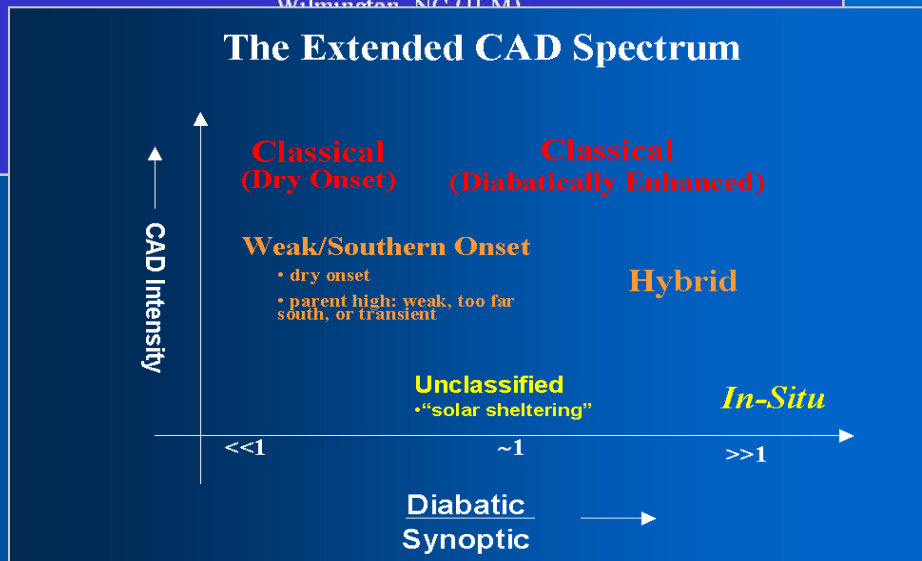




NWS-NCSU Collaborations: A long and storied road

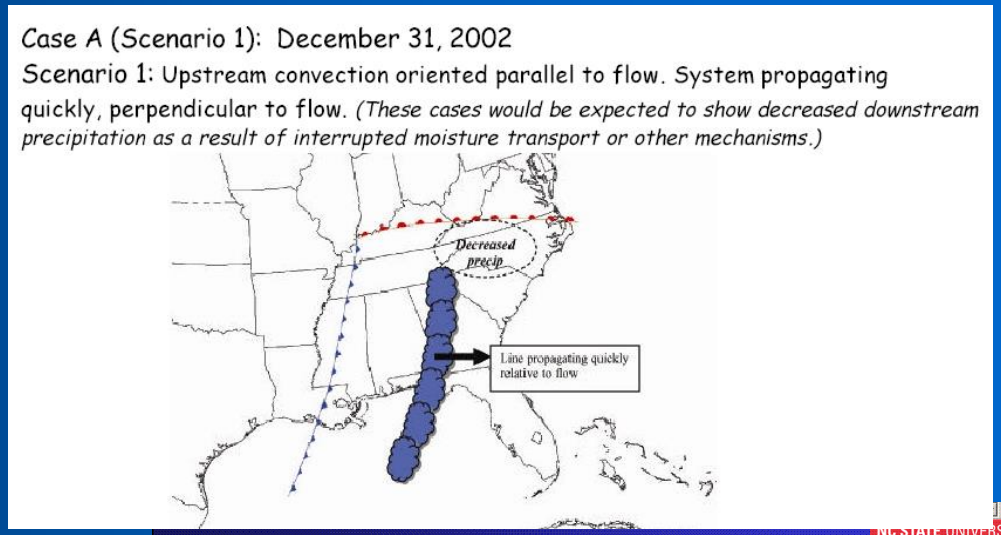
- 2000s:
  - 3 major NOAA-funded projects and other NSF and COMET projects; numerous papers & case studies published
  - Several VISITview seminars for NWS offices
  - Cold air damming climatology & development of classification system
  - Coastal front climatology & forecast aids

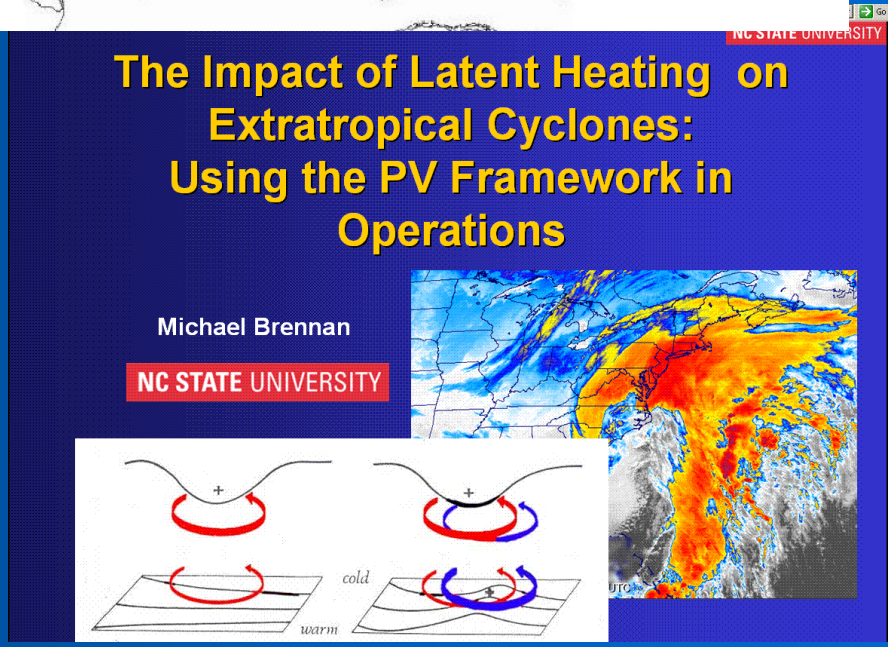




NWS-NCSU Collaborations: A long and storied road

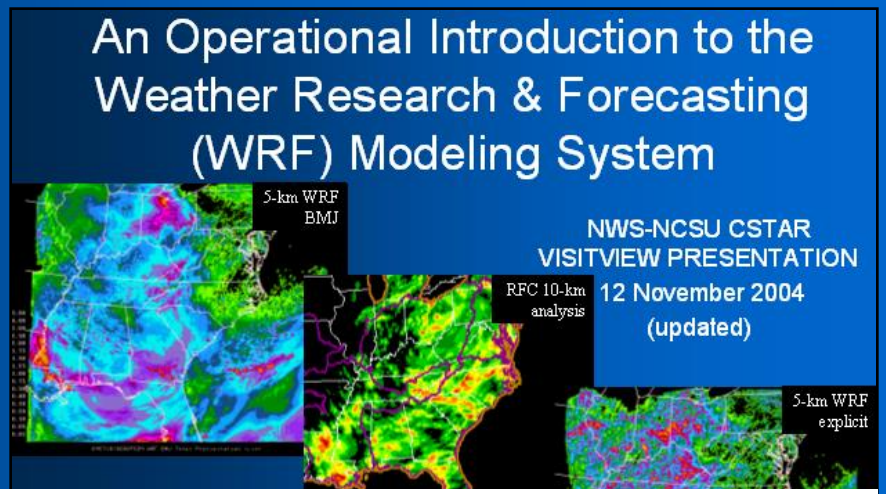
- 2000s (continued):
  - Assessing the effects of Gulf Coast storms on precipitation amounts in the Carolinas/mid-Atlantic region
    - Case studies led to conceptual models
    - Concepts have been applied operationally with success
  - Potential vorticity: "PV thinking" in operational forecasting





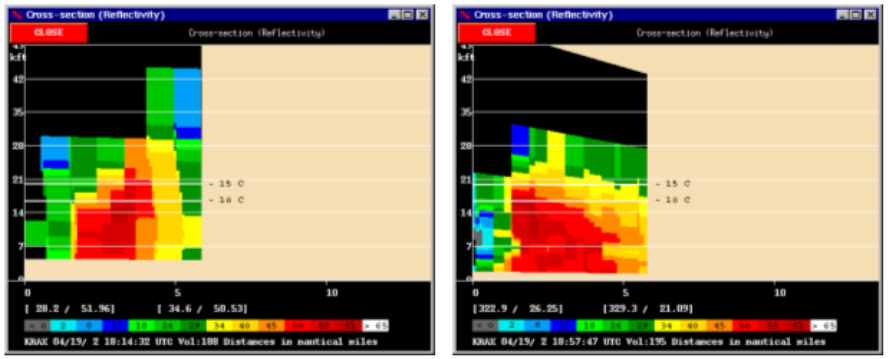
NWS-NCSU Collaborations: A long and storied road

- 2000s (continued):
  - Introduction to the Weather Research & Forecast (WRF) modeling system
  - Radar technique for forecasting the first lightning strikes was developed and implemented operationally



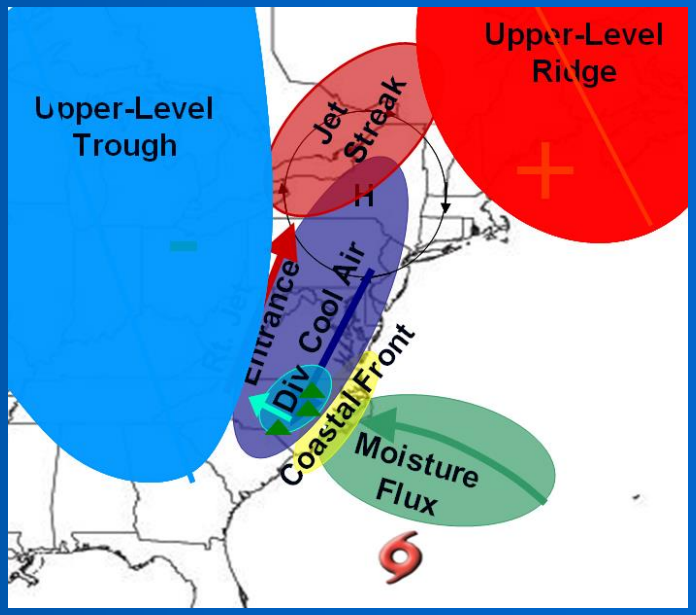
Detection Examples

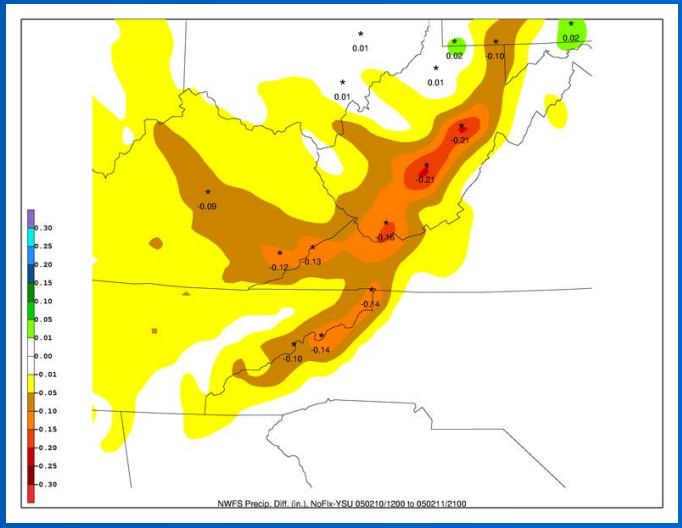
Reflectivity of 40 dBZ and greater easily exceeded the -10°C and -15°C heights



NWS-NCSU Collaborations: A long and storied road

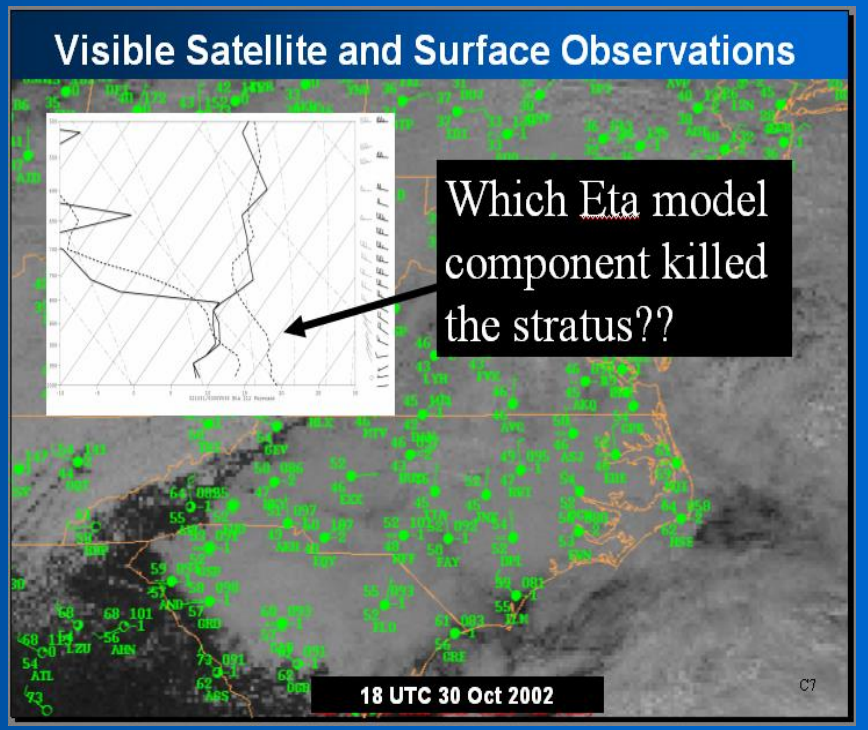
- 2000s (continued):
  - Examining Multi-Scale Features that Enhance Precipitation Associated with Landfalling Tropical Cyclones in North Carolina
  - The Role of the Great Lakes in Northwest Flow Snowfall in the Southern Appalachian Mountains



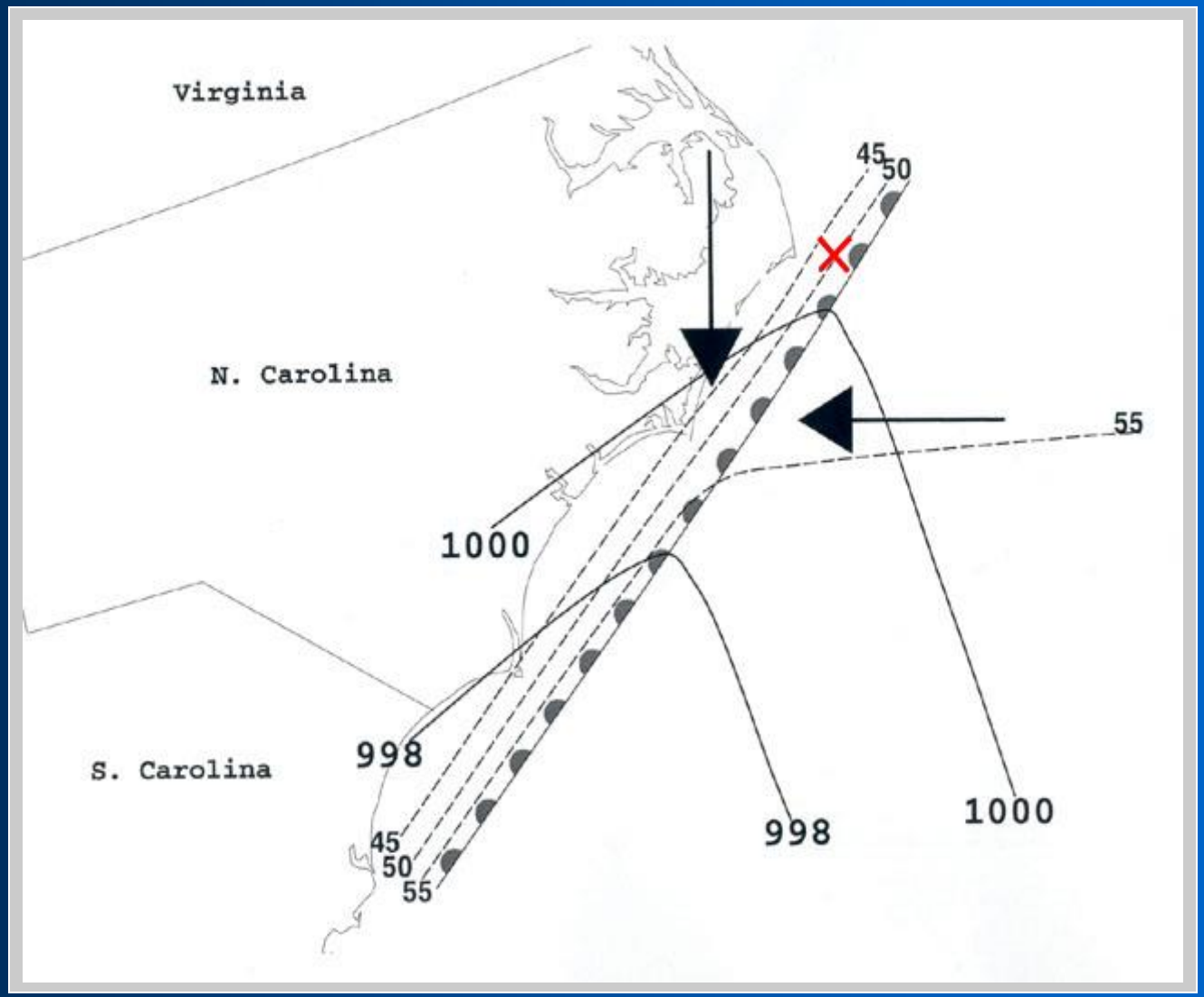


NWS/NCSU Research Focus

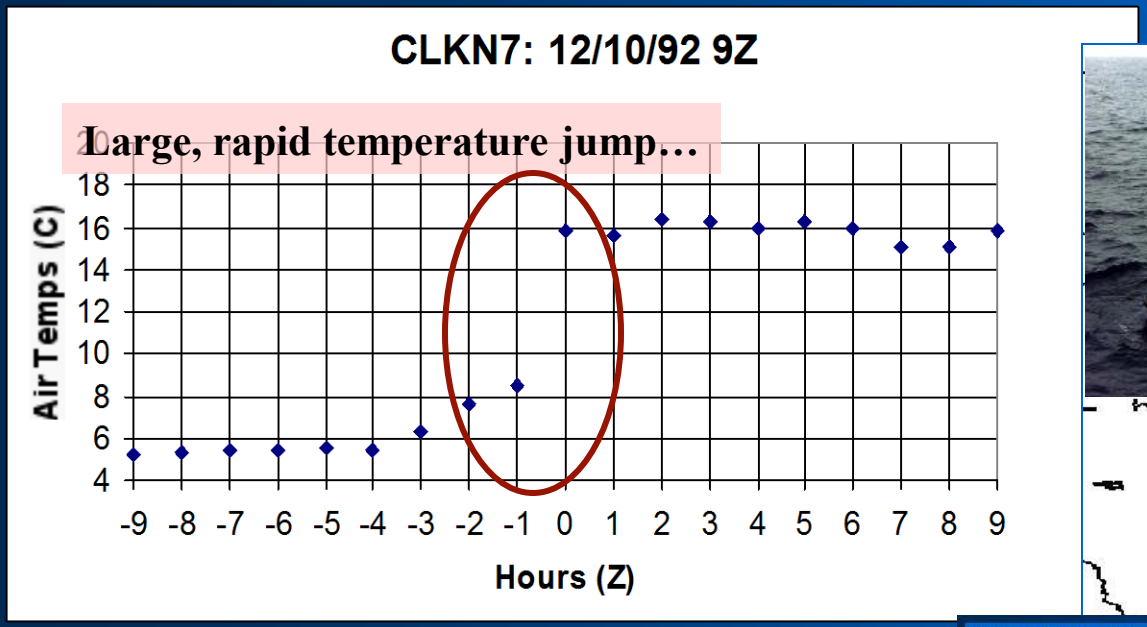
- Forecast Problems…for example:
  - Poor representation of coastal fronts and cold air damming by models
  - Coastal front forecast problems: inland movement, timing, sensible weather
  - Cold air damming forecast problems: development and erosion, precipitation amounts & type
  - Precipitation amounts: addressing deficiencies in the computer models in the mid-Atlantic/Carolinas
- Research Strategy:
  - Climatologies
  - Case study analysis, modeling

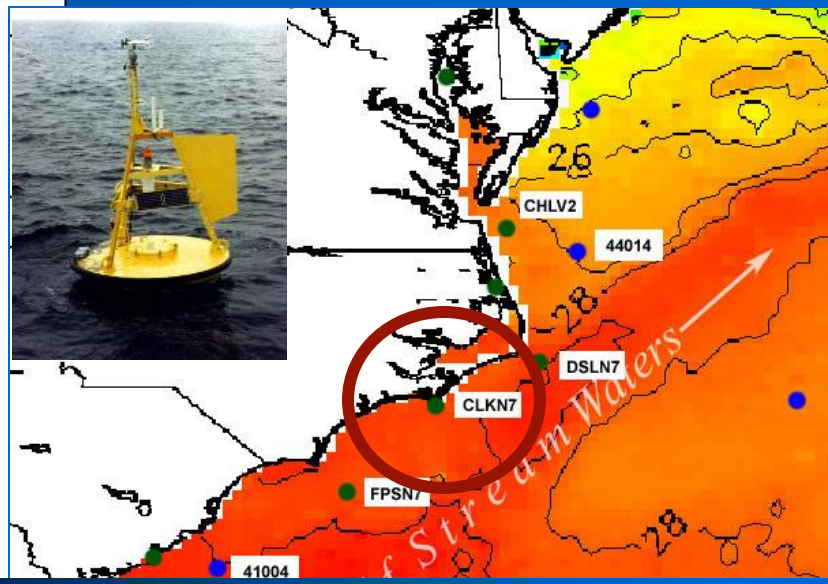


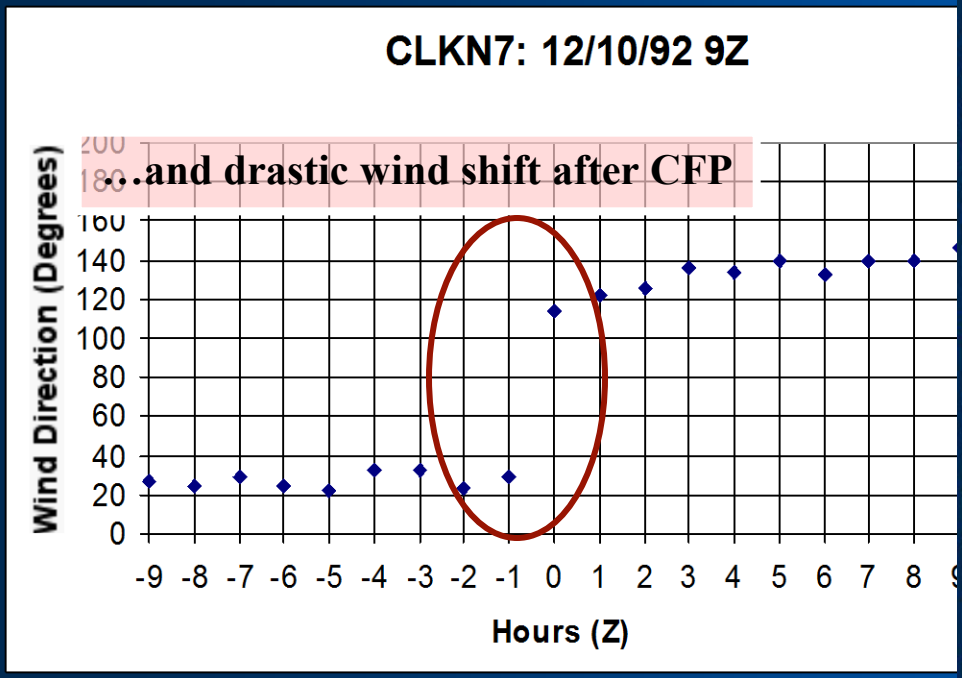
An example: How does the weather evolve as coastal front passes?

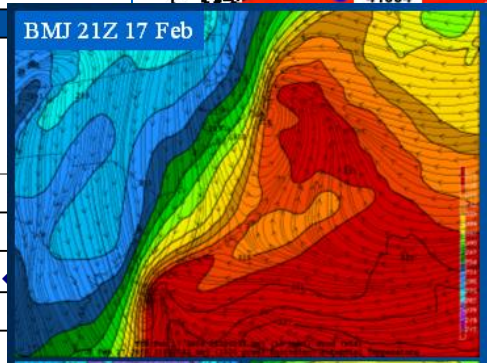


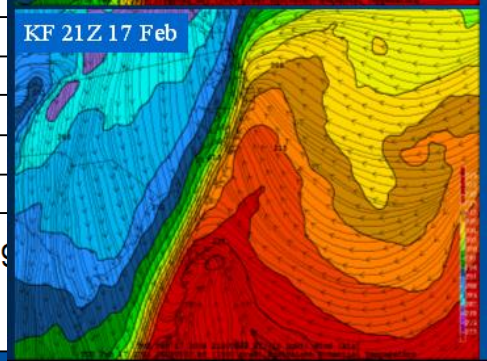
Accurate forecasts for coastal FP are critical!











Coastal Front Representation

BMJ

- less-defined coastal front
- farther offshore
- distinct surface cyclone centers

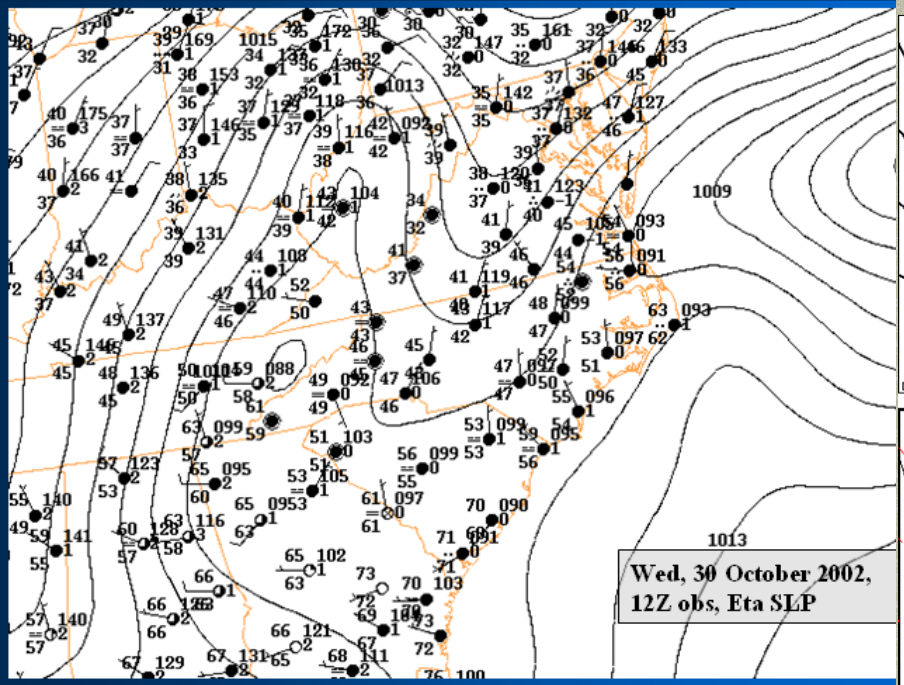
KF

- better-defined
  - stronger temperature gradient
  - more convergence
- closer to coast
- less distinct cyclone centers

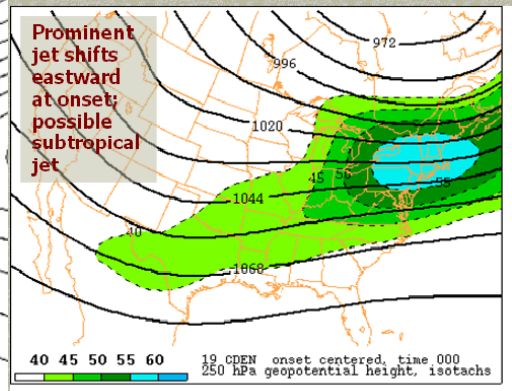
C47

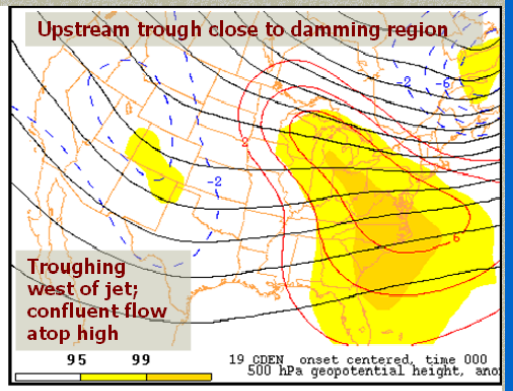
What have we learned about cold air damming ?

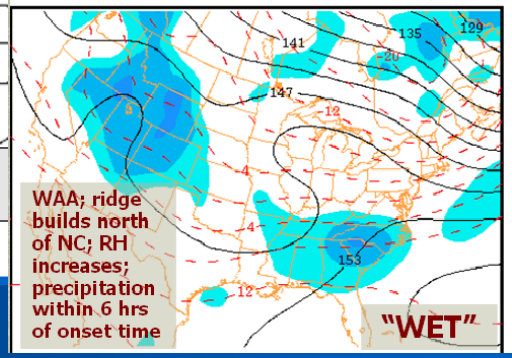
- There are many different varieties
- It is not limited to the cool season
- Weather impact (clouds, temps, weather) correlates to specific patterns, surface and aloft
- Erosion: 4 distinct synoptic scenarios & 5 erosion processes were identified

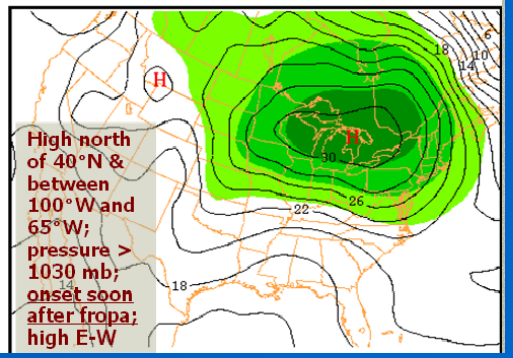


1) Classical, Diabatically Enhanced (CDEN)



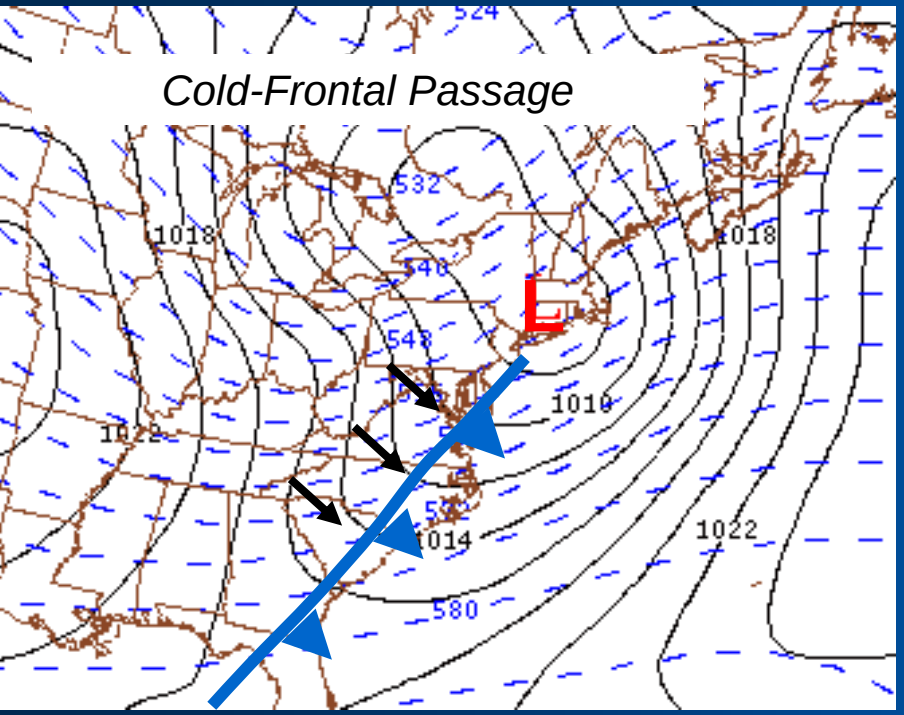




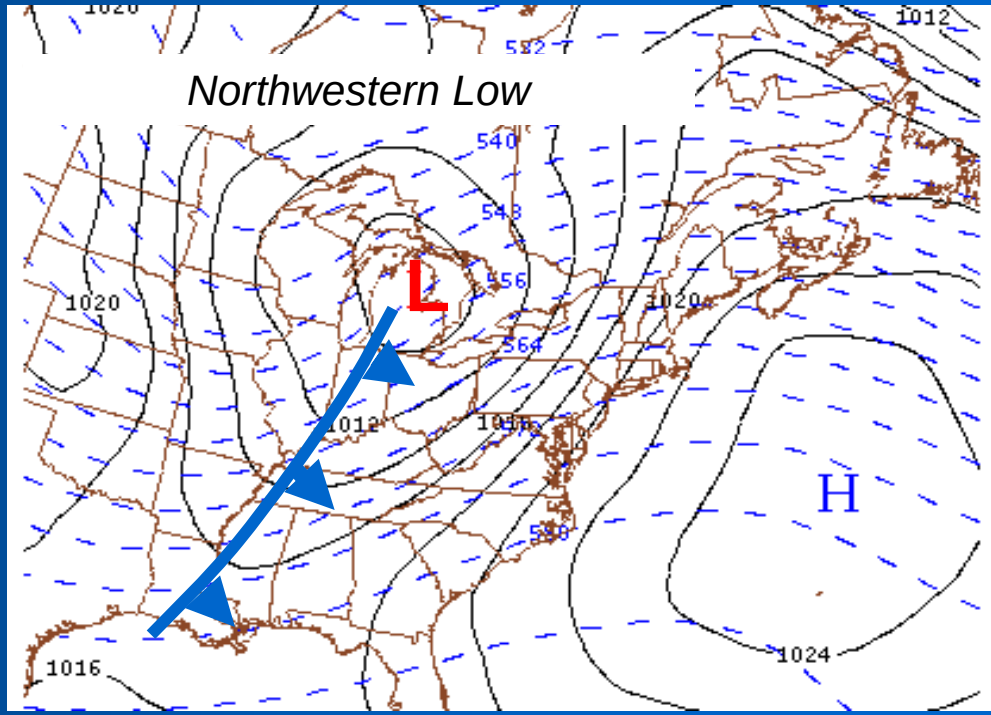


Research findings: cold air damming erosion scenarios

Cold-Frontal Passage:
Relatively small model error



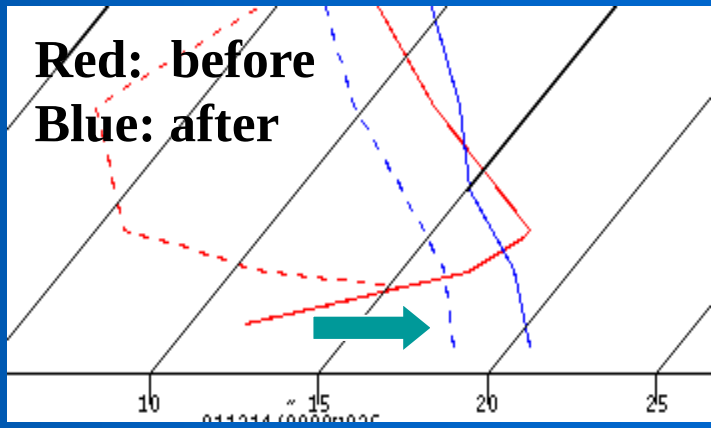
Northwestern Low (no CFP):
Large model error



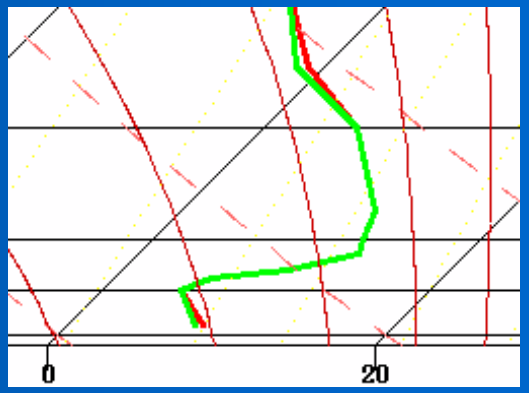
…These findings were brought directly into operations, and immediately resulted in improved forecasts

Research finding: cold air damming erosion processes

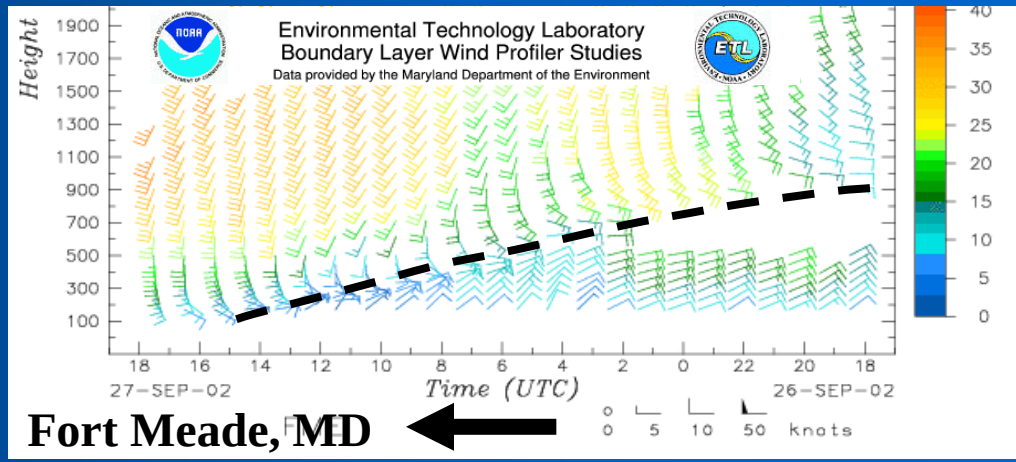
- Surface heating (bottom-up erosion)
  - Eta allows excessive surface heating; premature erosion results



- Cold advection aloft (promotes mixing)
  - Can be problematic for models



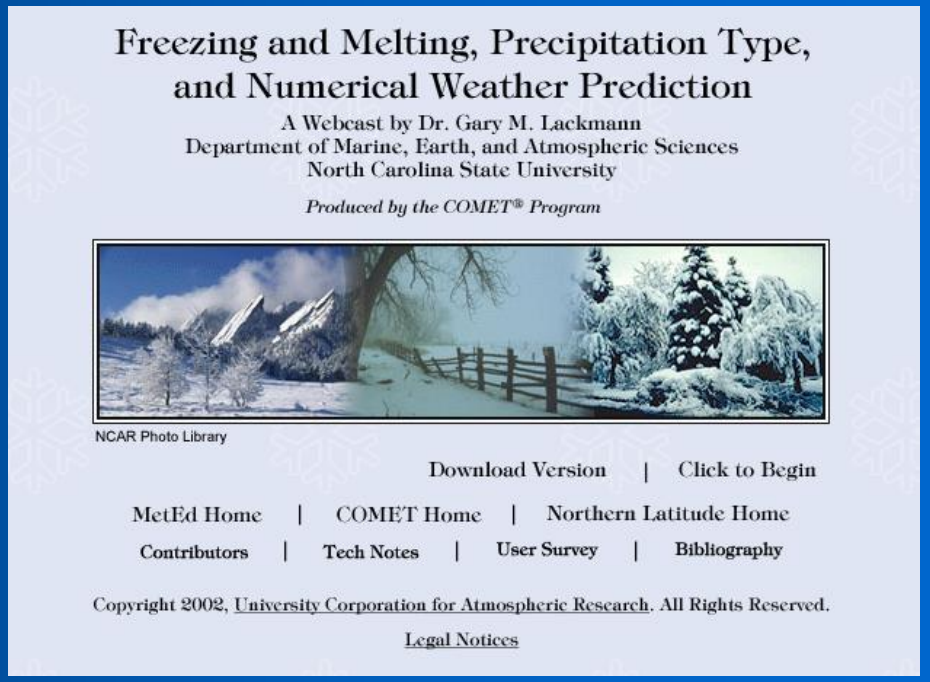
- Shear-induced mixing at inversion ("top-down" erosion)



Winter weather computer model discoveries

- Precipitation type forecasting:
  - Comparison of techniques via case studies
  - Model discoveries: warm bias with cold air damming; cold bias with freezing rain
  - Biases depend on precipitation amounts

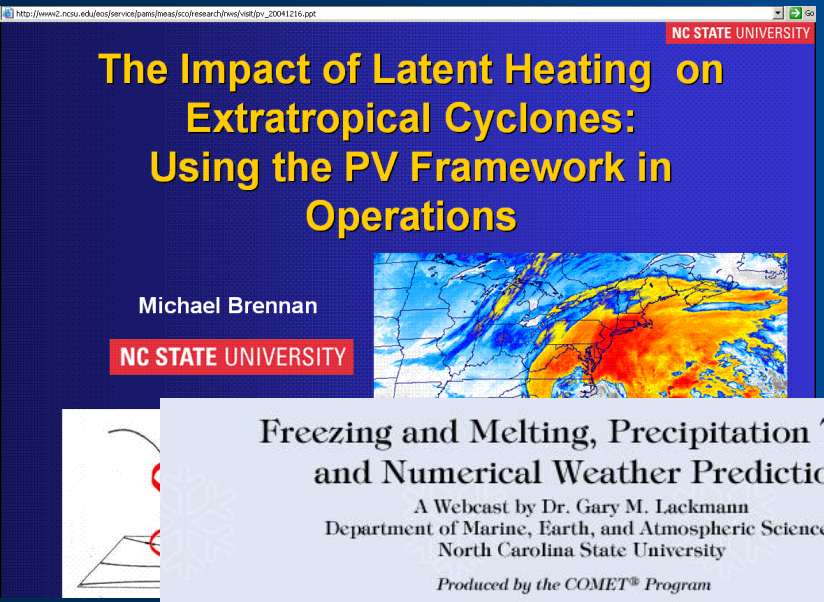
- Model biases:
  - Freezing rain was "misinterpreted" by one model's physics
  - Collaboration with the National Centers for Environmental Prediction (NOAA/NWS)
  - The model's bias was corrected

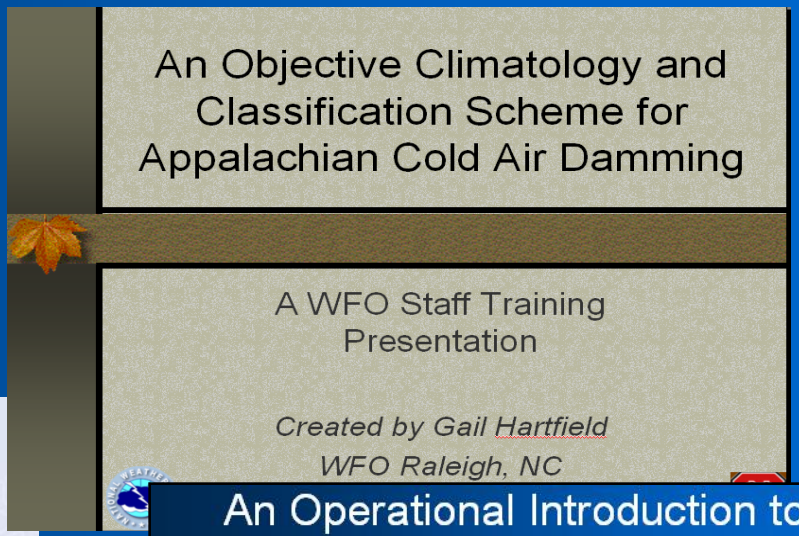


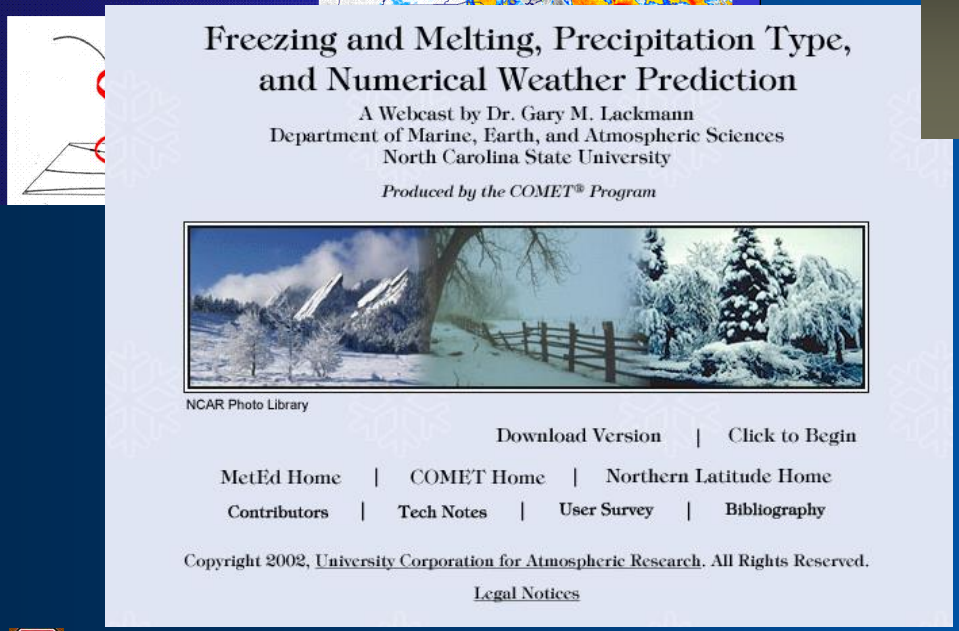
…These findings were brought directly into operations via web pages and training sessions, and immediately resulted in improved forecasts for cold air damming and ice (glaze) accrual

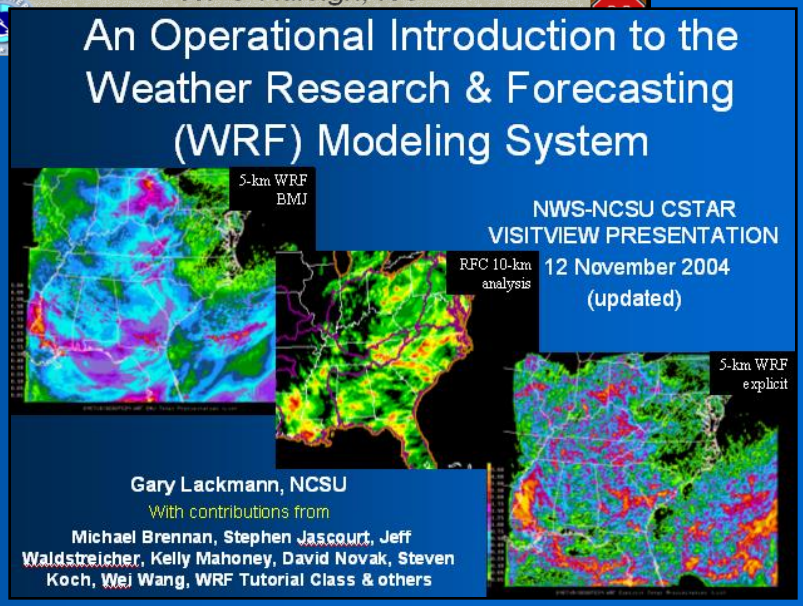
More research results

- Transfer of research findings via:
  - Online case studies, hard copy materials (posters)
  - Site visits, co-labs, online training sessions, webcasts





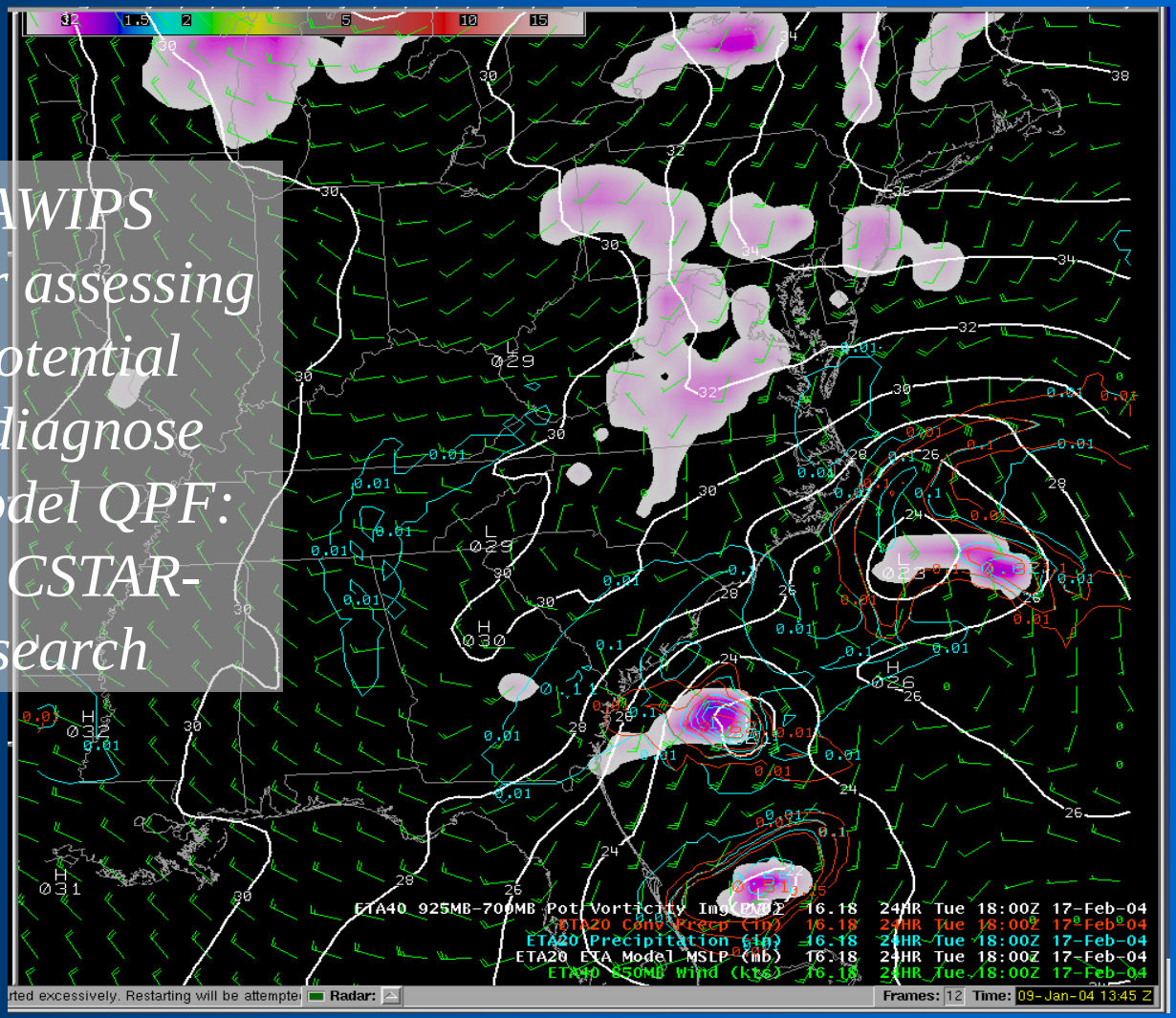




More research results

- Development of computer-based procedures to facilitate real-time application of research results

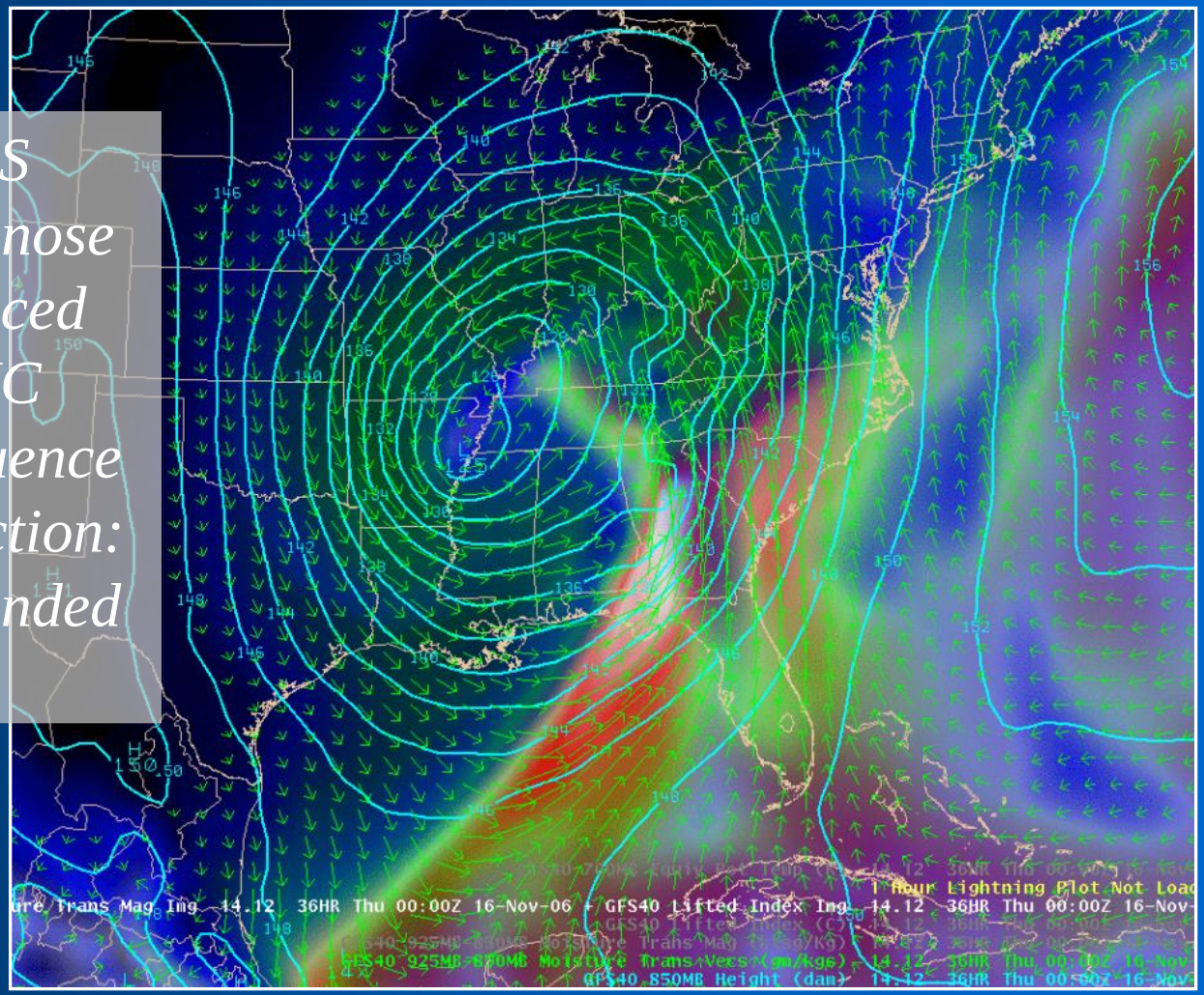
Targeted AWIPS procedures for assessing low-level potential vorticity to diagnose erroneous model QPF: COMET- & CSTAR-funded research



More research results

- Development of computer-based procedures to facilitate real-time application of research results

Targeted AWIPS procedures to diagnose potential for reduced convection in NC resulting from influence of upstream convection: current COMET-funded project



Research results

- Operational enhancements:
  - Improved pattern recognition
  - Objective detection and classification algorithms
  - Area Forecast Discussions reflect the science behind the predictions
    - *Our single most popular web page product*
  - Forecasters can now better recognize physical processes, and biases & weaknesses of models
  - Has resulted in improved weather forecasts

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FXUS62 KRAH 071938
AFDRAH

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RALEIGH NC
235 PM EST FRI JAN 7 2005

.SHORT TERM (TONIGHT THROUGH MONDAY)...
TONIGHT...WEAK HIGH PRESSURE SLIDING OFFSHORE TONIGHT WITH LIGHT
SOUTHEAST FLOW DEVELOPING IN THE LOW LEVELS. THEN MODELS INDICATING
WARM FRONTAL (DEWPOINT BOUNDARY) LIFTING NORTH ACROSS THE AREA LATE
TONIGHT (06Z-12Z) AS LOW PRESSURE LIFTS NORTHEAST ACROSS THE
TENNESSEE VALLEY. CHANCE FOR RAIN OVERNIGHT LOOKS SLIM WITH THE BEST
CHANCE OVER NORTHWEST WHERE AREA OF LIFT/MOISTURE CONVERGENCE CROSS
TOWARD DAYBREAK. TIME/HEIGHT CROSS SECTIONS AND FORECAST SOUNDINGS
INDICATE PLENTY OF MOISTURE INTO CWA OVERNIGHT. SO WILL INDICATE
SMALL CHANCE OF SHOWERS NORTHWEST AND FAR NORTH WITH MAINLY
SPRINKLES FOR THE REST OF THE CWA. MILD TEMPERATURES WILL CONTINUE
WITH READINGS IN THE UPPER 40S TO LOWER 50S.

A FEW STRAY SHOWERS/SPRINKLES POSSIBLE FAR N EARLY SATURDAY THEN
PASSAGE OF MID LEVEL TROUGH VEERS FLOW TO WESTERLY AND DRIES COLUMN
OUT BY MID DAY. SURFACE FRONT CROSSES AREA LATE SATURDAY
AFTERNOON/EARLY EVENING.

SURFACE RIDGE OVER CENTRAL NC SUN SHOULD PROVIDE REGION WITH DRY
CONDITIONS. THICKNESSES VARY WITH ETA WARM AND NGM COOL. THIS
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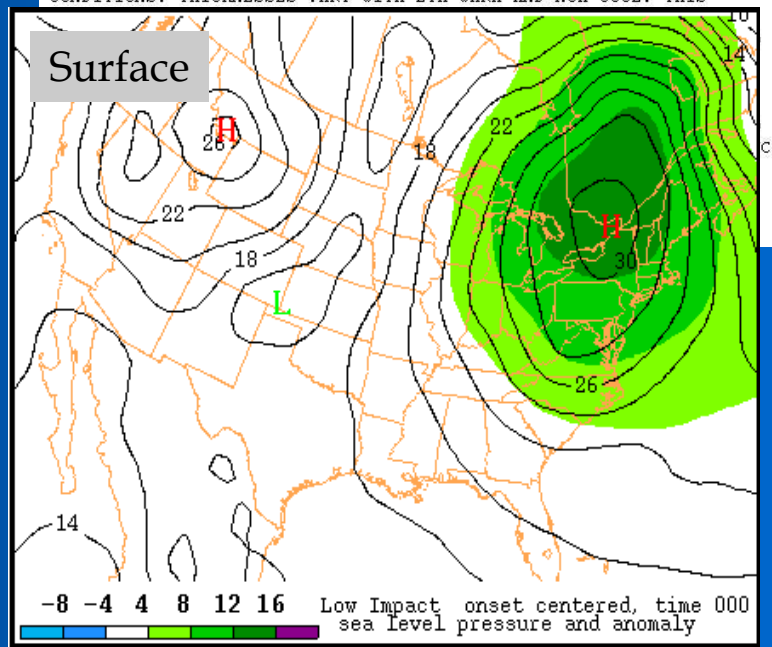
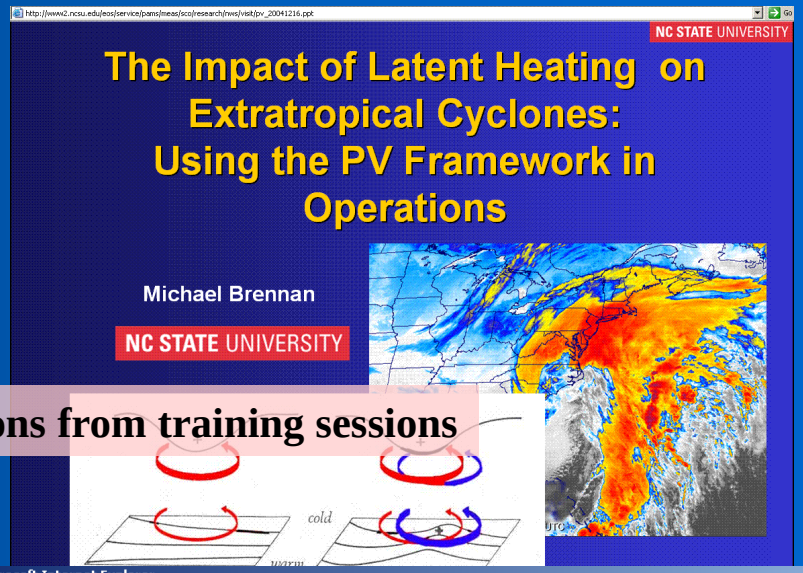
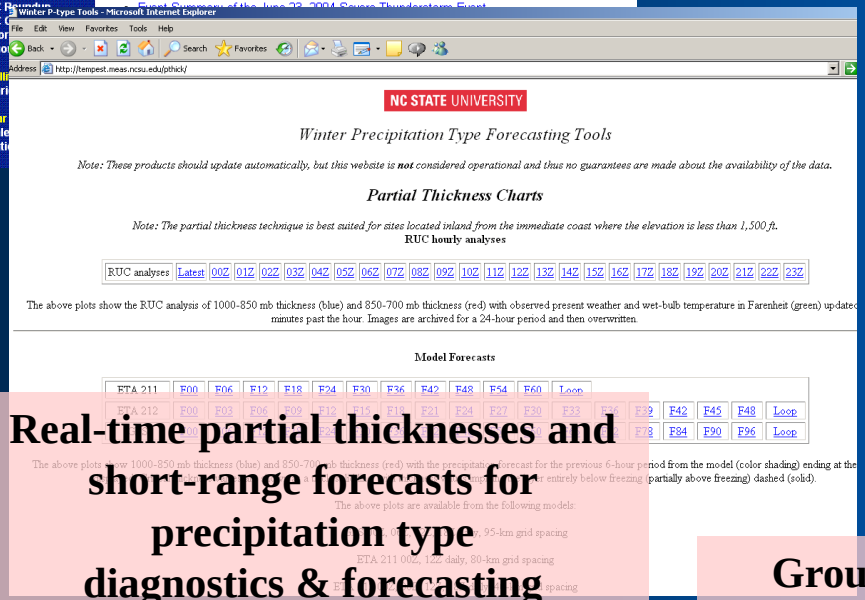


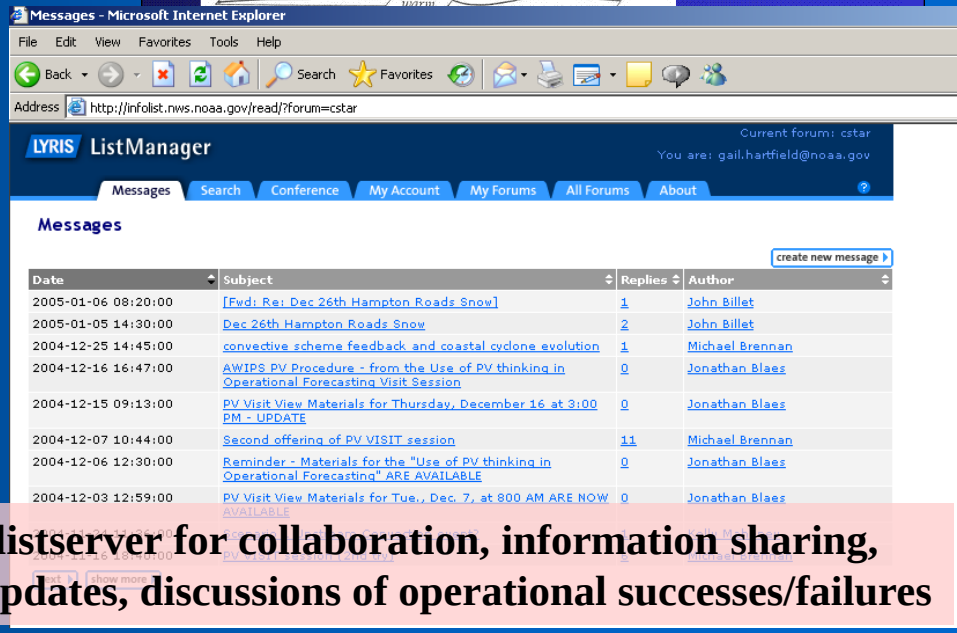
More results: Operational web pages, references, & forecast tools

Vast archive of winter, severe, & tropical case studies (contributions by NWS forecasters & NCSU students/faculty) www.erh.noaa.gov/rah/events/



Archived presentations from training sessions





Real-time partial thicknesses and short-range forecasts for precipitation type diagnostics & forecasting (tempest.meas.ncsu.edu/pthick/)

Group listserver for collaboration, information sharing, research updates, discussions of operational successes/failures

NCSU student internship course at NOAA-NWS Raleigh

- Credit course; began in 2004 and continues today
- Students gain real-world experience, learn typical NWS tasks
  - Collecting hydrometeorological data, data analyses, introduction to forecast/warning processes and forecast preparation methodologies
  - Students keep journal of experiences & attend various training courses

The Inaugural Class: Spring Term 2004

The NWS/NCSU Collaboration Process:

Transferring and implementing research results to achieve long-lasting benefits ("connecting the dots")

http://www.meas.ncsu.edu/nws/

Level 1 - Discover & Share (Only the beginning)

Level 2 - Demonstrate added value (So what? Show me!)

Level 3 - Operational Implementation (Practical?)

Level 4 - Mastery (By all, not a few)

Level 5 - Periodic review (A necessity)

NOAA/National Weather Service and
North Carolina State University
thank you for your interest in our collaborations!

Visit us at

http://www.meas.ncsu.edu/nws/

Some images courtesy of Michael Brennan, Dr. Gary Lackmann, Dr. Al Riordan, Kelly Mahoney, Keith Contre, and Wendy Sellers (NCSU); and Gail Hartfield, Rod Gonski, Jonathan Blaes, and Kermit Keeter (NWS RAH)