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TITLE: **Comparison of SSM/I Measurements to Numerically-Simulated Cloud and Precipitation During ERICA**

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SIGNIFICANT ACCOMPLISHMENTS IN THE PAST YEAR:

Investigations of rainbands embedded within extratropical cyclones have documented a spectrum of linear features with varied characteristic dimensions, preferred development locations with respect to hyperbaroclinic zones, and differing physical growth mechanisms. The largest structures are those which have length scales comparable to the supporting baroclinic wave, and which define the macroscale ascent of air in a system-relative sense. Included in this class of structures would be the warm and cold "conveyor belts" that constitute the main influxes of moisture and heat into baroclinic waves. At the other end of the spectrum are mesoscale bands which vary widely in width from a few kilometers to several tens of kilometers. These features evolve with characteristics thought to be constrained by the environmental shear and the thermodynamic stabilities of the larger airstreams.

Recent increases in computational power and advances in physical parameterizations have made numerical simulations attractive as a complementary means of investigating the dynamics of these moist atmospheric systems. We are currently using a version of the Drexel University LAMPS (Limited Area Mesoscale Prediction System) as a source for internally consistent data sets to diagnose processes in synoptic and mesoscale flows. The objective of this work is to understand the processes determining the morphology and bulk microphysical composition of condensation in baroclinic waves. The LAMPS model is notable in that it carries grid-scale predictive equations not only for water vapor, but also for cloud and precipitation. Recently, the model has been extended to account for ice condensate. This addition, along with other improvements, enables a more physically complete treatment of precipitation initiation and growth.

Our investigations this year have focused essentially on the macroscale organization of cloud and precipitation which occurred during the 4th Intensive Observing Period (IOP-4) of the Experiment for Rapidly Intensifying Cyclones over the Atlantic (ERICA). This experiment, held off the East Coast of the United States and Canada during the winter of 1989, documented several episodes of rapid cyclonic storm development. Also playing a major role as validation and ground truth in these studies are SSM/I (Special Sensor Microwave Imager) retrievals of precipitable water, total liquid water and ice, generated by other MSFC-supported investigations. Model simulations produced to date suggest that, while the large-scale atmospheric dynamics was an essential driving mechanism, the role of condensation was crucial in facilitating the exceptionally rapid spinup of the cyclone and the low surface pressure. A model simulation of the precipitation rate at the time of most rapid storm intensification is shown in the accompanying figure. Heavier precipitation rates in the crescent shaped region are associated with deep convection along the leading edge of a dry intrusion behind the surface low. The majority of precipitation in the stratiform region to the northeast involved the production of ice with deposition from vapor to ice being the dominant process of growth. Some small amount of mixed phase cloudiness was present. Model condensate distributions matched well with SSM/I observations. The accompanying SSM/I imagery which delineates areas of large (> several hundred micron effective radius) precipitating ice over the ocean suggests that the model has done well in capturing the essential mechanisms responsible for the horizonal distribution of precipitation.

FOCUS OF CURRENT RESEARCH AND PLANS FOR NEXT YEAR:

The next phase of this work will be to compare the model simulations and SSM/I observations to aircraft radar returns and in situ measurements of atmospheric temperature, moisture, wind and microphysics data. This will enable some verification of simulated vertical structure to the LAMPS condensate fields, and also help to interpret more accurately the SSM/I data. During the next year we also anticipate studying the role of ocean surface fluxes of moisture and heat in preconditioning the overlying lower atmosphere prior to storm development. The approach of combining remote observations from space, in situ ground truth measurements, and model simulations should enable a more thorough study of the rapid cyclogenesis process.

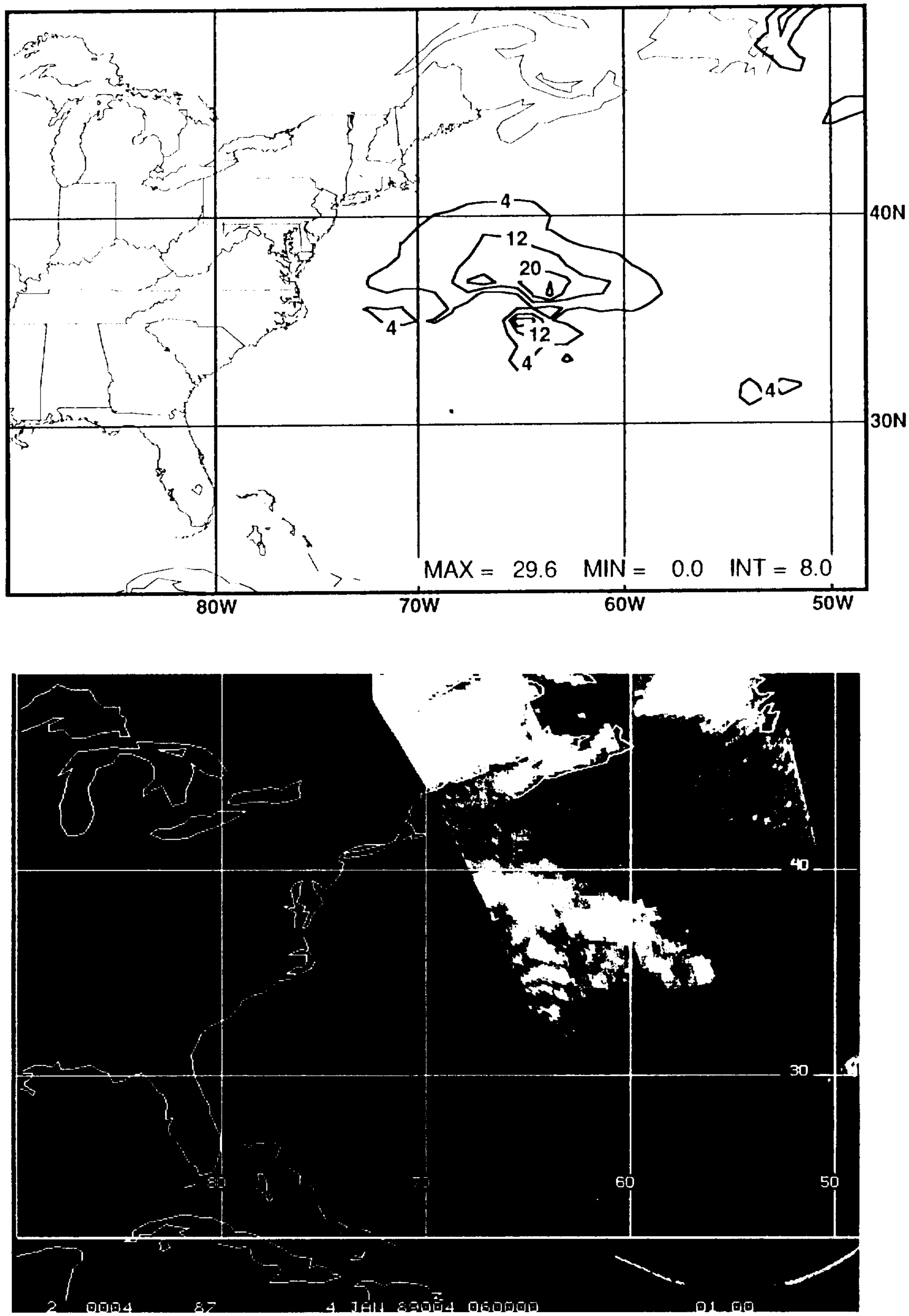
Our experience with regional modeling of moisture patterns supports the concept that these models can be used to study moist processes in an effective manner since they have resolutions comparable to the scales on which precipitation is organized and also to the footprint sizes of passive microwave imagers and sounders. We propose to extend these studies by examining the effect of moisture on regional scale energetics processes. This approach would also involve comparison to climate model integrations to understand how shortcommings in their spatial resolution and parameterized moist physics, which degrade the simulated climate, can be alleviated.

PUBLICATIONS:

Robertson, F.R. and D.J. Perkey, 1990: Comparison of SSM/I measurements to numerically-simulated cloud and precipitation data during ERICA. Preprints, 4th Conference on Mesoscale Processes, American Meteorological Society. June 25-29, 1990 Boulder, Co.

Perkey, D.J., F.R. Robertson, W.M. Lapenta, and C. Cohen, 1990: Comparison of SSM/I measurements to numerically-simulated cloud and precipitation during ERICA. Preprints, 5th Conference on Satellite Meteorology and Oceanograpy, American Meteorological Society, September 3-7, 1990, London, England.

Robertson, F.R., K. Doty and D.J. Perkey, 1990: Numerical Simulation of Cloud and Precipitation Structure during GALE IOP-2. In revision for Mon. Wea. Rev.



(Top) LAMPS simulated Total Precipitation Rate at 1200 UTC 4 January 1989 (12 hours into model integration). Contour interval 8 mm / 10^3 s. (Bottom) SSM/I 85 GHz Polarization Corrected Temperature (a signature of precipitating ice and snowcover) at approximately 0945 GMT 4 January.