P5.23 AN EVALUATION OF A NEW AMSU-DERIVED FALLING SNOW RETRIEVAL ALGORITHM

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1. INTRODUCTION

NOAA continues to operate three Polar Orbiting Environmental Satellites (POES), NOAA-15, -16 and -17, to support its mission goals. These satellites contain instruments that observe the Earths surface and atmosphere at the visible, infrared and microwave portions of the electromagnetic spectrum. Through the use of sophisticated retrieval algorithms, the POES satellites provide global, ~4-hourly information vital to NOAA scientists.

Since 1999, NOAA/NESDIS has been generating operational hydrological products from the Advanced Microwave Sounding Unit (AMSU) through a system known as the Microwave Surface and Precipitation Products System (MSPPS) (Ferraro et al. 2002). The MSPPS product suite includes global rain rate and ice water path; land surface temperature, emissivity and snow cover; oceanic sea-ice concentration, cloud liquid water and total precipitable water.

The retrieval of falling snow and cold season rain has been a never-ending challenge for passive microwave remote sensing. This is because of the non-uniqueness of the scattering signature associated with precipitation and snow on the ground in the frequency range between 18 and 90 GHz. However, for many parts of the world, snowfall is the primary source of precipitation, so the scientific community continues to pursue this difficult research problem. Future sensors such as the CMIS on board the NPOESS satellites and the planned NASA Global Precipitation Measurement (GPM) mission will be better equipped to perform precipitation retrievals under a wide variety of surface conditions.

Based on the ground breaking study of Kongoli et al. (2003) which utilizes measurements near the 55 GHz oxygen and the 183 GHz water vapor absorption bands, NOAA/NESDIS implemented an enhanced precipitation retrieval algorithm in November 2003 that includes the detection of rainfall and snowfall over cold surfaces (e.g., frozen land and snow covered land). This algorithm is presently operational for the NOAA-15 and NOAA-16 satellites via MSPPS (note that due to failure of the AMSU-A1 module on NOAA-17 in November 2003, only rainfall can be retrieved). It is limited for use in temperate latitudes which are near the southern limit of the established snow pack.

It is the purpose of this paper to present an evaluation of the snowfall detection algorithm over the United States for the 2003-04 winter season. In addition, an expansion of the current technique to colder climate regimes has been developed and is also evaluated. The improved algorithm is planned for implementation in the fall of 2004. Furthermore, the readers are encouraged to refer to the paper (P5.21) by H. Meng to learn more about the MSPPS product monitoring and validation.

2. EXAMPLES OF FALLING SNOW

As described in Kongoli et al. (2003), utilization of a combination of AMSU sounding and window channels can be used to delineate falling snow from rainfall, as well as extend the retrieval to over snow covered surfaces. Prior to this, regions where the surface temperature is estimated to be 269 K or less or where snow cover was detected were simply flagged as indeterminate in the operational AMSU precipitation algorithm. Similar potential benefits of high frequency measurements have been found by Bennartz and Petty (2001), Liu and Katsumata (2002) and Chen and Staelin (2003).

Shown in Figure 1 is an example of the current operational AMSU precipitation retrieval scheme for NOAA-15 on 25 January 2004. The rain rates are retrieved using the algorithm described in Weng et al. (2003), then, falling snow (no rate assigned) is retrieved using the Kongoli et al. (2003) method only in instances where the rain rate was determined to be zero or indeterminate. Areas only where the limb corrected AMSU channel 5 (53.6 GHz) brightness temperatures (TB54) exceed 245 K are considered. As can be seen, an "expected" pattern of snowfall is retrieved by AMSU, i.e., on the northern extent of the precipitation field. The remaining indeterminate areas (gray shades) are where TB54 < 245 K and are regions where the current algorithm is trying to be extended.

For comparison, Figures 2 and 3 present the surface weather and hourly radar composites, respectively, near the time of the AMSU retrievals. There is excellent qualitative agreement between the AMSU retrievals and the surface reports. Note how the rain/snow demarcation across the Carolinas is comparable between AMSU and the surface reports. It does appear that the northern extent of the AMSU snowfall field is erroneous, in particular, across northern WV and south central OH. In the Midwest, the AMSU appears to

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underestimate the areal extent. However, looking at the radar field, there is much closer correspondence, in particular, when looking at the level 3 or greater echoes. Also in the Midwest, there is a large area of freezing rain which AMSU is calling snow. In many instances, freezing rain is caused by a narrow layer of warm air beneath the precipitation origin and the surface. This is likely a source of error but the retrievals are encouraging because the area of snow retrieved would have been previously classified as indeterminate.

3. VALIDATION METHODOLOGY

To thoroughly validate the AMSU falling snow product, a variety of surface reporting stations have been selected across the U.S., representative of various climate regimes. A manually intensive matching procedure is being conducted where the surface weather observations are being matched with AMSU precipitation retrievals for the period of December 2003 through February 2004. Performance statistics will be computed to determine the accuracy of the AMSU snowfall retrievals.

In addition to the current operational algorithm, alternative approaches are being evaluated. In particular, techniques which lower the TB54 value to expand the retrieval area are being compared with the same surface observations. These results will be presented in our poster at the conference.

Future extensions to the algorithm will include an expansion to over ocean (Liu and Curry 1997) and a falling snow rate (Kim et al. 2003).

The views, opinions, and findings contained in this report are those of the author(s) and should not be construed as an official National Oceanic and Atmospheric Administration or U.S. Government position, policy, or decision.

4. REFERENCES

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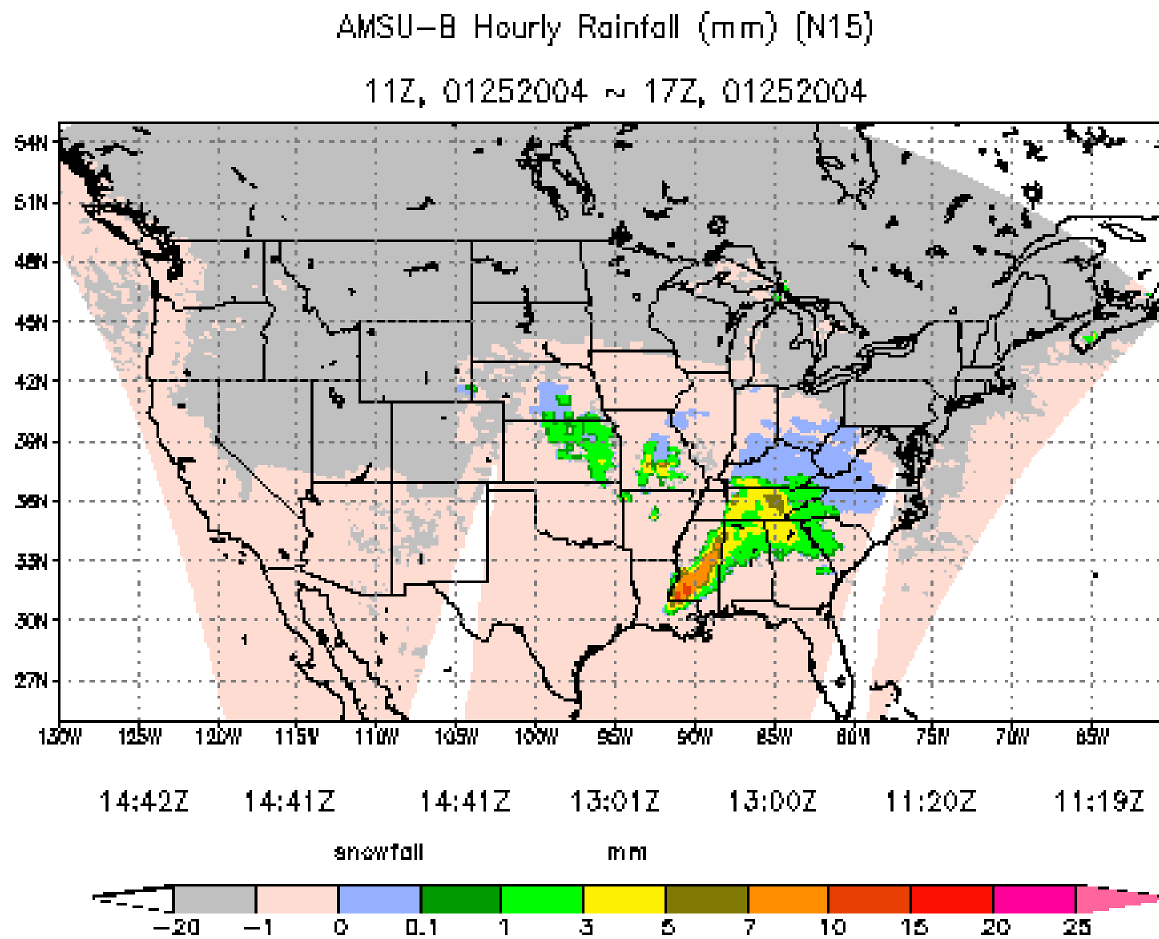

Figure 1 – NOAA-15 AMSU derived precipitation estimates between 1100 and 1500 UTC for 25 January 2004. Rain rates are indicated by the various colors while falling snow is denoted in blue. Precipitation free areas are colored pink while indeterminate regions are in gray.

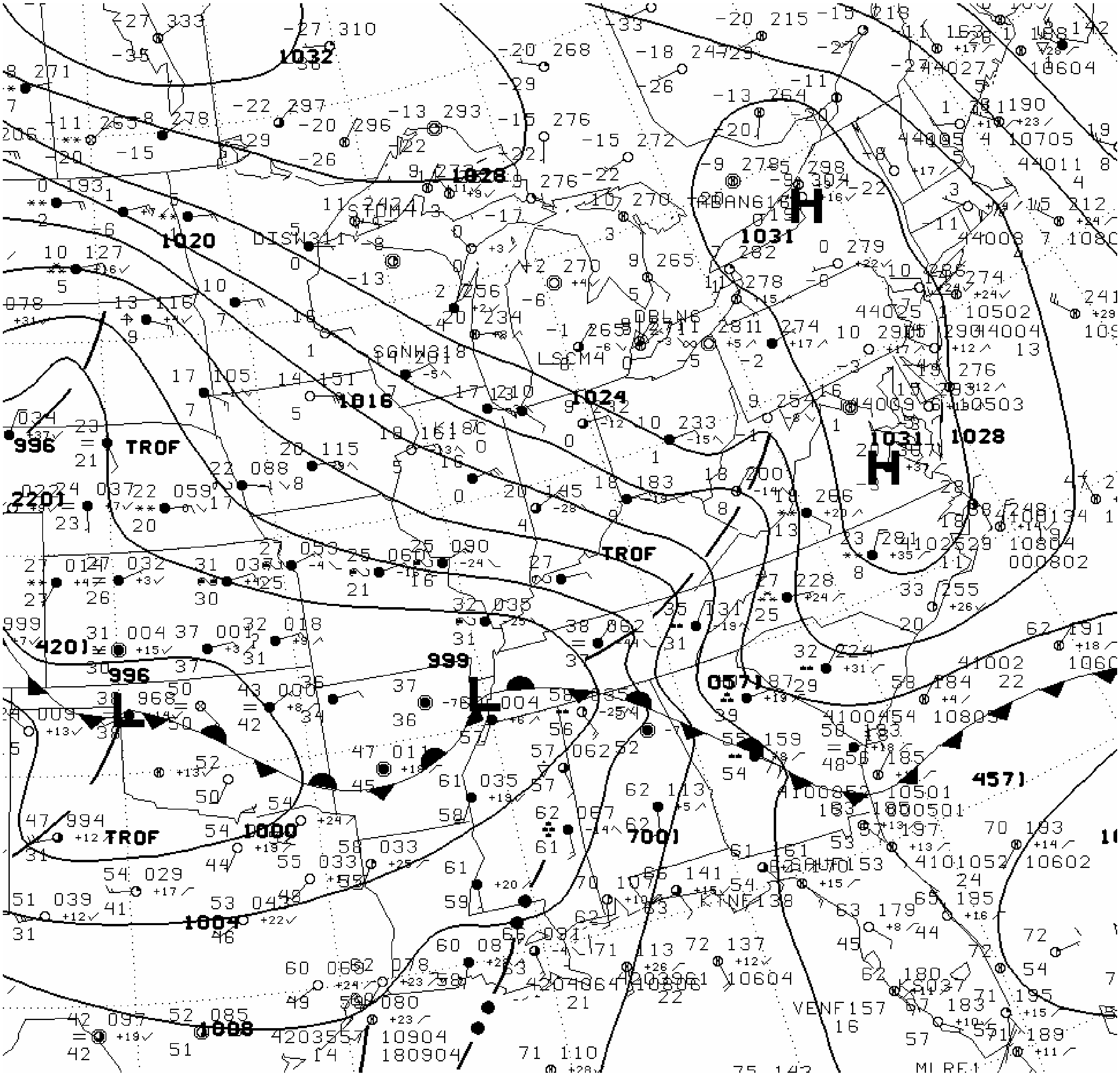

Figure 2 – NCEP surface weather for 1200 UTC 25 January 2004.

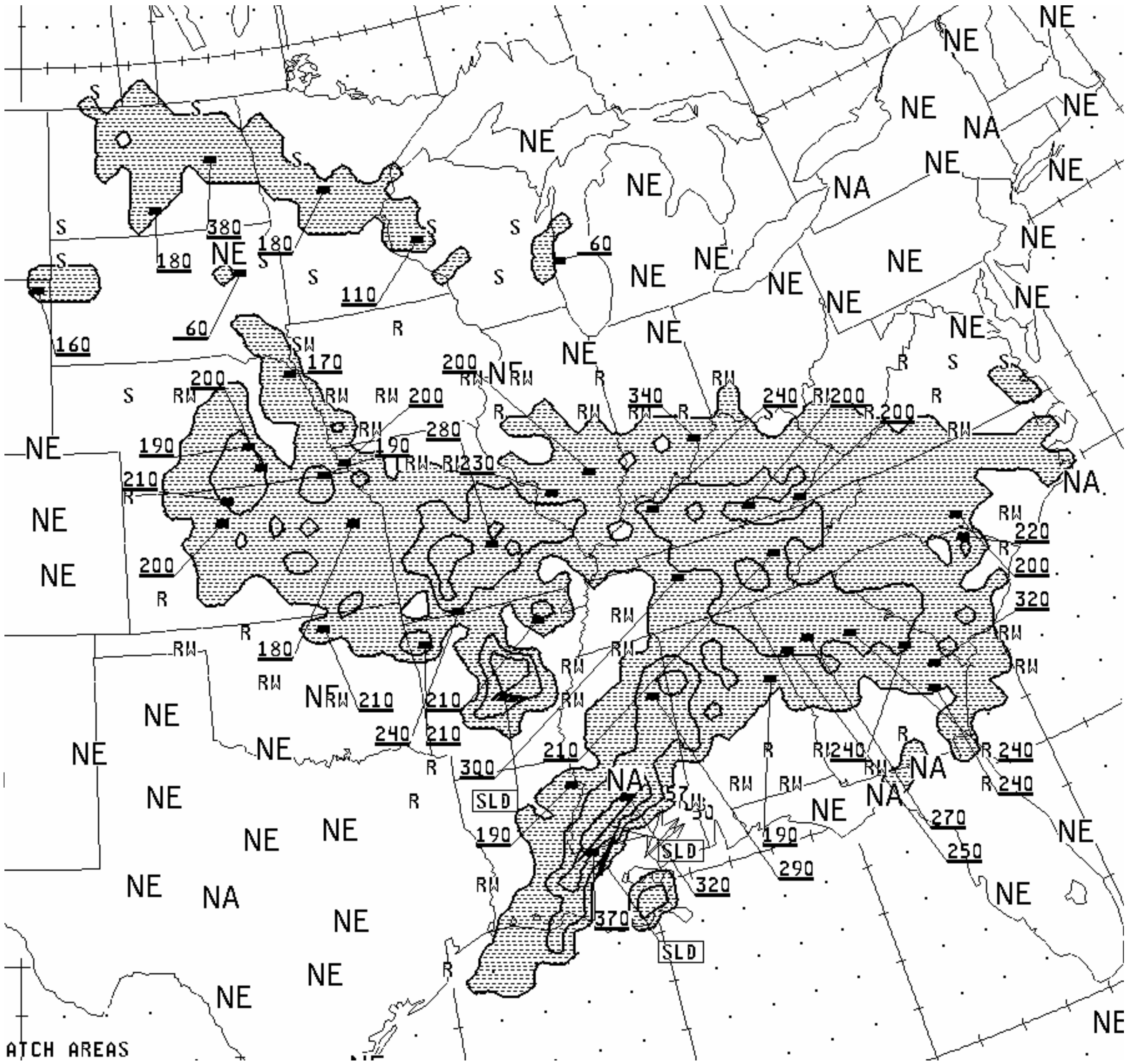

Figure 3 – NCEP Hourly Radar Summary for 1315 UTC 25 January 2004.