JP5.16 GLOBAL PRECIPITATION CLIMATOLOGY FROM AMSU PASSIVE MICROWAVE SATELLITE OBSERVATIONS

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1. ABSTRACT

This paper presents a preliminary climatological study of global precipitation space-time statistics based on a rain-rate estimation algorithm derived for the Advanced Microwave Sounding Unit (AMSU) aboard the NOAA-15, -16, and -17 satellites, and aboard the NASA Aqua satellite with the Humidity Sounder for Brazil (HSB). The algorithm uses brightness temperatures in 17 channels, principally in the 54-GHz oxygen band and the 183-GHz water vapor band, and produces global rain maps at 15-km resolution that are generally insensitive to surface variations. This algorithm was trained on all-season NEXRAD data over the eastern U.S. and has shown promising agreement with it (Chen and Staelin, 2003). This algorithm has also produced morphologically plausible global rain maps and has demonstrated the ability to map snowstorms over polar ice. A fleet of as many as four AMSU satellites has observed each point on the globe approximately eight times a day. Illustrative samples of global precipitation and statistics are presented.

2. INTRODUCTION

AMSU is a passive microwave instrument with channels in the opaque 54-GHz oxygen and 183-GHz water vapor resonance bands; it also includes some window channels near 23.8, 31.4, 89, and 150 GHz. AMSU's are aboard the NOAA-15, -16, and -17 polar-orbiting satellites, which were launched in 1998, 2000, and 2002, respectively. These three satellites have local equatorial crossing times that are separated by ~3-5 hours. AMSU/HSB aboard the Aqua satellite (launched in 2002) provided a nearly identical set of channels. These four satellites observed each point on the globe ~8 times daily for a period of about seven months and at least two are expected to operate into the future.

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A method for estimating precipitation rate using opaque channels together with window channels has been developed (Chen and Staelin, 2003; Staelin and Chen, 2000). Previous satellite-based methods have relied primarily on window channels. Opaque channels are useful because they are insensitive to surface variations and they are sensitive to humidity, grauple size, and cloud-top altitude, which are important determinants of precipitation.

In addition to rain, AMSU also has been shown to be useful for estimating snow (Chen and Staelin, Feb. 2003; Chen et al., 2003; Chen and Staelin, July 2003; Kim et al., 2003; Skofronick-Jackson et al., 2002).

3. GLOBAL OBSERVATIONS

While the method was trained using only data from the eastern U.S., it is able to detect precipitation globally as Fig. 1 shows. In Fig. 1, one can see morphologically plausible precipitation events all over the world, including snow. One interesting example is the equatorial wave evident between 0° and 15° N and between 150° W and 90° W in the ~2 AM image.

Also, the consistency of monthly rain frequencies from year to year shown in Fig. 2 suggests that the algorithm is stable.

4. SINGLE-SATELLITE VS. MULTI-SATELLITE COMPARISON

Fig. 3 shows a comparison of monthly rain frequencies over a 5-day period computed using only the NOAA-16 satellite (top) and using the NOAA-15, -16, and -17 satellites (bottom). In the 0.5°×0.5° image produced using only NOAA-16, one can see sharp and noisy features due to an inadequate sample size. The image produced using three satellites is noticeably smoother than the one produced using only the NOAA-16 satellite and shows that using multiple satellites can yield more useful climatological results than using just one.

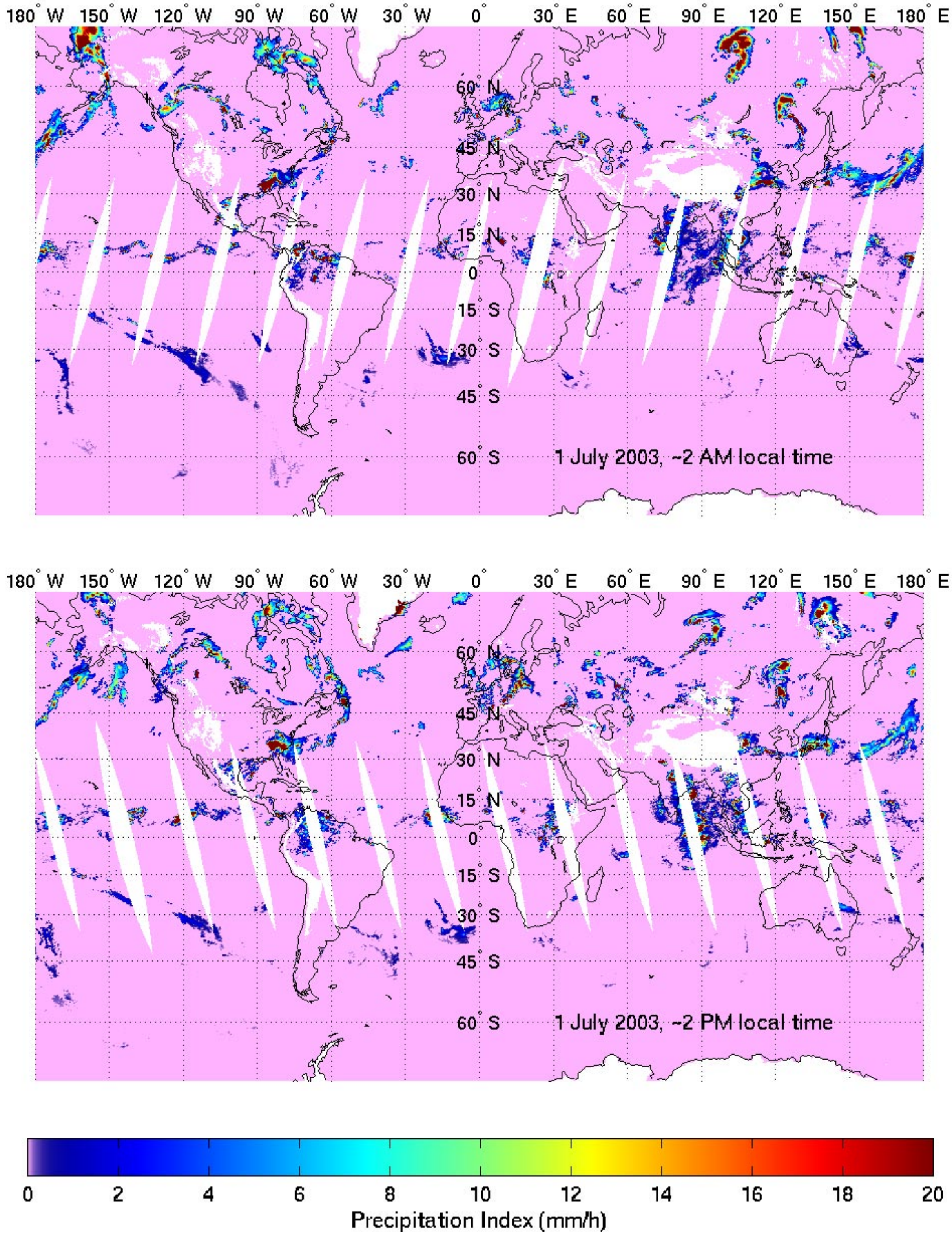

Figure 1. 0.1°×0.1° rain rate images (> 0.02 mm/h) computed using NOAA-16 AMSU data on 1 July 2003 at ~2 AM (top) and ~2 PM (bottom) local time. Points not observed and points above the altitude threshold function are colored white.

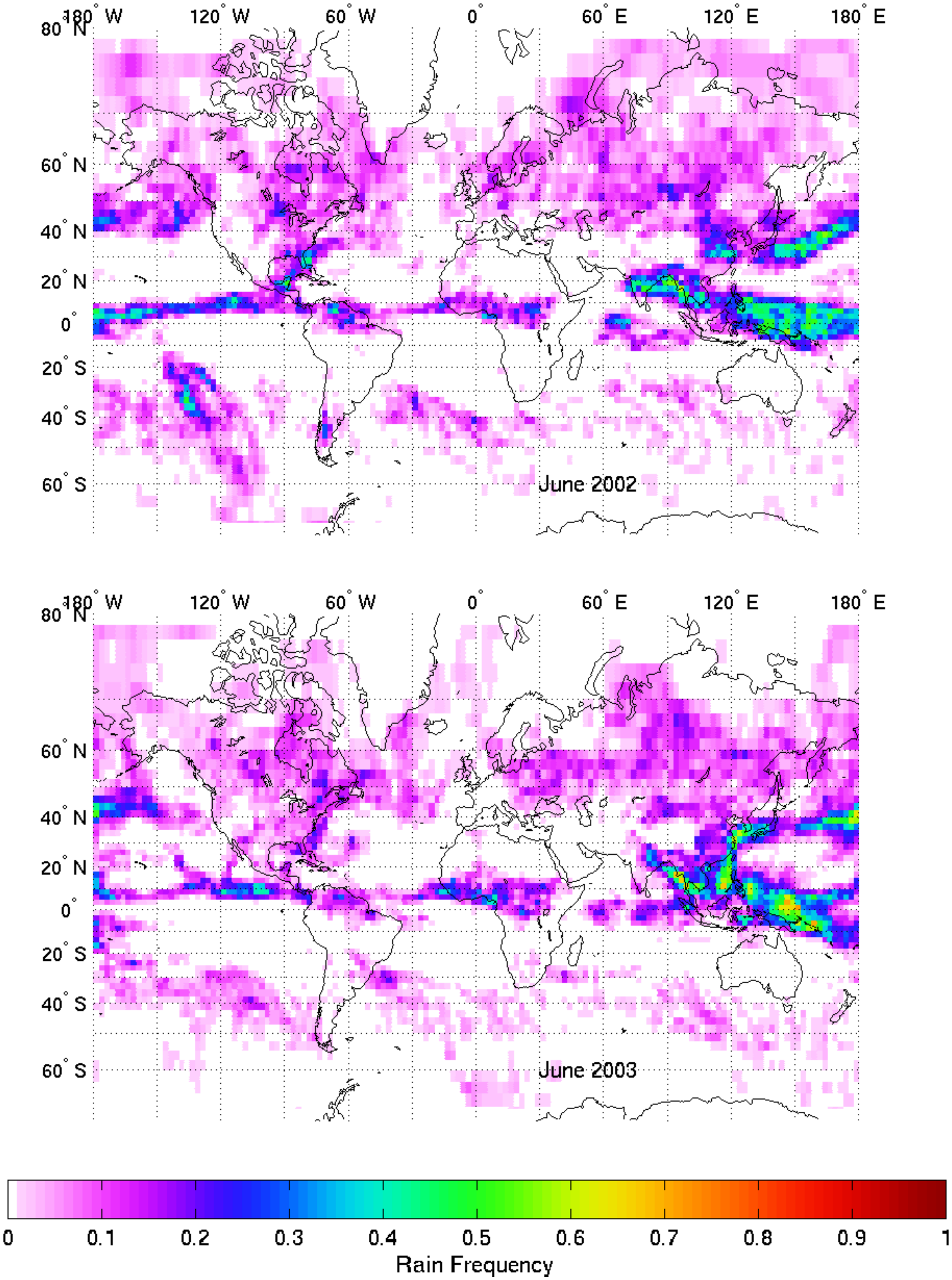

Figure 2. 2.5°×2.5° monthly NOAA-16 AMSU rain frequencies for June 2002 (top) and June 2003 (bottom).

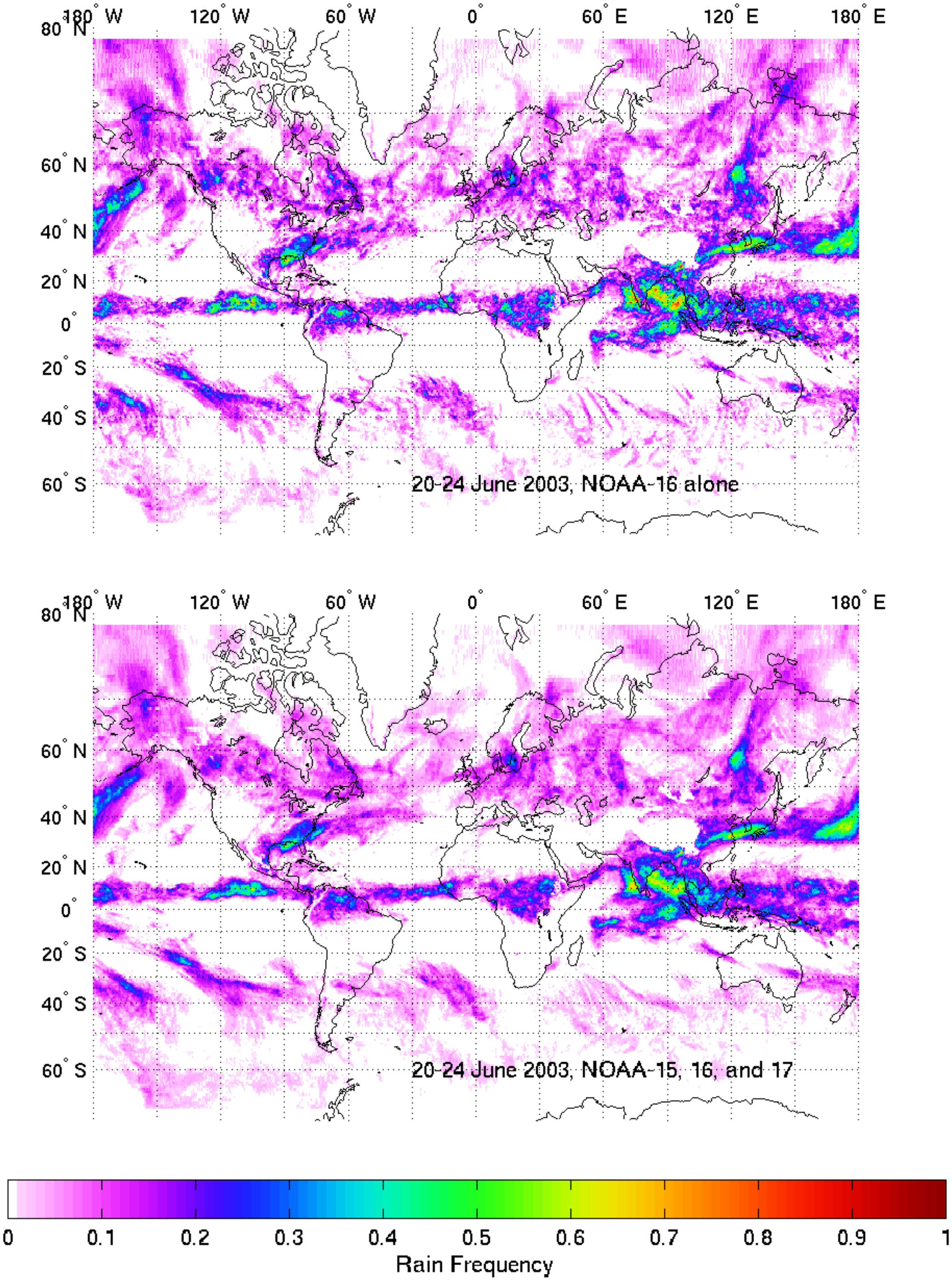

Figure 3. 0.5°×0.5° rain frequencies for 20-24 June 2003 using the NOAA-16 satellite alone (top) and NOAA-15, 16, and 17 satellites (bottom).

5. FUTURE WORK

The method used in this paper was trained using NEXRAD data over the eastern U.S. for 38 orbits distributed over one year. As a result, it does not accurately estimate rain rates for certain other climates. Specifically, this retrieval method currently does not estimate warm rain well, and it tends to overestimate high-latitude precipitation during the summer and underestimate it during the winter. The algorithm also tends to underestimate snowfall. Global calibration and correction of the estimates is in progress.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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