Azimuthal Scanning with the Polarized 89 GHz and 150 GHz Radiometer

R. Ware
Radiometrics Corporation, July 12, 2003

Introduction

During 13-15 June 2003 the radiometer observed at 15 degrees elevation with azimuthal scanning at 0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, and 330 degrees. During this period there were three convective events including rain showers. Rain was flagged by the rain sensor on the radiometer, indicating rainfall from near zenith.

For this observation period, threshold values of averaged azimuthal scans could have been used to provide 30 minutes or more advance warning of rain, with no false alarms. In addition, significant positive and negative differential polarization (V-H) signals were observed in association with the convective events. A positive difference is associated with enhanced vertical dimensions and orientation of liquid hydrometeors. A negative difference is associated with enhanced horizontal dimensions and orientation of frozen hydrometeors.

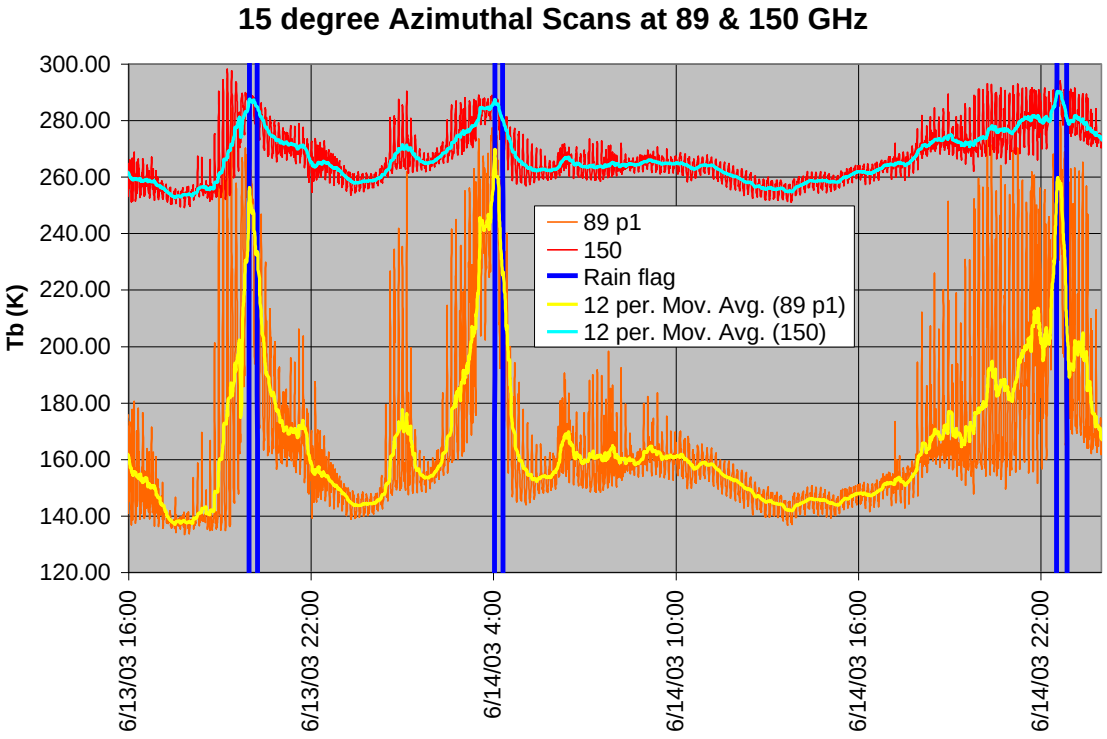

Figure 1. Brightness temperatures observed at 89 and 150 GHz. Three convective events are clearly seen in both channels. For these three cases, threshold brightness temperatures at 89 or 150 GHz could be used to forecast rainfall. For example for the 12 pt running average a threshold of 180 K for 89 GHz (yellow line) would have provided more than 30 minutes advance warning of rain. A threshold of 275 K for 150 GHz (turquoise line) would have provided similar warnings. There would have been no false alarms.

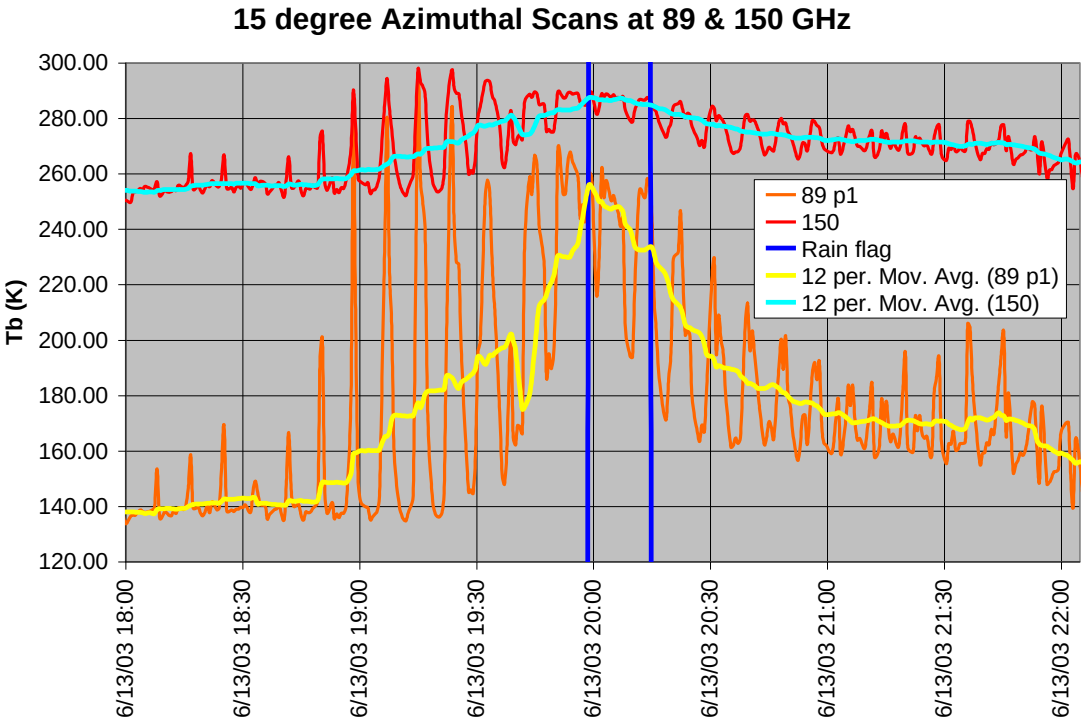

Figure 2. Details of first rainfall event. A threshold of 180 K for the 89 GHz trend would provide 40 minutes advance warning of rain, with similar warning for a 275 K threshold for the 150 GHz trend.

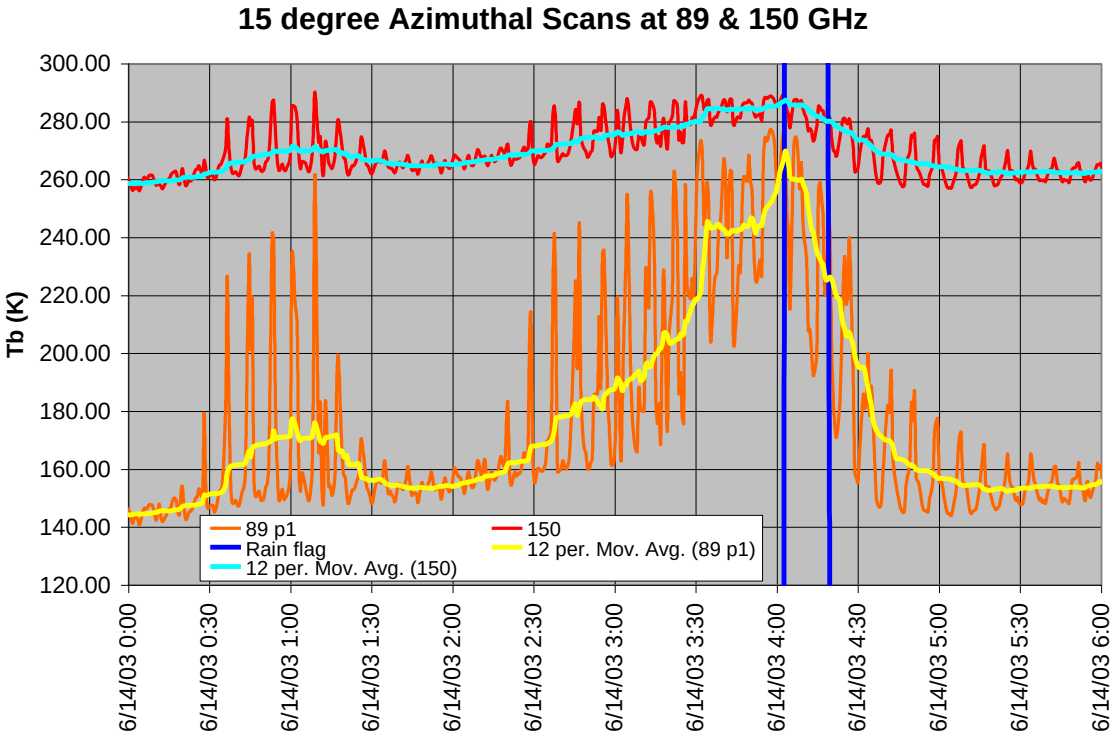

Figure 3. Details of second rainfall event. A threshold of 180 K for the 89 GHz trend would provide 75 minutes advance warning of rain, with similar warning for a 275 K threshold for the 150 GHz trend.

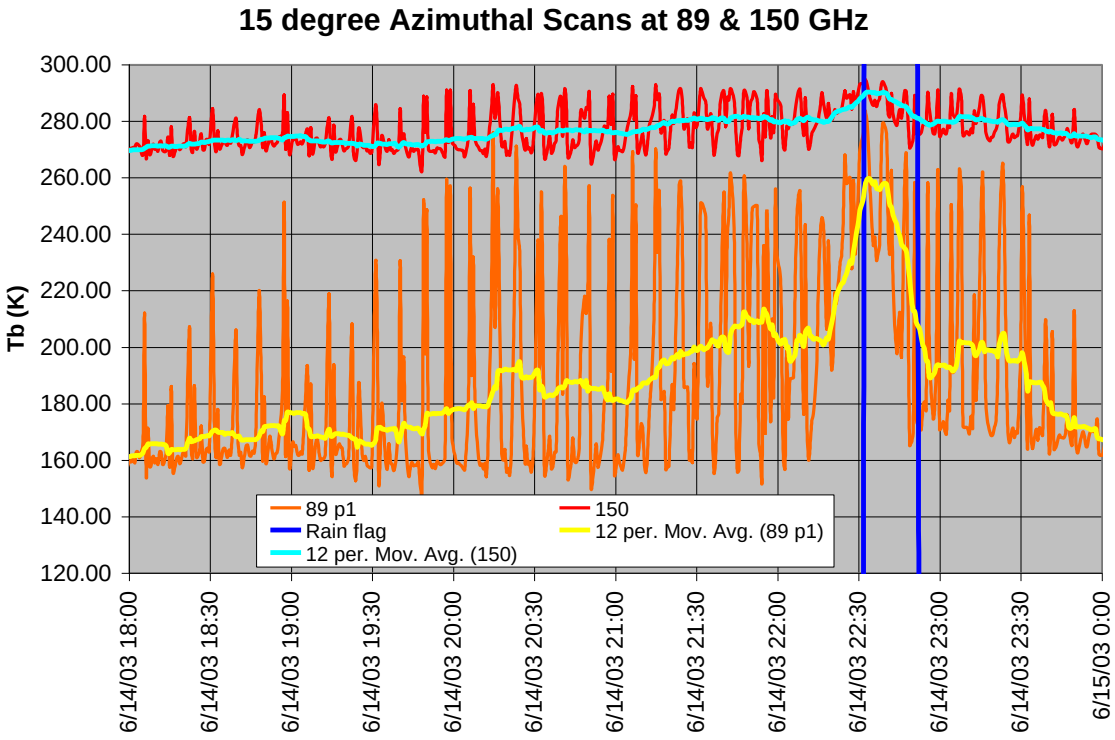

Figure 4. Details of third rainfall event. A threshold of 180 K for the 89 GHz trend would provide 75 minutes advance warning of rain, with similar warning for a 275 K threshold for the 150 GHz trend.

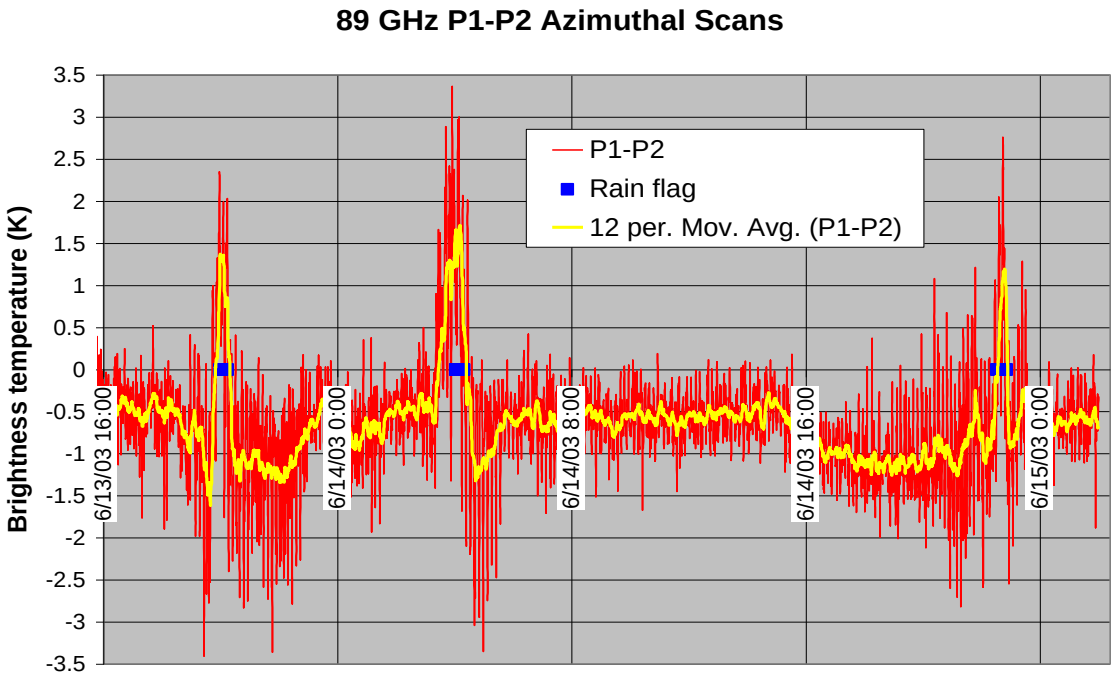

Figure 5. Scanning of 89 GHz P1-P2 (vertical minus horizontal polarization) at 15 degrees elevation with 30 degree azimuth steps. The scanning interval is approximately 9 min.

Three convective events including rain are clearly seen in Figure 5. Significant vertical polarization associated with rainfall is seen in all three cases. The vertical polarization is as large as 3 K, significantly larger than the ~0.3 K rms noise level.

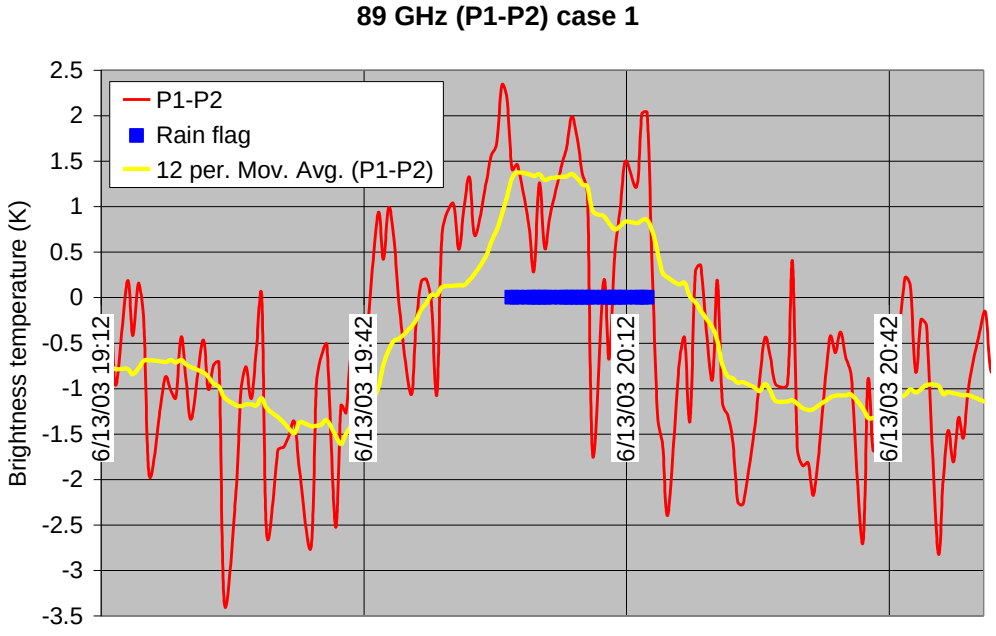

Figure 6. Details of the first rainfall event.

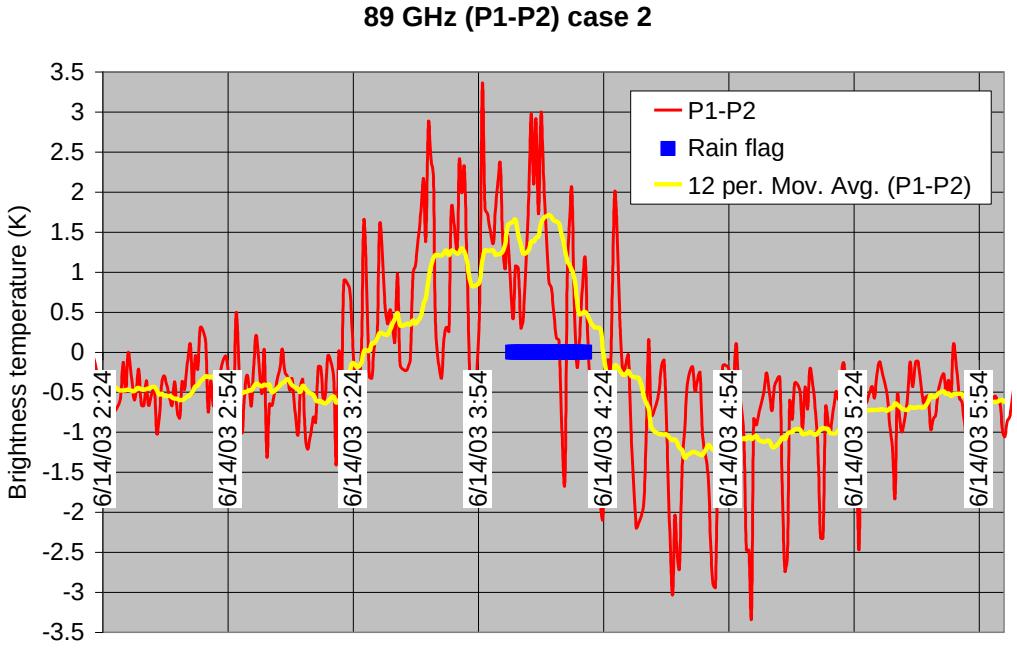

Figure 7. Details of the second rainfall event. Vertical polarization as high as 3 K was seen 5 minutes before rainfall, consistent with observation of liquid hydrometeors. Similar magnitudes of horizontal polarization (-3 K) were observed 20 minutes after rainfall, consistent with observation of a convective anvil containing ice particles.

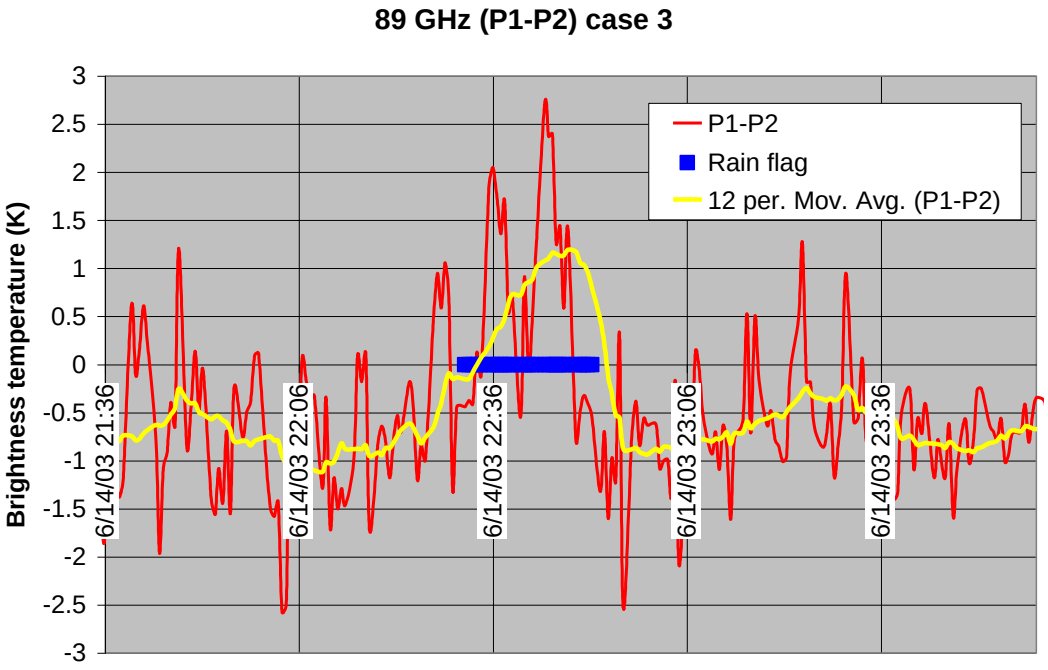

Figure 8. Details of the third rainfall event.

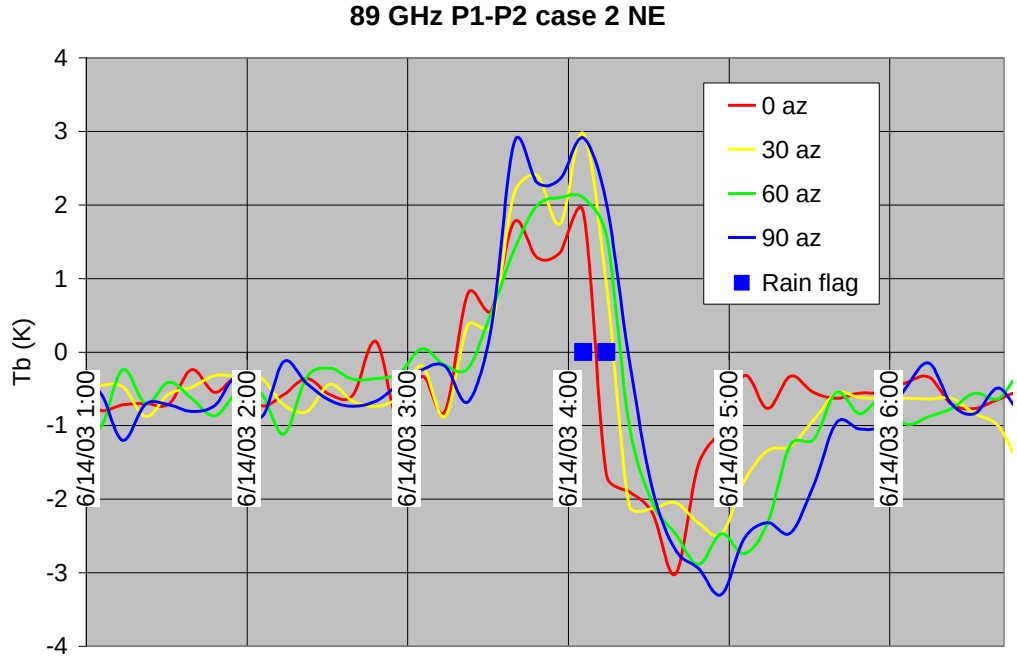

Figure 9. Vertical (+) and horizontal (-) polarization associated with the second rainfall event, observing to the northeast. Significant positive polarization associated with liquid hydrometeors is seen prior to rainfall. Significant negative polarization associated with ice crystals develops after the start of rainfall.

Conclusions

Preliminary results presented suggest a variety of applications for scanning radiometers observing dual polarization near 89 GHz and at 150 GHz. Included are short term forecasting of rainfall and detection of liquid and solid hydrometeors. For this observation period, threshold values of averaged azimuthal scans could have been used to provide 30 minutes or more advance warning of rain, with no false alarms. In addition, significant positive and negative differential polarization signals (V-H) were observed in association with the convective events. A positive difference is associated with enhanced vertical dimensions and orientation of liquid hydrometeors. A negative difference is associated with enhanced horizontal dimensions and orientation of frozen hydrometeors. These results are preliminary and analysis of more extensive observations is required to validate and refine the method. However, these results demonstrate the method's potential to provide advance warning of cloud and precipitation.