

Short Term Convective Storm Prediction

Microwave radiometry provides continuous atmospheric water vapor and liquid measurements. With azimuth scanning at low elevation angles, a radiometer can detect water vapor and cloud liquid in the early stages of convective storm formation. For example, azimuthal scans during a time period including three convective rain events are shown in Figure 1. A flag on the radiometer detected rainfall three times during the 32-hr period. A brightness temperature threshold of 180 K provides one-hour rainfall prediction with no false alarms.

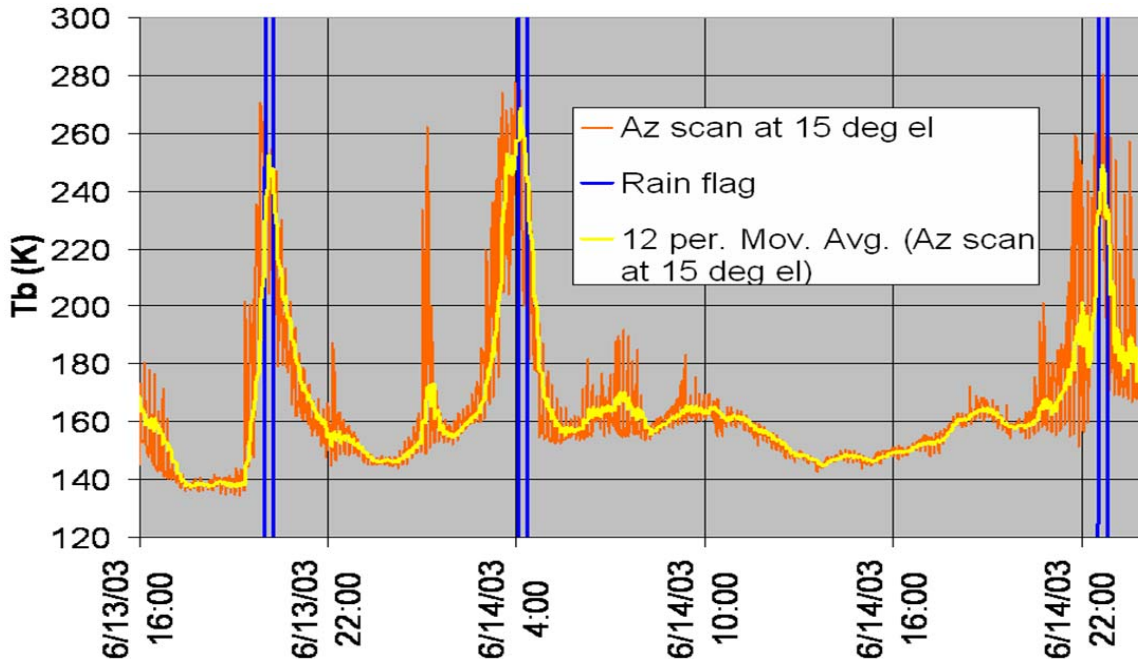


Figure 1. Radiometric brightness temperature (T_b) observed at 15° elevation in 30 deg azimuth steps (orange), and averaged over 360° (yellow). The rain flag detects water on top of the radiometer (blue). In this example, a 180 K T_b threshold predicts rainfall with an average 1 hour warning, with no false alarms.

Validation of convective storms that correlated in time and azimuth -- at 30 km distance from the radiometer -- was provided by on-line Denver weather radar. It is likely that detection distance can be roughly doubled using narrow-beam radiometer technology at lower elevation angles.

This example shows that an azimuthally scanned microwave radiometer can detect water vapor and liquid in convective storms. The radiometer can detect increases in water vapor density that occurs about one hour before liquid (and hydrometeors) are formed that are detectable by weather radar.

Forecast indices based on radiosonde temperature and humidity soundings are widely used to predict local convection. This approach works well for convective storms that occur within several hours of the radiosonde sounding. However, a serious shortcoming of this approach is poor forecast skill obtained with radiosonde soundings from several hours (or more) in the past. In contrast, continuous temperature and humidity soundings provided by microwave radiometers provide timely soundings and dramatically improved forecast skill.

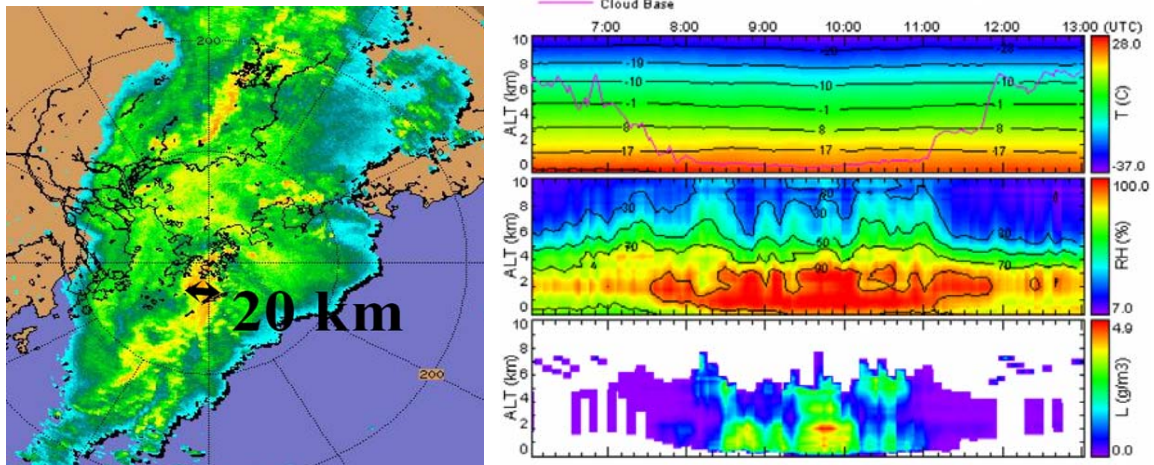


Figure 2. Hong Kong convective storm with 20 mm/hr peak rainfall – 10:00 UT radar (left), and 6:00-13:00 UT radiometer (right) demonstrating optimal performance during heavy rain [Chan and Tam, 9th IOAS-AOLS, AMS, 2005].

A convective storm with heavy rain is shown in Figure 2. The K-index calculated from continuous radiometer data, and the number of lightning strikes, are shown in Figure 3, along with correlation in range from the radiometer site. Lightning strikes occur when the radiometric K-index exceeds 35.

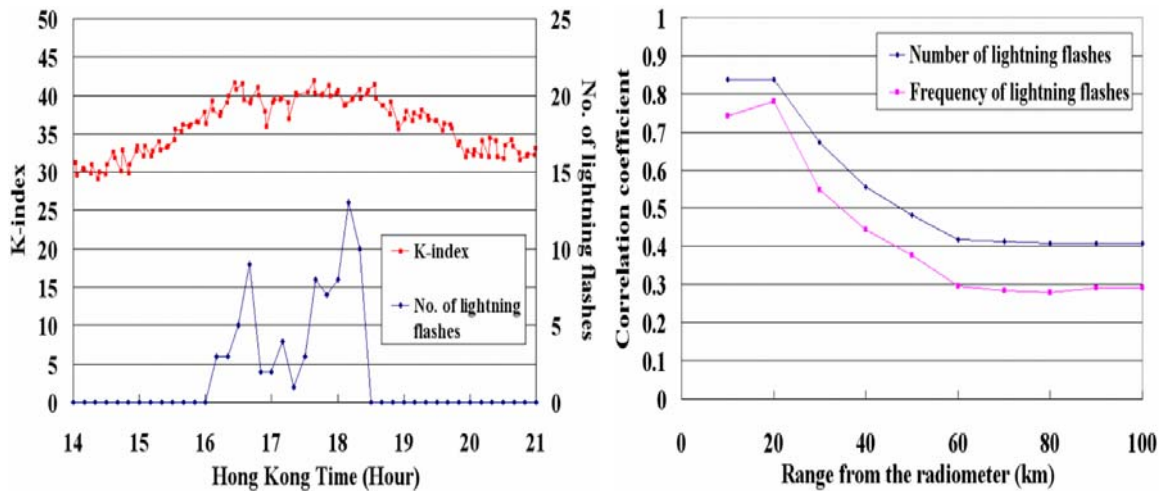


Figure 3. K-index calculated from continuous radiometer data and the number of local lightning strikes (left), and their correlation with distance from the radiometer (right) [Chan and Tam, 2005].

A similar approach using other traditional forecast indices can provide large improvements in convective prediction. In addition, entirely new indices based on radiometric liquid profiles can be developed to improve precipitation forecasts.

References

- Chan, P.W., [Monitoring and Observation of Föhn Wind in Hong Kong Using a Multi-Channel, Ground-Based Microwave Radiometer](#), 28th Int. Conf. Alpine Meteor. (ICAM) & Ann. Sci. Meet. Mesoscale Alpine Prog. (MAP), 2005.
- Chan, P.W., and C.M. Tam, [Performance and Application of a Multi-wavelength, Ground-based Microwave Radiometer in Rain Nowcasting](#), 9th IOAS-AOLS, AMS, 2005.