Radiative heating and temperature profiles over the diurnal cycle during TWP-ICE

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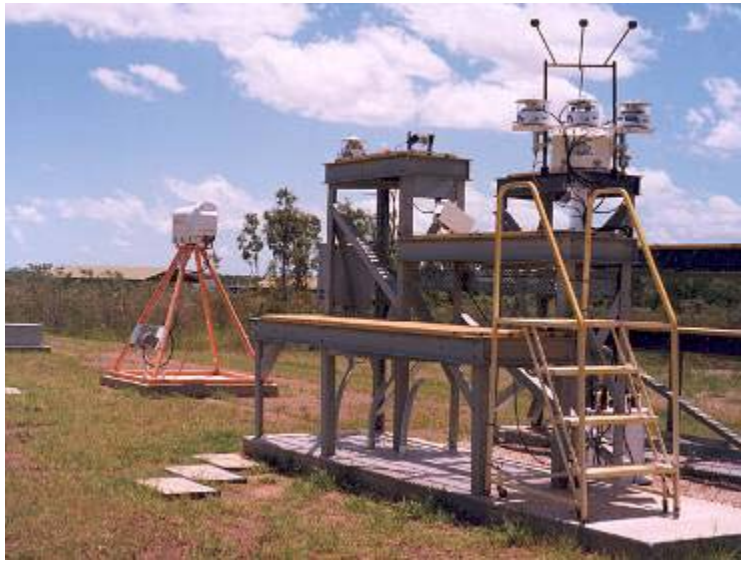
Jim Mather, PNNL
Richland, Washington

Tropical ARM Measurements

- **Cloud Profiles - mm radar and lidar**
- **T/RH/Wind Profiles – radiosondes (BOM)**
- **Column water - microwave radiometer**
- **Column Aerosol – solar spectral radiometer**

- **Surface radiation budget - solar and terrestrial**
- **Surface meteorology - T, RH, Wind**



Procedure for obtaining Cloud and Radiative Heating Rate Profiles from ARM Measurements

Radiosonde profiles of temperature and humidity +
Microwave radiometer precipitable water +
High temporal resolution surface air temperature

→ Constrained profiles of temperature and humidity at high temporal resolution

35 GHz Radar profiles of reflected power +
Radiosonde temperature profiles +
Field observations of cloud particle distributions

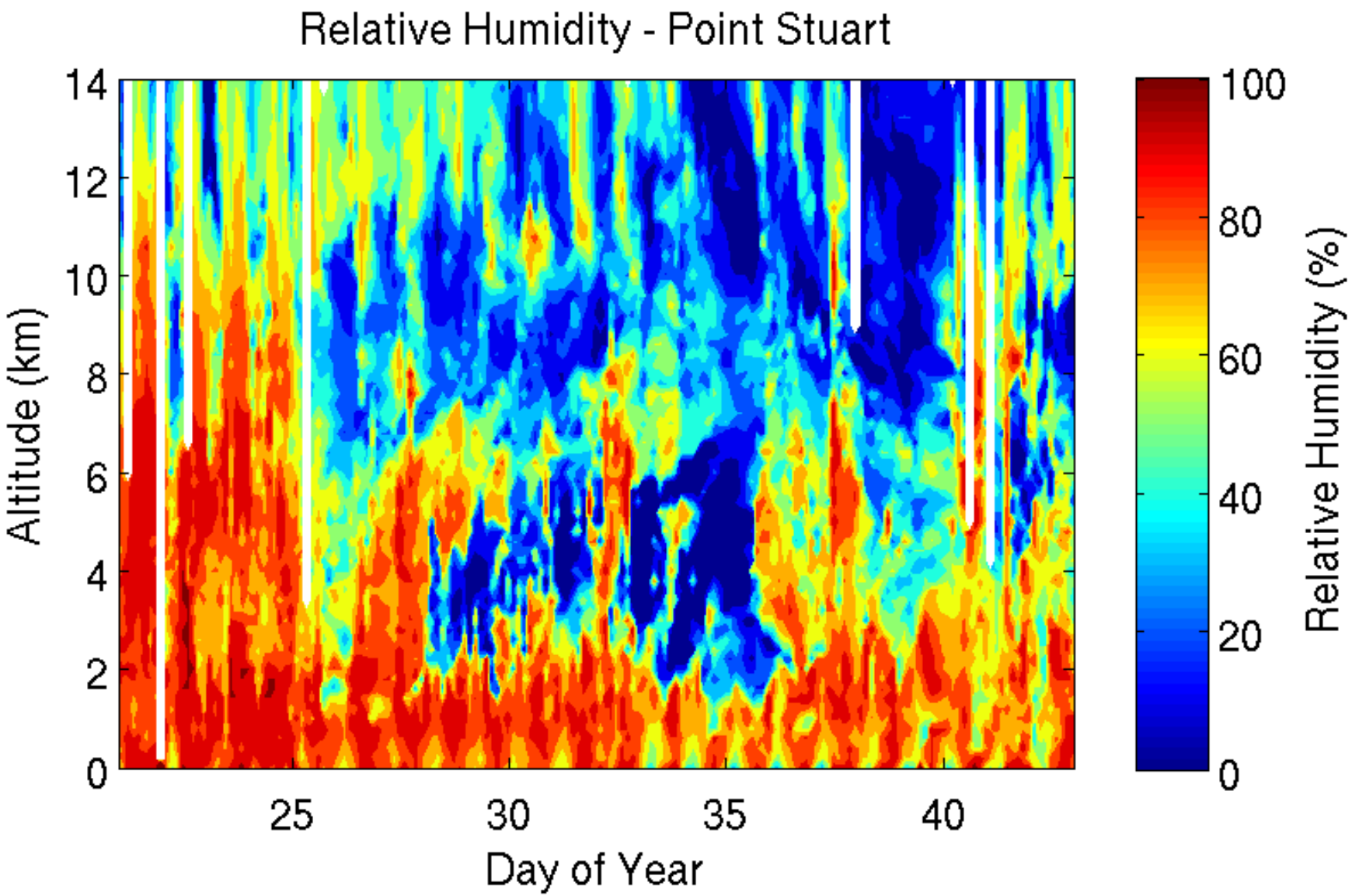
→ Profiles of liquid and ice water content and effective particle size

Derived profiles of temperature and humidity +
Derived profiles of cloud water content and particle size

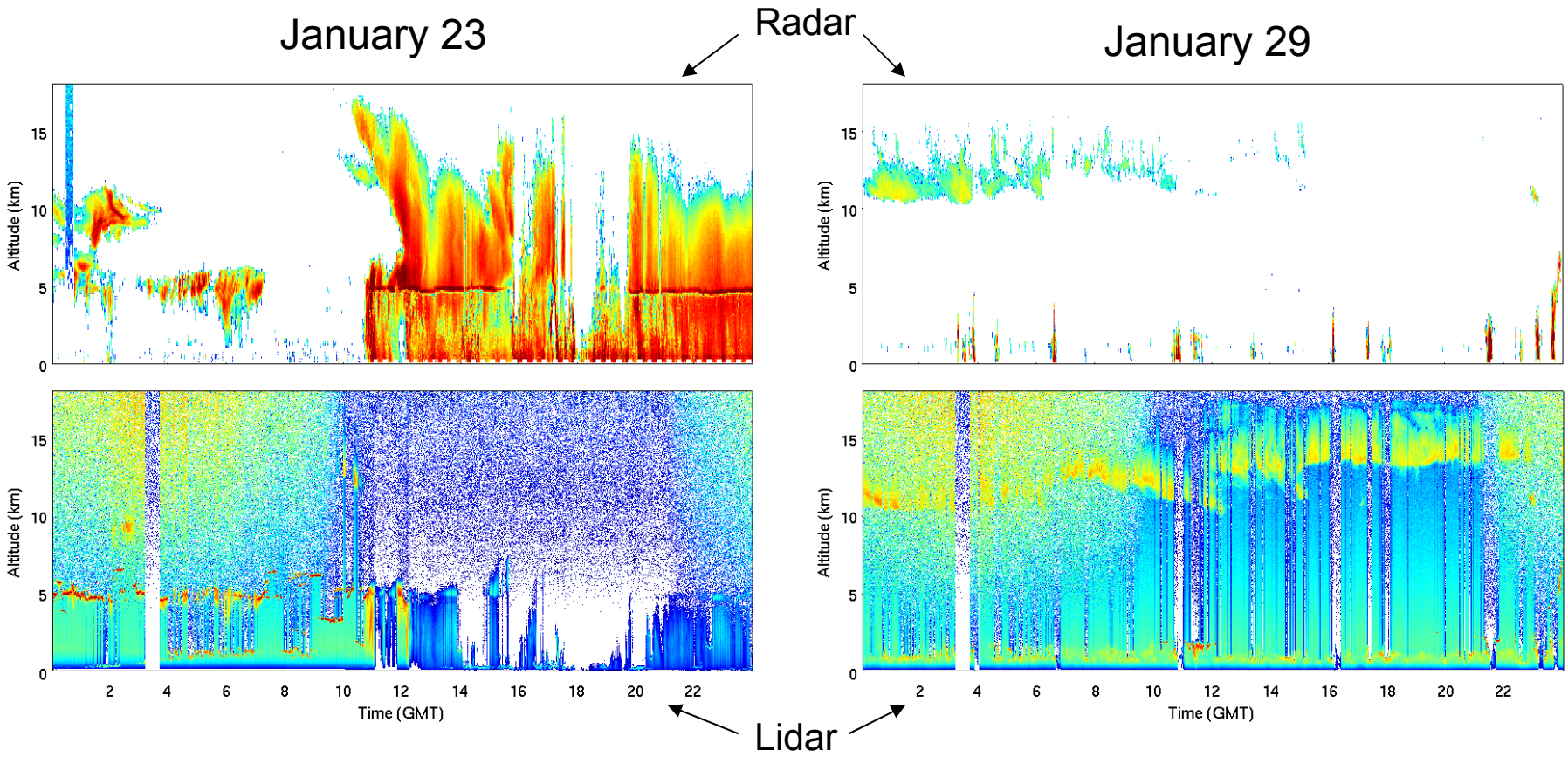
→ 4-stream radiative transfer model (Fu and Liou, 1992)
→ Radiative Fluxes and heating rates

Mather et al., 2006, JGR

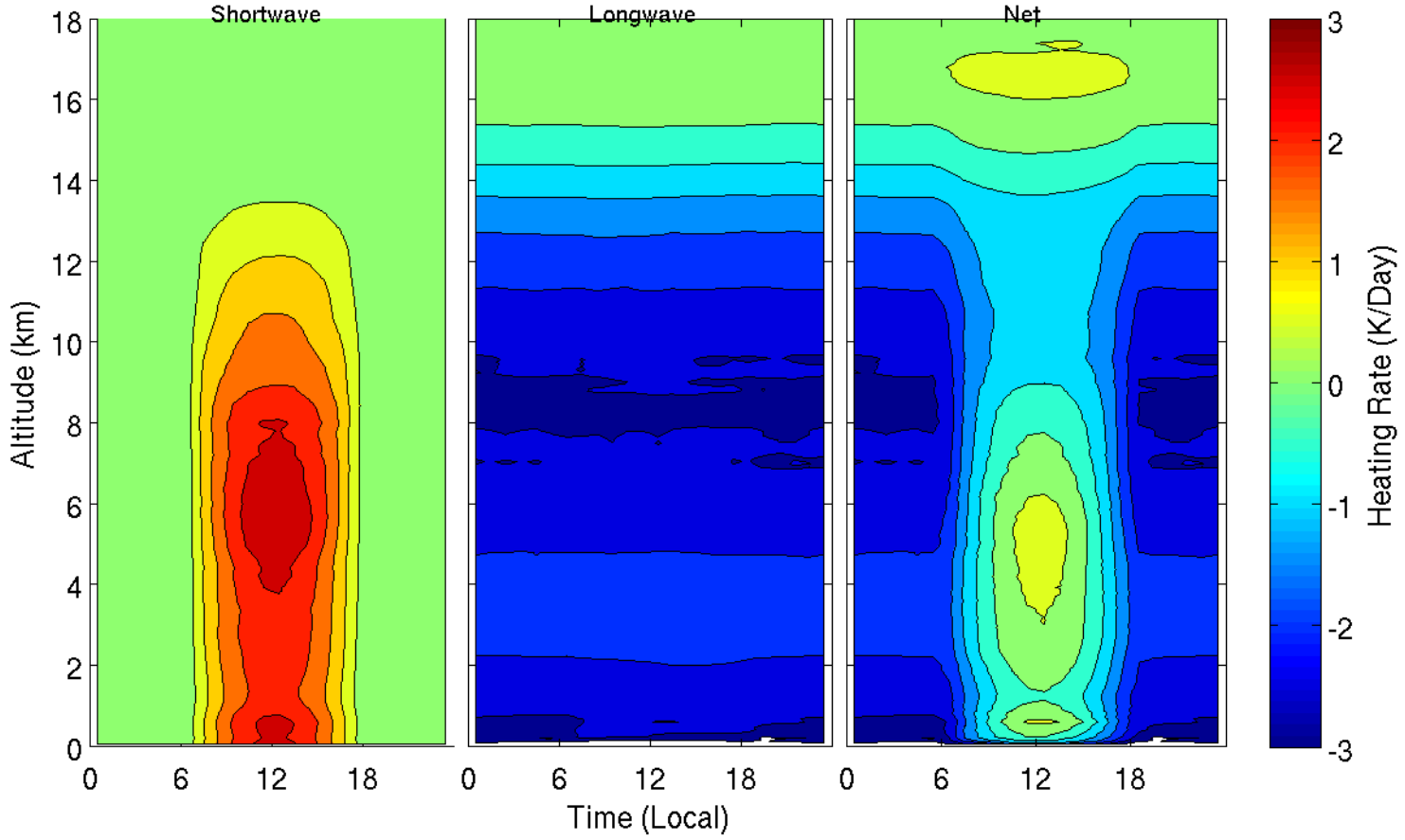
Upper Troposphere Daytime Water Vapor Bias



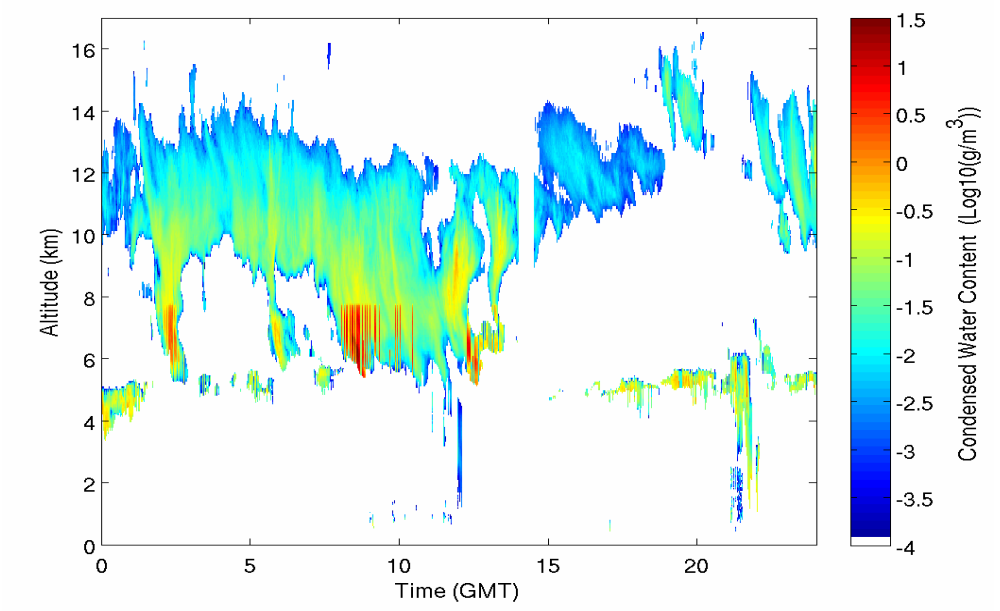
35 GHz Radar/Lidar Profiles from Darwin ARM site

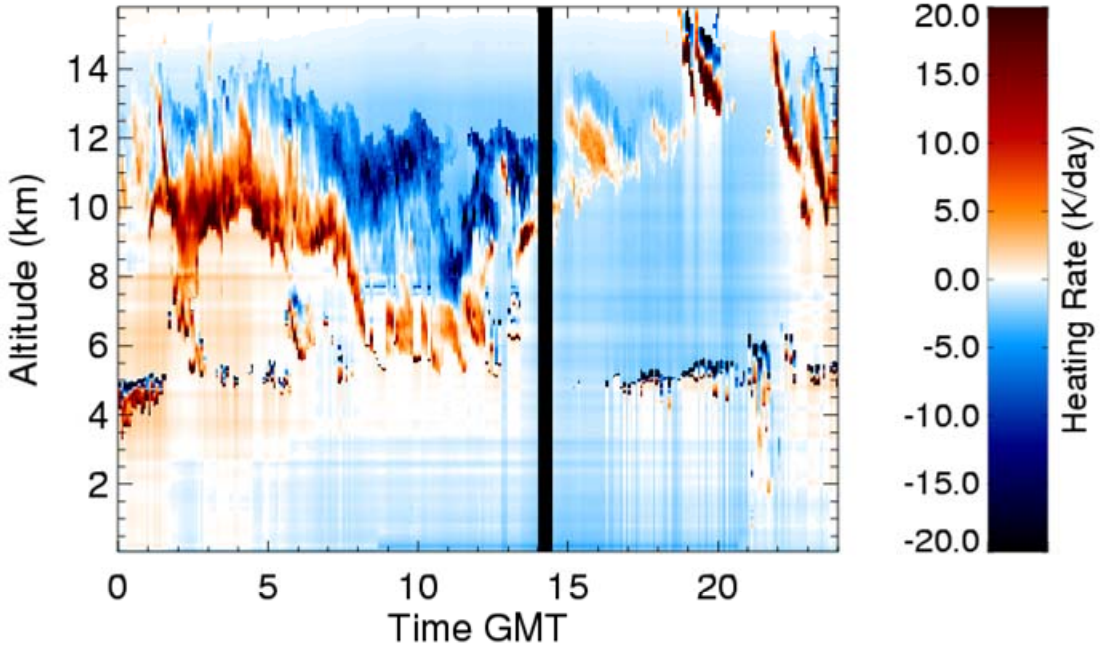


Diurnal Composites of Manus Clear-Sky Heating Rates (K/day)

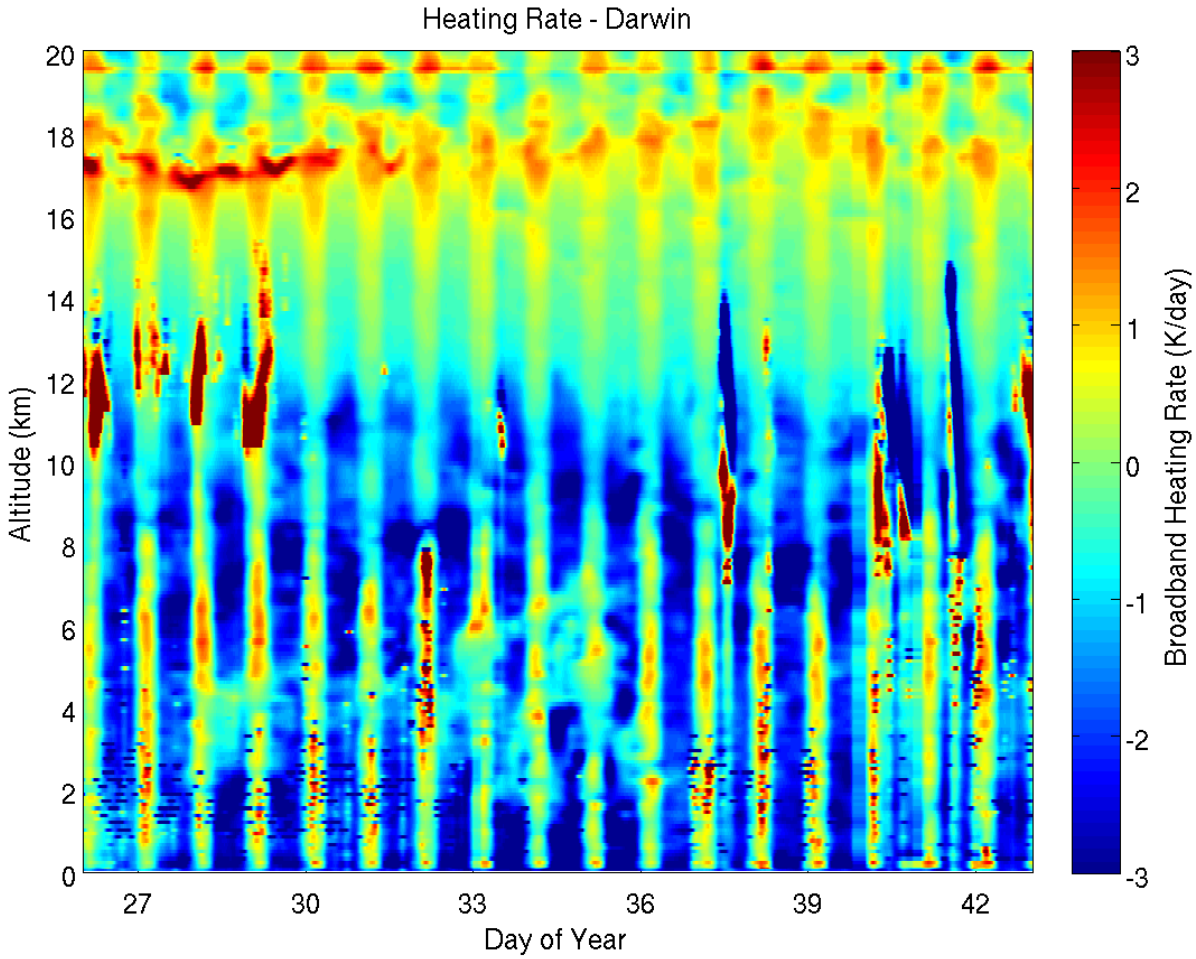


Ice Water Content
+
Liquid Water Content

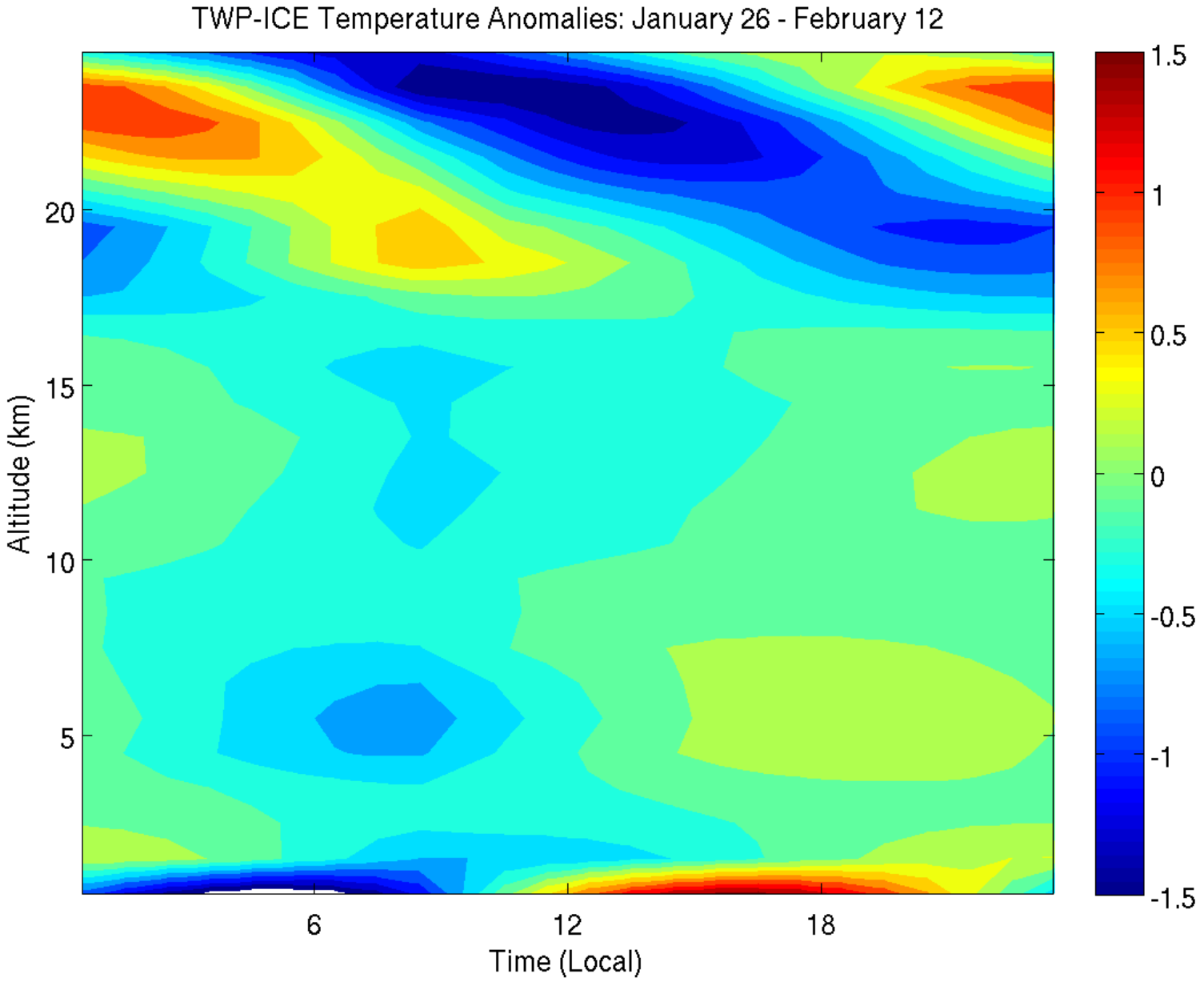




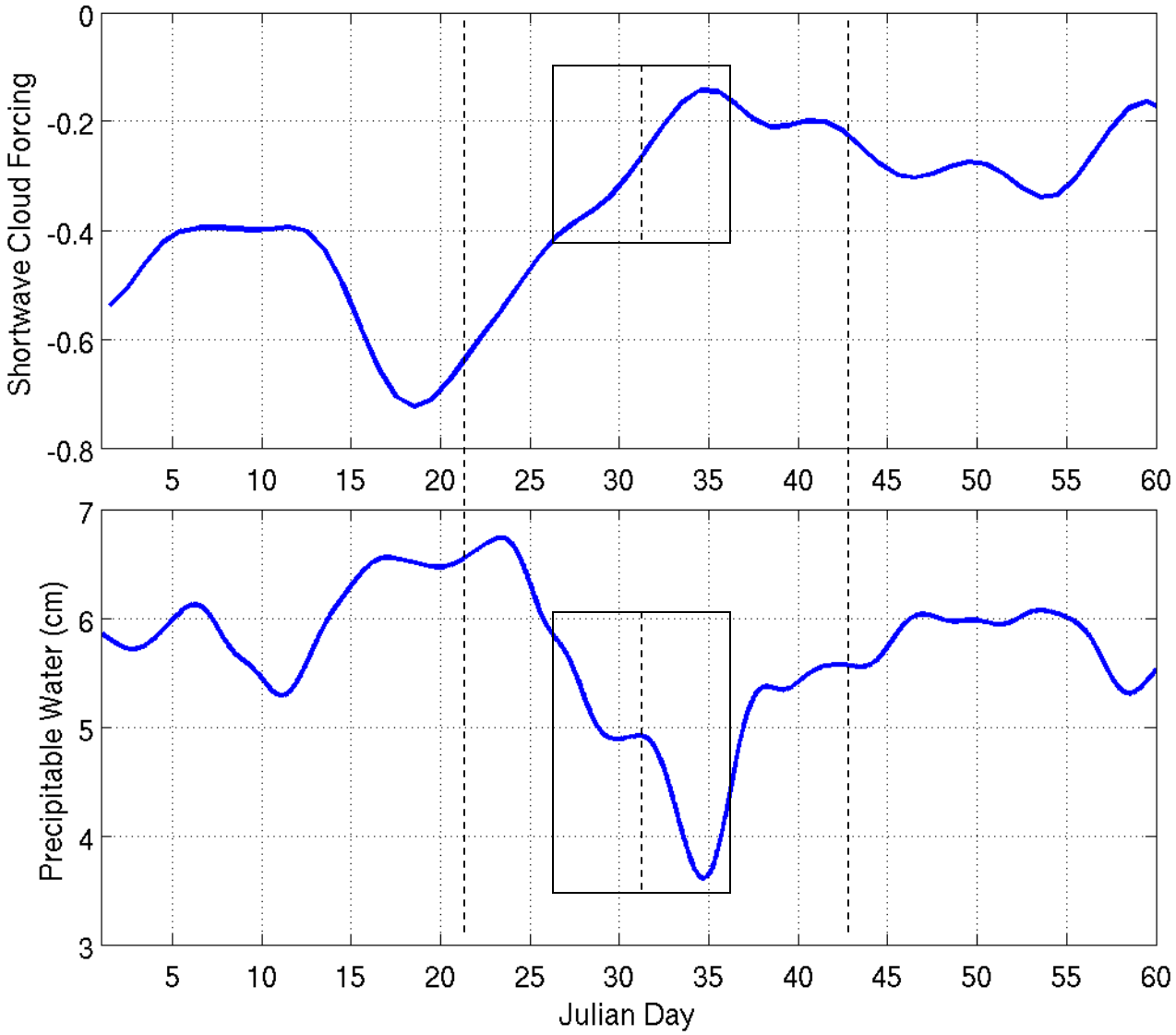
Radiative heating profiles for the period January 26 – February 12, 2006 over Darwin.



Temperature Anomalies: Diurnal Composite, Point Stuart



Time Series of Shortwave Cloud Forcing and Precipitable Water from ARM Site



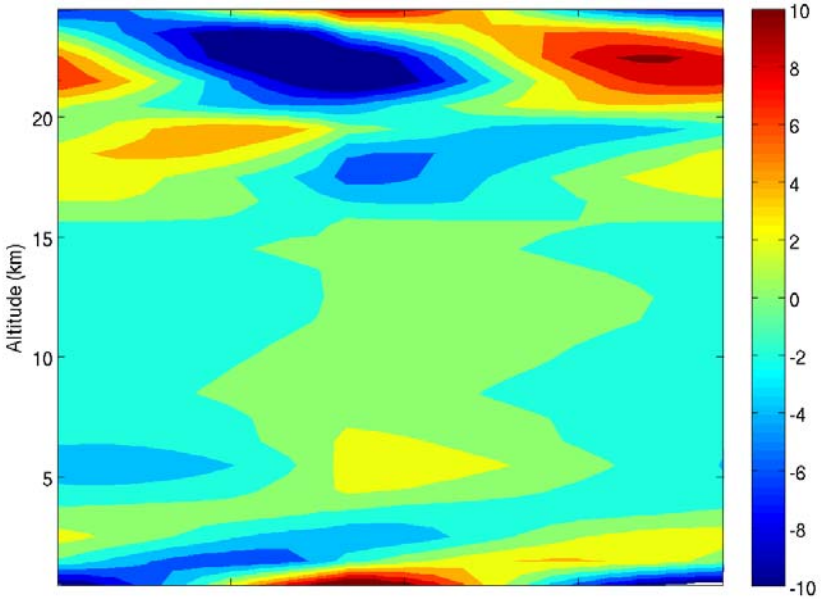
From Eppley PSP radiometers and clear sky calculations

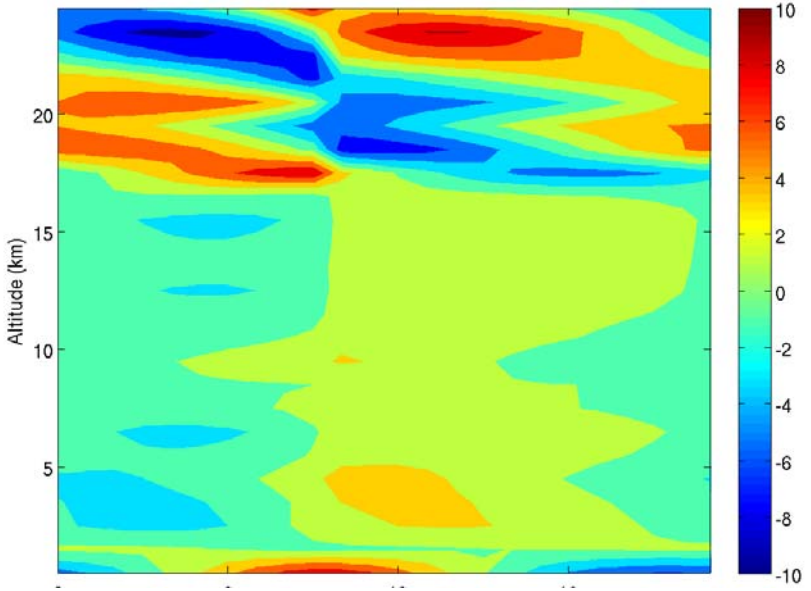
From Radiometrics two-channel microwave radiometer

Feb 1 - 5

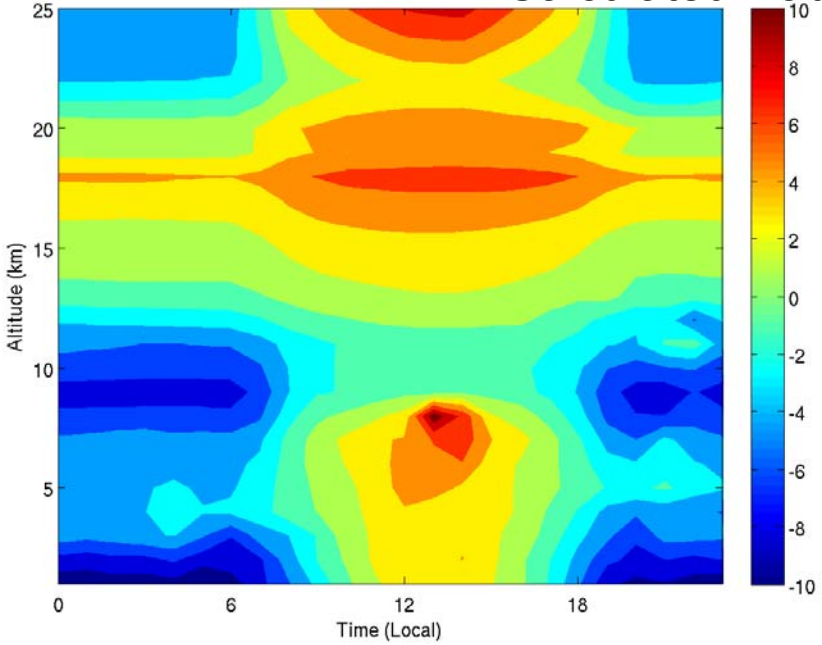
Apparent Heating from Radiosondes (K/day)

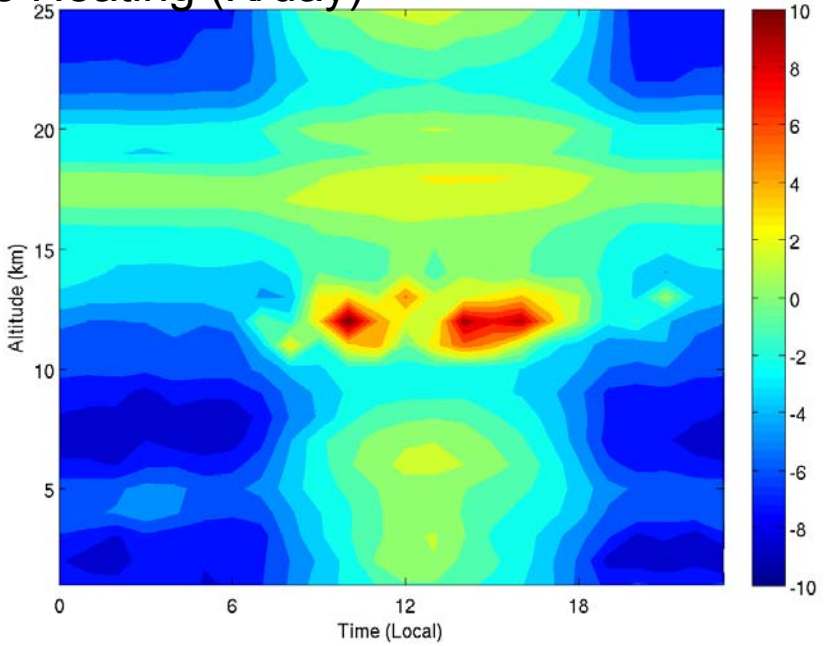
Jan 26-31





Calculated Radiative Heating (K/day)

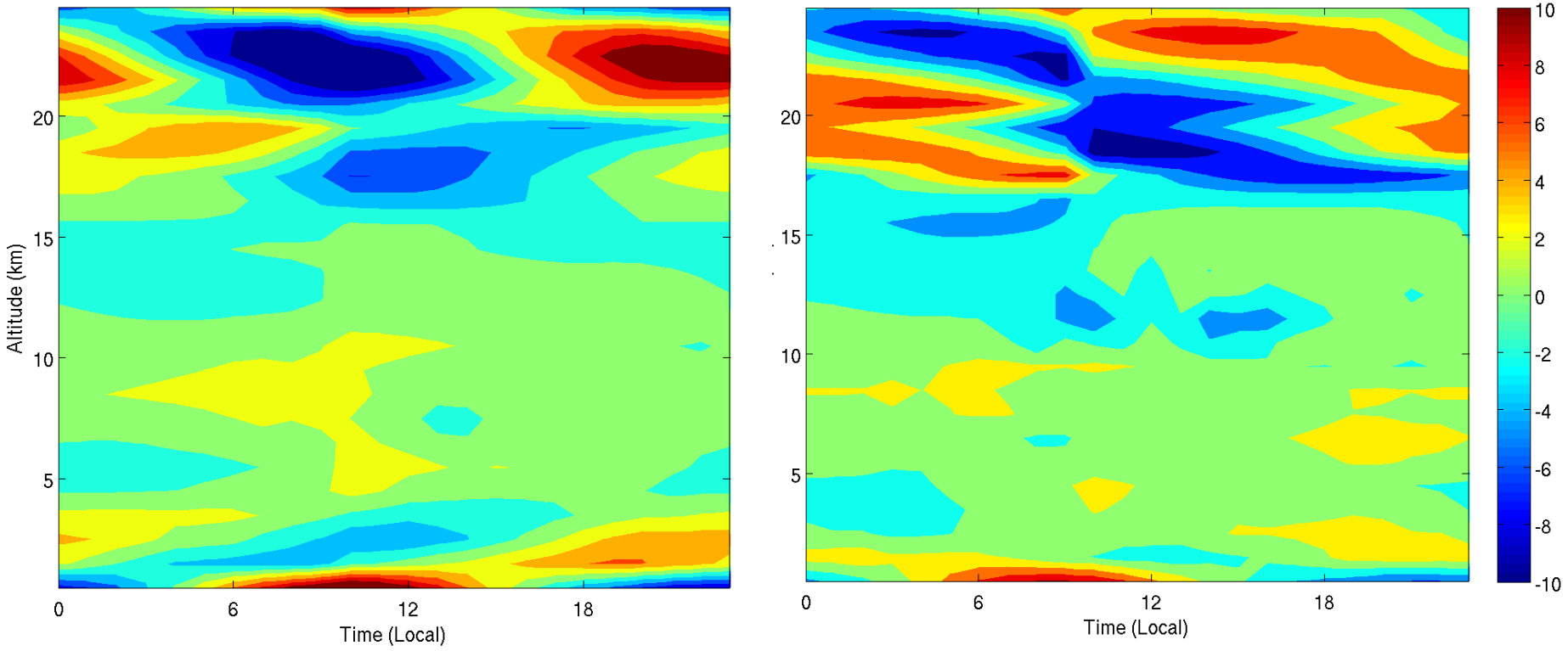




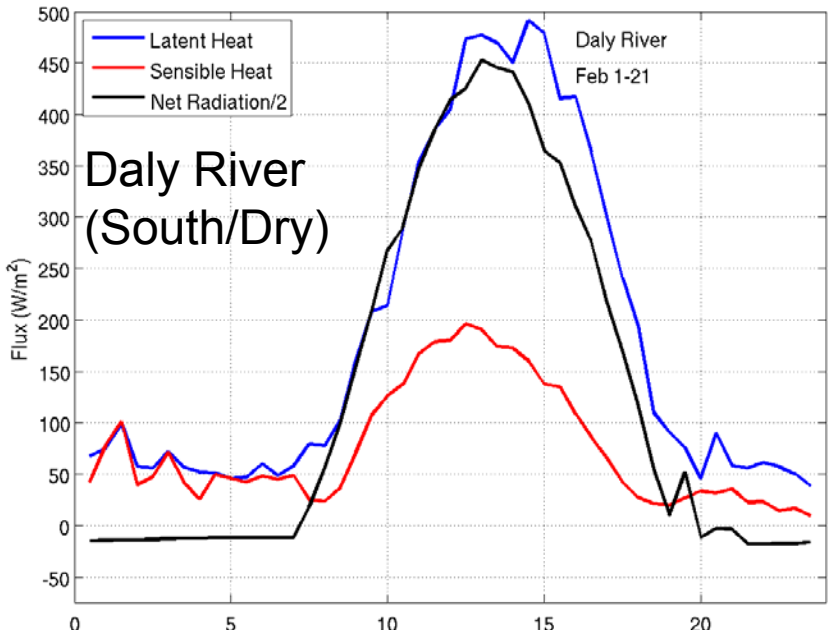
Heating Residuals: apparent heating – radiative heating (K/day)

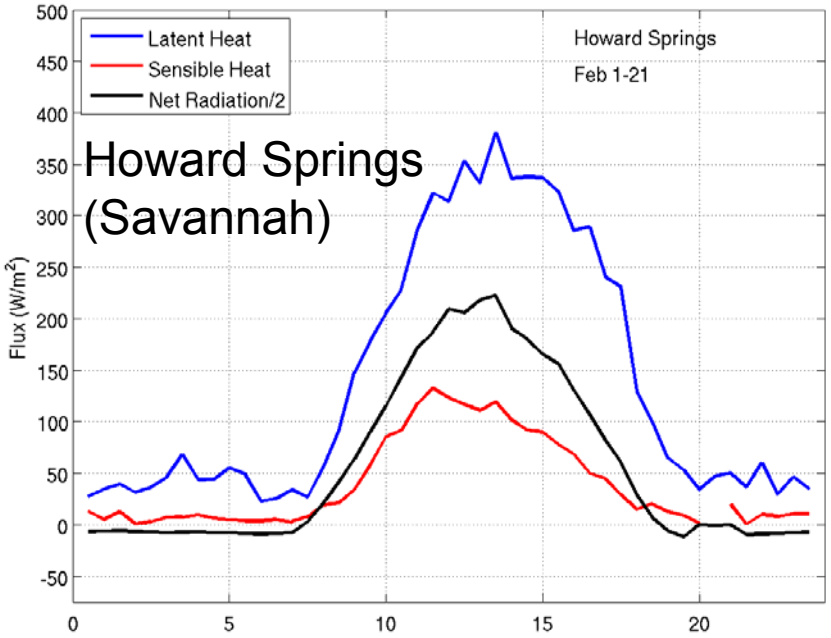
Feb 1 - 5

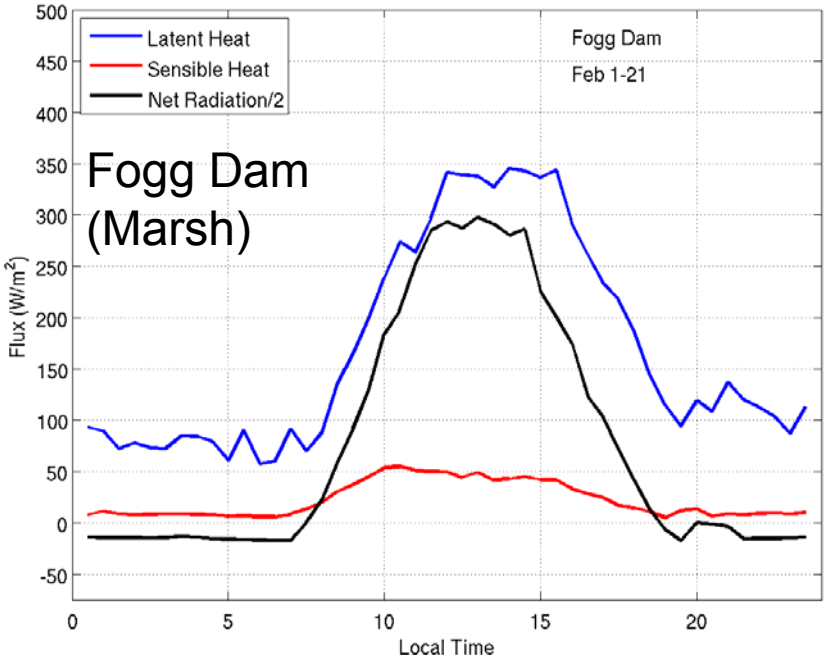
Jan 26-31

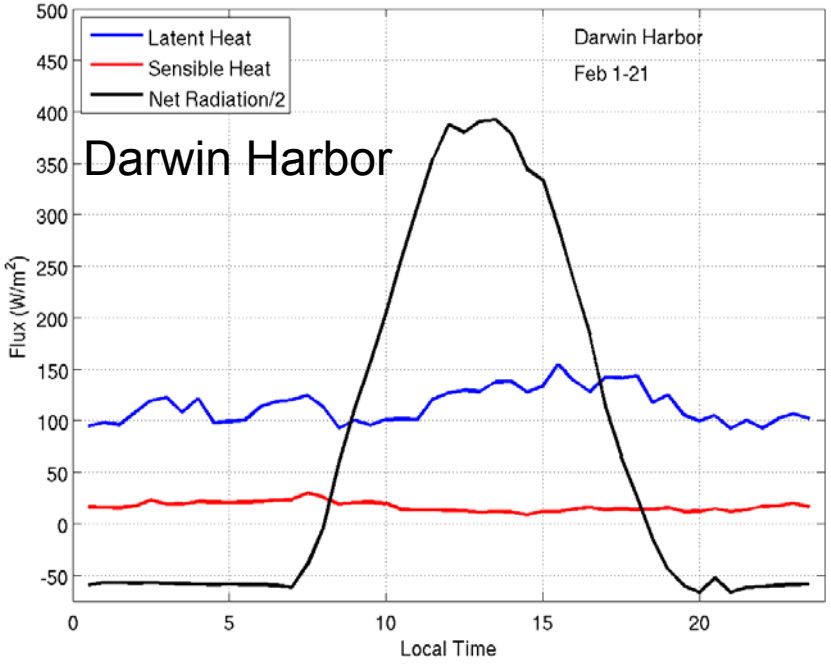


Surface Fluxes from Monash University (Tapper)

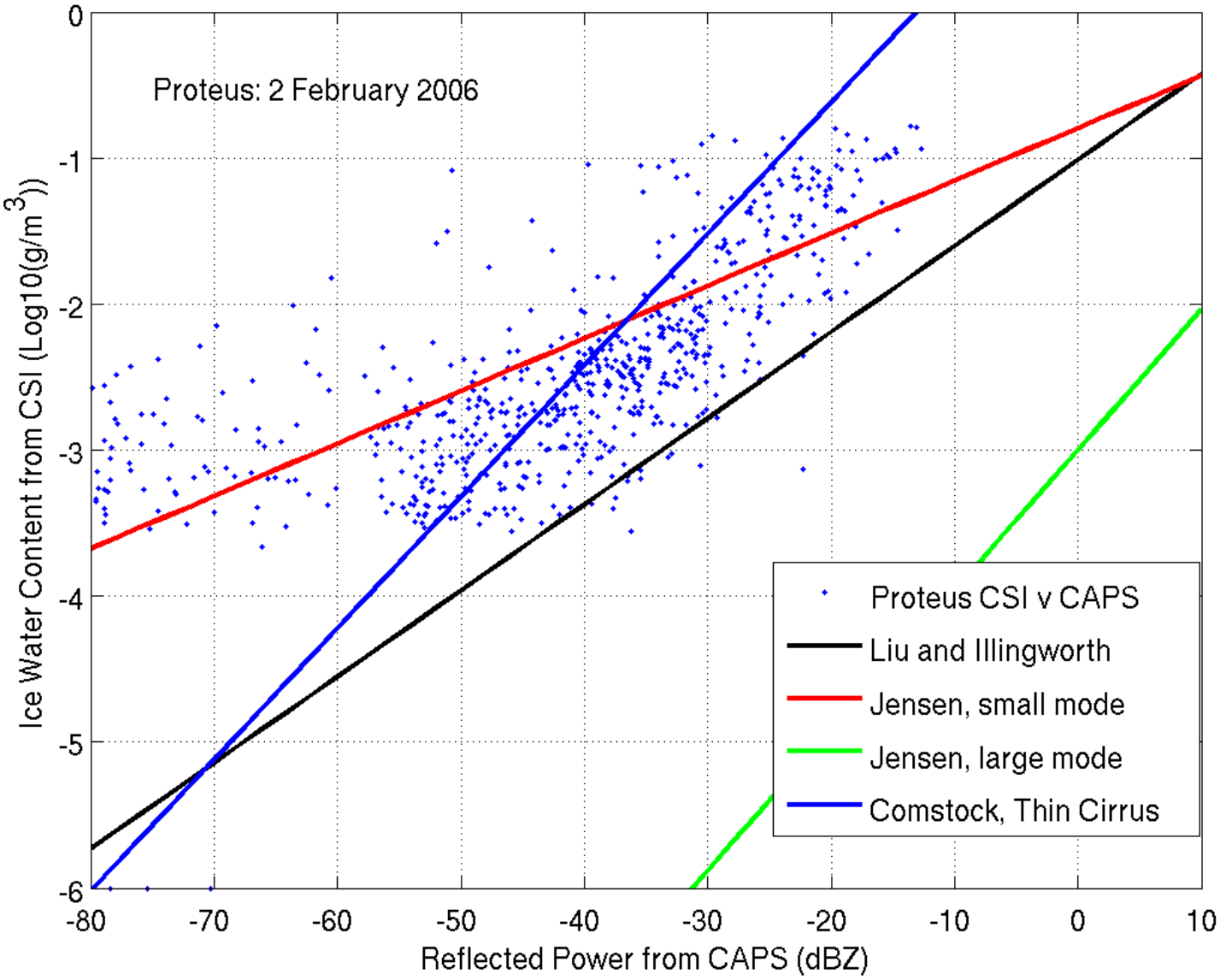








Observations from the microphysics probes



Summary

•Using radar, surface meteorology, microwave and radiosonde data to derive radiative heating profiles for Darwin (as well as the other tropical ARM sites)

•Beginning to use microphysics observations from TWP-ICE to assess and (eventually) improve ground-based microphysical retrievals

•Use high temporal resolution radiosonde temperature profiles to derive diurnal temperature composite and apparent heating composite

•Co-analysis of radiative calculations and radiosonde profiles allows partitioning of radiative and non-radiative heating effects

•Beginning to add analysis of surface fluxes and other measurements and analysis to develop description of heating profiles

•Data analysis challenges include radar sensitivity to small particles and daytime RH bias