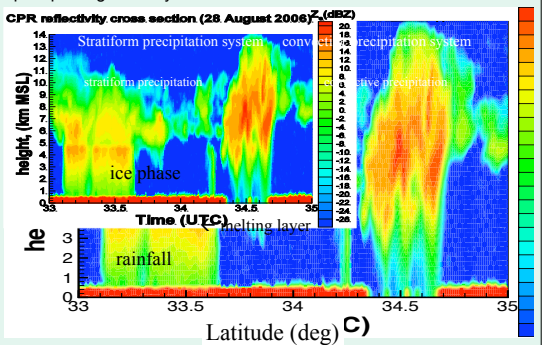
Space-borne Estimates of Atmospheric Water Cycle Parameters

Sergey Matrosov[1,2], Gary Wick[2], Christopher Williams[1,2], and Darren Jackson[1,2]
[1]CIRES, University of Colorado, [2]NOAA ESRL Physical Sciences Division

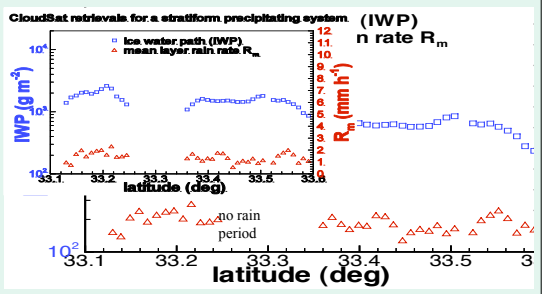
CloudSat Retrievals of Parameters of Precipitating Cloud Systems

The CloudSat satellite carries a W-band (94 GHz) nadir-pointing radar. While originally designed for measurements of non-precipitating clouds, it is also a very useful tool for studies of precipitating cloud systems.



The figure above shows an example of CloudSat measurements of two precipitating cloud systems. In stratiform precipitating cloud system, the reflectivity enhancement in a melting hydrometer layer allows vertical separation of an ice/snowfall area above and rainfall below precipitating cloud systems from ice cloud tops to the surface (though surface returns may be lost for very intense precipitation).

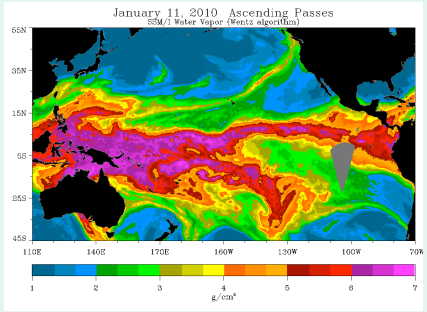
Radar signal attenuation is weak in ice phase and strong in rainfall. Ice water content retrievals are performed using the absolute radar backscatter data above the melting layer and rainfall rate estimates are conducted from the vertical gradients of radar backscatter in a liquid layer. As a result simultaneous estimates of atmospheric ice and resulting rainfall are available in the vertical column (see below).



Generally there is a positive correlation between the total amount of ice observed aloft and rain rate of precipitation observed in the liquid hydrometer layer. The simultaneous retrievals of cloud and precipitation information provide valuable verification information for the modeling community. It leads to better parameterizations of different components of the atmospheric water cycle and to better understanding of precipitation formation processes.

Passive Microwave Retrievals of Integrated Water Vapor

Passive microwave data from the Special Sensor Microwave Imager (SSM/I) and Special Sensor Microwave Imager Sounder (SSMIS) enable retrieval of the total integrated water vapor (IWV) content over the oceans.

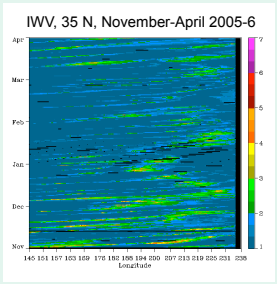


The combination of SSM/I and SSMIS data provides us with an IWV climate record of over 20 years. Work at ESRL/PSD developed a mapping of SSMIS brightness temperatures to SSM/I to extend the record.

Applications

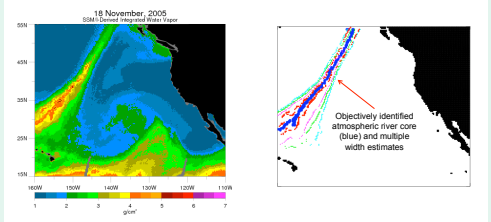
Applications have included studies of atmospheric river events and exploration of whether a potential "widening" of the tropics could be distinguished from moistening.

The time-longitude diagram helps characterize extent, frequency, and propagation speed of atmospheric river events.



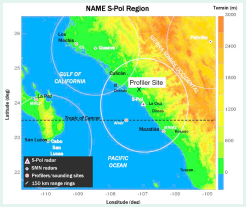
Automated Detection of Atmospheric River Events

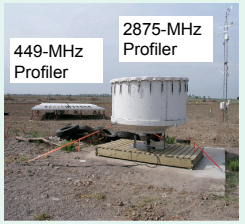
Initial criteria were developed to identify atmospheric river events in IWV imagery and forecast fields. These techniques were expanded to enable fully automated detection of the events and have been applied to the verification of forecasts of the events.



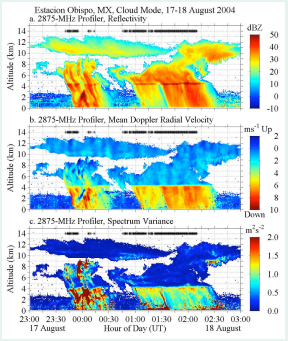
Statistical Comparison of Profiler and TRMM Reflectivity

Vertically-pointing 449-MHz and 2875-MHz profiler observations were collected North of Mazatlan, MX, in support of the North American Monsoon Experiment (NAME) in July-August 2004.





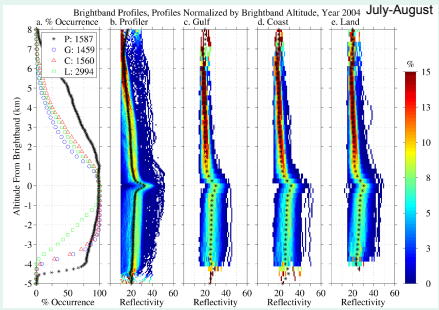
The 2875-MHz profiler is ideal for studying the precipitation vertical structure as the rain event passes over the profiler site.



During the NAME campaign, there weren't any TRMM satellite observations directly over the profiler while it was raining.

The TRMM observations over the NAME domain during July-August 2004 were grouped into 3 regions: **Gulf**, **Coast** and **Land**.

The reflectivity vertical structures from the TRMM satellite are compared with the profiler during stratiform rain regimes and were similar for each region.



Williams, White, Gage and Ralph, 2007: Vertical Structure of Precipitation and Related Microphysics Observed by NOAA Profilers and TRMM during NAME 2004. *J. Climate*, **20**, 1693-1712.