A Comparison of Heating Rates and Related Cloud Properties from CloudSat and ARM Observations at Manus Island

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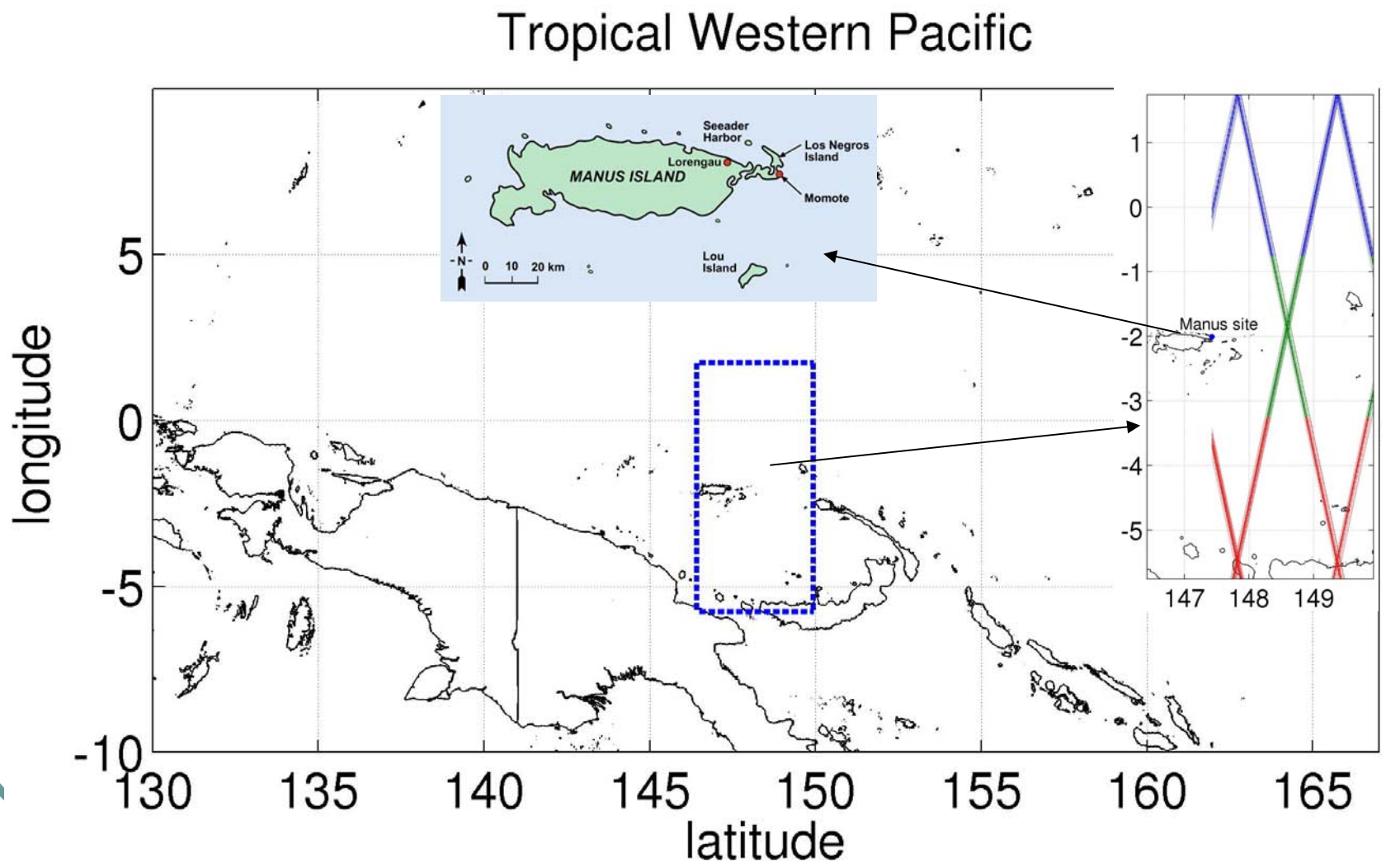
Motivation

- Radiative heating is important
  - Cloud vertical differential heating affects local convective dynamics
  - Horizontal differential heating helps to maintain large scale tropical dynamics
- Challenge and solution
  - Radiative heating calculation requires information about vertical structures of cloud properties
  - CloudSat mission: a cloud radar in space provide opportunity to observe vertical structure of cloud in global coverage.
  - Together with ARM surface measurements, it enable us to compare the heating rates retrievals from different perspectives.

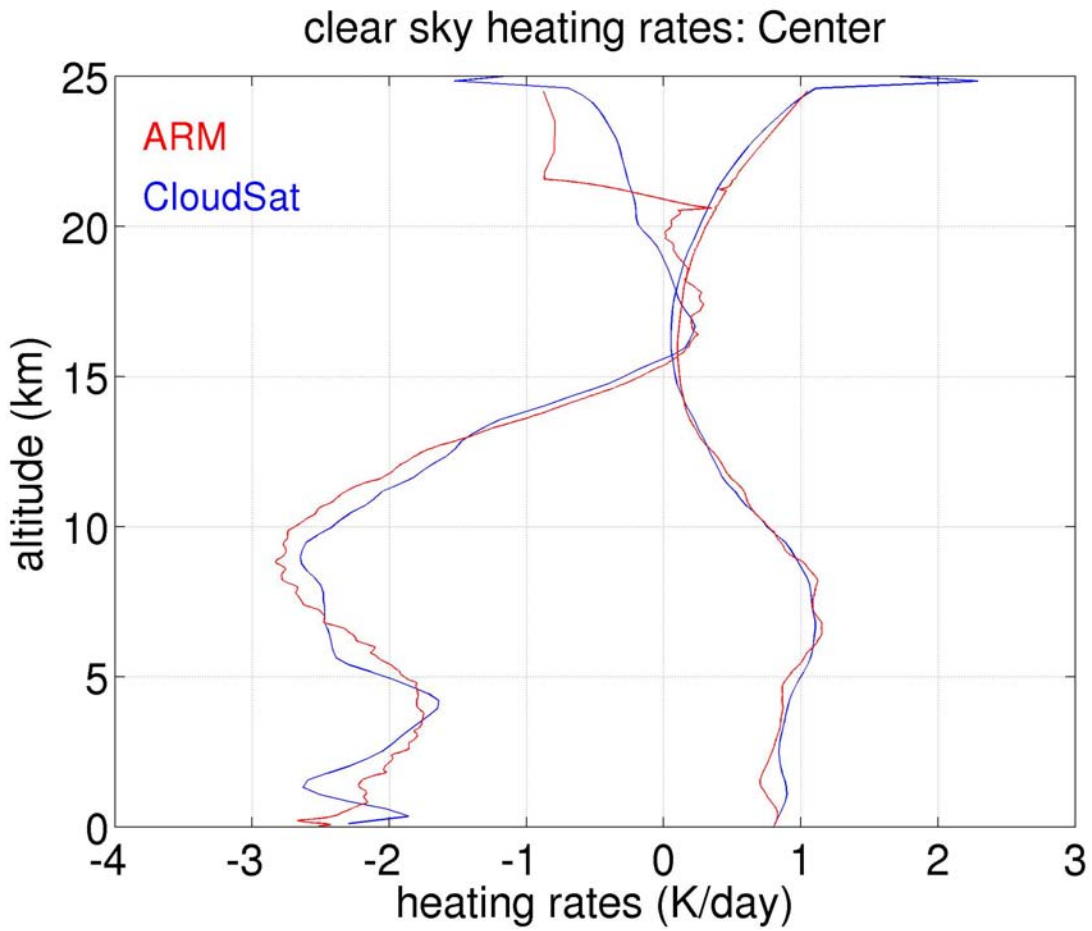
Where are we?


Tropical Western Pacific
MANUS ISLAND
Seeader Harbor
Lorengau
Los Negros Island
Momote
Lou Island
N
0 10 20 km
Manus site
longitude
latitude
5
0
-5
-10
130
135
140
145
150
155
160
165
1
0
-1
-2
-3
-4
-5
147
148
149

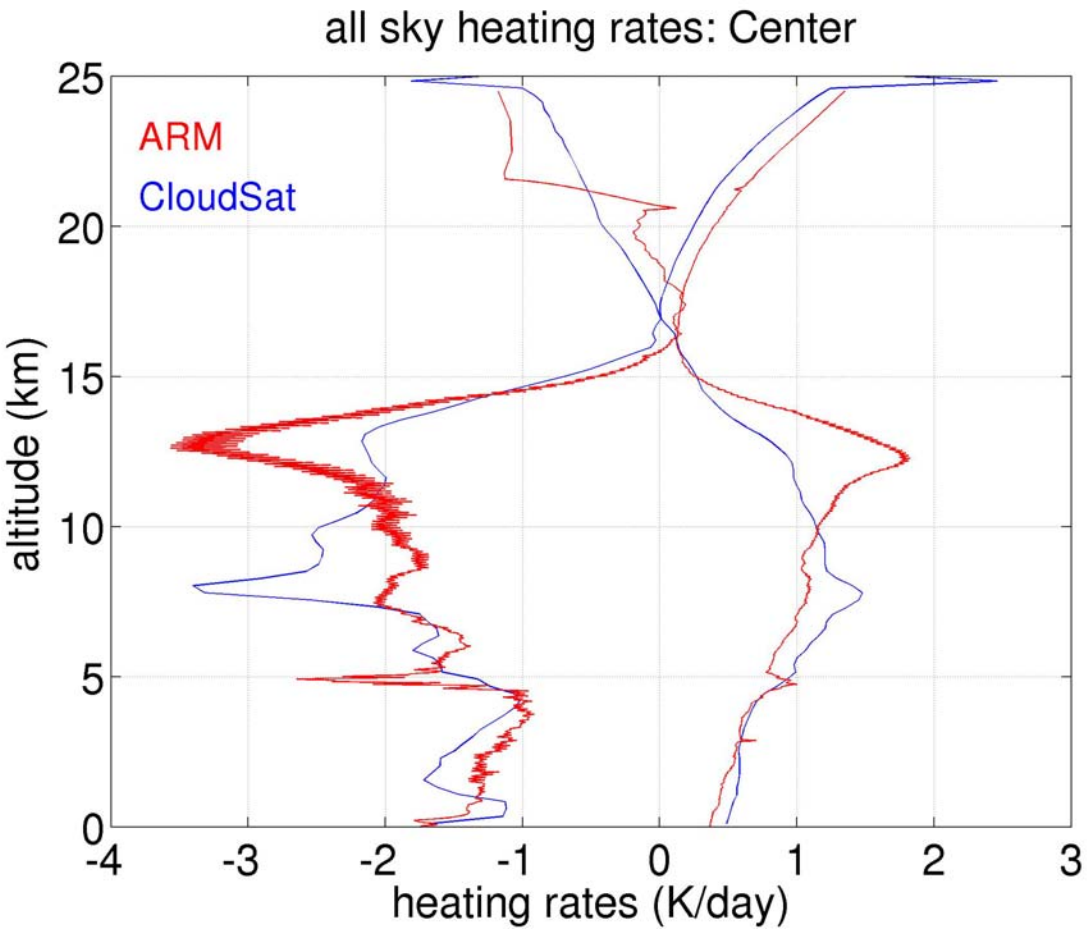
Data description

- The CloudSat data products (version R04, Jun 2006~Aug 2007) we use in this work includes:
  - 2B-GEOPROF: cloud mask and radar reflectivity factor
  - 2B-CWC-RO: ice and liquid water content by radar only algorithm.
  - 2B-FLXHR: radiative fluxes and heating rates
- ARM Manus retrievals, Jan 2007~March 2007
  - Active Remotely-Sensed Clouds Locations (ARSCL) product
  - Combined retrievals of cloud properties (*Marchand et al, 2007, JGR*)
  - Heating rates calculations (*Mather et al 2007, JGR*)

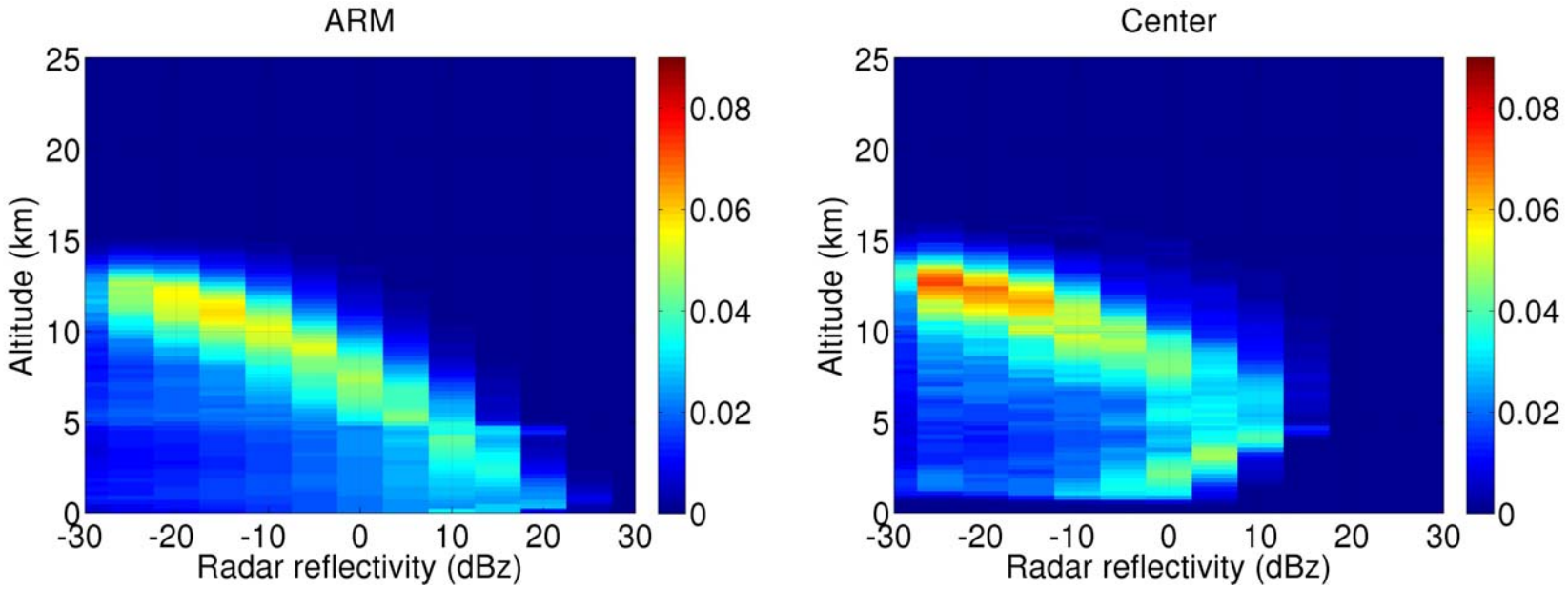
Heating rate: a first impression



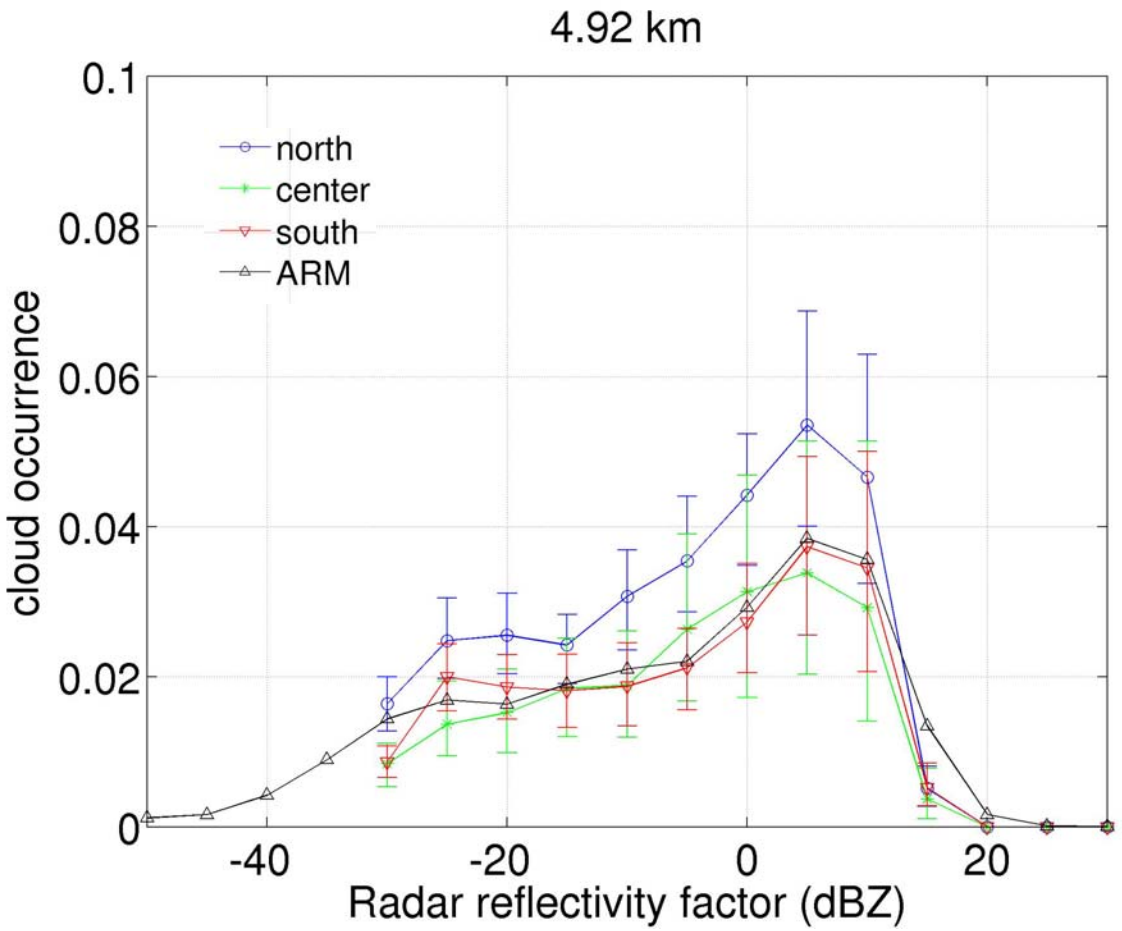
Heating rate: a first impression



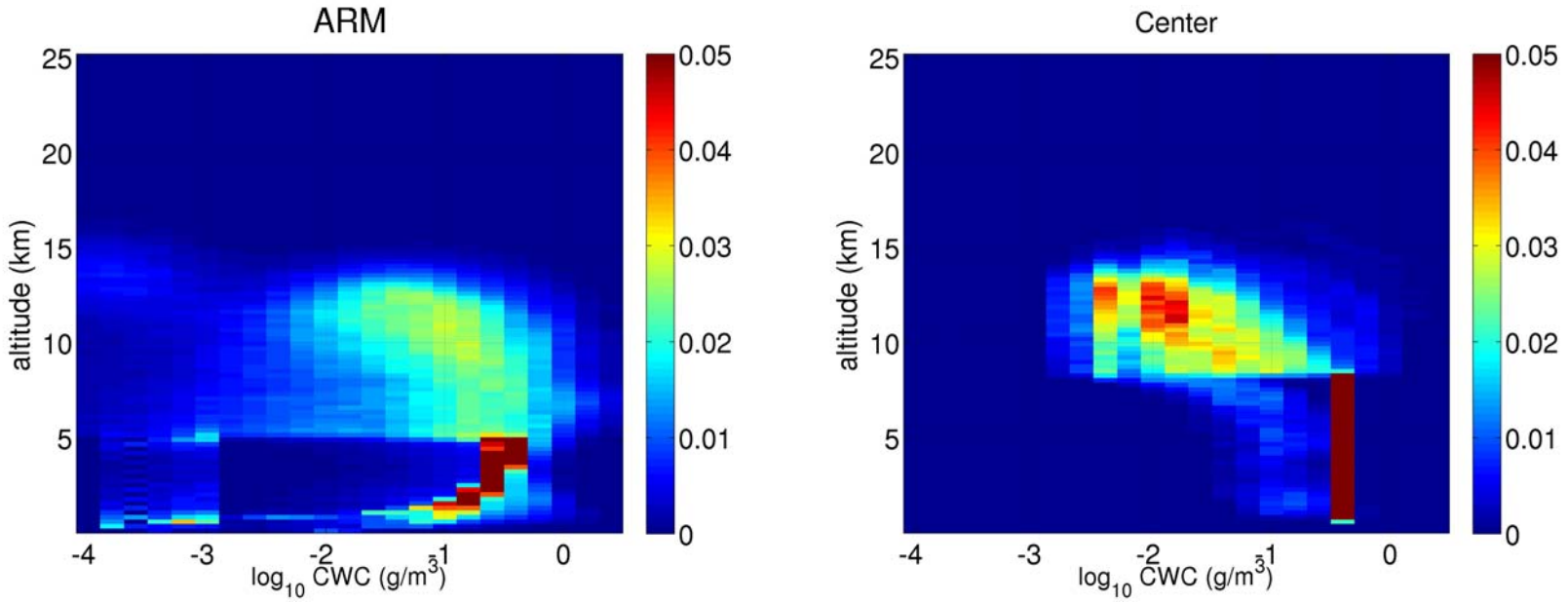
Radar reflectivity factor



Example


4.92 km
0.1
0.08
0.06
0.04
0.02
0
cloud occurrence
north
center
south
ARM
-40
-20
0
20
Radar reflectivity factor (dBZ)

Cloud water content



Conclusion so far

- All-sky heating rates from CloudSat and ARM differ a lot, but clear-sky rates agrees well.
- Cloud statistics observed from CloudSat center cell and ARM Manus site are consistent.
- A better understanding and treatment of mix-phased clouds is necessary to remove the artificial cooling.

Future work

- How about other differences in CWC retrievals?
  - Study the heating rates and CWC classified by some atmospheric states.
  - We have tried on OLR, but … . Next, some other independent indicators will be tested such as cloud optical depth and cloud top height from MODIS.