Ground-based Microwave Cloud Tomography Experiment, SGP, May 15-June 15, 2009

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multiple radiometers

BROOKHAVEN NATIONAL LABORATORY

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ARM Atmospheric Radiation Measurement

Radiation Processes Working Group
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All good cloud radiation modelers should close their airplane window shades so as not to be corrupted by the spectacle of real 3D clouds.

- Roger Davies

In case you forget to do this, you see

Effects of cloud structure on radiation

Typical climate model
- Cloud fraction & mean water content
- Horizontally uniform clouds, no side radiation
- Assumption on overlap

Cloud structure important to radiation

- Cumulus (Benner & Evans 2001, Pincus et al. 2005), deep convection (DiGiuseppe & Tompkins 2003)

- Horizontal and vertical variability (Gounou and Hogan, 2007; Shonk and Hogan, 2008)
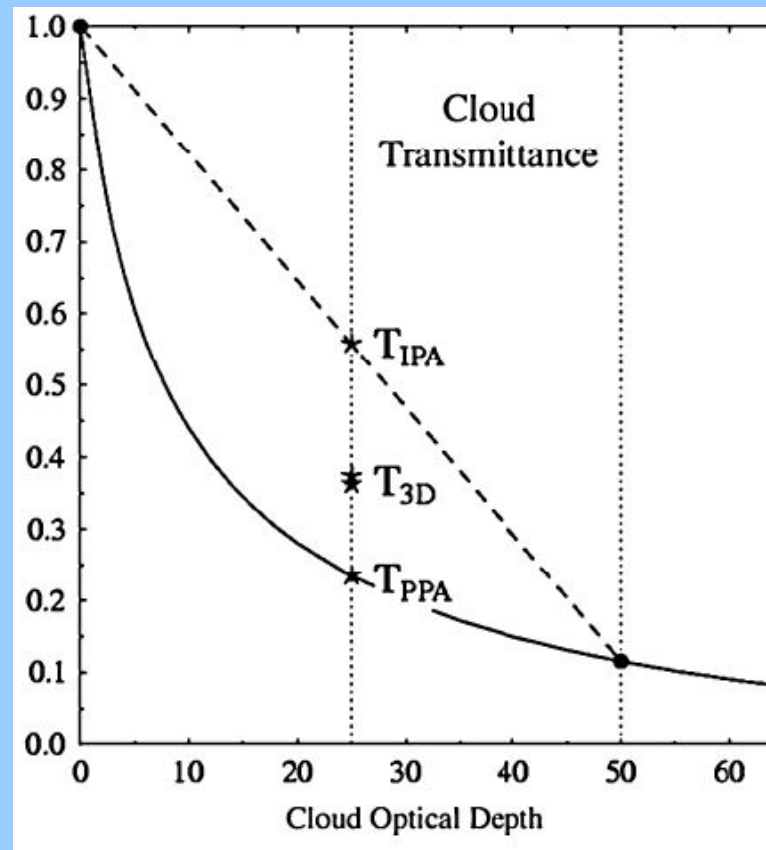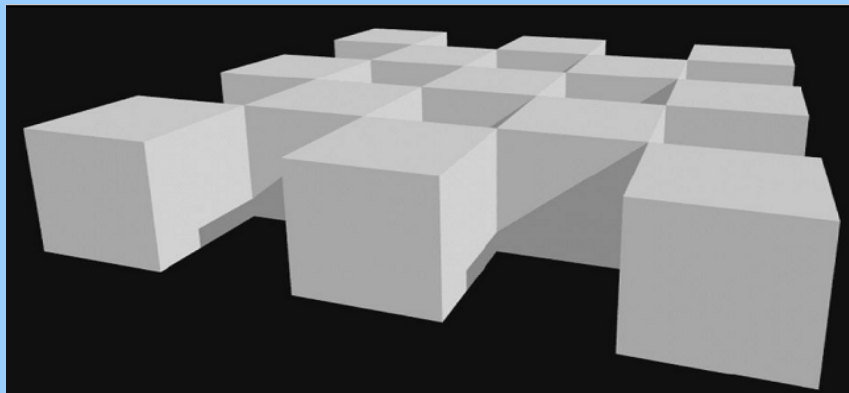
Global effect of cloud horizontal structure

(a) SW TOA

(c) LW TOA

minus
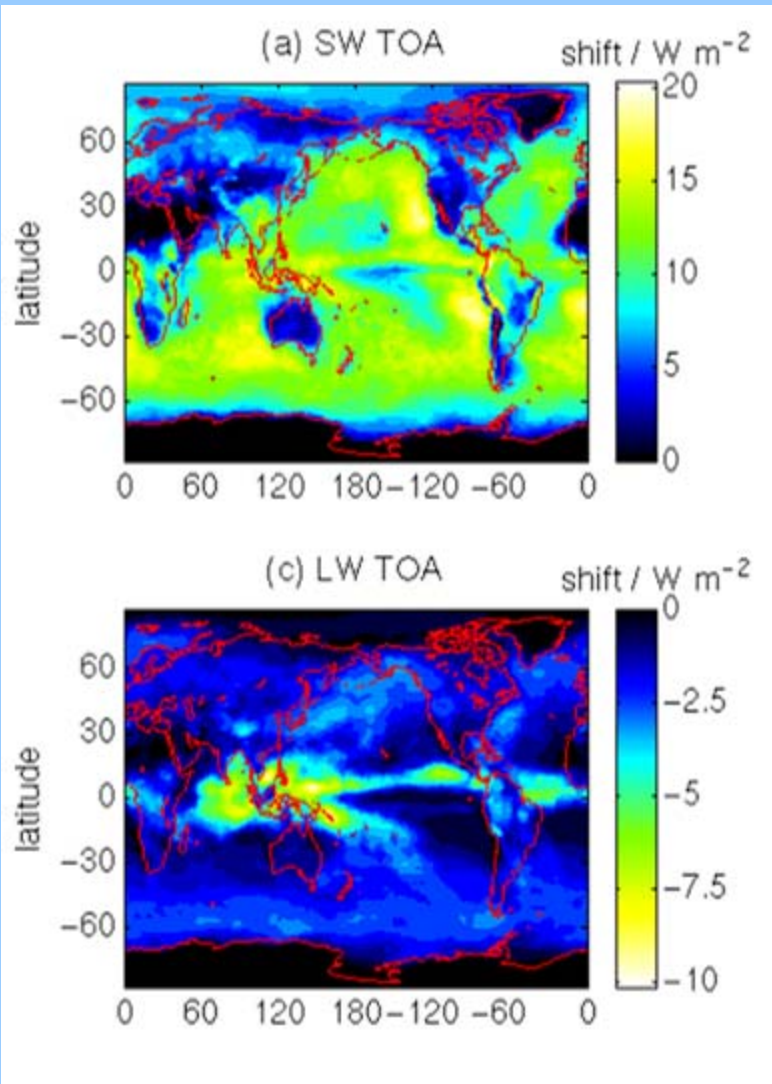
Change in top-of-atmosphere cloud radiative forcing when considering cloud horizontal structure (maximum random overlap)

Largest shortwave effect in regions of marine stratocumulus

Largest longwave effect in regions of tropical convection

Main objective: to evaluate the validity of the cloud tomography technique for long-term observation of 3D cloud properties

(1) How can advanced remote sensing help to further characterize the atmosphere?

(2) To what extent can 3D cloud properties impact a cloud's radiative property?

(3) How well can numerical models reproduce the statistics of 3D cloud properties?

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Cloud tomography field campaign, this May, SGP site

Five scanning radiometers, scanning WACR, RACORO flights

Two Polarimetric Scanning Radiometers

 - 5 channels at 10, 18, 21, 37, and 89 G
 - 21 channels at 18-24, 30-31, 51-56 ,89 G and infra-red

Three MWRs from ARM

- 2 channels at 21, 37G
- operate in tip-curve mode

Possibly one more from Frederic Fabry

Expected results: 2D/3D cloud liquid water and water vapor distributions, yes vapor is a by-product

Challenges

- make sure all instruments work in the continuous scan mode

- overwhelming scanning data

- we plan to use spatial smoothing to constrain the retrieval, should we also include temporal smoothing (4D VAR)?

- validation, how to compare with the in-situ data?

A limited cloud tomography test during the 2003 AMSR-E validation campaign

ARM RPWG

Retrieved cloud liquid water content

Radar reflectivity, ACR

$t = t_0$ $t = 2t_0$ $t = 3t_0$
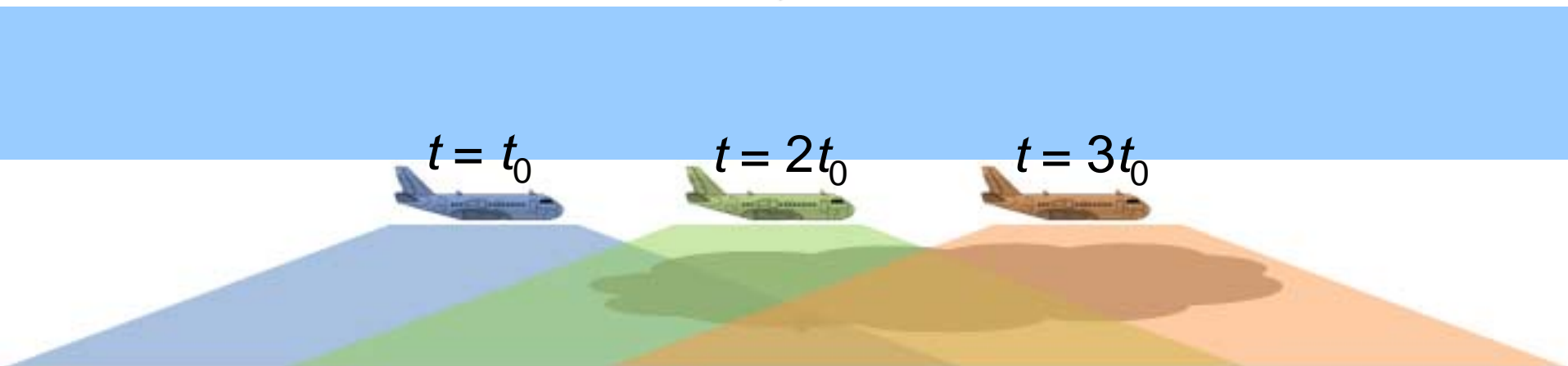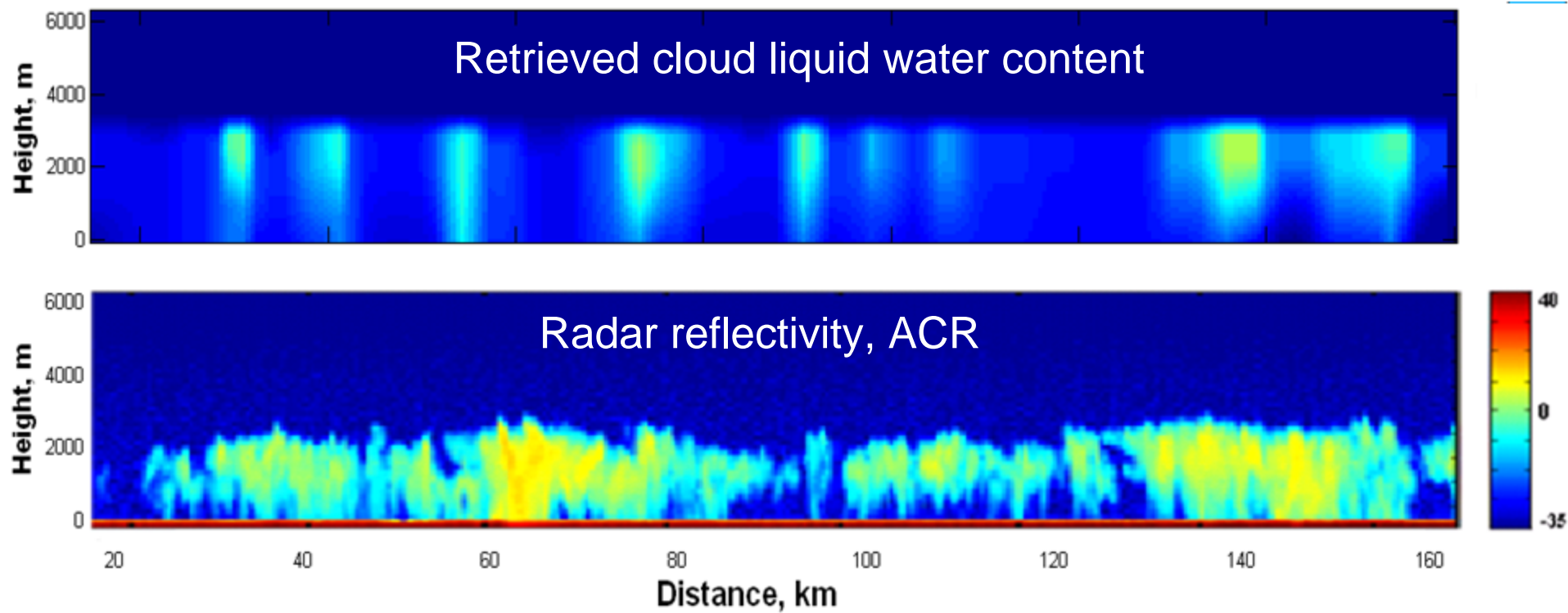
Too many conditions were not optimal during the Wakasa Bay field test, e.g., the aircraft was too fast.