Using MISR to Evaluate the MMF

Roger Marchand and Thomas Ackerman
University of Washington
*Joint Institute for the Study of Atmosphere and Ocean (JISAO)*

Three-month MMF runs with modest increases in resolution

- Control
  - 4 km horizontal
  - 64 columns
  - 26 vertical layers
- Test A
  - 1 km horizontal
  - 64 & 128 columns
  - 26 vertical layers
- Test B
  - 1 km horizontal
  - 64 columns
  - 52 vertical layers

2.5°

2°

64 or 128 Columns
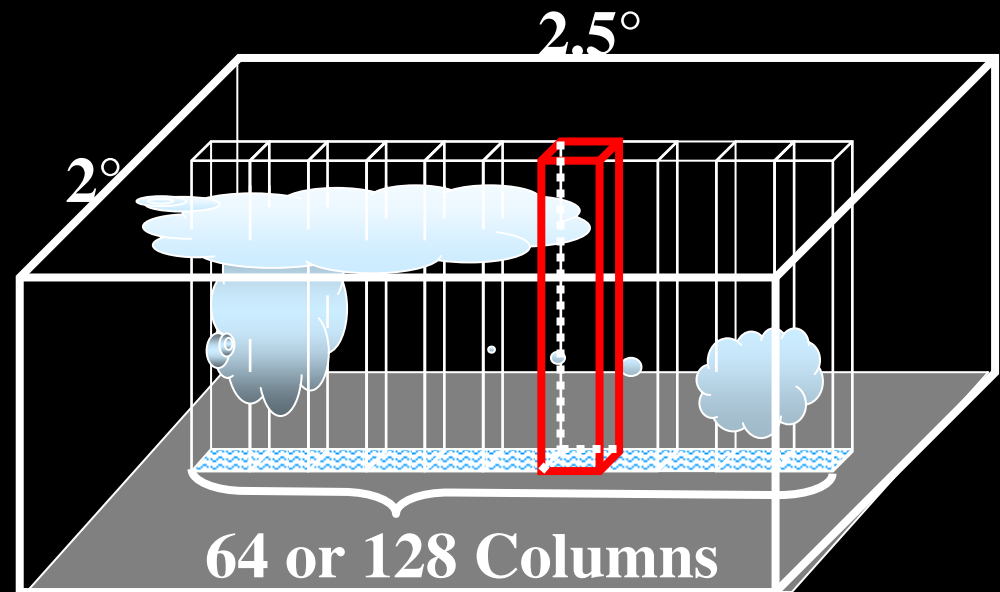
Run on SDSC Datastar with support from CMMAP

MISR Observational attributes
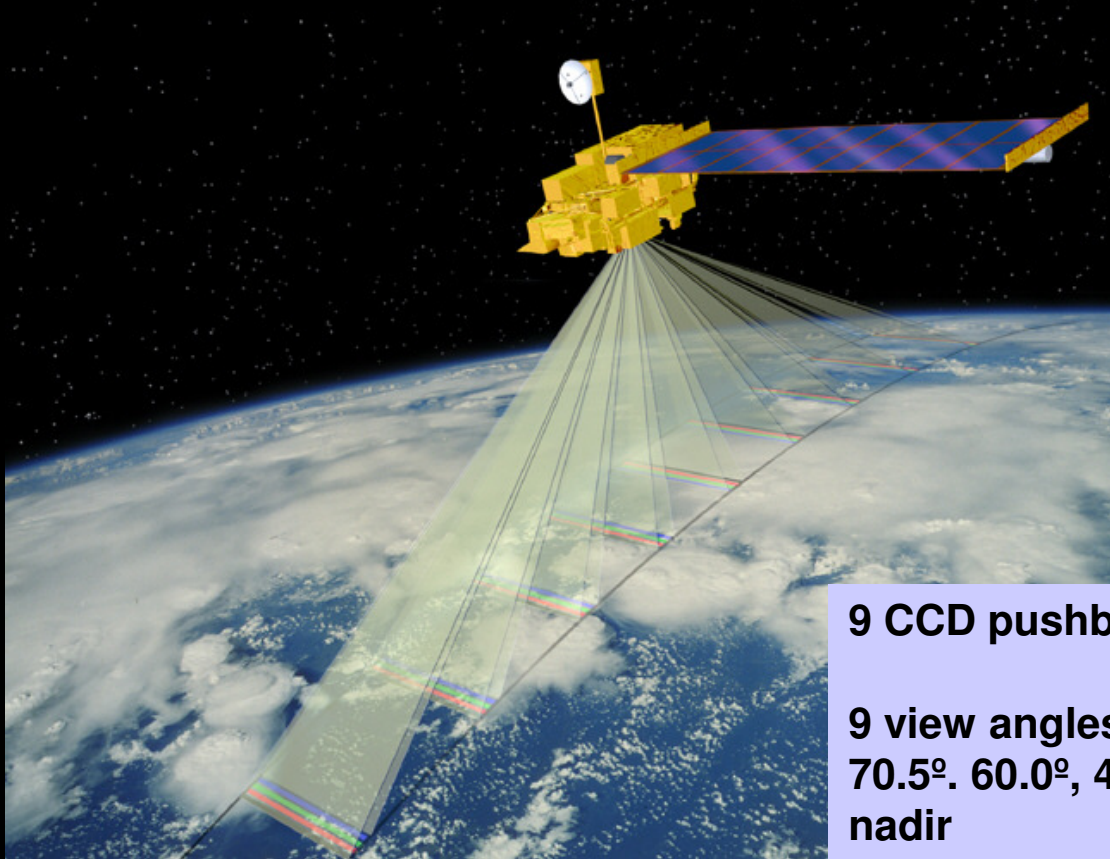
Polar Orbit with 400-km swath

Contiguous zonal coverage:
9 days at equator
2 days at poles

275 m sampling

7 minutes to observe each scene
at all 9 angles

9 CCD pushbroom cameras

9 view angles at Earth surface:
70.5º. 60.0º, 45.6º, 26.1º forward of nadir
nadir
26.1º, 45.6º, 60.0º, 70.5º backward of nadir

4 spectral bands at each angle:c
446, 558, 672, 866 nm

14-bit digitization
On-board calibration system

Stereo-imaging

- A significant advantage of the MISR CTH retrieval is that the technique is purely geometric and has little sensitivity to the sensor calibration.

- The retrieval has been the focus of several studies including Marchand et al. (2007) Naud et al. (2002, 2004, 2005a,b) Seiz et al. (2005) Marchand et al. (2001)
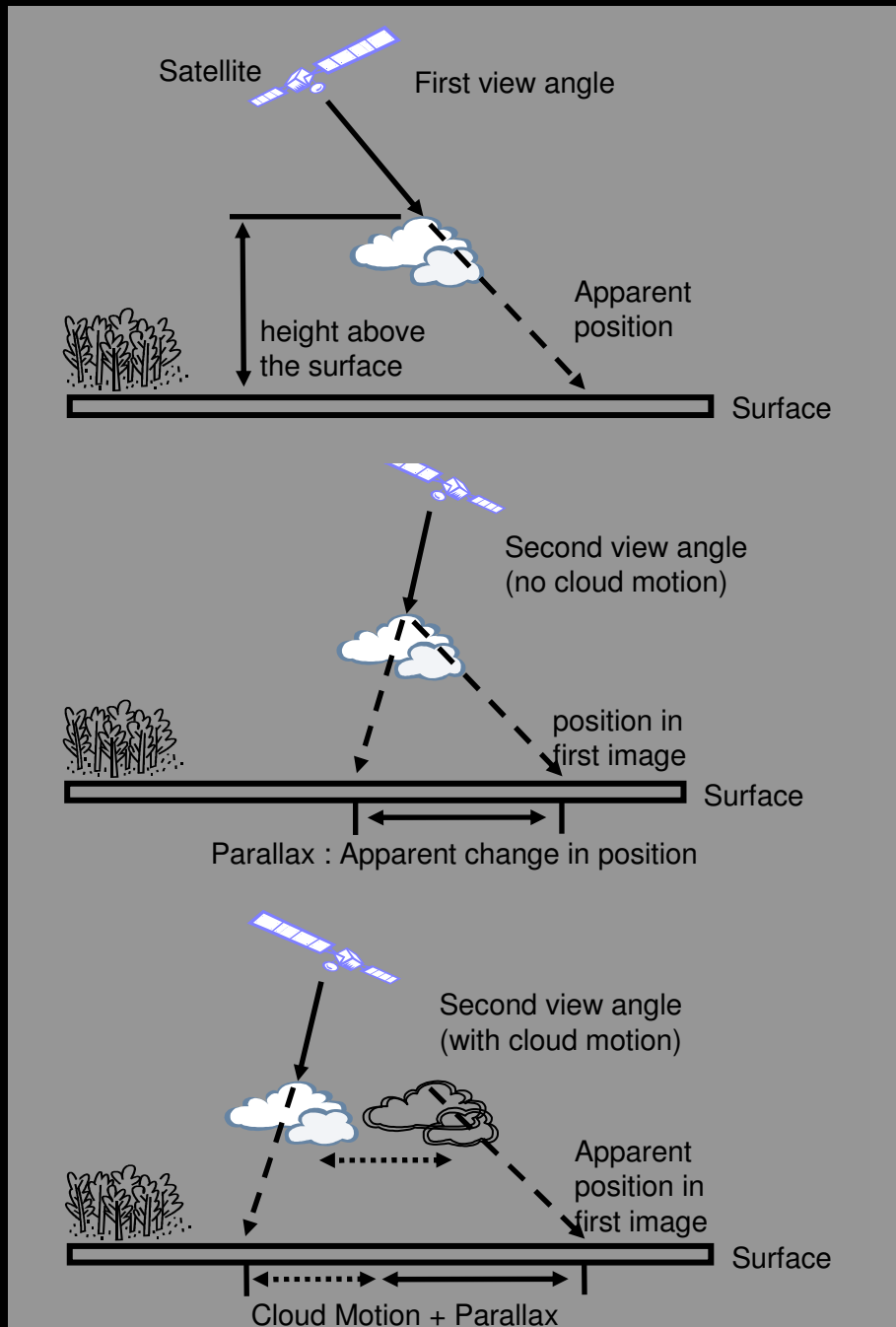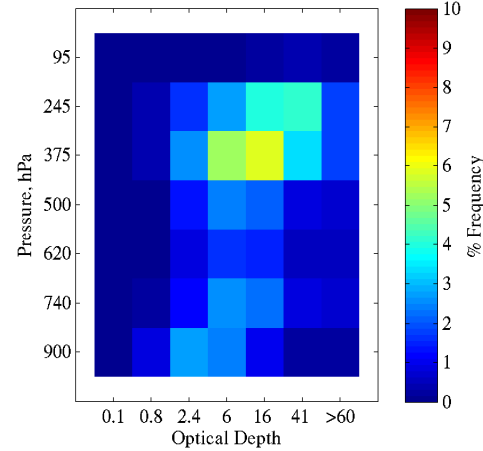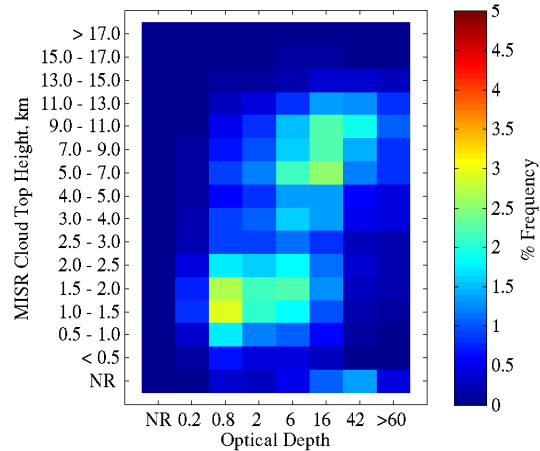
North Pacific (DJF 2001)

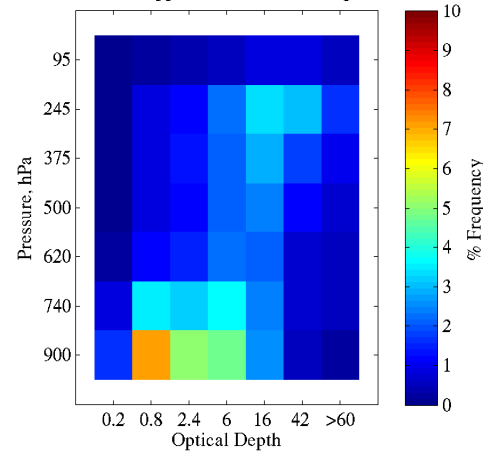ISCCP CF=83.3(48.2)% , H/M=53.2(34.6)% , L=30.2(13.6)%
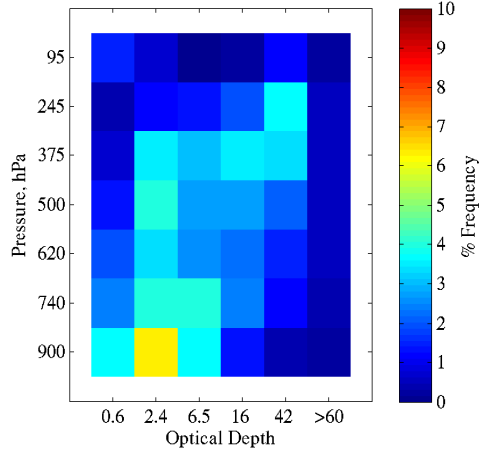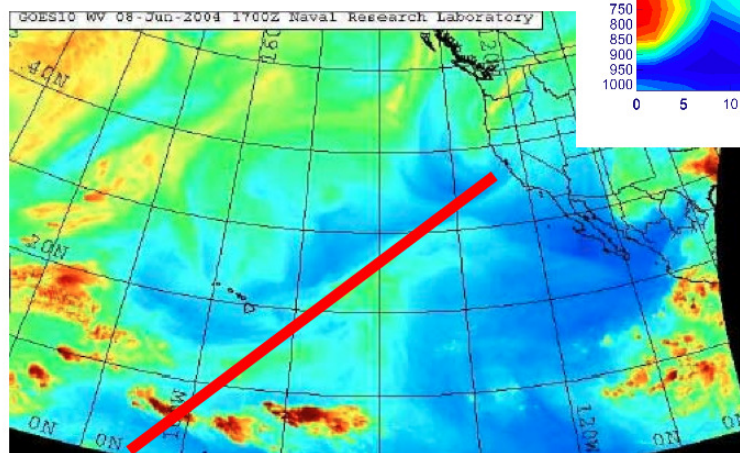
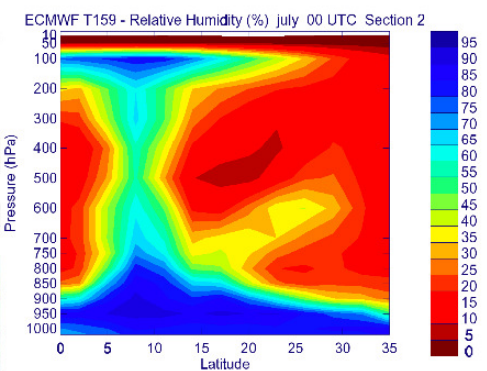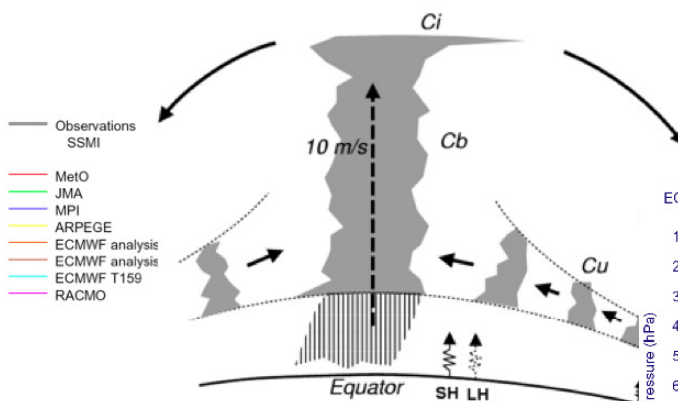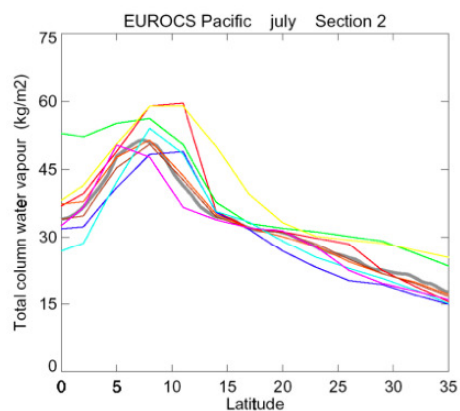MODIS CF=63.2(50.8)% , H/M=47.9(40.3)% , L=15.3(10.5)%

MISR CF=84.6(52.0)% , H/M=43.3(33.0)% , L=37.4(15.7)%

MISR mapped to ISCCP/MODIS grid

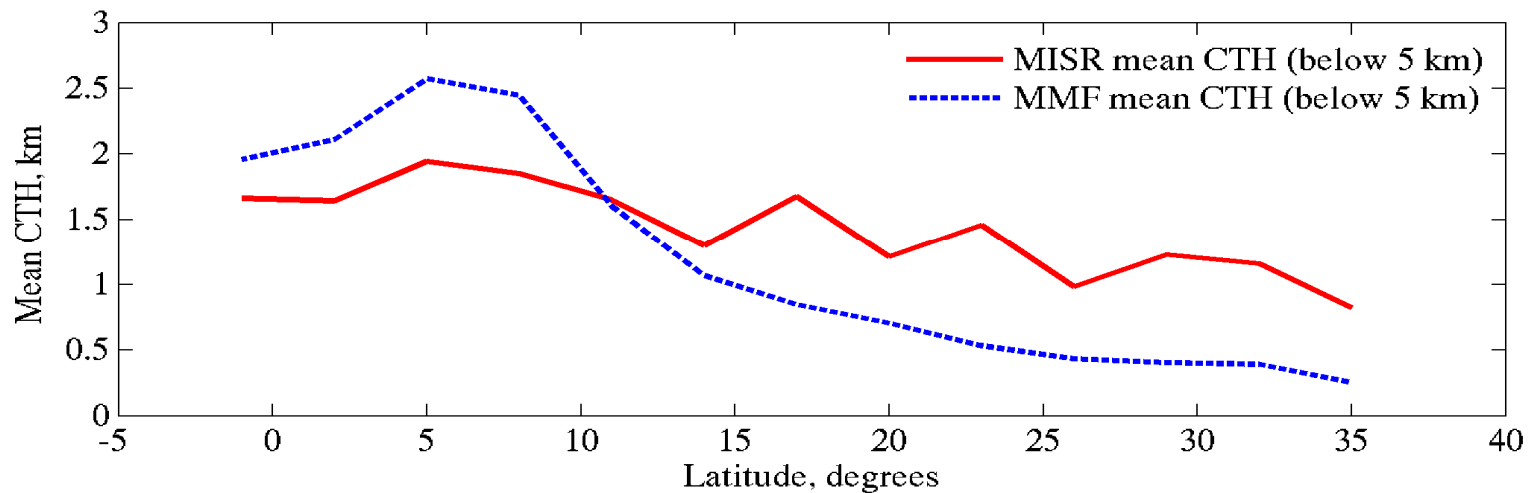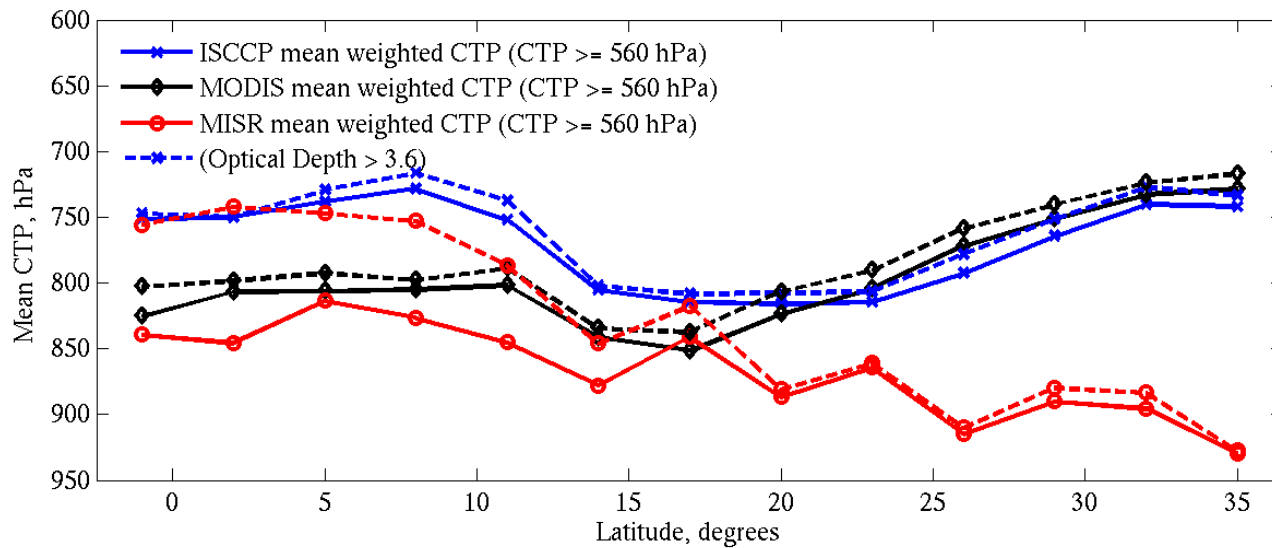# The GCSS Pacific Cross section Intercomparison (GPCI)

More on
www.gewex.org/
gcss.html

Courtesy C. Jakob

# GCSS Pacific Cross Section (August 2001)

Summary of Low Cloud Response

- **Increasing horizontal resolution from 4 km to 1 km resulted in a reduction of low cloud amount.**
  - Much (but not all) due to dissipation of "stratofogulus"
  - Generally, little change in amount of low cloud with optical depths less than 10.

- **Increasing horizontal resolution <u>and</u> vertical resolution to 52 levels (50 in CRM) resulted in …**
  - Small increase in the amount of low-level cloud relative to the simulations with 4 km horizontal resolution.
  - There is an increase in the amount of cloud with optical depths less than 10, bringing the model results into better agreement with MISR observational data.
  - Stratocumulus zones show a significant improvement in cloud top height.
  …
  - Nonetheless, the total amount of model low cloud remains too low and there is still too much low cloud with optical depths larger than 23 (the largest two optical-depth bins).

- Analysis make use of a "MISR simulator".   This code has been added to the suite of instrument simulators in the CFMIP Observation Simulator Package (COSP).

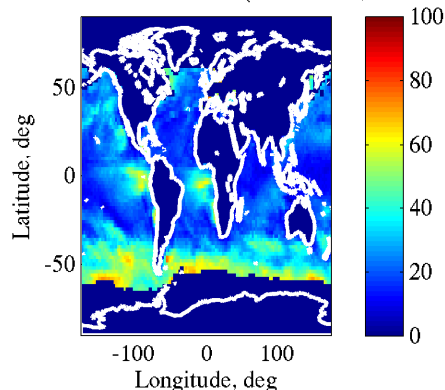## http://cfmip.metoffice.com/COSP.html

Sensitivity of low cloud amount to CRM resolution
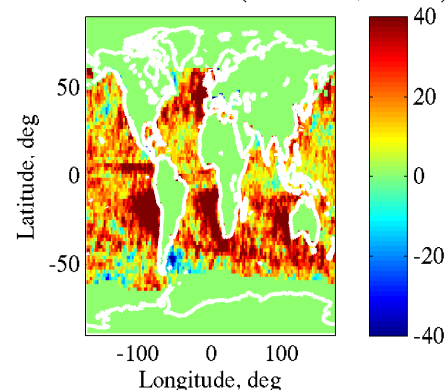

MISR L Cloud Fraction (CTH<3 km, tau>0.3)
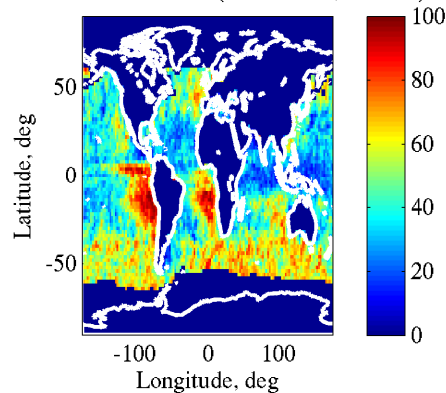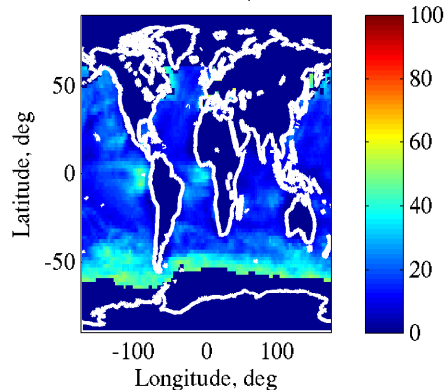

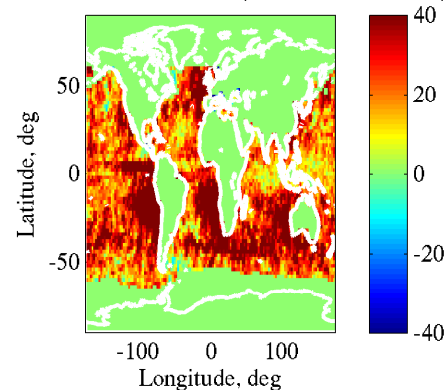Sim. 4km L26 Cloud Fraction (CTH<3 km, tau>0.3)

MISR L - Sim. 4km L26 CF (CTH<3 km, tau>0.3)
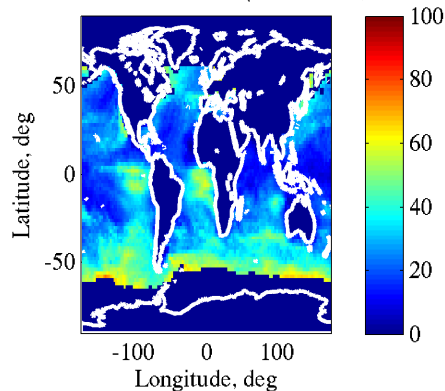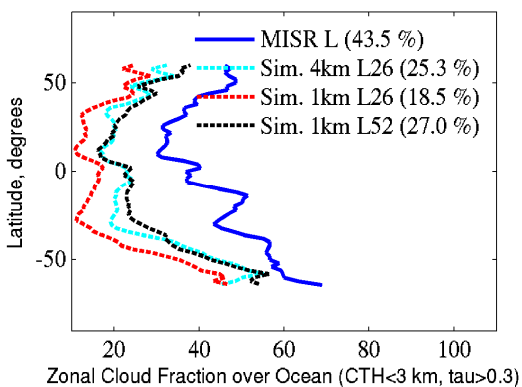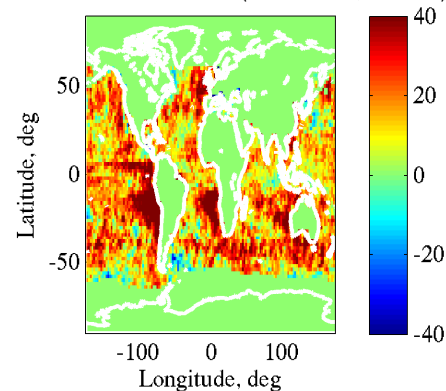

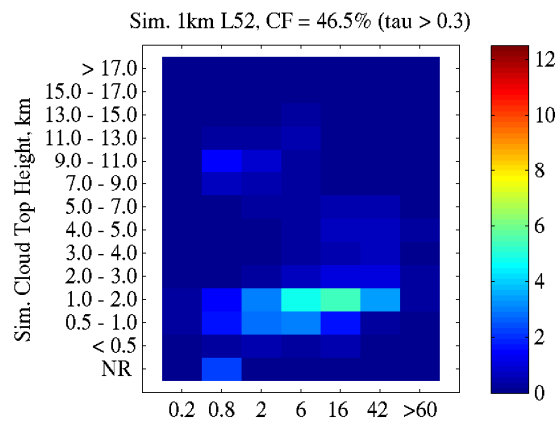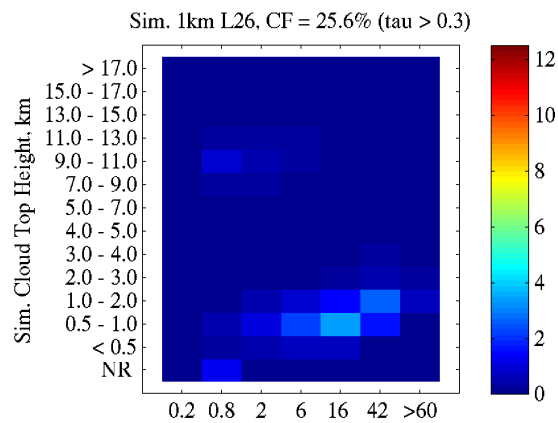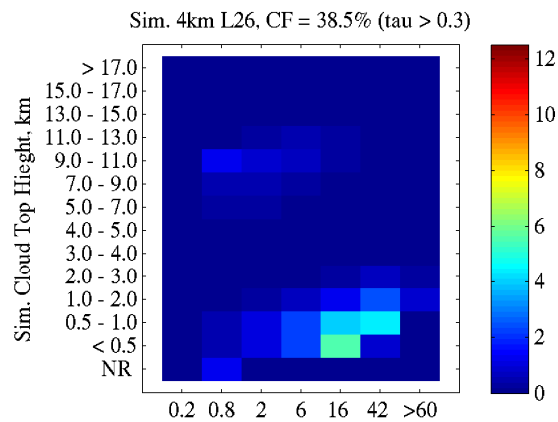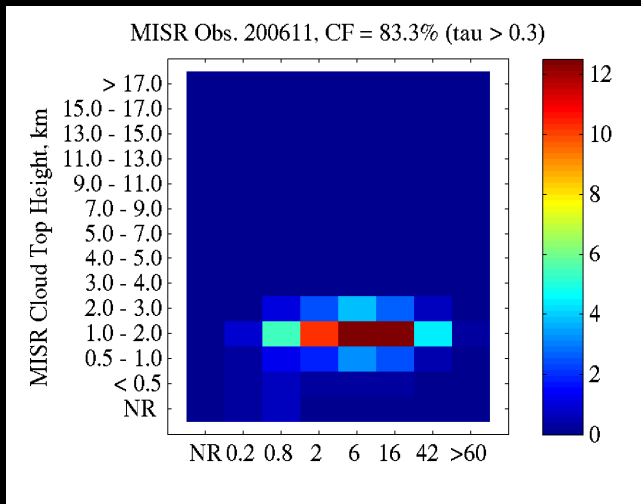Sim. 1km L26 Cloud Fraction (CTH<3 km, tau>0.3)

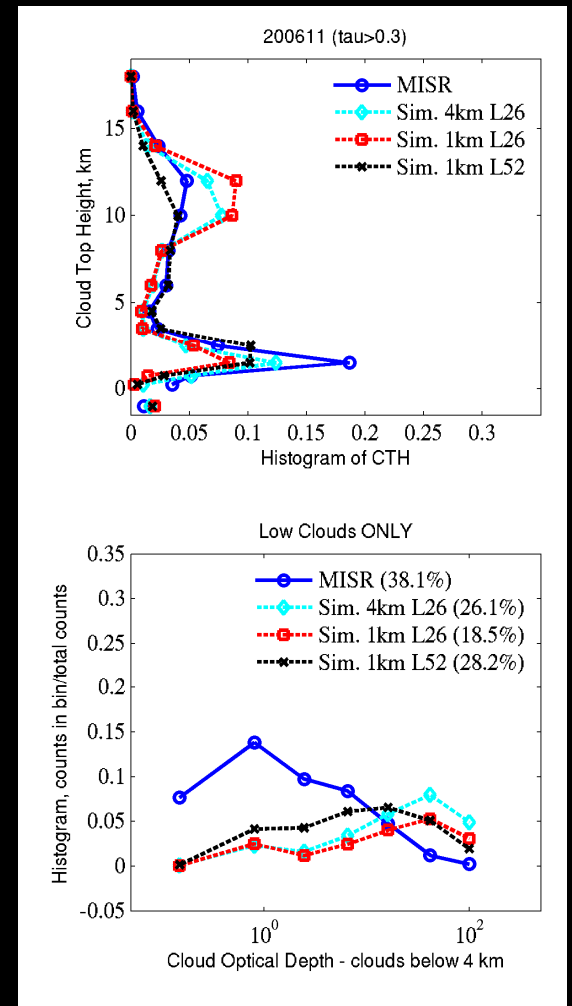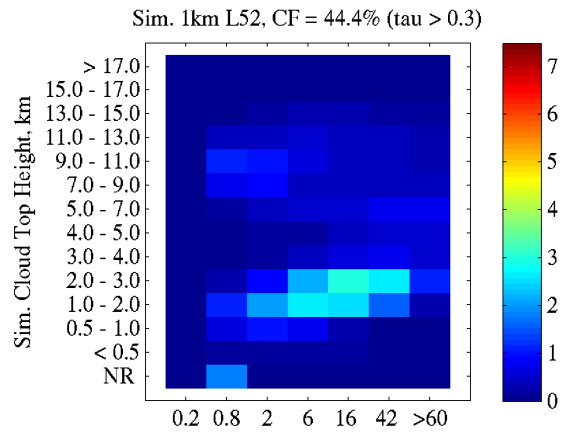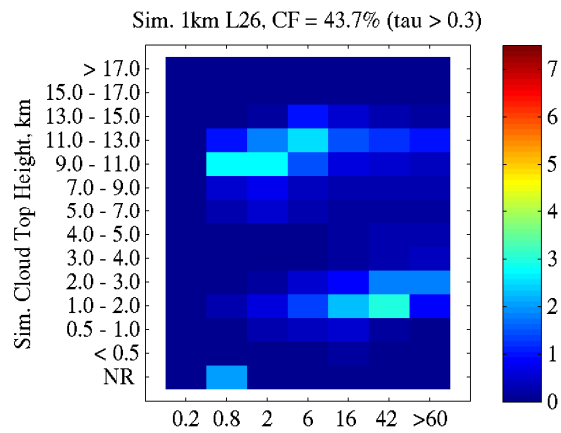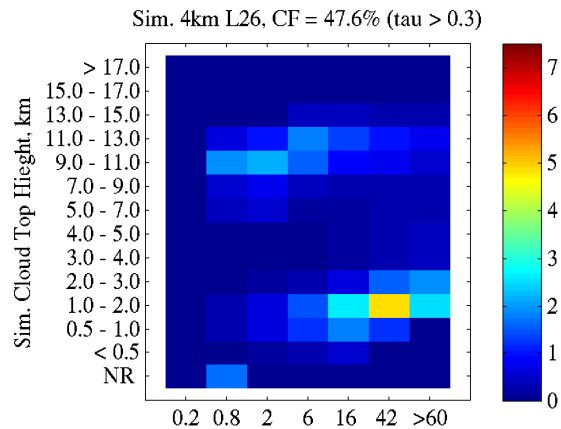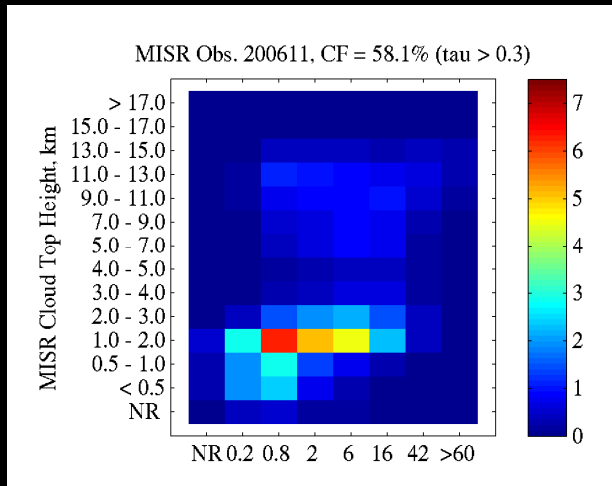MISR L - Sim. 1km L26 CF (CTH<3 km, tau>0.3)

Sim. 1km L52 Cloud Fraction (CTH<3 km, tau>0.3)

MISR L - Sim. 1km L52 CF (CTH<3 km, tau>0.3)
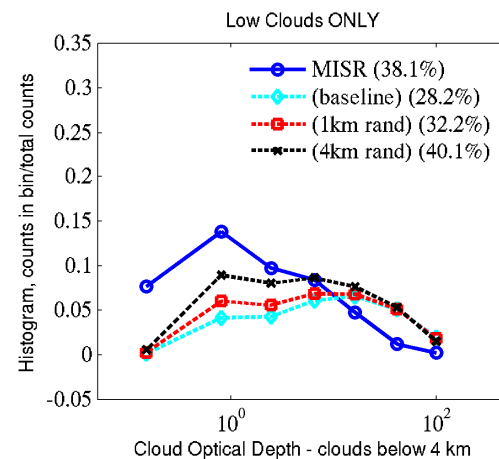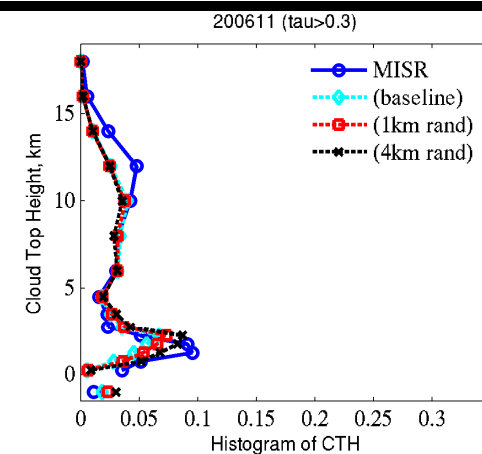

MISR L (43.5 %)
Sim. 4km L26 (25.3 %)
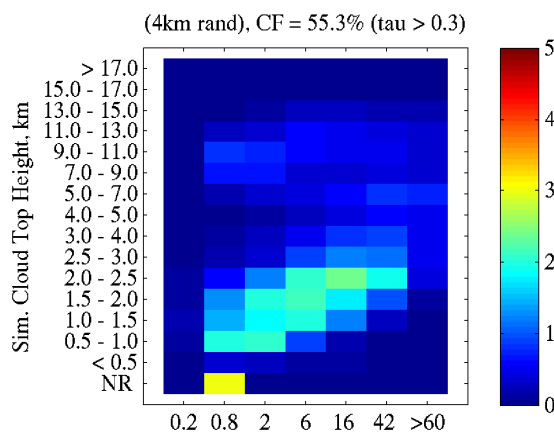Sim. 1km L26 (18.5 %)
Sim. 1km L52 (27.0 %)
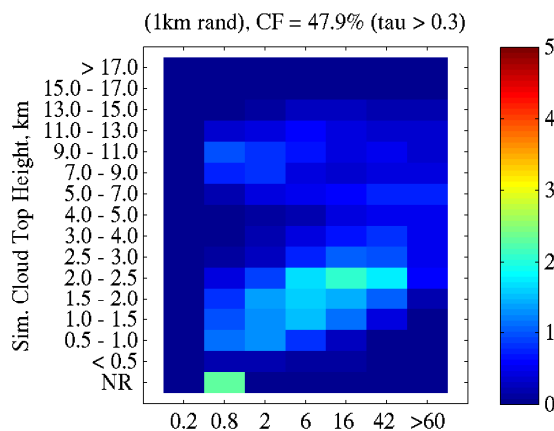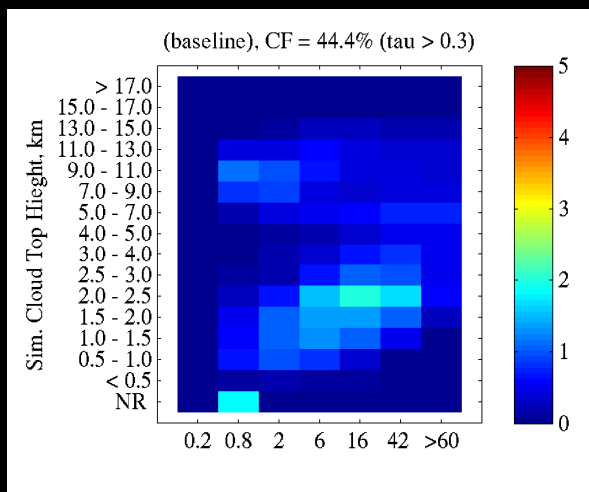
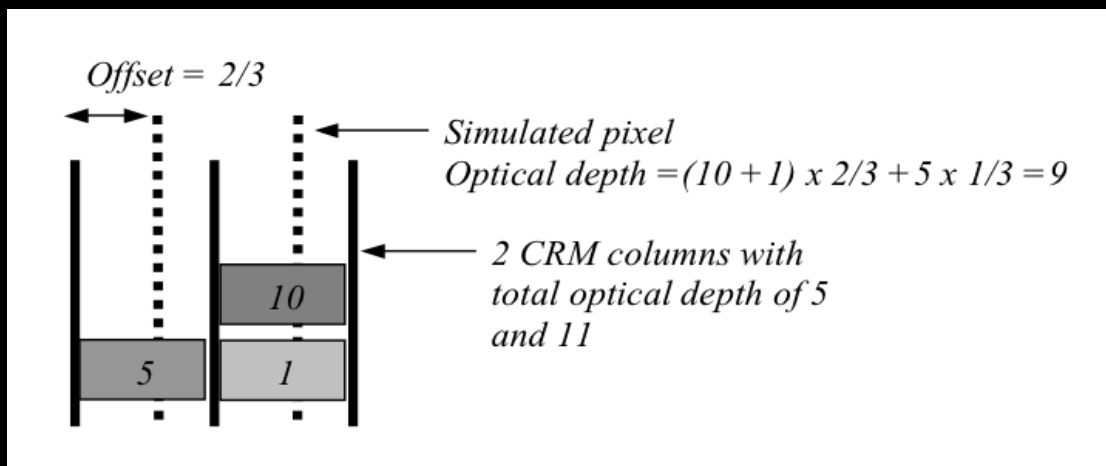Zonal Cloud Fraction over Ocean (CTH<3 km, tau>0.3)
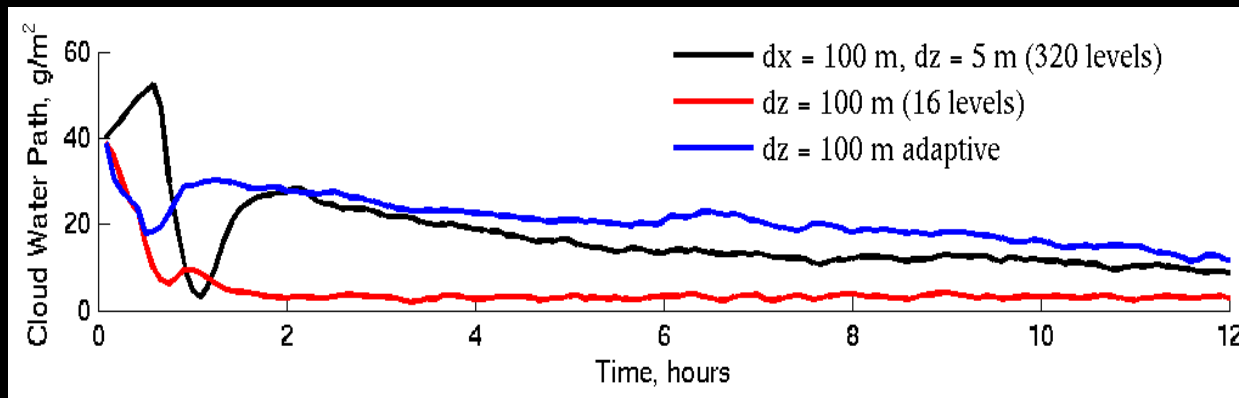
South American Stratocumulus
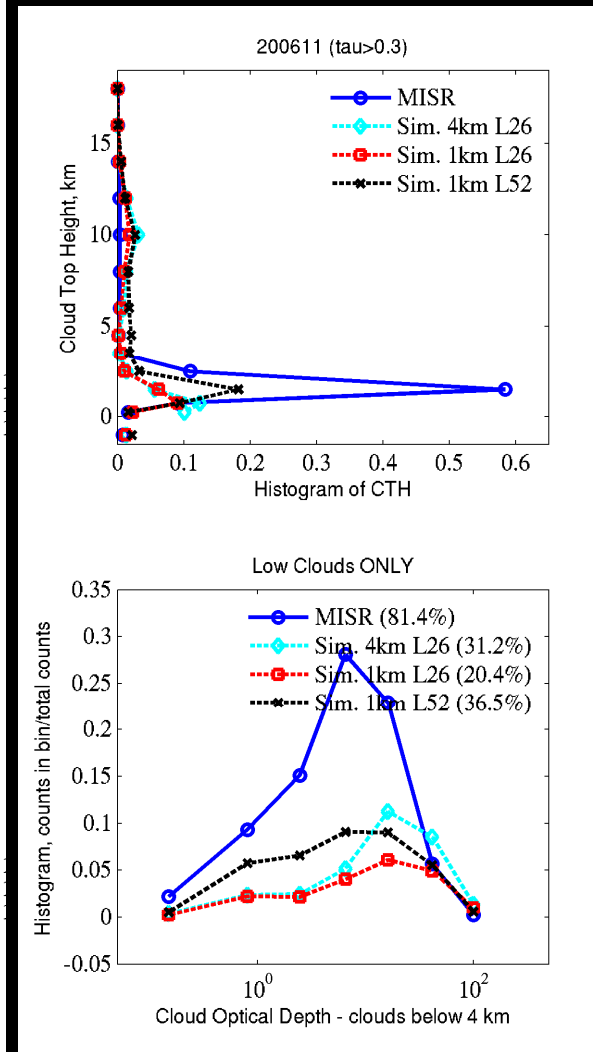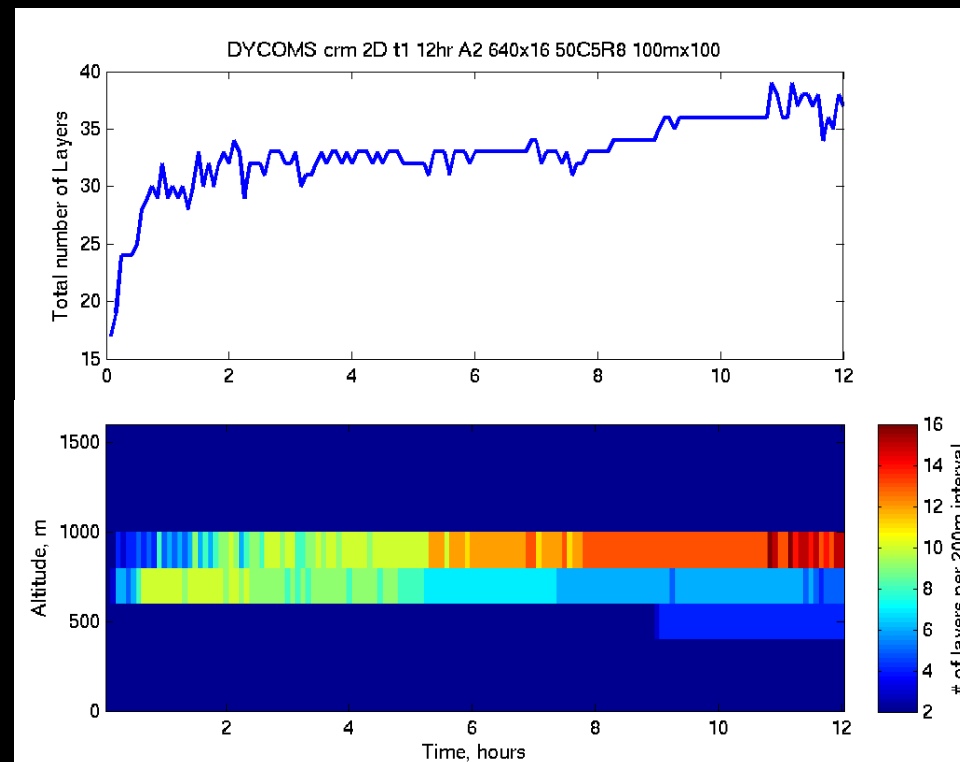
Hawaiian Trade Cumulus

Sensitivity of MISR Simulator to "Pixel" Alignment

Future Directions …

Adaptive Grid Simulation of DYCOMS-II

Closing thoughts

- What horizontal / vertical scales do we need to capture boundary layer clouds? 200 m MMF simulation?

- Will microphysical improvements "fix" the cirrus cloud problem? (or do we need 3D CRMs?)

- Do we need a more structured approach to the MMF development problem?