

# **An Evaluation of Cloud Vertical Layer Structure Simulated by the NCEP Model against Satellite Retrievals**

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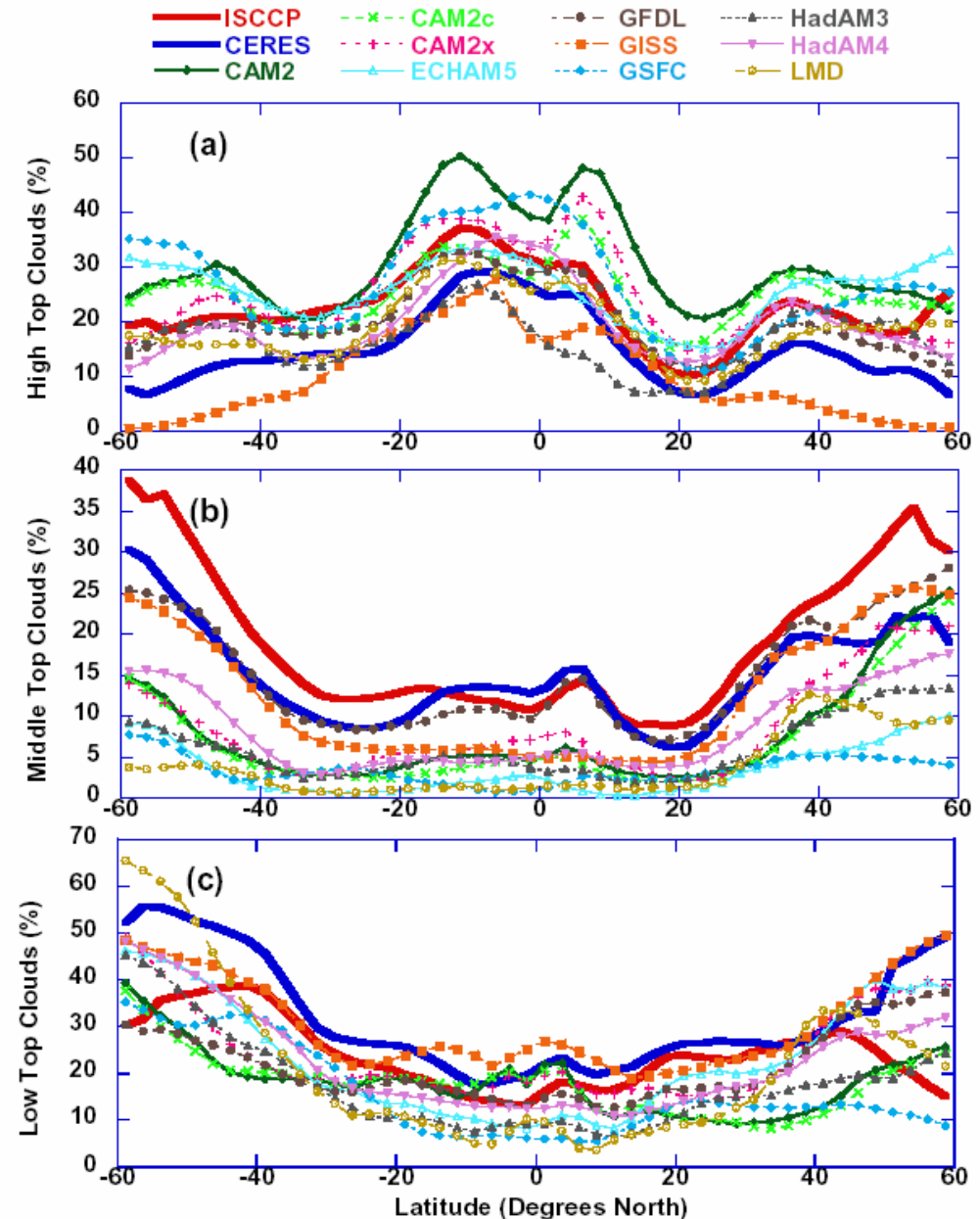
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# Science Questions

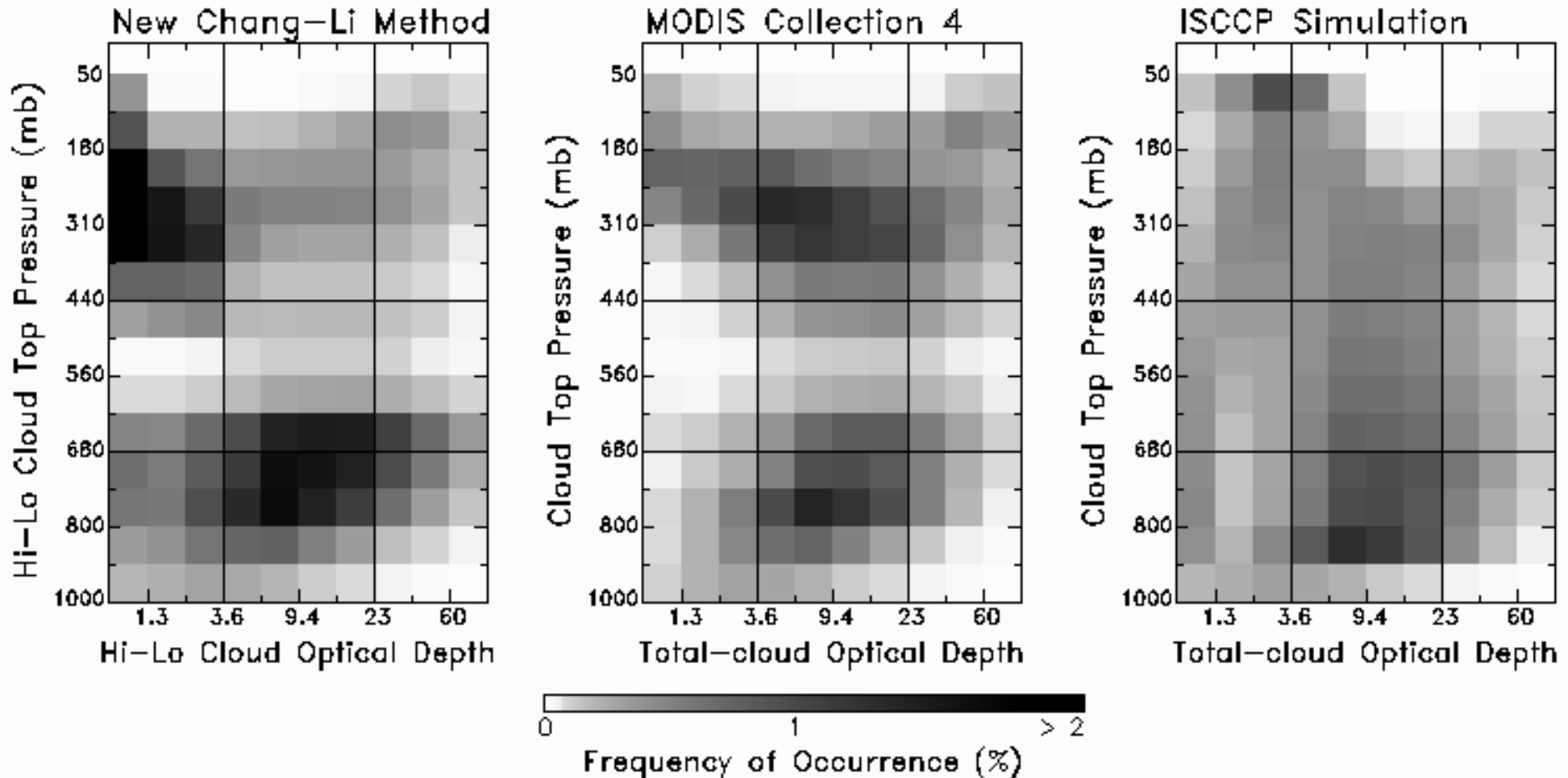
- Can the NCEP operational model generate a sound cloud vertical structure and cloud optical properties?
- How much cirrus clouds overlap with lower-level clouds on regional and global scales?
- What are the major uncertainties existing in current model simulation of cloud layers?

# Status of GCM Simulation of Cloud-Layering

- Satellite cloud properties
- ⇒ Model validation
- (Zhang et al. 2005, JGR)

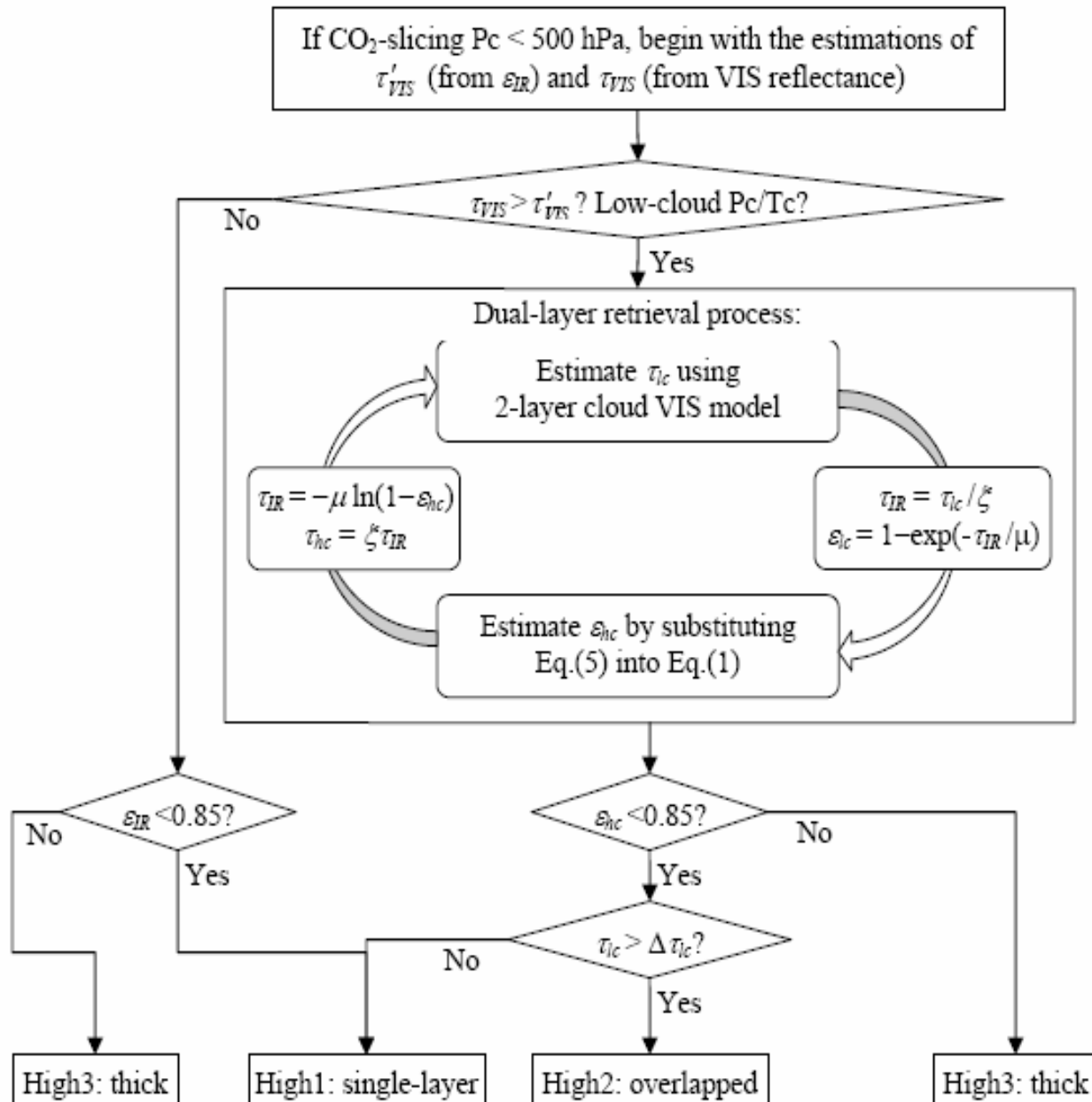


# Status of Satellite Remote Sensing of Cloud-layering



- All MODIS, ISCCP, and our cloud retrieval algorithms are applied to April 2001 Terra/MODIS L1B radiance data.

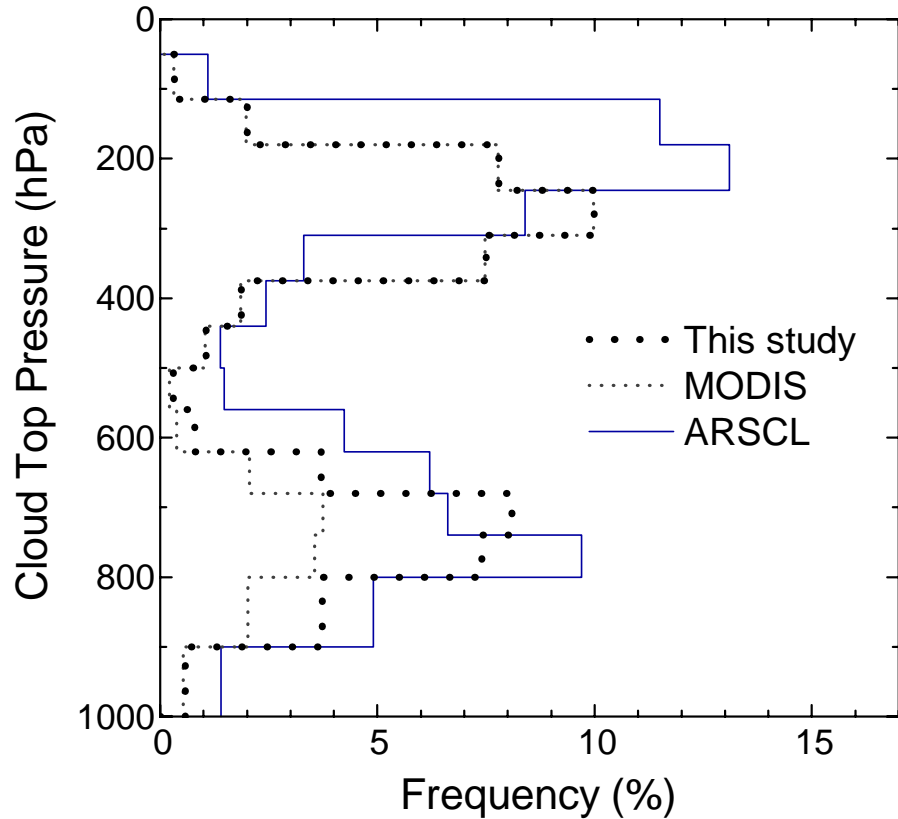
# Algorithm (Chang and Li 2005, JAS)



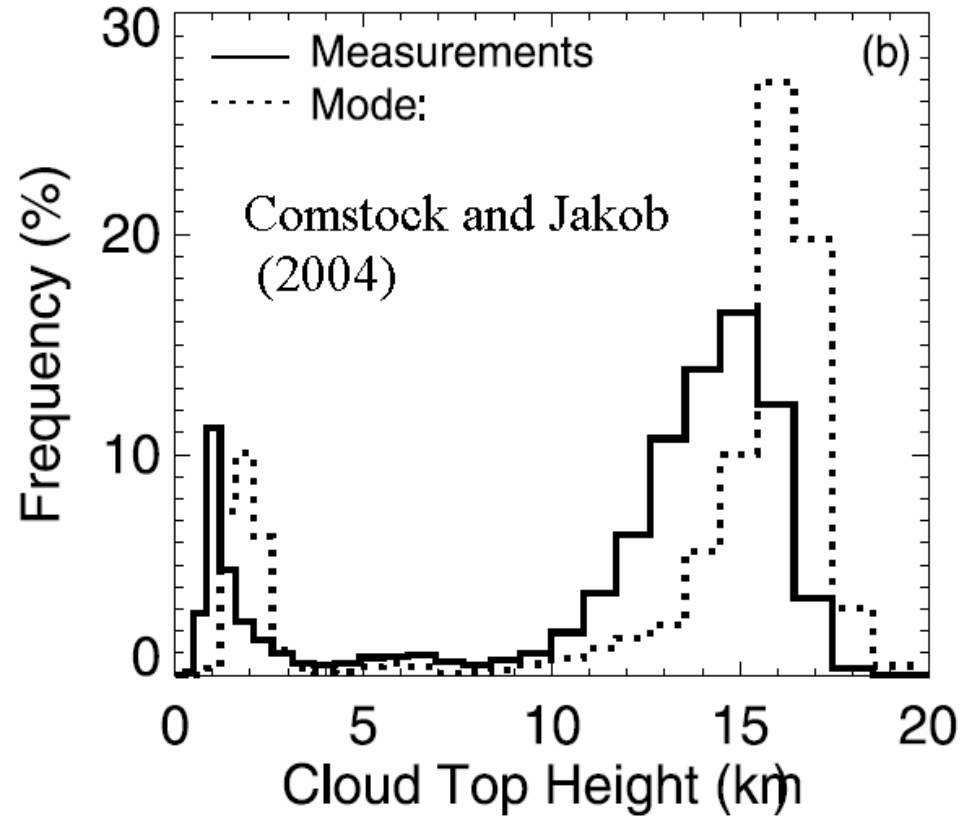
↳ Lookup-table radiances are generated based on an ice-over-water cloud radiative transfer calculations.

# A Distinct Bimodal Distribution of High and Low Clouds

Apr.-Nov. 2001 at SGP



Apr.-Nov. 1999 at NAU



# Evaluating Cloud Fields Generated by the NCEP Models

- ❑ Implement and validate our retrieval algorithm
- ❑ Get cloud data from the model for selected days & months
- ❑ Retrieve cloud properties from MODIS satellite
- ❑ Comparing cloud layers derived from satellite and models
- ❑ Quantify major discrepancies
- ❑ Study the causes for the discrepancies

# NCEP Model Simulations

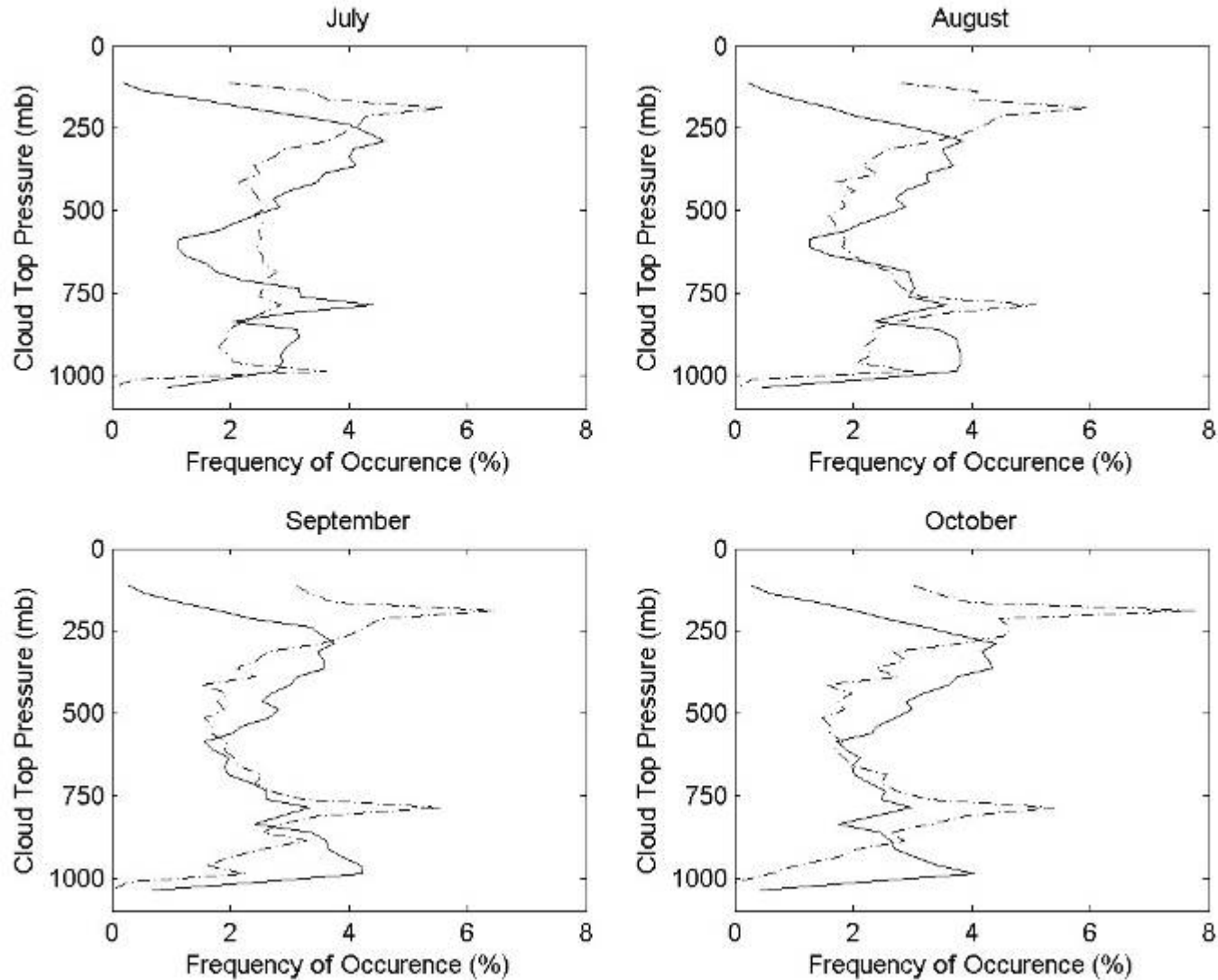
- Model Type: North American Model (NAM)
- Model Runs: Hourly forecast cloud fields for the HYSPLT air quality model
- Model Period: July-October, 2006
- Model Resolution: 12-km

## MODIS Retrievals

- Input Data: Level 1b radiances in Collection 5
- Data Processed: Daily data in Jul-Oct 2006
- Algorithm: Chang and Li (2005, JAS)
- Pixel Size: 1-km
- Output: cloud top, optical depth, emissivity,



# Overall Comparisons of Cloud Vertical Structure



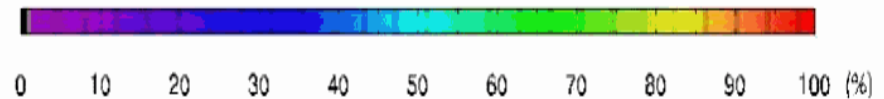
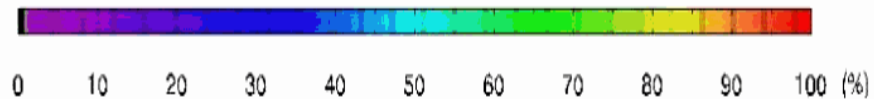
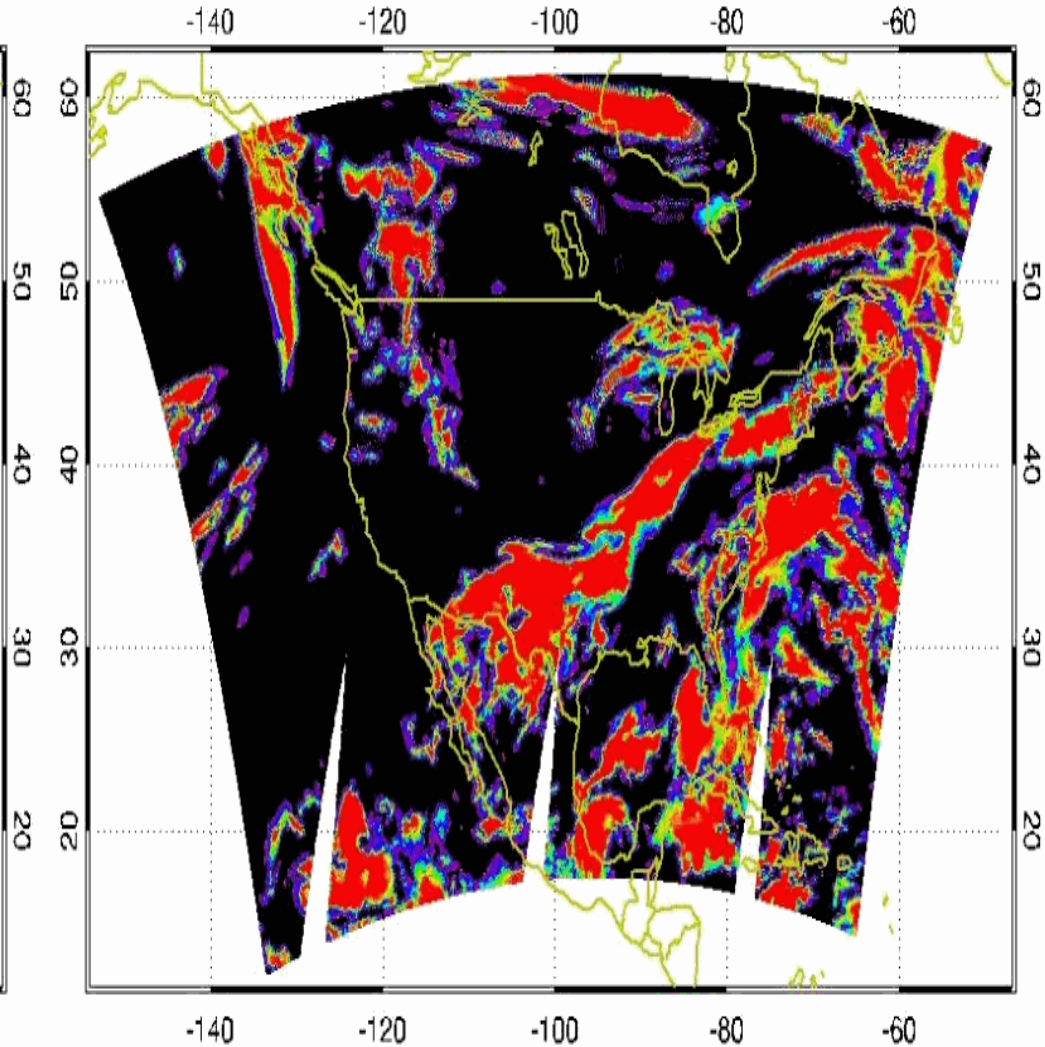
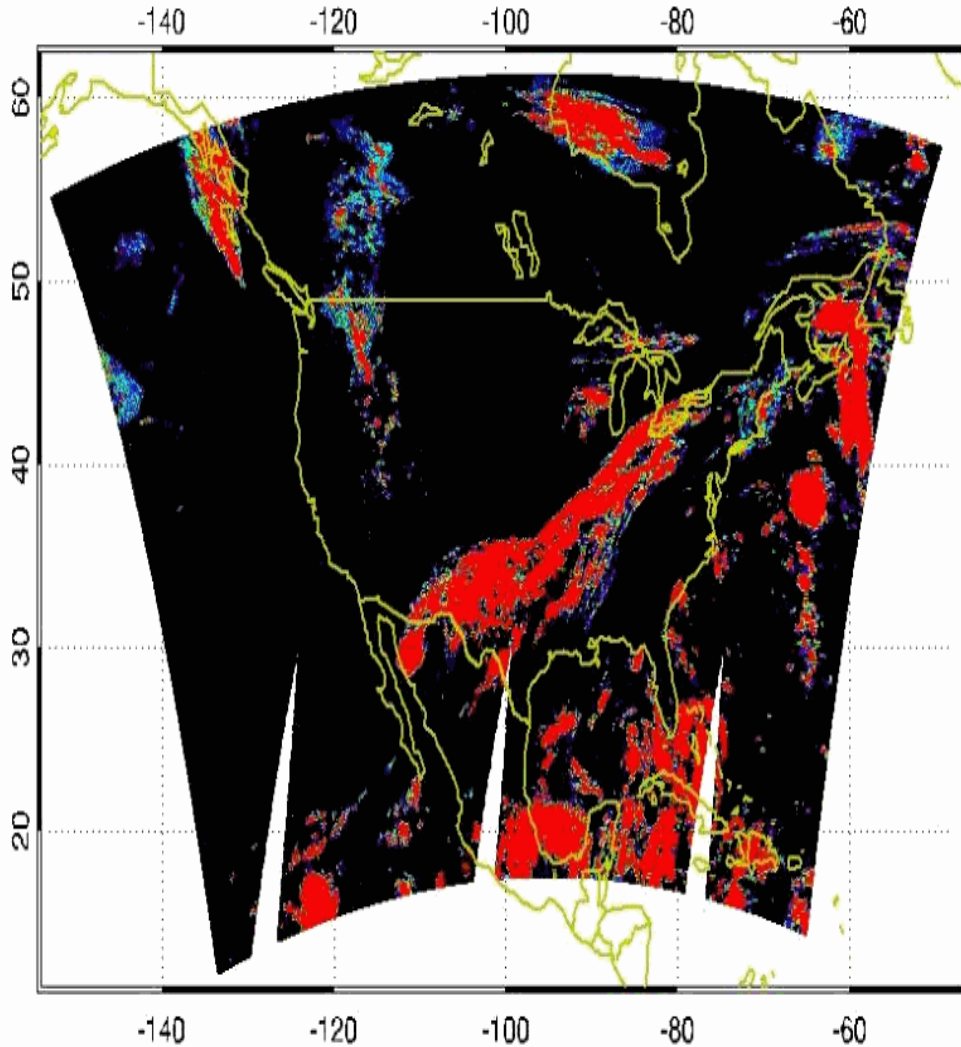
# Definitions of Cloud Layers

- Low clouds:  $CTP > 642 \text{ mb}$
- High clouds:  $CTP < 350 \text{ mb}$
- Mid clouds:  $350 < CTP < 642\text{mb}$

# Comparison of High Clouds

MODIS\_High\_Sep\_4

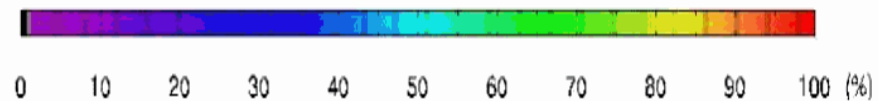
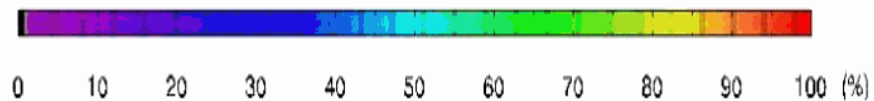
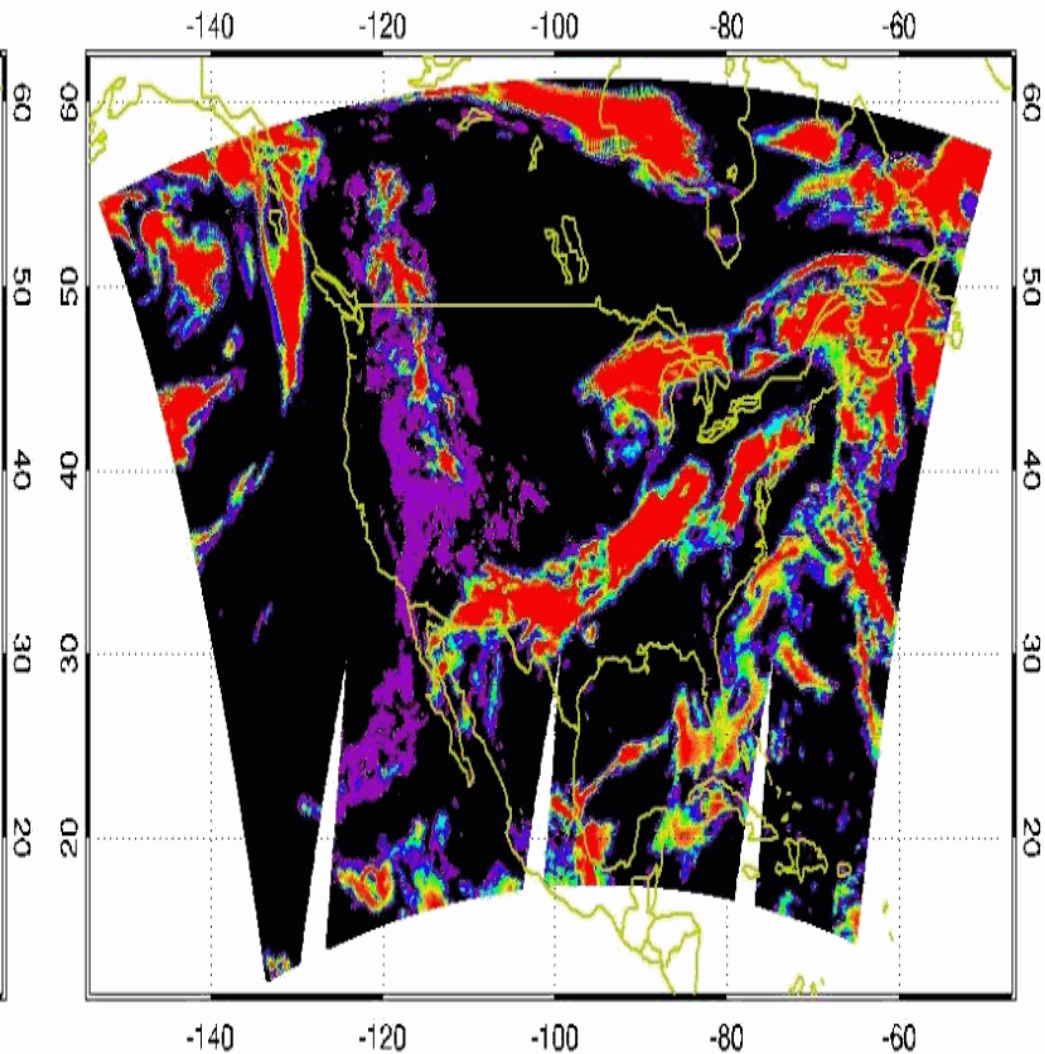
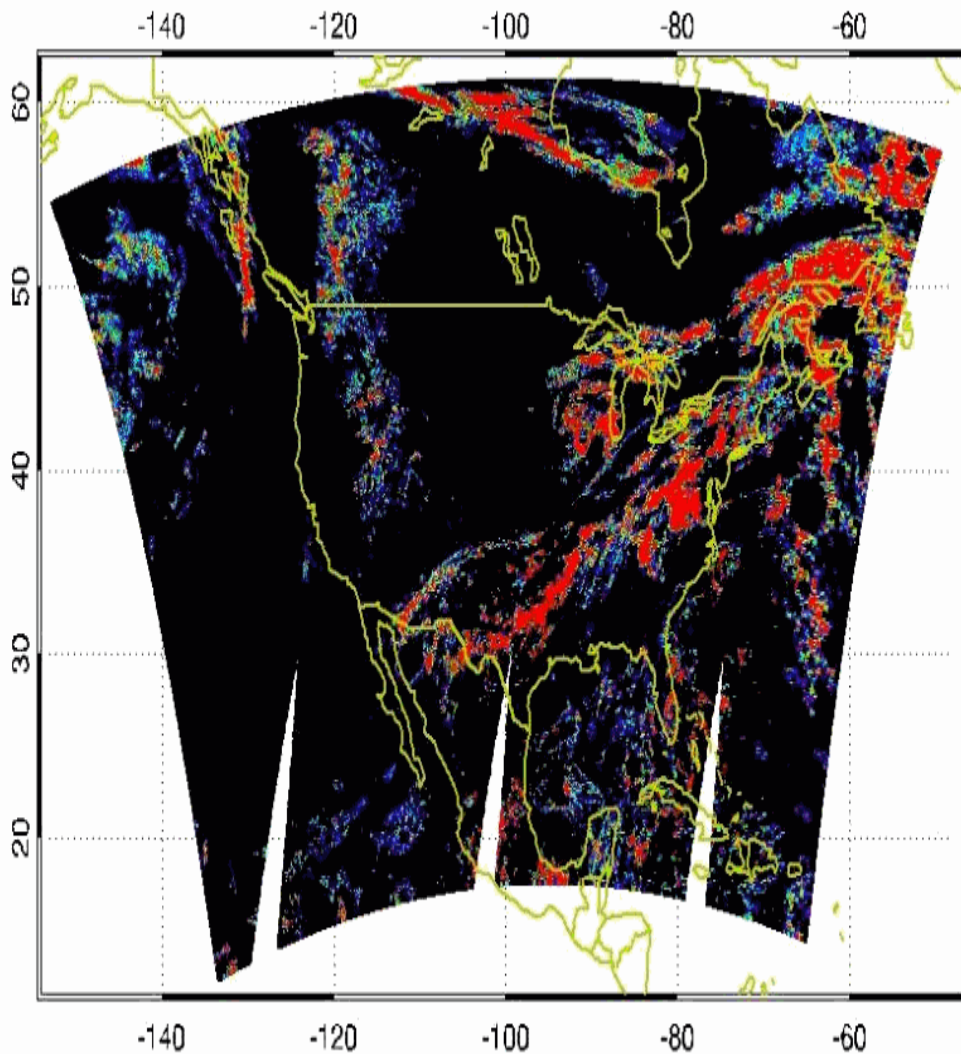
MODEL\_High\_Sep\_4



# Comparison of Mid Clouds

MODIS\_Middle\_Sep\_4

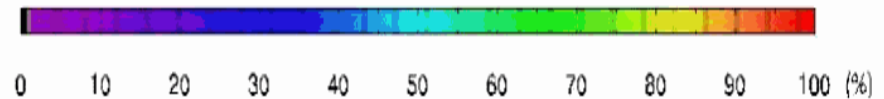
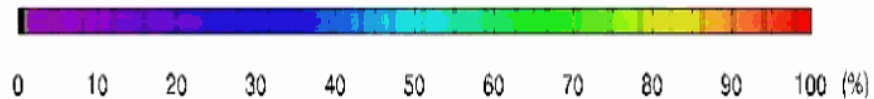
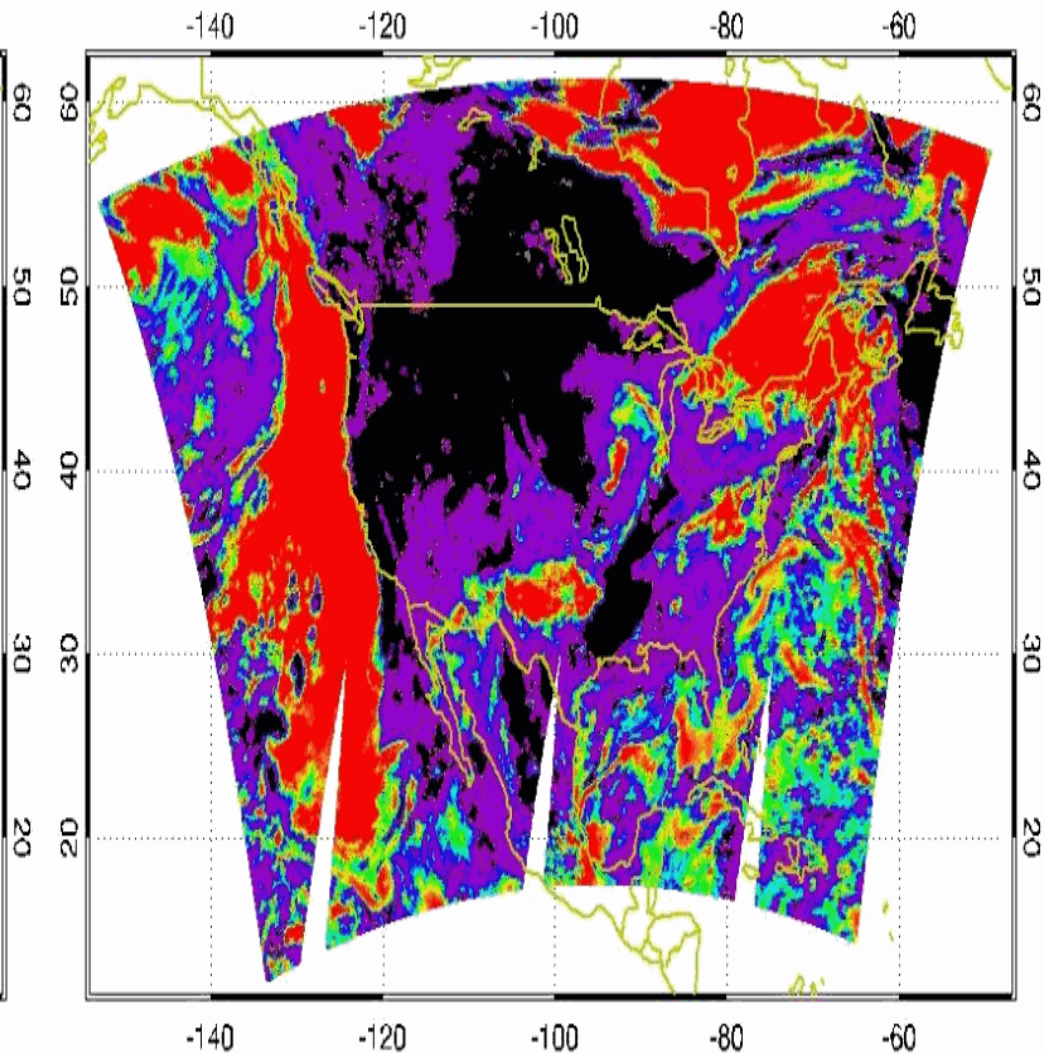
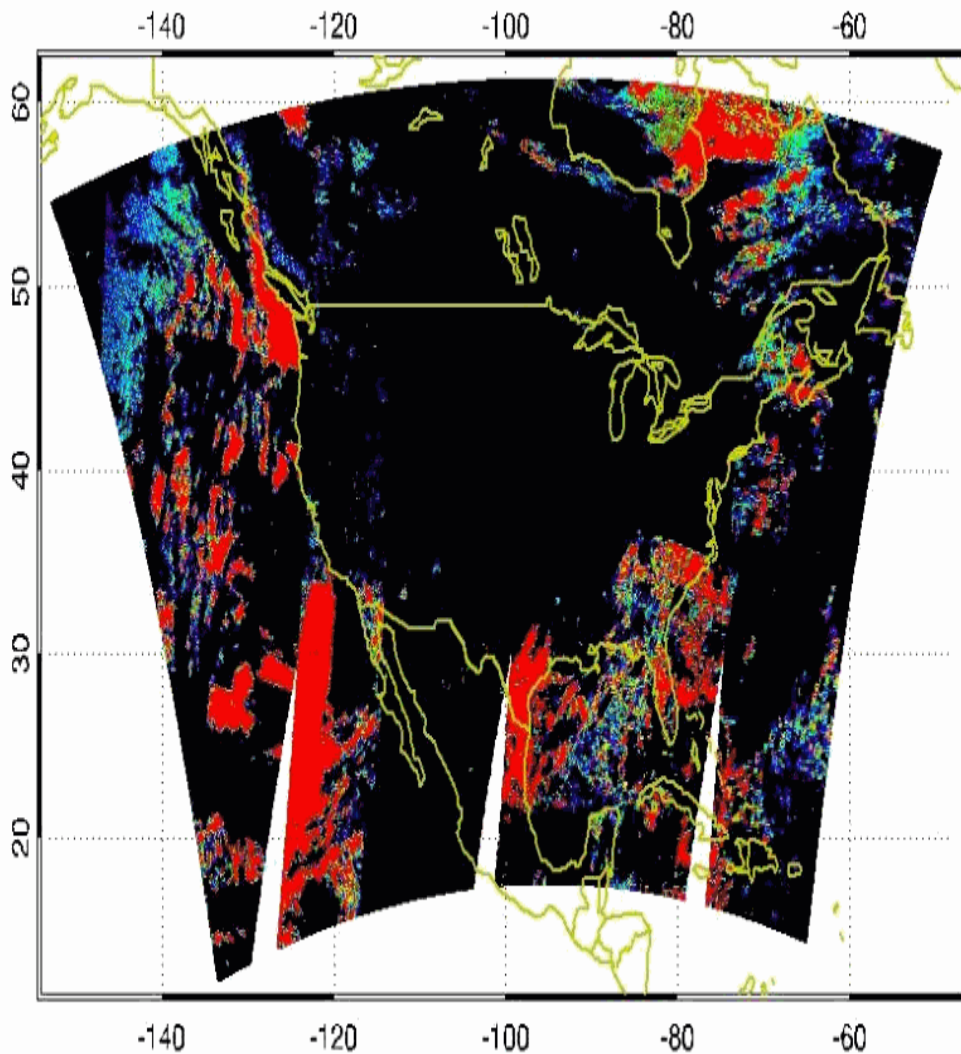
MODEL\_Middle\_Sep\_4



# Comparison of Low Clouds

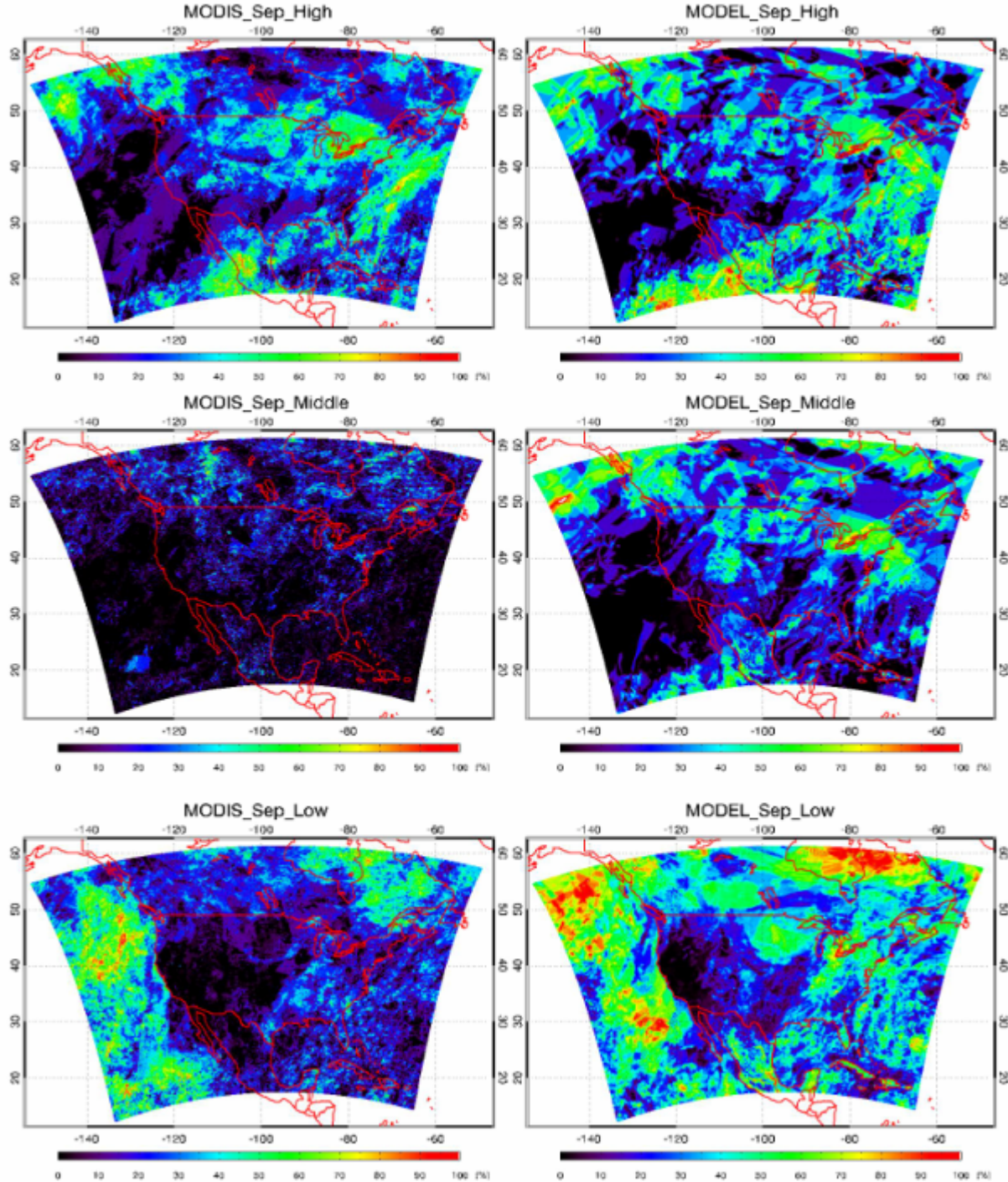
MODIS\_Low\_Sep\_4

MODEL\_Low\_Sep\_4



“Some experimental runs have shown large variations in low-level cloudiness resulting from the use of different convective schemes (and to a lesser extent the boundary layer schemes), particularly over the oceans. Convective schemes exert strong influences on a wide range of clouds from deep thunderstorms to fair weather cumuli to extensive stratocumulus.” (Brad Ferrier)

# Sep Mean



# Summary

- The NAM model can reproduce the general feature of two dominant cloud layers with sharper peaks than the MODIS retrievals
- Cloud top heights from NAM model tends to be higher than the satellite retrievals.
- The agreements between the NAM model and the satellite retrievals are VERY good for high clouds, MODERATE for mid clouds and POOR for low clouds.
- The NAM model tends to overestimate low clouds and mid clouds.
- The NAM simulates the synoptic pattern very well in terms of the movement of weather systems.