

# **Analysis of Boundary-layer Cloud Properties for the GCSS Pacific Cross- Section and Climate Process Team**

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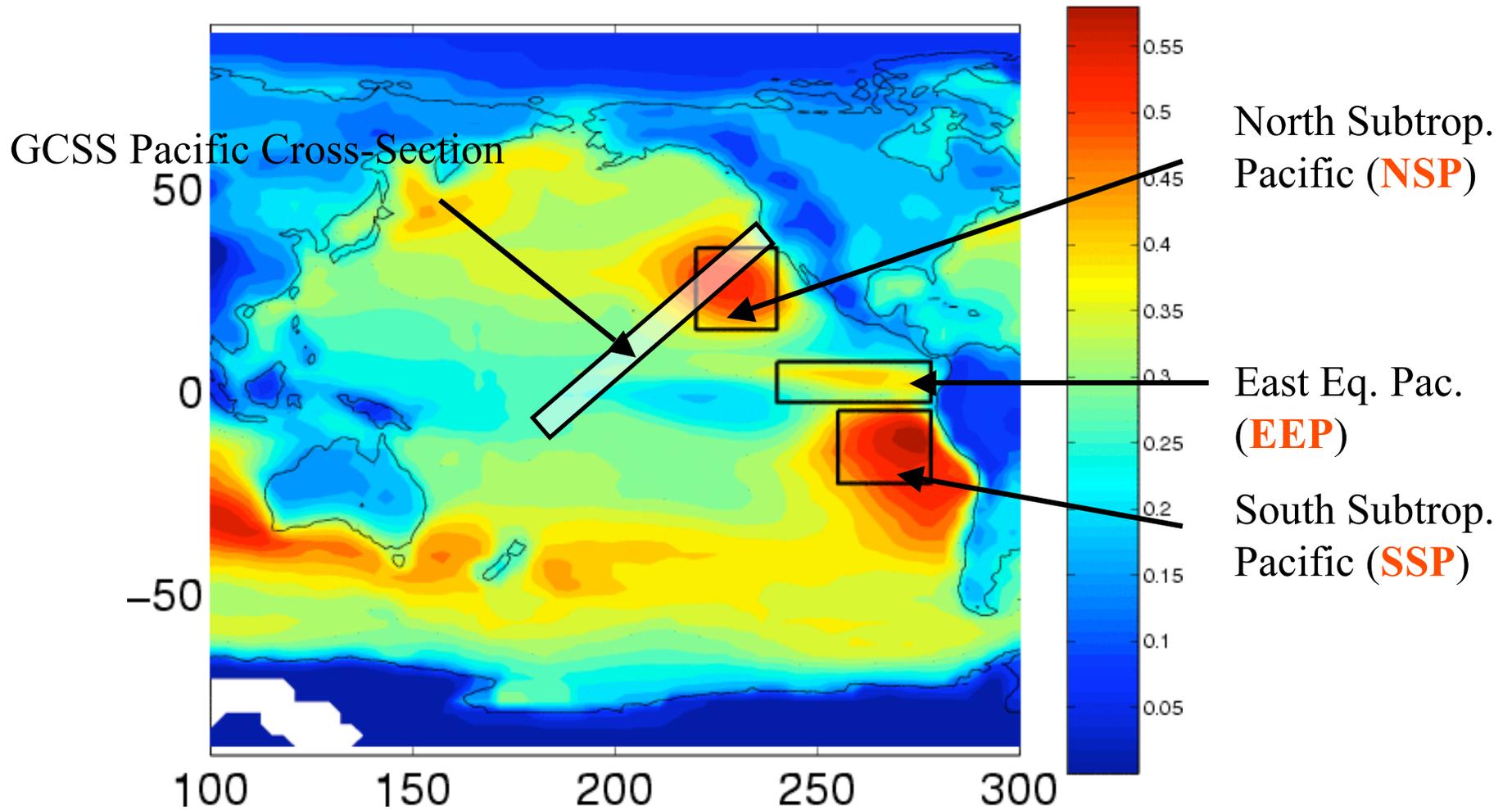
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Hampton, VA**

# Outline

- Introduction
- Status of satellite cloud-object data analysis
- Analysis of BL cloud objects in three Pacific regions for Climate Process Team (CPT)
- Analysis of BL cloud objects for the GCSS Pacific Cross-Section
- Summary and future plans

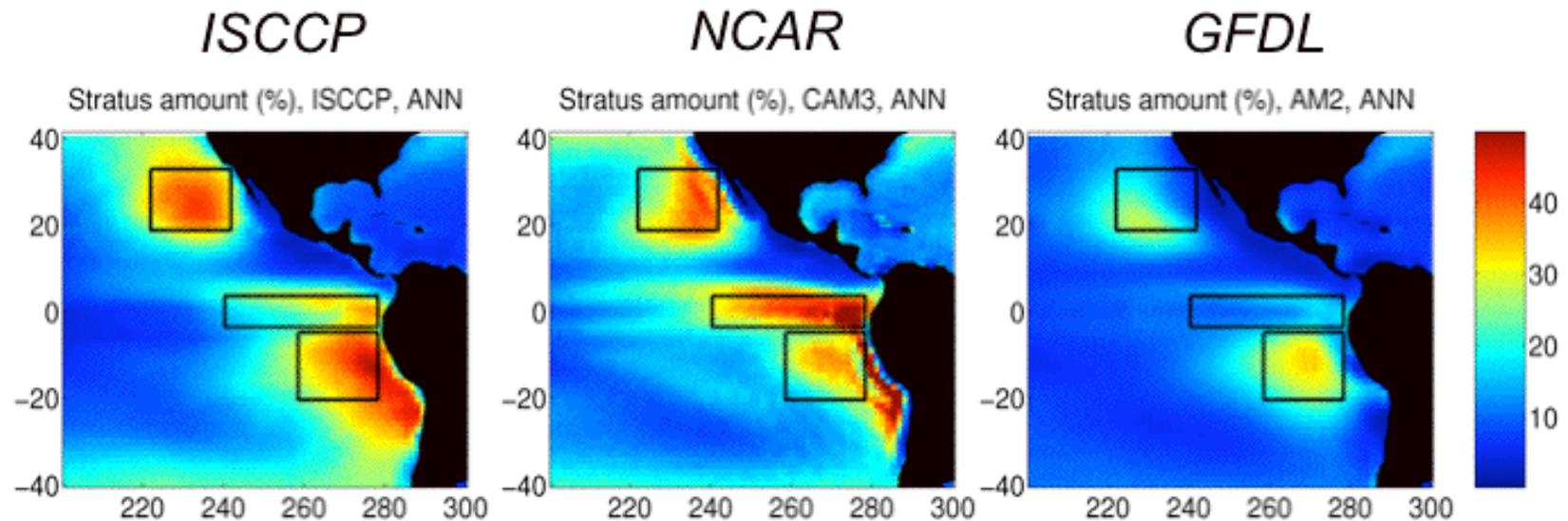
# BL Cloud Regions in the Pacific

ISCCP, ANN, CLDLow (fraction)



## Eastern Pacific Stratocumulus: models versus ISCCP

from Hannay et al. (2005; Pan GCSS meeting)

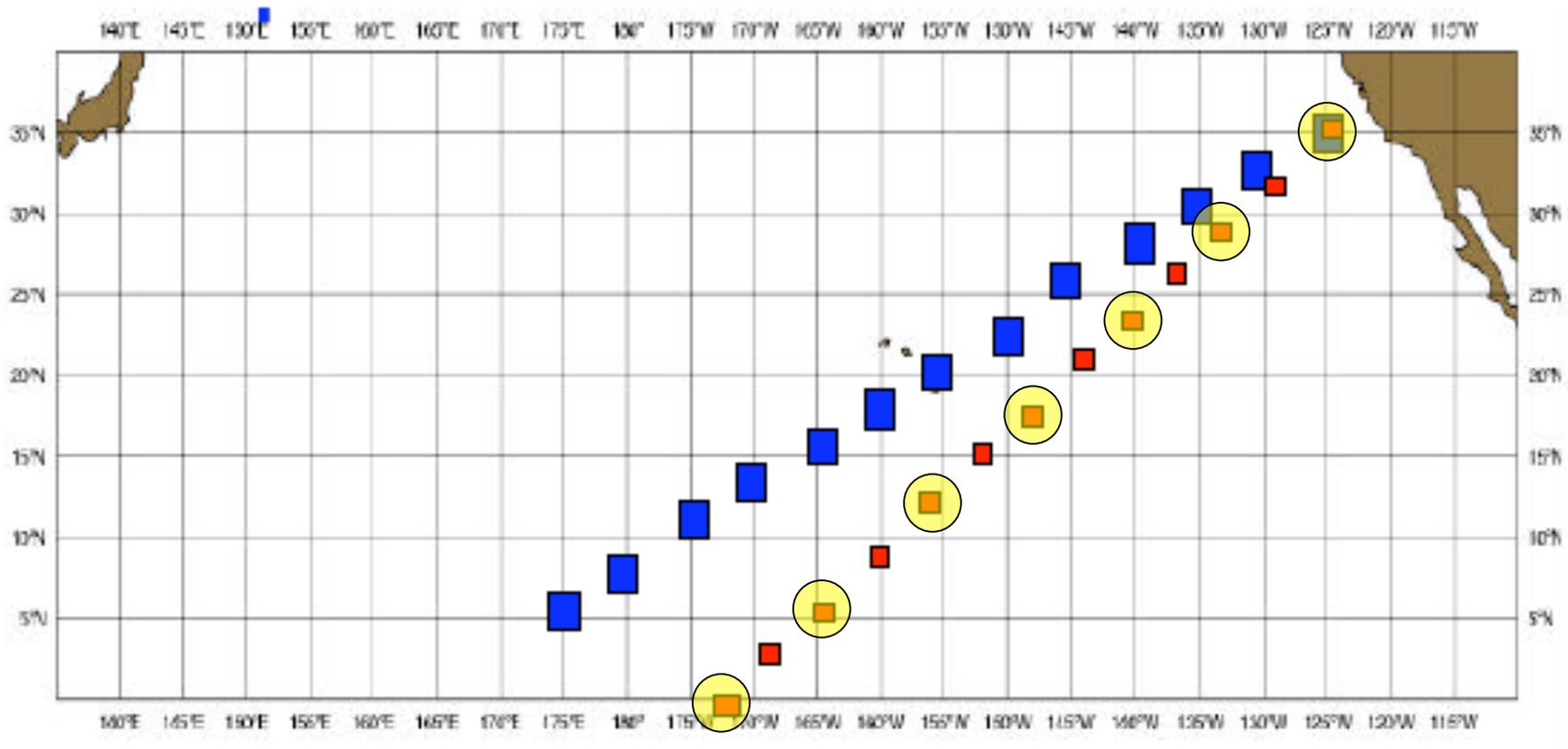


- NCAR model: - clouds **too close** from the coast  
- **over-predicts** clouds in East Equatorial zone
- GFDL model: - **underestimates** stratocumulus  
- clouds **too far** from the coast

# GCSS Pacific Cross-Section

## Transition of cloud types

Solid stratus → deep convection



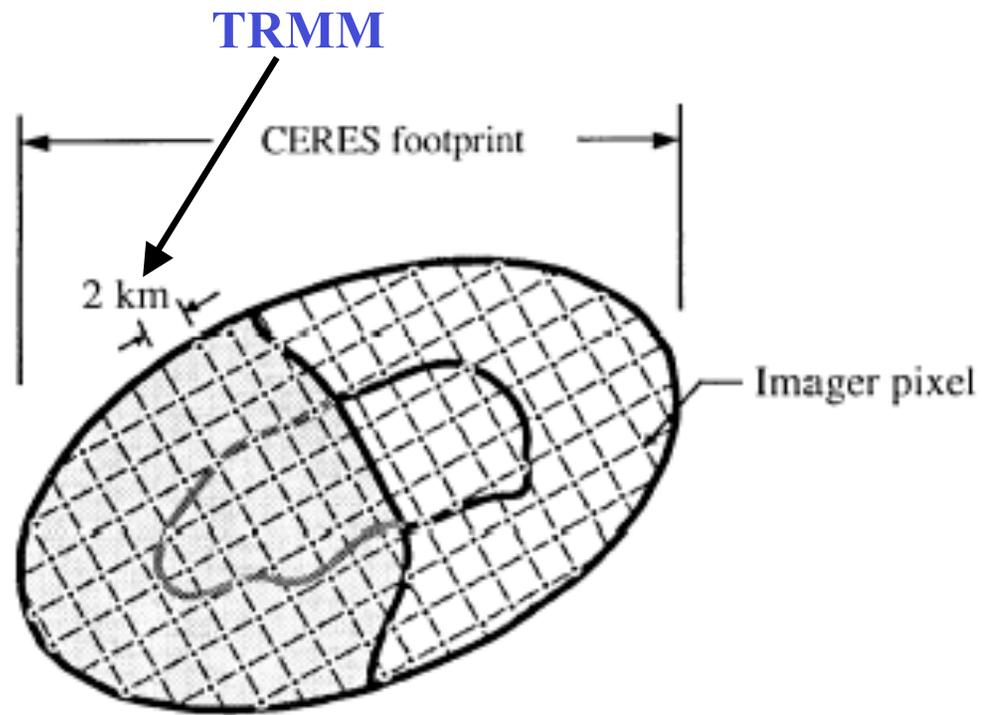
# Cloud Objects:

*predetermined clusters (Xu et al. 2005)*

- The shape and size of a cloud object is determined by the **satellite footprint data** and by the footprint **selection criteria** for a given cloud-system type
- A cloud object is a contiguous patch of the Earth with a **single dominant** cloud-system type, shifting from Eulerian to Lagrangian views of cloud systems

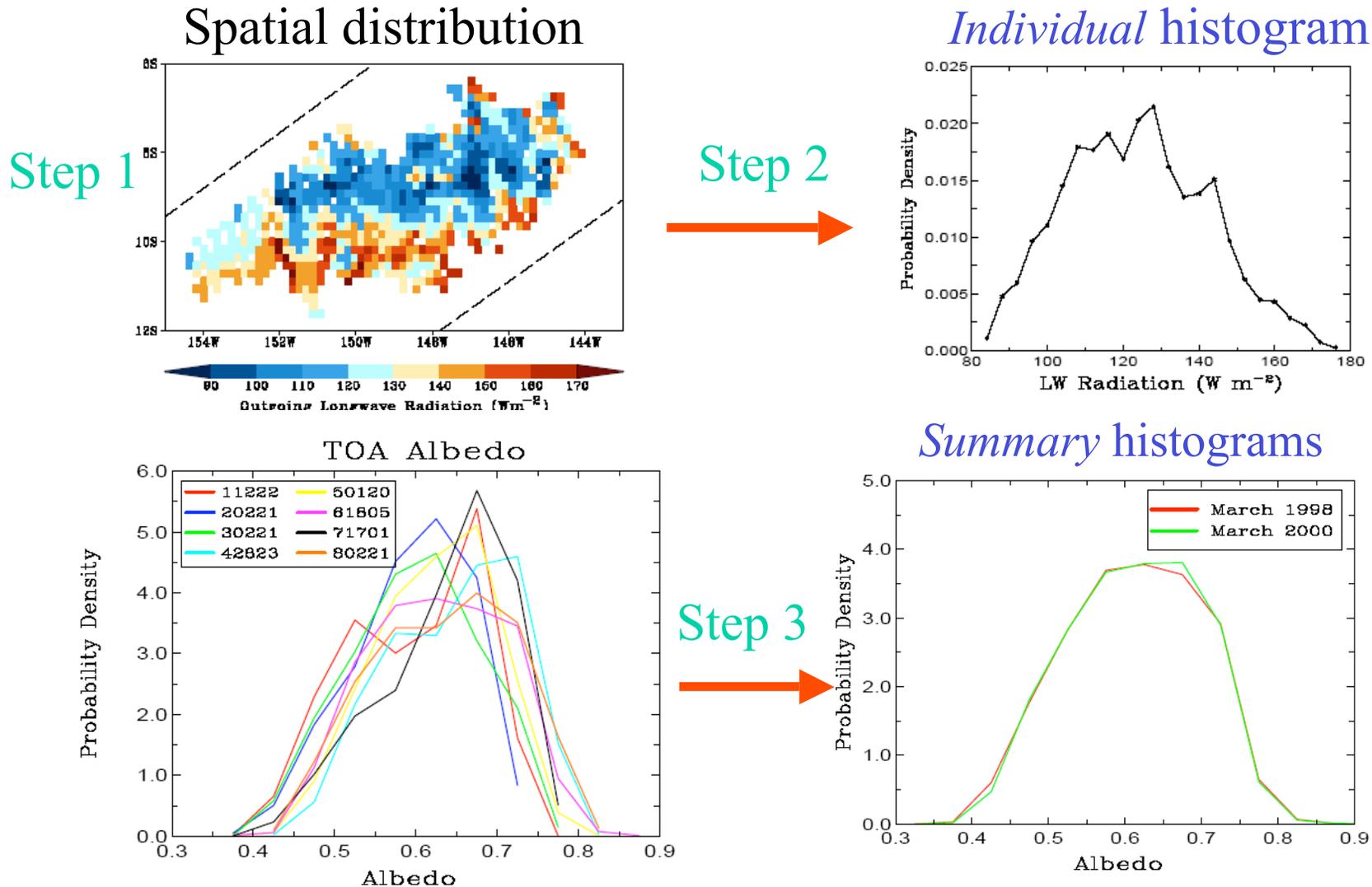
Type of cloud objects	Cloud top height	Cloud optical depth	Cloud cover	Latitude band
Tropical convection	> 10 km	> 10	100%	25S – 25N
<b>Solid stratus</b>	< 3 km	-	<b>99 - 100%</b>	40S – 40N
<b>Stratocumulus</b>	< 3 km	-	<b>40 - 99%</b>	40S – 40N
<b>Shallow cumulus</b>	< 3 km	-	<b>10 - 40%</b>	40S – 40N

# Satellite Footprint (Field of View)



# Procedures of the Cloud Object Analysis

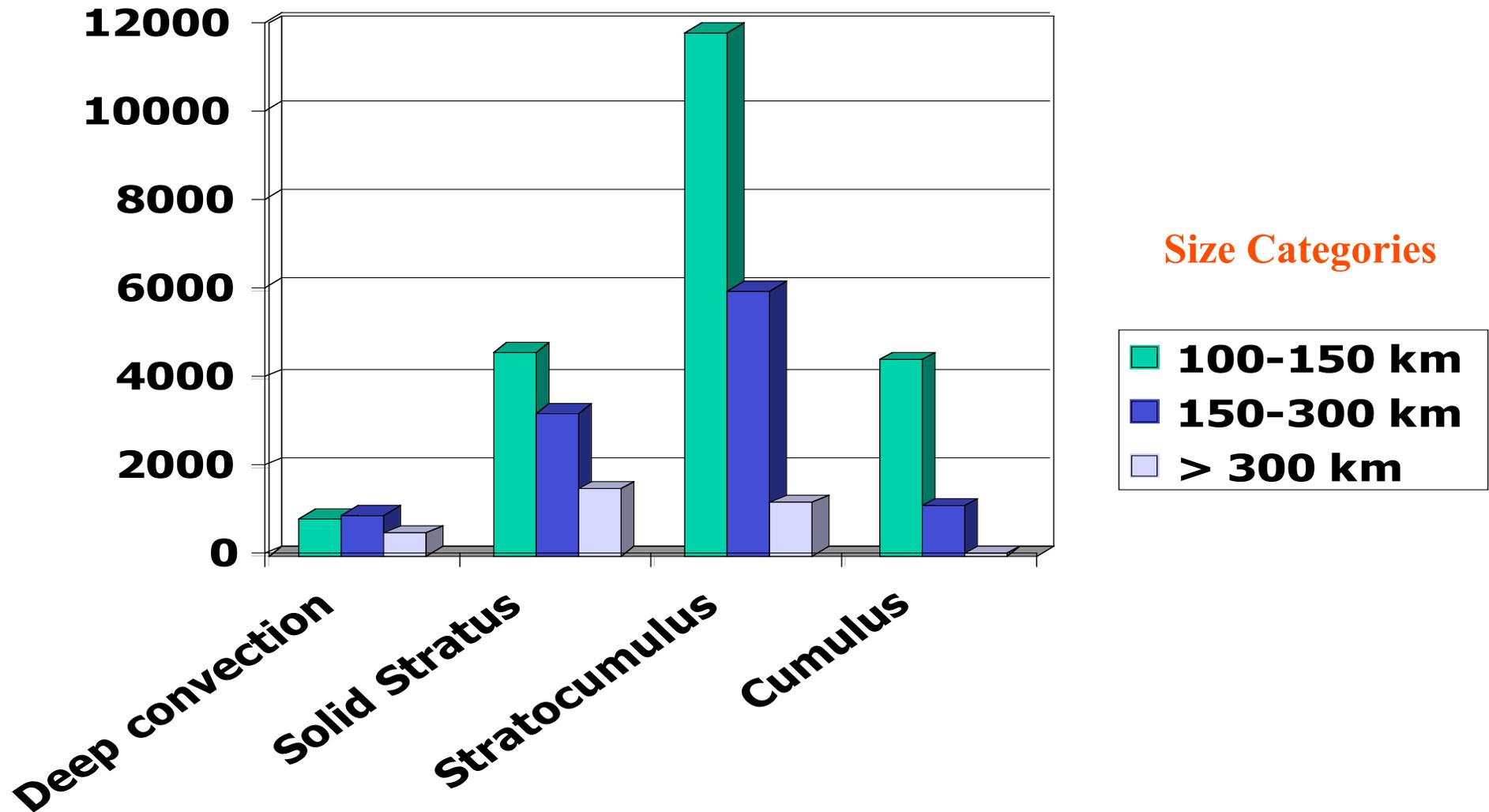
see Xu et al. (2005; *J. Climate*)



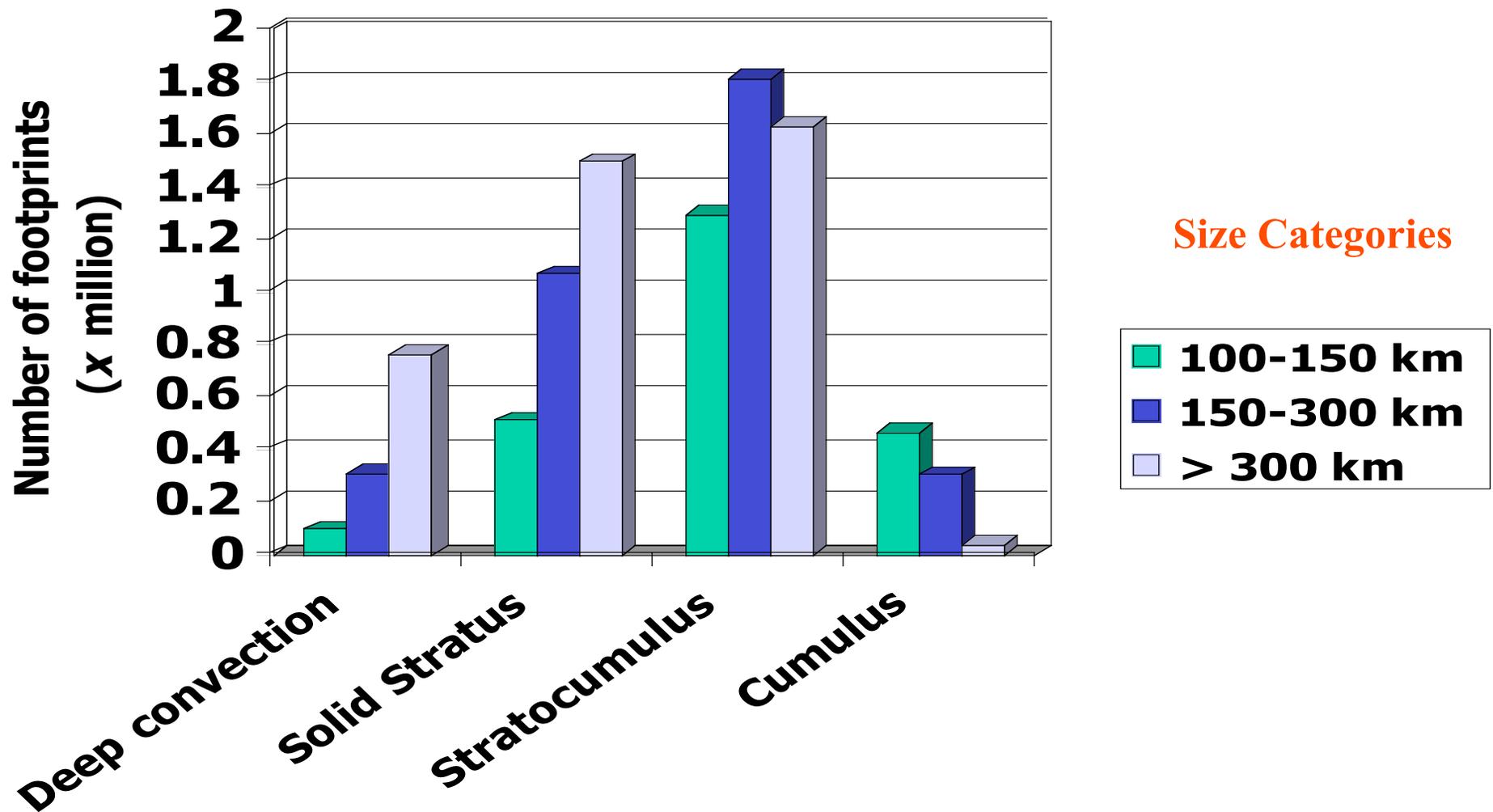
# Current Status

- Finished the analysis of all four cloud-object types for the TRMM period (Jan. – Aug. 1998; March 2000)
- Created a webpage (<http://cloud-object.larc.nasa.gov>) for hosting the cloud-object data product, including
  - Cloud object footprint data, histogram data, and statistical data
  - Matched ECMWF meteorological and forcing data over 13x13 grids
- Published the cloud-object methodology paper (Xu et al. 2005; *J. Climate*, **18**, 2497-2514)
- Analyzing 2000-2002 Terra/CERES data now

# Number of Cloud Objects in the Pacific during Jan.-Aug. 1998 period

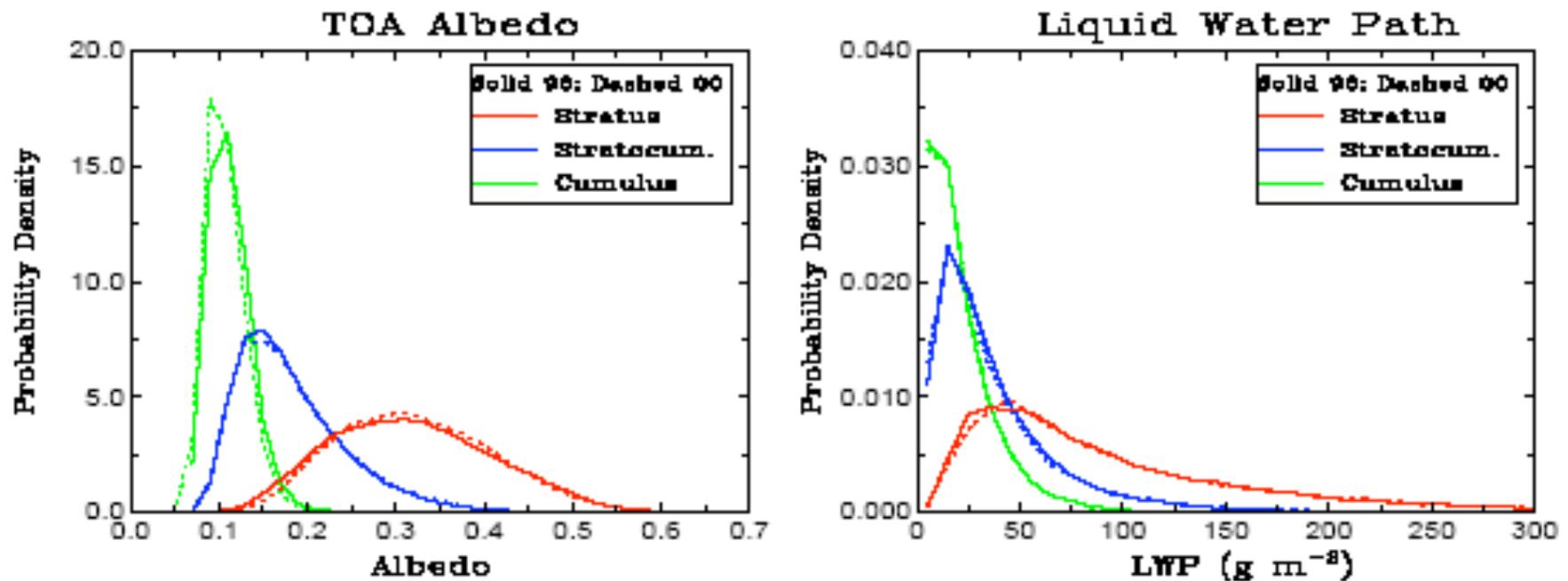


# Total Number of Footprints of Cloud Object Types during Jan.-Aug. 1998



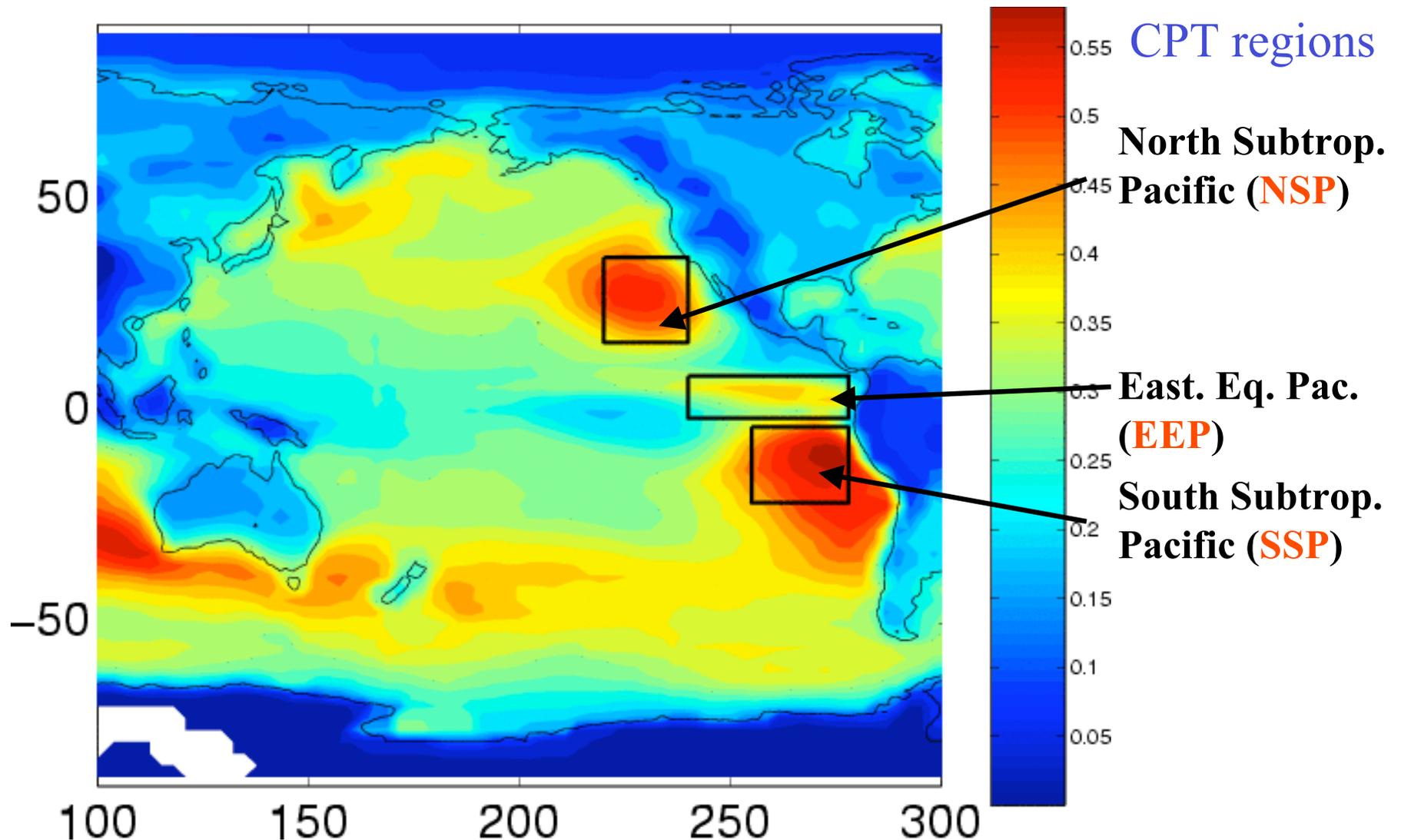
# Typical Histograms for BL Cloud Types (Xu et al. 2005)

Solid: March 1998; Dashed: March 2000



These histograms are consistent with those obtained from high-resolution LandSat data (Wielicki and Parker 1992).

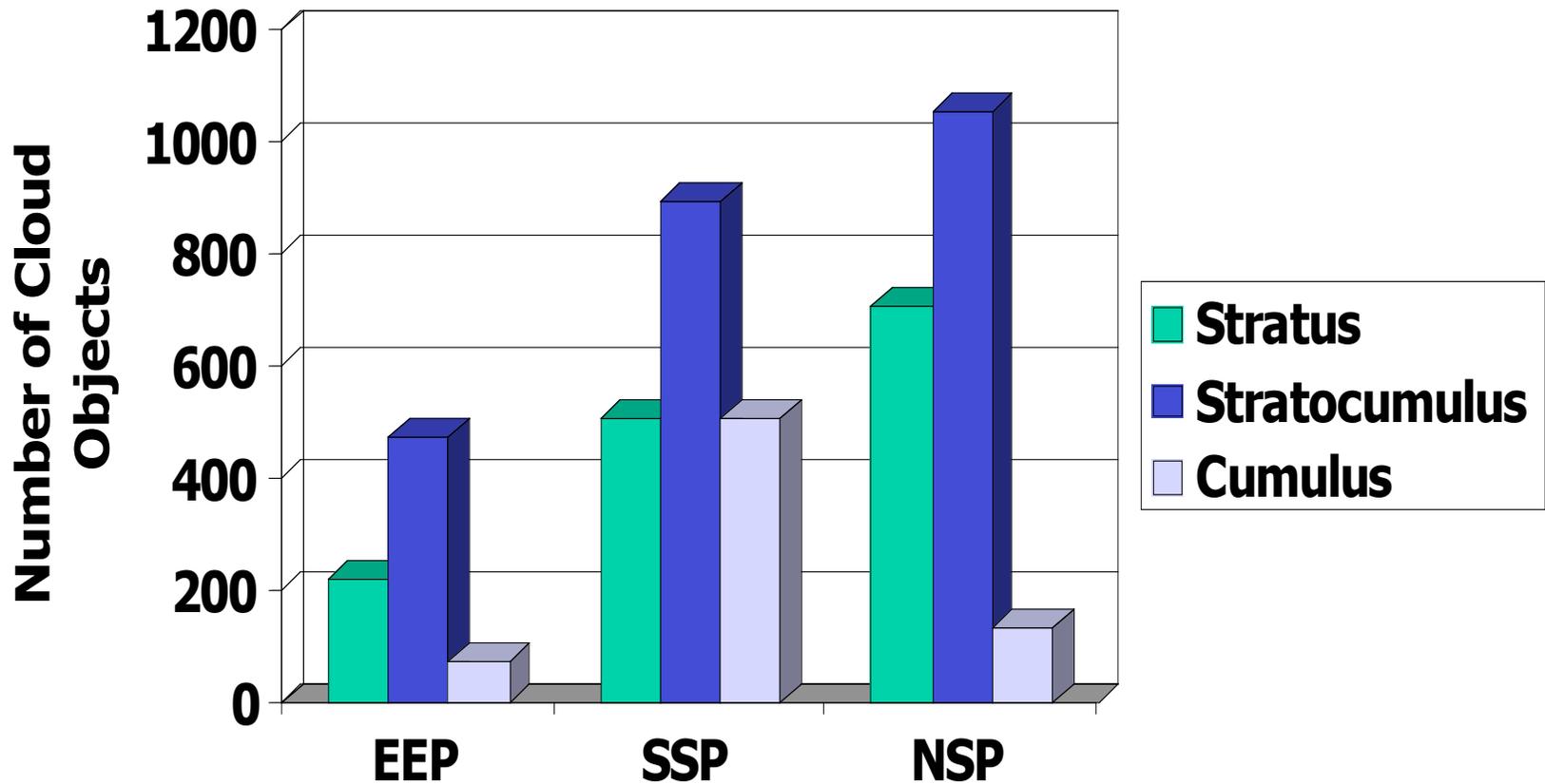
# Are Cloud Properties of the Same Type Different in Different Regions?



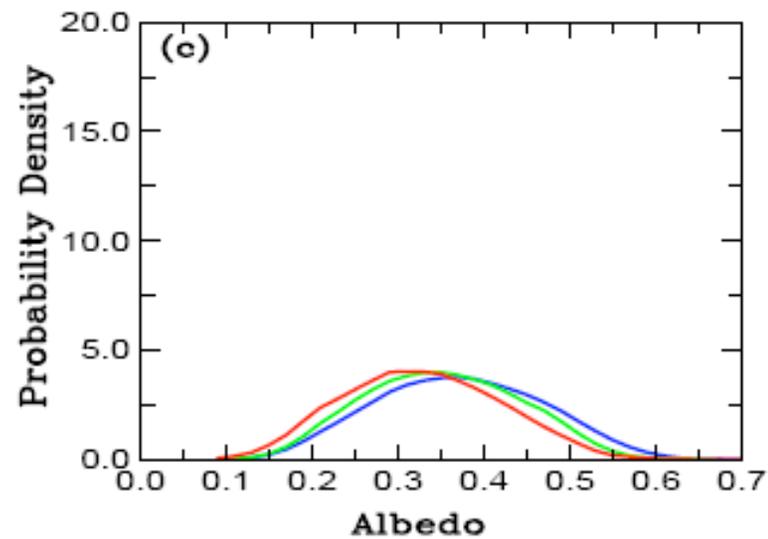
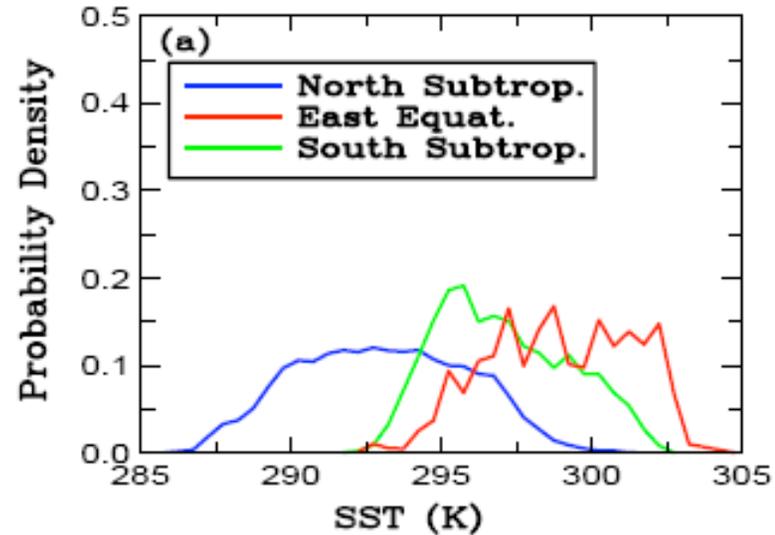
# Parameters in the Cloud Object Data

Parameter type	Names of parameters
Cloud macrophysics	Cloud fraction, Cloud top height, Cloud top temperature, Cloud top pressure
Cloud microphysics	Ice diameter, ice water path, droplet radius, liquid water path
Cloud optics	Visible cloud optical depth, Cloud infrared emissivity
Radiation	OLR, TOA broadband albedo, TOA broadband SW
Environment	Sea surface temperature

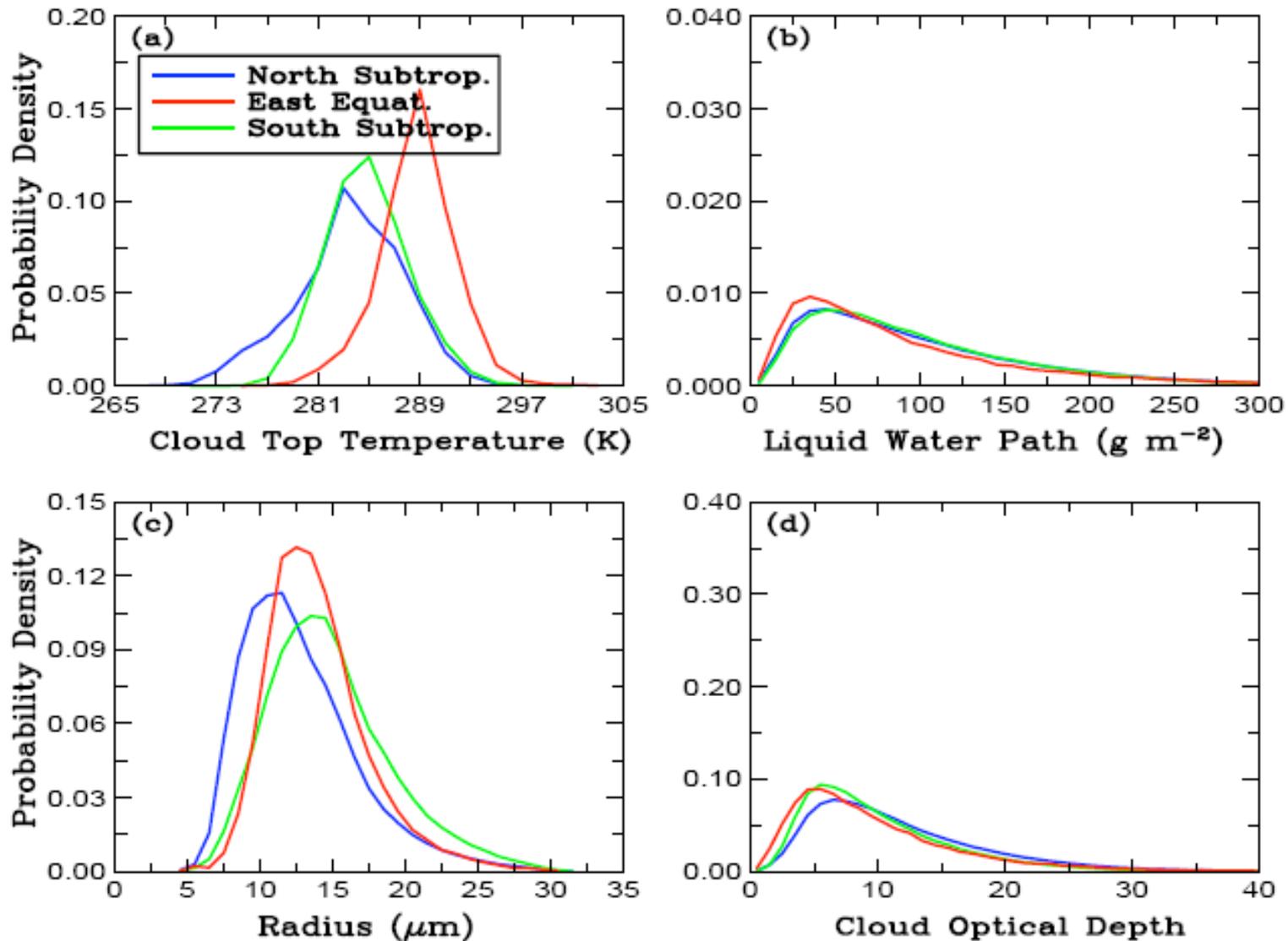
# Number of Cloud Objects in the CPT Regions during Jan.-Aug. 1998



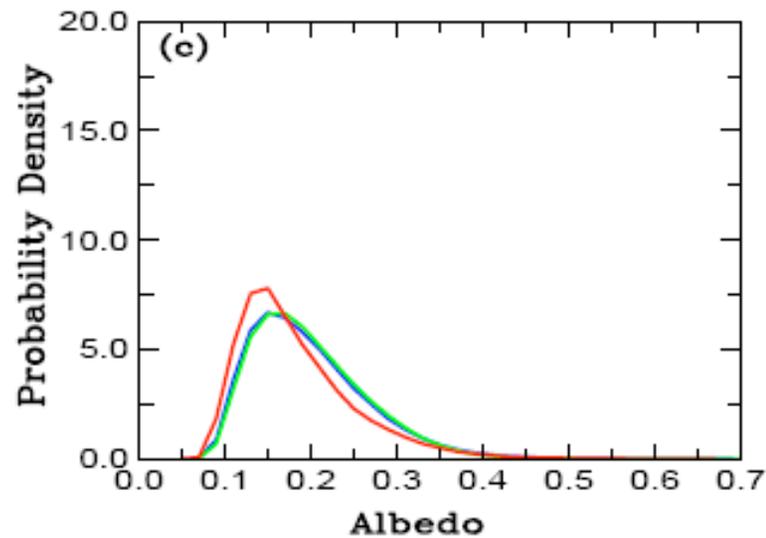
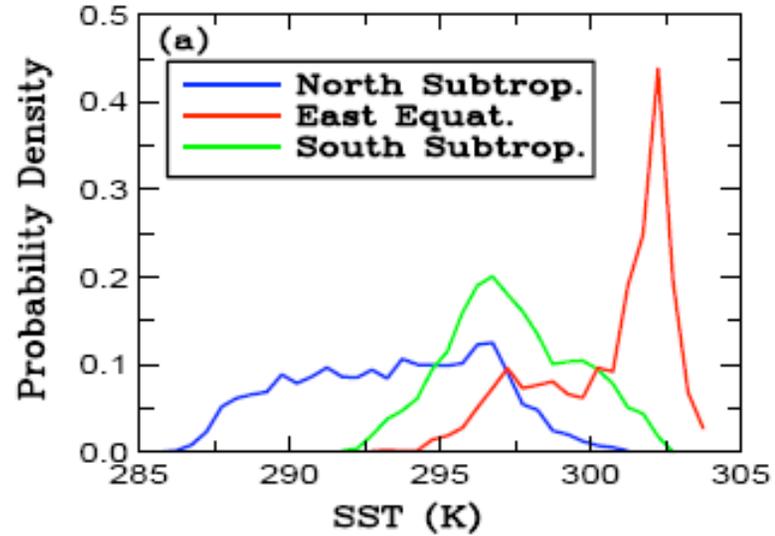
# CPT BL Regions – Stratus (1)



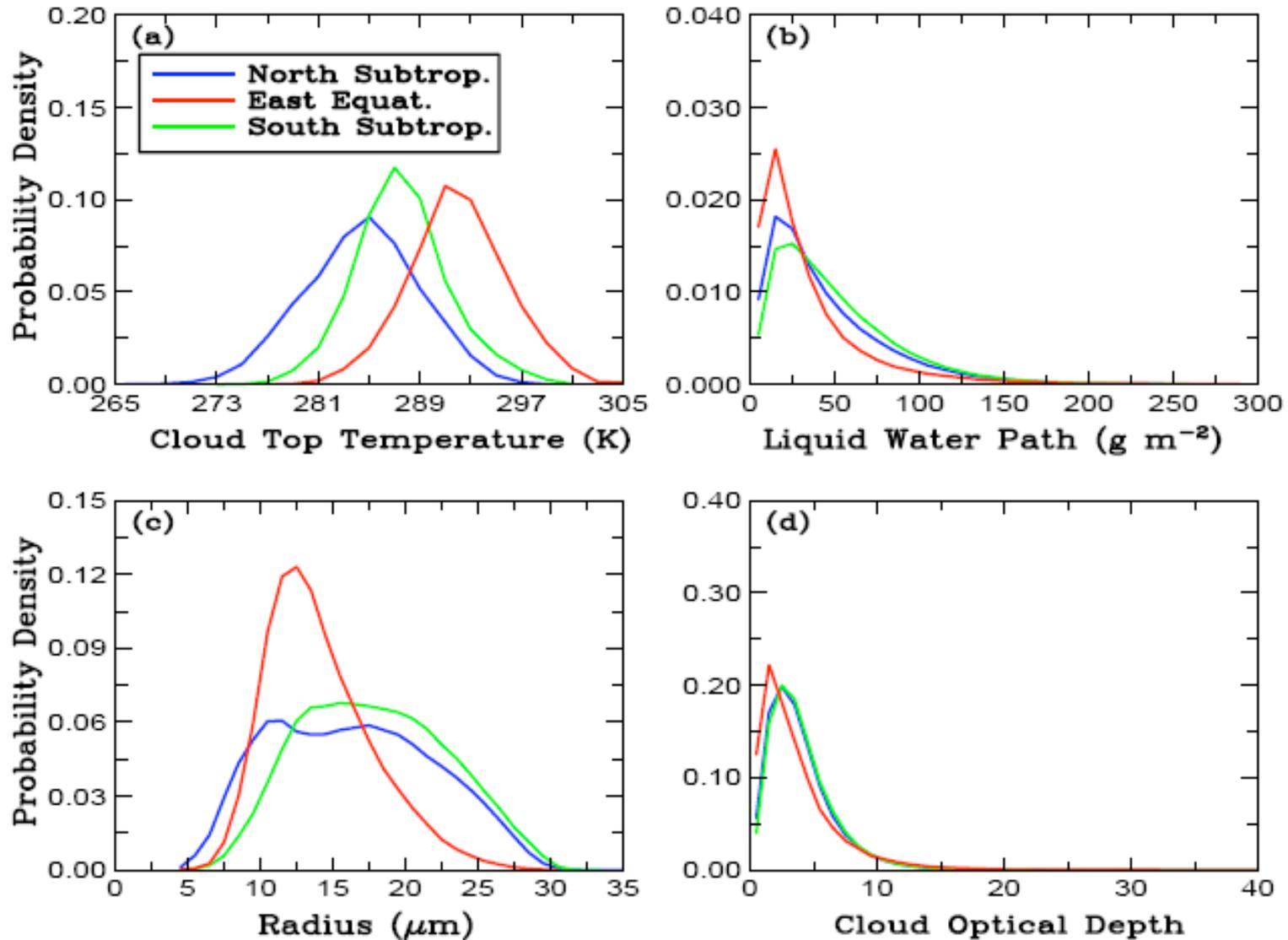
# CPT BL Regions – Stratus (2)



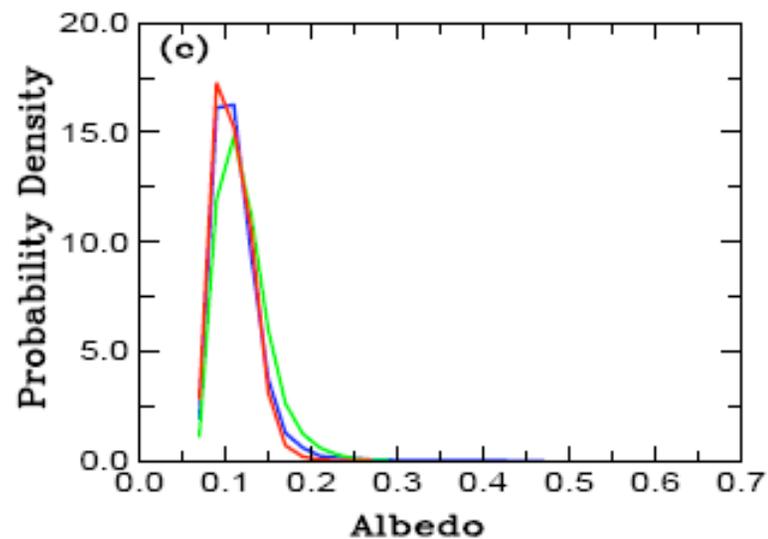
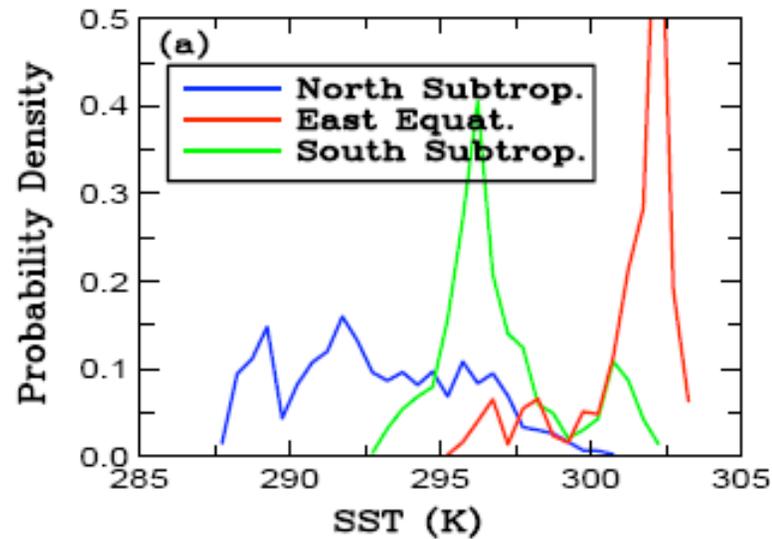
# CPT BL Regions – Stratocumulus (1)



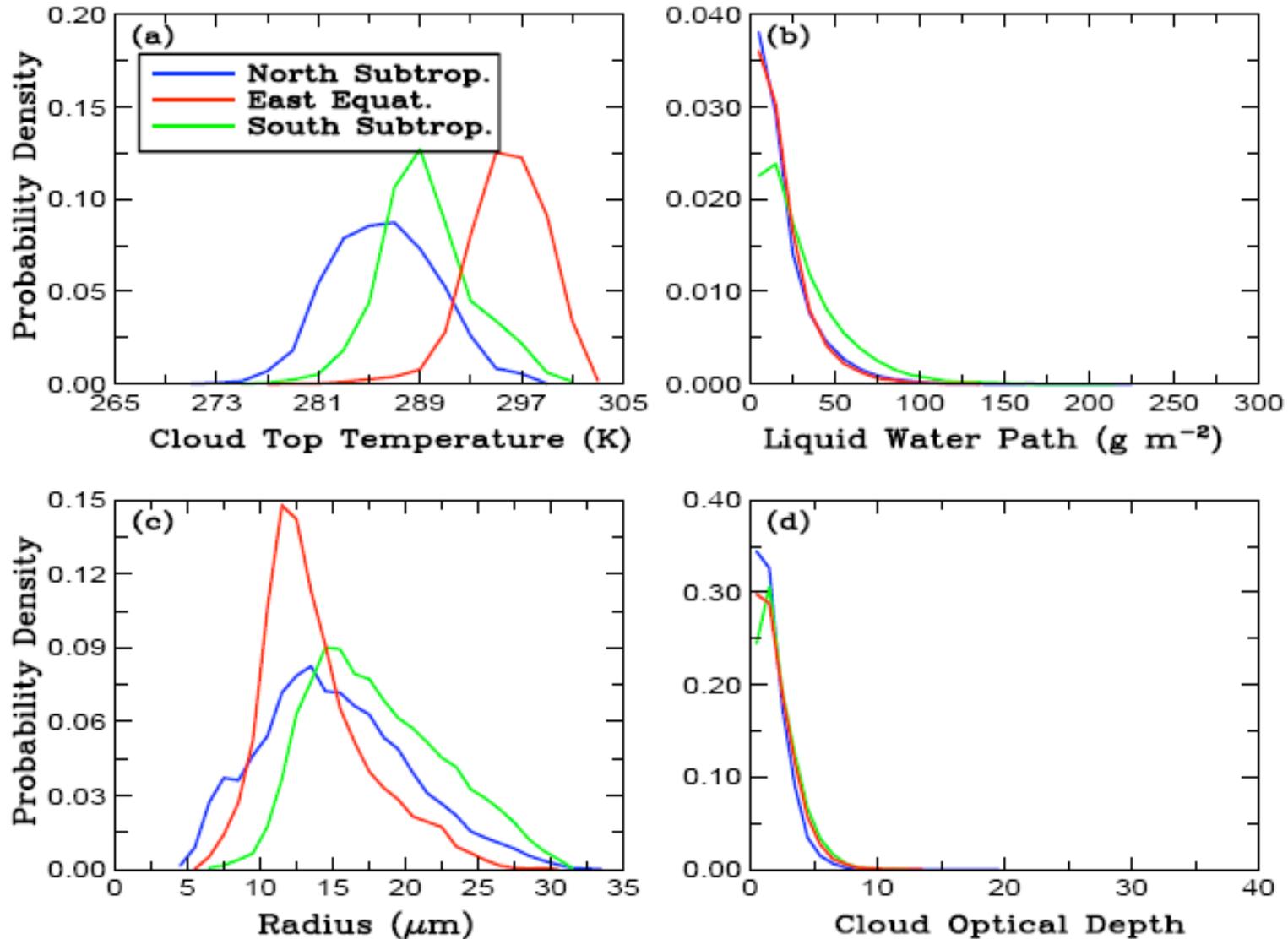
# CPT BL Regions – Stratocumulus (2)



# CPT BL Regions – Cumulus (1)



# CPT BL Regions – Cumulus (2)

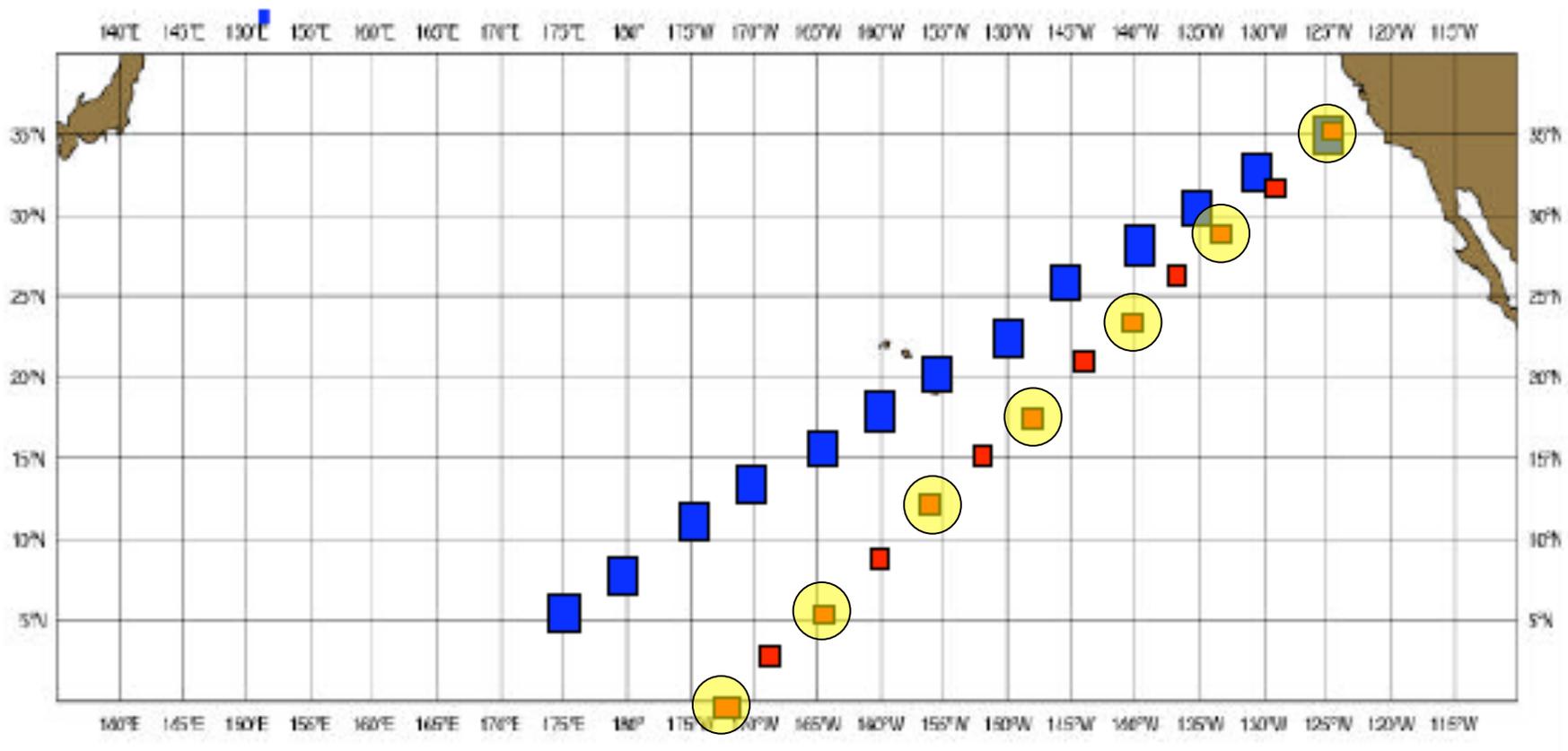


# GCSS Pacific Cross-Section

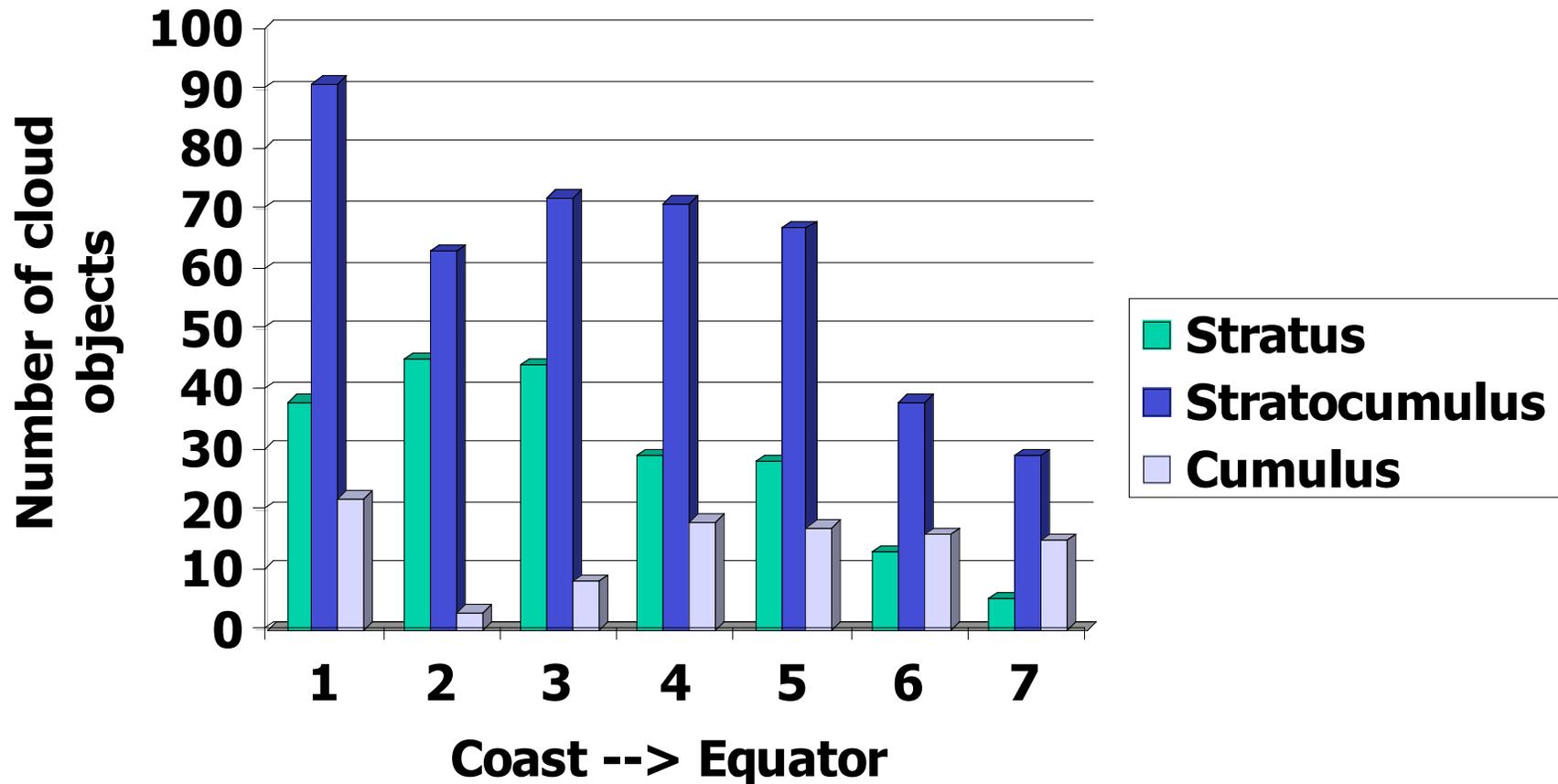
## Transition of cloud types

Solid stratus → deep convection

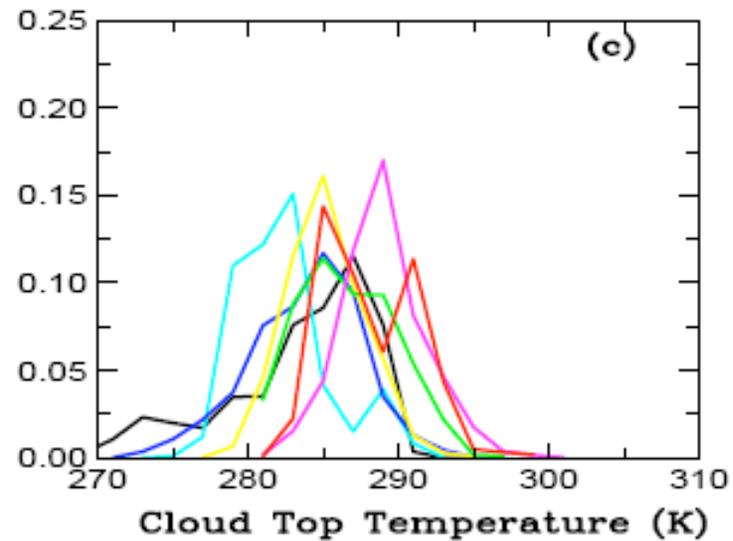
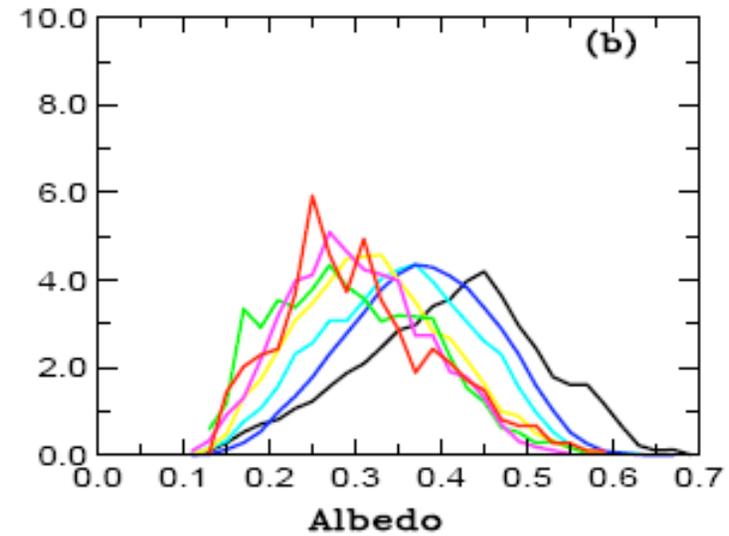
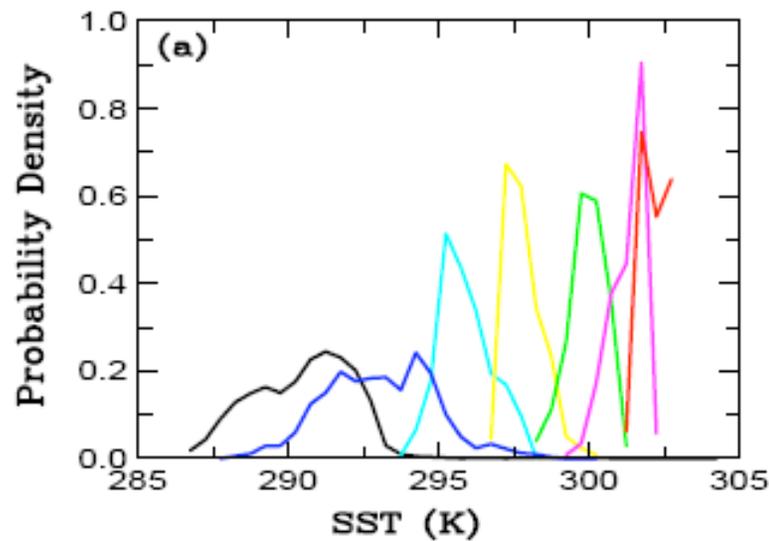
5° x 5° box



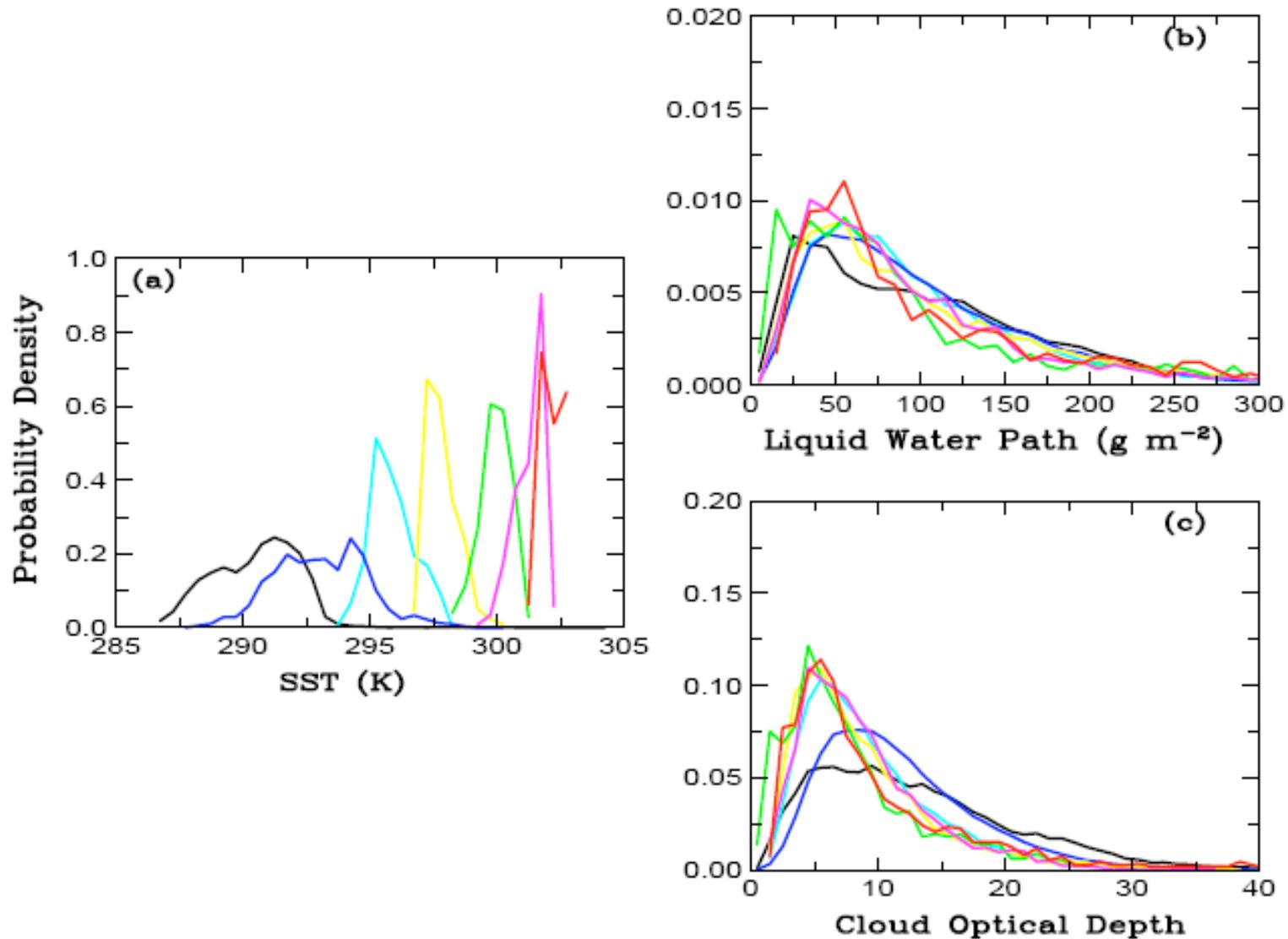
# Number of Cloud Objects in the GEWEX Pacific Cross-Section during Jan.-Aug. 1998



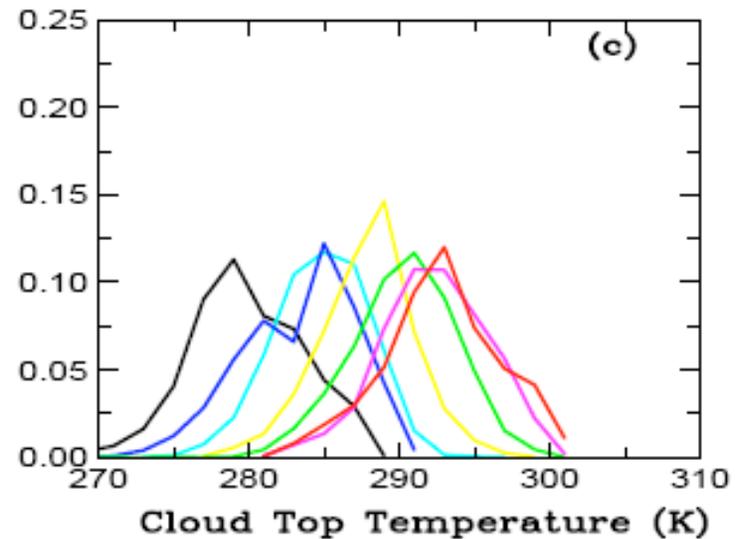
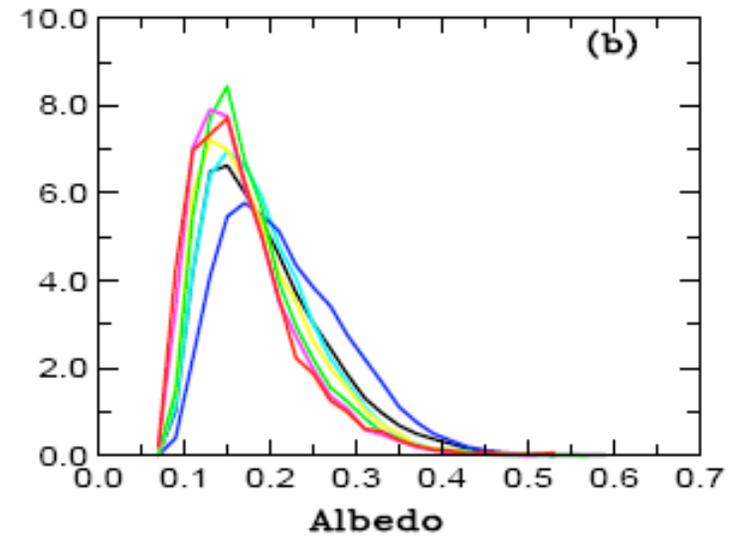
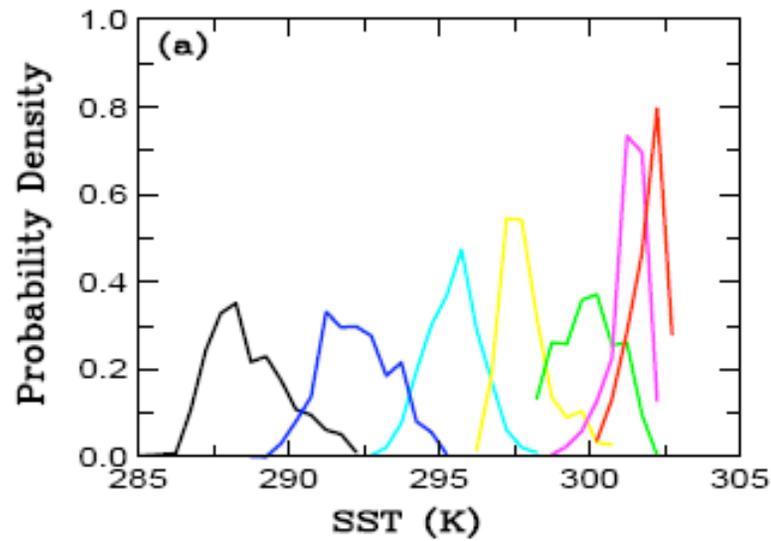
# The GCSS Pacific Cross-Section Stratus (1)



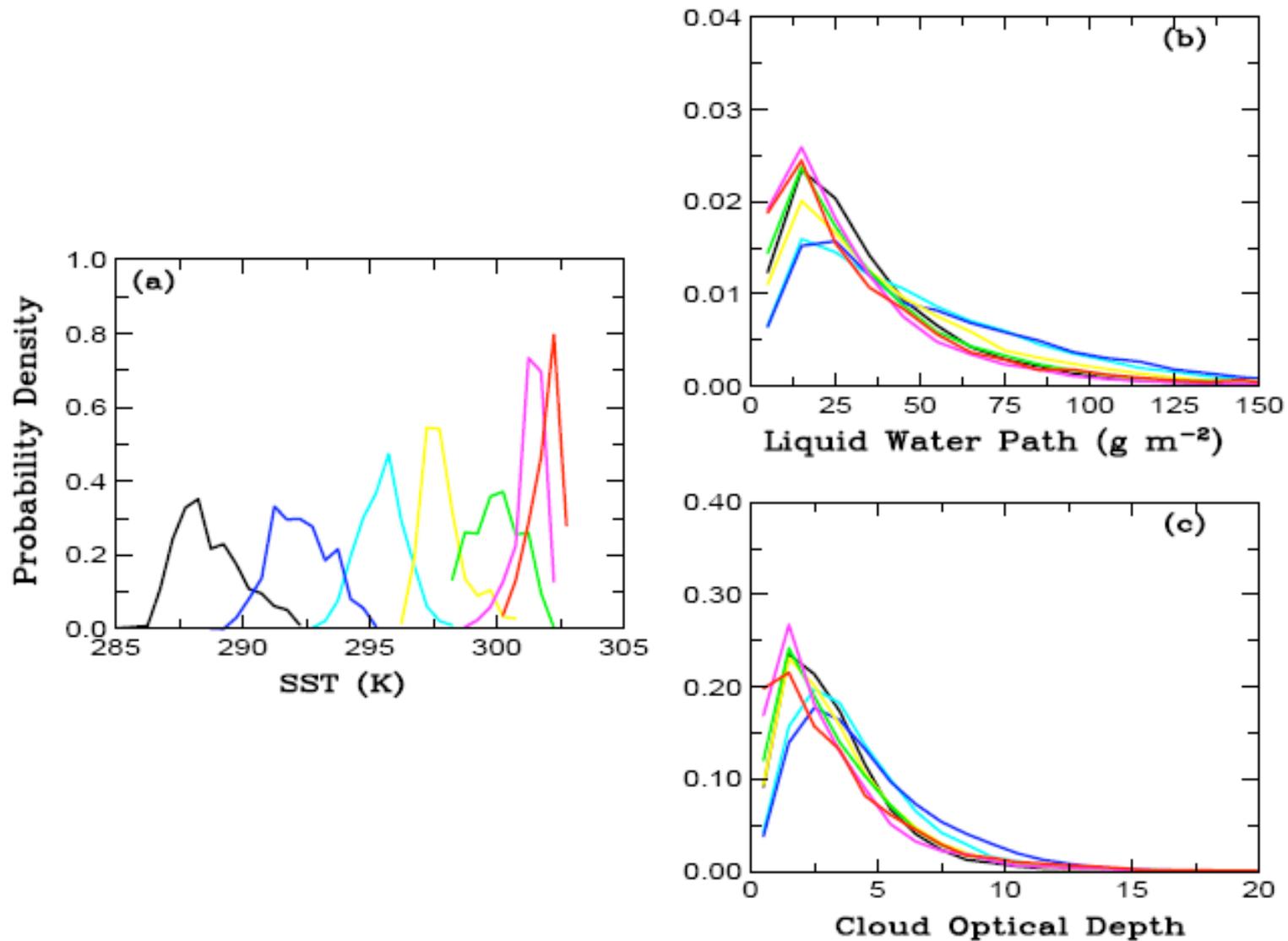
# The GCSS Pacific Cross-Section Stratus (2)



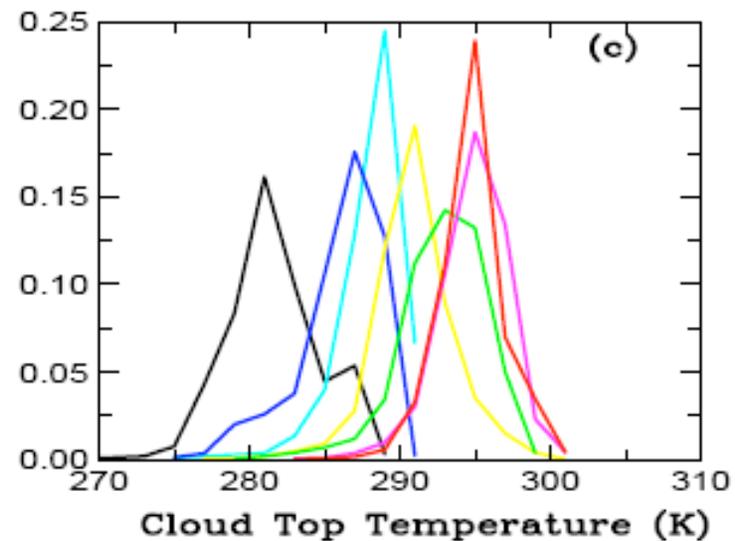
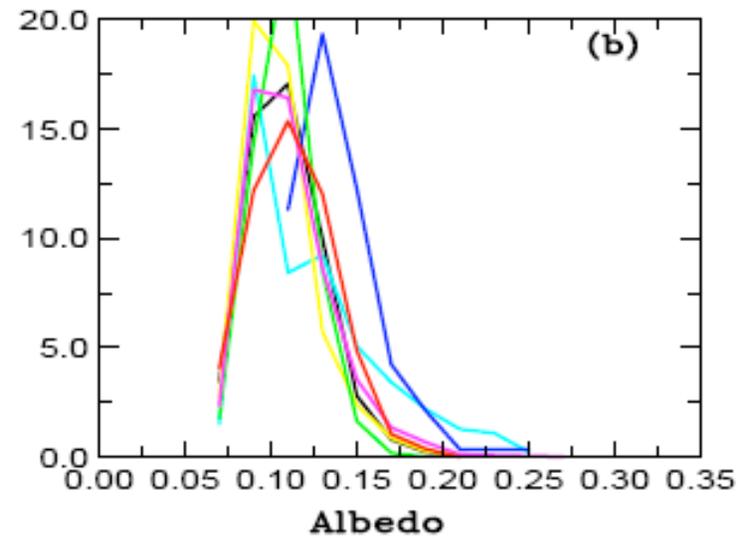
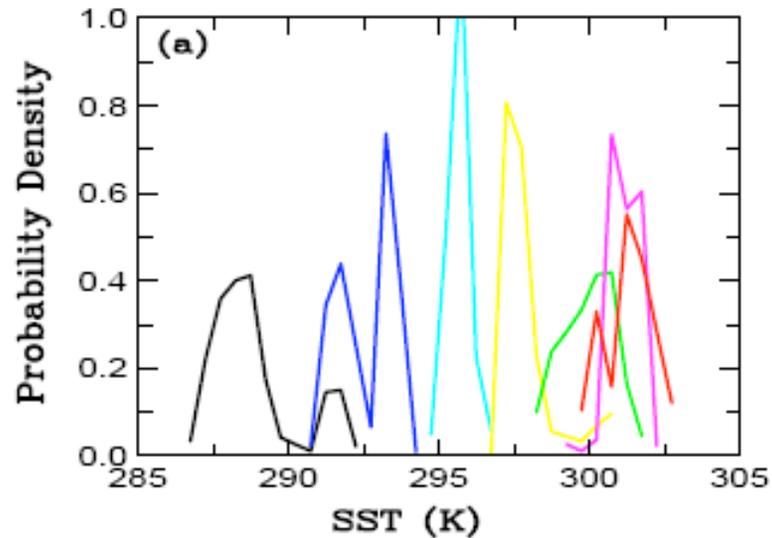
# The GCSS Pacific Cross-Section Stratocumulus (1)



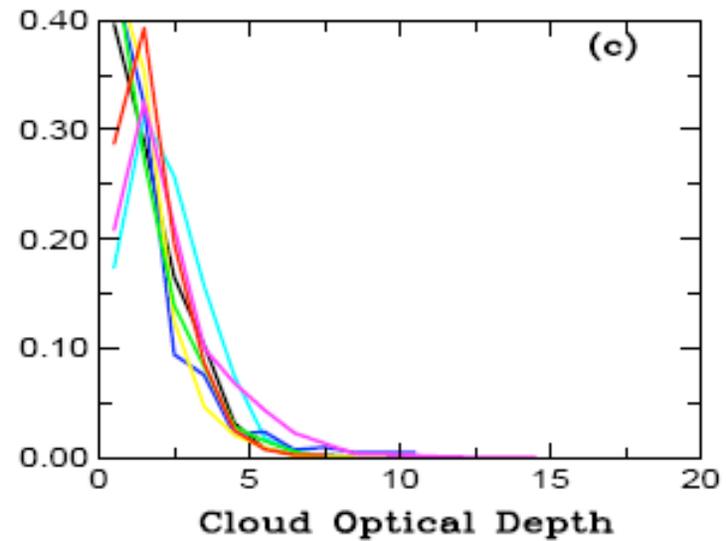
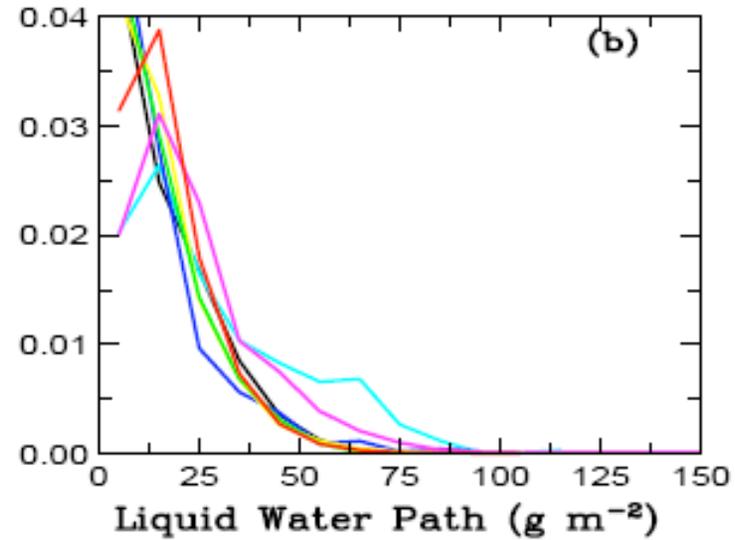
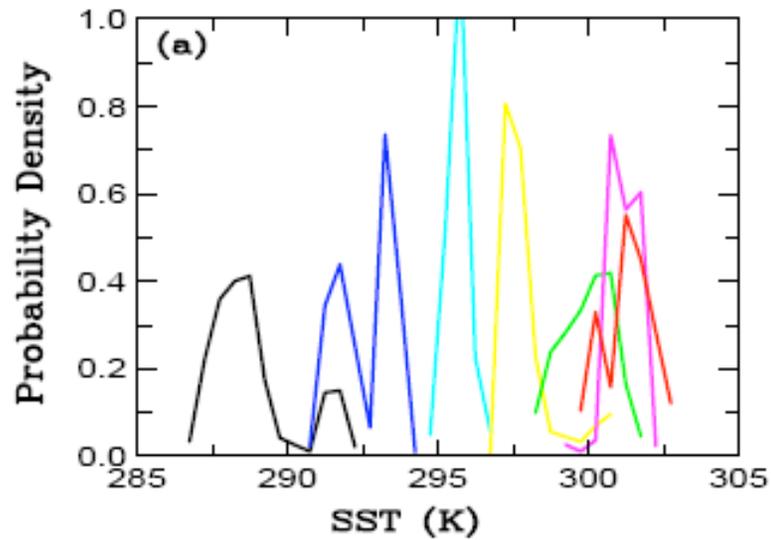
# The GCSS Pacific Cross-Section Stratocumulus (2)



# The GCSS Pacific Cross-Section Cumulus (1)



# The GCSS Pacific Cross-Section Cumulus (2)

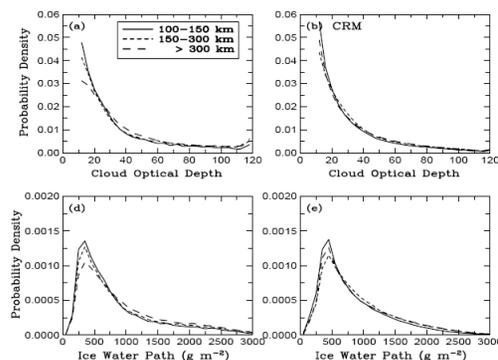


# Summary and Future Plans, 1

- **Stratocumulus** clouds dominate the total BL cloud population in all regions. **Stratus** clouds are more prevalent in the subtropics and near the coastal regions while **cumulus** clouds are relatively prevalent over open ocean and south subtropics.
- For all four regions in the Pacific, summary histograms of cloud physical properties are very different among the **three cloud-object types** although cloud top temperature and droplet radius differ less.
- For a given cloud-object type, regional differences in the cloud **macrophysical** properties (e.g. cloud top temperature) are significant although those of cloud **microphysical** properties (ex. droplet radius) and TOA albedo differ less; differences in the SST *cannot* explain these differences.
- For the GCSS Pacific cross section, differences from one  $5^\circ \times 5^\circ$  grid box to another are significant for all cloud properties.

# Summary and Future Plans, 2

- Further categorize the observed cloud objects according to matched atmospheric state to better understand the regional differences.
- Run CRM simulations for boundary-layer cloud objects
- Compare the simulation of GCSS Pacific cross section from ECMWF data with the satellite observations
- The data product is available at <http://cloud-object.larc.nasa.gov/>



# UCLA/LaRC CRM Simulations of Deep Convective Cloud Objects

