An analysis of satellite data for studying deep convective cloud feedbacks

Zachary A. Eitzen, SSAI, Kuan-Man Xu, and Takmeng Wong, NASA-LaRC
http://cloud-object.larc.nasa.gov

1. Cloud object data

The cloud object data were taken from CERES-TRMM, over Jan-Aug 1998. Each deep convective (DC) cloud object is a contiguous region of overcast CERES footprints that have cloud top heights of at least 10 km and cloud optical depths of at least 10. The cloud objects in this work were all observed over the Pacific Ocean within 25 degrees of the Equator. In this work, we are also interested in the footprints in the neighborhood defined by a box around the cloud object. We want to know how the DC, non-DC, and overall distributions of cloud properties vary as the size of the cloud object changes, and how these distributions vary as the mean SST of the cloud object neighborhood changes.

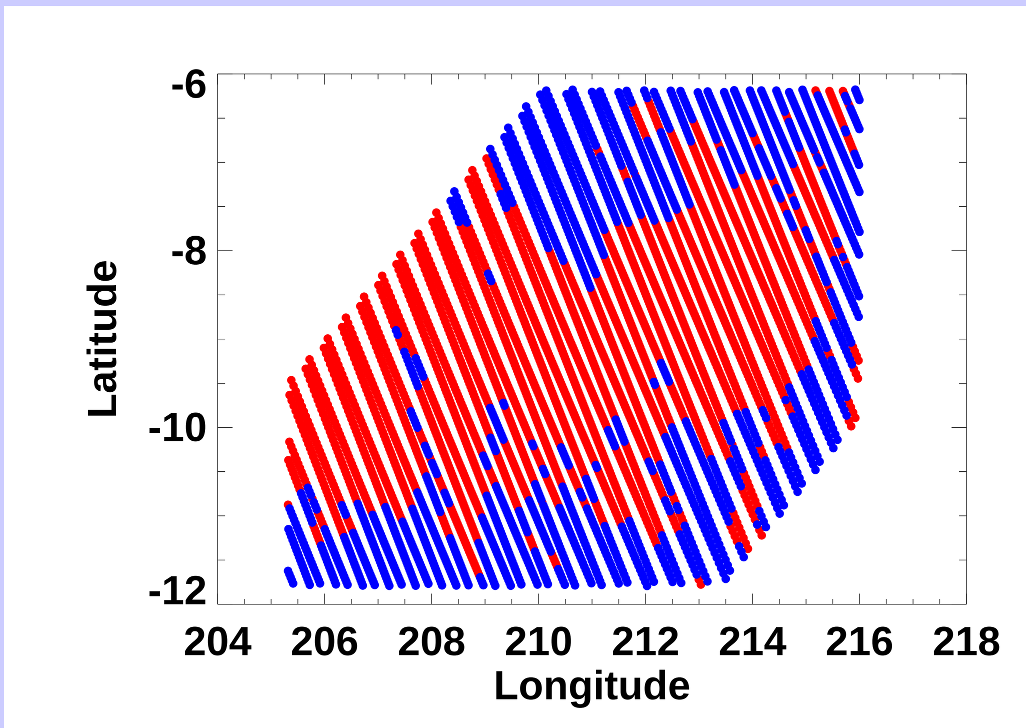

Fig. 1: Example of a cloud object and its neighborhood. The large contiguous red area represents the cloud object, the other red dots represent footprints that meet the DC criteria, and the blue dots are non-DC footprints.

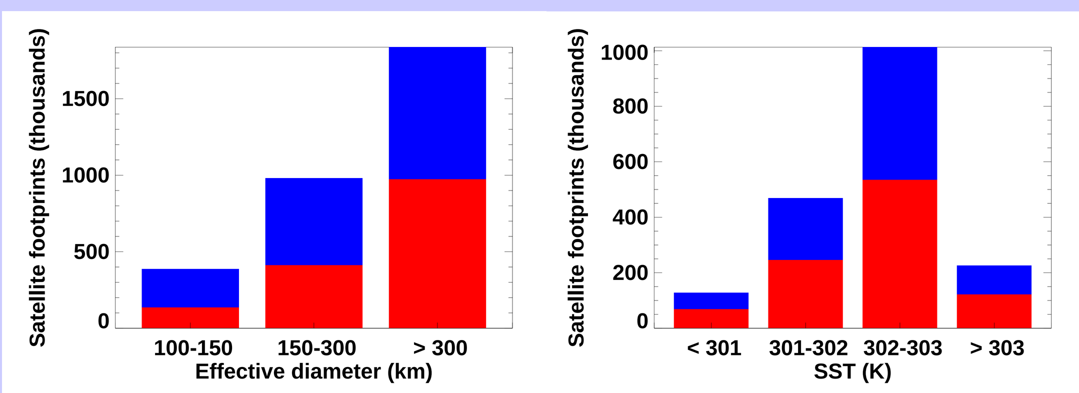

Fig. 2: Number of footprints for (a) each size class and (b) each SST range within the large (> 300 km) size class. DC footprints are denoted by red portion of bars, non-DC footprints by blue portion of bars. The proportion of DC footprints increases from 0.35 to 0.53 with size, but stays nearly constant at 0.53 with SST.

2. Sensitivity to size

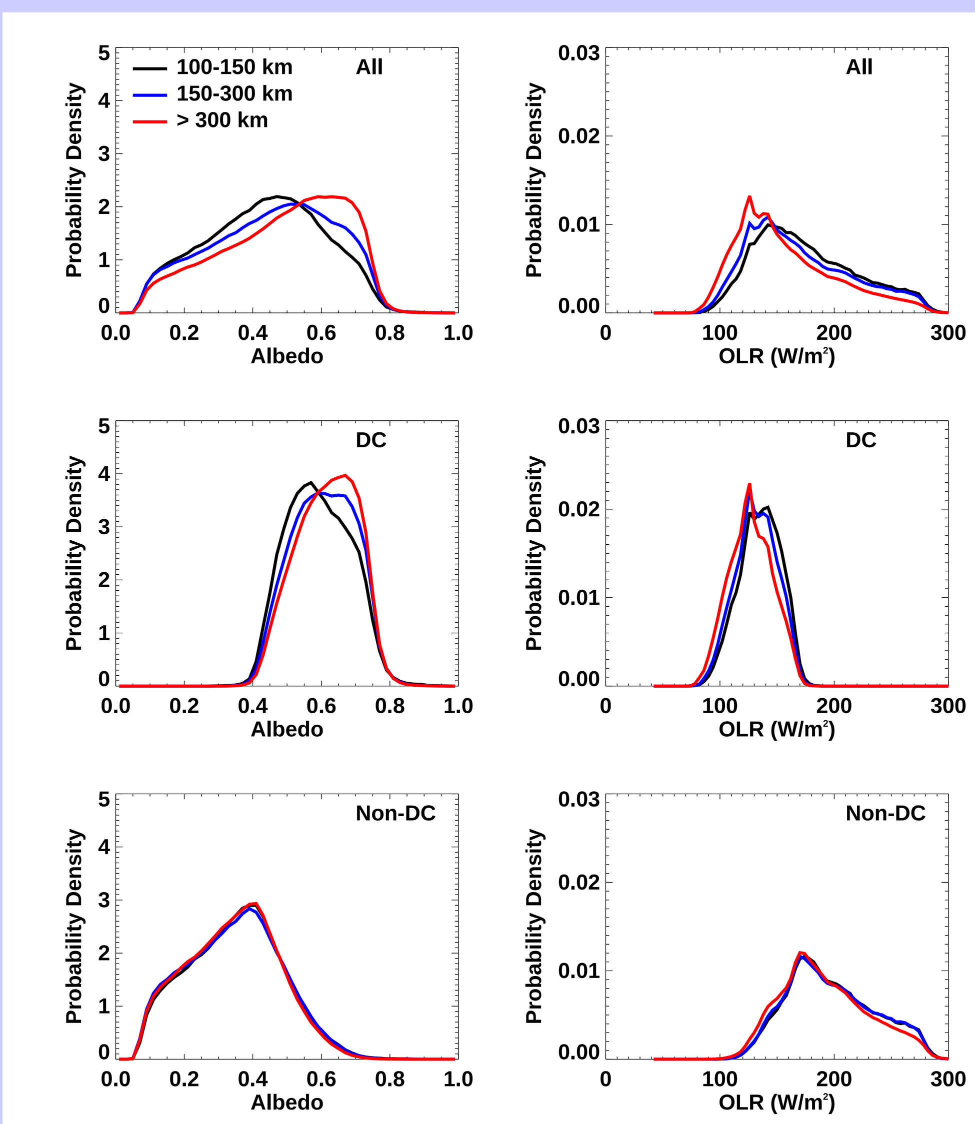

Fig. 3: Distributions of albedo (left panels) and OLR (right panels) for small, medium, and large size classes. Overall (DC and non-DC combined), DC, and non-DC distributions are on the top, center, and bottom panels, respectively.

Summary

- The neighborhoods in which larger deep convective cloud objects occur tend to have higher values of albedo, cloud top height, ice water path, τ, and lower values of OLR, and cloud top temperature. These changes in the overall distributions with size are a combination of changes in the DC distributions (similar to Xu et al. 2007) and an increase in the proportion of DC footprints. The non-DC distributions of these properties change very little with cloud object size.
- As SST increases, the overall distributions of albedo, τ, OLR, and cloud top temperature tend to be shifted towards lower values, while cloud top height increases with SST. The changes in the overall distributions are largely due to changes in the non-DC distributions of albedo and τ, while changes in the DC distributions are important for the other properties. These changes with SST are broadly consistent with the modeling results of Eitzen and Xu (2008).

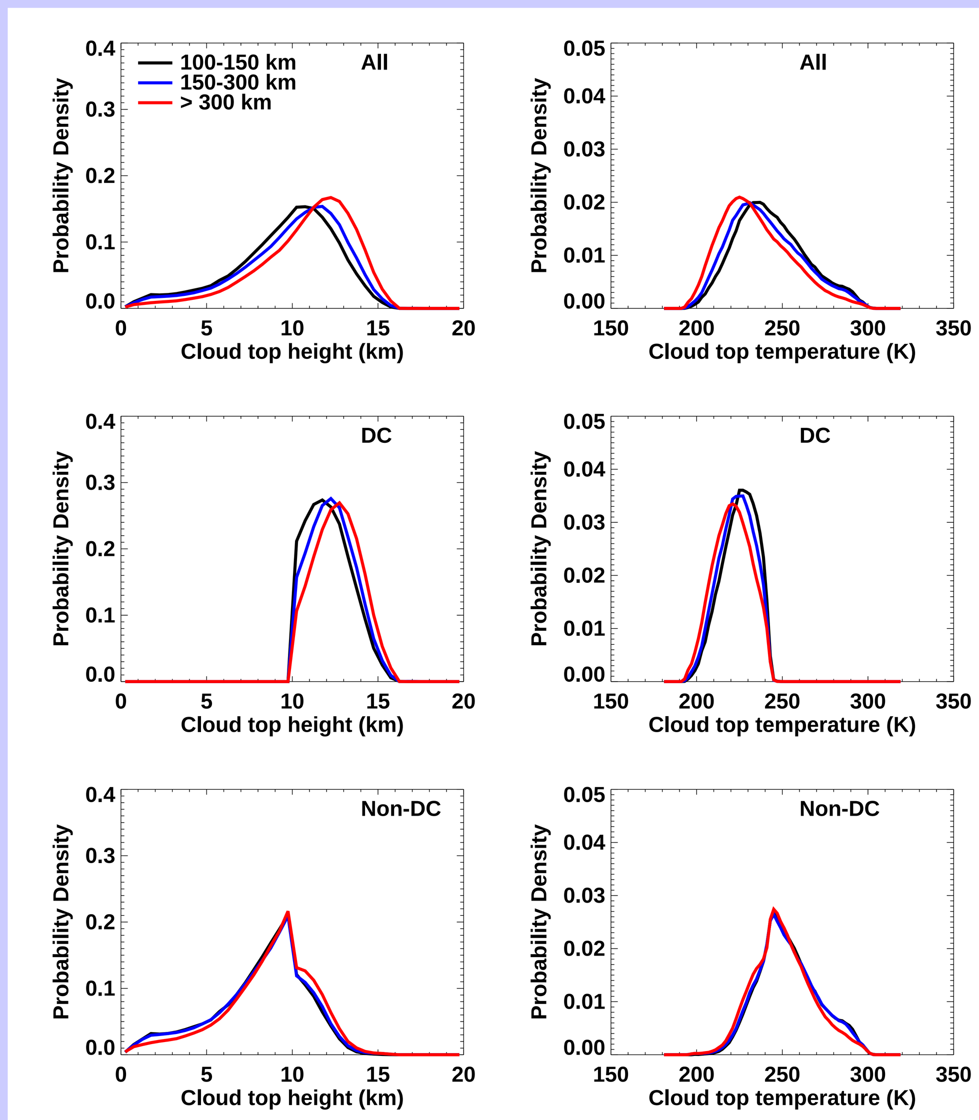

Fig. 4: As in Fig. 3, except for cloud top height and cloud top temperature.

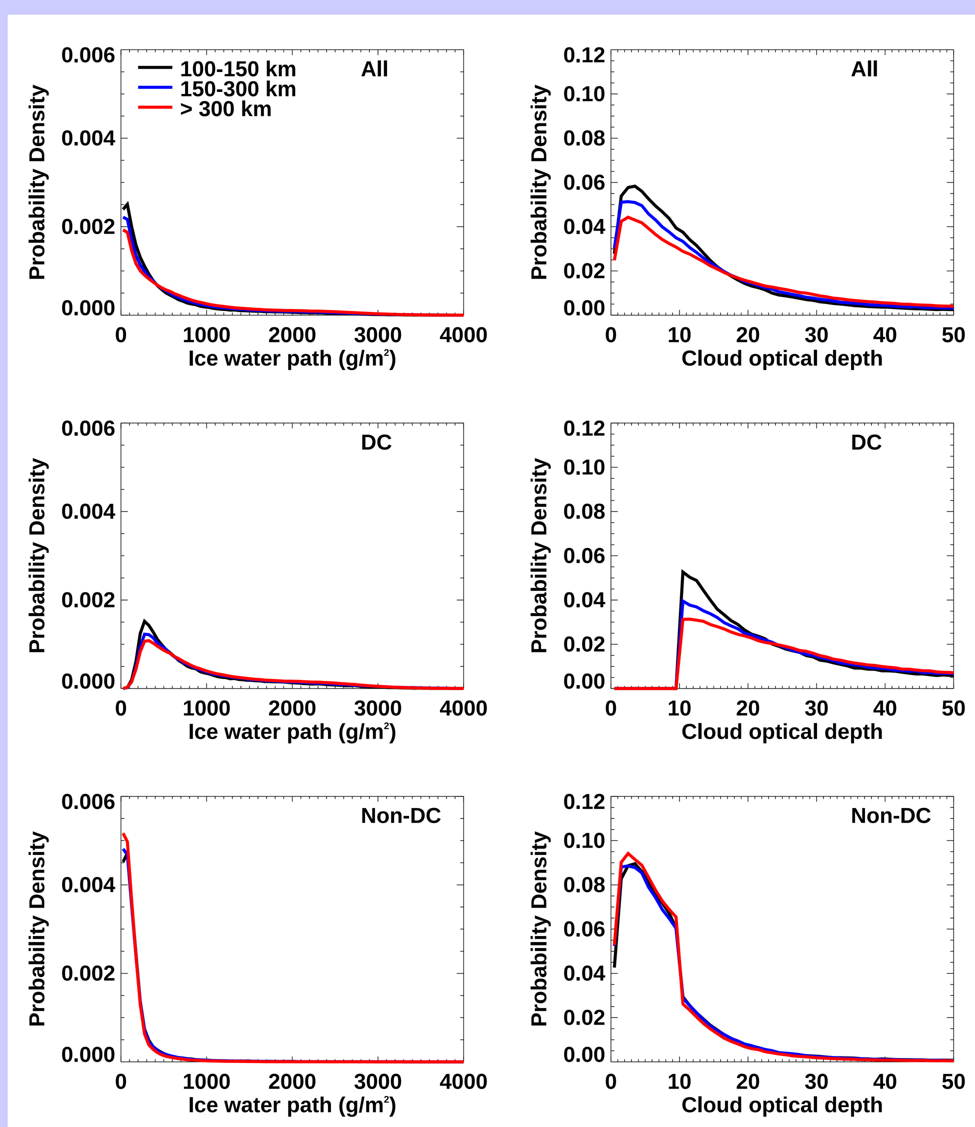

Fig. 5: As in Fig. 3, except for ice water path and τ.

3. Sensitivity to SST

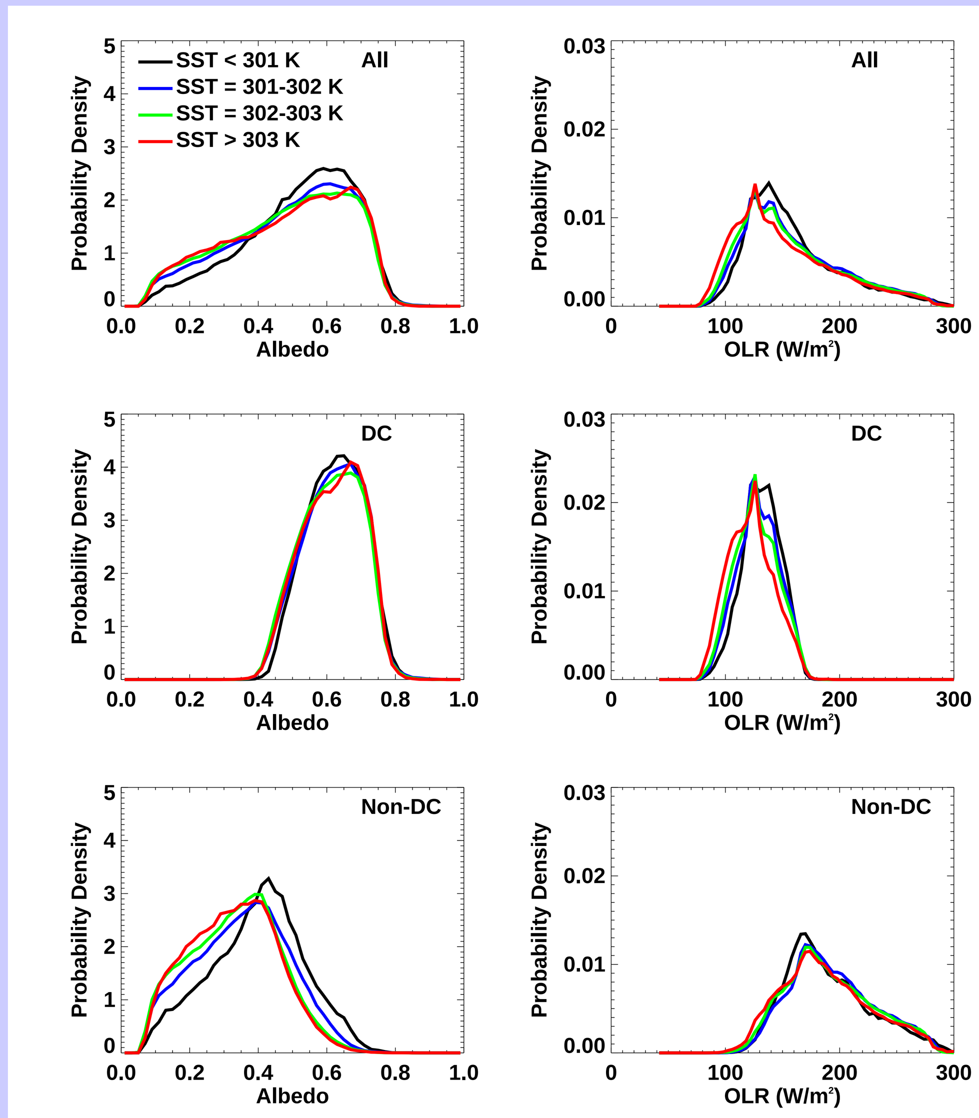

Fig. 6: Distributions of albedo (left panels) and OLR (right panels) for different ranges of SST within the large cloud object class. Overall (DC and non-DC combined), DC, and non-DC distributions are on the top, center, and bottom panels, respectively.

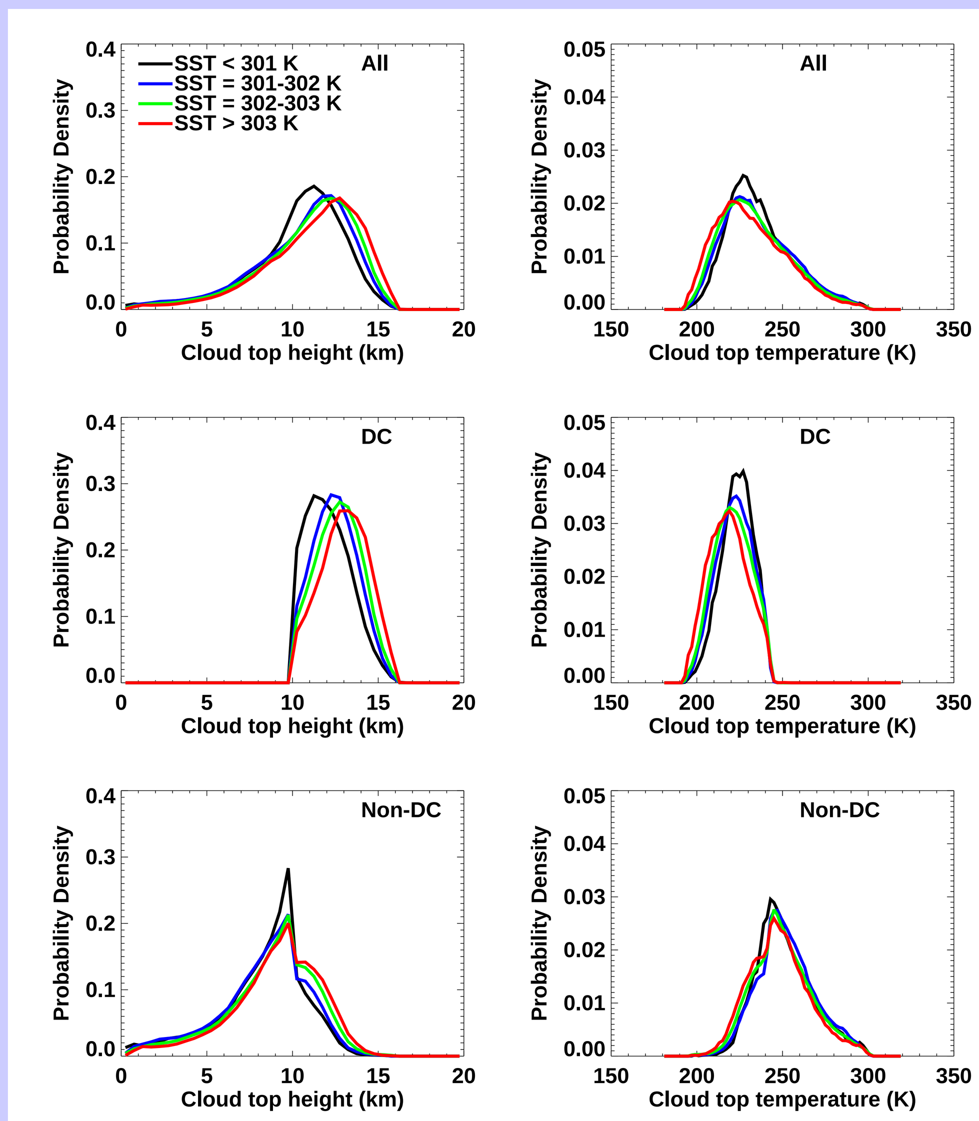

Fig. 7: As in Fig. 6, except for cloud top height and cloud top temperature.

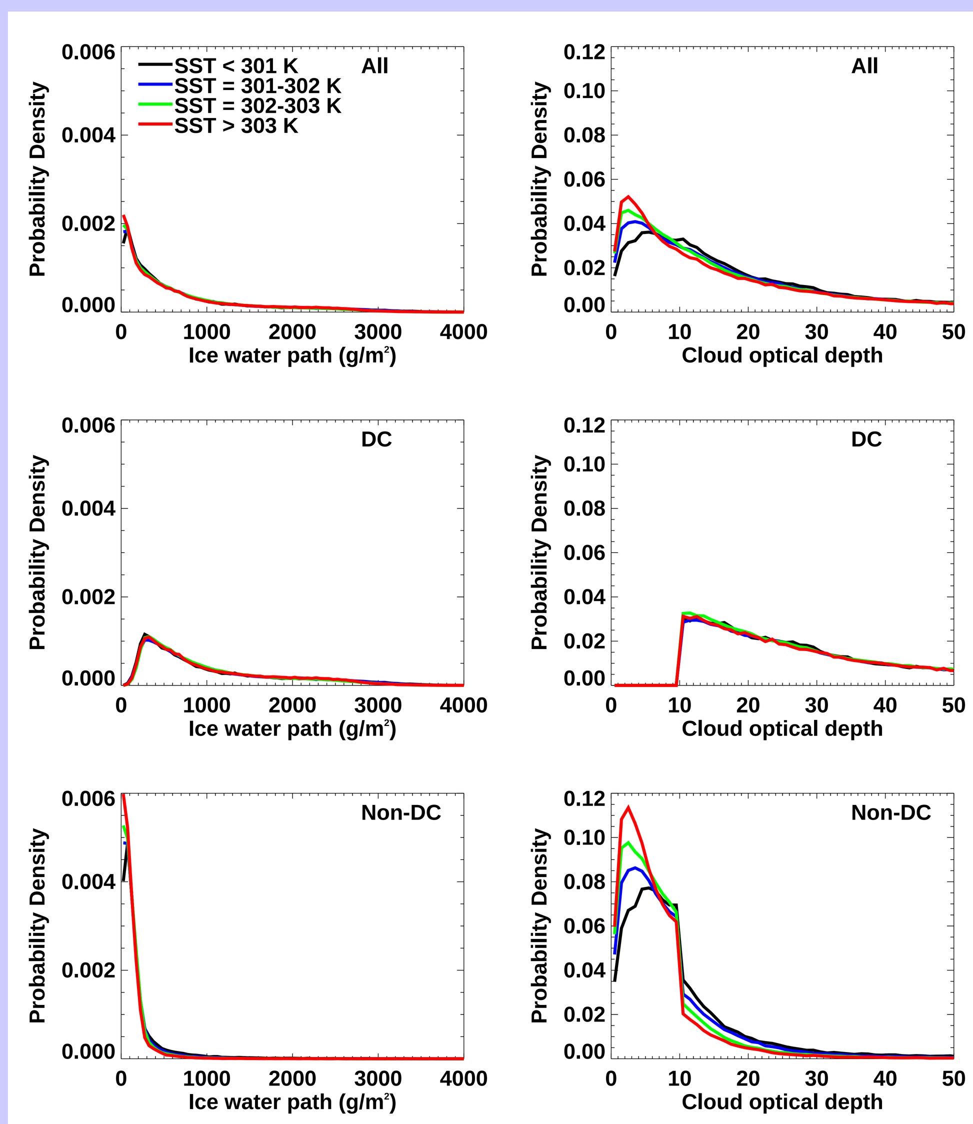

Fig. 8: As in Fig. 6, except for ice water path and τ.

References

Xu, K.-M., and Coauthors, 2007: Statistical analyses of satellite cloud object data from CERES. Part II. *J. Climate*, **20**, 819-842.
Eitzen, Z. A., and K.-M. Xu, 2008: Sensitivity of a large ensemble of tropical convective systems to changes in the thermodynamic and dynamic forcings. *J. Atmos Sci.* (in press)