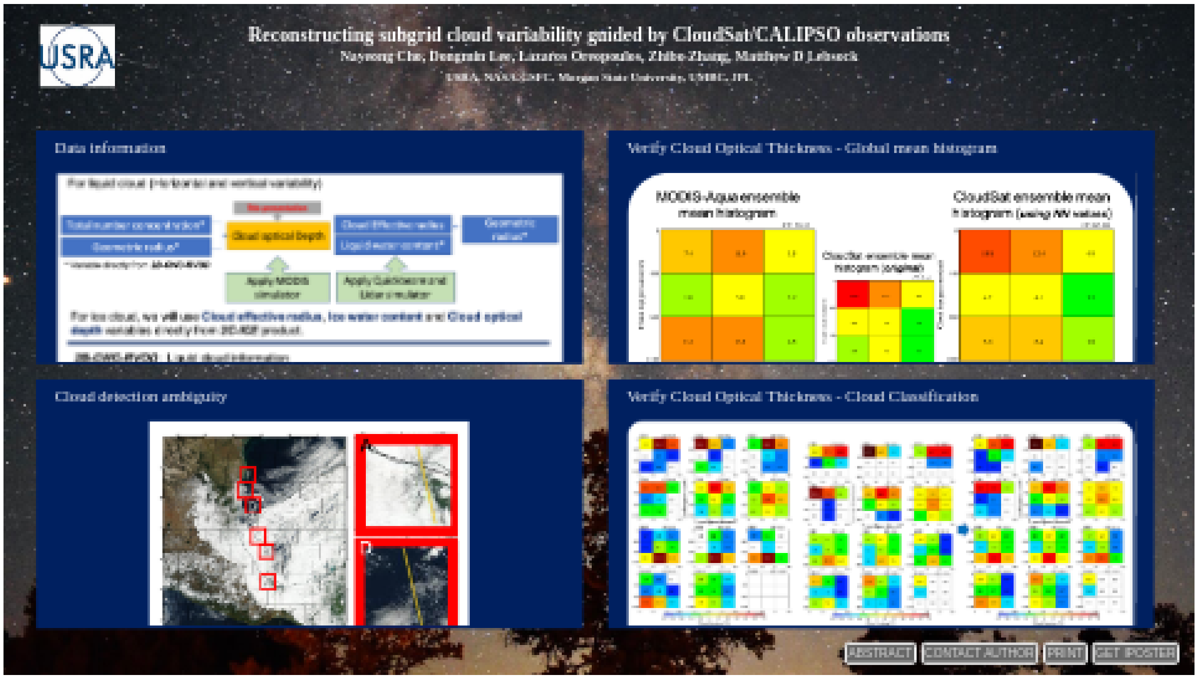
Reconstructing subgrid cloud variability guided by CloudSat/CALIPSO observations



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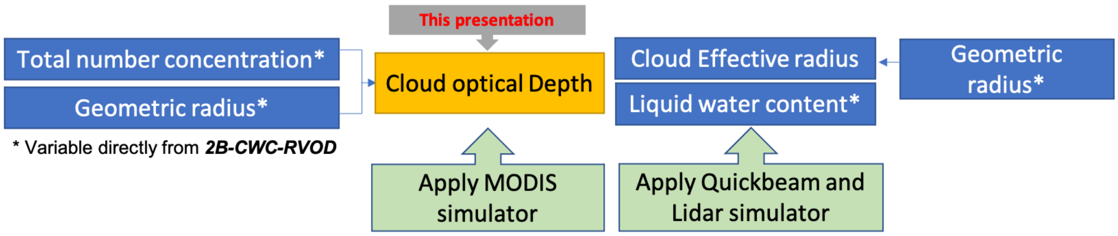
PRESENTED AT:

AGU FALL MEETING
Online Everywhere | 1–17 December 2020

DATA INFORMATION

For liquid cloud (Horizontal and vertical variability)

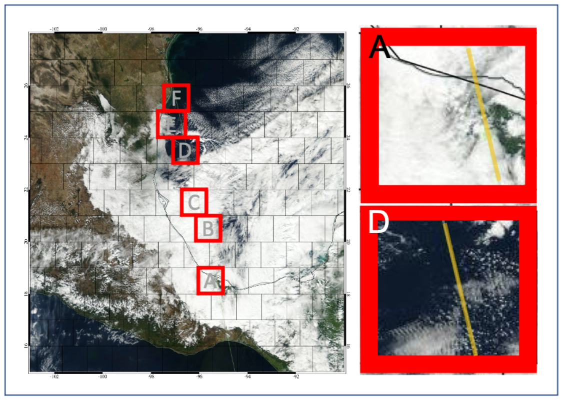


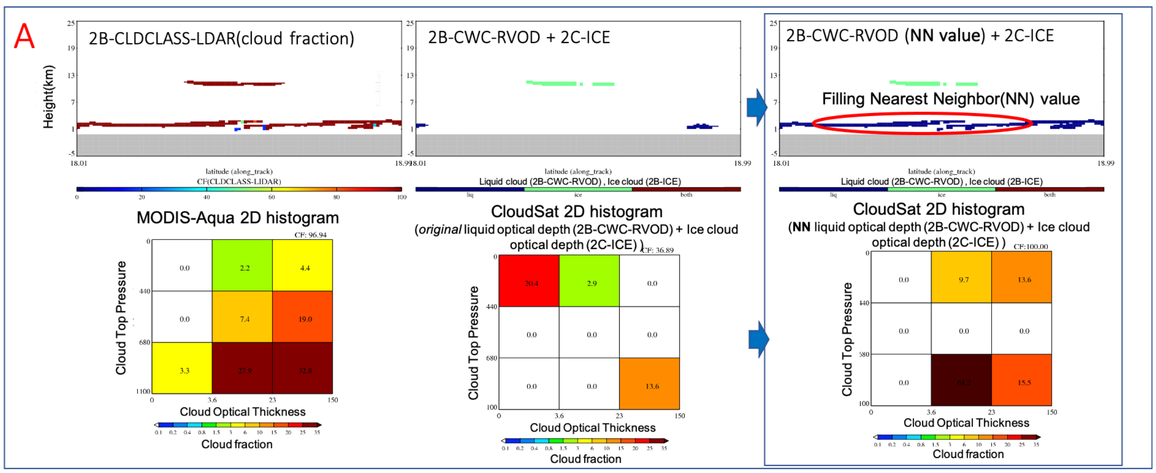
For ice cloud, we will use **Cloud effective radius**, **Ice water content** and **Cloud optical depth** variables directly from ***2C-ICE*** product.

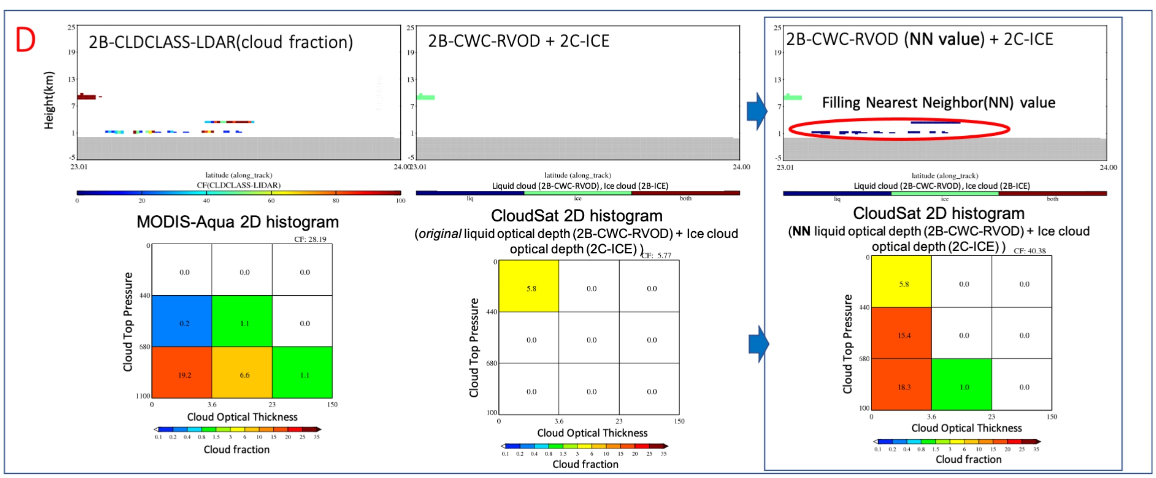
2B-CWC-RVOD : Liquid cloud information
2C-ICE : Ice cloud information
2B-CLDCLASS-LIDAR : Hydrometeor mask and cloud fraction information
ECMWF-AUX : **Cloud Top Pressure** and Variety of meteorological data

Data Period : 2007 Jan

CLOUD DETECTION AMBIGUITY





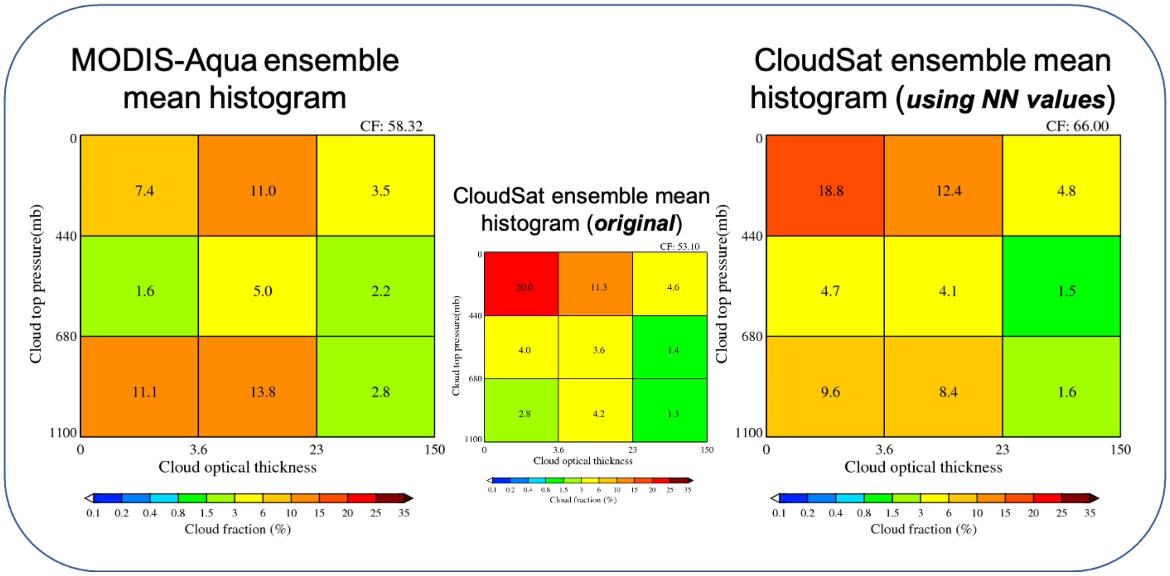


- 2B-CWC-RVOD retrievals are Radar-only, so there are some low thin liquid clouds that the radar misses (*top middle panel for A and D cases*).

- 2B-CLDCLASS-LIDAR includes radar(CPR) and lidar(CALIPSO) information (*top left panel for A and D cases*). Based on mask information at the profile level from 2B-CLDCLASS-LIDAR, we improved 2B-CWC-RVOD low liquid cloud mask using available Nearest Neighbor(NN) values (*top right panel for A and D cases*).

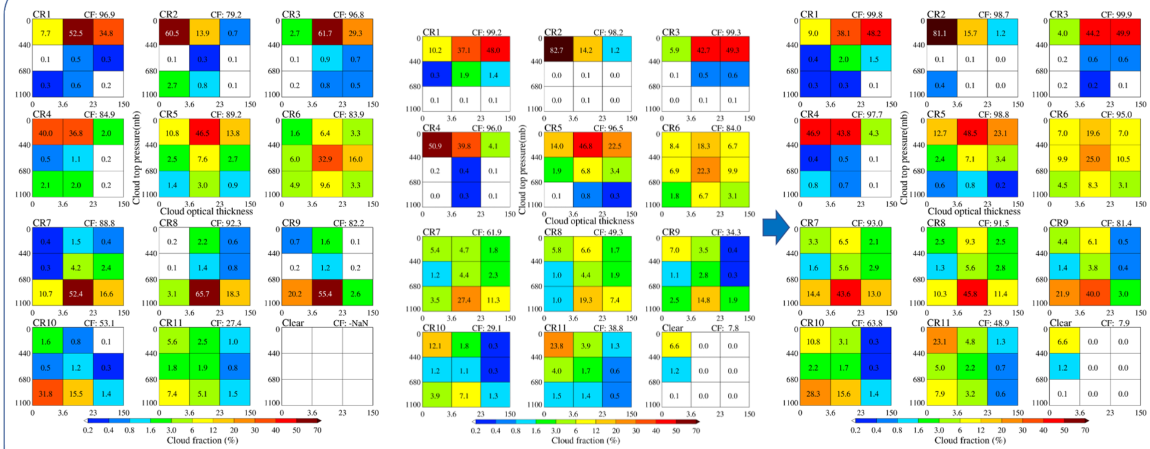
• The agreement of joint histograms (Cloud top pressure vs. cloud optical depth) between
MODIS and CloudSat becomes better (*bottom left and right panels for A and D cases*).

VERIFY CLOUD OPTICAL THICKNESS - GLOBAL MEAN HISTOGRAM



- Improved low and thin cloud frequency

VERIFY CLOUD OPTICAL THICKNESS - CLOUD CLASSIFICATION



Ensemble mean histogram of MODIS-Aqua CR for 2007 year

CloudSat histogram (***original***) composited by MODIS-Aqua CR

CloudSat histogram (***using NN values***) composited by MODIS-Aqua CR

• MODIS Cloud Regimes (CRs) derived from clustering Cloud Top Pressure and Cloud optical thickness histograms *(left panel)*. [See more analysis, click (/Default.aspx?s=BB-39-C4-86-71-44-A5-52-DB-2F-97-33-AE-36-01-7F)]

• Low Liquid cloud regimes (CR7-CR11, *right panel*) results will improve agreement with MODIS CRs (*left panel*) than original CloudSat histogram composition (*middle panel*).

• We expect that simulator results get improved as well using NN filled hydrometeor variability from CloudSat/CALIPSO.

ABSTRACT

Predicting realistic cloud subgrid variability remains a challenge for Global Climate Models (GCMs) even though it can play an important role for proper representation of processes pertaining to cloud microphysics, precipitation, and radiation, but also for comparisons with satellite observations which are of much higher resolution than model grids. The diagnostic approach of subgrid cloud variability is commonly handled by subcolumn cloud generators. For a specific GCM, one ideally wants the subgrid variability used for comparisons with satellite observations to be created by the same generator and with the same rules as the one used for model integration. With this in mind, we have embarked in an effort to test and improve cloud subcolumn generators appropriate for GCMs. For this purpose, we use cloud (hydrometeor) products from active observations by the CloudSat radar (CPR) and the CALIPSO lidar (CALIOP). Cloud products from active sensors while suffering significant sampling and coverage drawbacks have the advantage of resolving both horizontal and vertical variability.

The main question is: given a profile of cloud condensate mean and variance, can we create a subgrid cloud field that is statistically similar to the observed subgrid cloud field? By “statistically”, we suggest that we do not aspire to reproduce “well” each individual subgrid cloud field of a GCM-scale region, but that our generator performs well for a large ensemble of cases. We simulate radar, passive imager, and radiation flux fields from the observed 2D cloud fields and create one-point statistics; we use the profiles of cloud condensate mean and variance as input to the generator to create subgrid cloud fields; we compare the statistics; we adjust the rules of the generator to create the best possible agreement between the radar, imager and radiation field statistics. In this process, the active observations have actually a dual role: they provide the actual subgrid cloud field which can be reduced to a profile of mean and variance used by the subcolumn generator, but they also provide the rules needed by the generator, such as measures (e.g, decorrelation length) of the vertical overlap of cloud fraction and of the condensate horizontal variability. This presentation will show our progress using Cloudsat and CALIPSO products in this dual fashion.