A comparison of optical properties, precipitation characteristics, and vertical profiles for three mesoscale cloud morphology classifiers

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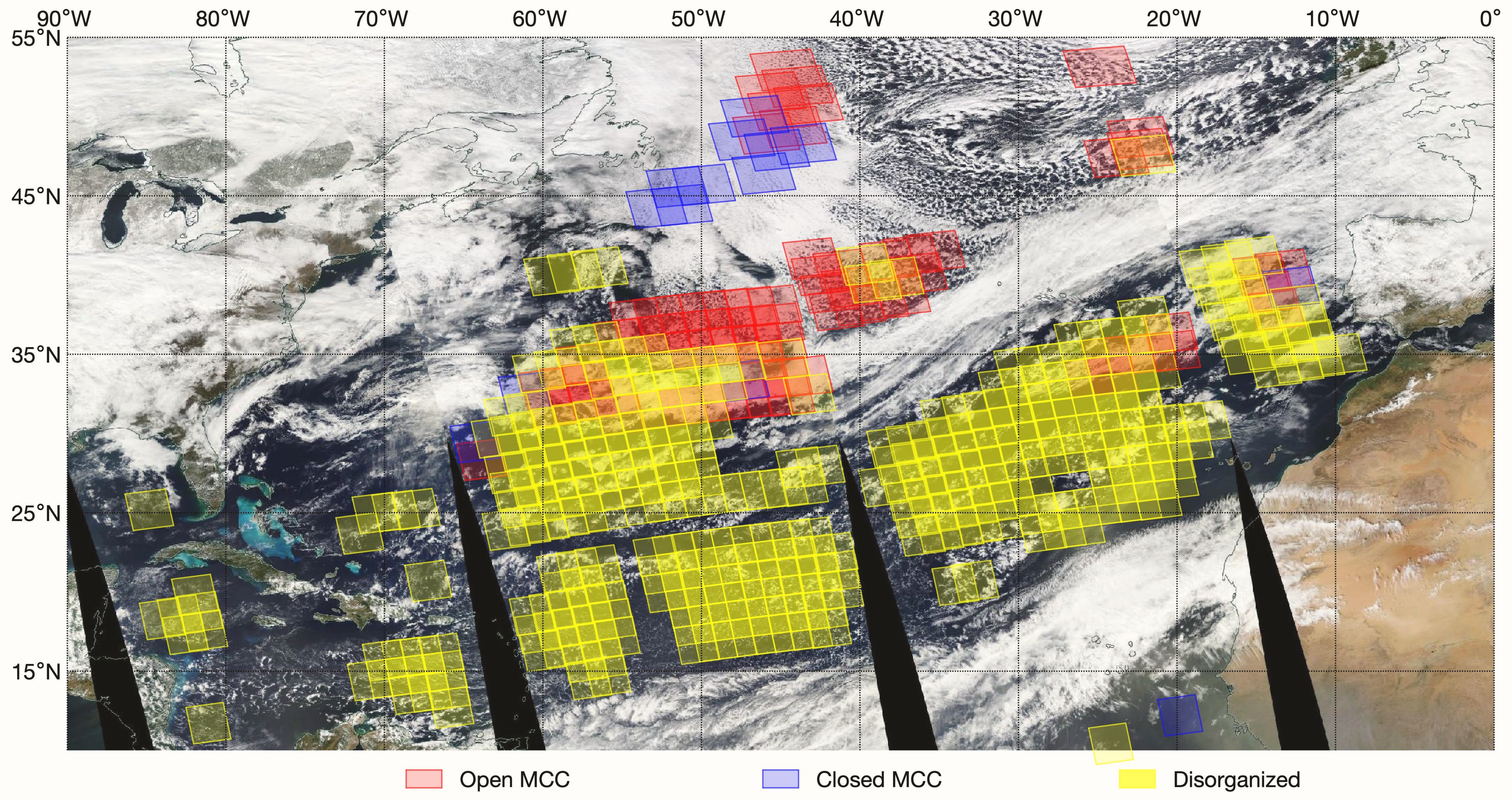
1. Classifying Cloud Organization

We compare three routines that apply human-trained machine learning techniques to classify cloud organization. Classifier output is compared for the North Atlantic MODIS cloud field on February 14th, 2018. These routines are trained in different regions by different human 'classifiers', motivating a comparison.

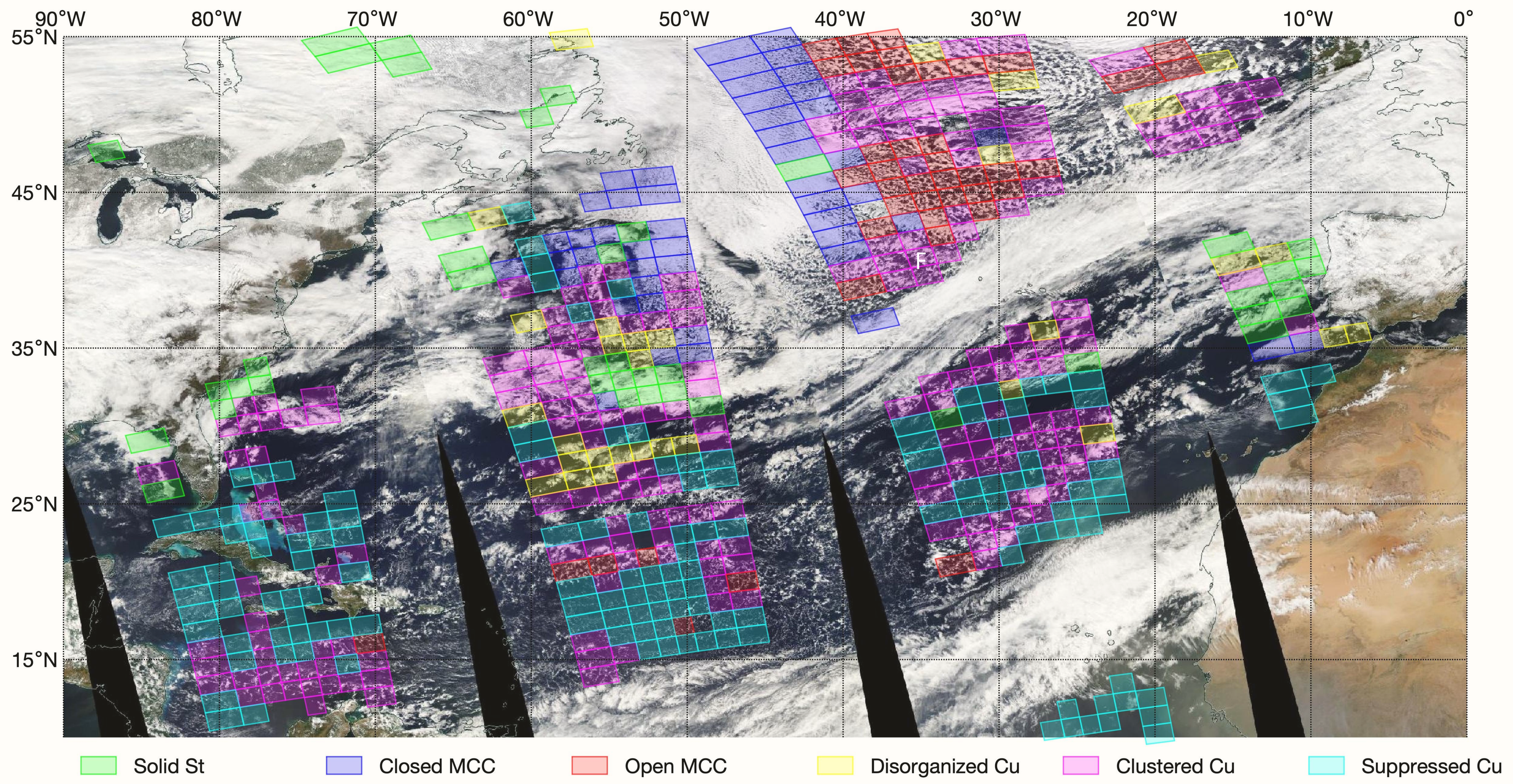
a) Mesoscale Cellular Convection (MCC). Wood & Hartmann (2006), McCoy et al (2017):

- 3 Types: Open & Closed Cell MCC, Disorganized
- Using MODIS Aqua Daytime LWP 2003-2018.
- Overlapping 256 km^2 square boxes.
- Trained in subtropical Sc regions.



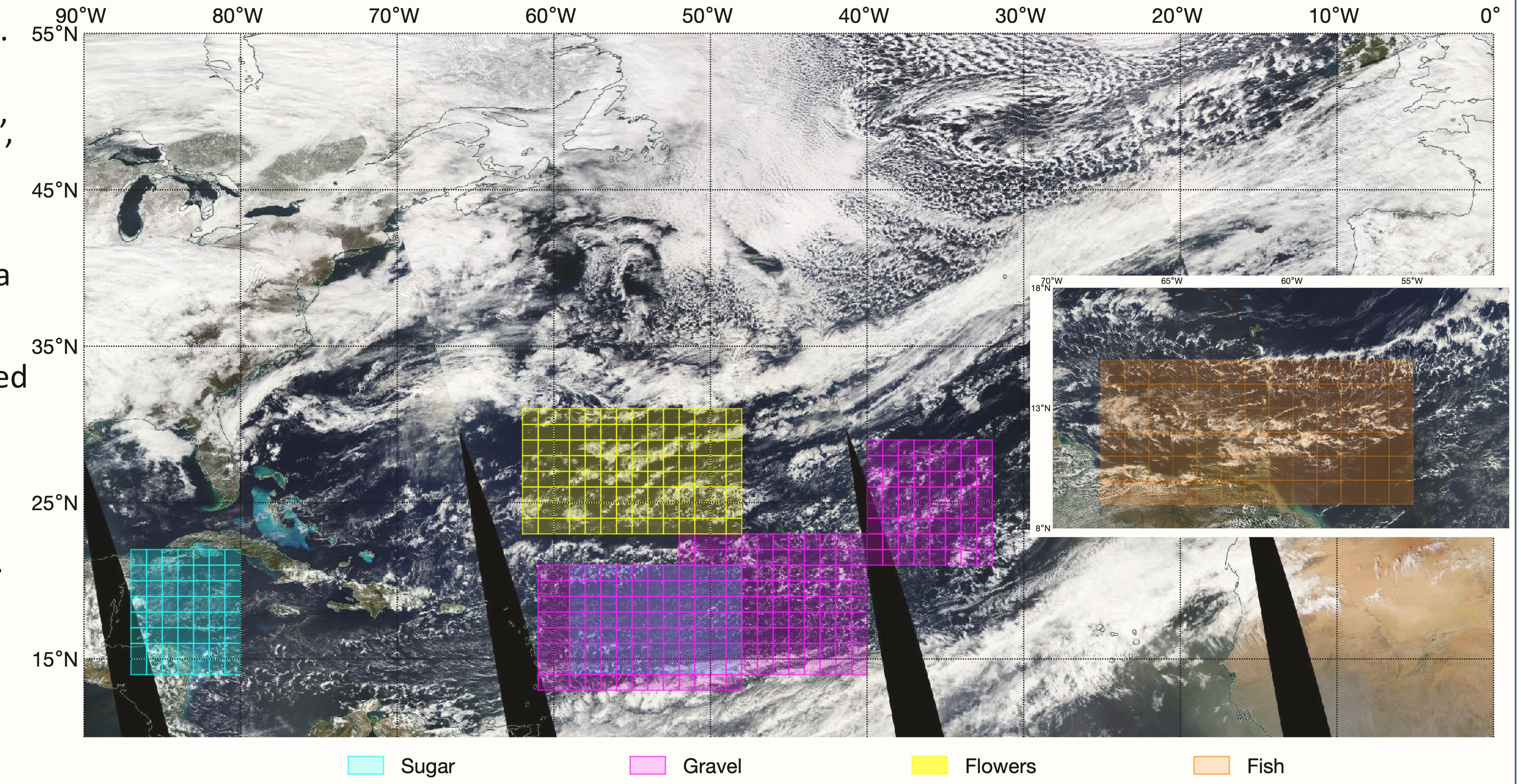
b) NASA MEASURES Yuan et al. (2020):

- 6 Types: Solid St, Open & Closed MCC, Disorganized Cu, Clustered Cu, and Suppressed Cu
- Using several MODIS Aqua daytime products.
- 128 km^2 grid boxes, omitting swath edges.
- Trained globally.



c) SGFF, Stevens et al. (2019):

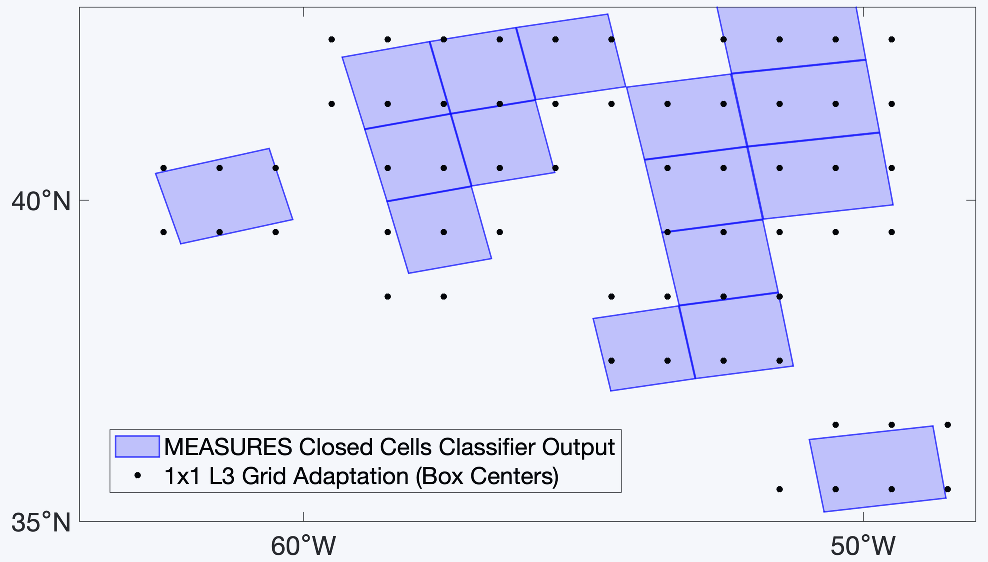
- Four types: 'Sugar', 'Gravel', 'Flowers', 'Fish'
- Using MODIS Aqua visible or IR.
- Large, variable sized boxes, spanning hundreds of km.
- Fish image from January 30th 2018. No 'Fish' were observed on February 14.
- Trained in tropics.

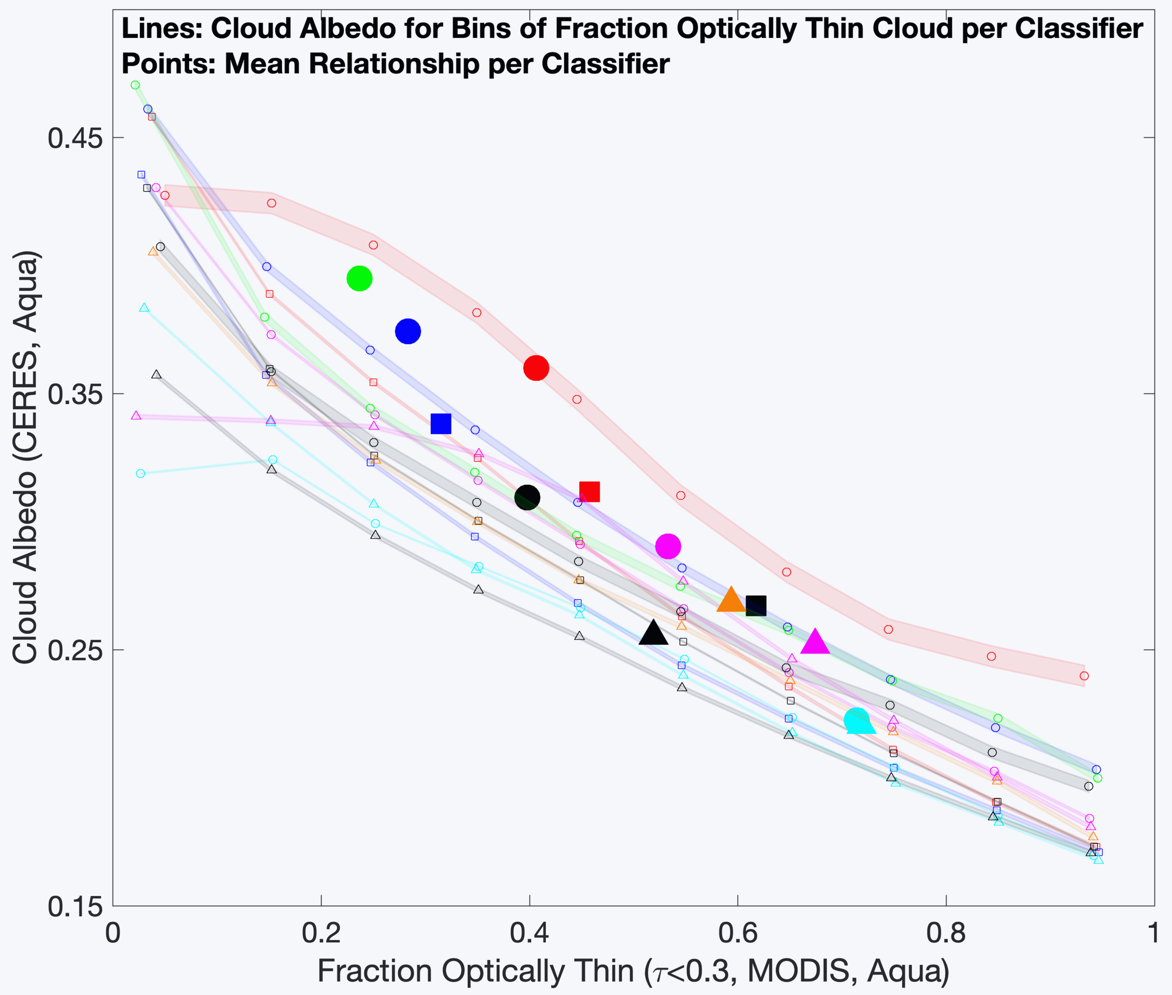


2. Common 1°x1° grid

To compare all three classifiers, we project each onto a 1°x1° latitude-longitude grid.

If any portion of a 1°x1° grid box contains a classified cloud type, that grid box is assumed to represent that cloud type. Grid boxes may contain multiple classifications, allowing for the creation of overlap statistics.





3. Albedo & Optical Thickness

CERES cloud albedo estimates are computed as a function of fraction of optically thin cloud for each cloud type.

Stratiform cloud scenes classified by MEASURES and MCC have the highest albedos, with aggregated Cu or disorganized scenes showing lower albedos, and suppressed Cu clouds showing the lowest albedos

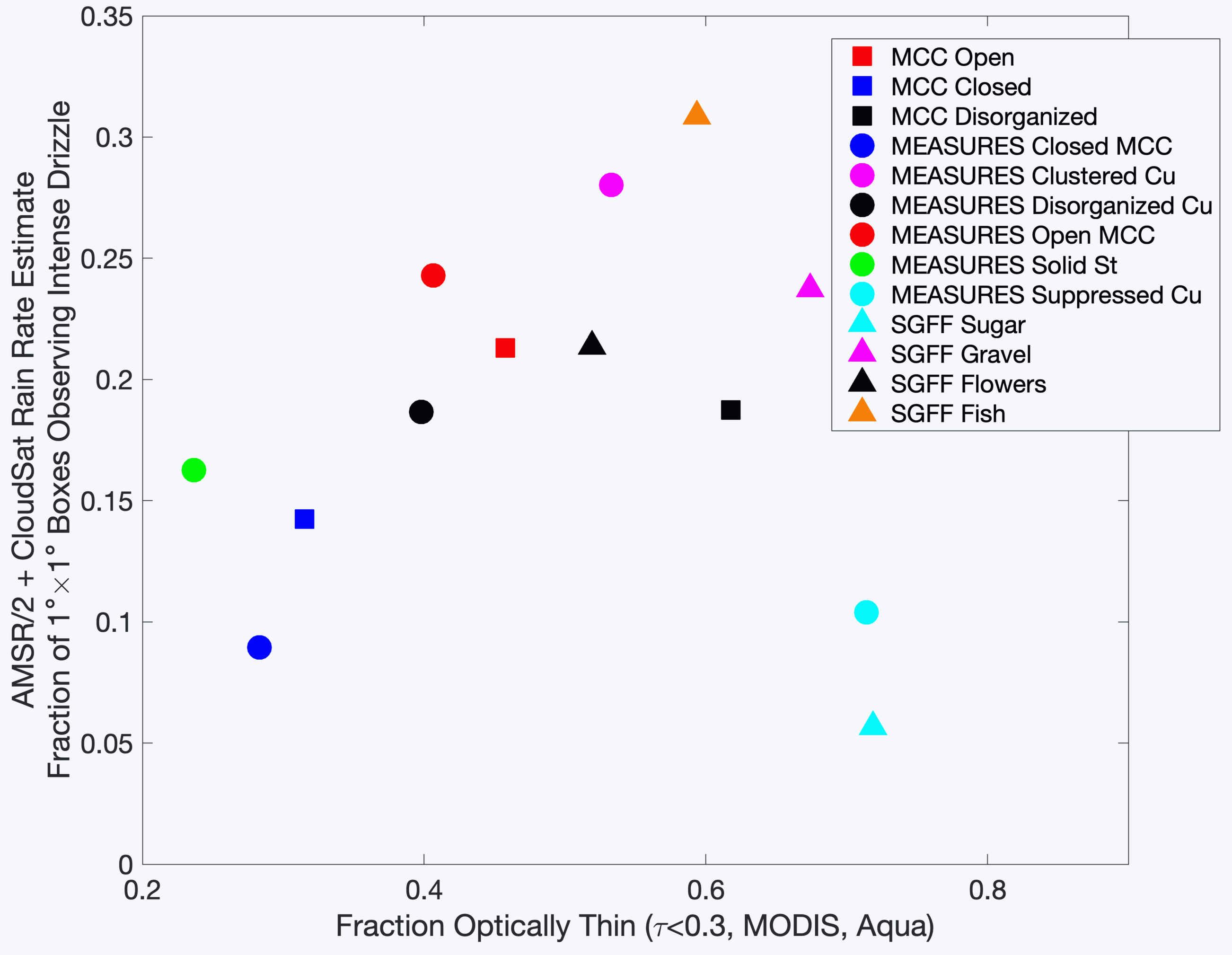
The relationship between the fraction of optically thin cloud cover and albedo differs for each type. This suggests that **radiative cloud properties are in-part dependent on the morphological structure of the cloud scene.**

4. Optical Thickness & Precipitation

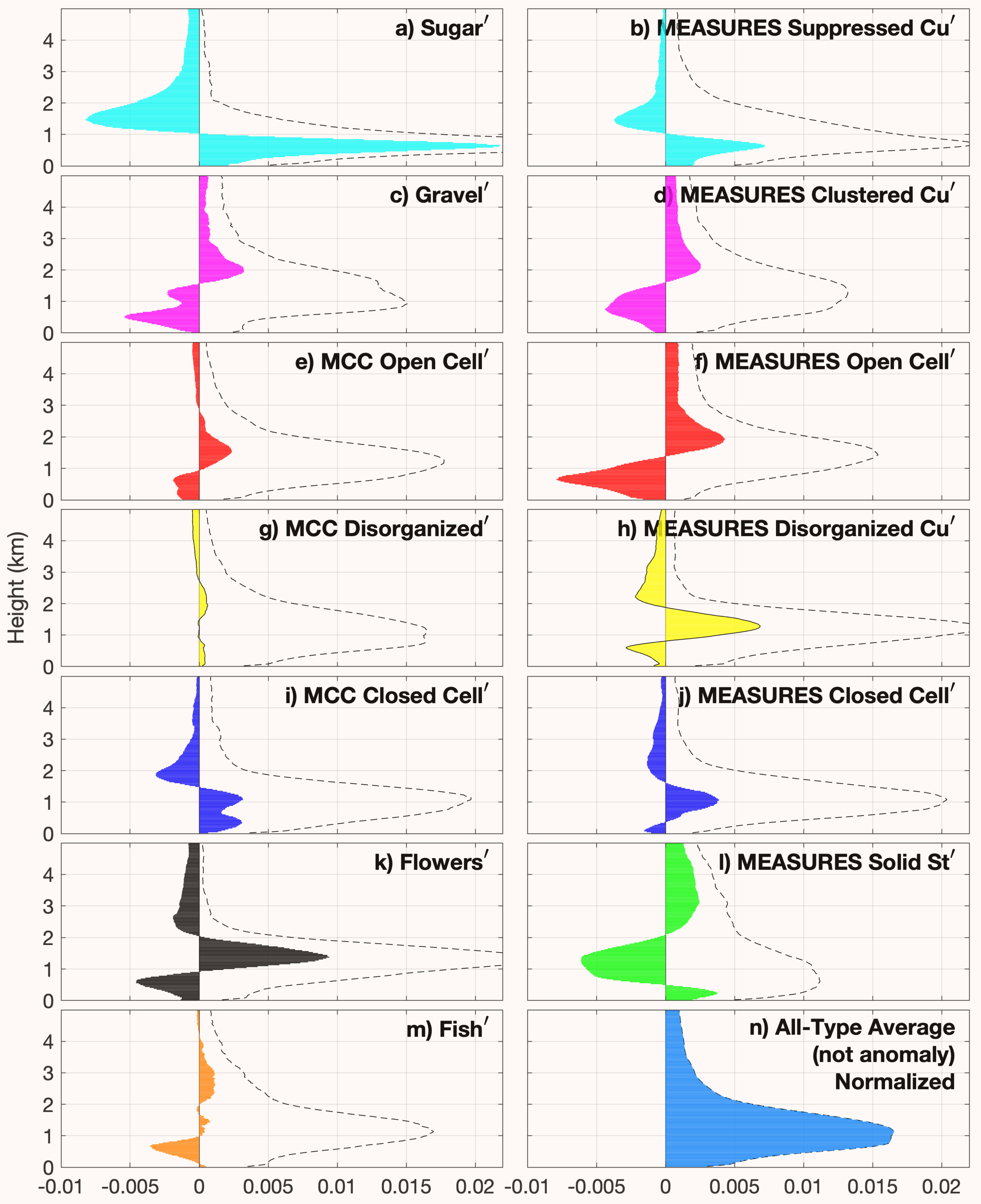
Rain rates are estimated from AMSR/E 89 GHz brightness temperatures, tuned using co-located CloudSat Rain-Profile rain rates. Statistics are compiled for each classified 1°x1° grid box. The fraction of classified boxes showing rain rates above 1 mm/hr is plotted as a function of fraction of optically thin cloud cover per classifier.

Classified types with more frequent intense drizzle are associated with a greater fraction of optically thin clouds, except for suppressed Cu types.

More frequent intense rain is seen for convective types compared to stratiform types



5. CALIPSO LIDAR Vertical Profiles



Dashed Line: Normalized Distrubution of "Cloud" Identifications by CALIPSO VFM,
Color Bars: Anomaly relative to All-Type Average Normalized Distrubution

CALIPSO Vertical Feature Mask profile anomalies are computed in 30m bins by subtracting the mean profile for all types (bottom right) from each types' profile (dashed lines). **Suppressed Cu types and closed cell Sc tend to be lower in height than solid St, open cells, and more developed convection.** MEASURES classifications tend to have slightly more higher-level cloud.

References

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