

Variability of the mesoscale organization of shallow convection over the tropical Atlantic

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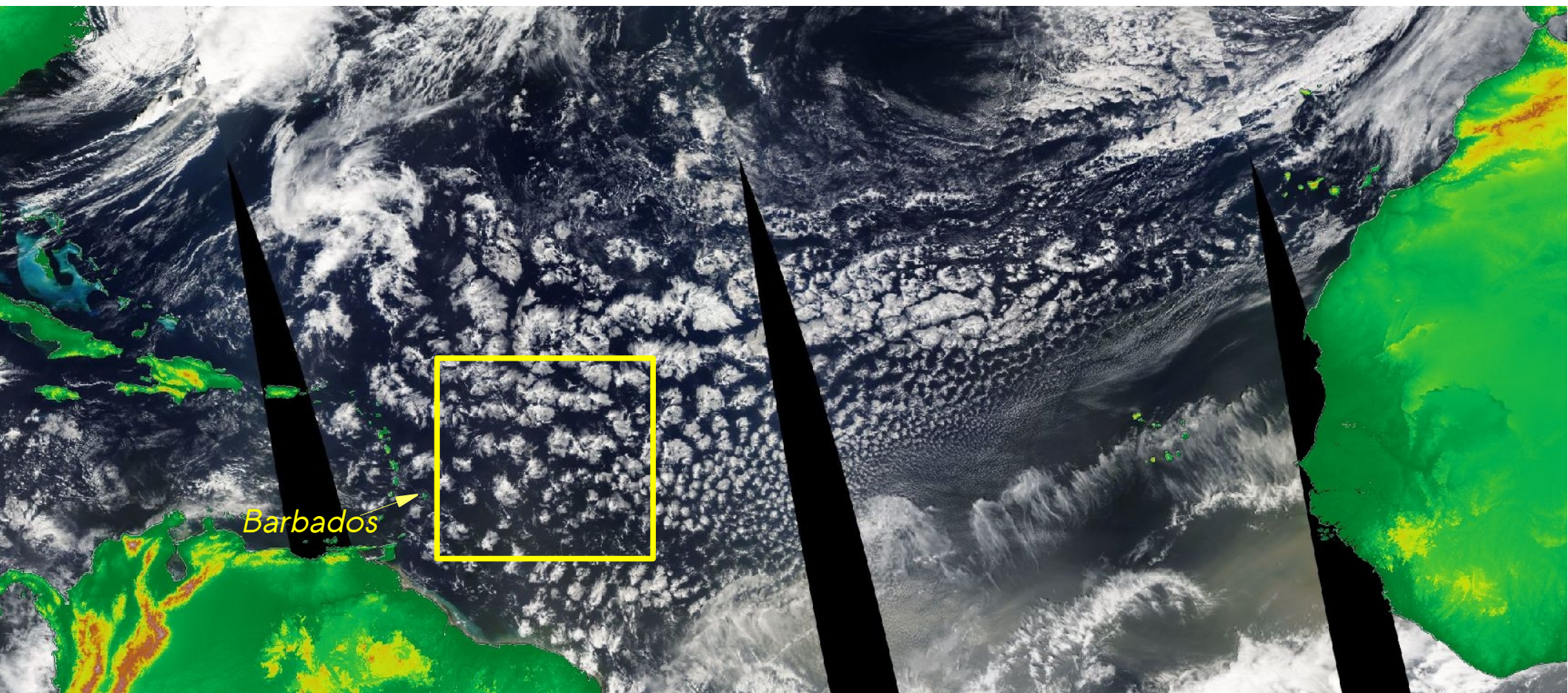
³: University of Wisconsin-Madison, Madison, WI, USA

⁴: ISSI: International Space Science Institute, Bern, Switzerland



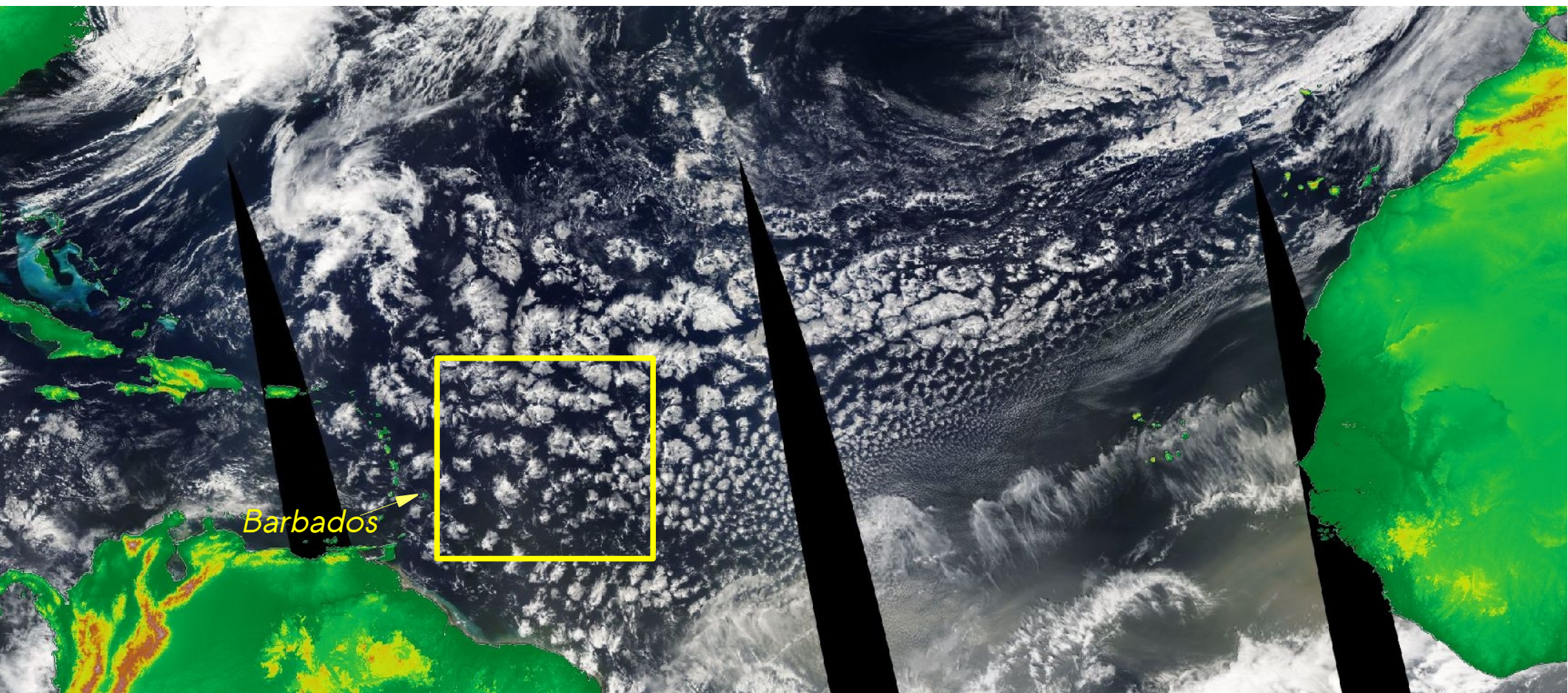
CFMIP, October 2018, NCAR, Boulder

Mesoscale organization of trade-wind shallow clouds during winter



MODIS Aqua 10 Feb 2017 (NASA Worldview)

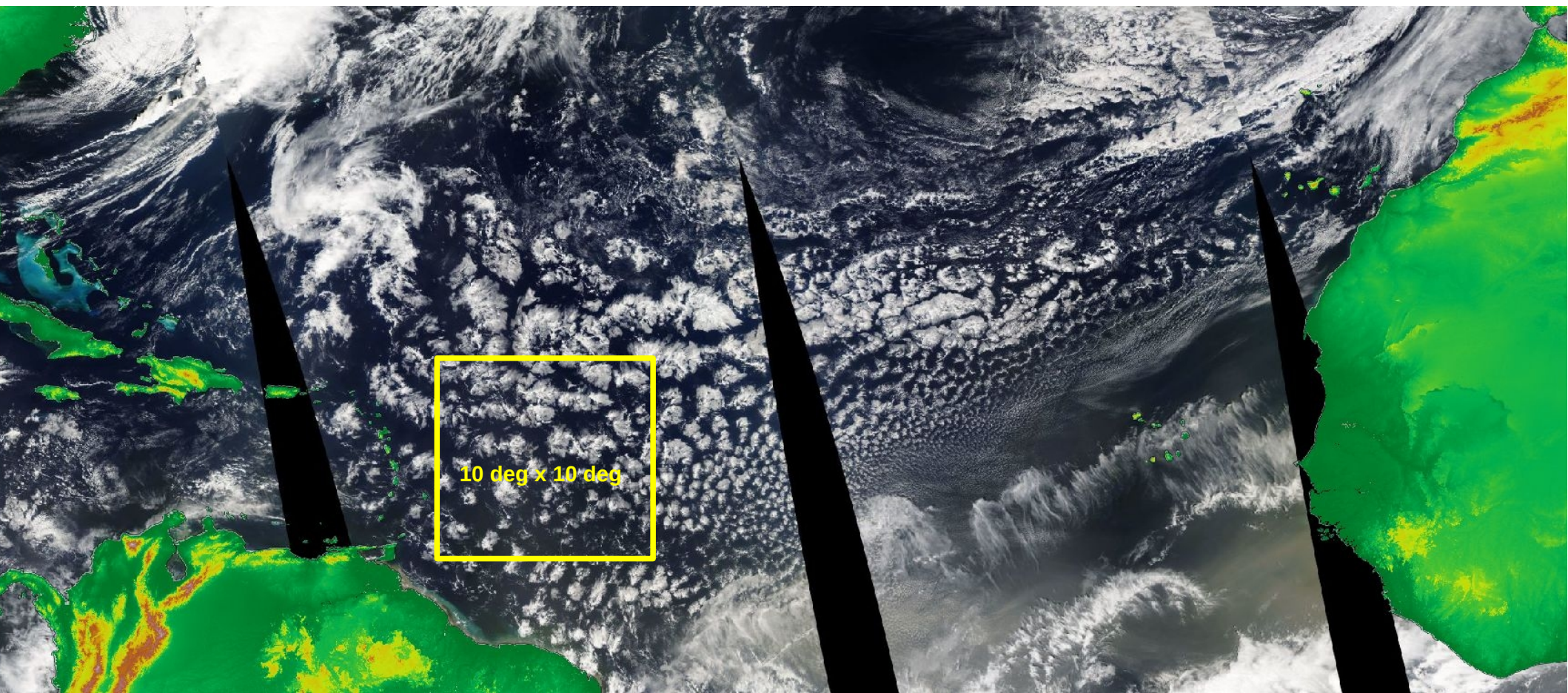
Mesoscale organization of trade-wind shallow clouds during winter



MODIS Aqua 10 Feb 2017 (NASA Worldview)

1. How variable is it?
2. How does it relate to large-scale conditions?
3. Does it matter?

Mesoscale organization of trade-wind shallow clouds during winter



A group of 10 scientists (B Stevens, S Bony, H Brogniez, L Hentgen, C Hohenegger, C Kiemle, T L'Ecuyer, AK Naumann, C Schär, P Siebesma, J Vial, D Winker and P Zuidema) looked at MODIS imagery and classified visually the type of mesoscale organization present in the area (each day of DJF for 10 years, i.e. 900 images, each being analyzed by 5 different persons).

Visual classification of MODIS imagery by a group of scientists

→ 4 main patterns of mesoscale organization

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“Cold pools” (53 %)



200 km

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“Flowers” (16 %)



Visual classification of MODIS imagery by a group of scientists

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“Fish” (17 %)



“Cold pools” (53 %)



“Flowers” (16 %)



200 km

Visual classification of MODIS imagery by a group of scientists

→ 4 main patterns of mesoscale organization

“Sugar” (14 %)



“Fish” (17 %)



“Cold pools” (53 %)

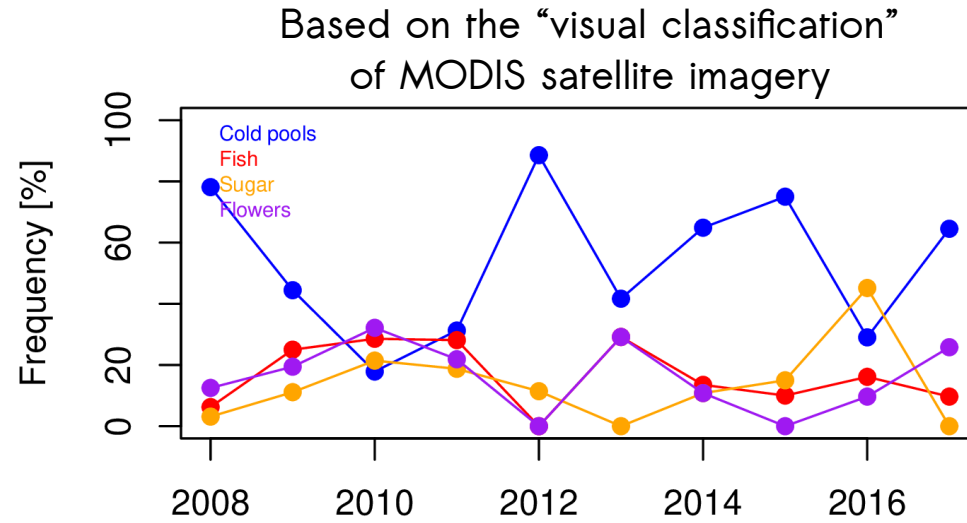


“Flowers” (16 %)



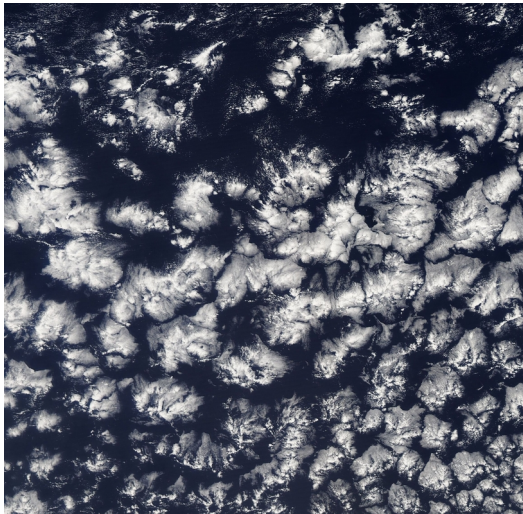
200 km

Interannual variability of mesoscale organization patterns

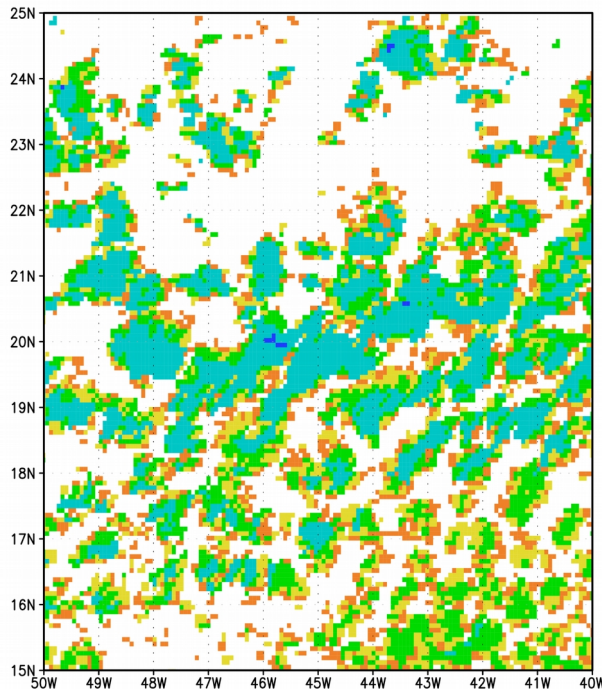


Cold pools
Fish
Sugar
Flowers

Characterization of the mesoscale organization of shallow clouds



Clusters 2017.02.08.15



Use geostationary data:

- GridSat-B1 data (gridded, 0.07° resolution)
- Dec 2000 to Feb 2017, DJF, 3-hourly

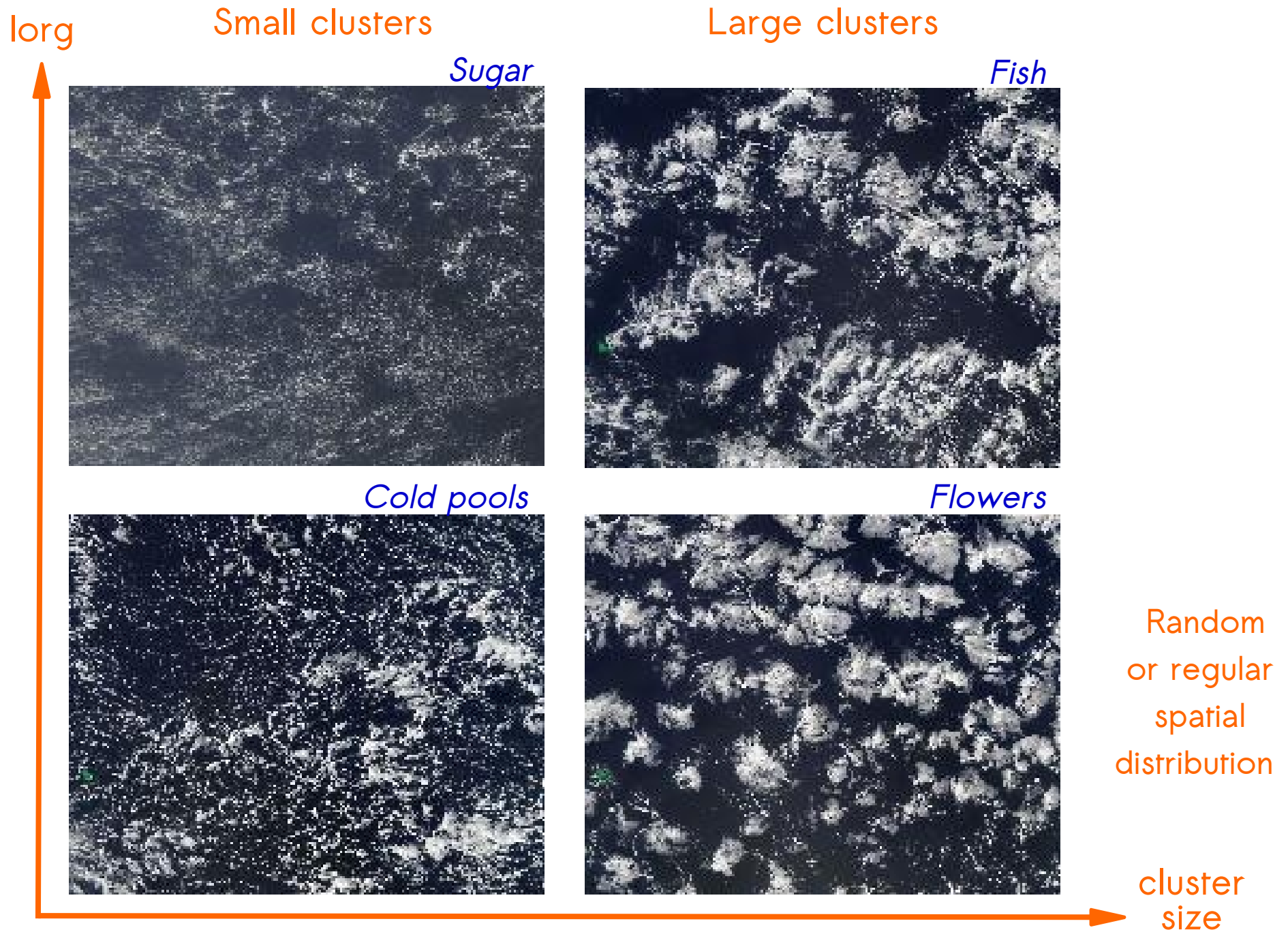
Use IR brightness temperature to:

- select situations with a prominence of shallow convection
- identify shallow clouds and cloud clusters

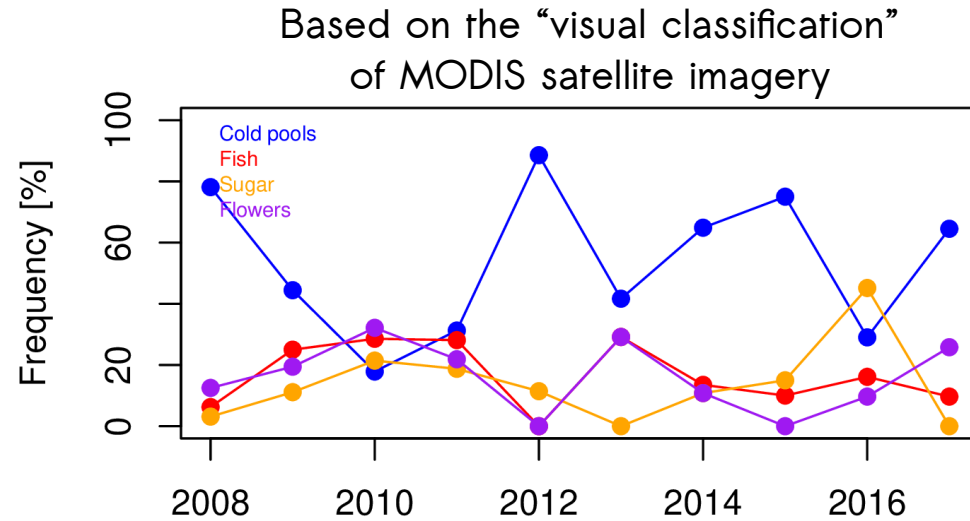
Characterize organization through:

- number of clusters
- total area covered by shallow clouds
- mean cluster size
- spatial distribution of cloud clusters (lorg)
(comparison to a theoretical random distribution of the CDF of nearest neighbor distances, Tompkins and Semie 2017):

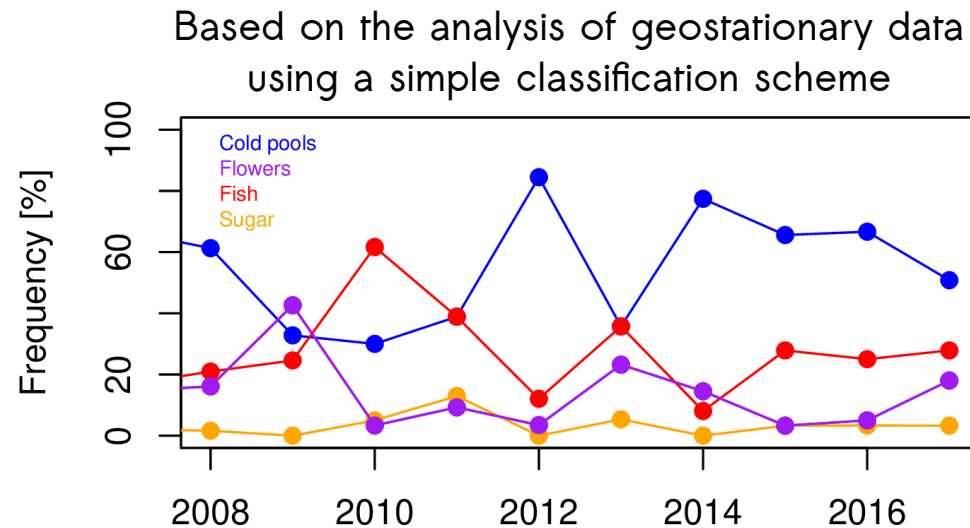
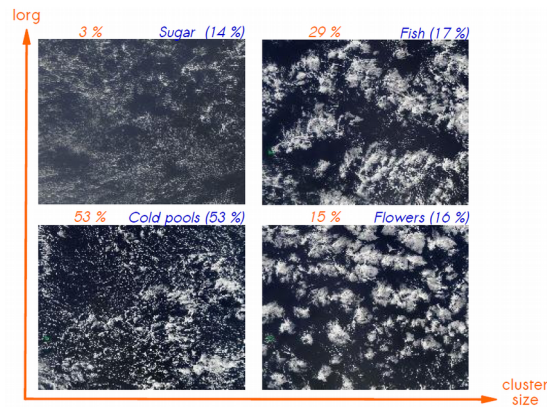
Characterization of the main convective organization patterns



Interannual variability of mesoscale organization patterns

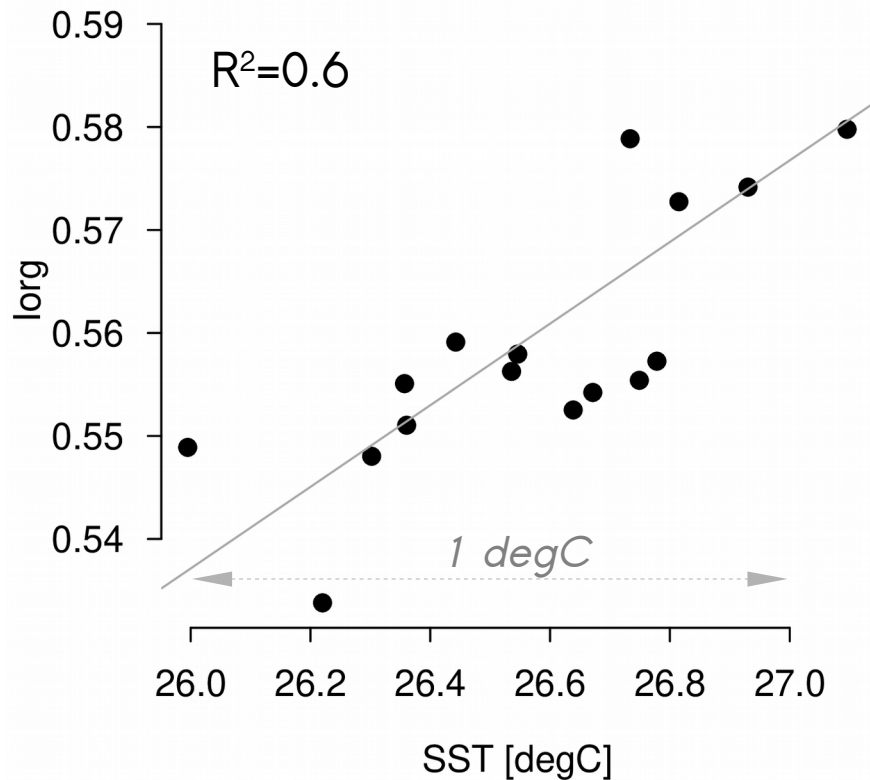


Cold pools
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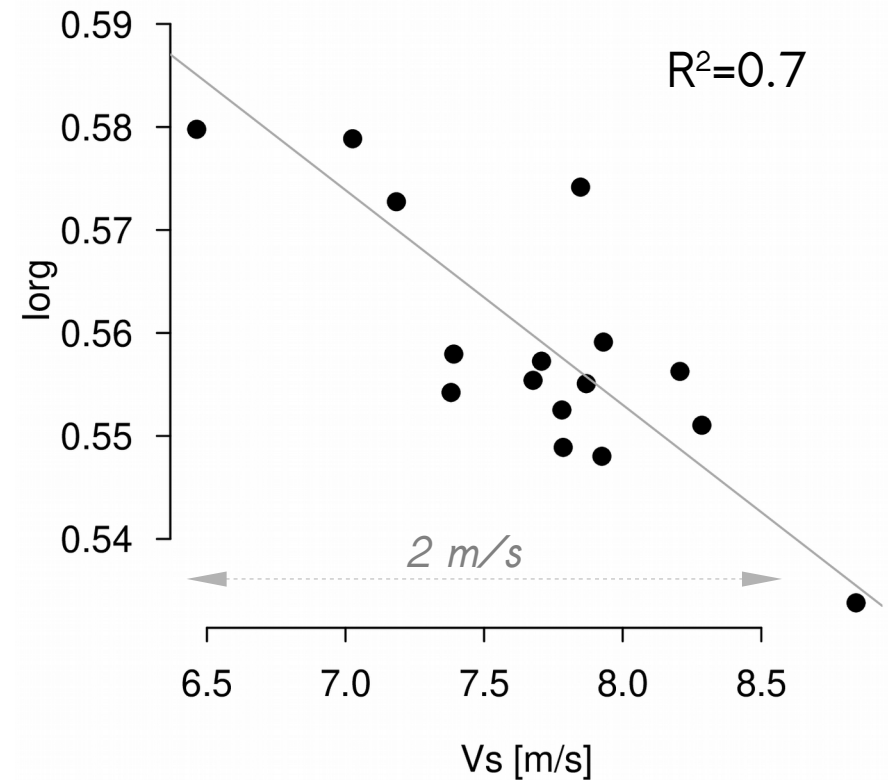


Correlation with large-scale meteorology (interannual time scale)

Sea Surface Temperature
[Reynolds, 2000-2017]



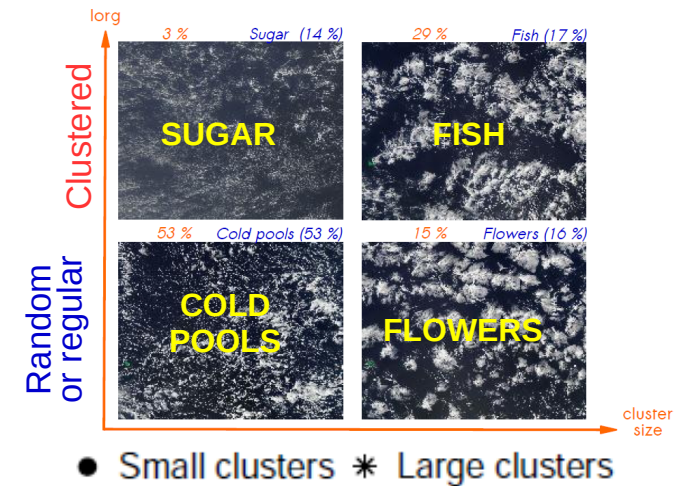
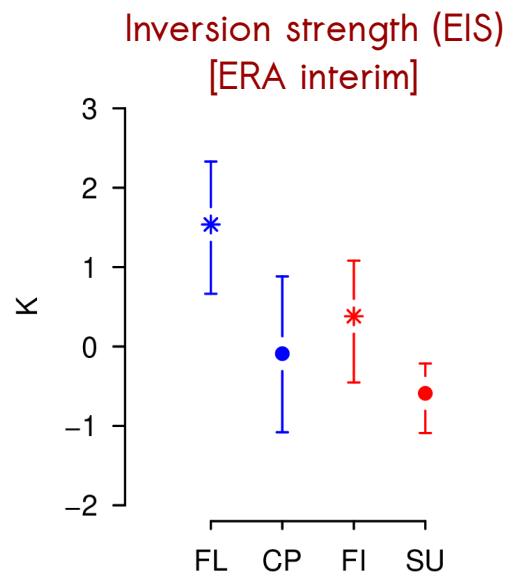
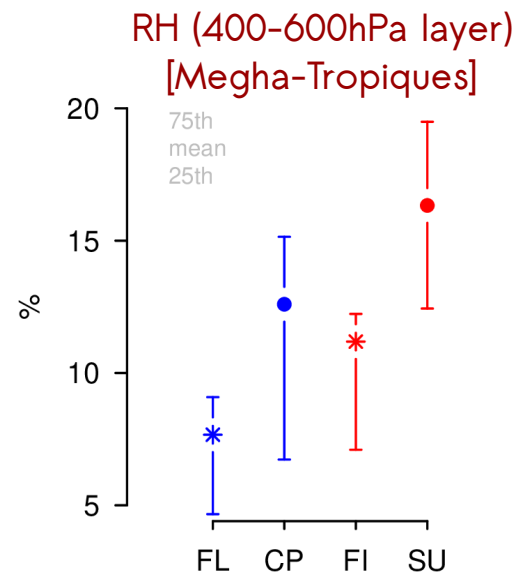
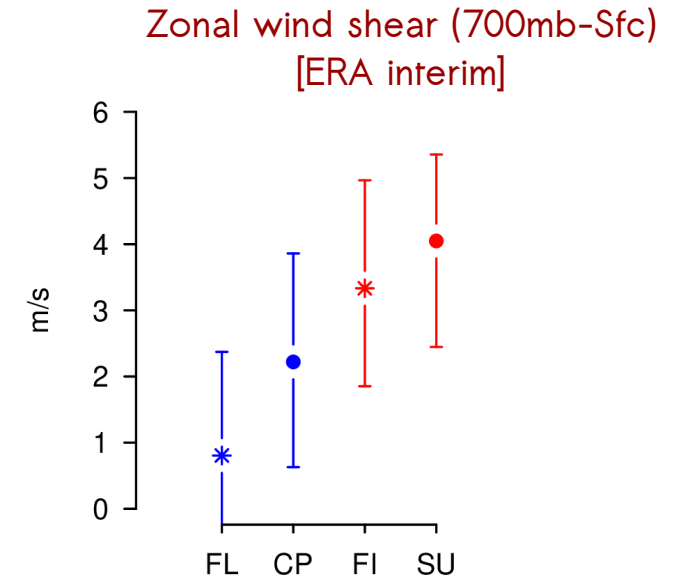
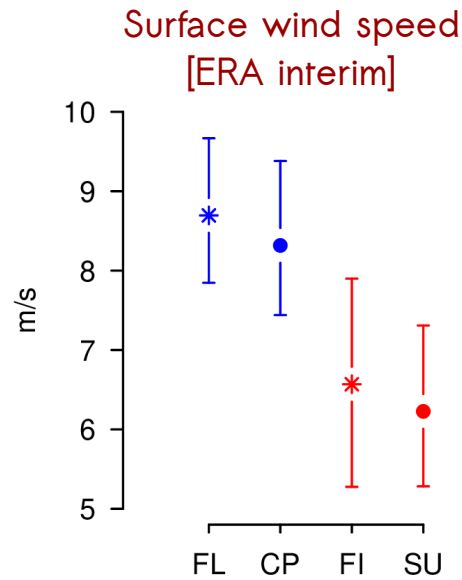
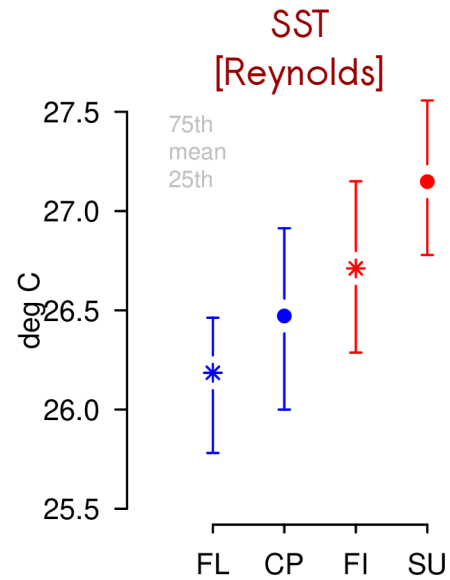
Surface wind speed
[ERA interim, 2000-2017]



- Clustering favored in warm, weak wind regimes
- Random or regular organizations favored in cold, windy regimes

Correlations with LTS, EIS, Tair-Ts, ω_{700} , etc much less significant

Correlation with large-scale meteorology (daily timescale, 2000-2017)



How contrasted are cloud properties?

Cloud mask along A-Train orbits
[CloudSat and CALIPSO]

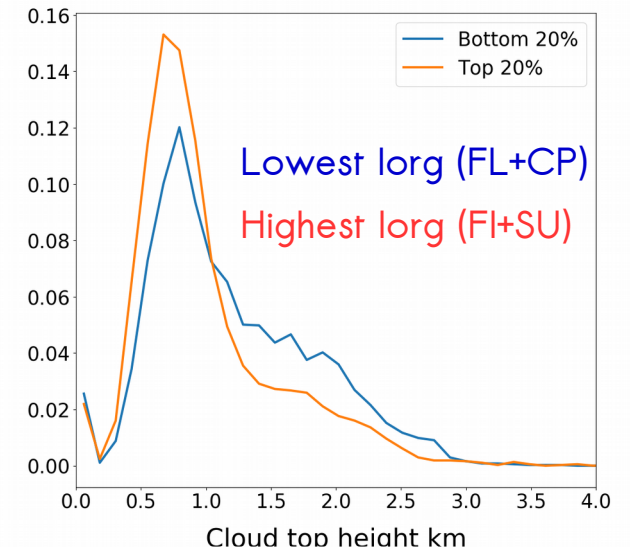
9 Feb 2007

20 Feb 2007

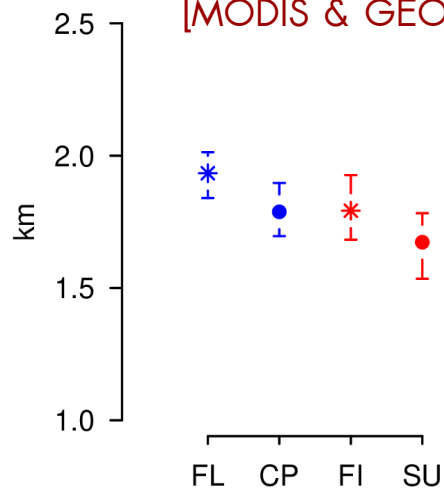
7 Jan 2008

7 Feb 2007

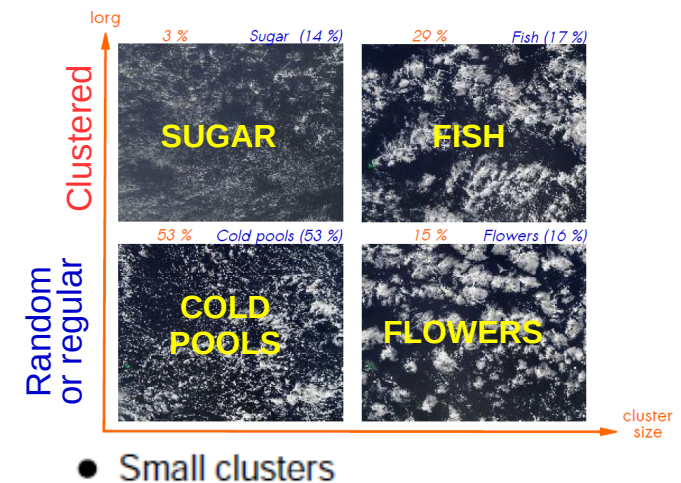
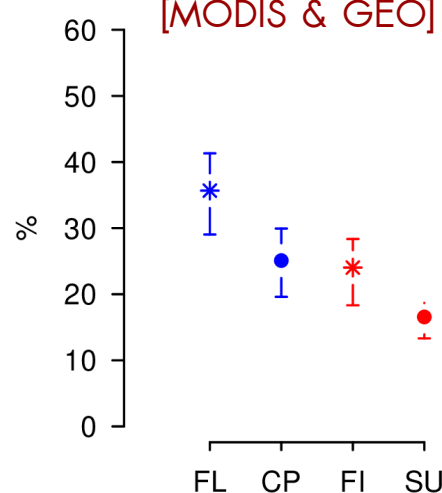
Cloud top height stratified by long
(CloudSat and CALIPSO)
2007-2011



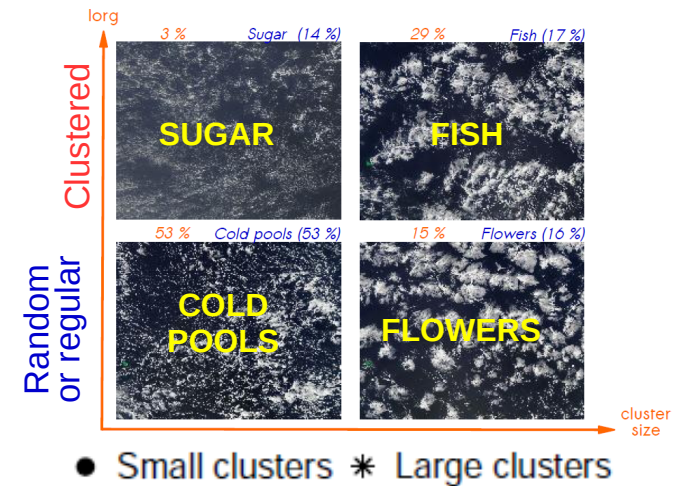
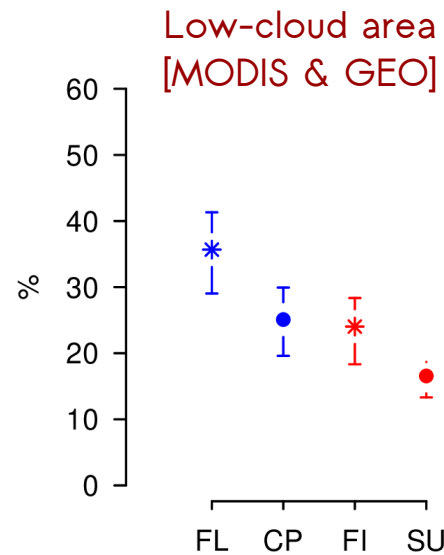
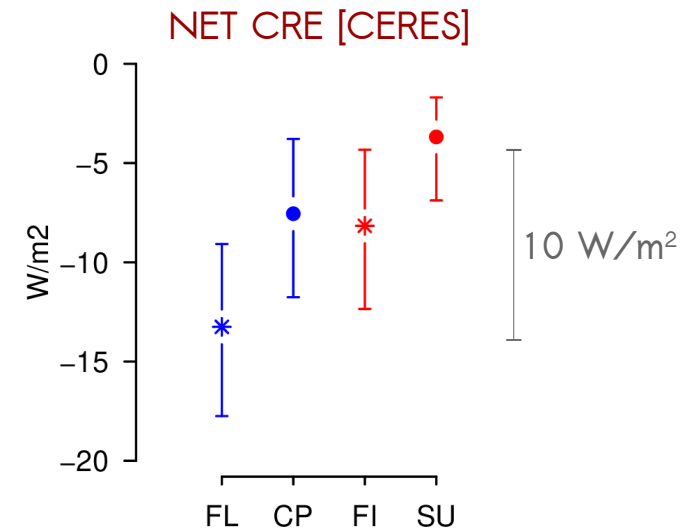
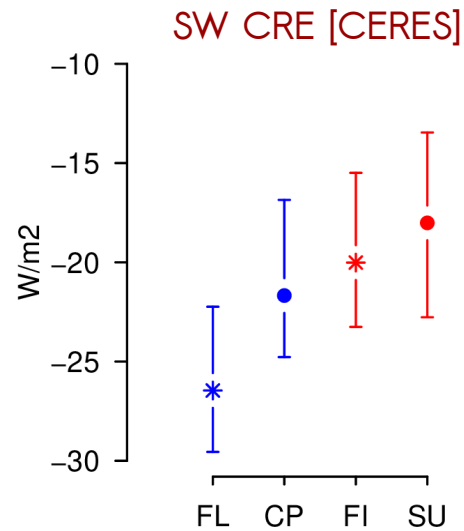
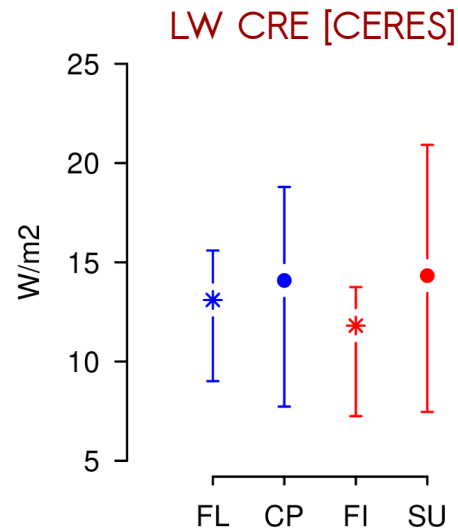
Low-cloud top height
[MODIS & GEO]



Low-cloud area
[MODIS & GEO]



Does it matter for TOA radiation? (Daily timescale, 2001-2017)



Conclusions

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- The 4 main patterns of mesoscale organization are associated with contrasted large-scale conditions:

Regular or random organizations (cold pools/flowers):

→ low SST, high wind speed, small wind shear

Clustered organizations (sugar/fish):

→ high SST, low wind speed, strong wind shear

Large cloud clusters (flowers/fish):

→ dry free troposphere, strong trade inversion

→ deeper, larger cloud fraction

Small cloud clusters (cold pools/sugar):

→ moist free troposphere, weak trade inversion

→ shallower, smaller cloud fraction

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- Physical mechanisms underlying these different organization patterns?
 - EUREC⁴A field campaign (Jan-Feb 2020)

Thank You

