AIRS V6 cloud thermodynamic phase and ice cloud properties: The diurnal cycle & comparison to MODIS

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Two main objectives of today's talk

(1) What do the AIRS monthly maps look like?

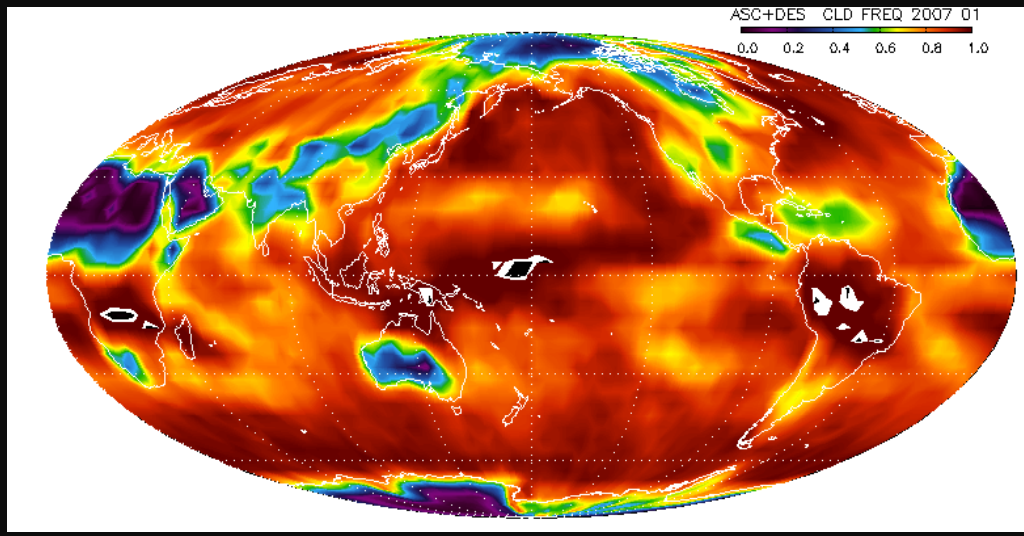
January 2007, v6.0.2, 4x4 degree spatial resolution
cloud thermodynamic phase: ice, liquid, unknown
ice cloud optical thickness and effective diameter
emphasize diurnal cycle variability

(2) How do AIRS/MODIS ice cloud retrievals compare when MODIS pixel-scale variability used to classify the AIRS FOV?

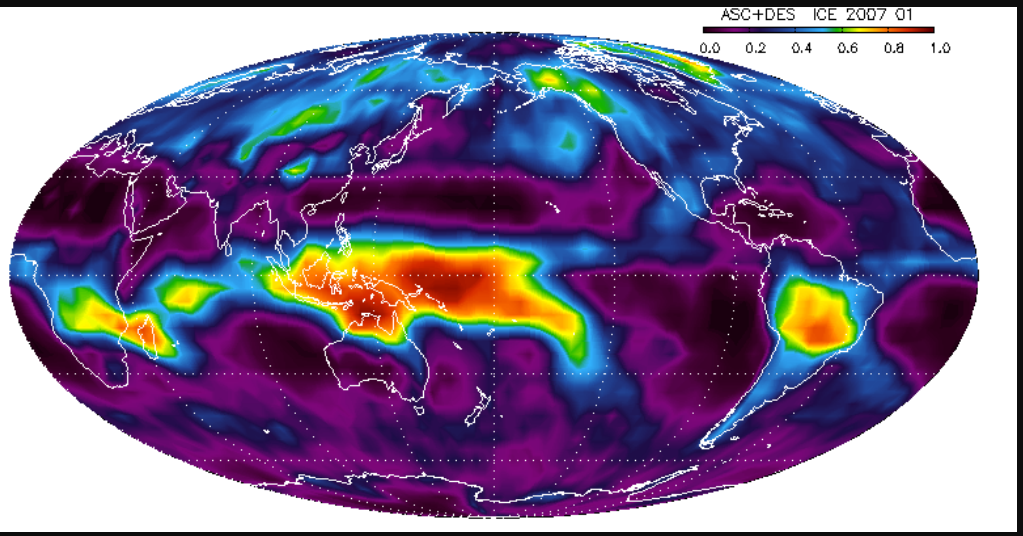
AIRS FOVs with 100% ice cloud phase according to MODIS
AIRS FOVs with mixture of cloud phase according to MODIS
AIRS FOVs with only liquid cloud phase according to MODIS

Global Estimates of Cloud Thermodynamic Phase – AIRS is a Robust Ice Cloud Detector

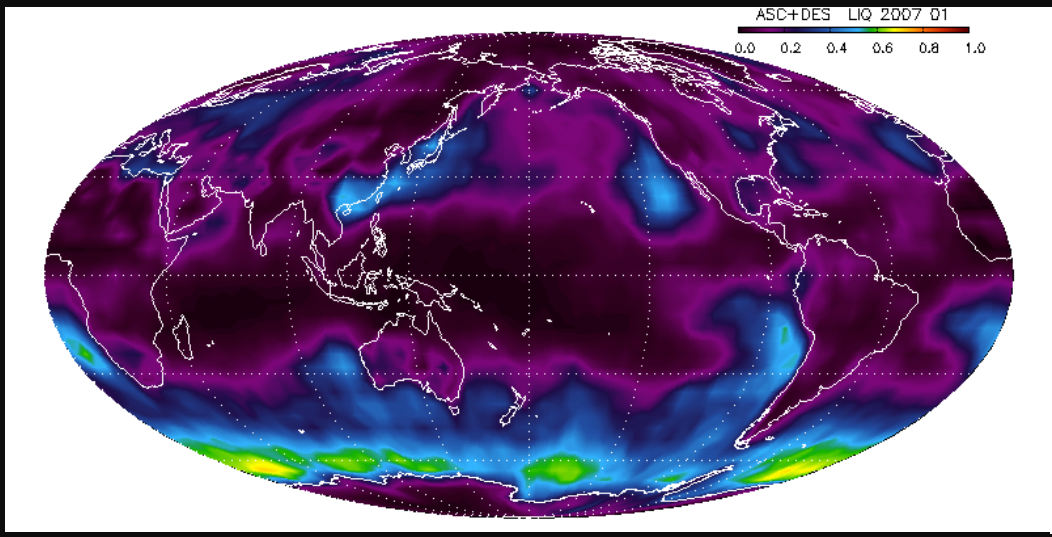
Cloud Frequency



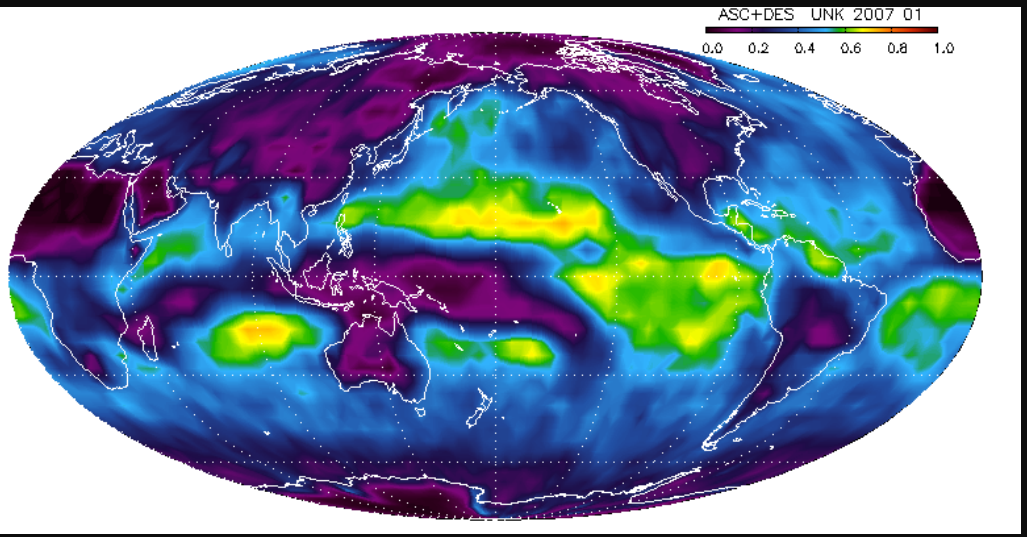
Ice



Liquid

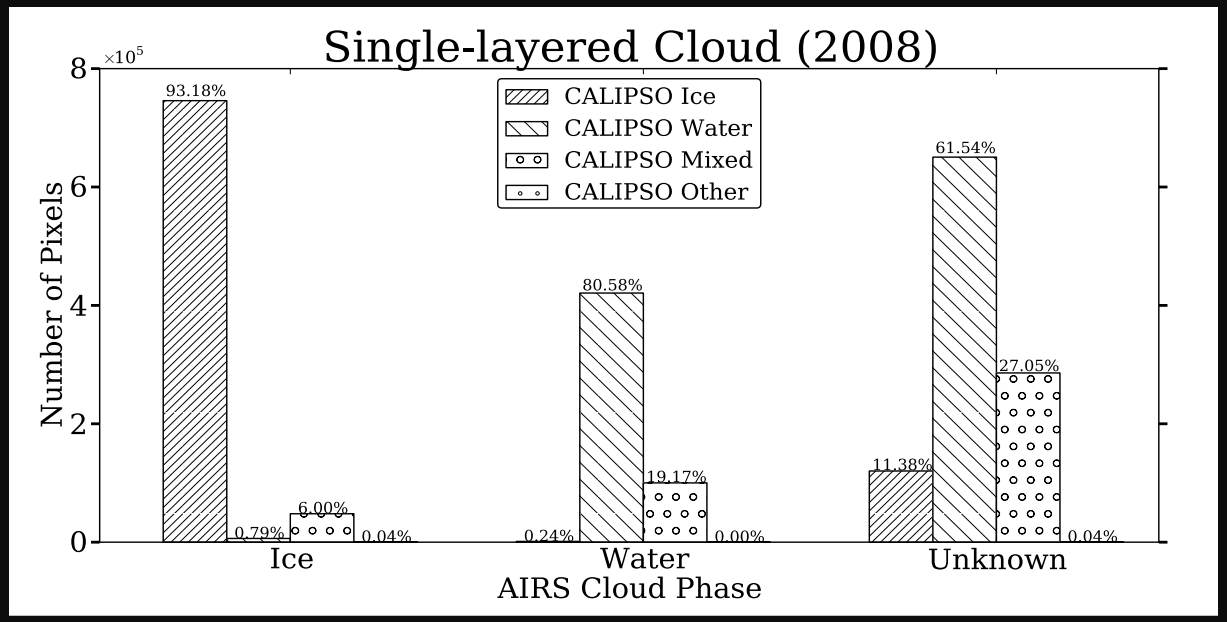


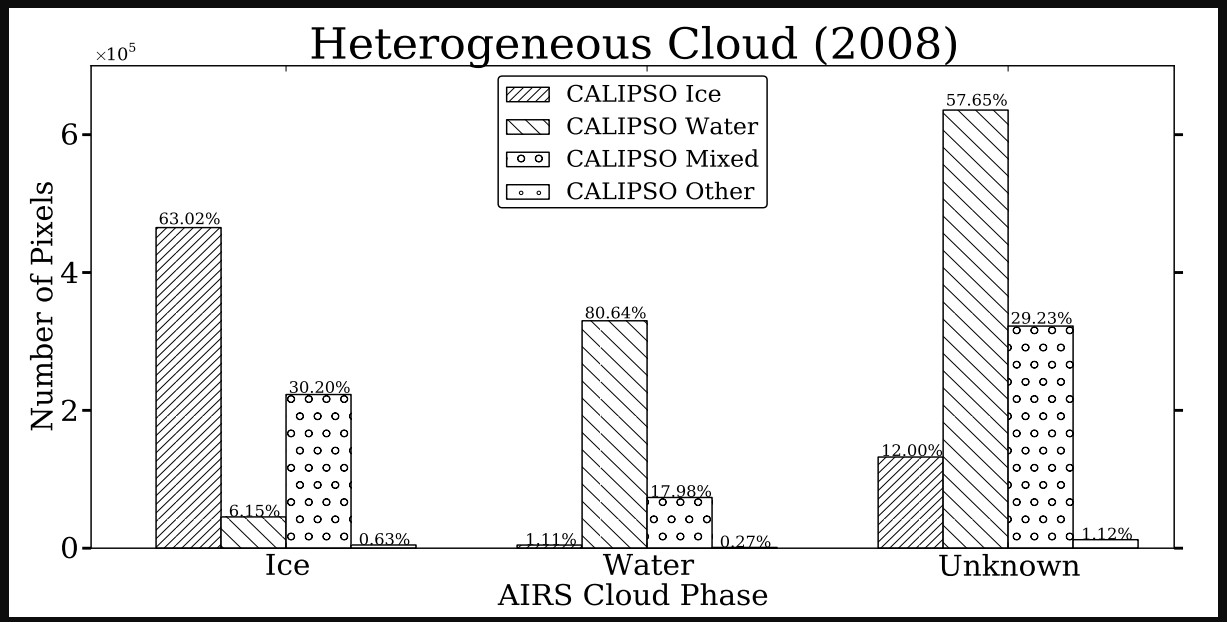
Unknown



Kahn et al., 2013, in preparation

AIRS is excellent at detecting ice, with less skill at detecting liquid water

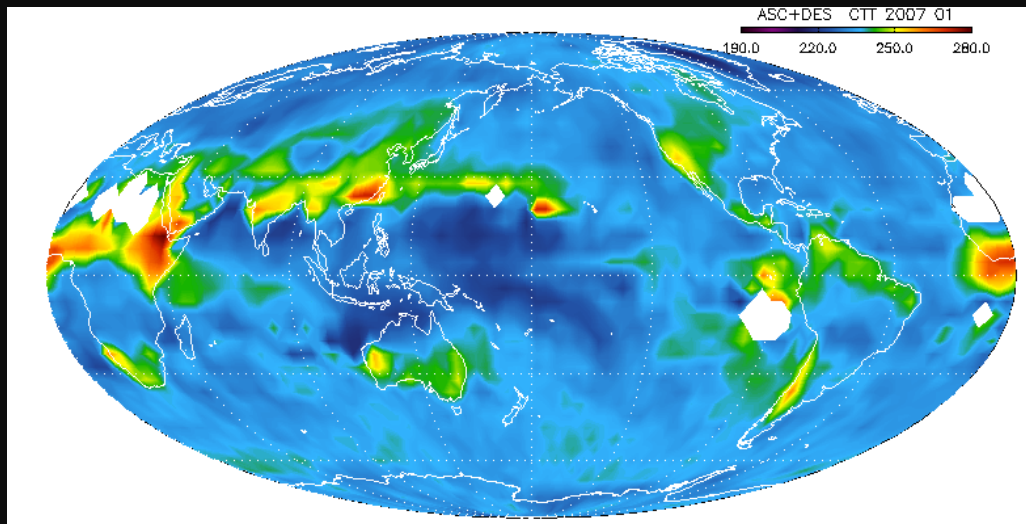




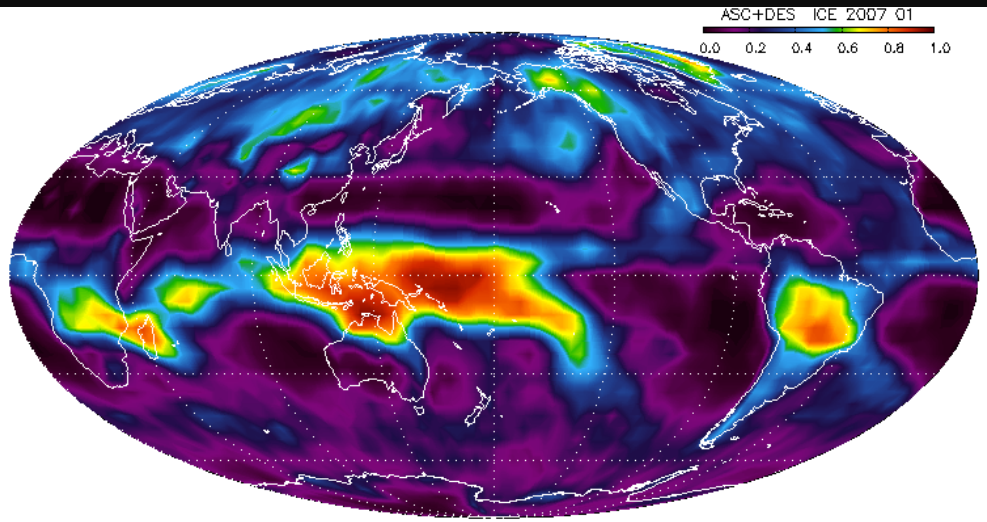
Credit: Hongchun Jin and Shaima Nasiri (TAMU)

Global Estimates of Ice Cloud Effective Diameter and Optical Thickness

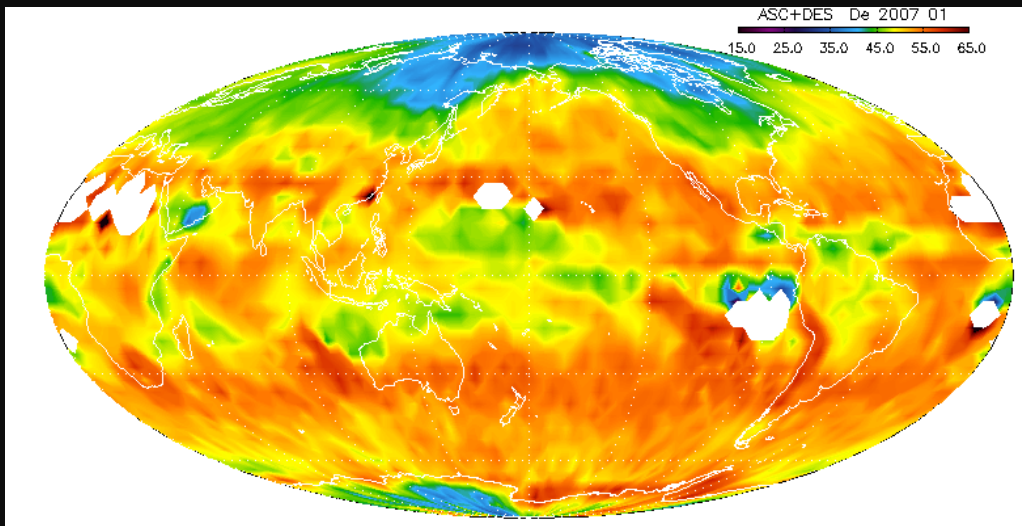
Cloud Top Temperature



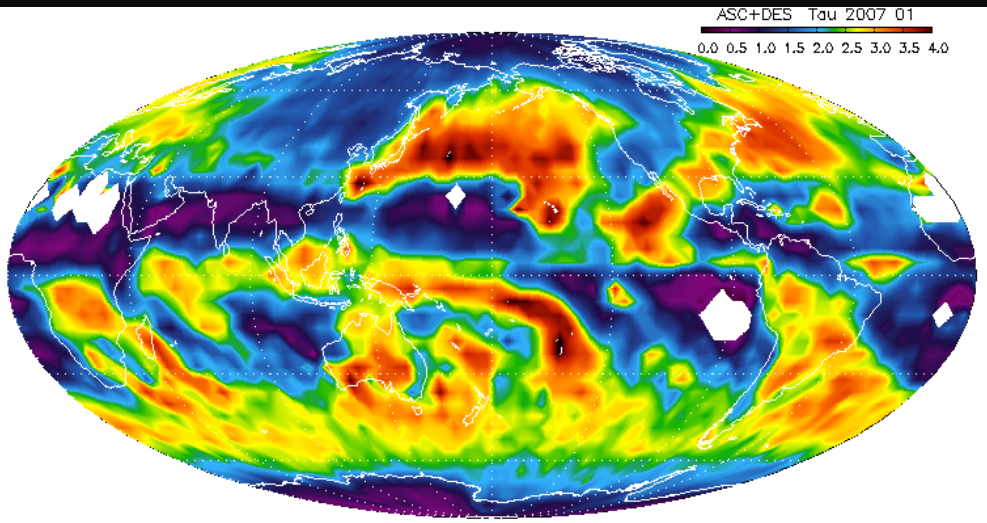
Ice Cloud Frequency



Effective Diameter



Optical Thickness (0.55 μm)

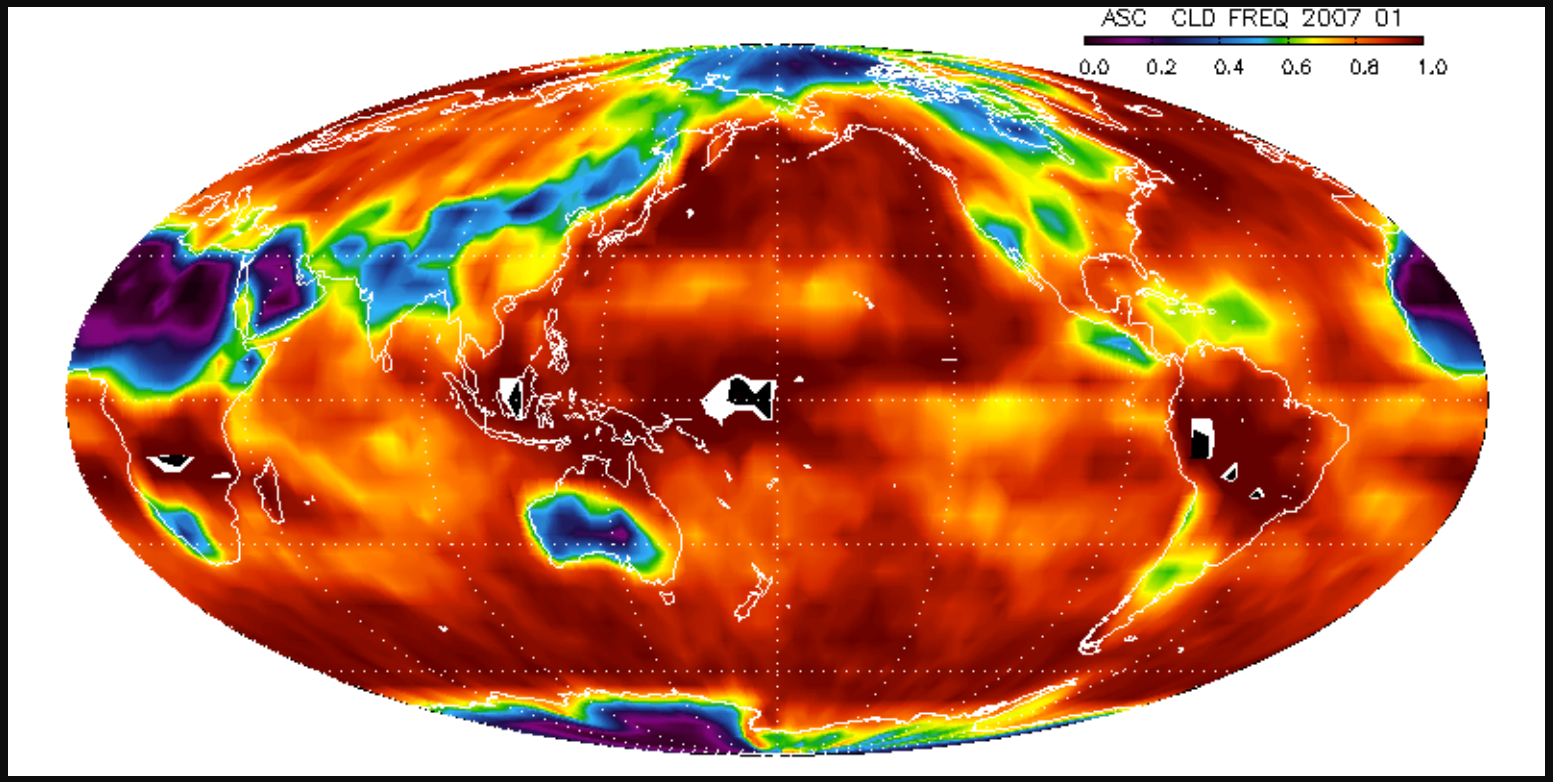


Kahn et al., 2013, in preparation

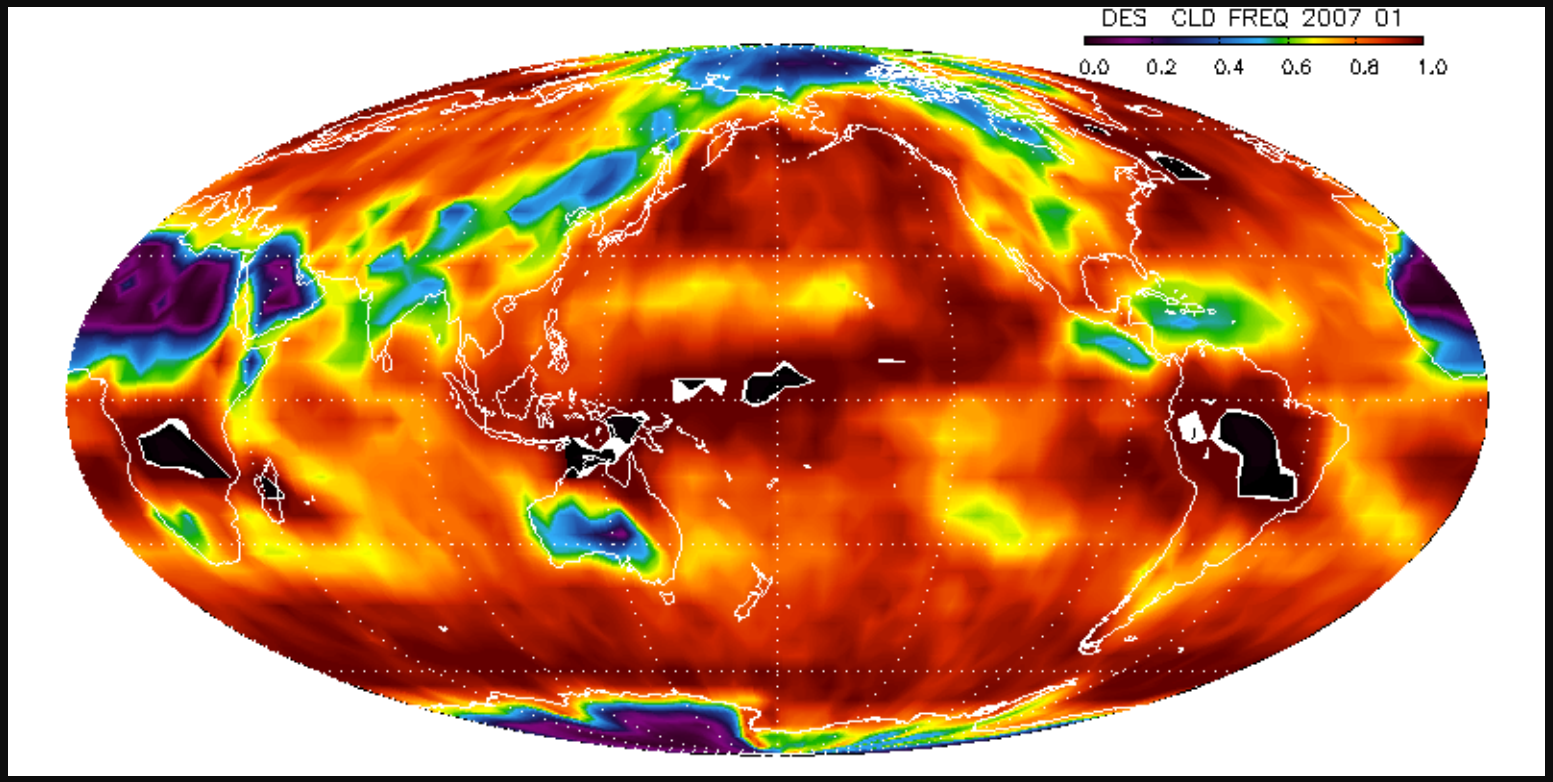
One of the great strengths of AIRS is diurnal sampling

How do the cloud fields change from the ascending to descending nodes?

Cloud Frequency Varies a Little Over Diurnal Cycle (ascending)

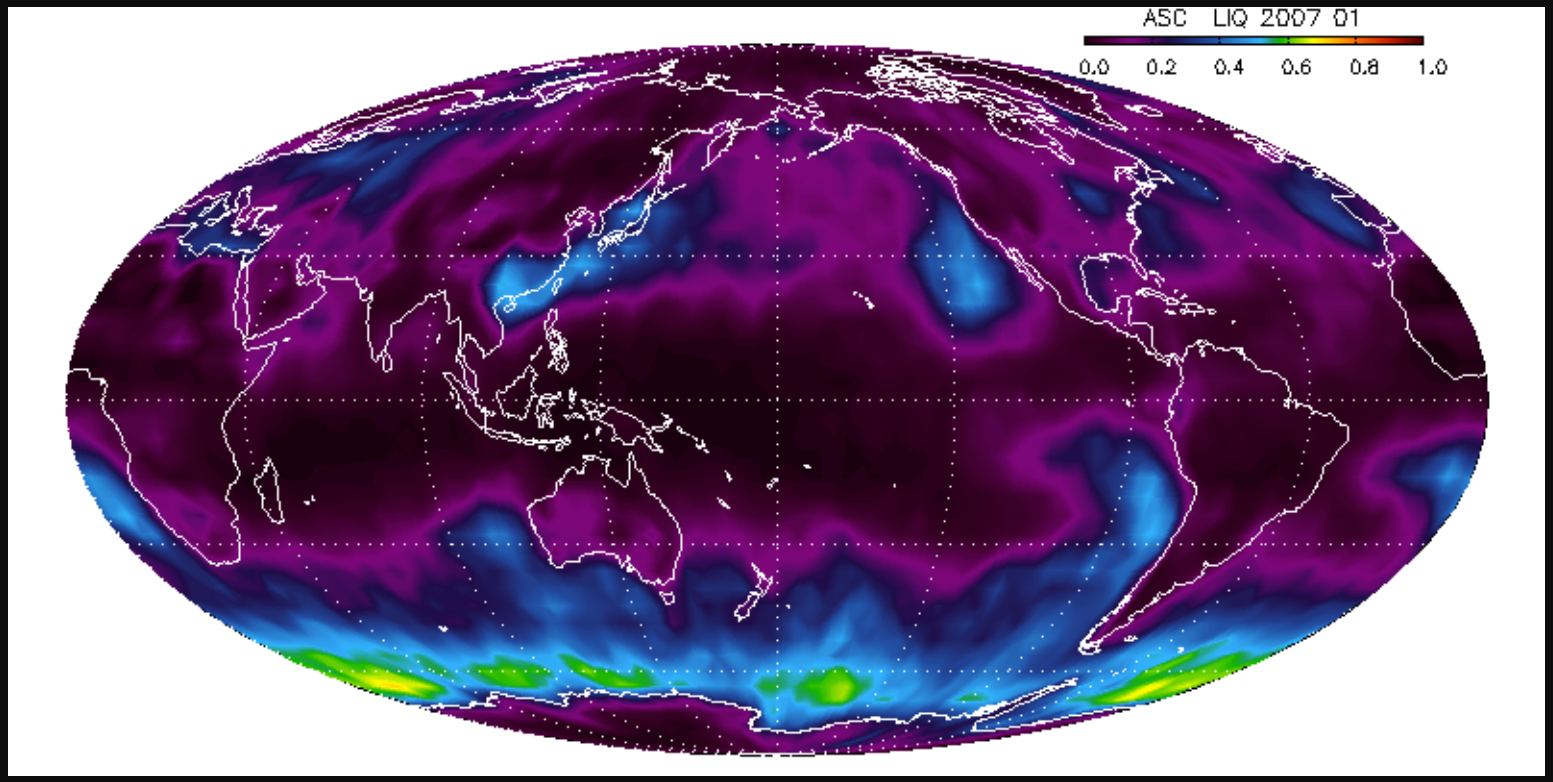


Cloud Frequency Varies a Little Over Diurnal Cycle (descending)

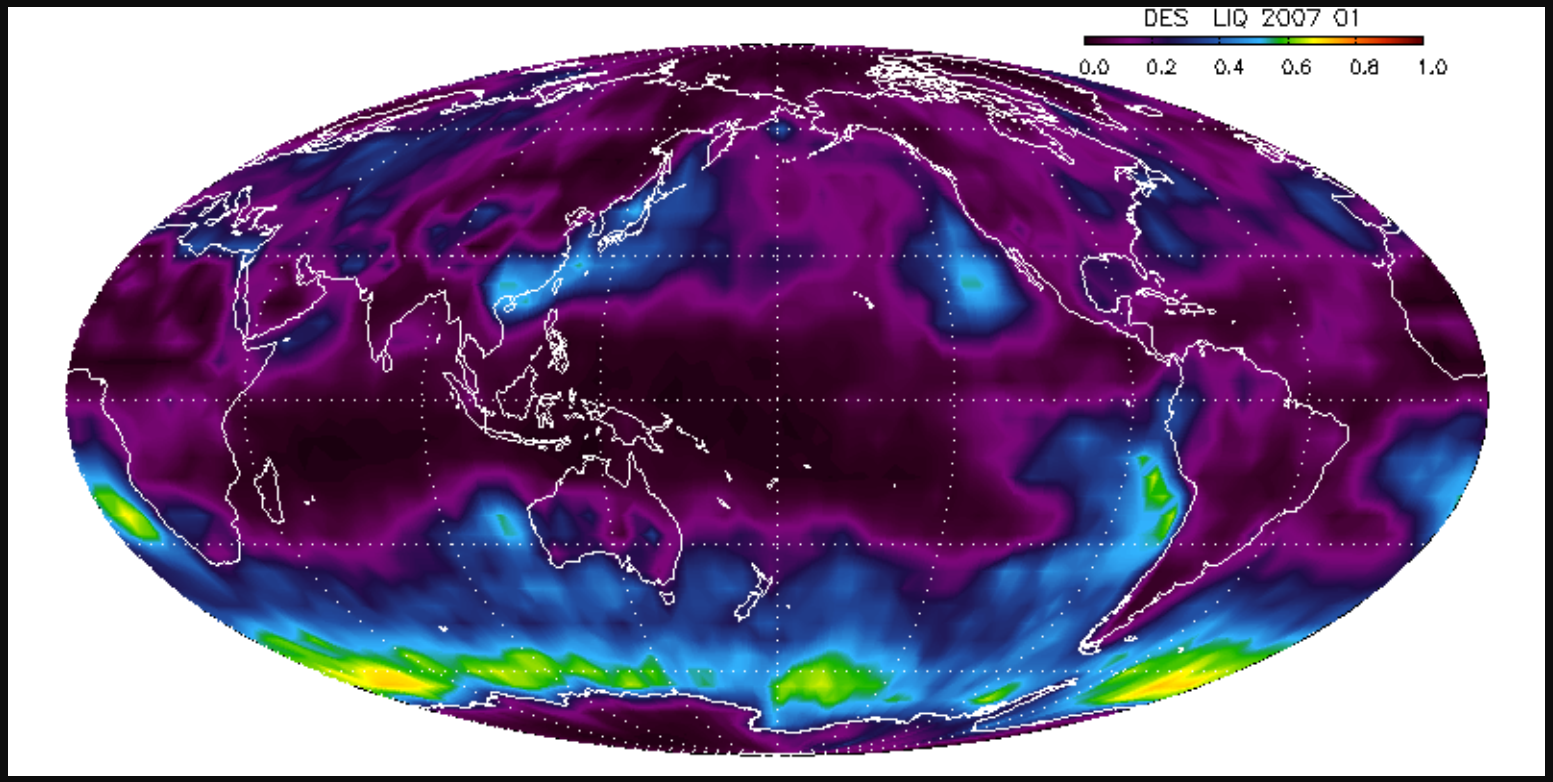


A few changes here and there. Land/ocean differences a bit larger during day.

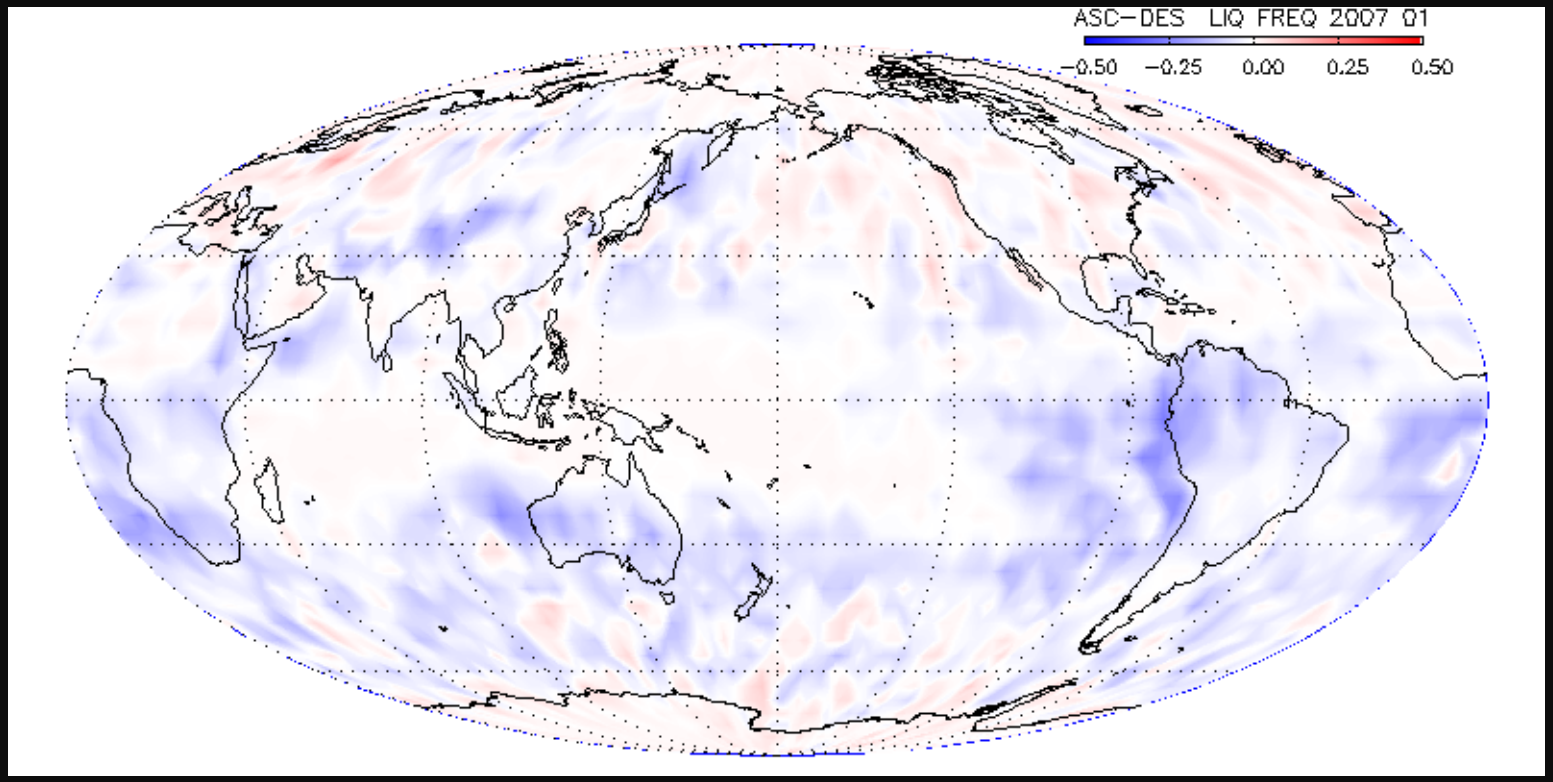
Liquid cloud frequency varies somewhat more over diurnal cycle (ascending)



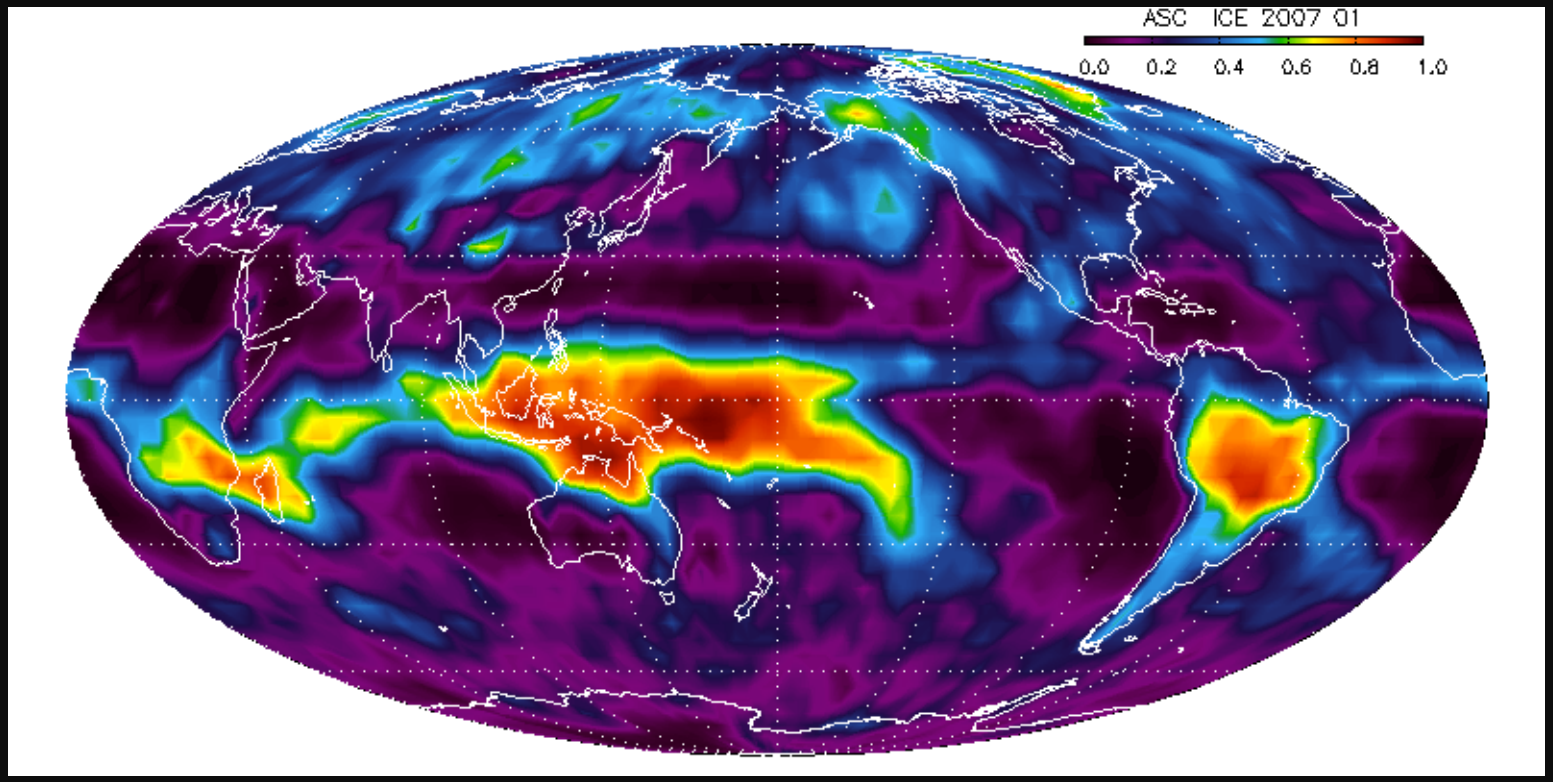
Liquid cloud frequency varies somewhat more over diurnal cycle (descending)



Liquid cloud frequency ascending–descending



Ice cloud frequency varies in a few regions of convection, and perhaps orography (ascending)



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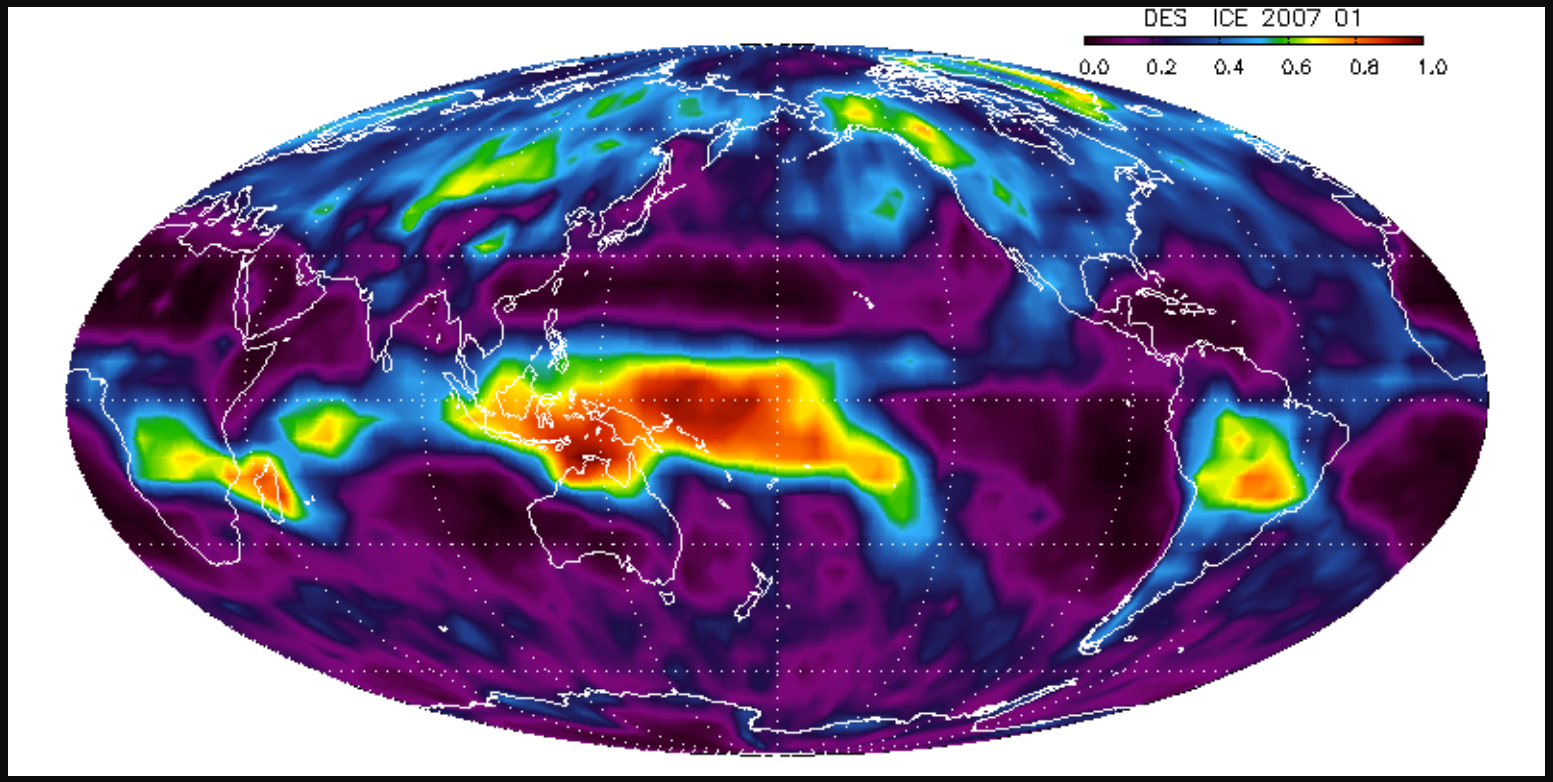
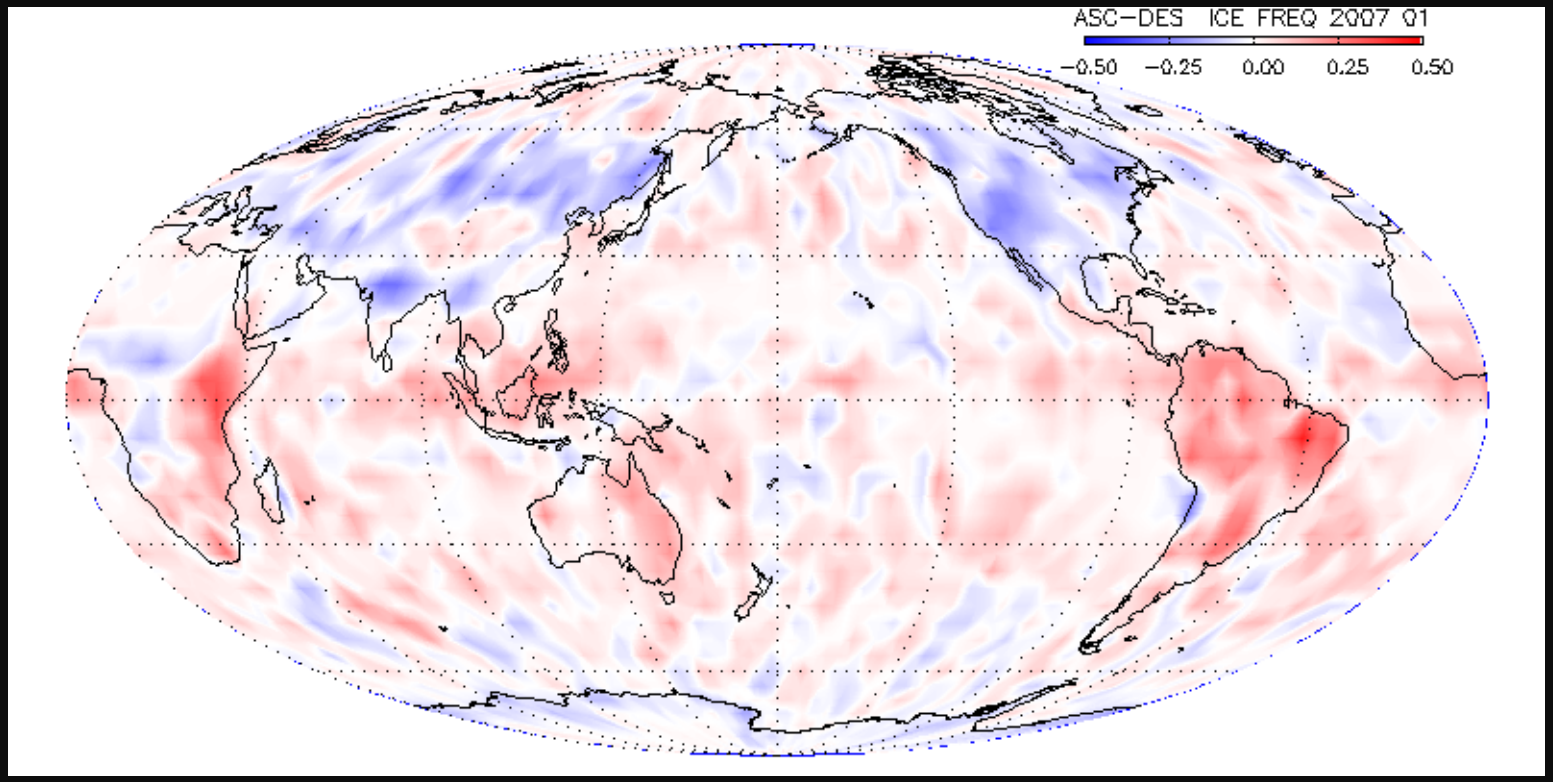
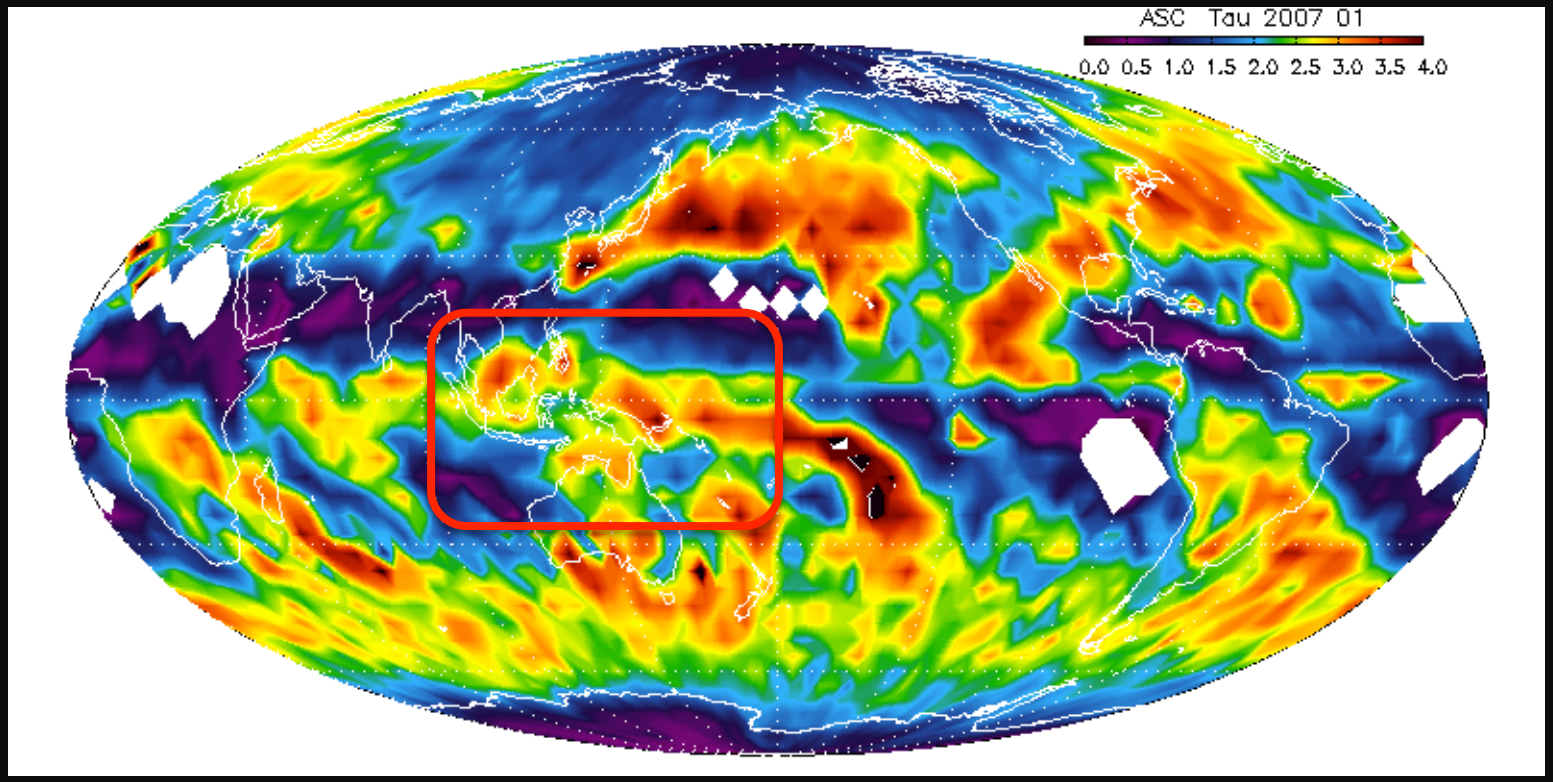


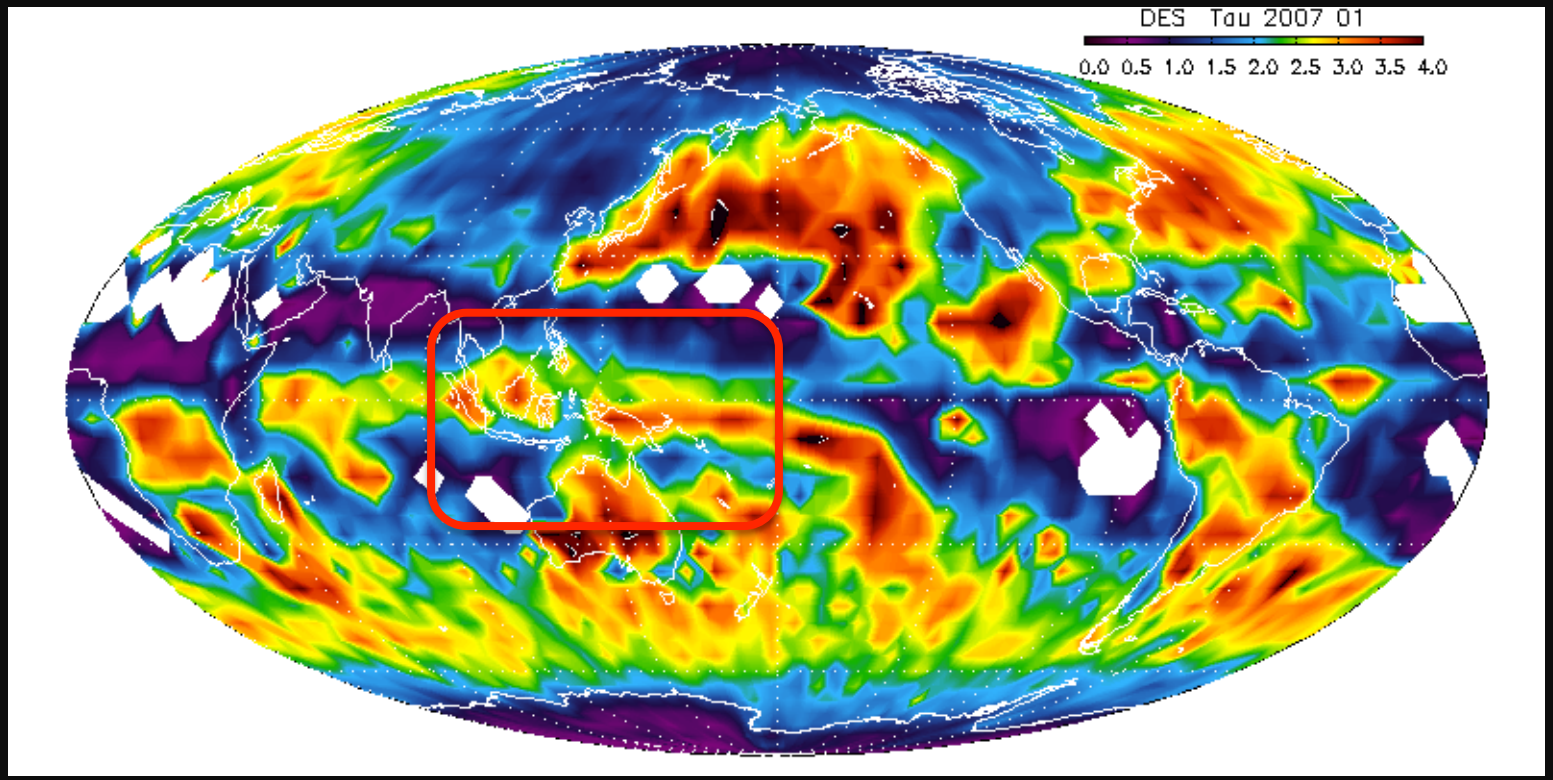
Ice cloud frequency ascending–descending



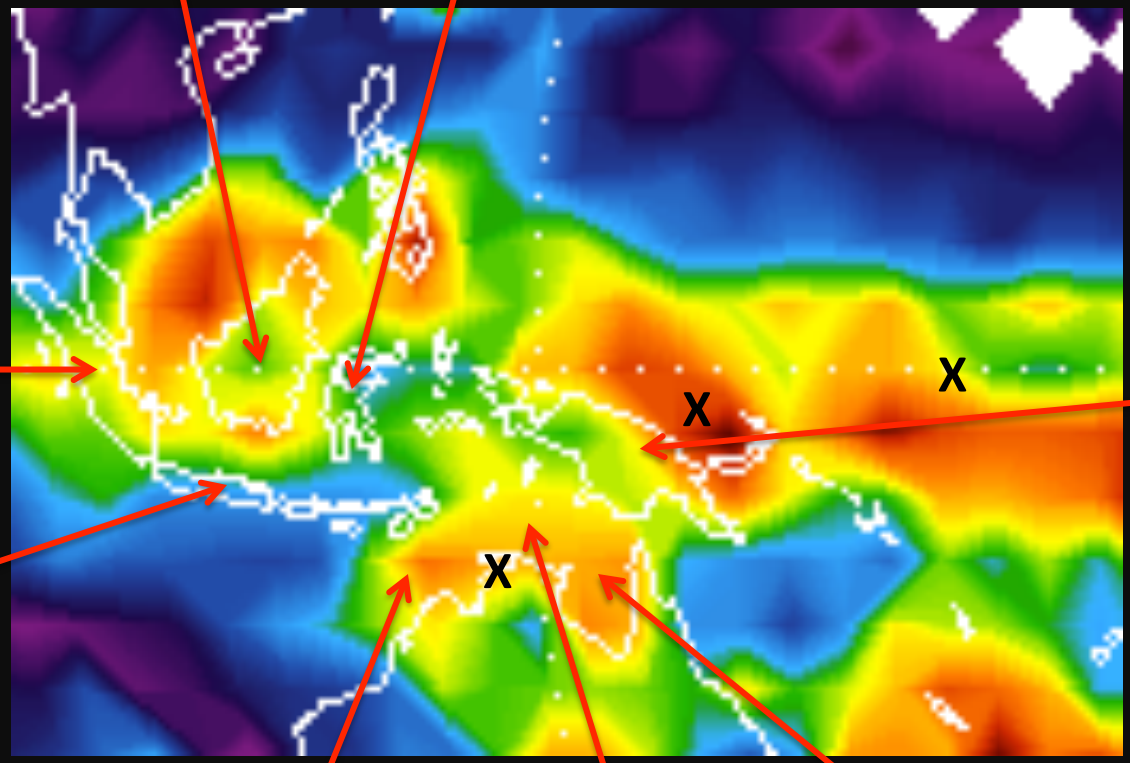
Much more (localized) significant diurnal impacts in ice cloud optical thickness (ascending)



Much more (localized) significant diurnal impacts in ice cloud optical thickness (descending)



Reduced (increased) optical thickness over tropical islands during day (night)



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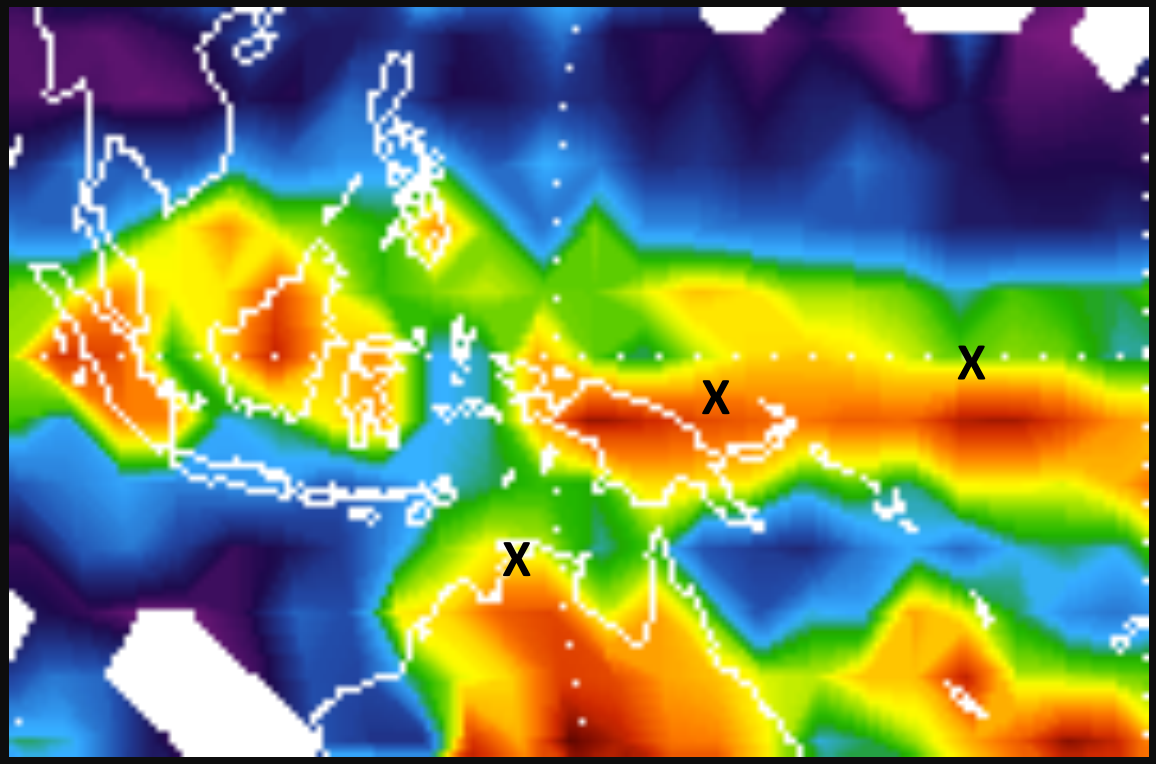
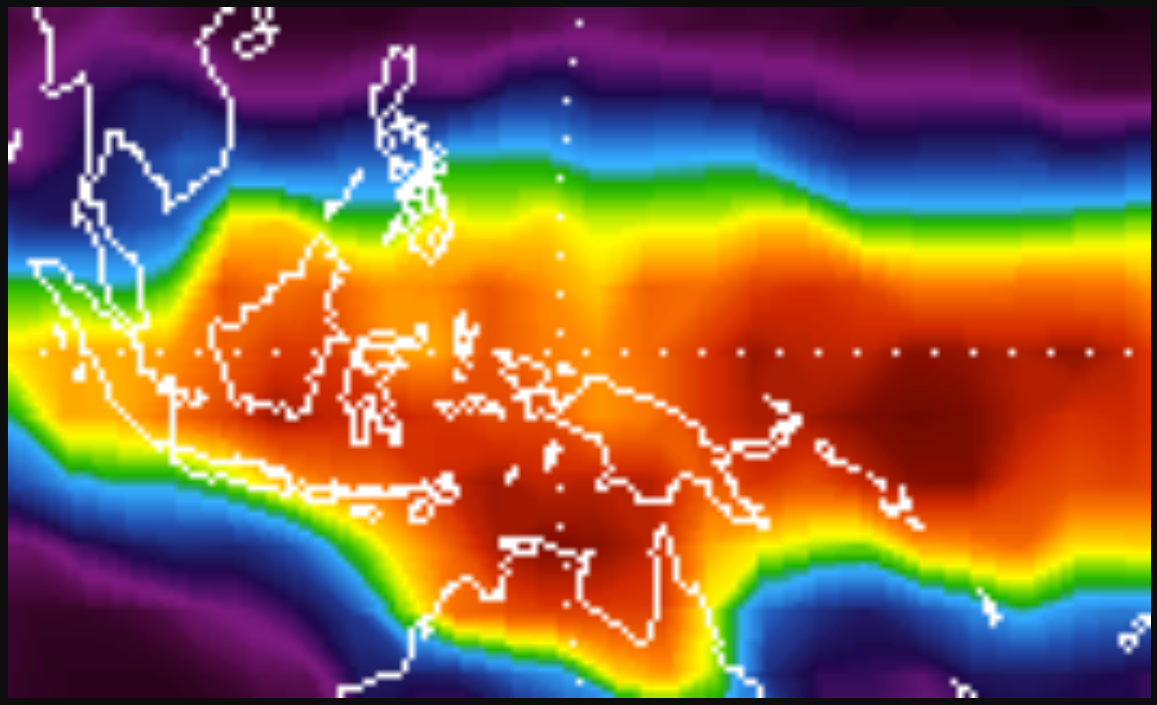


Descending

Diurnal cycle in ice cloud frequency smaller



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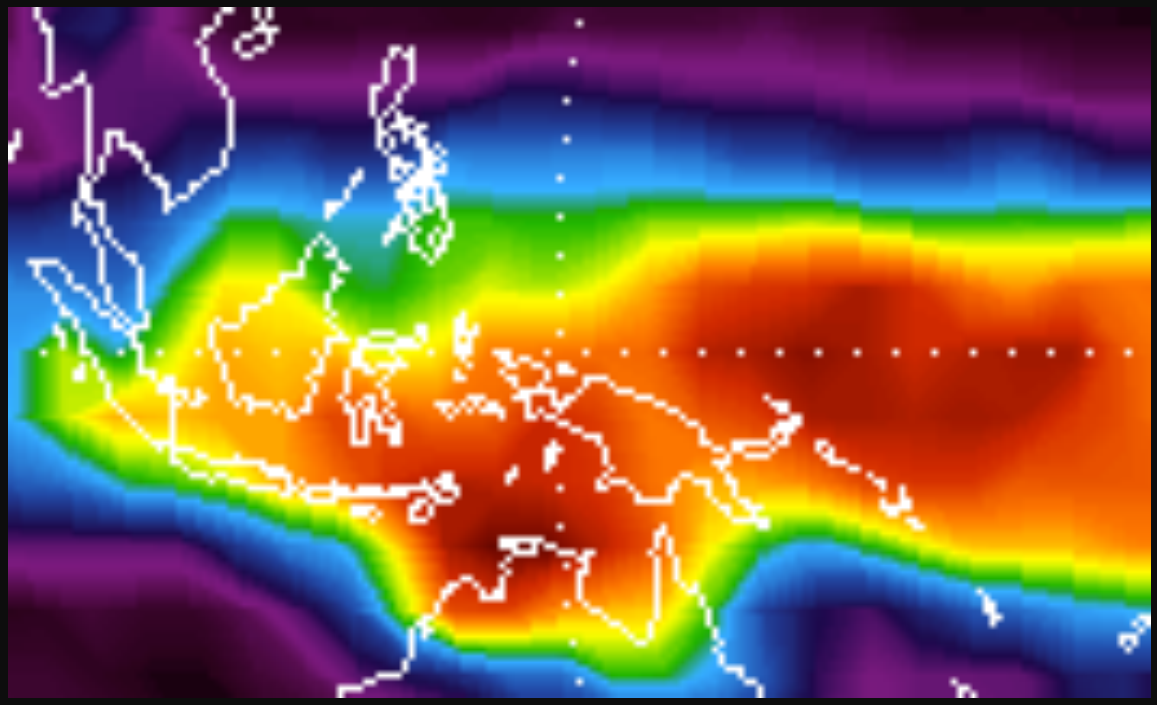
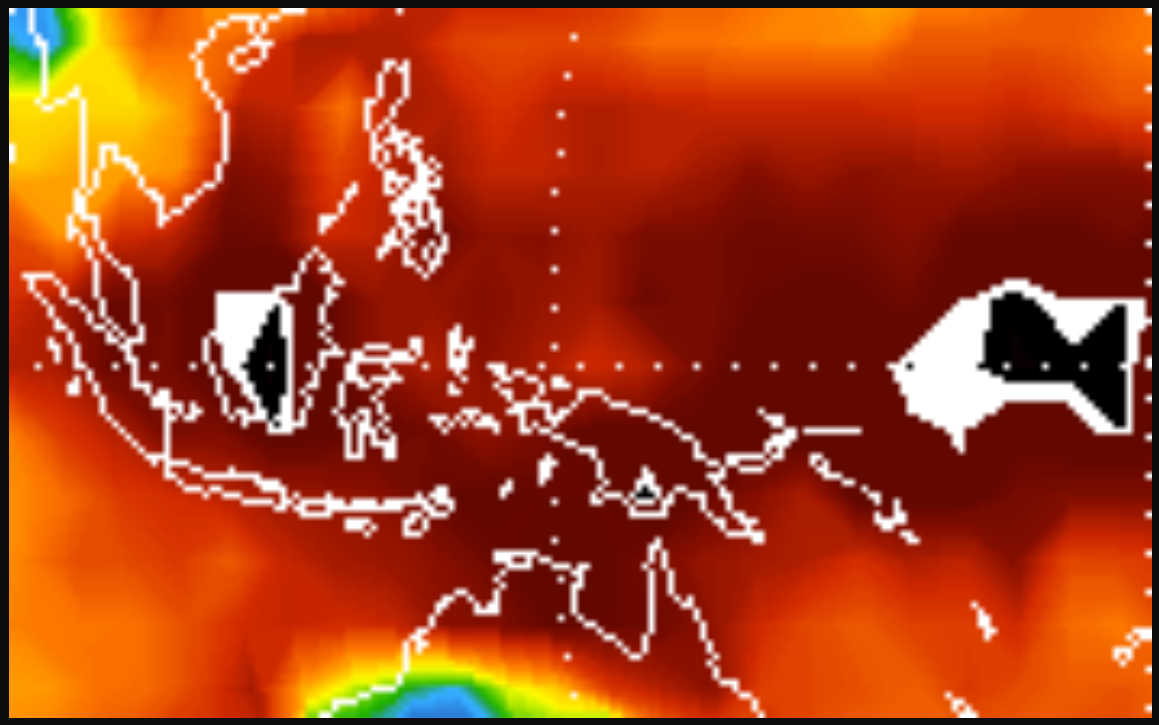
Diurnal cycle in ice cloud frequency smaller



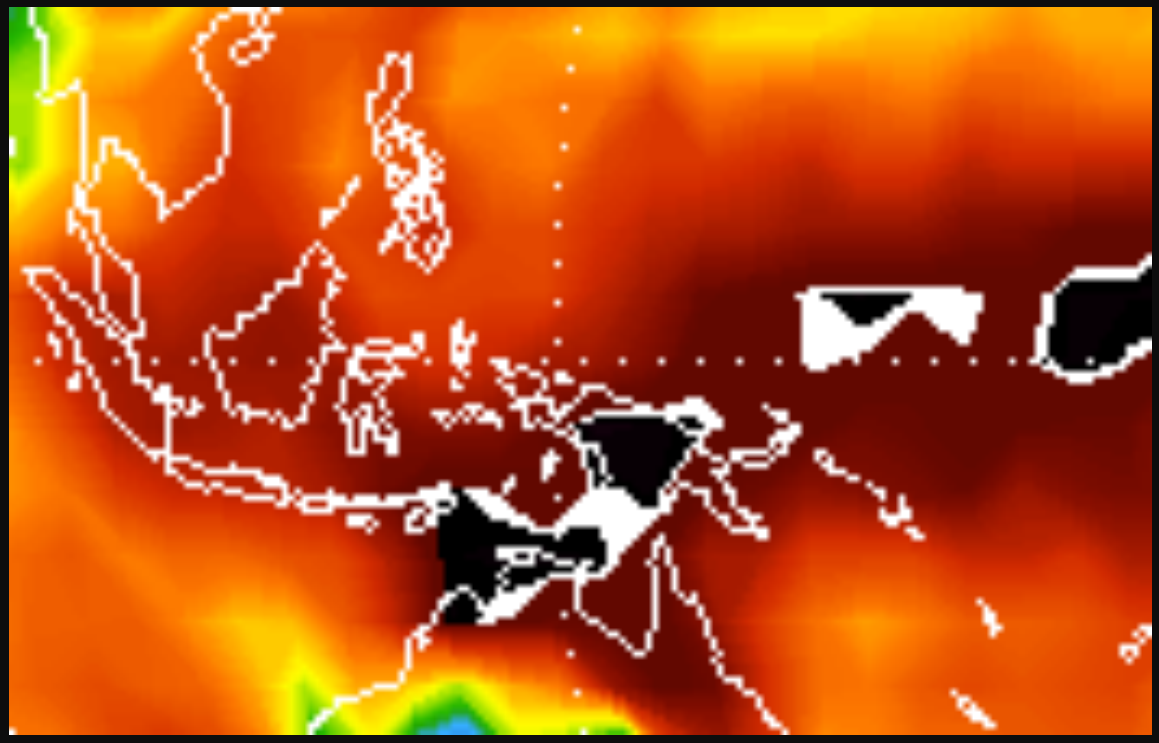
Descending

Diurnal cycle in total cloud frequency smaller



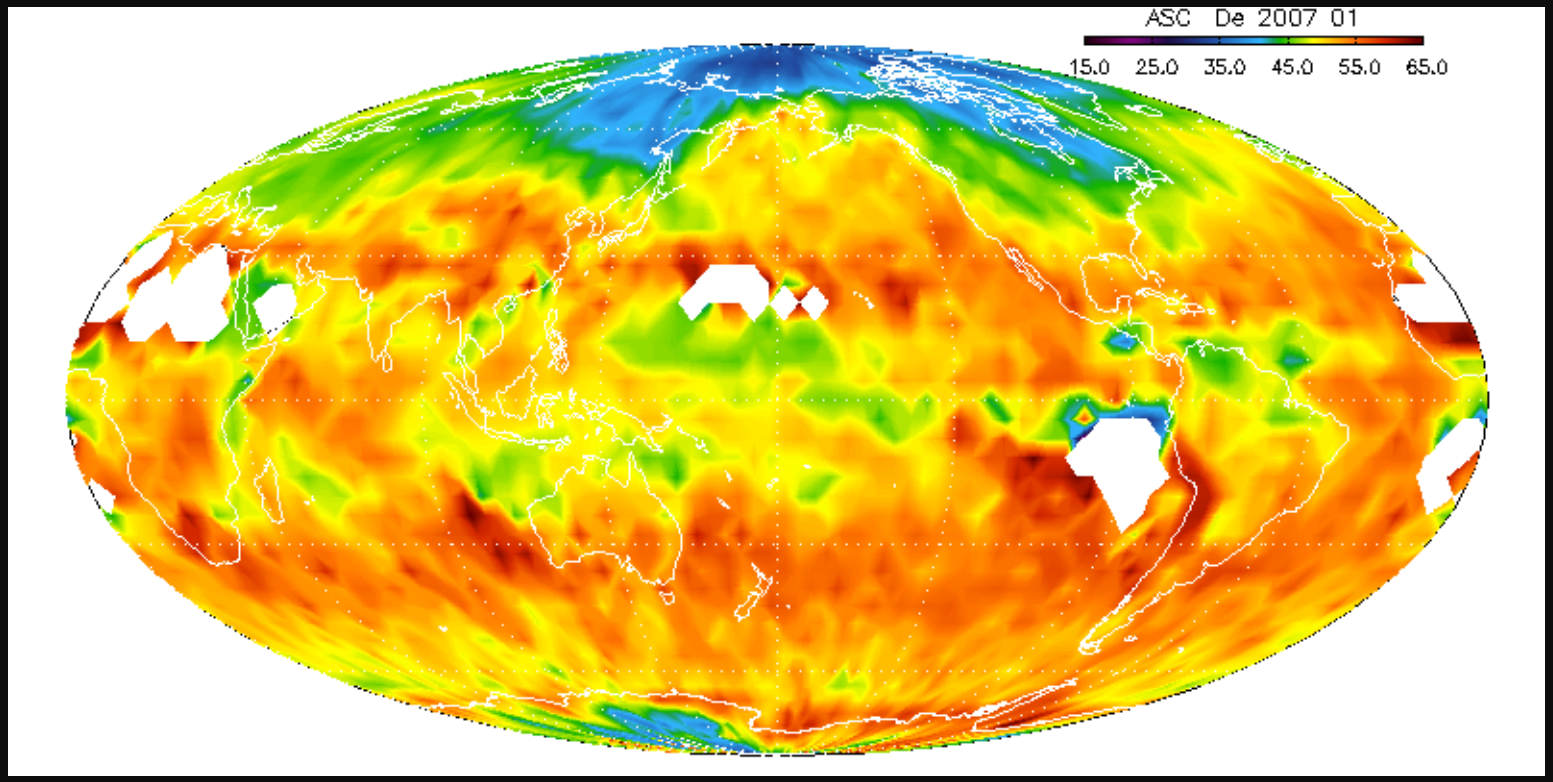
Ascending

Diurnal cycle in total cloud frequency smaller

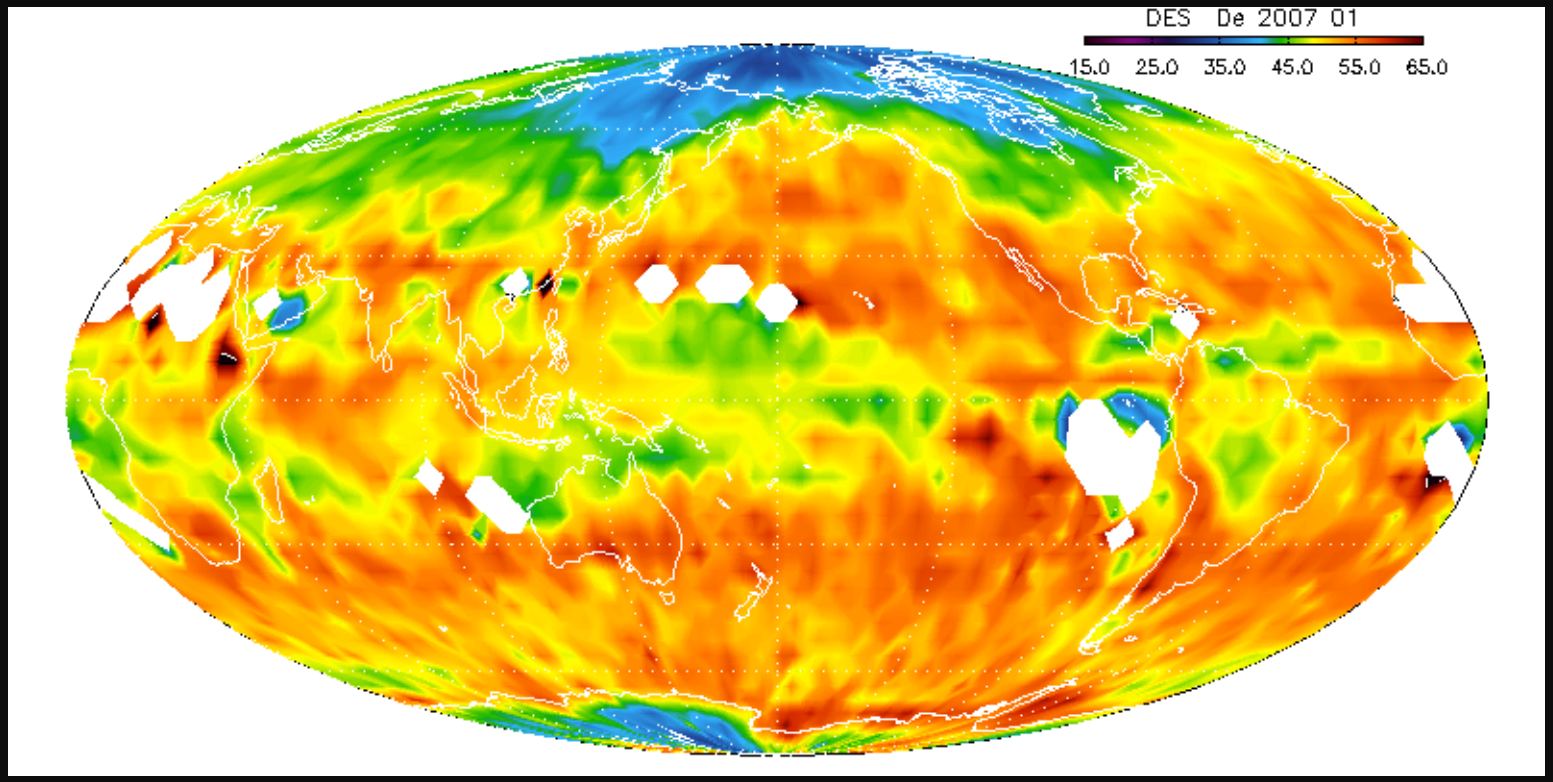


Descending

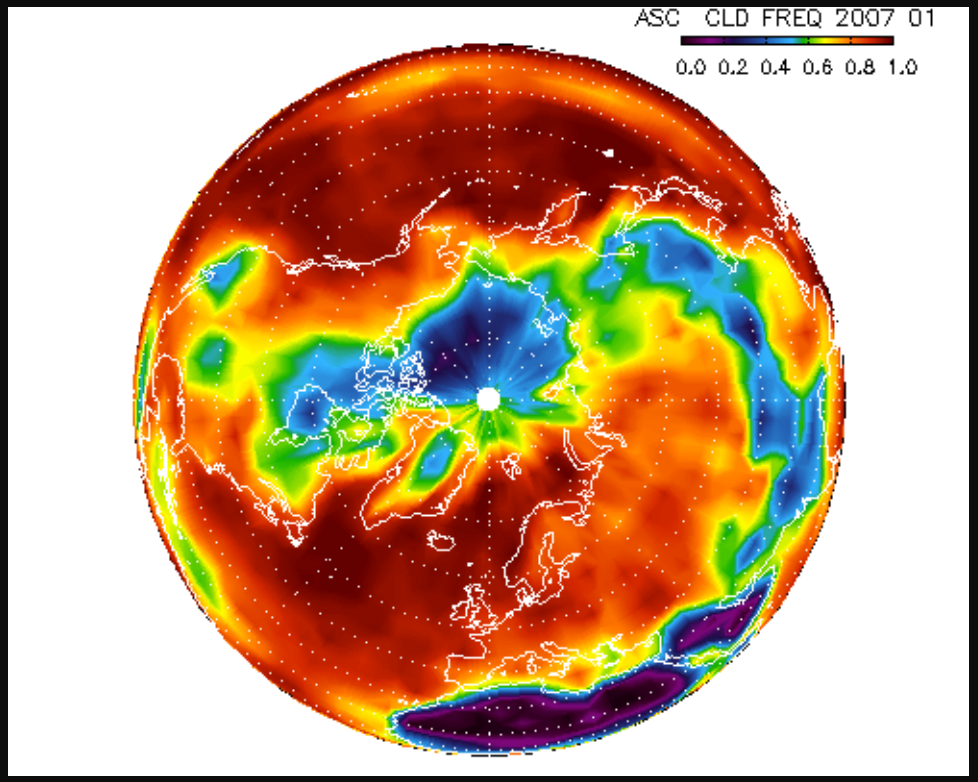
Diurnal impacts in ice cloud effective diameter over land (ascending)

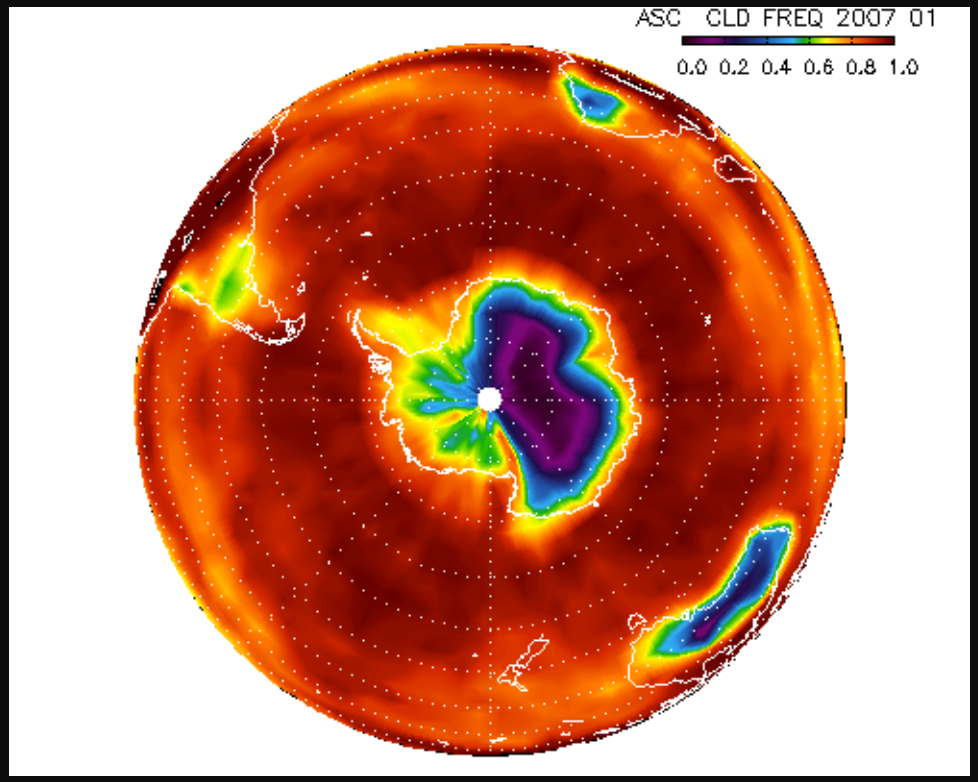


Diurnal impacts in ice cloud effective diameter over land (descending)



Larger diurnal variability in SH Ocean compared to NH Ocean (ascending)





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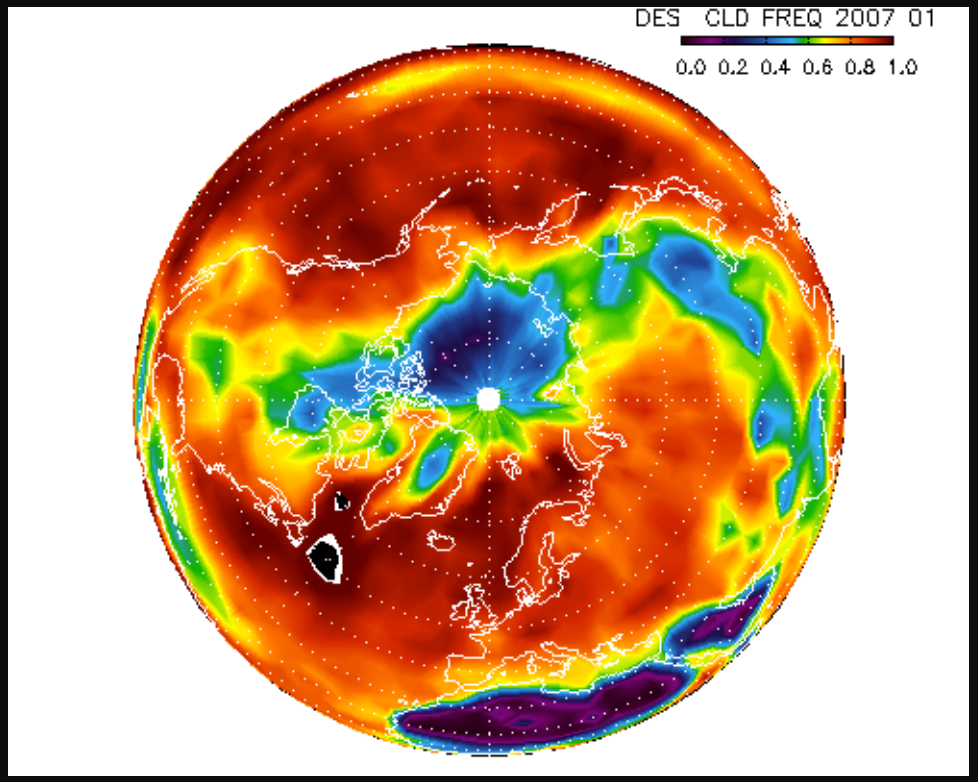
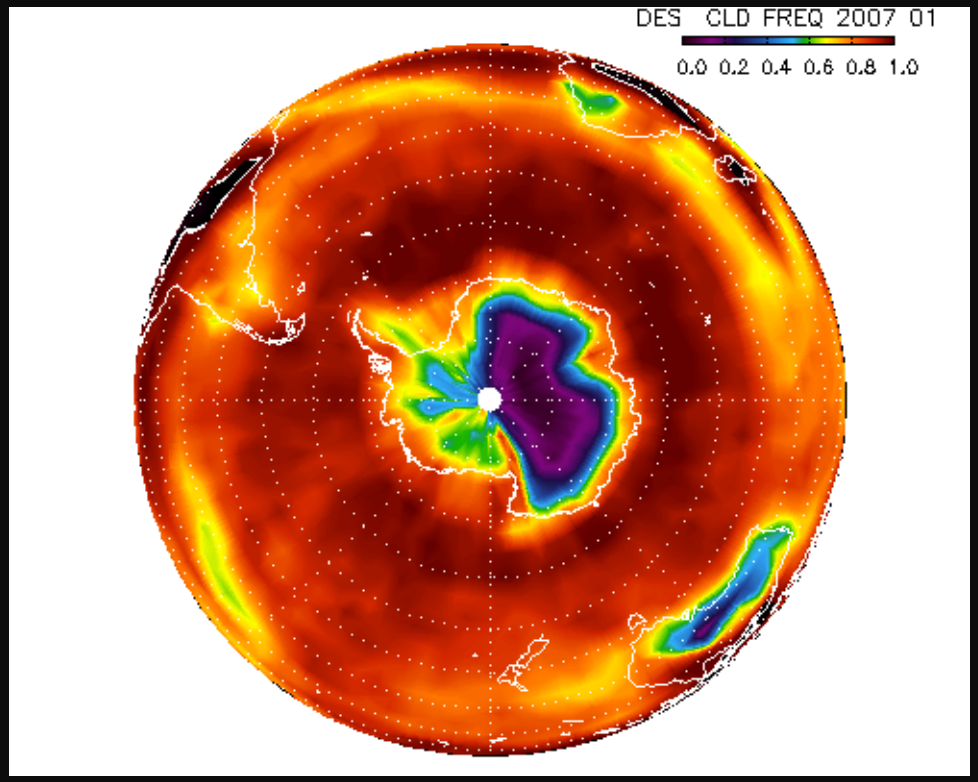
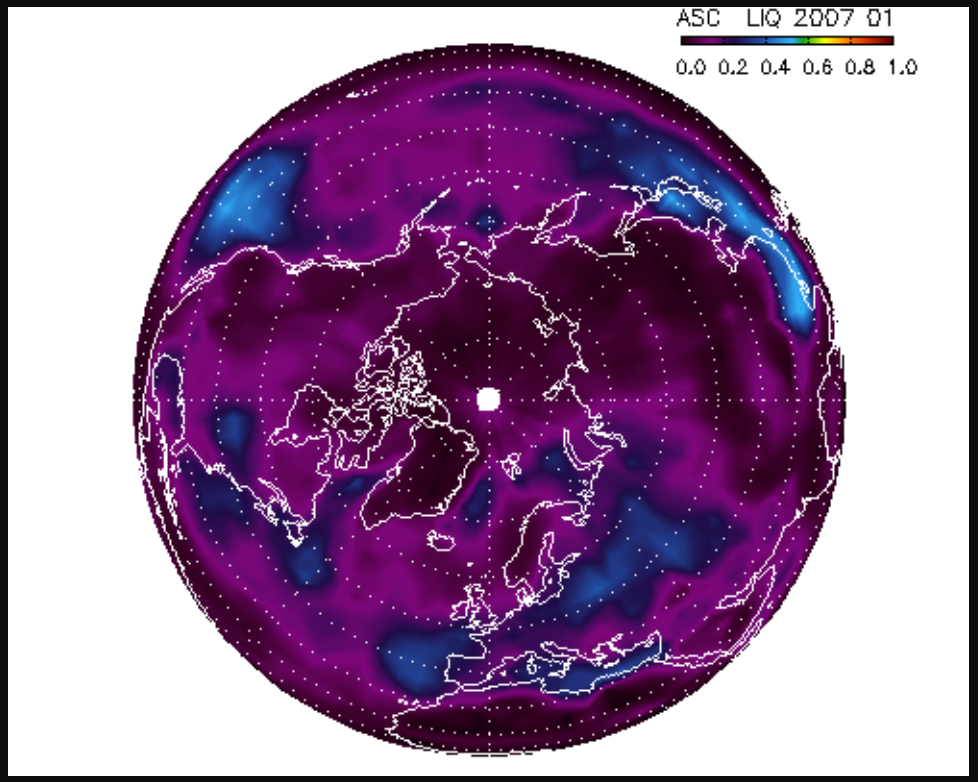
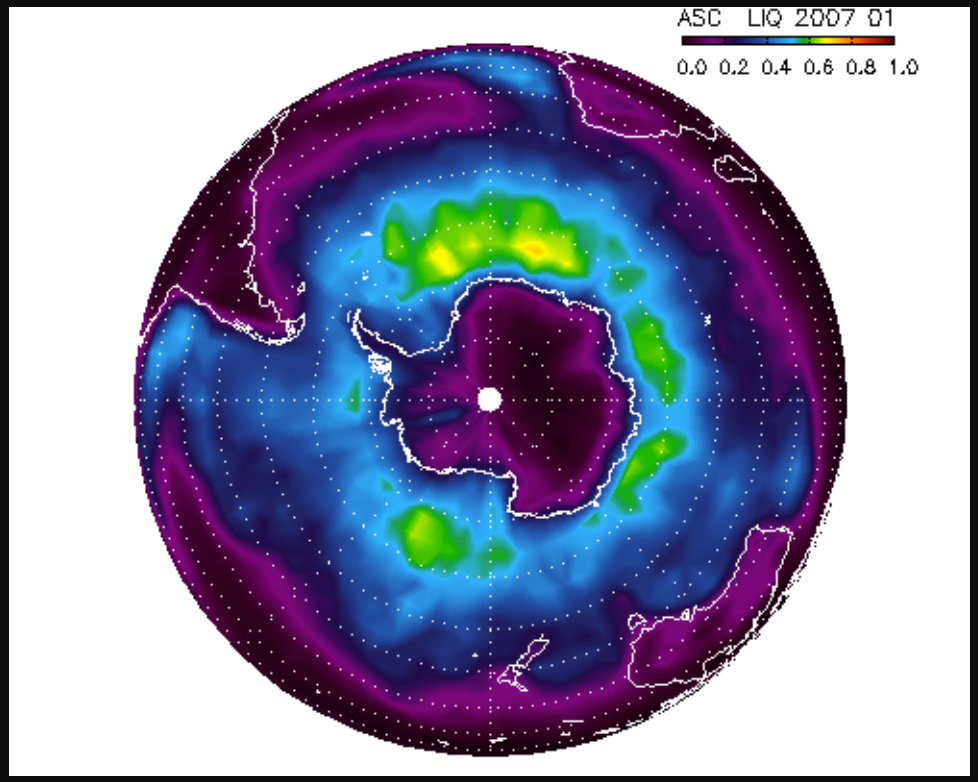




More liquid cloud in SH Ocean at night (ascending)





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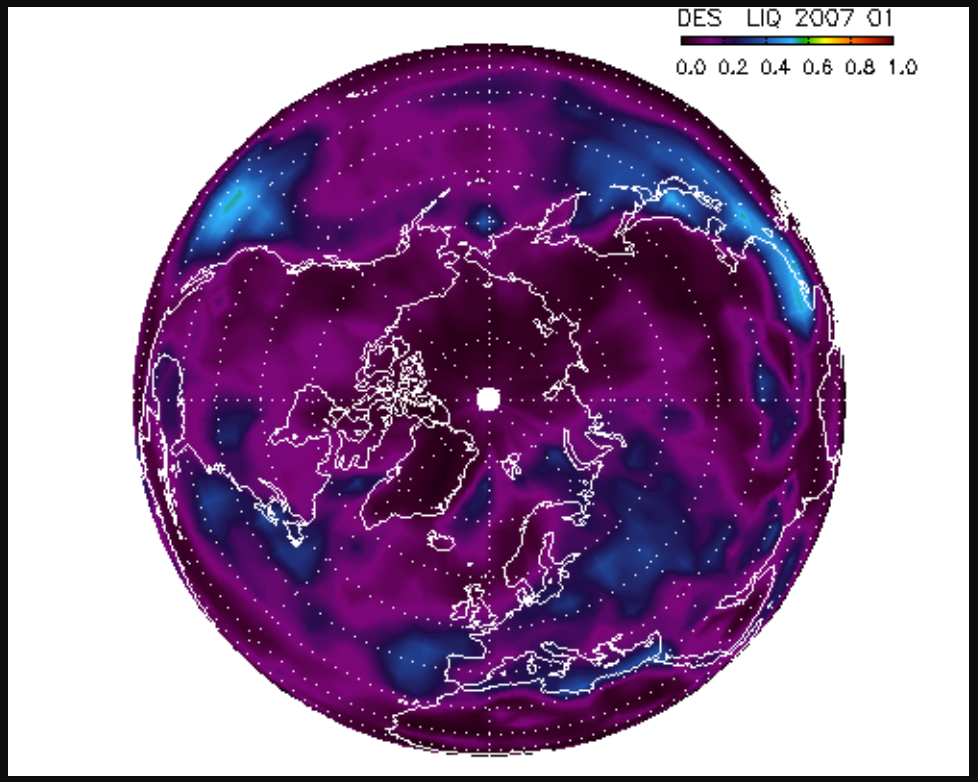
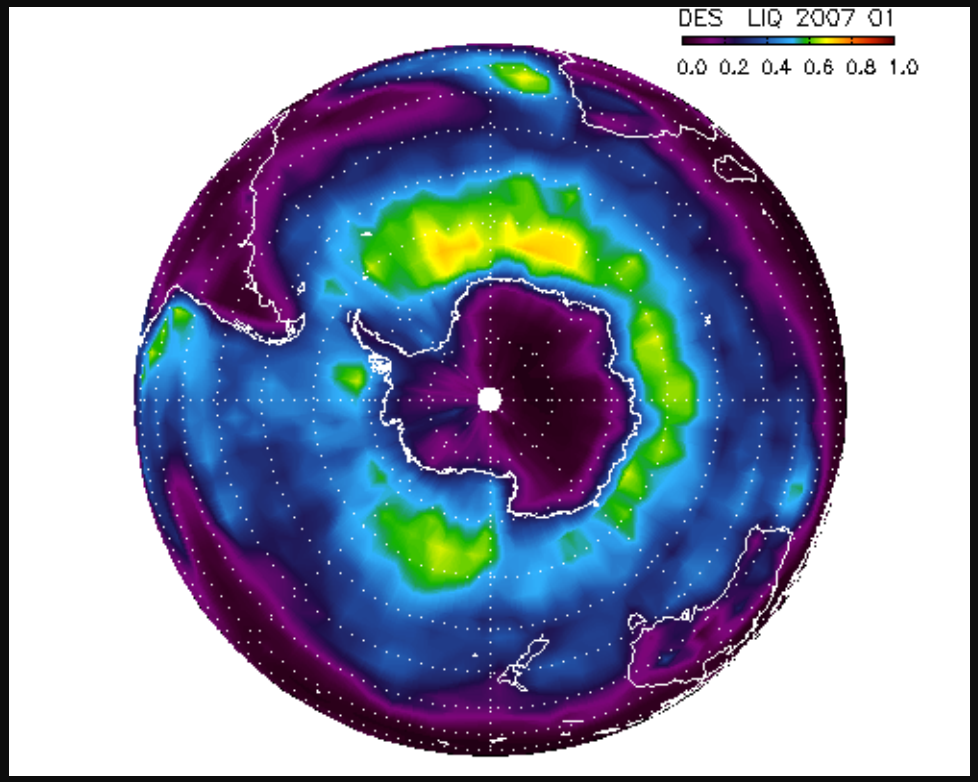
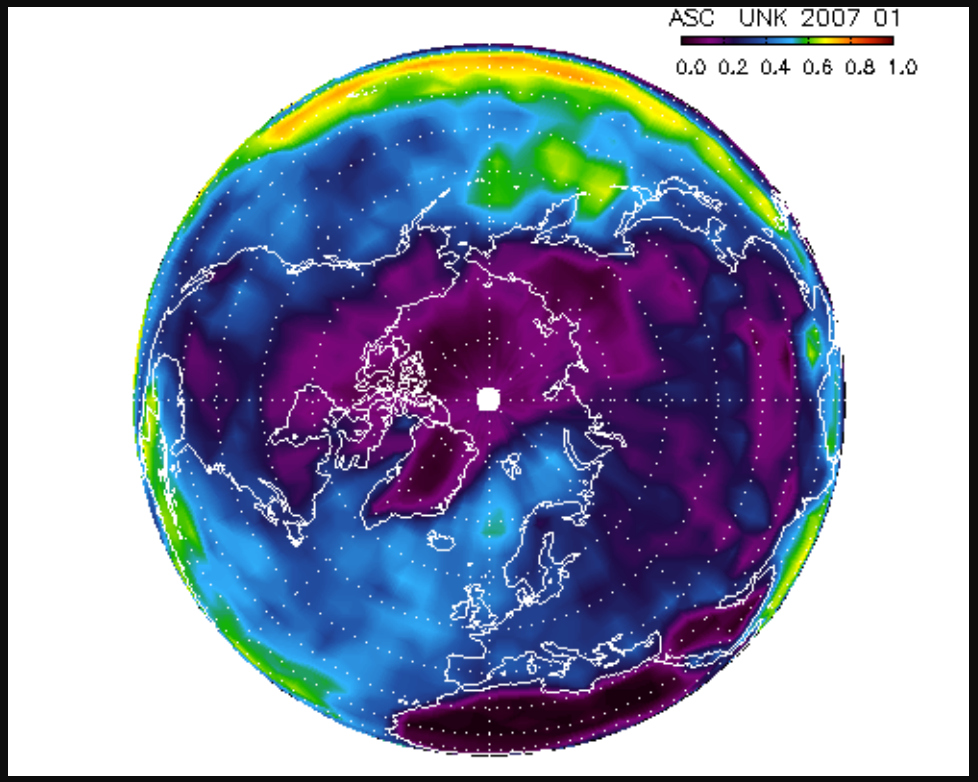
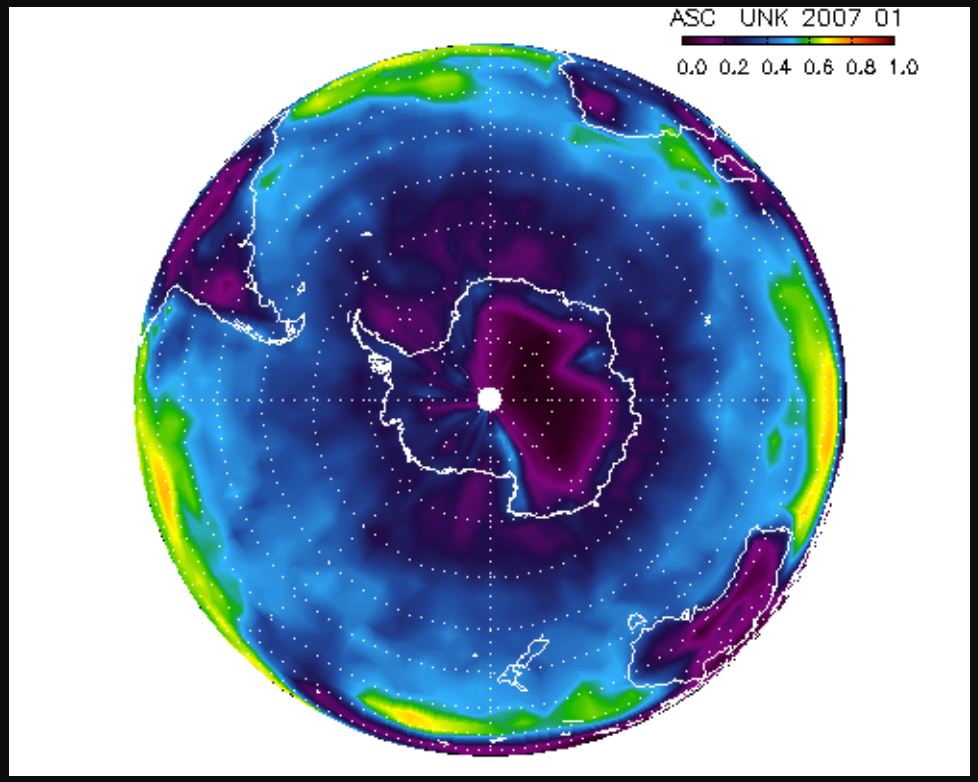




The opposite seems to be true of “unknown” phase, with big land effects in NH (ascending)





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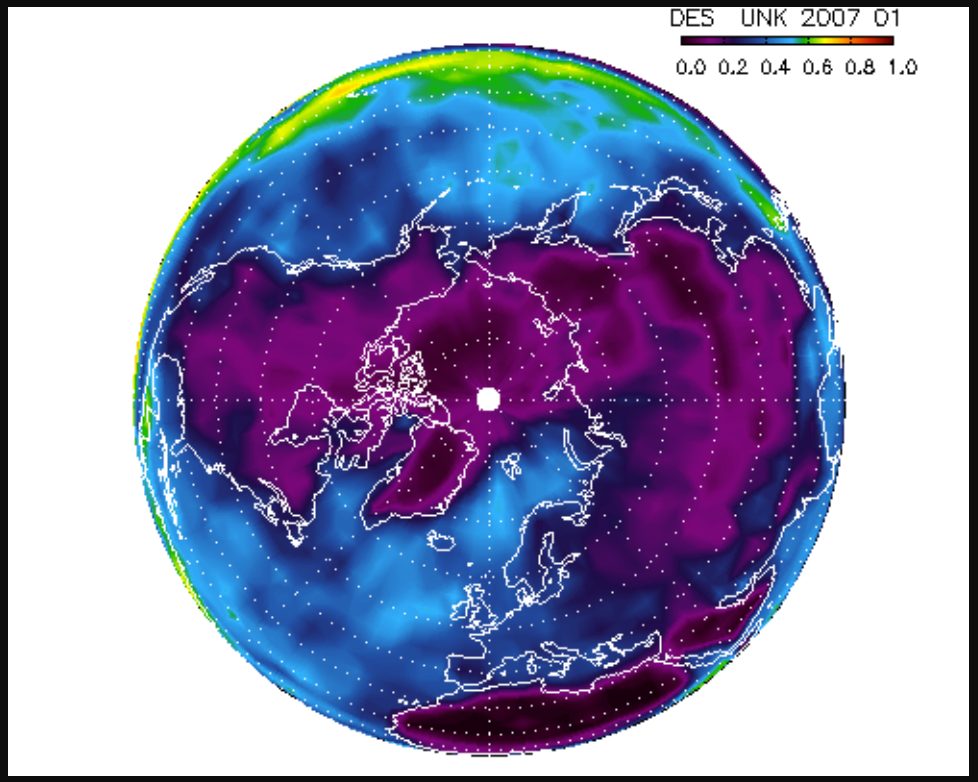
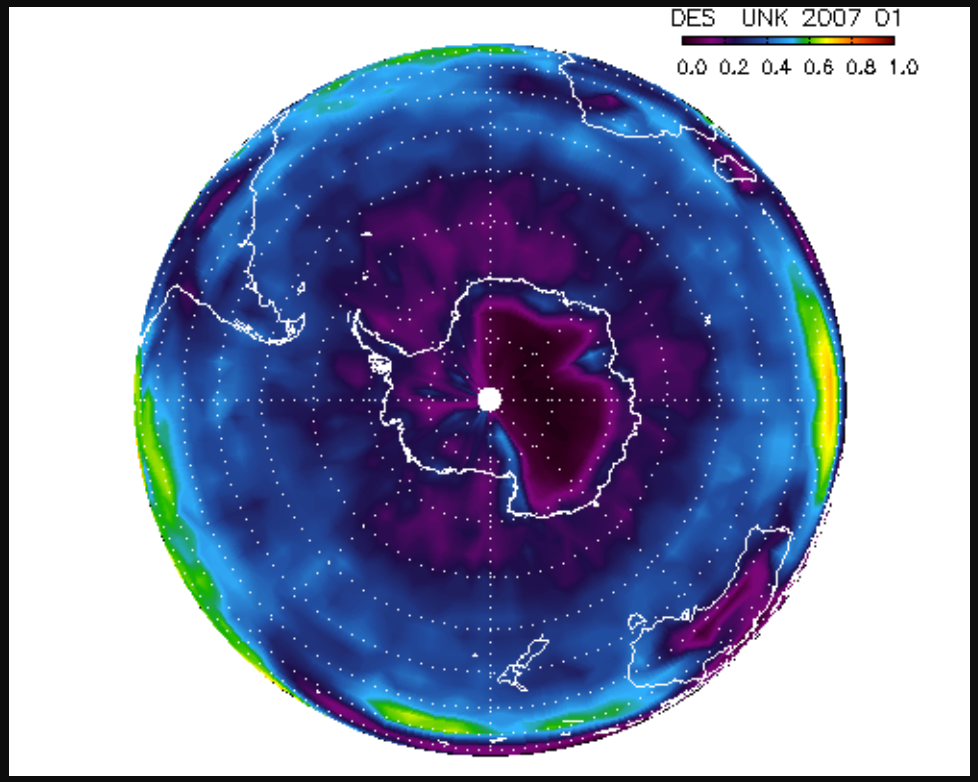


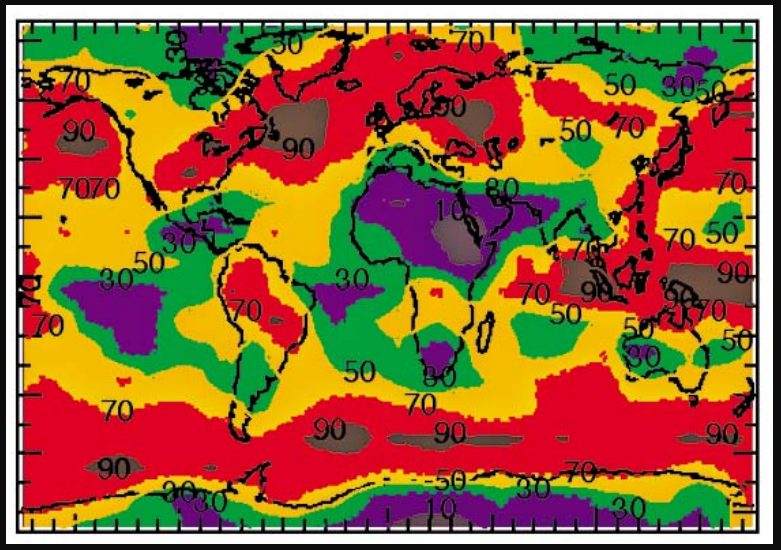


Matching AIRS and MODIS ice cloud effective radius and optical thickness at pixel scale

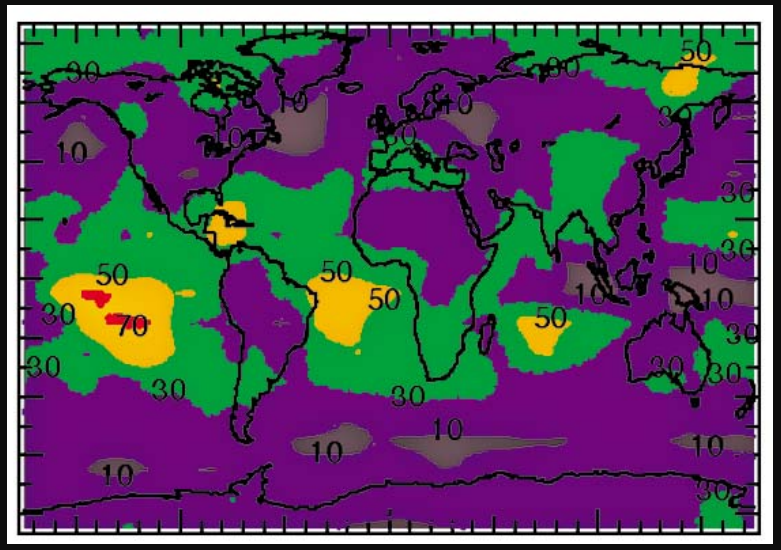
How strongly correlated are these quantities?

Where are the homogeneous/heterogeneous/clear AIRS FOVs located?

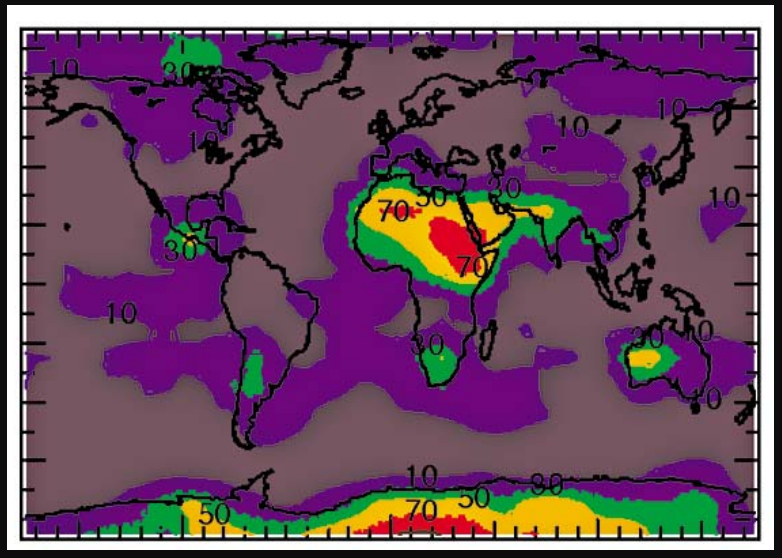
Homogeneous Cloud



Heterogeneous Clouds



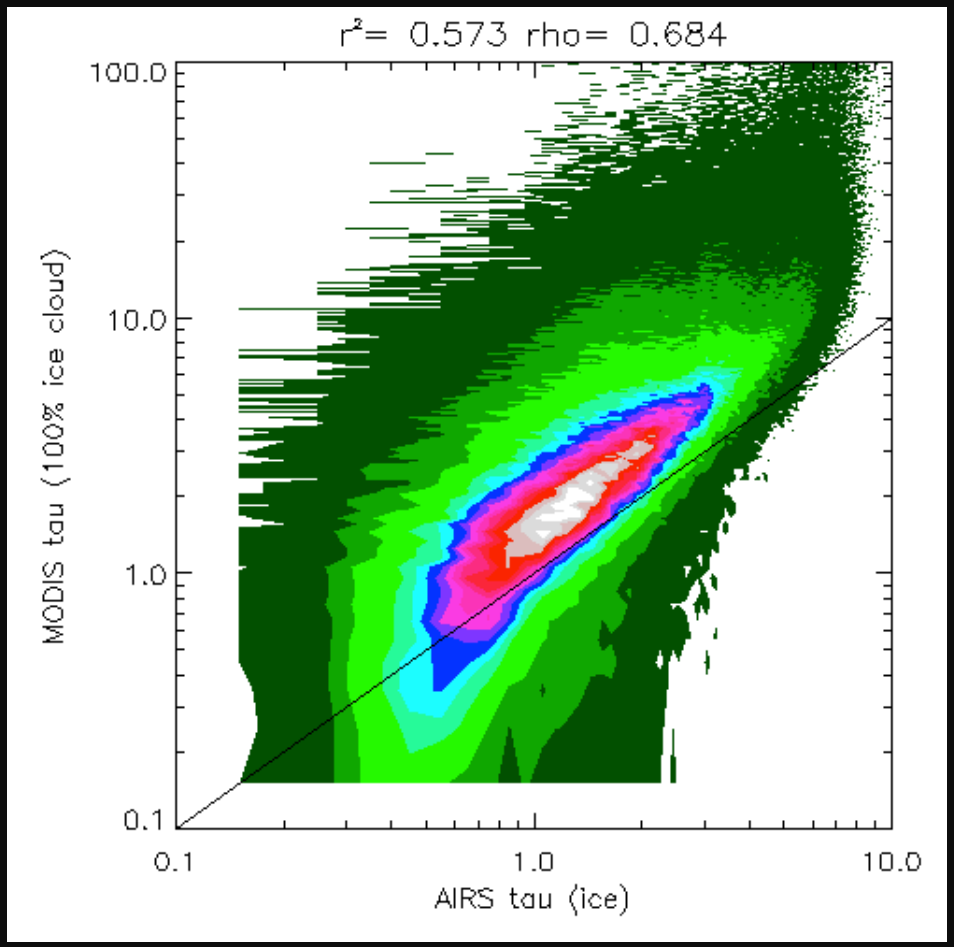
Clear Sky

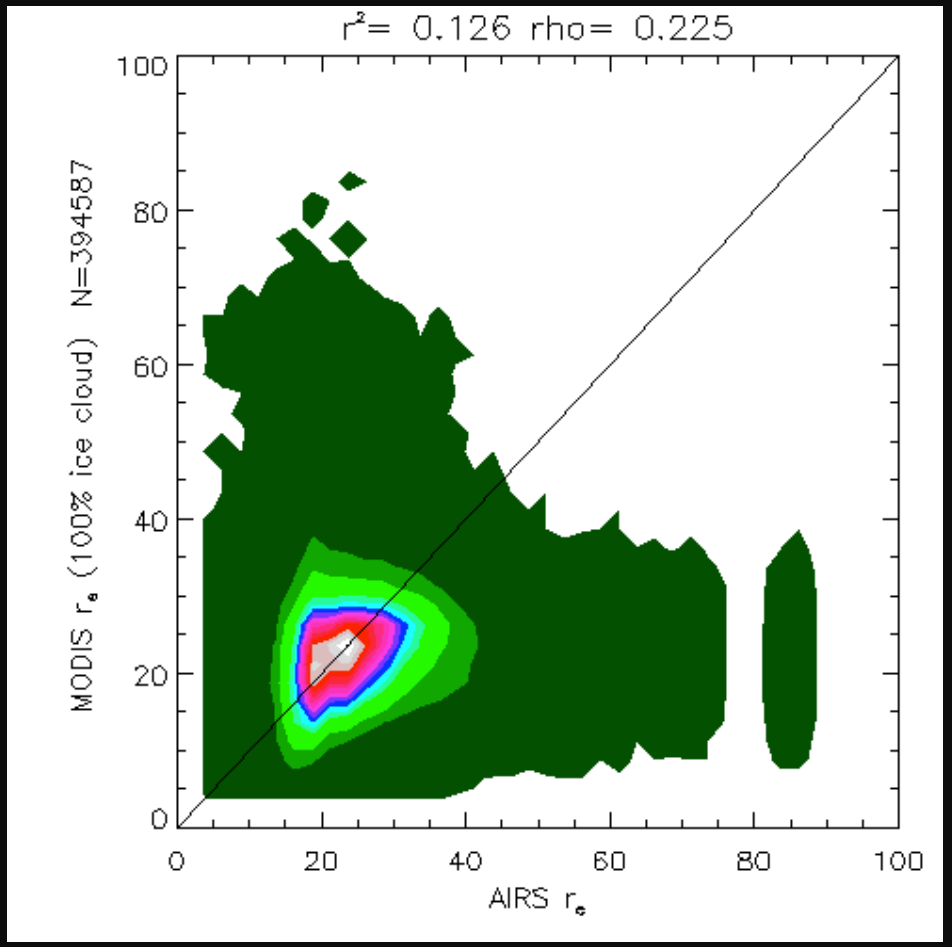


Jan 1–6, 2005

Kahn et al., 2011, J. Geophys. Res.

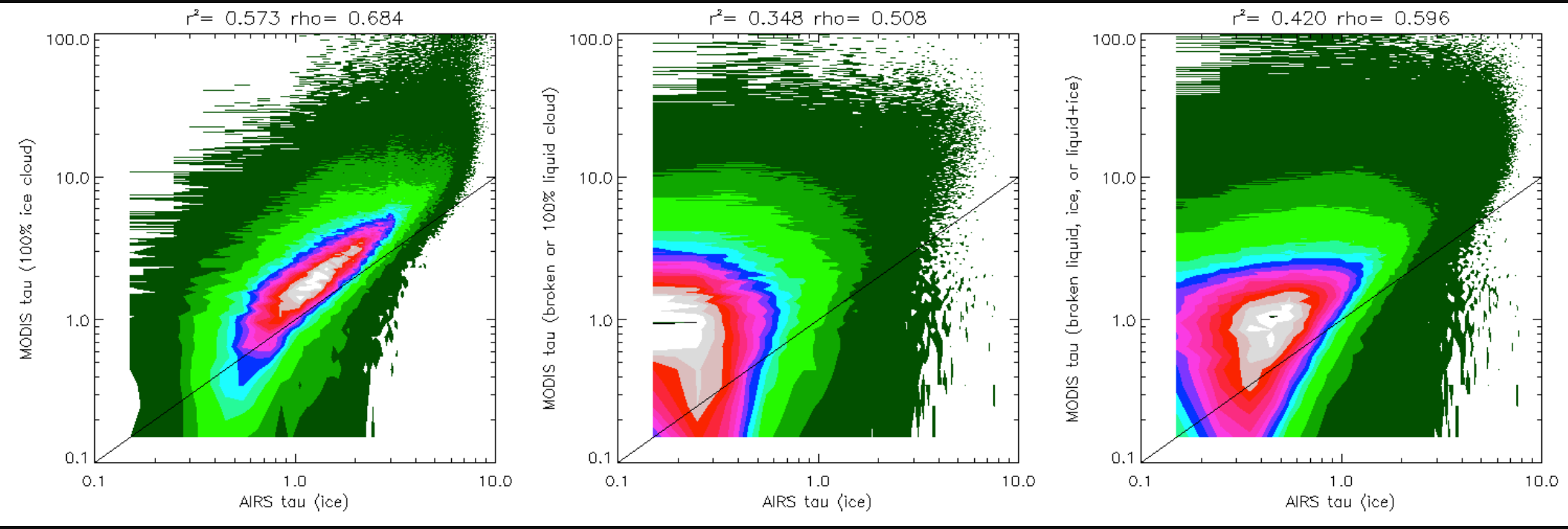
AIRS and MODIS correlations for AIRS FOVs with ice cloud=100%





Kahn et al., 2013, in preparation

When AIRS FOV contains less than 100% ice cloud (according to MODIS), correlation breaks down



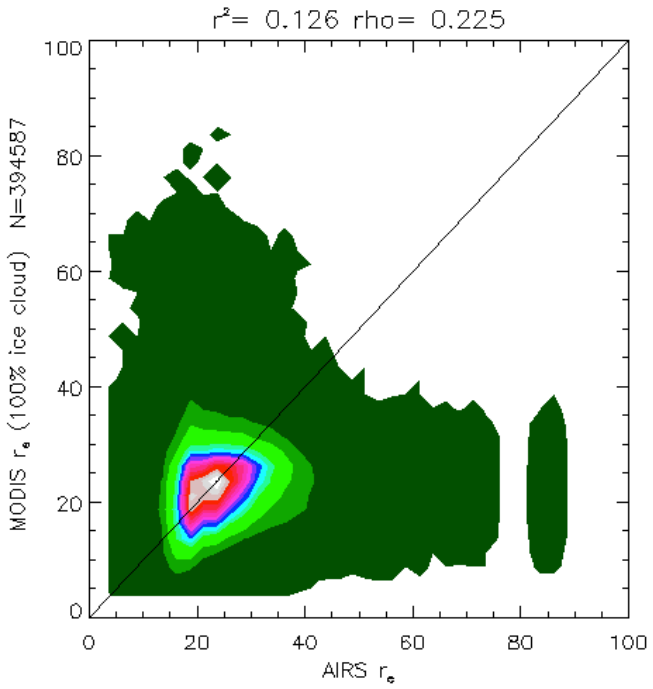
100% ice

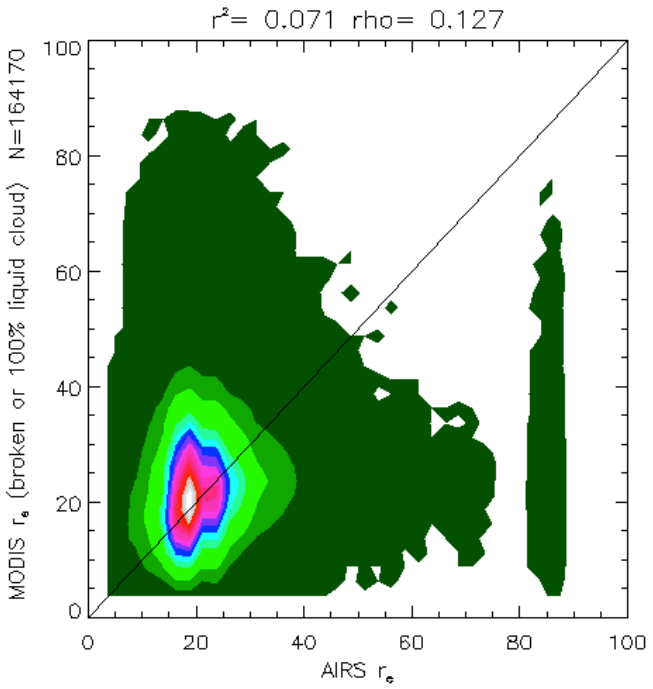
0% ice , <100% liquid

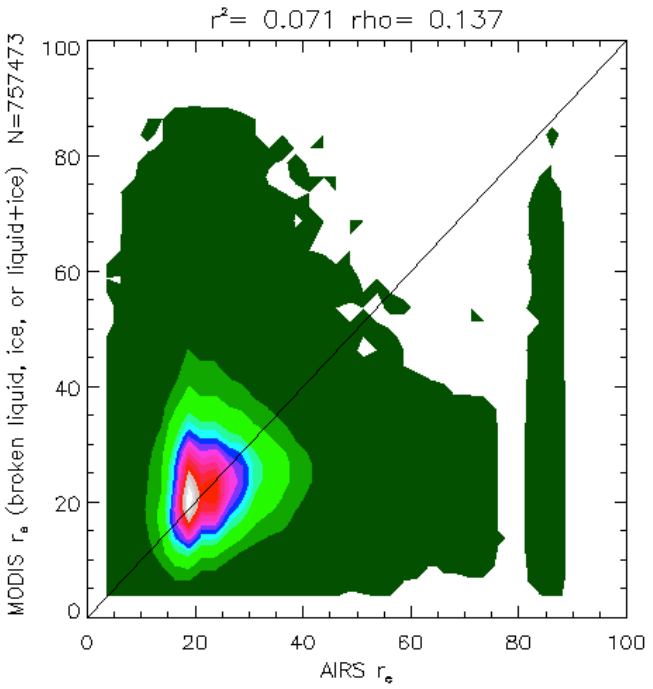
Mix of ice and liquid

Kahn et al., 2013, in preparation

Weak correlation in effective radius comparisons and little dependence on pixel heterogeneity: a difficult retrieval







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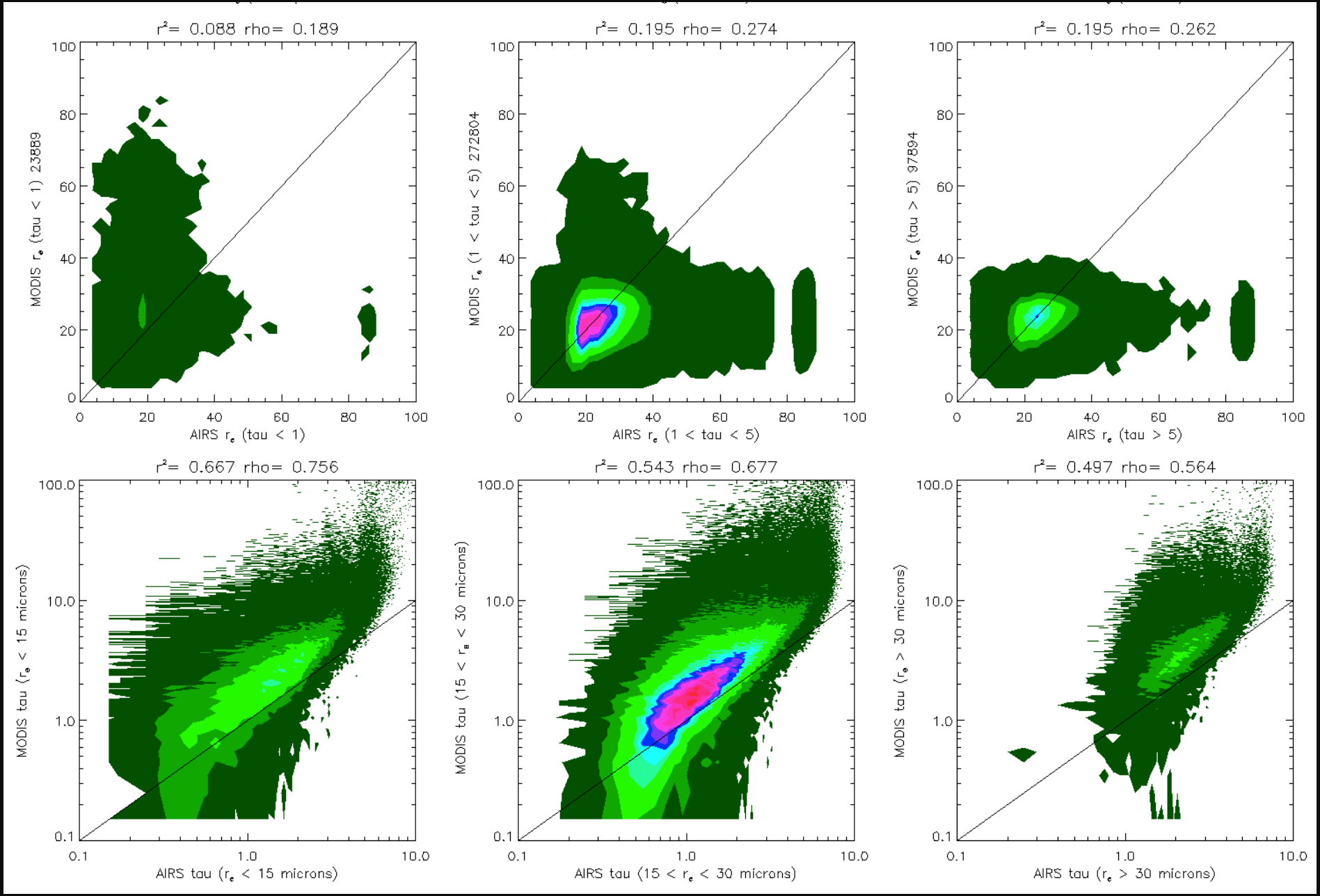
Mix of ice and liquid

Kahn et al., 2013, in preparation

Binning optical thickness & effective radius by each other shows "sweet spots" in sensitivity



Kahn et al., 2013, in preparation

Highlights from the new AIRS cloud products

- AIRS is excellent at characterizing ice clouds over the diurnal cycle
  - Sensitive to detection and retrieving geophysical information
- The diurnal cycle is locally stronger in optical thickness, effective diameter, and cloud thermodynamic phase components compared to cloud frequency
  - Some hints of continental scale and hemispheric scale diurnal cycle?
- Liquid water clouds very common around Antarctica in summer
  - This is determined despite AIRS' suboptimal ability to detect liquid
- MODIS and AIRS effective diameter and optical thickness agree best in FOVs with 100% ice cloud
  - "Sweet spots" in correlation depend on value of binning in effective radius, optical thickness, and latitude

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- What's next? Perhaps joint retrievals make sense… stay tuned!