New AIRS Version 6 cloud top retrievals of ice cloud properties and thermodynamic phase

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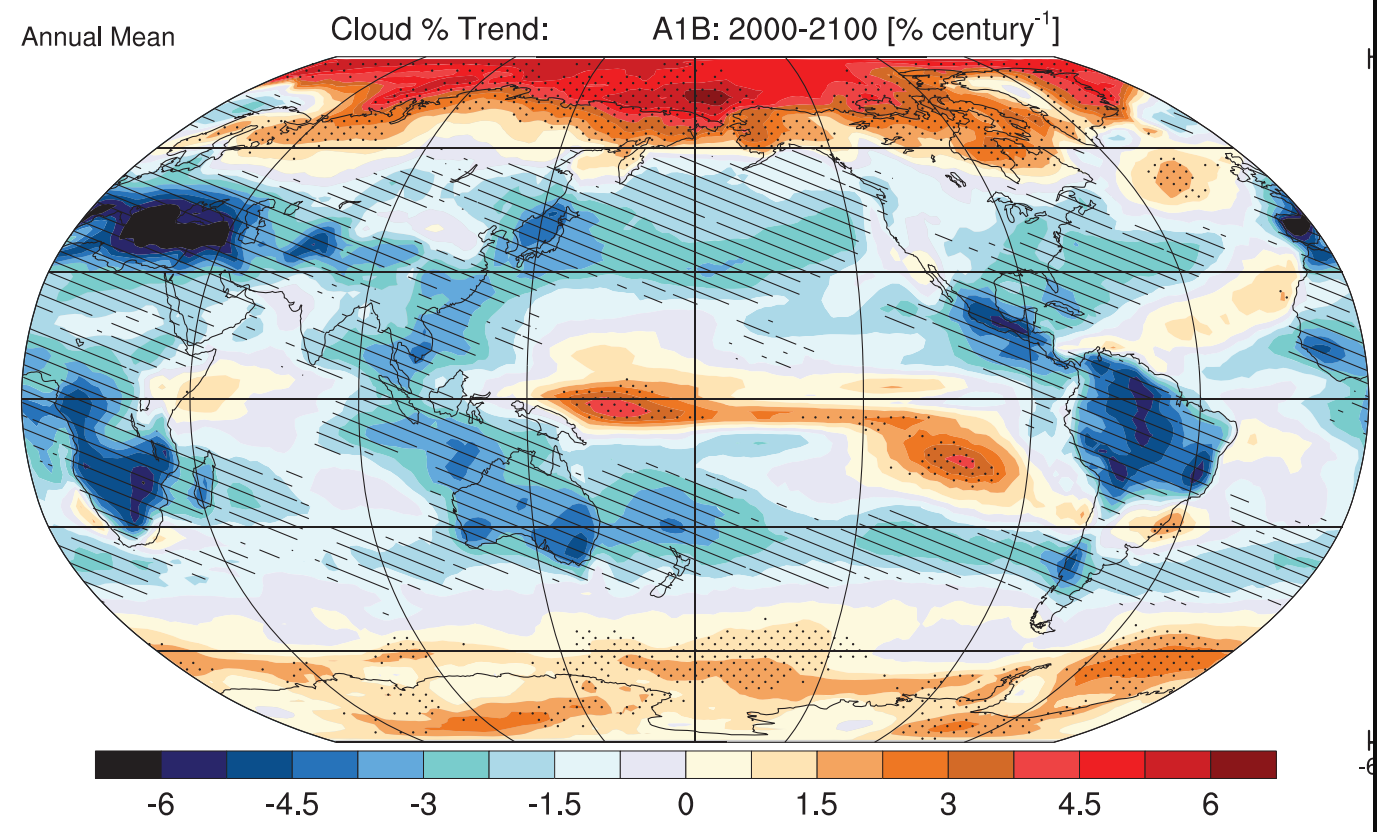
Highlights from the new AIRS cloud products

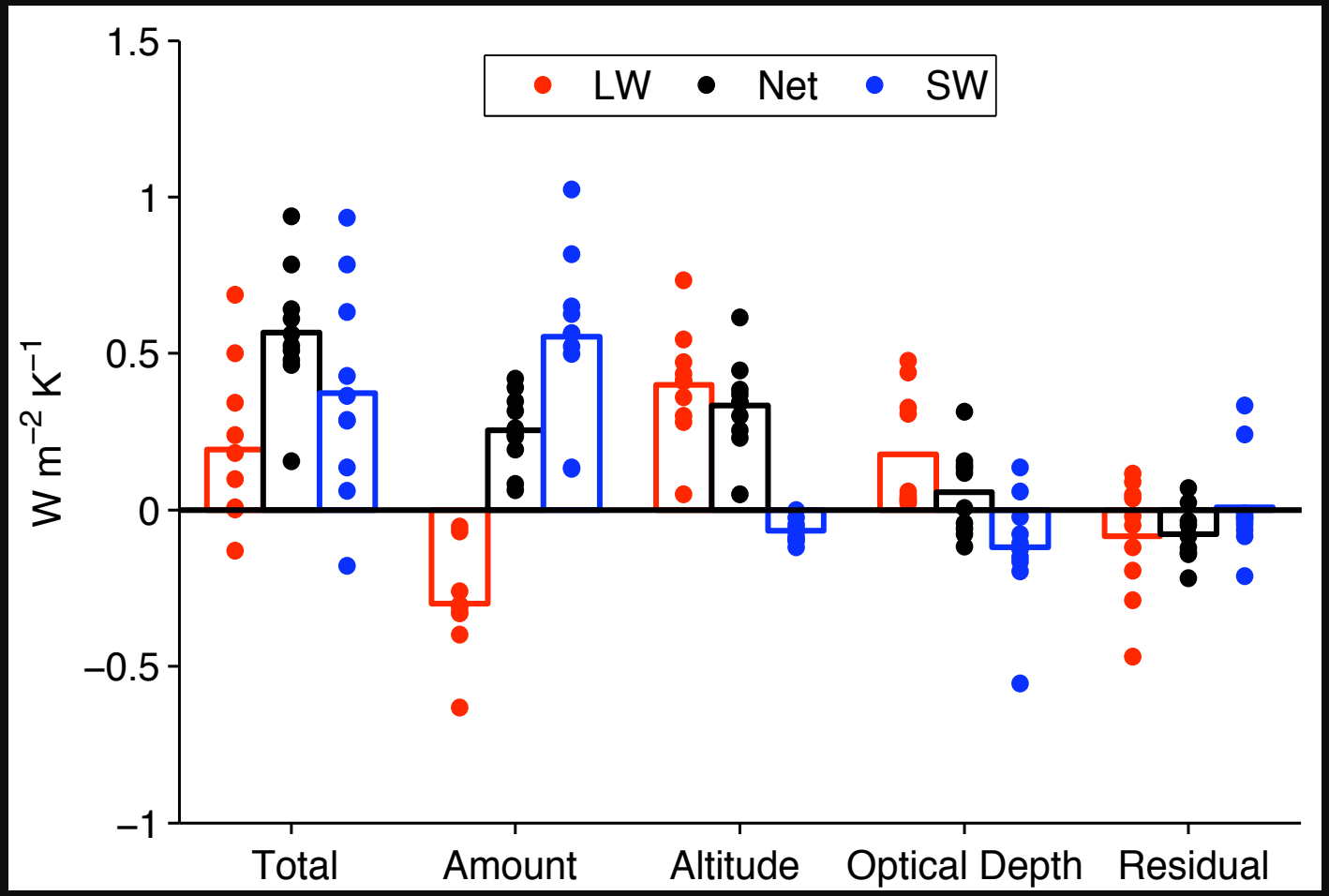
- The quantification of cloud properties, and their spatial and temporal distributions, is necessary for climate change research
- Distributions of AIRS thermodynamic phase and ice cloud properties is realistic
  - Complex spatial and temporal behavior is observed
- AIRS is excellent at characterizing ice clouds
  - Sensitive to detection and retrieving geophysical information
- AIRS is suboptimal at characterizing liquid water clouds
  - Persistent summertime occurrence around Antarctica is a big surprise
  - "Unknown" phase appears to track shallow cumulus frequency
- Cloud frequency and phase spatial distributions responsive to atmospheric modes of variability
  - Two examples with ENSO

AR4 Climate Models have Distinct Latitude, Regional, And Cloud-Type Trends



Trenberth and Fasullo (2010), J. Climate

Cloud-Climate Feedbacks in IPCC Models Differ in Sign and Magnitude



Zelinka et al. (2012), J. Climate (in press)

Summary of New AIRS Version 6 Cloud Products

- Optimal estimation retrieval (post-processor) of:
  - *ice cloud effective diameter* (D_e)
  - *ice cloud optical depth* (OD)
  - *ice cloud top temperature* (T_{cld})
  - *cloud thermodynamic phase: ice, liquid, unknown*

- These are ***different*** from AIRS standard product retrieval

- Retrieval heritage from Tropospheric Emission Spectrometer (TES) instrument team

- SARTA+D4S RT model; AIRS L2 atmospheric inputs and a priori surface, and single-layered cloud; Baum et al. (2007) scattering models; ~60 channels in 8–15 μm region

- Chi-squared fits (observed vs. simulated radiances) and scalar averaging kernels (AKs) >> "user friendly" Quality Control (*Best*, *Good*, and *Bad*)

- Retrievals restricted to AIRS FOVs identified as *possibly* or *likely* containing ice

Summary of New AIRS Version 6 Cloud Products

- Both OD and T_{cld} have *Best*, *Good*, and *Bad* indicators

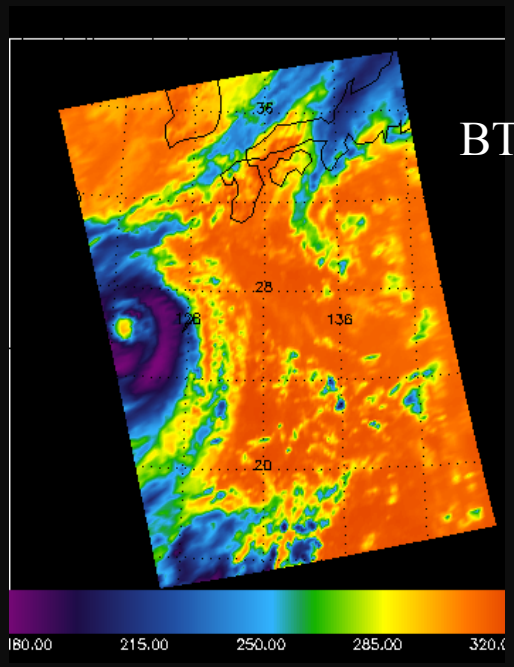
  Best: chi-squared < 10 and AK > 0.8
  Good: chi-squared > 10 or AK < 0.8
  Bad: chi-squared > 10 and AK < 0.8

- D_e only has *Good* and *Bad* – the hardest parameter to retrieve

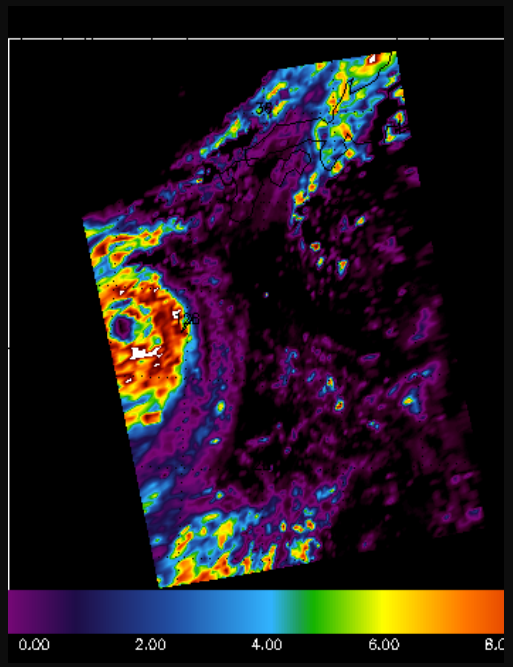
  Good: chi-squared < 10 and AK > 0.8
  Bad: chi-squared > 10 or AK < 0.8

- Quality control indicators are not absolute nor quantitative

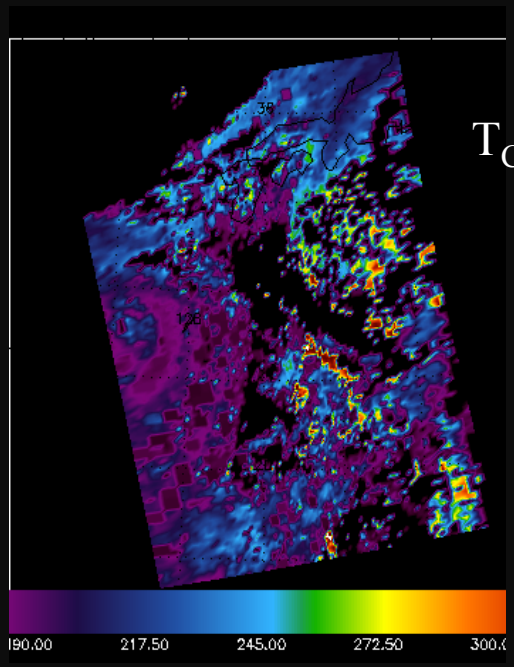
An Example AIRS Granule



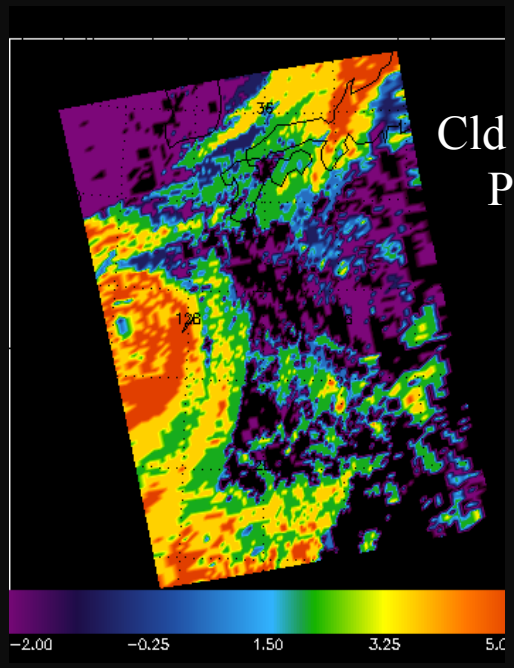
BT @ 960



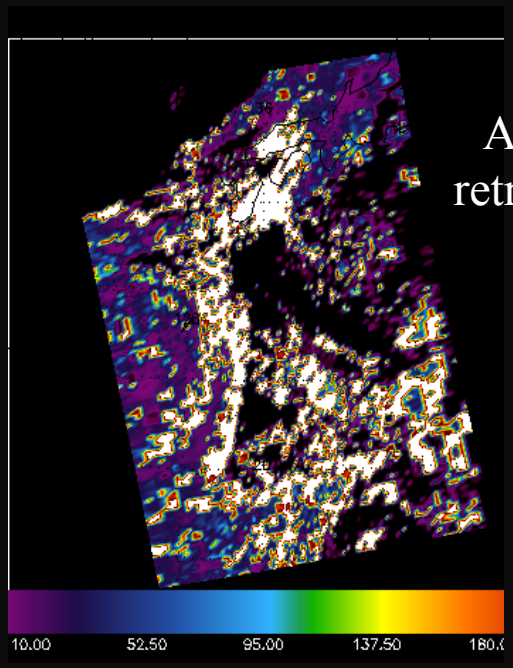
OD



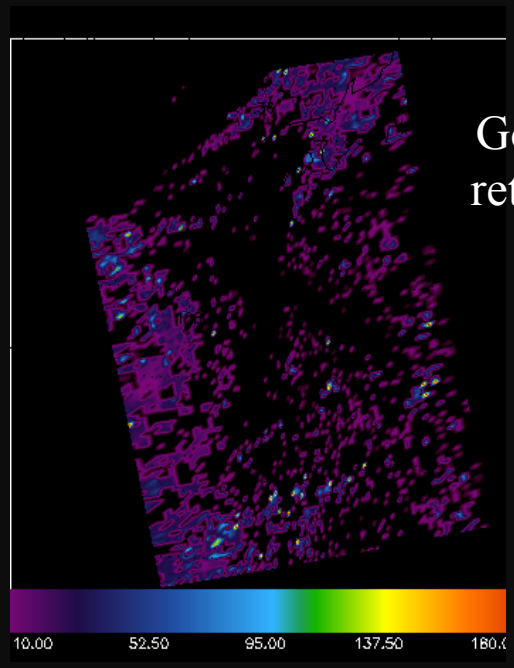
T_{CLD}



Cld Therm Phase



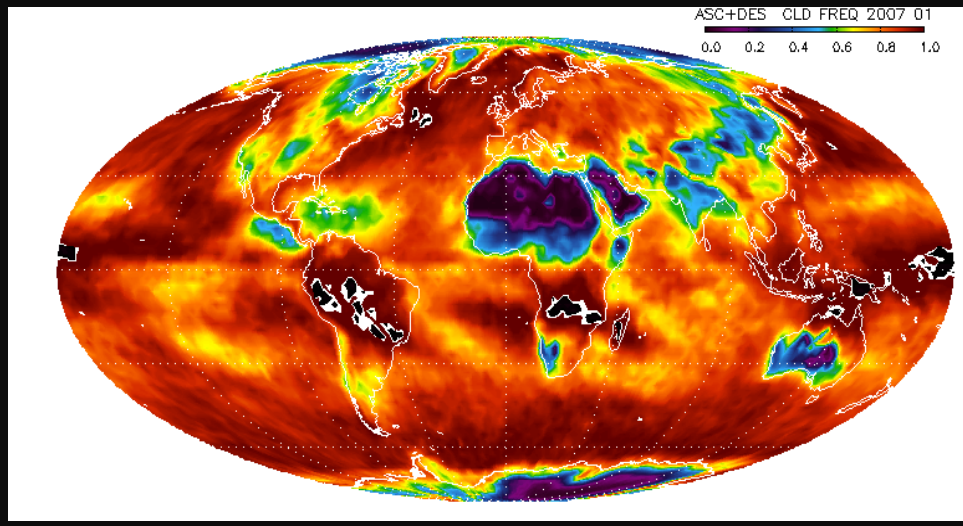
All D_e retrievals



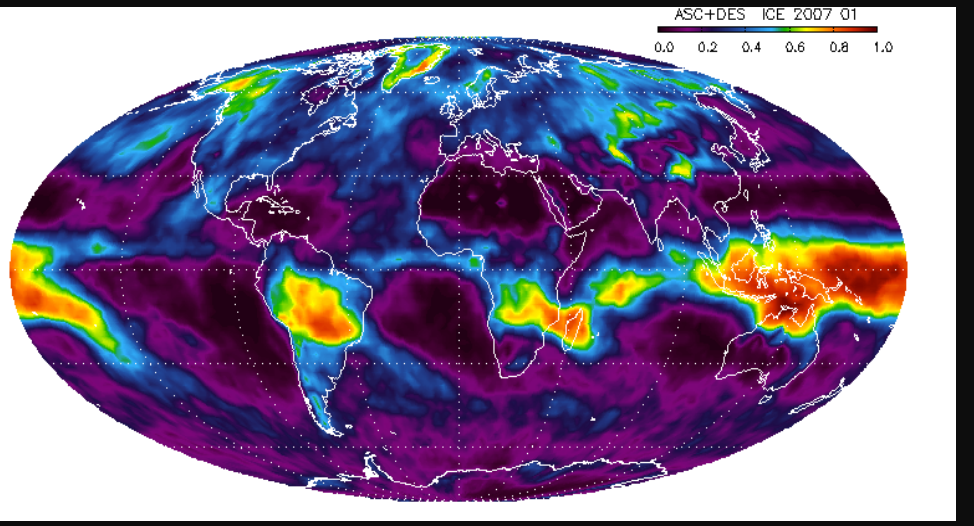
Good D_e retrievals

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

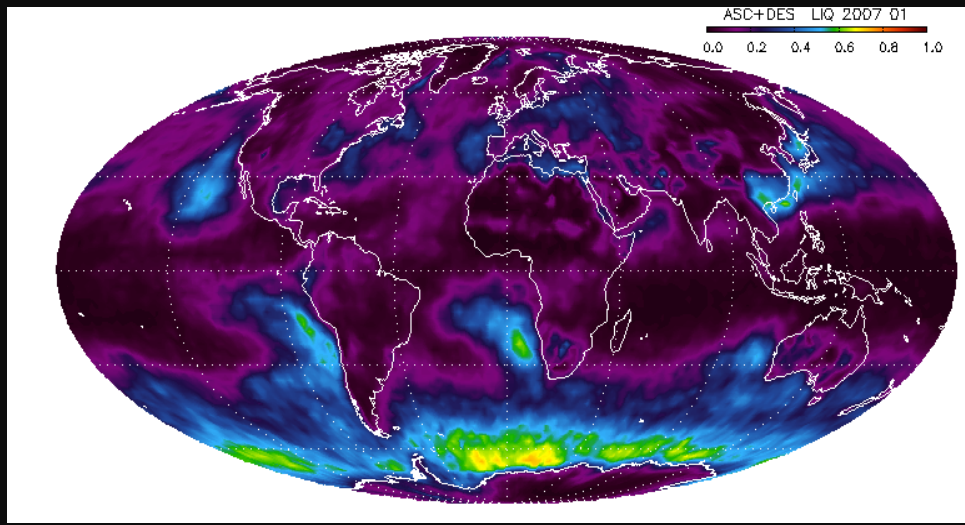
Cloud Frequency



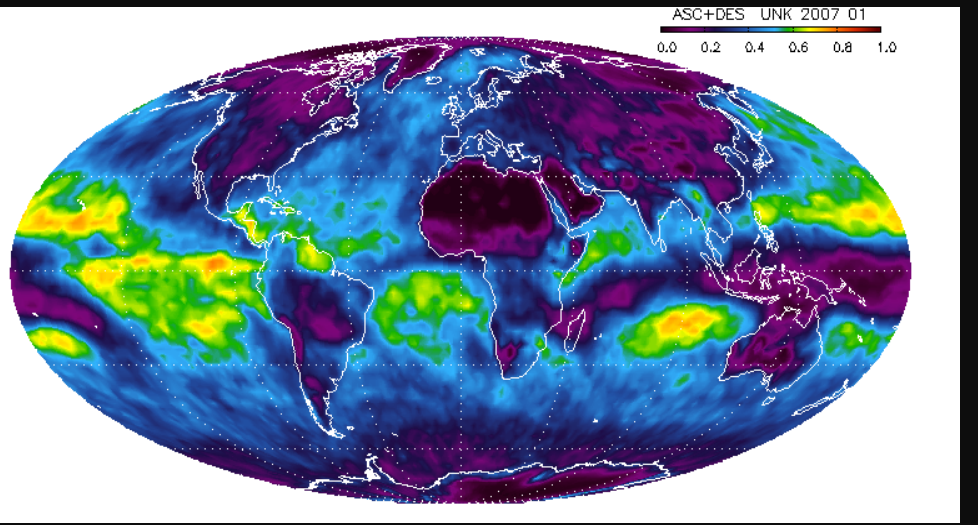
Ice



Liquid



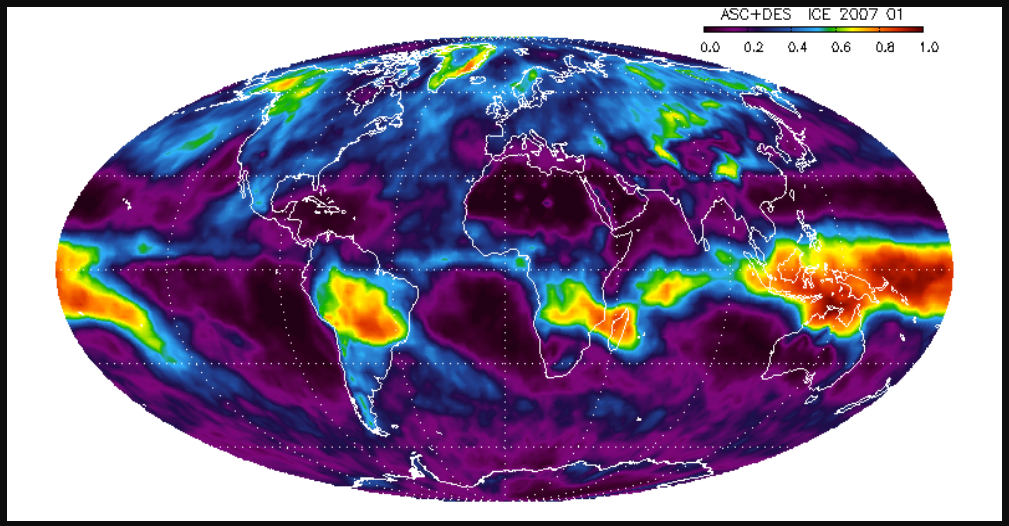
Unknown



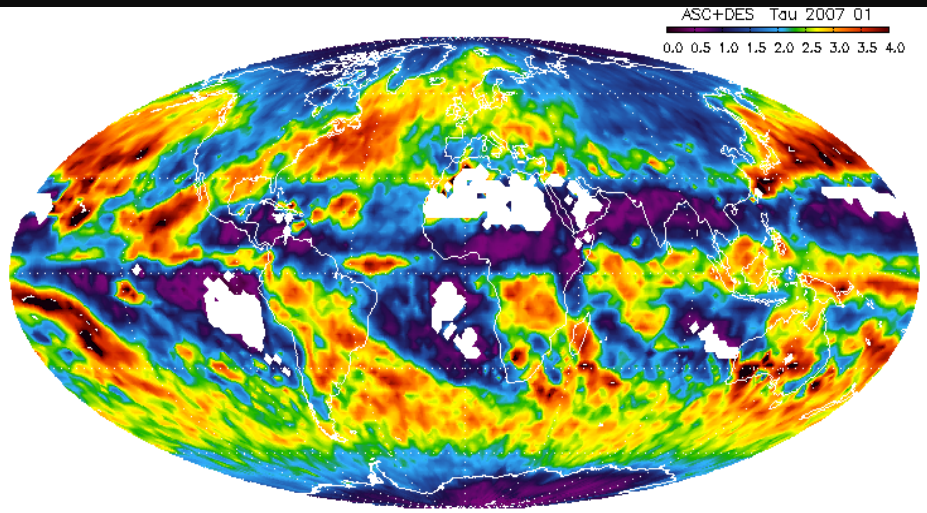
Kahn, Jin, Nasiri et al. (2012) (in preparation)

Global Ice Cloud Microphysical Properties – The First Day/Night & Land/Ocean Climatology

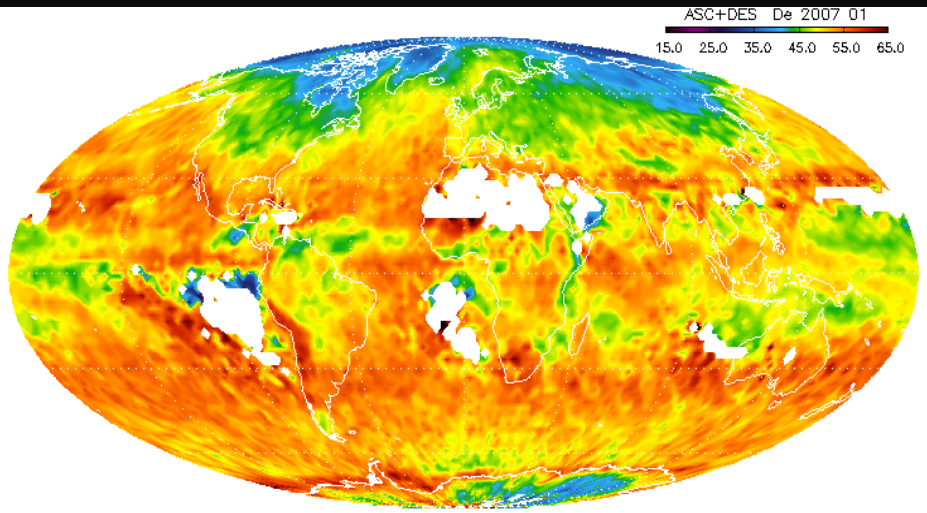
Ice Cloud Frequency



Optical Thickness



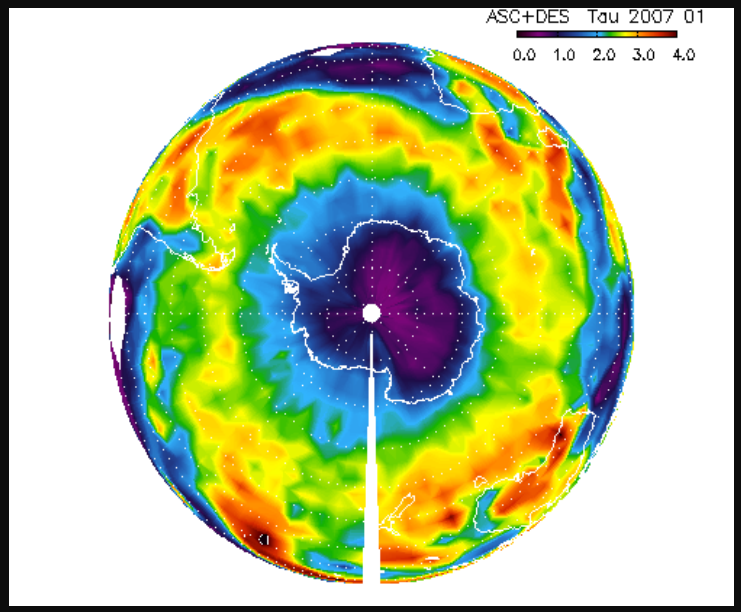
Ice Cloud Effective Diameter



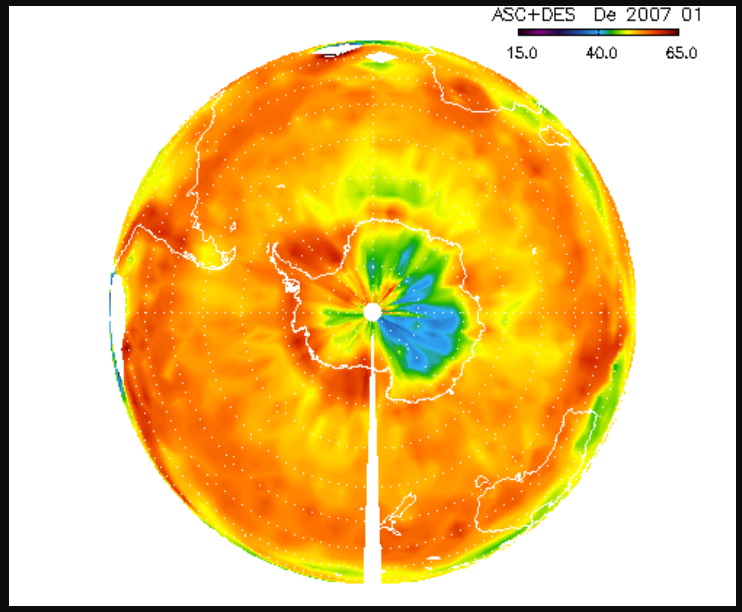
Kahn, Irion, et al. (2012) (in preparation)

AIRS has a Unique Viewing Perspective of High Latitudes

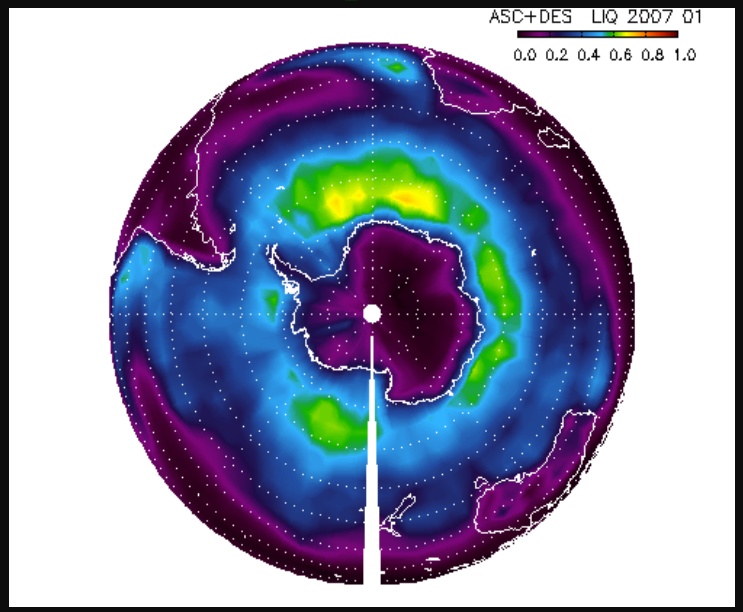
Optical Thickness



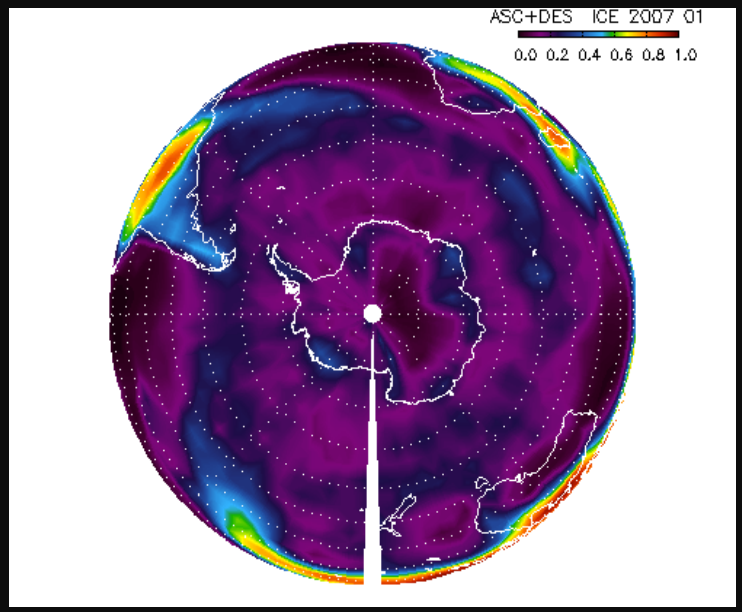
Ice Cloud Effective Diameter



Liquid

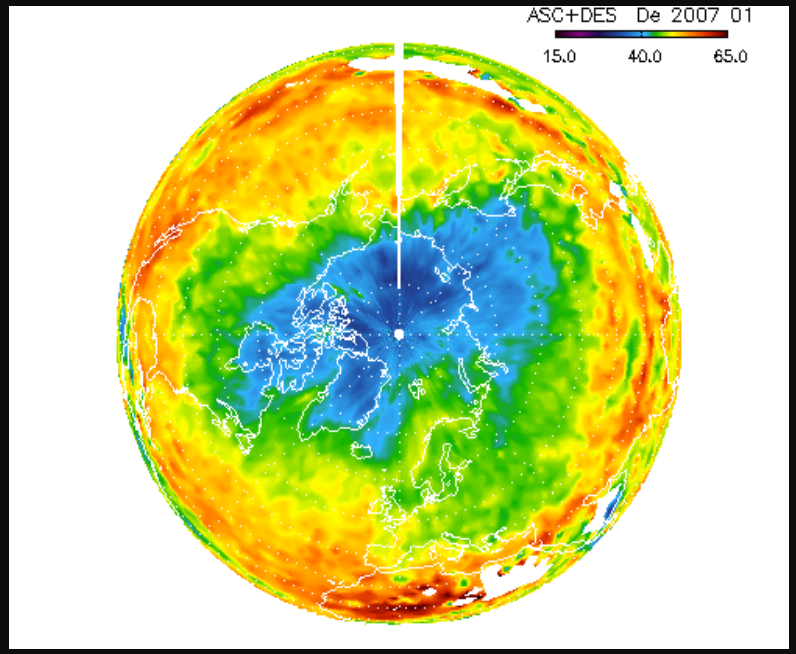


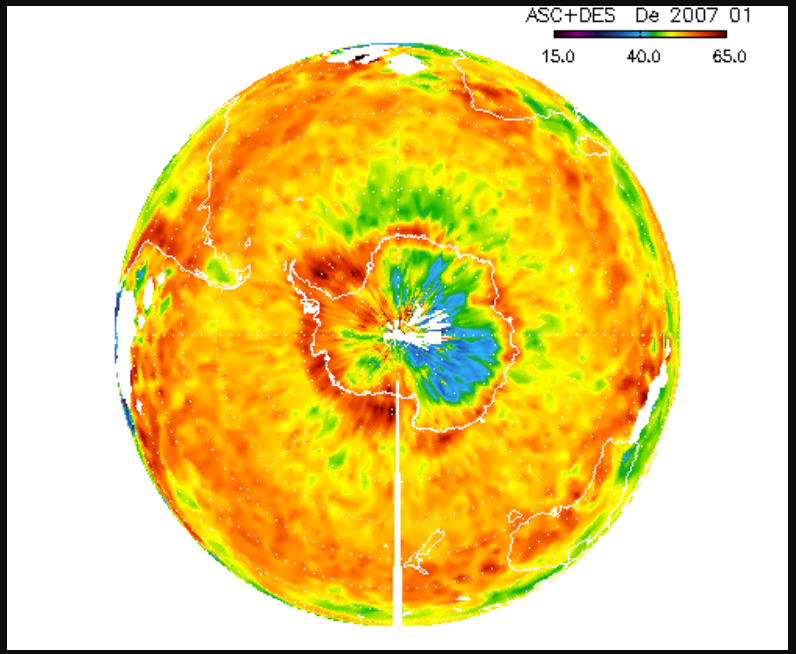
Ice

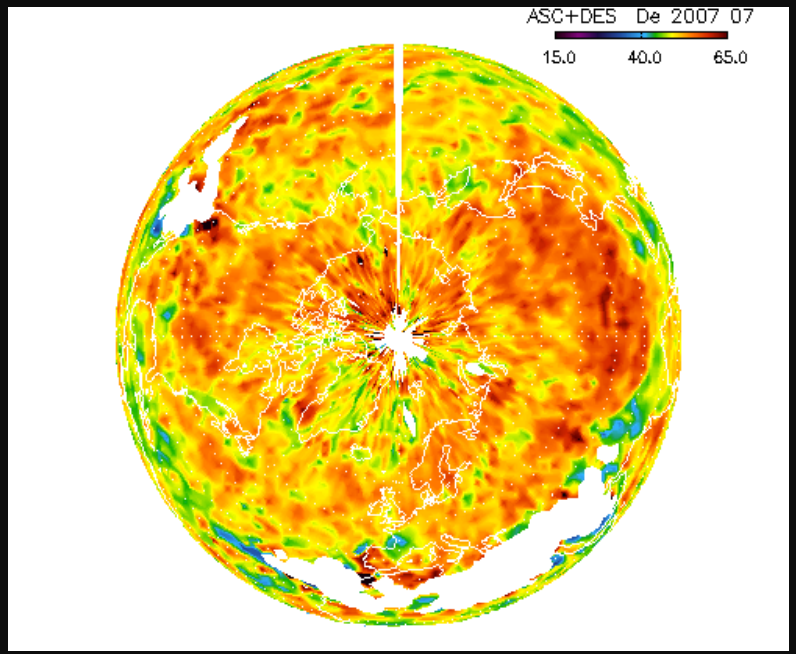


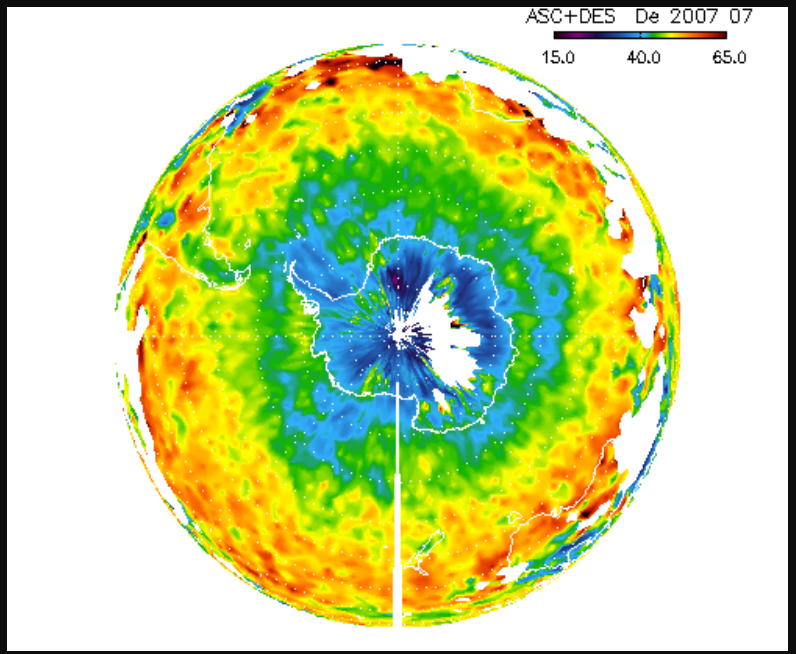
Kahn, Lubin , et al. (2012) (in preparation)

Seasonal variations of D_e in polar regions





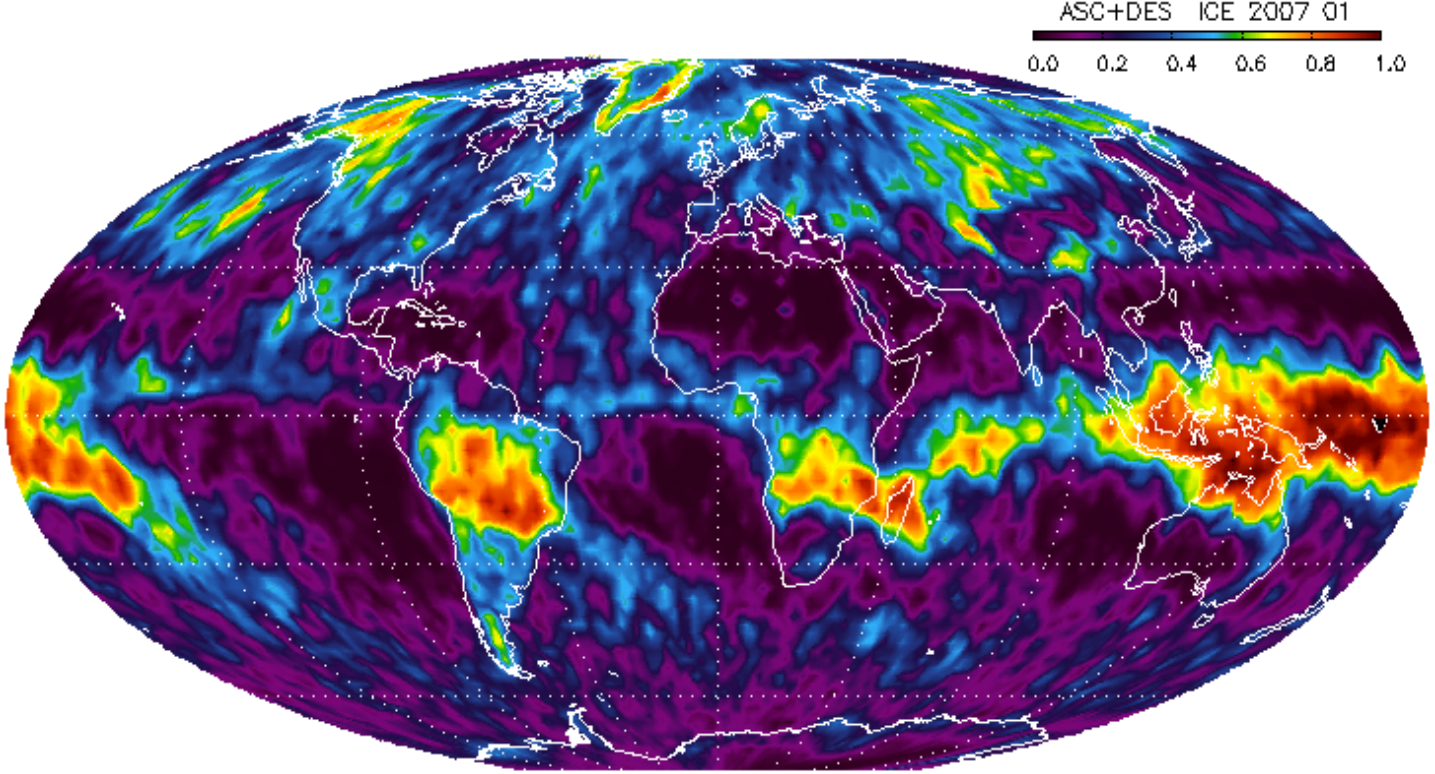




ENSO modulation of ice clouds and convection

This is well known and obvious to most

+0.7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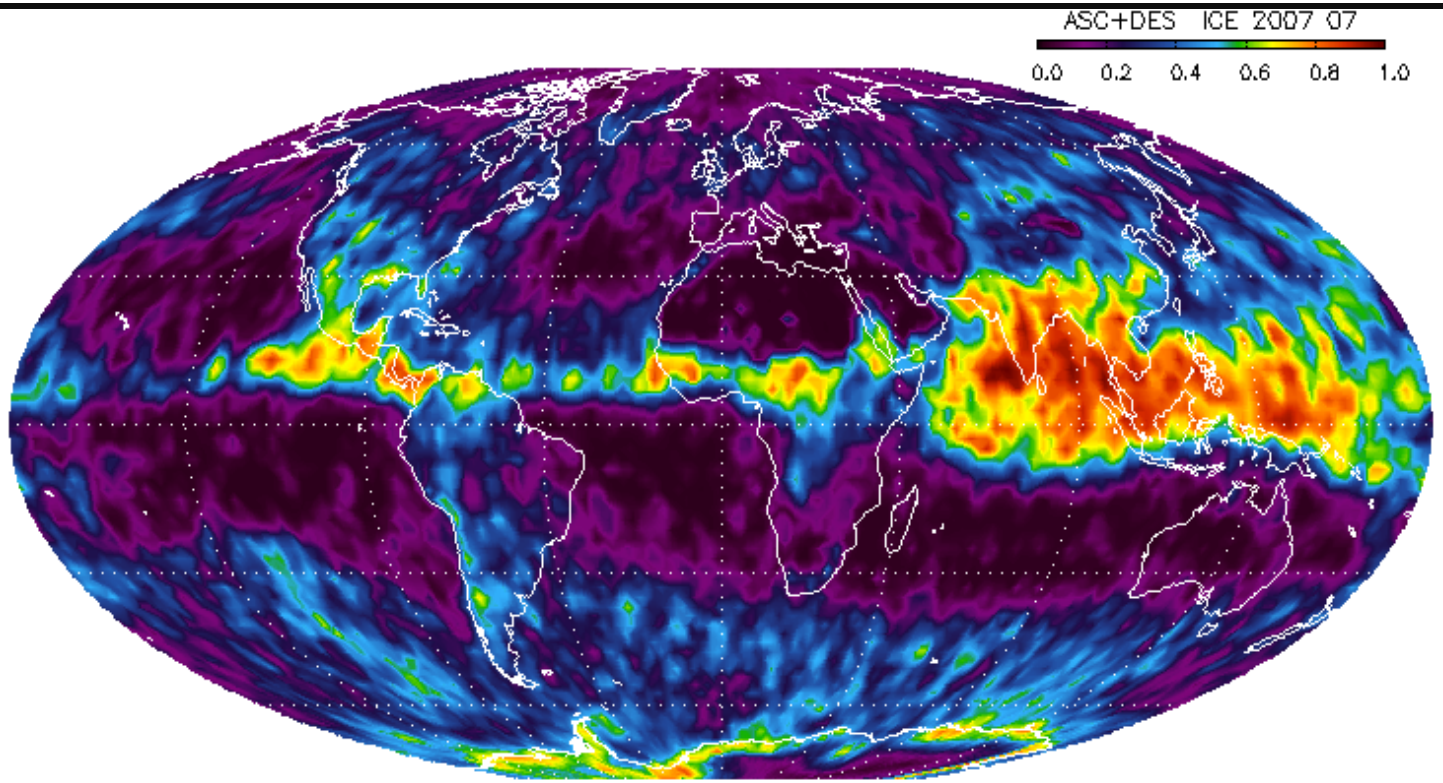
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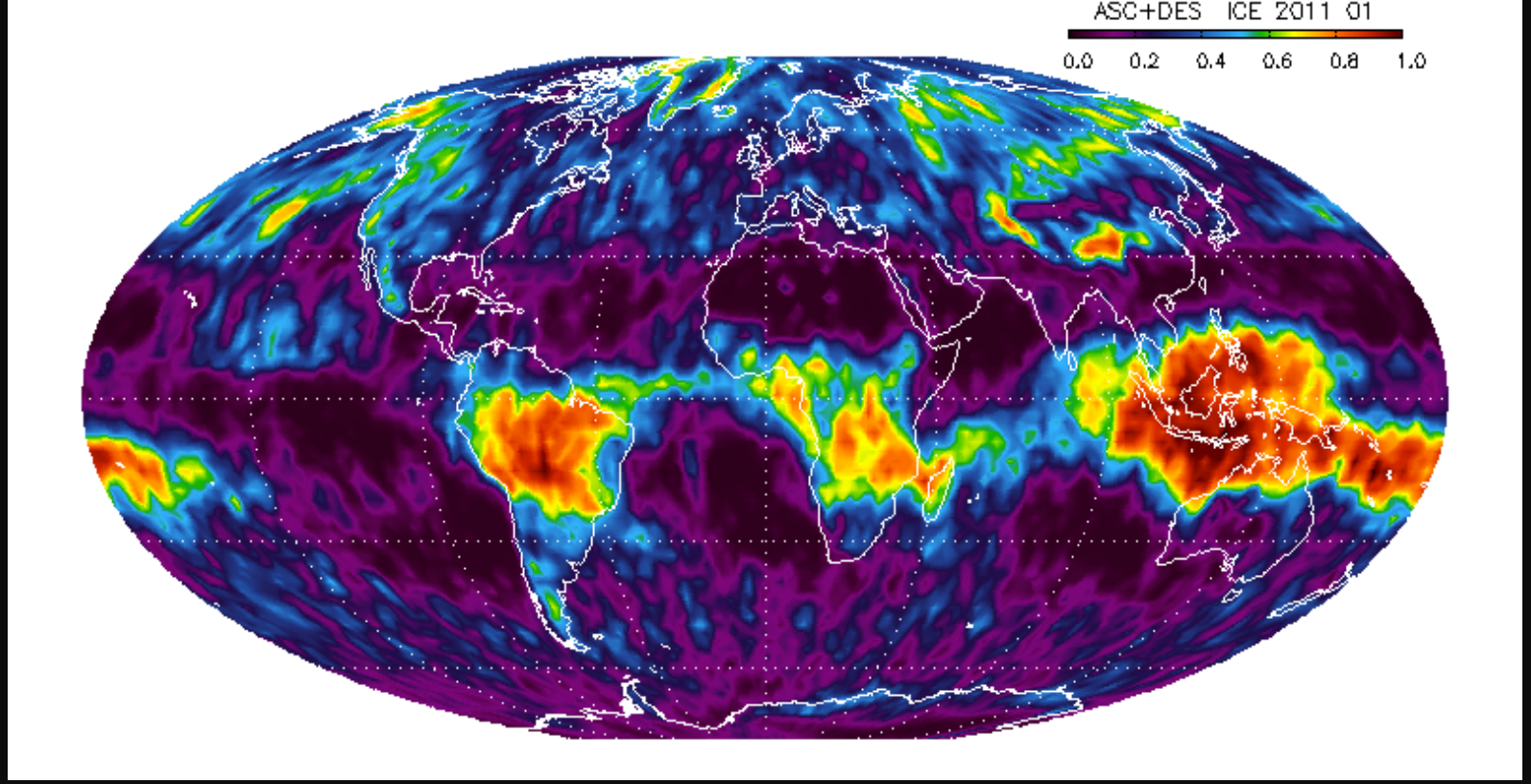
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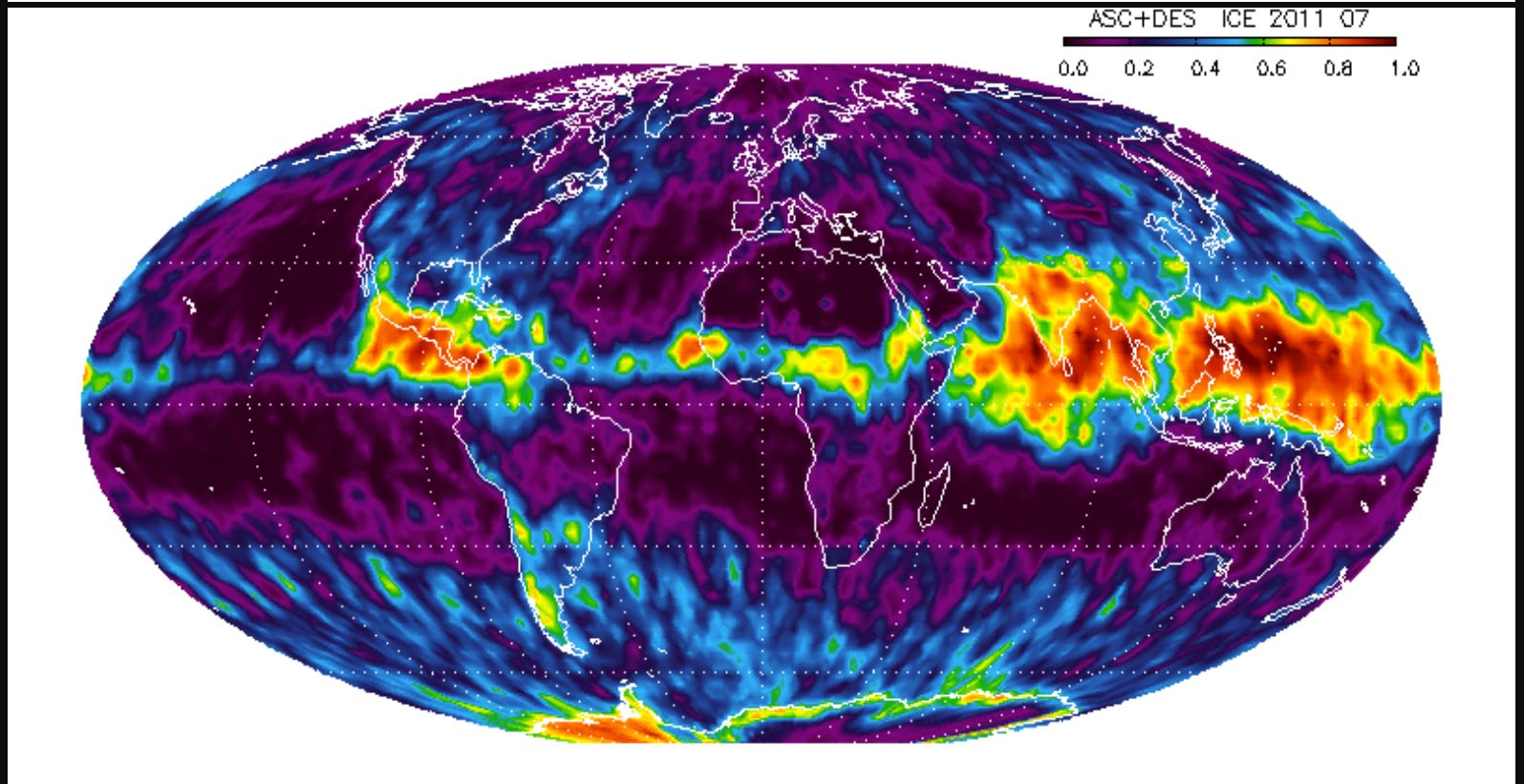
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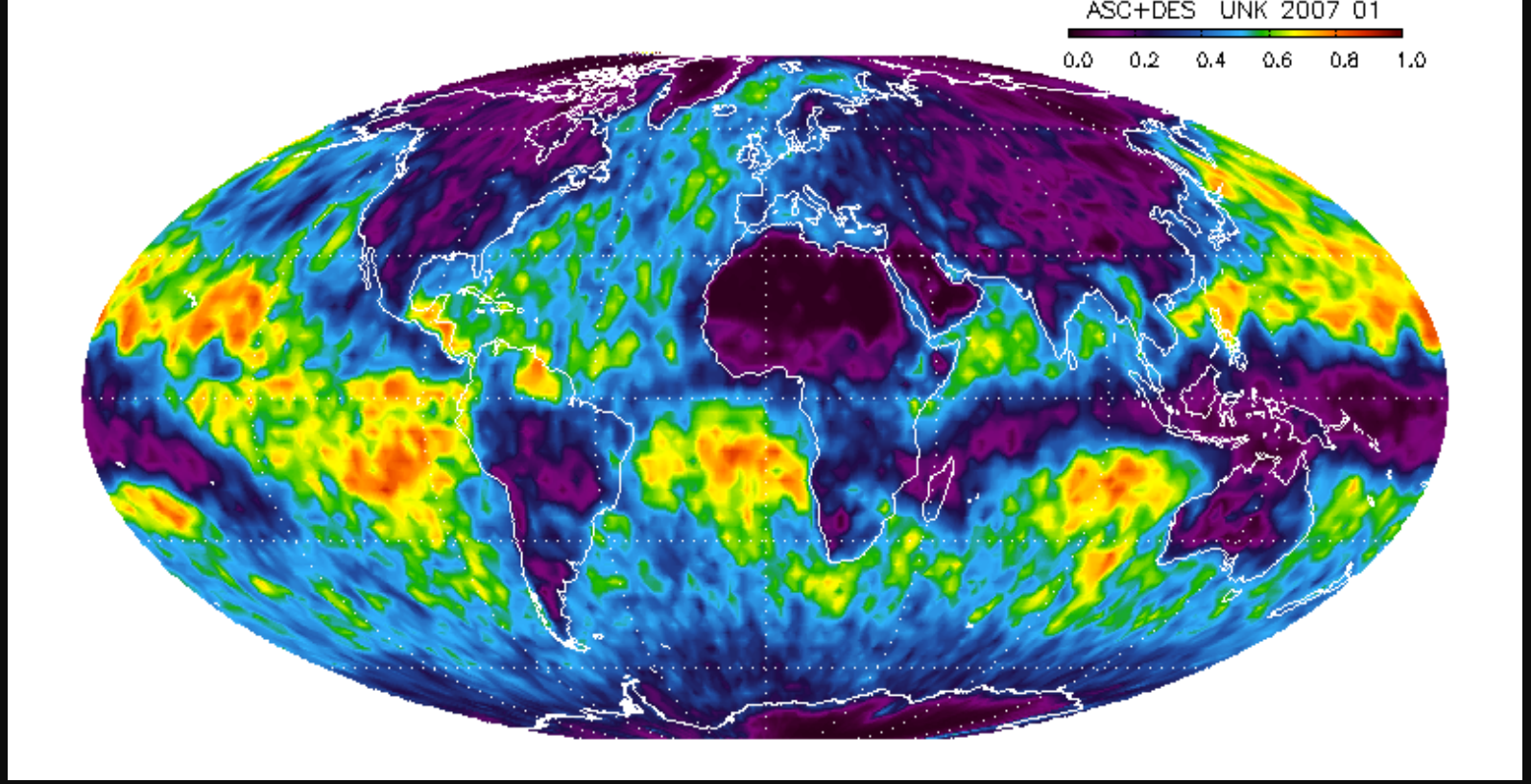
ENSO modulation of “unknown” clouds – these resemble shallow/trade cumulus

This is consistent with H. Aumann’s result shown on Tuesday

+0.7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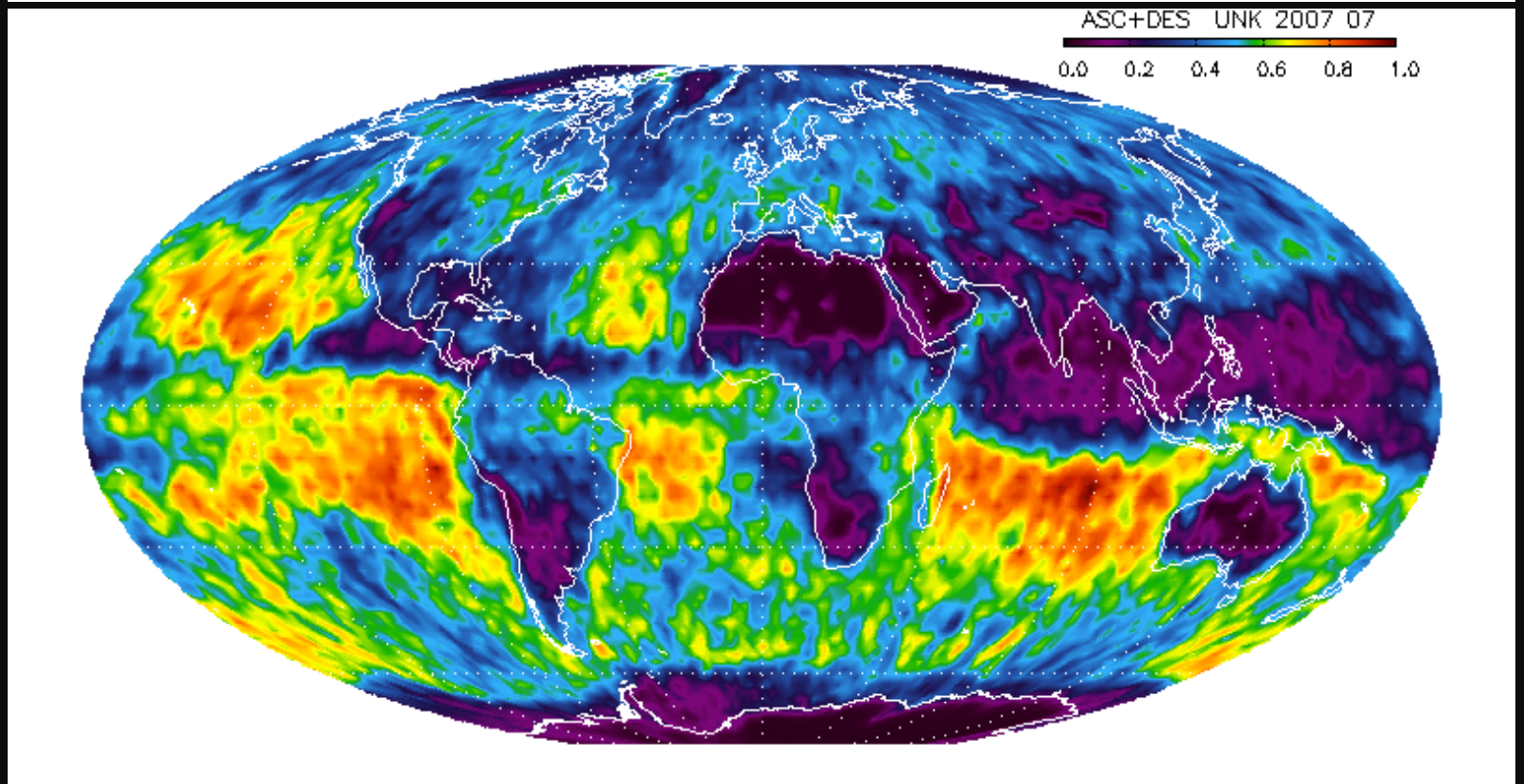
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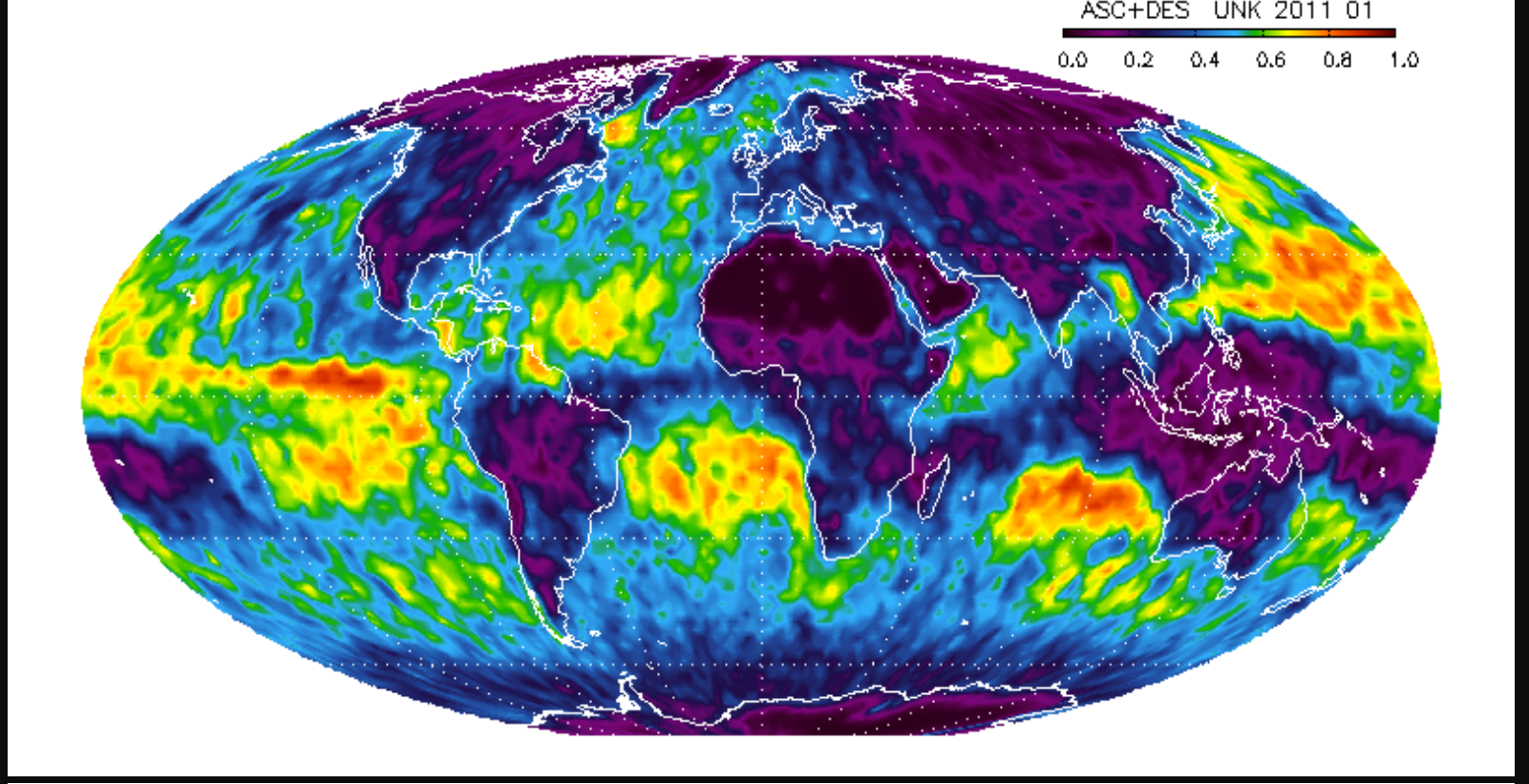
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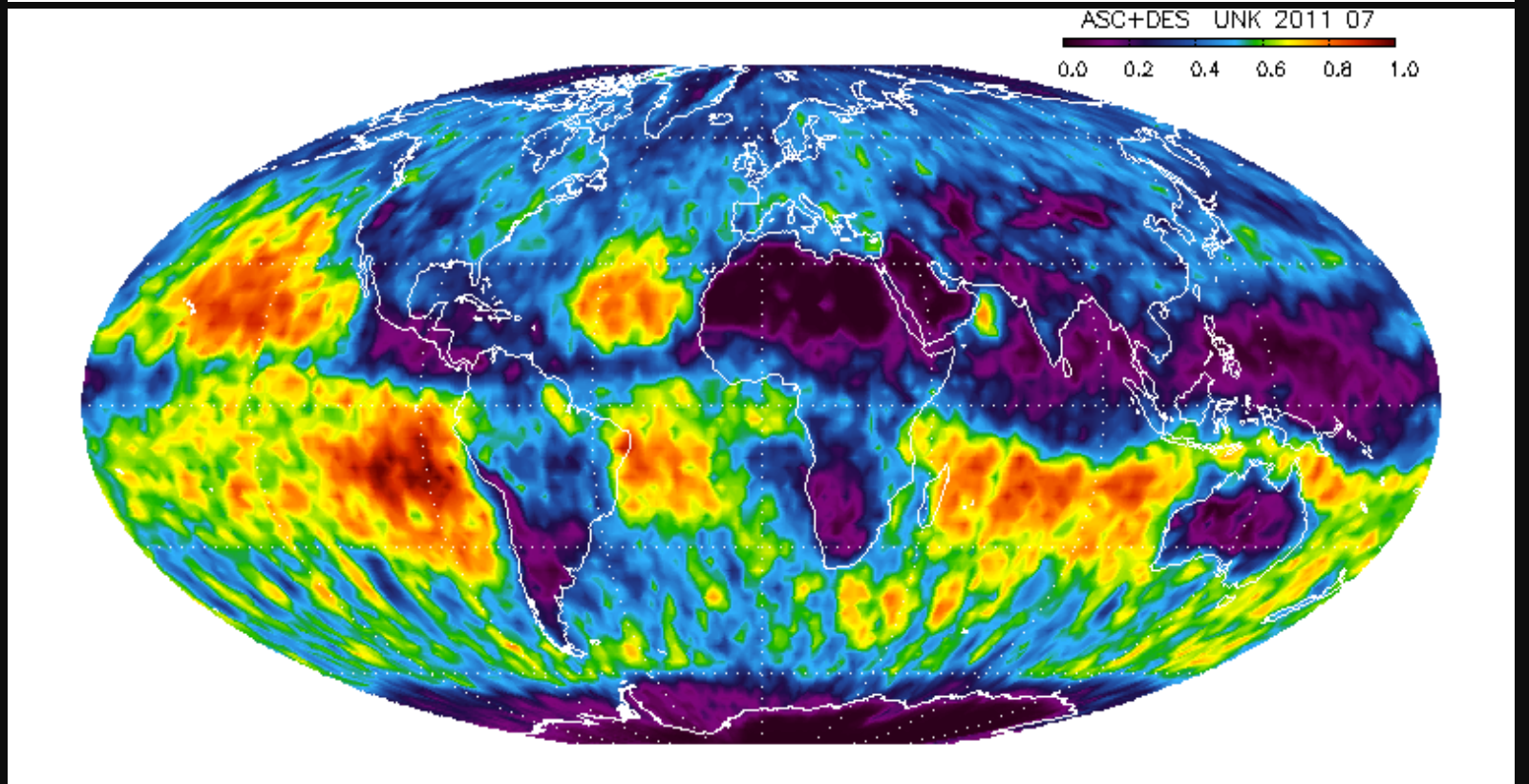
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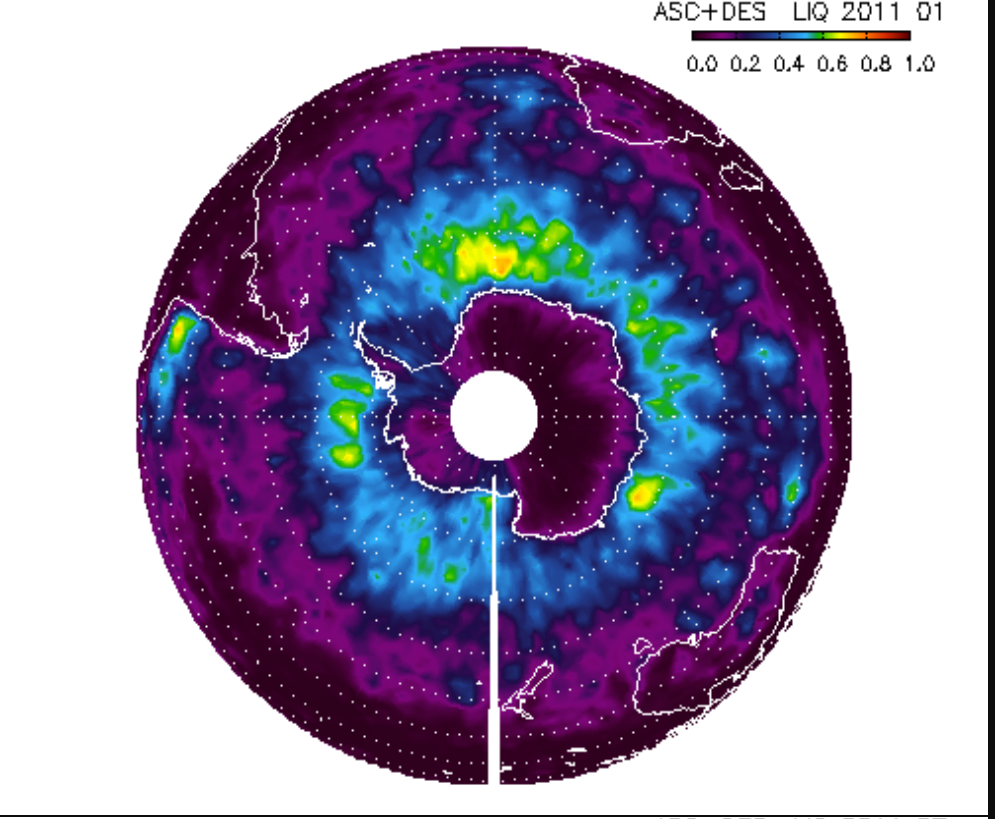
Liquid water clouds in the high latitudes

The high frequency surrounding Antarctica during summer (but not winter) appears to be a new insight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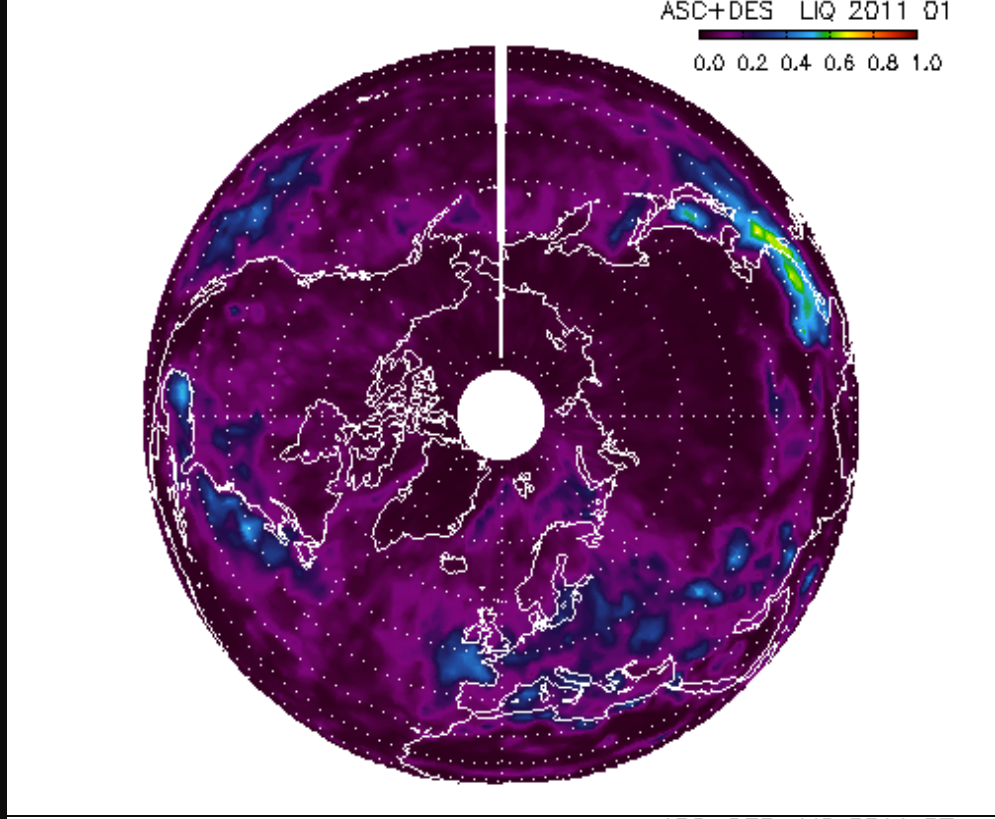
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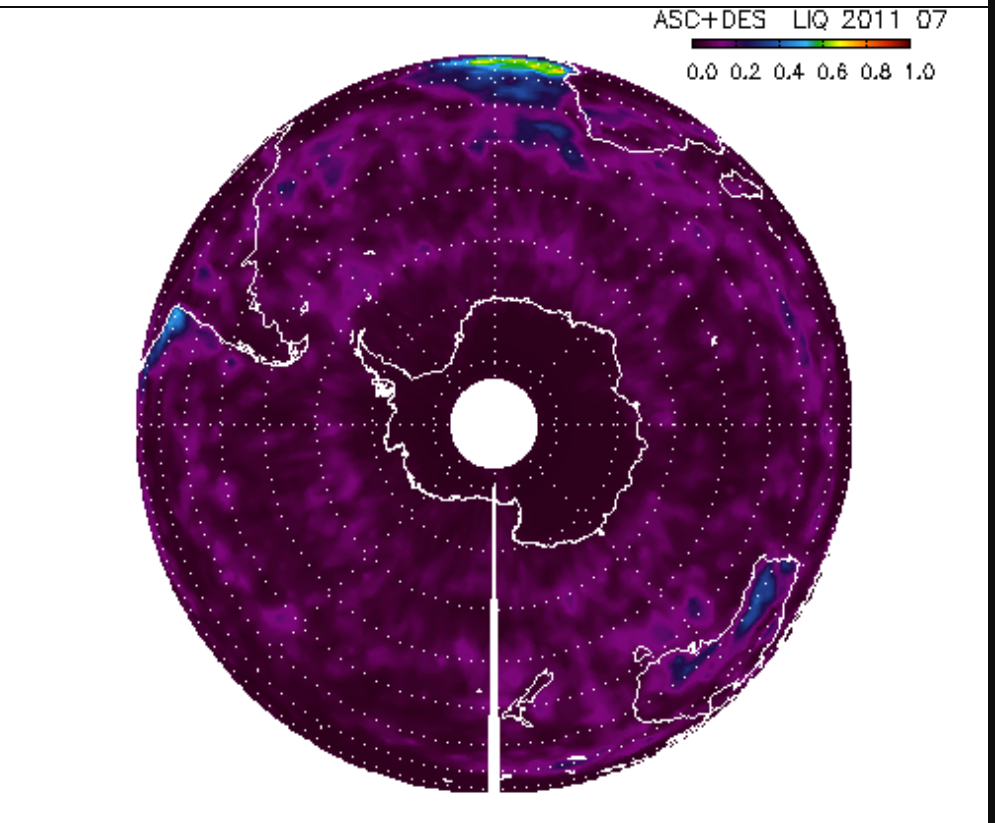
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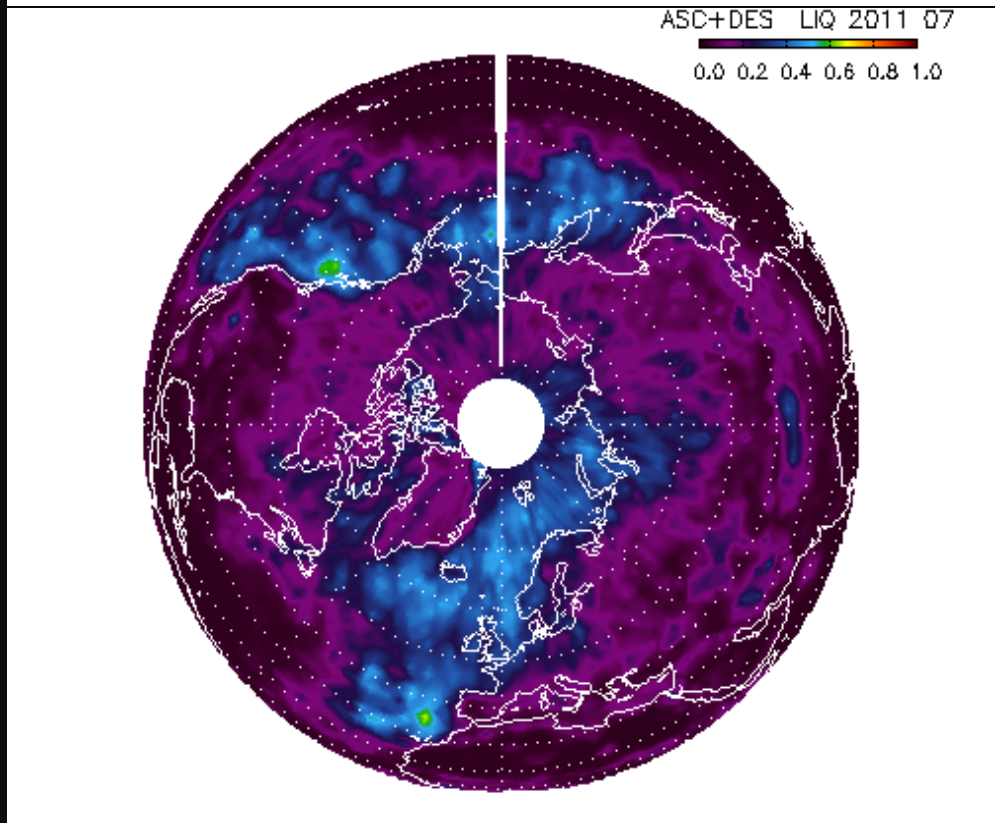
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