MODIS Cloud Optical and Microphysical Properties Product Collection 6 Update

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MODIS Science Team Meeting
Adelphi, MD
18 May 2011

MOD06 Optical/Microphysical Product

Collection 6 plans and schedule

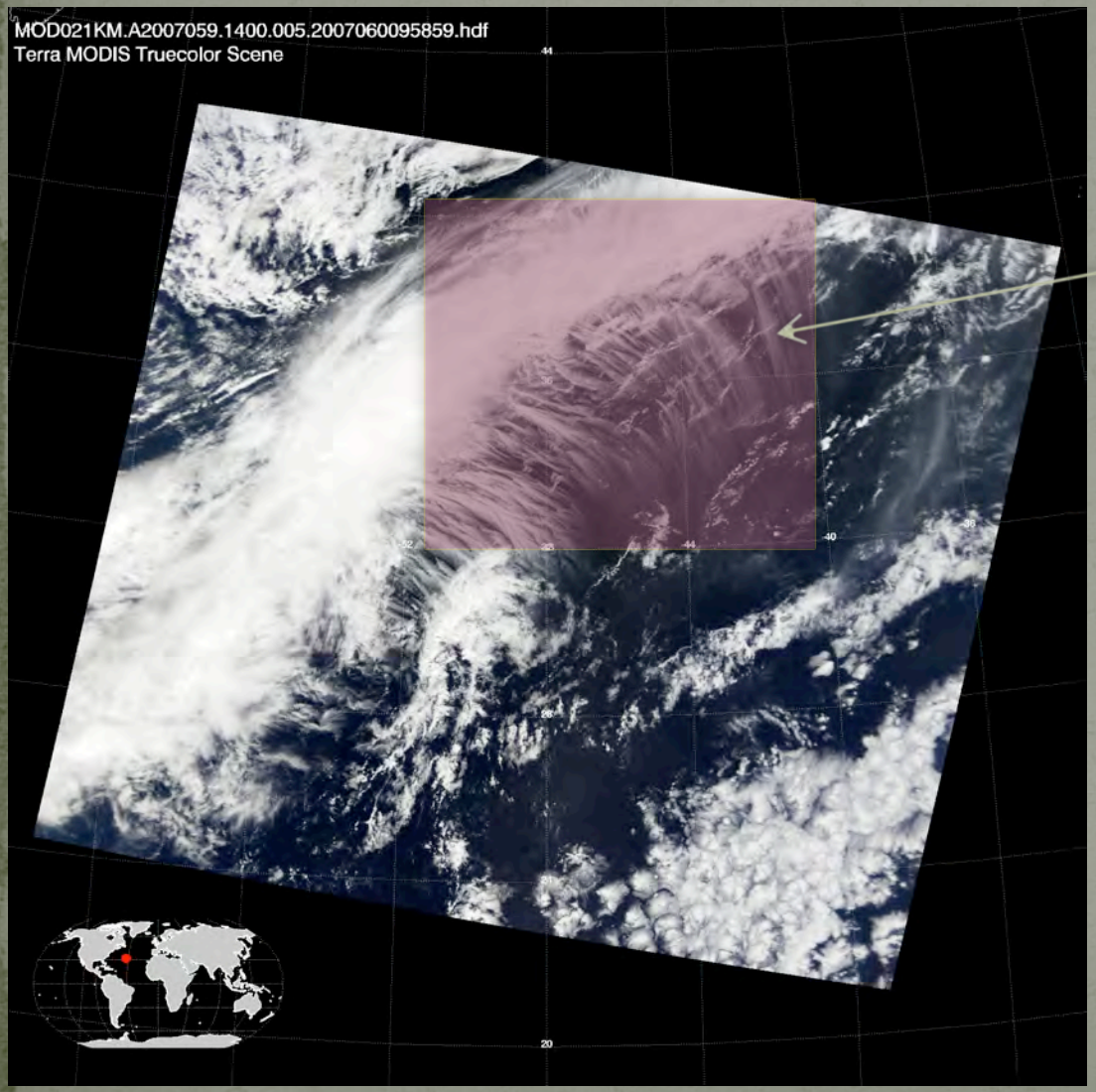
- **MOD_PR06OD**
  - Thermodynamic phase, τ, r_e, *WP*
  - 1 km retrievals, global (land, ocean, ice), daytime
- **C5 highlights**
  - As before, primary r_e from band combination w/2.1 μm; 1.6 and 3.7 μm retrievals given as differences. L3 aggregations for 2.1 μm retrieval only.
  - Ice cloud radiative models from Baum, Yang, et al. (2005)
  - Various QA including:
    - "Clear Sky Restoral" (CSR): spatial (edge removal, 250m cloud mask over water surfaces) and spectral tests, used to help eliminate cloudy pixels not suitable for retrievals or incorrectly identified cloudy pixels. MOD35 pixels eliminated via CSR are not processed.
    - multilayer/phase cloud detection (separate aggregation in L3)
  - Land and snow/ice spectral surface albedo: gap-filled BU C4 product, Moody et al. (2005)
  - Pixel-level baseline uncertainties

MOD06 Optical/Microphysical Product

Collection 6 plans and schedule

- **C6 Plan Highlights**
  - Includes 1.6 and 3.7 μm retrievals as absolutes, allowing for L3 aggregations.
  - Ice cloud radiative models: TBD, but understood to be an important issue. Have included arrays of g_λ and $\varpi_{0,\lambda}$ so users can compare/scale retrievals to their own radiative models.
  - Thermodynamic Phase: replace SWIR to VIS/NIR ratio tests with separate ice and liquid water retrievals; continue validation vs. CALIOP. (Benjamin Marchant)
  - Various QA including:
    - "Clear Sky Restoral" (CSR): Considering processing likely partly cloudy pixels identified by CSR; add appropriate flag to allow for separate L3 aggregation (which L3 statistics are TBD).
    - multilayer/phase detection: included Pavolonis & Heidinger algorithm.
  - Land spectral surface albedo: new combined Aqua/Terra gap-filled C5 product from BU team.
  - Pixel-level baseline uncertainties: link to retrieval QA assignments.
  - New LUTs: Full LUT (no asymptotic parameters) using DISORT w/wind-speed-interpolated Cox-Munk BRDF. (Nandana Amarasinghe)
  - Improved ancillary data product handling

Cox-Munk Surface Reflectance Example



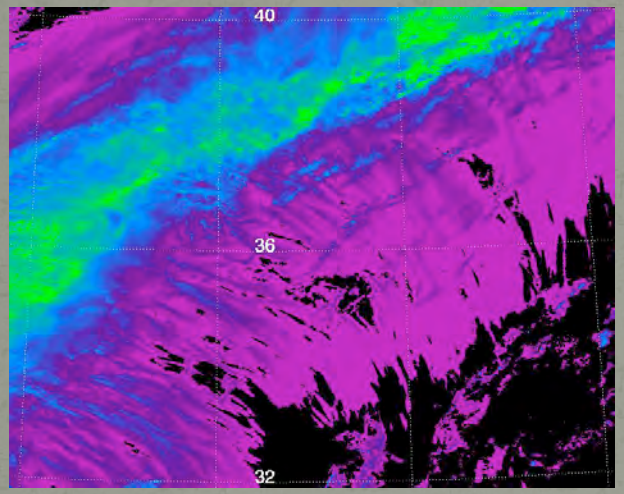
Terra 2007 day 059 14:00 UTC

Study area
(40N,52W – 32N,40W)

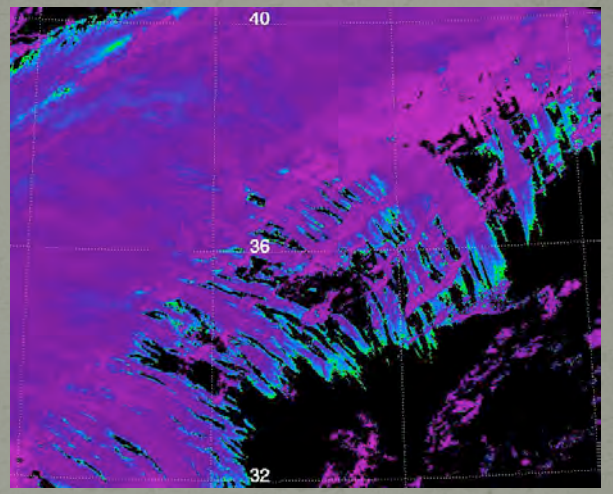
Cox-Munk Surface Reflectance Example

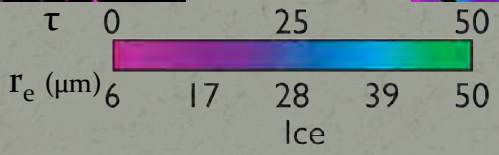
Lambertian ocean surface reflectance A_s = 0.05. Science Test (ST) 5A

Cloud Optical Thickness

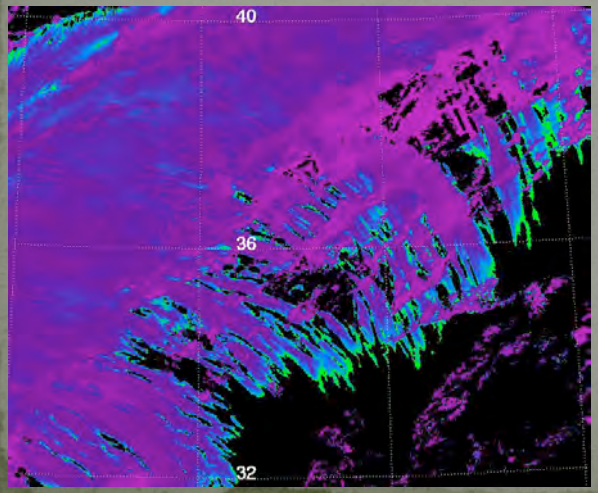


Cloud Effective Radius 2.1μm



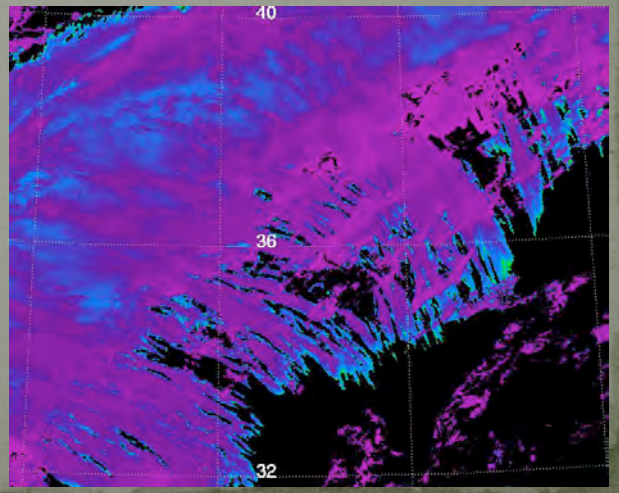


Cloud Effective Radius 1.6μm



Thermodynamic phase forced to ice

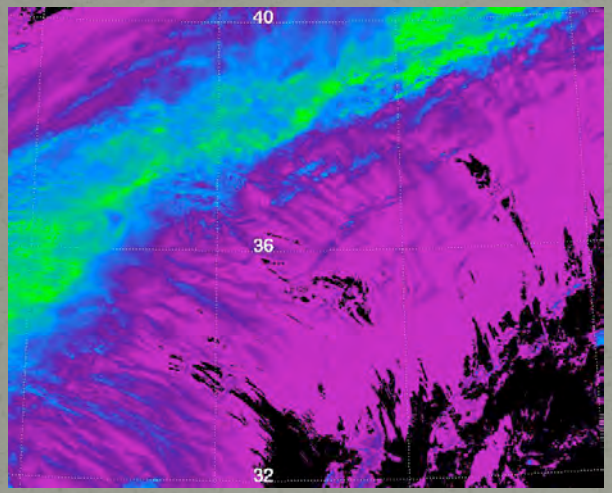
Cloud Effective Radius 3.7μm



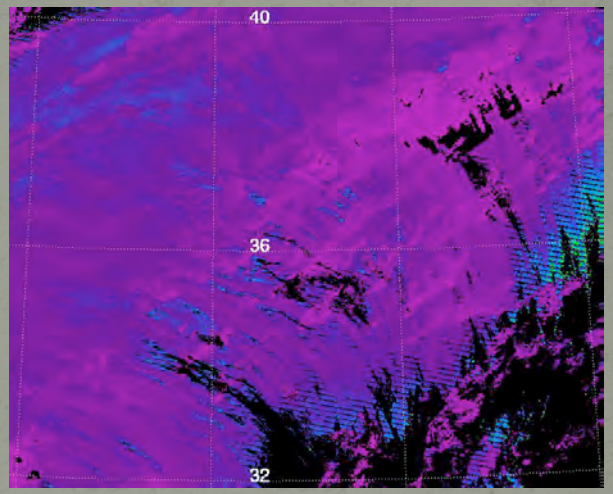
Cox-Munk Surface Reflectance Example

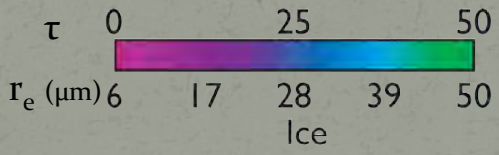
Cox-Munk ocean surface reflectance, averaged wind direction. ST 5

Cloud Optical Thickness

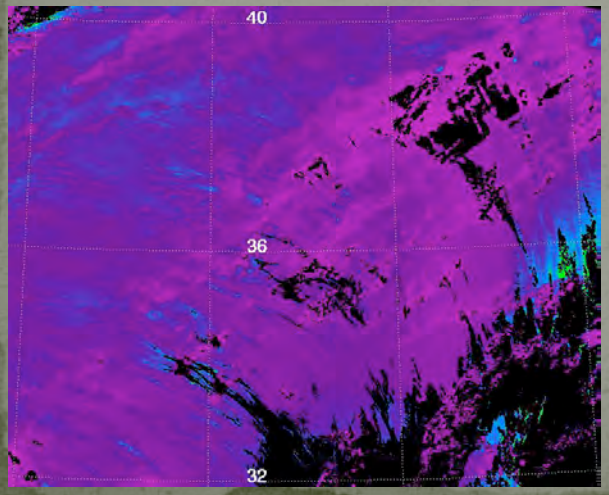


Cloud Effective Radius 2.1μm



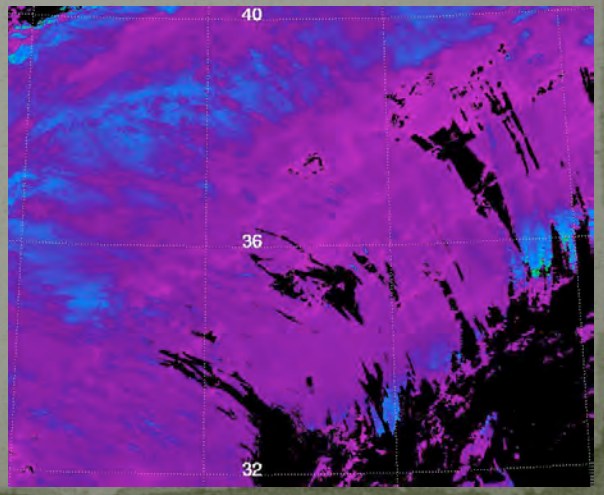


Cloud Effective Radius 1.6μm



Thermodynamic phase forced to ice

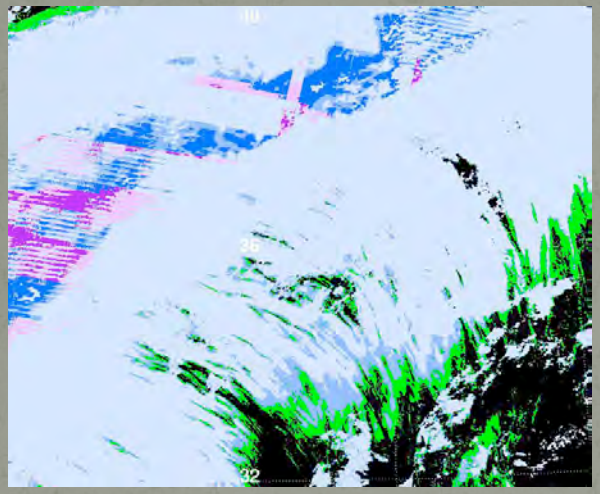
Cloud Effective Radius 3.7μm



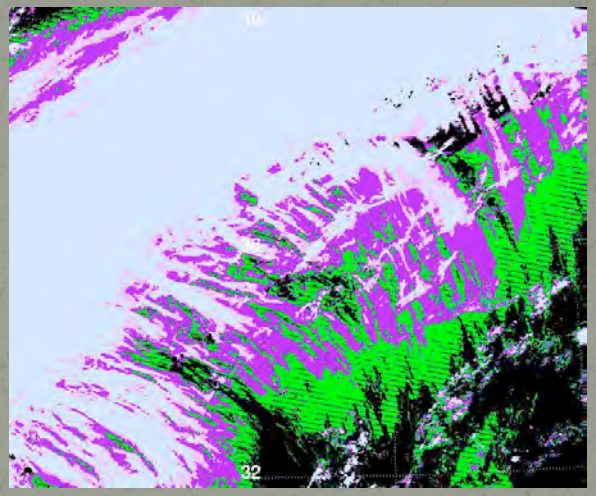
Cox-Munk Surface Reflectance Example

Difference between Cox-Munk and Lambertian surface models. ST 5 – ST 5A

Cloud Optical Thickness



Cloud Effective Radius 2.1μm

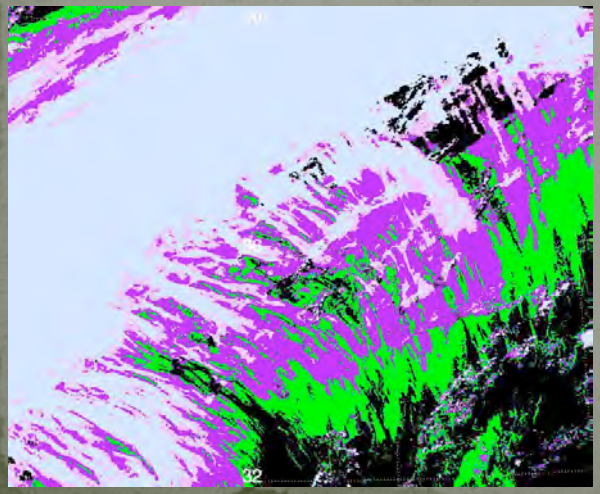


-1 1 τ

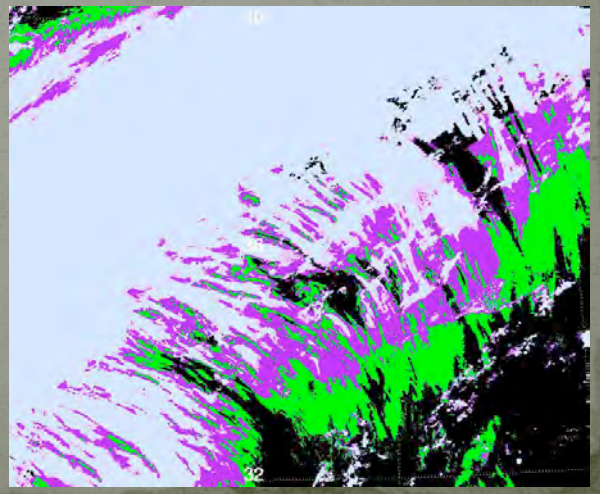
-5 Ice 5 r_e

Newly successful retrieval

Cloud Effective Radius 1.6μm



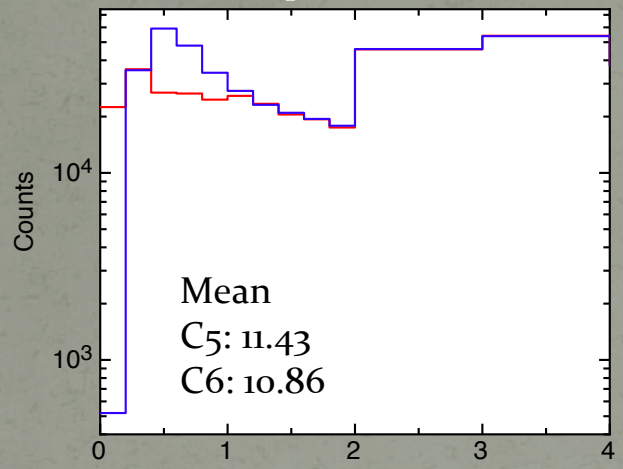
Cloud Effective Radius 3.7μm



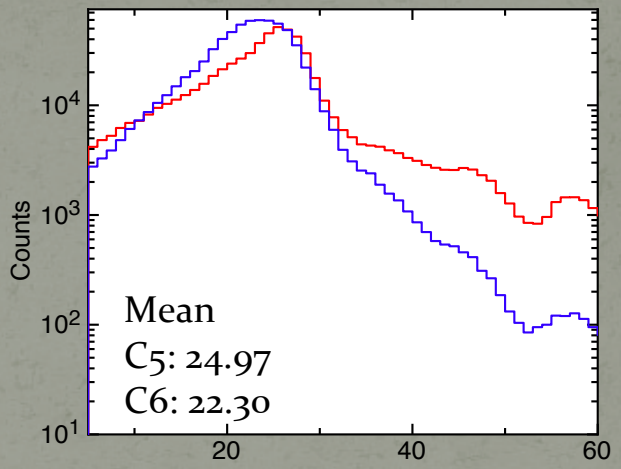
Cox-Munk Surface Reflectance Example

Retrieval histograms, all successful retrievals

Cloud Optical Thickness

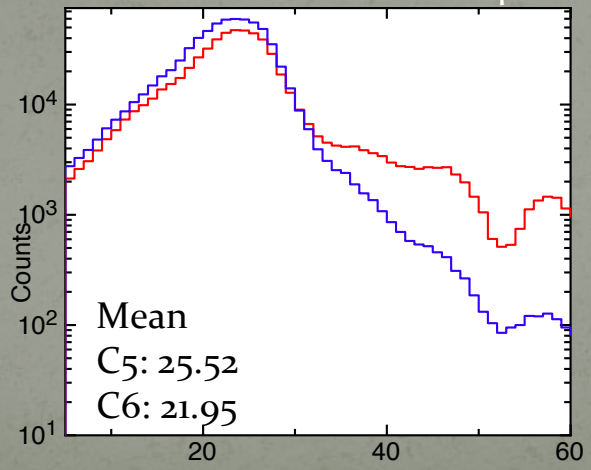


Cloud Effective Radius 2.1μm

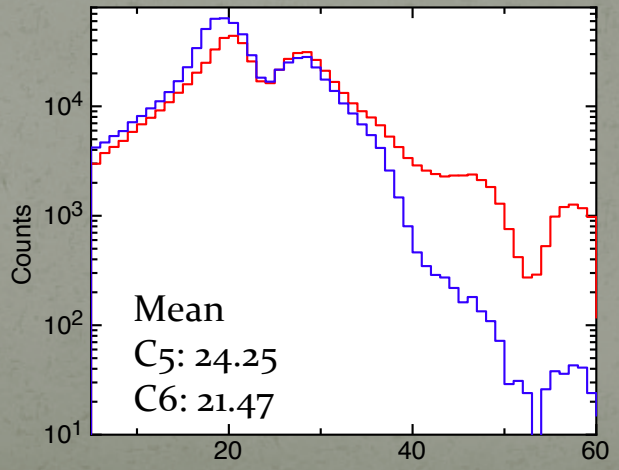


C5
C6

Cloud Effective Radius 1.6μm



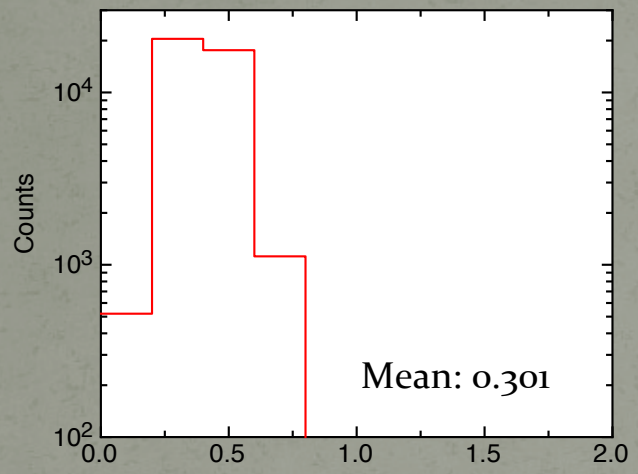
Cloud Effective Radius 3.7μm



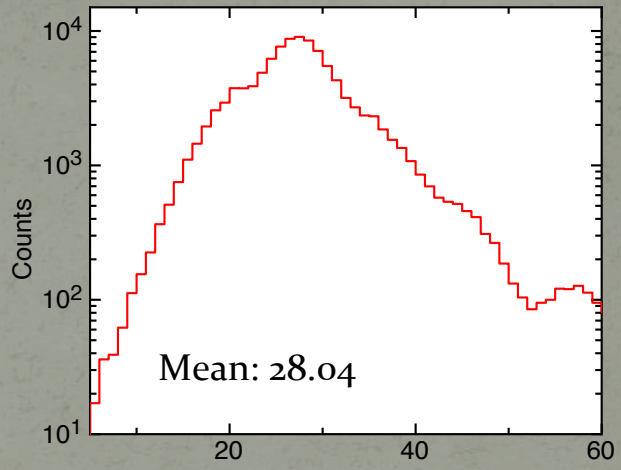
Cox-Munk Surface Reflectance Example

Retrieval histograms, new successful retrievals only

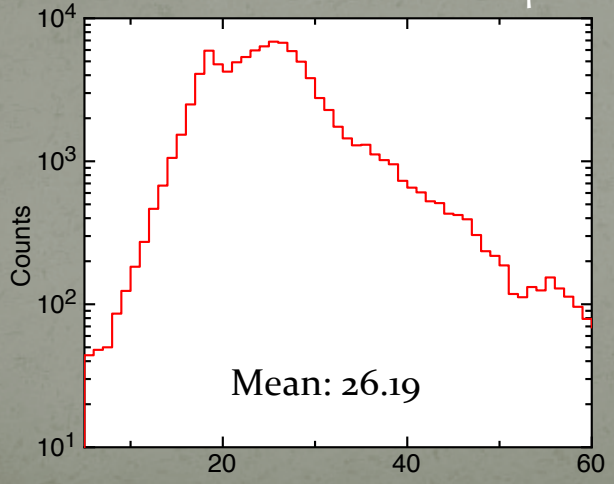
Cloud Optical Thickness



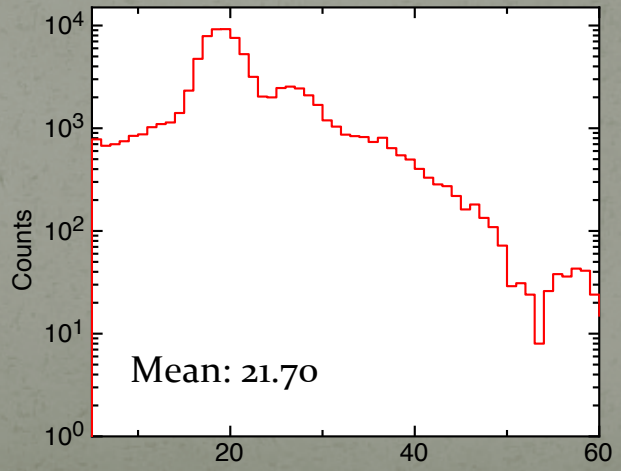
Cloud Effective Radius 2.1μm



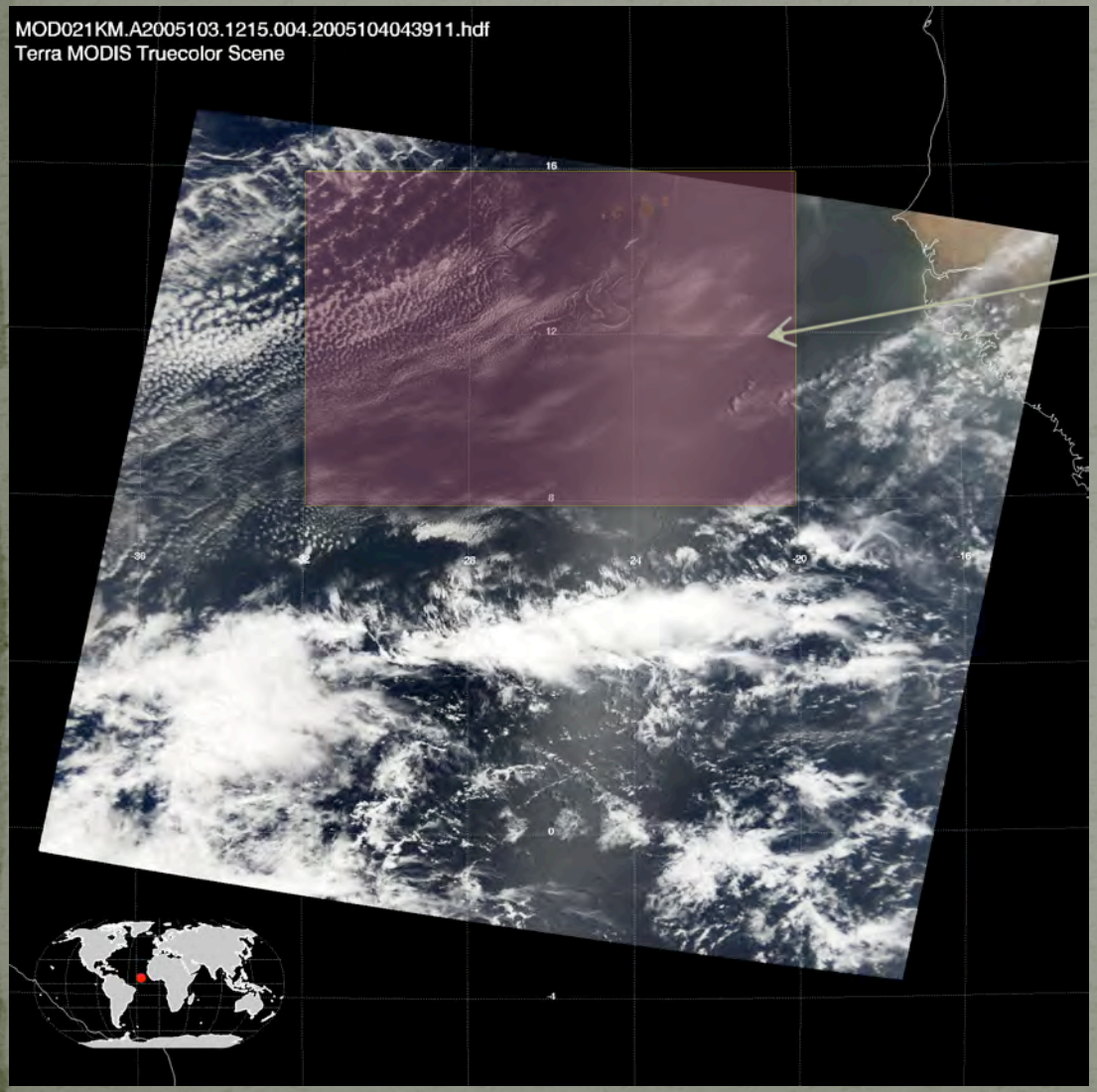
Cloud Effective Radius 1.6μm



Cloud Effective Radius 3.7μm



Cloud Edge and 250m Partly Cloudy Pixels



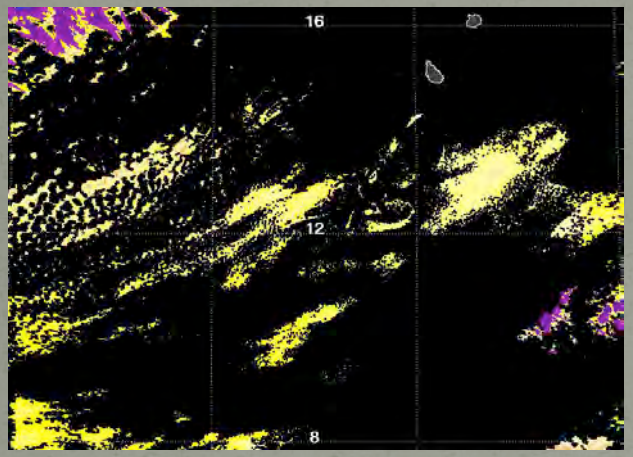
Terra 2005 day 103 12:15 UTC

Study area
(16N,32W – 8N,20W)

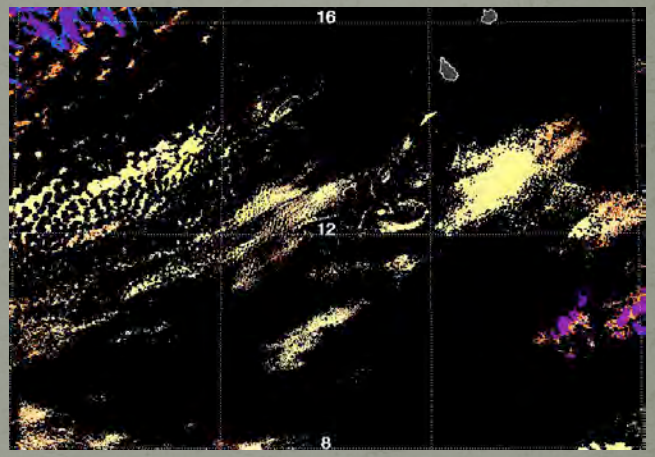
Cloud Edge and 250m Partly Cloudy Pixels

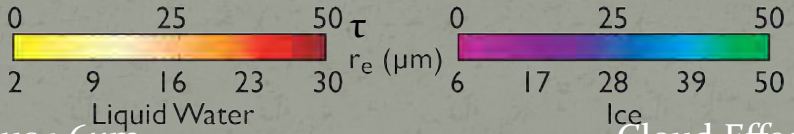
Example retrieval without the cloud edge and 250m partly cloudy pixels

Cloud Optical Thickness

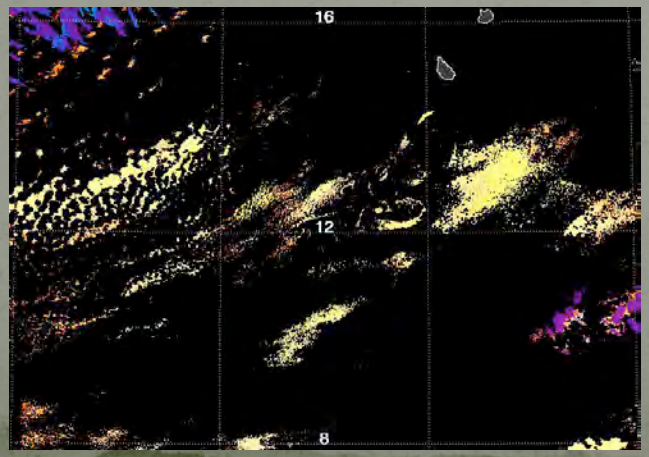


Cloud Effective Radius 2.1μm

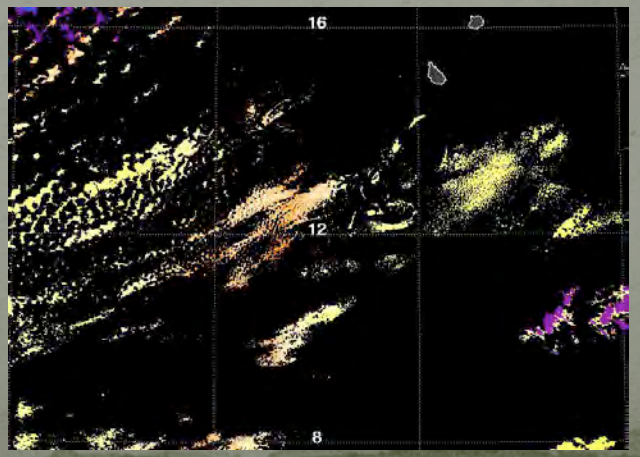




Cloud Effective Radius 1.6μm



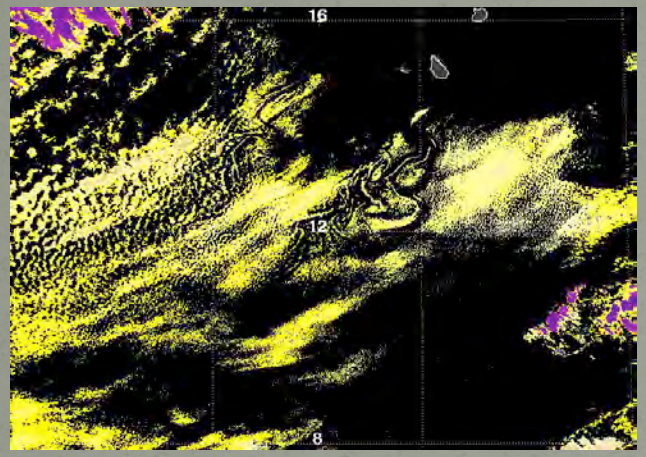
Cloud Effective Radius 3.7μm



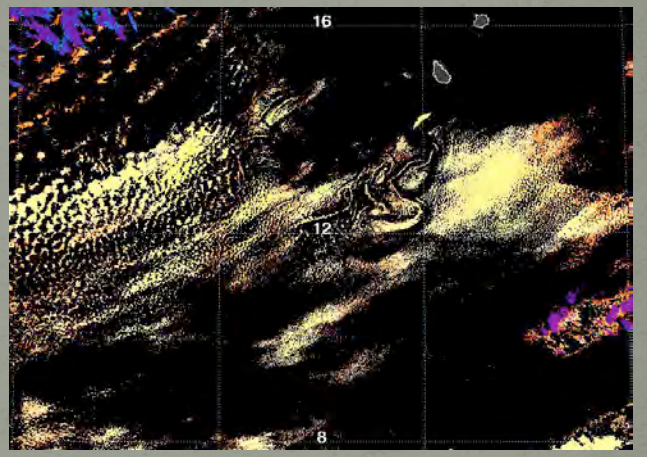
Cloud Edge and 250m Partly Cloudy Pixels

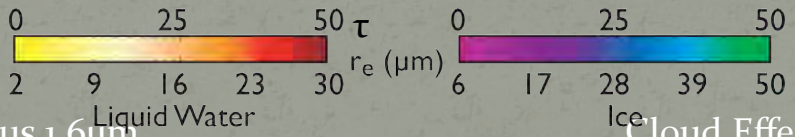
Example retrieval with the cloud edge and 250m partly cloudy pixels present

Cloud Optical Thickness

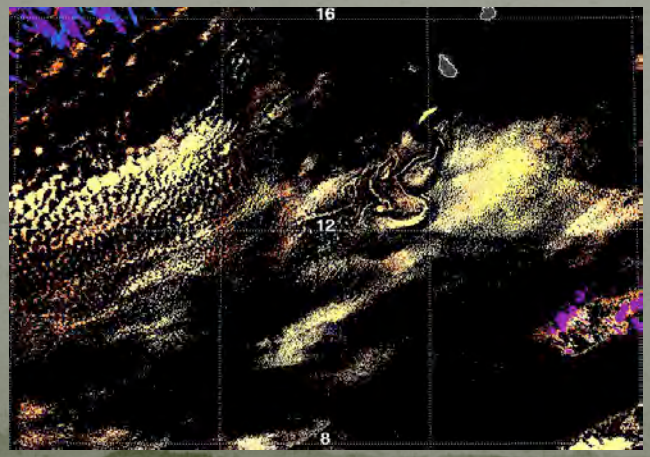


Cloud Effective Radius 2.1μm

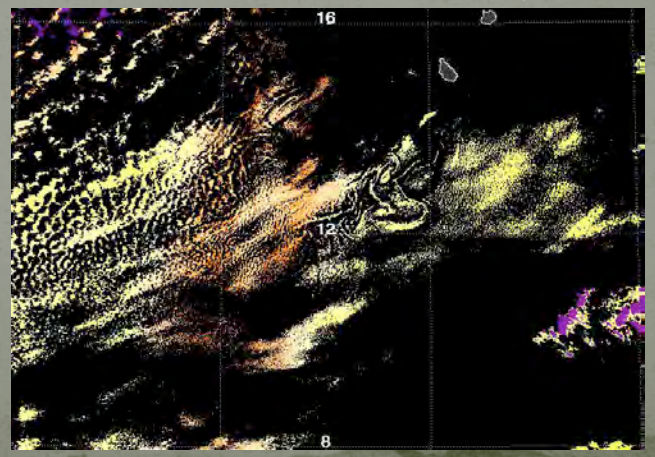




Cloud Effective Radius 1.6μm



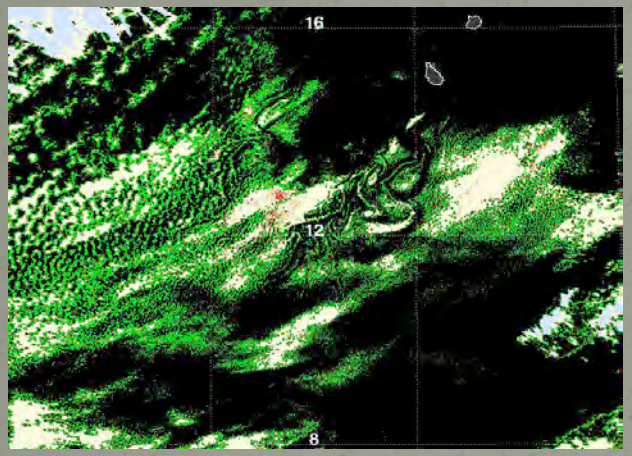
Cloud Effective Radius 3.7μm



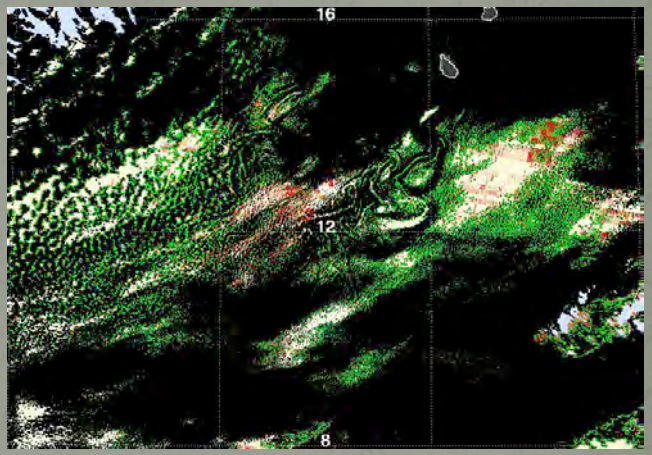
Cloud Edge and 250m Partly Cloudy Pixels

Retrieval differences with edge – without edge

Cloud Optical Thickness



Cloud Effective Radius 2.1μm

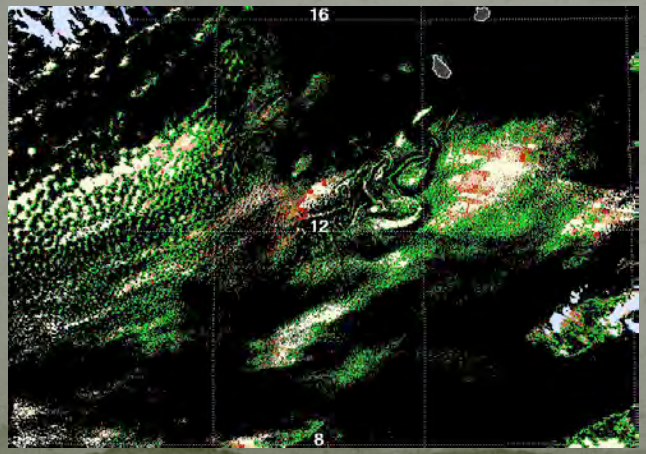


-2 2 -2 2

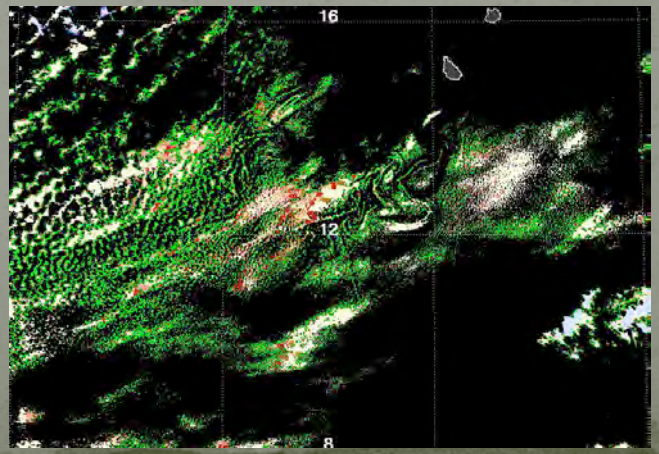
Ice Liquid Water

Newly successful retrieval

Cloud Effective Radius 1.6μm



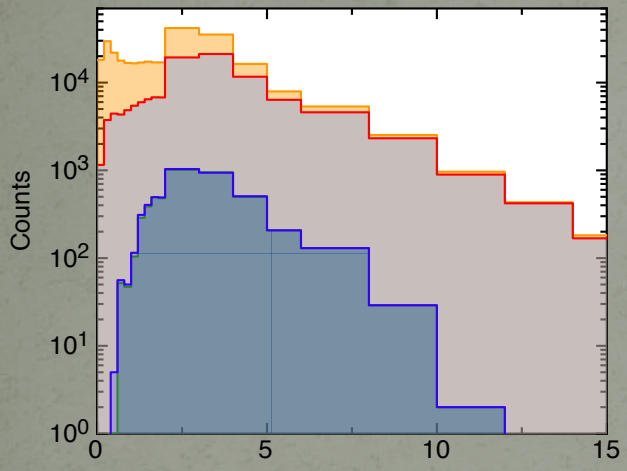
Cloud Effective Radius 3.7μm



Cloud Edge and 250m Partly Cloudy Pixels

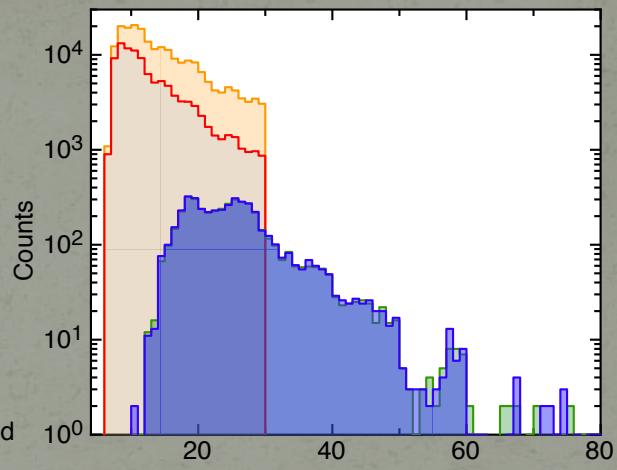
Retrieval histograms before and after

Cloud Optical Thickness (with partial)



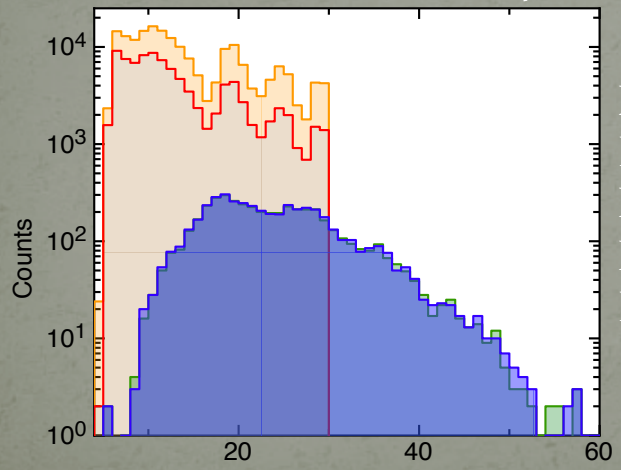
Means:
EL: 1.773
NL: 2.594
NI: 2.517
EI: 2.499

Cloud Effective Radius 2.1μm



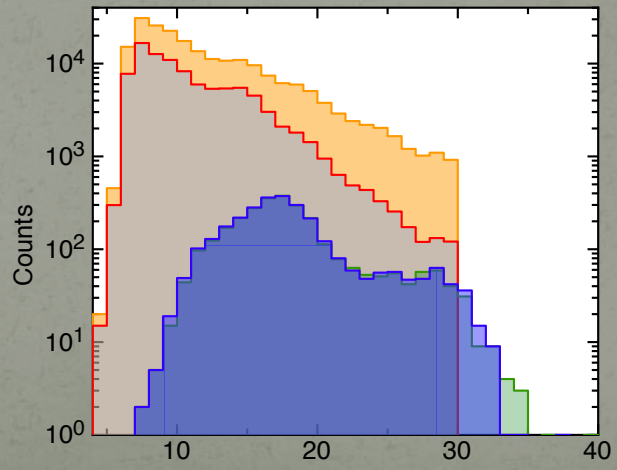
Means:
EL: 14.757
NL: 13.323
NI: 25.989
EI: 18.076

Cloud Effective Radius 1.6μm



Means:
EL: 14.634
NL: 13.568
NI: 24.327
EI: 24.348

Cloud Effective Radius 3.7μm

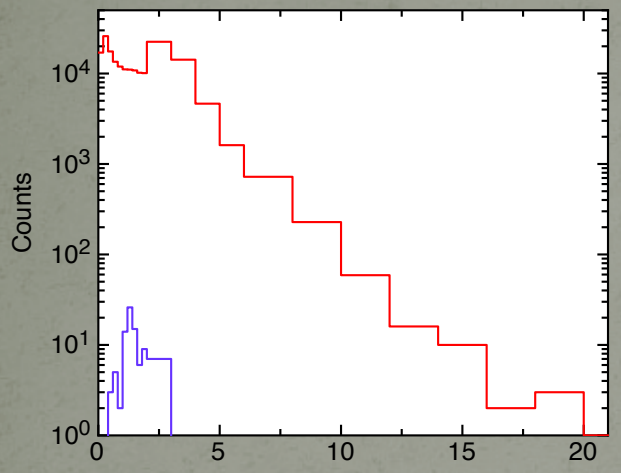


Means:
EL: 12.211
NL: 11.169
NI: 18.107
EI: 18.075

Cloud Edge and 250m Partly Cloudy Pixels

Retrieval histograms for edge and 250m pixels only

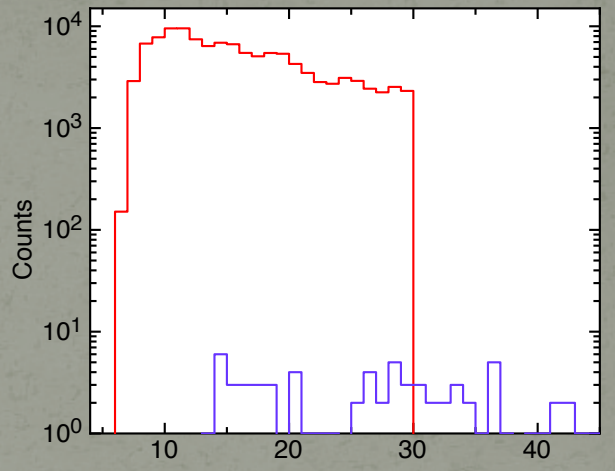
Cloud Optical Thickness (with partial)



Means:
Liq: 1.247
Ice: 1.292

Fraction:
Liq: 0.686
Ice: 1.000

Cloud Effective Radius 2.1μm

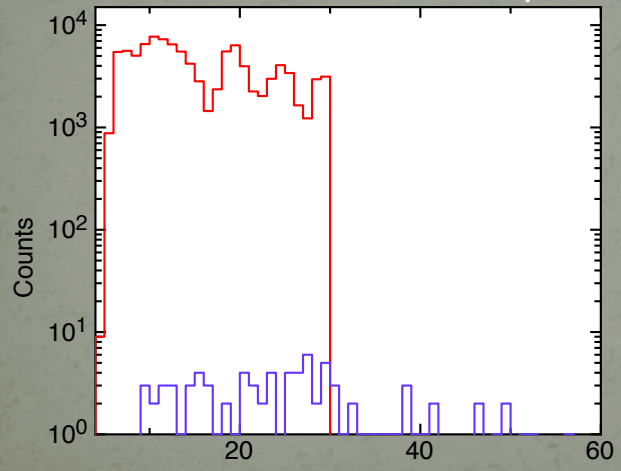


Means:
Liq: 16.084
Ice: 30.679

Fraction:
Liq: 0.428
Ice: 0.897

Llquid Water
Ice

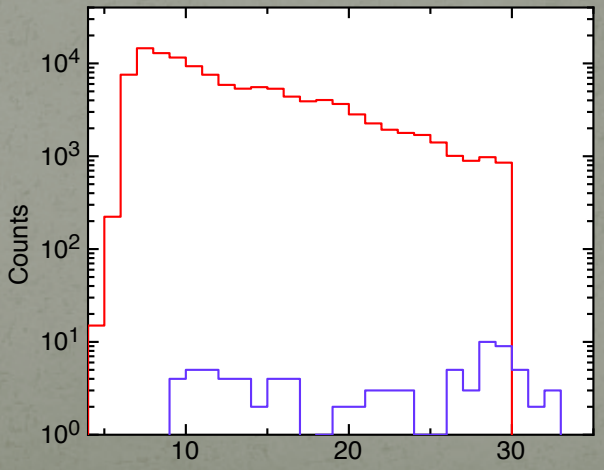
Cloud Effective Radius 1.6μm



Means:
Liq: 15.745
Ice: 26.406

Fraction:
Liq: 0.371
Ice: 0.989

Cloud Effective Radius 3.7μm

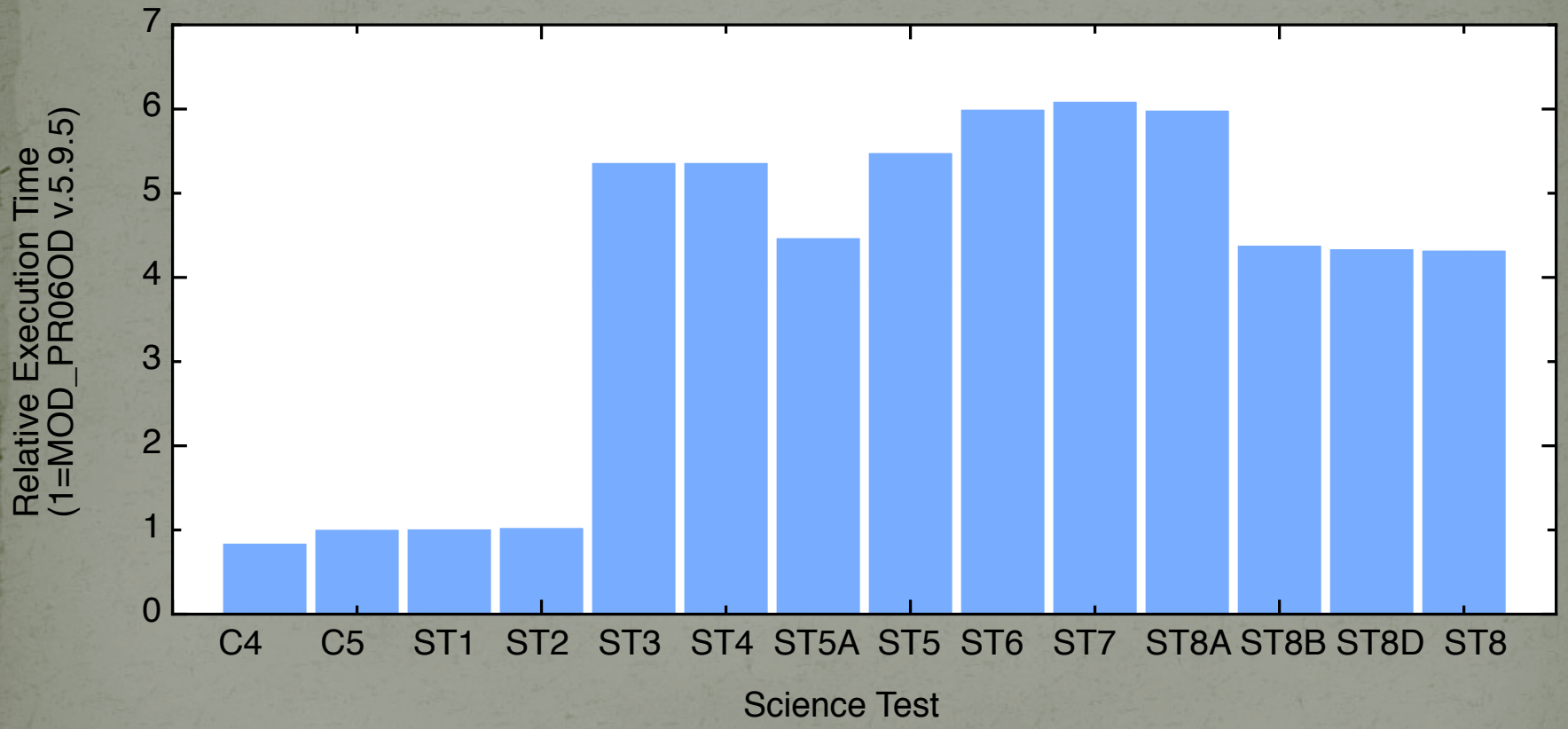


Means:
Liq: 13.045
Ice: 21.827

Fraction:
Liq: 0.439
Ice: 0.529

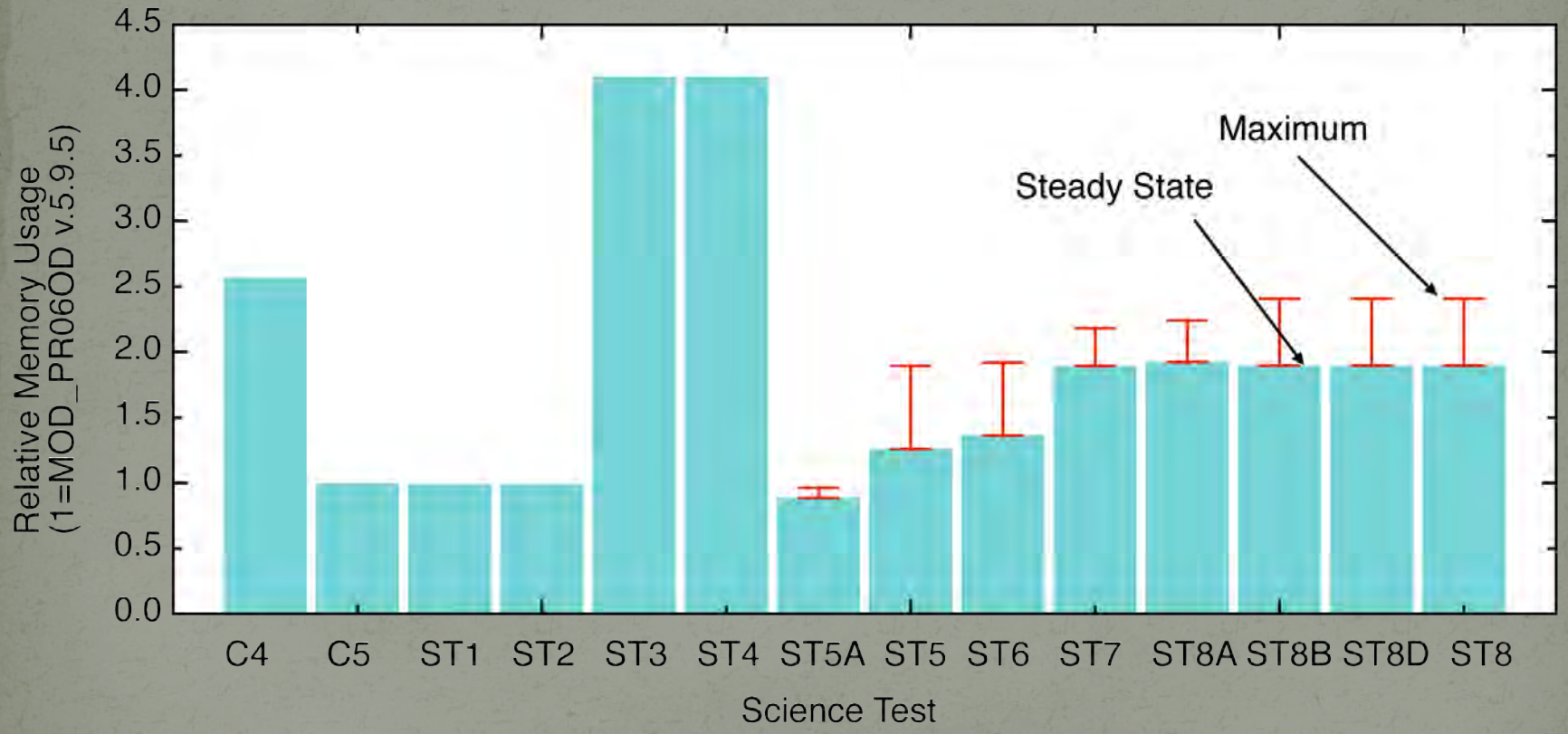
MOD_PR06OD Through the Ages

Product execution time for an average granule (70% cloudy)



MOD_PR06OD Through the Ages

Product RAM usage for an average granule (70% cloudy)



Conclusion

- **Current Status: PGE06 v.6.0.24 in science test**
  - 8 out of planned 14 tests completed
  - Science changes left to implement:
    - 3.7μm atmospheric emission
    - New solution logic to retrieve pixels just outside library space (with appropriate QA)
    - New thermodynamic phase
    - New surface albedo
    - New ice crystal models
    - RGB color tests for clear sky restoral
    - Uncertainty for ice cloud model error source (approximate method, but TBD)
    - Finalize L3 aggregation additions and changes (possible impact on L2 QA)
- **Take a look at our L2 poster for complete development status and timeline**