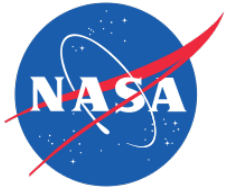


GEOS-5 During ORACLES: Status Update

Arlindo da Silva and Karla Longo

Global Modeling and Assimilation Office

NASA Goddard Space Flight Center

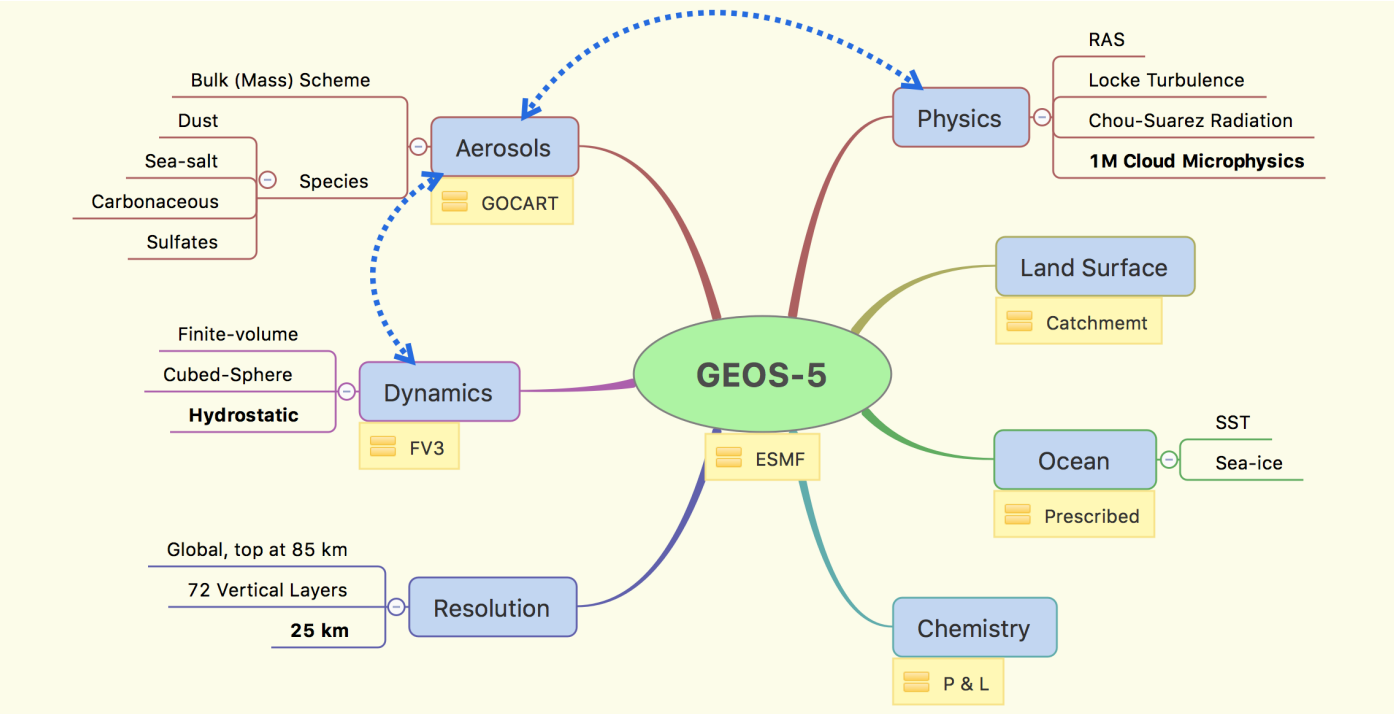
ORACLES Science Team Meeting

Moffett Field, CA, May 15-18, 2017

Outline

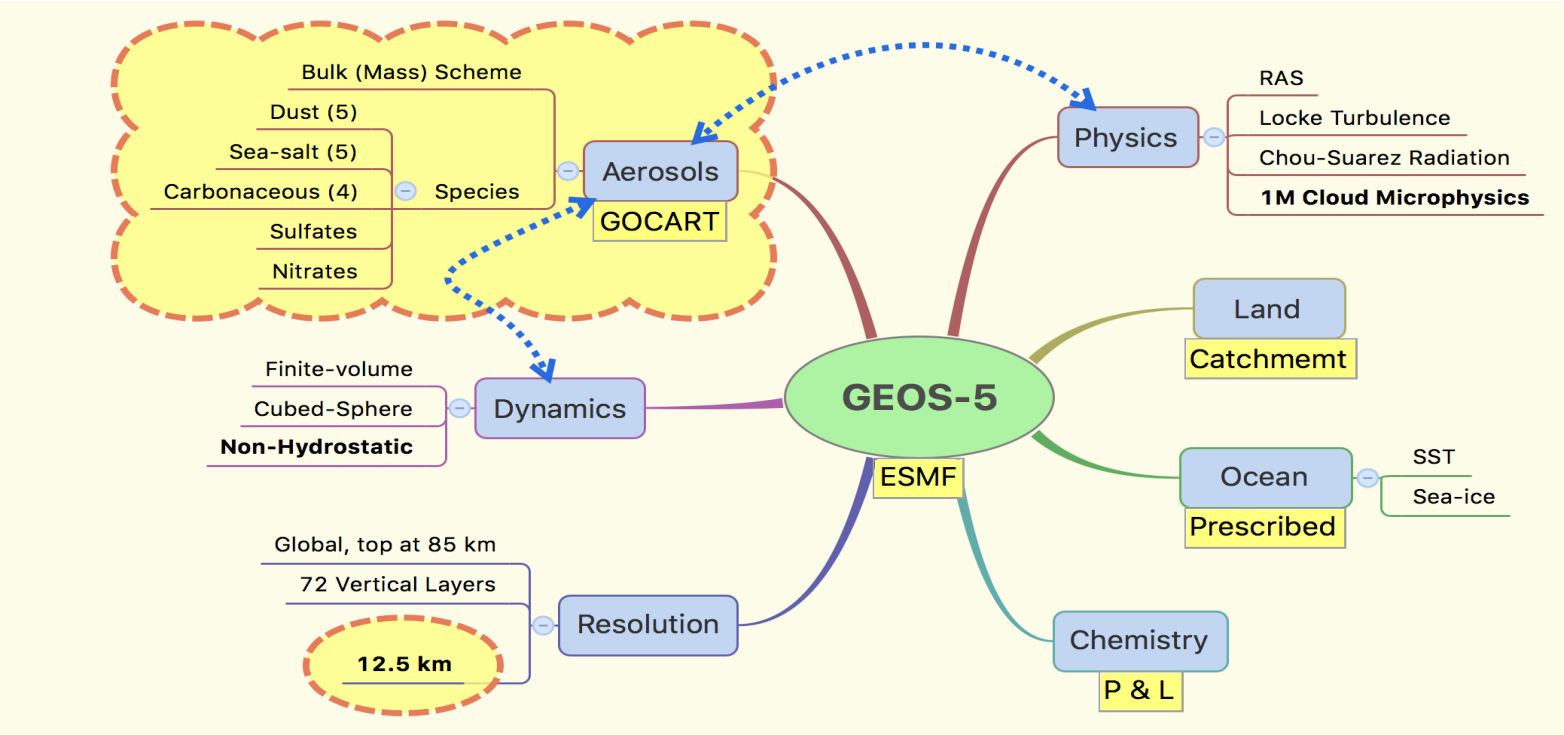
- **GEOS-5 Model Status:**
  - Forward Processing:
    - September 2016 → August 2017
    - Recent development (cloud & aerosol *μ*physics)
- **Aerosol vertical structure**
  - Tracking down low placement of plume
- **Cloud cover: spatial distribution and diurnal cycle**
- **Plans for mini-reanalysis**
  - Evaluating Aerosol Above Cloud Retrievals: OSSE study
- **Concluding remarks**

GEOS-5 Model Configuration during ORACLES 2016



Global, 25 km, 72 Levels, top at 0.01 hPa

GEOS-5 Model Configuration for ORACLES 2017



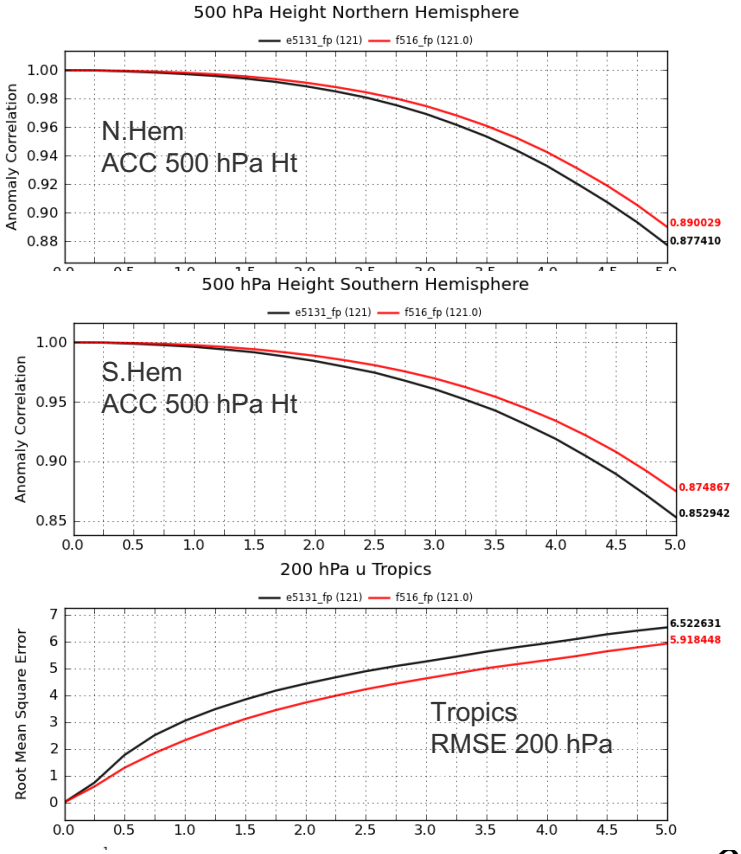
Global, 12.5 km, 72 Levels, top at 0.01 hPa

GEOS Hybrid 4D-EnVar Implemented December 2016

- **FV³ Dynamical Core**
- **Goddard Physics**
- **GOCART Aerosols**
- **Hybrid GSI**
  - GCM: C720 L72 (12.5 km)
  - GSI: 1152x721 L72 (25 km)
  - EnKF: 32xC180 L72 (50 km)
  - Semi-coupled skin SST analysis
  - Aerosol data assimilation
    - » NNR 3: MODIS C6, including Deep Blue
    - » NRT AERONET L1.5: coming soon

Forecast Skill Significance
25km 3D-Hybrid
12.5km 4D-EnVar

Dec. 2016 – Mar. 2017



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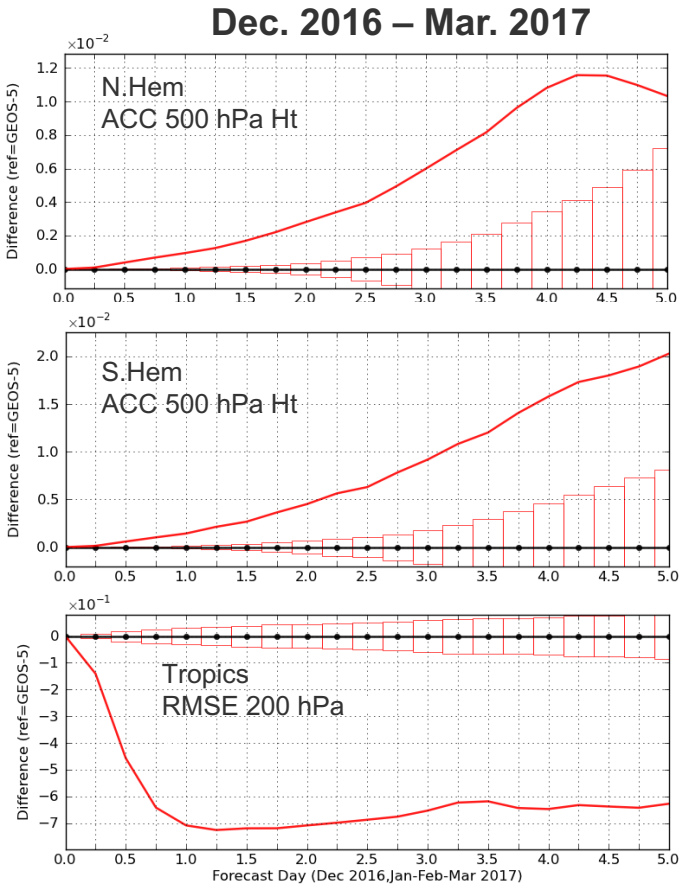
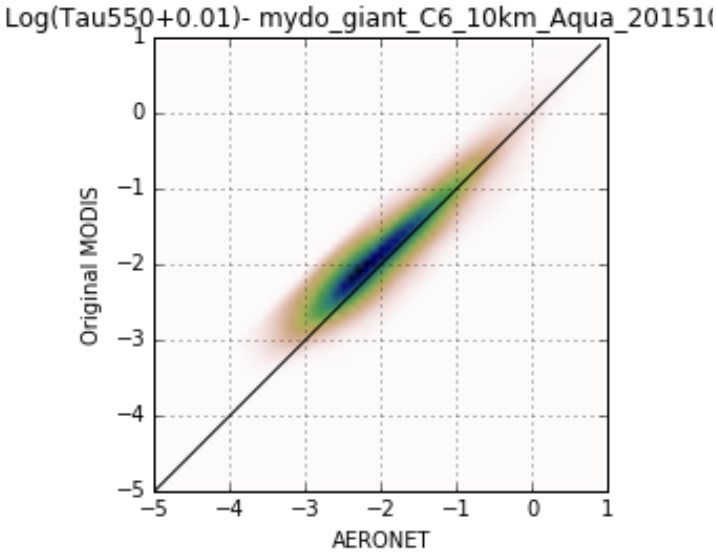
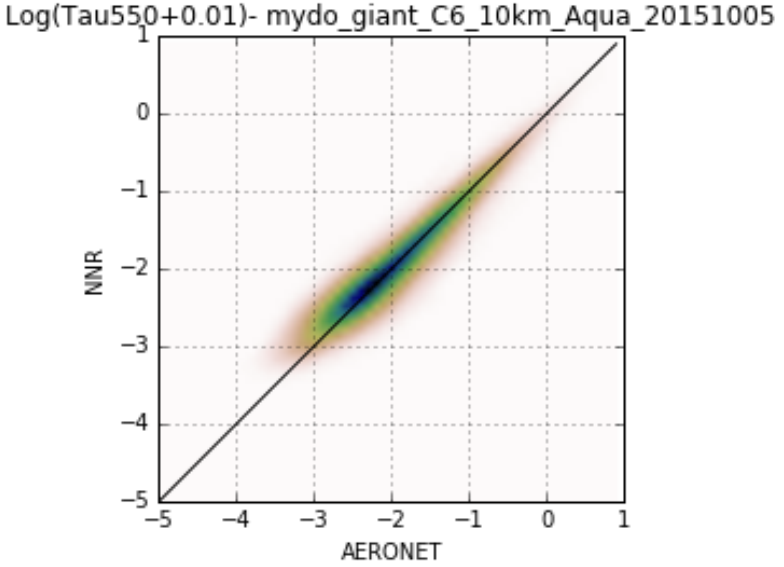


Observational Bias

Original MODIS C6 AOD

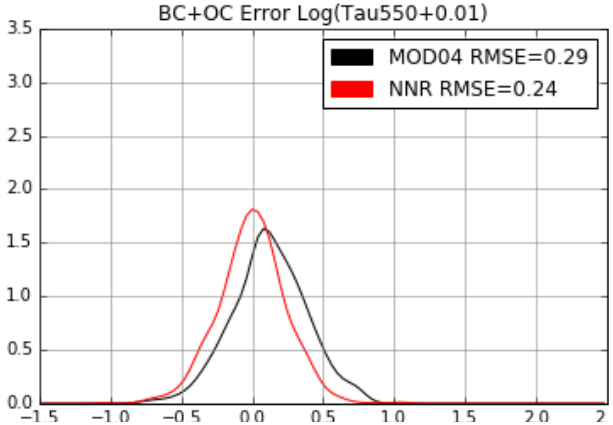


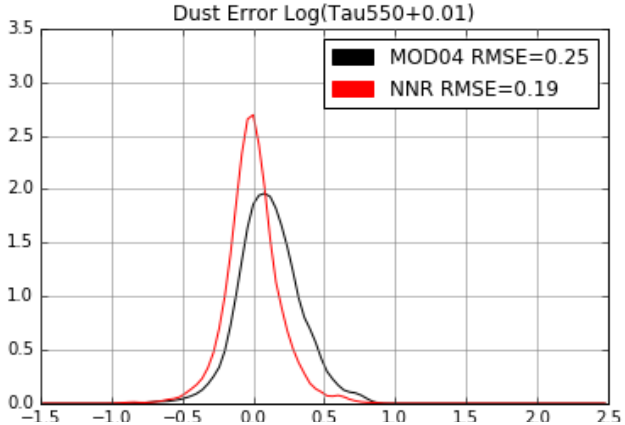
Bias Corrected AOD

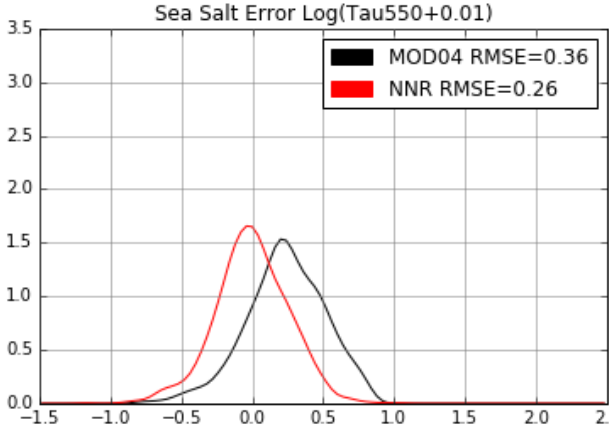


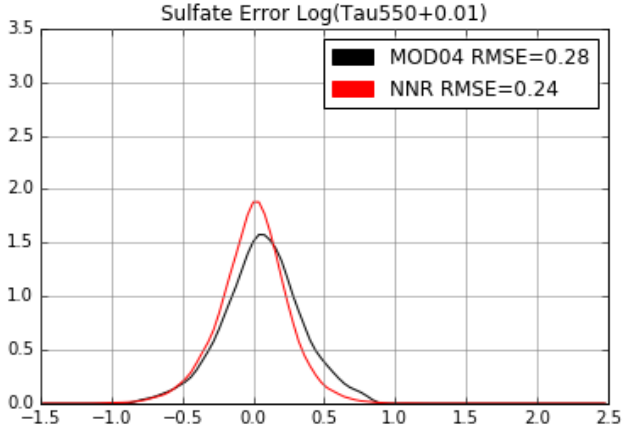
MODIS Neural Net AOD Retrievals trained on AERONET

MODIS Collection 6: Aqua

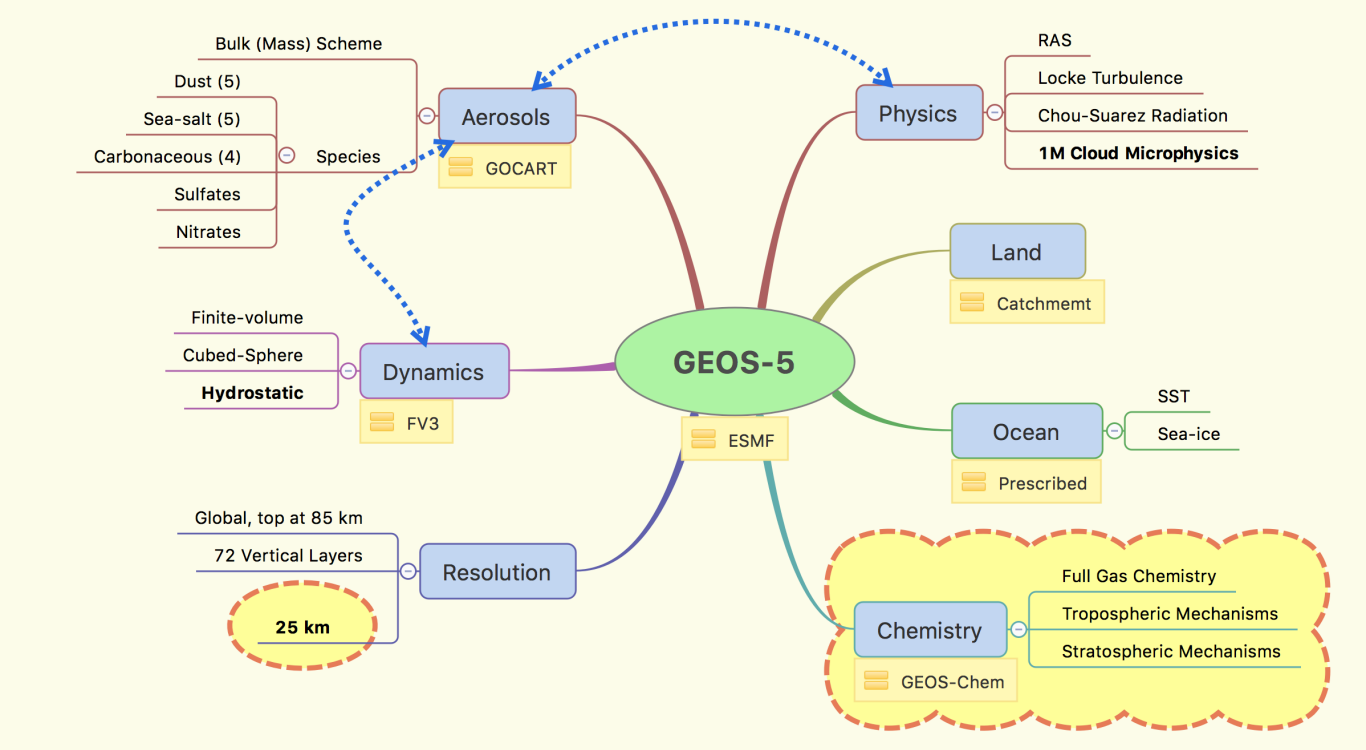






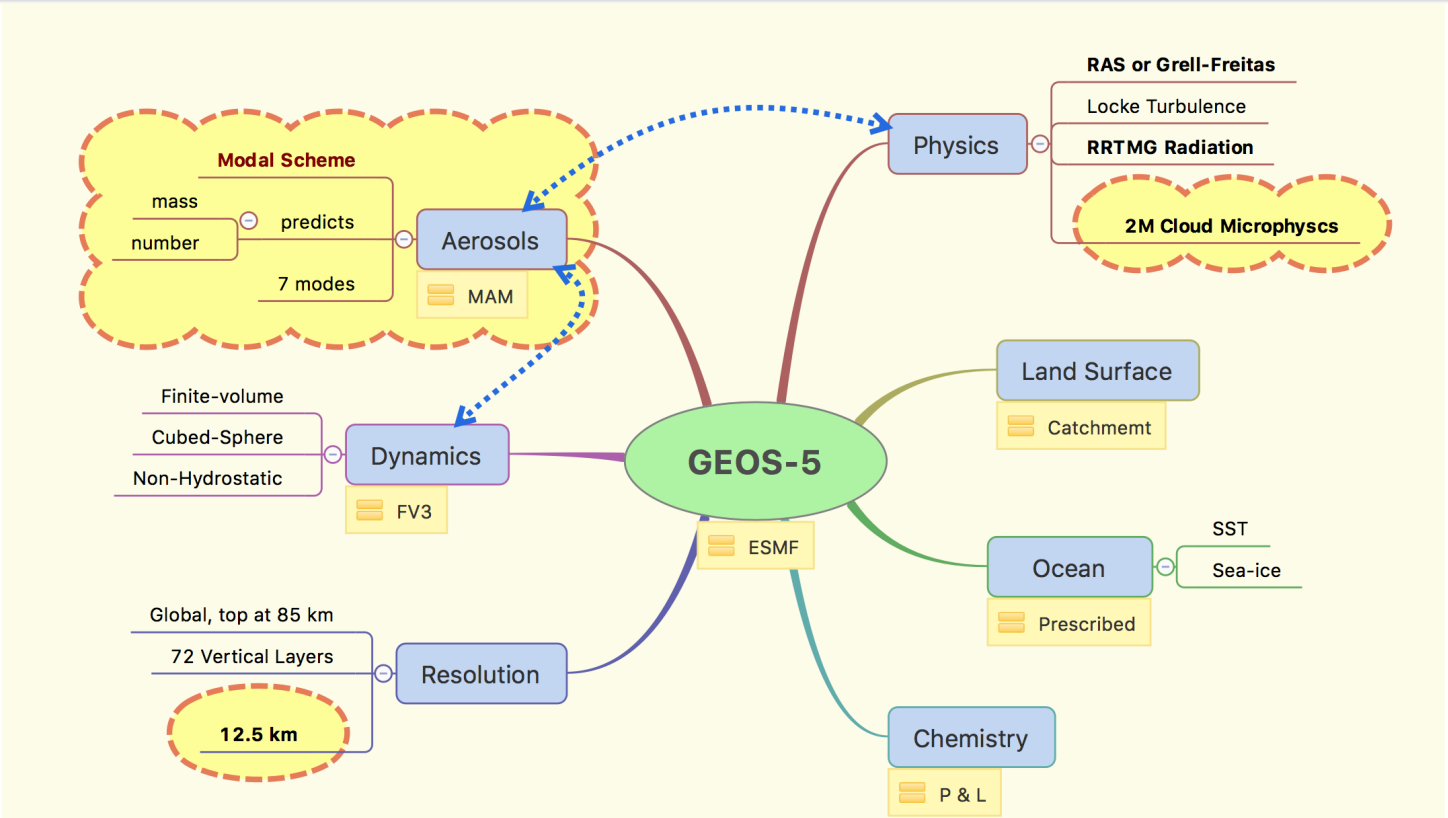


GEOS-5 with Full Chemistry for ORACLES 2017 (NRT Tentative)



Global, 25 km, 72 Levels, top at 0.01 hPa

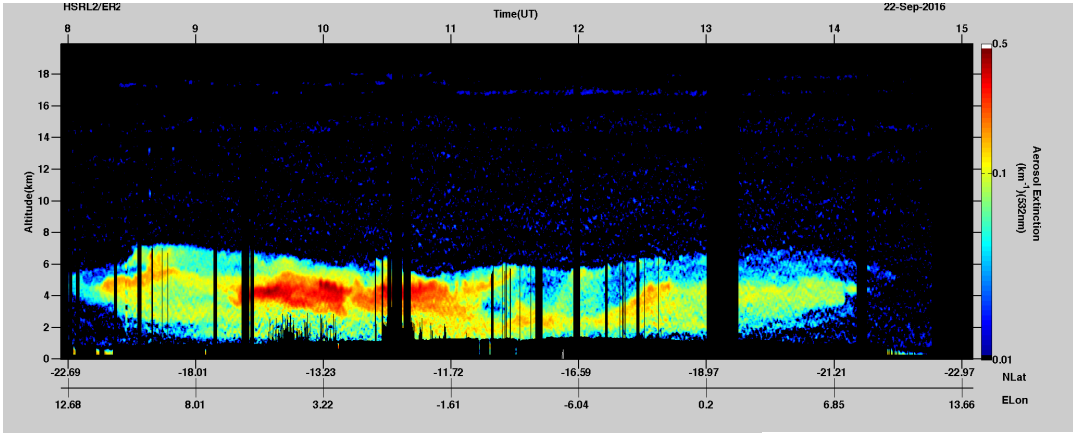
GEOS-5 with Cloud/Aero μPhysics (for ORACLES Mini-Reanalysis?)

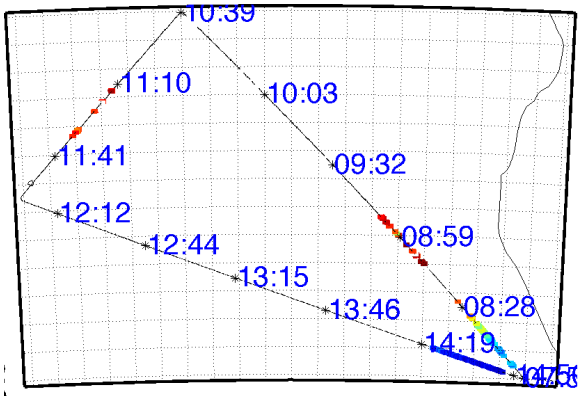


GEOS-5 Issues

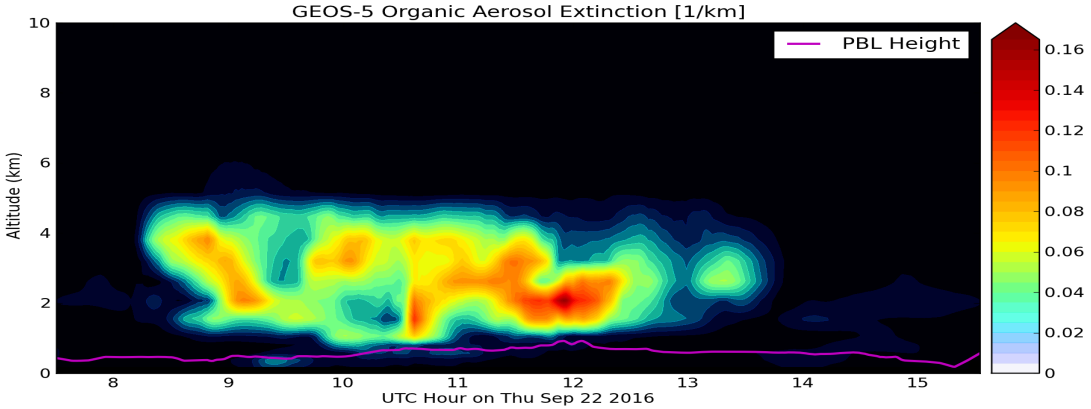
SMOKE AEROSOL: PLUME VERTICAL EXTENT

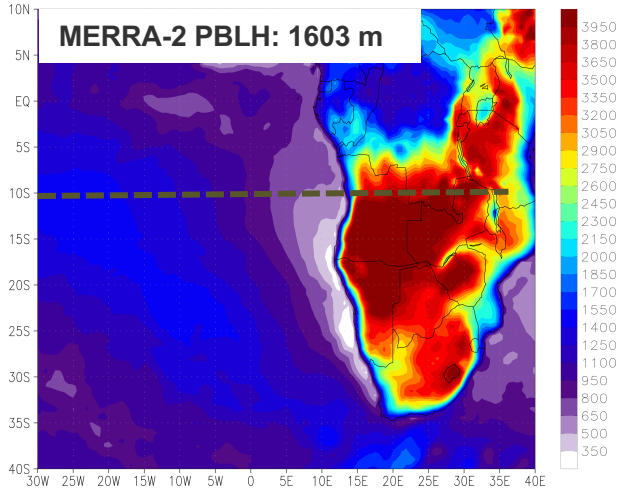
Aerosol 532 Extinction: 9/22/2016

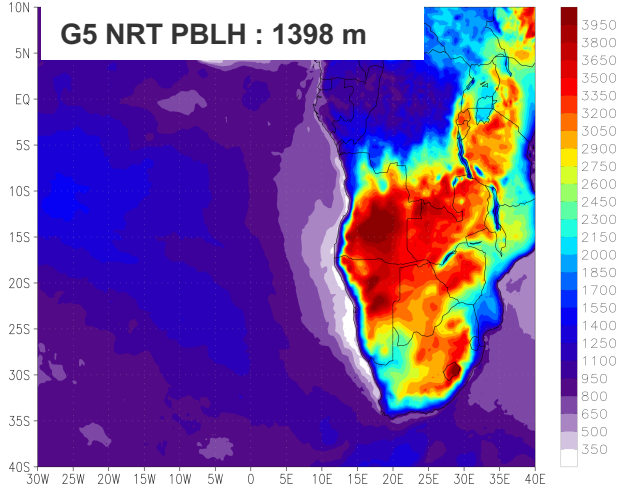




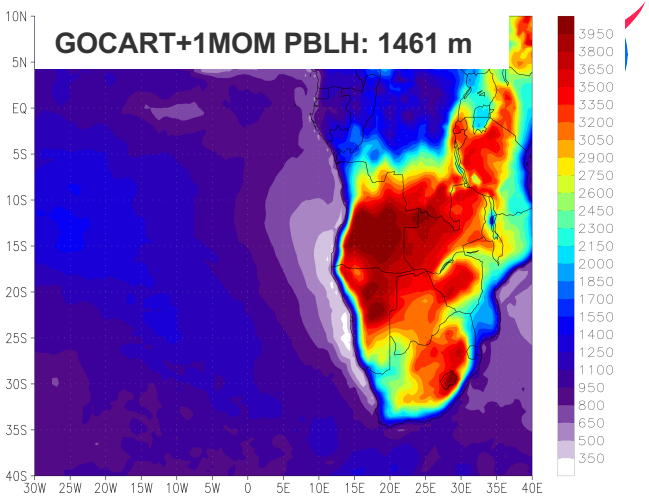
During the ampaign, GEOS-5 Smoke Plume was systematically Lower than observations

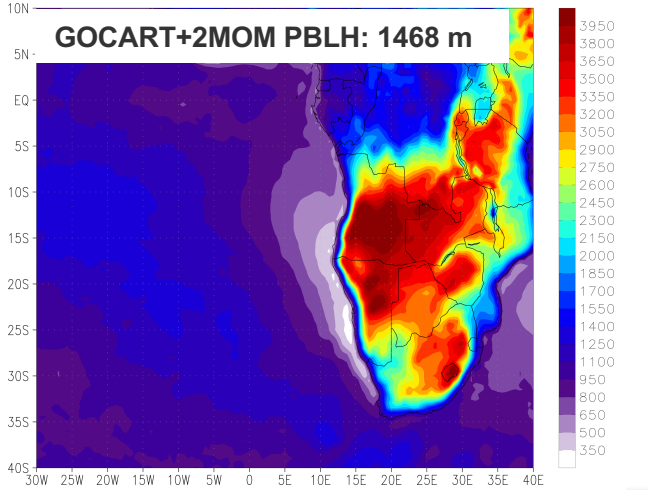




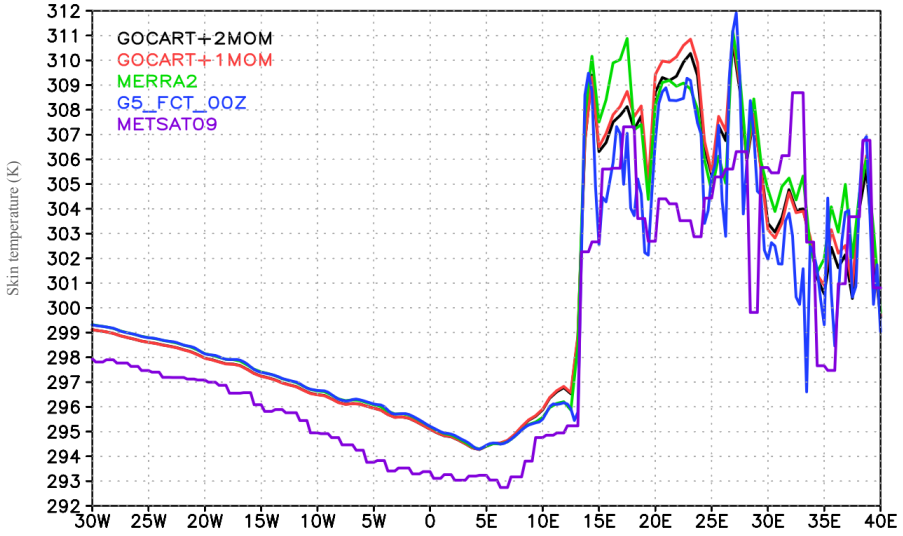


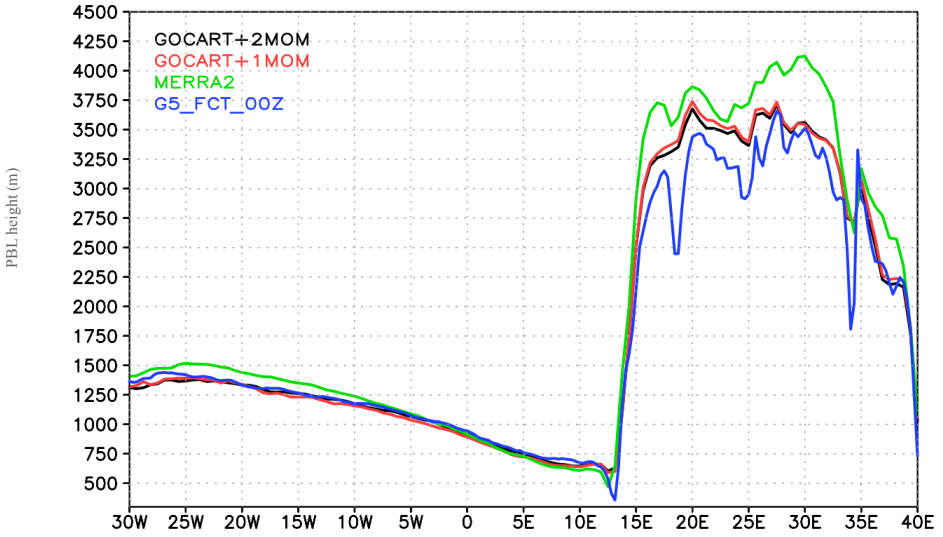
PBL height ASL (m)
September 2016





Skin temperature (K) and PBL height ASL (m) September 2016

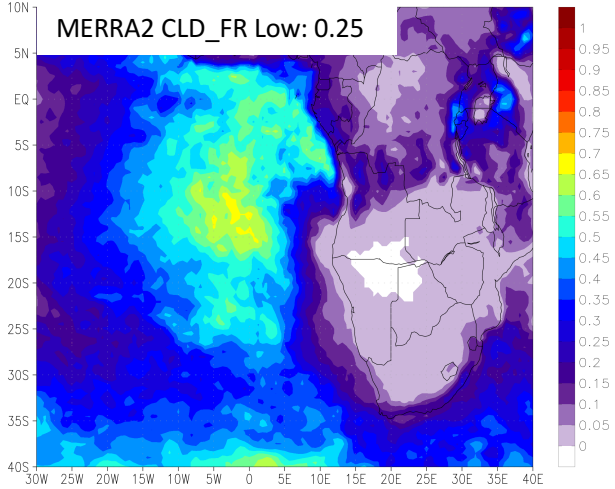


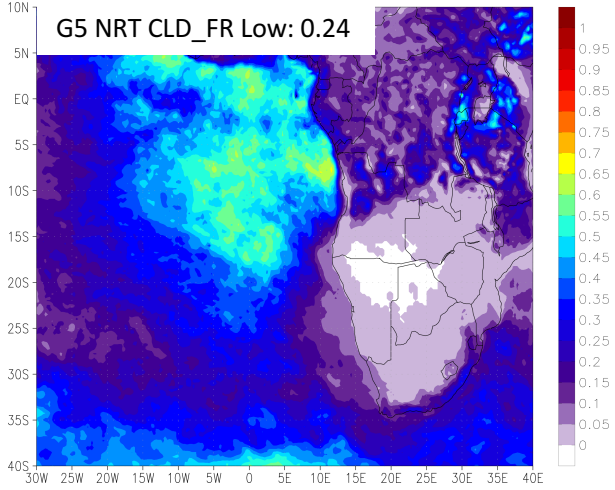


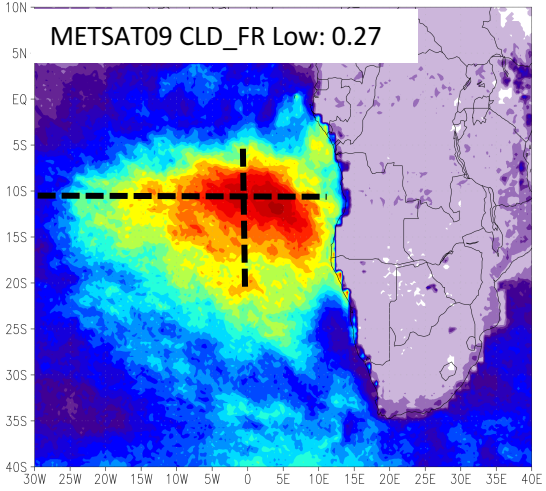
GEOS-5 Issues

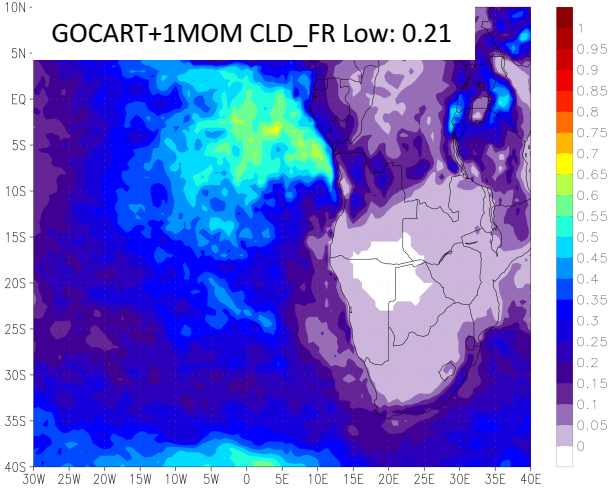
LOW-CLOUD COVER

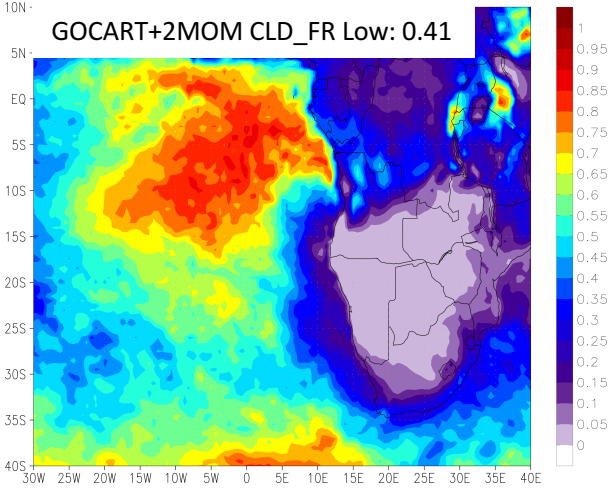
Low-cloud Fraction
September 2016



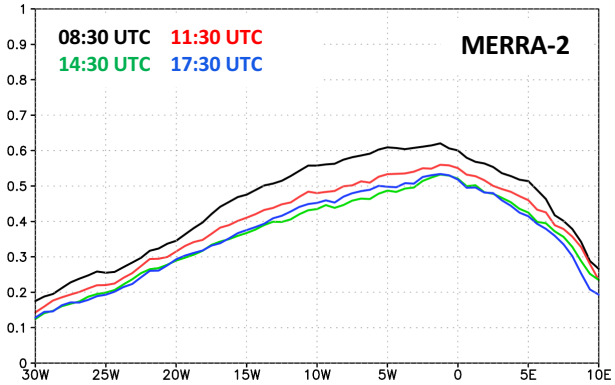


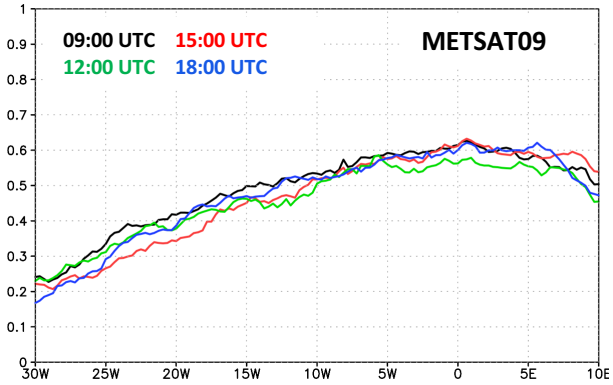


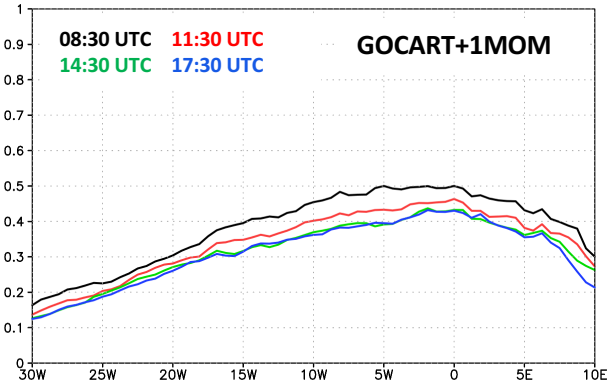


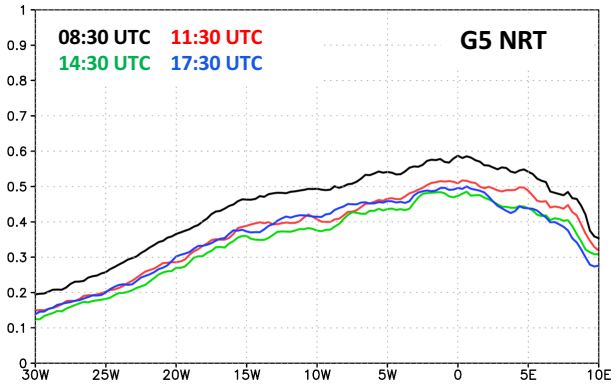


Low-cloud Fraction (20S-5S)

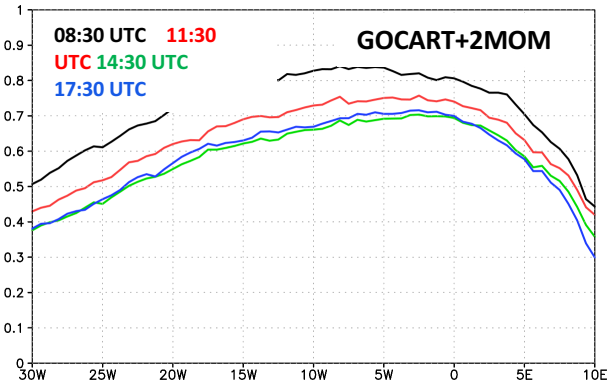








Diurnal Cycle
September 2016



Observation System Simulation Experiment (OSSE)

AEROSOL ABOVE CLOUD RETRIEVALS

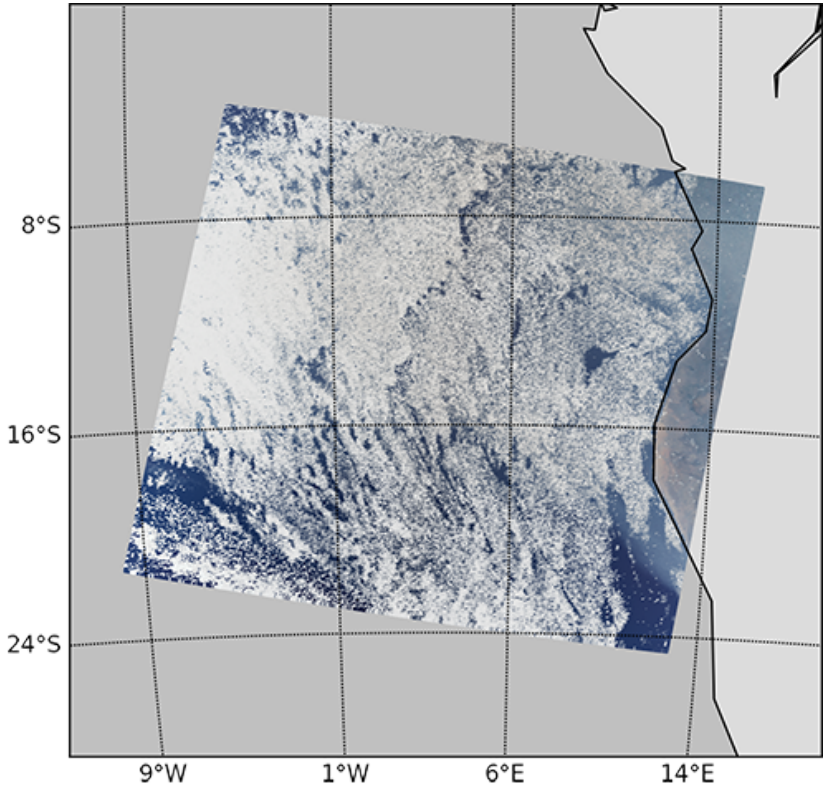
with Gala Wind, Kerry Meyer, Steve Platnick

MODIS Cloud & Aerosol Retrieval Simulator

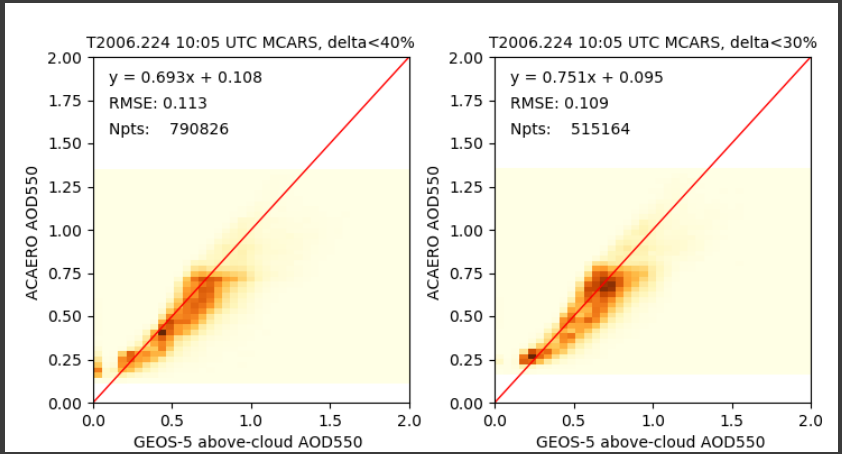
- Algorithm proofing sandbox
- 1km MODIS sensor geometry + 7km GEOS-5 Nature Run + Total Water PDF sampling to go from 7km to 1km
- 25 MODIS channels (410nm – 14.2μm)
- Correlated-k atmospheric transmittance model
- DISORT-5 radiative transfer core
- Output to standard 1-km MODIS radiance file
- Any data product code runs as if presented with real data, no awareness of radiance source
- Can examine retrieval code in fine detail
- Supercomputing application (400 processors, 8.5 hours wall-clock-time, 32 streams per granule)

MODIS ACAERO Algorithm Evaluation

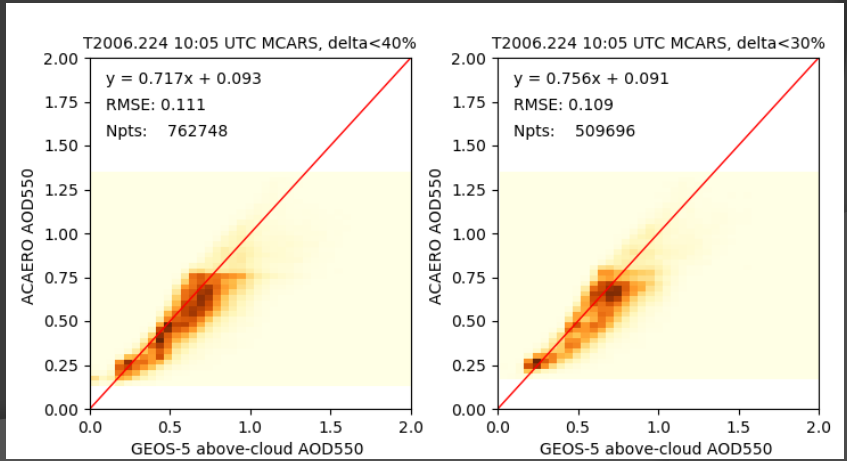
- MODIS Above-Cloud Aerosol Optical Properties by K. Meyer
- Returns aerosol optical depth, cloud optical thickness and cloud effective radius with pixel-level uncertainty at 1km resolution
- Uses 6 MODIS channels (440nm – 2.1μm)
- MODIS Dark-Target operational absorbing aerosol model
- Above-cloud retrievals over marine boundary layer clouds
- Uses MODIS Cloud product for cloud top pressure and cloud thermodynamic phase information
- Ran during ORACLES campaign as a near-real-time (NRT) product



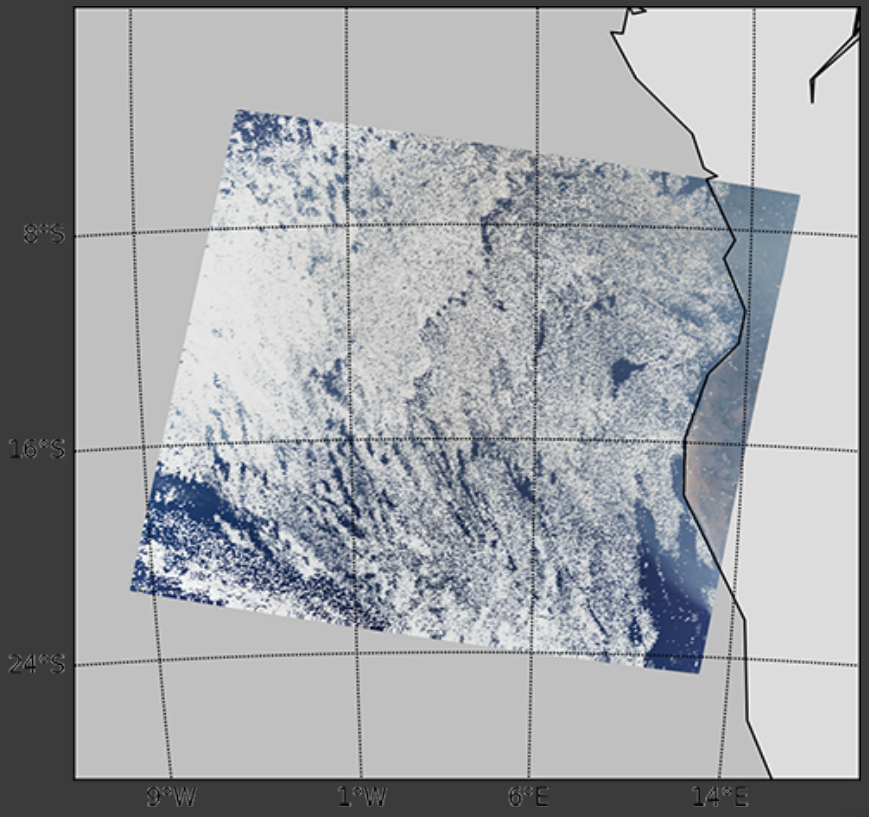
Uncertainty-only screening



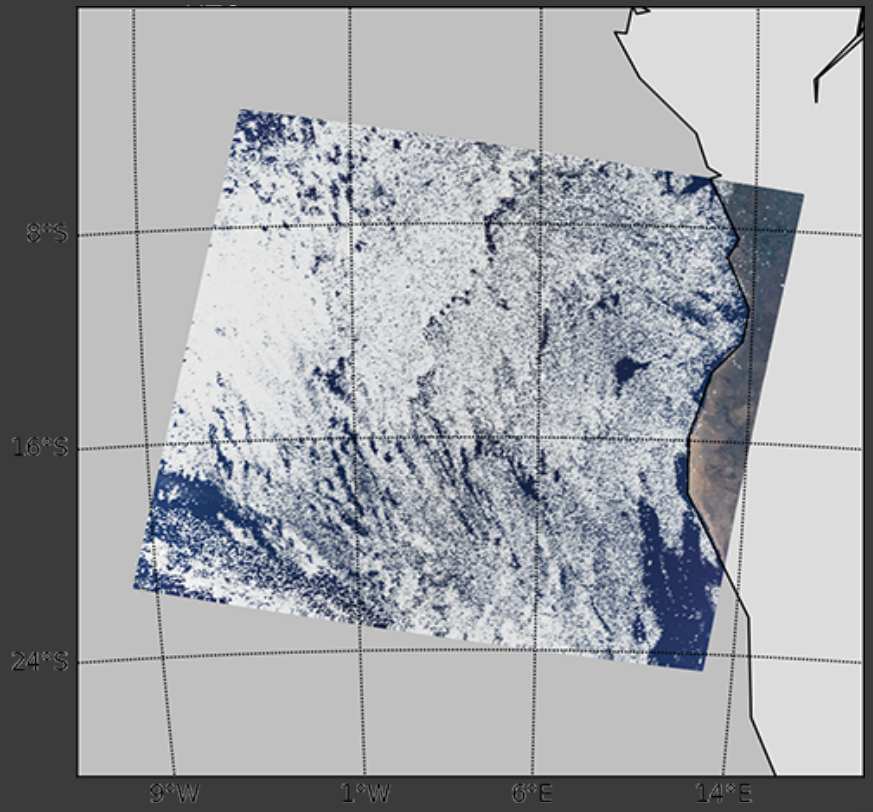
Uncertainty
Cloud Optical Thickness > 4



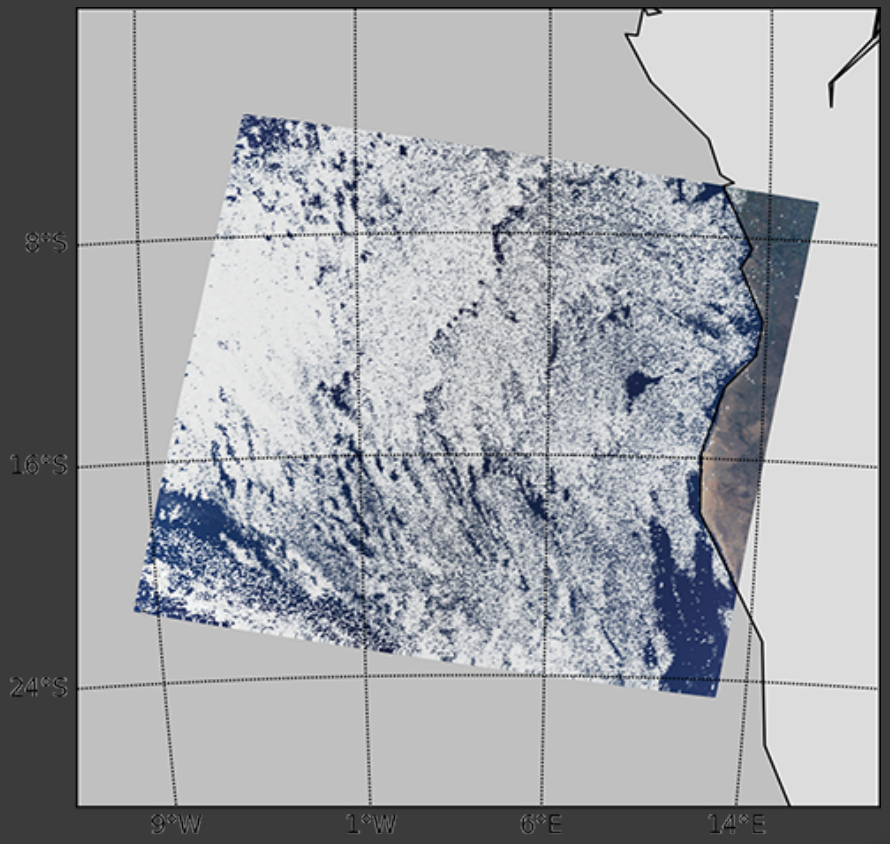
MCARS Terra MODIS 12 Aug 2006 10:05 UTC



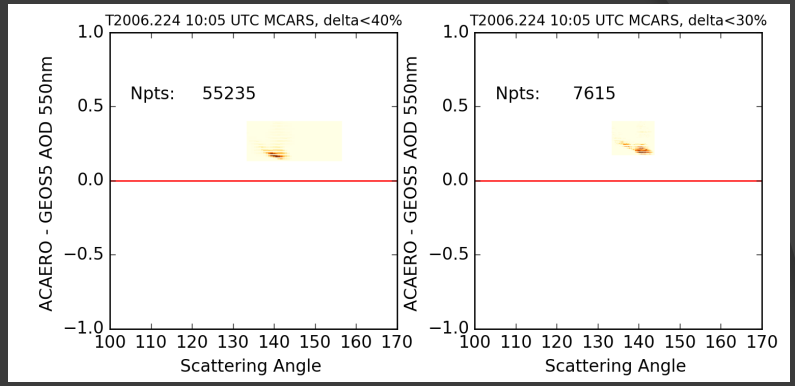
MCARS Terra MODIS 12 Aug 2006 10:05



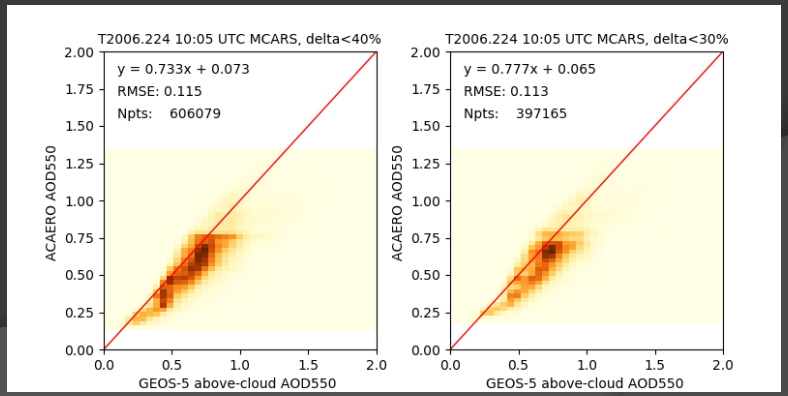
MCARS Terra MODIS 12 Aug 2006 10:05 UTC



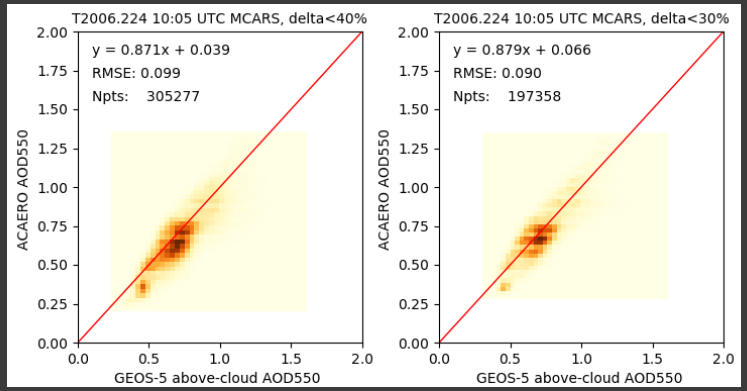
False positives as a function of scattering angle



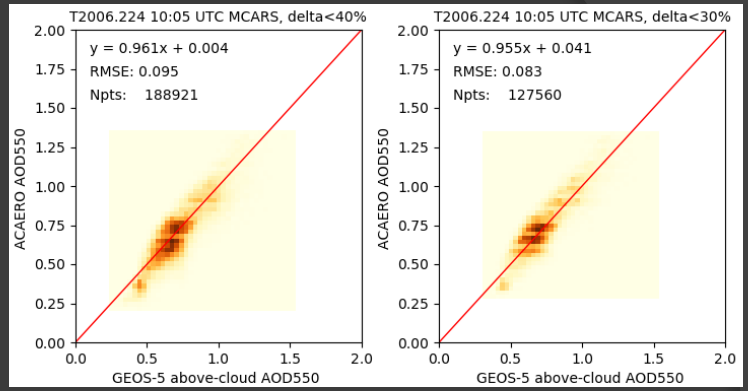
Uncertainty
Cloud Optical Thickness > 4
Exclude the rainbow angle



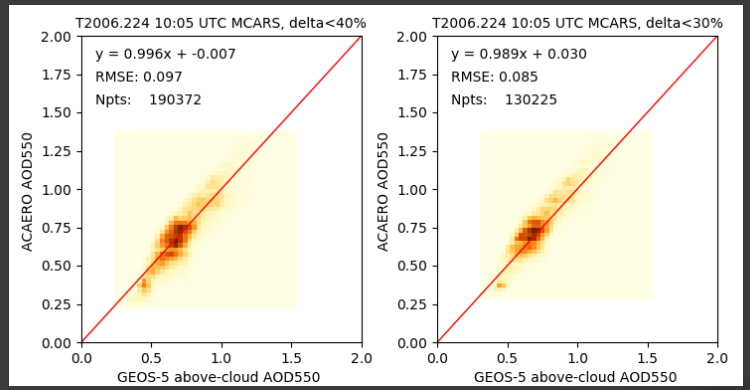
Add screening by sensor zenith < 30 degrees



by sensor zenith < 20 degrees



Add GEOS-5 input as ancillary



Recipe

Assimilate points with:

1. Pixel-level uncertainty < 40%
2. Cloud optical thickness > 4
3. Avoid the rainbow scattering angle
4. Select pixels with sensor zenith < 20^{o}

Concluding Remarks

- **For ORACLES 2017 GEOS-5 will have**
  - Higher resolution (12.5 km), retuning
  - Improved met assimilation & skills
  - NNR 3 MODIS C6 AOD, AERONET
  - Nitrates
- **New GEOS-5 with Full Chemistry (25 km)**
- **Finalizing test of cloud aerosol *μ*physics (2M & MAM-7) implementation:**
  - Tuning of aerosol optical properties (BrC absorption in particular)
  - ORACLES measurements will be critical
- **Perform mini-reanalysis for Sep 2016:**
  - Met assimilation: Hybrid 4DEnVar
  - Aerosol assimilation:
    - » Current LDE scheme: NNR 3 AOD
      - MODIS (Ocean, Dark & Bright Targets)
      - AERONET
    - » New Aerosol EnKF:
      - multi-wavelength NNR 3.1
      - AERONET, MODIS ACAero
  - Sampled datasets to be uploaded to archive