



10 Years of GEO-CAPE: GMAO Activities and Highlights

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With significant contributions from:

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Michael Long (Harvard University) and the GEOS-Chem Development Team
Shobha Kondragunta and Pubu Ciren (NOAA /NESDIS/STARR)

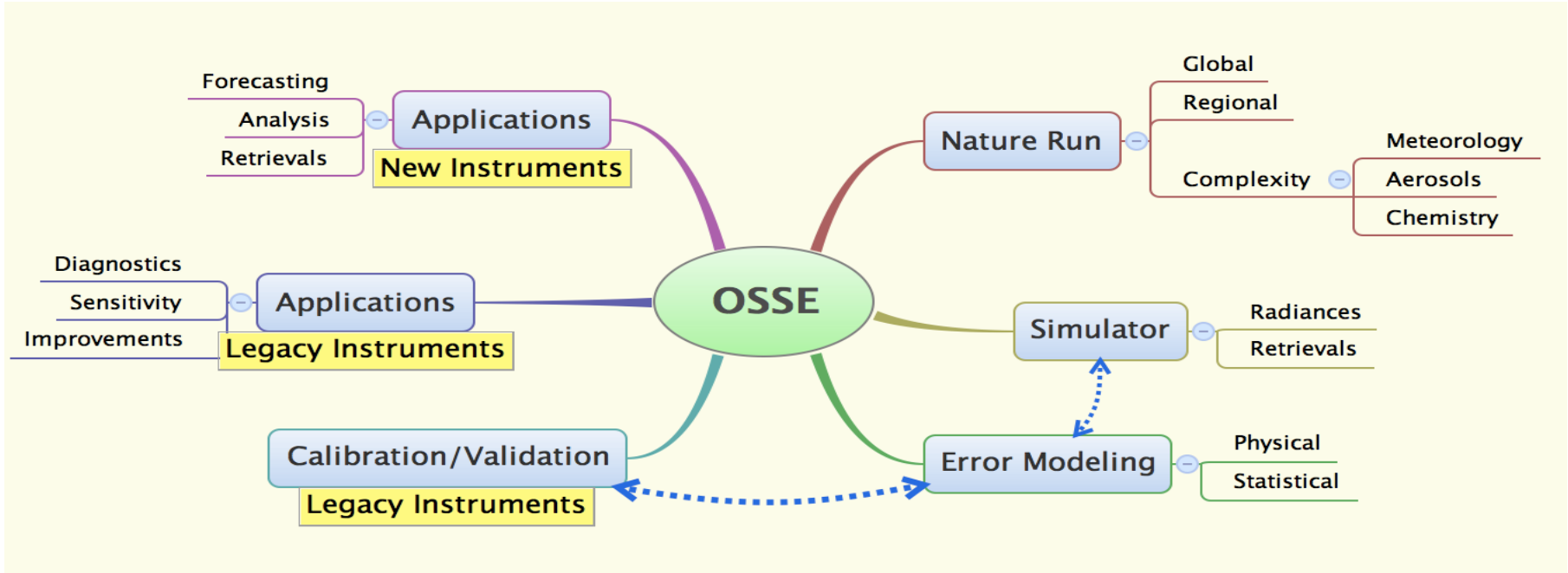
AC-VC 14 & Joint GEO-CAPE Workshop
NOAA Center for Weather and Climate Prediction
College Park, Maryland



Outline

- GEOS-5 Nature Runs
 - 7 km GEOS-5 Nature Run (G5NR)
 - 12 km GEOS-5 Nature Run with Full Chemistry
- Observation simulators for geostationary constellation
 - Instruments: TEMPO, GEMS, SENTINEL-4, GOES-R
 - Sub-Grid Cloud Models
- Retrieval simulators
 - UV & GOES-R synergy for aerosol type detection
 - UV AOD retrieval

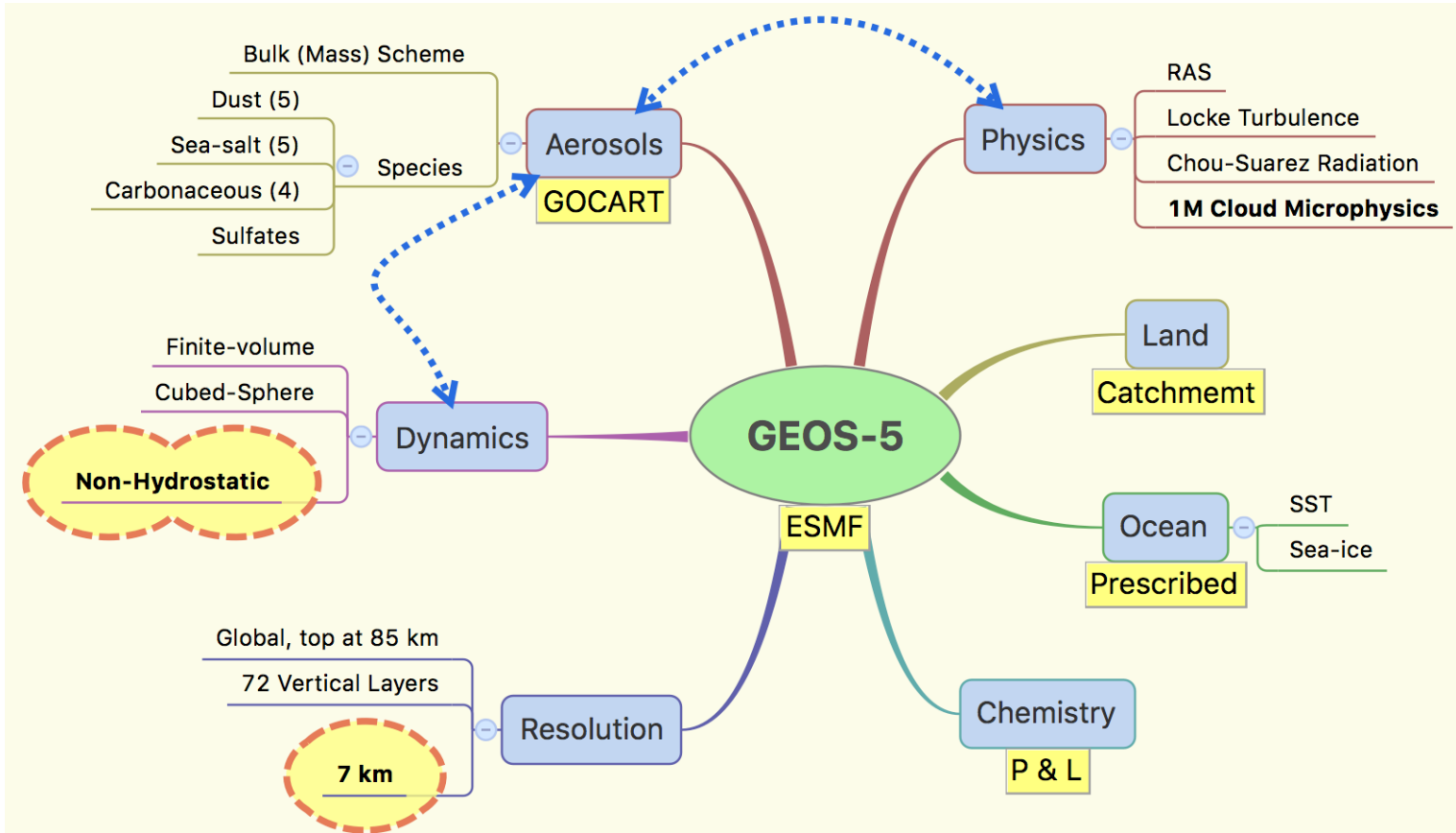
Elements of an OSSE System





Nature Runs

G5NR Model Configuration

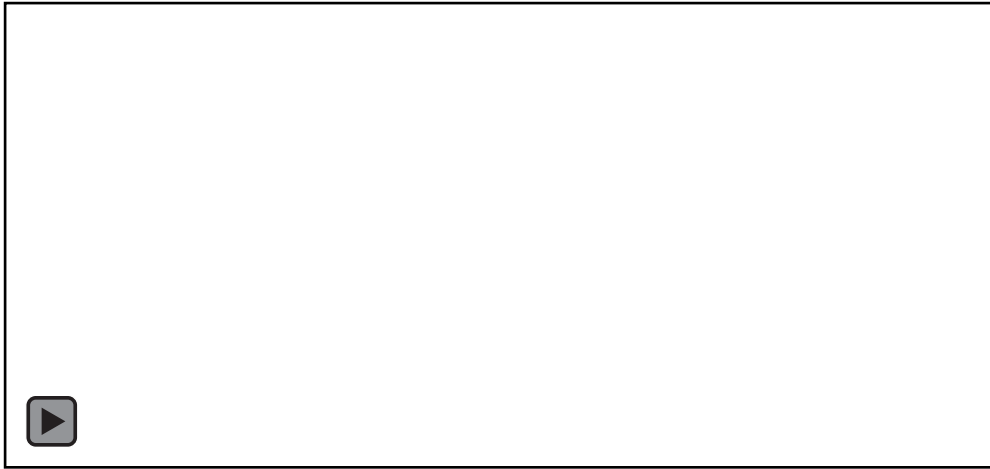




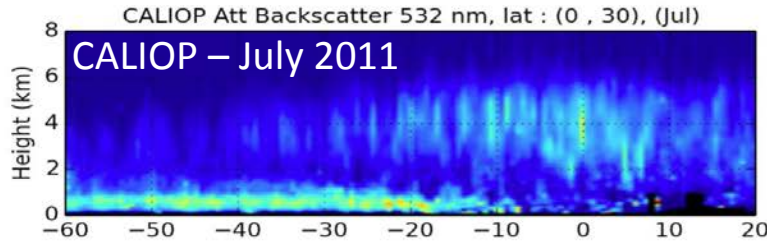
G5NR Validation

Compare to long-term datasets

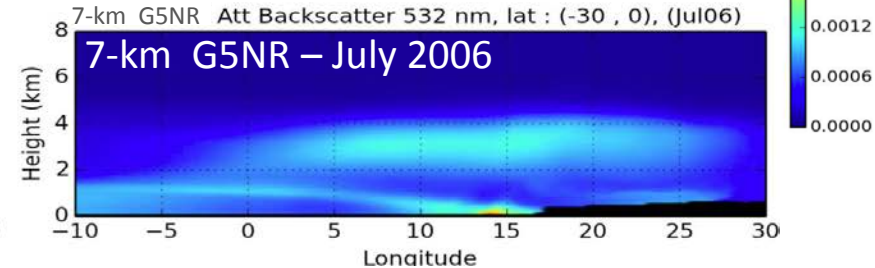
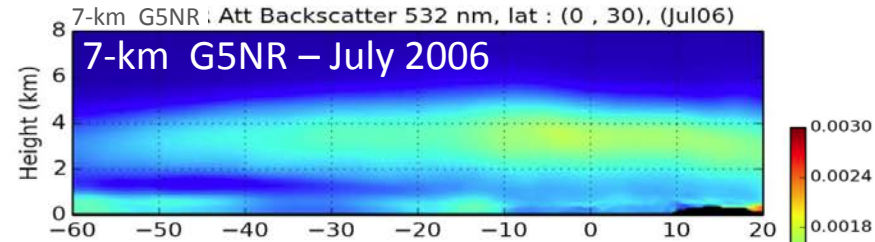
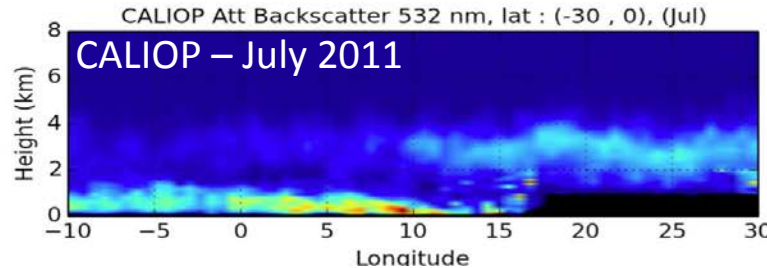
- Monthly mean observations
- Reanalysis: MERRA & MERRAero
- Multi-model Statistics: e.g. AeroCom



North African Dust



South African Fires

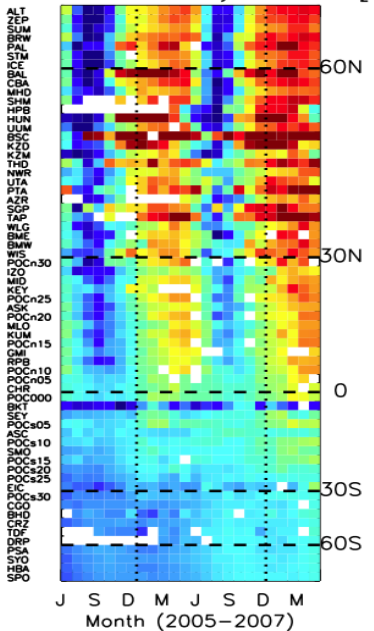




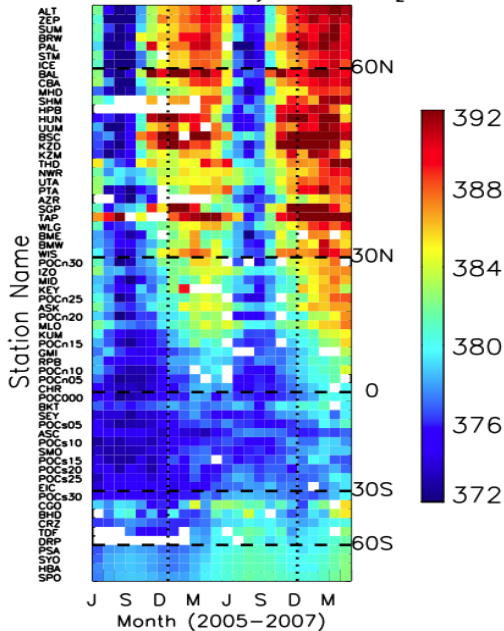
G5NR Validation

Monthly mean CO₂ (ppmv) at NOAA surface sites for the 2005-2007 period

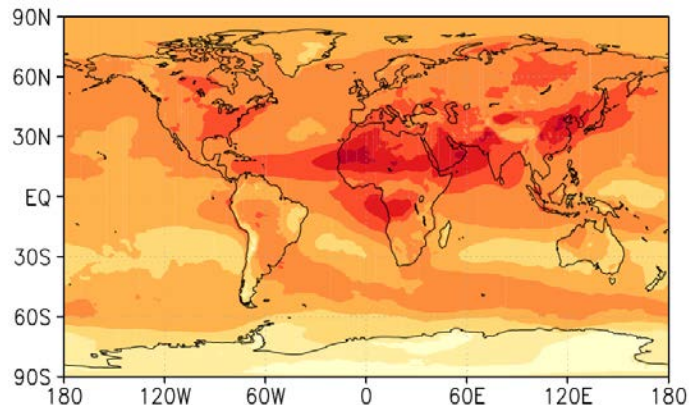
Observed Monthly Mean CO₂



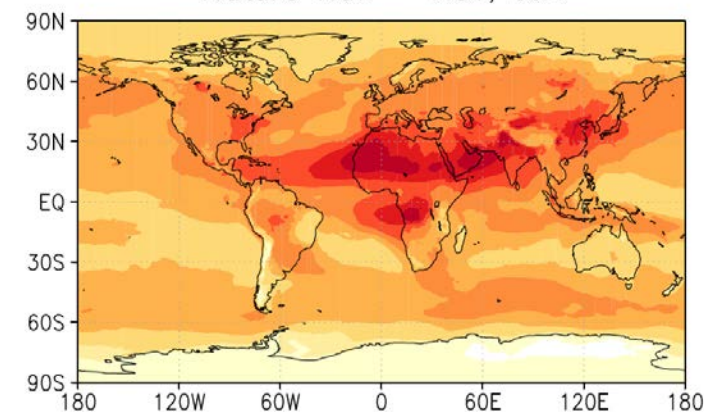
Simulated Monthly Mean CO₂



MERRAero - AOT, JJA

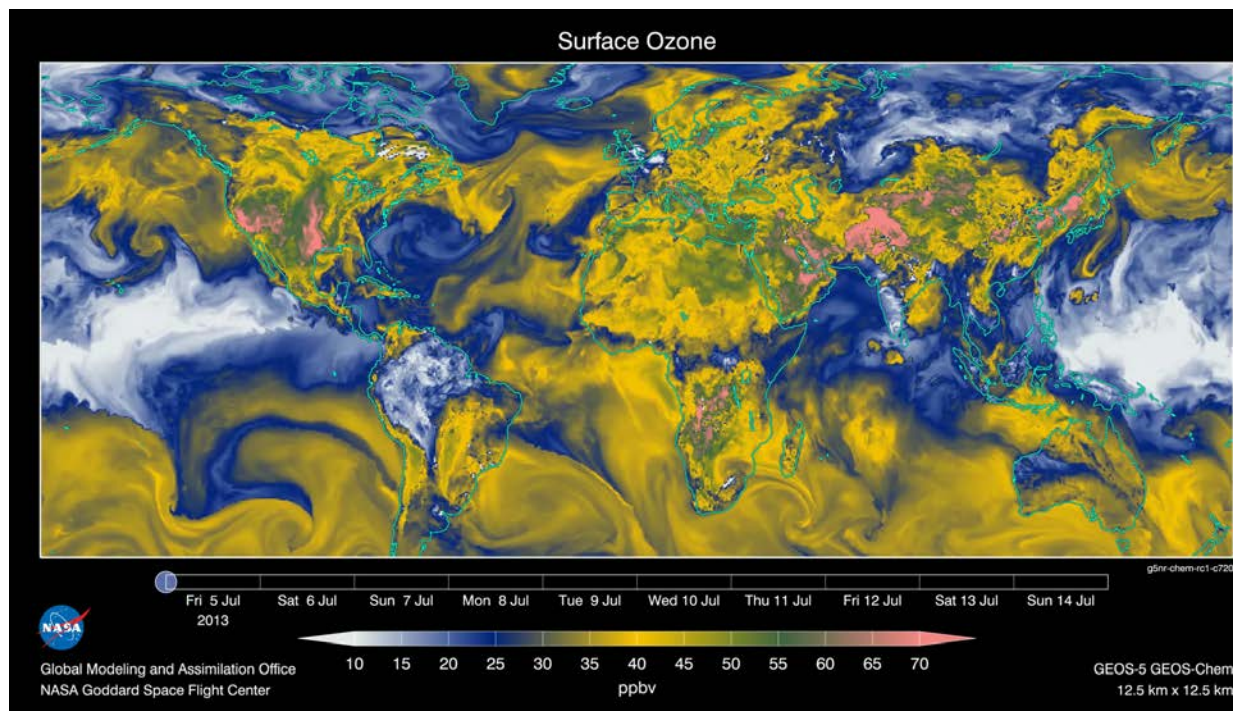


Nature Run - AOT, JJA



G5NR-Chem: GEOS-5 Nature Run with Full Chemistry

- Time Period:
 - July 2013 – June 2014 (overlap with **SEAC4RS**)
 - May-June 2016 (overlap with **KORUS-AQ**)
- GEOS-Chem chemical mechanism with simplified stratosphere
- Meteorology constrained by MERRA-2 downscaled to 12.5 km
- Hourly output of 3D trace gas concentrations
- Validation manuscript in preparation: Lu et al., GMD



G5NR-Chem: GEOS-5 Nature Run with Full Chemistry

Time Period:

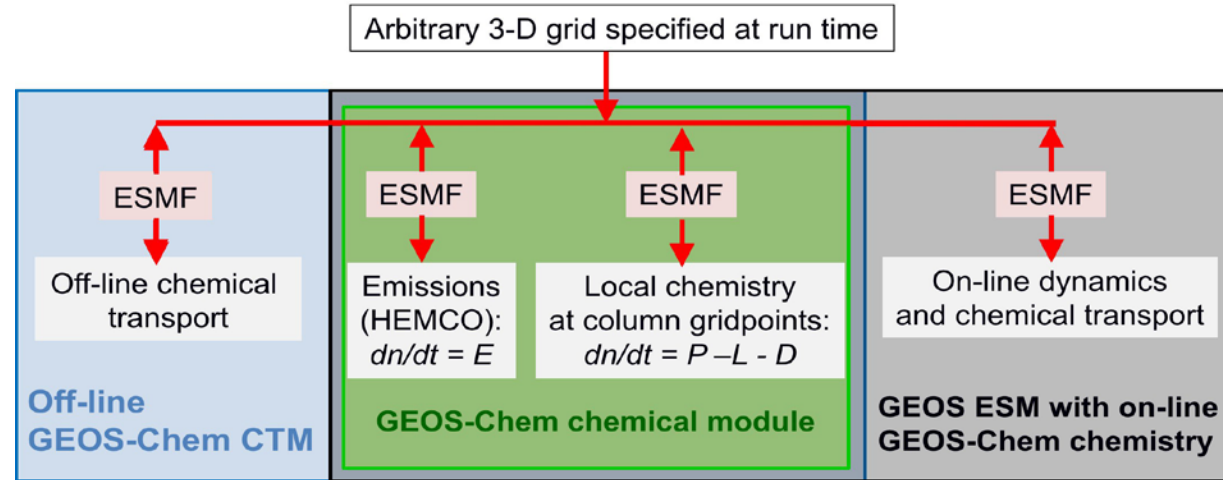
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GEOS-Chem chemical mechanism with simplified stratosphere

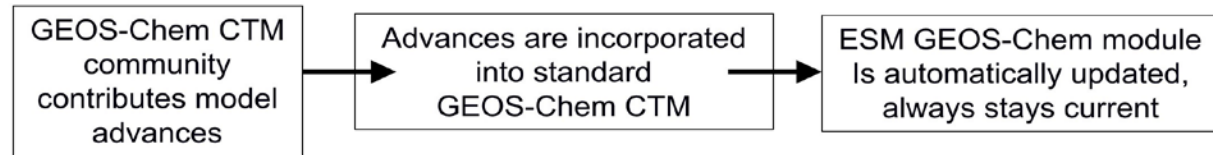
Meteorology constrained by MERRA-2 downscaled to 12.5 km

Hourly output of 3D trace gas concentrations

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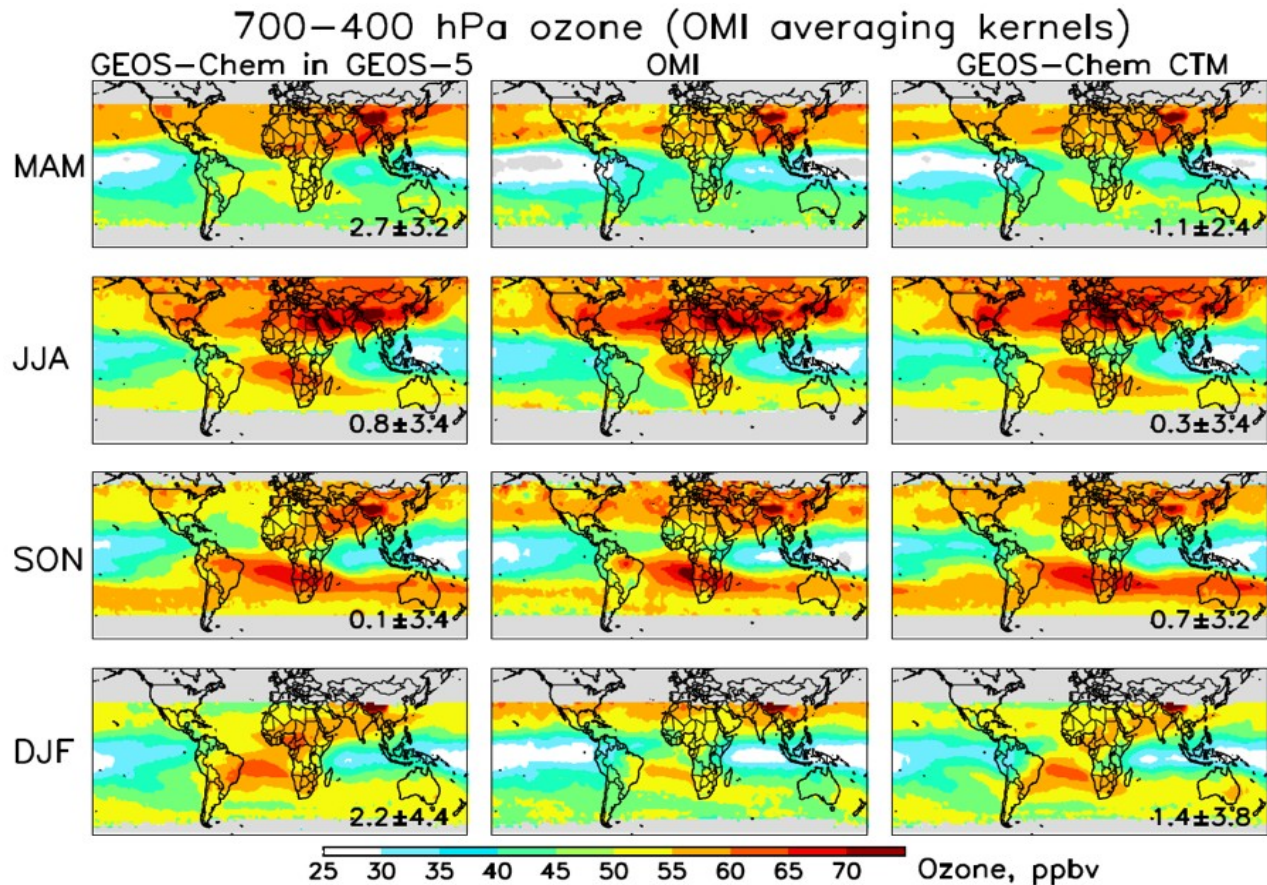


GEOS-Chem chemical module in CTM and ESM is exactly the same code

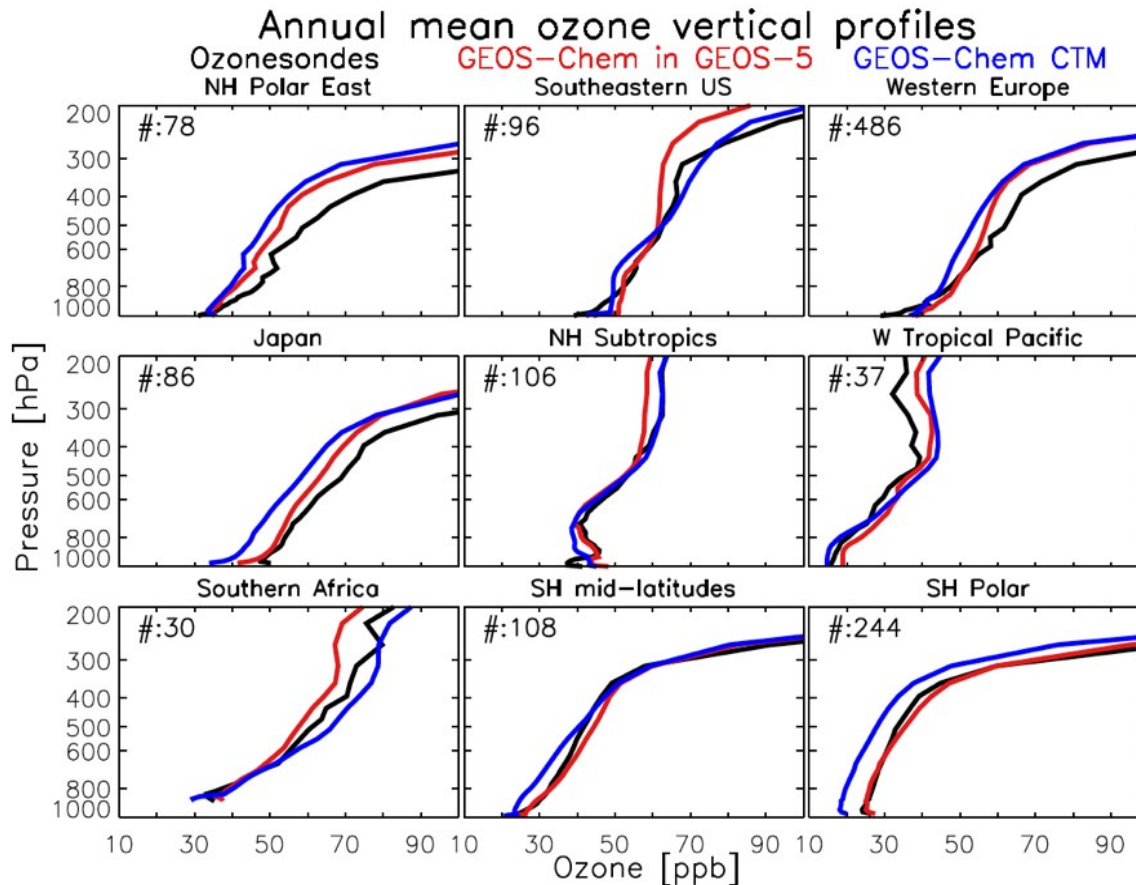


Lu et al., GMD, In Prep.

G5NR-Chem Validation: OMI Tropospheric Ozone

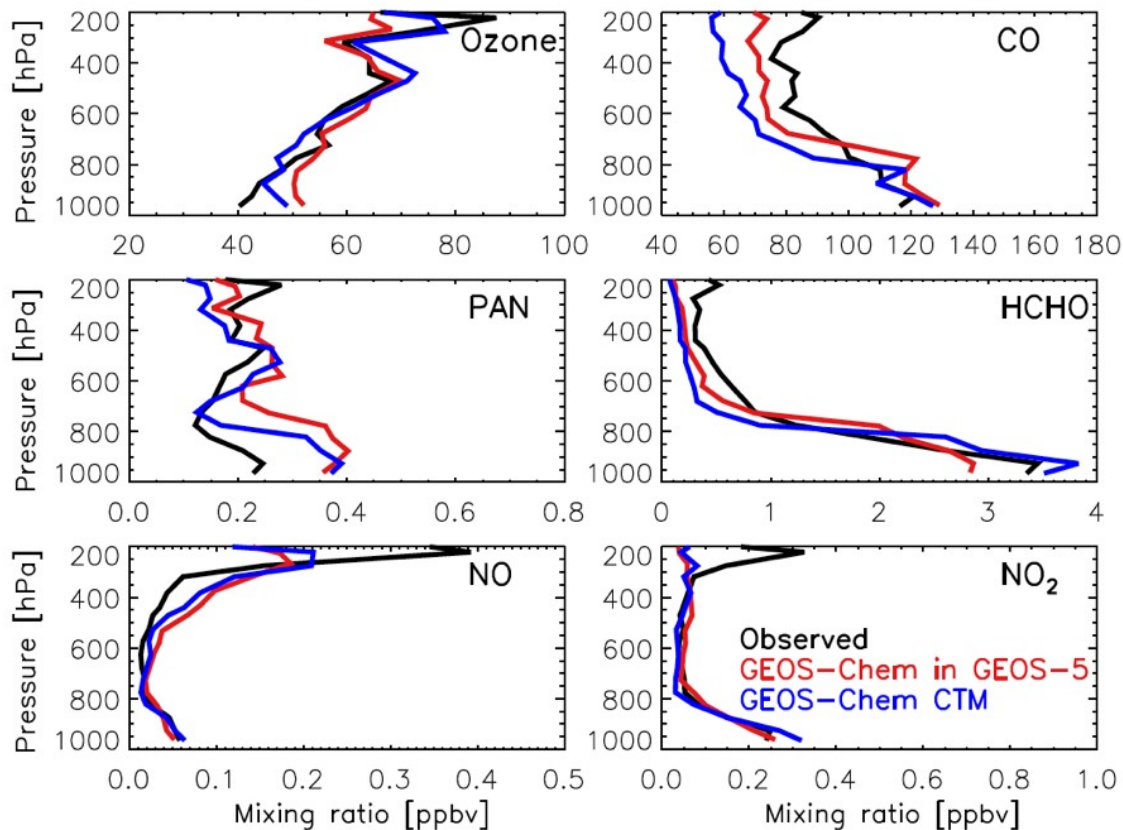


G5NR-Chem Validation: Ozonesondes



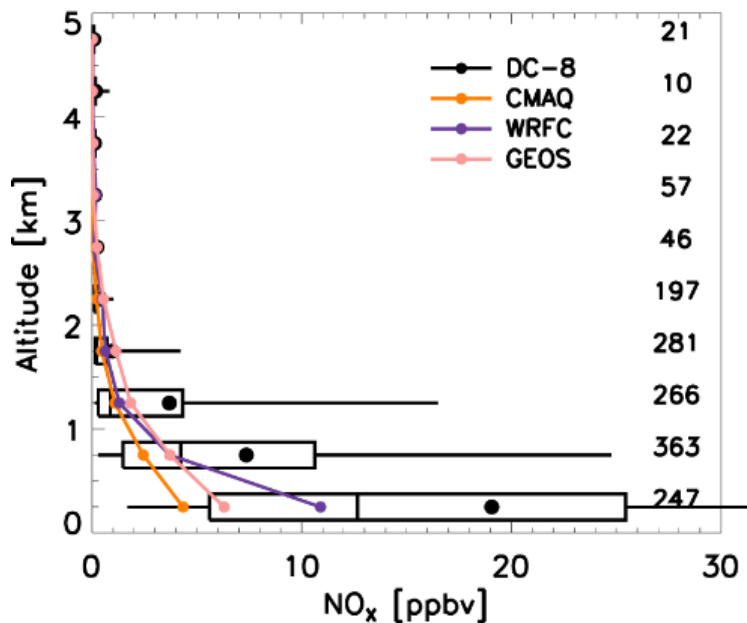
G5NR-Chem Validation: SEAC4RS

Mean profiles over Southeast US (SEAC⁴RS)

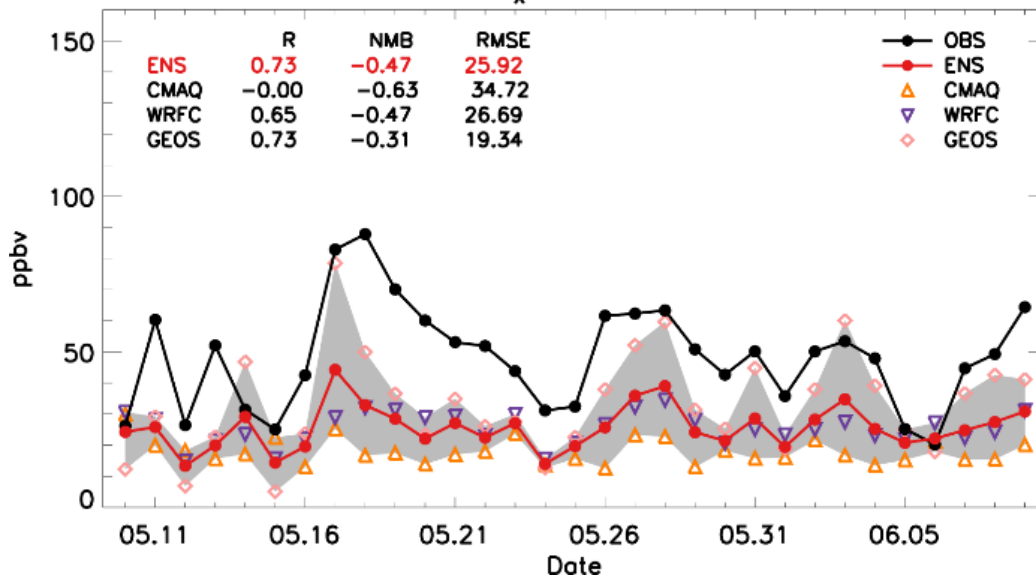


G5NR-Chem Validation: KORUS-AQ

Vertical Profile over SMA



Surface NO_x at OLYMPIC PARK

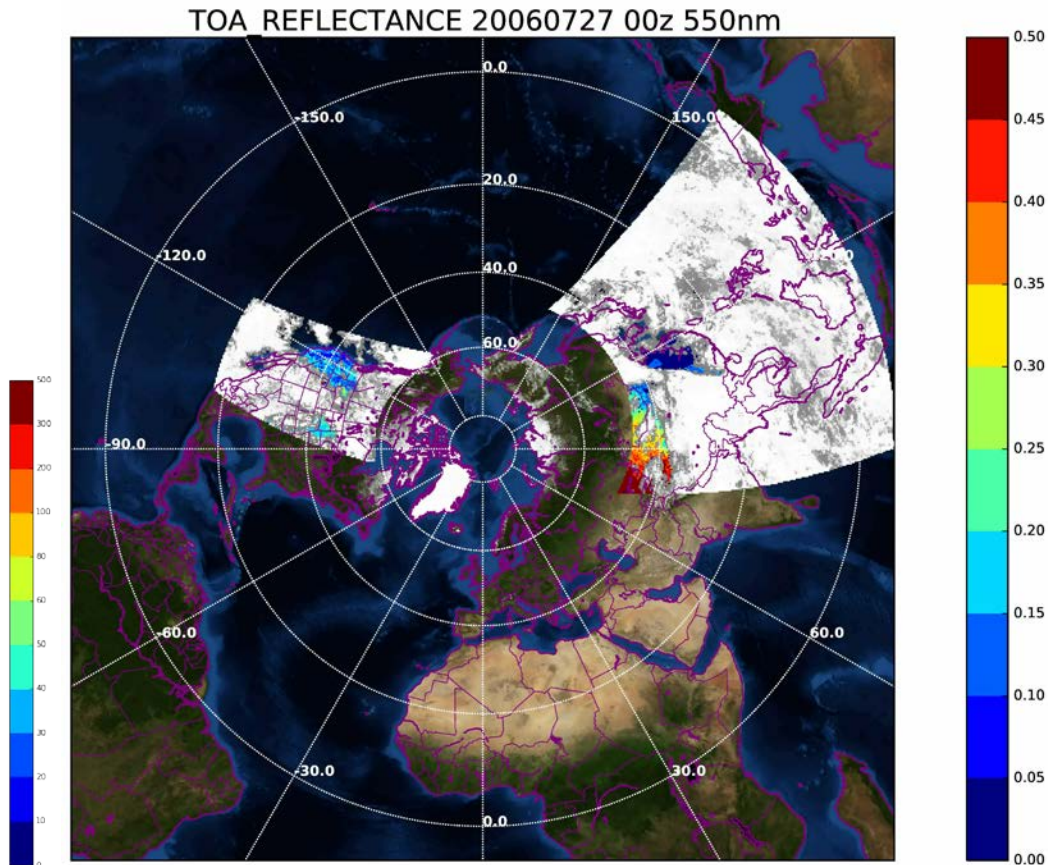
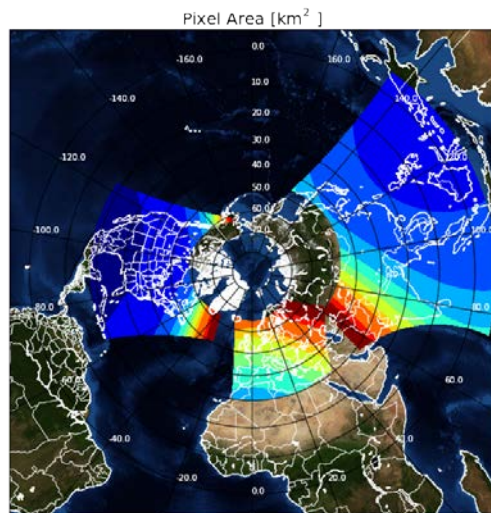




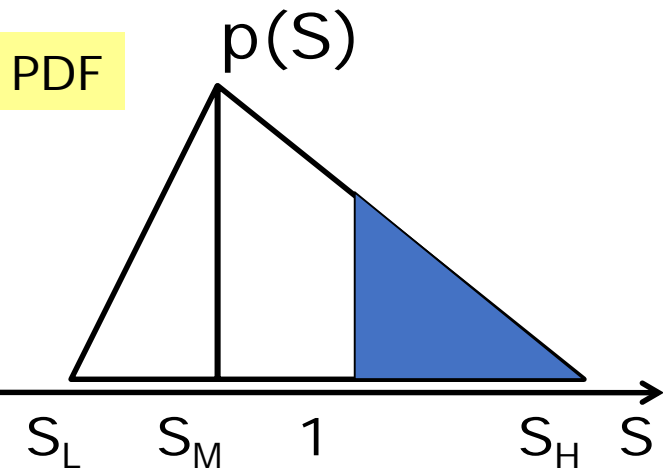
Observation Simulations

Geostationary Constellation: TEMPO+GEOS-R, GEMS, & Sentinel-4

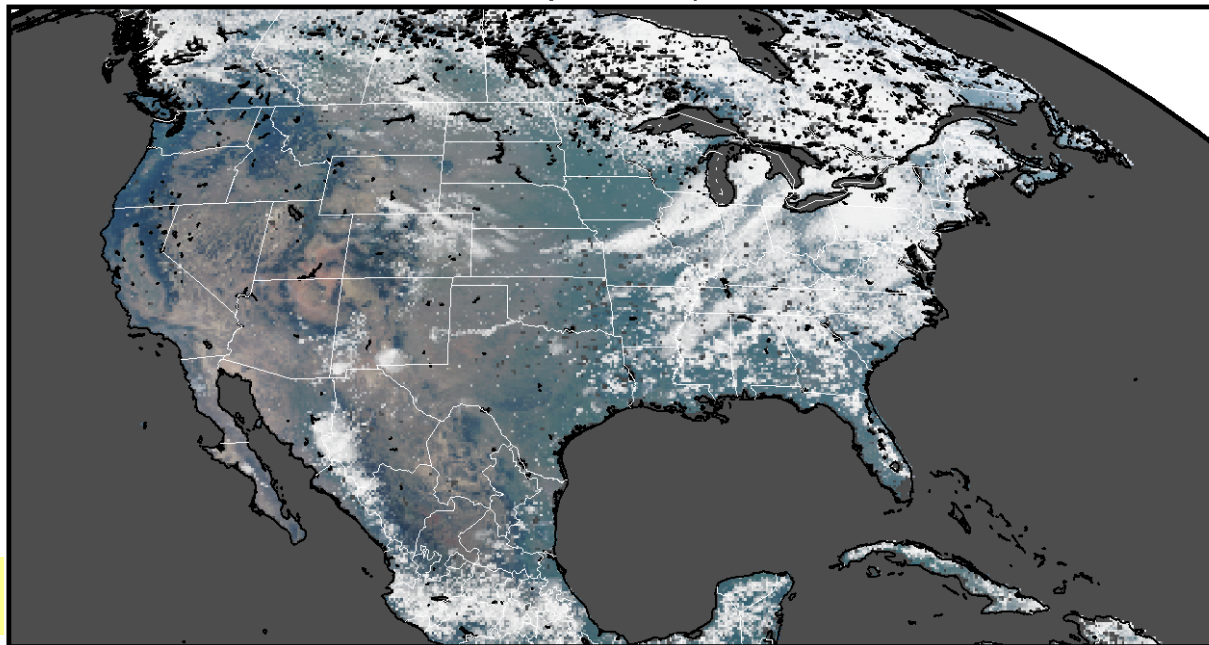
- UV-Vis TOA Reflectance for aerosol relevant channels
- Radiative Transfer Model: VLIDORT
 - Surface BRDF
 - G5NR GOCART aerosols



Sub-Grid Cloud Variability



Simulated TEMPO True Color Image (Atmosphere + Surface) 20060615 21z



$$S = (q_v + q_L + q_I) / q_S(T)$$

Norris and da Silva, 2016

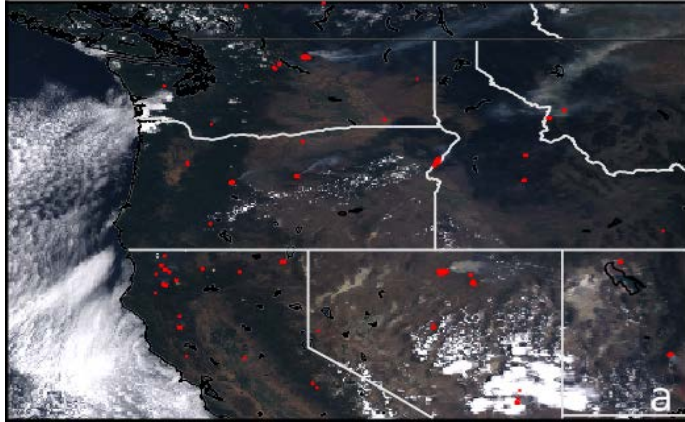


Retrieval Simulators

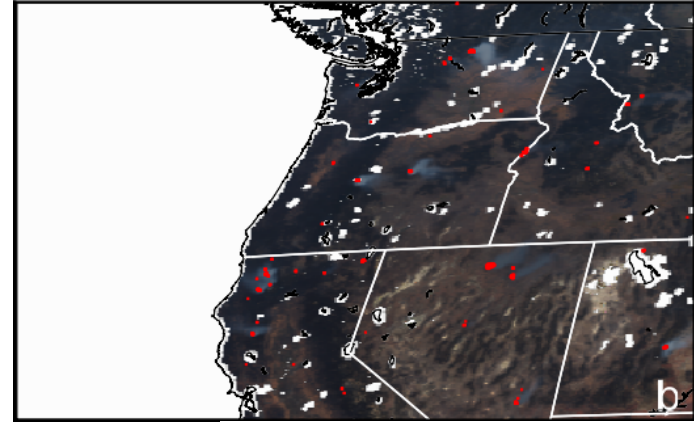
Applying Retrieval Codes to Simulated Observations

Aerosol Type Detection

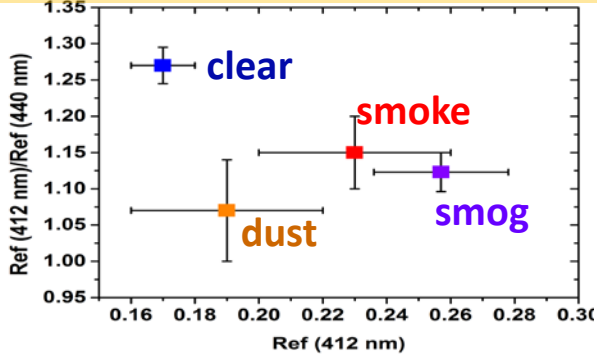
MODIS AQUA Observed 1 km True Color Image 20060727



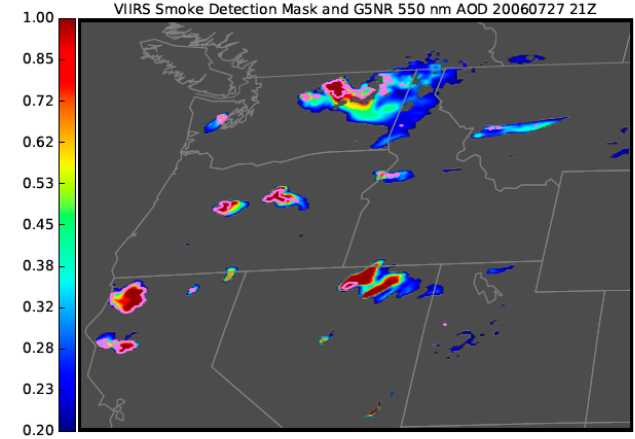
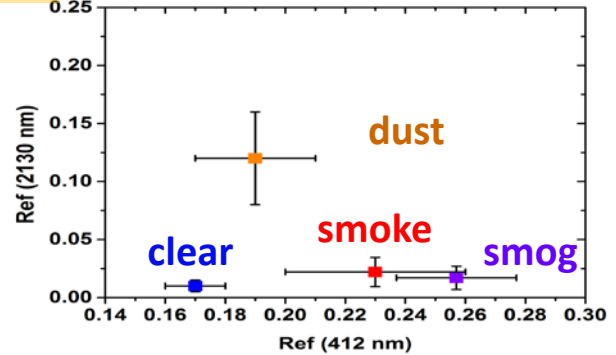
Simulated TEMPO True Color Image 20060727 21z



Absorbing Aerosol Index
 $AAI = -100[\log_{10}(R_{412}/R_{440}) - \log_{10}(R'_{412}/R'_{440})]$

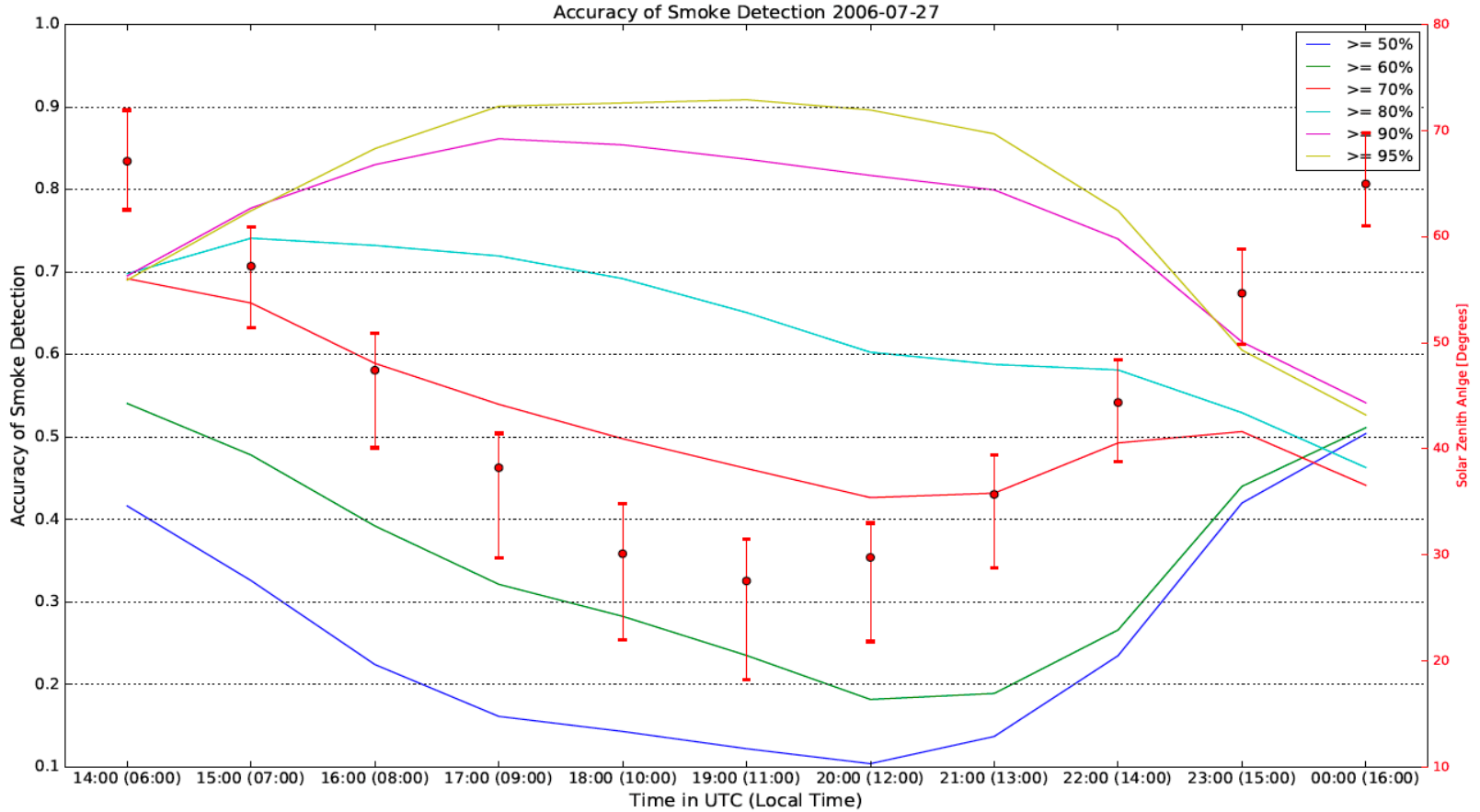


Dust Index
 $DSDI = -10[\log_{10}(R_{412}/R_{2250})]$

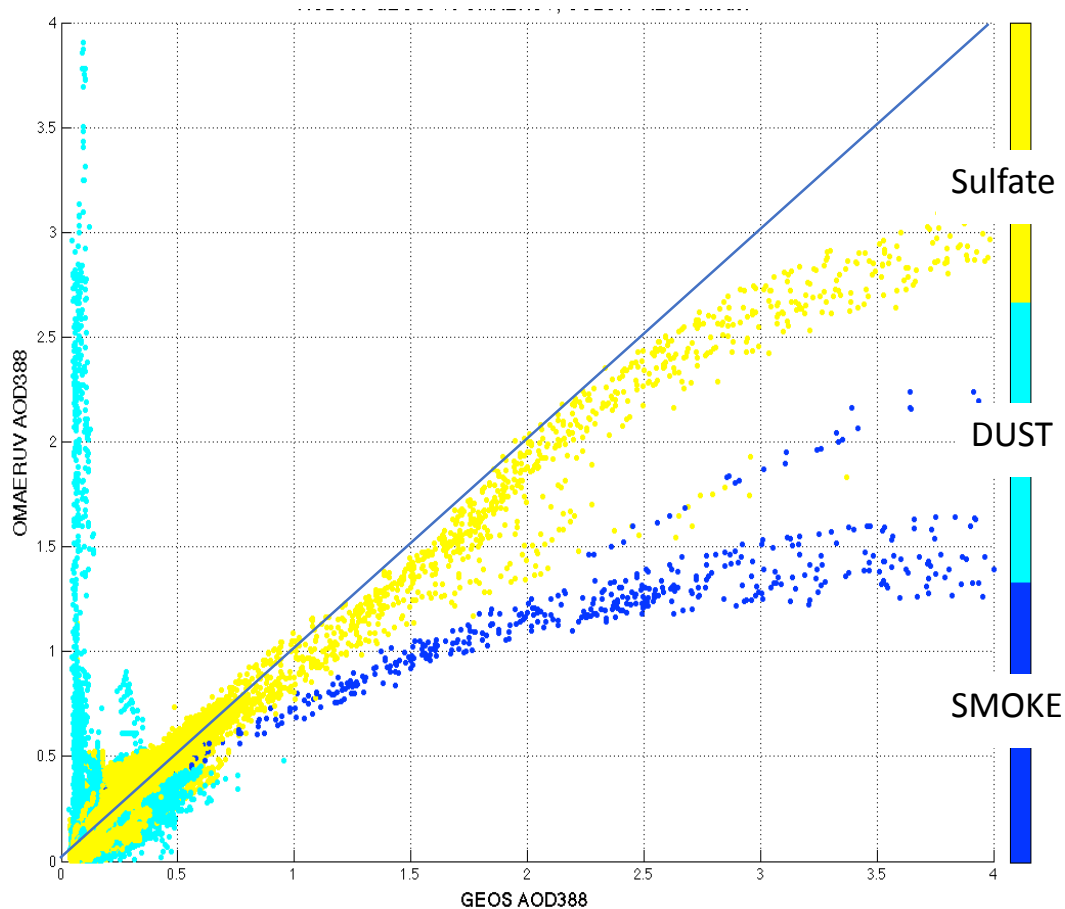




Aerosol Type Detection



UV Aerosol Retrieval



- OMI SULFATE models have less absorption and low AAE than its SMOKE models.
- OMI SULFATE models resemble more the optical properties of GEOS-5 models.