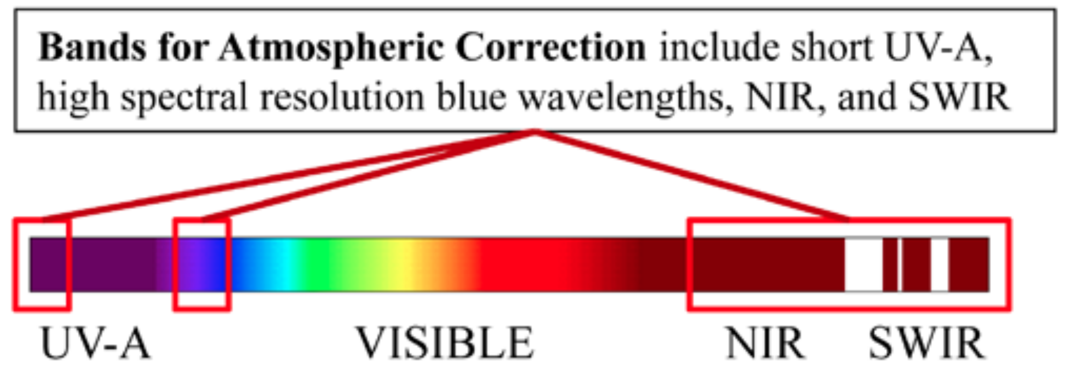
Aerosol absorption retrievals from the PACE broad spectrum Ocean Color Instrument (OCI)

Shana Mattoo[1,2], Lorraine A. Remer[3], Robert C. Levy[2], Pawan Gupta[4,2], Ziauddin Ahmad[5,2], J. Vanderlei Martins[6], Adriana Rocha Lima[3,2], Omar Torres[2]
[1] SSAI; [2] NASA GSFC; [3] JCET UMBC; [4] USRA; [5] JHT; [6] Dept of Physics, UMBC

Motivation and Objectives

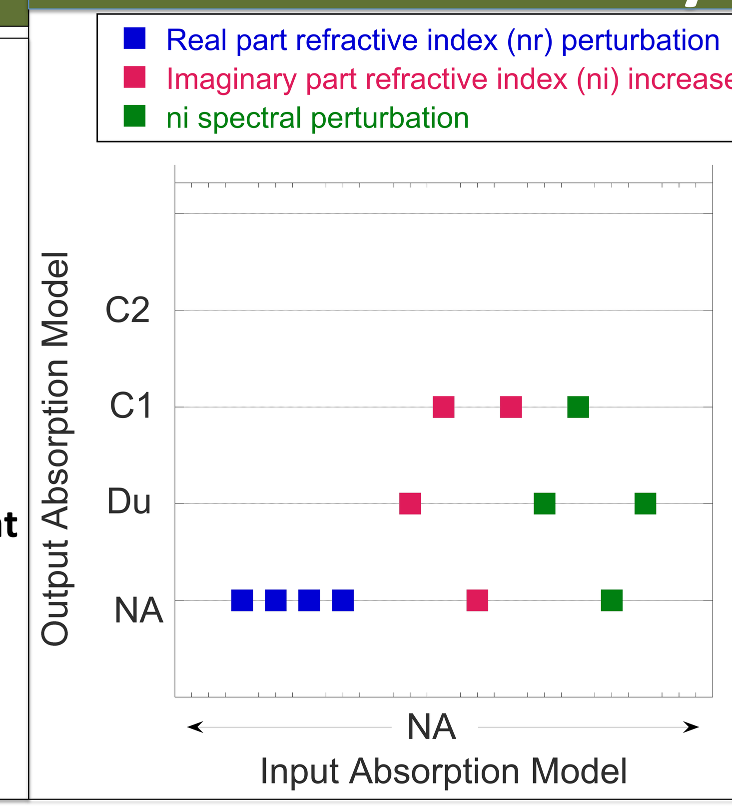
The PACE (Pre- Aerosol, Clouds and ocean Ecosystem) mission, anticipated for launch in the early 2020s, is designed to characterize oceanic and atmospheric properties. The primary instrument on-board will be a moderate resolution (~1 km nadir) radiometer, called the Ocean Color Instrument (OCI). OCI will provide high spectral resolution (5 nm) **from the UV to NIR (350 – 800 nm)**, with additional spectral bands in the **NIR and SWIR.**



The OCI itself is an excellent instrument for atmospheric objectives, providing measurements **across a broad spectral range that in essence combines the capabilities of MODIS and OMI**, but with the UV channels from OMI to be available at moderate resolution. (Image credit: PACE Science Definition Team Report)

Objective: Can we make use of the UV-SWIR measurements to derive information about aerosol absorption when aerosol loading is high?

Sensitivity to model, surface and aerosol height assumptions

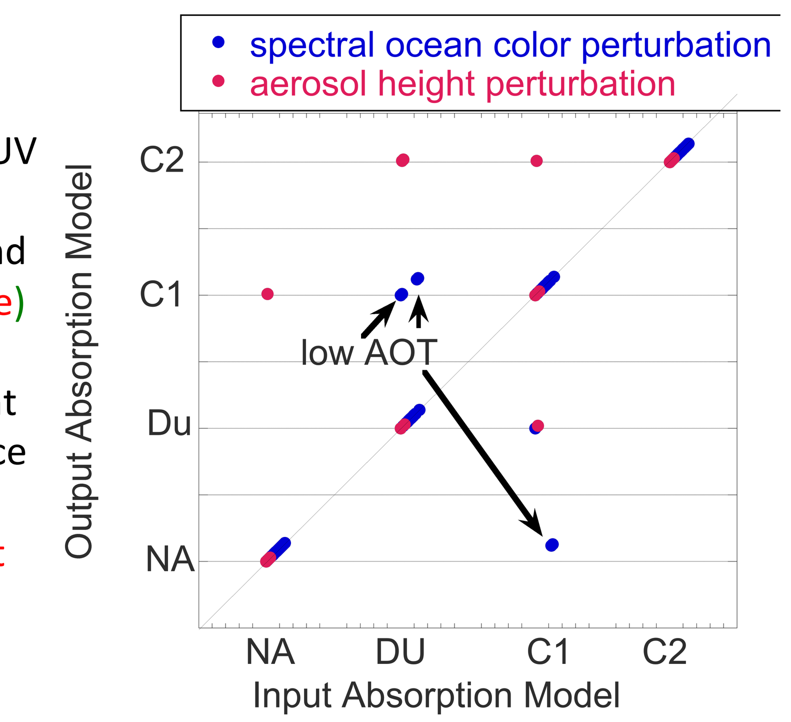


Left Panel: Sensitivity to perturbing optical properties to each UV channel, applied to different weightings of Modes F1 and C7.

- Real part of the refractive index (nr) increased to 1.50 for both UV channels, and both modes (less sensitive)
- Imaginary part of the refractive index (ni) increased (to 0.002 and 0.007) for both UV channels, and for each mode (more sensitive)
- ni increased for each UV channel separately. (more sensitive)

Right Panel: Sensitivity to perturbing ocean color and aerosol height

- Spectral ocean surface perturbation. Increased UV to red surface reflectance by 0.005. Sensitive, but only for AOT <= 0.20 .
- Change in aerosol height from 2 km to 6 km. Sensitive in at least 25% of the aerosol AOT combinations.



Proto-algorithm description

MODIS Dark Target (MDT)

INPUT: 6 OCI wavelengths (0.55 µm to 2.1 µm)

↓

Apply standard MODIS Dark Target ocean aerosol retrieval

↓

OUTPUT: AOT at 0.55 µm, choice of fine and coarse non-absorbing model and fine mode fraction

New OCI addition (DT+UV)

INPUT: AOT at 0.55, choice of non-absorbing model plus 2 OCI wavelengths in the UV (0.354 µm and 0.388 µm)

↓

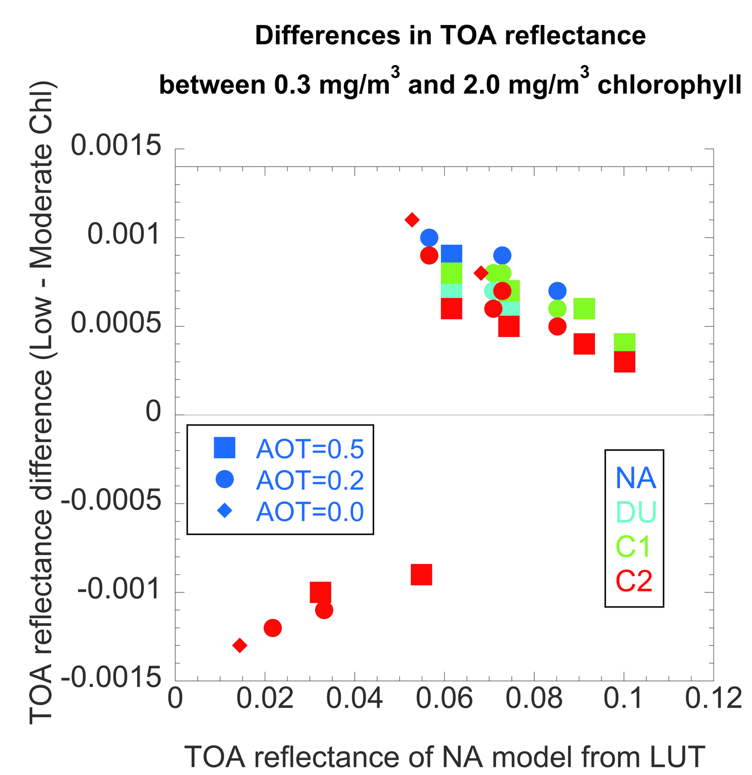
Match measured UV reflectances to LUT consisting of four new models: Non-absorbing (NA), Dust (Du), and 2 types of combustion (C1 and C2)

↓

OUTPUT: Choice of one of the 4 types of absorbing aerosol models

- MDT: Use the 0.55 µm to 2.1 µm range to retrieve AOT and size distribution
- DT+UV: Use the UV to determine absorption characteristics.
- Now, qualitative. Eventually quantitative.

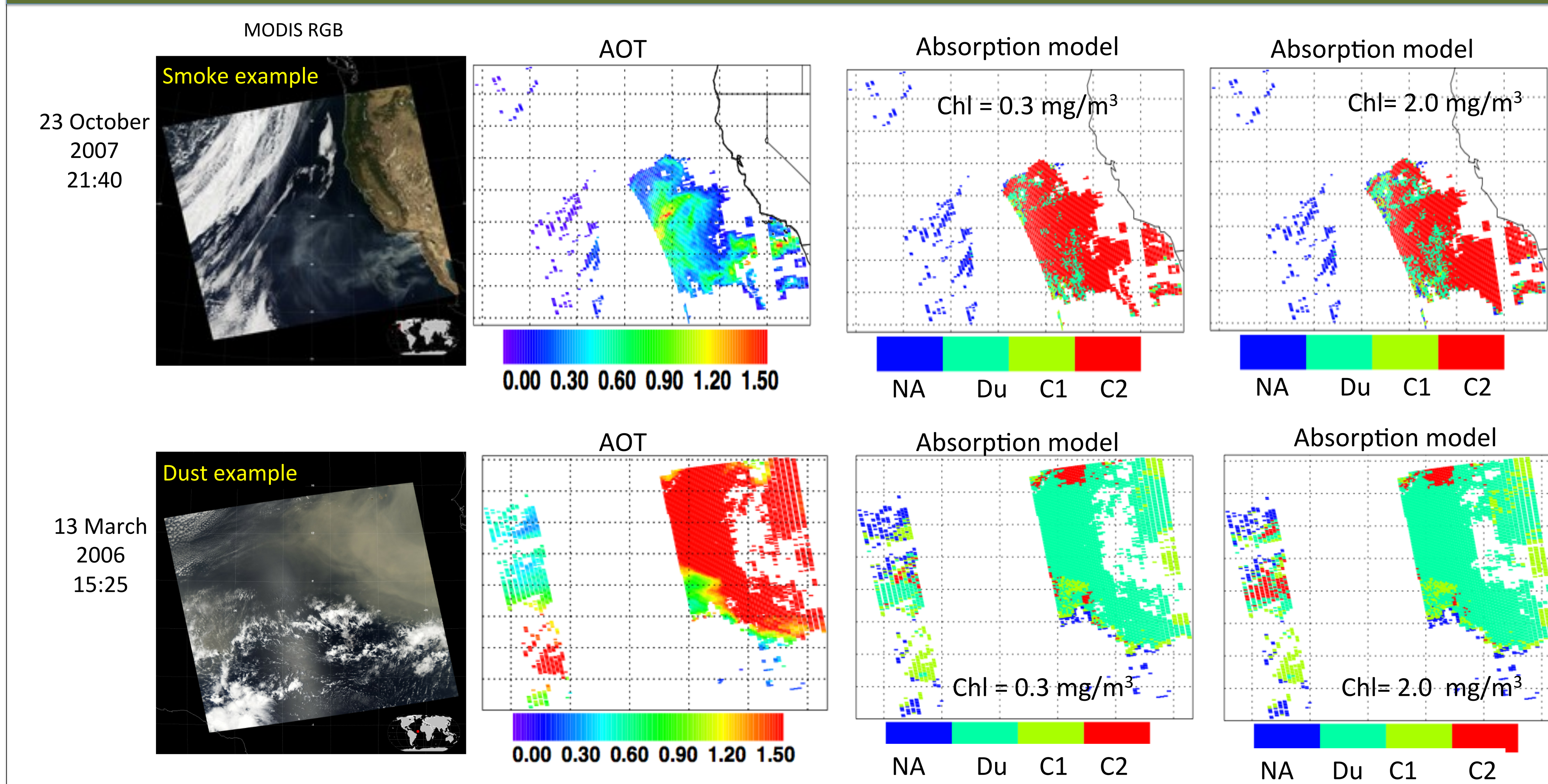
Sensitivity to chlorophyll



Differences in TOA reflectances from LUTs, one calculated with ocean leaving reflectance corresponding to chlorophyll concentration of 0.3 mg/m³ and the other corresponding to 2.0 mg/m³.

For no aerosol, we see differences of 8.5%.
For AOT = 0.2, differences of at most 5%.
For AOT =0.5, differences of at most 1.5%

Retrieval testing on merged MODIS-OMI granules

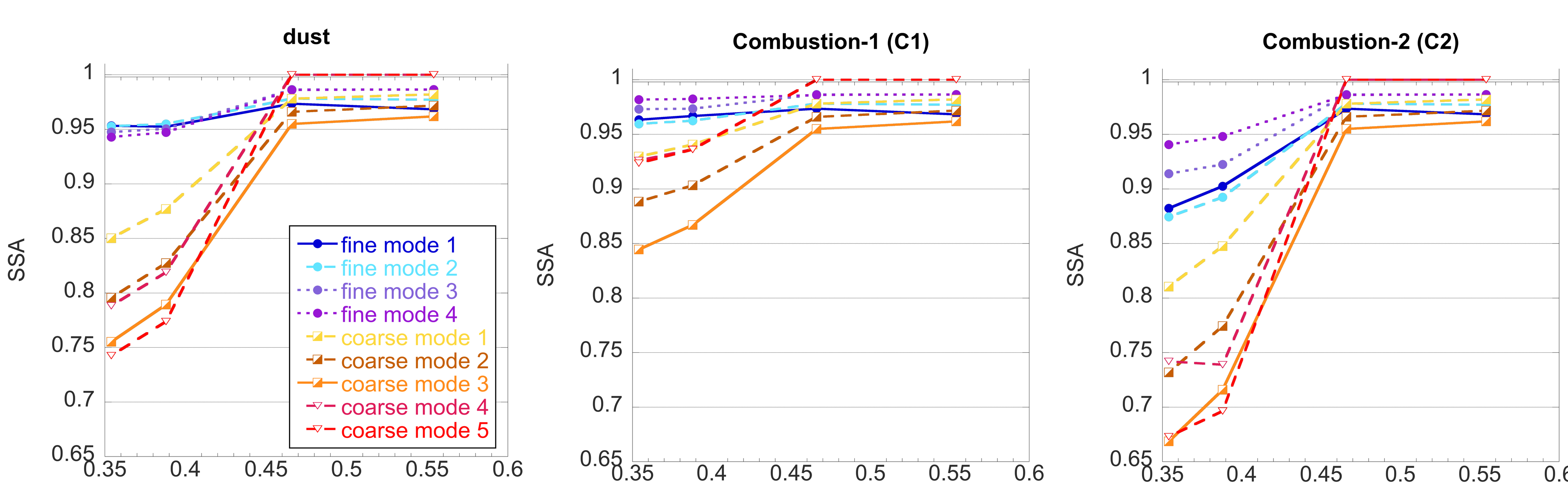


MODIS and OMI spectral radiances and geometry are collocated to test the broad spectrum DT+UV algorithm. MODIS DT is applied to MODIS reflectances (0.55 µm to 2.1 µm) and MODIS geometry to produce the AOT and non-absorbing modes. Then DT+UV is applied to OMI reflectances and OMI geometry to determine which of the four absorbing models best represents the UV spectral absorption.

DT+UV algorithm mostly chooses a combustion aerosol for the smoke case and the dust model for the dust case.

For high AOT there is minimal sensitivity to changes in assumed chlorophyll concentration in the ocean beneath. There is greater sensitivity at lower AOT and for particular geometries. These results are preliminary, but encouraging.

Calculated Spectral Single Scattering Albedo (SSA) from PACE OCI LUT1



Wavelengths 0.47 µm and 0.55 µm are based on standard MODIS models that exhibit little absorption and are used by MDT to define size distribution and AOT.

The new algorithm and new aerosol models are applied only at the UV wavelengths and are used to identify the type of absorption.

Conclusions

1. We have developed a proto-algorithm (DT+UV) for deriving AOT and aerosol absorption information over the ocean, from broad spectrum OCI measurements.
2. We have created a merged MODIS-OMI dataset to simulate OCI, and test the algorithm.
3. At this point, DT-UV is able to identify aerosol absorption and shows some skill at differentiating between combustion aerosol and dust aerosol, when loading is high, but the results preliminary.
4. Sensitivity to chlorophyll is manageable once AOT_550 > 0.4 to 0.5
5. Quantifying the information will depend on fine-tuning the spectral absorption of the LUT absorption models and controlling for aerosol layer height.