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

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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 (550 – 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?

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

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

- 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

The sensitivity to chlorophyll is manageable once AOT$_{550}$ > 0.4 to 0.5.

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

Absorption model

Chl = 0.3 mg/m$^2$

Chl = 2.0 mg/m$^2$

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.

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 > 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.