Hyperspectral algorithms for PACE OCI atmospheric correction and UV penetration using Aura Ozone Monitoring Instrument (OMI)

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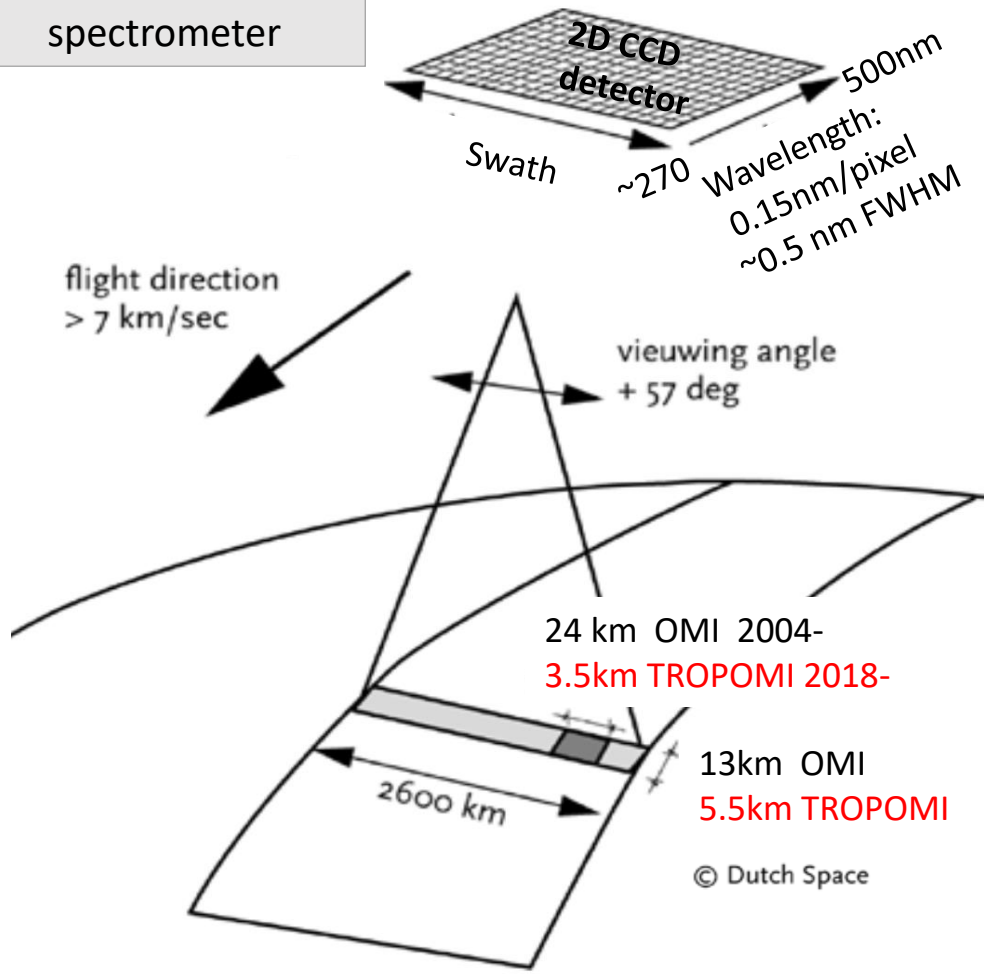
Dutch-Finnish "Push broom" spectrometer



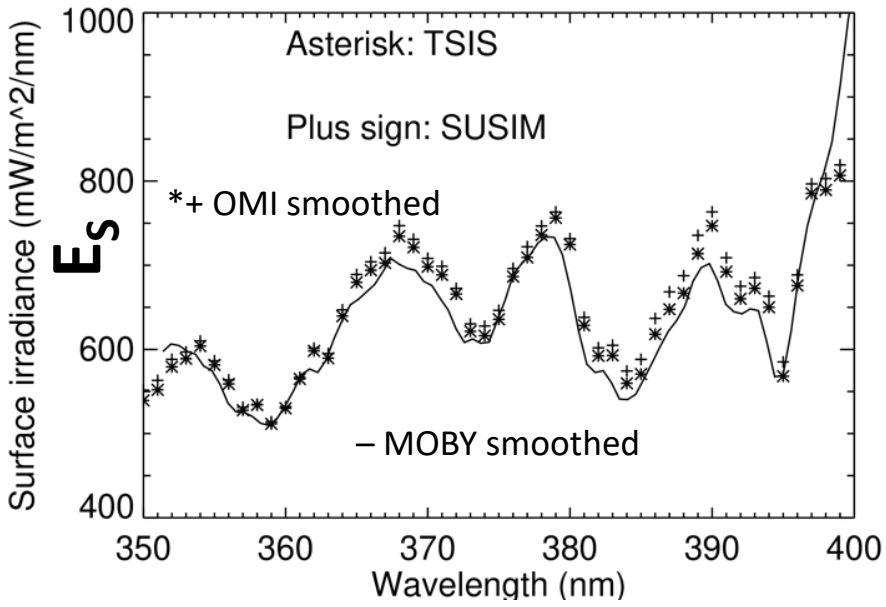
Goals and Accomplishments:

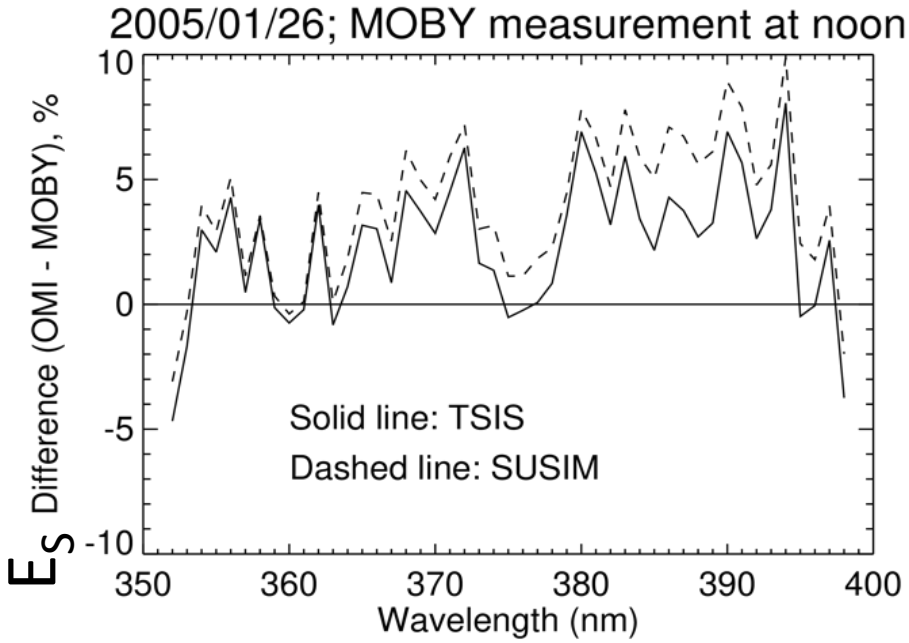
1. Develop OCI algorithms for hyperspectral **surface and underwater UV irradiance** and biological action spectra weighted UV penetration depths.

2. Develop and evaluate new physics-based algorithm for **OCI atmospheric correction** using satellite hyperspectral UV-Vis (blue) spectrometers (**OMI and TROPOMI**) through synergistic use of an on-line Radiative Transfer (RT) model and the GMAO aerosol MERRA-2 re-analysis.

3. NEW: Demonstrate an alternative data-driven **machine-learning (ML) hyperspectral algorithms** for OCI atmospheric correction and Chl retrievals

New OMI hyperspectral surface UV irradiance E_S validated with MOBY



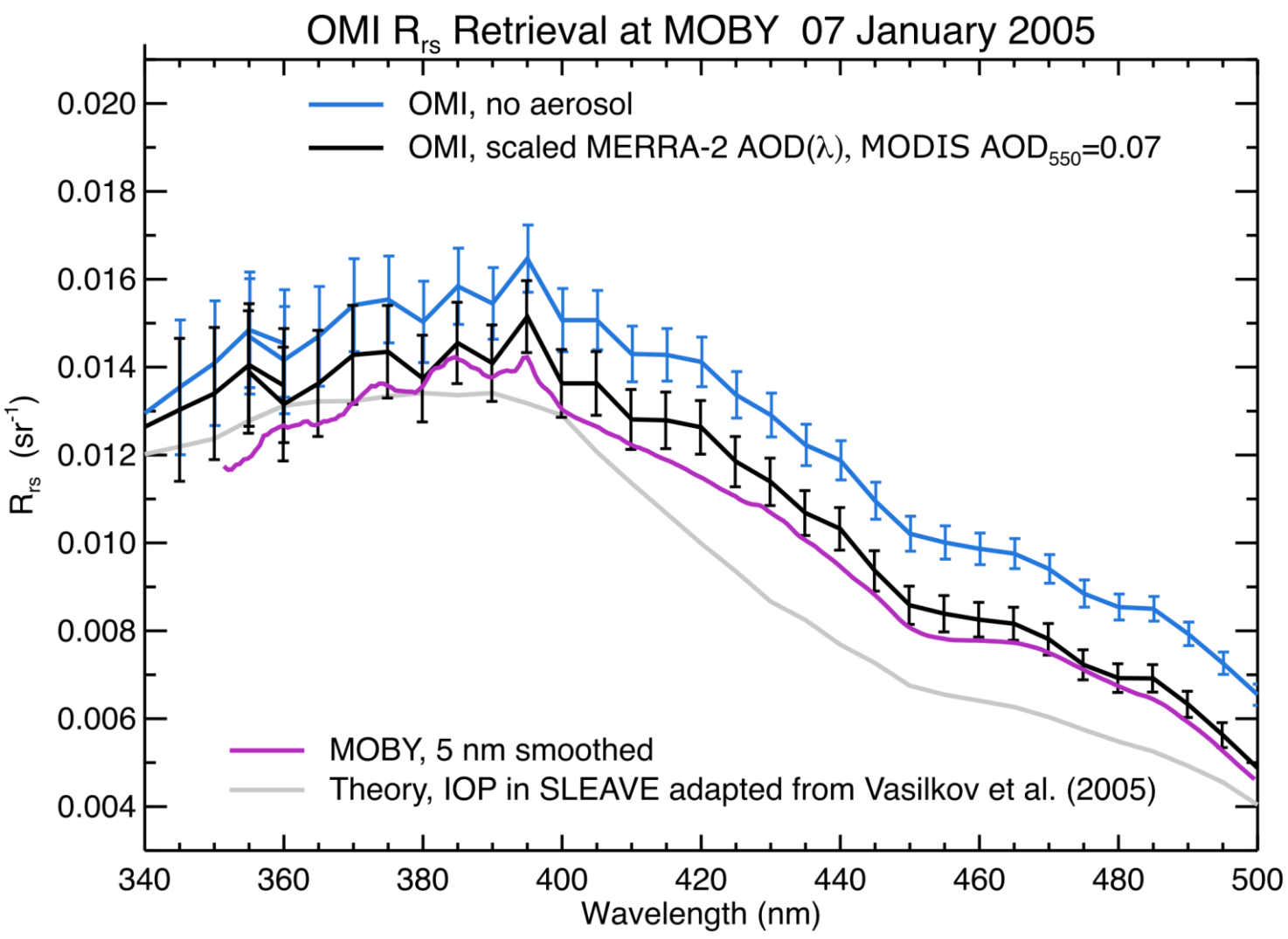


- ✓Modified OMI/TROPOMI surface UV irradiance (E_S) algorithm to calculate hyperspectral E_s every 1nm at OCI spectral resolution 5nm.
- ✓Validated with MOBY hyperspectral clear-sky E_S measurements within 5%.
- ✓ Using new TSIS solar irradiance reduces OMI bias compare with MOBY.
- ✓High frequency spectral structures in (OMI-MOBY) difference are highly correlated , but the cause is not understood.

Next year:

- Spectrally extend E_s algorithm to 290nm – 400nm
- Calculate underwater UV irradiance (E_d) and scalar irradiance (actinic flux, E_0) as function of depth, Z
- Compare with MOBY and cruise measurements

Radiative transfer (RT) approach to OCI atmospheric correction (AC)



- ✓ Matched smoothed OMI reflectances with on-line VLIDORT using GISS Cox-Munk BRDF and water leaving (SLEAVE) supplements.
- ✓ Re-evaluated OMI Calibration performed for Collection 4 (uncertainty ~ 1%)
- ✓ Investigated impact and feasibility of Total O_3 retrieval from OCI at UV wavelengths.
- ✓ Performed detailed review of Rayleigh optical property calculations.
- ✓ Compared $\mathbf{R_{rs}}$ retrievals for Pacific regions with independent data sources (SeaWIFS, MODIS) and MOBY in UV.
- ✓ Used MERRA-2 aerosol optical profiles extended into UV and scaled with MODIS AOD_{550}.
- ✓ Found large OMI retrieved $\mathbf{R_{rs}}$ sensitivity to aerosols even at low AOD.
- ✓ OCI R_{rs} retrievals will use PACE cloud mask and aerosol products.

Machine learning with hyper-spectral data enhances coverage for ocean products in cloud-, aerosol-, and glint-contaminated conditions

NE cost of S. America on October 15, 2020

Train neural network to predict physically-based MODIS chlorophyll concentration using hyper-spectral data (similar approach over land with HICO has been published, Joiner et al., 2021, Front. Rem. Sens.)

Method performs atmospheric correction and glint removal, separating the spectral signatures of clouds, aerosol, glint, and trace-gases from those of water leaving radiance (in light to moderate amounts of cloud)

Right: approach applied to NE coast of South America

- TROPOMI (UV and blue spectra) provides enhanced spatial coverage compared with MODIS in cloud and sun glint conditions
- Some features not captured in 8-day MODIS composite, but are captured with our TROPOMI data (dashed circle)

Method is not meant to replace physically-based retrievals (physical retrievals needed for training!), but rather complement those retrievals by providing data in challenging conditions with an efficient algorithm