Advanced ocean color sensor observations for retrieval of cloud, aerosol and water vapor properties

Lorraine A. Remer
And the PACE Atmospheric Correction Science Team

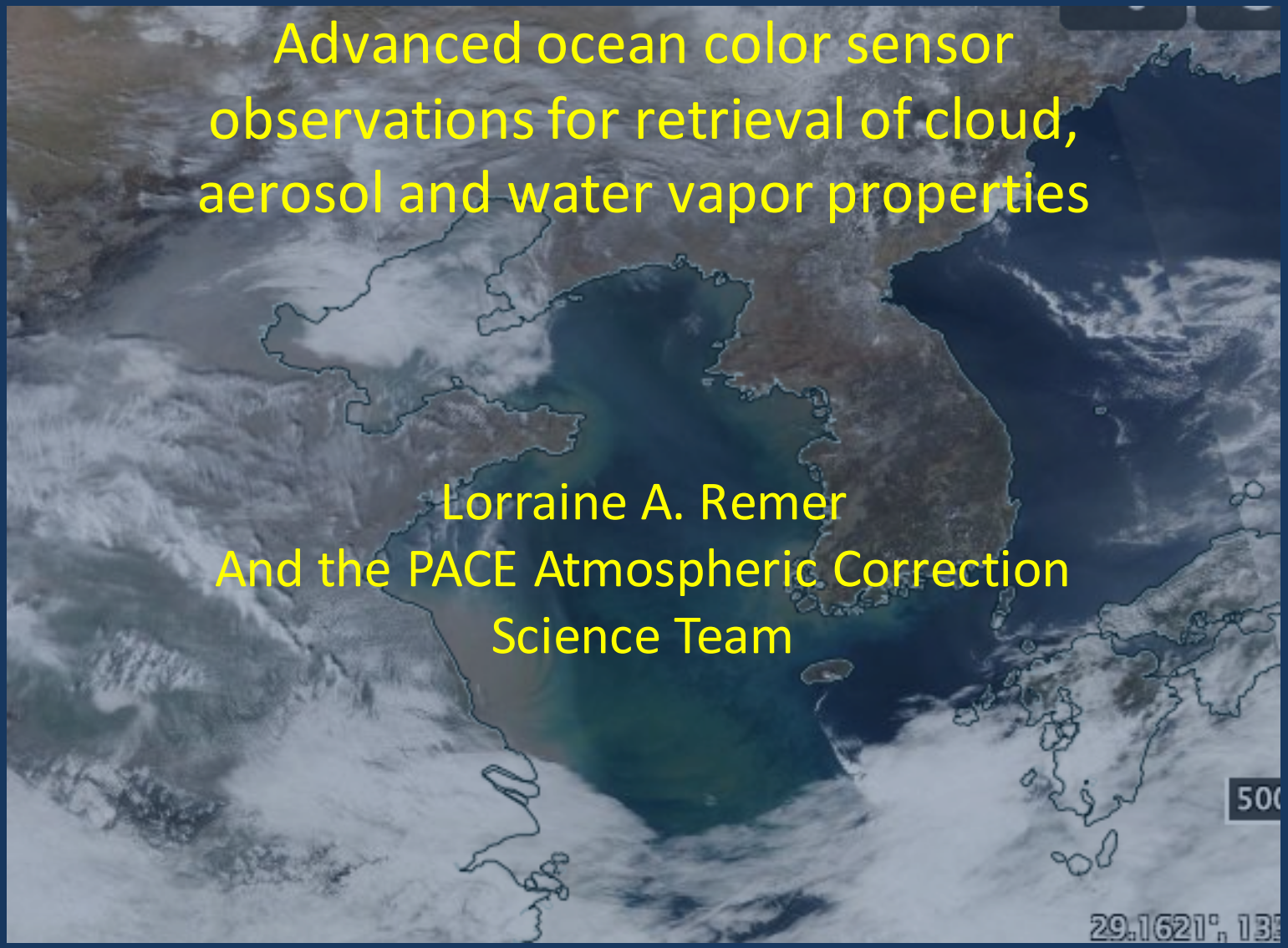
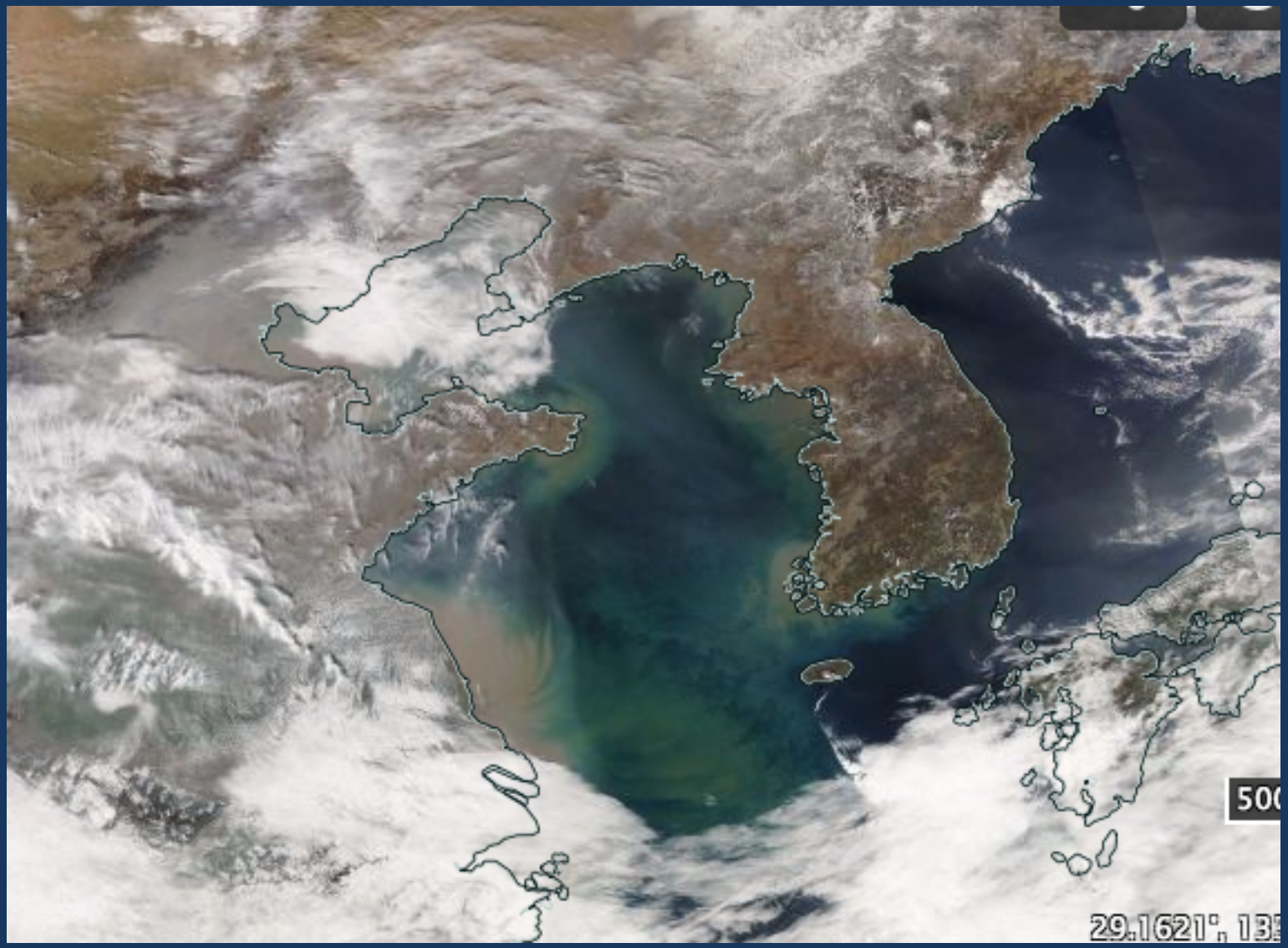
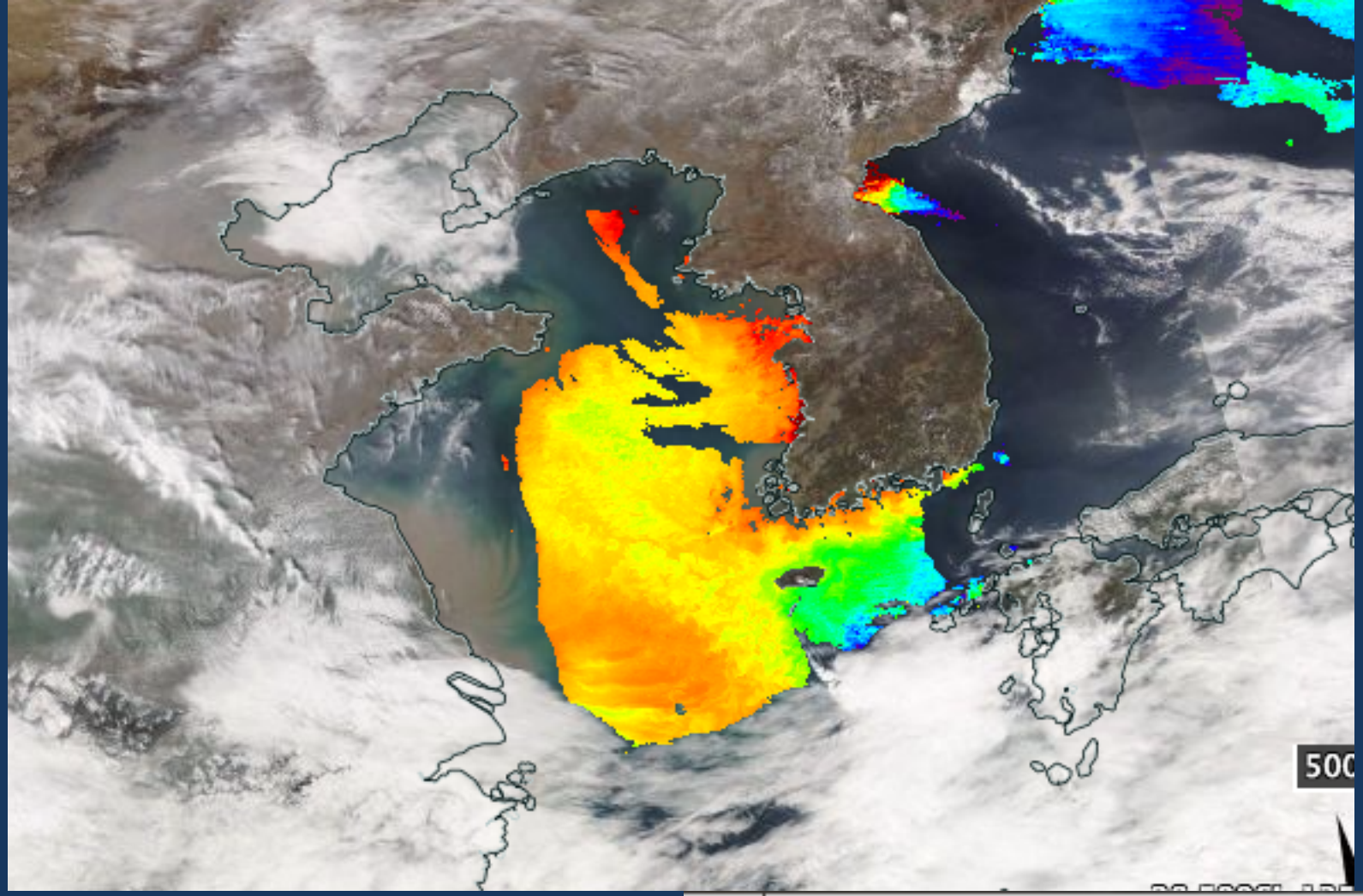


Image from NASA Worldview



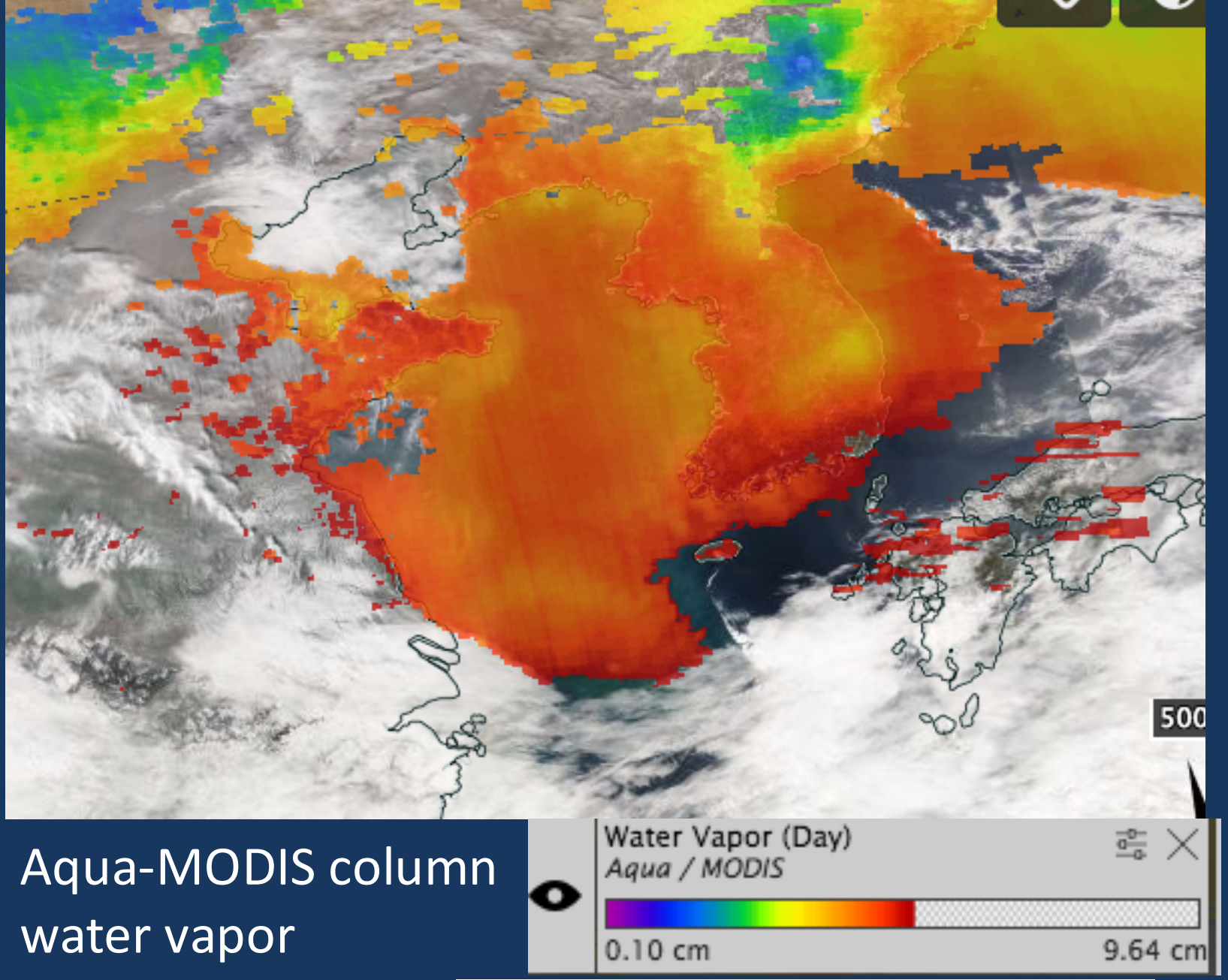
Aqua-MODIS 24 February 2015

Image from NASA Worldview



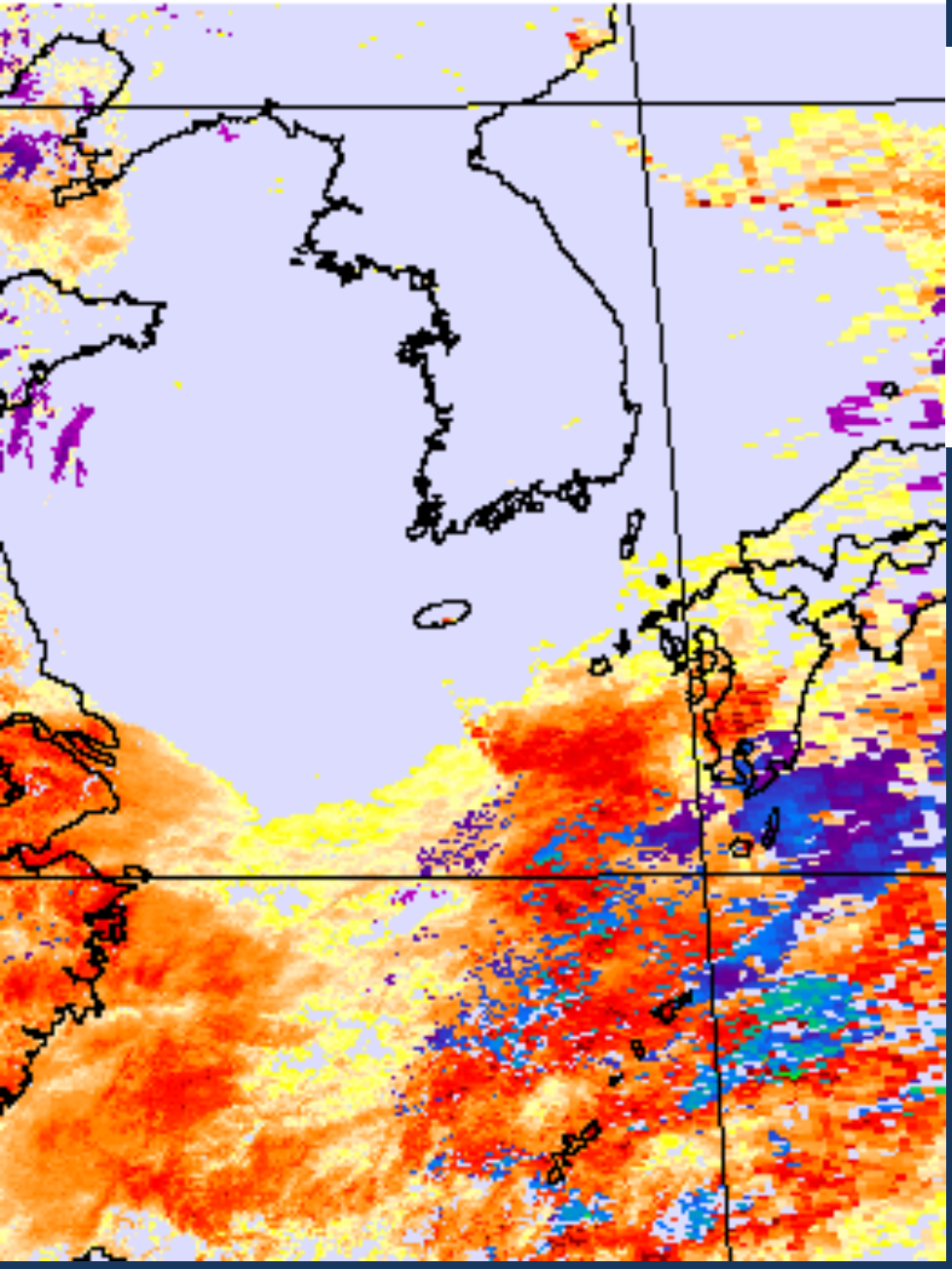
Aqua-MODIS Chlorophyll-a

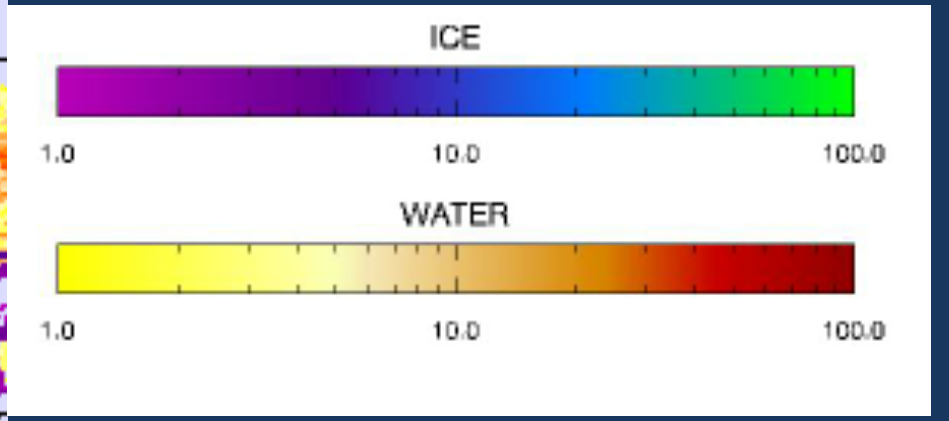
Image from NASA Worldview



Aqua-MODIS column water vapor

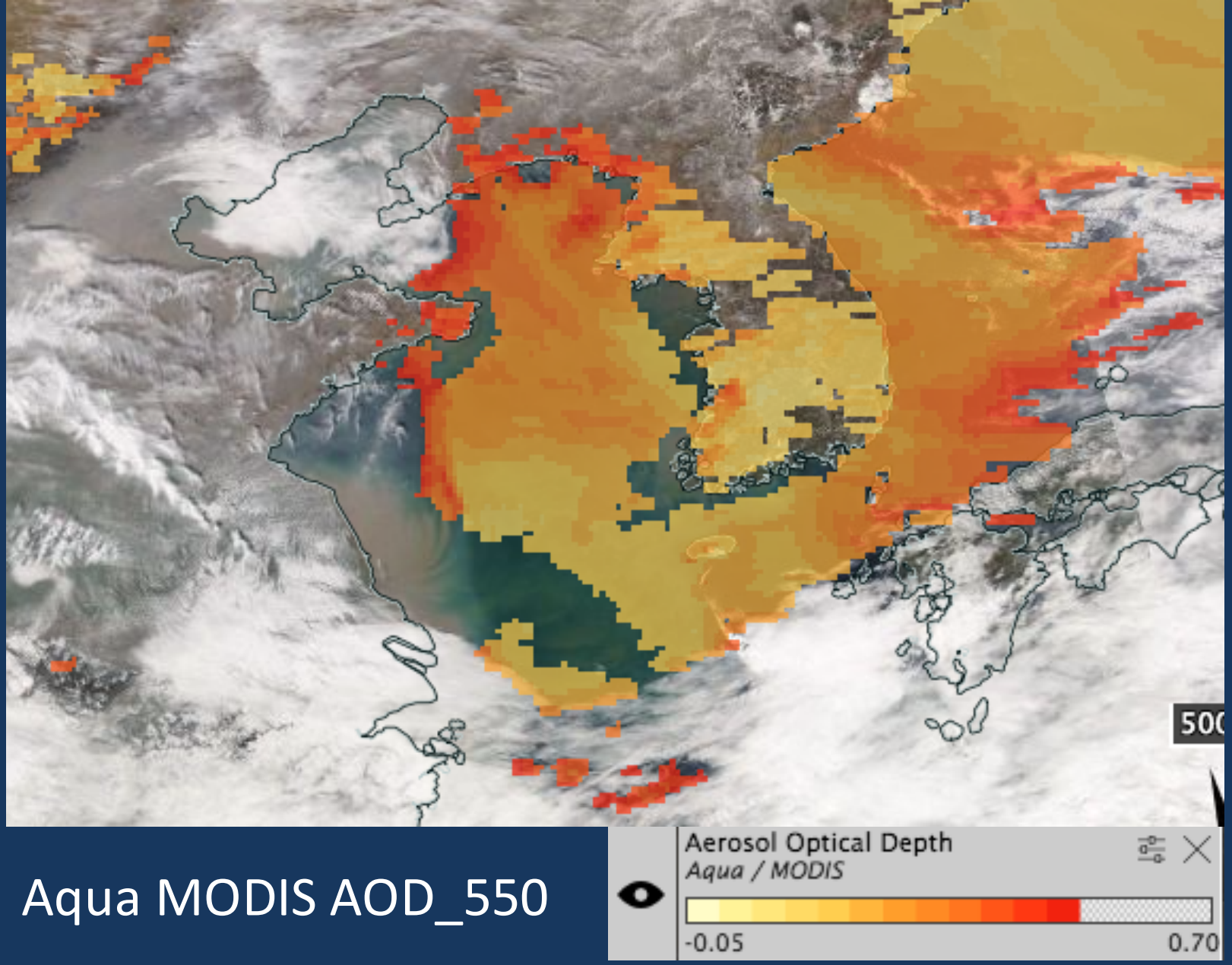
Image from NASA Worldview





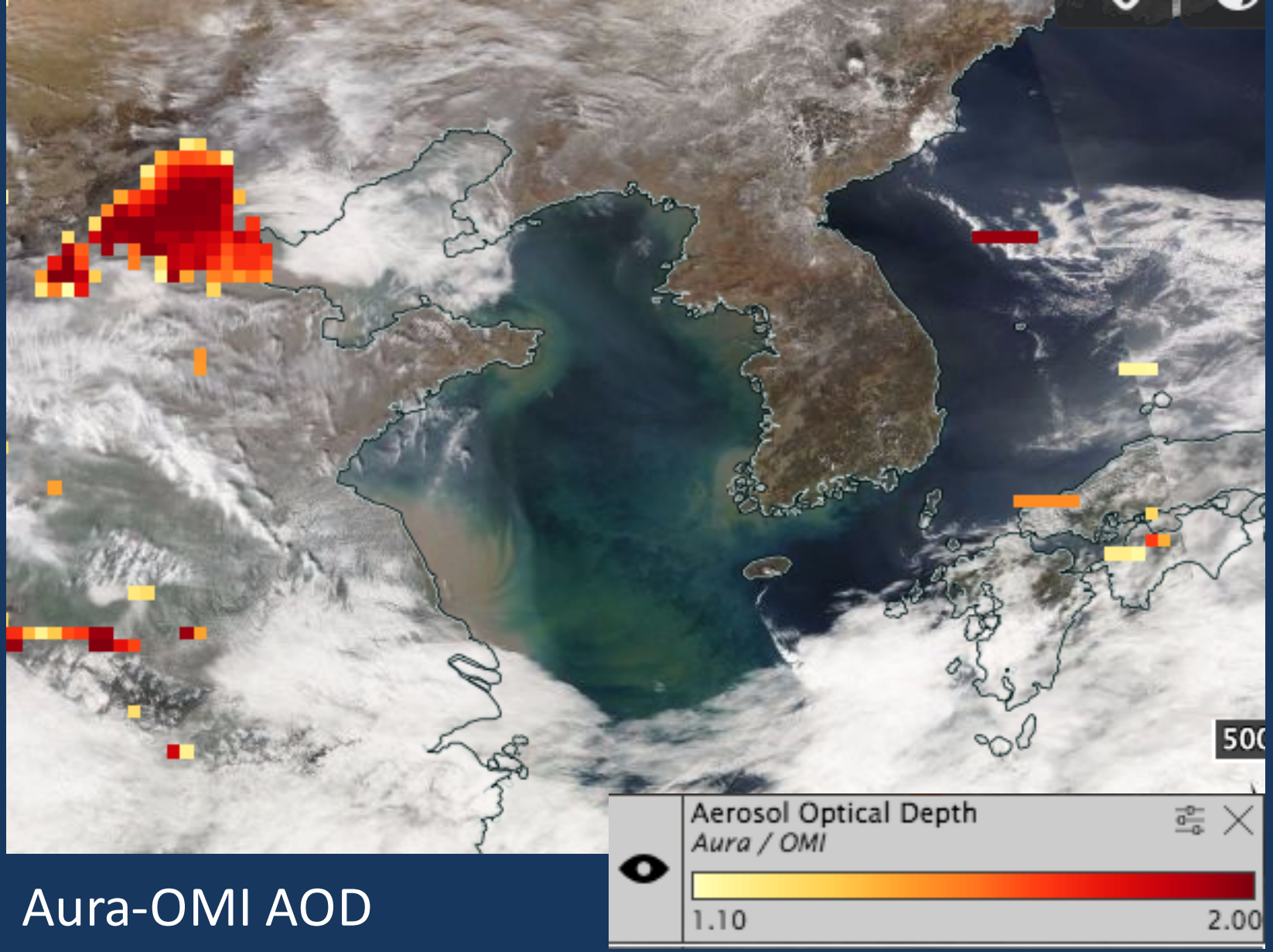
Aqua-MODIS cloud optical thickness

Image from NASA MODIS Atmospheres Web Page



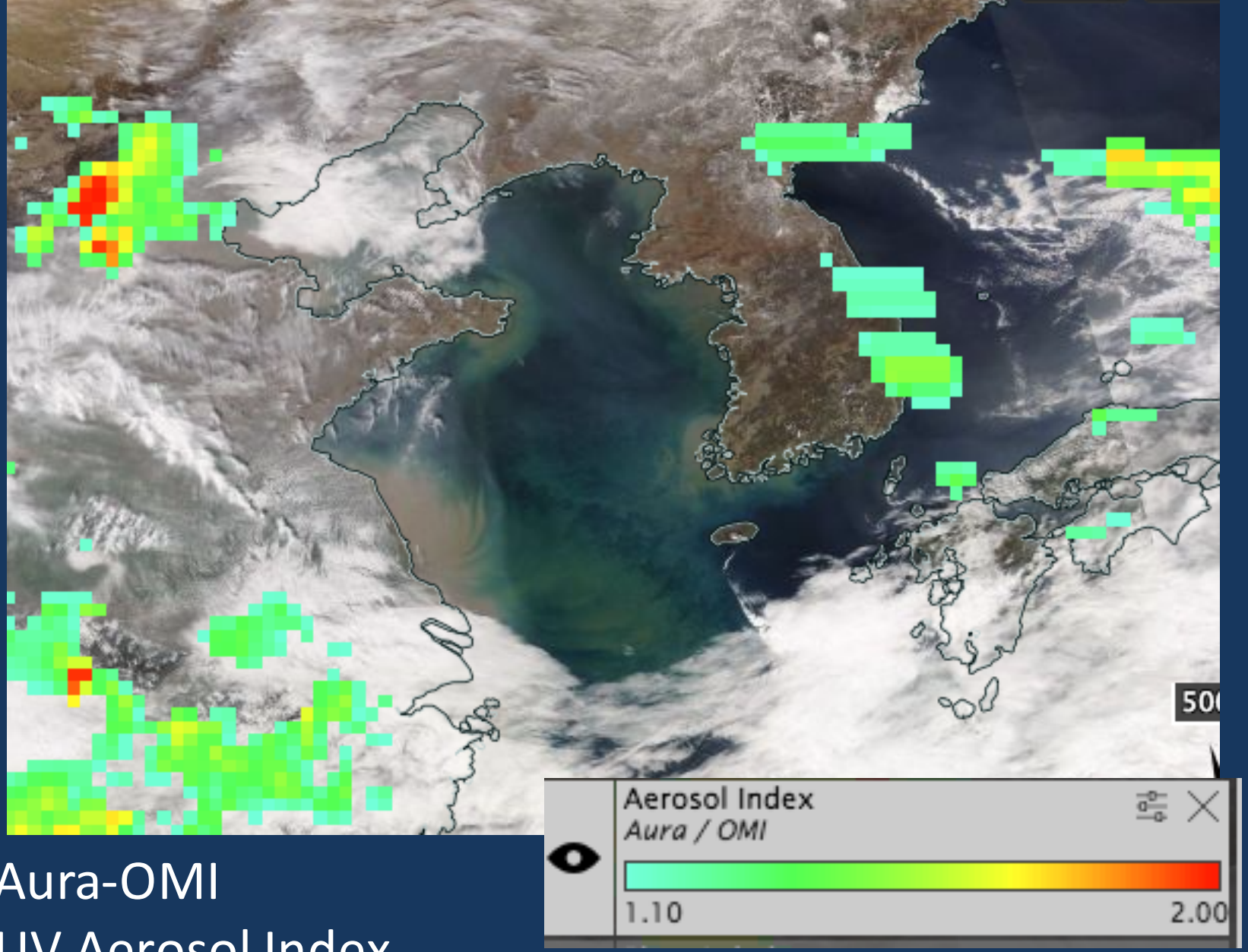
Aqua MODIS AOD_550

Image from NASA Worldview



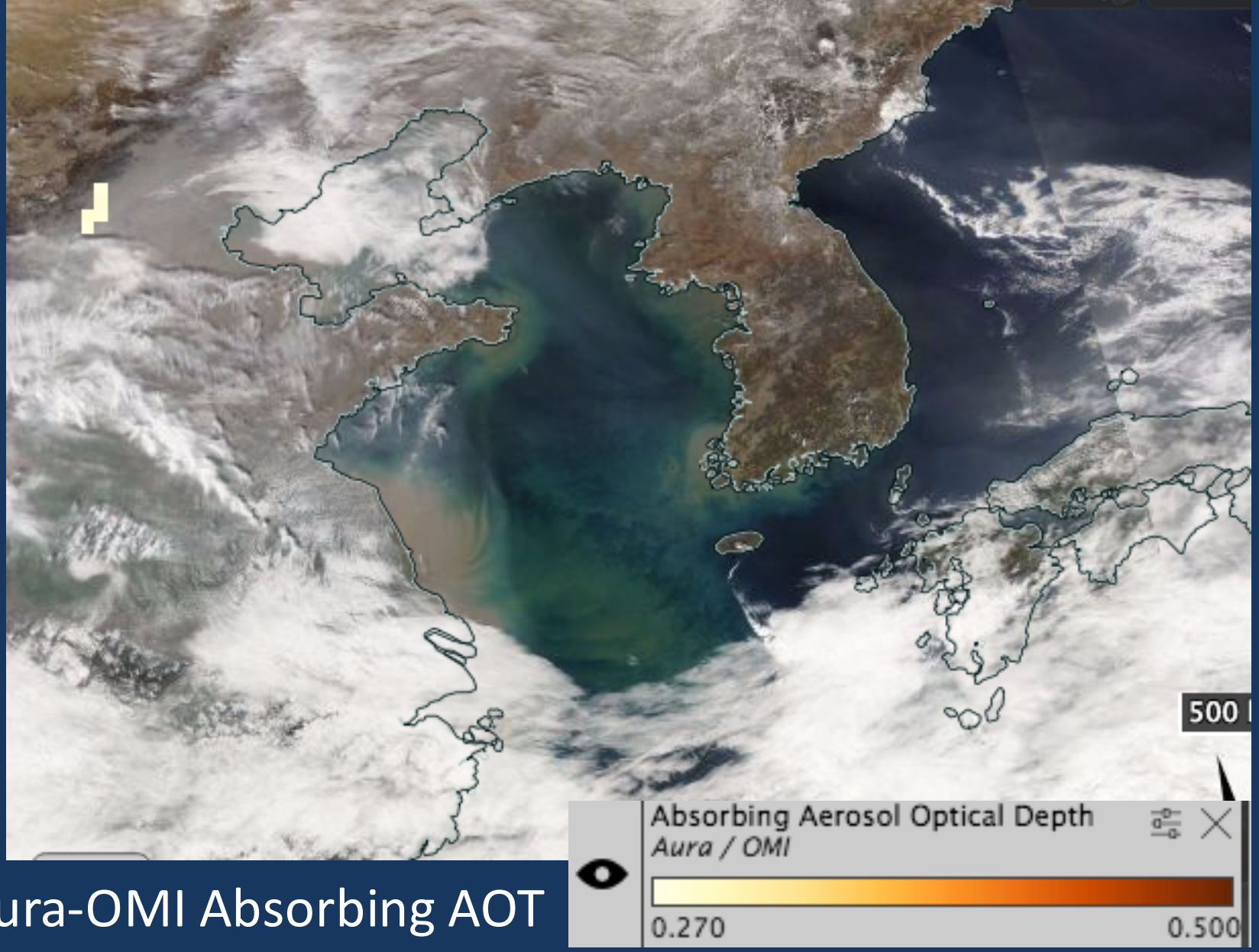
Aura-OMI AOD

Image from NASA Worldview



Aura-OMI
UV Aerosol Index

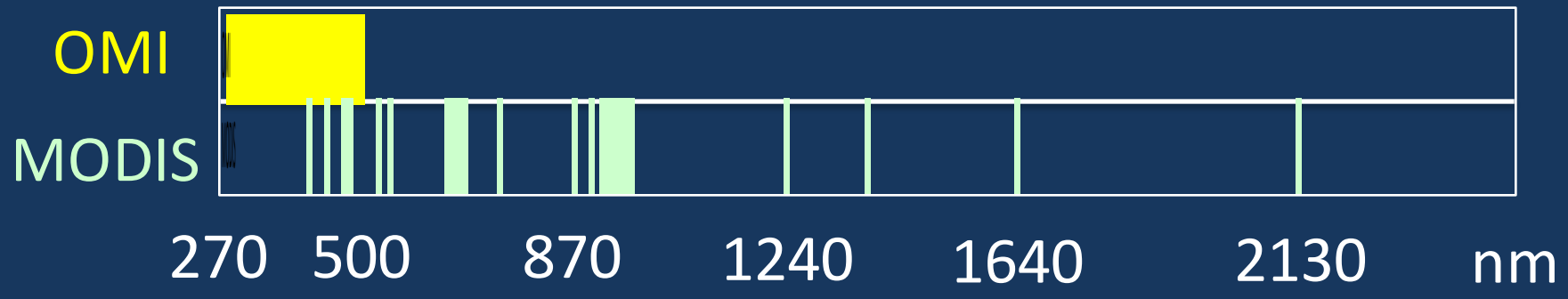
Image from NASA Worldview



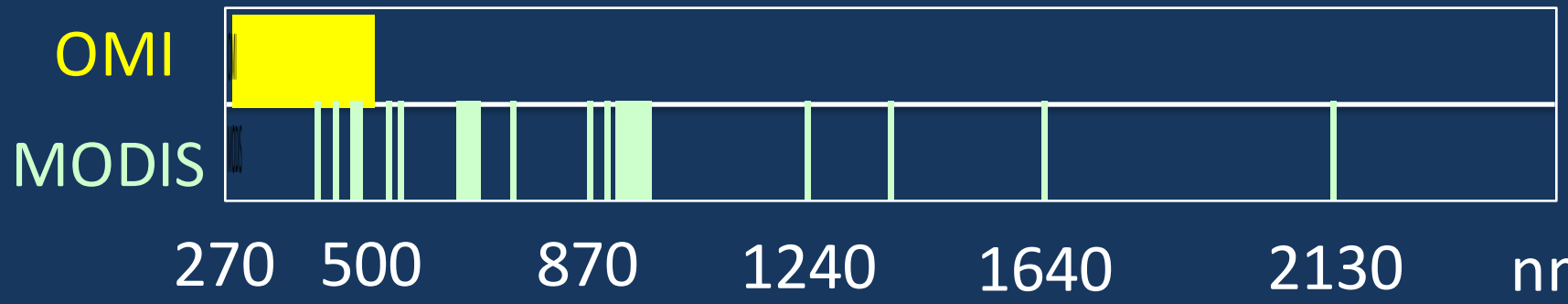
Aura-OMI Absorbing AOT

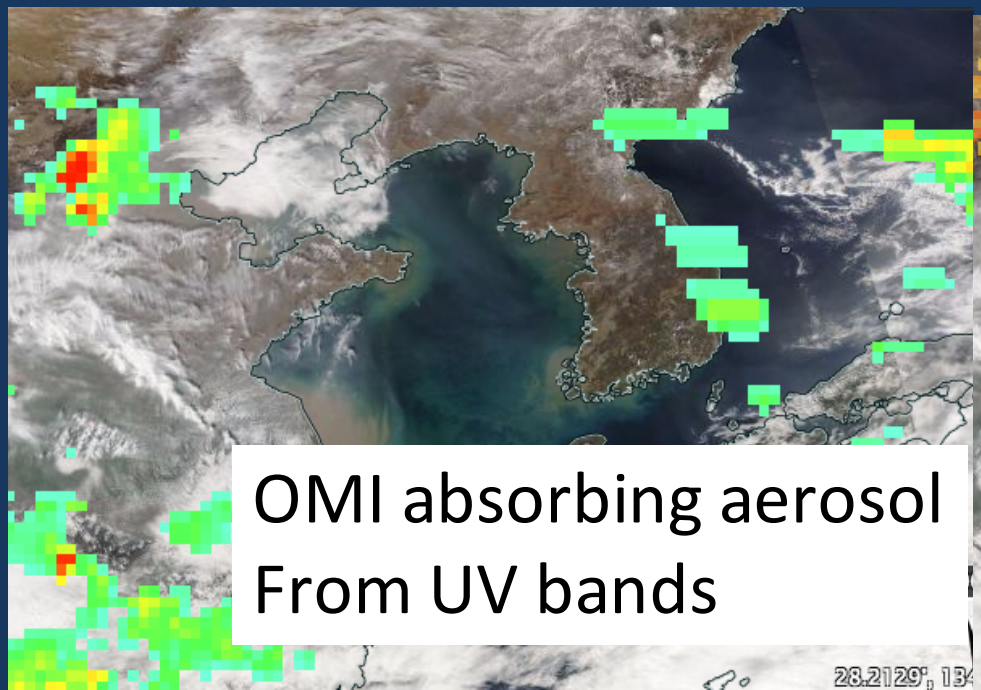
Image from NASA Worldview

OMI and MODIS spectral coverage of reflective bands

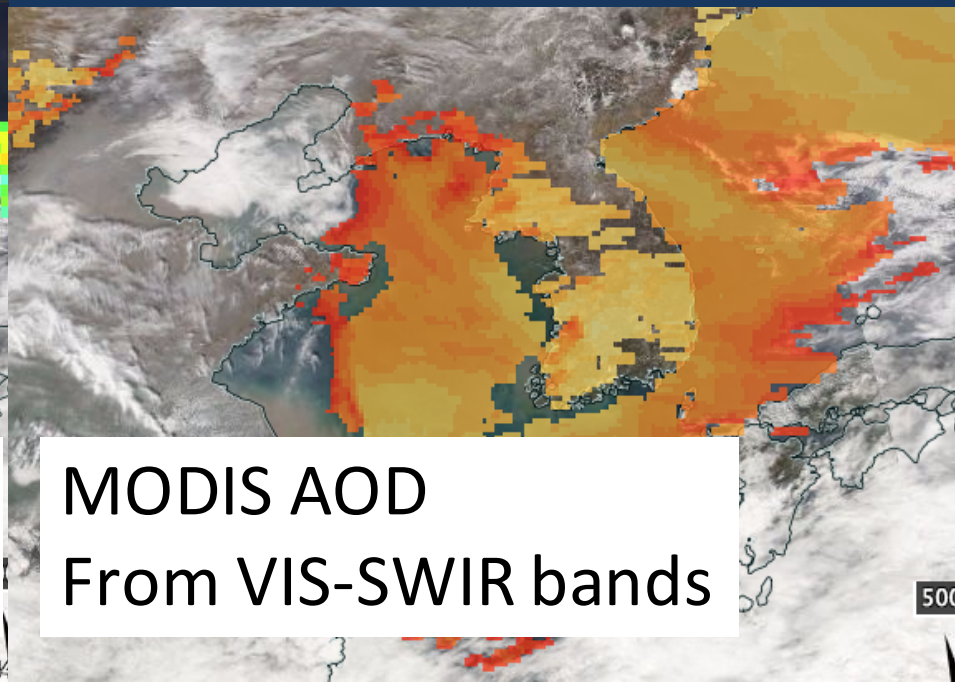


OMI and MODIS spectral coverage of reflective bands





OMI absorbing aerosol
From UV bands

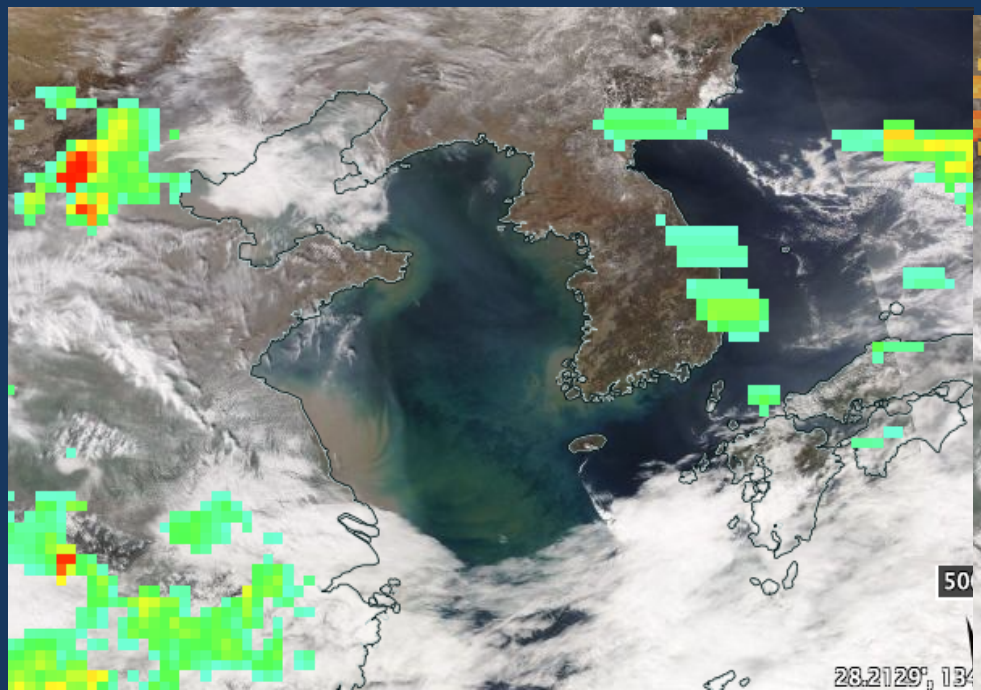


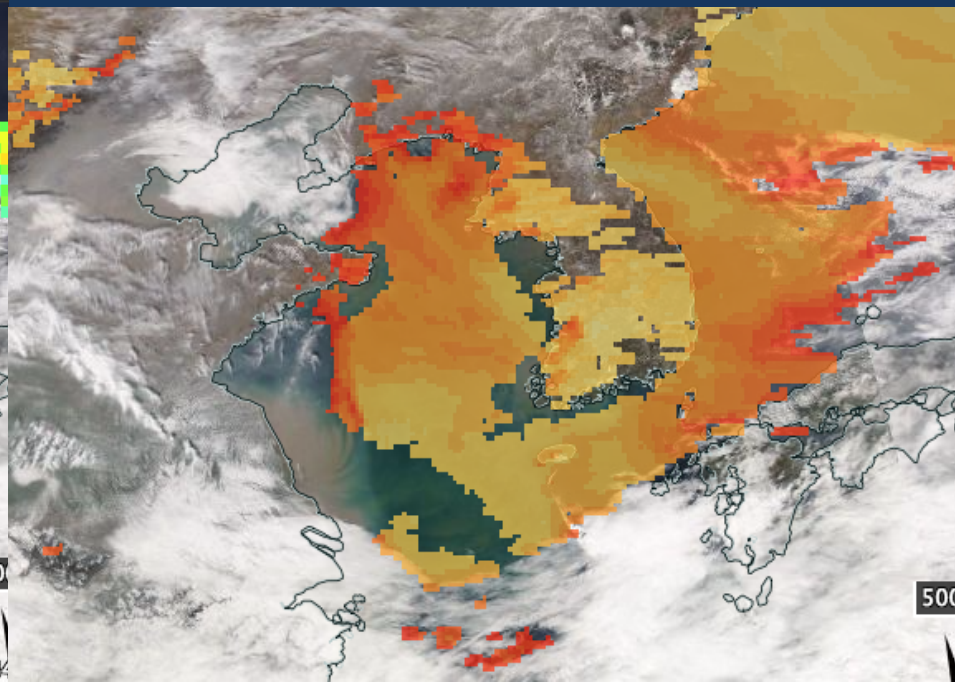
MODIS AOD
From VIS-SWIR bands

OMI and MODIS spatial resolution

OMI spatial resolution: 13 x 24 km

MODIS spatial resolution: 0.25 to 0.50 km





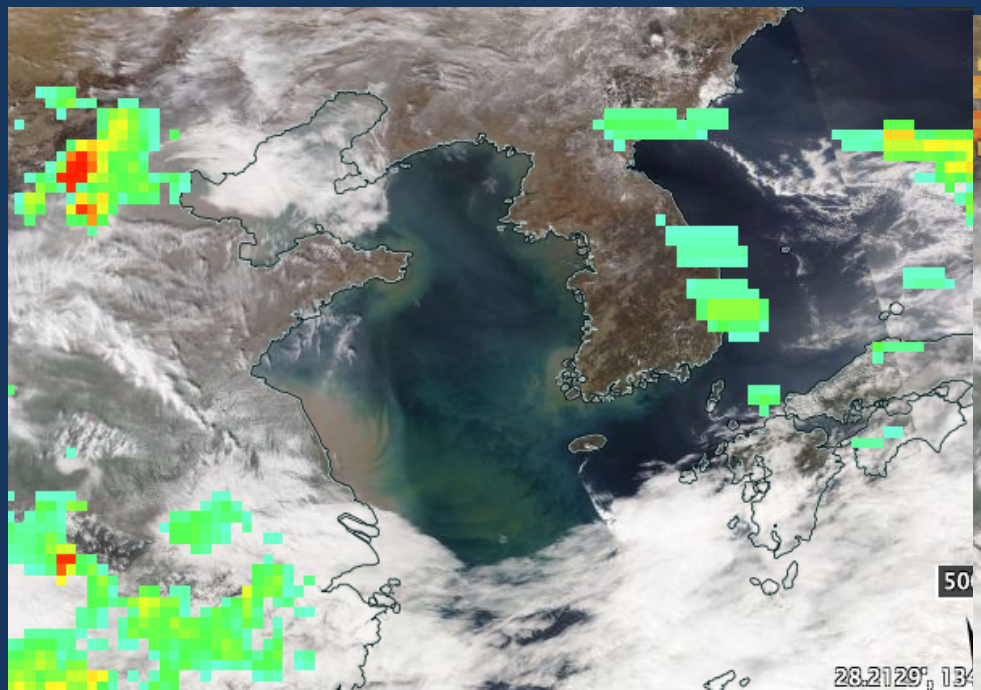
OMI and MODIS spatial resolution

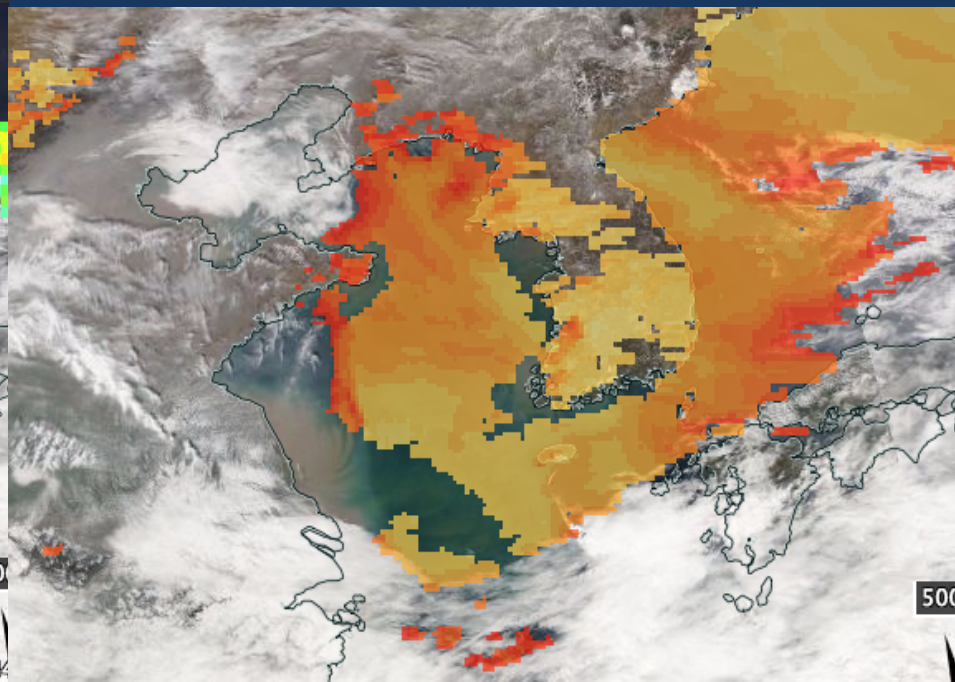
OMI spatial resolution: 13 x 24 km

MODIS spatial resolution: 0.25 to 0.50 km

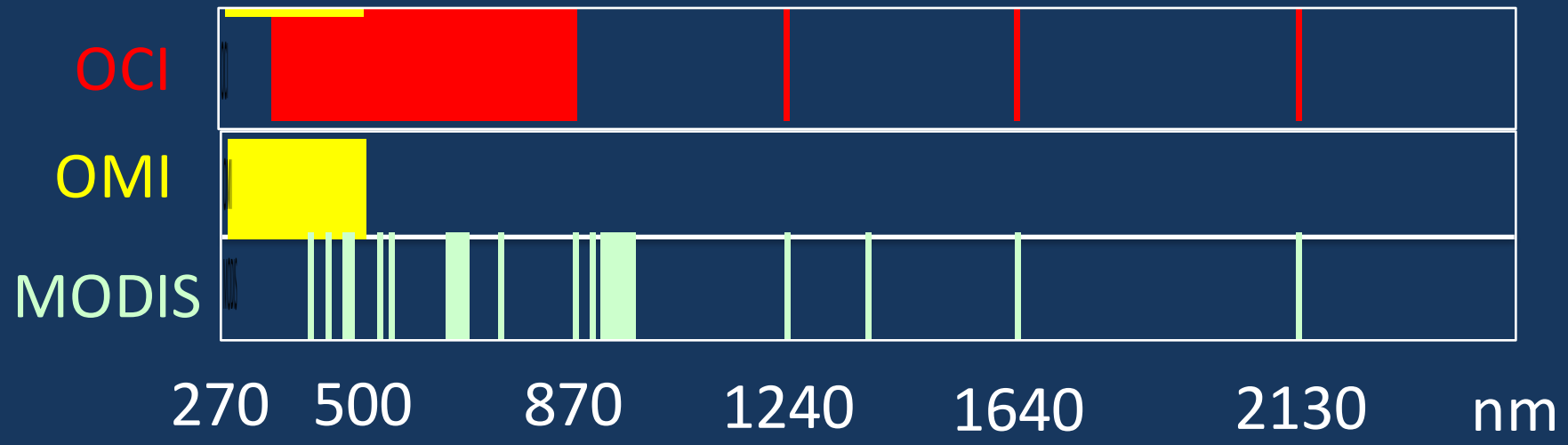
MODIS aerosol product is more robust, less cloud affected and has information on particle size.

OMI can offer information on aerosol absorption.



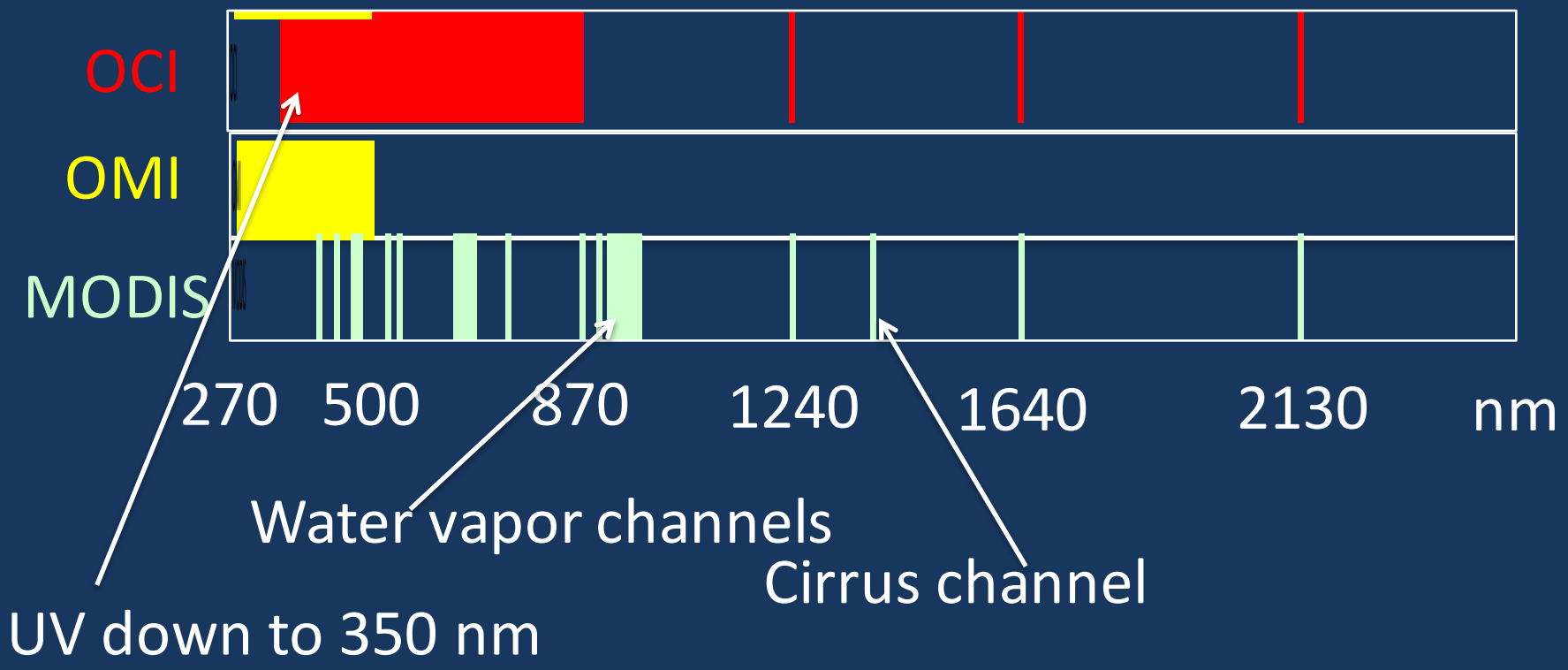


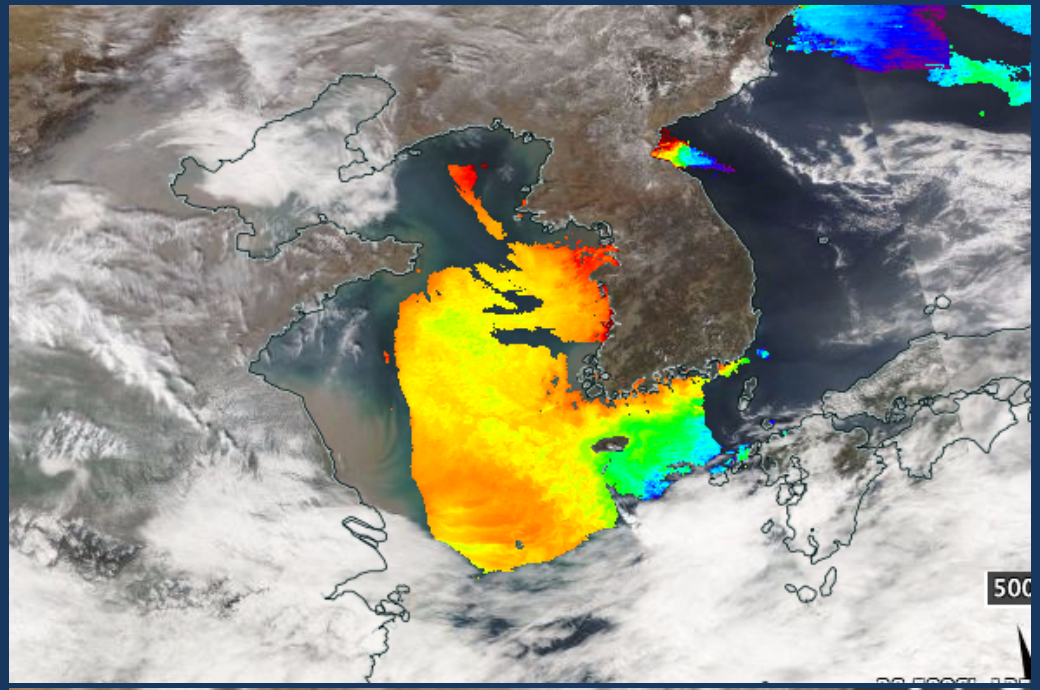
OMI, MODIS and OCI spectral coverage of reflective bands

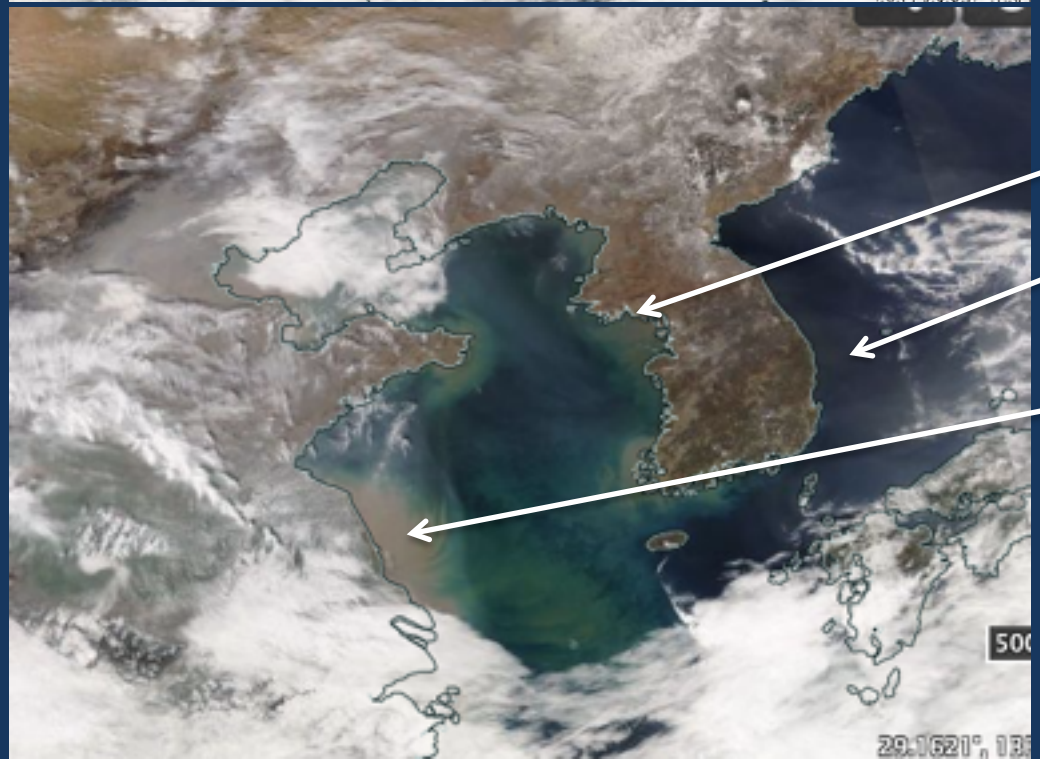


OCI (Ocean Color Instrument) is a proposed design for the PACE mission

OMI, MODIS and OCI spectral coverage of reflective bands



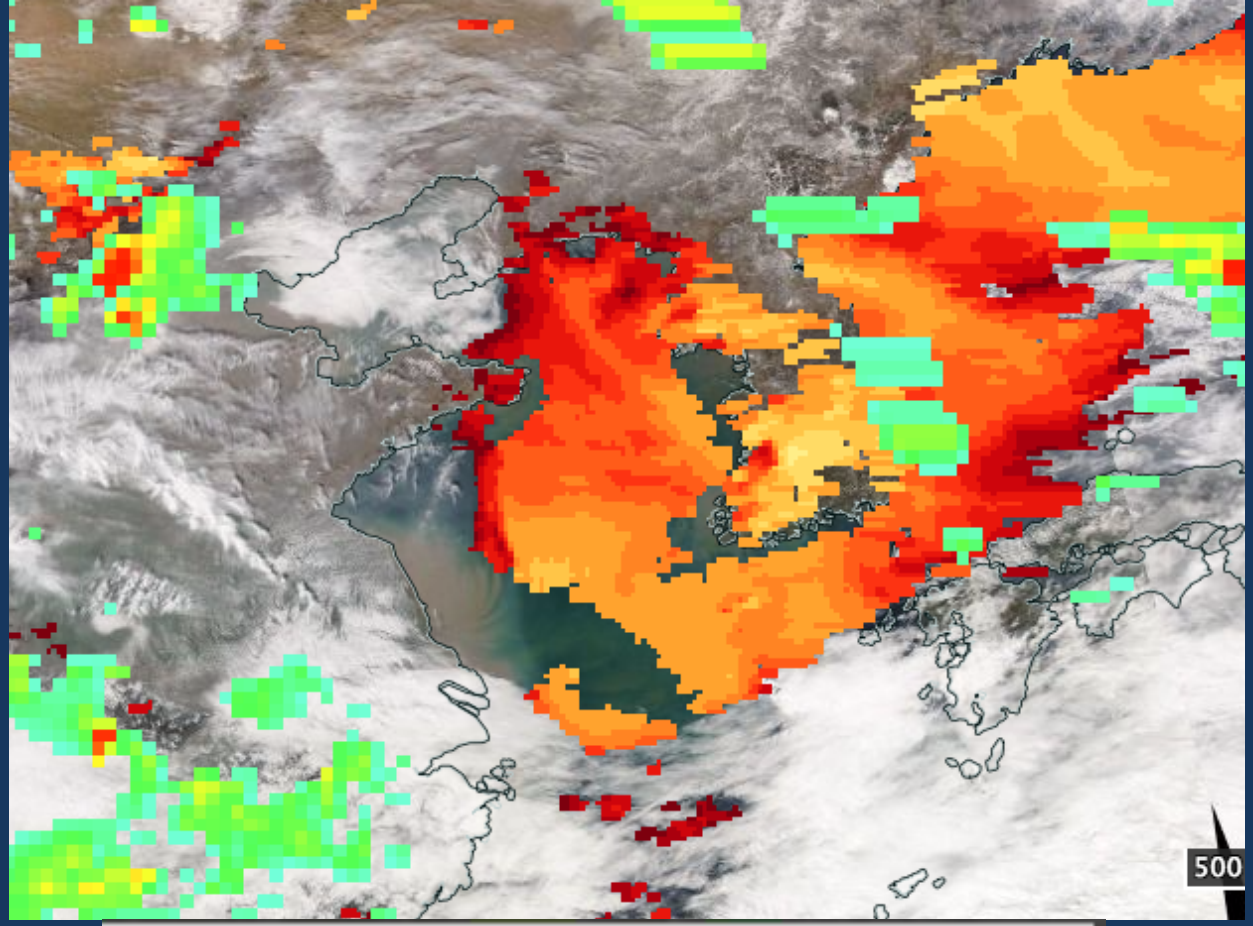




From the oceanic perspective

Current capabilities: Chlorophyll

Goal: Open new vistas in aqautic biogeochemistry



Aerosol Index
Aura / OMI

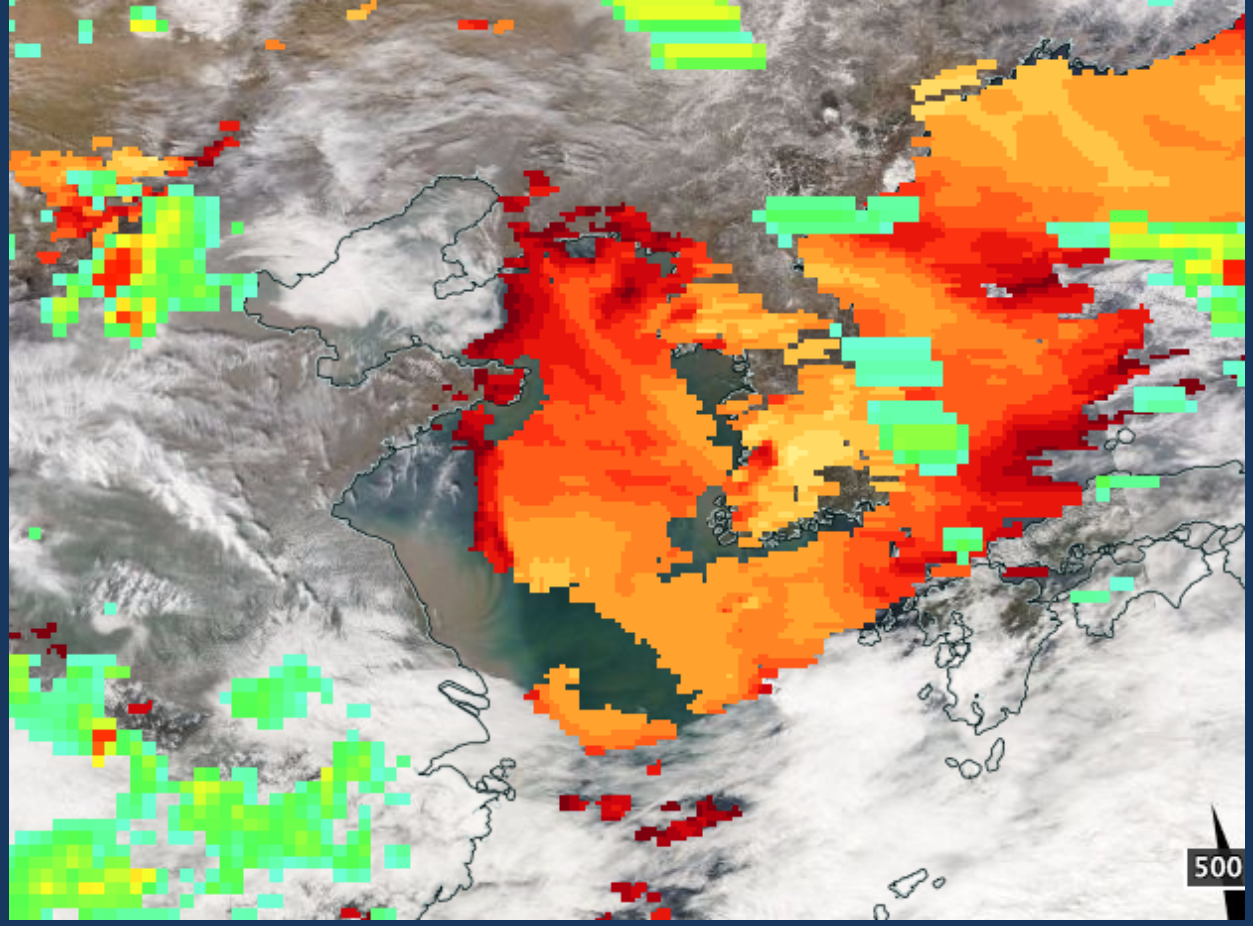
1.10 2.00

Aerosol Optical Depth
Aqua / MODIS

-0.05 0.70

From the atmospheric perspective

Here aerosol retrievals of both AOT and aerosol absorption

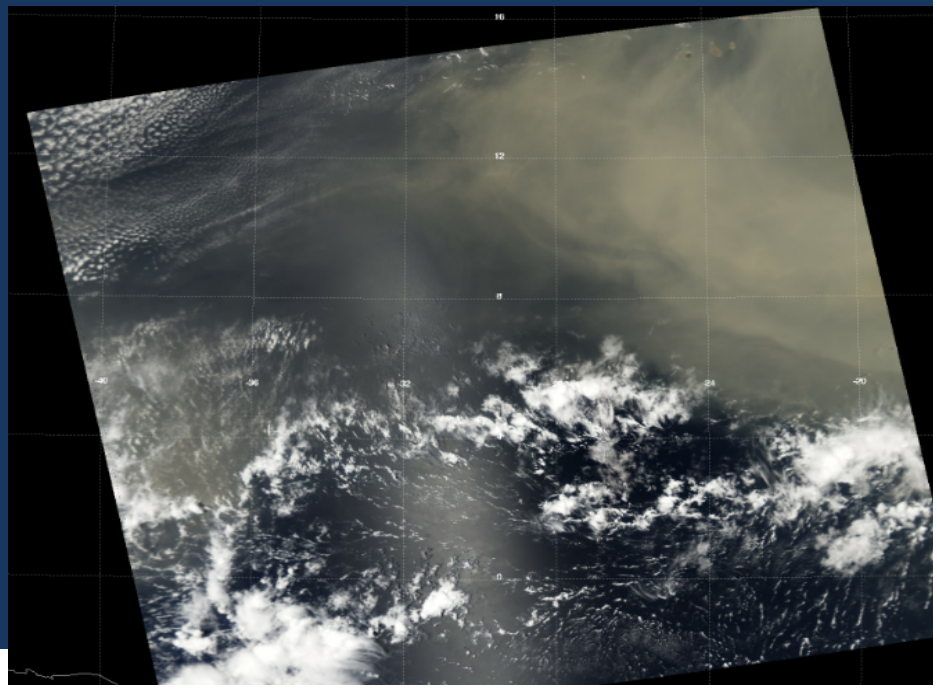


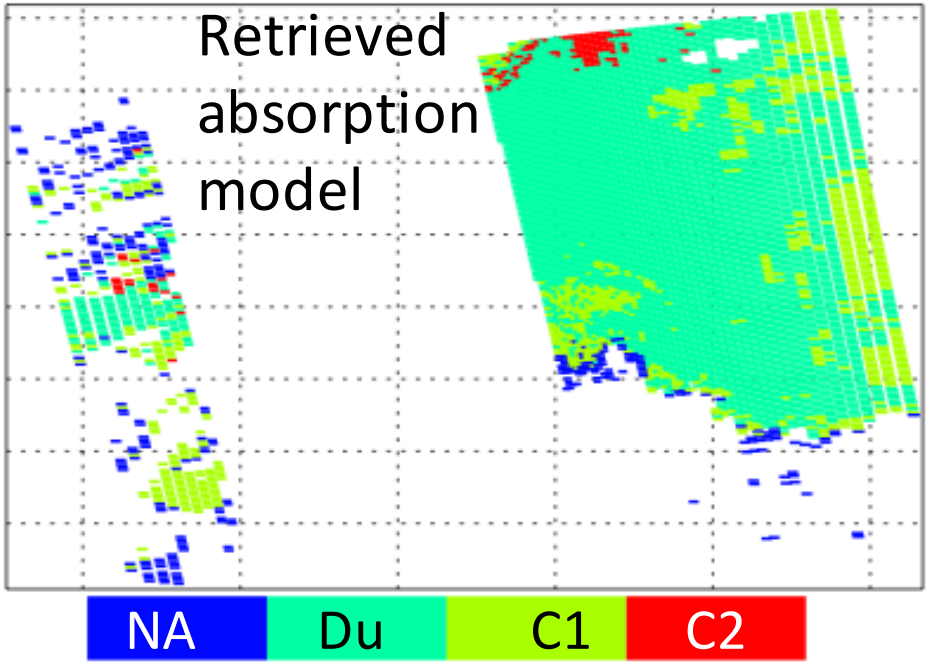
From the atmospheric perspective

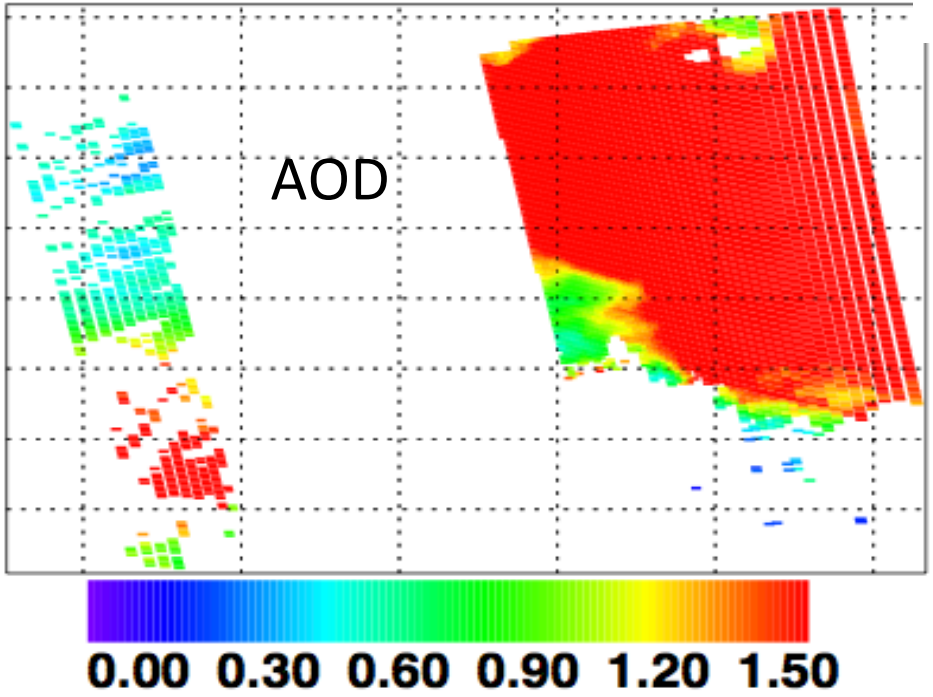
Here aerosol retrievals of both AOT and aerosol absorption

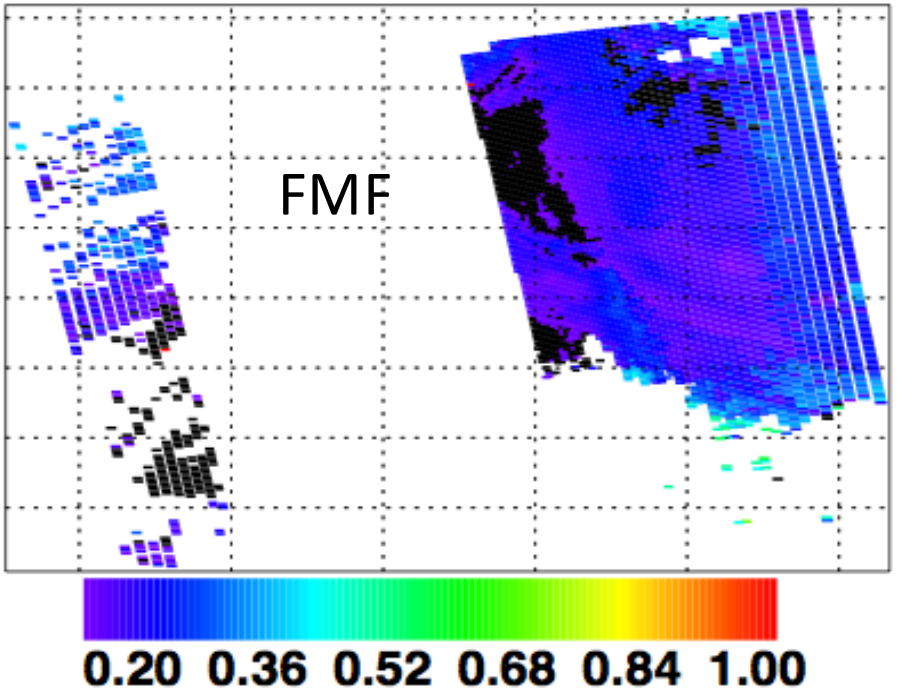
OCI will be the first instrument with wavelengths spanning UV to SWIR

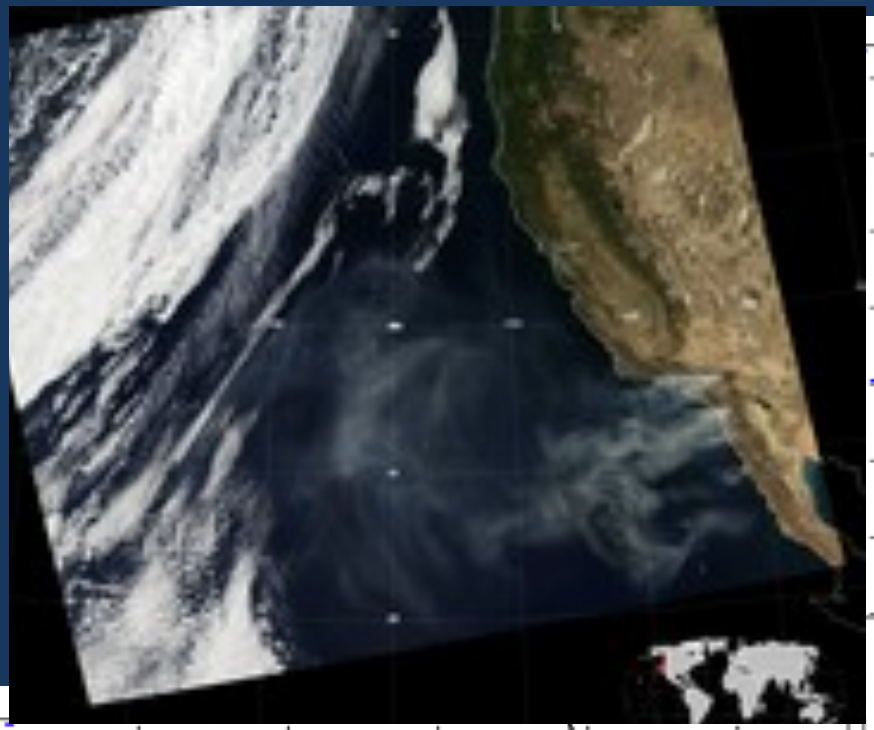
….. And the first with UV capability ~ 1 km spatial resolution

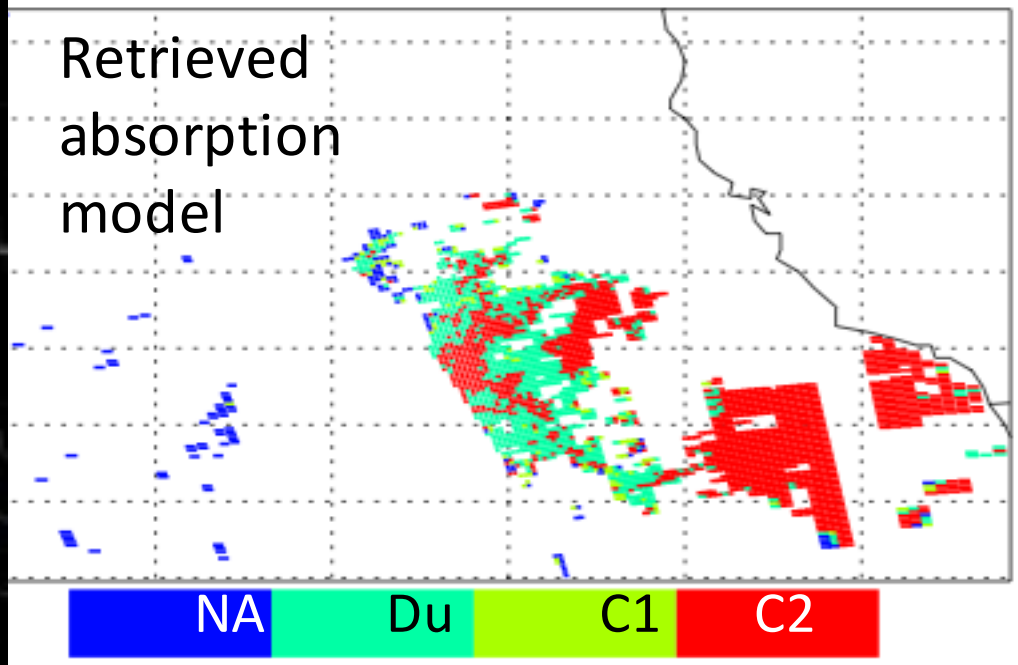


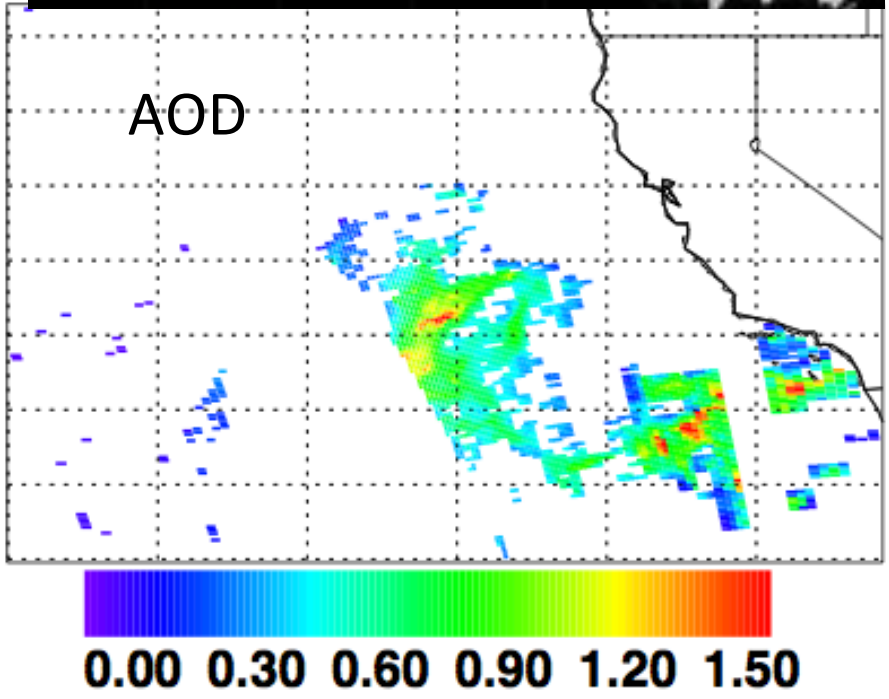

Retrieved
absorption
model
NA
Du
C1
C2

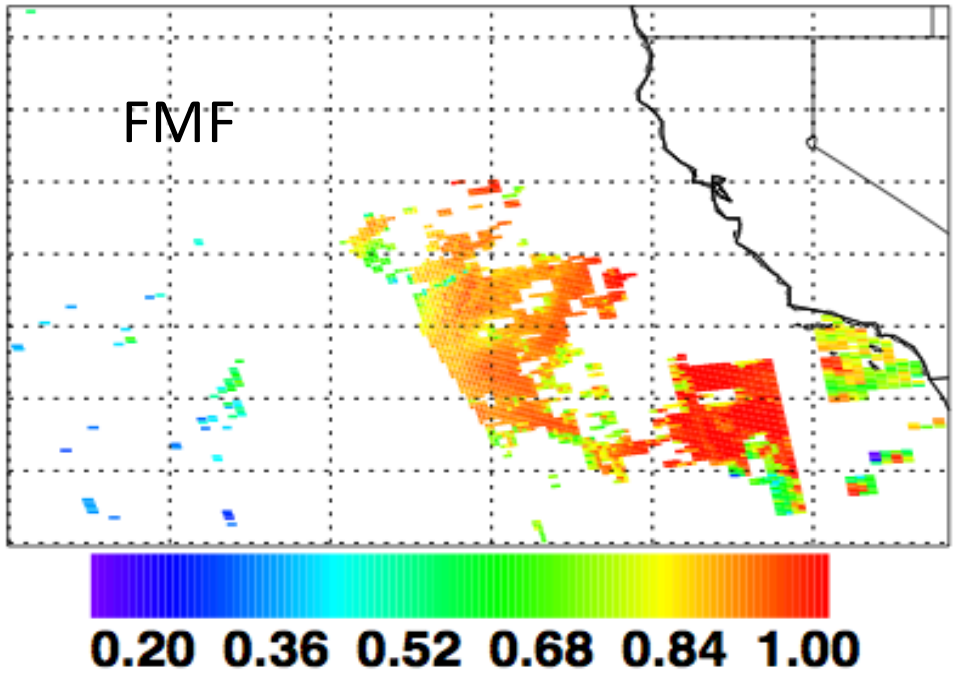

AOD
0.00 0.30 0.60 0.90 1.20 1.50


FMF
0.20 0.36 0.52 0.68 0.84 1.00




Retrieved
absorption
model
NA
Du
C1
C2


AOD
0.00 0.30 0.60 0.90 1.20 1.50


FMF
0.20 0.36 0.52 0.68 0.84 1.00

Atmospheric perspective

Enhanced capabilities to exploit:

- UV-SWIR at moderate spatial resolution: aerosol characterization
- Oxygen-A band: aerosol and cloud heights
- Broad spectrum and hyperspectral: water vapor, trace gases and advanced atmospheric correction

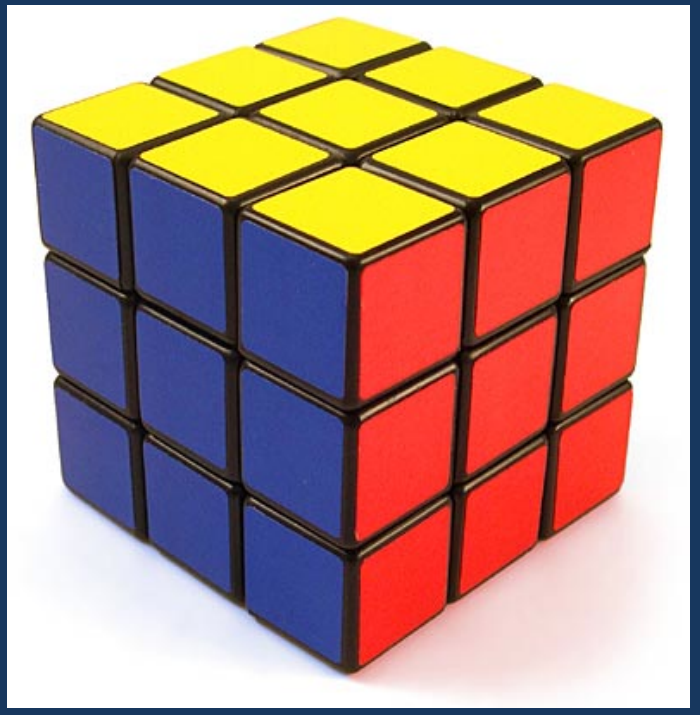
Climate continuity (MODIS and OMI continuation): aerosols and clouds over ocean and land

An advanced ocean color sensor still looks at each scene with one view angle and measures only intensity.

Information content is limited.

We are looking at incremental advances in atmospheric retrievals.

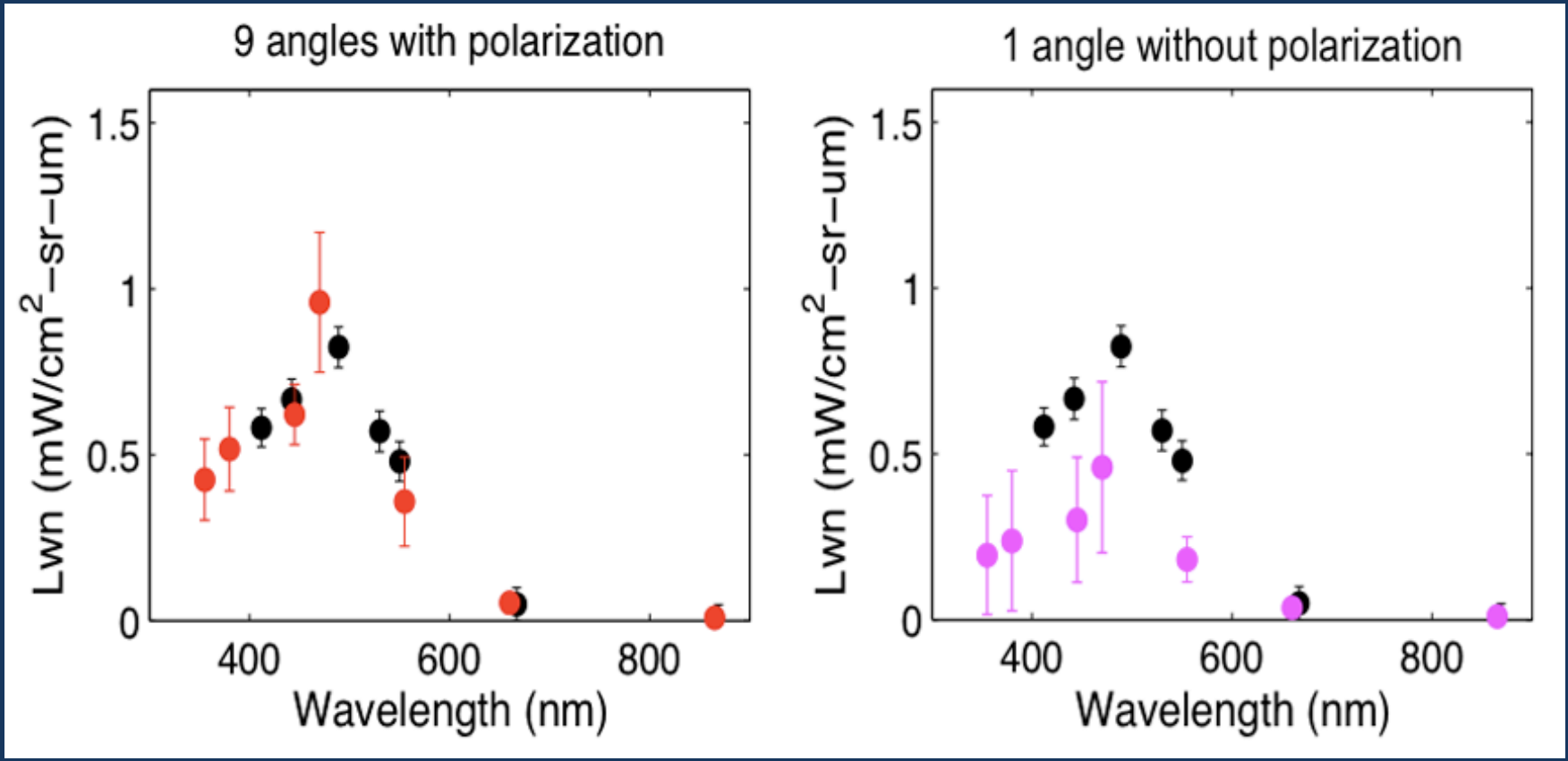
Multiangle polarimetry increases information content considerably.



Introduces whole new dimensions for atmospheric and oceanic retrievals.

Polarimetry and atmospheric correction

Retrievals from data with ground truth



Olga Kalashnikova and the PACE ST

Back up

Conclusion:

PACE with OCI and a polarimeter will add significant capability.

- Broad spectral range
- Hyperspectral subrange
- Moderate resolution pixels
- Mulitwavelength multiangle imaging polarimeter

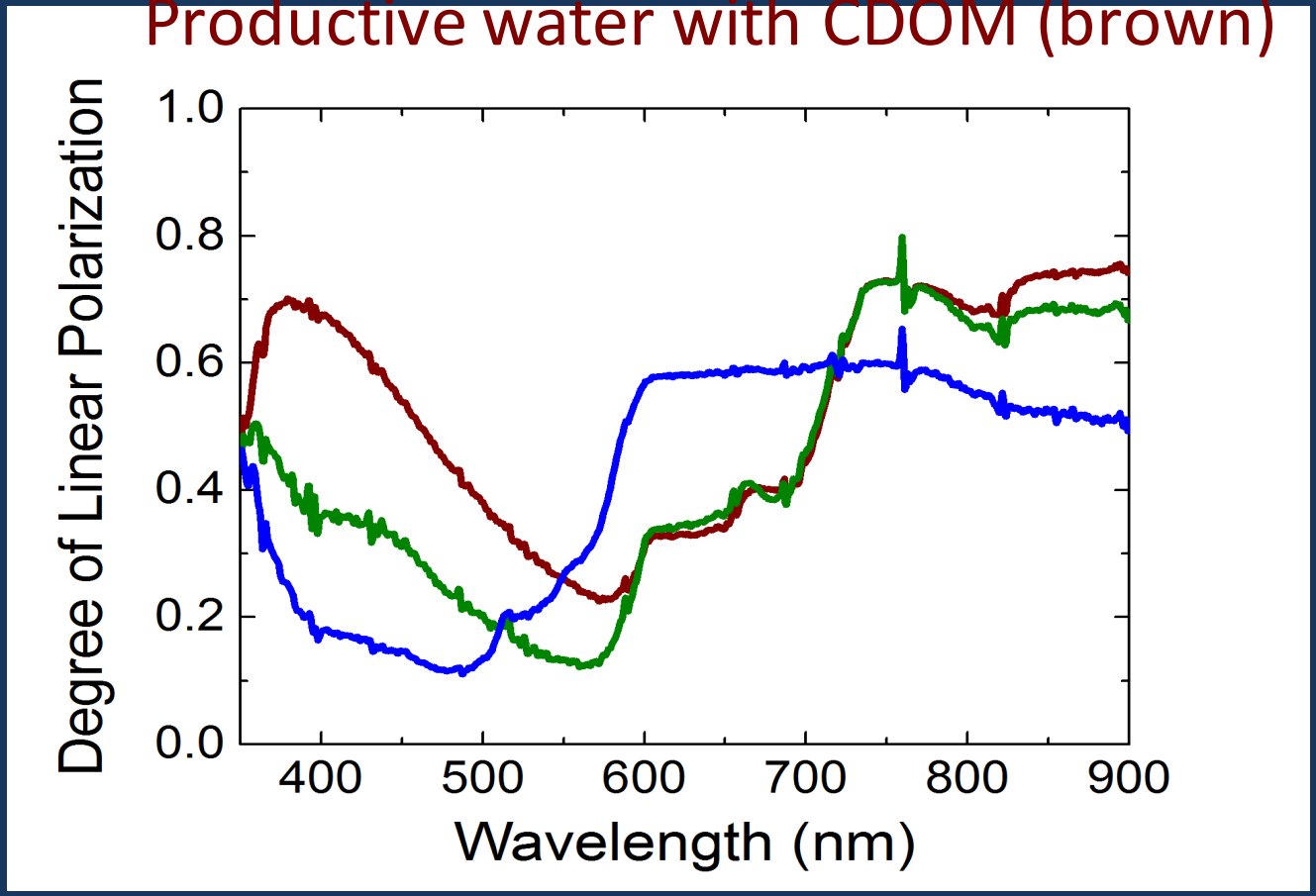
- Take aquatic biogeochemistry into new territory
- Will advance atmospheric correction to support aquatic goals
- And will advance characterization of atmospheric properties at no cost to the aquatic component

Polarimeter and retrieval of hydrosols

Clear water (blue)

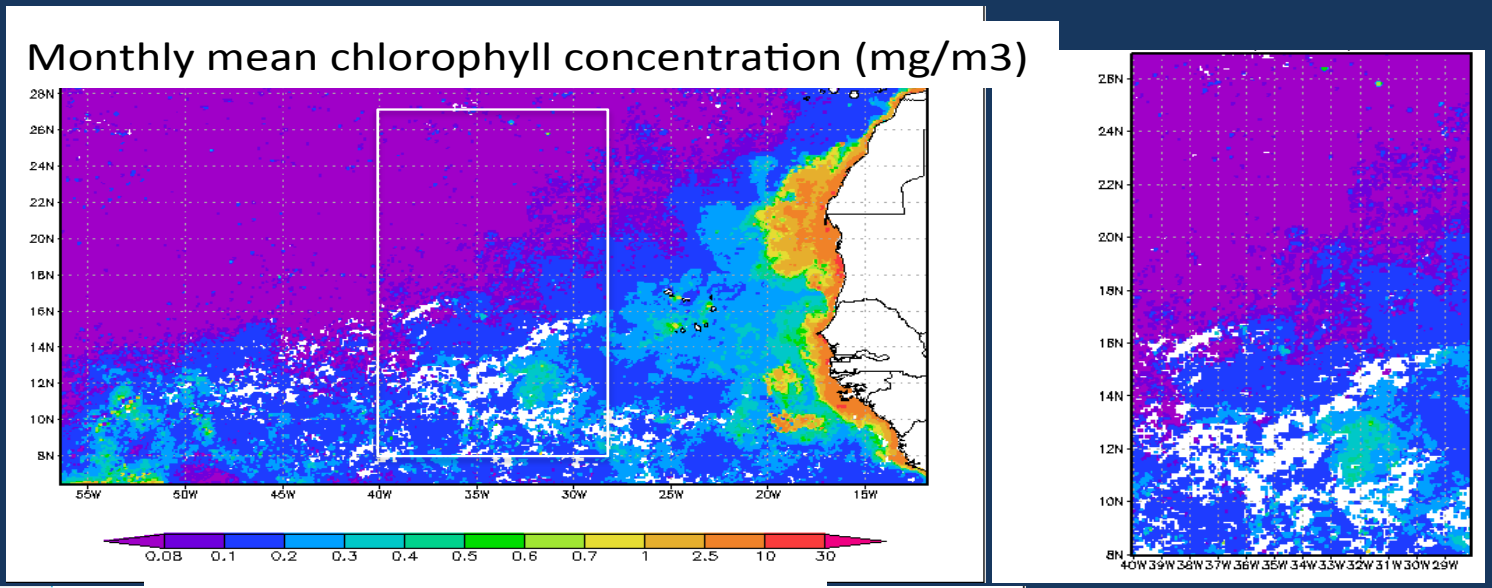
Biologically productive water (green)

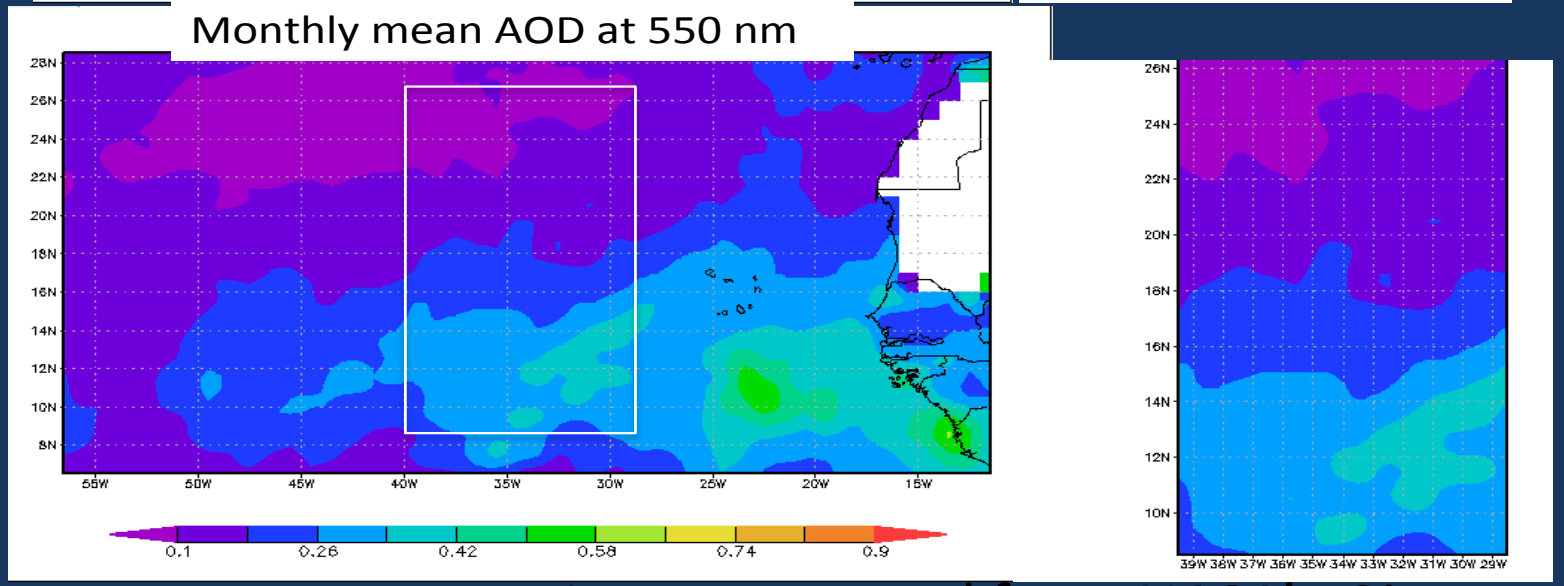
Productive water with CDOM (brown)



Deric Gray and the PACE ST

November 2007 monthly mean chlorophyll concentration in mg/m^3 (top) from SeaWiFs and AOD at 550 nm from Terra MODIS





Images created from NASA's Giovanni

What can we do with PACE expanded capabilities?
OCI broad spectral range

Retrieve aerosol absorption information

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)

↓

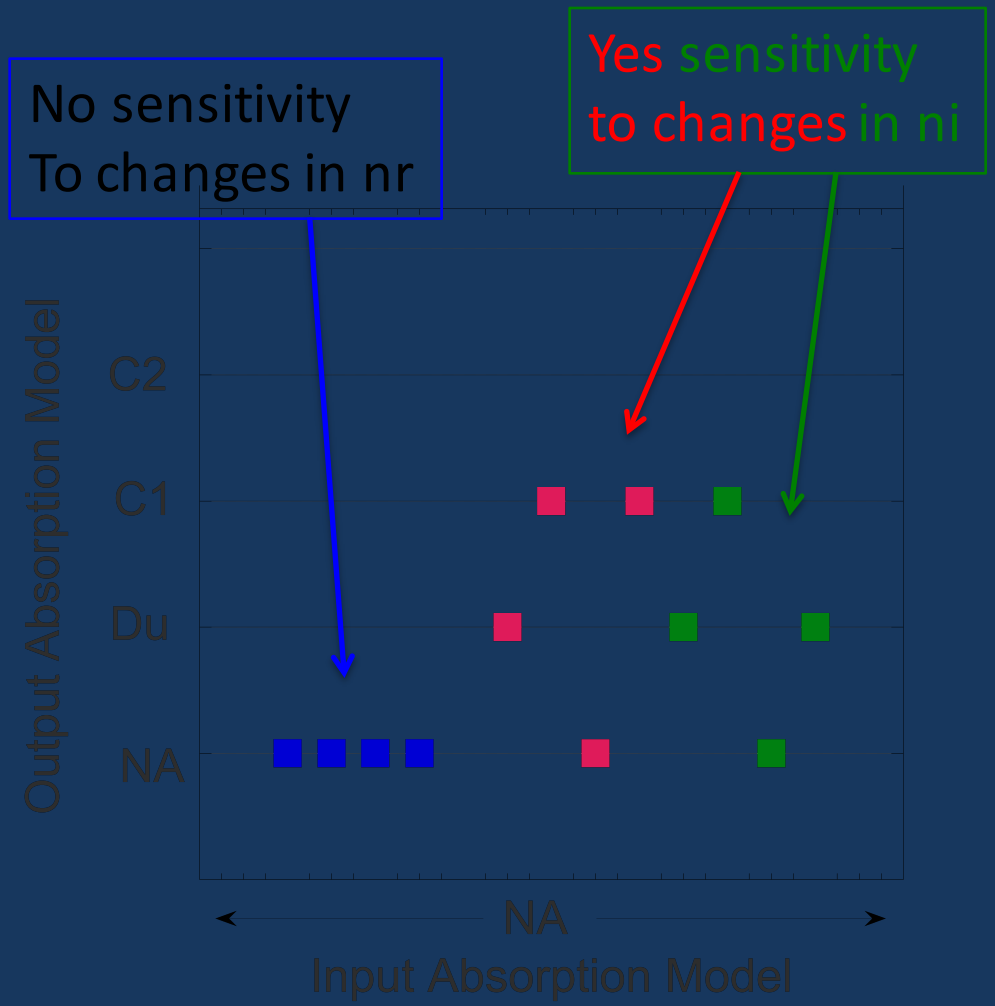
Match measured UV reflectances to LUT consisting of four new models: Non-absorbing (NA), Dust (Du), and 2 types of combustion (C1 and C2)

↓

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

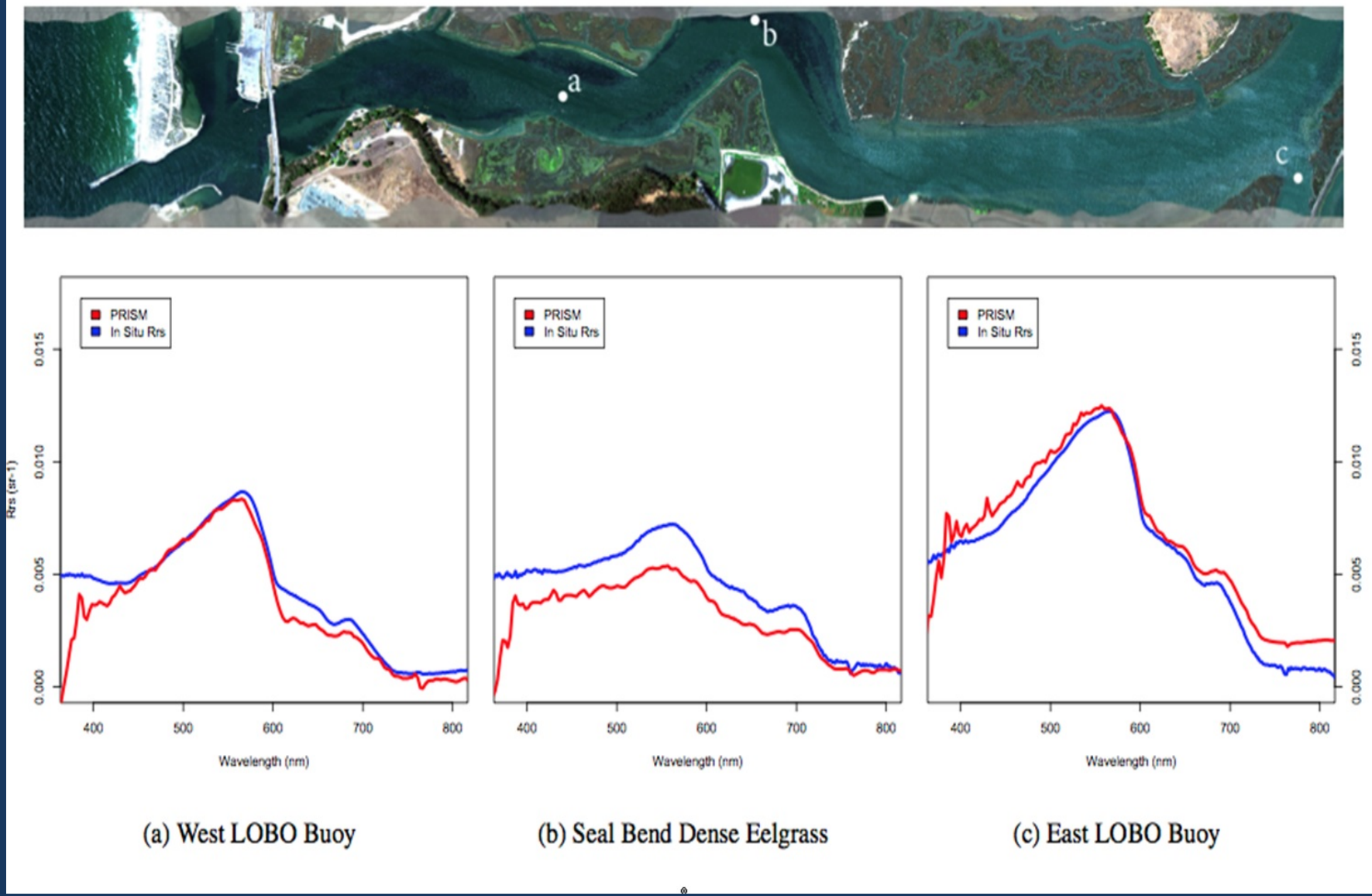
Retrieve aerosol absorption information

NA = non-absorbing
Du = Dust
C1 and C2 are combustion aerosol models with different spectral absorption in the UV

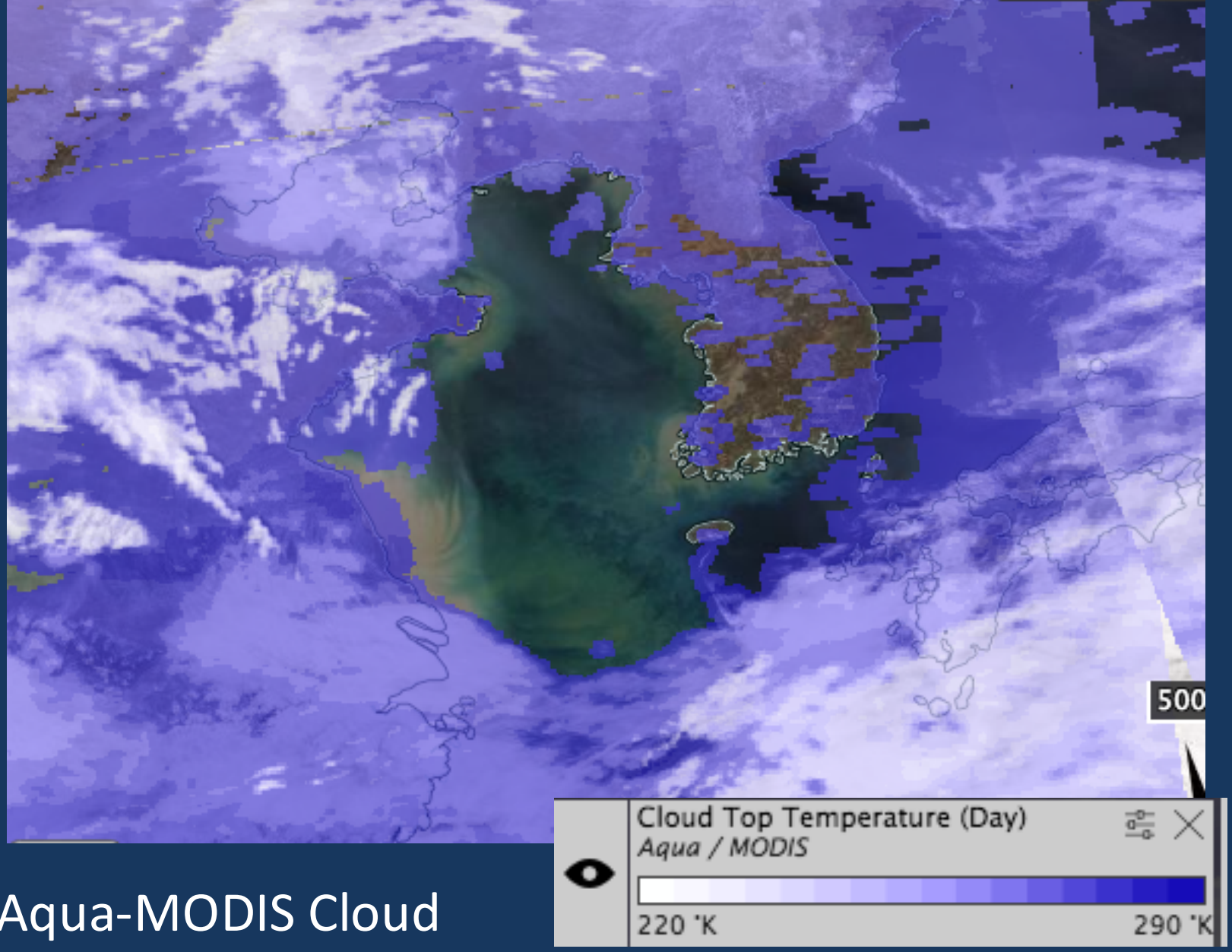


Mattoo et al. (poster)

Sample Retrieval Results From PRISM Data & Comparison with Ground Measurements

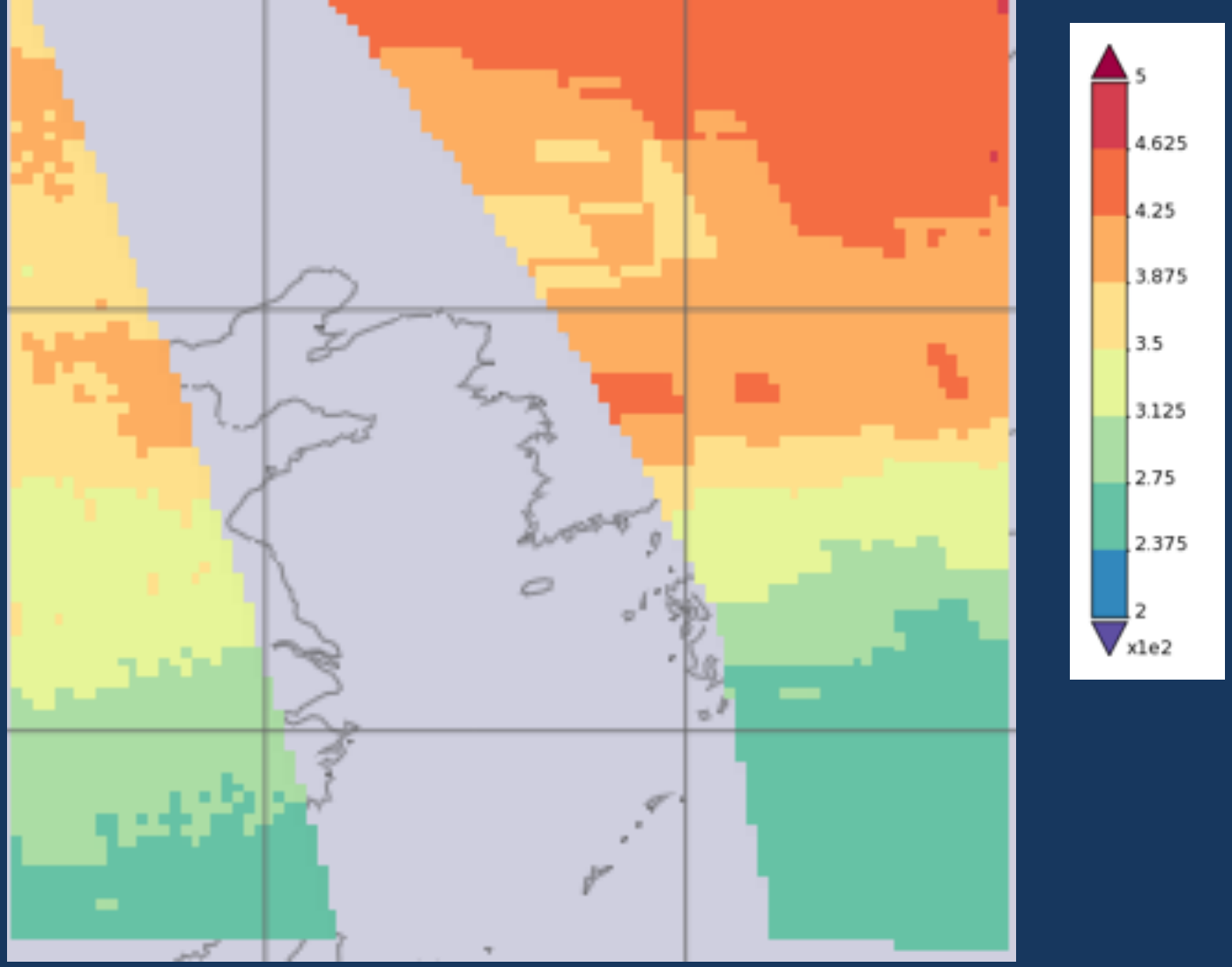


(a) West LOBO Buoy (b) Seal Bend Dense Eelgrass (c) East LOBO Buoy



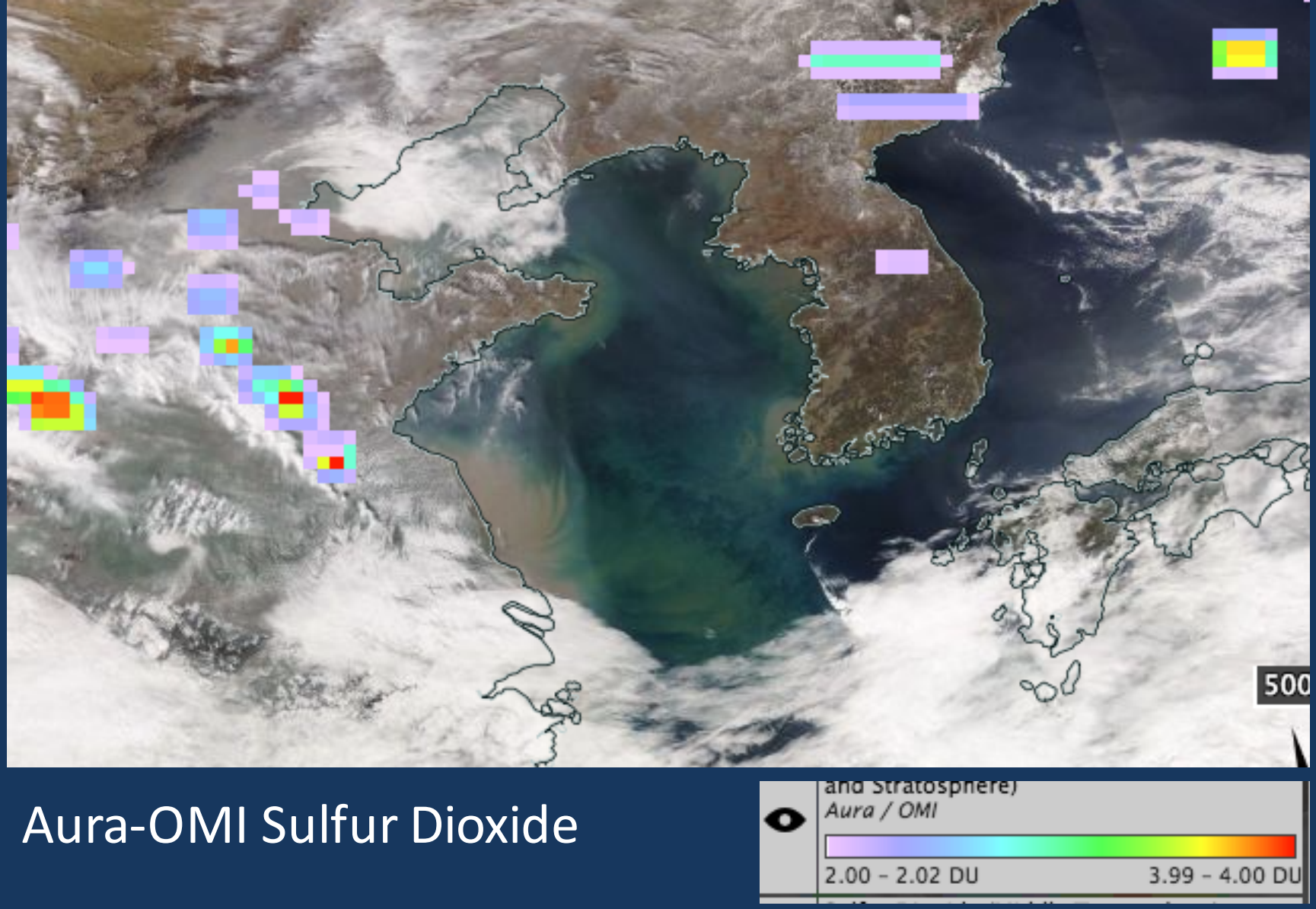
Aqua-MODIS Cloud top temperature

Image from NASA Worldview



Aura OMI total column ozone

Image from NASA Giovanni



Aura-OMI Sulfur Dioxide

Image from NASA Worldview