Comparison of an Aerosol Assimilation System of MODIS Radiances with AERONET retrievals

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Arlindo da Silva — GMAO

GOCART
- Mian Chin
- Paul Ginoux

AERONET
- Brent Holben
- Oleg Dubovic
- Dave Giles

MODIS
- Loraine Remer
- Rob Levy
- Yorum Kaufman

Radiative Transfer
- Dave Flintner
- Ahamd Zia

Chlorophyll
- Watson Gregg

Introduction

Goal: Construct simple offline Aerosol Assimilation System
Draws to MODIS radiances
Validates with AERONET retrievals.

Observations

MODIS level 2 Reflectance (cloud screened)
Ocean 7 channels .47 - 2.1um
Land 5 channels .47 - 2.1um

Forward Model

Aerosol 3D Transport MODEL (GOCART) provides
spatial and size distribution of aerosols.

Herman Radiative Transfer Model (Vector Code)
converts aerosol concentrations to reflectance

Motivation

Why not assimilate retrieved Aerosol Optical depth from MODIS-Atmos group

?

Differences in assumptions used in GOCART and MODIS-Atmos retrieval algorithm complicate assimilation

MODIS Observed Level 2 Reflectance → MODIS ATMOS Retrieval → MODIS Aerosol Optical Depth

Assumptions: optical parameters, size and type

Look-up-tables
9 ocean: water soluble, seasalt, dust ...
5 land: continental, urban, absorptive, dust ...

Aerosol type determined by geography

GOCART 3D Aerosol concentrations → GOCART Aerosol Optical Depth

Assumptions: optical parameters

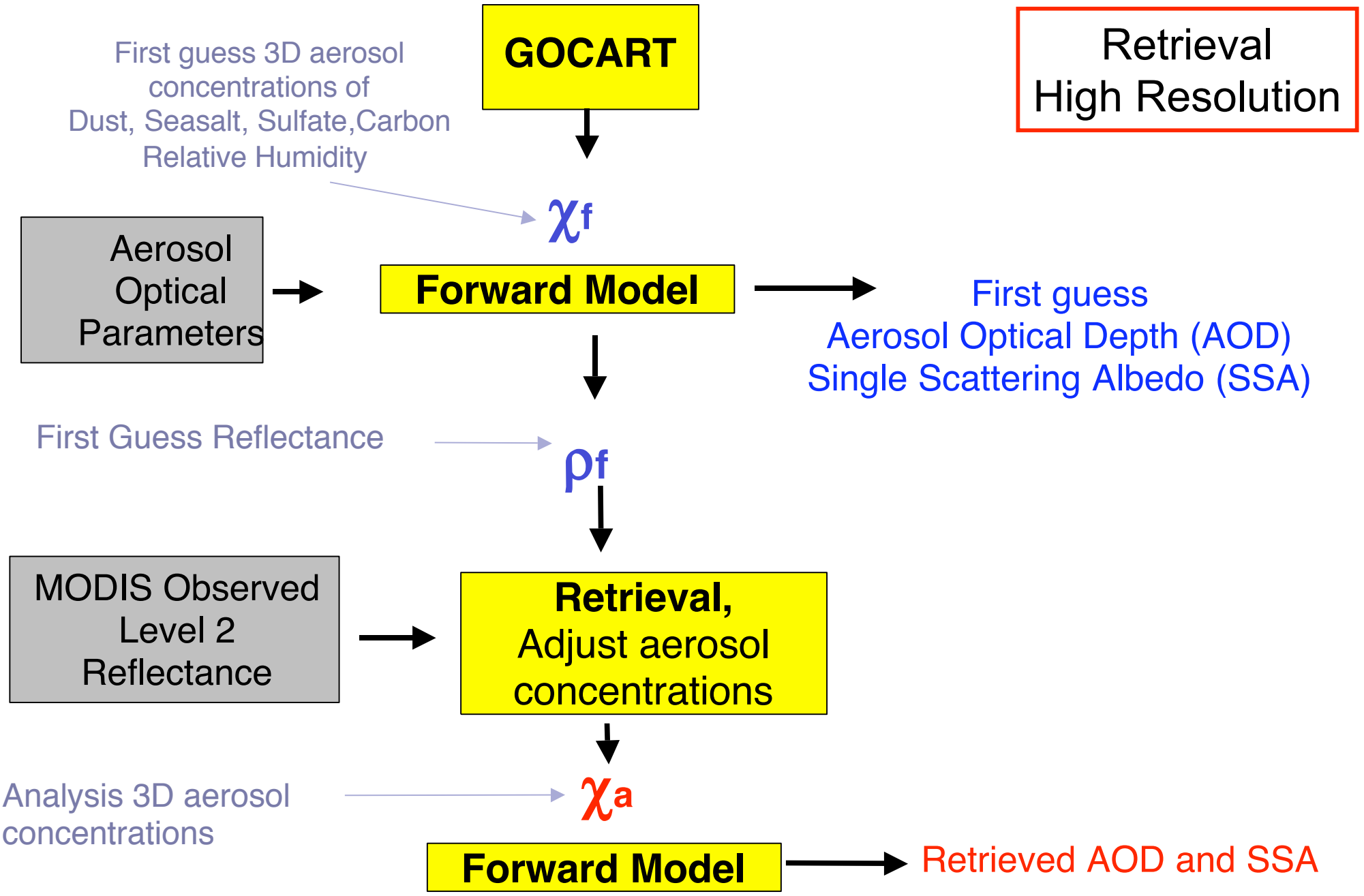
Species simulated: Sulfate, Carbon, Seasalt, Dust
Aerosol type determined transport, sources, sinks

GOCART Retrieval

High resolution (.500 x .625 ^{o})
Compare with AERONET
GOCART fields as a first guess
Consistent with GOCART aerosol species

Assimilation

Low resolution (2 x 2.5 ^{o})
Turn on cycling


Retrieval
High Resolution
GOCART
First guess 3D aerosol concentrations of
Dust, Seasalt, Sulfate,Carbon
Relative Humidity
χ_f
Aerosol Optical Parameters
Forward Model
First guess
Aerosol Optical Depth (AOD)
Single Scattering Albedo (SSA)
First Guess Reflectance
ρ_f
MODIS Observed Level 2 Reflectance
Retrieval,
Adjust aerosol concentrations
Analysis 3D aerosol concentrations
χ_a
Forward Model
Retrieved AOD and SSA

Forward Model (Aerosol Input)

GOCART

Aerosol transport model developed by Mian Chin and Paul Ginoux.

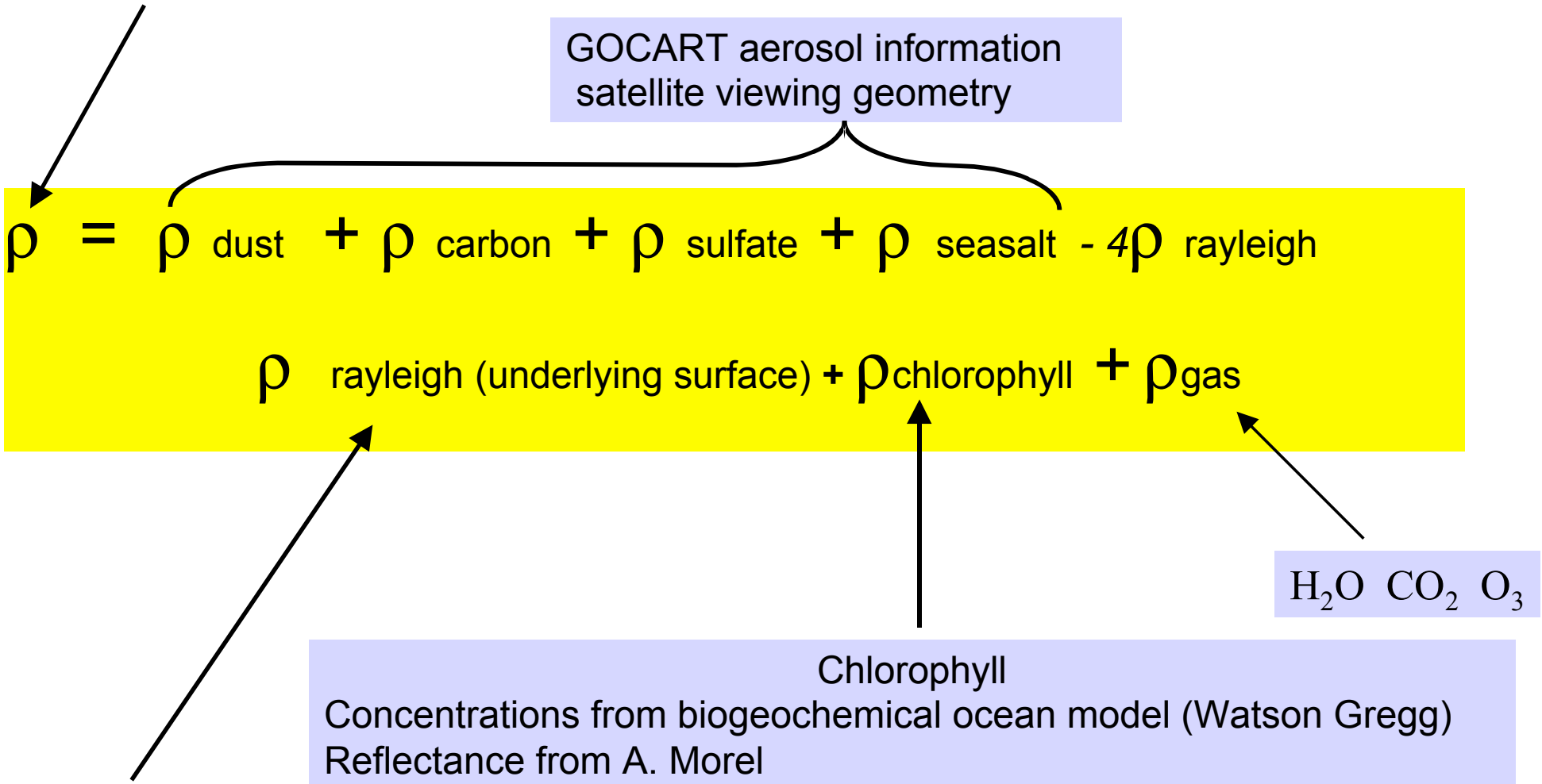
Assimilated Meteorology (winds, relative humidity)

Simulates 3D concentrations

Dust (0.1-6um)	Seasalt (0.5-10um).
Sulfate	Black and Organic Carbon

Humidification growth

Forward Model MODIS simulated Reflectance



Ocean: Surface reflectance uses appropriate wind speed (2, 6, 12 m/s)

Land: Rayleigh reflectance dependent on surface pressure

Forward model

Set of 48 look-up-tables per MODIS channel generated by the University of Arizona radiative transfer model.

Variants: Aerosol species, Relative humidity

Species

- Dust (dry R_{eff}= 1.0, 1.4um)
- Sulfate
- Seasalt (dry R_{eff}= 1.0, 1.3um)
- Black Carbon-Organic Carbon mixtures

Variants: Underlying Surface Properties

- Rough Ocean (2, 6, 12 m/s wind speeds)
- Land (Lambertian surface)

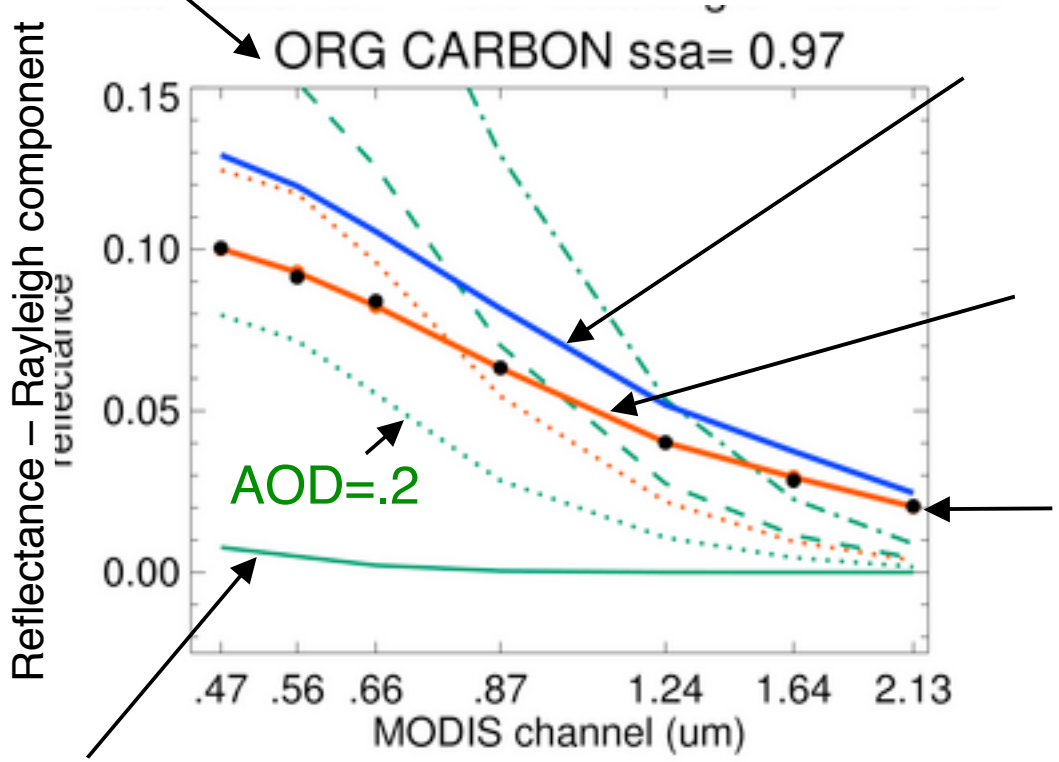
Ocean wind speed is from GMAO meteorological assimilation.

Land reflectivity:

1) Dark target approach used by MODIS-Atmos only for ρ (2.13 μm < 0.16)
2) MODIS filled Land Surface Albedo Product for “black sky” generated by Eric Moody

Comparison of Modis Reflectance from Ocean location with Look-up-table (LUT) reflectances

AOD=.5



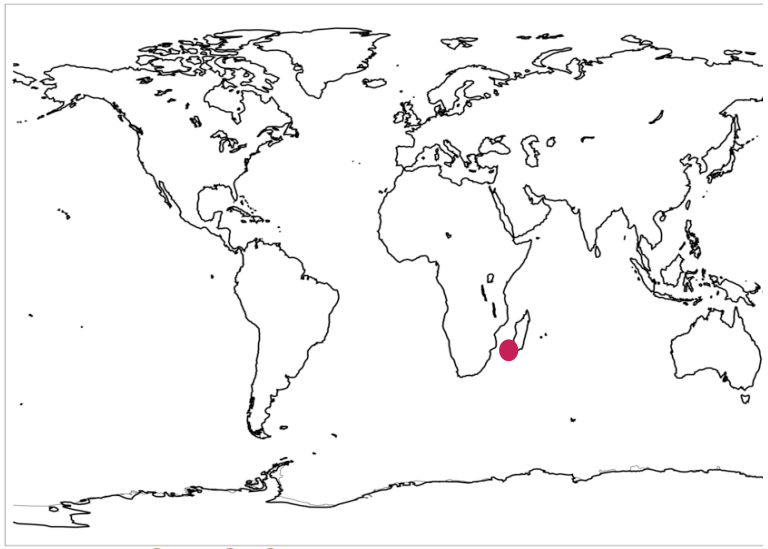
AOD=.2

AOD=0.0

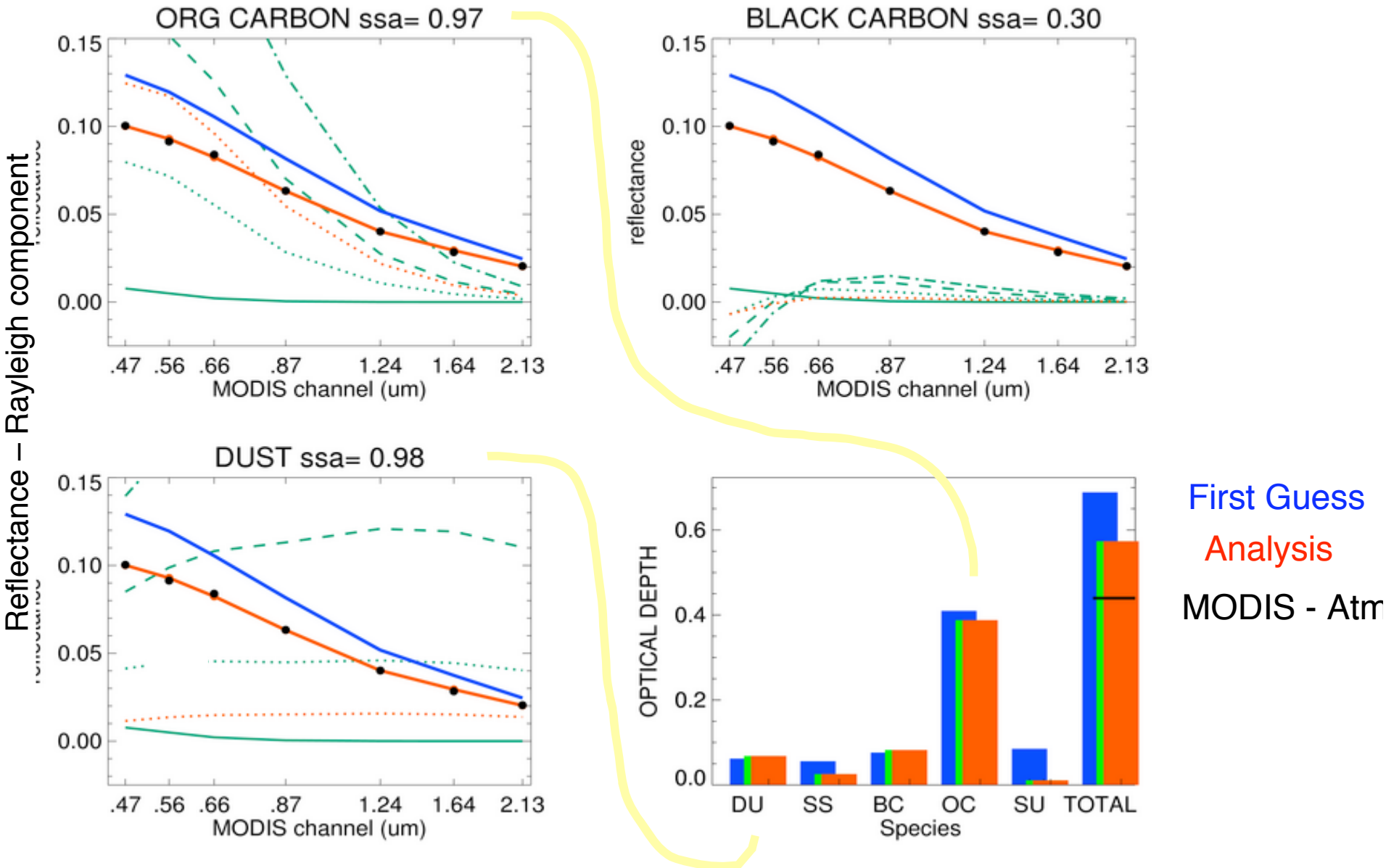
First guess Reflectance

Analysis Reflectance

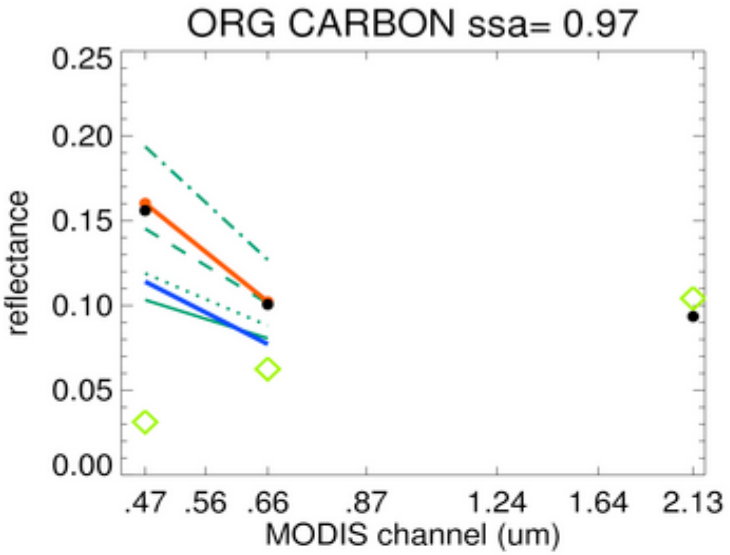
MODIS Reflectance

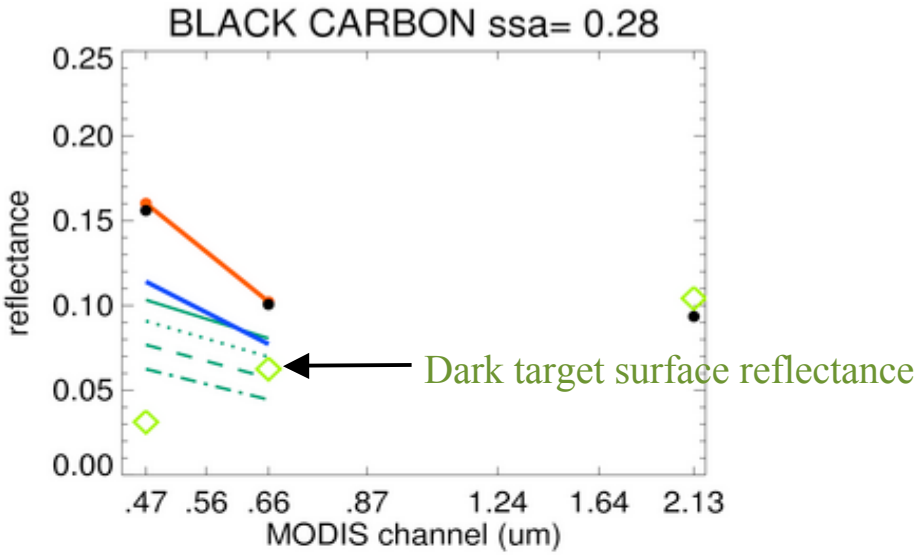


Comparison of Modis Reflectance from Ocean location with LUT reflectances

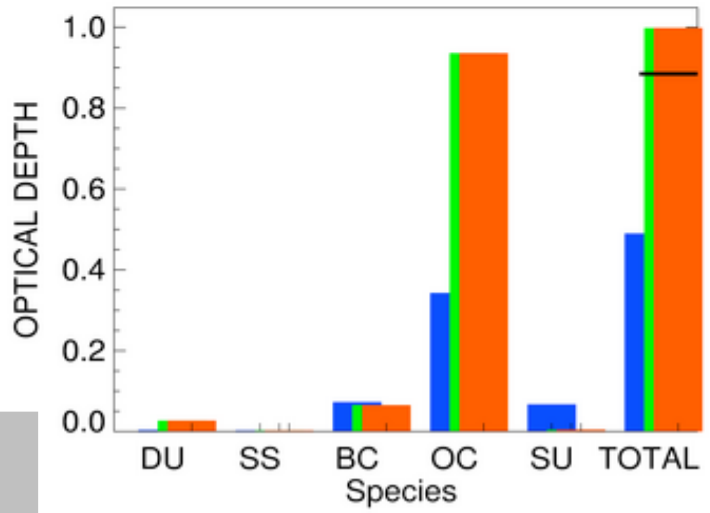


Comparison of Modis Reflectance from Land location with LUT reflectances





Abracos Hill
AERONET AOD=1.7

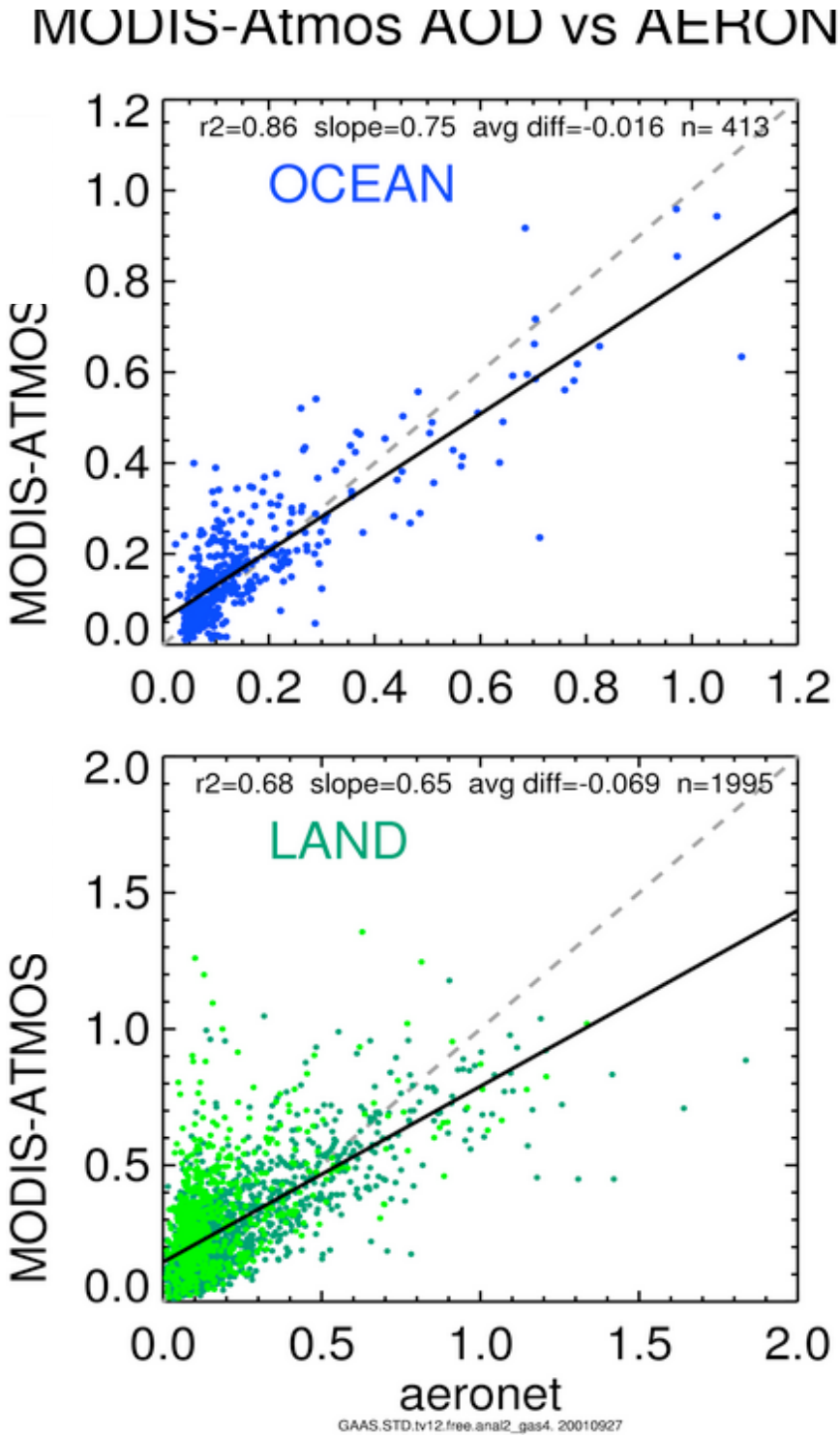


Analysis

MODIS - Atmos

First Guess

convergence.1.outof.1.GAAS.STD.tv12.free.anal2_gas4.20010912.12.dat

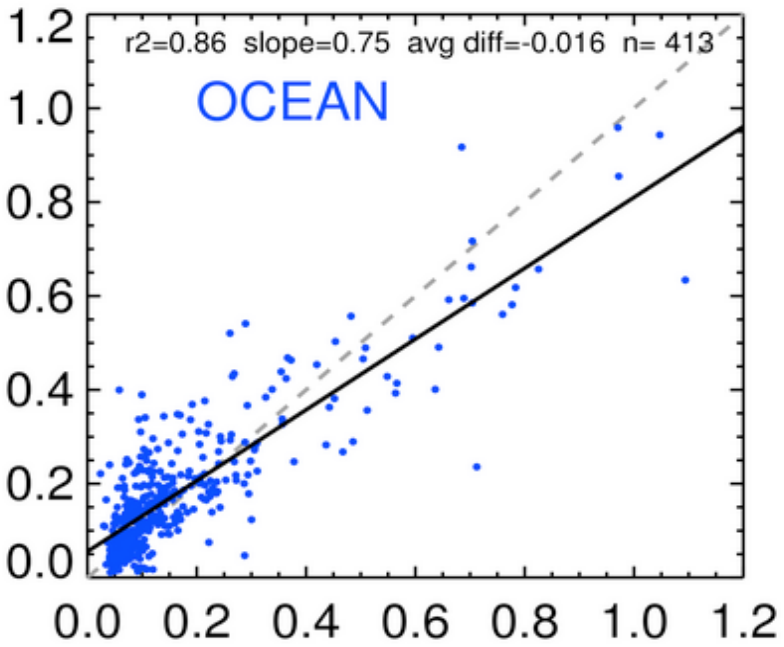


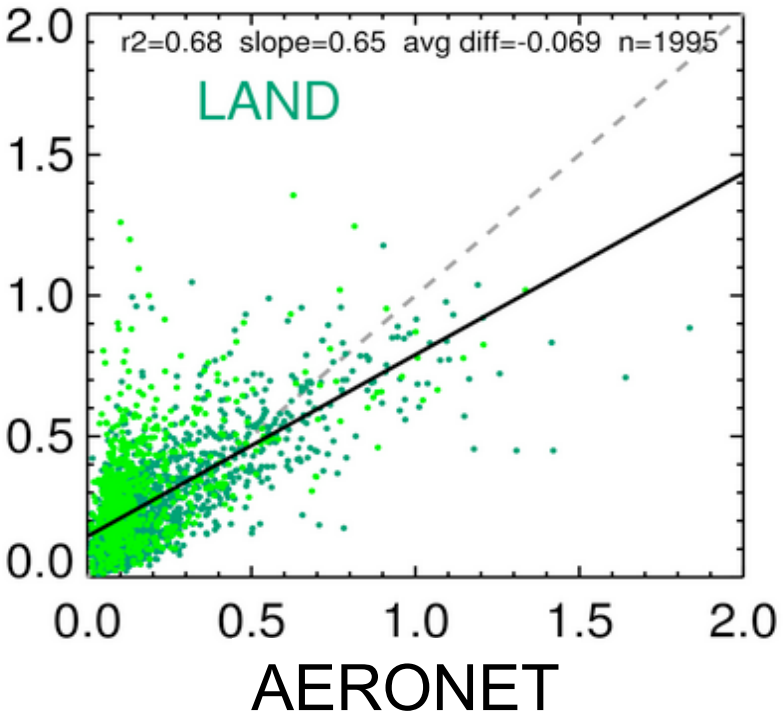
July-Sept 2001

.500 x .625 ^{o} Resolution

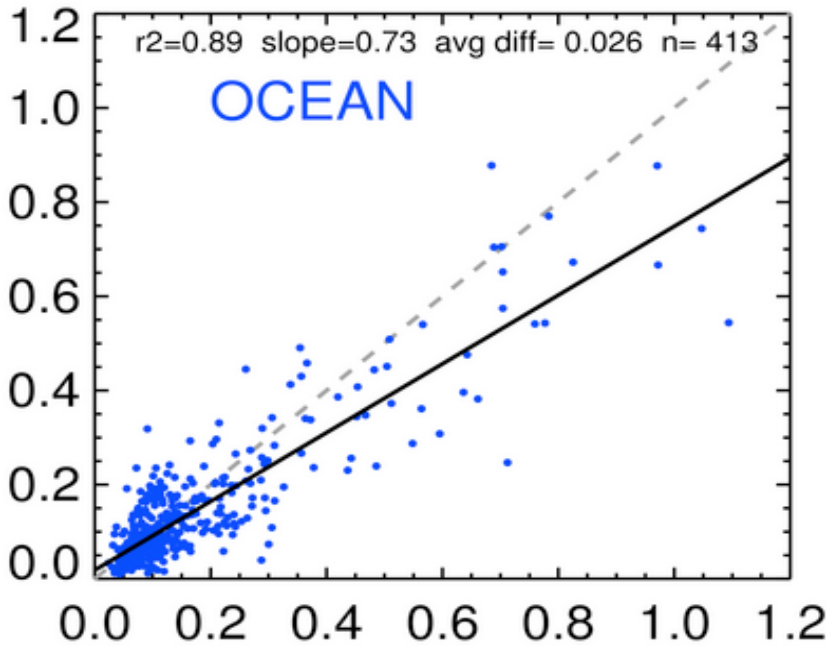
- High Surface reflectance (> .16, 2.13um)
- Low Surface reflectance

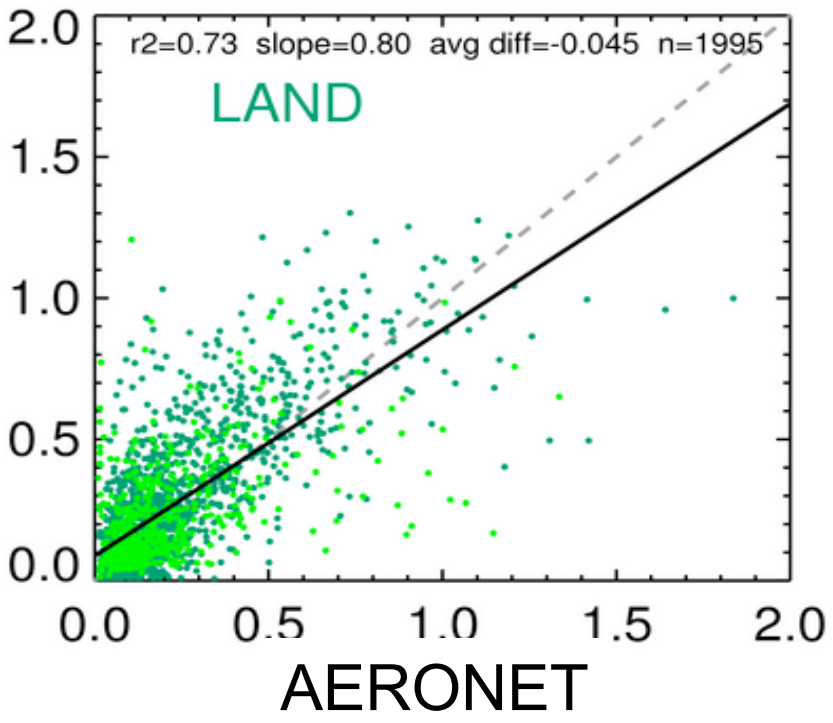
MODIS-Atmos AOD vs AERONET



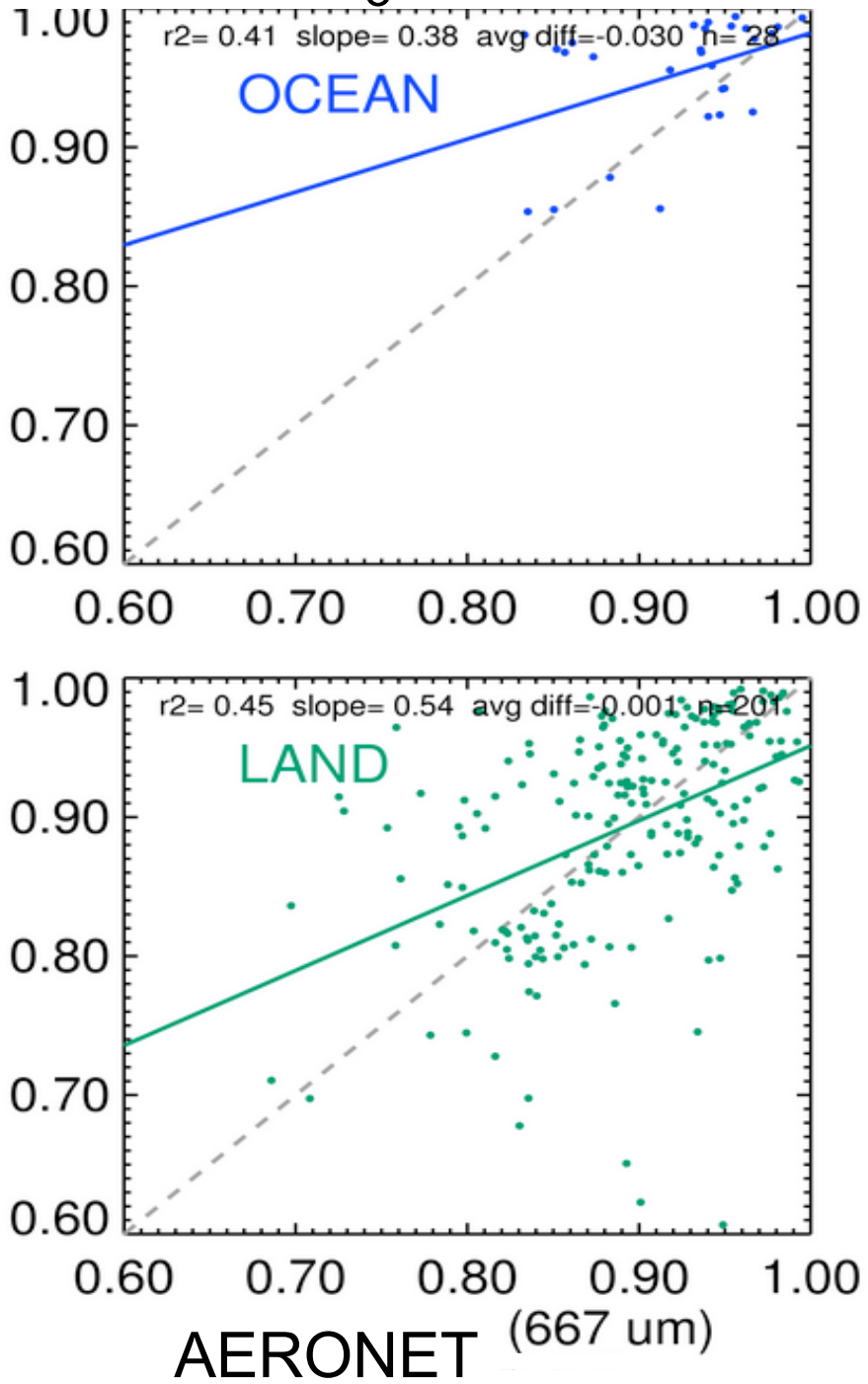


GOCART Retrieval vs AERONET

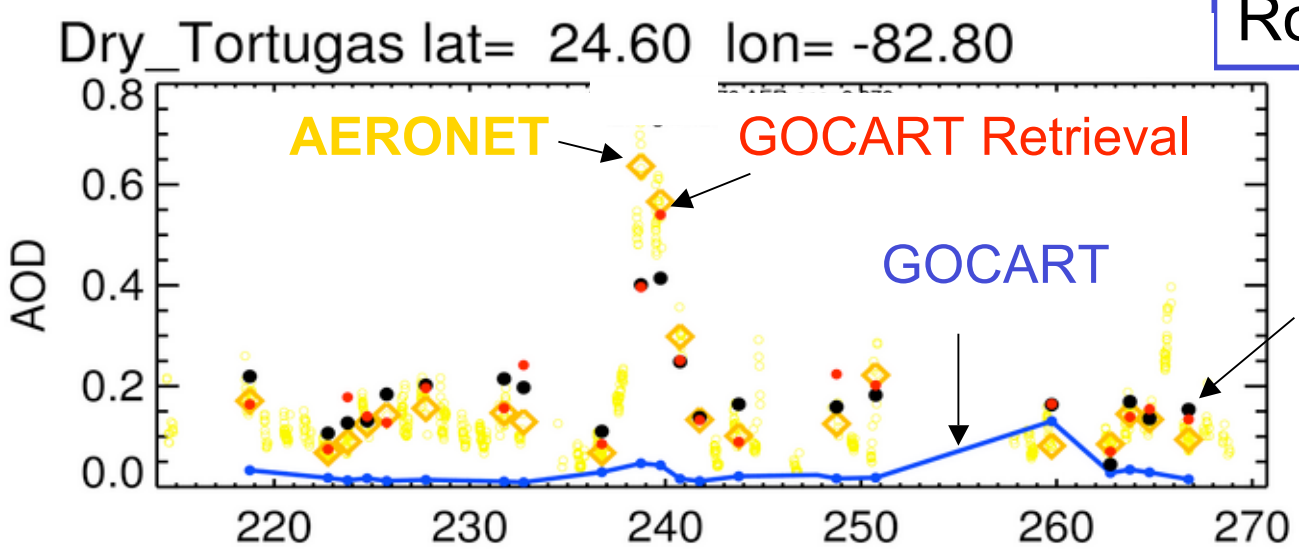


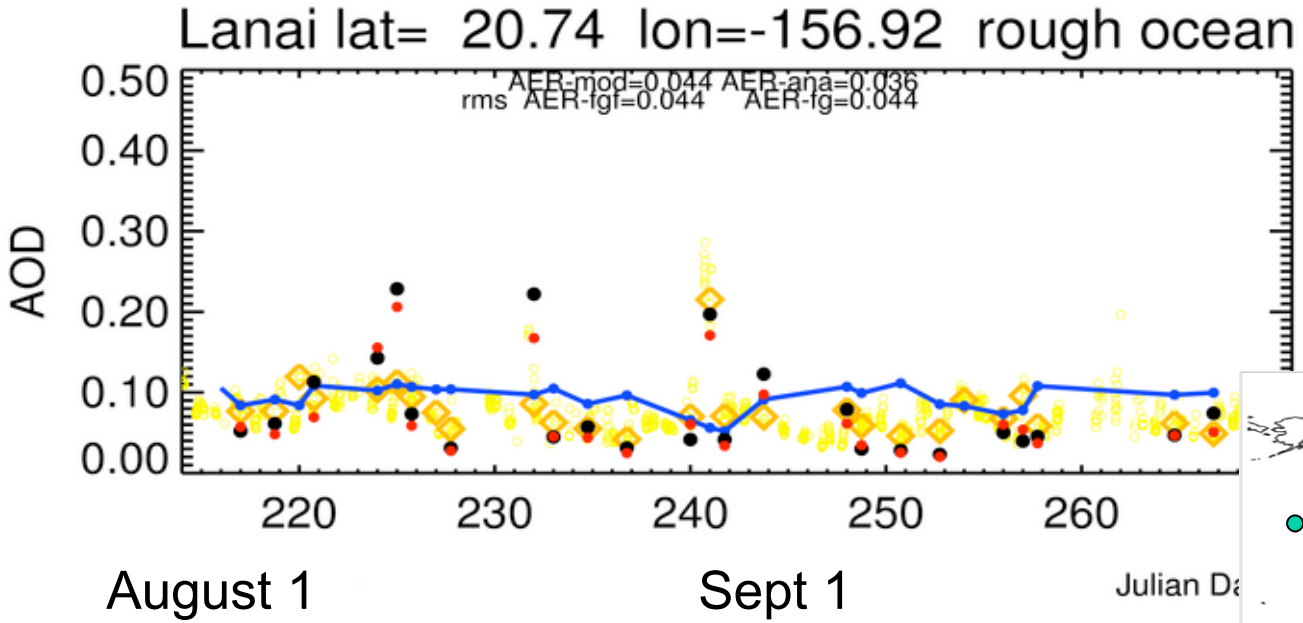


GOCART Retrieval ω_o vs AERONET

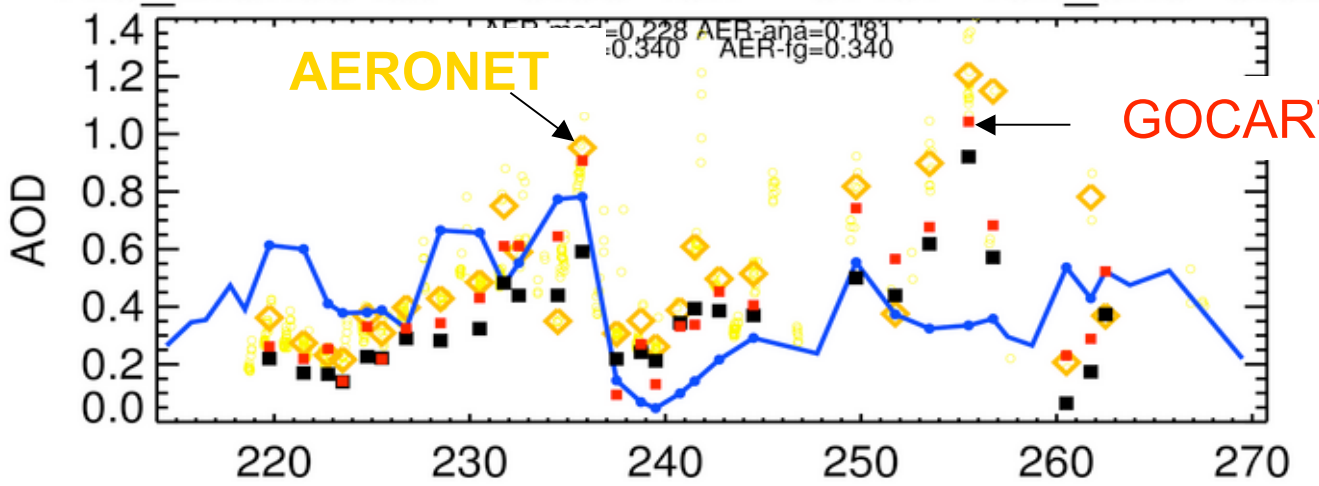


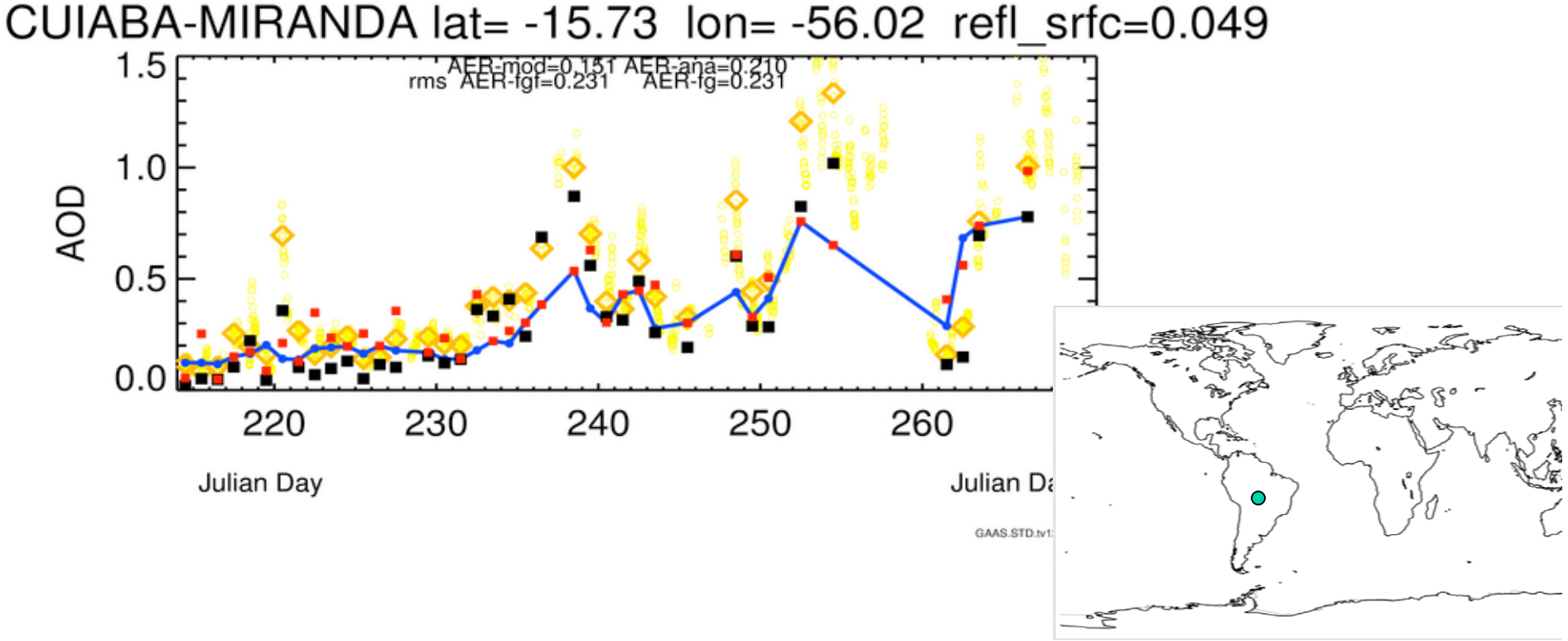
Rough OCEAN retrieval

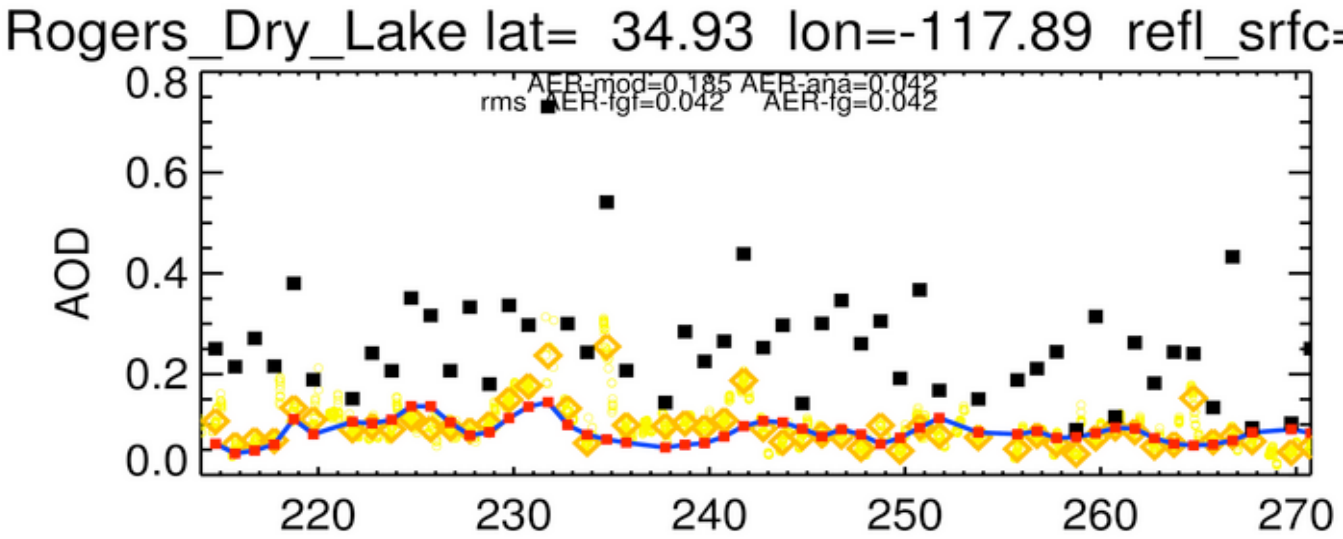




Land retrieval



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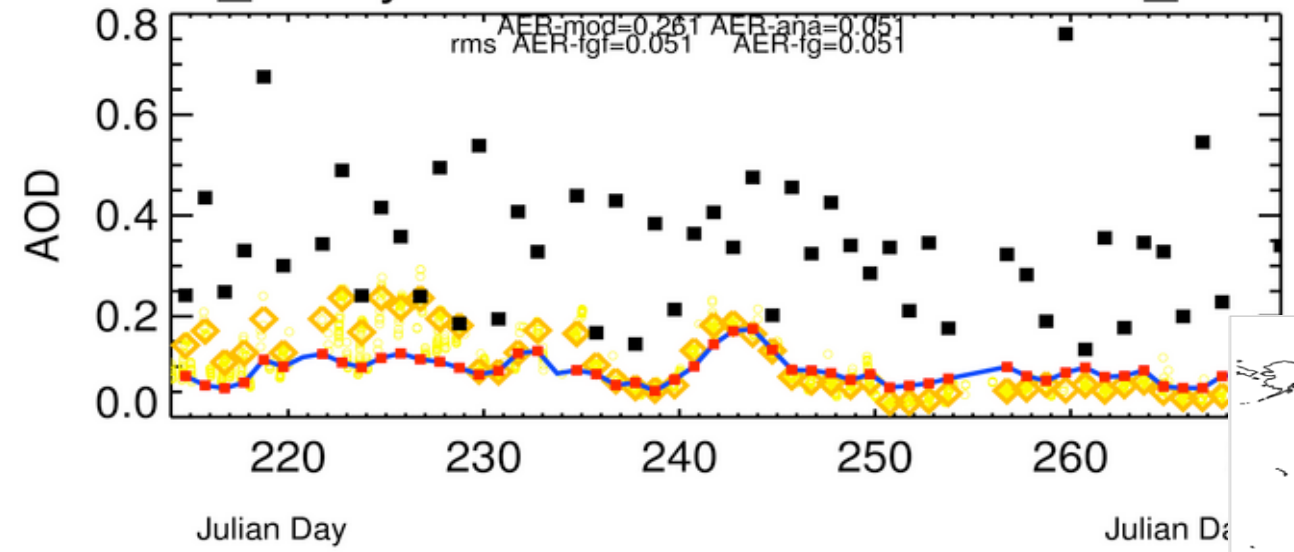
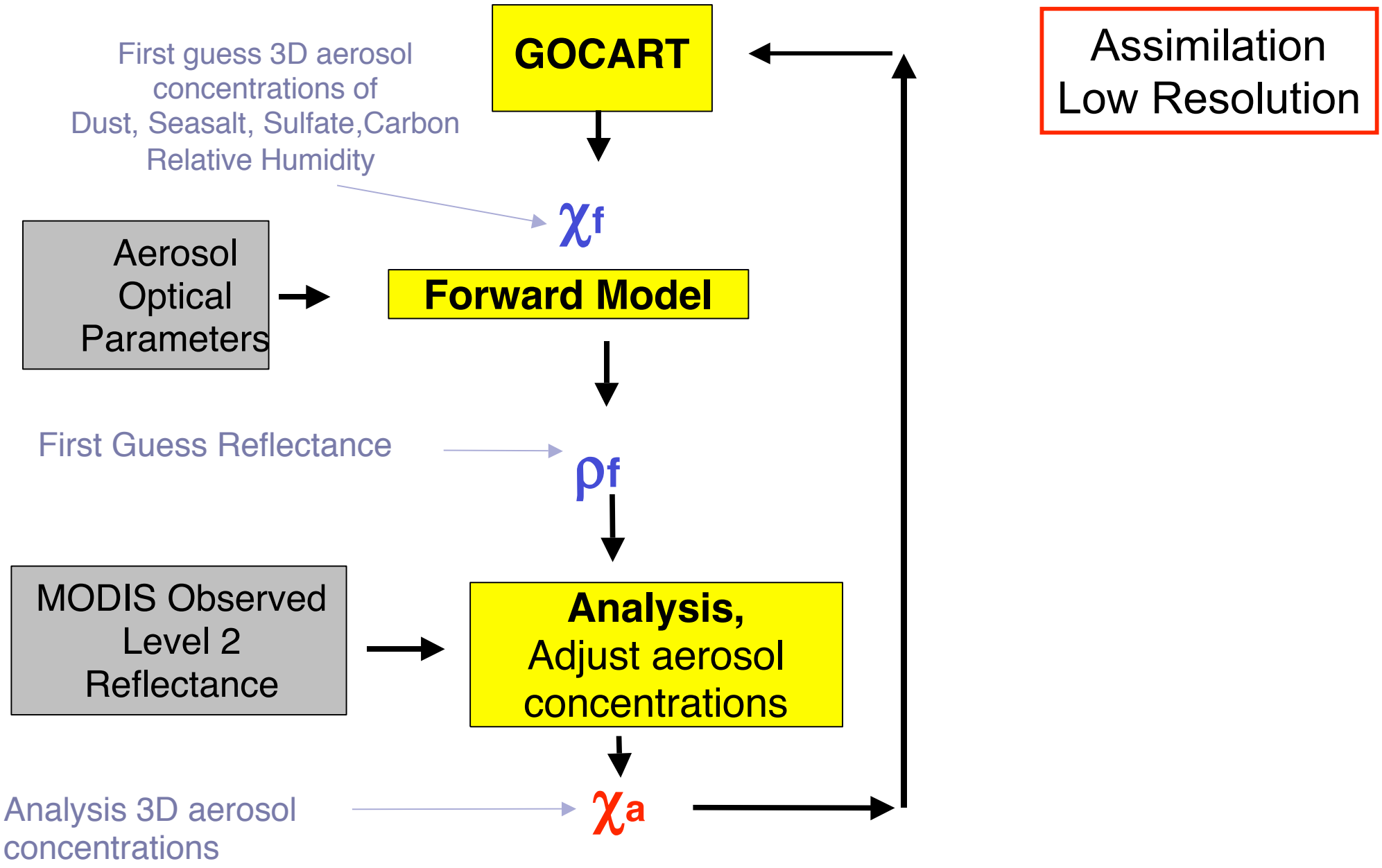
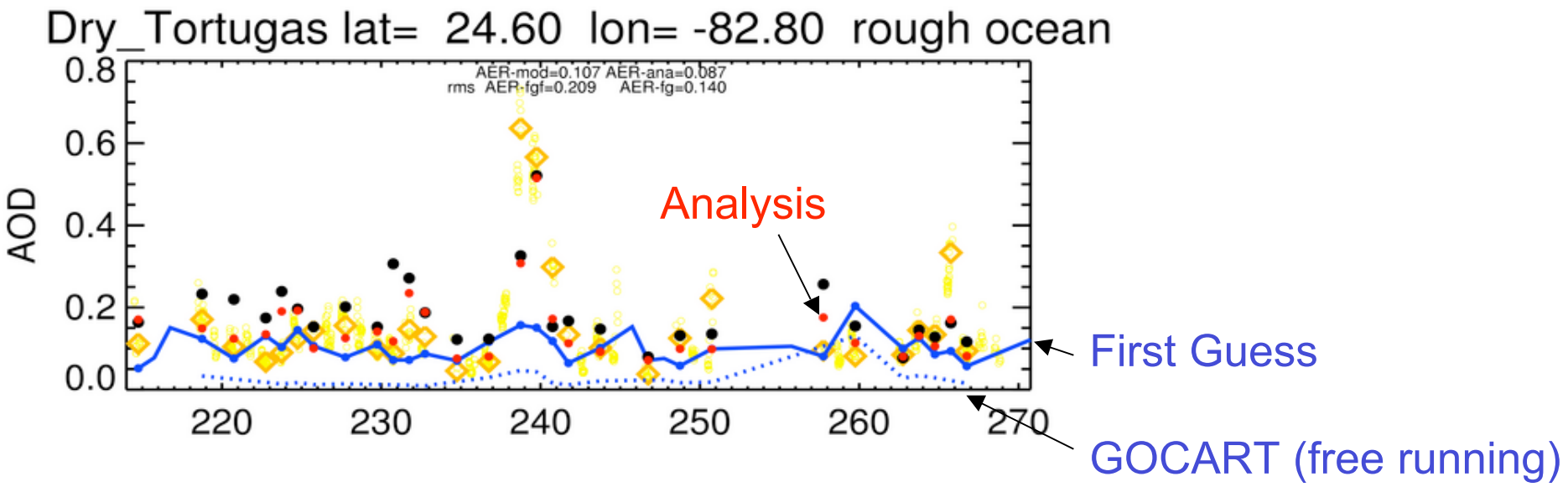
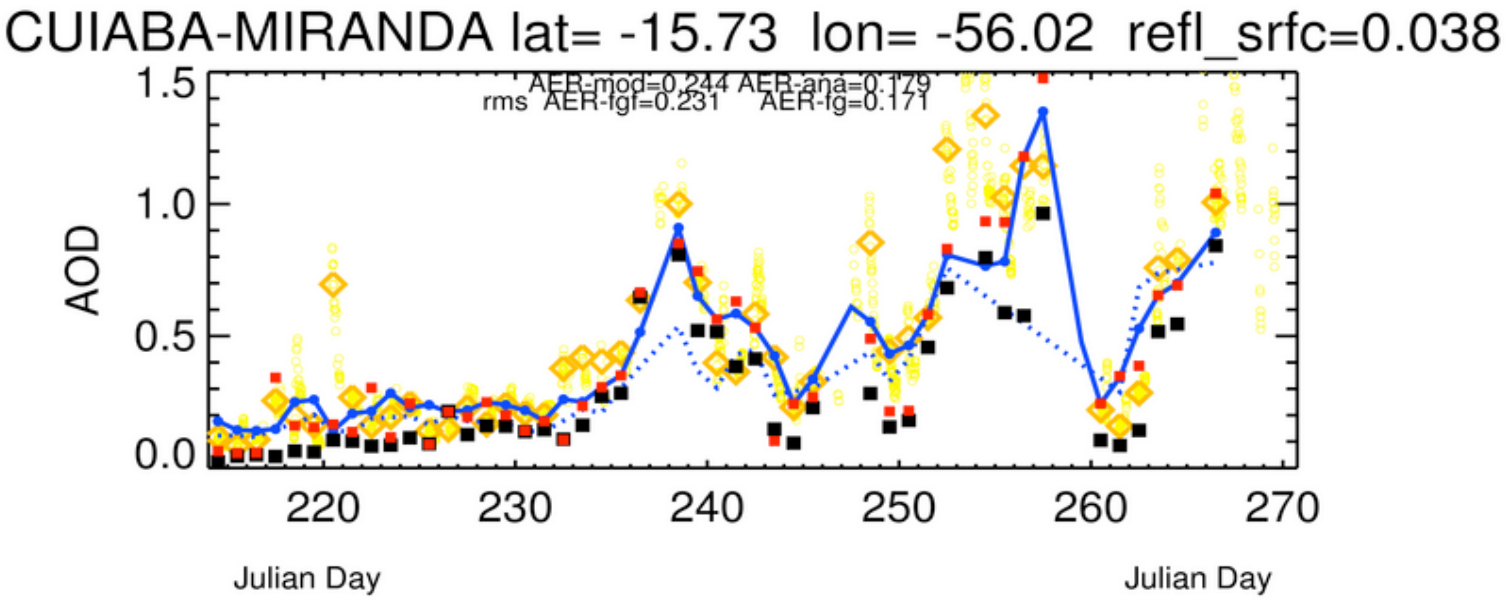
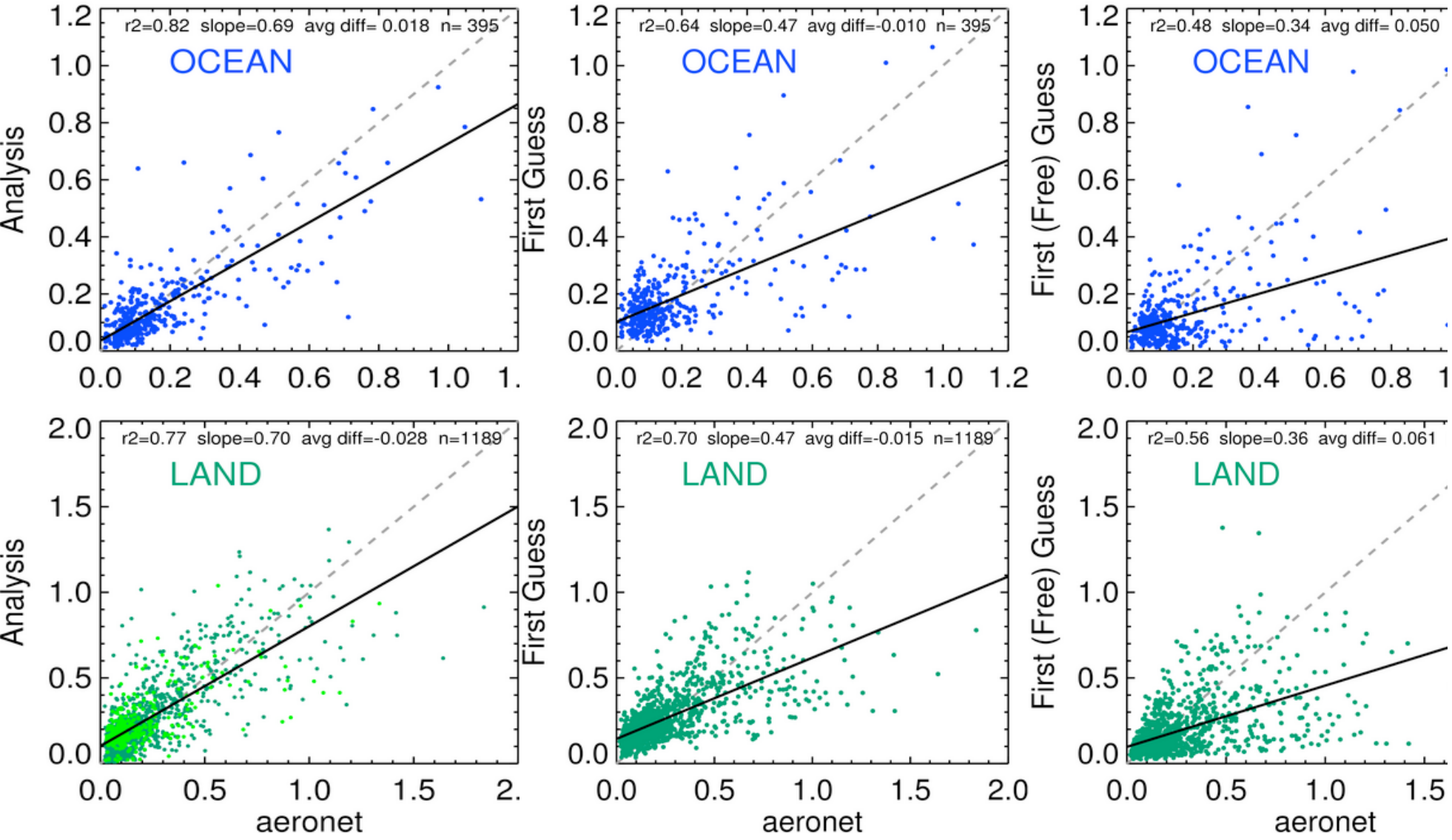
AER-mod=0.185 AER-ana=0.042
rms AER-fgf=0.042 AER-fg=0.042
AOD
0.0
0.2
0.4
0.6
0.8
220
230
240
250
260
270


Railroad_Valley lat= 38.50 lon=-115.96 refl_srfc=0.059
AER-mod=0.261 AER-ana=0.051
rms AER-fgf=0.051 AER-fg=0.051
AOD
0.0
0.2
0.4
0.6
0.8
220
230
240
250
260
Julian Day
Julian Da
GAAS.STD.tv1


GOCART
Assimilation
Low Resolution
First guess 3D aerosol
concentrations of
Dust, Seasalt, Sulfate,Carbon
Relative Humidity
χ_f
Aerosol
Optical
Parameters
Forward Model
First Guess Reflectance
ρ_f
MODIS Observed
Level 2
Reflectance
Analysis,
Adjust aerosol
concentrations
Analysis 3D aerosol
concentrations
χ_a


Dry_Tortugas lat= 24.60 lon= -82.80 rough ocean
AER-mod=0.107 AER-ana=0.087
rms AER-fgf=0.209 AER-fg=0.140
AOD
0.0
0.2
0.4
0.6
0.8
220
230
240
250
260
270
Analysis
First Guess
GOCART (free running)


CUIABA-MIRANDA lat= -15.73 lon= -56.02 refl_srfc=0.038
AER-mod=0.244 AER-ana=0.179
rms AER-fgf=0.231 AER-fg=0.171
AOD
0.0
0.5
1.0
1.5
220
230
240
250
260
270
Julian Day
Julian Day

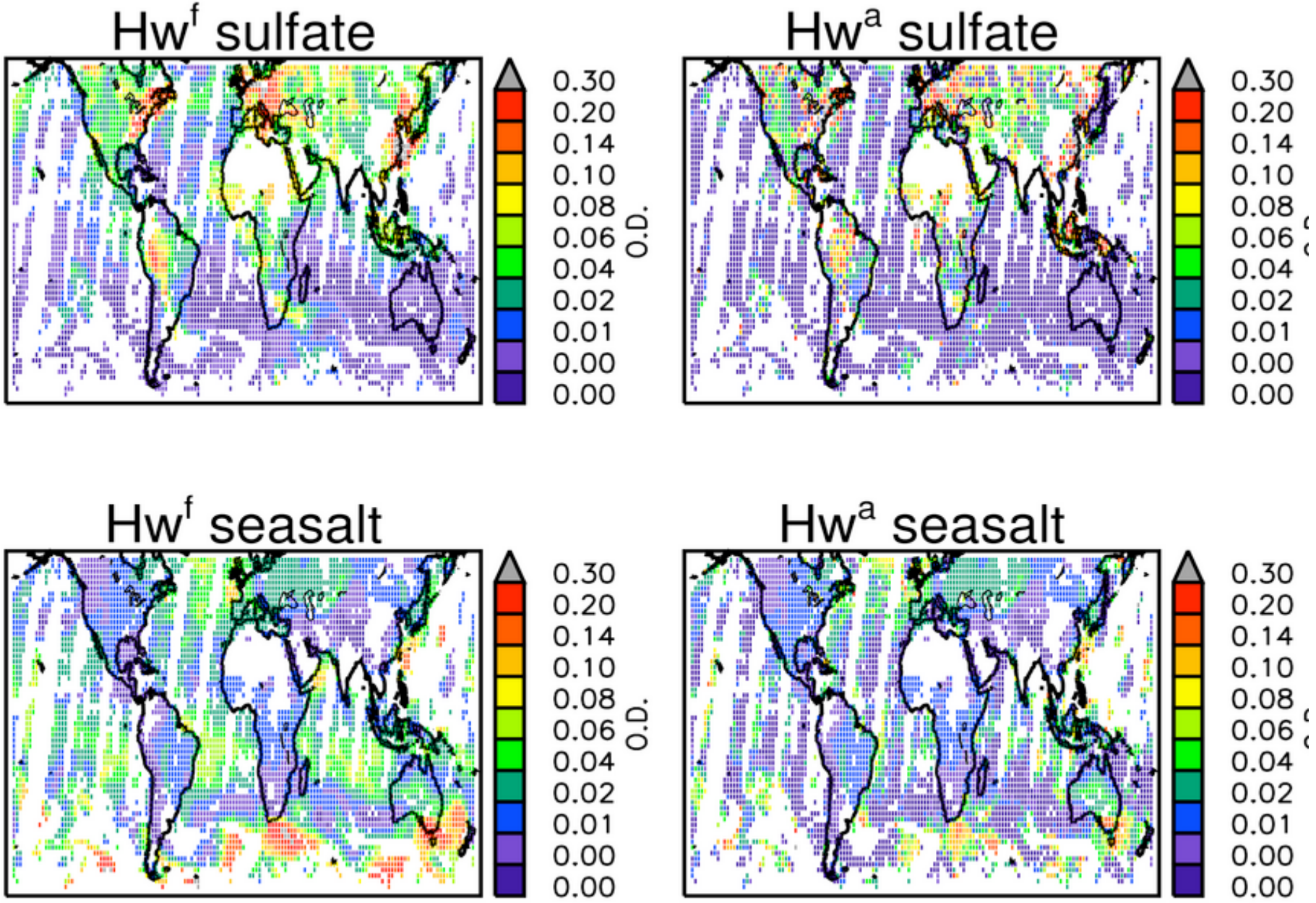


MODIS Radiances just inserted

MODIS Radiances Inserted 6 hours ago

MODIS Radiances Never ever inserted

Land-440 Ocean-All



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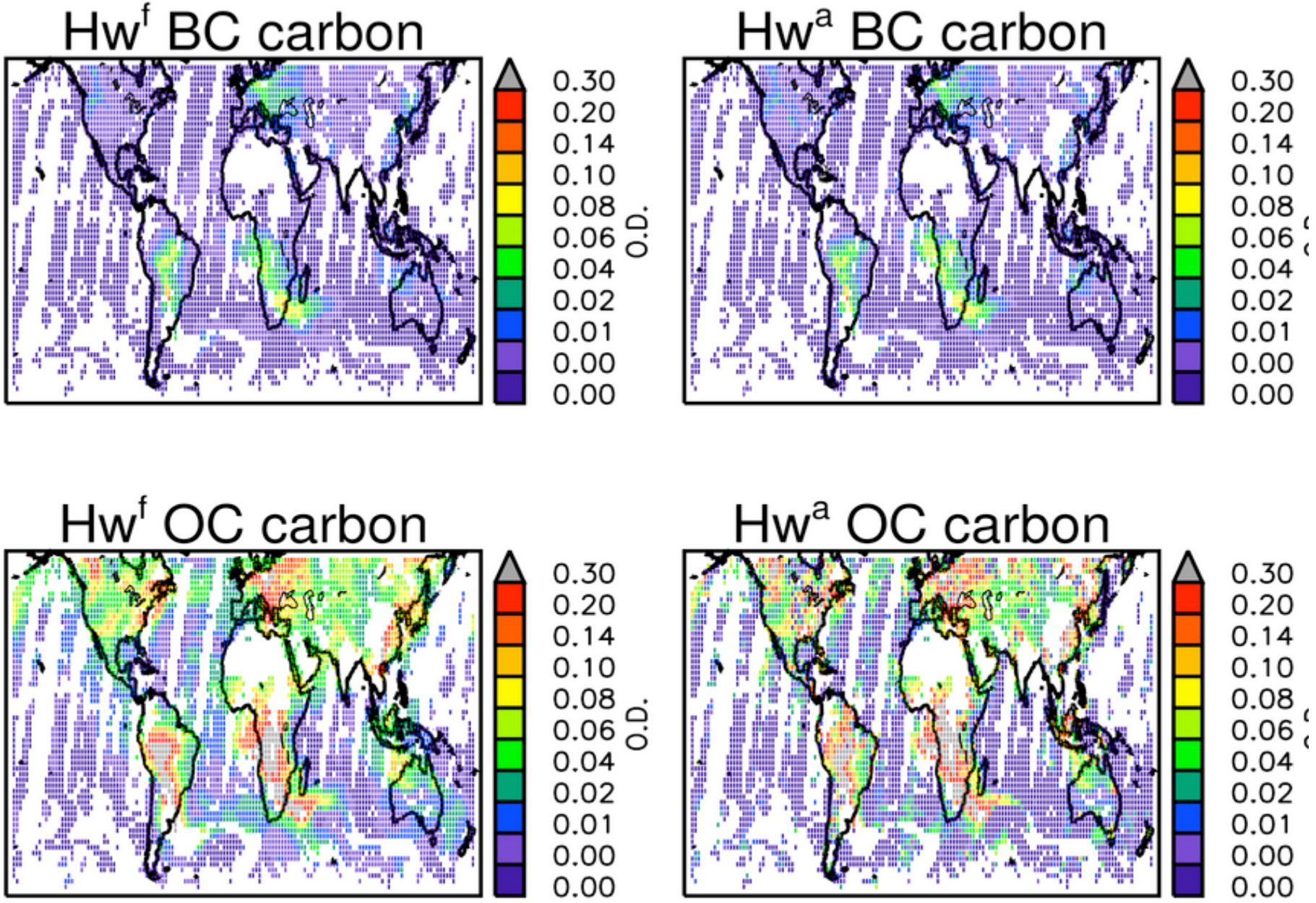
Land-440 Ocean-All



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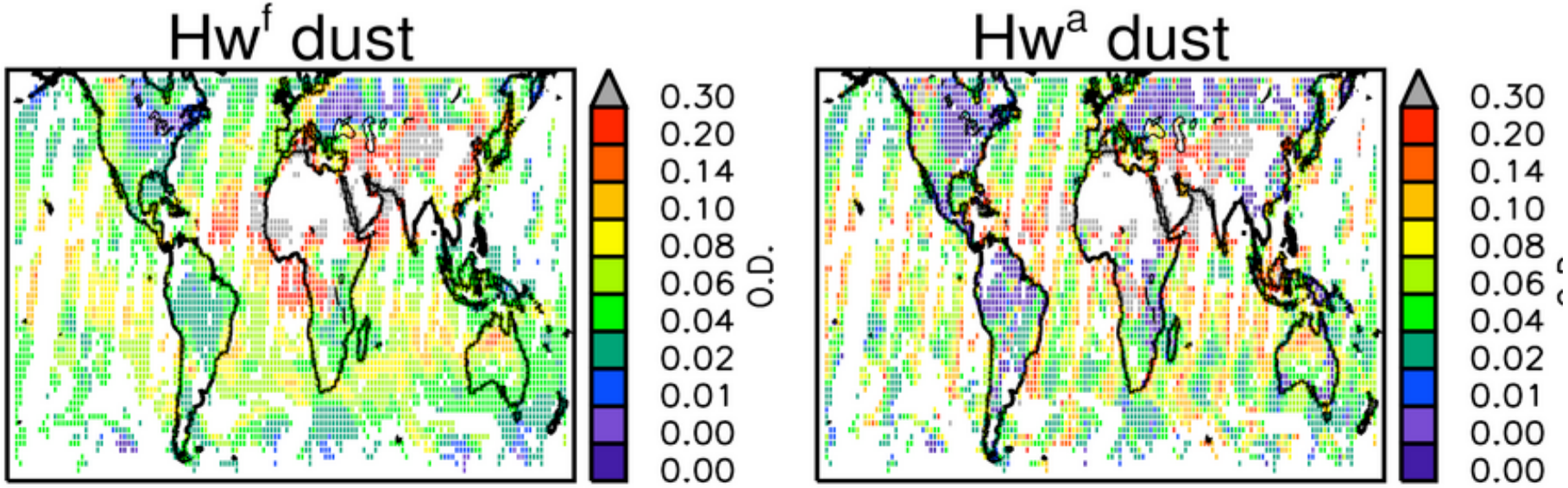
Land-440 Ocean-All



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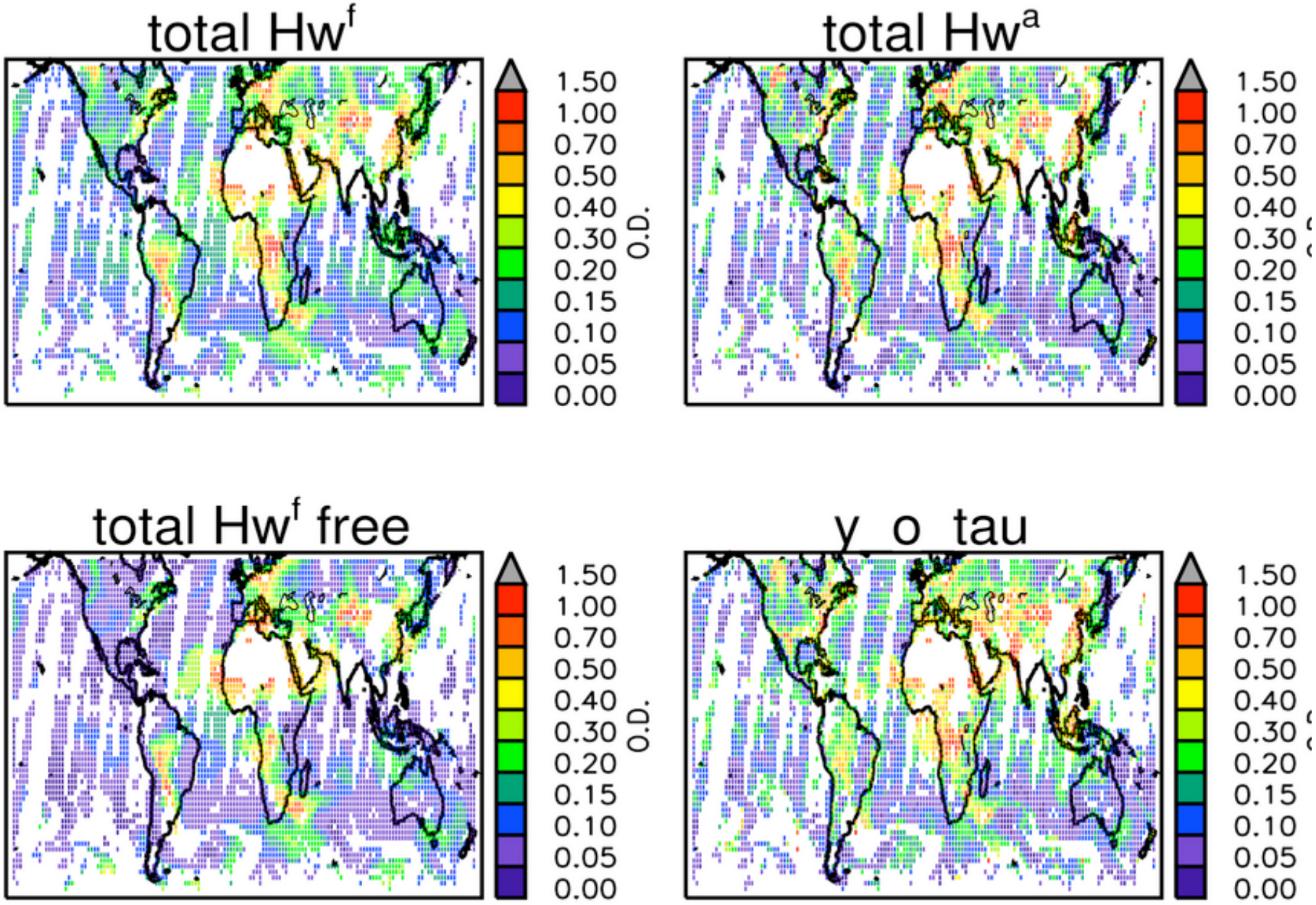
Land-440 Ocean-All



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Comments

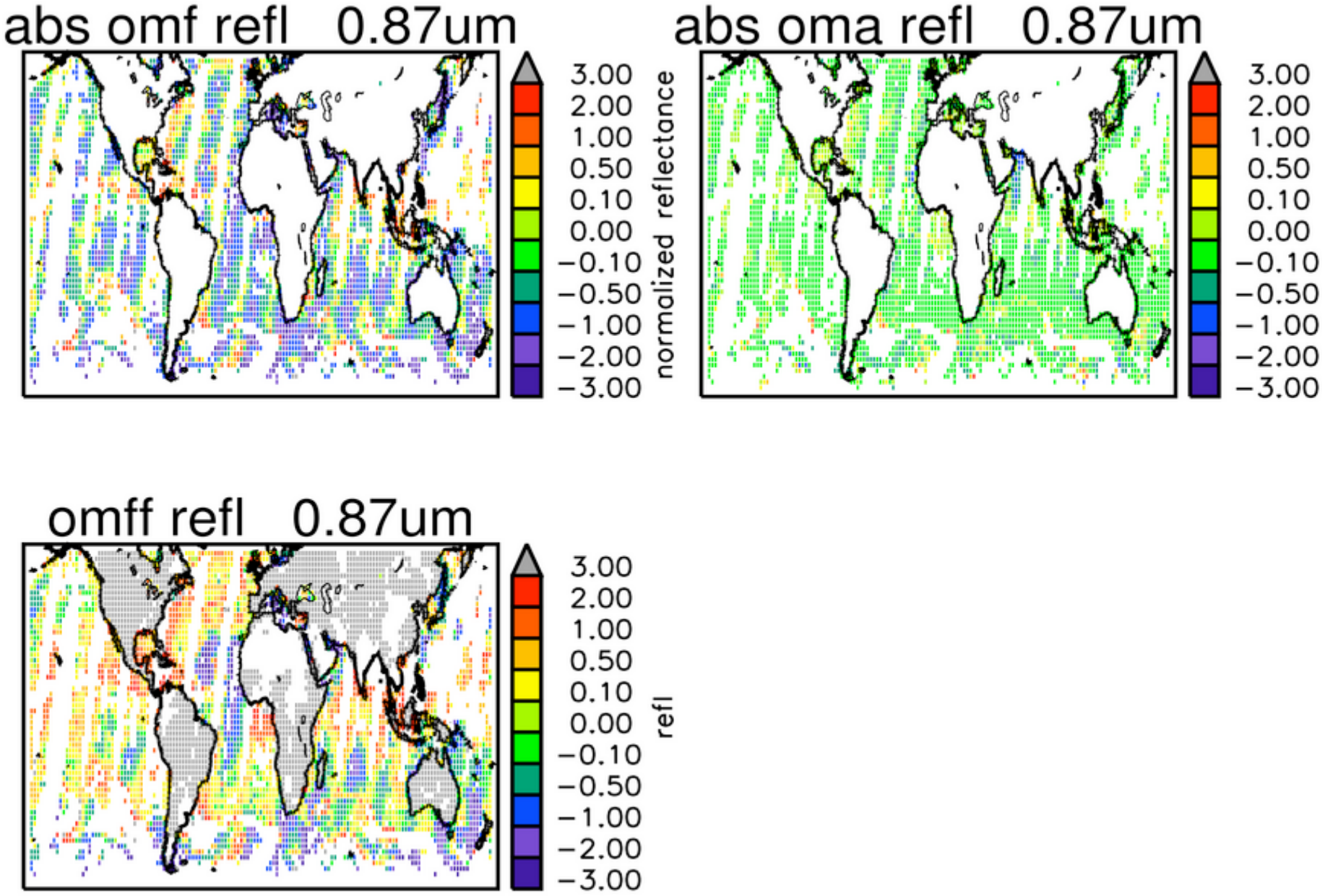
Developed Simple Aerosol Assimilation System for MODIS Radiances

Inserting MODIS radiances brings GOCART model closer to AERONET

Problems:

Surface reflectance
Black Carbon absorption
Data Retention

Land-440 Ocean-All



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