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Global Maps of Aerosol Single Scattering Albedo using Combined CERES-MODIS Retrievals

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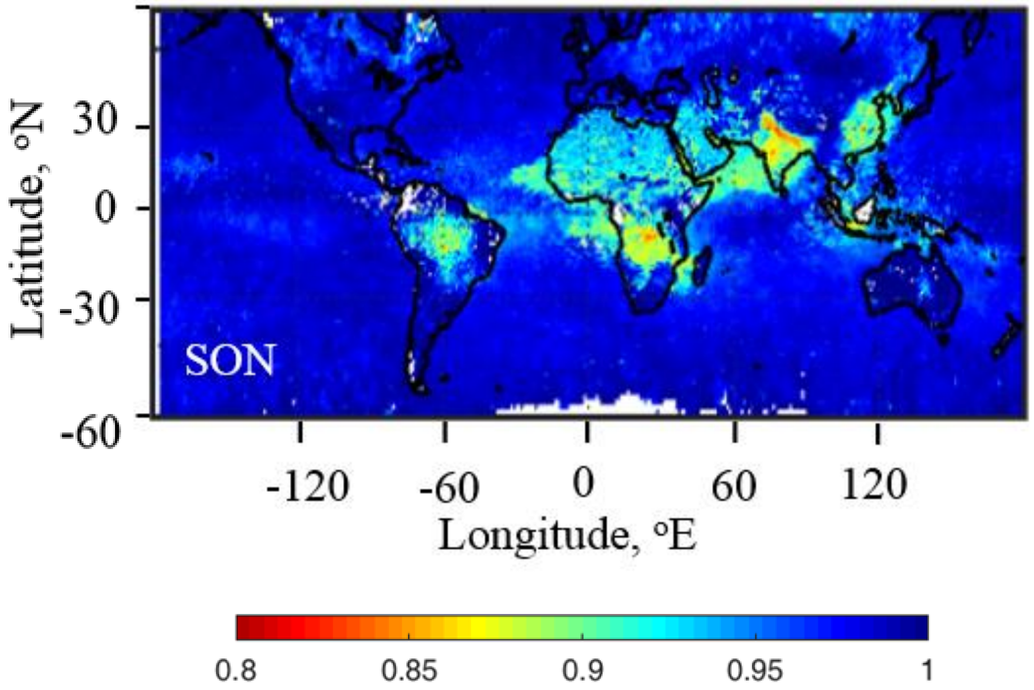
Objective and Overview

Objective

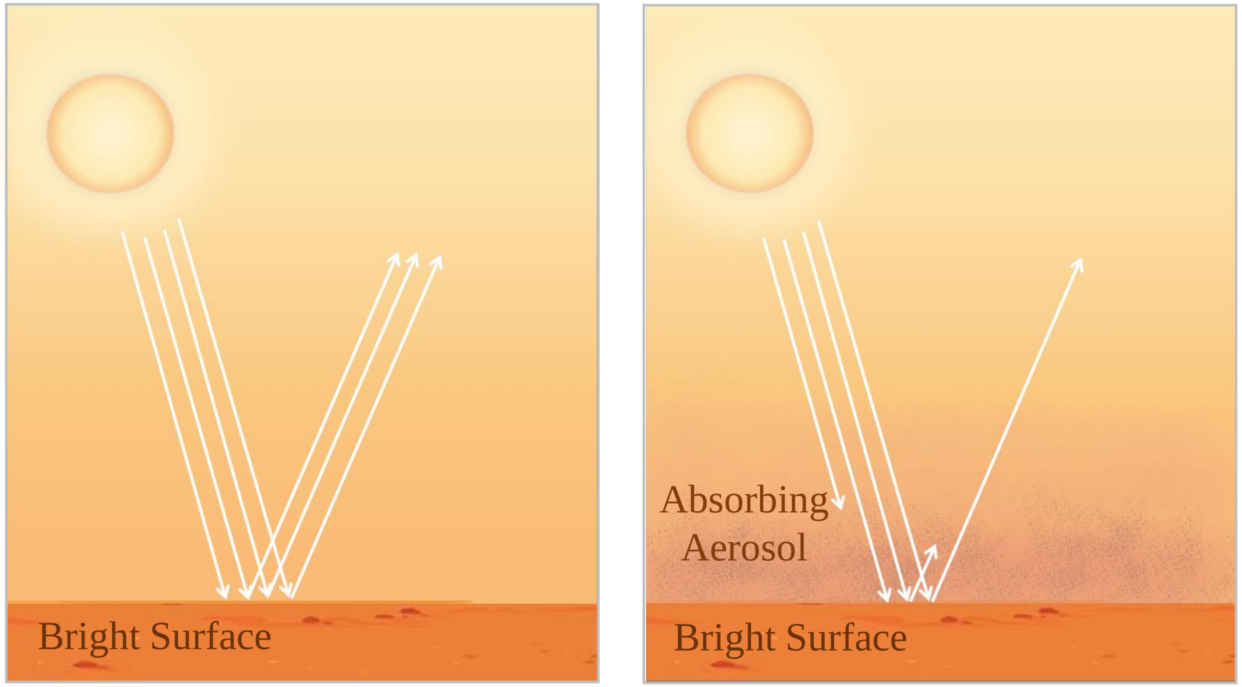
To generate global maps of aerosol single scattering albedo (SSA) using CERES-MODIS retrievals

- Introduction
- Critical optical depth
- Combined CERES-MODIS algorithm
- Results
  - Comparison with existing satellite datasets
  - Comparison with AERONET field data
  - Comparison with aircraft data
  - Uncertainty analysis

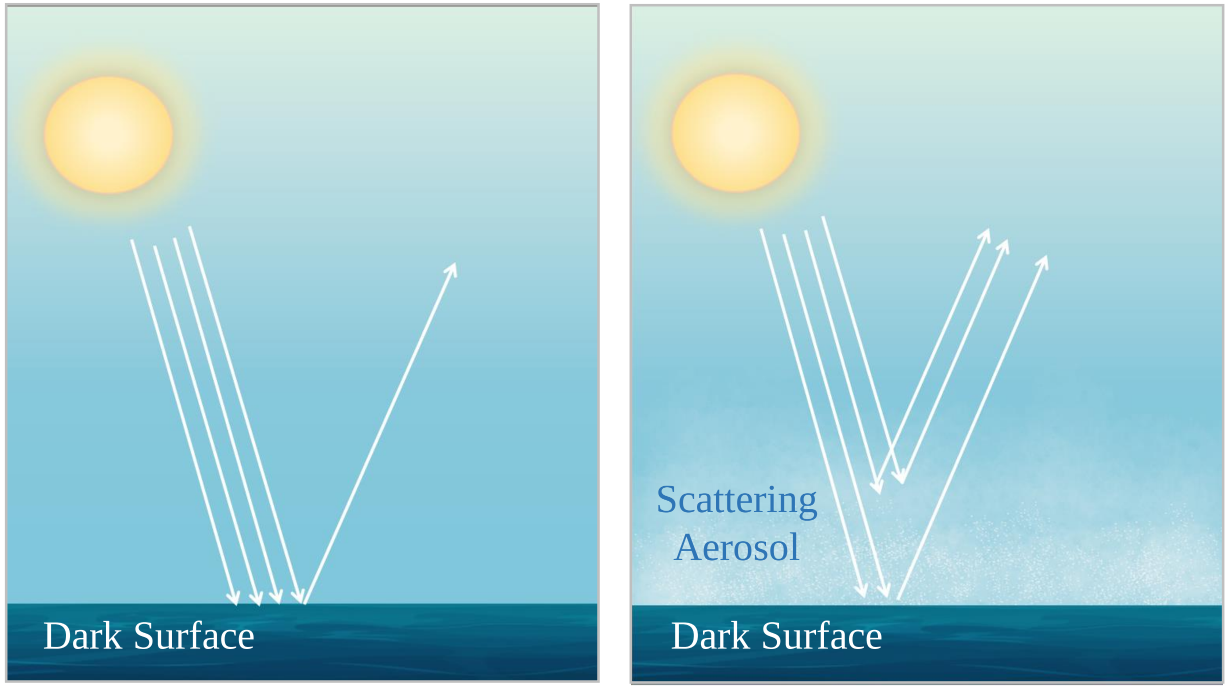


Effect of surface albedo

Absorbing aerosols above bright surface



Scattering aerosols above dark surface



Surface albedo and aerosol loading

MODIS Blue Marble

MODIS Aqua (07 Nov 2015)

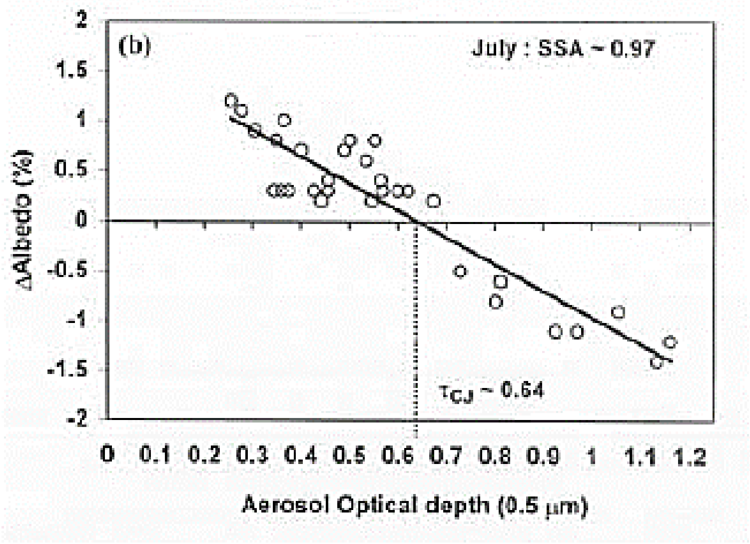
Critical Optical Depth (τ_c)

GEOPHYSICAL RESEARCH LETTERS, VOL. 32, L13814, doi:10.1029/2005GL023064, 2005

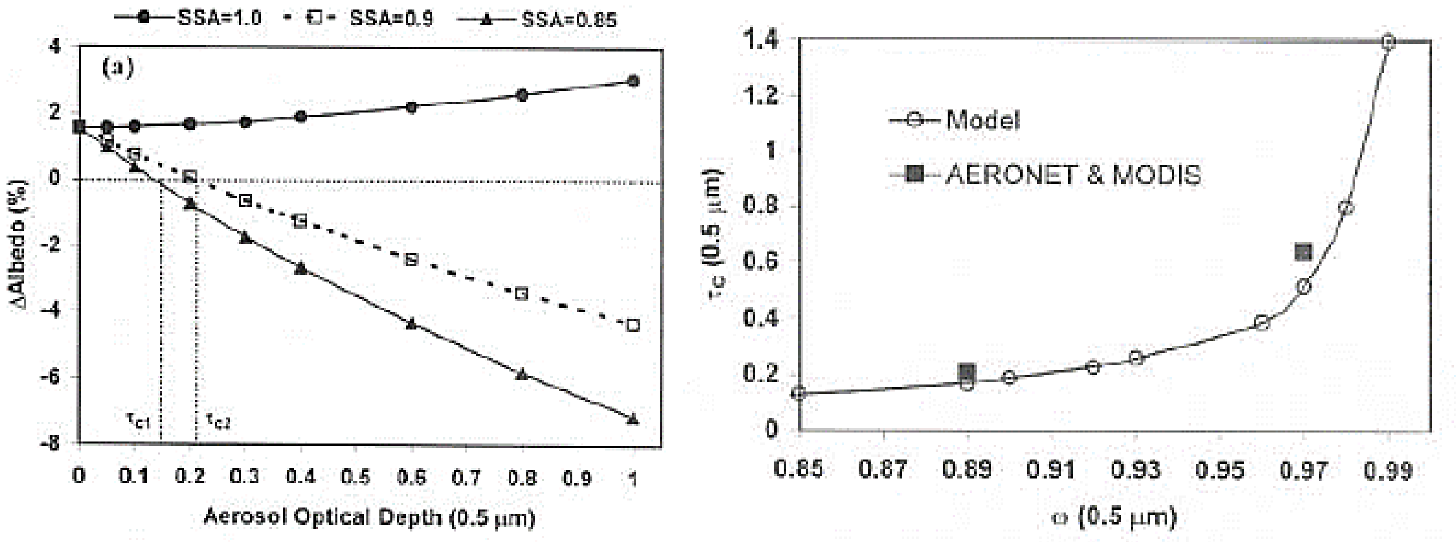
A method to infer short wave absorption due to aerosols using satellite remote sensing

S. K. Satheesh and J. Srinivasan
Centre for Atmospheric and Oceanic Sciences, Indian Institute of Science, Bangalore, India

- Bright Surface
- Absorbing Aerosol



AERONET Measurements



SBDART Simulations

Data & RT code used

Data

Sensor	Satellite	Product	Data
CERES	Aqua and Terra	SYN1deg-Day Edition 4	TOA and surface fluxes
MODIS	Aqua and Terra	MxD08_D3 Version 6.1	Aerosol Optical Depth
			Water Vapour

Time Period of Study:	2014 – 2018
Spatial Resolution:	1^{o} x 1^{o}
Temporal Resolution:	Daily data

SBDART

Santa Barbara DISORT Atmospheric Radiative Transfer

Important Input Parameters	
Wavelength Range	0.3 – 5 microns
Cloud optical depth	0
Asymmetry Parameter	*Aerosol Model (OPAC)*
Angstrom Exponent	*Aerosol Model (OPAC)*

Output

Wavelength integrated:

- TOA upward flux
- TOA downward flux
- Surface upward flux
- Surface downward flux

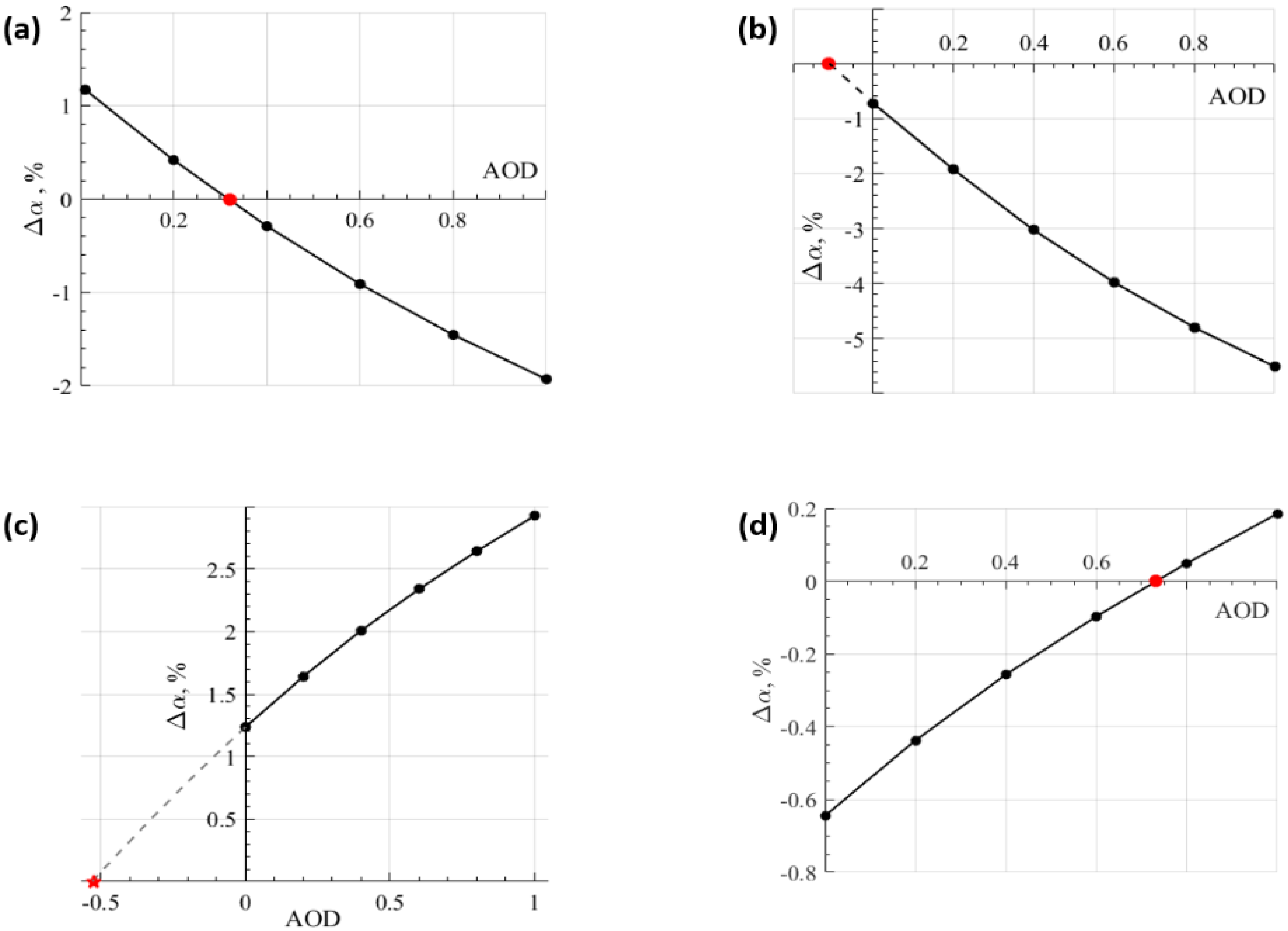
Critical Optical Depth (τ_c)

Rel. Dark Surface

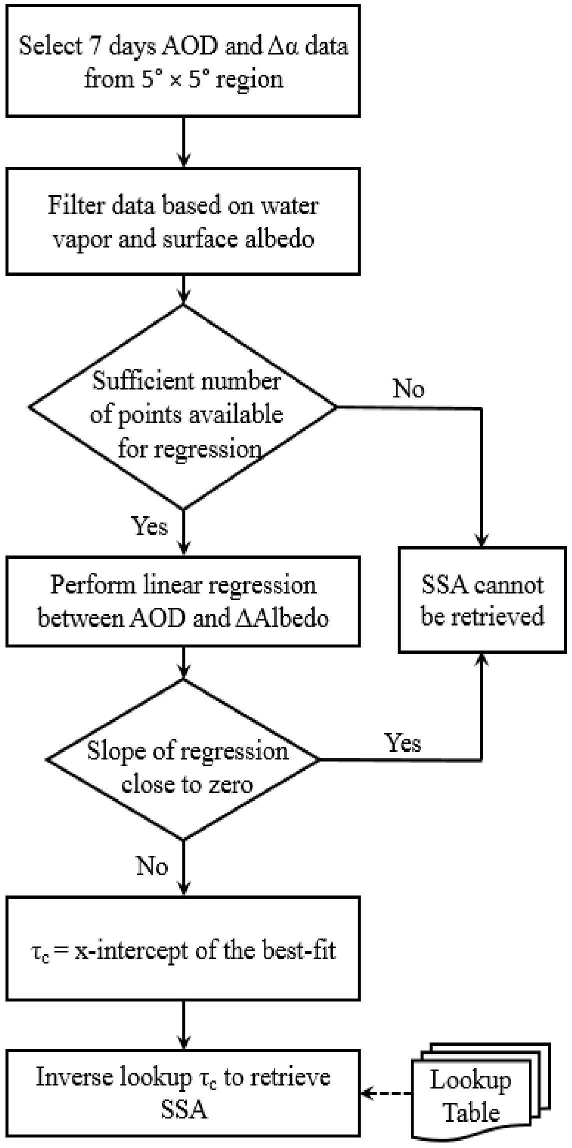
Rel. Bright Surface

Absorbing Aerosol

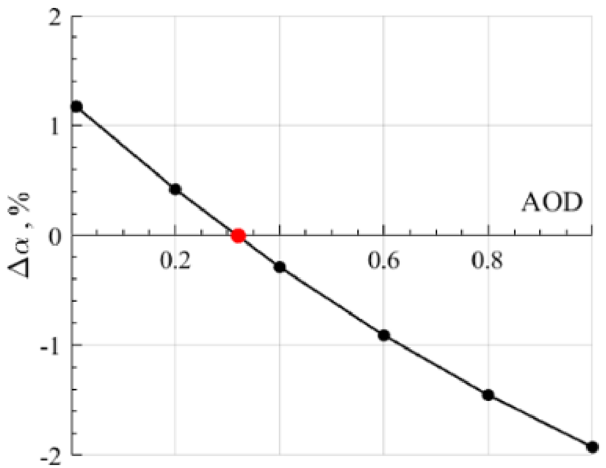
Scattering Aerosol



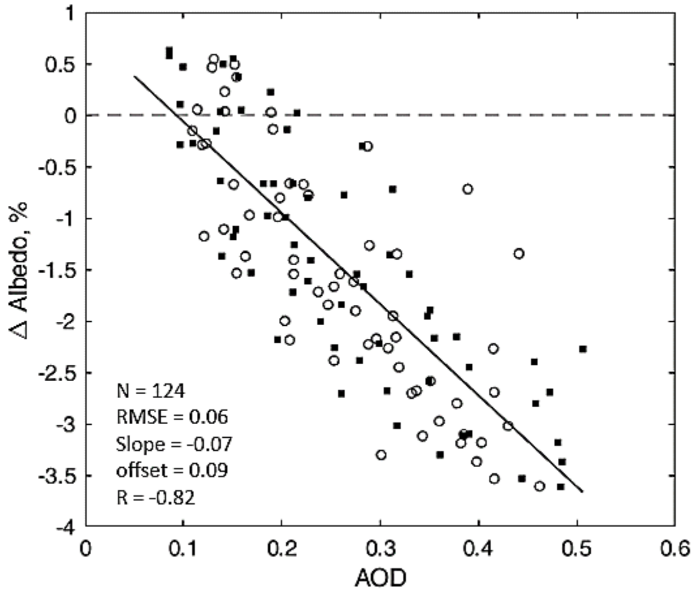
Combined CERES MODIS algorithm



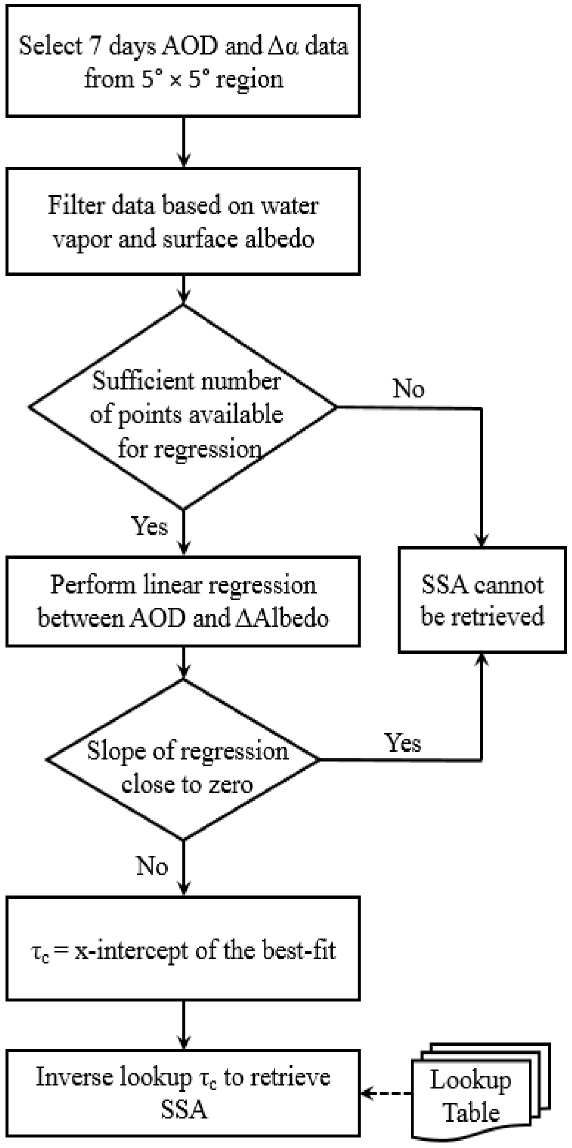
Radiative Transfer Simulations



Satellite Data

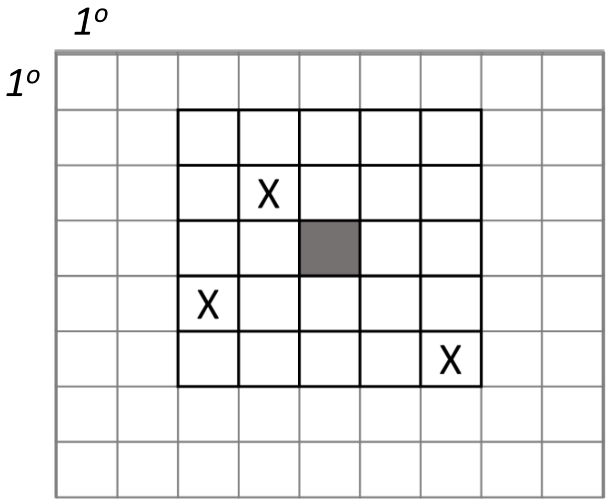


Obtain τ_c



Data points for correlation

Temporal:	7 days
Spatial:	5^o x 5^o grid around the pixel

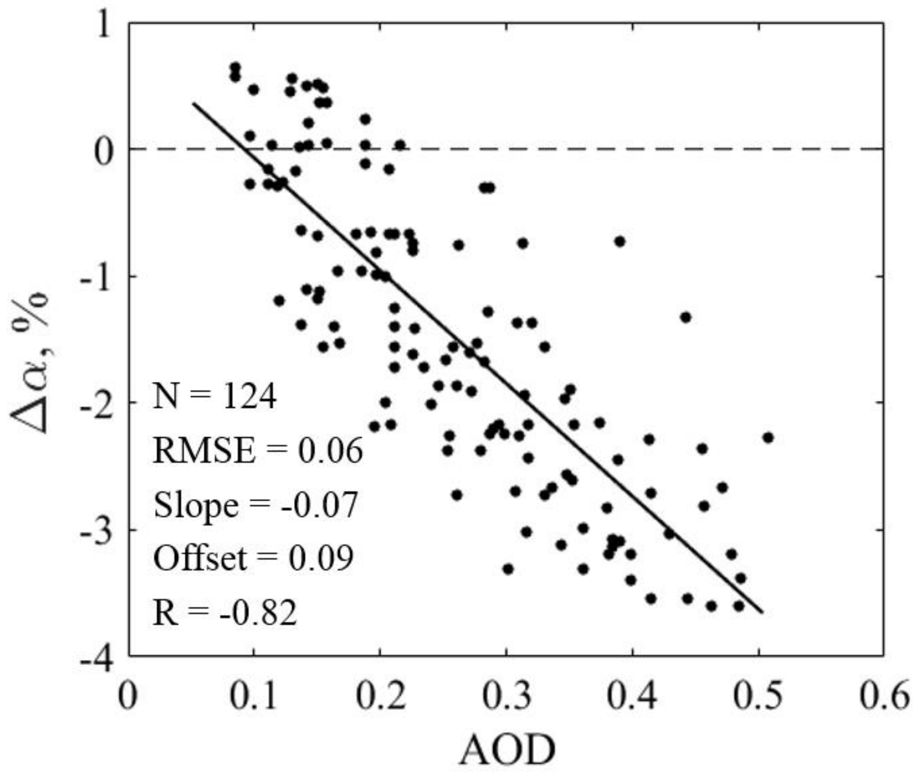


Filtering

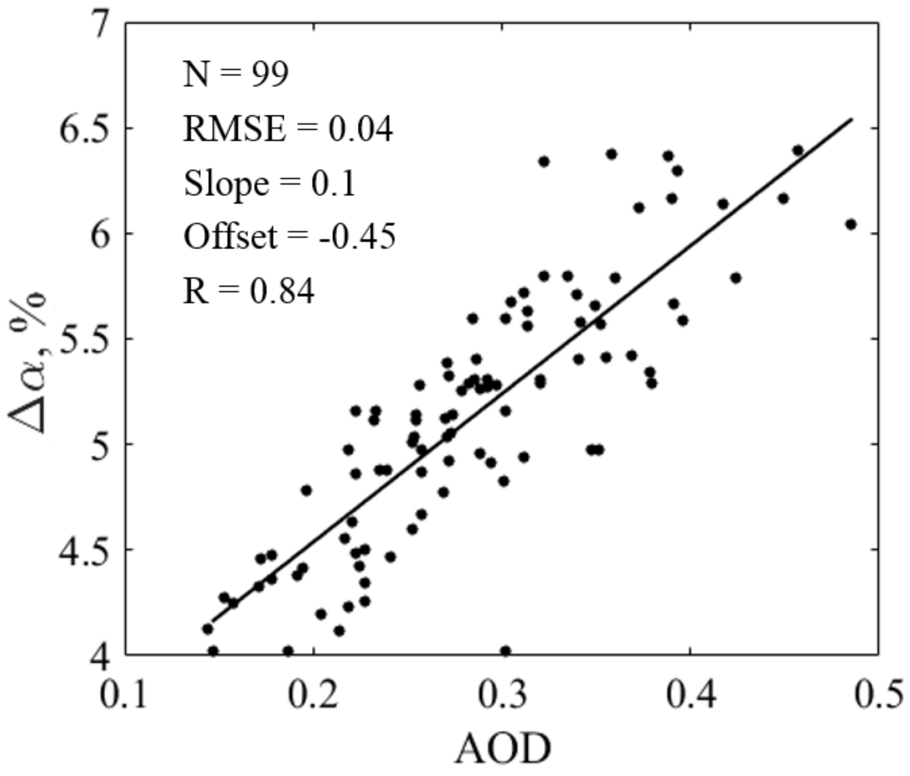
AOD	
SSA	
WV	± 0.25 cm
Surf Alb	± 0.025

Obtain τ_c

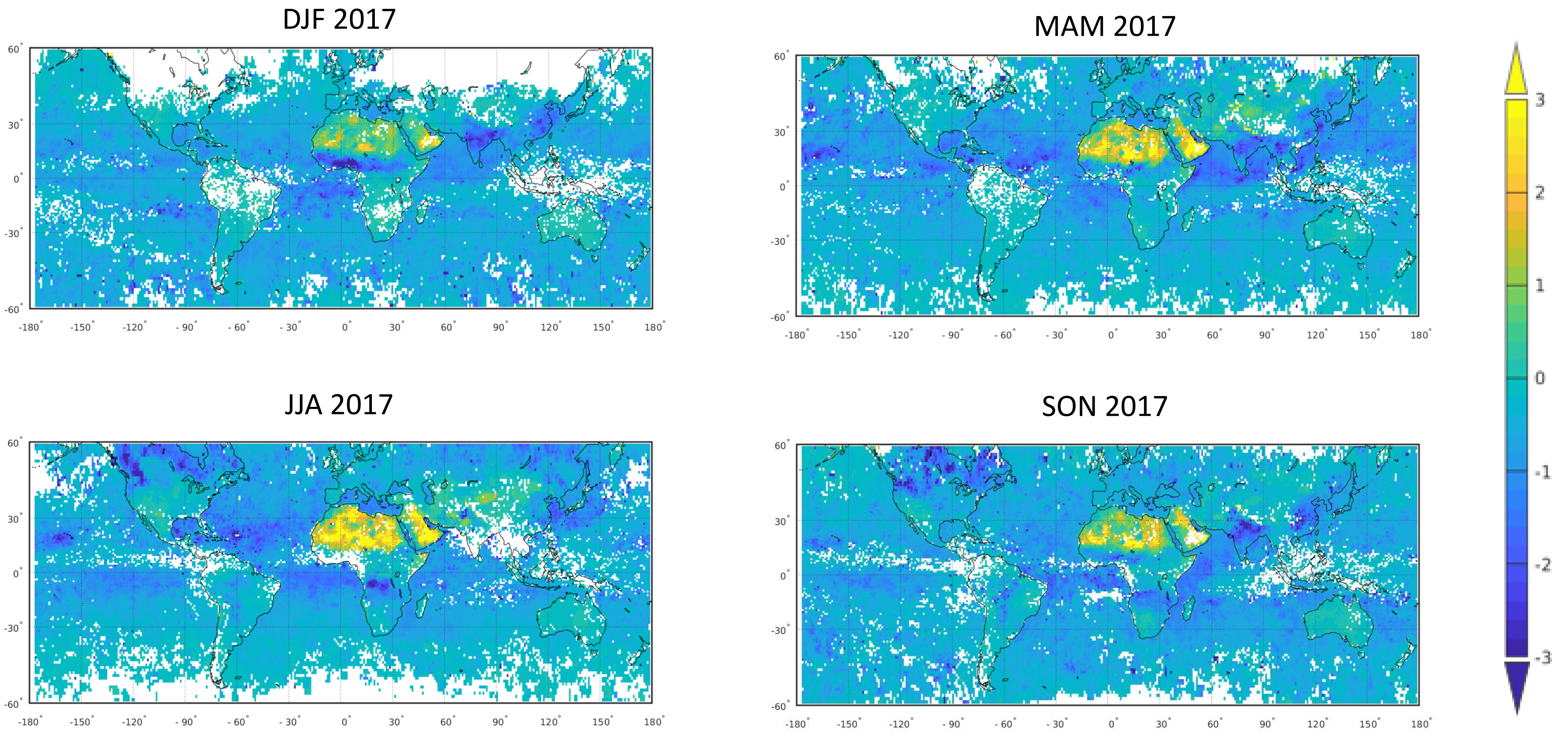
CERES – MODIS
Negative Correlation
Sahara



CERES – MODIS
Positive Correlation
Arabian Sea



τ_c maps

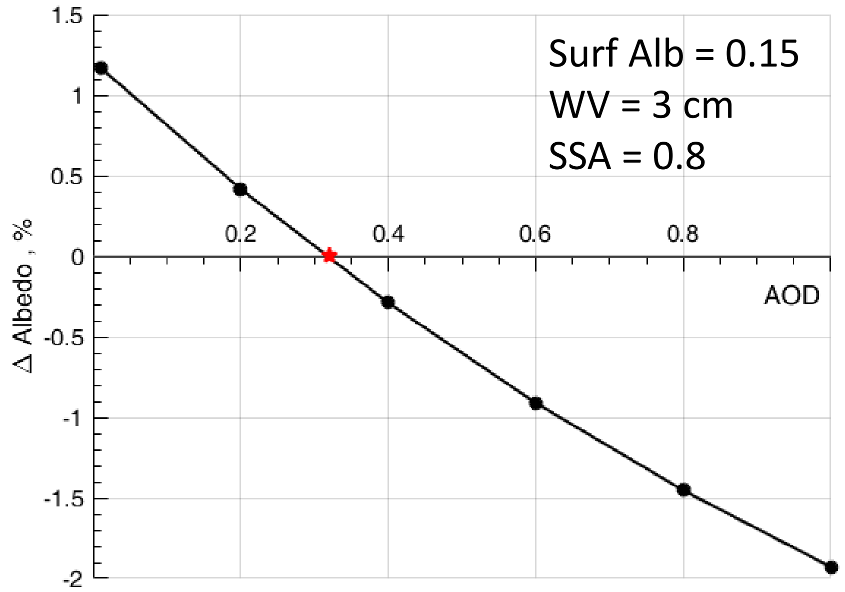


DJF 2017
MAM 2017
JJA 2017
SON 2017
60°
30°
0°
-30°
-60°
-180°
-150°
-120°
- 90°
- 60°
- 30°
0°
30°
60°
90°
120°
150°
180°
3
2
1
0
-1
-2
-3

Look up Table (LUT)

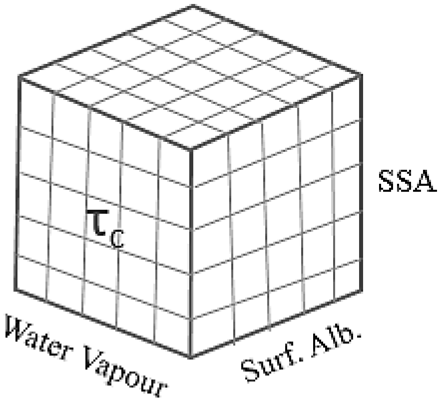
$$\tau_c = f(\text{Surface Albedo, Water Vapour, SSA})$$

Surface Albedo	0 to 0.5, increments of 0.05
Water Vapour	0 to 8 cm, increments of 0.5 cm
SSA	0.8, 0.83, 0.85, 0.87, 0.9, 0.92, 0.95, 0.97, 0.99, and 1
AOD	0 to 1, increments of 0.2
SZA	0^o to 84^o, increments of 12^o

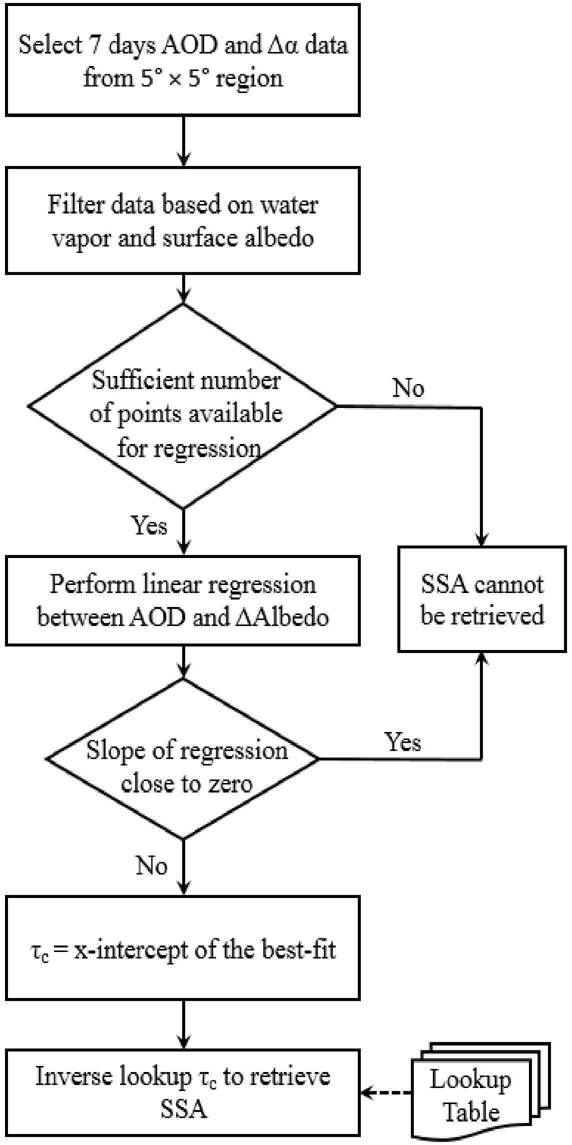


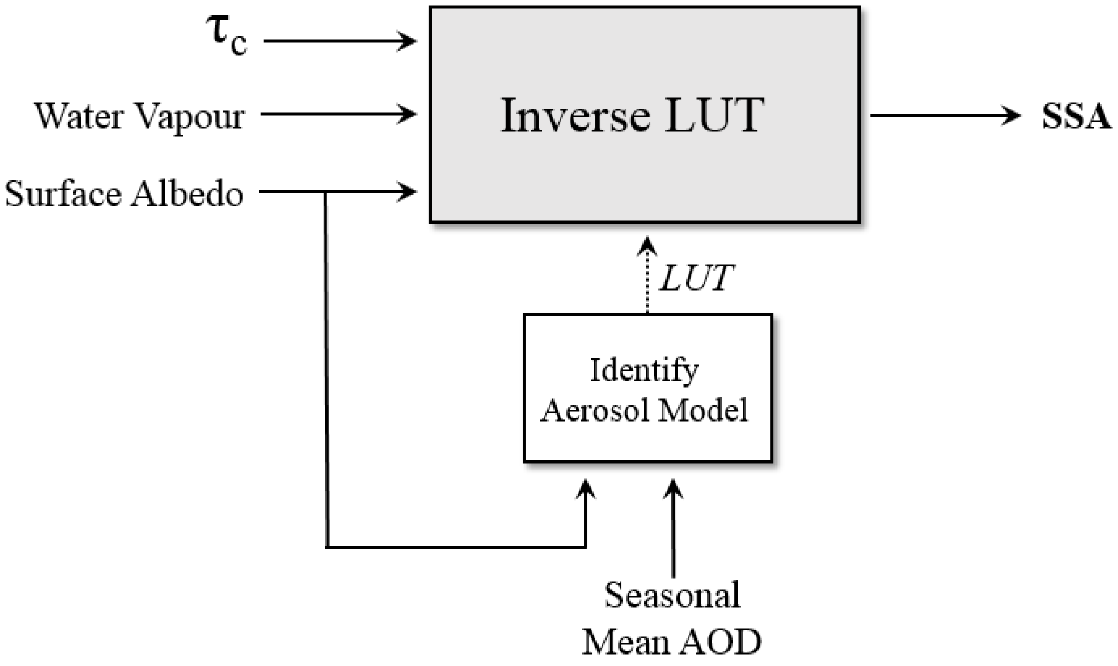
6 Aerosol Models X 11 Surface Albedo X 17 Water Vapour X 10 SSA X 6 AOD X 8 SZA

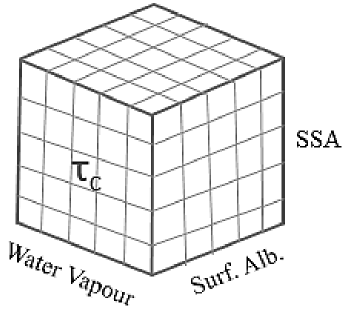
= 5,38,560 RT simulations



Inverse lookup

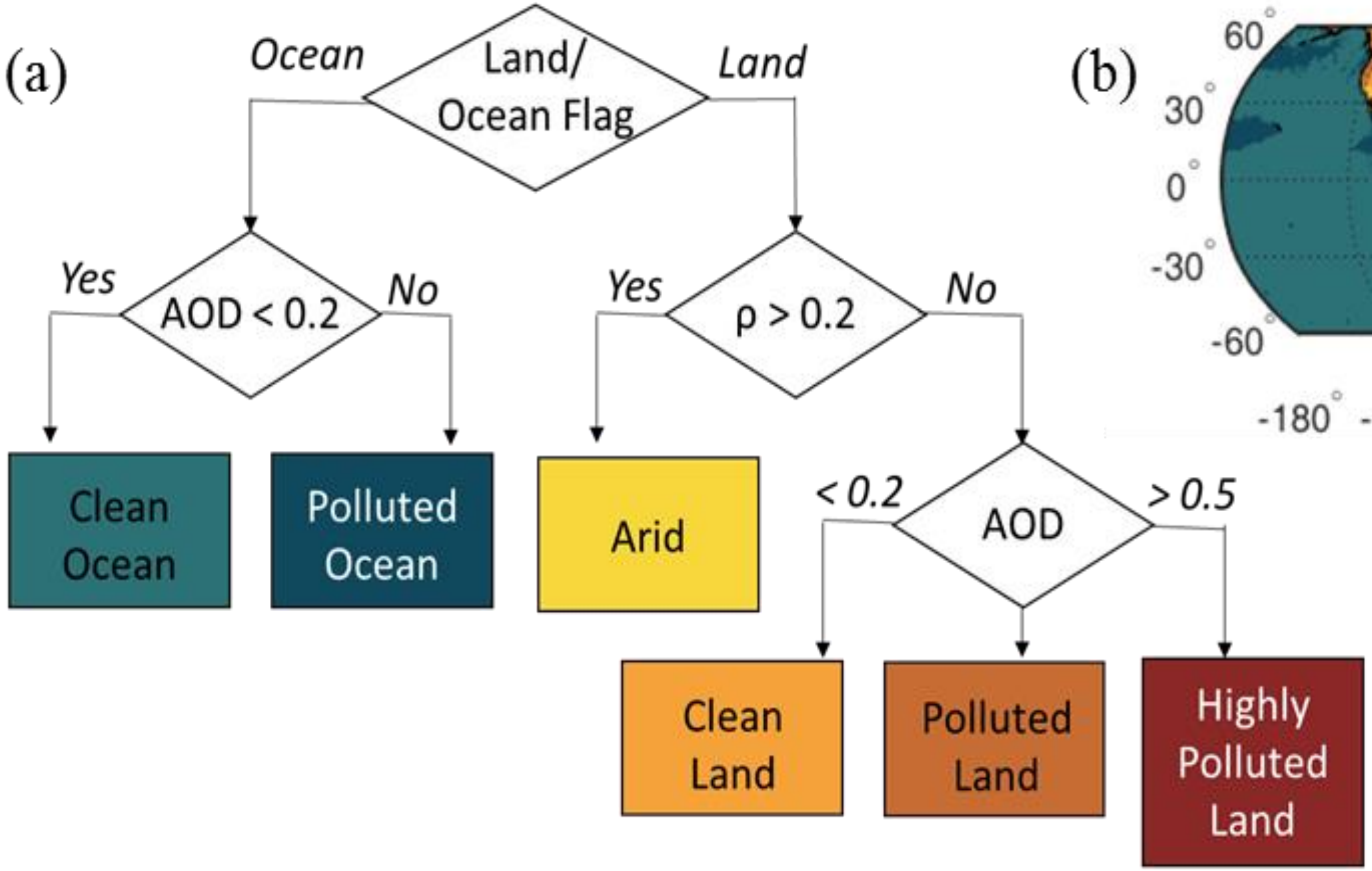




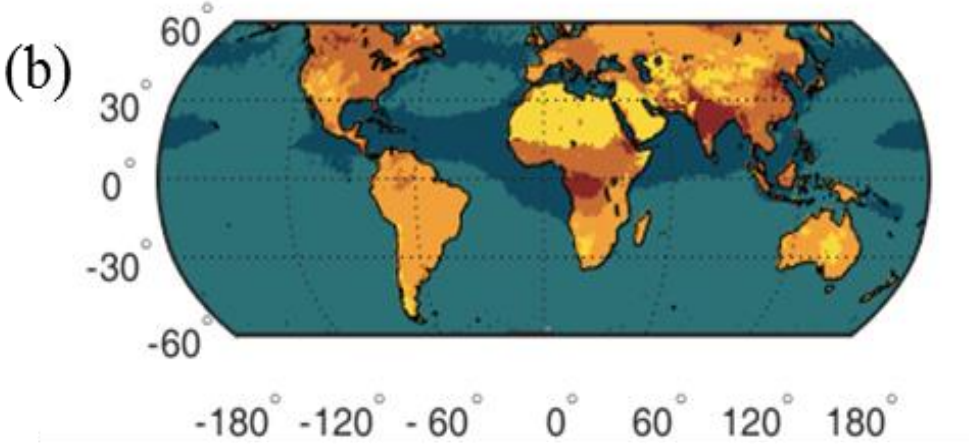


Aerosol model selection

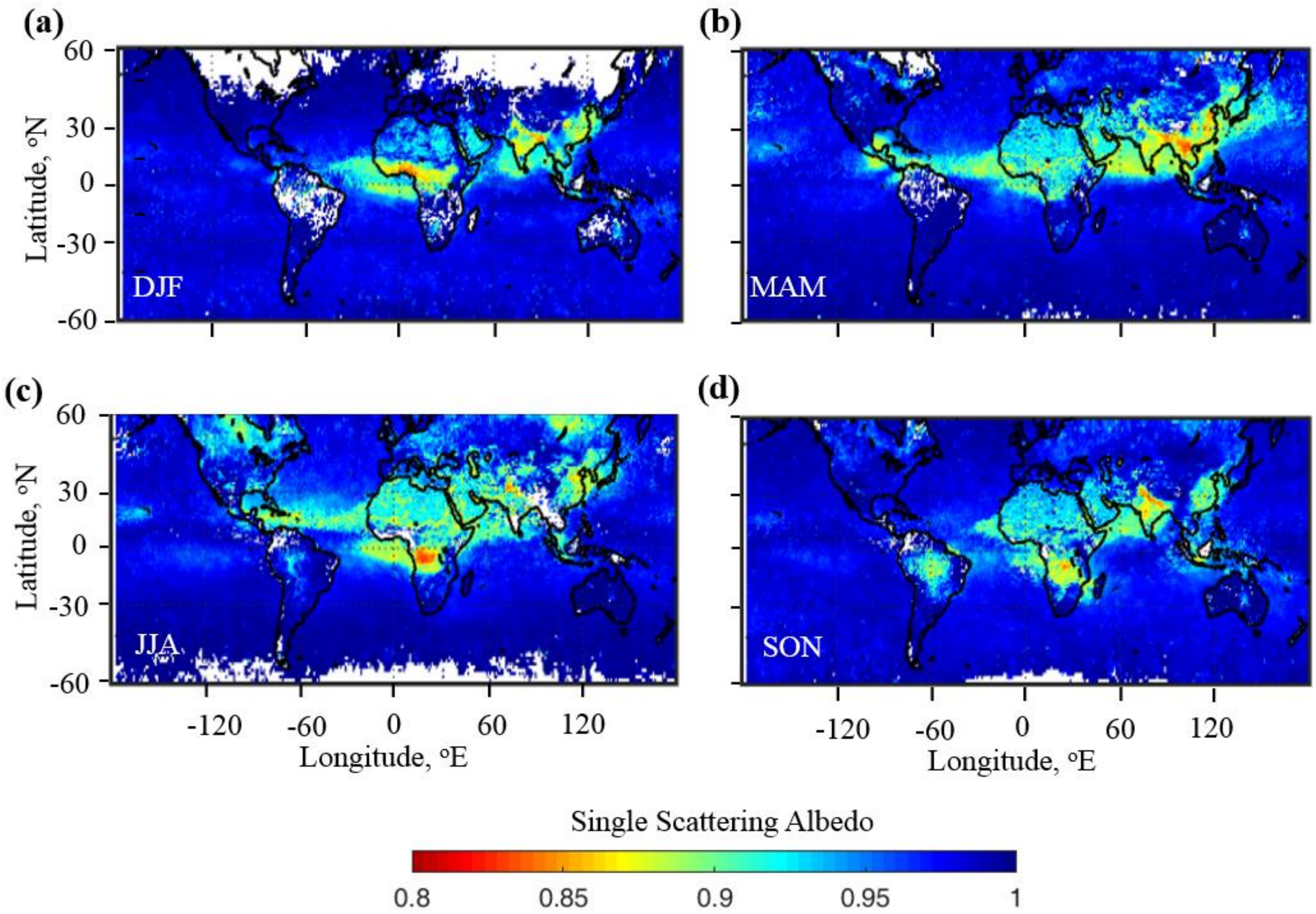
Decision Tree



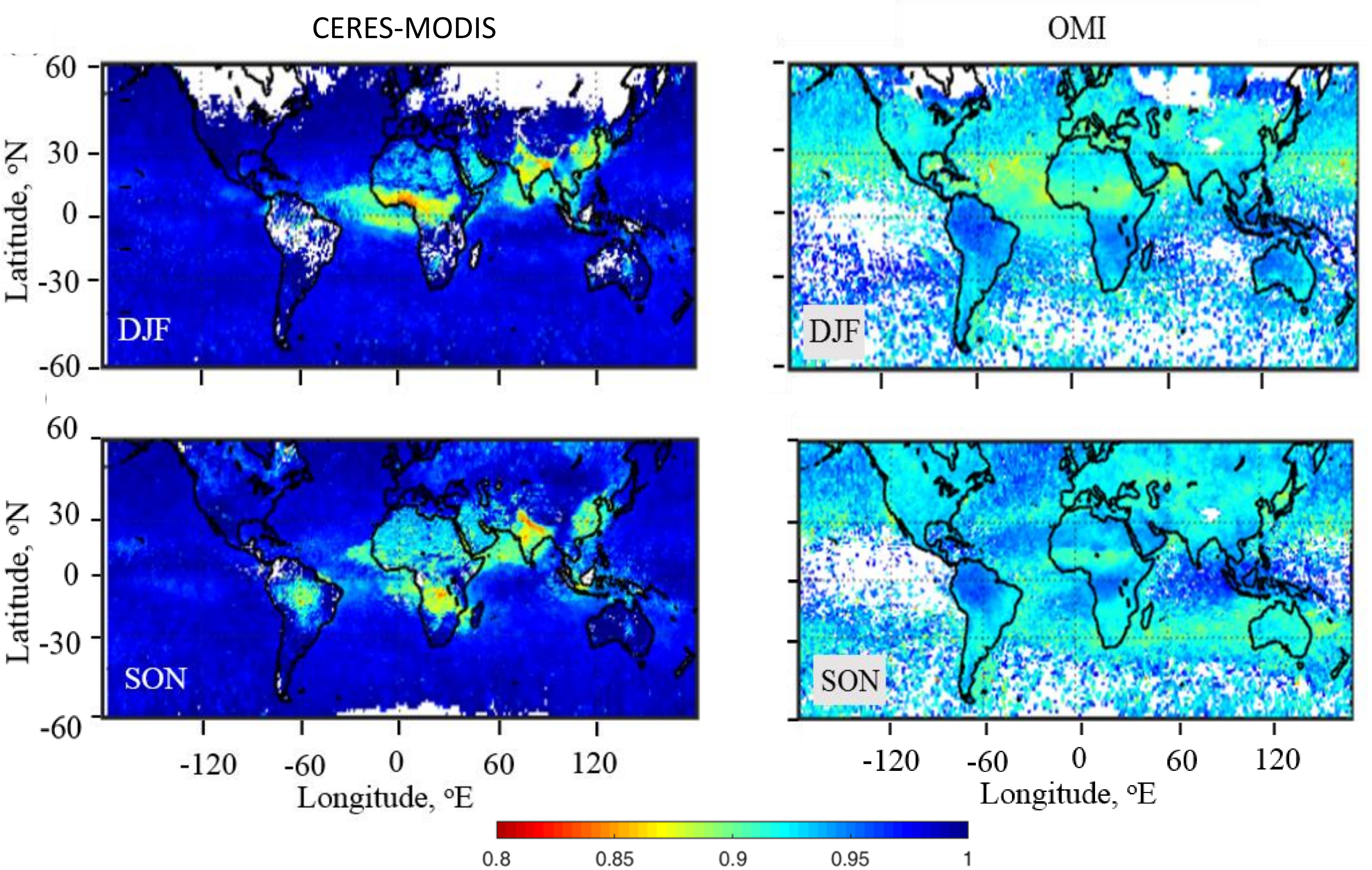
Sample Aerosol Model Used (03 March 17)



CERES-MODIS SSA maps



Comparison with OMI SSA

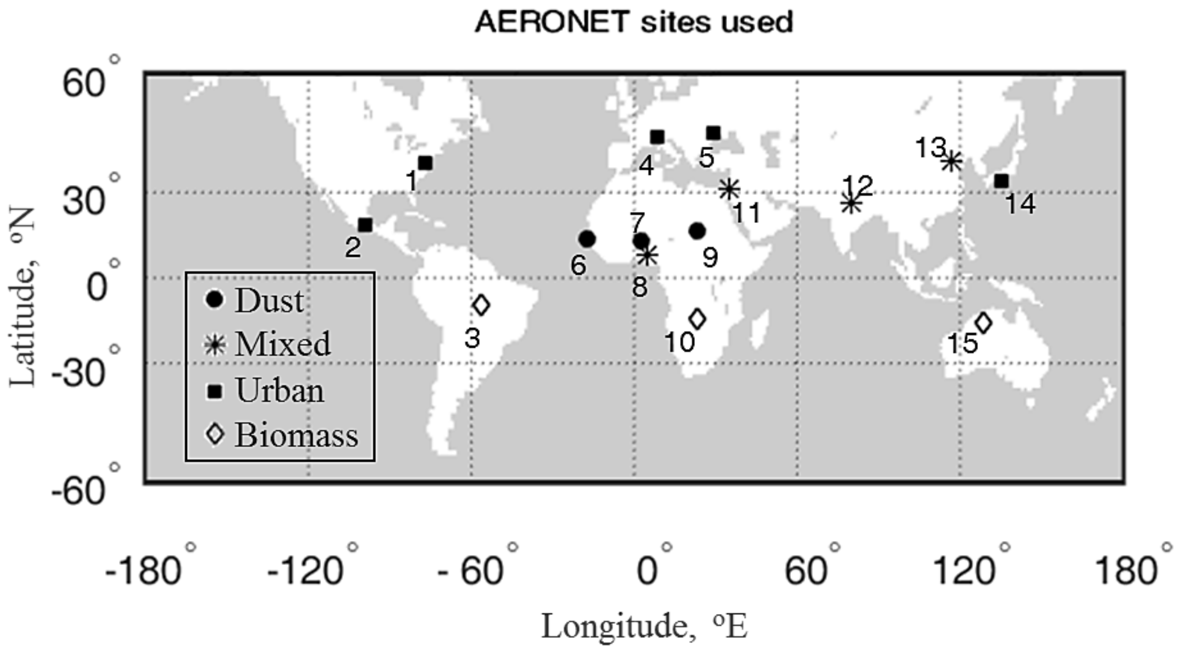


Uncertainty

Estimates of the uncertainty in retrieved SSA

Parameter	Input Uncertainty	Retrieval Uncertainty
Surface albedo	±0.01	±0.03
AOD	20% ±0.05 (land) 5% ±0.03 (ocean)	±0.02
Angstrom exponent	±0.4	±0.01
Refractive index	±0.01	±0.01
Aerosol height	±1 km	±0.01
Aerosol type	Smoke vs dust	±0.01
Residual of fit	±0.05	±0.02

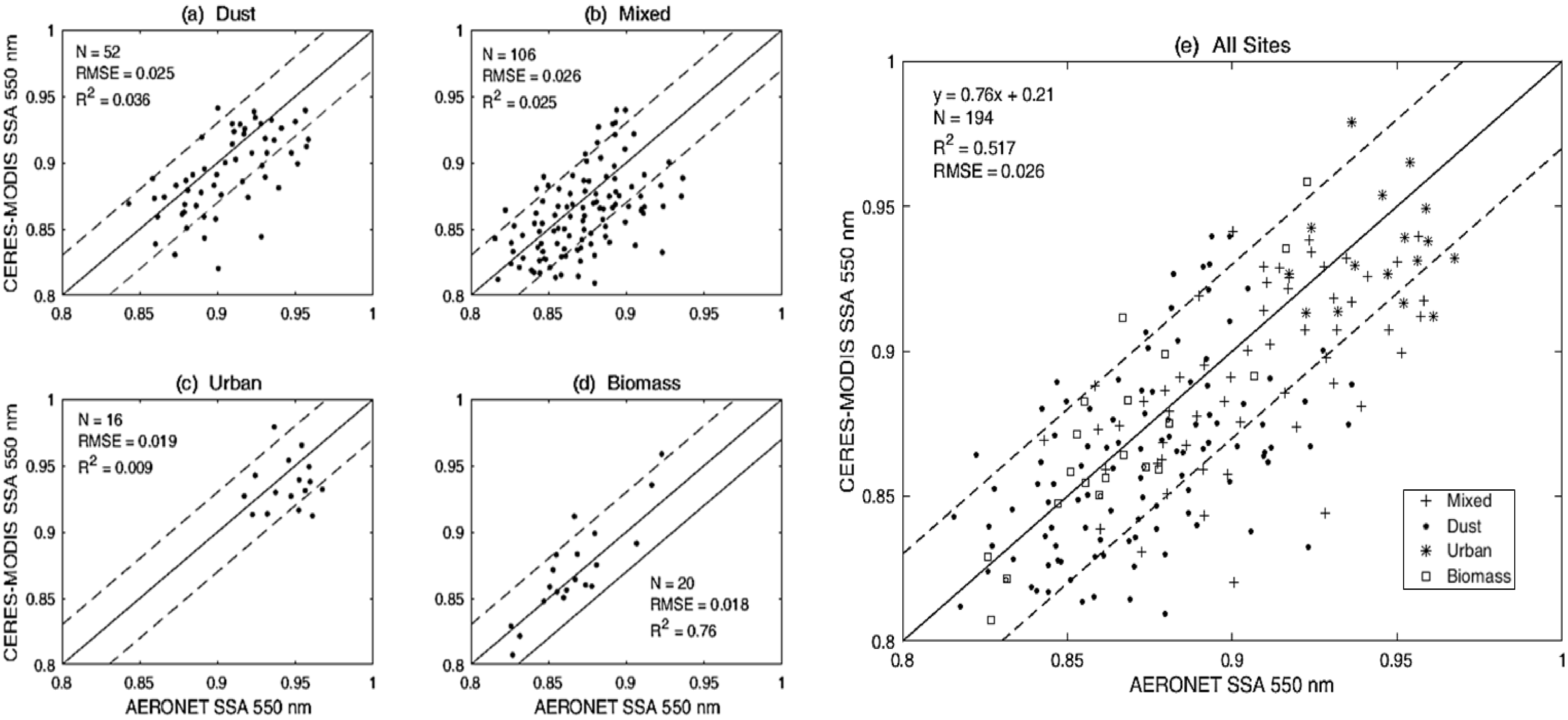
Comparison with AERONET data



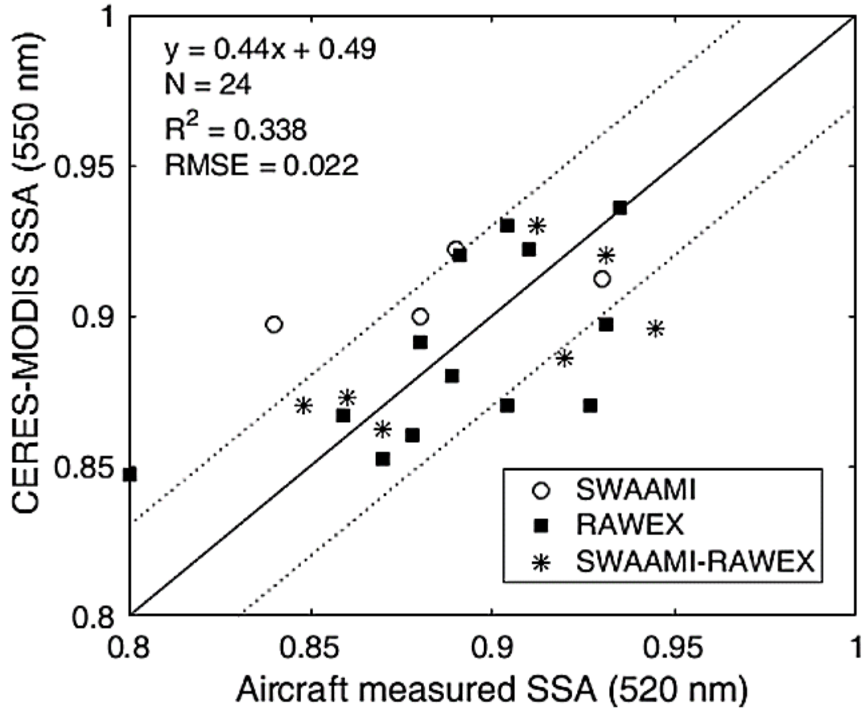
Classification of dominant aerosol type is based on Giles et al., 2012

No.	Name	No.	Name	No.	Name
1	GSFC	6	Capo_Verde	11	SEDE_BOKER
2	Mexico_City	7	Dakar	12	Kanpur
3	Alta_Floresta	8	Illorin	13	XiangHe
4	Ispra	9	Banizoumbou	14	Shirahama
5	Moldova	10	Mongu	15	Lake_Argyle

Comparison with AERONET data



Comparison with aircraft data



RAWEX	IGP & Central India (Winter 2012 & spring 2013)	Babu et al., 2016 Moorthy et al., 2016
SWAAMI	IGP, Arabian Sea & BoB (Monsoon 2016)	Manoj et al., 2019
SWAAMI-RAWEX	IGP (June 2016)	Vaishya et al., 2018

South West Asian Aerosol Monsoon Interactions (SWAAMI)
Regional Aerosol Warming Experiment (RAWEX)

Publication

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References

- Babu, S. S., Nair, V. S., Gogoi, M. M. and Moorthy, K. K.: Seasonal variation of vertical distribution of aerosol single scattering albedo over Indian sub-continent: RAWEX aircraft observations, Atmos. Environ., 125, 312–323, doi:10.1016/j.atmosenv.2015.09.041, 2016.

- Giles, D. M., Holben, B. N., Eck, T. F., Sinyuk, A., Smirnov, A., Slutsker, I., Dickerson, R. R., Thompson, A. M., and Schafer, J. S.: An analysis of AERONET aerosol absorption properties and classifications representative of aerosol source regions, J. Geophys. Res. Atmos., 117, 17203, https://doi.org/10.1029/2012JD018127, 2012.

- Manoj, M. R., Satheesh, S. K., Moorthy, K. K. and Coe, H.: Vertical profiles of sub-micron aerosol single scattering albedo over Indian region immediately before monsoon onset and during its development: Research from the SWAAMI field campaign, Atmos. Chem. Phys. Discuss., 1–29, doi:10.5194/acp-2019-657, 2019.

- Moorthy, K. K., Satheesh, S. K. and Kotamarthi, V. R.: Evolution of aerosol research in India and the RAWEX–GVAX: an overview, Curr. Sci., 111, 53–75, doi:10.2307/24910009, 2016.

- Satheesh, S. K. and Srinivasan, J.: A method to infer short wave absorption due to aerosols using satellite remote sensing, Geophys. Res. Lett., 32(13), 1–4, doi:10.1029/2005GL023064, 2005.

- Vaishya, A., Babu, S. N. S., Jayachandran, V., Gogoi, M. M., Lakshmi, N. B., Moorthy, K. K. and Satheesh, S. K.: Large contrast in the vertical distribution of aerosol optical properties and radiative effects across the Indo-Gangetic Plain during the SWAAMI–RAWEX campaign, Atmos. Chem. Phys., 18(23), 17669–17685, doi:10.5194/acp-18-17669-2018, 2018.

Thank You