Evaluation of AEROCOM models with remotely sensed observations

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Introduction

Our main interest

We'd like to minimise this

$$M - O = \varepsilon_{\text{model}} + \varepsilon_{\text{representation}} + \varepsilon_{\text{retrieval}}$$

Schutgens et al. ACP 2016a   (temporal sampling)
Schutgens et al. ACP 2016b   (spatial sampling)

Schutgens et al. ACP 2017   (spatio-temporal sampling)
- Error estimates for diverse remote sensing scenarios
- Optimal construction of L3 data
- Representativeness MODIS vs AERONET

Datasets

Platform	Sensor	Algorithm
AERONET	AERONET	DirectSun
	AERONET	Inversion
MAN	AERONET	DirectSun
Aqua	MODIS	DarkTarget
		BayesianDarkTarget
		DeepBlue
		FL-MOC
AURA	OMI	OMAERUV
ENVISAT	AATSR	ADV-FMI
		ORAC-RAL
		Swansea U
PARASOL	POLDER	SRON
noaa18	AVHRR	SOAR
		DeepBlue
SeaStar	SeaWiFS	SOAR
		DeepBlue
Terra	MODIS	DarkTarget
		BayesianDarkTarget
		DeepBlue

Remote sensing datasets:
- aggregated
  - 1° by 1°, 30^{min}
  - 4^{hr}
- od550aer
- if available:
  - od???aer
  - abs550aer
- error estimates
- NetDCF

Model
CAM5
CAM5.3-Oslo
ECHAM6-HAM
ECHAM6-SALSA
ECMWF-IFS
GEOS5
GEOS-Chem
HadGEM
IMPACT
INCA
OsloCTM3
SPRINTARS
TM5

Models:
- 3-hourly output
  - od550aer
  - od???aer
  - abs550aer
  - NetCDF

Analysis tool

- Allows arbitrary collocation of diverse datasets

  - aggregation for remote sensing data

  - linear interpolation for models

- Subsequent aggregation over regions & weeks/years

- Fast: 1 year of 12 models and 5 remote sensing datasets can be collocated to the same spatio-temporal grid in less than 5 minutes (1 processor, IDL code)

- Data also accessible by Community Intercomparison Suite (Watson-Parris et al. 2016)
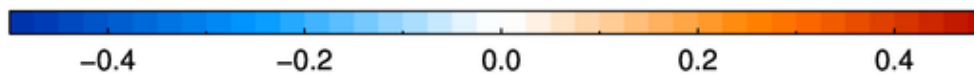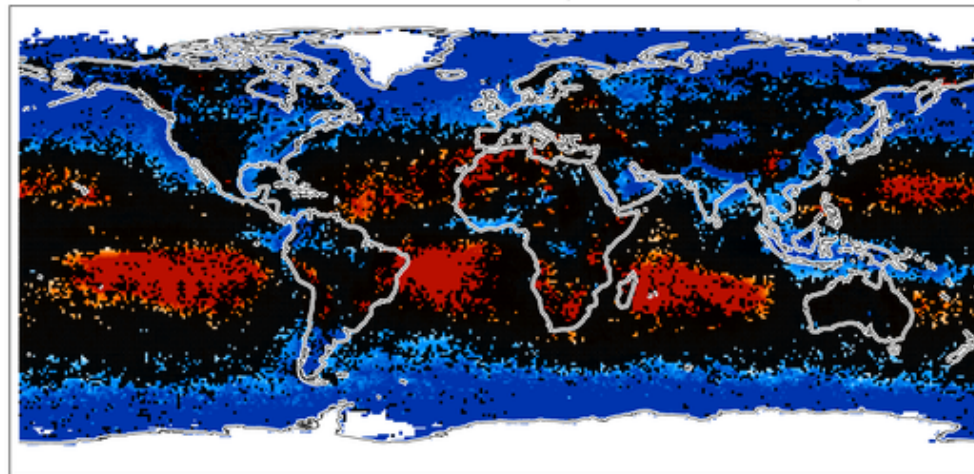
The Challenge

First look

Rel diff AOD (ECHAM6–SALSA vs Aqua–DT)

Rel diff AOD (ECHAM6–SALSA vs Terra–DT)

Rel diff AOD (ECHAM6–SALSA vs AATSR–SU)

Rel diff AOD (ECHAM6–SALSA vs Aqua–DB)

Rel diff AOD (ECHAM6–SALSA vs Terra–DB)

Rel diff AOD (ECHAM6–SALSA vs AATSR–RAL)

Rel diff AOD (ECHAM6–SALSA vs Aqua–BayesDT)

Rel diff AOD (ECHAM6–SALSA vs Terra–BayesDT)

Rel diff AOD (ECHAM6–SALSA vs AATSR–FMI)

Rel diff AOD (ECHAM6–SALSA vs SeaWiFS)

Rel diff AOD (ECHAM6–SALSA vs AVHRR)

Rel diff AOD (ECHAM6–SALSA vs OMAERUV–NASA)

Definition of consistency

$$(M - O) / O$$

median

0.0

-1.0   1.0

< 80% = bad , ½ * median,   **> 80 % = ok**
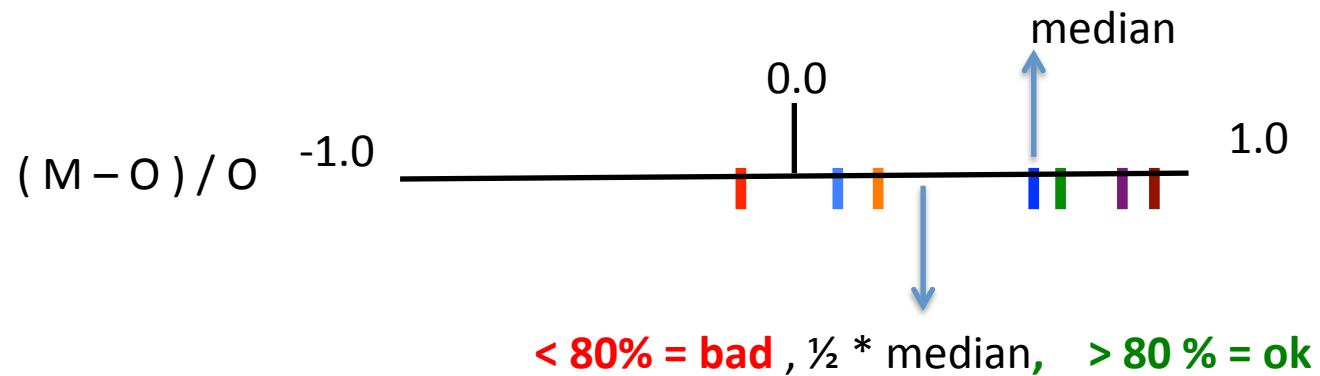
Median relative error AOD (ECHAM6−SALSA)

AEROCOM models
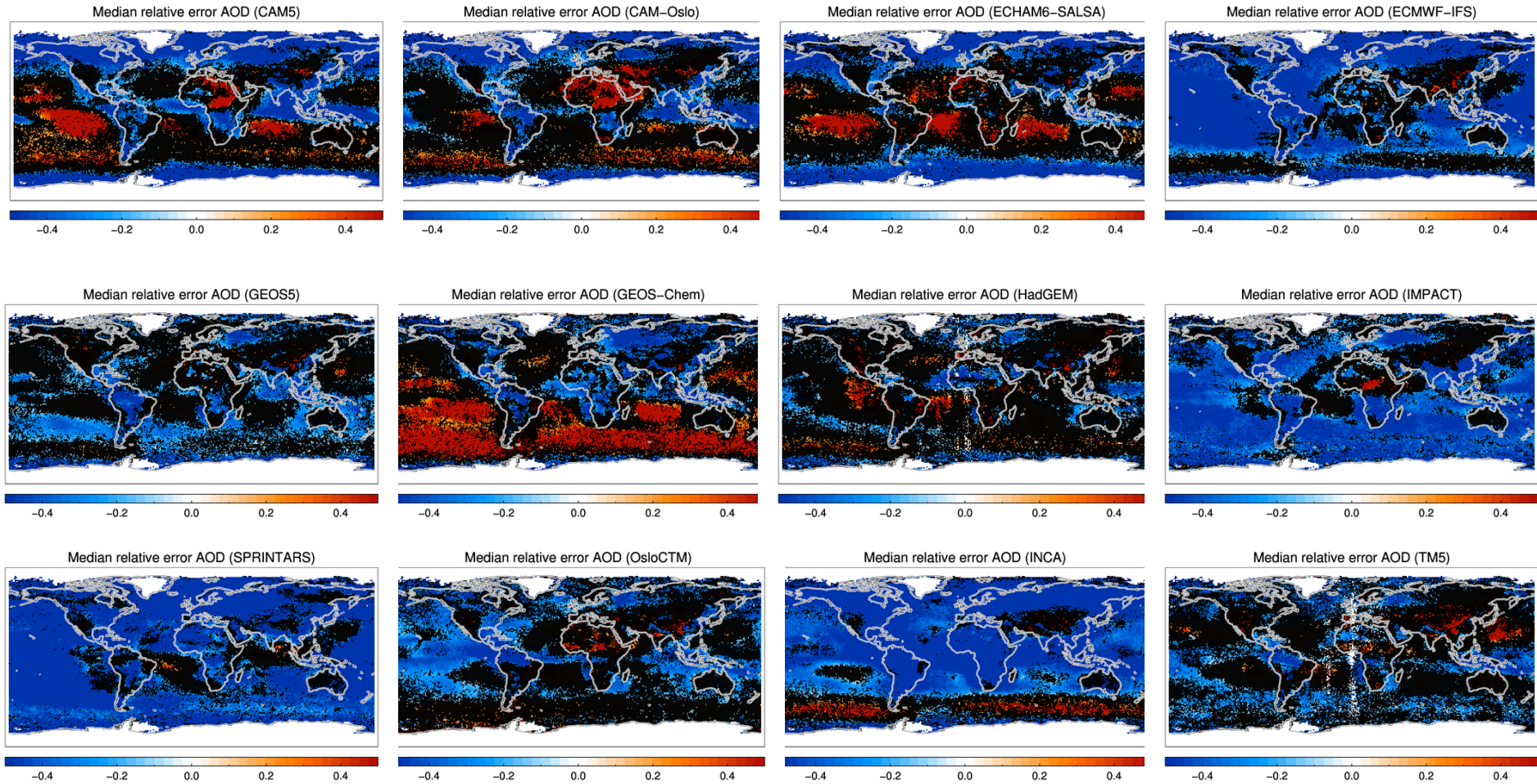
AAATSR (3x), Aqua & Terra MODIS (3x), AVHRR, SeaWiFs, OMAERUV

Impact of sampling

Aqua MODIS (3x), AVHRR, SeaWiFs
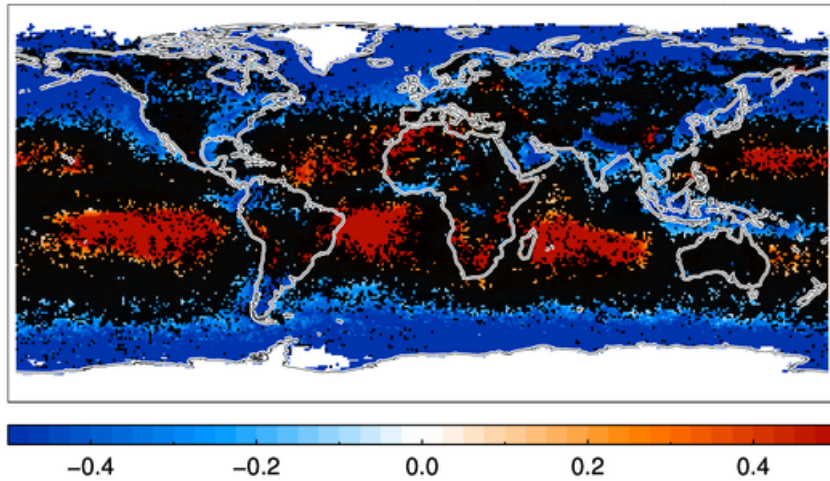
Median relative error AOD (ECHAM6−SALSA)
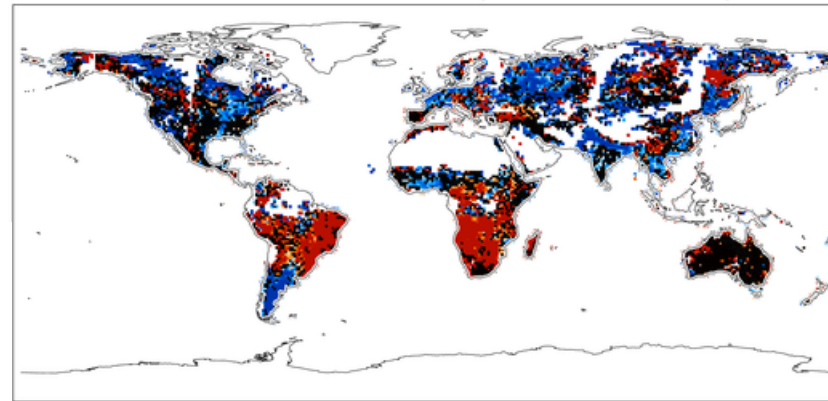
Afternoon

Median relative error AOD (ECHAM6−SALSA)

Morning

AAATSR (3x), Terra MODIS (3x)
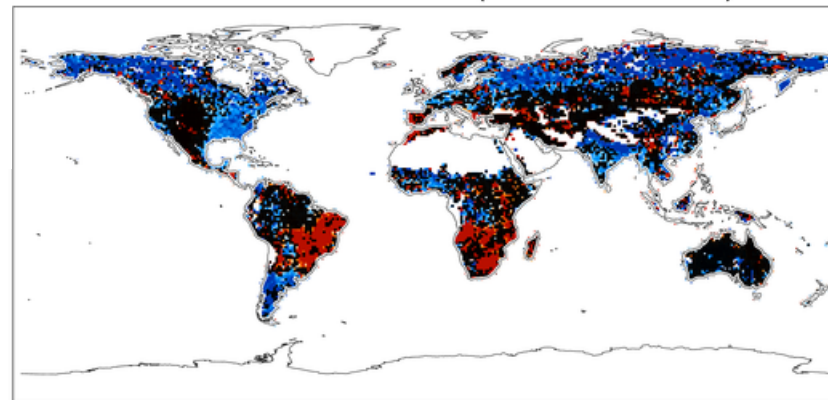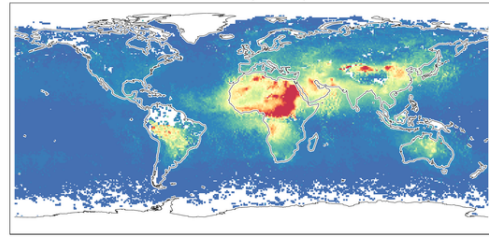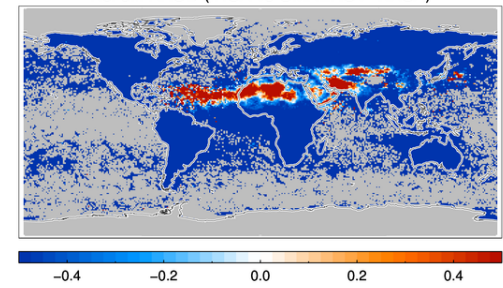
| AAOD (CAM5) | Rel diff AAOD (CAM5 vs POLDER–SRON) | Rel diff AAOD (CAM5 vs OMAERUV–NASA) |
AAOD (CAM–Oslo)	Rel diff AAOD (CAM–Oslo vs POLDER–SRON)	Rel diff AAOD (CAM–Oslo vs OMAERUV–NASA)
AAOD (ECHAM6–SALSA)	Rel diff AAOD (ECHAM6–SALSA vs POLDER–SRON)	Rel diff AAOD (ECHAM6–SALSA vs OMAERUV–NASA)
AAOD (HadGEM)	Rel diff AAOD (HadGEM vs POLDER–SRON)	Rel diff AAOD (HadGEM vs OMAERUV–NASA)
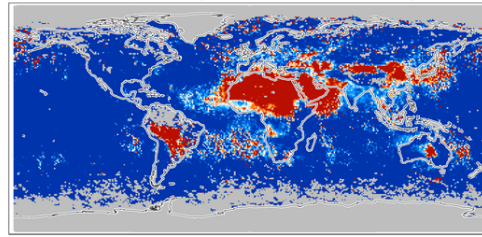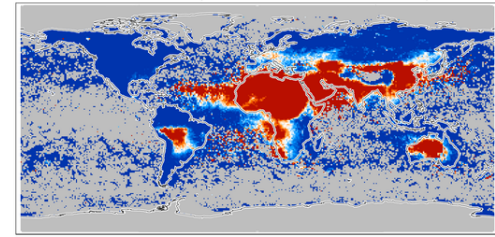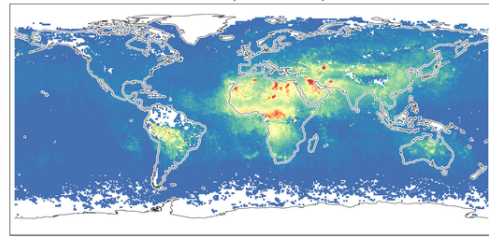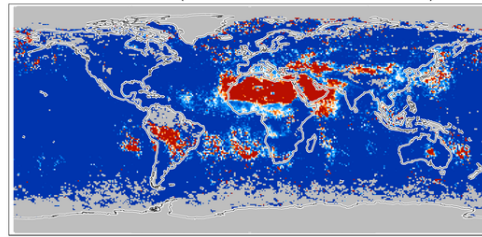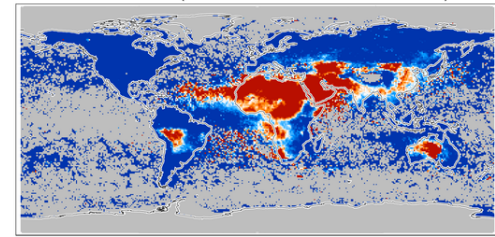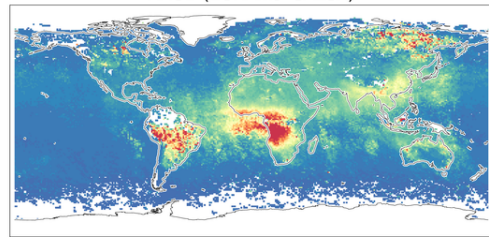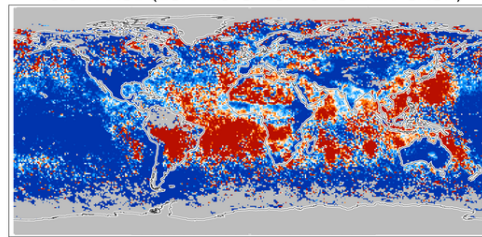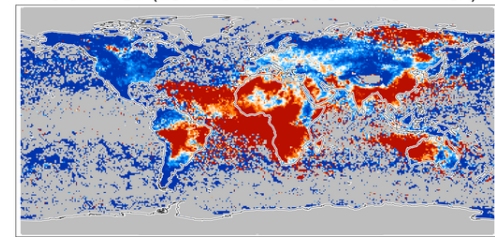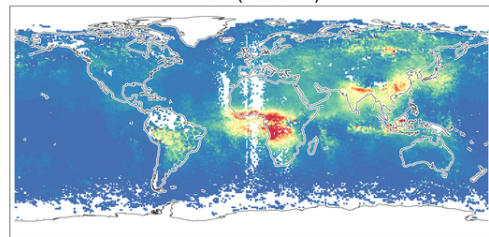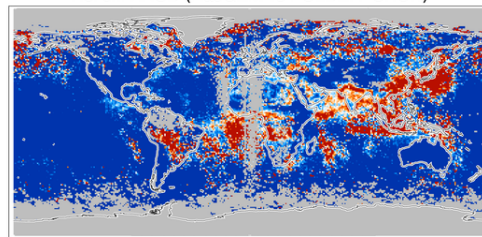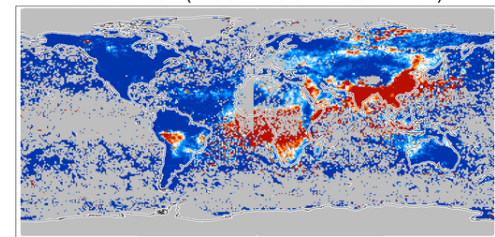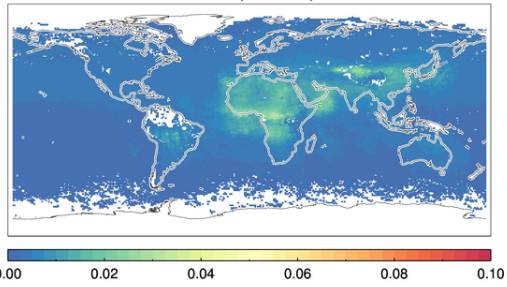
AAOD (IMPACT)   Rel diff AAOD (IMPACT vs POLDER−SRON)   Rel diff AAOD (IMPACT vs OMAERUV−NASA)
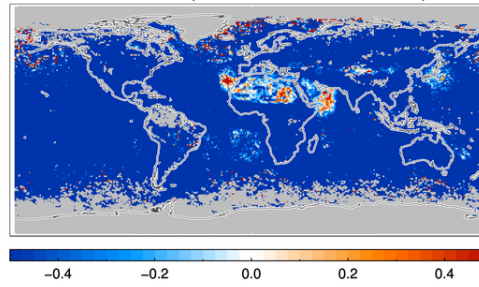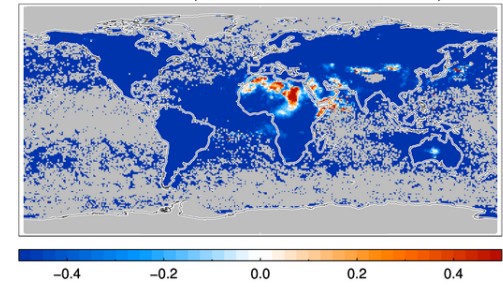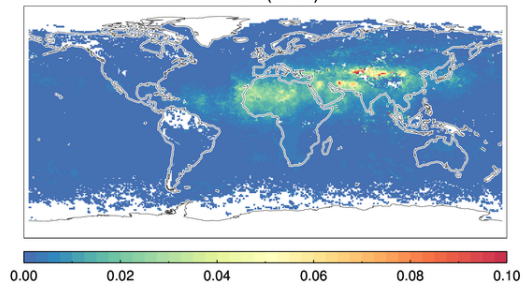
AAOD (INCA)   Rel diff AAOD (INCA vs POLDER−SRON)   Rel diff AAOD (INCA vs OMAERUV−NASA)
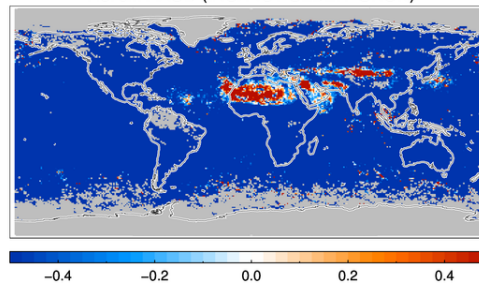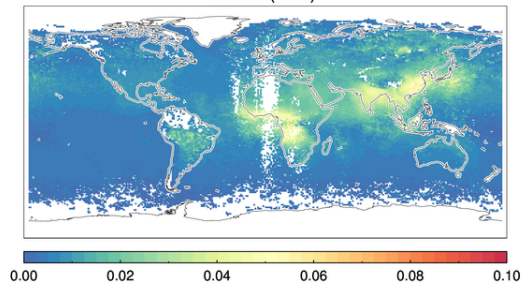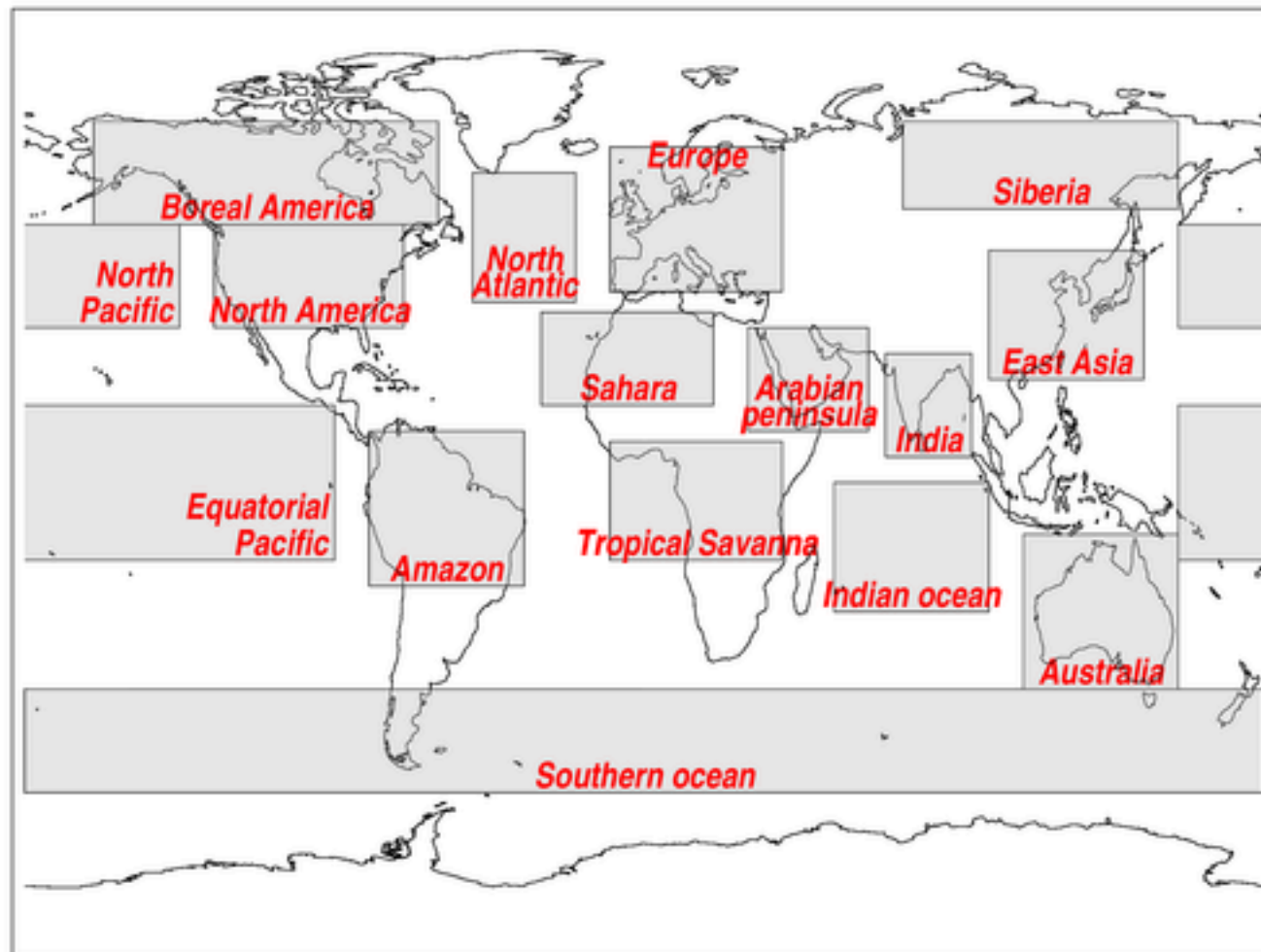
AAOD (TM5)   Rel diff AAOD (TM5 vs POLDER−SRON)   Rel diff AAOD (TM5 vs OMAERUV−NASA)
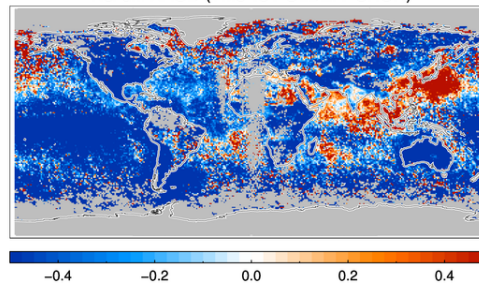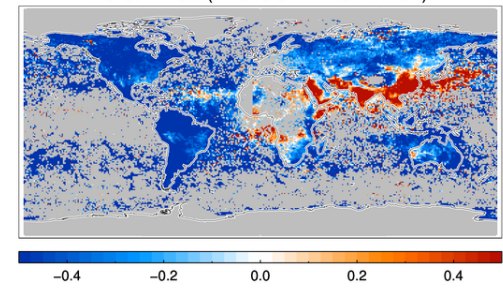
Regions

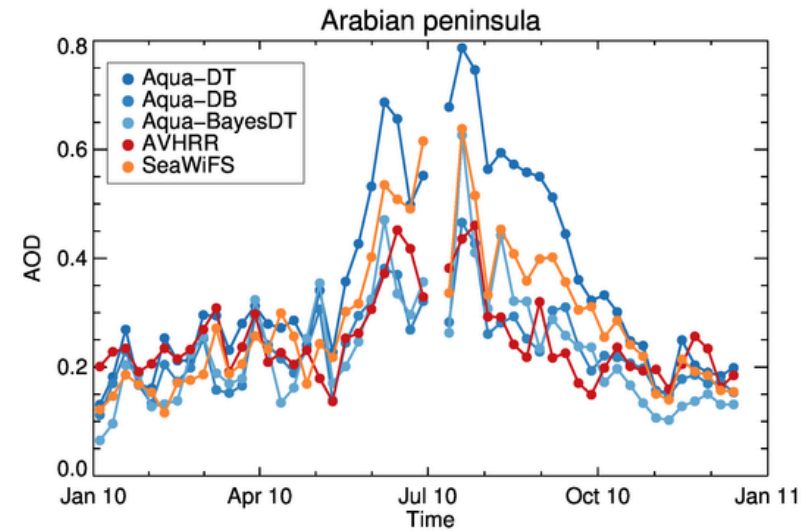# Time-series for regions
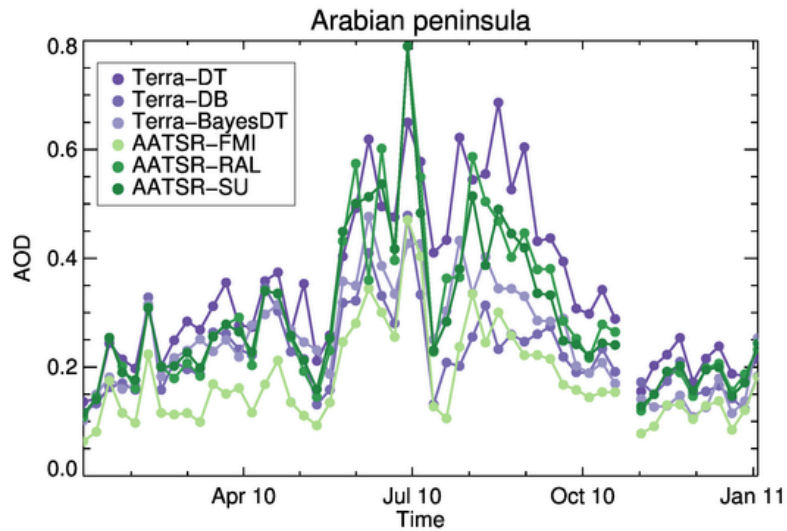
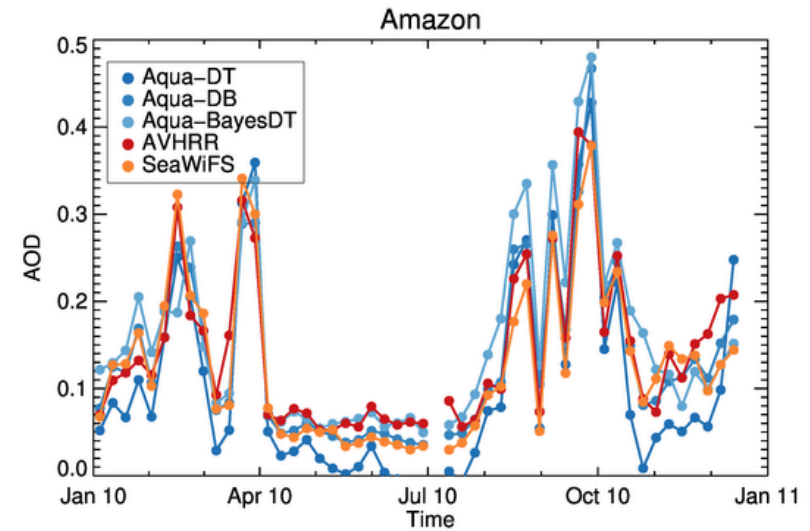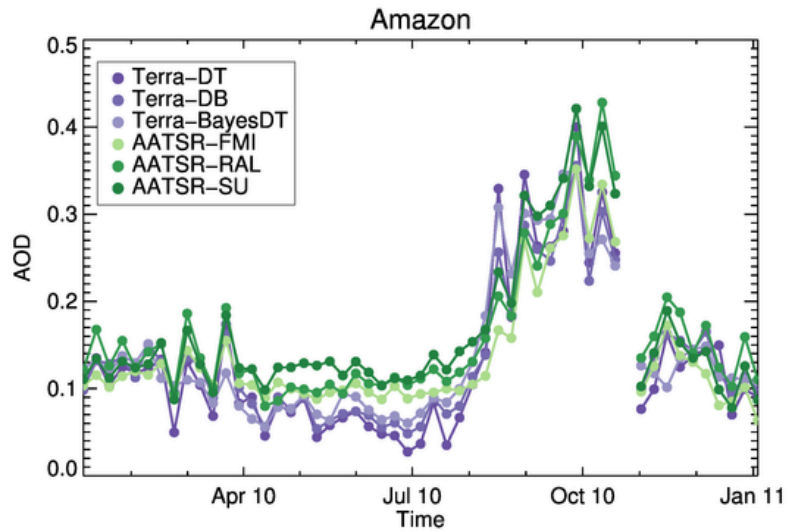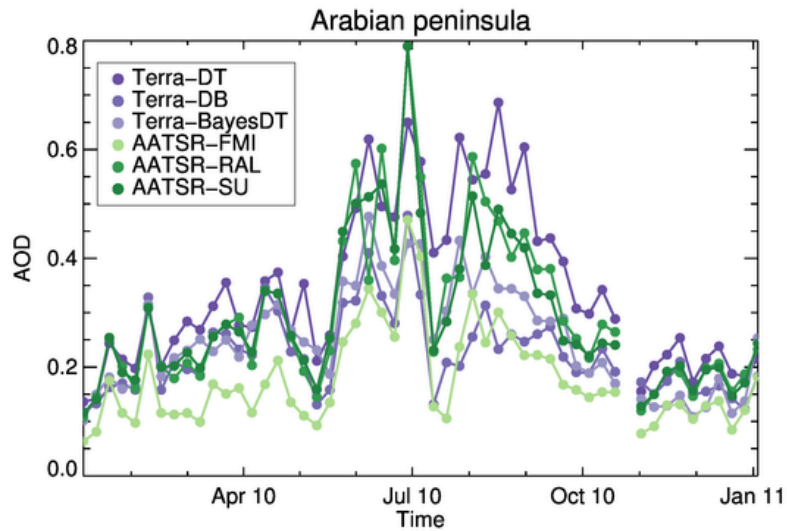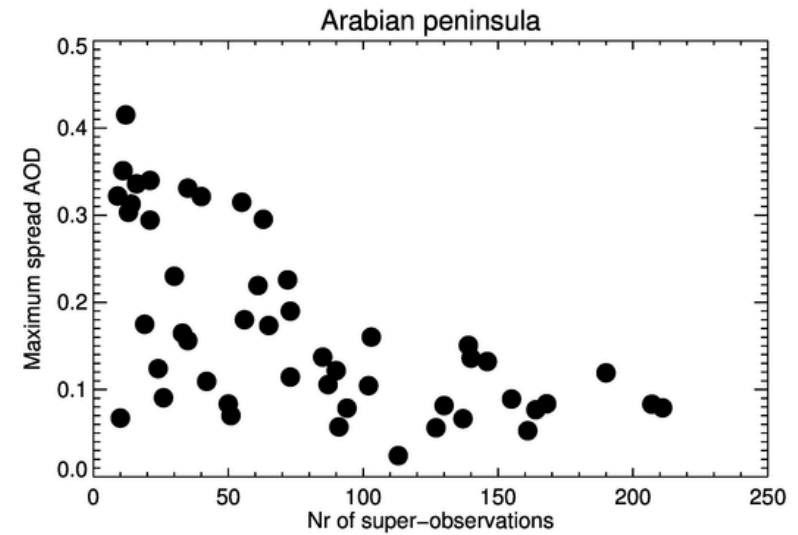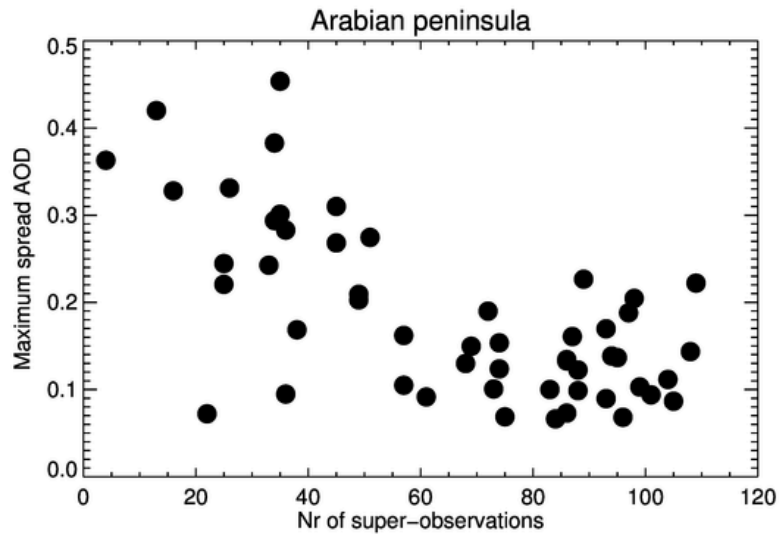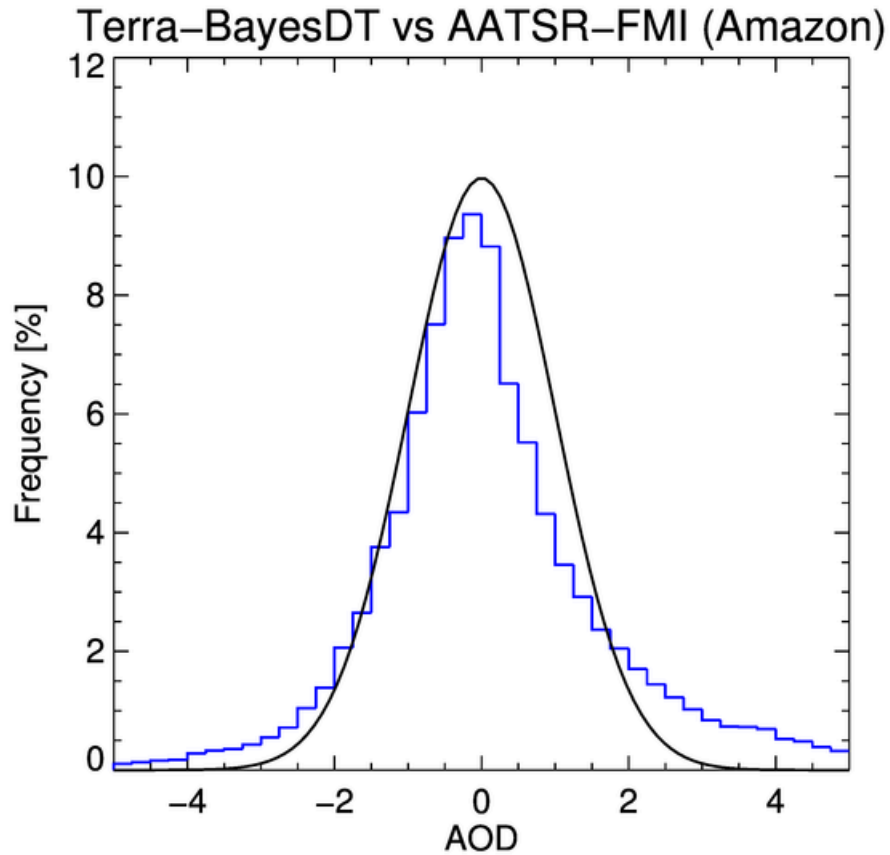# Time-series for regions

Intercomparison of datasets

Terra–BayesDT vs AATSR–FMI (Amazon)
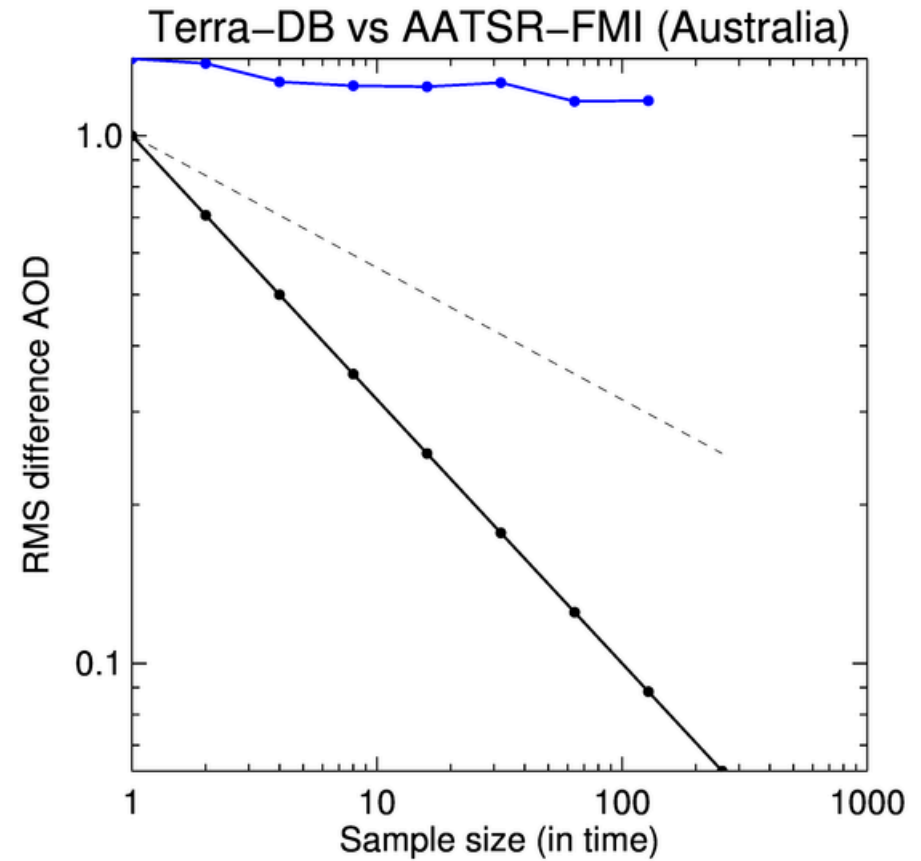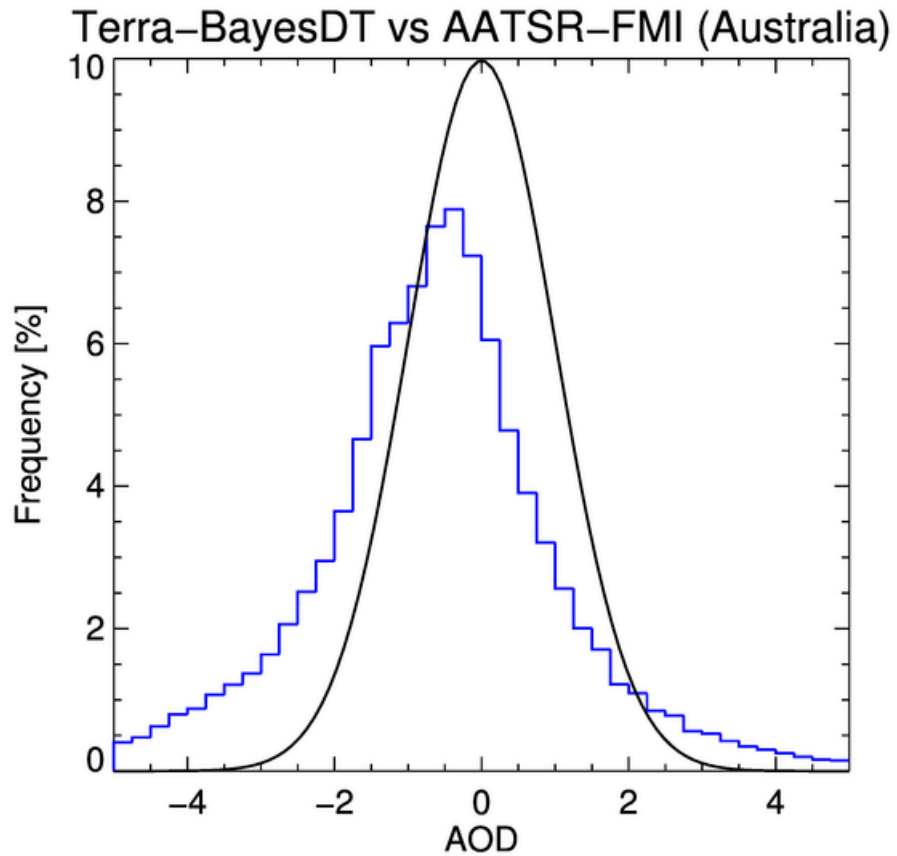
$$\frac{\tau_a - \tau_b}{\sqrt{\sigma_a^2 + \sigma_b^2}}$$

$$\frac{1}{\sqrt{N}}$$

Intercomparison of datasets

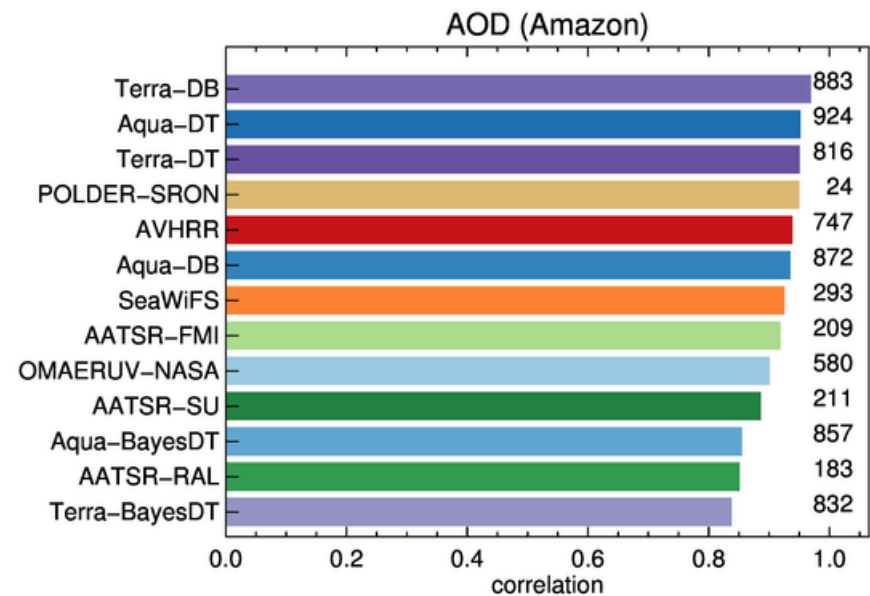Terra–BayesDT vs AATSR–FMI (Australia)
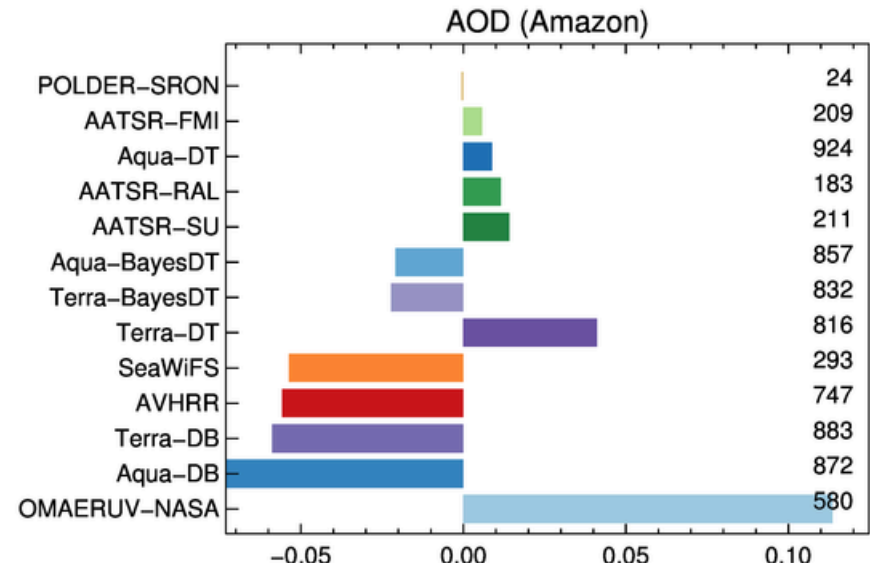
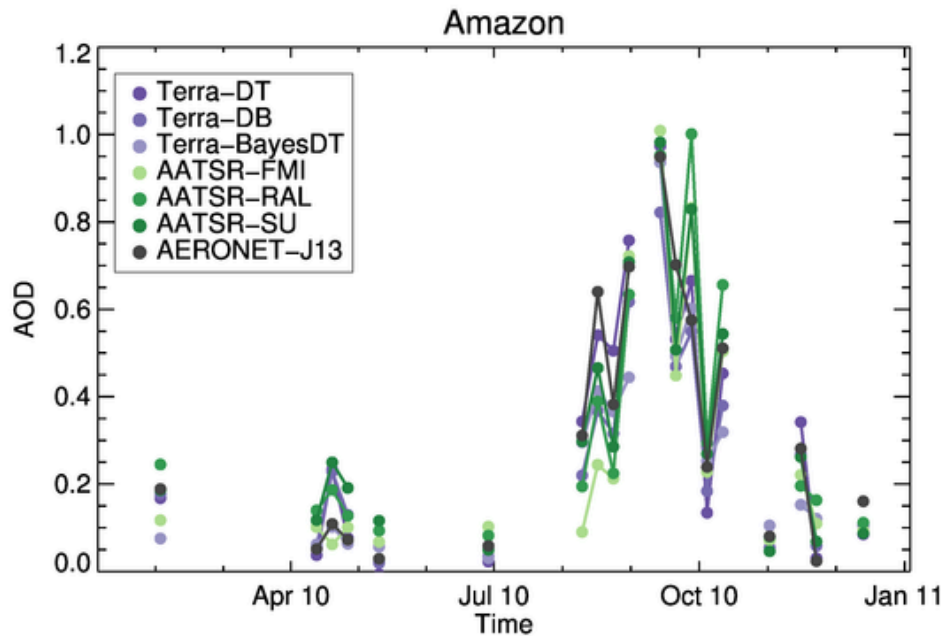Terra–DB vs AATSR–FMI (Australia)
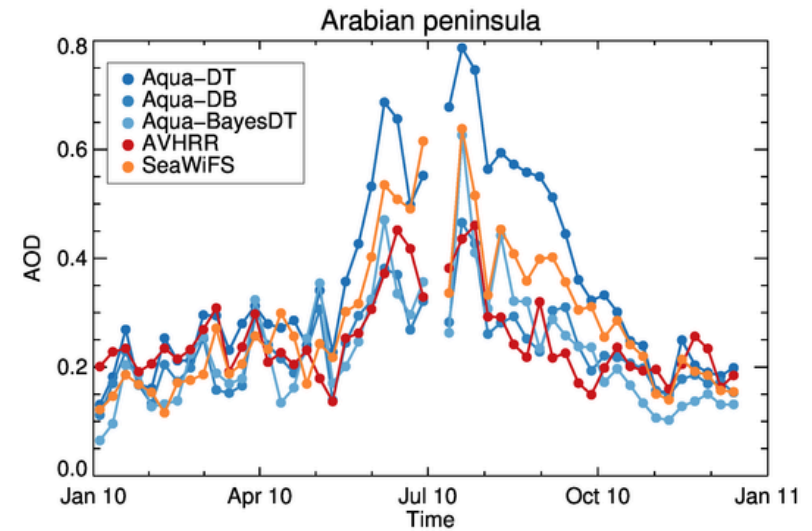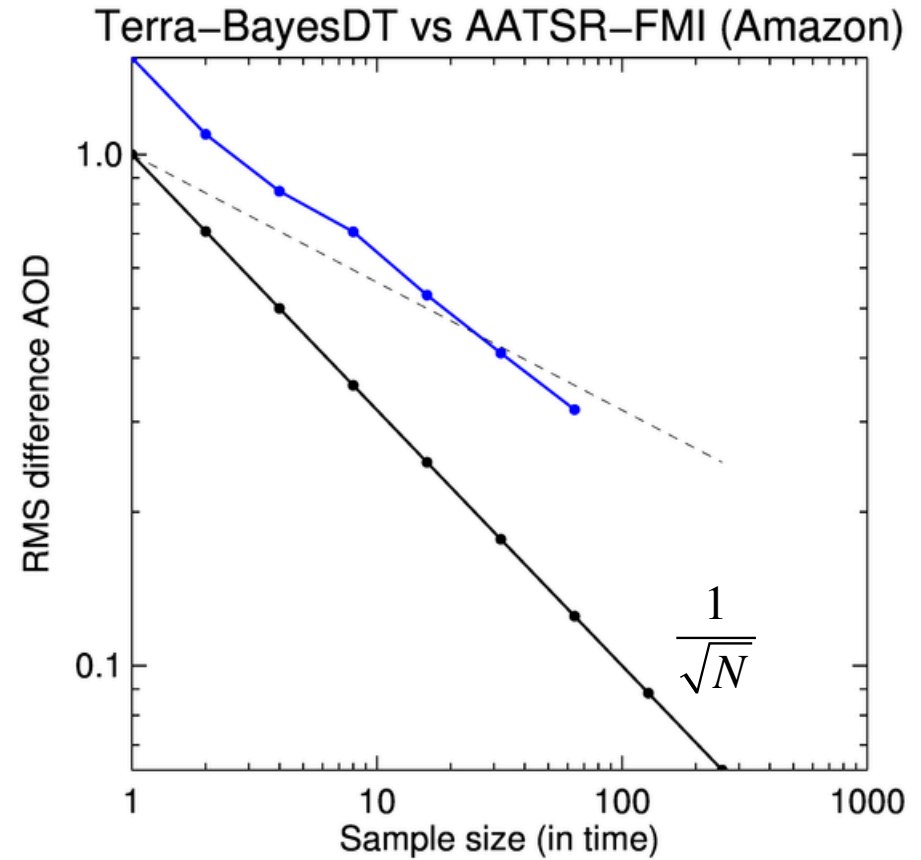
$$\frac{\tau_a - \tau_b}{\sqrt{\sigma_a^2 + \sigma_b^2}}$$

Intercomparison of datasets
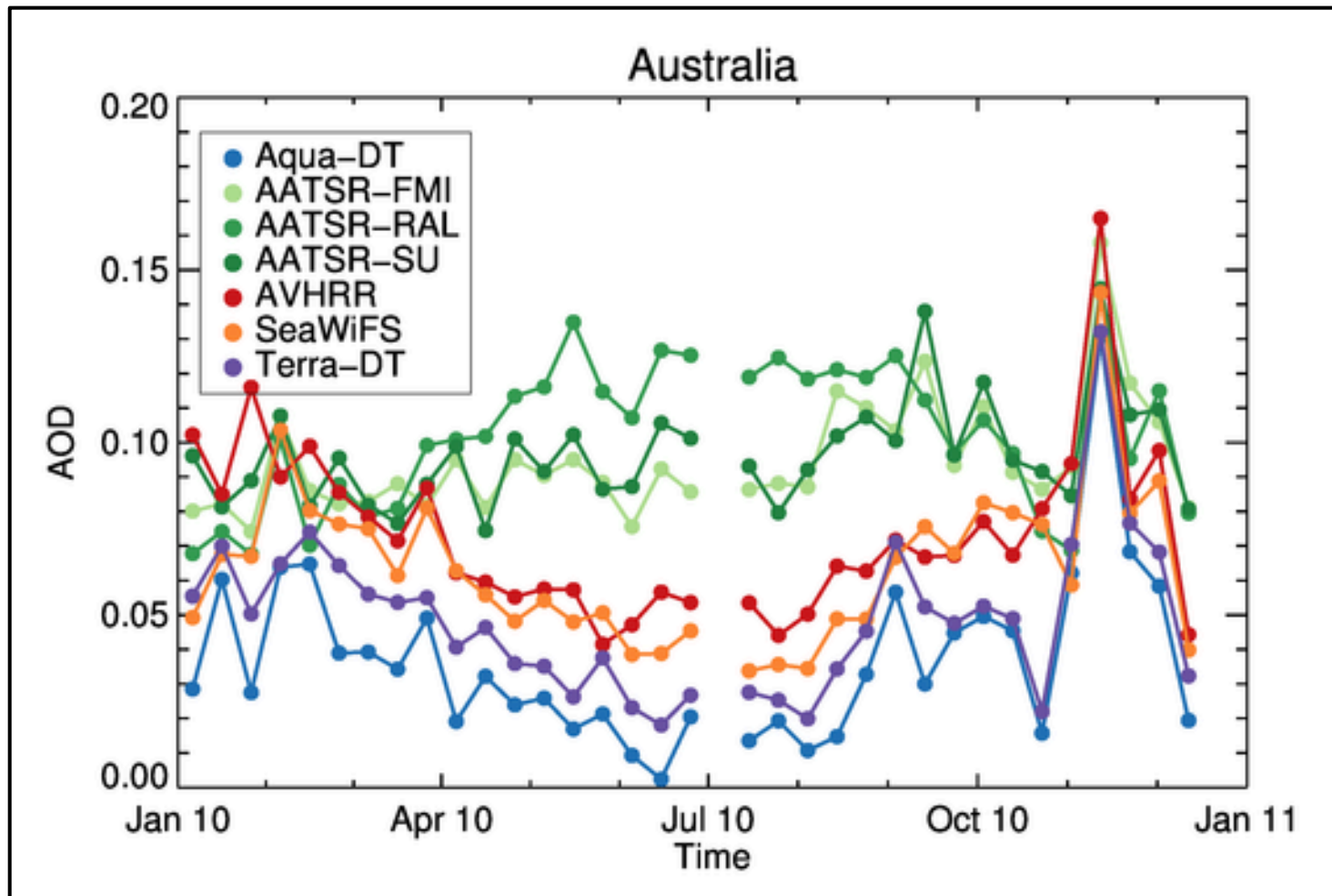
Comparison against AERONET
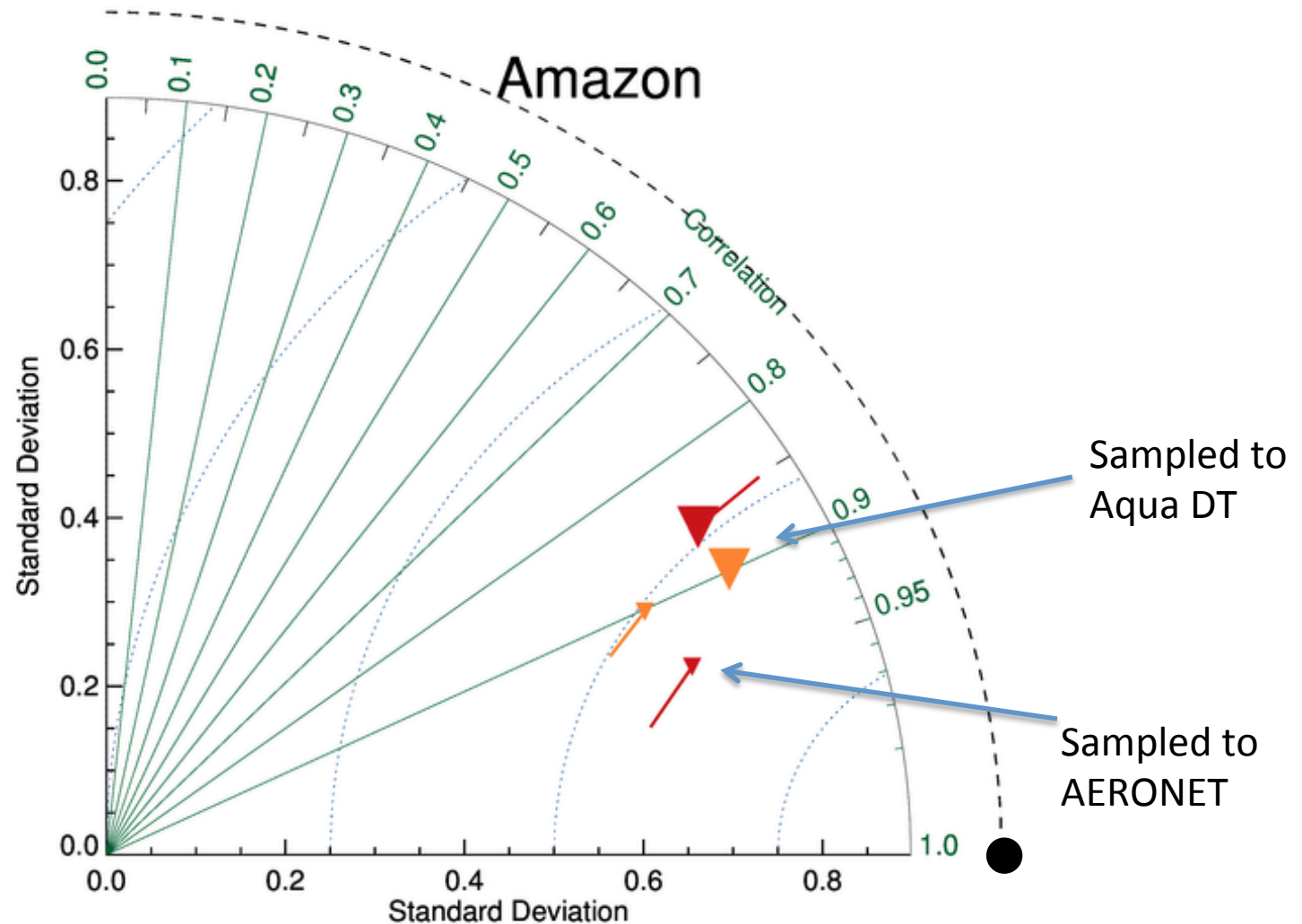
How representative is AERONET?

Summary

- Received a lot of remote sensing datasets and model data, more welcome!
- Models seem to seriously underestimate AOT & AAOT but often overestimate dust AAOT
- Definition of best AOT estimate is an issue
  - real issue is definition of truth
  - but I'm not without hope
- Next up:
  - evaluation of models
  - interpretation in terms of aerosol lifetimes, MEE, MAC, etc