What we have learned in validating Aerosol_cci pixel-level uncertainties?

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Metric for AOD uncertainty validation

$$\Delta = \frac{AOD_{ATSR} - AOD_{AERONET}}{\sigma_{ATSR} + \sigma_{AERONET} + \sigma_{RE}}$$

AOD_{ATSR} at 550 nm, 10 km x 10 km superpixel (L2)
$AOD_{AERONET}$ direct sun AOD calculated for 550 nm
σ_{ATSR} satellite uncertainty

- AERONET AOD substantially more accurate than satellites products
- Neglecting the uncertainty in AERONET observations and possible issues with their ability to represent a satellite pixel area, temporal and spatial mismatches,…
- **If Δ is normally distributed, 68.3% of values should fall within the range [1,+1].**
- If the fraction is smaller, uncertainties are underestimated;
  if it is larger, uncertainties are overestimated.

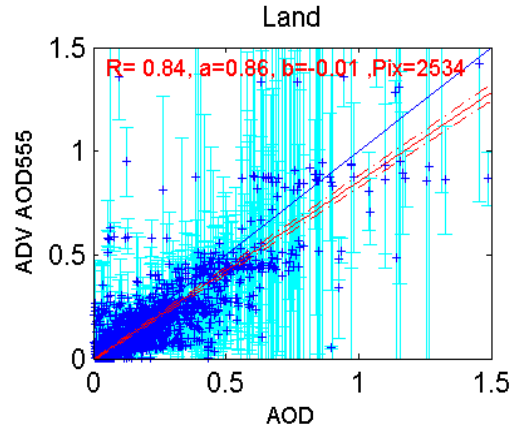
Co-location criteria: 50 km spatial and 30 min. temporal, <= 2000 m

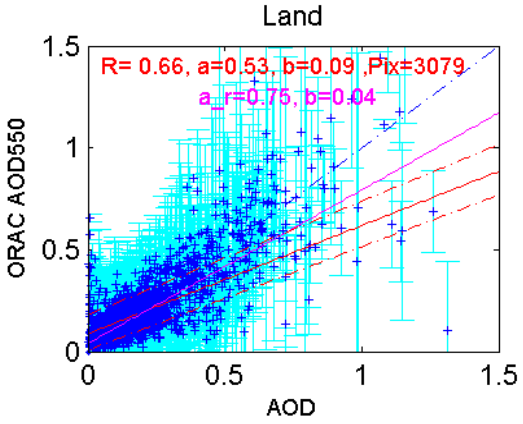
AOD algorithms

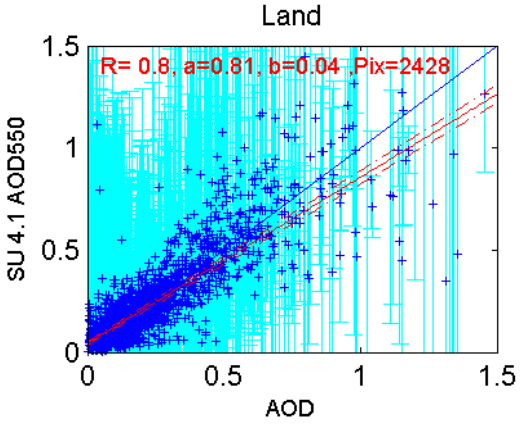
- AOD retrieval from ATSR-2 06/1995 – 06/2003, AATSR 05/2002 – 04/2012
  - ADV/ASV (AATSR Dual/Single View from FMI) v23_plume
  - ORAC (Oxford RAL Aerosol and Cloud retrieval) v4.01
  - SU (Swansea University) v43
  - Ensemble (DLR) v2.6 (uncertainty weighted) → v2.7 available
    - ADV land *2, ADV ocean *2
    - ORAC land *1, ORAC ocean *3 (v3.02)
    - SU land *1, SU ocean *1.25
- All retrieval include a **AOD pixel level uncertainty**

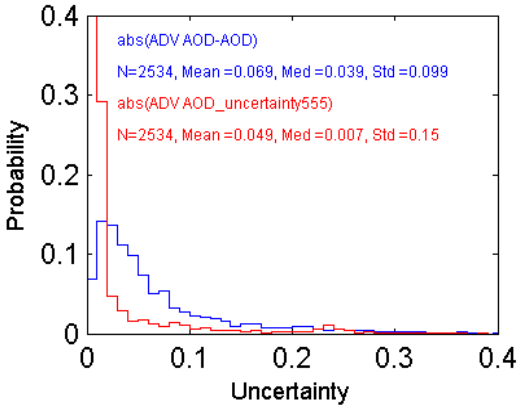
- De Leeuw et al., Remote Sens. Environ. 2015

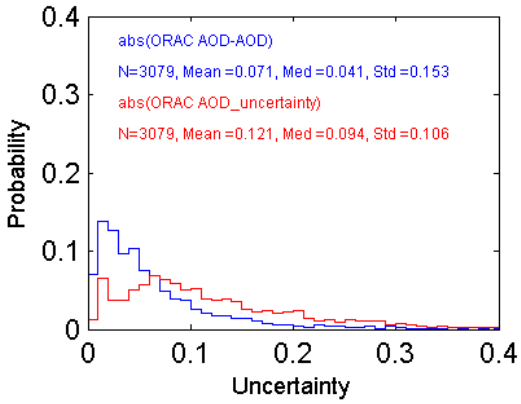
aCCI phase 1 – 1 yr dataset (2008)

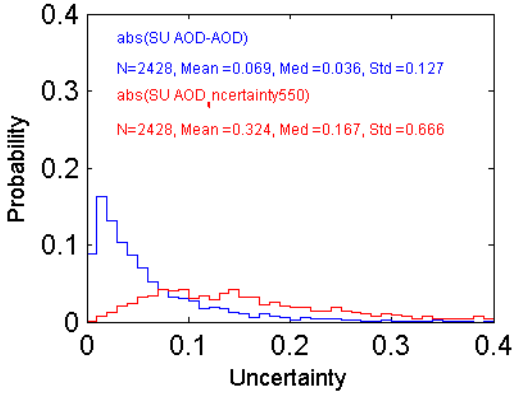








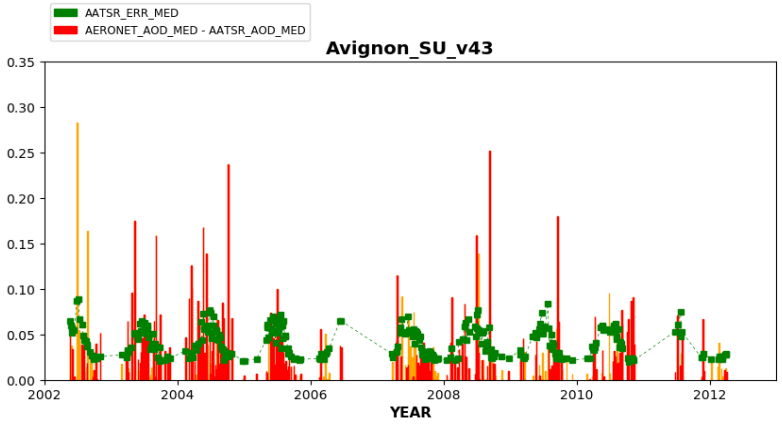


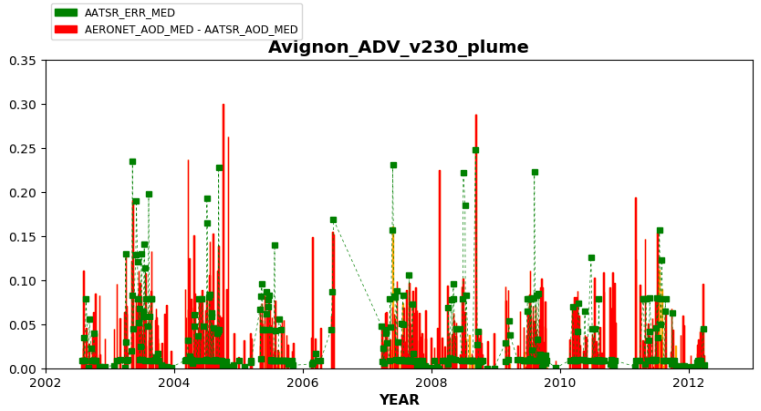


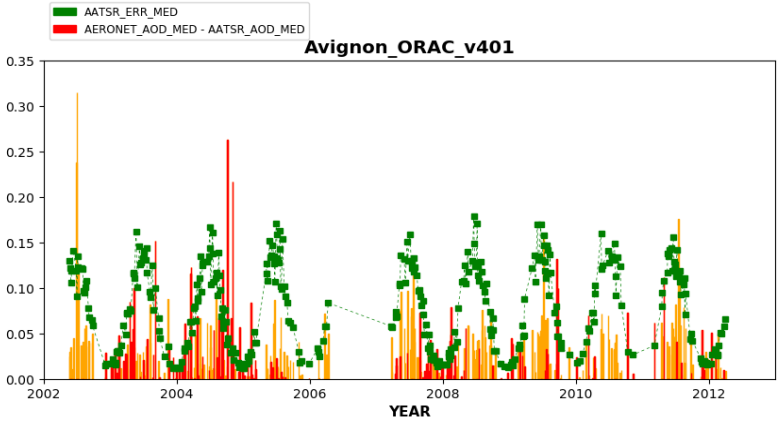
Status 2012-11-27

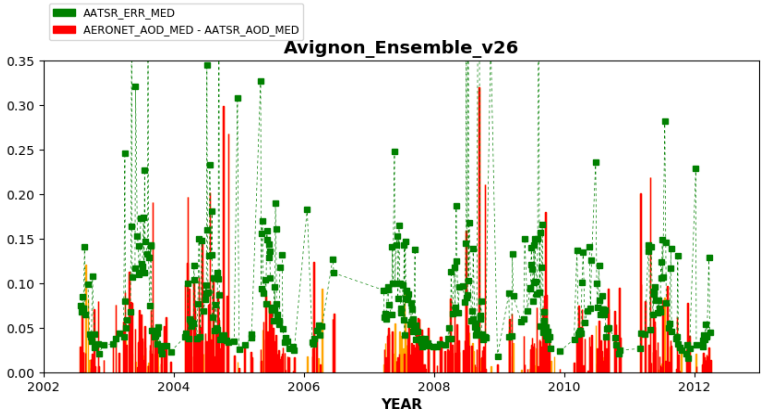
AATSR 2008	land	coast
aatsr_adv_v142	18 %	08 %
aatsr_orac_v202	76 %	26 %
aatsr_su_v41	93 %	78 %

Avignon (43.9°N, 4.9°E, 32 m)









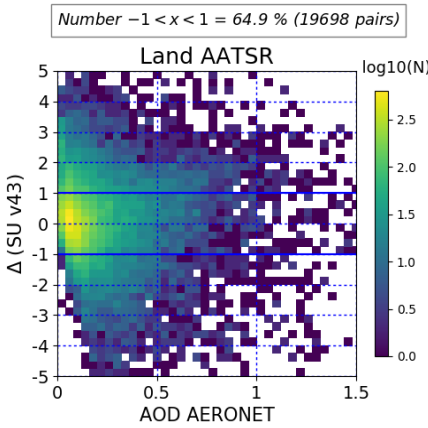
Land cover: 60% rainfed cropland, trees_needleleaves_evergreen, grassland, urban

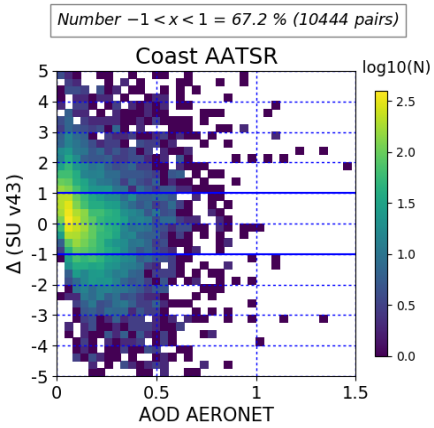
Aerosol: polluted

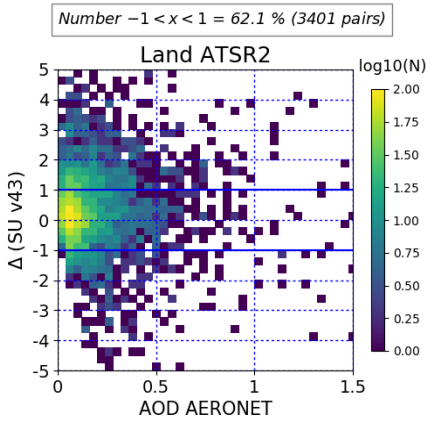
AE

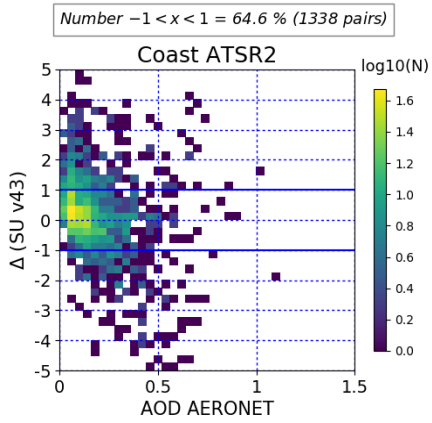
AOD uncertainty - SU vers 4.30

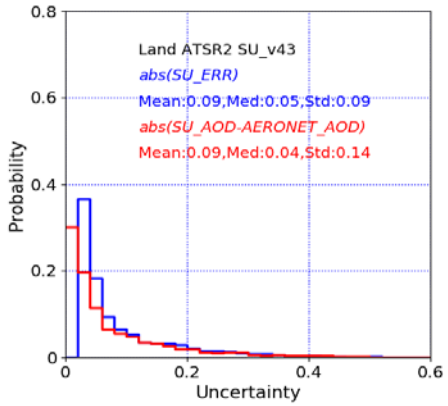
ATSR2/AATSR	land		coast	
	ATSR-2	AATSR	ATSR-2	AATSR
SU v43	62 ± 04	65 ± 02	65 ± 12	67 ± 03

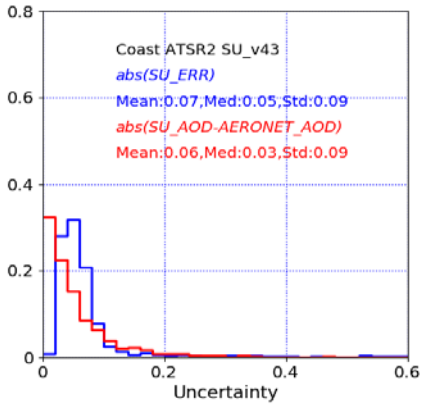


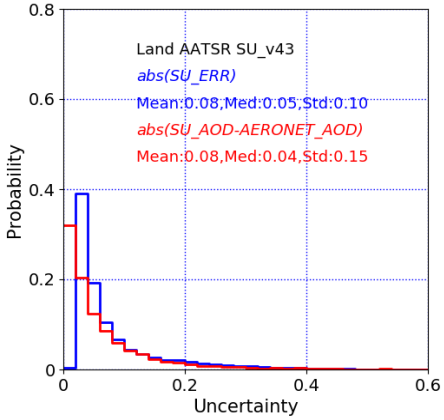


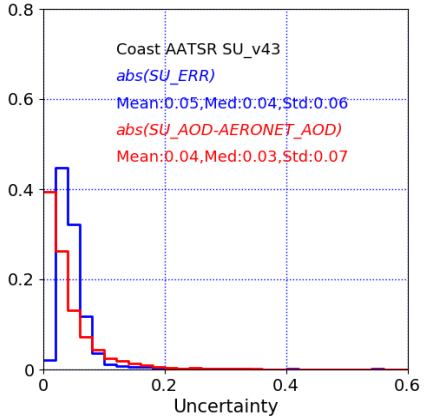




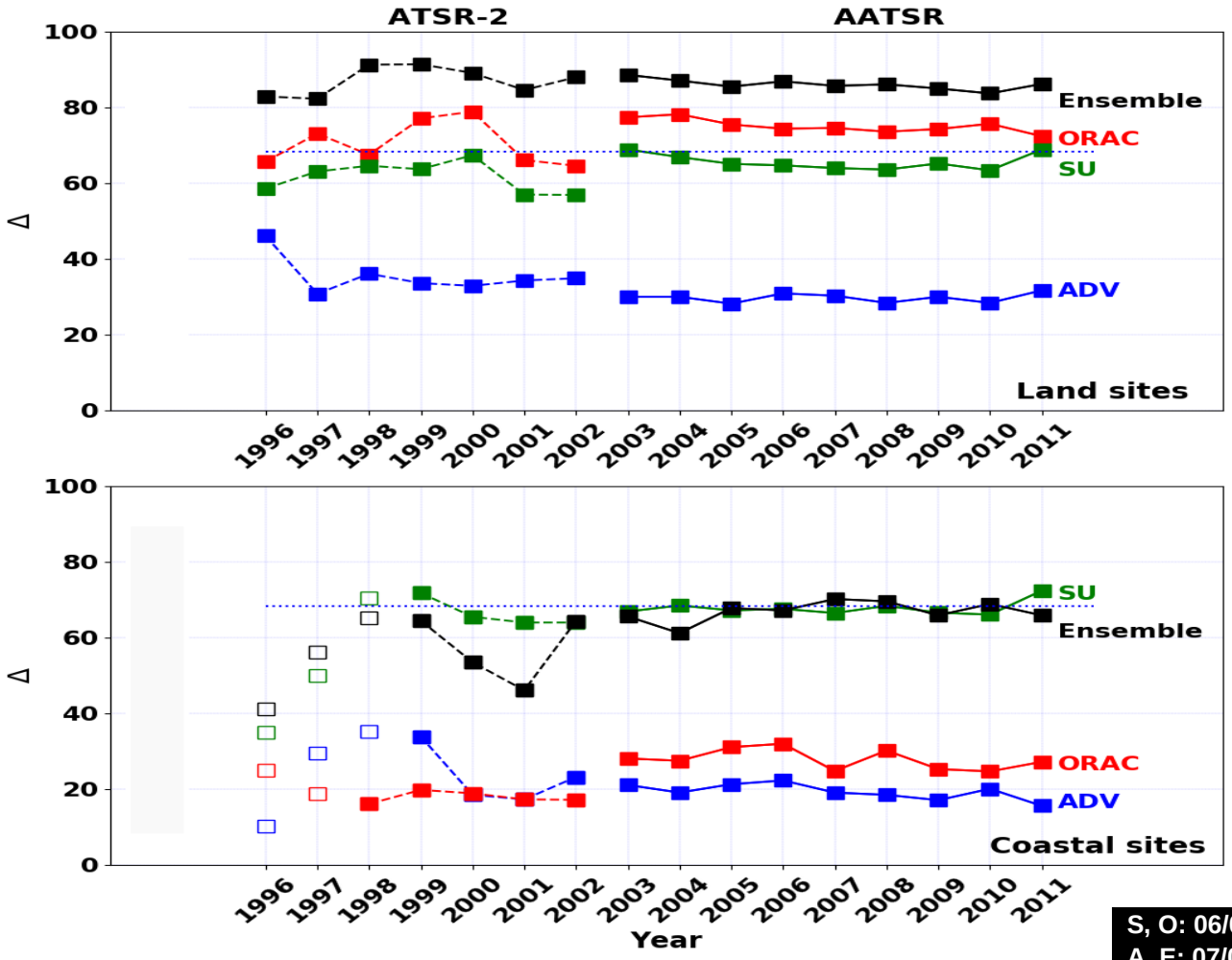








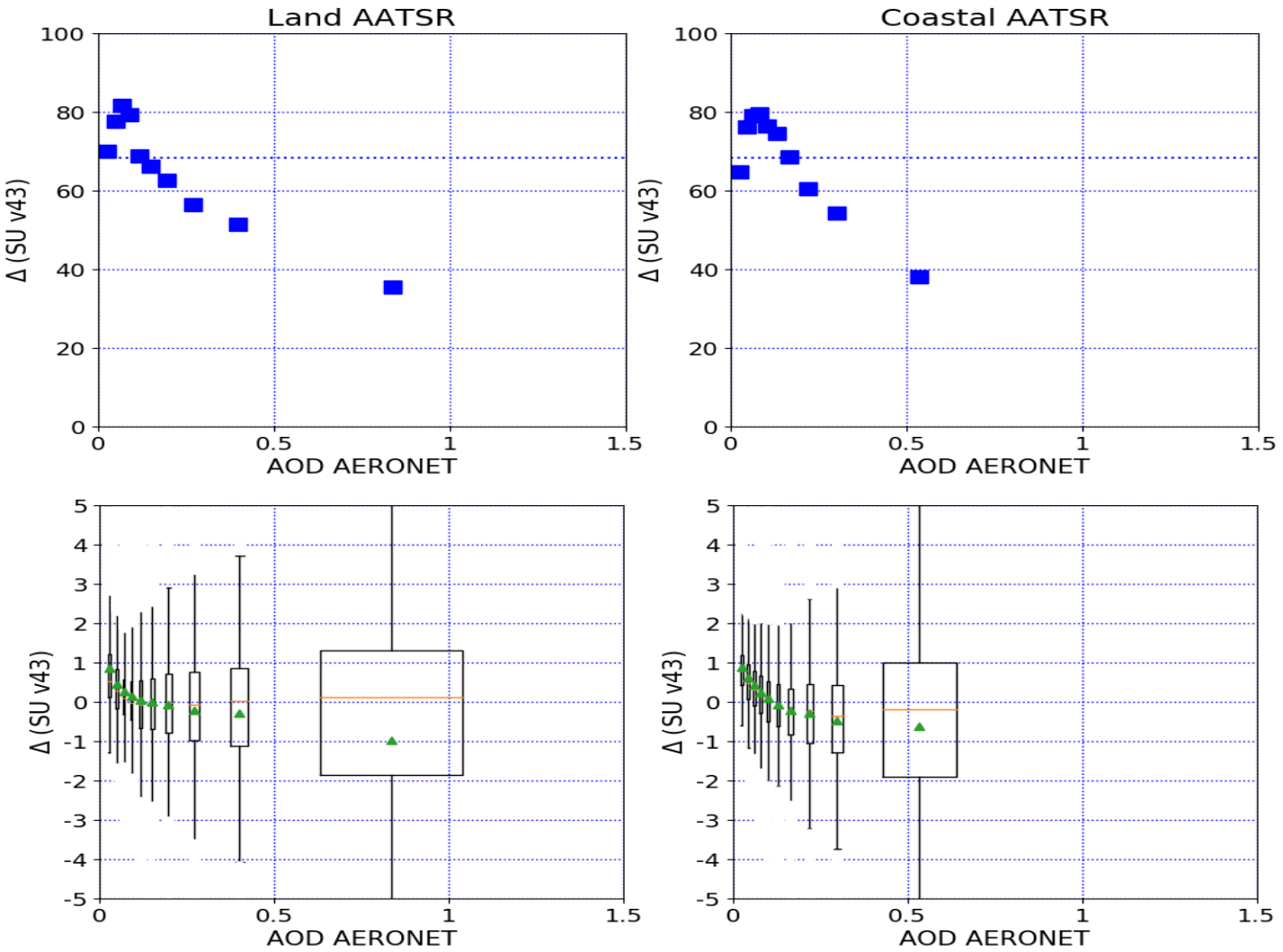
Algorithm comparison, Long term stability, Cross sensor consistency



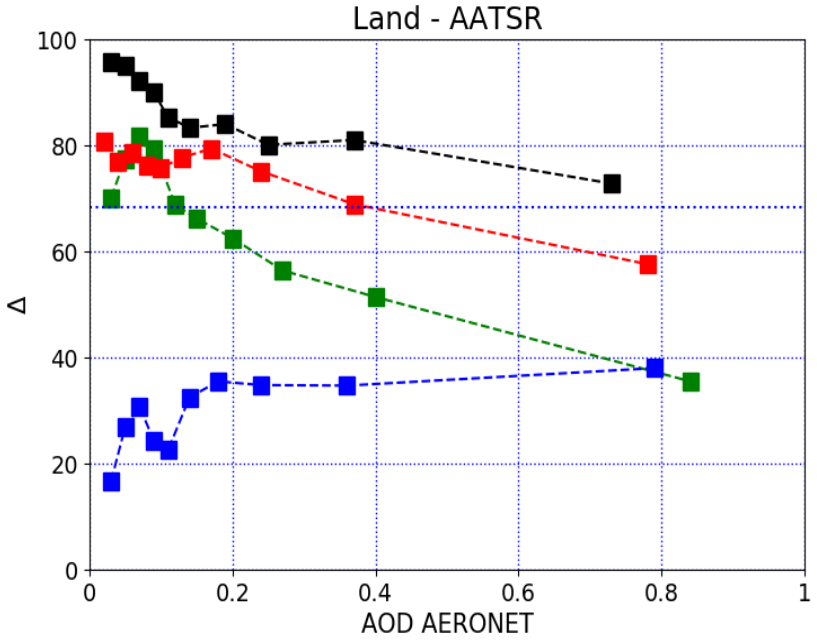
Overlapping period

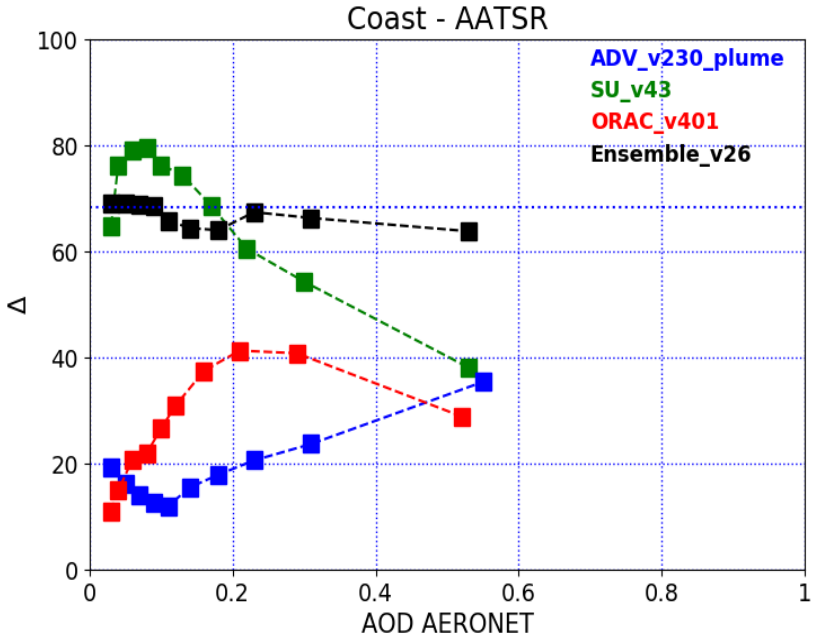
S, O: 06/02-05/03 A, E: 07/02-12/02	land		coast	
	A2	AA	A2	AA
ADV v230_plume	36	33	22	14
ORAC v401	66	75	24	24
SU v43	56	62	61	61
Ensemble v26	88	88	58	59

Dependence on AOD

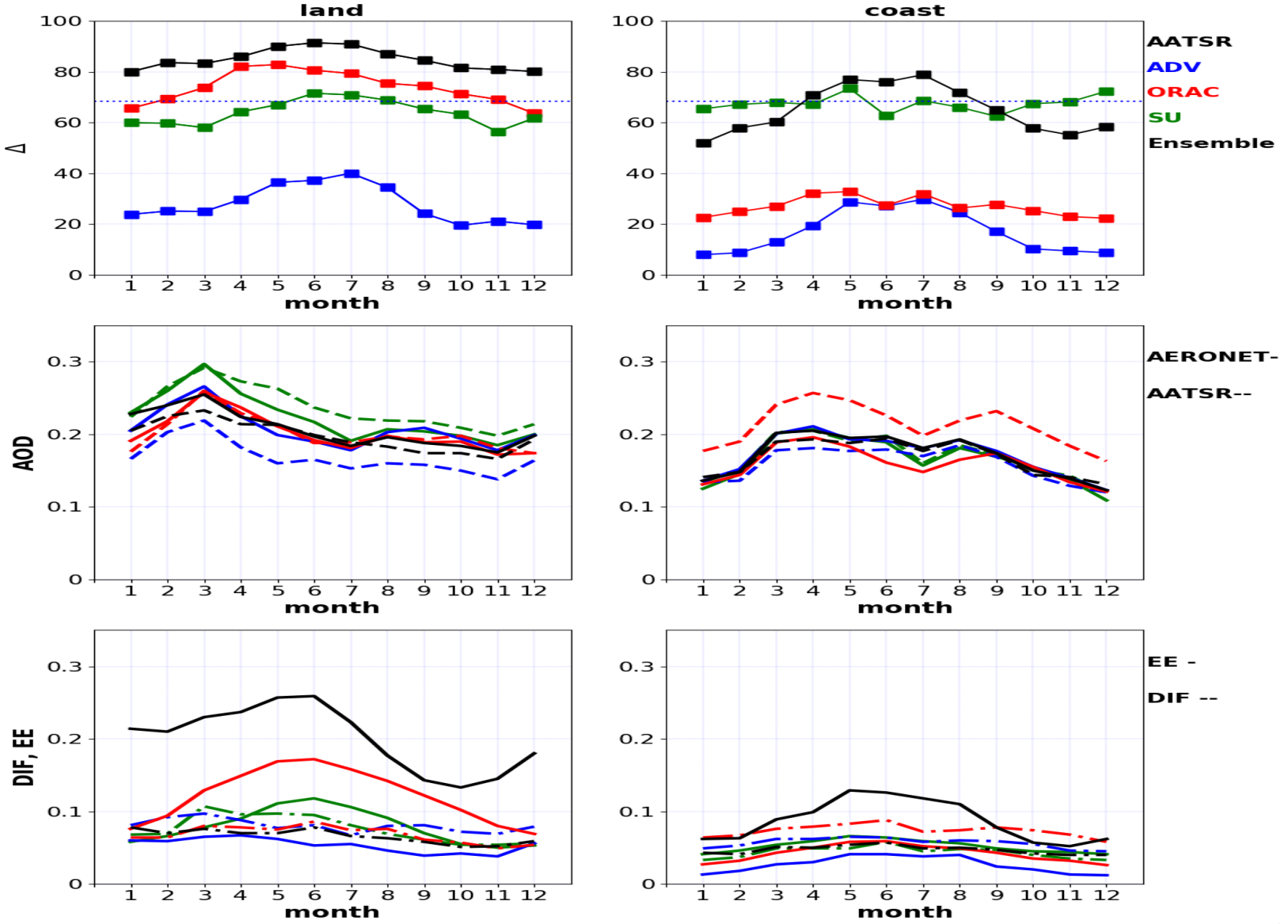


Dependence on AOD

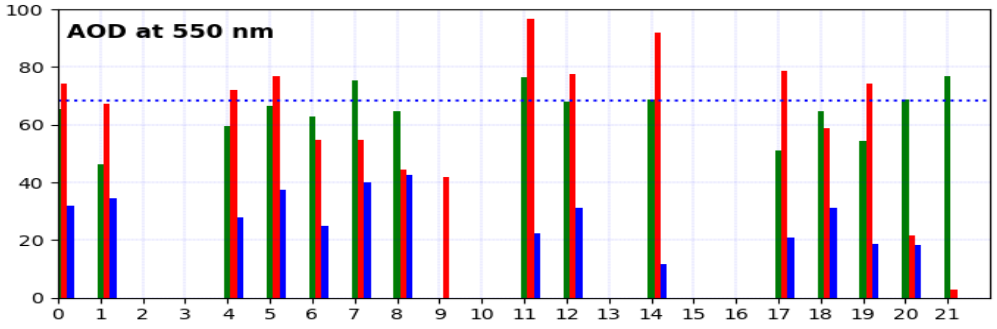


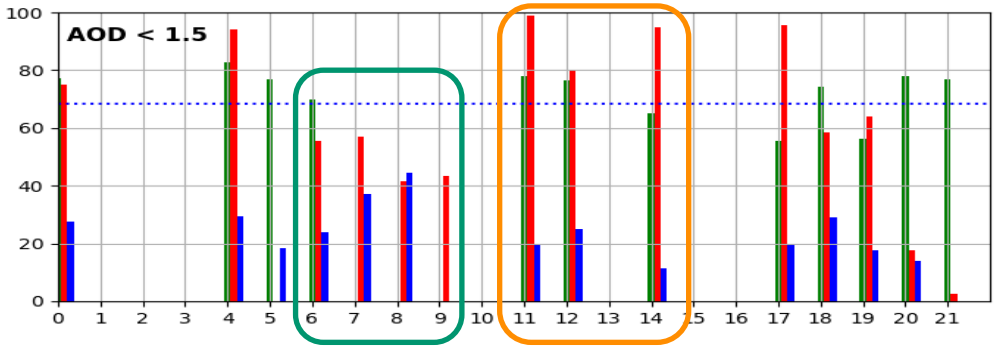


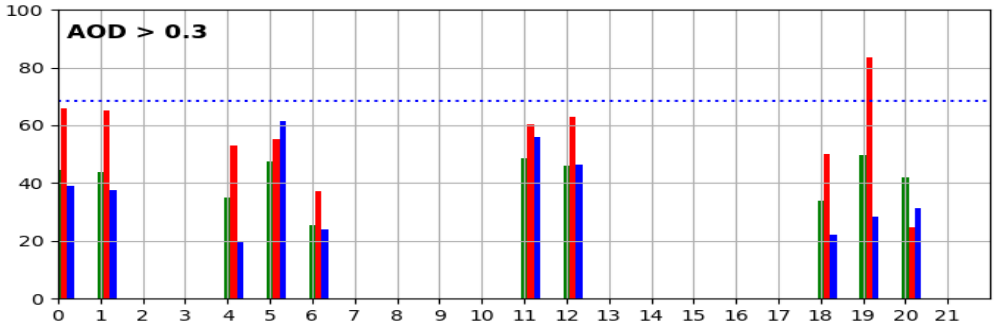
Seasonal variability in σ_{ATSR}



Dependency on surface type (use LC)

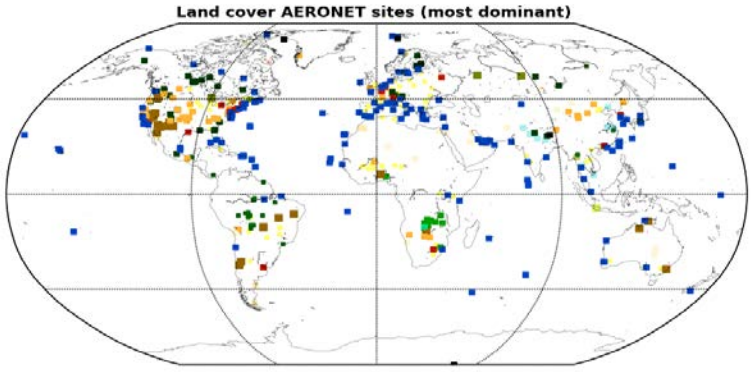






00 cropland_rainfed
01 cropland_irrigated
02 mosaic_cropland
03 mosaic_natural_vegetation
04 tree_broadleaved_evergreen_close_to_open
05 tree_broadleaved_deciduous_open
06 tree_needleleaved_evergreen_close_to_open
07 tree_needleleaved_deciduous_close_to_open
08 tree_mixed
09 mosaic_tree_and_shrub
10 mosaic_herbaceous
11 shrubland
12 grassland
13 lichens_and_mosses
14 sparse_vegetation
15 tree_cover_flooded_fresh_or_brakish_water
16 tree_cover_flooded_saline_water
17 shrub_or_herbaceous_cover_flooded
18 urban
19 bare_areas
20 water
21 snow_and_ice

ADV
SU
ORAC
N > 100



Summary L2 and questions

- Distribution of uncertainty ratio Δ is useful tool for «validation» of
  Level 2 pixel level uncertainties
- Aerosol_cci iterative evolution cycle improved pixel-level uncertainty estimates
- Uncertainty evaluation used to generate an uncertainty weighted
  Ensemble AOD data product

- Can we apply the mothodology to IASI dust AOD @ 550 nm 2007-2016 ?

- Methodology for validation of Level 3 uncertainties ?

Empirical investigation of the representation of Level 3 uncertainty

- The mean of the reported uncertainty in the pixels $\overline{AOD} = \frac{1}{N}\sum_i \sigma_i$, representing the confidence in the retrievals that went into this L3 pixel;
- The standard deviation of the pixels $\sqrt{\sum_i \frac{(AOD_i - \overline{AOD})^2}{N-1}}$, approximating the natural variability in this L3 pixel;
- The propagation of the uncertainties into the mean $\frac{1}{N}\sqrt{\sum_i \sigma_i^2}$, treating each retrieval as independent and contributing a random error
- The sum of 2 and 3, assuming that these terms represent the expected dominant sources of error
- A worst-case propagation $\frac{1}{N}[\sum_i (AOD_i + \sigma_i) - \sum_i (AOD_i - \sigma_i)]$, a very simplistic approach that should replicate twice the value of metric 1 if the distribution is symmetric.

Level 3 uncertainties

47 % 34 % 17 % 56 % 63%