USER CASE STUDIES

of ESA's aerosol CCI program

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user case studies ?

- to promote the use of their aerosol products
  - use demonstration were supported by ESA
- 8 studies

user case study	institute	lead author
Temporal trends in AOD	Met-NO	Michael Schulz
Aerosol direct radiative forcing	MPI-Met	Stefan Kinne
Aerosol-cloud interactions	ETHZ	David Neubauer
Long-term data record on UV aerosol index	KNMI	Pepijn Veefkind
Assimilations of IASI dust AOD	BSC	Sarah Basart
CCM evaluation and improvement with CCI data	MPI-C	Christoph Brühl
Temporal trends in (natural) coarse-mode AOD	Met-NO	Jan Griesfeller
Aerosol-Cloud relations in satellite data	MPI-Met	Stefan Kinne

major topics

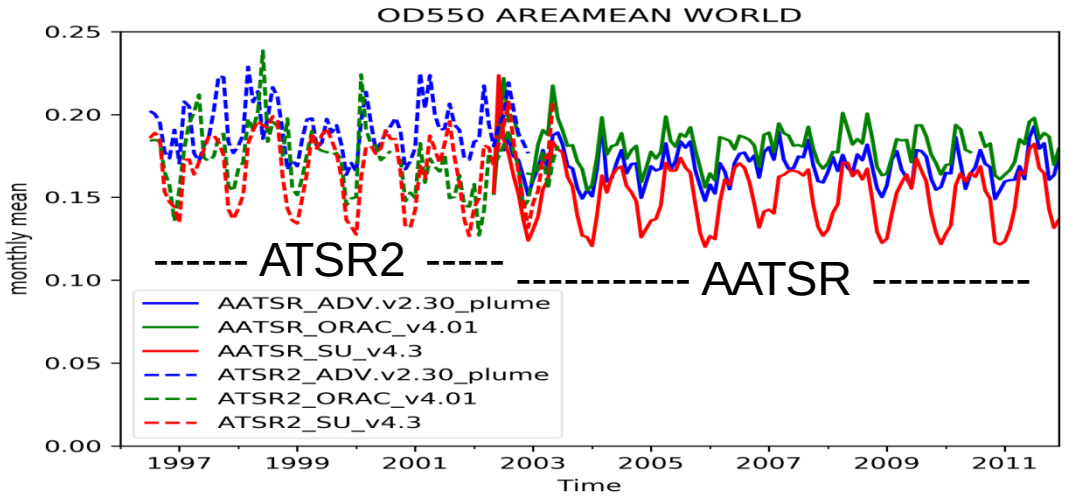
- trends in AOD
  - total AOD, fine-mode AOD, coarse-mode AOD
- aerosol cloud interactions
  - pure observations constraints
  - detailed stratifications with modeling
- modeling applications
  - assimilation / evaluation
- long-term data record development
  - UV Aerosol index … more than 35 years
- radiative transfer application
  - radiative effect and climate forcing

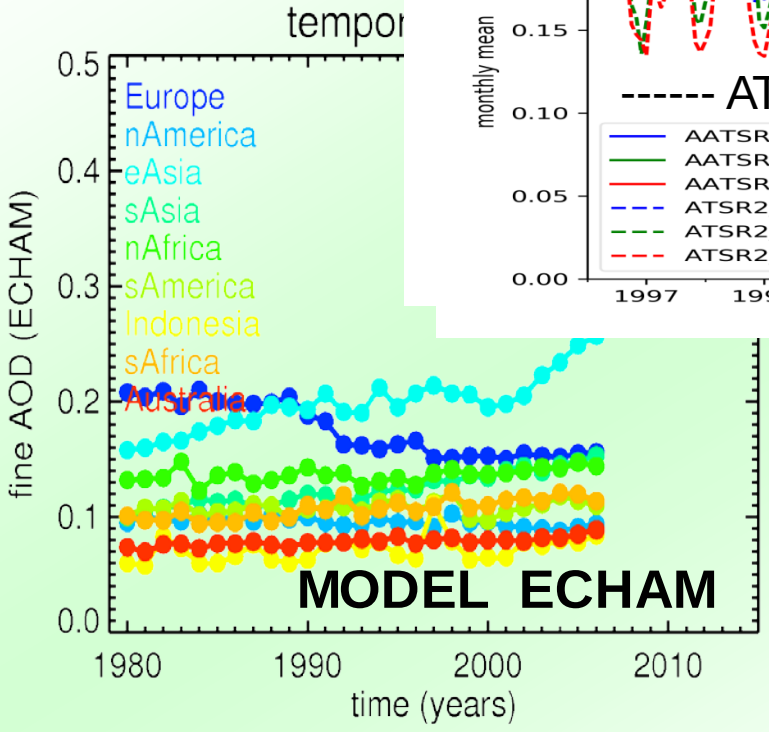
trends ? … in AOD

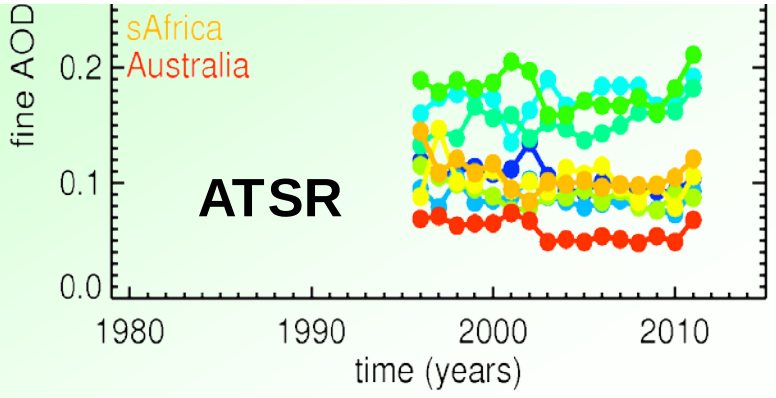
- … based on the ATSR data record (1997-2012)
- global AOD did not change much
- considering ATSR2/AATSR overlap globally AODf weakly in- and AODc weakly decreased
- regional shifts in AOD (and AODf) as expected from emission data (US/EU → S/E Asia) are confirmed … but smaller than in modeling
- regional AODc changes are uncertain as ATSR retrievals over bright surfaces are poor/missed

ATSR changes	SU		FI		OX		O4	
global averages	AOD	AODf	AOD	AODf	AOD	AODf	AOD	AODf
(2008-11) – (1996-99)	-.002	+.001	.000	+.002	+.006	+.006	+.006	+.006
(1996-99) variability	.009	.007	.016	.013	.010	.009	.019	.013
(2008-11) variability	.004	.002	.002	.003	.006	.007	.003	.004

global trends are small







fine mode regional AOD shifts larger in modeling that with satellite data

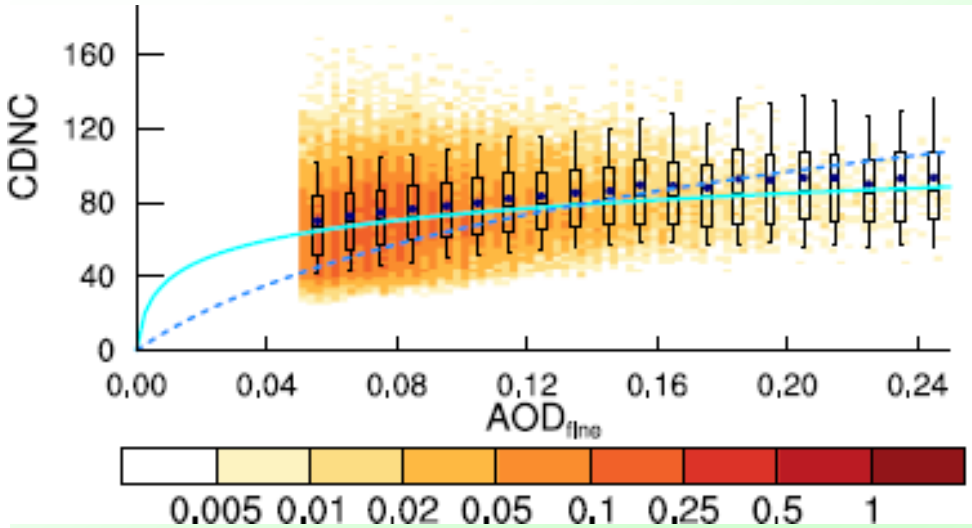
aerosol cloud interactions

- different satellite sensors (e.g. MODIS, ATSR) agree on a logarithmic relationship between aerosol and (water-cloud) droplet number
- similar aerosol-cloud relationships in modeling are much larger
- using a dry AI (rather then a wet AI - removing the aerosol water) as aerosol number proxy brings cloud-aerosol relationships more in line with those by satellites

‘twomey’ dominates

more aerosol -> smaller drops – higher albedo

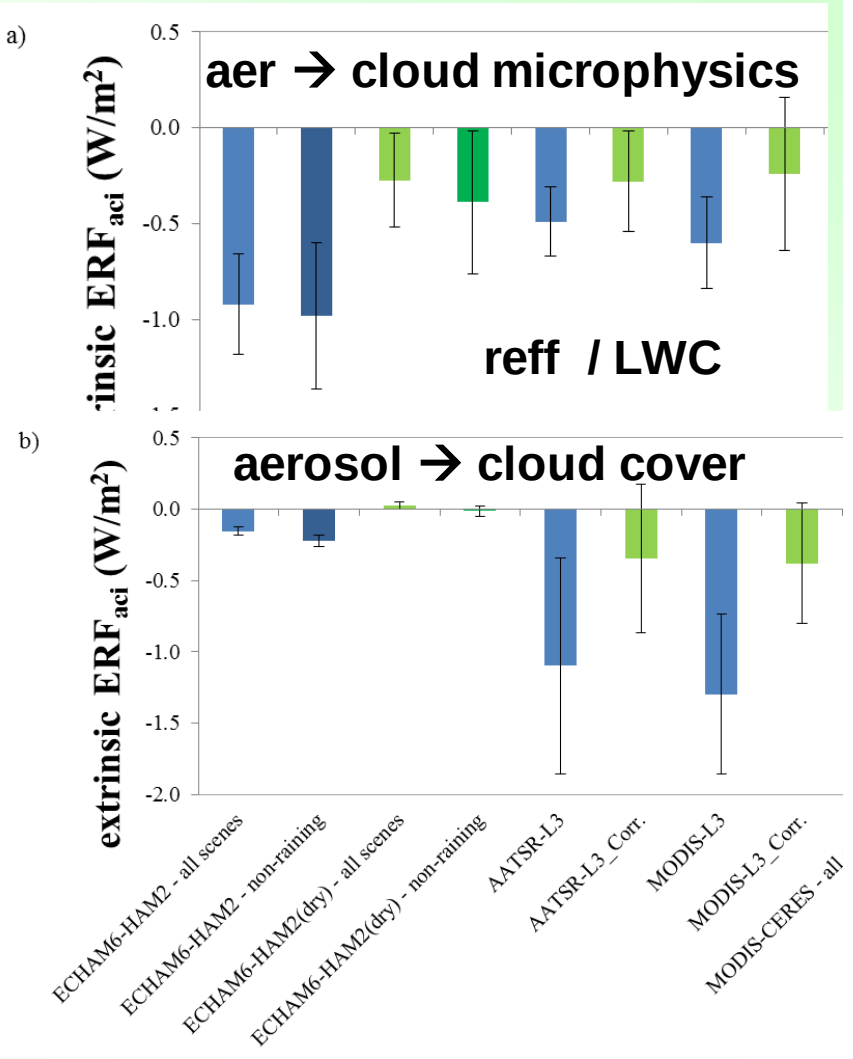
- **logarithmic relation**



aerosol number proxy

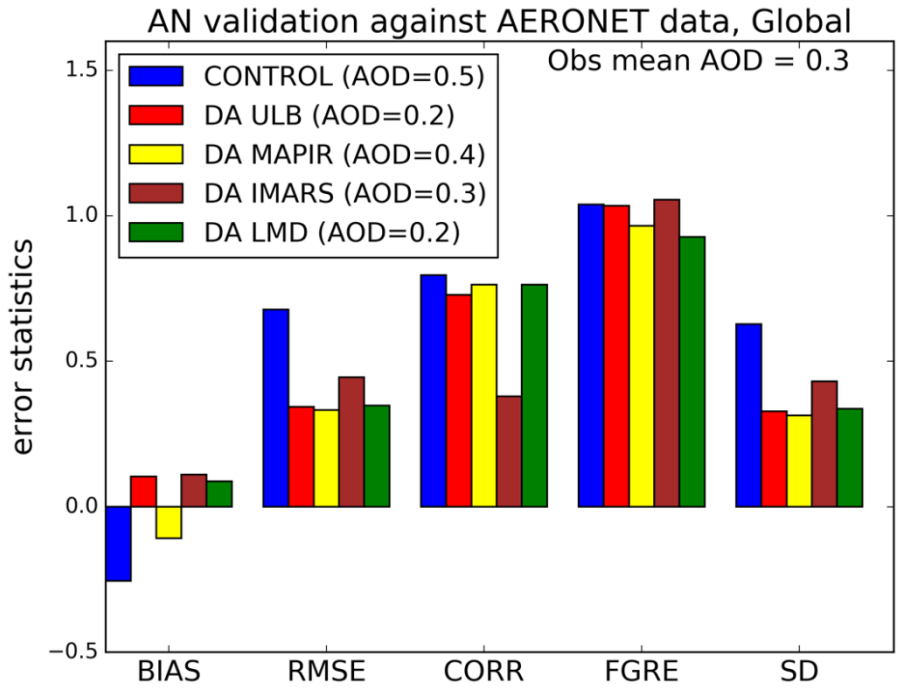
Satellite CDNC = a *ln(-1000*AODf)
Model CDNC = b*ln(-20*AODf)

- **much stronger in AeroCom modeling**



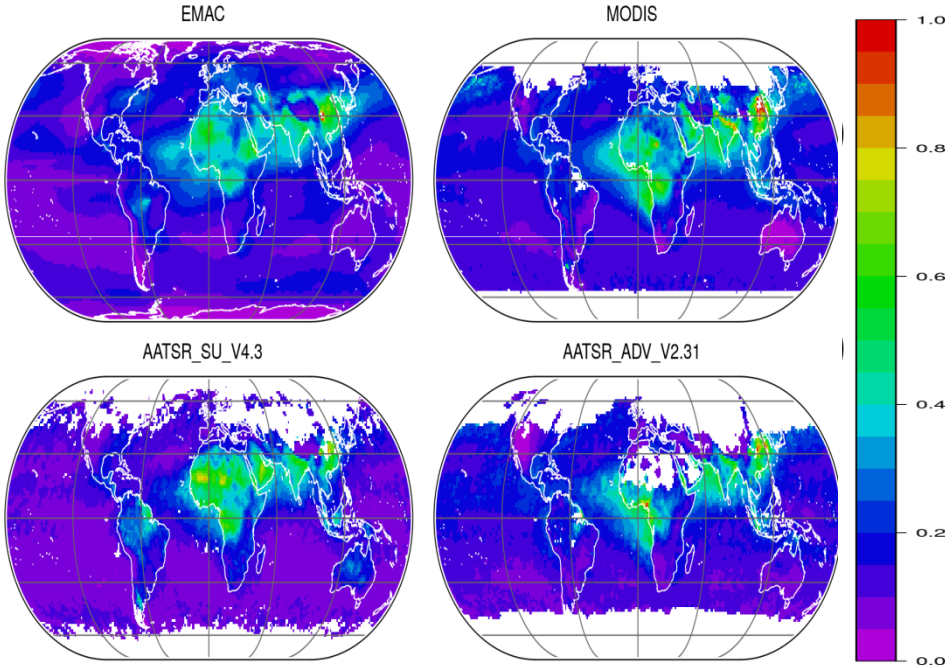
applications in modeling

- **Multi-annual AOD maps by different sensors (ATSR, IASI) are used to constrain component properties (e.g. dust size, dust amount)**
- **Validated model is used to simulated observed regional features as function of altitude (e.g. GOMOS, MIPAS)**
- **Data from different aerosol retrievals are applied in assimilation to rank through forecast quality their usefulness (e.g. IASI)**



assimilation

- lower RMSE with IASI dust AOD assim.
  - 4 diff. retrievals



evaluation

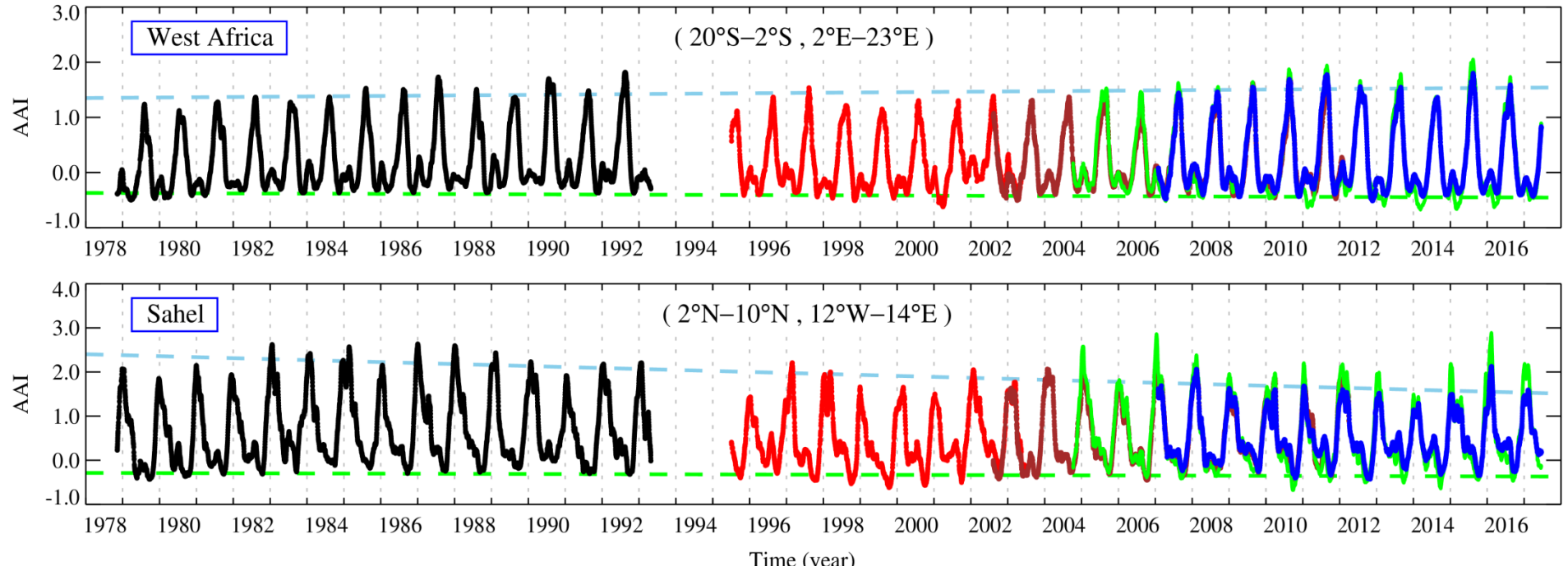
- Model vs retrievals
  - MODIS
  - two diff ATSR.

Long-term data records

- **ATSR (1995-2012) AOD, AODf** (AODc)
  - **3 different versions by 3 retrieval groups**
    - **ATSR2 (vs AATSR): less cover, consistent?**
    - **AATSR time-series (2002-12) more stable**
- **IASI dust AODc (2002-2012)**
  - **4 different versions by 4 retrieval groups**
    - **only sensitive to large dust sizes (>1um)**
    - **IR to vis conversion adds uncertainty**
- **TOMS/OMI/GOME UV AI (1979 - …)**
    - **qualitative info on aerosol absorption**
    - **limitation: dep on both altitude and absorption**

UV-AI time-series

- very sensitive to biomass burning activity
  - seasonal varibility
  - interannual strength (assuming same altitude)

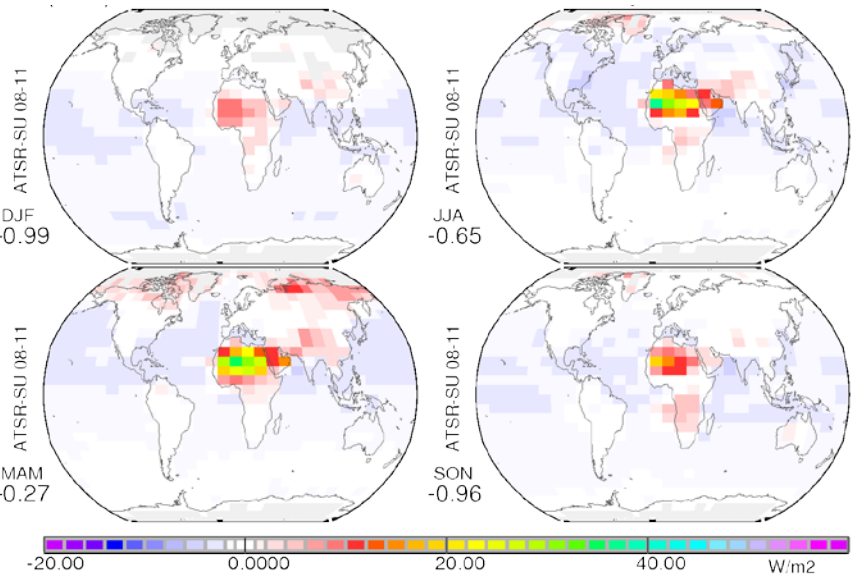


data record from different sensors: **TOMS** **OMI** **GOME** **GOME-2**

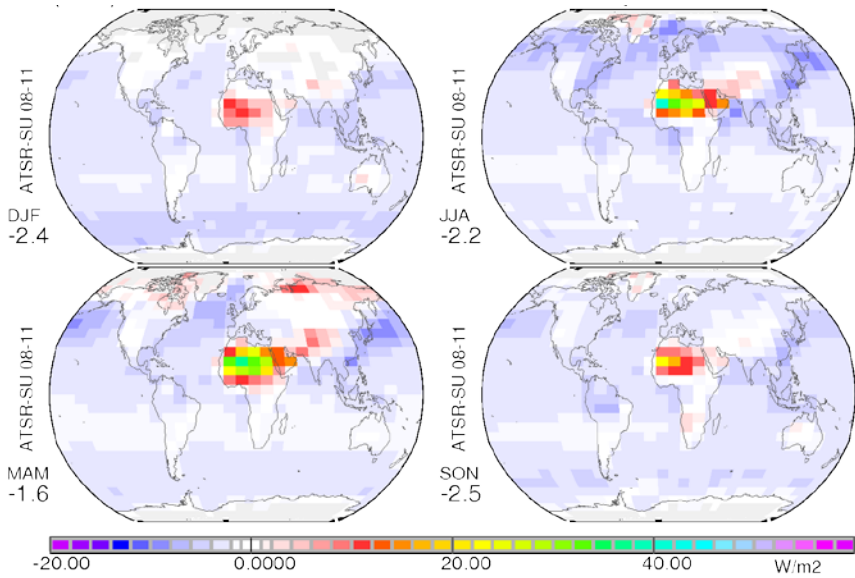
radiative transfer application

- ATSR (Swansea) data are applied in RT code
  - AOD values are substituted in MACv2
  - nice demo of radiative forcing anomalies
- general radiative forcing results
  - direct aerosol radiative effects / forcing have a strong regional and seasonal character
  - today's anthropogenic aerosol accounts only for 30% of AOD … but > 50% in number
  - clouds modulate the clear-sky aerosol cooling forcing but likely strengthen the cooling
  - aerosol induced changes to clouds are more important for climate cooling than direct eff.s

seasonal rad. effects with 2008-11 ATSR AOD data

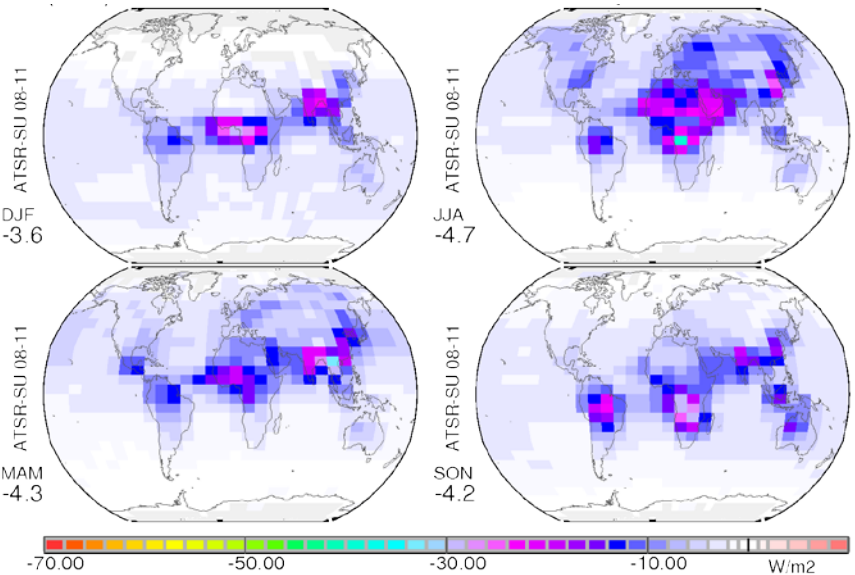


TOA

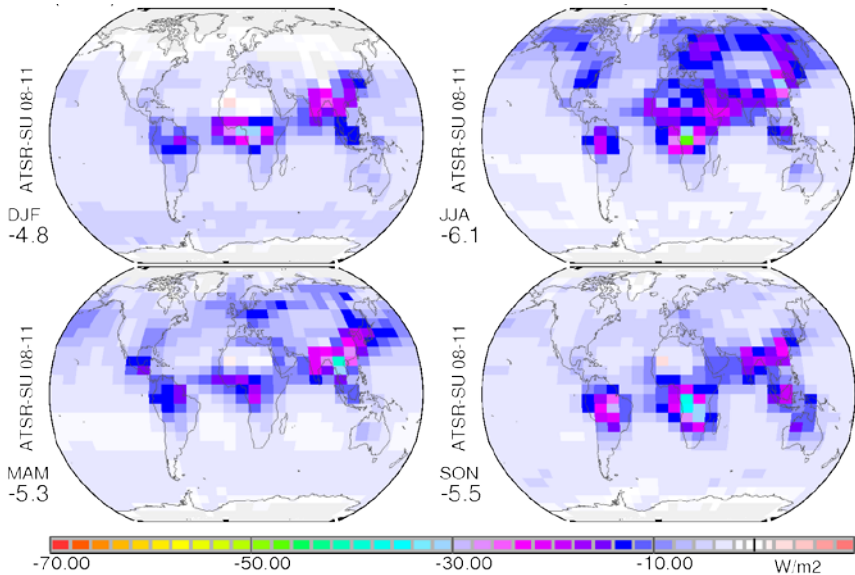


all-sky (with clouds)

clear-sky (no clouds)



surf



summary

- major results of the 8 (aerosol CCI) supported user case studies are summarized in a CCI-document (available at the end of the year)
- the seed money yielded interesting results especially in comparisons to modeling
- some studies also revealed data limitations (e.g. length of record, biases) when it came to deriving trends … but strengths of continuous data are rather (seasonal) anomalies