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Spatial and Seasonal Variations of Aerosols over China from multi-satellite observations

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Objectives

- Create a multi-satellite* based climatology of aerosols over China
- Use this climatology to describe the spatial and temporal variations of aerosols of China
- Determine trends

* Satellite-based instruments used:

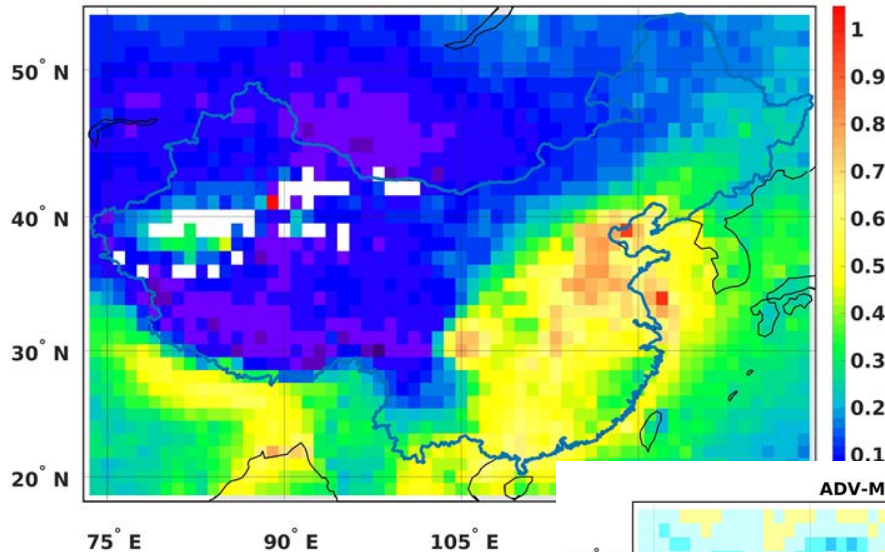
- ESA: ATSR-2 (ERS-2) 1995-2003 (Aerosol_cci)
- ESA: AATSR (ENVISAT) 2002-2012 (Aerosol_cci)
- NASA: MODIS (Terra) 2000-present
- NASA/CNES: CALIOP (CALIPSO) 2007-present



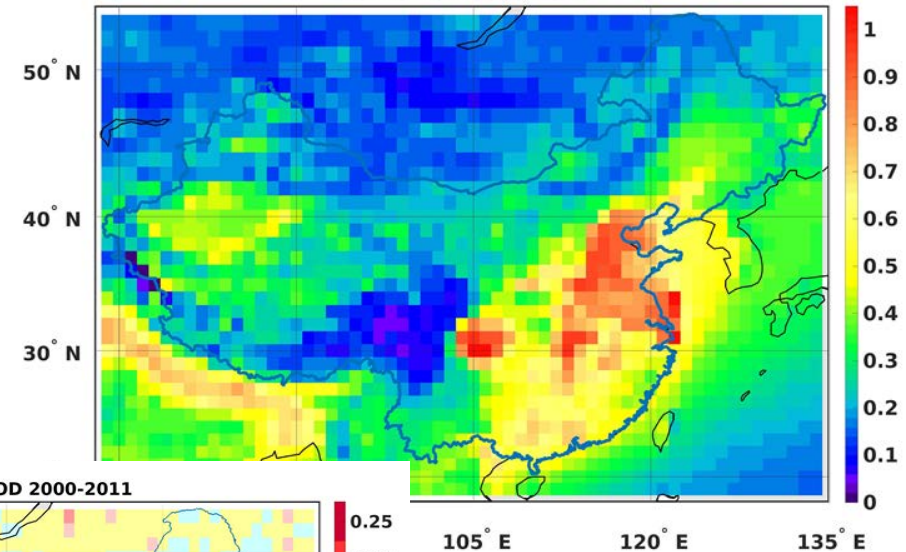
AOD data sets 1995-2015

ATSR: ADV v2.30-plume L3: 1995-2012 **MODIS-T C6 DTDB merged L3: 2000-2015**

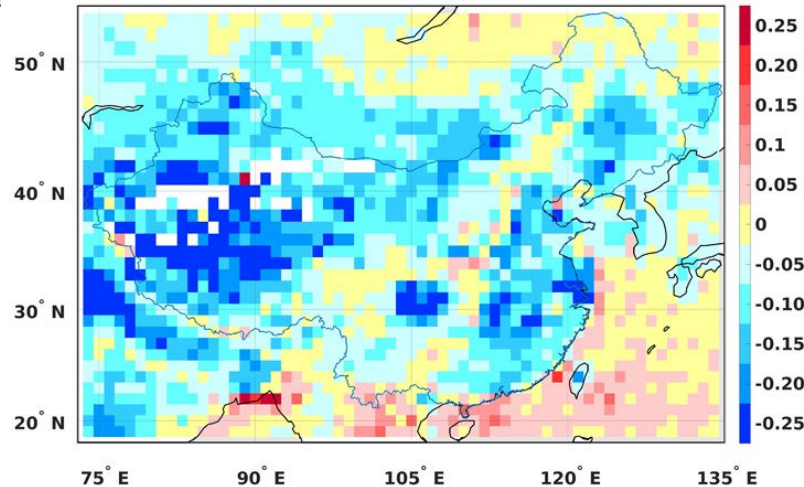
ATSR ADV AOD 2000-2011



MODIS AOD 2000-2011

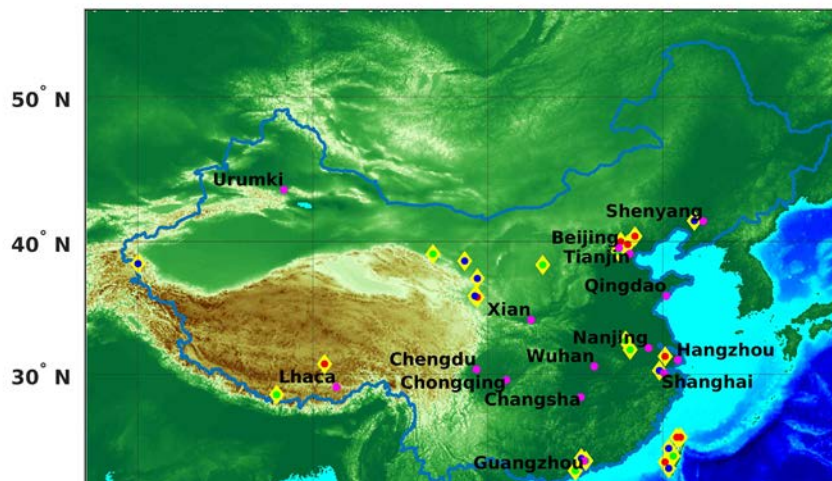


ADV-MODIS AOD 2000-2011

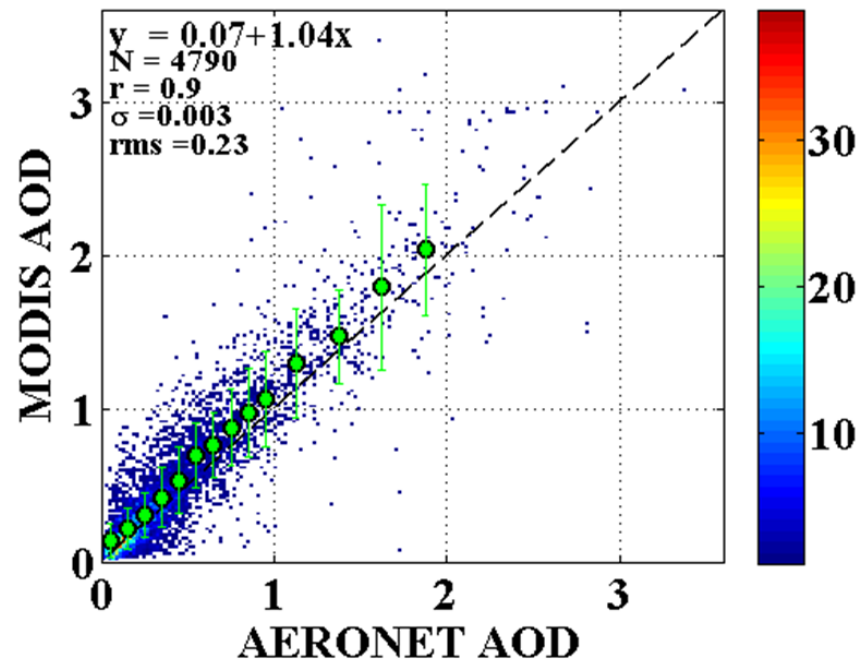
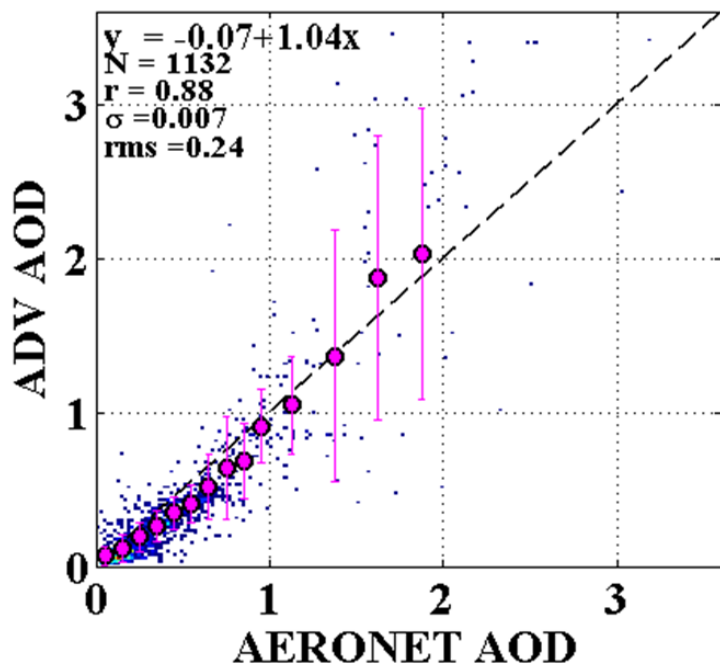


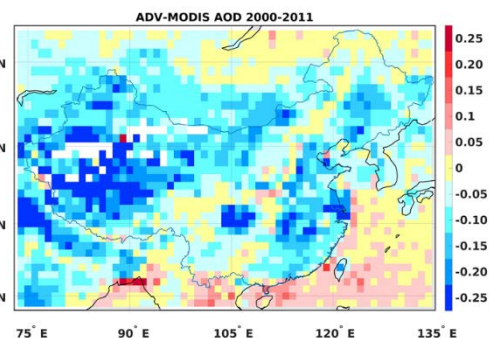
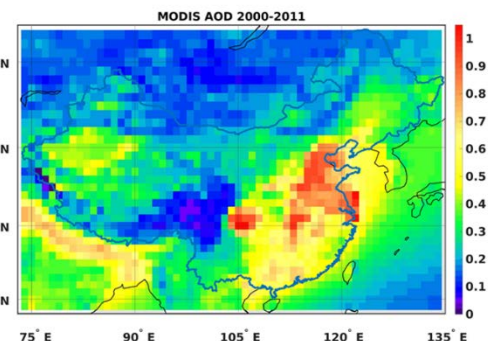
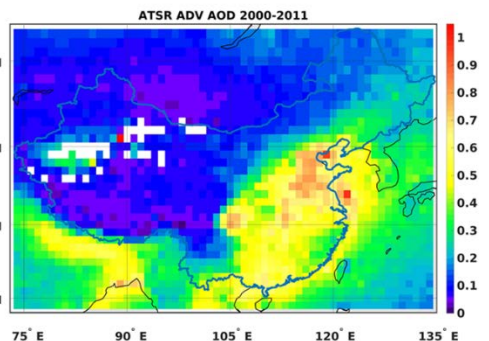


Validation vs AERONET



AERONET (◇) data series
red: years
green: months
blue: days

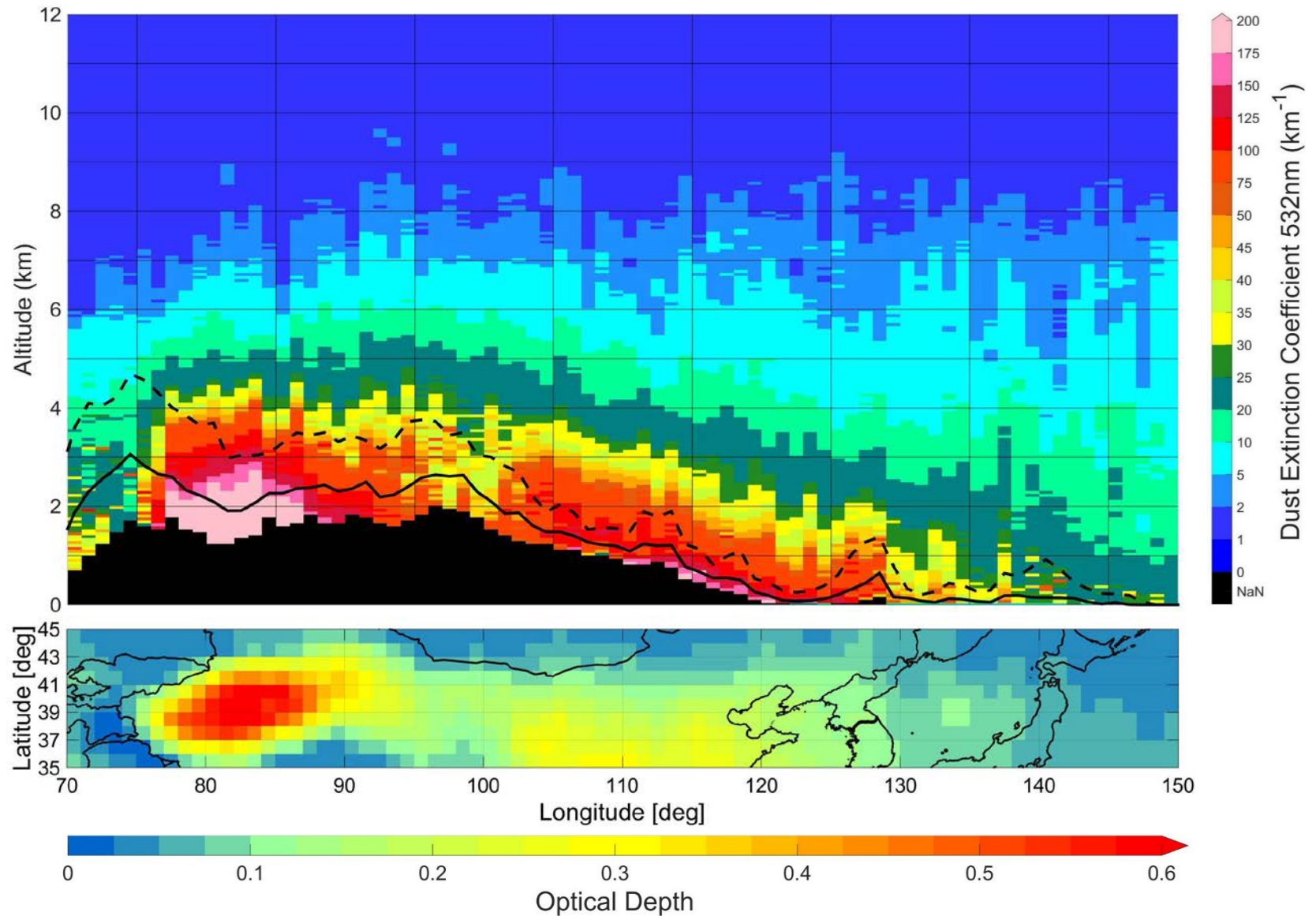




Conclusions:

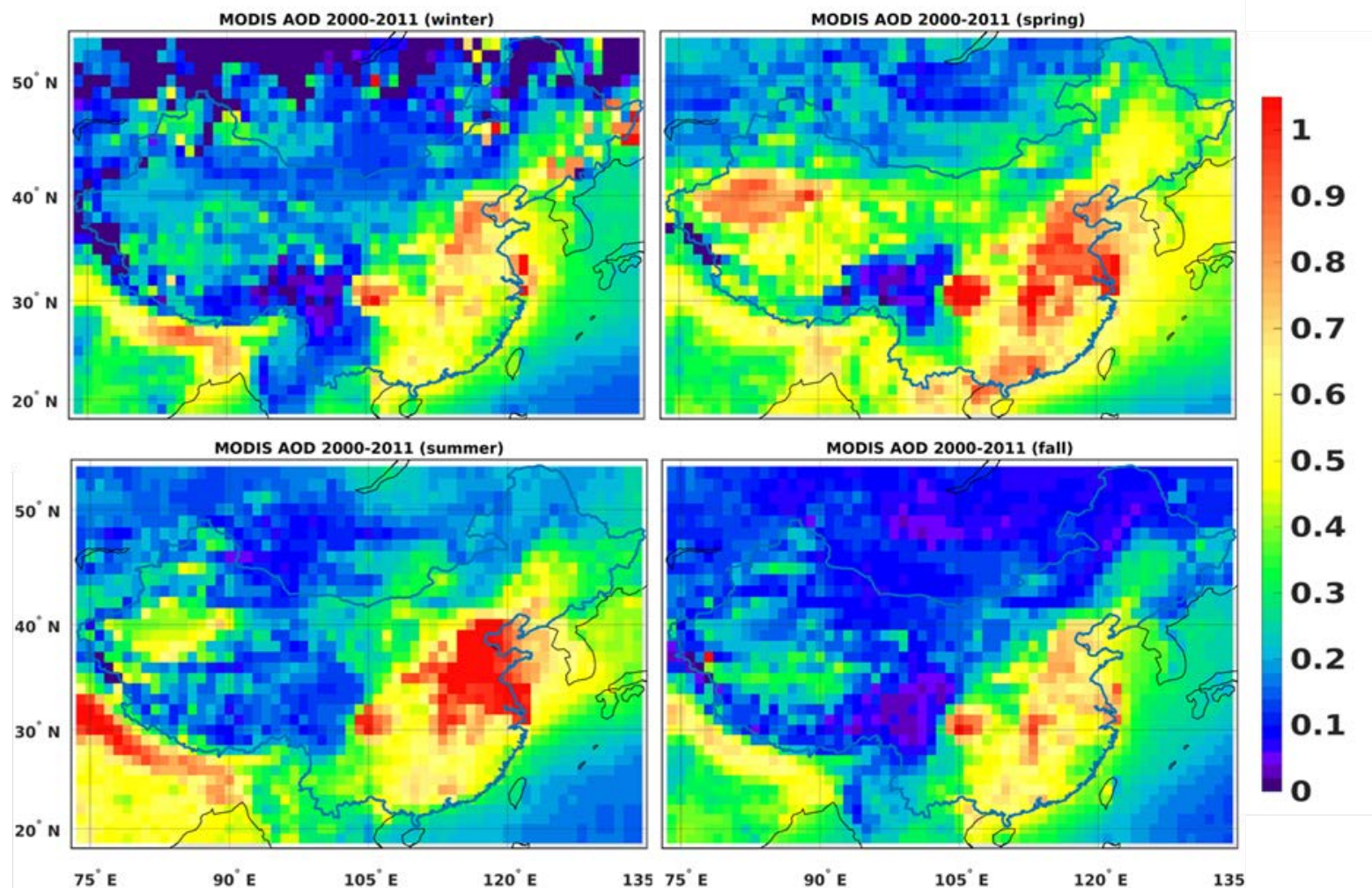
- MODIS AOD is generally higher than that from ATSR, in particular over the Taklimakan desert where the ADV algorithm is not performing well (bright surface)
- However, both MODIS and ATSR compare very well with AERONET, with similar metrics
- MODIS slightly overestimates
- ATSR slightly underestimates
- Together this results in a difference of up to ~ 0.2
- The discrepancy increases with increasing AOD
- Using MODIS and ATSR together extends the temporal coverage
- The use of both ATSR and MODIS adds information over the use of only one of these sensors
- This conclusion was also reached from CMUG data assimilation experiments

CALIPSO 3D (horizontal and vertical) variability of Dust (MAM 2007-2015)



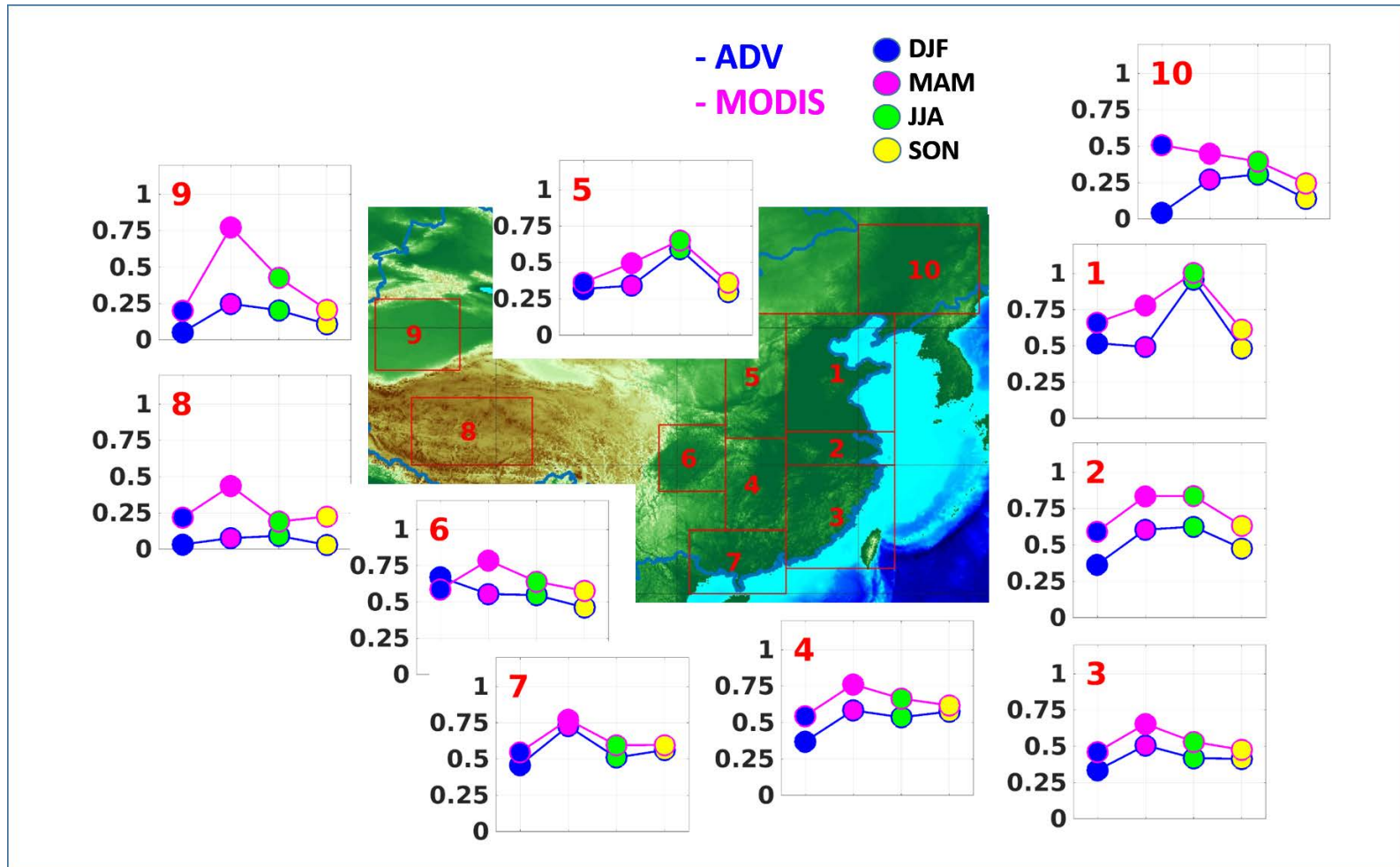


AOD seasonal variation



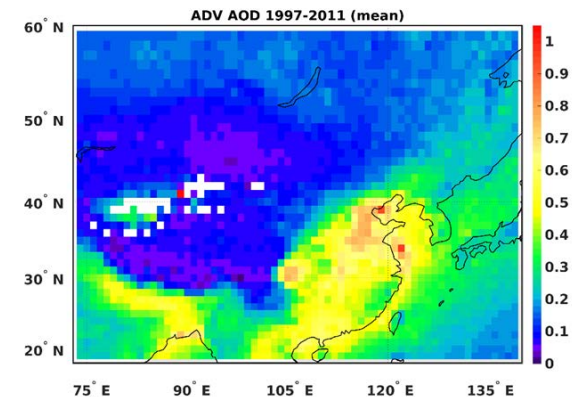
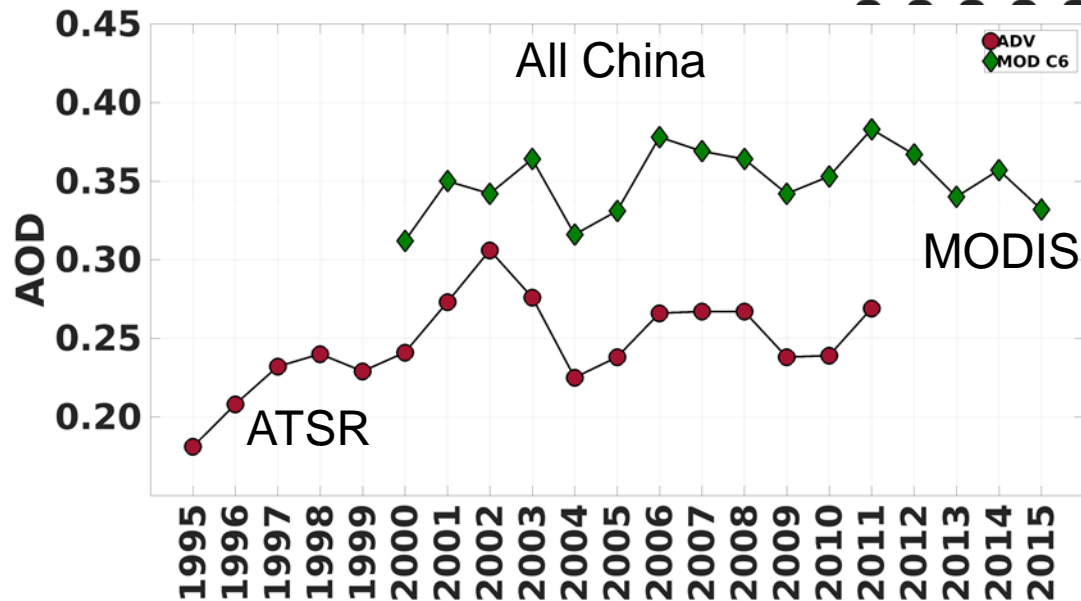
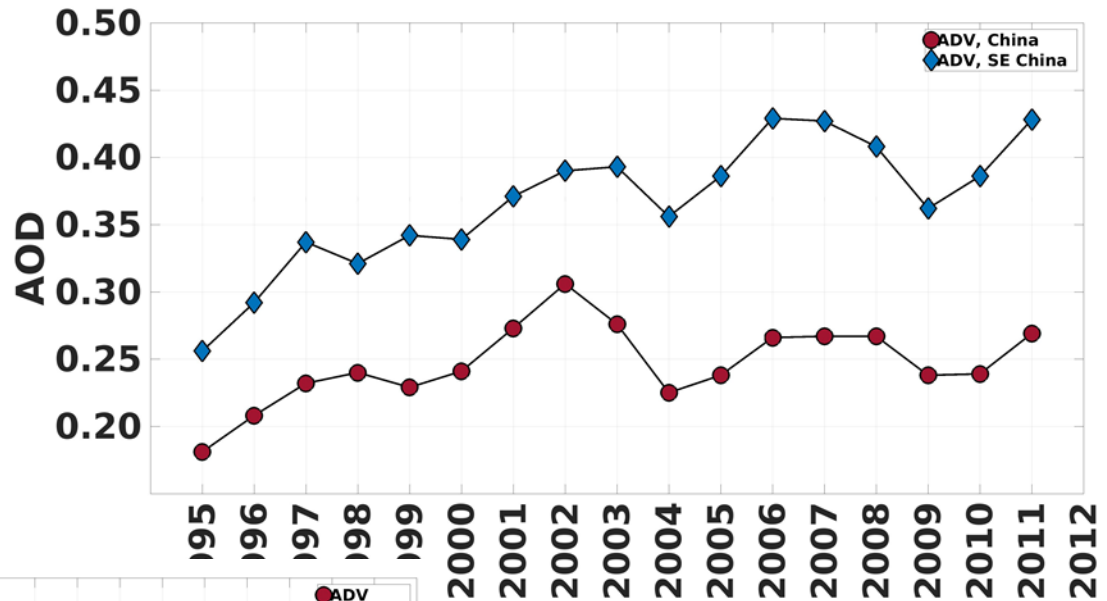


AOD seasonality changes by region





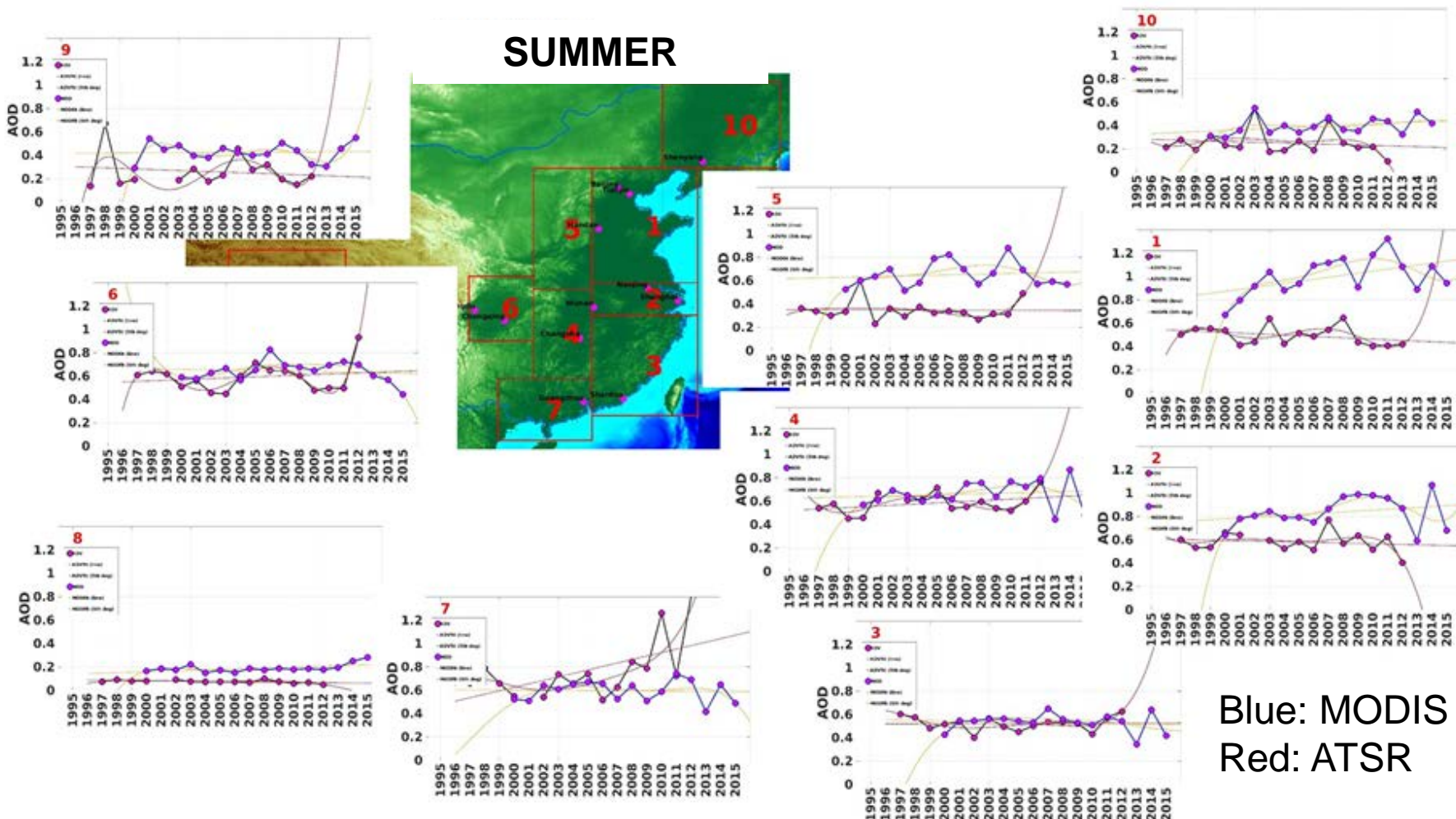
AOD time series: 1995-2011-2015 (Annual means)





Time series by region, over land (1995-2011-2015)

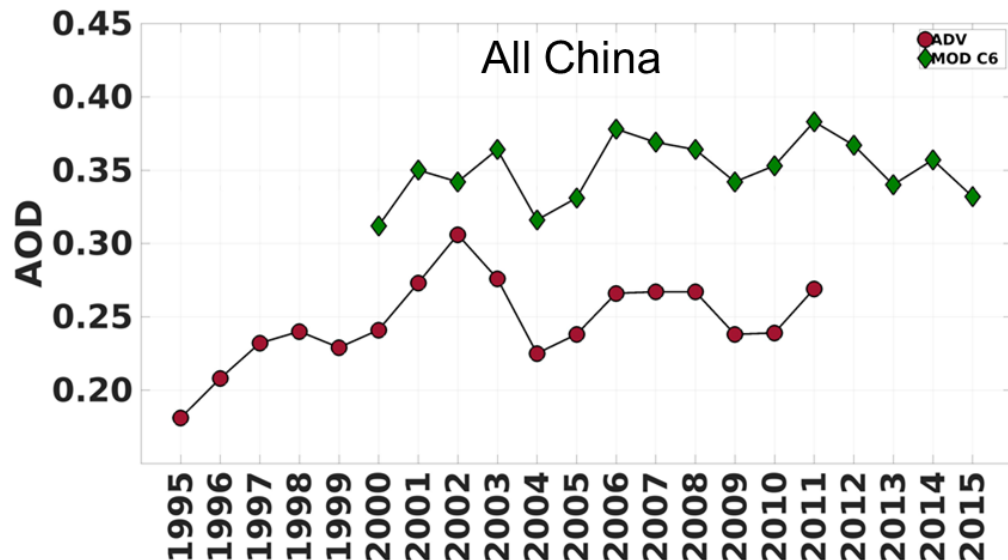
SUMMER



Blue: MODIS
Red: ATSR



AOD time series: 1995-2011-2015 Annual means



Discussion:

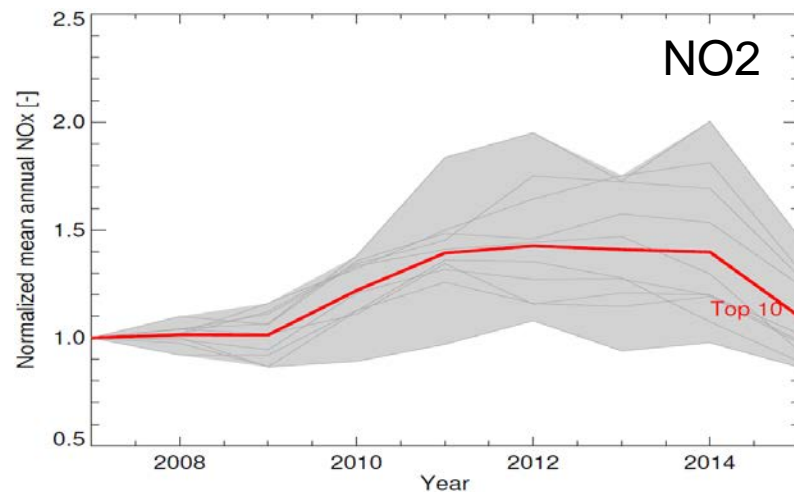
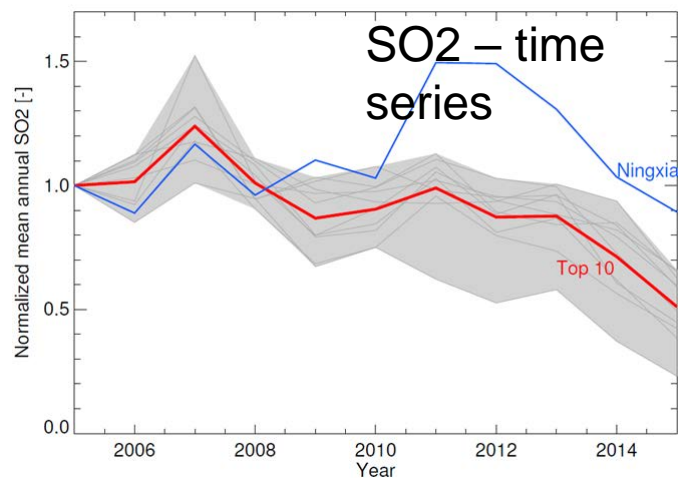
Trends:

- 2006-2008 pivot point (refs)
- Economic recession end 2008(refs)

- Emission policy (refs)

Natural variability:

- Natural emissions (e.g. dust, natural fires, VOCs)
- Meteorological factors and large scale circulation





Conclusions

- **ATSR improvements:**
 - ADV v2.30-plume better coverage of high AOD episodes
- **MODIS C5.1 > C6**
 - Merged DB and DT
 - Differences in AOD distribution: MODIS C6 vs C5.1 & MODIS vs ATSR
- **Analysis**
 - Satellites provide the spatial, vertical and temporal distribution of aerosols
 - Time series regional variation varies S-N and E-W
 - Seasonal variation is anti-correlated with PM2.5
 - Decadal time series: trend analysis per region
- **Better understanding of processes:**
 - Regionally seasonal differences in meteorology, emissions, large scale circulation
 - Year-to-year variations
 - Precursor emissions in response to policy measures and / or natural causes (SO₂, NO₂; VOC)



Acknowledgements

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- The ATSR algorithm (ADV/ASV) used in this work is improved with support from ESA as part of the Climate Change Initiative (CCI) project Aerosol_cci