Review of revised paper:

Satellite observations of aerosol and clouds over southern China from 2006 and 2015: analysis of changes and possible interaction mechanisms.

by N.Benas et al.

Positives

- changes in aerosols properties (now also MISR) are examined over the last decade
- changes in satellite retrieved cloud properties over last decade are analyzed
- exploring co-located changes in aerosol and cloud retrievals (if not for insights in potential aerosol-cloud processed then at least) are constraints for transient model simulations.

Concerns

- GFED (biomass) emissions are insufficient to explain AOD(f) trends - and industrial emissions apparently neither … but at least show both seasonal cycles and their changes over time the figures – could meteorology be an explanation (monsoon?, clouds?).
- the examined region is relatively small
- many data limitations / inconsistencies are recognized but not further explored … so the value of the paper is limited (suggested links remain speculative).

General comments:

This study examines co-located 'observational data' based on satellite retrievals for aerosol and clouds. By exploring monthly retrieval data over a decade in relatively small region over southern China speculation on aerosol cloud interactions/processes are made.

Compared to the initial version I am happy to notice that the poorly defined CALIPSO type has been removed from the argumentation chain, that now MISR AOD and fine mode AOD have been included and that there is a move to a coarser temporal averaging from one to two months (although only in tables, but not in the Figures).

My analysis shows for the MODIS data an AOD decrease in the region, which is at maximum in fall with -0.23 (from 0.57 to 0.35) for the AOD decadal decrease and -0.15 (from 0.34 to 0.19) for the decadal fine-mode decrease. For MISR data we have an AOD decrease in the region, which is at maximum in fall with -0.13 (from 0.40 to 0.27) for the AOD decadal decrease and -0.09 (from 0.23 to 0.14) for the decadal fine-mode decrease (see attachment with plots with special distributions of absolute values and anomalies). These are very large changes in AOD, so the idea to related responses in associated cloud properties seems to have its merit. For that time-range the decrease in seasonal MODIS based CCN data over the ocean is consistent though not associated with the fall season (annual, monthly data available on request).

The paper is about aerosol properties trends and cloud property changes over the last decade and there are still gaps in data interpretations. While it is assuring that data from different sensors often agree, the association among the different aerosol properties (AOD, AODf, AODc spatially and seasonally) and cloud properties (COT, phase, LWP, reff spatially and seasonally) should be better harvested to draw a better basis (before trying to link aerosol and cloud data for potential processes/interactions).

The authors addressed all comments, which more focused on explaining what and why things were as they are. This way, opportunities for improvements were avoided and missed. The paper is an analysis of retrieved cloud properties and retrieval aerosol properties both for the last decade over small region over southern China. Even if significant temporal trends are identified it is still a big task to draw potential interactions from trend associations.

As long as the paper keeps focusing on a solid analysis for aerosol and cloud retrievals and observed (relative) changes this contribution is interesting and useful, even though the applied region is relatively small. I still wonder about the changes to other related properties (e.g. cloud top height, rain, surface temperature). The interpretation certainly is tempting though speculative … and rather an element for the discussion section. Try to be more convincing!

Figure 1

I am not sure if this plots is necessary as the focus is on changes. Still I wonder why MODIS is so much different to MISR (I tend to trust more MISR retrieval capabilities over continents and I would show MODIS AODf and AODc to add up to total AOD (I do not understand the large gap between AOD and (AODf+AODdust). I suggest to plot seasonal data (if you have to show regional average instead of maps) for a period near 2006 and a period near 2015 one for MISR (total, fine, coarse AOD), one for MODIS (total, fine, coarse AOD), one for GFED and one for fossil fuel emissions.

Figure 2

the AOD change (should be 2015-2006) seem way too small – based on my analysis for this region (check!). And patterns are more informative to me than trend plots.

Figure 3

The GFED data are down not only in fall but also in winter, while AODf an AOD values are minly down in fall. Thus, lower GFED emissions are a contributing factor but not the sole explanation. I love to see differences in fossil fuel emission (S.Smith has published data). Have you considered an shift in monsoon activity (e.g. are there seasonal precipitation data?) If it was more wet in fall the this also could explain (by wet removal, lower AOD, AODf and CDNC data).

Figure 4

Same complains as in figure 1: Show typical seasonal data for periods near 2006 and periods near 2015. I rather trust relative difference (which are just needed here) than absolute retrievals.

Figure 5

changes: 2015 minus 2006. I take from this figure that the liquid water path increase is much larger than the cloud cover increase → more convection → more wet removal? I am also puzzled why the effective radius increase is much larger than the COT increases. Does that mean that cloud tops are higher (with larger droplets on top). There is more interpretation needed to understand these retrieval cloud properties … that is if we can trust them.

Figure 6

In the last 10 years for clouds reff, COT, LWP and cover all increased … what does this mean for cloud type frequency … and then we can think about potential impact on aerosol.

Figure 7

You are talking about 2 month data analysis … but plots still show monthly anomalies. Maybe you can show 3 month running averages? The largest aerosol reductions are in fall… but the largest cloud properties are in winter. Is there really a link (e.g. do you believe in a seasonal time-lag?)

Figure 8

I am puzzled about the big changes in Calipso profiles within 2 months. Is there a good reason why these extinction profile changes are so different?

minor comments to the responses

in the response it is mentioned that the reasons for why properties observed as they are, are only of secondary concern, as in the end associated changes between aerosol and clouds are of interest. I disagree and I think we first should understand why satellite retrievals do change over time so we have more confidence that what we eventually do compare is meaningful.

Thanks for checking that industrial emission apparently even increased. Unfortunately it is not clear if seasonal variations are offered (as I could not find the supplement). This background information deserves to be part of the paper. Other background changing elements would be temperature, [solar] radiation, precipitation and the monsoon time-period.

In the response to reviewer 2 there is a figure with CEOS emission. Now it would be interesting if there is a seasonality to these emissions or do they just provided annual averages?

Overcast cloud conditions: since these are required for bi-spectral retrievals methods (COT, reff) I wonder if that frequency changed? Are there other properties that can provide insights on why the cloud properties have changed? Did the cloud-top change?

minor comments to the new text

in the abstract you talk about a 40% AOD reduction. This is an exaggeration. My seasonal analysis shows ca 30% reduction between 2006 and 2015 only for fall (other seasons are much less) and a significant part of the reduction (ca 30%) is related to coarse mode aerosol (which little link to GFED emissions).

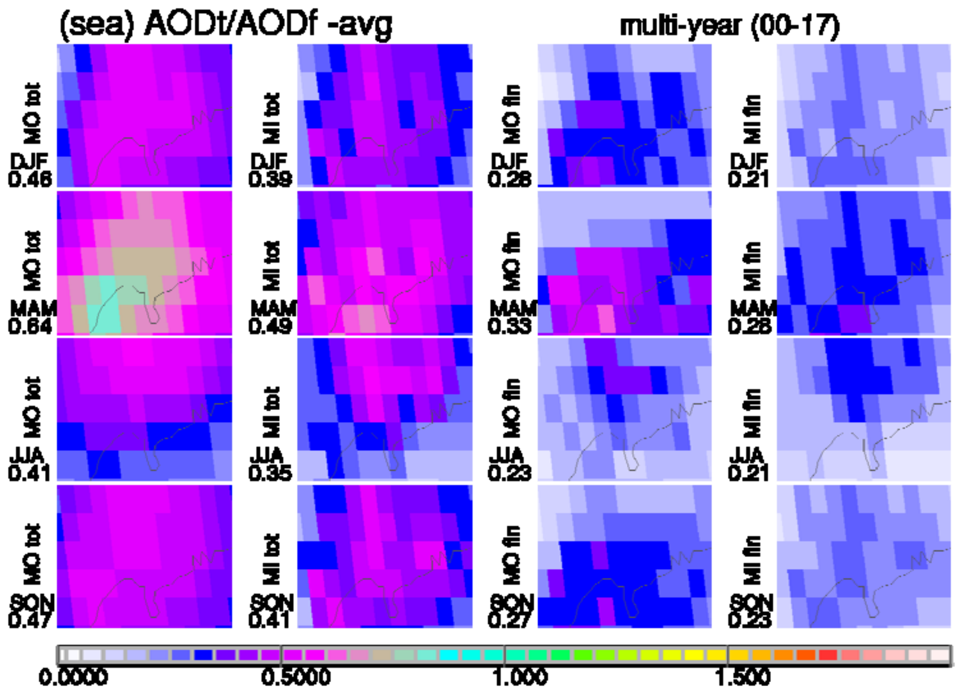
in the abstract the last sentence comes across as a statement but is highly speculative at best.

aerosol results: why is the dust AOD so small? AODc (mainly dust over continents) and AODf should add up to AOD. … and please show industrial emission change for that region, preferably with a seasonal cycle (in the warmer/humid summer the pollution related AOD should be larger)

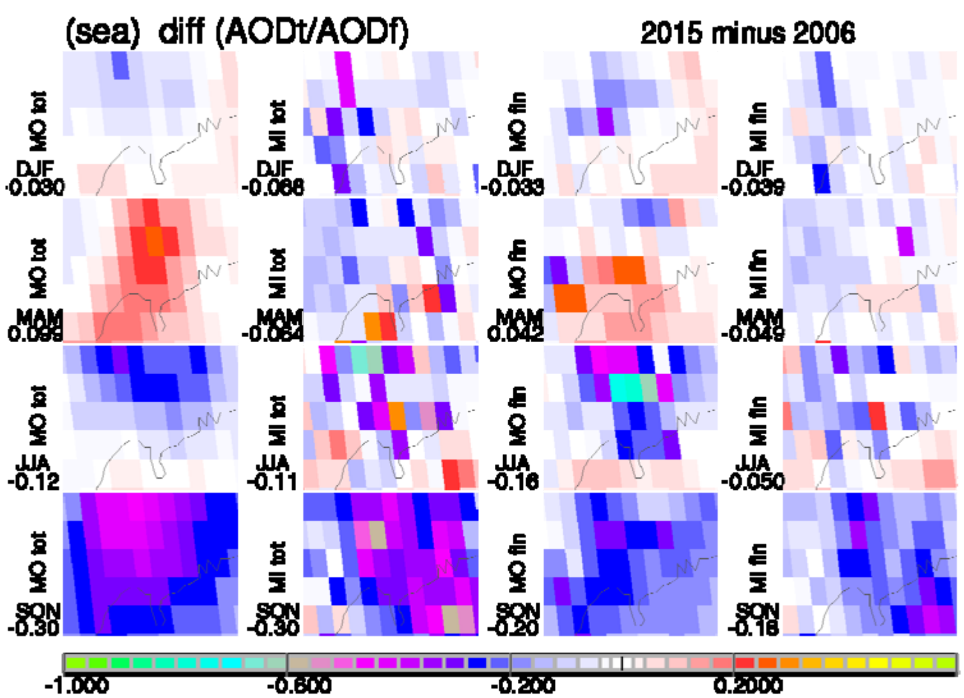
the discussion section is much improved. I like the idea with the reduced semi-direct effect. Would this not also imply a more unstable atmosphere and with a stronger convection a higher cloud top?

assuming the altitude assignment of AOD change is correct … what can be reason that elevated AOD is so much reduced in fall? why not at the ground?

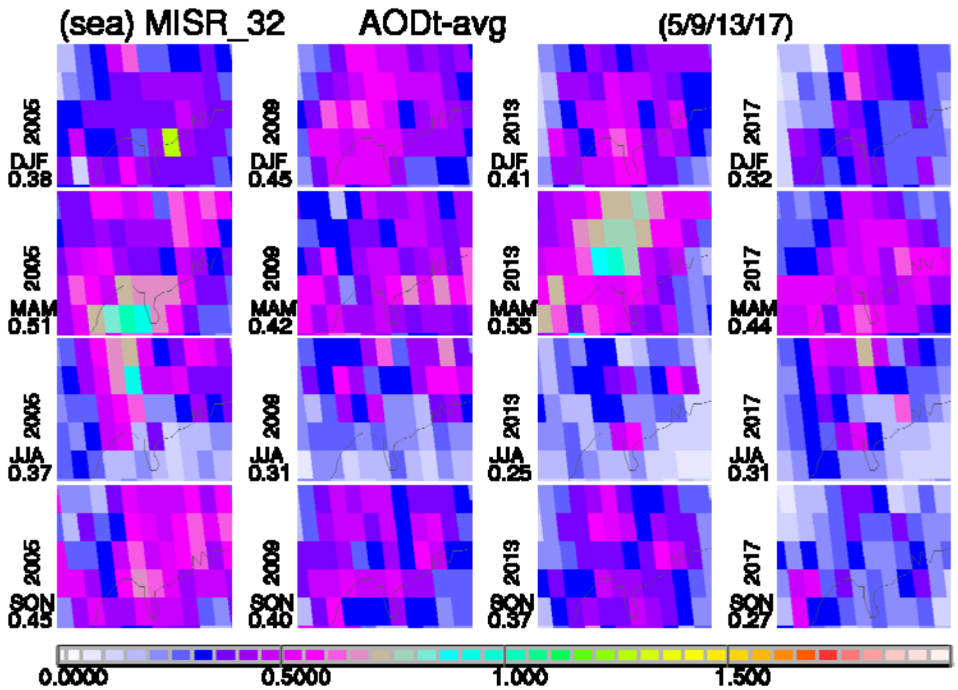
AOD multi-annual seasonal averages (over the SE China region)



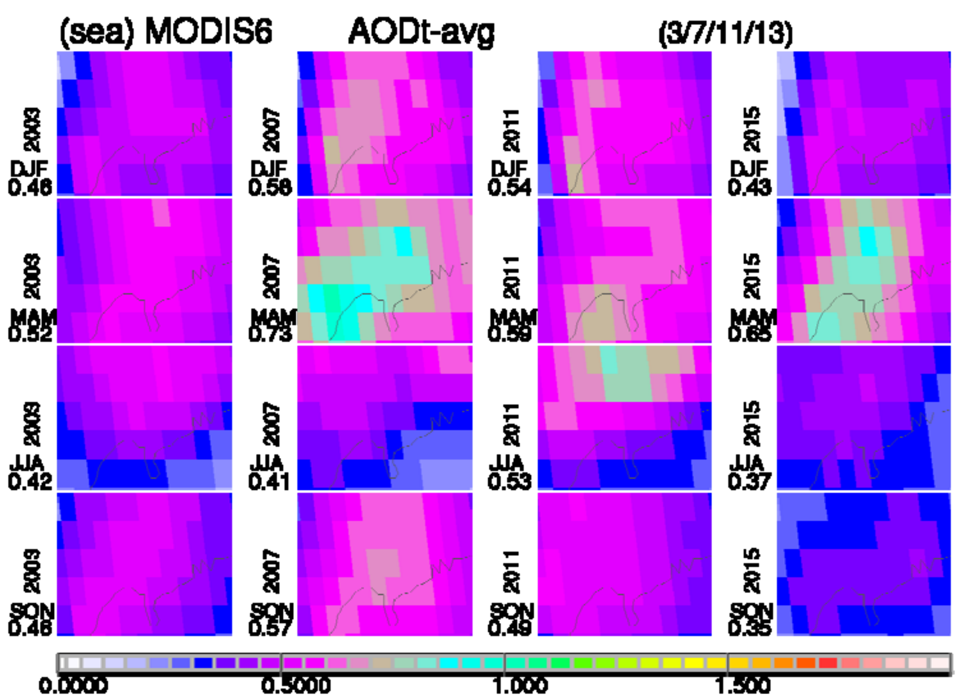
2015 minus 2006 AOD seasonal averages (over the SE China region)



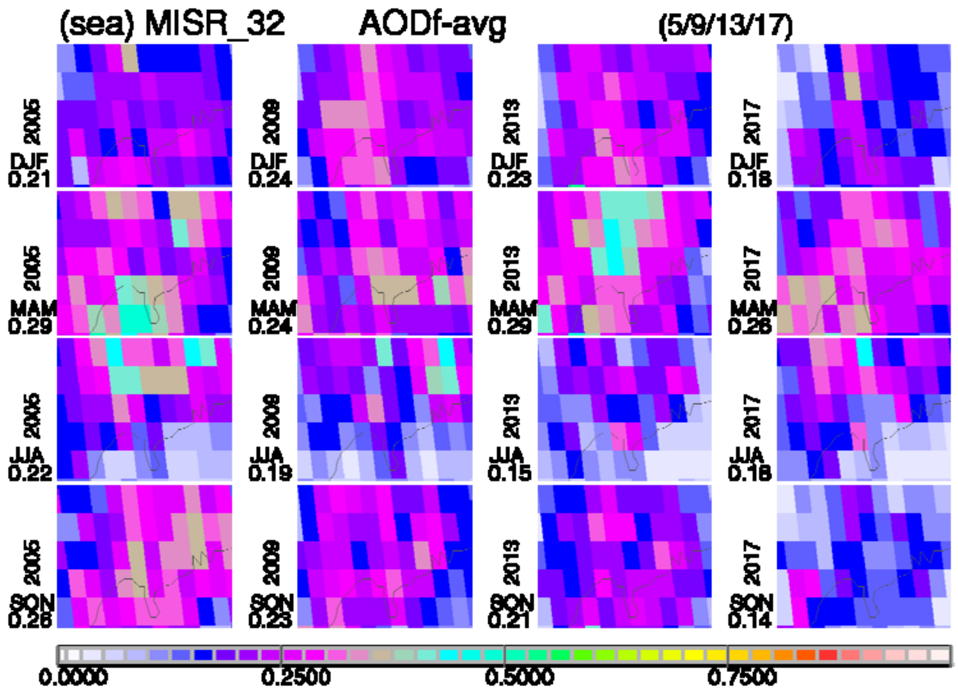
MISR total aerosol opt.depth 550nm (seasonal for diff years)



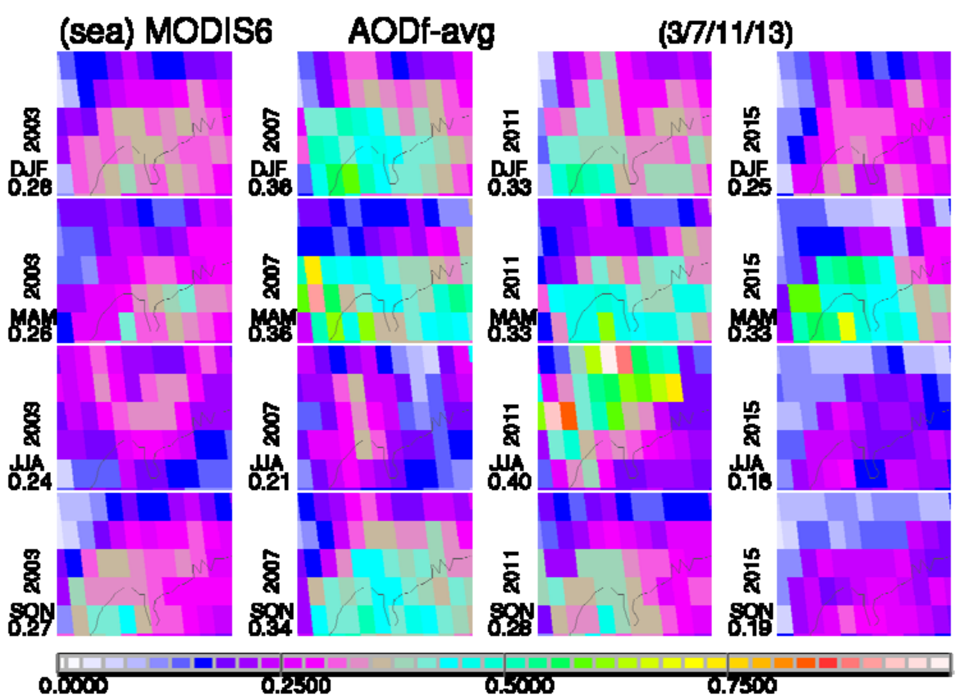
MODIS total aerosol opt.depth 550nm (seasonal for diff years)



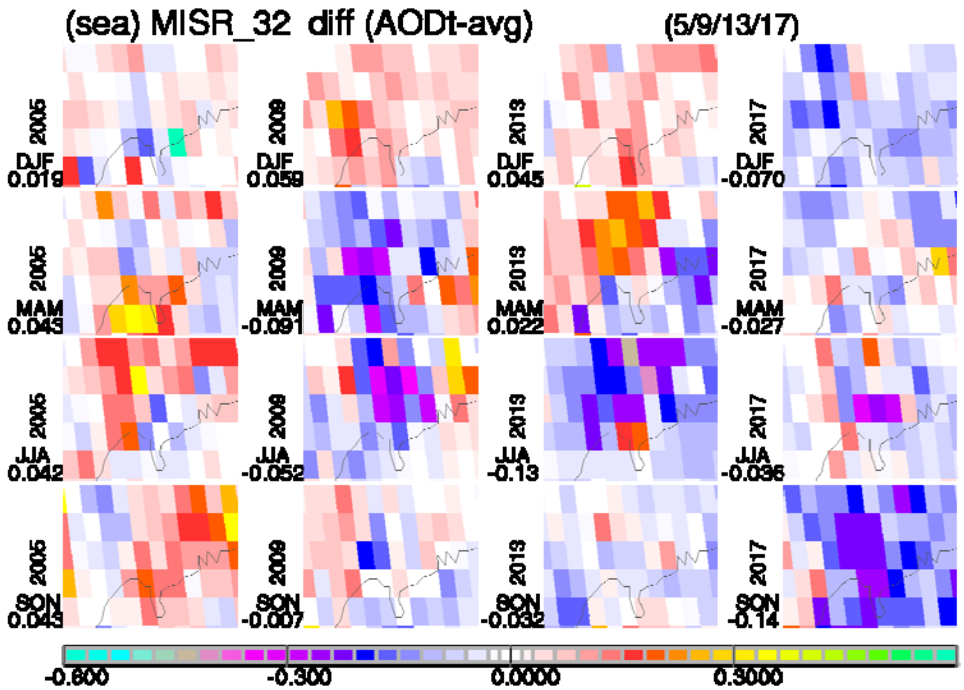
MISR fine aerosol opt.depth 550nm (seasonal for diff years)



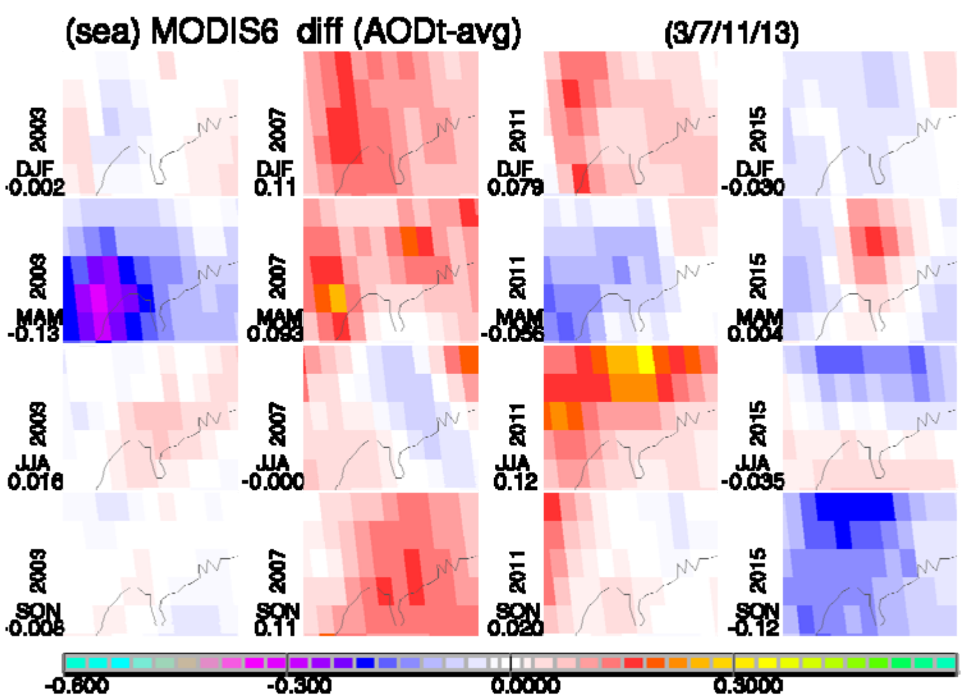
MODIS fine aerosol opt.depth 550nm (seasonal for diff years)



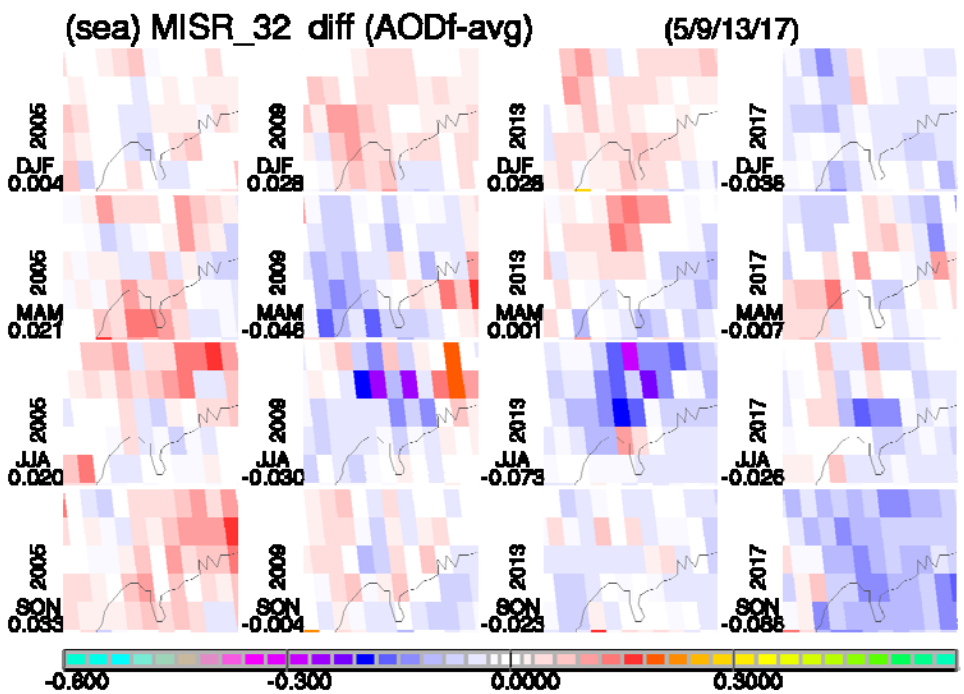
MISR diff in total AOD 550nm (seasonal for diff years) comp to multi-year



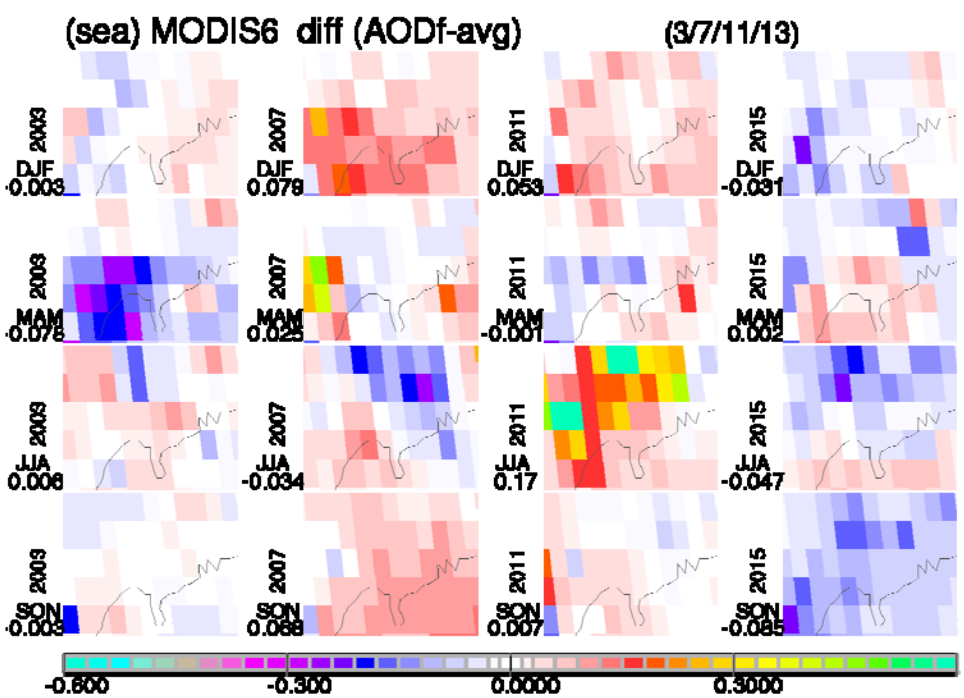
MODIS diff in total AOD 550nm (seasonal for diff years) comp to multi-year



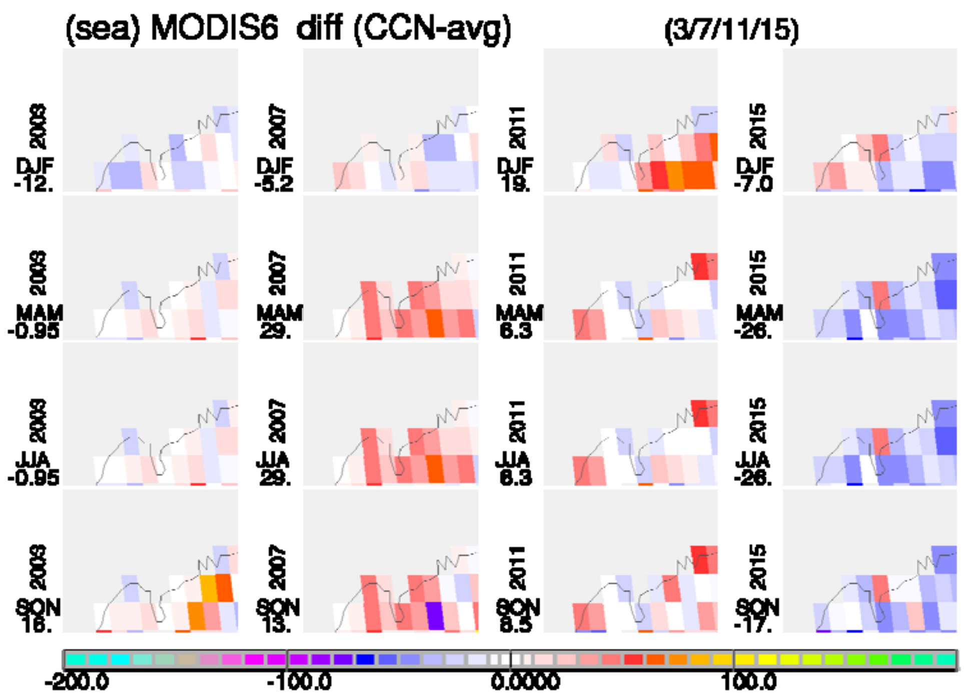
MISR diff in fine AOD 550nm (seasonal for diff years) comp to multi-year



MODIS diff in fine AOD 550nm (seasonal for diff years) comp to multi-year



MODIS diff in CDNC (seasonal for diff years) compared to multi-year



Here seasonal averages and anomalies with respect to multi-seasonal average are compared for fine-mode AOD and for total AOD from both MODIS and MISR for the SE China region in the Benas paper. Due to the smaller swath the MISR data are much noisier.

in recent years during the fall-season (Sep, Oct, Nov) there are large reductions to the AOD in the SE-Asia study region. Hereby fine-mode AOD reduction account for ca 2/3 and still 1/3 can be attributed to coarse mode AOD reduction.
Also Modis based CDNC show reduced concentrations over the entire year over the adjacent ocean.