AeroCom-Aerosat Board for keeping discussions, comments, question and answers
Day4, Thursday 15 October 2020
Edit your name, or put your name in front of a comment
Use the agenda to insert comments, Q&As in a chronological order
Let us develop this document jointly, in a stuctured way - can serve as useful minute taker tool
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REMEMBER, we start with a photo
Join a short group photo session on zoom, switch on the camera !!
Thursday before plenary EU:1:30pm/NY:7:30am/CA:4:30am/JP:8:30pm/CN:7:30pm
https://eu01web.zoom.us/j/68970213682?pwd=czRtVnRRVHJQZSsvSTlSL294WEhvUT09
Display an item indicating where you are?
For example, a clock showing the current time, a small national flag, or logo of our organizations...

Plenary Session 8 - compare model and satellite data: treating clouds, derived trends [90min] *one slide by moderator with main issues + key questions / 4 presentations*
Moderator: Andrew Sayer **//** Rapporteur: Larisa Sogacheva

- Gunnar Myhre: model simulated historical (HIST) forcing and trends [7min]
R: main problem rised in presentation: Most CMIP6 models have too rapid global mean temperature increase over last decades compared to observations. How important contributor are aerosols to the differences between observations and CMIP6?Any change in the aerosol forcing over the last decades? Model diversity has been discussewd; importance of measurements; multimodel prospective
Yves: trend of natural vs anthropogenic aerosols. How to identify natural aerosols in the last decade?
Mian Chin@Gunnar: Do you have gridded dimming/brightening data up to 201x to share? Do you have clear/all sky and direct/diffuse data?
R:Michael promised to share data
    - We should contact Kine Moseid, who is doing this dimming/brightning comparison work (Martin Wild is involved and should know more).
Michael: nice summary :: Maybe worth to distill, what we believe and what not from all trend papers, an overview paper would be nice indeed.
Tero Mielonen: Which natural aerosols have a trend in recent years? Dust, sea salt or organics? And is it global or regional?
Hongbin: MODIS observations show significant decline trend of dust in Gobi deserts from 2000 onward.
    - Hongbin: also in NW Pacific. The trend is consistent with CALIOP observation and ADNet in Japan.
    - Tero: Thanks Hongbin!

- Wenying Su: comparing historical (HIST) trends with (CERES) observations [7min]
R: summary: Consistency in observed clear-sky flux/DARE and AOD trends is very encouraging;Model simulation captured many notable aerosol changes derived from satellite observations, though at smaller magnitudes. Problem: emission dataset issues
discussions: Michael - on surface albedo trend
Kostas: can't you use CMIP6 data for this study? Do we need long AeroCom simulations?
Jane Mulcahy: for sure there should be annual and even monthly data from the cmip6 models available.
Pete Colarco: Do the CMIP6 models attempt to cope with the trend in surface albedo she is talking about?
    - Twan van Noije: to sme extent: for instance, land use change is included, but vegetation is not interactive in all models; snow cover responds to climate changes
Michael: Can you be sure that the surface albedo trend observation is not impacted by aerosol trends?
Wenying: @Michael, the consistency btw surface albedo trend and the TOA clear-sky SW flux trend also adds confidence to the robustness of the surface albedo trend
Michael: very nice, what is needed from the AeroCom / CMIP6 models to make it a multimodel comparison?
Wenying: @Michael, my wish list is monthly output from July 2002 to now, preferably on 1 deg by 1 deg spatial resolution.
Michael: "every 5 year AeroCom output"... I think the CMIP6 historical simulations could be used. Models having done CMIP6 hist could be possibly motivated to add missing diagnostics, if any....
    - Kostas: Certainly!
Mian@wenying: SO2 decrease over China does not mean all aerosols have the same trend. especially if the model does not include ammonium nitrate.
Wenying: @Mian, I agree, SO2 is just one piece of the puzzle of AOD.

Paul Ginoux: Any reason for surface albedo decreasing over pretty much all deserts?
Wenying: @Paul, not quite sure, will look into that!

Twan van Noije: which anthropogenic emissions were used in the model? CMIP6/CEDS?
    - Gunnar: Yes, the CMIP6/CEDS emissions.
    - Mian@Gunnar: CEDS just released an updated version of emission that covers the more recent years (to 2019).
        - Kostas: This is still beta, and they have not released gridded emissions yet (although they are available on request by Steve).
        - Steve Smith: Yes, we have a pre-release version out until 2019 for comment and testing. We'd appreciate any comments so we can try to address any issues in the final release.
Susanne Bauer: Very nice talk, we compared also the trends in the GISS model to AOD and CERES you can find the results here: http://dx.doi.org/10.1029/2019MS001978

Larisa Sogacheva: AOD monthly satellite merged 1-deg resolution product : https://doi.org/10.5194/acp-20-2031-2020, data access: https://nsdc.fmi.fi/data/data_aod
@Larisa, the point of the study is not just look at AOD but also adding other constraints to the comparison (i.e., TOA flux and surface albedo).

Susanne: Does anybody has an understanding of the reasons behind the trend we see over Pakistan? In AOD and radiation? Its opposite from India and I never found a good explanation in the literature.Irrigation was one thought, but no idea if that is the cause.

- Yang Yang: modeled 1980-2018 trends over E.Asia [7min]
R:Constructing long-term PM2.5 based on machine learning
Visibiity data in ncdc archive https://www.ncdc.noaa.gov/paleo-search/study/23410
Gerrit: before 2000, there is ATSR-2 (1995- 2002), AVHRR, and MERRAGerrit@

- Pete Colarco: MERRA-2 is a model reanalysis, assimilating AVHRR_derived AOD. Skeptical of its utility to understanding trends here.
- Andy Sayer: also SeaWiFS from late 1997-2010. Although the last update to the SeaWiFS Deep Blue product was 2012 and there's no funding to revisit it now. I would like to if there were an opportunity. I do like SeaWiFS because it can help bridge some of these gaps and extends the early-afternoon record back a few years (as ERS-2, Envisat, Terra are all AM). AVHRR is early PM too but quite different bands.

Claire Ryder: Are the station data (specifically for visibility) publicly available?

- Paul Ginoux: Check Mahowald et al. Global trends in visibility: implications for dust sources, 2007 in Atm. Chem Phys. This may be the most extensive use of visibility for dust research Claire: Thanks Paul, will check that out. See also my point below with a publication linked.
- Kostas: Yes, but the data are not as simple to interpret as other datasets.
  - Paul Ginoux: Indeed, you have to visually check any time series for all stations as jumps may appear when the person in charge of measuring visibility has changed.
  - Kostas: or the point of reference changes.
  - Rob Levy: I have had some experience with automated airport visibilty data: doi:10.1016/j.atmosenv.2013.08.050.. But it was easy access for the U.S. and would have to think about before that era.
  - Claire: Some similar (same?) station visibility data has previously been published wrt dust (https://www.sciencedirect.com/science/article/pii/S0169809518308688) - looks like it should be useful for longer term dust evaluation in China. But accessing the data appears tricky.
- Mian Chin - 50% decrease of PM2.5 after 2014 from 1980 level does not seem realistic. Air at the surface now is much dirtier than that in the 1980s from my own eyes and nose...
- Zhining Tao - PM2.5 before 2010s was constructed based on visibility data, just like linking AOD to PM2.5, I suspect that visibility ~ PM2.5 relationship is very complicated.
- Svetlana: Looks like this 50% PM2.5 reduction is in summer, while the annual mean shows like 20-25% decrease

Sabine Undorf: Would the strong recent decrease, if real, indicate a large role for non-local emissions, a decrease of which would have mostly compensated for an earlier increase in local ones symmetric to the visible decrease?
Larisa Sogacheva : satellite seasonal AOD trends in Fig. 7 https://acp.copernicus.org/articles/18/16631/2018/
Yang, what are the uncertainties in estimated PM2.5 using machine learning algorithms from AOD? especially on the higher end?

- Ryan Kramer: Observed aerosol forcing trends over the A-Train satellite era (7 min)
R: conclusions :
- Nearly all of the increase in CERES-observed TOA radiative imbalance is due to an increase in instantaneous radiative forcing of roughly 0.53+/-0.11 W/m2
- Roughly 0.1+/-0.05 W/m2 of this increase comes from SW aerosol radiative forcing
comments: increase in radiativ forcing from GHG
Mian: feedback maybe estimated wrong
Mian Chin: There is a strong decrease of SW IRF over Sahara - dust has increased? This does not seem to be consistent with AOD trend there?
Ed: Very nice Ryan - similar to Mian, what is going on over the Pacific in MERRA?

- Ed: I guess that was answered just now?
- Ryan: As I said on the Webex, Sahara "may" be kernel/AIRS error in diagnosing the feedback. Not sure yet. MERRA Pacific forcing is apparently sea salt. But the MERRA folks think it may be a misclassification by the reanalysis. Also looking into that.

Michael: nice indeed, can you point to the papers describing the methods?

- Ryan: My specific work is not published yet but I'll try to get a preprint out soon. General kernel method is in Soden et al. 2008 https://doi.org/10.1175/2007JCLI2110.1. We also used CloudSat-based kernels described here https://doi.org/10.1029/2018JD029021

Michael: Do you think the small positive aerosol trend is consistent with eg AOD trends?
Ryan: Generally yes but would be good to quantify this a bit more. Especially regionally to understand some of the discrepancies mentioned above..
Ed: Can you link this trend to the overall magnitude of the RFari?
Ryan: Bellouin et al. puts observed RFari between -0.37 and -0.12 W/m2, so my +0.1 W/m2 from 2003-2018 is a big (opposite) chunk of that, but seems consistent with CERES-Match trends e.g. https://doi.org/10.1002/asl.975
Michael: Have you compared your analysis with Wenying Su's analysis? Its the "same" data, or am I misunderstanding?

Ryan: Same CERES fluxes, different way of getting the forcing, but yep they look consistent, including for the albedo trends she saw

- Nick Schutgens: An AEROCOM/AEROSAT study: evaluation of global models with satellite AAOD and SSA (7 min)
R: summary:
- AERONET may not provide globally representative satellite eval.
- Significant biases in satellite products
- Model biases are often larger so satellite data are still useful
- Phase II low AAOD appears due to emissions (30%) and MACs (50%)
Nick's message - satellite divercity can be an estimate of the satellite uncertainty
Comments on spatial sampling of AERONET, availability of other SSA and AAOD products (MISR, Sentinel/AATSR, MODIS over land)
Mian: what is the detection limit for AAOD and SSA? Uncertainty levels?

- Nick: Sinyuk recently published AERONET AAOD & SSA uncertainty levels at different AOD. However, they make no statement as to the nature of the errors: will they behave as biases or random errors. Our upcoming paper will show agreement between datasets as function of AOD and temporal averaging. Unfortunately I have not found a single value that might serve as your detection limit.

Michael: repeating the question from Yves: How shall we use AAOD from Aeronet and satellites? Have we made progress here?

- Nick: there is a lot I did not talk about, e.g. over source regions there is a clear correlation between model BC emissions and AAOD. We can use observed AAOD to infer BC emissions this way.
- Greg: Oleg's group has done some work in this area. e.g. https://doi.org/10.5194/acp-18-12551-2018 and https://doi.org/10.5194/acp-19-14585-2019
- Nick: Thanks Greg, I'm familiar with that work. We're working on something very similar but using a different dataset, model and assimilation system: https://acp.copernicus.org/preprints/acp-2020-468/
- Hi Nick -- yes, I had seen that. Looks very nice. One comment that I believe that I had mentioned before. If using V3 L1.5 AERONET, be sure to check that the flag if_Lev2_except_AOD_threshold = 1. Otherwise, the L1.5 retrievals will sometimes be based upon very few scattering angles.

Ralph: The MISR dataset (Version 23, which is current) is freely available from the NASA Langley ASDC (http://eosweb.larc.nasa.gov).

- Felix: ASDC has changed their website links. If the above link doesn't work, try: https://earthdata.nasa.gov/eosdis/daacs/asdc or https://asdc.larc.nasa.gov/
- Andy Sayer: Ralph, Felix - to decrease the download overhead, Nick had asked groups to provide data in a specific consistent format (basically a regridding to common resolution and variable naming conventions). Similar to his AOD comparison from a few years ago. It may be that the team just didn't have time to provide him the data.
- Nick: actually, I have often spoken with Ralp and Mike about MISR but I guess they were busy with other jobs and could not participate

Ross H: did you do the analysis on a regional basis too? do the conclusions still hold or are there compensating differences between regions? (or would you expect that to be the case..)

- Nick: Yes, over individual regions, the differences between models and obs are usually larger than in a global sense. Uncertainty due to disagreement between datasets does not increase that much. So this analysis is useful in a regional sense as well.

Yves: What was your point about the 2 products from Polder SSA, are they systematically off by 0.04 or 0.05 in SSA? You seem to say that if we explained why this could be a giant step. Can you explain better? thanks

- Nick: they have a mean difference of about 0.044 in SSA. Their differences consist of both random differences and a constant difference (bias). The latter is 0.044. Random differences can be averaged out so identifying (and hopefully resolving) the constant difference will improve agreement between the datasets.If this resolution is physical, I would bet it also improves the datasets vs the truth.
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- Sebastien Garrigues: AOD monitoring within the CAMS data assimilation (7 min)
R: Needs for new observational data streams and Use of data assimilation system to evaluate aerosol satellite products are discussed. Potential of DA system is in Consistent comparison of multi-satellite and simulated AOD; Identifying deficiencies in satellite AOD products: bias and their spatiotemporal structures; evaluation of the observation error. Strategies for assimilating multiple satellite AOD are bias correction, adaptive thinning, ets. The impact of satellite observation diversity on the analysis has to be assessed. Further documentation is needed on uncertainty in each individual AOD product; multi-satellite product consistency/discrepancies; Spatiotemporal structure of observation uncertainties (spatial and temporal length scales). Collaboration with AEROSAT is important in that activity. Need for more NRT products
Mian@Sebastien: we have used CAMS forecast data and found AODs are normal but the components concentrations are a bit strange, especially in higher altitudes. Have you looked aerosol components?

- Zak: Yes, the operation of the data assimilation (which sees only column-integrated total AOD) tends to produce artefacts in the aerosol speciation and vertical distribution, even as it improves the total AOD. This is something we're considering how to address.

Sebastien, the VIIRS data we gave is 750m pixel level data. You said 6 km. Is this VIIRS data from somewhere else?

- Andy Sayer: Shobha, I am guessing they used VIIRS Deep Blue as that is 6 km and also near real time. VIIRS Dark Target is 6 km but not sure if they have NRT yet. This ties to Bertrand's point that we should try to keep clear which exact products and versions we are using when we present.

- Istvan Laszlo: Andy, the slide says NOAA-EPS VIIRS, and also lists the algorithm version number as v2r1, which is the NOAA enterprise VIIRS AOD algorithm at 750-m.
    - Andy: thanks Istvan! I do not know why it would be 6 km then. Hadn't spotted that.

Paul Ginoux: Is your assimilation methodology (assimilate AOD and assume the model right for aerosol composition and vertical profile) similar to what Phil Rash did 20 years ago for INDOEX? Rash et al. (JGR, 2001): https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2000JD900508

- Zak: I'm not familiar with Phil Rash's work, but yes the analysis increment preserves relative proportion of species (at the point of application, but of course increments to some species have a much longer lifetime than others, causing an imbalance). Vertical distribution of the increments is through the usual 4DVar cost function depending on the model-error covariance matrix e methodology is essentially still as described in Benedetti et al. (2009).
- Hongbin: @Paul good point. Models need to be reasonable in characterizing species (or at least types). Then people can have confidence in components from the data assimilation.

Adam Povey: There's a surprising amount of structure in your zonal averages of the MODIS products, especially relative to the other sensors. I'm in the middle of making an equivalent plot and haven't seen such peaks. Any idea where they come from?+1

Thanos Tsikerdekis: Great presentation! A question tied a bit with the previous presentation about absorption. Are you planning to assimilate into CAMS other kinds of observations (except AOD), like Angstrom Exponent or Single Scattering Albedo? (e.g. from AERONET). Although the evaluation of the effect of this would be impossible, it would certainly help with the speciation of aerosol particles.

- Zak: AERONET is extremely sparse spatially to use for assimilation; in principle we'd like to get other types of observation into use, more likely from satellite, but Sebastien probably knows much more about the practicality of doing so.
- Thanos: Indeed AERONET is sparse and useful for independent evaluation of the system.
- Zak: yes, independent validation is the other reason we've preferred to keep it out of the assimilation so far.
- Thanos: If you are planning to go to historical periods, POLDER/PARASOL and OMI might be useful for SSA.
- Zak: thanks - our focus is primarily on near-real-time work as a forecasting centre, but better historical observations may certainly be useful when it comes to the next version of the CAMS reanalysis (or where similar operational instruments are expected to come online in coming years).
- Thanos: Exactly what I had in mind the next CAMS reanalysis :) ! Also the PACE mission will carry similar multi-angle polarimetric instrument to POLDER that will provide absorption retrievals. Maybe they can be useful for near-real time assimilation.
    - Andy Sayer: I should caution that the processing latency of the PACE polarimeter data will depend on the computational overhead of the retrieval algorithms. There is no formal requirement for polarimeter level 2 data production. If there is a demonstrated use for it (globally and/or NRT), it could become a higher priority. There are prototype algorithms from the HARP2 and SPEXOne teams and we're working together to evaluate the computational burden. It is generally much higher than traditional algorithms due to the higher dimensionality and also online RT vs lookup tables. There are also various efforts in development from the funded Science Team.
    - Thanos: Thank you for the comment Andy. From the discussion of the last two sessions I am getting the feeling that complementary observations to AOD (e.g. AE/AOD other than 550nm and SSA/AAOD) would be needed. From retrievals point of view, I am not an expert, my colleagues (Otto Hasekamp and Guangliang Fu) work on SPEXone prototype retrieval algorithms and they may know more about retrieval algorithm burden. But from a data assimilation point of you I would certainly prioritize the development and use of these retrievals.
- Zak: :-) We haven't really started planning for that yet, but (assuming there is a next phase to CAMS!) it's something that we expect to happen. I think there's a lot of potential to something like PACE, yes, although quite a lot of development work on observation operators etc. will probably be needed to make use of it.
- Thanos: Indeed that is true. Thank you for the discussion and the info!
- Zak: Thanks too - you're welcome!
- Istvan Laszlo: The NOAA/VIIRS AOD algorithm is almost identical to the MODIS algorithm over ocean in terms of aerosol models used. Solution of the radiative transfer and internal test used to select pixels for AOD retrieval are, however, different. These, and differences in cloud mask and input TOA reflectances, will inevitably lead to differences in the retrieved AOD. This is true even for instruments from the same family. For example, the NOAA-20 VIIRS TOA reflectances have been consistently lower than those from S-NPP, resulting in smaller NOAA-20 AOD over ocean. Interestingly, evaluation showed that NOAA-20 VIIRS AOD agreed better with AERONET AOD.
    - Andy: thanks for the note about SNPP vs. NOAA20!

Discussion (50 min): Best practices to integrate information from satellites and modeling
What are conditions of high / low consistency within satellite data / modeling and between both?
Development priorities to improve on some of them
Best way to compare different products and resolve differences for data assimilation

Sabine Undorf: I have a question/comment on the suggested focus on discrepancies: Do you we understand enough as to why datasets agree where they do and don't? if not, would someone who finds it more important not to underestimate uncertainty/erroneously identify something non-robust as robust, put as least as much effort in scrutinising where datasets do agree?

- Adam: I don't think there's much understanding of why datasets disagree in some areas. (I'm looking into it and was surprised that there was nowhere that all of the data I was looking agreed; I'm adding SeaWifs and MAIAC to see if that remains true.) The ORAC team typically blame disagreement on differences in cloud flagging.
- Tero: I think typical situations for poor agreement are linked to bright surfaces, low aerosol loads, unexpected aerosol types (e.g. smoke plumes in locations where you don't usually have smoke), thick aerosol plumes masked as clouds, etc.
- Andy: I think Sabine's point is to look at the flip side: if there is good agreement are they all right? And are they agreeing for everything or just midvisible AOD?
- Tero: OK, that makes sense. They could agree for the wrong reasons like models sometimes do :)

Rob Levy is running his DT algorithm on multiple sensors. What is he seeing? When you run same algorithm you eliminate any algorithm dependent differences. Rob?

- Adam: ORAC has also been run on several instruments (ATSR, SLSTR, SEVIRI, on a good day MODIS) but it doesn't make things much clearer. (Issues with calibration and gas lines remain.) The DT team might have had more time to pick the results apart.
  - Pekka: How is ORAC handling the SLSTR geometry? We have issues with NH geometries
- Tero: Also the FMI's ADV algorithm runs on ATSR-2, AATSR and SLSTR but I don't know if these instruments have any overlap in time series.
  - Pekka: there is overlap between ATSR2 - AATSR. Results with over land time series very good. Over ocean we had to make some adjustments due to calibration differences
- Andy Sayer: I know Rob's team recently had a paper (led by Virginia Sawyer: https://www.mdpi.com/2072-4292/12/2/308) comparing VIIRS and the two MODIS for DT. The short answer seemed to be some regional offsets linked to calibration and band differences (e.g. 488 vs 488 nm, 2.1 vs 2.2 micron) and sometimes spatial resolution. Even Terra/Aqua has a roughly 0.01 offset over open ocean. In general though the spatial and temporal patterns seem very close. So I think things like larger offsets over Australia are primarily algorithmic than sensor-specific. I don't know how different the GEO data are but guess the different geometries could also led to larger differences.

Michael: it would be nice to concentrate a bit on (anthropogenic aerosol dominated) AOD trend consistency among satelite products... What is the assessment here?

Wenying, @Michael, I think most of the data agree over US/China/India. I would emphasize using independent datasets and not only focusing on AOD.

Michaek @tall I would be interested to learn who is working on the "stability" of bias over time between different satellite products ?

- Andy Sayer: It seems to be up to individual teams. While on Deep Blue I included analysis of bias vs. time for MODIS Terra, Aqua, and VIIRS against AERONET. Results for "all sites" and "long term sites only" were fairly consistent. However, this is an assessment only at AERONET sites, not global. See section 3.7 here: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JD029598
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- R: discussion points
- - Australia. does strong disagreement relate to certain conditions?
- TP: for assimilation, bias correction is needed. How to sipmlify that process?
- Sebastian: more documentation about the discrepancy between products is needed
- TP: what do you need to qualify datasets? which kind of validation has to be done by data providers?
- Adam : For trend evaluation, AERONET might be not representative; MODIS might be high
- Bertran: Combination of different satellites; Limit of validation data over the Southern Ocean; Different algorithms, performances: when we describe discrepancies, which also we should reffer to?
- Yves: Australia, high albedo region
- Angella: expertise from retrieval community is critical; need to work with data providers; work on L2 reflectances/radiances assimilation is in progress, assumptions are all consistent in that case, first resuts are good
- Michael: contribution of uncertainties in satellite retrievas to trends; if offset is systematic, bias is not important
- Linlu: long-time trends seems to be reasonable also with less accurate (low quality) products
- Others: usage of quality flags provided in the products ; clear documentation is important
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15 minutes break

Plenary Session 9 - Spectral dependence of AOD / constraining aerosol type [90 min] *one slide by moderator with main issues + key questions / 3 presentations*
EU:3:45–5:15pm/NY:9:45–11:15am/CA:6:45–8:15am/JP:10:45pm–0:15am/CN:9:45–11:15pm
Starts 5 minutes delayed
Moderator: Thomas Popp Rapporteur: Marta Luffarelli

- Kostas Tsigaridis / Lucia Mona: Simulating instrumentally-defined aerosol type(10min)

Ed: Is clear-sky the AOD the AOD calculated without aerosol humidification/cloud effects or is it also sampled in low cloud fraction gridboxes? Those definitions may also differ if large scale airmass properties cause aerosol and cloud to be correlated

- Kostas: This depends on the models, but my understanding is that they report ambient AOD (so humidified) at clear-sky conditions, based on whatever definition they have.

Hongbin: how to calculate clear-sky AOD in models?

- Toshi @ Hongbin: It is not clearly defined. We should define it at least in the multimodal comparison.
- Toshi: MIROC-SPRINATRS makes the clear-sky AOD by picking up all-sky AOD from grids where the 2-D cloud cover is less than 0.2 every time step.
- Kostas: I hope to attack this question in the near future.

Michael: @Kostas- I dont think you know well all models that provide clear-sky AOD / if models provide "just" AOD it may be ClearSky or AllSky AOD !!! I agree asking models to provide clear sky AND all sky AOD might resolve some questions here. (see also Gliss et al. 2020 ACPD revised manuscript on that)

- Kostas: When there is od550aer and od550csaer, I would expect that people report all-sky in od550aer, no?

Mian: But the time/location of clear sky would very likely be different from the real world. Also satellite is a snap shot while model has certain time window.
Mian: Also, models have different spatial resolutions and different definition of clear sky (e.g., cloud fraction threshold)

- Kostas: Absolutely. In long-term means (e.g. monthly or longer) this should diminish, but it is a real issue. Colocation is important.

Michael: Also: humidity used in the clear and all sky should be documented.

- Kostas: Agreed. Also what the decisions are in partial-cloudiness cases.

Peter Colarco: We have been working on observation simulation like this for quite some time. A similar example relevant to this group is Ed Nowottnick's paper on the CALIOP type definition, as reconstructed from MERRA-2 model output. https://amt.copernicus.org/articles/8/3647/2015/ This is useful for interrogating the satellite retrieval algorithm assumptions too.

- Kostas: Thanks! I'll take a look. I want to repeat these plots following several different definitions.

Mian: Also, what is the "type" are we after? Composition? Size? Source origin (anthro vs natural)? Scattering vs absorption? Fine vs coarse mode? Or whatever?

- Kostas: we can't ask the satellites to give us the type we want, so the models need to adopt to whatever types each instrument is able to identify.
- Ralph: Mian -- We retrieve what we can. These are optical constraints on particle spectral AOD (interpreted to first order as size), shape, and SSA in most cases. The rest is interpretation, sometimes informed by relationships to sources (e.g., wildfires, deserts, etc). We make some simple associations, e.g., non-spherical might be dust, especially if associated with a desert source, but the rest needs to come from models or other assumptions.
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Ralph: One question about whether there should be a focus regarding aerosol type on severe events, such as major wildfires or volcanic eruptions. Those are places where the "usual" type can be overwhelmed. Those are also places where AOD can be large and regionally or globally impactful (also easier to retrieve "type" in higher AOD plumes).+1+1

- Andy Sayer: Ralph, I agree with you. This partly motivates my presentation (breakout 8, plenary 13) as well as some other stuff I am independently working on.
- Kostas: Agreed. We are only starting, so much to do!

Zak: I think it's to be expected that resolution differences show up less in column quantities (which are mostly what we can observe from satellite) than perhaps for in-situ quantities in source regions or strong plumes. But it's certainly a good question what resolution gives us, since it always has to be traded off against other things (like a more detailed size distribution).
Shobha: GISS model missing dust outside of Sahara (China, middle east) surprising. Capturing synoptic scale features by all models not surprising. Especially if source terms are the same of similar. It is really specific events when you zoom in you will begin to see differences, not?

- Kostas: Note that these plots are not where the dust is, but where the AOD and AAOD of dust is. If the selection criteria says something about absorption, the model might miss it if the model assumes less absorbing dust.

Santiago: when you talk about fine mode fraction are you talking about columnar FMF as in satellite retrievals or in the microphsycial sense like FMF per unit volume ?

- Kostas: Column FMF as retrieved by the satellite. Same calculation as total AOD, but only taking into account the fine mode aerosols, as if coarse does not exist.

Greg: The Lee types here are pretty basic, and based mainly upon FMF. So although the results are encouraging, I would hope that the models can do this. Nice talk. +1

- Kostas: Thanks! I was more pessimistic when I started this, and got pretty excited to see that (if anything) the models capture the structure.

- Tero Mielonen: Comparing aerosol types in climate models and satellite retrievals (5 m
Alcide Zhao: is it possible to extract a lump-up for dust aerosols from the FMI AOD ?

- Pekka: Do you mean dust AOD? Yes
- Pekka: Yes it is possible @Pekka, can you point me to a plcae to get this? many thanks! I am currently using the FMI merged AOD for all aerosols species
- Pekka: It is possible but we would have to extract it from our raw data.
- @Pekka, I will contact you after this. We (me, Claire Ryder, Laura Wilcox and our collagues at Readng are very interested in using it for model evulation work.)
- Pekka: There was an action for us to provide dust AOD but now I cannot remember if it is already in the product. I will check
- Alcide: Great and many thanks!

Mian Chin: this is CALIOP-like definition of aerosol type. But nothing here is 100% and how models deal with this is an art or philosophical work. For example, "mostly dust" - is it 99% or 51%? optical based or mass based?

- Tero: I totally agree on philosophical side. As the examples show the models disagree quite a lot regarding the types but the actual differences in optical properties can be quite small. For example, one model might have a

SSA value of 0.94 and the other 0.95 but otherwise the properties are the same. This would mean that the aerosol types are different but in reality the models agree really well. So, as a first step I would be happy if the models and satellite data would agree on the most common aerosol type regardless of the percentage of the type. And yes, these are optical based. When I used only 4 aerosol types in the analysis, the agreement improved but there are still interesting differences. So, we are now looking into the SSA, AE and AOD histograms in different regions to understand the reasons for the differences better.

Michael: slide 5: are the type cases really so cleanly separated on the scales used?

- Pekka: No and here more robust classification is needed
  - Michael:Are there any cases which are just not classified?
    - Pekka: Yes and this is partly why we also did an excercise with the limits Kostas was showing
- Greg: Russel JGR 2014 did this as well. There are multi-dimensional spaces that need to be considered, not just SSA and EAE. I am not sure if the Hamill paper did this or not. If you apply the full Mahalanobis classification scheme to the models, you might get a different result. See Russell, P. B., et al. (2014), A multiparameter aerosol classification method and its application to retrievals from spaceborne polarimetry, J. Geophys. Res. Atmos., 119, doi:10.1002/2013JD021411. Really enjoyed the talk, Tero. I like the idea of applying the retrieval typing schemes to models.
- Tero: Thanks, Greg! Yes, I'm familiar with Russel's paper and I agree that "proper" typing cannot be done with SSA and EAE solely. This was just the first step and we are now thinking how to improve from here. And this is something that I've been discussing with Antti Arola for years :D
-

yves: Where did you infer that SSA is less than 0.94 for 550nm for dust. Is it cause by the optical properties you chose in the model or are you using measurements
from campaigns? If campaigns can you say from which datasets you are starting? thanks

- Pekka: it is coming from some conference presentation for AERONET classification. I don't recall which, sorry

Gerrit@Pekka: Is Dust still prescribed by the Kinne climatology?

- Pekka: yes it is as pointed in the slide, but the mixture with fiine particles is retrieved

Sorry, I misssed that. L

- Pekka: No worries. Speed is quite high :)

- Larisa Sogacheva: Comparisons of satellite AOD at multiple wavelengths (5 min)

Michael: Can you remind me: Why is the spectral AOD "better" than the AE for comparison to models?

- Andy Sayer: AE is often a gradient of small numbers, so uncertainties propagate differently. When AOD is low, spectral AOD is probably more useful (as we care most about absolute AOD). Also, AE is an approximate metric for spectral curvature while spectral AOD is more direct.
  - In analogy we are discussing AAOD AND SSA as well... so I am just thinking we should still evaluate also AE.
    - Andy: good to evaluate as many parameters as practical :) Likewise FMF and fine/coarse AOD.

Hongbin: MODIS FMF is not a standard product over land.

- Andy: agreed - it is in the files though (for VIIRS Dark Target at least, not sure about latest MODIS Dark Target). Also important to note for MODIS over land it is a fine MODEL fraction and note a fine MODE fraction. Also over water it is fine mode fraction under the single scattering assumption, so breaks down when AOD is high.
- Yingxi: We are talking about putting the FMF back into MODIS over land product, so people know how to use them can have access. However, we want to have a good way to prevent users to use them incorrectly.
  - Kostas: If users don't read documentation, there is so much you can do about it.
- Shobha: Just a FYI that NOAA VIIRS does not report FMF over land. Andy, presuming you are refering to NASA VIIRS product
  - Andy: yep, Dark Target. (and I should note too that VIIRS Deep Blue has no fine mode fraction over land, but does over water).

Ralph: It is useful to distinguish between retrieval algorithms that report generic properties (size, shape, SSA, SSA spectral slope; e.g., MISR) and interpretive algorithms, that jump directly to a compositional constraint (pollution, dust, etc., e.g., CALIPSO), which requires additional assumptions..

Mian Chin: I think "aerosol type" is a descriptive quantity and cannot be quantified. Maybe this should be treated as some kind of "index" rather than quantitative comparisons between model and satellite.

Ralph: This might be worth pursuing. Also, as some models are attempting to assimilate radiances, perhaps a middle ground can be found to interpret the information content from the satellite in terms of the generic properties first (maybe within the model itself, to benefit from consistence, as Angela mentioned today), and then use the model to make further interpretation based on source-receptor relationships, etc., in a self-consistent way.

Rob Levy: I can't figure out what to write here, but I will discuss with a group at later date. Dark Target provide some information about the models chosen, and probably the information you need can be back-calculated, but it's not easy.

- Andy: it's missing in the VIIRS Dark Target now. I know there is a balance between completeness, data volume, and user misuse. So not sure what the best solution is. Maybe we need two output file sets: one that is comprehensive, one that is only QA-filtered AOD, latitude, longitude?
- Yingxi: two output files might be too complicated and doubles the processing time. I don't know if writing a note in the parameter description will work? I don't know how many "new" users actually read these before use the data.
  - Andy: yeah, I know. Shouldn't double processing time though, you could just write two files from the same processing chain? The MISR product file contains a second group called "auxiliary" where they put all this extra data sets. That is nice as it requires the user to dig a bit, but a lot of info is there.
  - Rob Levy: I am willing to discuss. It keeps me up at night trying to decide what diagnostics should be reported, and the balance of providing information to be misused. (all keeping file size in control).

Gerrit@Yves about 1 size distribution that is observed: even ground-based instruments have discrepancies, even when using the same type of instrument (optical or other physical principle)

- Claire: Regarding dust - there has been a shift towards understanding the prevalence of coarser particles in recent years - due to better/improved processing of optical measurements, and use of measurements not based on scattering, and avoidance & better understanding of the biases of observations made behind inlets.

Discussion (70 min):
How can we progress on constraining aerosol type with satellite observations?

Peter Colarco: To the general discussion, there is some work our group as done that tries to bridge the gap of the models.And I just said this out loud, but here are the two papers I mentioned: Ed's on the CALIPSO typing algorithm: https://amt.copernicus.org/articles/8/3647/2015/ . And my own modest contribution to understanding the OMI AI algorithm: https://amt.copernicus.org/articles/10/4121/2017/. And various papers by Gala Wind, Patricia Castellanos, Virginie Buchard...+1
Rob Levy: Yay for OSSEs! Also assimilation: One thing we provide within our product are the "radiances" used for the coarse-resolution dark-target retrieval. If they have been cloud-cleared correctly (and that is a big "if"), and sufficently corrected for trace-gas absorption, and they are sufficiently representative of coarse resolution scene (also "ifs"), then models can use these radiances and fit their own aerosol optical properties and assumptions.

Greg: Just wanted to say that the satellite types are empirical, and often based upon location (or altitude, as with CALIPSO). Thus, it should be easy for models to get the type correct in regions where the types are defineed. Dust in Africa, urban at AERONET sites located in cities, Biomass burning in S. Amer and Africa. Marine over ocean, unless it is elevated. The trick is getting it away from these areas with clear types. So I would like to echo Mian's point that we need to quantify the "mixed" types to make some progress.

- Andy Sayer: Greg, I agree with you. Speaking for myself, part of this is coding logistics. Constraints on RAM and CPU and dimensionality from lookup tables. Some of this can be overcome with clever coding... but some of us (me) are not proficient enough to implement more comprehensive approaches without unfeasible processing time and/or RAM overhead. Need to find time to learn some better coding skills. Training a neural network to replace a lookup table is a good option, I think. On my list to get better at Python for that purpose. I guess what I am getting it is that algorithmic assumptions are motivated not only by satellite information content but also programming concerns.
- Greg: Right, but aren't we always stuck with assuming certain optical properties represent our "pure" species, and that 1) how often are we truly observing "pure", and 2) how to handle different species with overlapping optical properties. AAE is my favorite parameter to be up on, for instance. And then how to quantify the mix when we get away from pure regions.
  - Andy: yep, you are right. But I think we can relax some of the assumptions about mixtures of these pure components with clever coding. Which will help in the mixed case. E.g. take model components and retrieve weights of those, rather than the current optical models.
  - Ralph: Andy -- This is what we do with the MISR Research Algorithm, as I think you know. The *aggregate* of retrieved components we interpret as the "Retrieved Effective Particle Size" (REPS) and "Retrieved Effective Particle Absorption" (REPA).
    - Andy: yes, exactly. :) But other retrieval products don't do that level of detail. I think this is partially a coding issue. Can be overcome but needs big rewrite of retrieval codes.
  - Greg: I wonder what would happen if we created the Hamill/Russel diagrams (SSA vs EAE, etc) with the models. Would we get similar separations?
  -

Ralph: to Greg -- with MISR we do NOT make any geographical assumptions in our aerosol-type retrievals. The whole point is not to "report" what we think we already know without any measurement constraints, but to report whatever new we can offer from observations.
Greg: Ralph -- I was referring to the Hamil plot that Tero showed which was not based upon MISR.Also the CALIOP discussion, which uses location and altitude for almost everything except dust (where they use linear depolarization ratio).
Ralph: Ok,. Greg. I agree. I just noticed there was some confusion between MISR and other aerosol-type products in several talks and comments, so I wanted to clarify. We've put a lot of work into offering what we can with MISR in terms of aerosol type with a minimum of assumptions, and with a clear understanding of what these assumptions are.
Greg: The problem still remains, though. We know there is dust over Africa, etc., so we don't need to know the type there. We need to be able to quantify the amount of smoke vs dust over the Atlantic, for instance.
Ralph: Agreed. We actually did this very thing with MISR, for example, in the following paper: Guo et al. (2013; JGR. , doi:10.1002/jgrd.50409).
Greg: Thanks Ralph. Cut and paste of the link did not work. :(I'll send you the paper...
Greg: Nice -- thanks! So that is dust and smoke, so now all we need is marine and urban. Would be nice to have smoldering/flaming or dark/light smoke, too. Or smoke with high/low BrC/BC ratios. Great that you quantified those two types, though.
Ralph: Greg -- With the MISR Research algorithm, we distinguish in wildfire plumes small, spherical, strongly light-absorbing, and spectrally flat absorbing particles from small-medium, spherical, moderately absorbing and spectrally steep particles as Black Carbon and Brown Carbon, respectively. An example of this work, with coincident aircraft validation during the BBOP campaign, is in this paper (Junghenn et al., Remt. Sens. 2020 doi:10.3390/rs12050769). Similarly, in volcanic plumes we distinguish ash from sulfate, and can see changes in REPS and REPA that we then interpret in terms of particle evolution (size-selective and size-independent deposition, particle hydration or coating, secondary aerosol formation, etc.). An example is Flower & Kahn (JGR 2020, doi:10.1029/2019JD031625). Plumes have high enough AOD so we have confidence in the particle microphysical property retrievals; the interpretations in terms of particle composition or evolution are a second step, with lower confidence, but we have validated where possible.

Dave W: a late follow-up on the CALIPSO typing algorithm - in Version 4, the only location information we use is land/ocean. If we're over land we assume there is no marine aerosol (which is not always correct), and over ocean we assume marine unless it appears to be another type. In Version 4 we've added a 'dusty marine' type to flag dust-marine mixtures. With more effort, we could quantify the dust fraction. The original purpose of our typing algorithm was to estimate an aerosol lidar ratio. It turns out CALIOP can't really distinguish between fine mode pollution and smoke, but they tend to have similar lidar ratios so that is not a big problem for our aerosol extinction retrievals. The actual type information in CALIOP signals is quite limited. For ACCP we hope to have joint HSRL-polarimeter observations which will have substantially more information on type.
Ralph: So Dave, clearly the Omar et al. (JAOT 2009) paper giving the CALIPSO typing scheme is outdated. Is there a new reference?
Greg: There is a V4 special issue at https://amt.copernicus.org/articles/special_issue903.html . The paper you want is https://doi.org/10.5194/amt-11-6107-2018 , Fig 1. No Snow/Ice decision box anymore, but there is still an altidude decision box at Z=2.5 km in a few places.

Michael: following Yves idea: Any volunteers for a Commission on Constraining Aerosol Properties ? (setting up bounds on any useful global aerosol property, revised annually.. what should models respect "at least"?)
Please put your name here or write email to me:
Yves/ Michael you should also announce it, not everyone will read your post. Y+1

- Volunteers: Kostas. Rob Levy, Tero Mielonen, Don Grainger/Adam Povey, Yves Balkanski, Pekka Kolmonen, Ralph Kahn, Claire Ryder, Thomas PoppNick SchutgensPeter ColarcoDave WinkerHongbin YuGerritdeLeeuw/Ying Zhang, Andy Sayer Greg SchusterClaudia Di Biagio
-

How can satellite AOD at multiple wavelengths be used in modeling?
Christoph: Models can output at different wavelengths
Shobha: I actually like this. approach
Adam: And can be interesting! I've found Angstrom < -1 in model output that was otherwise sensible.

How far can satellite interpretation schemes for aerosol type be applied to models?
Mian Chin: We need to define a commonly agreed upon approach+1
Christoph: We should have a common datbase for refractive indices between satellites and models+1

ATTENTION! ATTENTION! ATTENTION! - We will use a different WebEx link for tomorrow's AeroCom/AeroSat plenary session:
https://nasaenterprise.webex.com/nasaenterprise/j.php?MTID=md1b7e3c1939fa2bea1168885a63dc958
Meeting number (access code): 199 186 0006
Meeting password: 5BqffdJ2j*4

15 minutes break

BREAKOUT sessions
EU:5:30–7pm/NY:11:30am–1pm/CA:8:30–10am/JP:00:30am–02am/CN:11:30pm–1am

Moderators: Thomas Popp, Ralph Kahn/Larisa Sogacheva, Adam Povey (see more info in breakout.v3.pdf) Rapporteurs: Hongbin Yu, Andrew Sayer, Pekka Kolmonen
Breakout 7: Aerosol type from satellite
Moderator: Thomas Popp Rapporteur: Hongbin Yu
https://nasaenterprise.webex.com/nasaenterprise/j.php?MTID=me721ebac70f533c586b1d866775d3c93

Jafariserajehlou, Soheila, PMAp: synergistic global Aerosol product from Metop satellites

Kauppi, Anu , Studying aerosol type selection and retrieved AOD estimates when applied to TROPOMI measurements

Lipponen, Antti, Model Enforced Post-Process Correction of Satellite Aerosol Retrievals

Song, Quianqian, Comparison Study of Global Dust Climatology derived from CALIOP and MODIS Aerosol retrievals
Mian Chin: I think this "conditional DAOD" is problematic in a way that excluding "zero" values will definitely over estimate the DAOD, because the zero is not really zero but close or below the CALIOP detection limit. In reality, some of the zeros should be included in the average but others should be excluded, which is not possible to do until we have a better sensitivity instrument...
Qianqian: yes, I agree, thanks so much for your comment.

Jason Tackett: Great work! I was curious in the CALIOP dust AOD averages, how are aerosol layers not classified as dust treated? Are they excluded in the average?
Qianqian: Thanks for the question, in the CALIOP-based dust AOD retrieval, we derived the backscattering fraction of dust aerosol in each CALIOP-detected aerosol layers. Then by multiplying lidar ratio of dust aerosols to get dust extcntion vertical profile. In this way, we could further get dust column AOD.Therefore, this study is not based on the standard CALIOP aerosol classification in which each layer of aerosol is classified as one type. In other words, we derived dust extinction for each layer and then calculate column AOD.
In the climatological data product, we include those cases that the derived CALIOP-based AOD is equal to 0 in our average. Hopefully this could answer your question, thanks!

- Jason: Thanks! Yes that answers my question.

Tackett, Jason, CALIOP Aerosol Typing Performance of Smoke from the 2019-2020 Australian Bushfire Event

Zhang, Ying, Improved inversion of aerosol components in the atmospheric column from remote sensing data
see : Zhang, Y., Li, Z., Chen, Y., de Leeuw, G., Zhang, C., Xie, Y., and Li, K.: Improved inversion of aerosol components in the atmospheric column from remote sensing data, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1062, in press, 2020.

General discussion:

Breakout 8: Aerosol Representation Beyond AOD
Moderator: Ralph Kahn Rapporteur: Andrew Sayer
https://nasaenterprise.webex.com/nasaenterprise/j.php?MTID=m70ef7246fe7f5708b02f16633b562c62

Reed Espinosa *– Surface/Aerosol RT simulation + GRASP retrieval testbed*
Monte Carlo simulator to draw various realistic real-world state vector of atmospheric properties. Forward-simulate satellite signals, add noise, and do retrievals with GRASP. Purpose is to test capabilities of potential future sensors. Focus on multiangle polarimeters, and polarimeter/lidar combinations.
Fine mode particle shape is important for polarimeters to get right, but not so much for intensity-only measurements. So, more information can mean more challenges too!
Mode-resolved simple vertical profiles can be achieved using a polarimeter and backscatter lidar.
Anin: Hi Reed, when you are using the monte-carlo method finding the uncertainty in retrieved parameters, are you using a normal distribution around initial guess of each retrieved parameter? or using a uniform distribution around the bounds of retrieved parameters?

- Reed: Hi Anin, the simulated state variables are chosen from a relatively wide uniform distrubution. The retrieval initial guess is also selected randomly, but from a second uniform distribution that is slightly narrow than the one used to derived the simulated state varaibles.
  - Anin: I am just curious to know if using a normal vs uniform distribution will give us different uncertainties. Which one represents the realistic retrievals uncertainties?
  - Reed: I havn't tried using a normal distribution, but I would expect the results to be a little different. I think the standard deviation (or bounds of uniform distribution) would likely play a larger role though.

Athanasios Tsikerdekis *– Aerosol size and absorption from POLDER/PARASOL*
Assimilate AOD, AE, and SSA rather than only AOD. Allows adjustment of model component mixing ratios.
Find this does better than assimilating AOD alone, in comparison to reference satellite data and also AERONET. Using the trio helps as assimilating only AOD can sometimes make e.g. AAOD worse.
Paper in discussion in ACPD now: https://acp.copernicus.org/preprints/acp-2020-468/

Bastiaan van Diedenhoven *– RSP retrievals from CAMP2Ex, results & issues*

- CAMP2Ex data available here:
- https://www-air.larc.nasa.gov/cgi-bin/ArcView/camp2ex

Simultaneous retrieval of aerosol and surface (over water) properties from MAPP algorithm (Stamnes). Notes instrument flown in other campaigns too.
CAMP2EX data (including level 1 and retrievals) available at link above. Sampled a variety of aerosol (and cloud) conditions.
Good comparison of AOD with HSRL over largeish range; layer height uncertainty around 1 km (depends on HSRL definition)
Anin: Hi Bastiaan, Are you using all the spectral bands from RSP in MAPP algorithm?. Have you explored if you filter out the retrievals which has AOD < 0.4 at 410 nm

- Bastiaan: All bands except the 960 and 1880 nm bands that are at water vapor absorption regions are used. These plots showed results for all data points. I'll have a look at AOD_440<0.4 only.

- Anin: For the case of AirHARP I was using the pixels with AOD_440 > 0.4 for the RRI, IRI and SSA. However, for the case of RSP, this might be an overkill since you have longer wavelengths.
- The extra wavelengths add some information but mainly for coarse mode. I think others often use a AOD at 550 of 0.2 as a cut off. When I do that, the histograms do not change much. It should also be reflected in the error covariance matrix if the info content for size, refractive index become small. What I showed was an overview and prelimirairy comparison to HSRL, but indeed we need to take a better look at information content and estimated errors.

Pete Colarco *– June 2020 Saharan Dust Event – Testing ICAP models w/data*
Looking at the Saharan dust event from a forecast model (NRT, assimilation) rather than climate perspective. 3 AERONET sites at various points downwind for evaluation. With assimilation, transport path of ICAP models is pretty consistent. However, there remain larger differences near the sources, and magnitudes of AOD in the Caribbean (~factor 2).
Models with assimilation have lower diversity than those without.
Thanos: Thank you for the presentation! Very interesting how the assimilation of AOD can ensure such consistency in the long-range transport of dust over Caribbean! Is aerosol mixing ratio or aerosol emissions the state vector in these assimilation experiments? Also, I may have missed that information, are these assimilation experiments using the same meteorology (or nudged to the same meteorology) ?
AOD is what is assimilated in the models that do it, I think 550 nm MODIS-based AOD in all cases. They translate back to their mixing ratios with whatever assumptions they make about the aerosol composition. In the NASA model for example it practically amounts to a rescaling of the prior concentration distributions. There is little information about speciation or altitude in the assimilation in our model except that we look locally around the target assimilation point.
The models are all using their own meteorology. This is something I hope to work on deconvolving in a proposal we wrote to NASA with the ICAP colleagues to run the various meteorologies through a single CTM framework. We've worked out the approach, but have not yet been funded to do the work. It would be interesting!
Thanos: I would be very interested to see the results of the different meteorology experiment, I hope it gets funded. We have done some similar work under an OSSE framework (my yesterday poster), and show that ERA-5 and ERA-interim meteorology may lead to quite different transport paths of aerosols and can impact emission estimation. Although they are both reanalysis products and ERA5 just an upgrade of ERAinterim. Also I am suspecting that if you were scaling emissions in your data assimilation experiments you might not get the same level of consistency in this long-range transport.

Daniel Robbins *– AI to separate Himawari smoke/cloud for the 2020 Australia fires*
Trained a neural network on CALIOP-Himawari cloud mask to separate smoke and cloud. Tends to perform better than operational (JMA) cloud mask.
Neural network seems better at dust/smoke vs cloud identification, but misses some edges and thin clouds.
Caroline: AI techniques rely on accurate training data, we have found that CALIOP type is not very accurate at least in the Himawari region.

Marta Luffarelli *– Consistent retrieval of cloud, aerosol, and surface properties*
Optimal Estimation retrieval where optical properties of cloud/aerosol are parameterised in SSA and g space (different classes which are linearly mixed).
Attempting retrieval of all pixels as clouds and aerosols bypasses the need for a preprocessing cloud mask. Presented application to SLSTR.
Caroline @Marta what uncertainty do you use in your retrievals?

General discussion
Yves: assimilating AOD and absorption is a good idea. There are many instruments/algorithms coming up. How important do you think the absorption is as the quantity to go after?

- Andy: I think absorption and height (at least boundary layer vs. free troposphere) are most important as they feed directly to both climate and air quality goals.
- Thanos: In terms of retrievals it is important to narrow the uncertainty of absorption aerosol properties (SSA, AAOD) and the upcoming instruments (e.g. SPEXone and HARP-2) can certainly help with that. Although from what I am seeing from my experiment, there is already valuable information in SSA and AAOD despite their big errors, since models have way higher errors in absorption. To answer more specifically Yves question, if we don't get absorption correct we certainly misrepresent the radiative effect of models and hence their effect on climate. So I think it is quite important to get it right (to the extent that we can, considering the errors of absorption retrievals).

Ralph: Angela's discussion of radiance (rather than AOD) assimilation earlier points to a way to bypass some assumptions that might differ between satellite-world and model-world.

- Pete: have also been able to develop emulators (e.g. CALIOP aerosol type, OMI UV) to facilitate the "translation" between satellite and model contents. Helps iterate improvements in models and retrievals.
- Greg Schuster: isn't the computational burden of large scale radiance assimilation too high?
  - Pete: not sure but it is done routinely in the NWP community. They may have simplified radiative transfer.
  - Angela: there is a whole group of people who work to make RT codes that are fast and accurate enough for assimilation. These are e.g. regression approaches. Fairly mature for the IR. For aerosols, they have adapted the ORAC lookup table approach.
  -

Ralph: we also need lab/suborbital constraints on the fundamental particle properties like mass extinction efficiency and hygroscopic growth. Needed to reduce the uncertainties in those assumptions. See Claudia presentation tomorrow.

- Pete: this also applies to satellite emulators - an additional source of uncertainty we need to be mindful of when developing these and doing the comparisons. Modeled state (icluding optical properties) needs to be realistic.

- Yves: as Christoph Bruehl pointed out earlier, the model really starts at spectral refractive index, so we should come to consistency on that and provide recommendations. (And we don't have enough measurements now.)
- Ralph: Here is a reference giving an approach to obtaining systematic in situ measurements of aerosol microphysical properties that are either unobtainable from remote-sensing, or cannot be obtained with adequate accuracy for climate and/or air quality applications: Kahn et al., BAMS 2017, doi:10.1175/BAMS-D-16-0003.1.

Related presentations from plenaries tomorrow (not discussed in this breakout):
Claudia di Bagio *– Lab measurements of aerosol microphysical properties*
Andrew Sayer *– 2020 Australia fires AOD and AAOD retrieval results & prospects*
Larisa Sogacheva**–** *Comparisons of multi-spectral satellite AOD*

Breakout 9: New retrievals
Moderator: Adam Povey Rapporteur: Pekka Kolmonen
https://nasaenterprise.webex.com/nasaenterprise/j.php?MTID=m66b5b6a82b5ebd0ed1265fc1811155e7

Chimot, Julien) Copernicus Sentinel-3 near-real-time aerosol optical depth baseline Collection 1 product by EUMETSAT
Adam Povey: What techniques did you use to evaluate the information content? I'm familiar with these being used in spectrometer retrievals but they're rarer with imagers.
The geometrical part was an important part of it (see our other contribution on it) in the case of SLSTR. It rapidly informed us on why the retrieval was failing.

Litvinov, Pavel) Surface and aerosol retrieval from S5P using GRASP: baseline requirements and expected performance

Marbach, Thierry) EUMETSAT aerosol missions and products: focus on 3MI, the multi-view polarimeter flying on Metop-SGA
Istvan Laszlo: Is the input to GRASP the L1B or the L1C 3MI data? What is the data granule size for the aerosol product?
Today the input are L1C because in line to what was done on POLDER. Later we can image starting from L1B and use the fact that the pixels have not been co-registered (which can induce lost of information).
concerning the data granule size, do you mean time or MB?
Istvan Laszlo: I mean time, this of course translates to number of scan lines by number of pixels per scan line.
3MI does not scan, all pixels are acquired (e.g. 512*512 for VNIR). The preliminary results for the NRT GRASP is about 0.2-0.4 second (core average time)
Istvan Laszlo: Yes, I am aware of 3MI is not scanning; I meant the number of pixels in one granule when I said scan lines. Apologies for the unclear question, and thanks for the answer.

Piontek, Dennis) Recent advances in satellite retrieval of volcanic ash properties
Adam: Any idea why the errors in top height are a function of latitude rather than zenith angle?
Dennis: I assume this might be connected to a lowering of the tropopause at higher latitudes. As we still have ash plumes at heights up to 18km those samples are probably harder to retrieve. Also it is possible that the neural network learns mainly the temperature profile at low latitudes, leading to wrong estimates towards the poles.

I've run into the Azimuth angle while working with OMI and MODIS Level 1b data, very simple yet very to get confused definition
Thompson, Sabrina) Analysis of scattering angle sampling by multi-angle imaging polarimeters for different orbit geometries

Zheng, Jianyu) Research-level retrieval algorithm of dust thermal infrared optical depth properties using collocated IIR/CALIOP observations
I am sorry for not presenting the poster online due to the time conflict. Mainly the poster shows the advantage of combining active lifts CALIOP and passive infrared radiometer IIR with 1-km resolution to actively identify cloud-fee dust layers with accuracy dust vertical distributions. The retrieved dust AOD at 10.6 um can be retrieved by assuming dust particle size distribution and refractive index along with atmospheric states. We have tested that the uncertainty of assumed particle size distribution is not obvious compared with that of the assumed atmospheric states (atmospheric profiles and surface properties).

Povey, Adam) Making the old new again: Overhauling ORAC
Pekka: the azimuth is a headache here. Our best estimate is that mirroring is needed with respect to LUT
- That was sort of where we started. DISORT et al use a different definition to the surface reflectance people bv

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Lar