UKESM General Assembly

Wednesday 17th June 2020: 9.15 – 10.30 Science Talks (A)

Chat & discussion supporting document

This document is to capture discussions during the UKESM General Assembly 2020.

During presentations, please write down your full name and your questions/comments in this document, below the specific talk.

This process enables us to keep track of questions, avoid their repetition and foster discussion. We will encourage presenters to review comments after the presentations.

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1. *Evaluation of sulfur species in UKESM1 – **Catherine Hardacre***

Name: type your name and question/comment/response below

Till Kuhlbrodt: What would you change in the UKESM1-SO2 model to increase the SO4 (2-) concentration while keeping the SO2 concentration low?

David Stevenson: Hi Catherine - so it looks like oxidation of SO2 to SO4 is too slow. The main route is in-cloud +H2O2 - do you know if that looks OK (e.g. compare to other models)? Or possibly SO2+OH.

Jane Mulcahy: yes we are planning to look at the production fluxes in more detail, this is the clear next step in this work I think.

Ashok Luhar: Are OMI data columns? Any influence of clouds on the data?

Graham Mann: It looks like the biases in the historical are emerging through the 1960s into 197s0s, could you test how the chemistry re: SO2 and sulphate in the 1960s/70s oxidising capacity?

Jane Mulcahy: focussing on those periods sounds like a good idea although comparing against any obs is obviously limited.

2. *Bounding global aerosol radiative forcing of climate change -* ***Nicolas Bellouin***

Name: type your name and question/comment/response below

Chris Jones: We've learned a lot from perturbations like volcanic eruptions. Do you think there are prospects for evaluation following the aerosol-reductions due to covid lockdown?

David Stevenson: Many aerosols (nitrate, organic) are poorly represented in models, and increasingly important as S declines. How important is the neglect of these?

Nicolas:Nitrate is increasingly important and its neglect in global models cannot be justified. Having said that, other lines of evidence like global satellite analyses account for those species, so they are not missing everywhere!

Philip Stier: we should have presented this here but in recent work we have decomposed forcing into cloud regimes and HadGEM-UKCA forcing seems heavily dominated by warm stratocumulus decks.

Nicolas: Yes, and effective cloud fractions calculated in the Ringberg paper also put much emphasis on stratocumulus decks, or the edges of those decks for cloud fraction responses.

3. *An emissions-driven simulation of the methane cycle with UKESM -* ***Gerd Folberth***

Name: type your name and question/comment/response below

Jeremy Walton: can you say more about how you're going to investigate the future changes in the CH4 recovery process?

Gerd Folberth: The key question really is the methane lifetime which is controlled by the reaction with OH. Here, co-emitted pollutants, in particular NOx, play a crucial role, but also BVOC emissions, because BVOCs compete with methane for OH. So I am planning to analyse this aspect of the chemistry. We need to do some work on

evaluation, too, joining force with Rob Parker. This all assumes that the chemistry is doing reasonably well and there are no biases in that.

Graham Mann: Is there any plan to investigate the Pinatubo impact on CH4 growth rates through the 1990s (e.g. Dlugokencky papers)?
Gerd Folberth: Thanks for this suggestion Graham. I think this would be a very nice application of this new configuration.

Pmc205: very nice. Where do the CH4 anthropogenic emissions come from? Could they have been derived in part from the atmospheric concs? Or are they completely 'bottom-up'.
Gerd Folberth: Please excuse my ignorance on this point and what I said in my response. The emissions are completely bottom-up.

Fiona: I think we may have a gas-phase reaction to act as a surrogate for aerosol uptake of N2O5

@Paul, looking again at the GMD paper, we do include aerosol uptake of N2O5 so, I had that incorrect. Apologies

David Stevenson: I think the difference between the conc-driven and emissions-driven simulations is due to too much NOx in the model. Bill asked yesterday about heterogeneous removal of NOx. How is that handled?

Chris Jones: Thanks - there are many differences between emiss-driven runs and prescribed conc. Wetland emissions are not well known, although we're within uncertainty. Anthro emissions are not well known - Fiona showed CMIP5 vs CMIP6 yesterday. Atmos removals are not well known - and NOx could be an issue. We shouldn't jump to conclusions which are causing the difference - how could we evaluate the sources of the differences to know better which is the cause?

David Stevenson: Gerd/Chris/Fiona - I get a similar result to you (ie emissions driven CH4 is too low) with simple box modelling - unsurprisingly, to fix the difference you need to increase the CH4 emissions, or reduce the NOx emissions (NOx generates OH), or reduce the NOx lifetime (i.e. keep NOx emissions same, reduce NOx concs). Comparisons of UKCA with satellite NO2 over Asia shows much too much NO2, and too great a sensitivity of UKCA NO2 concs to NOx emissions; I think the NO2 lifetime is too long - increasing heterogenous removal is one possible way to shorten the

NO2 lifetime, but there may be other reasons why the NO2 lifetime is too long. I think we need to look at the NOx budget in detail, in order to better understand the CH4 budget.

Garry Hayman: Very encouraging. What would be the the implication for the 13-CH4?
Gerd Folberth: Thanks Garry. However, my knowledge on this topic is too limited to give you a meaningful answer. See below, also (reply to Olaf).

Morgensterno: The CH4 changes around 2000 are also reflected in 13CH4 variations that seem to rule out that the changes are predominantly driven by fossil-fuel emissions. Do you have any thoughts on this?
Gerd Folberth: Not at this point, no. Going through the literature it seems that there is a back and forth going on with respect to this question. I am only looking at budget terms for now and unfortunately we don't have isotopes in the model yet.

Fiona O'Connor: There is a complete disconnect between historical ch4 emissions and ch4 concentrations. It is only for the future ssp's that emissions are linked
No heterogeneous removal

> Bill: Is the disconnect really complete? Could there not be some unconscious tuning in the CMIP6 dataset so that it doesn't give unrealistic historical concentrations?
> David Stevenson: I think the disconnect is fairly complete. Almost no-one to date has used the CH4 emissions to derive CH4 concentrations. (Sophie Szopa did this ~2007, and got a similar result to Gerd, I think). I've checked and actually she got the opposite result - and it was 2012 - too much CH4 when driven by emissions (see https://doi.org/10.1007/s00382-012-1408-y, Supplementary Figure S5).

Pat Hyder: Great talk, Question for text chat (to repeat my off topic question to Fiona yesterday): are permafrost CH4 emission feedbacks expected to be a significant term to 2100, given polar amplifcation and arctic changes of 10 C even for global mean changes of less than 2 deg C?
(in some models) *global mean changes of less than 3 deg C NOT 2 deg C

Gerd Folberth: Thanks Pat. I have discussed this question with Eleanor Burke who leads the work on the permafrost model in JULES. According to Eleanor the methane source from thawing permafrost soils is to small to become a major controlling factor. Most of the emissions seem to be in the form of CO2. Possibly methane is oxidised microbially in the soil before it can reach the atmosphere, but that's me surmising.

Bill Collins: @Chris, Fiona: Is there any value in trying to tune the (present) methane lifetime - e.g. to Prather or the like? Similar to the way the models reviewed the aerosol parameters when the forcing was too high.

Fiona: @Bill With the out-of-the-box modelled methane lifetime at the PI, we can exactly replicate the observed global mean concentration, which suggests that at least at that time period, the lifetime may be correct. Scaling to Prather's observational constraint at the PI would probably cause a high bias

Bill: So it sounds as if the lifetime decreases with NOx too strongly?

David: I think this is correct - I think there is too much NOx in the model - if the NOx emissions are OK, then the NOx lifetime must be too long, and this means the decrease in CH4 lifetime as NOx emissions increase is too big. The sensitivity will presumably work the other way as NOx emissions fall.

Gerd Folberth: Methane lifetime and NOx evolution is what I want look at next in my simulations. We do have a lifetime bias, so emissions alone cannot be the answer in my opinion. I have only looked at surface methane concentrations so far, but the OH sink is driven by the whole troposphere. Lots of interesting stuff in this. Would be nice to understand what drives the hiatus in the model and how that compares to the discussion in the literature.

4. *Evaluation of aerosol in the UKESM against an ensemble of satellite observations -* ***Adam Povey***

Name: type your name and question/comment/response below

Peter Cox: looks like 2012 was a major fire year in the US. Could that be the cause of your peak? https://earthobservatory.nasa.gov/images/79921/us-fires-2012

A: Yes, that is a likely explanation.

Graham Mann: I like these histogram comparisons and think they are a useful way of understanding the contribution from strong AOD days (e.g. frequency of dust outbreaks), is it possible to use this to test the dust specifically in the model?

A: Thank you - I try. As the model outputs are divided by species, it should be possible to make a comparison to dust, though the satellite products have an imperfect identification of dust.

Philip Stier: @Adam: I like the histograms but there is an issue of limited sensitivity of satellite retrievals in low AOD bins. Have you taken this into account? And how?

A: Indeed, they are and I both have and haven't accounted for that. In the plots shown, there is nothing done. When making aggregated statistics (not shown here), I have tried weighting by the number of satellite observations in order to judge the model by how well it captures what the satellites see. Using AERONET and MAN also provides more confidence at the low end of AOD.

5. *Tropospheric ozone burden and budgets in AerChemMIP experiments* - ***Paul Griffiths***

Name: type your name and question/comment/response below

Xin Yang: Surface ozone in the Arctic is badly simulated. Does UKCA version include halogen (in particular bromine) emitted from sea ice ?

Apologies Xin - your changes didn't make it out of UM-UKCA vn7.3 (or *did they*?)

Morgensterno: Why does the stratospheric infkux of ozone go to zero around 2000? That's inconsistent with other literature.

Thanks Olaf - It definitely shows the limits of the residual approach, and we'd have been better using a dynamical flux. There is some discussion of what drives this feature in UKESM in the paper (https://doi.org/10.5194/acp-2019-1216)

Bill Collins: Can you get diagnostics from UKESM1 to check your residual=STE?

Thanks Bill. Good idea. This will be done in AerChemMIP and has been done for UM-UKCA vn7.3 in https://doi.org/10.1029/2019GL086901 that I co-led with James Keeble. In that work, residual = STE pretty closely.

Bill: I'll be interested to see if the diagnosed STE really is zero in the early 2000s!

David Stevenson: Hi Paul, does the residual, stratospheric input term mirror lower strat O3 concs, or is there an enhanced Brewer-Dobson circulation component?

Definitely the former, and most likely the latter, but will update when we have some circulation diagnostics.

Paul: definitely expect enhanced BDC to have a role!

David: I was thinking if the change in the residual term was simply proportional to the lower strat O3 concentrations, then there would be no need for BDC changes. By making such an assumption, you could perhaps attempt to separate the residual term into changes in LS O3 and changes in BDC.

Ashok Luhar: @Paul, in this model version used, is the oceanic ozone deposition mechanistic or constant?

I will check, but the UKESM1 coupled AO configuration was frozen quite early so it may be that your work was not incorporated. Sad face. But we'll be doing some runs in the near future looking at the effect of the updated DD scheme.

Bill: It might be interesting to look at your loss terms as lifetimes - i.e. scaling by the total O3 burden. Obviously loss increases as burden increases, but do the losses increase proportionally more or less than the burden? This also might make the terms easier to compare i.e. does the loss lifetime to dry dep become more or less important than the chemical loss with time?

6. *UKESM volcano-climate experiments: comparing impacts from satellite-based (CMIP6-GloSSAC) and microphysically-consistent (SMURPHS/ACSIS) Pinatubo forcing datasets* - ***Graham Mann***

Name: type your name and question/comment/response below

7. *Earth System Music: the creation and reach of music generated from UKESM data* – ***Lee de Mora***

Name: type your name and question/comment/response below

Andrew Yool: Q: Would it be possible to illustrate how the separate components going into the arias affect it? That might make it easier for someone who's tone deaf like me understand how, say, CO2 uptake appears in the final piece? (And I full appreciate that I should have made this comment when the paper was being written!)

Jeremy Walton: QUESTION: how do the musical choices affect emotion? Is it more than the choice between major & minor, slow & fast...?

Douglas Kelley: Q: Could you quantify your reeach audibly as well as visually? ;)

Chris J: Lee - nice talk - I'm wondering if these can be merged with animations? E.g. could have 2D animations of the fields which are varying as backgrounds to the music. This caters for visual and audio fans…

Anonymous comments:
Hello Lee, I was not aware at all about this work of yours. I find it awesome. what a great idea you have had here. Would you authorize me to suggest a potential additional feature : representing the uncertainty in our simulations (estimated from ensemble spread of historical simulations, for example) as noise (strictly speaking), to highlight how some signals are concealed prior to 1950 and then become dominant ? again congratulations for being so creative. I am sharing links to your videos extensively. thanks !

that would be fun to try out. Perhaps like a gainy/distorted effect would be nice, where the gain gets stronger as the data is more uncertain.

cool! have you any plan for provide this tool on website for someone ? thanks for your works and link:

At some point, I'd like to publish the code on GitHub, but for now it's still a bit rough around the edges.

That sounds great thanks ! I would like to share this youtube link with my colleagues!

By all means, please share it! That's what it's for!

I feel like representing warming and cooling would be more appropriate than happiness and sadness here?

There is a piece where we show ocean warming exclusively, the Sea surface temperature aria: https://www.youtube.com/watch?v=SYEncjETkZA&list=PL27v682n8E2Sla8U7jJph9w9M6nYln-W3&index=4&t=0s

The pitch of the notes conveys the warming, but the tone and the harmonies can attempt to convey an emotional context. The warming should make us uncomfortable.

Jerry Blackford: Its a like from my teen age kids. The different cultural interpretations of music is fascinating, but contrasts with the portability of numerics. With music, do we have to think about the particular audience first?

Good question Jerry. Lee has tried to do some evaluation of audience reaction, but they're largely self-selected (whoever tunes in on youtube).

Glad the kids like it! I think that we can assume a relatively western set of musical sensibilities in the audience. Though it would be great if this music received more attention from international audiences. There is also the influence of the underlying musical tools that has an impact. MIDI itself is very much built for the Western ear.

Could you engage with say Asian modellers and try and do something in an Eastern style?

That would be interesting, but I'd just need to find virtual instruments to perform the instruments. I'd also need to learn about the musical notation (ie: https://en.wikipedia.org/wiki/Shakuhachi_musical_notation), which doesn't always translate well to the Western notation.