

Breakout Session Report
ARM/ASR Virtual User and PI Meeting June 23-26, 2020

Session Title: Pairing SCM/LES and GCM/ESM for observation-guided model development

Session Conveners: Ann Fridlind, Shaocheng Xie, Israel Silber, Bobby Jackson, Scott Collis

Session Date: 25 June 2020

Session Time: 11AM EDT

Number of Attendees: 120

Summary Authors: Ann Fridlind with edits from all co-conveners

Main Discussion

The first hour was spent on three presentations outlining the concepts being proposed (Ann), the currently ongoing GASS Diurnal Cycle of Precipitation (DCP) project (Shaocheng), and an open source ground-based lidar-radar simulator tool to enable ESM evaluation using long-term data sets (Israel and Bobby). Questions were asked about the DCP project results thus far and the capabilities of the simulator—whether scattering libraries could be expanded with an ensemble approach and whether microphysics PDF assumptions could be altered. Bobby and Israel answered that those capabilities could be readily added in an open source and community code manner, by design.

The second hour was spent in open discussing re the following leading questions:

- Is there a need for more organized modeling activities within ASR?
- Should a model-centric focus group be reinstated?
- Should the focus be expanded beyond IOPs to harness long-term data?
- Could such a group support multiple, diverse group activities with varying group sizes?

A wide range of participants from both domestic and international institutions shared concise and thoughtful reactions. We have appended at the end a rough transcript of all discussion period contributions as a numbered list ([view recording](#)).

Key Findings

There was unanimous support for some kind of more organized modeling activities but some diversity of opinion on how best to pursue that. We refer to the appendix list by number in the following summary findings:

- Wary of the enormous overhead associated with past intercomparisons, there was wide support for a more limited bulletin board (web page) approach to stimulating smaller group activities (2,4,6,8). But some were concerned that that would be "another place to forget to check" (3) or felt that that would be insufficient to develop the scientific excitement and sustained momentum of direct community interaction such as occurred around past GCSS case studies (3,6,17).
- Others favored an explicit group activity that would be capable to span modeling activities from LES to ESM (5,14), noting for instance that it is possible to intentionally focus observational constraint studies on the physics to which ESMs are actually established to be most sensitive (14). This bears similarity to the DCP project example, spanning modeling frameworks and focused on the physics behind a well-known climate model bias.

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- Some fully supported the value of new and revisited intercomparison activities to study model physics (7,14,17), and also welcomed the LES/SCM and ESM pairing to address the pitfalls of tuning to limited cases or specific sites that have been problematic (7,16). In the case of intercomparison activities, there was support for low-overhead participation options (1,5).
- There was wide and unopposed support for creating a readily accessible and easy-to-use LES/SCM case study library (4,5,9,11,12) and for using a standardized format like [DEPHY](#) (4,5). Efforts are also already being made towards that goal (10,13,20).
- A two-pronged approach was suggested to in parallel pursue the value of getting a wide community pointed in the same direction for intercomparison activities, in addition to supporting a "one stop shop" for time-pressed modelers to be able to quickly access existing case studies off the shelf and readily use them (11).
- The importance of large-scale forcing uncertainty led to discussion of an ensemble forcing approach, existing and past efforts to use an ensemble approach (LASSO and VARANAL examples), and the potential value of a covariance matrix approach to assessing uncertainty in large-scale forcing (18-20,23).

Decisions

We conclude that there is sufficient interest and perceived value among a wide enough group that further discussion is warranted. However, concerns about the amount of overhead on giant omnibus studies are also well warranted. We recommend to develop a low-overhead plan with the following modular elements:

- A modeling focus group with participants spanning LES, ESM and observational expertise and entirely optional participation. Such a group could operate in parallel to and entirely deprecated to existing working groups. Discussions could consider development of new LES/SCM cases with any number of participants, paired analyses of ESMs versus long-term data, considerations relevant to the case study library, etc. The group could also serve as a clearinghouse to testing and coordination of the case study library. Joint activities could involve any number of participants but all main work would be done via offline coordination (similar to GCSS serving as an umbrella for many case studies simultaneously in the past).
- A readily accessible case study library using a standardized format such as DEPHY being developed under French leadership (with widespread U.S. participation) for any SCM and LES input forcing and outputs. Development could include ingesting E3SM's existing case study library, and testing the work flow in the course of group activities (e.g., revisiting M-PACE LES/SCM, perhaps paired with an AWARE case and long-term data analysis as proposed).
- A bulletin board (web page) to track activities and any other community communications.

Group activities should be as low-overhead, high-impact, and optional as possible. Tools should be as easy to use as possible. Open source and community codes should be used to build the input files (allowing for ease of tweaking any case elements), plot SCM or LES results versus observations, etc.

Issues

Some wish to meet and discuss across modeling expertise and pursue intercomparison studies and paired physics work whereas others feel the overhead is problematic. We propose that maintaining an

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entirely optional participation is desirable. It may also be desirable to maintain periodic virtual meetings to support international and non-PI participation.

Needs

Program support is needed for the case study library. It would also be highly desirable to offer limited computing environment support where participants can upload results and plot against specific case study observations and other uploaded model results. Aside, we note that DEPHY workshop participants running SCMs desired to be able to download LES results for cases without having to generate that part themselves.

Future Plans

Begin meeting as a focus group. Group leadership of some type will be needed but should ideally take a light hand and simply assist in enabling development of impactful projects and helping to keep them streamlined, advertised, etc.

Action Items

Decide when to have a first meeting and organize that. Likely proposal: rerun M-PACE and perhaps an AWARE case, but keep the door wide open to any other ideas. Use such a first group activity to develop and test a case study library approach, open source and computing tools, etc.

Appendix A: Rough Transcript of Discussion

1. Richard Forbes: I support low-overhead options to participate (with few runs and few diagnostics) since many groups do not have support for inter comparison work.
2. Steve Klein: Mindful of the overhead involved in organizing community efforts, instead of a big organized effort, we could host a bulletin board where people could make requests re tools they wish to use or offer tools that they have to share—a collaboration clearinghouse, in other words, could be helpful to facilitate collaboration and use of data in modeling exercises
3. Thijs Heus: I miss a good modeling group and our discussions at meetings in person. We have potentially a good framework in ARM/ASR with LASSO and VARANAL and ARM-BE, etc. So all we have to agree is that, hey, this is a research question that some subset of ARM modelers agree is a question of interest. Bulletins boards are nice, but that's one more place I have to look; I will probably forget about it. One thing we had a few years ago is a couple of virtual meetings that I massively enjoyed, and perhaps we could do the same thing.
4. Mikael Witte: The bulletin board is great! Then if there's something I need, I can go look for it. I've been concerned that there is a proliferation of differing forcing data sets. It would be really helpful to have a central repository. Using the DEPHY format is a great idea to remove at least one ambiguity (set-

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up). It would be great to see more forcing data sets come out for projects where there won't be a large-scale inter comparison but some PIs have interest in that. It doesn't require 15 different people.

5. Lulin Xue: I participated in the DEPHY workshop. At NCAR we developed the common community physics framework to test different packages. EMC3 appears to have a similar philosophy and that would be desirable to make the obs/model inter comparison easier. That lowers the bar for groups to participate and I concur that we want to have a modeling centric group to really span the hierarchy of models to make sure the different tools and approaches are available, along with the long-term data, which would be super valuable. Making things easier for participants is likely to stimulate many new ideas and collaborations. I really hope this takes off. Also, Shaocheng, your hierarchy approach is exactly what we're using at NCAR and it will be great if we can get together to share experiences.

6. Roj Marchand: I am supportive of a bulletin board (I'd call it a web page), but I'd support the voices here are that there should be more than a web page. What made GCSS exciting was their meetings. It was very interactive. Experiments often had phases in order to figure out exactly how to configure the cases. That has to be a moderated activity, which is in part why the lead person was so important to making that work. I agree that tools that are more easily used is a great idea, but that won't replace the importance of the human interaction. Leadership, meetings and the cycling process to improve studies over time are crucial. It's a great idea to repeat M-PACE, for instance.

7. Susannah Burrows: Wearing my hat as someone who spends my time on aerosol INP, I am often asked to calculate the ECS implications. I've been hesitant to do that kind of thing because the models are not in a strong place to support answering that question. Having new inter comparisons to show how the new generation models is working—to me that would be a very helpful thing. Another comment: pairing LES studies with ESM evaluation. We see a lot of benchmarking to local site data, but then models do not necessarily perform well globally; we see that over and over. So having a plan to pair LES benchmarks with some approach to ESM evaluation as suggested here is a very good idea.

8. Hugh Morrison: I strongly support Steve and Mikael's suggestions to have a bulletin board. The biggest problem is finding a lead for large groups. Smaller groups working rather than big top-down efforts could potentially get more mileage out of these cases.

9. Marcus van Lier-Walqui: I foresee these cases as informative to GCM model tuning. Thus the applicability is very broad and efforts will reap huge benefits for many.

10. Andy Vogelmann: It's always bugging us how to make better use of resources and this is a timely discussion. Following on McKenna's point, LASSO is here. Already quite a bit of effort has already gone into a first cut on many data sets. LASSO is not meant to be the PI cut on the data (just the first cut), but is meant to complete some time-consuming steps, such as vetting forcing data sets. LASSO is focusing more on IOPs going forward (e.g., CACTI) and we will be pushing into the ACE-ENA data set. We're going to be doing the heavy-lifting wrt forcing, for instance, but we'll also need area expertise and retrievals. So these efforts can be a focal point for PI retrievals. I can see how LASSO can play a role in something like this. We have finite resources, with a focus on the IOP part, without the focus described here on long-term data. What is being address here is really a big problem, but I can see how LASSO's short-term

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aspect could be more readily accessible. Partnership would be required to populate the broader vision suggested here.

11. Maike Ahlgrimm: It is actually good to have a mix of two things. On the one hand, trying to get the modeling groups together to work on one thing as a focused group. But on the other hand, having an “easy shop” for modelers who don’t have a lot of time. The DEPHY format will help with that, with less overhead to get into it. For instance, “the ARM case” is still around and still being looked at! If we had an easy format and easy way to look at them, it would invite more modelers. So I think having these two streams going in parallel would be great.

12. Philip Griewank: What I want to say follows quite closely [to Maike]. I’ve been working a lot with LASSO data and I find that all the work and work that has gone into preparing all this very impressive. The missing cherry on top would be the ability to grab all the cases and run your SCM model for the 100 cases and then plug your model results back into the default evaluation. In the future someone will say, let’s look at the 100 LASSO days, and you can just plug and play and compare to some of the easy reference models. So much is there already; that would be very nice.

13. Response from Andy Vogelmann: Had we had the full meeting, we had a LASSO session planned and we are now working on getting exactly this type of capability out there. This is something that we’re looking to hold in the fall, so stay tuned. It is something we’ve been working on.

14. Johannes Mulmenstadt: I just want to emphasize what Susannah said. From firsthand experience, we recently did a study where it turned out in our model the cloud lifetime effect was much more sensitive to the occurrence of precipitation rather than precipitation susceptibility to aerosols. If GCMs come into a comparison with observations knowing what they are most sensitive to, that will help a lot. It is something that GCMs can know, by doing PPEs or whatever.

15. Peter Caldwell: I agree with Maike that having a big library of past cases would be hugely useful for model development. To amplify, I think having many models run the same case is useful for understanding the physics of model world versus the real world. But having many cases run with a single model is best for optimizing or tuning one’s particular model for release.

16. Unattributed Comment in Q/A: I’m a big fan of pairing LES and SCM using long-term observations at permanent sites. This reminds me of Christian Jakob’s strategy, which we adopted when configuring long-term SCM and LES using data from the Netherlands and it really delivered.

17. Paquita Zuidema: Agrees with Roj that occasional get-togethers are valuable for developing and maintaining momentum. We will have one in the fall for the ORACLES/LASIC activity Ann mentioned. The prior preparation for how to focus this in a meaningful way for the interested participants will be important, too, of course.

18. Marcus van Lier-Walqui: Given that the uncertainty in the forcing will be significant, I wonder if there is an ensemble approach to forcing.

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19. Response from Ann: Yes, that is exactly what LASSO is doing. That said, at GISS we're usually taking case studies with LES producing the physics that we want to see and using those for GCM development, leaving the observations behind at that point. I would welcome further discussion of that approach.

20. Response from Shaocheng: For VARANAL, we also tried varying the constraints to produce an ensemble forcing, which partially addresses this issue of uncertainty in large-scale forcing. We did this for MC3E and also for TWP-ICE, which was used by Christian Jakob's group. Another comment re the case library: I have been promoting to create ARM data category specifically to collect all those cases that have been widely used in inter comparison studies and for modeling work. But the problem is that ARM wants all the cases to be easily found so all cases would need to be put into the ARM archive in production mode. On the ARM home page, if there is a symbolic link there, including forcing and evaluation and details, then people can have a "one stop shop". I'm working with the ARM infrastructure team to try to make that happen. Also we work with the E3SM SCM team led by Peter Caldwell and Peter Bogenschutz. We provide all the ARM forcing data for maybe more than 20 cases, which is standardized. People can go to the E3SM SCM page to download that.

21. Richard Forbes: LASSO is a really great initiative that will hopefully address development issues. What else could we do enhance the value of LES for GCM parameterization development?

22. Response from Ann: Great question, and I would welcome the chance to talk about that more going forward.

23. Marcus: I just wanted to quickly say that if there is a standardized format for ensemble forcing, then it would be nice if uncertainty were considered as a covariance matrix or something like that. That would be great.

24. Courtney Schumacher: In Go-Amazon I think we have a lot of good targets for use of long-term data.

Appendix B: Q&A

#	Asker Name	Question	Answer(s)
1	Thijs Heus	Ann, do the new models (with constraints) now also do better at MPACE and SHEEBA?	live answered
2	Marcus van Lier-Walqui	What are the quantitative limits of SCM/LES comparison to obs? Relatedly, how much of obs-model mismatch is owing to forcing/environment uncertainty?	live answered
3	Richard Forbes	Just a comment that having a minimum package of runs/diagnostics can be great to get wider participation. Some groups really want to participate, but have little resources to devote to it. So I would definitely recommend having different options for participation for	live answered

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		each new group activity	
4	McKenna Stanford	Shaocheng: When you say no clear improvement in diurnal cycle of precipitation with increasing model horizontal resolution, what is the range of the resolutions tested to arrive at this conclusion?	live answered
5	Katia Lamer	When you talk about precipitation rate (e.g., slide 8), is that surface precipitation rate?	-Yes, it is surface precipitation rate.
6	Courtney Schumacher	Did you calculate the fraction of total rain that comes from the large-scale rain for each model? That would be an interesting statistic!	live answered
7	Zhanqing Li	1. For the Amazon exp, there seem to be two clusters of models in terms of timing of PM rain. Do they have anything in common for the two clusters in model physics. 2. Aerosol is known to delay PM rainfall, any consideration for aerosol effects, especially radiative effect?	-For #1, yes, this is something we will do by looking at if the behavior is linked to some common treatments of convection in these models. For #2, We probably can test different aerosol treatments to see the impact. Thanks for the comment.
8	Roj Marchand	Shaocheng: I can't speak to PECAN or M3CE (as I was not involved in these projects) but in general the overnight peak in precipitation is strongly associated with propagation of MCSs that form near the Rockies in the early afternoon. I did a statistical analysis of 14 year of ARM radar data that looks at this topic. See Zhao et al (2017). https://doi.org/10.1002/2017JD027542 . the MMF models captures this feature (there is a paper by Mike Pritchard on this). Cheers, roj.	-Thanks, Roj. I will read the paper. I believe this is also the case for PECAN and M3CE.
9	Zhao Yang	Land surface impact, especially underestimation of LH (Evaporative Fraction) over the SGP might contribute to the precipitation diurnal cycle problem. Irrigation might help to partly alleviate it and form more MCSs during night.	-For SCM tests, we have models that use both specified LH and other surface conditions or interactive surface to examine the impact. -Shaocheng, do you have any SCM that

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			<p>have good way to initialize the land and surface parameters for land-atmosphere interactions?</p> <p>-Thank you, do you happen to have any reference to it? I'd like to read it if it is available.</p>
10	Courtney Schumacher	Are the observations averaged/coarsened to match the chosen number of subcolumns (In particular, the radar profiles)?	-Generally speaking, we want to retain all information content in the observations and converge the subcolumn statistics with a large enough sample (small number shown in this example). So averaging the observations should not be significant.
11	Susannah Burrows	nice job with the acronym (EMC^2) :)	-all credit to Collis and Jackson!
12	Zhanqing Li	<p>I see. Thanks Xiaocheng!</p> <p>For 2, you may refer to the following observational and modeling studies on the effect of aerosols on diurnal variation.</p> <p>Guo, J., M. Deng, S. S. Lee, F. Wang, Z. Li, P. Zhai, H. Liu, W. Lv, W. Yao, and X. Li, 2016: Delaying precipitation and lightning by air pollution over the Pearl River Delta. Part I: Observational analyses, <i>J. Geophys. Res. Atmos.</i>, 121, 6472-6488, doi:10.1002/2015JD023257.</p> <p>Lee, S.-S., J. Guo, and Z. Li, 2016: Delaying precipitation by air pollution over the Pearl River Delta. Part II: Model simulations, <i>J. Geophys. Res. – Atmos.</i>, doi/10.1002/2015JD024362.</p>	-Zhangqing: Thanks. I will read these papers.
13	Mikael Witte	Is it possible to adapt the subcolumn generator for different subgrid variability assumptions (e.g. different PDFs, scale awareness)?	live answered
14	Katia Lamer	Any plans on implementing a different scattering lookup table to improve the representation of non-spherical particles? Perhaps having different scattering formulations could allow to run the forward simulator in an ensemble approach like done in (GO)2-SIM to provide a sense of the uncertainty.	live answered

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15	Philipp Griewank	Would it be a lot of work to enable LES comparisons where the subcolumns could be randomly sampled from the LES columns?	-Subcolumn generation is mainly a tool for artificially increasing the resolution of GCMs to approach that of observations. If the LES resolution is already close to that observations then it may not be necessary to run the LES through a subcolumn generator.
16	Stephen Klein	Speaking as a developer of COSP, EMC2 looks like a great simulator for comparison to ARM remote sensing instruments. While it appears to have a lot of nice features, the hard part is how you can adapt to a particular's physics assumptions. This requires good documentation.	live answered
17	Susannah Burrows	Just want to note that my recent experience (in conversation/collaboration with Katia and Po-Lun Ma) suggests some mods in the E3SM code itself would also probably be necessary to get the required info out of E3SM and make sure it's consistent with the assumptions made in the forward simulator. Have you been thinking about this already for your code?	-Ann: yes, I mostly meant reporting additional things (more diagnostic output) -But also, just making sure we understand the physics assumptions and where they are and are not consistent has taken some time -So I guess I am also agreeing that clear documentation would be super helpful to users
18	Peter Caldwell	What are the benefits/drawbacks to implementing/using a new instrument in EMC ² rather than COSP? It seems like COSP could accomplish EMC ² 's goals as well?	live answered
19	Stefan Kneifel	Regarding the scattering properties: I think key is to be consistent between the forward operator and the assumption in the microphysics. If the model assumes dendrites (m-D, v-D) and the forward operator assumes soft spheres, differences are unavoidable	live answered

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20	Stephen Klein	<p>Some comments on COSP:</p> <p>COSP is oriented to satellite data. One big difference I see is that COSP is implement ONLINE into the GCM code to facilitate output.</p> <p>COSP is also oriented to open-source and community input. COSP has a github site.</p> <p>One of the challenges with community projects is that code gatekeepers need to put in effort to maintain code working. This is non-trivial.</p>	live answered
22	Courtney Schumacher	<p>GoAmazon (which provides a 2 year data set) would be a good target for pairing LES/SCM cases with ESM evaluation. Although I guess Shaocheng already showed result from this.</p>	live answered
23	Ivy Tan	<p>Ann, regarding the polar cloud pairing and tests of supercooled clouds, what is the temporal resolution of the AWARE ground-based observations? Would there be any interest in gathering statistics on the spatial structure of cloud phase? This may be important for WBF. (Sorry for jumping back to this topic now)</p>	<p>-Hi Ivy, The temporal resolution varies between instruments, e.g., 2 s in the case of the zenith-pointing radars, 10-s in the case of the HSRL. I agree re statistics (we already described that in a few JGR papers in 2018 and 2019). We can talk about it more.</p>
24	Hugh Morrison	<p>Not a question but comment. I strongly support Steve's and Mikael's suggestion for a bulletin board linking case study data for individual modeling groups. The biggest barrier to large model intercomparisons is finding someone to lead the effort, this is arguably much more of a barrier than getting participation from individual modelers. If smaller groups can work on this rather than a big top-down effort perhaps could get more mileage out of these cases</p>	live answered
25	Marcus van Lier-Walqui	<p>I'll add a comment that I forsee these efforts as directly informative on GCM model tuning. Thus the appliability is very broad, and efforts will reap huge benefits for many!</p>	<p>-Marcus, this is a big focus of the French groups that are leading the crusade for a standard SCM format - I think the opportunity for synergy with ARM to produce long-term, geographically diverse model forcing datasets would be huge for GCM</p>

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			<p>development</p> <p>-Yeah, this sounds great. I think however the observational insights are used to confront models, there is an essential step of developing common standards, and open availability of forcings.</p>
26	Paquita Zuidema	I agree with Roj's comment that occasional get-togethers are valuable for developing and maintaining momentum. We will have one in the fall for the ORACLES+LASIC activity Ann mentioned. The prior preparation for how to focus this in a meaningful way for the interested participants will be important too of course.	live answered
27	Marcus van Lier-Walqui	I don't have a good sense for how the forcing datasets are put together, but given that uncertainty in the forcings may be significant, I wonder if approaches have addressed the possibility of an ensemble/collection of equally-probable (or a PDF of) forcings for a given case?	<p>-I think this is a great point and not tangential at all. An ensemble approach is 100% feasible in an SCM framework and would be very useful to explore.</p> <p>-I'll second this...the affordability of SCM frameworks make such an approach not only interesting but some may argue essential.</p> <p>-The LASSO should use 3 different types of forcing (VARANAL, ECMWF, data assimilation) with different scales to try encompassing the forcing uncertainty. For LASSO-CACTI, we are looking to use ensemble members from ERA5 etc. and vetting using the obs.</p>
28	Peter Caldwell	I agree with Maike that having a big library of past cases would be hugely useful for model development. To amplify, I think having many models run the same case is useful for understanding the physics of model world vs real world, but having many cases to run with a single model is best for optimizing/tuning one's particular model for release.	live answered

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29	Roel Neggens	Just a comment: I am a big fan of pairing of LES/SCM with ESM using long term obs at permanent sites. The bullet points on the discussion slide reminded me of the strategy that Christian Jakob proposed a while ago for doing this: https://doi.org/10.1175/2009BAMS2898.1 . We adopted this method when configuring long-term SCM and LES at the Cabauw site in the Netherlands, and it really delivered.	live answered
30	Richard Forbes	Although there are some successes using LES data for improving GCM/ESM parameterisations, I think LES data has been generally under-used for this activity. This may be for many reasons including historically non-convergence of different LES, large data volumes etc. LASSO is a really great initiative which will hopefully address this to some extent. What else could we do to enhance the value of LES for GCM parameterisation development?	live answered
31	Greg Elsaesser	All this Q&A discussion is great and there is much to follow up on. Broad question since we can't talk about some of this at a coffee session or over evening beer: while the session vocal discussion is being recorded, will all the Q&A discussion text be saved and accessible for future reference? Is that possible or planned? It is easier to scan text quickly versus scrolling through a recorded discussion.	-Yes, chat and Q&A will be exported. -Great job!