GEOS-Chem Steering Committee Telecon
11 February 2020

Attending/Missing**:**
Becky Alexander, Kevin Bowman, Sebastian Eastham**,** Mathew Evans**,** Emily Fischer**, Jenny Fisher, Tzung-May Fu, Jeff Geddes, Colette Heald,** Barron Henderson**,** Daven Henze**, Chris Holmes, Lu Hu, Daniel Jacob,** Dylan Jones**,** Prasad Kasibhatla**, Christoph Keller,** Hong Liao**, Jintai Lin, Hongyu Liu, Lizzie Lundgren, Jingqiu Mao, Eloise Marais, Randall Martin,** Dylan Millet**,** Andrea Molod**, Lee Murray, Jeff Pierce,** Susan Strahan**, Melissa Sulprizio, Amos Tai,** Jun Wang**, Yuxuan Wang, Bob Yantosca,** Fangqun Yu**, Lin Zhang, Yanxu Zhang**

1. **Planning for GCA2 and GCE1 (Daniel, Eloise)**
    - Now have registration pages up for both meetings.
    - Will extend registration deadline for GCA2 in light of coronavirus.
    - GCE1 – have a tentative registration cut-off but fluid. So far 22 people signed up. Can accommodate 50-60 people (exact cap to be confirmed by Mat). Will be sending a Dear Colleague email to European colleagues who might be interested – if there are people who should be contacted, please tell Eloise.

2. **Version 12.7 release, work on versions 12.8 and 12.9 (Daniel)**
    - 12.7 released last week after inspection of the benchmarks. Includes small alkyl nitrate chemistry, methanol as part of standard chemistry.
    - 12.7 includes as option the SUNY scheme for scavenging. Issue – seemed to be scavenging from the stratosphere, related to GEOS met fields with small precipitation in stratosphere. To be fixed in 12.7.1 by account for scavenging from cloud ice.
    - 12.7.1 will also update the global budget table for transport tracers – important for checking aerosol lifetimes and the effect of the new scavenging option.
    - 12.8 will include isoprene chemistry from Kelvin Bates as well as wet deposition updates from Sarah Safieddine and ozone deposition to the ocean from Ryan Pound. GCST has the code for all of this.
    - 12.9 will be the updated halogen chemistry version based on Xuan Wang's paper but including a number of updates vetted by the Chemistry WG. Currently in testing.
    - Other scientific updates in the pipeline, in particular aromatic chemistry, but that might wait until after structural updated in version 13.0.

3. **Engineer's report (Bob)**
    - 12.7 structural update: dry-run capability = fake GEOS-Chem simulation with no computation; steps through time and prints list of files that would have been read so that you can determine which files GEOS-Chem needs. There is a script in the run directory that allows you to then download the necessary files. Replaces the HEMCO data downloader. One benefit is that you can download just the year(s) of data that you need. There is a wiki page and a YouTube tutorial about this.
    - GEOS-Chem narrative & new developments webpages have been updated.
    - Major update to GEOS-FP from 30 January, 2020 onwards – different convection & radiation. Need to be very careful using 2020 data and comparing to older data. GCST plans to do some comparisons here working with Andrea. Can always use MERRA-2 instead if you need consistent data.

- Have been working on resolving differences that occur when you break a long simulation into smaller simulations. One issue is related to precision of restart files.
- Major restructuring of HEMCO in the works (see below).
- GCHP will have stretched grid capability in the next year or so.
- Q: GEOS-FP update: can there be an error message or warning in the code if user tries to run over that period of the changeover?
    - Will add this.
- Q: FlexChem files build_mechanism.sh seems to be missing?
    - Files have moved up one level; wiki will be updated
- Q: Computational cost increasing (since ~12.3). 12.7 cost 2x higher than 12.0. Do we know why?
    - Need to do more testing of this
    - Increasing number of advected species and complexity of chemical mechanism, reading more and higher resolution HEMCO files
    - Did implement some fixes into HEMCO in 12.7 to try to improve this (e.g. reading files daily instead of hourly) – should make some difference and more to come in restructure
    - Profiling of GEOS-Chem is on to-do list

4. Plans for version 13.0 (Lizzie, Melissa)

- GCHP will have significant differences. GEOS-Chem will be a submodule within GCHP sub-wrapper (instead of the other way around). Will also have other submodules from GMAO (will be able to see full history); latest MAPL; replace GNU Make with CMake which will simplify build process; ESMF will be separate from GCHP, so it will only need to be built once, which will cut build time in half; HEMCO to move out of GEOS-Chem (see below).
- Memory leak issue in GCHP will be fixed in version 13.0. There is also a small advection problem in the current GCHP version that a recent update to FV3 may fix. This will be tested in version 13.0
- GEOS-Chem classic: CMake will become default and GNU Make will be retired. Recommend trying CMake now as it is available (since 12.5). HEMCO will be moved outside GEOS-Chem as a separate component. The UnitTester repository will be retired and all files will be in the code repository.

5. Software engineering WG update (Lizzie, Melissa)

- Dynamic allocation of memory for diagnostics based on what you choose to use.
- Spack issues in China have been resolved.
- Going to retire F77 files.
- Using continuous integration to detect coding problems in model updates
- Improving GCPy package
- Profiling GEOS-Chem Classic

6. GEOS-FP switch (Christoph)

- Important to recognize that the change in the GEOS-FP GCM on January 30 is a REALLY big change. Change to deep convection and for the first time has shallow convection, plus change to radiation.
- Expected to cause some major differences in GEOS-Chem – to be checked with a 1-month benchmark. Recommendation to use January 2020 as 1-month benchmark to enable consistent full-year GEOS-FP simulations for 2020 with the new version. Also, recommendation to issue warning to users conducting simulations over the 30 Jan 2020 boundary.
- Hopefully GEOS-Chem convective scheme will still work with the new GMAO convection. Basic idea is the same but there may be differences in convective transport. Need to benchmark.
- MERRA-2 remains as stable option.

- GEOS-FP change in convection will impact lightning NOx (and other emissions that rely on environmental variables, and scavenging…).

7. Managing lightning as GEOS-FP changes (Lee)

- Lee has recently finished processing offline NOx for 2019.
- The GEOS-FP fields use an evolving GCM and no rescaling has been applied to global lightning. There have been significant changes to global lightning in the GEOS-FP fields in the past and large change might be expected after the January 30 switch.
- MERRA-2 on the other provides a stable lightning simulation. Need to make clear to users that MERRA-2 is the more stable product and is preferable to use unless the very fine resolution of GEOS-FP is needed (MERRA-2 run at 0.5°, GEOS-FP at 0.25°).
- Q: can we just use MERRA-2 lightning with all simulations including GEOS-FP?
    - Lee has recommended this. Possible issue is if the convection doesn't happen at the same time in both met models, then lofted precursors and lightning NOx won't be at same time/place. But Lee's tests indicate that this is not a big problem.
- Q: What does GMAO do for lightning in forecast?
    - Christoph – forecast uses MERRA-2
- Q: Why DO we support global GEOS-FP simulations?
    - Bigger time lag for MERRA-2. (~1-month more)
    - Useful to have two met fields to compare.
    - Concern about not supporting GEOS-FP if the new GEOS-FP is going to be better.
- Q: is one system better than another?
    - New FP does extremely well for tropospheric dynamics – but not validated against stratospheric dynamics (to be incorporated into benchmarks)
- Can we manage this with better communication to users?
    - Benchmark is presently done with GEOS-FP → signaling?
    - Default run directories → maybe only MERRA-2 in future?
    - New run directory creation will ask questions about what you want → can include a note to users at this stage

8. Benchmarking and documenting updates to off-line emissions (Daniel)

- Switch to Yuan LAI has affected biogenic emissions. Jintai's group has been producing offline biogenic emissions with both LAI products in parallel so can use in benchmarking.
- How would we have dealt with this if we didn't have both?
- Going forward makes more sense to benchmark the online emissions rather than the offline emissions (even though some differences/non-linearities). Would allow us to identify & fix problems in online code BEFORE creating the offline emissions.
- Changes in off-line emissions can then be separately benchmarked.

9. AIST GCHP project update (Randall)

- Had kick-off meeting. Project focus is to make GCHP highly accessible. Several ongoing tasks.
- Update of GMAO MAPL software
- Stretch-grid capability – specifiable at runtime (no prior archiving required)
- Improving GCHP performance and portability: better parallelizing, simplifying build process
- Enabling GCHP on AWS cloud
- Generating operational cube-sphere archive

10. Progress toward cubed-sphere archive (Christoph)

- GMAO plans to provide cubed-sphere archive for GCHP advection

- First figuring out what is optimal cubed-sphere temporal/spatial resolution to be archived. Will output a large dataset, then figure out which data need to be on cube-sphere to drive GCHP appropriately.
- Christoph in the process of generating the data at native resolution
- Current plan is to generate archive for GEOS-FP, not sure about MERRA-2
- Would make sense to include MERRA-2 since it will be maintained even after MERRA-3 (may be called differently) is initiated. Including MERRA-2 in archive may help with the signaling of MERRA-2 vs GEOS-FP
- Q: will there be timing tests of online vs. offline runs?
    - Yes that is one of the planned tests.

11. WRF-GC update (May)

- v1 (presented at IGC9) paper is now online at GMDD.
- Working on nested grid capability and 2-way coupling capability. Latter is based on bulk aerosols and is based on what's done in WRF-Chem. Feedback is based on RRTMG. Test cases seem reasonable.
- Have updated to GC 12.6.3 – in the testing stages and there is some bug in the chemical solver at the moment but should be resolved soon. After that there should be no significant hurdles to nested grid. Expect available for testing in 1-2 months.
- Q: where will very high resolution emissions come from for multiple nests?
    - Still use HEMCO – so will have to rely on underlying available inventories
    - Users can provide higher resolution data if they have it
    - No real reason to go finer than 10-km unless you have a very specific application (e.g. urban).
    - Best option is to keep emissions at 0.1° resolution for input in HEMCO even if higher resolutions available (with info for how to access/process if a user really needs it). If we have e.g. 0.5° resolution emissions that have been downgraded, we should think about re-processing those.
    - What about soil NOx? Use same coupling as in standard, there may be a problem with soil moisture initialization.
- Q: what about land surface model options?
    - Not sure – haven't tested beyond the default yet.

12. CESM-GC update (Daniel)

- Harvard-MIT-NCAR meeting in early January
- Item to be deferred to next telecon with Seb to discuss

13. HEMCO restructuring update (Melissa)

- HEMCO will have its own repository, accessible in GEOS-Chem Classic and GCHP and other models
- Will also be implemented into CESM-GC
- Re-organising into functionalities to make turning different parts on/off easier
- Looking at implementing new internal HEMCO grid to allow applying scaling factors at higher resolution to capture the details before applying emissions at resolution of the models
- Some of the updates will go into 13.0 but will be working on updates beyond this.

14. HEMCO as a stand-alone component used by other models (Daniel, Christoph)

- NOAA would like to bring HEMCO into operational model; also planning to bring in deposition / surface exchange – but will repackage and rename

- HEMCO is becoming a code that is independent of GEOS-Chem (still used in GEOS-Chem and managed by GCST)
- One advantage is that it will be on github, so people from other modelling communities can contribute, make improvements