GEOS-Chem v11-02 to be released this week

- V11-02a: chemical updates including PAN chemistry *(US EPA, U. York, CSU)*
- V11-02b: GCHP capability *(GEOS-Chem Support Team)*
- V11-02c: isoprene chemistry and SOA updates *(U. Wollongong, U. Birmingham, Caltech, CSU, Harvard)*
- V11-02d: comprehensive halogen chemistry (*U. York, U. Copenhagen, MIT, Harvard)*
- V11-02e: stratospheric chemistry updates, full NetCDF diagnostics *(MIT, FSU)*
- V11-02f: many new emission inventories, new methane simulation, new Hg chemistry *(Dalhousie, Harvard, UW, U. Birmingham…)*

Building GEOS-Chem v11-3: expected release in May 2019

- Search “GEOS-Chem development priorities” to get the list of potential updates
- Weigh in through your WG chairs on the items you want!

Some major items:

- Grid-independent natural emissions
- Enabling 12-km resolution in both GCHP and GC-Classic
- Rediagnosed convection to improve transport in coarse-resolution simulations
- Updated tropospheric isoprene and halogen chemistry
- Mesospheric chemistry
- Many emission updates including MEIC
- Enable nested simulations over any custom domains
- CESM coupling off-line and on-line
- Harmonized biosphere-atmosphere exchange, coupling to CLM

Chemistry challenges

- How do we get to a unified mechanistic mechanism for SOA?
  - Simple seems to do best, but are we satisfied with that?
- Full tropospheric-stratospheric Cl-Br-I chemistry
  - Major tropospheric ozone sink at mid-latitudes from seasalt aerosol – how do we fix?
- Updating isoprene chemistry
  - New “reduced” Caltech mechanism has 150 species…
- Aromatic chemistry and terpene chemistry are still sketchy
- Speeding up the model
  - Mechanism reduction?
  - Machine learning?
  - Crowd sourcing through the cloud?

Progress in emissions

- HEMCO has made updating emission inventories much easier but beware of black box – need to check what comes out
- Grid-independent natural emissions will be major advance
- Harmonized biosphere-atmosphere exchange, coupling to CLM
- Continual challenge to update emissions to latest years
  - Community participation is key

Need to facilitate update of “specialty” simulations

- Hg chemistry moving to KPP
- Need to maintain aerosol microphysics simulations

Push to higher resolution

AQ applications look for higher resolution,
also evidence that coarse model resolutions produce transport errors

Two approaches:

- Off-line simulations matched to highest GEOS resolution (now 12 km)
  - Advantages:
    - Ease of use
    - Cost
    - Reproducibility
    - Inverse applications
  - Disadvantages:
    - Loss of information in temporal archiving of met data
    - Management of large archive
    - Cannot go finer than GEOS resolution
- On-line simulations with hi-res met model using GEOS-Chem chemical module
  - Advantages:
    - Specific on-line applications: chem-climate, data assimilation
    - Explore different meteorological simulations, high resolution
  - Disadvantages: see off-line advantages

Some other considerations:

- As resolution increases, on-line becomes more desirable
- Many of our applications don't need very high resolution

….so a model with both on-line and off-line capabilities makes sense

- Have the exact same GEOS-Chem chemical module in all applications

Off-line approaches: GC-Classic and GCHP

GC-Classic is to be maintained indefinitely (or until it has outlived its usefulness)

- Ease of access and use
- Nested model capability can be extended to higher resolutions

GCHP: a powerful tool for the future

- High-performance applications through MPI
- Better transport through FV3 on cubed sphere
- Challenge #1: difficulty of use
  - Solve with access through cloud?
  - Simplify the MAPL coupler?
- Challenge #2: Availability of cubed-sphere native archive
  - Prototype archive being tested: air mass fluxes and pressure
- Challenge #3: dealing with model nesting
  - Use stretched-grid approach?

On-line approach: GEOS-Chem chemical module

- Coupling to GEOS-5 and to BCC is already in place
  - But these models are not open access…

- Coupling to WRF – very exciting for AQ applications!
  - a much better, more transparent chemical module than current WRF-Chem

- Coupling to NCAR CESM – development being led by Seb Eastham
  - Prototype version to be presented to NCAR next week
  - Strong buy-in from NCAR – they want GEOS-Chem

Looking to the future: balancing community needs for innovation and stability

GEOS-Chem Community Mission: *to advance understanding of human and natural influences on the environment through a comprehensive, state-of-the-science, readily accessible global model of atmospheric composition*

- GEOS-Chem is unique among atmchem models in its ease of use; allows atm chemists with low computing resources to contribute scientific innovation
- But they wouldn't use it if it didn't stay at the cutting edge of science – meaning that we have to continuously innovate in both the science and the underlying software engineering
- But somebody's "cutting edge of science" is someone else's "unnecessary update" and users are stressed when the model keeps changing
- This is particularly the case for specialty simulations that get broken in model updates
- On the other hand, continued support for older versions would unduly stress the Support Team

Best solution is for GEOS-Chem Steering Committee to provide guidance in striking a balance between innovation and stability

See you at IGC9!

May 6-9 2019, Harvard University

IGC8 meeting (Harvard, May 2017)