# GEOS-Chem Newsletter—Fall 2015 Edition
# 13 Nov 2015

# The GEOS-Chem Support Team
# geos-chem-support@as.harvard.edu


## GEOS-Chem v11-01 development is continuing at a fast pace!

**GEOS-Chem v11-01** is our current version in development. This newsletter provides an update of what we have accomplished since our last GEOS-Chem newsletter in August 2015.

### GEOS-Chem v11-01c

GEOS-Chem v11-01c was approved on 14 Sep 2015. GEOS-Chem v11-01c contains several updates to the mercury simulation, as well as several bug fixes. In addition, v11-01c adds a new GEOS-Chem timers feature as well as the capability for reading MERRA2 meteorology from disk.

NOTE: Jenny Fisher reports that benchmarking of the v11-01c mercury simulation has revealed some discrepancies that are still under investigation:

> While full-chemistry has been benchmarked, the Hg & POPs simulations are still in the process…we have found some weird & buggy behavior in the v11-01c Hg simulation with GEOS-FP that we are still working to identify. At this stage we would recommend Hg users NOT use this version until we have sorted this out.

| Feature | Type | Submitted by |
|---|---|---|
| Updates to PAH code | Science | Carey Friedman (MIT) |
| Hg Ocean MLD bug fixes | Bug fix | Amanda Giang (MIT) |
| Hg Ocean rate coefficients (as an option, not default) | Science | Shaojie Song (MIT) |
| Hg Arctic process updates | Science | Jenny Fisher (Wollongong) |
| Hg emission updates (NEI2011, NPRI2011, UNEP2010 with adjustments for and emission controls) | Science | Yanxu Zhang (Harvard)<br>Amanda Giang (MIT) |
| Update CO2 files for HEMCO | Science & Bug fix | Ray Nassar (Environment Canada) |
| Bug fix for sea salt alkalinity in sulfate_mod.F | Bug fix | Johan Schmidt (Harvard) |
| Correct problem in OTD-LIS local redistribution files for GEOS-5 | Bug fix | Christoph Keller (Harvard)<br>Lu Hu (Harvard) |

| | | |
|---|---|---|
| Bug fixes for the ND21 diagnostic | Bug fix | Sebastian Eastham (MIT) |
| Bug fix for custom nested grid in tpcore_bc_mod.F | Bug fix | Shannon Koplitz (Harvard), GCST |
| Bug fix for monoterpenes in ND46 diagnostic | Bug fix | Jared Brewer (CSU) |
| GEOS-Chem timers | Structural | Matt Yannetti (GCST) |
| Initial modifications for running GEOS-Chem with the GMAO MERRA2 reanalysis met field product | Structural | Bob Yantosca (GCST) |

### GEOS-Chem v11-01d

Approval for GEOS-Chem v11-01d is pending. The 1-month benchmark for v11-01d was sent to developers for approval on 03 Nov 2015. Plots and tables from our 1-year benchmark simulation are now available at our *GEOS-Chem v11-01 benchmark history* wiki page. The GCSC is currently reviewing these results.

In GEOS-Chem v11-01d, we added several updates to chemistry and emissions, plus various bug fixes reported by GEOS-Chem users. Notable in this version is the implementation of a new data structure that contains physical properties of GEOS-Chem species (aka the "species database").

*NOTE: The GCSC is investigating an increase in tropospheric aerosol concentrations in the 1-month and 1-year benchmark output, which we think may be due to the "Quick fix for low Pb tropospheric lifetime" from Bo Zhang and Hongyu Liu.*

| Feature | Type | Submitted by |
|---|---|---|
| CO2 direct effect on isoprene emissions | Science | Amos Tai (CUHK) |
| Criegee intermediates | Science | Dylan Millet (UMN)<br>Eloïse Marais (Harvard) |
| Update biomass burning emissions to GFED4.1, includes Daily and diurnal factors | Science | Prasad Kasibhatla (Duke)<br>Christoph Keller (Harvard) |
| Update implementation of optical properties for brown carbon | Science | Melanie Hammer (Dalhousie) |
| Species Database Phase 1: Store physical properties of GEOS-Chem species in a centralized species database object | Structural | GEOS-Chem Support Team |
| Resolve very high tracer concentrations in MERRA wet deposition | Bug fix | Viral Shah (UW) |
| Bug fix for European grid range in tagged Ox simulation | Bug fix | GEOS-Chem Support Team |
| Quick fix for low Pb tropospheric lifetime against deposition in GEOS-FP | Bug fix | Bo Zhang, Hongyu Liu |

| | | |
|---|---|---|
| and MERRA2 | | (NIA / NASA Langley) |
| Fix for reading hourly NEI2011 emissions | Bug fix | Viral Shah (UW) |
| Bug fix for PBLTOP and MTTOP values in tagged Ox simulation | Bug fix | GEOS-Chem Support Team |
| Parallelization bug fix in Online emission of marine primary organic aerosol (POA) | Bug fix | GEOS-Chem Support Team |
| Bug fix for offline dust aerosols when UCX is on | Bug fix | Seb Eastham (Harvard) |

### GEOS-Chem v11-01e

GEOS-Chem v11-01e is currently in development. This version will include several structural updates, including Phase 2 of the "species database" installation and Phase 1 of the conversion of tracer units to mass mixing ratio (see below). In addition, the HEMCO emissions component will be updated to a more recent version.

| Feature | Type | Submitted by |
|---|---|---|
| Update HEMCO from version 1.1.005 to version 1.1.011 | Structural | Christoph Keller (Harvard) |
| Species Database Phase 2a: Remove inconsistencies in the definitions of physical properties of GEOS-Chem species | Structural | GEOS-Chem Support Team |
| Species Database Phase 2b: Update the wetdep module to use the same Henry's law functions as are used in HEMCO, for consistency's sake | Structural | GEOS-Chem Support Team |
| Tracer Units Phase 1: Initial implementation of area-independent tracer units | Structural | Lizzie Lundgren (GEOS-Chem Support Team) |

### GEOS-Chem v11-01f

GEOS-Chem v11-01f will contain science updates that were not ready for v11-01d. Some of these updates were made to GEOS-Chem versions that pre-dated HEMCO and therefore require extra time to implement.

| Feature | Type | Submitted by |
|---|---|---|
| PAN updates | Science | Emily Fischer (CSU) |
| Monthly mean surface methane distributions | Science | Lee Murray (NASA GISS/LDEO) |
| Ocean ammonia emission inventory | Science | Fabien Paulot (NOAA/GFDL) |

| | | |
|---|---|---|
| Temporary fix for remove SO2 scavenging in convective updrafts | Science | Duncan Fairlie (NASA/LARC) |
| Bug fixes for aerosol effective radius and surface area density | Bug fix | Seb Eastham (Harvard) |

### Updates "in the pipeline" for GEOS-Chem v11-01

The following features are planned for GEOS-Chem v11-01g and later versions. The timelines for these versions are TBD. Many of these updates had been identified as priorities at the IGC7 meeting in May 2015.

| Feature | Type | Submitted by |
|---|---|---|
| Implementation of FLEXCHEM chemical solver<br>NOTE: May be ready sooner! | Science | Mike Long (GCST)<br>John Linford (ParaTools)<br>GCST |
| Additional support for MERRA2 meteorology (see below) | Structural | GCST |
| NetCDF output: Flexible diagnostic package and tracer restart file | Science | GCST |
| Tracer units, Phase 2 | Science | Lizzie Lundgren (GCST) |
| Fix to direct/diffuse radiation | Science & Bug Fix | Katie Travis |
| Fix for NO3 + ISOP product | Science | Katie Travis |
| Update MODIS LAI fields through 2015 | Science | Barron Henderson (UF) |
| Updated organic deposition | Science | Katie Travis (Harvard)<br>Jenny Fisher (U. Wollongong) |
| Hg code updates (emissions, chemistry, ocean, land) | Science | Hg and POPs WG |
| EPA-derived BC/OA emissions over US (1990-2012) | Science | David Ridley (MIT) |
| Update density of BC to 1.8 and add absorption enhancement factor in input.geos | Science | Xuan Wang (MIT) |
| Updates to isoprene chemistry, includes:<br>• Fast photolysis of carbonyl nitrates<br>• Aerosol uptake of organic nitrates | Science | Jenny Fisher (U. Wollongong)<br>Eloïse Marais (Harvard)<br>Kelvin Bates (Caltech)<br>Katie Travis (Harvard) |
| Nighttime isoprene chemistry updates | Science | Rebecca Schwantes (Caltech) |
| Remove dependence of species drydep on HNO3 drydep | Science | Katie Travis (Harvard)<br>Jenny Fisher (U. Wollongong) |
| A snow NOx source from deep snowpack | Science | Maria Zatko (UW)<br>Becky Alexander (UW) |

| | | |
|---|---|---|
| Land cover module in GEOS-Chem | Science | Jeffrey Geddes (MIT)<br>Michael Long (GCST ) |
| Merge standard simulation with specialty simulations for OVOC, acids, aromatics, dicarbonyls, terpenes | Science | Dylan Millet (UMN)<br>Xin Chen (UMN) |
| Automate redistribution of NOx in HEMCO | Science | Lee Murray (NASA GISS/LDEO) |
| Injection height for fire emissions | Science | Emily Fischer (CSU) |
| Improved lightning emission scheme | Science | Lee Murray (NASA GISS/LDEO) |

## Important GEOS-Chem updates that you should be aware of

### Fix to prevent low lifetime of $^{210}$Pb for simulations using GEOS-FP or MERRA2

Bo Zhang and Hongyu Liu (National Institute of Aerospace) report that:

> The tropospheric 210Pb lifetime against deposition of 6.6 days (G-C/GEOS-FP) is the shortest among G-C versions. **Switching from GEOS-5 to GEOS-FP met fields (v9-02r) reduced 210Pb lifetime from 9.3 to 7.7 days**. If v11-01b had been driven by GEOS-5, the 210Pb lifetime may very well be ~8 days. Wang, Q. et al. [2014] used G-C/GEOS-5 and "find a lifetime of tropospheric 210Pb aerosol against deposition of 8.6 days, as compared to a best estimate of 9 days constrained by observations [Liu et al., 2001]." So it appears that the short 210Pb lifetime (6.6 days) in v11-01b is largely due to switching to GEOS-FP. Wet deposition needs to be re-evaluated and tuned for GEOS-FP.

They recommend the following quick fix, which we have now added to GEOS-Chem v11-01d:

> For GEOS-FP and MERRA2, turn off cold cloud scavenging (i.e. set rainout fraction = 0 when T < 258 K) and change the condensed water content (CWC) back to 1.5 x $10^{-3}$ kg $m^{-3}$ (= 1.5 x $10^{-6}$ $cm^{-3}$ H2O $cm^{-3}$ air).

For more information about this fix, please see this post on our *Wet deposition* wiki page. Note that this update as implemented currently applies to ALL soluble aerosol species, not just $^{210}$Pb and $^{7}$Be.

*NOTE: The GEOS-Chem Steering Committee is currently investigating increases in tropospheric aerosol burden caused by this update. The GCSC is currently reviewing the results of the v11-01d 1-year benchmark simulation, which were made available on 12 Nov 2015.*

### Prevent floating point errors in the convection module for GEOS-FP, MERRA, and MERRA2

Very small values of PDOWN (downward precipitation) can occur in the v10-01 convection routines, which may cause problems such as floating point overflow, high tracer concentrations, and failure of SMVGEAR to converge to a solution. Fixes for this issue have been submitted by Lee Murray and Viral Shah.

Lee Murray (LDEO/Columbia) writes:

> We need to add a trap in `DO_MERRA_CONVECTION` to prevent floating point overflows from occurring when aerosols are potentially re-evaporated. There are times when `PDOWN` gets small enough (e.g., 2013-11-13, GEOS-FP, 2º x 2.5º, `i,j,k = 131,29,14`) that it triggers an overflow, ultimately leading the solver to choke.

Viral Shah (U. Washington) had previously submitted a fix to be incorporated into v11-01d that corrects this problem. He writes:

> I am running v10.01, nested-grid NA full-chemistry w/ SOA simulation with the GEOS-FP met fields, and have found instances of extremely high concentrations of certain tracers that develop all of a sudden....I traced this back to a bug in the `DO_MERRA_CONVECTION` routine...the value of `ALPHA`, which should be less than or equal to 1, is sometimes much higher than 1, and for the attached example was > $10^5$. Since `ALPHA` is used to calculate resuspension of precipitating mass from above, these high values of `ALPHA` lead to a gain in tracer mass at the lower levels in excess of what is coming from above.

We have implemented Viral's fix into v11-01d. Please see this post on our *Wet deposition* wiki page for more information about the specific modifications that we made.

### Bug fix for reading hourly NEI2011 emission fields

Viral Shah (U. Washington) writes:

> I have just started using GC v10-01, in more or less an "out of the box" configuration. I am using the NEI 2011 emissions over NA, and found a factor of 2 overestimate in OC concentrations compared to previous model version. It was mainly because of an error in my HEMCO_Config.rc file in the NEI 2011 settings. An example line is below:

```
0 NEI11_SURFACE_NO  $ROOT/..nc   NO  2006-2013/1-12/1-31/$HH R xy  …
```

> The **$HH** in the time field was forcing the model to read emissions once daily at 0Z, instead of reading them every hour. I think the **$HH** should be replaced by 0-23 for them to be read hourly, as the NEI emissions should be.

Christoph Keller (Harvard) replied:

> The **$HH** flag is misplaced in this context. But I think reading the files every hour slows down the code quite a bit. If you set the hour attribute to the wildcard character HEMCO will read all 24 hour slices at once and pick the currently valid one based on UTC time. This should be more time efficient (but less memory-efficient):

```
0 NEI11_SURFACE_NO  $ROOT/..nc   NO  2006-2013/1-12/1-31/* R xy  …
```

We have modified the standard HEMCO configuration files that ship with GEOS-Chem v11-01d and higher versions to use the wildcard character * instead of the **$HH** flag in the above line.

#### Bug fix for dust aerosols when RRTMG is used with UCX

Seb Eastham (Harvard) writes:

> On or around line 1450 of `dust_mod.F` [in v10-01], the dry radius and extinction of dust are retrieved from QQAA and RDAA. If RRTMG is active, the single scattering albedo and asymmetry factors are…always read from entry `[X,Y,Z,6]` of the corresponding array[s].
>
> Unfortunately, this index is only correct if the UCX is off; if the UCX is on, the entry should be `[X,Y,Z,8]`, not `[X,Y,Z,6]`....It looks like an index variable was prepared for this purpose but it's not used. As it is, when the UCX is on, dust radius, surface area and scattering will actually be calculated based on stratospheric sulfate aerosol properties.

We have added a fix for this issue in GEOS-Chem v11-01d.

## Other fundamental software development efforts

#### Creating a common data structure for storing physical properties of species

Phase 1 of the GEOS-Chem Species Database has now been completed, and is included in v11-01d. The GEOS-Chem Species Database stores physical properties for each GEOS-Chem species (e.g. Henry's law constants, molecular weight, density, aerosol radius, F0 reactivity factor for dry deposition, retention factor, rainout efficiency, etc.) in a single data structure. This helps to reduce confusion that was caused by defining (and sometimes re-defining) the same properties independently in different modules. Keeping all physical properties in the same data structure has also allowed us to remove redundant sections of legacy code. This will allow GEOS-Chem to execute more efficiently.

Further phases of GEOS-Chem species database implementation are slated for v11-01e and higher versions. This work will involve standardizing Henry's law functions throughout GEOS-Chem, removing inconsistencies in the definition of dry deposition properties, and updating Henry's law constants to the most recent values in the literature (with input from the GEOS-Chem Working Groups).

### Correcting inconsistencies in physical properties of GEOS-Chem species

During the implementation of the species database of physical properties into GEOS-Chem, we discovered several issues with how species were defined in the dry deposition module `drydep_mod.F`. Some of these errors are typos, others (we think) are historical baggage.

| Species | Issue | Solution | Status |
|---|---|---|---|
| ACET | In the prior code, a molecular weight of 0.058 kg/mol was assigned to drydep_mod.F array XMW for ACET.<br><br>But ACET is emitted and transported as equivalent carbon atoms (3 mole C per mol ACET), with molecular weight 0.012 kg/mol. | Use 0.012 kg/mol for the MW of ACET (obtained directly from the species database). | **UNRESOLVED.** The current behavior was preserved so that our development code could pass difference tests w/r/t the prior code. |
| ALD2 | In the prior code, a molecular weight of 0.044 kg/mol was assigned to drydep_mod.F array XMW for ALD2.<br><br>But ALD2 is emitted and transported as equivalent carbon atoms (2 mol C per mol ALD2), with molecular weight 0.012 kg/mol. | Use 0.012 kg/mol for the MW of ALD2 (obtained directly from the species database). | **UNRESOLVED.** The current behavior was preserved so that our development code could pass difference tests w/r/t the prior code. |

| | | | |
|---|---|---|---|
| NITs | In the prior code, a molecular weight of 0.036 kg/mol was assigned to drydep_mod.F array XMW for ALD2.<br><br>But the given molecular weight of NITs used throughout GEOS-Chem is 0.062 kg/mol. | Use 0.036 kg/mol for the MW of NITs (obtained directly from the species database). | **UNRESOLVED.** The current behavior was preserved so that our development code could pass difference tests w/r/t the prior code. |
| MTPO | In the prior code, a molecular weight of 0.136 kg/mol was assigned to drydep_mod.F array XMW for MTPO.<br><br>But the given molecular weight of MTPO used throughout GEOS-Chem is 0.13623 kg/mol (136.23 g/mol). | Use 0.13623 kg/mol for the MW of MTPO (obtained directly from the species database). | **UNRESOLVED.** The current behavior was preserved so that our development code could pass difference tests w/r/t the prior code. |
| SALA<br>SALC | In the prior code, molecular weights of 0.036 kg/mol were assigned to drydep_mod.F array XMW for SALA and SALC.<br><br>But a recent update to the code changed the molecular weights of SALA and SALC to 0.0314 kg/mol (31.4 g/mol). | Use 0.0314 kg/mol for the MW of both SALA and SALC (obtained directly from the species database). | **UNRESOLVED.** The current behavior was preserved so that our development code could pass difference tests w/r/t the prior code. |
| SO4s | In the prior code, a molecular weight of SO4s was assigned to drydep_mod.F array XMW as 0.036 kg/mol.<br><br>But the given molecular weight of SO4s used throughout GEOS-Chem is 0.096 kg/mol. | Use 0.096 kg/mol for the MW of SO4s (obtained directly from the species database). | **UNRESOLVED.** The current behavior was preserved so that our development code could pass difference tests w/r/t the prior code. |

*NOTE: During the GCSC telecon on November 13th, 2015, Prasad Kasibhatla noted that the actual molecular weight of hydrocarbon species is important for dry deposition calculations, particularly those involving computation of the Schmidt number. Therefore, many of the inconsistencies reported in the table above may not actually be inconsistencies at all. The GCST will update the documentation on the wiki and in the dry deposition module accordingly.*

### Implementation of FLEXCHEM into v11-01

FLEXCHEM is a more flexible implementation of the KPP chemistry solver. We expect to be able to use the KPP-Accelerated (KPPA) solver from John Linford (ParaTools, Inc.). KPPA is a newer, faster version of the previous KPP chemical solver software. Preliminary tests show significant speedup (50-

70%) over the existing SMVGEAR chemical solver software.

Mike Long is now actively integrating FLEXCHEM into GEOS-Chem v11-01. We expect this to be ready for testing in GEOS-Chem v11-01 in the next few weeks. Stay tuned!

**Adding support for MERRA2 meteorology into GEOS-Chem**

GEOS-Chem v11-01c and higher versions now contain the initial modifications to read in the MERRA2 meteorological data product from NASA/GMAO. MERRA2 is a long-term reanalysis data product (similar to the prior MERRA product) generated with the GEOS-Data Assimilation System version 5.12.4. The native resolution of MERRA2 data is 0.5° lat x 0.625° lon x 72 vertical layers. The 72-layer vertical grid used by MERRA2 is identical to that used by the GEOS-5, MERRA, and GMAO "forward processing" (i.e. what we call GEOS-FP) met data products.

Melissa Sulprizio has processed 5 years of MERRA2 data for input into GEOS-Chem. The native resolution data was downscaled to the GEOS-Chem 0.5° x 0.625° NA nested grid and to the 2° x 2.5° and 4° x 5° global grids. Melissa ran an internal 1-year Rn-Pb-Be benchmark simulation using MERRA2 meteorology for 2013 and found Pb210 and Be7 budgets were similar to those of GEOS-5.7.2 (aka "GEOS-FP") for the same period. Our archive of processed MERRA2 data will facilitate research projects using GEOS-Chem's CH4 "specialty" simulation. (NOTE: The processed MERRA2 data files are considered experimental, and are not yet intended for wider distribution at this time.)

More work will be necessary before MERRA2 can be used to drive GEOS-Chem's "full-chemistry" simulations. Scale factors for lightning, dust, and various other emissions will need to be derived by running 1-year GEOS-Chem simulations with MERRA2 meteorology.

MERRA2 "raw" data files are now available for download through the NASA GES-DISC data distribution service. We have also prepared some MERRA2-related pages on the GEOS-Chem wiki.

- MERRA2
- List of MERRA2 met fields used as input to GEOS-Chem
- MERRA2 implementation details (under construction!)

### Making units consistent throughout GEOS-Chem

In GEOS-Chem v10-01 and prior versions, GEOS-Chem tracer units were converted between molar mixing ratio (`v/v`) and mass per grid box (`kg`). The conversion between (`v/v`) and (`kg`) inherently requires knowledge of grid area, which is incompatible with the grid-independent high-performance GEOS-Chem (aka "GEOS-Chem HP"). Furthermore, the switch between units is confusing and inconsistently documented. In order to achieve grid-independence and bring greater clarity to GEOS-Chem, the GEOS-Chem Support Team is working towards implementing consistent area-independent tracer units throughout the model.

Our goals are as follows:

1. To use mass mixing ratio (`kg/kg`) throughout GEOS-Chem with minimal exceptions.
2. To remove all uses of tracer mass (`kg`) per grid box.
3. To remove all uses of grid box area.

Because this project touches nearly all parts of GEOS-Chem and is being conducted concurrently with several other development projects, we are working towards these goals in distinct phases, as described in the table below:

| Phase | Version | Description | Status |
|---|---|---|---|
| 1 | v11-01e | Initial implementation of area-independent tracer units<br>• Some specialty simulations will remain in kg since they require input from 3rd party developers (TOMAS, RRTMG, two-way coupling, Hg)<br>• Chemistry will remain in kg until FlexChem is implemented<br>• All other components use area-independent tracer units (mixing ratio or kg/$m^2$) | Substantially complete. |
| 2 | TBD | Removal of area-dependent tracer units in chemistry | On hold until implementation of FlexChem. |
| 3 | TBD | Removal of area-dependent tracer units remaining in specialty simulations | • TBD pending input from 3rd party developers TOMAS developers contacted and have been provided preliminary Phase 1 version merged with v11-01c<br>• 3rd party developers for RRTMG and two-way nesting not yet contacted<br>• Necessity of 3rd party developer input for mercury emissions under |

| | | | |
|---|---|---|---|
| | | | investigation. |
| 4 | TBD | Removal of remaining area usage | TBD |

GEOS-Chem will benefit from this work in the following ways:

1. The surface area of each grid box will not have to be known.
2. Several commonly-repeated multiplications and divisions will be eliminated, thus increasing computational efficiency.
3. Coupling of GEOS-Chem to Earth System models (such as the NASA GEOS/DAS system) will be facilitated.

Lizzie Lundgren is currently leading the effort to make the units consistent throughout GEOS-Chem. She writes:

> This work will complement our work to correctly incorporate air moisture into GEOS-Chem. We intend to use `[kg/kg dry air]` throughout GEOS-Chem except in transport where units will be in `[kg/kg total air]`.

For more information, please see our *GEOS-Chem tracer units* wiki page. We plan on completing these updates before the v11-01 public release.

### Migrating diagnostics from binary output to netCDF output

For many years, GEOS-Chem has saved diagnostic output to binary punch file format—that is, unformatted Fortran binary output with standardized data fields. But binary files cannot be read efficiently in distributed high-performance computing environments. Therefore, we have begun to recode GEOS-Chem so that diagnostic outputs can be saved to COARDS-compliant netCDF files.

Christoph Keller has modified HEMCO so that we can use HEMCO's internal data structure to archive diagnostic output for any GEOS-Chem quantity. We have opened a new branch of development into which we are placing these modifications. We envision that netCDF diagnostic output will be standardized in GEOS-Chem v11-01 (timeline TBD).

As of this writing, we have not yet begun removing the last vestiges of binary output in GEOS-Chem. We are currently concentration on the implementation of both the GEOS-Chem species database and

area-independent units. We are also waiting on the FLEXCHEM update from Mike Long, which will go into GEOS-Chem as soon as we receive it. But we are hopeful that we will be able to convert the GEOS-Chem diagnostics to pure netCDF output before the v11-01 public release.

## High-performance computing with GEOS-Chem

### GEOS-Chem HP update

We have succeeded in compiling and running GEOS-Chem in a high-performance computing (HPC) environment. GEOS-Chem can now utilize the Earth System Modeling Framework (ESMF) with Message-Passing Interface (MPI) parallelization to run on distributed computing architectures. It also uses the MPI-enabled NASA/GMAO finite-volume dynamics core (FVdycore) as the transport operator.

Matt Yannetti and Mike Long are currently working on creating Lmod "modules" for the ESMF and MAPL libraries. These libraries form the core of the interface between GEOS-Chem and high-performance computing environments. Currently, each time a small change is made to the GEOS-Chem source code, GEOS-Chem HP's build sequence will search through all of the ESMF and MAPL source code directories in an attempt to rebuild those libraries. This causes compilation to take much longer than it should.

On the other hand, by creating ESMF and MAPL "modules", a GEOS-Chem HP user can load these libraries into his or her startup runtime environment simply by typing commands such as `"module load esmf"` or `"module load mapl"`. This will also make the ESMF and MAPL libraries more portable across computer systems. At present, Matt and Mike are doing initial testing on the Odyssey supercomputer at Harvard.

In addition to the module work, Matt, Mike and Seb Eastham are performing test runs with GEOS-Chem HP on Odyssey. They have also created wiki documentation to assist interested users in setting up GEOS-Chem HP on their systems.

If you would like to take the new GEOS-Chem HP out for a spin on your local supercomputer or cluster, then please contact Mike Long (mlong [at] seas [dot] harvard [dot] edu) and Matt Yannetti (myannetti [at] seas [dot] harvard [dot] edu).

## Electronic media updates

### New and updated wiki pages

We have added and/or updated several GEOS-Chem wiki pages since the last newsletter:

- GEOS-Chem species database (new)
- GEOS-Chem tracer units (new)
- Global burden history (new)
- Physical properties of GEOS-Chem species (new)
- Currently unresolved issues in GEOS-Chem (updated)
- Dry deposition (updated)
- GEOS-Chem v11-01 and GEOS-Chem v11-01 benchmark history (updated)
- GEOS-Chem model development priorities (updated)
- GFED4 biomass burning emissions (updated)
- Implementation of HEMCO into GEOS-Chem (updated)
- The HEMCO User's Guide (updated for HEMCO v1.1.011)
- Wet depositon (updated)

Thank you for your continued support of GEOS-Chem!

Sincerely,

Bob Yantosca
with the GEOS-Chem Support Team
(Melissa, Matt, Lizzie, Mike, Junwei, Yanko)
13 Nov 2015