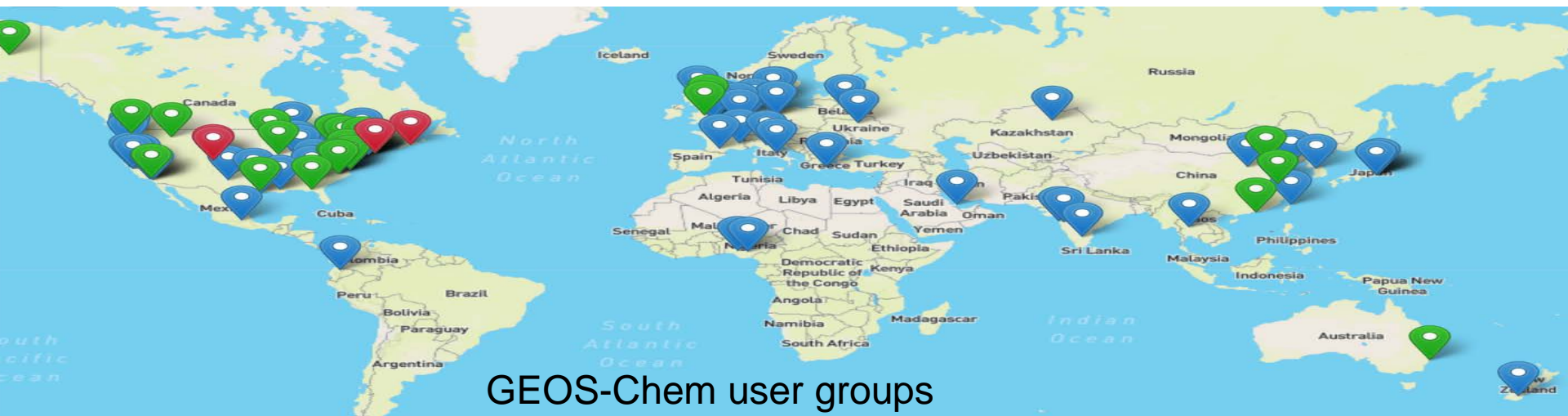


# GEOS-Chem model overview

Daniel J. Jacob, Harvard University

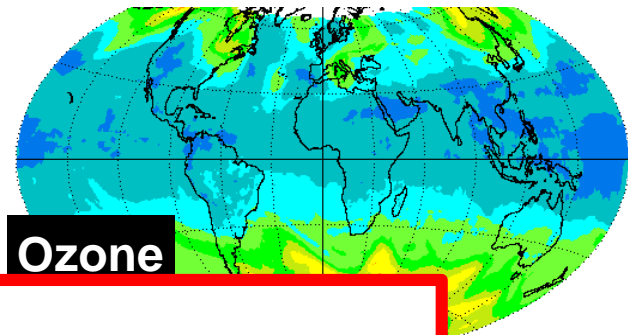
**GEOS-Chem Community Mission:** to advance understanding of human and natural influences on the environment through a comprehensive, state-of-the-science, readily accessible global model of atmospheric composition



# Atmospheric chemistry: many problems, many scales



**Disasters**



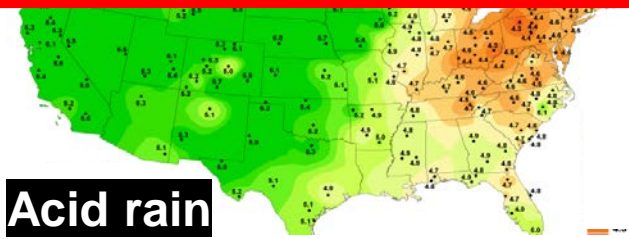
**Urban sm**

We need models to

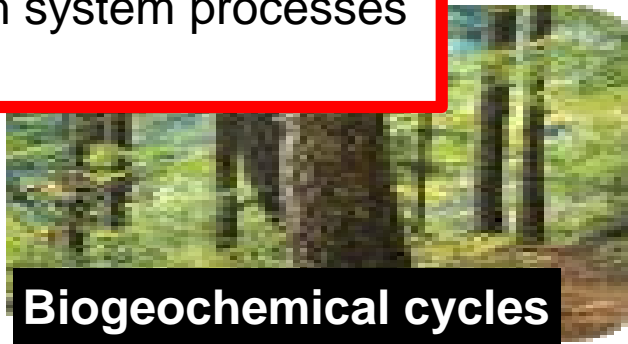
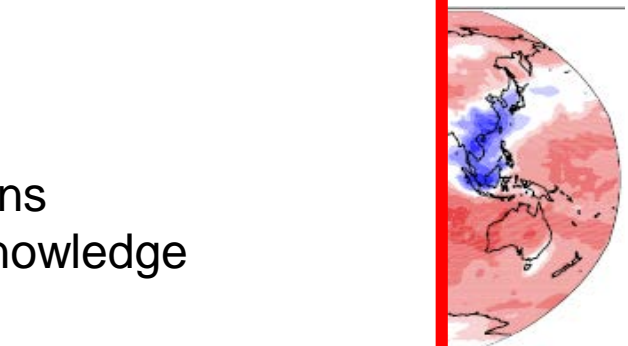
- Understand processes
- Confront our understanding to observations
- Interpret observations to generate new knowledge
- Make projections
- Link atmospheric chemistry to other Earth system processes



**Plume dispersion**



**Acid rain**



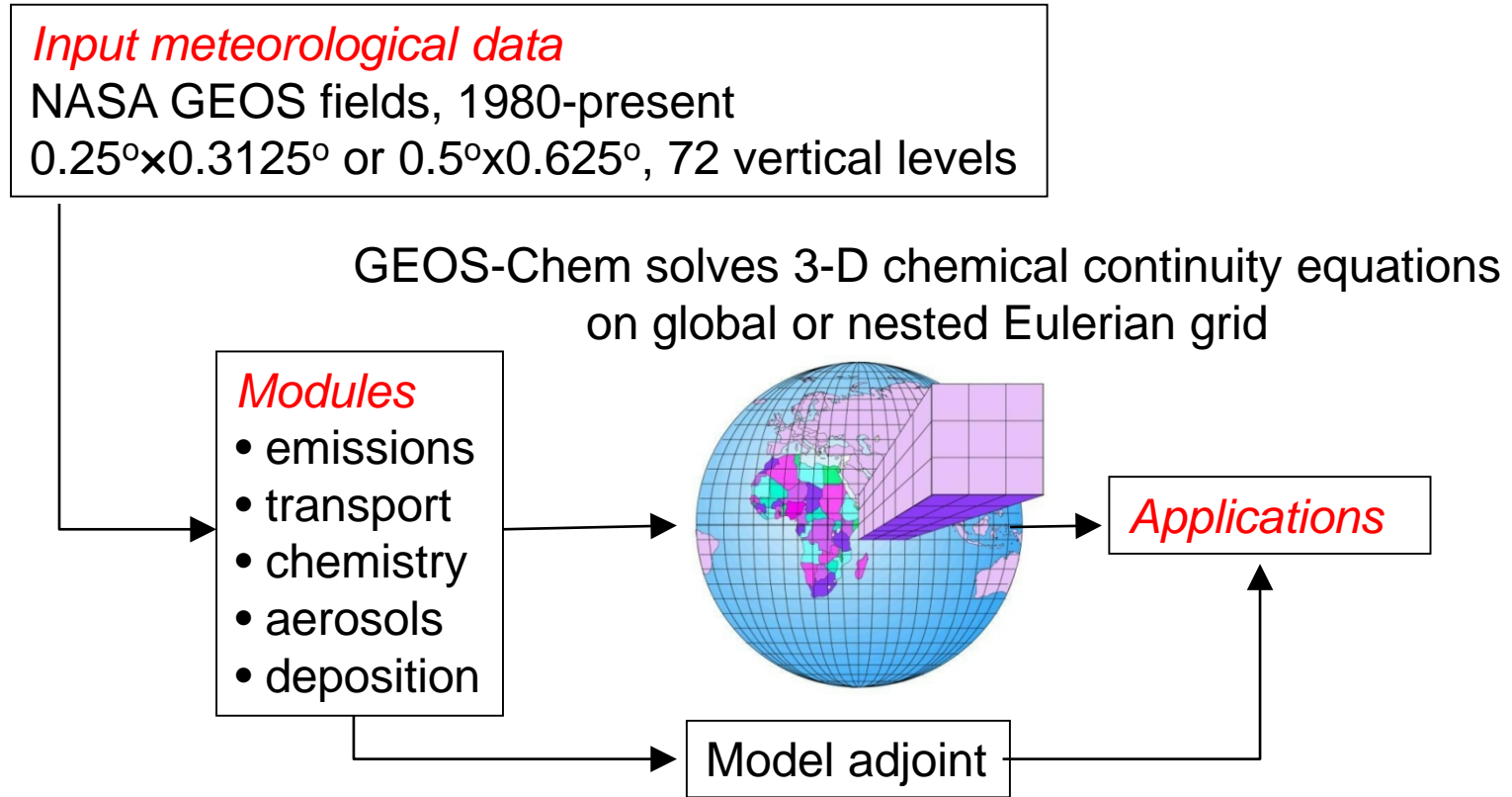
**Biogeochemical cycles**

**LOCAL**  
**< 100 km**

**REGIONAL**  
**100-1000 km**

**GLOBAL**  
**> 1000 km**

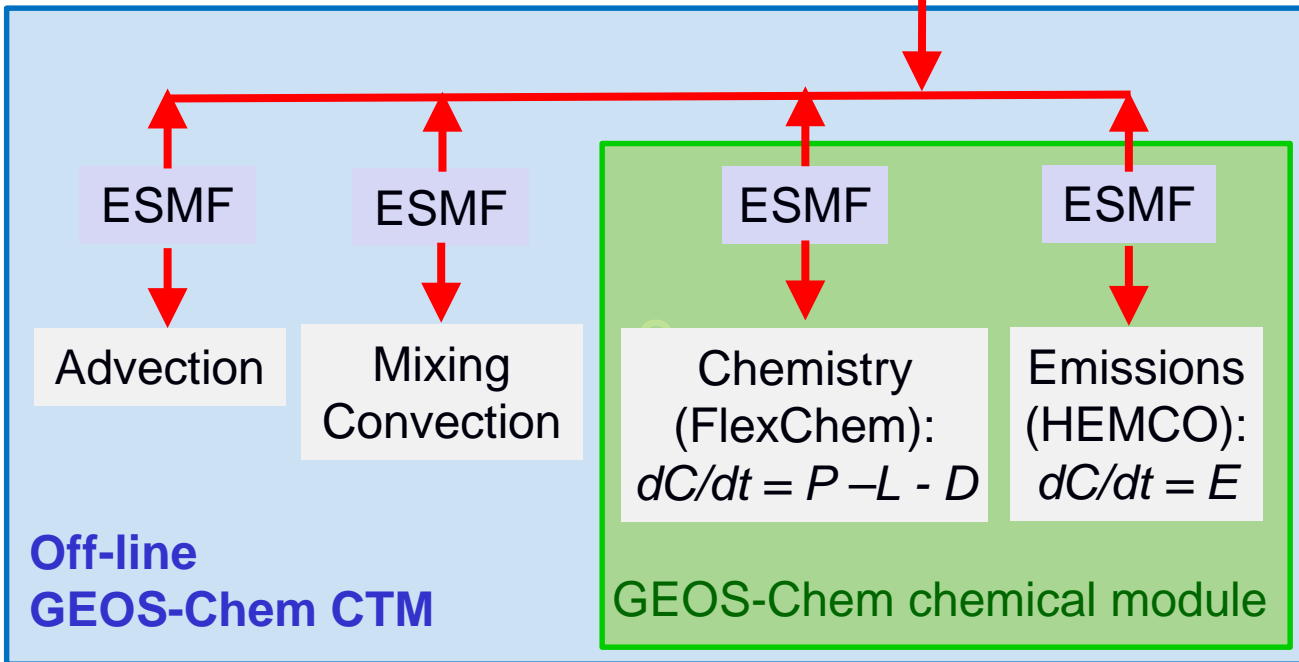
# GEOS-Chem atmospheric chemistry model



- Tropospheric and stratospheric chemistry, aerosol microphysics, carbon gases, mercury including biogeochemical coupling, POPs, isotopes...
- New version releases every year: v11-2 (May 2018) to include updated SOA, isoprene chemistry, tropospheric halogen (Cl-Br-I) chemistry, methane, emissions...
- Grid-independent, ESMF-compatible architecture for coupling to Earth System models

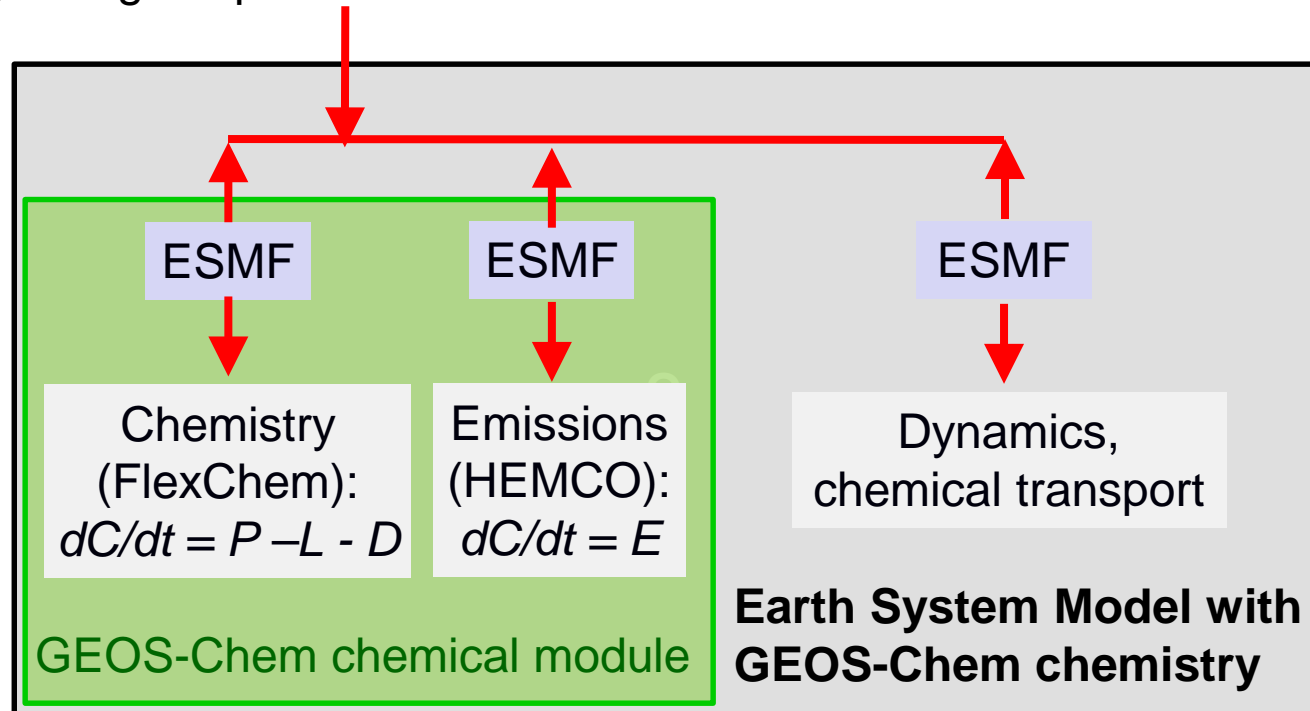
# GEOS-Chem as on-line chemical module for Earth system models (ESMs)

any 3-D grid specified at run time



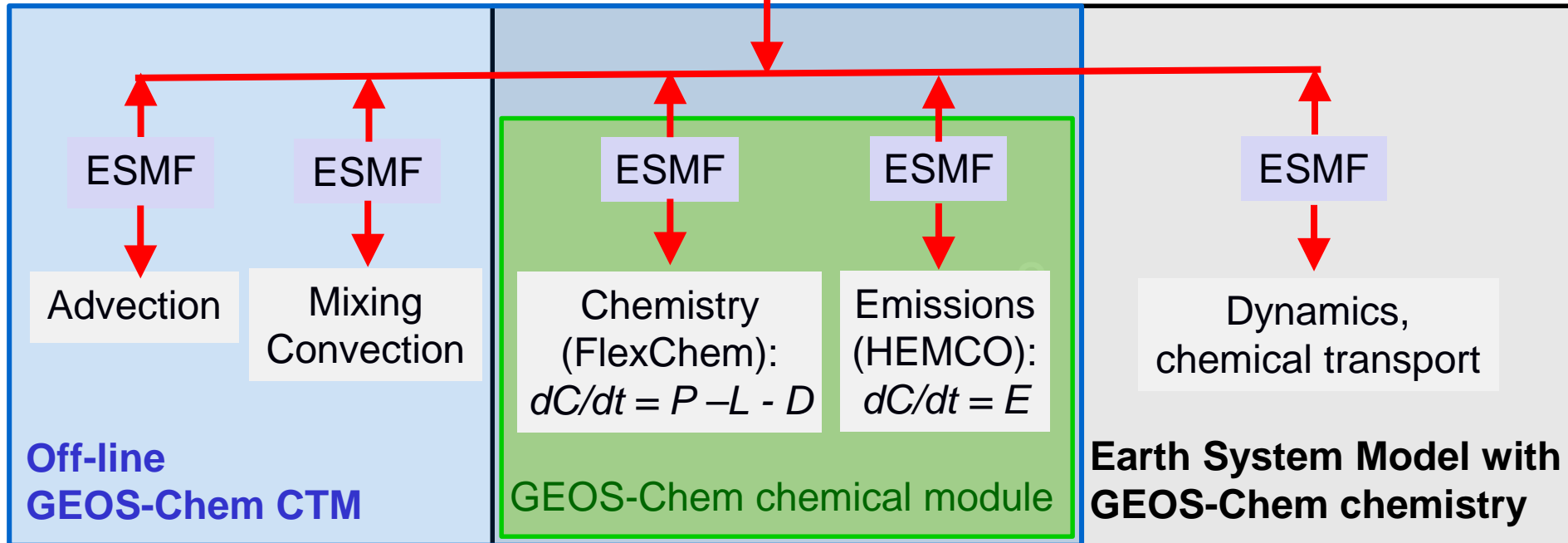
# GEOS-Chem as on-line chemical module for Earth system models (ESMs)

any 3-D grid specified at run time



# GEOS-Chem as on-line chemical module for Earth system models (ESMs)

any 3-D grid specified at run time



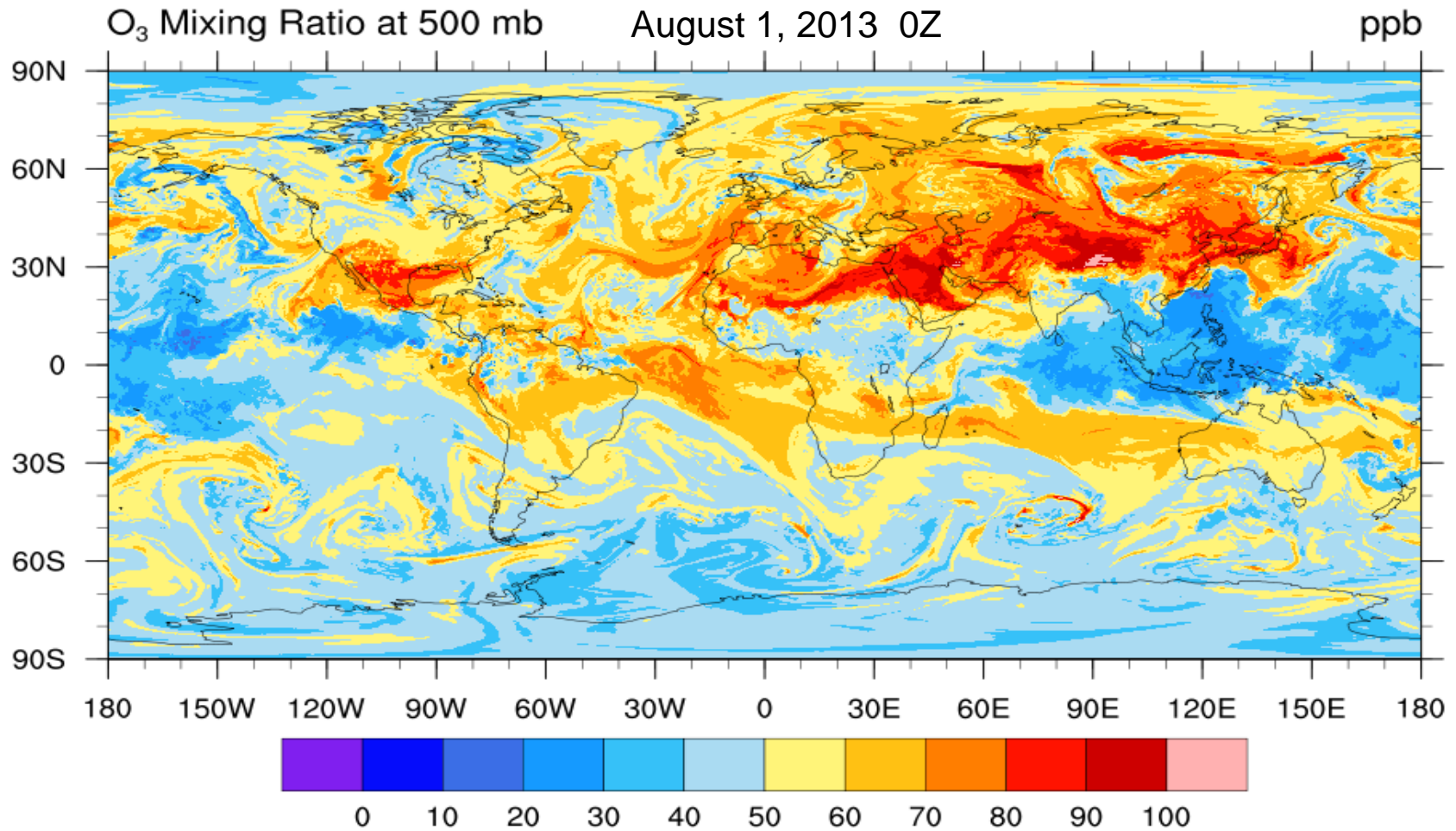
**CTM and ESM use exactly the same GEOS-Chem code**

GEOS-Chem CTM users contribute model advances

Advances are incorporated into GEOS-Chem

ESM GEOS-Chem module always stays referenced to latest version

# Full-year tropospheric chemistry simulation at c720 (~12 km) resolution using on-line GEOS-Chem in GEOS ESM



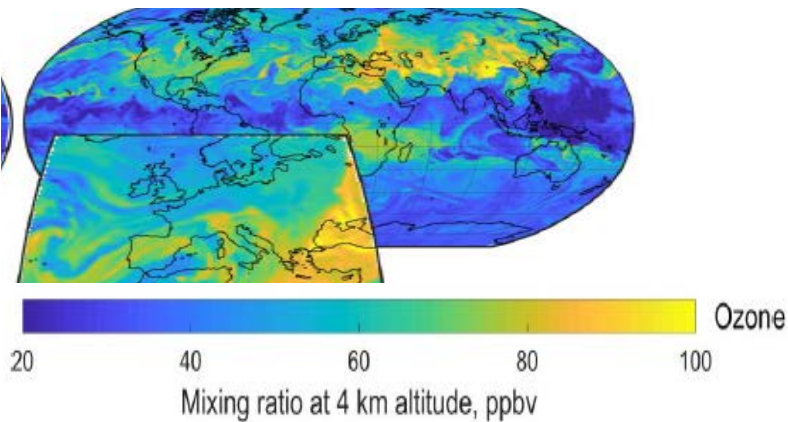
# GEOS-Chem high performance (GCHP):



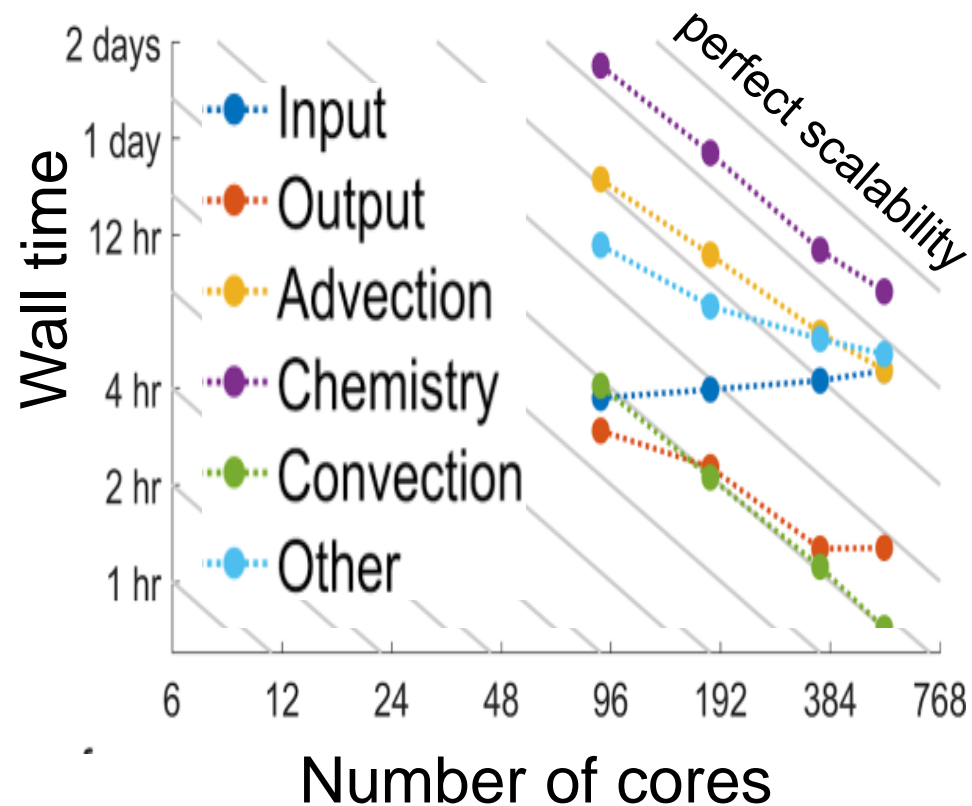
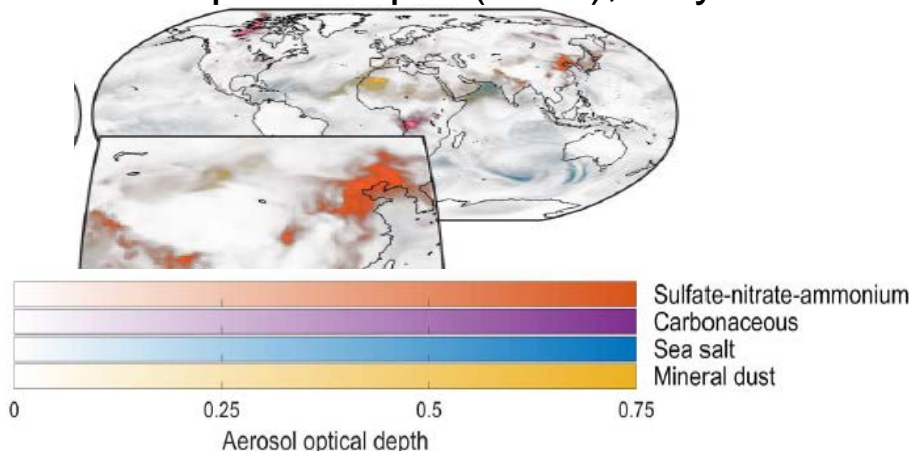
Massively parallel capability with cubed-sphere advection  
uses distributed-memory MPI parallelization enabled by ESMF

1-month simulation of troposphere-stratospheric chemistry at c180 (~50 km) resolution  
requires only 1 day of wall time with 540 cores

Ozone at 4 km altitude, July 2016



Aerosol optical depth (AOD), July 2016



# Running GEOS-Chem on the cloud

GEOS-Chem is now fully operational on the AWS cloud; GCHP is on the way

Many advantages for access, reproducibility, sharing of model versions and data

The screenshot shows a web browser window displaying the GEOS-Chem on cloud documentation. The browser's address bar shows the URL `cloud-gc.readthedocs.io/en/stable/index.html`. The page features a dark red sidebar on the left with a search bar and a navigation menu. The main content area has a white background with a dark red header. The page title is "GEOS-Chem on cloud computing platforms" and it includes a "Warning" box and a "How to use this documentation" section.

**GEOS-Chem on cloud**

Search docs

- Overview
- Beginner tutorials
- Advanced tutorials
- Developer guide
- AWS concepts and services in detail
- Appendix

```
function countSpaces(str) {  
  // What's the result?  
}  
a) return str.indexOf(' ');  
b) return str.split(' ').length - 1;  
c) return str.count(' ') - 1;  
d) return str.words().length - 1;
```

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Read the Docs v: stable

Docs » GEOS-Chem on cloud computing platforms [Edit on GitHub](#)

## GEOS-Chem on cloud computing platforms

[GEOSChem-on-cloud](#) project aims to build a cloud computing capability for [GEOS-Chem](#) that can be easily accessed by researchers worldwide.

See [Why move to the cloud](#) for the motivation of this project. See [Quick start guide for new users](#) to start your first GEOS-Chem simulation on the [Amazon Web Services \(AWS\)](#) cloud within 10 minutes (and within seconds for the next time).

This project is supported by the AWS Public Data Set Program and the NASA Atmospheric Composition Modeling and Analysis Program (ACMAP).

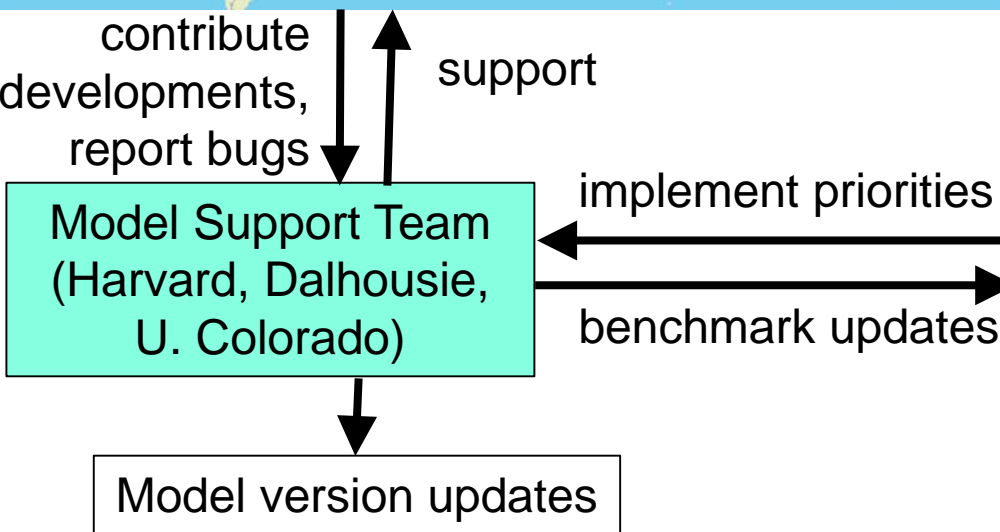
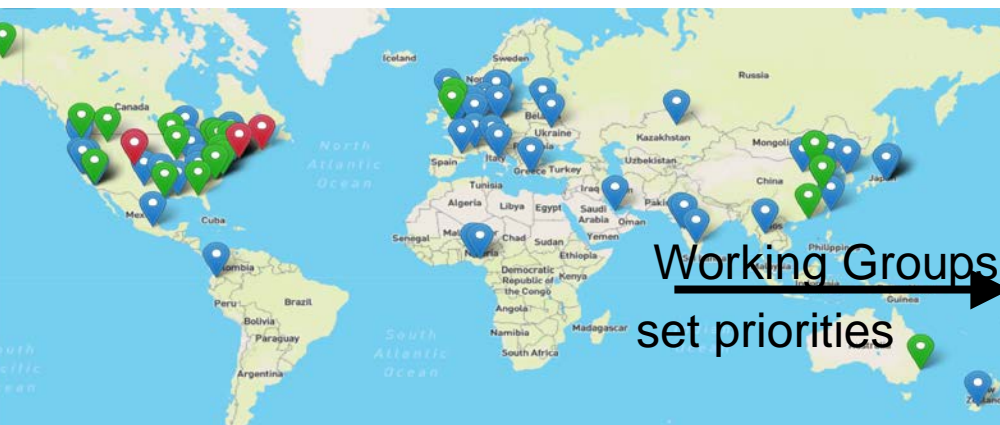
**Warning**

[GEOSChem-on-cloud](#) is at initial development and things are moving very fast. Please use the [GitHub issue tracker](#) to request new functionalities, report bugs, or just discuss general issues.

## How to use this documentation

For GEOS-Chem users, this website contains everything you need in order to use GEOS-Chem on

# GEOS-Chem development is driven by its user community



Emphasize grass-roots development, fast innovation, traceability, user support

## GEOS-Chem Steering Committee

**Model scientist:** Jacob (Harvard)

**co-scientist:** Martin (Dalhousie)

**Adjoint scientist:** Henze (U. Colorado)

**Nested model scientists:** Wang (Tsinghua/UH), Zhang (PKU)

**Engineer:** Yantosca (Harvard)

### Aerosols WG:

Heald (MIT), Alexander (UW), Pierce (CSU), Yu (SUNYA)

### Chemistry WG:

Henderson (EPA), Evans (York), Mao (U. Alaska), Hu (U. Montana)

### Emissions and Deposition WG:

Lin (PKU), Fischer (CSU), Millet (U. Minnesota)

### Chemistry-Ecosystems-Climate WG:

Liao (NIUST), Tai (CUHK), Murray (U. Rochester), Geddes (Boston U)

### Carbon WG:

Jones (U. Toronto), Bowman (JPL)

### Adjoint and Data Assimilation WG:

Wang (U. Iowa), Henze (U. Colorado)

### Transport WG:

Liu (NIA), Molod (NASA)

### Hg and POPs WG:

Holmes (FSU), Fisher (U. Wollongong)

**GCHP WG:** Martin (Dalhousie), Eastham (MIT)

**GMAO Liaison:** Keller (NASA)

**At large:** Kasibhatla (Duke.)