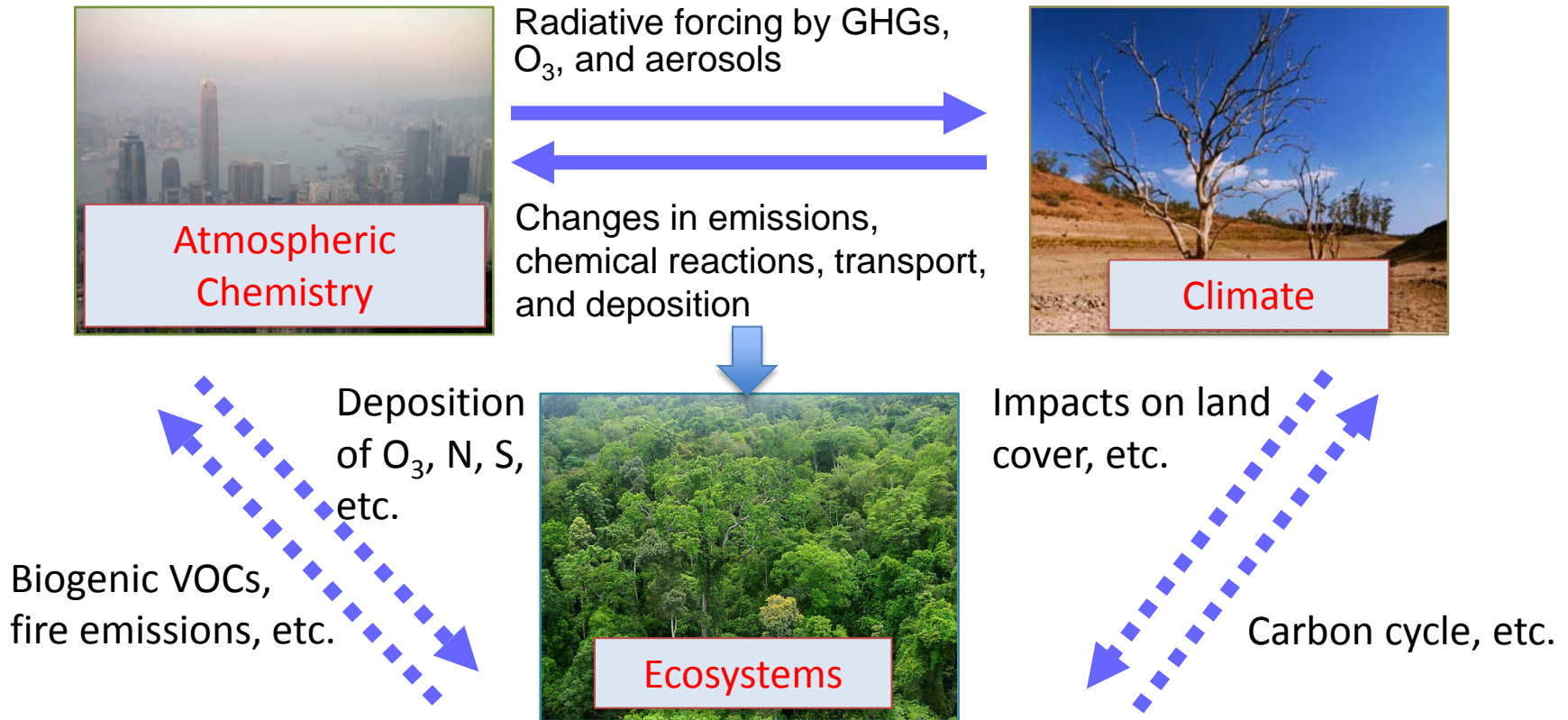


The 7th International GEOS-Chem Meeting (IGC7)

Chemistry-climate working group

2013-2017 Co-chairs: Hong Liao, Shiliang Wu

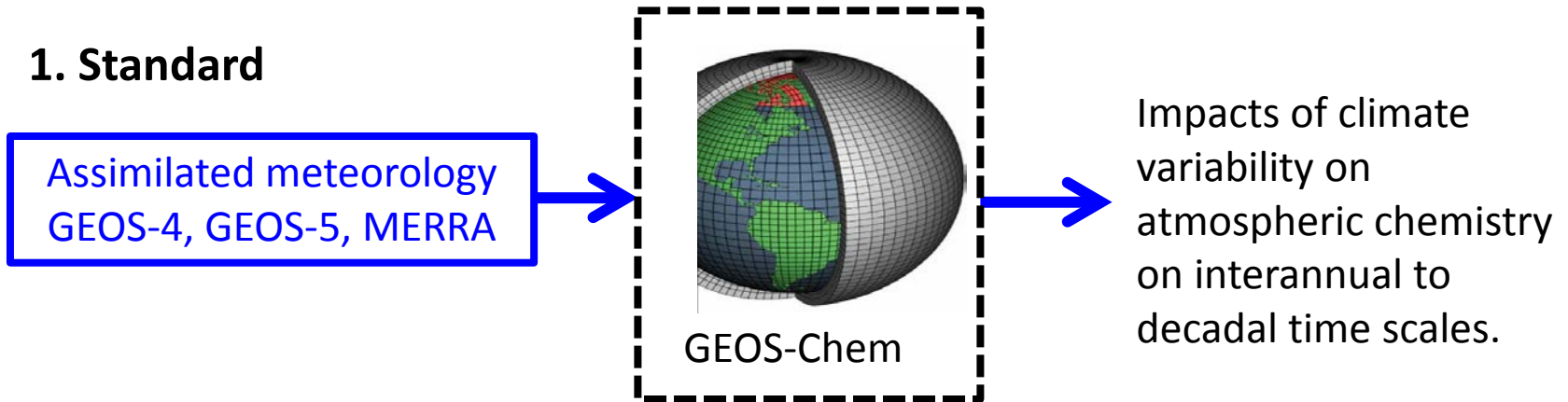
Chemistry-climate interactions



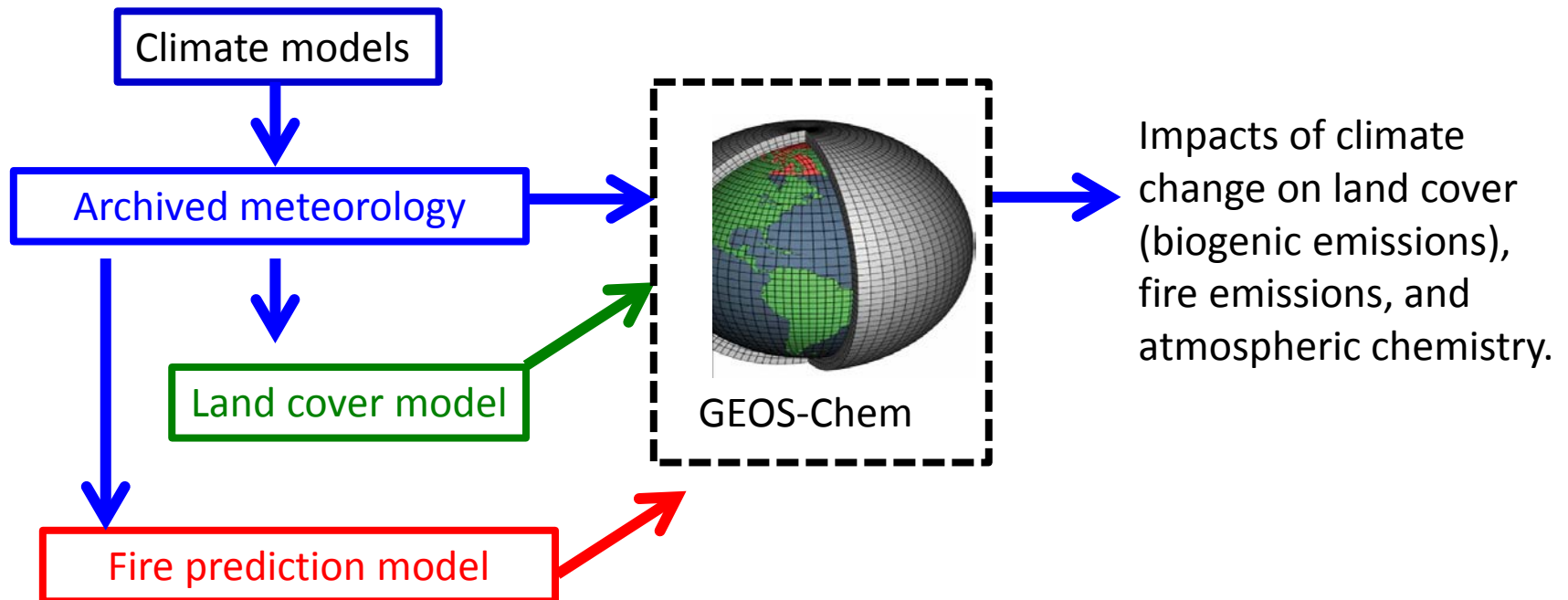
Interactions on interannual, decadal, or centennial time scales

Model frameworks

1. Standard

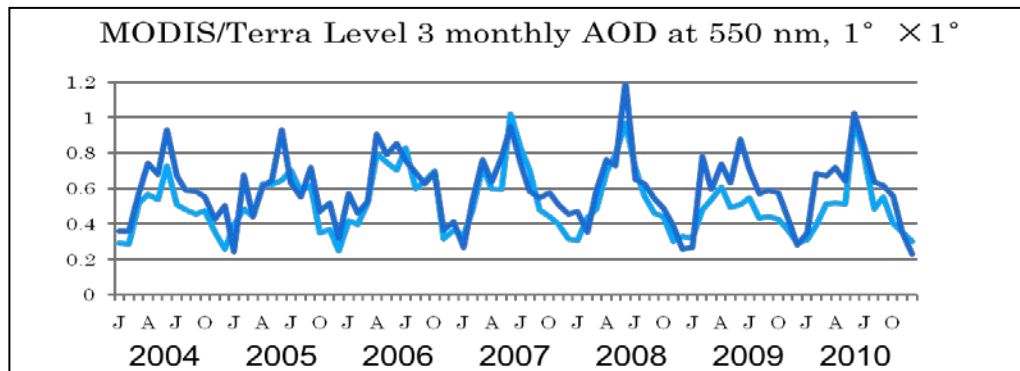


2. Global Change and Air Pollution (GCAP)



The standard GEOS-Chem has been used to understand historical changes in atmospheric Chemistry

- To quantify the variations in chemical species;
- To understand the drivers (meteorological parameters vs. emissions) of the variations of different species;
- To help with the interpretation of year-by-year variations in measurements;
- To assess the effectiveness of short-term air quality control strategies.



Mu and Liao, 2014
Yang et al., 2014
Yang et al., 2015

The GCAP model framework can be used to investigate past and future atmospheres

Three versions of GCAP are available:

1. GISS Model 3 + GEOS-Chem (4° x 5°, by Loretta Mickley in year 2003)
2. GISS Model E + GEOS-Chem (2° x 2.5° or 4° x 5°, by L. T. Murray and E. M. Leibensperger in year 2014)
3. CESM + GEOS-Chem (2° x 2.5°, by Rokjin Park in year 2014)

GCAP has been used extensively for projection of future air quality

1. GCAP: Future changes in air quality and tranboundary transport

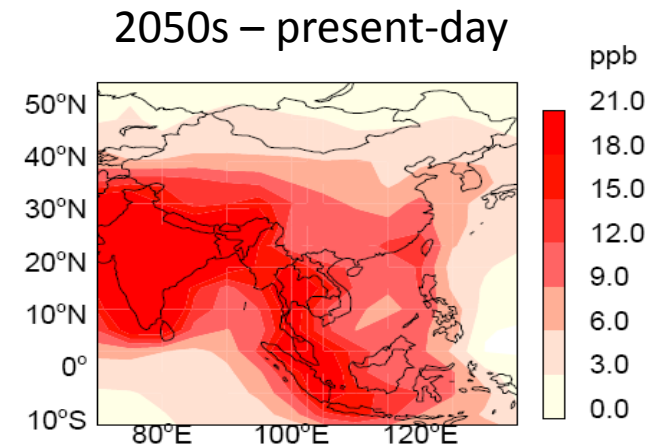
Wang et al., 2013; Jiang et al., 2013; Wai et al., 2014

2. GCAP + changes in land cover

Wu et al., 2012; Tai et al., 2013.

3. GCAP + changes in fire emissions

Yue et al., 2013; 2014



2000-2050 increase in surface ozone over Asia due to changes in emissions + climate. Wang et al., 2013.

GCAP2 has been applied to paleo- and preindustrial simulations

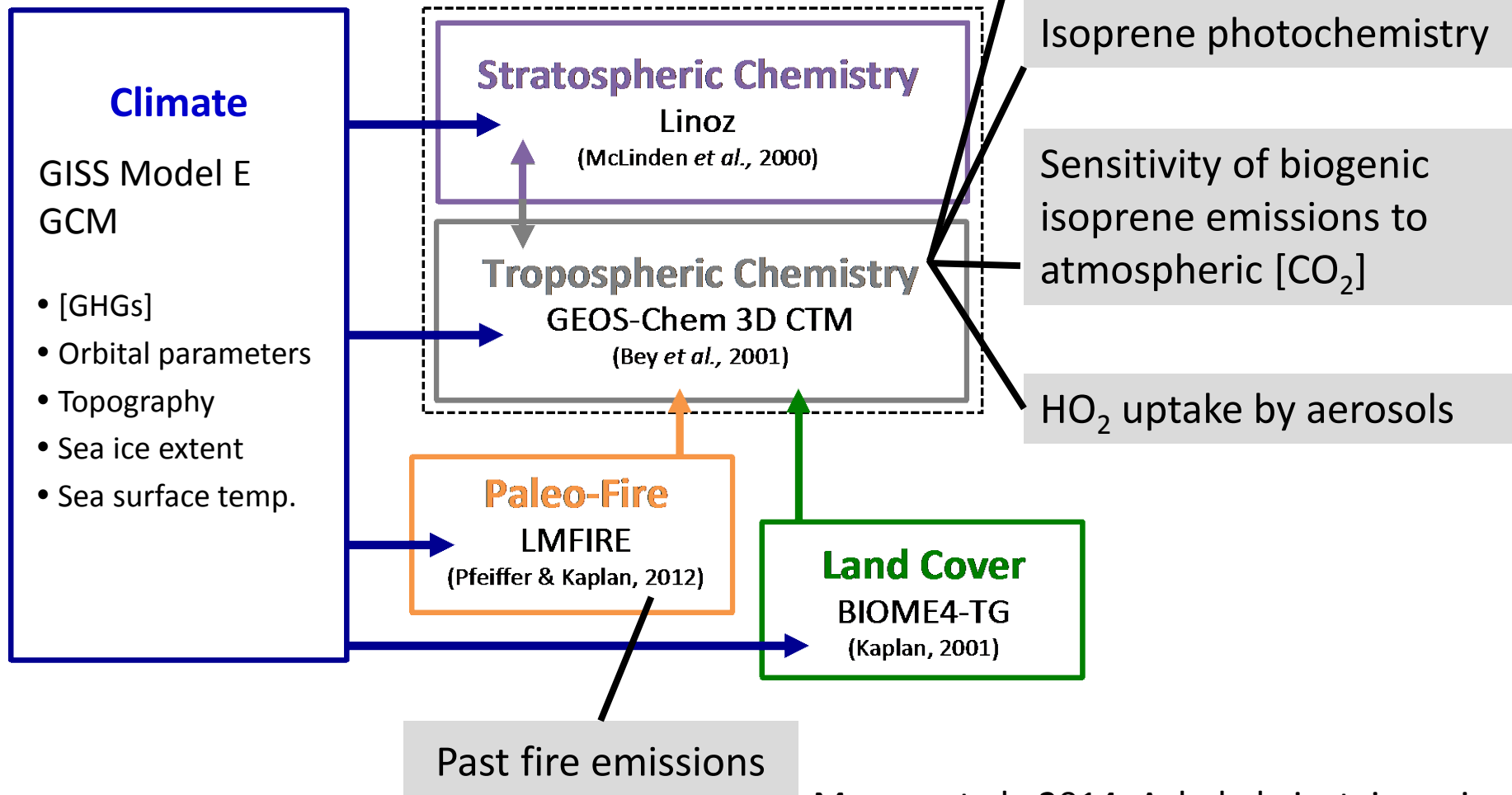
Meteorological fields for 4 time-slices:

Present day: ca. 1990s

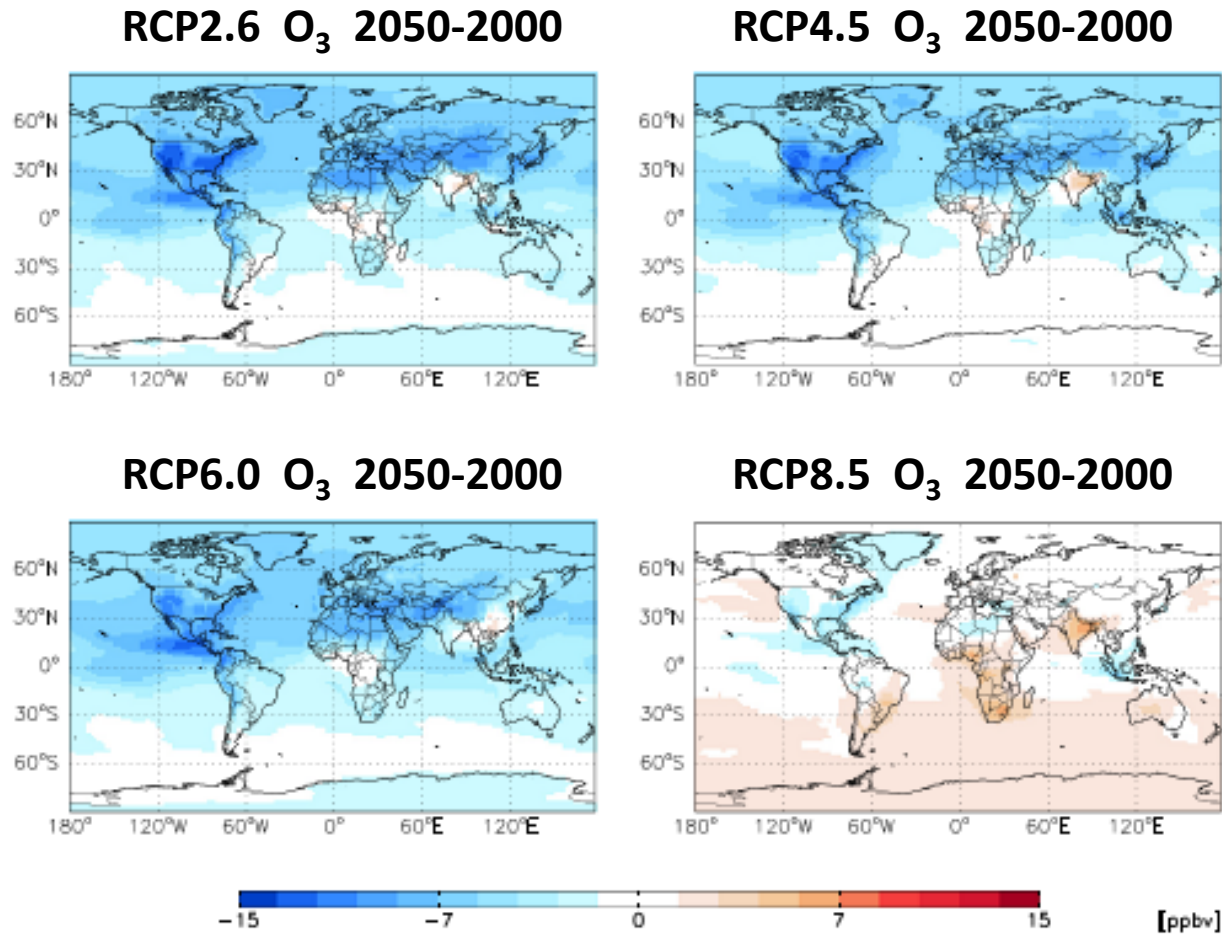
Pre-industrial: ca. 1770s

warm LGM: ~21ka

cold LGM: ~21ka



GACP 3 has been used to study future O₃ and oxidants under the RCPs



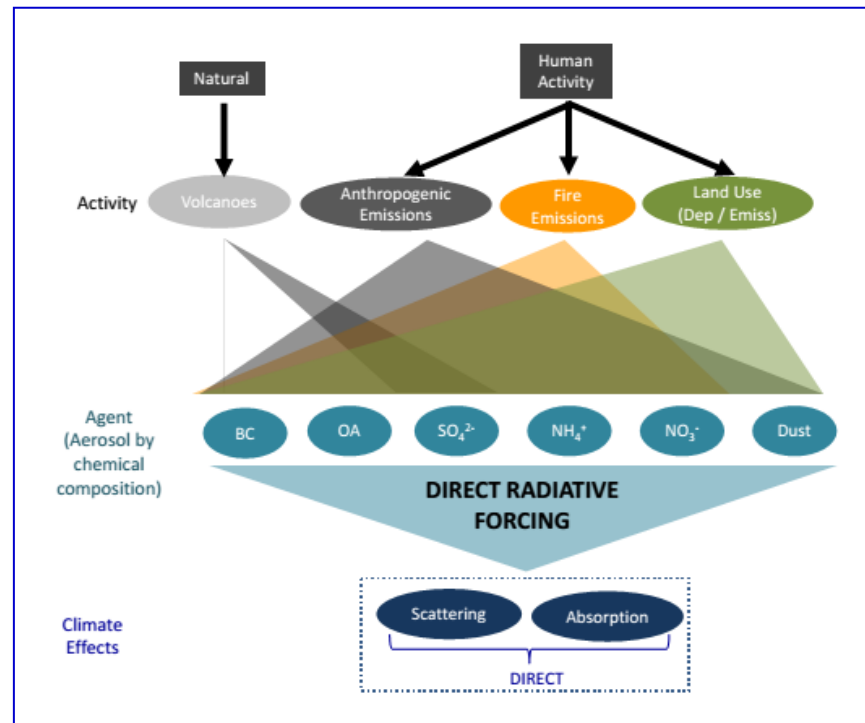
Updates in GEOS-Chem that are important for chemistry-climate

□ Online radiative transfer model

--- The Rapid Radiative Transfer Model for GCMs (RRTMG) has been coupled online with the GEOS-Chem model as described by Heald et al. (2014);

--- The RRTMG solves the radiative transfer equation in shortwave bands and 16 longwave bands that cover from 230 nm through 56 μm .

□ RCP future emission scenarios in GEOS-Chem (Holmes et al., 2013)



Heald et al. (2014)

Future directions: The two-way coupling of chemistry-climate

1. Coupling of the grid-independent GEOS-Chem with climate models will allow us to easily link chemistry with climate, vegetation, ocean biology, fire, carbon cycle .
2. On-line interface between GEOS-Chem and the Goddard Earth Observing System (GEOS) Earth System Model from the NASA Global Modeling and Assimilation Office (GMAO) is ready, using the Earth System Modeling Framework (ESMF);
3. Can the GEOS-Chem simulations be conducted on any model grid and interfaced with any ESM?

