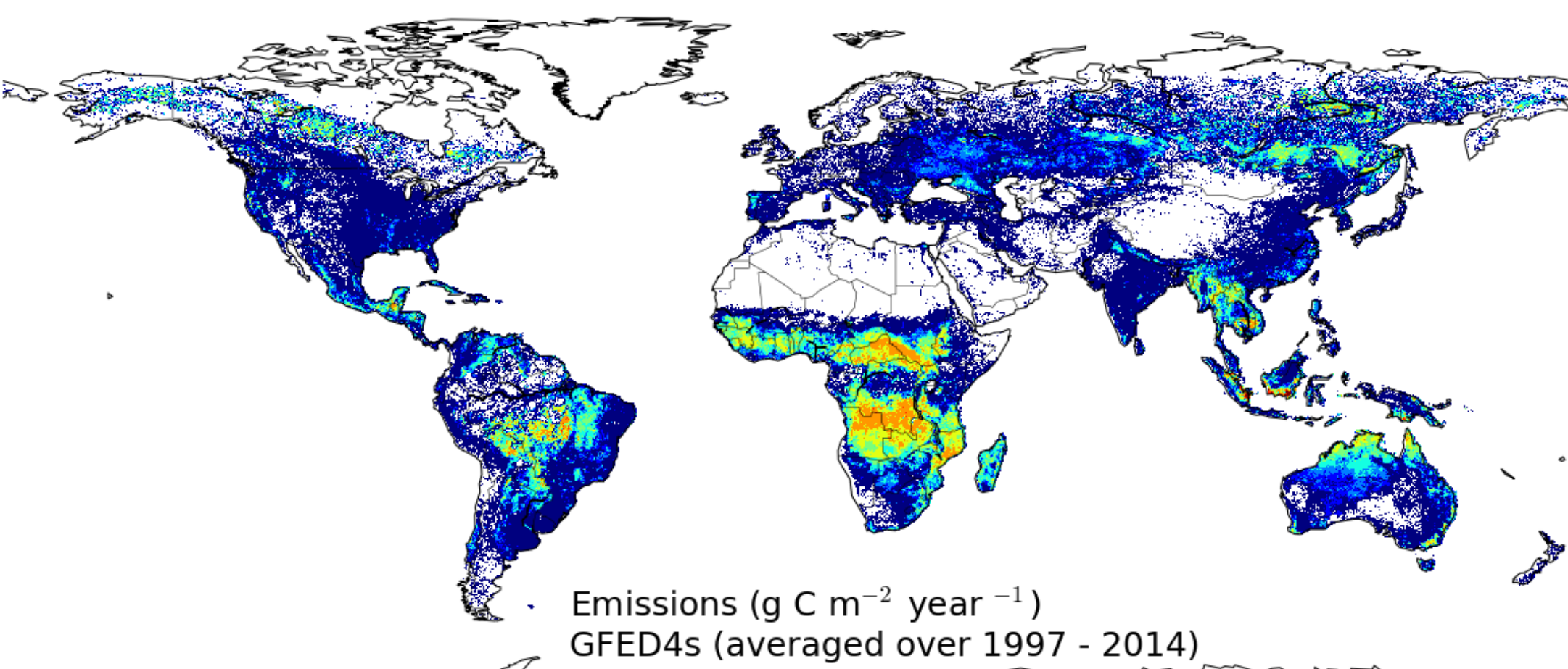


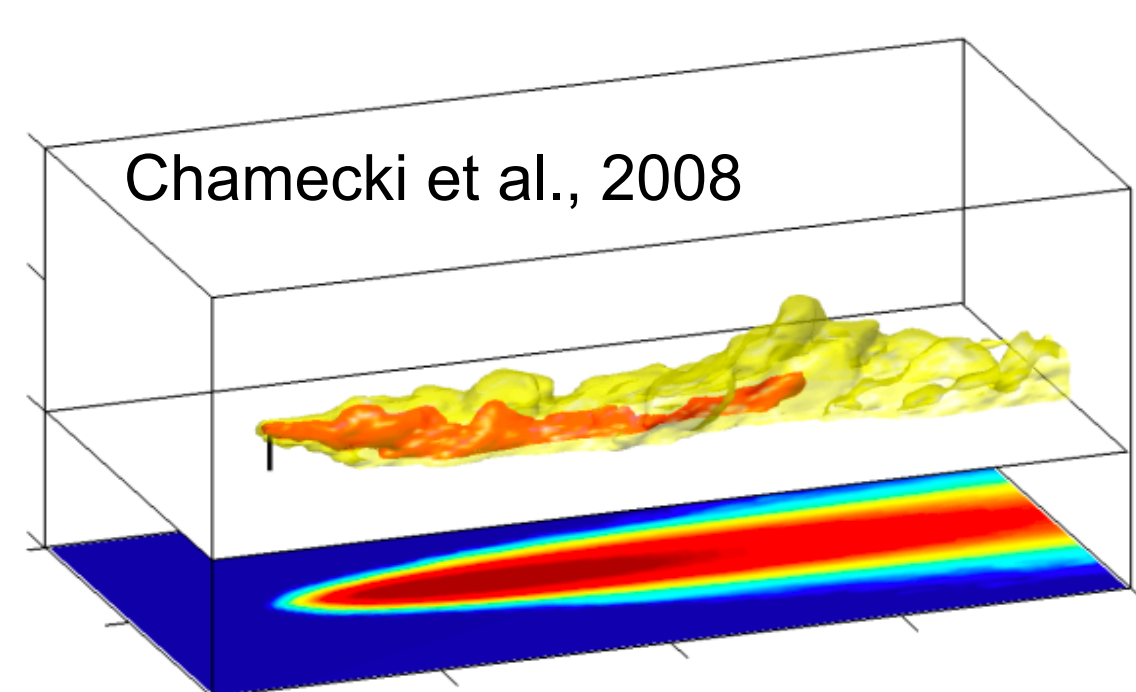
Motivation and Model

Biomass Burning Impacts Air Quality and Climate

Biomass-burning provides a large global source of trace gases and aerosols. Emissions are highly variable between fires and much of organic chemistry is unknown (e.g., SVOCs). Rapid near-source chemistry creates O₃, PAN, SOA, etc. **Understanding this chemistry is critical to assessing air quality and climate impacts from biomass burning.**



Annual carbon emissions (as g C m⁻² year⁻¹), averaged over 1997-2014, derived using MODIS fire counts and burned area according to GFED4 burned area data (Randerson et al., 2014)

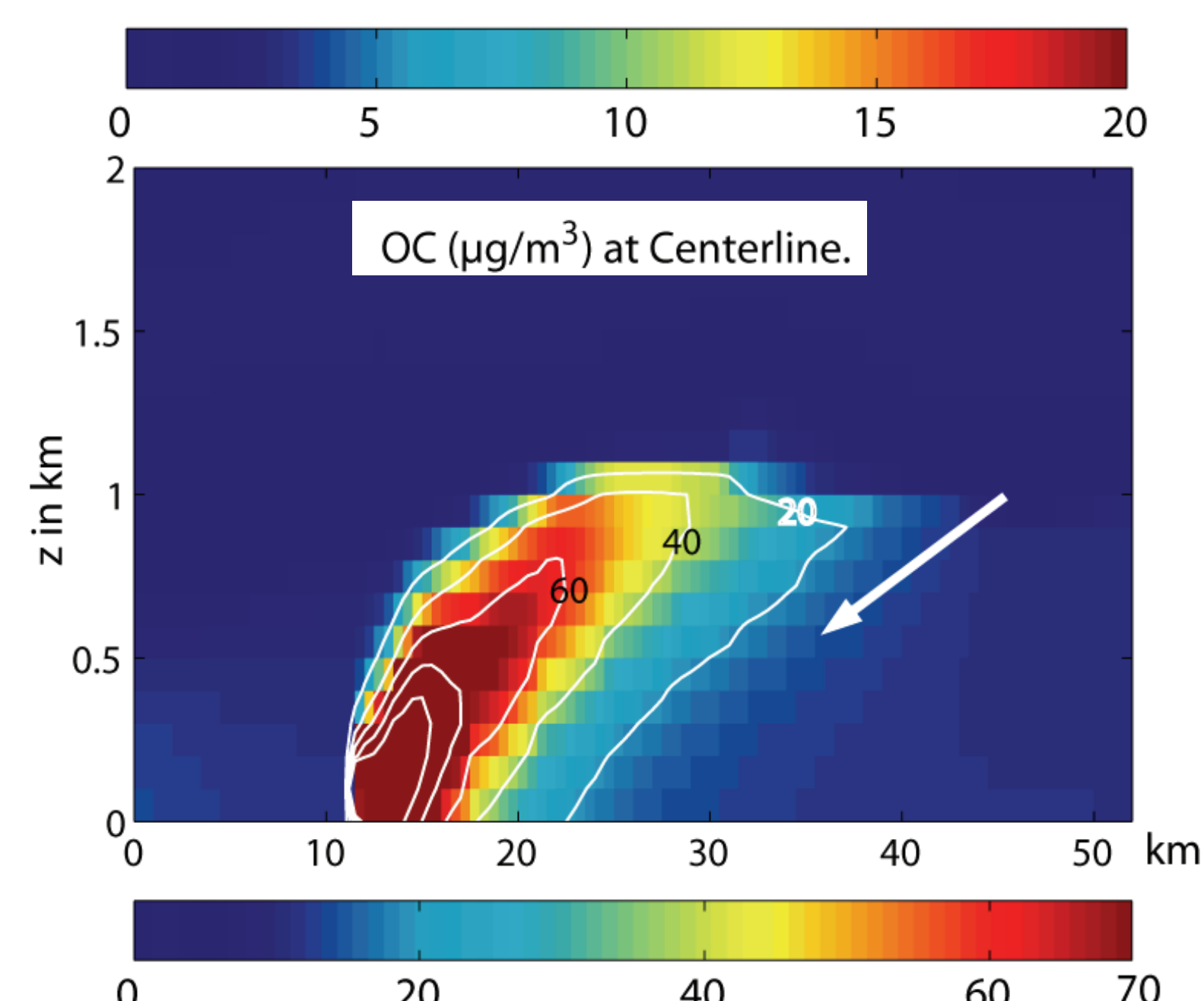
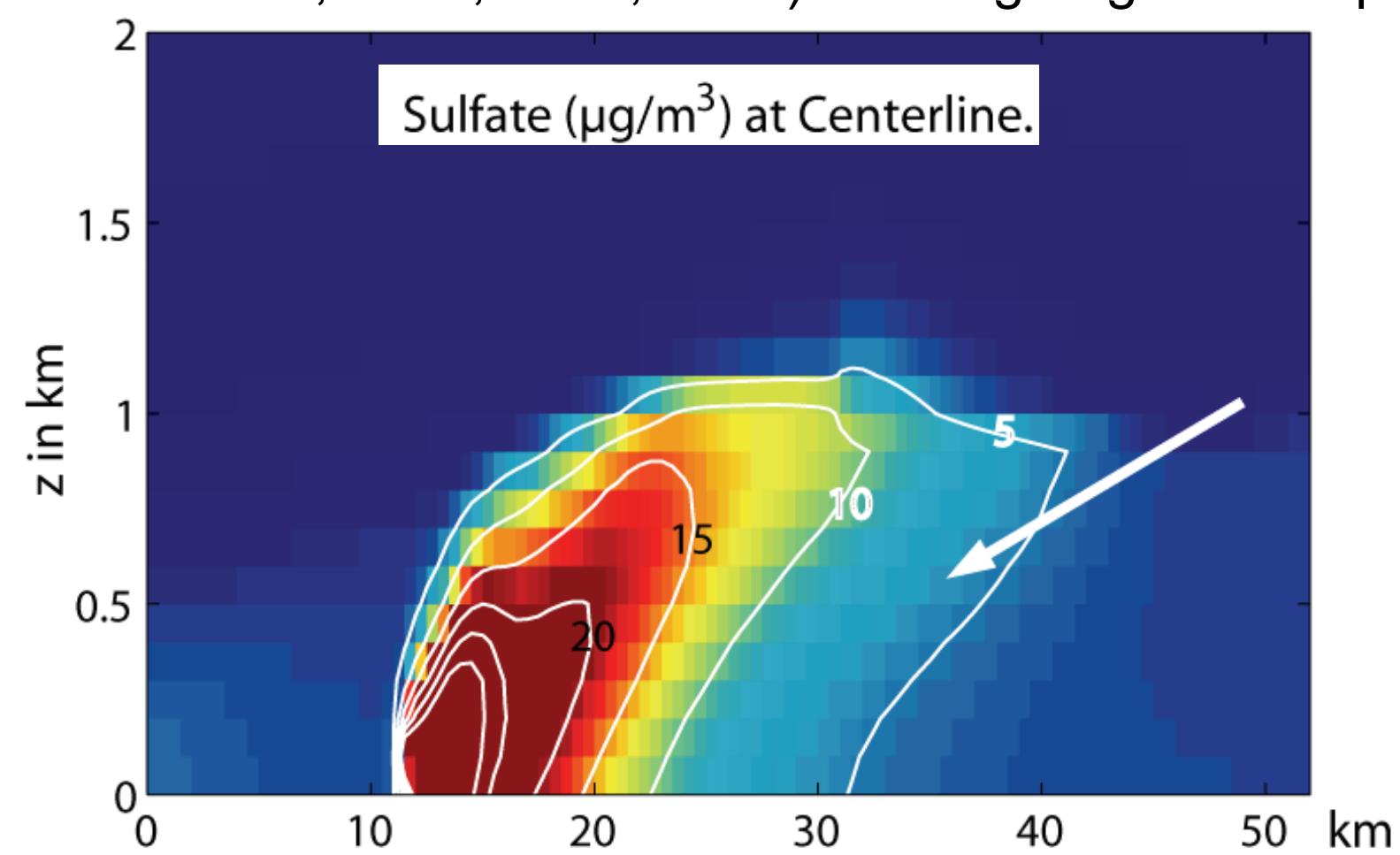


Fires can have large impacts on aerosol concentrations, and thus air quality and climate. **Global CTM estimates of the primary emissions from biomass burning can unphysically "mix" across large-scale grid boxes leading to inaccurate chemical modeling and incorrect estimates of the impact of biomass burning on air quality and climate.**

Plume-scale process models like AER's Aerosol Simulation Program allow us to examine the chemical and physical transformations of aerosols within biomass burning smoke plumes and to develop parameterizations for this aging process for coarser grid-scale models.

Aerosol Simulation Program (ASP v2.1)

- ASP models the formation of O₃ and SOA in smoke plumes.
 - Gas-phase chemistry
 - ≤C₄ gases follow MCM v3.2 (Saunders et al., 2003).
 - Other organic gases follow RACM2 (Goliff et al., 2013)
 - Inorganic aerosol thermodynamics
 - OA thermodynamics using the VBS (Robinson et al., 2007)
 - S/IVOC oxidation following Ahmadov et al. (2012)
 - Evolution of the aerosol size distribution and optical properties
 - ASP can be run as a subroutine within 3D Eulerian (Alvarado et al., 2009, 2015, 2016) and Lagrangian transport models

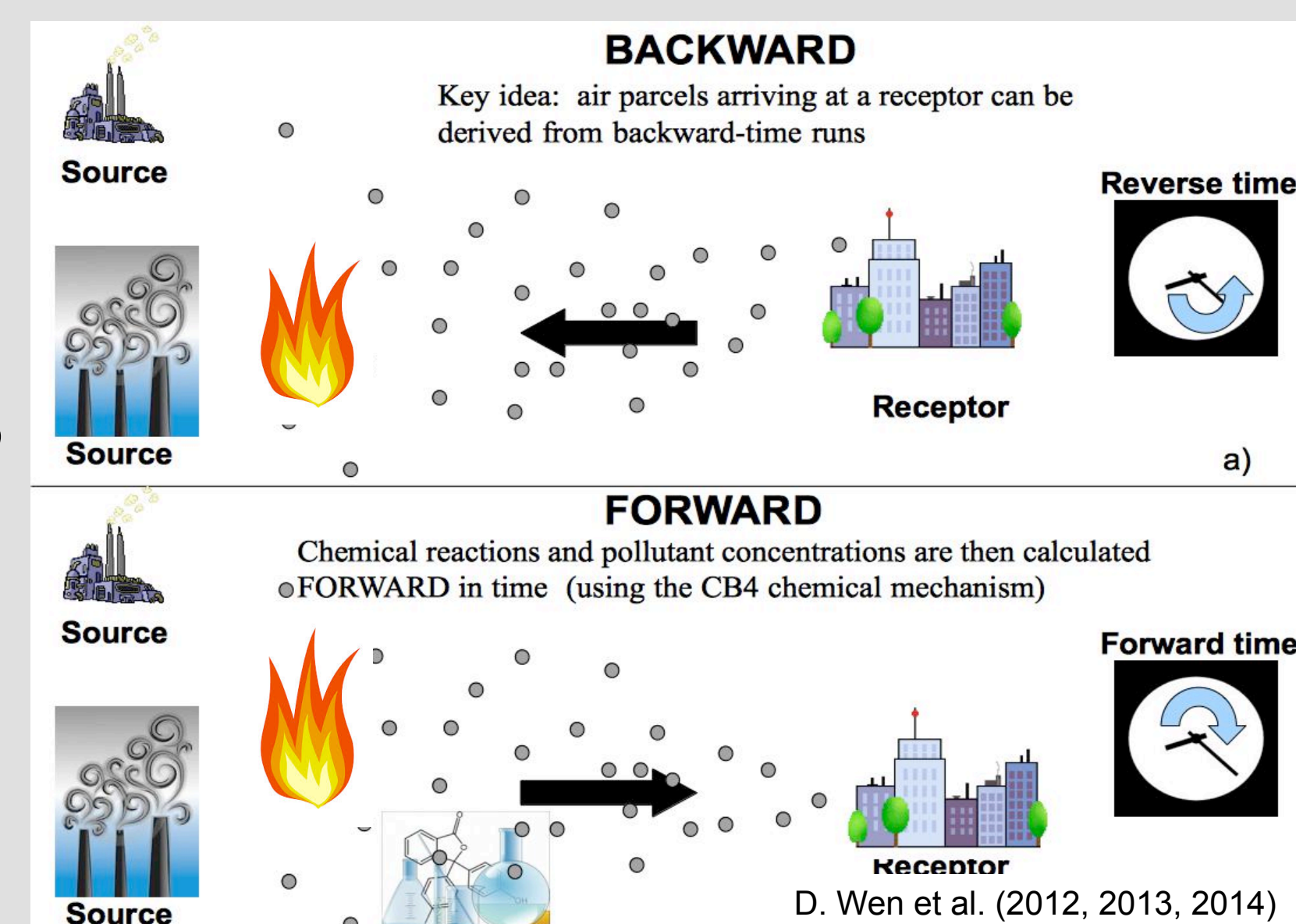


Modeling Biomass Burning Aerosol with ASP

Lagrangian particle dispersion model derived from HYSPPLIT that includes:

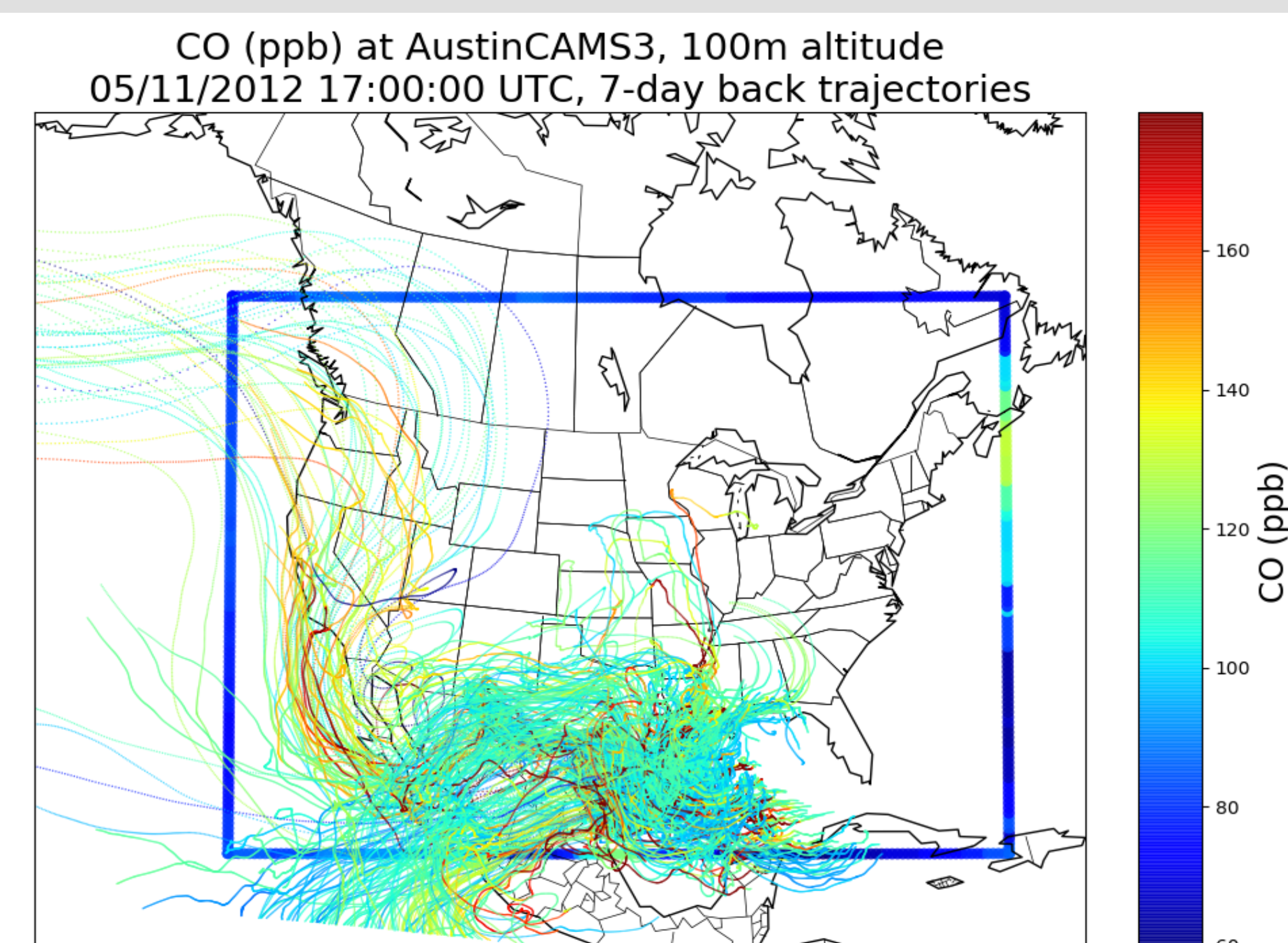
- improved mass-conservation
- Allow the use of customized WRF meteorological fields (Nehrkorn et al., 2010).
- used in inverse modeling studies to improve emission estimates for greenhouse gases (Henderson et al., 2015).
- coupled STILT with ASP to better account for the impacts of long-range transport of biomass burning emissions on CO, O₃, aerosols and other pollutants on the boundary conditions.

STILT-ASP

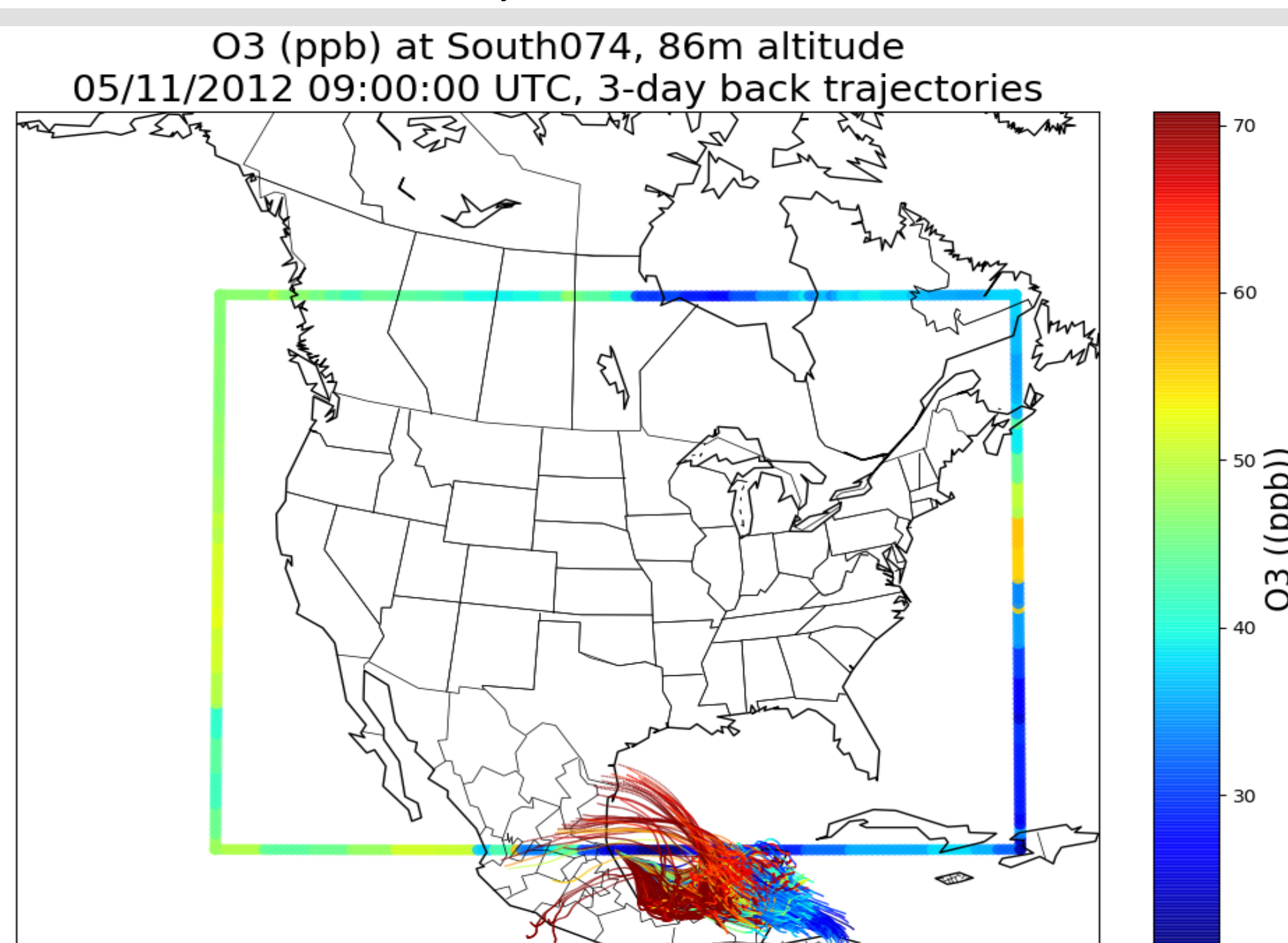


MODEL SETUP:

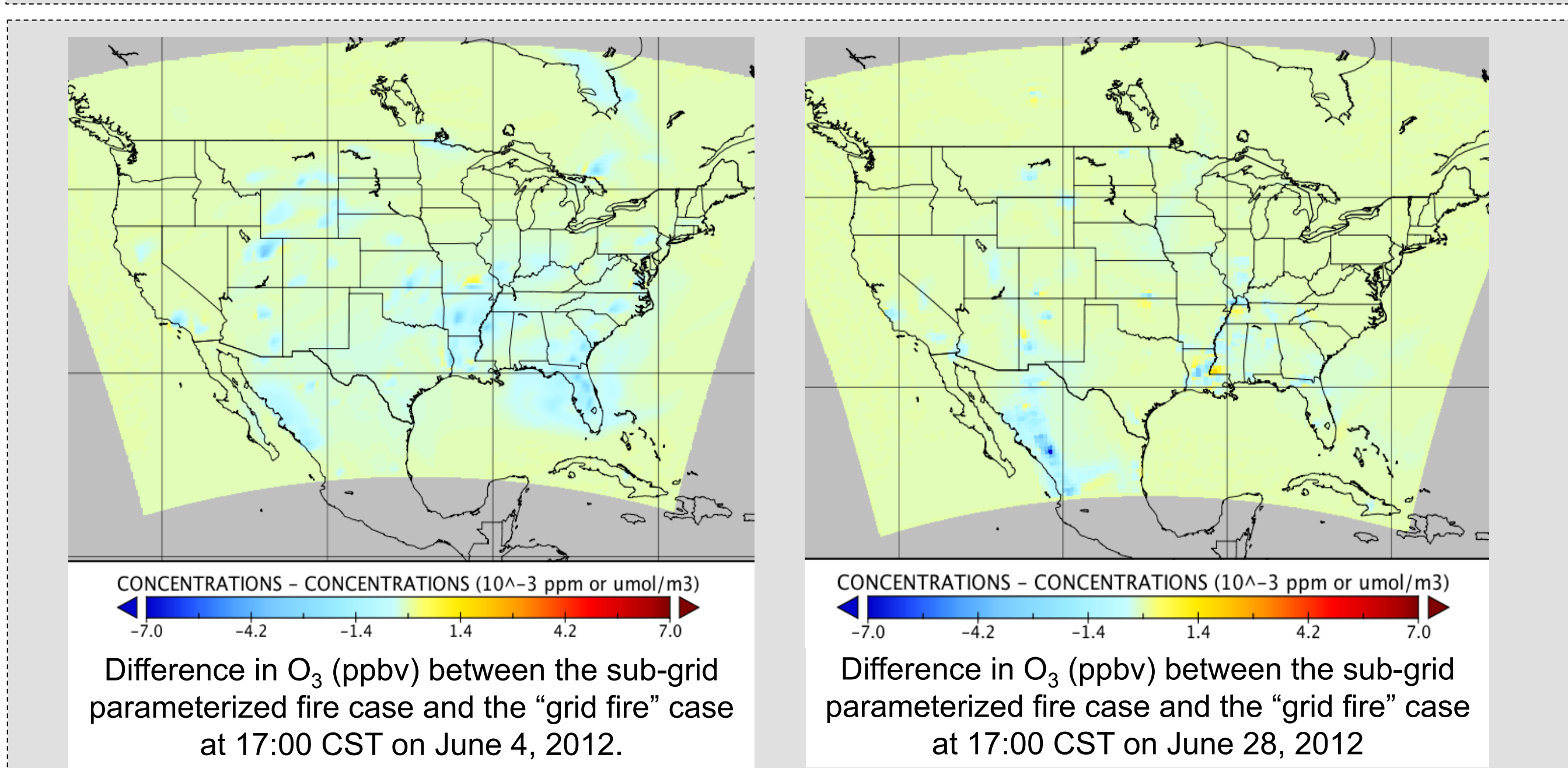
- Initialize, emission, and deposition routines from STILT-Chem described in Wen et al., (2012, 2013, 2014)
- initialized at endpoint of each back-trajectory using output values from global CTM MOZART-4/GEOS-5
- default emissions calculated with emission pre-processor using FINN v1.5 fire emissions
- 32 km NARR to drive MEGAN v2.10 daily biogenic emissions mapped to RADM2 mechanism



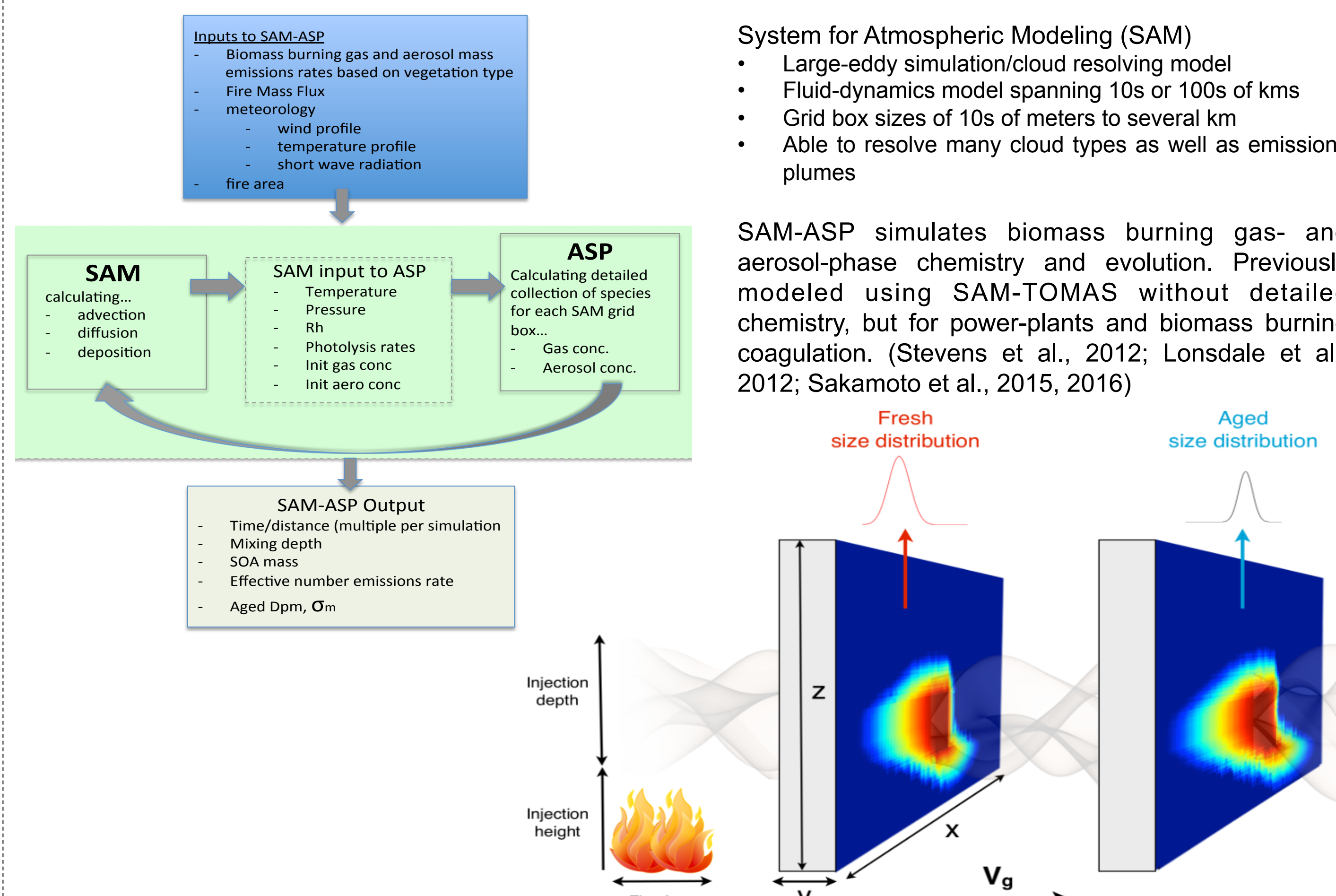
CO (ppbv) from a 7-day back trajectory run of STILT-ASP v2.0 for May 11th, 2012 at 17:00 UTC (11:00 CST) for Austin/Round Rock CAM33 site. The GEOS-Chem boundary conditions are also shown.



O₃ (ppbv) from a 3-day back trajectory run of STILT-ASP v2.0 for May 11th, 2012 at 09:00 UTC (03:00 CST) for the 74th grid box of the southern boundary of the CAMx modelling domain. The GEOS-Chem boundary conditions are also shown.



SAM-ASP



Williams Chaparral Fire – San Luis Obispo, CA

- Burning scrublands were sampled near San Luis Obispo, CA from 10:50-15:20 LT on November 17, 2009. Skies were clear all day and RH was low (11 to 26%) with variable winds (2 to 5 m/s).
- Measurements included U. Montana airborne FTIR (CO, O₃, NO_x, PAN, C₂H₄, etc.), compact ToF-AMS (OA, sulfate, nitrate, ammonium), SP2 (BC), nephelometer, and meteorological data.
- Significant chemical formation of O₃ and PAN, but slight loss of OA downwind! (Akagi et al., 2012, Alvarado et al., 2015)

