FY24 Strategic University Research Partnership (SURP)

Studying 2020 western US mega-fires using carbon monoxide from satellites, models, and reanalyses

Principal Investigator: Kazuyuki Miyazaki (329)**; Co-Investigators:** Kevin Bowman (329), Rong Fu (UCLA), Pablo Saide (UCLA), Mackenzie Arnold (UCLA)

Objectives

The overall objective is to study smoke and air pollution from the 2020 western US mega-fires using satellite retrievals and multiscale modeling systems. The specific objectives are:

a) Evaluation of satellite carbon monoxide (CO) retrievals developed by JPL TROPESS
b) Evaluation and improvement of regional and global models using satellite CO retrievals
c) Assessment of atmospheric loads and emissions from bottom-up/top-down approaches for air pollutants.

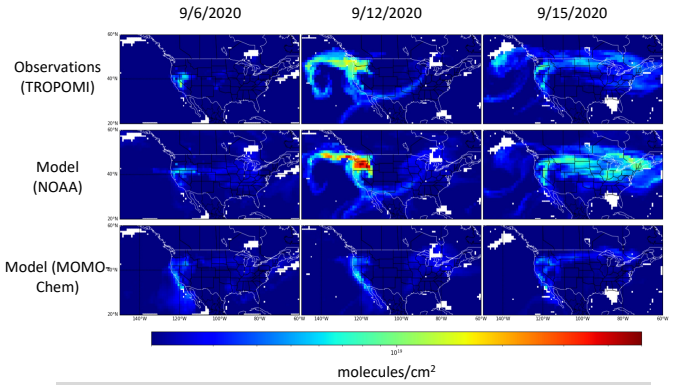

Figure 1: *Spatial maps of total CO column for TROPOMI retrieval (top), NOAA's RAP-Chem simulation with TROPOMI AK (middle), and MOMO-Chem simulation with TROPOMI AK (bottom).*

Approach and results

Satellites: Both *TROPOMI* (7km resolution) and *CrIS* (14km) retrieve the CO total columns in the early afternoon. TROPOMI is sensitive to the entire troposphere while CrIS is sensitive to the free troposphere.

Models: *MOMO-Chem* is a global chemical reanalysis product developed at JPL (Miyazaki et al., 2020). 1.1 degrees resolution, no parametrized plume rise. *RAP-Chem* is a regional model developed at NOAA. Wildfire emissions computed using Fire Radiative Power (FRP). 14 km resolution with parametrized plume rise.

CO columns (Fig. 1): If two satellites show similar vertical columns, then we expect that most of the plume in these areas is in the free troposphere. If not, we expect more plumes near the surface.

- *RAP-Chem* is capturing the extent of the plume well.
- *MOMO-Chem* underestimates CO, due to the coarser resolution, underestimated emissions, no plume rise.

Background

- In 2020, there were 58,083 wildfires in the United States, burning a total of 8.5 million acres, an area > Belgium. The U.S. government spent more than $3 billion in 2020 to suppress wildfires, but it impacted the society and economy.
- Combining recent multiple satellite measurements with different vertical sensitivities has the potential to distinguish CO at different levels of the atmosphere, thus contributing to reducing the uncertainty associated with smoke prediction.

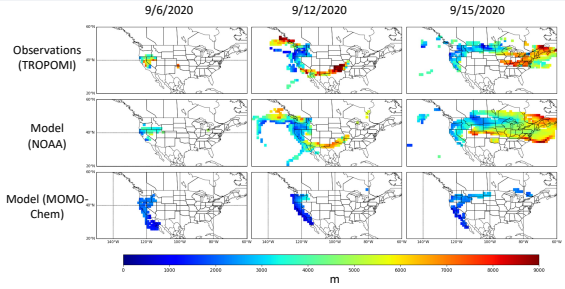

Figure 2: *Spatial maps of aerosol scattering heights for TROPOMI retrieval (top), NOAA's RAP-Chem simulation (middle), and MOMO-Chem simulation (bottom).*

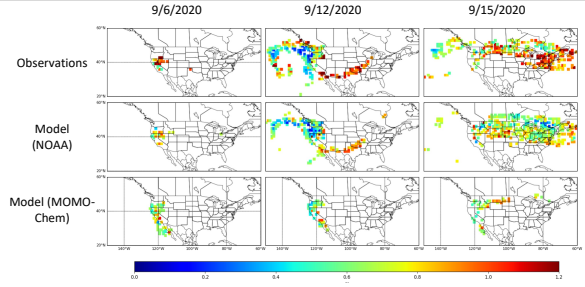

Figure 3: *Spatial maps of total CO column ratio between CrIS and TROPOMI (CrIS/TROPOMI) for satellite retrievals (top), NOAA's RAP-Chem simulation (middle), and MOMO-Chem simulation with CrIS and TROPOMI AKs (bottom).*

Plume heights (Fig. 2): RAP-Chem both tends to overestimate low injections and underestimate high injections

CrIS/TROPOMI (Fig. 3): The ratio can be used to inform what percentage of the total column is in the range of CrIS sensitivity. The lower ratio in RAP-Chem than the satellite retrievals is partly because RAP-Chem always puts some emissions at the surface and may not inject high enough.

Significance and benefits to JPL

- By combining UCLA's strengths in regional modeling with JPL's strengths in global modeling, JPL will be better able to characterize multi-scale processes.
- This capability will make JPL more competitive with science proposals and support new mission designs through OSSEs, including evaluations of the potential of the recent/future GEO from TEMPO and NOAA's GEO-XO.

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

RPD-000 Clearance Number: CL#00-0000

Publications: None at this juncture.

PI/Task Mgr. Contact Information:
kazuyuki.Miyazaki@jpl.nasa.gov
+1-818-354-3266