National Aeronautics and Space Administration

FY23 Strategic University Research Partnership (SURP)

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

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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.

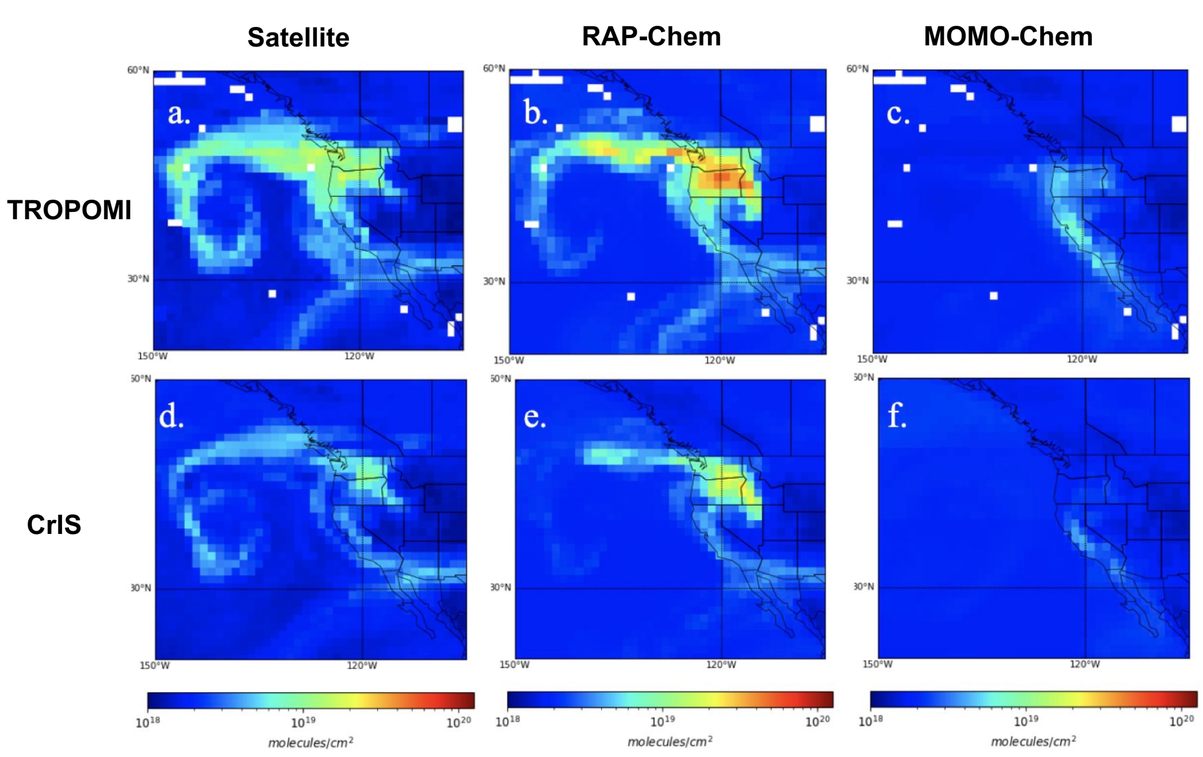

Figure 1: *Spatial maps of total CO column for (a) TROPOMI retrieval, (b) RAP-Chem simulation with TROPOMI AK, (c) MOMO-Chem simulation with TROPOMI AK, (d) CrIS retrieval, (e) RAP-Chem simulation with CrIS AK, (f) MOMO-Chem simulation with CrIS AK on September 12th, 2020.*

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.
- Predicting and warning the population of smoke events can help avoid smoke exposure. Satellite observations can help reduce the uncertainty associated with smoke prediction.
- Combining recent multiple satellite measurements with different vertical sensitivities has the potential to distinguish CO at different levels of the atmosphere.

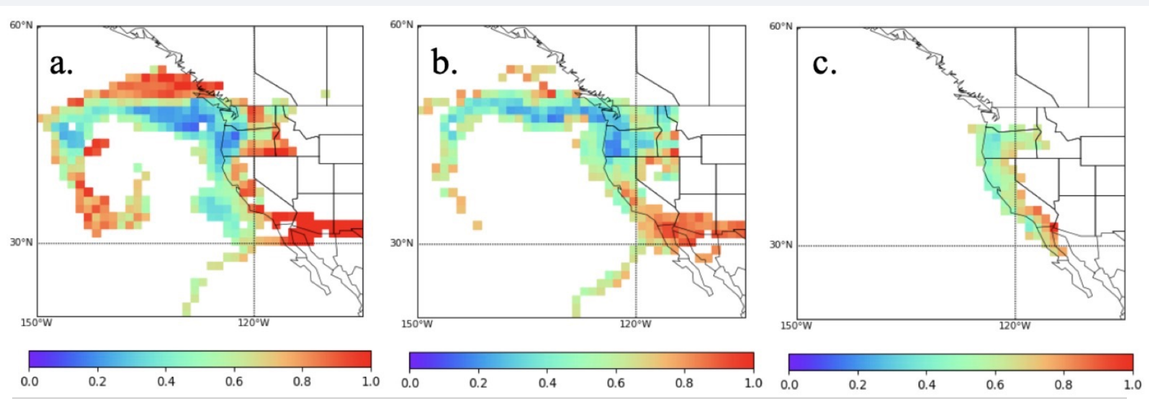

Figure 2: *(a) Ratio of CrIS to TROPOMI total CO columns over fire smokes. Same as (a), but for (b) the RAP-Chem simulation with CrIS and TROPOMI AKs and (c) the MOMO-Chem simulation with CrIS and TROPOMI AKs.*

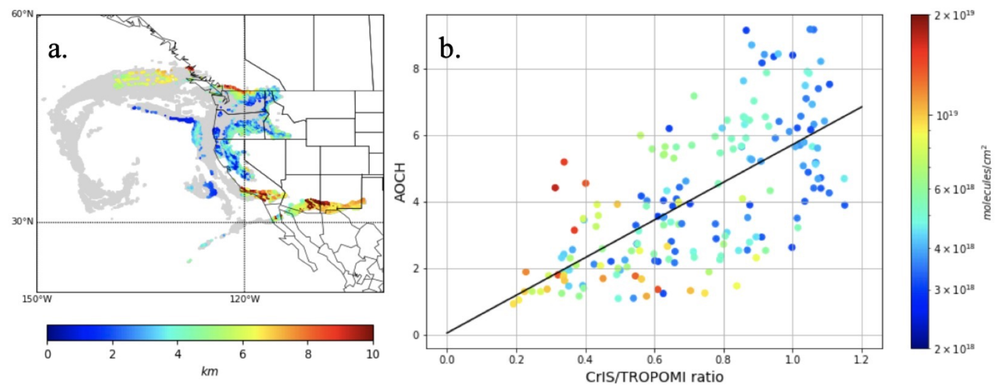

Figure 3: *(a) TROPOMI Aerosol Optical Central Height (AOCH) in km. (b) Scatter plot between CrIS/TROPOMI ratio and TROPOMI AOCH over smoke plumes. Colors coded by the TROPOMI CO total vertical column.*

CrIS/TROPOMI (Fig. 2): 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.

Plume heights (Fig. 3): The high correlation between AOCH and the CrIS/TROPOMI ratio shows that these two datasets are complementary but contain different information about the plume.

Significance and benefits to JPL

- This will allow JPL to better exploit the constellation of Decadal Survey missions by building technical skills in the current missions for fires and smoke research.
- 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.

Publications: None at this juncture.

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