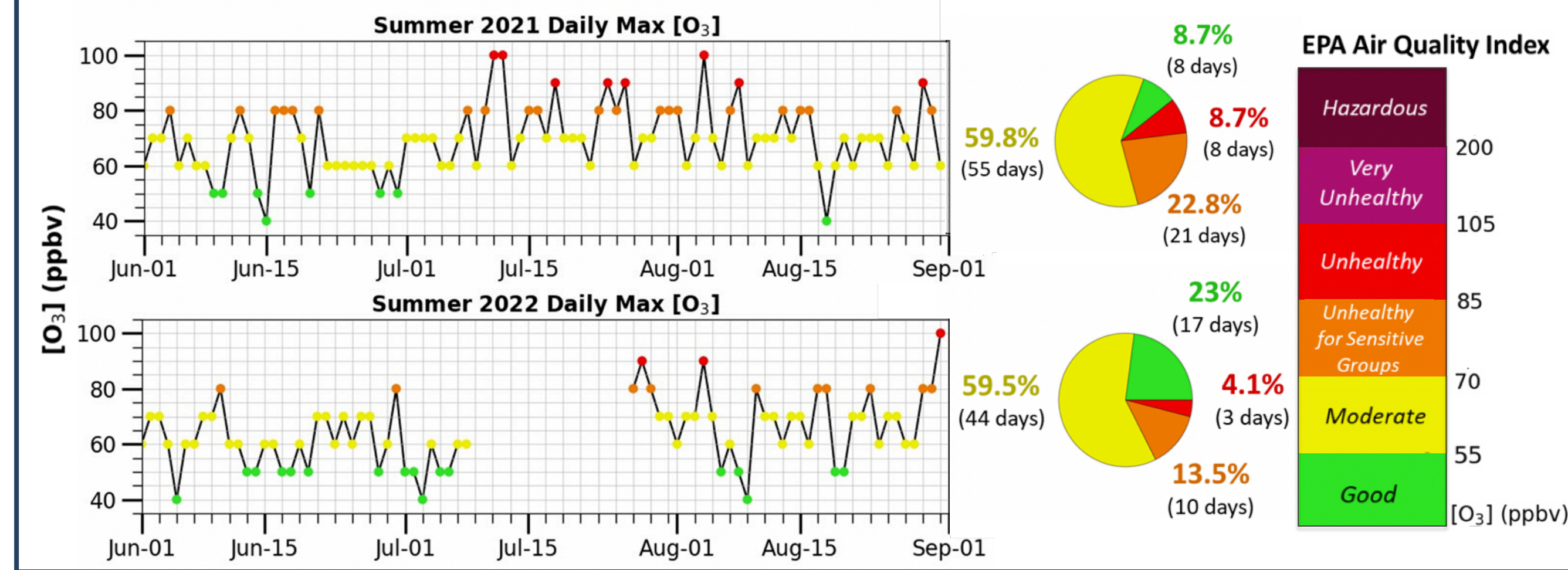


I. Background

Tropospheric ozone (O₃) is a pollutant with major impacts on human health, including:

- difficulty breathing
- inflammation and damage of the lungs
- aggravation of asthma and bronchitis

Salt Lake City sees frequent unhealthy summer O₃

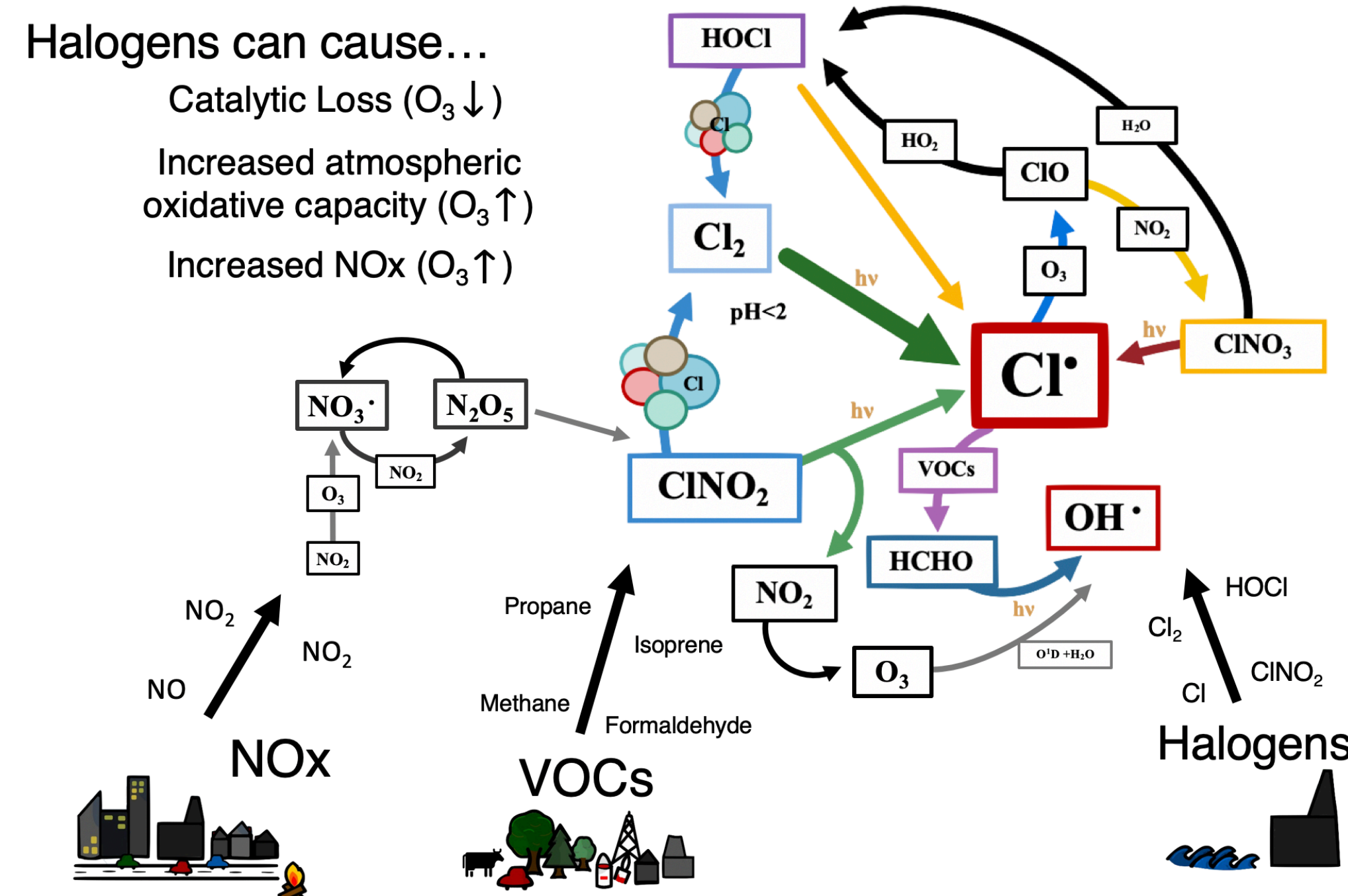


O₃ production depends on complex reactions involving NO_x and VOCs

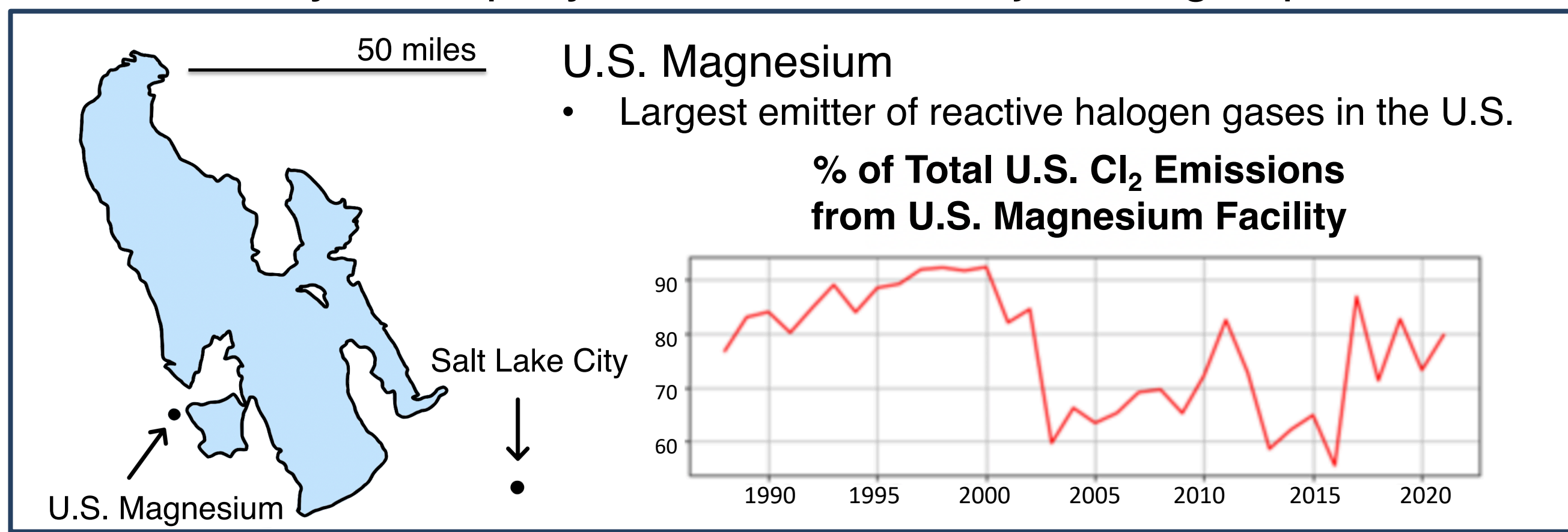
- NO_x is emitted from combustion, fossil fuels
- VOCs are emitted from vegetation, solvents, industry, cows, etc.

Halogens further complicate these reactions

- Halogens are released from sea spray, industry, salts



Salt Lake City is uniquely located near a major halogen point source



II. Measurements

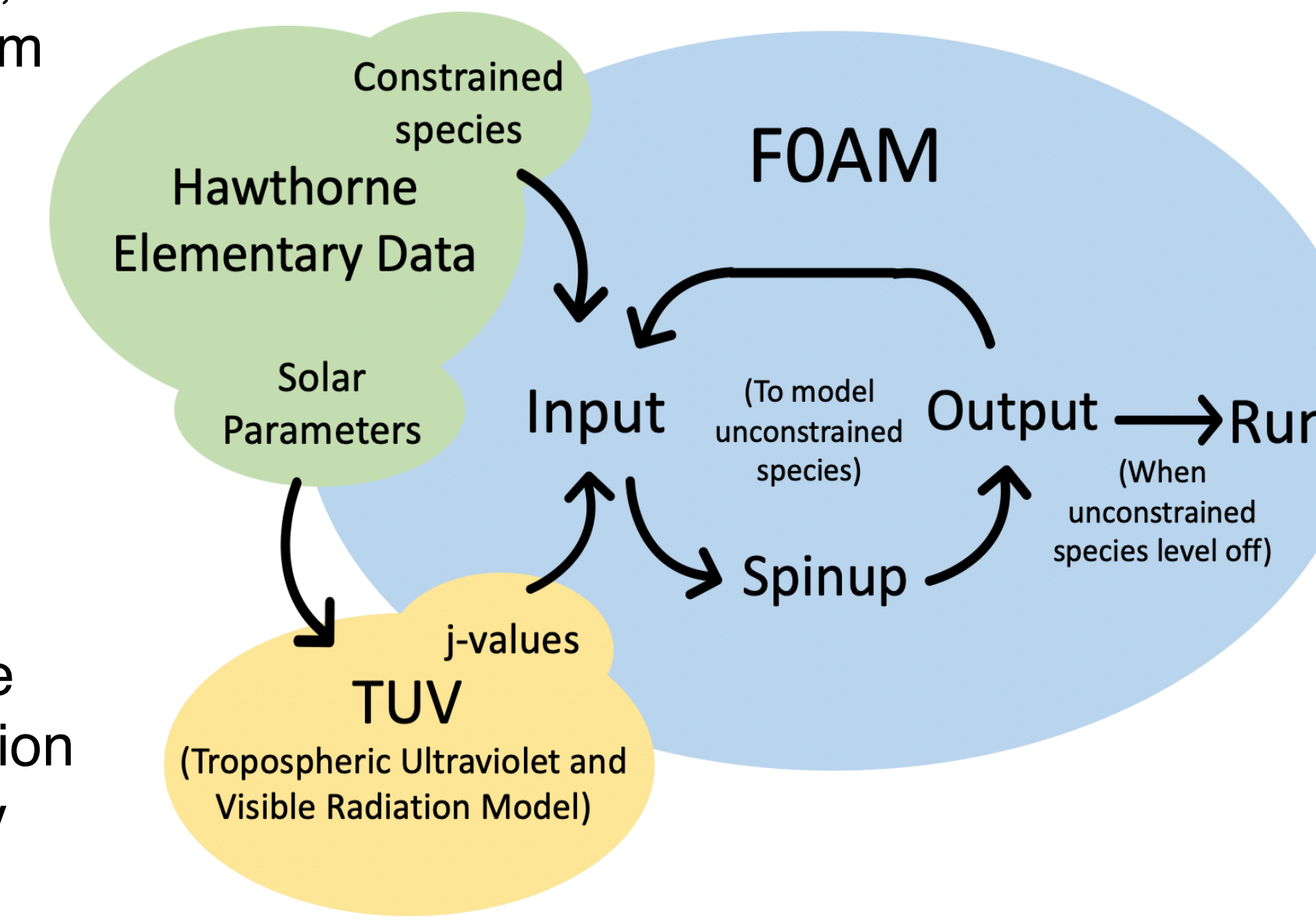


- Hawthorne Elementary DEQ site
 - Gas concentration and meteorological data
- Data from 06/01/2021 – 08/31/2021 and 06/01/2022 – 08/31/2022
 - Number weighted median hourly summer values
- TUV (Tropospheric Ultraviolet and Visible Radiation) Model
 - Photolysis rates

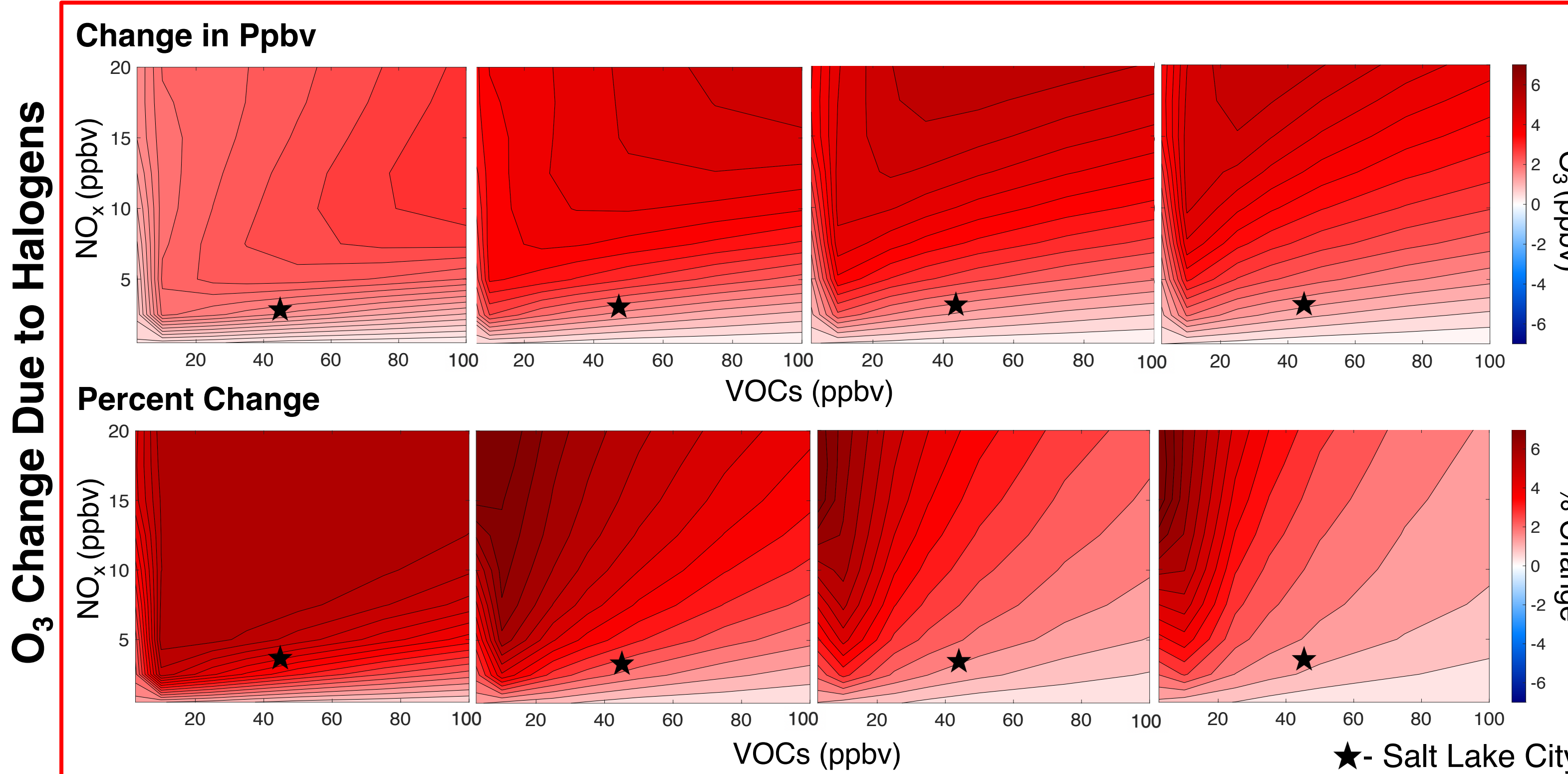
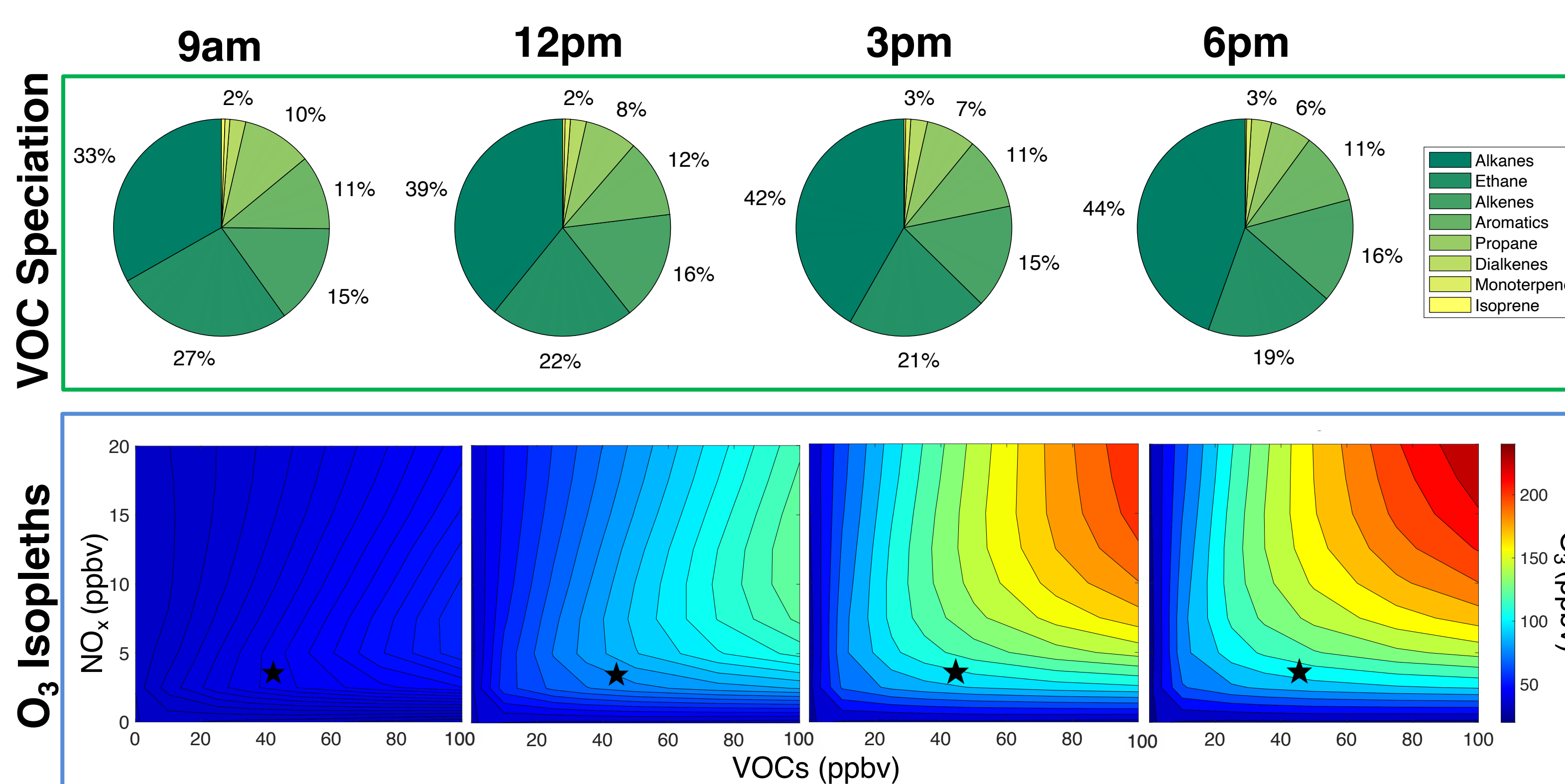
III. Methodology

Framework for 0-D Atmospheric Modeling (FOAM)

- Explicit box model with >15,000 reactions
- MCMv331 (Master Chemical Mechanism), Riedel et al., 2014 halogen submechanism
- We ran 96 hours (4 days) of 'spinups' to model unconstrained species, spinup outputs act as run inputs
- Meteorological and solar parameters are input as measured
- All constrained species are held constant throughout spinups
- On a run, NO_x, halogens, and O₃ evolve
- Isoleth NO_x and VOC concentrations are calculated by multiplying each gas's fraction of the total family with the intended family concentration, meaning speciation is as measured throughout the isopleths



IV. Results



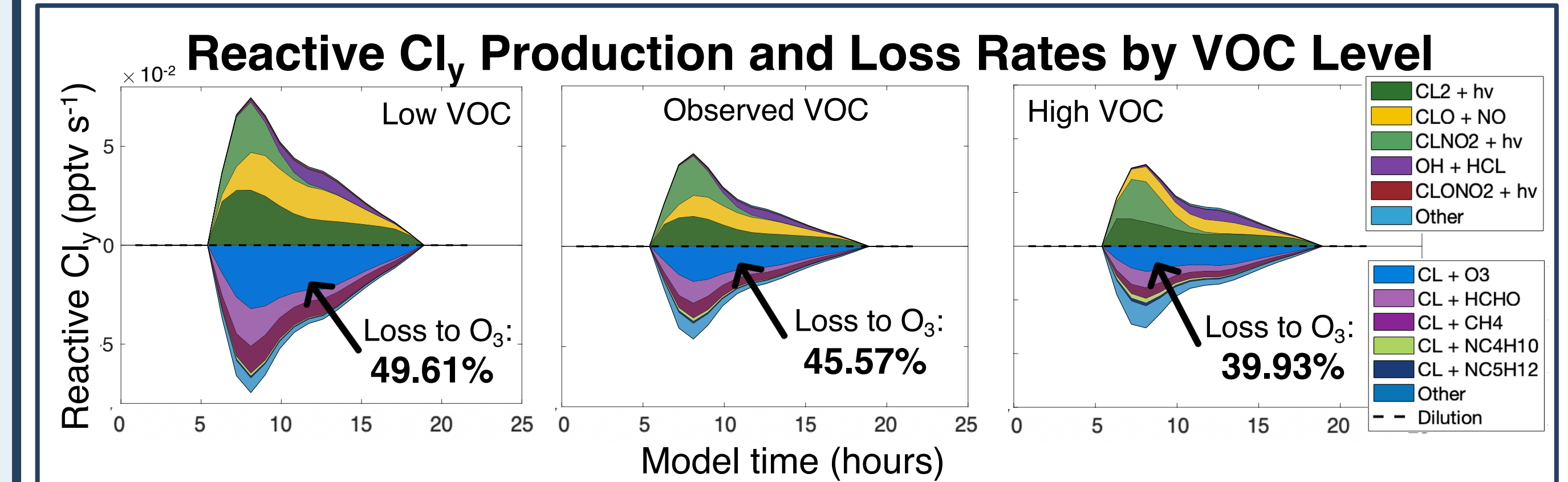
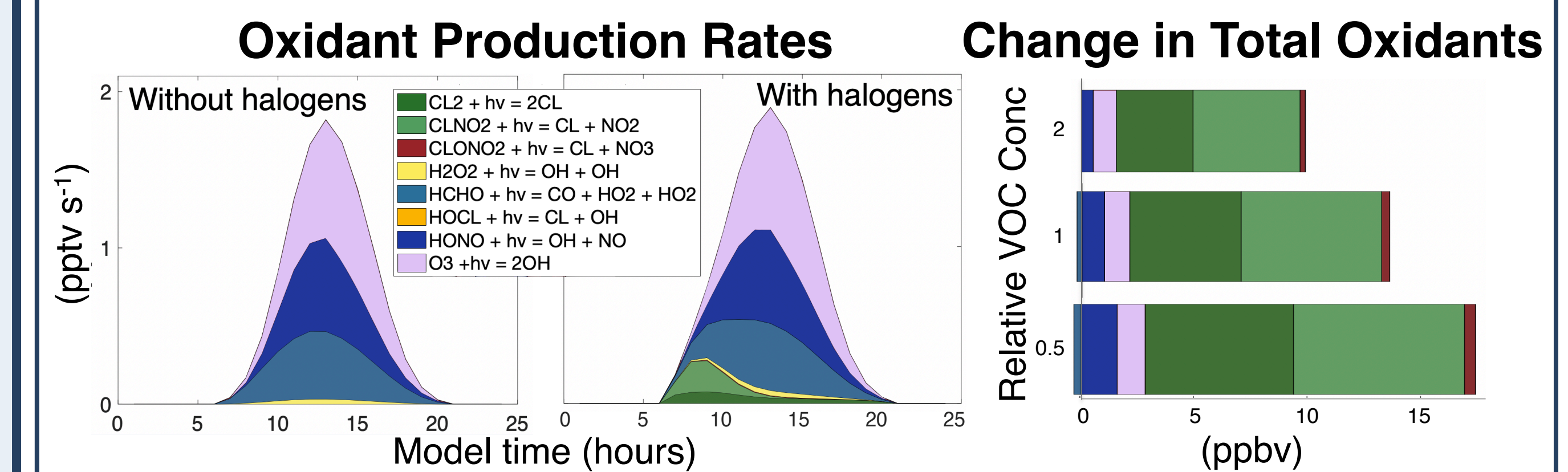
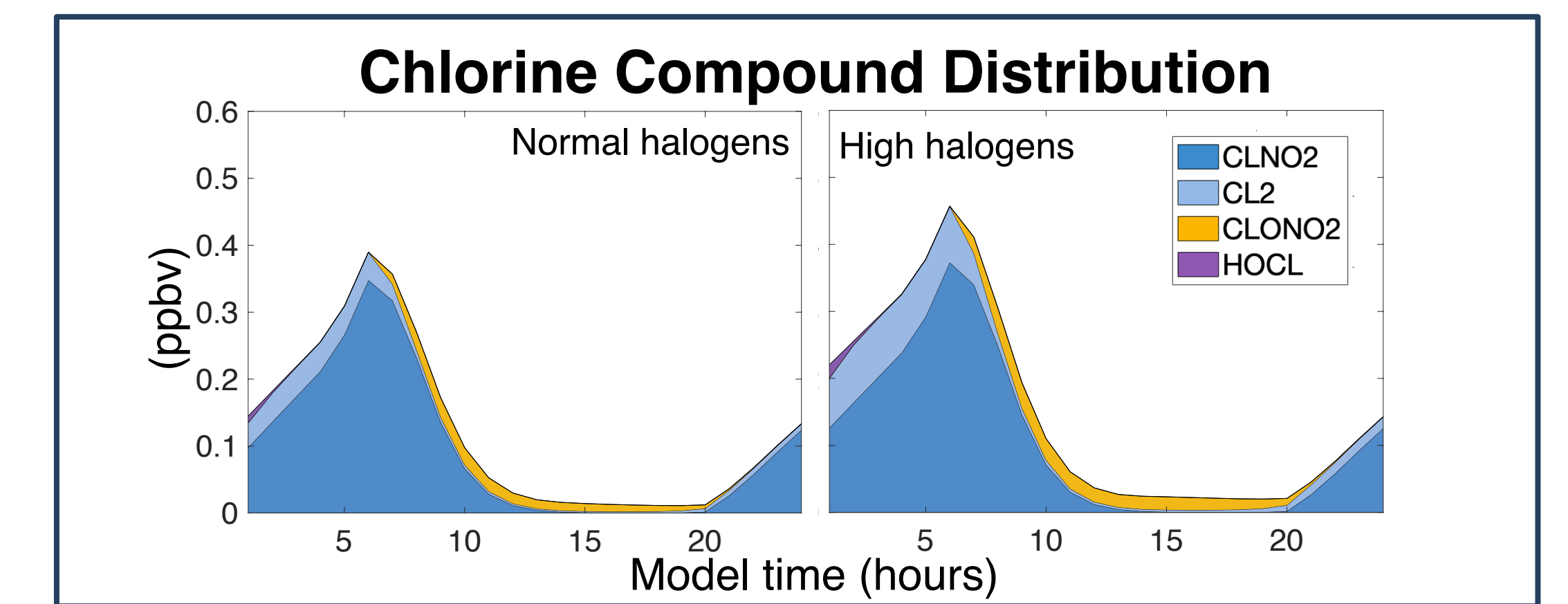
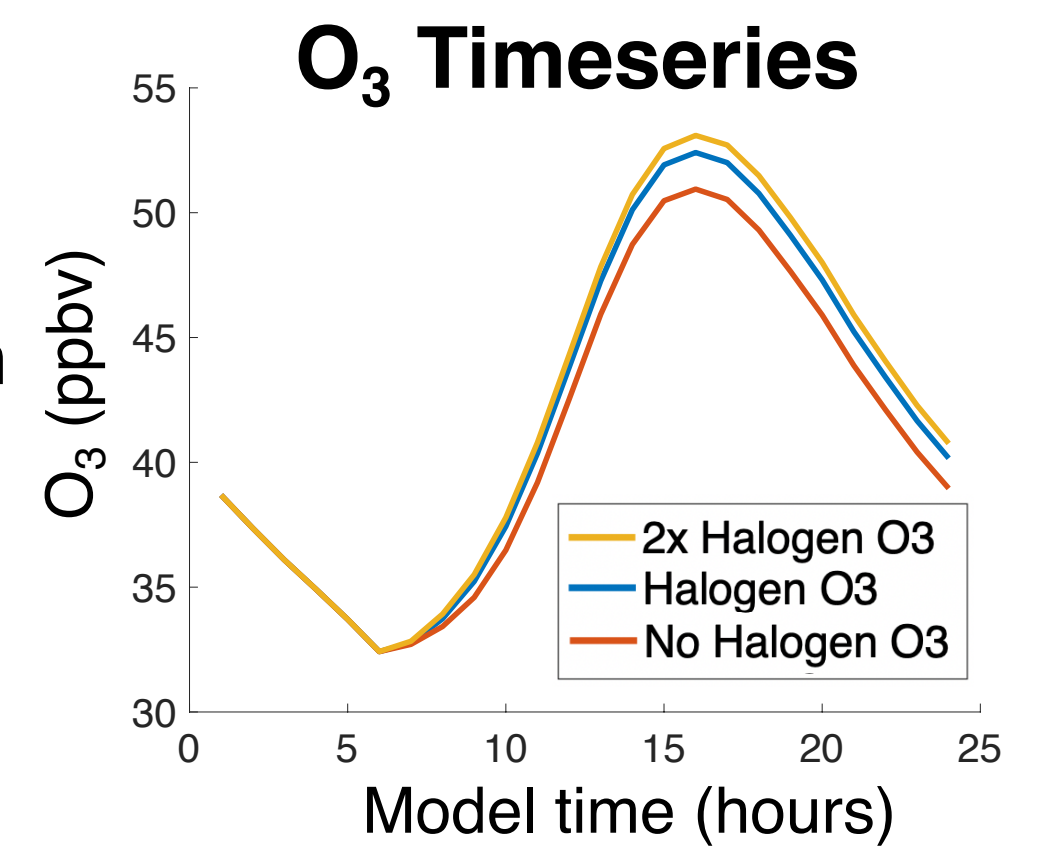
Halogens can cause a 2.5 ppbv or a 5% increase in O₃ concentrations in Salt Lake City

V. Sensitivity Analysis

Model runs near measured values

- VOCs at 0.5- and 2-times Salt Lake City values
- Runs with and without halogens, high halogen runs with 2-times Salt Lake City estimates

O₃ concentrations, oxidant concentrations, and halogen reaction distributions respond to changes in halogens and VOCs



IV. Future Work

Improve constraints on halogens and VOCs

- Our halogen concentrations are estimates, accurate concentrations and speciation of Salt Lake City halogens are not currently known
- Many VOCs are unmeasured, although we spin them up, more extensive measurements are needed to accurately represent VOC speciation

What is the role of halogens in the O_x cycle?

Inclusion of bromine and iodine chemistry

IV. Acknowledgements

This research was made possible by the University of Utah REALM REU, funded by the National Science Foundation award #1851943. Hawthorne Elementary data taken and provided by the Utah Department of Environmental Quality. Thank you to Randal Martin and Gerardo Carrillo-Cardenas for their help estimating Salt Lake City halogen and aerosol concentrations.

