

Tropospheric Emissions:  
Monitoring of Pollution



# Application of Synthetic TEMPO Products to Investigate Air Quality Impacts on Community-Level Public Health

Aaron Naeger, Michael Newchurch,  
Susan Alexander, Emily Berndt, and  
other NASA SPoRT Team members

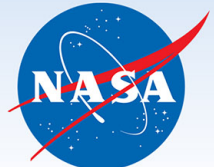
Jan 03, 2019

HAQAST5 meeting

Phoenix, AZ

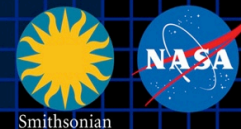


Smithsonian

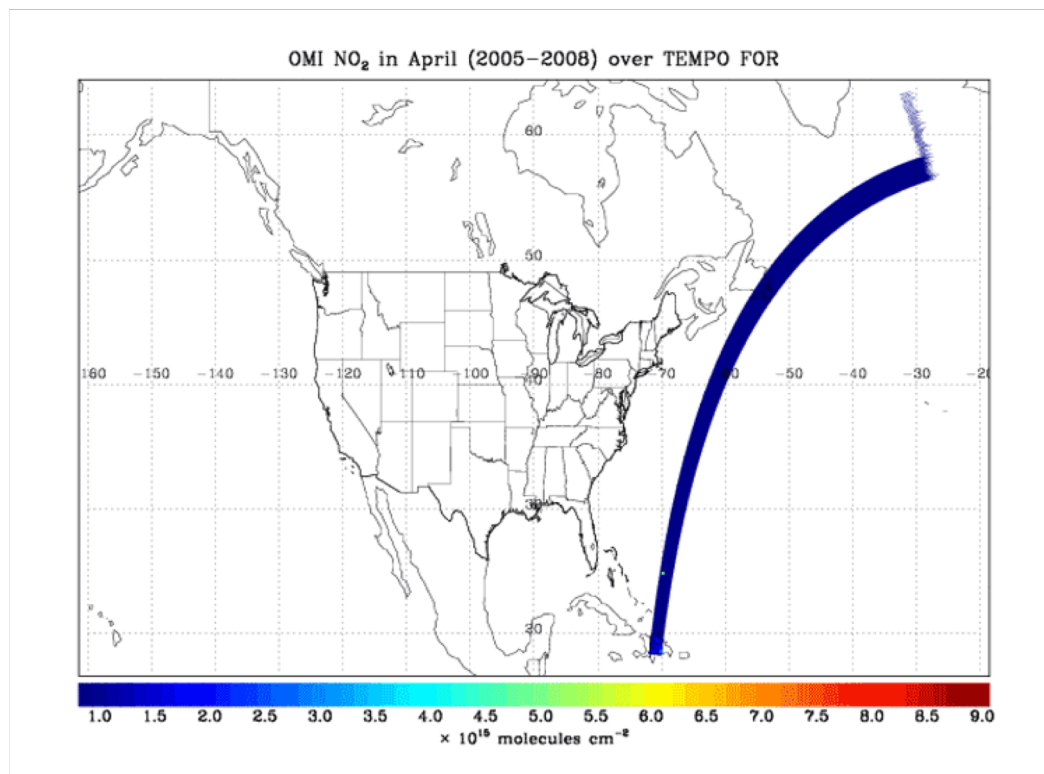




# TEMPO measurements



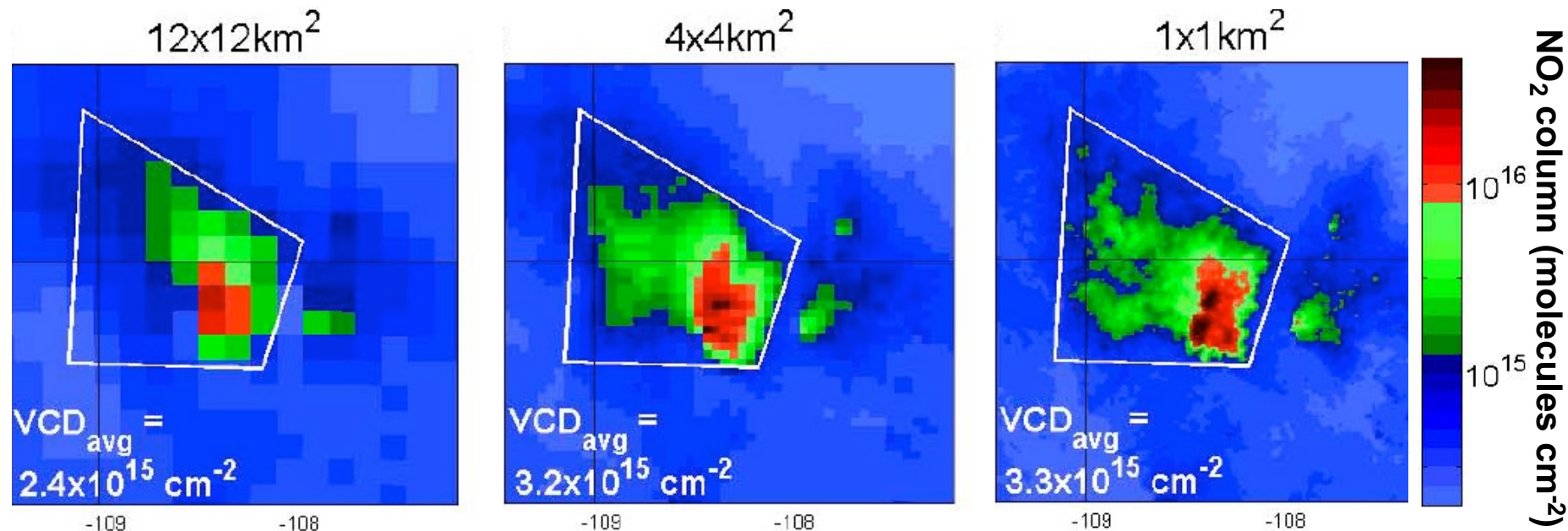
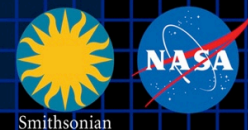
- Hourly daylight measurements from TEMPO will effectively monitor the air quality conditions over North America
- Monitoring will be accomplished at sub-urban scales due to spatial resolution of  $2.1 \times 4.7$  km
- Multi-spectral capabilities (ultraviolet & visible channels) will help distinguish between BL, free tropospheric, and stratospheric  $O_3$







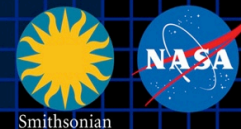
# OMI vs TEMPO resolution



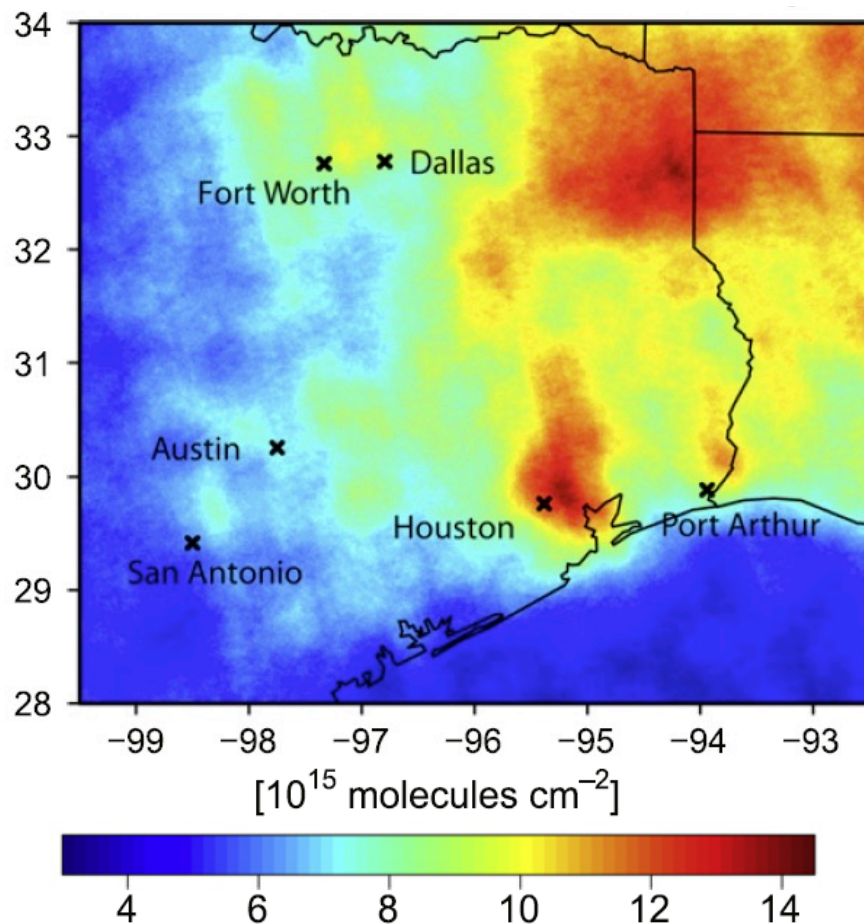
- Current spatial resolution of satellite sensors are too coarse for resolving emission source regions
- TEMPO's high spatial resolution will lead to a drastic improvement in monitoring emission source regions



# OMI vs TEMPO resolution



## OMI $\text{H}_2\text{CO}$ columns oversampled to $0.02^\circ$ resolution

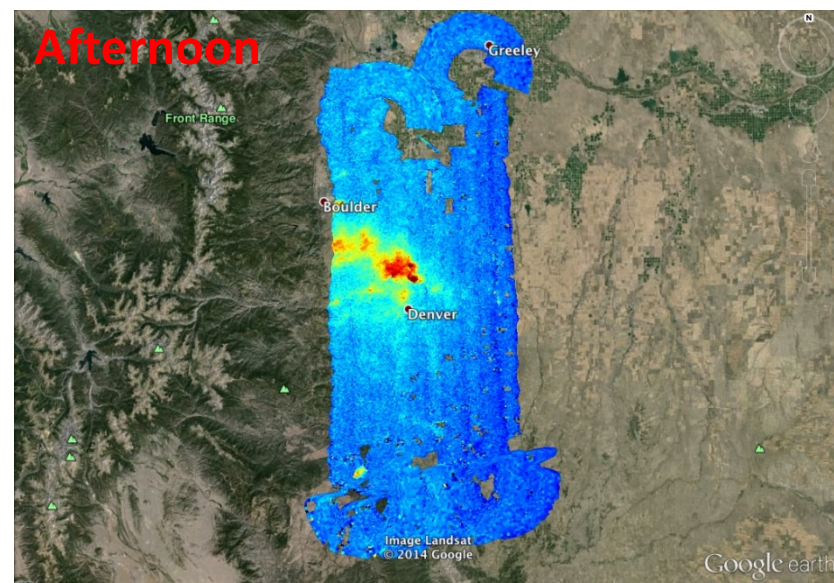
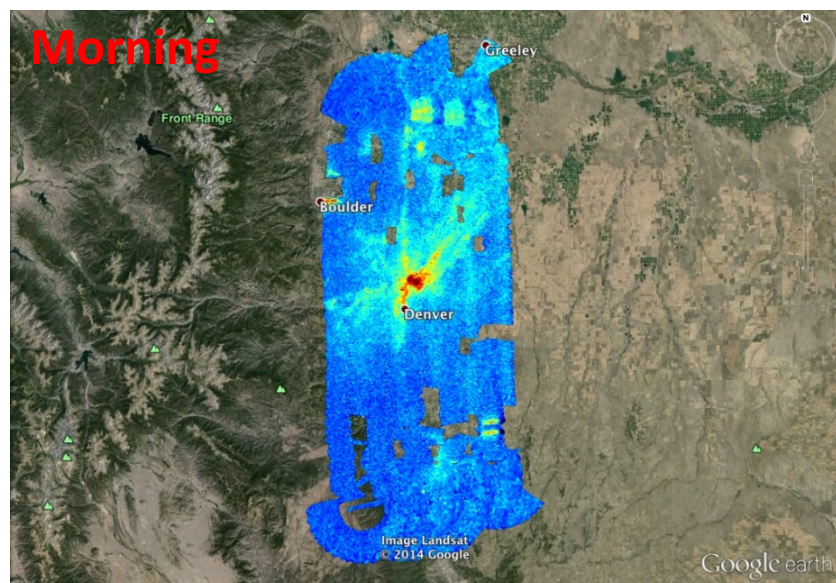
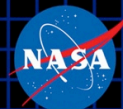


- TEMPO's high spatial resolution will allow it to resolve emission sources, including urban areas
- TEMPO will provide constraints on inventory emission magnitudes, spatial allocation, and possibly even sector partitioning





# TEMPO Aircraft-simulator data

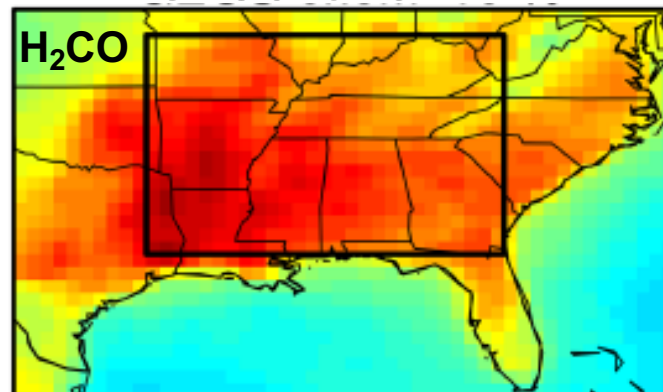


GeoTASO data (Credit: Caroline Nowlan, SAO)

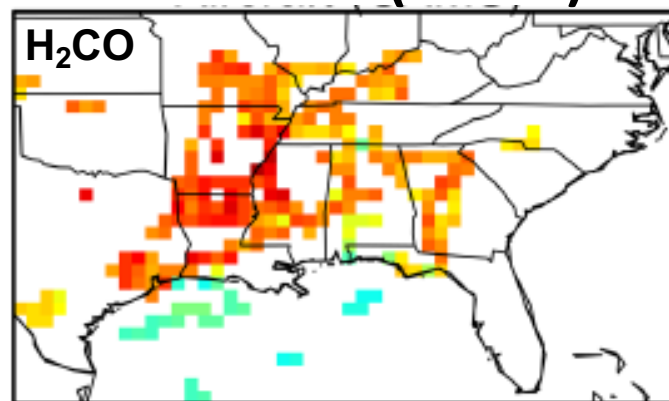
- Quality of TEMPO data will be similar to GeoTASO, albeit with lower spatial resolution than the  $250 \times 250 \text{ m}^2$  pixel size of GeoTASO
- $\text{NO}_2$  slant columns from TEMPO data will be able to monitor the rapidly varying emissions from source regions across North America

- Synthetic TEMPO observations generated using simulated gaseous and aerosol composition from GEOS-NR
- GEOS-NR spatial resolution of  $\sim 12 \times 12 \text{ km}^2$  spatiotemporally interpolated to finer TEMPO grid
- Profiles and vertical column amounts of species obtained from interpolation

## GEOS-Chem



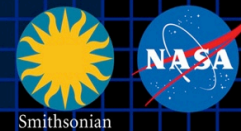
## Aircraft (CAMS)



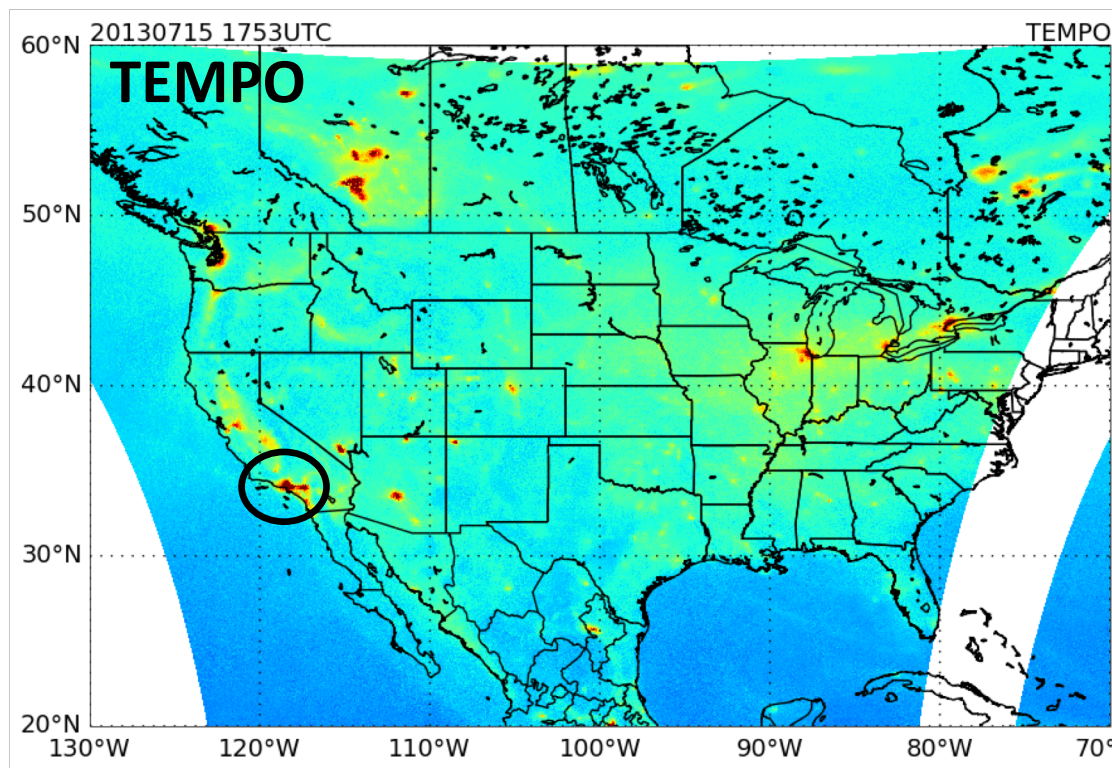




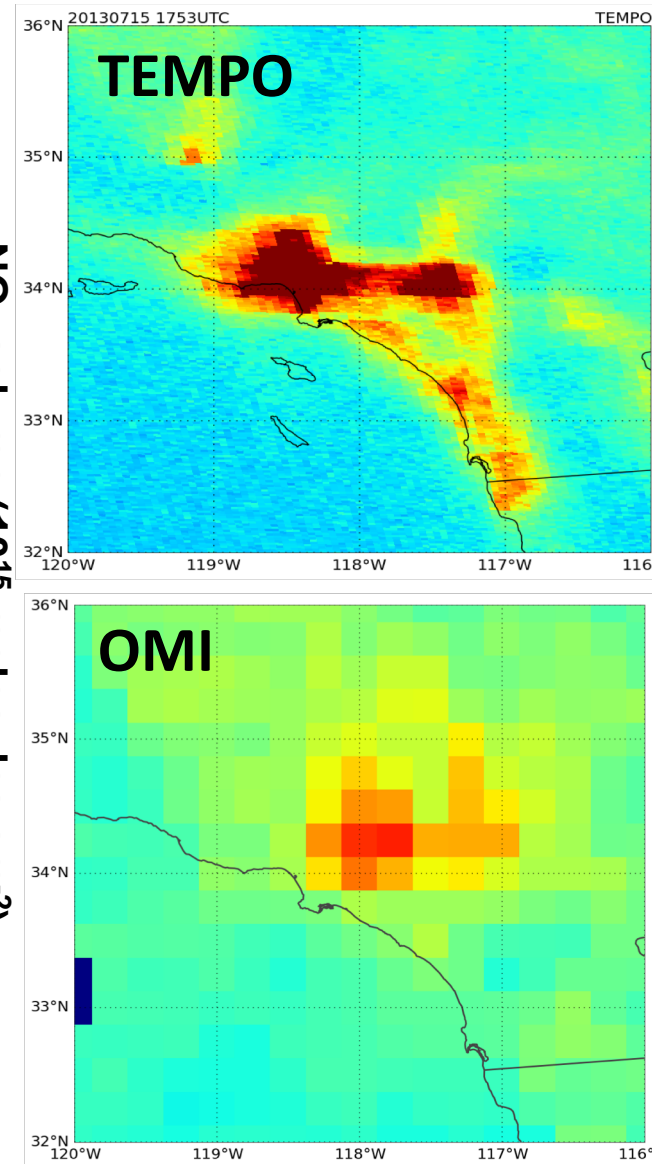
# TEMPO synthetic observations



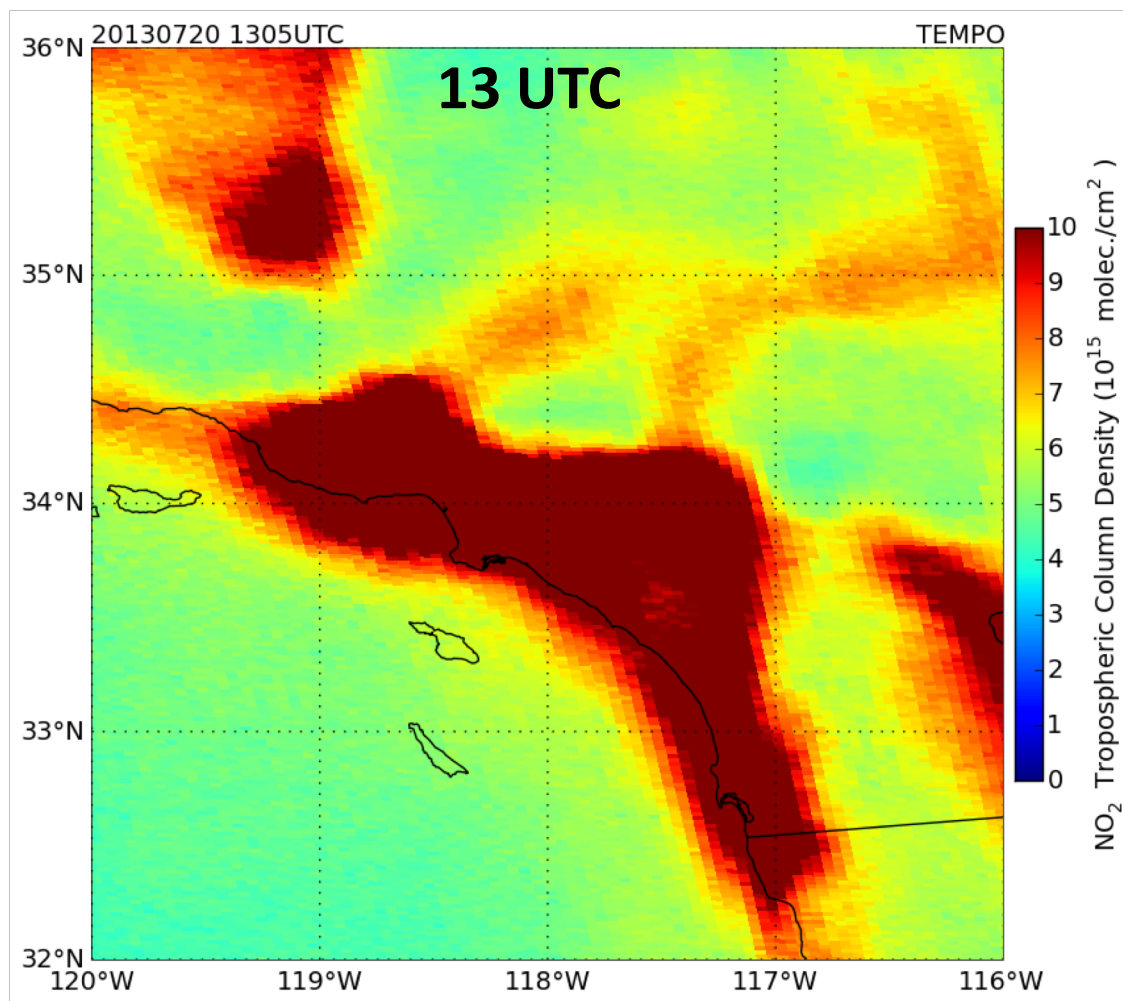
NO<sub>2</sub> columns modeled at approximate TEMPO resolution



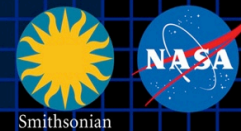
NO<sub>2</sub> column ( $10^{15}$  molecules  $\text{cm}^{-2}$ )



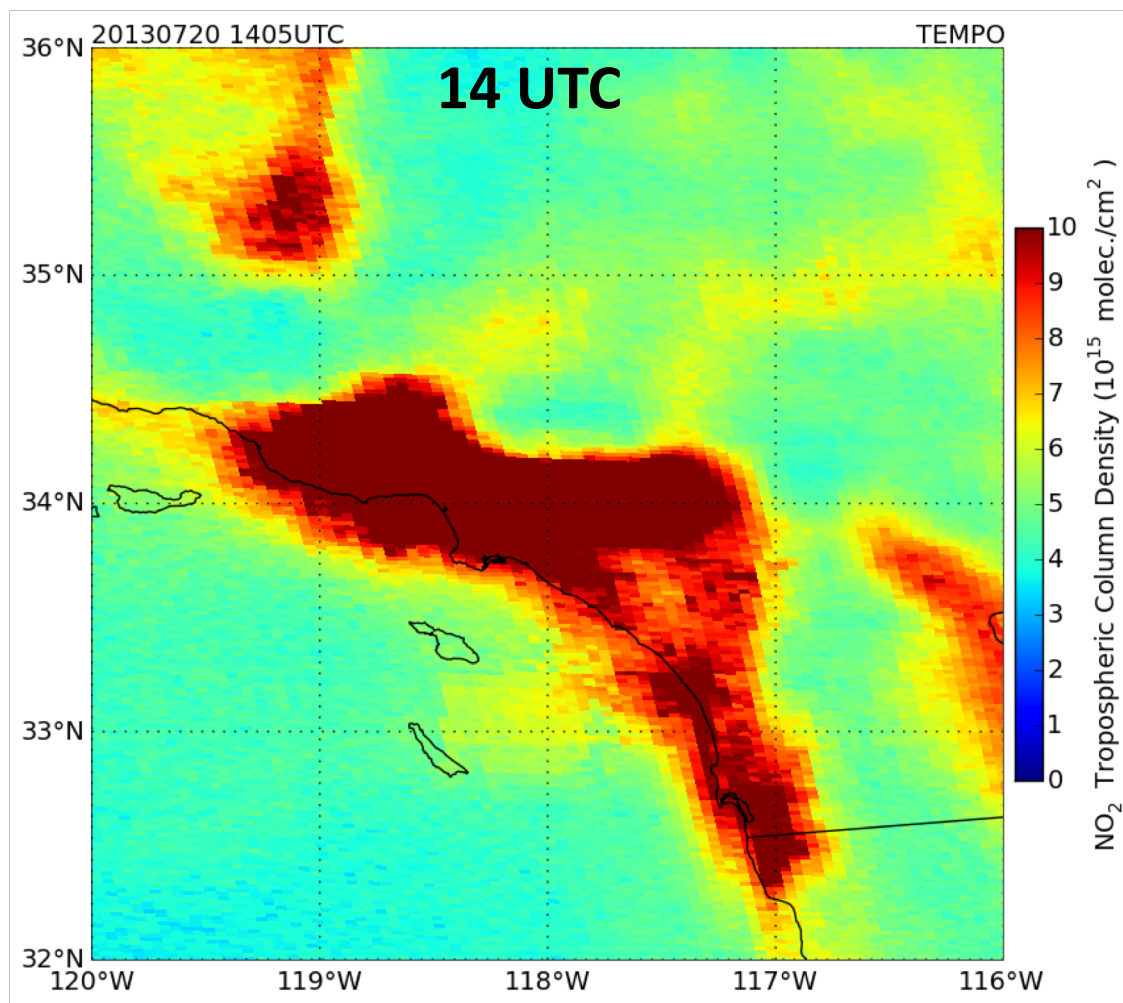
## NO<sub>2</sub> columns throughout the diurnal cycle

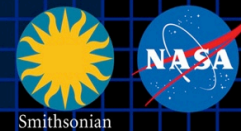




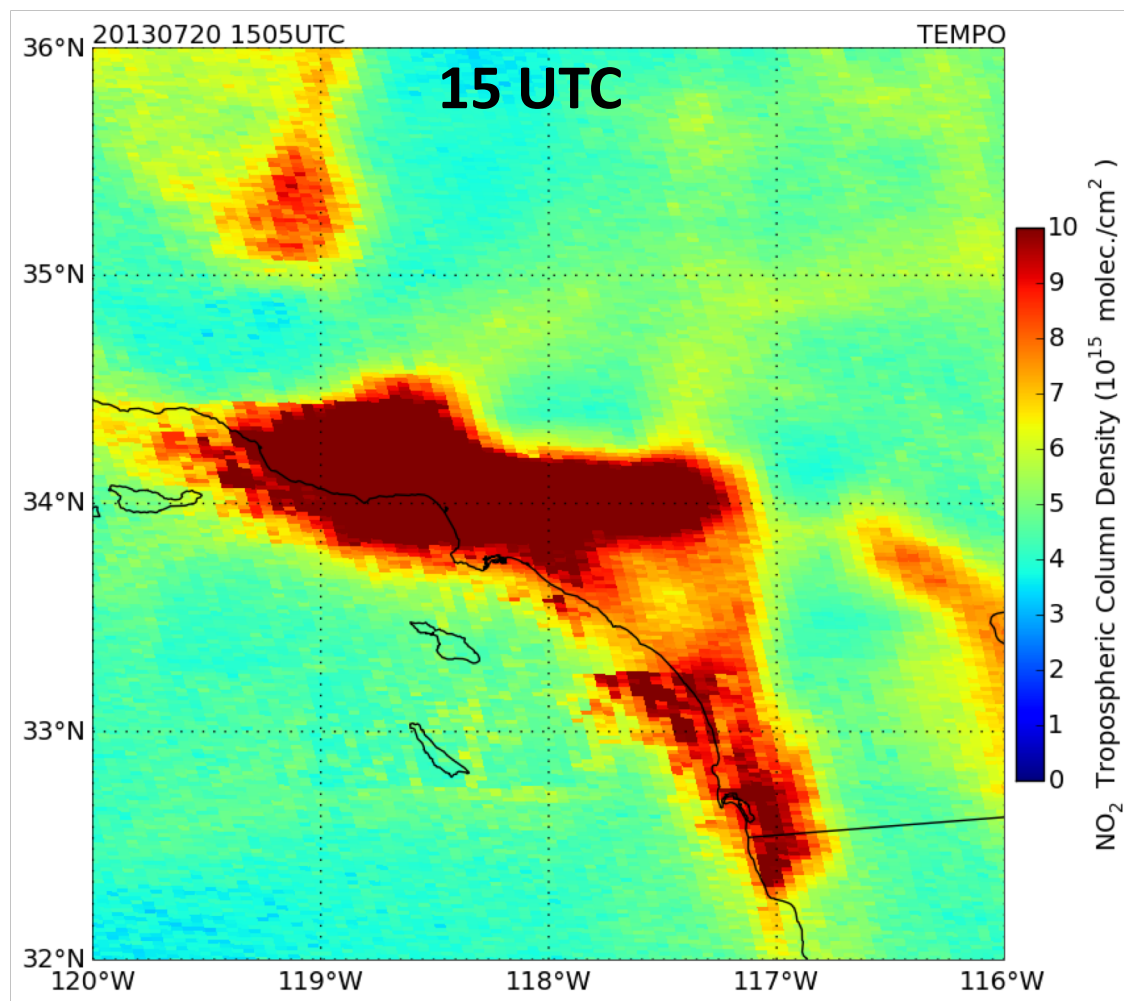


## NO<sub>2</sub> columns throughout the diurnal cycle

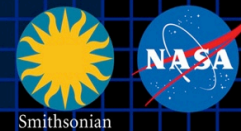




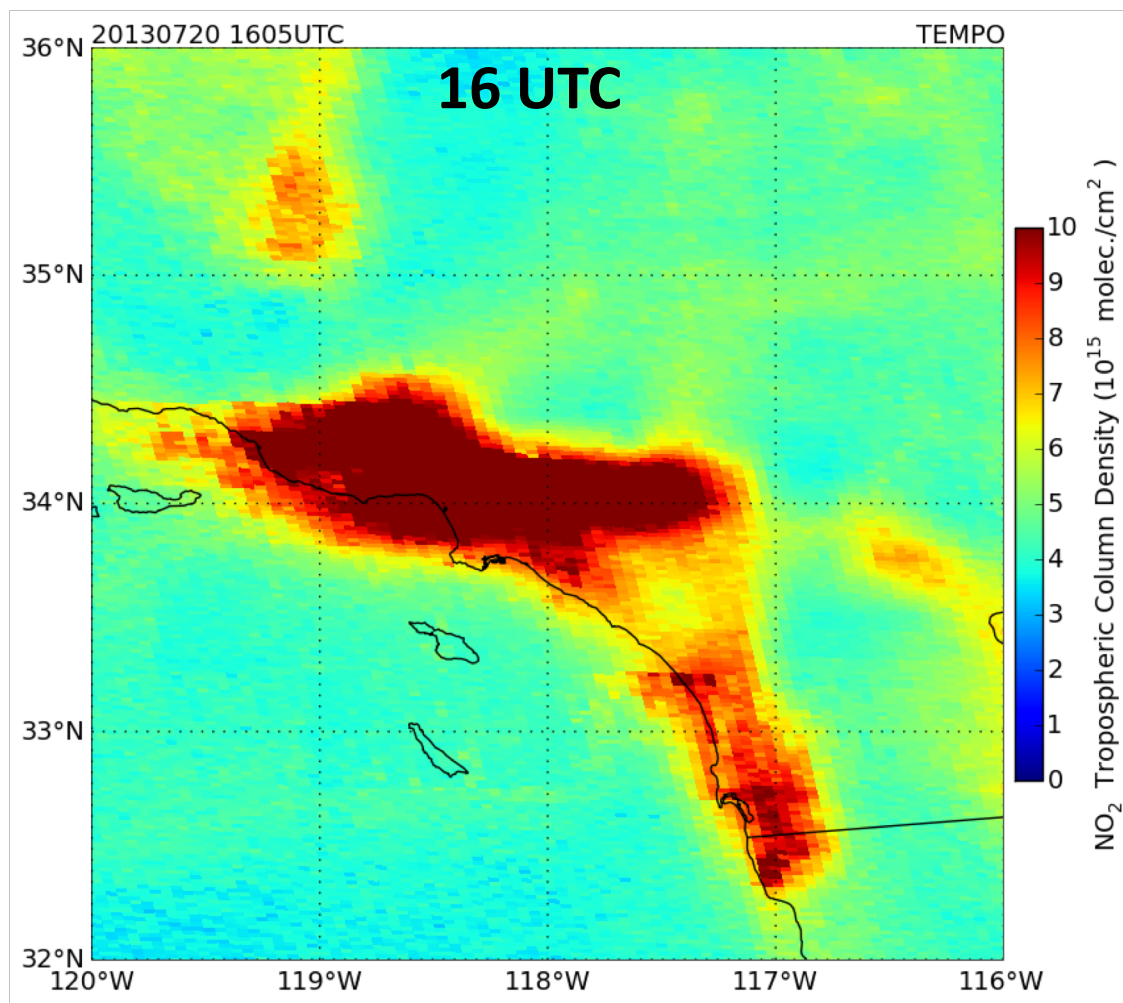
## NO<sub>2</sub> columns throughout the diurnal cycle

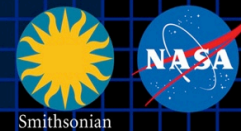




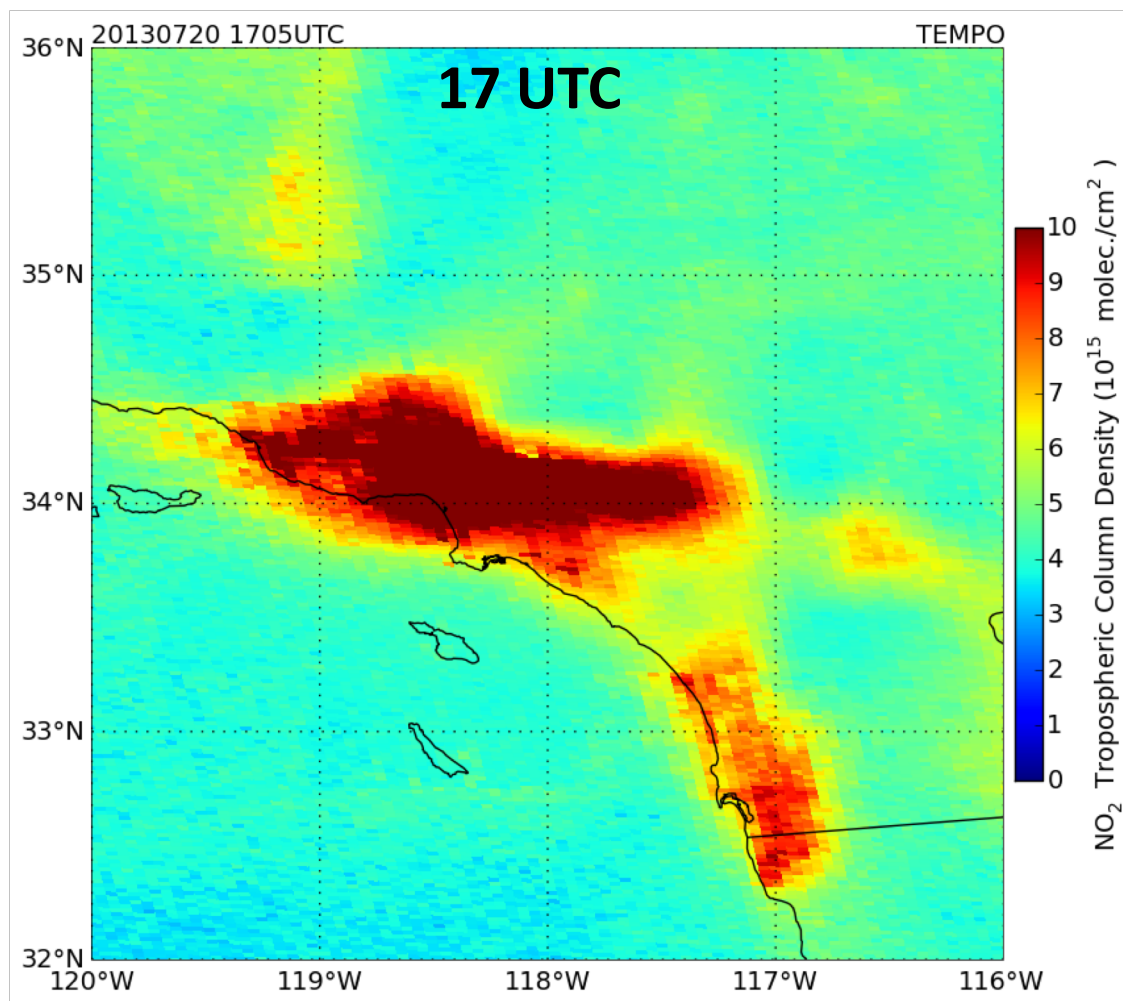


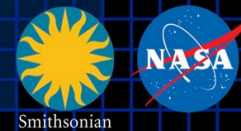
## NO<sub>2</sub> columns throughout the diurnal cycle



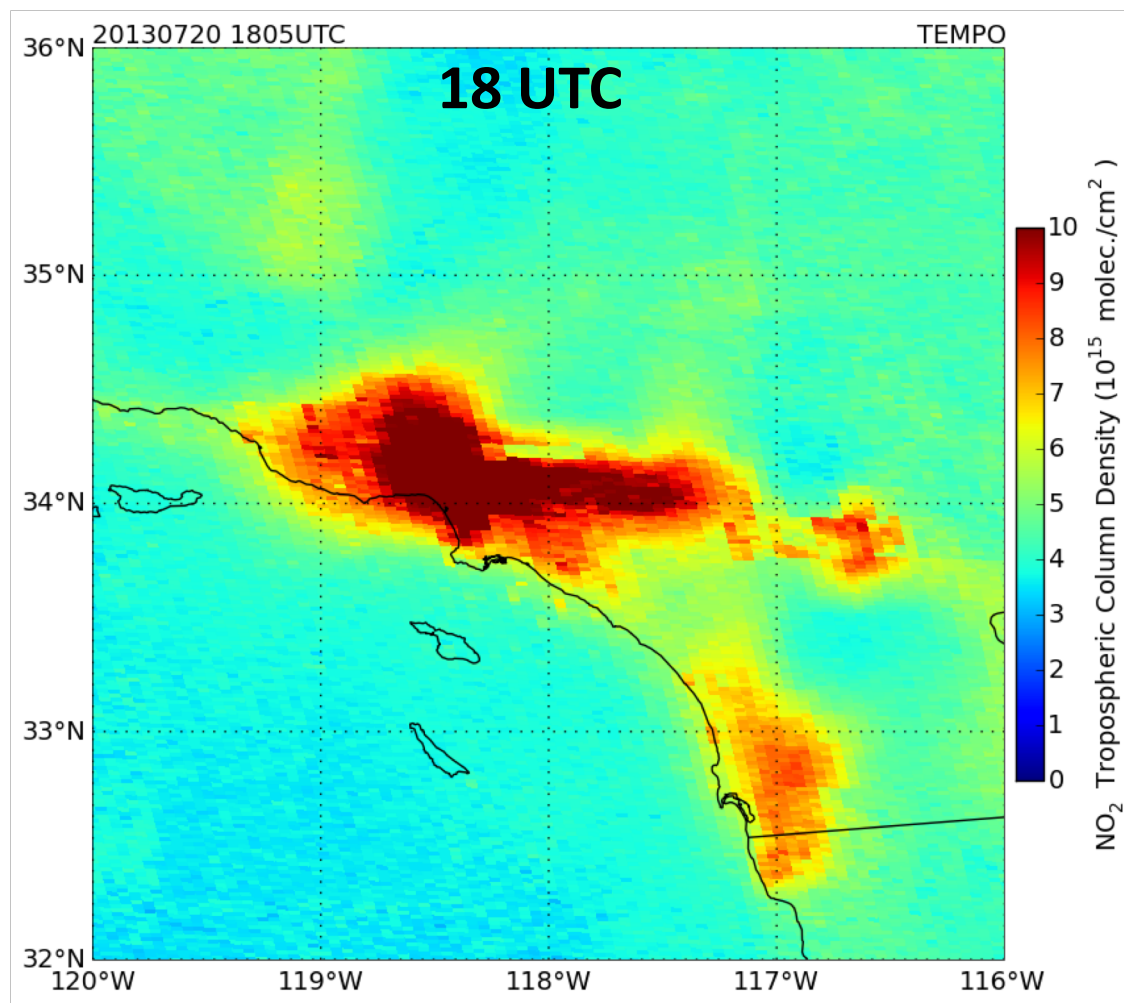


## NO<sub>2</sub> columns throughout the diurnal cycle

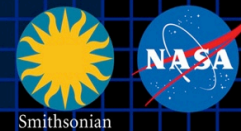




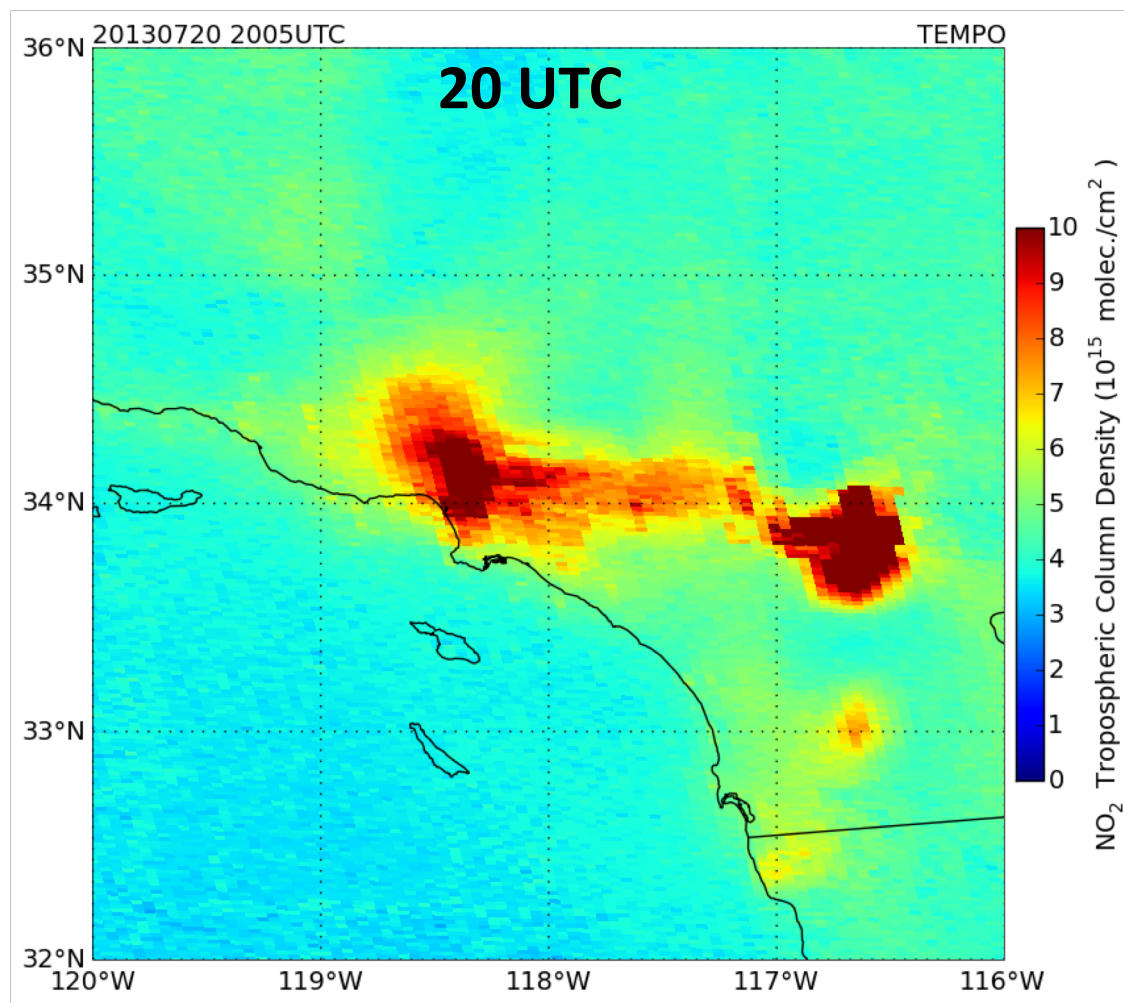
## NO<sub>2</sub> columns throughout the diurnal cycle



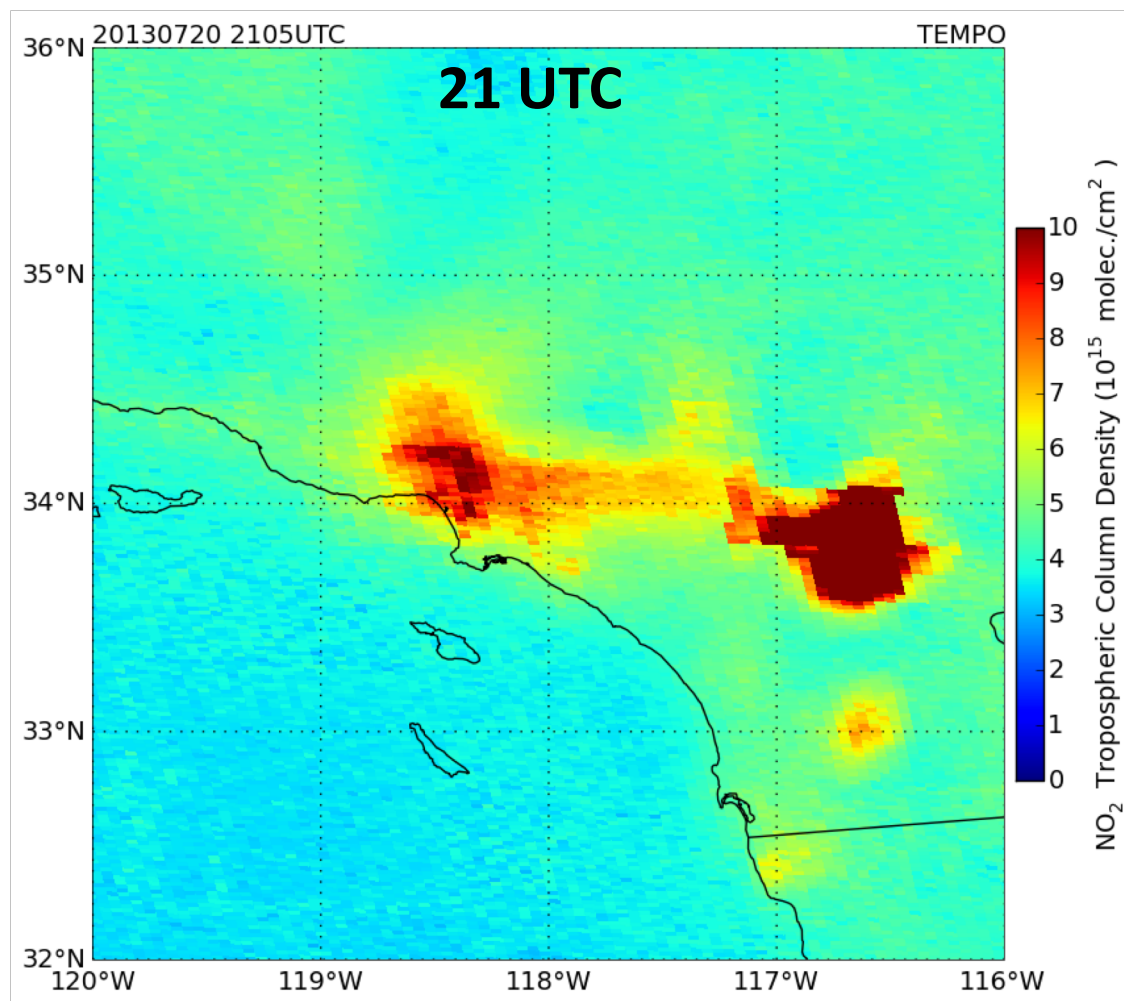




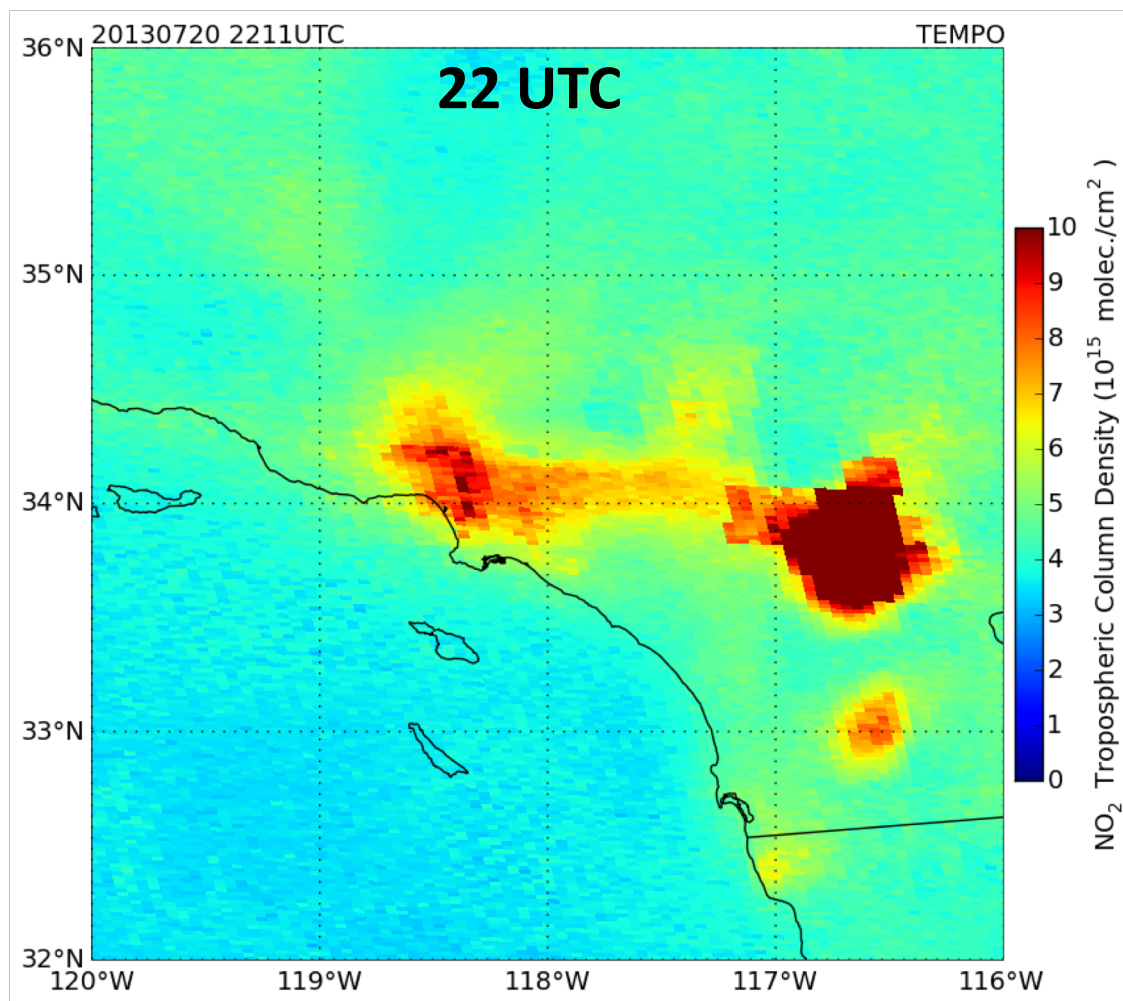
## NO<sub>2</sub> columns throughout the diurnal cycle



## NO<sub>2</sub> columns throughout the diurnal cycle

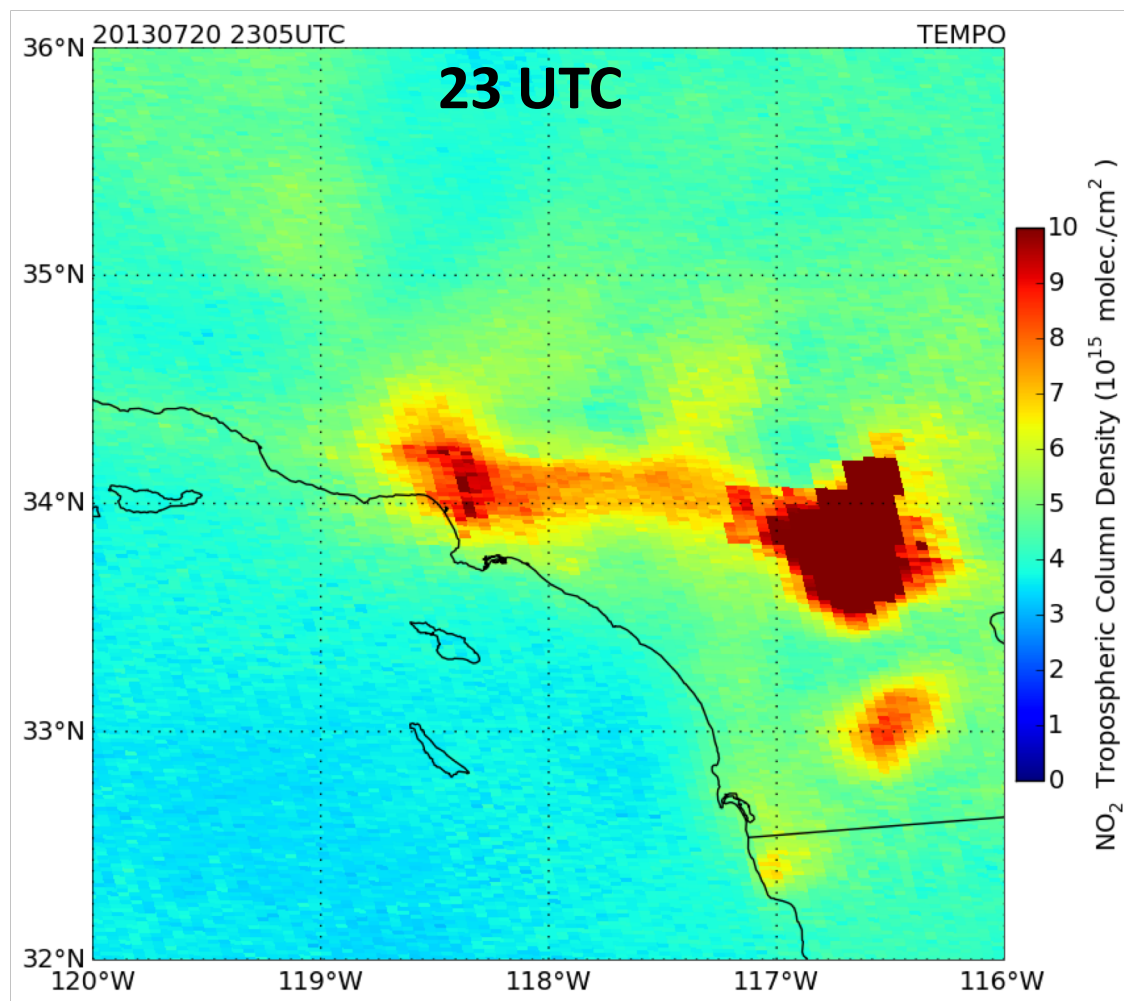


## NO<sub>2</sub> columns throughout the diurnal cycle



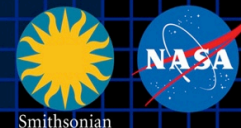


## NO<sub>2</sub> columns throughout the diurnal cycle





# Public Health Project

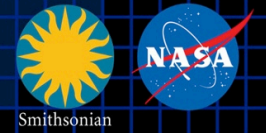


- Utilize TEMPO synthetic data from a “dirty” and “clean” month for assessing the impact of AQ on health and hospital readmissions over northern Alabama.
- Regrid fine-scale TEMPO data onto a zip code level map for a direct comparison to the hospital data.
- Perform a statistical analysis between the hospital data and hourly  $\text{NO}_2$ ,  $\text{O}_3$ ,  $\text{CH}_2\text{O}$ , and AOD from TEMPO to understand significant relationships between the satellite and health data.
- Assess current operational satellite AQ data (OMI, OMPS, GOES-16, MODIS) to fully realize the benefits for using TEMPO data for health studies.

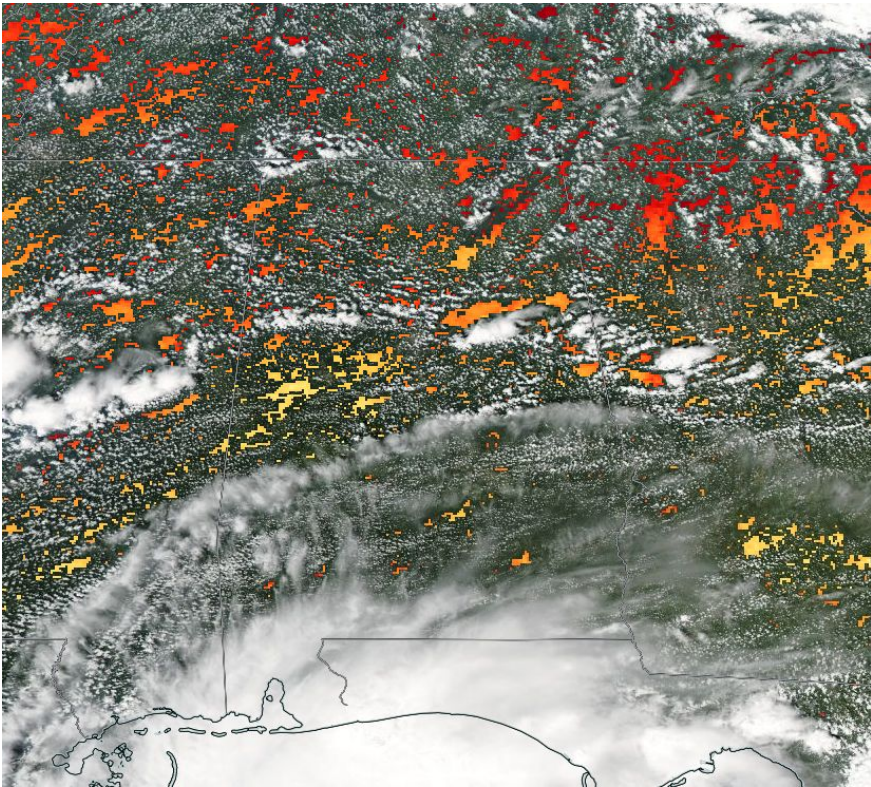




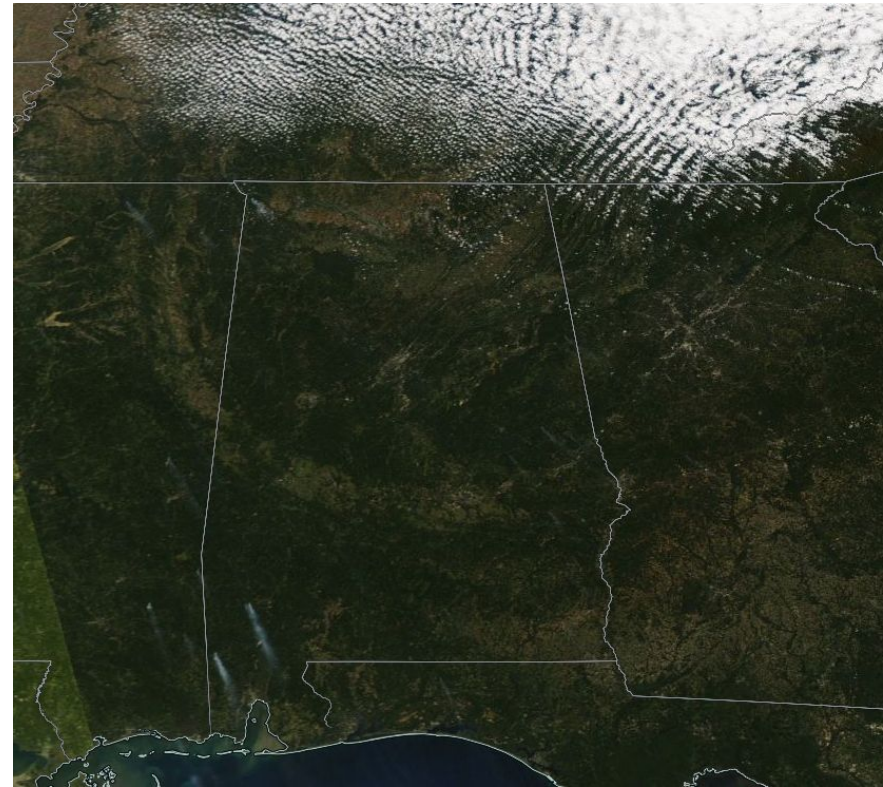
# Public Health Project



## Smoke transport over North Alabama in Aug 2013



## Clean conditions over North Alabama in Oct 2013

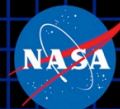


**NASA Worldview**





# Short-term Prediction Research and Transition (SPoRT)



- Over the past 15 years, SPoRT has successfully transitioned unique observations from more than 40 satellite datasets to operational end users
- Established research-to-operations/operations-to-research paradigm that engages in solving specific forecast problems
- SPoRT plans to use this successful approach to prepare the user community for TEMPO data
- Plan to host a TEMPO Early Adopters site

