

# Air Quality Modeling Using the NASA GEOS-5 Multispecies Data Assimilation System

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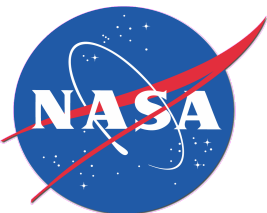
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<sup>1</sup>NASA Global Modeling and Assimilation Office (GMAO)

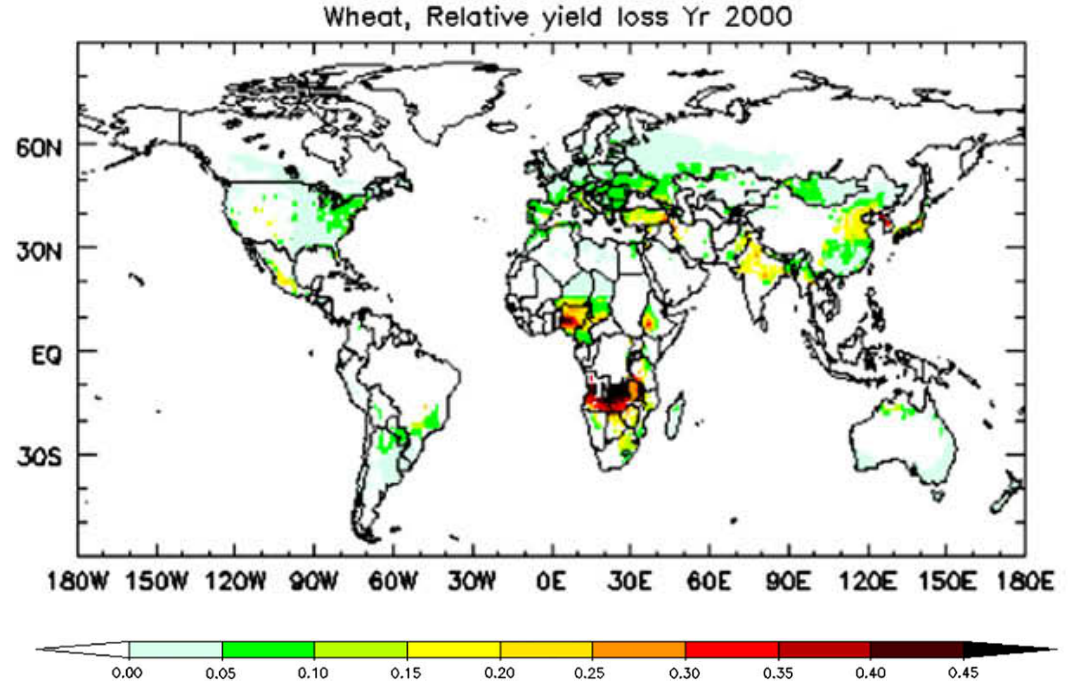
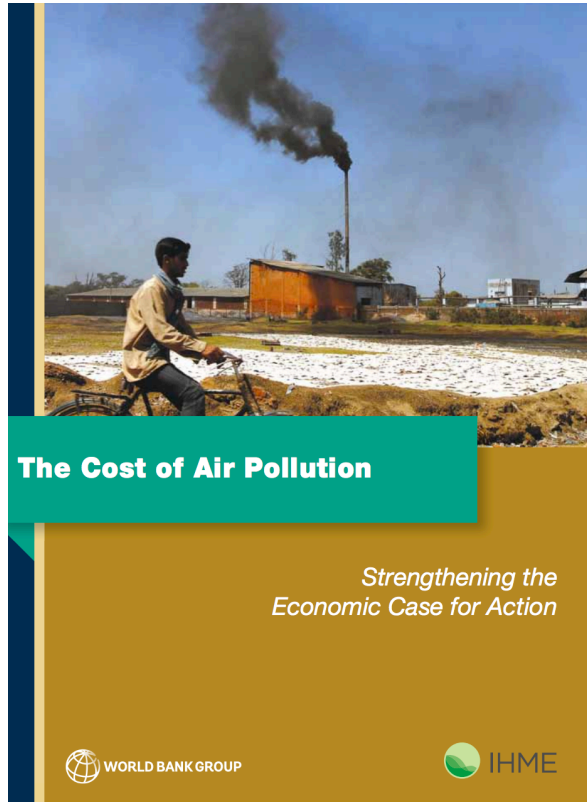
<sup>2</sup>Universities Space Research Association (USRA)



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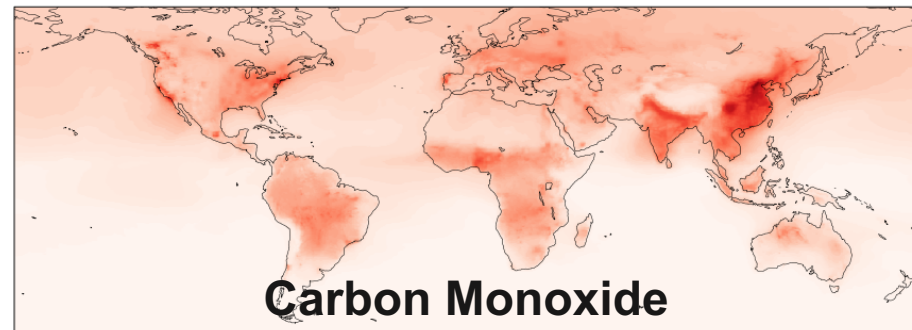
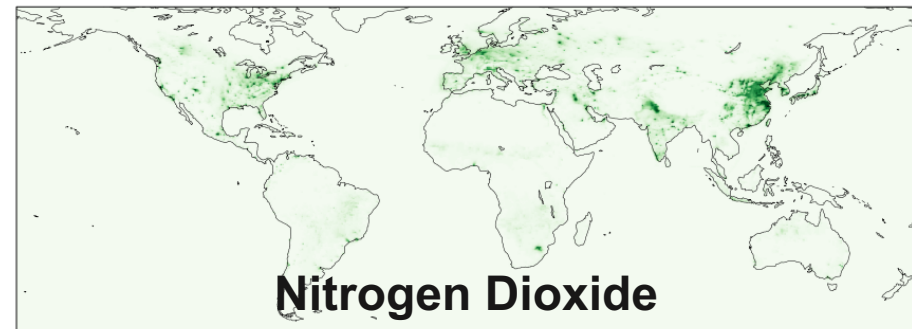
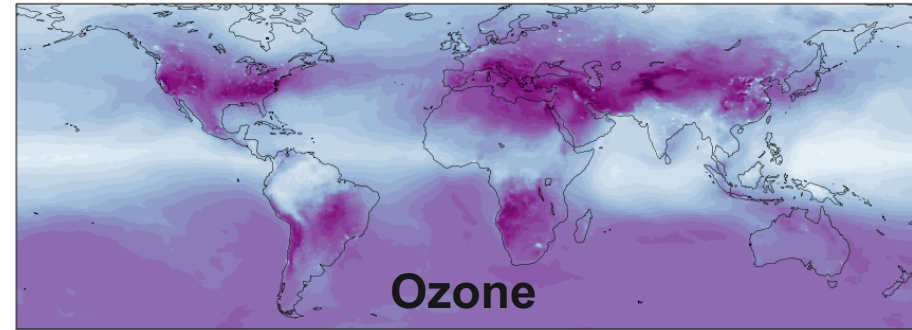
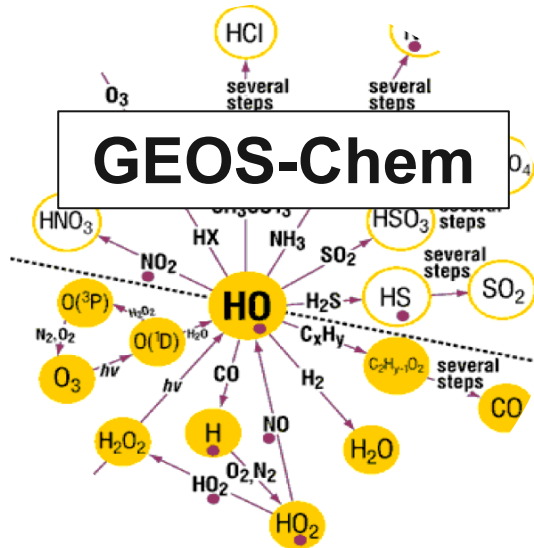
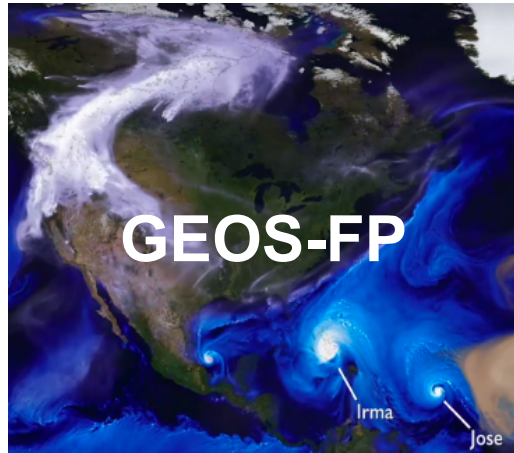
# Air quality is a global problem



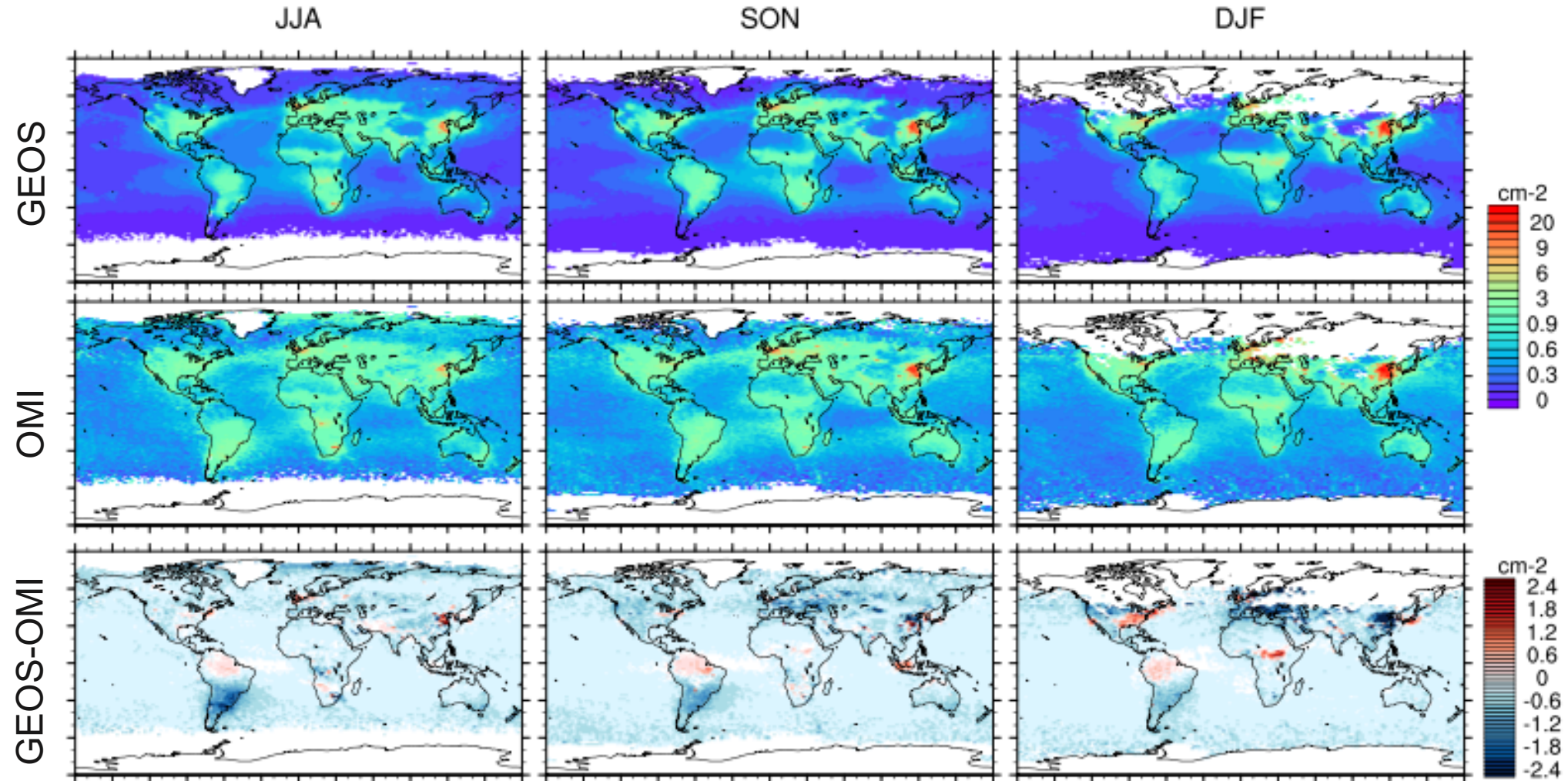
World Bank: ~\$5 trillion in welfare losses in 2013

Up to 50% of crop yield can be lost to ozone pollution (e.g. VanDingenen, 2009)

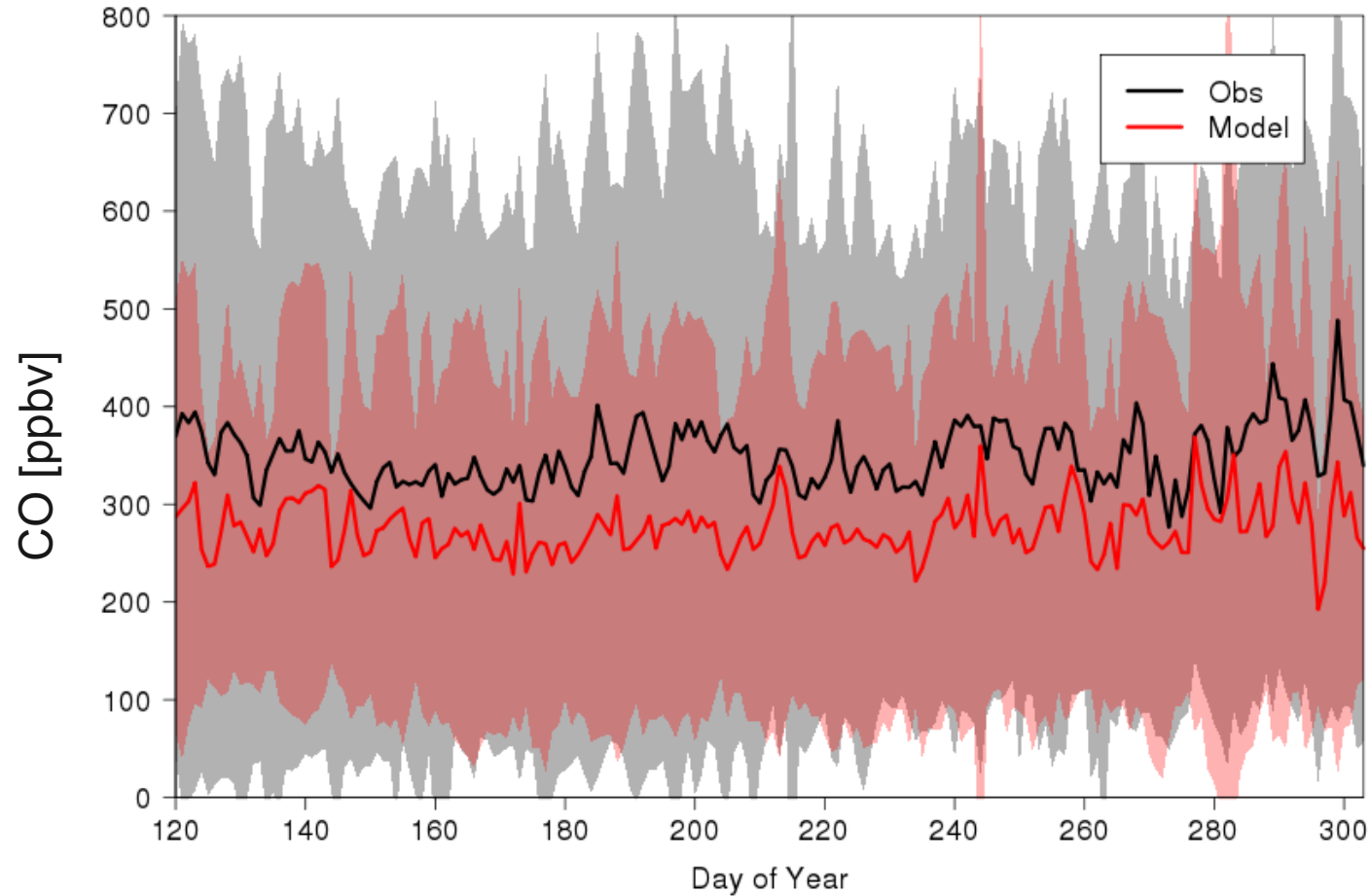
# GEOS-CF model produces near real-time air quality forecasts



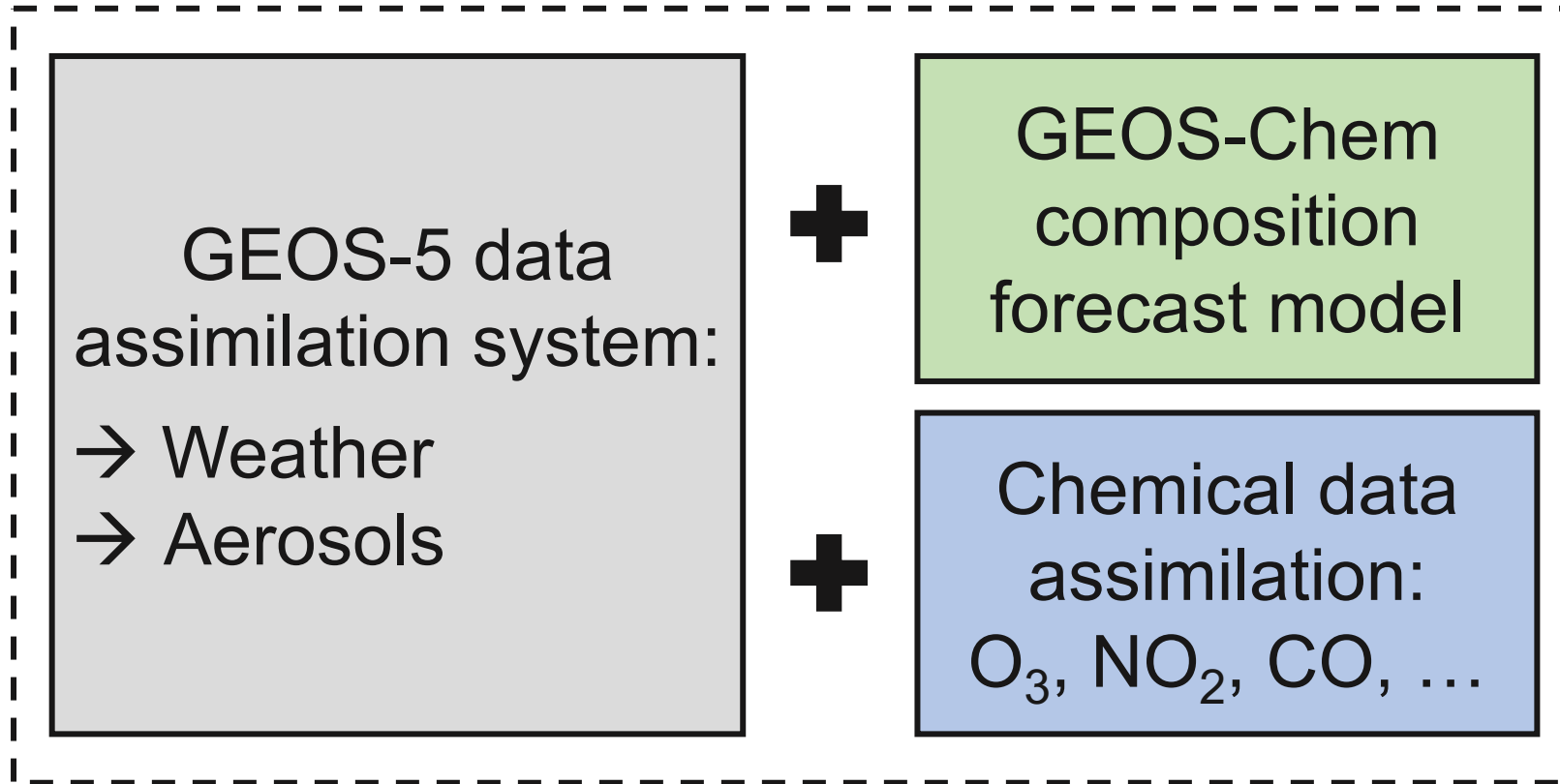
# Model has low bias compared to OMI NO<sub>2</sub> observations



# Also low bias in (surface) carbon monoxide CO



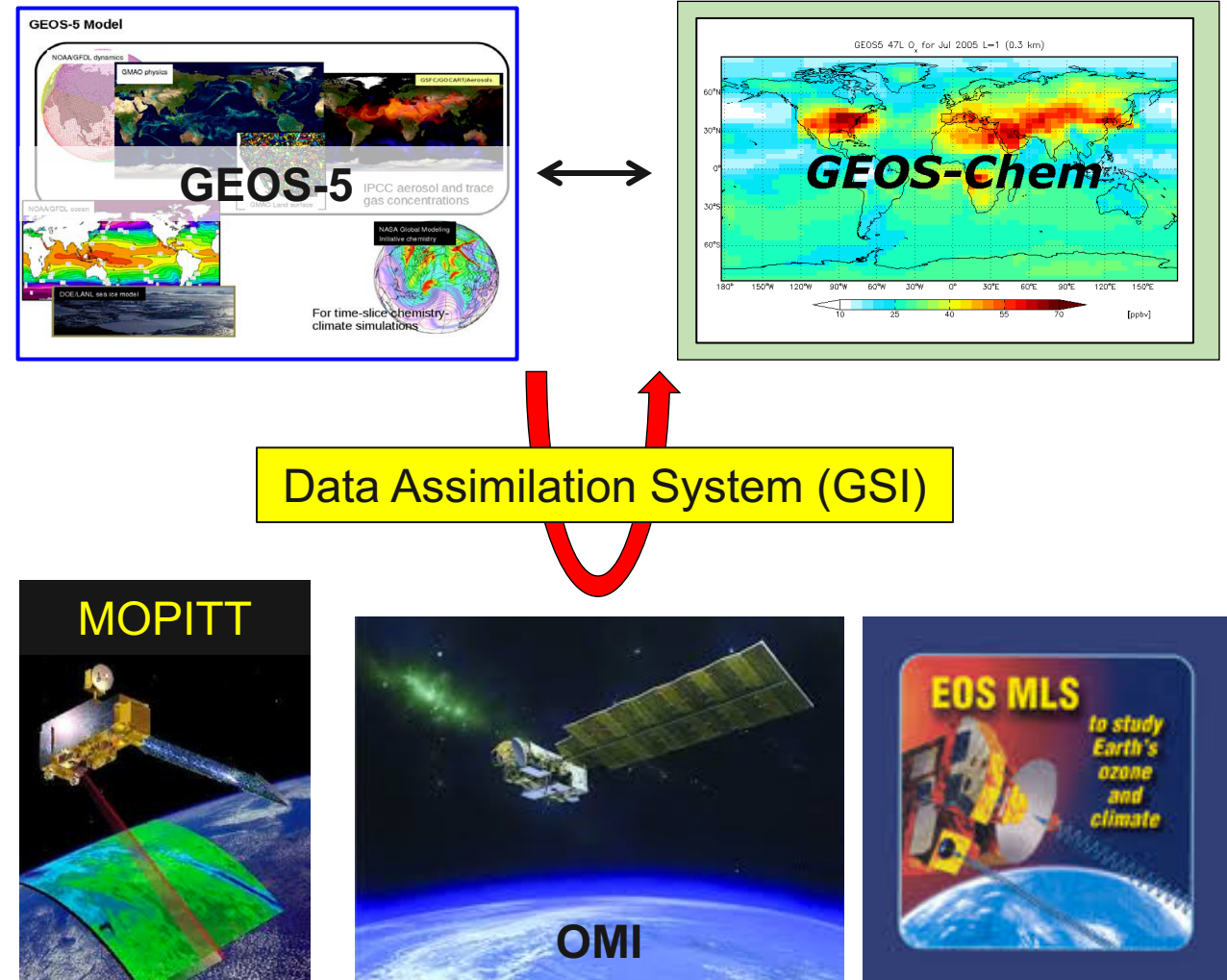
# Toward an air quality modeling system in the NASA GEOS model



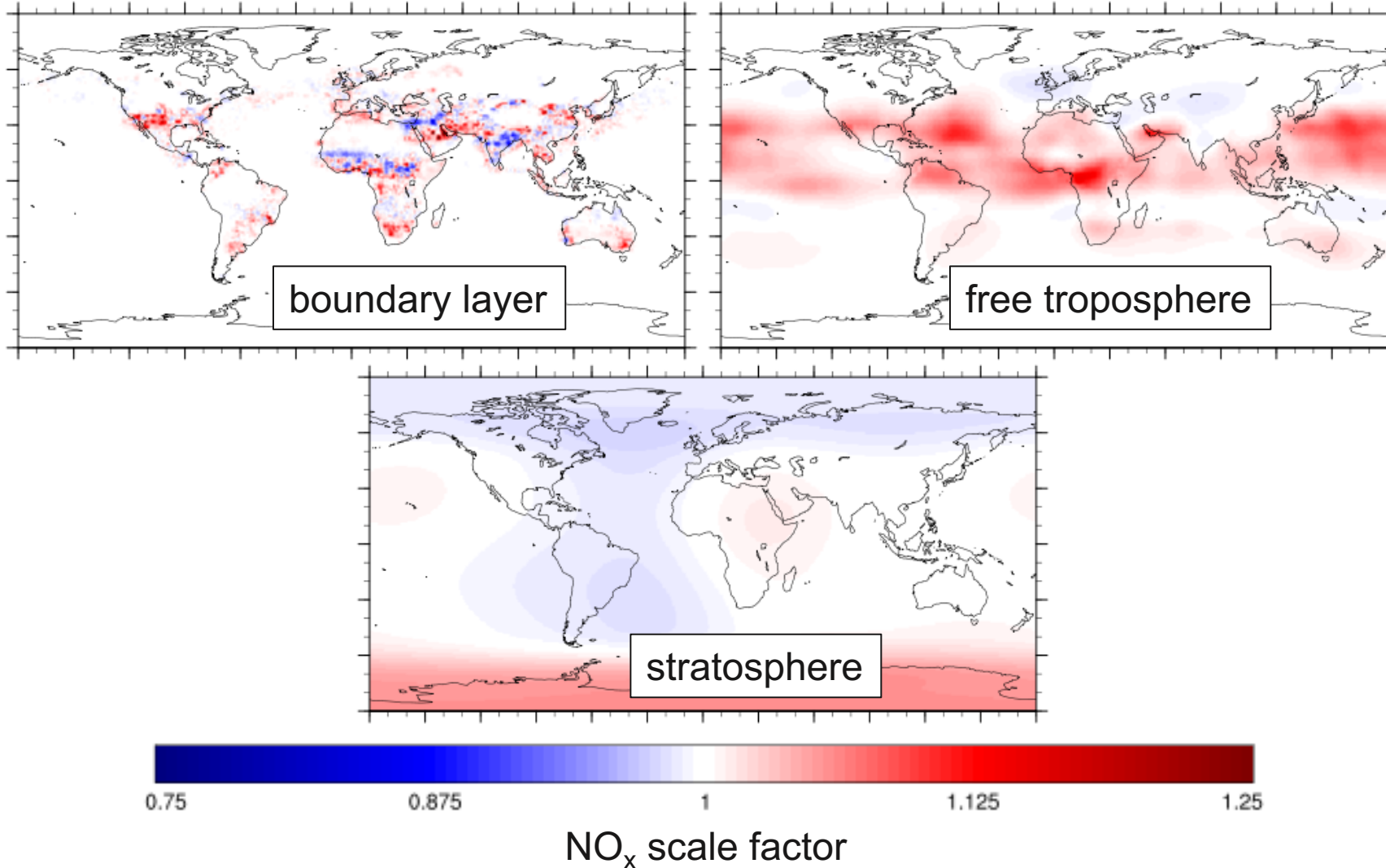
Air Quality Modeling System

# The GEOS chemical data assimilation system

- Based upon GEOS-ADAS (GSI)
- Joint assimilation of  $\text{NO}_2$ ,  $\text{CO}$ ,  $\text{O}_3$
- Weakly coupled (no covariances)
- 6-hour assimilation window

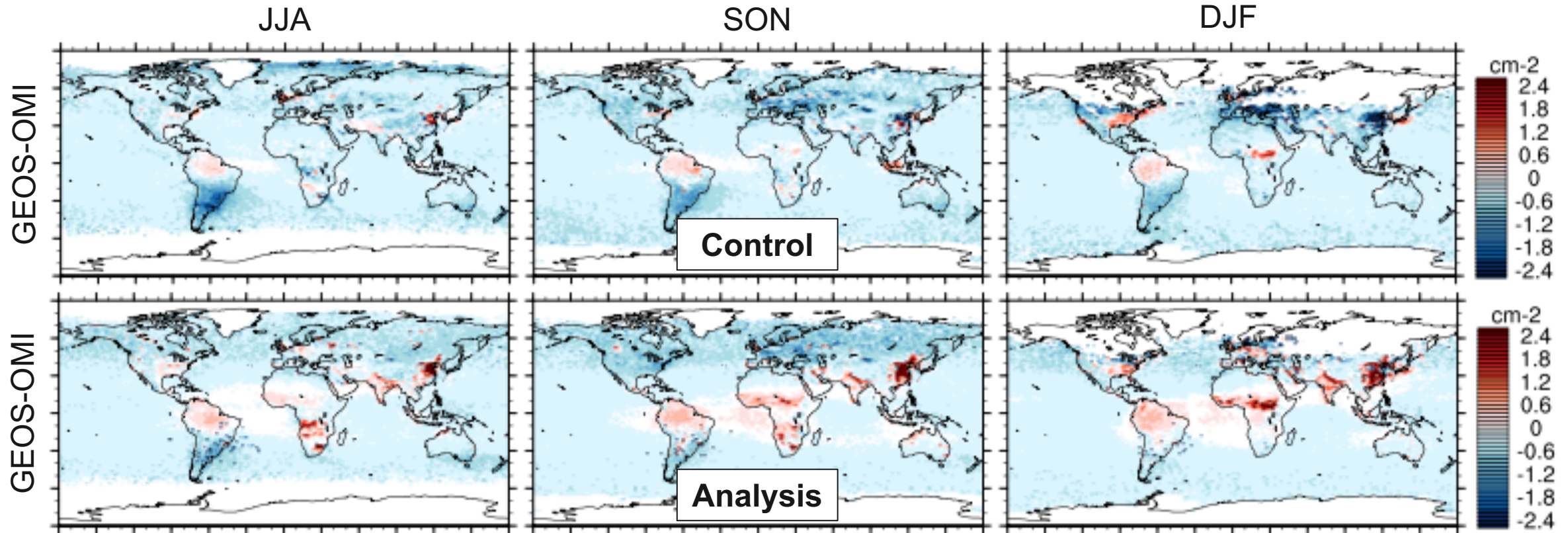


# Assimilate independent $\text{NO}_x$ scale factors for three layers





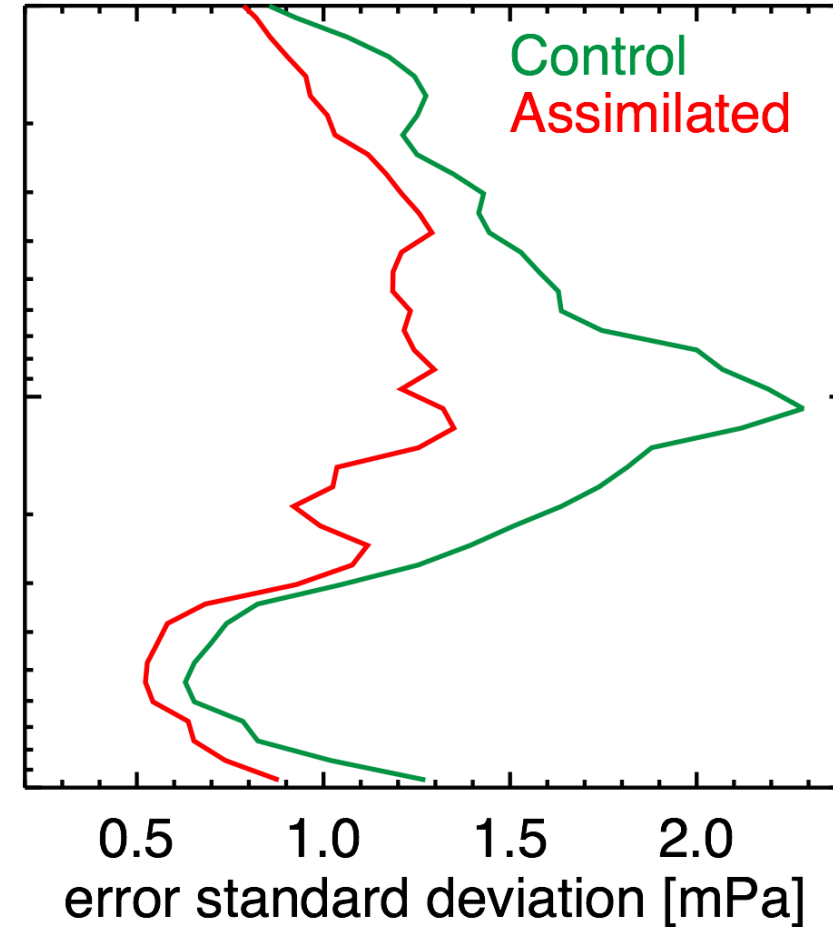
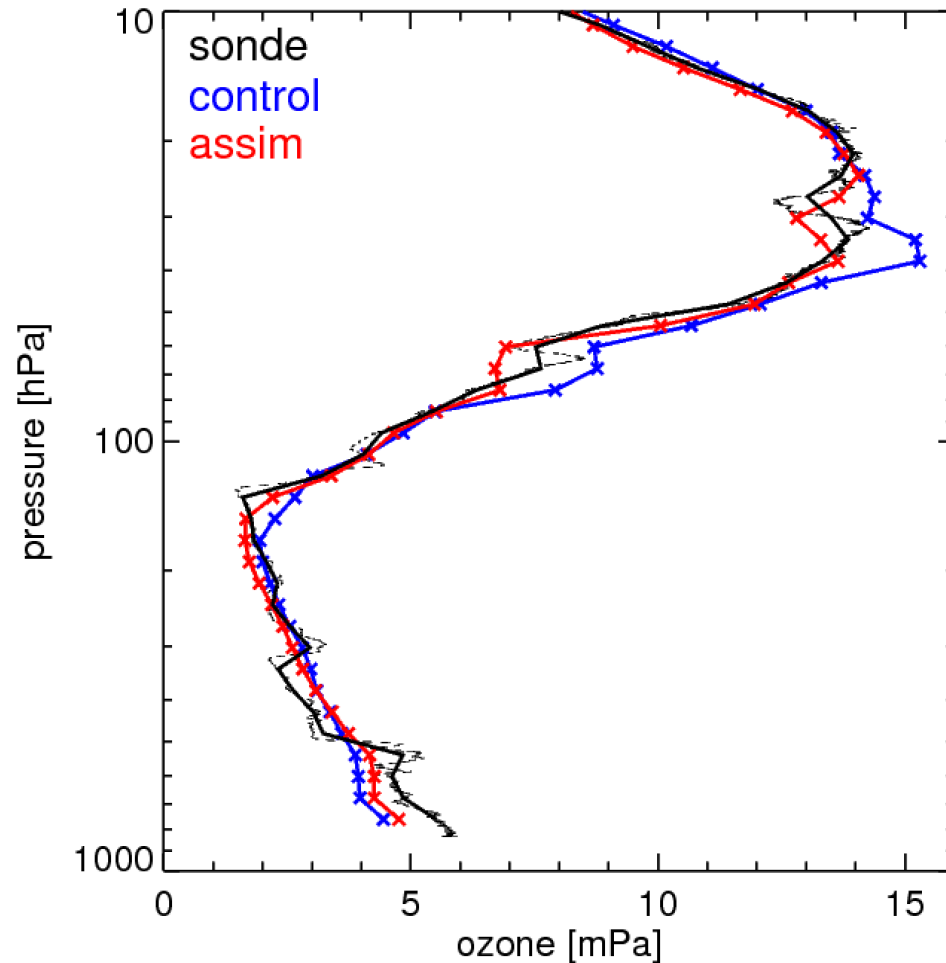
# NO<sub>2</sub> assimilation reduces model-observation mismatch



➤ Are we now overestimating NO<sub>2</sub> over polluted regions?

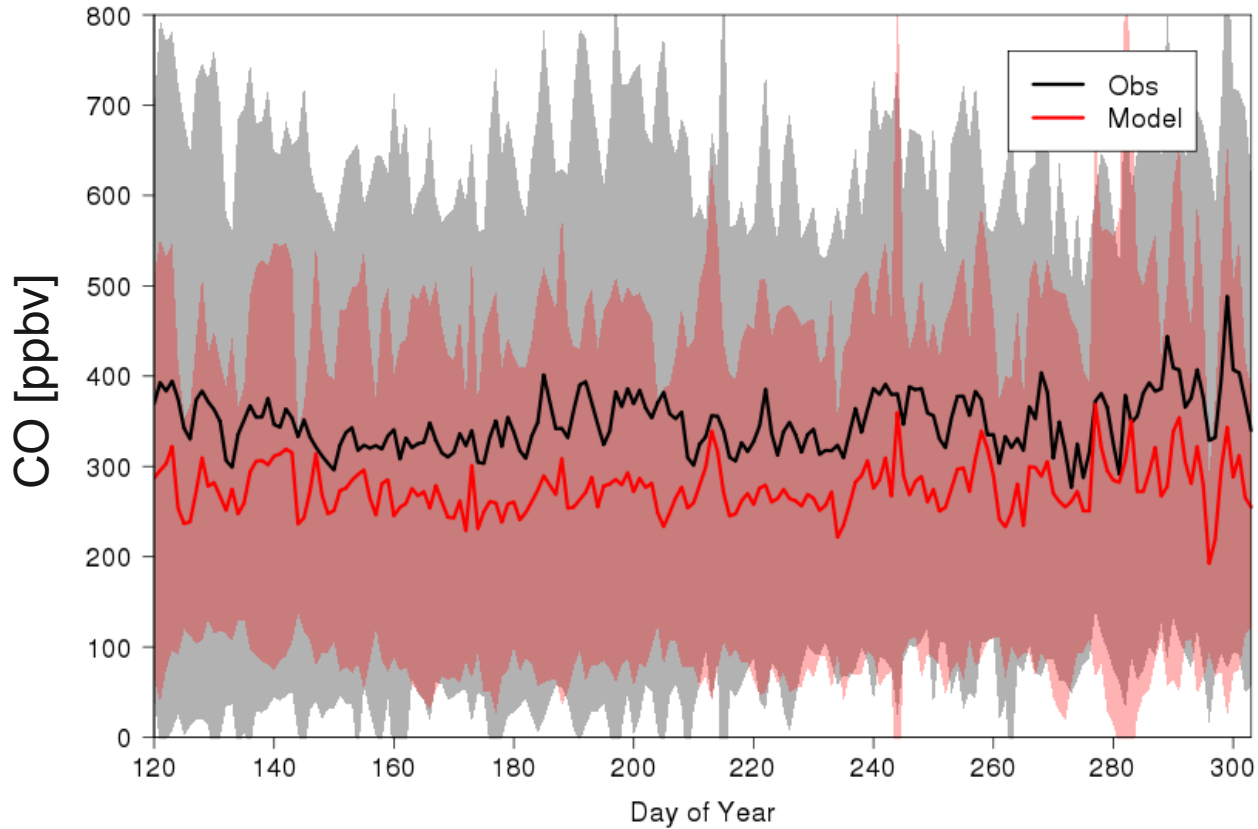
# Impacts of ozone assimilation are primarily seen in stratosphere

Boulder, 2013-07-25

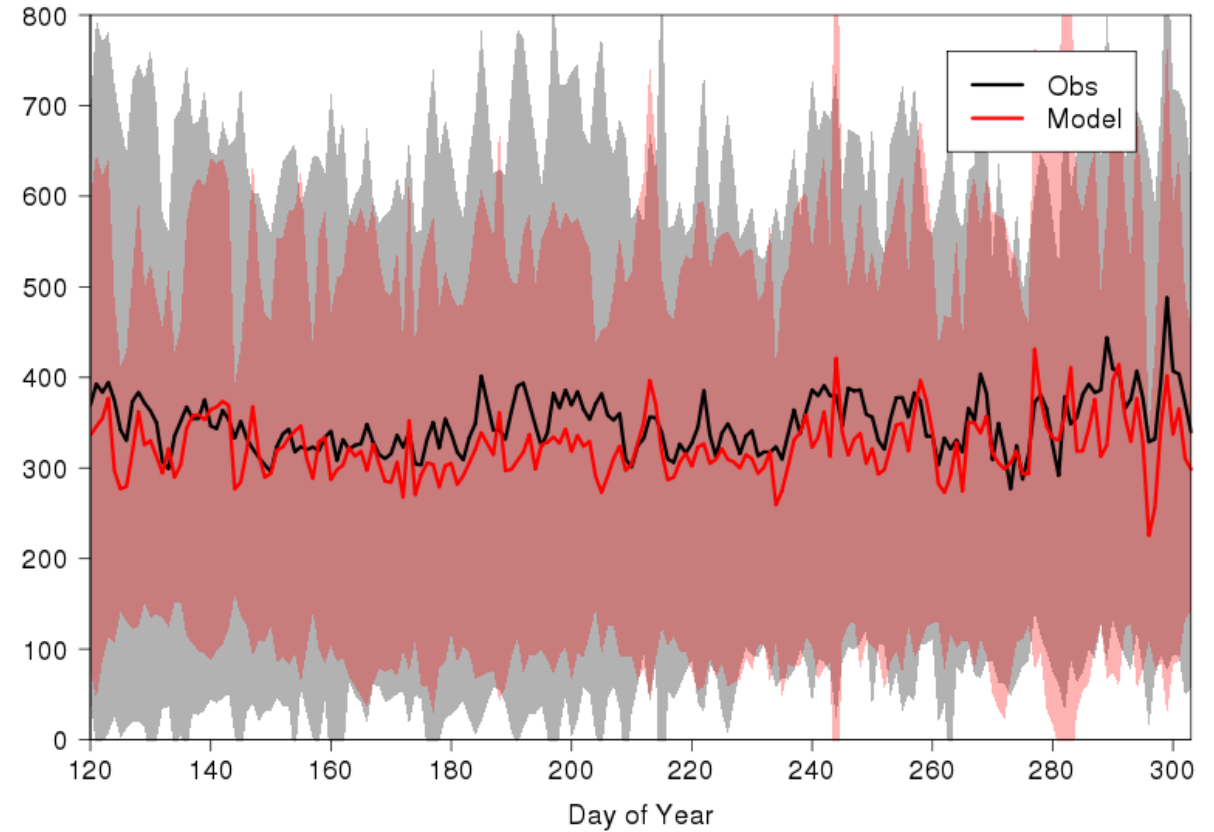


# CO: improved comparison against surface observations

Control (no assimilation)

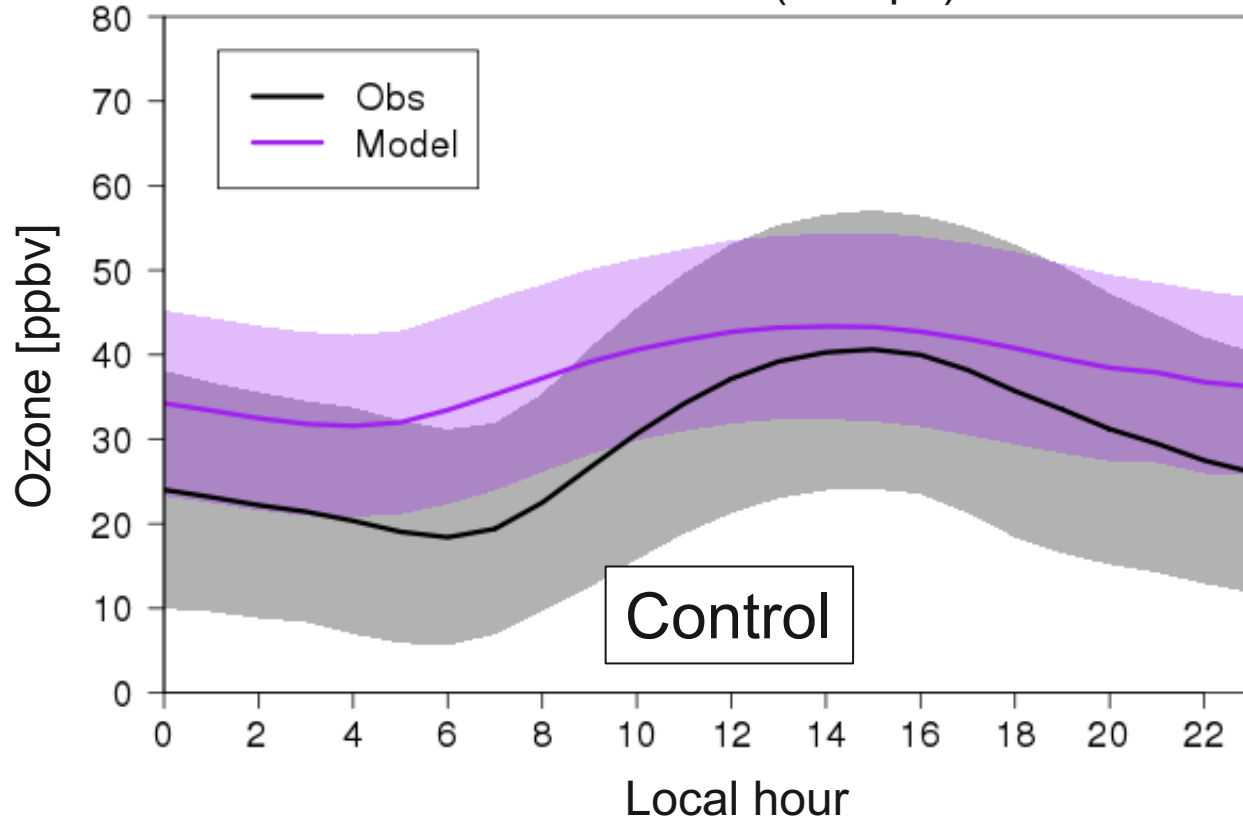


With assimilation

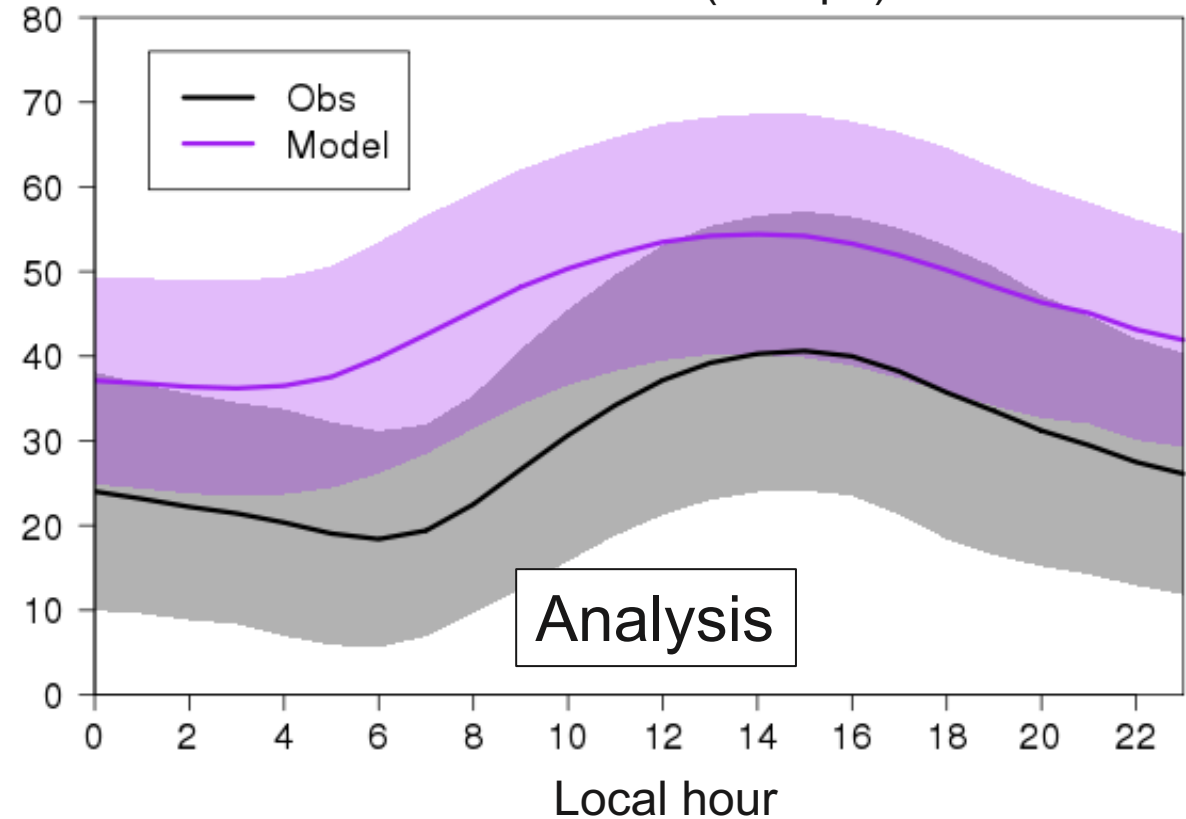


# Assimilation of $\text{NO}_2$ and CO exacerbates tropospheric ozone bias

Surface ozone (Europe)



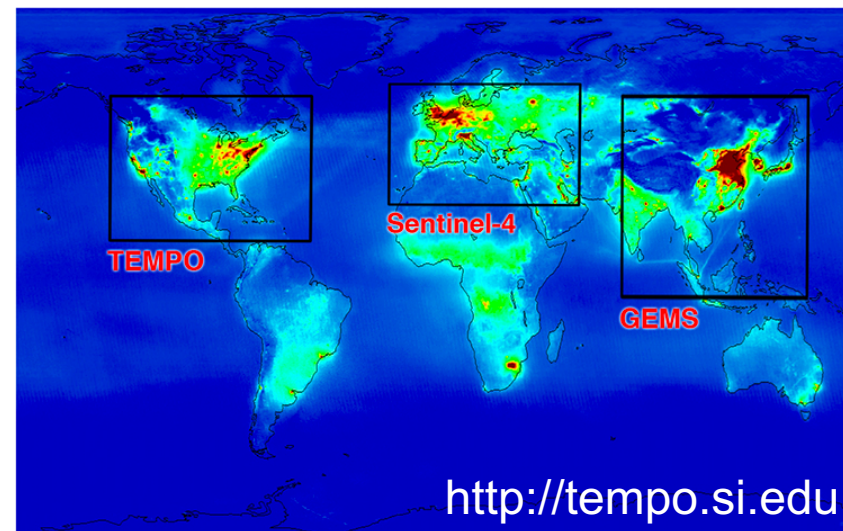
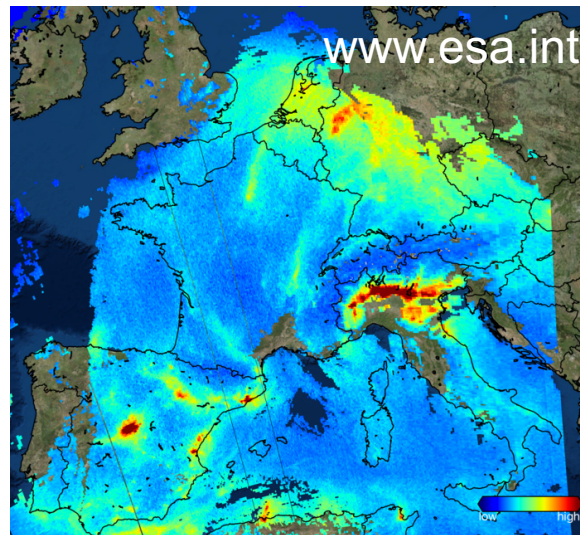
Surface ozone (Europe)



➤ Improved diurnal cycle, but (background) ozone increases

# Data assimilation system for tropospheric constituents

- Impacts of joint assimilation of O<sub>3</sub>, NO<sub>2</sub> and CO:
  - ✓ Reduction of CO bias
  - ✓ Better spatiotemporal representation of NO<sub>2</sub>
  - ✗ Further increase of tropospheric ozone
- Weak observational constraint in current configuration



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