

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

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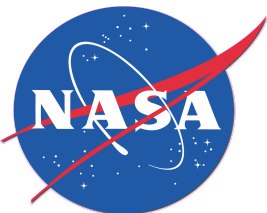
Steven Pawson¹, Krzysztof Wargan¹, Brad Weir^{1,2}

¹NASA Global Modeling and Assimilation Office (GMAO)

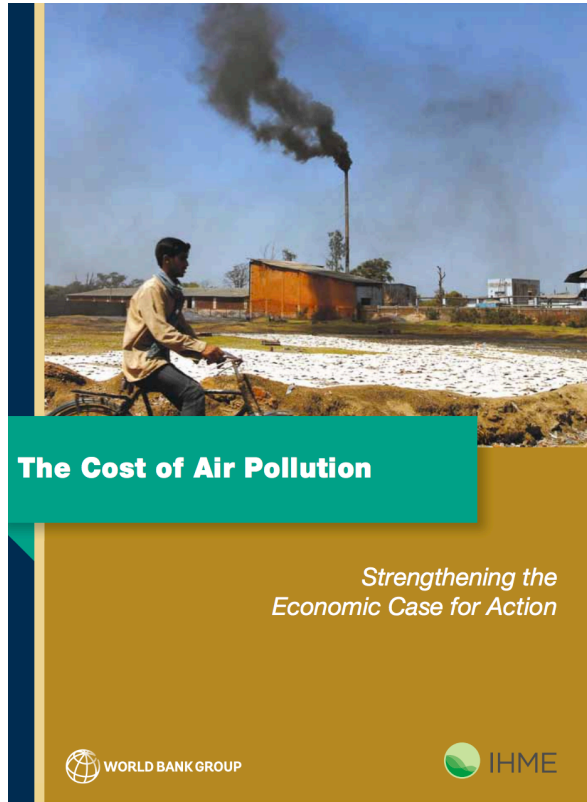
²Universities Space Research Association (USRA)



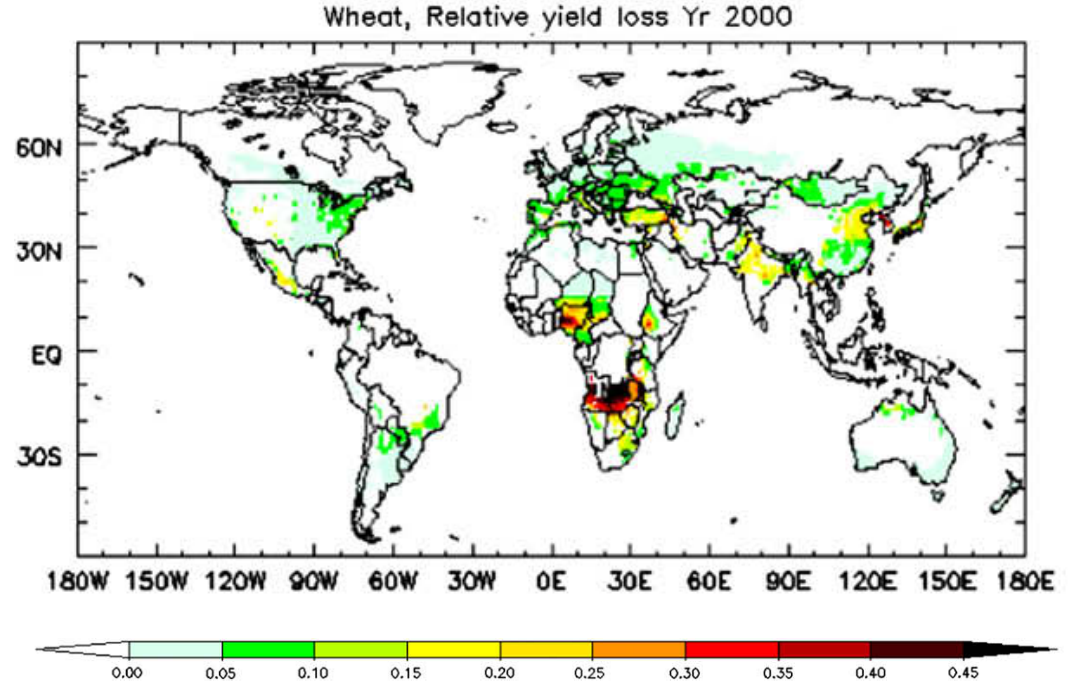
AMS 98th Annual Meeting
10 January 2018



Air quality is a global problem

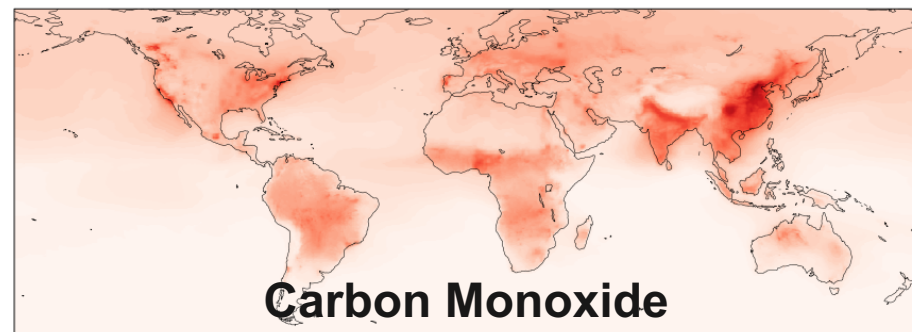
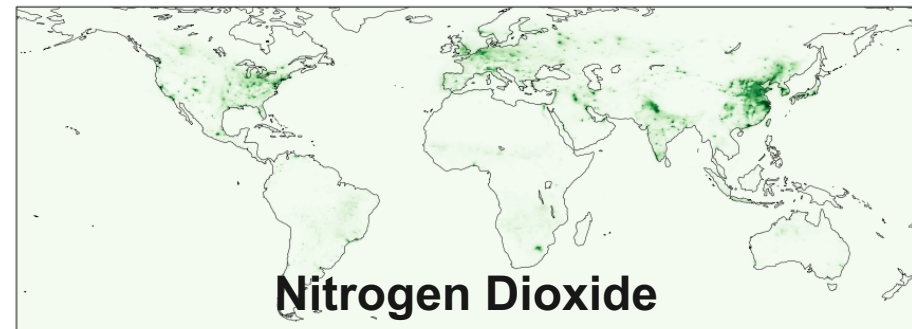
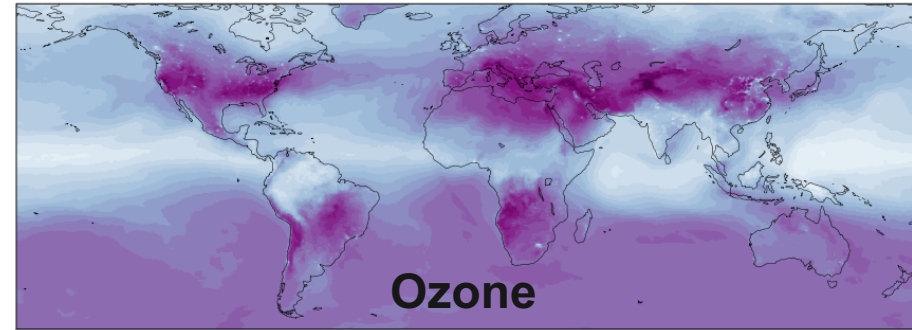
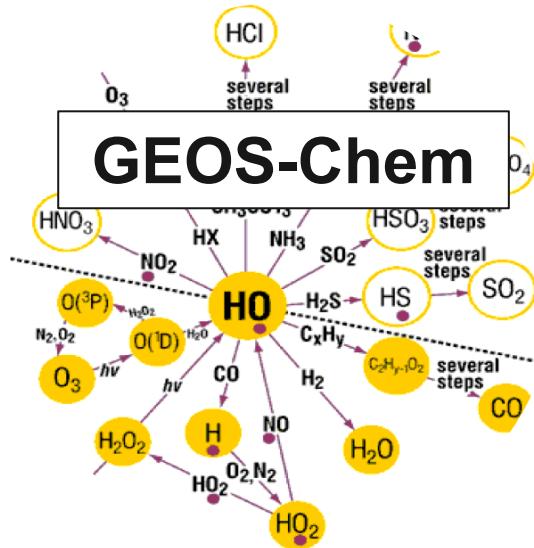
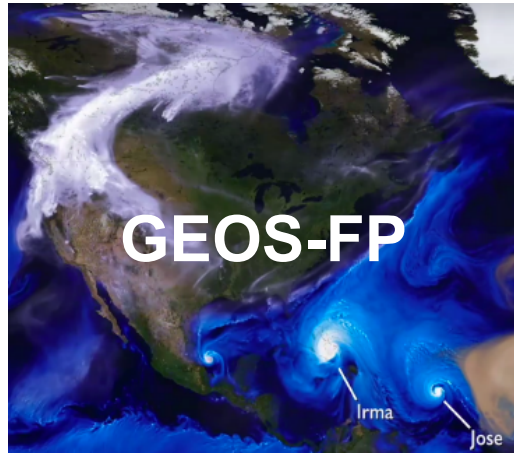


World Bank: ~\$5 trillion in welfare losses in 2013

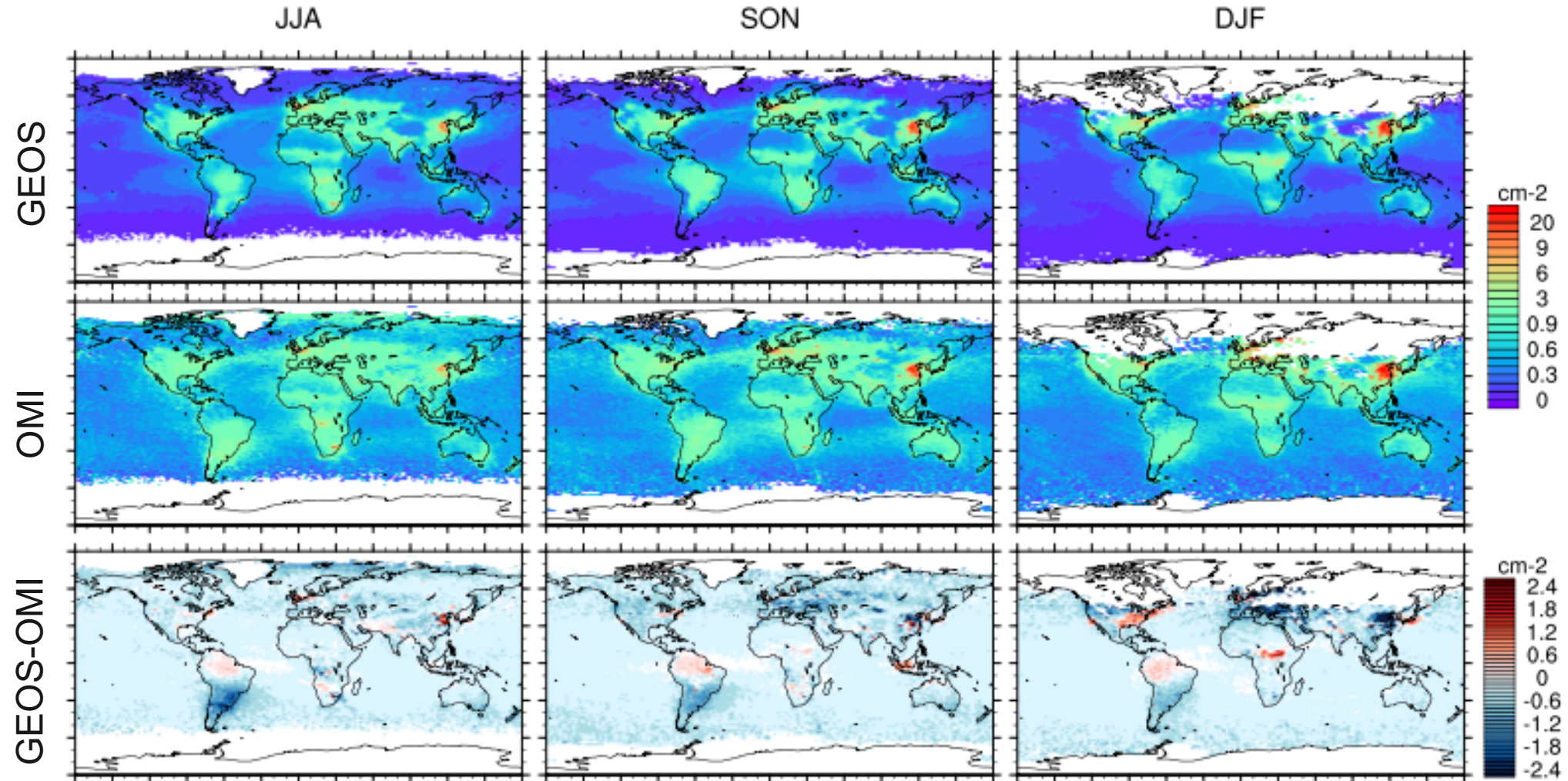


Up to 50% of crop yield can be lost to ozone pollution (e.g. VanDingenen, 2009)

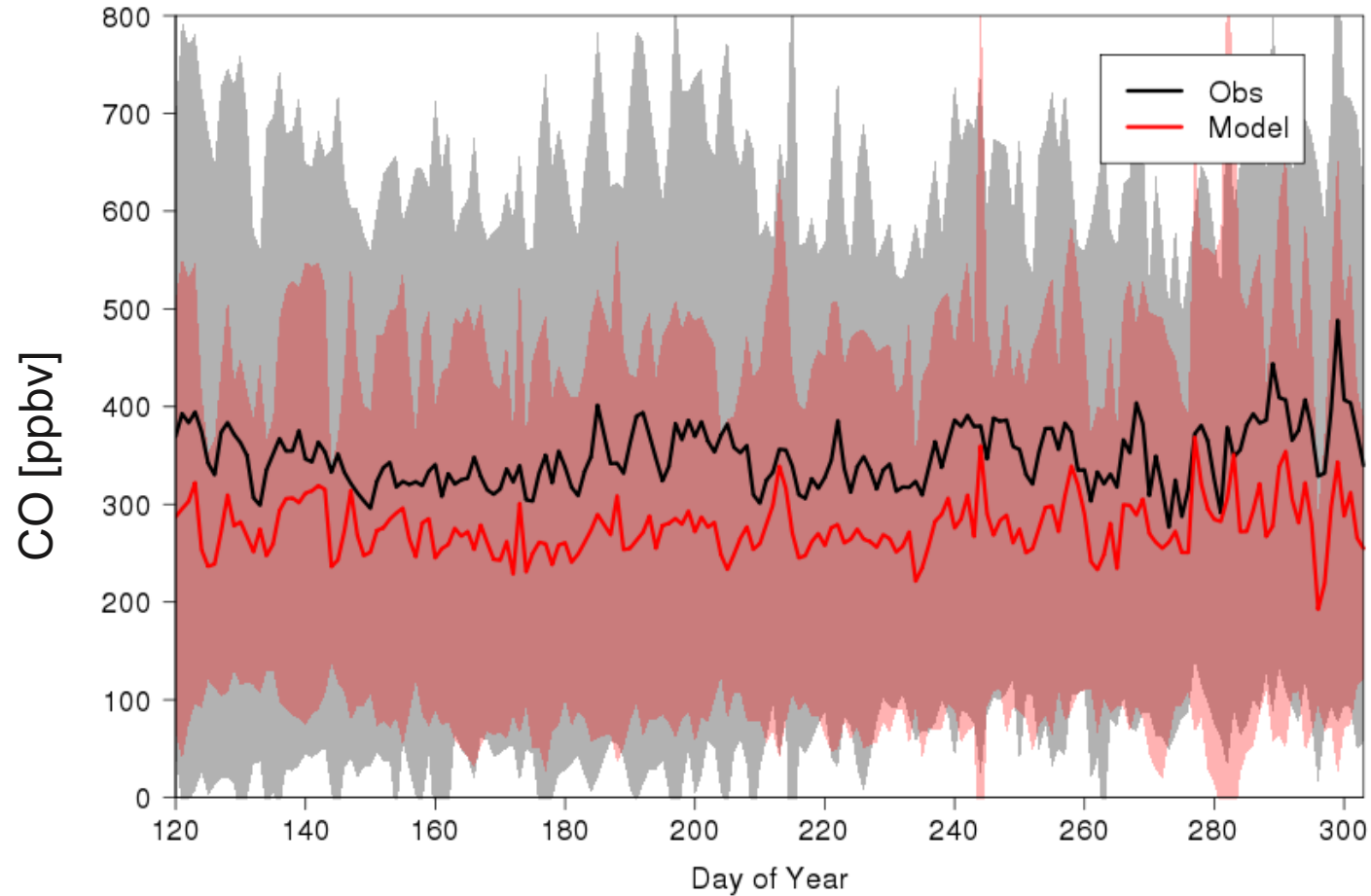
GEOS-CF model produces near real-time air quality forecasts



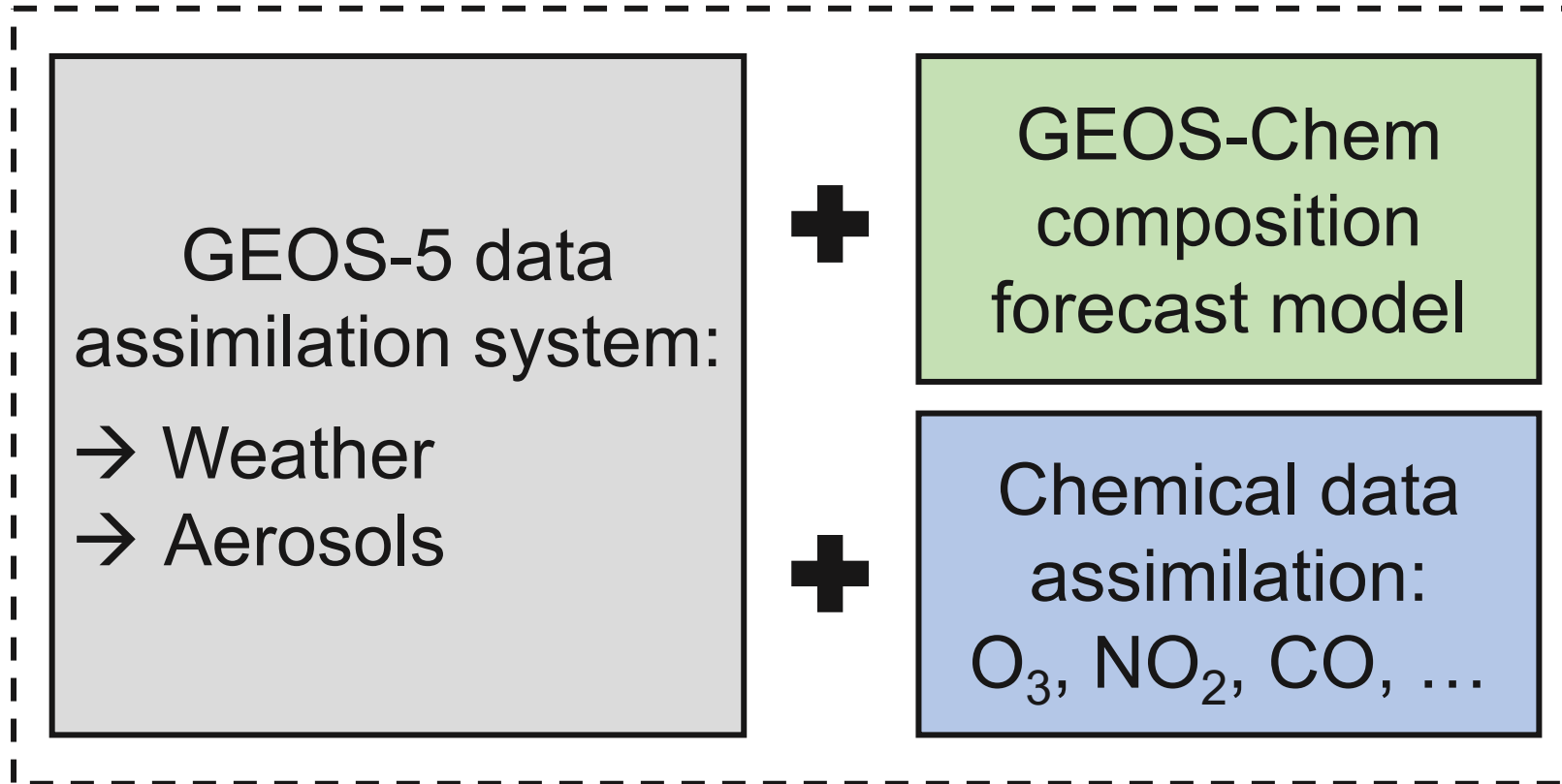
Model has low bias compared to OMI NO₂ observations



Also low bias in (surface) carbon monoxide CO



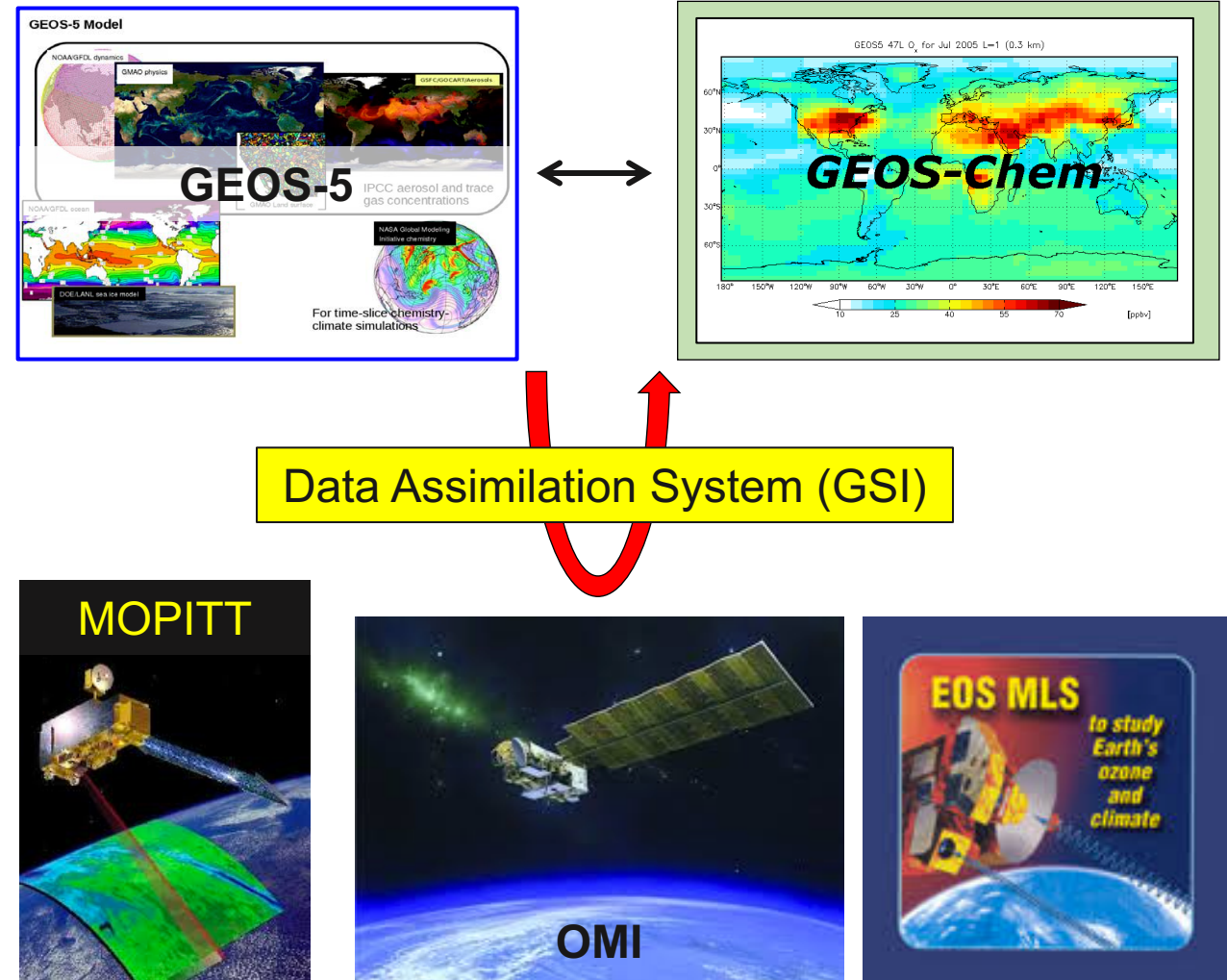
Toward an air quality modeling system in the NASA GEOS model



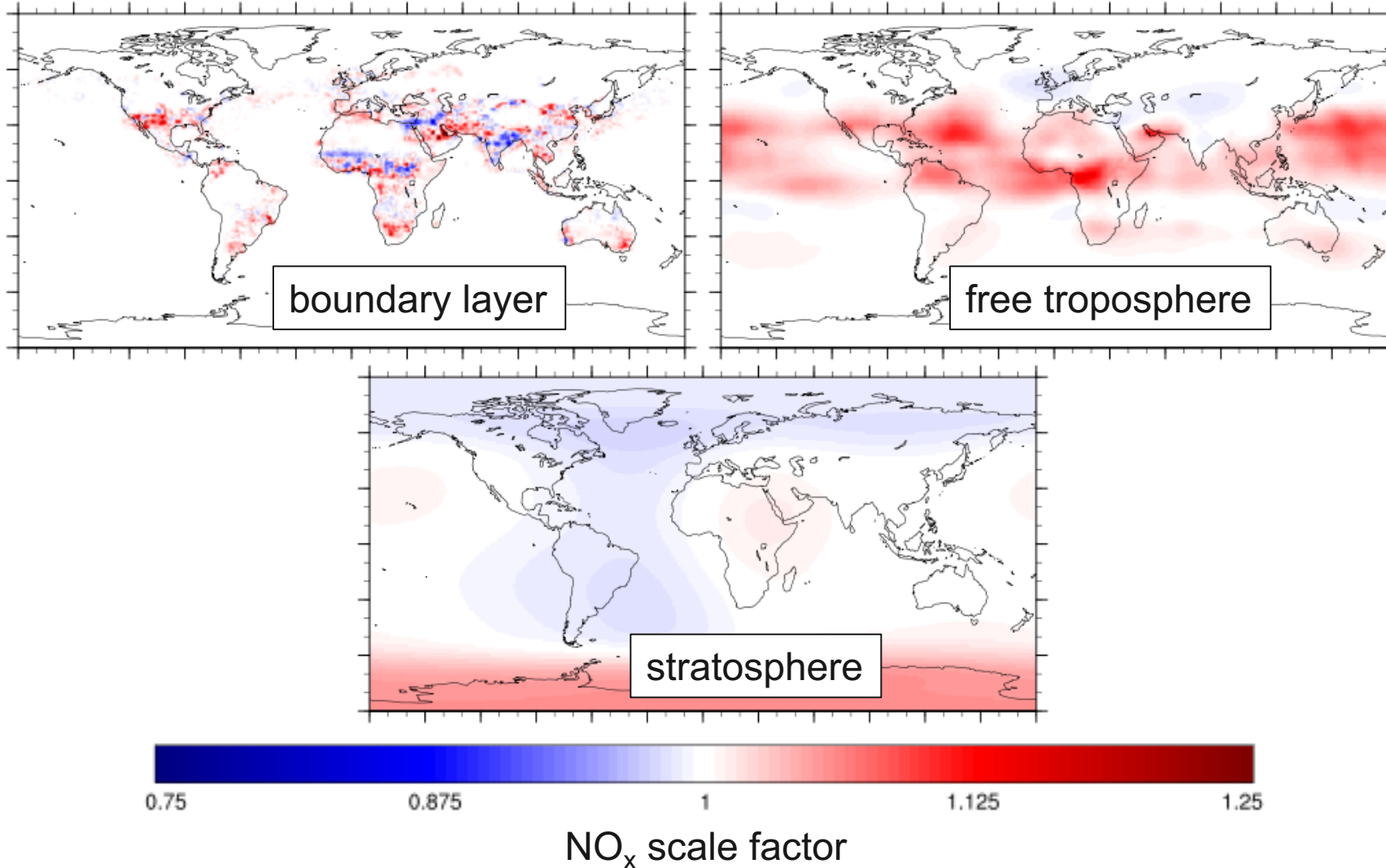
Air Quality Modeling System

The GEOS chemical data assimilation system

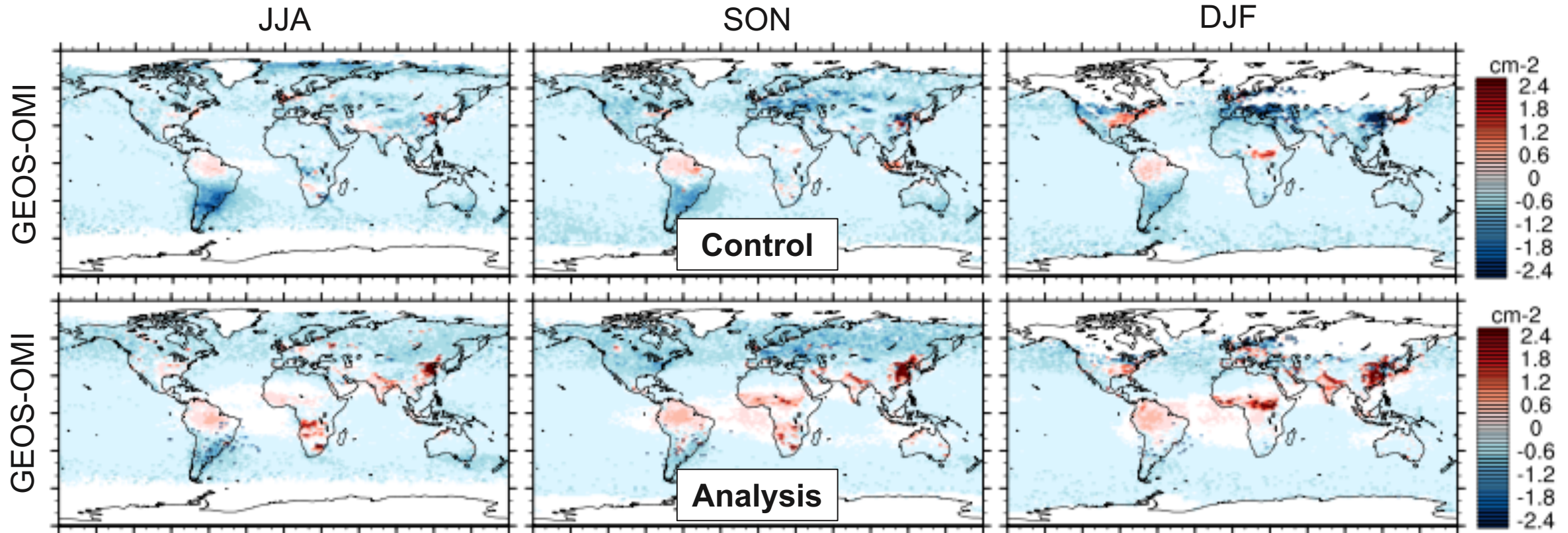
- Based upon GEOS-ADAS (GSI)
- Joint assimilation of NO₂, CO, O₃
- Weakly coupled (no covariances)
- 6-hour assimilation window



Assimilate independent NO_x scale factors for three layers



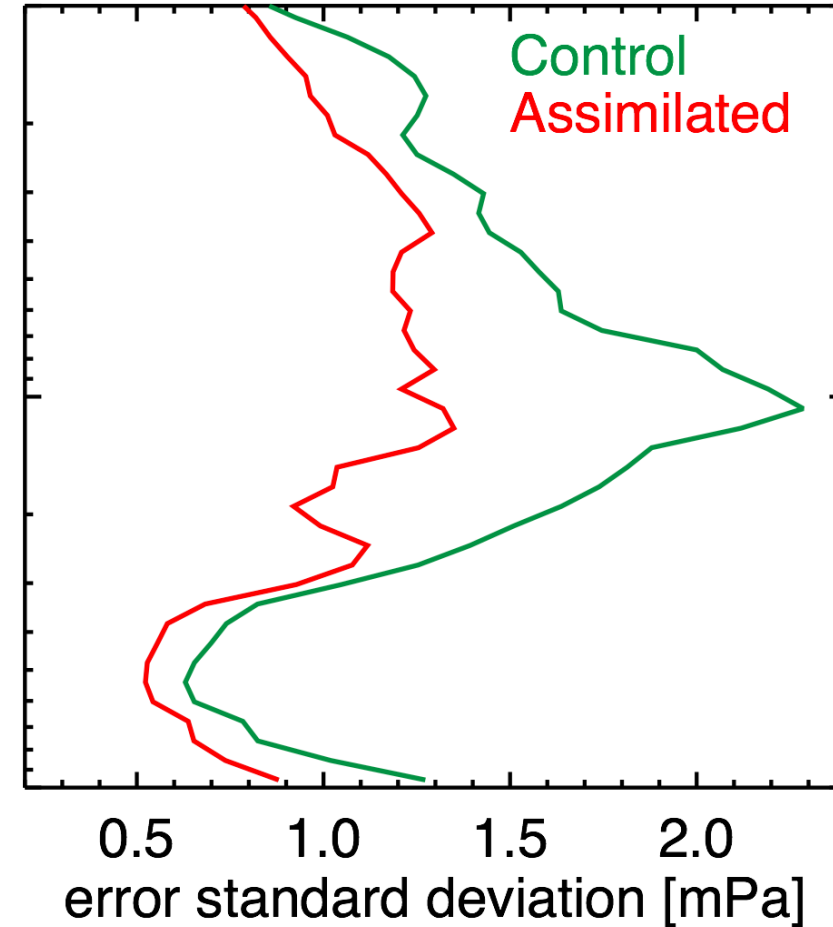
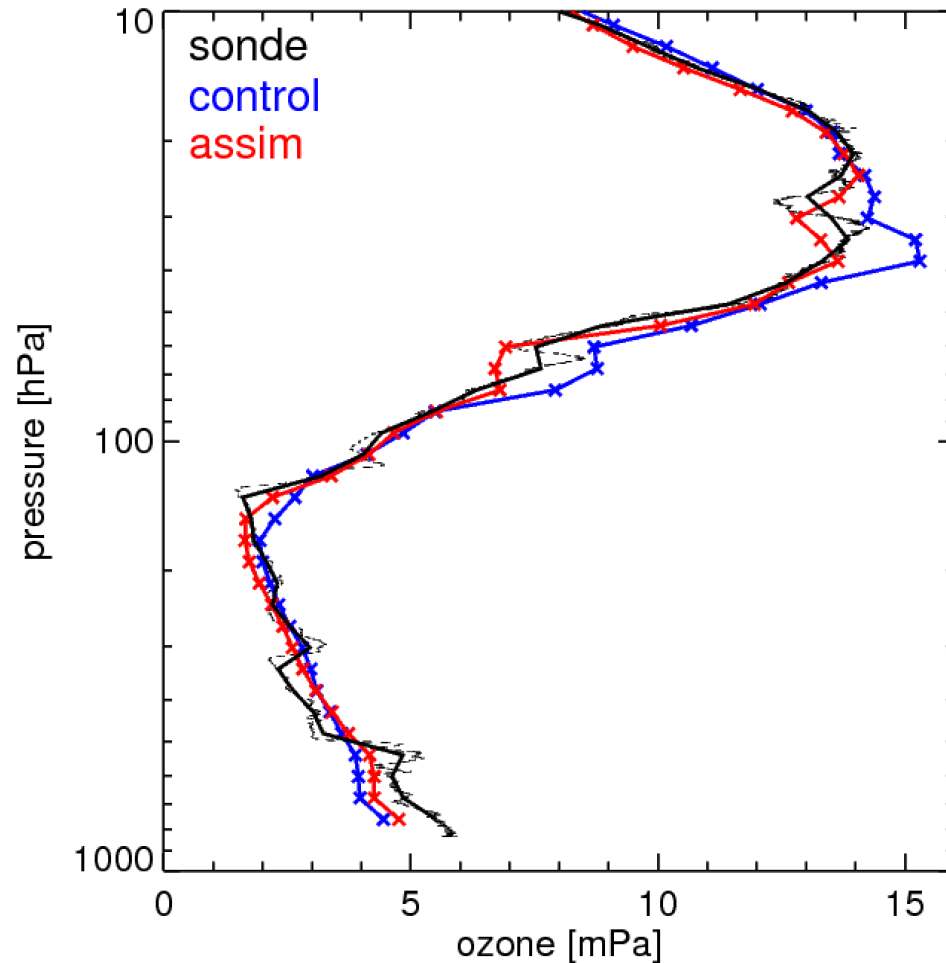
NO₂ assimilation reduces model-observation mismatch



➤ Are we now overestimating NO₂ over polluted regions?

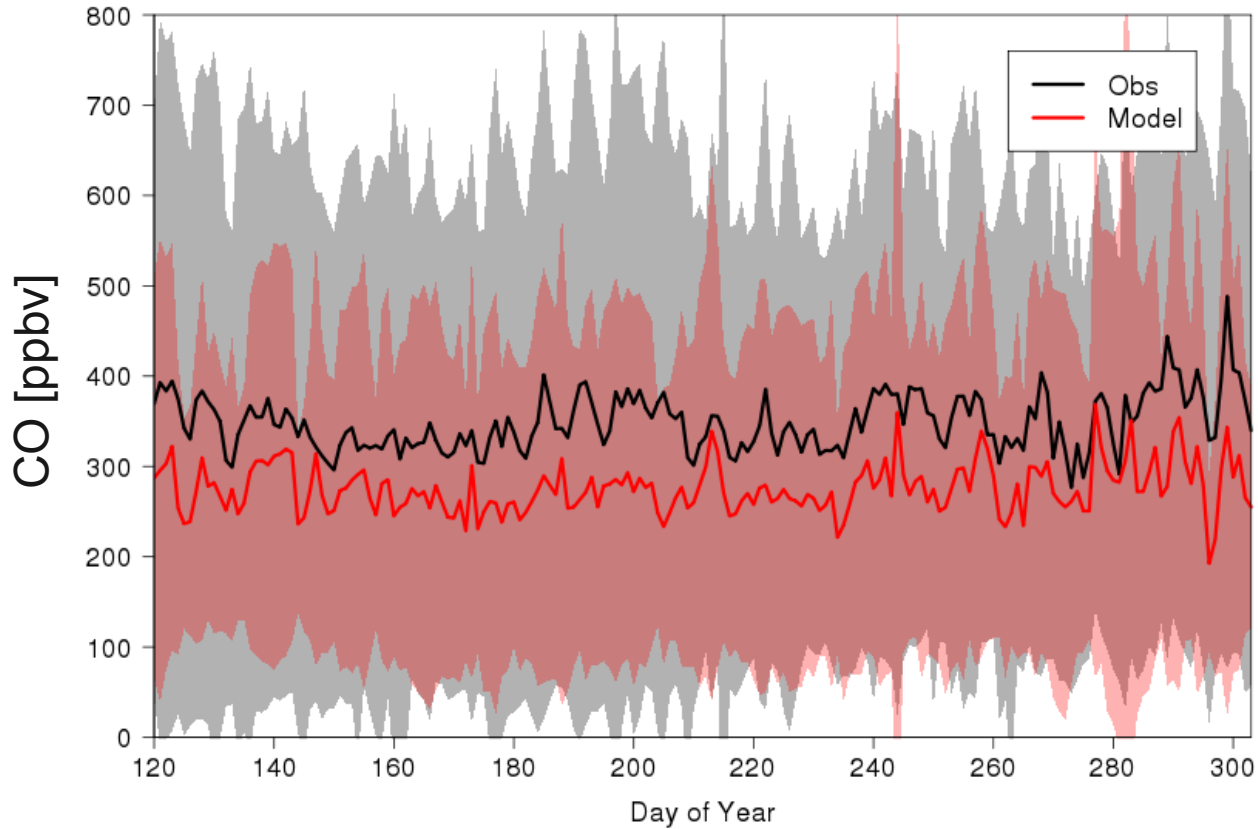
Impacts of ozone assimilation are primarily seen in stratosphere

Boulder, 2013-07-25

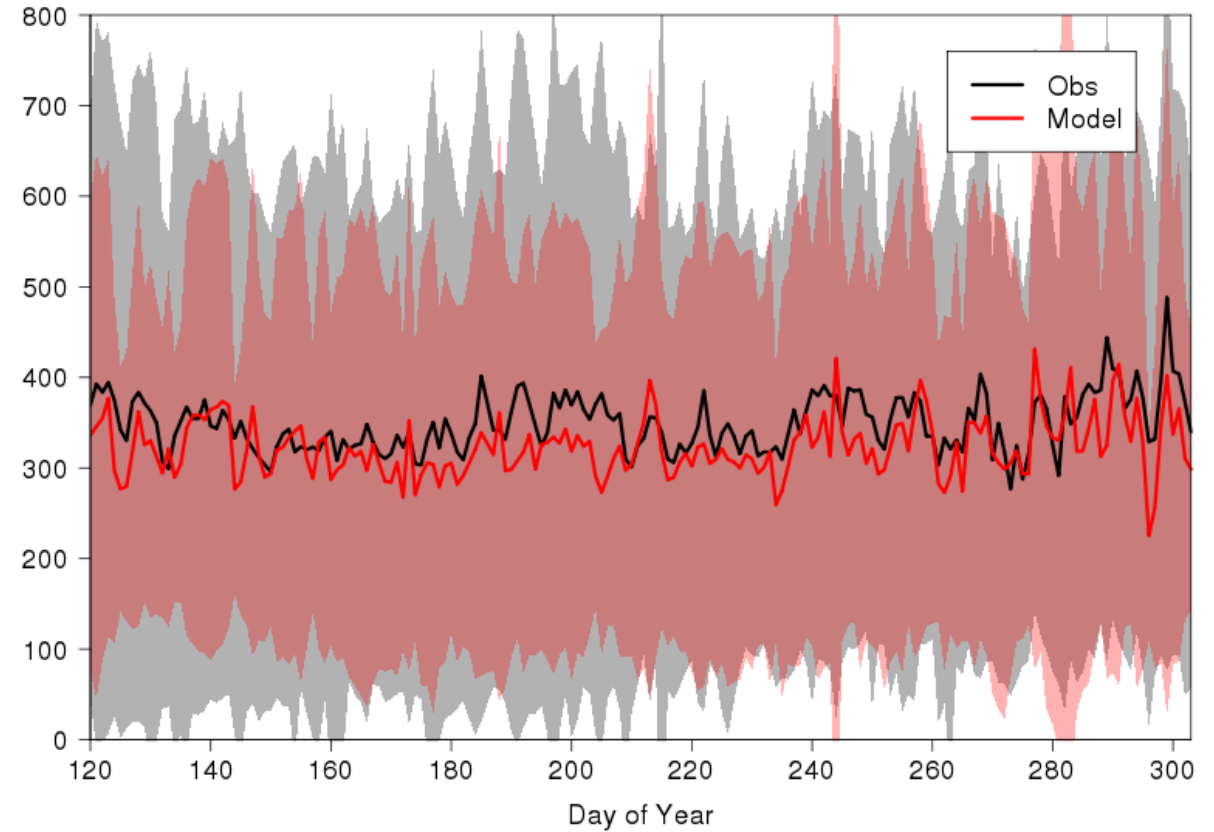


CO: improved comparison against surface observations

Control (no assimilation)

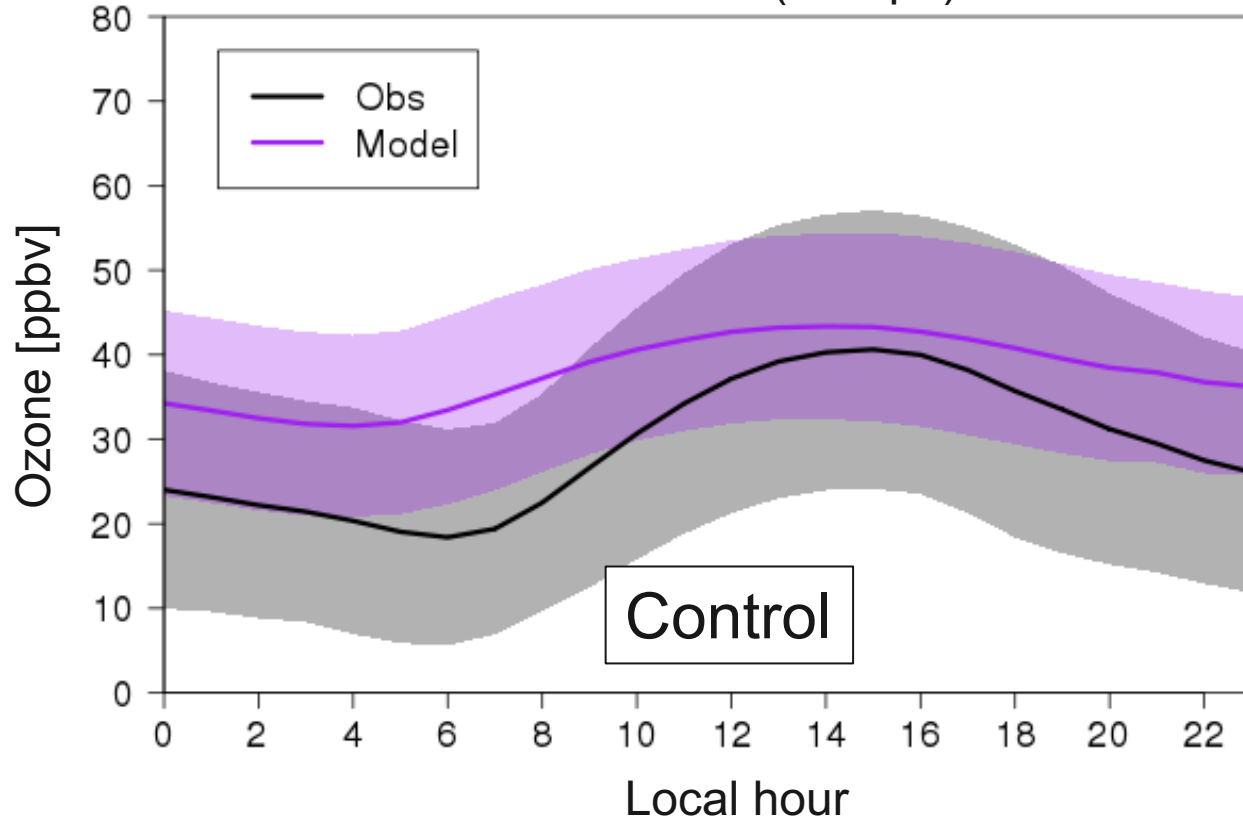


With assimilation

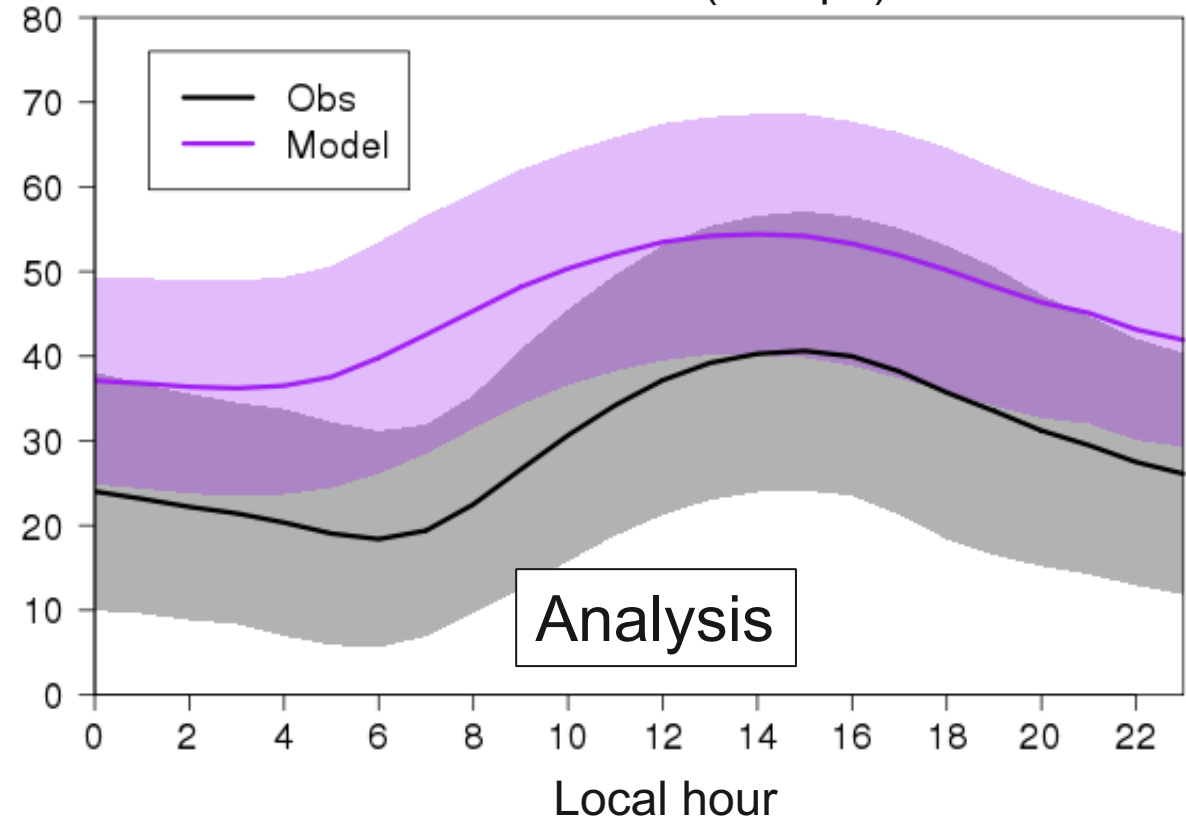


Assimilation of NO_2 and CO exacerbates tropospheric ozone bias

Surface ozone (Europe)



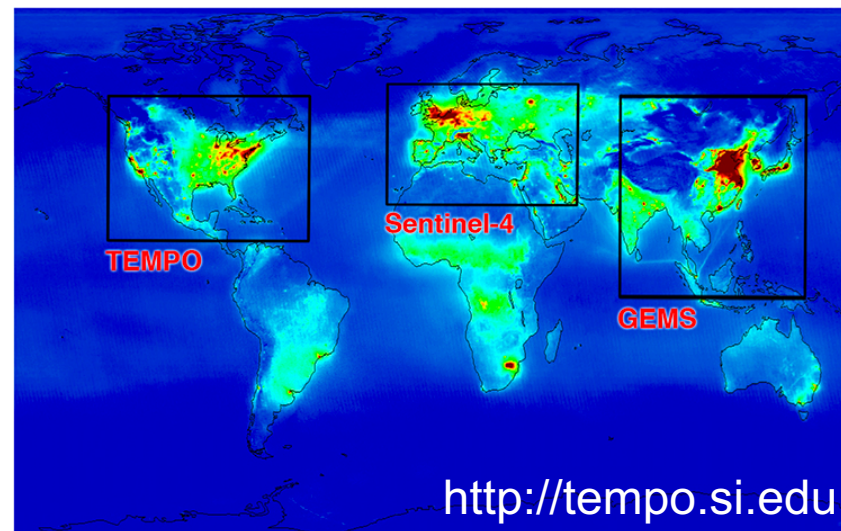
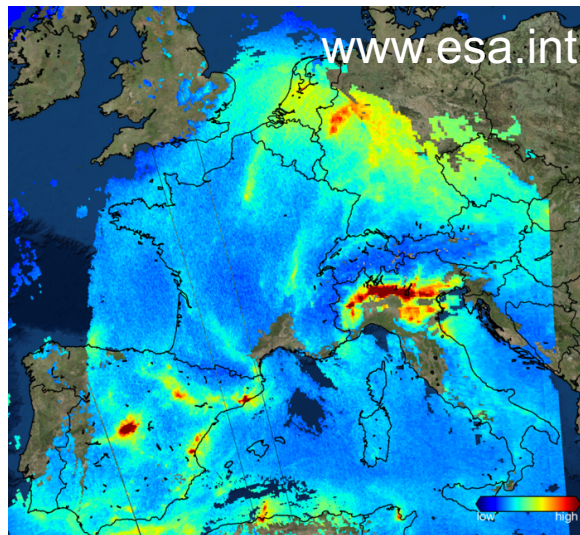
Surface ozone (Europe)



➤ Improved diurnal cycle, but (background) ozone increases

Data assimilation system for tropospheric constituents

- Impacts of joint assimilation of O₃, NO₂ and CO:
 - ✓ Reduction of CO bias
 - ✓ Better spatiotemporal representation of NO₂
 - ✗ Further increase of tropospheric ozone
- Weak observational constraint in current configuration



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