Assimilation of Chemical Data from NASA's EOS Instruments:

- Experiences from the GMAO
- Thoughts for planning

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Community Workshop on Air Quality Remote Sensing from Space: Defining an Optimum Observing Strategy

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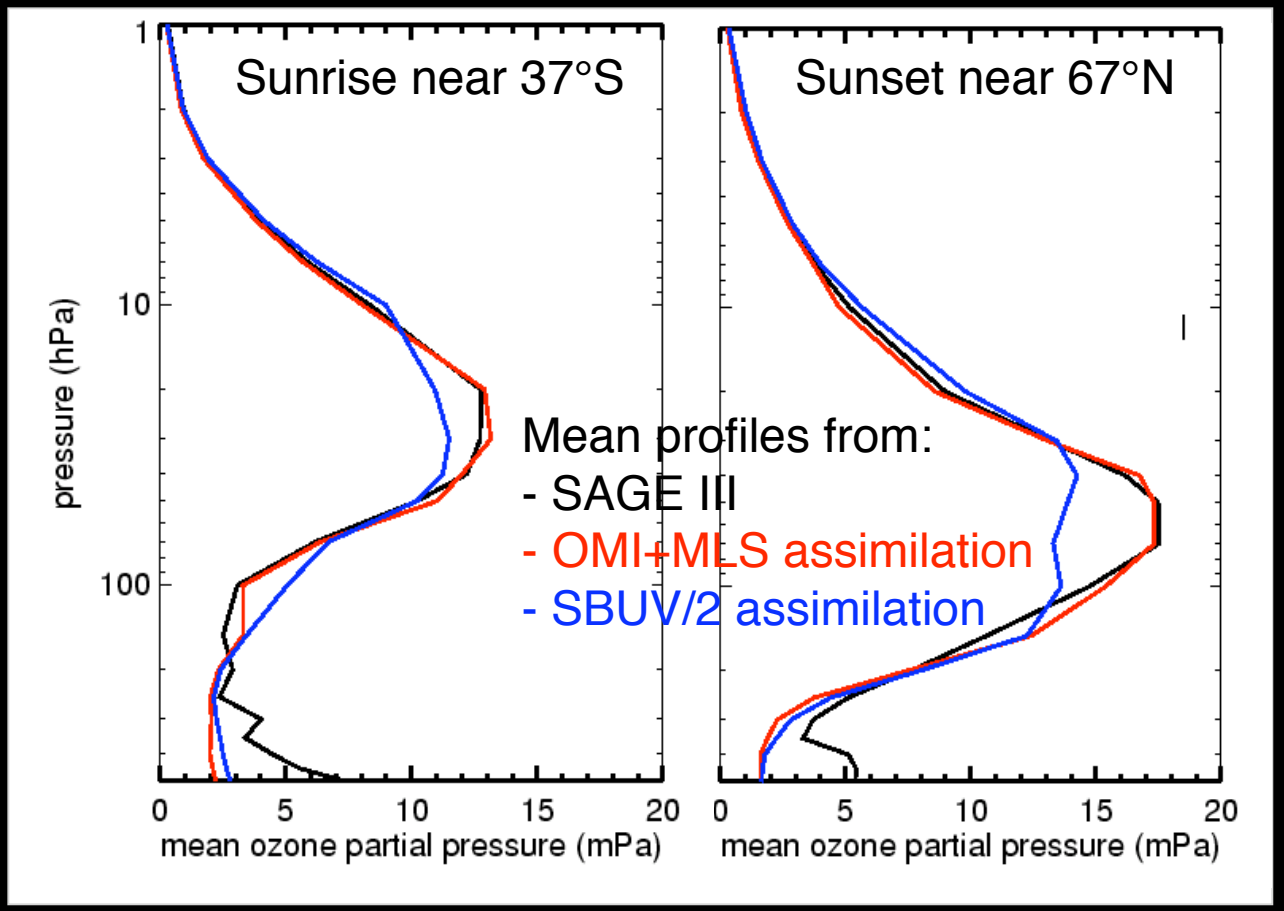
Objectives of Presentation

- ✓To illustrate some impacts of different types of satellite data on assimilation of ozone and carbon monoxide (OSEs)
- ✓To promote discussion about the role of OSSEs in future mission design

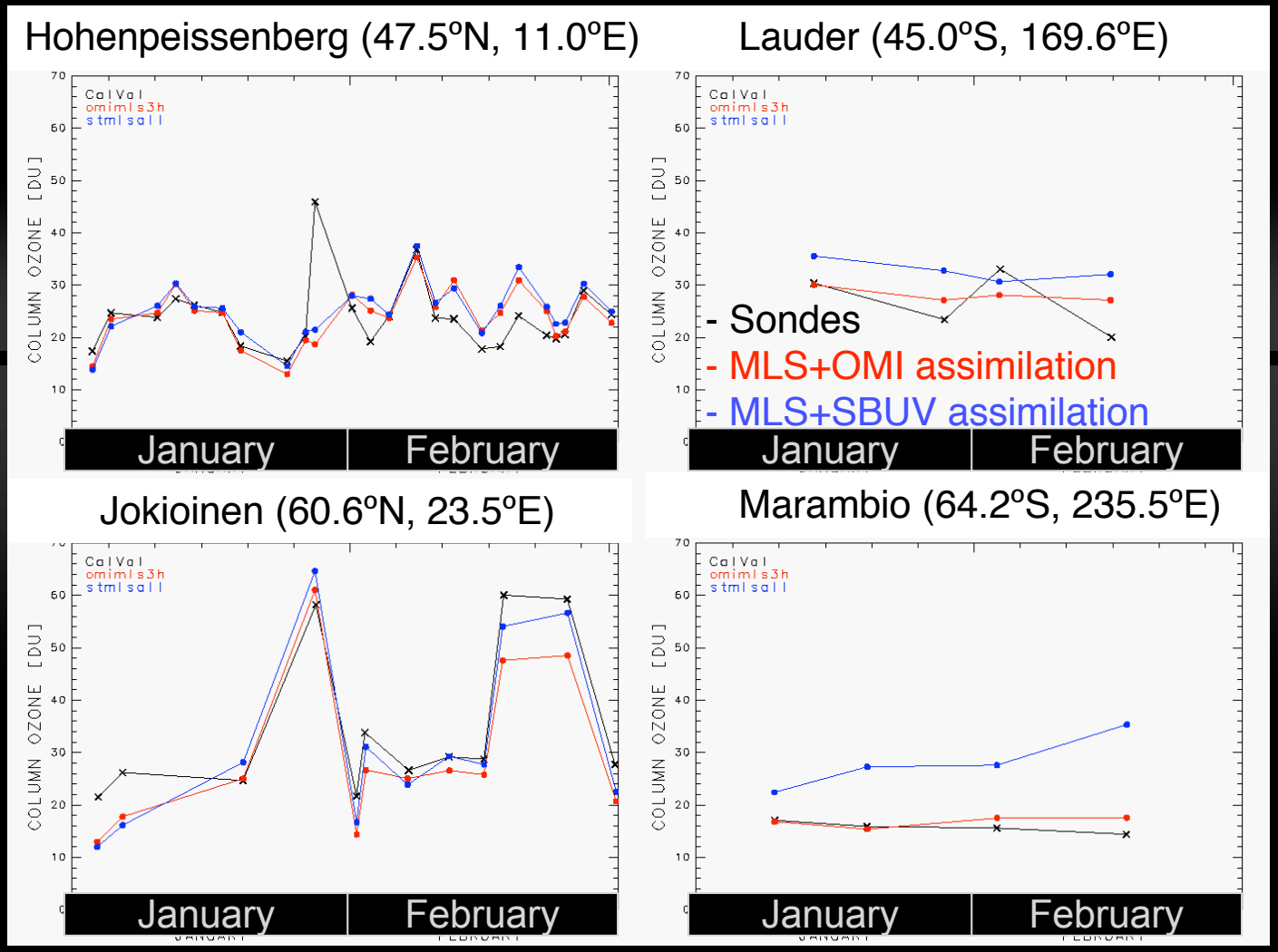
Impact of Aura OMI and MLS ozone data: realistic profile shape in lower stratosphere because of information content of MLS

Comparisons at SAGE III measurement locations on January 11-13, 2005.

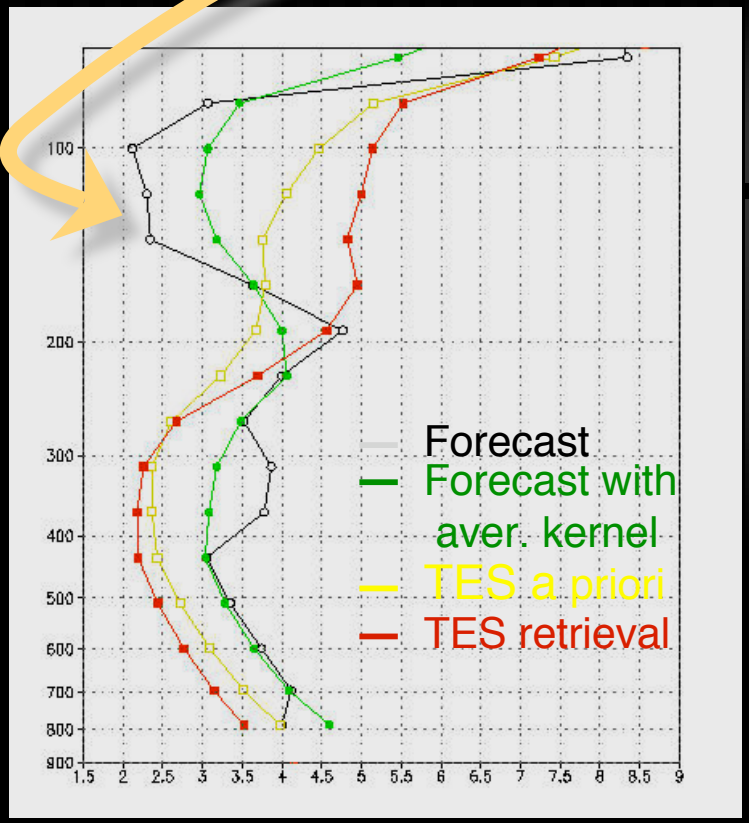


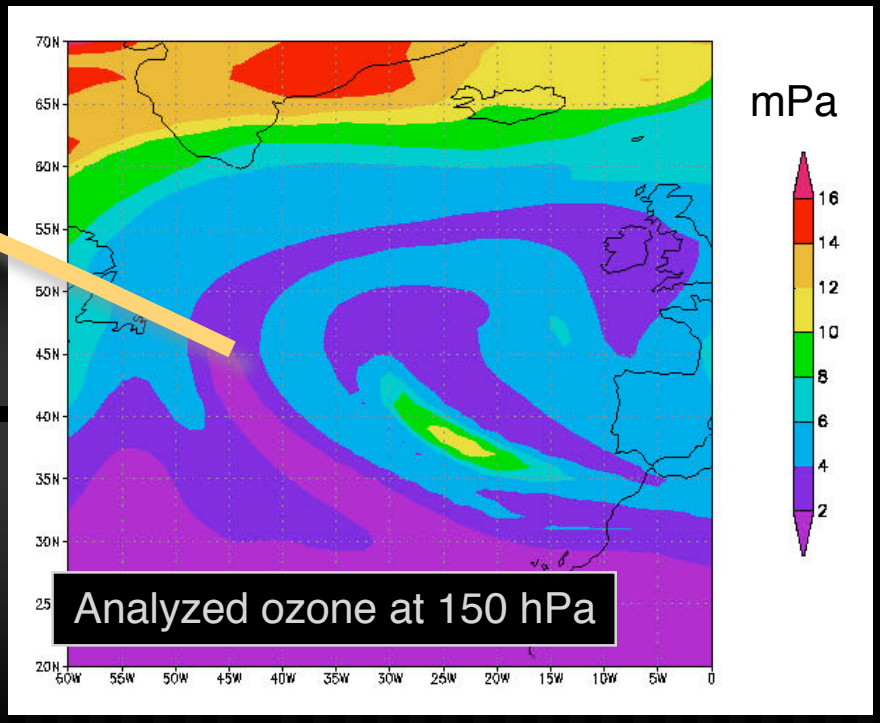
Similar results obtained by assimilating MIPAS (limb IR) and POAM/ILAS (limb occultation) data for different years and locations

OMI data have a beneficial impact on total tropospheric ozone columns from assimilation: Spatial and temporal variability are captured



Towards an OMI+MLS+TES assimilation: Potential capabilities of the model to isolate layering not evident with “smooth” nadir data





A dynamically driven low-ozone feature over the Atlantic on Feb. 17 present in the assimilated (OMI+MLS) field is smoothed out in the TES retrieval. This shows that OMI+MLS+TES assimilation has the potential to resolve vertical features that are obscured in the TES retrievals.

Summary of EOS-Aura ozone assimilation

- ✓ OMI+MLS assimilation yields accurate representations of stratospheric profile and (generally) tropospheric column
- ✓ Optimism that TES retrievals can be incorporated, with appropriate weight given to information content (a priori, averaging kernel)
- ✓ Concept of OSEs (Observation Sensitivity Experiments) - combining several data types
- ✓ Basis for other constituent assimilation (e.g., carbon species) in GMAO

… but, how well can present tropospheric data be utilized for Air Quality?

- ✓ Need near-surface analyses and (say) 24-hour forecasts, yet most present space-based constituent data constrain upper-middle troposphere - address pollution export issues, with less immediate relevance to air quality (aerosols somewhat different)
- ✓ Source estimates determined from space-based instruments can play an important role, as demonstrated clearly in summer 2004 (Intex-NA):
  - ✓ Alaskan/Canadian emissions calculated from MODIS fire observations included in GEOS-4 helped link this burning to degraded air quality in Houston (Morris et al., JGR submitted)
  - ✓ Layering of air masses exposed to various sources of pollution transported over the Eastern US

Global contributions to East-Coast USA pollution modeled during Intex-NA

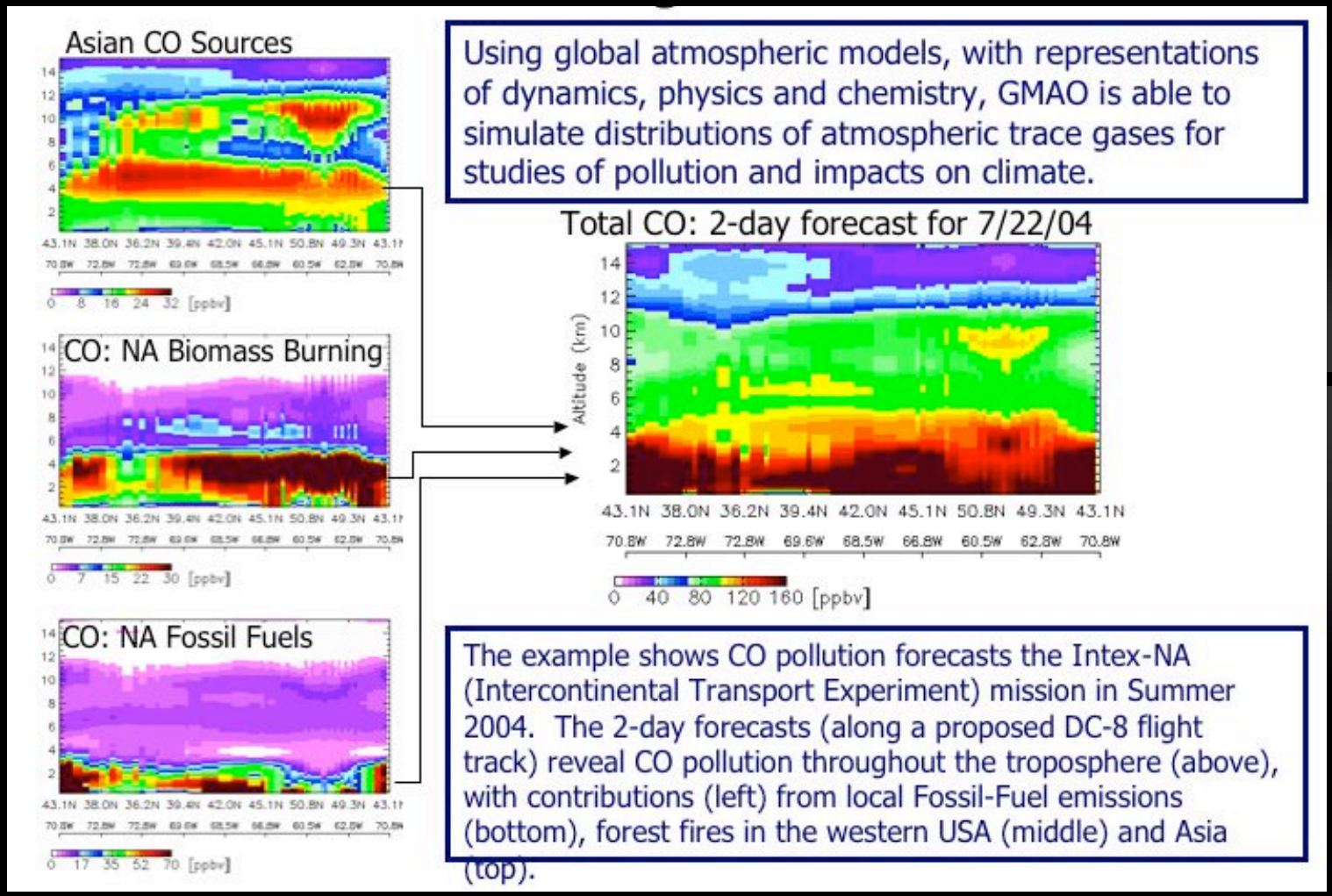


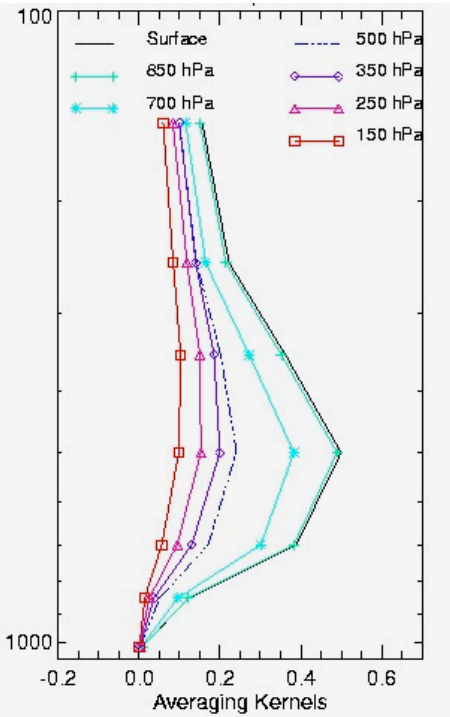
Figure produced by Harvard group as part of Intex-NA mission planning

The following questions arise (maybe more):

- ✓ What is the value of nadir IR (MOPITT CO, AIRS/IASI CO/ozone) measurements for Air Quality forecasting?
- ✓ How adequately do space-based estimates of biomass-burning emissions constrain pollutant concentrations?
- ✓ Are we exploiting present-day satellite observations (e.g., emissions, precursors)?
- ✓ …
- ✓ What do the demands of AQ forecasting really imply for observational requirements?
- ✓ What are the limitations of the models used in assimilation and prediction?

What might be wrong with the models (specifically, the transport)?

MOPITT averaging kernels



- ✓ Integrity of the meteorological analysis impacts the value of the assimilation and forecast
- ✓ Model error is much more complex in the troposphere than in the stratosphere:
  - ✓ Have some confidence in large-scale advection
  - ✓ Aware of uncertainties in sub-grid processes (e.g., existence of clouds) and associated transport (e.g., outflow), but do not possess a full understanding of these issues
  - ✓ What type of observations will help us correct for detrainment occurring at the wrong level?
  - ✓ Value of cloud observations?

The importance of OSSEs (Observing System Simulation Experiments)

- A planning tool - what impact will a new data type "really" have on our ability to forecast air quality?
  - Typical application: "instrument X will be launched in orbit A - what impact will the data have?"
  - Better: "what would be the optimum orbit for instrument X?"
  - Best: "what is the observational requirement for Air Quality and can any combination of proposed instruments meet this?"
- Should be wary of model limitations on interpretation
- OSSEs require much infrastructure and planning, but potentially help the community and funding agencies make wise choices