Data Assimilation Activities Using CAMChem/DART

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1. Explore the synergy between numerical weather prediction (NWP) and air quality forecasting (AQF), particularly the impact of CO retrievals to model predictions of horizontal wind.

2. Proposed 16-month assimilation of MODIS AOD and MOPITT CO in CAMChem/DART
synergies between NWP and AQF

- provides opportunities to evaluate models and observations under one data assimilation approach
- towards an integration of modeling systems
- ability to investigate chemistry feedbacks and representation of dynamical/physical processes controlling chemistry
Research-Based Regional to Global NWP with Chemistry

- Leveraging on state-of-the-art community models (CAM-Chem, WRF-Chem) and Community DA facility (DART)

OBSERVATIONS
- Current: Rawinsondes, ACARS, Aircraft, Satwinds, MOPITT CO, MODIS AOD
- Planned: TES CO, \( \text{O}_3 \), IASI CO, \( \text{O}_3 \), OMI NO\(_2\), \( \text{O}_3 \), GOME \( \text{O}_3 \)

APPLICATIONS
- Chemical OSSEs
- Chemical Weather Field campaign support

In collaboration with NCAR/IMAGE & NCAR/MMM
an ensemble-based DA framework

adapted from Jeffrey Anderson
CO as a good tracer of pollution transport

e.g. natural /anthropogenic combustion-related processes

\[
\frac{d[CO]}{dt} = \left( \frac{\partial[CO]}{dt} \right)_{\text{transport}} + \left( \frac{\partial[CO]}{dt} \right)_{\text{emissions}}
\]

\[
+ \left( \frac{\partial[CO]}{dt} \right)_{\text{chemistry}} + \left( \frac{\partial[CO]}{dt} \right)_{\text{deposition}}
\]

\[-k_{CO-OH}[CO][OH]
\]

\[k_{CH_4-OH}[CH_4][OH]\]
CO is relatively well-observed

IASI Column CO Sept. 15, 2009

from D. Edwards/M. George
### Experiment Assimilation Impact

<table>
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<td>Assim0 (uncoupled)</td>
<td>NCEP Bufr</td>
<td>Met Obs $\rightarrow$ Met States</td>
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<tr>
<td>Assim1 (uncoupled)</td>
<td>NCEP Bufr, MOPITTv4 CO</td>
<td>Met Obs $\rightarrow$ Met States, CO Obs $\rightarrow$ CO State</td>
</tr>
<tr>
<td>Assim2 (coupled)</td>
<td>NCEP Bufr, MOPITTv4 CO</td>
<td>Met Obs $\rightarrow$ Met States, CO State, Met States</td>
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**assimilation period: April to May, 2006**

#### Radiosonde

![Radiosonde Image](image1)

**04/17/06**

#### MOPITT CO

![MOPITT CO Image](image2)

**04/17/06**
Model U Wind Component Relative to Assimilated Radiosonde Observations

Assim 0 → uncoupled assimilation  Assim 2 → coupled assimilation
results (model space)

Model Mean CO @ 500 hPa (April 11-April 30, 2006)

Assim2 (coupled) vs. Assim0
Model Mean U Wind @ 500 hPa (April 11-April 30, 2006)

Assim2 (coupled)

Assim0

Assim2 – Assim0
• Is the fit to rawinsonde observations better with data assimilation of MOPITT CO?

• Preliminary results suggest that:
  a) while there are some indications of improvements on the fit relative to rawinsonde observations, there are some degradation on the CO fit relative to independent observations
  b) further investigation is warranted, particularly on localizing the impact of observations and larger ensemble-size (to minimize possible spurious correlations)
  c) has implications to high-density CO observations like IASI CO
Constraining the distribution of chemically-active and radiatively-relevant species in CAM-Chem

under Jeff Anderson’s CSL project on ‘Ensemble Data Assimilation for Climate Model Development’

**Objective**

conduct 2 sets of 16-month assimilation using CAMChem/DART (full chemistry?) at 1.9x2.5 degree resolution

**Results**

1) analyses of CO and AOD with comparisons to PacDEx and ARCTAS
2) impact of associated changes in species distribution to radiative forcing
Any suggestions on:

1) CAMChem version
2) Full-Chem / Reduced chemistry
3) Bulk-Aerosol / MAM
4) Other issues