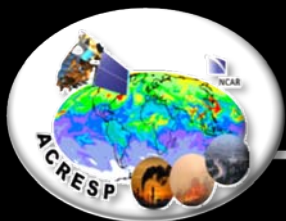


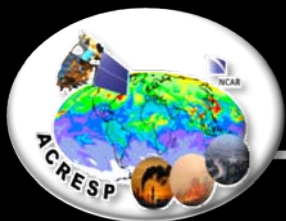
# Data Assimilation Activities Using CAMChem/DART

**Ave Arellano**

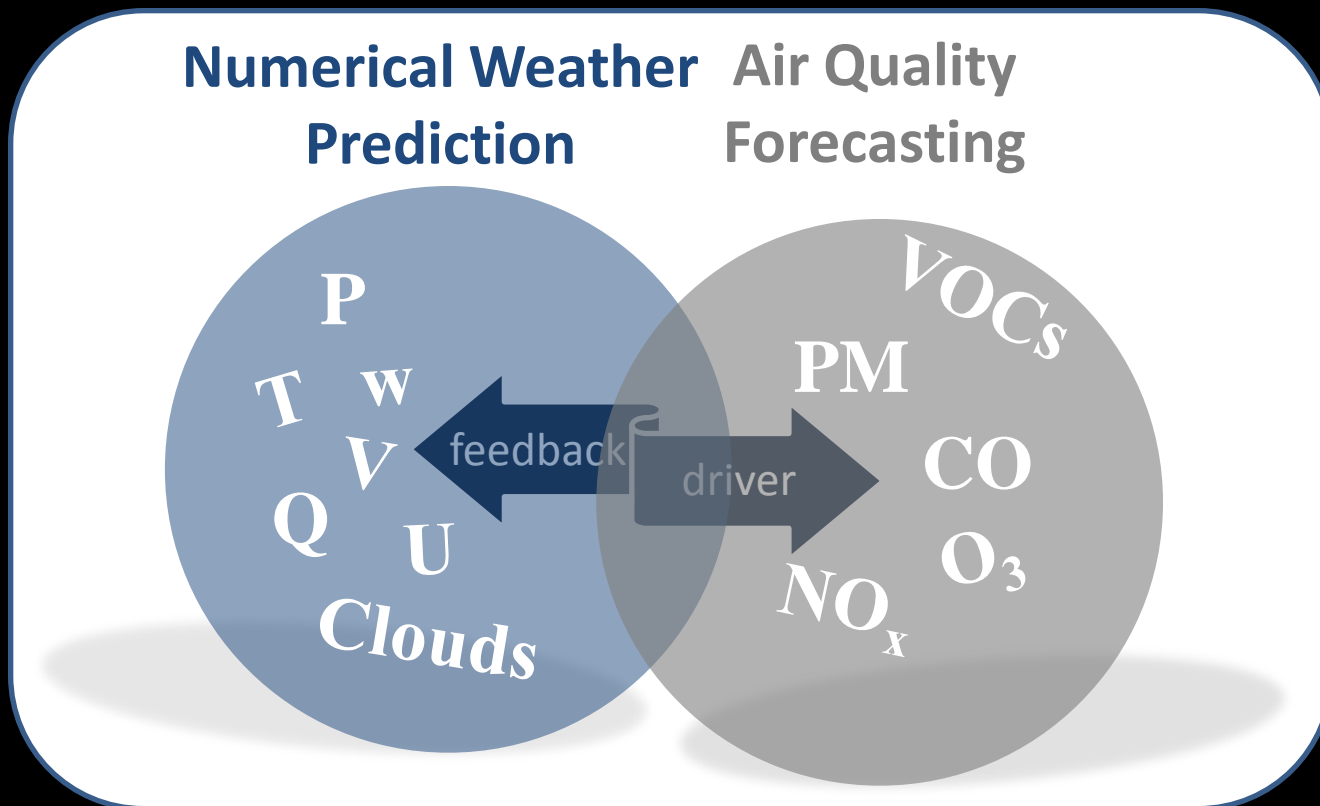
Atmospheric Chemistry Division  
National Center for Atmospheric Research



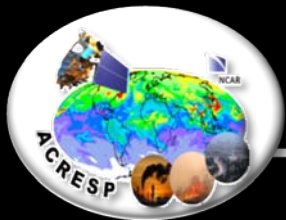
1. Explore the synergy between numerical weather prediction (NWP) and air quality forecasting (AQF), particularly the impact of CO retrievals to model predictions of horizontal wind.
2. Proposed 16-month assimilation of MODIS AOD and MOPITT CO in CAMChem/DART



# synergies between NWP and AQF

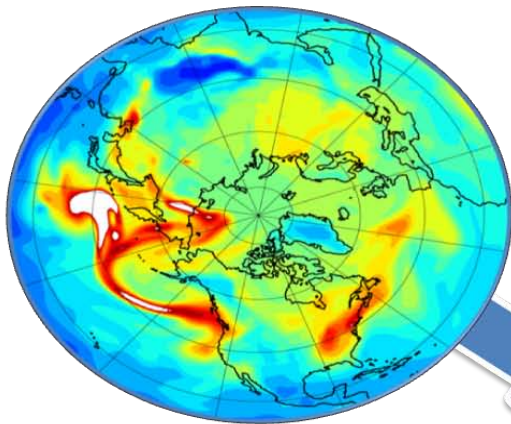


- provides opportunities to evaluate models and observations under one data assimilation approach
- towards an integration of modeling systems
- ability to investigate chemistry feedbacks and representation of dynamical/physical processes controlling chemistry



# air quality forecasting/assimilation system

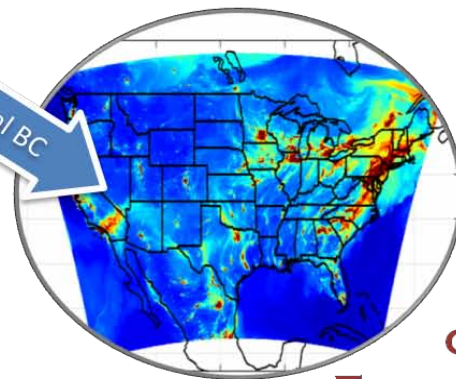
## CAM-CHEM/DART



## 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)

## WRF-CHEM/DART



### OBSERVATIONS

#### CURRENT:

- RAWINSONDES
- ACARS
- AIRCRAFT
- SATWINDS
- MOPITT CO
- MODIS AOD

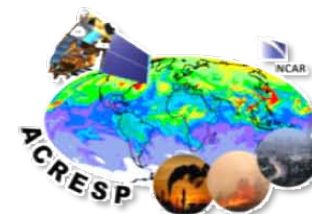
#### PLANNED:

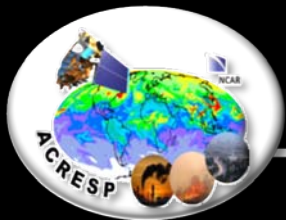
- TES CO, O<sub>3</sub>
- IASI CO, O<sub>3</sub>
- OMI NO<sub>2</sub>, O<sub>3</sub>
- GOME O<sub>3</sub>

### APPLICATIONS

- CHEMICAL OSSES
- CHEMICAL WEATHER
- FIELD CAMPAIGN SUPPORT

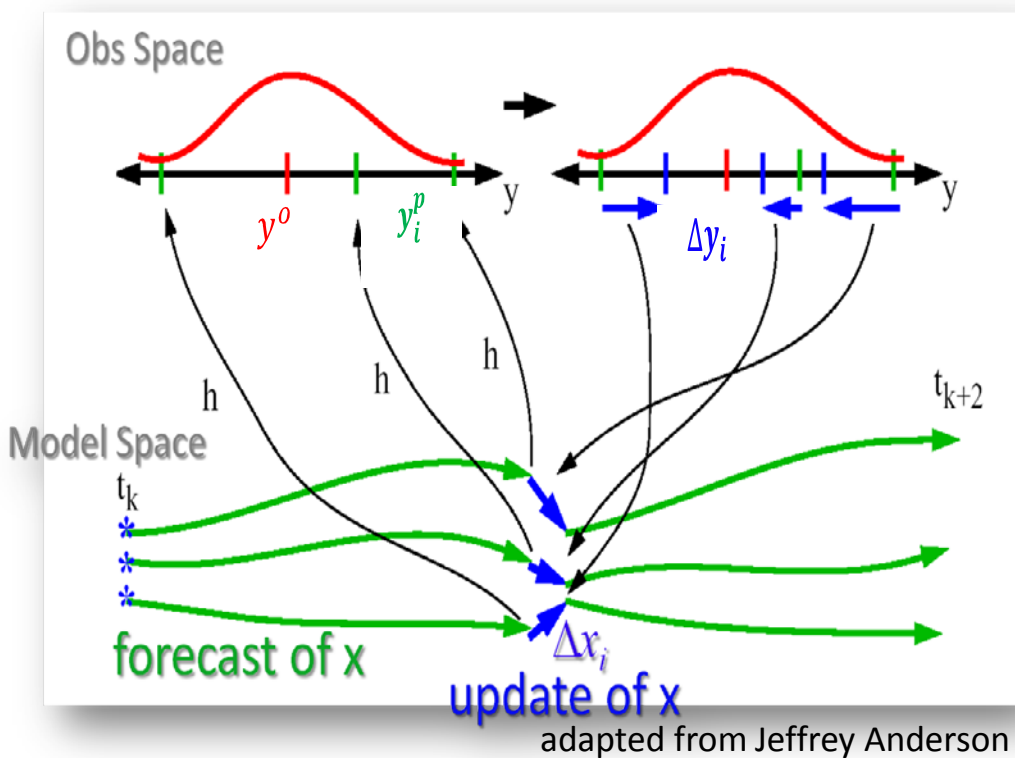
IN COLLABORATION WITH NCAR/IMAGE & NCAR/MMM





# data assimilation research testbed (DART)

an ensemble-based DA framework



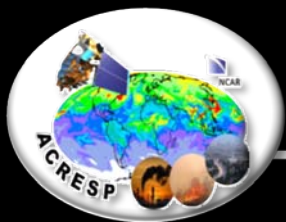
Volume 90 Number 9 September 2009

# BAMS

Bulletin of the American Meteorological Society

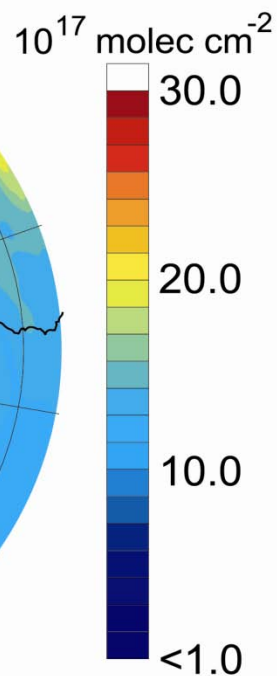
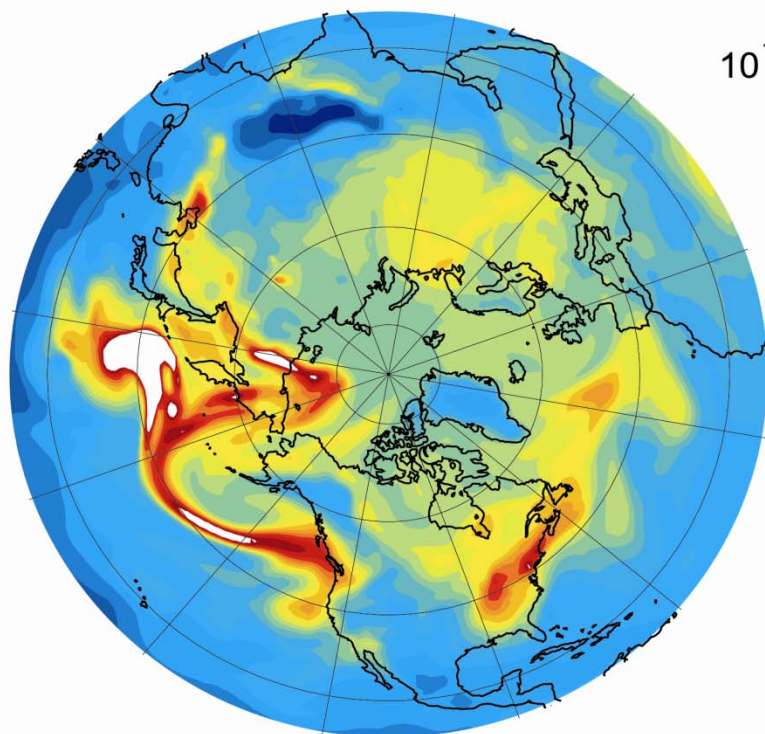
- NEW YORK CITY'S HEAT ISLAND
- ALPINE FORECASTS DEMONSTRATED
- GULF STREAM FIELD STUDY

**AIMING FOR BETTER PREDICTION**  
The Data Assimilation Research Testbed



# CO as a good tracer of pollution transport

CAM-Chem/DART CO Column



July 07, 2008 00:00 UTC

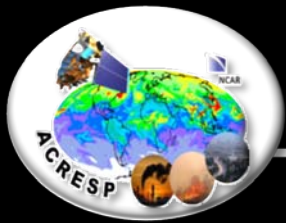
e.g.  $-\vec{v} \cdot \nabla[CO]$  *natural / anthropogenic combustion-related processes*

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

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

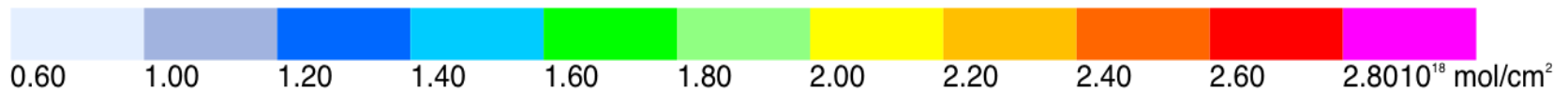
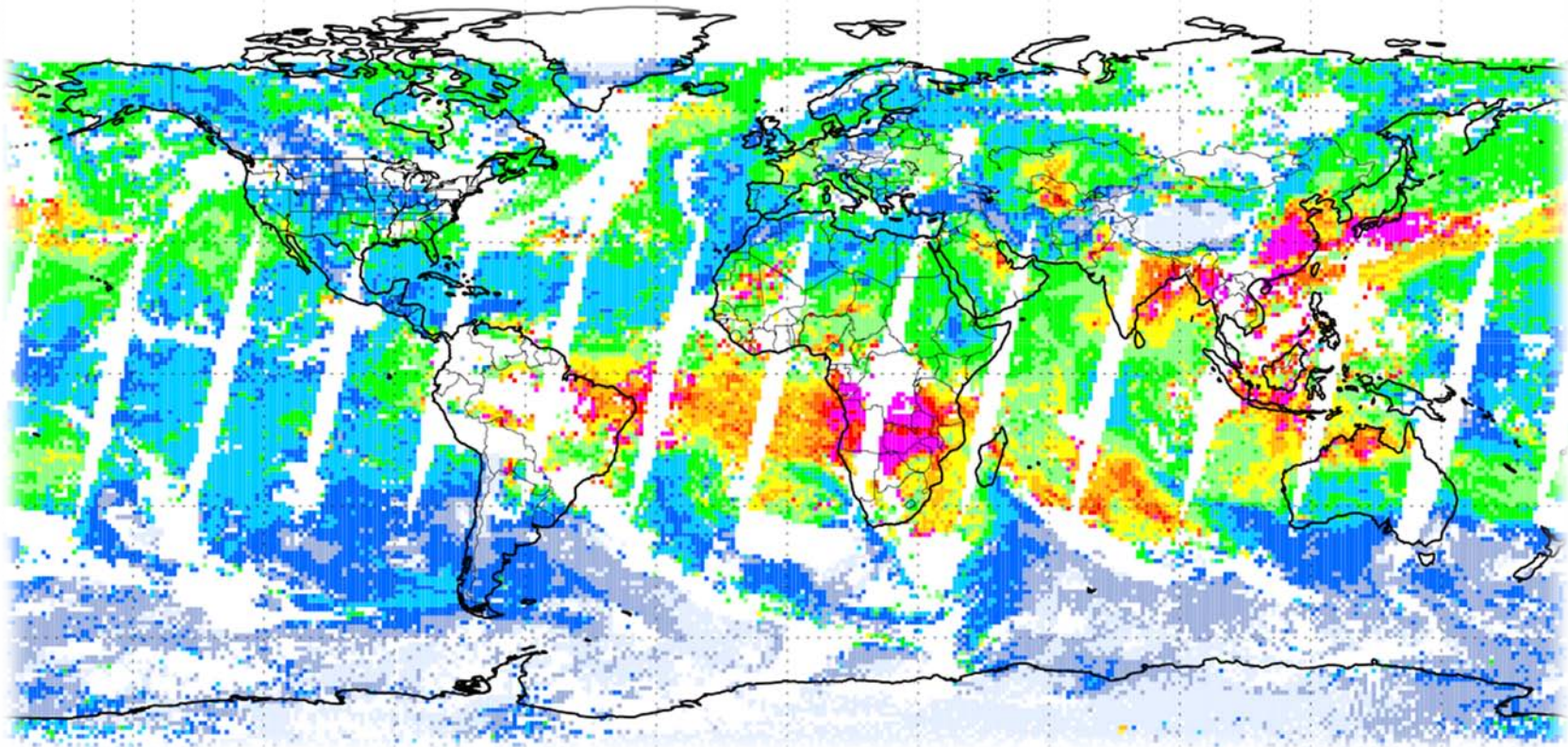
$-k_{CO-OH}[CO][OH]$   
 $k_{CH_4-OH}[CH_4][OH]$



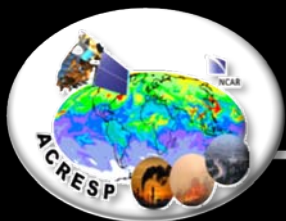


# CO is relatively well-observed

IASI Column CO Sept. 15, 2009



from D. Edwards/M. George

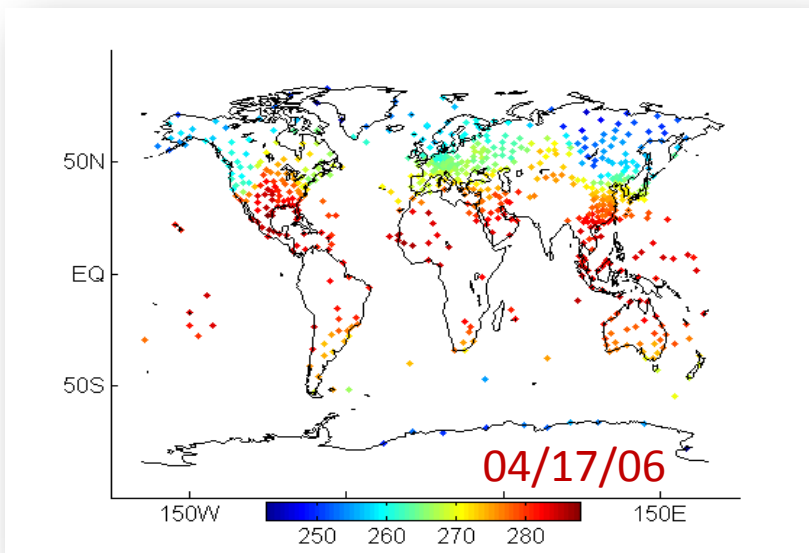


# cam-chem/dart experiments

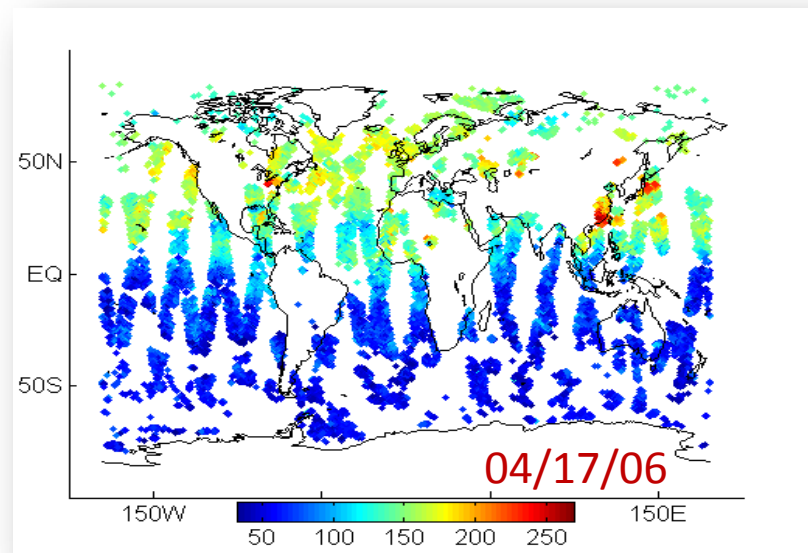
assimilation period: April to May, 2006

Experiment	Assimilation	Impact
Assim0 (uncoupled)	NCEP Bufr	Met Obs → Met States
Assim1 (uncoupled)	NCEP Bufr, MOPITTv4 CO	Met Obs → Met States CO Obs → CO State
Assim2 (coupled)	NCEP Bufr, MOPITTv4 CO	Met Obs → Met States, CO State CO Obs → CO State, Met States

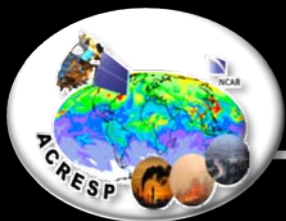
## Radiosonde



## MOPITT CO

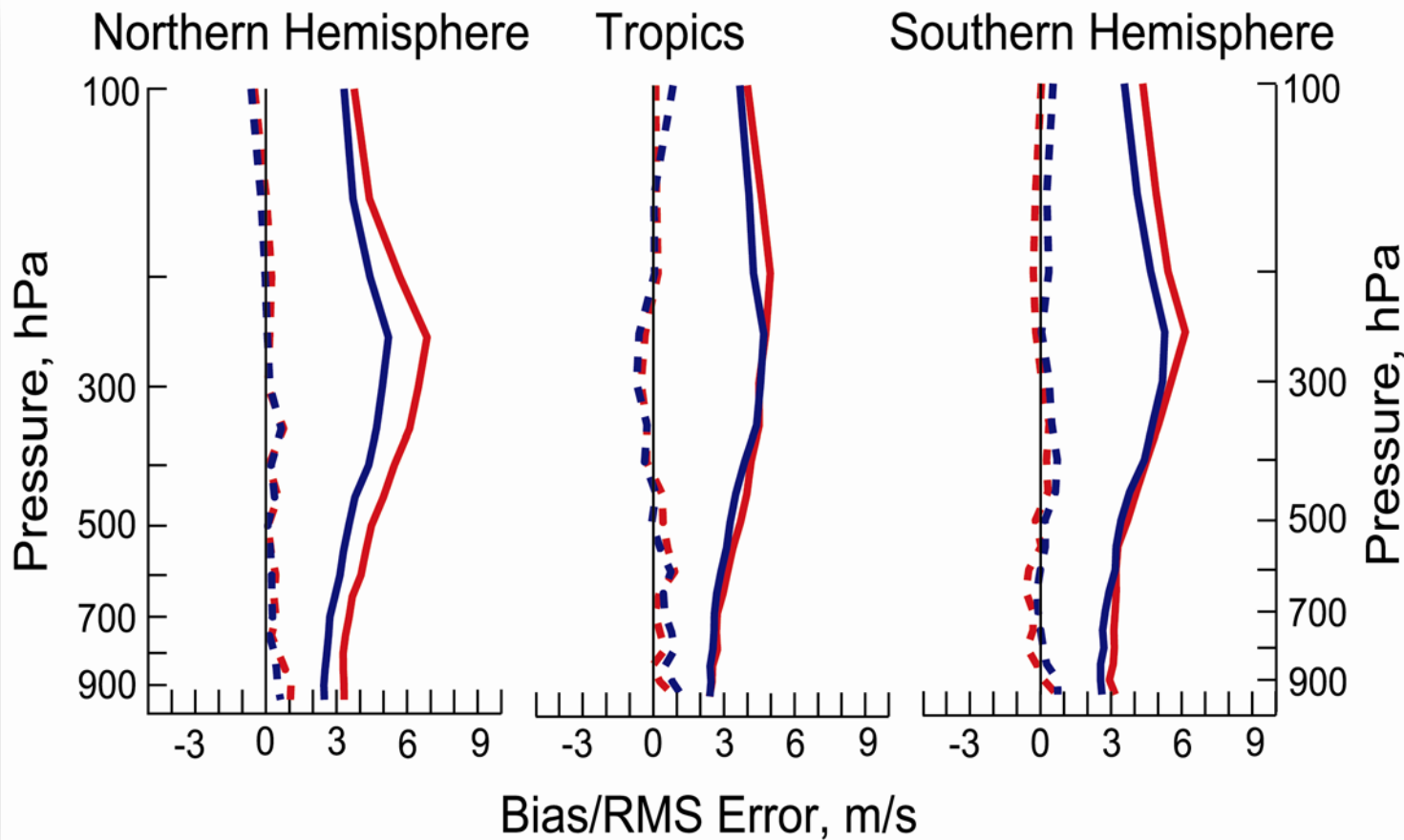






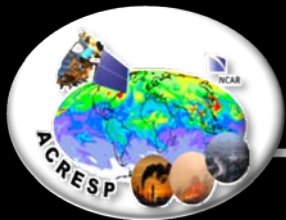
# results (assim0/assim2 U wind)

## Model U Wind Component Relative to Assimilated Radiosonde Observations



Assim 0 → uncoupled assimilation

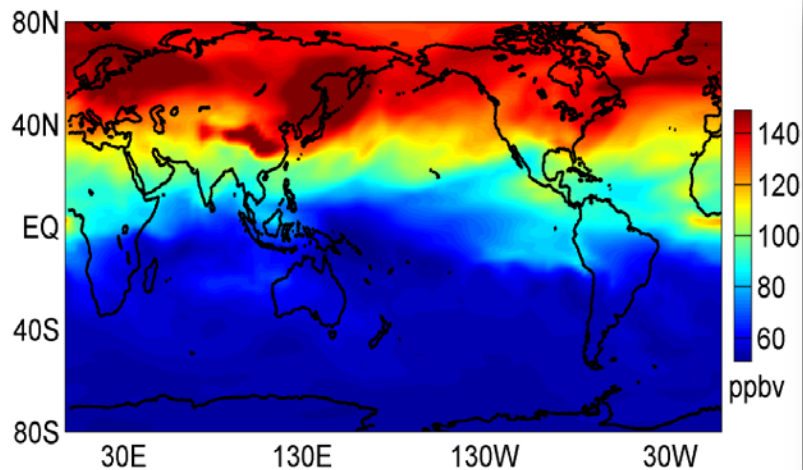
Assim 2 → coupled assimilation



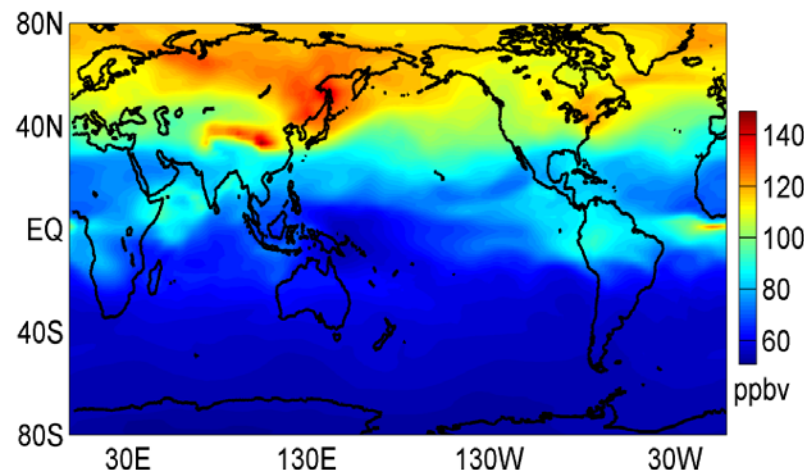
# results (model space)

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

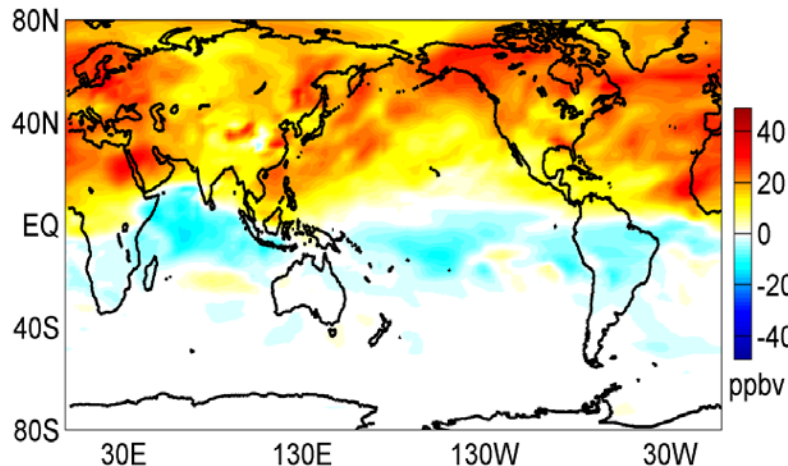
Assim2 (coupled)

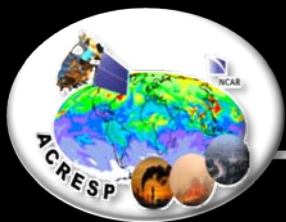


Assim0



Assim2 - Assim0

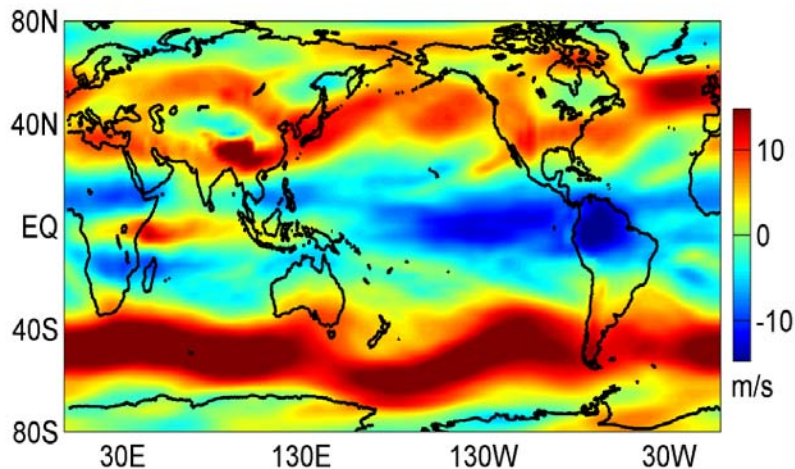




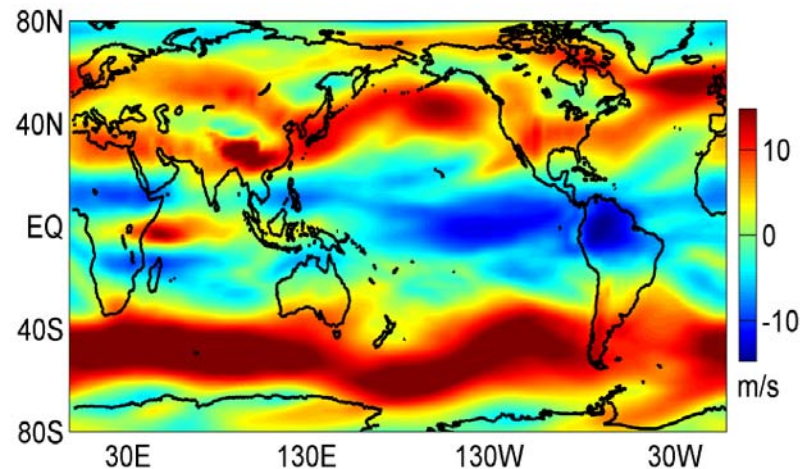
# results (model space)

## Model Mean U Wind @ 500 hPa (April 11-April 30, 2006)

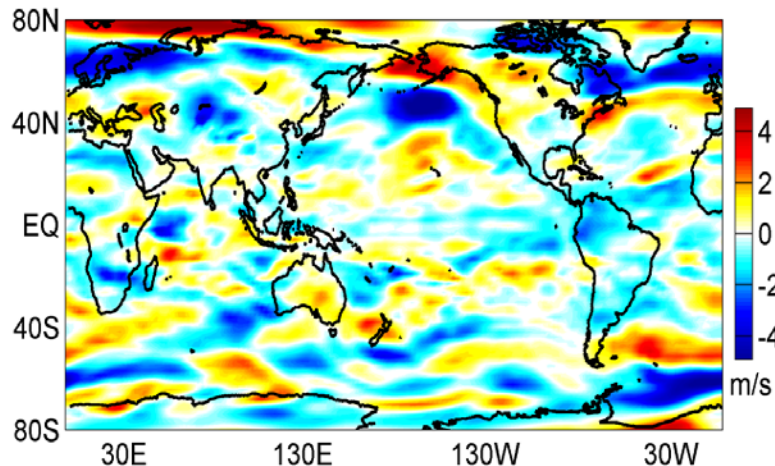
Assim2 (coupled)

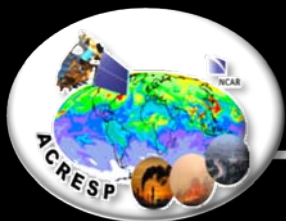


Assim0



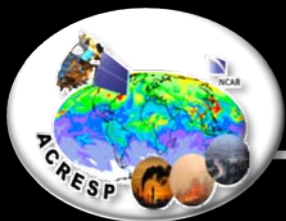
Assim2 – Assim0





- Is the fit to rawinsondes 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





# Assimilating MODIS AOD and MOPITT CO

## Constraining the distribution of chemically-active and radiatively-relevant species in CAM-Chem

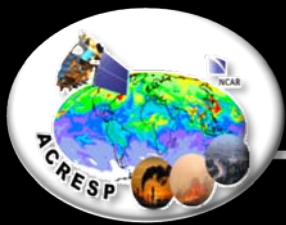
under Jeff Anderson's CSL project on 'Ensemble Data Assimilation for Climate Model Development'

### 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



# Assimilating MODIS AOD and MOPITT CO

Any suggestions on :

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