Hindcasts of Chemistry and Aerosols

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Atmospheric Chemistry and Climate (AC&C):

Effort focused on representation of chemistry-climate interactions in earth system models

Activity #1: CHEMICAL HINDCASTS

Objective: Evaluate the performance of global chemistry-transport models (CTMs) in preparation for their use in future climate projections.

-Test the capability of current atmospheric chemistry models to integrate over the variations and trends in circulation and climate, in emissions, and in chemical feedbacks that control atmospheric composition.

-Quantify and derive objective measures of uncertainty when global chemistry models are used in climate system models to project conditions of the 21st century

Experimental Approach

-Use the past few decades for which we have observations of trends and variability in atmospheric composition.

-Focus on large space (1000+ km) and time scales (multi-year to decadal variability) that are essential in projecting 21st century change, and that effectively integrate over many atmospheric processes.

-Take an integrative approach and not focus on process validation, which will be examined in other activities.

Why a coordinated exercise?

- Coordinated framework to compare/evaluate model results.
- Ability to formulate more objective measures of the inherent uncertainty in modeling atmospheric chemistry and transport and thus in projecting future composition.
- The best estimate of model response, and arguably the most actionable in terms of policy implications, is one produced from a multi-model ensemble using different models and model formulations.
- Multi-model experiments run with common diagnostics and selected specified common forcings allow a better understanding of the differences in the model behavior.
- Biases in comparison with measurements across a wide range of models suggest systematic problems may exist in the model formulation
- A systematic comparison across different models is helpful in improving the individual models and their processes

Hindcast Experiments

We are not proposing a single hindcast experiment from 1980

But, a series of interrelated experiments

***Chemical Hindcasts Proposed*:**

- **1)** *Simple tracers (CFCs and N2O)*
- **2)** *Aerosols*
- ***3)*** *Ozone Variability (including simulations of OH)*
- *4) Methane Variability.*

***Each hindcast experiment defined by*:**

- -- a multi-year series (post-1980) of measurements of atmospheric trace species.
- -- a clear objective grading criteria for evaluating model success.
- -- a set of required diagnostics to facilitate model comparison and evaluation.
- -- multi-year external forcings (e.g., emissions) needed to drive the simulations.
- -- guidelines on the types of chemical models and meteorological fields that can usefully participate.

Simple Tracer Hindcast

(C. Nevison, M. Prather, N. Mahowald)

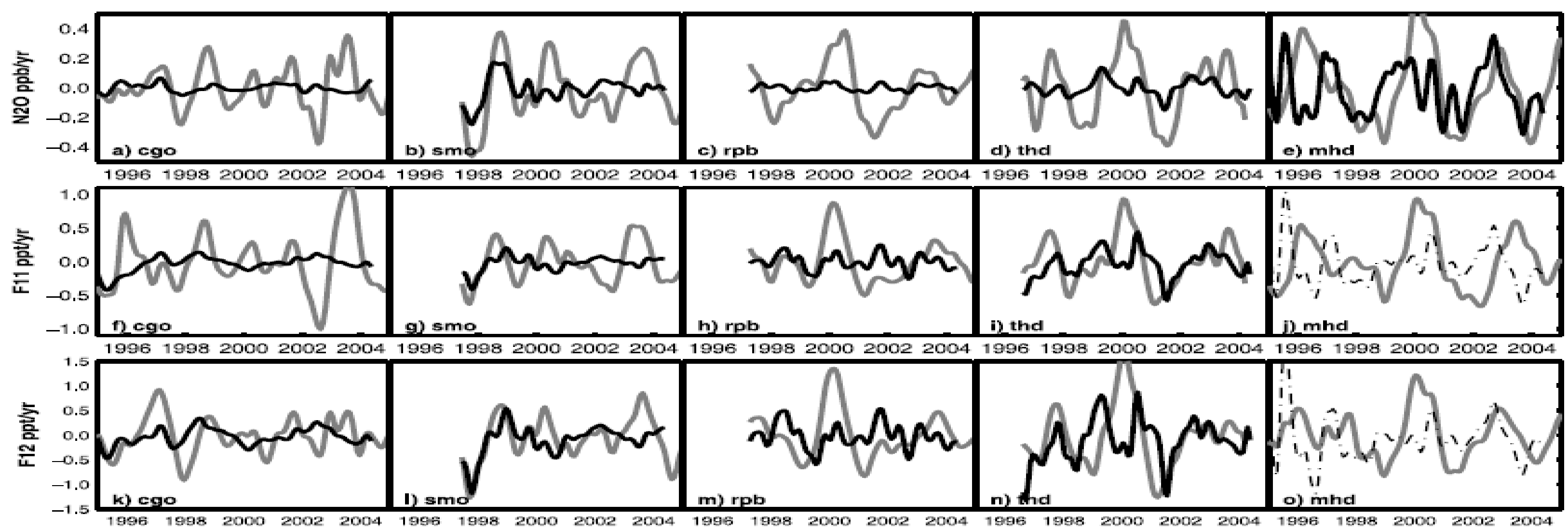
Goal: Match the trends and variability of the nearly-inert trace gases CFCs and N_2O as measured by stations of the ALE/GAGE network.

Quantify importance of:

-changing emissions

-tropospheric meteorology

-stratosphere-troposphere exchange variability.



From Nevison et al., Interannual Growth Rate Anomalies: Match and AGAGE

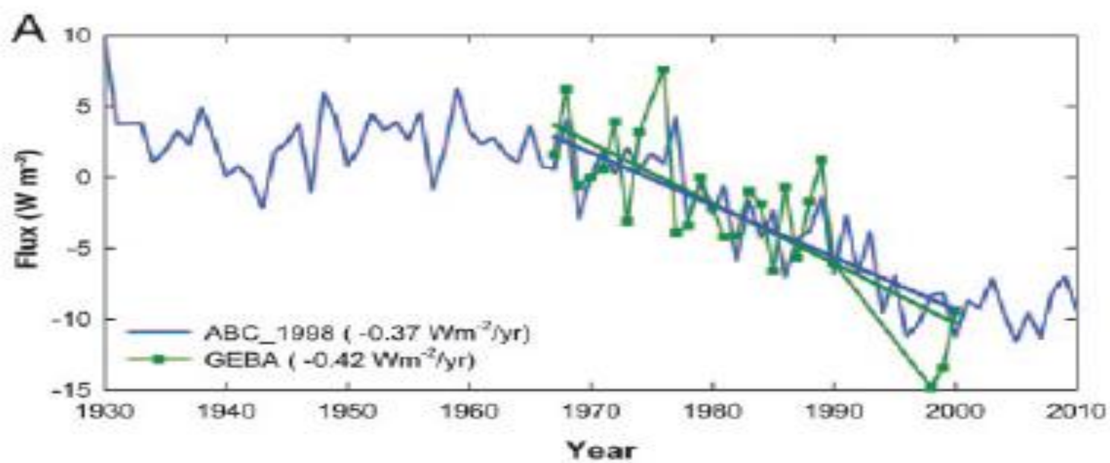
Aerosol Hindcast

(Michael Schulz, Mian Chin)

Goals: Better understanding of:

-regional and global satellite observed trends in AOD
-regional differences in sulfate and black carbon deposition from the Arctic to the Alpes
-temporal trends in aerosol concentration, composition, optical properties and deposition
-emission trends of primary aerosols and aerosol precursor gazes
-the impact of changing meteorology vs changing emissions on aerosol trends
-dimming and brightening trends observed by surface radiation networks
-the evolution of the anthropogenic aerosols perturbation of the Earth radiative balance

To be run as part of AEROCOM



From
Ramanathan et al., 2005

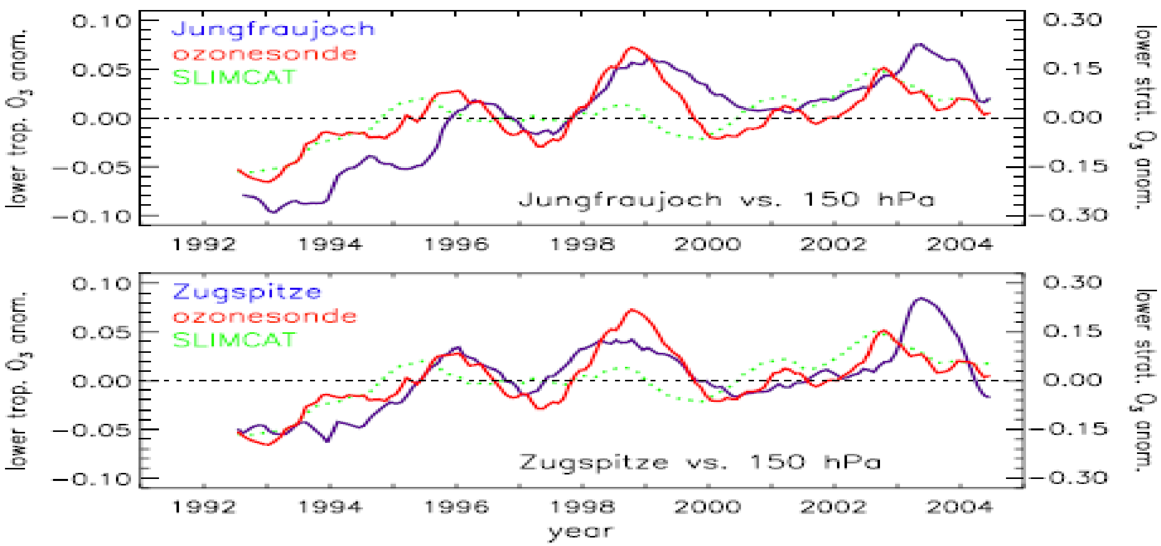
Observed and simulated
Surface Radiation
Fluxes over India

Ozone Hindcast

(Jennifer Logan, Peter Hess)

Goals: quantify impact on tropospheric ozone of:

-changes in emissions of ozone precursors (NO_x, CO, hydrocarbons)
-changes in methane
-changes in ozone in the lower stratosphere
-dynamical variability including STE, ENSO, NAO/AO



From Ordonez et al.

Interannual Ozone Variations and trends.

Methane Hindcast

(I. Bey, F. Dentener, A. Fiore, P. Hess, P. Bergamaschi)

Goal*:* Match the observed methane trends and variability.

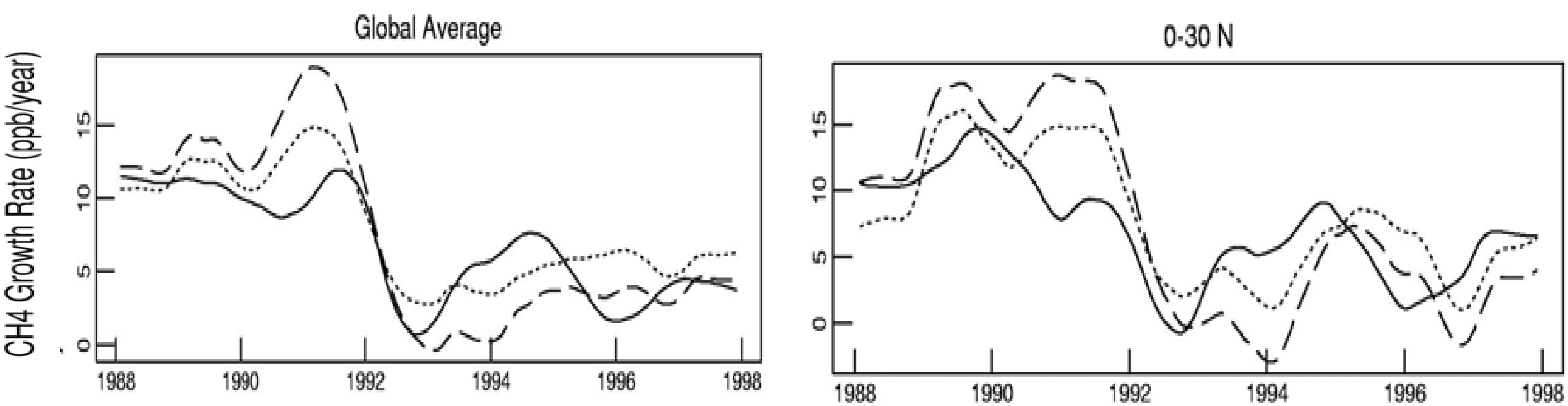
Quantify:

-the importance of changing anthropogenic and natural emissions

-the importance of OH variations.

Procedure:

use OH fields from the ozone hindcast in an inverse modeling calculation for methane emissions – reconcile top-down and bottom-up emission estimates.



From Wang et al, Modeled and Observed changes in CH4 growth rate.

Where do we go from here?

Strawman proposals have been formulated.

We need your:

-input

-enthusiasm

-leadership

-help in coordination with ongoing activities

Thanks.