AC&C Hindcasts: The Emerging Format

Overview of Timeline:

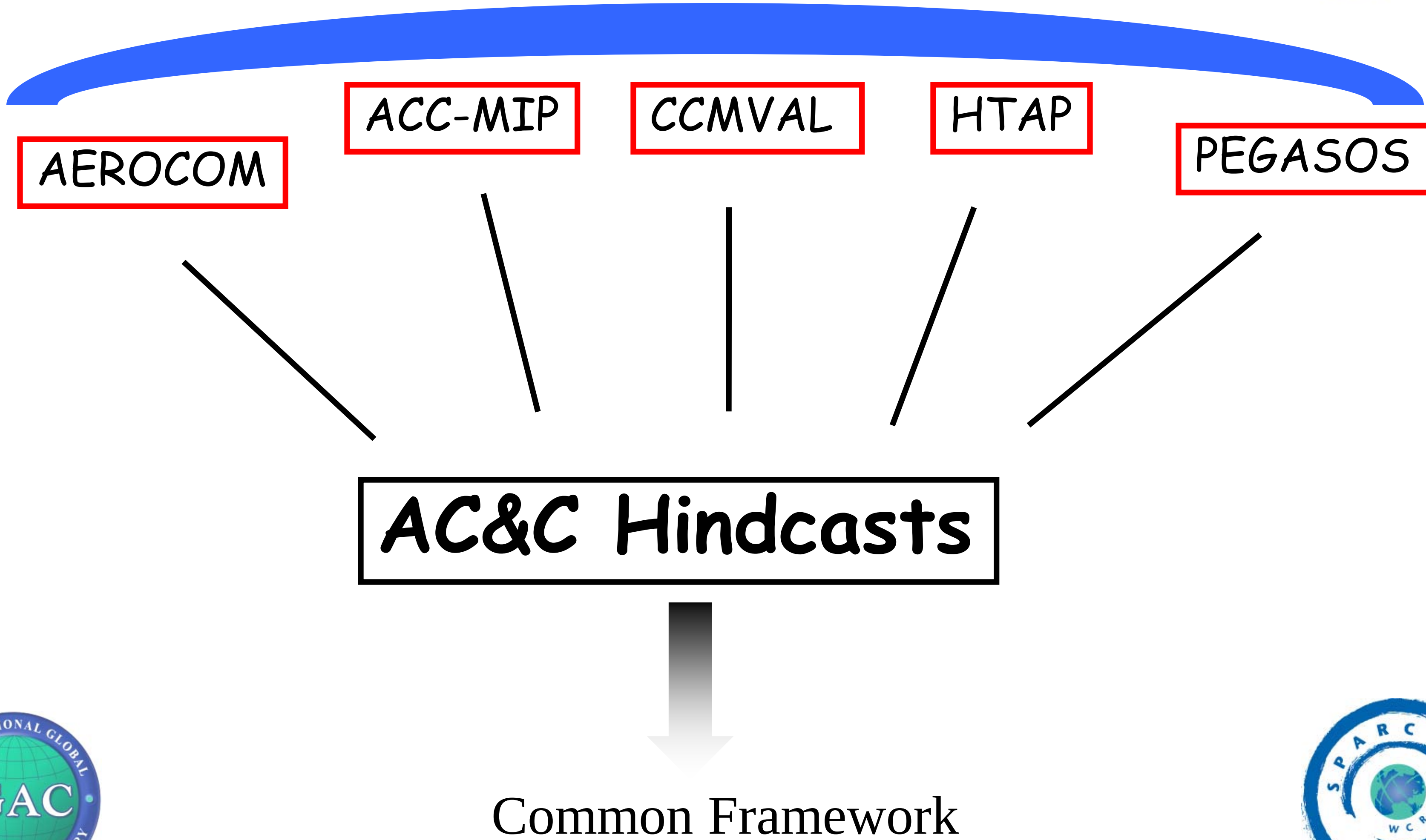
- ✓ May 2011 Initial Discussions: **P. Hess** (ACC1), M. Schulz, M. Chin (AEROCOM), J.F. Lamarque, D. Shindell (ACC-MIP), D. Waugh (CCMval), F. Dentener, T. Keating (HTAP), P. Monks (IGAC), I. Bey, C. Granier (PEGASOS), J. Stahelin (SPARC)

- Aug-Sept 2011 Straw-man document for community input and comment
  - Hindcast Specifications and Procedures
  - Initial identification of multi-year measurement timeseries

- Nov-Dec 2011 Finalize document and begin hindcasts

AC&C Hindcasts

Contributing Hindcast Activities



AC&C Hindcasts

Foci of Various Partners

AEROCOM: Focus on Aerosols, but many models include chemistry and Oxidants

ACC-MIP: Focus on Chemistry-Climate Interactions. Hindcast simulations include climatological SST w/o interannual variability

CCMVAL: Focus on lower stratosphere/upper troposphere, impact of stratosphere on tropospheric chemistry including STE

HTAP:Focus on intercontinental transport and air pollution

PEGASOS: Focus on air quality and climate

AC&C1 Hindcasts

Unify Various Hindcast Experiments by:

- Required output/diagnostics to facilitate model comparison and evaluation.
- Specification of 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
- Initial identification of multi-year measurement timeseries
- A common site to archive data
- A common data access policy

NOTE: *Output defined by various participatory groups may differ. For example ACC-HTAP may request output of source-receptor tracers of intercontinental transport; ACC-CCMVAL may request stratospheric chlorine loading. ACC will specify common output to be provided by all participating groups.*

AC&C1 Hindcasts

Advantage of common hindcast framework:

•One model simulation necessary to participate in various hindcast activities.

•Increased participation in any particular hindcast activity is more likely.

•Single data repository will allow broader use of data.

•More widespread data sharing and analysis methods between groups.

•Larger variation in types of models participating.

AC&C1 Hindcasts

Overall Goals and Focus

- Focus on tropospheric oxidants (OH, O3)

- Evaluate 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

-Identify most important processes that determine tropospheric interannual variability including: emission changes, stratospheric changes, dynamical influences including STE, ENSO, NAO/AO and climate

-Derive objective measures of uncertainty in modeling atmospheric chemistry and transport and thus in projecting future composition

AC&C1 Hindcasts

Participating Models:*

1)Chemistry-Transport Models driven by reanalysis winds.

- *These models allow for more straightforward model-data comparisons.*
- *They have some disadvantages in accurately representing stratospheric circulation as well as problems in tropospheric temperature and humidity trends (Hess and Mahowald, 2009; Trenbert et al., 2011 and references)*

2)GCMs driven by observed SSTs.

- *These models allow best evaluation of models used in the IPCC and allow best comparison with ACC-MIP experiments.*
- *Can be used to evaluate forced response to SST changes.*

3) Models that include explicit stratospheric circulation and chemistry

- *Includes more realistic representation of stratospheric processes.*
- *Allows best comparison with CCMval.*

**All models will be global with defined minimum resolution and tropospheric photochemistry. Analysis concentrated on large spatial and temporal timescales.*

Table 6: Change in globally averaged selected variables with year in SCAM and SNCEP. Three dimensional fields are density weighted and averaged between the surface and 280 hPa. Only results significant at the 95 percentile are shown. Results significant at the 99^{th} percentile are shown in bold. Three dimension quantities evaluated at the surface are prefixed with Sfc. The units of the "change"/year are the units given for each variable.

	SCAM	SNCEP
O3 (ppbv)	NS	**7.17E-02**
CO (ppbv)	-3.24E-05	NS
OH (mole/mole $x10^{15}$)	5.26E-02	NS
HNO3 (pptv)	NS	**-1.18E-01**
Sfc O3 (ppbv)	**-9.10E-03**	**4.80E-02**
Sfc T (C)	**1.11E-02**	NS
Sfc JNO2 (s^{-1} x 10^{-3})	**-4.14E-04**	NS
LNO (TgN/year)[1]	7.10E-03	**1.52E-02**
PBLH (m)[2]	NS	2.60E-01
PRECT (mm/day)[3]	**1.40E-03**	**5.20E-03**
Q (g/kg)[4]	**3.30E-03**	NS

[1] Source of lightning odd nitrogen in Tg N yr^{-1}; [2] Planetary Boundary Layer Height; [3] Total Precipitation; [4] Water Vapor

Hess and Mahowald, 2009

AC&C1 Hindcasts

Participating Models:*

1)<u>Chemistry-Transport Models driven by reanalysis winds</u>.

- *These models allow for more straightforward model-data comparisons.*
- *They have some disadvantages in accurately representing stratospheric circulation as well as problems in tropospheric temperature and humidity trends (Hess and Mahowald, 2009; Trenbert et al., 2011 and references)*

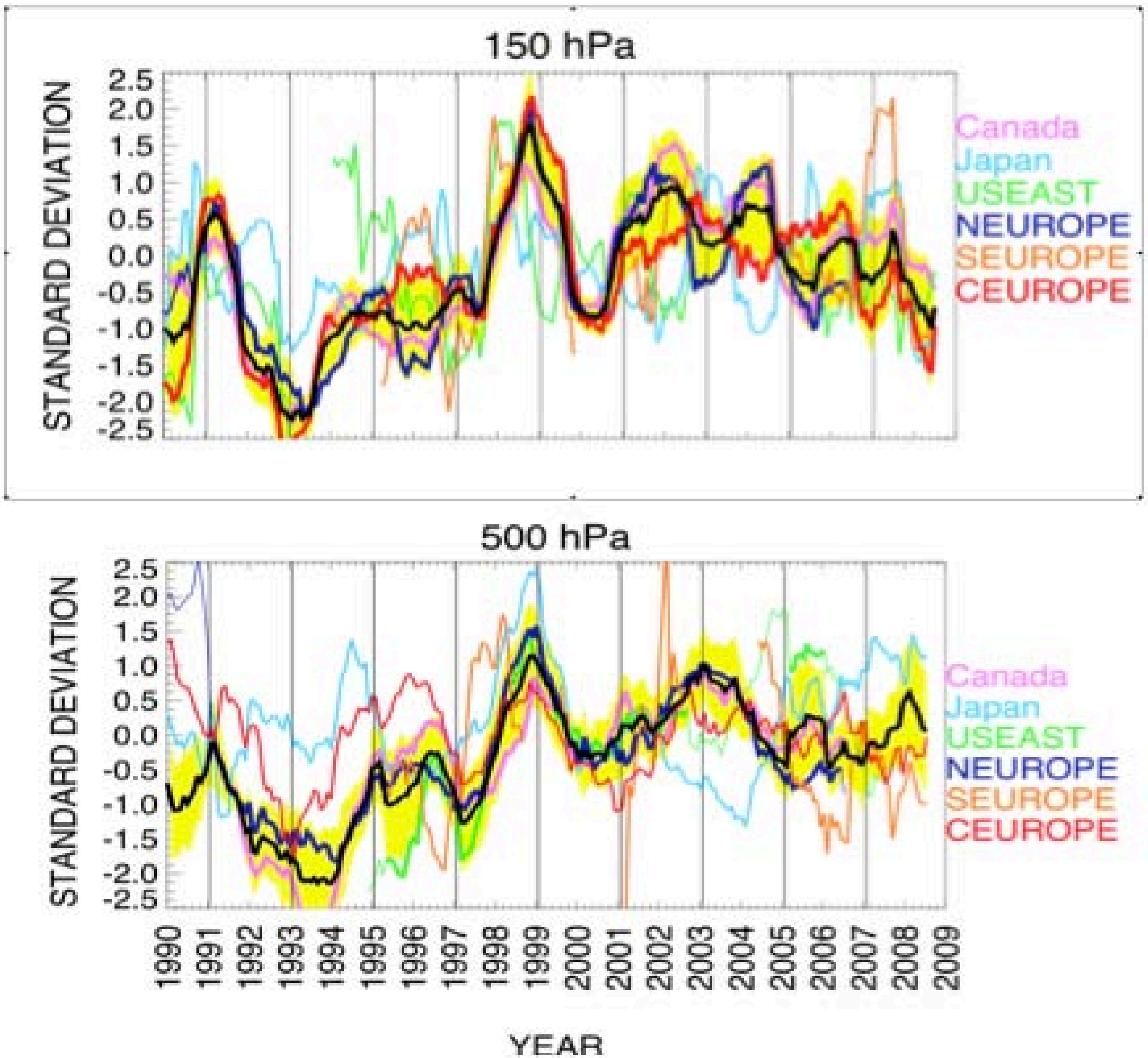
2)<u>GCMs driven by observed SSTs.</u>

- *These models allow best evaluation of models used in the IPCC and allow best comparison with ACC-MIP experiments.*
- *Can be used to evaluate forced response to SST changes.*

<u>3) Models that include explicit stratospheric circulation and chemistry</u>

- *Includes more realistic representation of stratospheric processes.*
- *Allows best comparison with CCMval.*

**All models will be global with defined minimum resolution and tropospheric photochemistry. Analysis concentrated on large spatial and temporal timescales.*



R=0.83

Hess and Zbinden, 2011

AC&C1 Hindcasts

Time Periods for Hindcasts:

Primary period:

1)1980 – Present Day

- Reanalysis products reasonably consistent and measurement network increasing dense

Secondary periods:

2) 1960 – Present Day.

- Captures stratospheric ozone destruction and recovery.
- Allows better statistics between climatological forcing and atmospheric chemical response (e.g., correlation with El Nino)
- But, is problematic with the use of analyzed winds due to incorporation of satellite data after 1979(Hess and Mahowald)

3) 1997 – Present

- Proposed intensive analysis period with more frequent model output.
- Allows evaluation against satellite measurements
- Probably too short to allow interannual variability to be assessed.

AC&C1 Hindcasts

Forcings for Hindcasts:

Anthropogenic Emissions:

-MACCity project Emissions/Global Reactive Gases group (http://www.gmes-atmosphere.eu/)

- Prior to 2000: Based on ACC-MIP emissions
- Post 2000: Based on RCP 8.5, which includes some information concerning emissions in North America, Europe and Asia.

Natural Emissions:

-Dust, Sea-salts, BVOC, soil NOx, lightning NOx. Calculated on-line if possible or obtained from participating group

AC&C1 Hindcasts

Forcings for Hindcasts Continued:

Radiative gasses including methane:

-Specified at lower boundary

Solar cycle and stratospheric aerosol loading

- Specified as in CCMVAL http://www.pa.op.dlr.de/CCMVal/Forcings/CCMVal_Forcings_WMO2010.html)

SSTs:

-Specified from common dataset

Meteorogical Reanalysis

- Users Choice

AC&C1 Hindcasts

Outputs (under discussion):

-Ozone budget terms
-OH budget terms
-PAN budget terms?
-Longlived tracers (e.g., CFCs) for diagnosing transport and STE
-Diagnostic Tracers (under discussion)
- *For boundary layer transport*
- *For STE*
- *For convection*

- *Species diagnosing surface air quality*

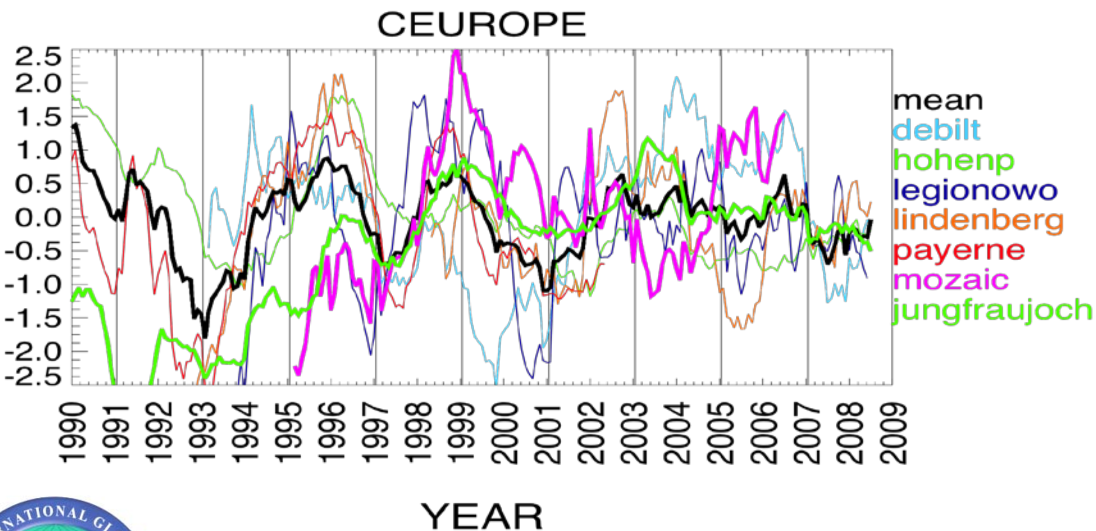
Future Sensitivity Experiments:

-Constant emissions
-Specified Methane emissions w/ varying OH fields

AC&C1 Hindcasts

Coordination w/ measurements/analysis

-***Ozone Trends:*** *(orgnizers* Thouret, Cammas, Logan, Shultz, Oltmans, Parrish, Staehelin, Tarasick, Galbally, Tarasova) **Charge:** use of available tropospheric measurement to give regionally robust tropospheric ozone trends and variability.

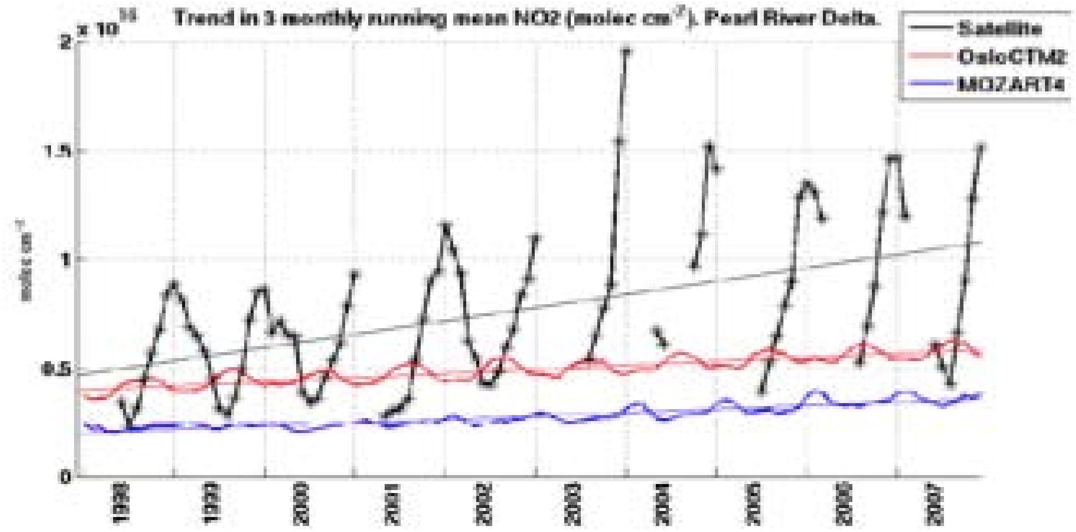


European Ozonesondes and other measurements. Interannual variations, 1990-2009
Hess and Zbinden (2011)

AC&C1 Hindcasts

Coordination w/ measurements/analysis

-<u>Satellite observations</u> (Randall Martin for NO2, but will enlist others)
Charge: evaluate model output against satellite record



Courtesy: Claire Granier
Satellite and model NO2
over Pearl River Delta
Models cannot reproduce
Trends or observations.

AC&C1 Hindcasts

Inputs necessary and welcome:

-Hindcast formulation

-Measurement datasets/analysis for verification

-Interesting and necessary model output

-Comments

Thanks!