Scientific Objectives of SPARC* and the Value of Data Assimilation

*Stratospheric Processes and their Role in Climate:
 a project of the World Climate Research Programme

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Aim of SPARC

- To bring stratospheric expertise to bear on scientific issues concerned with climate processes and climate prediction;
- for the benefit of:
  - World Climate Research Programme
  - WMO/UNEP Ozone Assessment
  - IPCC
  - Space Agencies
SPARC’s Approach

• To focus effort on
  – manageable scientific tasks, with a
  – well-defined outcome, over a
  – short period of time, while seeking to
  – anticipate needs of the wider community
Recent Deliverables

- "Stratospheric temperature trends: observations and model simulations" (paper by STTA group, awarded the WMO Norbert Gerbier-MUMM Award, 2003).
- Stratospheric reference climatology
Stratospheric Chemistry and Climate

• How will stratospheric ozone and other constituents evolve?
• How will changes in stratospheric composition affect climate?
• What are the links between changes in stratospheric ozone, UV radiation and tropospheric chemistry?
Ozone and aerosol have multiple roles

Ozone—
- Greenhouse gas
- UV shield
- Drives atmospheric chemistry
- Toxic to living things upon contact

Ozone is MADE in the atmosphere

Aerosols
- Interacts with radiation: absorbs or scatters radiation
- Alters composition of the atmosphere (medium for reactions)
- Affects cloud formation and cloud properties
- Harmful to humans (in some cases, e.g., PM 2.5)

Aerosols are
- made in the atmosphere from the gas phase
- emitted into the atmosphere
- transformed in the atmosphere
Distinction between ozone and aerosol

O$_3$ - We know what it is! With all its properties defined

Aerosol - not a single entity!
- Composition - highly complex
  - Size distribution
  - Optical properties - Absorbing vs. scattering
  - Phase - liquid, solid, mixture

All these "properties" change in the atmosphere

All the properties make a difference
ASAP – The SPARC Aerosol Assessment

ASAP
Assessment of Stratospheric Aerosol Processes

El Chichón  Pinatubo

Aerosol Processes
Precursor Gases
Aerosol Record
Trend Analysis
Modeling
Detection and Attribution of Past Stratospheric Changes

- What *are* the past changes and variations in the stratosphere?
- How well can we explain past changes in terms of natural and anthropogenic effects.
Mean vertical profile of annual & decadal temperature trend at 45°N.

Compiled using radiosonde, satellite and analysed data sets.
O$_3$ Combined Trend (1 & 2 sigma) 1980–96

Altitude (km)

Trend (%/decade)
Ozone-trends and why

- In-situ O3 destruction
- Other Dynamical Forcings
- Forcing by Weather Systems
- Cirrus processing
- Contributions from polar processed air

Cl ClO
Stratosphere-Troposphere Coupling

- What is the role of dynamical and radiative coupling with the stratosphere in extended range tropospheric weather forecasting?
- What is the role of dynamical and radiative coupling in determining long-term trends in tropospheric climate?
- By what mechanisms do the stratosphere and troposphere act as a coupled system?
Some Data Assimilation Requirements for SPARC Science

- Long term, global data sets for the troposphere and stratosphere, free of artificial trends.
- 3-D velocity fields with reduced data assimilation “noise” at ?-hourly intervals.
- Parametrized mass fluxes.
- Diabatic heating rates.
- Ozone, tracers and aerosols.
- Attention to B in the UT/LS region.
Data Assimilation Working Group

- Collect information on stratospheric data sets on meteorology and chemistry (quality, availability, software…).
- Process-focused quality assessments.
- Collect and document information in data assimilation systems.
- Liaise with space and other agencies on SPARC data needs.
End