# 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
- WMO/UNEP Ozone Assessment 2002
  - Chap. 4 Global Ozone: past and future.

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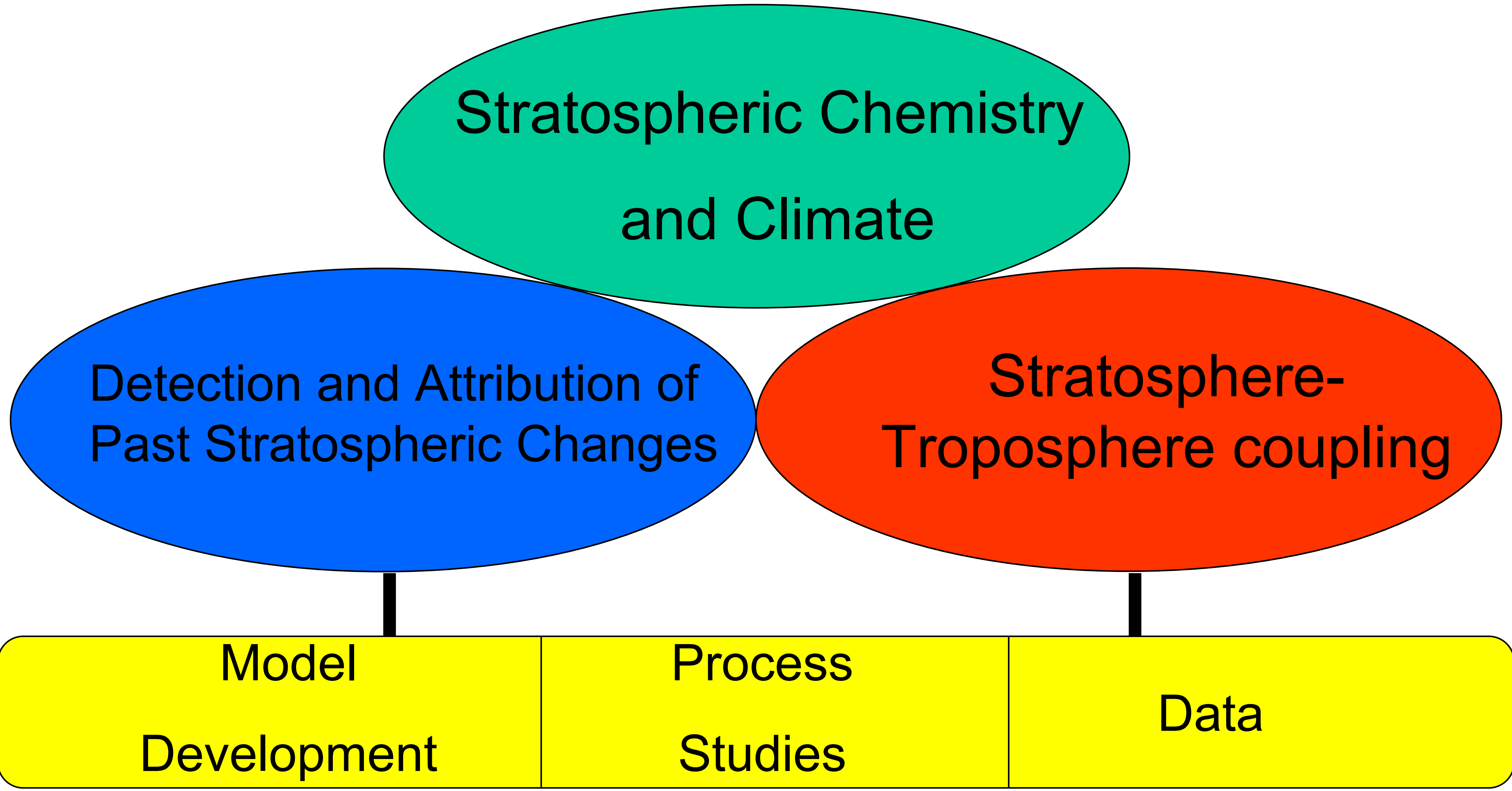


# Future Themes

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# 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?

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# 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

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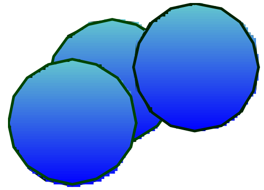
# Distinction between ozone and aerosol

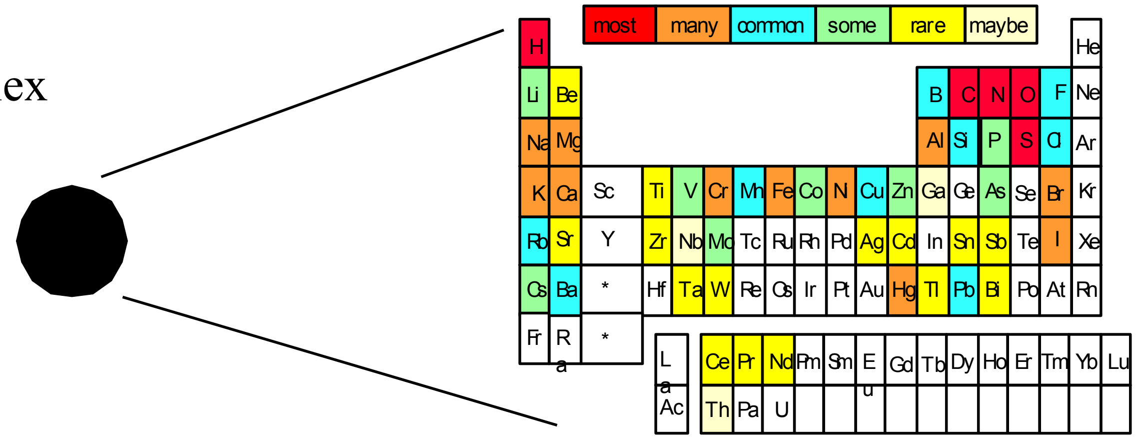
$O_3$ - We know what it is!



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

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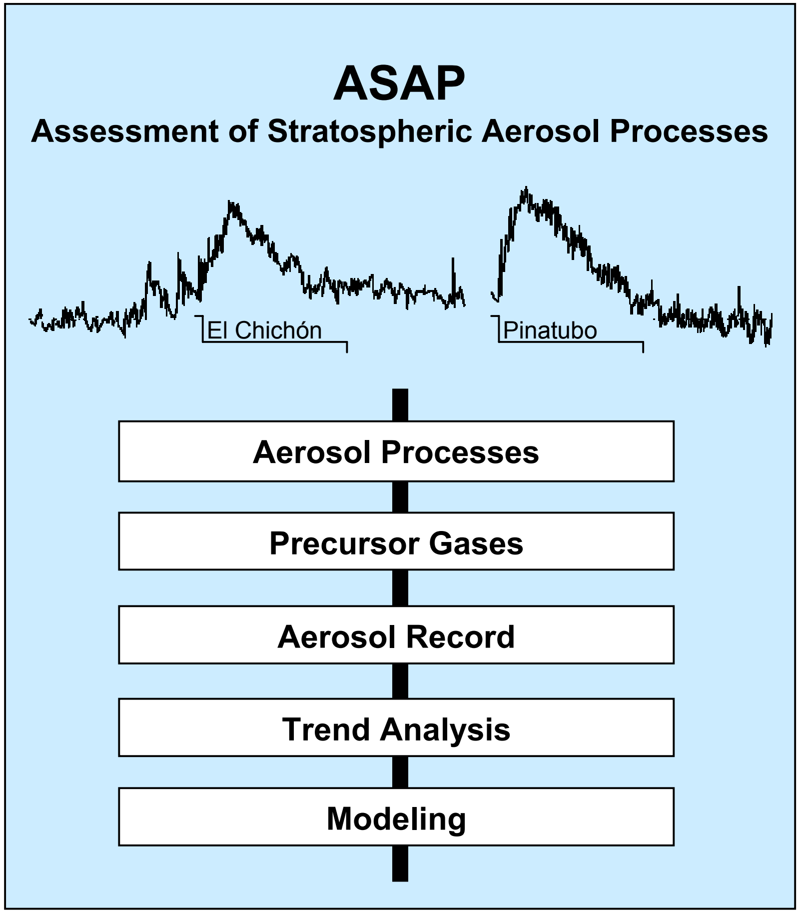
# ASAP – The SPARC Aerosol Assessment

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# 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.

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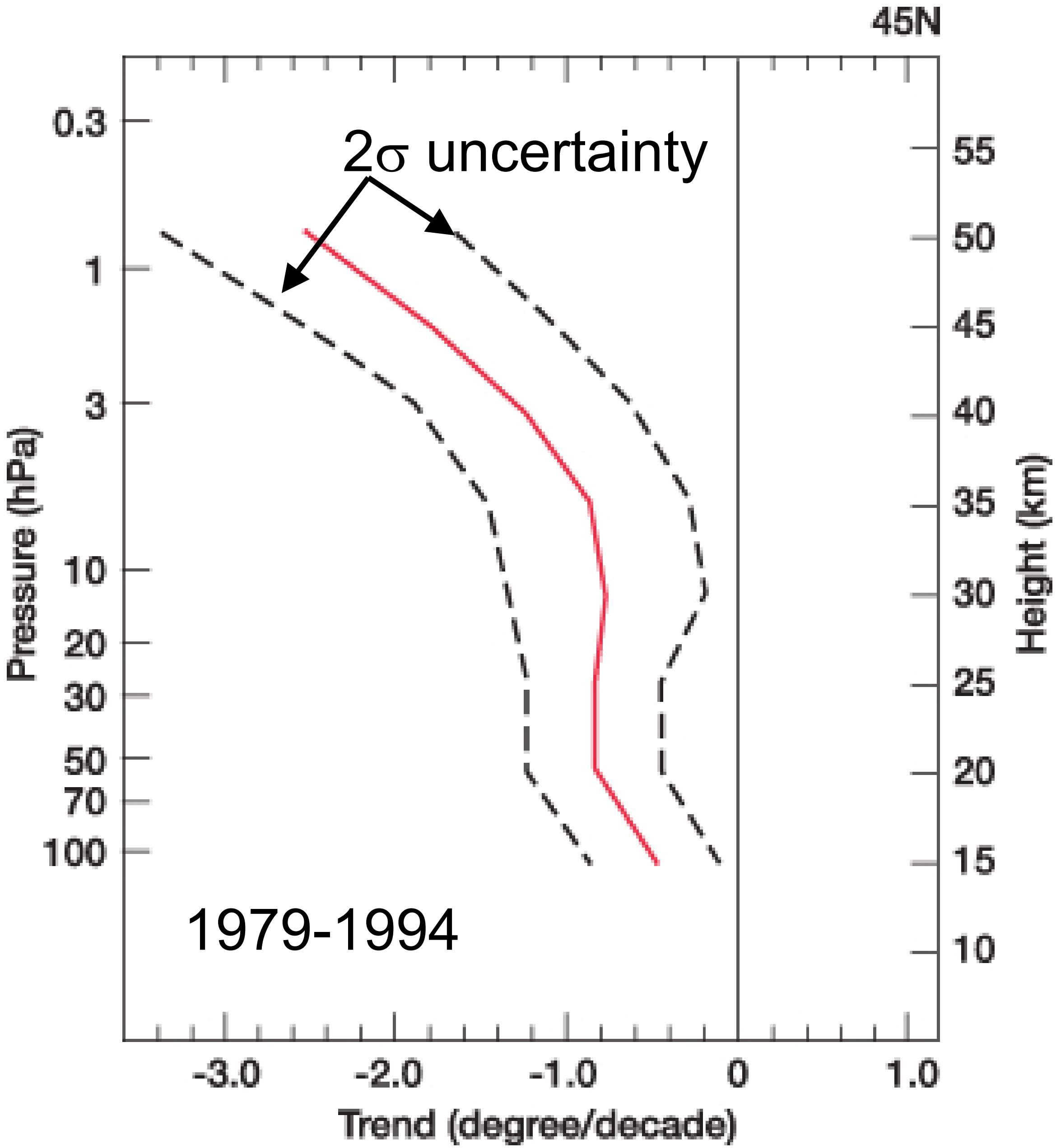
SPARC WCRP




Mean vertical profile of annual & decadal temperature trend at 45°N.

Compiled using radiosonde, satellite and analysed data sets

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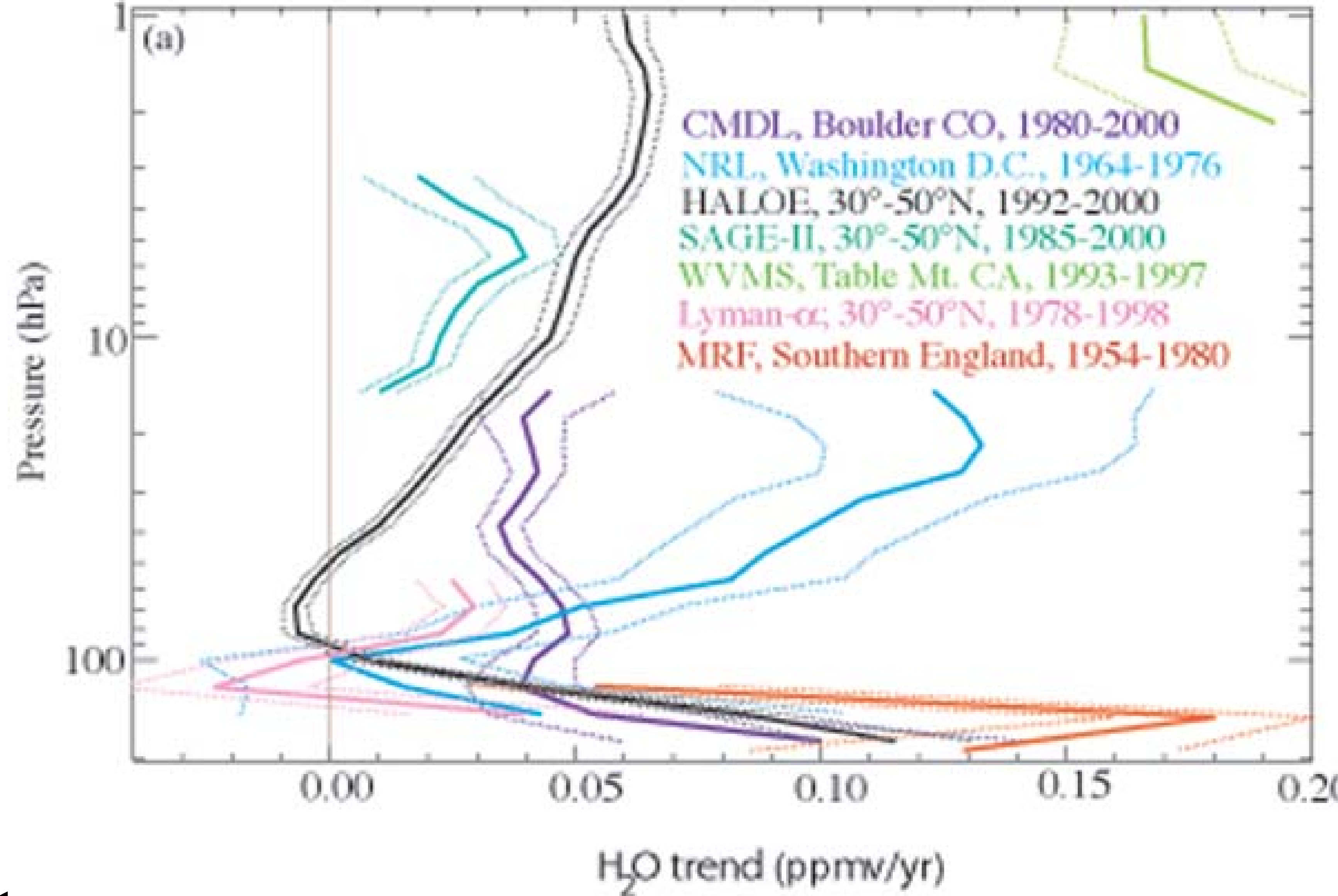
(a)
CMDL, Boulder CO, 1980-2000
NRL, Washington D.C., 1964-1976
HALOE, 30°-50°N, 1992-2000
SAGE-II, 30°-50°N, 1985-2000
WVMS, Table Mt. CA, 1993-1997
Lyman-α; 30°-50°N, 1978-1998
MRF, Southern England, 1954-1980
Pressure (hPa)
1
10
100
0.00
0.05
0.10
0.15
0.20
H2O trend (ppmv/yr)

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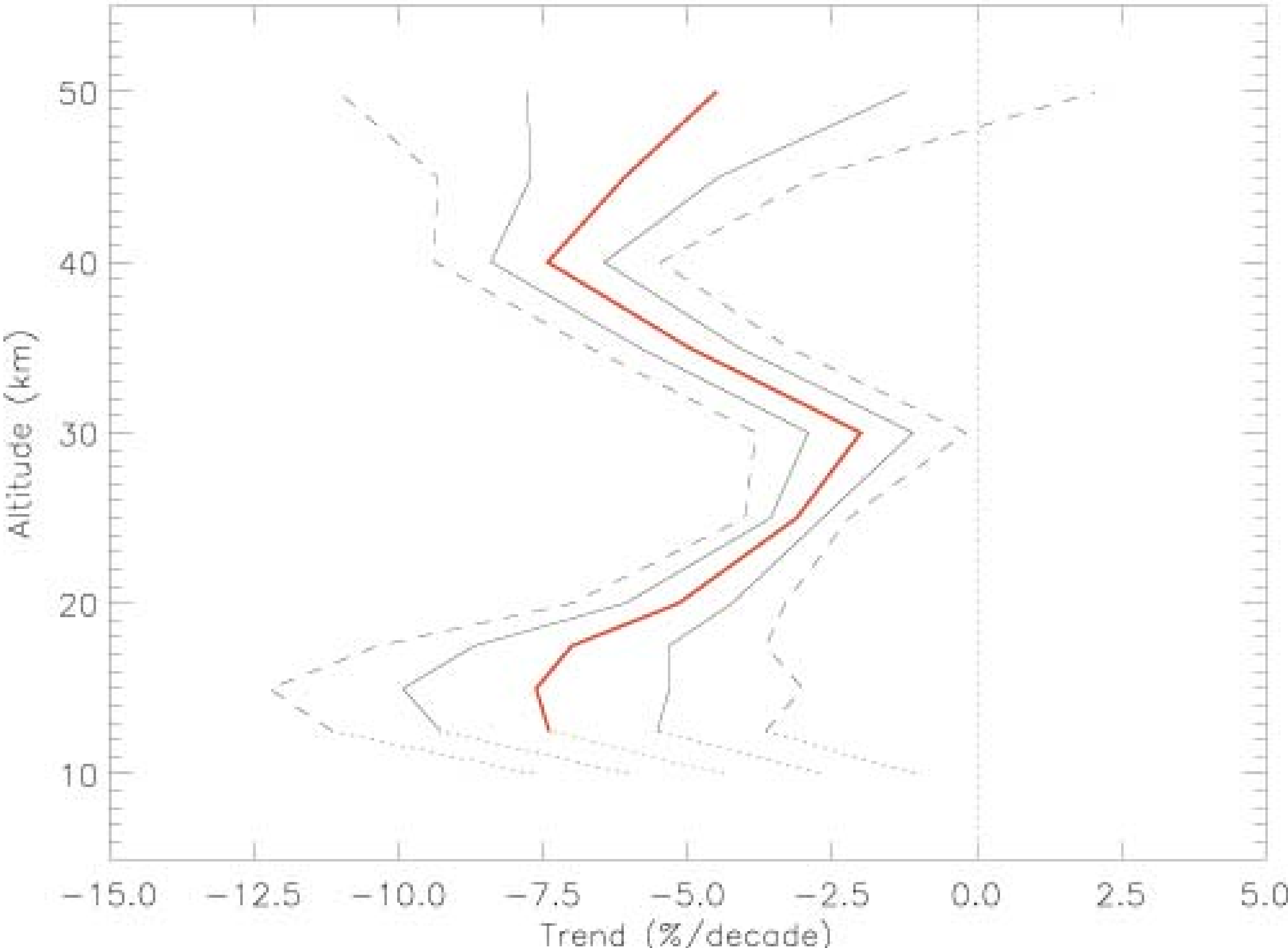
$O_3$ Combined Trend(1 & 2 sigma) 1980–96

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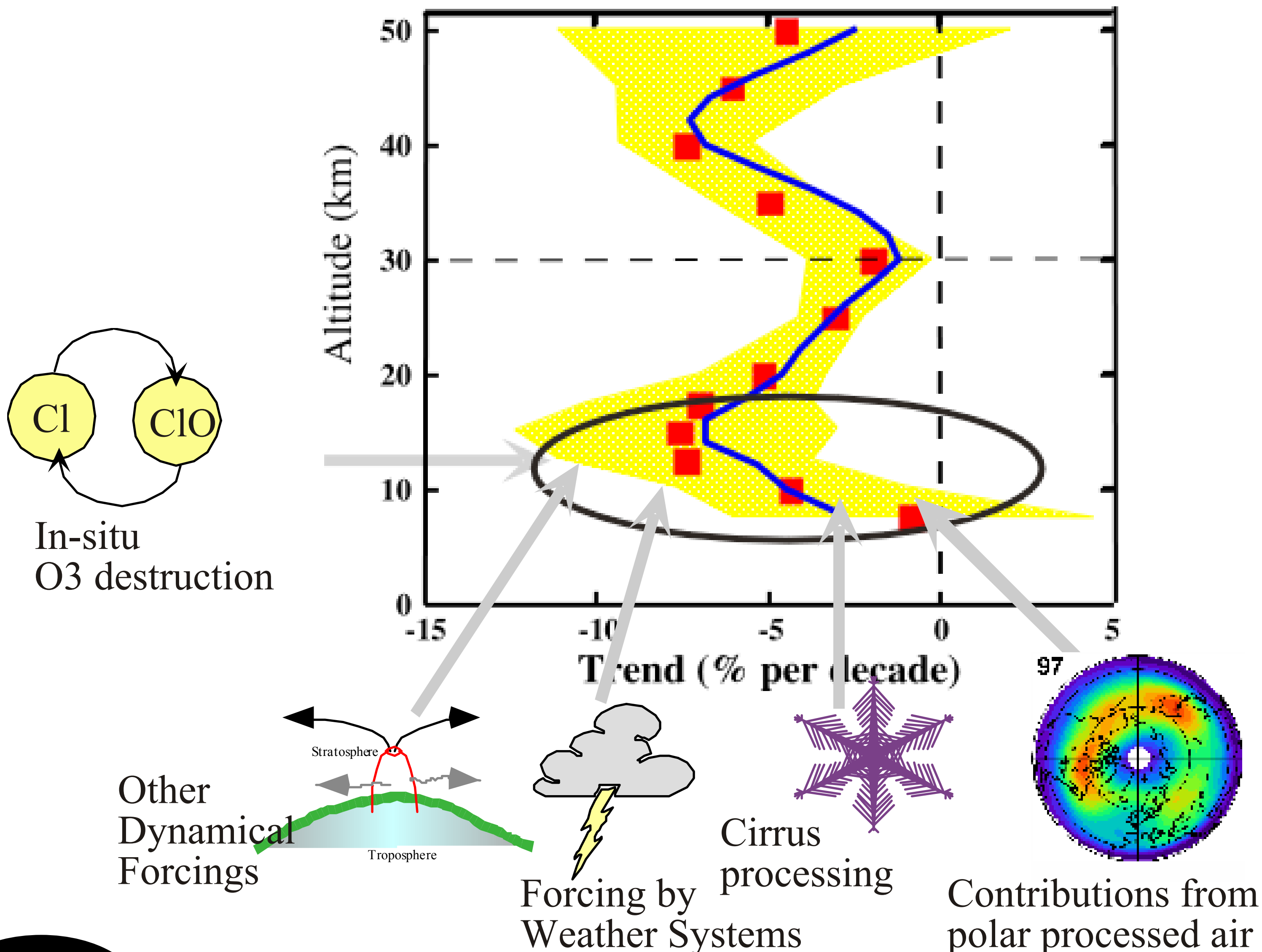
# Ozone-trends and why

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# 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?

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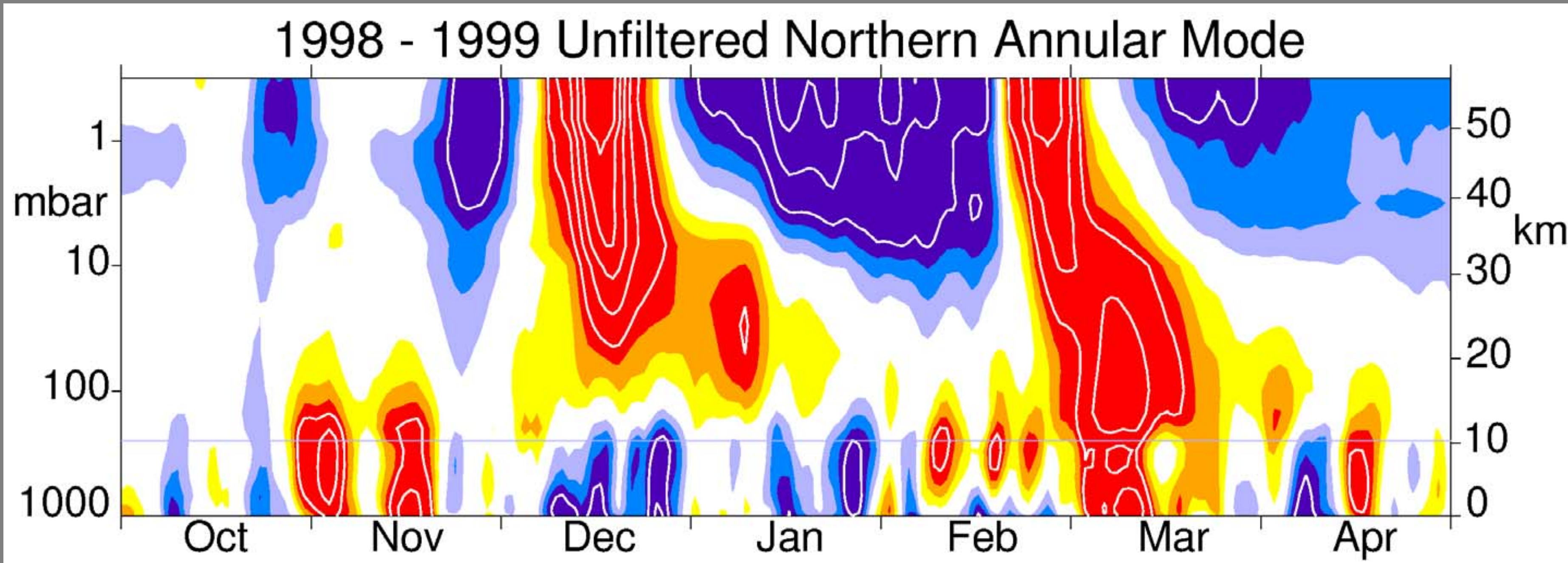
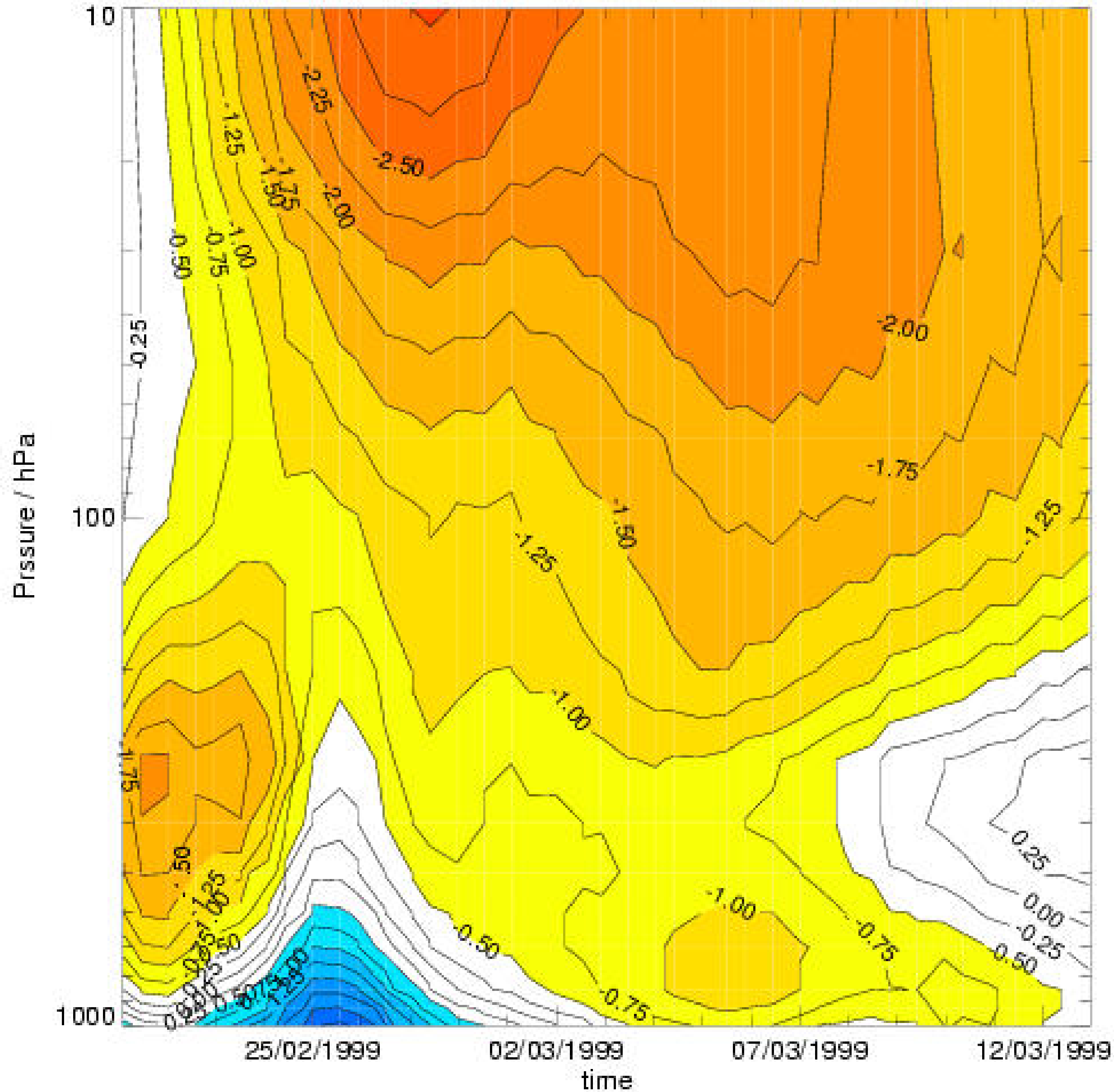

1998 - 1999 Unfiltered Northern Annular Mode
mbar
1
10
100
1000
km
50
40
30
20
10
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr

## AO Index from Control Run

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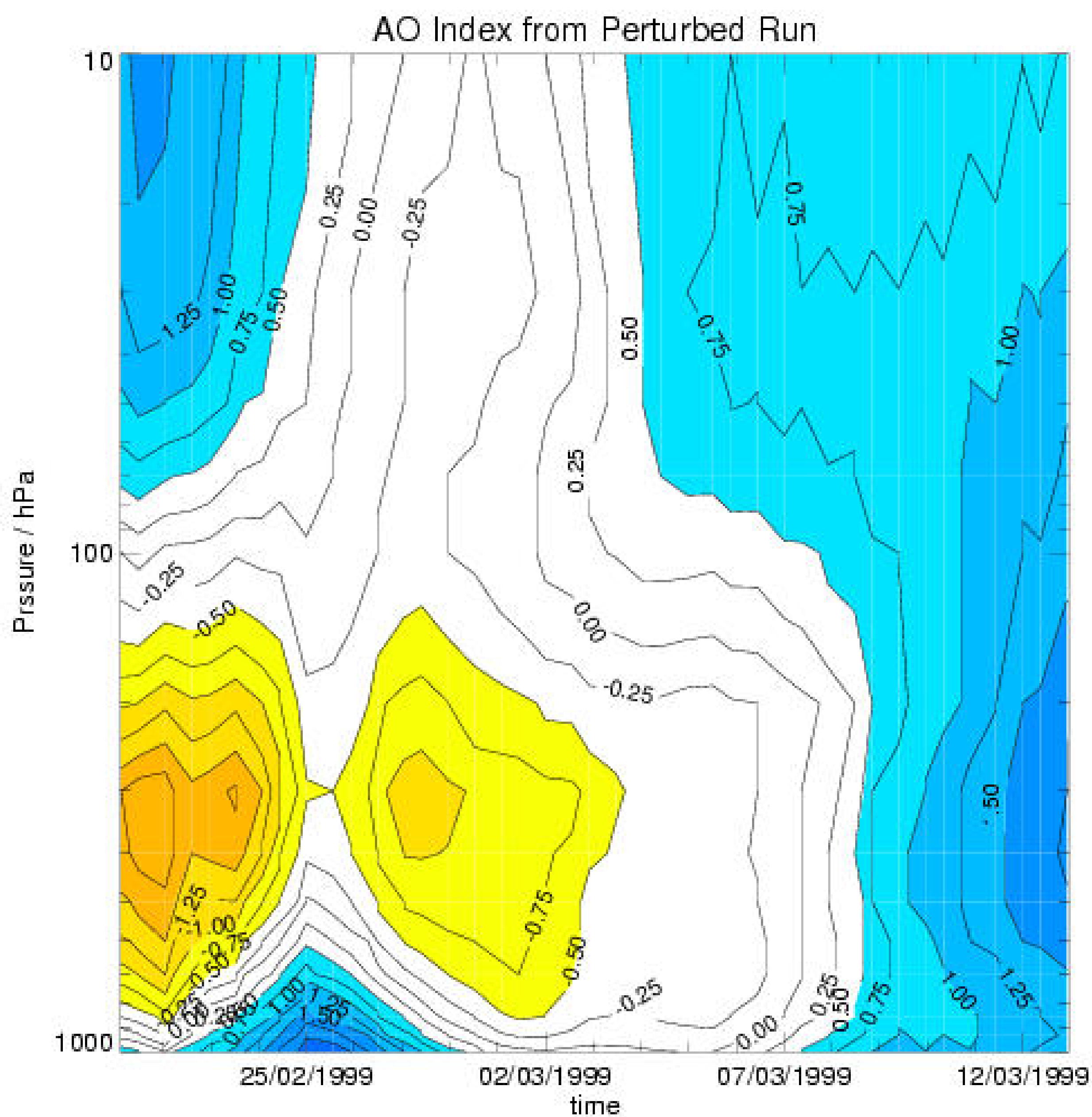
AO Index from Perturbed Run
Prssure / hPa
10
100
1000
25/02/1999
02/03/1999
07/03/1999
12/03/1999
time

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# 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.

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# 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