CCM Modelling : LMDz-Reprobus

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GCM: Dynamics and physics

- Extended version of the LMDz-4 general circulation model (Lott et al., 1999; 2005)
  - Grid point model (2.5° lat - 3.75° lon)
  - hybrid sigma-pressure vertical coordinate
  - 50 levels from surface to 0.07 hPa (65 km)

- LMDz-4: atmospheric component of the IPSL Earth System model (Dufresne et al., 2002; IPCC, 2007)
  - used by a wide community in France
  - Also includes carbon cycle, tropospheric chemistry, etc..
  - Involved in IPCC simulations

- Physical parameterisations
  - Radiation scheme: ECMWF scheme (Morcrette, 1989)
  - Convection scheme: Emanuel scheme (Emanuel, 1993)
  - Subgrid scale orography: Lott and Miller (1997), Lott (1999).
  - Doppler-spread non orographic gravity waves scheme: Hines (1997) and adapted from Manzini (1997)
  - Rayleigh drag sponge layer between 55 km to 65 km (Shepherd et al.,1996)
  - Transport of tracers: Van Leer I scheme (Van Leer, 1977)

REPROBUS: stratospheric chemistry module

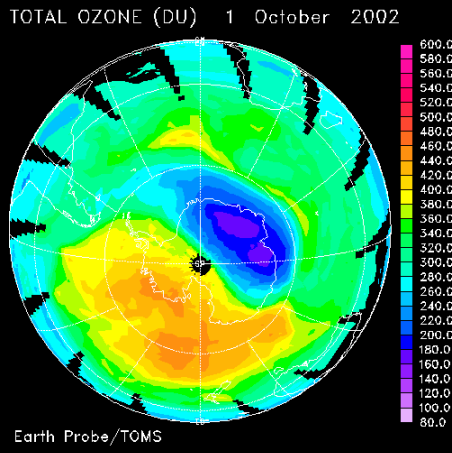
- Reprobus:
  - initially designed as a chemical-transport model (Lefèvre et al.,1998; Ricaud et al., 2005; Tripathi et al., 2007)
  - Coupled interactively to LMDz since 2004

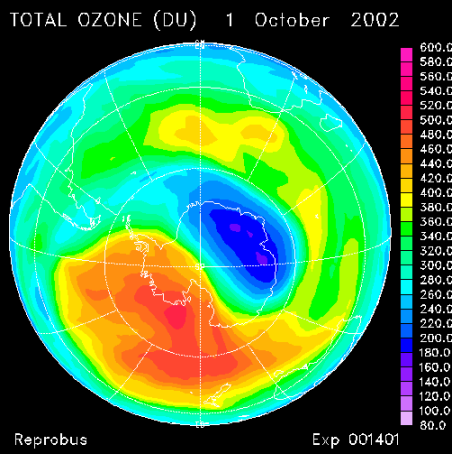
- Gas-phase chemistry:
  - detailed description of Ox, NOx, HOx, ClOx, BrOx et CHOx chemistries.
  - 55 species, 160 gas-phase reactions
  - Includes CH2Br2* as a proxy for bromine VSLS (CH_2Br_2* = CH_2Br_2 + $CHBr_3$ + CH_2BrCl + $C_2H_4Br_2$ + … = ~ 5 pptv)

- Heterogeneous chemistry:
  - flexible microphysical scheme: can handle liquid binary (H2O/H2SO4), liquid ternary (H2O/H2SO4/HNO3) aerosols, solid NAT, solid ice particles. Different microphysical scenarios can be assumed: mixture of solid/liquid particles, varying radius, bimodal distribution, varying particle number density, etc...
  - Liquid aerosol composition: Carslaw et al., (1995)
  - 6 heterogeneous reactions (Shi et al. for reactions on liquid aerosols)

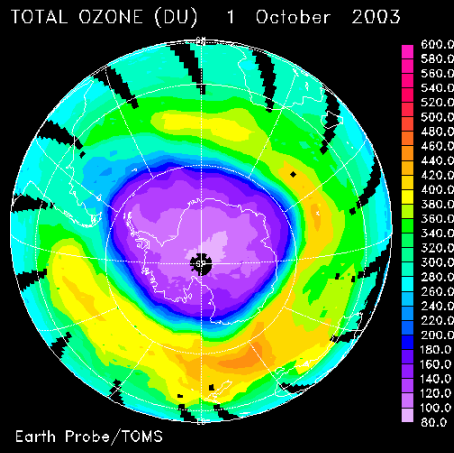
- Photolysis rates:
  - J values calculated at high spectral resolution from the TUV model (Madronich and Flocke, 1998). Stored in a 4-dimensional lookup table

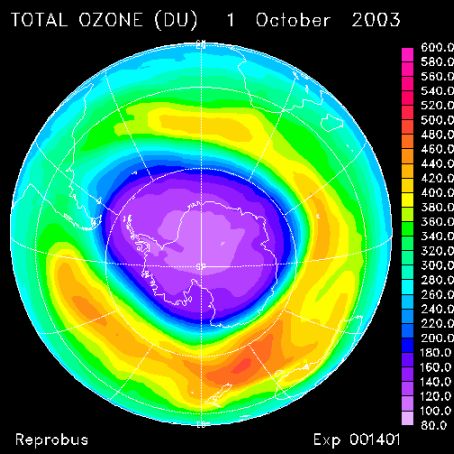
2002



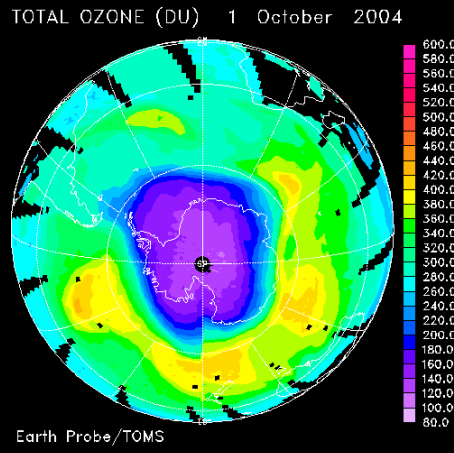


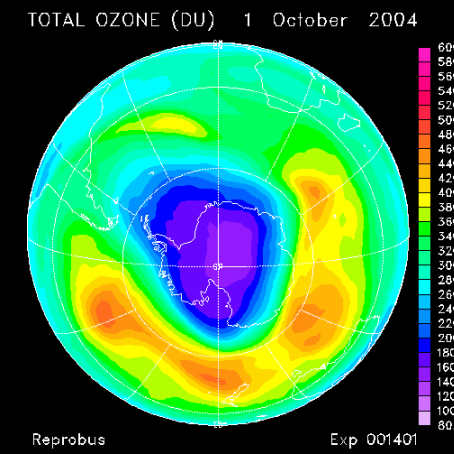
2003



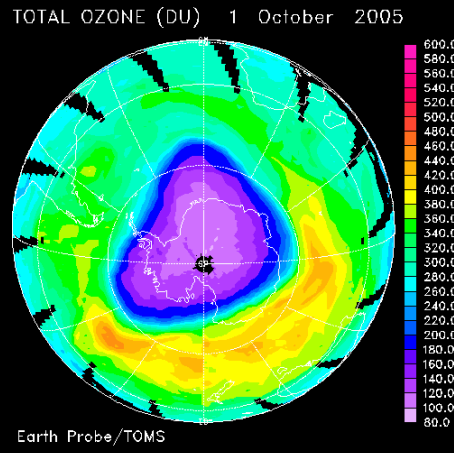


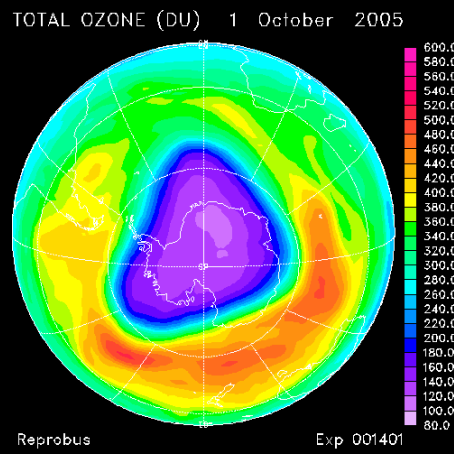
2004



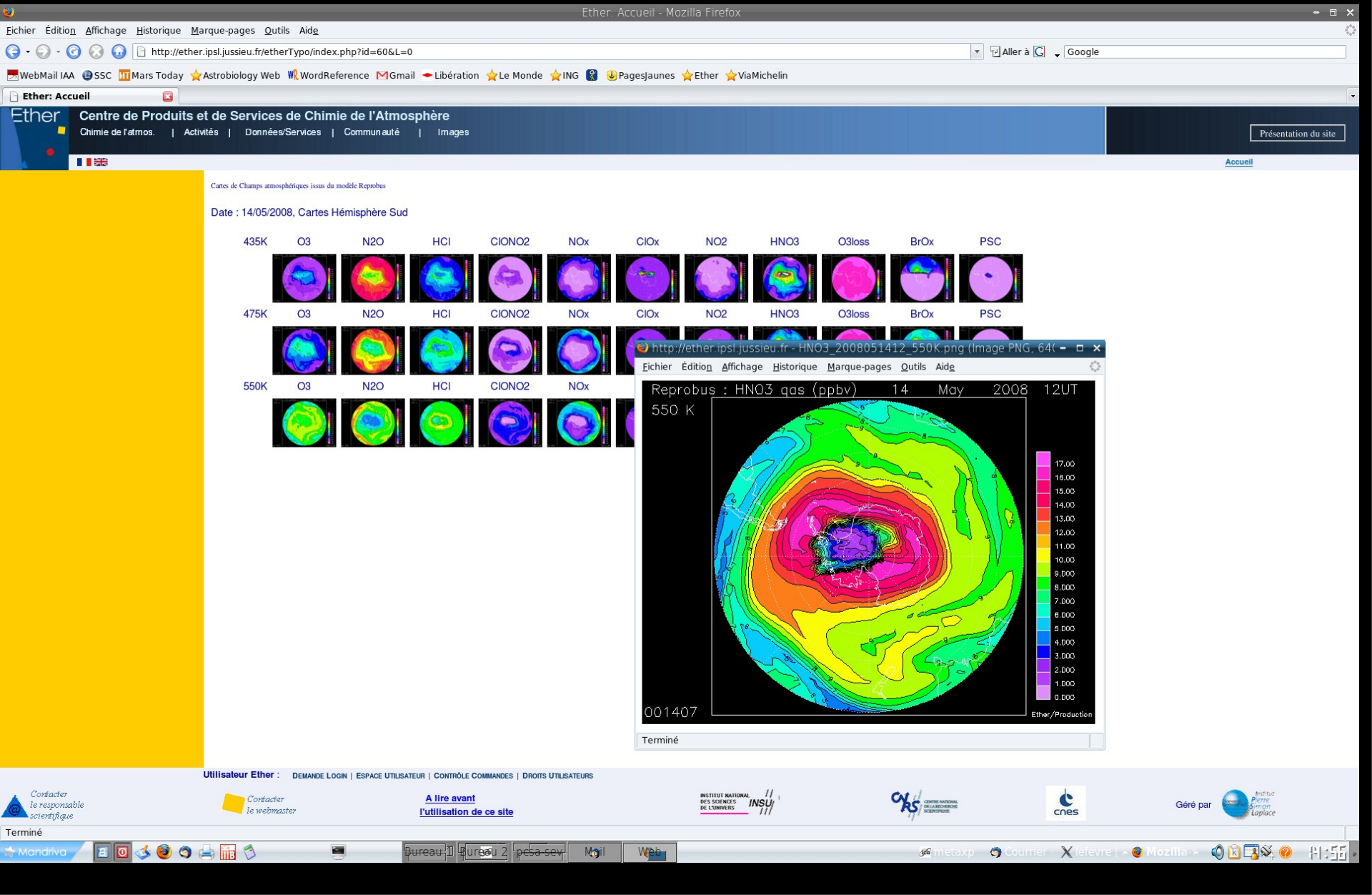


2005





Near real time (D+1) Reprobus results available at: http://ether.ipsl.jussieu.fr



Chemistry-Climate Model Validation Activity for SPARC (CCMVal)

goal = improve understanding of ChemistryClimate Models (CCMs) and their underlying GCMs (General Circulation Models) through process-oriented evaluation, along with discussion and coordinated analysis of science results.

MODEL	GROUP	PI
AMTRAC,	GFDL USA	**J. Austin**
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UMSLIMCAT,	University of Leeds, UK,	**M. Chipperfield,** W. Tian
WACCM (v.3,)	NCAR, USA,	**R. Garcia,** D. Kinnison

CCMVAL simulations

REF-B0 = time-slice experiment for 2000 conditions (over 20 annual cycles)

Goal: **facilitate the comparison of model output against constituent datasets**

(done, in validation phase)

REF-B1 (1960-2006) = transient run from 1960 to the present.

Goal: **reproduce the well-observed period of the last 35 years during which ozone depletion is well recorded** All forcings in this simulation are taken from observations (changes in trace gases, solar variability, volcanic eruptions, quasi-biennial oscillation, and SSTs/SICs).

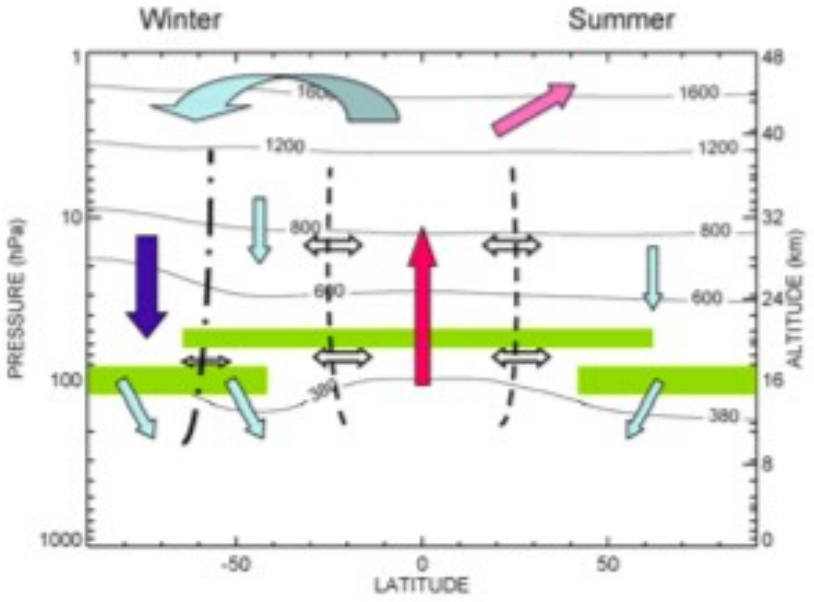
(done, in validation phase)

REF-B2 (1960-2100) = internally consistent simulation from the past into the future.

Goal: **produce best estimates of the future ozone-climate change up to 2100 under specific assumptions about GHG increases (Scenario SRES A1B) and decreases in halogen emissions (adjusted Scenario A1) in this period.**

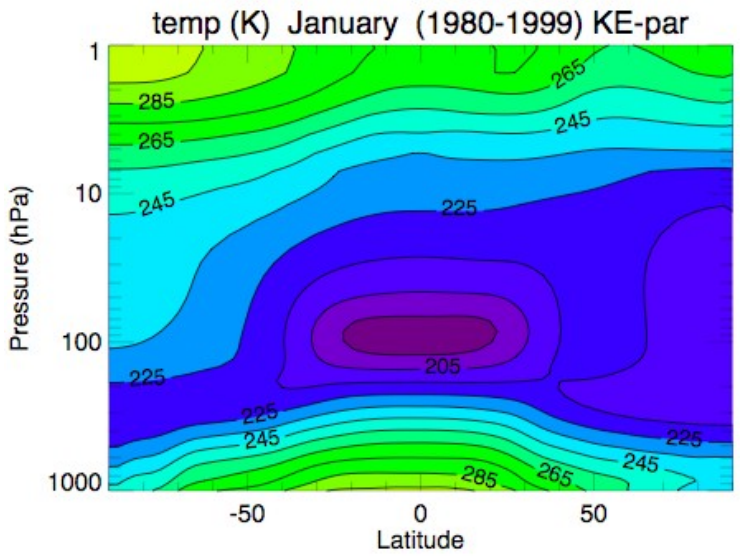
(in progress)

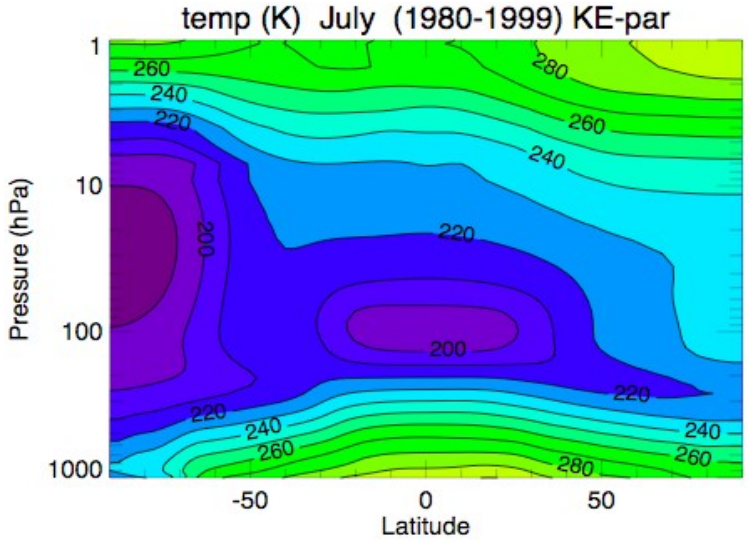
Schematic of stratospheric transport



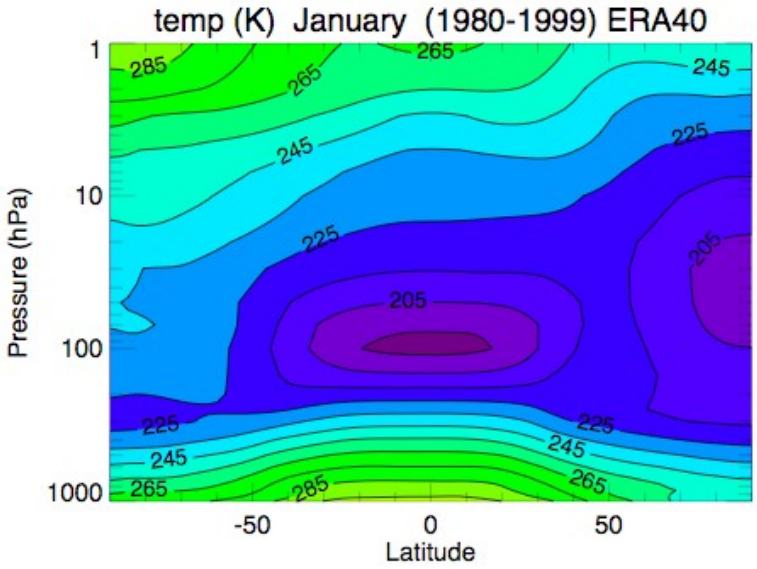
Zonal mean temperature

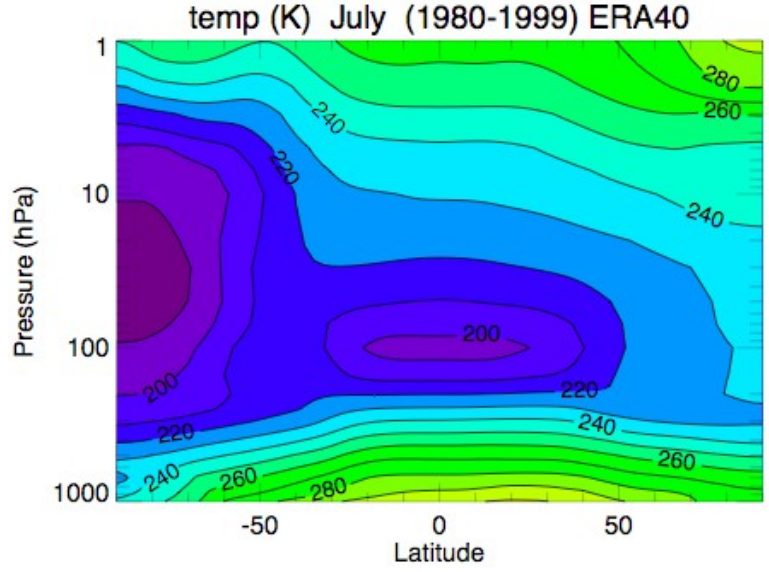
LMDZ-Repro





ERA40

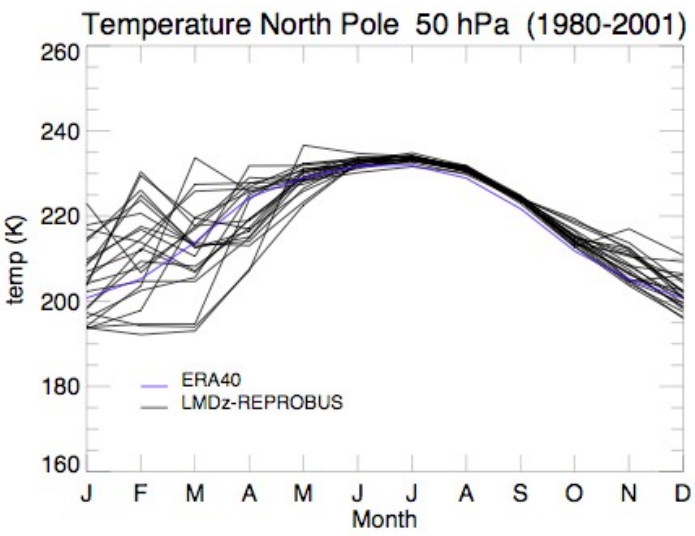


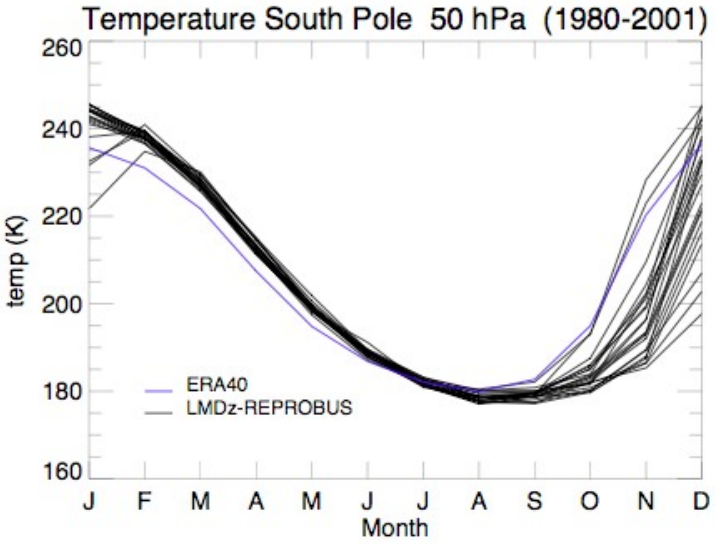


Seasonal cycle of polar temperatures at 50hPa

LMDz-Repro

----- ERA40





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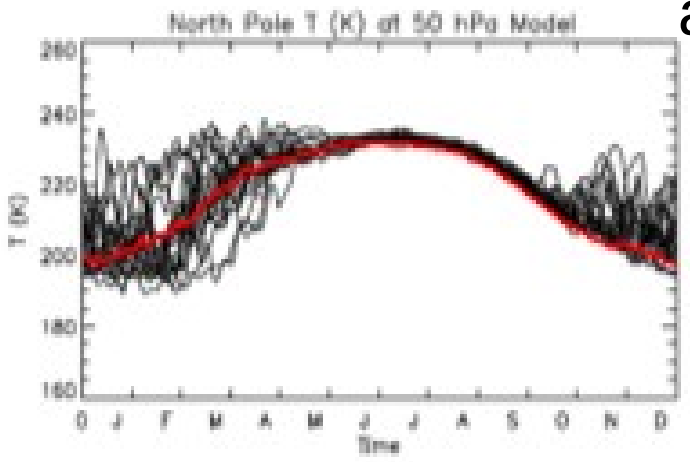
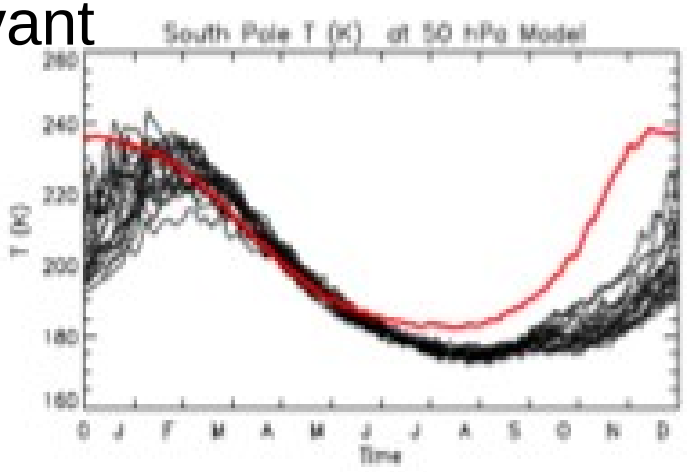
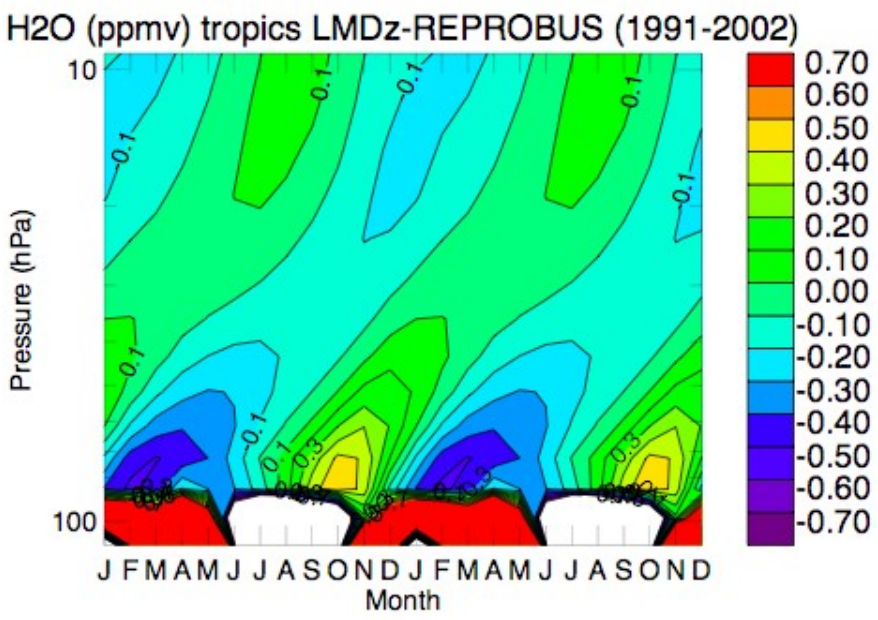


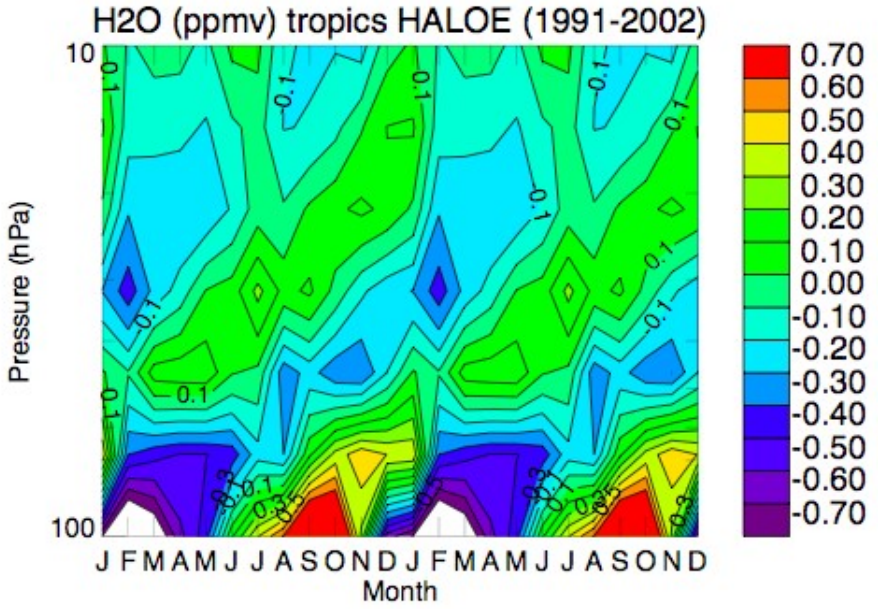


H2O Tape recorder

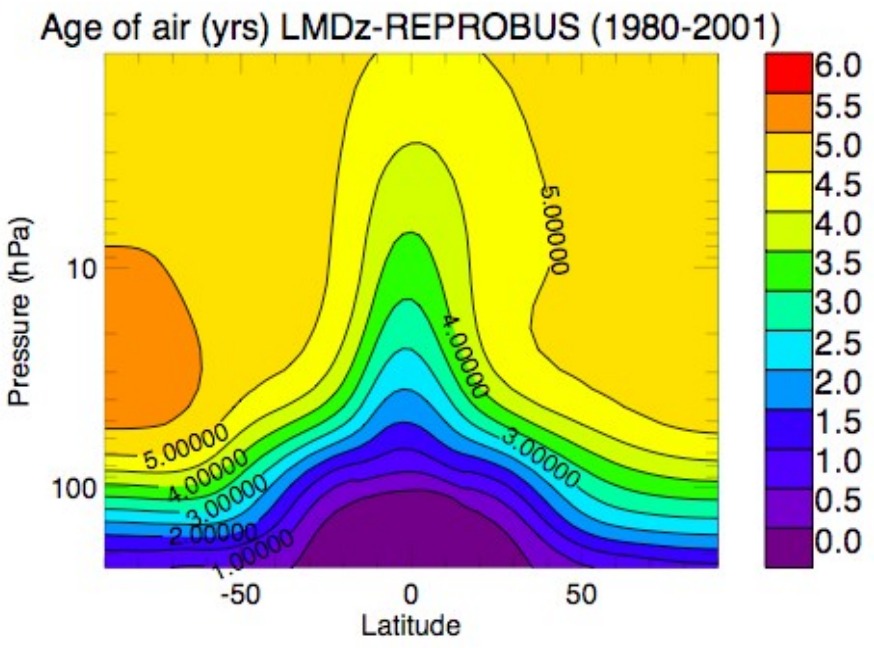
LMDz-Reprobus

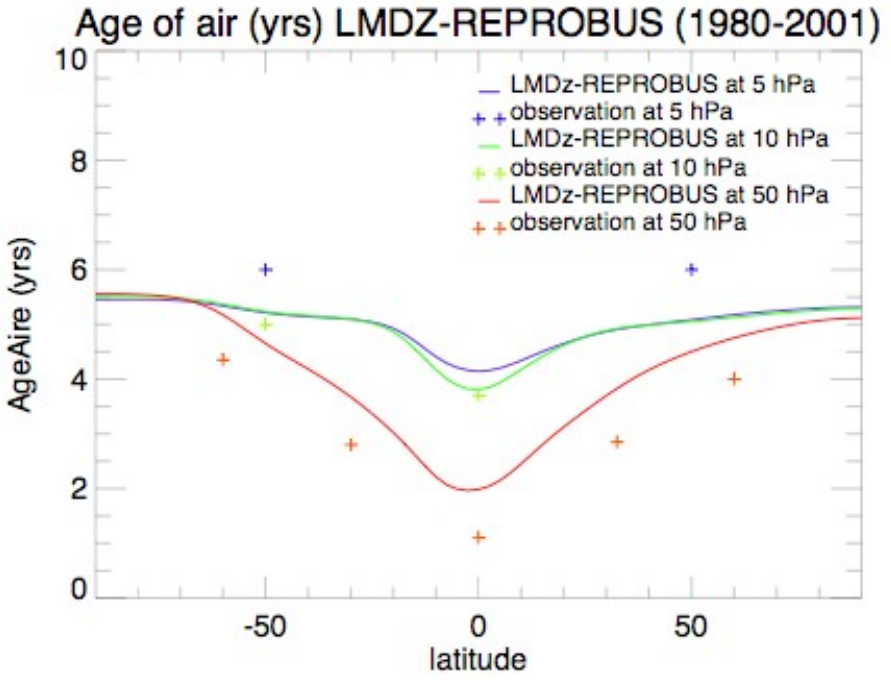


HALOE

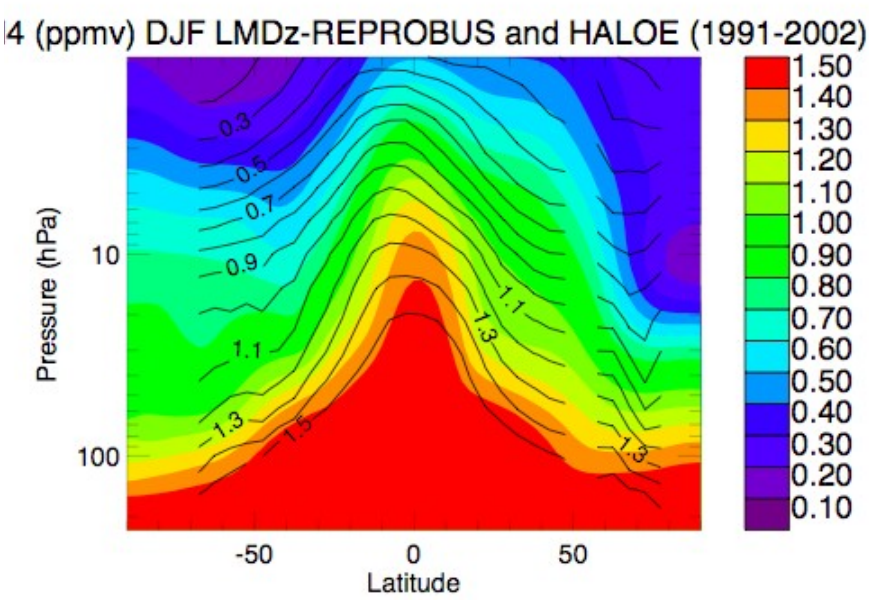


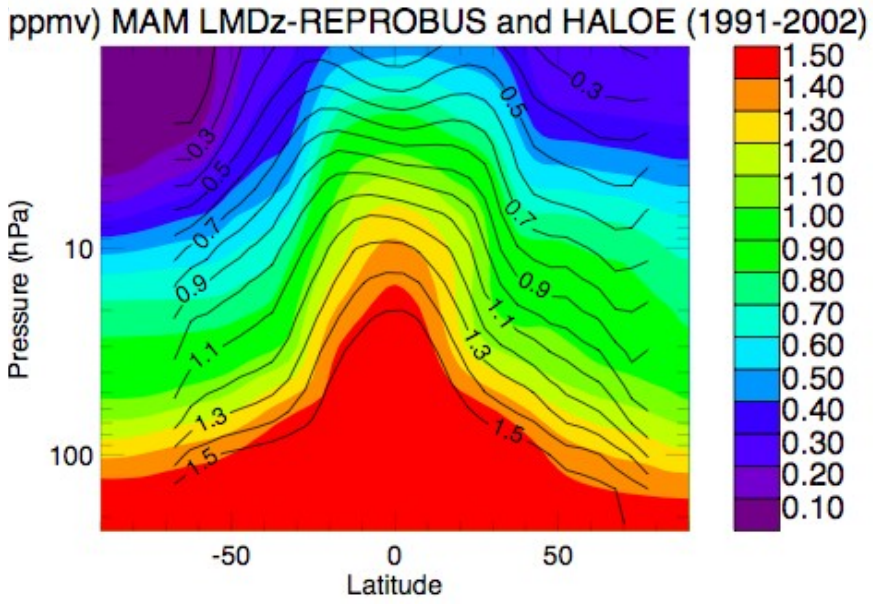
Latitudinal variation of the annual mean age of air

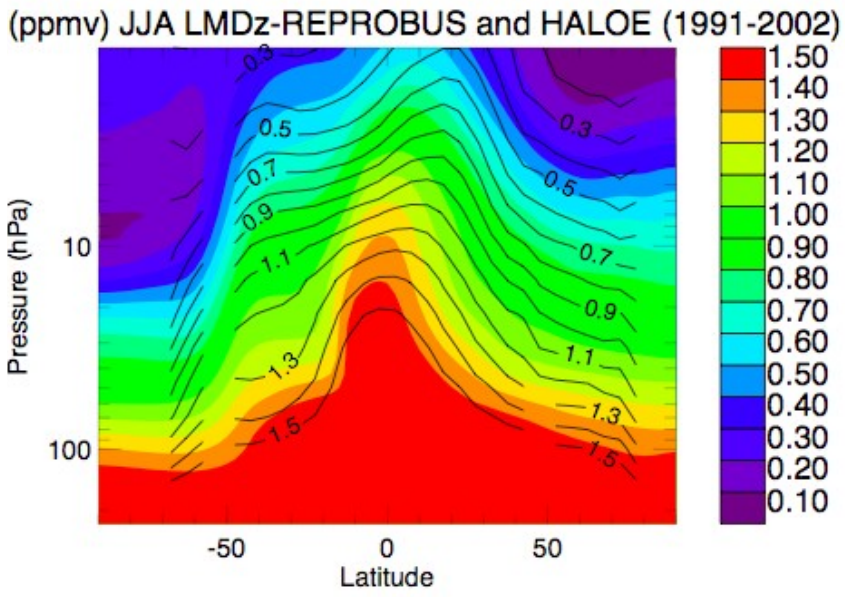


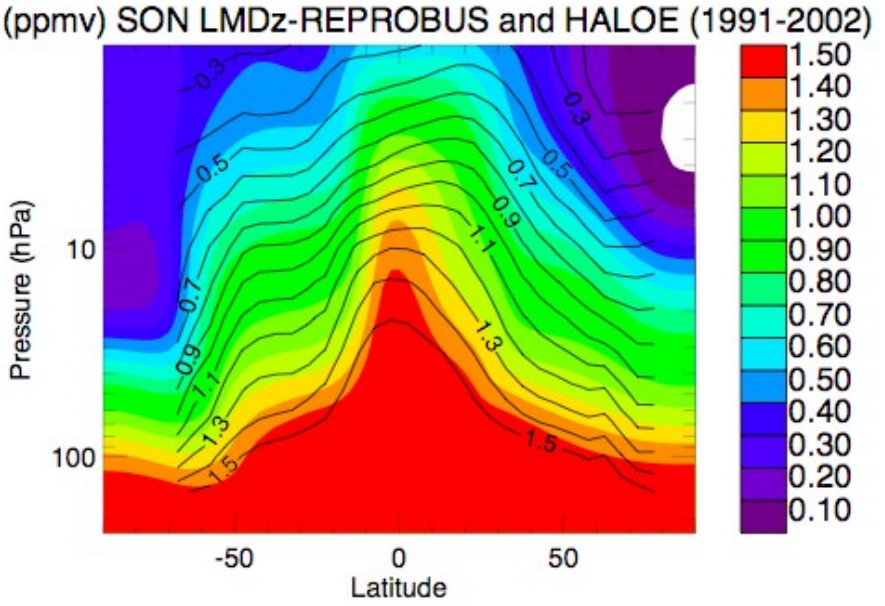


Climatological zonal mean CH_4 mixing ratios

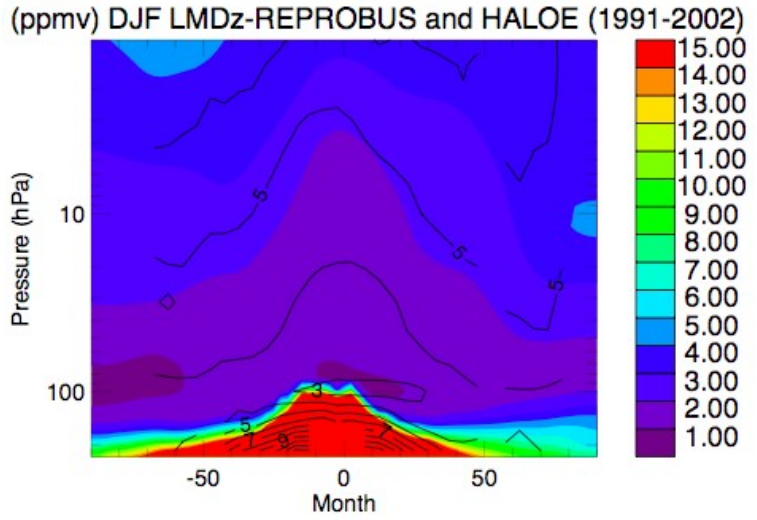


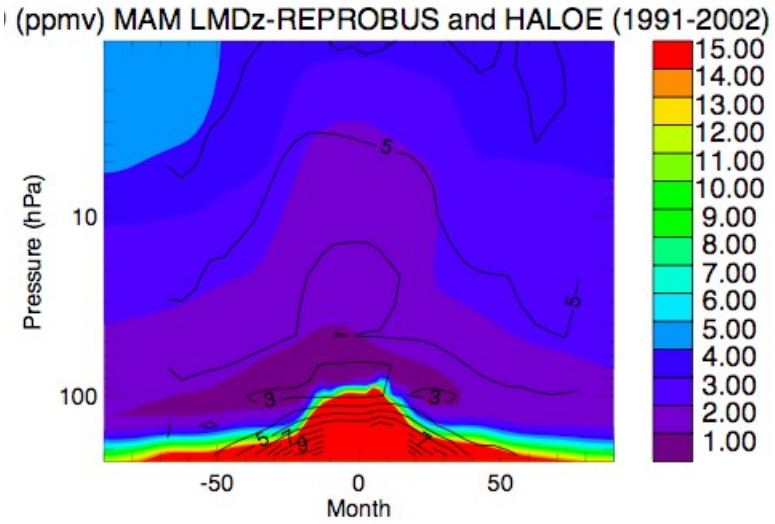


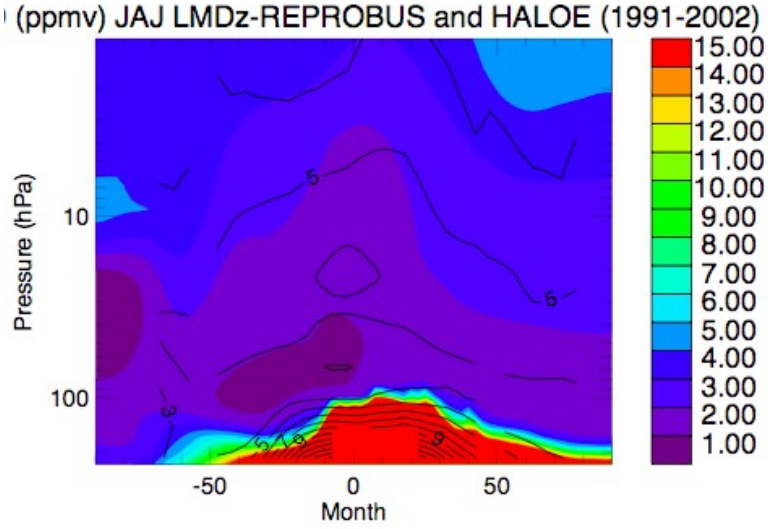


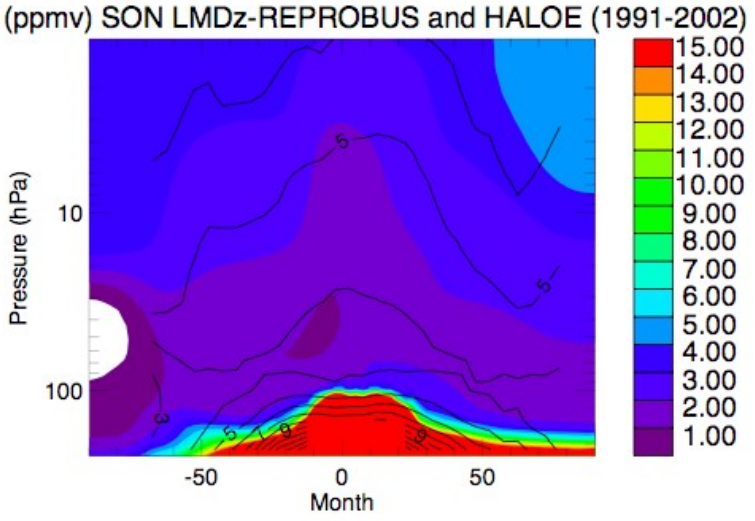


Climatological zonal mean H2O mixing ratios









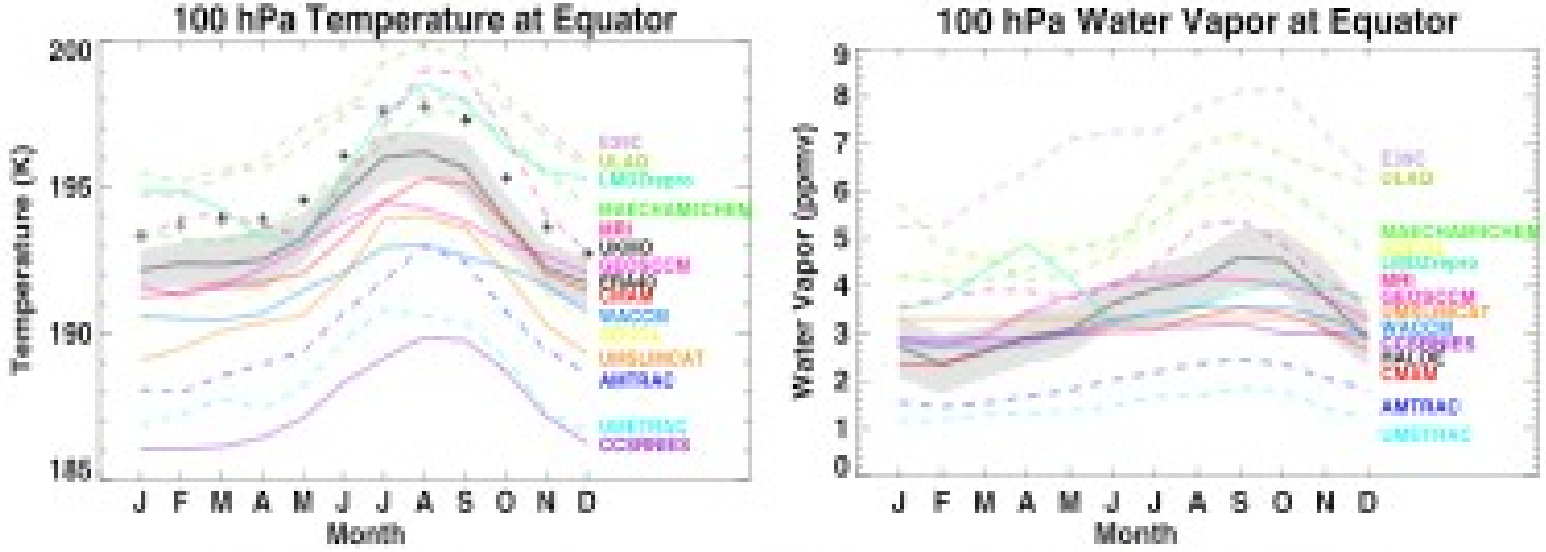


Figure 7. Seasonal variation of climatological means at 100 hPa at the equator for (left) temperature and (right) water vapor. Modeled fields for the 1990s are compared to the 1991–2002 HALOE water vapor climatology and the 1992–2001 temperature climatology from UKMO and ERA-40.

Seasonal variation of O_3 column (DU) zonal mean 1991-1999

TOMS