LMDz-Reprobus
Interaction Chimie-Climat

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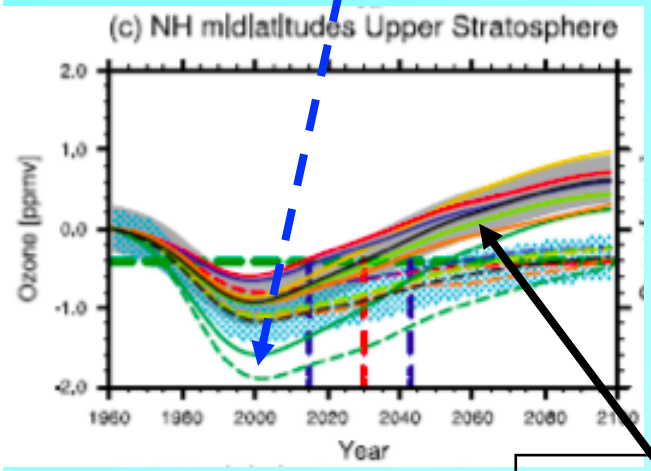
AG Pôle de Modélisation- 29/06/2010

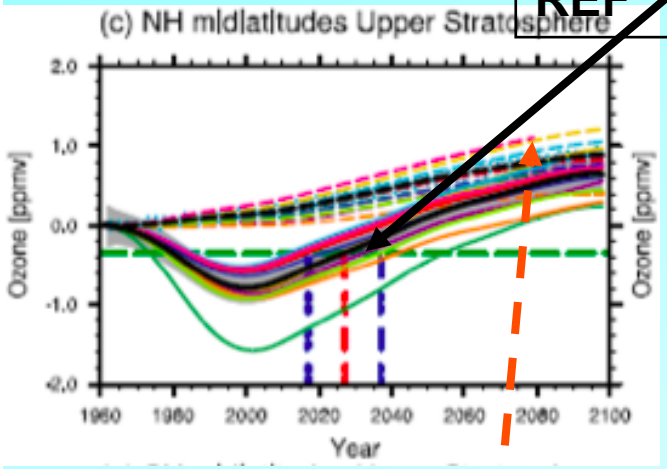
Evolution de l'ozone stratosphérique et le climat

Projection d'ozone ajustée % à 1960

GHG fixé à 1960 – – – –

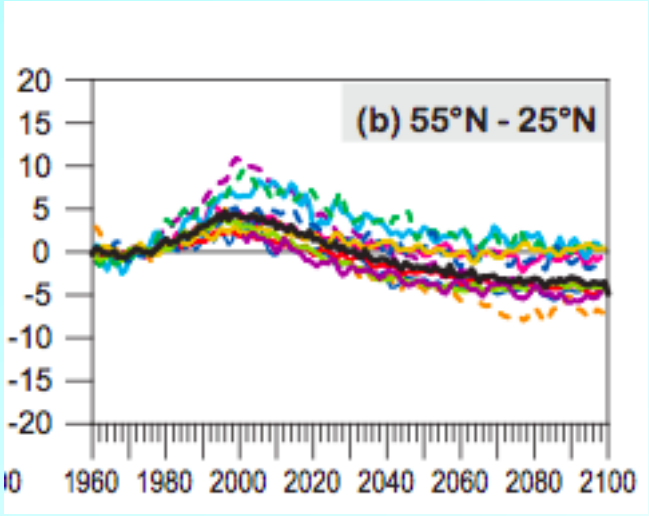


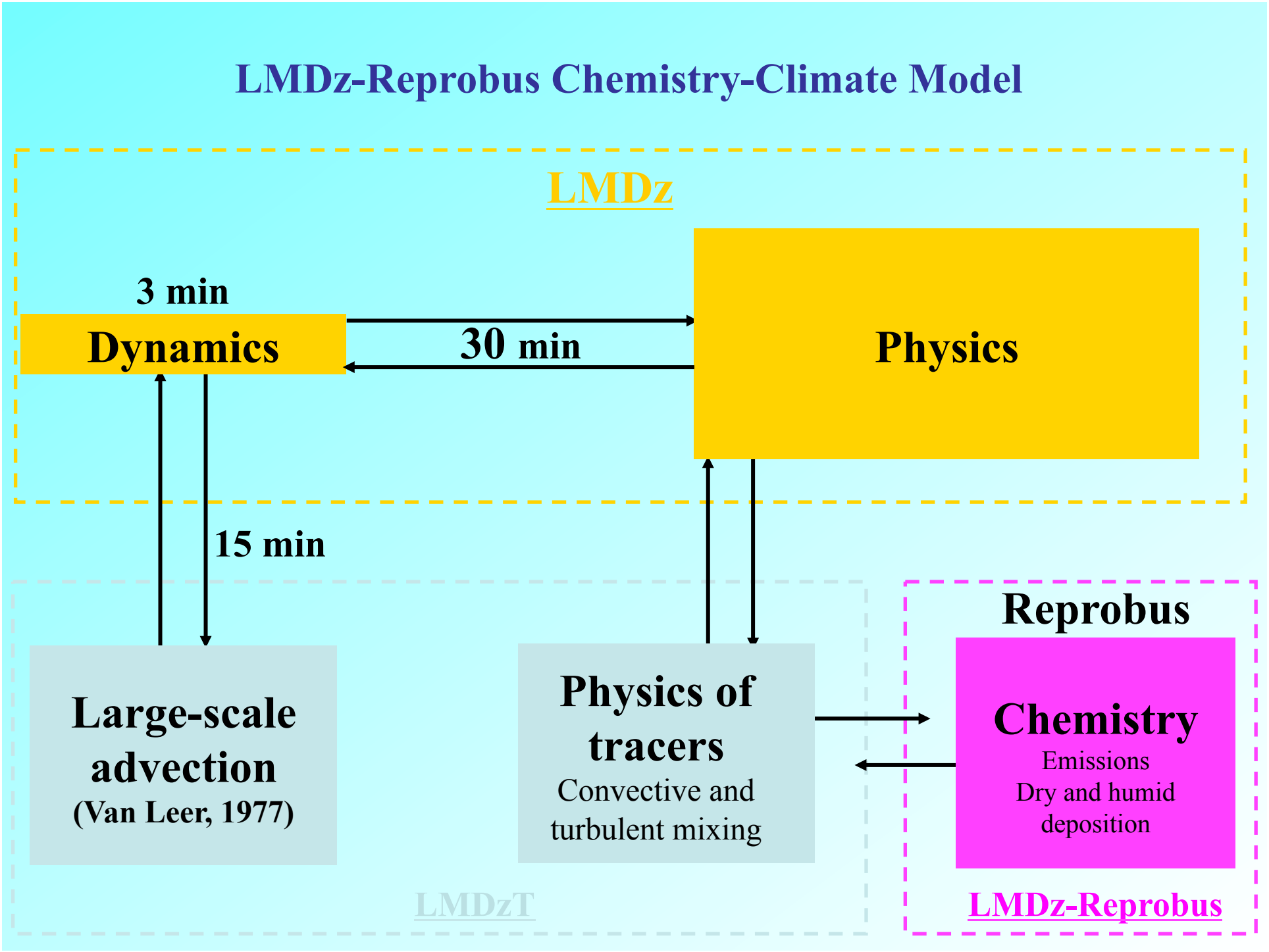
REF ——



ODS fixé à 1960 – – –

Anomalies (moy. Annuelle) du rayonnement UV à la surface (% moy. 1965-1979)




LMDz-Reprobus Chemistry-Climate Model
LMDz
3 min
Dynamics
30 min
Physics
15 min
Large-scale advection
(Van Leer, 1977)
Physics of tracers
Convective and turbulent mixing
Reprobus
Chemistry
Emissions
Dry and humid deposition
LMDzT
LMDz-Reprobus

- 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:
  - 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

Chemistry-Climate Model Validation Activity for SPARC (CCMVal)

simulations

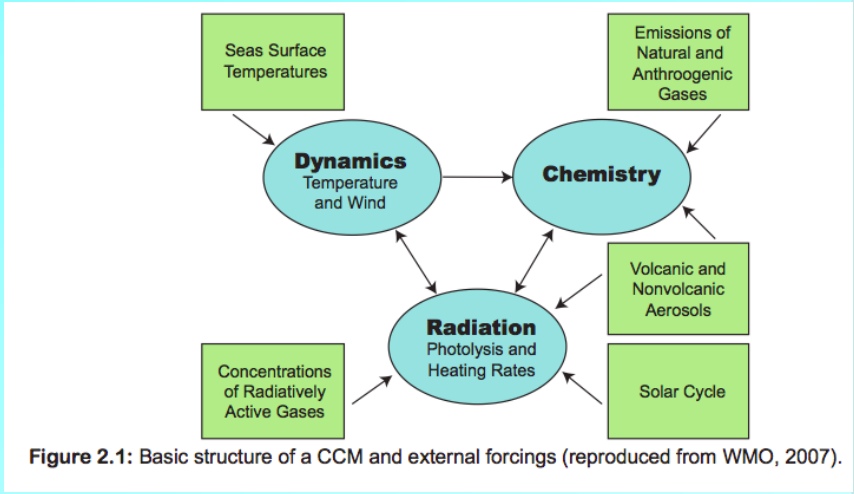


Figure 2.1: Basic structure of a CCM and external forcings (reproduced from WMO, 2007).

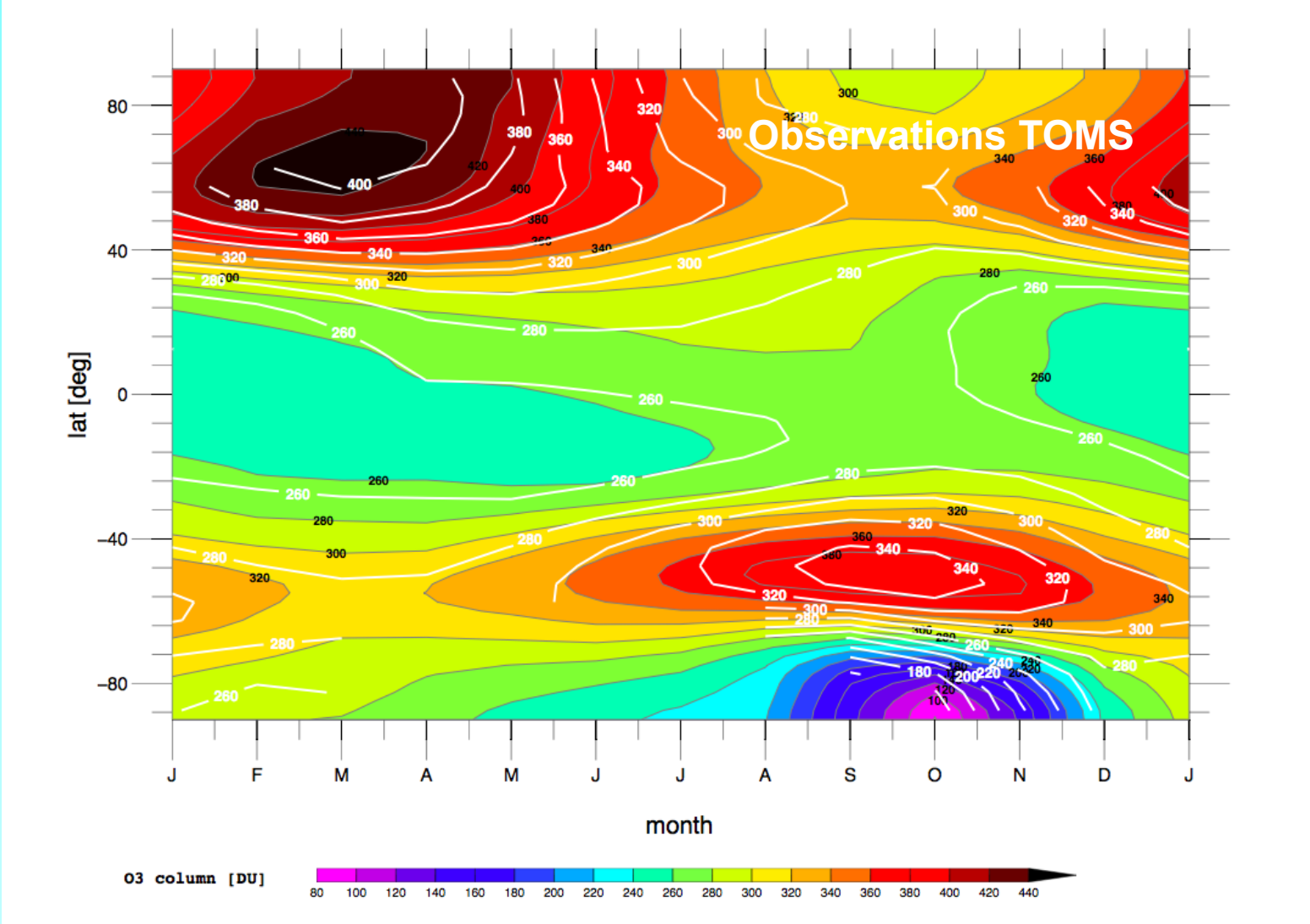
REF-B1 (1960-2006) = transient run from 1960 to the present.

Goal: reproduce the well-observed period of the last 35 years during which ozone depletion is well recorded

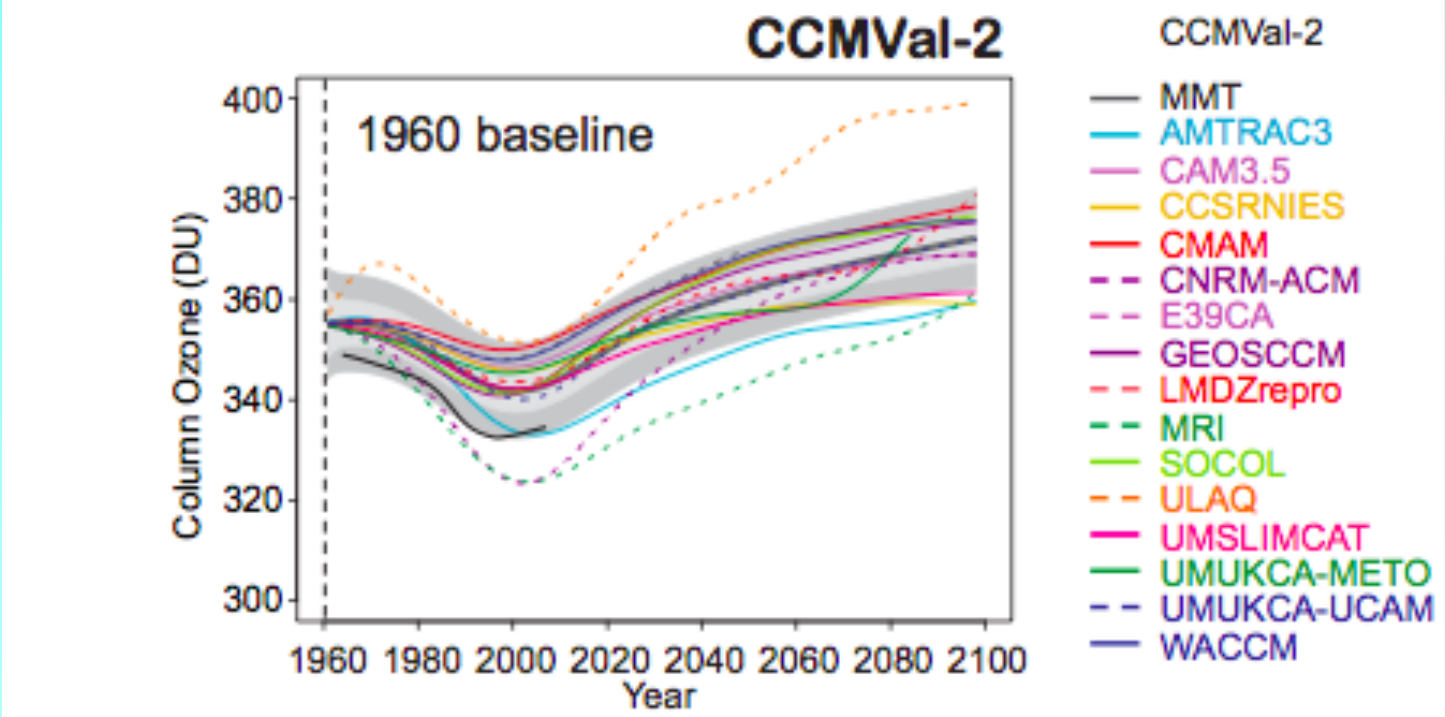
REF-B2 (1960-2100) = internally consistent simulation from the past into the future.

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.

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



Annual O3 Column 35N-60N



Prise en compte de l'évolution de l'O3 stratosphérique dans les simulations CMIP5

Climatologie d'ozone issue des simulations LMDz-Reprobus:

* 1960-présent: Simulation REF1/CCMVal

* présent-2100: Linéarisation par rapport au forçage radiatif à partir de 3 simulations futures LMDz-Reprobus:

- REF2/CCMVAL (RCP4.5)
- SENREF2/CCMVAL (RCP3-PD)
- NEW RUN (RCP8.5)

Intêrets et objectifs

Impact des CFCs et GHGs sur l'évolution de l'ozone

Impact de la variabilité solaire

Impact de l'évolution de l'ozone sur le climat

Couplage ocean/LMDz-Reprobus (version 39 niveaux)

Simulation du présent et du millénaire