Chemistry-Climate Modelling with UMUKAC: CCMVal-2 and beyond

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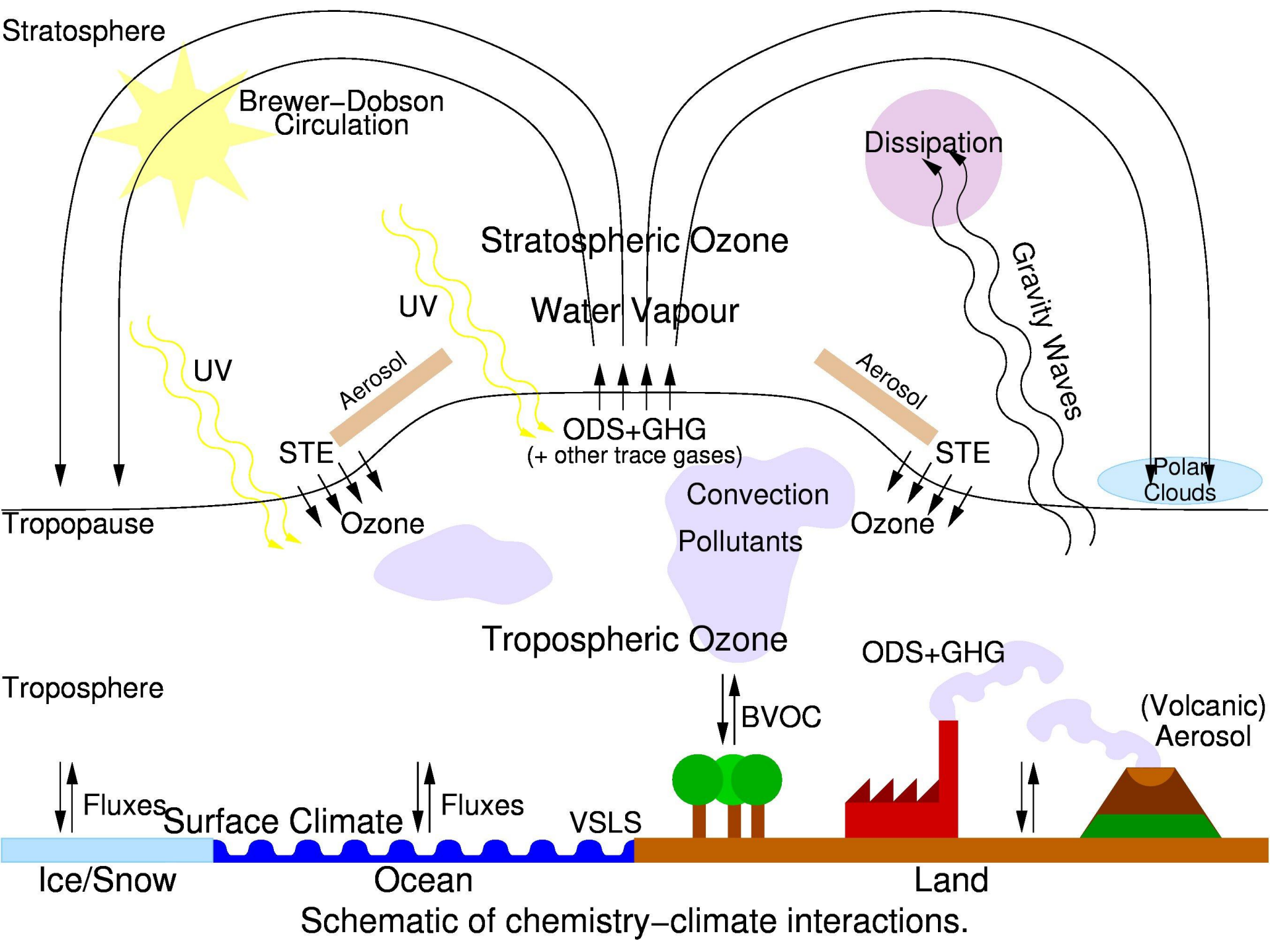
With thanks to all current UKCA users and developers!

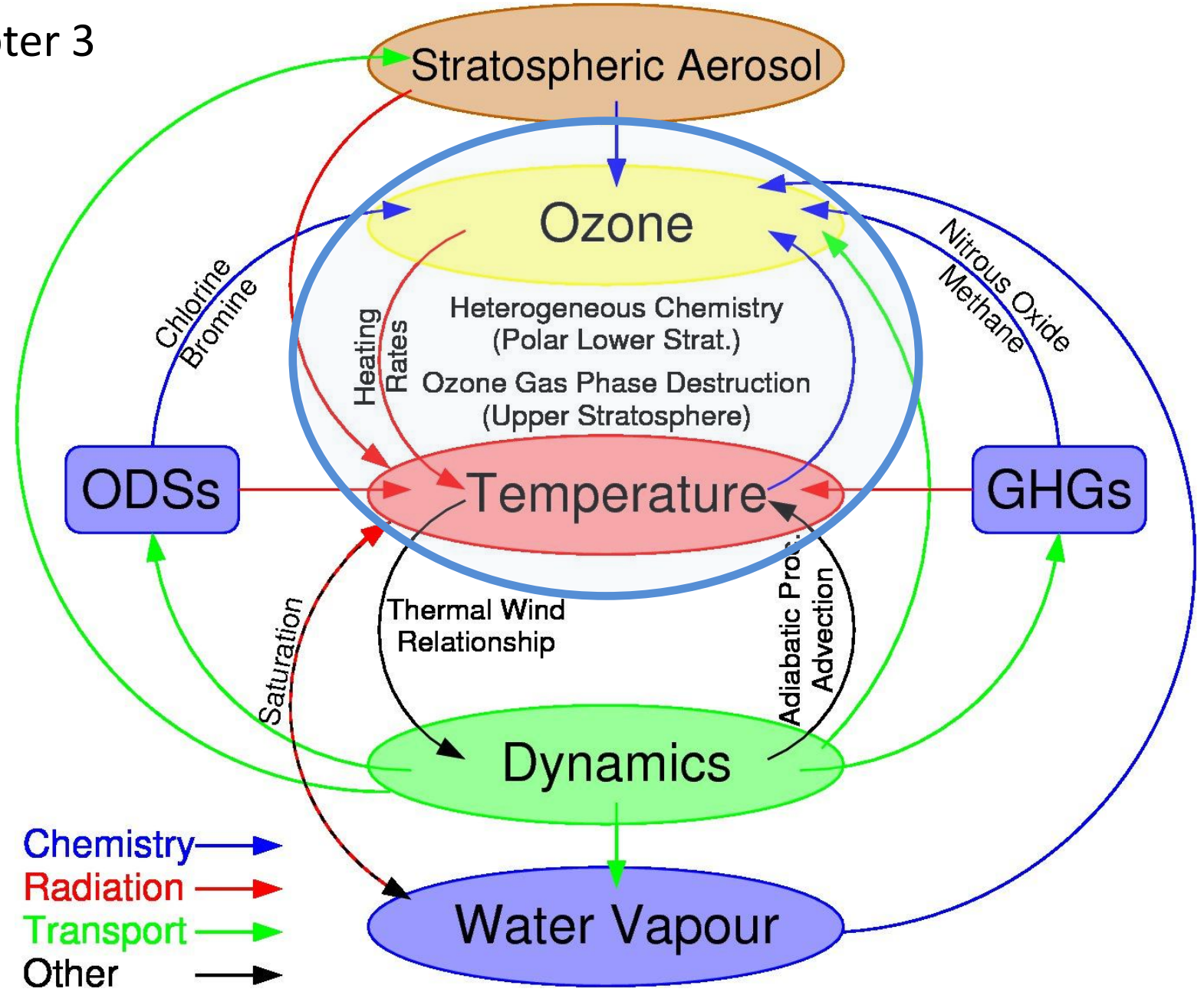
Structure

- Scene setting (WMO/UNEP O3 Assessment):
  - Emphasis on chemistry-climate interactions
- Modelling ozone in the UTLS
  - How did we do?
  - What has changed?
- Modelling ozone recovery
  - How did we do?
  - What has changed?
- Summary and conclusions

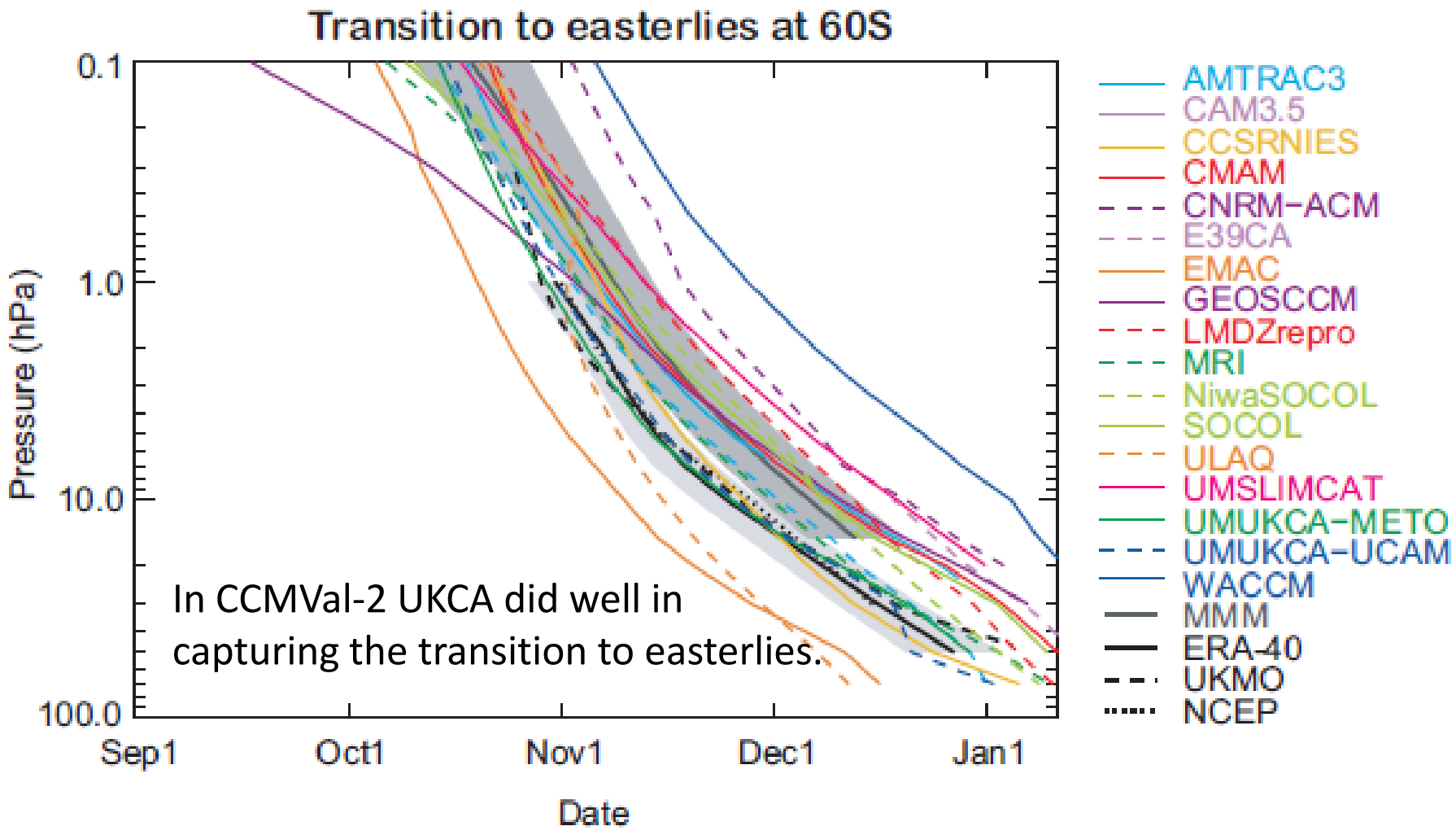


Schematic of chemistry–climate interactions.

Chapter 3



http://www.unep.ch/ozone/Assessment_Panels/SAP/Scientific_Assessment_2010



Hurwitz et al., JGR, 2010 for UKCA versus GEOSCCM comparison

http://www.atmosp.physics.utoronto.ca/SPARC/ccmval_final/index.php

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CCMVal-2 and beyond: The model did perform well in many aspects, but had some (known) weaknesses ...

MODELLING OZONE IN THE UTLS

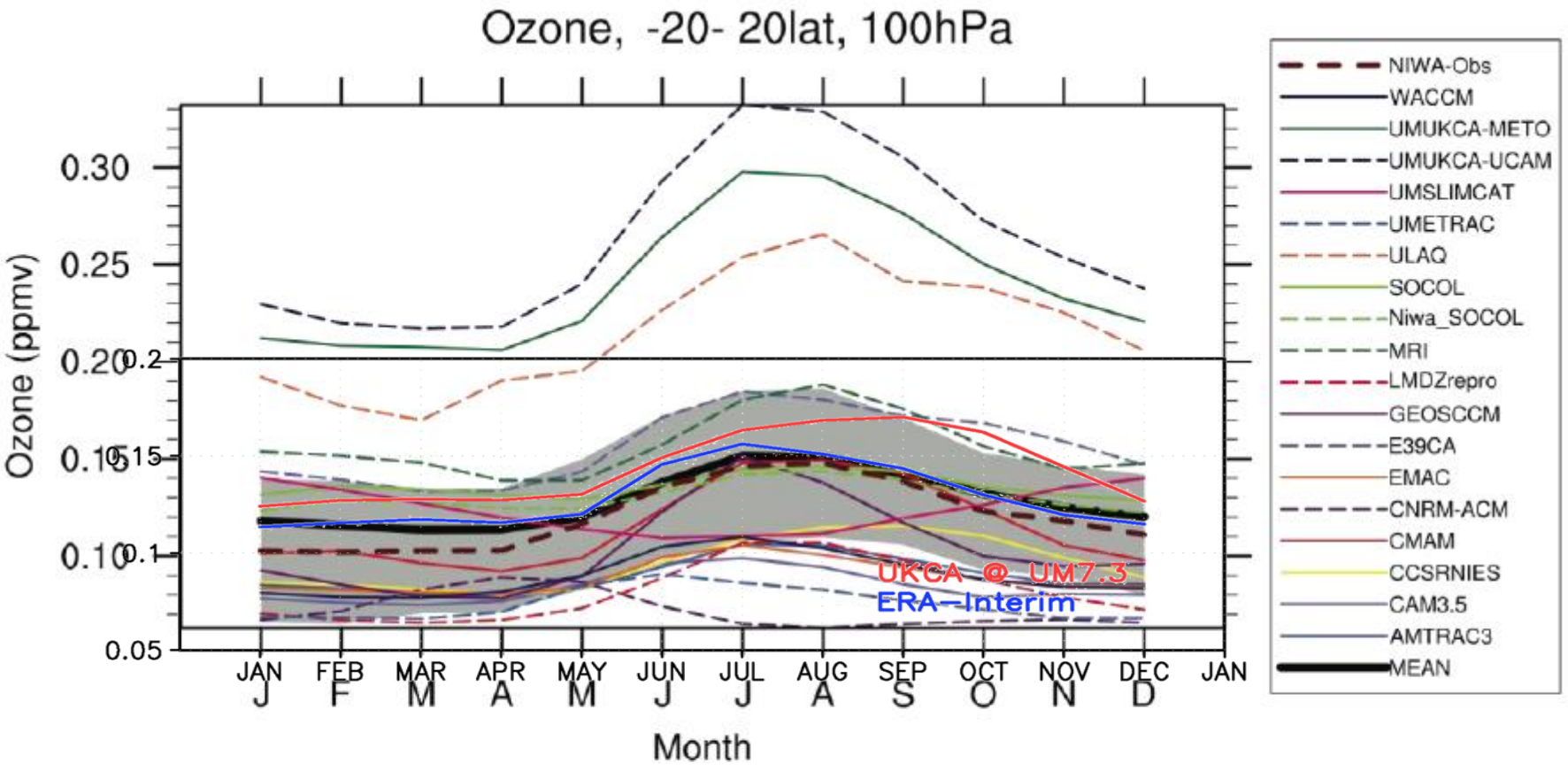
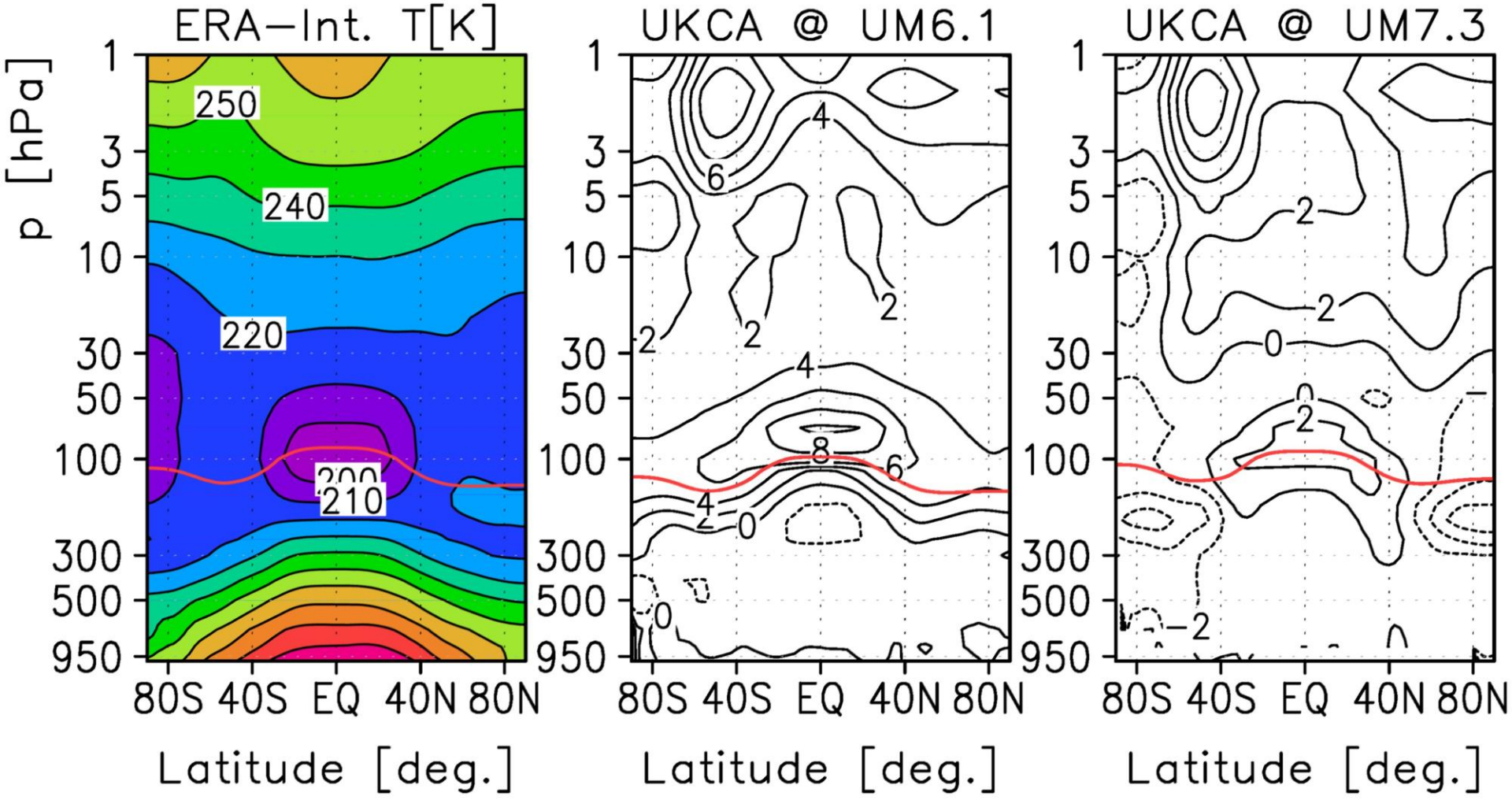


Figure 7.9: Annual cycle of tropical (20S-20N) ozone mixing ratio from models and observations. Output and observations are from the period 1980-1999. Gray shaded region is 3σ variability from NIWA observational data set (dashed brown line). The multi-model mean (MEAN) is the thick black line.

SPARC CCMVal Report, Chapter 7: Transport, 2010

UKCA Temperature Biases



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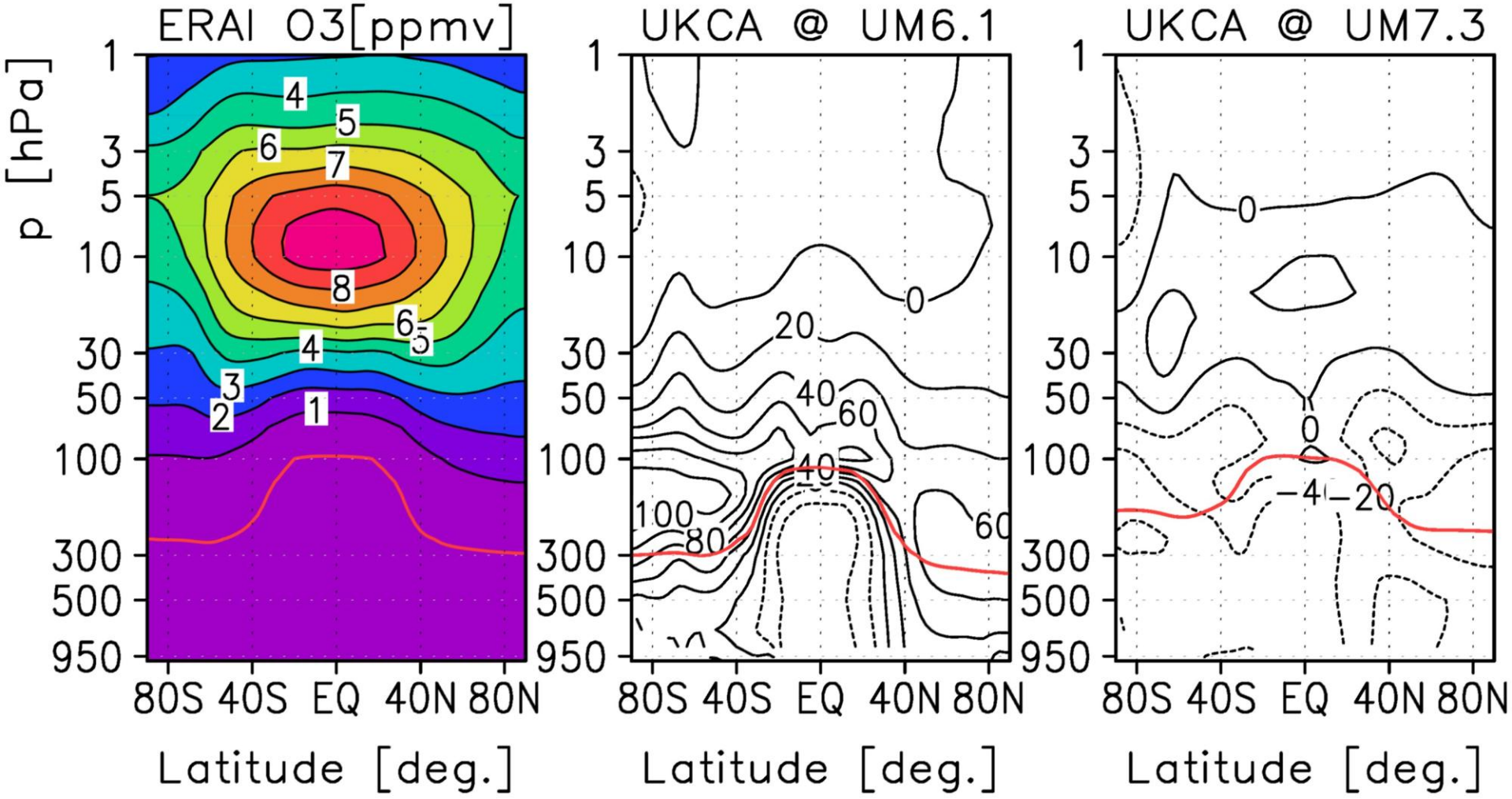
Θ=390K

UKCA Ozone Biases



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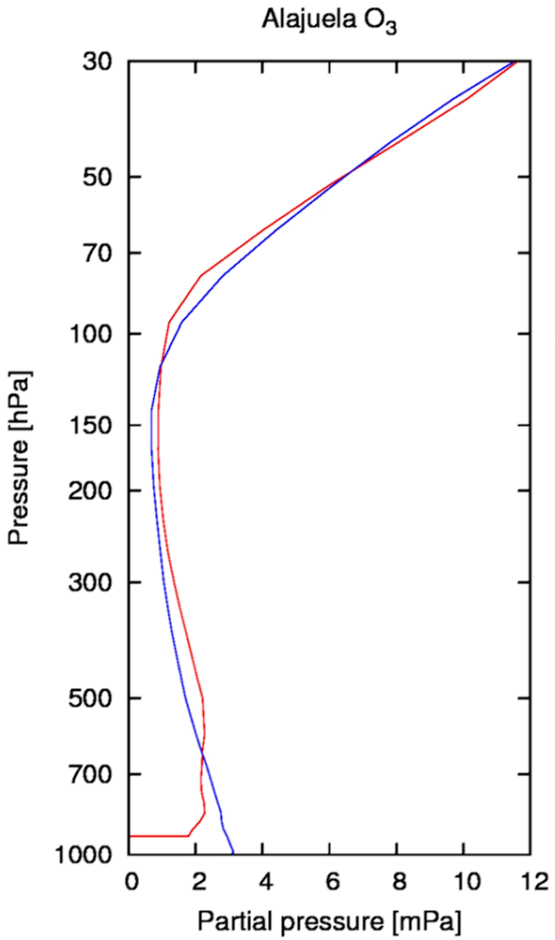
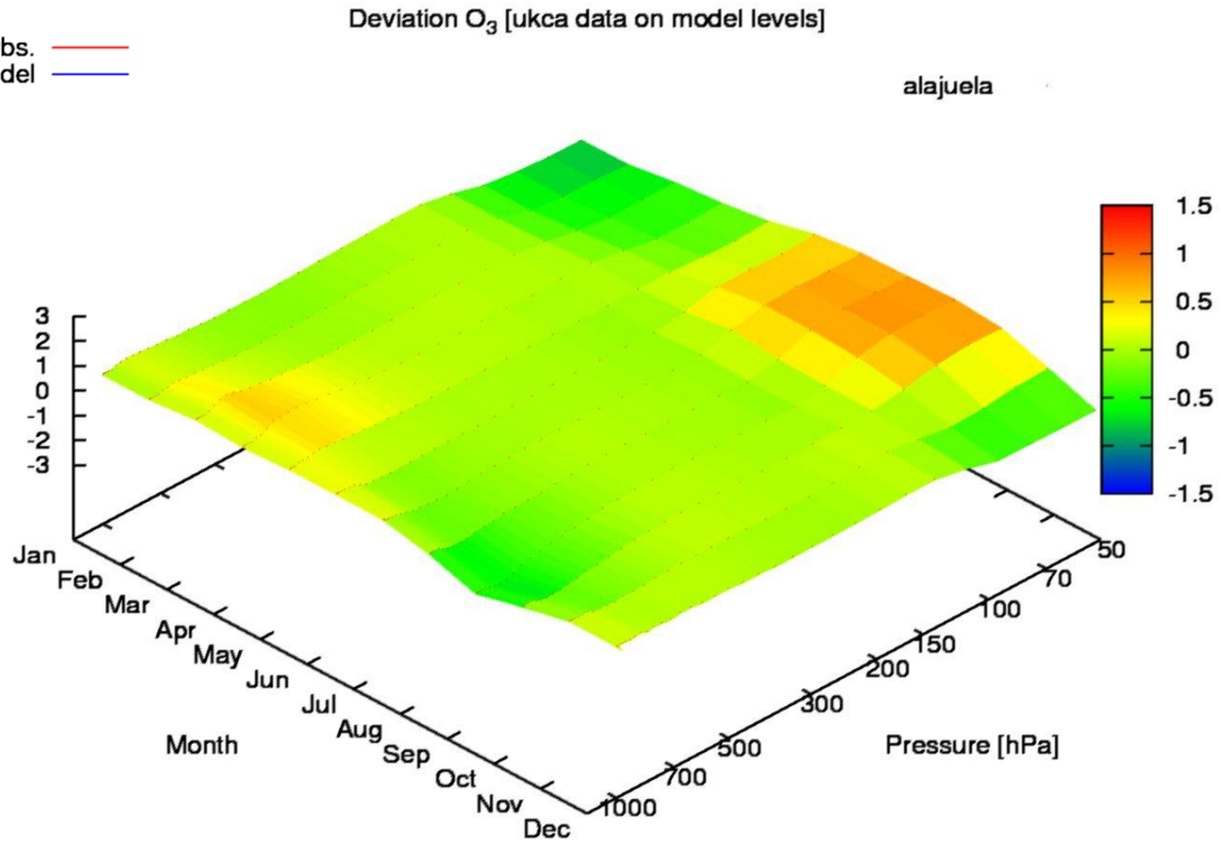
O3=150 ppbv

UKCA vs SHADOZ Ozone





Alajuela (2007-present):
Lon=-84.21
Lat=9.98
Costa Rica

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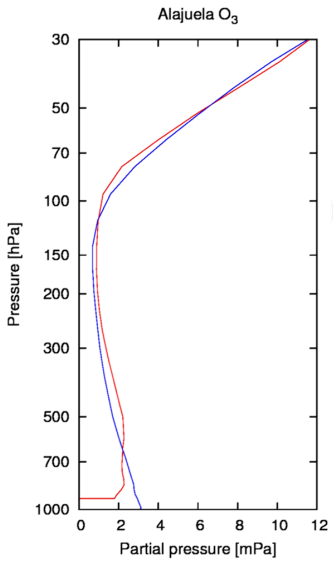
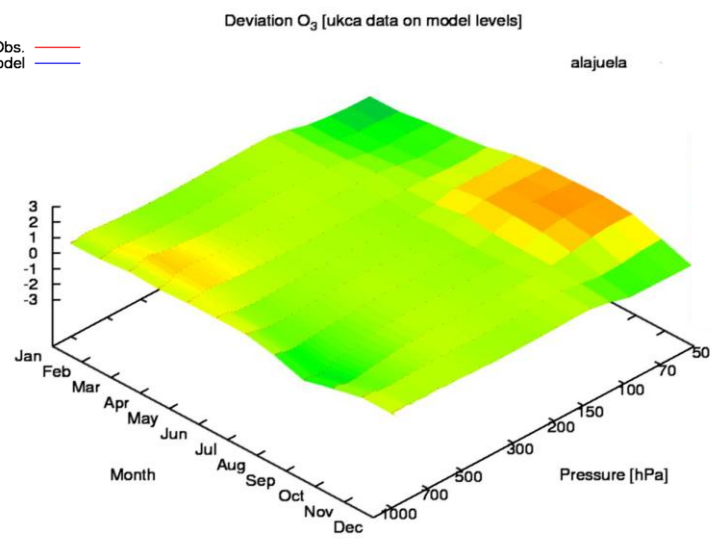
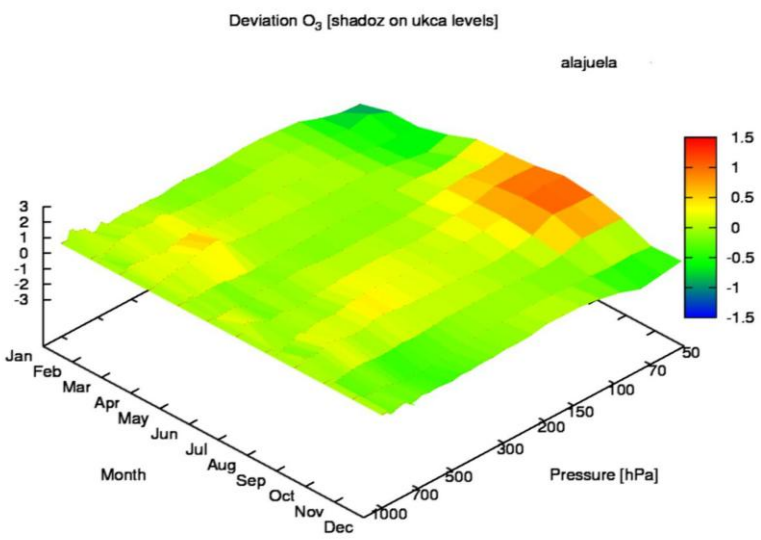
UKCA vs SHADOZ Ozone

Model

Observations







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CCMVal-2 and beyond

MODELLING FUTURE OZONE RECOVERY

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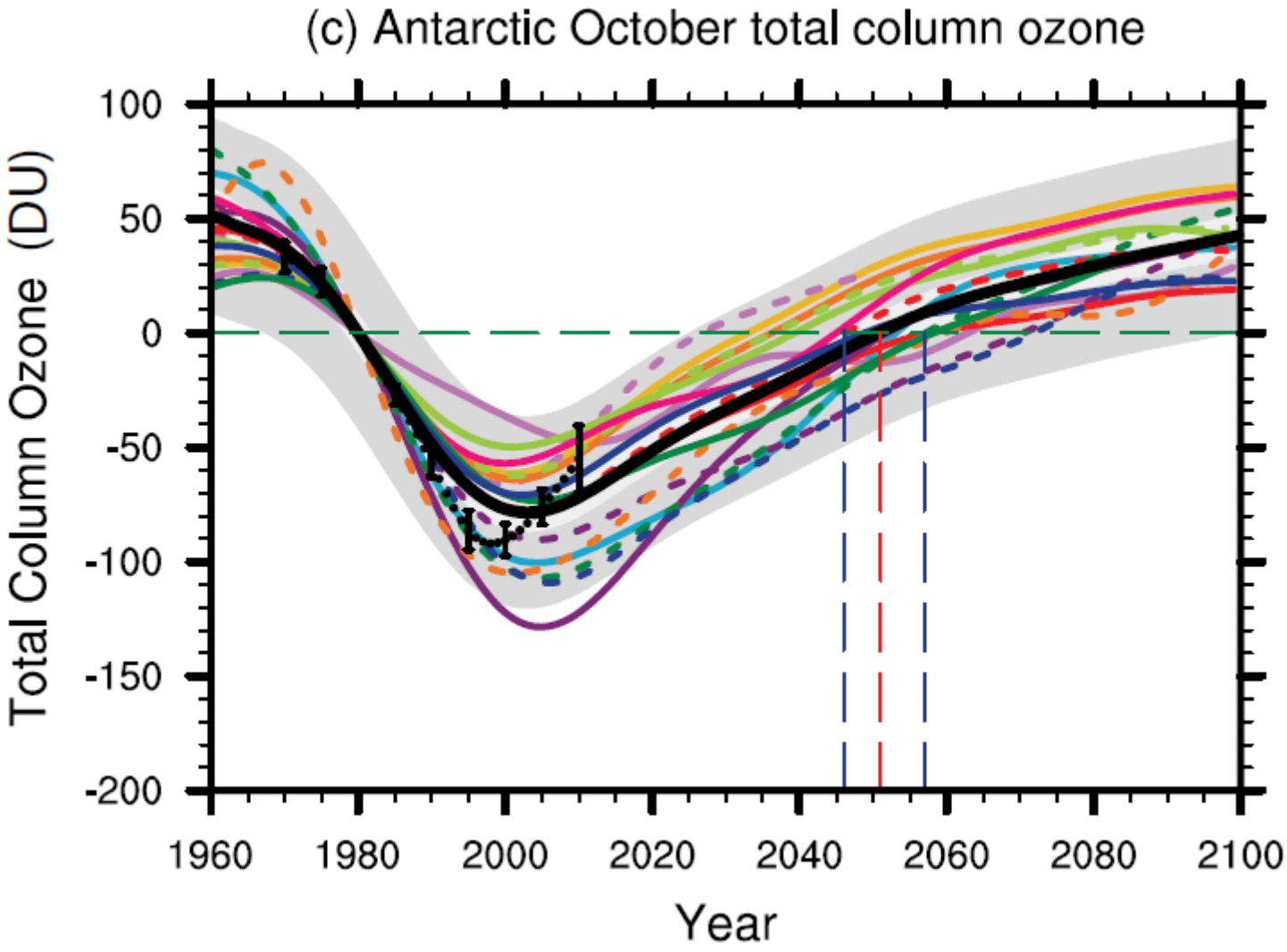
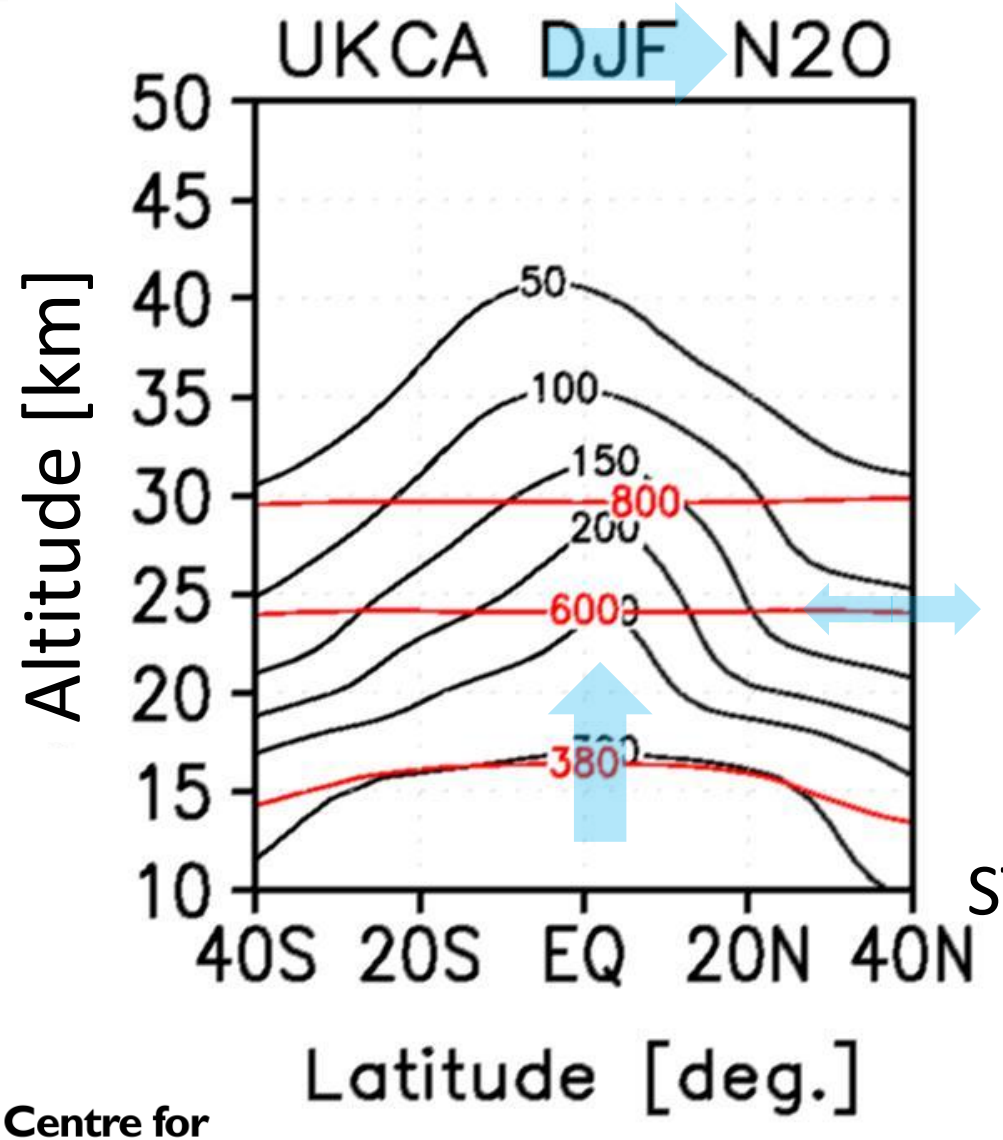
UNEP/WMO O3A Chapter 3



http://www.unep.ch/ozone/Assessment_Panels/SAP/Scientific_Assessment_2010

Brewer-Dobson Circulation



BDC!

STE!

N_2O (ppbv)

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Transport and Chemistry

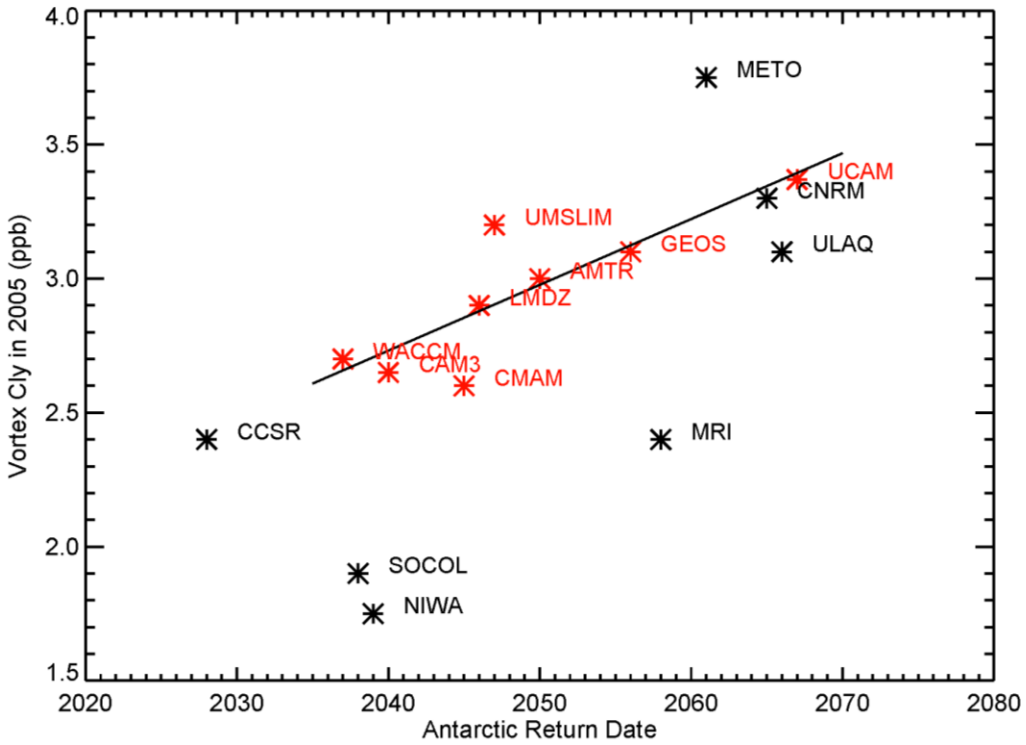
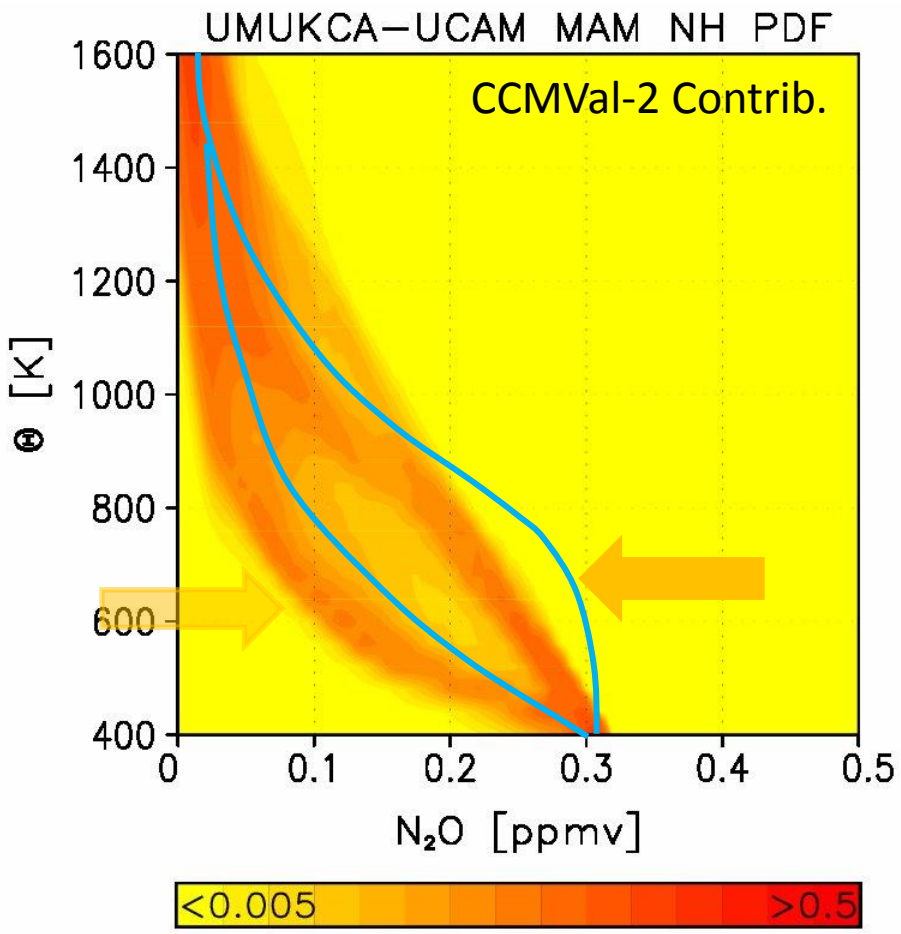
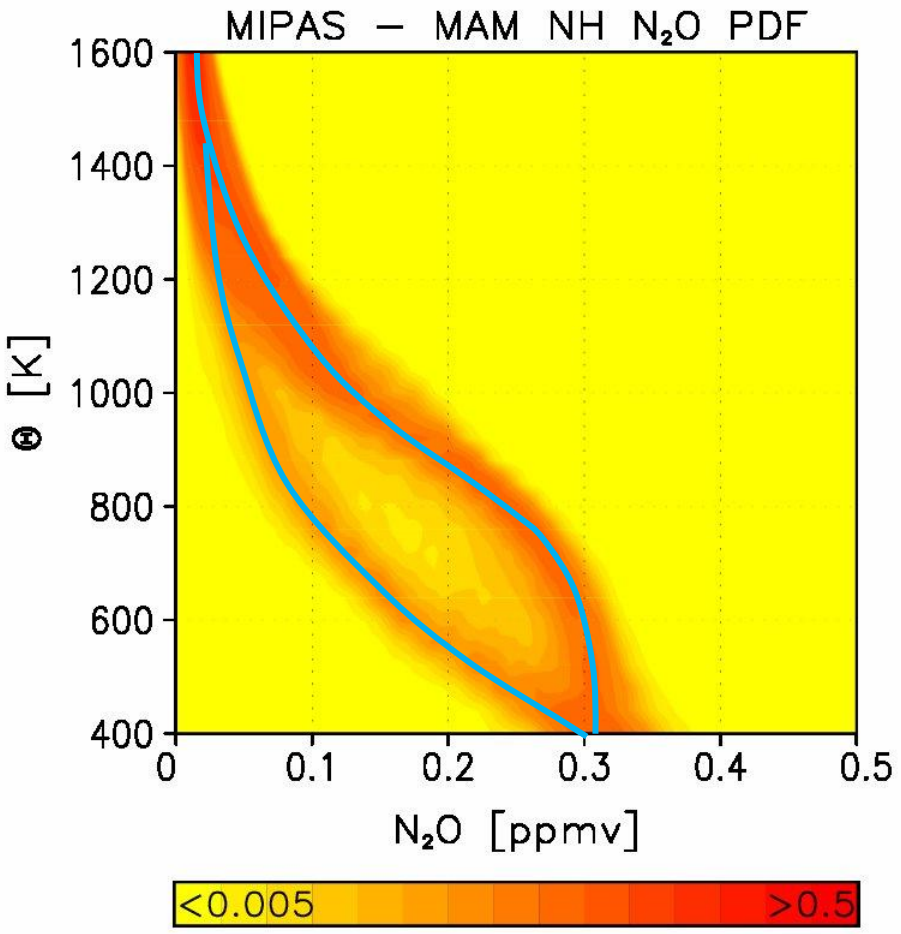


Figure 9. The relationship between model return-to-1980 date for the October Antarctic column O_3 and model Cl_y at 80°S 50 hPa in 2005. Results are from the REF-B1 simulation of the recent past. Models in black have a problem with Cl conservation (CCSRNIES, Niwa_SOCOL, SOCOL), or tropospheric HCl removal (UMUKCA-METO), or the photochemical steady state of ClO/Cly (CNRM-ACM, MRI, ULAQ). Models in red have no Cl chemistry problems. The linear relationship between vortex Cly and Antarctic return date is shown for the eight CCMs that have no Cl problems.

Strahan et al., under review @ JGR, 2011

Transport Evaluation: N_2O PDFs





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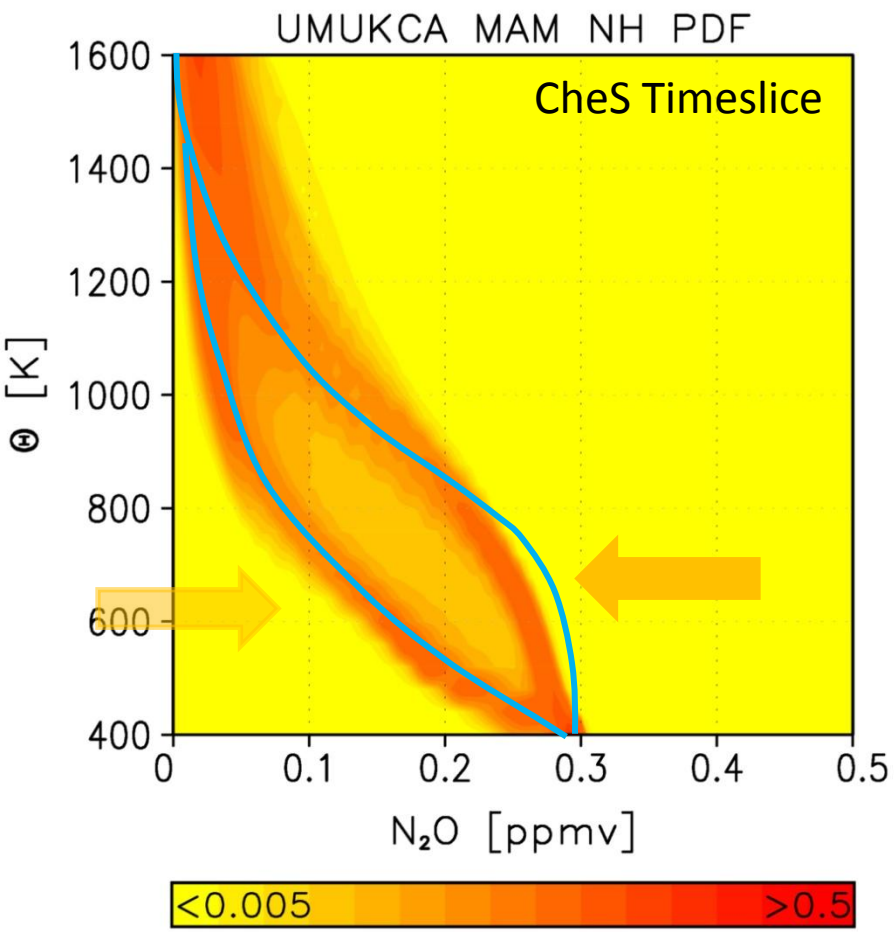
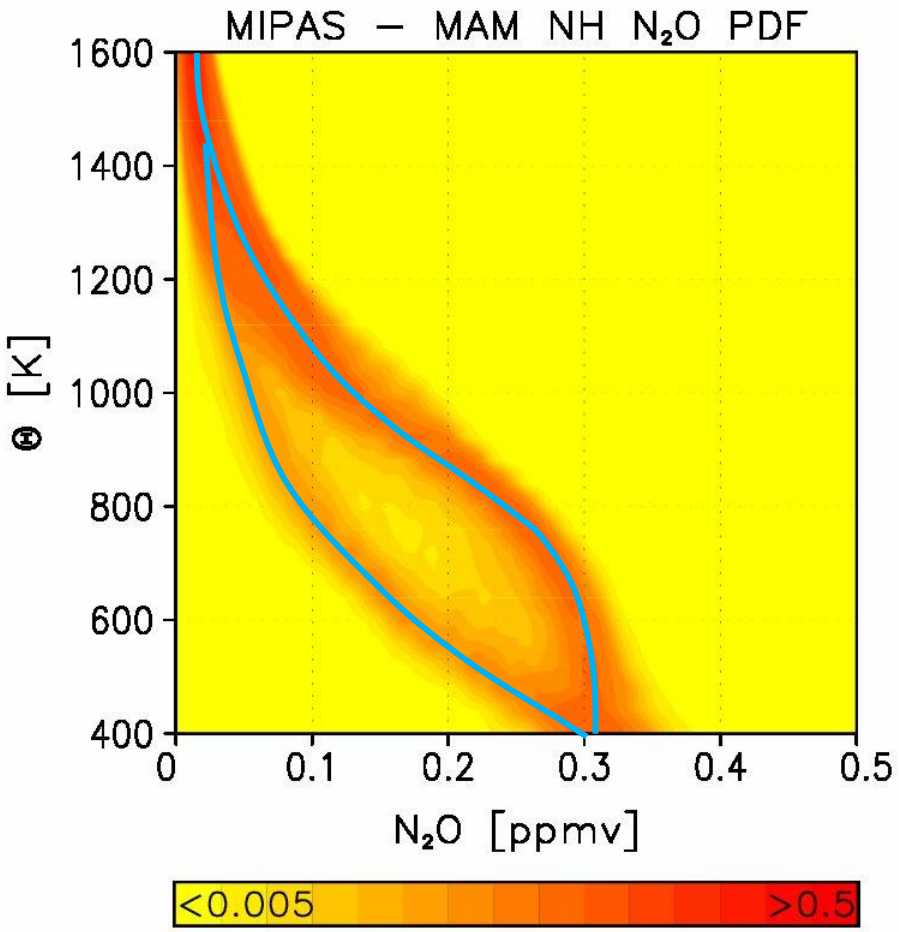
SPARC CCMVal Report, Chapter 5: Transport, 2010

Transport Evaluation: N_2O PDFs





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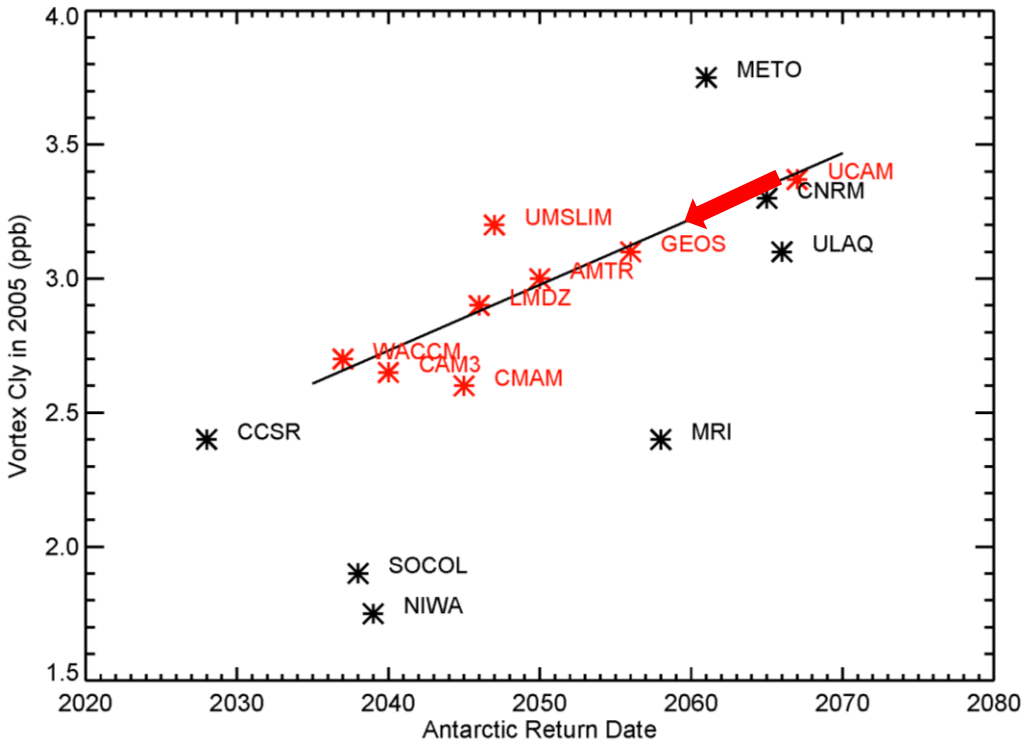
Transport and Chemistry



UKCA@UM7.3: Improved transport, including faster BDC (evidenced by N2O PDF)

Consequences: decreased Cly in 2005 and an earlier return date for O3

Strahan et al., under review @ JGR, 2011

Summary and conclusions

- CCMVal-2: Early UKCA proofed to be a consistent performer; issues were linked to changes that occurred when the base climate model “used” more realistic ozone.
- Current UKCA: UTLS ozone and temperature have improved; in low latitudes the model compares well with SHADOZ data.
- Due to transport issues in the early model the projected ozone return date was late. The current model shows improved transport, as evidenced by N2O PDFs.
- UKCA is a good tool for many forthcoming projects, including a CFC lifetime reassessment and GeoMIP (Geoengineering Model Intercomparison) ...

http://www.ukca.ac.uk/wiki/index.php/UKCA

Thank You!

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