

# MODELLING STRATOSPHERIC OZONE CHEMISTRY IMPACTS ON SOUTHERN HEMISPHERE CIRCULATION

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# Outline

- Why do we care about ozone
- SAM and ozone
- Ozone chemistry
- ACCESS model and preliminary results

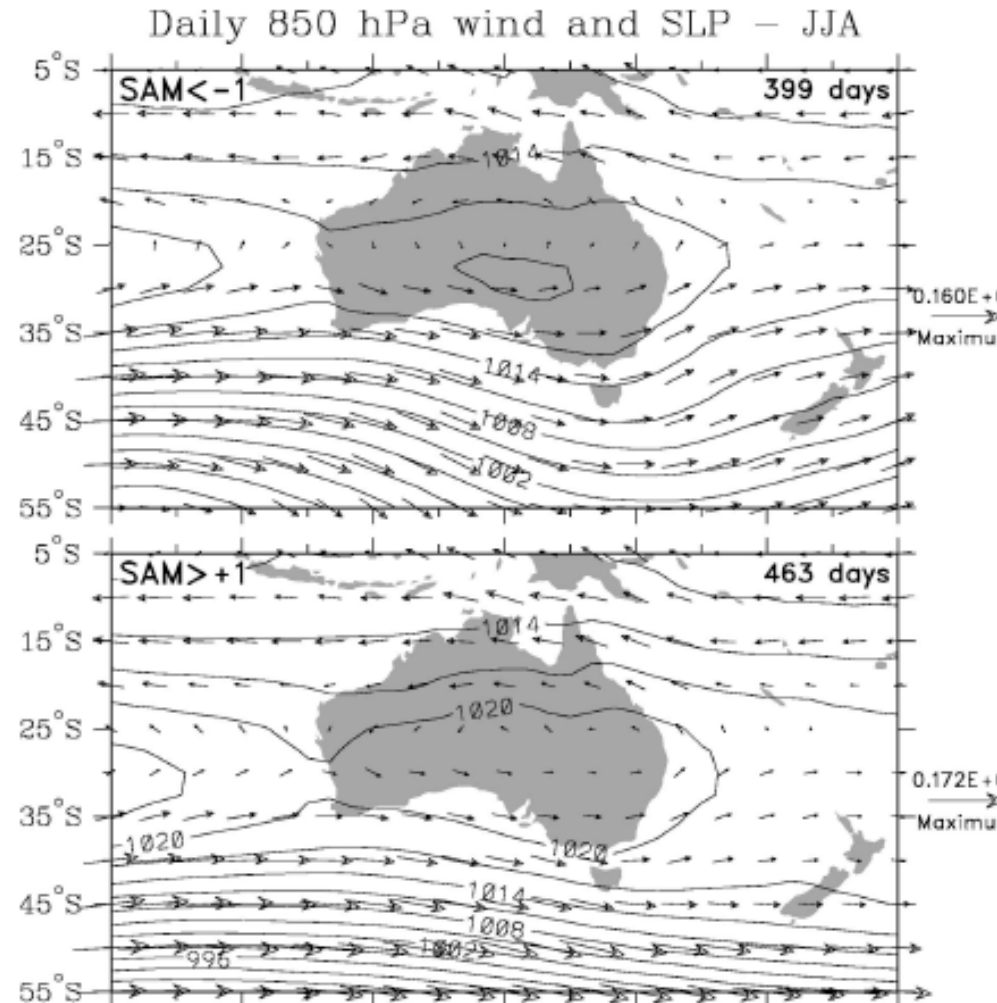
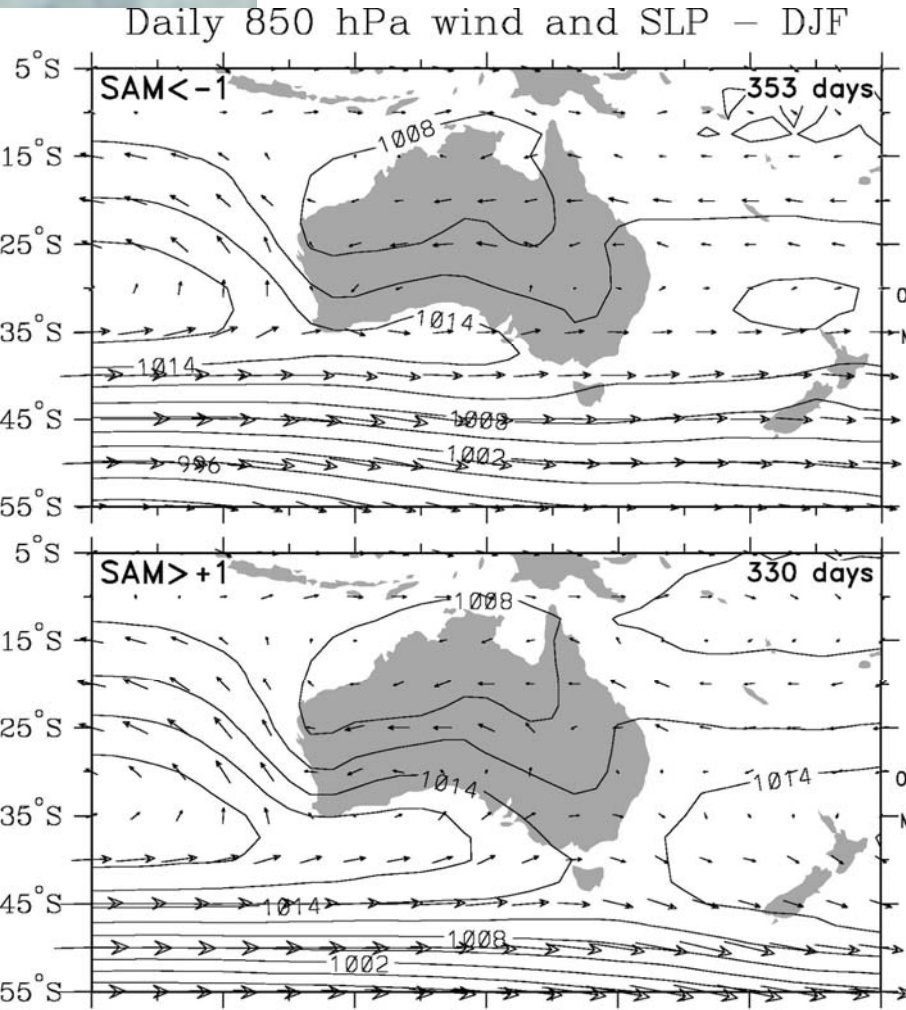


# Why are we interested in ozone?

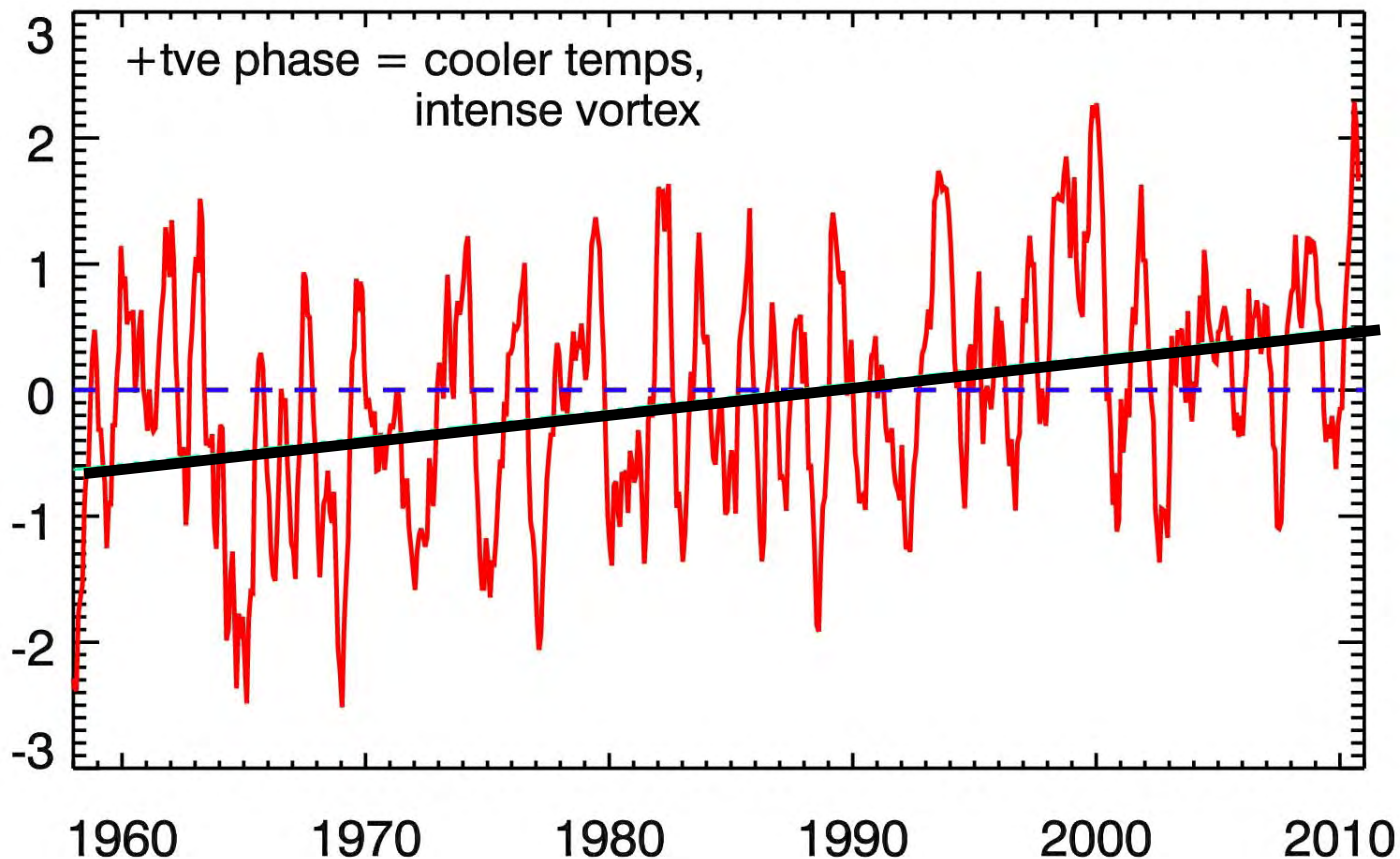
- Ozone protects us from harmful UV radiation
  - The discovery of the ozone hole led to fears that widespread ozone destruction would result in dangerous amounts of UV reaching the surface in populated areas
- Ozone concentrations affect temperature structure of the stratosphere
  - Hypothesis that the ozone hole and cooling of the stratosphere has increased the intensity of the polar vortex which has impacts on storm tracks in the southern hemisphere

# SAM, SLP and 850hPa winds

(Hendon et al. 2007)

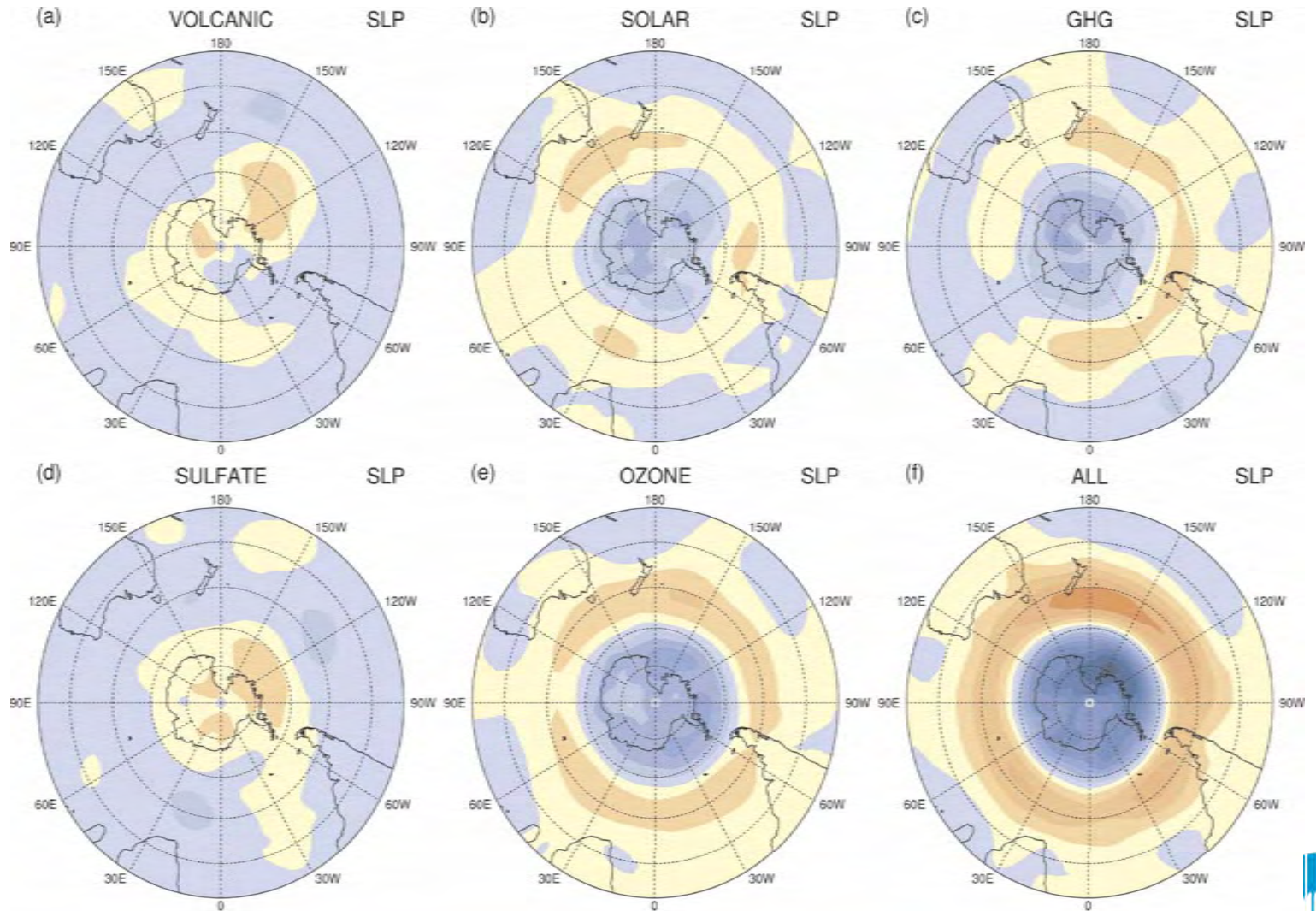


# SAM index

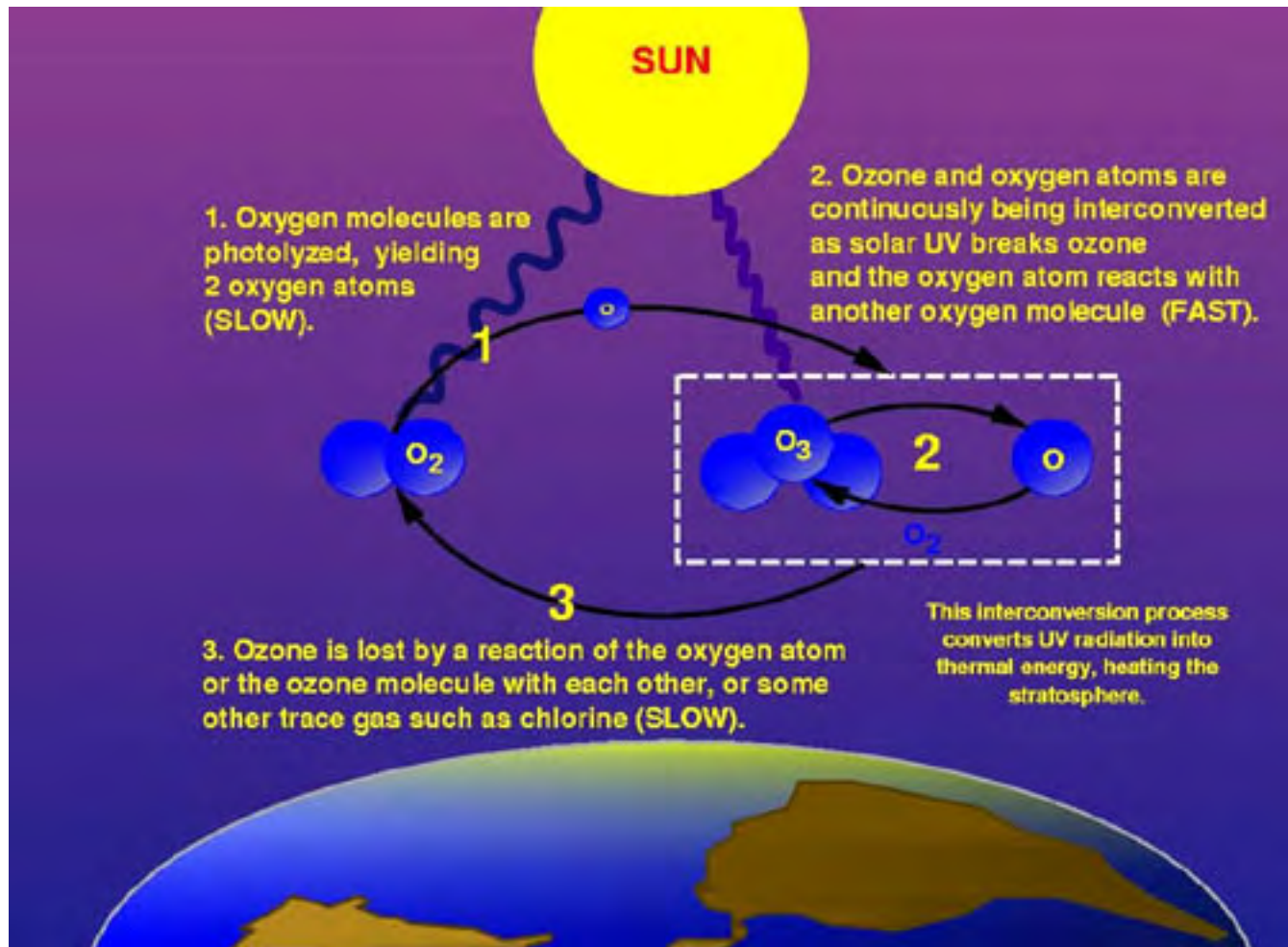


# SLP trends 1958-1999 in NCAR CCSM

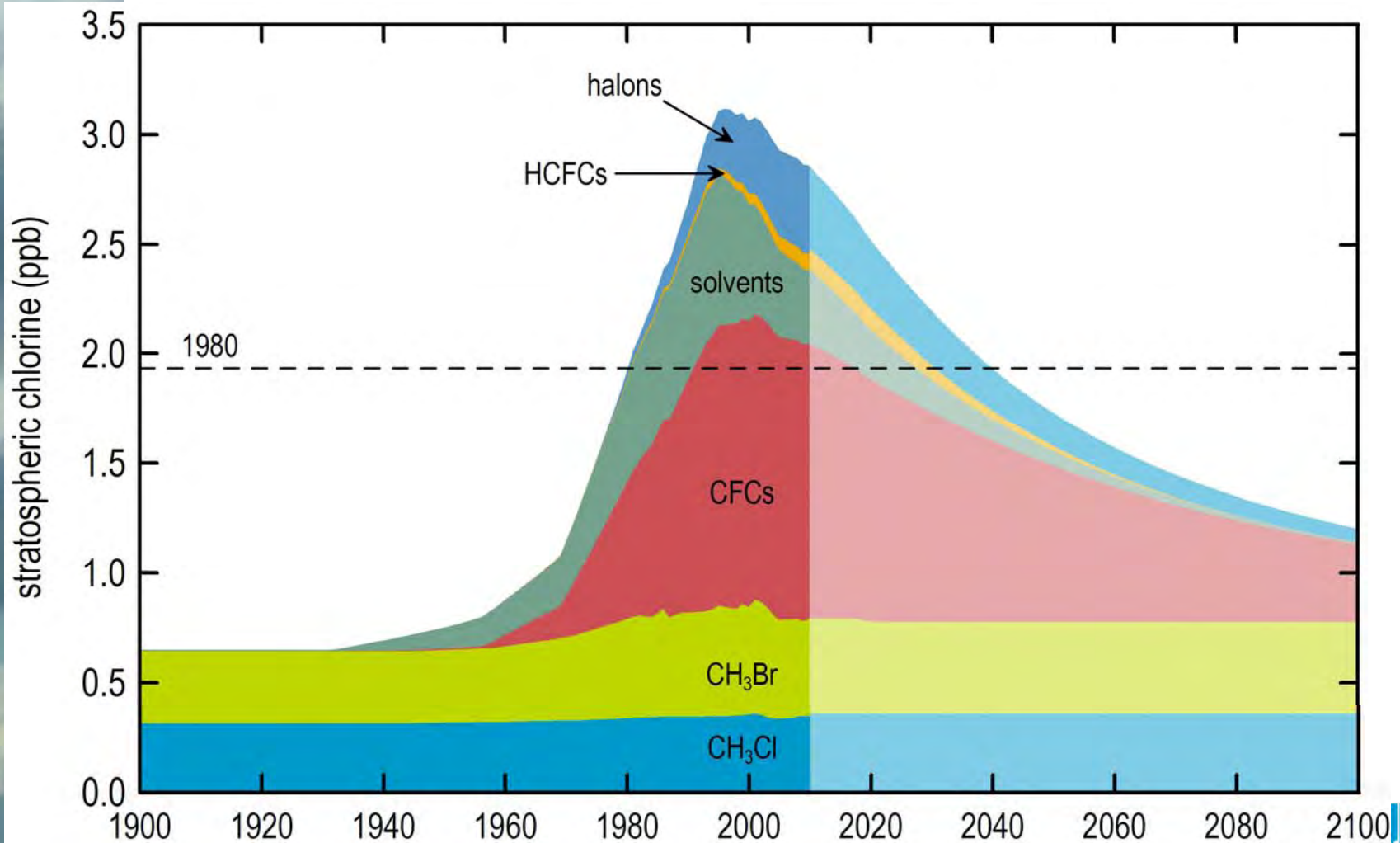
Arblaster and Meehl, 2006



# “Normal” O<sub>3</sub> chemistry

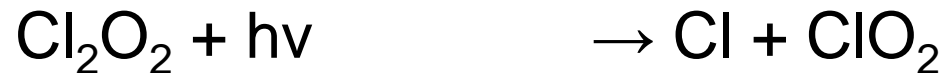
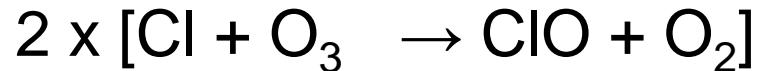


# Ozone Depleting Substances & the Montreal Protocol





# Chlorine-catalyzed ozone depletion



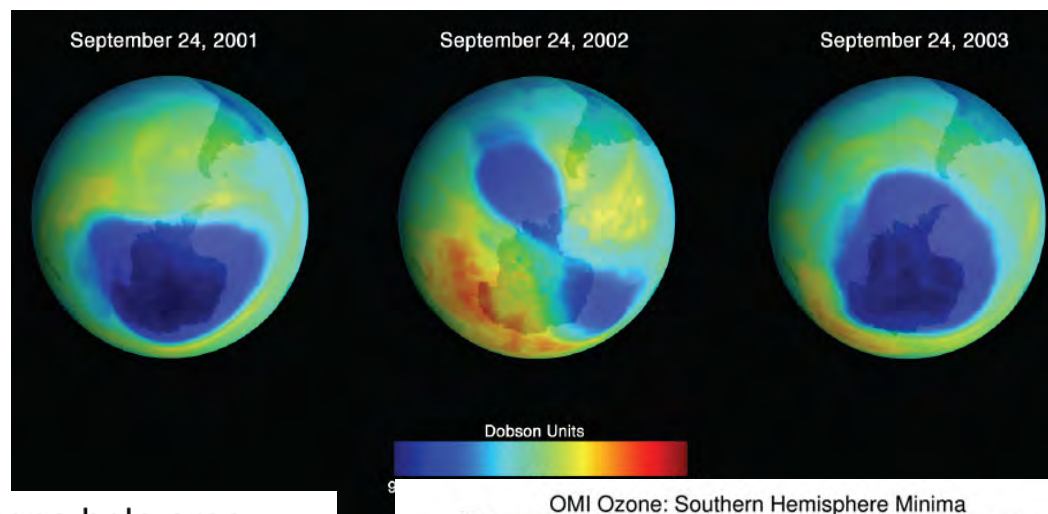
This is the dominant ozone-depleting cycle responsible for the Antarctic ozone hole.

Chlorine is activated from HCl, ClNO<sub>3</sub> on **PSCs**, and deactivated by Cl + CH<sub>4</sub> → HCl

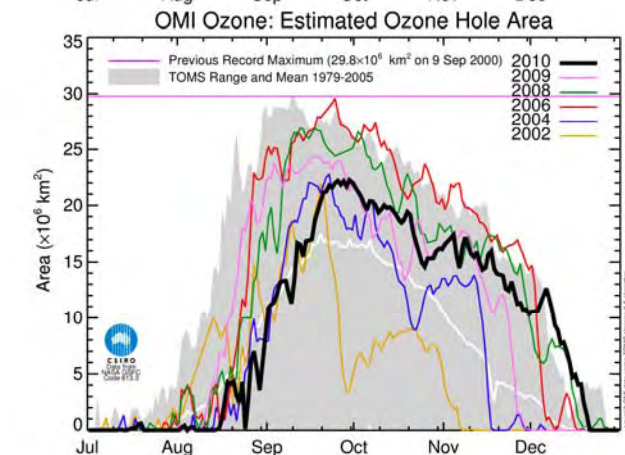
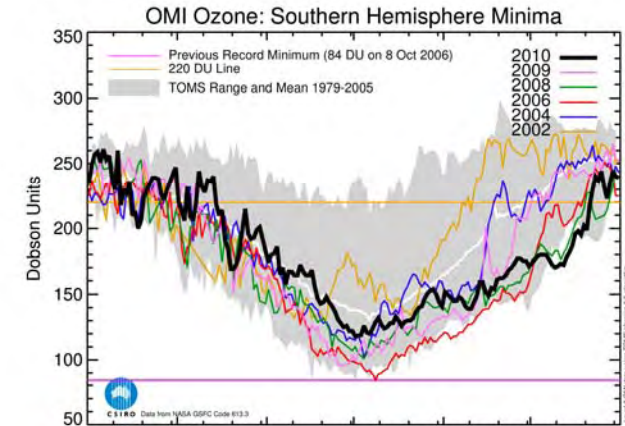
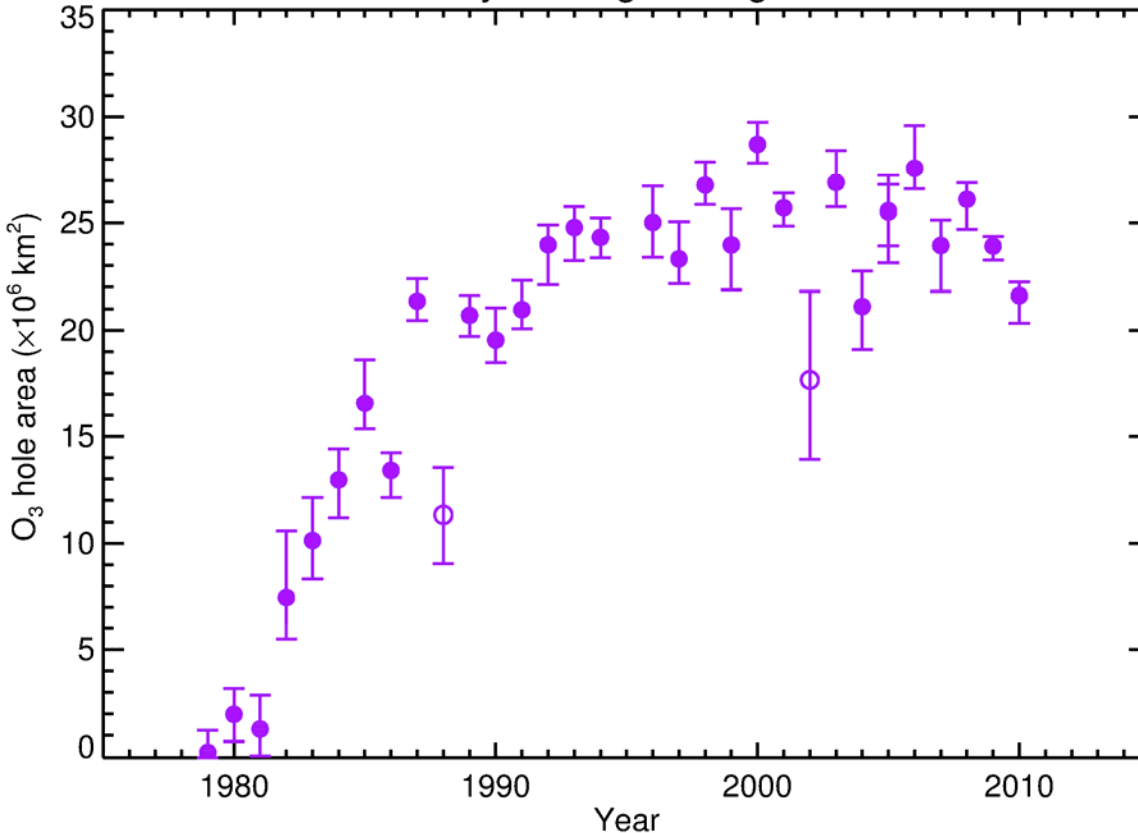
Need for light means ozone hole occurs in spring.

# Evolution of the Ozone Hole

<http://ozonewatch.gsfc.nasa.gov>



TOMS/OMI 15-day moving average ozone hole area



Last updated on Mon Jan 03 23:27:01 2011 by knu021@PBRK-AS

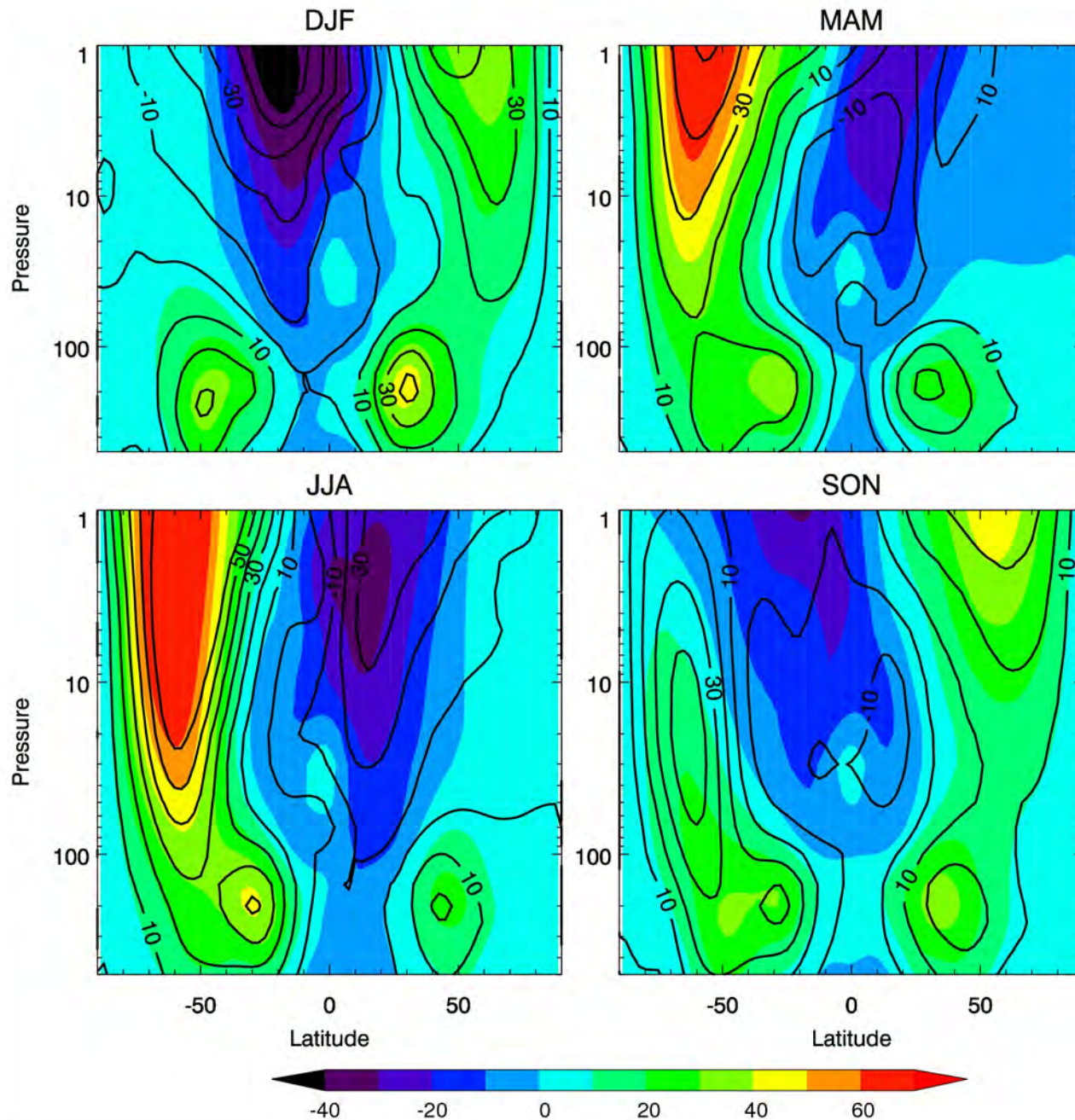
# UK Chemistry and Aerosols Model (UKCA)

- Comprehensive stratospheric chemistry with chlorine and bromine chemistry including heterogeneous processes on PSCs
- Flexible non-family compiler with Newton-Raphson solver
- 35 species and over 150 reactions
- Radiation feedbacks for  $O_3$ ,  $CH_4$ ,  $CFCl_3$ ,  $CF_2Cl_2$ ,  $H_2O$  and  $CO_2$
- L60 and N96/N48 horizontal resolution

# Zonal Wind

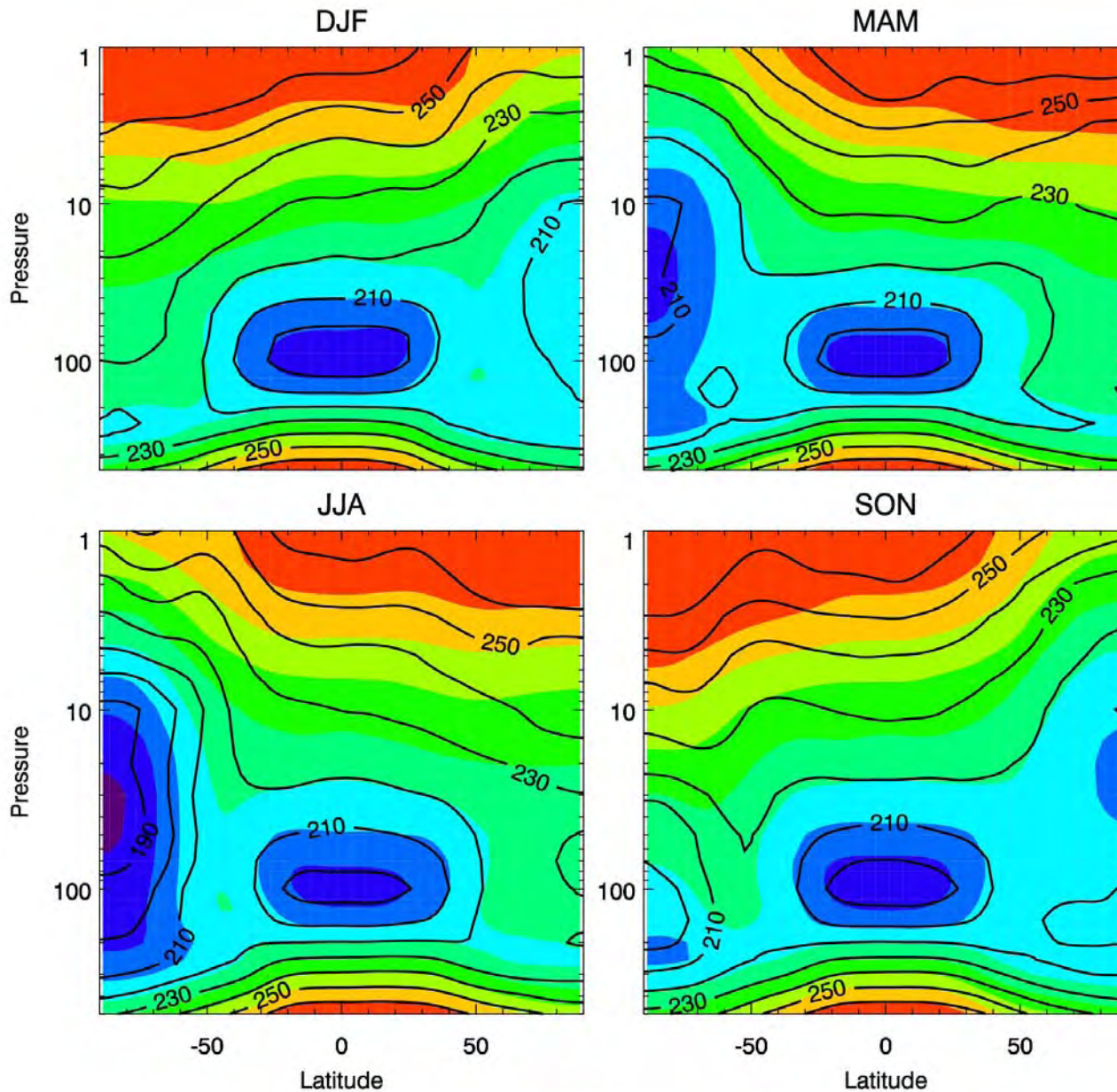
Tropospheric features mostly well resolved

Polar vortex is too weak in spring



Greenhouse2011, Cairns April 2011





## Temperature

Tropospheric T looks very good.

Stratospheric isolines in model too flat – too much B-D circulation

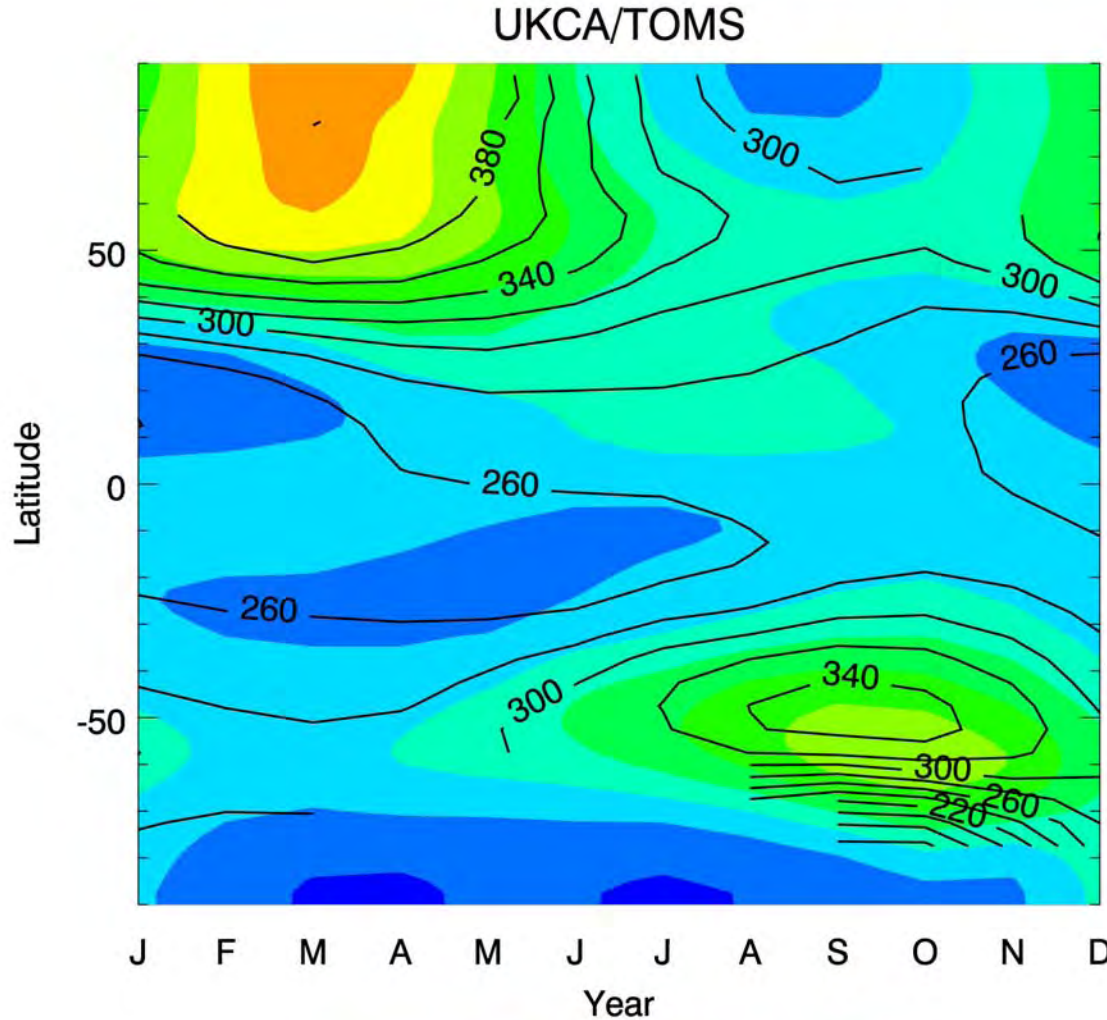
S Pole is too warm in winter and spring



Greenhouse2011, Cairns April 2011



# Total column O3 (DU)



Northern Hemisphere and tropical ozone too low.

Antarctic ozone hole too early and not nearly deep enough.

# Summary

- Stratospheric ozone has an impact on Southern Hemisphere circulation, but the resultant effect on climate is poorly understood
- Coupled Climate-Chemistry model is required, and we are on our way to having this capability in the Southern Hemisphere

