3D CTM Study of 2002/03 Arctic Winter Ozone Loss and Early December Mini-hole Event

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1. Introduction

- In winter 2002/3 Arctic stratospheric temperatures were colder in December and mid-March than recent years (**Fig. 1**): minimum temperature at 475 K were even below 188K.
- An Arctic O_3 minihole, with column values of 190 DU, was observed to coincide with the cold 475 K temperature in early December.
- This poster uses a detailed 3D CTM to diagnose chemical activation associated with the minihole and the overall chemical loss for the winter/spring.

2. SLIMCAT 3D CTM

- 3D off-line chemical transport model.
- θ vertical coordinate
- Detailed chemical scheme (see Chipperfield [1999]).

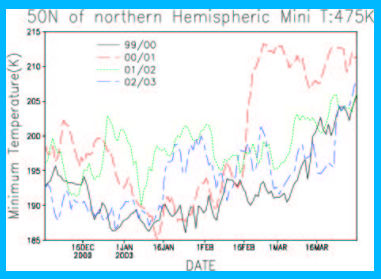

Fig 1. Minimum T poleward of 50ºN at 475K from ECMWF operational analyses for 1999/00 onwards.

3. Early December Minihole event

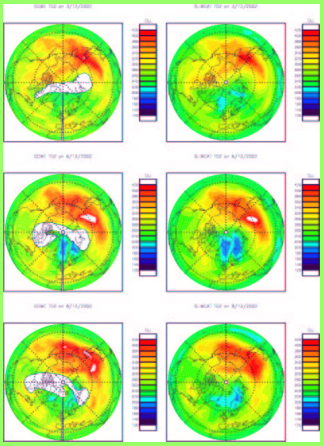

Fig 2. Comparison of SLIMCAT total column ozone with GOME data during the minihole event

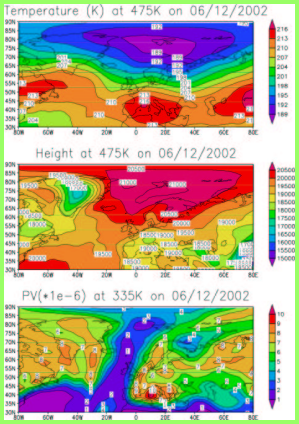

Fig 3. Adiabatic uplift mechanism contributing to the formation of ozone minihole on December 6, 2002.

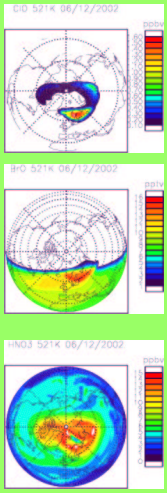

Fig 4. Model ClO (ppbv), BrO (pptv) and HNO_3 (ppbv) at 521 K on December 6, 2002.

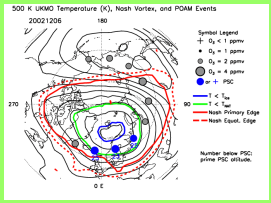

Fig 5. Location of PSCs observed by POAM on 6/12/2002.

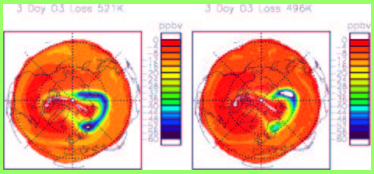

Fig 6. Accumulated chemical ozone loss at 521 K and 496 K from December 3 to December 6.

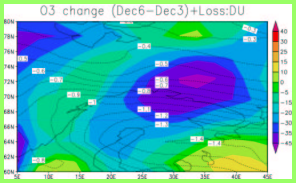

Fig 7. Modelled O_3 change (colour) and chemical loss (contours) (DU) between December 3 and 6, 2002.

Discussion

- SLIMCAT forced by ECMWF analyses captures the minihole event (**Fig. 2**).
- Adiabatic uplift mechanism played dominant role in causing O_3 decrease (**Fig 3**).
- Cl activation (**Fig 4**) and fast chemical ozone loss (**Fig 6**) diagnosed in region of minihole – consistent with observed location of PSCs (**Fig. 5**).
- However, chemical depletion makes minor contribution to local O_3 column change (**Fig. 7**).

4. 2002/3 Arctic winter O_3 loss

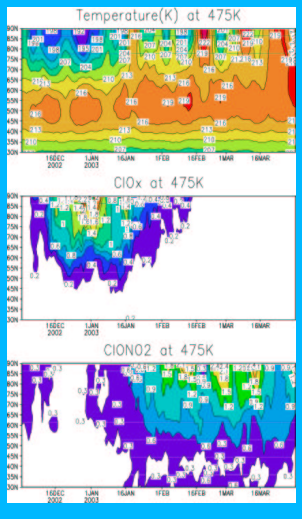

Fig 8. Time series of temperature (K), ClO_x (ppbv) and $ClONO_2$ (ppbv) at 475K.

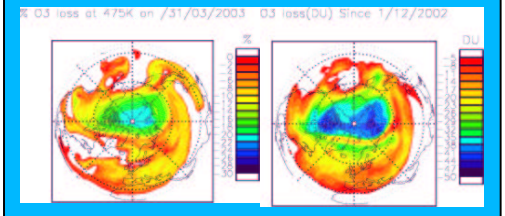

Fig 9. Modelled Arctic ozone loss on 31/3/2003 (since 1/12/2002) at 475K (%) and total column loss (DU).

Discussion

- Arctic stratospheric temperatures were colder in December 2002 and mid-March 2003 than previous recent years.
- Modelled chemical O_3 loss by end of March is ~50 DU in the column and ~22% at 475K (since 1/12/2002).

Acknowledgments

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References

Chipperfield, M.P. , JGR, **104**, 1781-1805, 1999.