A Global View on Diurnal Ozone Variation in the Stratosphere with WACCM

Ansgar Schanz, Klemens Hocke and Niklaus Kämpfer
Institute of Applied Physics and Oeschger Centre for Climate Change Research
University of Bern, Bern, Switzerland

Motivation

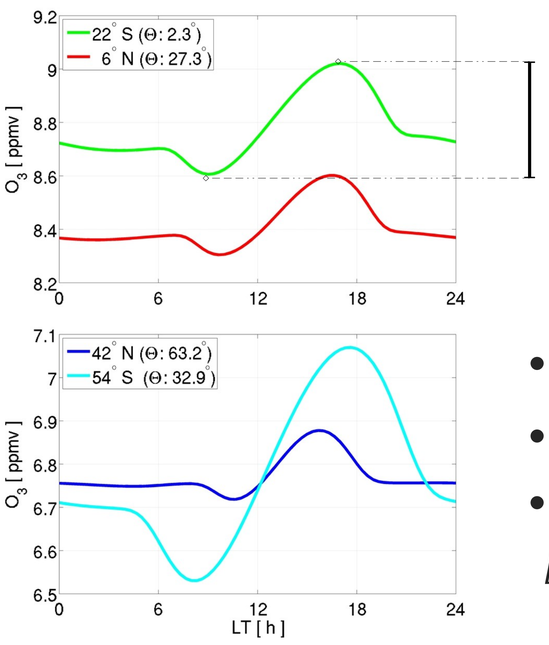
- Diurnal variation of ozone in the stratosphere is little-known – especially local effects
- Satellite-based ozone trend analysis is affected by diurnal variations in the stratosphere
- Diurnal ozone variation is an excellent test-bed for ozone simulations

The model

- Fully coupled 3D Chemistry Climate Model (CCM)
- Altitude range: 0-140km, 4˚lat x 5˚lon, #55 species
- Open community access, WACCM runs PC or Cluster

Characteristics of the diurnal ozone variation at 5 hPa / 37 km

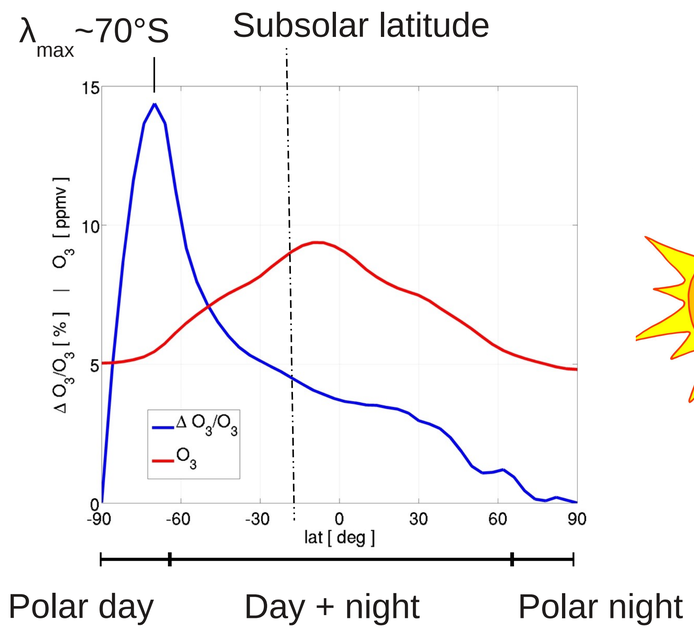
Data set: mean January WACCM F 2000 (reflects a perpetual year 2000)

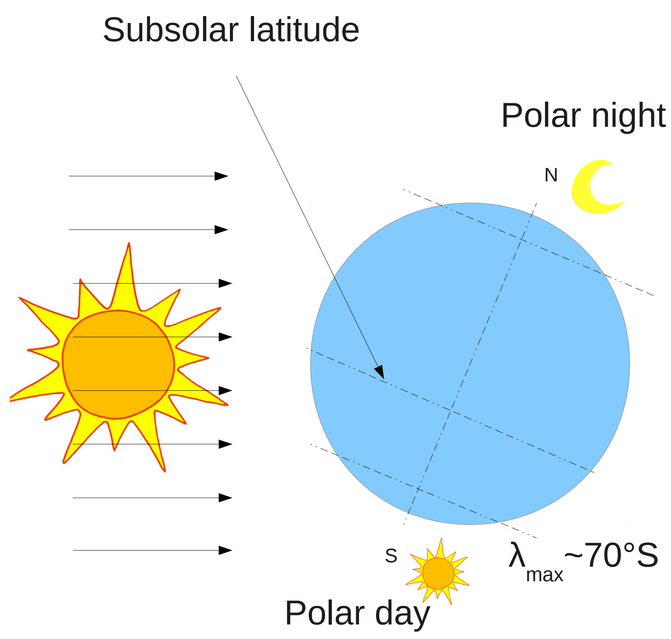


$\Delta O_3 = \max(O_3) - \min(O_3)$

- Minimum of ΔO_3 after sunrise
- Maximum of ΔO_3 in the late afternoon
- WACCM agrees with observations

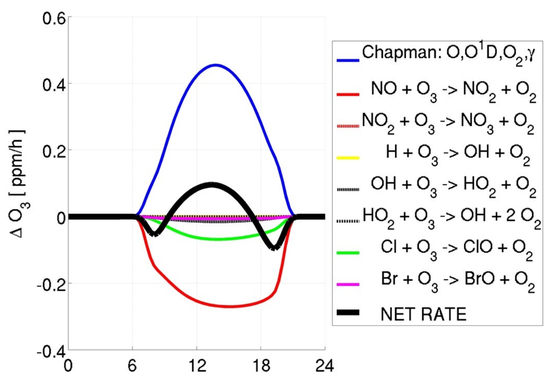
[Haefele et al., JGR 2008]



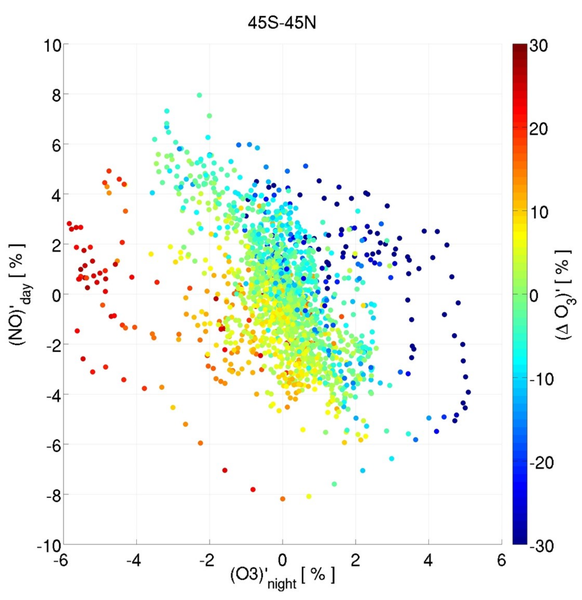


Are there local effects of the diurnal ozone variation in the stratosphere?

Ozone budget at 5hPa



- Conversion of O_3 during day time
- Major contribution of NO depletion cycle
- Minor contribution of Cl depletion cycle



Anomaly of concentrations:

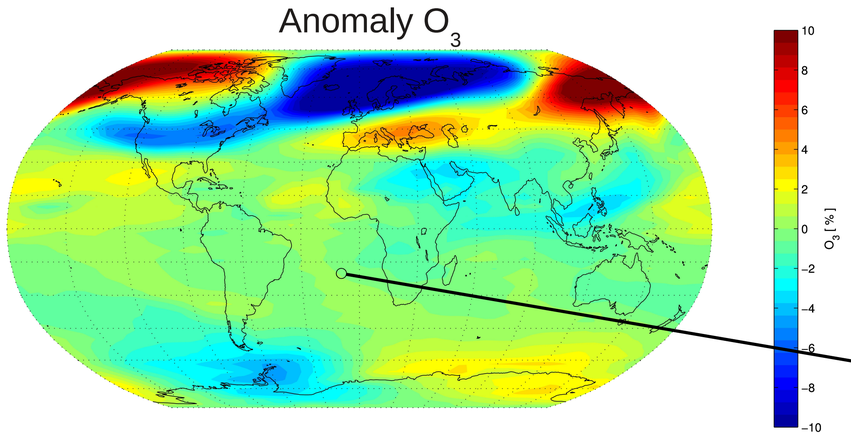
$$X'_{anomaly}(\lambda,\varphi,z,t) = X(\lambda,\varphi,z,t) - \overline{X}_{zonal}(\varphi,z,t)$$

- Anomaly of NO affects local variability of ΔO_3
- Anomaly of O_3 affects local variability of ΔO_3

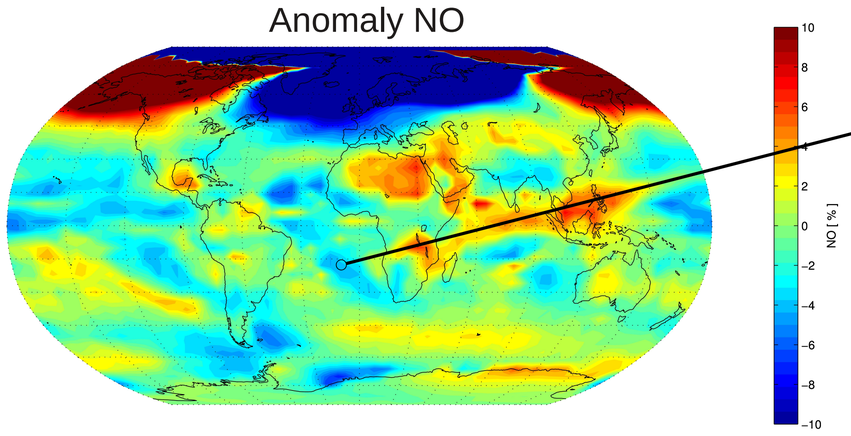
$NO \uparrow \rightarrow \downarrow \Delta O_3$

$O_3 \uparrow \rightarrow \downarrow \Delta O_3$

Anomaly O_3



Anomaly NO



Example: mean January at 5hPa

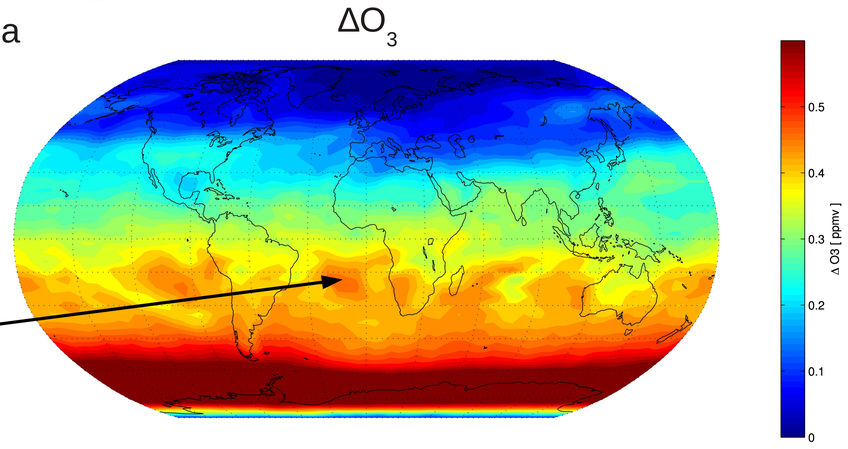
Southern Atlantic Ocean

$O_3' = 0$

$NO' < 0$

$\Delta O_3' > 0$

ΔO_3



Conclusions / Outlook

✓ WACCM gives a 3D view on ΔO_3 in agreement with observations

✓ O_3 and NO are main parameters for ΔO_3 in the stratosphere and their anomalies cause local variability of ΔO_3 from 45ºS to 45ºN

➔ Can temperature, transport and mixing processes be related to these anomalies?

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