STE Diagnostic To Evaluate Transport and Chemistry

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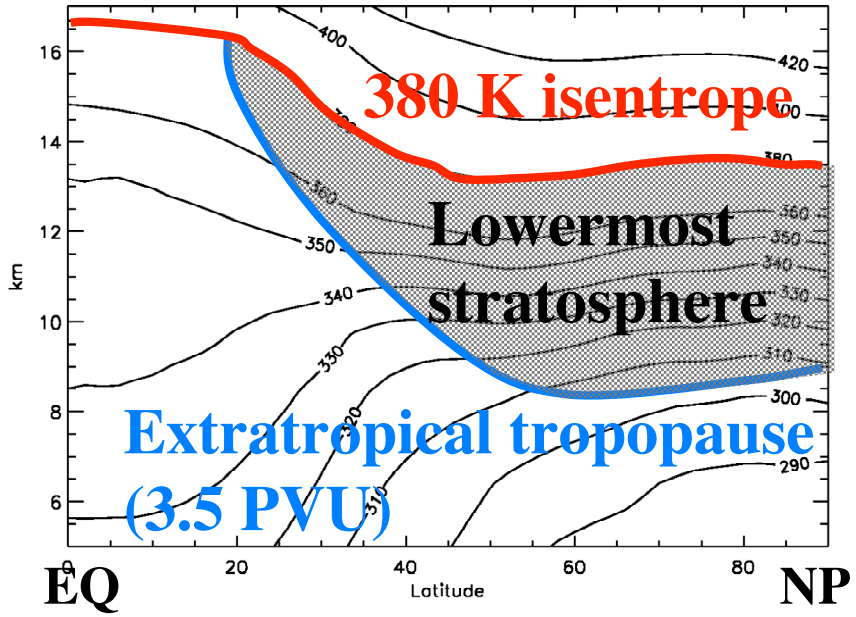
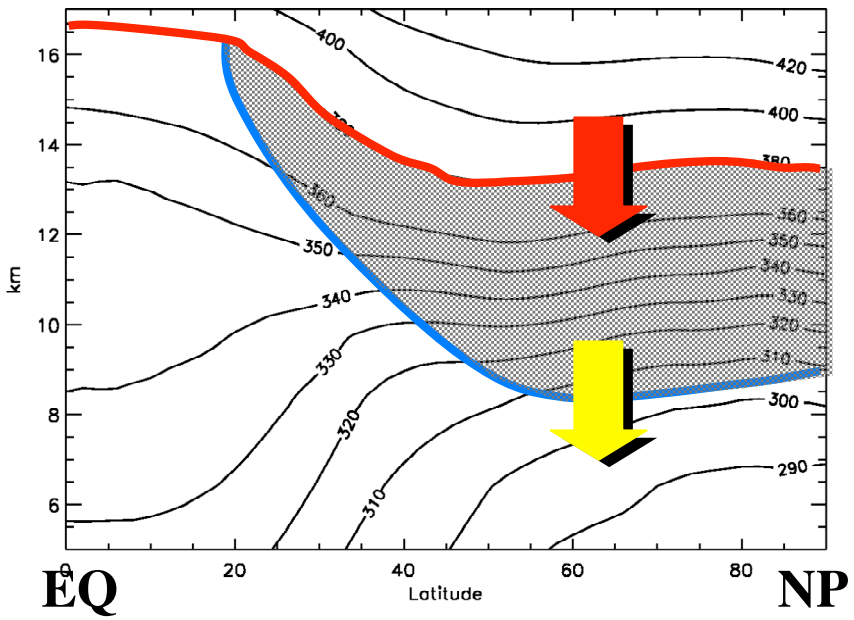
Motivation

- STE of mass and ozone across the extra-tropical tropopause is very sensitive to the large-scale model transport and chemistry
- Impact of chemistry mechanisms may be tested by simulations using same met fields
- Similarly, varying the met fields used enables an evaluation of the transport

Method


380 K isentrope
Lowermost stratosphere
Extratropical tropopause (3.5 PVU)
EQ
NP
km
Latitude
16
14
12
10
8
6
0
20
40
60
80
400
420
360
350
340
330
320
310
300
290

Method



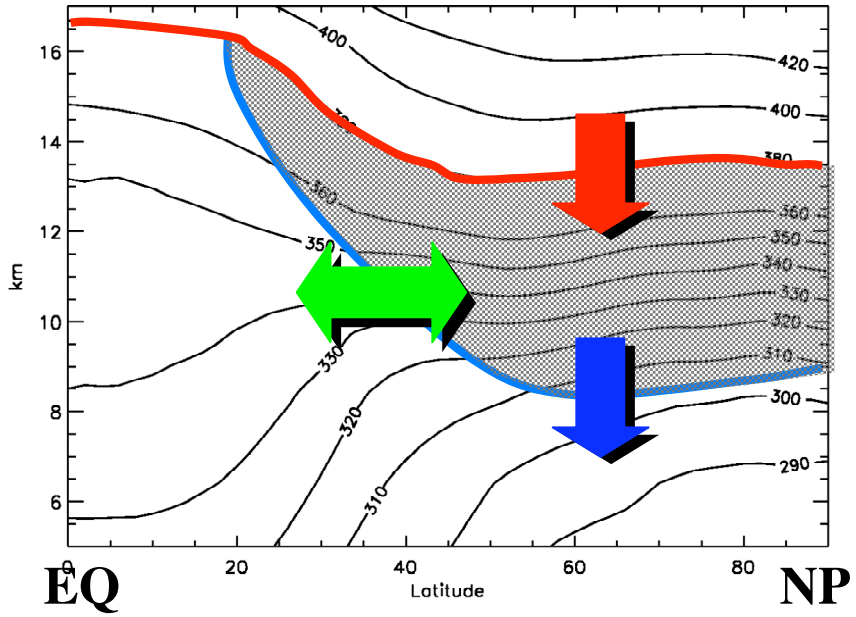
Note:
$F_{trop}=F_{380K}$
on a long term average

Simply mass balance

$$F_{trop} = F_{380K} + dM/dt$$

(Appenzeller et al. 1996)

Method

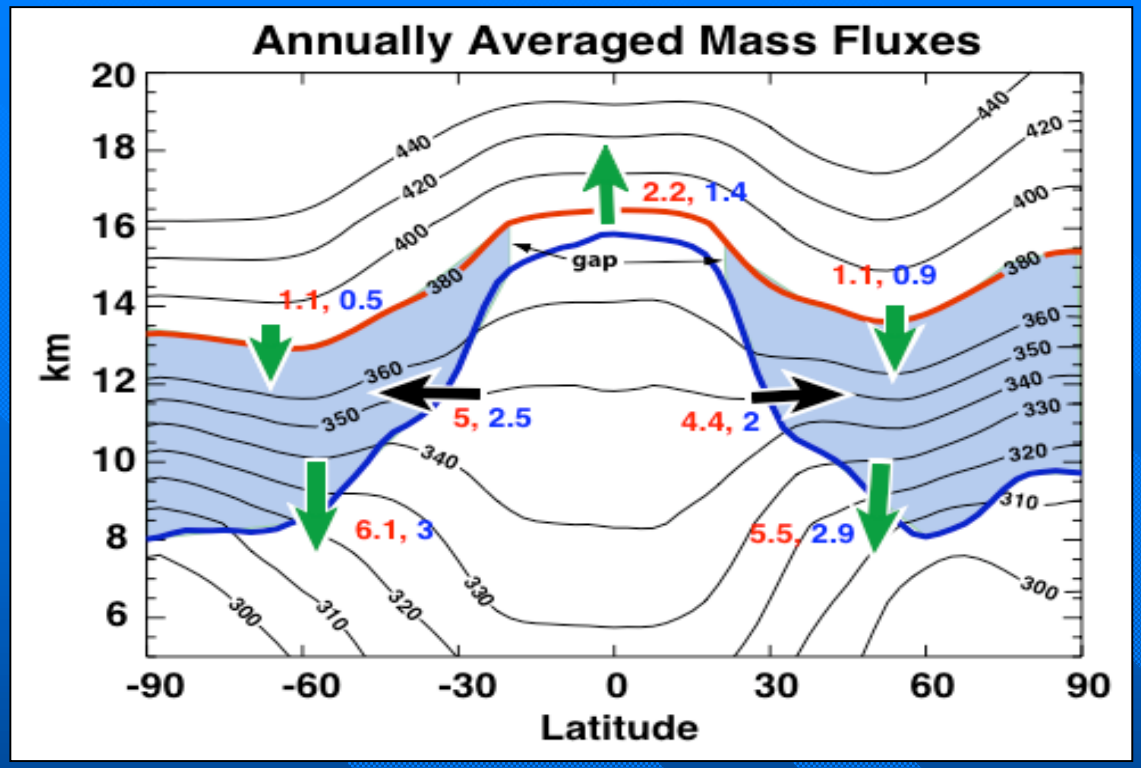


$$F_{diab} + F_{adiab} = F_{380K} + dM/dt$$

Schoeberl, 2004

Use heating rate on tropopause

Difference of F_{diab} and RHS

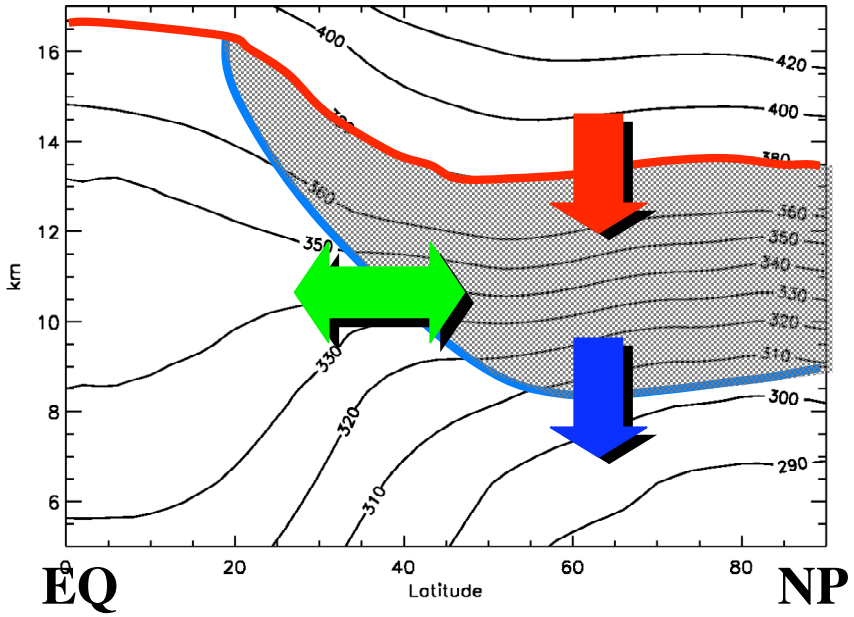


Units
10^{10} kg/s

UKMO (Red)
1992-2001
FVDAS (Blue)
2000

- Schoeberl [2004] used this method to compare transport in UKMO, FVDAS, and FVGCM.
- Differences found to be due to temperature and heating rate biases (and tropopause height).
- Also found annual net adiabatic transport from trop to strat (extratropics)

Method



$$F_{diab} + F_{adiab} = F_{380K} + dM/dt$$

Convolve with ozone mixing ratio -> ozone STE

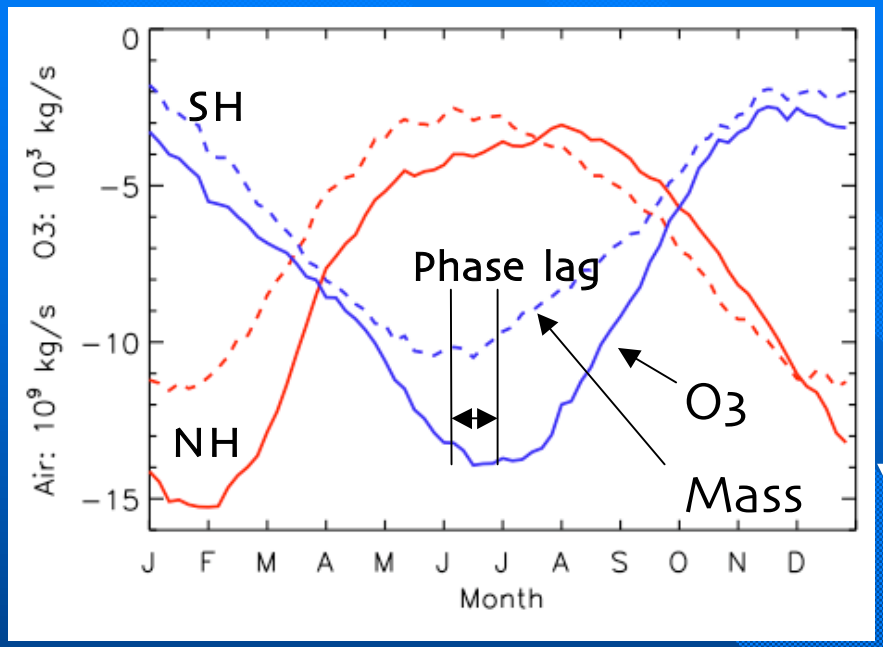
Results With GMI Combo Model

Comparisons with Goddard Stratospheric CTM

- Both CTMs driven with FVGCM met fields
- GCTM results are five year means; GMI is one year
- GCTM chlorine load corresponds to 1979-1983 levels
- GMI ozone fields used are monthly means (met fields are daily)

Extratropical 380 K Flux

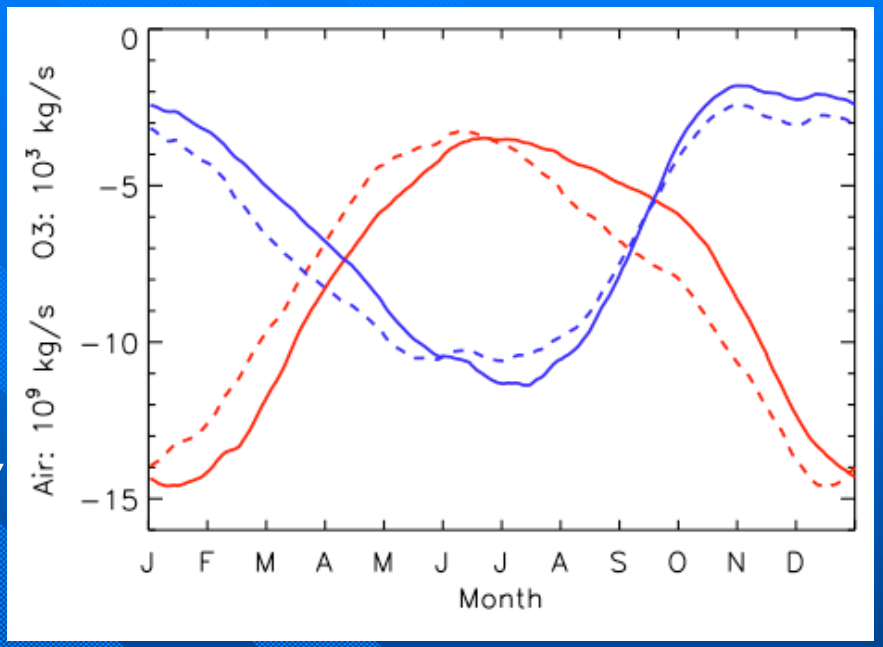
Goddard CTM



NH mass: 2.2×10^{17} kg/yr
SH mass: 1.9×10^{17} kg/yr

NH ozone: 252 Tg/yr
SH ozone: 248 Tg/yr

GMI Combo

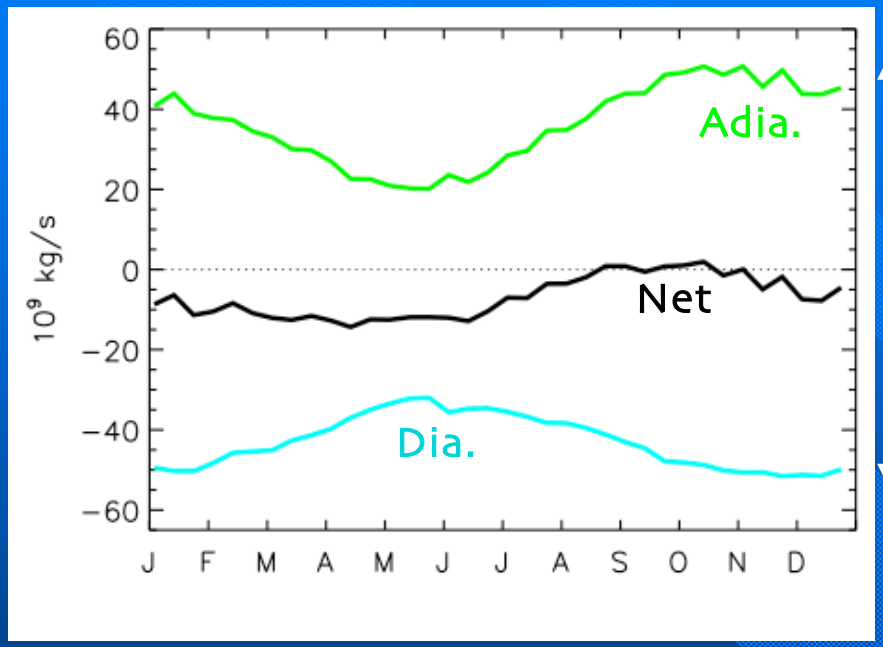


NH mass: 2.6×10^{17} kg/yr
SH mass: 2.1×10^{17} kg/yr

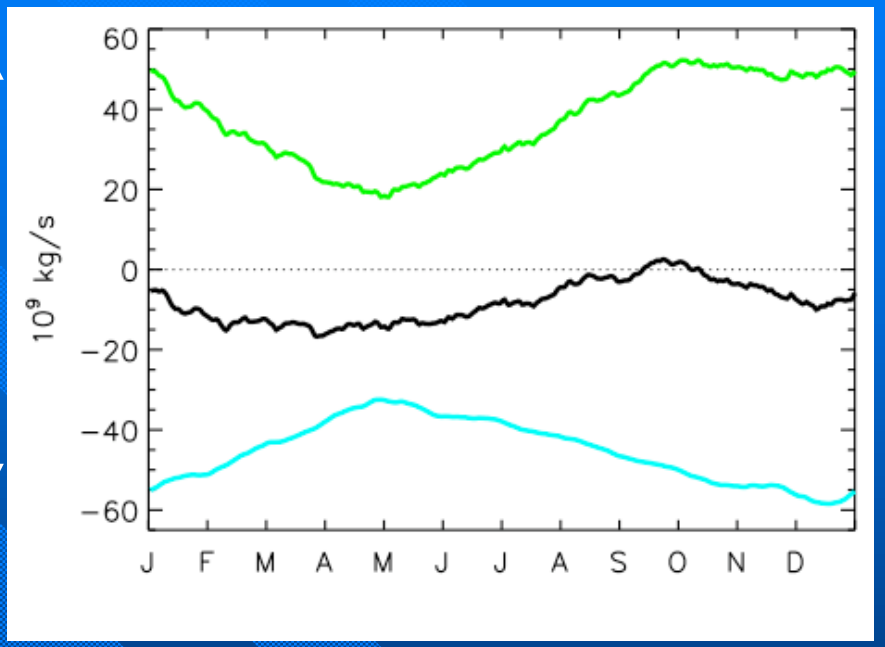
NH ozone: 260 Tg/yr
SH ozone: 190 Tg/yr

NH Extratropical TP Mass Flux

Goddard CTM



GMI Combo

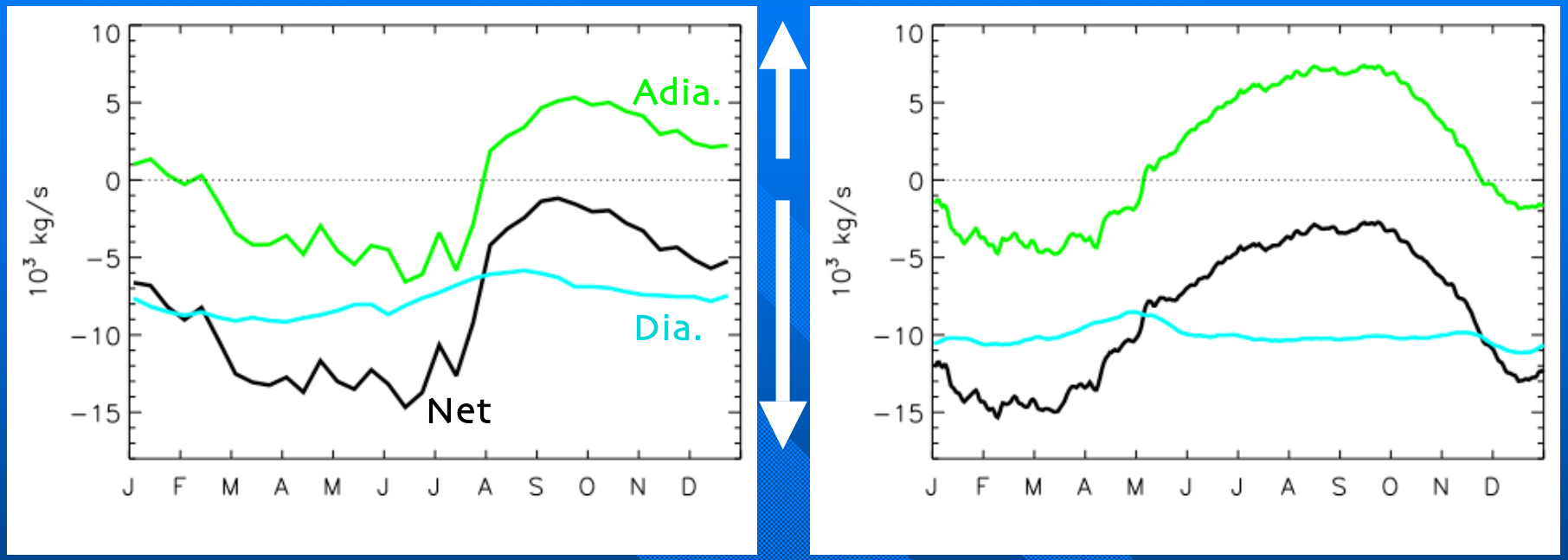


- Seasonal cycles similar; Both CTMs using FVGCM met fields
- The significantly greater GMI NH 380 K flux (diabatic by def.) revealed primarily in the diabatic TP flux; -13.6 vs. -14.3 x 10^{17} kg yr^{-1}

NH Extratropical TP Ozone Flux

Goddard CTM

GMI Combo



- Time of max net ozone flux in GCTM significantly lags the GMI
- Much more rapid decrease of net flux in the GCTM
- Diabatic ozone flux in GMI relatively flat (but not the diabatic mass flux)

Questions

- Are the GMI met fields a 2_ year revealed by the NH annual mass flux? Do the FVGCM differences produce more diabatic cooling in the NH?
- Is the difference of SH ozone flux magnitude entirely due to different BCs (chlorine, etc.)?
- What is the source of the seasonal cycle differences of the ozone TP flux?
- How much does using the monthly mean ozone fields (GMI) effect the results?