GMI Science Team Meeting
17-19 Nov 2004 Boulder

Michael Prather
UC Irvine

+ Susan Strahan, GSFC

1) TRACER-TRANSPORT ERRORS

UCI's doubling-to-convergence

+ GMI resolution studies with strat runs

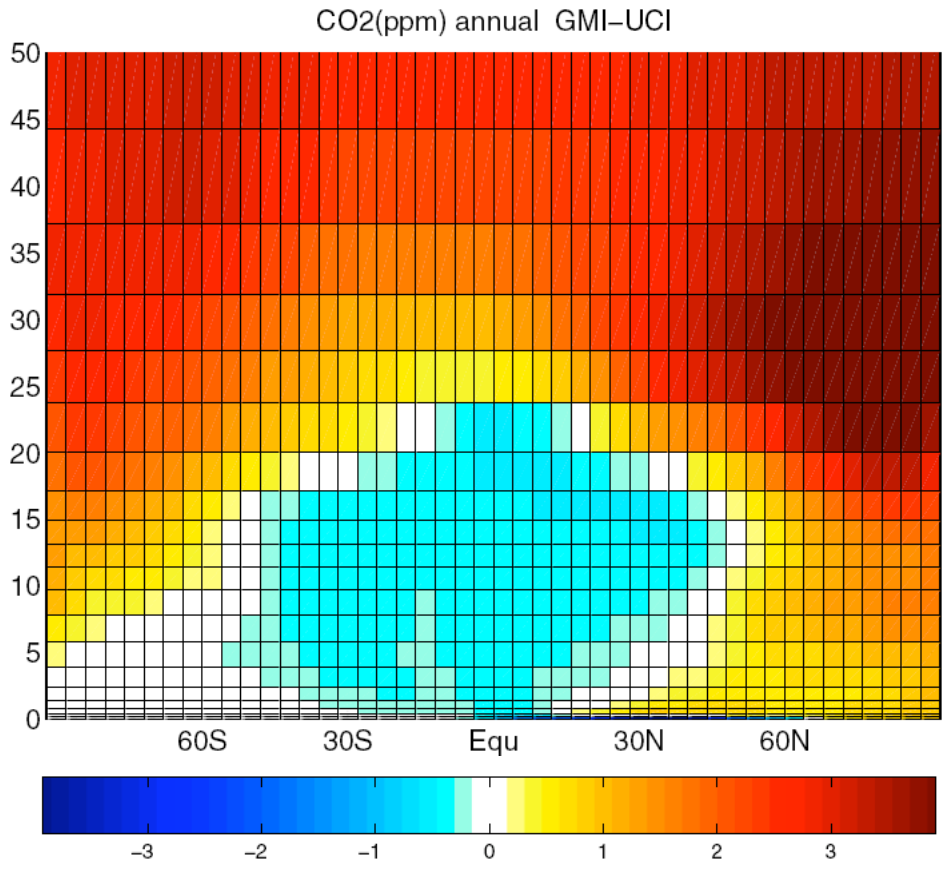
2) PHOTOLYSIS RATES

JPL-02 and other updates

fast-JX

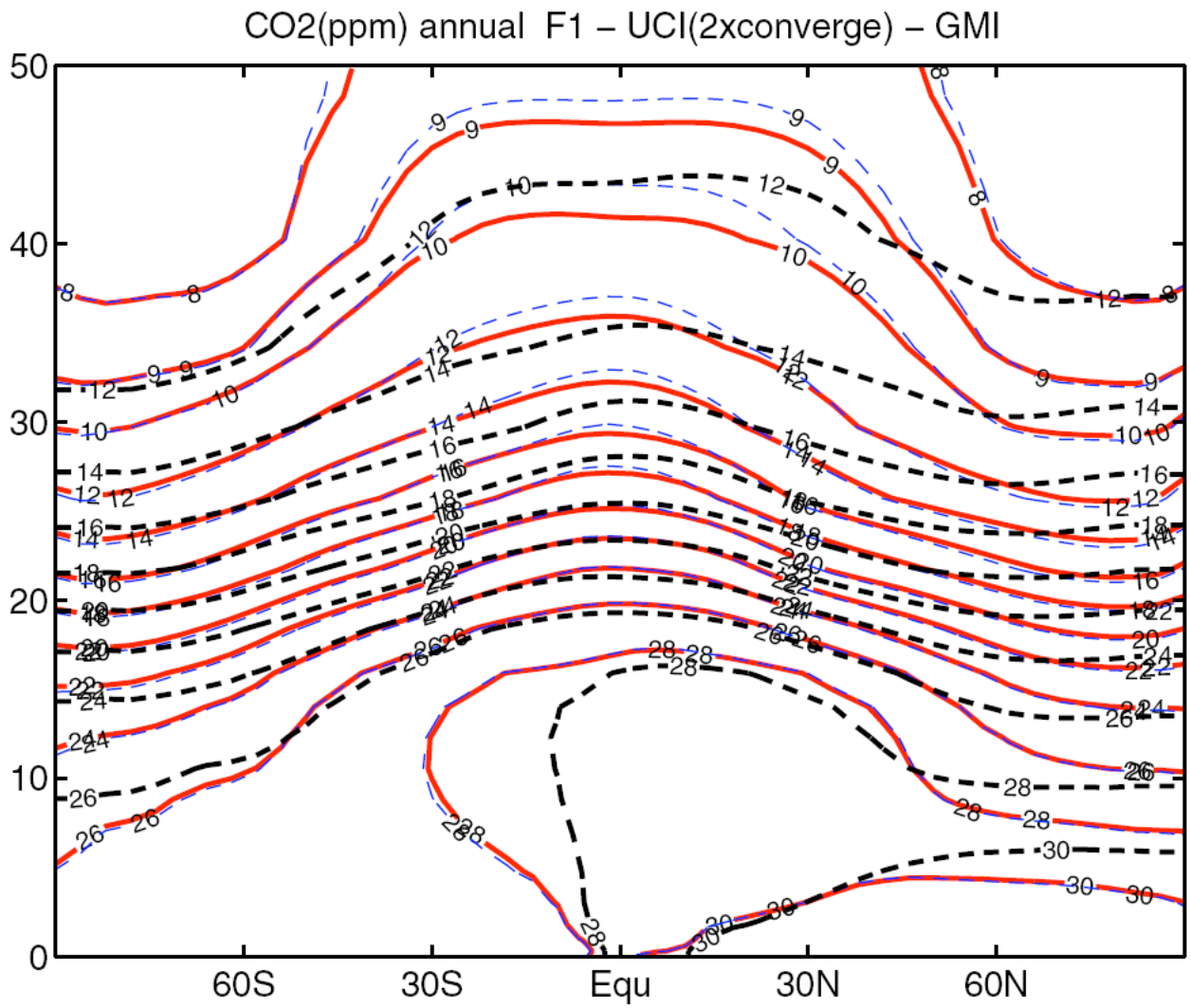
TRACER-TRANSPORT ERRORS - Stratosphere

10 year fun with fossil-fuel CO2 (2.91 ppm/yr) with GISS met fields
zonal mean of year-10: **GMI – UCI (± 4 ppm)**



TRACER-TRANSPORT ERRORS - Stratosphere

10 year fun with fossil-fuel CO2 (2.91 ppm/yr) with GISS met fields
zonal mean of year-10: **UCI(solid)** vs. **GMI(dashed)**



Aitken's acceleration: assume that the series obtained by successive doubling of the number of grid points converges

$$A^{true} = A(\Delta) + [A(\Delta/2) - A(\Delta)] + [A(\Delta/4) - A(\Delta/2)] + [A(\Delta/8) - A(\Delta/4)] + \ldots$$

$$= A1 + (A2 - A1) + (A4 - A2) + (A8 - A4) + \ldots$$

In the above pairing of terms, for a convergent sequence(!), each successive difference is smaller than previous by factor *k:*

$$k = (A4 - A2) / (A2 - A1) = (A8 - A4) / (A4 - A2) = \ldots$$

Then the convergence goes as

$$A^{true} = A1 + (A2 - A1)(1 + k + k^2 + k^3 + k^4 + \ldots)$$

$$= A1 + (A2 - A1) / (1 - k)$$

Note that we need the sequence A1, A2, and A4, but we also want to calculate A8 to check that the k-values are stable and possibly constant.

$$k_{421} = (A4 - A2) / (A2 - A1)$$

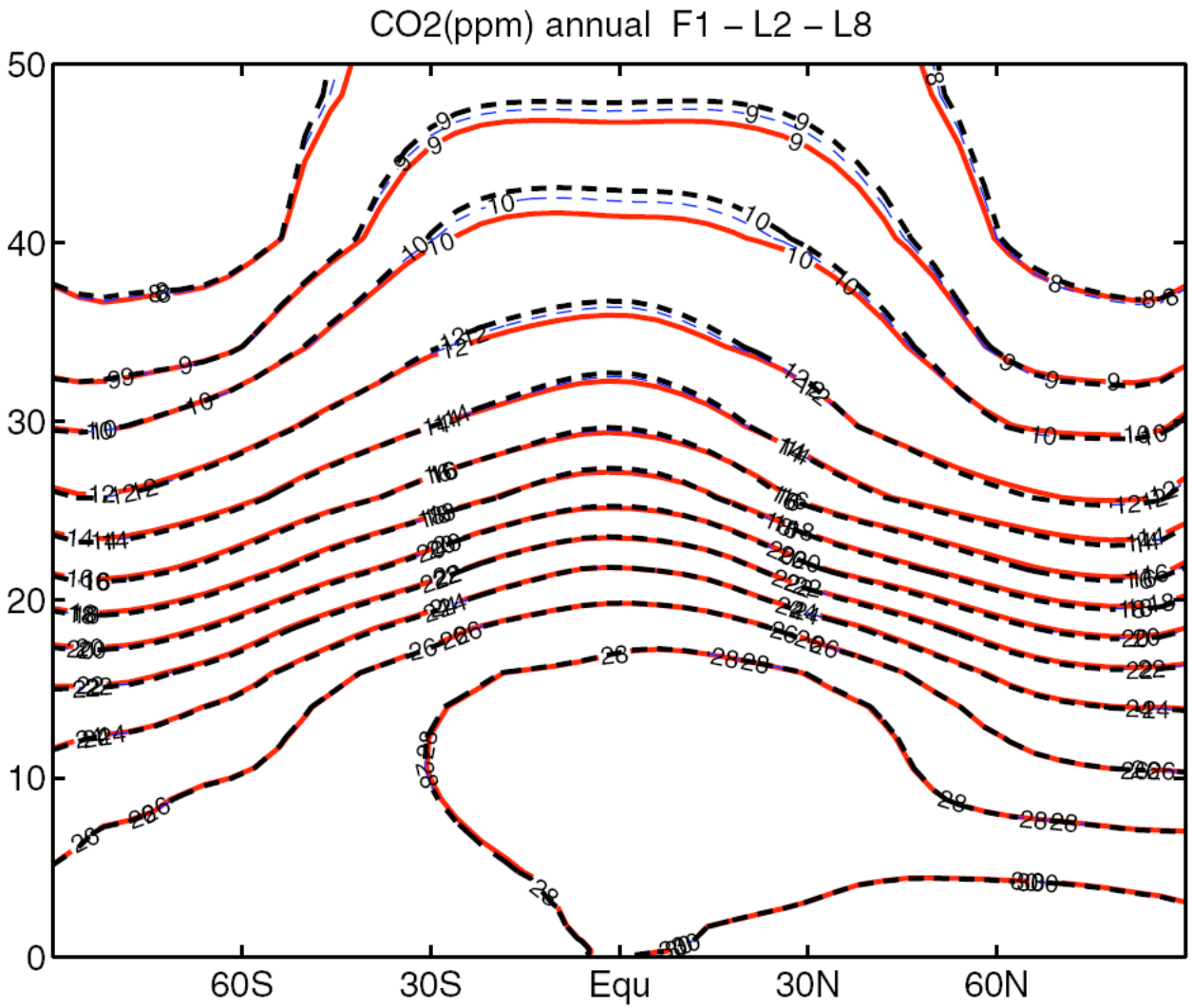
$$k_{842} = (A8 - A4) / (A4 - A2)$$

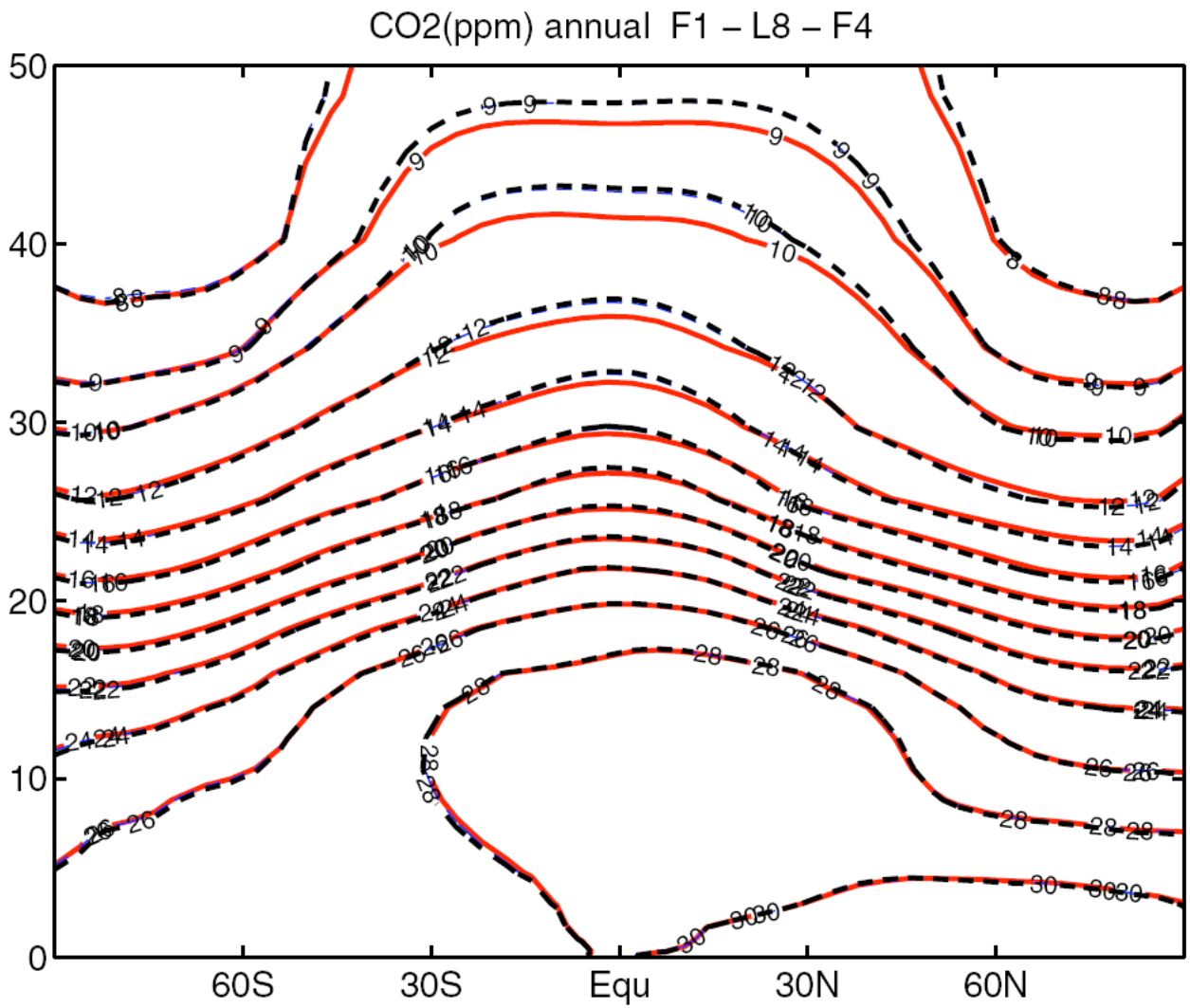
UCI CTM 2xConvergence

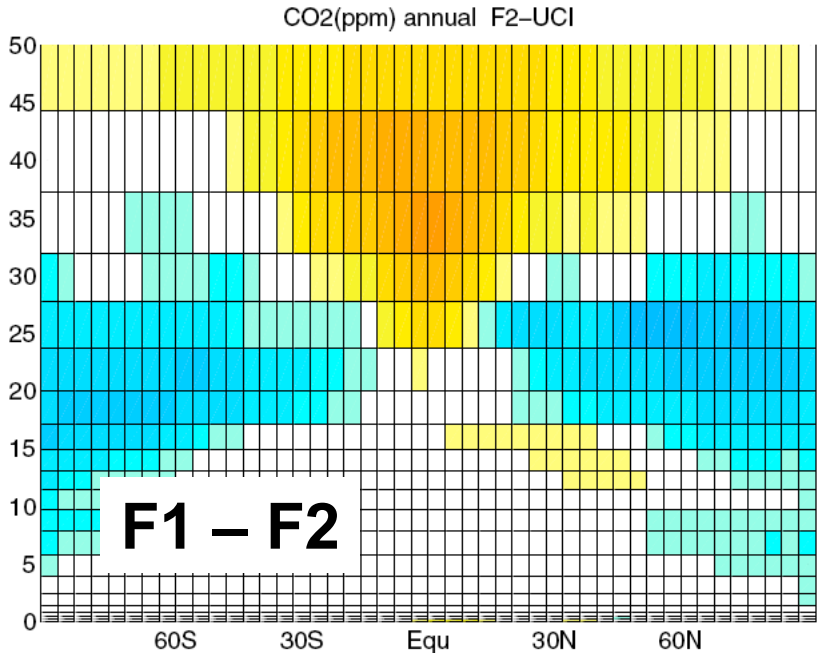
doubling grid notation

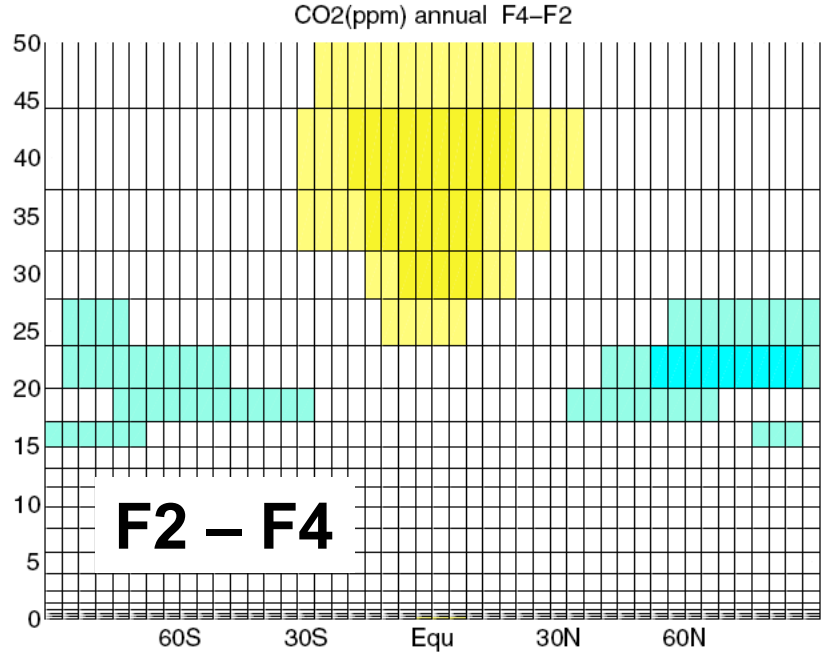
L1 *(Ix1,Jx1,Lx1,Tx1)* = ***72 x 46 x 23***
L2 *(Ix1,Jx1,Lx2,Tx2)* = ***72 x 46 x 46***
L4 *(Ix1,Jx1,Lx4,Tx4)* = ***72 x 46 x 92***
L8 *(Ix1,Jx1,Lx8,Tx8)* = ***72 x 46 x 184***

F1 *(Ix1,Jx1,Lx1,Tx1)* = ***72 x 46 x 23***
F2 *(Ix2,Jx2,Lx2,Tx2)* = ***144 x 90 x 46***
F4 *(Ix4,Jx4,Lx4,Tx4)* = ***288 x 178 x 92***
F8 *(Ix8,Jx8,Lx8,Tx8)* = ***576 x 354 x 184***

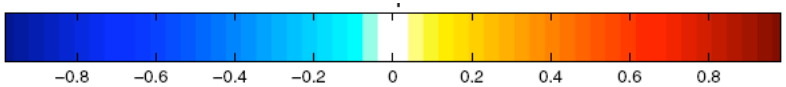

CO2(ppm) annual F1 – L2 – L8
50
40
30
20
10
0
60S
30S
Equ
30N
60N

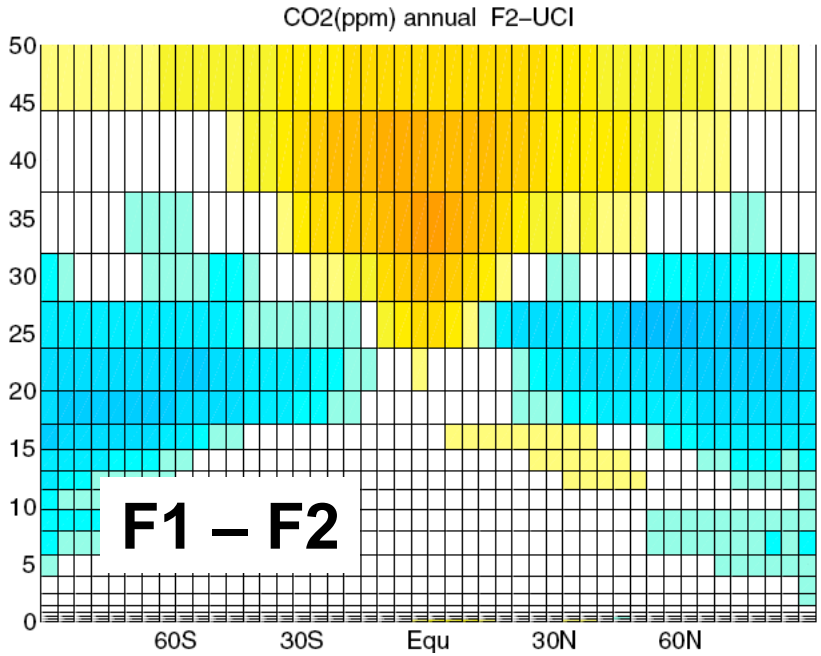

CO2(ppm) annual F1 – L8 – F4
50
40
30
20
10
0
60S
30S
Equ
30N
60N

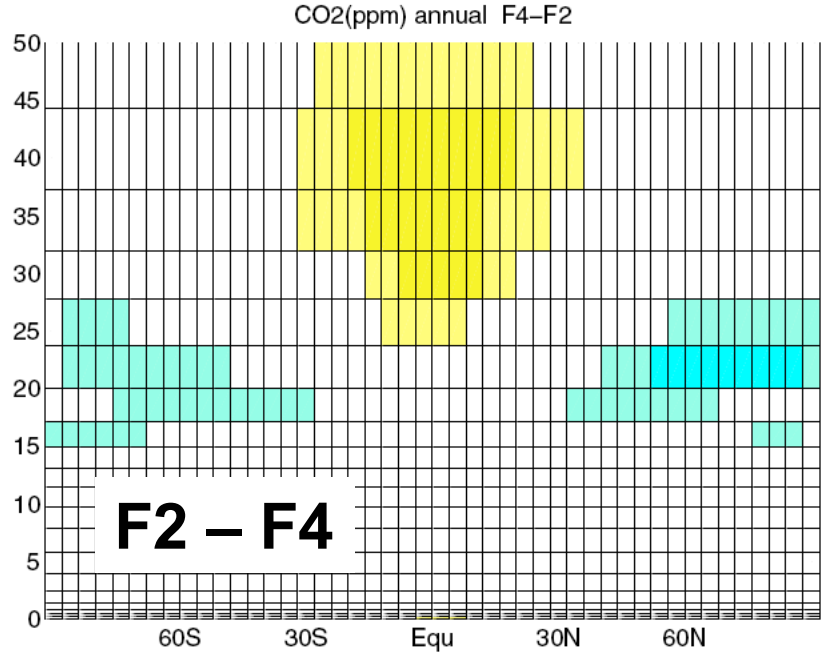




UCI: F1-F2; F2-F4; F1-F^{ex} (± 1 ppm)







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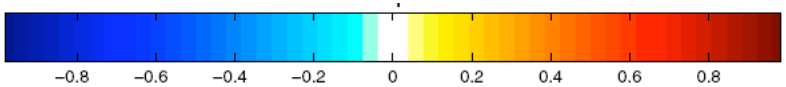
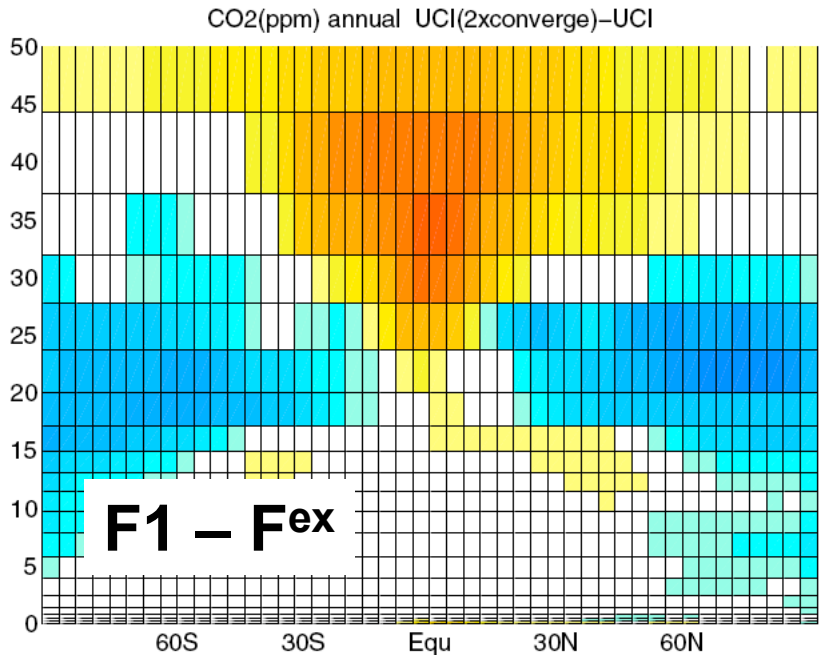
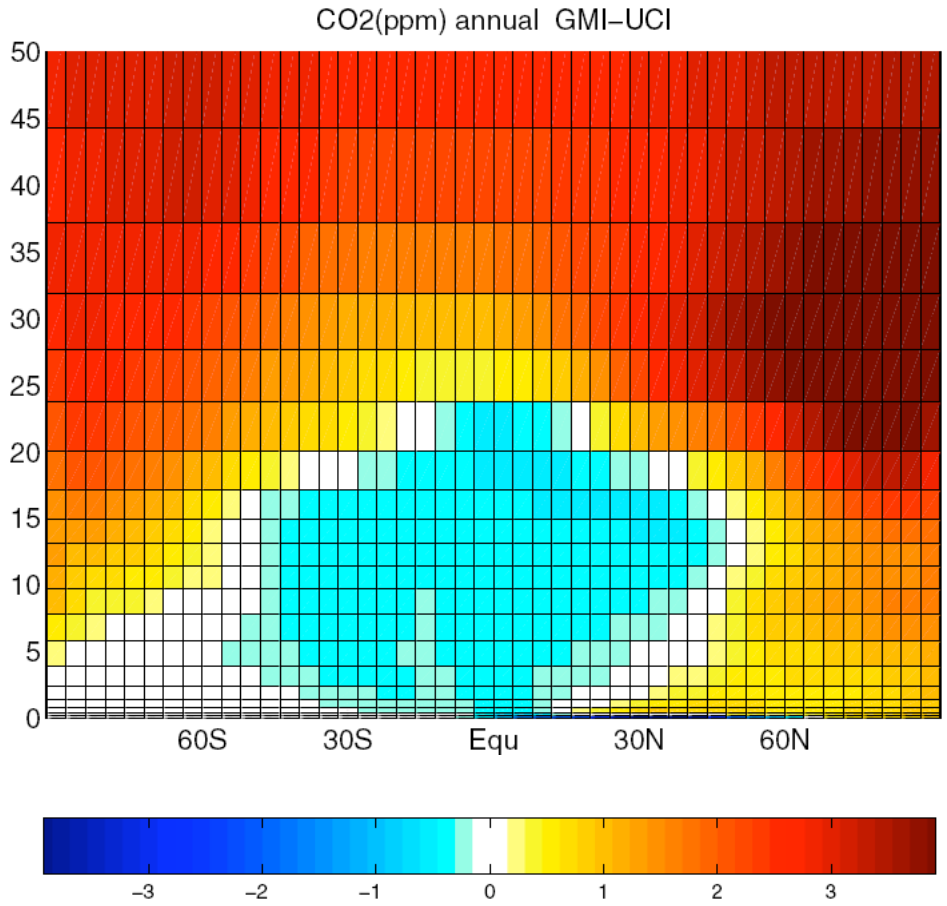
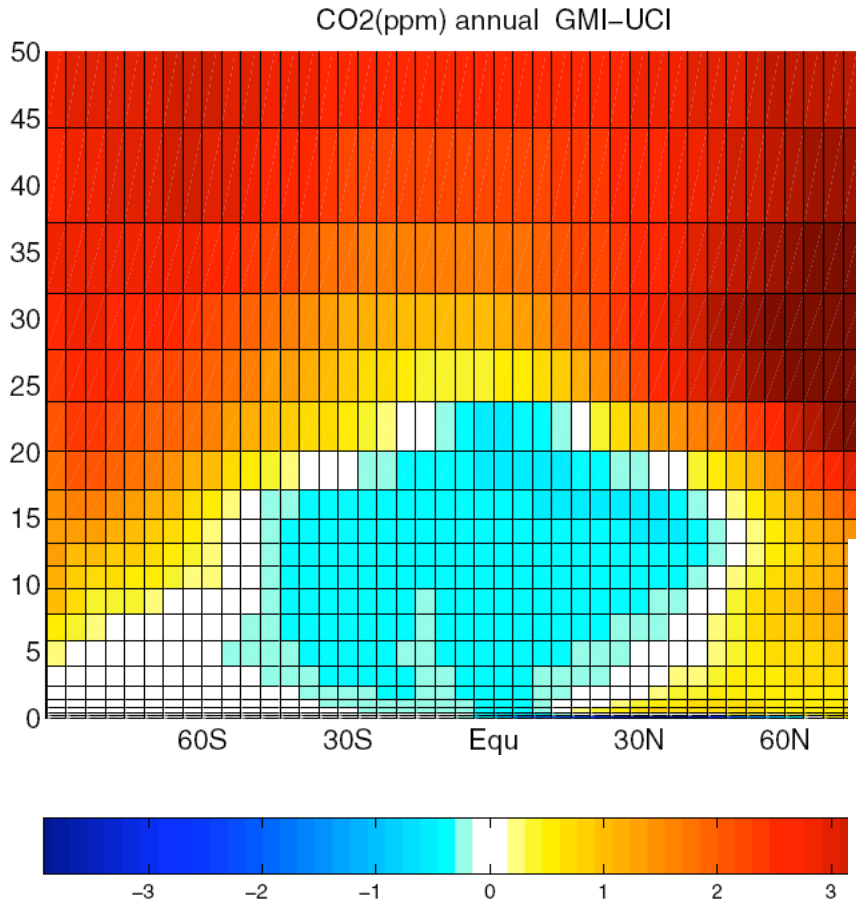
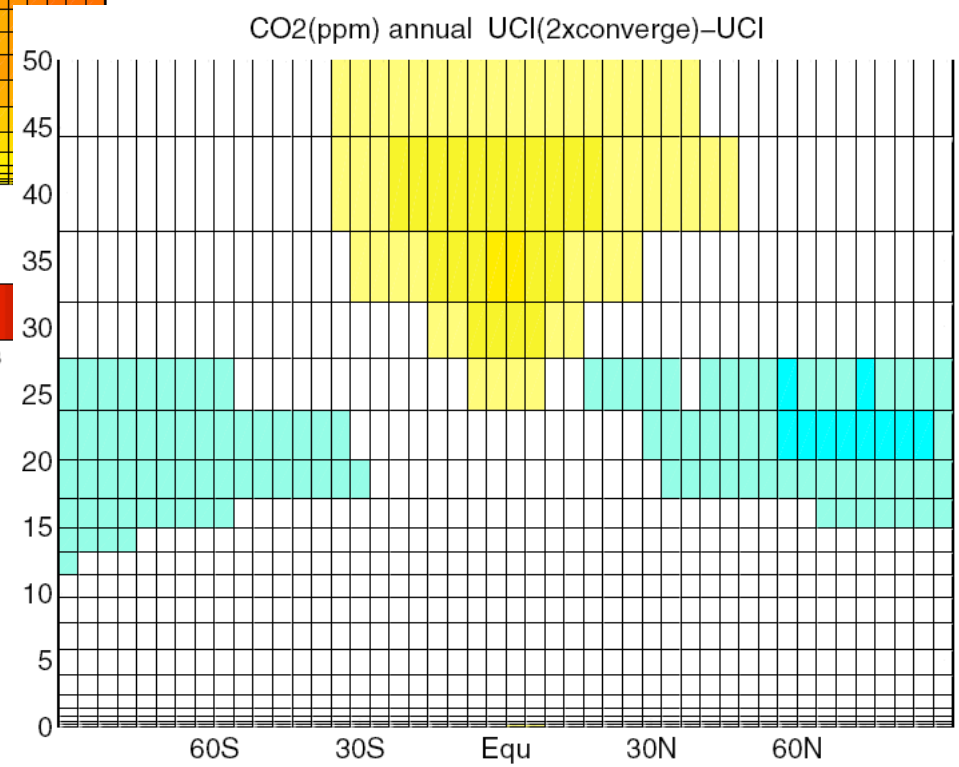






GMI – UCI & UCI F1-F^{ex} (± 4 ppm)

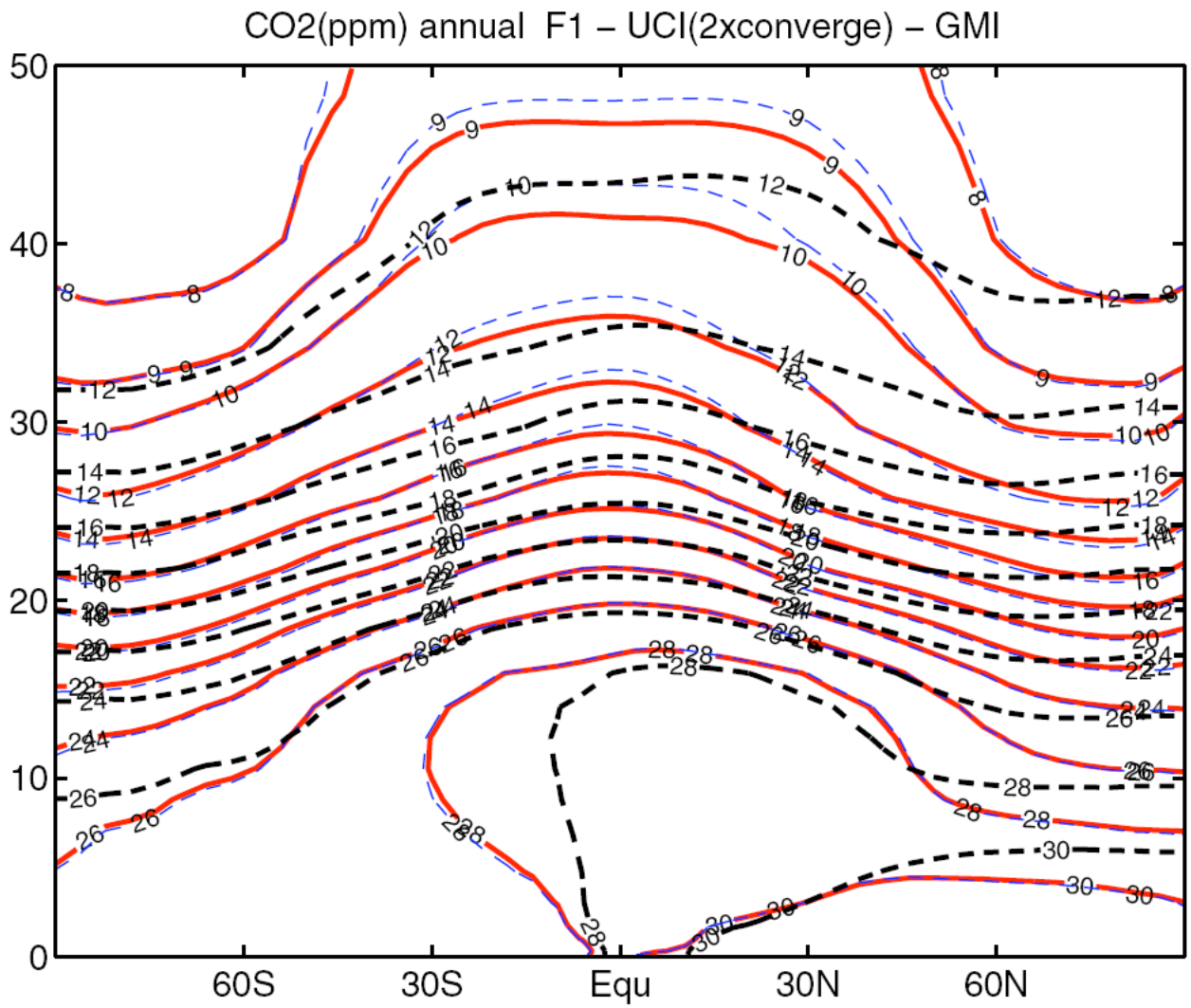




GMI – UCI & UCI F1-F^{ex} (± 4 ppm)

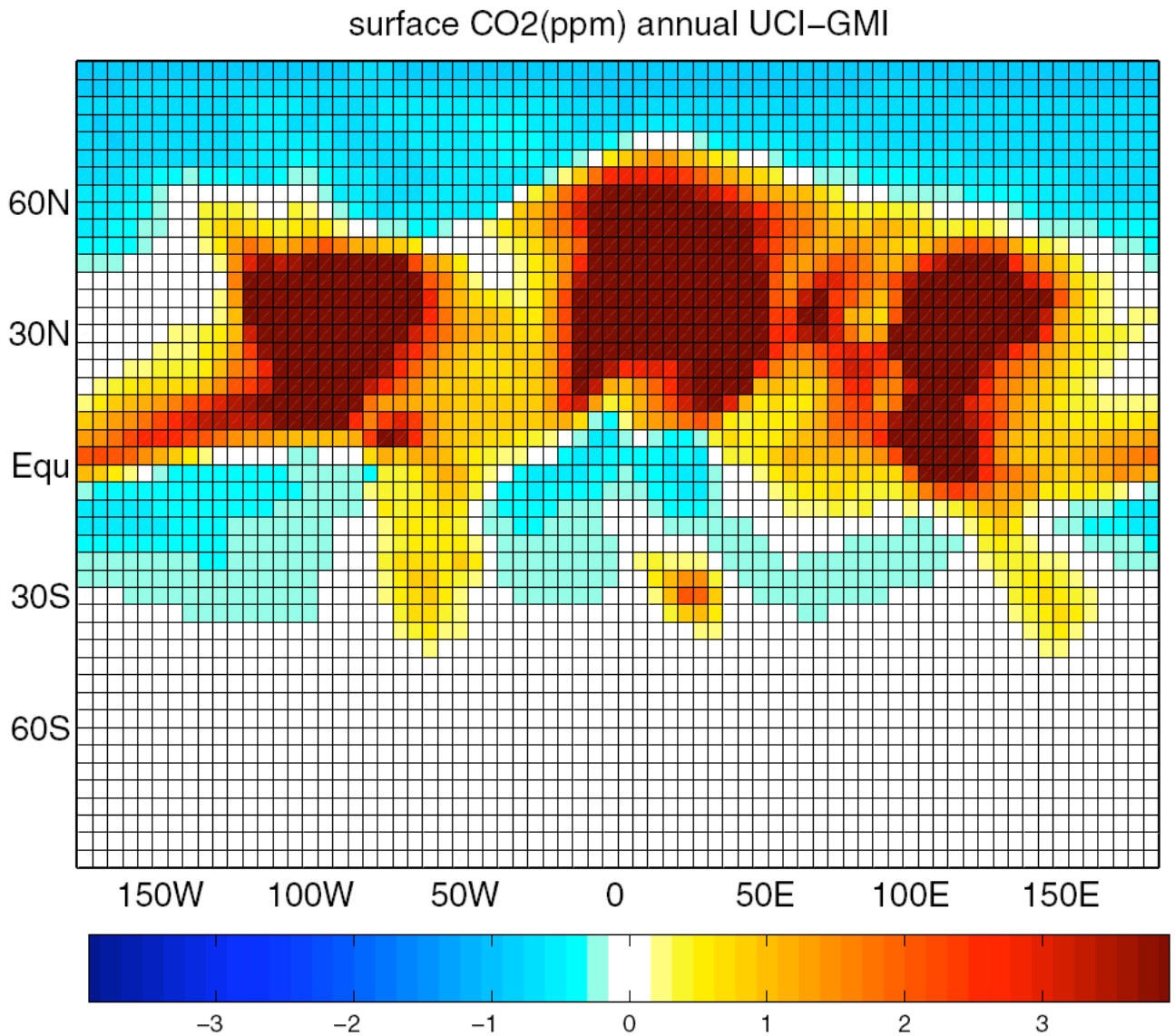
TRACER-TRANSPORT ERRORS - Stratosphere

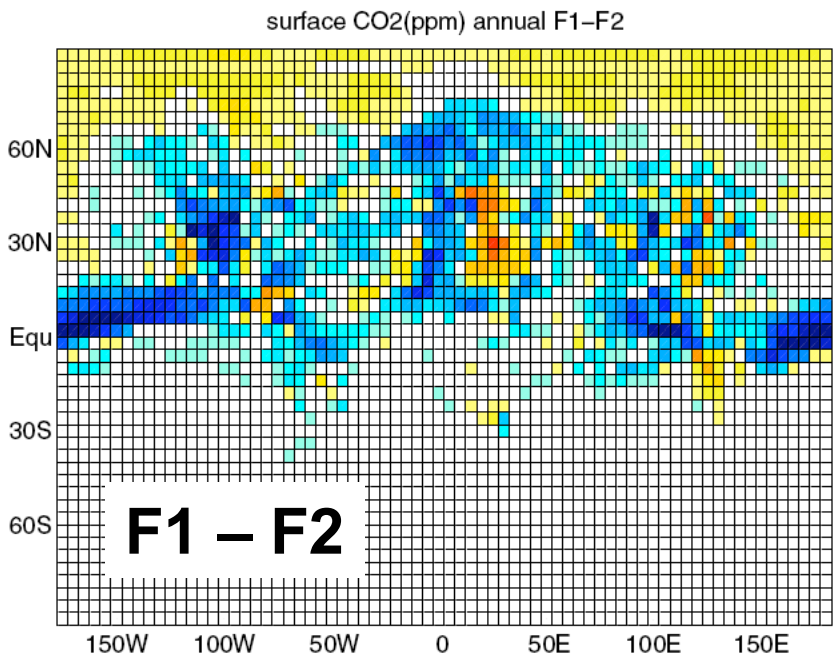
10 year fun with fossil-fuel CO2 (2.91 ppm/yr) with GISS met fields
zonal mean of year-10: **UCI^{ex}(dashed)** vs. **GMI(dashed)**

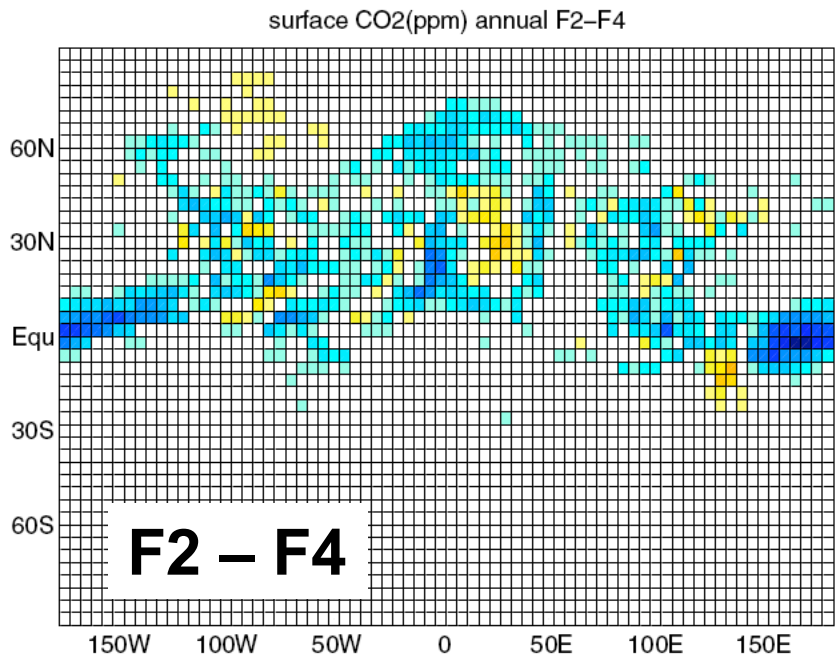


TRACER-TRANSPORT ERRORS - Surface

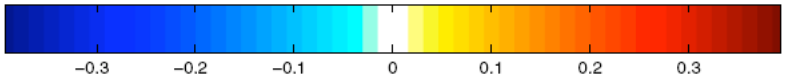
10 year fun with fossil-fuel CO2 (2.91 ppm/yr) with GISS met fields
std CTMs, annual mean of year-10: **UCI - GMI (± 4 ppm)**

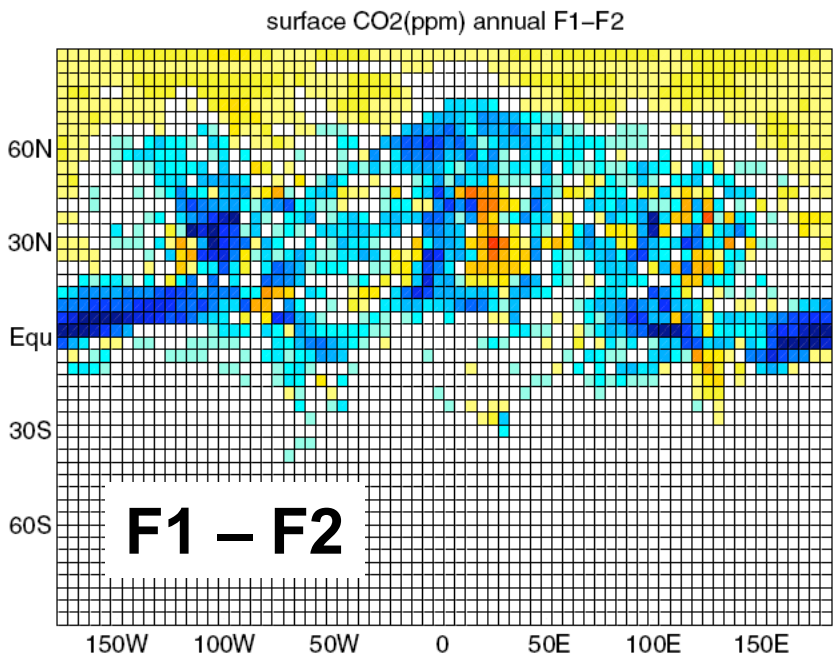


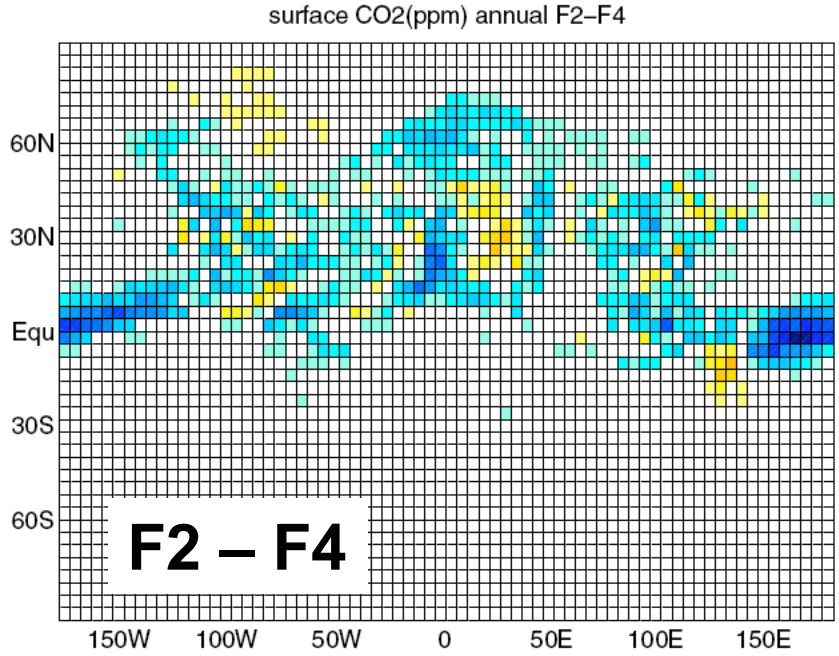




UCI: F1-F2; F2-F4; F1-F^{ex} (± 0.4 ppm)







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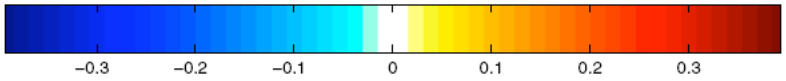
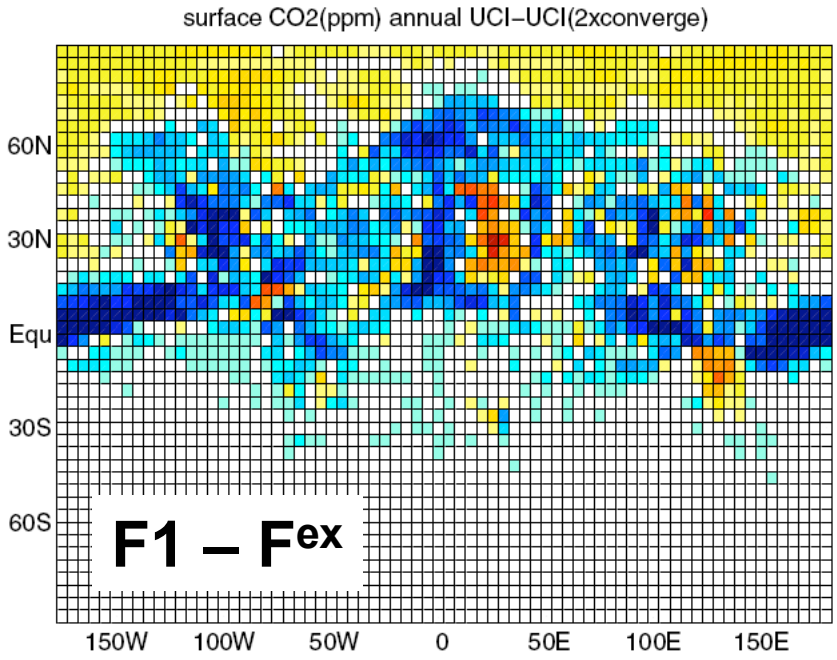
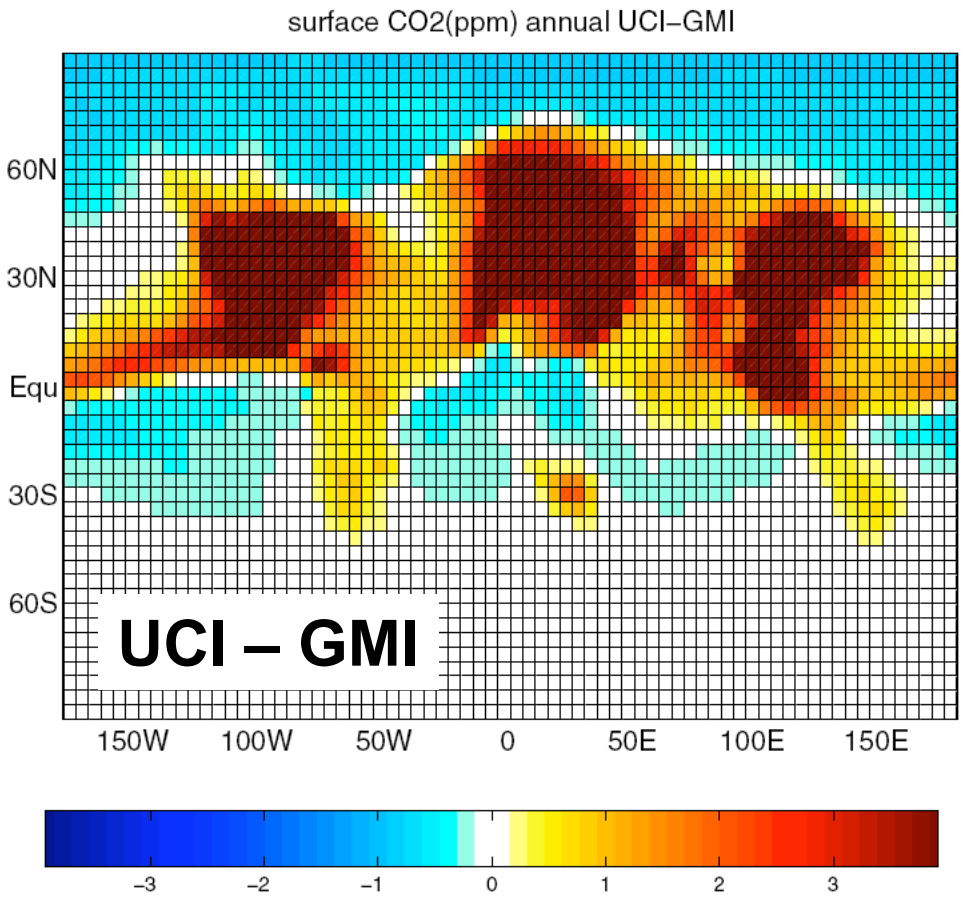
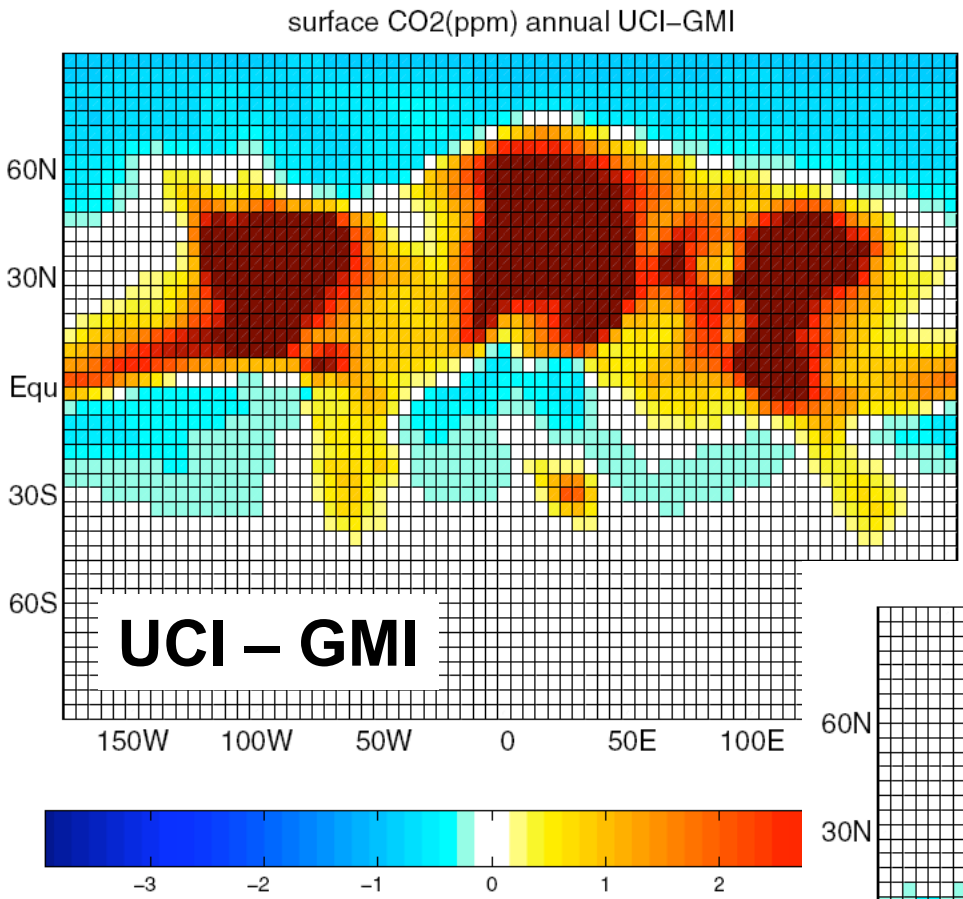
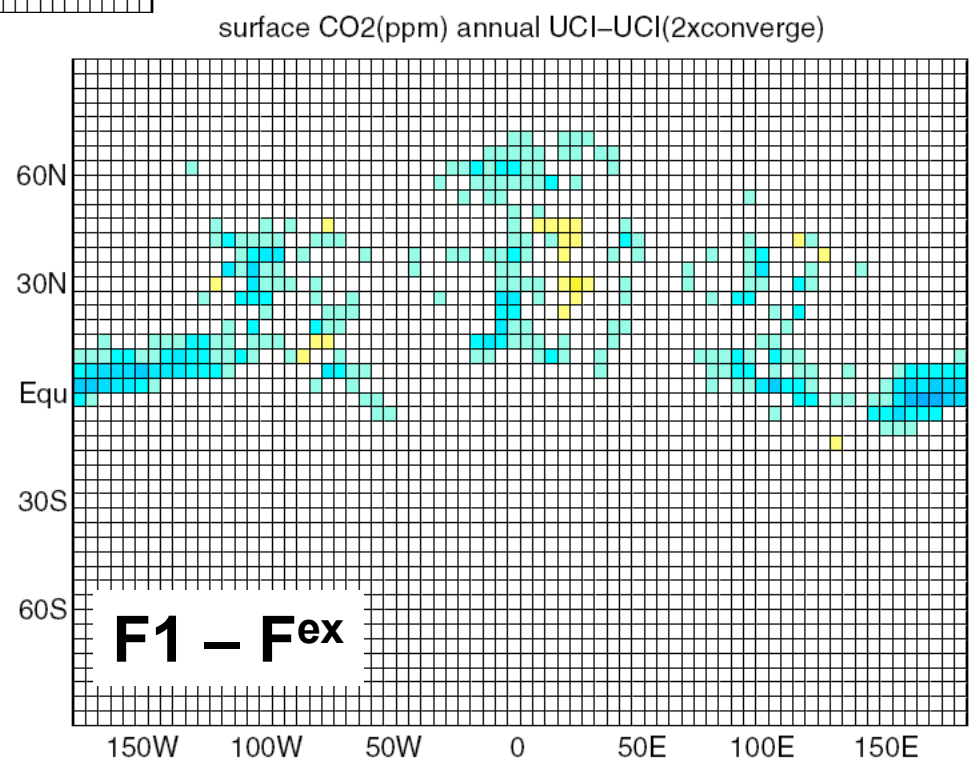





surface CO2(ppm) annual UCI–GMI
60N
30N
Equ
30S
60S
UCI – GMI
150W
100W
50W
0
50E
100E
150E
−3
−2
−1
0
1
2
3





UCI – GMI & UCI F1-F^{ex} (± 4 ppm)

Aitken's acceleration: assume that the series obtained by successive doubling of the number of grid points converges

$$A^{true} = A(\Delta) + [A(\Delta/2) - A(\Delta)] + [A(\Delta/4) - A(\Delta/2)] + [A(\Delta/8) - A(\Delta/4)] + \ldots$$

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In the above pairing of terms, for a convergent sequence(!), each successive difference is smaller than previous by factor *k:*

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Then the convergence goes as

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$$= A1 + (A2 - A1) / (1 - k)$$

Note that we need the sequence A1, A2, and A4, but we also want to calculate A8 to check that the k-values are stable and possibly constant.

$$\mathbf{k_{421} = (A4 - A2) / (A2 - A1)}$$

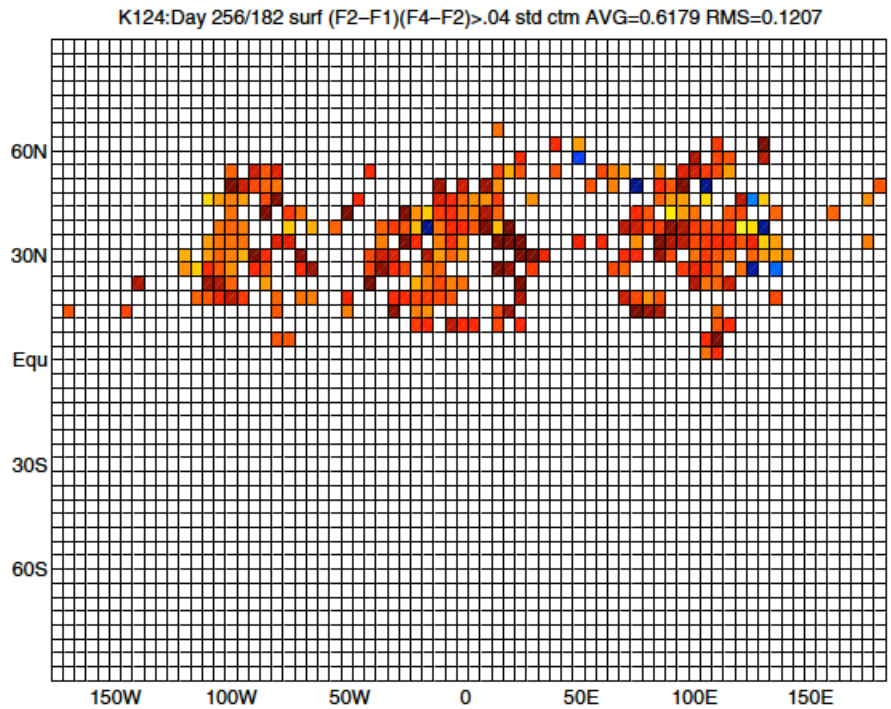
$$\mathbf{k_{842} = (A8 - A4) / (A4 - A2)}$$

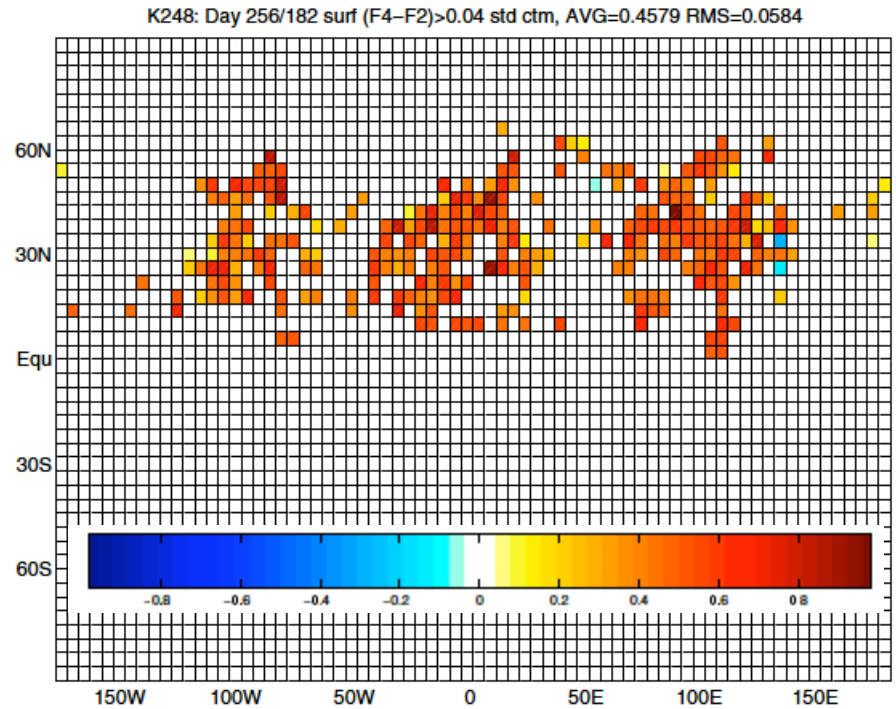
TRACER-TRANSPORT – 2xConverge k values

F8 run for 2 months look at instant surface abundance at end
Local k's (where large corrections) vary, but reasonable

k_{421} = 0.46 ± 0.17

k_{842} = 0.46 ± 0.06



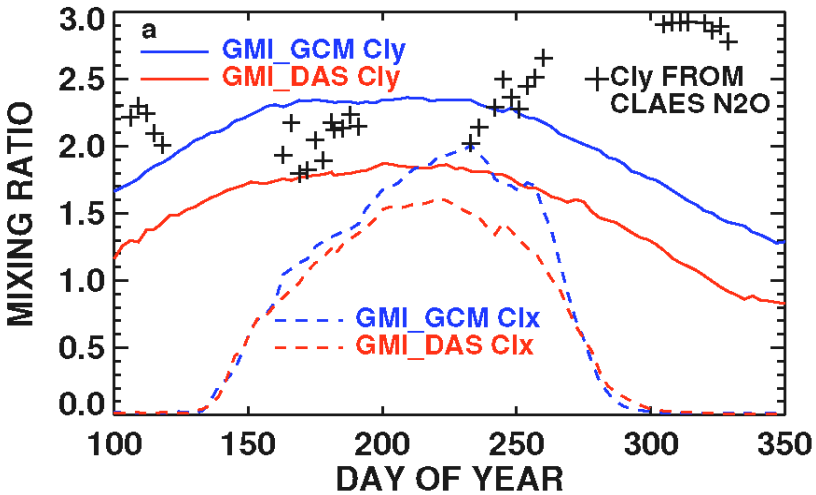


<rms> k_{421} = 0.49
<abs> k_{421} = 0.49

k_{842} = 0.49
k_{842} = 0.49

Motivation: Problems in the WMO Trend Runs (S. Strahan)

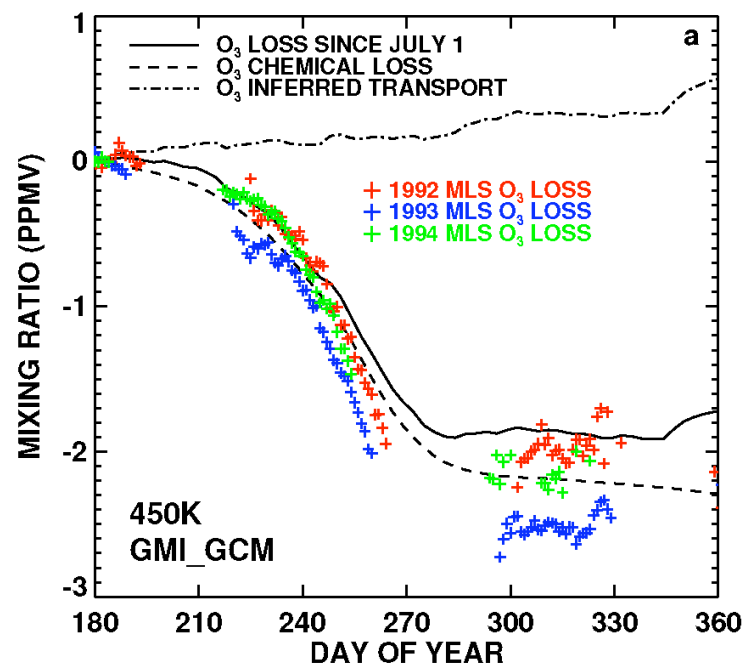
- *Considine et al*. [2004] showed high ClO and Cl_y levels not maintained into October.



•Antarctic vortex 'mixing test' using HALOE CH_4 [*Strahan and Douglass*, 2004] showed that 4x5° GMI vortex does not create a barrier to mixing with midlatitudes.

A significant problem: GMI Trend Runs don't lose enough O_3 in the LS vortex

- Without high Cl_x in Sept and Oct, Antarctic O_3 loss is slower and ends prematurely (Considine et al., 2004).
- We would have more confidence in an ozone recovery prediction if the model vortex were more realistic.



GMI-CTM: Horizontal Resolution Sensitivity

- 1 year simulations of GMI stratospheric model with full chemistry
- $2x2.5^o$ and $4x5^o$ horizontal resolutions
- Same 28 vertical levels (lid at 0.4 mb)
- Year 2029 of the WMO trend experiments
- 12 species saved

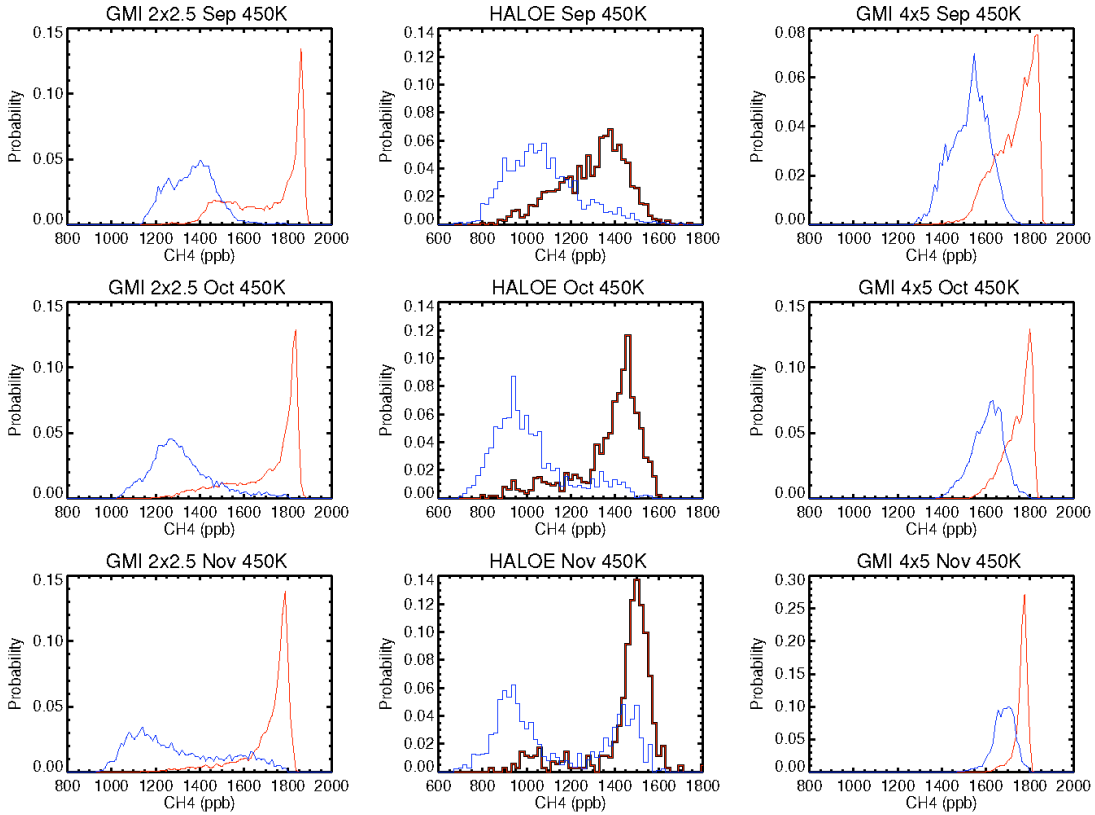
Horizontal Sensitivity: Antarctic Vortex Edge

60-80°S PDF in blue *40-60°S PDF in red*

Results:

2x2.5° resolution shows better agreement with HALOE CH_4.

The 2x2.5° vortex has a more realistic mixing barrier.



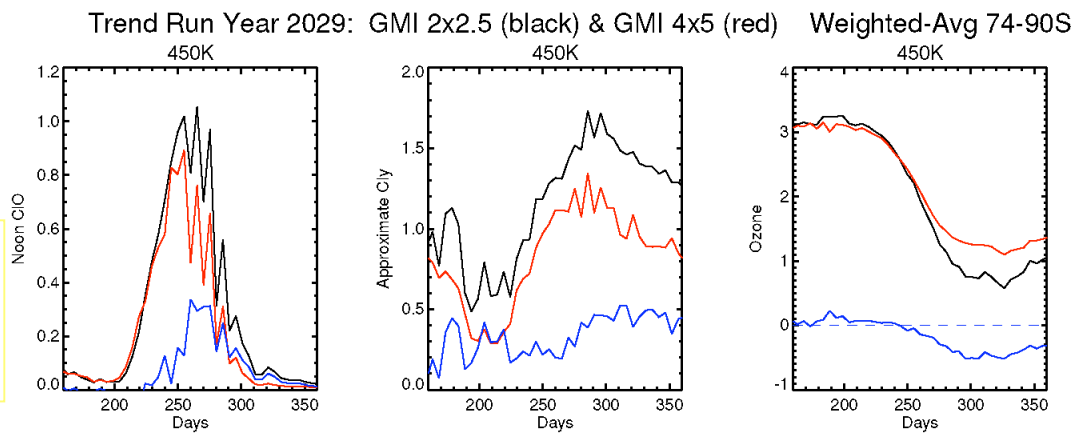
Horizontal Sensitivity: Cl in the Vortex

2x2.5° = black

4x5° = red

Blue Line:

2x2.5° minus 4x5°



- 2x2.5° has higher ClO in the vortex during Sept and Oct
- "Approx. Cl_y" (= ClNO3 + HCl + noon ClO) is higher all winter and spring at 2x2.5°
- O_3 loss is more rapid in Sept and continues into Oct, in better agreement with MLS

PHOTOLYSIS RATES:

What happened with JPL-02?

many small adjustments in stratosphere
NO_2 cross-sections & T-dependence (IPMMI!)
acetone quantum yields w/Blitz et al.'04

fast-JX update

combines 180-292 nm with 292-850 nm
same scattering code in both
can still run as trop-only
compare with reference code
can now do Pinatubo !

ratio: JPL-02 / JPL-00

30deg	J-NO	J-O2	J-O3	J-O3(1D)	J-H2COa	J-H2COb	J-H2O2	J-CH3OOH	J-NO2-b	J-NO3
79.1	1	1	1	0.95	1	1	1	1	0.98	0.99
68.7	1	1	1	0.95	1	1	1	1	0.98	0.99
58.8	1	1	1	0.95	1	1	1	1	0.99	0.99
50.0	1	1	1	0.95	1	1	1	1	0.99	0.99
41.1	1	1	1	0.95	1	1	1	1	1.00	0.99
34.9	1	1	1	0.95	1	1	1	1	0.99	1.00
31.0	1	1	1	0.96	1	1	1	1	0.99	1.00
27.2	1	1	1	0.97	1	1	1	1	0.99	1.00
23.4	1	1	1	0.98	1	1	1	1	0.98	0.99
19.7	1	1	1	1.00	1	1	1	1	0.99	0.99
17.9	1	1	1	1.01	1	1	1	1	0.98	0.99
16.1	1	1	1	1.01	1	1	1	1	0.99	0.99
14.3	1	1	1	1.01	1	1	1	1	0.98	1.00
12.4	1	1	1	1.02	1	1	1	1	0.99	1.00
10.6	1	1	1	1.02	1	1	1	1	0.99	0.99
8.7	1	1	1	1.02	1	1	1	1	0.99	0.99
6.7	1	1	1	1.01	1	1	1	1	0.99	0.99
4.6	1	1	1	1.01	1	1	1	1	0.99	0.99
2.4	1	1	1	1.00	1	1	1	1	1.00	1.00
0.0	1	1	1	0.98	1	1	1	1	1.00	1.00

ratio: JPL-02 / JPL-00

30deg	J-N2O5	J-HNO2	J-HNO3	J-HNO4	J-ClNO3t	J-Cl2	J-HOCl	J-OClO	J-Cl2O2	J-ClO
79.1	1	1	1	1	1.02	1	1	1.01	1	1
68.7	1	1	1	1	1.00	1	1	1.01	1	1
58.8	1	1	1	1	1.00	1	1	1.00	1	1
50.0	1	1	1	1	1.00	1	1	1.00	1	1
41.1	1	1	1	1	1.00	1	1	0.99	1	1
34.9	1	1	1	1	1.00	1	1	1.00	1	1
31.0	1	1	1	1	1.00	1	1	1.01	1	1
27.2	1	1	1	1	0.99	1	1	1.01	1	1
23.4	1	1	1	1	0.99	1	1	1.01	1	1
19.7	1	1	1	1	0.99	1	1	1.01	1	1
17.9	1	1	1	1	0.98	1	1	1.01	1	1
16.1	1	1	1	1	0.98	1	1	1.01	1	1
14.3	1	1	1	1	0.99	1	1	1.01	1	1
12.4	1	1	1	1	0.99	1	1	1.01	1	1
10.6	1	1	1	1	0.98	1	1	1.00	1	1
8.7	1	1	1	1	0.99	1	1	1.01	1	1
6.7	1	1	1	1	0.99	1	1	1.00	1	1
4.6	1	1	1	1	0.99	1	1	1.00	1	1
2.4	1	1	1	1	0.99	1	1	0.99	1	1
0.0	1	1	1	1	0.99	1	1	0.99	1	1

ratio: JPL-02 / JPL-00

30deg	J-BrO	J-BrNO3	J-HOBr	J-N2O	J-F11	J-F12	J-F113	J-F114	J-F115	J-CCl4
79.1	1	1.07	1	1	1.04	1.03	1.27	1.04	1.20	0.88
68.7	1	1.07	1	1	1.02	1.02	1.14	1.04	1.24	0.88
58.8	1	1.07	1	1	1.01	1.01	1.05	1.04	1.34	0.92
50.0	1	1.07	1	1	0.99	1.01	1.01	1.04	1.46	0.97
41.1	1	1.08	1	1	1.00	1.00	1.00	1.05	1.57	0.94
34.9	1	1.09	1	1	1.02	1.00	1.00	1.06	1.57	0.94
31.0	1	1.10	1	1	1.04	1.00	1.00	1.08	1.54	0.94
27.2	1	1.09	1	1	1.05	1.00	1.00	1.09	1.50	0.95
23.4	1	1.10	1	1	1.06	1.00	1.00	1.09	1.45	0.96
19.7	1	1.10	1	1	1.07	0.99	1.00	1.10	1.41	0.97
17.9	1	1.10	1	1	1.07	0.99	1.00	1.11	1.41	0.98
16.1	1	1.10	1	1	1.07	0.99	1.00	1.11	1.41	0.98
14.3	1	1.09	1	1	1.07	0.99	1.00	1.11	1.43	0.98
12.4	1	1.09	1	1	1.07	0.99	1.00	1.11	1.45	0.97
10.6	1	1.09	1	1	1.06	0.98	1.00	1.10	1.48	0.97
8.7	1	1.09	1	1	1.04	0.99	1.00	1.08	1.52	0.97
6.7	1	1.09	1	1	1.03	0.98	1.00	1.06	1.55	0.98
4.6	1	1.09	1	1	1.01	0.98	1.00	1.04	1.60	0.98
2.4	1	1.09	1	1	0.99	0.98	1.00	1.01	1.71	1.00
0.0	1	1.09	1	1	0.98	0.98	1.00	1.00	1.85	1.01

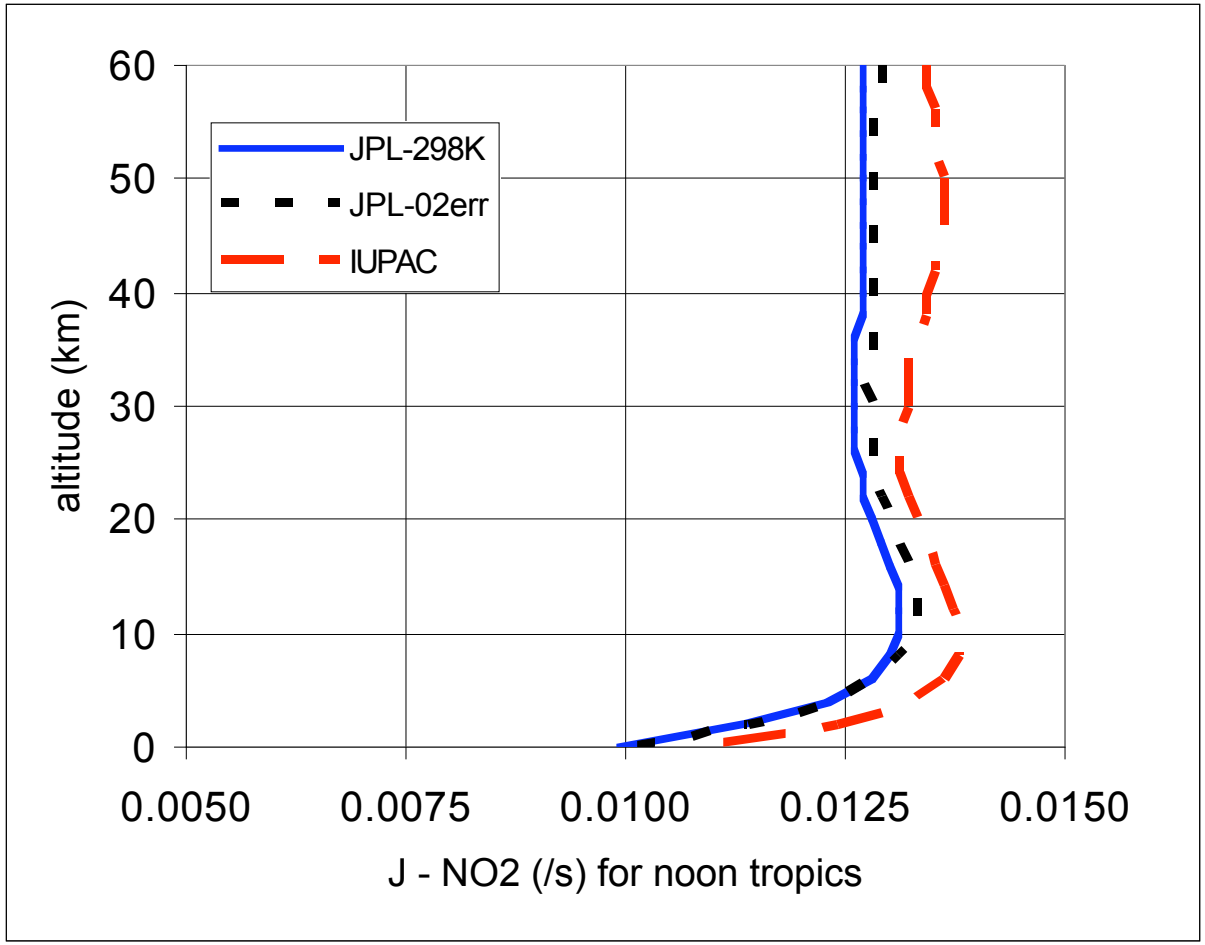
ratio: JPL-02 / JPL-00

30deg	J-CH3Cl	J-MeCF	J-CH3Br	J-h1211	J-h1301	J-h2402	J-HF22	J-HF123	J-HF141b	J-CHBr3
79.1	1.72	1.24	0.96	0.98	0.94	0.99	1.05	1.55	1.53	0.98
68.7	1.41	1.18	0.94	0.97	0.94	0.99	1.07	1.31	1.35	0.98
58.8	1.17	1.12	0.95	0.97	0.96	0.99	1.13	1.17	1.20	0.98
50.0	1.06	1.09	0.96	0.96	0.97	0.99	1.21	1.09	1.11	0.99
41.1	1.01	1.09	0.96	0.99	0.99	1.00	1.30	0.92	0.99	1.01
34.9	0.95	1.10	0.96	1.03	1.03	1.02	1.34	0.81	0.92	1.04
31.0	0.92	1.10	0.96	1.04	1.06	1.03	1.37	0.76	0.89	1.05
27.2	0.90	1.11	0.97	1.05	1.08	1.04	1.38	0.74	0.88	1.04
23.4	0.89	1.11	0.97	1.06	1.10	1.05	1.39	0.72	0.87	1.03
19.7	0.88	1.12	0.97	1.08	1.10	1.07	1.40	0.71	0.86	0.99
17.9	0.88	1.12	0.97	1.12	1.11	1.10	1.40	0.70	0.86	0.96
16.1	0.88	1.12	0.97	1.29	1.11	1.24	1.42	0.70	0.86	0.96
14.3	0.87	1.12	0.97	2.23	1.11	2.00	1.43	0.70	0.86	0.95
12.4	0.88	1.12	0.97	9.89	1.12	8.24	1.46	0.70	0.86	0.95
10.6	0.89	1.12	0.97		1.22		1.47	0.71	0.86	0.95
8.7	0.90	1.12	0.97		3.99		1.47	0.75	0.88	0.96
6.7	0.93	1.11	0.98				1.47	0.80	0.91	0.95
4.6	0.95	1.12	1.33				1.48	0.85	0.93	0.95
2.4	0.97	1.11	22.75				1.53	0.90	0.96	0.95
0.0	0.99	1.10					1.62	0.96	0.99	0.95

ratio: JPL-02 / JPL-00

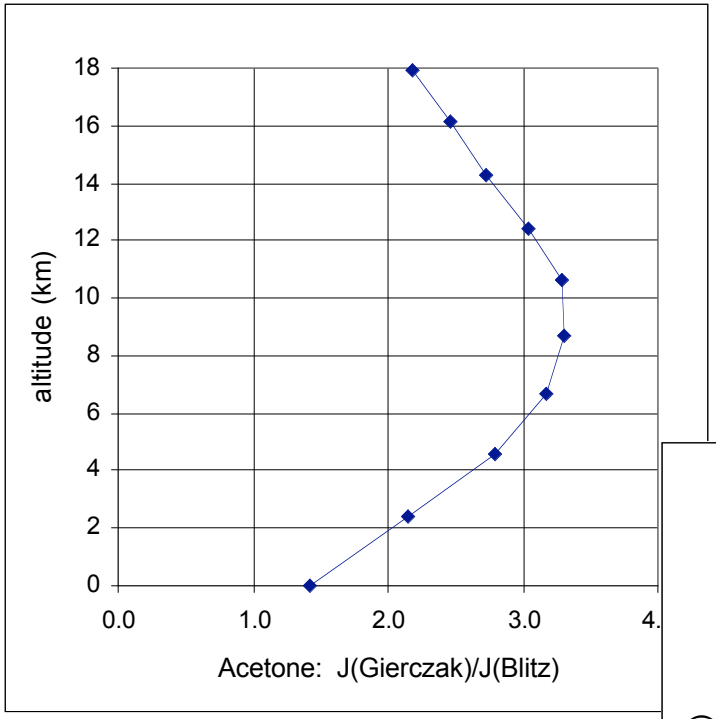
30deg	J-CH3I	J-CF3I	J-C3H6O
79.1	**0.84**	**1.04**	**0.71**
68.7	**0.85**	**1.03**	**0.71**
58.8	**0.88**	**1.00**	**0.73**
50.0	**0.91**	**0.99**	**0.72**
41.1	**0.95**	**1.01**	**0.61**
34.9	**1.02**	**1.03**	**0.46**
31.0	**1.03**	**1.02**	**0.36**
27.2	**1.06**	**1.01**	**0.28**
23.4	**1.05**	**1.00**	**0.22**
19.7	**1.04**	**0.99**	**0.18**
17.9	**1.04**	**0.99**	**0.17**
16.1	**1.04**	**0.99**	**0.15**
14.3	**1.04**	**0.98**	**0.13**
12.4	**1.04**	**0.98**	**0.12**
10.6	**1.08**	**0.99**	**0.10**
8.7	**1.18**	**0.99**	**0.10**
6.7	**1.31**	**0.99**	**0.09**
4.6	**1.45**	**1.00**	**0.08**
2.4	**1.60**	**1.00**	**0.07**
0.0	**1.76**	**1.01**	**0.06**

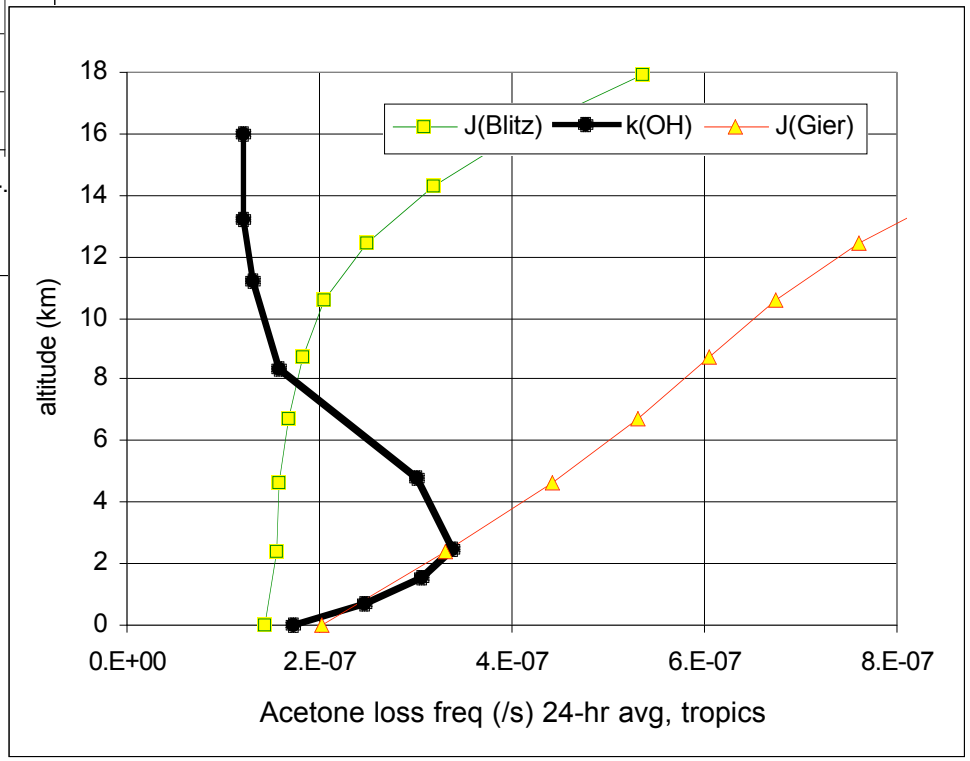
J – NO_2


60
50
40
30
20
10
0
altitude (km)
JPL-298K
JPL-02err
IUPAC
0.0050
0.0075
0.0100
0.0125
0.0150
J - NO2 (/s) for noon tropics

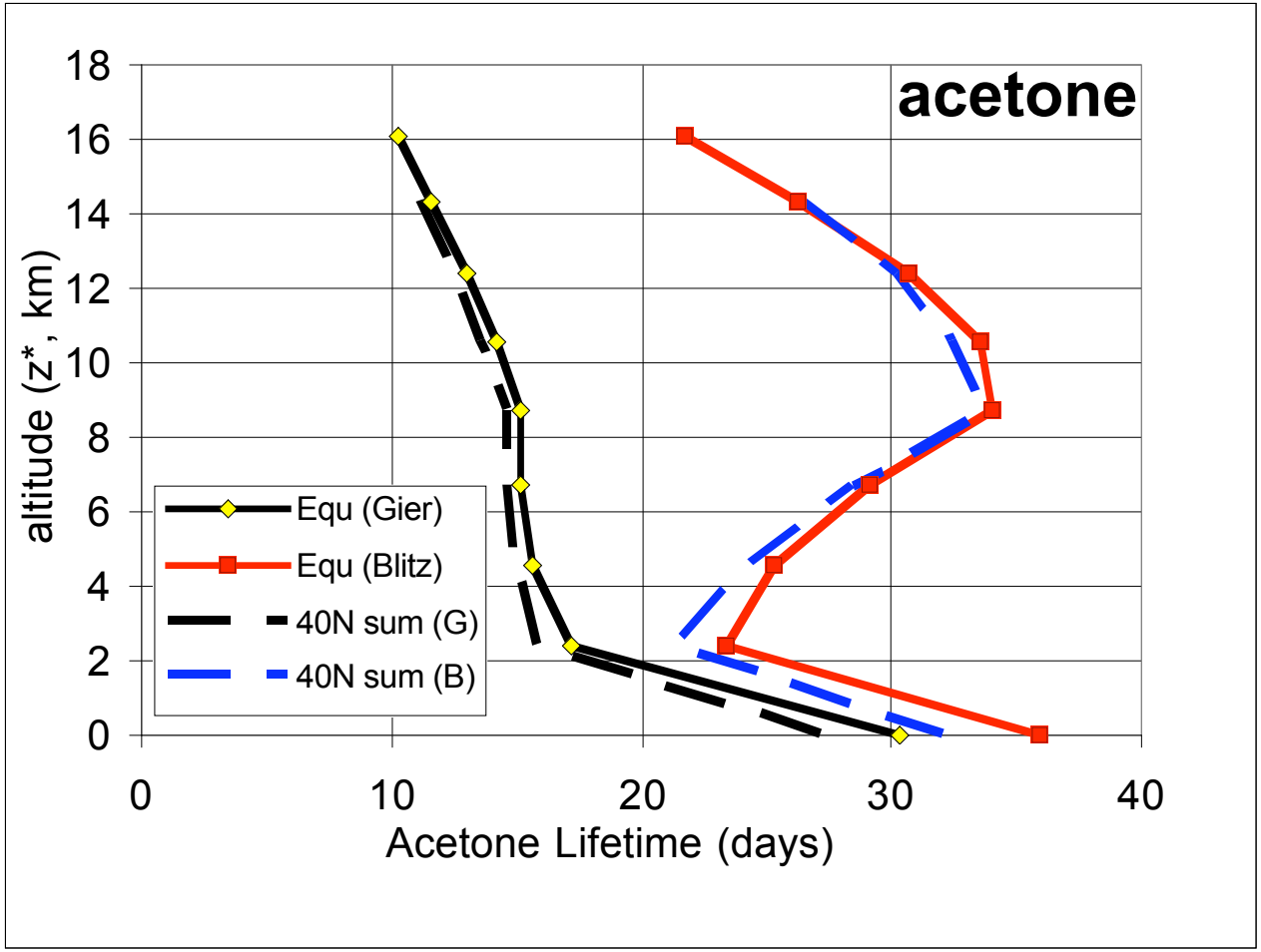
J – $CH_3C(O)CH_3$

acetone





J – $CH_3C(O)CH_3$


acetone
altitude (z*, km)
18
16
14
12
10
8
6
4
2
0
0
10
20
30
40
Acetone Lifetime (days)
Equ (Gier)
Equ (Blitz)
40N sum (G)
40N sum (B)

fast JX:

updated X-sections
(Nov 2004)

JPL-02
+ fixed-T NO_2
+ near IR HNO_4
+ IUPAC VOC
+ Blitz'04 acetone

(FT10_K04f.x) UCI JX-data (JPL02+IUPAC+fixNO2+irHNO4+VOC)ver8.2f

X-sect	*T1*	*T2*	*T3*	*X-sect*	*T1*	*T2*
O2	180	260	300	CH3Cl	210	298
O3	180	260	300	CH3CCl3	210	298
O3(1D)	180	260	300	CH2Cl2	295	298
NO	300	300		CHF2Cl	210	298
H2COa	223	293		F123	210	295
H2COb	223	293		F141b	210	298
H2O2	200	300		F142b	210	298
CH3OOH	297	298		CH3Br	210	296
NO2	273	298		H1211	210	298
NO3	297	298		H1301	210	298
N2O5	225	300		H2402	210	298
HNO2	297	298		CH2Br2	210	298
HNO3	200	300		CHBr3	210	296
HNO4	297	298		CH3I	210	298
ClNO3a	210	296		CF3I	210	300
ClNO3b	210	296		OCS	225	295
Cl2	200	300		PAN	250	298
HOCl	297	298		CH3NO3	240	298
OClO	204	298		ActAld	297	298
Cl2O2	229	230		MeVK	297	298
ClO	297	298		MeAcr	297	298
BrO	297	298		GlyAld	297	298
BrNO3	230	298		MEKeto	297	298
HOBr	297	298		EAld	297	298
BrCl	295	298		MGlyxl	297	298
N2O	200	300		Glyxla	297	298
CFCl3	210	298		Glyxlb	297	298
CF2Cl2	210	298		C3H6O	220	300
F113	210	295		Q2-Ac	240	300
F114	210	298		Q1A-Ac	240	300
F115	210	298		Q1B-Ac	240	300
CCl4	210	298				

fast JX:

spectral data
version 04e
(Nov 2004)

JPL-02
+ fixed-T NO_2
+ near IR HNO_4
+ IUPAC VOC
+ Gierczak'98 acetone

```
(FT10-K04e.x) UCI JX-data (JPL02+IUPAC+fixNO2+irHNO4+VOC)ver>>>8.1e<<<8/04
NW-JValues   64   18    1   18     NJVAL, NWWW, NW1:NW2=01:18 or 12:18
w-eff (nm)      187.      191.      194.      196.      202.      208.
                211.      214.      261.      268.      278.      295.
                303.      310.      316.      333.      380.      574.
SOL#/cm2/s 1.211E+12 1.417E+12 1.474E+12 8.409E+11 7.218E+12 4.394E+12
        8.905E+12 1.093E+13 6.106E+14 4.102E+14 3.091E+14 5.751E+14
        7.331E+14 5.022E+14 8.709E+14 3.786E+15 1.544E+16 2.110E+17
Raylay cm2 5.083E-25 4.468E-25 4.184E-25 3.904E-25 3.355E-25 2.929E-25
        2.736E-25 2.579E-25 1.050E-25 9.375E-26 8.043E-26 6.124E-26
        5.422E-26 4.921E-26 4.515E-26 3.645E-26 2.082E-26 3.853E-27
BCarb m2/g     10.08     10.08     10.08     10.08     10.08     10.08
                10.08     10.08     10.08     10.08     10.08     10.08
                 9.96      9.87      9.79      9.58      9.00      6.50
O2     180 1.728E-21 1.990E-22 3.006E-23 9.843E-24 7.305E-24 6.835E-24
        6.243E-24 5.798E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O2     260 2.268E-21 3.059E-22 4.913E-23 1.409E-23 7.688E-24 6.835E-24
        6.243E-24 5.875E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O2     300 2.754E-21 4.239E-22 7.402E-23 2.102E-23 8.352E-24 6.835E-24
        6.243E-24 5.974E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O3     180 5.861E-19 4.685E-19 4.130E-19 3.546E-19 3.228E-19 4.555E-19
        6.287E-19 9.129E-19 8.866E-18 3.463E-18 1.494E-18 7.480E-19
        2.365E-19 8.722E-20 3.694E-20 4.295E-21 1.804E-23 1.630E-21
O3     260 5.928E-19 4.772E-19 4.223E-19 3.648E-19 3.330E-19 4.610E-19
        6.325E-19 8.753E-19 8.877E-18 3.563E-18 1.553E-18 7.931E-19
        2.571E-19 9.673E-20 4.141E-20 5.457E-21 2.775E-23 1.630E-21
O3     300 5.895E-19 4.712E-19 4.159E-19 3.555E-19 3.301E-19 4.688E-19
        6.372E-19 8.997E-19 8.882E-18 3.596E-18 1.596E-18 8.305E-19
        2.777E-19 1.075E-19 4.725E-20 6.782E-21 4.824E-23 1.630E-21
O3(1D) 180 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.926E-01 4.463E-01 8.621E-02 7.739E-02 0.000E+00 0.000E+00
O3(1D) 260 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.934E-01 5.045E-01 1.473E-01 8.643E-02 0.000E+00 0.000E+00
O3(1D) 300 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.954E-01 5.682E-01 2.363E-01 9.965E-02 0.000E+00 0.000E+00
NO     300 1.021E-18 1.158E-18 5.498E-19 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 1.390E-20 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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fast JX:

spectral data
version 04f
(Nov 2004)

JPL-02
+ fixed-T NO_2
+ near IR HNO_4
+ IUPAC VOC
+ Blitz '04 acetone

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(FT10_K04f.x) UCI JX-data (JPL02+IUPAC+fixNO2+irHNO4+VOC)ver>>>8.2f<<<8/04
NW-JValues   63   18   1   18    NJVAL, NWWW, NW1:NW2=01:18 or 12:18
w-eff (nm)    187.    191.    194.    196.    202.    208.
              211.    214.    261.    268.    278.    295.
              303.    310.    316.    333.    380.    574.
SOL#/cm2/s 1.211E+12 1.417E+12 1.474E+12 8.409E+11 7.218E+12 4.394E+12
        8.905E+12 1.093E+13 6.106E+14 4.102E+14 3.091E+14 5.751E+14
        7.331E+14 5.022E+14 8.709E+14 3.786E+15 1.544E+16 2.110E+17
Raylay cm2 5.083E-25 4.468E-25 4.184E-25 3.904E-25 3.355E-25 2.929E-25
        2.736E-25 2.579E-25 1.050E-25 9.375E-26 8.043E-26 6.124E-26
        5.422E-26 4.921E-26 4.515E-26 3.645E-26 2.082E-26 3.853E-27
BCarb m2/g    10.08    10.08    10.08    10.08    10.08    10.08
              10.08    10.08    10.08    10.08    10.08    10.08
               9.96     9.87     9.79     9.58     9.00     6.50
O2     180 1.728E-21 1.990E-22 3.006E-23 9.843E-24 7.305E-24 6.835E-24
        6.243E-24 5.798E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O2     260 2.268E-21 3.059E-22 4.913E-23 1.409E-23 7.688E-24 6.835E-24
        6.243E-24 5.875E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O2     300 2.754E-21 4.239E-22 7.402E-23 2.102E-23 8.352E-24 6.835E-24
        6.243E-24 5.974E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O3     180 5.861E-19 4.685E-19 4.130E-19 3.546E-19 3.228E-19 4.555E-19
        6.287E-19 9.129E-19 8.866E-18 3.463E-18 1.494E-18 7.480E-19
        2.365E-19 8.722E-20 3.694E-20 4.295E-21 1.804E-23 1.630E-21
O3     260 5.928E-19 4.772E-19 4.223E-19 3.648E-19 3.330E-19 4.610E-19
        6.325E-19 8.753E-19 8.877E-18 3.563E-18 1.553E-18 7.931E-19
        2.571E-19 9.673E-20 4.141E-20 5.457E-21 2.775E-23 1.630E-21
O3     300 5.895E-19 4.712E-19 4.159E-19 3.555E-19 3.301E-19 4.688E-19
        6.372E-19 8.997E-19 8.882E-18 3.596E-18 1.596E-18 8.305E-19
        2.777E-19 1.075E-19 4.725E-20 6.782E-21 4.824E-23 1.630E-21
O3(1D) 180 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.926E-01 4.463E-01 8.621E-02 7.739E-02 0.000E+00 0.000E+00
O3(1D) 260 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.934E-01 5.045E-01 1.473E-01 8.643E-02 0.000E+00 0.000E+00
O3(1D) 300 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.954E-01 5.682E-01 2.363E-01 9.965E-02 0.000E+00 0.000E+00
NO     300 1.021E-18 1.158E-18 5.498E-19 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 1.390E-20 0.000E+00 0.000E+00 0.000E+00 0.000E+00
```

fast-JX / pratmo std

app Z	HNO3	HNO4	ClNO3a	ClNO3b	Cl2	HOCl	OClO	Cl2O2	ClO	BrO	BrNO3	HOBr
60	0.99	1.00	1.00	1.00	0.98	0.99	0.98	1.00	1.00	0.98	0.98	0.97
50	0.99	1.00	1.00	1.00	0.98	0.99	0.98	1.00	1.00	0.98	0.98	0.97
40	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.99	0.99	0.98	0.98	0.97
32	0.98	0.99	0.99	1.00	0.98	0.99	0.98	0.99	1.03	0.98	0.97	0.97
28	0.98	1.00	0.99	1.00	0.98	0.99	0.98	0.99	1.05	0.98	0.97	0.97
24	0.99	0.99	0.99	1.00	0.98	0.99	0.98	0.99	1.05	0.98	0.97	0.97
20	0.99	1.00	0.98	0.99	0.98	0.99	0.98	0.99	1.05	0.98	0.97	0.97
16	0.99	1.00	0.98	0.99	0.98	0.99	0.98	0.98	1.05	0.98	0.97	0.96
12	0.99	0.99	0.98	0.99	0.97	0.98	0.98	0.98	1.05	0.98	0.97	0.96
8	0.99	0.99	0.98	0.98	0.97	0.98	0.98	0.97	1.04	0.97	0.97	0.96
6	0.99	0.99	0.98	0.98	0.97	0.98	0.97	0.98	1.04	0.98	0.97	0.96
4	0.99	0.98	0.98	0.98	0.97	0.98	0.98	0.98	1.03	0.98	0.97	0.96
2	0.99	0.99	0.98	0.98	0.98	0.99	0.97	0.98	1.04	0.98	0.97	0.97
0	1.11	1.11	1.06	1.10	1.06	1.08	1.04	1.08	1.17	1.08	1.04	1.04
app Z	HNO3	HNO4	ClNO3a	ClNO3b	Cl2	HOCl	OClO	Cl2O2	ClO	BrO	BrNO3	HOBr

fast-JX / pratmo std

app Z	O2	O3	O3(1D)	NO	H2COa	H2COb	H2O2	CH3OOH	NO2	NO3	N2O5	HNO2
60	1.03	1.00	1.00	0.95	1.01	0.99	1.00	1.00	0.99	1.03	1.00	0.98
50	1.01	1.01	1.00	1.01	1.01	0.99	1.00	1.00	0.98	1.03	1.00	0.98
40	0.98	1.01	1.01	0.99	1.01	0.99	0.99	0.99	0.99	1.03	1.00	0.97
32	1.00	1.01	1.01	1.02	1.00	0.99	0.99	1.00	0.99	1.03	1.00	0.97
28	0.99	1.02	1.02	1.03	1.00	0.99	0.99	0.99	0.99	1.03	1.00	0.97
24	0.99	1.02	1.02	1.25	0.99	0.99	0.99	0.99	1.00	1.03	0.99	0.98
20	0.98	1.02	1.01		0.99	0.99	0.99	0.99	1.00	1.03	0.99	0.98
16	0.97	1.02	1.00		0.99	0.99	0.99	0.99	0.99	1.03	0.99	0.98
12	0.95	1.02	1.00		0.99	0.99	0.99	0.98	0.99	1.03	0.99	0.97
8	3.03	1.02	0.99		0.98	0.98	0.98	0.98	0.99	1.03	0.98	0.97
6	49.03	1.02	0.99		0.98	0.98	0.98	0.98	0.98	1.03	0.98	0.97
4	1572.16	1.02	0.98		0.98	0.98	0.98	0.98	0.99	1.03	0.98	0.97
2		1.02	0.99		0.99	0.98	0.99	0.99	0.99	1.03	0.99	0.98
0		1.04	1.11		1.10	1.08	1.09	1.09	1.05	1.03	1.09	1.06
app Z	O2	O3	O3(1D)	NO	H2COa	H2COb	H2O2	CH3OOH	NO2	NO3	N2O5	HNO2

fast-JX / pratmo std

app Z	BrCl	N2O	CFCl3	CF2Cl2	F113	F114	F115	CCl4	CH3Cl	CH3CCl3	CH2Cl2	CHF2Cl
60	0.96	0.98	0.98	0.97	0.98	0.97	0.97	0.99	0.97	0.99	0.97	0.96
50	0.96	0.99	0.99	1.01	1.00	1.01	1.01	1.00	1.01	1.00	1.01	1.02
40	0.96	0.99	0.99	1.00	0.99	1.01	1.00	0.99	1.00	0.98	1.00	1.01
32	0.96	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.98	0.99	1.00
28	0.96	0.97	0.98	0.97	0.98	0.98	0.98	0.99	0.97	0.98	0.97	0.97
24	0.96	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97
20	0.96	0.97	0.97	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.98
16	0.96	0.95	0.94	0.97	0.96	0.96	0.96	0.95	0.96	0.94	0.95	0.96
12	0.96	0.89	0.89	0.92	0.91	0.91	0.91	0.91	0.92	0.89	0.91	0.91
8	0.96											
6	0.96											
4	0.96											
2	0.97											
0	1.02											
app Z	BrCl	N2O	CFCl3	CF2Cl2	F113	F114	F115	CCl4	CH3Cl	CH3CCl3	CH2Cl2	CHF2Cl

fast-JX / pratmo std

app Z	F123	F141b	F142b	CH3Br	H1211	H1301	H2402	CH2Br2	CHBr3	CH3I	CF3I	OCS
60	0.98	0.98	0.97	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00
50	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.00	1.00
40	0.99	0.99	1.01	0.99	0.99	0.99	0.99	0.98	0.99	1.03	0.99	0.98
32	0.98	0.98	0.99	0.99	1.00	0.99	1.00	1.00	1.00	1.01	1.01	1.00
28	0.97	0.97	0.97	1.00	1.00	1.00	1.00	1.02	1.01	1.02	1.01	1.03
24	0.98	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.01	1.01	1.01
20	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	1.00	1.01	1.01	1.00
16	0.95	0.96	0.96	0.95	0.96	0.96	0.96	0.97	1.01	1.00	1.00	0.99
12	0.91	0.91	0.91	0.93	0.98	0.94	0.97	1.16	1.01	1.00	1.00	1.09
8					1.00		0.99	2.54	1.01	0.99	0.99	5.79
6					0.99		0.99	2.59	0.99	0.99	0.99	
4					0.99		0.98	2.62	0.99	0.99	0.99	
2							0.98	2.68	1.00	0.99	0.99	
0									1.12	1.11	1.10	
app Z	F123	F141b	F142b	CH3Br	H1211	H1301	H2402	CH2Br2	CHBr3	CH3I	CF3I	OCS

fast-JX / pratmo std

app Z	PAN	CH3NO3	C3H6Ot	C3H6Os	ActAld	MeVKs	MeAcr
60	1.00	1.00	1.00	1.00	1.00	1.00	0.98
50	0.99	1.00	1.00	1.00	1.00	1.00	0.98
40	0.99	1.00	0.99	0.99	0.99	0.99	0.98
32	1.00	1.01	1.01	1.00	1.00	0.99	0.98
28	1.00	1.00	1.02	1.01	0.99	0.99	0.98
24	0.99	1.01	1.02	1.01	0.99	0.99	0.98
20	0.99	1.00	1.01	1.01	0.99	0.99	0.98
16	0.99	1.00	1.01	1.00	0.98	0.99	0.98
12	0.99	0.99	1.00	1.00	0.98	0.99	0.98
8	0.99	0.98	1.00	0.99	0.98	0.98	0.97
6	0.99	0.99	0.99	0.99	0.97	0.98	0.97
4	0.99	0.98	0.99	0.99	0.97	0.98	0.97
2	0.99	0.99	0.99	0.99	0.98	0.98	0.98
0	1.10	1.10	1.12	1.11	1.10	1.09	1.07
appZ	PAN	CH3NO3	C3H6Ot	C3H6Os	ActAld	MeVKs	MeAcr

fast JX:

spectral data
version 04f
(Nov 2004)

run for trop-only

JPL-02
+ fixed-T NO_2
+ near IR HNO_4
+ IUPAC VOC
+ Blitz '04 acetone

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(FT10_K04f.x) UCI JX-data (JPL02+IUPAC+fixNO2+irHNO4+VOC)ver>>>8.2f<<<8/04
NW-JValues   63   18   12   18     NJVAL, NWWW, NW1:NW2=01:18 or 12:18
w-eff (nm)      187.      191.      194.      196.      202.      208.
            211.      214.      261.      268.      278.      295.
            303.      310.      316.      333.      380.      574.
SOL#/cm2/s 1.211E+12 1.417E+12 1.474E+12 8.409E+11 7.218E+12 4.394E+12
        8.905E+12 1.093E+13 6.106E+14 4.102E+14 3.091E+14 5.751E+14
        7.331E+14 5.022E+14 8.709E+14 3.786E+15 1.544E+16 2.110E+17
Raylay cm2 5.083E-25 4.468E-25 4.184E-25 3.904E-25 3.355E-25 2.929E-25
        2.736E-25 2.579E-25 1.050E-25 9.375E-26 8.043E-26 6.124E-26
        5.422E-26 4.921E-26 4.515E-26 3.645E-26 2.082E-26 3.853E-27
BCarb m2/g     10.08     10.08     10.08     10.08     10.08     10.08
            10.08     10.08     10.08     10.08     10.08     10.08
            9.96      9.87      9.79      9.58      9.00      6.50
O2     180 1.728E-21 1.990E-22 3.006E-23 9.843E-24 7.305E-24 6.835E-24
        6.243E-24 5.798E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O2     260 2.268E-21 3.059E-22 4.913E-23 1.409E-23 7.688E-24 6.835E-24
        6.243E-24 5.875E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O2     300 2.754E-21 4.239E-22 7.402E-23 2.102E-23 8.352E-24 6.835E-24
        6.243E-24 5.974E-24 8.623E-26 4.745E-25 3.996E-25 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
O3     180 5.861E-19 4.685E-19 4.130E-19 3.546E-19 3.228E-19 4.555E-19
        6.287E-19 9.129E-19 8.866E-18 3.463E-18 1.494E-18 7.480E-19
        2.365E-19 8.722E-20 3.694E-20 4.295E-21 1.804E-23 1.630E-21
O3     260 5.928E-19 4.772E-19 4.223E-19 3.648E-19 3.330E-19 4.610E-19
        6.325E-19 8.753E-19 8.877E-18 3.563E-18 1.553E-18 7.931E-19
        2.571E-19 9.673E-20 4.141E-20 5.457E-21 2.775E-23 1.630E-21
O3     300 5.895E-19 4.712E-19 4.159E-19 3.555E-19 3.301E-19 4.688E-19
        6.372E-19 8.997E-19 8.882E-18 3.596E-18 1.596E-18 8.305E-19
        2.777E-19 1.075E-19 4.725E-20 6.782E-21 4.824E-23 1.630E-21
O3(1D) 180 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.926E-01 4.463E-01 8.621E-02 7.739E-02 0.000E+00 0.000E+00
O3(1D) 260 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.934E-01 5.045E-01 1.473E-01 8.643E-02 0.000E+00 0.000E+00
O3(1D) 300 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01 9.000E-01
        8.954E-01 5.682E-01 2.363E-01 9.965E-02 0.000E+00 0.000E+00
NO     300 1.021E-18 1.158E-18 5.498E-19 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 1.390E-20 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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ratio fast-JX(trop) : pratmo std

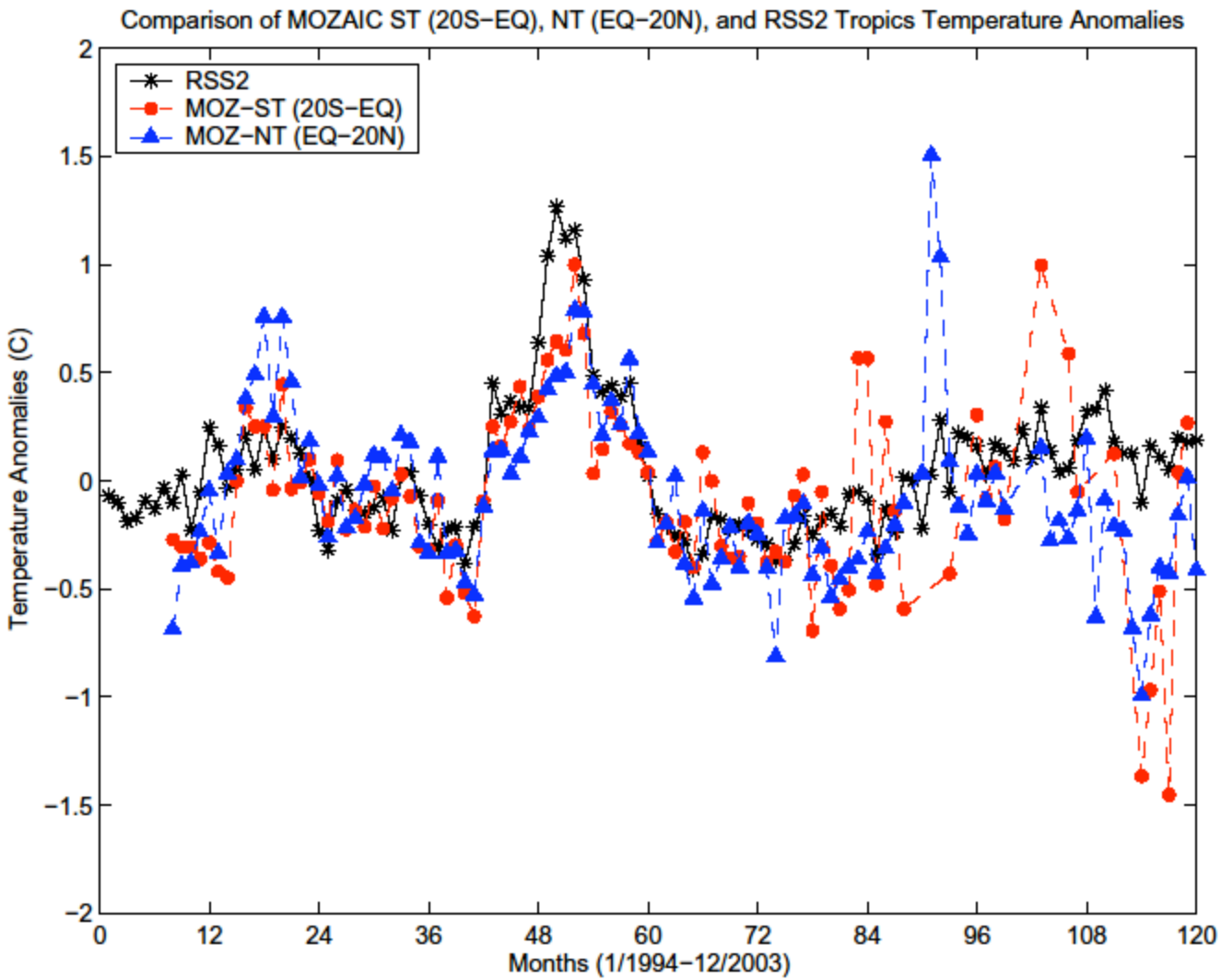
Z	O3	O3(1D)	H2COa	H2COb	H2O2	CH3OOH	NO2	NO3	N2O5	HNO2	HNO3	HNO4
18	1.02	1.01	0.99	0.99	0.99	0.99	0.99	1.03	0.98	0.98	0.79	0.96
16	1.02	1.00	0.99	0.99	0.98	0.99	0.99	1.03	0.98	0.98	0.92	0.98
14	1.02	1.00	0.99	0.99	0.99	0.99	0.99	1.03	0.99	0.97	0.98	0.99
12	1.02	1.00	0.99	0.99	0.99	0.98	0.99	1.03	0.99	0.97	0.99	0.99
10	1.02	0.99	0.99	0.98	0.98	0.98	0.99	1.03	0.98	0.97	0.99	0.99
8	1.02	0.99	0.98	0.98	0.98	0.98	0.99	1.03	0.98	0.97	0.99	0.99
6	1.02	0.99	0.98	0.98	0.98	0.98	0.98	1.03	0.98	0.97	0.99	0.99
4	1.02	0.98	0.98	0.98	0.98	0.98	0.99	1.03	0.98	0.97	0.99	0.98
2	1.02	0.99	0.99	0.98	0.99	0.99	0.99	1.03	0.99	0.98	0.99	0.99
0	1.04	1.11	1.10	1.08	1.09	1.09	1.05	1.03	1.09	1.06	1.11	1.11

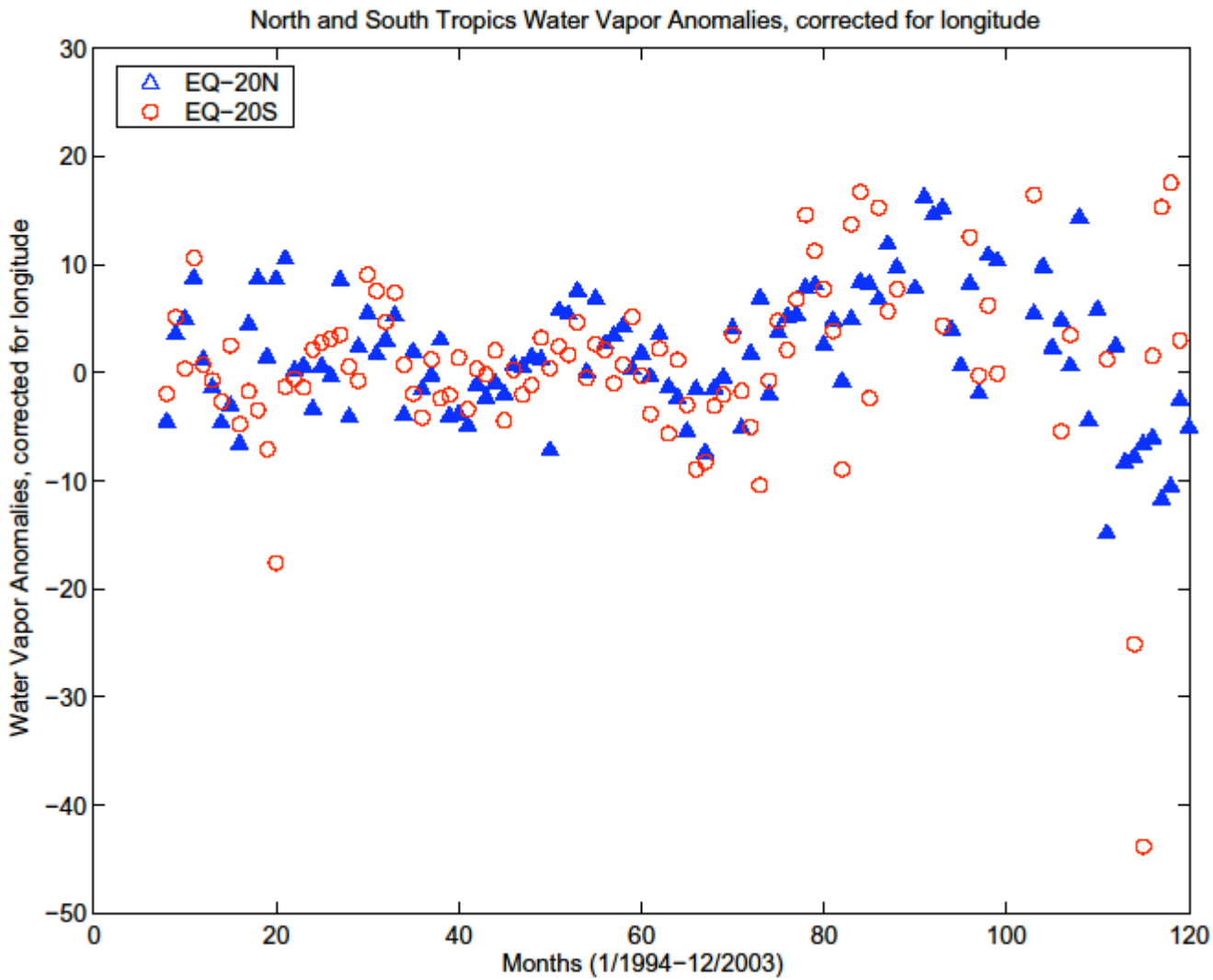
Z	ClNO3a	ClNO3b	Cl2	HOCl	OClO	Cl2O2	ClO	BrO	BrNO3	HOBr	BrCl	H1211
18	0.98	0.98	0.98	0.99	0.98	0.99	1.05	0.98	0.97	0.97	0.96	0.03
16	0.98	0.98	0.98	0.99	0.98	0.98	1.05	0.98	0.97	0.96	0.96	0.09
14	0.98	0.98	0.97	0.99	0.98	0.98	1.04	0.98	0.97	0.96	0.97	0.29
12	0.98	0.98	0.97	0.98	0.98	0.98	1.05	0.98	0.97	0.96	0.96	0.71
10	0.98	0.99	0.97	0.98	0.97	0.98	1.04	0.98	0.97	0.96	0.96	0.96
8	0.98	0.98	0.97	0.98	0.98	0.97	1.04	0.97	0.97	0.96	0.96	0.99
6	0.98	0.98	0.97	0.98	0.97	0.98	1.04	0.98	0.97	0.96	0.96	0.99
4	0.98	0.98	0.97	0.98	0.98	0.98	1.03	0.98	0.97	0.96	0.96	0.99
2	0.98	0.98	0.98	0.99	0.97	0.98	1.04	0.98	0.97	0.97	0.97	0.99
0	1.06	1.10	1.06	1.08	1.04	1.08	1.17	1.08	1.04	1.04	1.02	1.11

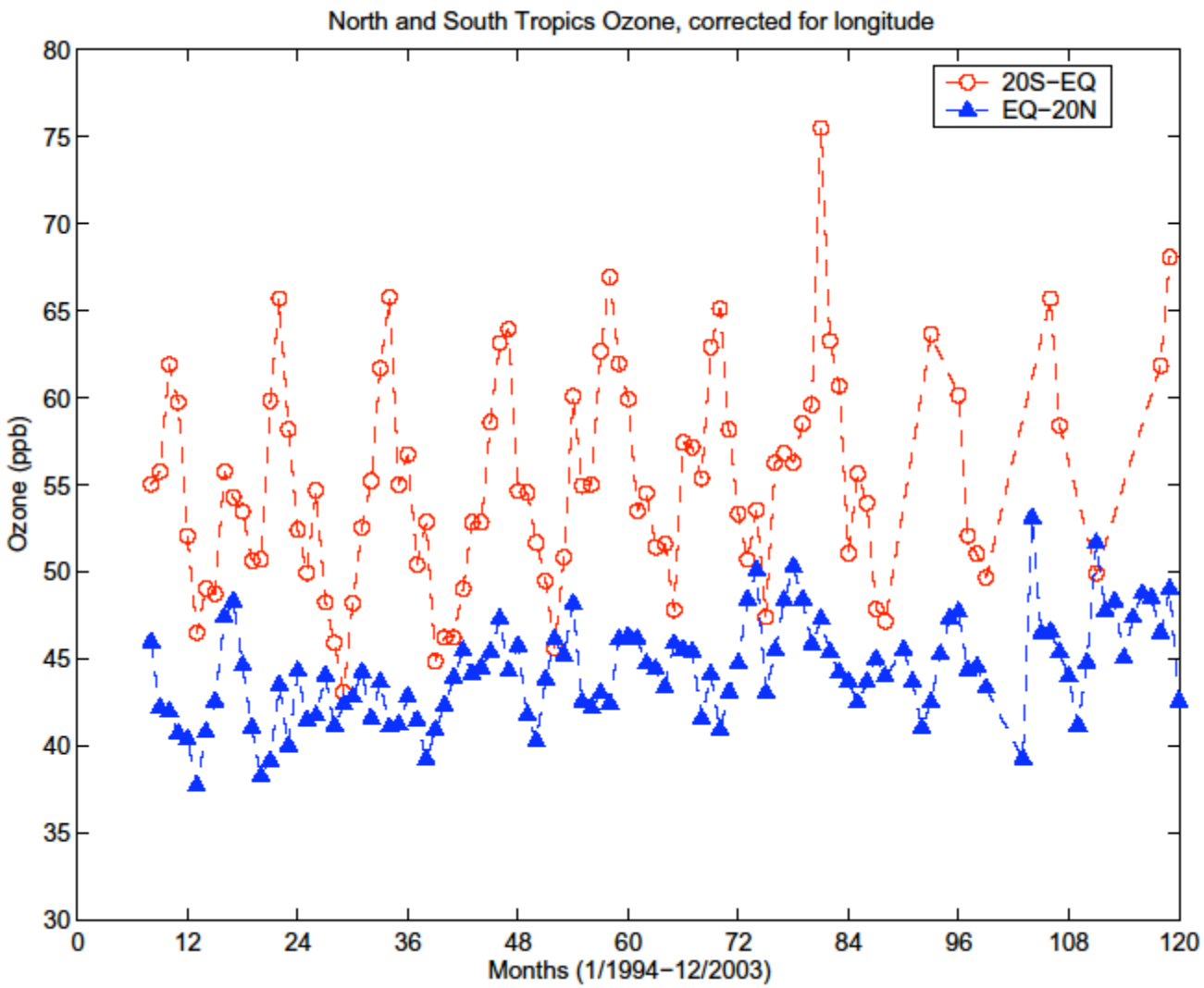
ratio fast-JX(trop) : pratmo std

Z	H2402	CH2Br2	CHBr3	CH3I	CF3I	OCS	PAN	CH3NO3	C3H6Ot	C3H6Os	ActAld	MeVKs	MeAcr
18	0.02	0.01	0.74	1.00	1.00	0.00	0.81	0.99	1.01	1.00	0.98	0.99	0.98
16	0.07	0.02	0.91	1.00	1.00	0.00	0.93	1.00	1.01	1.00	0.98	0.99	0.98
14	0.24	0.06	0.98	1.00	1.00	0.00	0.98	0.99	1.00	1.00	0.98	0.99	0.98
12	0.66	0.32	1.00	1.00	1.00	0.01	0.99	0.99	1.00	1.00	0.98	0.99	0.98
10	0.94	1.46	1.01	1.00	1.00	0.07	0.99	0.99	1.00	0.99	0.98	0.98	0.97
8	0.98	2.39	1.01	0.99	0.99	0.72	0.99	0.98	1.00	0.99	0.98	0.98	0.97
6	0.98	2.51	0.99	0.99	0.99	1.30	0.99	0.99	0.99	0.99	0.97	0.98	0.97
4	0.98	2.58	0.99	0.99	0.99	1.19	0.99	0.98	0.99	0.99	0.97	0.98	0.97
2	0.98	2.66	1.00	0.99	0.99	1.10	0.99	0.99	0.99	0.99	0.98	0.98	0.98
0	1.10	3.15	1.12	1.11	1.10	1.20	1.10	1.10	1.12	1.11	1.10	1.09	1.07

MOZAIC: Aug '94 – Dec '03 cruise-level data (7-11 km) in N & S Tropics




North and South Tropics Water Vapor Anomalies, corrected for longitude
EQ−20N
EQ−20S
Water Vapor Anomalies, corrected for longitude
Months (1/1994−12/2003)
30
20
10
0
−10
−20
−30
−40
−50
0
20
40
60
80
100
120


North and South Tropics Ozone, corrected for longitude
20S−EQ
EQ−20N
Ozone (ppb)
Months (1/1994−12/2003)
80
75
70
65
60
55
50
45
40
35
30
0
12
24
36
48
60
72
84
96
108
120