Model Equilibration to Initial Start-up Conditions

Evaluating the rate at which the TIEGCM adjusts to start-up histories that differ in known ways from the model run

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Example Equilibration Tests:

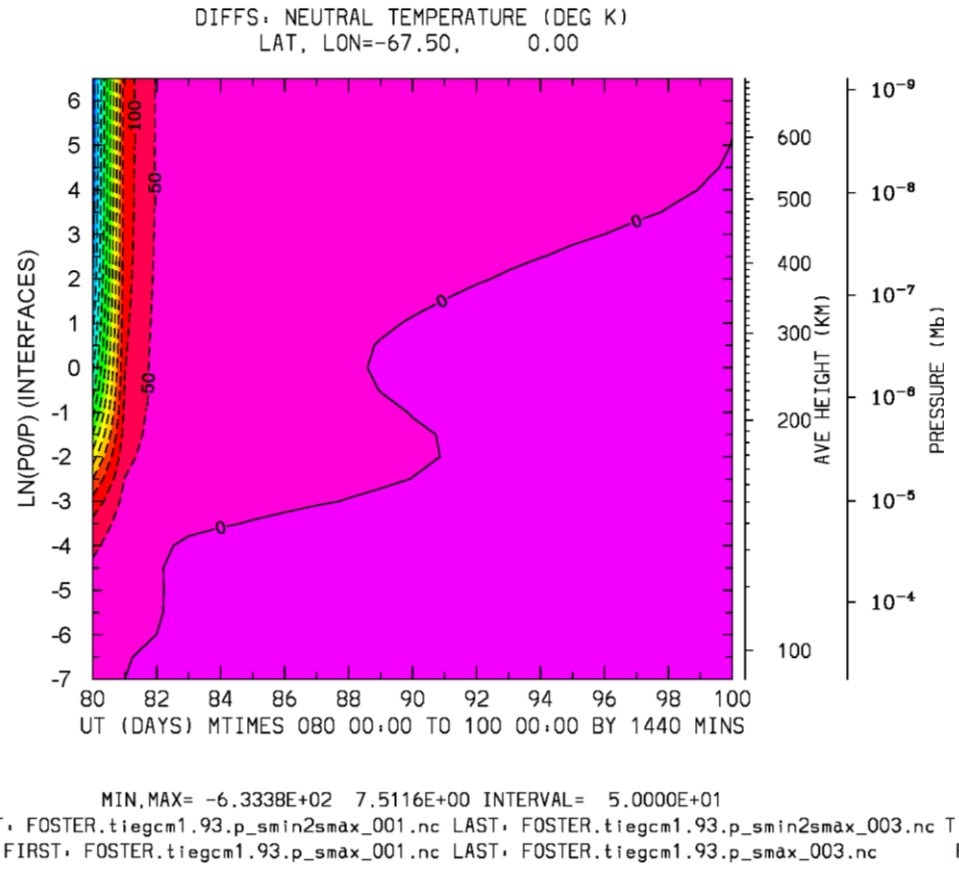
- Evaluate equilibration from a solar minimum startup history to solar maximum conditions.
- Evaluate equilibration from a startup history with a temporal/seasonal offset from model start time.
- Validation of CCMC output, using HAO runs with different equilibration run times.
- Test equilibration rates for any results-changing modification to the source code.

Equilibration from Solar Minimum to Solar Maximum Conditions

- Solar Min f10.7=70., Solar Max f10.7=250.
  - Offset of 180 f10.7 units
- Control run (case smax):
  - Days 80-100, solar maximum conditions, *started from solar maximum* start-up history.
- Offset run (case smin2smax):
  - Days 80-100, solar maximum conditions, *started from solar minimum* start-up history.
- Difference fields:
  - Daily histories, offset minus control
  - UT vs Zp and UT vs Latitude
  - Assess recovery times and structure

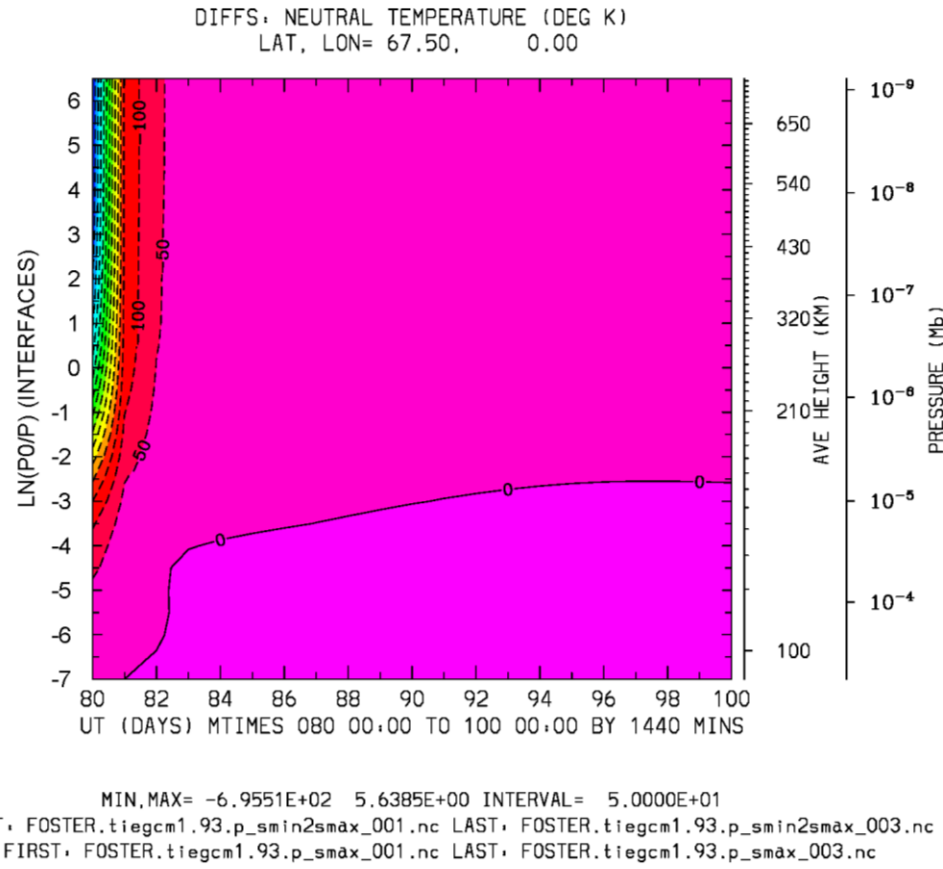
Difference: smin2max minus smax
UT vs ZP (days 80-100)
Neutral Temperature (deg K)

TN: Lat,lon = -67.5,0



Min,Max = -633, 7.5
Interval = 50

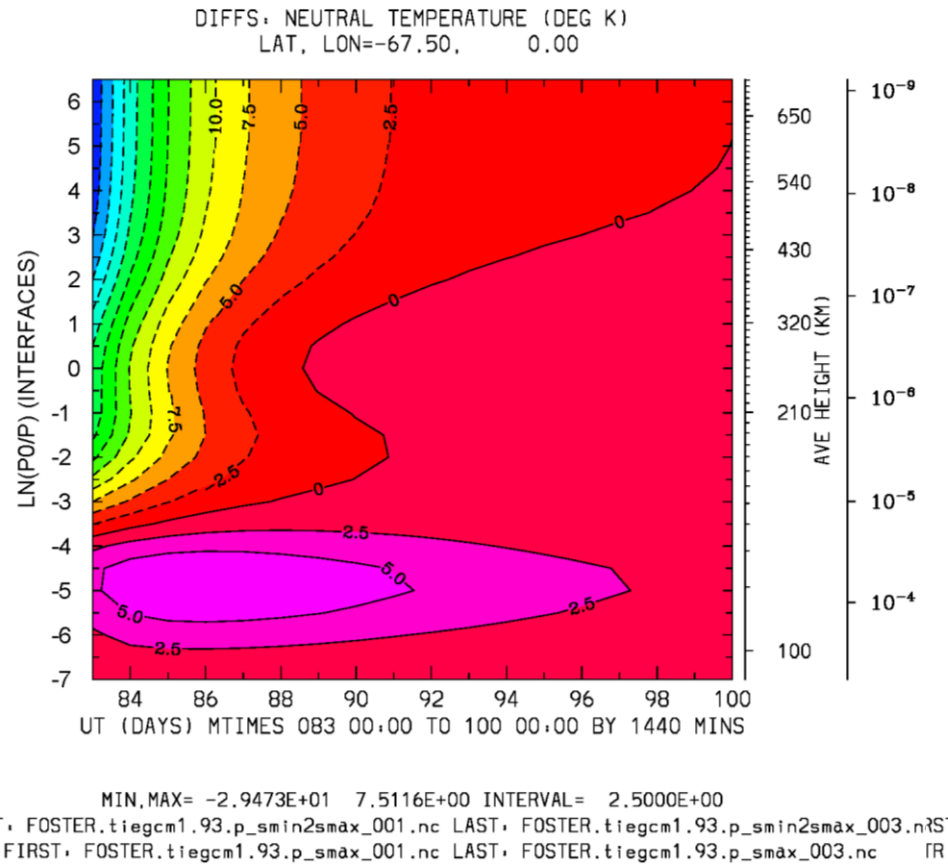
TN: Lat,lon = 67.5,0



Min,Max = -695, 5.6
Interval = 50

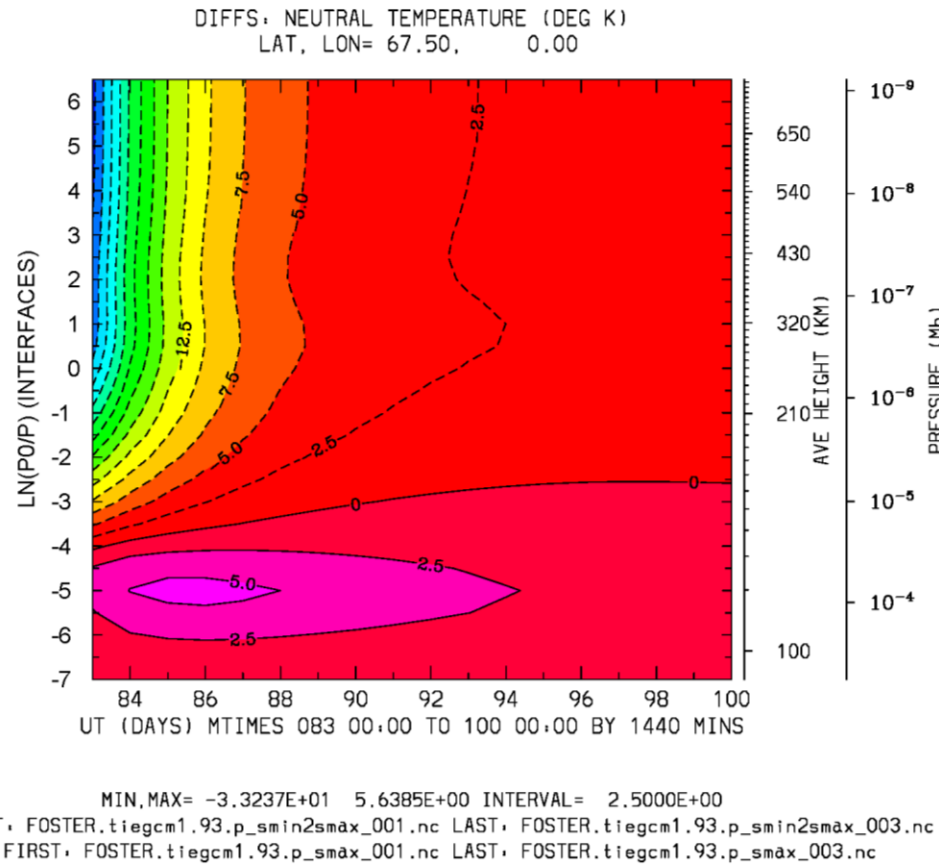
Difference: smin2max minus smax
UT vs ZP (days 83-100)
Neutral Temperature (deg K)

TN: Lat,lon = -67.5,0



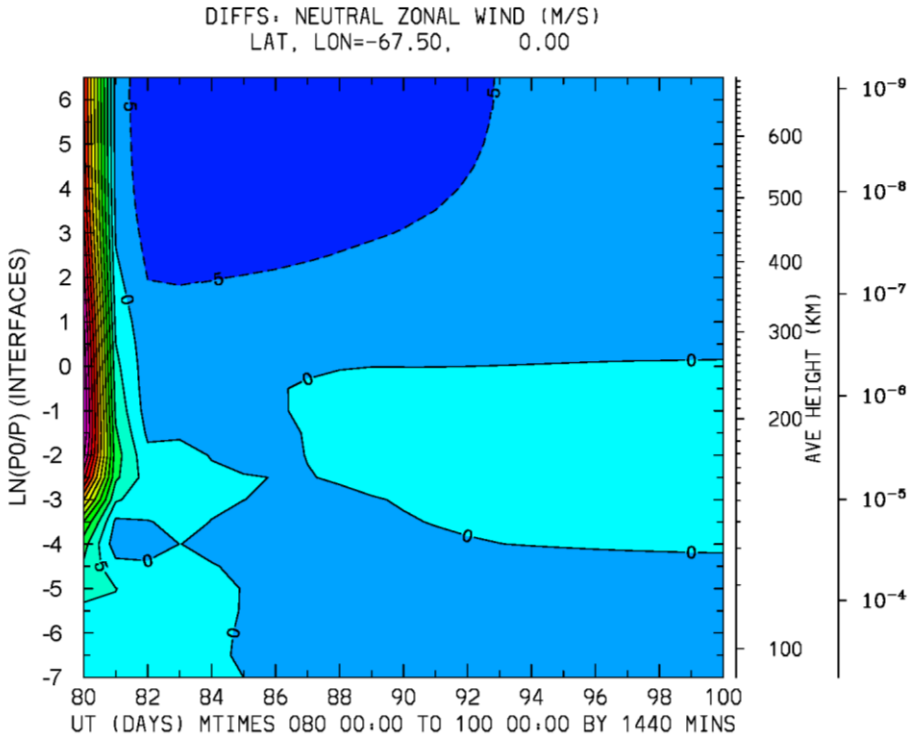
Min,Max = -29, 7.5
Interval = 2.5

TN: Lat,lon = 67.5,0



Min,Max = -33, 5.6
Interval = 2.5

Difference: smin2max minus smax
UT vs ZP (daily histories)
Neutral Zonal Wind (m/s)



MIN,MAX= -8.8817E+00 6.4880E+01 INTERVAL= 5.0000E+00

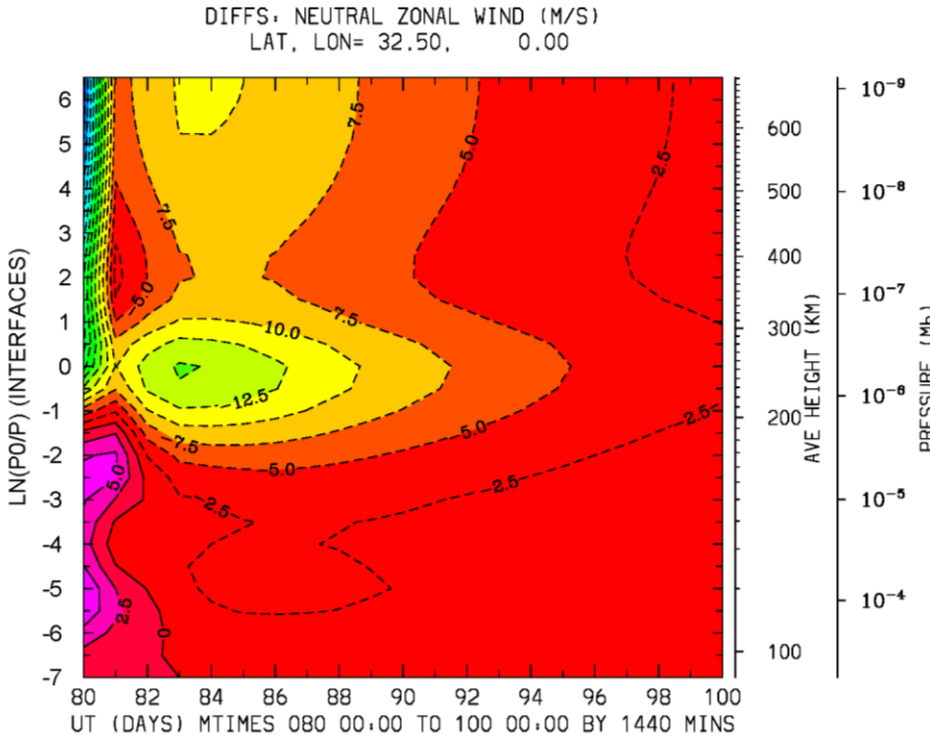
RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2smax_003.nc

TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_003.nc

Lat,lon = -67.5,0

Min,Max=-9, 65

Interval = 5.



MIN,MAX= -3.3735E+01 7.3668E+00 INTERVAL= 2.5000E+00

RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2smax_003.nc

TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_003.nc

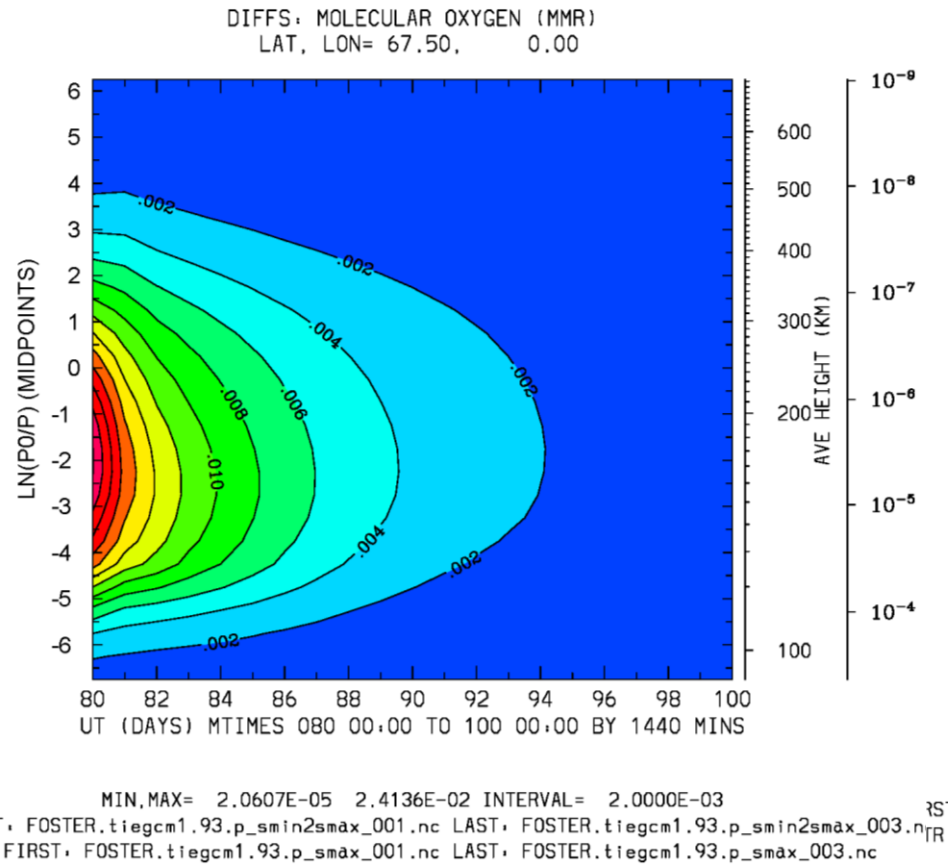
Lat,lon = 32.5,0

Min,Max = -34, 7

Interval = 2.5

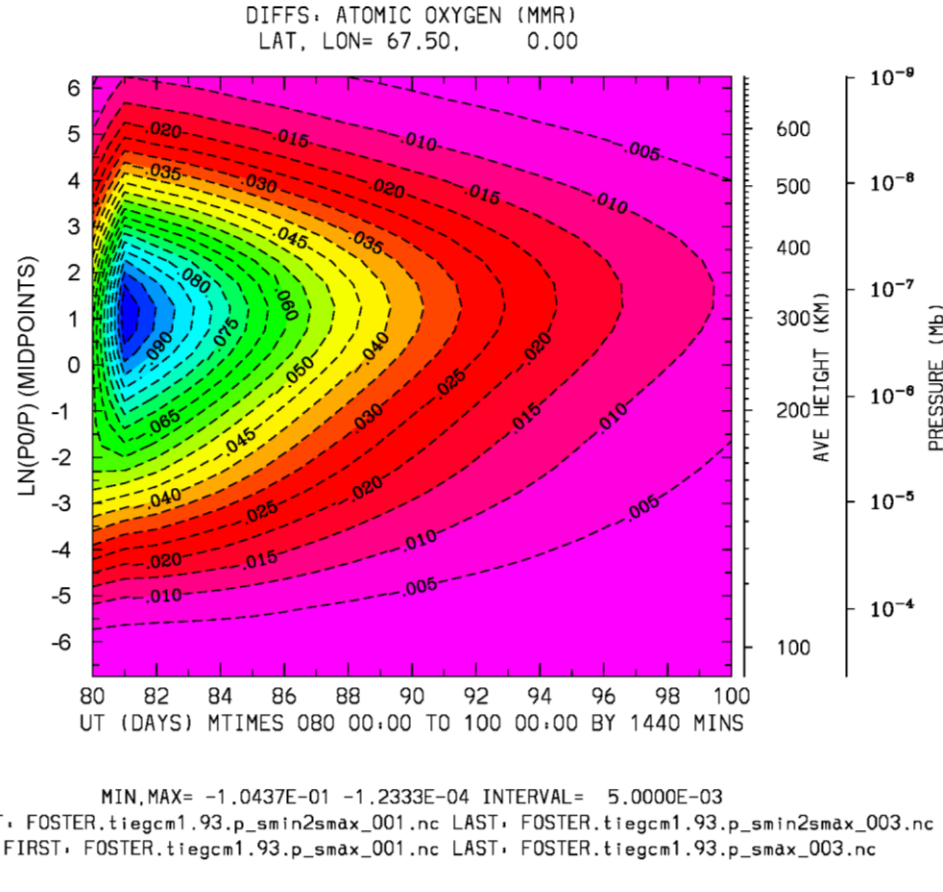
Difference: smin2max minus smax
UT (20 days) vs Zp

O2 (mmr) Lat=67.5



Min,Max = 2e-5, .024
Interval = 2.e-3

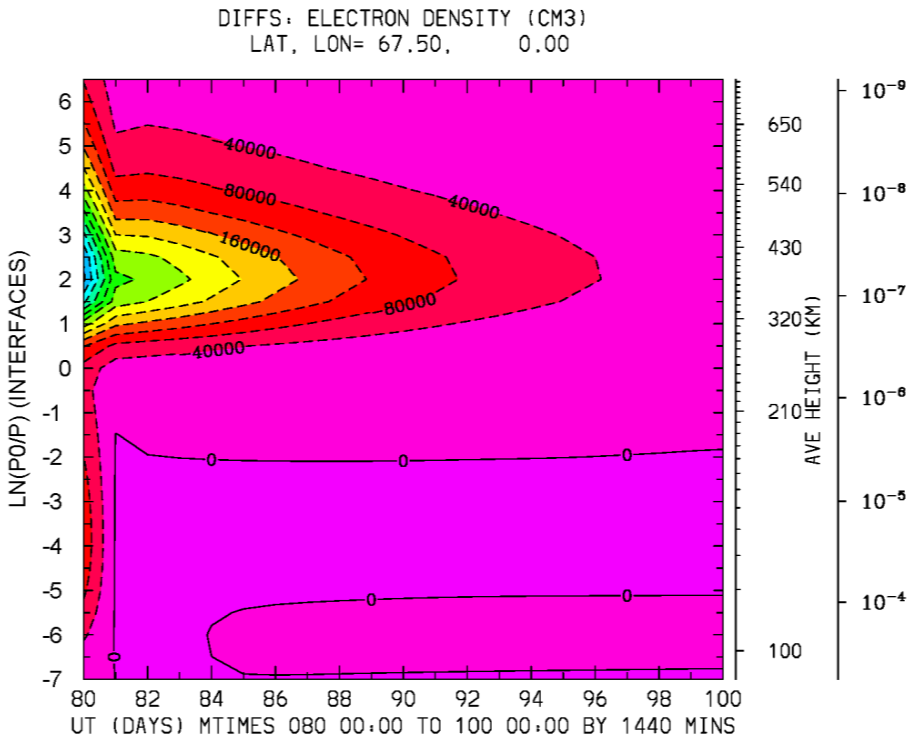
O (mmr) Lat=67.5



Min,Max = -.1, -1.2e-4
Interval = 5.e-3

Difference: smin2max minus smax
UT (20 days) vs ZP

NE (cm3) Lat=67.5

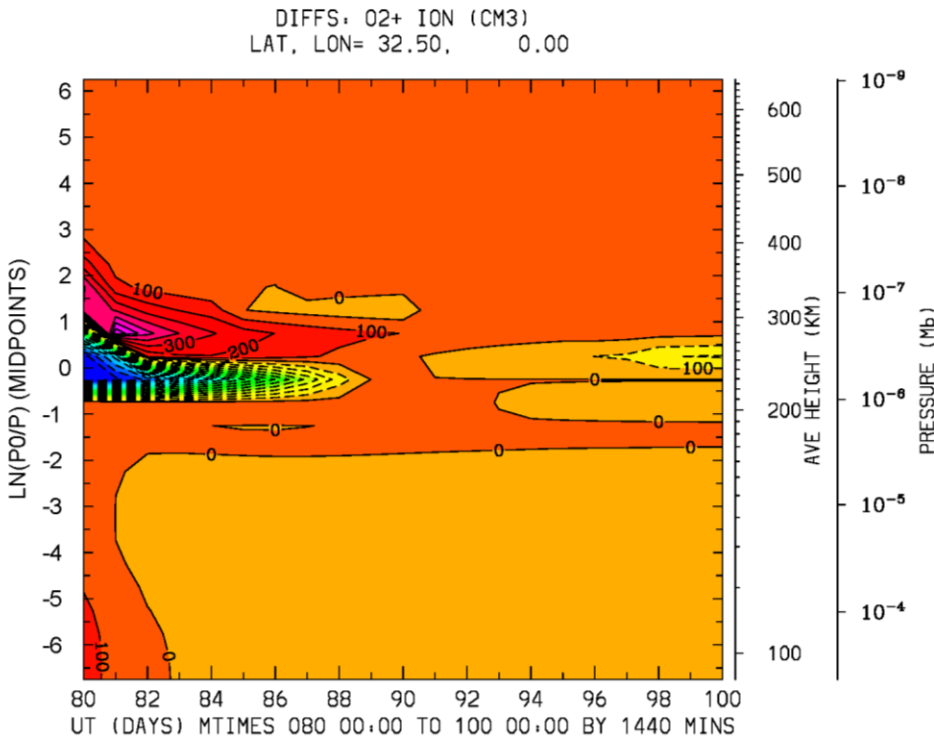


MIN,MAX= -4.8821E+05 3.2899E+03 INTERVAL= 4.0000E+04

RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2smax_003.nc
TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_003.nc

Min,Max=-5e5,3.3e3
Interval = 40,000

O2+ (cm3) Lat=32.5



MIN,MAX= -1.5989E+03 7.7723E+02 INTERVAL= 1.0000E+02

RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2smax_003.nc
TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_003.nc

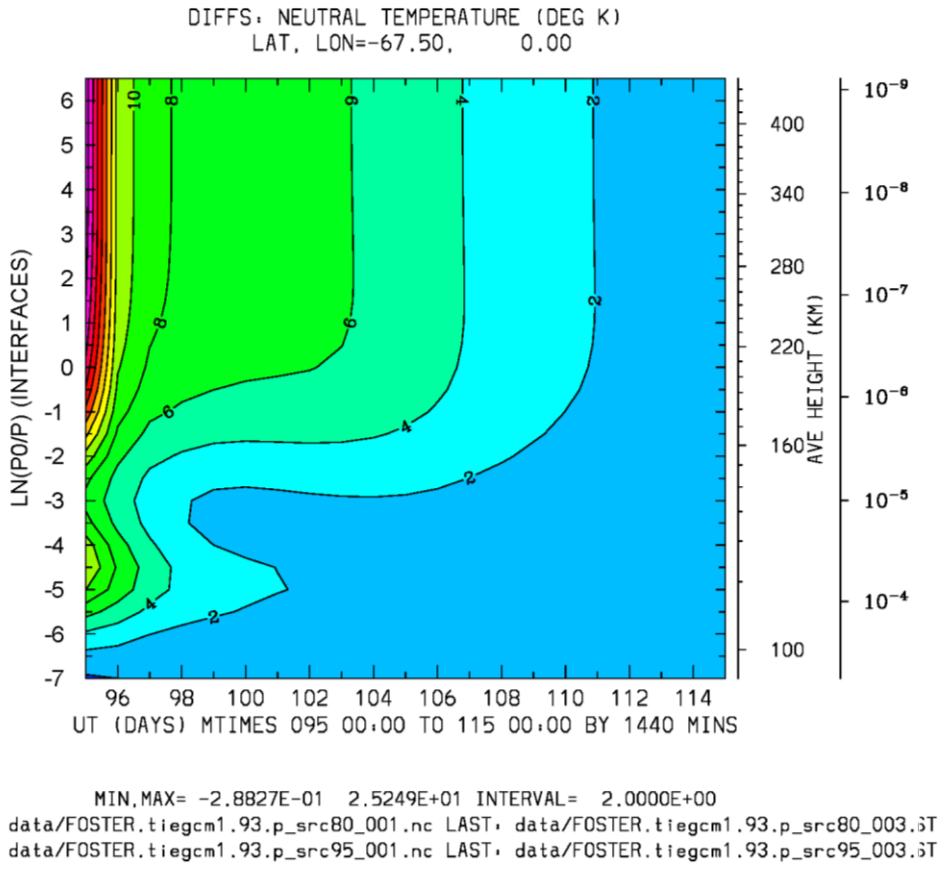
Min,Max=-1600,777
Interval = 100.

Equilibration to a 15-day Temporal Offset from the Source History:

1. Obtain a day 95 control source history:
   - Run days 80-95 from steady-state day 80 history
2. Control Run:
   - Run days 95-115 from day 95 source (step 1)
3. Offset Run:
   - Run days 95-115 from day 80 source (15-day offset)
4. Plot differences of Offset minus Control runs:
   - Ut vs Zp and Ut vs Latitude (daily histories)
   - Assess recovery time and structure

Difference: 15-day Offset run Minus Control
UT (20 days) vs Zp
Neutral Temperature (deg K)

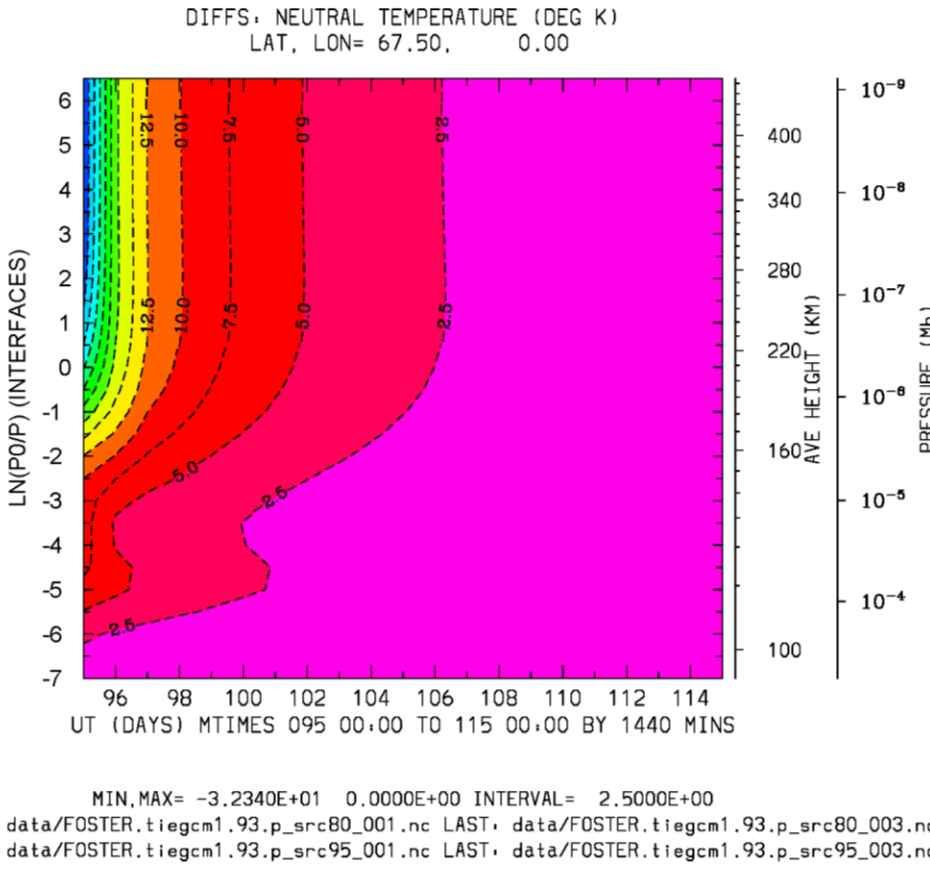
Lat, lon = -67.5, 0



Min,Max = -0.3, 25

Interval = 2.

Lat, lon = 67.5, 0

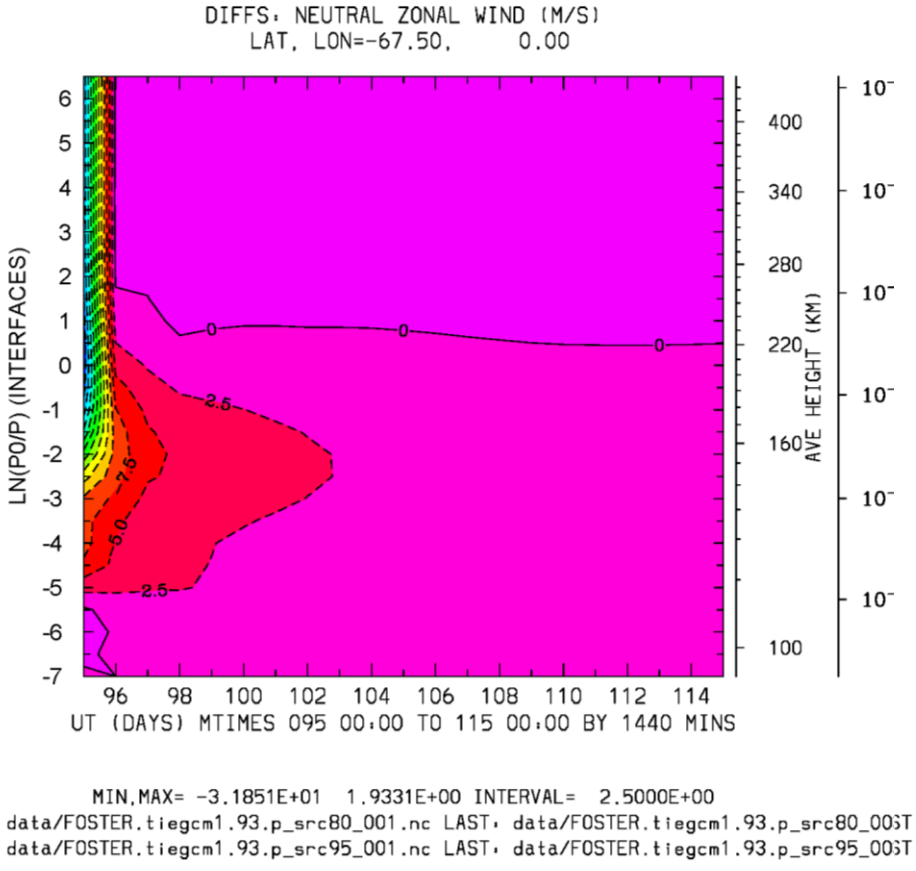


Min,Max = -32, 0

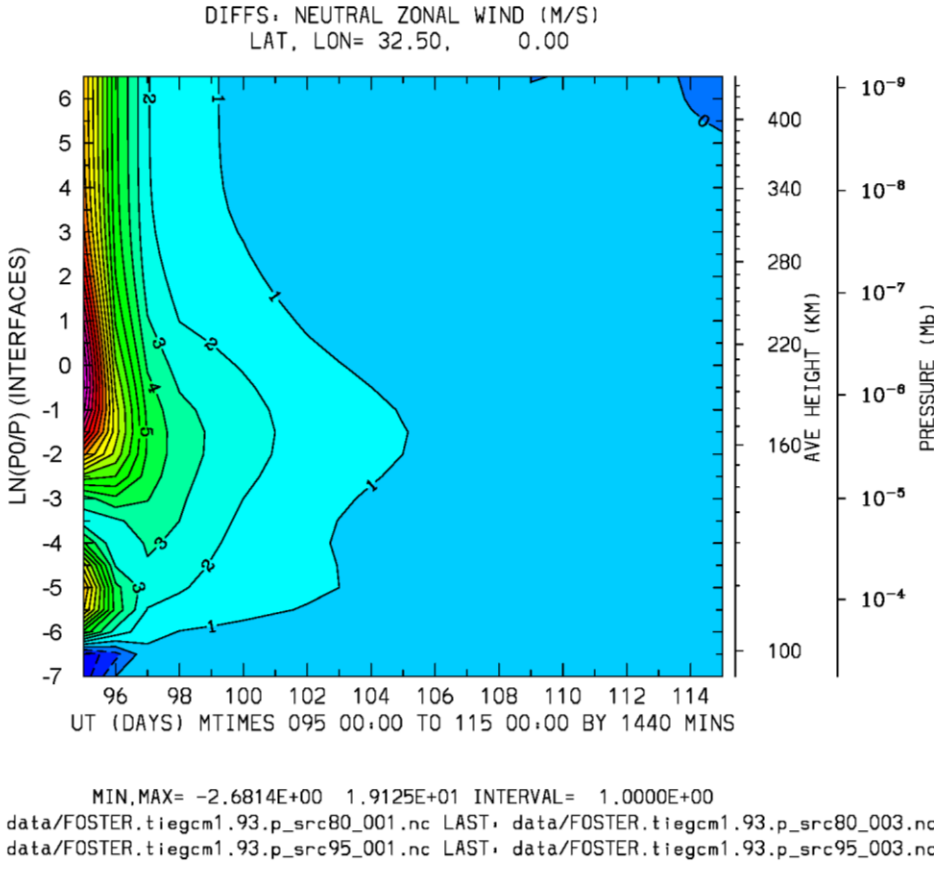
Interval = 2.5

Difference: 15-day Offset run Minus Control
UT (20 days) vs Zp
Neutral Zonal Wind (m/s)

Lat, lon = -67.5, 0



Lat, lon = 32.5, 0



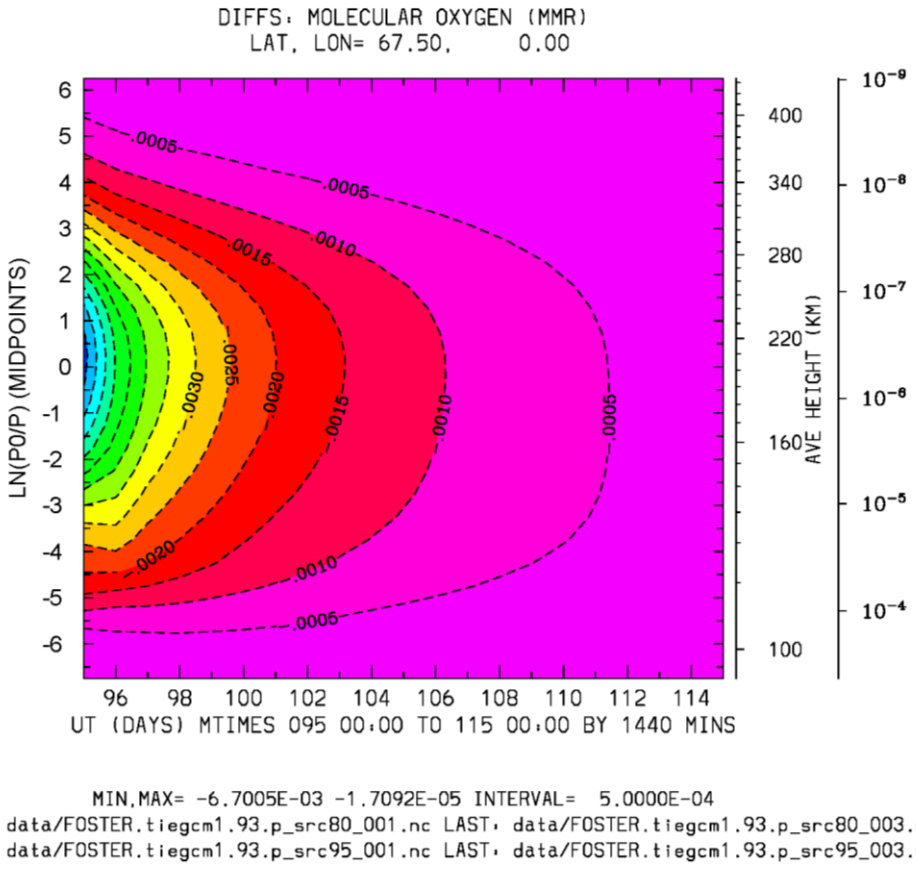
Min,Max = -32, 1.9
Interval = 2.5

Min,Max = -2.7, 1.9
Interval = 1.0

Difference: 15-day Offset run Minus Control
UT (20 days) vs Zp

O2 (mmr)

Lat, lon = 67.5, 0

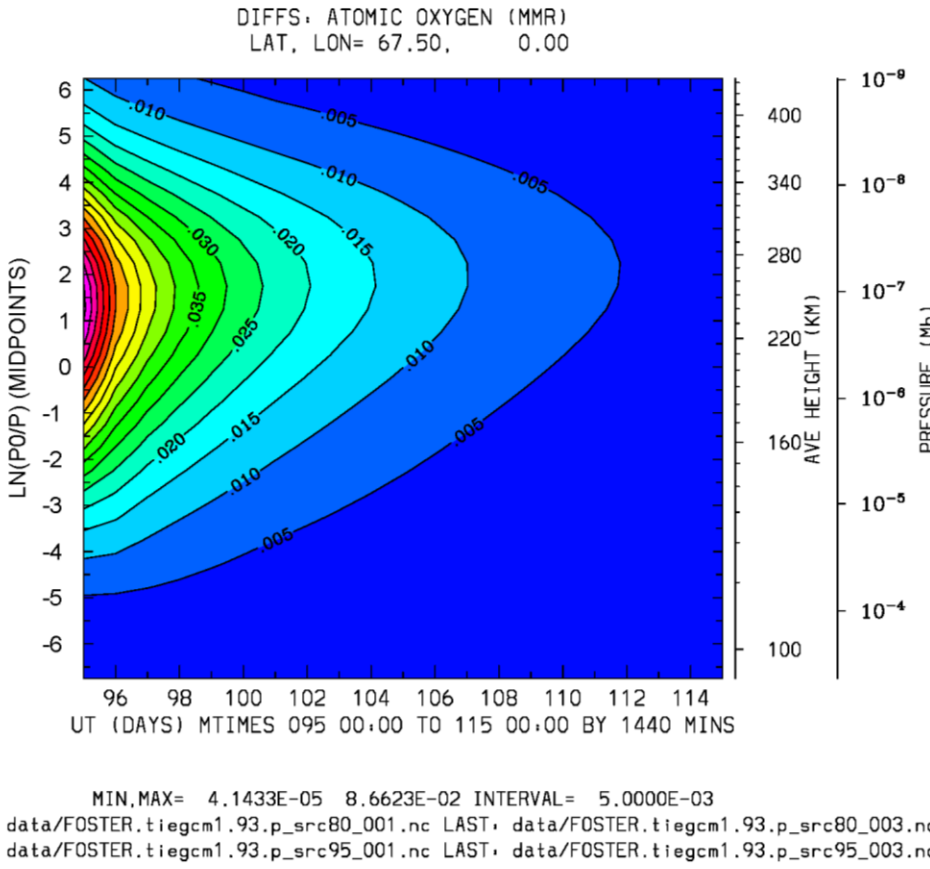


Min,Max = -6.7e-3, -1.7e-5

Interval = 5.e-4

O (mmr)

Lat, lon = 67.5, 0



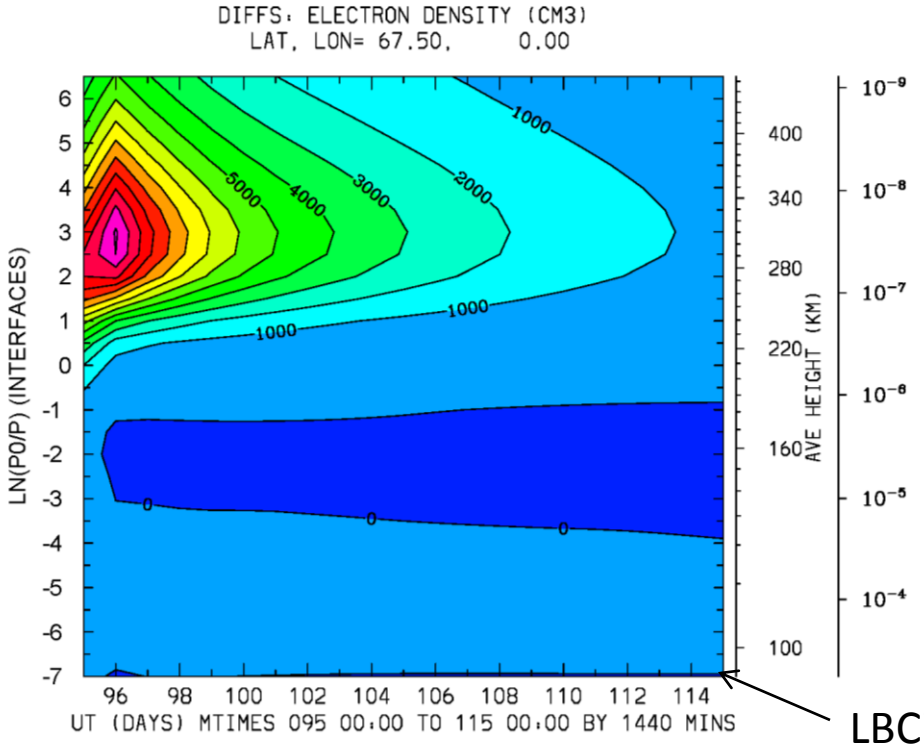
Min,Max = 4.1e-5, 8.7e-2

Interval = 5.e-3

Difference: 15-day Offset run Minus Control
UT (20 days) vs Zp

NE (cm3)

Lat, lon = 67.5, 0

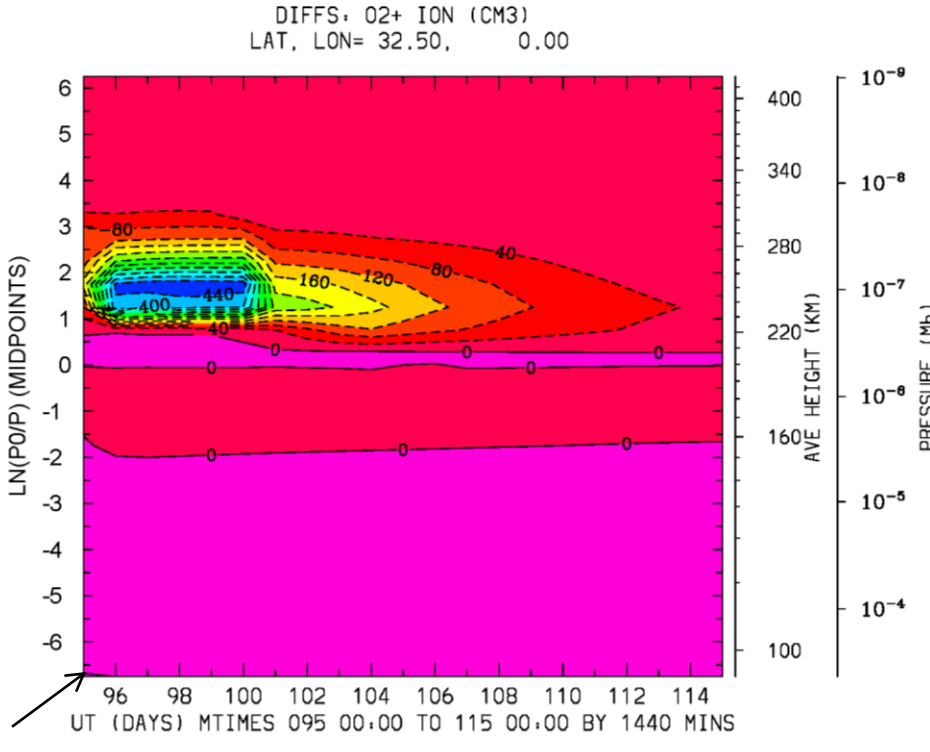


Min,Max = -93, 1.3e4

LBC?

O2+ (cm3)

Lat, lon = 32.5, 0

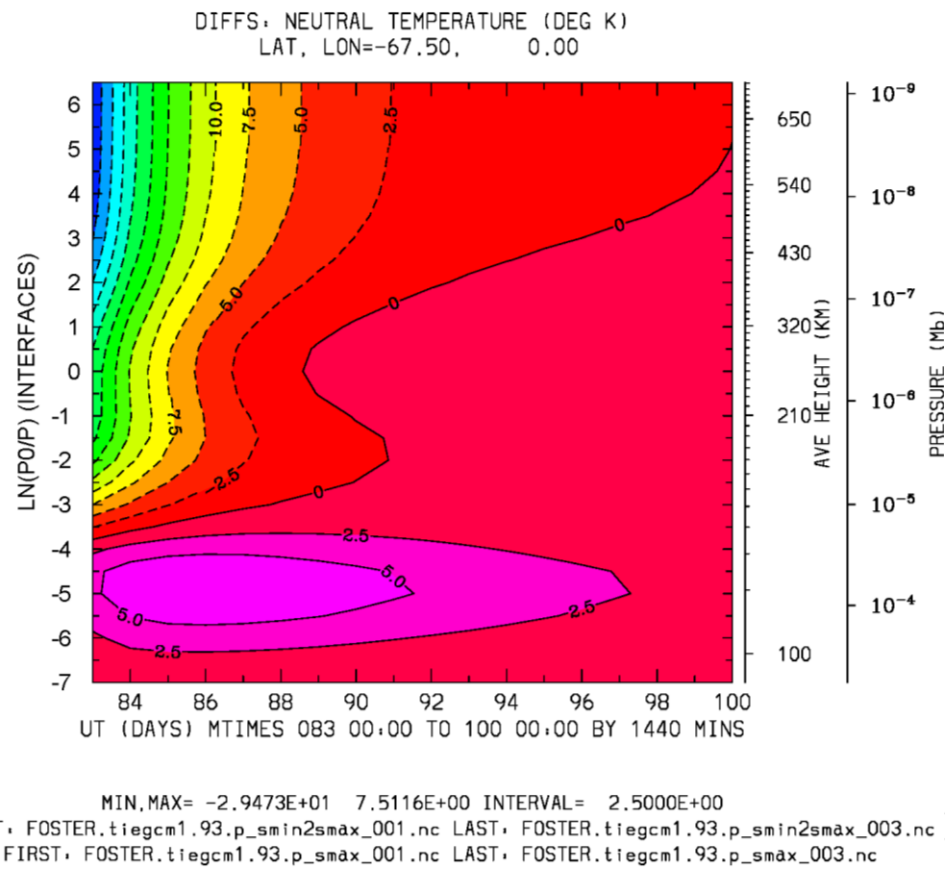


Min,Max = -471, 42

Side-by-side Comparisons of the two cases: smin2max and 15-day offset

Case Comparisons
TN: Ut vs Zp, Lat -67.5

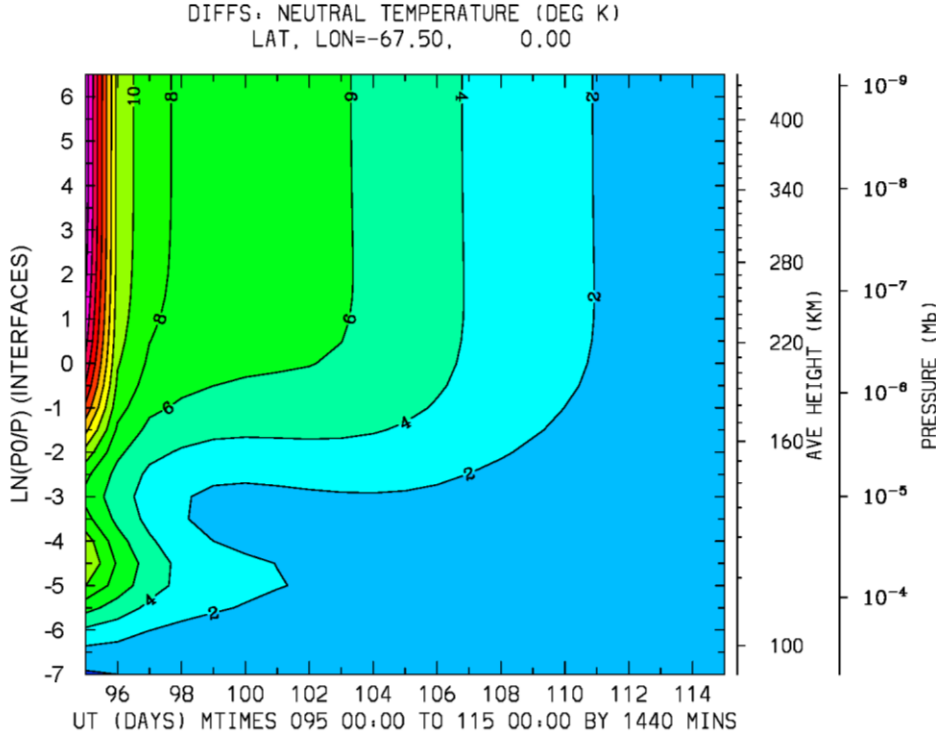
Differences: smin2smax
Days 83-100
TN: Lat = -67.5



MIN,MAX= -2.9473E+01 7.5116E+00 INTERVAL= 2.5000E+00
RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2smax_003.nc
TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_003.nc

Min,Max = -29, 7.5
Interval = 2.5

Differences: 15-day Offset
Days 80-100
TN: Lat = -67.5

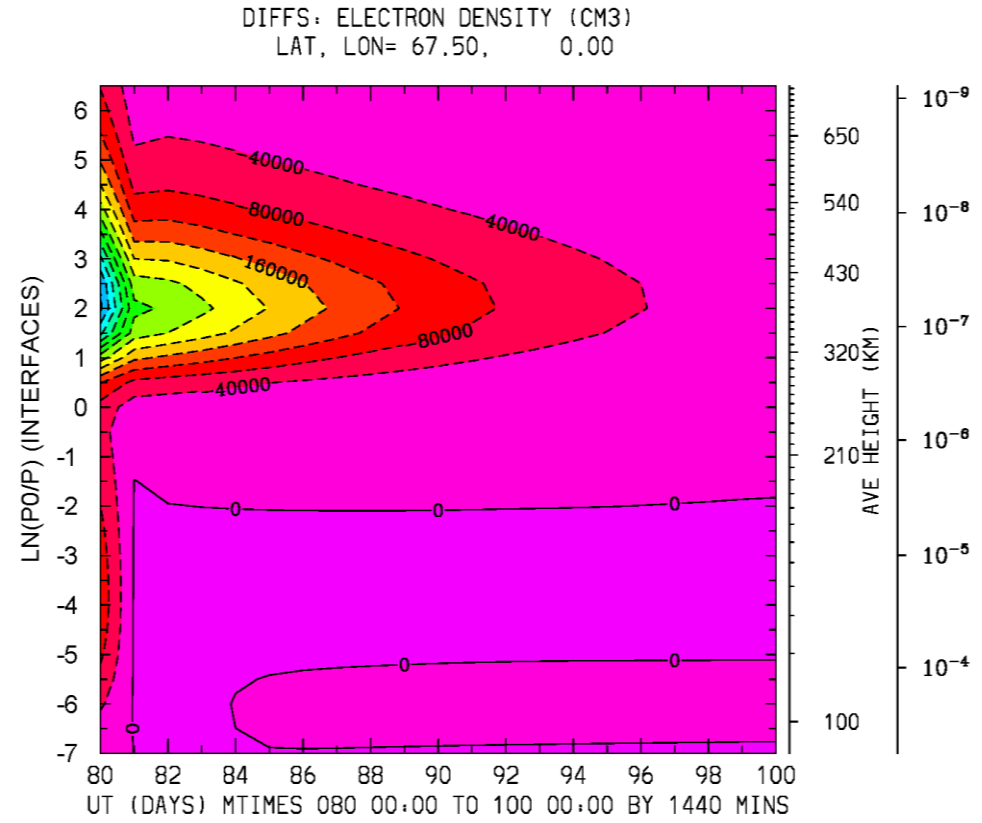


MIN,MAX= -2.8827E-01 2.5249E+01 INTERVAL= 2.0000E+00
data/FOSTER.tiegcm1.93.p_src80_001.nc LAST: data/FOSTER.tiegcm1.93.p_src80_003.nc
data/FOSTER.tiegcm1.93.p_src95_001.nc LAST: data/FOSTER.tiegcm1.93.p_src95_003.nc

Min,Max = -0.3, 25
Interval = 2.0

Case Comparisons
NE: Ut vs Zp, Lat 67.5

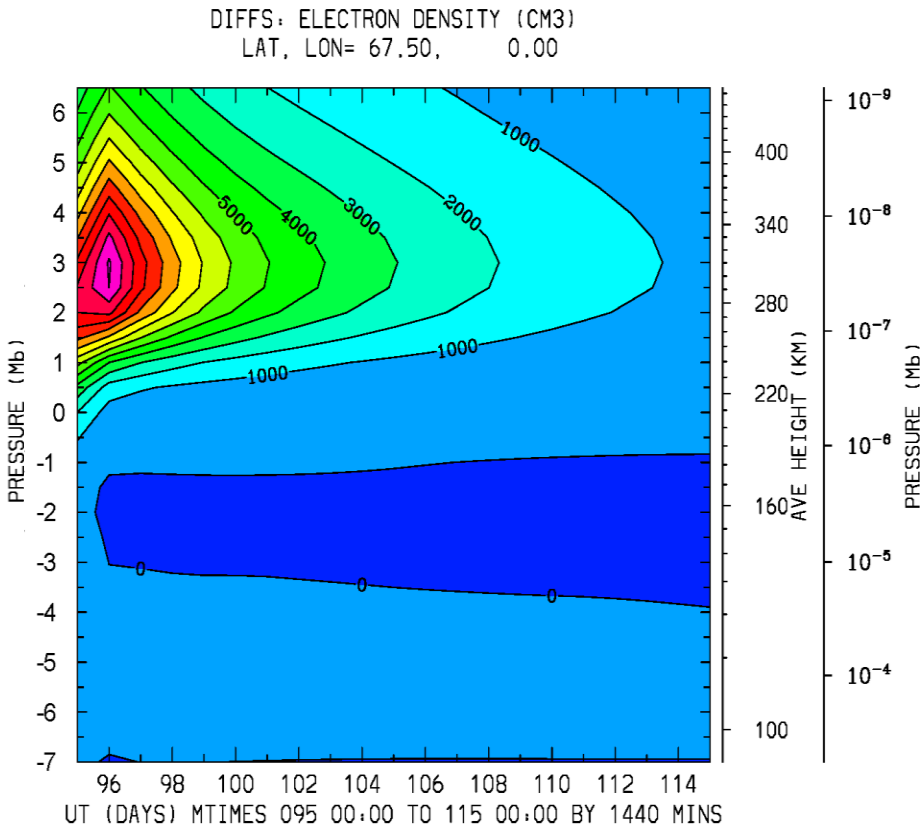
Differences: smin2smax



MIN,MAX= -4.8821E+05 3.2899E+03 INTERVAL= 4.0000E+04
RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2smax_003.nc
TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_003.nc

Min,Max=-5e5, 3.3e3
Interval = 40,000

Differences: 15-day Offset



MIN,MAX= -9.3387E+01 1.3139E+04 INTERVAL= 1.0000E+03
ta/FOSTER.tiegcm1.93.p_src80_001.nc LAST: data/FOSTER.tiegcm1.93.p_src80_003.nc
ta/FOSTER.tiegcm1.93.p_src95_001.nc LAST: data/FOSTER.tiegcm1.93.p_src95_003.nc

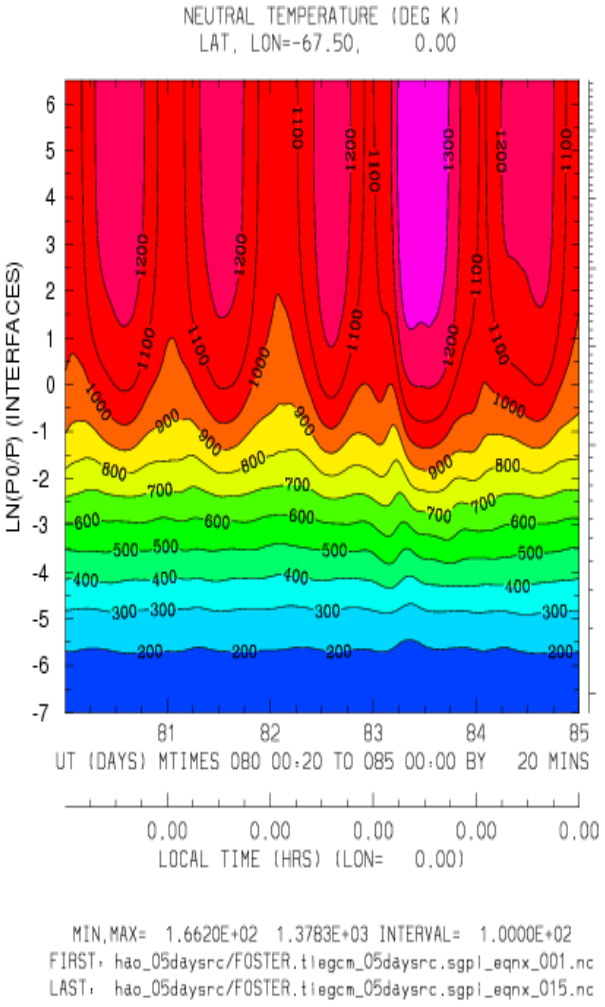
Min,Max = -93, 1.3e4
Interval = 1000

Replicating CCMC Simulations:

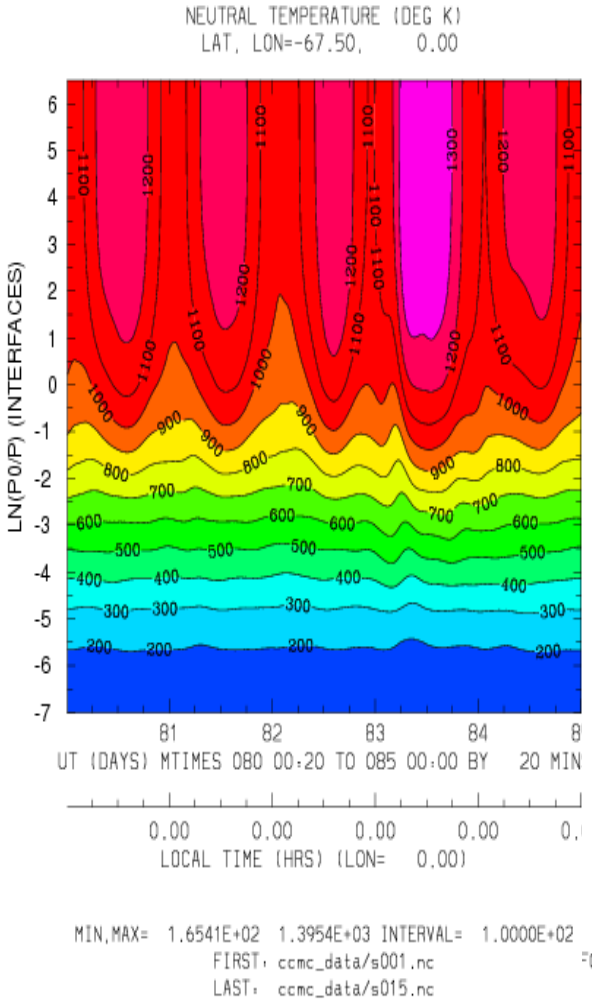
- A 5-day GPI/Linux run was made by the CCMC, following a 20-day equilibration run.
- A series of equivalent 5-day GPI runs were made on a 64-bit HAO Linux machine (arc), following different equilibration times:
  - 5-day equilibration preceding 5-day production run
  - 10-day equilibration preceding 5-day production run
  - 20-day equilibration preceding 5-day production run
- Comparisons are made between CCMC output and the three HAO runs.

CCMC vs HAO/5-day spinup
TN: Ut vs Zp (20-minute histories)

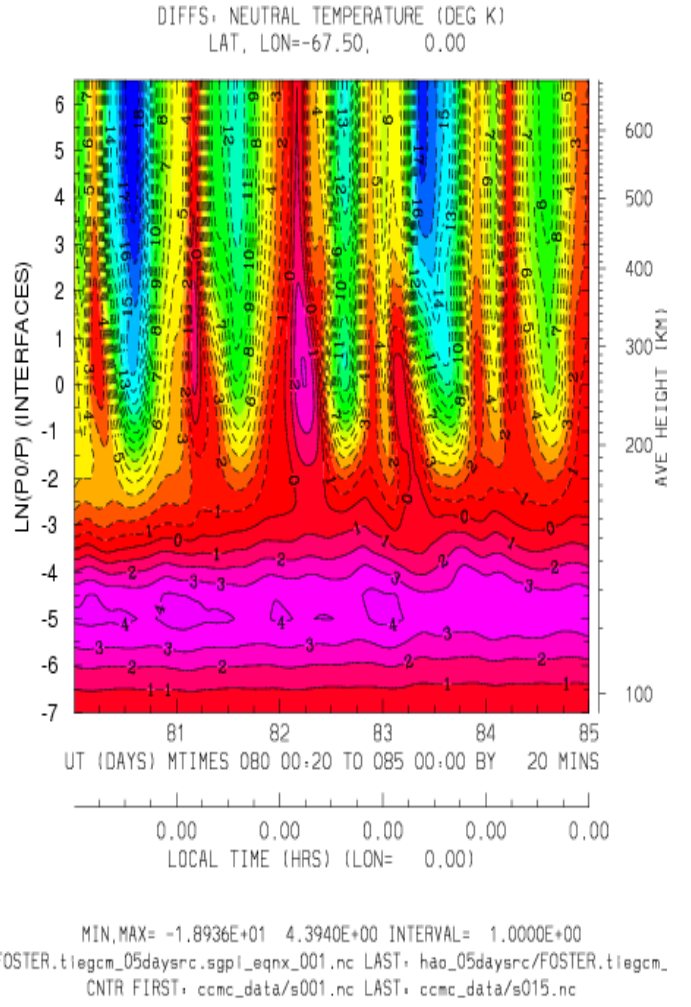
HAO



CCMC



Diffs: HAO-CCMC

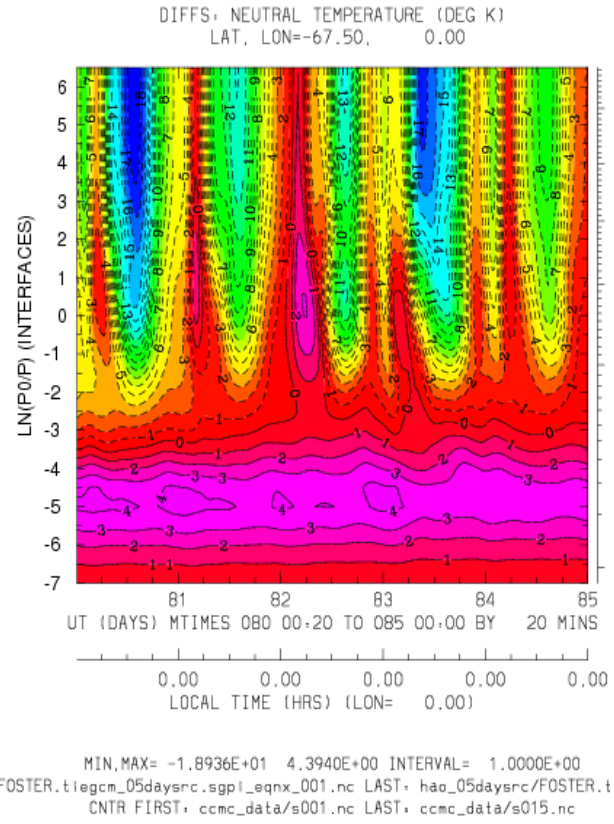


Full Field: Min,Max = 165, 1395 (deg K)

Diffs: Min,Max = -19, 4.4 (K)

Differences: HAO minus CCMC
(5, 10, and 20 day HAO spinups)
TN: Ut vs Zp (20-min histories)

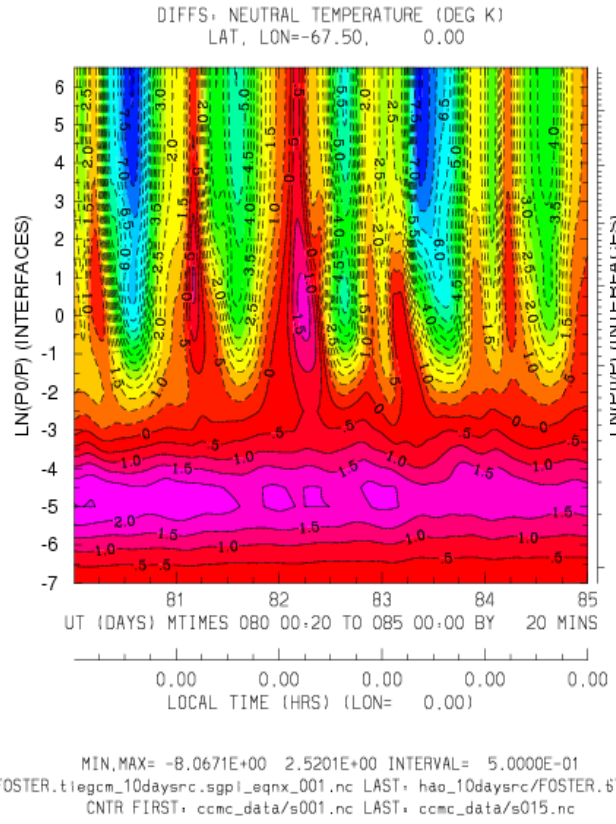
Diffs: 5-day spinup



Min,Max = -19,4.4 deg K

Interval = 1.

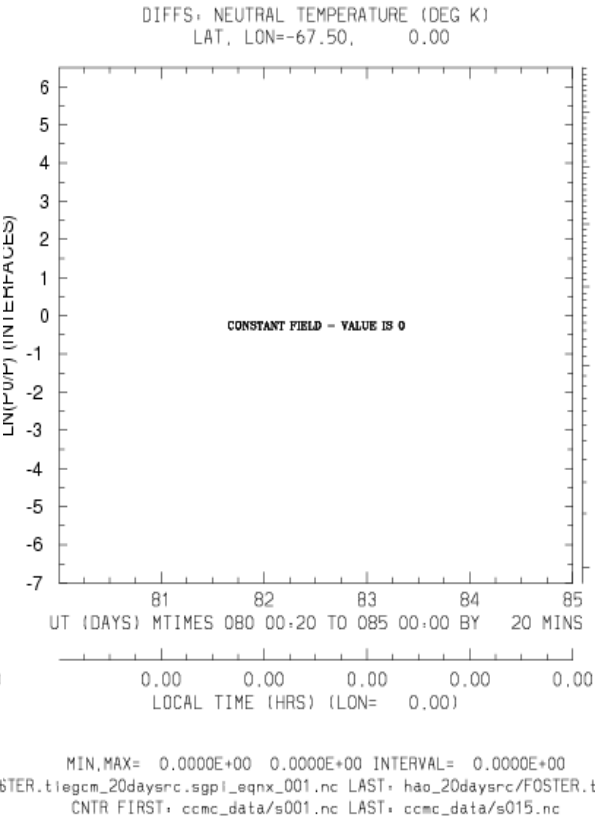
Diffs: 10-day spinup



Min,Max = -8,2.5 deg K

Interval = 0.5

Diffs 20-day spinup

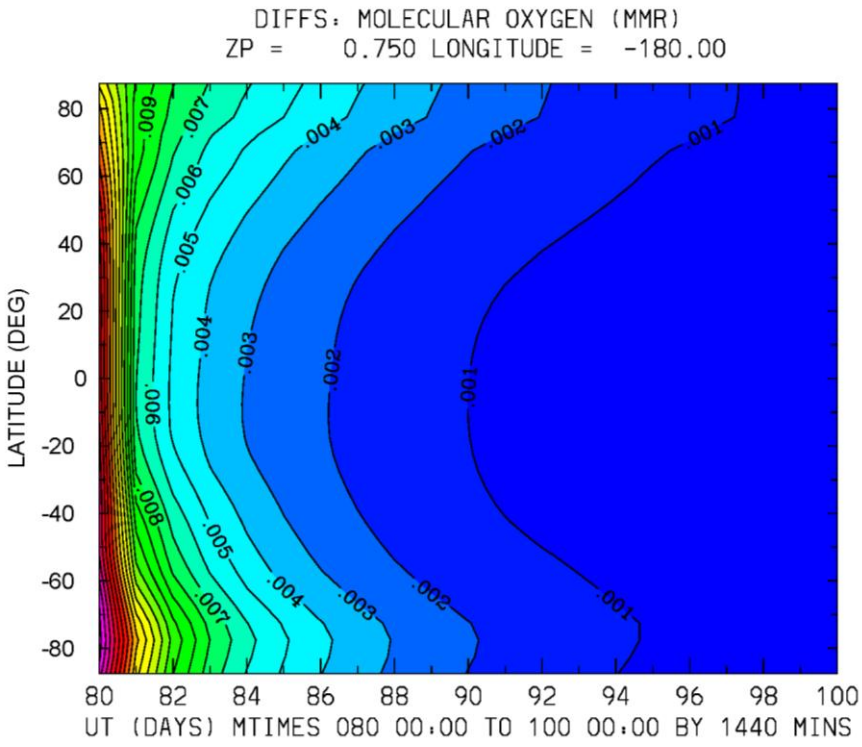


Min,Max = 0,0 deg K

The End
(additional plots follow)

Difference: smin2max Offset minus smax Control
UT (20 days) vs Latitude

O2 (mmr) Zp = 0.75



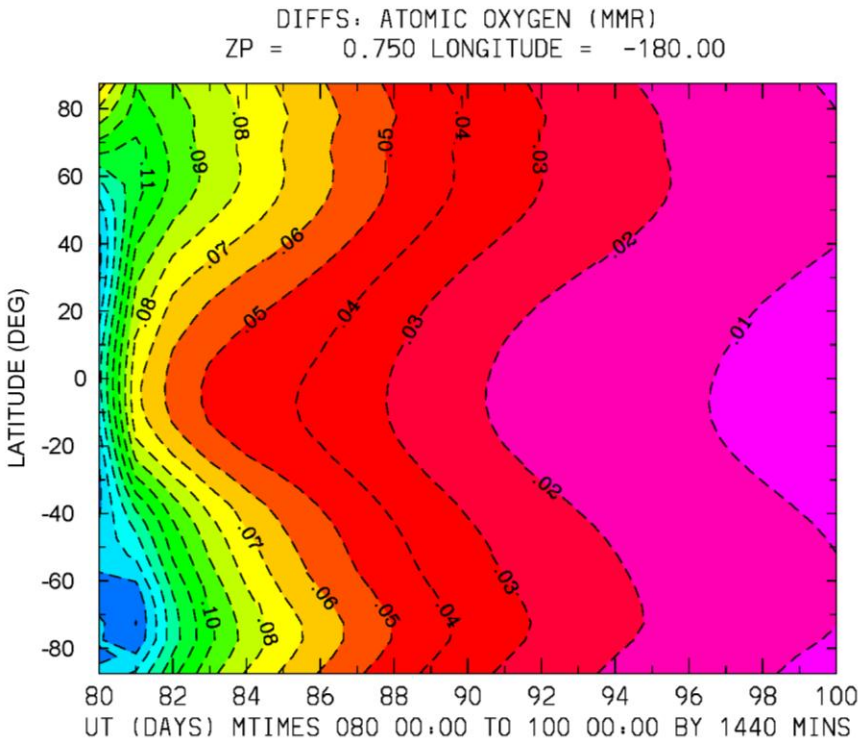
MIN,MAX= 2.4197E-04 2.3449E-02 INTERVAL= 1.0000E-03

IRST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smi

NTR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_sma

Min,Max = 2.4e-4, 2.3e-2

O (mmr) Zp = 0.75



MIN,MAX= -1.6018E-01 -6.5495E-03 INTERVAL= 1.0000E-02

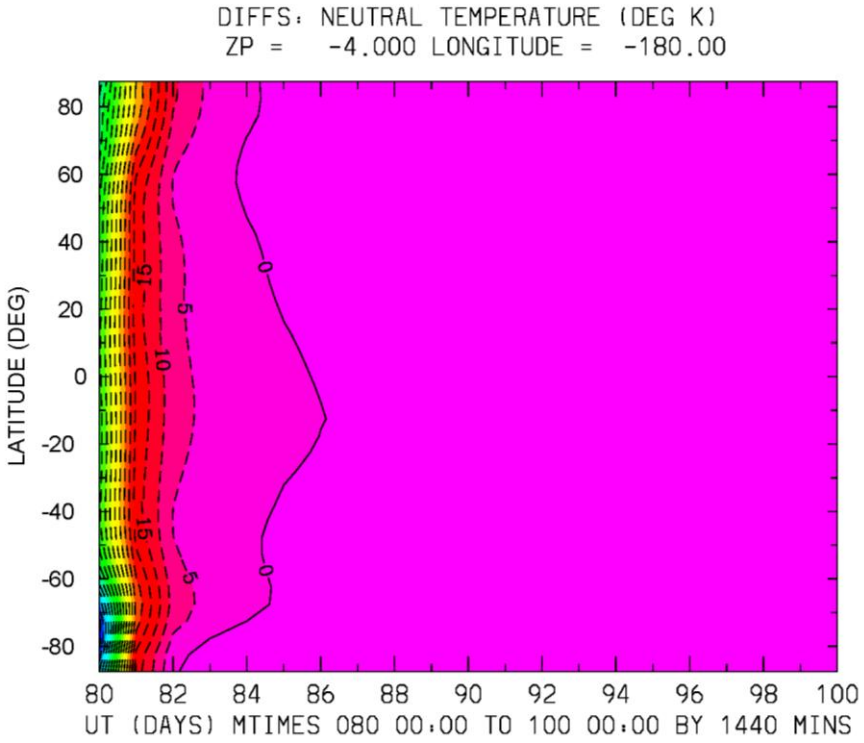
IRST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2

ITR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_

Min,Max = -1.6e-1, -6.5e-3

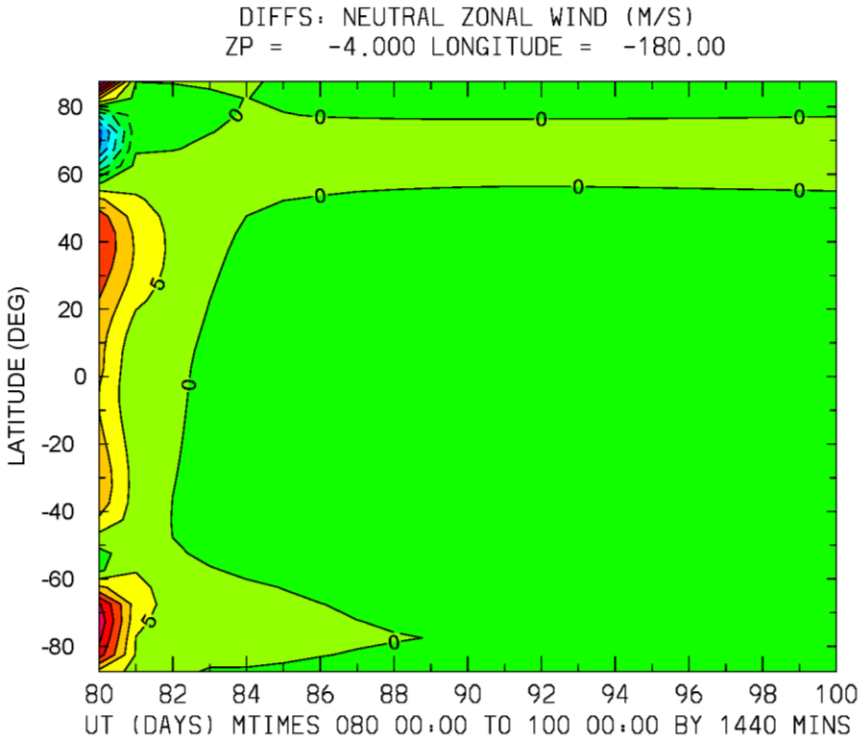
Difference: smin2max minus smax
UT vs Latitude (daily)

TN (deg K) Zp=-4



Min,Max = -100, 4.7
Interval = 5.

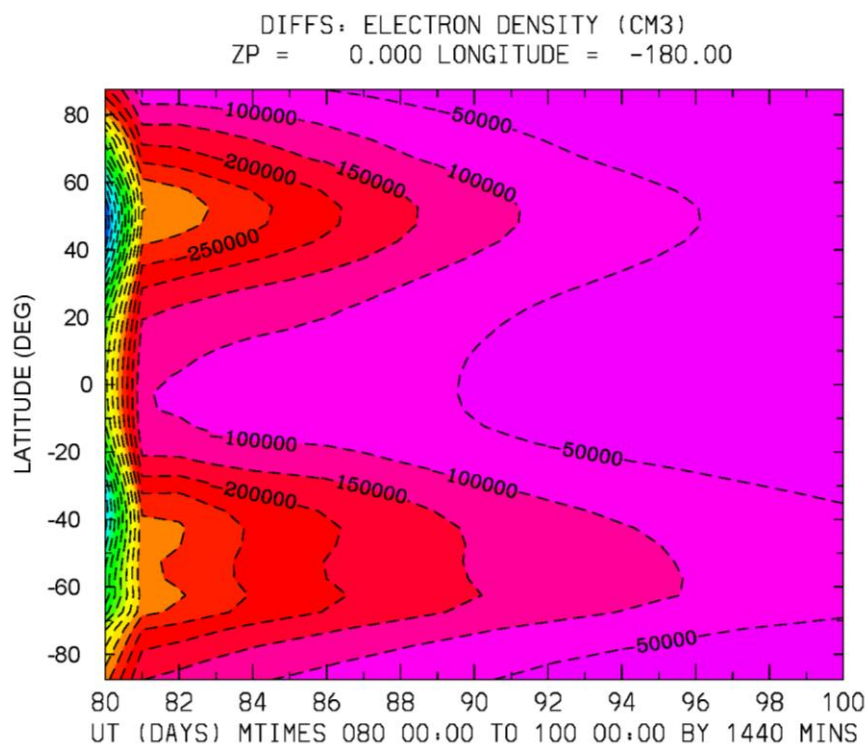
UN (m/s) Zp=-4



Min,Max=-27,37
Interval = 5.

Difference: smin2max minus smax
UT vs Latitude

NE (cm3) Zp = 0



MIN,MAX= -9.1238E+05 -5.4423E+03 INTERVAL= 5.0000E+04

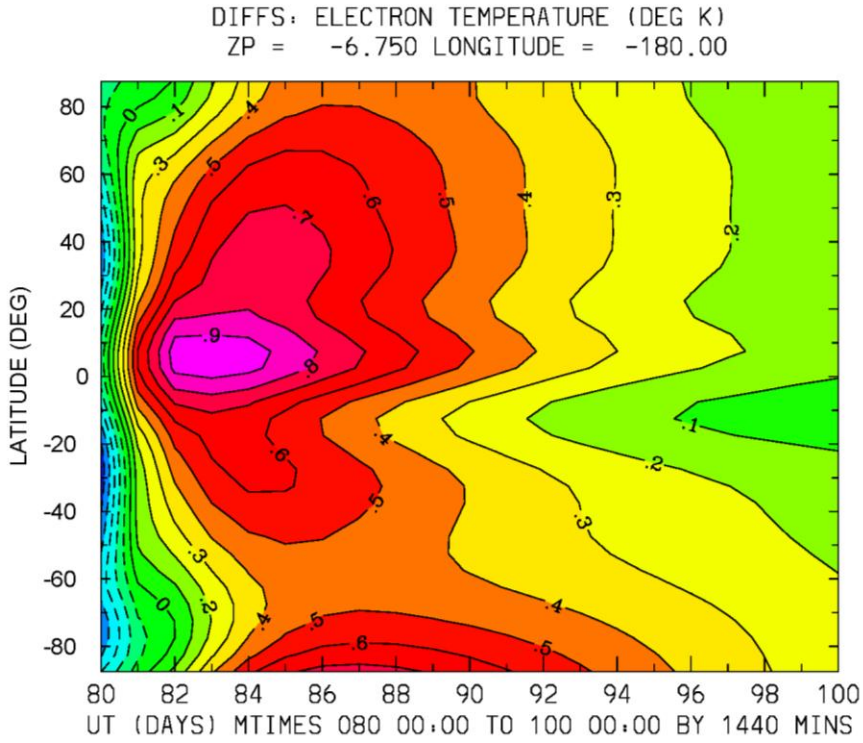
RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smi

TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_sma

Min,Max=-9e5,-5e3

Interval = 5.e4

TE (deg K) Zp = -6.75



MIN,MAX= -5.6381E-01 9.6094E-01 INTERVAL= 1.0000E-01

RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2

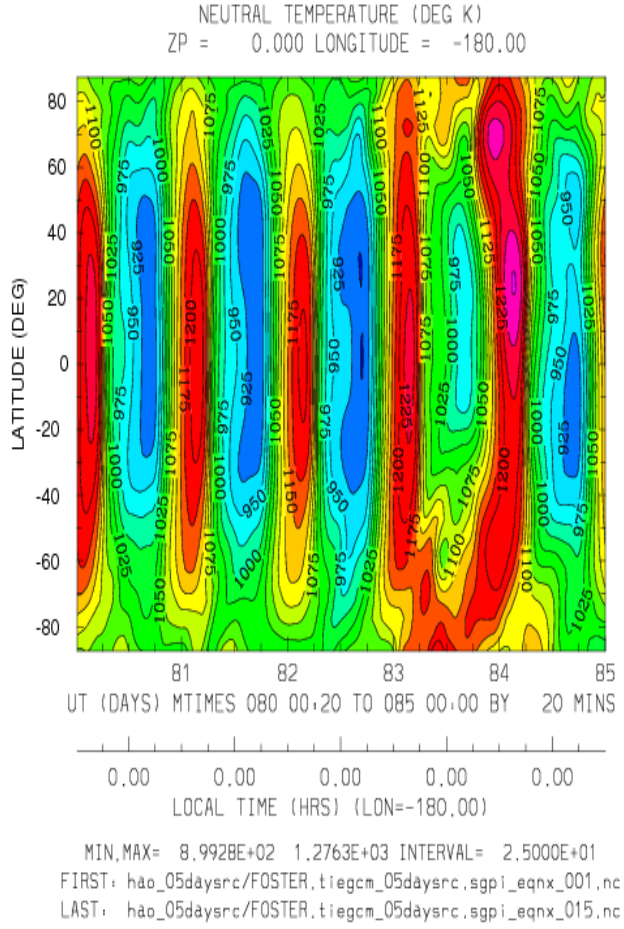
TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_

Min,Max=-.5,.96

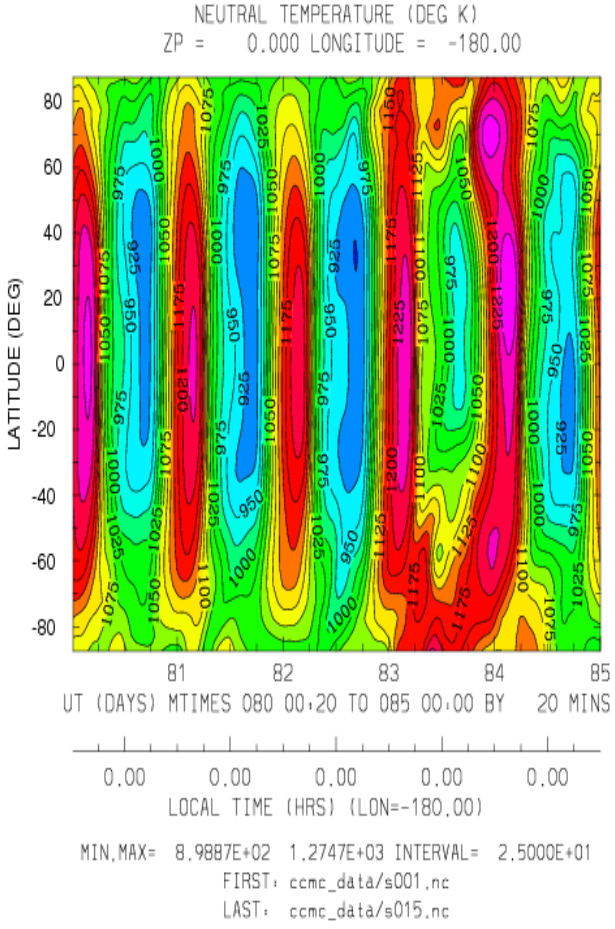
Interval = 0.1

CCMC vs HAO/5-day spinup:
TN: Ut vs Latitude (20-minute histories)

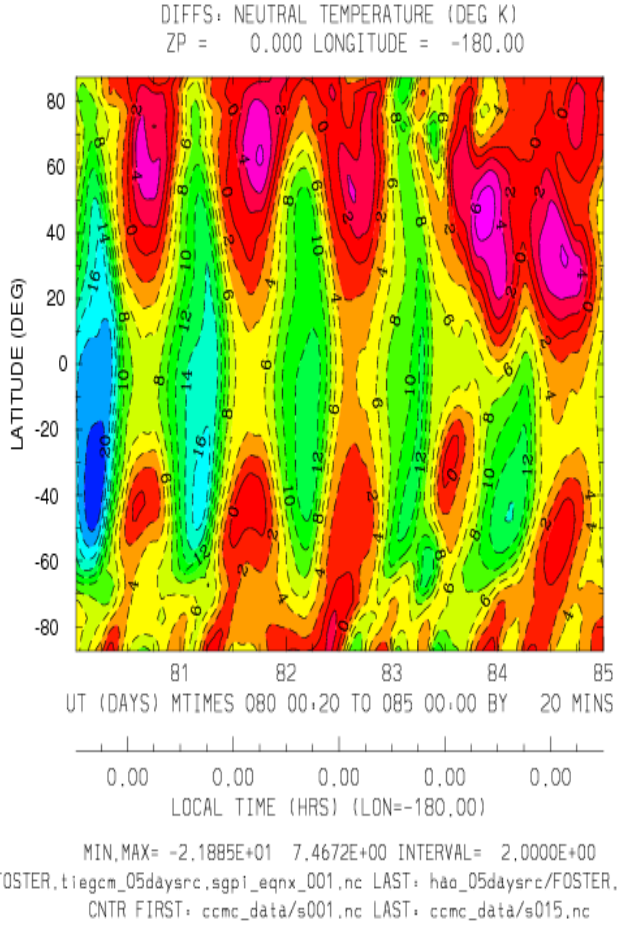
HAO



CCMC



Diffs: HAO-CCMC

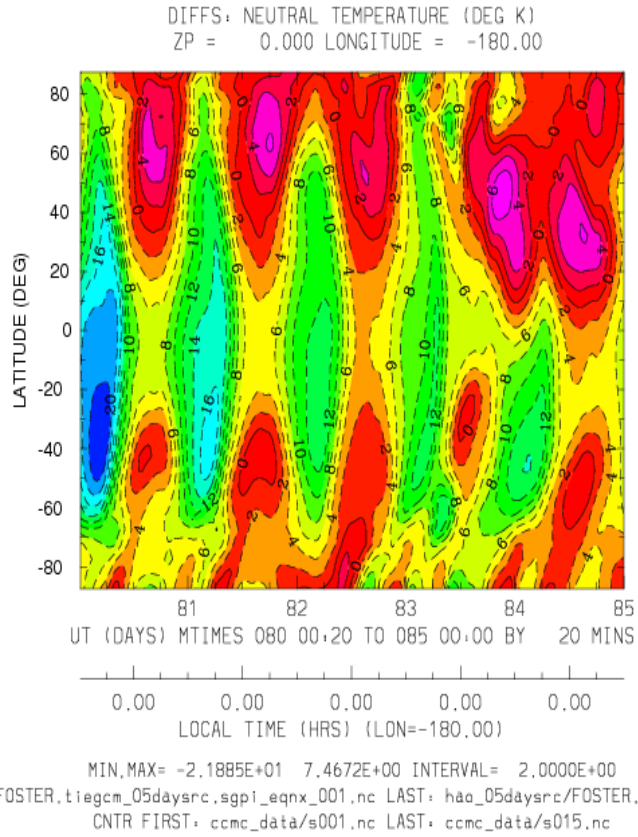


Full Field: Min,Max = 900, 1275 (deg K)

Diffs: Min,Max = -22, 7.5 (K)

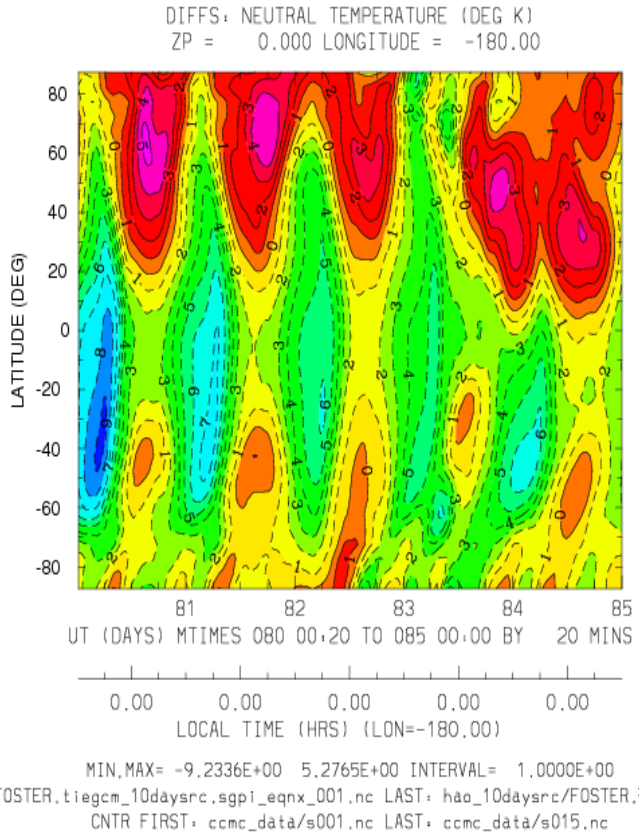
Differences: HAO minus CCMC
(5, 10, and 20 day HAO spinups)
TN: Ut vs Latitude (20-min histories)

Diffs: 5-day spinup



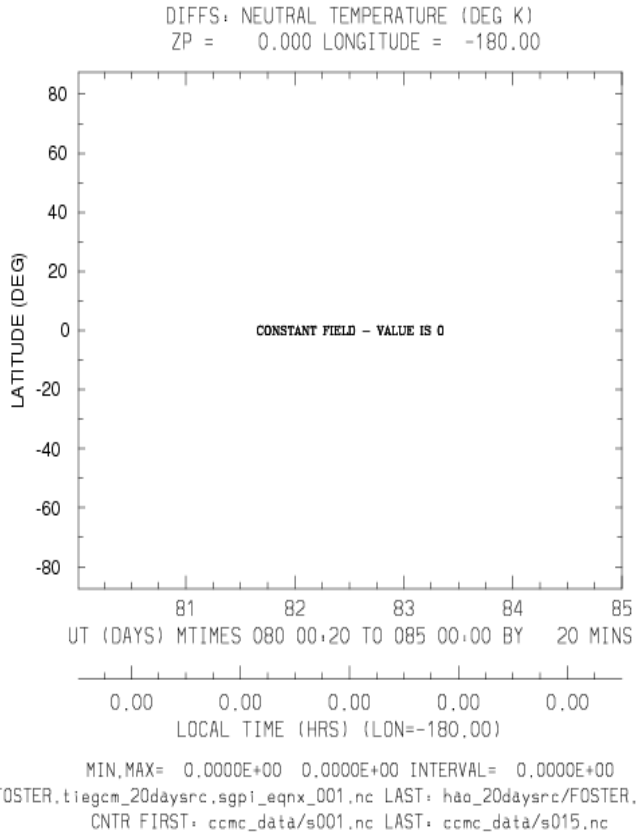
Min,Max = -22,7.5 deg K

Diffs: 10-day spinup



Min,Max = -9.2,5.2 deg K

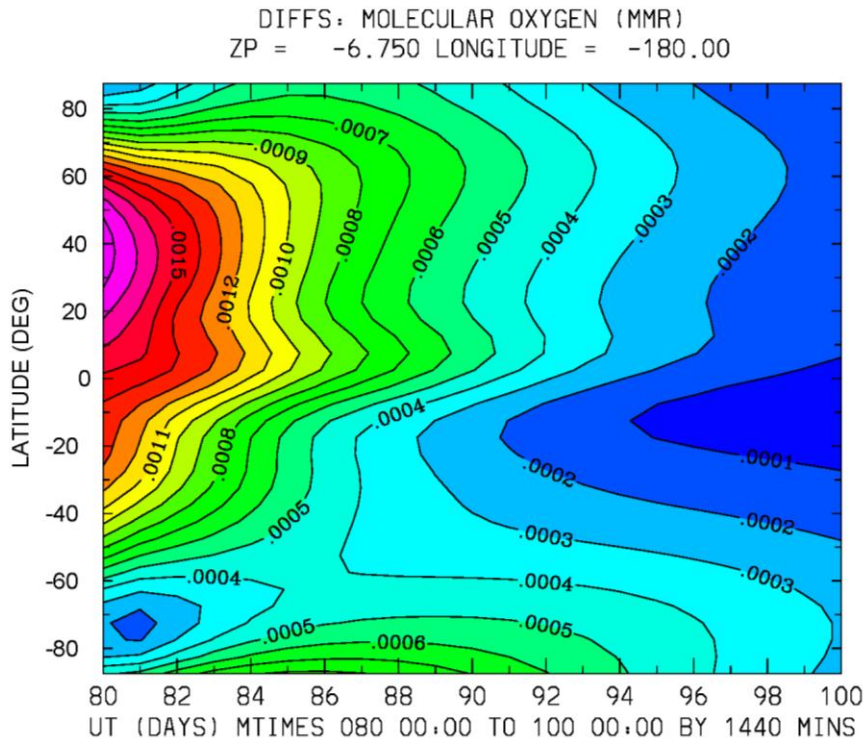
Diffs 20-day spinup



Min,Max = 0,0 deg K

Difference: smin2max minus smax
UT (20 days) vs Latitude

O2 (mmr) Zp = -6.75



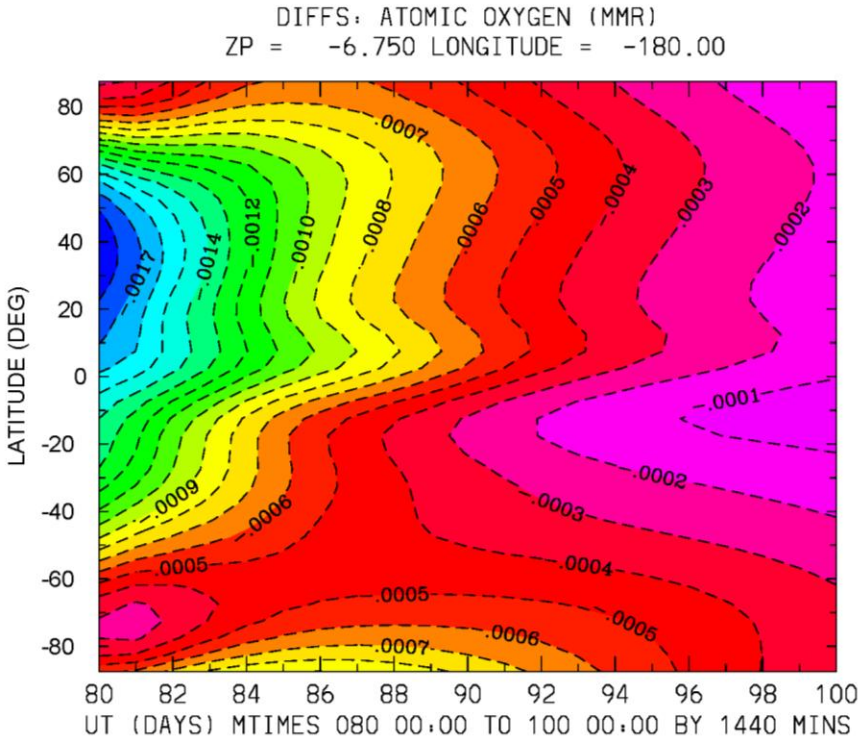
MIN,MAX= 4.2647E-05 1.8534E-03 INTERVAL= 1.0000E-04

RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smi

TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_sma

Min,Max=4e-5,2e-3
Interval = 1.e-4

O (mmr) Zp = -6.75



MIN,MAX= -1.8800E-03 -5.6044E-05 INTERVAL= 1.0000E-04

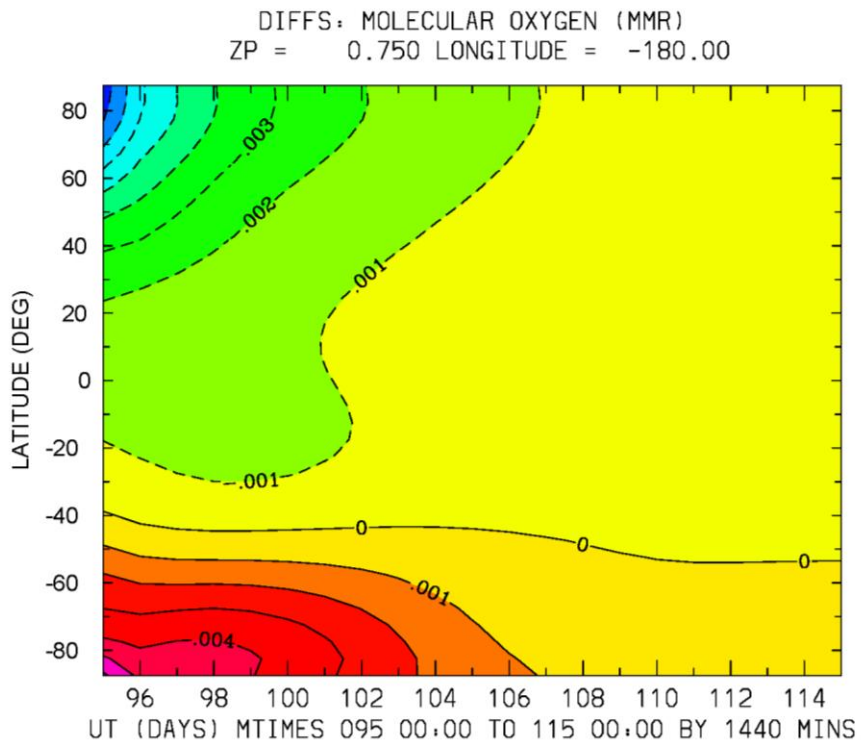
RST: FOSTER.tiegcm1.93.p_smin2smax_001.nc LAST: FOSTER.tiegcm1.93.p_smin2

TR FIRST: FOSTER.tiegcm1.93.p_smax_001.nc LAST: FOSTER.tiegcm1.93.p_smax_

Min,Max=-2e-3,-6e-5
Interval = 1.e-4

Difference: 15-day Offset run Minus Control
UT (20 days) vs Latitude

O2 (mmr) Zp = 0.75



MIN,MAX= -8.5536E-03 6.1983E-03 INTERVAL= 1.0000E-03

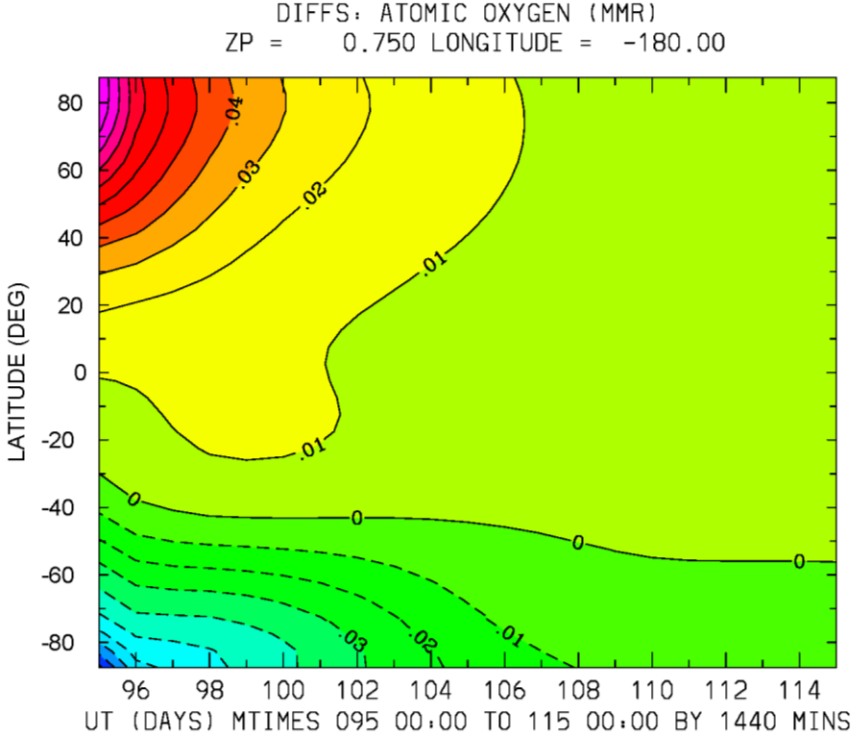
RST: data/FOSTER.tiegcm1.93.p_src80_001.nc LAST: data/FOSTER.tiegcm1.93.p

RST: data/FOSTER.tiegcm1.93.p_src95_001.nc LAST: data/FOSTER.tiegcm1.93.p

Min,Max = -8.5e-3, 6.2e-3

Interval = 1.e-3

O (mmr) Zp = 0.75



MIN,MAX= -9.2480E-02 1.0964E-01 INTERVAL= 1.0000E-02

RST: data/FOSTER.tiegcm1.93.p_src80_001.nc LAST: data/FOSTER.tiegcm1.93.p_

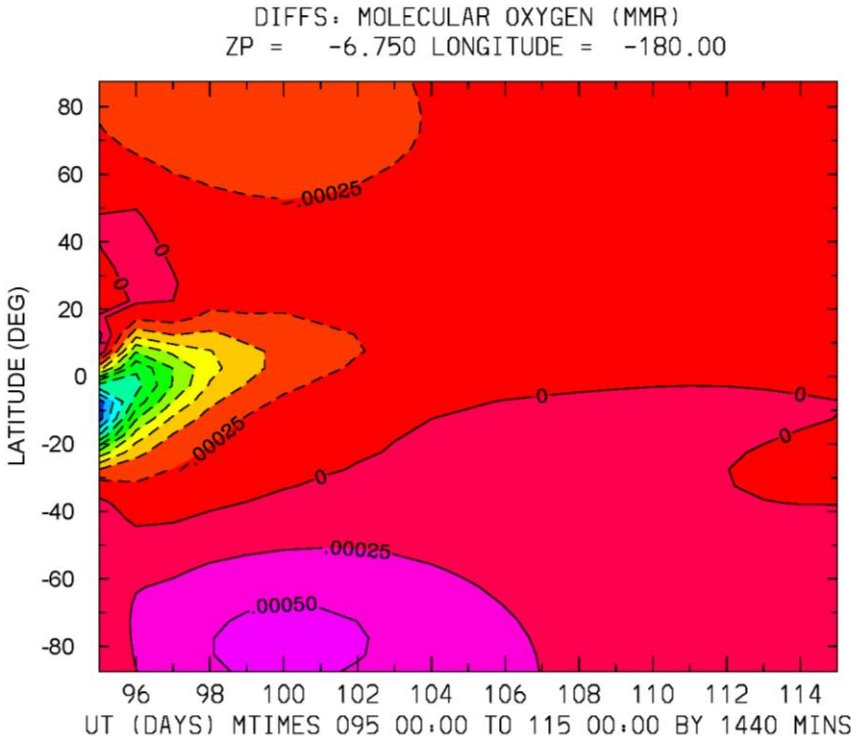
RST: data/FOSTER.tiegcm1.93.p_src95_001.nc LAST: data/FOSTER.tiegcm1.93.p_

Min,Max = -9.2e-2, 1.0e-1

Interval = 1.e-2

Difference: 15-day Offset run Minus Control
UT (20 days) vs Latitude

O2 (mmr) Zp = -6.75



MIN,MAX= -2.6149E-03 5.6478E-04 INTERVAL= 2.5000E-04

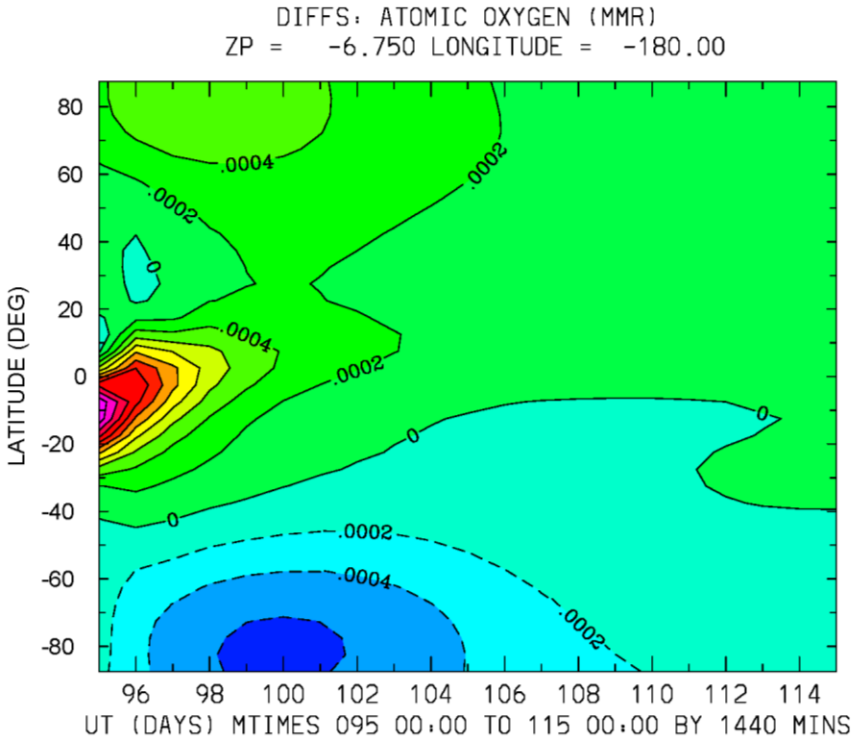
RST: data/FOSTER.tiegcm1.93.p_src80_001.nc LAST: data/FOSTER.tiegcm1.93.

RST: data/FOSTER.tiegcm1.93.p_src95_001.nc LAST: data/FOSTER.tiegcm1.93.

Min,Max = -2.6e-3, 5.6e-4

Interval = 2.5e-4

O (mmr) Zp -6.75



MIN,MAX= -6.5172E-04 2.1378E-03 INTERVAL= 2.0000E-04

RST: data/FOSTER.tiegcm1.93.p_src80_001.nc LAST: data/FOSTER.tiegcm1.93.p_

RST: data/FOSTER.tiegcm1.93.p_src95_001.nc LAST: data/FOSTER.tiegcm1.93.p_

Min,Max = -6.5e-4, 2.1e-3

Interval = 2.e-4