GMI Science Team Meeting
6-8 Jun 2005 Greenbelt

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UC Irvine

_new Fast-JX version 5.3 (major clean up)

_fractional cloud cover (solved in part!)

? Transport errors & doubling-to-convergence

_new Fast-JX version 5.3 (major clean up)

1) massive code cleanup

still some ‘heritage’ code

2) cleaner links to CTM

_ output (J_X’s to chemistry)

_ input (p, T, O3, aerosols, clouds, SZA, albedo)

3) split data files

jv_spec.dat = full IUPAC VOC, no Harvard extrap.

jv_scat.dat = same scattering phase fns

4) calculate ALL J_X’s

to save, cut # of X-sections, # of wavelengths

5) revised layer-adding for optically thick clouds

no limit on total optical depth

lower cost, higher accuracy

(from GMI Nov 2004)

PHOTOLYSIS RATES:

What happened with JPL-02?

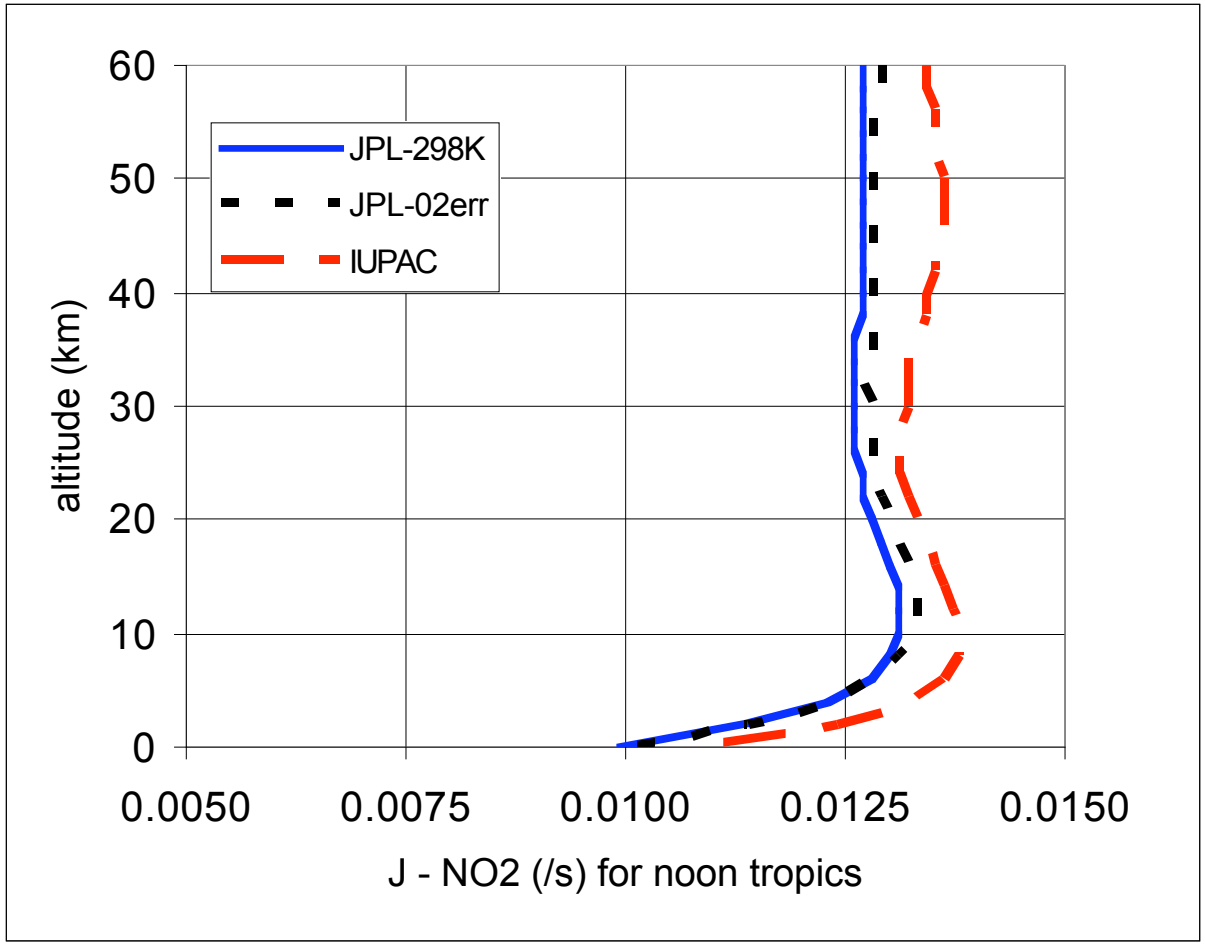
many small adjustments in stratosphere
IUPAC NO_2 cross-sections (IPMMI!)
added near-IR HNO_4 photolysis (@ 600 nm)
acetone quantum yields using Blitz et al.'04
IUPAC VOCs

fast-JX update

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

(from GMI Nov 2004)

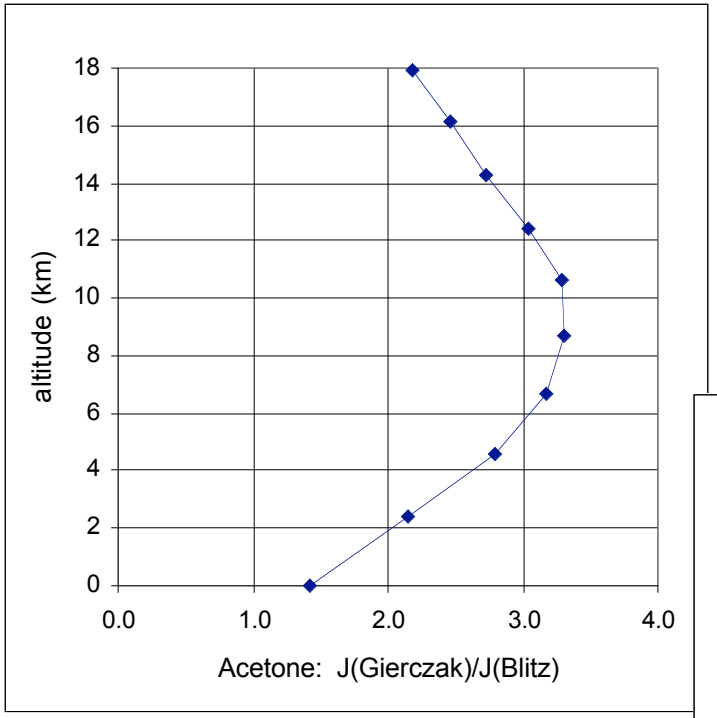
J – NO_2

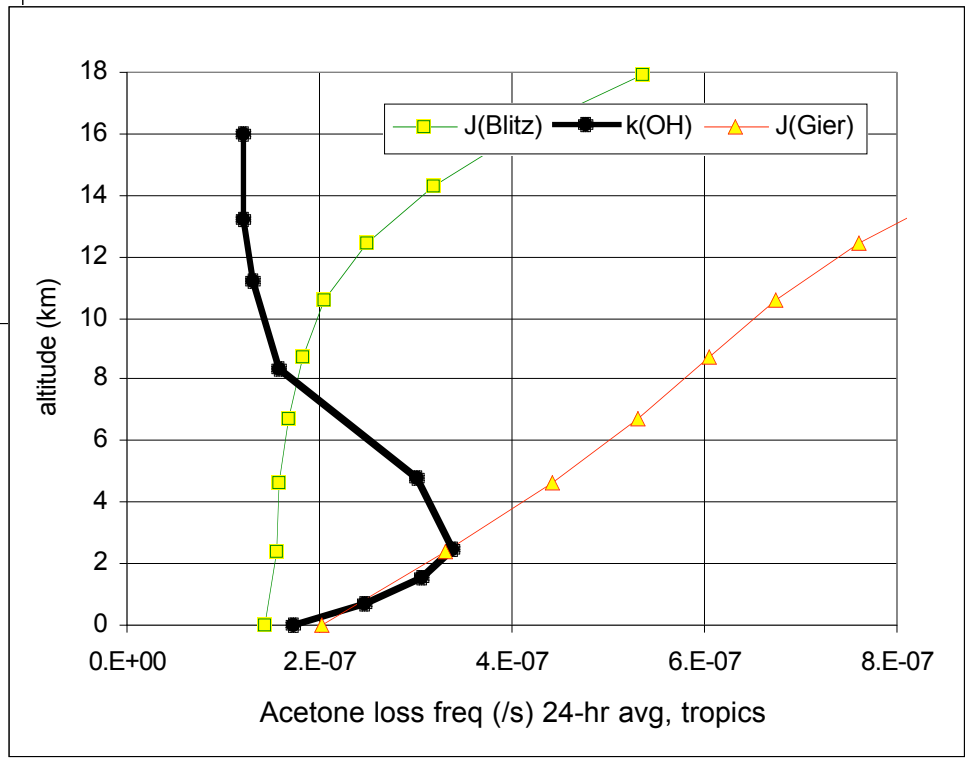


(from GMI Nov 2004)

J – $CH_3C(O)CH_3$

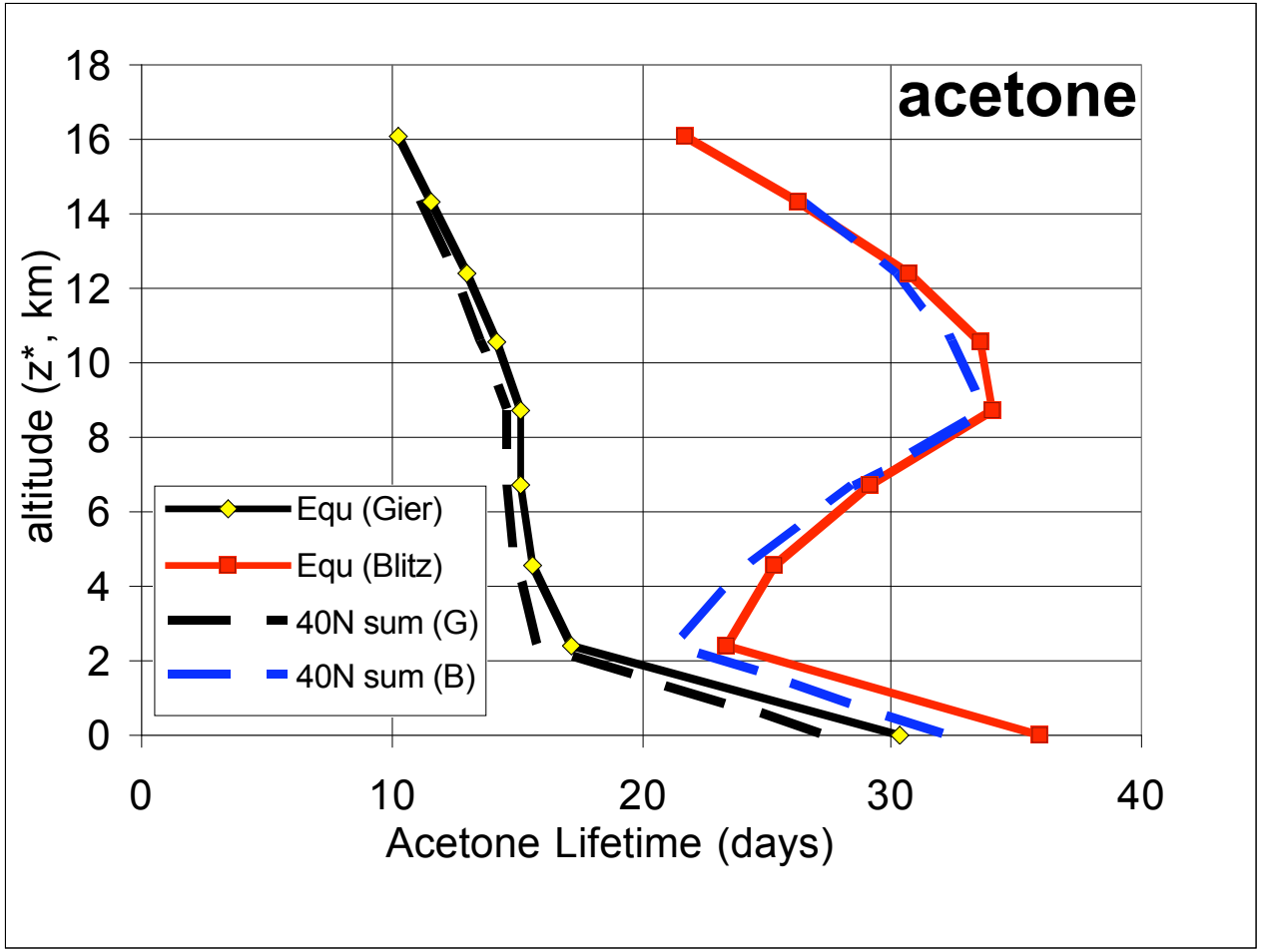
acetone





(from GMI Nov 2004)

J – $CH_3C(O)CH_3$



_new Fast-JX version 5.3 (major clean up)

1) massive code cleanup & 2) cleaner links to CTM

```
c<<<<<<<<<<standalone program to drive/test fast-JX version 5.3 (6/2005)

      include 'cmn_h.f'      ! CTM grid, time-of-day, std atmos, parms
      include 'cmn_w.f'      ! CTM 3-D arrays (clds, aersl, O3, p, T)
      include 'cmn_jv.f'     ! Xsects, Mie, etc., all for 1-D J-values
   >>>cmn_mie.f not included here<<<
     [include 'cmn_mie.f'    ! Mie scatter arrays, only <F>, no wavel data]
. . .
      call INPHOT
      call SET_CLD(TINIT,ODINIT)
      call SET_ATM(0)
      call SET_AER(0)
      call PHOTOJ(TIMEJ)
. . .
      stop
      end

c<<<<<<<<<<<<<<<<<<<<<begin CTM-specific subroutines<<<<<<<<<<<<<<<<<<<<

    subroutine INPHOT
      include 'cmn_h.f'
      include 'cmn_jv.f'
      call RD_XXX(IPH,'JX_spec.dat')
      call RD_MIE(IPH,'JX_scat.dat')
      call RD_JS(IPH,'ratj.dat')
      call RD_PROF(IPH,'jv_atms.dat')
```

_new Fast-JX version 5.3 (major clean up)

1) massive code cleanup & 2) cleaner links to CTM

```
subroutine RD_JS(NJ1,NAMFIL)
  include 'cmn_h.f'
  include 'cmn_jv.f'

subroutine RD_PROF(NJ2,NAMFIL)
  include 'cmn_h.f'
  include 'cmn_jv.f'

subroutine SET_CLD(TINIT,ODINIT)
  include 'cmn_h.f'
  include 'cmn_w.f'
  include 'cmn_jv.f'

subroutine SET_AER(ISW)
  include 'cmn_h.f'
  include 'cmn_w.f'
  include 'cmn_jv.f'

subroutine SET_ATM(ISW)
  include 'cmn_h.f'
  include 'cmn_w.f'
  include 'cmn_jv.f'

subroutine SOLAR2(TIMEJ)
  include 'cmn_h.f'
  include 'cmn_jv.f'
```

```
    subroutine PRTATM(N)
      include 'cmn_h.f'
      include 'cmn_jv.f'

c<<<<<<<<<<<<<end CTM-specific subroutines<<<<<<<<<<<<

c<<<<<<<<<<<begin CTM-fastJX linking subroutines<<<<<<

    subroutine PHOTOJ(TIMEJ)
      include 'cmn_h.f'
      include 'cmn_w.f'
      include 'cmn_jv.f'
      call SOLAR2(TIMEJ)
      call PRTATM(3)
      call SFLUXS
      call JRATET(PJ,TTJ,SOLF, VALJL)

    subroutine SFLUXS
      include 'cmn_h.f'
      include 'cmn_w.f'
      include 'cmn_jv.f'
      call SPHERE
      call EXTRAL(AER,ADX,NB,NC,JTAUMX,ATAU,ATAU0, JXTRA)
       = XSECO2(..
       = XSECO3(..
      call OPMIE(K,WAVE,XQO2,XQO3,AER,ADX,JXTRA,AVGF)

c<<<<<<<<<<<<end CTM-fastJX linking subroutines<<<<<<<<<<
```

_new Fast-JX version 5.3 (major clean up)

1) massive code cleanup & 2) cleaner links to CTM

```
c<<<<<<<<<<<begin core fast-J subroutines<<<<<<<<<<<

      subroutine JRATET(PPJ,TTJ,SOLF, VALJL)
        include 'cmn_h.f'
        include 'cmn_w.f'
        include 'cmn_jv.f'
         = XSECO2(..
         = XSECO3(..
         = XSEC1D(..

      subroutine RD_XXX(NJ1,NAMFIL)
        include 'cmn_h.f'
        include 'cmn_jv.f'

      real*8 function XSECO3(K,TTT)
        include 'cmn_h.f'
        include 'cmn_jv.f'
         = FLINT(..

      real*8 function XSEC1D(K,TTT)
        include 'cmn_h.f'
        include 'cmn_jv.f'
         = FLINT(..

      real*8 function XSECO2(K,TTT)
        include 'cmn_h.f'
        include 'cmn_jv.f'
         = FLINT(..

      real*8 function FLINT (TINT,T1,T2,T3,F1,F2,F3)

      subroutine RD_MIE(NJ1,NAMFIL)
        include 'cmn_h.f'
        include 'cmn_jv.f'

      subroutine SPHERE
        include 'cmn_h.f'
        include 'cmn_jv.f'

      subroutine EXTRAL(AER,ADX,NB,NC,JTAUMX,ATAU,ATAU0,JXTRA)
        include 'cmn_mie.f'

      subroutine OPMIE(KW,WAVEL,XQO2,XQO3,AER,ADX,JXTRA,FMEAN)
        include 'cmn_h.f'
        include 'cmn_jv.f'
        include 'cmn_mie.f'
        call MIESCT

c<<<<<<<<<<<<<<end core fast-J subroutines<<<<<<<<<<<<<<<<<<
```

_new Fast-JX version 5.3 (major clean up)

1) massive code cleanup & 2) cleaner links to CTM

```
c<<<<<<<<<<<<<<<begin core scattering subroutines<<<<<<<<<<

      subroutine MIESCT
        include 'cmn_mie.f'
        call GAUSSP (N,EMU,WT)
        call LEGND0 (EMU(I),PM0,MFIT)
        call LEGND0 (-ZU0,PM0,MFIT)
        call BLKSLV

      subroutine BLKSLV
        include 'cmn_mie.f'
        call GEN(1)
        call MATIN4 (B)
        call GEN(ID)
        call MATIN4 (B)
        call GEN(ND)
        call MATIN4 (B)

      subroutine GEN(ID)
        include 'cmn_mie.f'

      subroutine LEGND0 (X,PL,N)

      subroutine MATIN4 (A)

      subroutine GAUSSP (N,XPT,XWT)

      subroutine EFOLD (F0, F1, N, F)

c<<<<<<<<<<<<<<<end core scattering subroutines<<<<<<<<<<
```

_new Fast-JX version 5.3 (major clean up)

3) split data files & 4) calculate ALL J_X's

fast-JX v5.3

JX_scat.dat

```
21 (JX_spec.dat)  Scattering phase fns, scale extinct @ 999 nm  (mjp 5/05)
ATAU   200     1.180     0.010  sub-layers: max#, factor layer:layer, min dtau
 w(nm)    Q    r-eff  ss-alb  pi(0) pi(1) pi(2) pi(3) pi(4) pi(5) pi(6) pi(7)
01 RAYLE  = Rayleigh phase
  300   123.5  0.001  1.0000  1.000   0.0 0.500   0.0   0.0   0.0   0.0   0.0
  400    39.1  0.001  1.0000  1.000   0.0 0.500   0.0   0.0   0.0   0.0   0.0
  600     7.7  0.001  1.0000  1.000   0.0 0.500   0.0   0.0   0.0   0.0   0.0
  999     1.0  0.001  1.0000  1.000   0.0 0.500   0.0   0.0   0.0   0.0   0.0
02 ISOTR  = isotropic
  300     1.0  0.001  1.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  400     1.0  0.001  1.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  600     1.0  0.001  1.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  999     1.0  0.001  1.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
03 ABSRB  = fully absorbing 'soot',(m2/g) from Loiusse et al.JGR,1996 ? 999nm
  300    10.0  0.001  0.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  400     9.0  0.001  0.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  600     6.5  0.001  0.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  999     6.5  0.001  0.0000  1.000   0.0   0.0   0.0   0.0   0.0   0.0   0.0
04 S_Bkg = backgrnd stratospheric sulfate (n=1.46, log-norm: r=.09um/sigma=.6)
  300  2.7541  0.221  1.0000  1.000 2.157 2.767 2.627 2.457 2.098 1.792 1.518
  400  2.4017  0.221  1.0000  1.000 2.146 2.641 2.422 2.122 1.709 1.357 1.070
  600  1.6454  0.221  1.0000  1.000 2.076 2.377 2.023 1.608 1.177 0.846 0.599
  999  0.7449  0.221  1.0000  1.000 1.877 1.920 1.412 0.970 0.614 0.388 0.238
. . .
10 W_C08 = water cloud (C1/Deirm.) (n=1.335, gamma:  r-mode=8.0um / alpha=6)
  300  2.0539  12.00  1.0000  1.000 2.619 4.013 4.798 5.476 6.232 6.870 7.780
  400  2.0643  12.00  1.0000  1.000 2.611 3.999 4.773 5.451 6.194 6.826 7.716
  600  2.0883  12.00  1.0000  1.000 2.589 3.965 4.712 5.394 6.121 6.744 7.599
  999  2.1236  12.00  1.0000  1.000 2.563 3.917 4.625 5.302 5.992 6.593 7.385
. . .
21 Mdust 4.0 = mineral dust (R.V.Martin)
  300  2.1154  4.000   0.550  1.000 2.809 4.574 6.281 7.960 9.60711.22412.806
  400  2.1402  4.000   0.577  1.000 2.761 4.405 5.941 7.485 8.97410.46211.878
  600  2.1852  4.000   0.786  1.000 2.505 3.744 4.488 5.599 6.354 7.485 8.238
  999  2.2637  4.000   0.819  1.000 2.413 3.563 4.133 5.118 5.652 6.582 7.097
-------------------------------------------------------------------------------
```

fast-JX v5.3

JX_spec.dat (1)

```
(JX_spec.dat) UCI fastJX-5.3: JPL02+irHNO4+IUPAC/NO2/VOC+Bltz (J-v8.6,5/05)
NW-JValues  62  64  18   1  18  NJVAL,NQQQ, 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
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
...
```

fast-JX v5.3

JX_spec.dat (2)

```
...
Glyxlb 297 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.973E-22 2.210E-22
Glyxlb 298 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.973E-22 2.210E-22
XXXX   299 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
XXXX   300 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
C3H6O  220 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 3.816E-20 3.850E-20 3.504E-20 3.088E-20
        1.944E-20 1.084E-20 5.538E-21 4.705E-22 3.405E-25 0.000E+00
C3H6O  300 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 3.847E-20 4.048E-20 3.788E-20 3.428E-20
        2.255E-20 1.352E-20 7.280E-21 8.586E-22 6.641E-25 0.000E+00
Q2-Ac  240 3.000E-02 3.000E-02 3.000E-02 3.000E-02 3.000E-02 3.000E-02
        3.000E-02 3.000E-02 3.000E-02 2.374E-02 1.136E-02 5.107E-03
        1.931E-03 7.993E-04 4.148E-04 4.242E-05 0.000E+00 0.000E+00
Q2-Ac  300 2.000E-01 2.000E-01 2.000E-01 2.000E-01 2.000E-01 2.000E-01
        2.000E-01 2.000E-01 2.000E-01 1.788E-01 1.246E-01 8.522E-02
        5.100E-02 3.292E-02 2.215E-02 3.604E-03 0.000E+00 0.000E+00
Q1A-Ac 240 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
        1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
        1.208E+00 4.161E+00 2.494E+01 9.440E+01 1.000E+02 1.000E+02
Q1A-Ac 300 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
        1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.006E+00
        1.223E+00 2.421E+00 6.650E+00 1.966E+01 2.100E+01 2.100E+01
Q1B-Ac 240 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 2.453E-02 1.852E-01 1.049E+00
        1.066E+01 5.234E+01 2.629E+02 2.750E+03 3.210E+03 3.210E+03
Q1B-Ac 300 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
        0.000E+00 0.000E+00 0.000E+00 5.020E-02 2.467E-01 8.930E-01
        4.895E+00 1.624E+01 5.263E+01 3.015E+02 3.420E+02 3.420E+02
====End of X-section data======Supplementary Data & Notes follow=============
```

fast-JX v5.3

JX_spec.dat (3a)

```
O2        180 260 300
O3        180 260 300
O3(1D)    180 260 300
NO        300 300
H2COa     223 293
H2COb     223 293
H2O2      200 300
CH3OOH    297 298
NO2       220 298
NO3       297 298
N2O5      225 300
HNO2      297 298
HNO3      200 300
HNO4      297 298
ClNO3a    210 296
ClNO3b    210 296
Cl2       200 300
HOCl      297 298
OClO      204 298
Cl2O2     229 230
ClO       297 298
BrO       297 298
BrNO3     230 298
HOBr      297 298
BrCl      295 298
N2O       200 300
CFCl3     210 298
CF2Cl2    210 298
F113      210 295
F114      210 298
F115      210 298
CCl4      210 298
CH3Cl     210 298
CH3CCl3   210 298
CH2Cl2    295 298
CHF2Cl    210 298
F123      210 295
F141b     210 298
F142b     210 298
CH3Br     210 296
H1211     210 298
H1301     210 298
H2402     210 298
CH2Br2    210 298
CHBr3     210 296
CH3I      210 298
CF3I      210 300
OCS       225 295
PAN       250 298
CH3NO3    240 298
ActAld    297 298
MeVK      297 298
MeAcr     297 298
GlyAld    297 298
MEKeto    297 298
EAld      297 298
MGlyxl    297 298
Glyxla    297 298
Glyxlb    297 298
XXXX      299 300
Acet-a    220 300
Acet-b    220 300
```

fast-JX v5.3

JX_spec.dat (3b)

```
======Supplementary Data & Notes follow=============

a,b = combined cross-section x quantum yield,
                a = more radical branch

  H2COa => H + HCO
  H2COb => H2 + CO

  ClONO2a => Cl + NO3
  ClONO2b => ClO + NO2

  NO3a => O + NO2 (fixed q = 0.886) ***only one Xsect given***
  NO3b => NO + O2 (      q = 0.114)


============== new VOC & density-dep rates ========(IUPAC)=======

MeVK     MethylVinylKetone CH3C(O)CH=CH2  => C3H6 + CO (60%)
                                  => CH2=CHCO+CH3 (?40%)
         Xsect for M=0: Q(M) = 1/(1 + 1.67e-19*[M])


ActAld   Acetaldehyde     CH3CHO => CH3 + HCO


Glyxla   Glyoxal   (CHO)2     => HCO + HCO            w<340 nm
Glyxlb   Glyoxal   (CHO)2     => H2 +2CO or CO + CH2O  w>340 nm
```

fast-JX v5.3

JX_spec.dat (3c)

========== new VOC & density-dep rates ========(IUPAC)=======

MEKeto Methylethyl ketone CH3COC2H5 => CH3 + C2H5CO 15%
=> C2H5 + CH3CO 85%
Xsect for M=0: Q(M) = 1/(1 + 0.80e-19*[M])

MGlyxl Methyl glyoxal CH3COCHO => CH3CO + HCO
Xsect for M=0: Q(M) = 1/(1 + 1.67e-19*[M])

GlyAld Glycol aldehyde HOCH2CHO => HOCH2 + HCO
main channel, 0.75 yld included in Xsect

EAld Ethyl aldehyde C2H5CHO => C2H5 + HCO

Acet-a Acetone CH3C(O)CH3 => CH3CO + CH3 (Q1)
Acet-b => 2 CH3 + CO (Q2)

use Gierczak++ 1998 for Xsect (235K & 280K to generate 220-300K)
use Blitz++ 2004 for quantum yields
*Q2(w,T) is indep of [M], interp as [(T-240)/(300-240)]**2*
Q1(w,T,M) = (1 - Q2(w,T)) / (Q1A(w,T) + Q1B(w,T)[M/2.5e19])*
N.B. Q1A & Q1B curved in T, but interp linearly over 220-300K

JOURNAL OF GEOPHYSICAL RESEARCH,

Diagnosing the Stratosphere-to-troposphere Flux of Ozone in a Chemistry Transport Model

Juno Hsu,[1] Michael J. Prather,[1] Oliver Wild,[2]

Fast-JX application

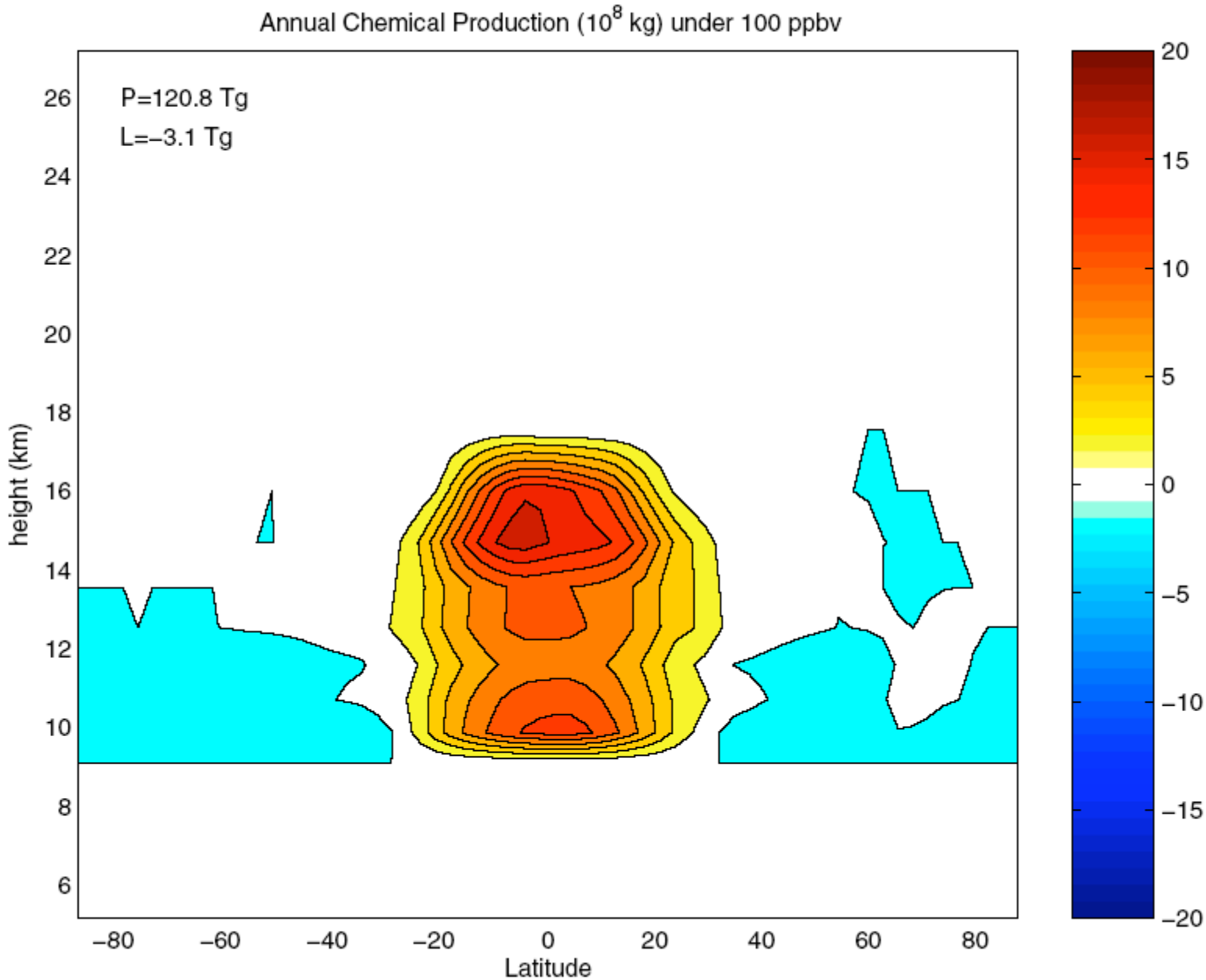
CTM modeled STE O_3 flux (Tg)

NH ~ SH 2000/2001
NH > SH 1997

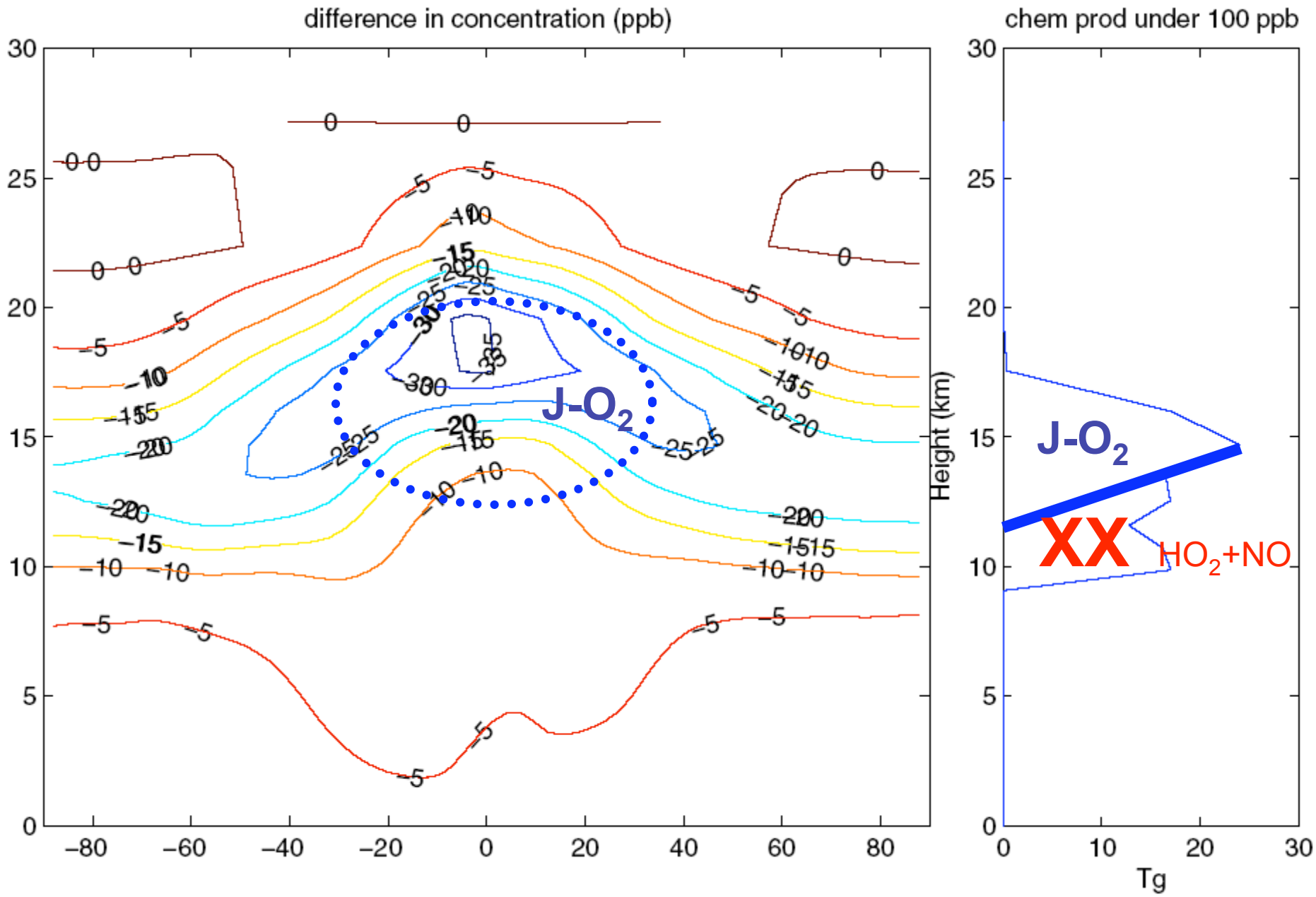
Total 530 ± 50? (due to lower/upper b.c.)

N.B. ~80 Tg from J-O_2 in tropical trop

BUT, there is considerable O_3 Production near and below the 100 ppb surface



N.B. Photolysis of O_2 is a significant source (>20 ppb) of trop O_3 in upper tropics



Diagnose O_3 flux into lower stratosphere:

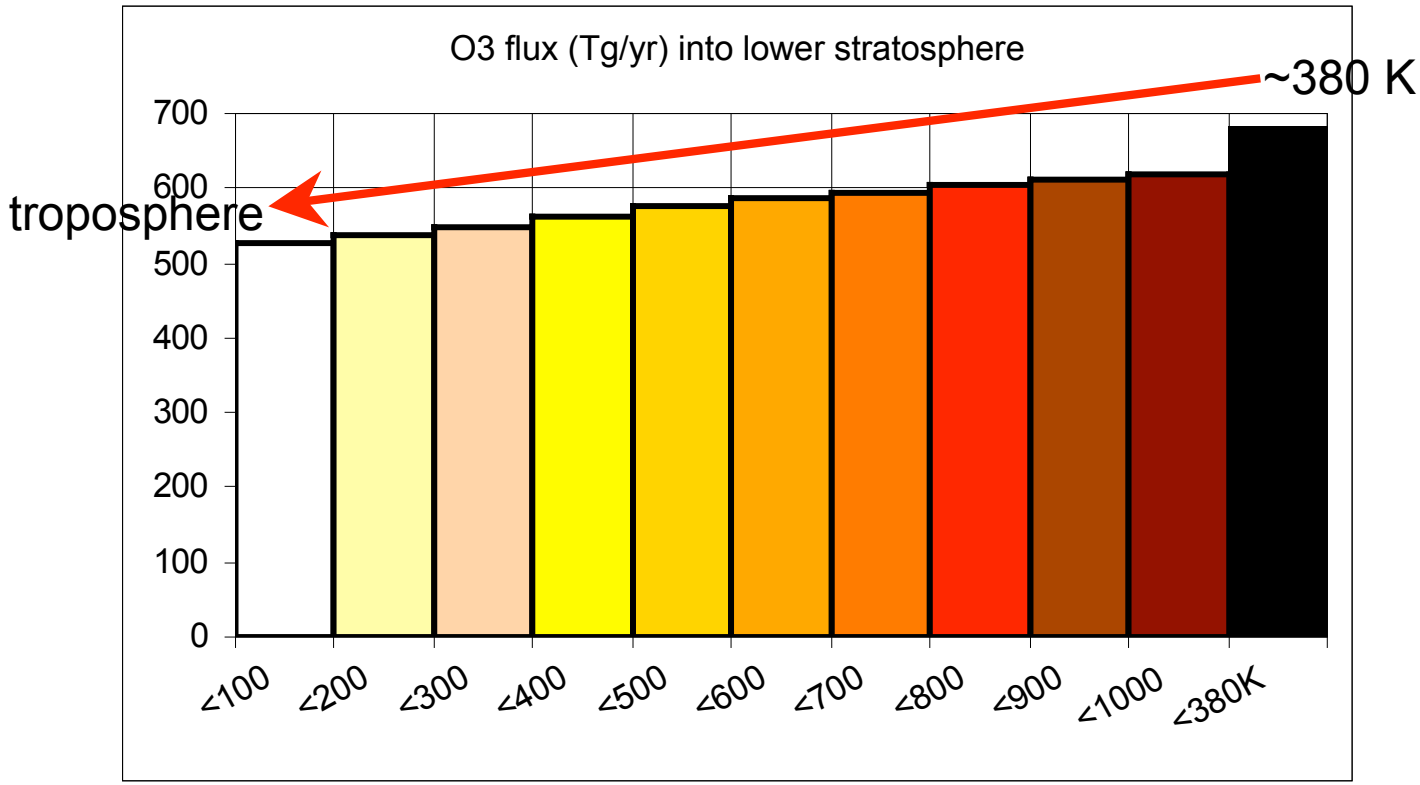
~675 Tg crosses L=33 (~?380K)

600 Tg crosses 1000 ppb surface

. . .

527 Tg crosses 100 ppb surface into troposphere!

? what observations can test this modeled 25% loss of the O_3 flux



_new Fast-JX version 5.3 (major clean up)

5) revised layer-adding for optically thick clouds

Fast-J solves the scattering problem using a finite-difference algorithm in optical depth (OD). Such solutions have errors proportional to the thickness of the layers (_).

To achieve reasonable accuracy, the original fast-J inserted extra layers when the scattering OD was large.
The criterion was _ ≤ 1, but for clouds with large OD > 100 this resulted in too many layers. *The cost of fast-J is linearly proportional to the number of layers*.

Further, to achieve reasonable costs and dimensions, the total OD was limited to 200, and the total column rescaled.

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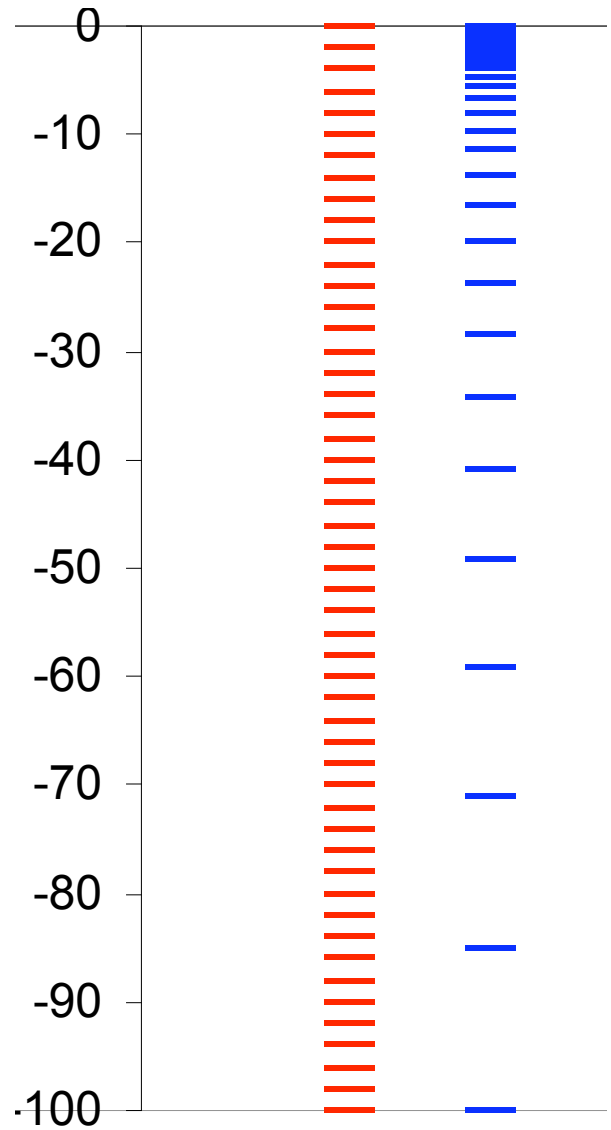
5) revised layer-adding for optically thick clouds



New for fast-JX v5.3, we have changed the add-levels to be log-spaced.

For a cloud in one CTM layer of OD = 100,

the old linear spacing _=2, adds 49 levels,

the new log-spacing starts at OD=0.01 and increases by a factor $OD_{l+1}/OD_l = 1.2$ to add 37 levels.

The log-spacing is far more accurate since it is most important to add levels at the top of the cloud where the rad. field is changing rapidly as opposed to the bottom where it is more isotropic

_new Fast-JX version 5.3 (major clean up)

5) revised layer-adding for optically thick clouds

Compare convergence, number of added levels needed

cloud OD = 100 surface albedo = 0% cos(SZA) = 1.00

Log-spacing, begin OD_2 = 0.01, ratio = OD_{l+1}/OD_l

pts	*ratio*	F_{top}	*max(F)*	F_{bot}
29	2.000	2.78	4.65	0.124
57	1.414	2.68	4.54	0.123
109	**1.189**	**2.66**	**4.51**	**0.124**
215	1.090	2.66	4.50	0.127
429	1.044	2.65	4.50	0.129

Linear-spacing, delta = OD_{l+1} - OD_l

pts	*delta*	F_{top}	*max(F)*	F_{bot}
101	2.00	2.65	4.06	0.118
201	1.00	2.63	4.35	0.127
401	**0.50**	**2.64**	**4.46**	**0.132**
801	0.25	2.65	4.49	0.133
1601	0.12	2.65	4.50	0.133

pts includes the additional ‘even’ points inserted for Feautrier solution
Ftop is at the top of the cloud; Fbot, at the bottom; max F occurs at or near top.

_new Fast-JX version 5.3 (major clean up)

5) revised layer-adding for optically thick clouds

Compare convergence, number of added levels needed

cloud OD = 100 surface albedo = 0% cos(SZA) = 0.10

Log-spacing, begin OD_2 = 0.01, ratio = OD_{l+1}/OD_l

pts	*ratio*	F_{top}	*max(F)*	F_{bot}
29	2.000	1.41	1.41	.0046
57	***1.414***	***1.39***	***1.39***	***.0045***
109	1.189	1.38	1.38	.0045
215	1.090	1.38	1.38	.0046
429	1.044	1.38	1.38	.0047

Linear-spacing, delta = OD_{l+1} - OD_l

pts	*delta*	F_{top}	*max(F)*	F_{bot}
101	2.00	2.18	2.18	.0218
201	1.00	1.73	1.73	.0102
401	0.50	1.51	1.51	.0056
801	***0.25***	***1.42***	***1.42***	***.0046***
1601	0.12	1.39	1.39	.0046

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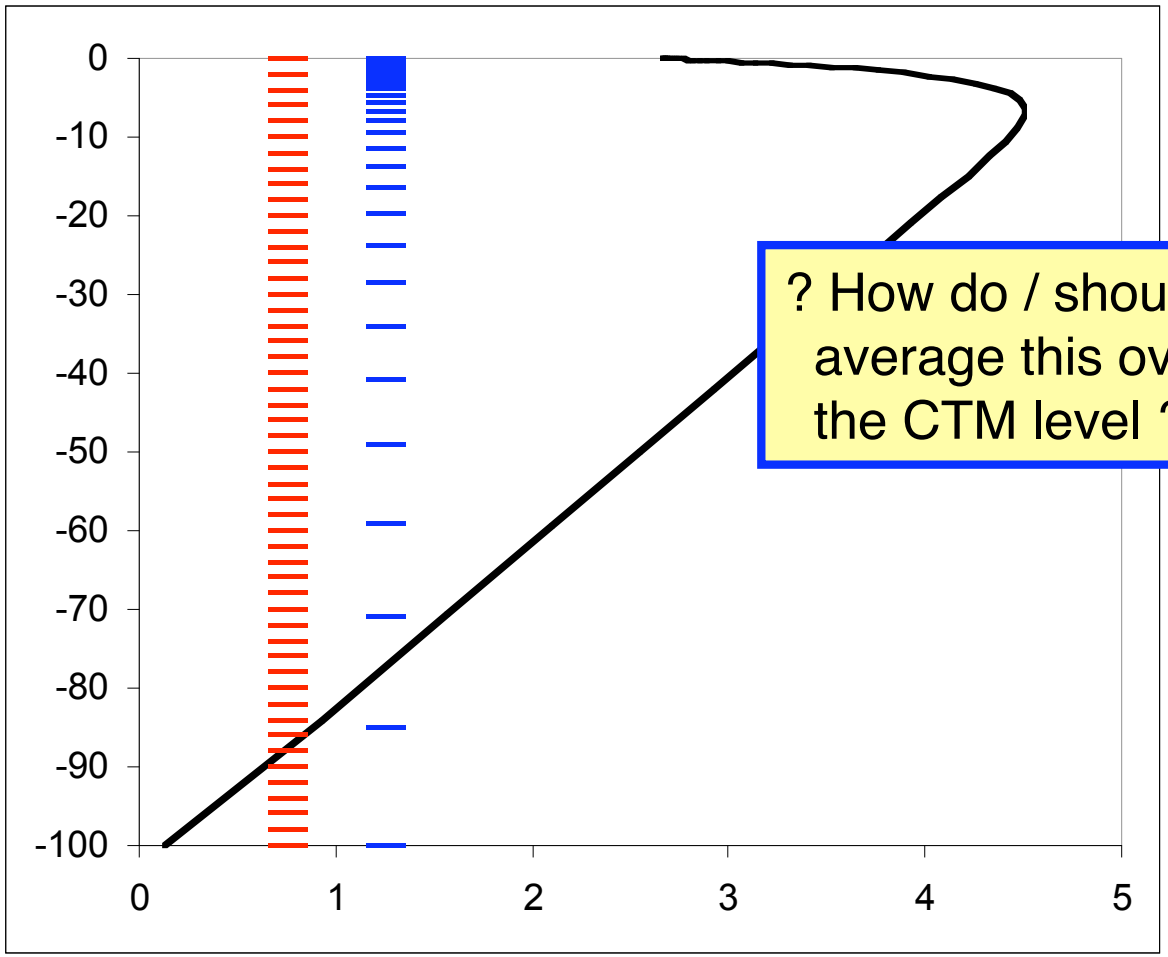


? How do / should we average this over the CTM level ?

_still needed for GMI photolysis module ? ? ?

6) Comparisons with independent data

test against IPMMI observations
compare with TUV code

7) Deal with fractional cloud cover !!!

current UCI+UMich effort, paper done this summer
calculate <J> for max-random cloud overlap
(? but is this what is needed ?)

8) Other recommendations

?
?

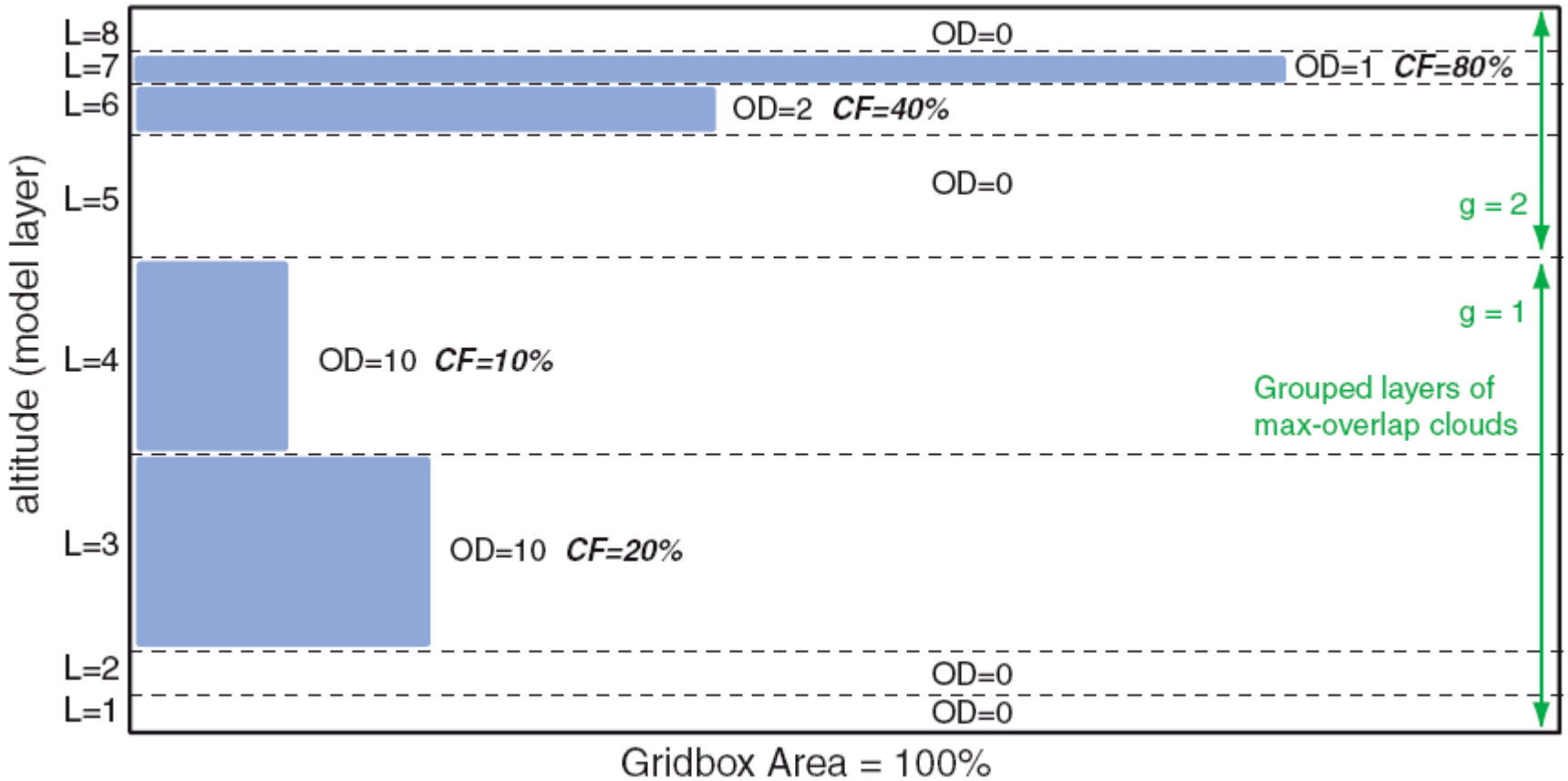
9) How to cultivate & maintain alternate J_X's for GMI

estimate / propagate uncertainty
do we need this ? vs. propagating (_, q) uncertainty

_fractional cloud cover (solved in part!)

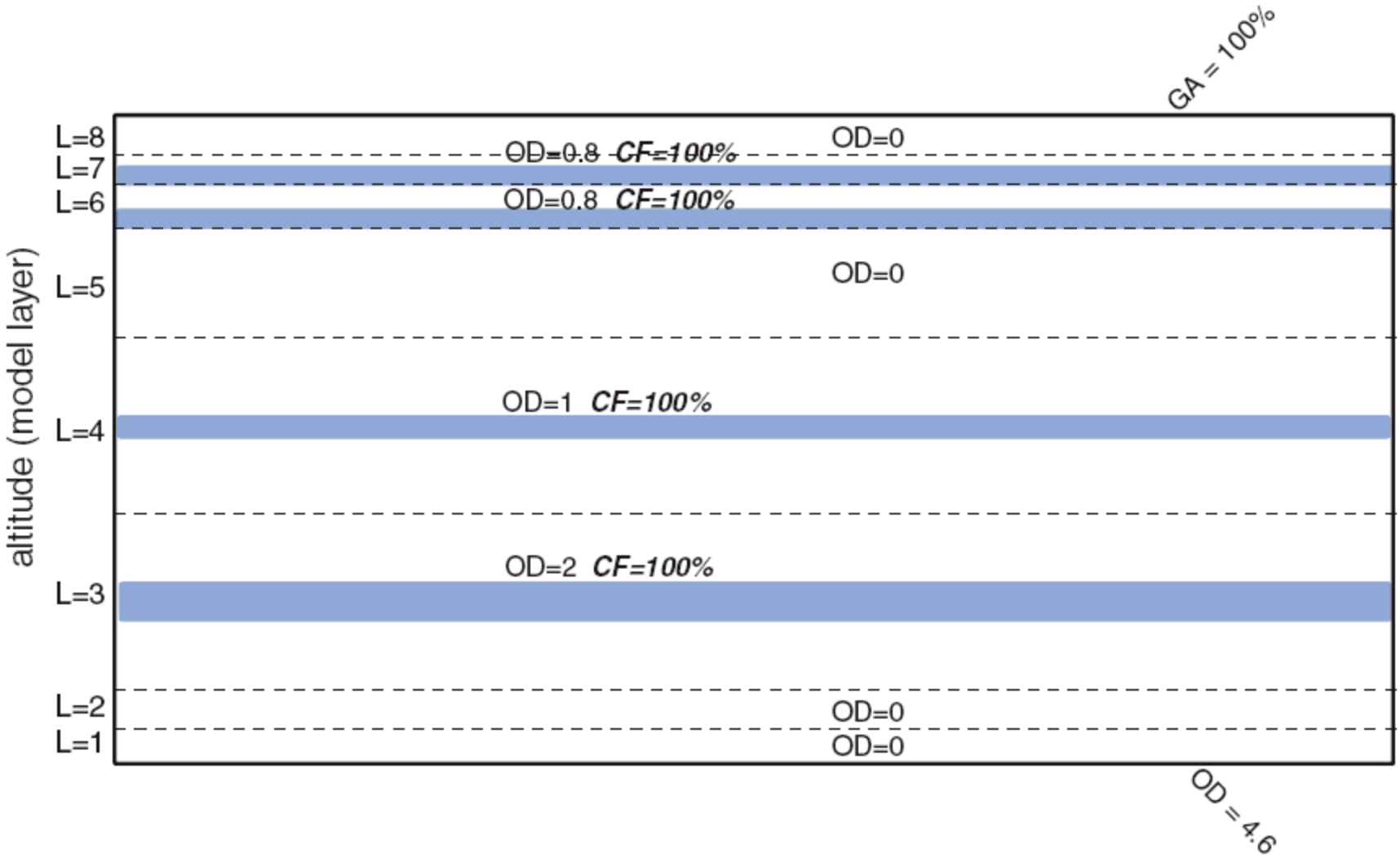
collaboration of UCI with UMich

cloud fraction & OD from met fields:



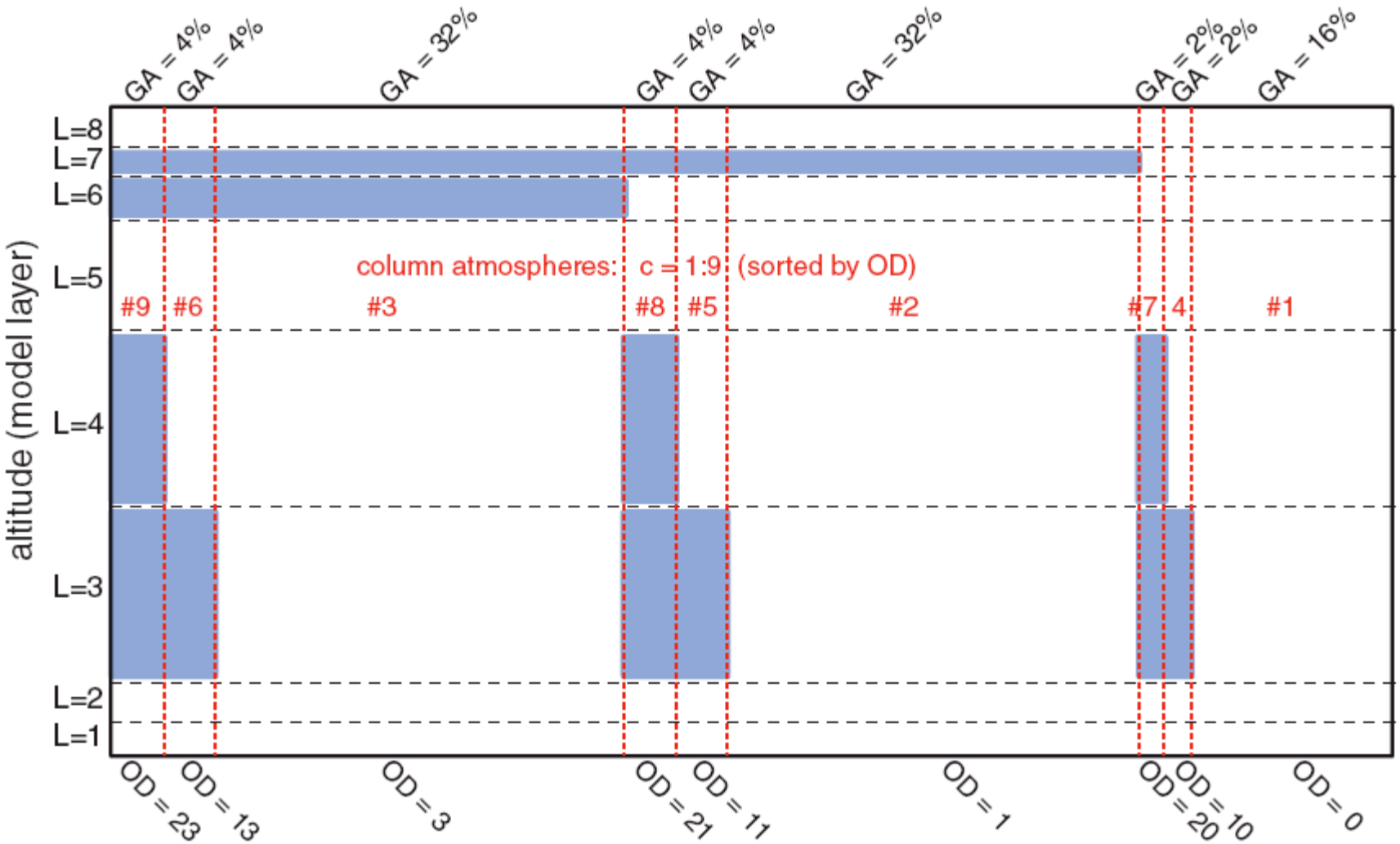
_fractional cloud cover

cloud fraction & OD as treated in fast-JX now



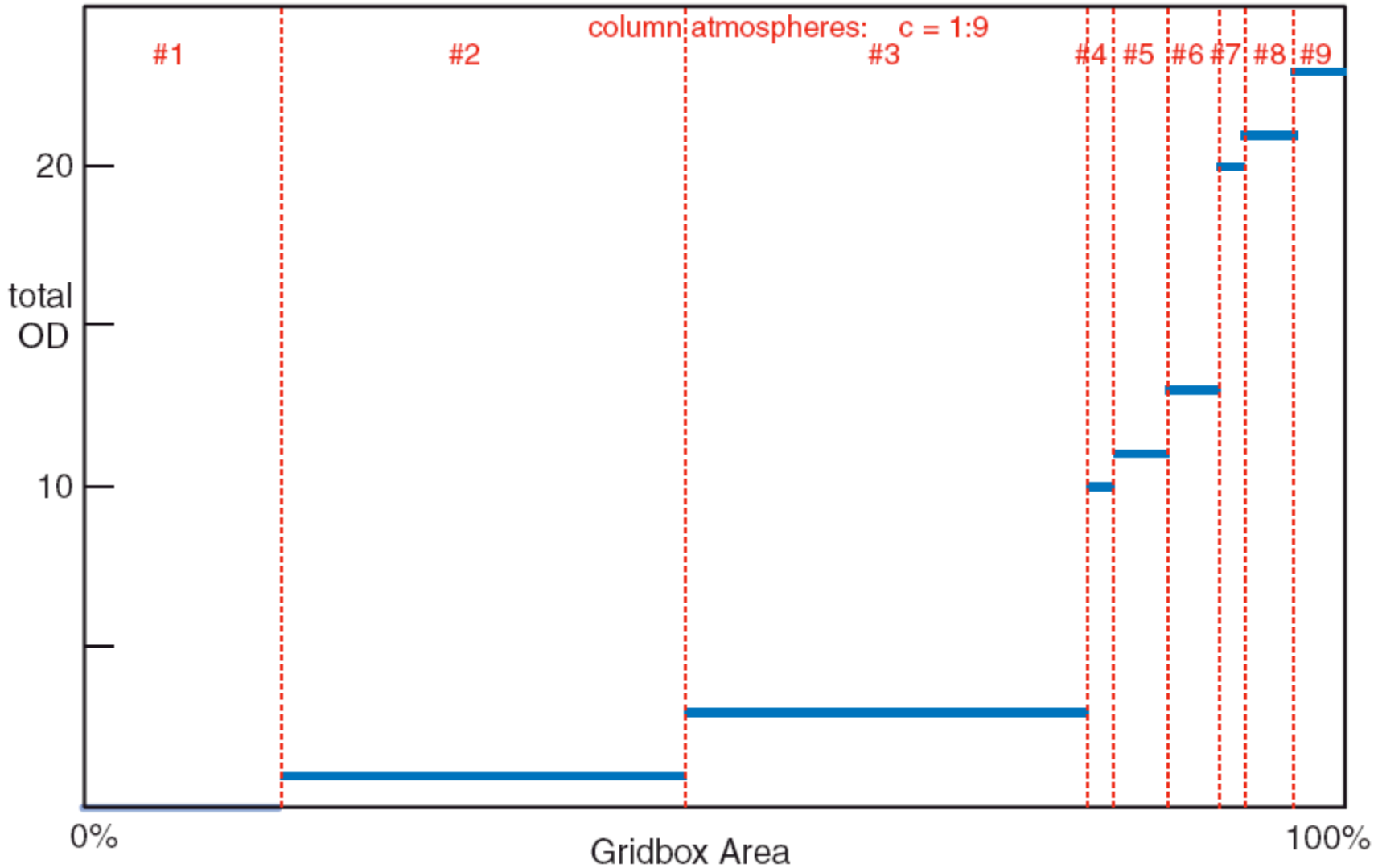
_fractional cloud cover

as interpreted in a max-random overlap model



_fractional cloud cover

as sorted in new UCI / UMich approach



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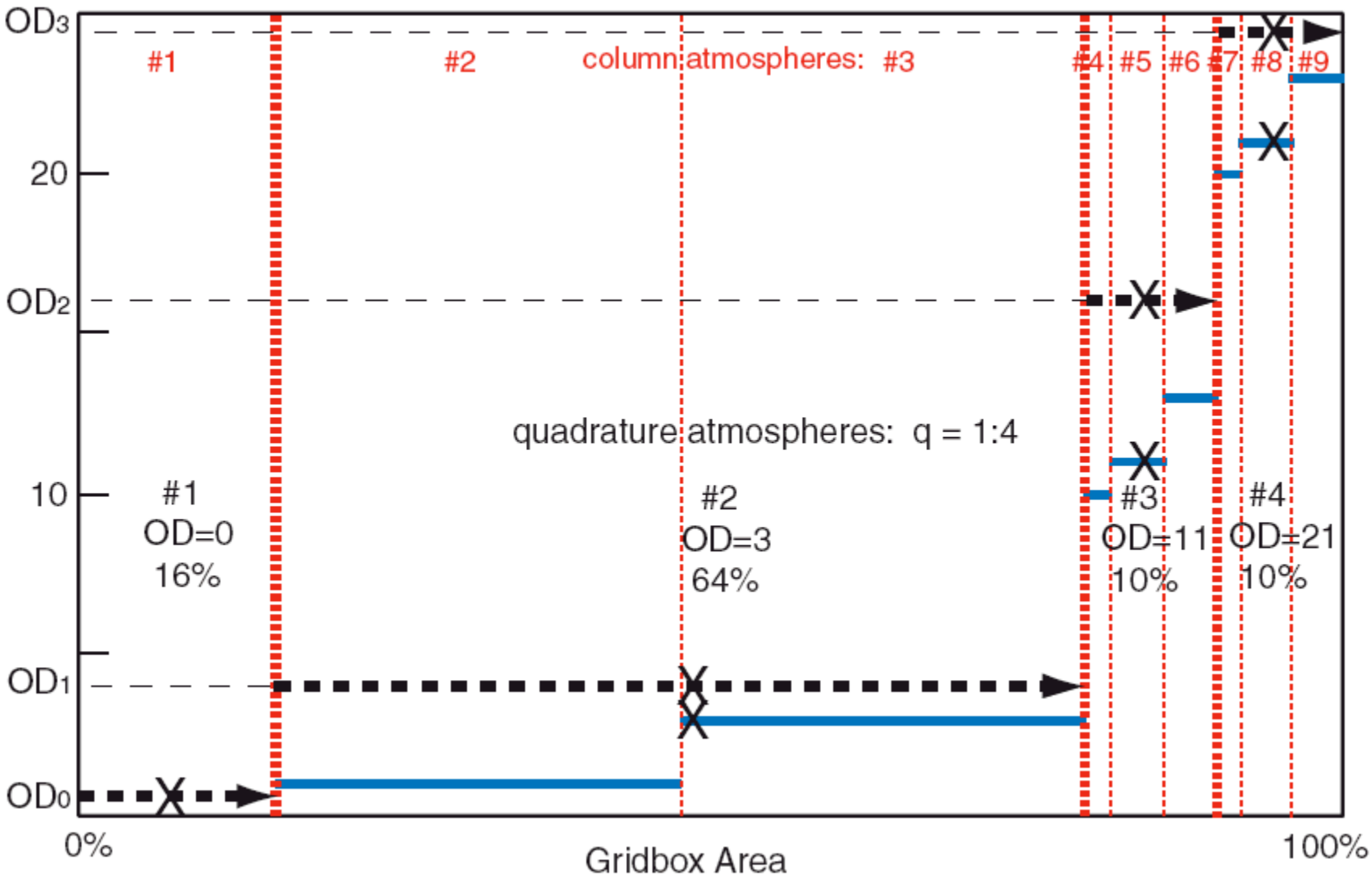
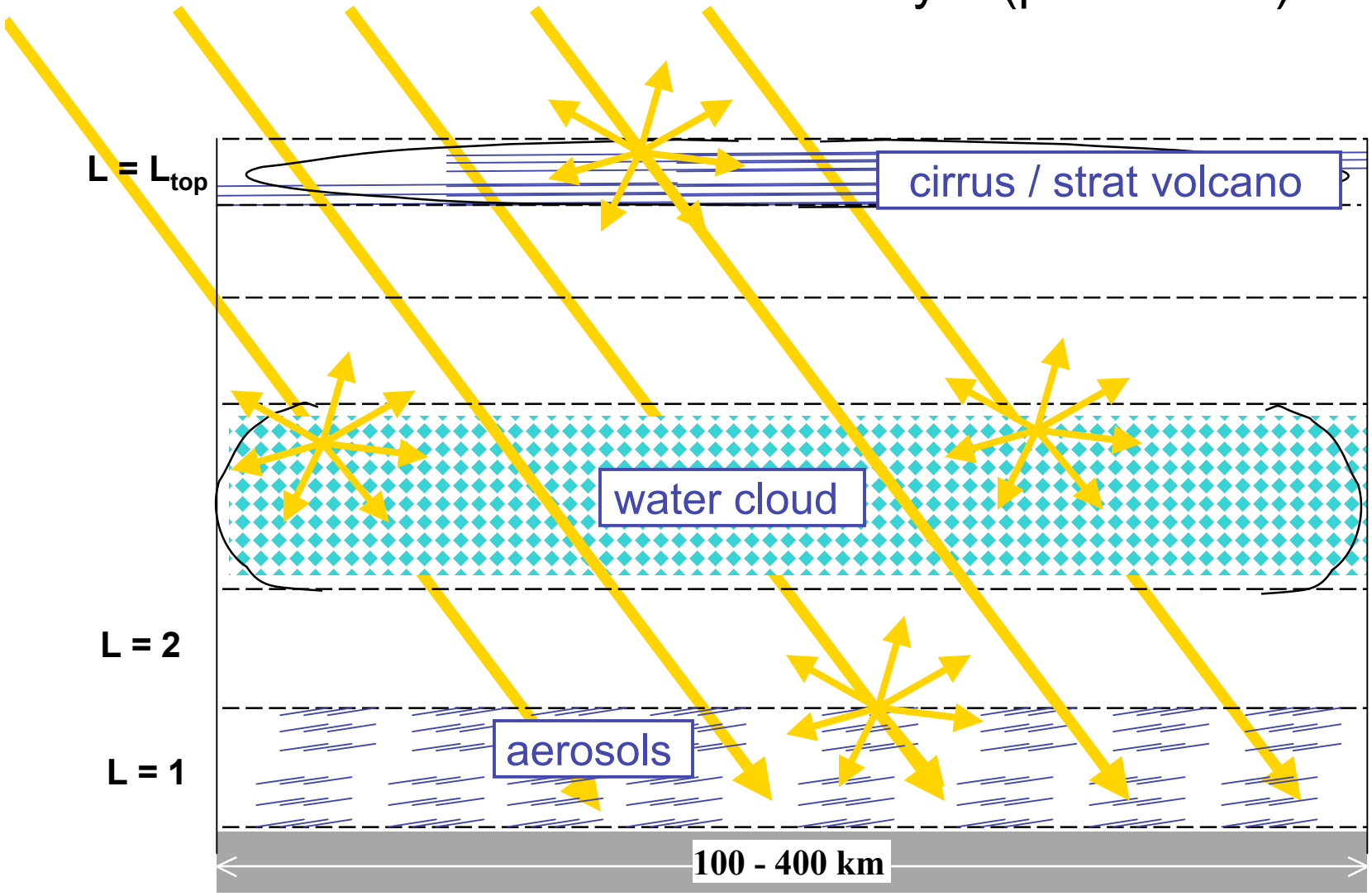


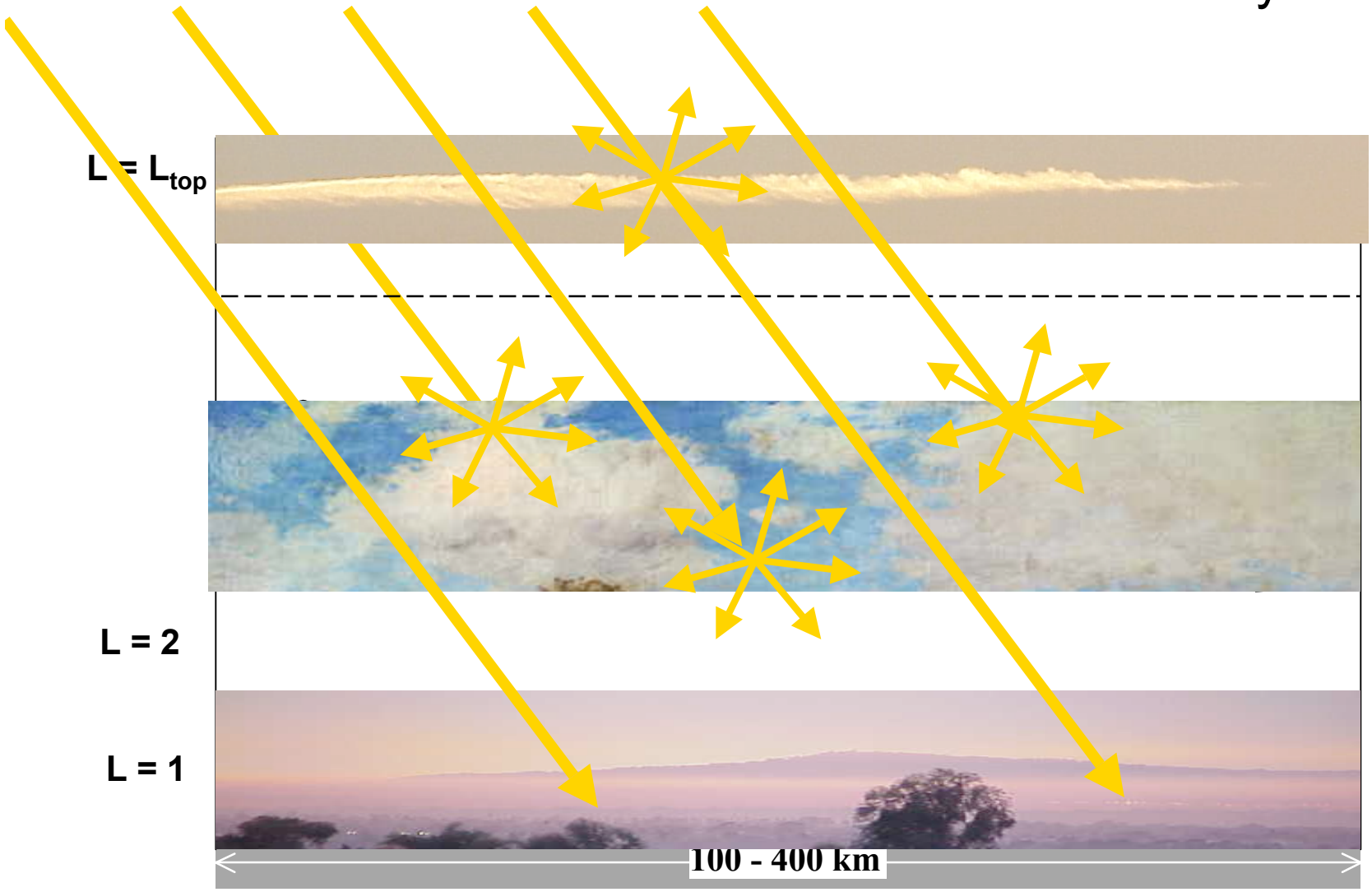
Photochemistry in a plane-parallel (1-D) world

=> mean J-value in each layer (per fast-JX)



Photochemistry in a real (3-D) world

=> different J-value environments in each layer

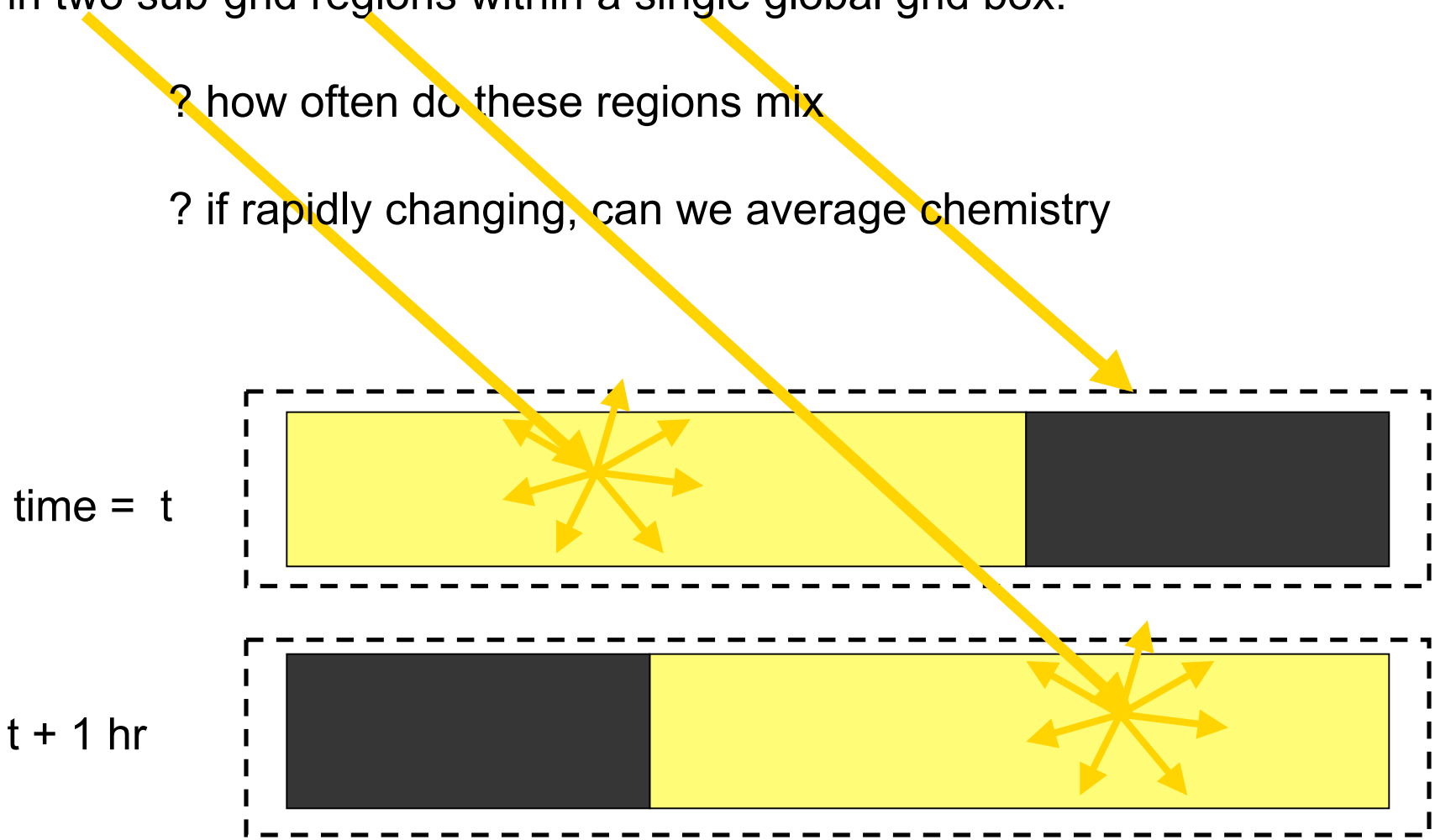


Photochemistry in a real (3-D) world

There is no clear formalism for treating different non-linear chemistry in two sub-grid regions within a single global grid box:

? how often do these regions mix

? if rapidly changing, can we average chemistry



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