Instructions for Outputting Monthly Eddy Fluxes from FOAM

Variables to output: uq, vq, ωq, uT, vT, ωT, uu, uv, vv, uω, and ωω.

General equation:

$$\left[\overline{vT}\right] = \left[\overline{v}\right]\left[\overline{T}\right] + \left[\overline{v}^{*}\overline{T}^{*}\right] + \left[\overline{v'T'}\right]$$

(1) (2) (3) (4)

Term 1 = northward transport of temperature averaged over a latitudinal circle and over time

Term 2 = Contribution from mean meridional circulation

Term 3 = Contribution from stationary eddies

Term 4 = Contribution from transient eddies

Therefore, terms 3+4 are the zonally averaged northward flux of temperature by eddies.

Term 2 can be computed as post-processing by simply multiplying the mean v by the mean T. I am adding the code here to output term 1. Term 3+4 (eddy) can be computed as post-processing by subtracting term 2 from term 1. Later, if you want to separate the stationary and transient eddies, you can compute the stationary eddy component by removing the zonal mean (*) as post-processing.

Files to change:
-bldfld.F
-physics.F
-pagrid.com

Add the lines between "MIKE BEGIN" and "MIKE END."

Changes to bldfld.F

```
C Latitude Pressure Gradient
C
     if = if + 1
     fieldn(1,if) = 'DPSLAT  '
     fieldn(2,if) = 'M/S2    '
     iflds(1,if)  = nmultf
     if (ninavg(1).eq.'Q') then
       iflds(3,if)  = nactve
     else
```

```
        iflds(3,if)  = ninact
      end if

CCC MIKE BEGIN
C
C Zonal water flux
C
      if = if + 1
      fieldn(1,if) = 'UQ      '
      fieldn(2,if) = 'M/S     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Zonal heat flux
C
      if = if + 1
      fieldn(1,if) = 'UT      '
      fieldn(2,if) = 'KM/S     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Zonal u-momentum flux
C
      if = if + 1
      fieldn(1,if) = 'UU      '
      fieldn(2,if) = 'M2/S2     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Zonal v-momentum flux
C
      if = if + 1
      fieldn(1,if) = 'UV      '
      fieldn(2,if) = 'M2/S2     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Zonal w-momentum flux
C
      if = if + 1
      fieldn(1,if) = 'UW      '
      fieldn(2,if) = 'Pa M/S2     '
```

```
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Meridional v-momentum flux
C
      if = if + 1
      fieldn(1,if) = 'VV      '
      fieldn(2,if) = 'M2/S2     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Vertical moisture flux
C
      if = if + 1
      fieldn(1,if) = 'WQ      '
      fieldn(2,if) = 'Pa M/S2    '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Vertical heat flux
C
      if = if + 1
      fieldn(1,if) = 'WT      '
      fieldn(2,if) = 'KPa/S2     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

C
C Vertical momentum flux
C
      if = if + 1
      fieldn(1,if) = 'WW      '
      fieldn(2,if) = 'Pa2/S2     '
      iflds(1,if)  = nmultf
      iflds(3,if)  = nactve

CCC MIKE END

C
C Sort the master field list by summation of ichar-s of 1st 4 characters
C pichsum = 127*4.  Minimum ichar output is 0. Maximum is 127.
```

Changes to physics.F

```
do k=1,plev
       do i=1,plon
         ftem(i,k) = v3m1(i,k)**2 + u3m1(i,k)**2
       end do
end do
call outfld('VVPUU   ',ftem  ,plond,lat,hbuf,lhbuf)

CCC   MIKE

     do k=1,plev
       do i=1,plon
         ftem(i,k) = u3m1(i,k)*q3m1(i,k,1)
       end do
     end do
     call outfld('UQ      ',ftem,plond,lat,hbuf,lhbuf)

     do k=1,plev
       do i=1,plon
         ftem(i,k) = u3m1(i,k)*t3m1(i,k)
       end do
     end do
     call outfld('UT      ',ftem,plond,lat,hbuf,lhbuf)

     do k=1,plev
       do i=1,plon
         ftem(i,k) = u3m1(i,k)*u3m1(i,k)
       end do
     end do
     call outfld('UU      ',ftem,plond,lat,hbuf,lhbuf)

     do k=1,plev
       do i=1,plon
         ftem(i,k) = u3m1(i,k)*v3m1(i,k)
       end do
     end do
     call outfld('UV      ',ftem,plond,lat,hbuf,lhbuf)

     do k=1,plev
       do i=1,plon
         ftem(i,k) = u3m1(i,k)*omga(i,k,lat)
       end do
     end do
     call outfld('UW      ',ftem,plond,lat,hbuf,lhbuf)
```

```
      do k=1,plev
        do i=1,plon
          ftem(i,k) = v3m1(i,k)*v3m1(i,k)
        end do
      end do
      call outfld('VV      ',ftem,plond,lat,hbuf,lhbuf)

      do k=1,plev
        do i=1,plon
          ftem(i,k) = omga(i,k,lat)*q3m1(i,k,1)
        end do
      end do
      call outfld('WQ      ',ftem,plond,lat,hbuf,lhbuf)

      do k=1,plev
        do i=1,plon
          ftem(i,k) = omga(i,k,lat)*t3m1(i,k)
        end do
      end do
      call outfld('WT      ',ftem,plond,lat,hbuf,lhbuf)

      do k=1,plev
        do i=1,plon
          ftem(i,k) = omga(i,k,lat)*omga(i,k,lat)
        end do
      end do
      call outfld('WW      ',ftem,plond,lat,hbuf,lhbuf)

CCC   MIKE
C     do m=1,pcnst
C       call outfld(tendnam(m),qtend(1,1,m),plond,lat,hbuf,lhbuf)
```

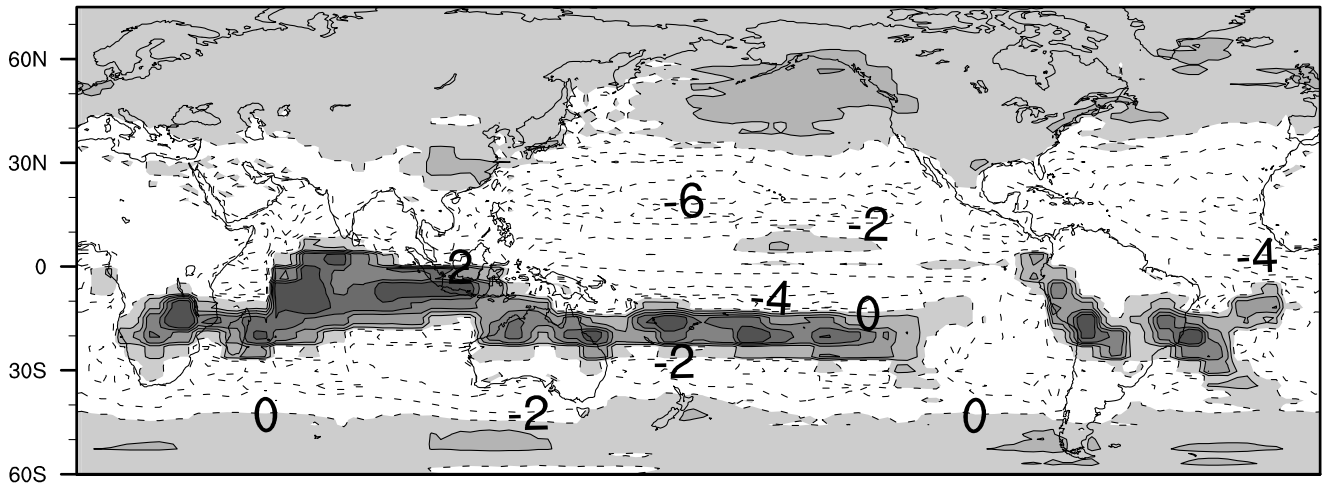
Changes to pagrid.com

```
C 8 fields in master list are pcnst-dependent 2 fields occur only
C if pcnst > 1
C

CCC   MIKE
CCC    $         pflds=90+8*pcnst+2*(pcnst-1)+plevmx)
     $         pflds=90+8*pcnst+2*(pcnst-1)+plevmx+9)
CCC   MIKE
      parameter(ptifld = 11, ptvsfld = 1, ptvofld = 2)
```

ALSO

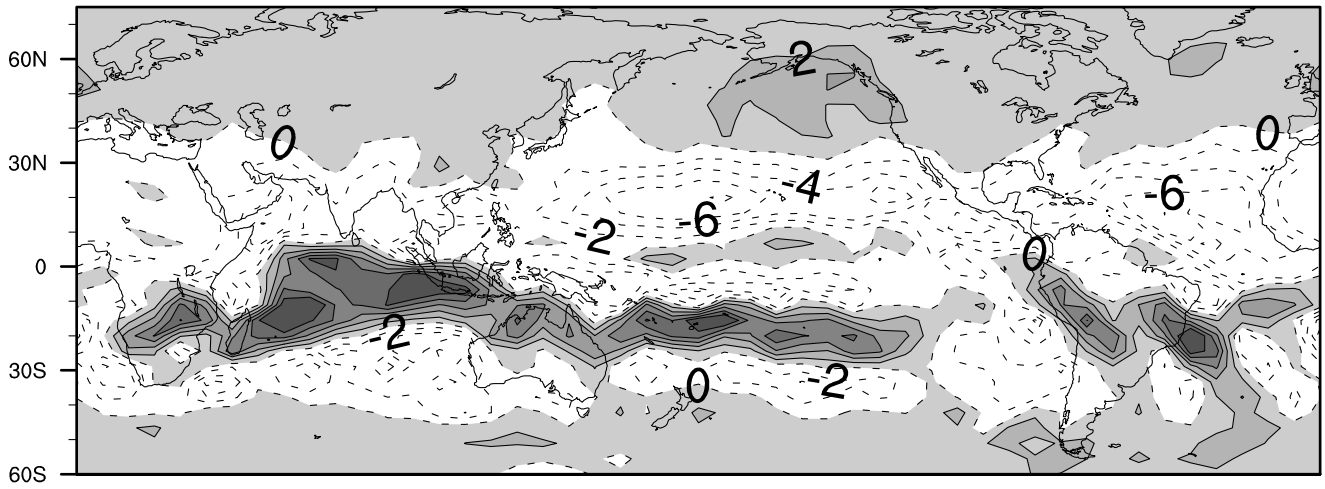
```
C  Length of the history tape buffer for fldsin (INIDAT) and
C  hbuf2 (WRTHARR)
C

CCC   MIKE
CCC      parameter(pmulti = 24 + pcnst*4,psingl=46 + plevmx,
CCC     $          phtbf = (pmulti*plev + psingl)*plon )

      parameter(pmulti = 24 + pcnst*4 + 9,psingl=46 + plevmx,
     $          phtbf = (pmulti*plev + psingl)*plon )
CCC  MIKE
```

Precipitation-Evaporation (January) mm/d

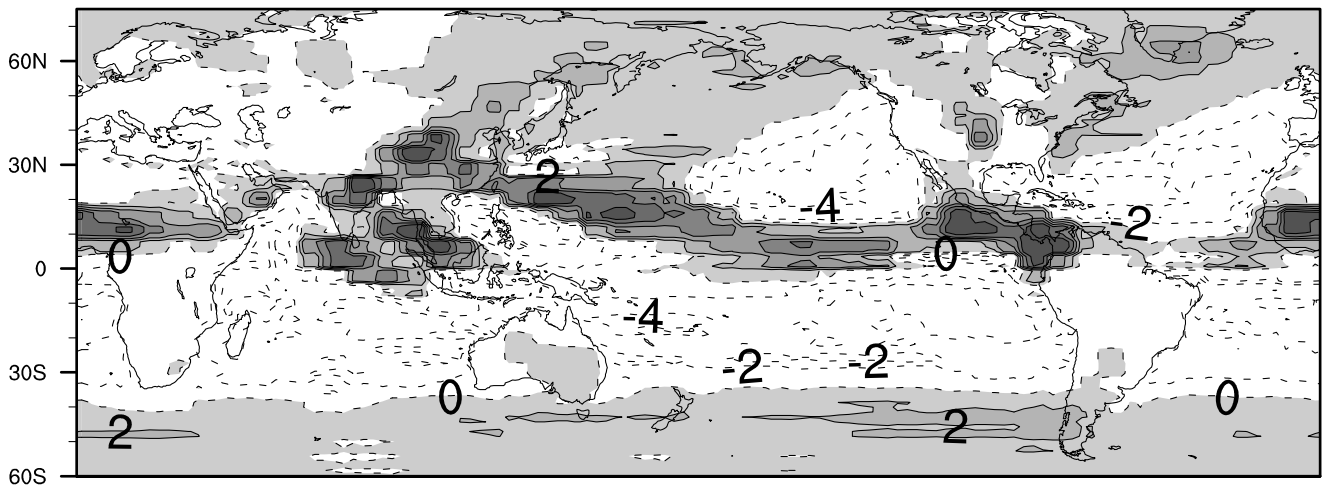


$$\nabla \cdot \frac{1}{g} \int q \vec{V} dp$$

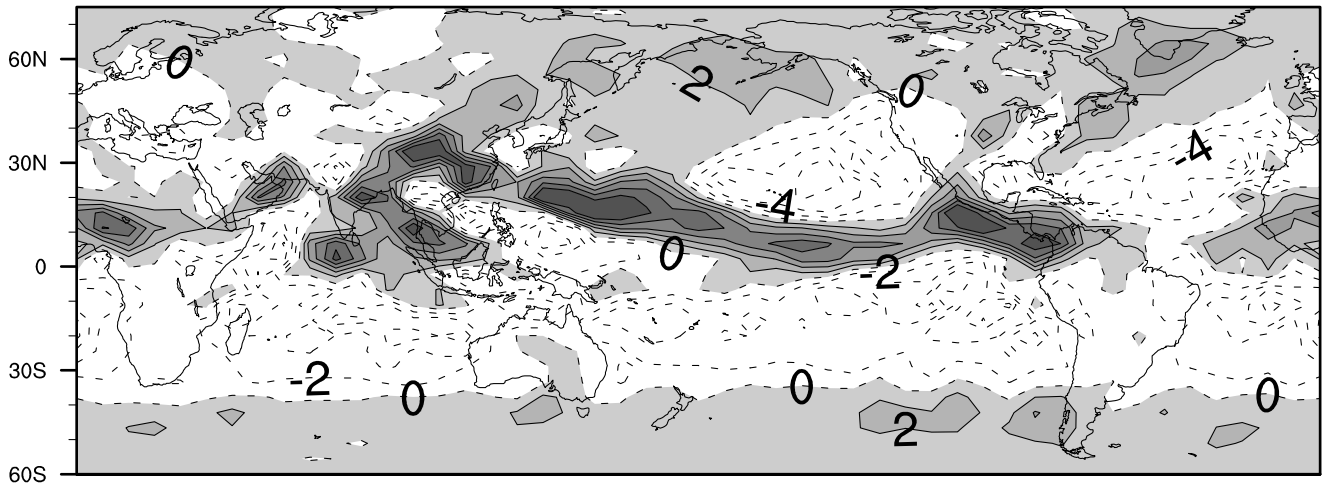
Moisture Flux Convergence (Jan) mm/d



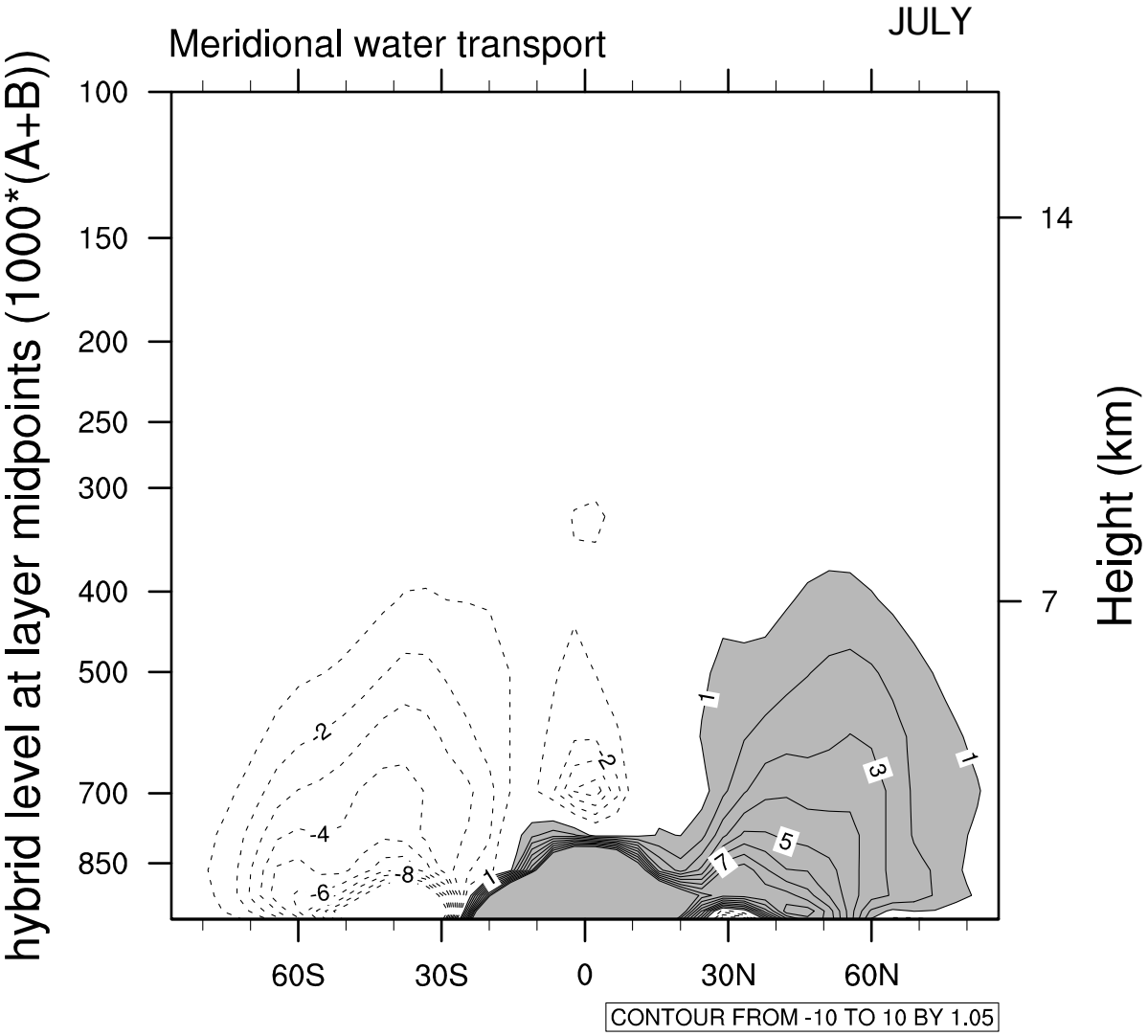
Precipitation-Evaporation (July) mm/d



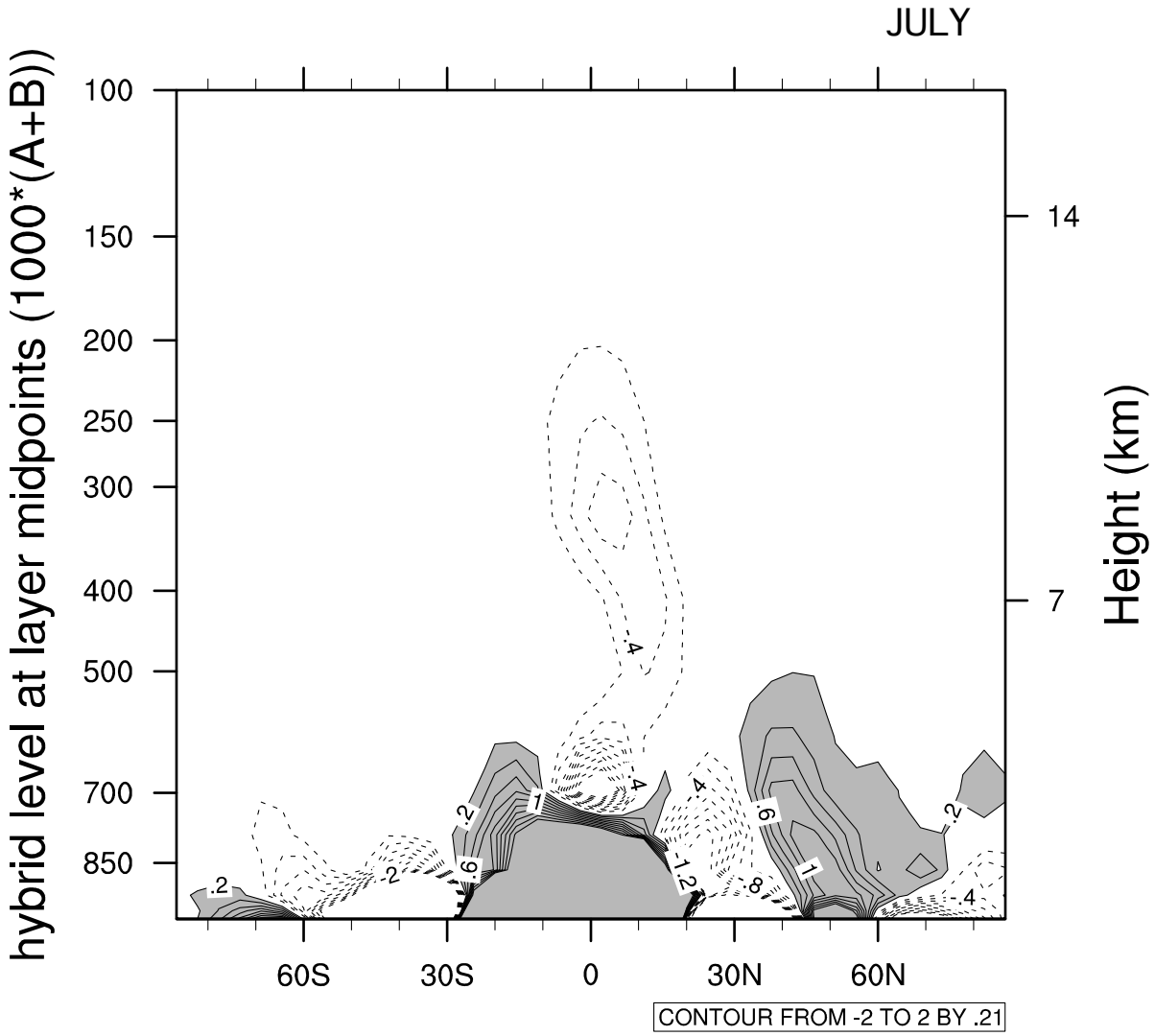
Moisture flux convergence (July) (mm/d)

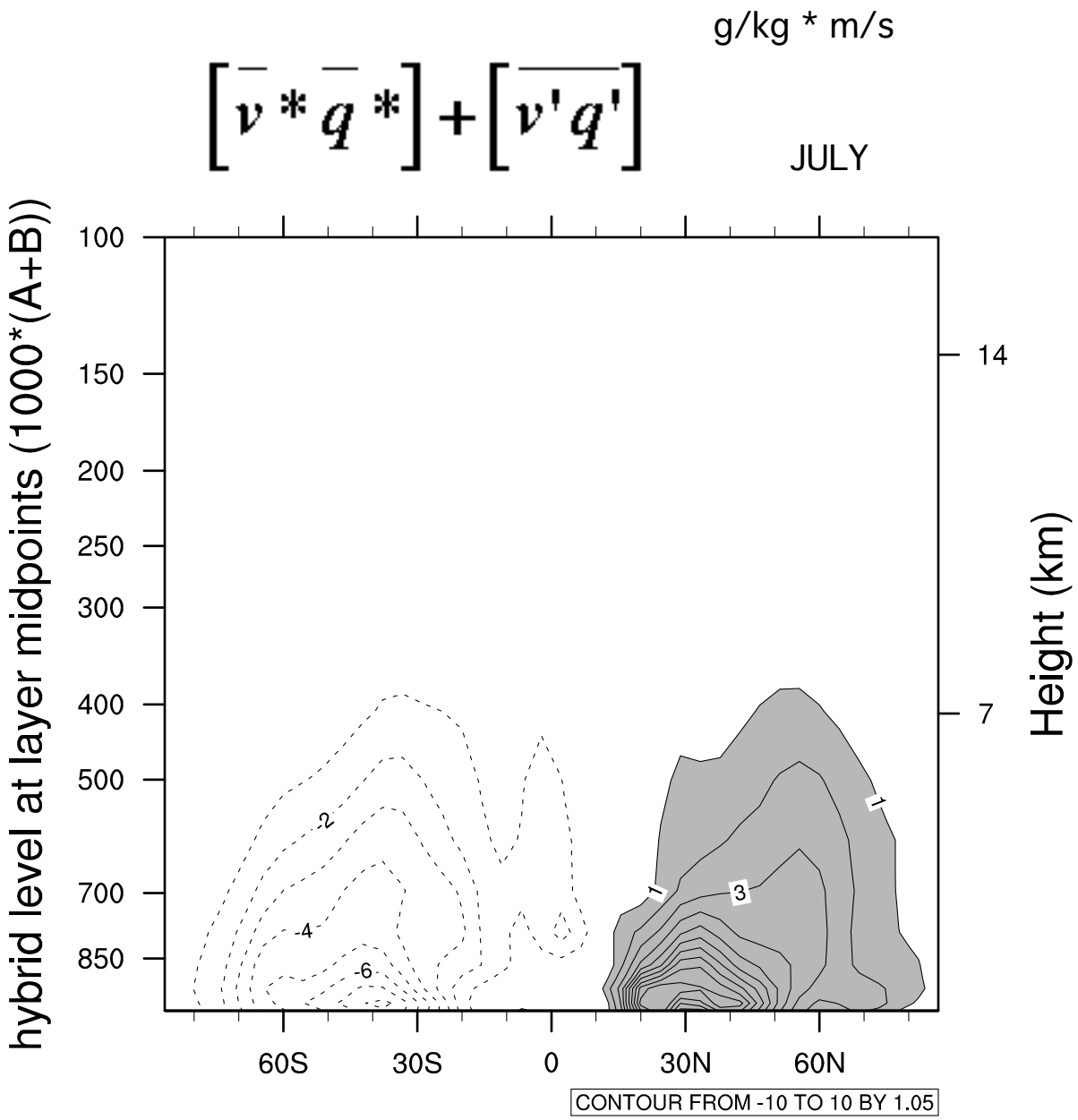


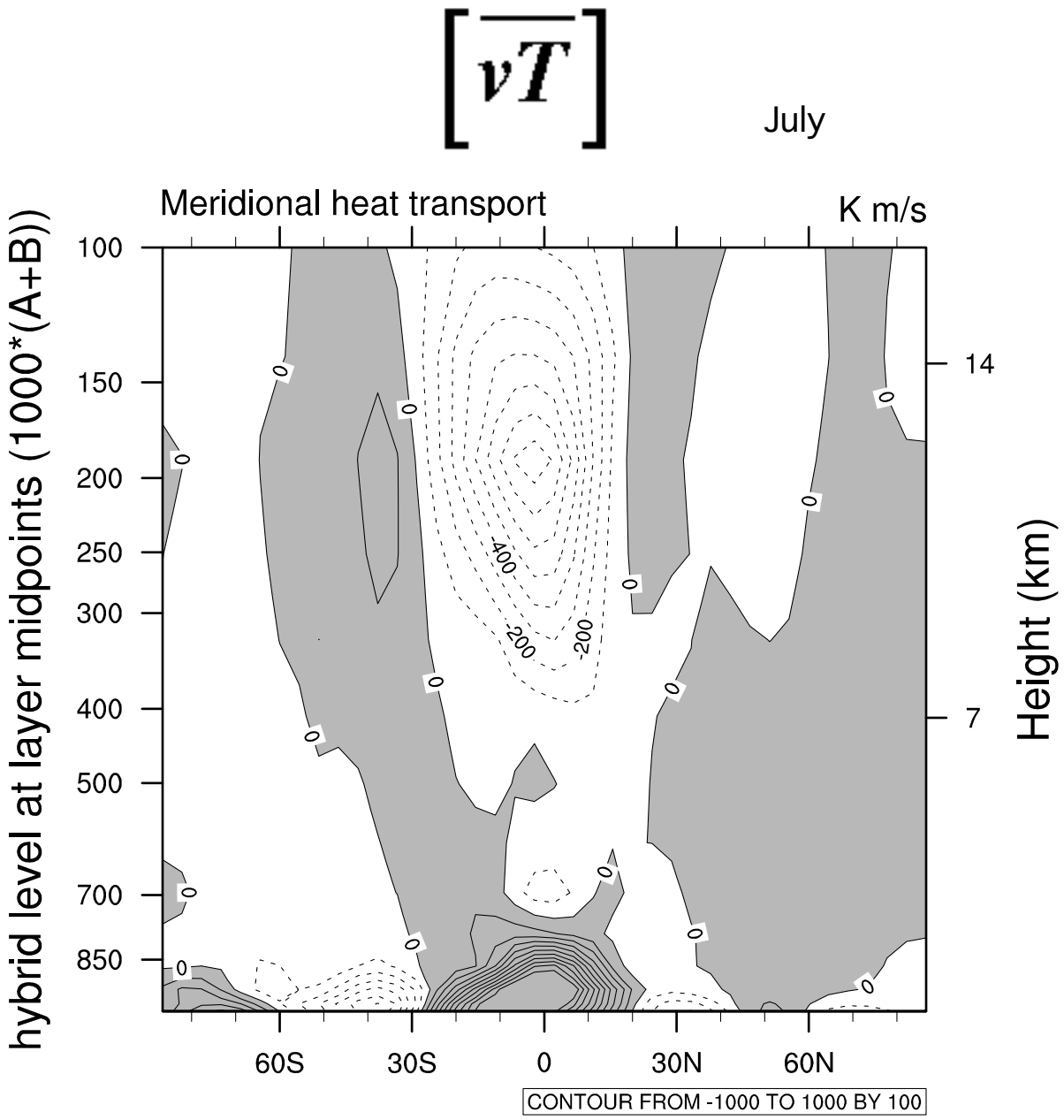
$[\overline{vq}]$ g/kg * m/s

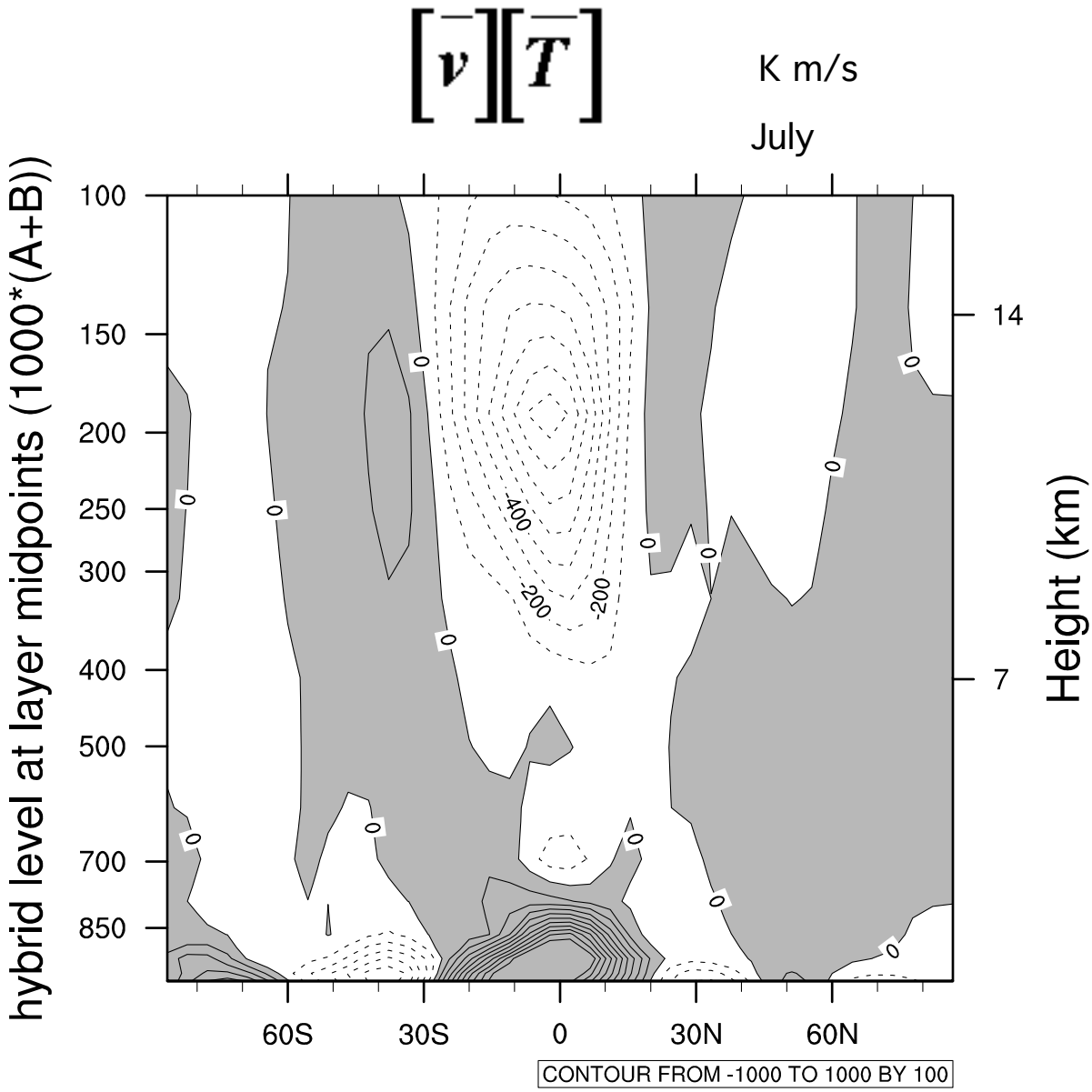


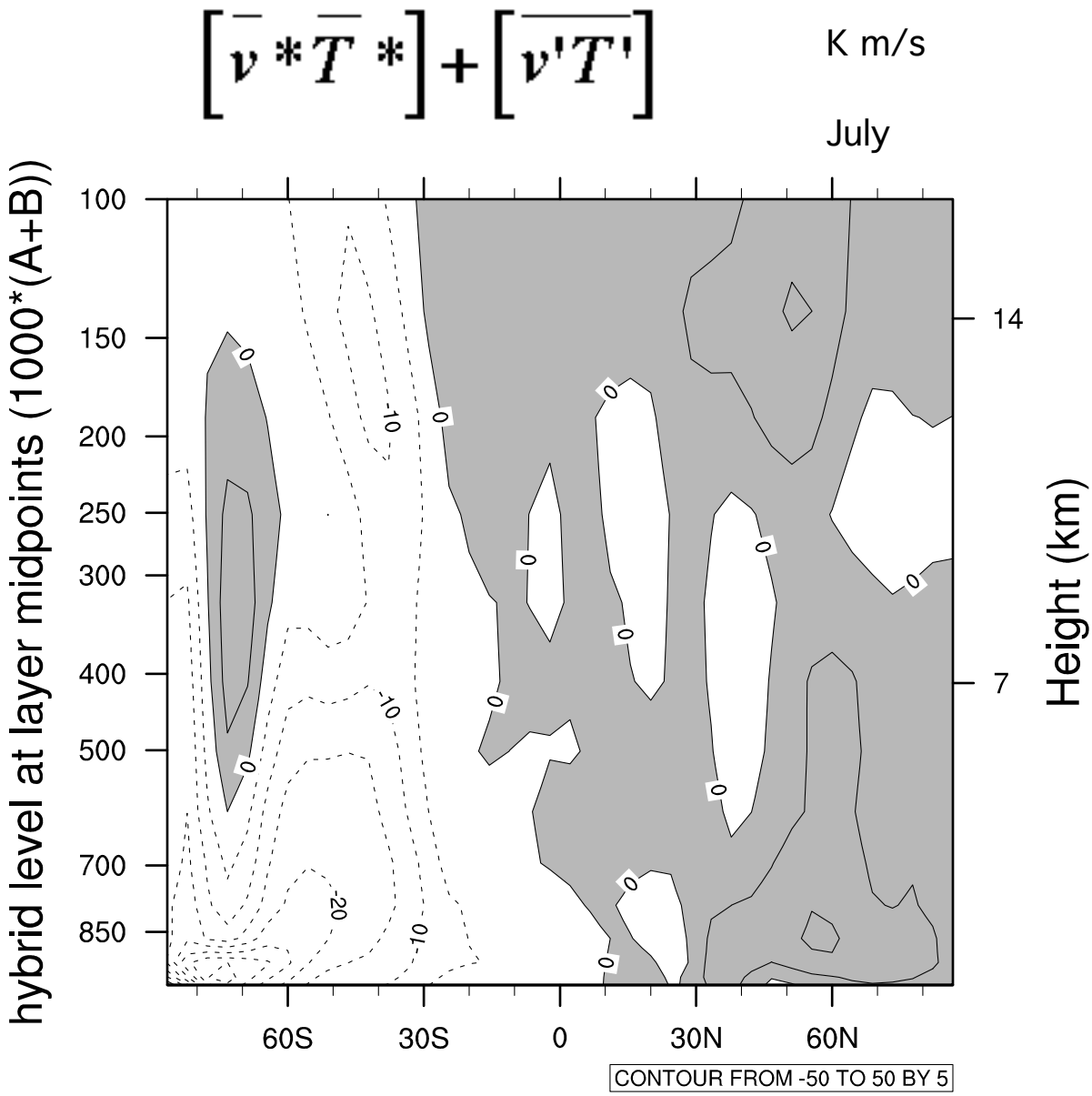
$[\bar{v}][\bar{q}]$ g/kg * m/s

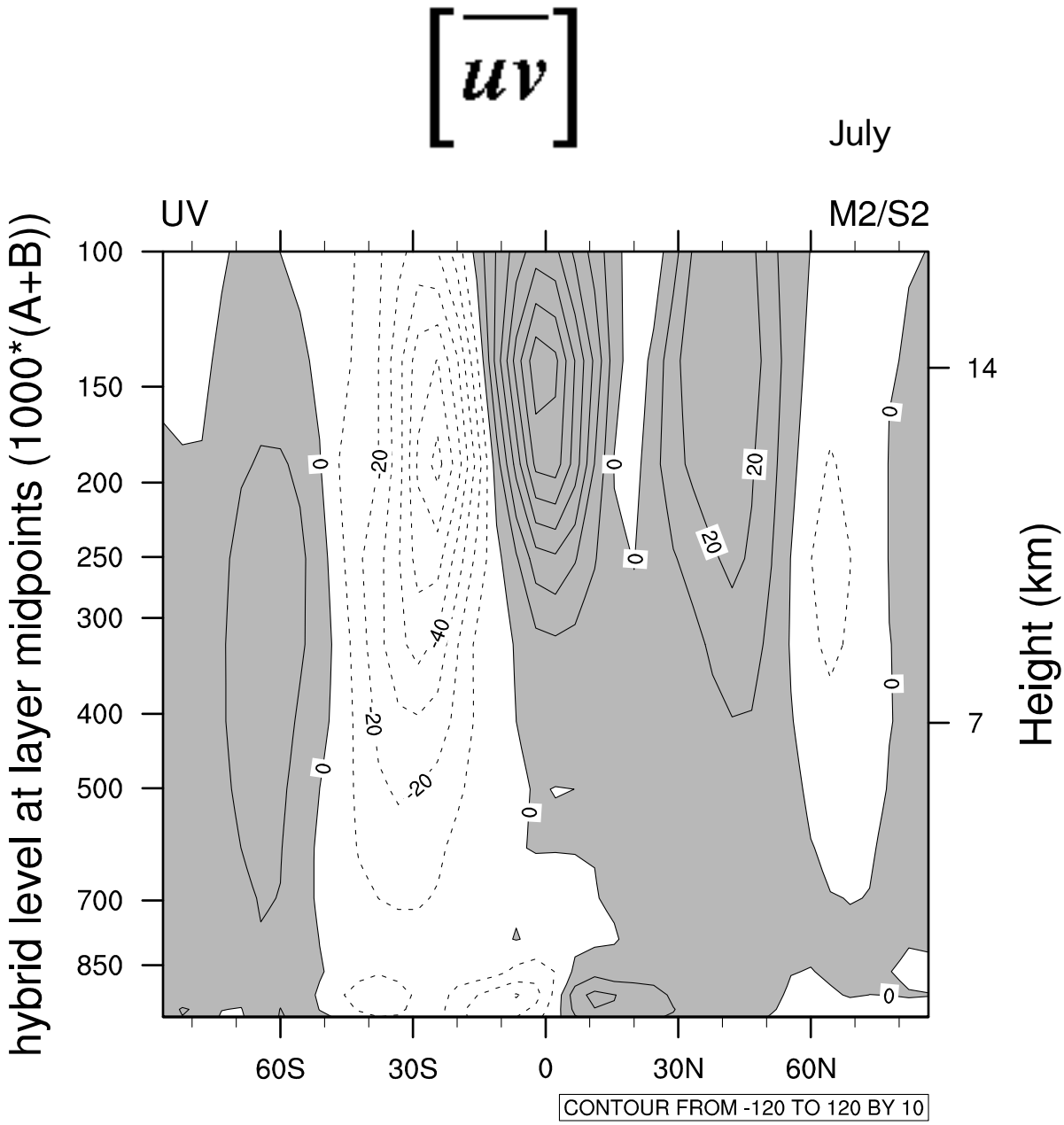


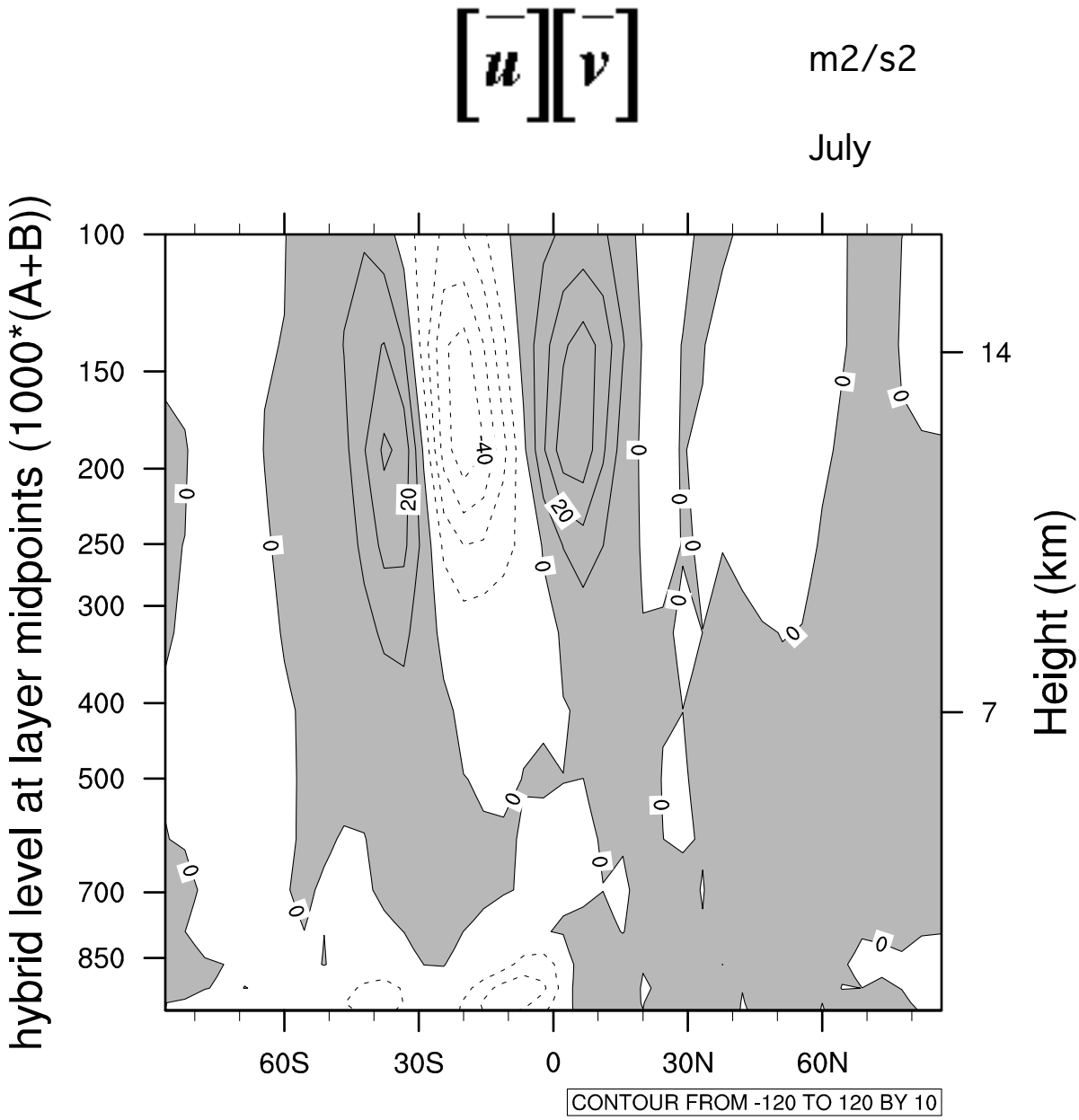

g/kg * m/s
$[\overline{v}^{*}\overline{q}^{*}]+[\overline{v'q'}]$
JULY
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
14
7
Height (km)
-2
-4
-6
1
3
1
60S
30S
0
30N
60N
CONTOUR FROM -10 TO 10 BY 1.05

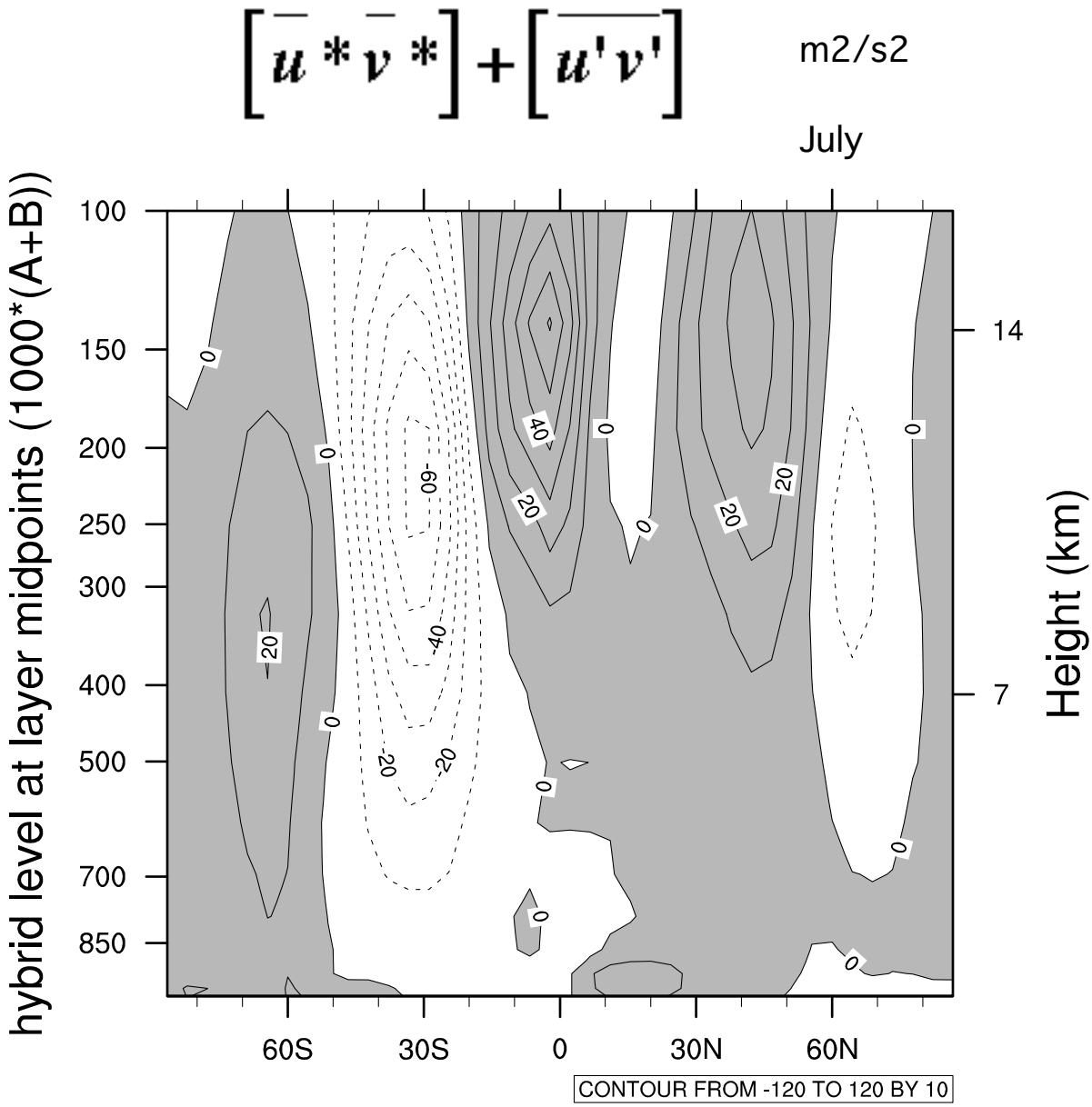

$[\overline{vT}]$
July
Meridional heat transport
K m/s
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
14
7
Height (km)
60S
30S
0
30N
60N
CONTOUR FROM -1000 TO 1000 BY 100

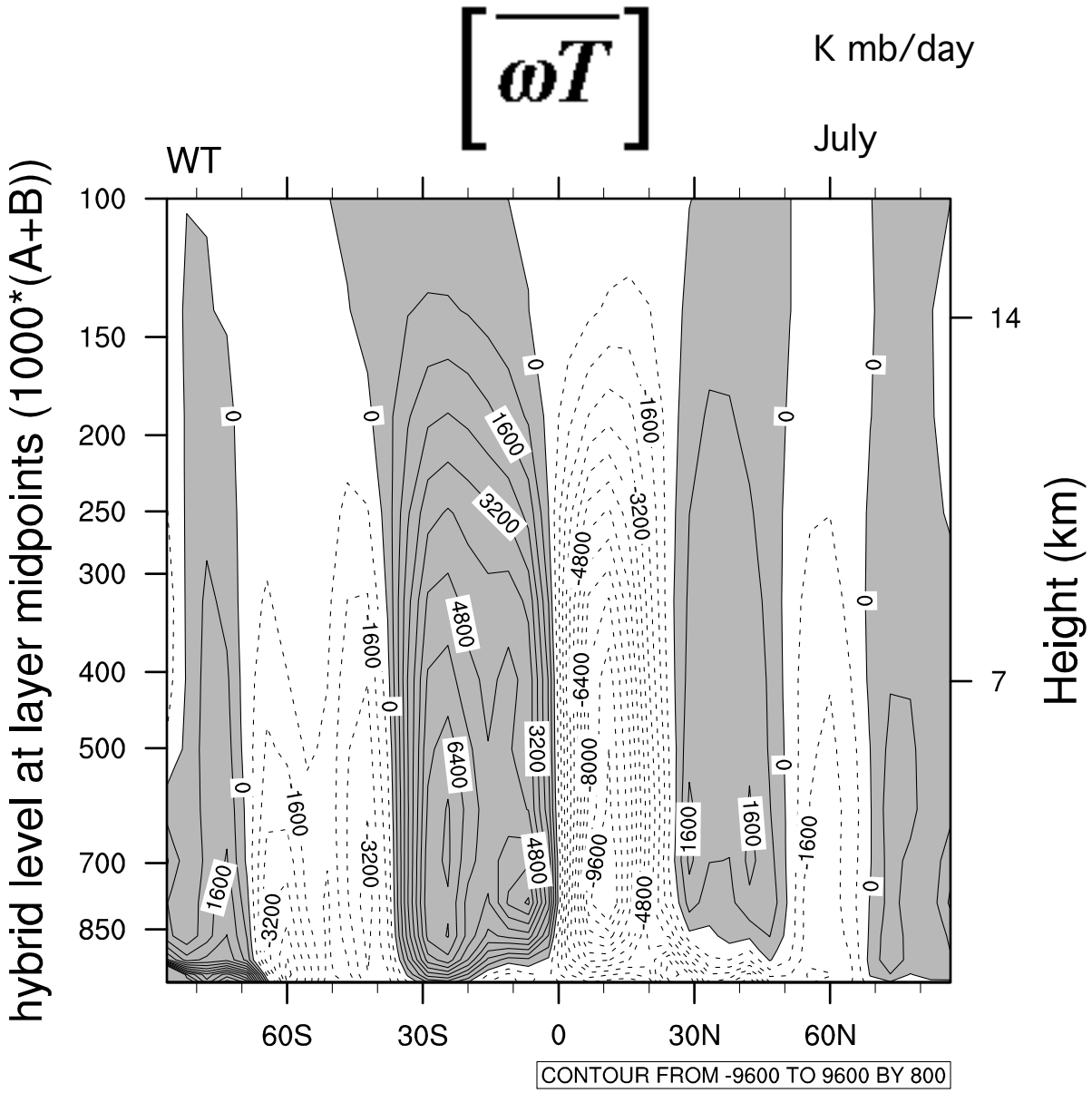

$[\bar{v}][\bar{T}]$
K m/s
July
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
14
7
Height (km)
60S
30S
0
30N
60N
0
400
200
-200
CONTOUR FROM -1000 TO 1000 BY 100

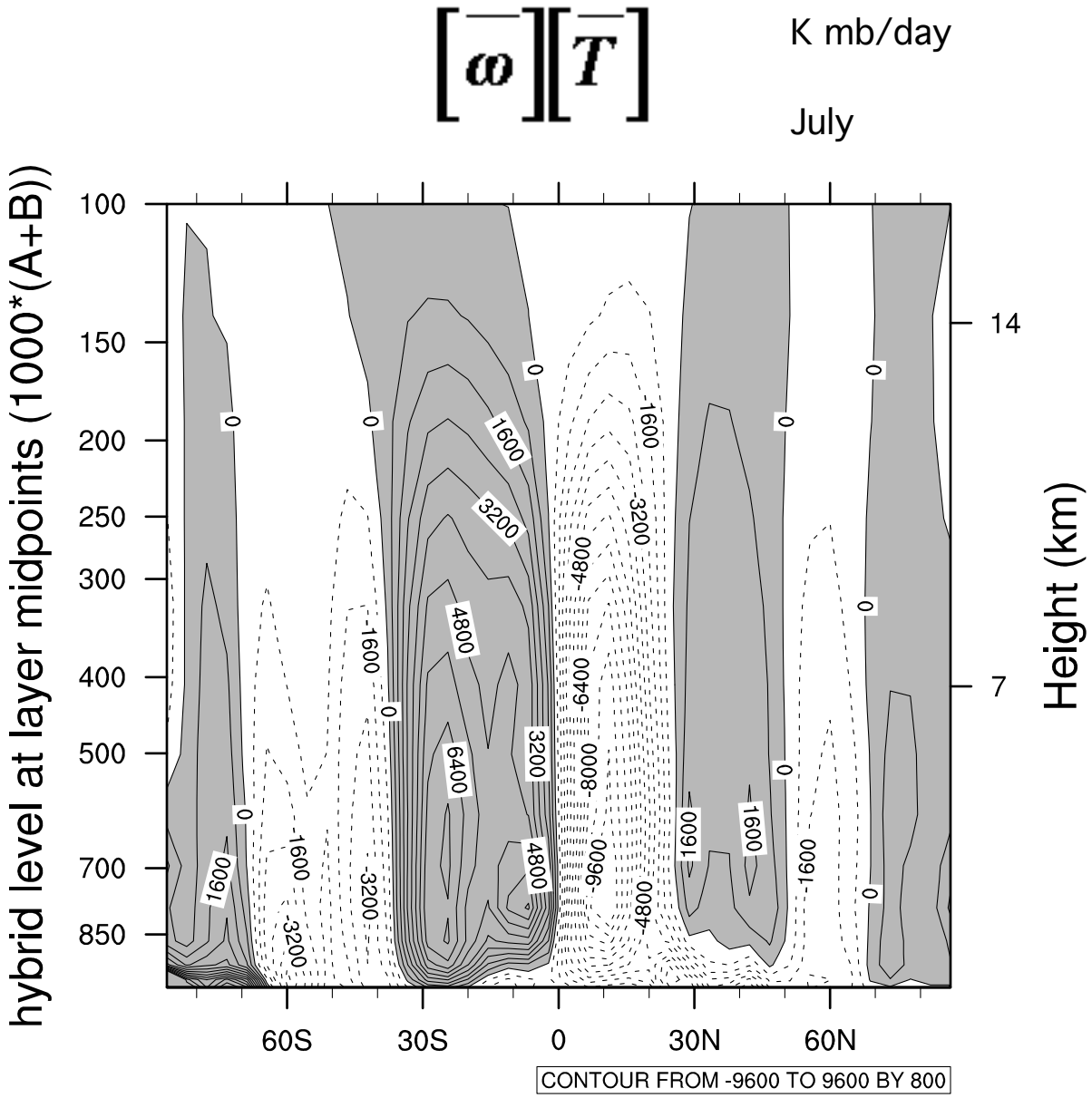

$\left[\overline{v} * \overline{T} *\right] + \left[\overline{v'T'}\right]$
K m/s
July
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
60S
30S
0
30N
60N
14
7
Height (km)
CONTOUR FROM -50 TO 50 BY 5


$[\overline{uv}]$
July
UV
M2/S2
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
14
7
Height (km)
60S
30S
0
30N
60N
CONTOUR FROM -120 TO 120 BY 10


$[\bar{u}][\bar{v}]$
m2/s2
July
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
60S
30S
0
30N
60N
14
7
Height (km)
CONTOUR FROM -120 TO 120 BY 10


$\left[\overline{u}^{*}\overline{v}^{*}\right]+\left[\overline{u'v'}\right]$
m2/s2
July
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
60S
30S
0
30N
60N
14
7
Height (km)
CONTOUR FROM -120 TO 120 BY 10


$[\overline{\omega T}]$
K mb/day
July
WT
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
60S
30S
0
30N
60N
14
7
Height (km)
CONTOUR FROM -9600 TO 9600 BY 800


$[\overline{\omega}][\overline{T}]$
K mb/day
July
hybrid level at layer midpoints (1000*(A+B))
100
150
200
250
300
400
500
700
850
60S
30S
0
30N
60N
14
7
Height (km)
CONTOUR FROM -9600 TO 9600 BY 800

$$\left[\overline{\omega} * \overline{T} *\right] + \left[\overline{\omega' T'}\right]$$

K mb/day

July