Clouds and water vapor in the northern hemisphere summertime stratosphere

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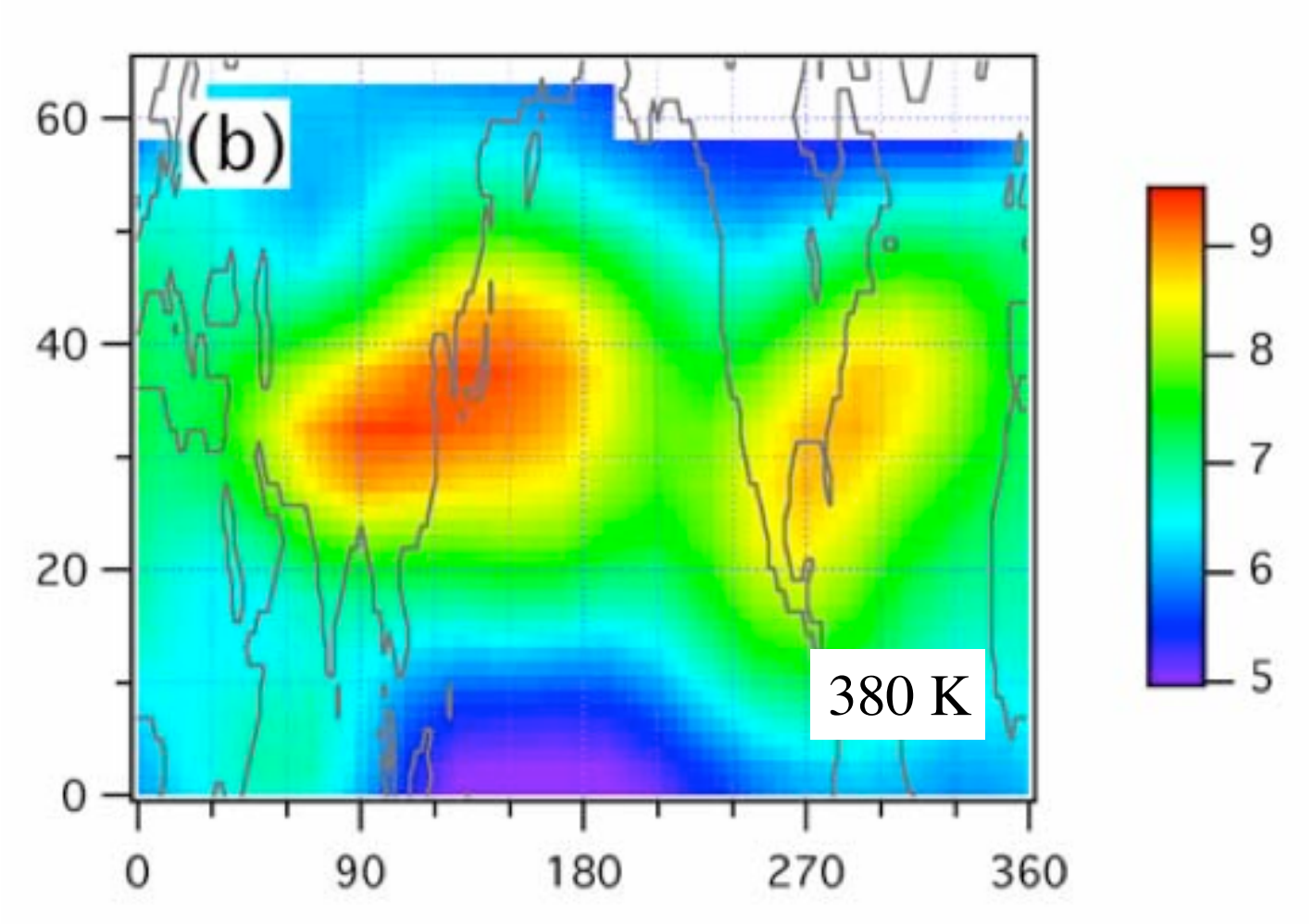
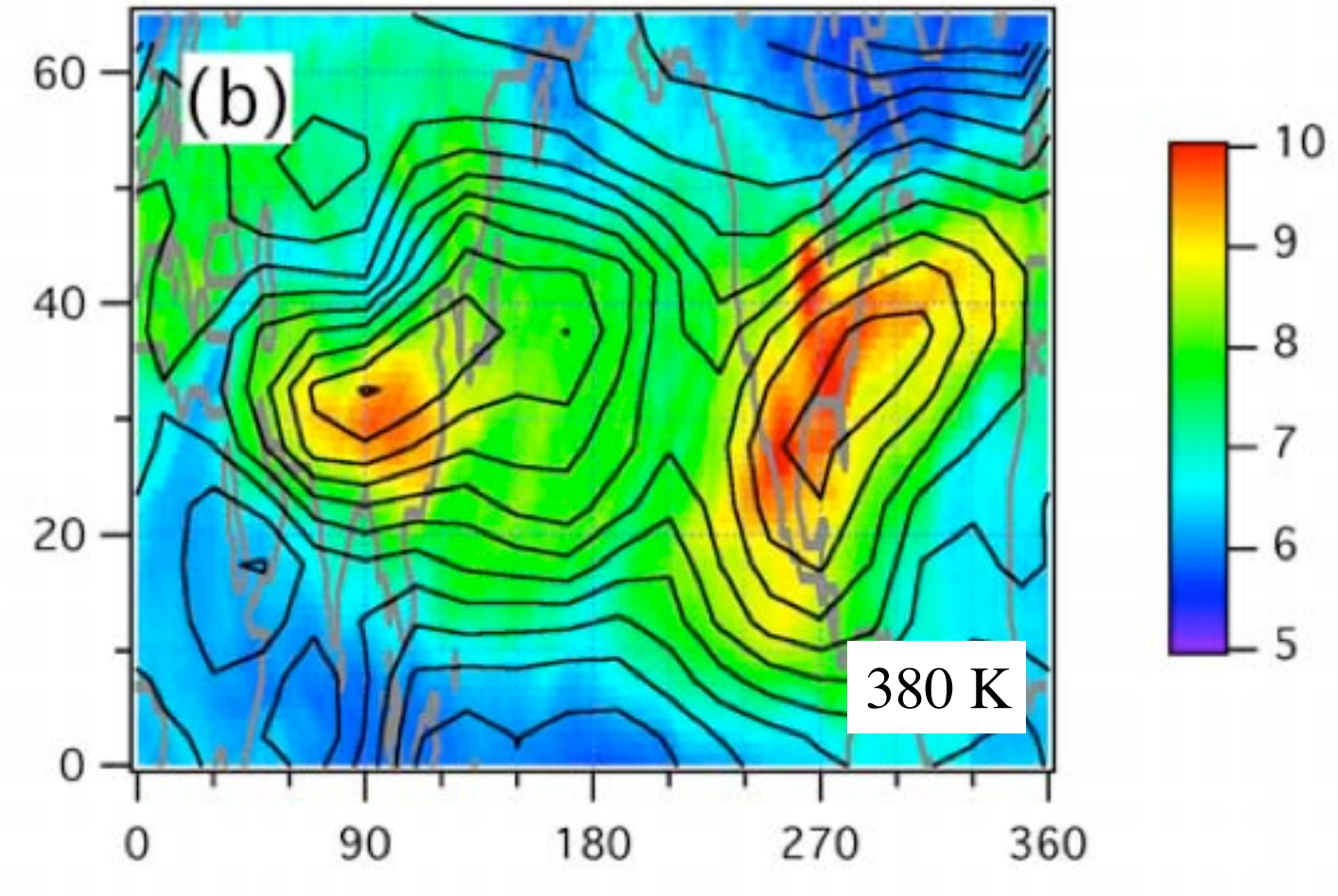
Dessler and Sherwood, Effect of convection on the summertime extratropical lower stratosphere, JGR, 2004



also: Randel et al., J. Geophys. Res., 106, 14,313-14,325, 2001.

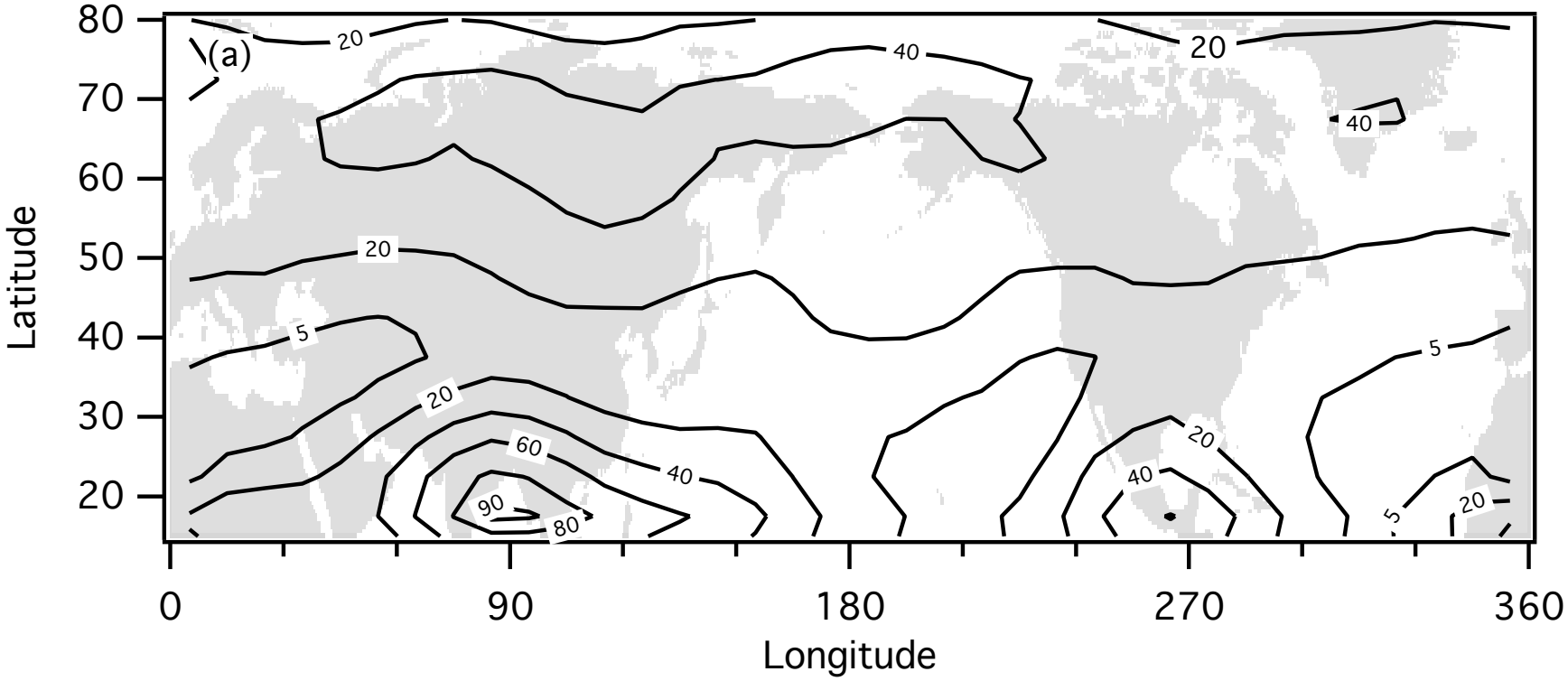
Dessler and Sherwood, Effect of convection on the summertime extratropical lower stratosphere, JGR, 2004



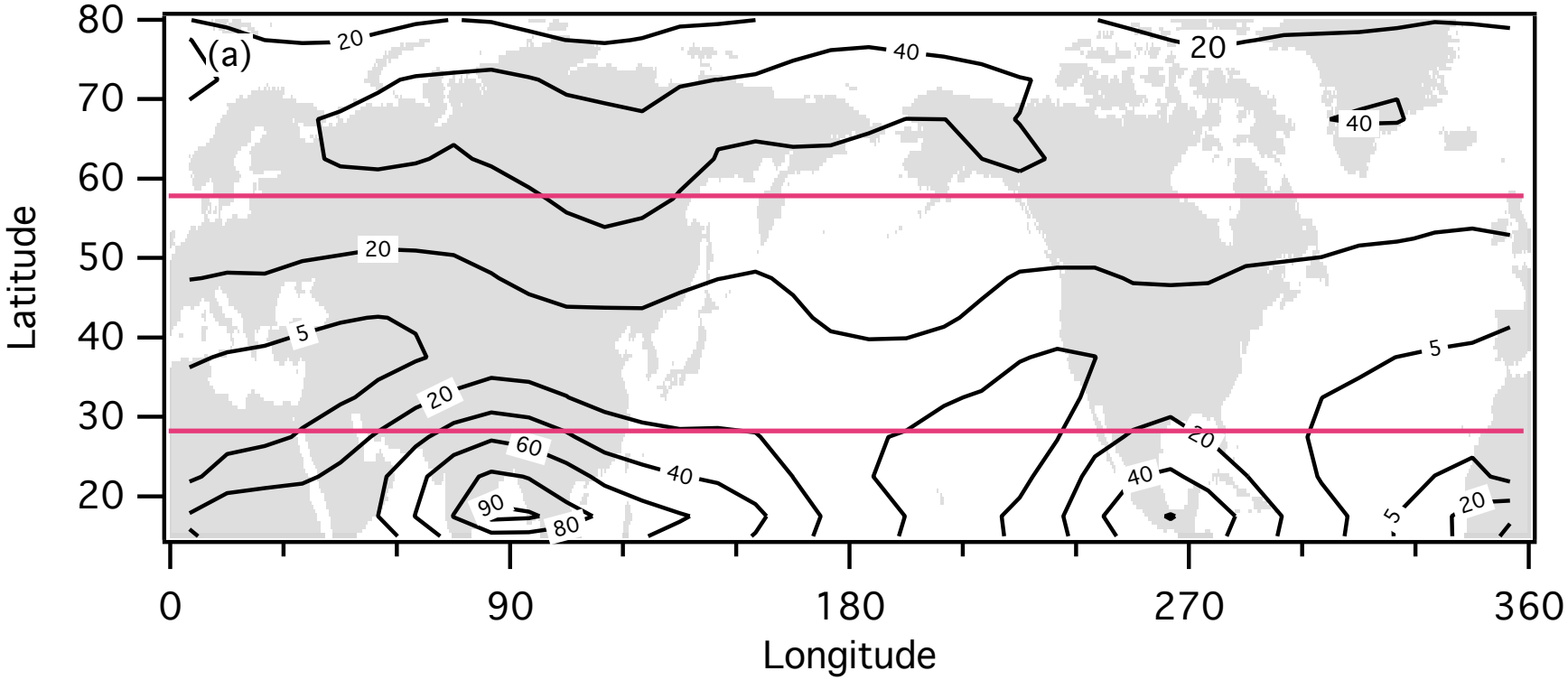
Data

- Calipso 5-km cloud-layer product, v2.01, 2.02
- June, July, August, September 2007-2008
- Nighttime data only
- Detection limit of optical depths of ~0.01
- Tropopause height from GEOS reanalysis
- Cloud tops as proxy for convection

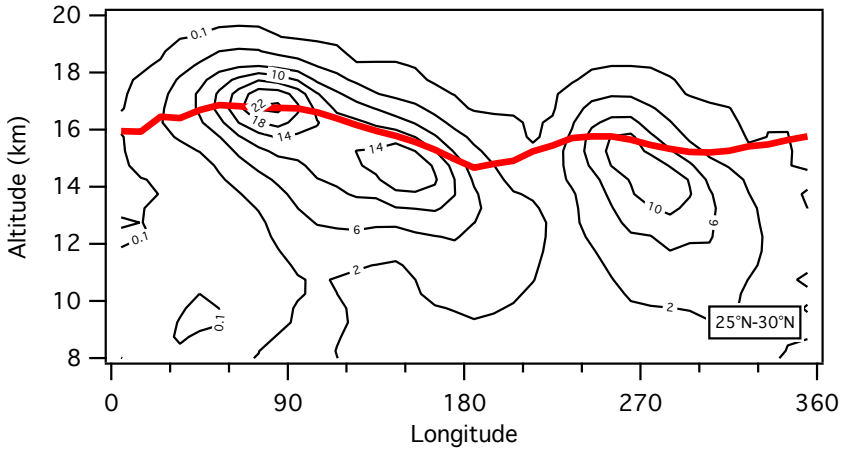
Fraction of measurements that show a cloud top above the tropopause

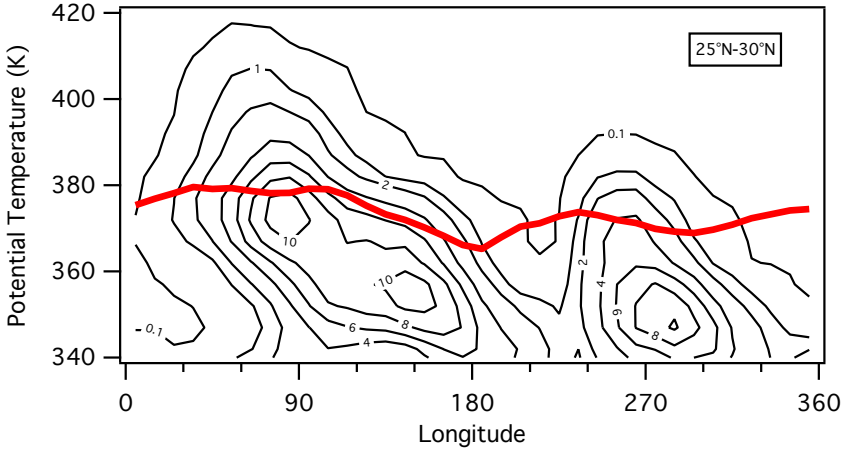


Fraction of measurements that show a cloud top above the tropopause

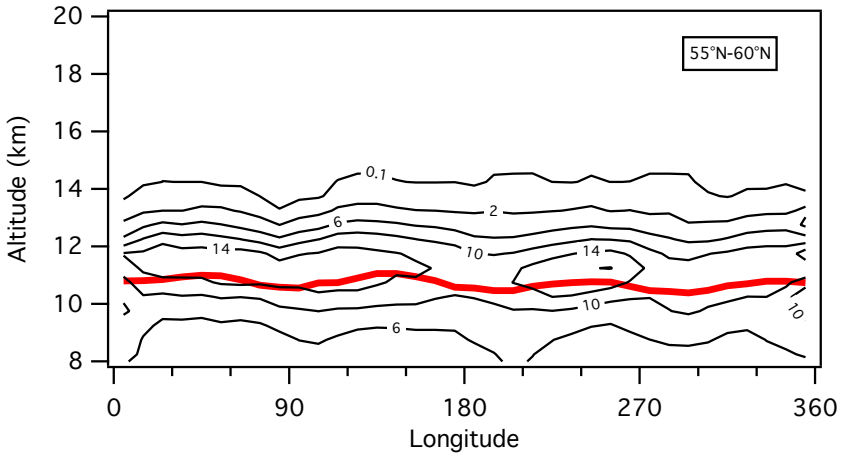


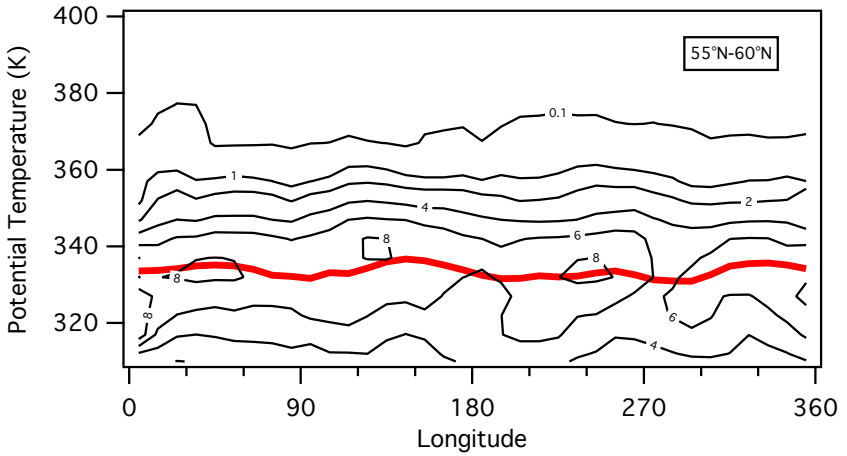
25°N-30°N

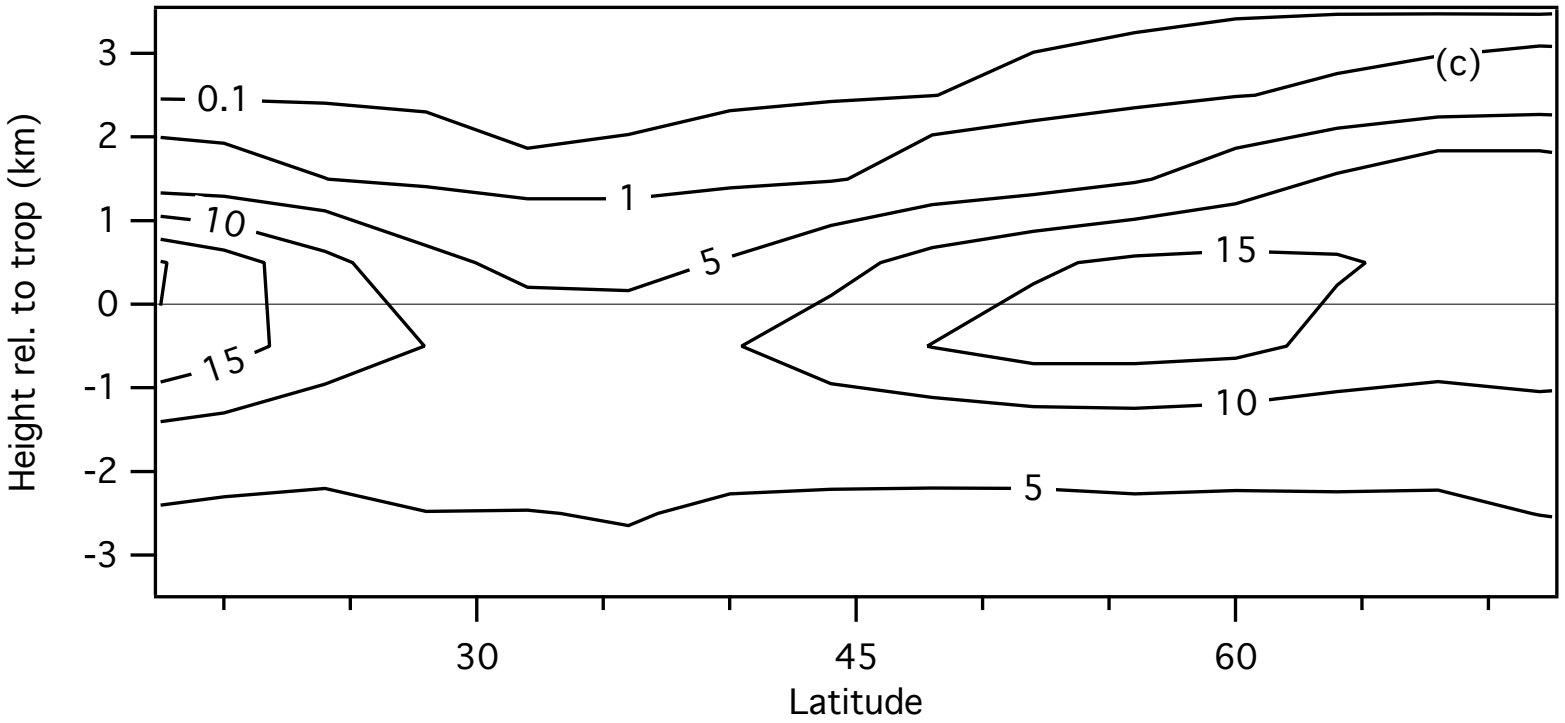

Altitude (km)
Longitude
25°N-30°N


Potential Temperature (K)
Longitude
25°N-30°N

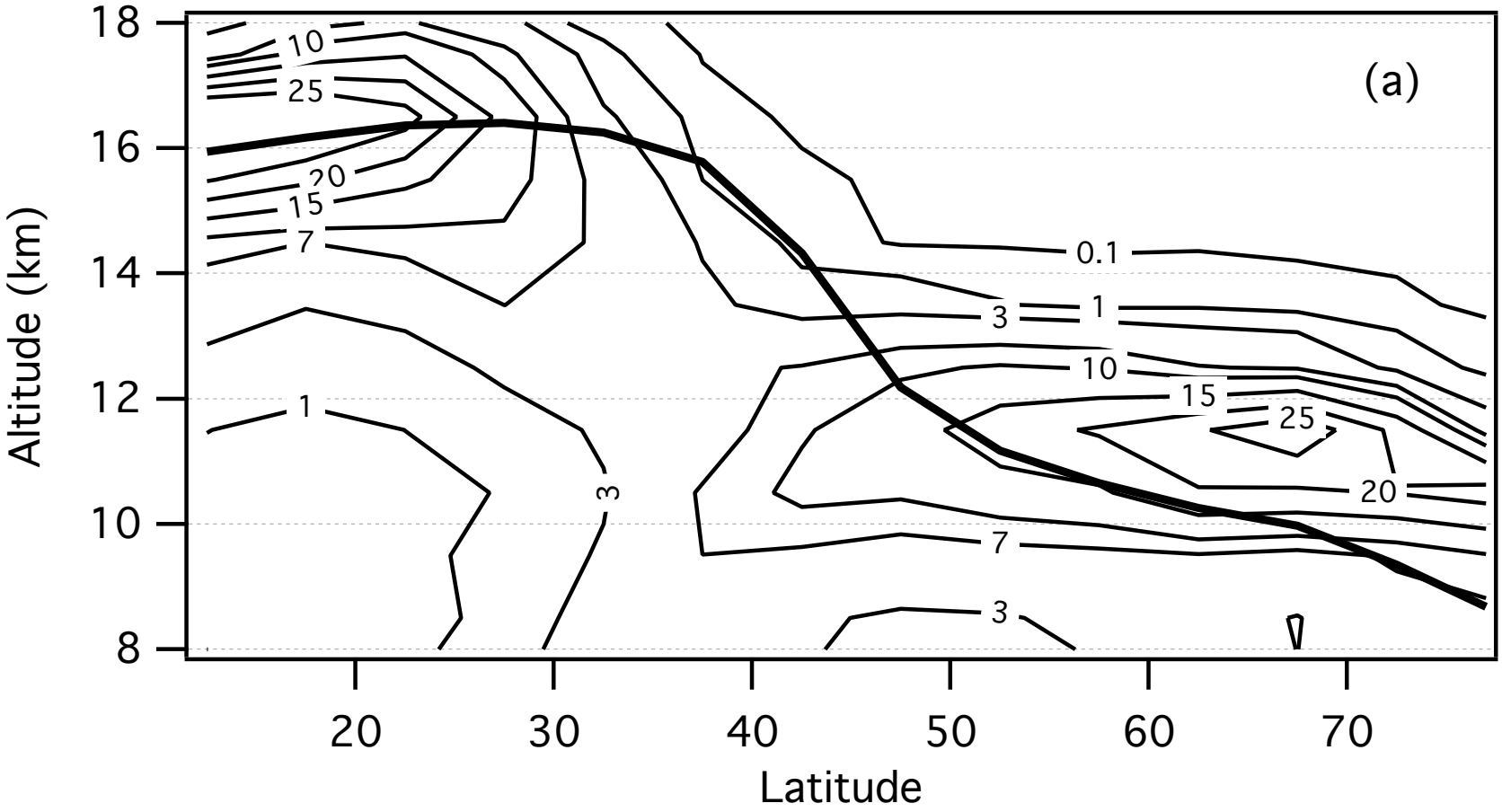
55°N-60°N

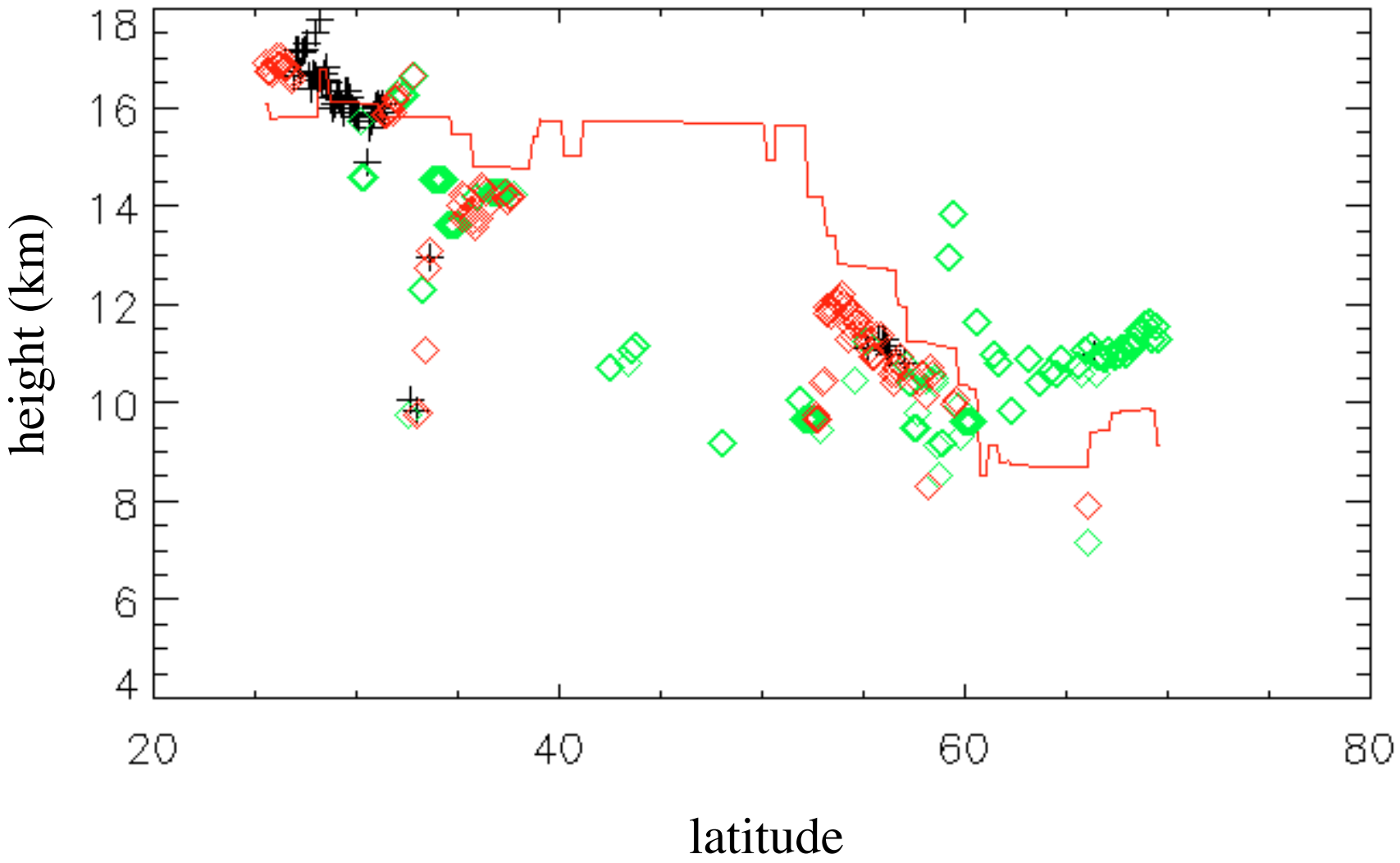

55°N-60°N
Altitude (km)
Longitude
20
18
16
14
12
10
8
0
90
180
270
360
0.1
2
6
14
10
14
10
10
6


55°N-60°N
Potential Temperature (K)
Longitude
400
380
360
340
320
0
90
180
270
360
0.1
1
4
2
8
6
8
8
6
4

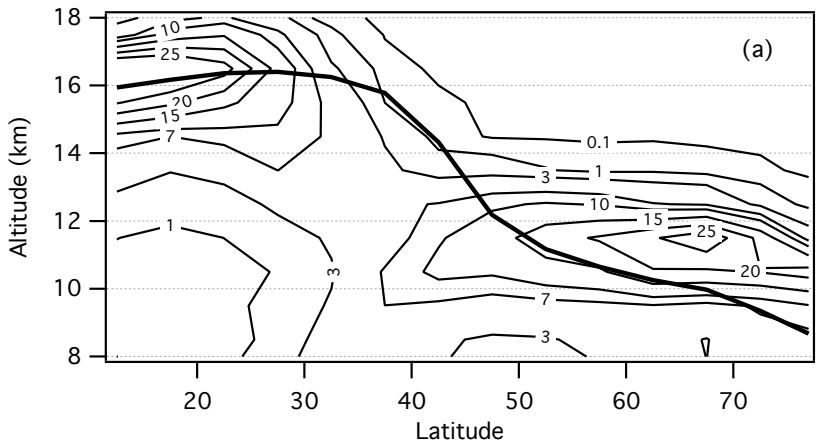

(c)
0.1
1
10
5
15
15
10
5
3
2
1
0
-1
-2
-3
Height rel. to trop (km)
30
45
60
Latitude

Cloud-top fraction (%)
Latitude cross-section through Asian monsoon

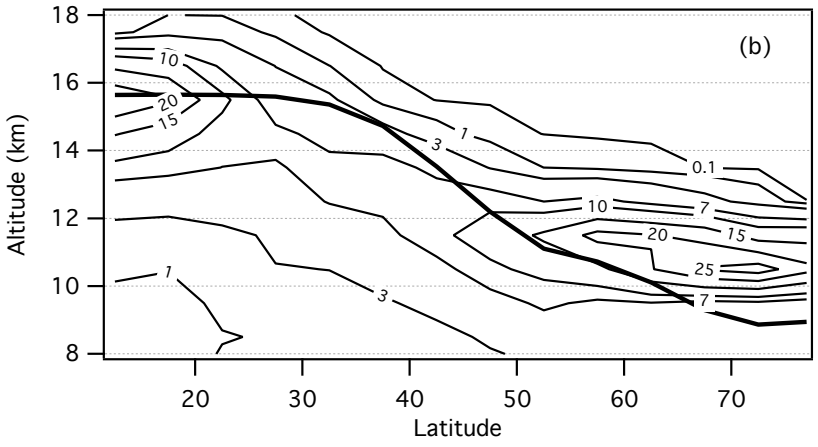



height (km)
18
16
14
12
10
8
6
4
20
40
60
80
latitude

Cloud-top fraction (%)
Latitude cross-sections

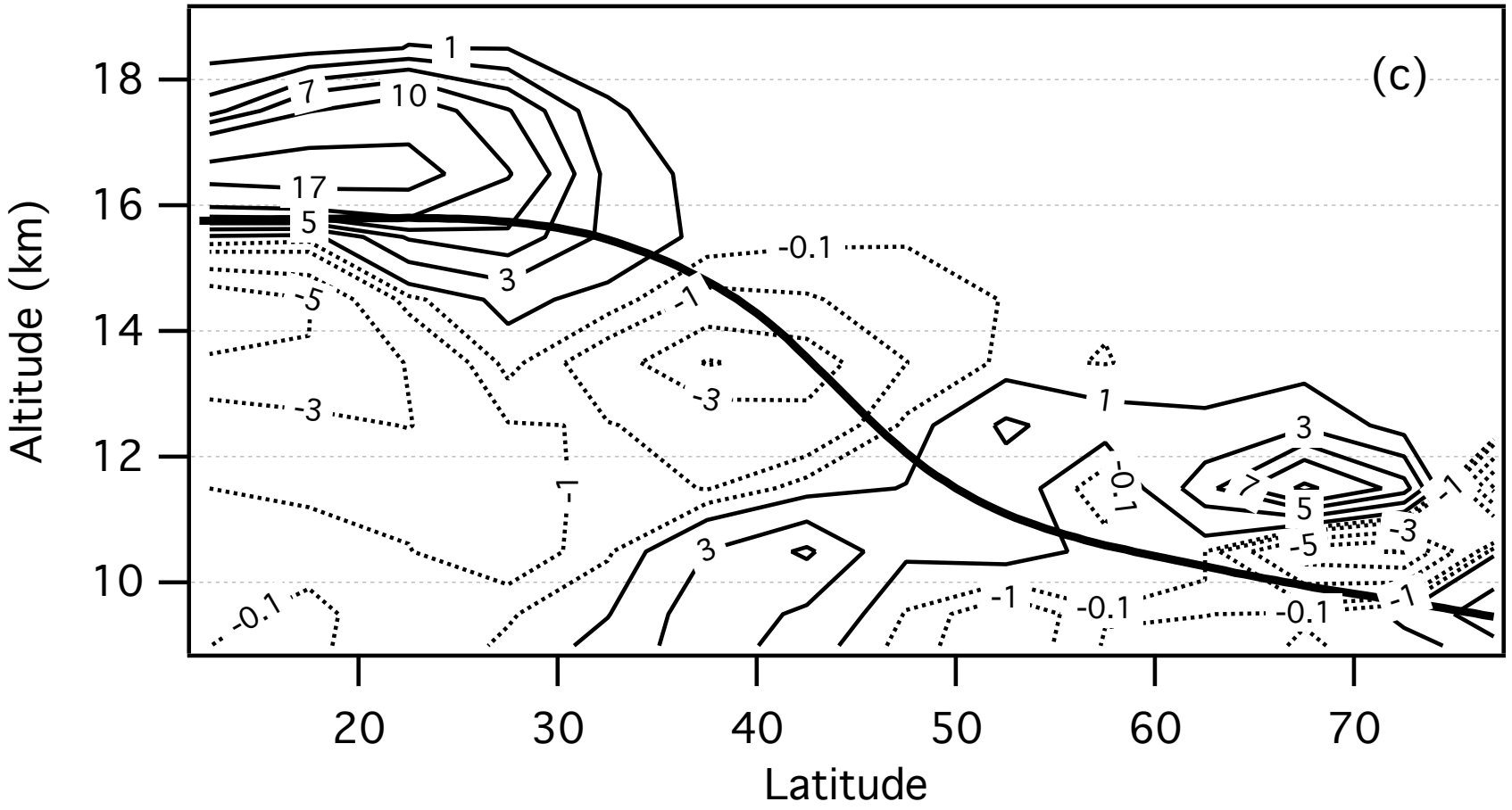


Asian sector



North American sector

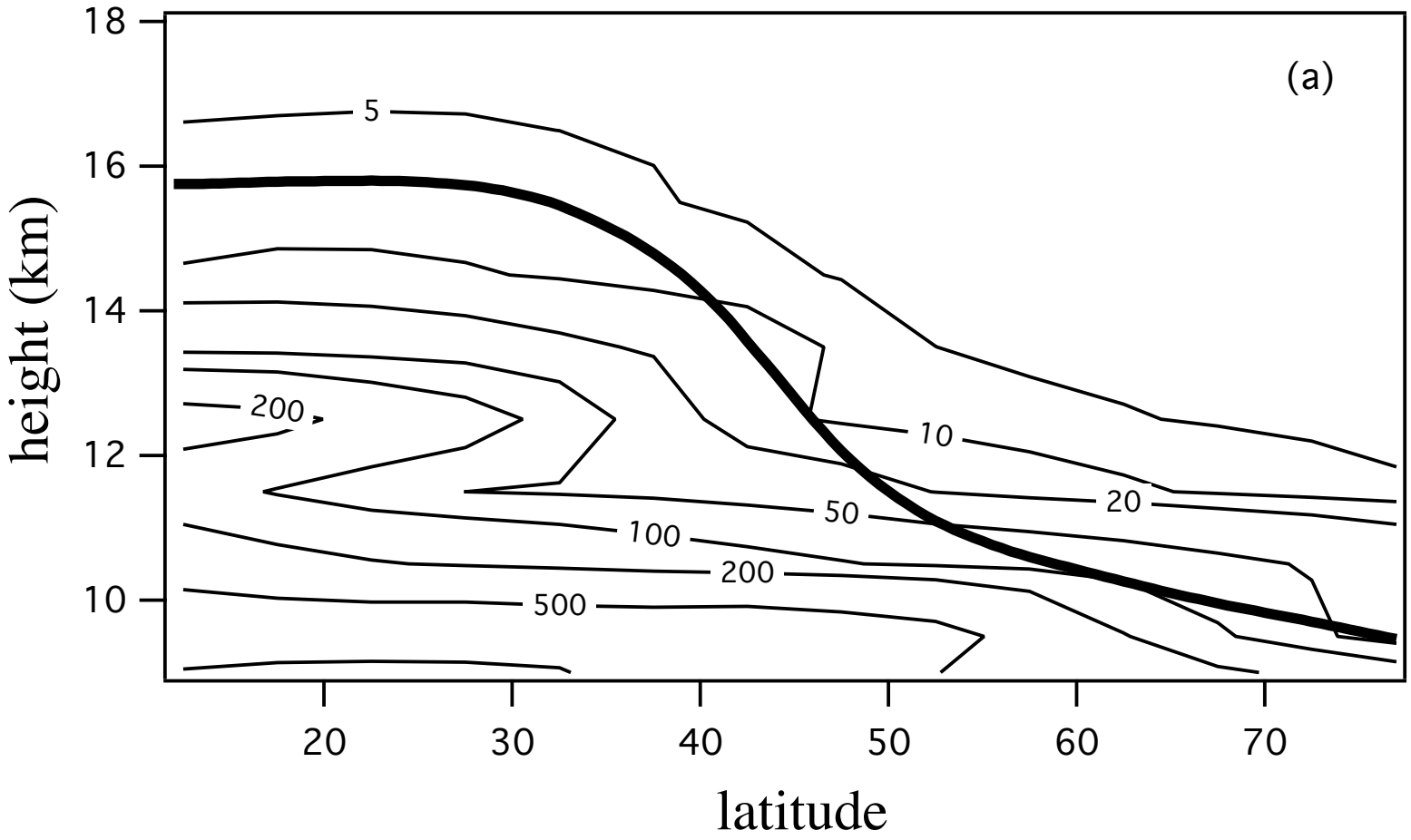
Abs. difference in cloud-top fraction between Asian and North American sectors



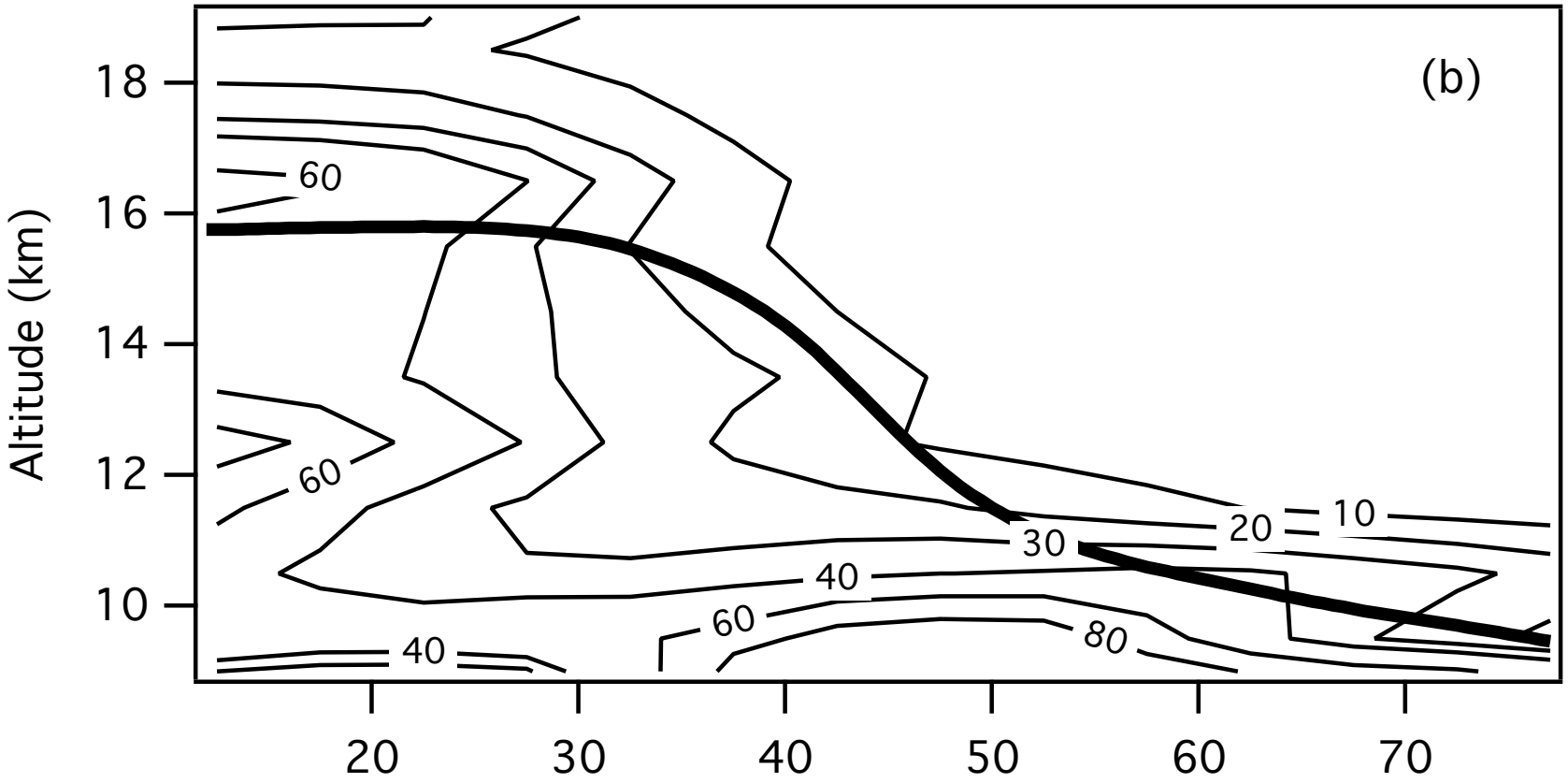
Data

- MLS v2.2
- June, July, August, September 2008
- Period when Calipso and MLS tracks aligned
- H_2O accuracy is ~10%
- Gridded Calipso data onto MLS grid

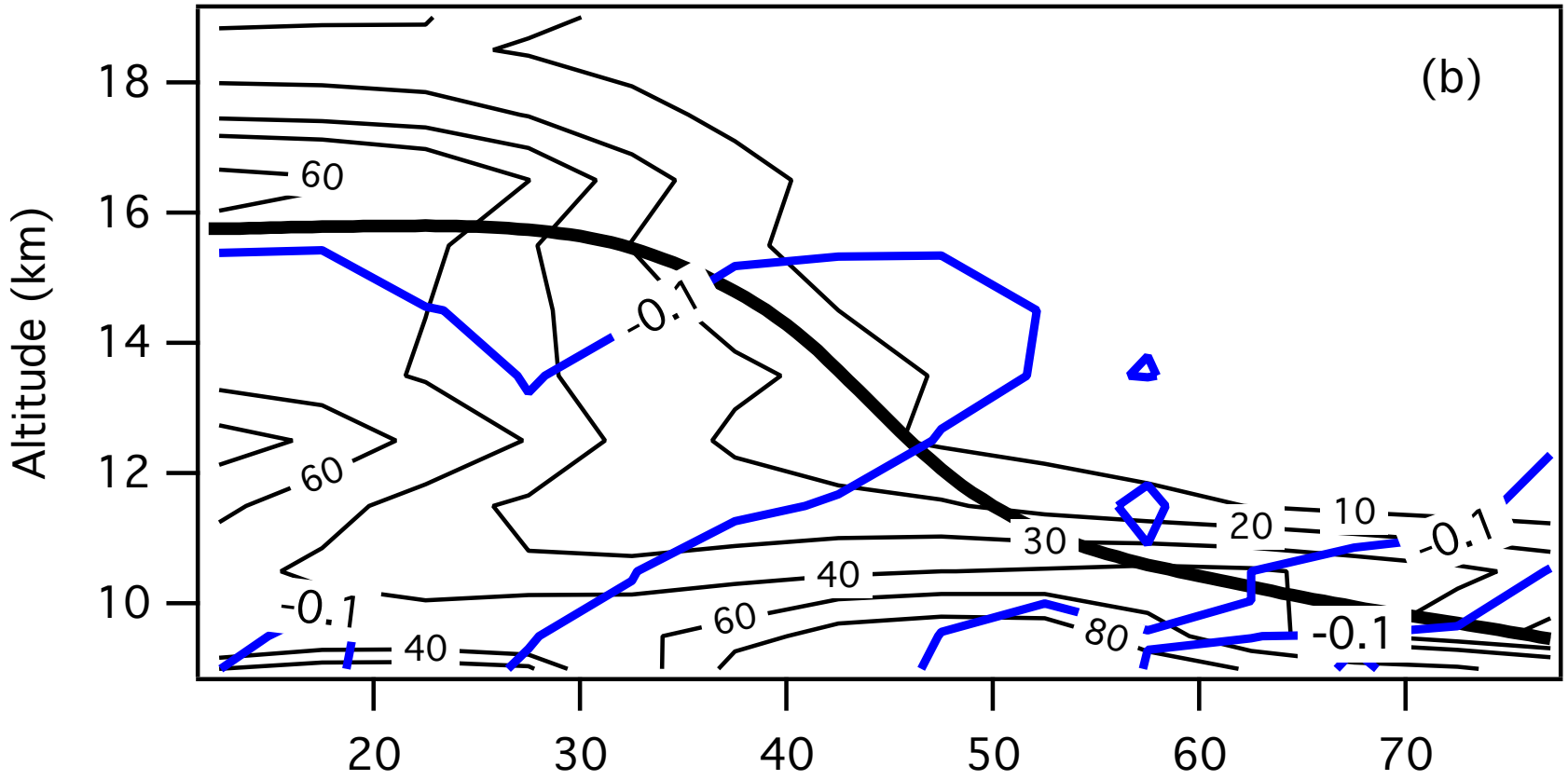
H_2O mixing ratio (ppmv)



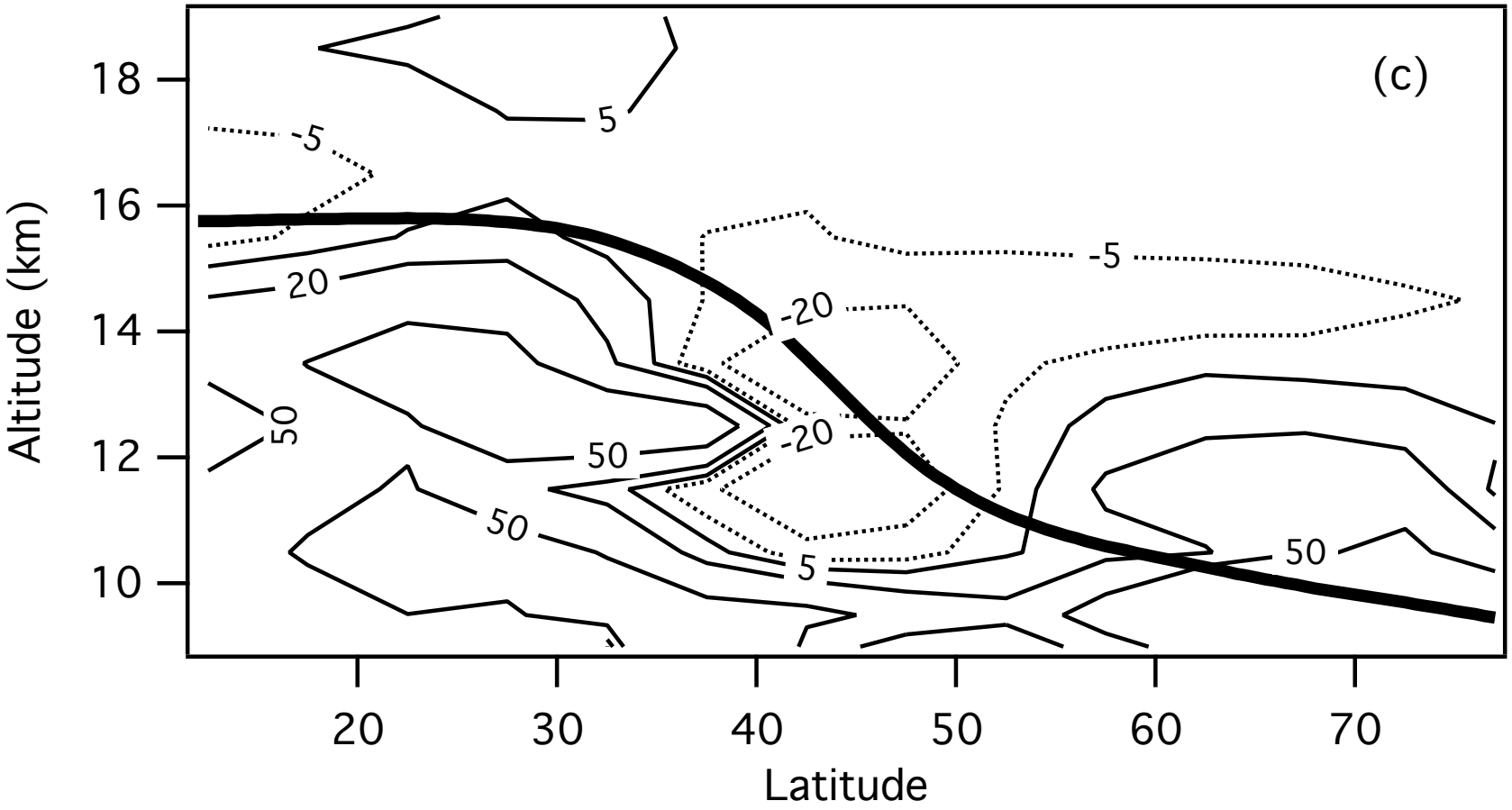
Relative humidity
(from MLS vmr + GEOS T)



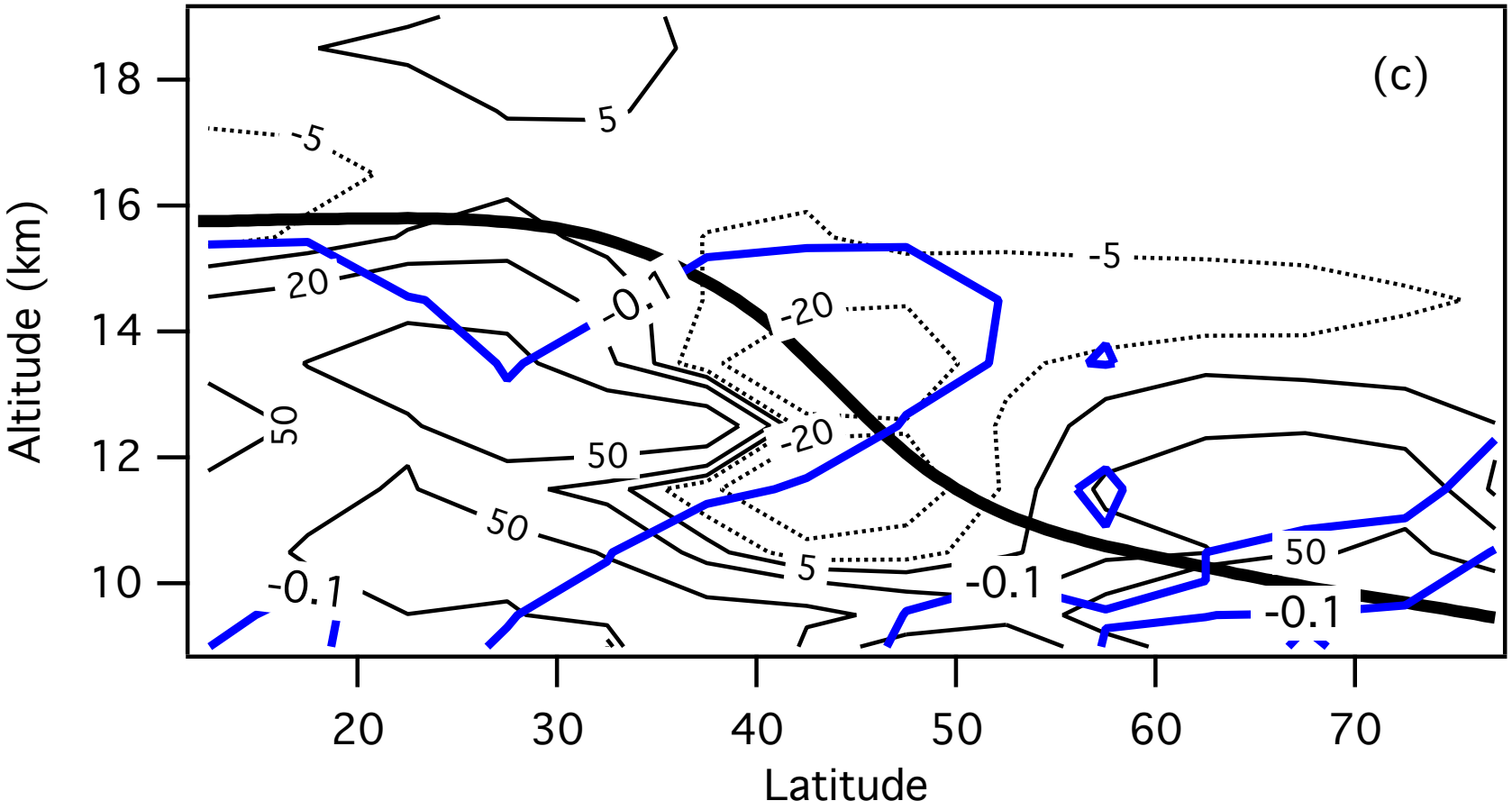
Relative humidity
(from MLS vmr + GEOS T)



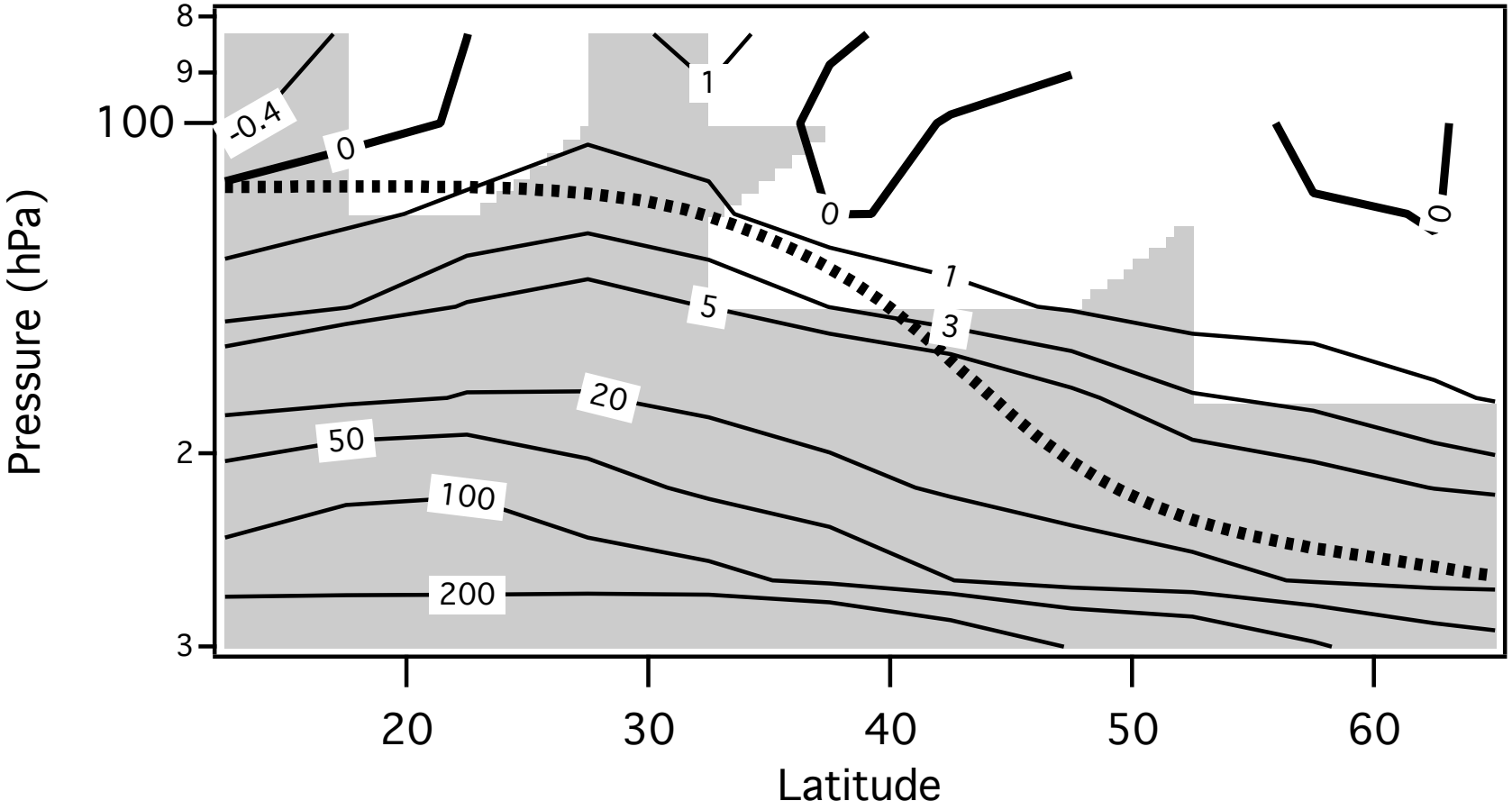
Percent difference in H_2O vmr between Asian and North American sectors



Percent difference in H_2O vmr between Asian and North American sectors

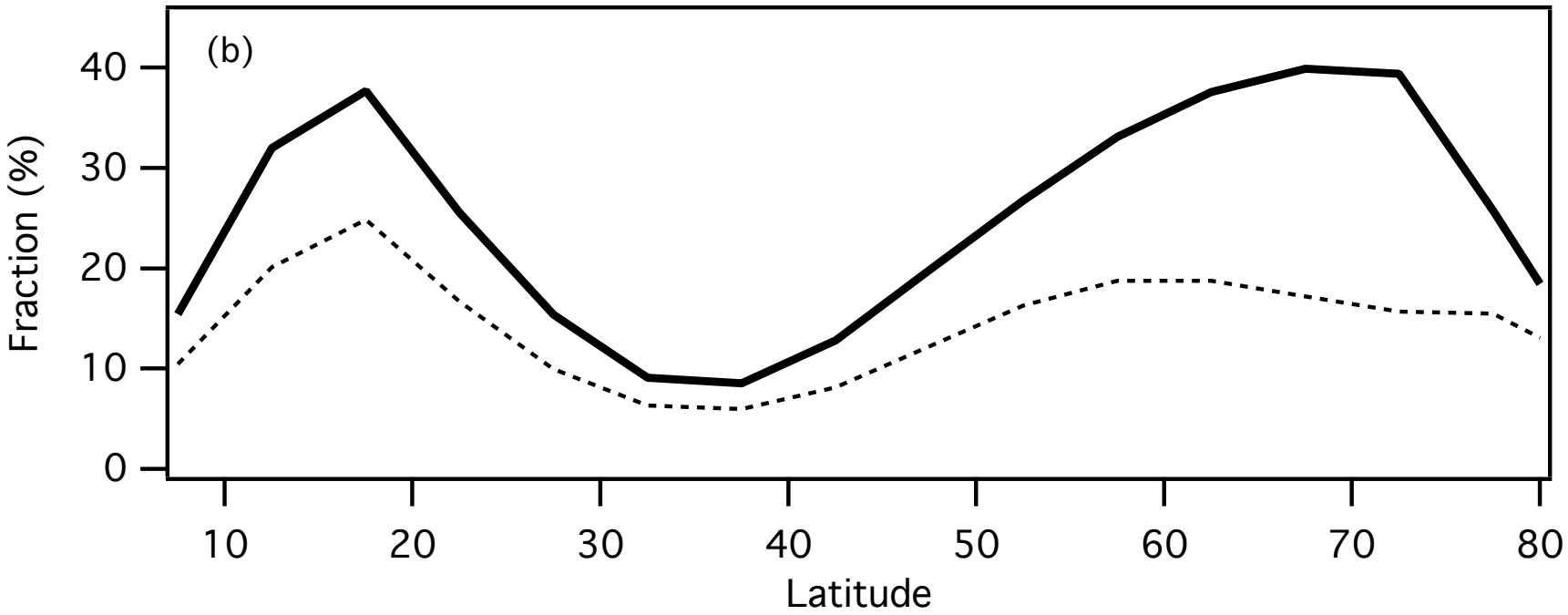


H_2O_{cloudy} minus H_2O_{clear}

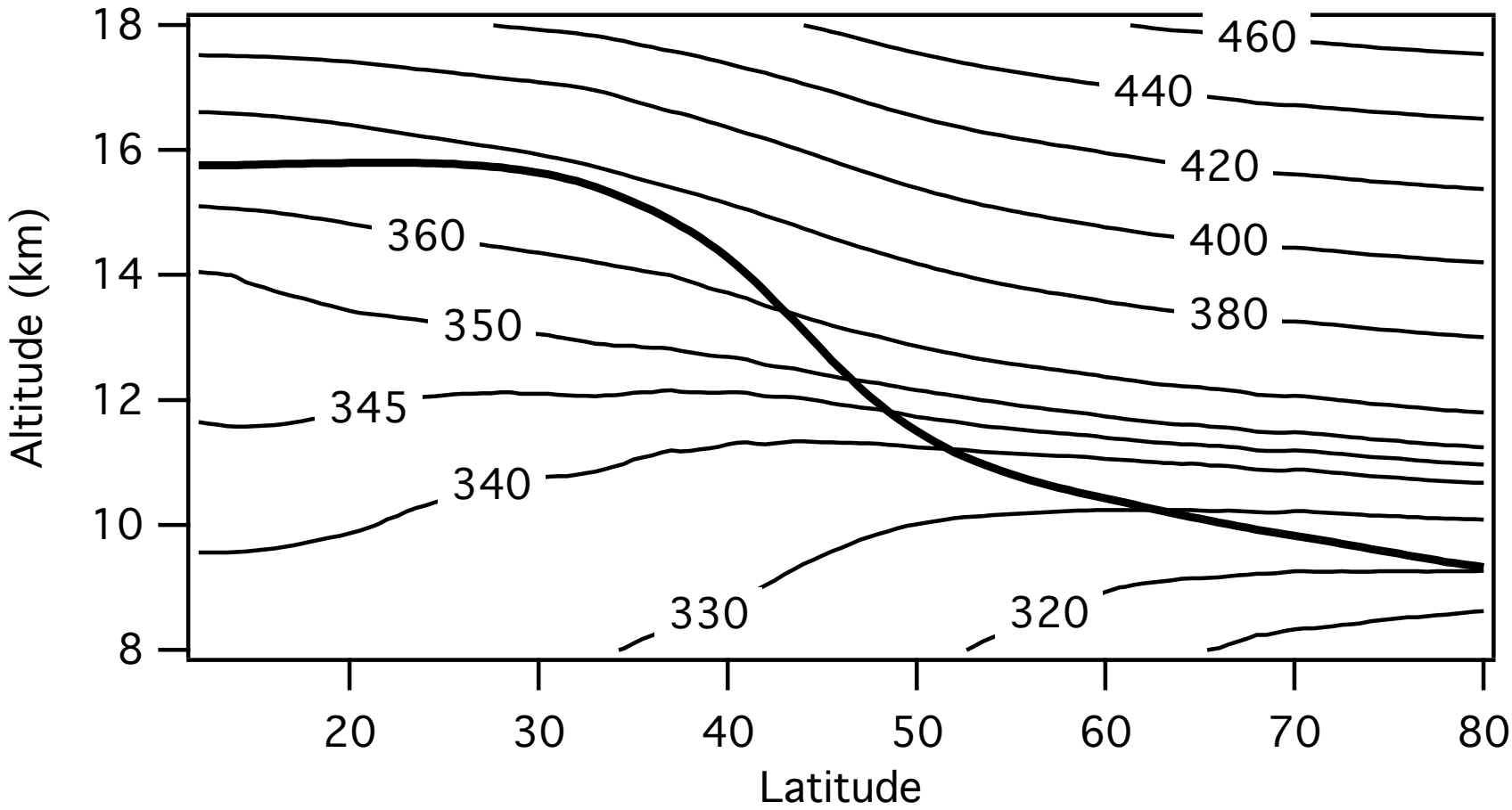


Conclusions

- The 0.1% cloud-top occurrence contour tends to be found ~3 km or 40-50 K of potential temperature above the tropopause.
- In mid and high latitudes, clouds are associated with enhanced water vapor, suggesting that clouds are associated with moistening events in the lower stratosphere.
- In the subtropics, the occurrence of clouds is associated with reduced water vapor.
- Our results are consistent with hydration or dehydration being determined by the local relative humidity.
- in press at JGR, e-mail me if you'd like a preprint

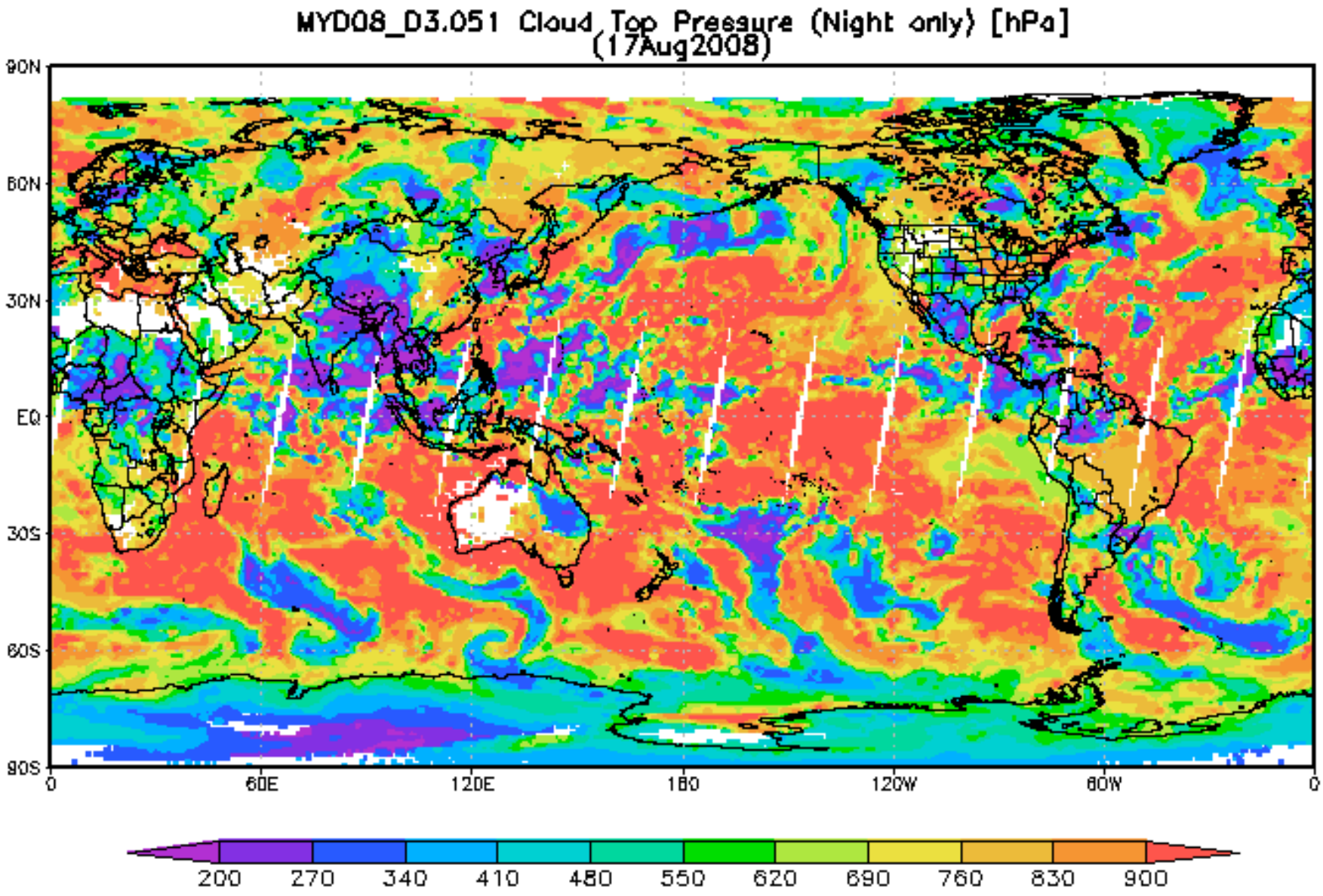


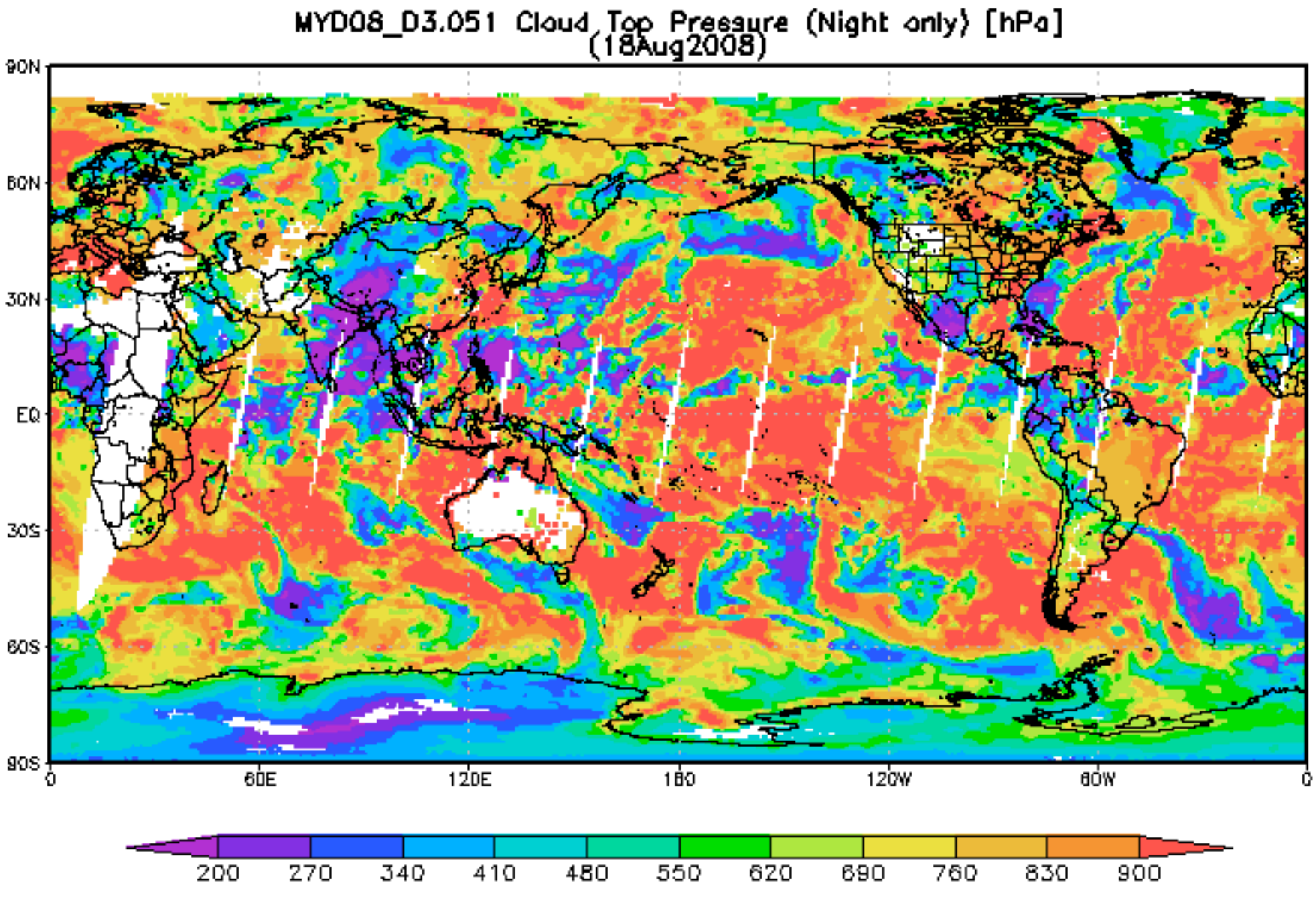
Solid line: nighttime cloud frequency
Dotted line: daytime cloud frequency

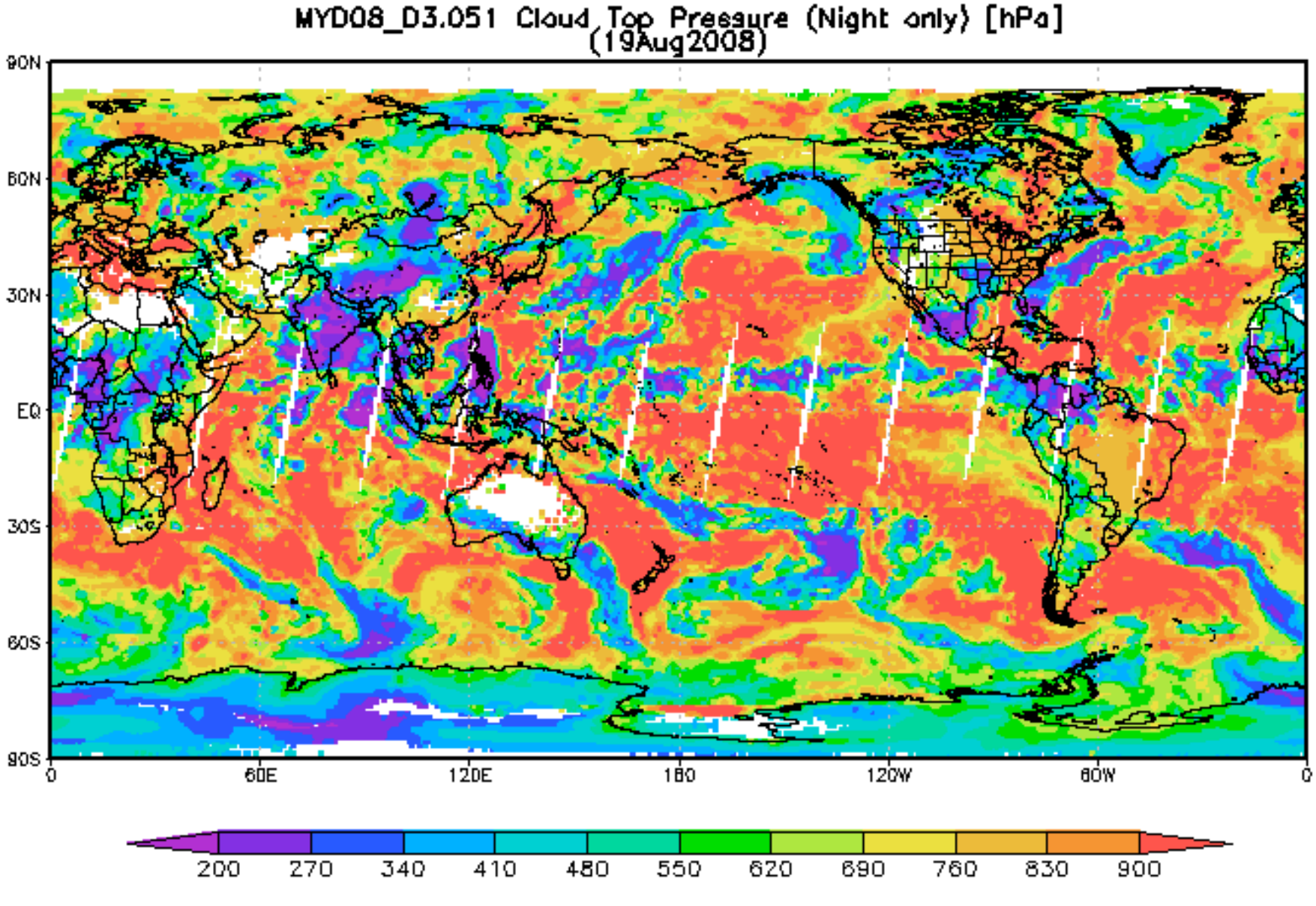

Altitude (km)
18
16
14
12
10
8
20
30
40
50
60
70
80
Latitude
460
440
420
400
380
360
350
345
340
330
320

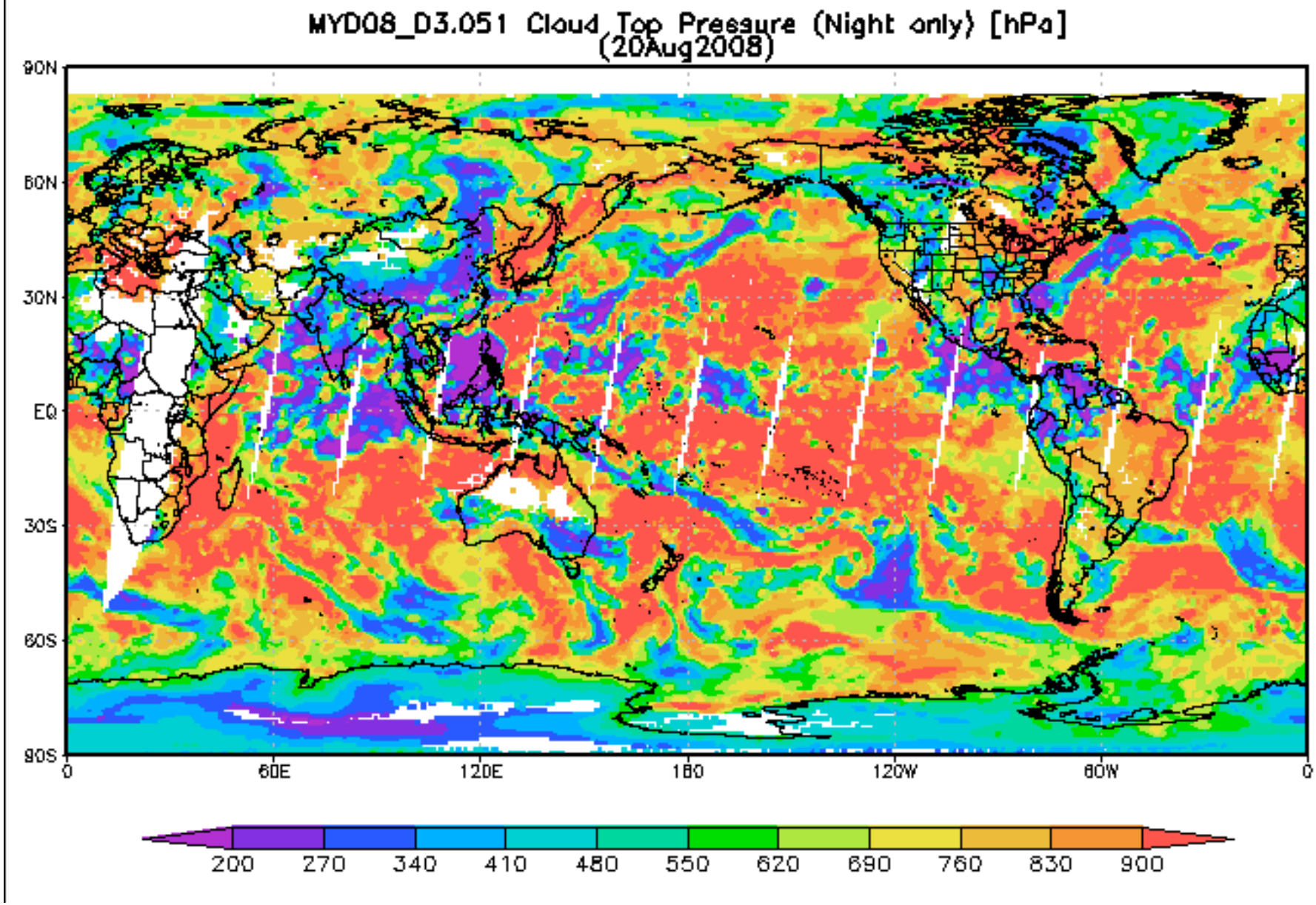
Movie of MODIS cloud heights

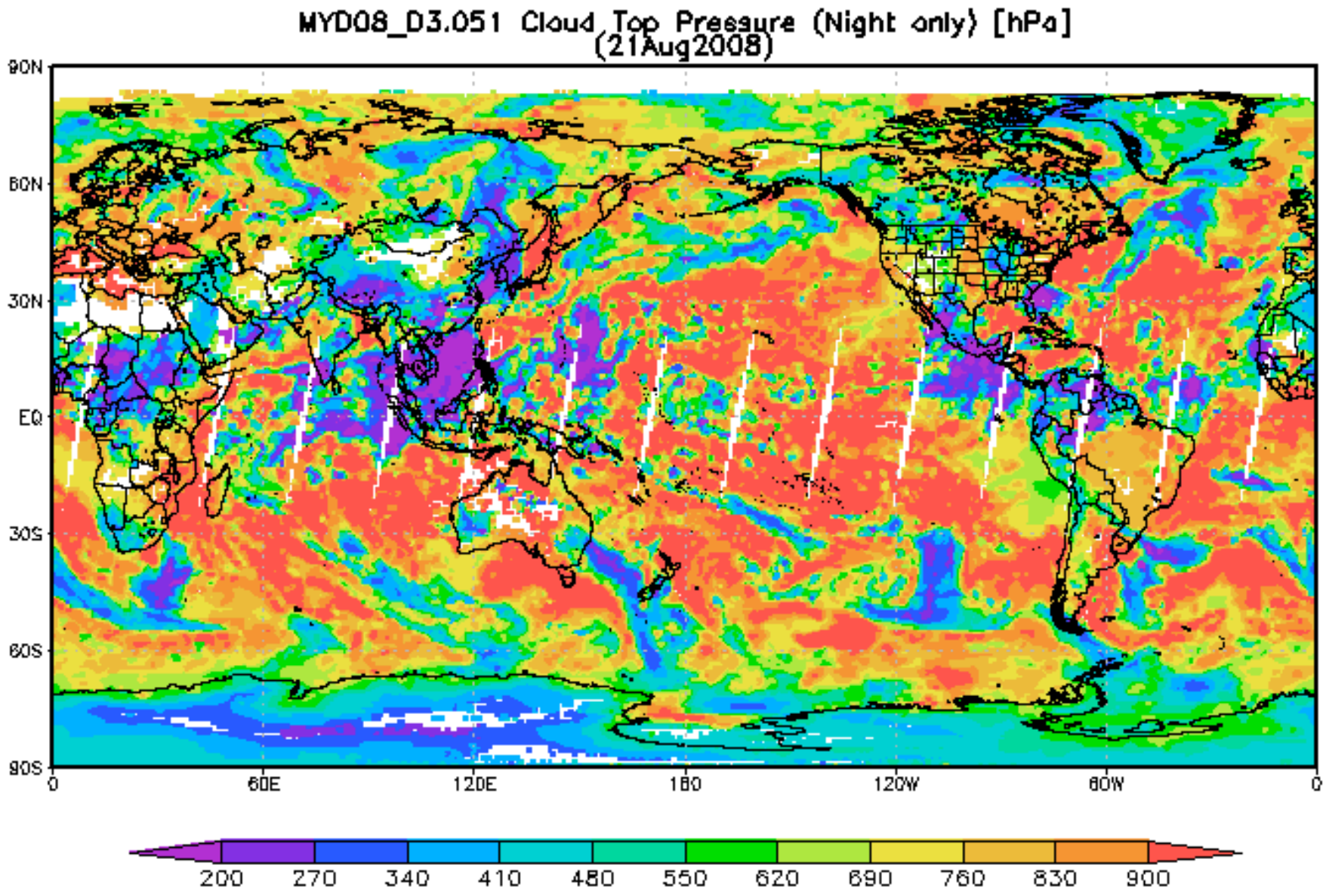
created by GSFC DISC Giovanni

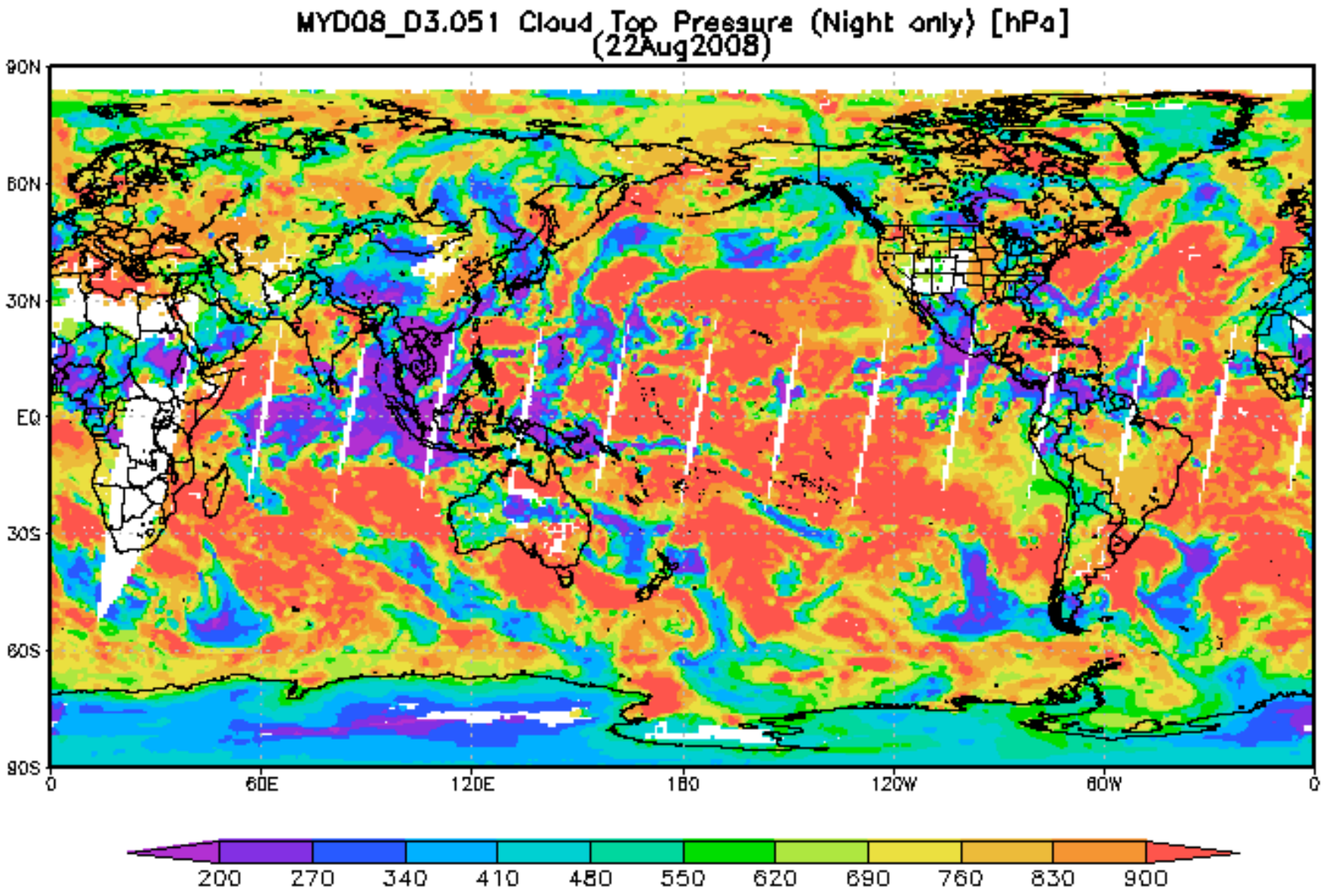

MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(17Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900

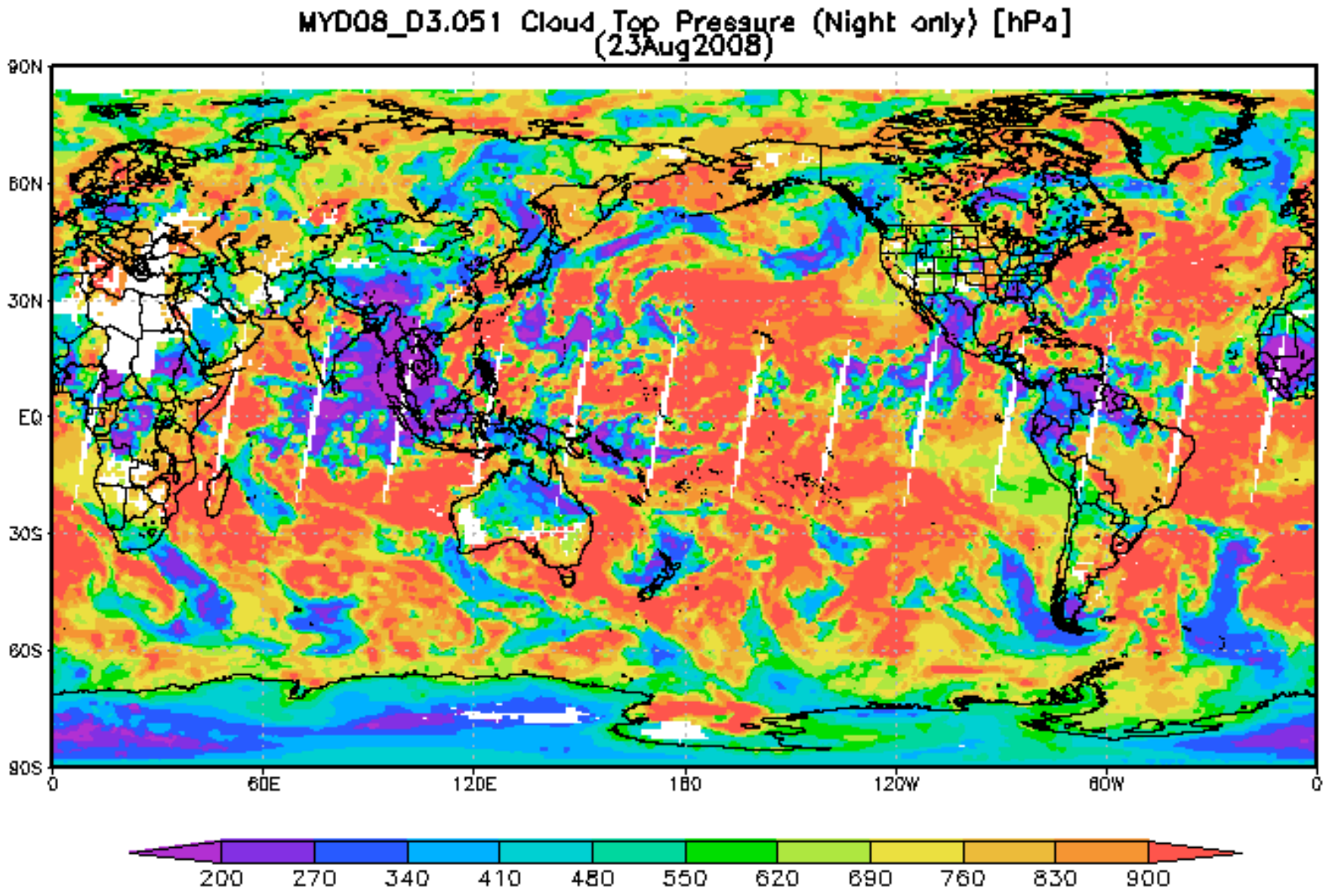

MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(18Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900


MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(19Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900

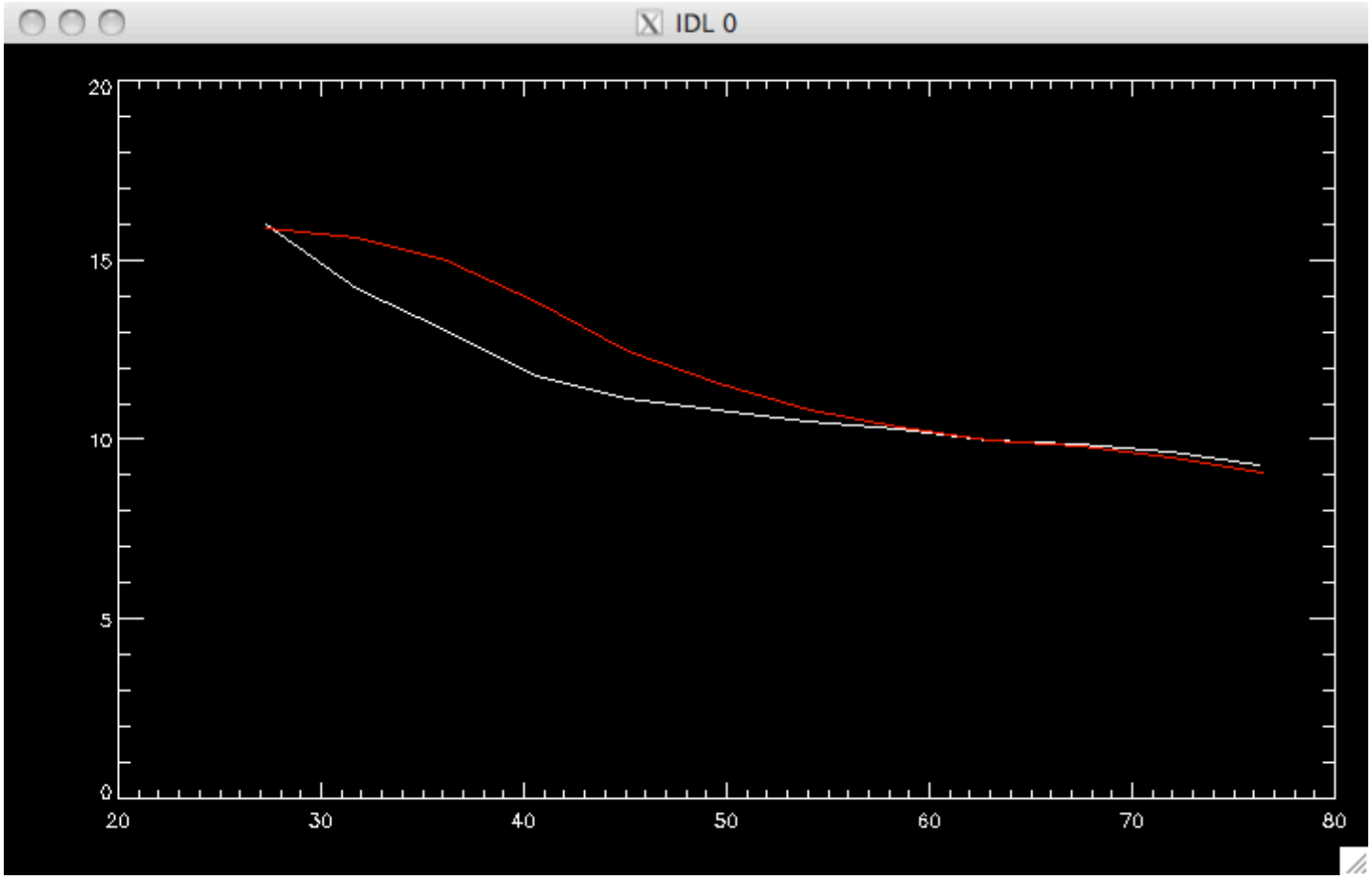

MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(20Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900


MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(21Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900


MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(22Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900


MYD08_D3.051 Cloud Top Pressure (Night only) [hPa]
(23Aug2008)
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
200
270
340
410
480
550
620
690
760
830
900

white: trop w/ clouds, red: trop w/o clouds
sept. 08 data



Trop height (km)

Latitude