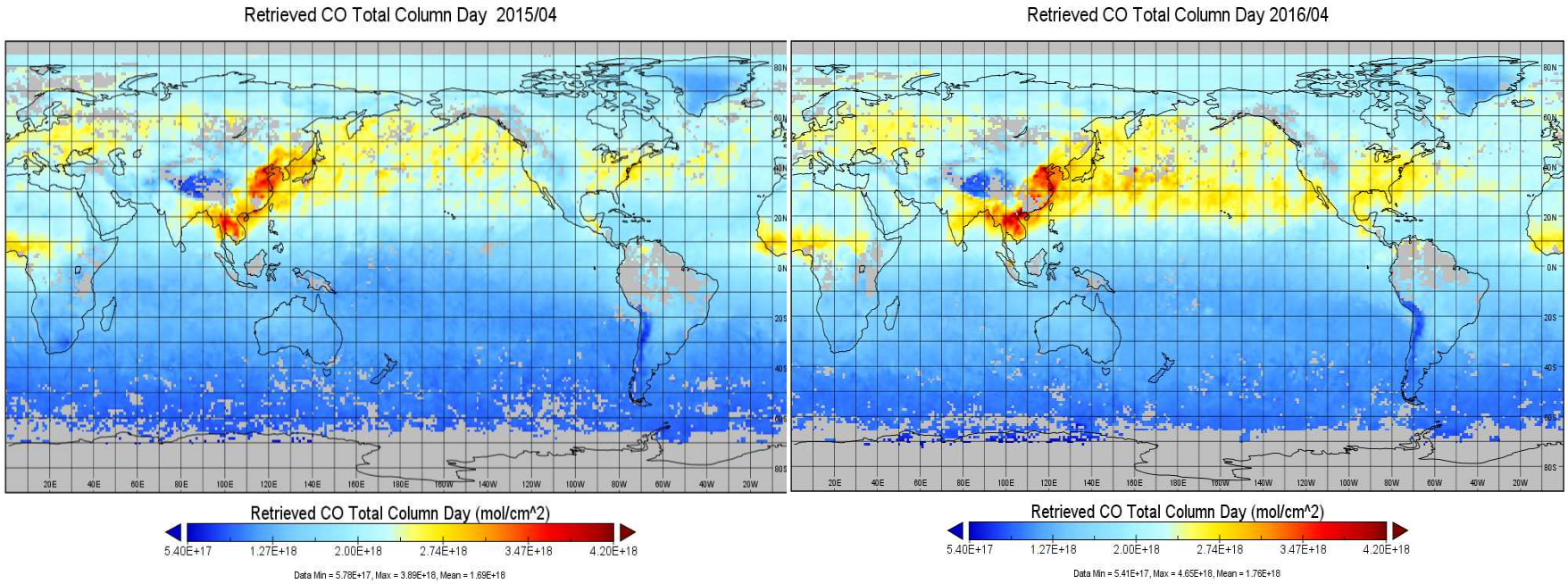
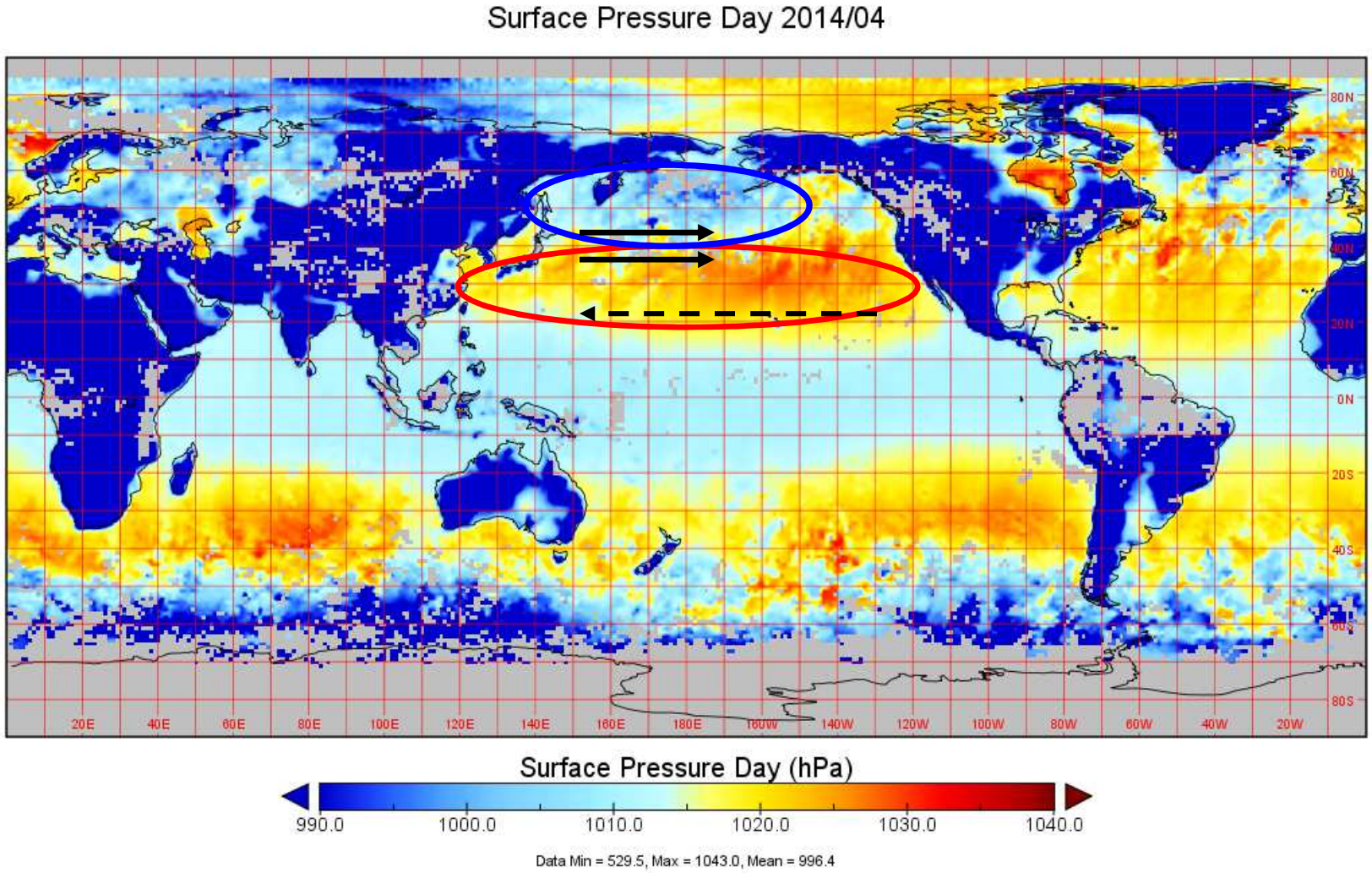
Spring CO pollution transport over Pacific as seen by MOPITT



Florian Nichitiu March 2017



The pathways of CO transport is most likely along the border between Aleutian Low and Pacific High, a quasi permanent cyclonic-anti-cyclonic structure.

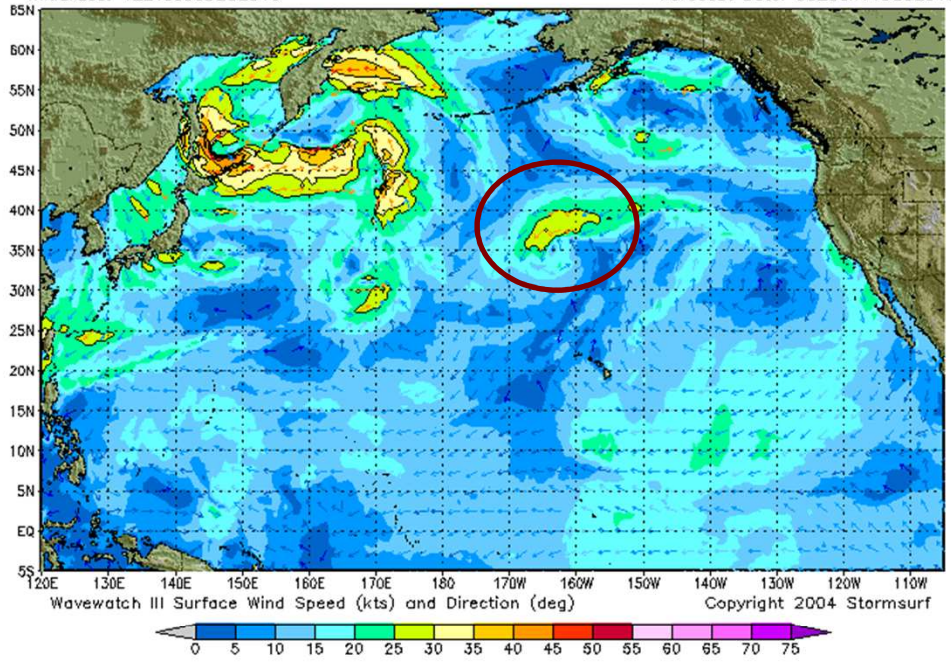
Blue ellipse: Aleutian Low ; Red ellipse: Pacific High.

Plot done using 'Pressure' from MOPITT

STORMSURF

+108hr Forecast

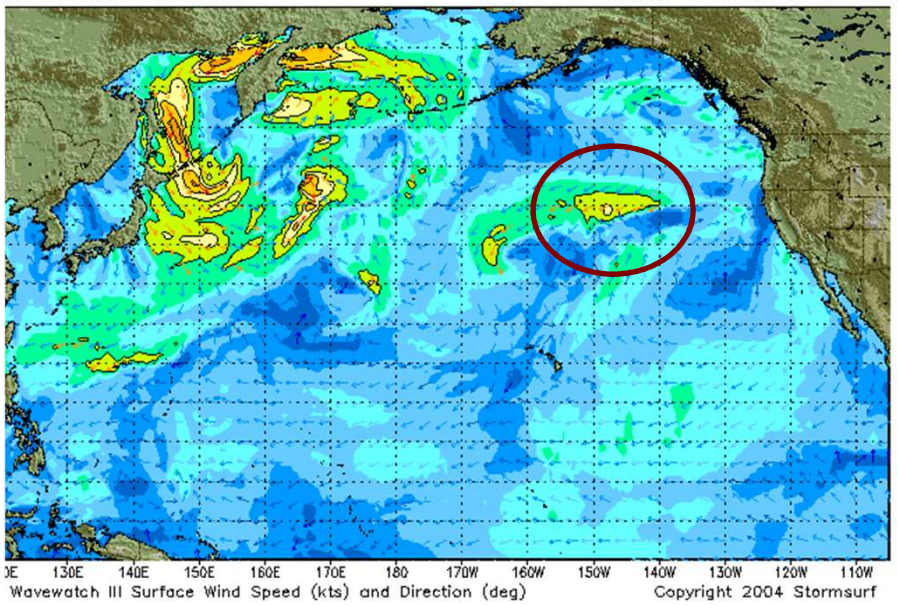
Initialized: 12ZTue06DEC2016 Forecast Date: 00ZSun11DEC2016



STORMSURF

+132hr Forecast

itialized: 12ZTue06DEC2016 Forecast Date: 00ZMon12DEC2016



+156hr Forecast

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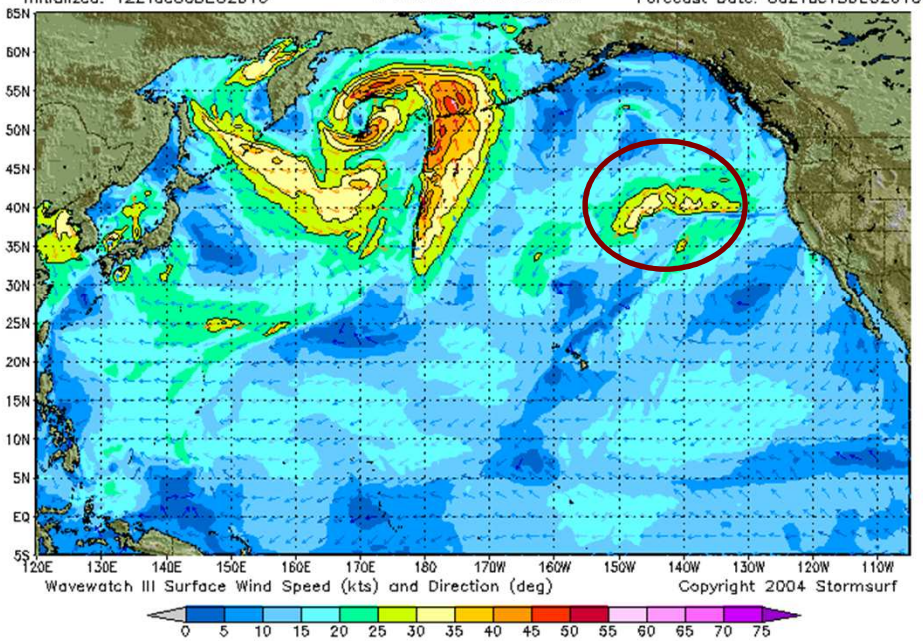

STORMSURF

+180hr Forecast

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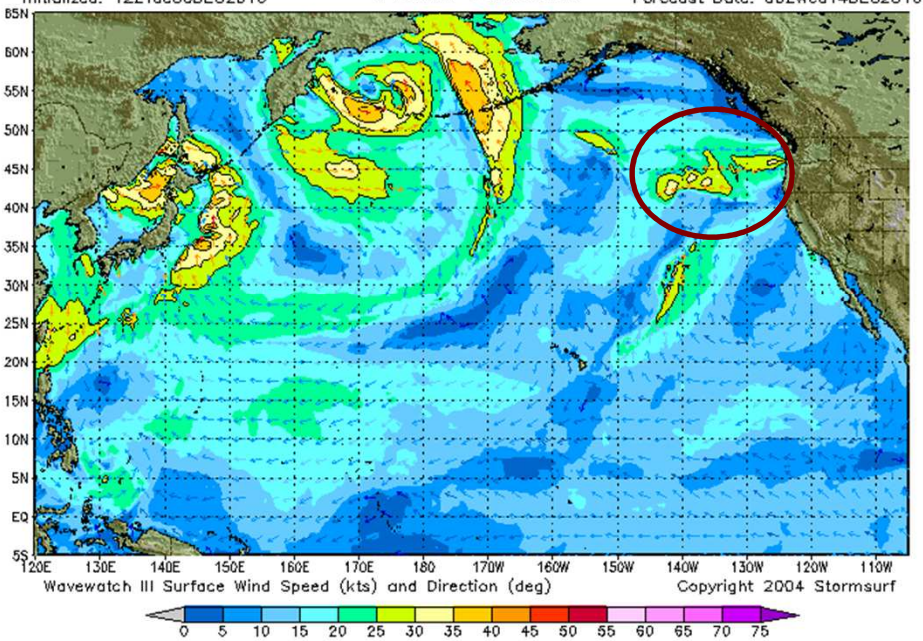


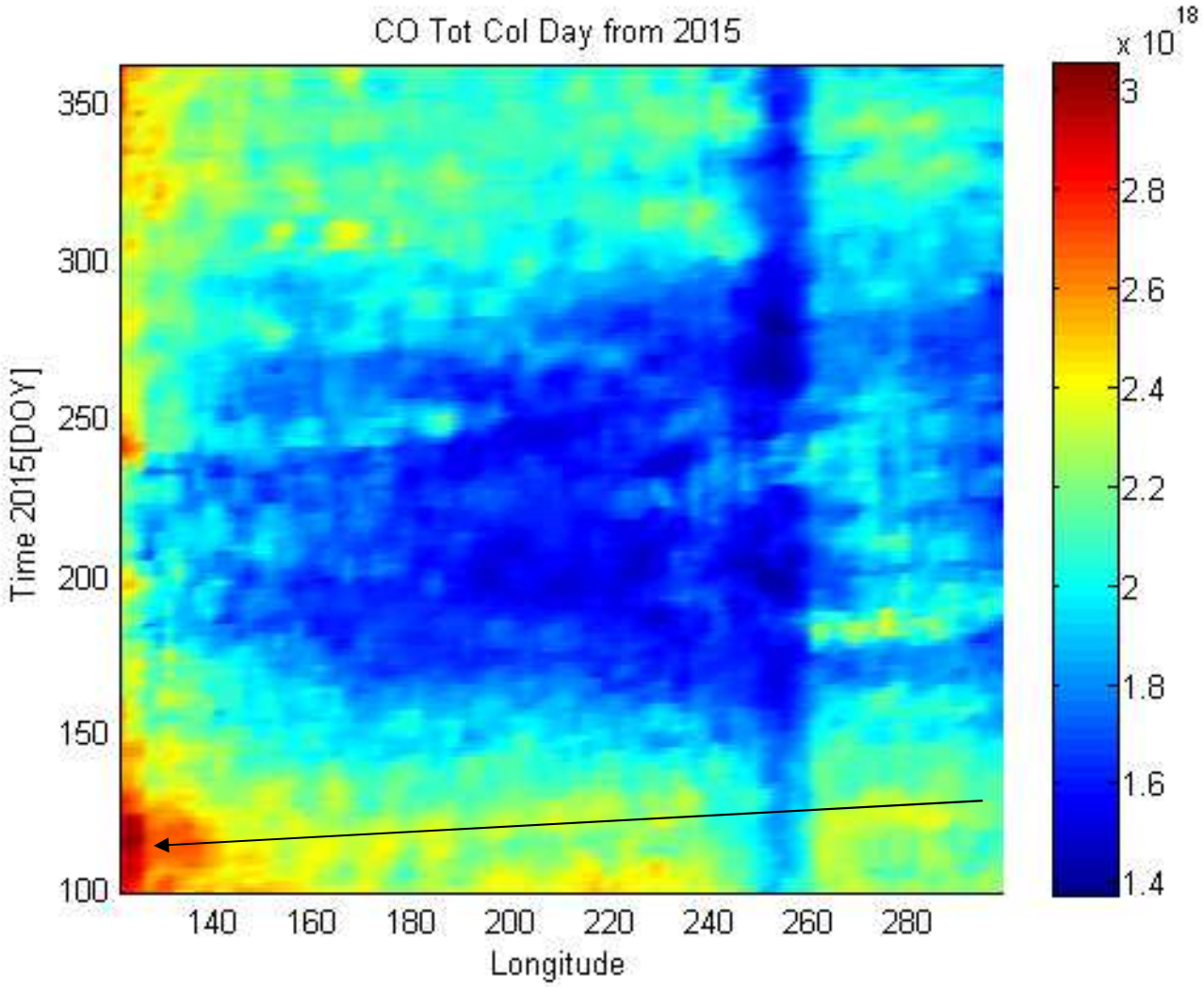
- Using **Wave Model - North Pacific Wind**
- (see the Animation at http://www.stormsurfing.com/cgi/display.cgi?a=npac_wind)
- we can do an estimate of the wind speed in the region between Canada and China/Russia border.

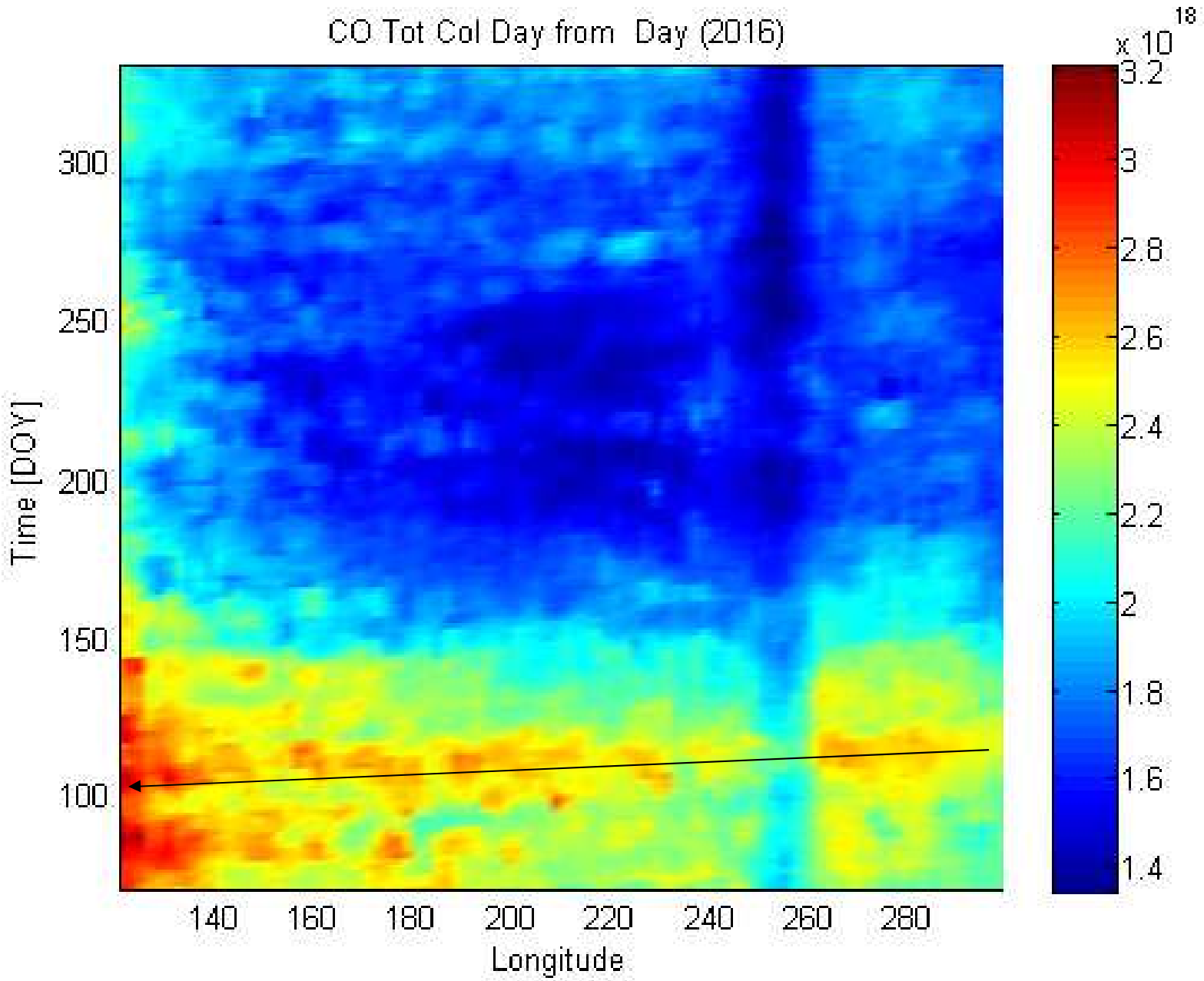
- From above plots (surf. Winds forecast at T=00 and days 11,12,13 and 14 Dec) we can guess a speed of the order:
- ~ 10 degrees in Longitude per Day, which means
- ~ **10 days to cross the ocean**. (V ~ 33Km/h), from China/Russia to North America.

- * Direction of wind as well as the time to cross the ocean seems to be OK, just like CO plume movement (from W to NE) observed by MOPITT. See next slide as example of daily CO transport in 2015. The slope of the CO stream indicate the advection speed.

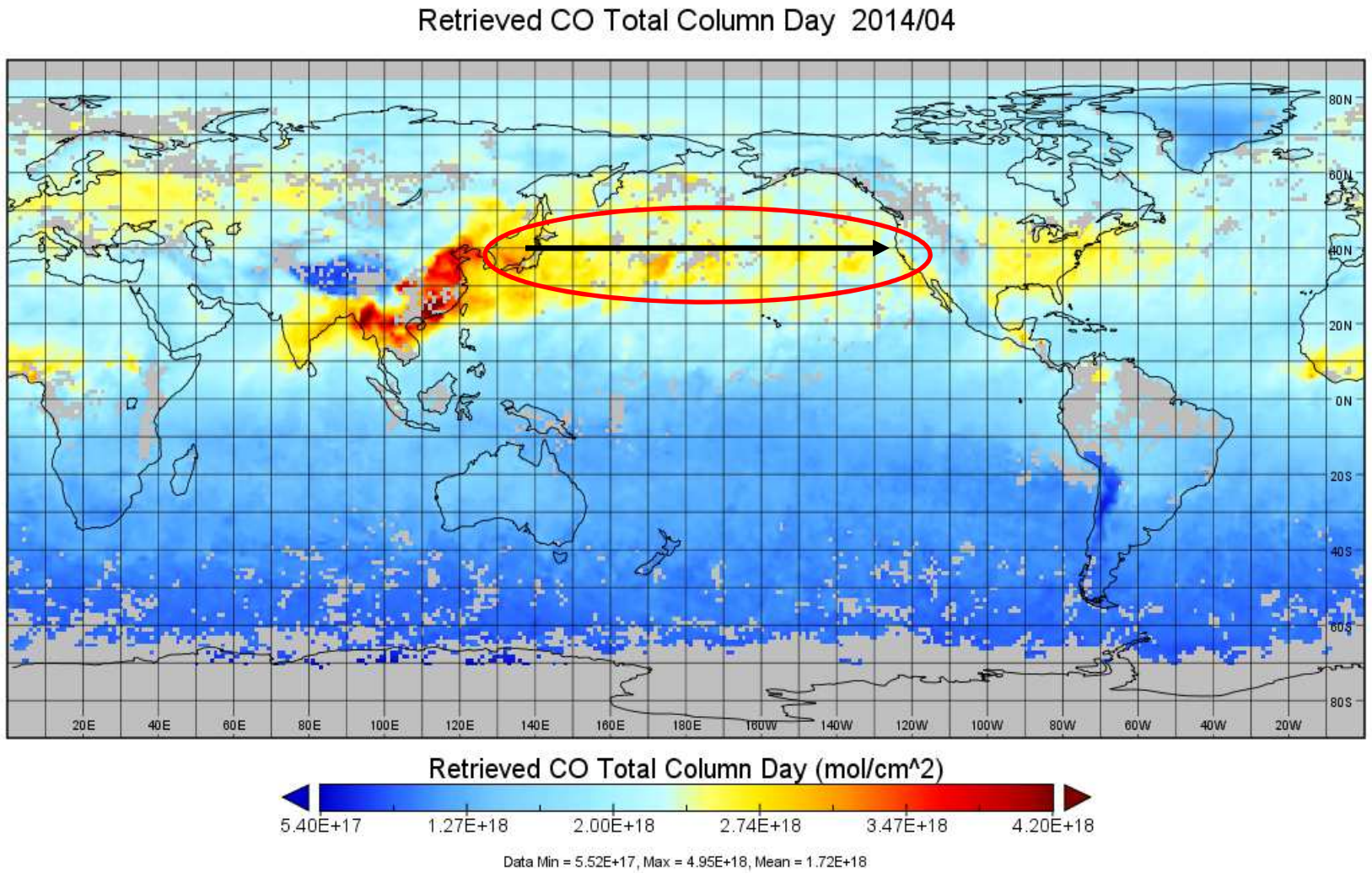
CO Tot Col averages:

Over two degree of longitude Inside a Lat. box= 20N to 50N



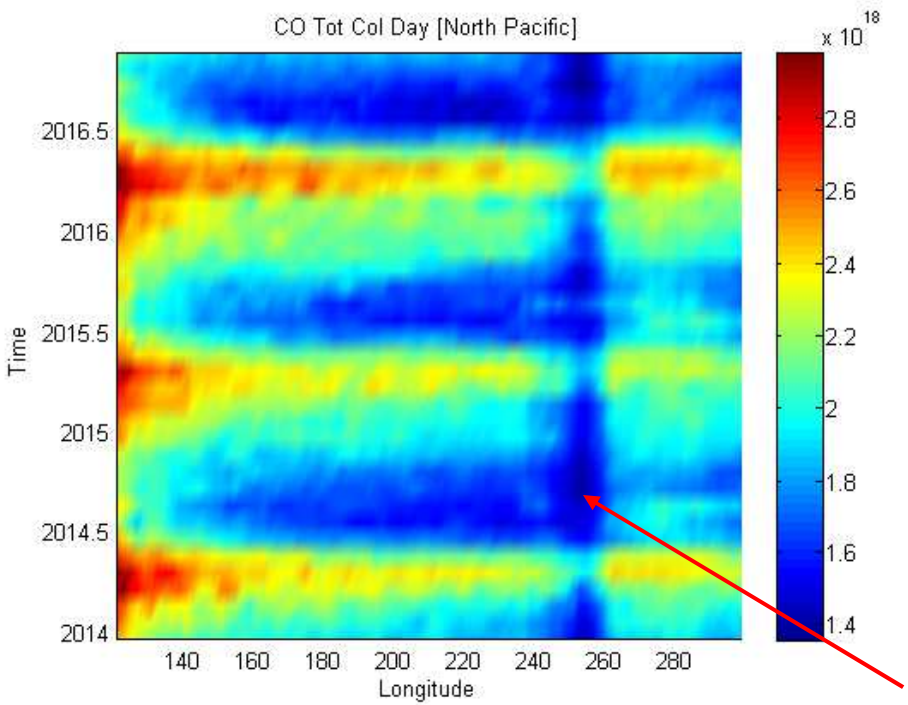


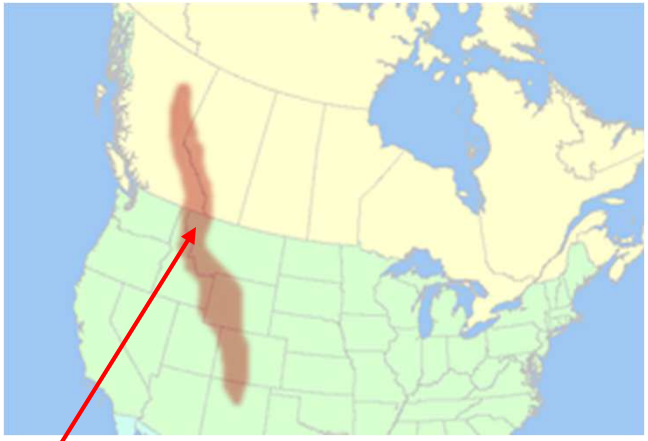
Averages inside Latitudinal Box: 50 N to 20 N



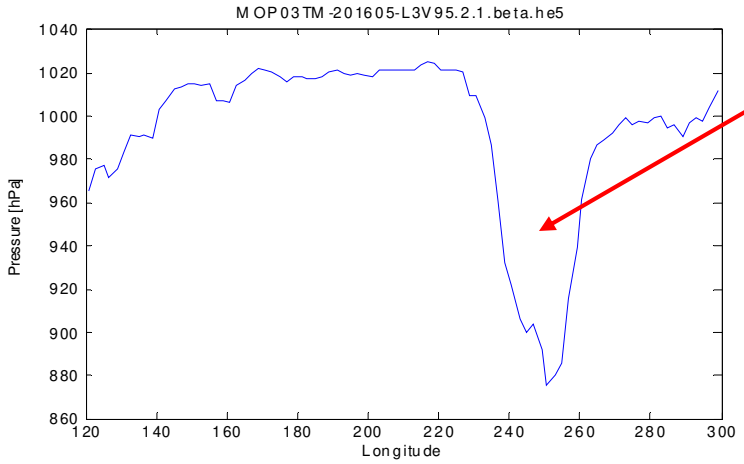
A typical CO transport event takes around a little bit more than one week to cross the Pacific.

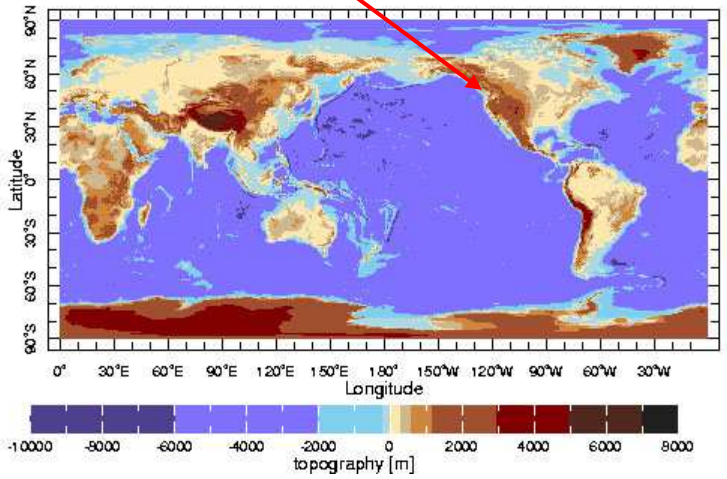
- In order to examine the phenomenology of the CO transport we are using here a larger time window (monthly instead of daily) for averages.
- Next three slides revealed the Total CO column monthly averages in the same latitude box (lat: 50 to 20) as in previous daily plots for 3, 7 years and for the full MOPITT mission: 17 years.
- Next five slides exposed the CO Mixing Ratio at different altitudes (pressures): 900,800,600,500 and 400 hPa for the full MOPITT mission.

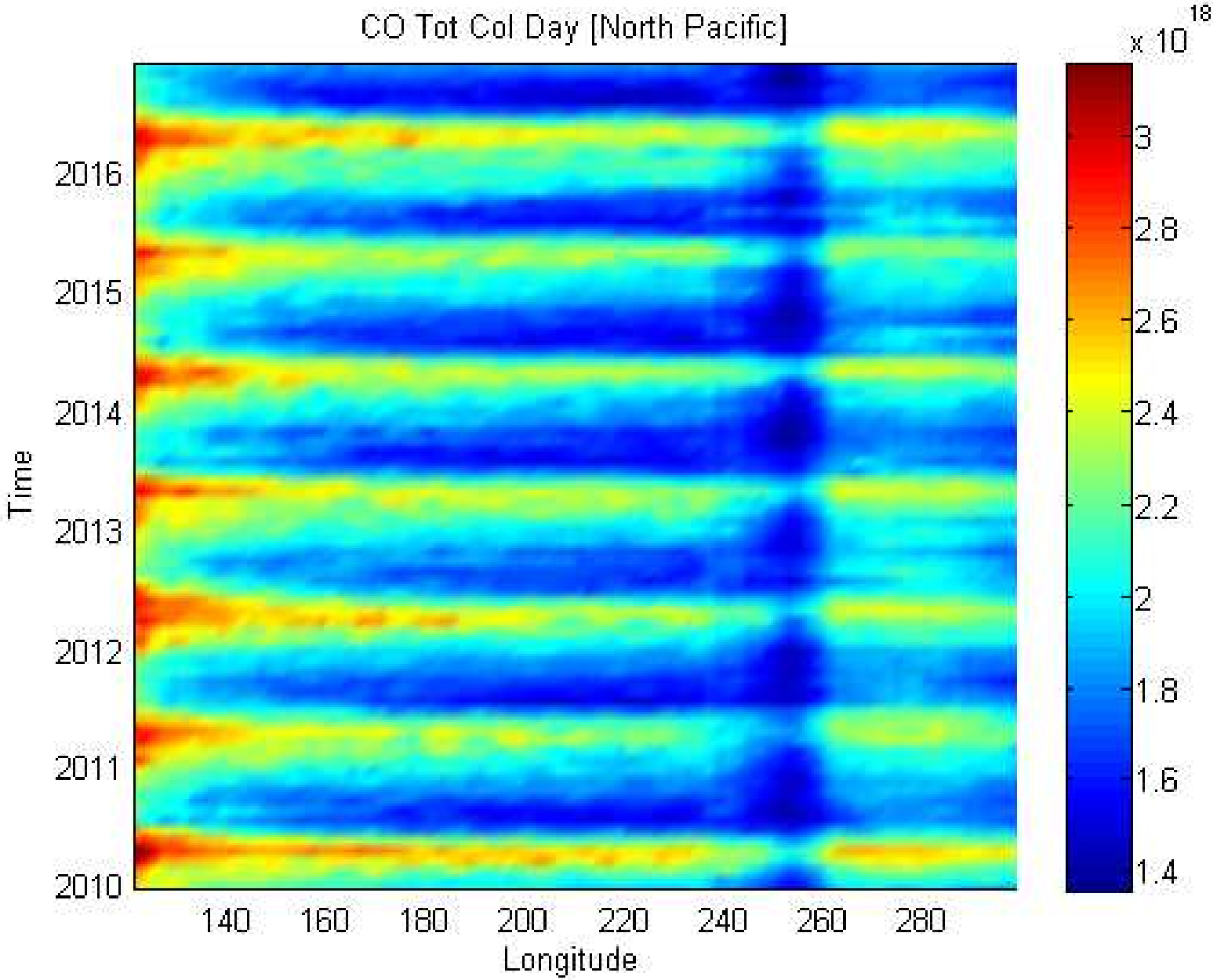


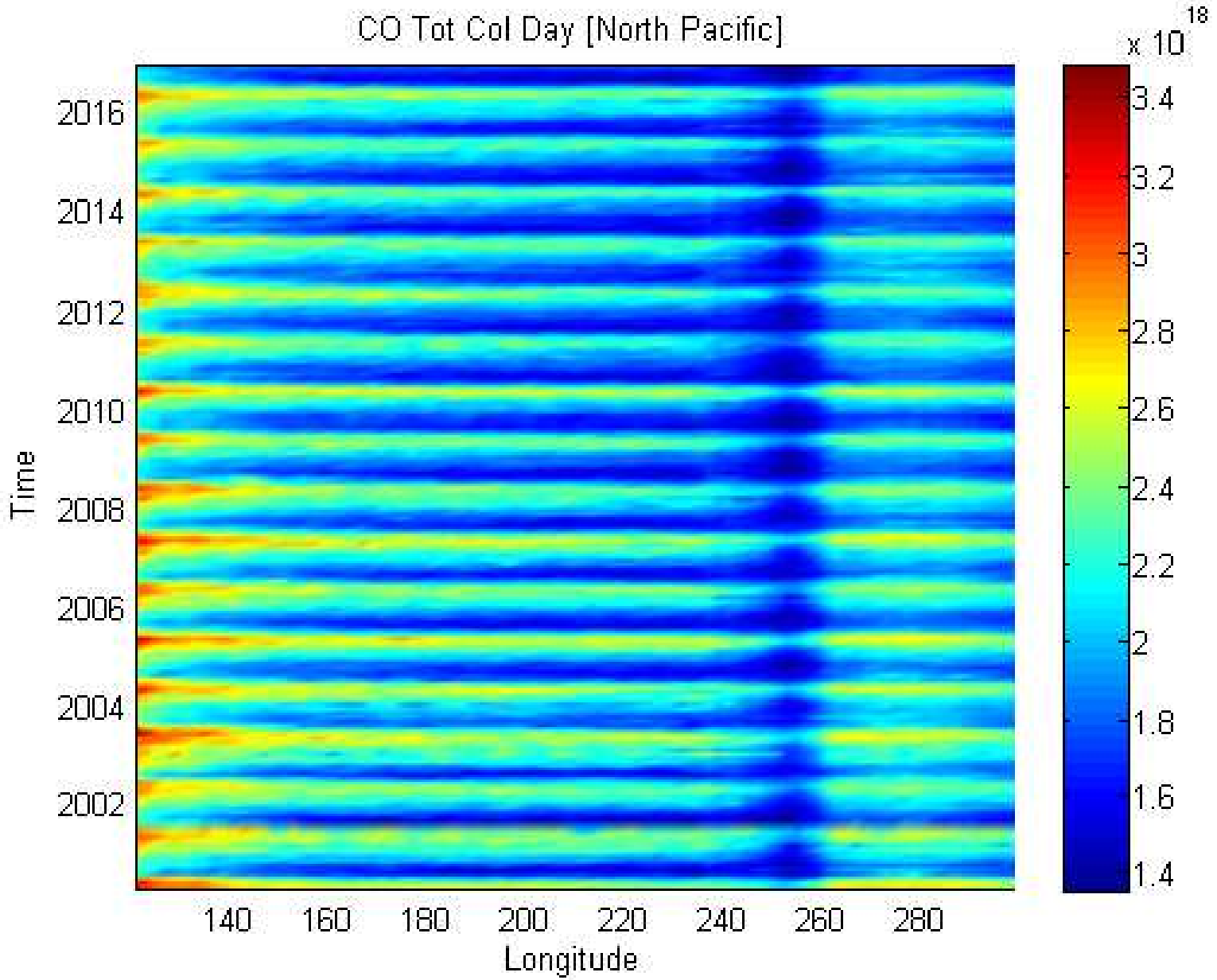


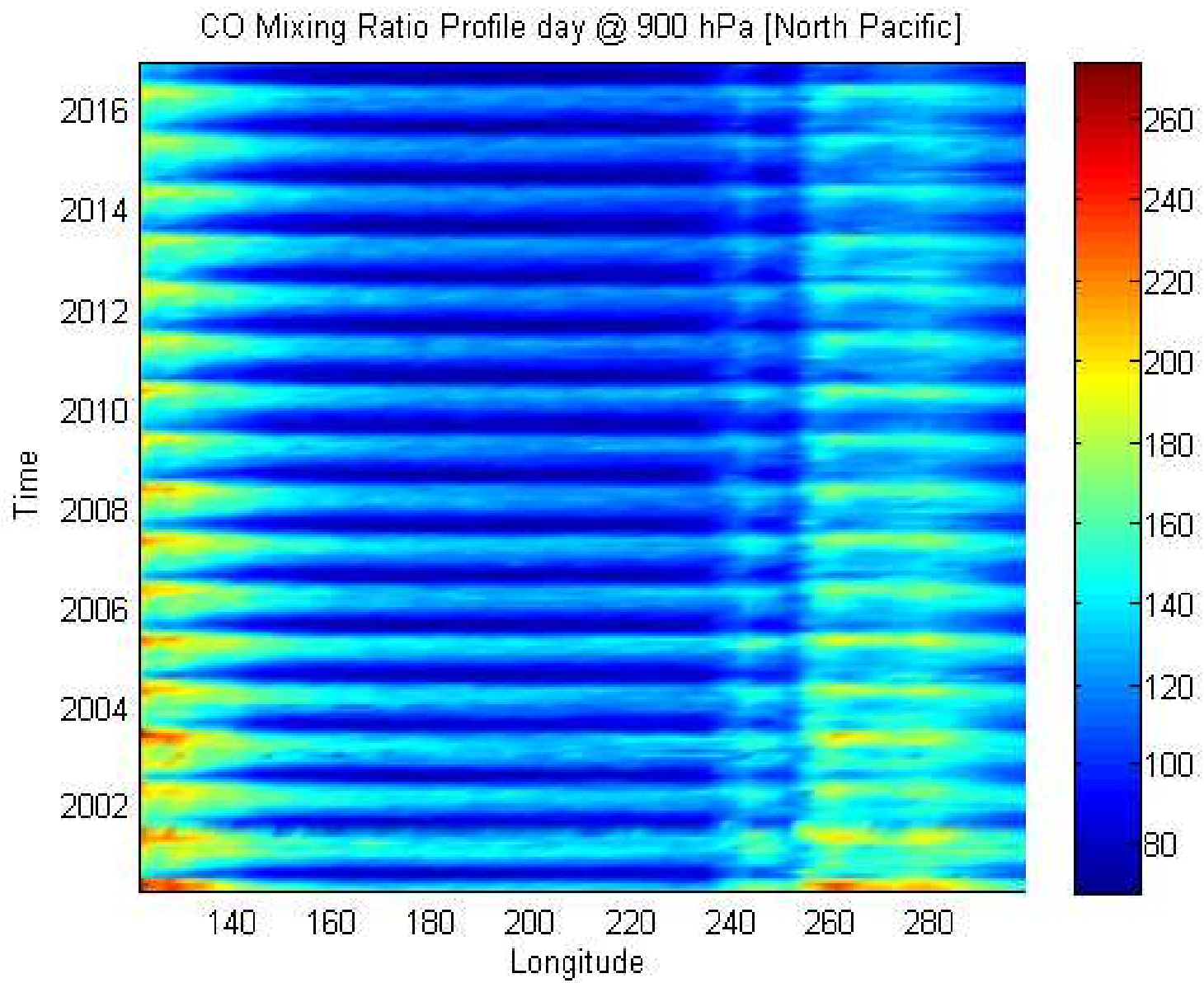
Rocky Mountains as natural "pollution barrier"

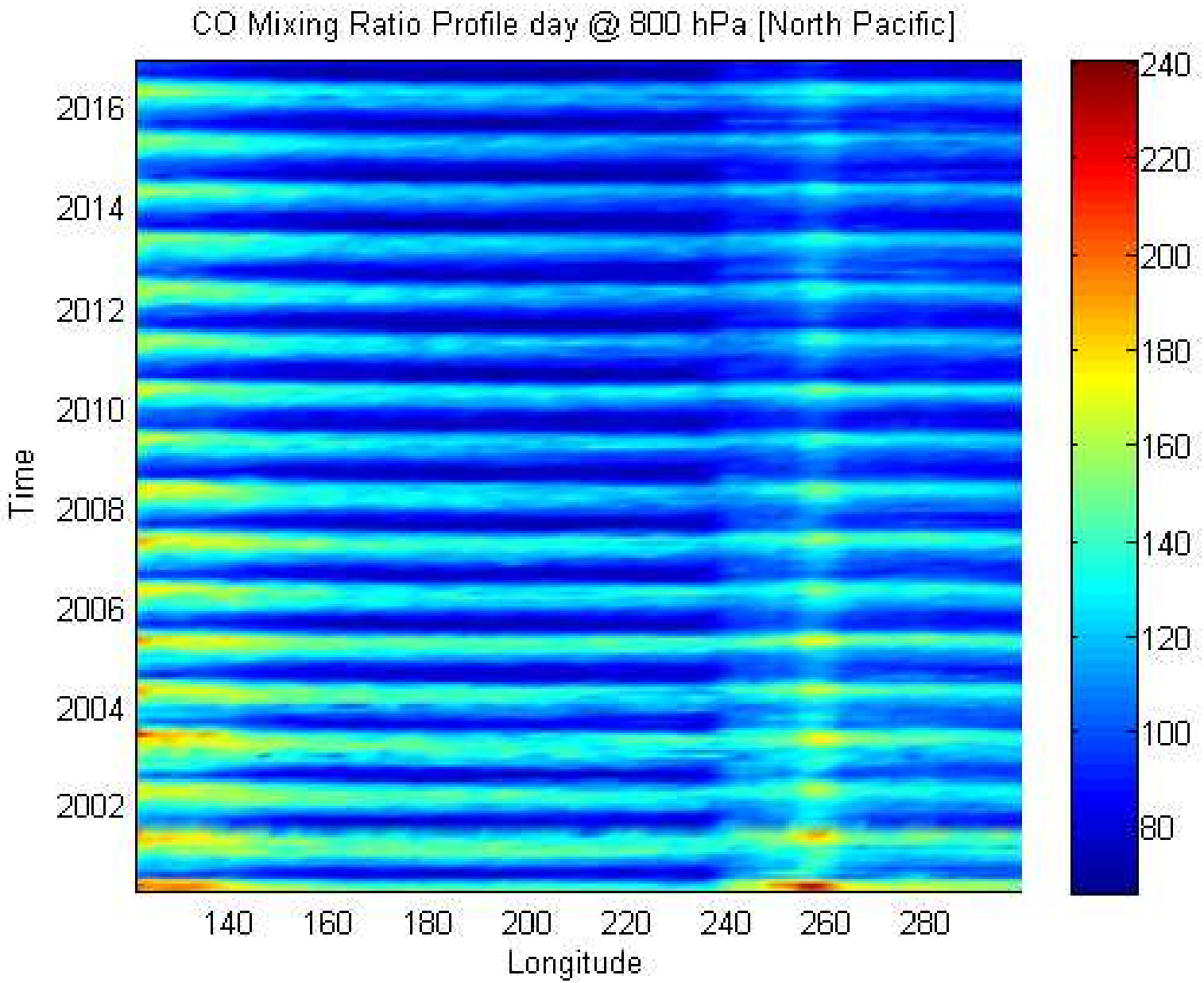


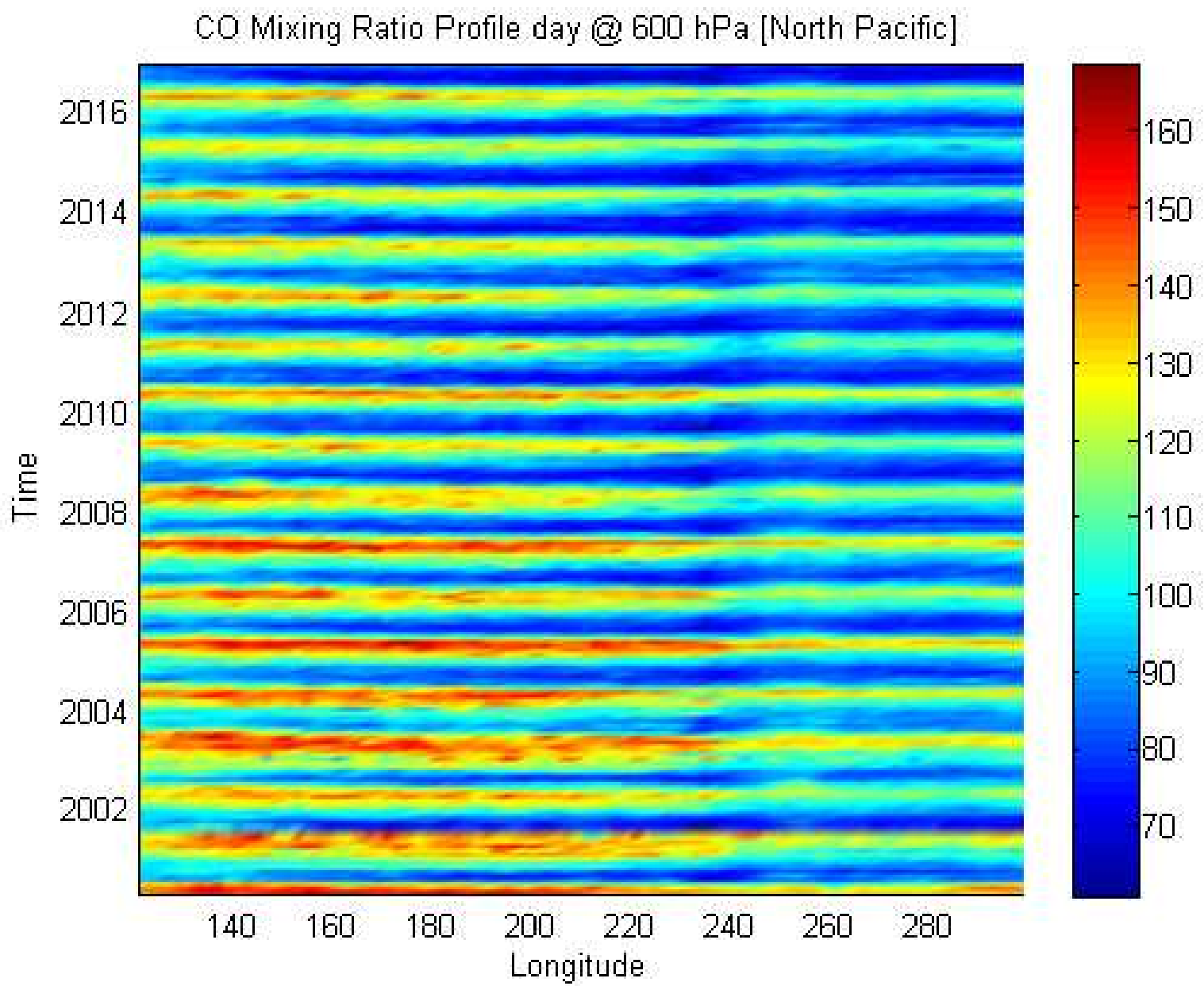


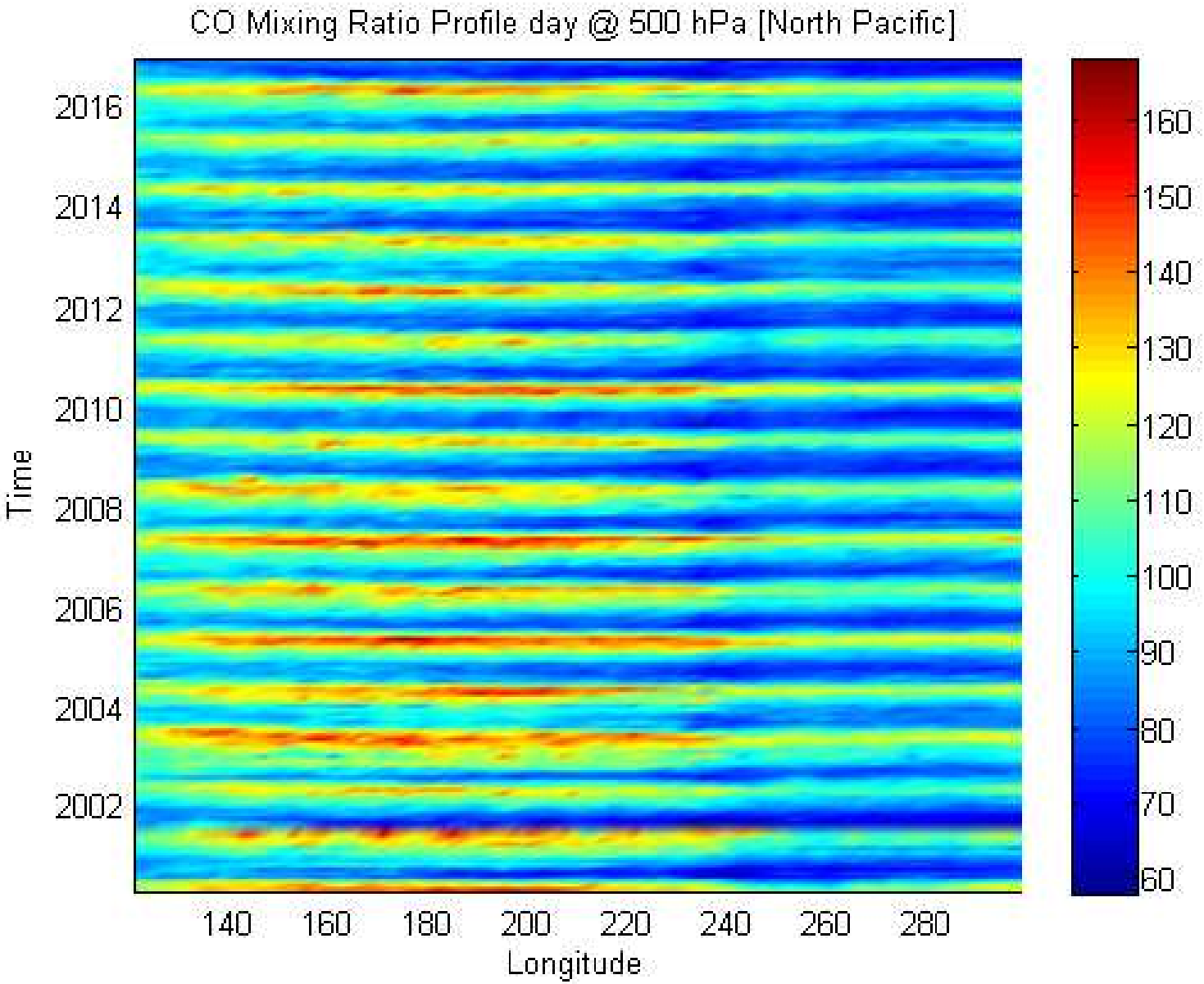

CO Tot Col Day [North Pacific]
x 10^18
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
Time
2016
2015
2014
2013
2012
2011
2010
140
160
180
200
220
240
260
280
Longitude

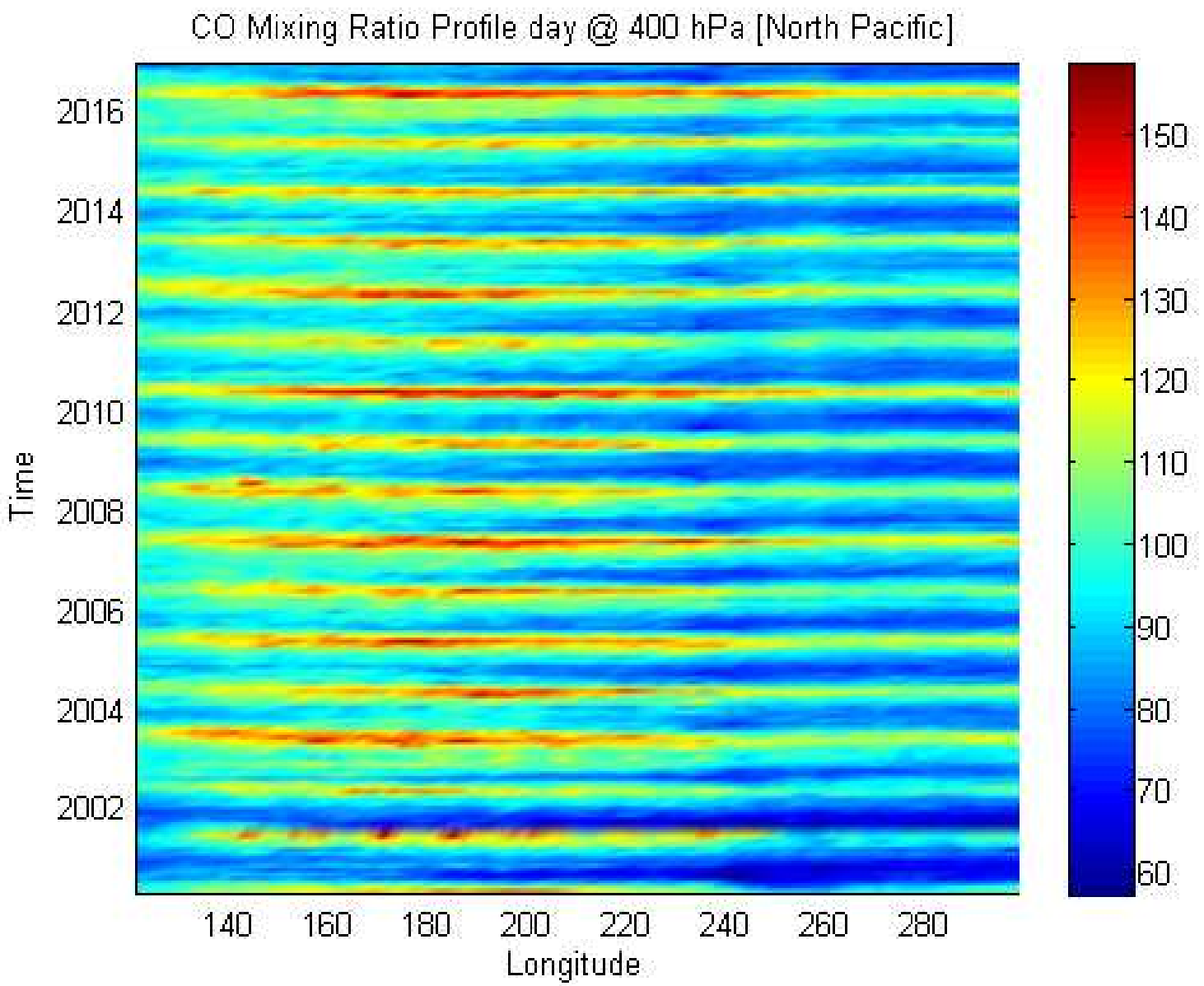

CO Tot Col Day [North Pacific]
x 10^18
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
Time
2016
2014
2012
2010
2008
2006
2004
2002
140
160
180
200
220
240
260
280
Longitude

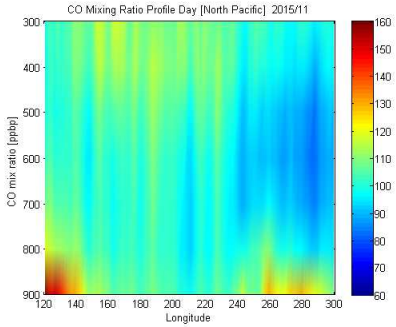

CO Mixing Ratio Profile day @ 900 hPa [North Pacific]
Time
2016
2014
2012
2010
2008
2006
2004
2002
140
160
180
200
220
240
260
280
Longitude
260
240
220
200
180
160
140
120
100
80

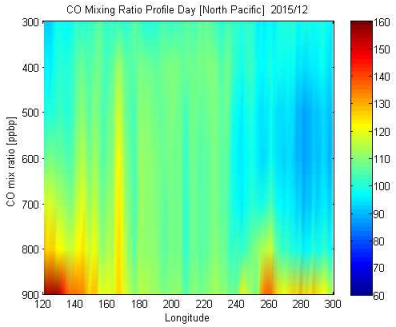

CO Mixing Ratio Profile day @ 800 hPa [North Pacific]
Time
2016
2014
2012
2010
2008
2006
2004
2002
140
160
180
200
220
240
260
280
Longitude
240
220
200
180
160
140
120
100
80

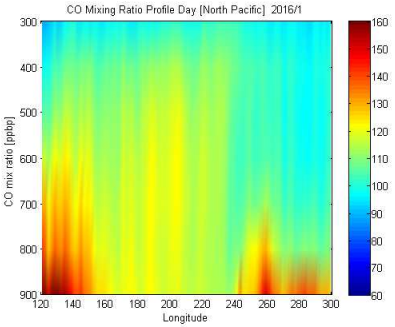

CO Mixing Ratio Profile day @ 600 hPa [North Pacific]
Time
2016
2014
2012
2010
2008
2006
2004
2002
140
160
180
200
220
240
260
280
Longitude
160
150
140
130
120
110
100
90
80
70

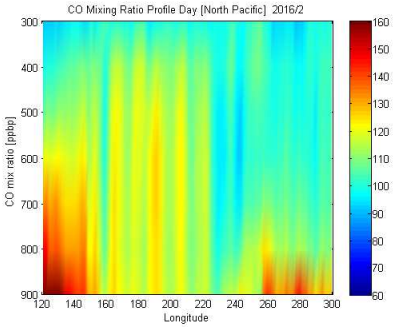

CO Mixing Ratio Profile day @ 500 hPa [North Pacific]
Time
2016
2014
2012
2010
2008
2006
2004
2002
140
160
180
200
220
240
260
280
Longitude
160
150
140
130
120
110
100
90
80
70
60

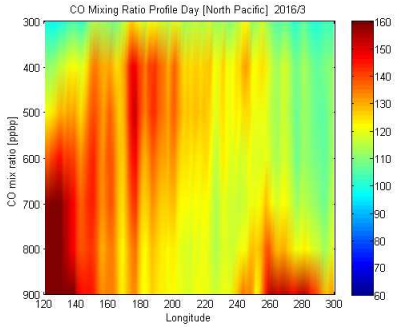

CO Mixing Ratio Profile day @ 400 hPa [North Pacific]
Time
2016
2014
2012
2010
2008
2006
2004
2002
140
160
180
200
220
240
260
280
Longitude
150
140
130
120
110
100
90
80
70
60

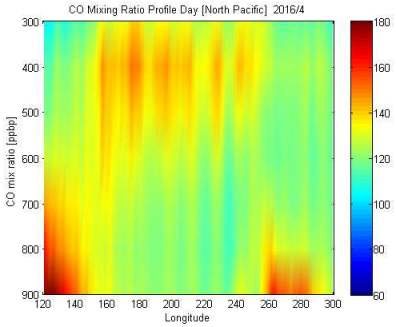


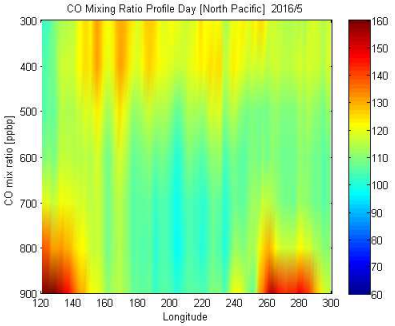


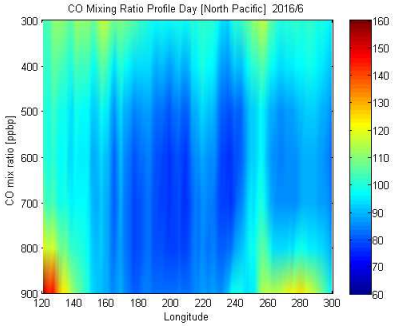


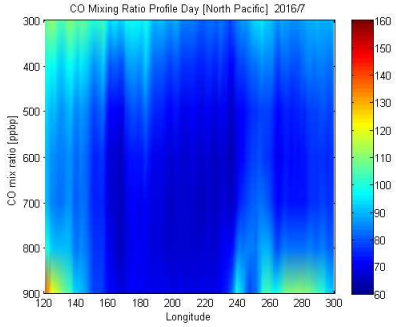


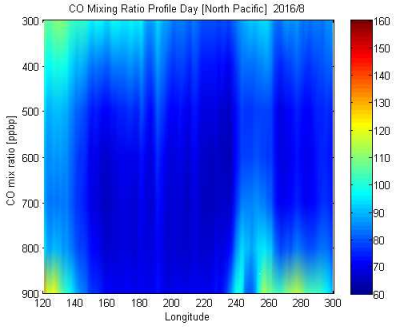


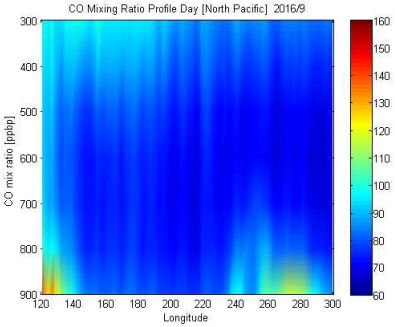


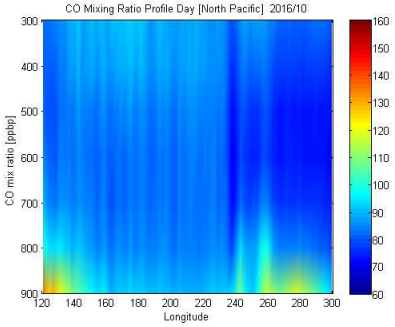


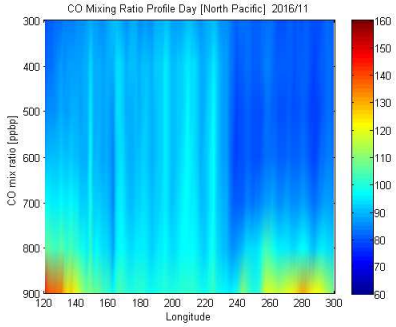




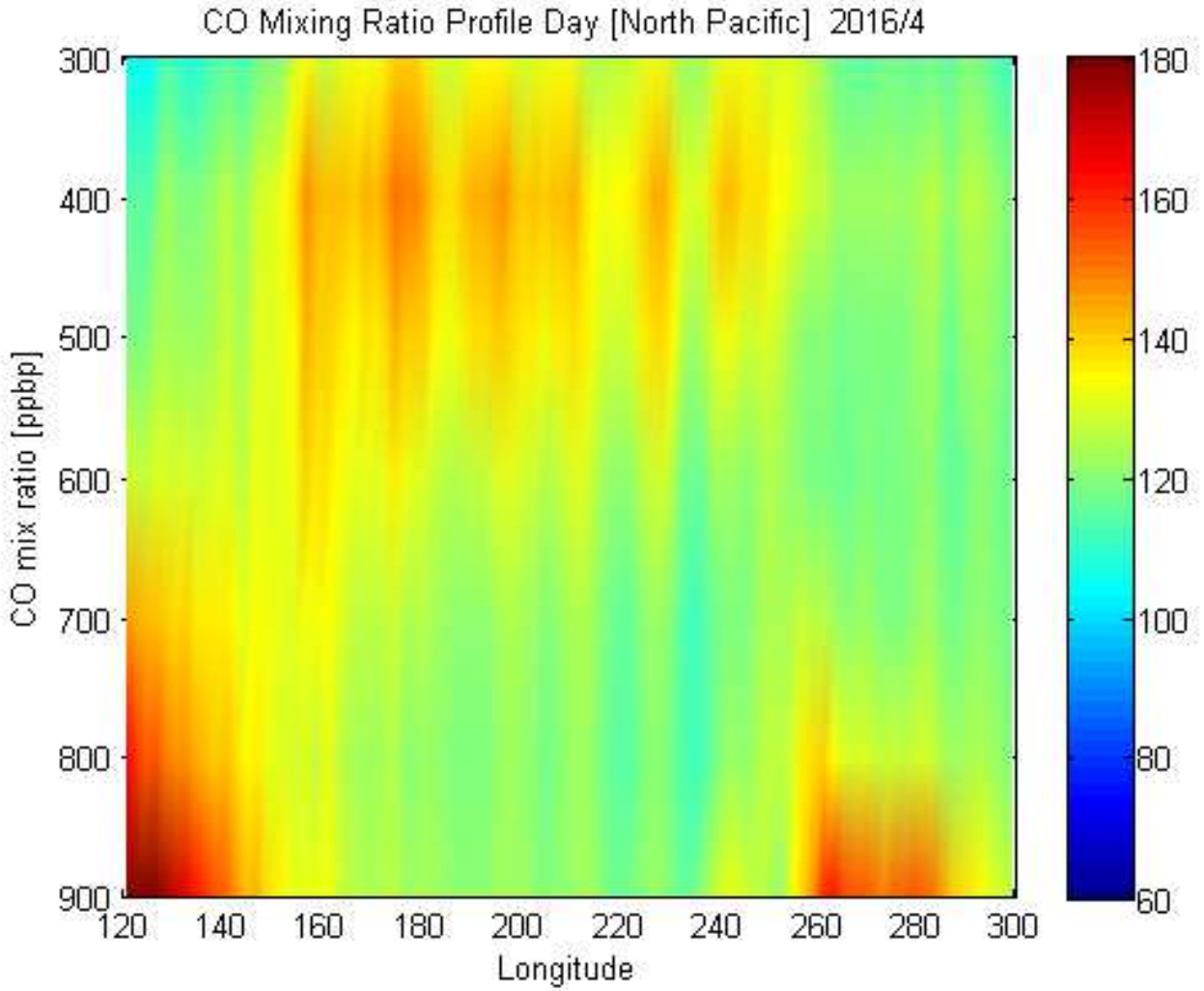




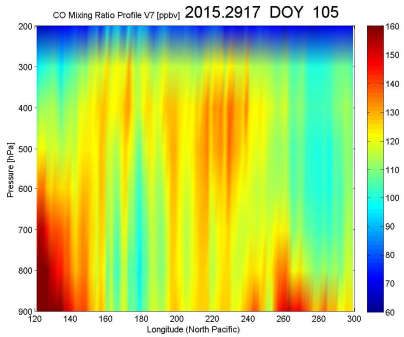


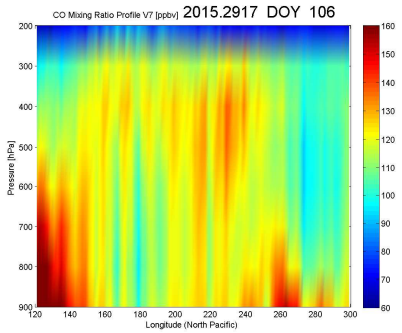


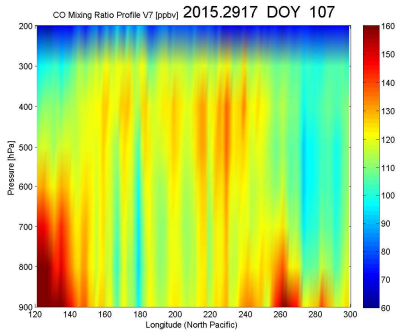
Monthly CO mixing Ratio
From Nov 2015 to Nov 2016

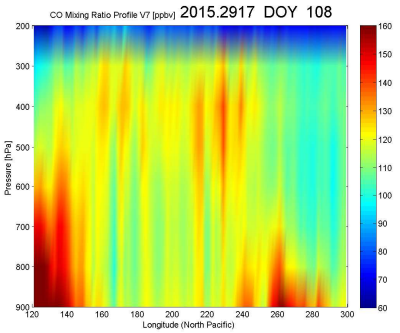


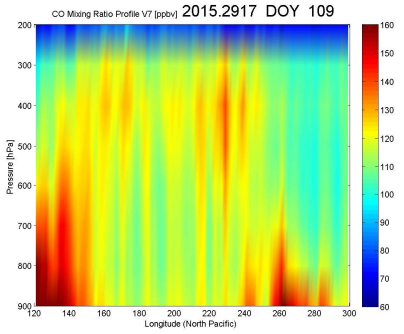
CO transport during 2016/04:

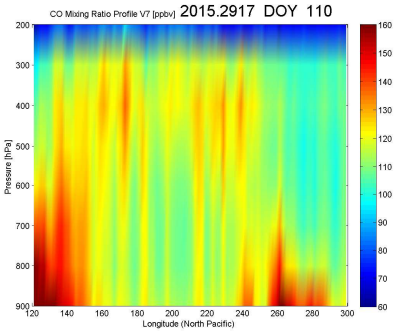


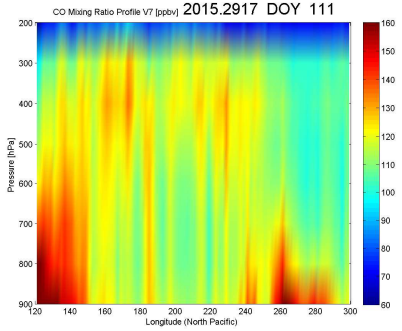


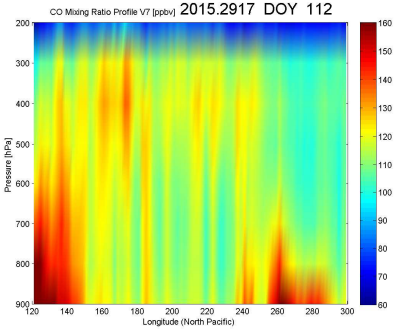


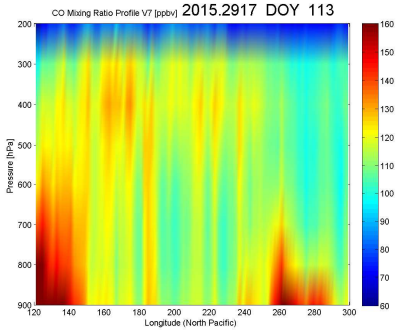


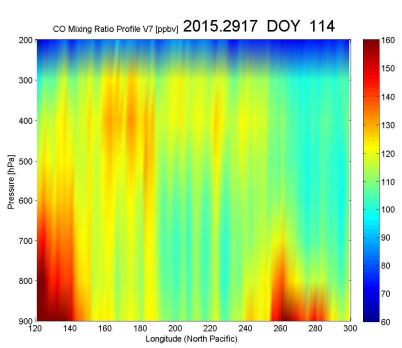


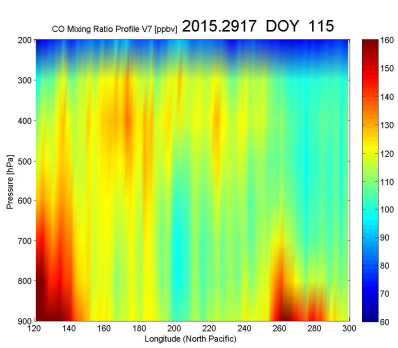


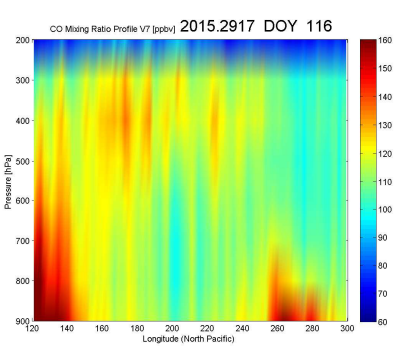


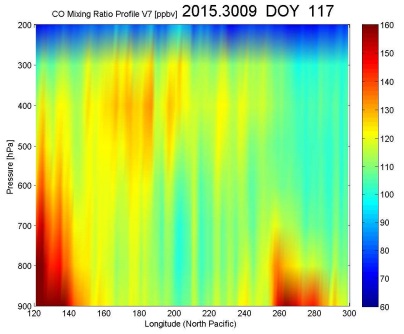












From April 15 (2016) to April 27 (2016)
Running Averages over 9 days
example: April 15 (DOY 105) means averages
from Apr.11 to Apr.19 (from DOY 101 to 109)

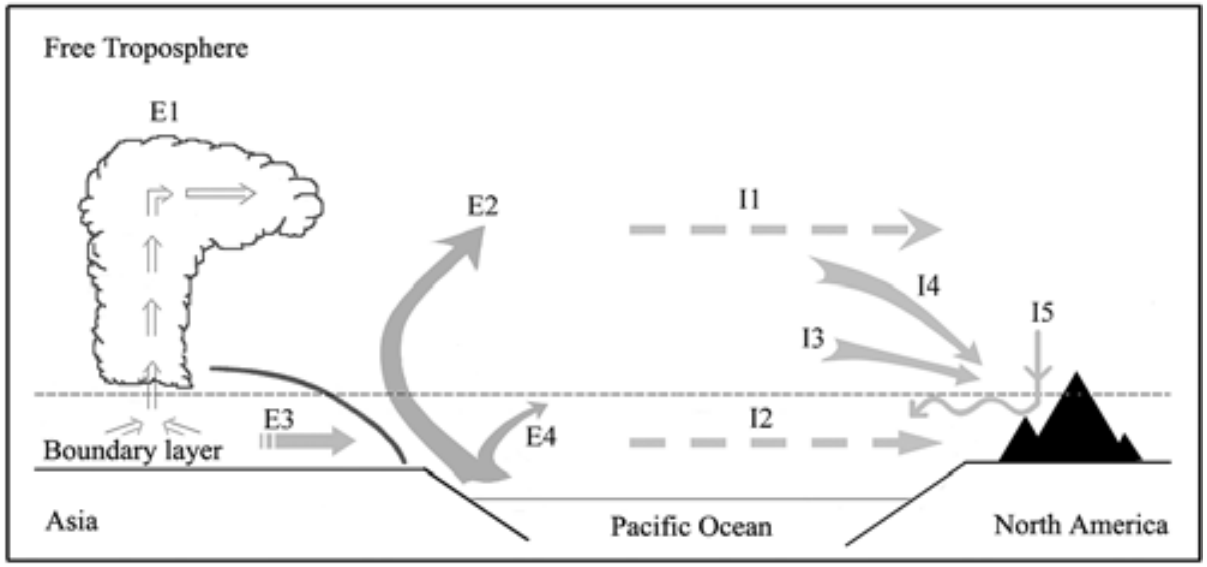


Figure 9. Schematic of export mechanisms over east Asia and import mechanisms over the NE Pacific for long-range transport of Asian pollutants. Outflow mechanisms over Asia include convective lifting (E1) and three transport pathways associated with midlatitude cyclones: warm conveyor belt lifting (E2), postfrontal boundary layer transport (E3), and low-level prefrontal jet transport (E4). Import mechanisms over the NE Pacific include advection in the mean free tropospheric westerly flow (I1), boundary layer transport (I2), large-scale subsidence in the Pacific High (I3), subsidence in the dry air stream of a cold front (I4), and subsidence induced by mountain waves (I5).

Long-range transport of Asian pollution to the northeast Pacific: Seasonal variations and transport pathways of carbon monoxide Qing Liang et al. *JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 109, D23S07, doi:10.1029/2003JD004402, 2004*