# Lab2

1. Plot the time series of the two areas for a certain time span (e.g., from 2003 to 2015), what can you tell from the results (e.g. Seasonal signal, long-term trend or jump)?

**Figure 1** is the time series of EWH at Amazon and Greenland from 2003 to 2015. The blue line is Amazon. An annual period is obvious but no long-term trend, which is proved by **Figure 2** and **Figure 3**. In **Figure 2**, the blue line is the raw EWH and the red one is detrended pattern. They match well, so there is not trend at Amazon. But from **Figure 3**, after the FFT process, we can find a period close to one year- 0.98077 year. This fits to its wet season and dry season alternation.

With the same process on Greenland, a large long-term trend is derived from **Figure 4**. Attention, the y-axis on the left is different from the right, which represent for 'raw' and 'detrend' data, respectively. This can be explained by the ice melting and global warming. The periodical signal of Greenland is much more complicated. The seasonal signal is not obvious but will three more periodical signal around 11.7, 3.7 and 0.97 year respectively.

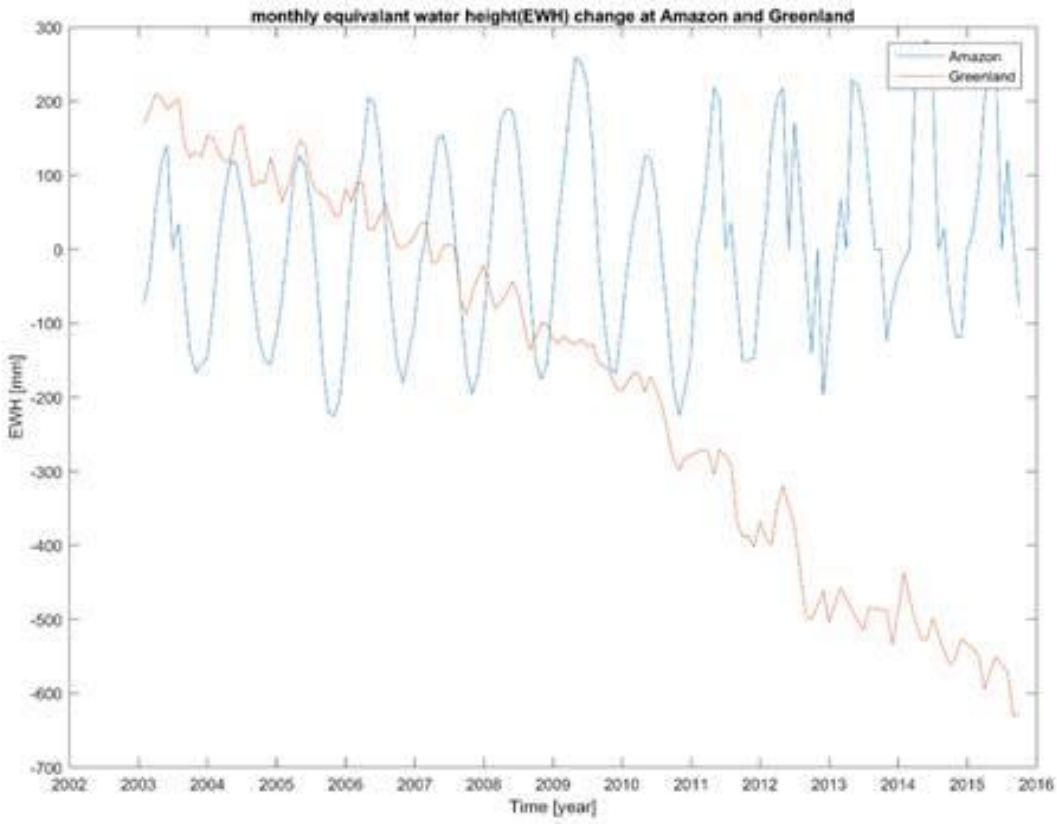

monthly equivalant water height(EWH) change at Amazon and Greenland
Amazon
Greenland
EWH [mm]
Time [year]
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

*Figure 1*

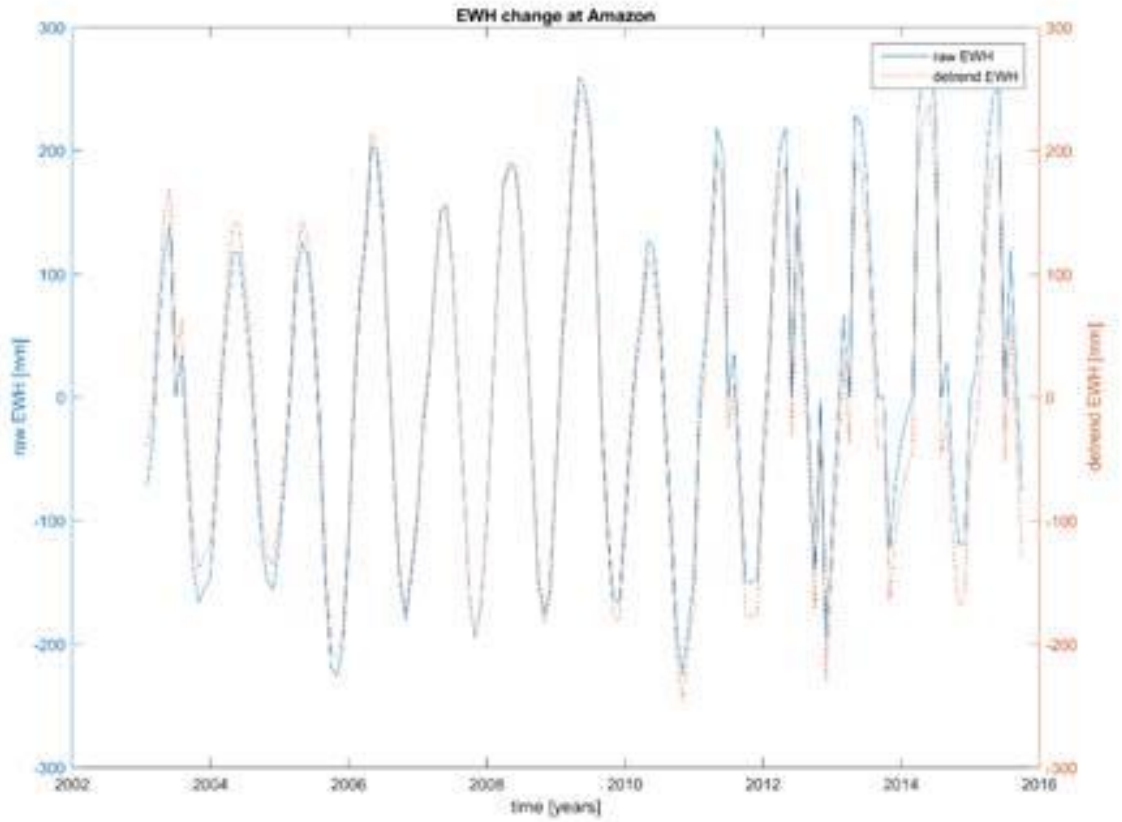

EWH change at Amazon
raw EWH
detrend EWH
raw EWH [mm]
detrend EWH [mm]
time [years]
300
200
100
0
-100
-200
-300
2002
2004
2006
2008
2010
2012
2014
2016

*Figure 2*

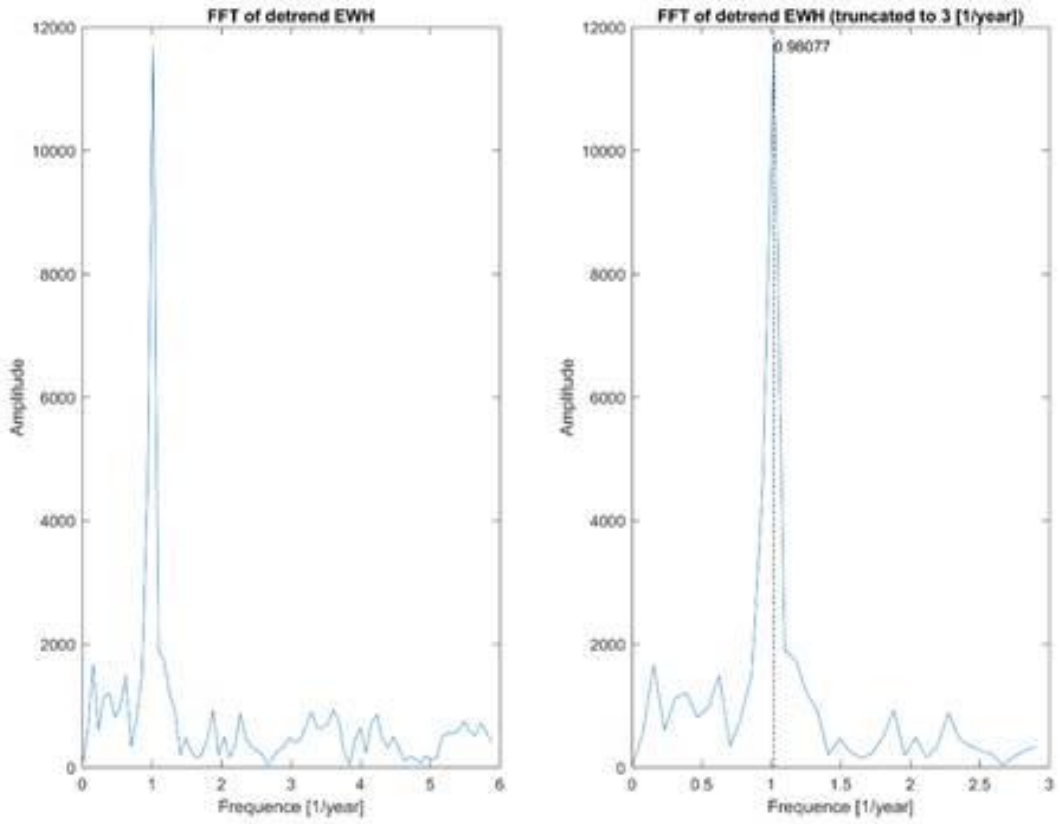

FFT of detrend EWH
Amplitude
Frequence [1/year]
FFT of detrend EWH (truncated to 3 [1/year])
0.98077
Amplitude
Frequence [1/year]

*Figure 3*

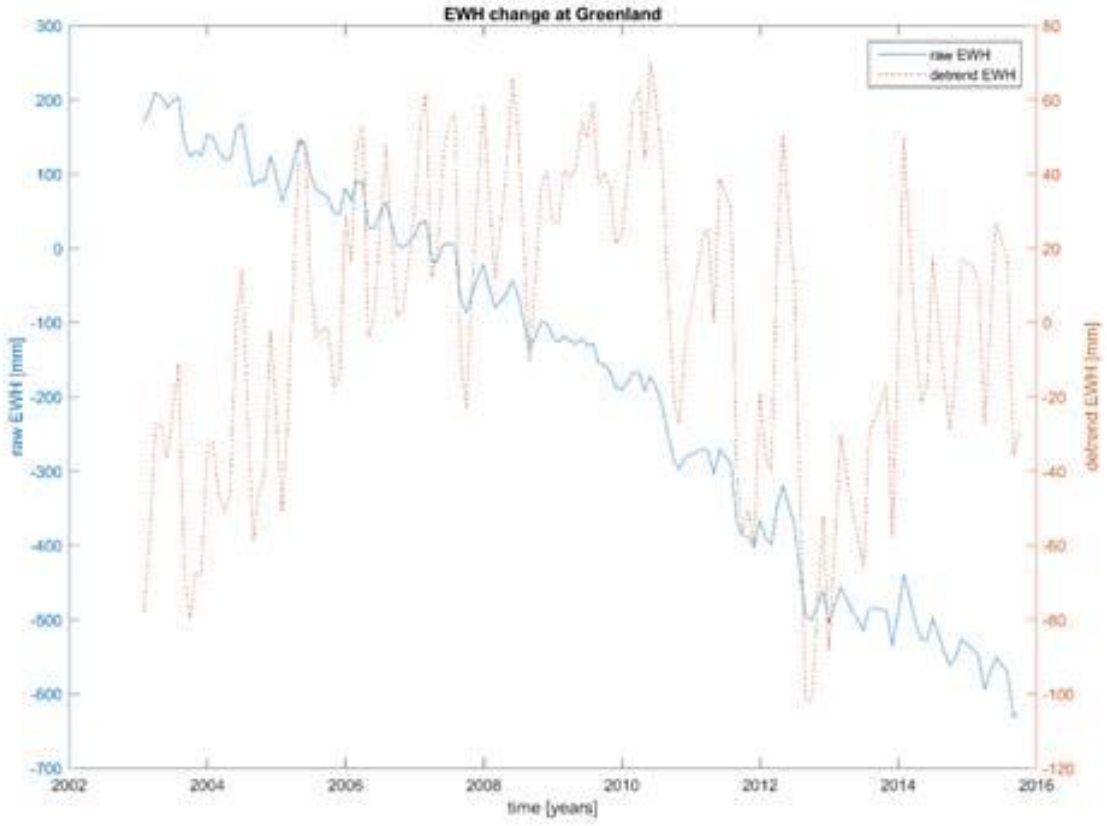

EWH change at Greenland
raw EWH
detrend EWH
raw EWH [mm]
detrend EWH [mm]
time [years]
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
80
60
40
20
0
-20
-40
-60
-80
-100
-120
2002
2004
2006
2008
2010
2012
2014
2016

*Figure 4*

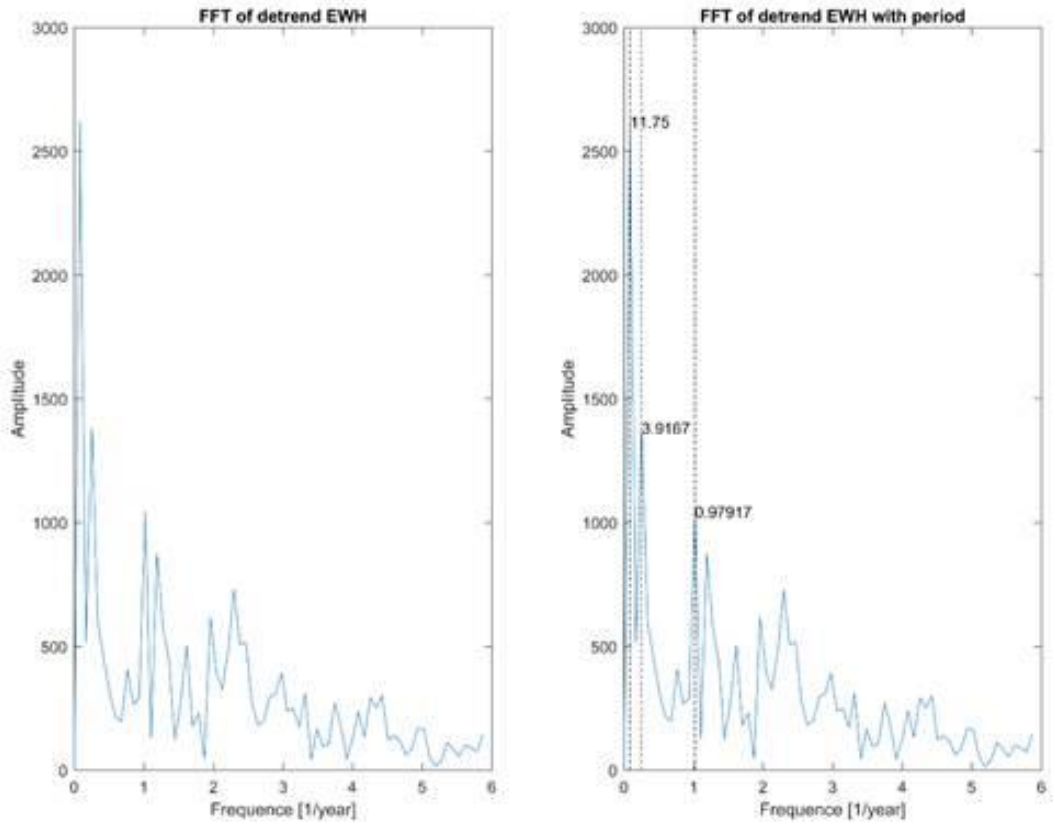



*Figure 5*

2. Plot geographic maps before and after each post-processing, i.e,, de-correlation and smoothing. Choose any least two months as example, one is in summer and one is in winter.

**Figure 6** the left three are the raw EWH change, with de-correlation and with smoothing, respectively, on Jan. 2003. The right three are on Jul. 2003. We can see the raw pattern is a mess and full of strips. But after the de-correlation the change of the EWH become clearer and the strips are only around the equator. Finally after the smoothing, the strips almost gone.

Comparing the patterns of summer (Jul.) and winter (Jan.) ,the bottom two, we can see, most place can be explained by the seasonal change. The Bangladesh and Amazon (red case) get more rainfall from Jan.(dry season) to Jul.(wet season). Similar at Antarctic (black case), on the southern hemisphere, the weather changes from summer to winter and more ice is generated, which cause the mass increase. But it is wired on Greenland (yellow case). As the temperature grows from winter to summer, the mass grows. This is contrary to what we know—the ice will melt during the summer.

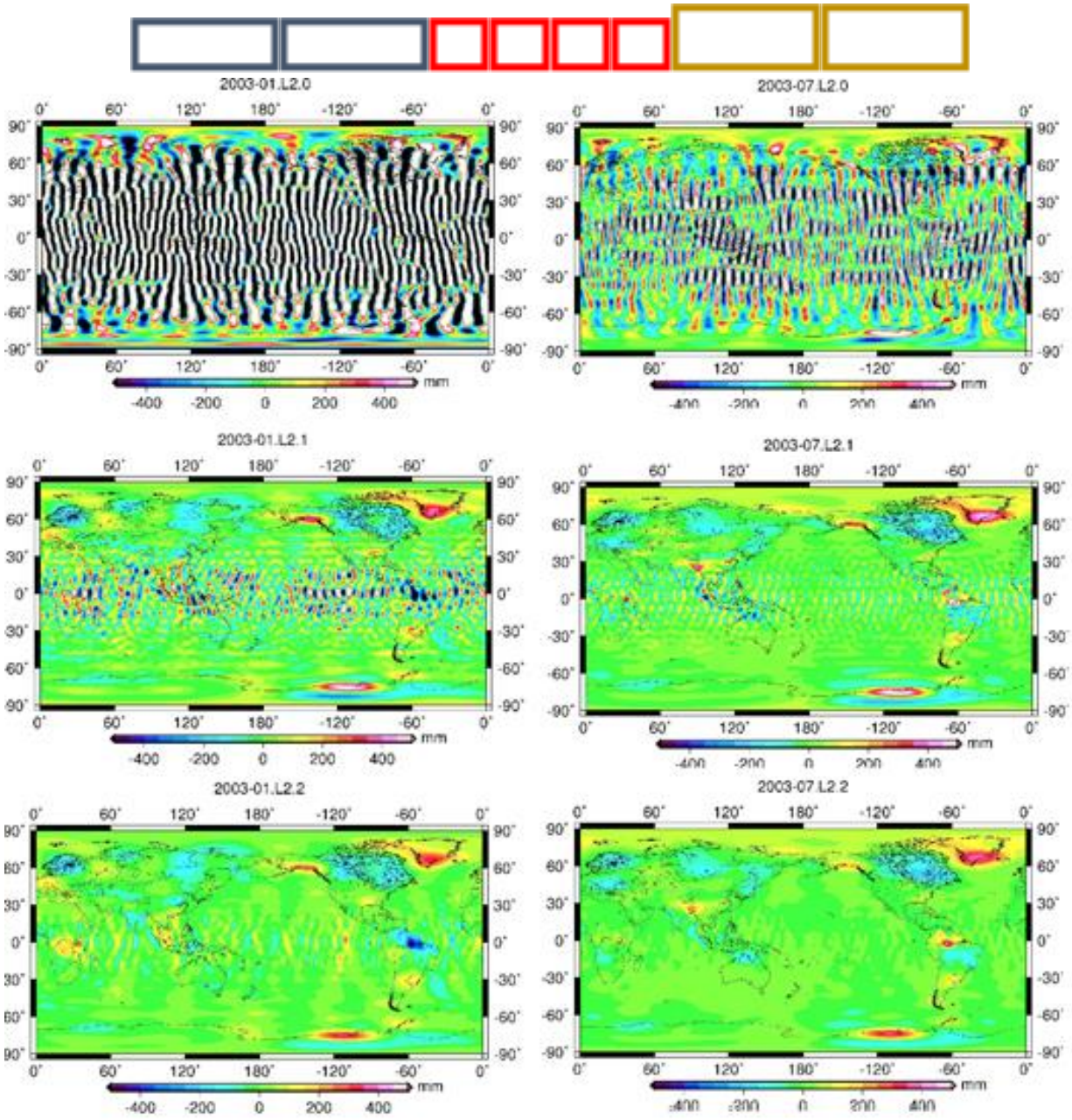


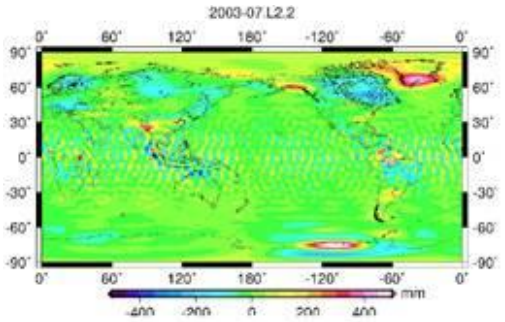

*Figure 6*

3. Try different smoothing radius (e.g. from 0 km to 500 km), what changes can you find from the results? How do you explain them?

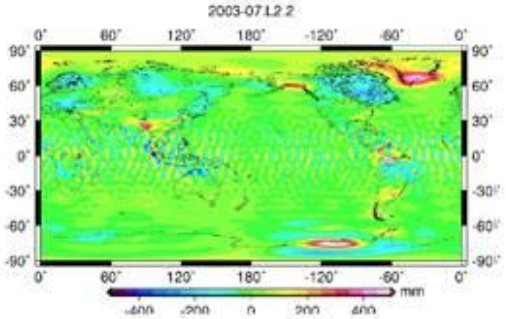
**Figure 7** shows the results after smoothing with different radius on the Jul. 2003.

The pattern without smoothing still has a lot strips around the equator. With the

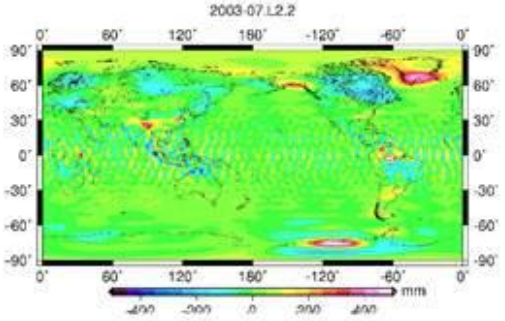
grows of the radius, the strips become less and less and disappear after 300km. But at the same time the signal is also smoothed. The bright spots on Greenland, Amazon, Bangladesh and Antarctic become gloomy. So a radius from 200 to 300 is recommended, which is close to the altitude of the GRACE and the distance between the two GRACE satellites.



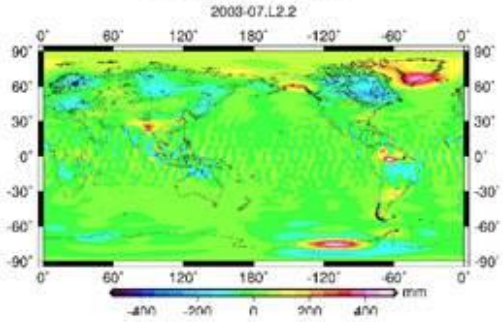

smooth radius=0[km]



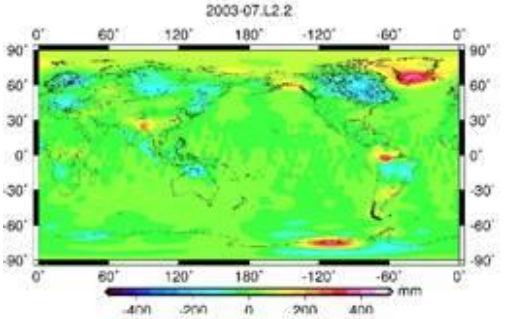

smooth radius=50km



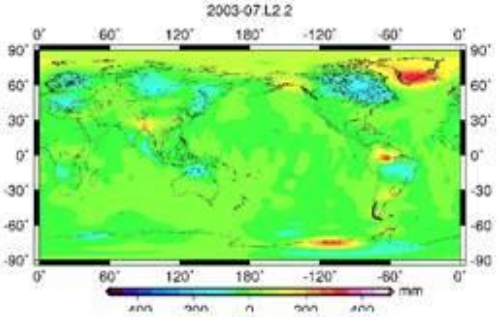

smooth radius=100km



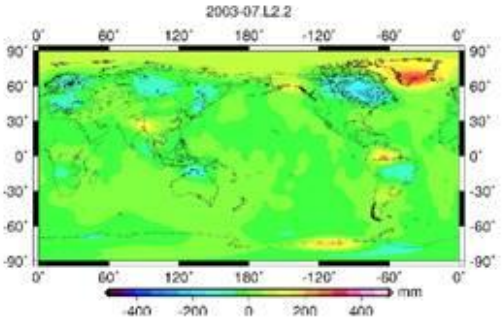

smooth radius=200km




smooth radius=300km




smooth radius=400km




smooth radius=500km

*Figure 7*

4. Bonus: Fit trend and annual signal using all the monthly results. Plot the geographic trend map. Explain the all the interested signals in the trend map (hint: refer to Figure 6 in Shang et al, GJI, 2015).

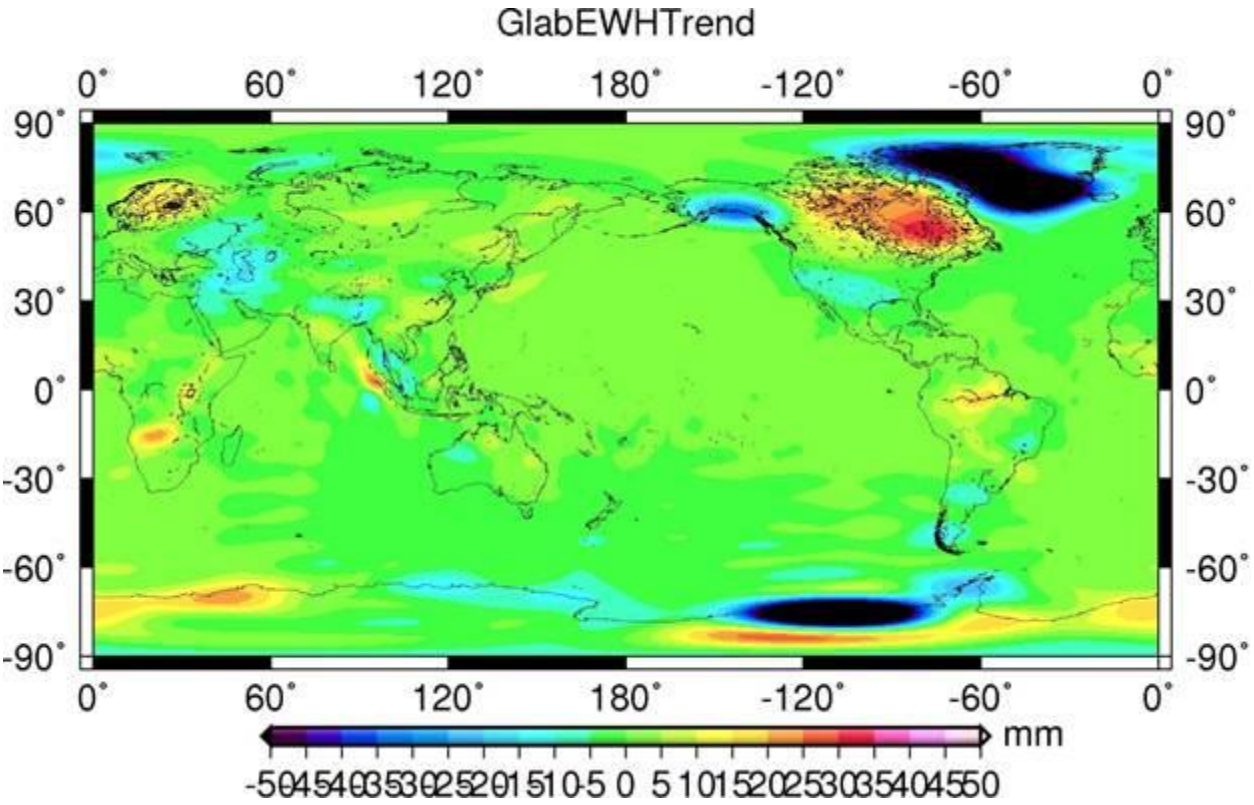



*Figure 8*

Here I give some guesses and explanations without proof

1. Greenland has a decrease trend which can be explained by the loss of the ice shell.
2. The earthquake happened on Sumatra on 2004 cause the contrary trends on two sides of the island.
3. A decrease trend on North China may be due to the over use of the underground water
4. The decrease trend of Tibet Plateau may come from the glacier melting
5. It is interesting that the Antarctica has the contrary trends, the inner with an increase trend and the boundary with a decrease trend.
6. Amazon has an increase trend I do not know how to explain.
7. Also the trend on South part of Africa, Alaska, west Europe and middle east cannot be explained by me