Filling GRACE Gaps Using GRACE-Derived Time Varying Model

By

Hussein A. Mohasseb [(1),] WenBin Shen [(1,2)], Hussein A. Abd-Elmotaal [(3)]

1) LIESMARS, Wuhan University, Wuhan, China
2) School of Geodesy and Geomatics, Wuhan University, Wuhan, China
3) Civil Engineering Department, Faculty of Engineering, Minia University, Minia, Egypt.

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2 Data and Methodology

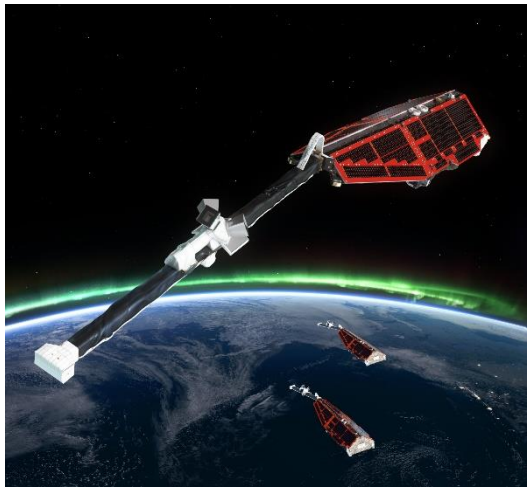
3 Results and Discussion

4 Conclusion

1 Introduction

In recent decades, using satellites to research changes in gravity has become a popular and important practice, particularly because it allows us to gain a deeper understanding of

- the Earth's water cycle,
- groundwater changes,
- sea level rise,
- and the declining of the ice sheets



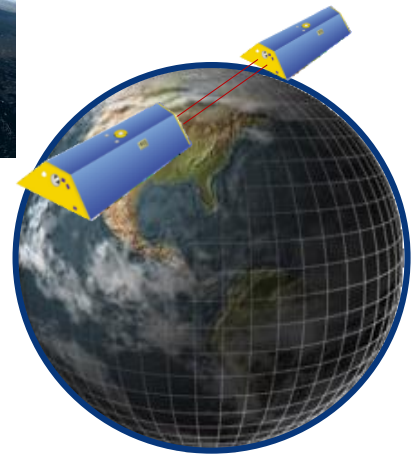


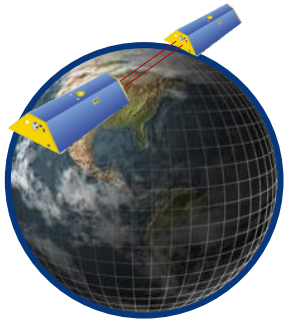
Figure 1. Gravity missions

1 Introduction

GRACE

Gravity Recovery And Climate Experiment

NASA - DLR

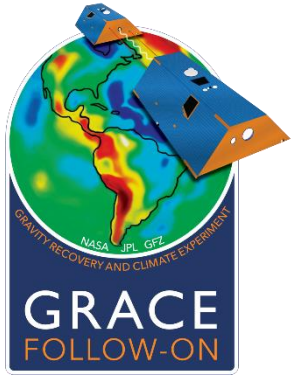


GRACE-FO

Gravity Recovery And Climate Experiment-Follow On

NASA - GFZ

Produce monthly maps of the Earth's gravity field



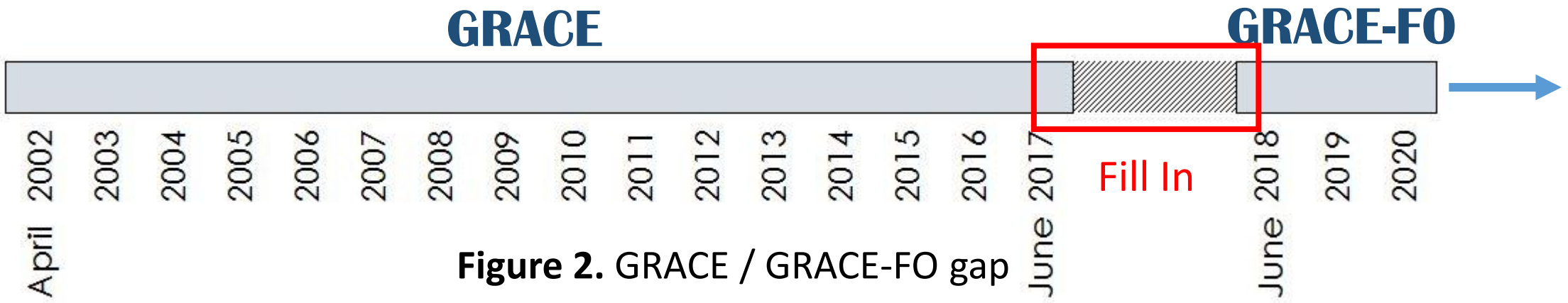


Figure 2. GRACE / GRACE-FO gap

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2 Data and Methodology

Data Sources and Processing

- GRACE, 2002.04 to 2017.06
  - ✓ CSR RL06
  - ✓ JPL RL06
  - ✓ GFZ RL06
- GRACE-FO, 2018.06 to 2022.02
  - ✓ CSR RL06
  - ✓ JPL RL06
  - ✓ GFZ RL06

2 Data and Methodology

Processing Model

(Parametric Least Square Adjustment)

$$\left(\bar{C}_{nm}(t)\right)_{GRACE} = \bar{a} + \bar{b}(t-t_o) + \sum_{i=1}^{2}\left\{\bar{c}(i)\sin\left[\frac{2\pi(t-t_o)}{p(i)}\right] + \bar{d}(i)\cos\left[\frac{2\pi(t-t_o)}{p(i)}\right]\right\}$$

where

$\bar{a} = \bar{C}_{nm}(t_o)$ is the stationary value of the C_{nm} coefficient,

$p(1) = 1$ year

$p(2) = 0.5$ year

Accordingly, the observation equation reads:

$$V_{nm}(t) = a + b(t-t_o) + \sum_{i=1}^{2}\left\{\bar{c}(i)\sin\left[\frac{2\pi(t-t_o)}{p(i)}\right] + \bar{d}(i)\cos\left[\frac{2\pi(t-t_o)}{p(i)}\right]\right\} - \left(C_{nm}(t)\right)_{GRACE}$$

To check the model, we will do an artificial gap from Jun 2014 to June 2015 (as the same place of GRACE/GRACE-FO gap)

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3 Results and Discussion

3.1. Frequency Domain

1- The potential degree variances

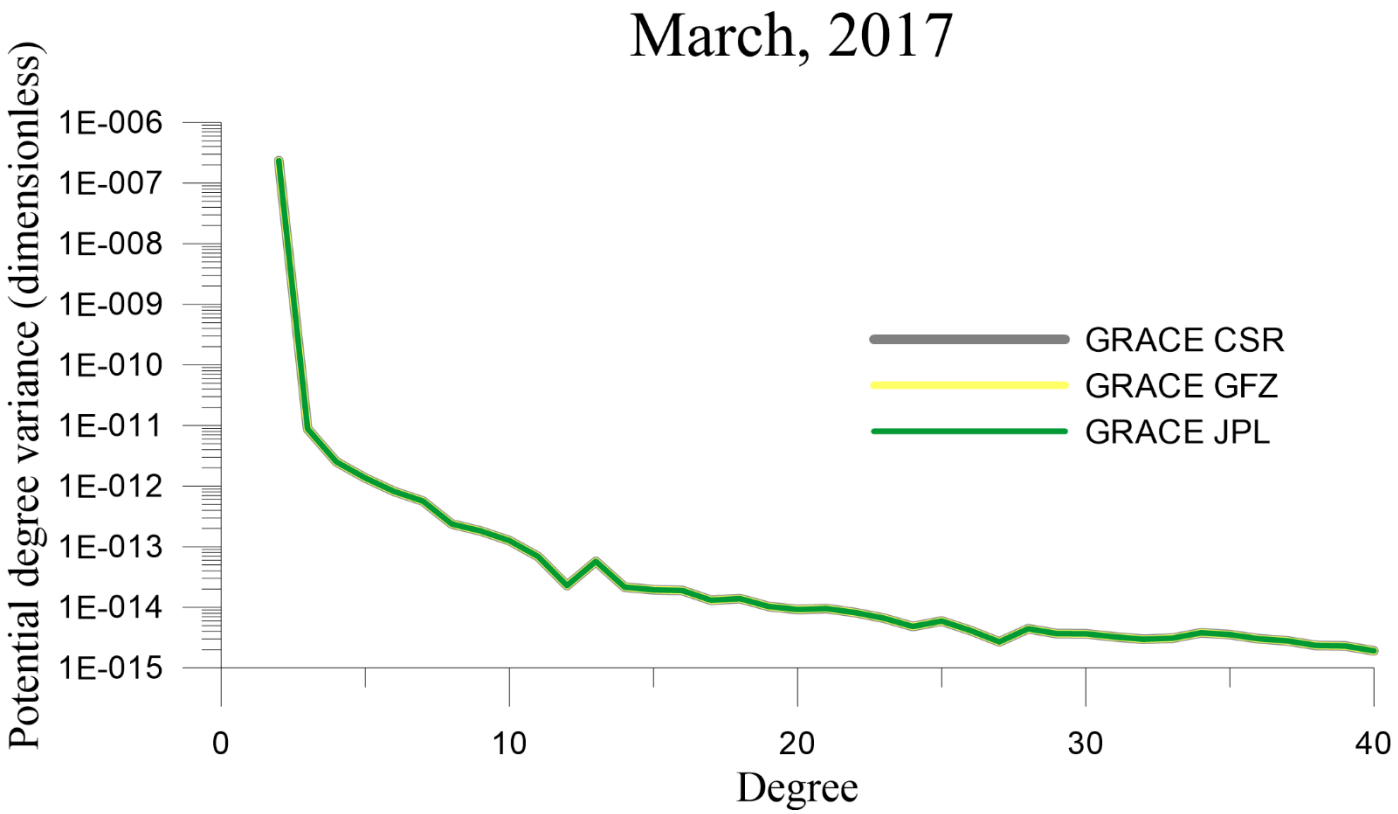
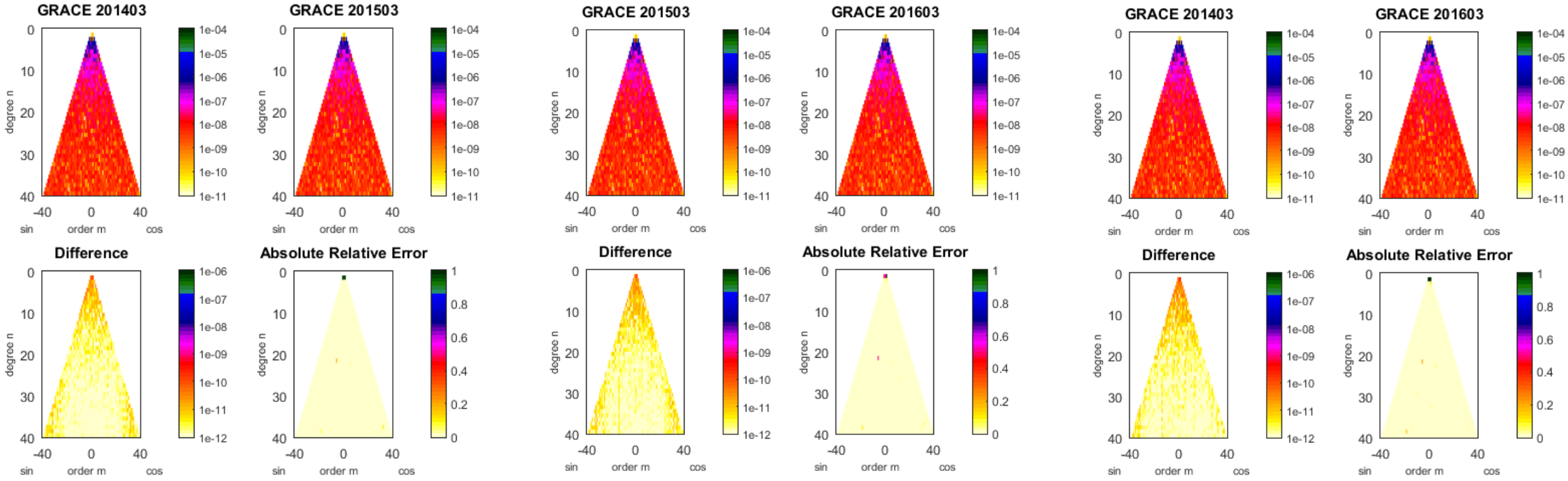


Figure 3. Potential degree variance

3 Results and Discussion

3.1. Frequency Domain

2- Spherical harmonics



2 consecutive years **2 consecutive years** **not consecutive years**

Figure 4. GRACE - GRACE Comparison

3 Results and Discussion

3.1. Frequency Domain

2- Spherical harmonics

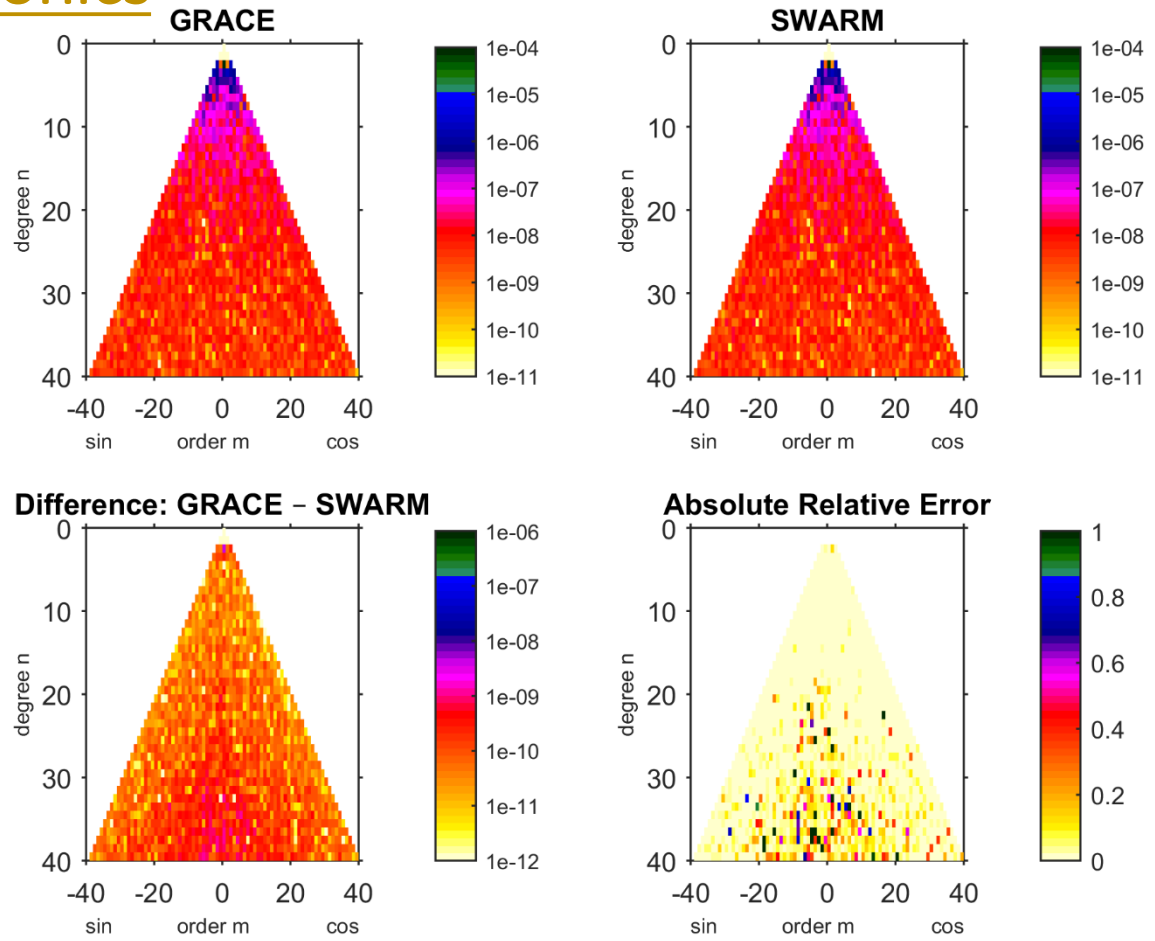


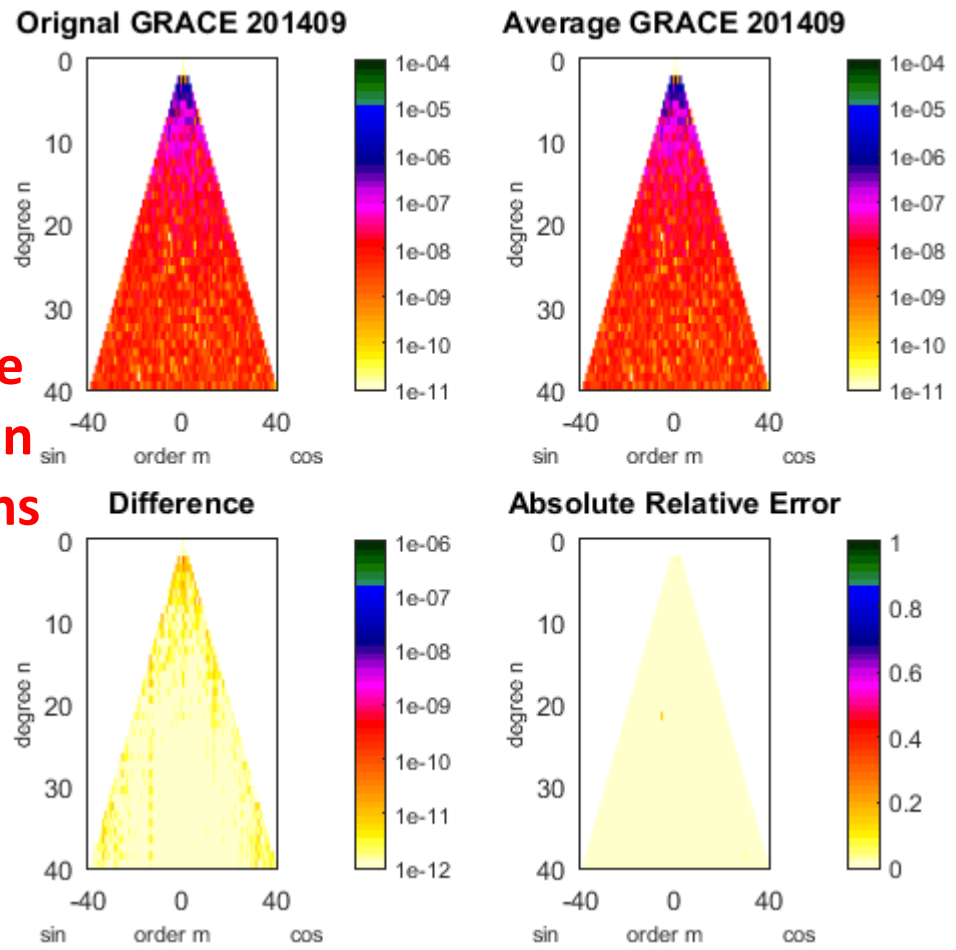
Figure 5. GRACE – Swarm Comparison

3 Results and Discussion

3.1. The NEW modified coefficients

1- Spherical Harmonics Itself:

Average between 2 months



Parametric LSA

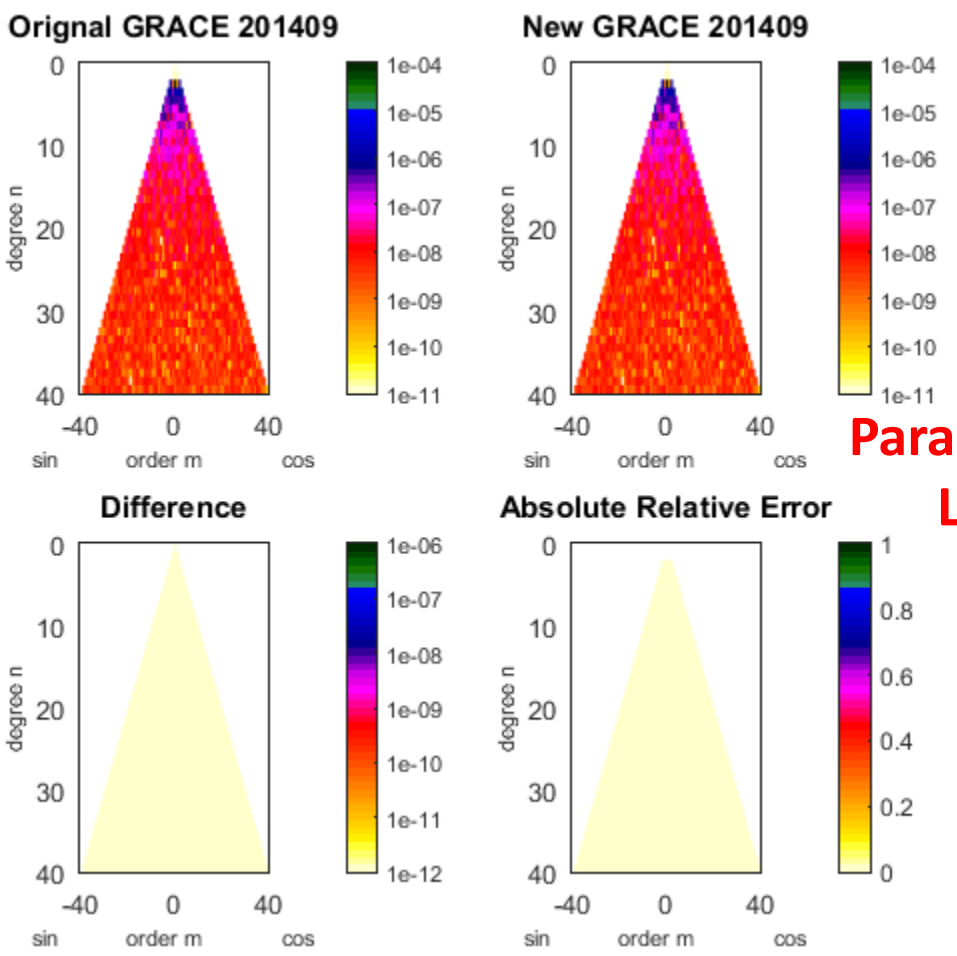


Figure 6. Spherical harmonics comparison

3 Results and Discussion

3.1. The NEW modified coefficients

2- Gravity Anomaly:

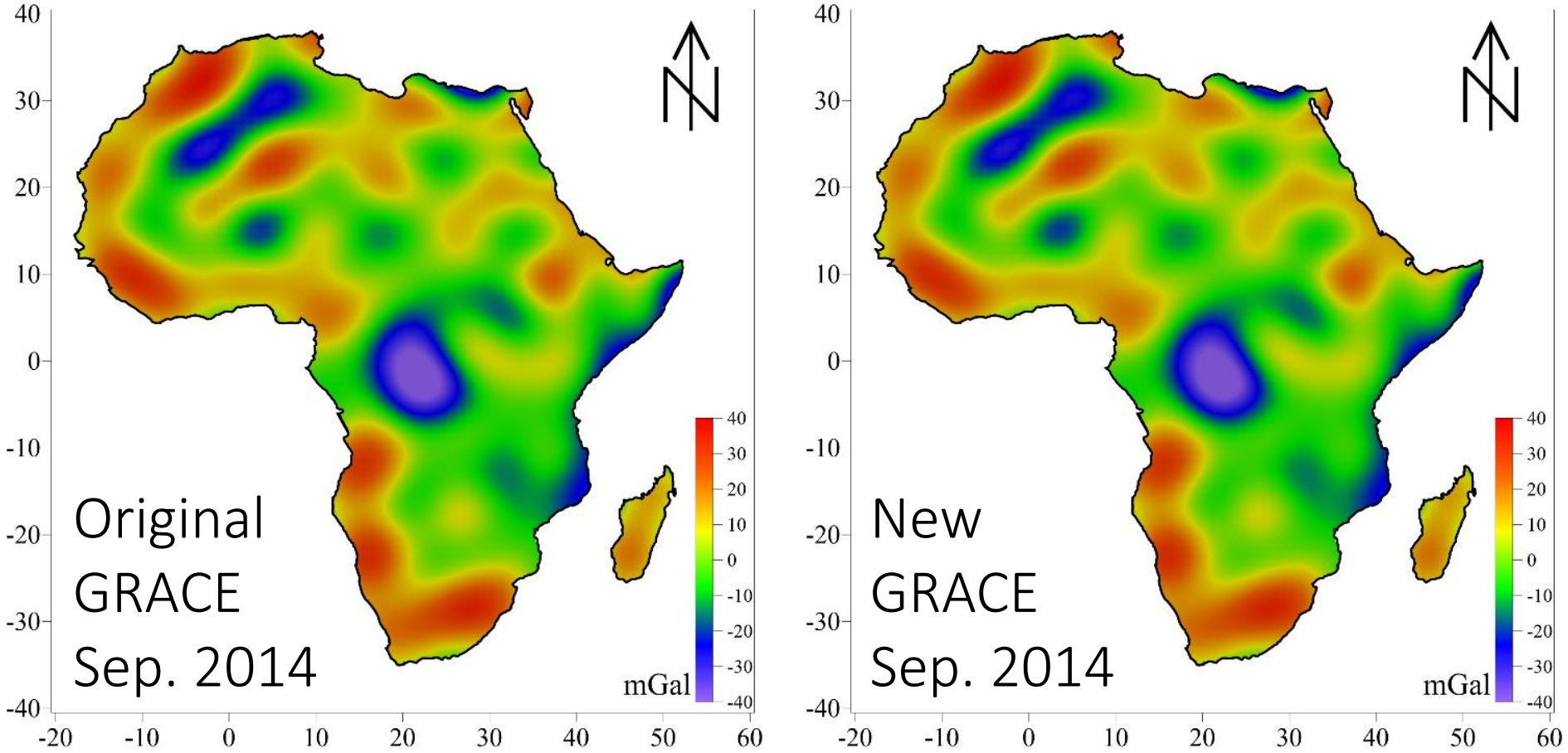


Figure 7. Gravity anomaly

3 Results and Discussion

3.1. The NEW modified coefficients

3- Terrestrial Water Storage trend:

We did an artificial gap from Jun 2014 to June 2015

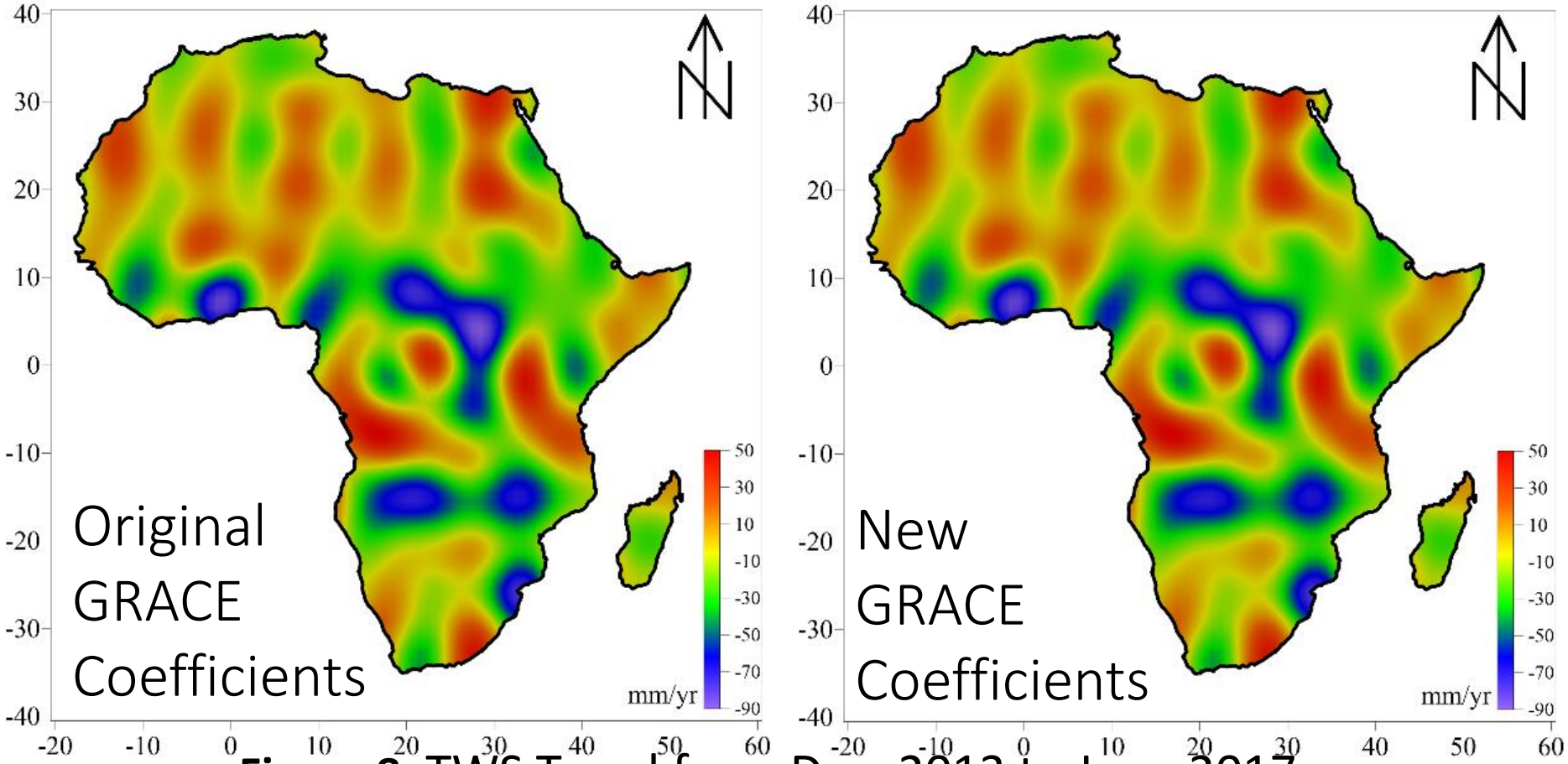


Figure 8. TWS Trend from Dec. 2013 to June 2017

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4 Conclusion

- In terms of potential degree variance in the frequency domain, the triple GARCE product data exhibit usual consistency.
- Making an artificial gap in the existing GRACE data make us sure that the LSA model is working well.
- We used a full monthly GRACE/GRACE-FO data to produce the missed months.
- Filling in the missing data using the GRACE/GRACE-FO original data yields more accurate results because there is a consistency in the same month data in the different years.
- To bridge the gap between GRACE and GRACE-FO, we recommend using a LSA regression.

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Thank you !