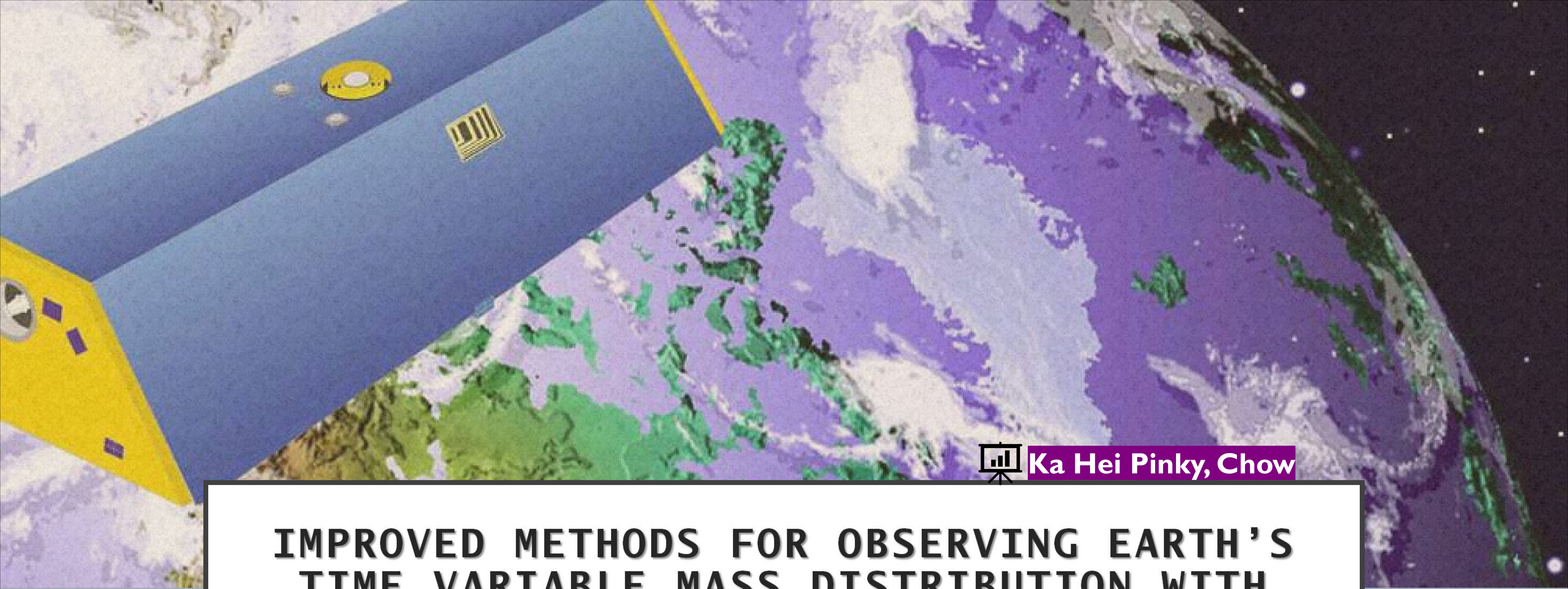


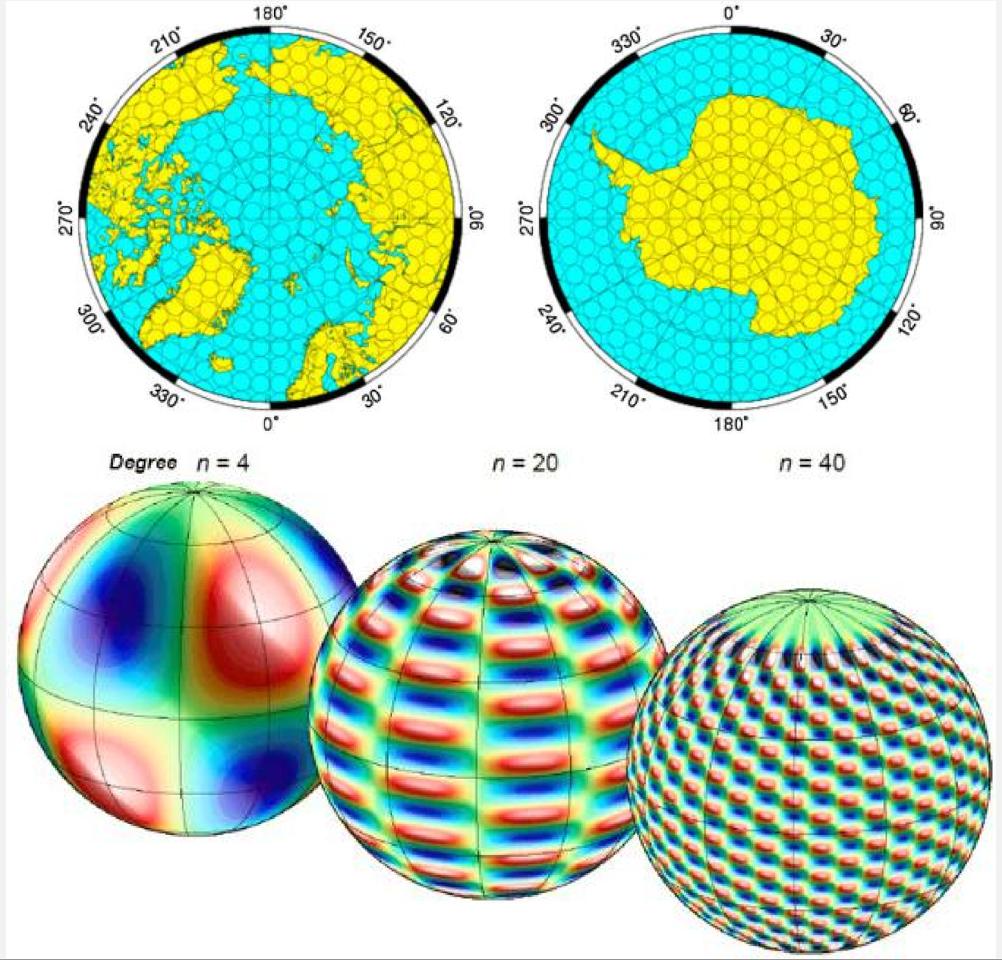
Ka Hei Pinky, Chow

IMPROVED METHODS FOR OBSERVING EARTH'S TIME VARIABLE MASS DISTRIBUTION WITH GRACE USING SPHERICAL CAP MASCONS

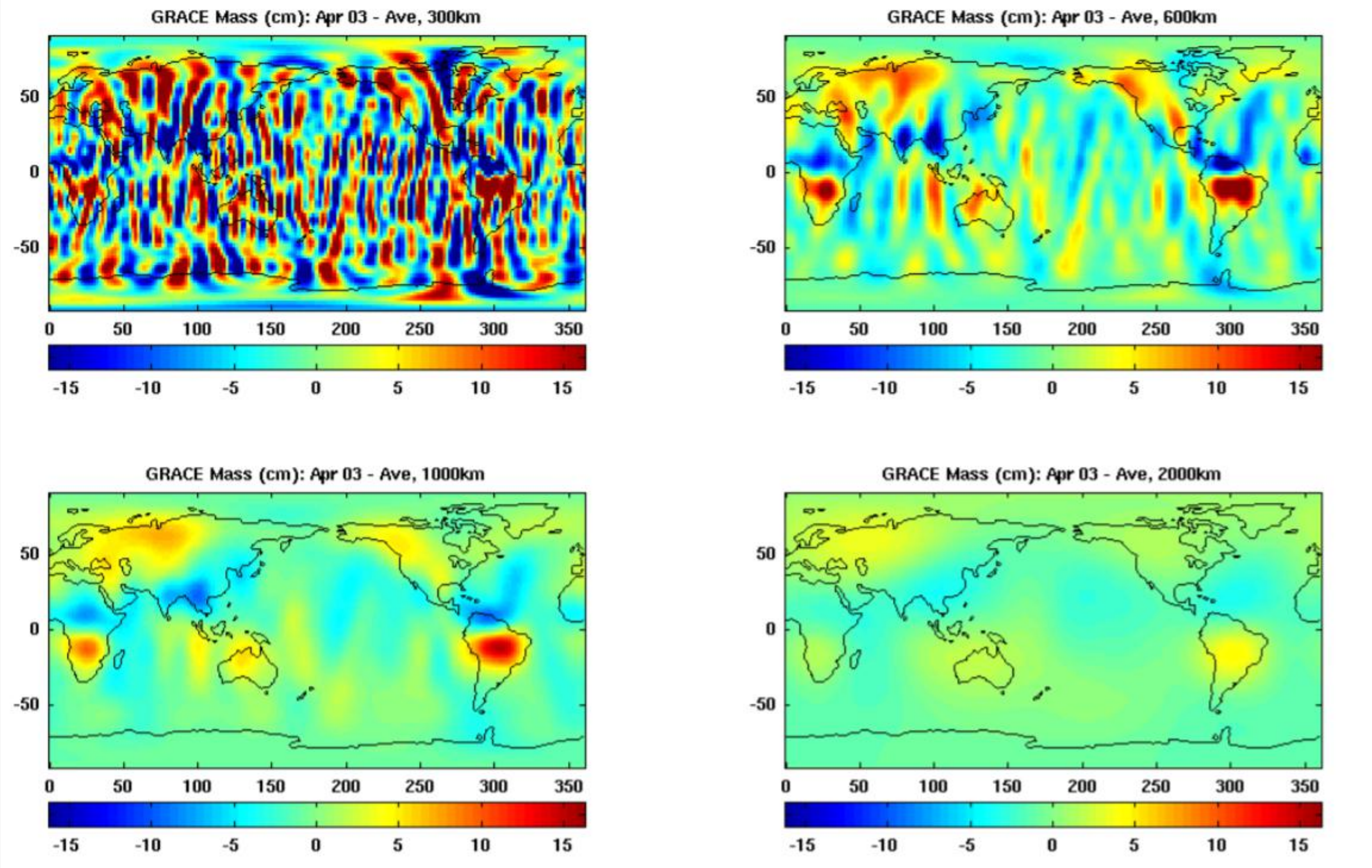
Michael M. Watkins, David N. Wiese, Dah-Ning Yuan, Carmen Boening, and Felix W. Landerer

SUMMARY

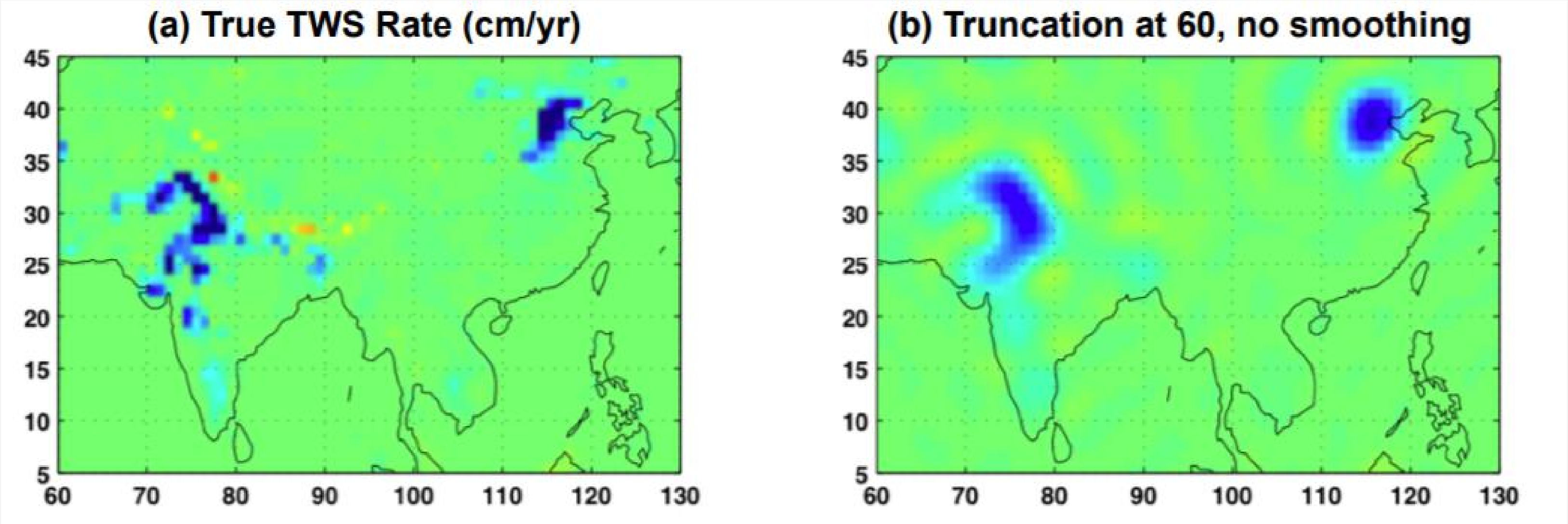
- Developing mascon solution instead of spherical harmonic solution
- Comparison between mascon solution, spherical harmonic solution and in-situ data
- Agreement between two solutions
- Reduce leakage error, increase resolution for applications, and minimized post-processing with scale factor
- Better performance for land-ocean boundary and low latitude ocean



RESIDUAL ALIASING EFFECTS: CHALLENGES TO BE SOLVED

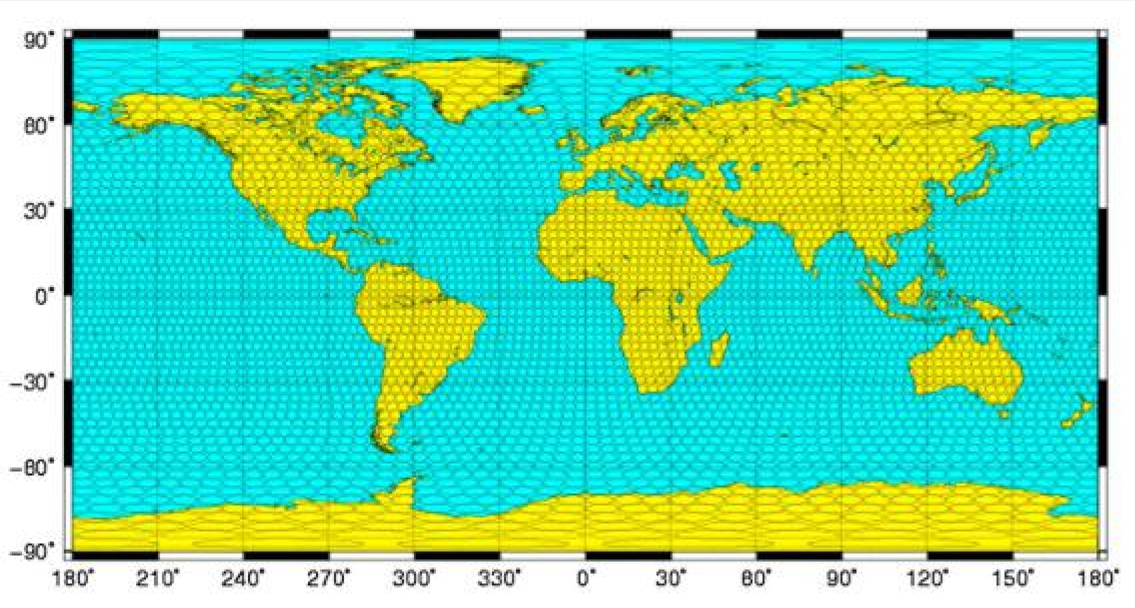


LEAKING ERROR: CHALLENGES TO BE SOLVED



MASCON SOLUTION JPL RL05M

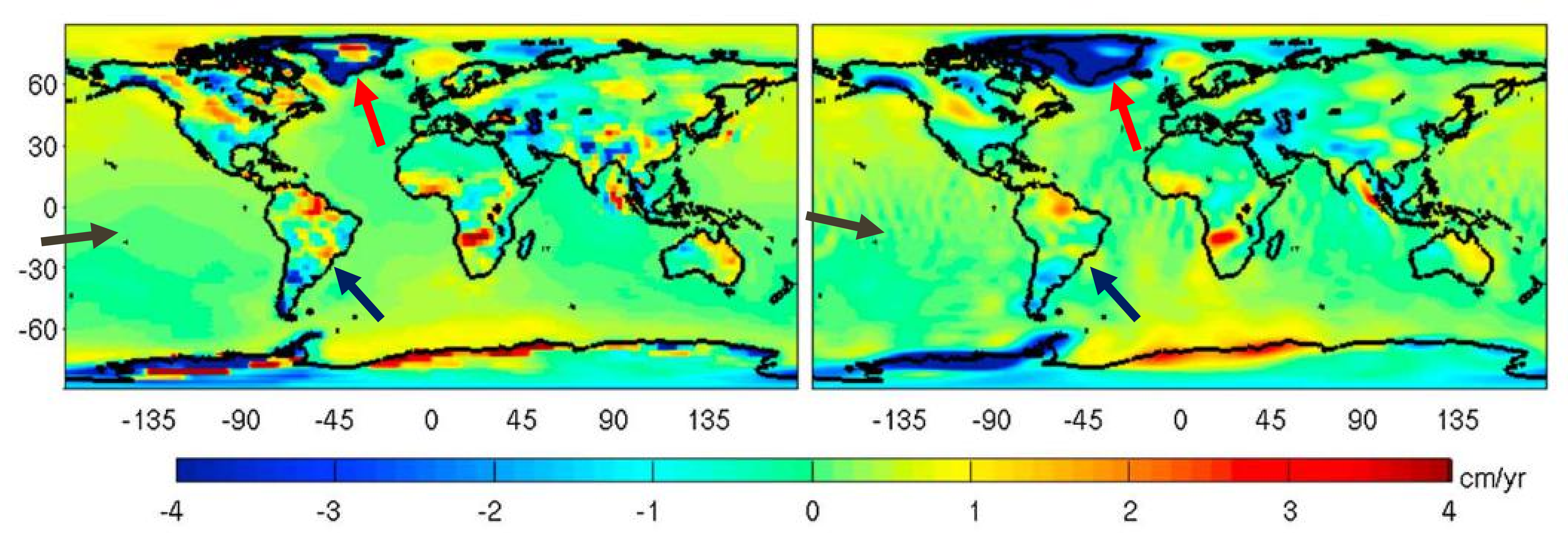
- Mass Concentration blocks
- 4551 equal-area, 3 arc-degree mascon cells
- localized signals are averaged over the whole mascon
- Calculate gravitational potential in local mascon coordinate system with density function
- Introduced geophysically based a-priori information



MASCON V.S. SPHERICAL HARMONICS

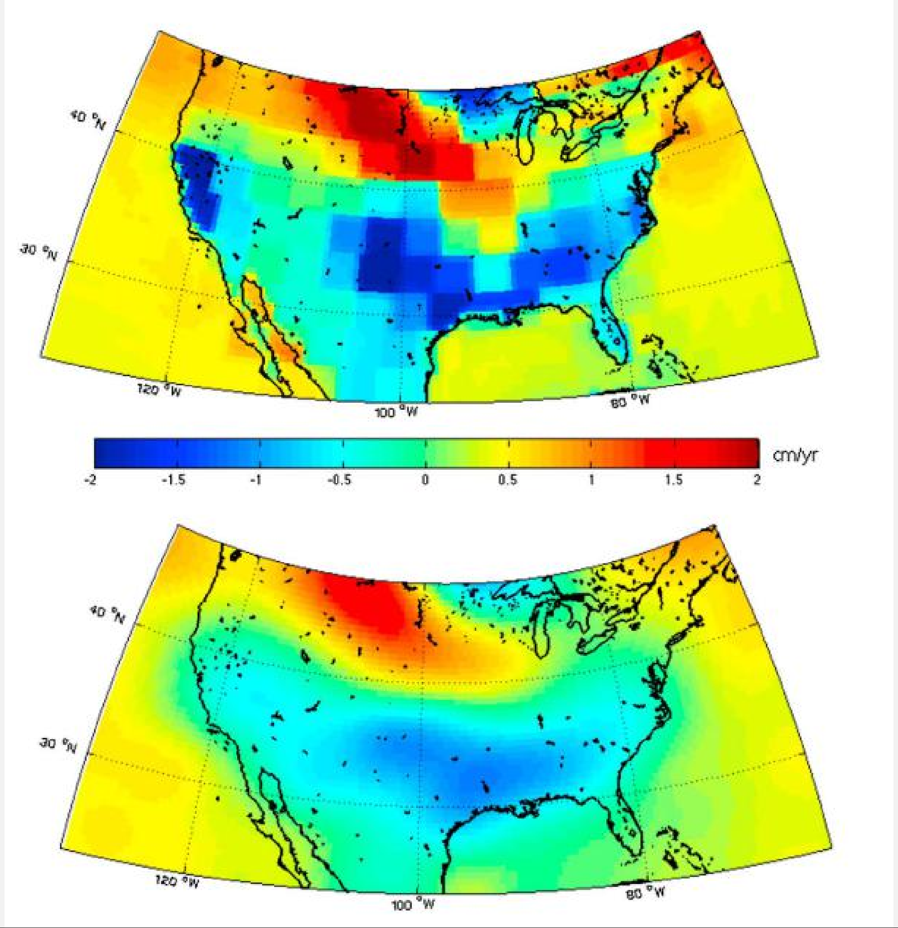
Mascon	**Spherical harmonics**
parameterizing the gravity field with regional mass concentration functions	parameterizing the Earth's gravity field using global spherical harmonics (SH) basis functions
Global to regional scale	Global scale
Limited resolution	Enhanced resolution
A priori constraints based on both GRACE data and geophysical models	Empirical post-processing filtering and hence signal loss ➢ Noise reduction ➢ Signal restoration
Coastline Resolution Improvement (CRI) filter	Cannot distinguish land and ocean areas

COMPARISON



The 2003–2013 trend for (left) JPL RL05M mascons and (right) JPL RL05 harmonics DS300 expressed in cm/yr and centimeter of EWH, respectively (Watkins, M. M., Wiese, D. N., Yuan, D. N., Boening, C., & Landerer, F. W., 2015)

SPATIAL RESOLUTION



The 2003–2013 trends for the United States comparing the (top) JPL RL05M mascon solution and (bottom) JPL RL05 spherical harmonic solution DS300

(Watkins, M. M. et. al., 2015)

UNDERSTANDINGS

- The disadvantages and the causes of spherical harmonics
- The post-processing needs and steps treating spherical harmonical solutions
- The general concept of mascon as an alternative solution
- A priori uncertainty in treating moscons
- Algorithm to resolve leaking error with mass redistribution at boundaries
- The advantages of mascon solution in particular applications (e.g. Greenland and drought signal)
- Comparison between different solutions in multiple settings

TO BE UNDERSTOOD

- The exact differences between three types of mascon solutions
- Calculations of gravitational acceleration expressed in the local mascon coordinate system, as well as the applied spatial constraints.
- How exactly the local mascon coordinate system and final inertial system works?
- What causes the K-band microwave ranging bias?
- Why do we need to replace the low degree of mascon solution with harmonics when treating the solution?
- How does the introduced a priori spatial correlation works?

WELL-DONE

- ***Clear step demonstrations and calculations: full technical details***
- ***Verification of signal absorption regarding gaps in between spherical caps***
- ***Bootstrapping methodology implemented to derive appropriate a priori values***
- ***Comparison in different regional settings: including Cryoshere and Ocean***
- ***GIA and seismic events considered in the a priori covariance***

POORLY DONE

- ***Criteria of exact defined values of a priori variance?***
- ***Uncertainty of mascons solutions?***
- ***Verification of solution with in-situ data instead of SH?***
- ***Limitations compared to spherical harmonics? They do have mentioned disadvantages, but very briefly in a small paragraph.***

Improved methods for observing Earth's time variable mass distribution with GRACE using spherical cap mascons
MM Watkins, DN Wiese, DN Yuan… - Journal of …, 2015 - Wiley Online Library
We discuss several classes of improvements to gravity solutions from the Gravity Recovery and Climate Experiment (GRACE) mission. These include both improvements in background geophysical models and orbital parameterization leading to the unconstrained spherical harmonic solution JPL RL05, and an alternate JPL RL05M mass concentration (mascon) solution benefitting from those same improvements but derived in surface spherical cap mascons. The mascon basis functions allow for convenient application of a …

Improved methods for observing Earth's time variable mass distribution with GRACE

In Artikeln mit Zitaten suchen

[PDF] High-resolution CSR GRACE RL05 mascons
H Save, S Bettadpur, BD Tapley - Journal of Geophysical …, 2016 - Wiley Online Library
The determination of the gravity model for the Gravity Recovery and Climate Experiment (GRACE) is susceptible to modeling errors, measurement noise, and observability issues. The ill-posed GRACE estimation problem causes the unconstrained GRACE RL05 solutions …

Emerging trends in global freshwater availability
M Rodell, JS Famiglietti, DN Wiese, JT Reager… - Nature, 2018 - nature.com
Freshwater availability is changing worldwide. Here we quantify 34 trends in terrestrial water storage observed by the Gravity Recovery and Climate Experiment (GRACE) satellites during 2002–2016 and categorize their drivers as natural interannual variability …

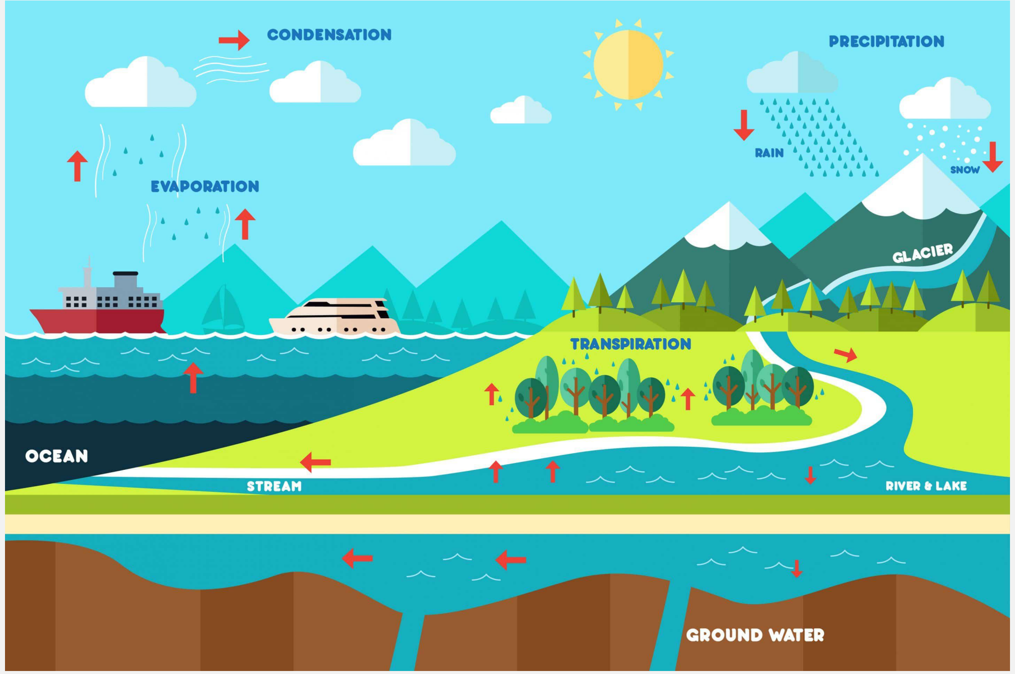
Climate-change–driven accelerated sea-level rise detected in the altimeter era
RS Nerem, BD Beckley, JT Fasullo… - Proceedings of the …, 2018 - National Acad Sciences
Using a 25-y time series of precision satellite altimeter data from TOPEX/Poseidon, Jason-1, Jason-2, and Jason-3, we estimate the climate-change–driven acceleration of global mean sea level over the last 25 y to be 0.084±0.025 mm/y 2. Coupled with the average climate …

A decade of sea level rise slowed by climate-driven hydrology
JT Reager, AS Gardner, JS Famiglietti, DN Wiese… - …, 2016 - science.sciencemag.org
Climate-driven changes in land water storage and their contributions to sea level rise have been absent from Intergovernmental Panel on Climate Change sea level budgets owing to observational challenges. Recent advances in satellite measurement of time-variable gravity …

- **Extensively citied in the international academia:**
  Over 40 cites in 6 months, ~200 in the next 3 years
- **Citations**
  - **Testing with in-situ data**
  - **Inter-comparison**
  - **Application in hydrological model**
  - **(Flood risk, Drought index, Sea Level Rise, Precipitation, Groundwater)**
- **Well-suited as precise constraints, recent advance**
- **Consistent Agreement with the performance**

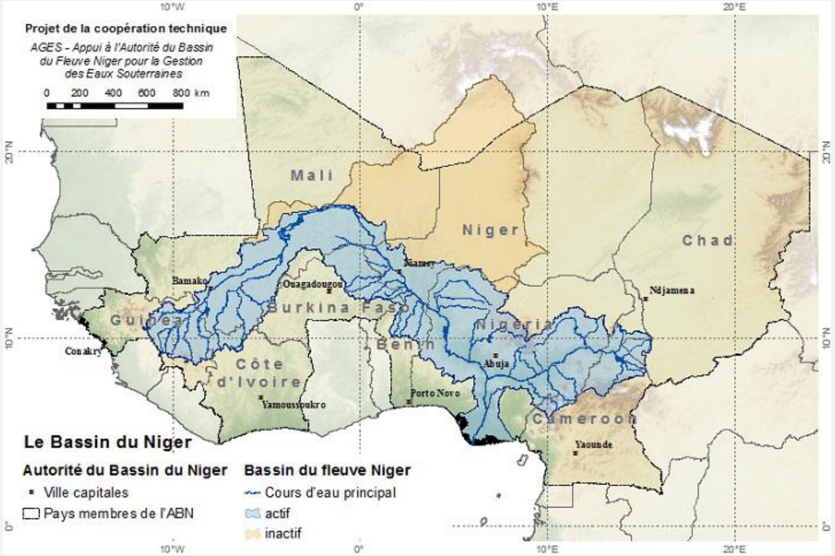
IMPACTS

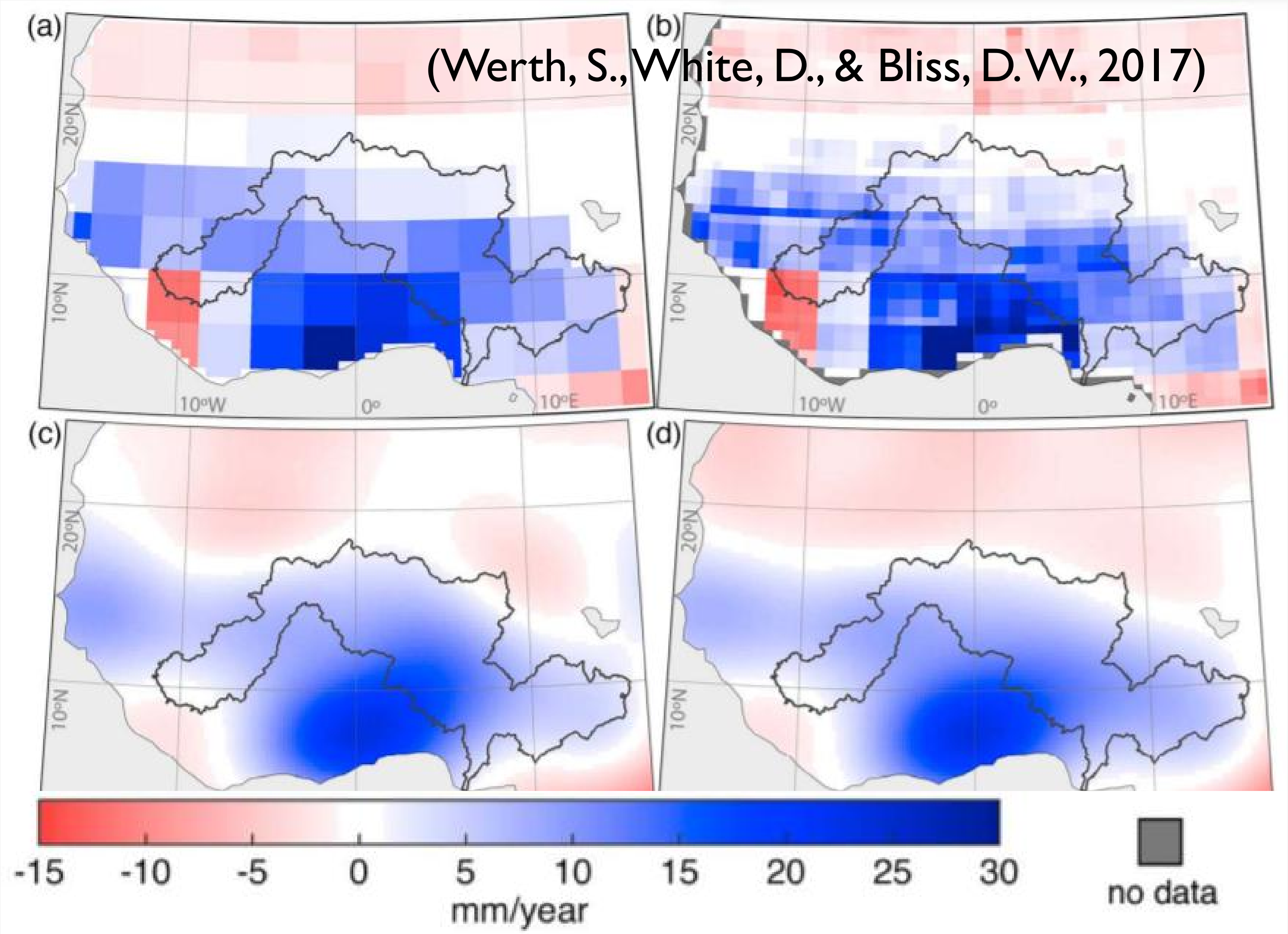
- Greatly facilitate regional hydrological modelling
- User-friendly for academic research
- More consistent results among studies
- Encourage remote sensing as alternative of survey and modelling
- More accurate predictions of hydrological cycle and climate impacts



CASE 1: **NIGER RIVER BASIN**

- **Long-term changes in terrestrial water storages (TWS)**
- **TWS increase about 7 mm/yr, or 14 km3/yr**
- **Dominated by groundwater**

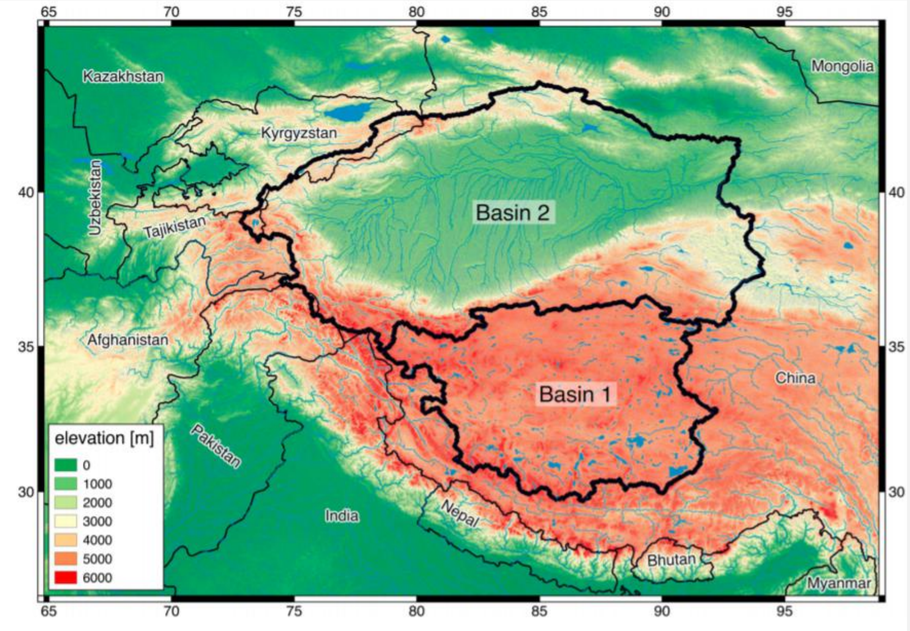


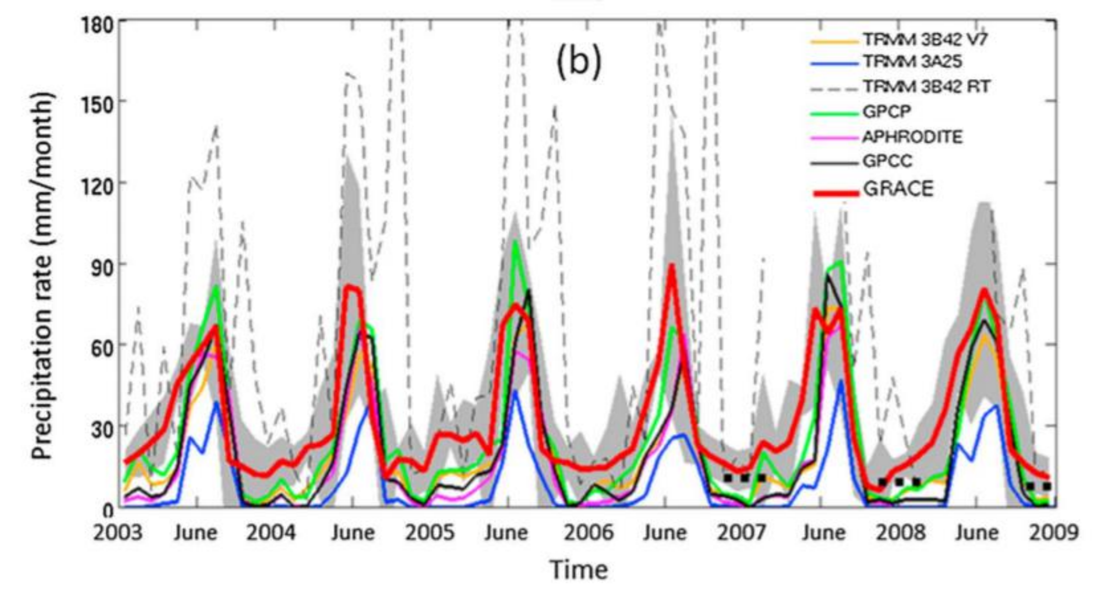


(Werth, S., White, D., & Bliss, D.W., 2017)

CASE 2: **WESTERN TIBETAN PLATEAU**

- Independent estimate of monthly accumulated precipitation using mass balance equation
- Good agreement with other precipitation product





(Behrangi, A., Gardner, A. S., Reager, J. T., & Fisher, J. B., 2017)

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