FIG WORKING WEEK 2019

22–26 April, Hanoi, Vietnam

"Geospatial Information for a Smarter Life and Environmental Resilience"

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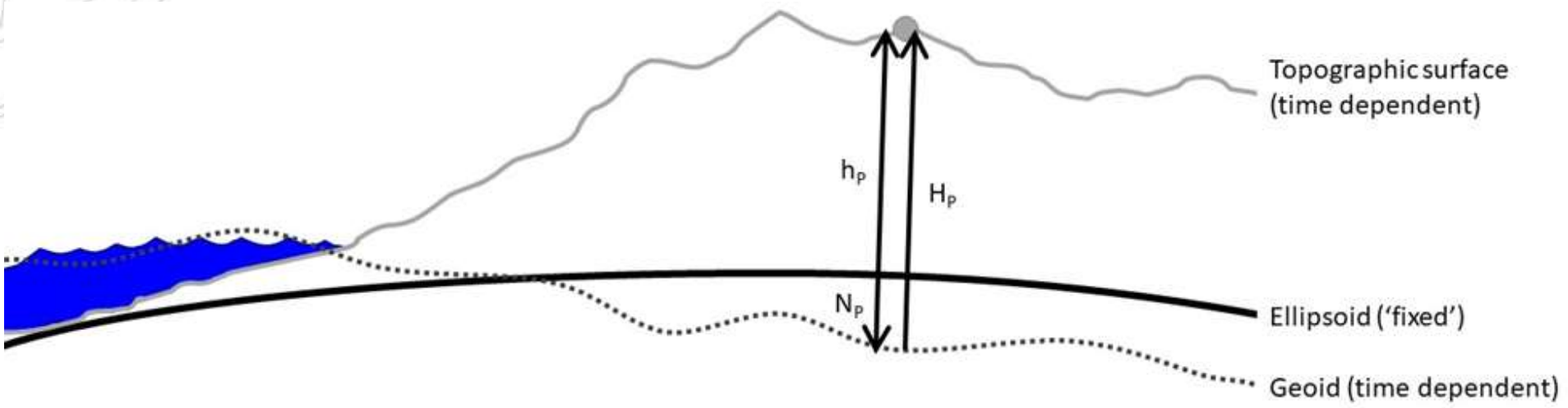
Practical Considerations in Implementing a Geoid Monitoring Service (10062)

Ahlgren, Kevin M.
NOAA's National Geodetic Survey

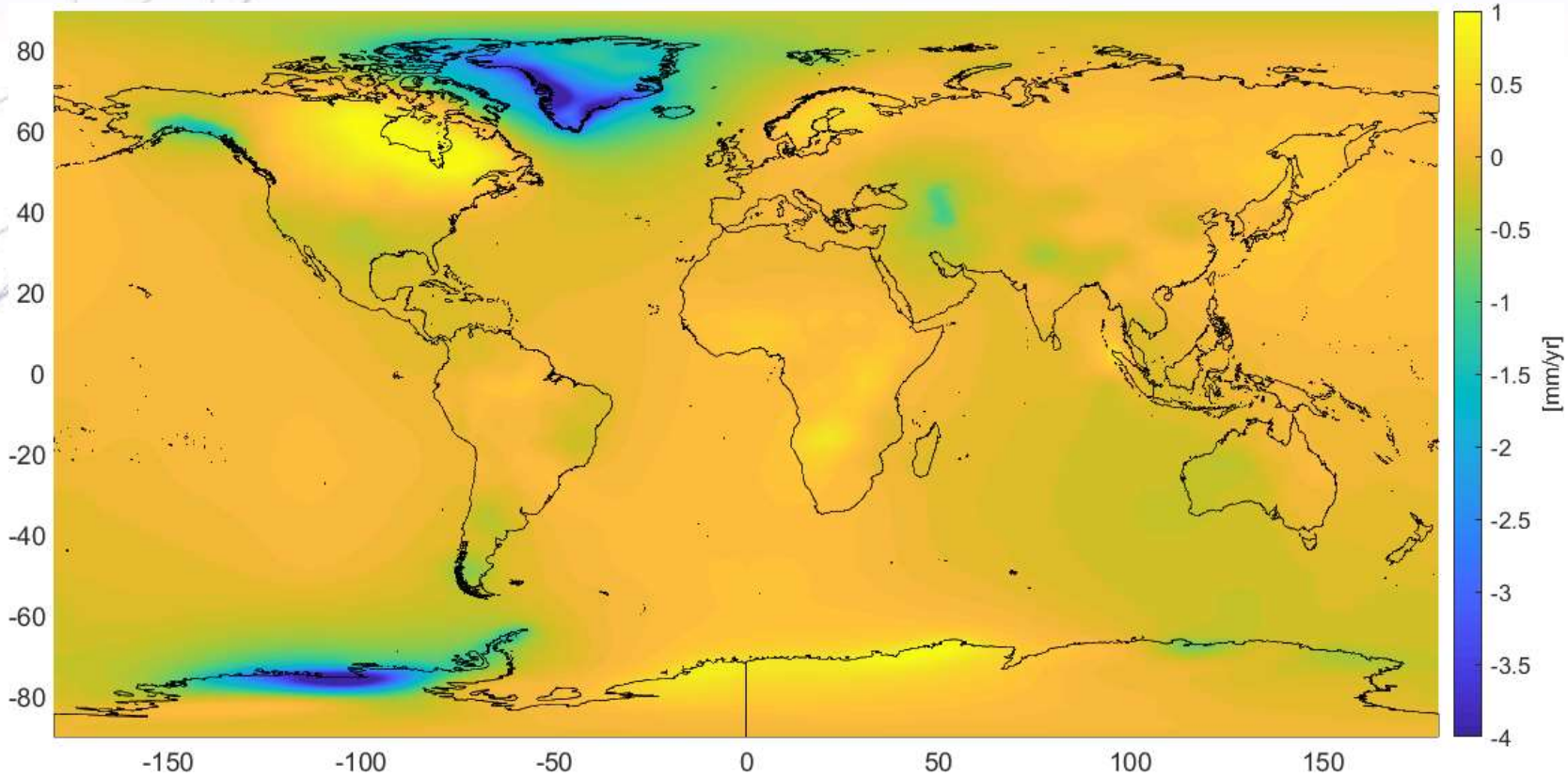
Outline

- What is GeMS?
- Motivation
- Causes of Geoid Change
- Temporal Frequency Signatures
- GeMS Products, Resolutions, Updates



GeMS

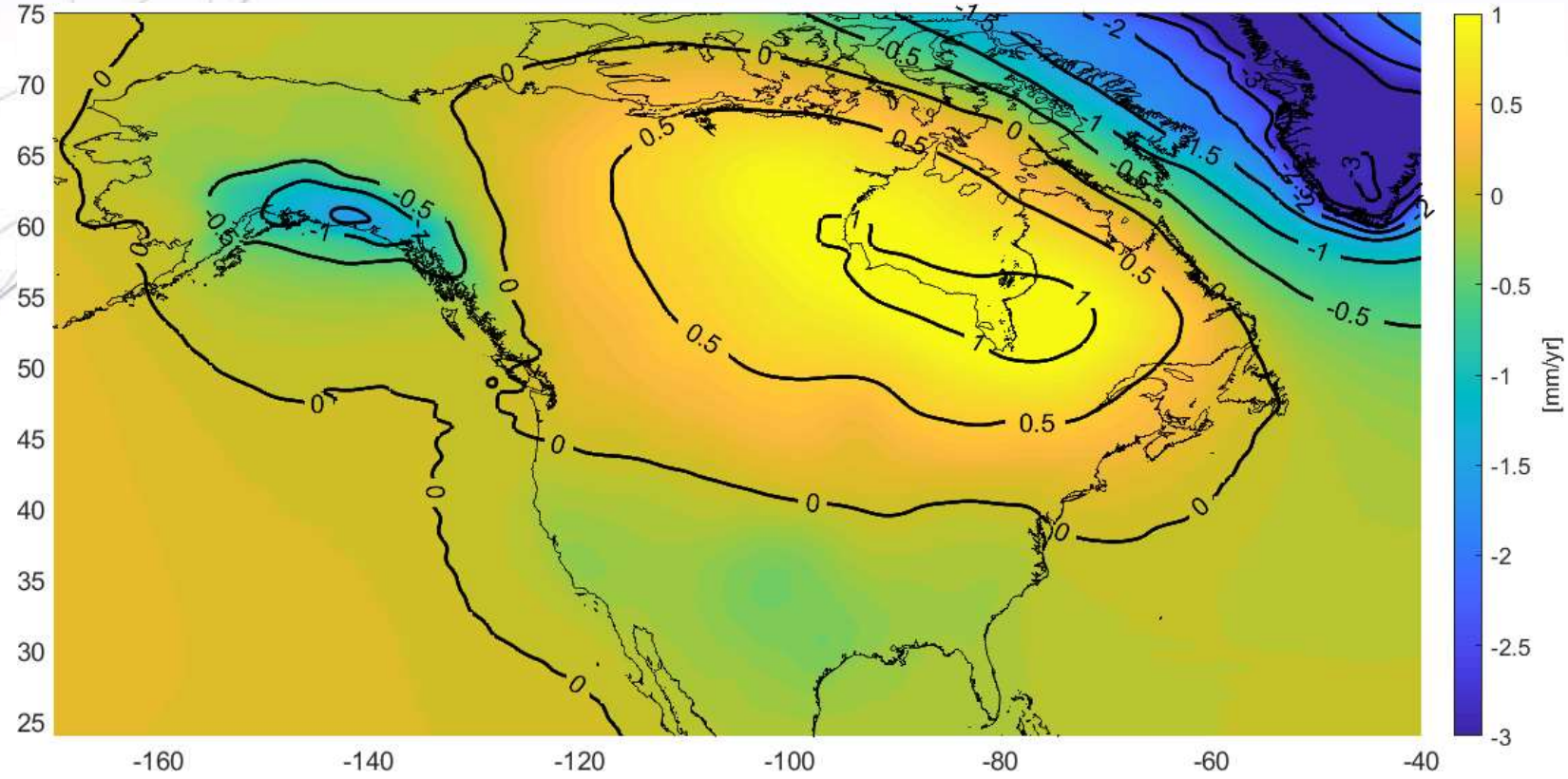
- Geoid Monitoring Service
- NGS Project to estimate time-dependent quantities and incorporate into vertical reference system (NAPGD 2022)
- Quantities: $\dot{N}, \dot{\Delta g}, \dot{H}, \dot{W}, \dot{\eta}, \dot{\xi}$



Geoid Time Rate of Change – secular trend from GRACE (NASA GSFC mascon v02.4, Luthcke, et al. 2013))

Motivation

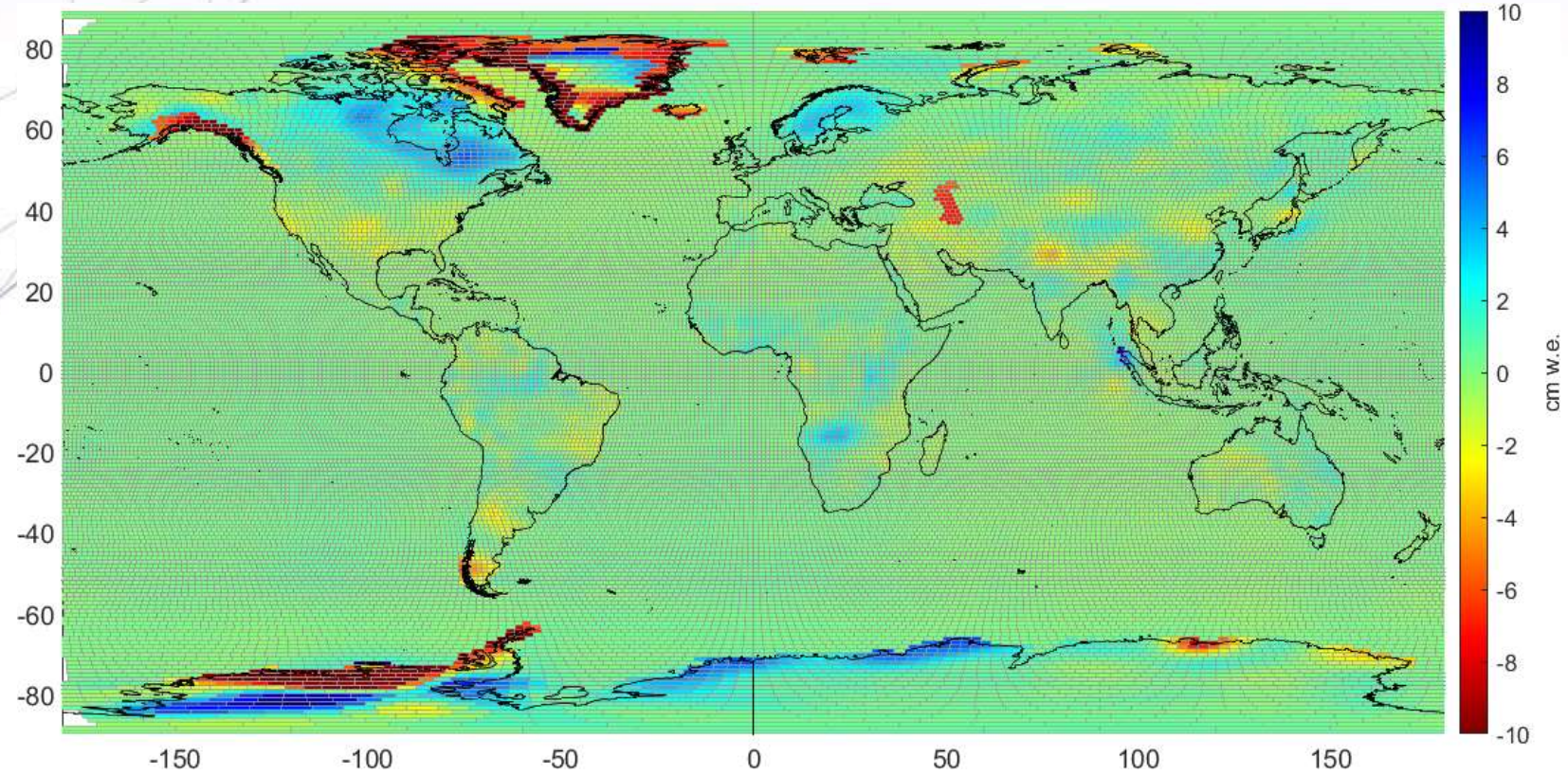
- Mission is to define the National Spatial Reference System (NSRS)
- Maintain the NSRS at the most accurate level as possible
- Systematic effects at 0.5 mm/yr need to be accounted for
- Continuation of GRAV-D (Phase 1 – Airborne, Phase 2 – GeMS)



Geoid Time Rate of Change – secular trend from GRACE (NASA GSFC mascon v02.4, Luthcke, et al. 2013))

Causes of Geoid Change

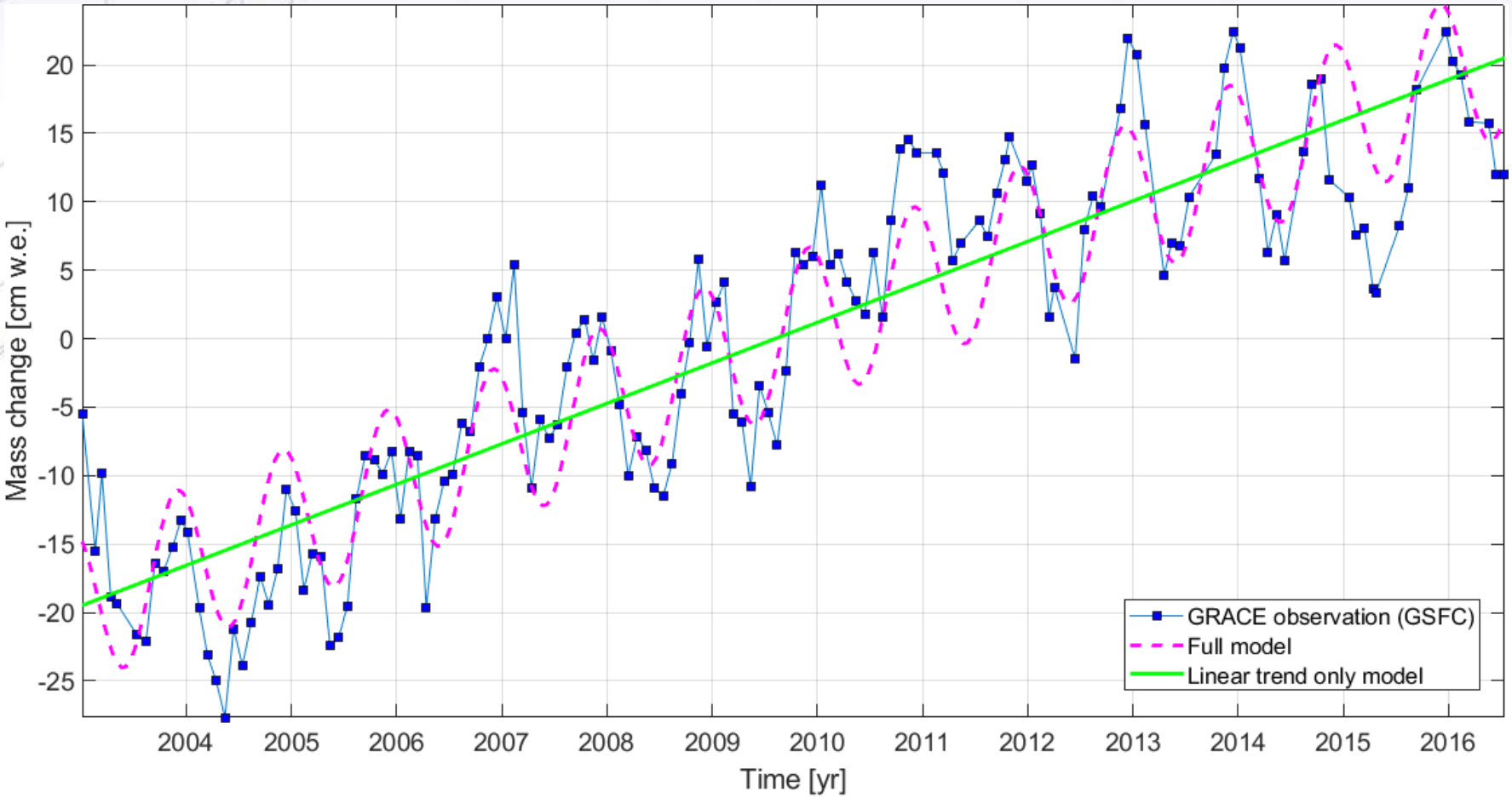
- Any mass change or redistribution
  - Glacial isostatic adjustment (GIA)
  - present day ice-mass changes
  - changes in hydrology (including ground water storage, snow, etc.)
  - large earthquakes
  - volcanic eruptions



Mass Change in cm water equivalent (cm w.e.) – secular trend from GRACE (NASA GSFC mascon v02.4, Luthcke, et al. 2013))

Looking at one of the mascons….

- Monthly time series from GRACE/GRACE-FO
- Temporal signatures: trend, sinusoids, instantaneous jump, (& residual)

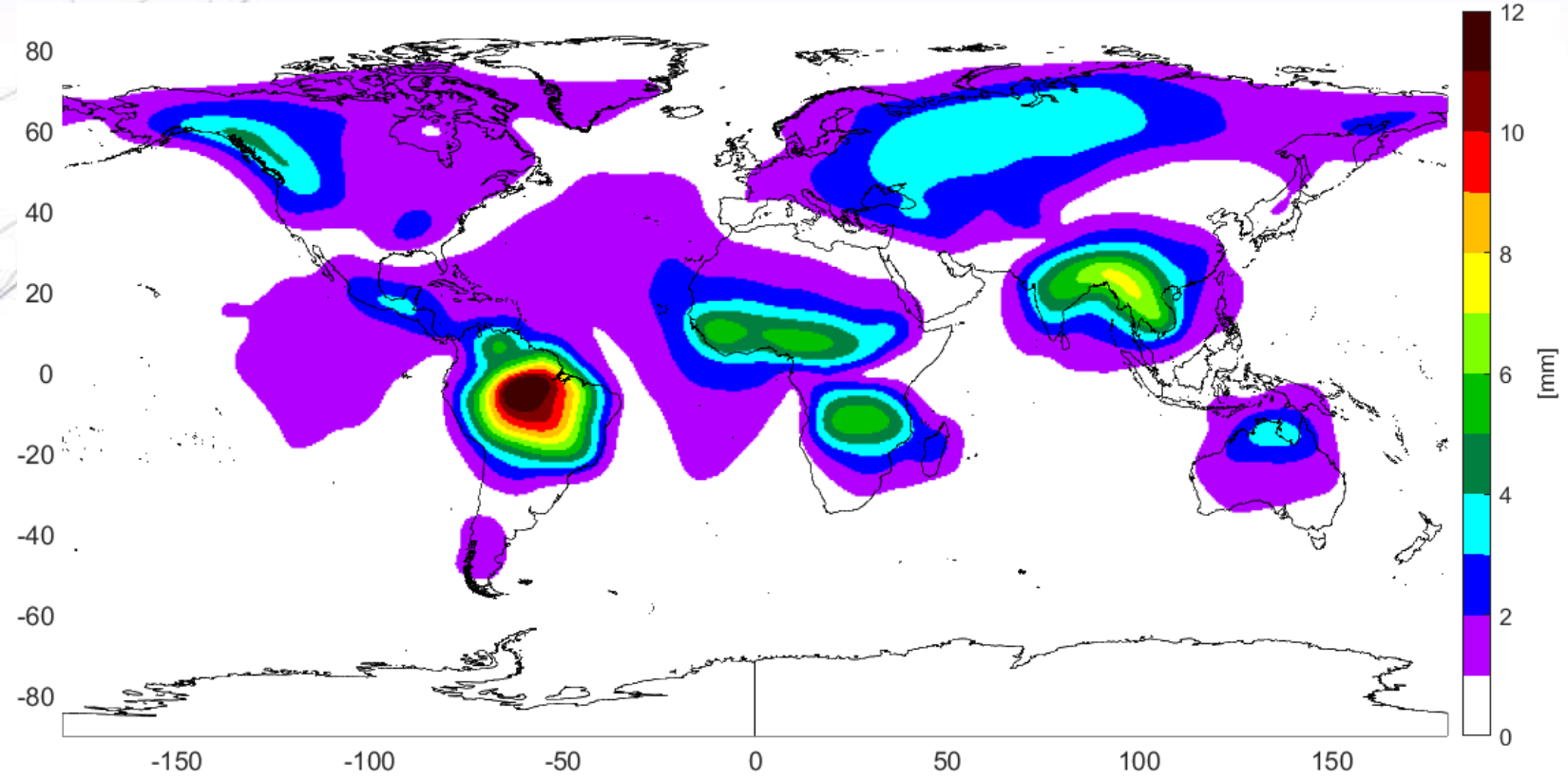


Temporal Frequency Signatures

- Secular (trend):
  - Long term shape change of the geoid
- Annual (sinusoid):
  - Geophysical processes that occur with periods of 1 year
- Sub-annual (sinusoids):
  - Can implement as much as one likes:
    - Periods with $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}$, ... years
- Episodic (Instantaneous Jumps)

Annual Amplitude

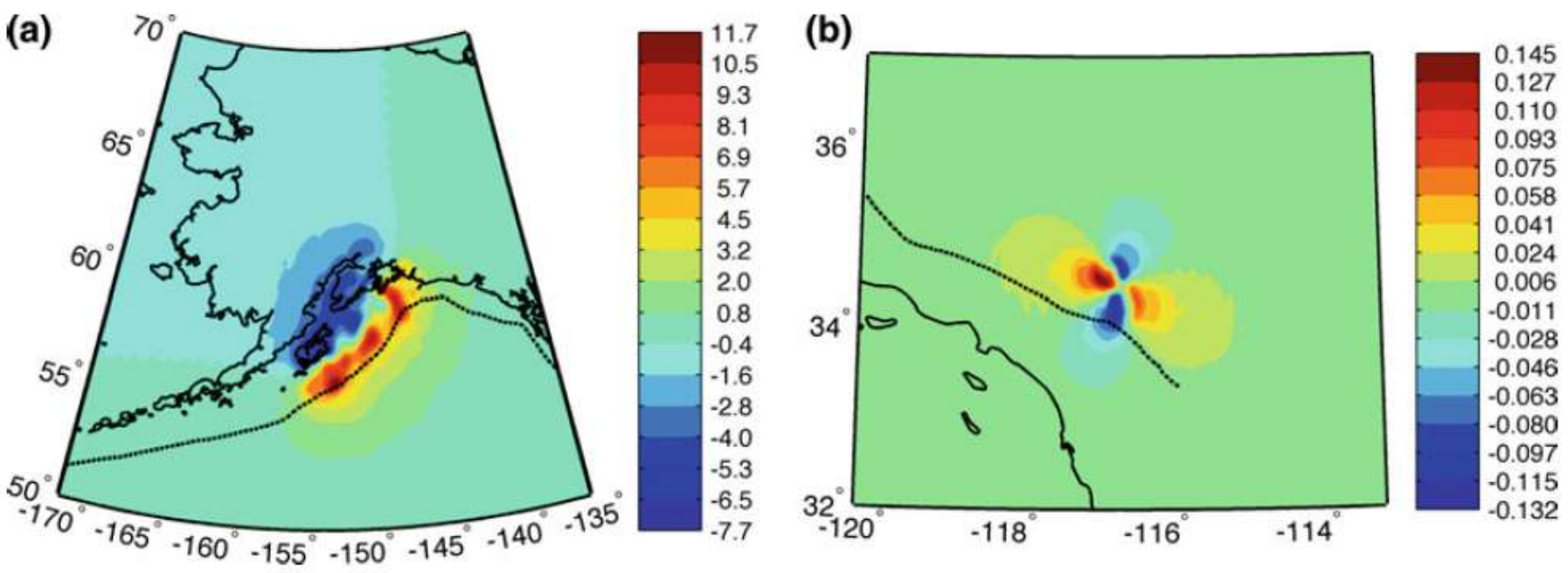
- Seasonal geoid model
  - Amplitudes are only 4-5 mm in North America
  - Amazon River basin in South America has 10+ mm



Geoid change annual amplitude (mm) from GRACE

Episodic Events

- Earthquakes, Volcanoes, Landslides…
  - Case by case
  - Possibly warrant a geodetic response
  - Very rarely occur at levels of significance
    - 1992 Landers M7.3 Earthquake produced ~0.1 mm
    - 1964 Alaska M9.2 had ~10 mm



Modeled geoid change in mm for (a) the 1964 Alaska earthquake and (b) the 1992 Landers earthquake. (from Jacob, *et al.*, 2012)

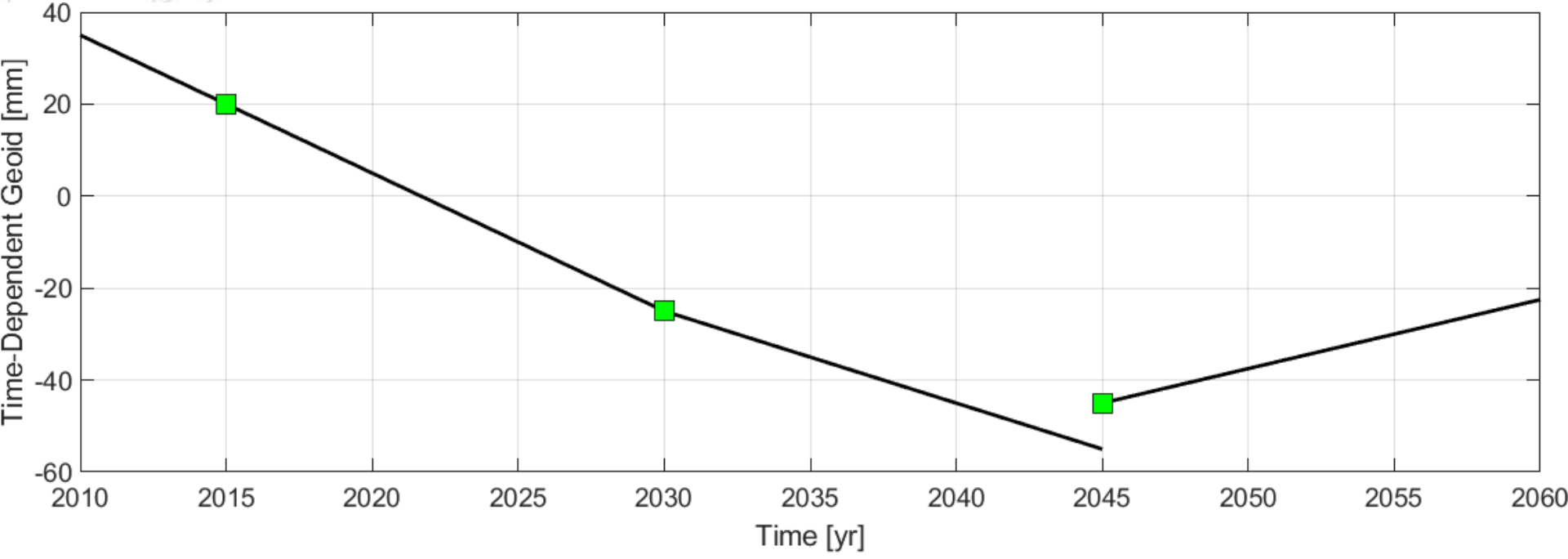
GeMS Products:

Relationship to NSRS Modernization

	The Old:	The New:
Orthometric Heights	NAVD 88	The North American-Pacific Geopotential Datum of 2022 (NAPGD2022)
Normal Orthometric Heights	PRVD 02	- Will include GEOID2022
	VIVD09	• *Static Geoid Model (SGEOID2022)*
	ASVD02	• ***Dynamic Geoid Model (DGEOID2022)***
	NMVD03	DEFLEC2022
	GUVD04	• *SDEFLEC2022*
Dynamic Heights	IGLD 85	• ***DDEFLEC2022***
Gravity	IGSN71	GRAV2022
		• *SGRAV022*
		• ***DGRAV2022***
Geoid Undulations	GEOID12B	DEM2022
		• *SDEM2022*
		• ***DDEM2022***
Deflections of the Vertical	DEFLEC12B	IGLD 2020

GeMS Products, Resolutions, & Updates

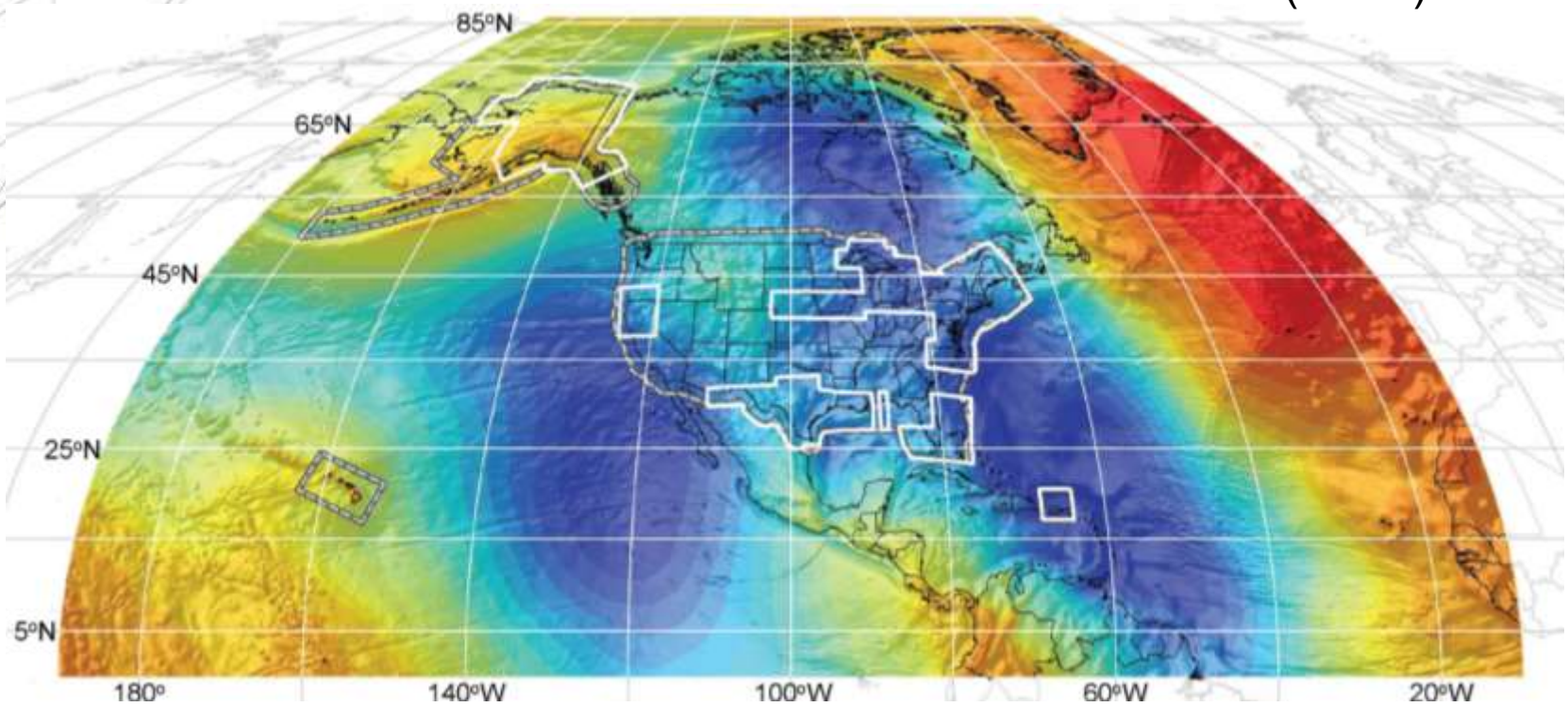
- Updates to the GeMS Model:
  - Forward looking model (v2 will incorporate v1…)
  - Patches are possible to incorporate episodic events (at < 1' res.)



GeMS Products, Resolutions, & Updates

- Spatial resolution: 1'
- Extents: 0°-90°, 170° - 350° with smaller grids over Guam/CNMI and American Samoa

xGEOID18 (Static) Model



https://beta.ngs.noaa.gov/GEOID/xGEOID18/maps/xGeoid18_Webpage_v2.png

Questions?

Kevin M. Ahlgren, PhD
+1-240-533-9894
kevin.ahlgren@noaa.gov