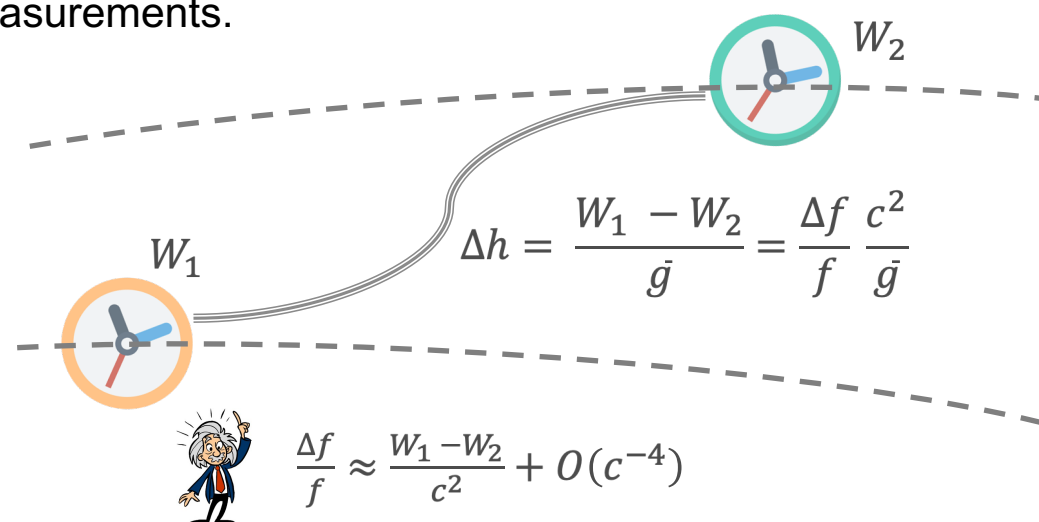


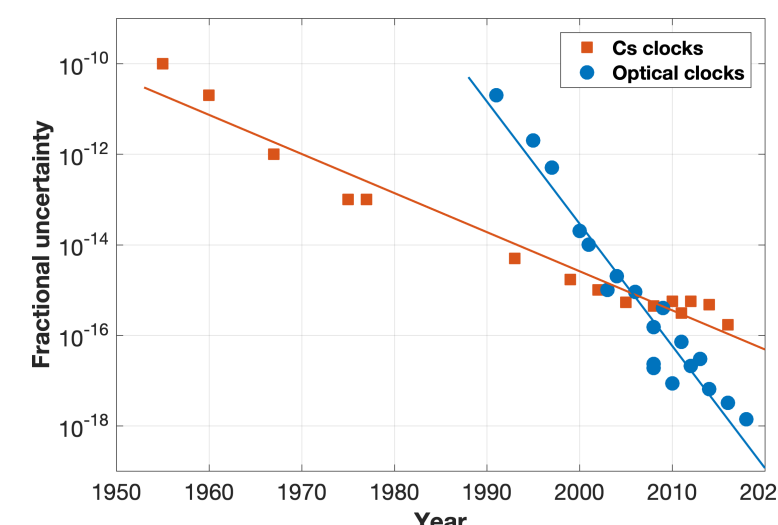
Relativistic Geodesy with Clock Networks

The precise frequency comparison of high-performance clocks will soon enable to determine the gravity potential difference (ΔW) or physical height difference (Δh) between distant sites with a targeted accuracy at the cm level. This opens up a novel and powerful way for geodetic measurements.



Optical clocks have achieved a fractional frequency uncertainty level of 10^{-18} .

$$\frac{\Delta f}{f} (1.0 \times 10^{-18}) \sim \Delta W \left(0.1 \frac{\text{m}^2}{\text{s}^2} \right) \sim \Delta h (1.0 \text{ cm})$$

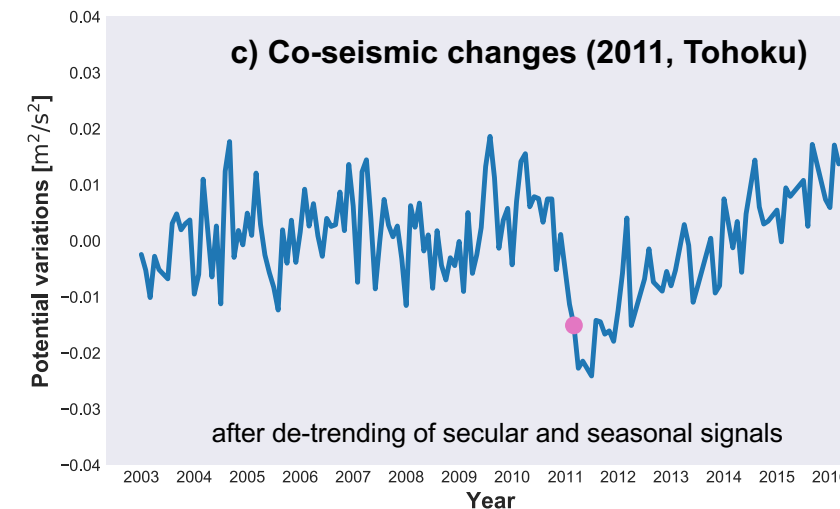
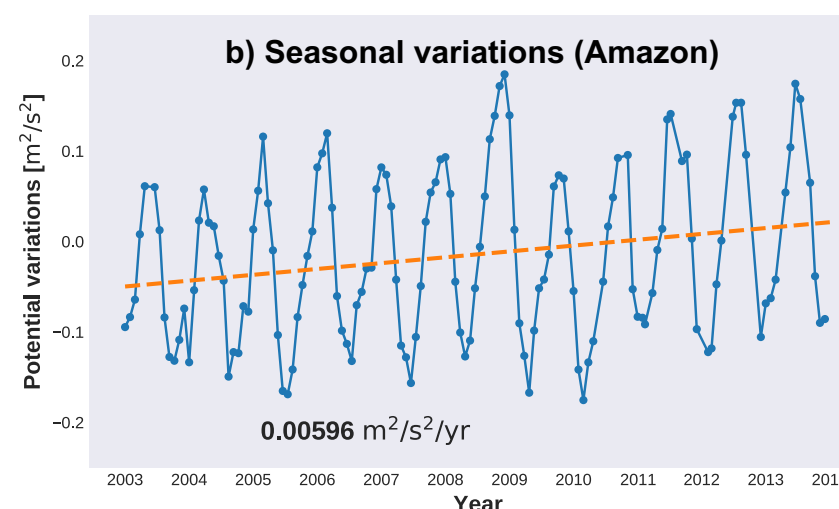
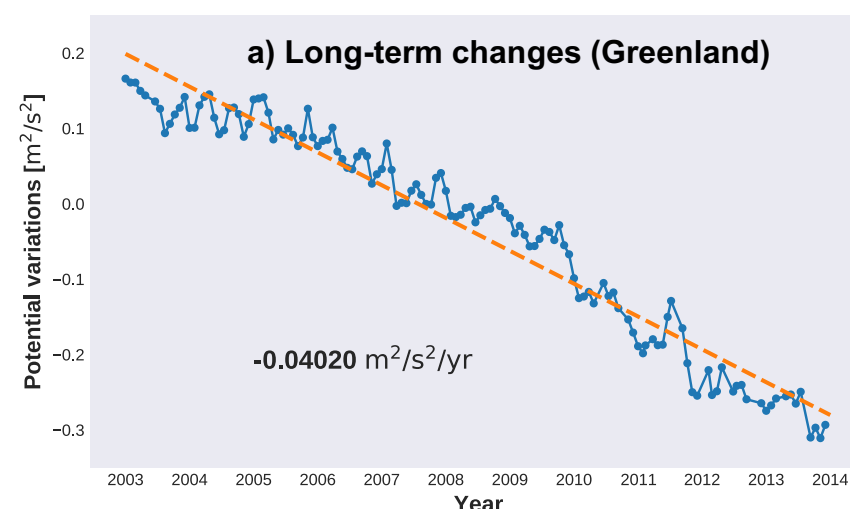


Conclusions

- Optical clock networks with the performance of 1.0×10^{-18} are promising to monitor point-wisely secular gravity potential changes in Greenland and seasonal changes related to hydrological cycles in Amazon;
- Short-term time-variable gravity signals as that caused by co-seismic changes of the great Tohoku earthquake in March 2011 (M_W 9.0-9.1) are at the sensitive level of 10^{-19} clocks.

Time-Variable Gravity Field Signals

- Long-term signals:** gravity potential changes in Greenland (mainly due to ice melting) reach $0.5 \text{ m}^2/\text{s}^2$ in about 12 years;
- Seasonal variations:** changes caused by annual and semi-annual hydrological cycles in Amazon reach $0.4 \text{ m}^2/\text{s}^2$;
- Short-term signals:** co-seismic changes of the great Tohoku earthquake in March 2011 (M_W 9.0-9.1) reach about $0.03 \text{ m}^2/\text{s}^2$



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