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Evaluating linear trends with respect to past decadal variability can help us assess the severity of GRACE observed water storage change

Jonathan L. Bamber¹, **Bramha Dutt Vishwakarma**¹, Paul Bates¹, Nico Sneeuw², and Richard M. Westaway¹

¹School of Geographical Sciences, University of Bristol, UK (bd.vishwakarma@bristol.ac.uk)

²Institute of Geodesy, University of Stuttgart, Germany

Often in geosciences, short time series are investigated to infer a linear trend (secular change), and the magnitude of trend is used to infer severity of change without considering the spatiotemporal variability of the observable. Therefore, it is not always known to what extent resultant trends are truly representative of severity of change, or whether the trends in short time series are driven by long wavelength signals that can only become apparent when additional years of data are available. Furthermore, same value of trend can have different interpretation over different regions.

GRACE, a novel satellite mission to monitor water mass redistribution, was launched in 2002 and a decade later several studies analyzed linear trends in GRACE time series to claim that some regions were experiencing unprecedented changes in regional water storage. Studies published more recently further suggest that some of those regions have recovered and some new regions have emerged as endangered. This update in our knowledge is driven by additional GRACE data that became available in the last five years, demonstrating that as the time series became longer, inferences from studying trends changed. In this presentation, we demonstrate that multi-decadal natural variability in water cycle influenced previous interpretations of linear trends from relatively short (<20 year) GRACE time series. We propose a new metric (trend to variability ratio or TVR) that incorporates standard deviation of historical natural variability to better interpret the severity of trends inferred from GRACE. Since, natural hydrological variability is different for different regions, same value of trend has different interpretation for different river catchments. Using this metric, we find that several regions that were thought to be losing water at a moderate rate are actually more endangered and vice-versa. We also provide a map that demarcates river catchments that have experienced severe water storage change between 2003 to 2015.