Geophysical Modelling in VLBI Analysis

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Introduction

Geophysical models play a crucial role in ensuring accurate data analysis in VLBI by facilitating the correction of various geophysical effects. One such effect is non-tidal loading, which can displace VLBI stations by a few centimetres on a sub-daily basis. This study compares the non-tidal loading products offered by four different services, each derived from distinct geophysical models. These loading products are subsequently implemented in VieVS to assess their impact on the VLBI analysis and evaluate their influence on the results.

Methodology and Data

Dataset spanning 20 years (2001-2020) has been extracted in the CM-frame for the chosen model from each loading service. The selection of the models was based on factors such as availability period, time steps, update frequency, and resolution of the data.

Loading	Services	Models	Data	Comparison	Impact on VLBI
NTAL	VMF, EOST, ESMGFZ	ECMWF	Selection of 163 stations	Site displacement time series of services	Percentage change in BLR
	IMLS	MERRA2			
NTOL	IMLS	MPIOM06	Extracting 20 years (2001 -2020) data		Station Height Standard deviation
	EOST	ECCO1			
	ESMGFZ	MPIOM	Formatting for compatibility with VieVS	RMS of difference of site displacement between two services	
HYDL	IMLS	MERRA2			Reduction of variance coefficient
	EOST	GLDAS2	Resampling (6 hourly)		
	ESMGFZ	LSDM			

Impact on VLBI Analysis

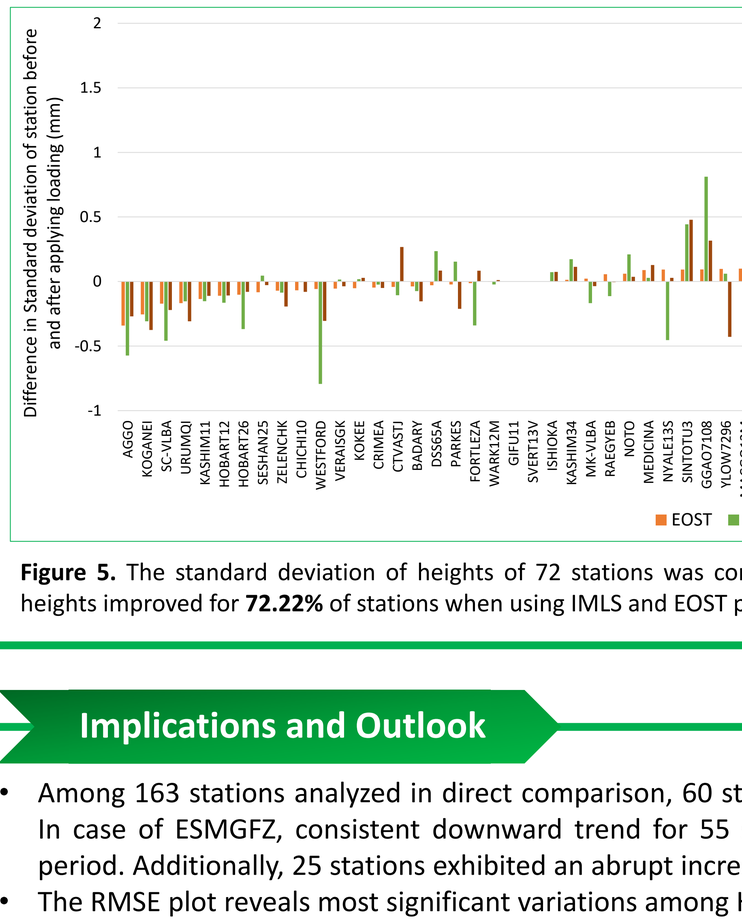

Figure 3. Percentage change in weighted BLR of 247 baselines with more than 100 sessions before and after applying all non-tidal loading. **89.87%** of baselines in case of EOST, **89.07%** of baselines in case of IMLS, and **84.62%** of baselines improve or show no change in case of GFZ.

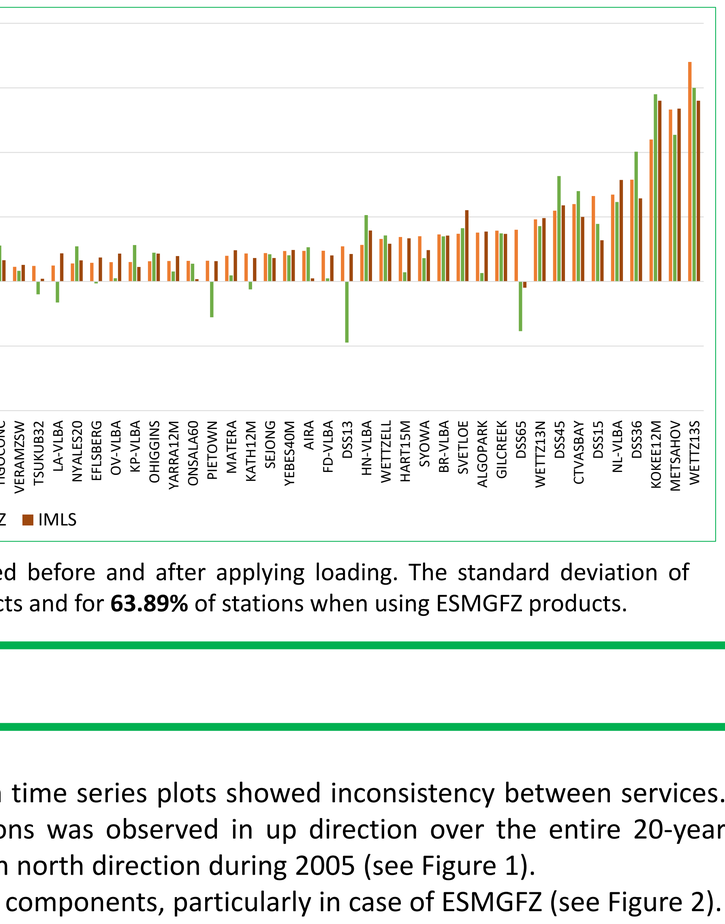

Figure 4. Histogram of the distribution of the reduction of variance coefficients of BLR of 102 baselines with more than 100 sessions. The mean value of R is **0.98** for IMLS, **0.94** for EOST and **0.67** for GFZ.

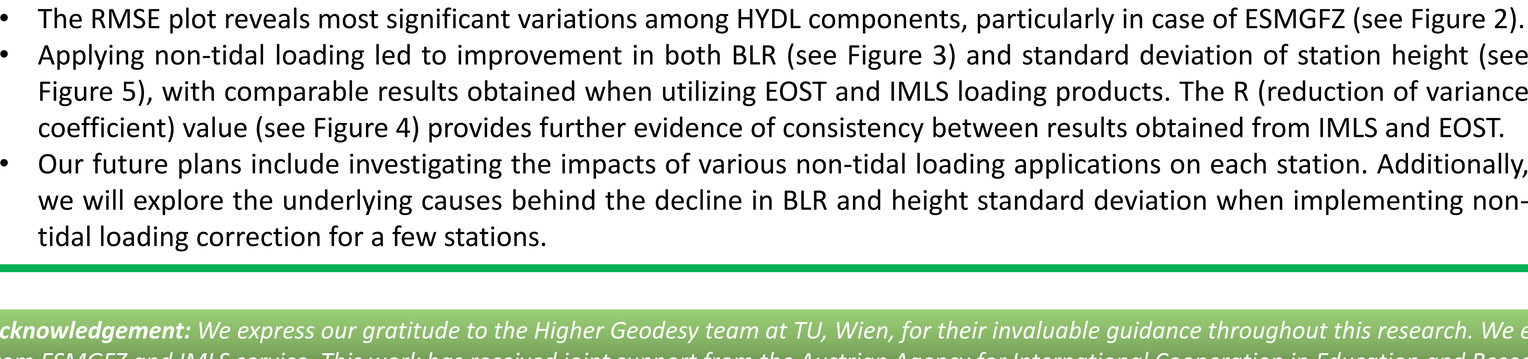

Figure 5. The standard deviation of heights of 72 stations was compared before and after applying loading. The standard deviation of heights improved for **72.22%** of stations when using IMLS and EOST products and for **63.89%** of stations when using ESMGFZ products.

Implications and Outlook

- Among 163 stations analyzed in direct comparison, 60 station time series plots showed inconsistency between services. In case of ESMGFZ, consistent downward trend for 55 stations was observed in up direction over the entire 20-year period. Additionally, 25 stations exhibited an abrupt increase in north direction during 2005 (see Figure 1).
- The RMSE plot reveals most significant variations among HYDL components, particularly in case of ESMGFZ (see Figure 2).
- Applying non-tidal loading led to improvement in both BLR (see Figure 3) and standard deviation of station height (see Figure 5), with comparable results obtained when utilizing EOST and IMLS loading products. The R (reduction of variance coefficient) value (see Figure 4) provides further evidence of consistency between results obtained from IMLS and EOST.
- Our future plans include investigating the impacts of various non-tidal loading applications on each station. Additionally, we will explore the underlying causes behind the decline in BLR and height standard deviation when implementing non-tidal loading correction for a few stations.

Comparison

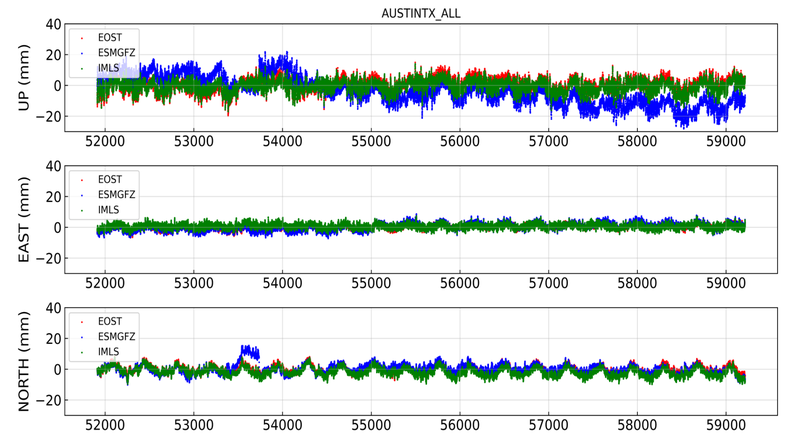

Figure 1. Time series of site displacement due to all non-tidal loading in CM-frame at AUSTINTX. Site displacement time series from different services are consistent with one another except in case of ESMGFZ, especially in up direction.

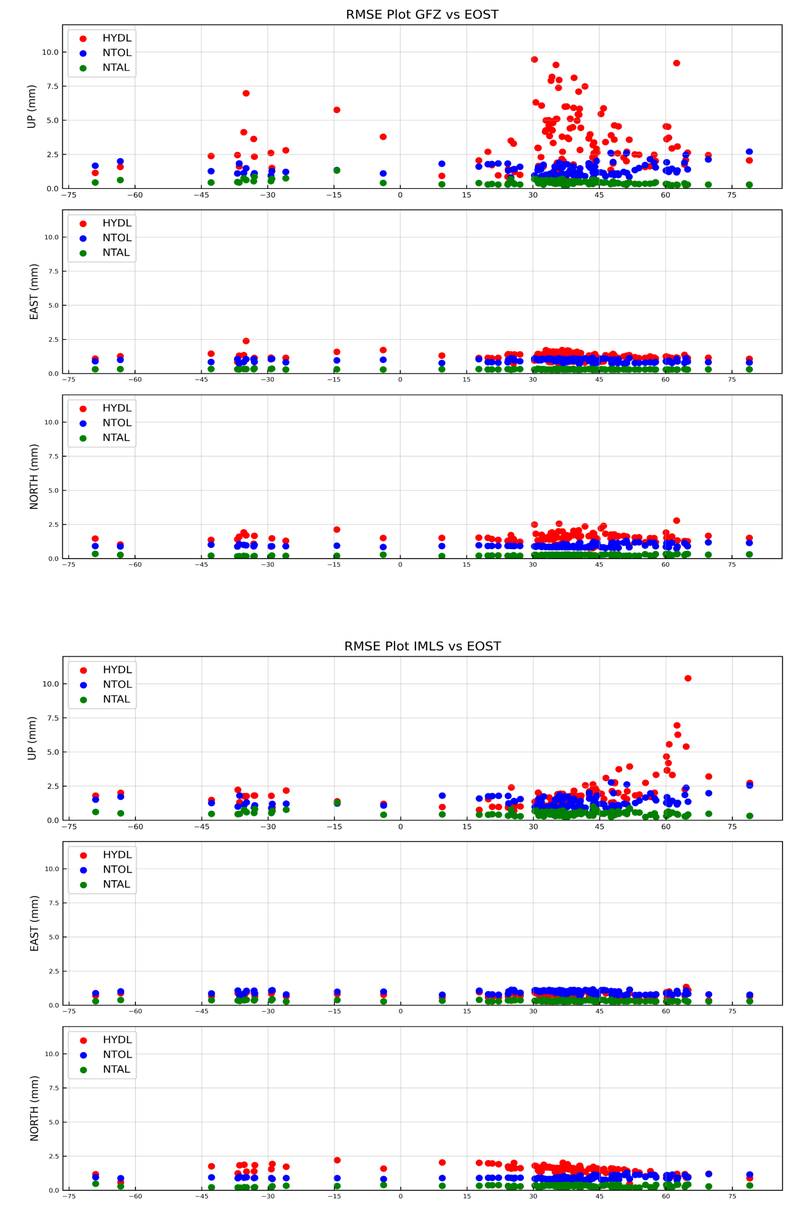

Figure 2. RMS values of difference of site displacement due to all non-tidal loading between ESMGFZ and EOST (top) and between IMLS and EOST (bottom). Large RMSE values are mainly observed between 30°N to 65°N for up direction. The RMSE values between two services are maximum for HYDL component, especially in case of ESMGFZ vs EOST.

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