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Synergetic analyses of Earth observation time series on land surface dynamics in large river basins

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Long-term Earth observation (EO) time series are an inevitable source for past quantification and analysis as well as future forecasting of land surface dynamics. This study investigates the joint use of geoscientific time series over the last two decades, including EO-based MODIS vegetation indices, DLR Global WaterPack, DLR Global SnowPack, and DLR World Settlement Footprint as well as further climate and hydrological variables to quantify and evaluate land surface changes and their potential drivers.

For this purpose, we focus on the Indus-Ganges-Brahmaputra-Meghna (IGBM) river basin in South Asia, being the most populated and one of the most diverse river basins worldwide. In detail, it is characterized by multiple climate zones, including arid climate in the west, polar climate in the north, and tropical climate in the south east. Moreover, the northern areas of these river basins are shaped by the Himalayan mountain range, also known as the water tower of Asia, whereas the downstream areas are characterized by fertile soils and intensive agriculture in the Indo-Gangetic Plain, being dominated by extreme rainfalls during southwest summer monsoon. Here, the availability of water is of paramount importance in social, economic, as well as political terms, but threatened by climate change as well as anthropogenic pressure.

To enhance the understanding of land surface processes in the IGBM river basin, we apply state-of-the-art time series analysis techniques, including quantification and evaluation of trends and changepoints. Furthermore, we use partial correlation and a causal discovery approach to explore driving factors of land surface change. Changes and patterns are investigated with respect to the prevailing seasons over the study area. Methods were implemented with focus on spatial and temporal transferability to enable further large-scale analysis in the future. Initial results covering the last two decades over the IGBM river basin indicate an increase in greening of vegetation, mostly in areas dominated by croplands. Considering snow cover extent, we observed a decline over the Eastern Himalayas and an increase over the Western Himalayas. Moreover, changes of surface water extent are mixed over the river basin, with negative trends along the Brahmaputra and Ganges rivers and positive trends close to the Bay of Bengal. In addition, preliminary results considering linkages between EO and climate variables reveal strong partial correlation between vegetation and precipitation in western areas, whereas temperature is the dominating climate

factor over eastern areas of the IGBM river basin.