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A review of spatial downscaling of satellite precipitation products

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Precipitation is an important component of the water cycle. Precipitation is characterized with high temporal and spatial variability. Accurate measurements of precipitation at high spatiotemporal resolution are essential for many applications in the fields of hydrology, meteorology and ecology. The traditional rain gauge stations provide direct measurements of rainfall at the surface but at a limited scale; rain gauge measurements are often considered as point-based measurements that are insufficient to represent the spatial variability of rainfall over a certain region, especially in the case of sparse rain gauge network. Satellite remote sensing has been developing with great ability of being used for estimating various water cycle components at different temporal and spatial scales. Considerable efforts have been made to develop satellite precipitation products at different spatial and temporal resolutions over the global or quasi-global scale. The majority of global/quasi-global precipitation products are at the spatial resolution of 0.25° (~25 km) with very few products at 0.05°-0.10° resolution. The usefulness of satellite precipitation products has been increasingly recognized but the relative coarse spatial resolution is still a limitation for many applications such as hydrological modelling at basin scales that generally require precipitation data at a desirable higher spatial resolution (e.g. 1 km). Over recent years, numerous spatial downscaling procedures/methods have been proposed to obtain precipitation products at higher spatial resolution. The relationships between precipitation and various auxiliary land-surface variables were explored and incorporated into spatial downscaling procedures using a large range of regression algorithms. Advanced machine learning and geostatistical methods have also been innovatively used to develop spatial downscaling procedures.

The aim of this study is to present a comprehensive review of studies on spatial downscaling of satellite precipitation products over the recent years. We will summarize the proposed spatial downscaling methods, investigated auxiliary land-surface variables and the evaluation strategy. The performance of spatial downscaling methods in studied regions and their applications will be

compared and discussed in terms of advantages and limitations. Finally, we will conclude this paper with outlook on future research needs and associated challenges about spatial downscaling of satellite precipitation products.