Rainfall Estimation over the Nile Basin using Multi-Spectral, Multi-Instrument Satellite Techniques

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Management of Egypt's Aswan High Dam is critical not only for flood control on the Nile but also for ensuring adequate water supplies for most of Egypt since rainfall is scarce over the vast majority of its land area. However, reservoir inflow is driven by rainfall over Sudan, Ethiopia, Uganda, and several other countries from which routine rain gauge data are sparse. Satellite-derived estimates of rainfall offer a much more detailed and timely set of data to form a basis for decisions on the operation of the dam. A single-channel infrared (IR) algorithm is currently in operational use at the Egyptian Nile Forecast Center (NFC). In this study, the authors report on the adaptation of a multi-spectral, multi-instrument satellite rainfall estimation algorithm (Self-Calibrating Multivariate Precipitation Retrieval, SCaMPR) for operational application by NFC over the Nile Basin. The algorithm uses a set of rainfall predictors that come from multi-spectral Infrared cloud top observations and self-calibrate them to a set of predictands that come from the more accurate, but less frequent, Microwave (MW) rain rate estimates. For application over the Nile Basin, the SCaMPR algorithm uses multiple satellite IR channels that have become recently available to NFC from the Spinning Enhanced Visible and Infrared Imager (SEVIRI). Microwave rain rates are acquired from multiple sources such as the Special Sensor Microwave/Imager (SSM/I), the Special Sensor Microwave Imager and Sounder (SSMIS), the Advanced Microwave Sounding Unit (AMSU), the Advanced Microwave Scanning Radiometer on EOS (AMSR-E), and the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI). The algorithm has two main steps: rain/no-rain separation using discriminant analysis, and rain rate estimation using stepwise linear regression. We test two modes of algorithm calibration: real-time calibration with continuous updates of coefficients with newly coming MW rain rates, and calibration using static coefficients that are derived from IR-MW data from past observations. We also compare the SCaMPR algorithm to other global-scale satellite rainfall algorithms (e.g., 'Tropical Rainfall Measuring Mission (TRMM) and other sources' (TRMM-3B42) product, and the National Oceanographic and Atmospheric Administration Climate Prediction Center (NOAA-CPC) CMORPH product. The algorithm has several potential future applications such as: improving the performance accuracy of hydrologic forecasting models over the Nile Basin, and utilizing the enhanced rainfall datasets and better-calibrated hydrologic models to assess the impacts of climate change on the region's water availability using global circulation models and regional climate models.