



Improving the Reconstruction of the Hydrological Cycle through Satellite Observations: The Case Study of the Po River Basin

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In the context of climate change, increasing competition for freshwater use across various sectors is intensifying pressures on water resources, placing many countries at heightened risk of water scarcity. To mitigate the growing risk of water scarcity, it is imperative to reduce water usage intensity across agriculture, industry, energy production, and domestic sectors. Achieving this requires a comprehensive and detailed understanding of water consumption patterns in each sector, and estimating water storage in groundwater, reservoirs, and snowpack is essential to safeguard water availability for future generations.

The Po River basin in northern Italy has experienced significant hydrological droughts in recent decades (1990-2023), highlighting the need to understand the complex interactions between climate factors and human activities. This study, conducted as part of the INTERROGATION project funded by the Italian Ministry of Universities and Research, presents an integrated approach for water resource management during drought events.

The study employs a flexible conceptual hydrological model (MISDc - Modello Idrologico Semistribuito in Continuo) that incorporates both natural processes and anthropogenic influences. The model is driven by three distinct precipitation datasets: long-term (2000-2023) daily in-situ measurements, high-resolution (1.8km) reanalysis data, and high-resolution (1km) satellite precipitation data. The Bluecat tool (Montanari et al., 2022) is utilized to evaluate the uncertainty in modelled river discharge.

The model's performance is validated using multiple satellite-derived observations including soil moisture, evaporation, groundwater, irrigation, and snow accumulation data developed within the framework of European Space Agency Digital Twin Earth (DTE) Hydrology Next project. The model is capable to reproduce both natural hydrological processes and anthropogenic activities such as irrigation and reservoir operations.

Results demonstrate the effectiveness of combining accurate satellite observations with a well-calibrated hydrological model for capturing spatiotemporal variations in the hydrological cycle within highly anthropized basins. This integrated framework provides valuable insights for developing a decision support system to guide stakeholders in managing water resources during future drought events in the Po River basin.

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