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Connecting different roles of globally systematic ground-based hydrological observations for Numerical Weather Prediction and Climate Reanalysis

Stephan Dietrich[1], Matthias Zink[1], and Wouter Dorigo[2]
[1]International Center for Water Resources and Global Change, Federal Institute of Hydrology, Koblenz, Germany
[2]Department of Geodesy and Geoinformation, Vienna University of Technology , Vienna, Austria

In this study we refer how hydrological observation systems impact not only hydrological applications but also numerical weather prediction and climate re-analysis. The terrestrial water cycle, vital to the Earth system, intricately links with the atmosphere, biosphere, and human activities. Climate change intensifies water storage and flux changes, escalating the frequency and severity of water-related disasters. Water-related deaths have doubled in the last decade, with projections indicating a continued rise. Hydrological observations, unlike atmospheric weather data, lack systematic exchange of measurement. Existing datasets, mainly annual yearbook data, lack timeliness for operational numerical weather prediction and are only rarely accompanied by near real time data or satellite observations.

The WMO Task team EarthHydNet explores extending the Global Basic Observing Network (GBON) to incorporate hydrological observations, enhancing surface-based data for weather forecasts. The workshop addresses bridging observational gaps for Numerical Weather Prediction (NWP) and Climate Reanalysis, focusing on user requirements and data standardization. The study will focus on two aspects:

- The status of the global terrestrial water observation architecture will be presented, showcasing the capacities and limitations of systematic observations, both in situ and via satellite remote sensing products.
- Three hydrological observations—precipitation, snow, and soil moisture—have been identified as key to improving NWP in previous workshops. Soil moisture is directly influenced by rainfall patterns and vegetation systems, and it influences in turn both rainfall regimes and vegetation development. Unfortunately, soil moisture observations, coordinated under the International Soil Moisture Network (ISMN), are currently sparse in space and time, limiting climate change applications and NWP. Yet in situ observations are crucial because satellite products only provide information about the top few centimetres of the soil, and their capabilities are limited by dense vegetation.

The GBON expansion to terrestrial hydrological variables aligns with the WMO Earth System Approach, aiming to understand the planet as a whole system where atmospheric, oceanic, and

terrestrial components are interconnected.