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Assimilation and modeling of the hydrological cycle in the ECMWF forecasting system: Future observational requirements

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The long-term strategy at ECMWF calls for a continued development of a fully coupled, modular Earth-system model, comprising all components relevant for the time scales of ECMWF's missions (from medium-range to monthly and seasonal time scale). The Earth-system model will be operated at various time and spatial scales and in ensemble mode, and work towards developing coupled data assimilation within the Earth system will be undertaken.
The assimilation and modeling of the hydrological cycle are certainly the most challenging areas for the development of the ECMWF's Earth system. Over the recent years, a strong emphasis has been put on the assimilation of remote sensing of humidity information from current and future satellite observations, in clear-sky, cloudy, and precipitation conditions. Likewise, the availability of new instruments has triggered focused efforts on the improvement of the soil moisture assimilation. Last but not least, major revisions to the description of clouds in the forecast model and a revised formulation of the humidity analysis have taken place or are underway, combining accuracy, consistency and balance throughout various forecast ranges.
Increased availability and improved accuracy of in situ and remote sensing observations of the water cycle are an essential component of such major developments. They are required for model developments (e.g. validation of the physical processes parametrisations, or description of model uncertainties), for assimilation, (e.g. allowing small-scale variability in atmospheric humidity to be consistently forced by dynamics and physics in all weather conditions) and for verification (e.g. model bias assessment, tropical cyclone performance,etc.). Such observations will become increasingly vital as the connection between data assimilation and model description of clouds, radiation, precipitation and soil moisture further develops.
This presentation will provide an overview of the ECMWF's recent achievements and future strategy for the development of an Earth-system assimilation and modeling system, with special emphasis on the hydrological cycle. The implications of these developments in terms of future observational requirements will be discussed.