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Datasets and tools for local and global meteorological ensemble estimation

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Ensemble gridded meteorological datasets are critical for driving hydrology and land models, enabling uncertainty analysis, and supporting a variety of hydroclimate research and applications. The Gridded Meteorological Ensemble Tool (GMET) has been a significant contributor in this domain, offering an accessible platform for generating ensemble precipitation and temperature datasets. The GMET methodology has continually evolved since its initial development in 2006, primarily in the form of a FORTRAN code base, and has since been utilized to generate historical and real-time ensemble meteorological (model forcing) datasets in the U.S. and part of Canada. A recent adaptation of GMET was used to produce multi-decadal forcing datasets for North America and the globe (EMDNA and EM-Earth, respectively). Those datasets have been used to support diverse hydrometeorological applications such as streamflow forecasting and hydroclimate studies across various scales. GMET has now evolved into a Python package called the Geospatial Probabilistic Estimation Package (GPEP), which offers methodological and technical enhancements relative to GMET. These include greater variable selection flexibility, intrinsic parallelization, and especially a broader suite of estimation methods, including the use of techniques from the scikit-learn machine learning library. GPEP enables a wider variety of strategies for local and global estimation of geophysical variables beyond traditional hydrological forcings. This presentation summarizes GPEP and introduces major open-access ensemble datasets that have been generated with GMET and GPEP, including a new effort to create high-resolution (2 km) surface meteorological analyses for the US. These resources are useful in advancing hydrometeorological uncertainty analysis and geospatial estimation.