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Advanced Methods for Climate and Regional Model Validation with Societal Applications

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Earth System Models (EaSMs) comprehensively encapsulate the complex interactions between physical, geochemical and biological subsystems, but their standard products are not directly useful for most planning and decision-making processes where it is necessary to account for climate change. Evaluations of EaSM performance are a particularly critical need to enhance usefulness of these products. Such evaluations need to address specific concerns depending on the system and decisions of interest; hence, evaluation tools must be tailored to inform about these specific issues. Generally, the spatial and temporal scales necessary for most such users are relatively fine, requiring more sophisticated tools than those often used currently, such as comparisons of zonal or other large spatial and temporal domain averages. Tools from weather forecast verification, which typically focus on much finer scales, should be very useful for these applications, but heretofore have been applied infrequently. Here, we employ some of these methods to climate model evaluation with the further aim of considering the specific needs of water management systems. In particular, hydrologic processes are examined using object-based evaluations in partnership with Denver Water (the water management agency in Denver, Colorado, USA). The Model Evaluation Tools (MET) and MODE (Method for Object-based Diagnostic Evaluation) software packages are adapted and applied for this purpose. Recent updates to these tools have allowed extension of deterministic, single event NWP forecast evaluation methods into tools for evaluating climate ensembles through time. Specifically, spatial-temporal evaluation approaches – including object-based methods that separately (but consistently) account for spatial, temporal, and intensity differences – are applied and demonstrated using output of the Community Earth System Model large ensemble.