Project: COLLABORATIVE PROJECT: Developing Coupled Data Assimilation Strategy for Understanding Model Bias and Extreme Climate Events in E3SM (DE-SC0019340)

**System Design and Evaluation of a Real Time Online Hybrid Data Assimilation System**

**based on E3SM**

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We present the preliminary results for a real time hybrid online data assimilation system developed for E3SM model. In our hybrid system, at each assimilation step, the covariance matrix is made of two parts. The first part is a temporally evolving component derived from a real time eight-member ensemble, while the second part is a stationary component derived from a one hundred member ensemble from a set of pre-existing runs (the five members of DECK historical runs.) The setup of our online data assimilation system starts from enabling a real time online parallel run, in which the E3SM model is made in such a way that several members can run simultaneously under one communicator for the fully coupled component set of A\_WCYCL1850S\_CMIP6. Then, necessary communicators for data assimilation are defined in the codes followed by the implementation of an ensemble adjustment Kalman filter (EAKF) package. A hybrid version is further developed by combining the real time online ensemble vectors with the stationary vectors. The observational data that has been tested is OISST. In this presentation, we will first show the testing results of a single observation experiment, in which only the SST observation at a single point around the center of NINO34 region is assimilated. In this experiment, we will demonstrate the impact of horizonal and vertical localizations in the data assimilation system. Then we will show results of assimilating the global SST, in which different values of hybrid parameters are examined. At last, we will show that our real time online data assimilation system gains substantial computational efficiency relative to an offline data assimilation system.