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Evaluation of S2S forecasts over India for renewable energy applications

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This study evaluates S2S forecasts of meteorological variables relevant for the renewable energy sector from six global coupled forecast models: ECMWF-SEAS5, DWD- GCFS 2.0, Météo-France's System 6, NCEP-CFSv2, UKMO- GloSea5-GC2-LI, and CMCC-SPS3. The variables include 10m wind speed, incoming shortwave radiation, 2 m temperature, and relative humidity because these variables are critical for estimating the supply and demand of renewable energy. The study is conducted over seven homogenous climate regions of India for 1994-2016 April and May when energy demand peaks throughout the country. The evaluation is done by comparing the forecasts at 1, 2, 3, 4, and 5-months lead-times with ERA5 reanalysis data. In order to assess the forecast quality, deterministic metrics such as bias and correlation and probabilistic metrics such as Ranked Probability Score (RPS) and Continuous Ranked Probability Score (CRPS) are calculated by spatially averaging the forecasts and reanalyses over each region. The tercile limits for each variable are determined separately for each homogenous region from the ERA5 reanalysis using leave-one-out cross-validation. The forecasts show the highest skill at 1-month lead-time and the skill reduces with the increase in lead-time. However, deviations from this pattern are observed in some cases. For example, the 2 m temperature forecasts tend to perform better at longer lead-times over the western Himalayas perhaps because the slowly-varying snow dynamics aids in long-term predictability. The 2 m temperature and relative humidity forecasts generally show high correlations with observations over the western coast of the Indian peninsula in May at all lead-times, indicating the ability of the models to simulate presence of moisture prior to monsoon onset. Results show that the model performance depends on time-period of initialisation, better representation of surface fluxes, interaction between radiation and microphysics schemes, land-surface processes and factors governing radiative forcing such as greenhouse gases and aerosols. Overall, the SEAS5 model performs better than other models, although the Météo-France's System 6 and UKMO- GloSea5-GC2-LI models also perform well in some regions.