Probabilistic forecasts have the potential to improve energy system management by anticipating climate fluctuations and possible weather extremes that influence energy consumption. Such forecasts must contend with a high level of natural variability as well as challenges posed by climate change. However, such forecasts are constrained by limited understanding of local and regional atmospheric predictability. This work bridges the gap between country-wide studies and specific, local studies of atmospheric predictability. These results indicate that statistical methods can provide predictability for seasonal anomalies of air temperature over much of California. The level of forecast skill may provide useful guidance for utility industry applications, but is not universally applicable because skill was found to vary over several elements, including forecasts of nighttime and daytime temperatures, location, season, lead time, and choice of predictor variables. The statistical forecast skill of seasonal air temperatures obtained for some regions and seasons can be superior to that provided by dynamical forecast models, according to results provided by a companion study (Zhang et al. 2018) submitted to California’s Fourth Climate Change Assessment. We developed and explored a statistical prediction model of minimum and maximum air temperature anomalies (T_{min} and T_{max}) over California using remote and local predictors. The first predictor variable field is sea surface temperature (SST) anomalies across the tropical and northern Pacific basin, representing the influence of large-scale climate variability patterns, which in turn affect local surface air temperature. The second predictor variable is soil moisture (SM), which is thought to exert a local or regional influence on temperatures near the surface through the effects on the surface energy balance. The evaluation of the predicted air temperature using historical observations indicates that both local and remote influences contribute to the prediction skill for air temperature. These influences vary with the season and vary between T_{min} or T_{max} predictands. At time leads of one season, SST has a strong effect on the summer temperatures, but SM provides little prediction skill. On the other hand, in the winter, both SM and SST anomalies provide significant skill in one season in advance predictions of T_{min} and T_{max}. However, those two predictands also present some important differences: while SST influence both T_{min} and T_{max}, the influence is stronger for T_{min} for both summer and winter. On the other hand, SM influences T_{max} more strongly during winter,
especially for lags of two and three months. These results exhibit positive forecast skill, but demonstrate considerable variability across seasons in model predictors and forecast performance of seasonal air temperature for California and the overall far western North America region. The results also demonstrate the importance of careful analyses that consider season, variable being predicted, predictors, and time lags in forming statistical forecast models that will be used for decision making.

HIGHLIGHTS

- Development of reliable probabilistic forecasts has the potential to improve energy sector management in California’s highly variable and changing climate. For instance, simple statistical models that relate patterns of variability of different variables can be used with certain confidence to develop the aforementioned forecasts. The advantage of such models is that they are easy and economical to implement when compared to more complex dynamical models.

- A linear statistical model was developed to test the seasonal predictive skill of air temperatures over California. Local and remote predictors were used and the results demonstrate that both influence this predictive skill. However, there is considerable variability in the forecast skill across seasons in models predictors and forecast performance of seasonal air temperature.

- Pacific sea surface temperature (SST) and western North America soil moisture (SM) exhibit positive skills from linear statistical forecasts of winter (December, January and February; DJF) and summer (June, July and August: JJA) seasonal average minimum temperature (Tmin) and maximum temperature (Tmax) for California.

- In summer (JJA), SST has a strong effect on the temperatures, but SM did not yield much predictive skill, whereas in winter, both SM and SST have some ability to predict Tmin and Tmax.

- Pacific SST influences both Tmin and Tmax, but the influence is stronger for Tmin for both summer and winter, whereas SM influences Tmax more strongly during wintertime.

- A simple model such as the one explored here may offer predictive skill for air temperatures over California at certain seasons, and may be useful for energy utility applications. Over parts of California, the forecast skill of these linear statistical models is comparable or better than that obtained by the North American Multi-Model Ensemble (NMME). For example, the summer (JJA) and winter (DJF) forecast skill obtained by the linear model using SST anomalies as a predictor is greater than the forecast skill obtained by NMME over parts Southern and coastal California regions.

- If the forecasts' uncertainties associated with the variability across seasons and model predictors can be better understood, there may be opportunities to perform
real-time air temperature forecasts for California at one season lead times using the linear statistical model developed here, in order to inform decision makers, especially in the energy sector.

ACCESS
For access to the full report, please email Susan.wilhelm@energy.ca.gov

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