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A Regional Climate Model Laboratory for Understanding Coastal Climate

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Midlatitude western coastal regions are recognized as being important for the global energy cycle, marine and terrestrial biodiversity, and regional economies. These coastal regions exhibit a rich range of weather and climate phenomena, including persistent stratocumulus clouds, sea-breeze circulations, coastally-trapped Kelvin waves, and wind-driven upwelling. During the summer season, when impacts from transient synoptic systems are relatively reduced, the local climate is governed by a complex set of interactions among the atmosphere, land, and ocean. This complexity has so far inhibited basic understanding of the drivers of western coastal climate, climate variability, and climate change.

As a way of simplifying the system, we have developed a hierarchical regional climate model experimental framework focused on the western United States. We modify the International Centre for Theoretical Physics RegCM4 to use steady-state initial, lateral, and top-of-model boundary conditions: average July insolation (no diurnal cycle) and average meteorological state (winds, temperature, humidity, surface pressure). This July *Base State* simulation rapidly reaches a steady state solution that closely resembles the observed mean climate and the mean climate achieved using RegCM4 in a standard reanalysis-driven configuration. It is particularly notable that the near-coastal stratocumulus field is spatially similar to the satellite-observed stratocumulus field during arbitrary July days: including gaps in stratocumulus coverage downwind of capes. We run similar *Base State* simulations for the other calendar months and find that these simulations mimic the annual cycle. This suggests that the summer coastal stratocumulus field results from the steady-state response of the marine boundary layer to summertime climatological forcing; if true for the real world, this would imply that stratocumulus cloud fraction, within a given month, is temporally modulated by deviations from the summer base state (e.g., transient synoptic disturbances that interrupt the cloud field). We describe modifications to this simplified experimental framework aimed at understanding the factors that govern stratocumulus cloud fraction and its variability.