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Diurnal Metrics for Evaluating GFDL and Other Climate Models

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The diurnal cycle is a fundamental feature of Earth's climate. Because of its short time scale and close coupling to surface and atmospheric processes, the simulation of the diurnal cycle provides an ideal test bed for evaluating many aspects of model physics. Despite recent improvements in model resolution and parameterizations, the diurnal amplitude and phase in surface temperature, cloudiness, convection, precipitation and other fields still differ considerably from observations in many climate models. These diurnal biases reflect deficiencies in various physical processes simulated by the models. The main goals of our study is to develop a new set of diurnal metrics and link them to specific underlying processes for evaluating model physics, and apply the diurnal metrics to diagnose and identify deficiencies in the GFDL and other CMIP5 models. Our current focus is on diurnal biases in surface temperatures in GFDL AM4 model. Preliminary results show that surface daytime maximum temperature (Tmax) in the GFDL model is generally too cold over most land areas except northern Asia in DJF, which is too warm, while surface daytime minimum temperature (Tmin) is slightly too warm over many land areas. As result, the diurnal temperature range (DTR) is too low by 1-6^{o}C over most land areas. The phase of diurnal temperatures is generally consistent with observations. Downward shortwave radiation shows positive biases over most land areas, and thus it cannot be the cause for the cold Tmax bias. Large biases in downward longwave radiation contribute to the warm DJF bias over northern Asia and cold biases in Tmax (and, to a lesser extent, Tmin) over South America and central Africa. Latent heating and sensible heating also contribute to the cold biases in South America and central Africa. More detailed analyses will be presented.