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The effect of Arabian Sea optical properties on SST biases and the South Asian summer monsoon in a coupled GCM

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This study examines the effect of seasonally varying chlorophyll on the climate of the Arabian Sea and South Asian monsoon. The effect of such seasonality on the radiative properties of the upper ocean is often a missing process in coupled general circulation models and its large amplitude in the region makes it a pertinent choice for study to determine any impact on systematic biases in the mean and seasonality of the Arabian Sea. In this study we examine the effects of incorporating a seasonal cycle in chlorophyll due to phytoplankton blooms in the UK Met Office coupled atmosphere-ocean GCM HadCM3. This is achieved by performing experiments in which the optical properties of water in the Arabian Sea — a key signal of the semi-annual cycle of phytoplankton blooms in the region — are calculated from a chlorophyll climatology derived from Sea-viewing Wide Field-of-View Sensor (SeaWiFS) data. The SeaWiFS chlorophyll is prescribed in annual mean and seasonally-varying experiments. In response to the chlorophyll bloom in late spring, biases in mixed layer depth are reduced by up to 50% and the surface is warmed, leading to increases in monsoon rainfall during the onset period. However when the monsoons are fully established in boreal winter and summer and there are strong surface winds and a deep mixed layer, biases in the mixed layer depth are reduced but the surface undergoes cooling. The seasonality of the response of SST to chlorophyll is found to depend on the relative depth of the mixed layer to that of the anomalous penetration depth of solar fluxes. Thus the inclusion of the effects of chlorophyll on radiative properties of the upper ocean acts to reduce biases in mixed layer depth and increase seasonality in SST.