The impact of incorporating flow-dependent oceanic background-error covariance information into air-sea coupled data assimilation on the evolution of a tropical cyclone

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Abstract

Tropical cyclones tend to result in distinctive spatial and temporal characteristics in the upper ocean, which means that traditional, parametrisation-based background-error covariances in oceanic data assimilation (DA) may not be suitable. Using the case study of Cyclone Titli, which affected the Bay of Bengal in 2018, we explore hybrid methods that combine the traditional covariance modelling strategy with flow-dependent estimates of the ocean's error covariance structures based on a short-range ensemble forecast. This hybrid approach is investigated in the UK Met Office's state-of-the-art system. Single-observation experiments in the ocean reveal that the hybrid approach is capable of producing more anisotropic and vertically less uniform analysis increments. When the hybrid oceanic covariances are included in cycled, weakly coupled atmosphere-ocean DA, the resulting temperature differences beneath the ocean mixed layer are brought to the surface as the cyclone passes through the region, due to vertical mixing induced by the strong surface winds. Through air-sea coupling, such differences in the sea-surface temperature can then change the analysed structure of atmospheric fields associated with the cyclone.

Keywords: Background error covariance modelling, air sea coupling, tropical cyclones

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