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Analysis and reduction of tropical systematic errors through a unified modelling strategy

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Systematic errors in climate models are usually addressed in a number of ways, but current methods often make use of model climatological fields as a starting point for model modification. This approach has limitations due to non-linear feedback mechanisms which occur over longer timescales and make the source of the errors difficult to identify. In a unified modelling environment, short-range (1-5 day) weather forecasts are readily available from NWP models with very similar dynamical and physical formulations to the climate models, but often increased horizontal (and vertical) resolution. Where such forecasts exhibit similar systematic errors to their climate model counterparts, there is much to be gained from combined analysis and sensitivity testing. For example, the Met Office Hadley Centre climate model HadGEM1 (Johns et al 2007) exhibits precipitation errors in the Asian summer monsoon, with too little rainfall over the Indian peninsula and too much over the equatorial Indian Ocean to the southwest of the peninsula (Martin et al., 2004). Examination of the development of precipitation errors in the Asian summer monsoon region in Met Office NWP forecasts shows that different parts of the error pattern evolve on different timescales. Excessive rainfall over the equatorial Indian Ocean to the southwest of the Indian peninsula develops rapidly, over the first day or two of the forecast, while a dry bias over the Indian land area takes $\tilde{1}0$ days to develop. Such information is invaluable for understanding the processes involved and how to tackle them. Other examples of the use of this approach will be discussed, including analysis of the sensitivity of the representation of the Madden-Julian Oscillation (MJO) to the convective parametrisation, and the reduction of systematic tropical temperature and moisture biases in both climate and NWP models through improved representation of convective detrainment.