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Benefits of initializing equatorial waves on extratropical forecasts

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Large initial uncertainties in the tropics are believed to compromise medium- and extended-range extratropical forecasts. A more reliable analysis of tropical Rossby and non-Rossby waves requires more tropical observations and improved data assimilation schemes. Wind observations are known to be more valuable than mass observations in the tropics, but it is not well-understood how different types of observations affect the accuracy of equatorial wave analysis and influence extratropical predictability.

We investigate these questions by assimilating only wind or mass observations within the tropics using a perfect-model framework and a global model based on shallow-water equations and 3D-Var data assimilation. The mass-wind relationships of equatorial waves are built into the background-error covariance matrix with Rossby and non-Rossby waves as control variables in 3D-Var and prognostic variables in the forecast model. Results demonstrate that wind observations are more efficient at reducing both tropical and extratropical forecast errors than mass observations. Adding mass-wind coupling further improves extratropical forecasts and it is especially beneficial for mass observations.Forecast benefits are quantified along latitude circles in terms of scales. A more accurate analysis of the equatorial Rossby waves is found to be the key for the propagation of observation impact from the tropics to midlatitudes.