Spectral nudging to improve hurricane forecasting

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Spectral Nudging is commonly used to constrain the forecast of a Limited Area Model (LAM) to a reference dataset, such as a global analysis or a reanalysis. A part of the wavelength spectrum of the LAM's solution, commonly the longer waves, is nudged to the corresponding part of the spectrum of a coarser model, ensuring that the LAM's forecast is closer to the reference dataset at the synoptic scale while still maintaining high resolution features. The resulting forecast contains elements of both the LAM and the global dataset to produce a better estimate of the actual atmospheric state than either one of them would provide separately. A cut-off wave number determines which spatial scales are nudged, and this is one of the key parameters to be selected when setting up this technique.

In this work, we study the benefits of using Spectral Nudging to simulate five major hurricanes from the seasons 2010 to 2012, one of the most active hurricane periods in recorded history. We focus on the impact of selecting different cut-off wave numbers, first using the same value for all nudged variables and, finally, using an optimal value for each variable. Results from the first set of experiments support the conclusions found in Gomez & Miguez-Macho (2017, QJRMS) that suggest that the cut-off wave number should be selected to match the Rossby radius of deformation, which, for this case, is slightly larger than 1000km. Our statistical analysis also shows that the scale when each nudged variable starts to be significantly different from ERA-interim occurs at different values of the cut-off wave number, suggesting that using a single cut-off wave number for all of them might not be the optimal approach. To explore this strategy, a final set of experiments was performed where an appropriate cut-off wave number was used for each variable. Results show that this configuration is able to produce the best results in terms of the hurricane track, centre pressure and maximum wind.