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Sensitivity of extratropical cyclone characteristics to horizontal resolution in the ECMWF model

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The sensitivity to horizontal resolution of Northern Hemisphere extratropical cyclone characteristics during the wintertime is investigated using a set of seasonal forecasts (1982-2001) with the ECMWF model. Three different horizontal resolutions (T95, T159 and T255) are employed. In order to test the realism of the simulations the model results are compared with those obtained from ERA-40 reanalysis data. The cyclone tracking is accomplished by applying an automatic tracking scheme to 6-hourly mean sea level pressure data. It is shown that many of the key-characteristics of extratropical cyclones in the ECMWF model are highly sensitive to horizontal resolution, with the low-resolution version (T95), for example, simulating only about 60% of the observed total number of extratropical cyclones. Regions found to be particularly sensitive include the North Pacific, the Arctic, Baffin Bay and the Labrador Sea as well as the Mediterranean Sea. For the latter region it is shown that even the relatively high-resolution version of the model (T255) underestimates the number of cases of Genoa cyclogenesis significantly. Furthermore, it is shown that in some regions, such as the entrance regions of the major Northern Hemisphere storms, model deficits are insensitive to increases in horizontal resolution. The same analysis has been repeated for the high-resolution operational ECMWF analysis truncated at different total wavenumbers (T95, T159, T255 and T511) in order to separate dynamical effects of differences in resolution from those due pure spectral truncation. It is found that the dynamical effect of changing horizontal resolution dominates over the pure truncation effect for intensive cyclones, whereas the truncation effect dominates for shallow cyclones.