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The Initiation of Frontal Cyclones

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This talk will illustrate the influences of dynamical forcing, intrinsic instability and geographical factors on the initiation (and indeed decay) of frontal cyclones, using 5 years of operational, high resolution, Met Office model data, over an extended North Atlantic domain. The term 'diminutive wave' will be used to describe the first (and sometimes last) stages of cyclonic development. Identifying these waves relies on partitioning the low-level vorticity into two components, the 'frontal vorticity' which is the vorticity of the front-parallel wind, and the 'disturbance vorticity' which is the vorticity of the cross-front wind. In turn this partition requires automatic computation of an along-front vector, which is achieved using objective front methodology. By comparing with the more widely known shear-curvature partition it will be shown that the new partition is much more relevant for investigating typical lower tropospheric frontal configurations.

From a geographical perspective, diminutive waves occur most commonly where aspects of the earth's surface exhibit discontinuous behaviour. This encompasses orographic features with steep slopes, ice edges, and land-water boundaries. Whilst other factors may also play a role in these regions, it is easier to see their influence where the underlying boundary is relatively uniform - a set of over 5000 cases in such a region was selected for analysis. Using these it will be shown that the integrated, local dynamical (quasi-geostrophic) forcing for ascent seems to not influence the 'disturbance vorticity', and therefore not the diminutive waves as such, but rather the 'frontal vorticity'. Instead the 'disturbance vorticity' itself relates much more closely to gradients in the dynamical forcing. There are also differences between warm and cold front diminutive waves, the former showing closer correspondance with the local positive forcing anomaly, the latter with the local negative forcing anomaly. Disturbance vorticity and frontal vorticity are also related, in a way that is consistent with the idea that frontal waves can also evolve through the release of barotropic instability on a

vorticity strip. The probable reasons for these various relationships will be discussed, as will their synoptic implications.

The relevance of diminutive wave identification, and the above results, to cyclone tracking and weather prediction will be illustrated with examples including the intense cyclonic storms that hit central Europe on 19 November 2004 and northern Europe on 8 January 2005.