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The role of microphysics in the development of mesoscale areas of high winds around occluded cyclones

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Extratropical cyclones are an integral part of the weather in north-western Europe and can be associated with heavy precipitation and strong winds. While synoptic-scale aspects of these storms are often satisfactorily forecast several days in advance, mesoscale features within these systems such as bands of heavy rain or localized wind maxima, which are often the cause of the most damaging effects, are significantly less well understood and predicted by operational forecasts. Accurate predictions of the location, timing and intensity of these features are, however, highly important for the mitigation of the adverse effects that they bring. This is one of the motivations for the UK consortium DIAMET (DIAbatic influences on Mesoscale structures in ExtraTropical storms) that is focused on improving the understanding and predictability of these potentially damaging mesoscale features embedded within larger synoptic-scale extratropical storms. The project is based around a number of field campaigns using the Facility for Airborne Atmospheric Measurements (FAAM) BAe146 research aircraft along with other remote and in-situ measurements. An overview of the project will be presented by Geraint Vaughan in this session.

This study analyses the effects of microphysics on the mesoscale dynamics within extratropical storms, in particular the high wind areas around occluded fronts wrapped around the core of a matured cyclonic storm. It has been hypothesized that evaporation and melting of hydrometeors in this region can lead to downward momentum transport and thereby increase near-surface winds (sometimes referred to as sting jets). The main tool for this study is the Weather Research and Forecasting (WRF) model. High-resolution simulations are run for several cases from the DIAMET field campaigns to examine how the development of strong winds around occluded fronts is affected by the microphysics. The model results using different microphysics schemes are compared with the observational data from the BAe146 aircraft and other sources such as wind profilers and radiosondes. In initial model simulations of a secondary frontal wave observed during the 2009 T-NAWDEX pilot flights, the microphysics in the parameterization scheme used has a large impact on the winds observed around the hook of the occlusion. The advanced double-moment Morrison and Thompson schemes show 12-hour mean 10m winds about 50% higher than the simpler WSM3 (WRF single moment) scheme in this area. These results suggest that ice processes could play an important role in the downward transport of momentum in this part of the cyclone. Further results from this and other cases from the field campaigns will be presented at the conference.