EMS7/ECAM8 Abstracts,
Vol. 4, EMS2007-A-00315, 2007
7th EMS Annual Meeting / 8th ECAM

The Sting Jet Hypothesis: A Case Study with the COSMO-Model

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The forecast of surface wind gusts is a very challenging topic due to their high variability in time and space. Because strong wind gusts can lead to large economic and societal impact, processes that might cause them are of major interest. A newly suggested phenomenon that can contribute to heavy surface wind gusts in strong extratropical cyclones is the so-called sting jet (Browning and co-workers). Slantwise circulations within the cloud head of a bent-back warm front cause air to exit the cloud head and enter a region of drier air. In these air parcels evaporation/sublimation of hydrometeors can take place and the related cooling may intensify the circulation. It is hypothesized that if the descending branches of the slantwise circulation reach the surface they can cause strong surface wind gusts.

To investigate the importance of the evaporative cooling processes for the strength and structure of sting jets a case study of a recent cyclone over Europe is performed with the nonhydrostatic COSMO-Model - the latest limited-area model developed by the German Weather Service. The selected cyclone "Oili" occurred from 5-11 February 2006 over NW and Central Europe. Its observed minimum pressure was about 980 hPa with a maximum decrease of 25 hPa within 24 hours and maximum wind gusts reaching values of about 30 m/s near the coast of Germany. A hindcast simulation has been performed with the COSMO-Model, with a horizontal resolution of 7 km, 40 layers in the vertical and the operationally used physical parameterizations. For the cyclone "Oili", the COSMO-Model appears to be able to reproduce a sting jet structure, confined in both space and time. A detailed trajectory analysis supports the hypothesis that the air within the sting jet was in contact with the cloud head some hours before getting close to the ground. In order to investigate the role of evaporative cooling sensitivity experiments are made with different microphysical settings and/or supressed

latent heating/cooling. The differences of the simulated sting jets are analysed and the importance of cloud microphysical processes for this phenomenon are quantified.