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SAR derived wind and ocean wave fields of mesoscale cyclones

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It is well known that Spaceborne Synthetic Aperture Radar (SAR) instrument provide information on the near ocean surface wind field with very high spatial resolution. SAR sensors are therefore particularly suitable for the investigation of mesoscale phenomena, e.g., mesoscale atmospheric storms.

In this study SAR data are used to study one particularly dangerous type of mesoscale storms: the polar mesoscale cyclone (PMC), e.g., cold air outbreaks (CAO) in Polar Lows (PLs). SAR images are used to infer information on wind field structure, storm center location, and rain band distribution.

Traditional visible and infrared space borne sensors such as the Medium Resolution Imaging Spectrometer (MERIS) on board the ENVISAT satellite or the the Moderate Resolution Imaging Spectroradiometer (MODIS) on board the AQUA/TERRA satellites are limited to providing information on the upper atmospheric levels in storm systems.

It is shown that the synergetic use of optical and microwave data leads to better understanding of severe weather systems, in particular regarding rain band features in (PLs) and the spatial evolution of the atmospheric boundary layer processes involved in cold air outbreaks. An analysis of the cold air outbreak associated with the storm Britta in 2006 showed cloud patterns parallel as well as perpendicular to the mean wind direction with about 10 km diameter. Patterns of comparable size and shape were observed in the ENVISAT ASAR images acquired simultaneously. A theory is developed which explains the observations by surface effects of gust fronts induced by the mesoscale cellular convection and enhanced by the overall northwesterly flow.

In particular the downward transport of higher momentum in convective clouds plays an important role in this model. The phase shift between the patterns observed in the radar data and optical images is investigated.

Finally the ability of SAR systems to observe high resolution ocean wave fields is used to investigate the ocean waves generated by storm events. In particular the effect of cell structures in the driving wind field on the resulting wave field is analysed. Of particular interest is the group structure and the occurrence of high individual waves.