C-band of radar signatures of convective rain: a case study using Sentinel-1 multi-polarization SAR images of the South China Sea

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Abstract

Detection of rain on C-band synthetic aperture radar (SAR) images of the ocean is a challenging task, since several processes contribute to the radar signature of rain, which are often ambiguous: 1) surface scattering from the sea surface whose roughness is modified by impinging raindrops, and 2) volume scattering and attenuation by hydrometeors in the atmosphere. Understanding the signature that rain imposes on SAR images of the sea surface is of relevance for interpreting other features visible on SAR images of the sea surface correctly. Rain disturbs other radar signatures, e.g., those of wind patterns and of **internal waves.** While the contribution of surface scattering to the radar signatures of rain over the ocean has been studied intensively, the contribution of volume was often considered negligible at C-band. One mechanism that was identified only recently as an important contributor to radar signatures of convective precipitation system over the ocean, is radar scattering at hydrometeors in the melting layer (ML). Building on a previous paper, we investigate this contribution in more detail by analyzing Sentinel-1 SAR images showing radar signatures of different types of convective rain over the northern part of the tropical South China Sea. We compare them with the dual-polarized weather radar data of the Hong Kong Observatory (HKO), with and data of the Global Precipitation Mission (GPM) and with radiosonde data. The comparison shows the radar signatures due to radar scattering at hydrometeors in the ML occurs in areas where updraft has carried moist air up to the freezing level. This occurs usually near the center of the rain cell, but in one case, we have observed it also at the rim of a downdraft pattern. Here, the updraft is so strong that it reaches the height of the freezing layer, which in this case had a height of 5325 m. Our analysis has also revealed that radar scattering at hydrometeors in the melting layer does not only give rise to the often observed patches or blobs of strongly increased NRCS values at co-and cross-polarization, but also to less strong increased NRC values which lie in the range of NRCS values caused by wind. Thus, such ML-related radar signatures can easily confounded with wind signatures. Furthermore, we point out that the theory describing the radar scattering at hydrometeors in the ML, which is applied in this paper to the C-band on board the Sentinel-1 satellites, is also applicable to L-band SARs, like the one flown on Seasat. Finally, we show examples how rain disturbs the radar signature of **internal waves.**