SAR observations of wind jets near the Japanese coast and the wind jet impact on ocean wave development

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Understanding of the wind jet and associated severe waves are essential to investigation of coastal marine environment. It is now also social demand for shipping, disaster prevention, marine plant maintenance, and improvement of forecast systems. Ocean surface wind is one of the most dominant driving forces for ocean circulation. Above all, in coastal seas, localized strong and weak wind regions are often formed by roughness difference between sea and land surface, thermal contrast, and orographic effects. On the other hand, ocean waves are directly affected by such highly localized winds. The wave is an important factor in air-sea coupled system because it has effects on turbulent mixing, change in sea surface roughness, and transport of material.

However, there are still many problems remaining in analysis and forcast of wind and wave. The major concern is to reveal and reproduce ocean surface winds in coastal seas with sufficiently high resolution. That is to say, to improve understanding of coastal ocean environment, it is dispensable to capture the wind fields with high resolution. In this point, SAR (Synthetic Aperture Radar) observations are very useful because wind retrieval method from SAR by using geophysical model functions has been investigated and almost established.

Focus of this study is to illustrate the true state of the wind jets near the Japanese coast and to examine their impacts on ocean wave development. We propose a synergistic approach combining high-resolution remote sensing data, numerical wave and meteorological models, and in situ observations. Above all, we utilize high-resolution wind fields derived from SAR to capture the whole pictures of the wind jets. In the presentation, we introduce a few case studies of terrain-induced wind jets near the Japanese coast. Then, we point the way to future work and discuss the role of SAR data such as recently released PALSAR data.

First, we investigate development of a coastal wind jet flowing through the Kanmon Strait and associated higher wind waves from a case study on 24-26 July 1999. While the core wind speeds depend on the SAR observation situations, high wind regions are similar in terms of shape. The wind jet has developed in 12 hours and it reaches the southern coast of the Korean Peninsula. The wind maximum region is highly localized until the wind jet is brought into the strong easterly winds. On the other hand, areal extent of higher waves grows with the development of the wind jet. The maximum wave height region is also highly localized more downward of the wind speed maximum. The high wave region completely reaches the southern coast of the Korean Peninsula in 18 hours. Then, it is confirmed that the simulated fields of wind and wave height coincide with observations.

Then, we present a case study of low-level wind jets induced in sequence by orographic effects in northern Japan during 7-10 June 2003. First, we analyze SeaWinds scatterometer wind measurements. Under the easterly wind, a strong wind jet forms in the lee of Cape Erimo. As the wind shifts to the southeast, the wind jet starts to decay. In turn, the southerly wind along the coast leads to another wind jet in the lee of the easternmost tip of the Sanriku coast. During the period, strong wind blows from the Tsugaru Strait. Then, we show that meteorological station data capture the two wind jet events. Onsets and decays of the wind jets are ascertainable from time series of wind speed. Finally, we clarify that the transition of the wind jets has local impacts on wave height variations. Accompanying the wind jet formation/decline, significant differences of wave height variations occur among wave observation stations located along the coast at intervals of up to 40 km.