

干渉合成開口レーダーによる集中豪雨時の水蒸気と降水粒子の同時検出：InSAR気象学の新側面

Simultaneous Detection of Water Vapor and Raindrop during Heavy Rain Episodes by Interferometric Synthetic Aperture Radar: A New Aspect of InSAR Meteorology

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Precipitable water vapor data are now operationally derived by GNSS (GPS) meteorology, based on non-dispersive phase delay data. In the actual GNSS phase measurement, dual-frequency measurements are performed to separate dispersive phase due to ionosphere and non-dispersive phases such as water vapor and crustal deformation. GNSS meteorology has developed from one of the latter "noisy" phase for GNSS geodesy.

While GNSS geodesy provides us with the receivers' position data and their changes, satellite-based interferometric synthetic aperture radar (InSAR) has been growing over the past two decades as another powerful technique to detect surface deformation signal with unprecedented spatial resolution. JAXA has launched ALOS1 in 2006 and its follow-on ALOS2 in 2014, both of which carries L-band SAR sensor, PALSAR1/2. Crustal deformation signals due to world-wide earthquakes and volcanic eruptions as well as glacier/ice sheet motion have been detected by InSAR based on PALSAR1/2.

Taking advantage of its extraordinary high spatial resolution, InSAR meteorological study has been gradually in progress. Kinoshita and Furuya (2017, SOLA) detected phase anomaly in ALOS/PALSAR InSAR data associated with a heavy rain over Niigata-Yamagata area, Japan, and performed numerical weather model simulations to reproduce the signals.

In contrast to GNSS precision positioning, however, SAR imaging is based on a single carrier frequency, and thus no operational ionospheric corrections have been performed in the InSAR data analyses, which is particularly important in L-band system because of lower frequency. Gomba et al (2016) detailed the split-spectrum method (SSM) for InSAR, which splits the finite bandwidth of the range spectrum and virtually allows for dual-frequency measurements. Furuya et al (2017, Earth Planets Space) applied the SSM to InSAR images that detected ionospheric sporadic-E episodes to separate dispersive and non-dispersive phases.

Here, we apply the SSM to the L-band InSAR data that detected heavy rain episodes. Originally, we expected no anomalies in the dispersive phase that is associated with heavy rain, even though there remained ionospheric effect. However, we noticed the presence of phase anomalies in both dispersive and non-dispersive phases, which were both localized and seemed unlikely due to ionospheric signals. The non-dispersive phase is apparently due to the water vapor anomaly associated with the heavy rain episodes, whereas the origin of the localized dispersive phase was not clear. Examining the frequency dependence of refractivity during heavy rain, we now interpret that the dispersive phase will indicate the locations of extreme heavy rain whose rain rate is greater than 50 mm/hour or so. This would be the first simultaneous detection of water vapor and raindrop during heavy rain by a single satellite radar sensor, suggesting a new possibility of InSAR for meteorological application.

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