[JJ] Evening Poster | A (Atmospheric and Hydrospheric Sciences) | A-TT Technology &Techniques

[A-TT32]Brand-new geoscientific observations by GNSS-Reflectometry

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Mon. May 21, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

GNSS-Reflectometry (GNSS-R) dares to use indirect GNSS signals reflected by an object, which cause multi-path errors in the positioning system, and extracts status information of the reflecting surface itself. It requires low-power and light-weight GNSS receivers alone, so that any platform can be adopted, including microsatellites or UAVs. This session will present various observations using GNSS-R, such as sea surface wind speeds, waves, sea surface height, soil moisture and ice detection.
In addition, possible scientific impacts are discussed with unprecedentedly frequent global observations by multiple satellites, such as NASA's eight-microsatellite CYGNSS GNSS-R mission.

[ATT32-P07]3D measurement of waves by using Stereo Camaera at Hiratsuka Tower

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Keywords:Stereo Camera, Wave, measurement

Waves Acquisition Stereo System(WASS) is an open source software developed by Bergamasco, and others [1], to reconstruct 3D sea surface by stereo photogrammetry. By using WASS, we can construct 3D sea surface without external parameters of the two cameras. Our goal is to conduct temporal and spatial analysis of waves by means of inverse analysis such as the a4DVAR [2]. As the first step to this goal, the precision of the reconstructed waves was estimated.

We have installed a stereo camera system facing south at the Hiratsuka tower. Hiratsuka tower is located in the Sagami-bay, Japan, at the depth of 20 m, one kilometer south of the shore. An antenna for the GNSS-R is also installed pointing at the same direction. Two cameras were installed about 4 m apart at the height of around 18 m. The number of pixels in each camera is 2048 by 2048. The camera system was installed in April 2017, and since then, we have been acquiring images. By using WASS, we obtain a 3D point cloud data of water surface in the camera coordinate system. First, the coordinate system was translated to a World coordinate system and 3D point cloud data was mapped on the grid on the mean sea surface plane. After that, the average displacement of the reconstructed points was calculated from the mean sea surface plane in each grid point which were treated as the displacement at the center of the grid. Then, the significant wave height and period were evaluated from this by using the zero-up-cross method in time.

A case starting at 2017/08/23 16:01 for 20 minutes will be shown as an example of the 3D reconstruction of the sea surface. At this time, significant wave height and period from the ultra-sonic sensor at Hiratsuka tower was 0.513 m and 6.1 s. Figures (a) and (b) show the distribution of significant wave height and period from WASS. Y-direction is parallel to the camera direction and X is parallel to the baseline of the two cameras. From these figures, it is clear that the data from WASS is partly consistent with the ultra-sonic sensor data and the errors tends to be larger near the edge of the observed area. In addition, the significant wave height from WASS tends to reduce with Y. These trends were also seen in the other cases.

Figure (c) is a histogram of non-dimensional wave height at two points normalized by the mean wave height. It can be said that the number of waves in each point corresponded well with each other when non-dimensional wave height is bigger than 1. However, for smaller non-dimensional wave heights, the number of waves at the point further away from the camera, i.e. for large Y, is much larger than that of the other point closer to the camera. The difference of the averaged significant wave height and period can be explained by that. A possible main cause of this is the false detection of waves by the zero-up-cross method due to noise. This is consistent with an average standard deviation of displacement of the surface, shown in Figure (d).
Verification of precision of WASS at the Hiratsuka tower was made. It became clear that a part of the reconstructed data corresponds well with another observation data at the tower. However, the distribution of error is not uniform in space. So far, we have looked into the validation of statistical mean quantities, and the verification of the phase-resolved quantities is yet to be done. We are planning to deploy wave observation buoy in the field of view of the stereo camera to do more verification. Additionally, we also have the plan to deploy buoy outside of observation area to test data assimilation method with data from WASS. Results from some of these future works will be presented at the meeting.

Reference

[1]Bergamasco, F., Torsello, A., Sclavo, M., Barbariol, F., Benetazzo, A. "WASS: An open-source pipeline for 3D stereo reconstruction of ocean waves”, *Computers and Geosciences*, vol. 107, pp.28-36, 2017

[2] Fujimoto, W., 2017, (Ph.D dissertation)