Ocean observations using Wave Gliders -called AOV in JCG- around Japan coasts

*Issei Nishimura[1], Mai Matsusaka[1], Chikara Tsuchiya[1], Takahito Masuda[1], Hiroto Itoi[1], Hiroki Katou[1], Satoshi Yamao[1]

1. Japan Coast Guard Hydrographic and Oceanographic Department

Japan Coast Guard has started observation using Wave Gliders, called Autonomous Ocean Vehicles (AOV), in 2016.The AOV is an autonomous unmanned ocean platform that individually delivers real-time oceanographic data to land stations for up to a year with no fuel.We overview our AOV and describe the result of ocean current observation by the AOV equipped with Acoustic Doppler Current Profiler (ADCP), for example Kuroshio current.
In addition, we show the result to observe winds and waves during a typhoon T1618 at peak strength, near Nagasaki, Japan.

Keywords: Wave Glider, Ocean observation, Platform

Development of simple CTD calibration method for Argo float.

*Mizue Hirano[1], Shigeki Hosoda[1], Takayuki Hashimukai[2], Satoko Hirota[2], Shuhei Masuda[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. Marine Works Japan Ltd.

The global Argo array produces huge accurate data which can be used for climate and oceanic changes by a lot of deployed Argo float. The Argo float is equipped with a CTD (SBE41; Conductivity (salinity), Temperature, Pressure) sensor, which is made from an US manufacturer: Sea Bird Electronics (SBE). Since long-term stability and accuracy of the CTD sensor are the most important point to detect the climate and oceanic change signals, checking and screening of the SBE41 before deployment is crucial. Therefore, JAMSTEC developed a simple CTD calibration method for SBE41 in a laboratory.

The international Argo program is a global project to monitor temperature and salinity changes of the upper 2000 m ocean by over 3000 Argo floats. The floats can automatically measure them for 3-4 years, sending variable kind of data via satellite in real time. The target accuracies of the SBE41 are within ± 0.005^{o}C for temperature and ±0.01psu for salinity, which had been decided by Argo Data Management Team. To maintain the accuracies of the sensors is a key to be better understanding mechanisms of global oceanic changes.

Up to now we has been deployed over 1100 floats with SBE41 since 2000. Although all the CTD sensors are fully checked and passed for the accuracies before shipping from the manufacturer (SBE), the sensors are not accidentally satisfied with the target accuracy due to sipping trouble etc.. To detect the failure sensors and avoid the fault floats, we had operated JAMSTEC’s CTD calibration system which was the same type system as SBE’s and checked the sensors as much as possible. From 2000, we had checked over 500 sensors and found 30 unhealthy ones. The reasons why the number of checked CTD is about a half of all deployed floats are mainly complexity of the system and too much time to check for each sensors (over 12 hours). Difficulty of the operation, such as to open a float and separate a sensor, requires higher skills of technicians. Therefore, we developed new and simple CTD calibration method without opening the float, separating CTD sensor and any special skills for technicians, to be able to check all sensors efficiently within shorter time.

The mechanism of the new CTD calibration method is very simple. Artificial sea water (35 within ±0.1psu, 23 within ±0.3degC), is made by NaCl, degassing in advance, is flown at a constant speed in reference temperature and conductivity sensors and some CTD on floats through a thin pipe, being driven by a high efficiency pump. Within a fixed time (30 minutes), the reference sensors and float sensors automatically measure temperature and conductivity frequently. The checked float sensor is evaluated for healthy or unhealthy by calculation of the difference of temperature and conductivity between the float sensors and reference ones. The important point to get accurate calibration result is to keep uniform air and the artificial salt water. Based on a lot of try and error to maintain temperature environment, we succeeded to reduce temperature gaps in between the laboratory room and checking sensor within ±0.3degC during a

calibration, which makes us the same calibration quality of the simple calibration method as SBE’s calibration system.

Keywords: Argo float, CTD sensor, Sensor calibration

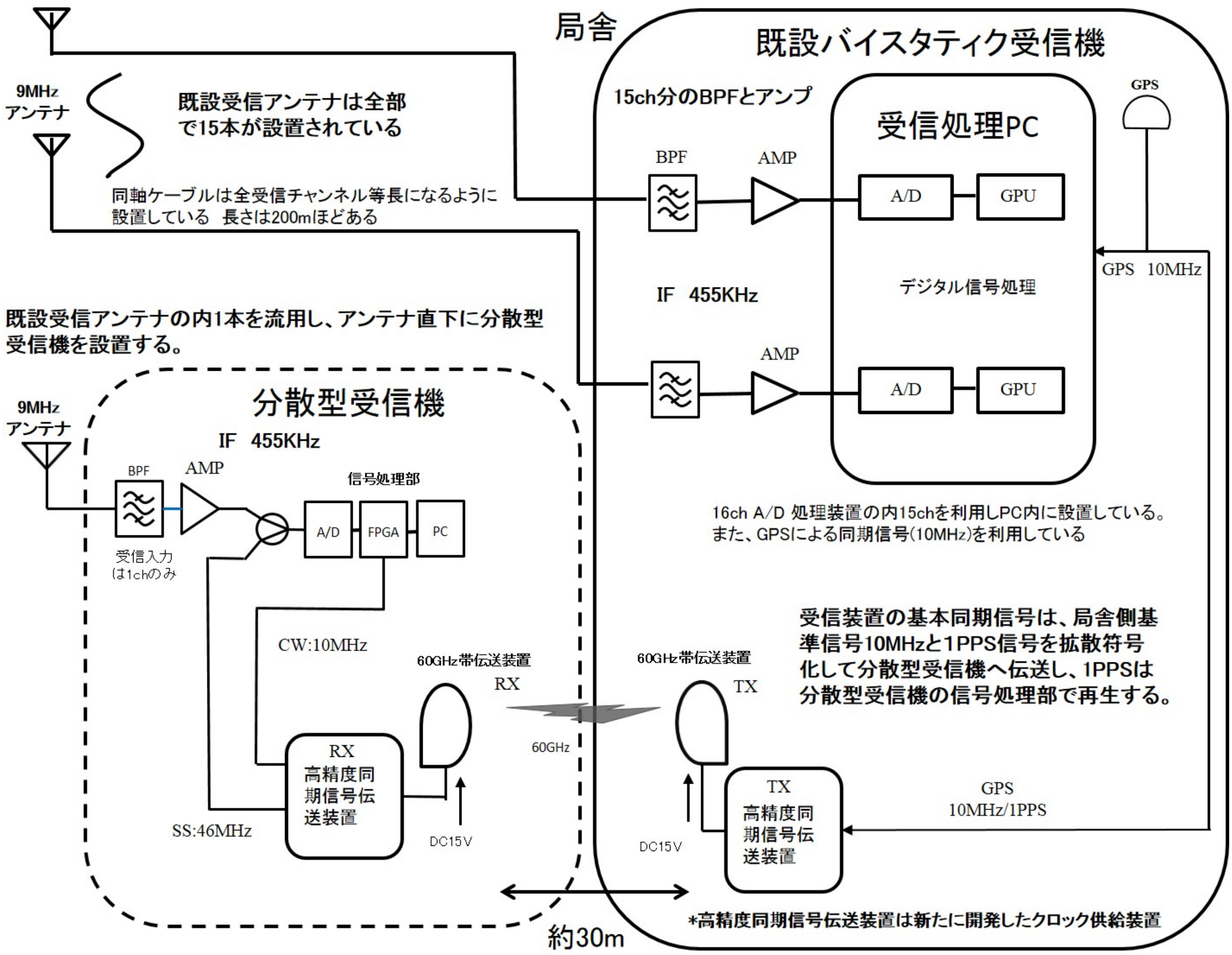
An Experimental Study on Distributed Ocean Surface Radar

*Shigeo Sugitani[1], Jyun Amagai[1], Hironori Iwai[1], Akihiko Morimoto[2], Meoto Kyushima[3], Satoshi Fujii[4], Tetutarou Takigawa[5], Kaoru Ichikawa[6]

1. National Insitute of Information and Communication Technology, 2. Ehime University, 3. Nagoya University, 4. University of the Ryukyus, 5. Nagasaki University, 6. Kyushu University

Ocean surface radar is installed along a coastline to observe ocean surface current in the range further than tens of kilometers to about 200km. Phased array antenna system of ocean surface radar needs hundreds of meters of land for its antenna installation as it uses lower frequency in HF bands. We have proposed Distributed Ocean Surface Radar System that enables efficient installation. Distributed Ocean Surface Radar System includes transceivers at each antenna and these transceivers work in synchronization without being-connected by coaxial cables.
This is the report of our first experiment in which we placed one distributed receiver at one of the existing antennas of our 9MHz band radar system.

Keywords: Ocean surface radar



Ocean wave motion detection with Hu-moments invariants using CCD images

*DongSeob Song[1], JongChul Yoon[1]

1. Kangwon National University

Computer vision (CV) is a research field in computer science for acquiring, processing, analyzing, and understating image and video to produce numerical or symbolic information. Among the various CV techniques, we used image moment to analyze the movements of ocean wave. Image moment is weighted average of image pixel intensities and we find that varying of moment between costal monitoring video frames can be associated with wave movement, such as period and height. Using the varying of image moment we analyze the numeric information of wave movement and tested our algorithm to the Gyoam beach in Gangwon province, Republic of Korea. To prove the algorithm we compared with the wave information collected by an acoustic wave gage (AWAC) and determine the usability of our system. We first extract a list of sample patches in the videos of coastal region that have immunity from external environments such as human or ship. Since general CCD camera is fixed, variance in the time domain of inlier video patch can caused by wave movement. To calculate the variance between the video patch, simple measure by difference the colors or intensity at each pixel can be used. But that is ineffective for a CCD video, because CCD video contains unwanted changes due to light variance or noise which make crucial miscalculation. Instead, we extract seven hu-moments that invariant a translation, scale, rotation and apply these for contour shape matching, which is a well-known technique for measuring the similarities between two shapes, between each sample in the different video frames. To comparing with ground-truth data, we also capture the wave movement by acoustic wave gage. After comparison, we found that the period of real wave were almost identical to the CCD image processing results. And amplitude of EV(i) and height of wave showed similar value changes relatively although absolute values are different. Length of higher amplitude region also has a similar pattern with wave length. Therefore our system can be used as a beach process monitoring system with low cost equipment.

Keywords: CCD, Hu-moments, Wave Period

Numerical Simulation of Wind Flow around an Ocean Observation Tower
-First Assessment of the Applicability of Numerical Simulation-

*hiroto iuchi[1], Takeshi Takemoto[1], Naoya Suzuki[2], Takenobu Michioka[2], Takuji Waseda[3], Hitoshi Tamura[4], Kaoru Ichikawa[5]

1. Department of Mechanical Engineering, Graduate School of Sience and Engineering Research, Kindai University, 2. Department of Mechanical Engineering, Faculty of Science and Engineering, Kindai University, 3. Department of Ocean Technology, Policy and Environment, Graduate School of Frontier Science, The University of Tokyo, 4. Marine Information Group, Port and Airport Research Institute, 5. Research Institute for Applied Mechanics, Kyushu University

The drag coefficient, C_D, used to quantify the wind stress, is generally expressed by a function of the wind speed 10 m above the sea surface, U_{10}. C_D, however, has not been established because of variations in field observation data. Alternatively, a number of drag coefficient models have been formulated. To develop a model of C_D, the wind stress needs to be calculated using the eddy-correlation method, which measures the horizontal and vertical wind components. In the field, observations of the wind velocity are difficult to obtain during various sea surface states because wind velocity measurements are limited to fixed installations, and the platform (e.g., the observation tower, and/or ships) affects the wind flow and wind direction. Recently, with the increasing availability of computers, it has become possible to visualize wind flow around an obstacle under various conditions via numerical simulations using computational fluid dynamics (CFD).

In this study, we investigate the applicability of a numerical simulation using CFD for selecting installation locations for measurement instruments and for determining a correction index. SolidWorks for 3D-CAD (computer aided design) was used to modeling of the Hiratsuka Tower, and the SolidWorks Flow Simulation was used in the CFD investigation and visualization of the wind flow around the Hiratsuka Tower. The inflow wind velocities are 5, 10, and 15 m/s, and the wind direction is tested at every 10° from 0° to 350°. In this study, we installed two 3-axis sonic anemometers on a handrail (at a height of 1.75 m) and on a pole (at a height of 3.75 m) on top of the Hiratsuka Tower. We started test measurements using both sonic anemometers on July 29, 2015. The effect of the Hiratsuka Tower on the wind flow was investigated by comparing the results obtained by the numerical simulation with the field measurements from these two sonic anemometers.

For the inflow wind velocities at 5 m/s, the scalar wind velocity, and wind component with flow direction at the sonic anemometer on the handrail is within 1.5 % accuracy of the sonic anemometer in the wind directions of 60° and 70°, where the sonic anemometer is located at the leeward side. The scalar wind velocity and all wind components at the top of the pole are larger than the inflow wind velocity in all wind directions. As a result of the flow visualization around the tower, the scalar wind velocity decreases on both the windward and leeward sides of the tower. The scalar wind velocity above the Hiratsuka Tower increases, owing to the separating flow generated at the windward front of the Hiratsuka Tower. The results of the inflow wind velocities at 10 and 15 m/s show the same tendencies in the differences between the calculated and inflow wind velocities for the same wind direction. The applicability of the numerical simulations is discussed by a comparison with the field measurements. We found that the wind velocity obtained by the numerical simulations tended to be similar to the measured wind speed values. Therefore, we also discussed the applicability of the numerical simulation using CFD to selecting installation locations for the measurement instruments and establishing of a correction index. The effect of the tower at distance from the center of the top of the tower was shown in the flow visualization as a

correction index at the actual installation locations.
Consequently, we showed that the numerical simulation using the CFD could be applied to the observation tower. We also showed the possibility of creating a correction index for the actual installation locations.
In this study, we calculated the numerical simulations using simple conditions as a first approach. In the future, we will investigate applications calculating the numerical simulation using complex conditions, such as shear flow.

Keywords: Wind speed measurement, Flow visualization, Numerical simulation, Computational Fluid Dynamics (CFD), Wind stress

The Mirai lidar for observation of atmospheric water vapor, clouds and aerosols over the ocean

*Taniguchi Kyoko[1], Ichiro Matsui[2], Tomoaki Nishizawa[3], Atsushi Shimizu[3], Masaki Katsumata[1]

1. JAMSTEC, 2. mss, 3. NIES

Lidar is an active remote sensing method; Lidar transmits light pulses to a target, then measures backscattering light intensity and its traveling time. The lidar target diameter extends as small as a molecular size with an adjustment of the light wavelength. A spatially fine resolution and a continuity of the lidar data capture a complex distribution of the target. These lidar characteristics suit to monitor the major atmospheric variables: water vapor, cloud, and aerosol.
Regardless of the lidar suitability, observation platforms for atmosphere over the ocean remain extremely rare, especially if excluding ones in the coastal region and islands. Conversely, a great coverage of the ocean on the earth surface suggests extensive interaction between atmosphere and ocean. Thus, disclosure the interaction requires an observation platform over the ocean. Since ship-borne observation is one approach, we selected the R/V Mirai as a lidar observation platform.
With modifications to the ship, the Mirai lidar has successfully archived vertical distributions of the atmospheric variables over diverse waters. The continuous data illustrated temporal transitions of the variables in details. We converted the obtained data into physical parameters, such as water vapor mixing ratio. After the conversions, we evaluated the lidar data quality thru comparison to other observations conducted on the R/V Mirai.

Keywords: lidar, atmospheric observation over ocean, water vapor, cloud, aerosols, ship-borne observation