Launch of GNSS-Acoustic observation for horizontal and vertical movements off Nemuro using a triangular PXP array with an optional centered-PXP.

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Recent studies on tsunami deposit revealed that M9-class huge earthquakes repeatedly occur along the Kuril trench. This suggests that the seismicity gap found in the shallow portion of the off-Nemuro subduction zone shall not be a stably sliding area but an interseismic locking area, which causes destructive tsunamis at the time of a huge earthquake like as the off-Miyagi region. Then the research groups in Tohoku and Hokkaido universities and JAMSTEC have started integrated geodetic and seismic surveys on July 2019 to reveal the interplate locking condition off Nemuro. In this talk, we focus on GNSS-Acoustic (GNSS-A) observation among the whole surveys.

Three GNSS-A sites were newly constructed along the survey line nearly perpendicular to the trench axis off Nemuro. They are G21 (four PXPs (Precision Transponders), ~100 km from the trench, 2920 m in depth) and G22 (four PXPs, ~35 km from the trench, 6242 m in depth) on the land-side slope, and G23 (three PXPs, ~30 km from the trench, 6700 m in depth) on the Pacific plate. The layout of G21 and G22 has a unique feature with a centered-PXP in the triangular PXP array, which can "resolve vertical motions even only by point survey" as well as horizontal motion. Thus, this layout will be useful for employing autonomous surface platforms which are not suited for moving survey. Different emission angles to PXPs are required to distinguish vertical motions from sound speed variation. The DOP (Dilution of Precision) based evaluation in geometrical strength [e.g., Imano, 2020] showed that putting a centered-PXP produced sufficiently different angles when dimension of the array (circumradius) to the site depth is larger than 0.7; in the viewpoint of detecting vertical motions, this four-PXP layout results in favorable geometry than our pre-existing six-PXP sites (consisting of large and small concentric triangles) which are specialized to solve horizontal gradients of sound speed structure.

In this campaign cruise, both moving and point surveys were conducted at each site for determination of array geometry and position of the array. In this talk, we firstly report on the positioning of the individual PXPs to determine the array geometries because of the first campaign survey. Reference sound velocity profile was calculated from concurrently-measured CTD or XCTD cast. We expressed temporal variation of the sound velocity by NTD (Nadir Total Delay) that consists of B-spline curves every 250 s. Then, we simultaneously solved NTDs and the 3-D position of three or four PXPs in a single array. The positions were successfully determined with accuracies of 4.9–13.8 cm in horizontal and 9.9–13.2 cm in vertical with RMSs in traveltime residuals of 0.070–0.085 ms. Significant positive bias in NTD by ~3.0 ms was obtained at the time of CTD casts, which should be zero in definition because of the reference velocity. This bias indicates that the true sound velocity is ~0.9996 of that calculated using our employed formula by Chen & Millero (1977).

The next survey is scheduled in May 2020 and tentative array displacements will be obtained after that. Now we try to analyze time variation of apparent vertical motions of the array during the point survey of this campaign, which can be a rough indication of the accuracy in the estimate of inter-campaign vertical displacement. We will also report on this issue in the talk.

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