Interferometric GPS SSH Measurements in the Tsushima Strait

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1. Introduction

Special treatments are required to retrieve sea surface height (SSH) in coastal areas by satellite altimetry.

Moreover, even if SSH is accurately observed, infrequent and sparse observations of the altimetrymay not be suitable for coastal phenomena. We may need additional SSH observations to increase temporal and spatial resolutions.

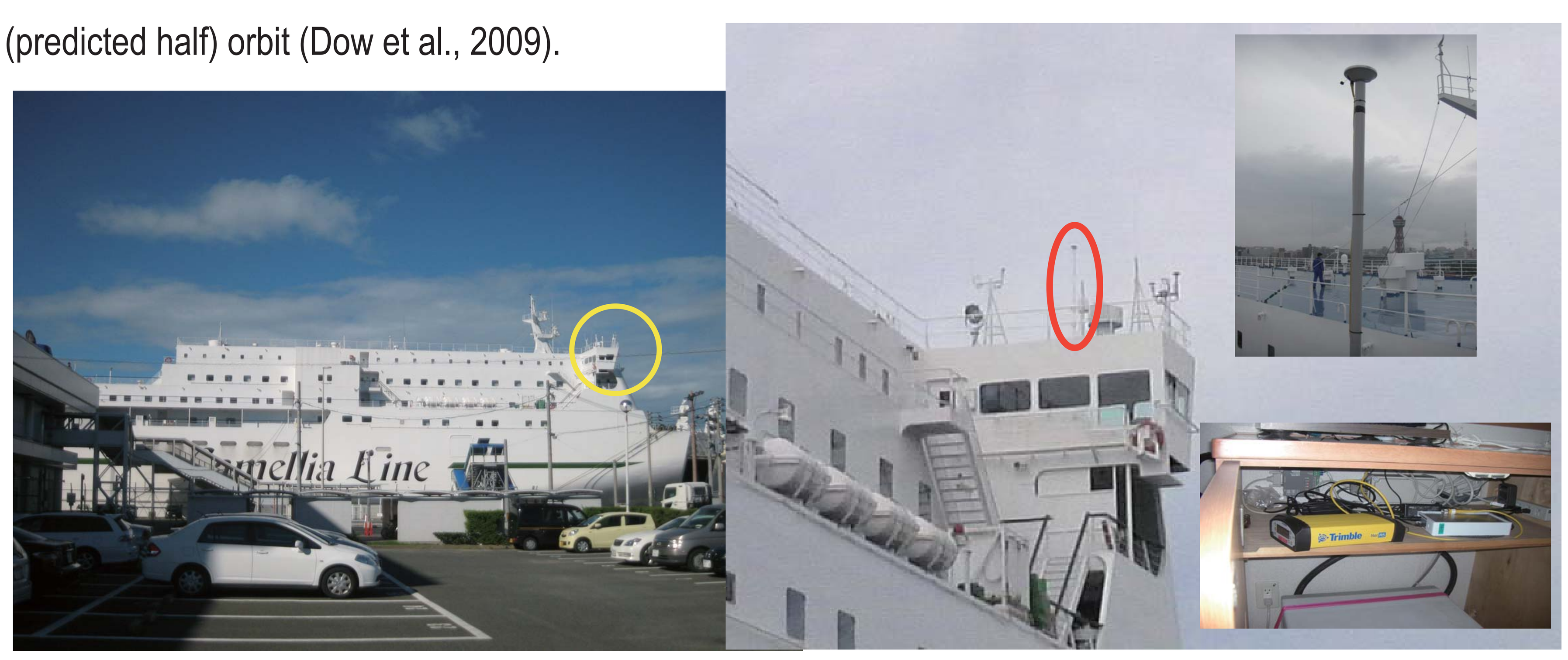
Similarly to the altimetry, GPS measures temporal differences to obtain the distances from the satellites, but its error is larger due to non-nadir EM paths. However, for closely located stations that would share almost the same EM path, precise observations are possible using the interferometry. In Japan, the Geographical Survey Institute provides a GPS network system (GEONET) that constitutes of >1231 fixed GPS sites, thus precise SSH observations can be expected.

In this poster, preliminary results are shown for the SSH observations by a GPS on an international ferryboat in the Tsushima Strait located between Japan and Korea.

2. GPS on "New Camellia" ferryboat

A set of GPS antenna (Zephyr Rover, Trimble) and receiver (NetR5, Trimble) was set on the bridge deck of the ferryboat "*New Camellia*" (19,961 Gross Tons) in August 2010.

The SSH data are obtained every 30 seconds, and the data are post-processed using the RTnet software (Hitachi Zosen) referring to the GEONET station 950456 on the Tsushima Island and the IGS ultra-rapid (predicted half) orbit (Dow et al., 2009).

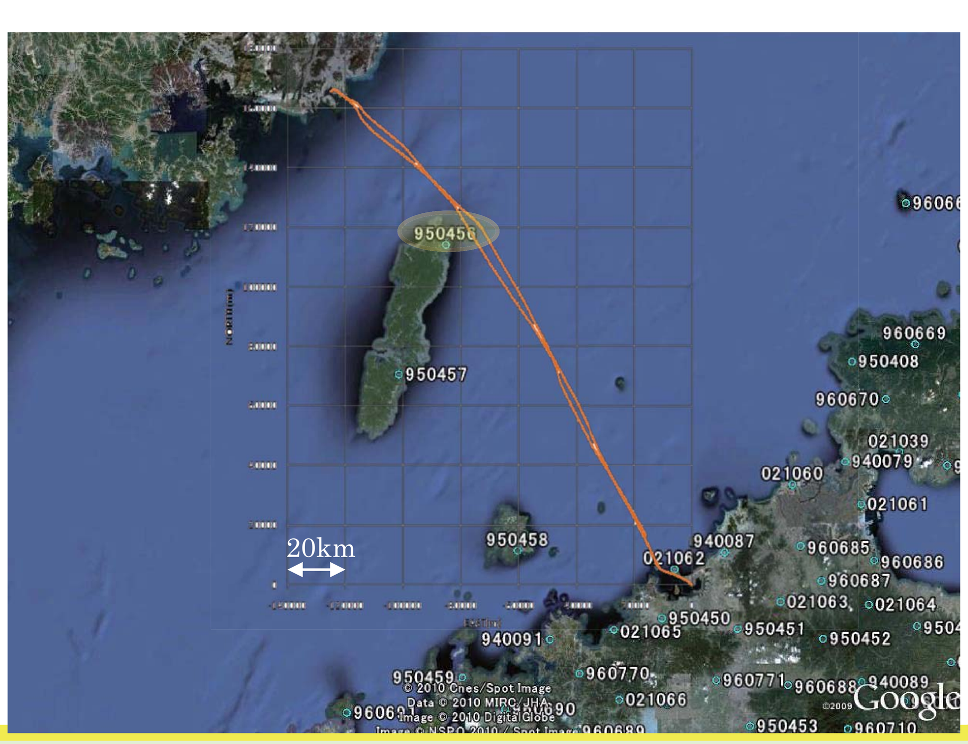


New Camellia regularly takes a return route/day;

from Fukuoka 12:30 (3:30 GMT) to Pusan 18:00 (9:00)

from Pusan 20:00 (11:00) to Fukuoka 7:30 (22:30)

In the present poster, the SSH data during 12 days (from 8/24 August to 9/4) are used.

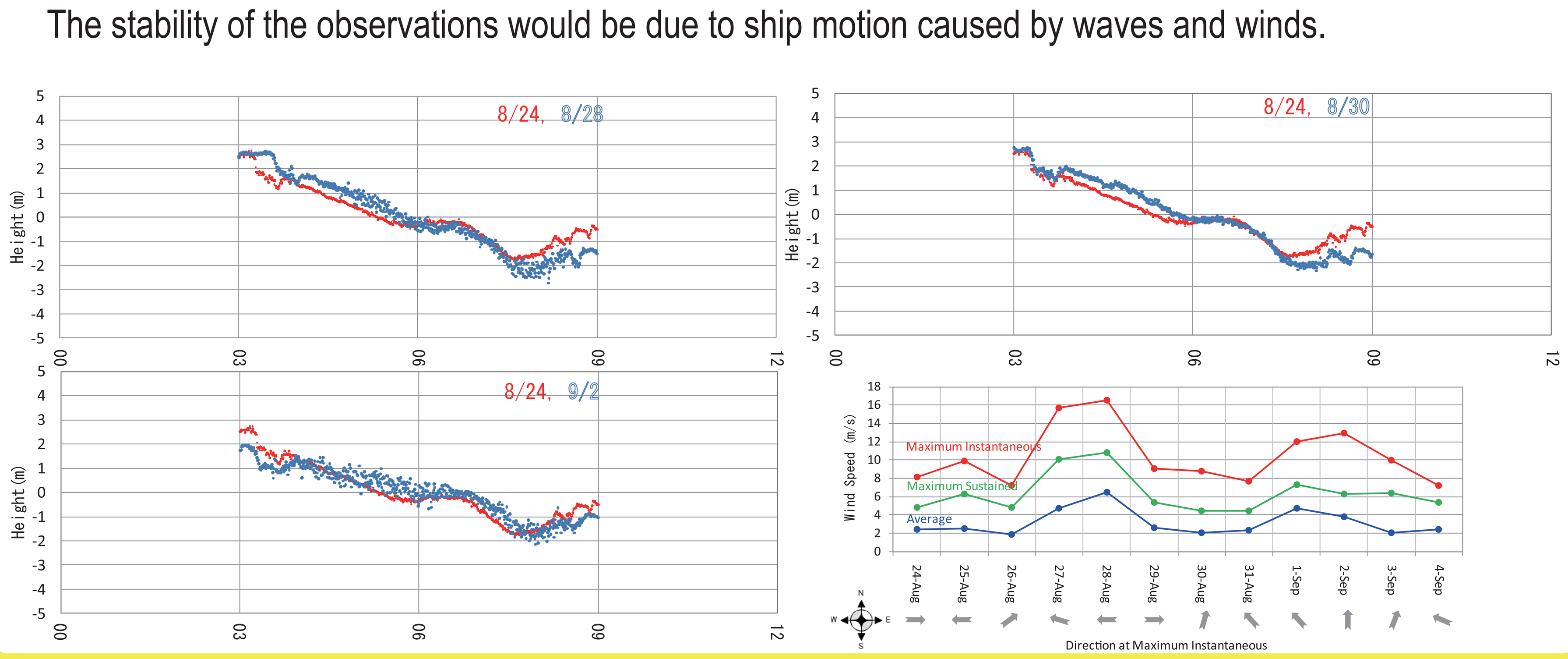


3. Raw Data

The panels below are examples of the observed SSH changes plotted versus the GMT time.

The SSH values on 8/24 and 8/30 are stable as indicated by narrow lines, while those on 8/28 and 9/2 fluctuate more and results in broader lines.

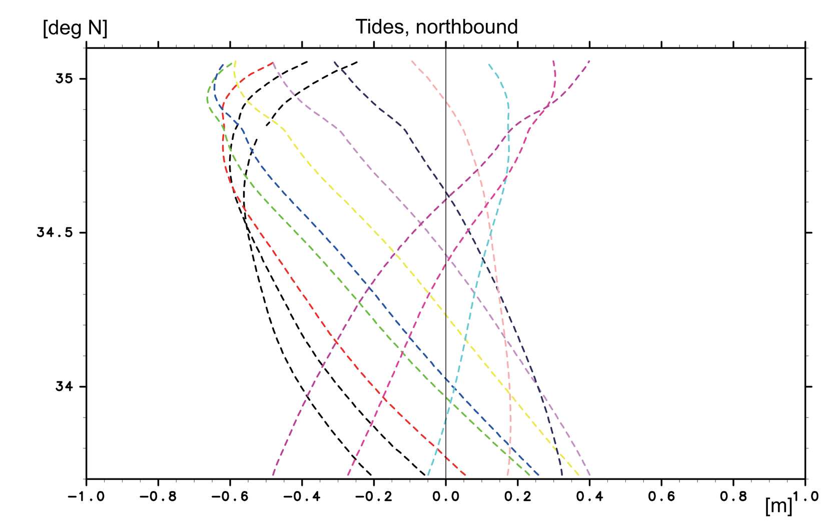
The stability of the observations would be due to ship motion caused by waves and winds.



4. SSHA retrieval

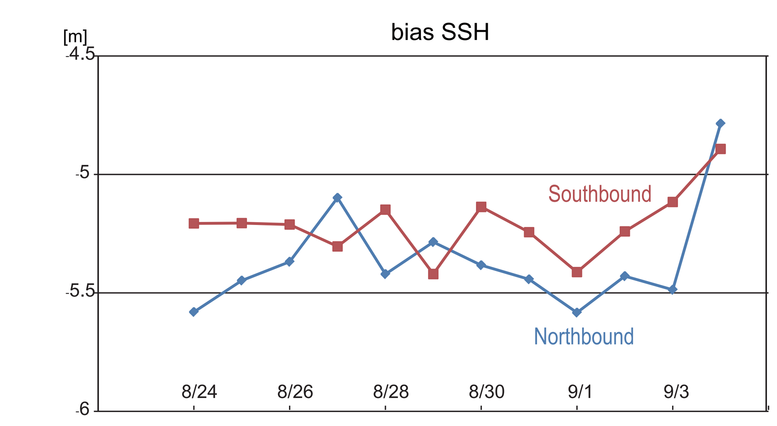
1) Removal of tides

Although the tides in the Tsushima Strait are not accurately determined at present, we usedf 9 tidal constituents (M2, S2, O1, K1, Q1, P1, K2, N2, Mm) extrapolated from surrounding T/P-Jason subsatellite tracks (e.g. Morimoto, 2009). The estimated tides for each northbound cruise are plotted in the right panel.



2) Removal of Bias height

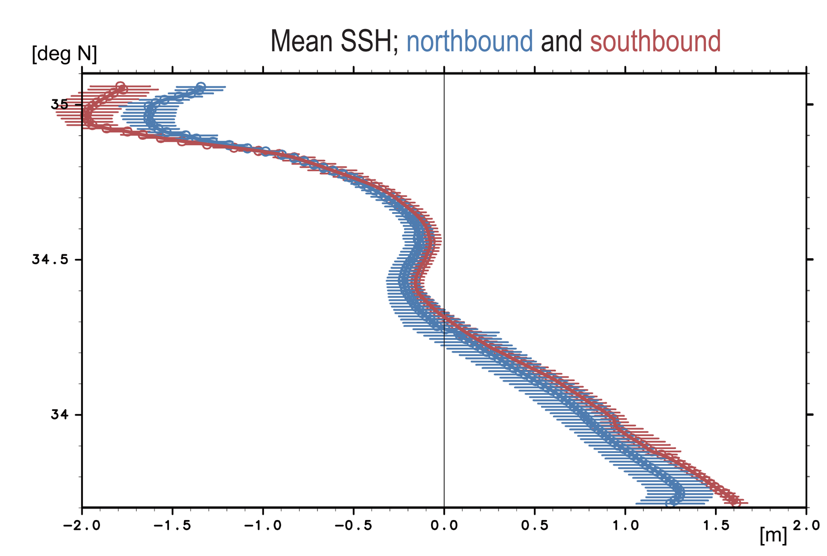
Because the load of the ferryboat would vary for each cruise, the bias height for each cruise (right panel) should be removed.



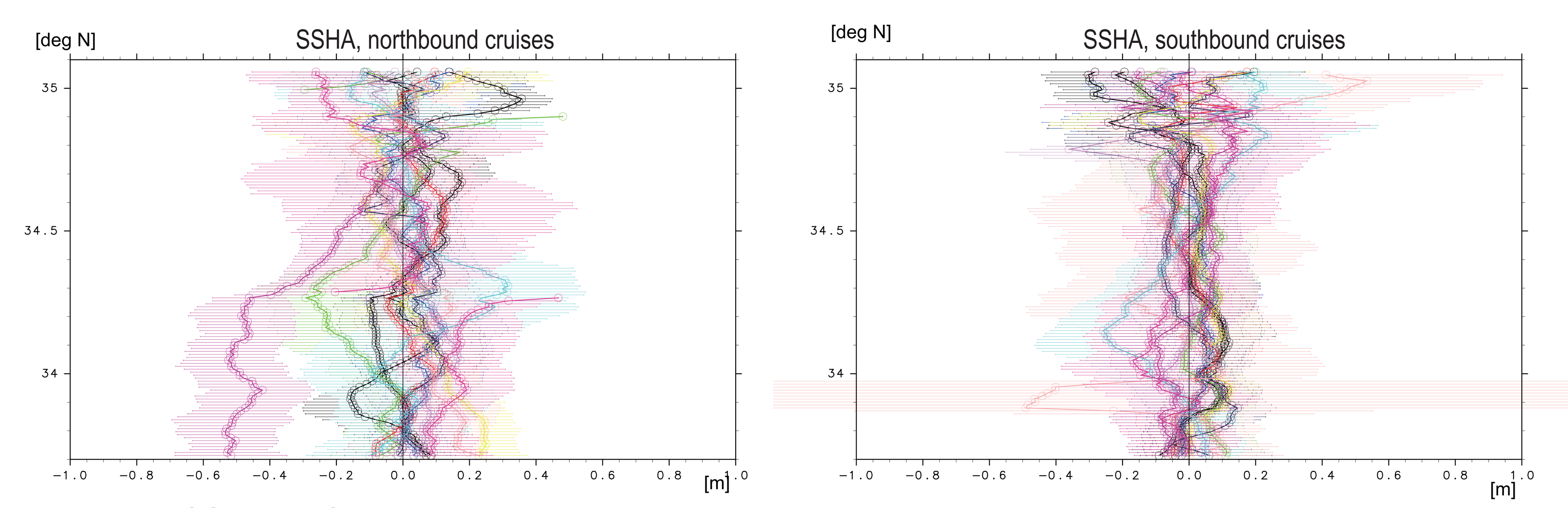
3) Resampling to Regular Points & Estimation of the mean SSH

The observed SSH data are interpolated to the regular ship route points (determined from 12 years of ADCP observations). However, as shown in the left panel, the ship routes have considerably fluctuated, so that no SSH observations are found within 1km of many regular points.

The mean SSH fro the northbound cruises within 7km of the regular poits is considerbly different from that of the southbound cruise. This is due to discrepancy of the ship route (right panel).

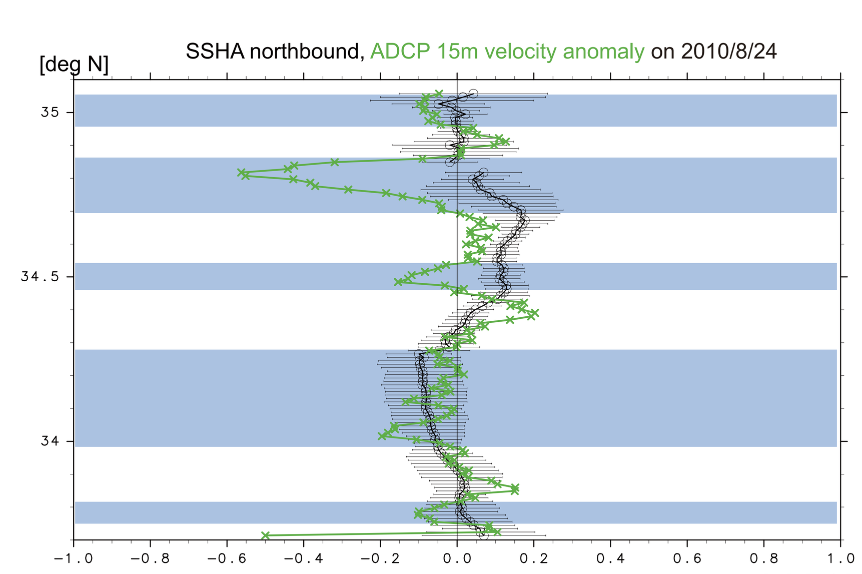


4) Separation of SSHA



The whole SSHA profiles are plotted in the panels above. They have undulations up to 50cm, and those unrealistic variations would be also due to the remaining geoid heights due to the ship route differences.

As an example, the SSHA in the northbound cruise on 8/24 is compared with the de-tided velocity anomaly at 15m depth measured by the ADCP mounted on New Camellia (Fukudome et al., 2010).

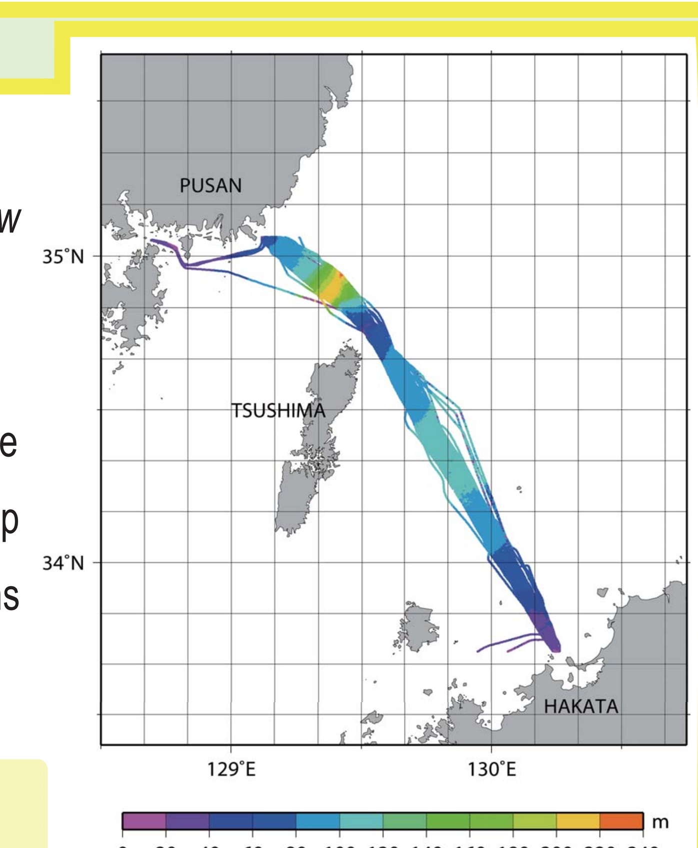


Although there are some coincidences between rapid SSHA changes and current direction changes (such as at 34.28N, 34.46N, 34.70N, 34.85N), they are inconsistent with the geostrophic velocity.

Rather, variations of the ship route in areas with large velocity shear would be a candidate for those coincidences.

5. Concluding Remarks

+ The SSH in the Tsushima Strait was observed by GPS on a ferryboat *New Camellia*.
+ Variations of the ship routes result in large SSHA variations.
+ In the next stage, the SSH variations due to ship routes should be corrected; e.g. as a function of the bottom topography beneath the ship routes that has been well observed by the 12 years of ADCP observations (right panel).



References;

Dow et al. (2009) J. Geodesy, 83:191-193, doi:10.1007/s00190-008-0300-3

Fukudome et al. (2010) J. Oceanogr., 66(4), 539-551.

Morimoto (2009) J. Oceanogr., 65(4), 477-485.