

Surface Height Measurements in the Tsushima Strait

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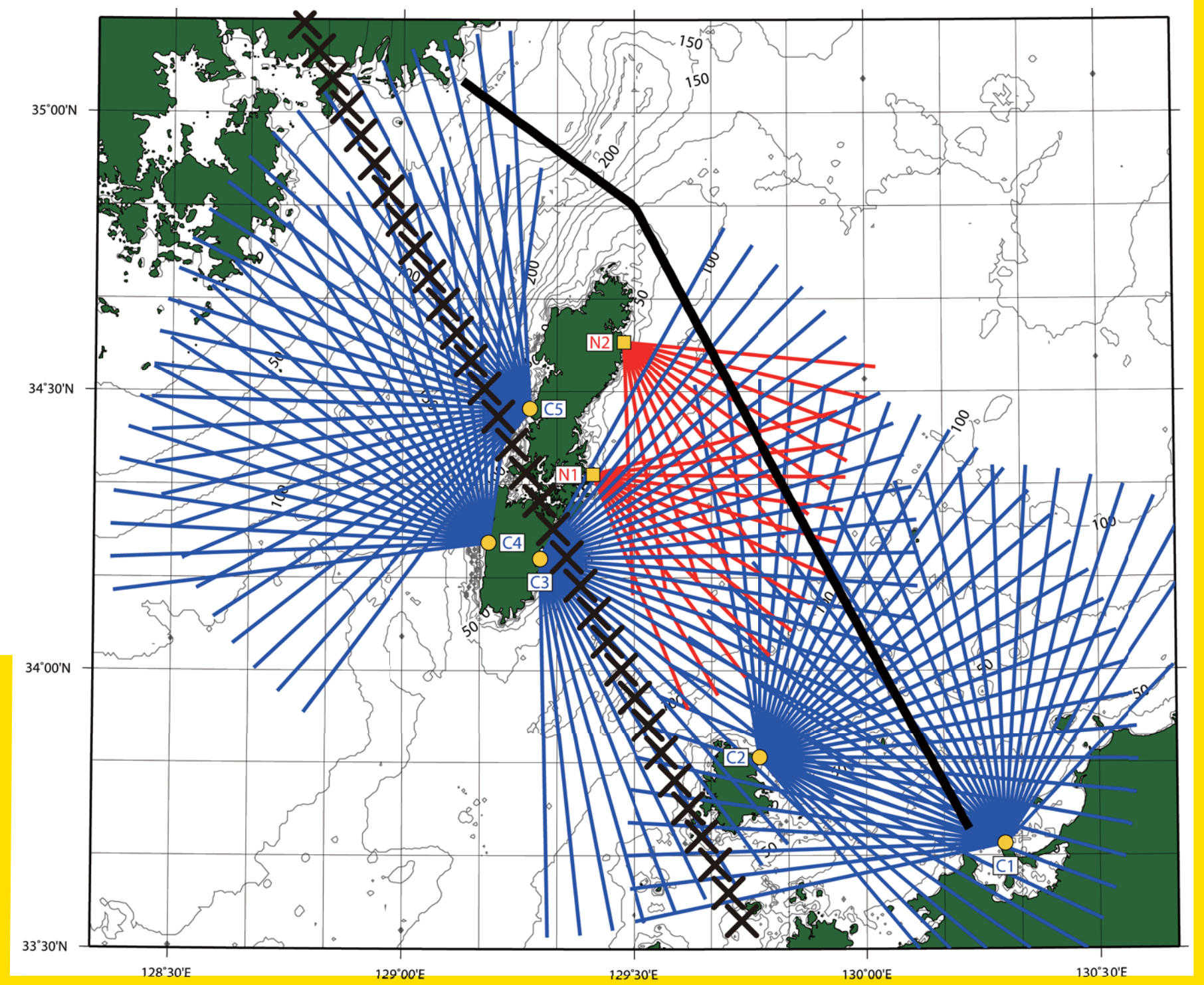


1. Introduction

The Tsushima Strait is located between Japan and Korea and connects the East China Sea and the Japan Sea. Variations of the volume transport of the Tsushima Warm Current affect regional climate changes in the Japan Sea and surrounding countries including Japan, Russia and Korea.

The Tsushima Warm Current in the strait has been monitored by RIAM, Kyushu University, using acoustic Doppler current profiler (ADCP; 300 kHz, RD Instruments) mounted to ferryboats "Camellia" (1997-2004) and "New Camellia" (2004-) that crossing the strait almost every day. In addition, surface velocity in the strait has been observed by the HF radar systems (CODAR and JRC) since 2002.

In the present poster, those observations are compared with two types of the sea surface height (SSH) measurements in the Tsushima Strait; namely, one from the satellite altimetry, and the other from a interferometric GPS system that has just been mounted on *New Camellia* since August 2010.



2. HF radar surface velocity vs. ALT geostrophic velocity

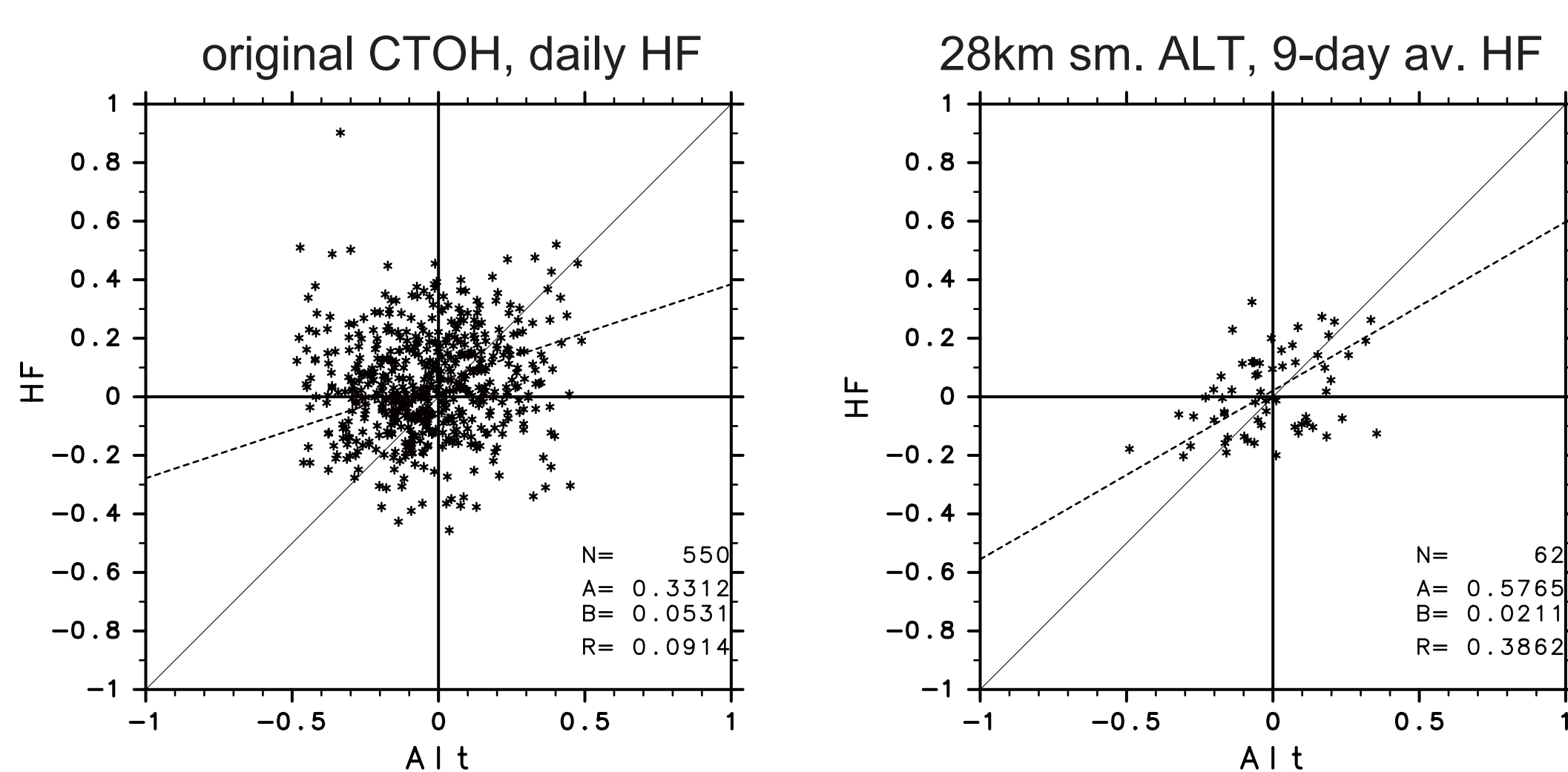
Altimetry data

- The regional product of CTOH/LEGOS along track sea level anomalies with the FES tide correction (developed, validated and distributed by the CTOH/LEGOS, France).
- Additional tidal corrections were applied by the harmonic analysis of 9 constituents (Tokeshi et al., 2007)
- Anomaly from the mean (2002/12 - 2008/04) along the T/P-Jason subsatellite track #36.
- Although the CTOH data have already smoothed, the SSHA is further smoothed along the track for *N*-km spatial scales, then the geostrophic velocity anomaly component normal to the track is calculated.

HF radar data

- Unfortunately, only a few points along the track #36 are obtained with good HF radar beam angles in our HF radar system (Yoshikawa et al., 2010). (See the top-right panel)
- For those points, the *M*-day averaged velocity anomaly component normal to the track #36 is calculated on the same day of the altimeter's observation.
- Note that the HF surface velocity has been corrected for the tidal currents and the wind driven currents estimated from local winds (Yoshikawa et al., 2007; Yoshikawa and Masuda, 2009).

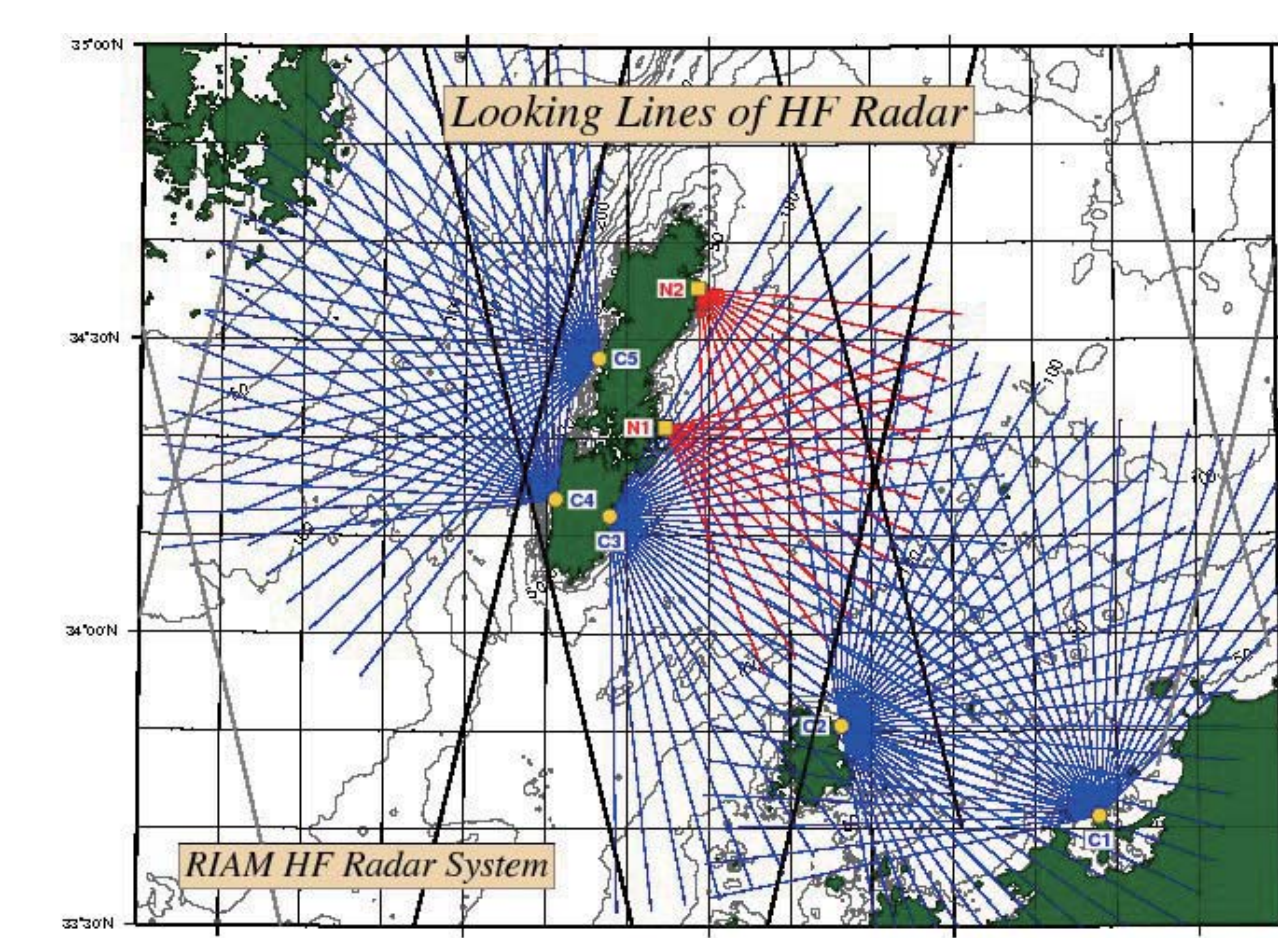
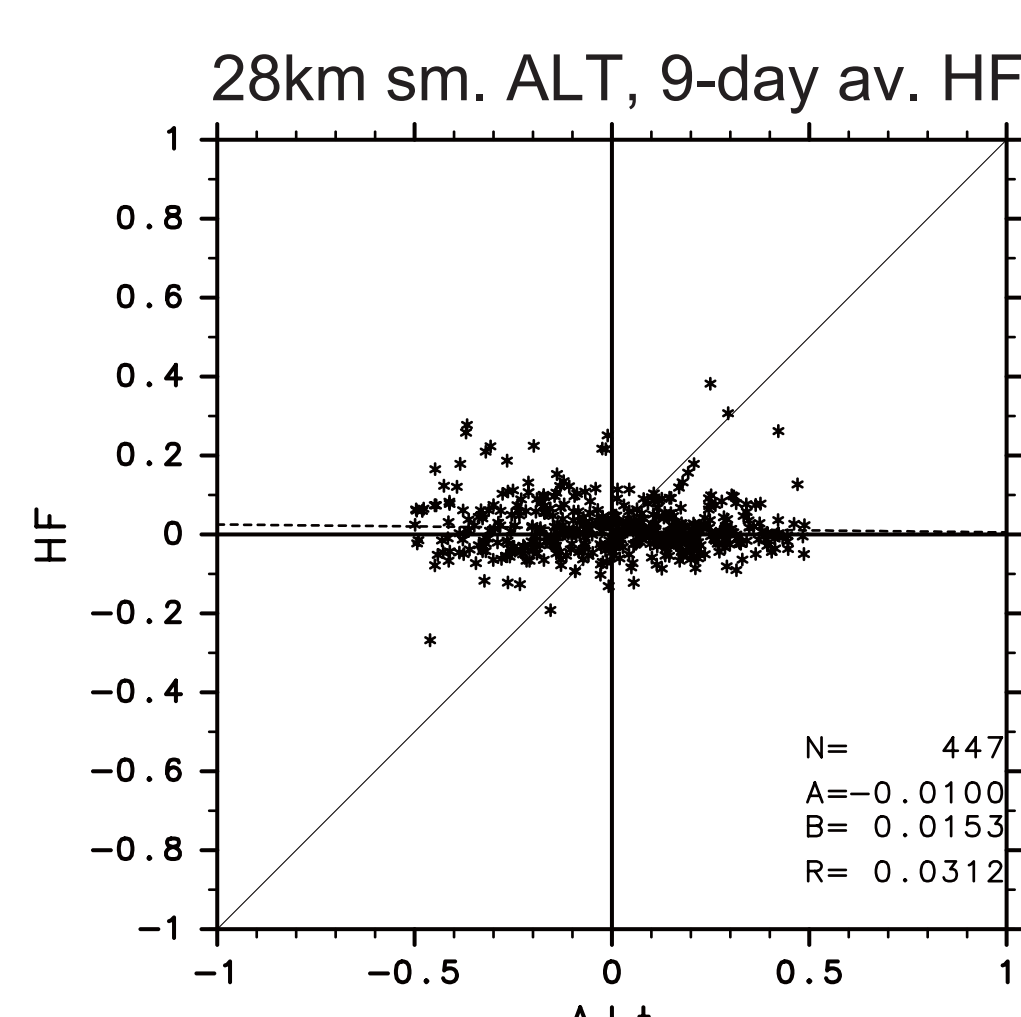
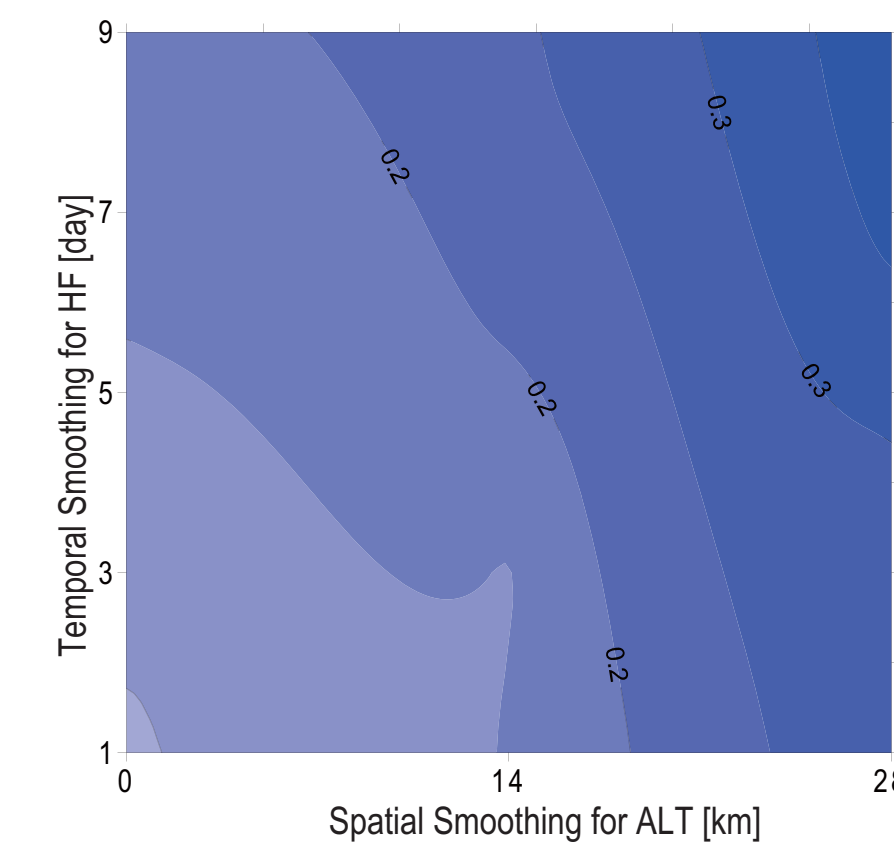
For various combinations of [*N*-km, *M*-days], we determine statistical values of comparisons such as the correlation coefficient and the RMS error; examples of the scatter plots for [no additional spatial smoothing, daily mean] and [28km, 9days] are shown below.



The correlation coefficient for each combination is plotted in the right panel. In order to obtain acceptable correlation with the HF radar surface velocity, the CTOH data need (at least in the Tsushima Strait) additional spatial smoothing.

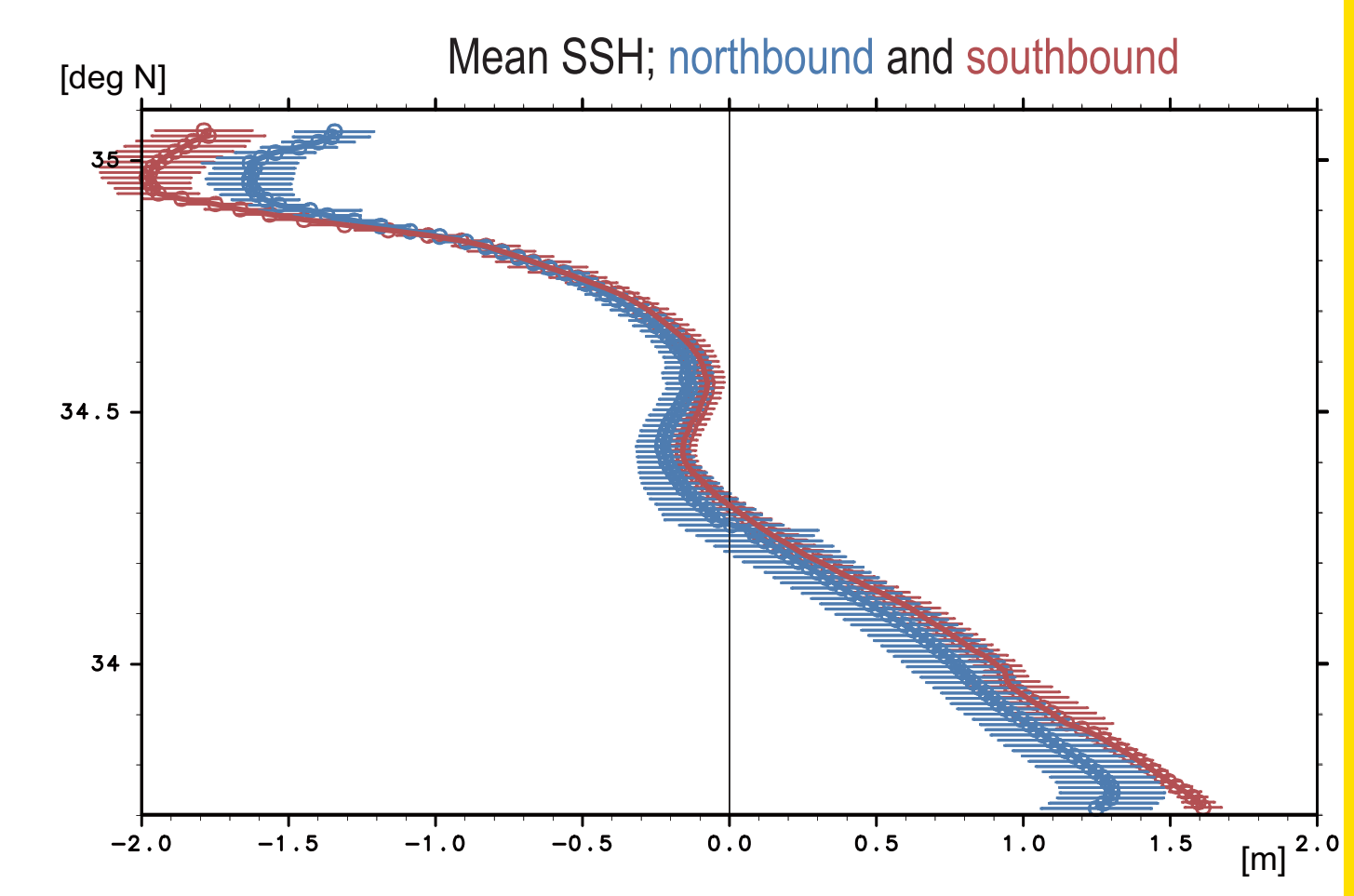
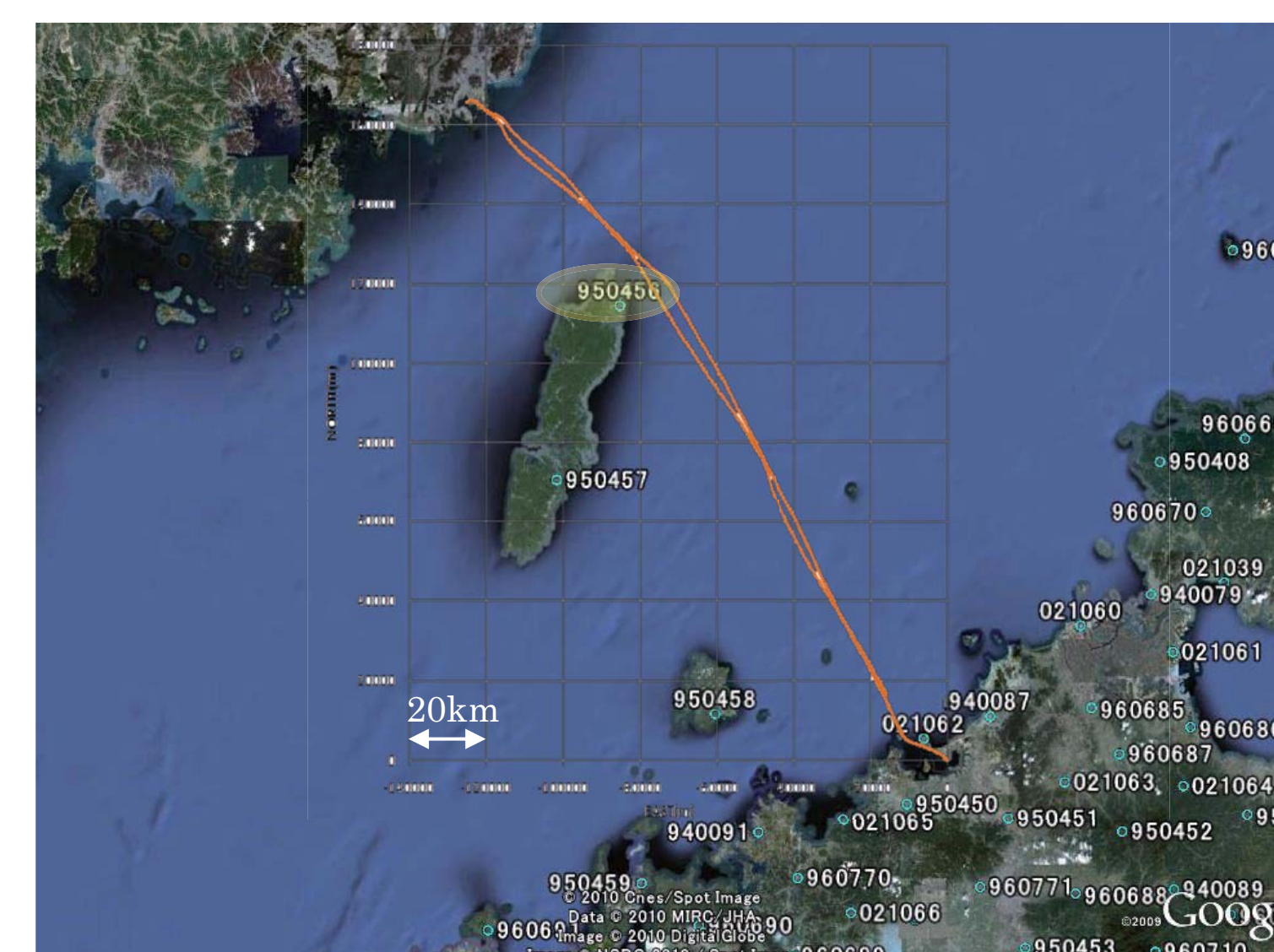
These correlations are generally worse than those in the open ocean (Tokeshi et al., 2007) even after smoothing in space and time. This may indicate either that the SSHA data includes non-geostrophic sea level elevations, or that the HF radar system measures some long-lasting local velocity variations.

Note that the scatter plot for [28km, 9days] for the AVISO Ssalto/Duacs DT-SLA "Updated" ERS/Envisat data (CNES, CLS) shown below indicates no correlation with HF velocity. Also note that no comparisons with the HF radar are available for the AVISO T/P-Jason data due to significant loss of data near lands.

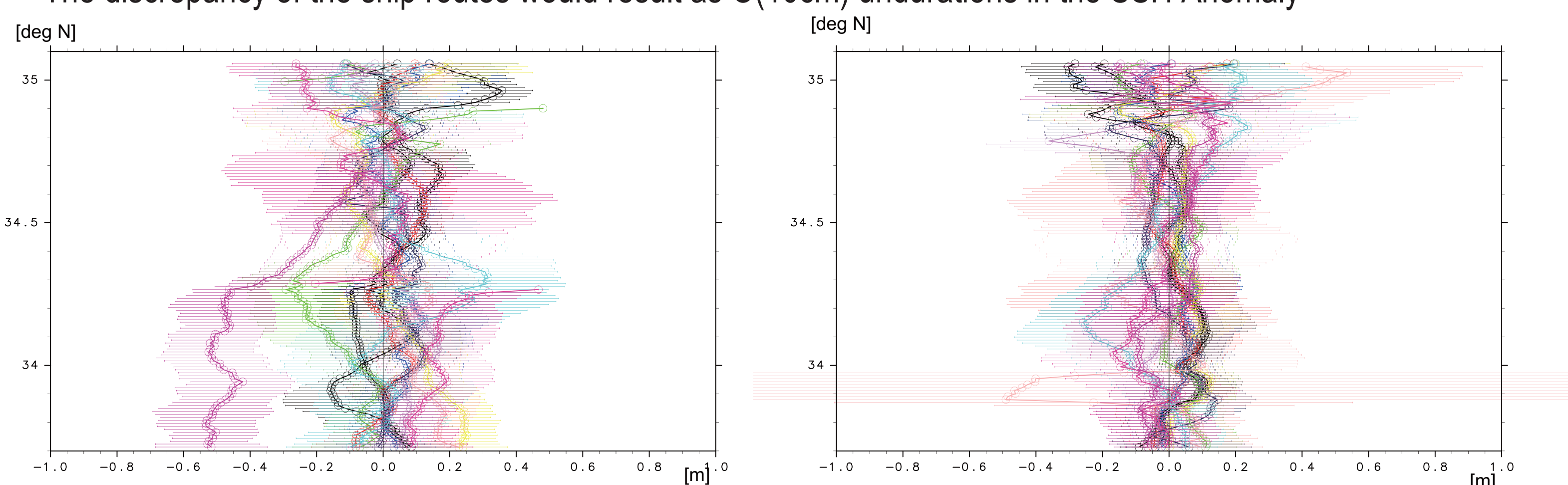


3. SSHA by GPS on New Camellia

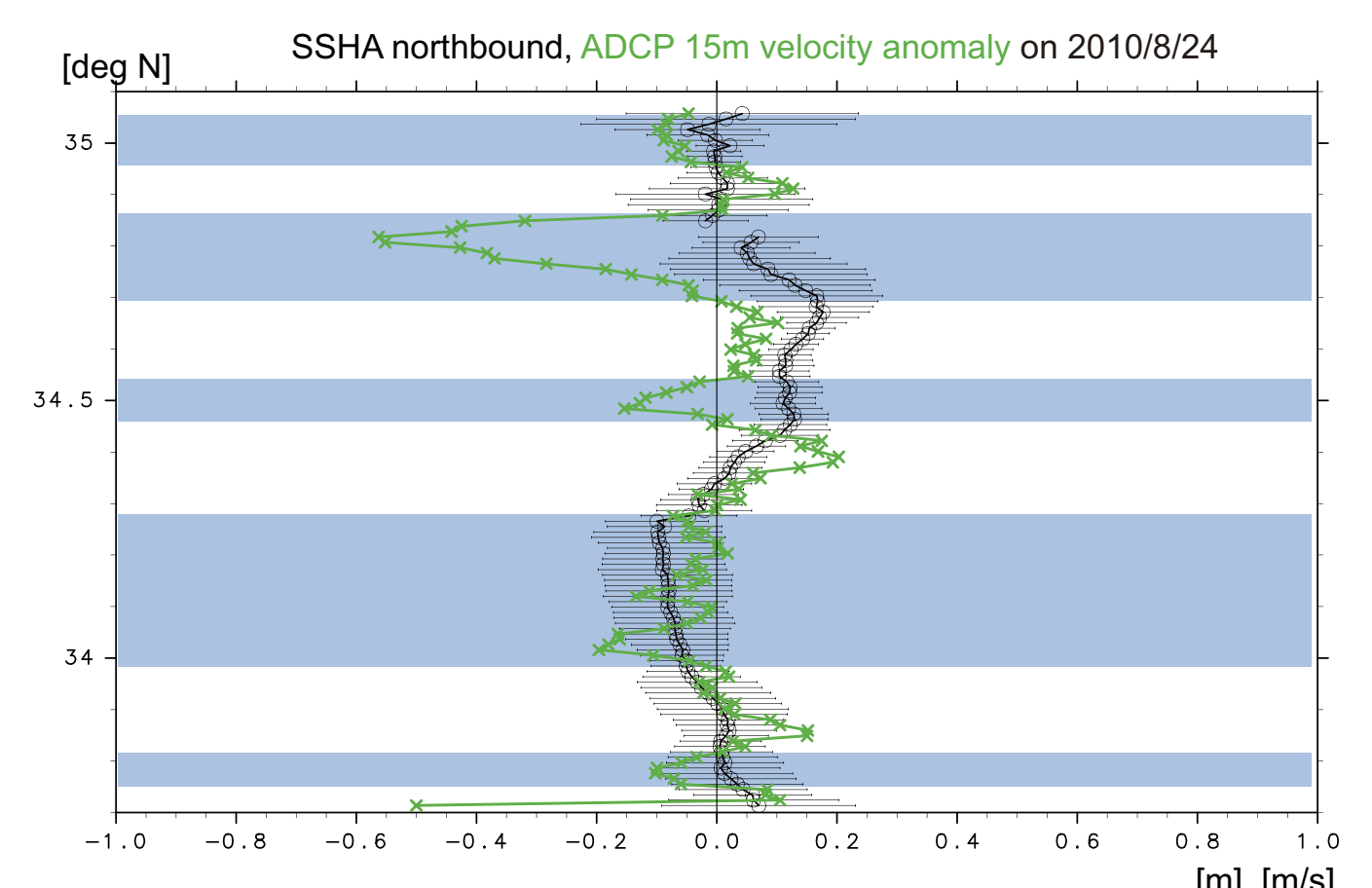
- *New Camellia* (19,961 Gross Tons) takes 1 return cruise/day
- SSH measured by GPS (NetR5, Trimble) every 30 seconds
- Refer GEONET Stn #950456 data provided by GSI, Japan
- Preliminary results from 12 days (8/24-9/4) observations
- Remove roughly-estimated tides (Morimoto, 2009) & bias of each cruise variable due to the ship load



- Resample the observed SSH to the regular ship route, but the actual routes are so variable that the mean SSHs become different for the northbound & southbound cruises (above right panel)
- The discrepancy of the ship routes would result as O(10cm) undulations in the SSH Anomaly



- Coincidences are found between rapid SSHA changes & current directions at 15m depth, as in the right panel (e.g., 34.28N, 34.46N, 34.70N, 34.85N)
- But they are not in geostrophy; more likely, variations of ship routes caused in areas with large current shear



4. Concluding Remarks

- + Two types of the SSH measurements are compared with observations in the Tsushima Strait.
- + The geostrophic velocity determined from the CTOH/LEGOS SSH results in reasonable correlation with the surface velocity observed by the HF radar, after some spatial and temporal smoothing applied.
- + The SSHA observed by GPS on the ferryboat in the Tsushima Strait is significantly contaminated by the geoid changes due to variable ship routes. Better results are expected by applying precise corrections of the spatial variations of the geoid.

References;

Morimoto (200); J. Oceanogr., 65(4), 477-485. Yoshikawa and Masuda (2009) JGR 114 C12022, doi:10.1029/2009JC005632
Tokeshi et al. (2007), JO, 63(4), 711-720 Yoshikawa et al. (2010) JO, 66, 223-232
Yoshikawa et al. (2007) JGR 112 C06022, doi:10.1029/2006JC003625