Sea Level Observing System in Japan
and Long-Term Sea Level Change along Japan Coast

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Sea Level Observing System

Japan is located in the western boundary of the North Pacific Ocean where western boundary currents such as Kuroshio dominate. As such, this area is regarded as one of the most important regions to monitor sea level changes of the Pacific Ocean. Many national and local governmental organizations in Japan have observed sea level at tidal stations for each purpose. The major organizations among them are; Japan Meteorological Agency (JMA), Hydrographic Department of Japan Coast Guard (JHD) and Geographical Survey Institute (GSI). These organizations have 66, 29 and 25 tidal stations respectively. 10 Pacific Ocean stations operated by JMA have been registered in the GLOSS Core Network (Figure 1).

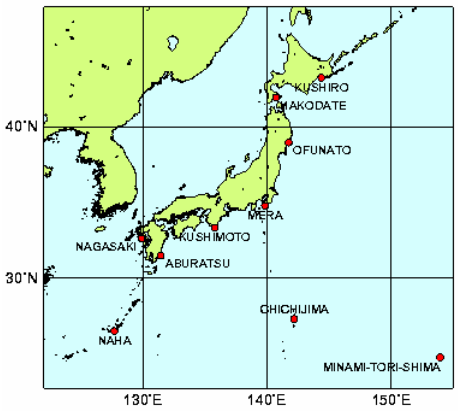

Figure 1: tidal stations registered in GLOSS

The principal purpose of sea level observations of JMA is to monitor and predict storm surges and tsunamis. In addition, to detect long-term sea level rise caused by global warming is also regarded as an objective of observations.

In 1996 JMA installed a tidal station at Minamitorishima Island, which is located on the southeasternmost part of Japan and about 2,000km from Tokyo. The purpose of this station is to detect tsunamis which occur in the Pacific region far from Japan before they arrive at the main land of Japan. Since there are no other tidal stations near the island, it is recognized to be profitable to monitor sea level changes at seasonal to decadal scales reflecting variations of oceanographic conditions such as El Niño, and registered in GLOSS for their objectives.

JMA adopts the Fuess-type tidal gauges with digital encoders with resolutions of 1cm at 55 tidal stations, and acoustic (ultrasonic wave) gauges at 10 stations mainly for the purpose of tsunami monitoring. A hydraulic pressure sensor is used at the Minamitorishima station.

All of tidal stations of JMA have data transmission devices and data are transmitted from a tidal station to the nearest local meteorological observatory via dedicated telephone lines. Furthermore, the data at local observatories are centralized to the computer system named “Earthquake Phenomenon Observing System” (EPOS) in the headquarters of JMA for real-time tsunami monitoring. The data observed at the Minamitorishima stations are transmitted to JMA by radio

through the Geostatic Meteorological Satellite (GMS-5) every 10 minutes.

The collected data are processed and stored on workstations as data files whose sampling rate is 15 seconds and used for the following purposes:

1) To determine observations such as hourly sea level, monthly mean, etc. after these data are quality-controlled and smoothed.
2) Recent sea level data are transmitted to local observatories via networks and used to display on computer screens at local observatories so that forecasters can monitor tidal phenomena such as storm surges.
3) Hourly sea level data are analyzed to calculate tidal harmonic constants and predict astronomical tides for every station.

Hourly data of 11 stations are sent to WOCE fast-delivery and monthly means are sent to ISLP-Pac every month via the Internet. The results of observations are also provided annually to related organizations on CD-ROM named “tidal observations”.

Long-Term Sea Level Changes

We examine the variation of the annual mean sea level using the results of sea level observations. There are 11 tidal stations which provide for nearly 100 years in Japan. We chose 5 stations for the following analysis because the other 6 stations seem to be obviously effected by ground level changes caused by excessive use of underground water or crustal movement. The principal component analysis is carried out for the annual mean sea level of the 5 stations. Figure 2 shows the time-series of the principal components. Each of contribution rates has the same signs and ranges from 0.4 to 0.5. This result does not indicate a tendency of sea level rise like the global mean sea level as reported in IPCC.

Figure 3 shows the result of the same analysis for the annual mean sea level of 26 stations since 1955. Regarding the mean sea level variation since 1955, the result seems to reveal the tendency of about a 2mm/year increment but further analyses are needed to confirm what the sea level change means, a gradual sea level rise or a cyclic variation with several decadal scale.

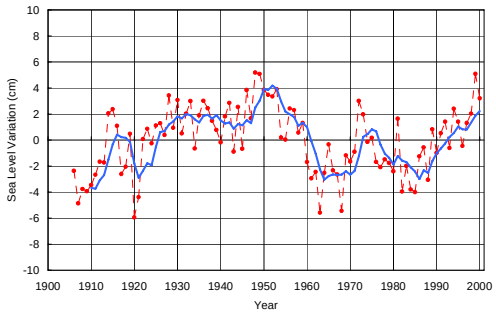

Figure 2: the principal component of sea level variation of 5 stations.
Thick line means 5 years moving average.

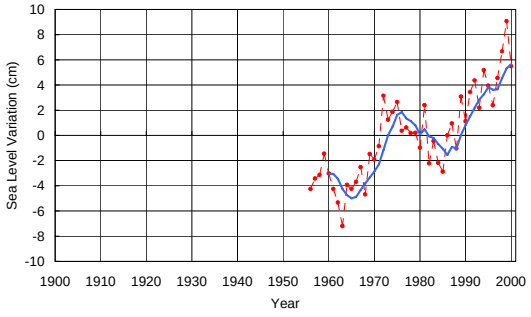

Figure 3: the principal component of sea level variation of 26 stations since 1955.