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Response of the Japan Sea to synoptic atmospheric forcing

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Synoptic atmospheric forcings drive the variations of flow and sea level of the semi-enclosed Japan Sea. The sea level response of the Japan Sea to synoptic pressure forcing lags behind inverted barometer because of the large drag in and around the shallow straits. Our analysis of sea level data at tidal stations around the Japan Sea reveals that the barometric response lags proportionally to the distances from the Tsushima or Tsugaru Straits. A numerical simulation shows that the barometric response has zonally asymmetric patterns of amplitude/phase in the Japan Sea. The response amplitude is larger (smaller) than 1 cm/hPa in the eastern (western) part of the basin. The phase lag takes the maximum near the central region and gradually becomes small in the eastern/western part of the basin. The simulated response is in good agreement with the analyzed response at each tidal station. It is found that the zonal asymmetry arises from the eastward traveling pressure forcing with the wavelength larger but not much larger than the spatial scale of the Japan Sea. Our numerical experiments also show that the growing low pressure systems generate the large phase lag in the western region of the Japan Sea. On the other hand, the wind forcing associated with synoptic system drives the water budgets through the straits and changes the mean sea level of the basin. The numerical simulation suggests that the water exchange through the Tsushima Strait contributes the main variation of the mean sea level due to the synoptic wind forcing. It is also suggested that the wind-driven transports through the Tsugaru and Soya Straits are mainly caused by the sea level difference between the Japan Sea and the Pacific or the Sea of Okhotsk. The transports due to the sea level difference seem to have larger variability than those driven by local wind stress. A simple

estimation based on Toulany and Garrett (1984) or Wright (1987) well accounts for the lags of the transports through the Tsugaru and Soya Straits behind the mean sea level in the Japan Sea.