# 論文の内容の要旨

論文題目:

**Intraseasonal Oceanic Variations in the Southeastern Tropical Indian Ocean**

**(インド洋熱帯域南東部における季節内変動)**

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The intraseasonal oceanic variations in the southeastern and equatorial Indian Ocean are examined using both observational data and simulation data from a high-resolution ocean general circulation model developed for the Earth Simulator (*hereafter* OFES). Along the southern coast of Sumatra and Java, analysis on *in-situ* sea level data and TOPEX/Poseidon satellite altimetry data reveals intraseasonal variations of two distinct time-scales: 20–40 days during boreal summer and 60–90 days during boreal winter. During boreal summer, the shorter time variations of the sea level along the coast of Sumatra and Java are traced back to the eastern equatorial Indian Ocean; this indicates the importance of the remotely forced equatorial Kelvin waves. During boreal winter, on the other hand, both the remote winds over the eastern equatorial Indian Ocean and the local alongshore winds are important in explaining the longer time variations of the sea level along the coast. Further analysis indicates that these intraseasonal variations are due to propagation of the coastal Kelvin waves with phase speed ranging from 1.5 to 2.86 m $s^{-1}$. A simple analytical model forced by daily wind stress confirms the above intraseasonal variations along the southern coast of Sumatra and Java.

On the basis of the above findings, ocean dynamics of intraseasonal variability in surface and subsurface currents off Java is explored using simulation data from the OFES. Within the intraseasonal time scale, the surface current, so-called the South Java Coastal

Current, shows significant energy at periods of about 25, 35, 50 and 90 days, among which the 90-day signal is dominant. On the other hand, in the subsurface current, which is referred to as the South Java Coastal Undercurrent, 60-day variations are the most prominent feature. A normal mode analysis demonstrates that the first baroclinic mode is the leading mode, which accounts for 70% of the total variance, whereas the second baroclinic mode explains 24% of the total variance. The 90-day variations in the South Java Coastal Current captured mostly by the first baroclinic mode are found to be primarily driven by winds. Those are associated with propagation of the first baroclinic Kelvin waves generated in the central equatorial Indian Ocean. On the other hand, the 60-day variations in the South Java Coastal Undercurrent enhanced by wind forcing over the eastern equatorial Indian Ocean off Sumatra are mostly capture by the second baroclinic mode.

On interannual time-scales, the intraseasonal winds over the equatorial Indian Ocean is modulated by a coupled ocean-atmosphere phenomenon in the tropical Indian Ocean, so-called the Indian Ocean Dipole (IOD) event. In the presence of the IOD event, the westerly zonal winds over the equatorial Indian Ocean are anomalously weakened or even reverse the direction, which leads to the absence of the equatorial jet and contributes to east-west zonal tilt of the equatorial thermocline. Using the output from OFES, the impact of the change in the background oceanic structure on intraseasonal Kelvin waves is investigated. The results show that characteristics of the intraseasonal Kelvin waves change during the IOD event. During the normal conditions without the IOD event, the intraseasonal Kelvin waves propagate eastward at phase speed of 2.01 m $s^{-1}$. The first mode explains about 40% of the total variance in the central and eastern basin, while the second mode explains about 30% of the total variance in the central basin. In contrast, during the 1997/98 IOD event, the fourth mode becomes dominant, explaining about 40% of the total variance in the central and eastern basin. Consequently, the phase speed is also significantly reduced from 2.38 m $s^{-1}$ in October – November 1997 to 0.93 m $s^{-1}$ in March – April 1998. During the 1994 IOD event, the contribution from the fourth baroclinic mode is significantly large in the eastern basin, reaching 50% of the total variance. In the central basin, the second and the fourth baroclinic modes explain almost the same variance (~40%). The phase speed changes from 0.91 m $s^{-1}$ in July – August 1994 to 1.21 m $s^{-1}$ in November – December 1994. The variations in the characteristics of the intraseasonal Kelvin waves are related to the variations in the vertical stratification. The presence of shoaled sharp pycnocline in the eastern basin during the IOD events accepts the wind forcing in a thin surface mixed-layer, allowing the wind forcing to project more preferentially onto the higher modes.

The impact of the IOD as well as ENSO on the intraseasonal Kelvin waves along the equator is further examined using a relatively new technique, called *self-organizing map* (SOM). The SOM analysis was able to give insight on the oceanic intraseasonal variations during the IOD events and the IOD co-occurred with ENSO events (*hereafter* IOD-ENSO events) in terms of the change in dominant modes of variability. The relative importance among various baroclinic modes during the IOD events and IOD-ENSO events is determined using the hit-repartition maps. In agreement with the wave decomposition results, the intraseasonal variations are mostly composed of the higher baroclinic modes during the positive IOD and the positive IOD-El Niño events. In contrast, the first mode tends to dominate the intraseasonal variations during the negative IOD and the negative IOD-La Niña events.