

Interactive comment on “Sea level trend and variability around the Peninsular Malaysia” by Q. H. Luu et al.

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Reviewer: This is a really interesting paper in which the authors have documented the Sea-Level Rise (SLR) rates around peninsular Malaysia using long-term sea-level data from tide gauges and also satellite altimetry data. While the monsoon circulation plays an important role in SLR at seasonal timescales, ENSO and IOD modulate the SLR rates at inter-annual timescales.

Answer: We thank the reviewer for his evaluation and comment.

Reviewer: However, even though long-term trends in SLR are given for various regions around peninsular Malaysia, I wonder to what physical mechanisms might these trends be attributed to. Are these trends purely resulting from thermal expansion of water due

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to global warming?

Answer: Primary contributors to the contemporary sea level trend are known to be the steric effect (changes in ocean temperature and salinity), eustatic effect (alternations in ocean volume including oceanic adjustment of glaciers and ice sheet melts, and changes in circulation) and other global/regional climatic events (such as ENSO, Pacific Decadal Oscillation and monsoons). Hsieh and Bryan (2006) pointed out that it is difficult to separate the relative influences of each component on the basis of the tide gauge records only. However, we can roughly estimate them around the Peninsular Malaysia from previous works (e.g., Stammer et al., 2013; Peng et al., 2013; Bamber and Riva, 2010) as follows. Contribution of steric effects (thermosteric and halosteric expansion of ocean water) to the sea level trend in the Peninsular Malaysia was estimated to be about 1.5 mm/year for the period 1993-2010 (Stammer et al., 2013). It corresponds to approximately 35% of the total sea level rise rate observed in this region for the same period. An alternative assessment for the eastern side of the Peninsular Malaysia conducted by Peng et al. (2013) exhibited the similar ratio. Contribution from ice mass losses to the sea level rise around the Peninsular Malaysia was roughly 1.5 mm/year for the period 2000-2008 (Bamber and Riva, 2010). This accounts for one third of the sea level rise, and is equally important as the thermosteric and halosteric components. The remaining one third may result from variability in the global and regional dynamics.

Reviewer: Also, the Walker circulation is projected to weaken in a warming planet. What is the role of these circulation changes?

Answer: The Walker circulation is widely known to modulate the lower atmosphere across the tropical basins of Pacific, Indian and Atlantic Oceans. It is associated with high sea level pressure in the east of equatorial Pacific and low pressure in the west, hence partly accounts for higher sea level along western Pacific coasts. Long-term changes in Walker cell thus may alter the sea level in influenced regions, including the marginal South China Sea. While this overturning circulation has been weakening

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since the nineteenth century (Vecchi et al., 2006); latest study employing more in situ measurements suggested that the Walker cell recently turn into strengthening episode (Qiu and Chen, 2011; L'Heureux et al., 2013). This strengthening probably caused the mean sea level along the western tropical Pacific coasts rising 3 times faster than the global trend during the observed period 1993-2009 (Qiu and Chen, 2011).

Reviewer: Is there a way to separate these different influences?

Answer: It is difficult to separate these different influences, say the thermosteric effect and Walker circulation strengthening, in the long-term sea level rise. For instance, the strengthen in Walker circulation not only increases the sea level height gradient along the equatorial Pacific toward the west, but also redistributes its upper-ocean water mass (Qiu and Chen, 2011). As warmer waters in the Warming Pool region carried westward and often intruded into the South China Sea through (mainly) the Luzon Strait (Qu et al., 2004), waters in the marginal sea may be mixed with the heats from two different sources, which is difficult to isolate. In summary, the reviewer's comment is interesting but beyond the scope of this study. There is a clear need for a dedicated study to quantify these contributions in regional sea level change.

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We appreciate the reviewer for his suggestions. The manuscript is revised accordingly to include relevant discussions.

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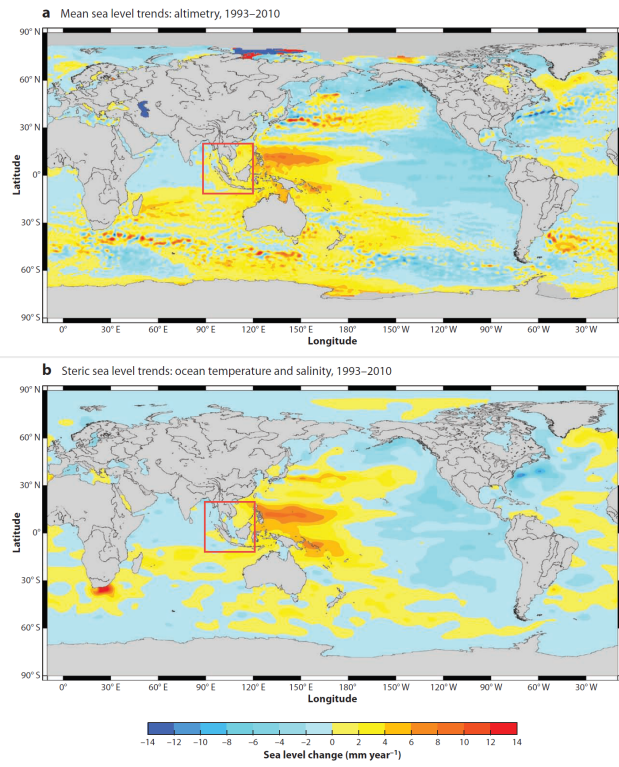


Fig. 1.

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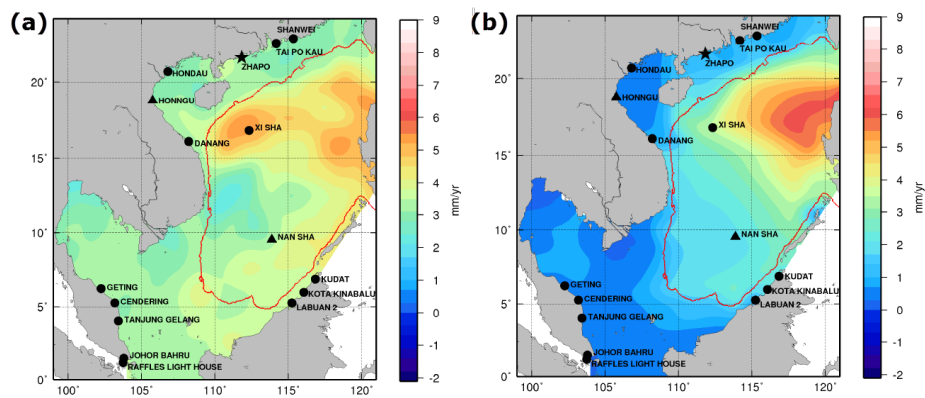


Fig. 2.

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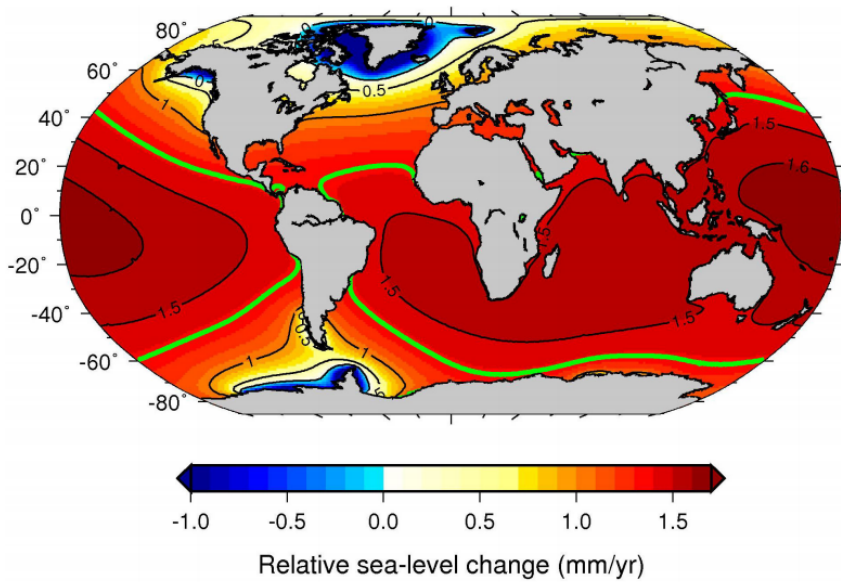


Fig. 3.

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