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Ocean Science Discussions

Interactive comment on "On the Indonesian throughflow in the OCCAM 1/4 degree ocean model" *by* U. W. Humphries and D. J. Webb

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As reported in the paper, when the model was forced by monthly winds, the transport through three of the northern straits (Makassar, Molucca and Halmahera) showed significant variability with periods between 5 and 7 cycles per year. We concluded that because the fluctuations are irregular they cannot be due to the local annually repeating winds. Instead we thought that they must be due to 'waves propagating through the ocean' which affected the northern straits but did not reach the southern straits.

Referee #3 requested more information about these 'waves', so we have looked at the data from the monthly wind run in more detail. As a result of this study we no longer think that the variability is due directly to propagating waves. Instead we think that the variability results from changes in the strength and position of the Mindanao Eddy and the associated current fields.

We first tried to identify propagating waves by first fourier transforming the model SSH and barotropic velocity fields and then plotting the phase of the 6 cpy component. This showed propagating features in an area extending from the Celebes Sea to the region south and east of Mindanao normally associated with the Mindanao Eddy. There were also propagating features SW of Sumatra and off Vietnam but these could not affect transports in the northern straits.

We also correlated the transport time series in the different straits with the SSH and velocity fields using a series of lags. With zero lag the background correlation field (i.e. in a remote area like the S Indian Ocean) has typical maximum values of +0.3 or -0.3. North of Indonesia, values of order 0.4 and -0.4 were found in the Celebes Sea, in the Mindanao Eddy region and, connected to this, in an extension to the east at 8 deg N where the Mindanao Current usually turns offshore.

At a lag of 15 days (the Throughflow transports calculated at a later time) the correlation in a small region to the east of Mindanao increased to 0.6 but by 30 days it had dropped to 0.4 and with greater lags it was back to the level of noise.

Additional information comes from fourier transforming the vertically integrated transport in each grid box of the model. In the Makassar Strait the resulting variance at 6 cycles per year has a maximum value of about 0.3 (Sv**2 per cycle per year through a 0.25 degree model interface). Values up to 0.6 are found in parts of the Molucca Passage and Halmahera Sea, a number of such boxes making up the section plotted in fig 4 of the paper. In comparison the Celebes Sea has values around 3.6 and values of 9 are found SE of Mindanao. Offshore values in the NE Pacific drop 0.01 but there is a band extending across the Pacific from Central America) with values of order 0.3.

Finally we investigated at the flow fields at times when the flow in the different channels changed rapidly. This showed that a drop in the Makassar transport was associated with the southward movement of the Halmahera Eddy and the westward movement of a second eddy in the Celebes Sea. Transport through the Halmahera Sea increased

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when the Mindanao Eddy was strong and in the south, but it dropped rapidly and reversed when the Eddy became elongated southwards to surround the Talaud Islands (Pulau Karakelong).

Unfortunately we were unable to carry out a similar study on the six-hourly run results because the main archive data set has been lost. However we conclude from these results that in the monthly wind run it is the variability of the energetic Halmahera Eddy and its associated currents which most simply explains the 5 to 7 cycles per year variability seen in the transport time series.

This does not explain why the transport variability was different in the run forced by six-hourly winds. If the wind is not involved then we would expect the transport variability to remain the same. However it is possible that relatively weak wind generated Rossby waves or other features are affecting the turbulent behaviour of the Mindanao Eddy. One feature that may be involved is the band of increased variability that spans the Pacific at low latitudes.

Interactive comment on Ocean Sci. Discuss., 4, 325, 2007.