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Ocean Science
Discussions

Interactive comment on “Tidal resonance in the Gulf of Thailand” *by* Xinmei Cui et al.

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The oceans and marginal seas around South-east Asia are unusual in that the diurnal tides are often much more significant than in the rest of the world’s ocean. In this paper the tides of the Gulf of Thailand are investigated to see how resonances enhance the tides of the region. The main result is that the high diurnal tides are not due to a resonance of the Gulf of Thailand but that they are probably due to a quarter wave resonance of the South China Sea. The paper builds on the model study of Cui et al (2015) but also includes an analytic 1-D model which supports the quarter-wave hypothesis.

The paper is well written and easy to understand and although I have some serious criticisms of the work I would like to commend the authors on the standard of their discussion paper.

Detailed comments

1. Abstract.

After reading the paper and that of Cui et al (2015) it seems obvious that it is the South China Sea which is responsible for the resonance. Thus changing the depth of the South China Sea changes the frequency of the resonance (fig 2) and the analytic resonance around 1 cy/day comes for the cos(beta_1 L_1) term in the equation on line 159. However the abstract says that the resonant period of the Gulf of Thailand is itself close to 1 cycle/day - which is incorrect.

It would be more correct to say that the South China Sea and the surrounding sea together have a resonance around 1 cycle/day which is primarily due to the South China Sea having very close to a quarter wavelength standing wave at this frequency. Although the Gulf of Thailand does have a large amplitude response around 1 cycle per day the results indicate that this is just a passive response of the Gulf to the increased amplitude of the main South China Sea wave along the Gulf’s southern boundary.

2. Lines 19, 22, 24

It would help if the geographical features Taiwan Strait, Mindoro Strait, Balabac Strait and any others referred to in the text were were included in figure 1.

3. Line 32

In some parts of the literature there is a tendency to refer to resonances in terms of their period. However because the angular velocity of resonances (or their frequencies) often form an arithmetic series corresponding 1/4, 3/4, 5/4, etc wavelengths I would recommend replacing periods here by angular velocities (or frequencies), possibly with the periods in brackets for those that need them.

4. Line 47-48

It is not that the resonant periods are related but that the two features are parts of the same resonance, the angular velocity of the resonance being determined primarily by the physical properties of the South China Sea.

5. Line 72: The Numerical Model

It is only in the code availability section that you say that you use the Princeton Ocean Model. I think this needs to be mentioned earlier in the paper as there are many types of ocean model of varying quality.

The Princeton Model is well known and is usually acknowledged to be of good quality. However it includes many options and parameters so, as in any other realistic model study, it is important to show that the version in use can realistically represent the actual tides in the region being studied. For this reason the paper needs an example of the model K1 (and/or O1) tides of the region and comparison with actual tidal observations either in the form of a chart or in the form of comparisons at key tide gauge positions. I realise that Cui et al (2015) did not do this, but if I had refereed their paper I would have made the same point.

You could also do with a figures showing the flux of tidal energy for both the realistic K1 tidal forcing and with a constant amplitude on the boundary as in your test experiments, to show that the main influx of tidal energy is through the Luzon Strait. If you do not do this it is possible that your analytic model which is based on this assumption is not valid.

6. Line 72: Boundary Condition

More information is needed on the boundary of the model. The domain described in the text seems to be similar to Cui et al (2015) which makes me suspect you used the same code in the same configuration. However the other paper shows a southern boundary south of the Equator, whereas according to your text the present one is north of the Equator. Why the difference?

Figure 1, which the caption calls the study area, shows only part of the model domain.

Why is this? When I first read the introduction and saw this figure, I assumed that this included the model domain with say Luzon Strait as an open boundary and the regions you described as having negligible fluxes as closed boundaries. Your need to make the difference clearer earlier in the paper.

You say that the northern and eastern boundaries as set well away from the South China Sea to limit the effect of the (fixed) boundary condition on the resonances of the South China Sea. However what about the boundaries to the south and east?

6. Line 64 and 80-90: Real and complex variables

Analysis of waves and oscillating systems tends to be a lot neater and easier to understand when the physical wave is treated as the real part of a function of the type A(x) exp(-i omega t) where A is a complex number and 'i' is the complex i. Then your G and phi are just the amplitude and phase of a complex response function. The appendix would also be a lot shorter if you used complex variables whenever possible.

7. Lines 94-96

This is a bit of a mess and needs to be rewritten. From Cui at al. (2015) you know that there are resonant like features which affect both the Gulf of Thailand and the South China Sea. We know that if the Gulf of Thailand was removed, changing the depth of the South China Sea would affect its resonances. Thus what you are really doing here is to see how much changing these resonances affects the resonances of the combined system. (You could have also carried out runs with changed depths in the Gulf of Thailand - in fact I am surprised that you didn't).

What you are not doing here is finding out how the resonances of the South China Sea are affecting (i.e. changing the shape and frequency of) the localised resonances of the Gulf of Thailand.

8. Line 100- : The Results

The paper does not specify the geographical location used for figures 2a and 2b.

The three SCSB peaks referred to in table 1 refer to the three main peaks of fig 2a. Changing the depth by a factor of 2 seems to change the frequencies by roughly sqrt(2), but this is not discussed.

Expt 3 shows a second resonance near 1 cycle/day which also seems to have an effect in fig 2b. Changing the depth of the South China Sea will change the frequency of resonances but will not generate new ones. So what is this feature of the South China Sea affecting the Gulf of Thailand?

In the case of fig 2b, representing the Gulf of Thailand response, there are indeed three main peaks matching the peaks in the South China sea plot - but there is also a lot else going on, especially in expt 1 and 2. What resonances are these?

It should help if the paper illustrated the amplitude and and phase of key resonances. The simplest solution would be to give the amplitude and phase of the solution when forced at the frequencies of the peaks in the response function. A better alternative would be to fit the (complex) response function R(x,w) at a set of w's around each of the resonance peaks to the equation A(x)/(w-w0) + B(x) + C(x)*(w-w0) Where A, B, C, w0 are complex, x is position, w is the (real) angular velocity of the forcing and w0 the estimated (complex) angular velocity of the resonance. A(x) would then be a better approximation to the amplitude and phase of the true resonance.

Following the changes, the conclusions to this section need to be rewritten.

9. Line 128

Semantics - the theory is 'applicable' to the Gulf of Thailand but does not explain the enhanced tides around 1 cycle day (although it might explain an enhancement if forced at 2 cycles/day).

10. Lines 147-160

It would be best if most of this was kept in the appendix. All you really need is eqn 15 and the approximation when r*p_1/p_2 is small.

11. Lines 165-185.

I think this needs a little more thought. You should be able to show that the resonances near 0.5 and 2 cycles per day are resonances of the short channel (where cos(beta_2 L_2) is zero) and the one near 1 cycle per day is a resonance of the long channel (where cos(beta_1 L_1) is zero). Then friction reduces the amplitude of the shallow short channel resonances but has little effect on the amplitude of the long channel resonances except within the shallow channel.

12. Lines 189-195

I suppose my main point here is that the diurnal resonance affecting the Gulf of Thailand in not 'closely related' to that affecting the South China Sea. Instead it is exactly the same resonance.

13. Appendix

This seems a bit long for the content. I suggest that you cut it down in size, trying to make it more elegant and leaving out some of the obvious steps.

14. !!

I know it is bad form but I was asked to review this paper because I have worked on tidal resonances. The authors may not be aware of the following papers but they may provide a more understandable background to some of my comments above: https://nora.nerc.ac.uk/id/eprint/271197 https://www.ocean-sci.net/10/411/2014/

Regards,

David Webb.

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