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Ocean Science Discussions

Interactive comment on "Co-existence of wind seas and swells along the west coast of India during non-monsoon season" *by* R. Rashmi et al.

Anonymous Referee #2

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Within this paper, an analysis of three wave temporal series collected during non-monsoon season at three different points along the Western coast of India is presented. The analysis consists in (i) separating wind waves and swell from observed directional wave spectrum, in (ii) estimating the predominance of each class of waves and (iii) fitting a formula relating wind speed to significant wind sea wave height and peak period. Technically speaking, the methodologies employed are not new. However, their application to these wave data allows gaining a better understanding of the wave dynamics at three locations along the Indian coast. The overall paper is well written although the paragraph "results and discussion" should be reorganised to gain clarity.

General comments:

The results presented in the paper offer a description of wave conditions for different locations along the western Indian coastline. The authors draw strong conclusions about the wave climate during non-monsoon season. However, these conclusions need further investigation. I wonder whether the selected periods of measurements are representative of the actual wave climate. Are three months of measurements sufficient to characterise the climate of wind waves and swell? Moreover, observations at one location are assumed to be representative of the entire western Indian coastline. That is an important assumption, given the distance between the three considered locations. Is there any evidence that could confirm this assumption? Eventually, a last comment, which is probably out of the scope of the current study, would concern the tidal effect on waves at locations where the water depth is 15m. A spectral analysis of the significant wave heights and peak periods would be beneficial to exhibit the diurnal and/or semi-diurnal effects on waves.

The present paper does not present a wave climate study of the west coast region, and rather, it discusses the co-existence of wind seas and swells along the west coast of India during non-monsoon season only. Wave data (off Goa during May 2005, off Ratnagiri during Jan-Feb 2008 and off Dwarka during Dec 2007-Jan 2008) had been collected in different years during non-monsoon season which is fairly a calm weather season along the west coast of India. As wave conditions of these three locations are season dependent, we can assume that these are the representative locations for the central and northwestern part of west coast of India. We have not studied the effect of tides on waves, as we are dealing with measured data, in which all shallow water effects are already taken care of; of course we need to include the effects of bottom topography, currents, tides, etc when we do wave modelling.

Specific comments:

1. Page 3100, I would recommend to remove the "cos2s(theta/2) " (l.19), E* (l.24), X* (l.25), fp* (l.25), unless they are defined. At the end of the paragraph "results and discussion", a relation between non dimensional energy and non dimensional peak period is presented. Is it possible to find a similar relation between the dimensionless fp and X*, to compare with the one stated in the literature review from Kahma (1981).

The sentence related to "cos2s(theta/2)", E*,X*,and fp* has been removed. It is possible to find a relation between the dimensionless fp and X, but it cannot be compared with the Kahma (1981) equation because we have used the same equation for the estimation of fetch, and we can expect the same results.

2. Sentence "As the situation is similar. . ." (Page 3101, line 1 to line 2) states a method used by the author to estimate the fetch. I recommend this line to be moved at the end of paragraph "Data and Methodology", and some explanation about this method should be added.

The above sentence has been removed from the introduction and moved to the Data and Methodology. The method is explained in the section "Data and Methodology".

3. On page 3101 Line (22), shamal swells could be described in more details, for non-specialists of the Arabian Sea. Moreover, I would recommend these events, if they took place during the measurements, to be represented on the temporal series presented on Fig.2 and on Fig.3.

The description about the shamal swells is added. The explanation is as follows:

Shamal swells (NW swells) (Aboobacker et al., 2011a) are generated in the NW Arabian Sea due to strong shamal winds during winter shamal events (November to March), which occur during post-monsoon and early pre-monsoon seasons. They propagate in the Arabian Sea influencing the west coast of India significantly. These events are included in Figures 2 and 4.

4. Variables Hs, Tz are introduced. They are usually considered as integrated wave parameters computed from the total wave spectrum. Here, I found odd the notation Hs(f) and Tz(f). I would recommend to remove eq (1) and (2) and to only keep eq. (3), although ksi is not a function of f, but of fl and fu. Moreover these equations are for unidirectional wave spectrum. Since the authors collected directional measurements, I wonder what was done to the directional information. I would appreciate that the authors state if any preprocessing have been performed prior computing eq (3).

The eqns (1) and (2) are removed. Even though, the directional wave spectrum is available, we have just used the 1D spectrum because, the available partitioning methods (e.g.: Gerling, 1992; Wang and Hwang, 2001; Portilla et al., 2009) primarily involve separation of wave spectrum into two frequency bands, low-frequency band representing swells and a high-frequency band representing wind seas. However, multidirectional peaks within the divided spectrum (swell or wind sea part) are usually merged, irrespective of the direction of each peak. The distinction between wind sea and swell is often not obvious. Under changing winds (both magnitude and direction) wave systems can overlap in the frequency direction domain, which are difficult to identify by automated procedures.

For the separation of swells and wind seas, we have used 1D spectrum. But, for comparing the directions of swells and seas separately, we used 2D spectrum. No pre-processing of the data has been done prior to computing the seas and swells, using the steepness algorithm.

5. I wonder how good equations 3 and 4 are to estimate fs in case of more than two peaks in the wave spectrum, as it is the case on fig. 5a and Fig.6a.

In reference to 1D identification methods, attention is given to two widely used methods, namely, the steepness method used operationally at the National Data Buoy Center (NDBC) and the Pierson–Moskowitz (PM) spectrum peak method.

Gilhousen and Hervey (2001) indicate that the steepness method of Wang and Hwang (2001) overestimates wind sea under certain conditions. They replaced the separation frequency eqn. by $f_s = 0.75\ f_m$ and introduced an extra mechanism similar to the one of PM spectrum to complement the algorithm.

Also, we have compared the Wang and Hwang (2001) and Gilhousen and Hervey (2001) methods and found that Gilhousen and Hervey method as suitable for the west coast of India.

6. On page 3104, eq. (7), the peak frequencies for swell and wind sea are introduced. How are these peak frequencies computed? If the method of maximum is considered, have the authors found the method to be stable?

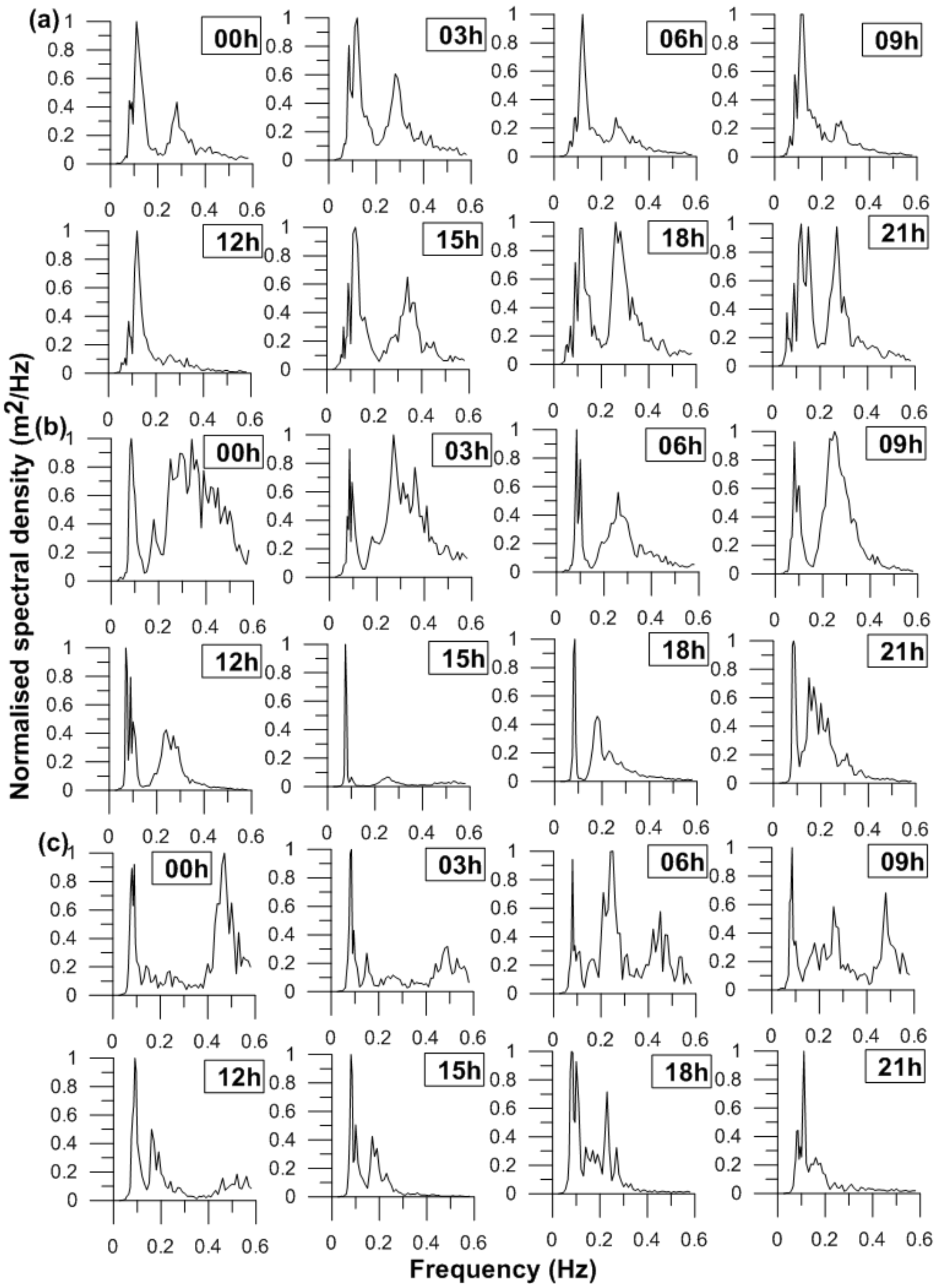
Yes, we have calculated the peak frequencies for swell and wind-sea through method of maximum in the swell and wind sea part of the spectrum. As per the definition the peak frequency is "the frequency associated with the maximum wave energy, determined from the wave spectrum". We found that the method is stable because we have done the sensitivity tests between the different partition methods and found Gilhousen and Hervey (2001) method was suitable for the west coast of India.

7. For readability, section "results and discussions" should be subdivided. I propose the following subsections: diurnal variability, relative importance between swells and wind waves, waves directionality, swell age, fetch analysis. These subsections could be done for each location individually and eventually a latter section could summarise the comparison between locations and seasons.

Results and Discussions section has been subdivided into subsections as suggested by the reviewer. Under each subsection, the characteristics related to each location is explained, and further, wave characteristics are compared between the locations and seasons, separately.

8. On Fig.2, the diurnal variations are present at each location. However, the authors state that at some locations (or for some seasons) these variations are more or less significant. A more quantitative comparison would beneficial. Could the authors consider a spectral analysis of the temporal series?

A new figure (Figure 3) is added, representing the spectral analysis of diurnal variations at each location is given below.



The description related to the figure is as follows:

Due to interaction of the multidirectional wind seas of varying magnitudes in the frequency domain with co-existence of swells during post-monsoon and early pre-monsoon seasons, we does not find systematic diurnal variability both in wave height and wave period, that is, increase in wave height and decrease in wave period with increase in wind speed.

9. What is the water depth on Fig.2? Fig.2 is used to explain the statement line 1 to 4 on page 3106, although this figure only represent the temporal series at one particularly water depth.

In Figure 2, measurements were carried out at the following depths: off Goa: 25m; off ratnagiri: 35m; off Dwarka: 30m. The sentence is removed from pg. 3106 and included under the subsection "Relative importance between swells and wind seas".

10. From the SSER, it appears that at the point Ratnagiri waves behave with water depth differently when compared to the two other locations. At Goa and Dwarka, swell importance increases as the water depth decreases and inversely the wind sea increases with water depth. At Ratnagiri, this behaviour is not apparent. Is this related to the numbers of peaks in the wave spectrum (page 3107 line 24) and the methodology used for spectral separation? At least this difference should be highlighted in the conclusions.

Off Goa and Dwarka, swell height increases as the water depth decreases; on the contrary, wind-sea increases with water depth. Whereas, off Ratnagiri, this behavior is not found because, the interaction between the multidirectional swells from SW and NW are almost perpendicular to each other. Also, we find that as the wave propagates towards the coast, wind seas are increasing. This behaviour is independent of number of peaks present in the spectrum.

11. On Fig.8, the authors plotted the function from eq. 9. Since the x-axis and y-axis are the same on the three panels, the line, representing eq. 9, should be the same in these three panels.

Equation 9 is a resolved eqn, after the best fit between log (Hsws*) and log (Tpws*). This eqn is valid for all the three locations.