

## ***Interactive comment on* “Influence of winds on temporally varying short and long period gravity waves in the near shore regions of Eastern Arabian Sea” by J. Glejin et al.**

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We would like to thank both the referees for their constructive comments. Responses to referee comments are given below.

Response to comments of Referee #1

Objective of the present work is to study the impact of winds on wave climate over the eastern Arabian Sea during an annual cycle. Swells play an important role in the air sea interaction and climate change. Most of the earlier studies on waves around this location are restricted to either seasonal or time bound studies for short period within an annual cycle. We used wave data with a high temporal resolution of 30 minutes

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throughout the annual cycle to get accurate values about temporal variation of wind sea maximum over a day rather than the data at three hourly intervals used in the previous studies. We also classified waves based on the peak period to identify the variation of long period, intermediate and short period waves in the eastern Arabian Sea. The study also identified observational evidence for the propagation of long period southern ocean swells to the nearshore areas of eastern Arabian Sea through the Indian Ocean basin.

As suggested by the referee “multipeakdeness of spectra is due to sea and swell” is removed from the conclusion section. Also we added more about the findings in relation to previous works in the results and discussion section.

#### Response to comments of Referee #2

The impact of winds on wave climate over the eastern Arabian Sea during an annual cycle is studied in the present work. The waves studied are the resultant of the interaction of swells with different kinds of wind system (light wind during the pre and post monsoon seasons and strong wind during the SW monsoon over the Arabian Sea). We used wave data with a high temporal resolution of 30 minutes over the annual cycle to get accurate temporal variation of wind sea over a day rather than the data at three hourly intervals used in the previous studies. Present study also identified observational evidence for the propagation of long period southern ocean swells to the nearshore areas of eastern Arabian Sea during the strong SW monsoon season. Long period waves observed are minimum during the SW monsoon season due to the dissipation of swells in strong westerly winds associated with the SW monsoonal winds over the tropical zone in South Indian Ocean.

As suggested by the referee now we have included and discussed the findings of our study in relation to previous work in the results and discussion section.

Reply to the specific comments are given below.

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Comment

1, Abstract, page 3022 line 15 and 3024 line 2: “wave induced wind regime” and “wave generated wind” are changed to “wave driven winds”. This term is used by Semedo et al. (2009) to explain the influence of fast moving swells on winds and generation of wind jet near the surface due to the subsequent momentum transfer from swells to the marine atmospheric boundary layer (MABL).

2, Abstract, page 3022 line 15 & page 3028 line 19: “indicates” is changed to “reflects”.

3, Introduction page 3023 line 20: blowing is removed and changed to “A general wave condition in Arabian Sea during the pre monsoon period also depend on the swells from far north-west Arabian Sea because of the north westerly Shamal winds (Aboobacker et al., 2011)”.

4, page 3024, lines 2-3: Hanley et al. (2010) is added as the reference for the definition of inverse wave age.

5, section 2 page 3024, line 18: The measurement location is now presented in degree, minute and second and the decimal places for the second are now removed.

6, section 3 page 3027 lines 3-5: Yes, we mean that maximum wave period is due to the presence of long period waves when land breeze is maximum. During the sea breeze, the mean wave period decreased due to the domination of wind sea. So the sentence is changed to “The influence of longer period swells over the region is high during the strong land breeze period between 06:00 - 09:00 UTC (Fig 3) and resulted in maximum mean wave period”.

7, page 3027 lines 5-6: it is observed that increase in sea breeze speed is varying with decrease in wave period. The sentence is changed to "Hourly average of mean wave period indicates the co-occurrence of maximum sea breeze and decrease in mean wave period at 09:30 UTC and 12:30 UTC (Figs 3 and 4) during pre and post monsoon season”.

8, page 3027 lines 7-8: slight increase in time lag is observed during the post monsoon

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season than the pre monsoon season due to the decrease in sea breeze wind speed during the post monsoon season compared to the pre monsoon season. The estimated difference in time lag between pre-monsoon and post monsoon is 1-2 hours.

9, page 3027 lines 20-21: During the South West monsoon period, analysis shows that the observed wave period and wave height depend on the SW monsoonal winds over the Arabian Sea. During rest of the year, nearshore wave climate is independent of the seasonal wind system over the Arabian Sea. During the pre and post monsoon season, wave climate depend on the diurnal local wind system (sea breeze and land breeze) and the remotely generated swells over the north and south Indian Ocean and over the Southern ocean. So we changed the sentence as “During the summer monsoon (June - September), the land and sea breezes are weak and the swells dominates the eastern Arabian Sea. The mean wave period and mean wave height are different from rest of the year and both are dependent on the SW monsoonal winds”.

10, page 3027 lines 23-25: Calculation is made to estimate the maximum extent of wind sea generation area due to sea breeze during the pre monsoon and post monsoon season. During SW monsoon, the Arabian Sea is influenced by swells generated by the SW monsoonal winds. During the SW monsoon, influence of sea breeze and land breeze wind system over waves in the eastern Arabian Sea is not found.

11, section 3.2 page 3028 lines 6-7: Mixed wind wave regime is the transitional state and in this state both wind-driven wave and wave-driven wind can occur. During the summer monsoon, dominance of swell is observed within the mixed wind wave regime due to the strong SW monsoonal winds present during summer monsoon season over the Arabian Sea.

12, page 3028 line 18: No, only during the pre monsoon in 2010. It is clearly written as “pre monsoon in 2010 and post monsoon in 2011”.

13, page 3028 line 27: Sentence is changed to "This will induce a higher occurrence of inverse wave age in the range of -0.2 to 0 compared to the frequency distribution peak

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at 0.15 (Fig 6) during the pre and post monsoon season over the Arabian Sea without cyclones". The term 'Typical' is used to represent the seasons without cyclonic activity in the Northern Indian Ocean.

14, page 3028 line 25 to page 3029 line 1: Sentence is changed to "It is observed that the higher occurrence (frequency more than 0.15) of inverse wave age in -0.2 to 0 during the pre monsoon of 2010 and post monsoon season of 2011 are characterized by the presence of cyclonic activity over the Arabian Sea".

15, page 3029 lines 5-6: we used NCEP wind 2.5 x 2.5 degree grid at 6 hourly interval for the calculation of Inverse wave age. Since the interval is 6 hourly, the sea breeze and land breeze is not found in these data. Near shore regions along the eastern Arabian Sea is influenced by the locally established sea breeze - land breeze system during the pre and post monsoon period as noticed in the AWS data. So we revised the inverse wave age calculation without incorporating the relative direction between wind and wave as  $U_{10}/C_p$  and the sea state is classified (Table 1). The classification based on  $U_{10}/C_p$  show that the sea state is dominated by mixed wind wave regime (sea and swell) instead of swell dominated regime identified earlier based on  $U_{10} \cos\theta/C_p$ . The hourly variation of the wave height and period during the pre and post monsoon season indicate that the mixed sea state is dominated by wind sea. Inverse wave age calculation using the measured wave data with relative wave angle between wave and NCEP wind provides ( $U_{10} \cos\theta/C_p$ ) interaction between swells and near surface atmospheric boundary layer outside the area influenced by sea breeze land breeze system.

16, Section 3.3.1, page 3030, line 10: Fig 3 represents the hourly variation of mean wave period ( $T_{m02}$ ). Classification of waves into short, intermediate and long period waves are based on spectral peak period ( $T_p$ ). Spectral peak period is varying from 2 to 25 s. In order to avoid this confusion we have modified the caption of Fig. 3 as "Figure 3: Hourly variation of mean wave period ( $T_{m02}$ ) at Ratnagiri during 2011 in UTC". Y-axis title is also corrected as "Mean wave period" instead of "wave period".

17, section 3.3.2 page 3030, lines 23-24.: Sentence is corrected as “shifts the spectral peak period ( $T_p$ ) towards the intermediate range of 8-13 s”.

18, section 3.3.3, page 3031, line 6-7. Sentence is corrected as “The long period waves are a minimum during the southwest monsoon season due to the dissipation of long period swells by the strong NE winds over Tropical south Indian Ocean”. Ardhuin and Jenkins (2005) suggest that wind speed and wind direction relative to the swell propagation direction are the two most important parameters that control swell dissipation. Ardhuin and Jenkins (2005) is included in the reference list.

19, section 3.4 page 3031, line 13: Sentence is corrected as “the spectral energy and direction associated with the wave propagation represent the wave parameters of the near shore wave climate”.

Page 3031 line 23: Year is 2010 and is added in the revised paper.

20, conclusions page 3034, line 3 & line 5: Year of occurrence of the southern ocean storm during 2011 is included in the conclusion as “Swells propagated from the southern ocean during an event in 2011 is identified with a travelling time of 5-6 days to reach the west coast of India during the SW monsoon period with an unique direction of  $240^\circ$ ”. “the waves” are changed to “these waves”.

21, Table 2: As per the suggestion maximum wave height is moved left to put alongside with significant wave height in Table 2. Since we are presenting the wave characteristics of the region, the information on maximum wave height in different months are provided.

22, Figure 1 caption modified as “Figure 1: Study area showing the wave measurement location. The depth contours are in metres”.

23, Figure 2 Axis: X axis minimum value of significant wave height is changed to zero in figure 2.

24, Figure 3 Axis: Y axis minimum value of wave period is changed to zero in figure 3.

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Figure 3 presents the mean wave period ( $T_{m02}$ ). Hence it is not consistent with Figure 9 which provide the information on peak wave period ( $T_p$ ).

25, Figure 4 wind speeds: wind speed presented in Figure 2 is the wind speed measured using Autonomous weather station (AWS) from a coastal land based station. Values presented in Figure 2 are similar to the values reported by Pushpadas et al. (2010) for Goa region which is 160 km south of present study area. The value given (“Average wind speed during SW monsoon period is 9.8 m/s”) in the text (page 3023 line 21) is the values from NCEP data. The difference in value is due to the change in wind speed from ocean to land. In order to avoid confusion, this is mentioned in the revised paper.

26, Figure 5, 7 arrows: Figures (5 &7) are changed into wind speed contours and direction as unit vectors. Necessary changes are made in color shades, arrow length and writing to make the figures clear and understandable.

27, Figure 9: Plots are slightly enlarged and now presented upto 0.4 Hz, since the spectral energy density is negligible beyond 0.4 Hz.

Please also note the supplement to this comment:

<http://www.ocean-sci-discuss.net/9/C1430/2013/osd-9-C1430-2013-supplement.pdf>

Interactive comment on Ocean Sci. Discuss., 9, 3021, 2012.

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