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A Study on the Swell and Sea Characteristics Along the South West Coast of India During the Monsoon Season

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Introduction

- Swell and wind seas co-exist in open waters and are difficult to segregate.
- Existing partitioning algorithms either under estimate or overestimate swell.
- It is attempted to extract wind and swell sea information from the observed directional spectrum using Overshooting Phenomenon (OP).

Spectral partitioning

The wave spectrum as a function of frequency and direction (f, θ) is composed of both swell and wind sea components. The steps involved in partitioning swell and sea components are as follows:

1. **Convolution:** The measured spectrum is subjected to convolution described by

$$\hat{S}(f,\theta) = S(f,\theta) * K(m,n) \qquad (1)$$

where

- S and $\hat{S}$ are the measured and the convoluted 2D spectra.
- K is the convolution kernel, a constant matrix of size 3 (Hasselmann and Heimbach 1996) with one as their entries.

2. **Partitioning and combining:** The spectral peaks are traced by the method of steepest ascent (mountaineer scheme) and the spectral partitioning is carried out by combining the neighboring peaks (partitions) upon setting a threshold value.

3. **Filtering:** Partitions with negligible energy compared to that of the total spectrum are considered as noise and are filtered by fixing energy threshold.

4. **Fixing Partitions:** Number of partitions can be prescribed prior to step 1.

- If the number of partitions exceeds the prescribed number, steps 1-3 have to be repeated until it reaches the target number of partitions.
- The repeated convolution process may end up with blurred or indiscernible partitions(wave systems).

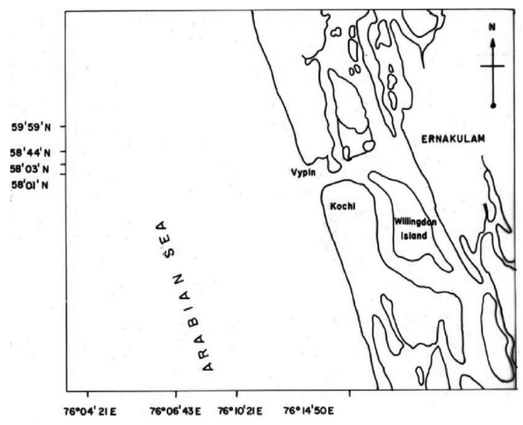
5. **Peakedness Phenomenon:** Following, Portilla et al. (2009) who proposed Peakedness or overshooting phenomenon (OP) which finds the ratio between the peak energy of a wave system and the energy of a PM spectrum at the same frequency, given by

$$\gamma^* = \begin{cases} \geq 1, & \text{wind sea} \\ \text{else}, & \text{swell} \end{cases}$$

- Theoretically, the value of $\gamma = 1$, indicates the fully developed wind sea.
- Obviously, the values larger than one indicates wind sea otherwise swell.

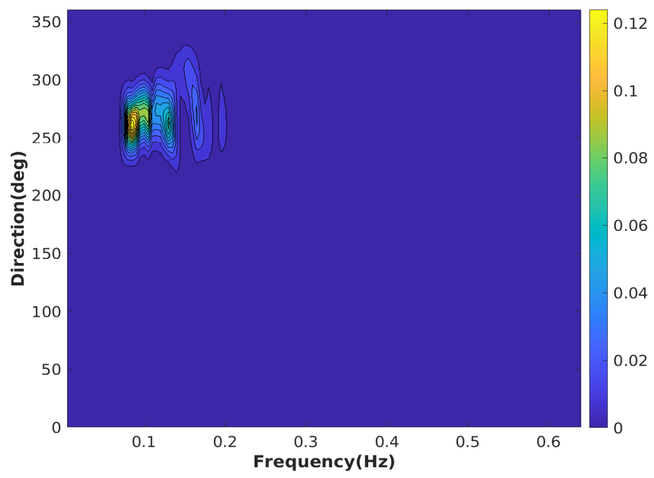
Observed spectra

The spectra from Directional Wave Rider buoy deployed at a water depth of 21 m observed during the monsoon season (Jun. 2016-Sept. 2016) off Kochi, along south-west coast of India in the Arabian sea, are used and analyzed.

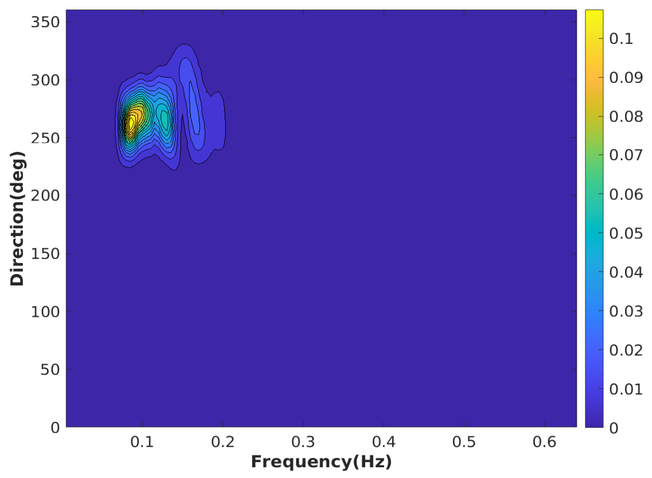


Off-Kochi.

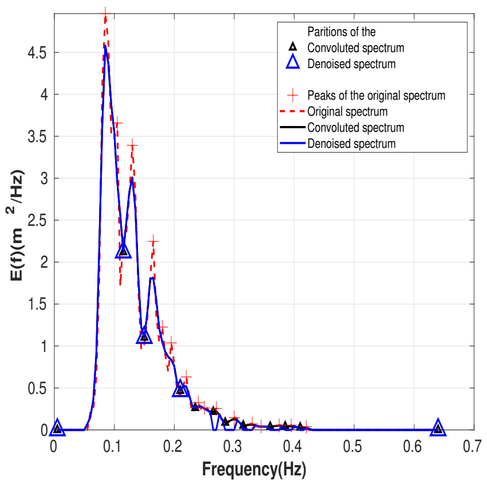
Results-Spectral partitioning



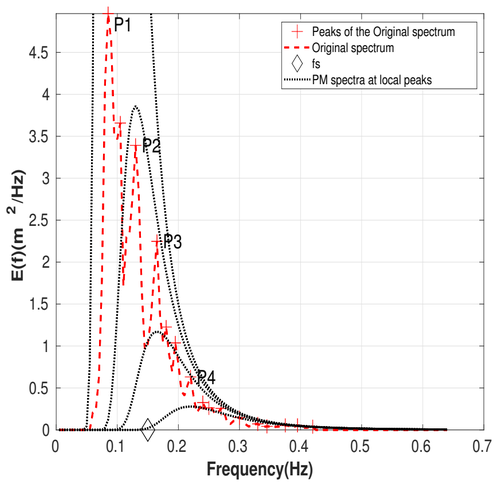
2D Actual directional spectrum at 1500 UTC 04 July 2016.



2D Convoluted spectrum.



1D partitioned spectra and their peaks.

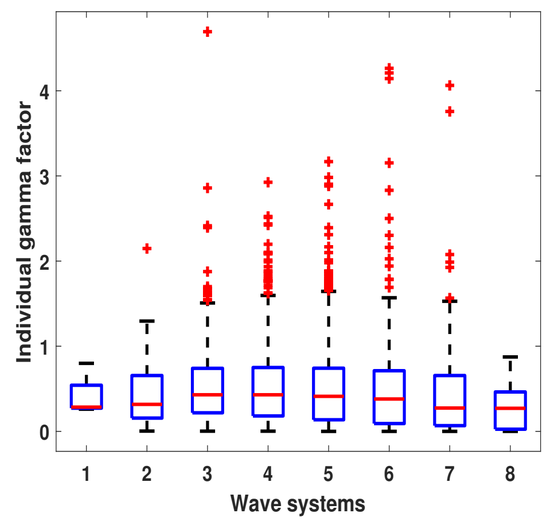


1D original spectra and PM spectra.

Wave systems	$H_{m0}(m)$	$E_p\ (m^2 s)$	$f_p(Hz)$	$\theta_m{}^\circ$
P1	1.58	4.96	0.085	263.2°
P2	1.18	3.39	0.13	270.5°
P3	1.07	2.24	0.165	273.3°
P4	0.70	0.63	0.22	251.8°
Overall	2.28	4.96	0.085	264.8°

Summary of wave systems parameters for the spectrum

Wave systems for the monsoon period



Wave system	No. of occurences
1	4
2	57
3	158
4	218
5	148
6	51
7	12
8	1

Conclusions

- A 2D convolution and a noise filtering procedure aiming to remove spurious peaks and to merge adjacent peaks are employed to the wave spectrum observed in the off-Kochi region, located along the south-west coast of India.
- OP enabled the wave spectra to be decomposed into individual wave systems representing wind seas or swells and thereby facilitating the computation of integral wave parameters of each partition