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The Effect of the South Asia Monsoon on the Wind Sea and Swell Patterns in the Arabian Sea

Alvaro Semedo (1)

(1) Escola Naval-CINAV, Lisboa, Portugal (milho.semedo@marinha.pt), (2) Uppsala University, Sweden

Ocean surface gravity waves have a considerable impact on coastal and offshore infrastructures, and are determinant on ship design and routing. But waves also play an important role on the coastal dynamics and beach erosion, and modulate the exchanges of momentum, and mass and other scalars between the atmosphere and the ocean. A constant quantitative and qualitative knowledge of the wave patterns is therefore needed.

There are two types of waves at the ocean surface: wind-sea and swell. Wind-sea waves are growing waves under the direct influence of local winds; as these waves propagate away from their generation area, or when their phase speed overcomes the local wind speed, they are called swell. Swell waves can propagate thousands of kilometers across entire ocean basins.

The qualitative analysis of ocean surface waves has been the focus of several recent studies, from the wave climate to the air-sea interaction community. The reason for this interest lies mostly in the fact that waves have an impact on the lower atmosphere, and that the air-sea coupling is different depending on the wave regime. Waves modulate the exchange of momentum, heat, and mass across the air-sea interface, and this modulation is different and dependent on the prevalence of one type of waves: wind sea or swell.

For fully developed seas the coupling between the ocean-surface and the overlaying atmosphere can be seen as quasi-perfect, in a sense that the momentum transfer and energy dissipation at the ocean surface are in equilibrium. This can only occur in special areas of the Ocean, either in marginal seas, with limited fetch, or in Open Ocean, in areas with strong and persistent wind speed with little or no variation in direction. One of these areas is the Arabian Sea, along the coasts of Somalia, Yemen and Oman.

The wind climate in the Arabian sea is under the direct influence of the South Asia monsoon, where the wind blows steady from the northeast during the boreal winter, and reverses direction to blow also steady but stronger from the southwest during the boreal summer months. During the summer monsoon the wind pattern in the north Arabian Sea is rather intricate, with a large scale synoptic forcing with a high pressure cell over the ocean and a thermal low pressure system in-land, but also with at least two low-level wind jets, the Finlater (or Somali) jet, and the Oman coastal jet. This wind pattern leads to a particular wave pattern and seasonal variability.

The monsoon wind pattern has a direct influence in the wave climate in that area, The particular wind-sea and swell climates of the Arabian Sea are presented. The study is based on the ERA-Interim wave reanalysis from the European Centre for Medium-Range Weather Forecasts.