Updated Oman Sea Hindcast

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Reliable wave information is essential to the design of any coastal facility and to the assessment of coastal processes, such as sediment transport. A detailed investigation of the wave climate on the Oman Sea coastline of Iran is being carried out in support of a comprehensive study of coastal zone processes (project MONITOR SB&B by PSO). The Oman Sea coast is subject to a complex wave climate with two distinct components: (1) seas that are generated in the Gulf of Oman and approach from a westerly to southwesterly direction; and (2) long-period swells that are generated in the Indian Ocean and approach from southerly to southeasterly directions. This paper presents preliminary results based on the work completed to date.

A twenty-five year hindcast of wave conditions in the Oman Sea and Indian Ocean will be completed using the Wavewatch III wave model. Wavewatch III, a 3rd generation wave model, was selected based on a recent comprehensive wave model comparison carried out for the Pacific Ocean (Hanson et al., 2006), in which it showed greater predictive skill than similar models, such as WAM. The overall model domain extended over the entire Indian Ocean with a 1.25° and 1.0° resolution in longitude and latitude, respectively. Within in this overall grid, a nested, higher resolution (0.25°) grid of the Oman Sea is employed.

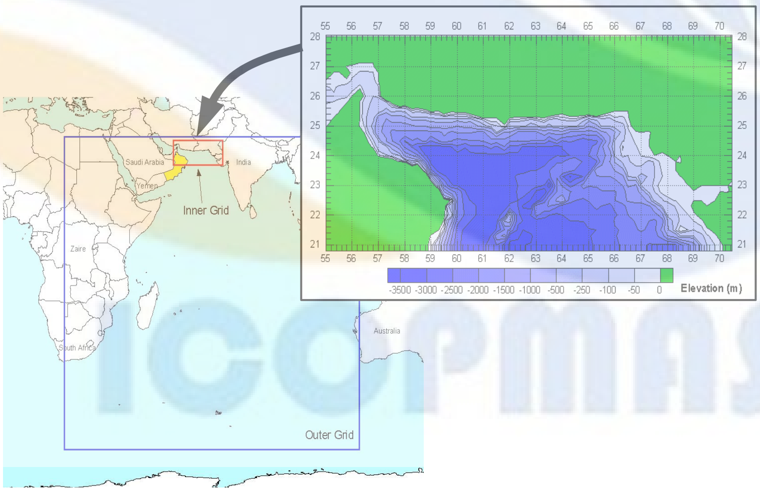

Figure 1 Wavewatch outer and inner model domains

Wind fields to drive the wave model are derived from a global atmospheric re-analysis model, statistically corrected through comparisons to QuikSCAT satellite scatterometer measurements of overwater wind speeds and directions. In addition, recorded wind data from Chabahar and Jask synoptic stations will later be blended into the overall wind field.

The following input parameters are assumed in the WAVEWATCH III model simulations:

- 24 directional bins (i.e. 15° directional resolution).
- 25 frequency bins using a logarithmic frequency distribution with a minimum frequency of 0.04177 Hz.
- Tolman and Chalikov (1996) source terms.
- Sub-grid representation of islands.
- Wind input at 6-hour intervals.
- Quickest/Ultimate third-order propagation scheme with Tolman averaging to alleviate Garden Sprinkler Effect.
- No bottom friction.

All other parameters are set to their default values.

Preliminary hindcast results were validated against both wave buoy data as well as through spatial comparisons of satellite altimeter estimates of significant wave height. The Chabahar buoy was a Waverider buoy deployed by Iranian Meteorological Organization outside of Chabahar Bay at a location east of Chabahar with 17 m water depth. The buoy was located at 25.267 ° N and 60.65° E. The buoy collected data from May 5th, 1998 to September 2nd, 2000 with occasional gaps. The buoy data are available in terms of representative wave parameters including significant wave height, peak wave period, mean wave period, mean wave direction and peak wave direction. Figure 2 shows the wave height rose. Waves at Chabahar predominantly arrive from SSE, S and WSW directions. Maximum wave energy comes from the south. Maximum wave height measured by the buoy was 2.1 m from the south. Joint distribution of wave height and peak wave period indicates that 70% of recorded waves had a wave period larger than 8 s (i.e. swell wave coming from the Indian Ocean). Only 26% of the recorded waves had a height over 1 m. About 44% of recorded waves were from S direction, 31% from SSE direction and about 15% from SW and WSW directions. Waves with periods larger than 8 s are mostly from S to SSE directions (swell), whereas shorter wave periods are frequently from WSW direction (local seas).

Deep water wave conditions offshore of Chabahar Bay were transformed into shallow water at the location of Chabahar Buoy using a simplistic approach (Snell's Law), and compared to the buoy data. Figures 3 to 5 show sample time series comparisons between measured and modeled wave height, peak wave period and peak wave direction. Generally, wave period and wave direction are very well predicted. Predicted wave height is also in reasonable agreement with the buoy data. Note that these are preliminary hindcast results before modification of the Oman Sea wind field. It is therefore anticipated that local seas may not have been well reproduced. In addition, offshore waves were transformed using linear shoaling and refraction theory to the buoy location. Later in this project nearshore wave transformation models will be used to transform offshore waves to the buoy location.

Looking at the wave period results in Figure 5 for example, it may be seen that the peak wave period between February 26 and March 1, 2000 decreases from 18 s to about 10 s. This is a typical result of dispersion of swell waves arriving from far distances. Longer period waves propagate faster and thus arrive first, followed by shorter period waves. Figure 5.15 is the quantile-quantile plot of the buoy data and the preliminary hindcast transformed waves. Smaller wave heights are slightly underpredicted, whereas larger wave heights are slightly overpredicted by the model.

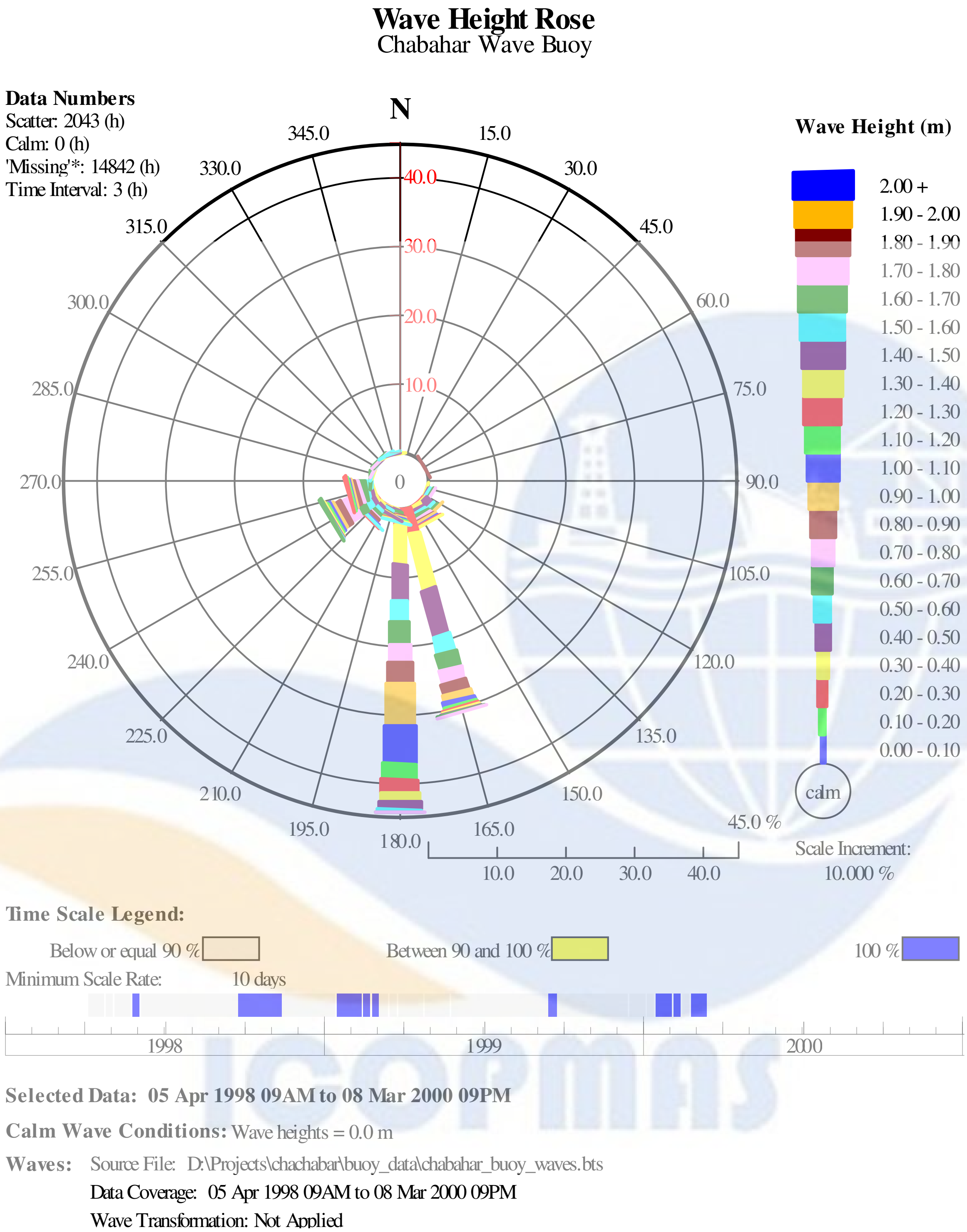

Figure 2 Wave Height Rose at Chabahar Buoy

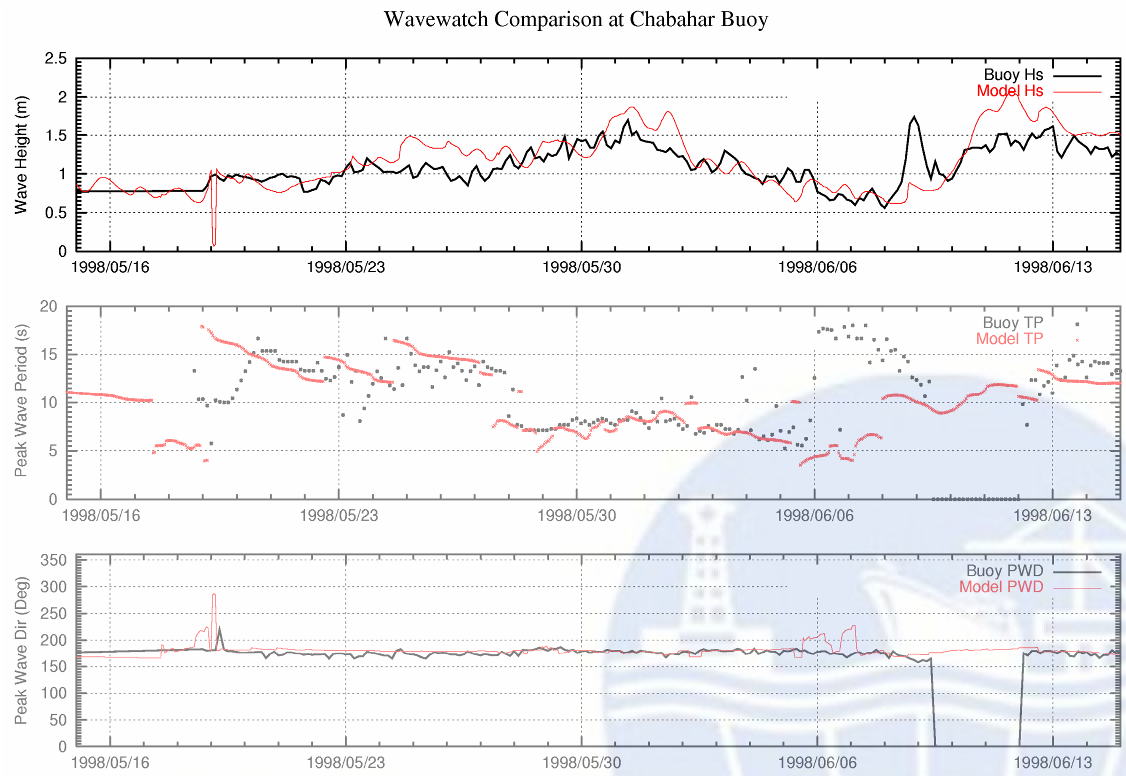

Figure 3 Time Series Comparison at Chabahar Buoy

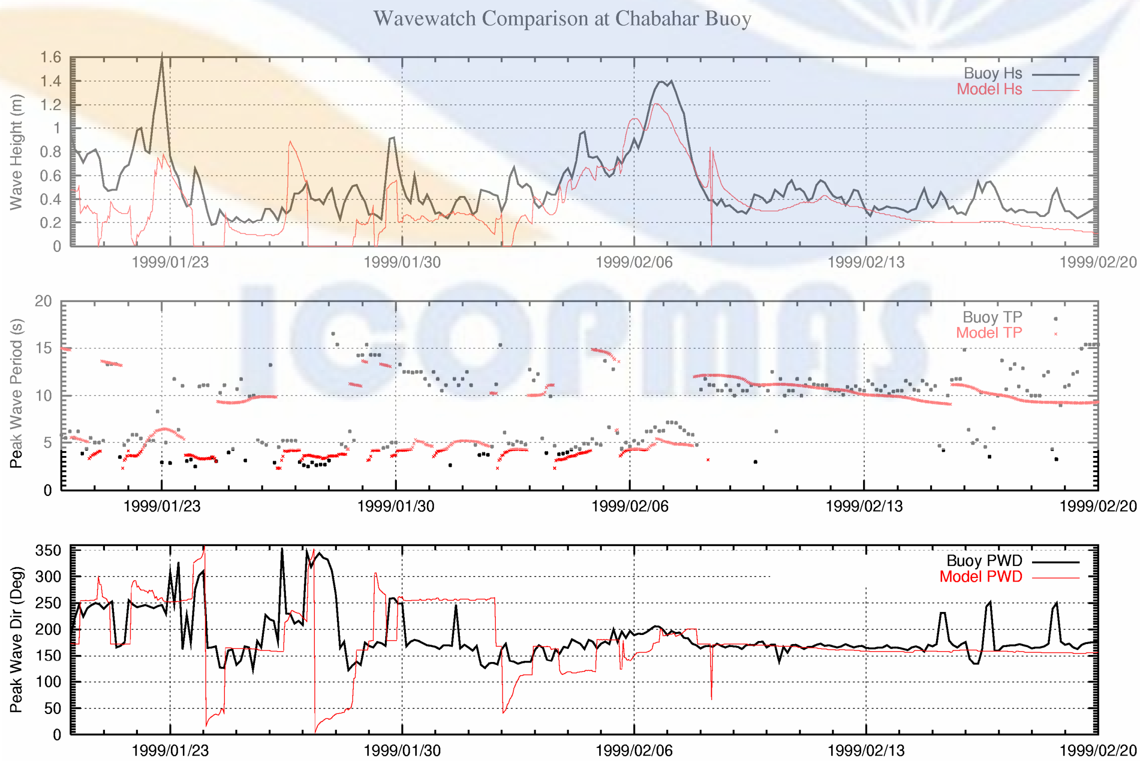

Figure 4 Time Series Comparison at Chabahar Buoy

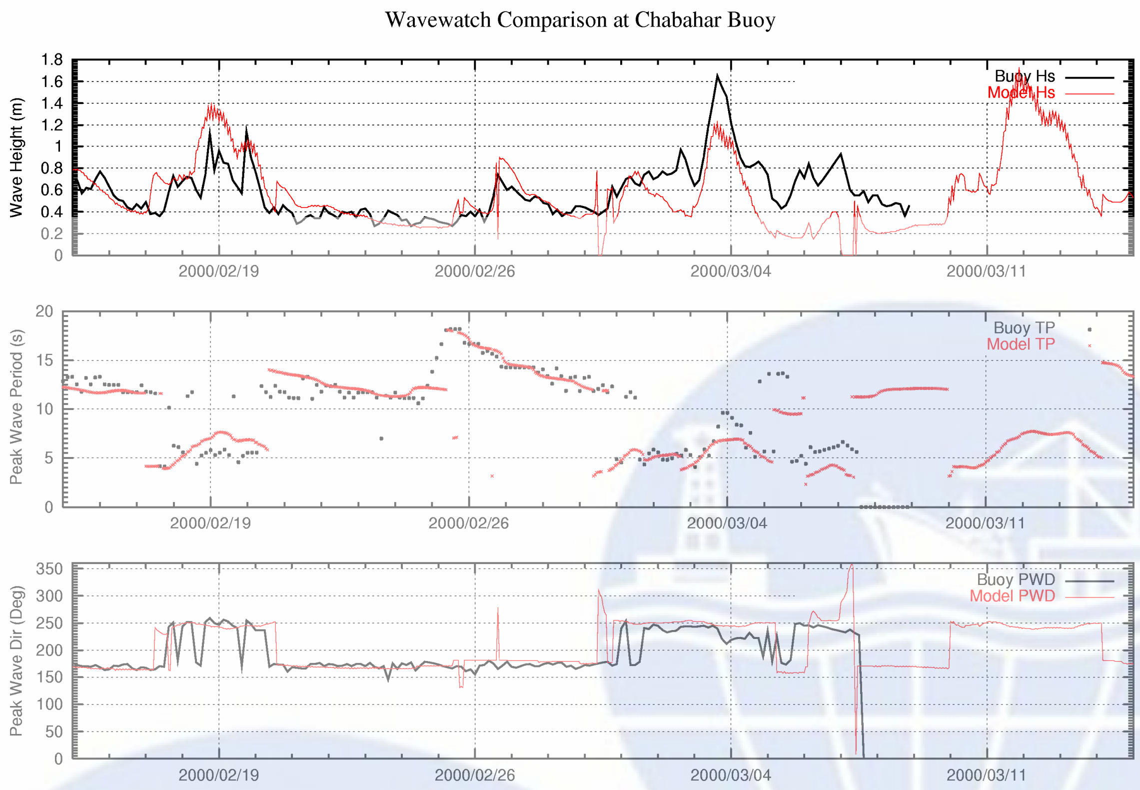

Figure 5 Time Series Comparison at Chabahar Buoy

The hindcast has so far been performed for the 1998 to mid-1999 period and two months in 2000. The results to date have shown excellent agreement in terms of reproducing Indian Ocean swells. Work is being carried out to refine wind fields over the Oman Sea through use of QuikSCAT satellite data and recorded wind data at Chabahar, Konarak and Jask, as well as from Seeb Airport in Oman. The long-term 1981-2006 hindcast will then be conducted.

Reference

Hanson, Tracy, Tolman and Scott. (2006). Pacific Hindcast Performance Evaluation for Three Numerical Wave Models. To be presented at 9th International Wave Hindcasting and Forecasting Workshop. Victoria, BC. September.

Tolman, H. L. (2002a) Testing of WAVEWATCH III version 2.22 in NCEP's NWW3 ocean wave model suite. NOAA / NWS / NCEP / OMB Technical Note Nr. 214.

Tolman, H. L. (2002b) User manual and system documentation of WAVEWATCH-III version 2.22. NOAA / NWS / NCEP / MMAB Technical Note 222.