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Local measurements and model wave data: complementary elements for large-scale climate assessment

Angela Pomaro, Luciana Bertotti, and Luigi Cavaleri
CNR-ISMAR Institute of Marine Sciences, Venezia, Italy (angela.pomaro@ve.ismar.cnr.it)

Multi-decadal time series of wave data needed for climate studies are generally provided by long term model simulations (hindcasts). Valuable as they are, these estimates are necessarily affected by the approximations involved within the modelling process.
On the contrary, multi-decadal observed time series are rare, but of course not exempt of problems. Local effects may prevent the identification of trends that are indeed present at large scale. Of course, where available for several decades, measured data are of great value for a number of reasons and can be valuable clues to delve further into the physics of the processes of interest, especially if considering that waves, as an integrated product of the local climate, can provide related compact and meaningful information.
The present study refers to the analysis of the 39-year long directional wave time-series recorded between 1979 and 2017 at the CNR-ISMAR (Institute of Marine Sciences of the Italian National Research Council) “Acqua Alta” oceanographic research tower, located in the Northern Adriatic Sea, 15 km offshore the Venice lagoon, on 16 m depth. The dataset is explored both to characterize the local average climate and its variability, and to detect the possible long-term trends that might be suggestive of, or emphasize, large scale circulation patterns and trends.
In addition, we take advantage of the availability for the area of interest of a 26-year long dataset of directional spectra (in frequency and direction), from the 3rd generation WAve Model (WAM) driven by the wind fields produced at the European Centre for Medium-Range Weather Forecasts (ECMWF), which offers an independent, but theoretically corresponding and significantly long, dataset at high resolution, allowing to penetrate the wave problem through different perspectives.
In particular, we investigate the contribution of the individual wave systems that modulate the variability of waves in the whole Adriatic Sea basin, by analyzing the spectra partitions. A characterization of wave conditions and storminess based on wave spectra in fact brings out a more detailed description of the different wave regimes, their associated meteorological conditions and their variation in time and geographical space (crossed sea conditions, distribution of energy on direction, etc.), allowing to explore large-scale atmospheric circulation patterns or weather regimes.
Hence we explore long-term trends of the relevant wave parameters in order to assess the possible correlation between the local scale and the general climate and use the measured data as long-term indicators of the its evolution, thus helping the overall understanding of models capability to reproduce the physical processes in a climate change perspective.