Regional meteo-marine reanalyses and climate change projections

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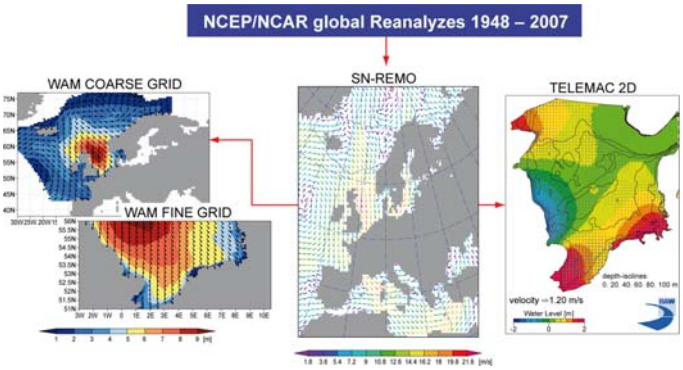
Summary

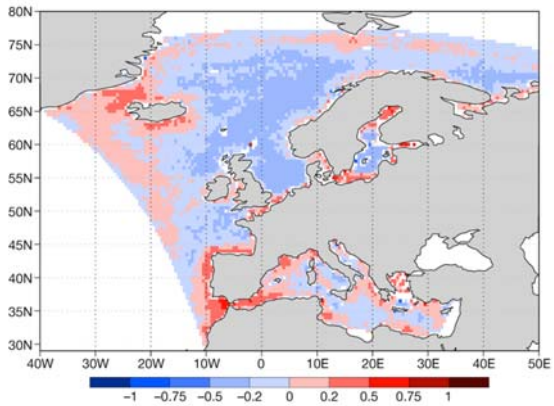
Coastal and offshore applications require appropriate planning and design. For most of them, statistics of extreme wind, waves, and storm surges are of central importance. To obtain such statistics long and homogeneous time series are needed. For marine areas, usually such time series are hardly available.

Global reanalyzes address these problems but remain limited for coastal applications because of their relatively coarse spatial grid size and their limited output frequency (often only daily or 6-hourly values are provided). Moreover, consistent information about wind waves or storm surges is missing. Some approaches for regional reanalyzes exist, greatly enhancing spatial grid size and output frequency but remain limited to the atmosphere.

Here we describe an effort to address these issues. It is commonly referred to as coastDat. The approach is based on generating consistent regional meteorological-marine data sets at high spatial and temporal detail by running a set of regional atmosphere, tide-surge and wind wave models finally driven by global reanalyzes. Eventually these are complemented with consistent climate change scenarios for the future. Data obtained from these exercises are integrated into a joint database referred to as coastDat available online at www.coastdat.de. Details are described in *Weisse et al. 2009, Regional meteorological-marine reanalyzes and climate change scenarios. Results for northern Europe and potential for coastal and offshore applications. Bull. Am. Met. Soc., 90, 849-860*.



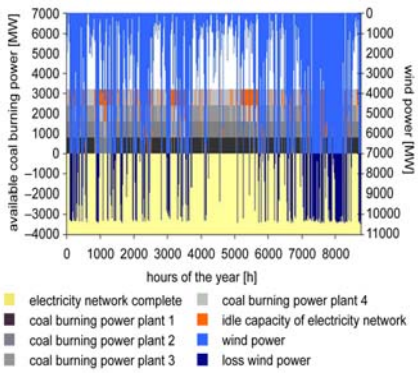
The figure shows the layout of the consistent meteorological-marine reanalysis for the southern North Sea as in 2007. A regional atmosphere model (SN-REMO) was driven by the NCEP global reanalysis. A simple data assimilation technique (spectral nudging) was applied to retain information about those scales in the global reanalyses that are supported by data assimilation. From this simulation (middle) hourly wind fields were used to force a (right) tide surge and a (left) wave model hindcast. As an example the figure shows the consistent meteorological-ocean conditions obtained for 1200 UTC 21 Feb 1993. For details see Weisse et al. (2009) . Presently the data base is upgraded using improved models and resolution covering the period from 1948-present. Similar efforts are underway or planned for other regions, e.g. in Southeast Asia and India.



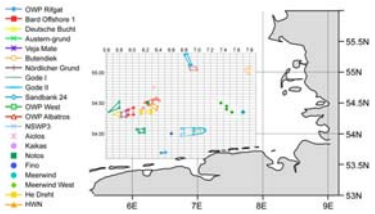
Data from coastDat have been extensively compared with observations. The figure shows the added value in near-surface marine wind speed compared to the driving reanalysis. Shown are so-called Brier skill scores between collocated Quickscat, NCEP and coastDat wind speeds where Quickscat serves as the referencing "truth". Red colors indicate improvement of the regionally downscaled wind speed compared to that from the NCEP reanalysis. Improvement mainly occurs in coastal areas and is more pronounced in the statistics of extreme events (not shown). For details see *Winterfeld et al. 2010, Using QuikSCAT in the added value assessment of dynamically downscaled wind speed, Int. J. Climatol., doi: 10.1002/joc.2105.*

Examples of Applications

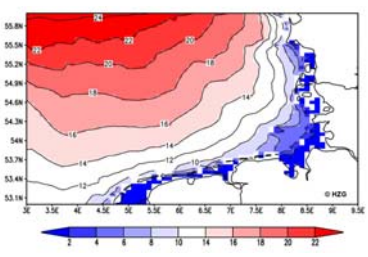
Data from coastDat have been used in a large variety of coastal, offshore and terrestrial applications. There are presently more than 60 external users of this data base ranging from academic and public sectors to commercial enterprises. Here we provide some examples from ship design, the construction and operation of offshore wind farms, their interplay with conventional power plants and the assessment of ocean energy potential. For more details, references and complete list of examples we refer to the coastDat webpage at www.coastdat.de.



Because of policy regulations in Germany, the efficiency of new conventional power plants in Northern Germany will to a large degree depend on the final installation of offshore wind parks. Data from coastDat have been used to assess the efficiency of a newly planned conventional power plant depending on the progress of installation of offshore wind farms *(from Wiese 2008: Auswirkungen der Offshore-Windenergie auf den Betrieb von Kohlekraftwerken in Brunsbüttel, Diploma-Thesis, Universität und Fachhochschule Flensburg, Energie- und Umweltmanagement)*



In the German sector of the North Sea there is presently considerable activity in establishing offshore wind farms. In face of the limited observational data available coastDat was used in many cases for the planning of the design and the operation of these farms. The figure shows the locations of wind farms where coastDat data are presently used in the planning process.



Data from coastDat have been used to assess the potential of ocean energy supply in the Southern North Sea. The study comprises potential energy supply from tidal, current and wave energy and synergies with offshore wind farming. The figure shows the long-term potential wave energy flux in kwm^{-1} derived from coastDat *(from Marx 2010, Langzeitige Variabilität der Wellenenergiepotenziale in der Nordsee, Master-Thesis, University of Basel in cooperation with HZG)*

Data from coastDat are used operationally in ship design at a German ship yard. Applications comprise the optimization of ship operation profiles by taking statistics of expected environmental conditions along fixed routes into account for vessels operating on these routes. The figure shows the launch of the first vessel for which coastDat data have been used in the design process.

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