Offshore wind power in the Aegean Sea

Hasager, Charlotte Bay; Badger, Merete; Hahmann, Andrea N.

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

DTU Wind Energy
Department of Wind Energy

Offshore wind power in the Aegean Sea

Charlotte Hasager, Merete Badger, Ioanna Karagali, Andrea Hahmann, DTU Wind Energy, Technical University of Denmark, Wind , 4000 Roskilde, Denmark,

The wind climate of the Mediterranean Sea has been estimated from atmospheric modelling (Cavaleri 2005, Lavignini *et al.* 2006) and QuikSCAT (Furevik *et al.* 2011). The latter shows the Aegean Sea as a promising area for offshore wind power development.

According to the Hellenic Wind Energy Association (HWEA), the sites of particular interest for offshore wind energy are located close to the mainland and islands in the Aegean Sea. See Figure 1. Wind farm developers aim to select local areas with favorable wind conditions to optimize the annual energy production and the economic profit.

In the Aegean Sea, where the spatial variations in wind speed are very high, accurate resource mapping is of great importance as the produced wind power is proportional to the cubed wind speed. It is challenging to model the wind resource and it is costly to measure from the ground at every place of interest.

Maps based on Synthetic Aperture Radar (SAR) are expected to prove valuable for the exploitation of the excellent wind resource of the Aegean, to the benefit of the national economy.

High-resolution SAR satellite data bring new information for pre-feasibility for instance at the policy planning level. For accurate wind resource mapping from satellite it is necessary to collect many images to reduce the uncertainty.

The 10-year Envisat ASAR archive has been used for wind resource mapping. Figure 2 shows the number of overlapping scenes. Wind maps from satellite are retrieved at 10 m. a map of the mean wind speed for the Aegean Sea is shown in Figure 3. This is given as mean Equivalent Neutral Winds (ENW).

The offshore wind resource is also calculated from Sentinel-1 wind fields from 2014-16. Figure 4 shows the number of overlapping samples and Figure 5 the mean wind speed at 10 m.

For comparison, a map of the mean wind speed from ASCAT is presented for year 2015 (Figure 6).

The work on Sentinel-1 and ASCAT is done for the New European Wind Atlas. This project will run until 2019, so it is work in progress.

The Sentinel-1 images are processed at DTU Wind Energy in near-real-time and we have updated our wind resource software.

A service-based on satellite SAR-derived winds for wind resource estimation is available at DTU Wind Energy.

In order to predict the wind resource for the turbine hub height, DTU Wind Energy has developed a method for extrapolation of winds to around 100 m using a combination of satellite wind fields and the long-term climate of atmospheric stability from the mesoscale model (Badger *et al.* 2016).

Over time, as more Sentinel-1 scenes are acquired, a combination of wind maps from Envisat ASAR and Sentinel-1 A/B will lead to a substantial improvement of the data coverage and the statistical robustness of satellite based wind resource maps.

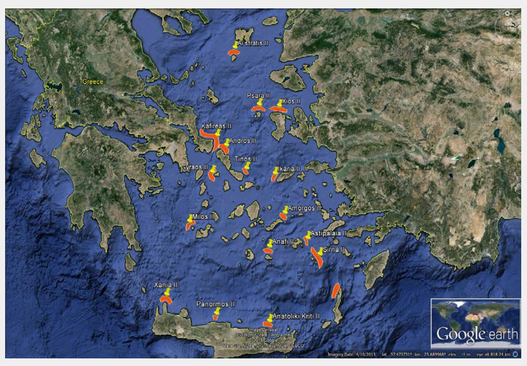

Fig. 1. Map showing the Phase I wind farm locations (top) and the Phase II wind farm locations (bottom) in the Aegean Sea. Image courtesy Google Earth and the Hellenic Wind Energy Association (HWEA).

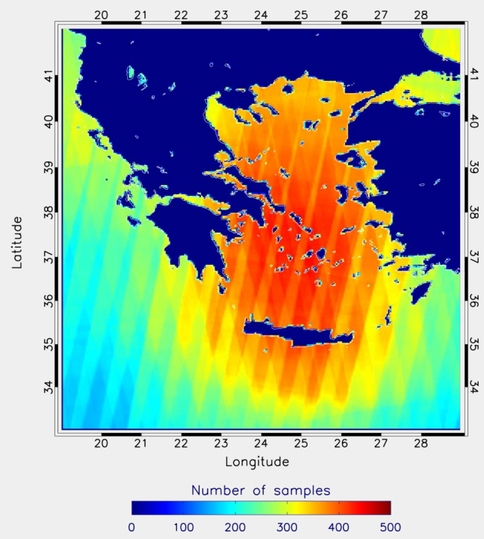

Fig. 2. Overlapping satellite Envisat ASAR scenes for the Aegean Sea for 2002-2012. It is based on more than 2,000 scenes.

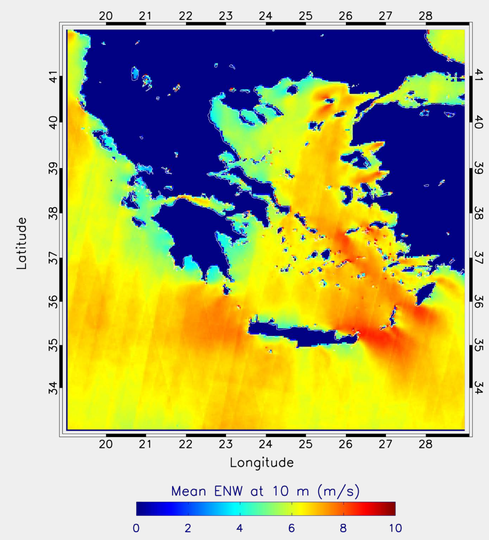

Fig. 3. Map showing the mean Envisat ASAR wind speed at the10 –m level.

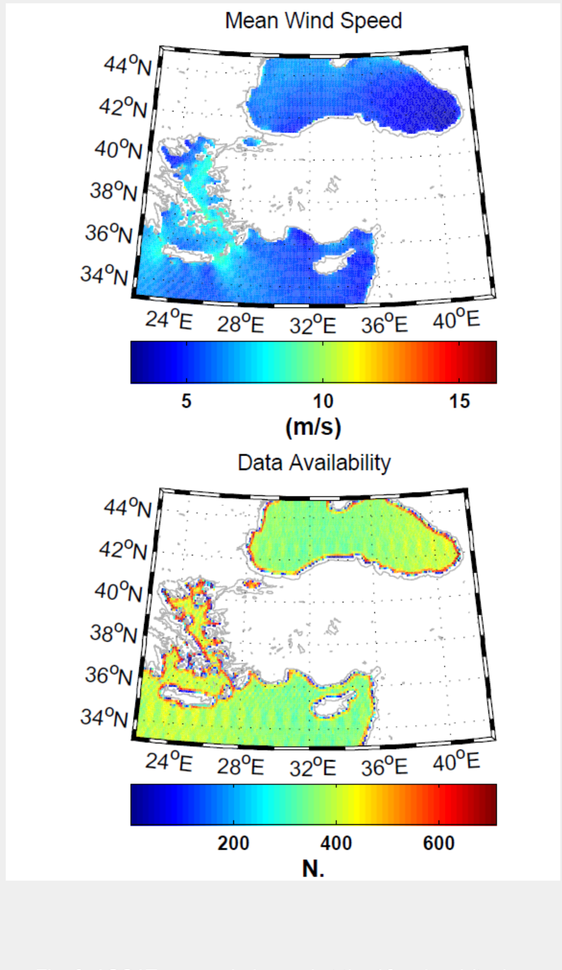

Fig. 6. ASCAT mean wind speed at the 10-m level (top) and number of overlapping samples (bottom). It is the data from year 2015.

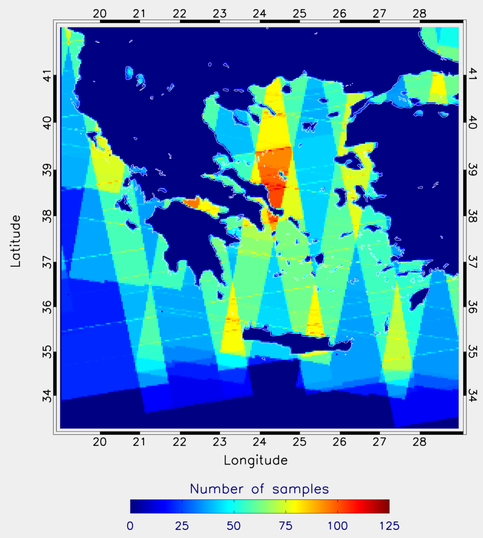

Fig. 4. Overlapping satellite Sentinel1- scenes for the Aegean Sea for year 2014-16.

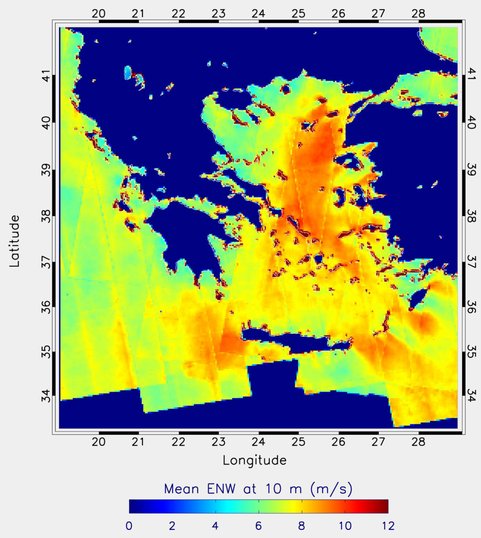

Fig. 5. Map showing the mean Sentinel-1 wind speed at the 10-m level.

Badger, M., Peña. A., Hahmann, A.N., Mouche, A., Hasager, C.B. (2016) Extrapolating satellite winds to turbine operating heights. *Journal of Applied Meteorology and Climatology,* doi:10.1175/JAMC-D-15-0197.1
Cavalari 2005 The wind and wave atlas of the Mediterranean Sea – the calibration phase. *Advances in Geosciences*, 2, 255–257.
Furevik, BR, Sempreviva, AM, Cavaleri, L, Lefèvre, J-M & Transerici, C 2011, Eight years of wind measurements from scatterometer for wind resource mapping in the Mediterranean Sea, *Wind Energy*, vol 14, no. 3, pp. 355-372.
Lavignini et al. 2006 Offshore Wind Climatology over the Mediterranean Basin. *Wind Energy*. 2006; 9:251–266

Acknowledgement: ESA for Envisat ASAR and Sentinel-1 scenes, ASCAT from OSI SAF, software from Johns Hopkins University Applied Physics Laboratory, information from HWEA about planning of wind farms and funding from ESA ResGrow project (http://resgrow.eu/wind/)and the New European Wind Atlas (NEWA) is kindly acknowledged.

DTU Wind Energy
Risø Campus
Frederiksborgvej 399
DK-4000 Roskilde, Denmark