Offshore wind farm clusters wakes observed from satellite SAR

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The EU project EERA DTOC (European Energy Research Alliance – Design Tools for Offshore Wind Farm Clusters, www.eeradtoc.eu) from 2012 to 2015 is led by DTU Wind Energy and there are 10 science partners, 11 wind industry partners and one satellite expert partner (CLS) involved.

One of the major aims of the project is to increase knowledge on the influence of very large offshore wind farms to the atmospheric flow downwind of the wind farms. This information is useful for strategic planning and development of new wind farms.

At the moment more than 4 GW offshore wind power capacity is installed and grid connected in the Northern European Seas with around 35.000 people employed directly and indirectly. According to the European Wind Energy Association (www.ewea.eu) the offshore capacity is expected to increase to 40 GW in 2020 and 150 GW in 2030.

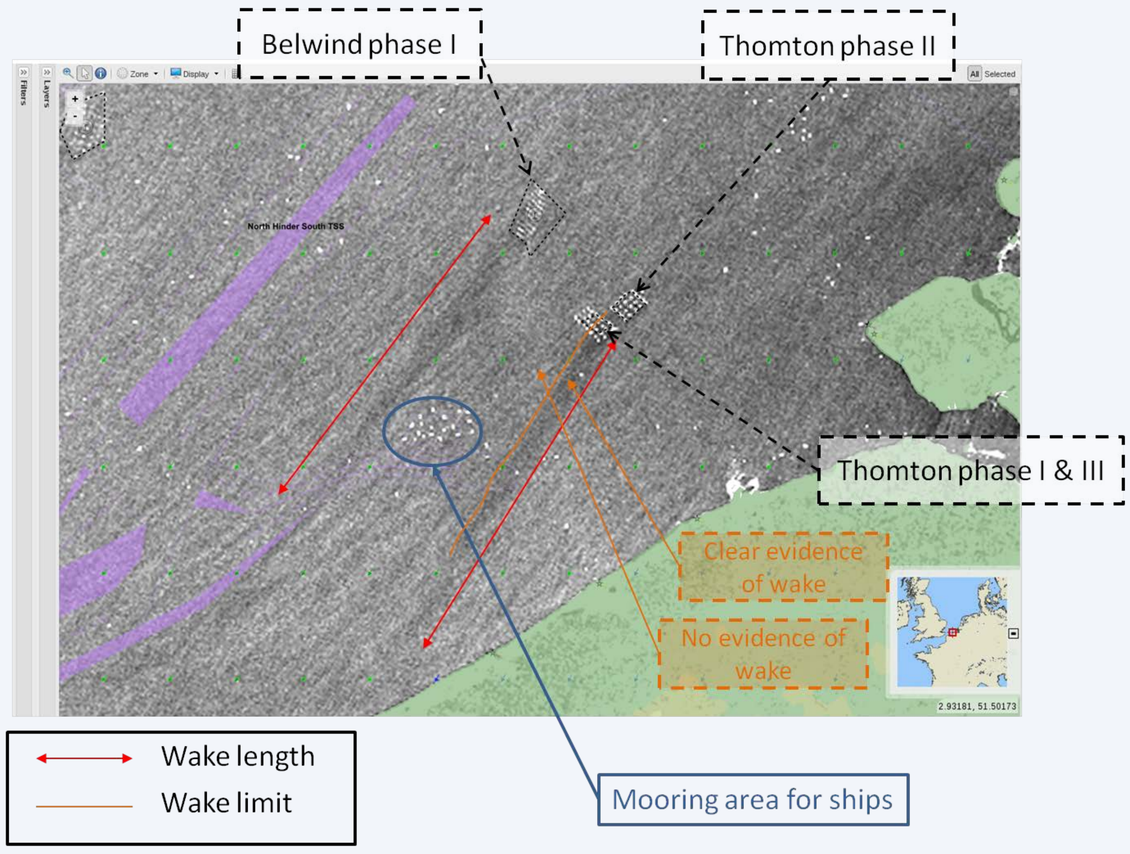
It has earlier been shown that for specific atmospheric conditions the wind farm wake behind the Horns Rev 1 offshore wind farm in the North Sea in Denmark persisted more than 20 km downstream. This may be an exceptional case as most other investigated ERS and Envisat SAR images showed somewhat shorter downstream wakes (Christiansen and Hasager 2005). Since this early study of the first large offshore wind farm in the world that started operation in December 2000, many new large offshore winds have been constructed.

CLS has collected a database of Envisat and Radarsat SAR images covering large offshore wind farms. These include Horns Rev 1 (21 km^2), Horns Rev 2 (33 km^2), Nysted 1 (26 km^2), Rødsand 2 (34 km^2), BARD Offshore 1, Scroby Sands, Robin Rigg, and Thanet (35 km^2). The surface area for some of the wind farms are listed in brackets. CLS developed a specific wind algorithm to filter out radar echoes from wind farms and ships (in particular in mooring areas) and selected several interesting cases. They can be seen on eoda.cls.fr website in the "offshore Wind Energy (wake from space)" demonstration section.

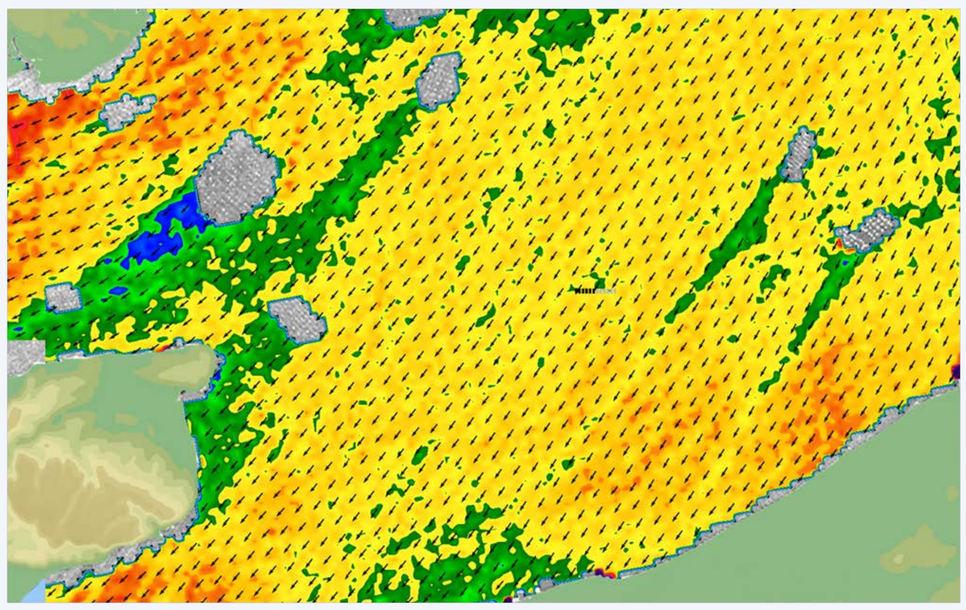
For the Horns Rev 1 and Horns Rev 2 in the North Sea and for the Nysted 1 and Rødsand 2 in the Baltic Sea the wind farms are relatively close, as twin wind farms, and there will for certain wind directions be a wake effect between the wind farms. This is particularly interesting to investigate as in the future many more large offshore wind farms will be located in relatively close proximity.

The two cases in the North Sea show wakes behind several large offshore wind farms. The wake climatology from a series of Envisat images is being studied currently.

Reference: Christiansen MB, Hasager C. Wake effects of large offshore wind farms identified from satellite SAR. Remote Sens Environ 2005; 98: 251–68.



Offshore wind farm wake in the North Sea observed by Radarsat-2. The SAR image is processed by CLS.



Ocean surface wind field from high resolution radar. We observe that behind Thomton, the wind field decreases from 9 to 7 m/s at the sea surface. In this case, wake seems to be larger and the decrease of wind higher for bigger wind farms (see London Array for instance). Image from Radarsat-2. Pruduced by CLS.

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