Pilot 3: Merging offshore wind products

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e-shape Renewable Energy Showcase:

Pilot 3: Merging offshore wind products

Team: Ioanna Karagali, Merete Badger, Charlotte Hasager, Neil Davis, Martin Steen Nielsen

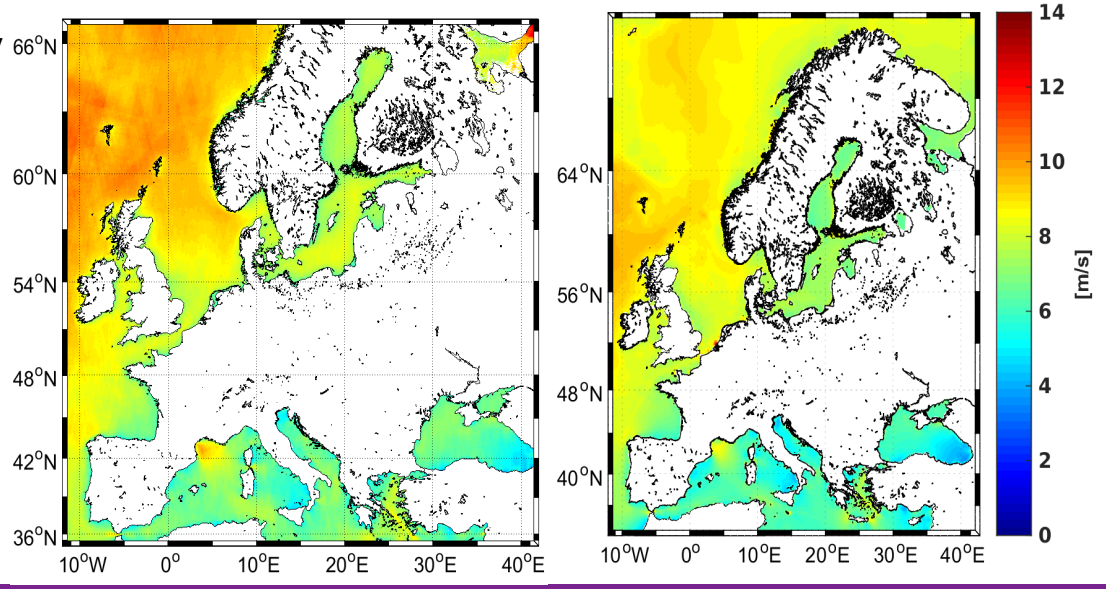
The e-shape project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 820852

#3: Merging offshore winds

- **Objective:** Provide EO-based enhanced offshore wind resource assessment from blended Synthetic Aperture Radar (SAR) and scatterometer wind retrievals, covering the European Seas.

- **Expected user community:** Offshore wind farm developers and operators, consultants for offshore wind farm siting and resource assessment, researchers and policy makers.

- **By: DTU Wind Energy**



Mean wind speed at 10m from SAR (left: 2002-2016) & ASCAT (right: 2007-2016). From Karagali et al. 2018*.

* Karagali, I., Hahmann, A. N., Badger, M., Hasager, C. B., & Mann, J. (2018). New European wind atlas offshore. Journal of Physics: Conference Series, 1037(5), 052007. https://doi.org/10.1088/1742-6596/1037/5/052007

Rationale & Objectives

- EO winds can serve as roadmaps for
  - "climatological" conditions
  - decision-making for installation of offshore meteorological masts
  - higher resolution model experiments
  - validation of models.

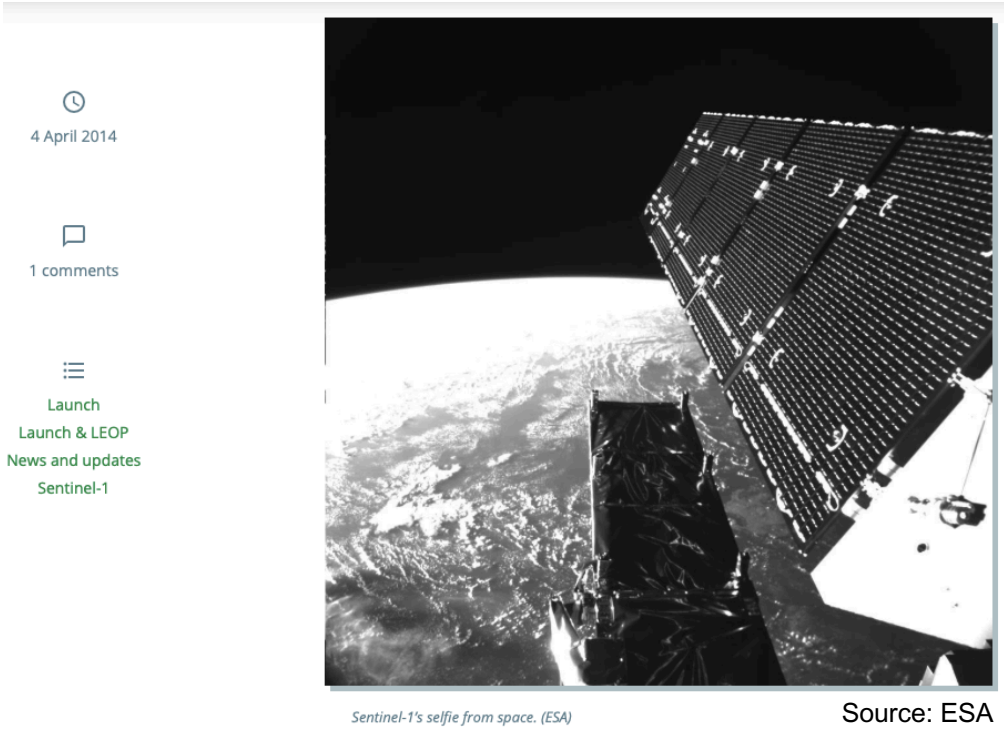
- Optimise, improve and "advertise" existing satellite-based services for offshore wind energy

- Develop a new, satellite-based wind product
- Add value to raw satellite observations and tailor to the wind energy industry needs
- Co-design the service together with end users

Satellite winds at 10 m over the ocean

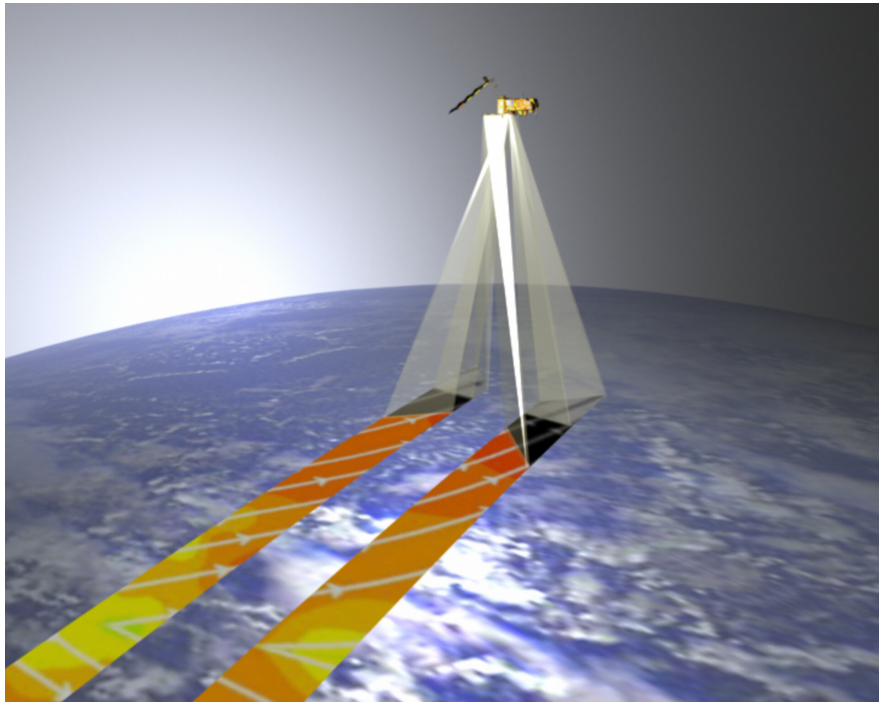
- Microwave radar technology
- Backscatter from small scale (~cm) waves

- Synthetic Aperture Radar (**SAR**)



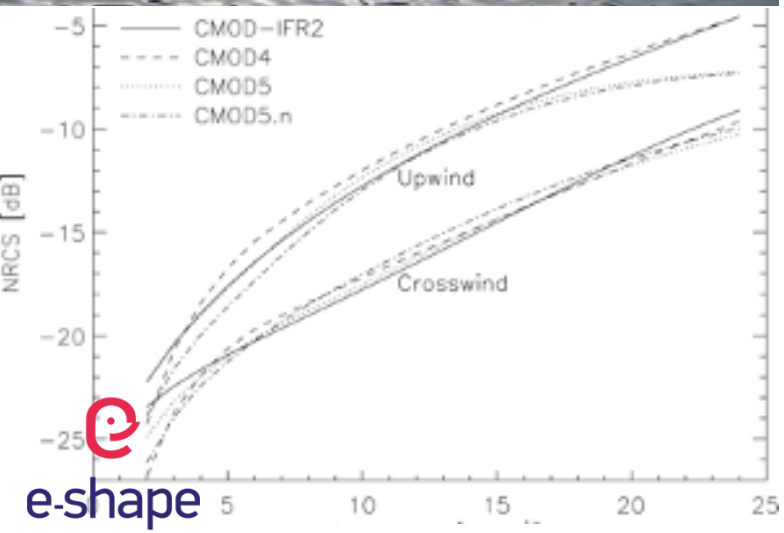
Source: ESA

- Scatterometer (**ASCAT**)



Source: EUMETSAT

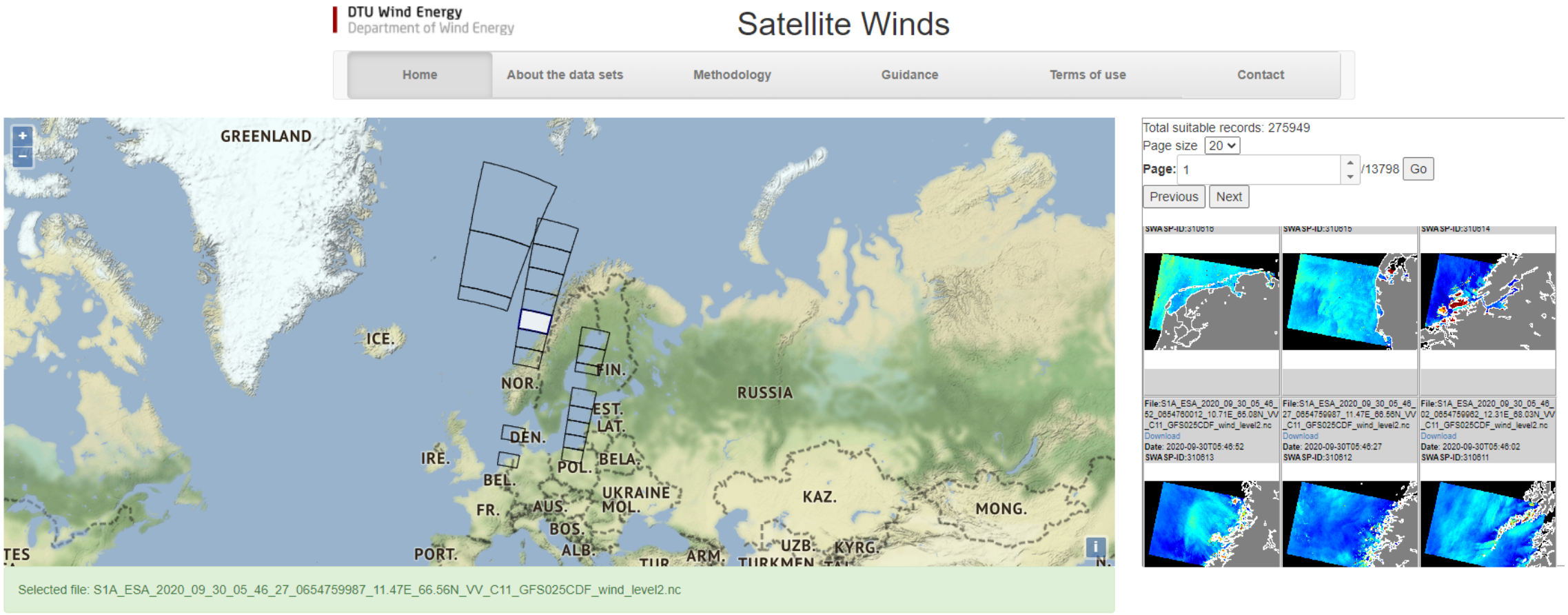
Sensor advantages



- SAR
  - Spatial resolution: 500 m
  - 2014 to now
  - Coastal coverage
  - Only wind speed
  - Requires wind direction input
- ASCAT
  - Spatial resolution: 12.5 km
  - 2007 to now
  - Global, consistent temporal coverage
  - Wind speed & direction

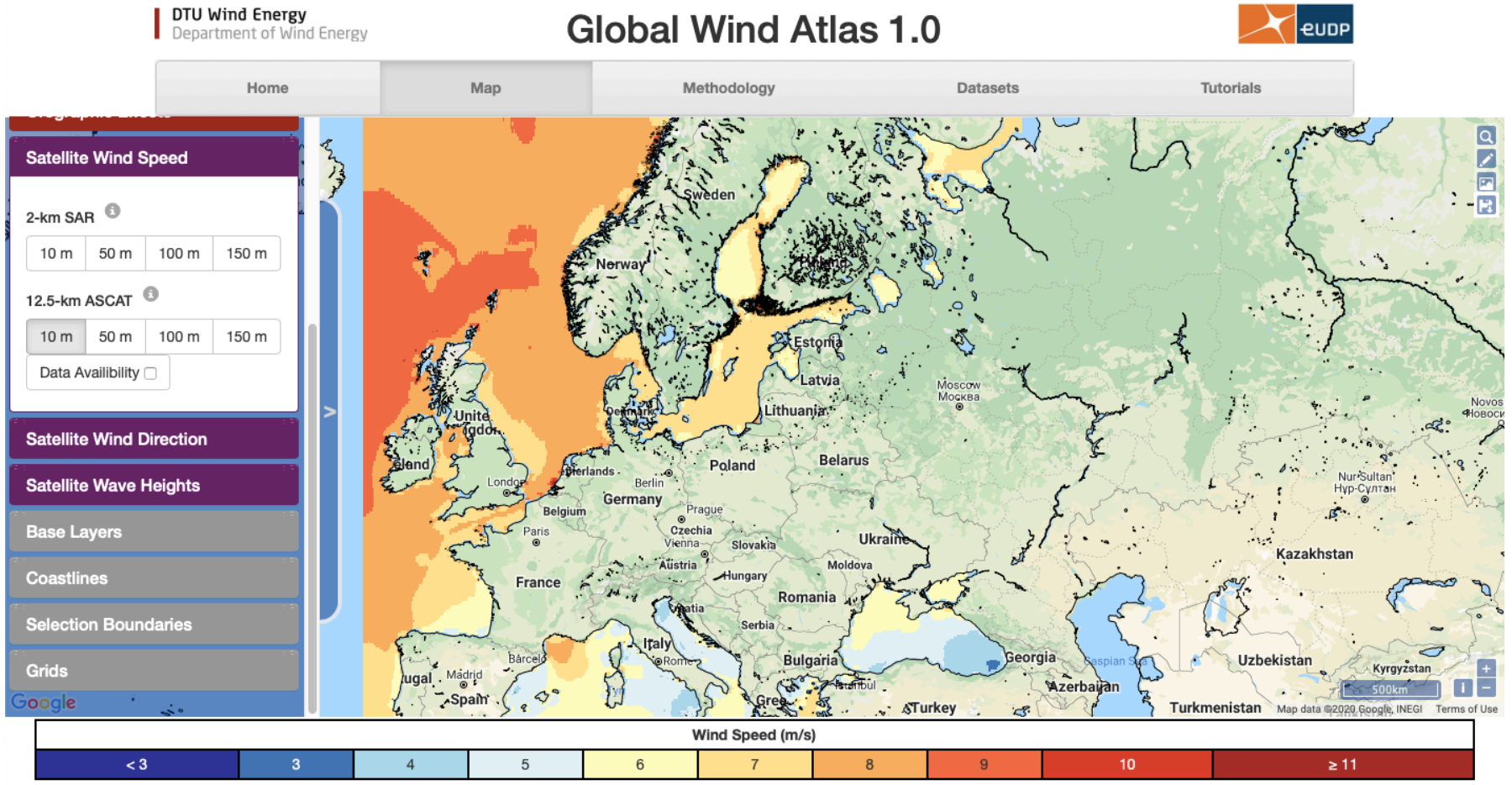
Existing DTU services: satellite wind fields

- https://satwinds.windenergy.dtu.dk/



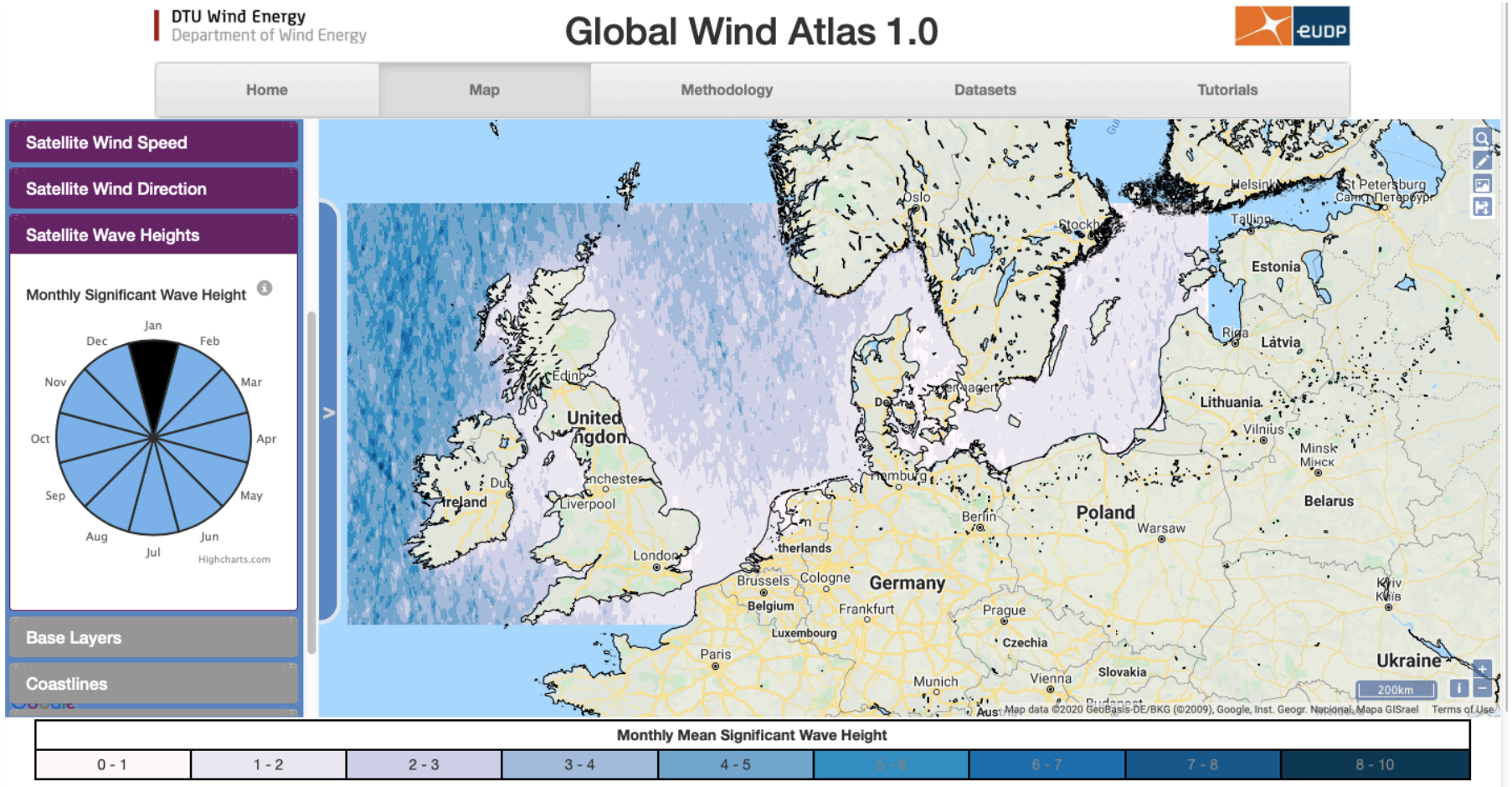
Existing DTU services: wind resources

- http://science.globalwindatlas.info/science.html



Existing DTU services: wave climate demo

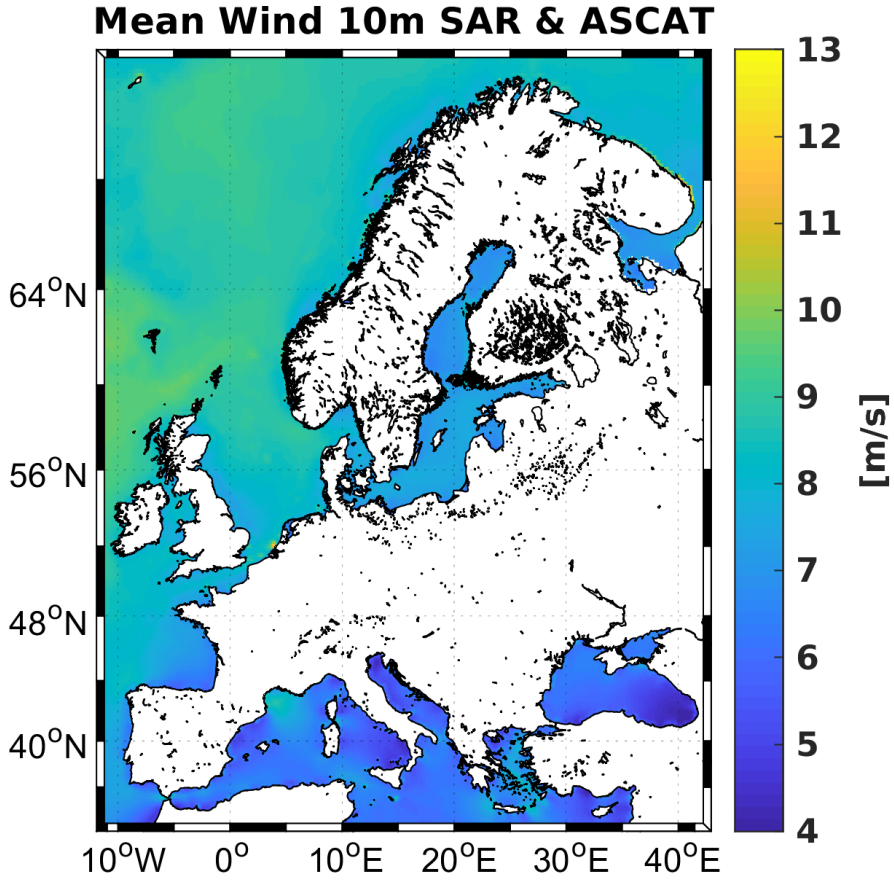
- http://science.globalwindatlas.info/science.html



DTU developments: Merging Offshore Winds

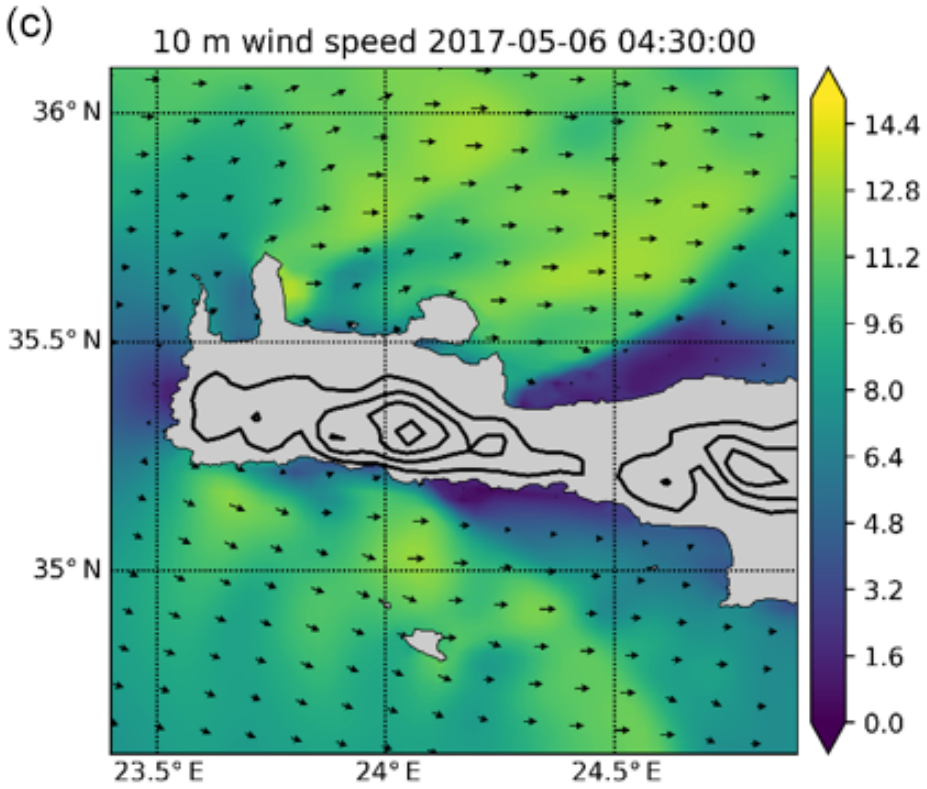
- A new, unique and unified wind product from existing EO wind data.

- Combine advantages from different sensors
  - long-term and global coverage
  - high spatial resolution near coast lines

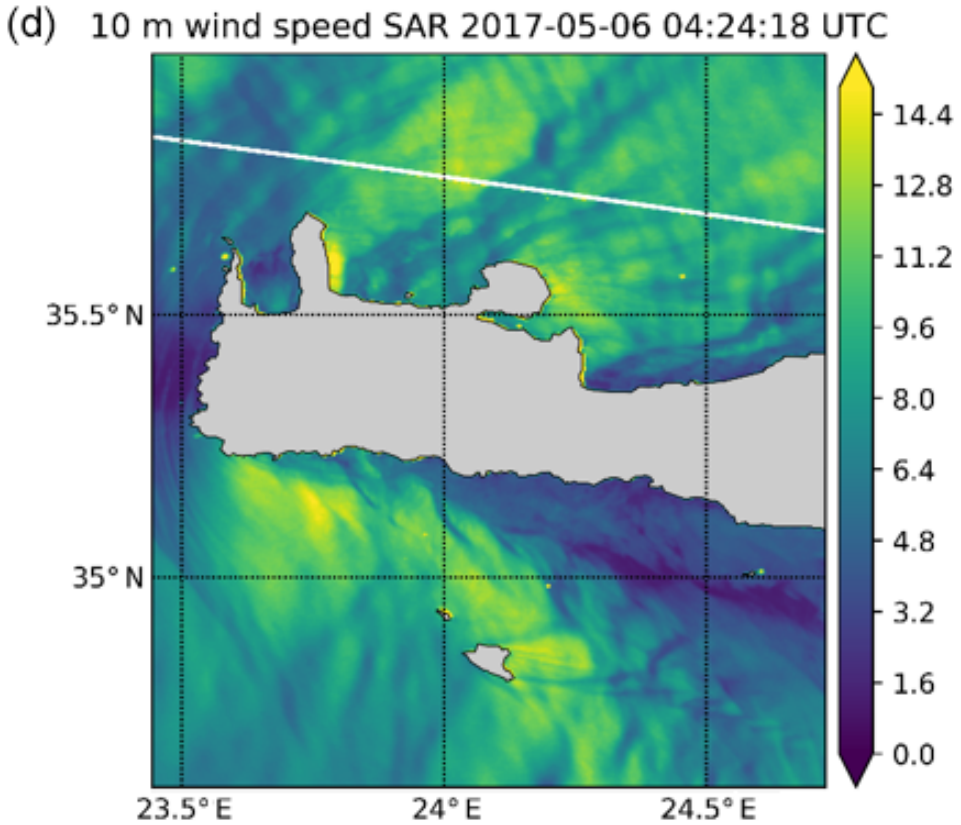


Demo: Instantaneous wind conditions

renewable energy sources



Simulated 10-m wind speed



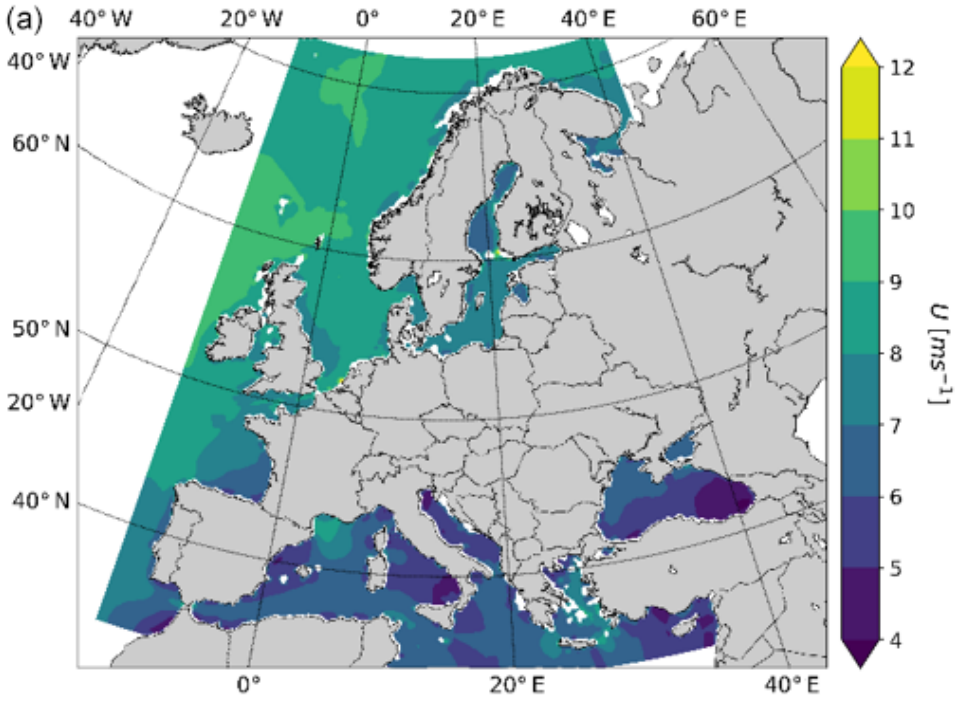
Satellite-based wind speed

e-shape

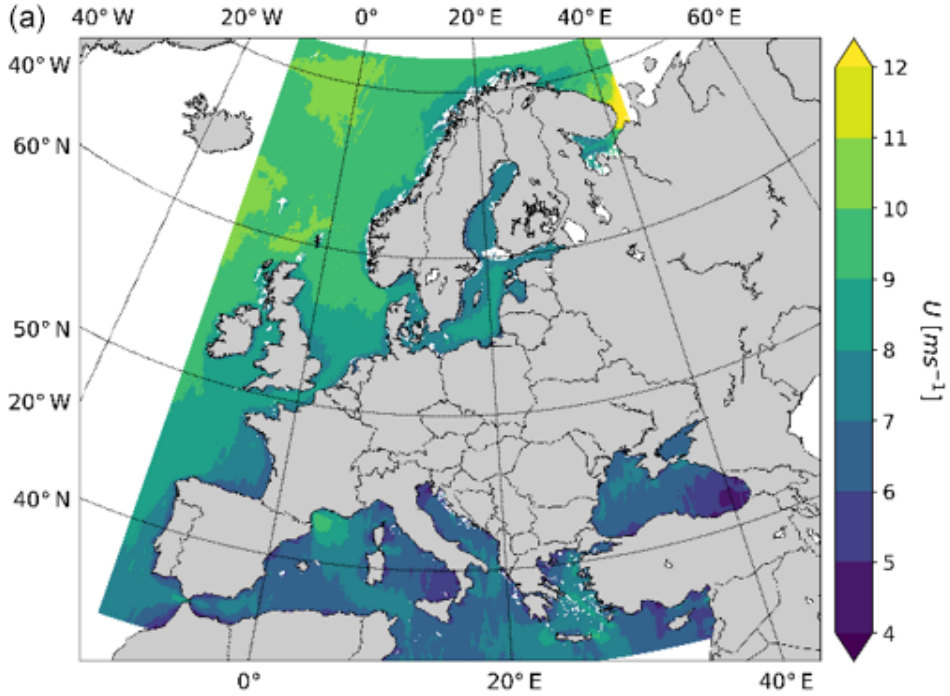
Source: Hasager, C. B., Hahmann, A. N., Ahsbahs, T., Karagali, I., Sile, T., Badger, M., and Mann, J.: Europe's offshore winds assessed with synthetic aperture radar, ASCAT and WRF, Wind Energ. Sci., 5, 375–390, https://doi.org/10.5194/wes-5-375-2020, 2020.

Demo: Wind Resources

renewable energy sources



ASCAT 10-m wind speed

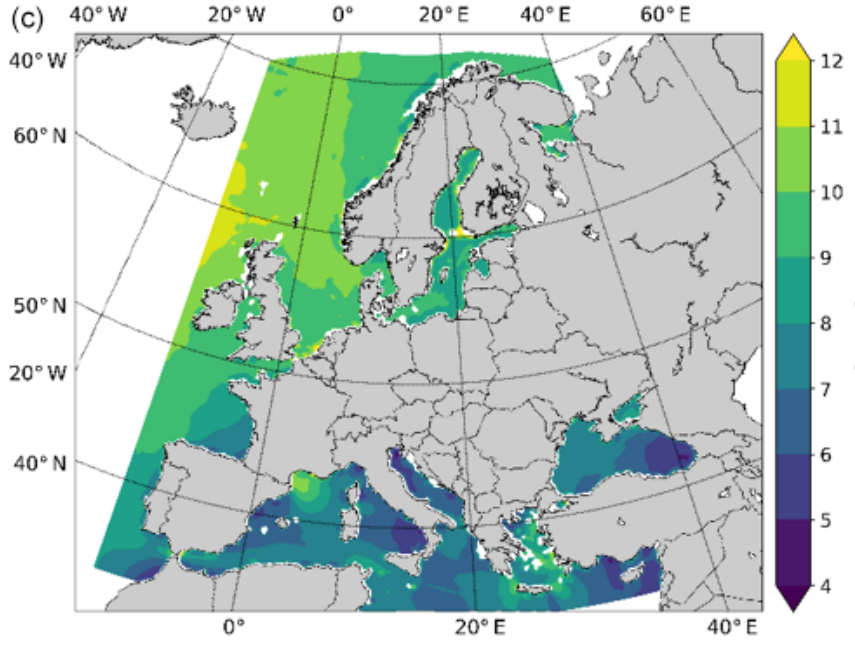


SAR 100-m wind speed

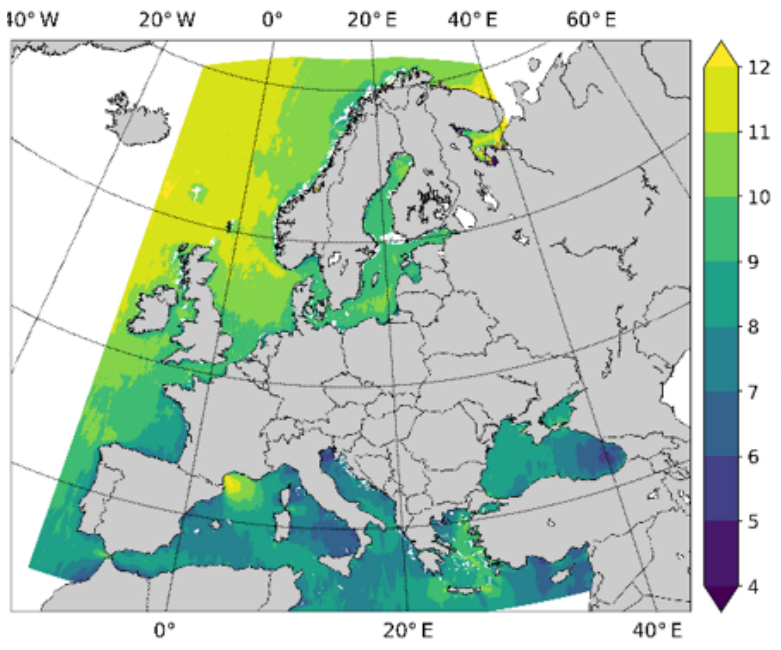
e-shape

Source: Hasager, C. B., Hahmann, A. N., Ahsbahs, T., Karagali, I., Sile, T., Badger, M., and Mann, J.: Europe's offshore winds assessed with synthetic aperture radar, ASCAT and WRF, Wind Energ. Sci., 5, 375–390, https://doi.org/10.5194/wes-5-375-2020, 2020.

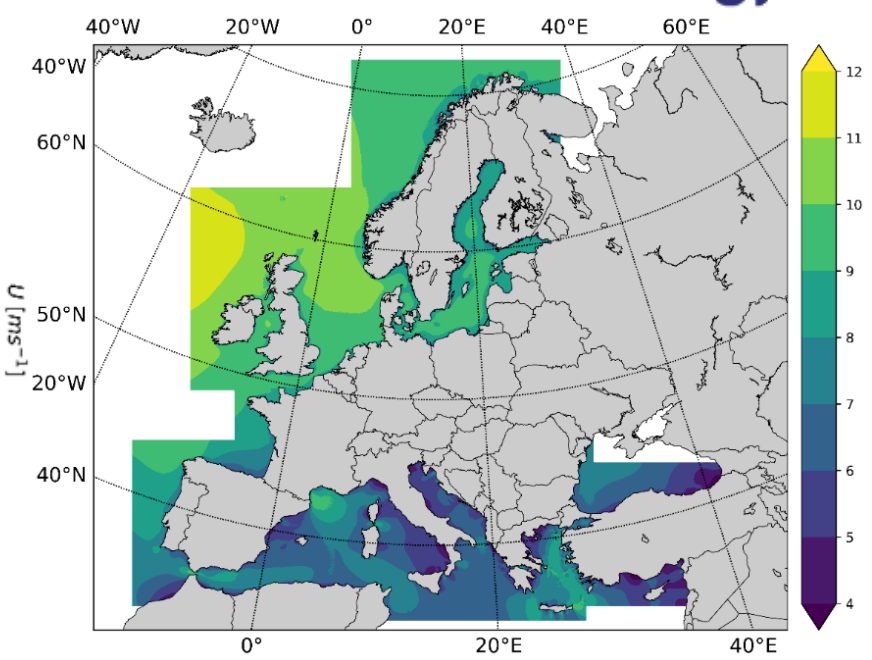
Demo: Wind Resources at hub height



ASCAT 100-m wind speed



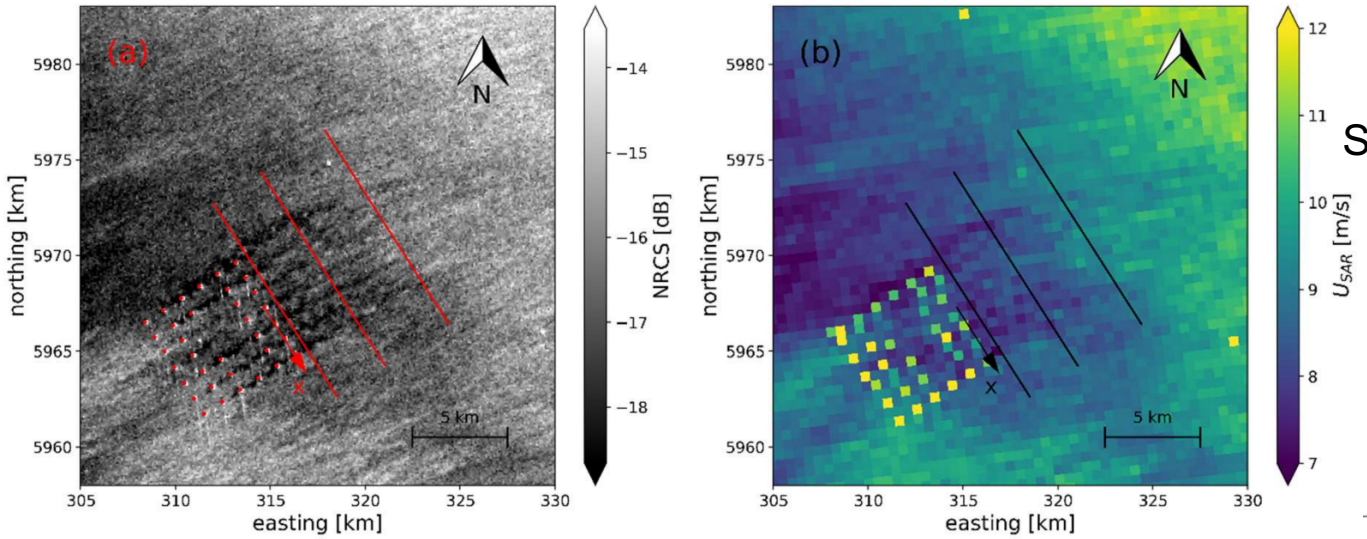
SAR 100-m wind speed



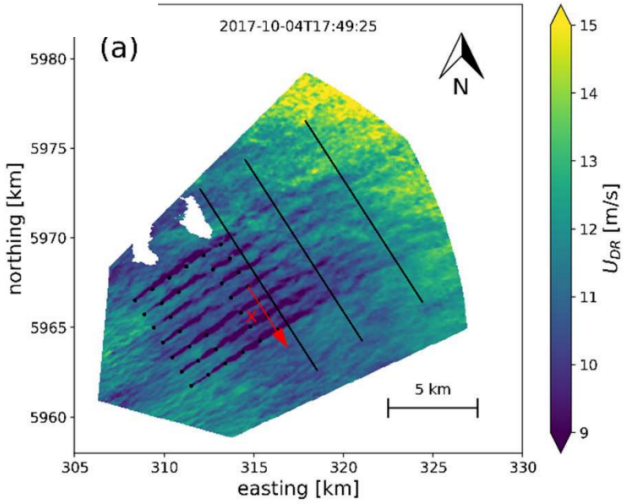
Simulated 100-m mean wind speed

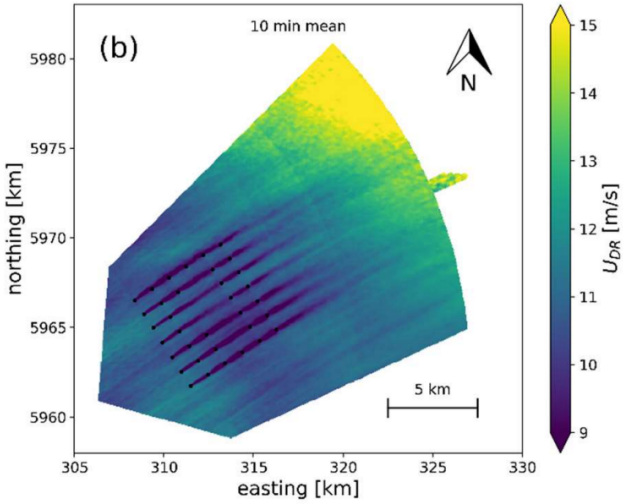
Source: Hasager, C. B., Hahmann, A. N., Ahsbahs, T., Karagali, I., Sile, T., Badger, M., and Mann, J.: Europe's offshore winds assessed with synthetic aperture radar, ASCAT and WRF, Wind Energ. Sci., 5, 375–390, https://doi.org/10.5194/wes-5-375-2020, 2020.

Demo: Wind variability near wind farms



Satellite-based radar backscatter & 10-m wind speed



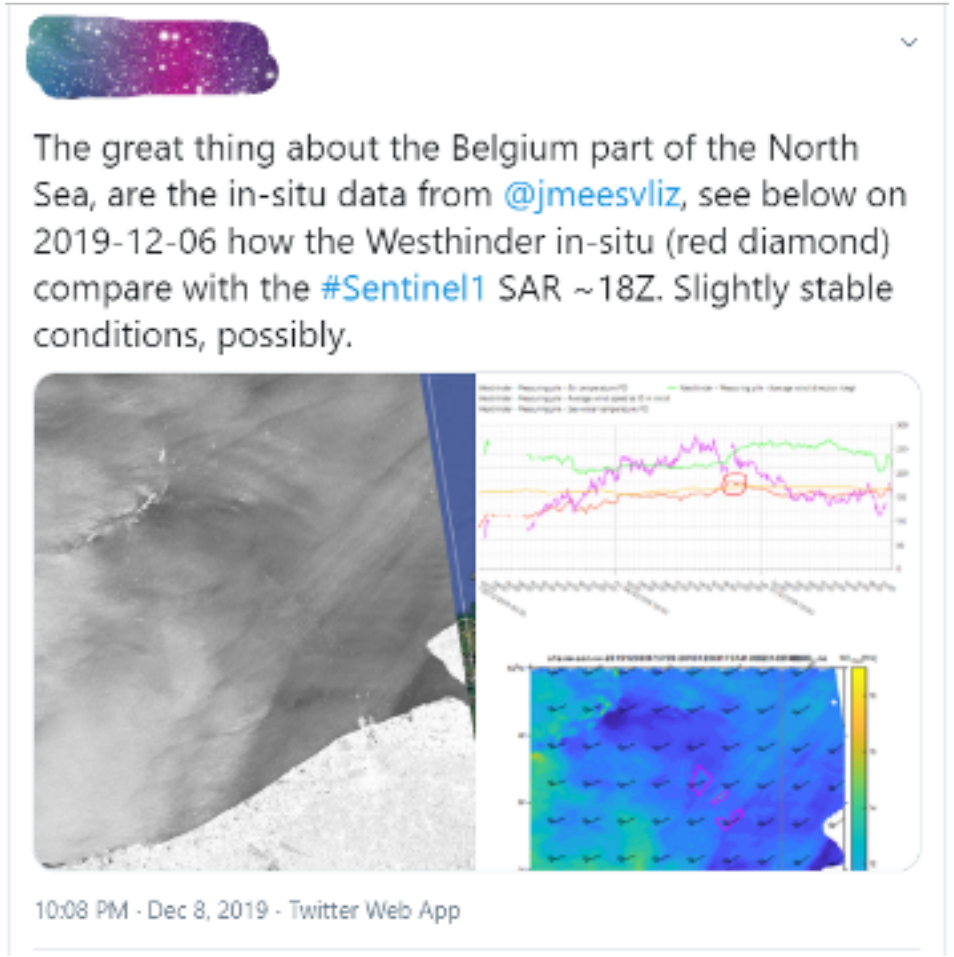


Ground-based Doppler Radar 10-m wind speed

Source: Ahsbahs, T.; Nygaard, N.G.; Newcombe, A.; Badger, M. Wind Farm Wakes from SAR and Doppler Radar. Remote Sens. 2020, 12, 462.

User involvement

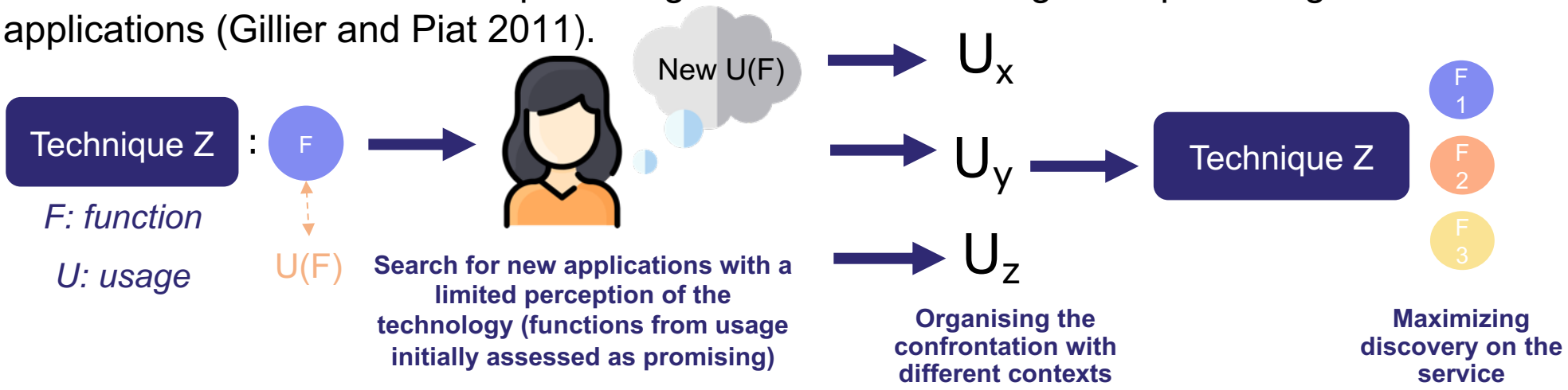
- Prior experience of servicing the industry
- Currently 4 users expressed support
- One more may be onboarded



Co-design: Type 2 “Technology-push”

- **Technology-push:** pilot looks for potential applications to a certain technology.

- **Major issue**: fixation on a **“presumed identity” of the technology**, drawing from an initial set of uses assessed as promising → risk of overlooking other promising applications (Gillier and Piat 2011).

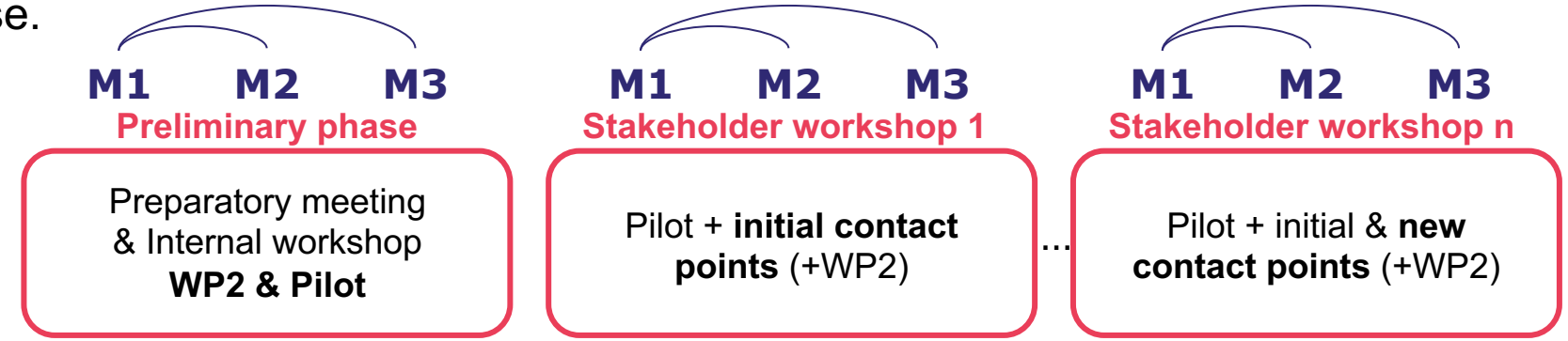


- **Solution:** Need of maximizing functional discovery on the technology by organizing the confrontation of the technology to several different contexts

Source: Gillier T and Gerald P (2011), Exploring Over: The Presumed Identity of Emerging Technology. Creativity and Innovation Management 20 (4): 238-52. https://doi.org/10.1111/j.1467-8691.2011.00614.x.

Organisation of Co-design Type 2

- Assessing the service in 3 Methods:
  - **M1**: known contexts as a substitute of existing tools
  - **M2**: contexts with unmet needs
  - **M3**: unknown contexts
- Analyses of related stakeholders for all **M1, M2, M3**
- Methods tested in sequence of several cycles:
  - Initially with the pilot alone (internal workshop)
  - Workshops with relevant stakeholders (stakeholder workshops)
- **Combination of relevant methods to be identified with the pilot** in the preliminary phase.



Thank you for your attention