Experiments in the New European Wind Atlas

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The New European Wind Atlas

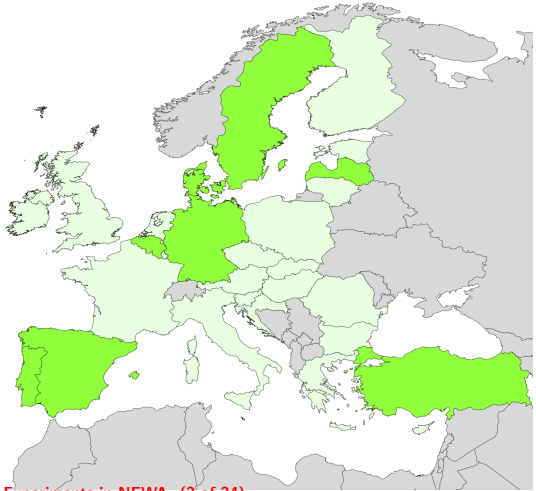
- Accurate mapping of wind conditions for the estimations of resources and loads
- Development and testing of the model chain
- A series of atmospheric field experiment to validate the model and atlas.

The New European Wind Atlas

- EU countries

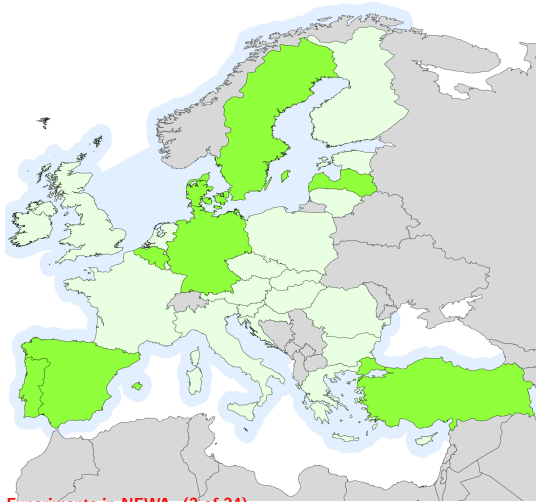
The New European Wind Atlas

- EU countries
- NEWA partners



The New European Wind Atlas

- EU countries
- NEWA partners
- Offshore coverage



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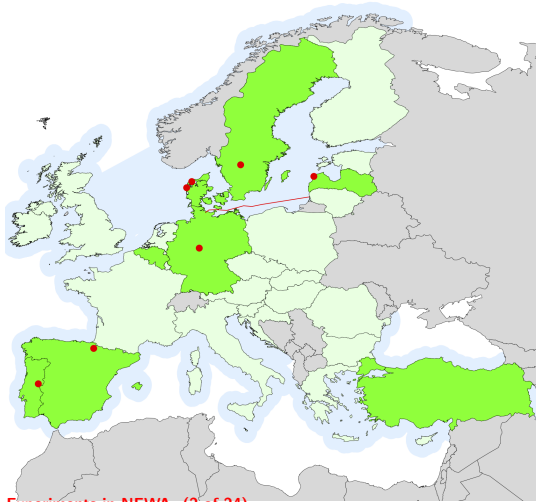
- Experimental sites



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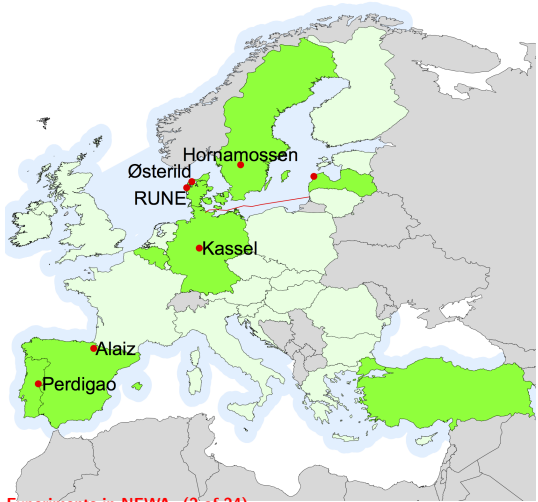
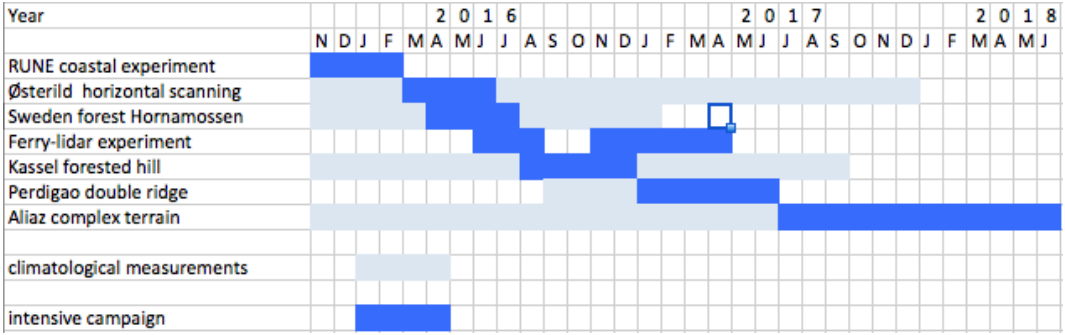


NEWA Outcome

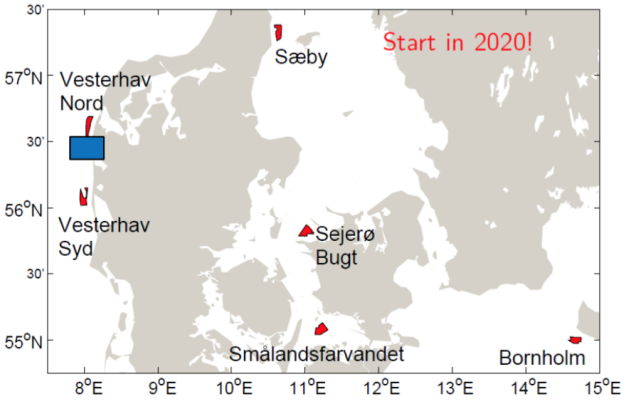
- A unified high resolution and freely available data-set of wind energy resource in Europe.
- Wind resources with a resolution < 100 meters in at least 10 wind turbine relevant heights.
- Data from large scale field experiments and at least 10 years of mesoscale simulations with a resolution of 2-3 km.
- Publicly available data for all EU countries, including 100 km offshore plus the Baltic and the North Sea.
- Measures of wind variability, wind power predictability from day-ahead to decadal as well as parameters for wind turbine design.

Time plan for experiments in NEWA



RUNE

Reducing **U**ncertainty of **N**ear-shore wind resource **E**stimates using onshore scanning lidar technology combined with ocean and satellite information

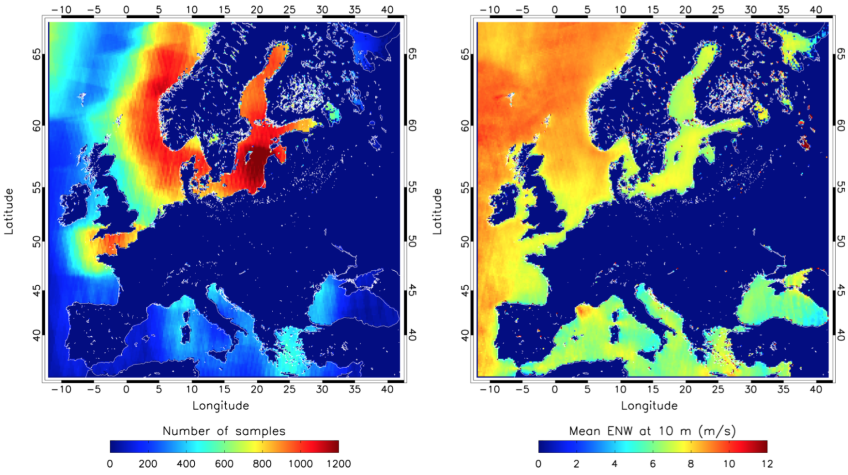


Date sources:

- 3 WindScanners on the coast
- 4 profiling lidars on the coast
- Floating lidar on buoy
- Sentinel-1 satellite winds
- TerraSAR-X satellite winds
- ASCAT satellite winds
- Sonic + Høvsøre met-mast
- Triaxys wave buoy

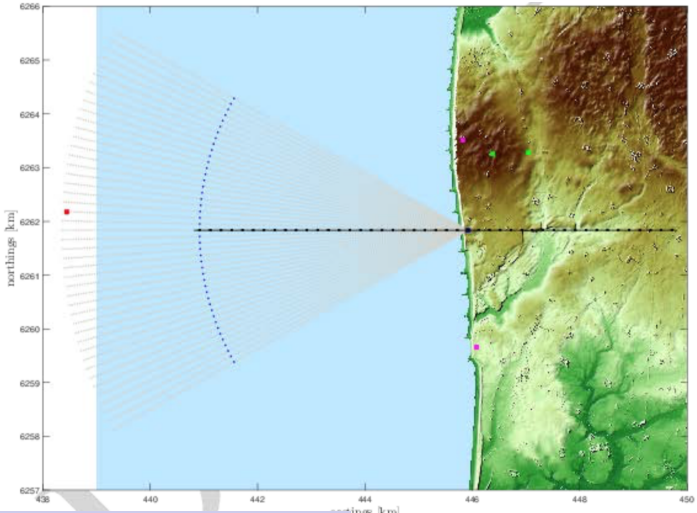
Preliminary 10-m wind atlas for Europe

Envisat ASAR and Sentinel-1A combined



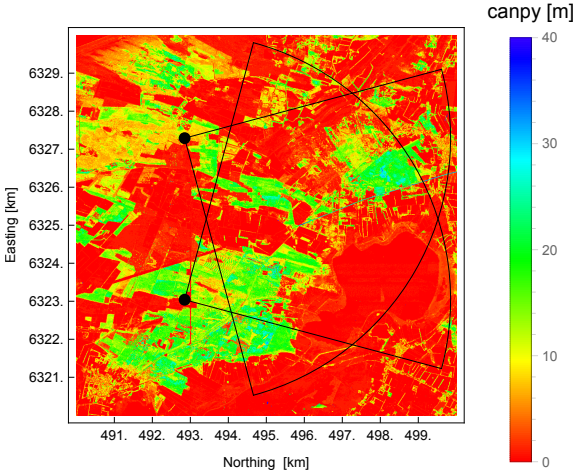
RUNE scanning lidar layout

Experimental period: November 4, 2015 – April 5, 2016



The Østerild Balcony Experiment

Canopy heights

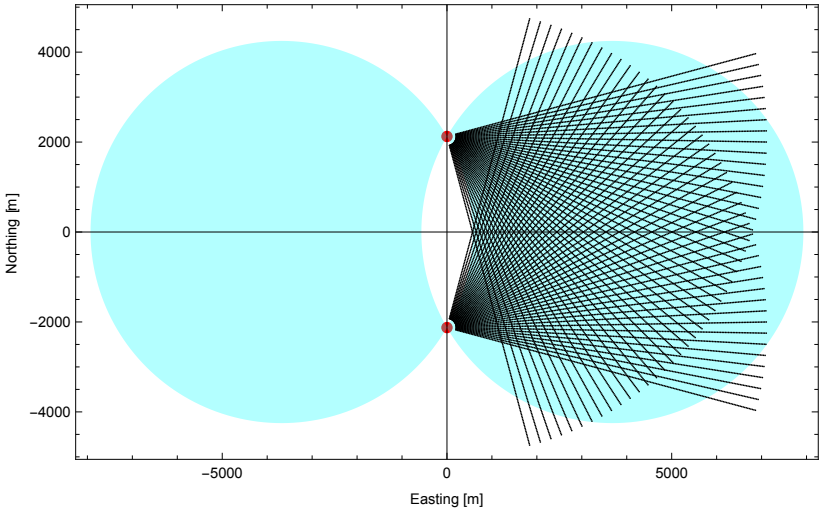


How does surface heterogeneities propagate to rotor height?

Scanning heights: 50 m & 200 m
Two months at each height

Scanning patterns

Easterly winds: One cycle is 45 seconds



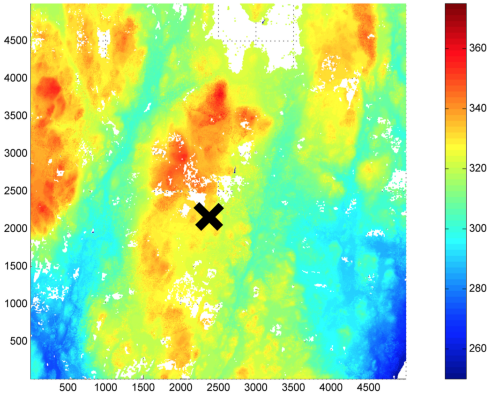
Scanning lidar data

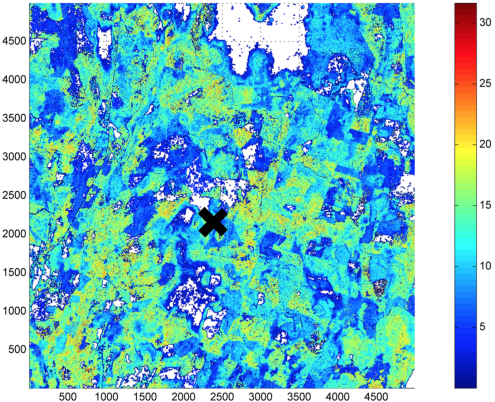
Hornamossen

Swedish rolling forested hills

Hornamossen

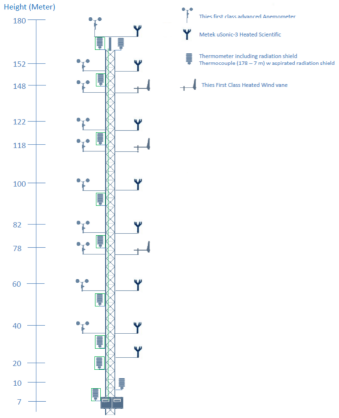
Swedish rolling forested hills





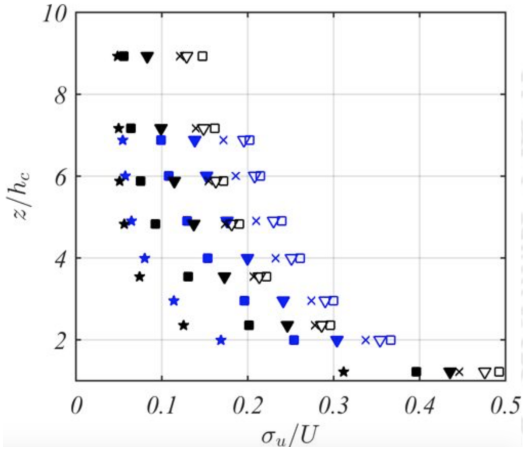
Hornamossen

Swedish rolling forested hills



Turbulence over the forest

Hornamossen and Ryningsnäs



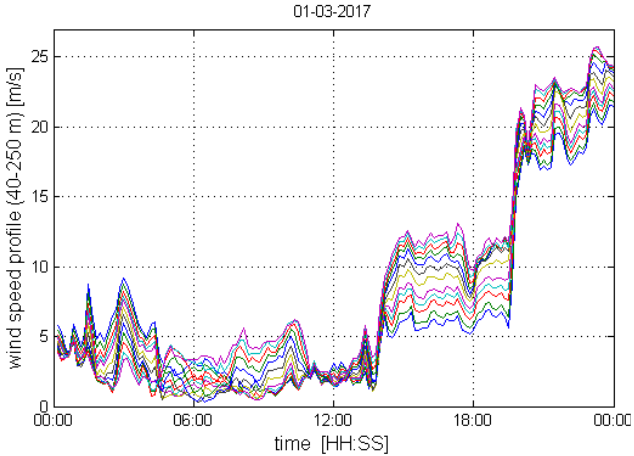
- ★ $L/h_c < 5$
- ■ $5 < L/h_c < 20$
- ▼ $20 < L/h_c < 50$
- × $|L/h_c| > 50$
- ▽ $-50 < L/h_c < -20$
- □ $L/h_c < -20$

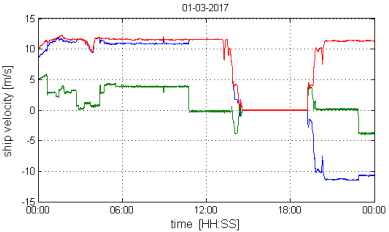
Ferry mounted lidars in the Baltic

- Route Kiel – Klaipeda selected
- Approved by DFDS Seaways
- Start of campaign early 2017

A day of winds from Kiel to Kleipeda

February – May 2017, wind speed 40 – 250 m, Ferry speed, East comp., North comp.

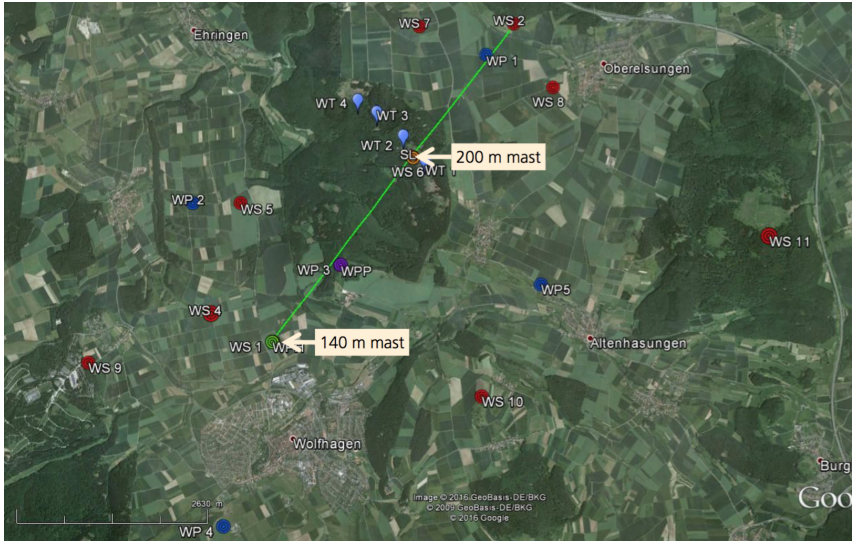




Kassel forested hill

Centered around Frauenhofer IWES' 200 m mast

Kassel 2016 experimental layout

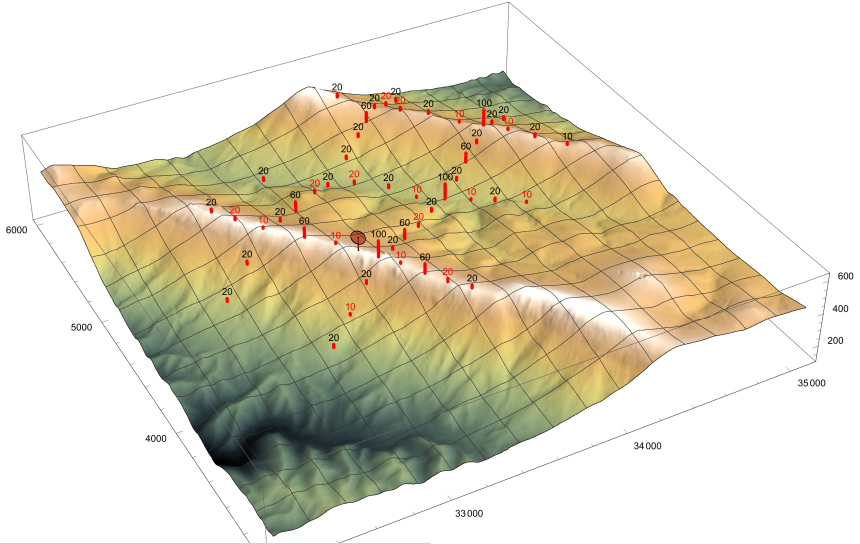


Kassel 2016 installation

The Perdigao experiment

Pilot experiment May – June 2015
Main experimental campaign January – July 2017

Perdigao 2017 mast layout



Perdigao 2017 installation

Perdigao 2017 installation

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Perdigao 2017 installation

shows that is what Vasy and his team's proof ... a key motivation for solving the geophysical problem was ...

Their assumption, which differed from Michel's, was that the curved space, or manifold, is structured with concentric layers. This allowed them to construct a solution in stages. "You go layer by layer, like peeling an onion," says Uhlmann. For practical applications, this means that researchers will not only know that there is a unique solution to the problem; they will also have a procedure to calculate that solution explicitly.

The three mathematicians circulated their 50-page paper among a small pool of experts and then posted it in the arXiv repository. Depending on the feedback they get, the authors hope to submit it to a journal in the coming weeks.

FROM THEORY TO REALITY

But applying the theory to real geophysical data will not happen immediately, says Maarten de Hoop, a computational seismologist at Rice University in Houston, Texas. One difficulty is that the theory assumes that there is information at every point. In reality, however, data are collected only at relatively sparse locations.

The theory could lead to a better understanding of known features, such as the mantle plumes underneath Iceland or Hawaii, and, perhaps, to the discovery of new ones, adds de Hoop.

As with every meaty mathematical result, it will take time to get to grips with the proof and vet it thoroughly, says Gabriel Paternain, a mathematician at the University of Cambridge, UK. Experts are taking the claim seriously, in part because it builds on a technical step from a linear form of the problem that the community has accepted as a breakthrough", adds UCL mathematician Yaroslav Kurylev. So far, says Paternain, the impression is "excellent". ■

1. Stefanov, P., Uhlmann, G. & Vasy, A. Preprint at https://arxiv.org/abs/1702.03638 (2017).
2. Michel, R. Invent. Math. 65, 71–83 (1981).
3. Pestov, L. & Uhlmann, G. Ann. Math. 161, 1093–1110 (2005).
4. Uhlmann, G. & Vasy, A. Invent. Math. 205, 83–120 (2016).

SMART-BOX.PT

Technicians install sensors for the Perdigão wind-mapping project.

ATMOSPHERIC SCIENCE

Huge wind-flow study spins up

International team in Portugal seeks to improve models of wind patterns over rugged terrain.

BY ALEXANDRA WITZE

Machines have invaded a windswept rural valley in eastern Portugal. Squat white containers stare at the hillsides, sweeping lasers across the eucalyptus-studded slopes, and towers bristling with scientific instruments soar 100 metres into the air.

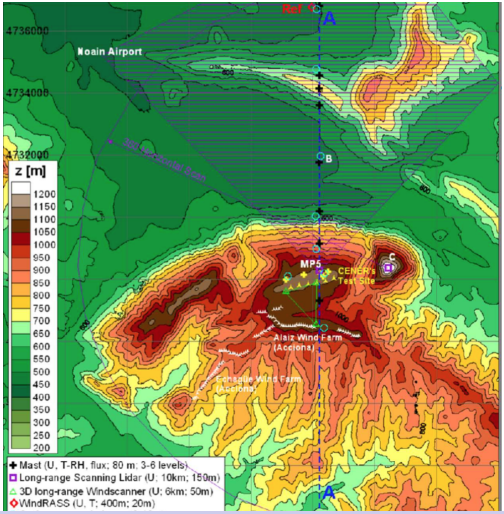
Their international team of minders will spend the next five months measuring nearly everything it can about the wind that blows through the site. An unprecedented arsenal of meteorological equipment will study speed, direction and other characteristics for the world's most detailed wind-mapping project. The aim is to illuminate fundamental properties of wind flow over complex terrain, to help researchers improve atmospheric computer models and enable engineers to decide where to put wind turbines to get the most energy from them.

The results of the project, called Perdigão, should also improve models of how air pollution sinks into valleys and help drones and aircraft to navigate gusty mountain terrain.

"This will be utterly transformative in both understanding the physics of the atmosphere and also how to optimally use wind energy," says Sara Pryor, an atmospheric scientist at Cornell University in Ithaca, New York, who

Complex terrain experiment at Alaiz

CENER's test station for wind turbines



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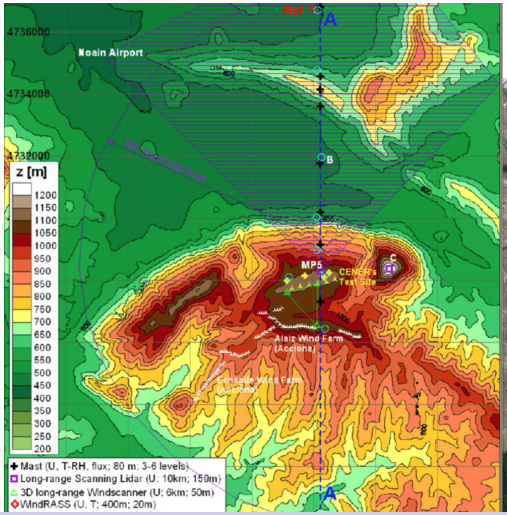

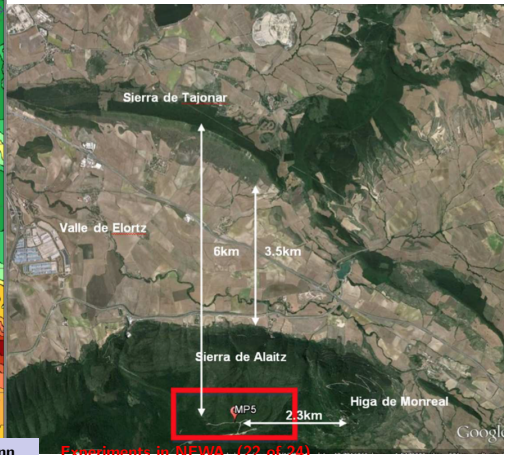

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- All experiments use lidar technology and are (more or less) on track
- Model comparison using experimental data are under way

Acknowledgments

and further reading

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Research

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