# Open Science in the New European Wind Atlas

JAVIER SANZ RODRIGO (CENER), JAKOB MANN (DTU), JULIA GOTTSCHALL (Fraunhofer IWES)

*On behlalft of the NEWA consortium*

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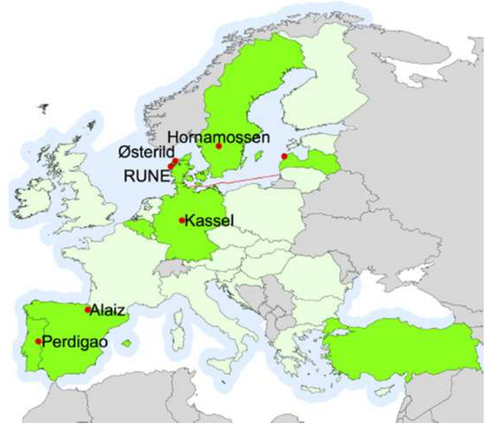
# Objectives of the NEWA Project

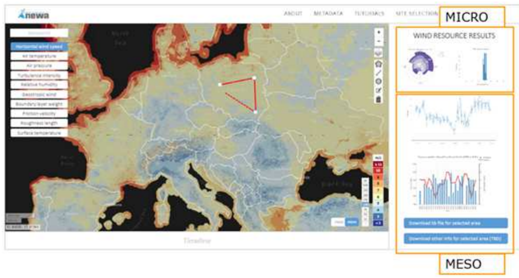
- Development of a high-value data base of **high-fidelity experiments**

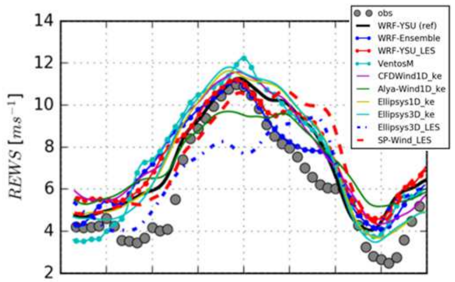
- Development of methodologies  for wind resource assessment and wind turbine site suitability based on a **mesoscale to microscale** mode-chain

- Publication of a **European Wind Atlas**  database accessible through a web interface

- Definition of a **verification and validation framework**  for the model-chain based on the experimental campaigns and means to quantify the **uncertainties** of the wind atlas

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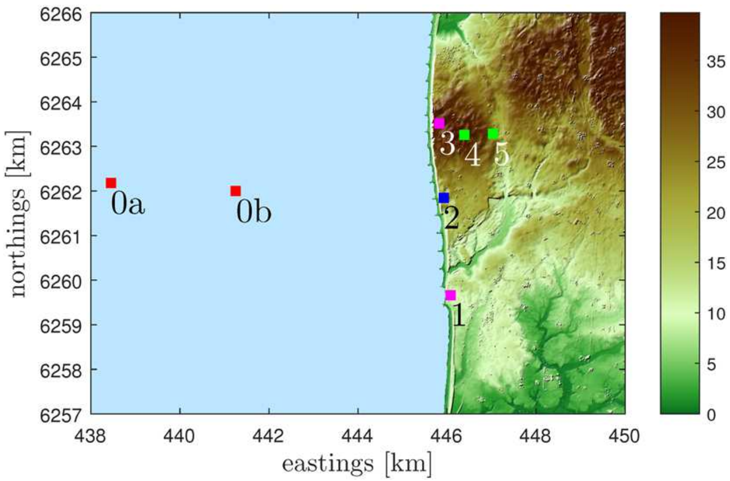
# Coastal and Offshore Experiments

## RUNE (Denmark)

Scanning lidars to investigate near-shore wind resources




Peña A, et al. (2016)

## FerryLIDAR (Baltic Sea)

Ferry-mounted profiling lidar to verify NEWA offshore wind atlas in the Baltic


Gottschall J, et al. (2017)

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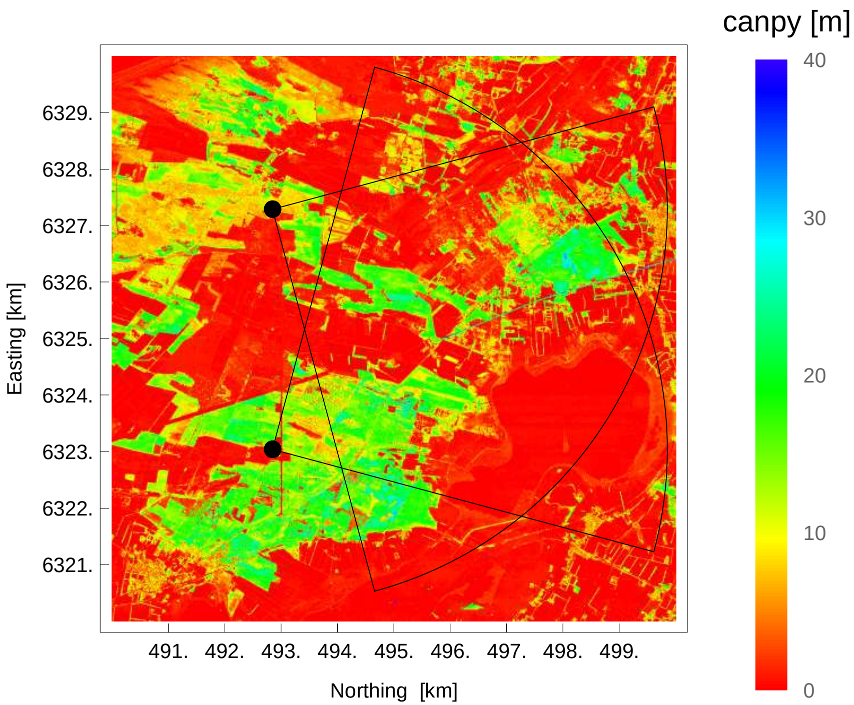
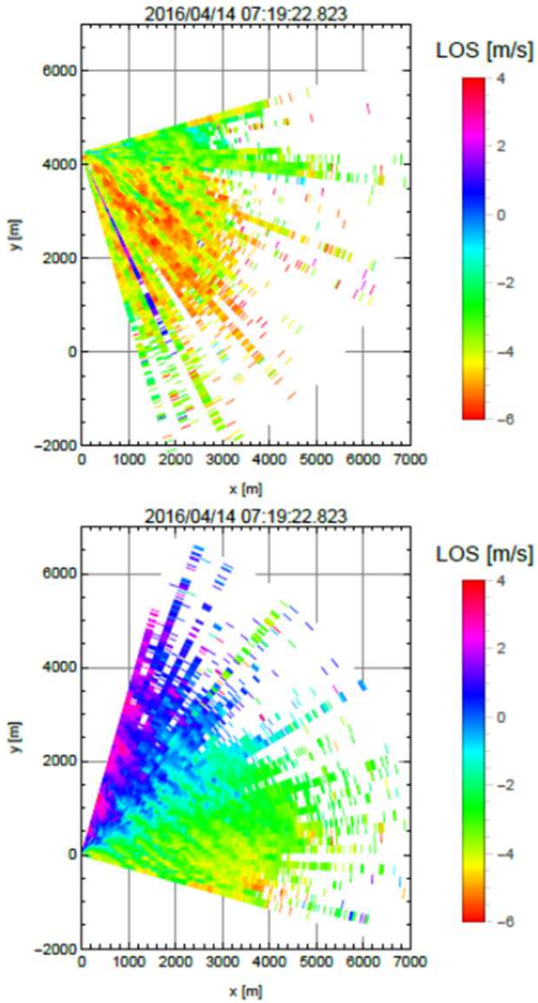
# Forested Landscape Experiments

## Østerild Balconies (DK)

Flat terrain with heterogeneous forest. Two horizontally scanning lidars on 250 m masts.




Karagali et al. (2017)

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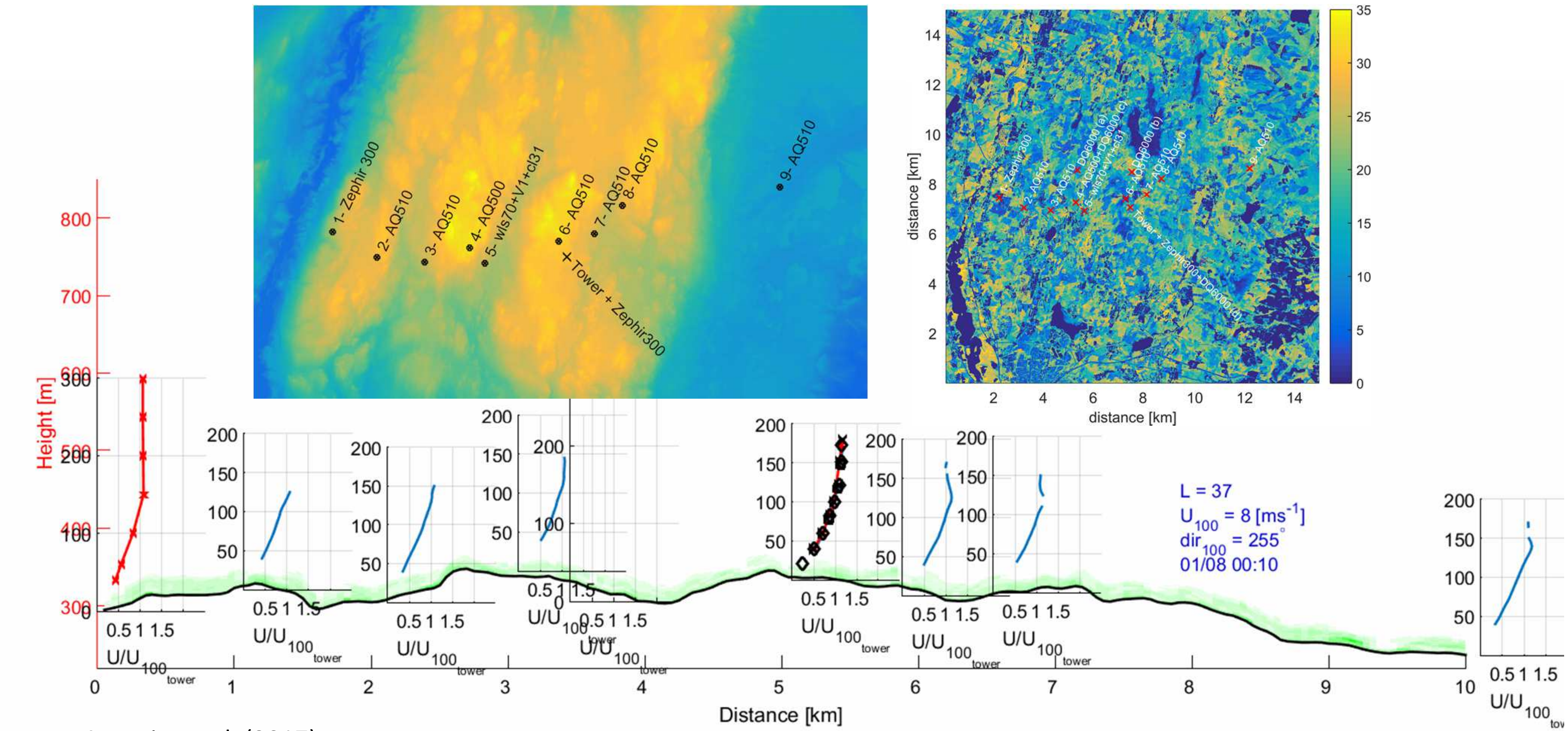
# Forested Landscape Experiments

## Hornamossen (Sweden)

Sodars, lidars and mast on a transect in rolling hills with forest.

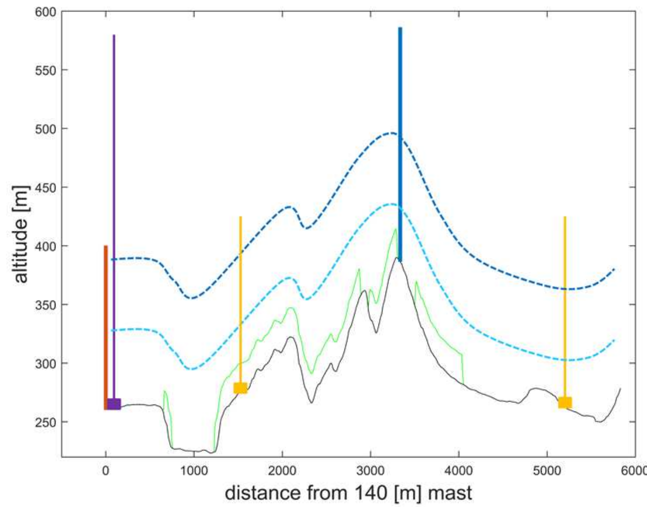


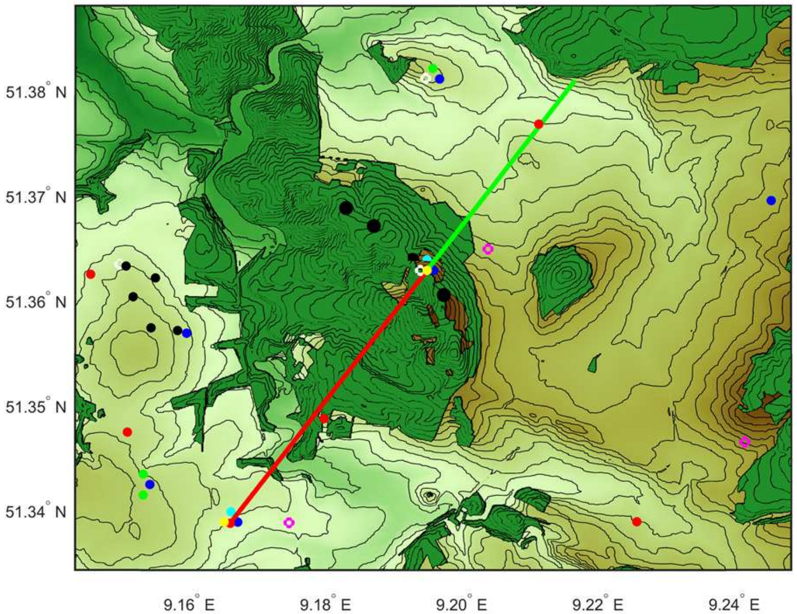

Arnqvist et al. (2017)

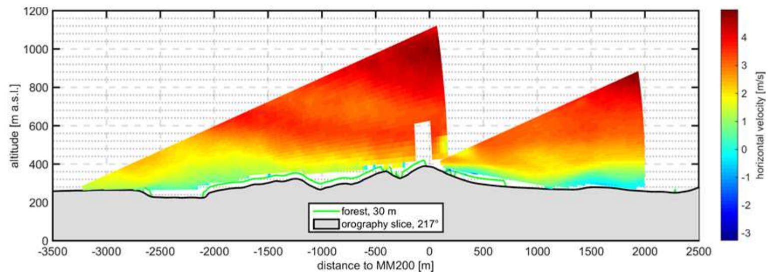
# Isolated Forested-Hill Experiment

## Rödeser Berg (Germany)

A tall forested hill with six scanning lidars, profiling lidars, sodar, and two met masts.




Kühn P, et al. (2017)

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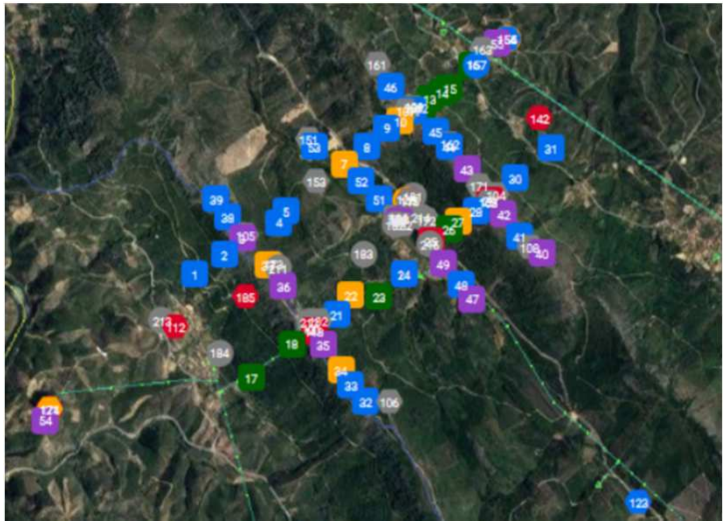
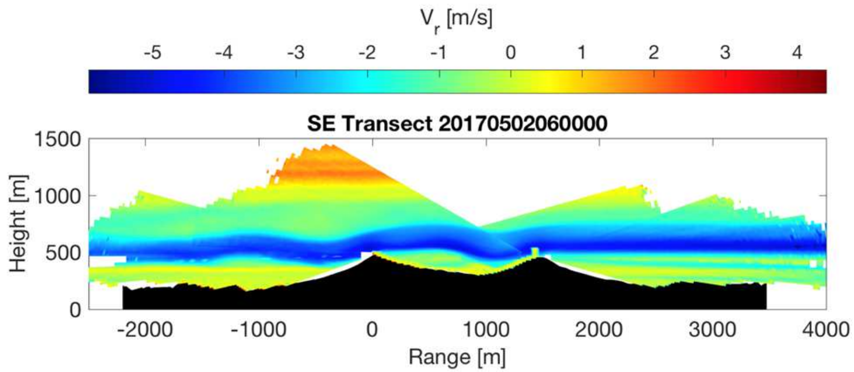
# Complex Terrain Experiments

## Perdigão (Portugal)

- Most comprehensive dataset for model evaluation in complex terrain to date
- Participation of 21 institutions (13 European + 8 USA) from 7 countries contributing with 72 field participants
- 186 3D sonic anemometers on 50 masts
- 20 scanning lidars + 7 profiling lidars
- Various temperature profilers, ballon launched every six hours, radars, etc






Palma et al. (2017)

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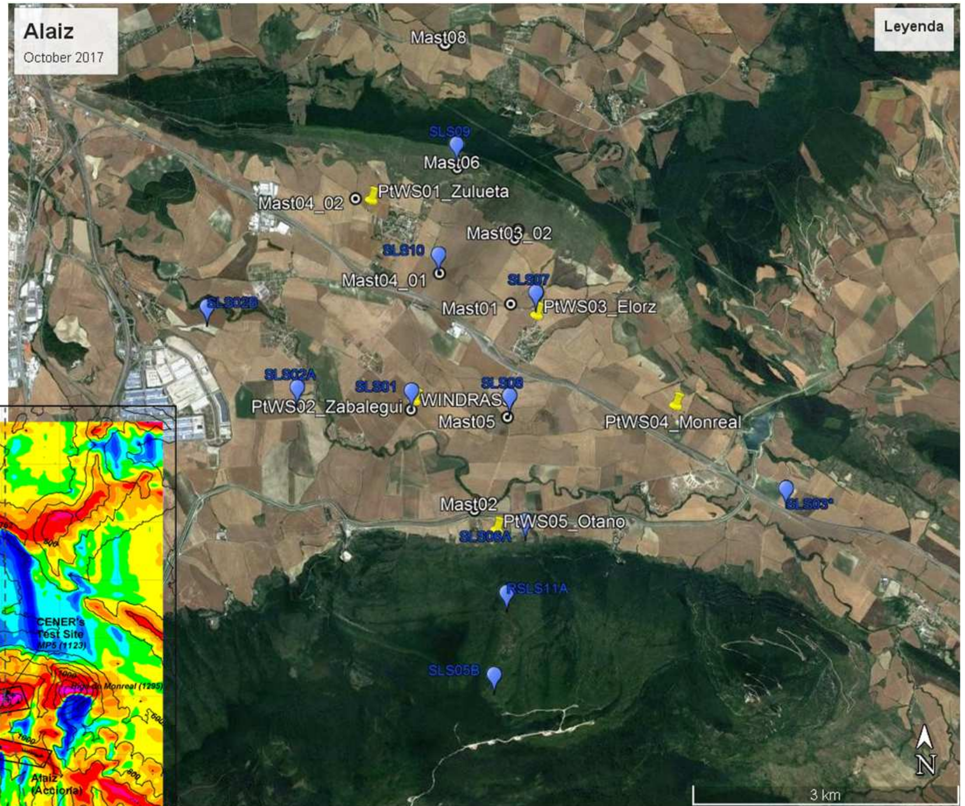
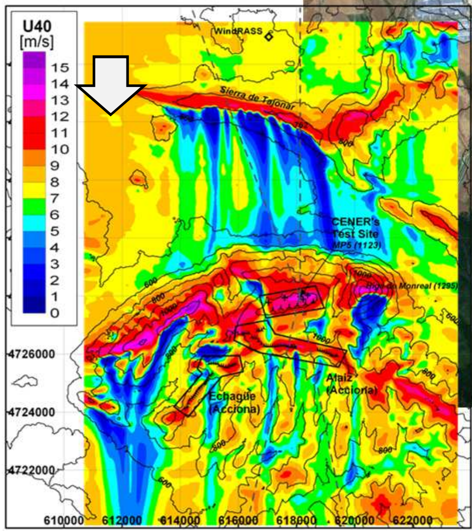
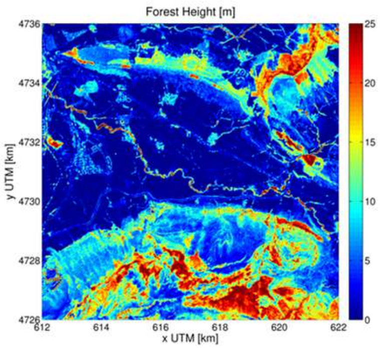
# Complex Terrain Experiments

## ALEX18 (Spain)

- Ridge-valley-mountain inflow conditions to Alaiz test site
- 5 scanning lidars
- 8x80 m met masts
- 10 surface flux stations
- CENER's Alaiz test site (4x118 m masts)



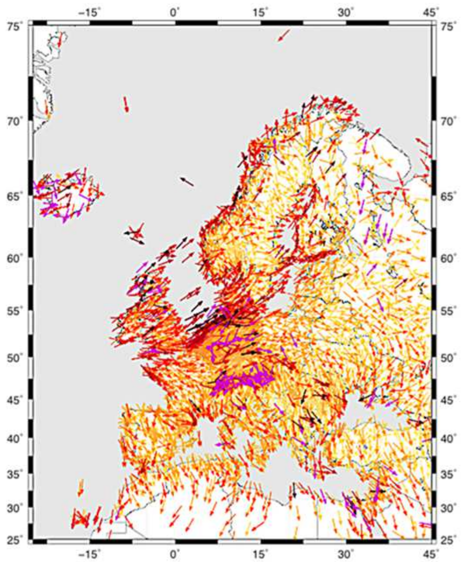




Cantero et al. (2016)

# Wind Surface European Database (WiSED)

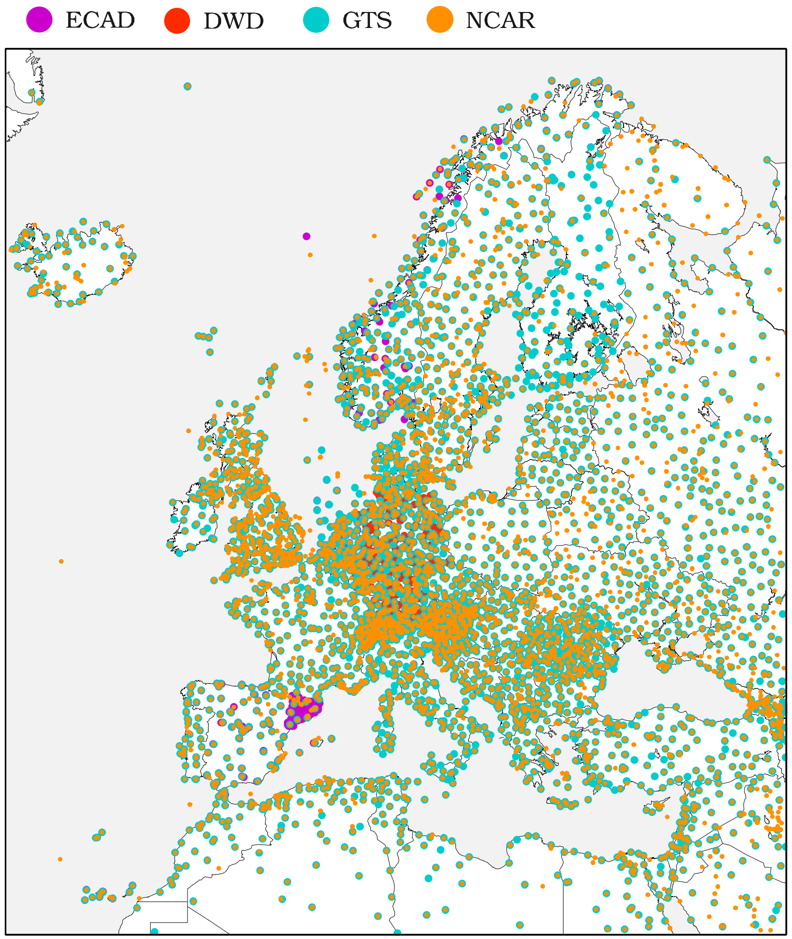
## WiSED

- Characterization of the whole European territory.
- 15000+ long term series.
- Wind speed and direction.
- Specific Quality Control procedure for wind observations




Gonzalez Rouco F, et al. (2017)

*Total stations before quality control*



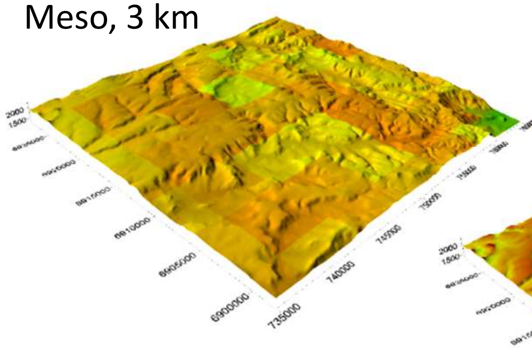
# NEWA Open Source Model-Chain

## Wind Atlas
## WRF-WAsP

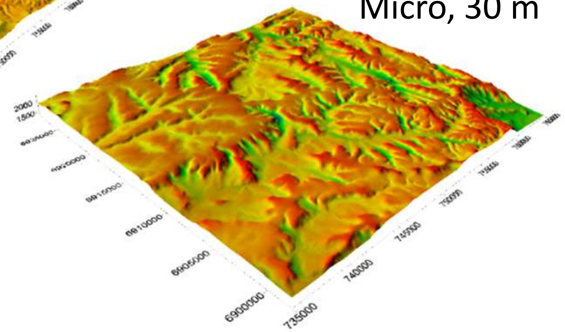
- Driven by **ERA5** reanalysis
- 30-year wind atlas integration at 3 km resolution with WRF
  - ➢ Time-series
- Downscaling to 30 m using WAsP generalized wind methodology
  - ➢ Statistics
- Mesoscale multiphysics ensemble
  - ➢ Uncertainties

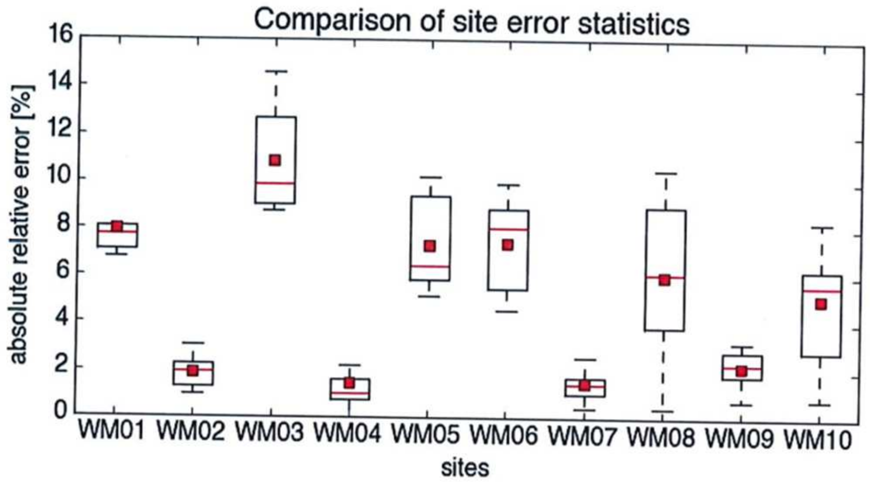
→ Open-source WRF config. files and modified source code

Meso, 3 km



Micro, 30 m






Hahmann A, Mortensen NG, et al. (2017)

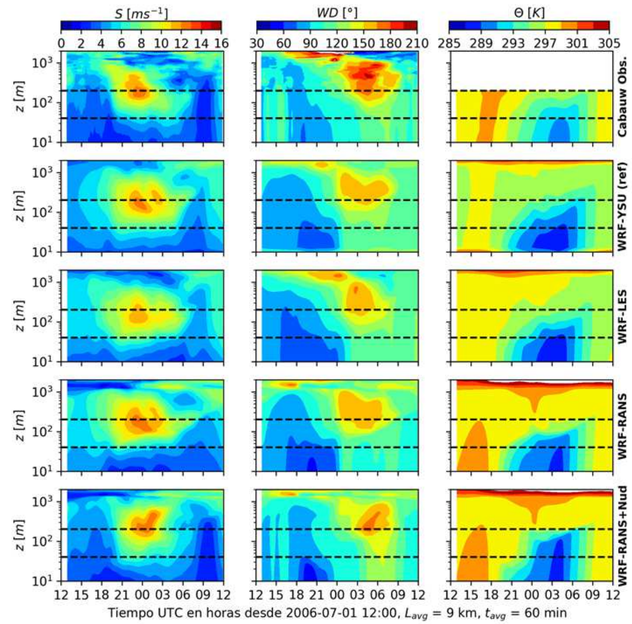
# NEWA Open Source Model-Chain

## Microscale
## Models for Siting

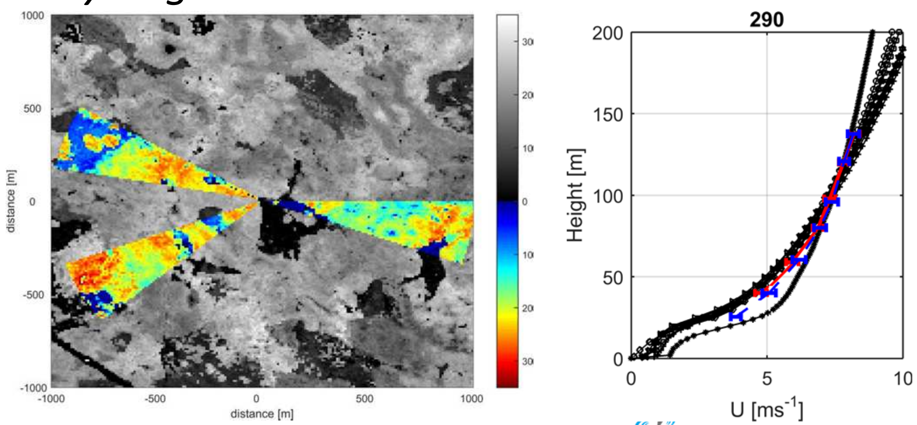
- Based on RANS or LES
- Driven by mesoscale forcings
- Diurnal-cycle thermal stratification
- Surface-layer characterization based on aerial lidar scans of vegetation canopy

→ Open-source URANS model built on OpenFOAM

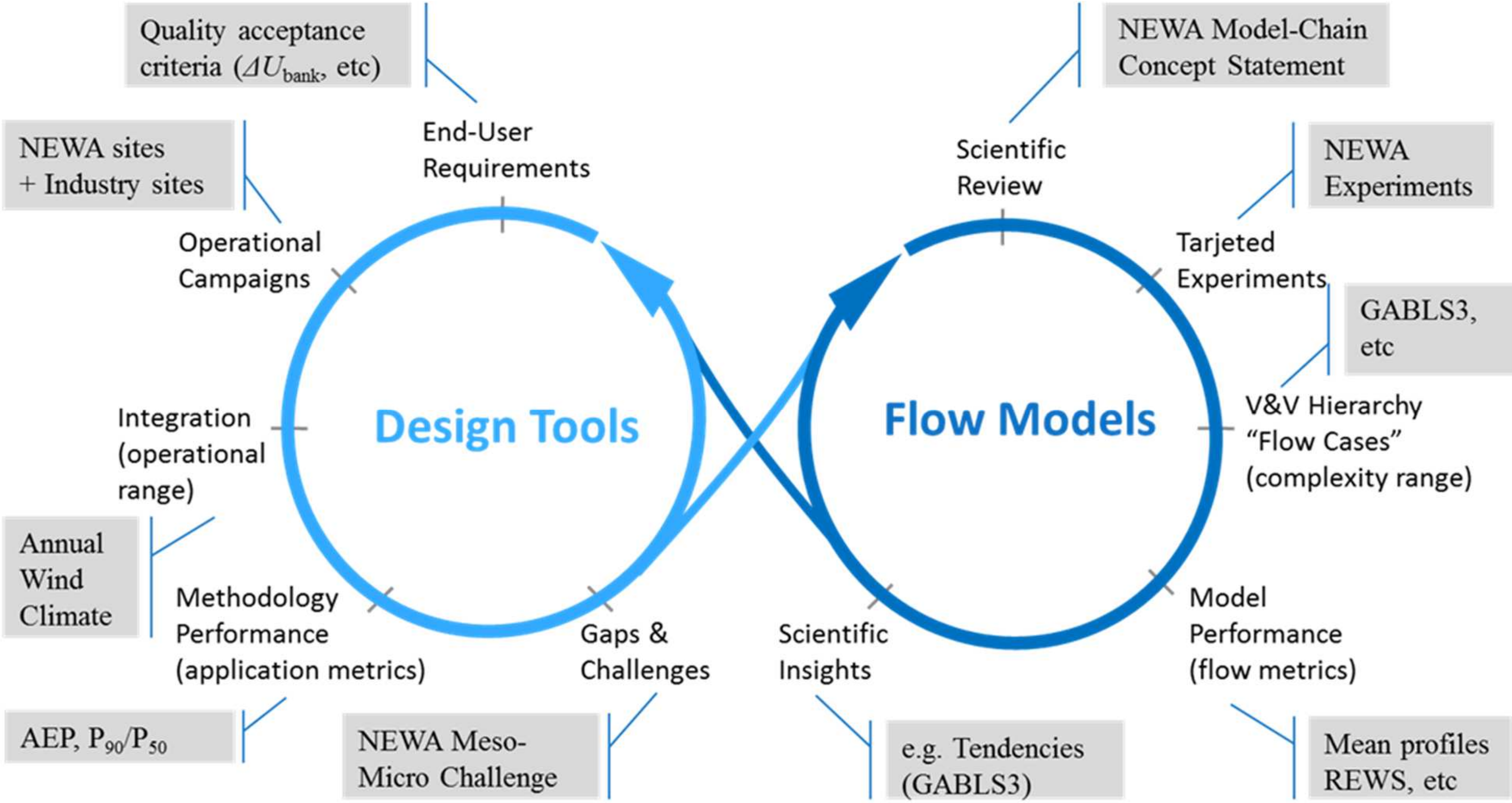
*GABLS3* Sanz Rodrigo J, et al. (2017)




*Ryningsnäs* Arnqvist J, et al. (2017)

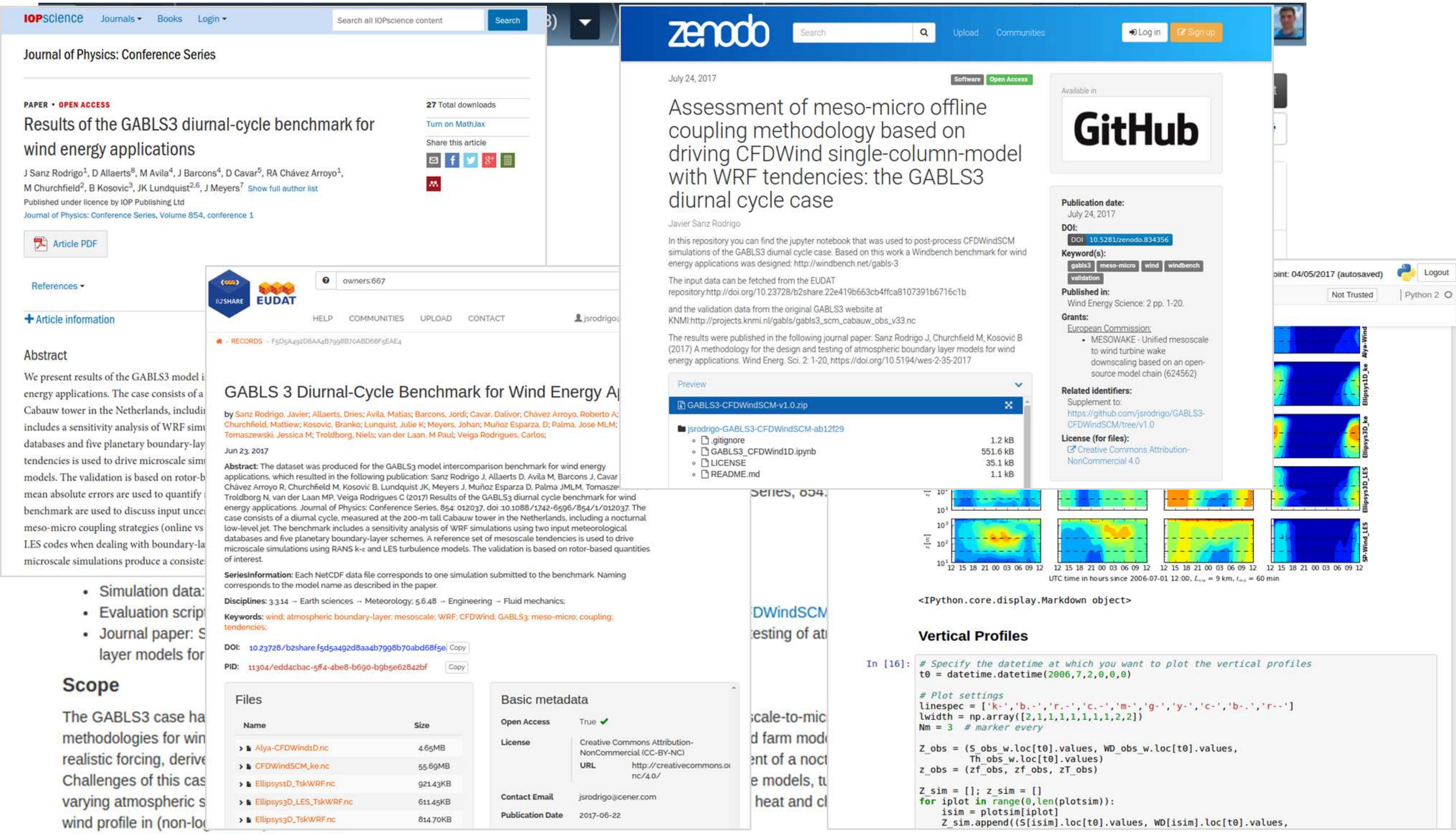


# Verification & Validation Framework




Sanz Rodrigo J, et al. (2017)

# Open Science Benchmarking




Sanz Rodrigo J, et al. (2017)

# Wind Atlas Output Parameters

## Mesoscale wind atlas

3 km, 30 years, 8 heights up to 500 m

- 30-min **time series** data and statistics
- Profile data: wind speed, direction, temperature
- Other characteristics: surface pressure, Monin-Obukhov length, geostrophic wind,boundary-layer height, friction velocity, roughness length

Additional parameters:

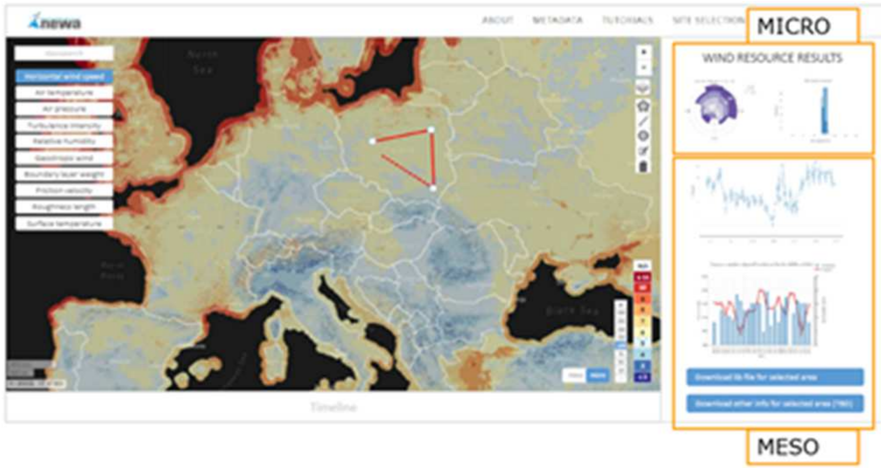
- Extreme winds (applying spectral correction method)
- Icing classes (in particular for cold climate)
- Uncertainty quantification (applying multi-physics-ensemble approach)

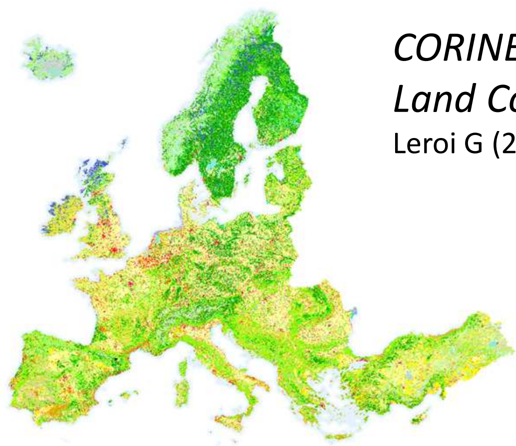
## Microscale wind atlas

30 m, 3 heights (50 m, 100 m, 200 m)

- Wind resource **statistics**

Bauwens I, et al. (2017)



*CORINE*
*Land Cover 2012*
Leroi G (2017)

Hahmann A, et al. (2017)

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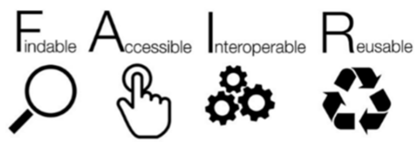
# Conclusions: Open-Access Resources

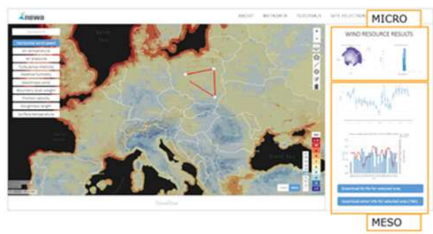
- **NEWA open-source model chain** based on WRF and OpenFOAM (beta release in Jan’18)

- **Database of experiments**, released throughout 2018 from the NEWA data server




- **Validation benchmarks** released through Windbench.net and open to external participation within the IEA Task 31 Wakebench

- **EU Wind Atlas database and web interface**, release at NEWA final workshop  next to WindEurope 2019 (April 2019)

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- Latvijas Zinatnu Akademija (Latvia)
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- Ministerio de Economía y Competitividad (Spain)
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- The Scientific and Technological Research Council of Turkey (Turkey)


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