

Scalable Offshore Wind Analysis With Pangeo

Derek O'Callaghan and Sheila McBreen

University College Dublin

EGU General Assembly ESS12.7 - May 25th 2022

Sustainable Energy Authority of Ireland (SEAI) funded project

Case Study Objectives

1. Investigate use of open EO etc data to increase wind measurement coverage of Irish Continental Shelf (ICS), for renewable energy assessment of offshore Areas Of Interest (AOIs)
2. Scalable data processing for offshore wind analysis e.g. wind speed extrapolation, power density estimation
3. Prototype wind atlas, demonstrating interactive offshore AOI wind and power density maps

Pangeo/Python Software Ecosystem



ICS Wind Intake Catalog

Zarr Stores/CSV 2001-2021



Products (NetCDF/GRIB) retrieved (API/Utilities, HTTPS, SSH)

Preprocessing e.g.

- ▶ Wind speed/direction from u , v variables (MetPy)
- ▶ Level-3 regridding (xESMF)
- ▶ Variable chunks with Dask arrays

Zarr stores created with xarray/Dask/rechunker

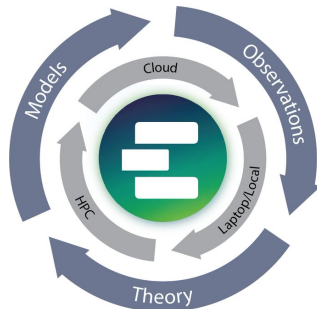
Data	Provider	Time	# Products	Products Size (GB)	Zarr (GB)
ASCAT Near Real Time L3 Sea Winds	Copernicus Marine Service	2016-01 to 2021-09	324	16	11
ASCAT Reprocessed L3 Sea Winds	Copernicus Marine Service	2007-01 to 2021-07	412	21	14
CCMP Wind V2.1 NRT	Remote Sensing Systems	2015-01 to 2021-09	2,436	109	0.5
ERA5 Hourly Single Level	Copernicus Climate Change Service	2001-01 to 2021-09	249	9.9	16
Met Éireann Re-Analysis (MÉRA)	Met Éireann	2001-01 to 2016-12	1,920	226	196
New European Wind Atlas (NEWA)	NEWA	2009-01 to 2018-12	14,611	27	20
Sentinel-1 L2 OCN	Copernicus Open Access Hub Alaska Satellite Facility	2015-06 to 2021-09	17,698	241	1.2
Irish Weather Buoy Network	Marine Institute	2001-05 to 2021-09	1	0.08	n/a

Scalable Wind Analysis

Lazy execution with xarray + Dask for AOI assessment

- ▶ Original variables e.g. mean wind speed over time
- ▶ New/extended variables e.g. wind speed extrapolation to turbine hub height; power density estimation
- ▶ **Variables computed as required -> reduces redundant storage requirements**

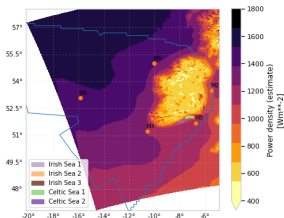
Same approach used for all data sets (size agnostic)



Julius Busecke 2022

Scalable Wind Analysis

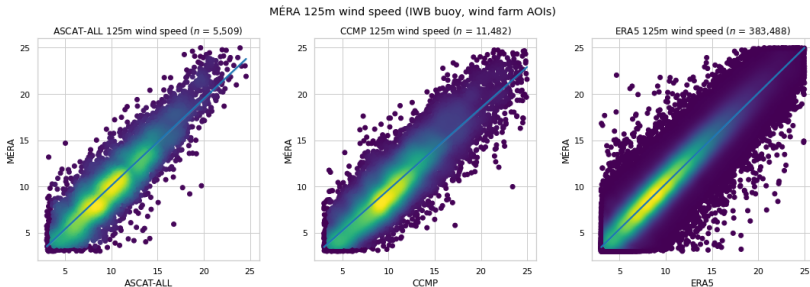
Example Outputs



MÉRA 125m ICS power density estimate

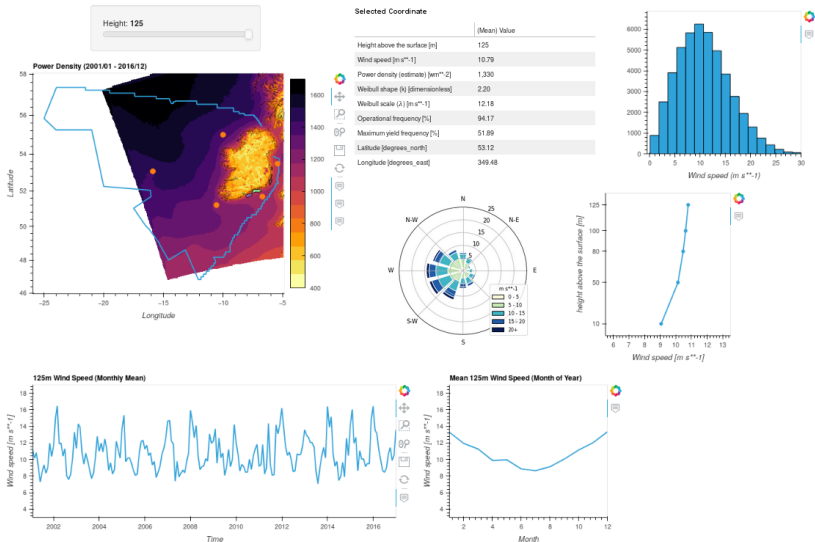
	n	RMSE	MAE	Bias	R^2	r
ASCAT-ALL	25,368	2.565	2.000	0.194	0.679	0.829
ASCAT-WQF	21,238	2.529	1.973	0.202	0.691	0.836
CCMP	21,104	2.554	1.995	0.665	0.658	0.841
ERA5	712,940	2.324	1.782	-0.607	0.731	0.866
Sentinel-1	2,410	2.912	2.265	-1.043	0.550	0.791

NEWA 150m wind speed comparison



Scalable Wind Analysis

Interactive Wind Atlas



Current Jupyter notebook outputs available at EOffshore website: <https://eooffshore.github.io>

- ▶ Zarr store creation
- ▶ Processing and wind atlas prototype
- ▶ Executed using Pangeo Docker base image

Plan to release data sets, possibly via Pangeo Forge

Acknowledgements

- ▶ SEAI funding
- ▶ AWS credits
- ▶ Data providers
- ▶ Pangeo/Python library teams

 @dgcollaghan @EoOffshore