DESTINATION EARTH

On-demand Extreme Events Digital Twin: Renewable energy

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DE_330-MF: Workpackage DE33012 Renewables & Health

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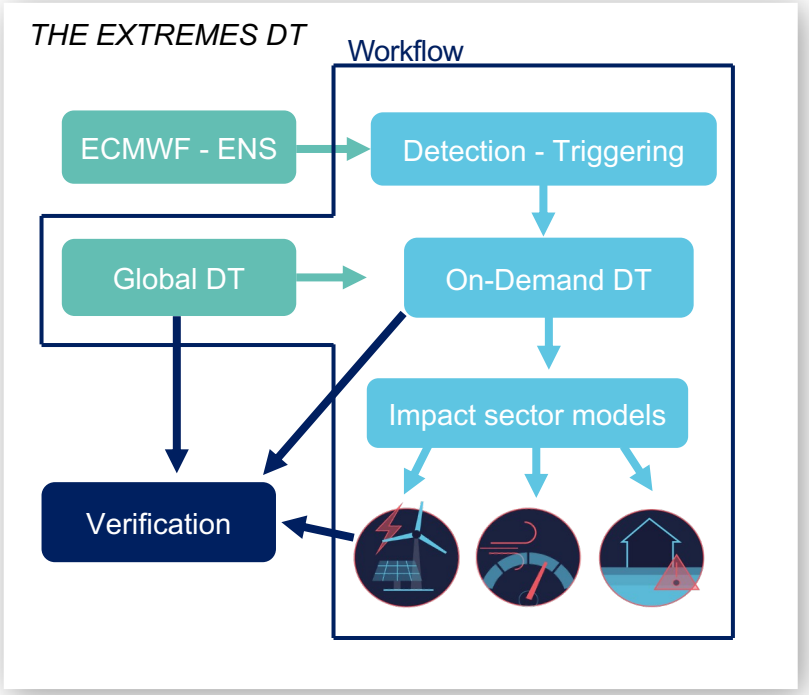
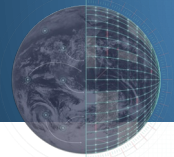
Destination Earth implemented by ECMWF esa EUMETSAT

The DE_330-MF On-demand Extremes Digital Twin in short

- A pan-European system and service combining weather and impact-specific observation and simulation capabilities
- Detection of possible extreme events, including severity levels, and triggering of the:
- Configurable, flexible, and scalable workflow with hectometric and, for some impact sectors, sub-hourly resolved NWP predictions that feed/connect to the different impact sectors





The renewable energy impact model(s)

Focus:

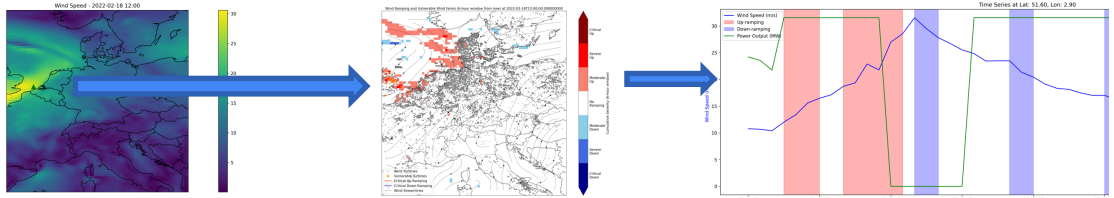
- **wind energy** production predictions in case of events
- **solar irradiance nowcasting** using satellite data w/o NWP data
- **PV production predictions**, including the (future) option to include satellite nowcasts
- **Definition of events** and defining of meteorological **detection thresholds/algorithms** for renewables events serving as triggering information (user interaction)
- **Covering uncertainties** and **product definition** helpful for users
- Compiling metadata for wind farm parametrizations and post-processing

Extremes – Definitions, detection, users

What are extremes for the you in terms of renewables? As an operator, TSO, DSO, owner, trader, etc.?

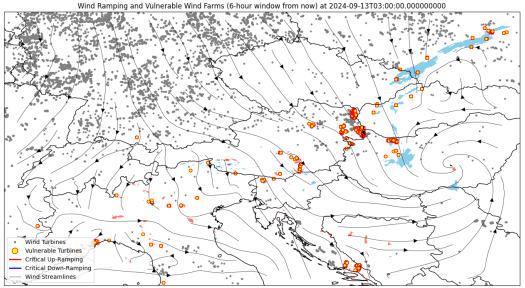
→ Different users, different types of turbines/panels, etc. = different needs

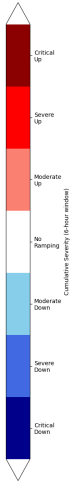
→ What needs to be detect, what can be used from the meteorological side? Ramping, gustiness plot, and EUNICE and Boris case



Storm Eunice – wind speed ramping

Storm Boris





Extremes – Definitions, detection, users

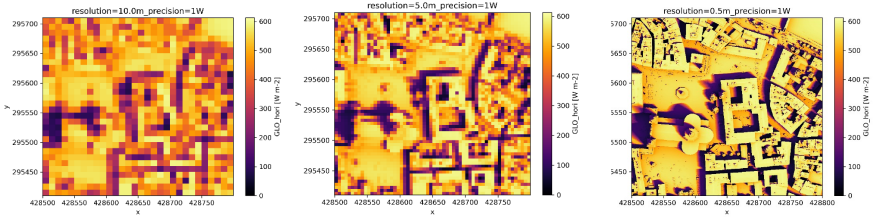
You can help us:

By answering a long and exhaustive questionnaire where we want to know you shoe size (just kidding)

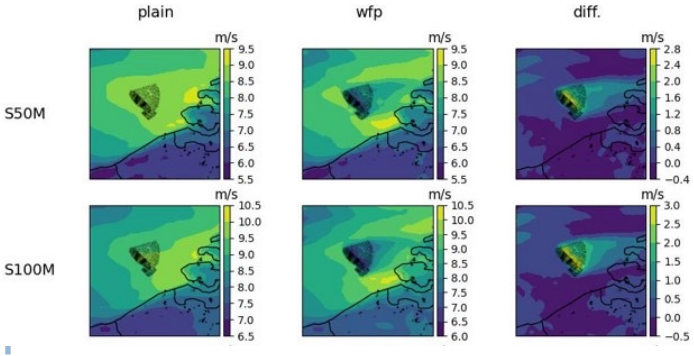
Play with a critically matrix of events

NWP configurations for events & metadata

- Both wind and solar need high spatial and temporal resolution → we use 5 minute frequency in forecasting and appr. 250m spatial resolution



- NWP configuration for wind power uses wind farm parametrization:



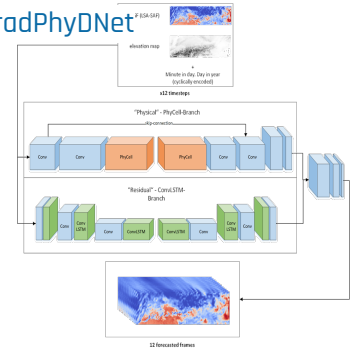
Need to know what type of turbine and the specifications for proper representation!

	Name	turbine type	rated power (MW)	Rotor diameter	hub height	cut-in wind speed (m/s)	rated wind speed (m/s)	cut-out wind spee (m/s)
0	Belwind	V90	3	90	72	3.5	15	25
1	Belwind	AH150	6	150	100	3	15	25
2	CPower	Senvion-6M	6.15	126	96	3.5	14	30
3	CPower	Senvion-5M	5	126	95	3.5	14	25
4	Mermaid	SG-D8	8.4	167	196	3	13	28
5	Nobelwind	MVOW-V112	3.3	112	135	3	13	25
6	Norther	V164	8.3	164	180	4	13	25
7	Northwind	MVOW-V112	3	112	127	3	12	25
8	Northwester 2	V164-9.5	9.5	164	180	3	14	25
9	Rentel	Siemens-D7	7.35	154	196	3	13	25
10	Seastar	SG-D8	8.4	167	196	3	13	28

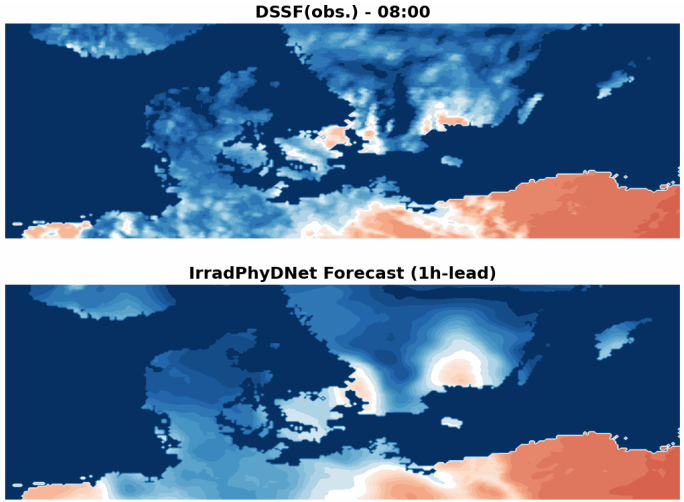
Solar nowcasting using satellite data

Data-driven and hybrid (data-driven + NWP) models

IrradPhyDNet



CMV (hybrid model)
& OF (optical flow)



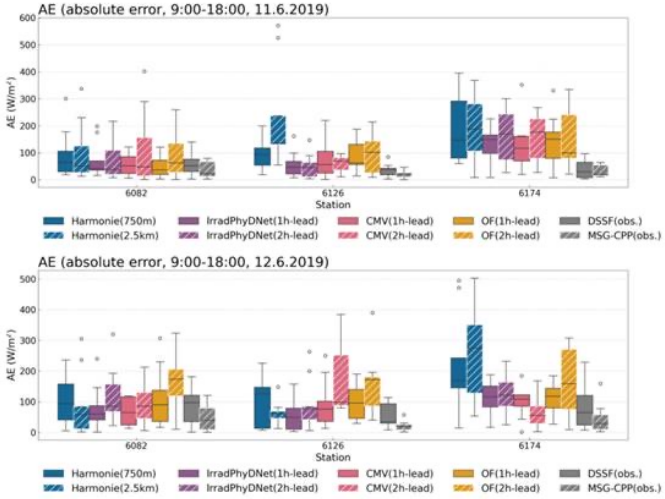
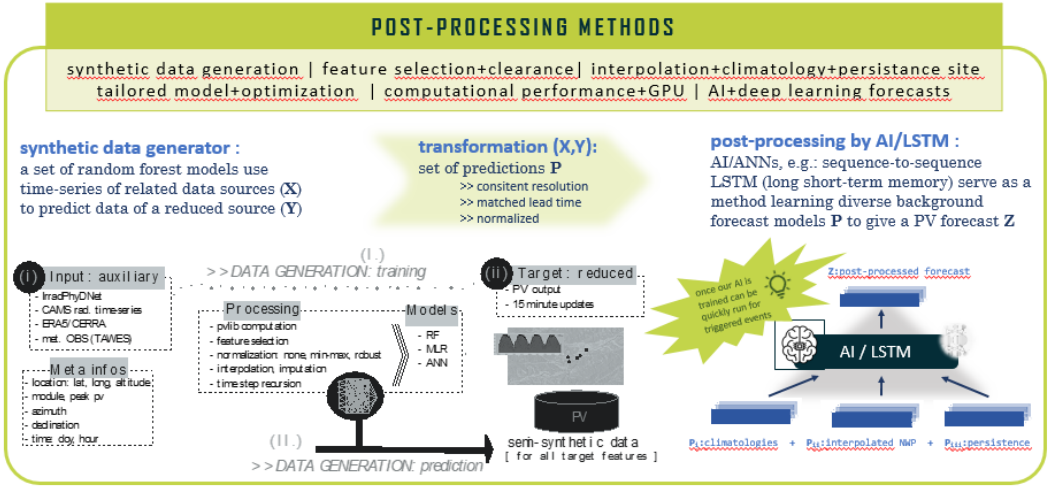


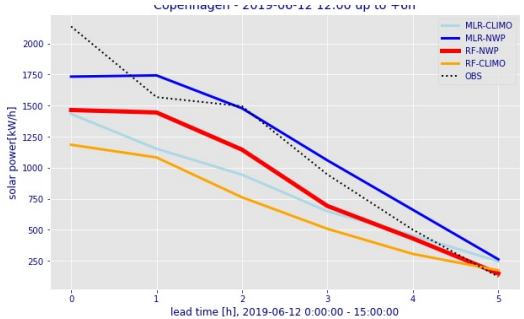
Figure 2: Boxplots of the absolute error of the satellite observations (DSSF (obs), MSG-CPP(obs)) and forecasts (same set as in Figure 1) against ground-based measurements at three stations in Denmark on 11 and 12 June 2019.

PV production post-processing

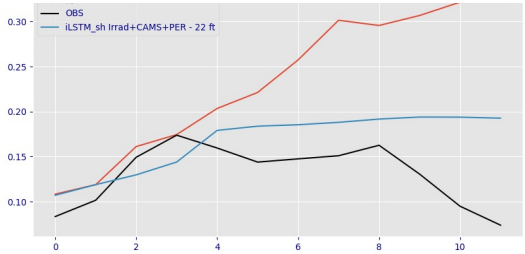
How does it work and why do we need synthetic data?



Use case Denmark 2019



Use case Austria using IrradPhyDNet as extra feature



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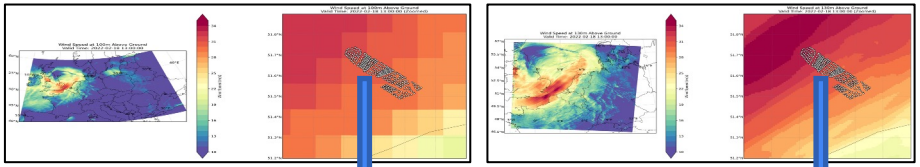
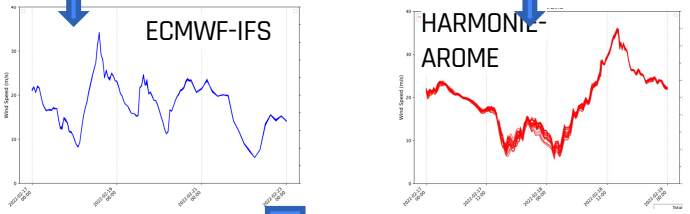
Wind post-processing workflow & added value of hectometric resolution

Step 1: NWP model data (multi-model f. uncertainty)

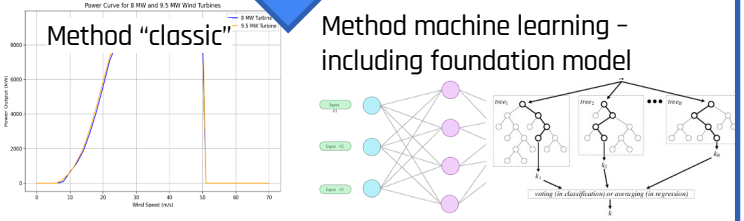
Coarse NWP model (e.g. ECMWF-IFS) vs. HARMONIE-AROME 750 m with WFP



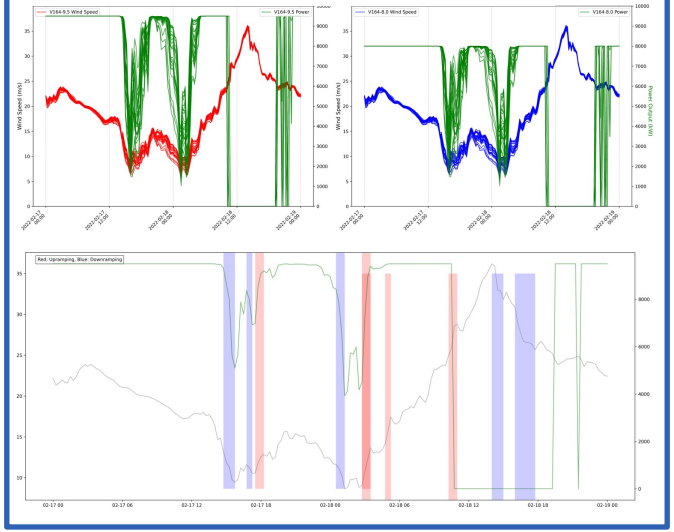
Step 2: extract meteorological



Step 3: convert to power



Step 4: power prediction including ramping and different uncertainty levels



ECMWF

Next steps:

- satellite nowcasting (one model) and first wind energy post-processing model operational
- Results questionnaire on extremes definitions available
- Concise metadata first iteration available

End of November

- Detection algorithm refinement and implementation of user feedback
- PV production prediction operational

End of February

Product refinement and coverage of level of uncertainty ongoing processes.