RES – Multiscale weather prediction for Renewable Energy Sources

HIDALGO2
CENTRE OF EXCELLENCE

Wojciech Szeliga
PSNC

Poznan Supercomputing and Networking Center

affiliated with the Institute of Bioorganic Chemistry
of Polish Academy of Sciences

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- R&D institution recognized in EU:
  - working in the field of ICT technologies
  - providing HPC, cloud, storage and networking infrastructure for science, research and development

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  - 200+ in total
  - 70+ Horizon 2020
  - coordinating 35 of them

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  - coordinating 35 of them
- Our headquarters, The Polish Optical Internet Research Center:
  - multiple laboratories
  - Altair & Eagle supercomputers
  - Main node of national optic fiber network PIONIER
  - Infrastructure and services associated with European intiatives such as PRACE, EUDAT, EOSC, EuroHPC

Renewable energy sources at PSNC

Modeling:

- Large Scale Applications and Services Department
- 10+ years experience in climate modeling: weather prediction, code optimization, visualization
- 5+ years experience in modeling for wind farms
- Currently focused on climate & environment models with uncertainty quantification and coupled with HPC job orchestrator QCG; HPDA+AI

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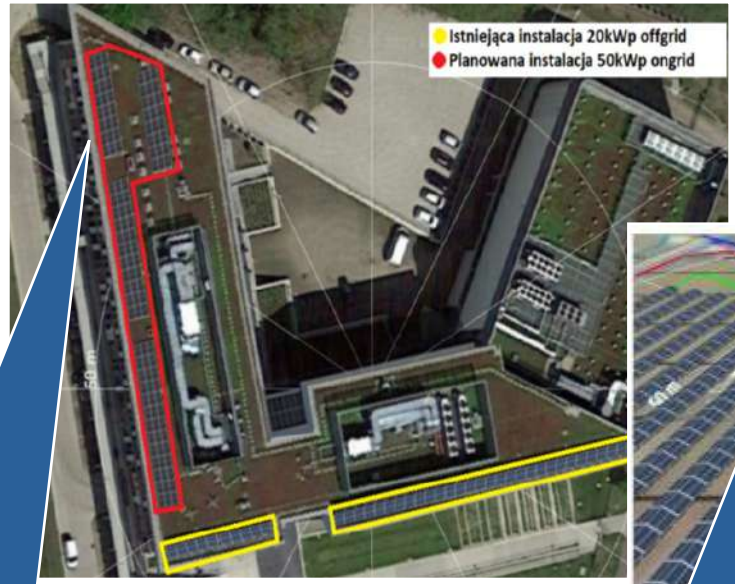
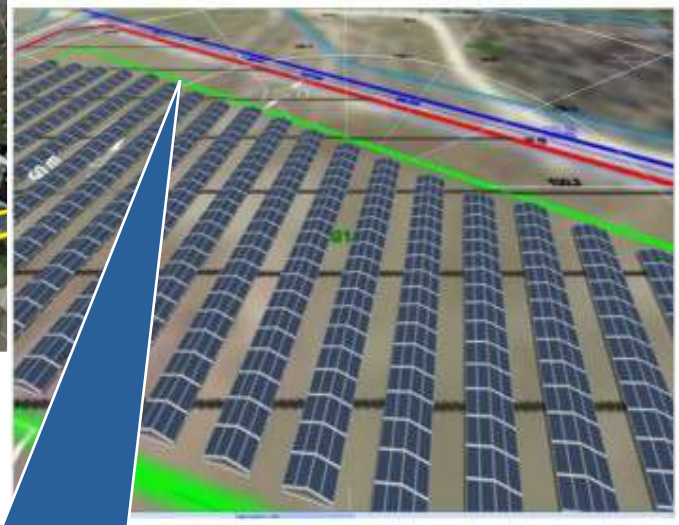
Infrastructure:





PSNC HQ
20 kWp off-grid oraz 50 kWp on-grid – dedicated lab with energy storage

Kąkolewo, Poland
990 kWp

Challenges:

- Finding the best locations for new objects
- Improvement of energy production predictions
- Enhancement of grid stabilization
- Prediction of damages to infrastructure due to weather conditions

Renewable energies

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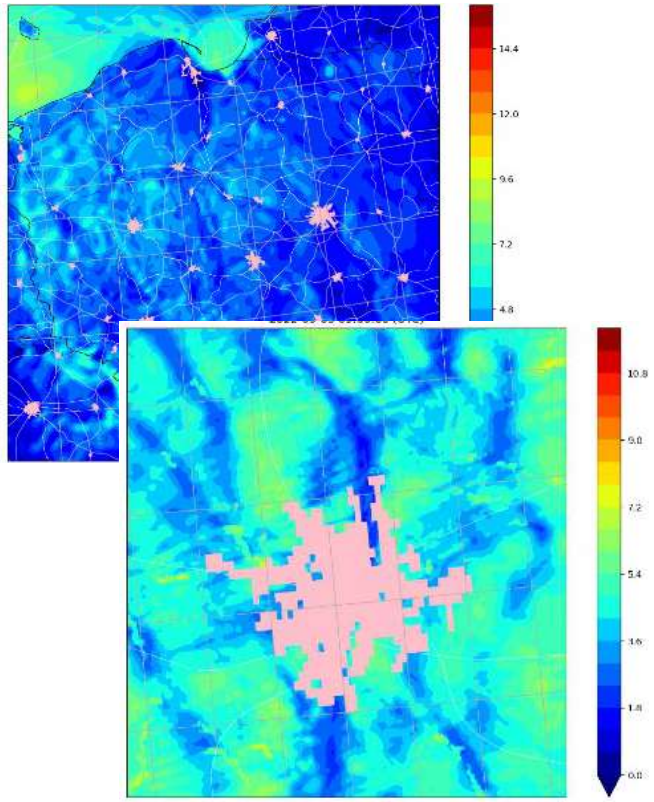
Our solution: RES software:

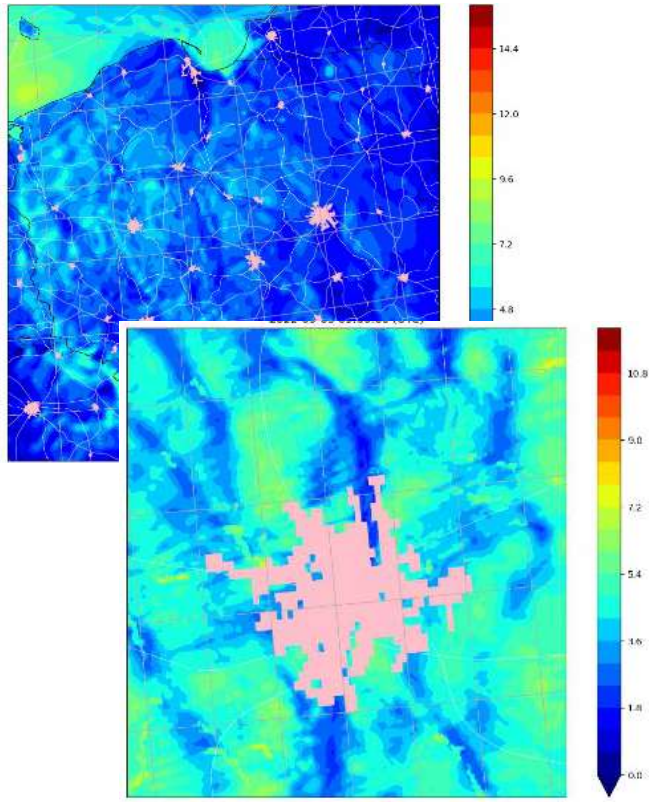
- Orchestrator of two meteorological software packages in the backend for different scales
- Provides an easy and automated workflow for several application
- Uses input data of several types from multiple sources
- Enhances resolution of forecasts up to scale of several meters
- Estimates energy production

Applications of the software



fine-grained weather prediction of general usage

Applications of the software



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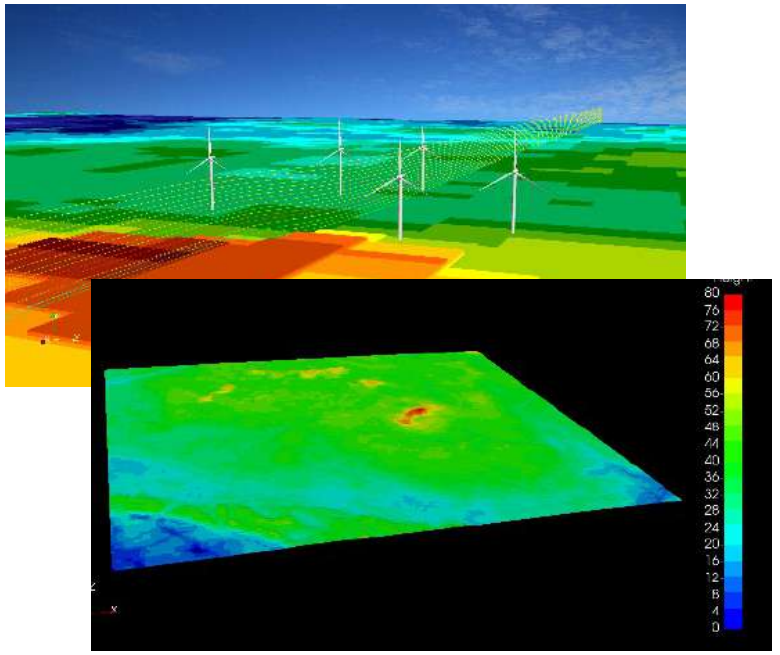
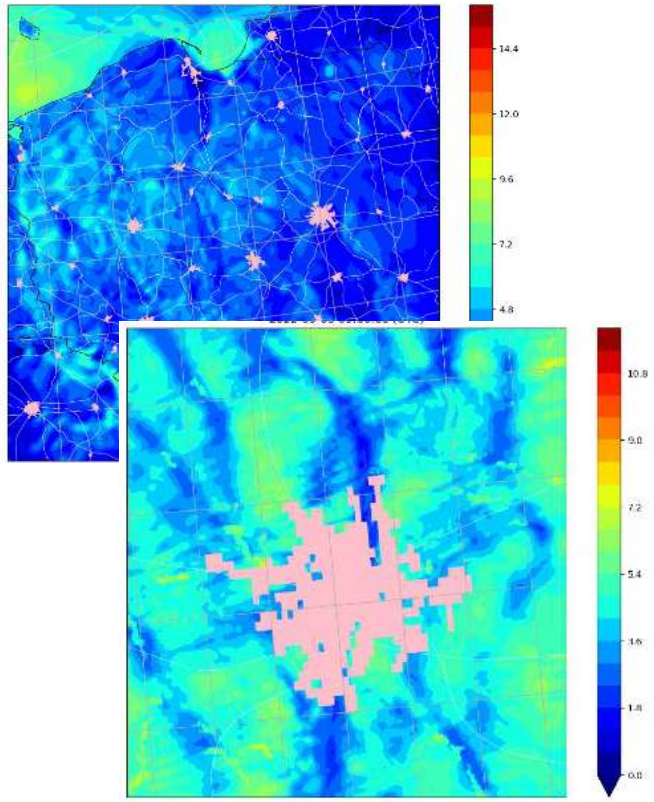


predictions
for renewable energy sources
operators

- Individual forecast data
  for each turbine
- energy production modeling
- customizable wind profile
- support for solar panels

Applications of the software



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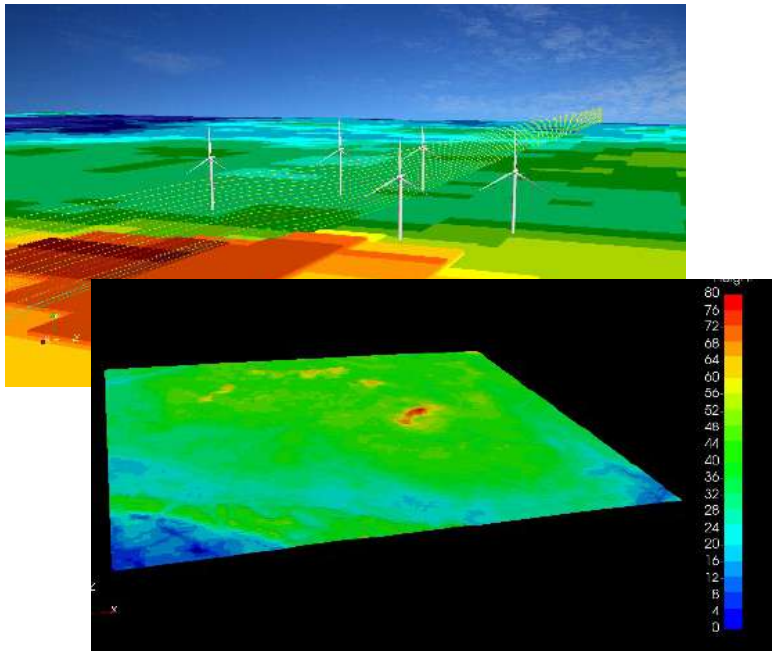

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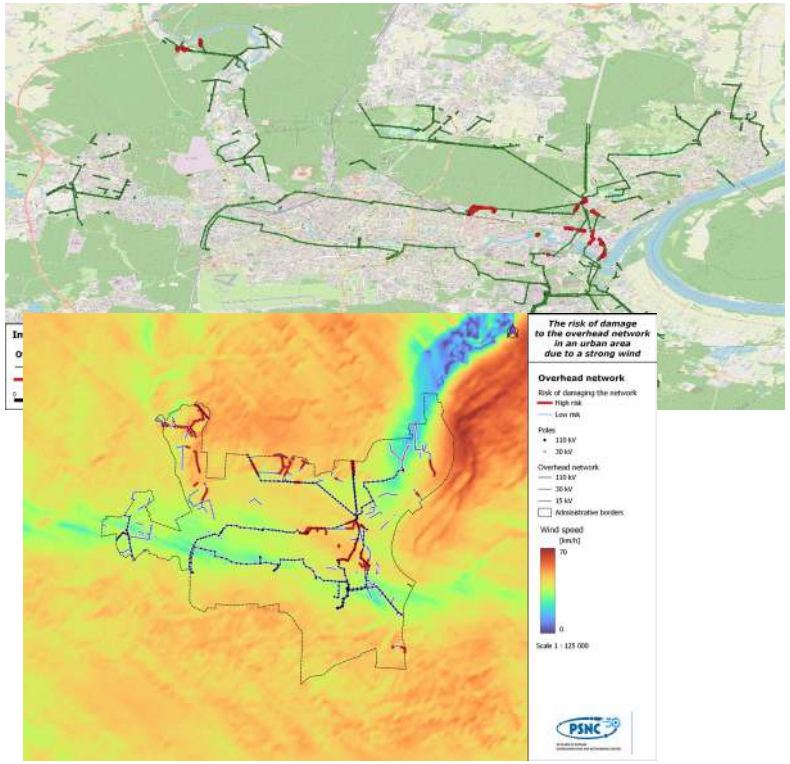
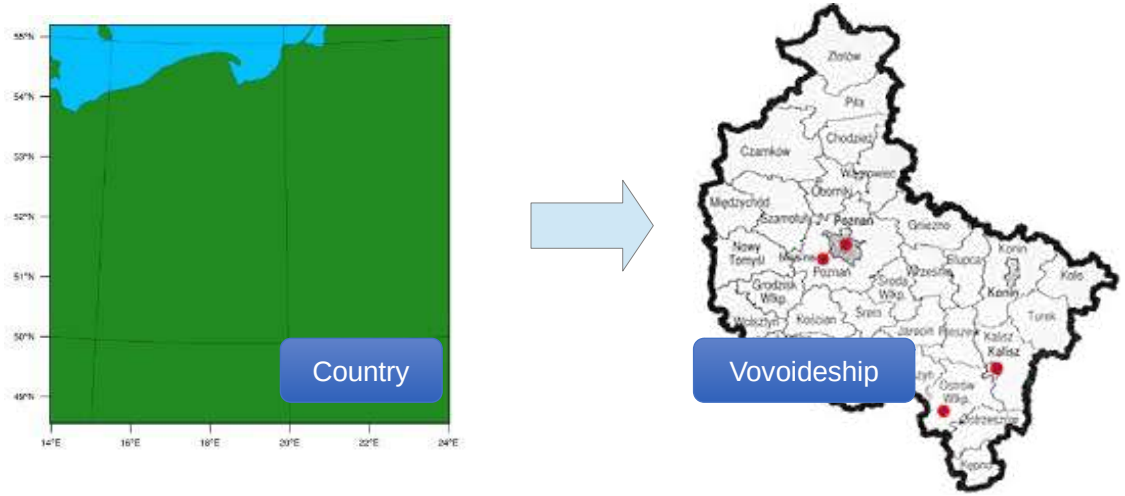
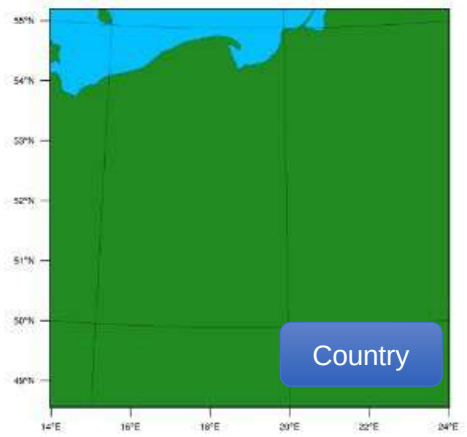


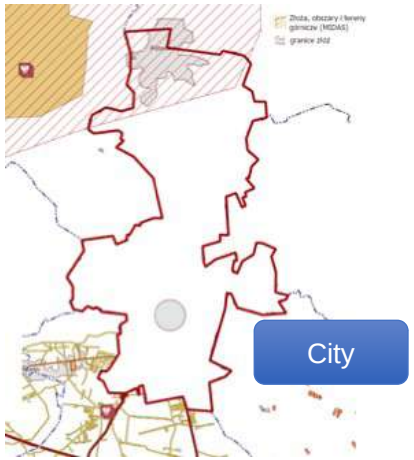
predictions of damages
to the infrastructure



WRF

- Mesoscale weather community prediction model
- Running at country, voivodeship and city scale
- Takes into account topography and land cover
- Delivers weather prediction to the second model





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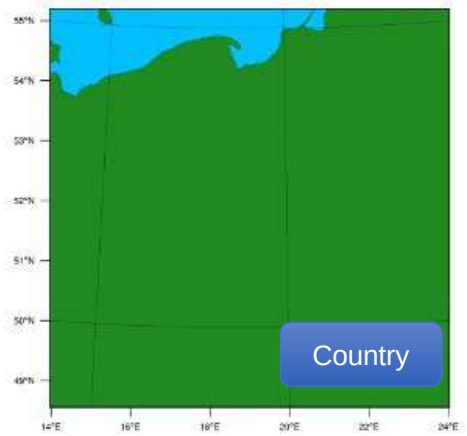
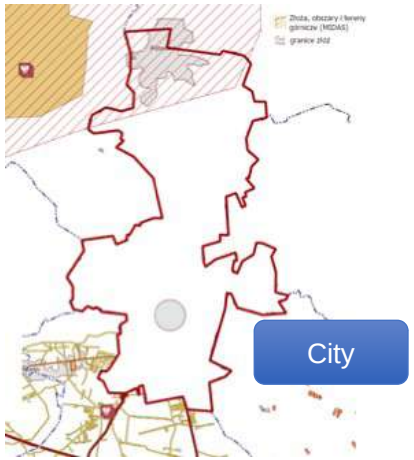
EULAG

- All-scale geophysical flow solver
- Running at city, district, street scale
- Immersed Boundary Method for buildings complex structure

RES in details





RES.ENERGY

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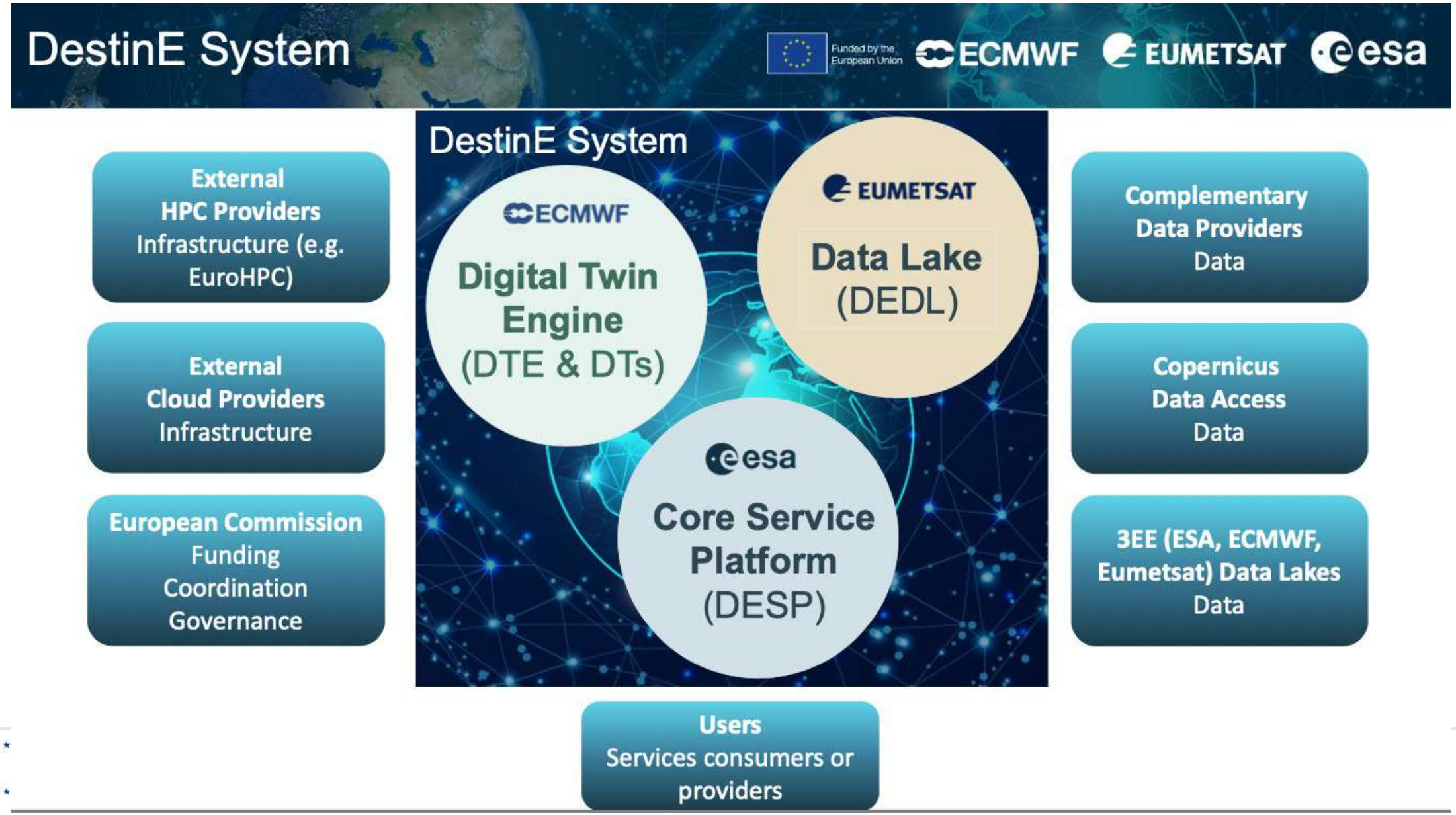
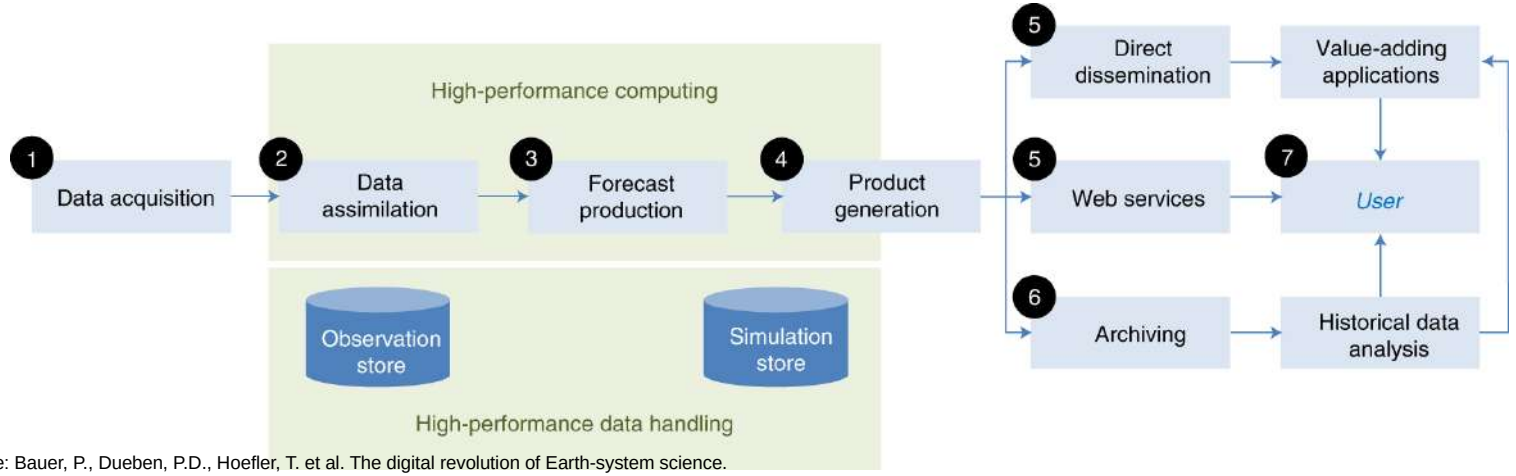
RES.ENERGY

- Estimation of energy production
- Separate models for wind farms and photovoltaic systems
- HDPA+AI

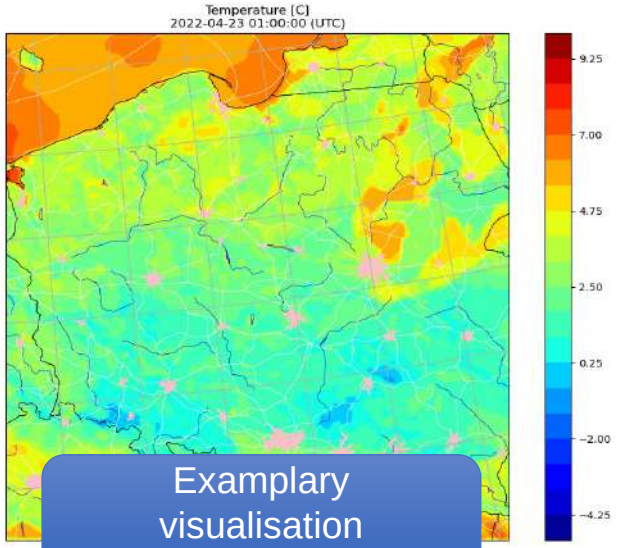

DestinE System
Funded by the European Union
ECMWF
EUMETSAT
esa
External
HPC Providers
Infrastructure (e.g. EuroHPC)
External
Cloud Providers
Infrastructure
European Commission
Funding
Coordination
Governance
DestinE System
ECMWF
Digital Twin Engine (DTE & DTs)
EUMETSAT
Data Lake (DEDL)
esa
Core Service Platform (DESP)
Complementary
Data Providers
Data
Copernicus
Data Access
Data
3EE (ESA, ECMWF, Eumetsat) Data Lakes
Data
Users
Services consumers or providers

Towards Digital Twin



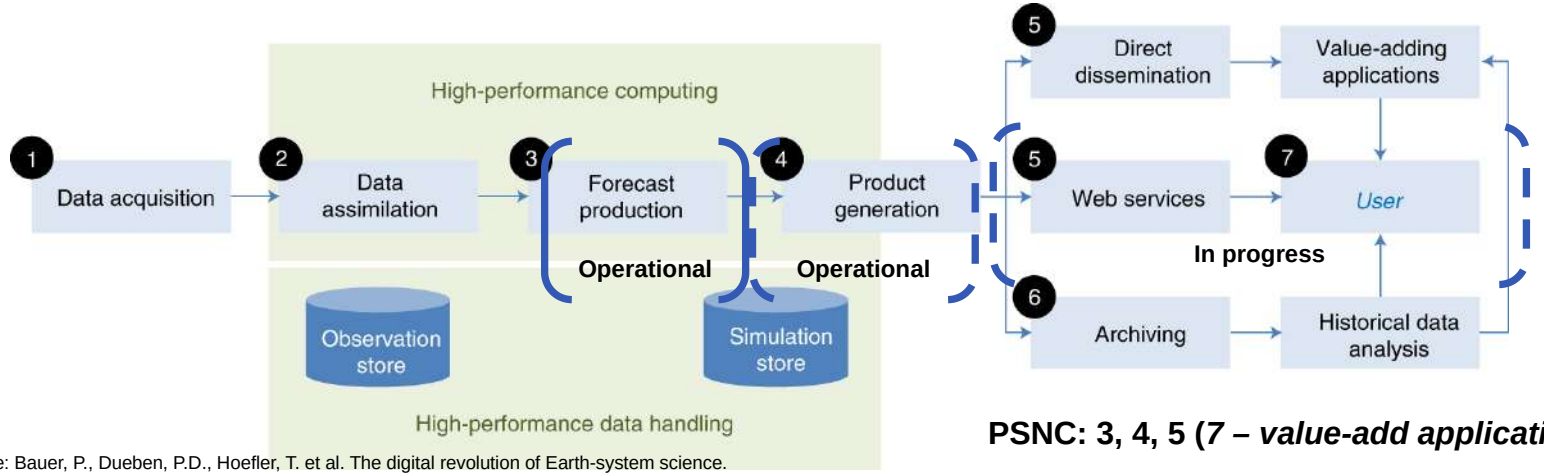
Source: Bauer, P., Dueben, P.D., Hoefler, T. et al. The digital revolution of Earth-system science. Nat Comput Sci 1, 104–113 (2021). https://doi.org/10.1038/s43588-021-00023-0

Towards Digital Twin



Examplary visualisation Source: PSNC

Operational forecast production for Greater Poland Voivodeship available online: https://meteo.apps.paas.psnc.pl



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PSNC: 3, 4, 5 (*7 – value-add applications, historical data analysis)*

Industry scenario – support for Polish Distribution System Operator

DSO profile

- One of the largest in Poland
- Owns multiple wind & photovoltaic farms
- Maintains power supply infrastructure in several voivodeships

DSO goals

- Improvement of RES energy production predictions
- Prediction of potential damages to the infrastructure

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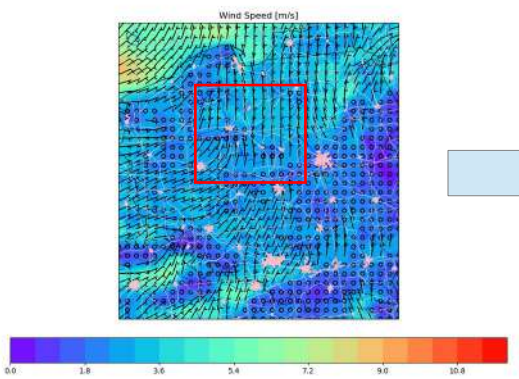
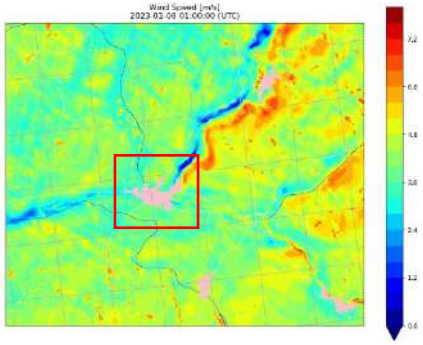
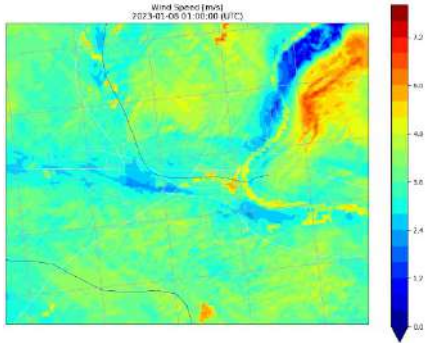


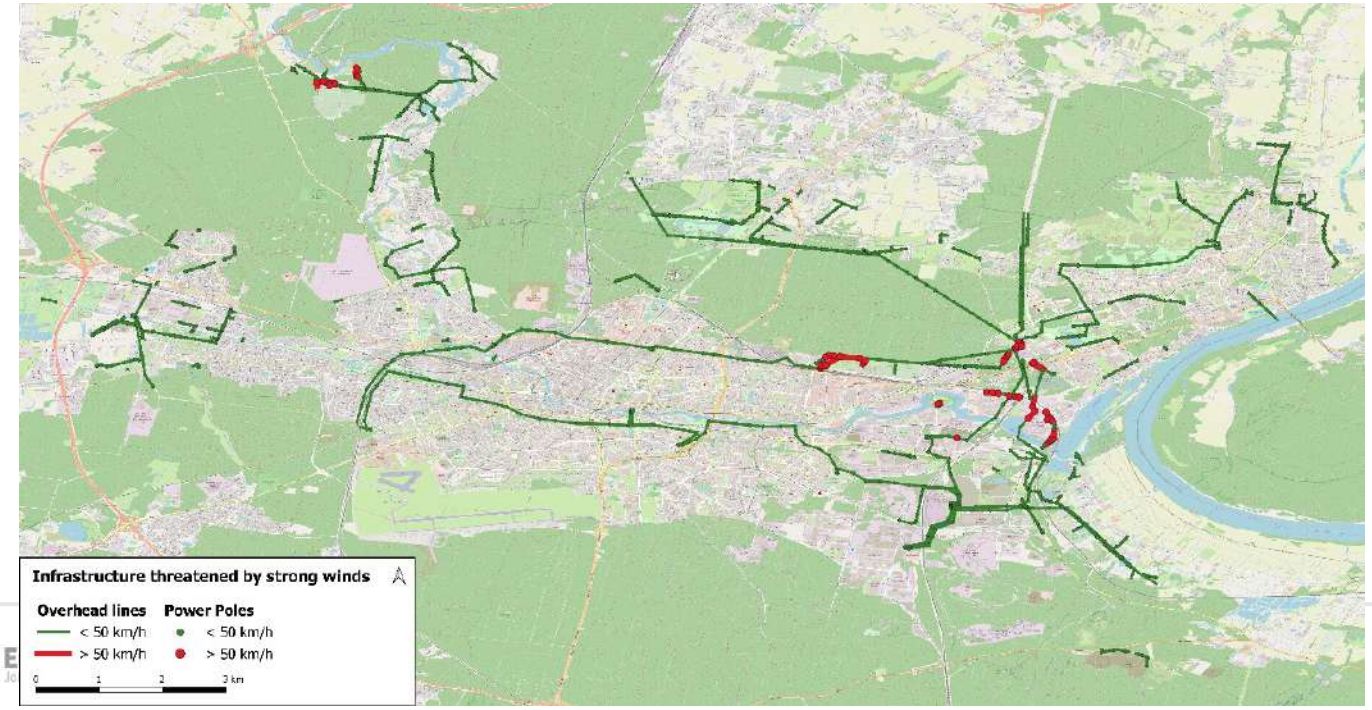
Resolution: 3600 m



Resolution: 600 m



Resolution: 100 m



- threat analysis for individual infrastructure components
- perspective of exascale simulations with the whole infrastructure of the DSO in Poland included for fine-grained analysis

- Provide advanced models for wind and solar energy production (HPDA + AI)
- Aim at exascale and use Euro-HPC infrastructure to:
    - Deal with uncertainties (UQ)
    - Run over larger domains and finer meshed
- Enhance sun/shade model to improve solar modelling
- Study sensitivity analysis to limit computational resources needed
- Improve user interface (portal for UQ, ensembles, running application)

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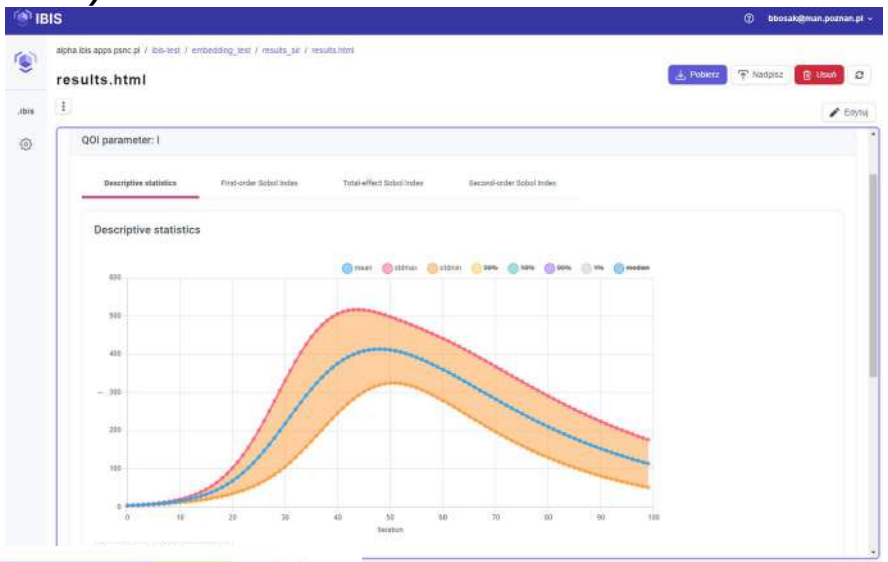

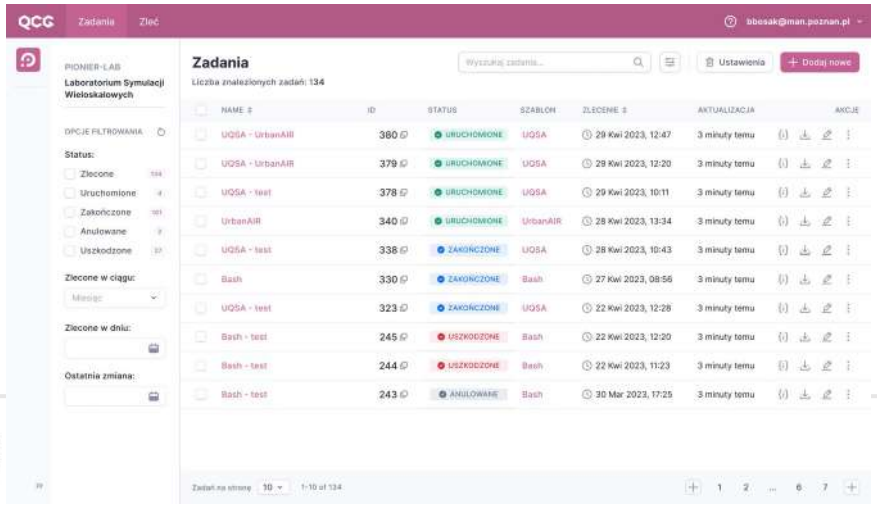

Summary

- Two cases for the industry, now being evaluated
- 24/7 online services for prediction of weather and potential damages to the infrastructure
- RES is coupled to the weather model used by HIDALGO2 Wildfires
- Aiming at 100k CPU cores per single analysis, with UQ+SA
  - Running on TOP500 #186 Altair from PSNC.
  - Running on EuroHPC is in progress
- Transition towards DigitalTwin is in progress

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CENTRE OF EXCELLENCE

Questions?

Poznan Supercomputing and Networking Center

Michał Kulczewski, michal.kulczewski@man.poznan.pl
Wojciech Szeliga, wojteks@man.poznan.pl
Ariel Oleksiak, ariel@man.poznan.pl