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Joint Research Centre

Climate derived data for the Energy Sector:

intermittent
climate related energy

Energy, Transport and Climate Directorate

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Content

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- **Policy context**
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- **On-going work**
- **Leverages between ECEM and EMHIRES**

Provide model based analysis for the Energy Union Package

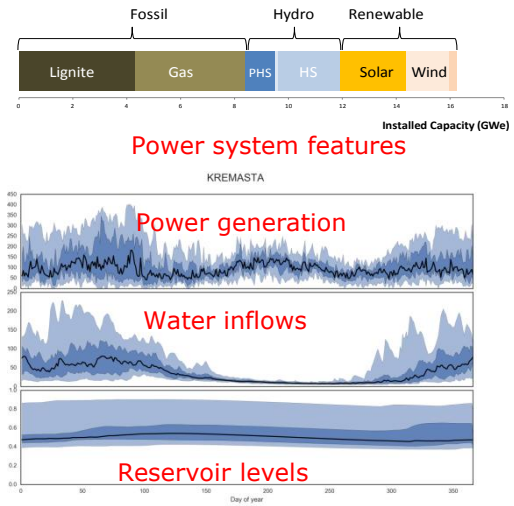
Power System and Market Modelling (PSMM)

Power market and storage modelling	WATERFLEX	Heat Roadmap Europe 2050
Focus on flexibility options (storage) • Develop & apply power system models. • Develop European wind and solar power generation dataset derived from meteorological sources for present and future scenarios	**Role of hydro power in future electricity systems** • Coupling of a water model (Lisflow) and power system models	**Decarbonisation of H&C/ H&C strategy** • Application of JRC-EU-TIMES Energy System model for heating & cooling sector

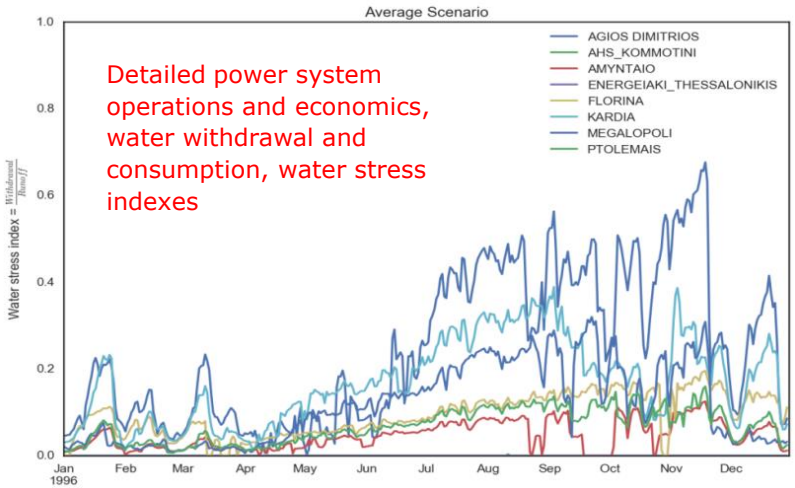
PSMM supports policy DGs by developing, maintaining, applying and disseminating open models and data to the public .

Water-Power Nexus: WATERFLEX

Current status: testing & validation-case study for Greece



LISFLOOD
Dispa-SET



Further research: modelling of water-related constraints, model coupling, data, climate scenarios, EU-wide analyses, link to new WEFE project

Challenges: accuracy/complexity balance, limited data & resources

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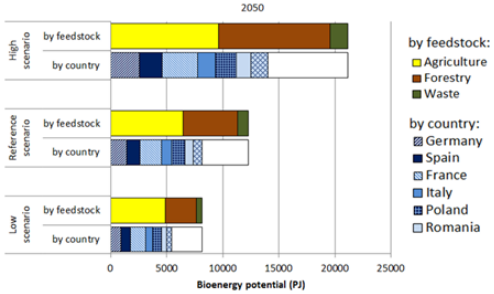
PSMM develops open datasets allowing transparent assessments

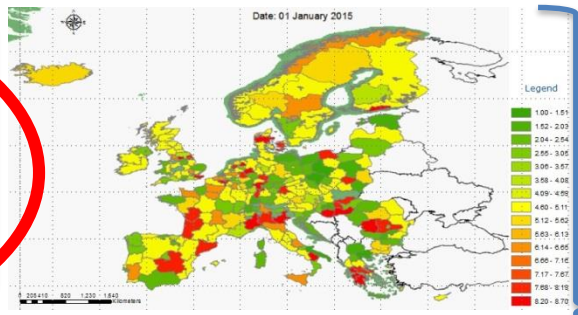
JRC datasets

RES-E potentials
Potentials and cost curves for biomass, solar and wind energy at NUTS 2 level

JRC EMHIRES
30 yr of wind, PV, hydro and demand hourly generation time series up to NUTS 2 level

JRC EPPD
Full set of technical power plant data (MW, efficiencies, ramps…)





Typical applications

- Long term energy system studies
- Energy system transitions

- RES-E integration
- Generation adequacy
- Power system flexibility and storage needs
- Power market design
- Network expansion
- …

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What is EMHIRES?

EMHIRES is the **first publically available** European wind and solar power generation hourly dataset derived from meteorological sources that is available on several geographical levels:
country, bidding zone, NUTS-1, NUTS-2.

It was generated developing *ab-initio* methodology **capturing local geographical information** to generate meteorologically derived wind and solar power **time series at high temporal and spatial resolution**.

Increased accuracy

- Generation adequacy assessments
- RES-E integrations studies
- Studies on flexibility technologies, e.g. storage

EMHIRES wind time series are derived in a three step process.

WIND SPEED AT HIGH SPATIAL RESOLUTION

RAW DATA
NASA (MERRA data)
Extraction of the time series at site level

→ Statistical spatial downscaling of hourly wind speed variations

→ Vertical interpolation at hub height

CONVERSION INTO WIND POWER GENERATION

Wind farm database completeness, gap filling and analysis

→ Power curve parameterization

→ Power curve for each wind turbine type

GENERATION OF TIME SERIES AT DIFFERENT AGGREGATION LEVELS

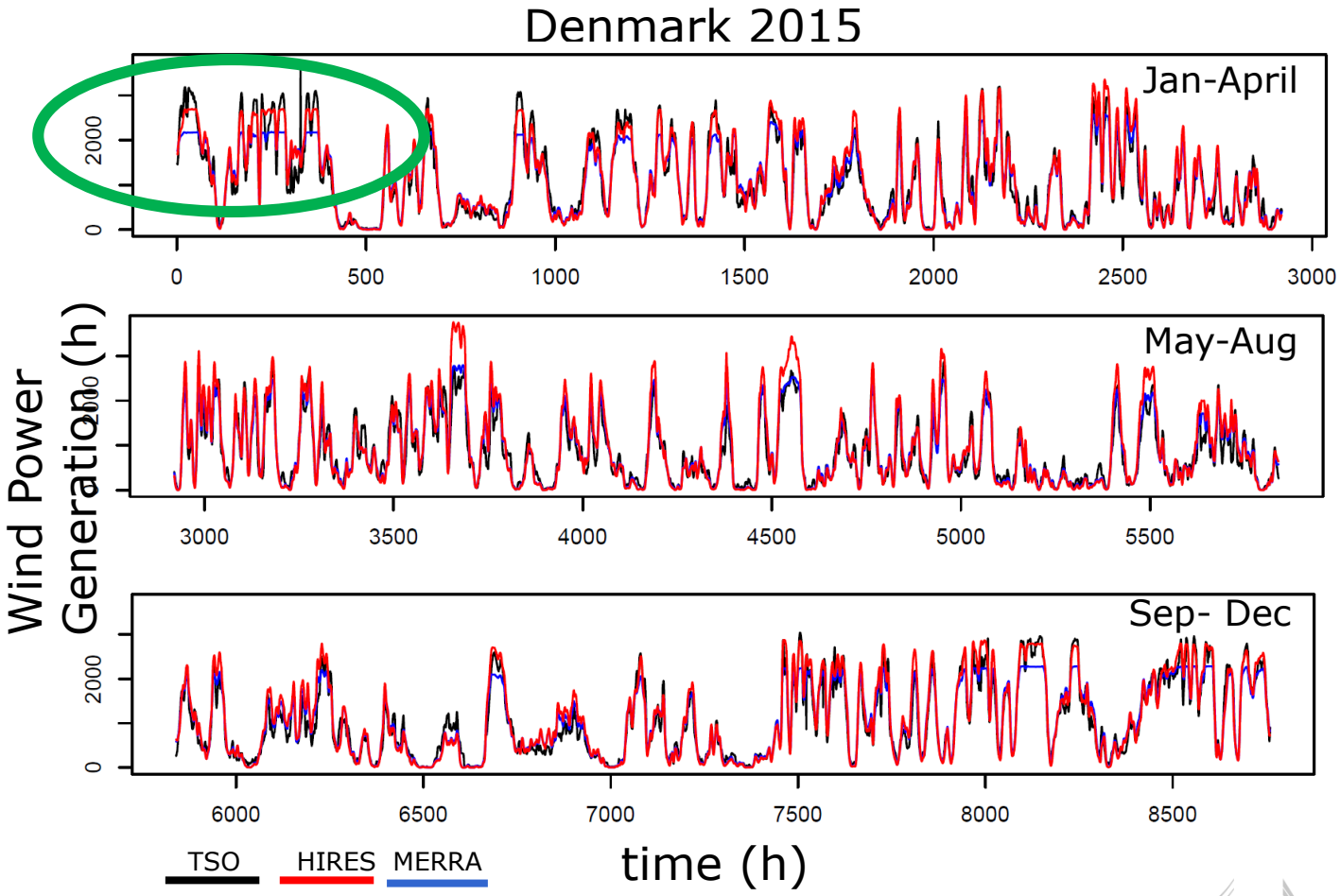
Sum up wind power time series at site to country, bidding zone and NUTS 2 aggregation

→ Validation with TSO wind power time series and statistics

→ Systematic error correction of the time series

→ European hourly time series during 1986-2015 at country, bidding zone, NUTS-1 and NUTS-2 level.

EMHIRES better captures ramp rates and wind power generation peaks



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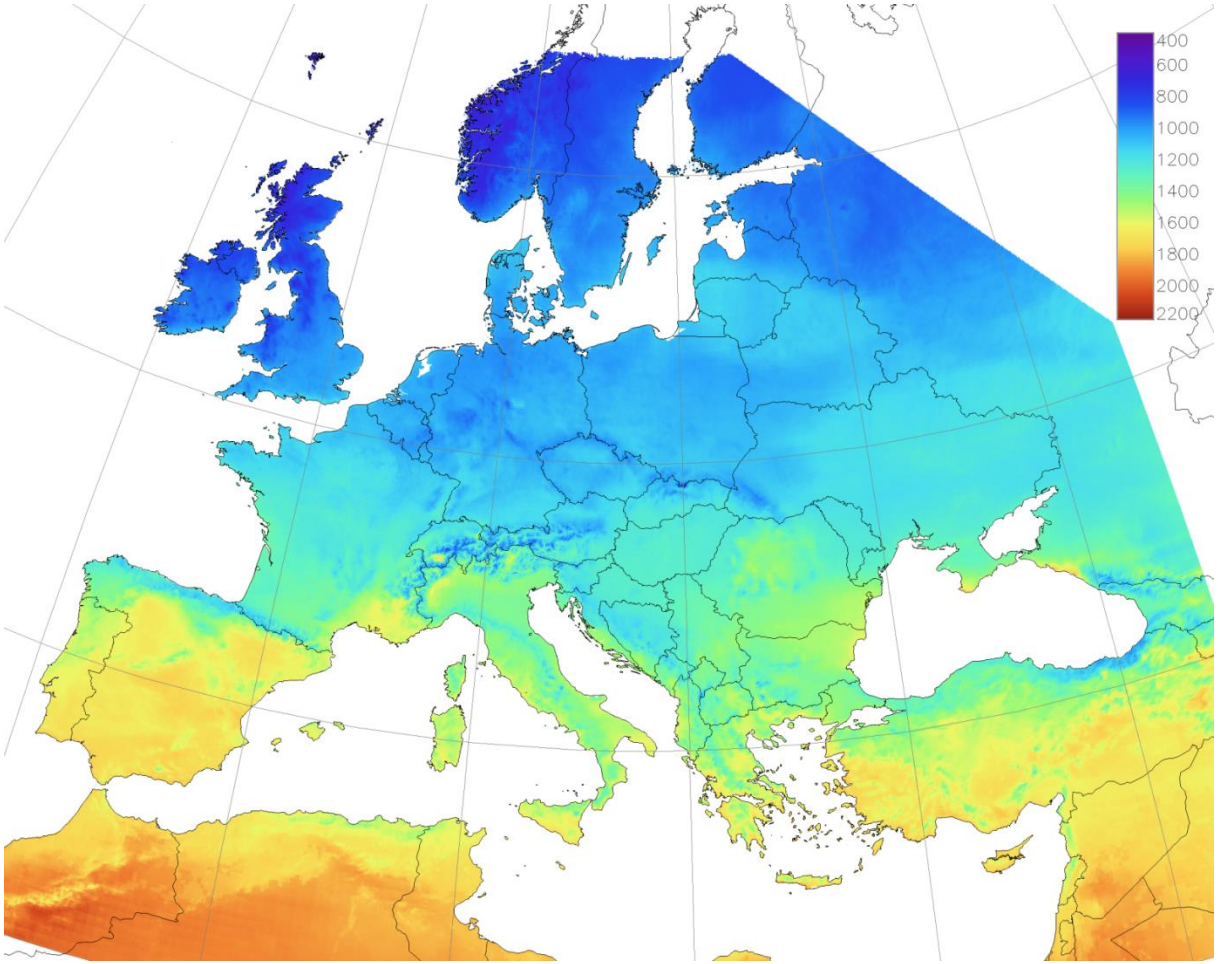
PV power hourly time series in EMHIRES

- Time-resolved geospatial maps of solar radiation are calculated from **geostationary satellite data**. The resulting data set has hourly time resolution and a spatial resolution of **~5km**. EMHIRES is based on the SARAH solar radiation data from the CM SAF collaboration, for a 1986-2015 period.
- Global and direct horizontal irradiance are used to calculated the **local optimum inclination angle and the in-plane irradiance**.
- Models for PV performance take into account the effects of **shallow-angle reflectivity, spectral variations, as well as the influence of air temperature and wind speed on PV performance**.
- The resulting maps of hourly PV power are then averaged spatially over the relevant regions.
- At country level, a factor has been applied to be in line with the TSO time series data

PV power hourly time series in EMHIRES

Annual PV capacity (KW/KWp)



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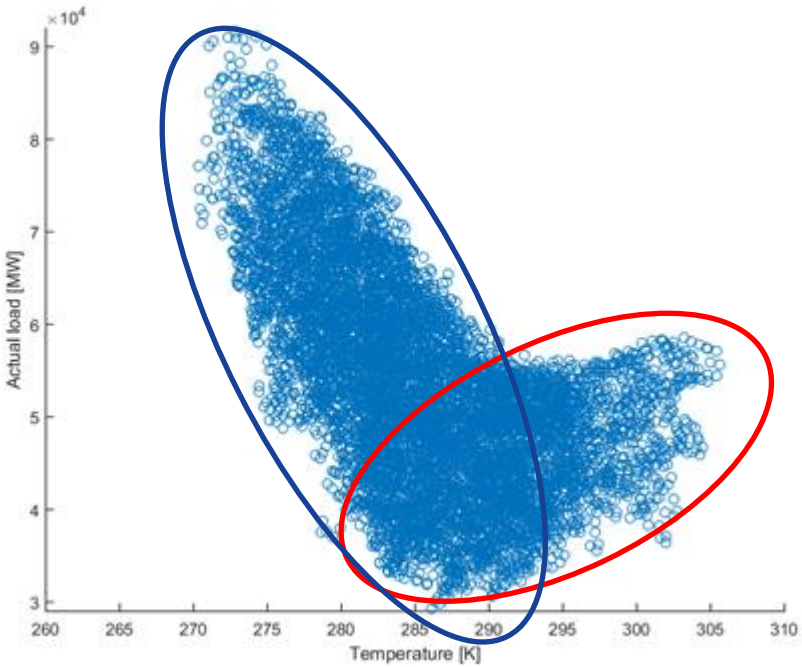
EMHIRES: Temperature corrected demand hourly time series

Effect of temperature T on electricity demand D

Example for France:

↓ T → higher electricity consumption for electric-based heating countries → ↑ D

↑ T → higher electricity consumption for air conditioning → ↑ D



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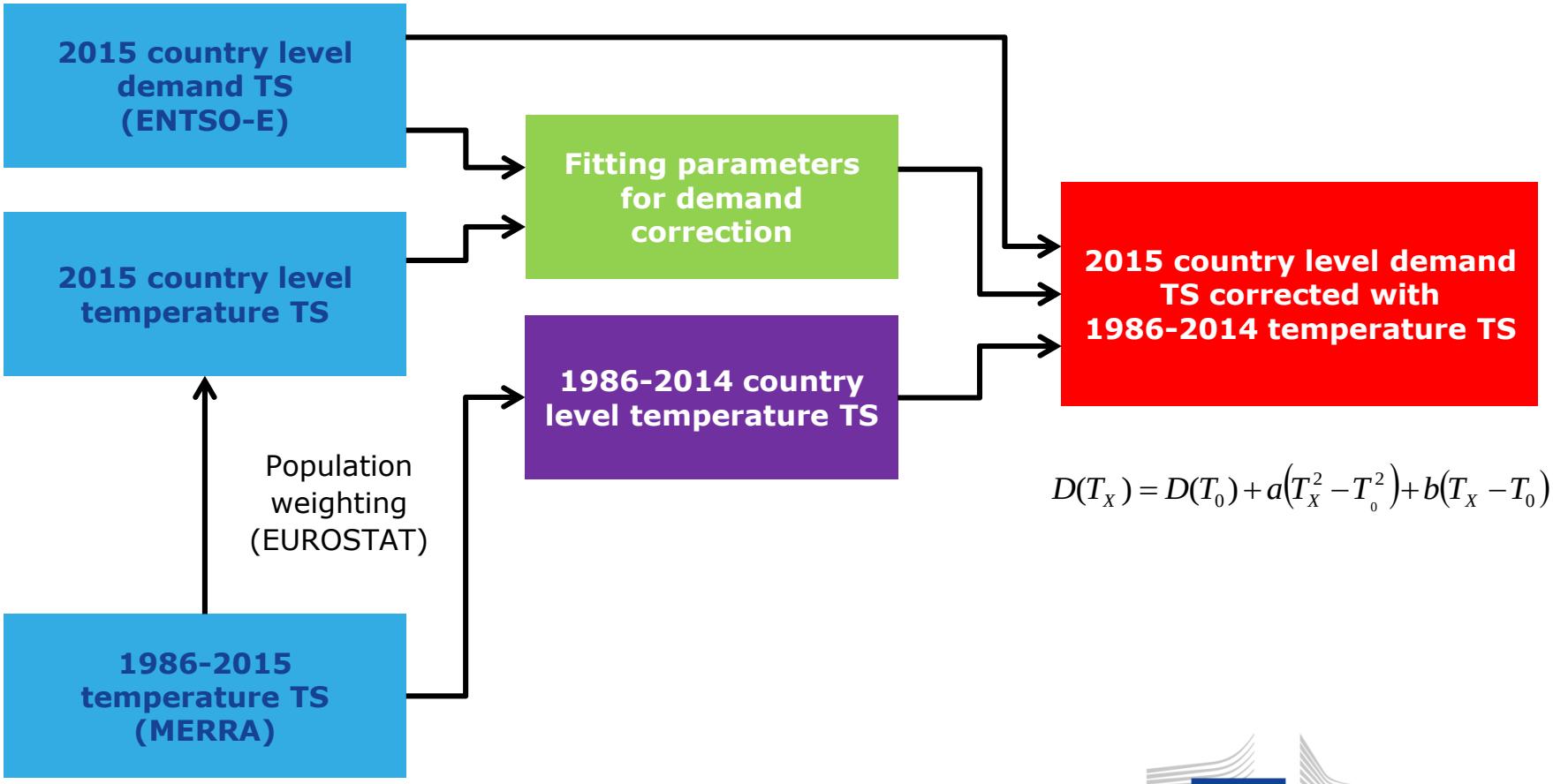
EMHIRES: Temperature corrected demand hourly time series

30 years of hourly temperature TS → 30 years of adjusted hourly demand TS for scenario analyses



$$D(T_X) = D(T_0) + a\left(T_X^2 - T_0^2\right) + b\left(T_X - T_0\right)$$

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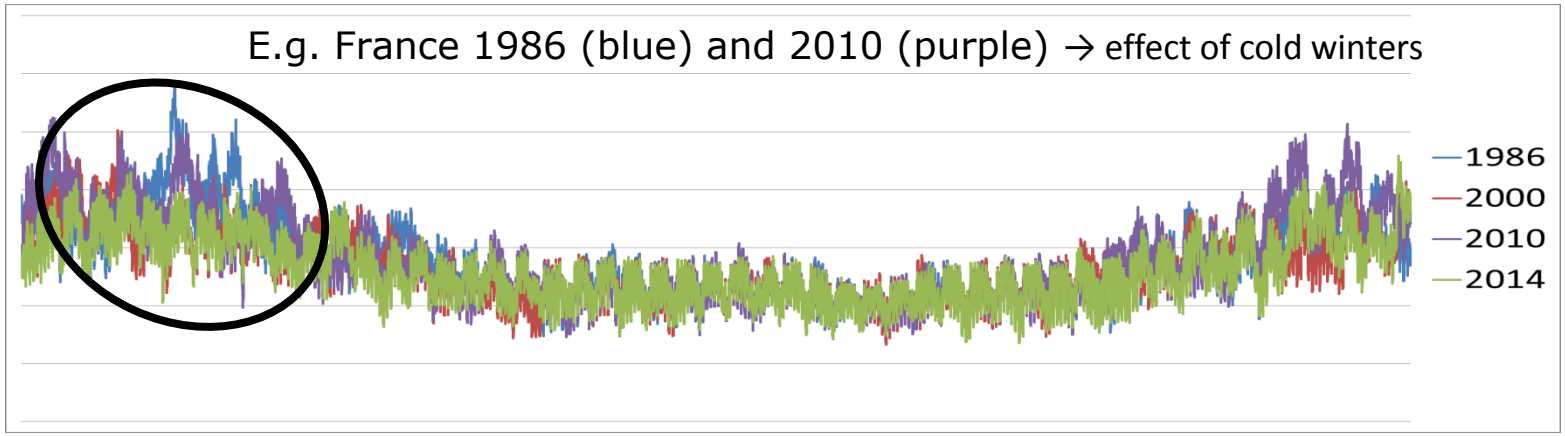
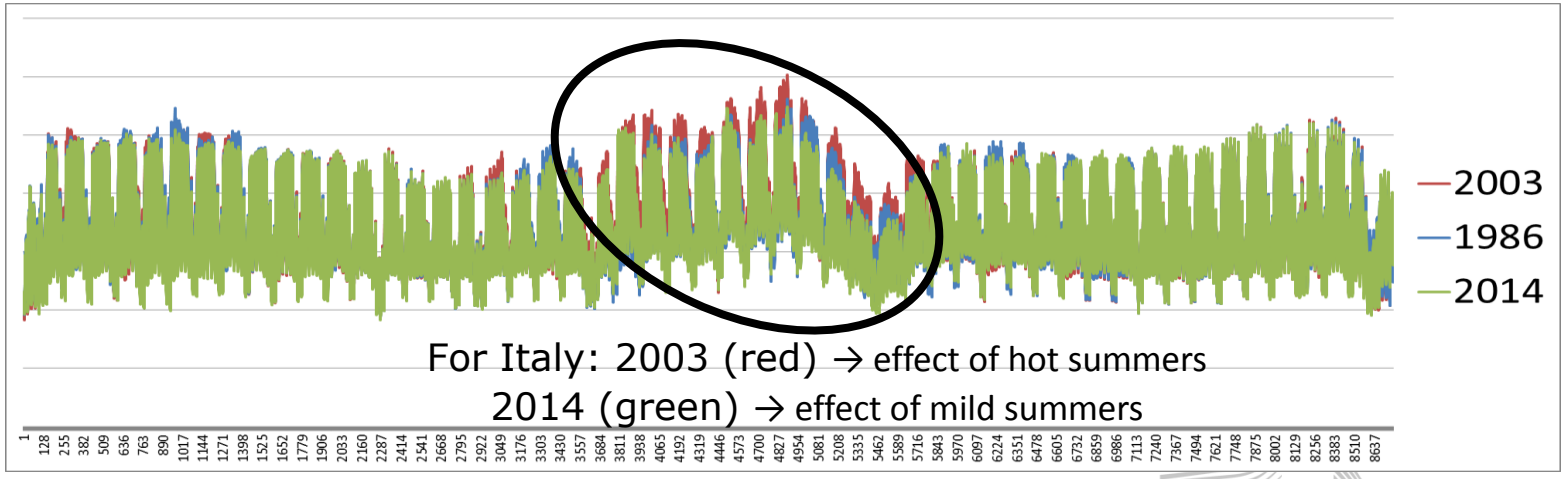
EMHIRES: Temperature corrected demand hourly time series

Effect of cold, mild and hot summers





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On-going work in EMHIRES dataset

- **EMHIRES-hydro:** 30 years of **run-of-the-river (ROR) generation and natural flow (m^3/s) at the reservoirs** daily time series forcing by LISFLOOD hydrological model over European domain at different aggregation levels (e.g. catchment level, MS level)

- **EMHIRES scenarios**: Future generation time series of intermittent climate related energy (wind + solar + hydro) assuming different scenarios (e.g. full RES power system, Reference scenarios of EUKO 27% for 2030). It accounts for the profitability of the total system optimizing at cost level (how to reach the scenarios by minimizing the cost) and if the generators are able to recover the investments

References: EMHIRES dataset

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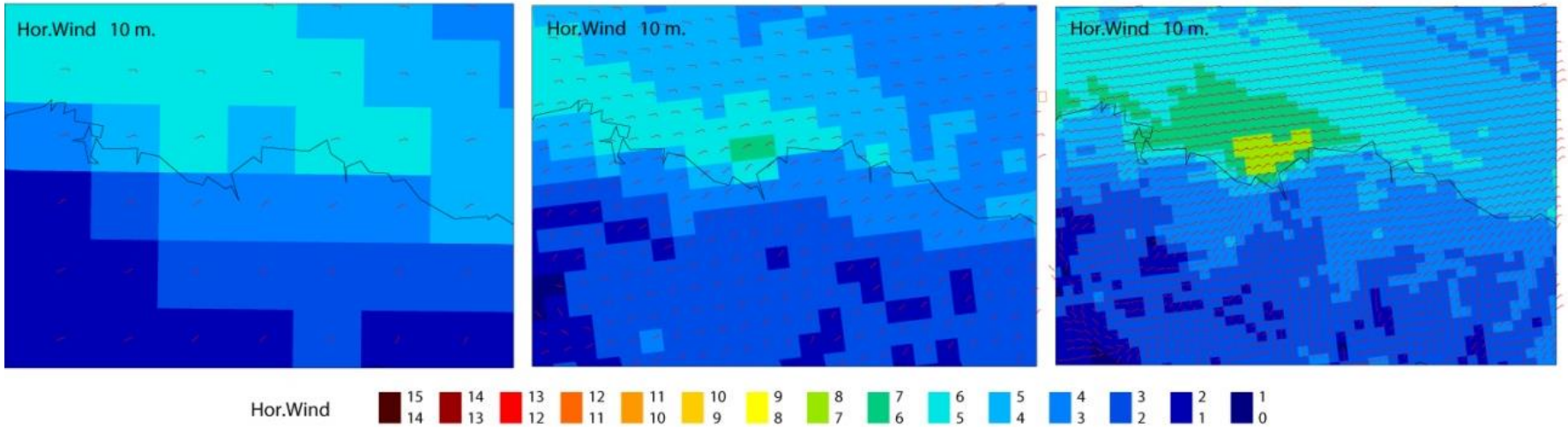
Spatial resolution of wind speed matters



ASSESSMENT OF IMPROVEMENT VS. UNCERTAINTIES

- **ECMWF forecasts**: 100 m hourly wind speed (12 x 12 km spatial resolution) available for 2012-2015
- **NASA – MERRA reanalysis**: 10 and 50 m hourly wind speed (70 km x 70 km spatial resolution) for 1986-2015
- **EMHIRES**: Downscaling to NASA-MERRA reanalysis at wind farm level