RES-ORIENTED IMPROVEMENTS IN NUMERICAL WEATHER PREDICTION IN THE SMART4RES PROJECT

Overview of the datasets and methodology
- Météo-France’s NWP models: ARPEGE (global) and AROME (regional) in their 2020 operational deterministic and ensemble versions (“oper.”)
- 4 month’s of ARPEGE and AROME enhanced ensemble simulations run specifically for the project (“HR”)
- Weather measurements from Météo-France’s national ground network
- Production measurements from Météo-France’s datasets
- Through assessment of AROME’s operational solar irradiance (GHI) forecasts
- Sensitivity tests and improvements of AROME’s cloud and aerosol modelling
- Quantification of the impact of enhanced size and spatial resolution on AROME ensemble forecasts
- 4-day seamless ensemble forecasts optimizing the junction between AROME and ARPEGE outputs
- 2-day pseudo-deterministic AROME forecast by choosing the most adequate scenario of the ensemble
- Design of other innovative ways to take advantage of high resolution NWP ensemble simulations for RES forecasts

AROME’s solar irradiance modelling

Detailed solar irradiance assessment
- Most errors are in well predicted cloudy conditions
- Simulated high clouds are too transparent, low clouds too opaque
- High clouds are largely responsible for the GHI bias

Cloud radiative impact
- Accounting for droplet size distribution (a) in the cloud optical properties
- Up to 30% variations in cloud transmittance
- Coupling between radiative transfer and cloud microphysics

Aerosols impact
- Taking type of aerosols into account is important
- Monthly climatologies are not reliable to simulate aerosols radiative effect
- Case studies of using near real-time aerosols (CAMS/MOCAGE) in AROME simulations: large bias reduction in GHI

Extraction of more relevant variables
- Spectral partition of direct/diffuse irradiance, cloud optical depth, cloud fraction as seen by the radiative code, etc.

3D radiative transfer
3D radiative transfer simulations using Monte Carlo ray tracing on realistic cloud fields generated by Large Eddy Simulations
- High resolution surface maps of solar irradiance
- Fully accounting for 3D effects (e.g. cloud edge increase in irradiance)

Ensemble prediction based products
Handling ensemble simulations
- Ensemble simulation can be used to capture and quantify the uncertainty
- Large amounts of data: require enough storage, transfer and processing capacity
- Need for understandable and easy to handle products for end-users

4-day seamless ensemble forecasts
- AROME-EP up to 51h, then ARPEGE-EP up to 96h (25 mbs)
- Hub-height wind speed or GHI, local forecast on each site
- Hungarian method: bijective match between 2 samples minimizing total distance (dynamic warping distance)
- Comparison to a random association: significantly smaller discontinuity
  → Lower CRPS on D1/D2 thanks to AROME-EP + temporal continuity up to D4

2-day optimized pseudo-deterministic forecasts
- Providing a single forecast to help end-users who cannot handle ensembles
- AROME-EP up to 51h, wind speed or GHI, local forecast on each site
- Different optimization methods compared, the best being
  - the location dependent optimized percentile (wind speed)
  - the leadtime dependent weighted mean of all members (GHI)
  → Improvement over ensemble mean and deterministic forecast on D1/D2

Assessment of HR AROME-EP vs oper version
- Comparison at same temporal (1h) and horizontal (2.5km) resolution
- Probabilistic scores: Brier score, CRPS, spread/skill ratio, ROC curve, reliability,
- HR simulations are slightly better than the operational version in resolution, CRPS and spread/skill ratio
- No significant difference in reliability

Taking advantage of high resolution outputs
Better representation of uncertainty
- More members and higher spatial and temporal resolution → better sampling of distribution
- Still slightly under-dispersive

Sub-hourly variability forecasts
- High frequency RES variations impossible to reproduce with hourly NWP outputs
- Internal NWP computing step time > 1 min → possible to issue hourly forecasts of sub-hourly variability of wind speed or GHI (e.g. “≤ 2m/s”)

Cut-out probability forecasts
- Caused by sub-hourly wind speed peaks
- Short internal NWP computing time step → possible to compute probability of exceeding threshold on 1 hour windows
- End-users may decide depending on their risk acceptance

Ramp probability forecasts
- Caused by sub-hourly variations
- Same approach as cut-out forecasts: taking advantage of short internal time step to compute hourly probability of positive / negative ramping events

Perspectives
- EcRad radiative transfer scheme and updated aerosol climatologies in oper. AROME
- Design and development of operational RES-oriented AROME diagnostics based on sub-hourly internal computing time step
- FineCast: pursuit of research activities for solar irradiance modelling enhancement and very high resolution NWP models for RES forecasting

References

The work presented here represents Météo-France’s contribution to the second work package (WP2) of the Smart4RES project. It aimed to improve RES forecasting accuracy by refining the quality and availability of Numerical Weather Prediction variables of interest for RES production and exploring innovative ways of exploiting NWP outputs for this purpose. More information about Smart4RES’ outputs can be accessed on the website of the project: https://www.smart4res.eu.