Mesoscale impacts of wind farms: a study of the wind farm scheme in WRF-ARW model
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Abstract
The widely used model Weather Research and Forecasting (WRF) includes a wind farm parameterization which represents the interaction of the atmosphere with wind turbines for mesoscale purposes by imposing a momentum sink and a source of turbulence.

In this study, the physical reliability of this scheme is discussed. The analysis includes a set of 1 km simulations run in Sotavento-Galicia (Northwestern Iberian Peninsula) wind farm for two case studies: a cold front and high pressure regime, both with strong winds.

The results show a reduction in wind speed reaching differences of around 0.8 ms\(^{-1}\) within the wind farm, being the wakes effect for more than 25 km downwind.

The set of analyses presented in this study shows that the wind farms scheme is a robust tool from the physical perspective and hence, an extended validation is necessary before a future implementation in real projects.

Objectives
- Study of the wind farm parameterization available in WRF based on Fitch et al. (2012).
- Analysis of the physical consistency.
- Learn about the impact of wind turbines in mesoscale models.

Methods
- Experiment configuration
  - ECMWF ERA-interim 0.75 deg
  - WRF Version 3.7.1

- Wind farm scheme
  - Power curve
  - Thrust coefficient
  - Wind farm layout

- TURbine
- CONtrol

- Study of the differences

Case studies
- Case 1
- Case 2

Conclusions
Experiments presented in this poster show that the wind farm scheme implemented in the WRF model produces results with physical consistency that can be summarized in the following diagram:

- Moment sink
- Wind reduction
- Wind shear
- Increment Temperature
- PBL neutralization
- Turbulence production

Model settings
<table>
<thead>
<tr>
<th>Type</th>
<th>Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microphysics</td>
<td>Kessler</td>
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<tr>
<td>Shortwave</td>
<td>Dudhia</td>
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<tr>
<td>Longwave</td>
<td>RRTM</td>
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<tr>
<td>Surface layer</td>
<td>MMS Similarity</td>
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<td>Land Surface Model</td>
<td>Unified Noah Land Surface Model</td>
</tr>
<tr>
<td>PBL</td>
<td>Mellor-Yamada Nakanishi Niino level 2.5</td>
</tr>
</tbody>
</table>

One-way nesting, 6 spin-up hours, 41 vertical levels

References

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