Shortwave Radiation in Reanalyses: Skill Scores and Spatial Patterns

Eadaoin Doddy

MÉRA workshop: 17-05-2018
# Reanalysis datasets

<table>
<thead>
<tr>
<th>Reanalysis product</th>
<th>Provider</th>
<th>Spatial resolution</th>
<th>Years covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MÉRA</td>
<td>Met Éireann</td>
<td>2.5km x 2.5km</td>
<td>1981 - present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5km</td>
<td></td>
</tr>
<tr>
<td>ERA-Interim</td>
<td>ECMWF</td>
<td>0.75° x 0.75° (~78km)</td>
<td>1979 - present</td>
</tr>
<tr>
<td>MERRA-2</td>
<td>NASA</td>
<td>0.5° x 0.625° (~50km)</td>
<td>1979 - present</td>
</tr>
</tbody>
</table>

Common validation period: 1982-2007
Shortwave radiation (SW)
Shortwave radiation (SW) skill scores

Reanalysis Skill Scores

SW [MJ/m²]

-1
0
1
2
3
4
5

Belmullet
Birr
Clones
Dublin Airport
Kilkenny
Malin Head
Valentia

ME MÉRA
ME ERA-Interim
ME MERRA2

underestimates
overestimates
Shortwave radiation (SW) skill scores

Reanalysis Skill Scores

SW [MJ/m²]

- Belmullet
- Birr
- Clones
- Dublin Airport
- Kilkenny
- Malin Head
- Valentia

Overestimates
Underestimates

ME MÉRA
ME ERA-Interim
ME MERRA2
Shortwave radiation (SW) skill scores

![Graph showing reanalysis skill scores for various locations with overestimates and underestimates indicated.]

- RMSE MÉRA
- RMSE ERA-Interim
- RMSE MERRA2
- ME MÉRA
- ME ERA-Interim
- ME MERRA2
Shortwave radiation (SW) skill scores

<table>
<thead>
<tr>
<th></th>
<th>ME [MJ/m²]</th>
<th>RMSE [MJ/m²]</th>
<th>Anomaly Correlation Coefficient (ACC)</th>
<th>Pearson’s Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MÉRA</td>
<td>0.13</td>
<td>3.23</td>
<td>0.77</td>
<td>0.91</td>
</tr>
<tr>
<td>ERA-Interim</td>
<td>1.12</td>
<td>3.17</td>
<td>0.71</td>
<td>0.93</td>
</tr>
<tr>
<td>MERRA-2</td>
<td>1.74</td>
<td>3.84</td>
<td>0.60</td>
<td>0.91</td>
</tr>
</tbody>
</table>
Shortwave radiation (SW) skill scores
Shortwave radiation (SW) skill scores

Kilkenny

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

MJ/m²

-5 0 5 10 15 20

RMSE - MÉRA
RMSE - ERA-Interim
RMSE - MERRA-2
Observations

ME - MÉRA
ME - ERA-Interim
ME - MERRA-2

Map showing locations: Main Head, Belmullet, Clones, Birr, Dublin, Valentia, Kilkenny
Shortwave radiation (SW) skill scores

![Graph showing Shortwave radiation (SW) skill scores in Kilkenny](image)

- **RMSE - MÉRA**
- **RMSE - ERA-Interim**
- **RMSE - MERRA-2**
- **ME - MÉRA**
- **ME - ERA-Interim**
- **ME - MERRA-2**

Observations
Daily SW spatial pattern

- North-south variation
- East-west variation (land/sea contrast)
‘Day Time Only’ Clouds

9:00 UTC

Total Cloud Cover [%]

0 15 30 45 60 75 90

Energy Systems Integration Partnership Programme
Daily mean cloud spatial pattern

- East-west variation (land/sea contrast)
- Matches well with SW
Daily SW spatial pattern

- North-south variation
- East-west variation (land/sea contrast)
Post-processing

- Adaptive Linear Least Squares (LLS) Method
Improvement with post-processing

Reanalysis Skill Scores

<table>
<thead>
<tr>
<th></th>
<th>ME [MJ/m²]</th>
<th>RMSE [MJ/m²]</th>
<th>Anomaly Correlation Coefficient (ACC)</th>
<th>Pearson’s Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MÉRA</td>
<td>0.13 / -0.00</td>
<td>3.23 / 2.81</td>
<td>0.77 / 0.75</td>
<td>0.91 / 0.92</td>
</tr>
<tr>
<td>ERA-Interim</td>
<td>1.12 / -0.00</td>
<td>3.17 / 2.70</td>
<td>0.71 / 0.77</td>
<td>0.93 / 0.93</td>
</tr>
<tr>
<td>MERRA-2</td>
<td>1.74 / 0.01</td>
<td>3.84 / 3.04</td>
<td>0.60 / 0.69</td>
<td>0.91 / 0.91</td>
</tr>
</tbody>
</table>
Improvement with post-processing
Large SW Error Events - MÉRA

- Most large errors only occur at one station at a time
- No large error events in winter
- 93 events overlap both categories
• ERA-Interim data
Temperature 500hPa

- ERA-Interim data

[Diagrams showing temperature anomalies and errors at 500hPa]
Summary

• MÉRA generally has better skill scores.
• A simple post-processing technique reduces systematic errors in all reanalyses.
• MÉRA captures the spatial variability of SW best.

• Future work:
  • PCA analysis.
  • Adaptive spatial multivariate post-processing for renewable energy.
This publication has emanated from research conducted with the financial support of Science Foundation Ireland under the SFI Strategic Partnership Programme Grant Number SFI/15/SPP/E3125. The opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Science Foundation Ireland.