Future photovoltaic power at the Atacama and Sonora deserts under climate change

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INTRODUCTION

Irradiance is the main variable for solar power, although temperature plays a role too in the efficiency of a solar installation. The Atacama desert (Chile) and the region of Sonora (Mexico) have some of the greatest irradiance levels; thus, its solar power installed capacity has experienced a significant boost in the last years. Knowledge of potential future photovoltaic resource (PVres) is key to improving the profitability and efficiency of a solar installations. Here, we analyse future variations in the PVres in these regions combining models and observations, in collaboration with Acciona Energia, which owns solar plants in these areas.

METHODOLOGY

- **Regions:** Atacama (Chile) and Sonora (Mexico); specifically 5 solar plants owned by Acciona Energía.
- **Periods:** 2020-2040 (near-future) & 2041-2060 (mid-term).
- **Data:**
  1. In-situ Meteorological data from Acciona Energía
  2. CORDEX simulations (3 models)
  3. ERA5 Reanalysis

\[
PV_{res} = \alpha_1 RSDS + \alpha_2 RSDS^2 + \alpha_3 RSDS \cdot TAS + \alpha_4 RSDS \cdot VWS
\]
TAS: surface temperature  
RSDS: shortwave radiation  
VWS: surface wind

RESULTS

Image 1. Atacama (left) and Sonora (right): Projected change in % days in the RCP8.5 scenario compared to the historical period (1980-2015) with PVres in the <25th, 25th-50th, 50th-75th, and >75th percentiles as a function of RSDS and TAS.

Image 2. \(\Delta PVres\) (%) for the near future (a,c) and mid-term future (b,d) under the RCP2.6 (a,b) and RCP8.5 (c,d) compared to 1980-2015. The image shows the multimodel mean. Region: Atacama desert.

Table 1. \(\Delta PVres\) (%) and the contribution of changes(%) in TAS, VWS and RSDS to the changes of \(\Delta PVres\) for RCP2.6 and RCP8.5 and for the near future and mid-term. Region: Atacama desert.

<table>
<thead>
<tr>
<th>RCP</th>
<th>near future</th>
<th>mid-term</th>
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<tbody>
<tr>
<td>RCP8.5</td>
<td></td>
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<tr>
<td>RCP2.6</td>
<td></td>
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<tr>
<td>(\Delta PVres) (%)</td>
<td>1.23 &amp; 0.52</td>
<td>1.53 &amp; 0.77</td>
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<tr>
<td>Contribution of changes in TAS to (\Delta PVres) (%)</td>
<td>12.81 &amp; 19.52</td>
<td>13.62 &amp; 15.73</td>
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<tr>
<td>Contribution of changes in surface wind to (\Delta PVres) (%)</td>
<td>0.3 &amp; -0.27</td>
<td>-0.34 &amp; 0.16</td>
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<tr>
<td>Contribution of changes in RSDS to (\Delta PVres) (%)</td>
<td>86.79 &amp; 81</td>
<td>86.72 &amp; 84.08</td>
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CONCLUSIONS

- The % of deviation in the PVres computed from CORDEX from the value from ERA5 is less than 3%.
- Changes in RSDS are the main cause of changes in PVres. The increase of TAS accounts for 14%-16% of the decreases in PVres (RCP8.5).
- Under the RCP2.6 PVres decreases 1.23% for the near future and 0.52% for the mid-term.
- Under the RCP8.5 PVres decreases 1.53% for the near future and 0.77% for the mid-term.

References

Bayo-Besteiro et al. Photovoltaic power resource at the Atacama Desert under climate change (under review.)

Acknowledgements