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 (PV_{res}) is key to improving the profitability and efficiency of a solar installations. Here, we analyse future variations in the PV_{res} 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 Energia.
- **Periods:** 2020-2040 (near-future) & 2041-2060 (mid-term).
- **Data: 1)** In-situ Meteorological data from Acciona Energia **2)** CORDEX simulations (3 models) **3)** ERA5 Reanalysis
- $\mathbf{PV}_{res} = \alpha_1\ \text{RSDS} + \alpha_2\ \text{RSDS}^2 + \alpha_3\ \text{RSDS} \cdot \text{TAS} + \alpha_4\ \text{RSDS} \cdot \text{VWS}$ **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 PV_{res} in the <25th, 25th-50th, 50th-75th, and >75th percentiles as a function of RSDS and TAS.

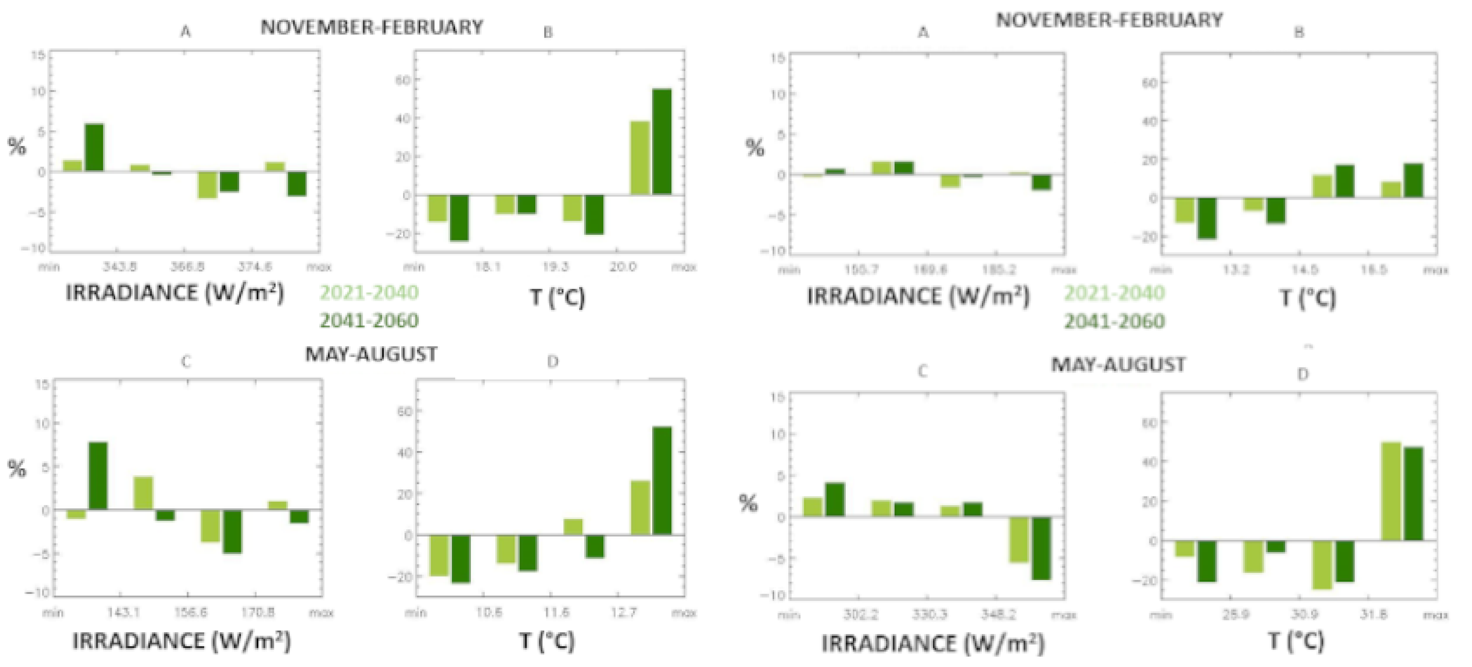

Image 2 $\Delta PVres$ (%) for the near future (a,c) and mid-term future (b,d) under the RCP2.6 (a,b) and RCP8.5 (c,d) compared to 1980-2015. The image shows the multimodel mean. Region: Atacama desert.

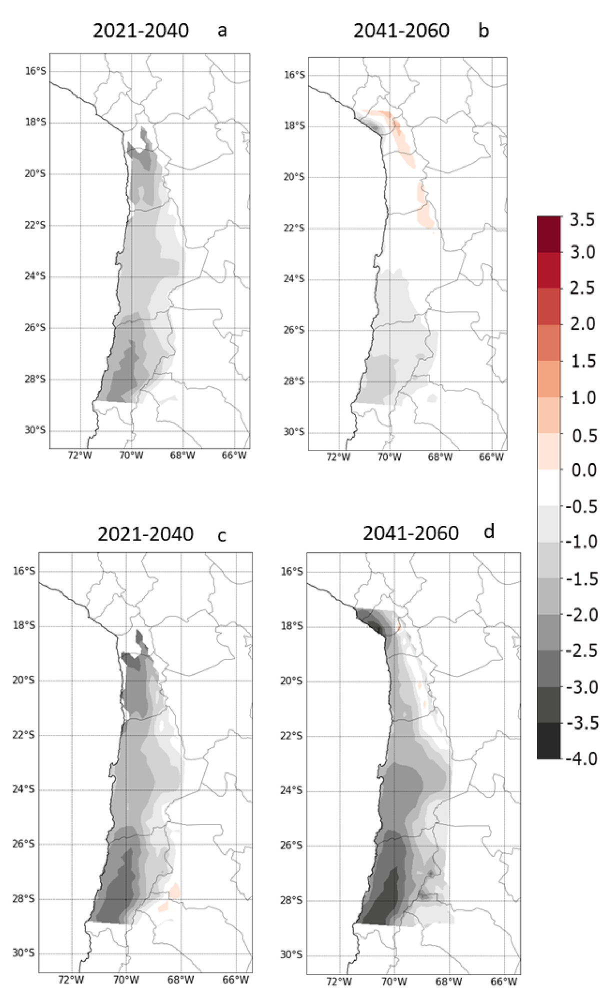

Image 3.(Left) Contribution of change in TAS to the changes of $\Delta PVres$ (%) for the near future (a,c) and mid-term future (b,d) under the RCP2.6 (a,b) and RCP8.5 (c,d) compared to 1980-2015. (Right) Similar to left plots but for the contribution of surface wind. The plot shows the multimodel mean. Region: Atacama desert.

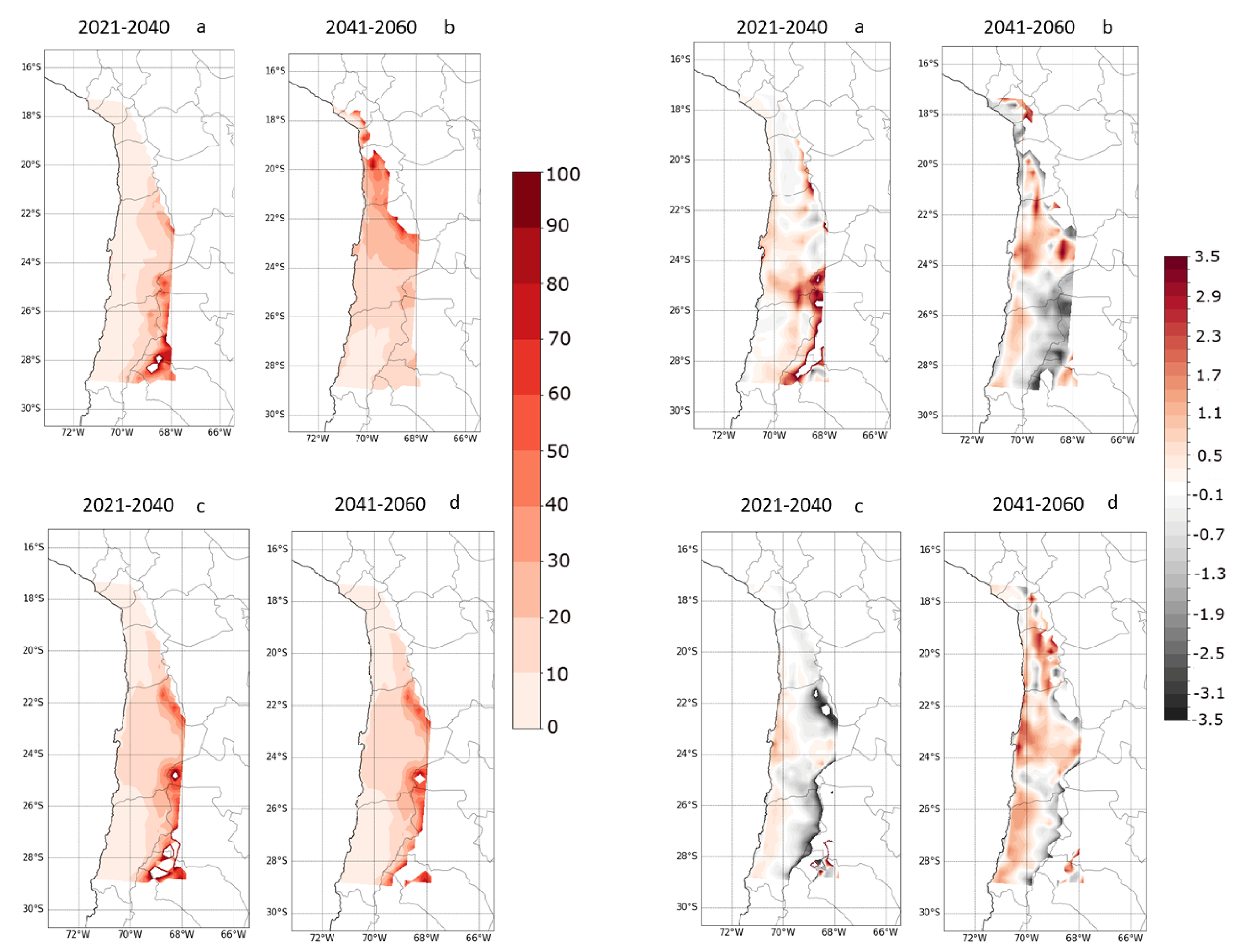

Table 1. $\Delta PVres$(%) and the contribution of changes(%) in TAS, VWS and RSDS to the changes of $\Delta PVres$ for RCP2.6 and RCP8.5 and for the near future and mid-term. Region: Atacama desert.

	RCP2.6		RCP8.5	
	(2021-2040)	(2041-2060)	(2021-2040)	(2041-2060)
ΔPV_{res} (%)	1.23	0.52	1.53	1.72
Contribution of changes in TAS to ΔPV_{res}(%)	12.91	19.52	13.62	15.75
Contribution of changes in scfWind to ΔPV_{res} (%)	0.3	-0.27	-0.34	0.16
Contribution of changes in RSDS to ΔPV_{res}(%)	86.79	81	86.72	84.08

CONCLUSIONS

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

References

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