



**Change in Wind Renewable Energy Potential under Stratospheric Aerosol Injections**

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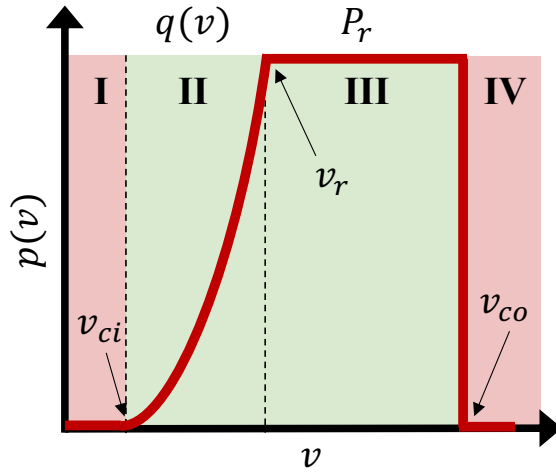
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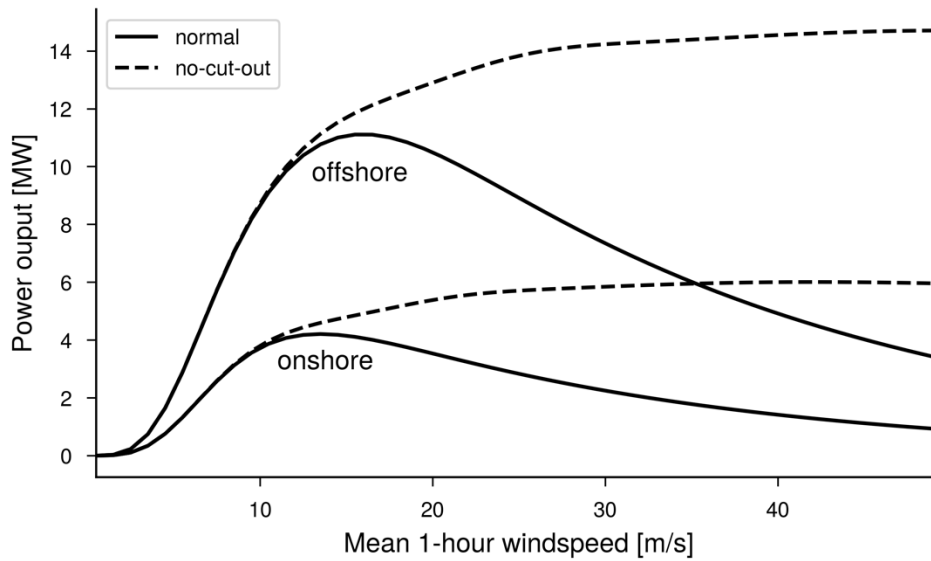
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**Introduction**

Figures S1-S4 and Tables S1-S3 illustrate and give more details to the methods of the analysis. Figures S5-S10 show more detailed results.

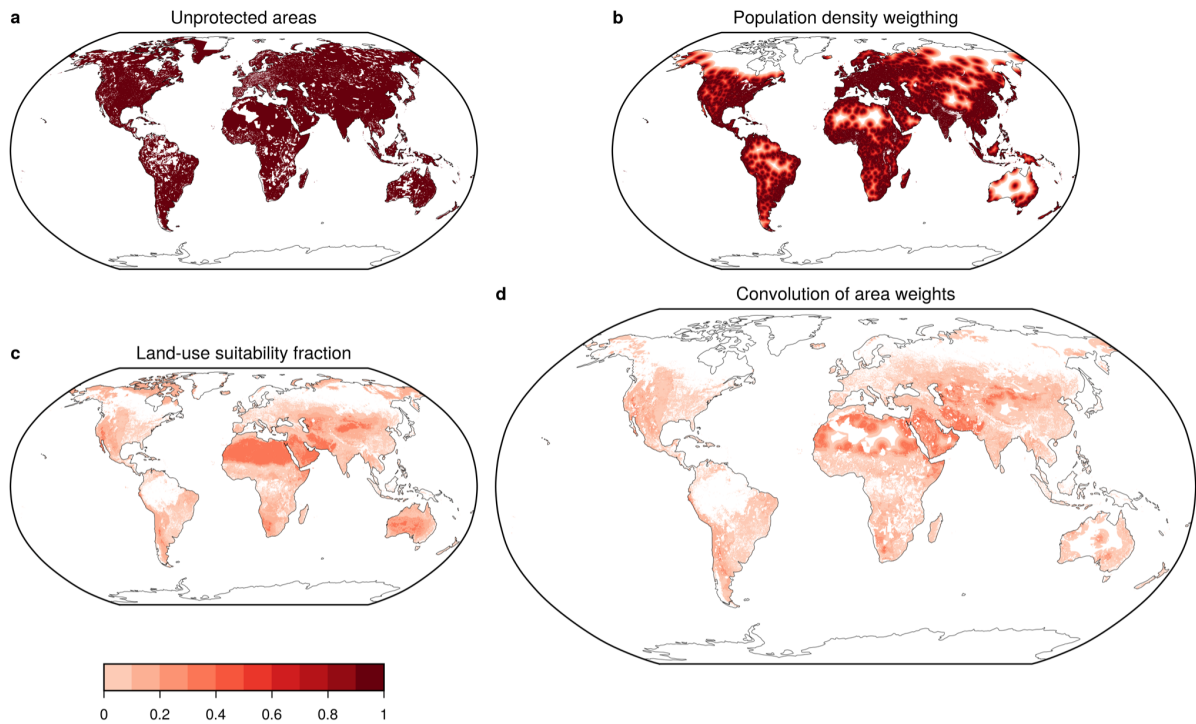


**Figure S1.** Turbine power curve schematic. Green shading signifies operation regimes where power is produced; red areas where no energy is produced.

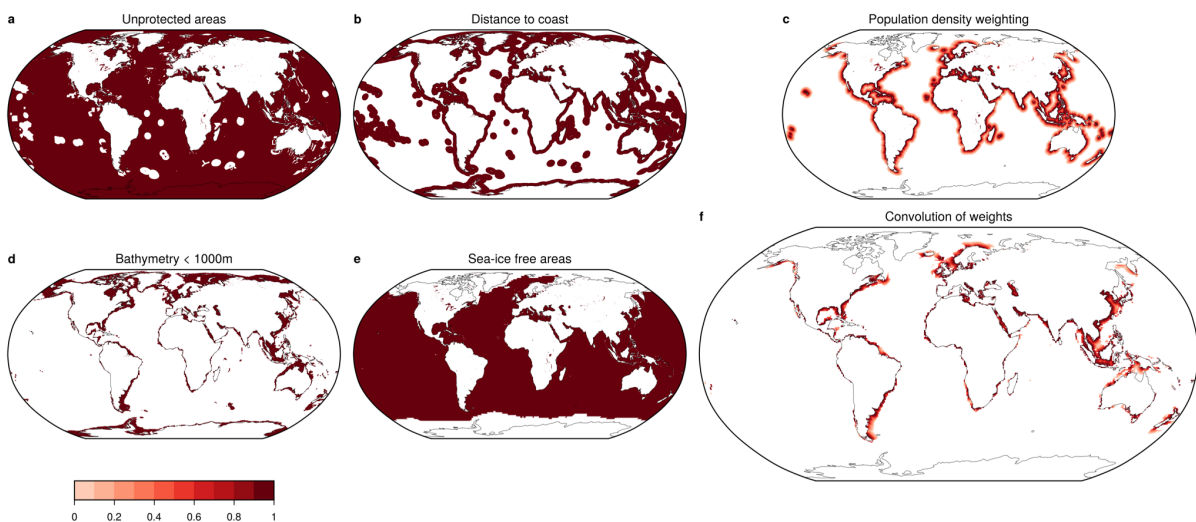


**Figure S2.** Fitted relationship between 1-hour mean wind speed and the power output of one grid cell. Dashed lines represent the power output when the turbines are not

shutoff for windspeeds higher than the cut-off; solid line for turbines that are shutoff after that threshold.

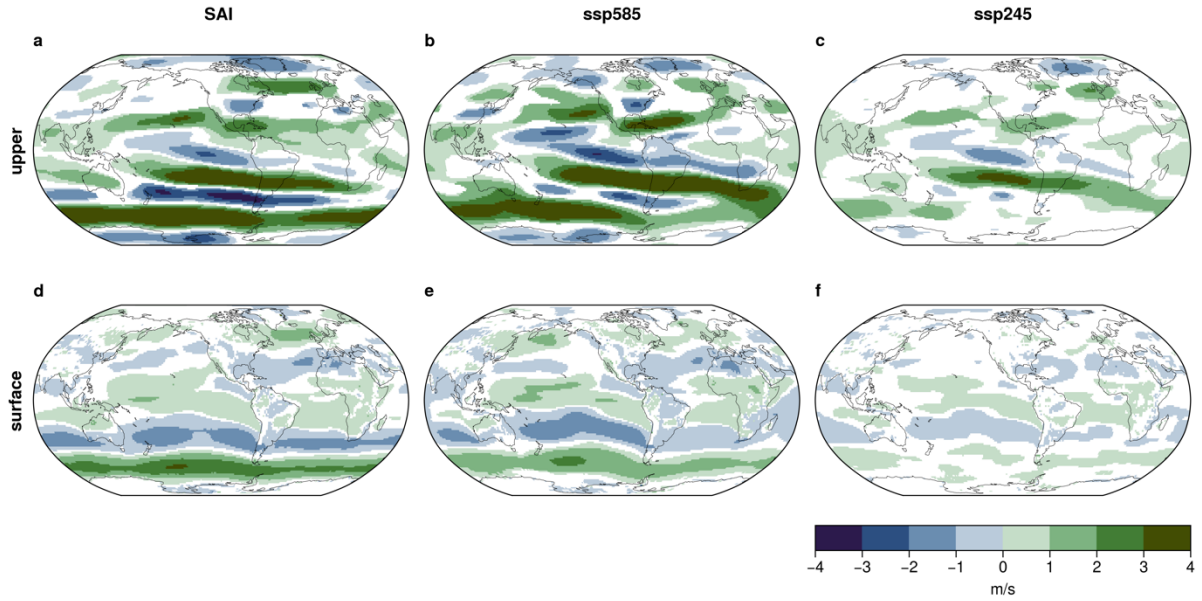


**Figure S3.** Area weights for onshore area restriction with a) unprotected areas (IUCN, 2023), b) weighting of distance to densely populated areas (Stehfest et al., 2014; Doelman et al., 2018), c) weighting according to land use cover (Stehfest et al., 2014; Doelman et al., 2018) and d) convolution of a,b and c.

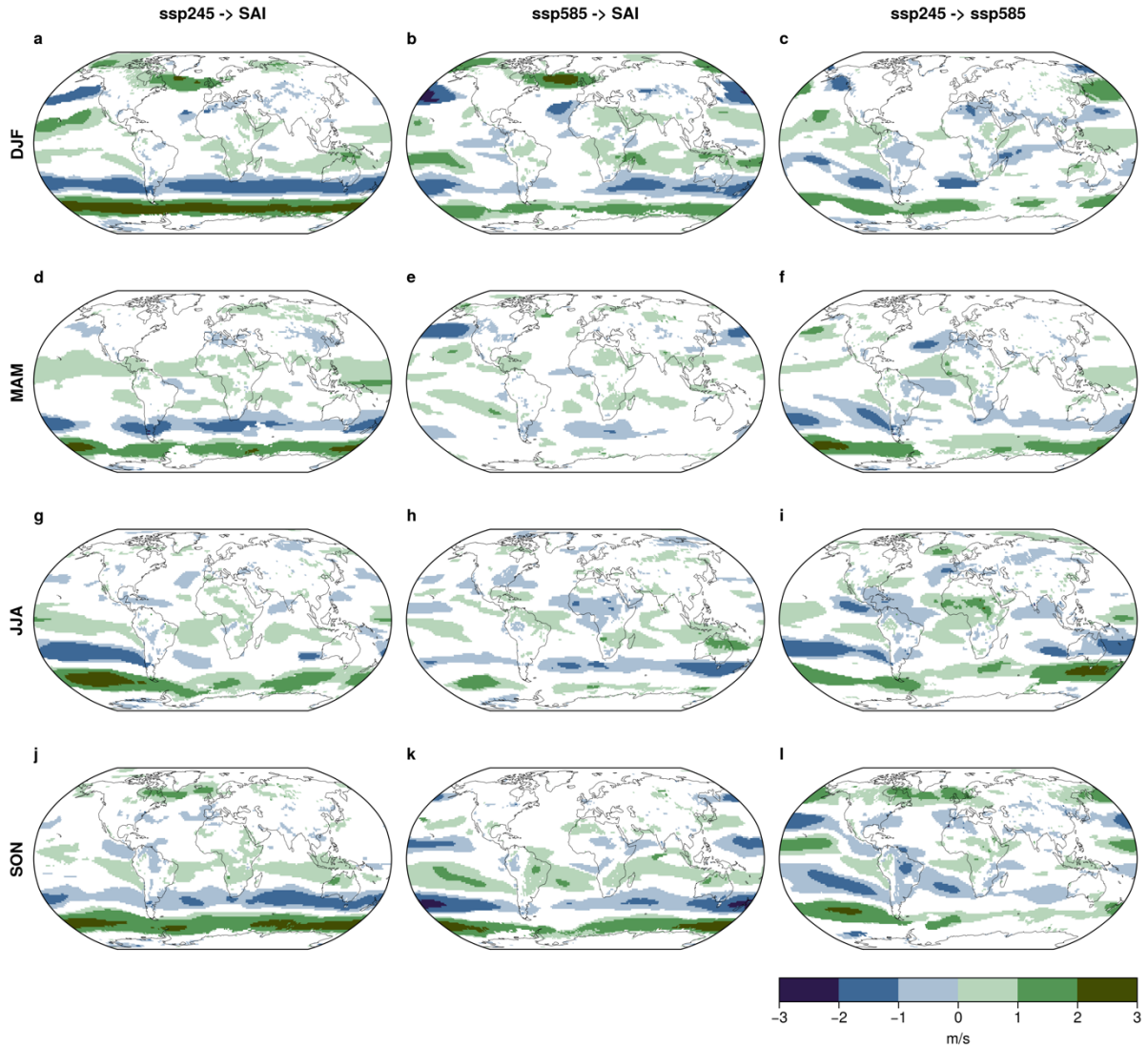


**Figure S4.** Area weights for offshore area restriction with a) unprotected areas (IUCN, 2023), b) the Exclusive Economic Zone (EEZ) (Flanders Marine Institute, 2019), e) the

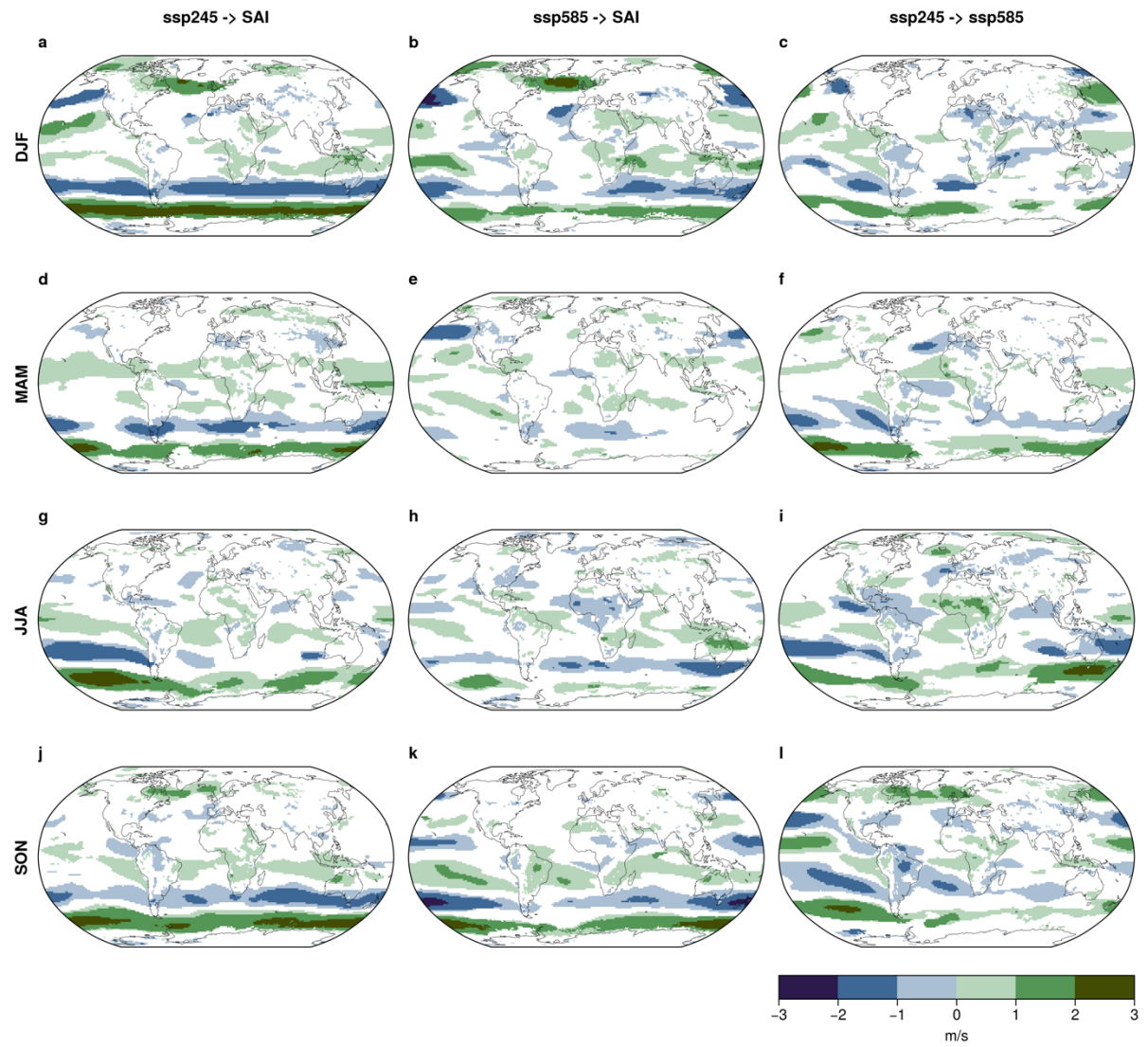
weighting of distance to densely populated areas (Stehfest et al., 2014; Doelman et al., 2018), d) bathymetry of under 1000m, e) at least 95% sea-ice free grid cells and f) the convolution of a,b,c,d and e.



**Figure S5.** Difference in average zonal mean winds between present (2015-2024) and future (2090-2099) for a,d) SAI, b,e) SSP585 and c,f) SSP245 at a-c) the upper troposphere and d-f) the surface. Colored areas are statistically significant  $p < 0.05$ .

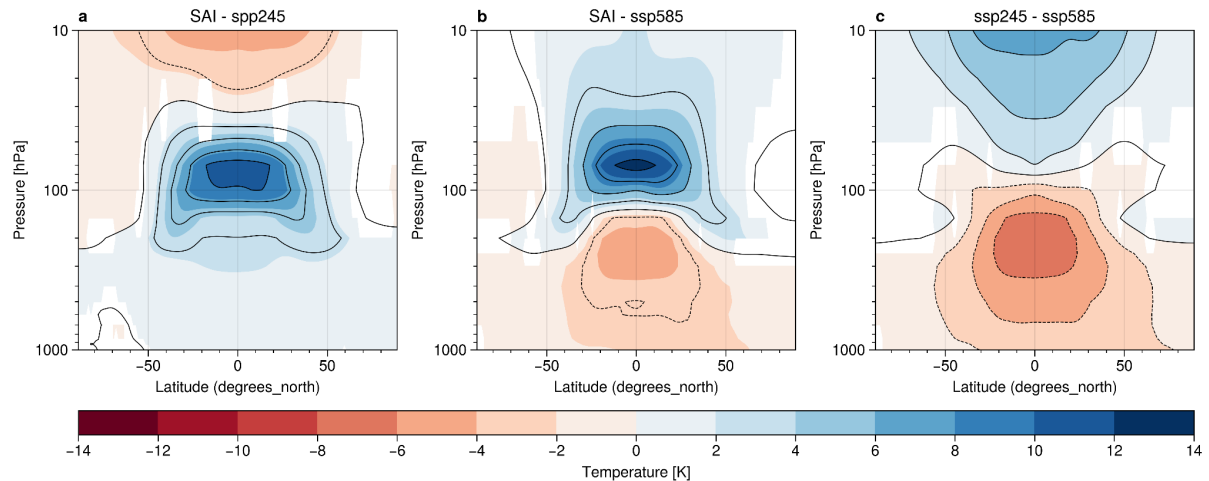


**Figure S6.** Difference in 2090-99 average zonal winds at the upper stratosphere (200-400hpa) during the seasons DJF, MAM, JJA and SON between a,d,g,j) SAI and SSP245, b,e,h,k) SAI and SSP585 and c,f,i,l) SSP245 and SSP585. Colored areas are statistically significant  $p < 0.05$ .

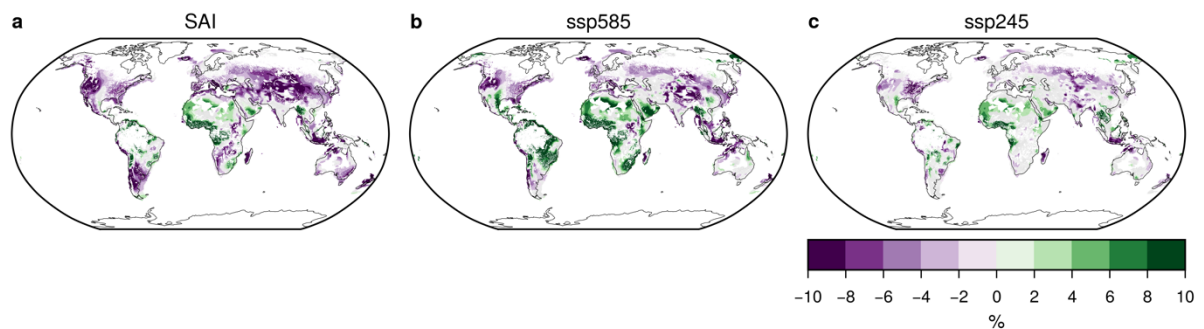


**Figure S7.** Same as Figure 4 but at the surface (850-1000hpa).

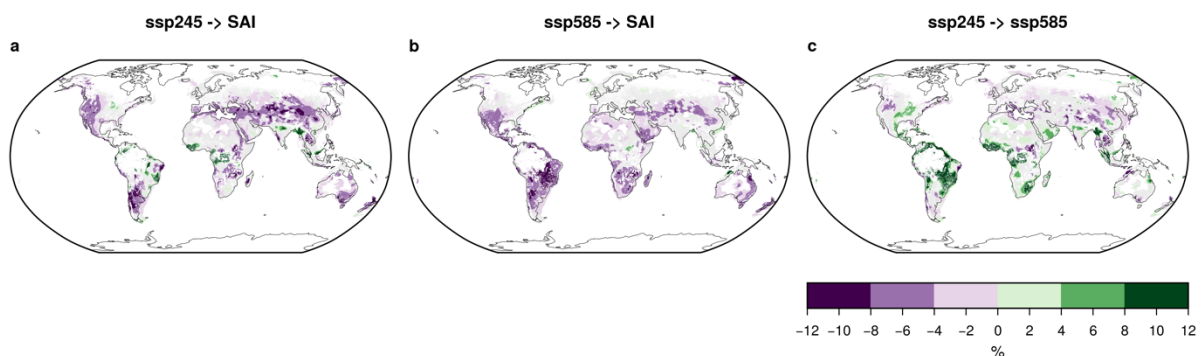




**Figure S8.** Difference in 2090-99 average zonal mean temperature between a) SAI and SSP245, b) SAI and SSP585 and c) SSP245 and SSP585. Contours represent the whole difference, shading indicates where the difference is significant  $p < 0.05$ .



**Figure S9.** Relative difference in present (2015-2024) and future (2090-2099) wind potential for a) SAI, b) SSP585 and c) SSP245. Gray areas have a Signal-to-Noise-Ratio < 1.  $x \rightarrow y$  denotes  $(y - x)/x$ .



**Figure S10.** Relative difference in 2090-2099 wind potential between a) SSP245 to SAI, b) SSP585 to SAI and c) SSP245 to SSP585. Colored areas are statistically significant  $p < 0.05$ ,



gray areas are considered suitable for wind production but show no significant change.  $x \rightarrow y$  denotes  $(y - x)/x$ .

**Table S1.** Constants and variables used for calculation of on- and offshore wind potential.

| Symbol              | Description                          | Value                     | Reference            |
|---------------------|--------------------------------------|---------------------------|----------------------|
| $u$                 | Wind component parallel to x-axis    | [m s <sup>-2</sup> ]      | model output         |
| $v$                 | Wind component parallel to y-axis    | [m s <sup>-2</sup> ]      | model output         |
| $h$                 | Hours in a year                      | 8670 [h]                  | -                    |
| $A$                 | Suitability factor                   | 0-1                       | -                    |
| $a$                 | Area of grid cell                    | [m <sup>2</sup> ]         | -                    |
| $n_a$               | Wind turbine availability            | 97 %                      | Bosch et al., 2017   |
| $n_{ar}$            | Wind farm array efficiency           | 90 %                      | Gernaat et al., 2021 |
| $D_{loc}$           | Power density                        | [MW/km <sup>2</sup> ]     | -                    |
| $spacing$           | Spacing between turbines             | 6x6                       | -                    |
| $P_r$               | Rated power                          | [MW]                      | Table S2             |
| $d_{Rotor,loc}$     | Rotor diameter                       | [m]                       | Table S2             |
| $p(v)$              | Electric power                       | [W]                       | -                    |
| $\rho$              | Air density                          | 1,2 [kg m <sup>-3</sup> ] | -                    |
| $\varepsilon_{loc}$ | Area swept by rotor blades           | [m <sup>2</sup> ]         | Table S2             |
| $pc$                | Power coefficient                    | 0.397                     | Dai et al., 2016     |
| $\beta$             | Weibull distribution shape parameter | 2                         | -                    |
| $\alpha$            | Weibull distribution scale parameter | [m s <sup>-2</sup> ]      | -                    |
| $WS_i$              | Mean 1-hour wind speed               | [m s <sup>-2</sup> ]      | -                    |
| $a_{onshore}$       |                                      | 9,01                      | -                    |

|                    |            |           |   |
|--------------------|------------|-----------|---|
| $b_{onshore}$      |            | 88,19     | - |
| $c_{onshore}$      |            | 28,74     | - |
| $d_{onshore}$      |            | 21,62     | - |
| $a_{onshore;nco}$  | No-cut-out | 5,28      | - |
| $b_{onshore;nco}$  | No-cut-out | 75499,32  | - |
| $c_{onshore;nco}$  | No-cut-out | 787,44    | - |
| $a_{offshore}$     |            | 24,16     | - |
| $b_{offshore}$     |            | 128,09    | - |
| $c_{offshore}$     |            | 23,66     | - |
| $d_{offshore}$     |            | 24,84     | - |
| $a_{offshore;nco}$ | No-cut-out | 12,98     | - |
| $b_{offshore;nco}$ | No-cut-out | 153832,00 | - |
| $c_{offshore;nco}$ | No-cut-out | 1181,97   | - |

**Table S2.** Exemplary on- and offshore wind turbine specifications. Data from Vestas (2023a), (2023b).

|  | <b>Vestas V162-6.2 (onshore)</b> | <b>Vestas V236-15 (offshore)</b> |
|--|----------------------------------|----------------------------------|
| <b>Rated power (<math>P_r</math>)</b>          | 6.2 MW                           | 15 MW                            |
| <b>Cut-in windspeed (<math>v_{ci}</math>)</b>  | 3.0 m/s                          | 3.0 m/s                          |
| <b>Cut-out windspeed (<math>v_{co}</math>)</b> | 25 m/s                           | 30 m/s                           |
| <b>Rotor diameter (<math>d_{Rotor}</math>)</b> | 162 m                            | 236 m                            |
| <b>Serial production</b>                       | 2021                             | 2024                             |

**Table S3.** Land use suitability fractions assigned to land use cover categories from IMAGE3.0-LPJ (Doelman et al., 2018; Stehfest et al., 2014).

| <b>Land use / land cover category</b> | <b>Reference suitability value</b> |
|---------------------------------------|------------------------------------|
| Agricultural land                     | 5 %                                |
| Extensive grassland                   | 15 %                               |
| Carbon plantation                     | 0                                  |

|                            |      |
|----------------------------|------|
| Regrowth forest abandoning | 0    |
| Regrowth forest timber     | 0    |
| Biofuels                   | 5 %  |
| Ice                        | 0    |
| Tundra                     | 20 % |
| Wooded tundra              | 10 % |
| Boreal forest              | 0    |
| Cool conifer forest        | 0    |
| Temp. mixed forest         | 0    |
| Temp decid. forest         | 0    |
| Warm mixed forest          | 0    |
| Grassland / steppe         | 20 % |
| Hot desert                 | 40 % |
| Scrubland                  | 20 % |
| Savannah                   | 15 % |
| Tropical woodland          | 0    |
| Tropical forest            | 0    |