Long term wind speed and wind power changes analysis over South Greenland using the MAR regional climate model

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Why doing this study ?

- Wind is an abundant renewable energy source
- South Greenland is one of the windiest places on Earth (Moore et al., 2015)
- Anti-correlated wind regime with western Europe (Radu et al., 2019) → addresses the intermittency issue
- The Arctic is undergoing the strongest climate change

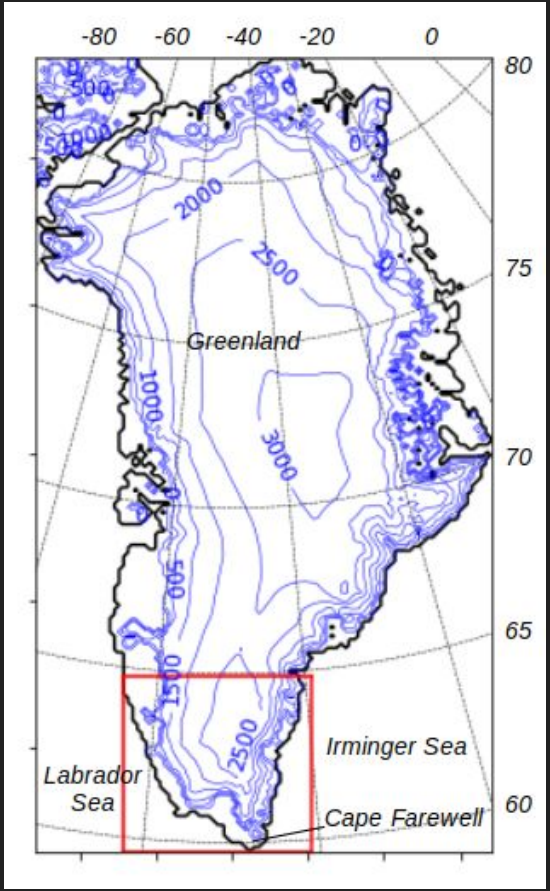


Fig. 1 : Greenland and surroundings. the blue lines represent the ice sheet topography in meters. The red box is the study area. (Lambin et al., under review)

Methods

MAR

Modèle Atmosphérique Régional

Present climate 2016-2021

→ forced with ERA5

→ Evaluation against *in situ* observations : KATABATA, DMI, PROMICE

Projections 1981-2100

→ forced with ensemble of CMIP6 ESMs with SSP5-8.5

Decreasing trends in winter

Betz equation:

$$P_{max} = (16/27) \times 0.5 \times \rho \times S \times v^3$$

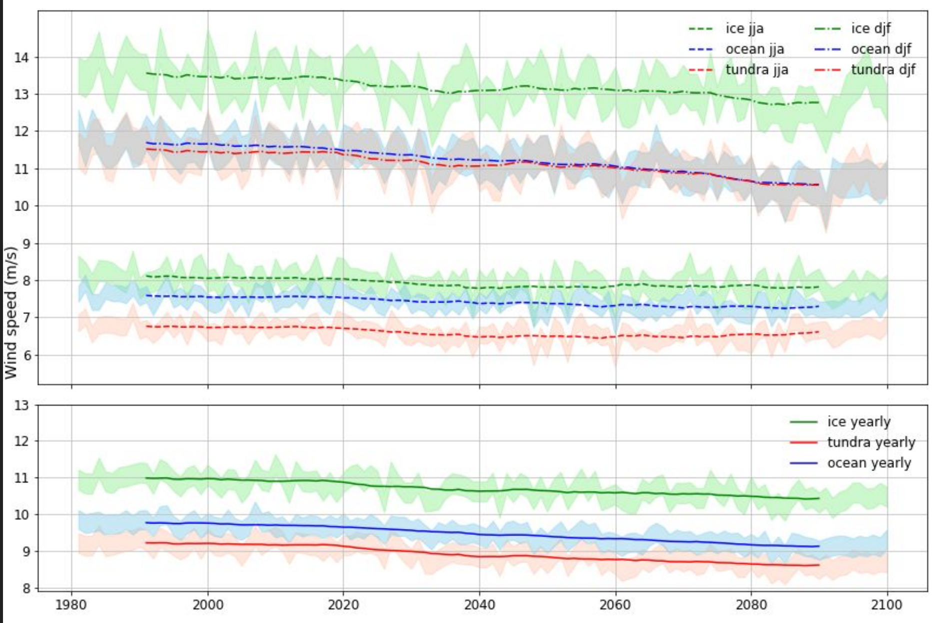


Fig. 2: Yearly, winter and summer wind speed trends above tundra, ocean and ice sheet between 1981 and 2100 over South Greenland in m/s

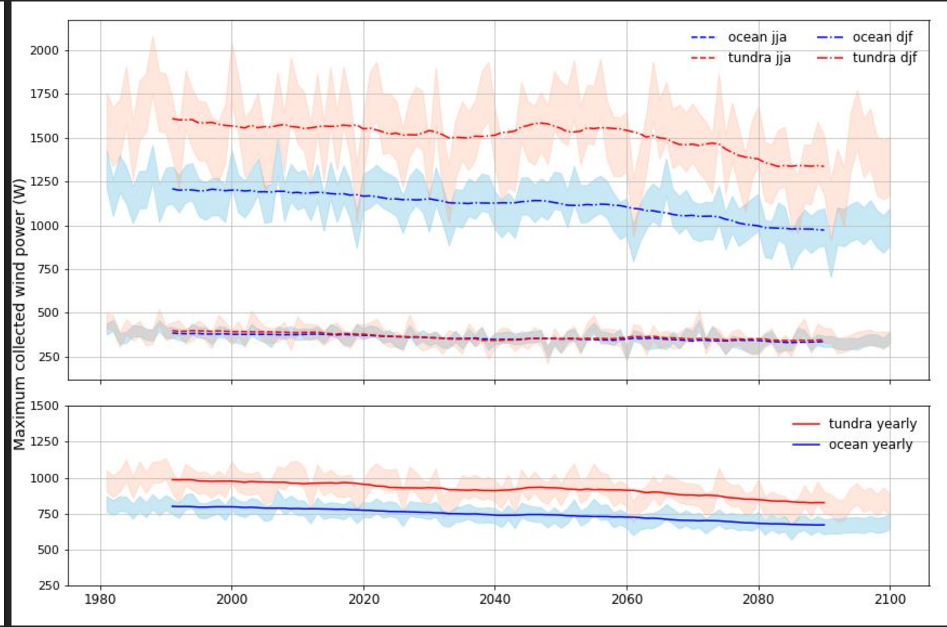
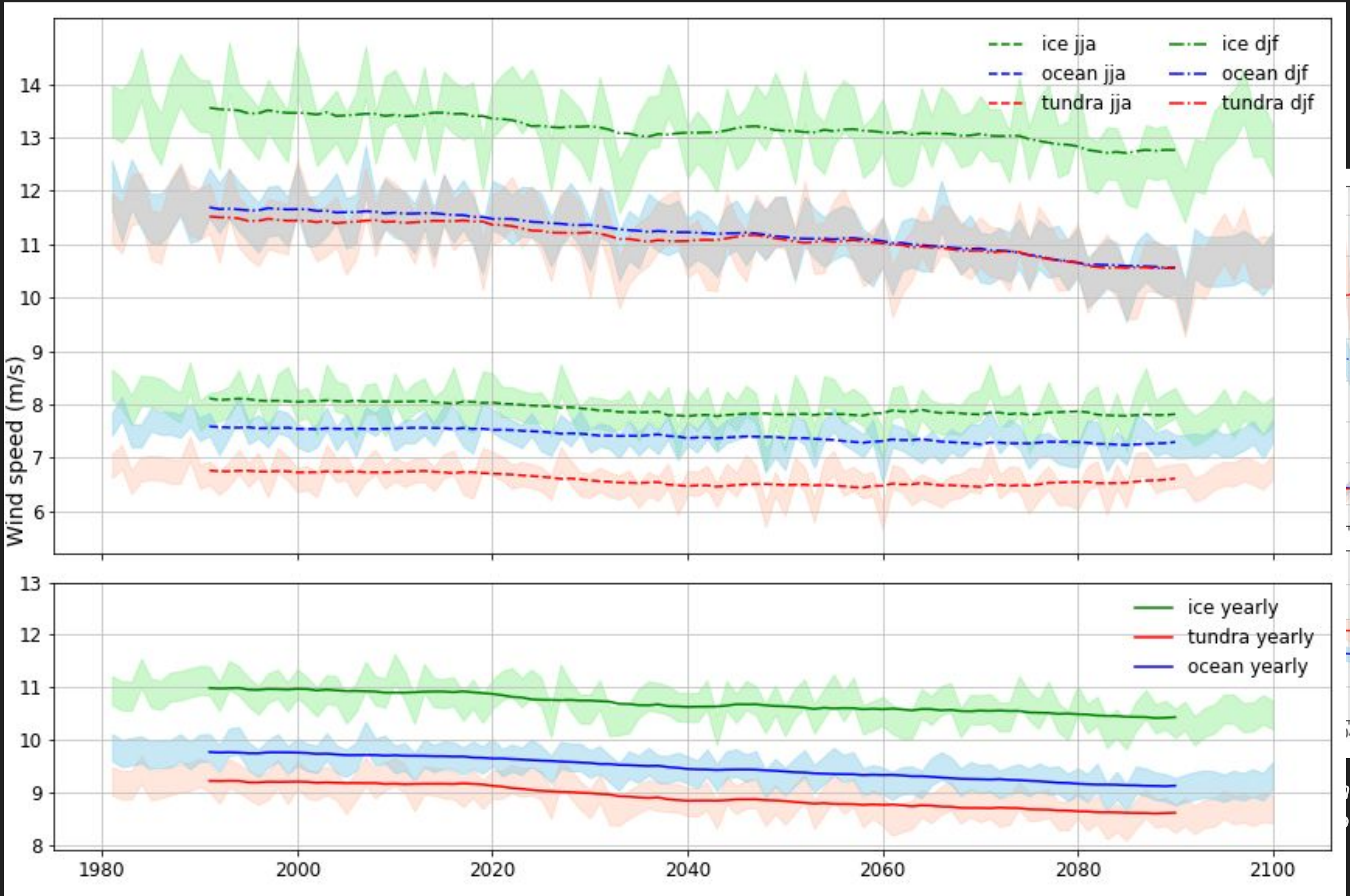
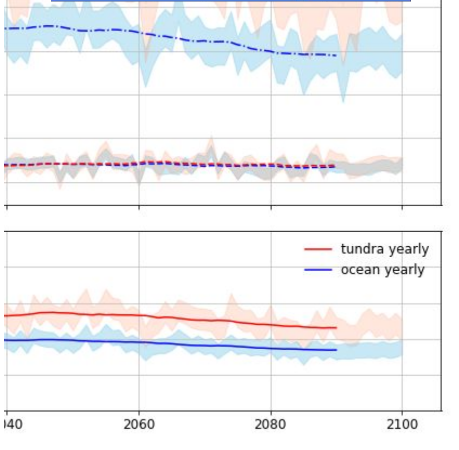
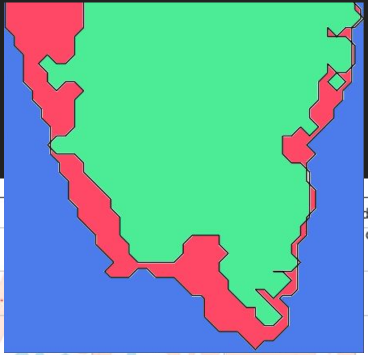


Fig. 3: Yearly, winter and summer wind power trends above tundra and ocean between 1981 and 2100 over South Greenland in W

(Lambin et al., under review)







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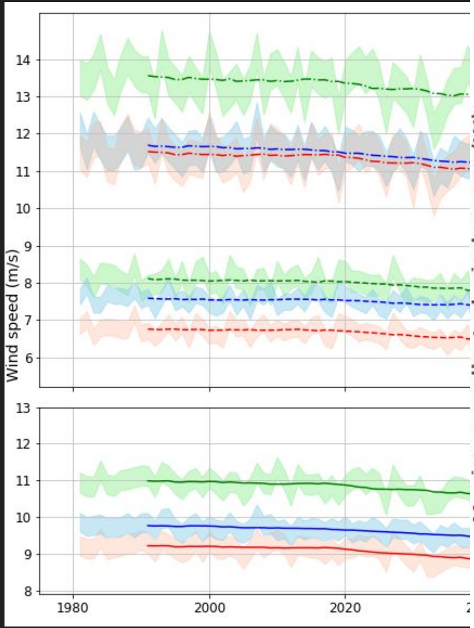

Fig. 2: Yearly, winter and summer wi
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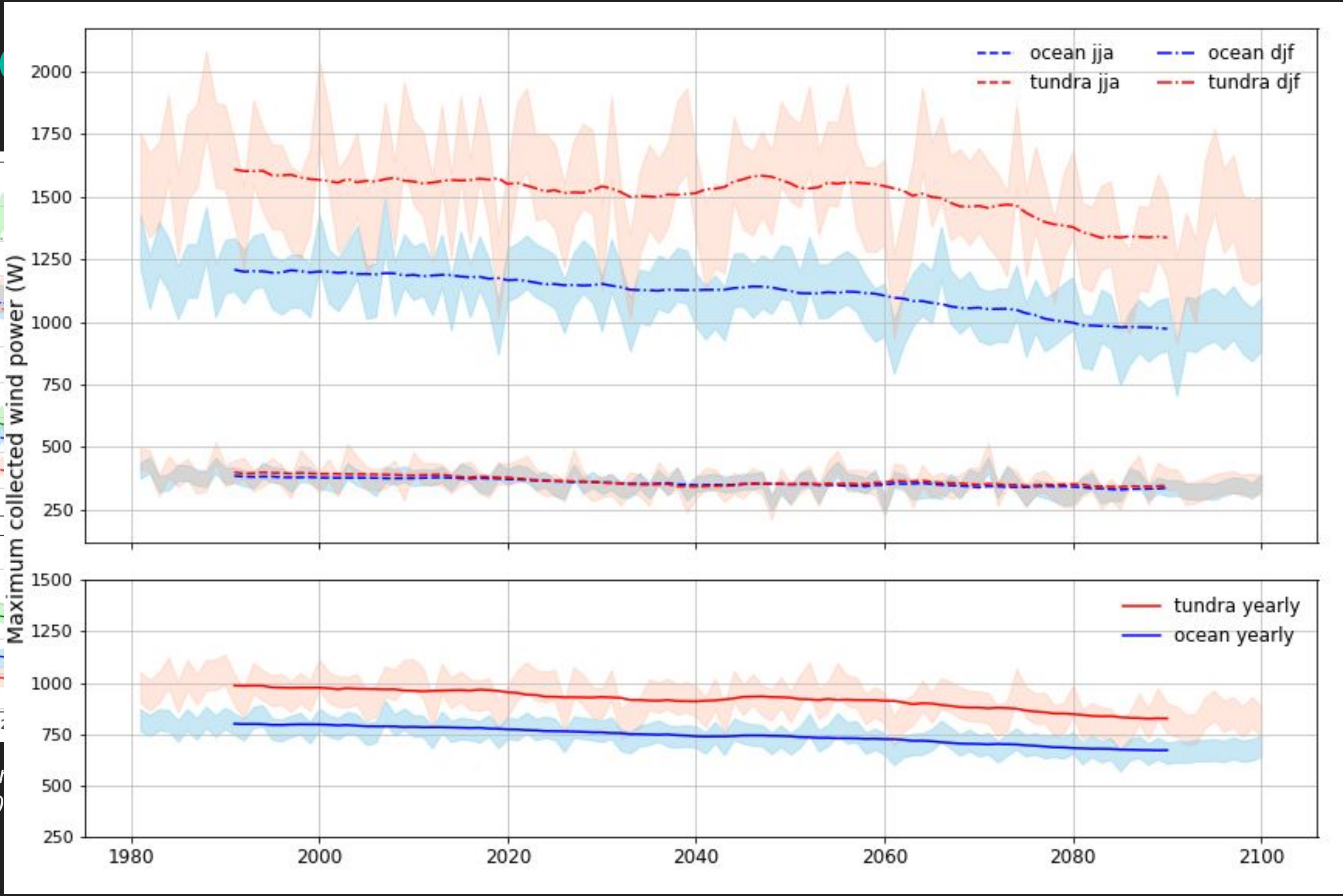

Spatial trends

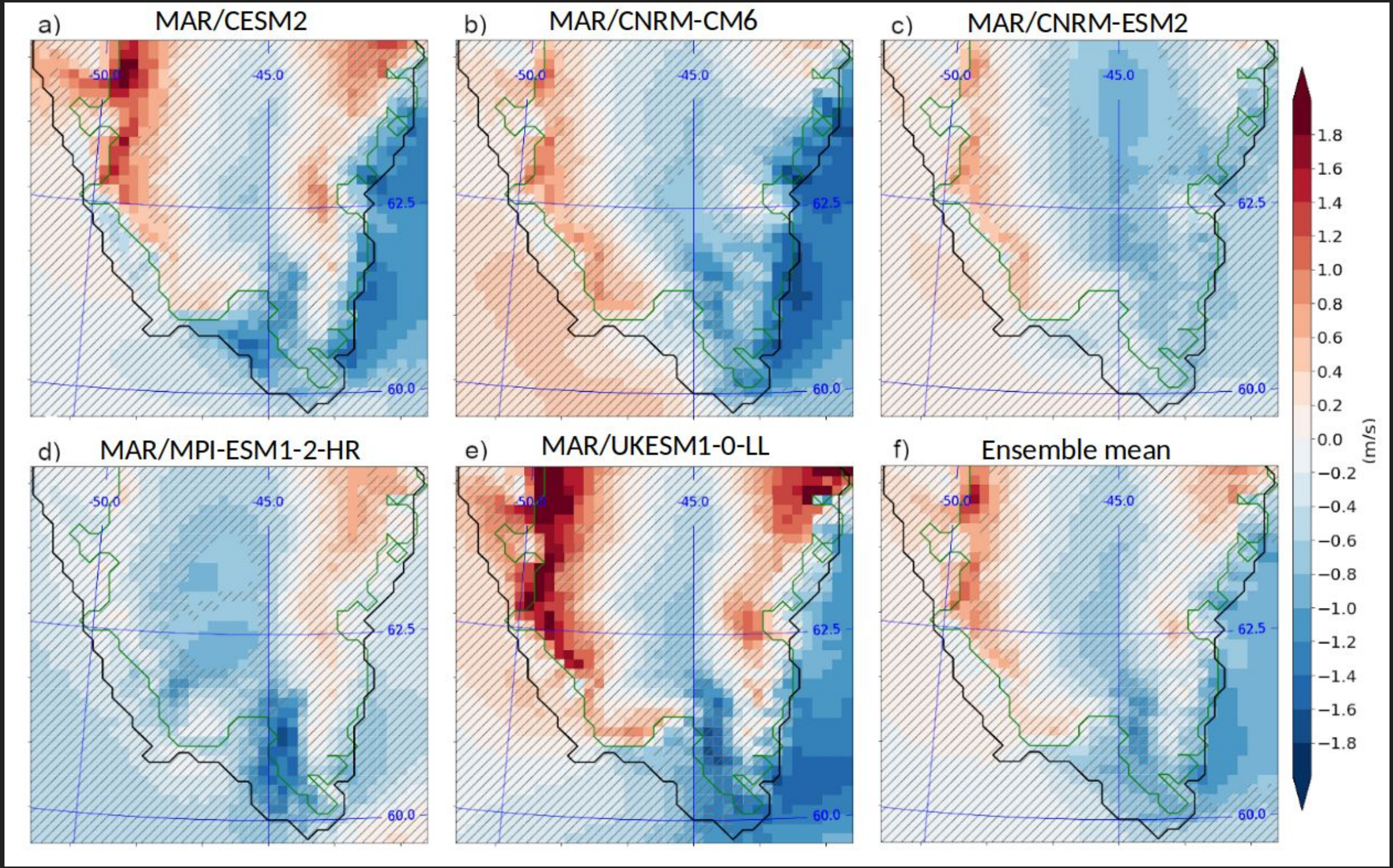

Fig. 4: Mean summer wind speed change over South Greenland from 1981 to 2100
(Lambin et al., under review)

Conclusions

- Significant wind speed decrease in winter by 2100
  ↳ Arctic Amplification ? (Jung and Schindler, 2019)

- Significant wind speed increase in summer along the ice sheet margins and the nearby tundra.
  ↳ enhanced temperature contrast between boundary layer and upper air layers → katabatic wind speed acceleration

References

- Jung, C. and Schindler, D. (2019). Changing wind speed distribution under future global climate. *Energy Conservation and Management*, 198:111841.
- Lambin, C., Fettweis, X., Kittel, C., Fonder, M. and Ernst, D. (under review) Assessment of future wind speed and wind power changes over South Greenland using the MAR regional climate model [preprint], available online on https://orbi.uliege.be/handle/2268/288534#statistics
- Moore, G. W. K., Renfrew, I. A., Harden, B. E. and Mernild, H. (2015). The impact of resolution on the representation of southeast Greenland barrier winds and katabatic flows. *Geophysical Research Letters*, 42:3011-3018.
- Radu, D., Berger, M., Fonteneau, R., Hardy, S., Fettweis, X., Le Du, M., Panciatici, P., Balea, L. and Ernst, D. (2019). Complementary assessment of south Greenland katabatic flows and West Europe wind regimes. *Energy*, 175:393-401.