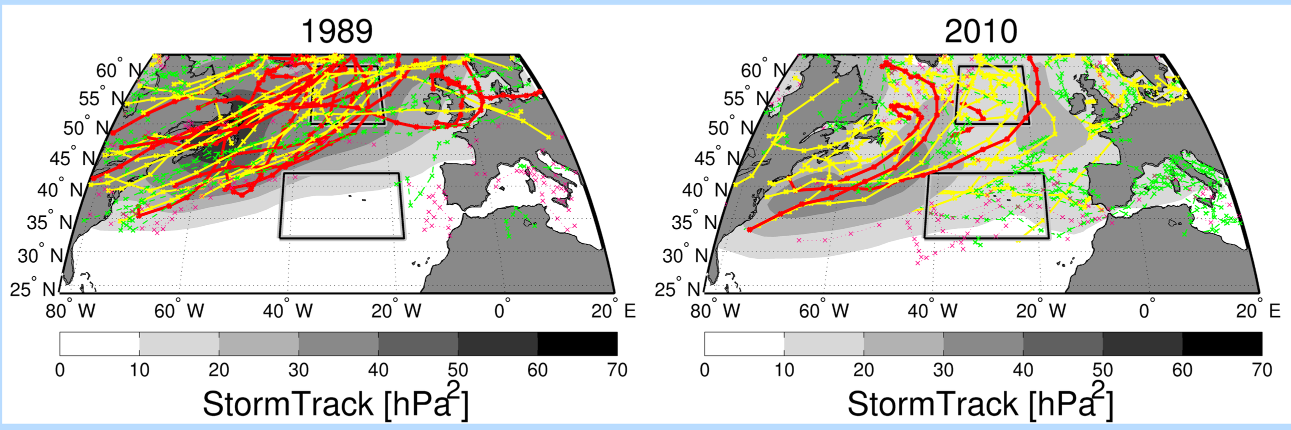
Estimating Wind Power Input to near-inertial Currents in the North Atlantic with a coupled regional Model

Tina Dippe[1], Xiaoming Zhai[2], Richard Greatbatch[1], Willi Rath[1]

GEOMAR

Do more storms produce more Wind Power Input?



Maximum intensity: < 960 hPa, < 980 hPa, < 1000 hPa, > 1000 hPa

Fig. 1: Storm track (grey shading) and individual storm paths. The line colour refers to the maximum intensity of the system in terms of minimum core pressure.

- Importance of Wind Power Input (WPI) to near-inertial currents: Generation of near-inertial energy in the ocean
  → Internal ocean mixing
  → Impact on global climate[1],[2]
- WPI is most efficient in response to passing storms[3]
  → Do stormy winters produce more WPI?
  → Relationship between the NAO – a good indicator of storminess[4] – and WPI?
- Use a 1/10° regional model of the North Atlantic and force it with NCEP/NCAR wind stress for two extreme NAO years: 1989 and 2010 (Fig. 1) – WPI response?

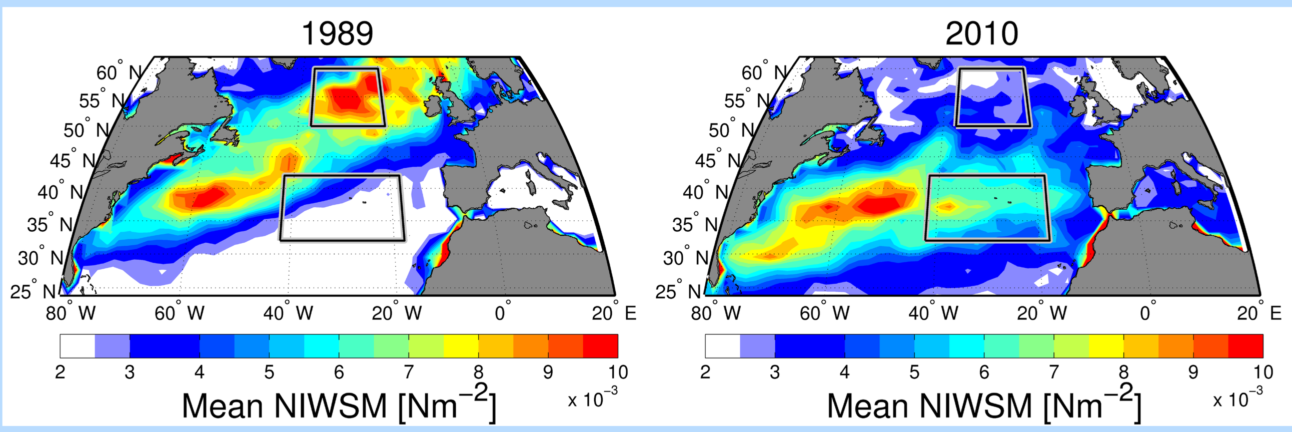


Fig. 2: Mean JFM near-inertial wind stress magnitude in left (1989) and (right) 2010. Boxes denote areas of enhanced Wind Power Input.

Wind Power Input is more effective in the subtropics

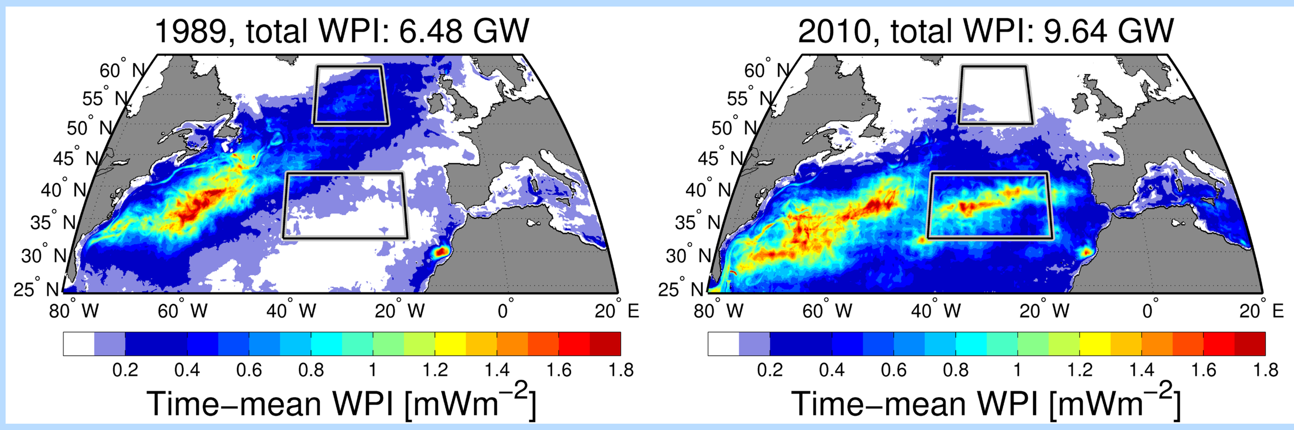


Fig. 3: Mean JFM Wind Power Input in (left) 1989 and (right) 2010. Boxes as in Fig. 2.

- Near-Inertial Wind Stress Magnitude (NIWSM, Fig. 3): The part of the wind stress spectrum that is most efficient in generating Wind Power Input. Related to the storm track (Figs. 1, 2).
- Compare Figs. 2 and 3: Subpolar NIWSM in 1989 is stronger than subtropical NIWSM in 2010. Yet, subtropical WPI is enhanced in 2010 relative to subpolar NIWSM in 1989, i.e. WPI is more effective in the subtropics. Why?
- Several factors. Most important: NIWSM creates near-inertial currents more effectively in the subtropics.
- Implications for interannual variability of WPI?
  → Build linear models of WPI for different latitude bands (Figs. 4, 5)

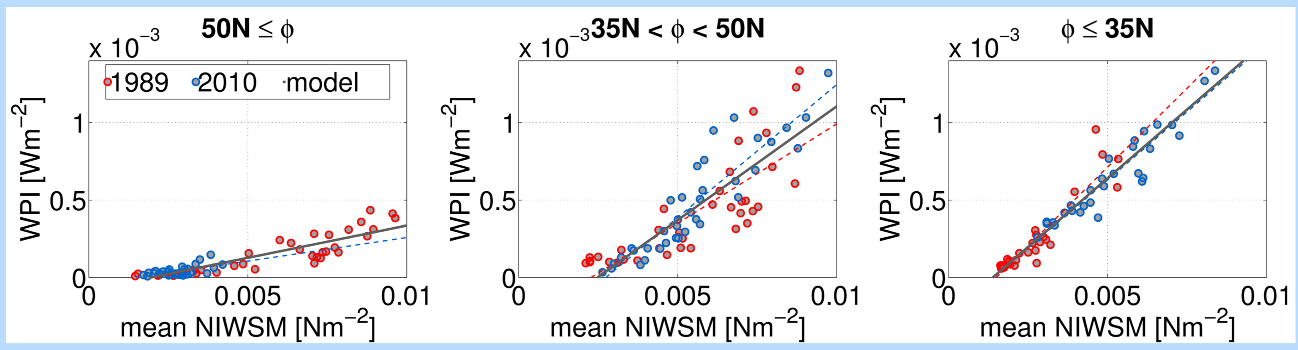


Fig. 4: Linear models of WPI for (left) high, (middle) mid-, and (right) low latitudes. Latitude specifications are given in the figure titles.Blue: 1989, red: 2010, grey: both years. Dashed coloured lines: Linear models for single years. Solid grey lines: Linear models for both years.

Wind Power Input and Storminess: An inverse Relationship

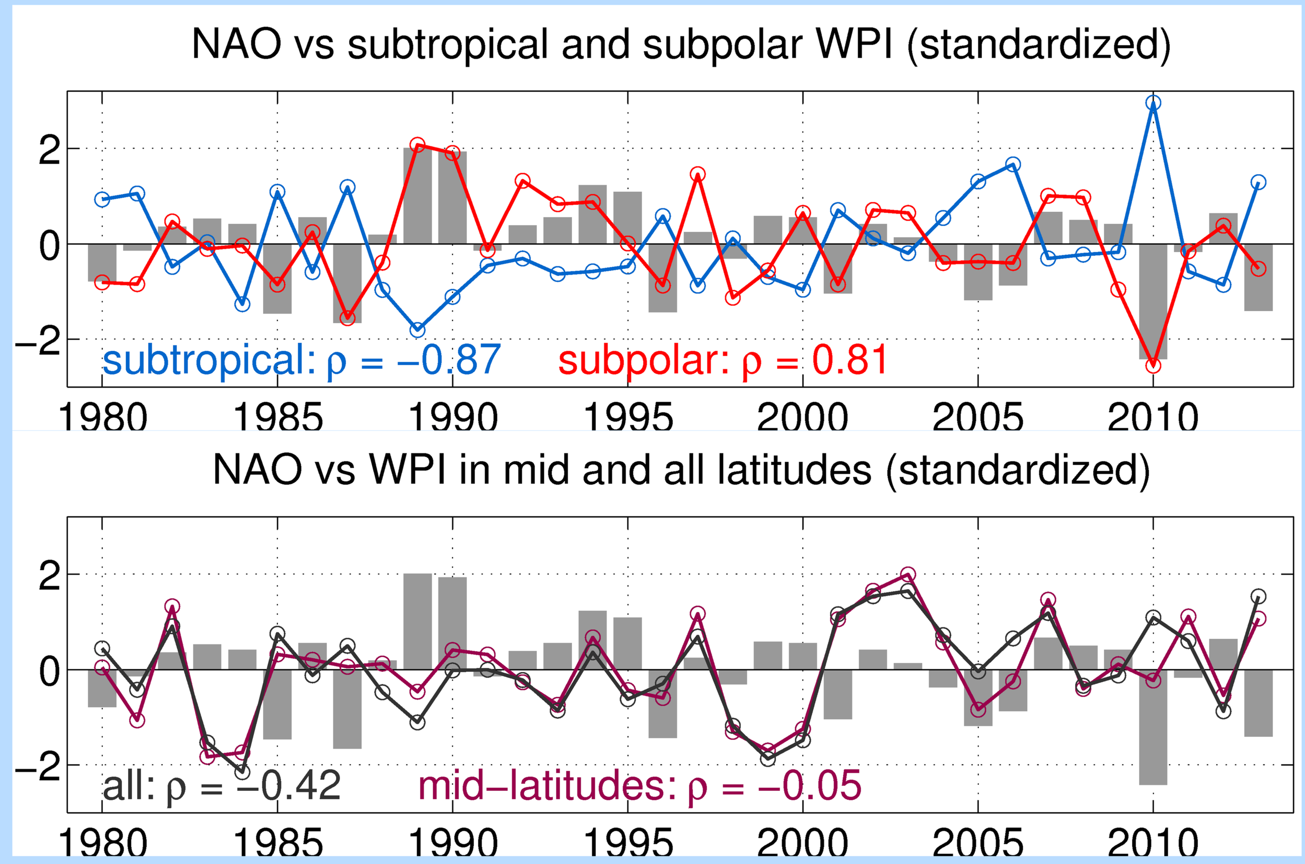


Fig. 5: Normalized time series of the NAO index (grey bars) and Wind Power Input (colored lines) estimated from the linear models. Correlation coefficients are for the time series of WPI and the NAO. Note that subtropical WPI is roughly an order of magnitude larger than subpolar WPI.

- Wind Power Input is more effective in the subtropics
  → Enhanced impact of subtropics on total WPI
- Overall: Inverse relationship with NAO (r = -0.42)
  → Total WPI: 6.84 (9.64) GW in 1989 (2010) (Figs. 4,5)

Outlook

- In the tropics: Inertial frequency band merges with low-frequency band
  → models are expected to realistically capture tropical Wind Power Input to near-inertial currents[1].
- Future study: Dominant impact on interannual variability of Wind Power Input in the tropical Atlantic? Relationship to variability of current system and current strengths? Impact?

Contact: Tina Dippe (tdippe@geomar.de)

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[1] GEOMAR Helmholtz Centre for Ocean Research, Kiel [2] School of Environmental Sciences, University of East Anglia

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HELMHOLTZ GEMEINSCHAFT

University of East Anglia