Southern Ocean surface warming variability linked to extended interstorm periods

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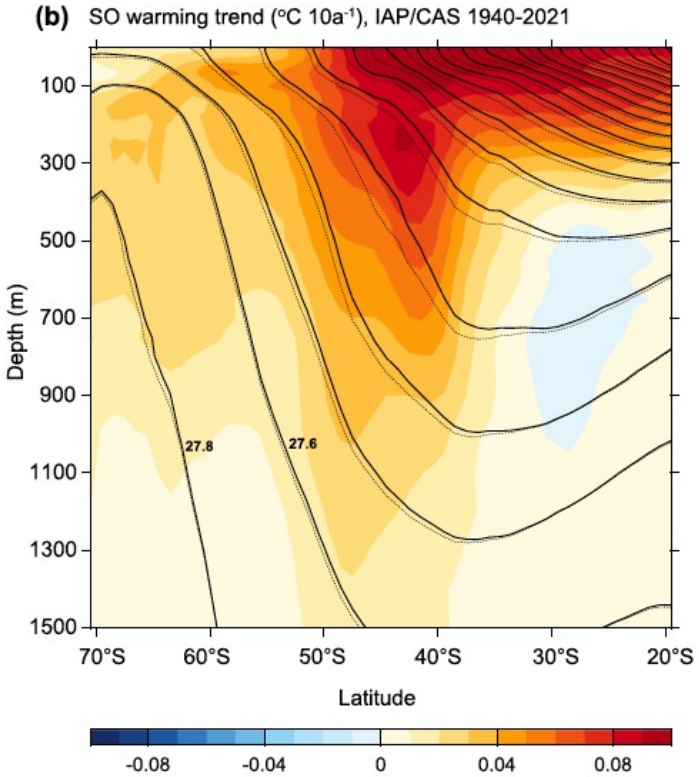
International Underwater Glider Conference | Gothenburg

11 July 2024

The Southern Ocean is warming

Yet a warm sea surface temperature bias persist in climate models

Observations indicate the Southern Ocean is warming



Cai et al. 2023

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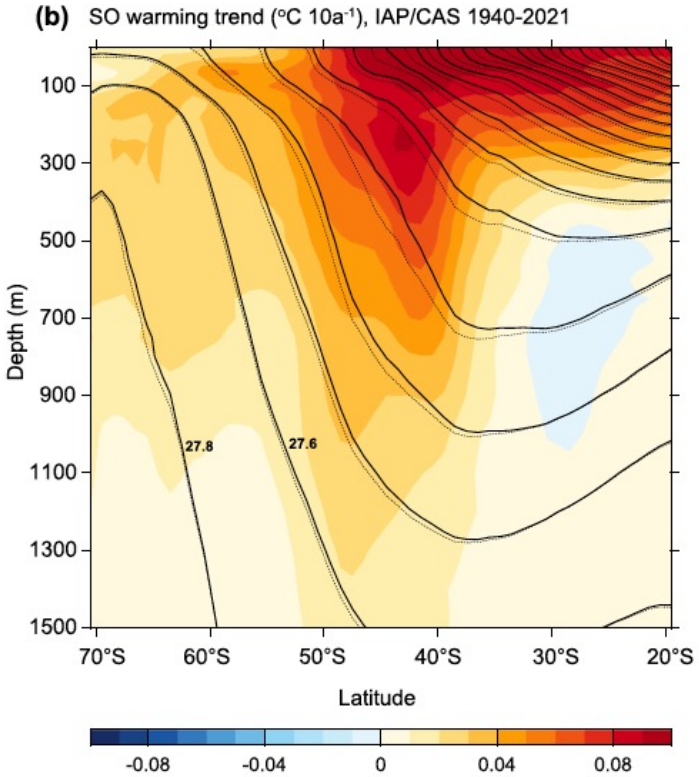

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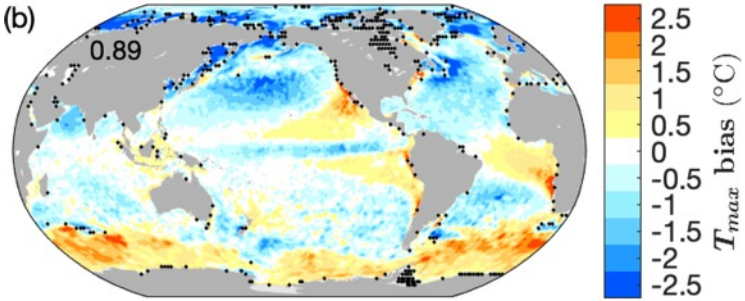
Climate models are biased warm

Bias driven by excessive SST_{max}



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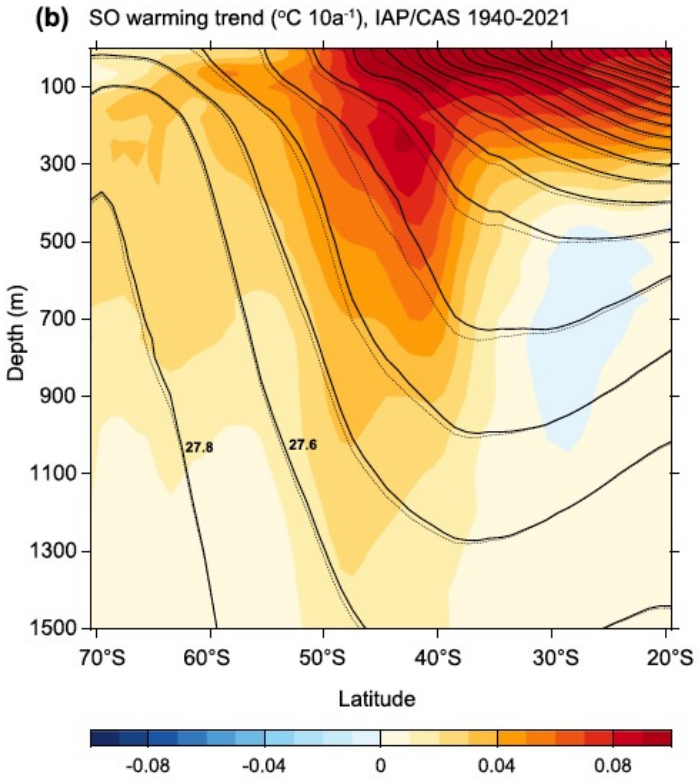

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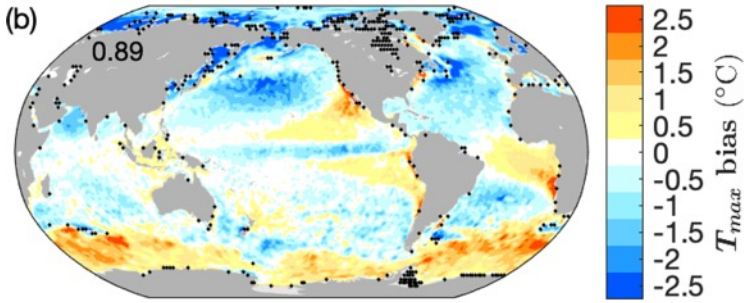
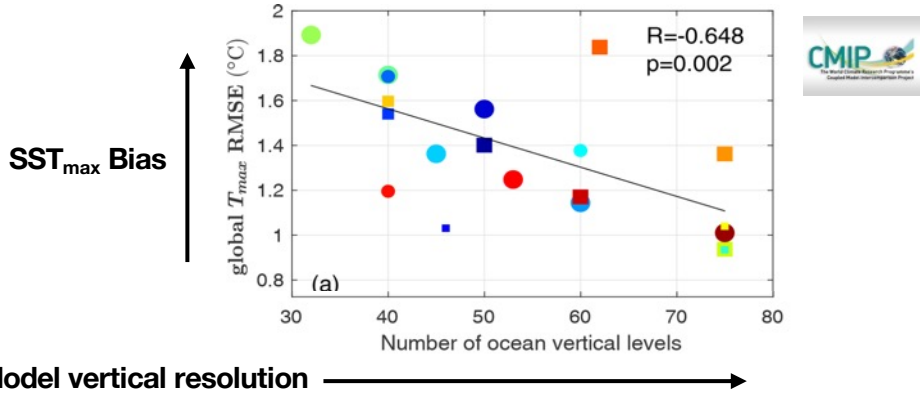
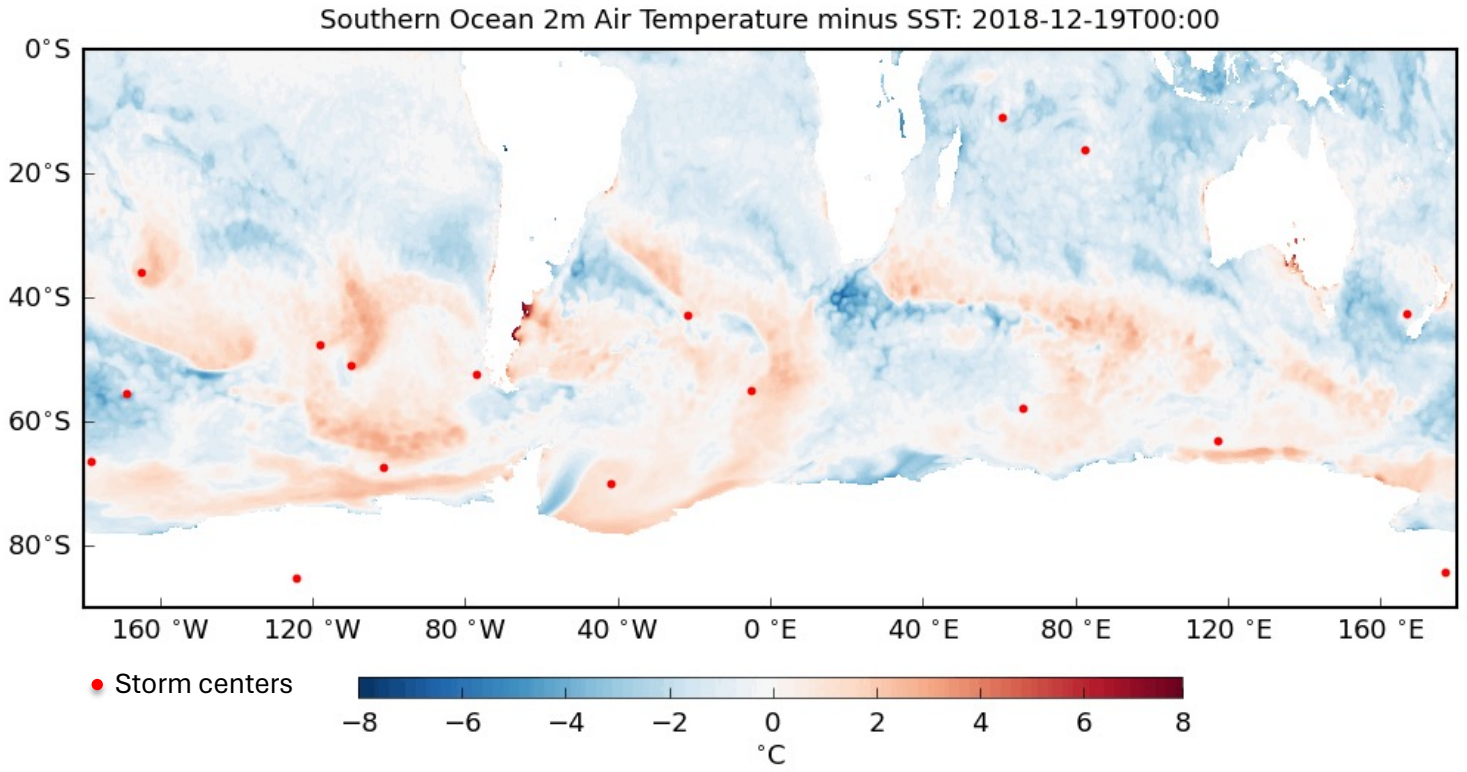




Wang et al. 2022

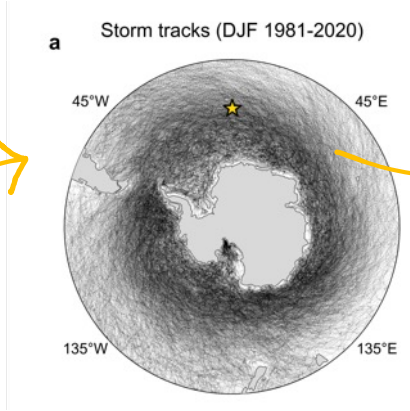
Synoptic impacts on longer-term SST unknown

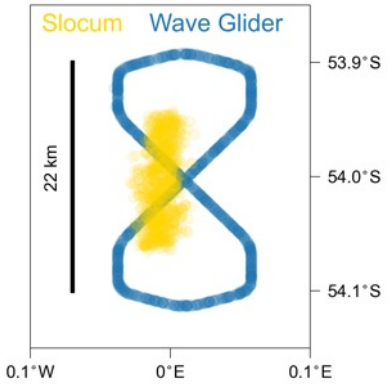
Do storms have a rectified effect on the sea surface temperature variability?



Observational campaign

3-month Slocum and Wave Glider deployment in the subpolar Southern Ocean





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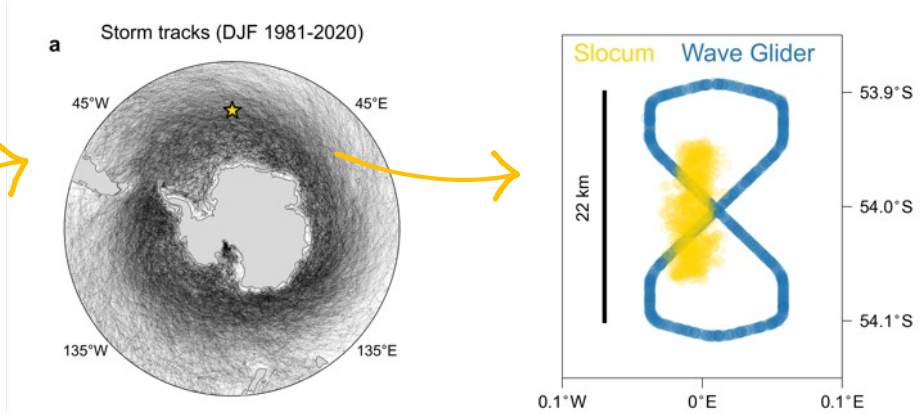
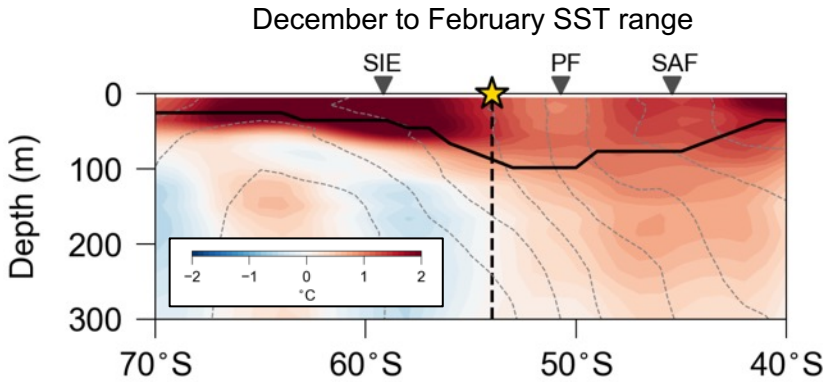
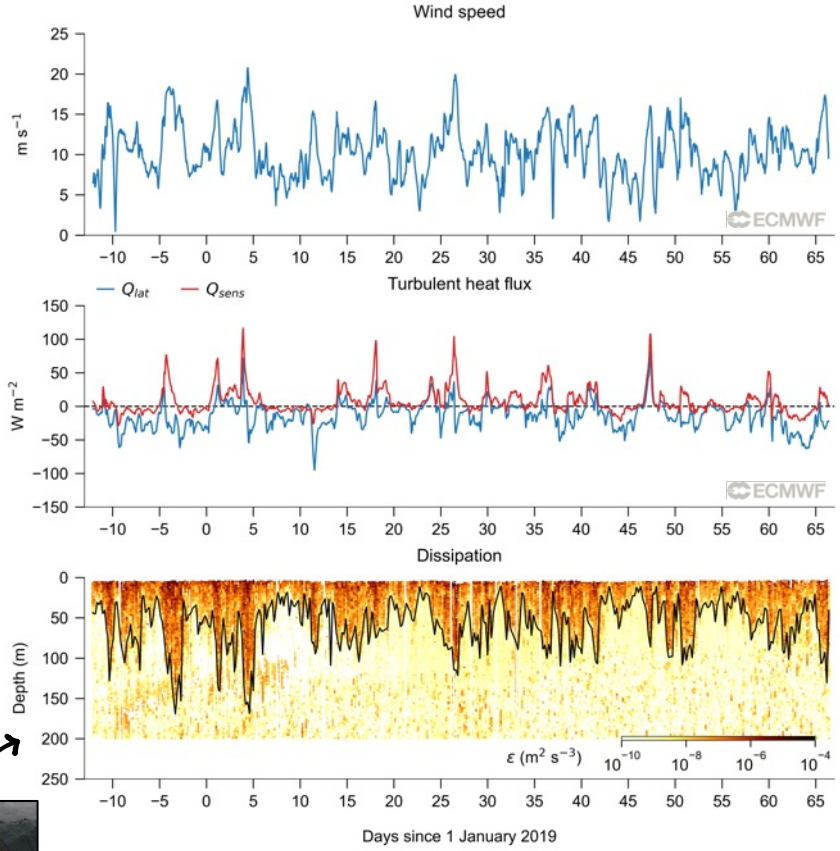




Storm observations

Identifying storm events during the 3-month deployment



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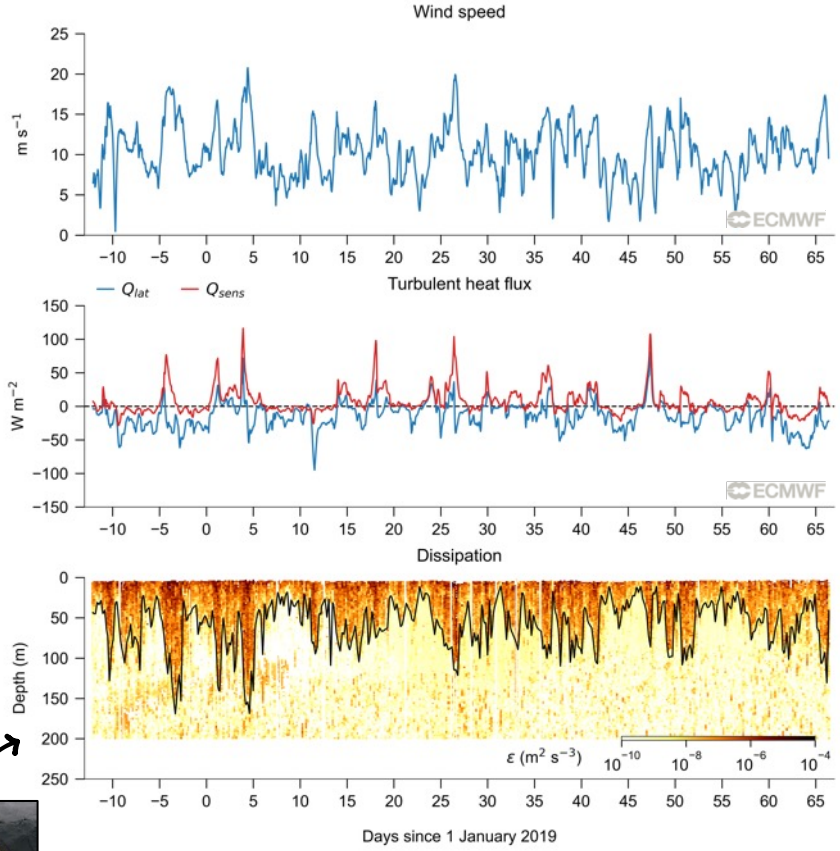
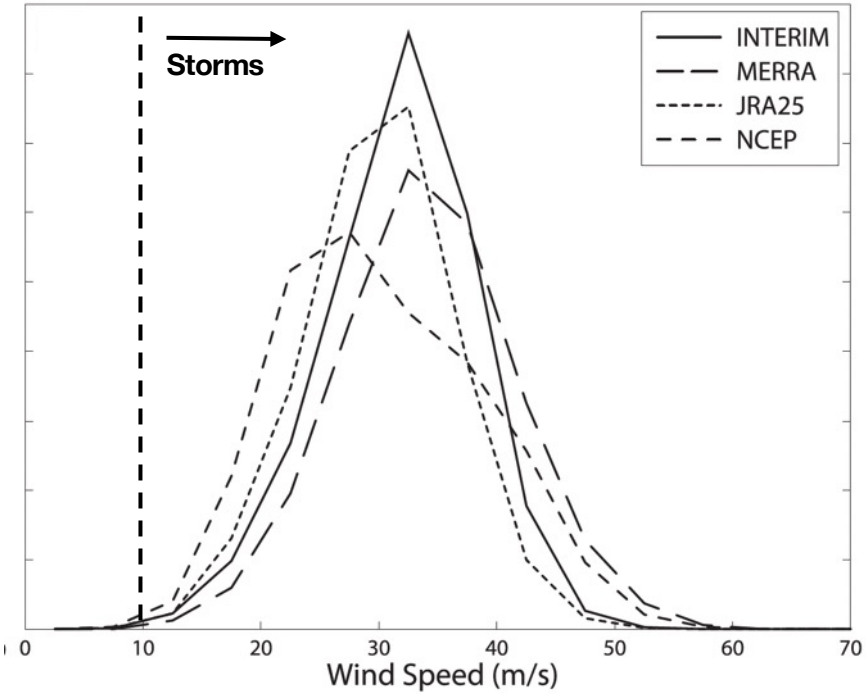
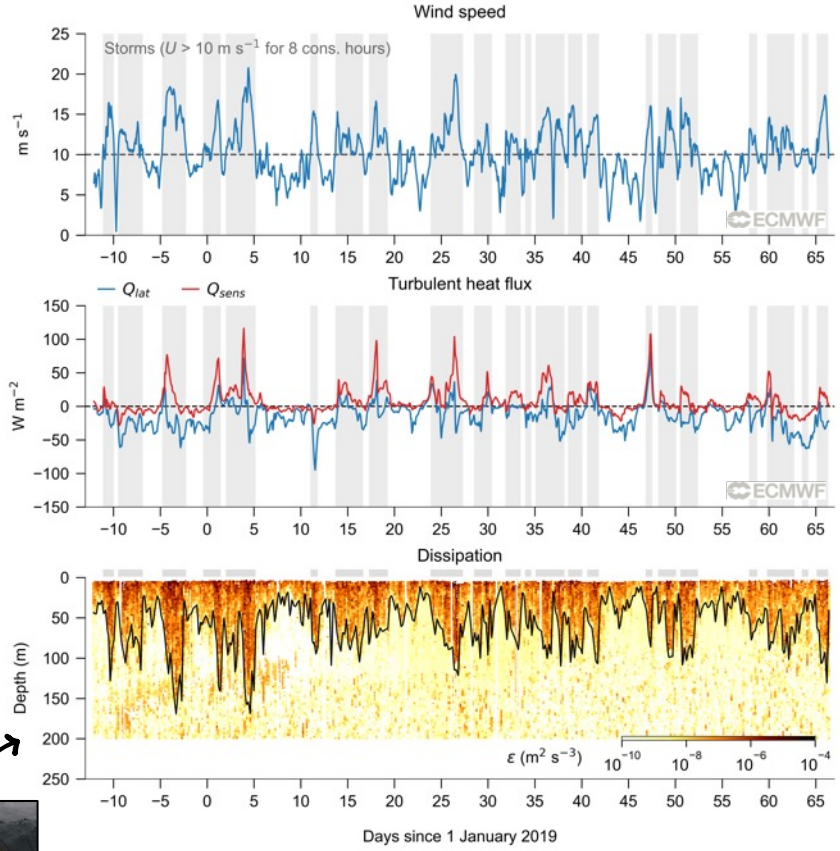




Hodges et al. 2011

Surface temperature warming rate

Sea surface temperature warming rate increase set by prolonged interstorm period



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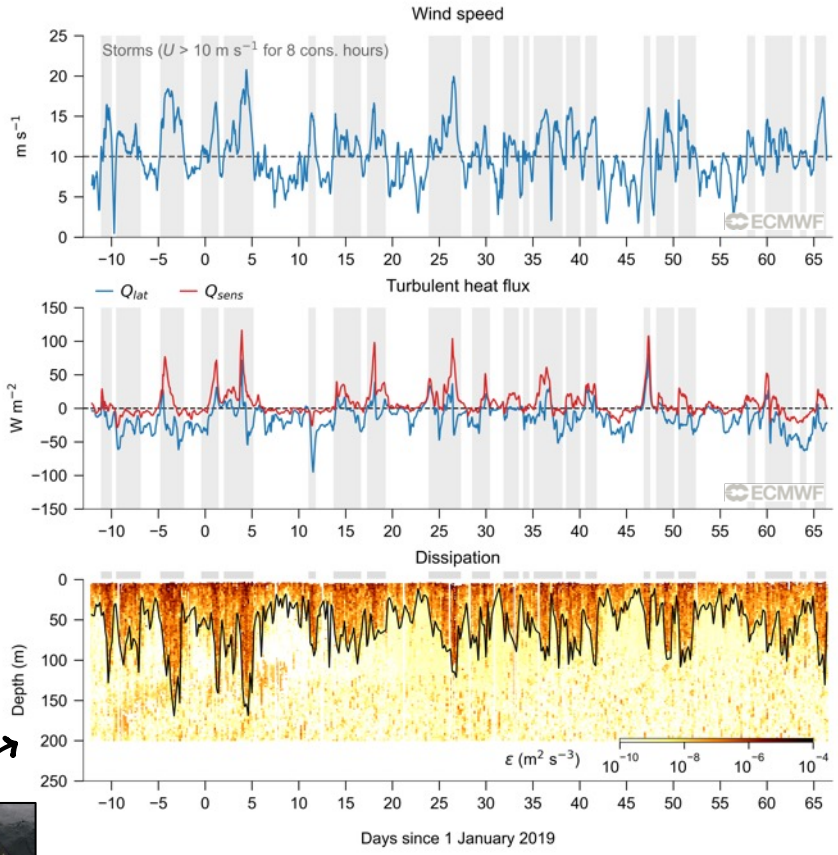

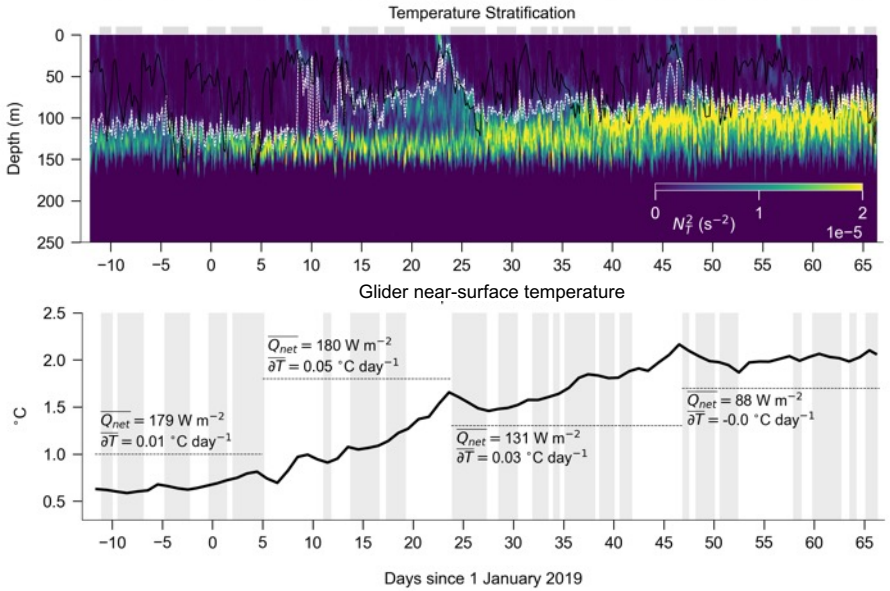

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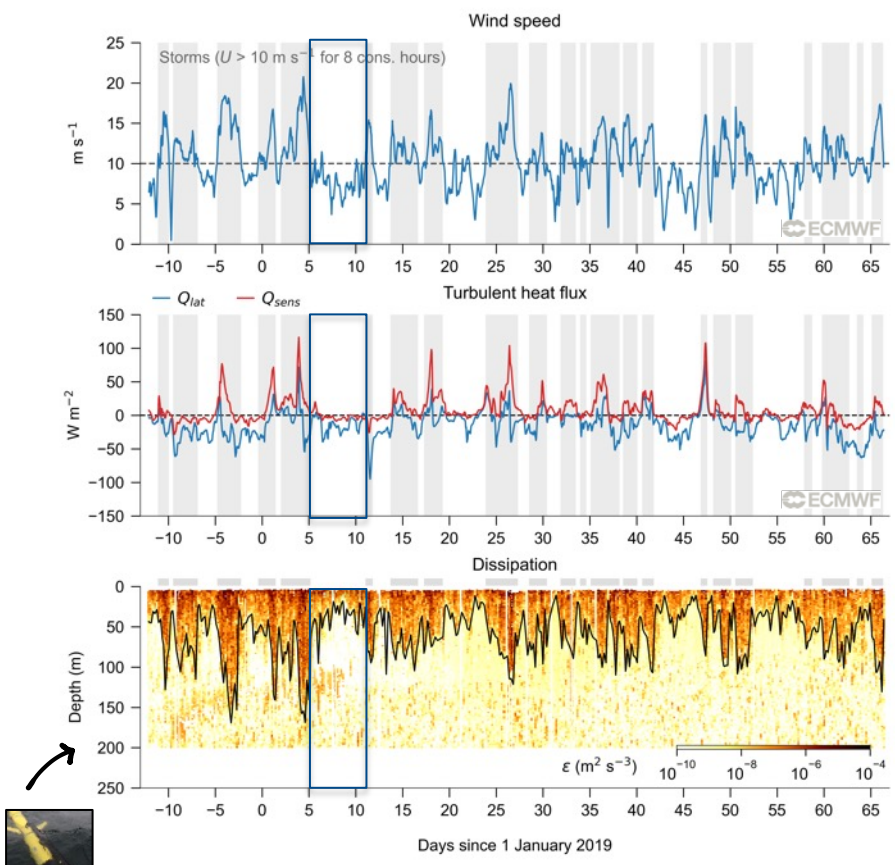

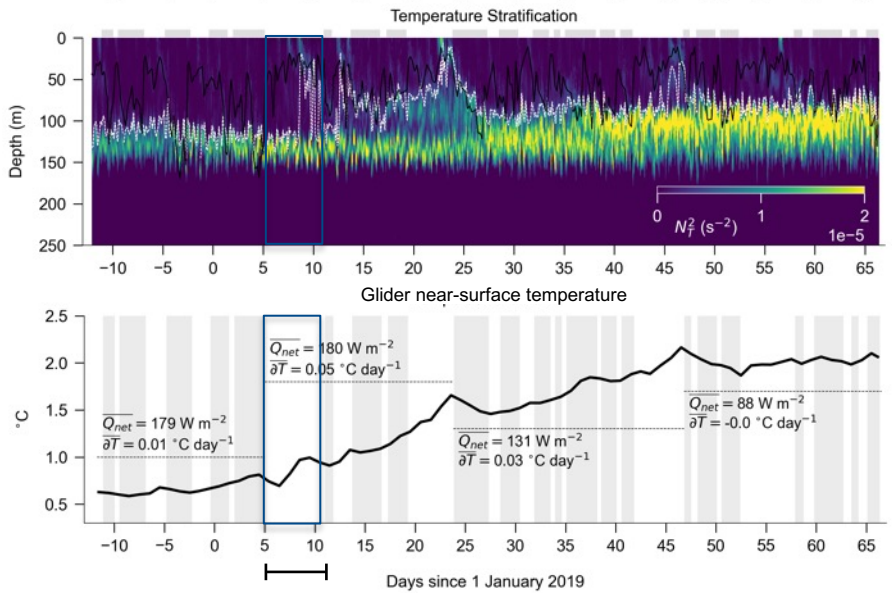

6-day interstorm period

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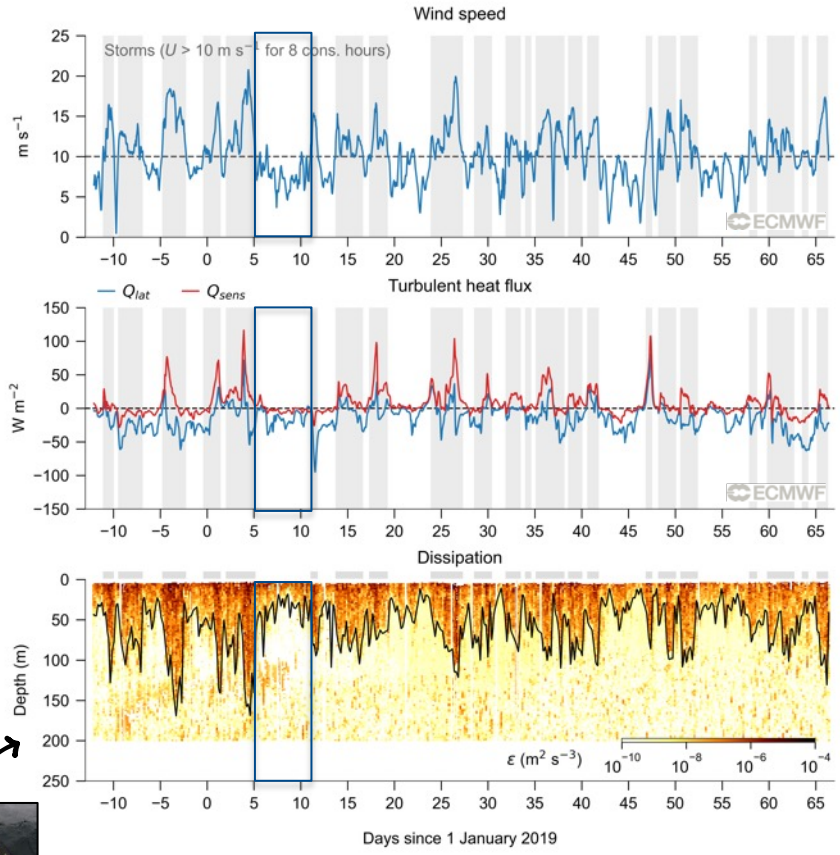
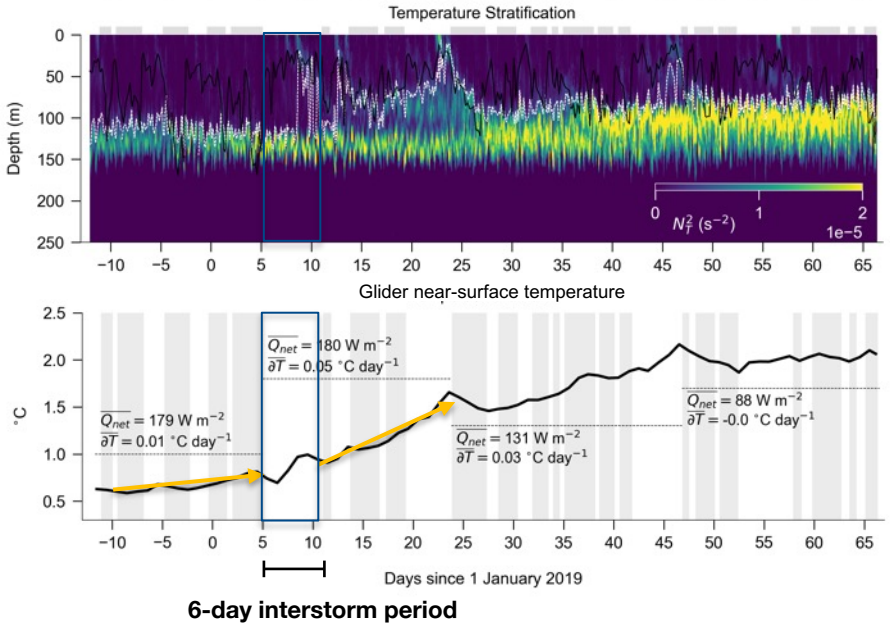




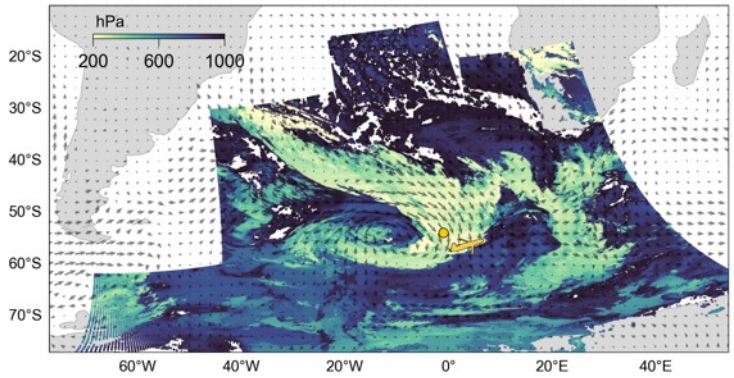
6-day interstorm period

- How do storms impact air-sea flux variability?
- Do storms have a rectified effect on the SST variability through changes in mixing?

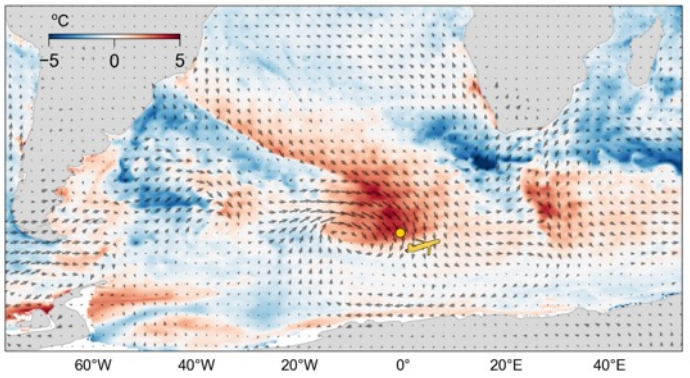
Storm-driven increase in sensible heat flux

Storms drive large scale advection of subtropical air to increase sensible heat flux

MODIS L2 Cloud Top Pressure - 4 January 2019



ERA5 Air-Sea Temperature Difference - 4 January 2019



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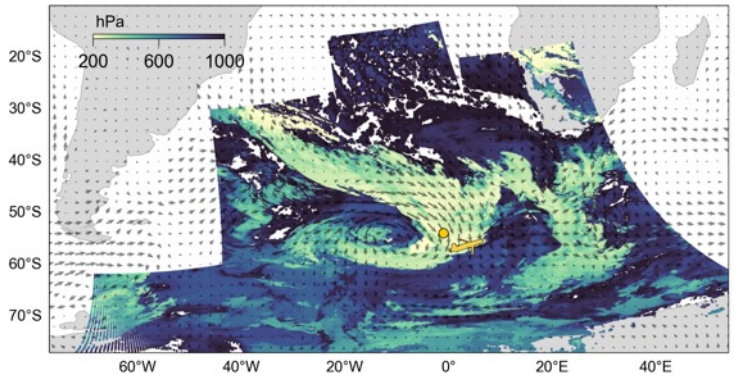

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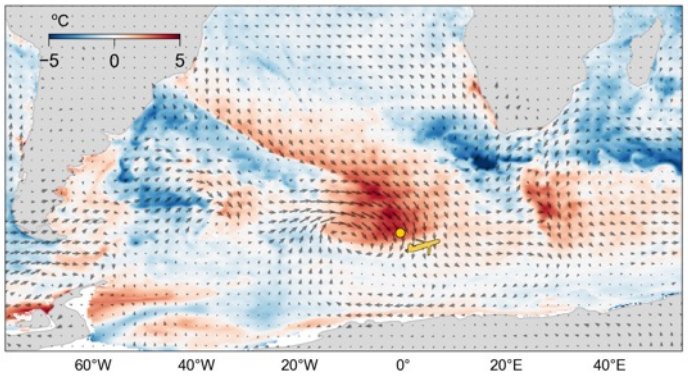
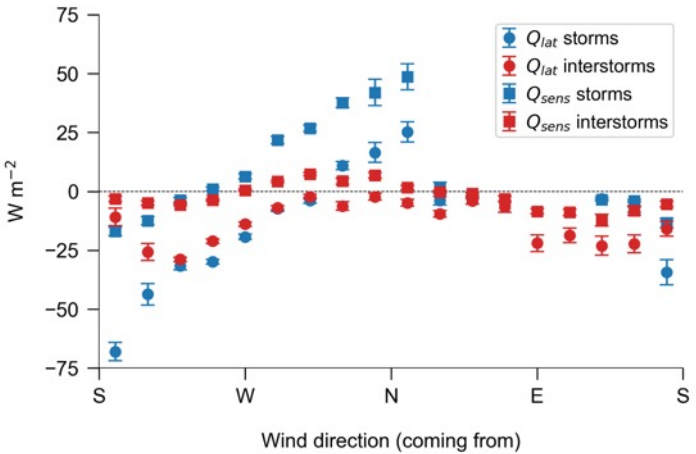


Storm-driven Heat Flux Differences Dependent on Wind Direction



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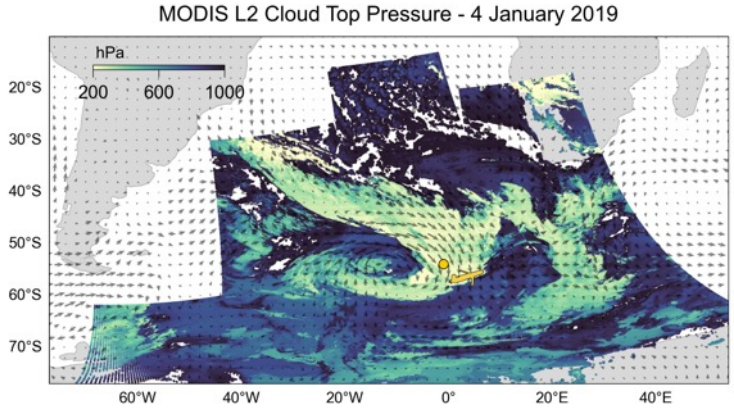

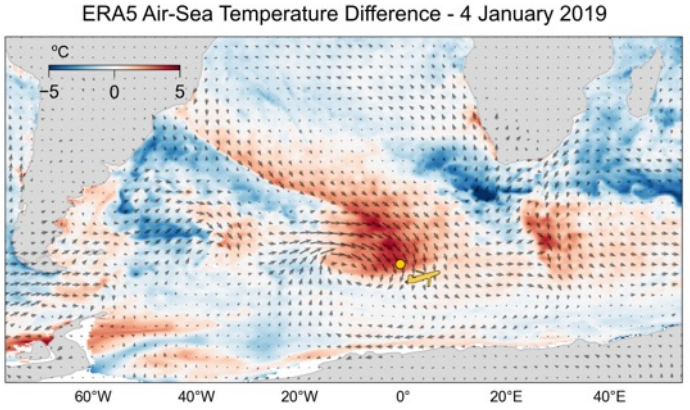

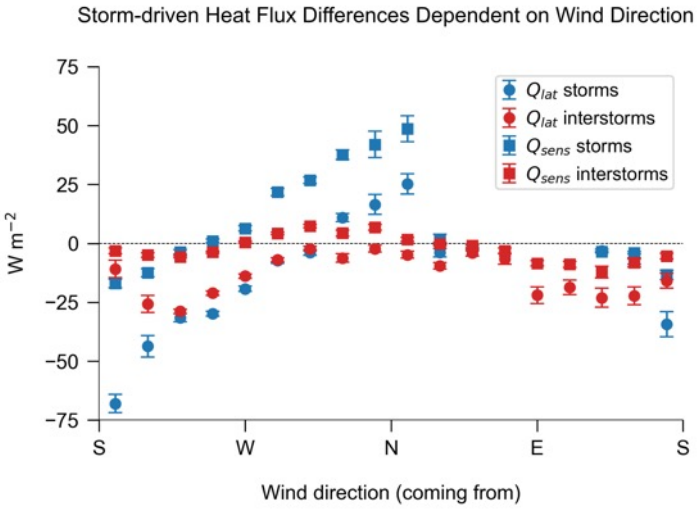

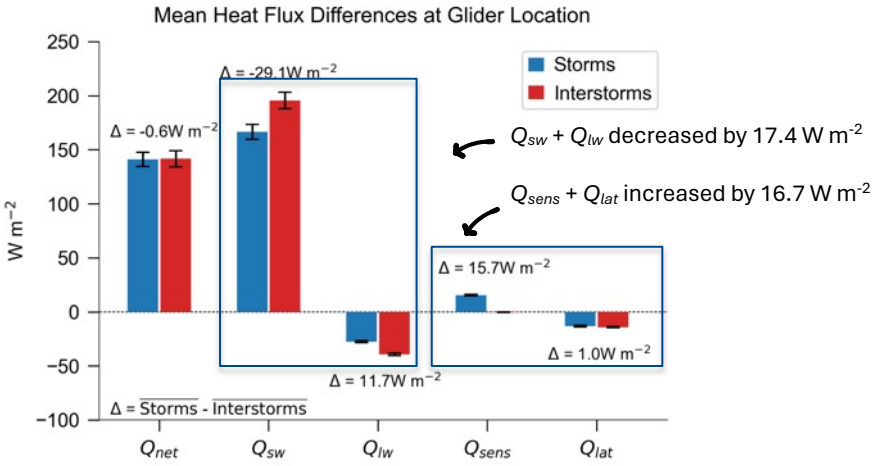

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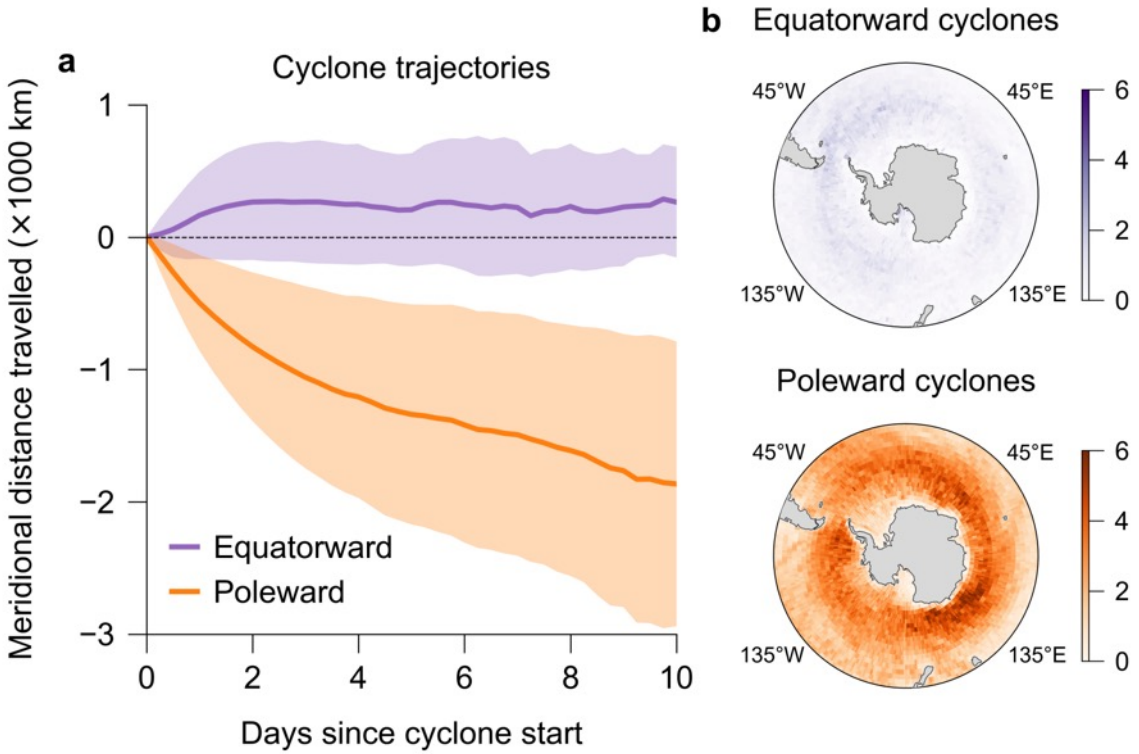

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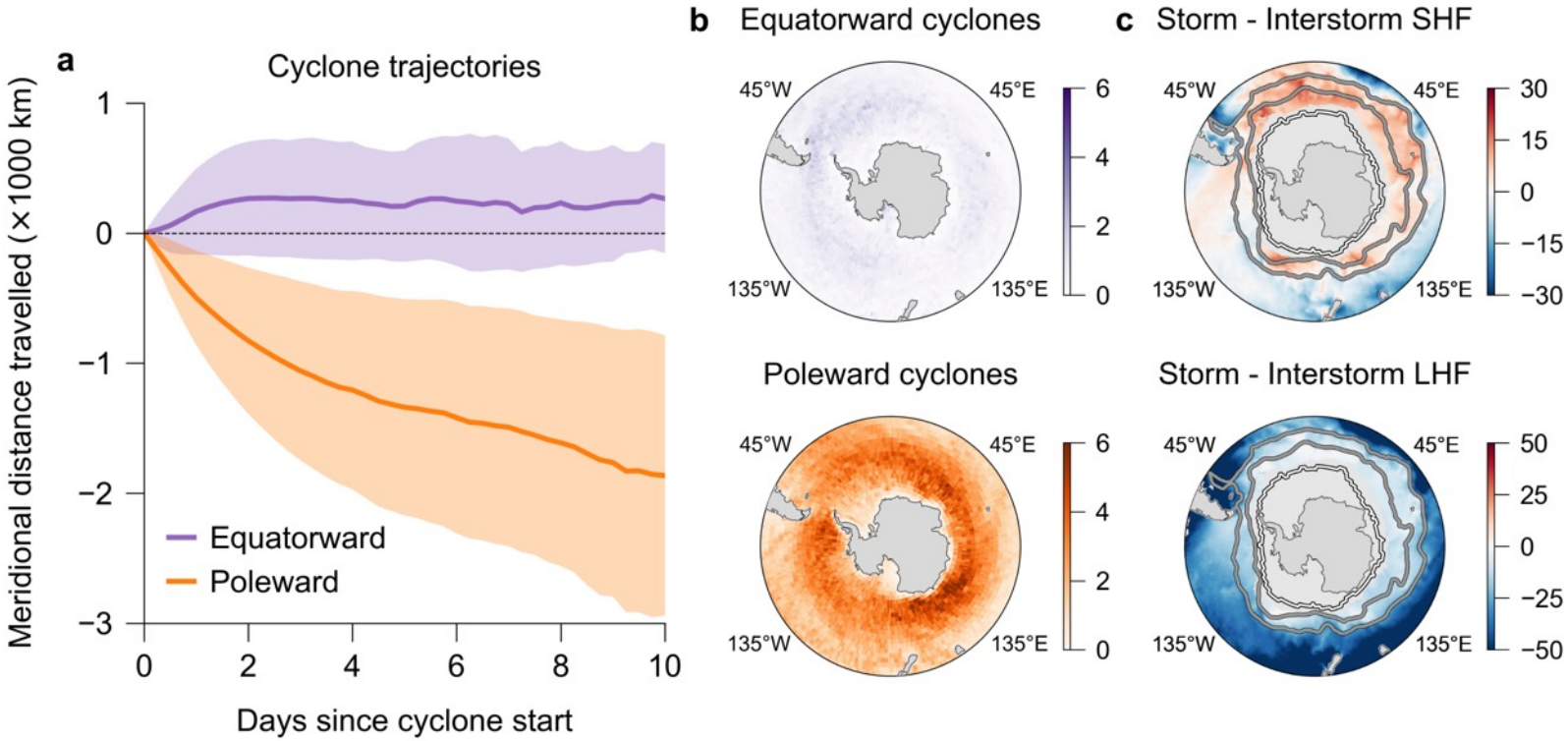

Interannual variability in the sensible heat flux

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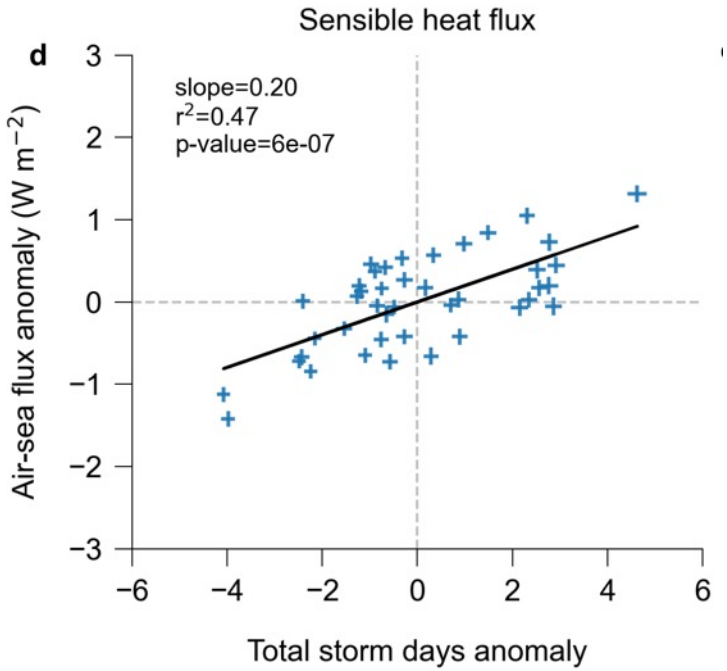
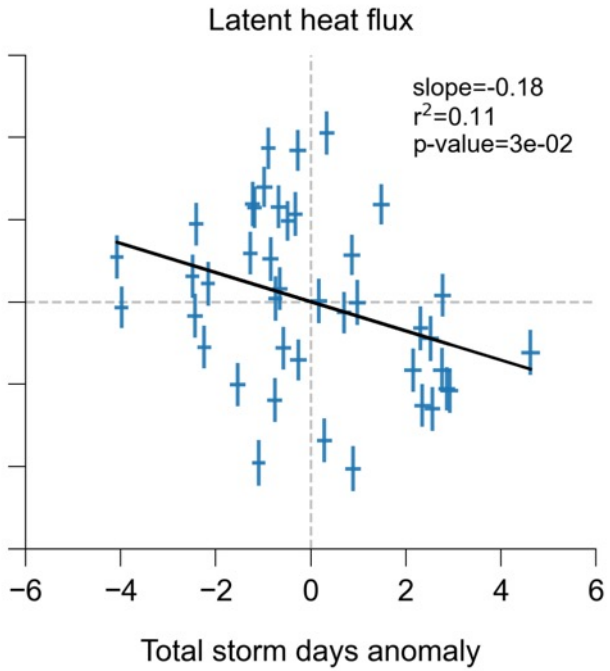
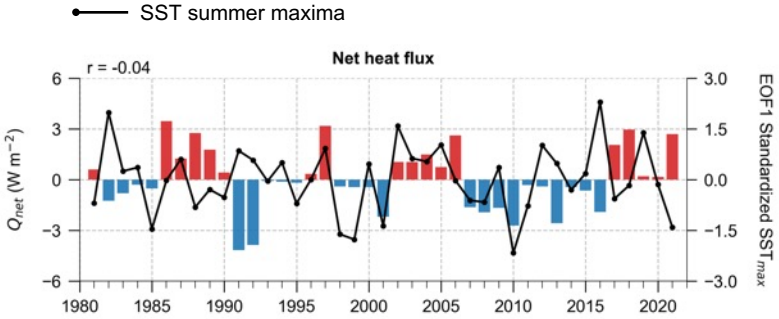
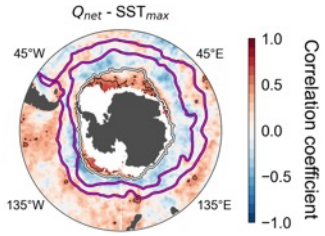




Interannual SST variability across the Southern Ocean

Southern Annular Mode accounts for most of SST variability via prolonged interstorm periods





Good qualitative agreement in air-sea heat flux and SST_{max}

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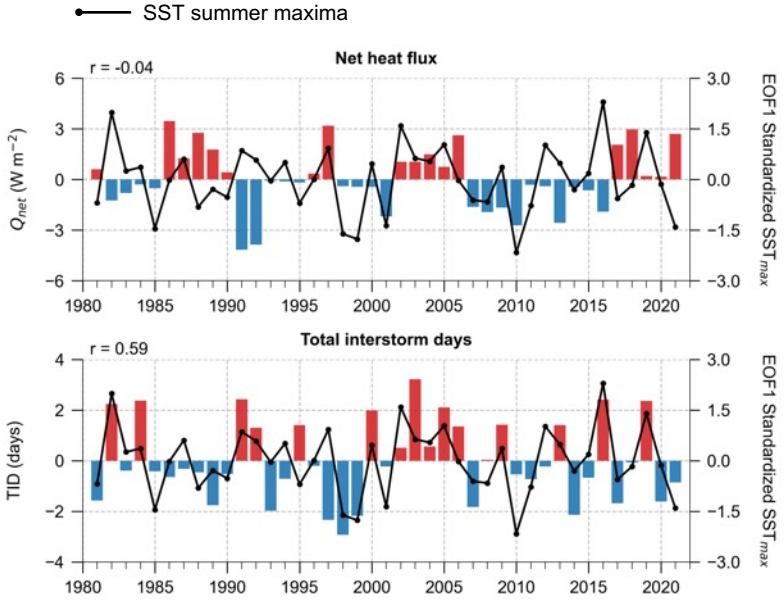

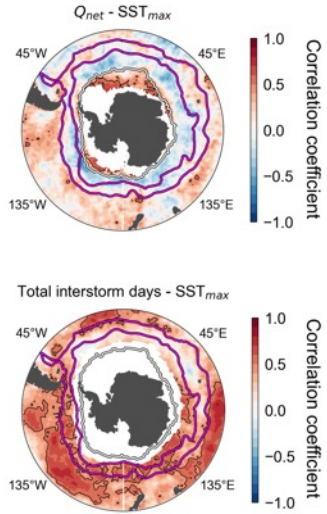

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Increased interstorm days lead to higher summer SST_{max}

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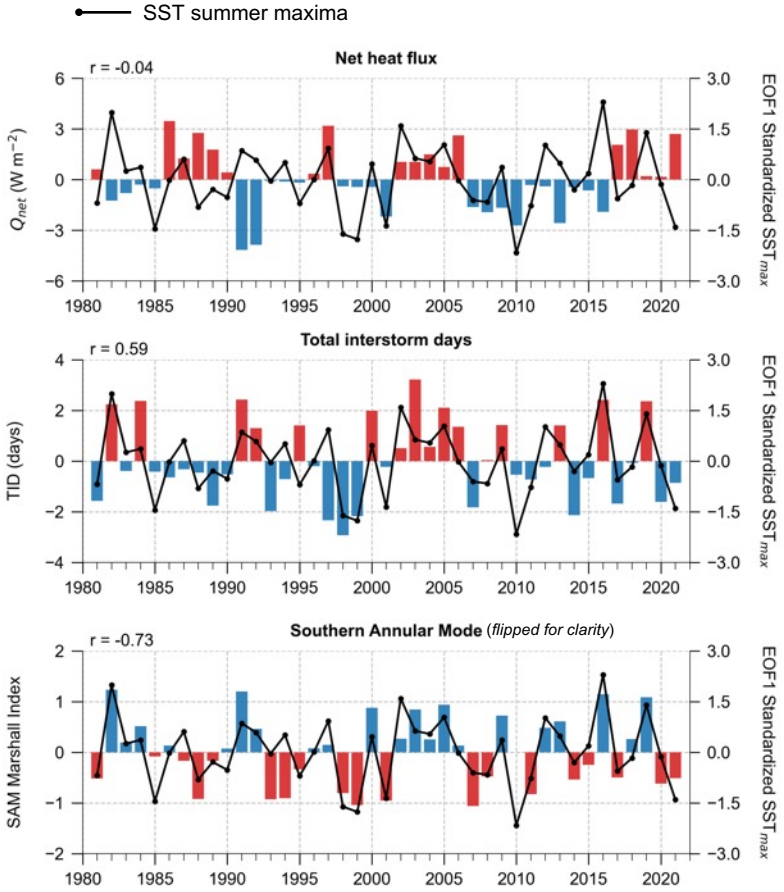

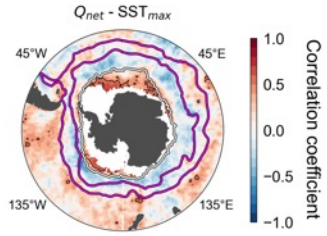

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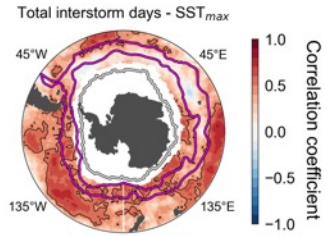
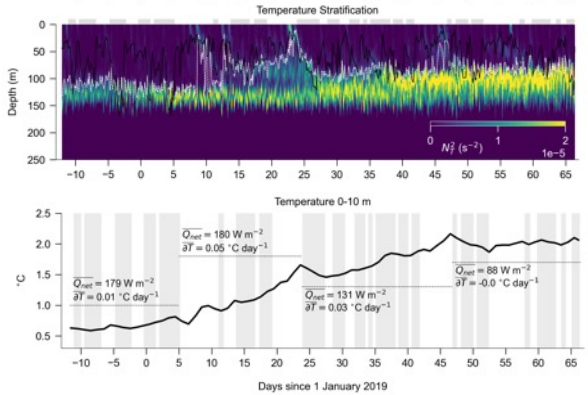


Increased interstorm days lead to higher summer SST_{max}

Southern Ocean interannual SST variability largely explained by Southern Annular Mode – potential mechanism through prolonged interstorm periods

Summary

Storms shown NB for interannual and possibly longer-term variability in Southern Ocean SST



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Five-fold increase in surface warming initiated by prolonged interstorm period.

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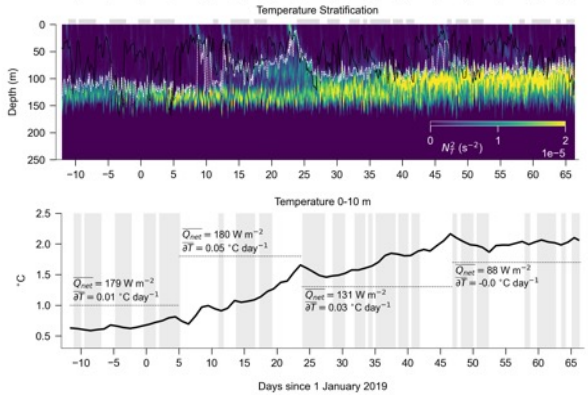

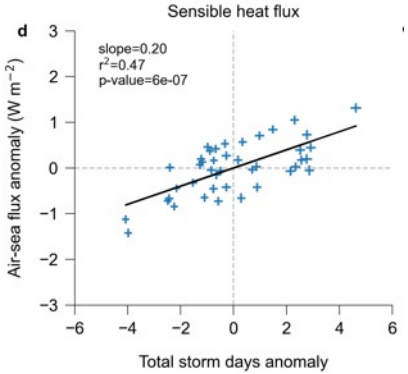

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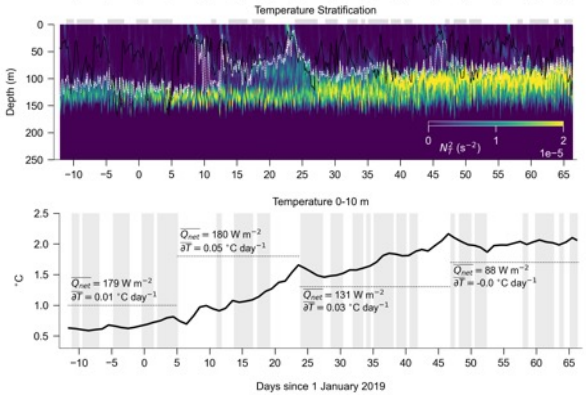

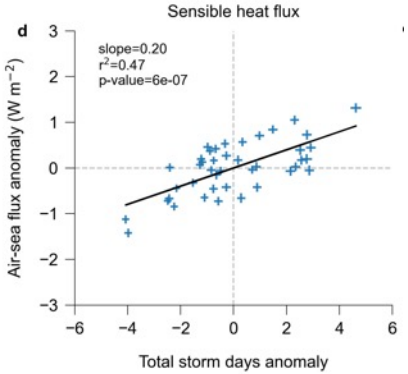

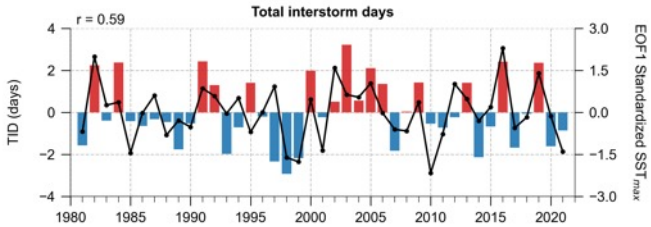

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Interstorm variability strongly linked to surface warming

SAM-modulated storm frequency explains most of the summer SST variability.