Slowdown of Antarctic Bottom Water export driven by climatic wind and sea-ice changes

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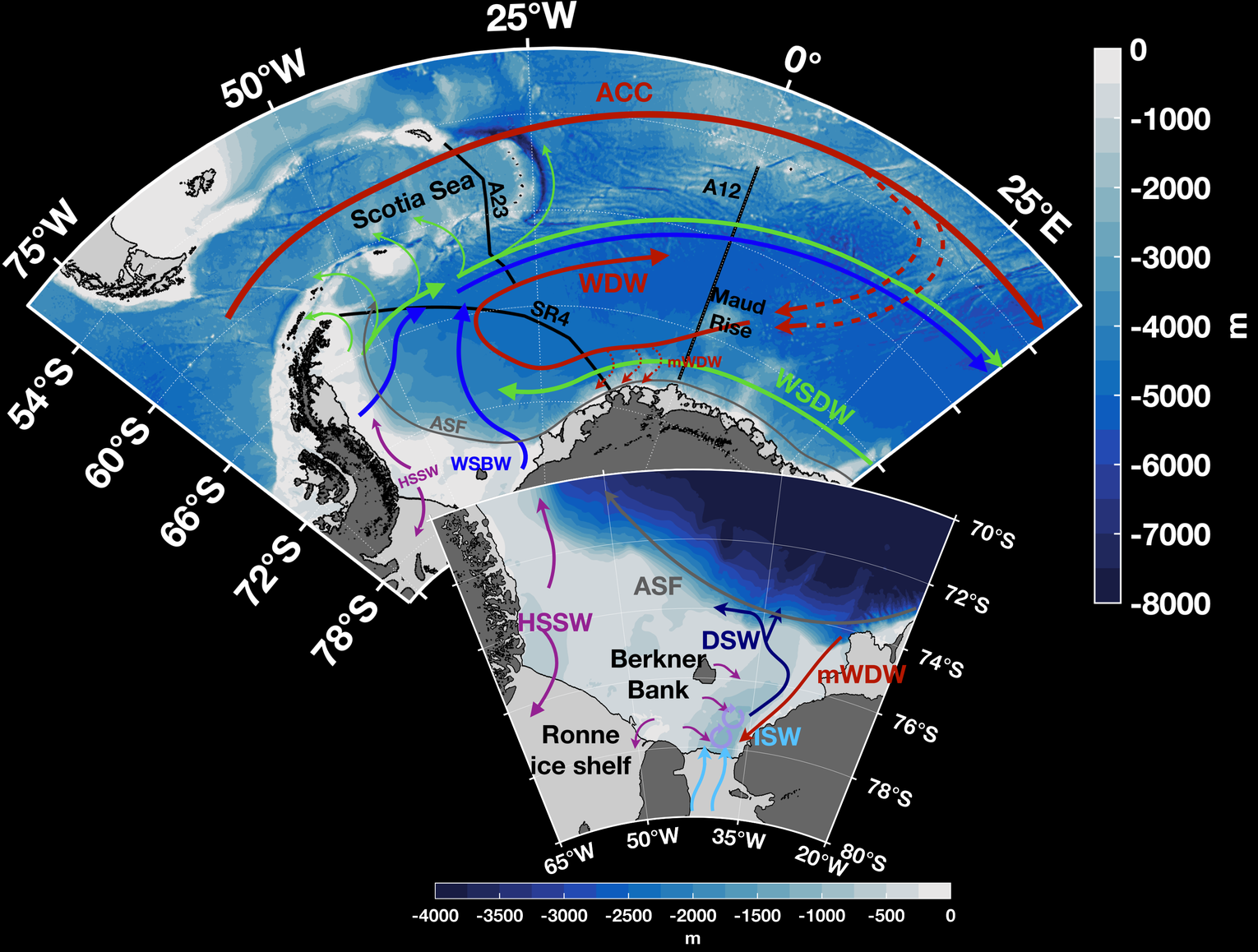
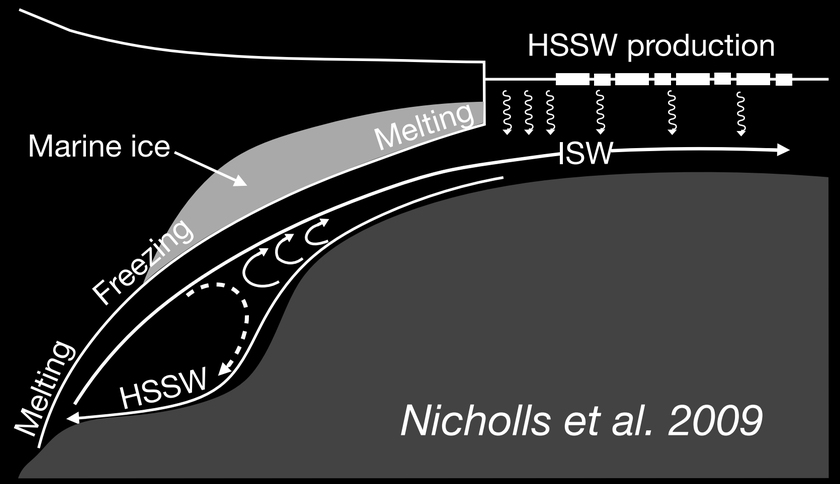
Yixi Zheng





- **WSBW** originated from **HSSW** formation and under-ice overturning (**ISW**)
- **WSBW** ***modulates*** exported **WSDW** (**Weddell-origin AABW**) properties through isopycnal heaving

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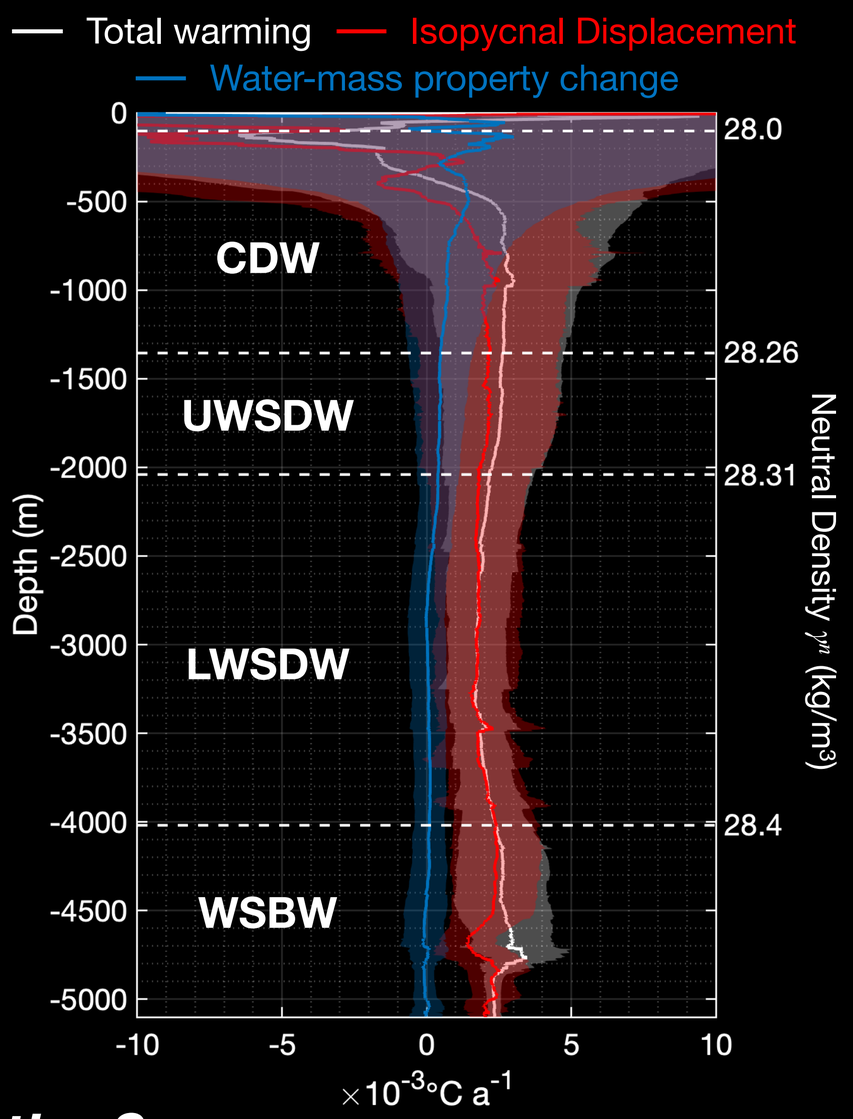

- Bottom Water volume reduced by ~ 30% over 30 yrs

➡ This reduction causes deep-Weddell-Sea warming of about 2 m°C / year (0.34 W/m² , global rate×5)

What is causing this reduction?

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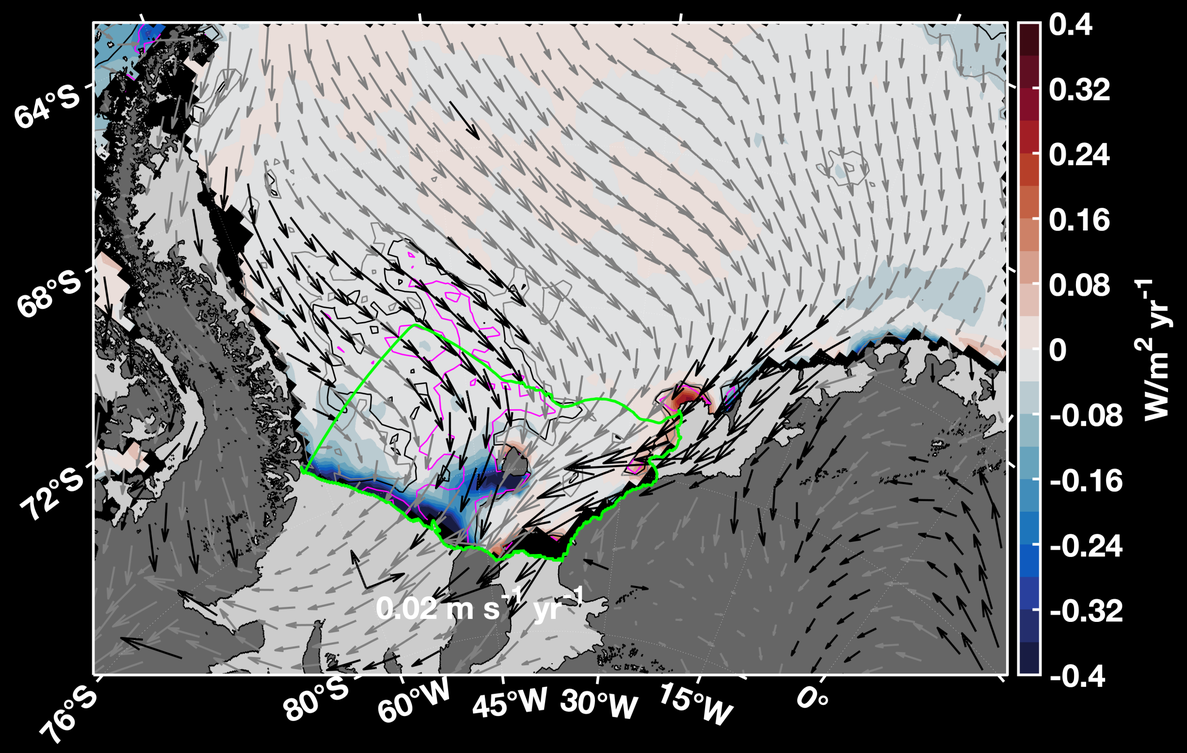
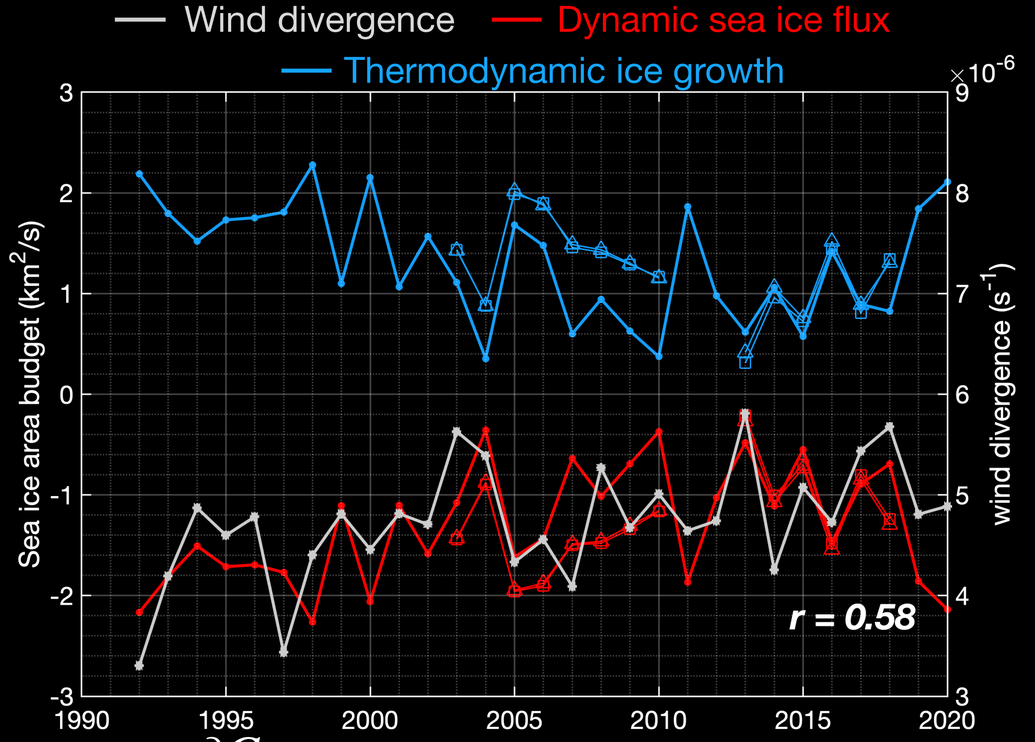


$$SFR = \rho_{air} C_p^{air} c_s (1 - SIC)(T_{air} - T_f) |\mathbf{U_{10m}}|$$



$$\frac{\partial C}{\partial t} = -\nabla \cdot (\mathbf{u}C) + residual$$

- Sea ice formation rate ***slowdown*** at RIS front
- Wind-driven sea ice flux ***less divergence*** in FRIS
- Thermodynamic ice growth ***reduced***

What is causing this wind trend?

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$$dV = \int_t (F + E - A - D)dt$$

30 years

DSW input

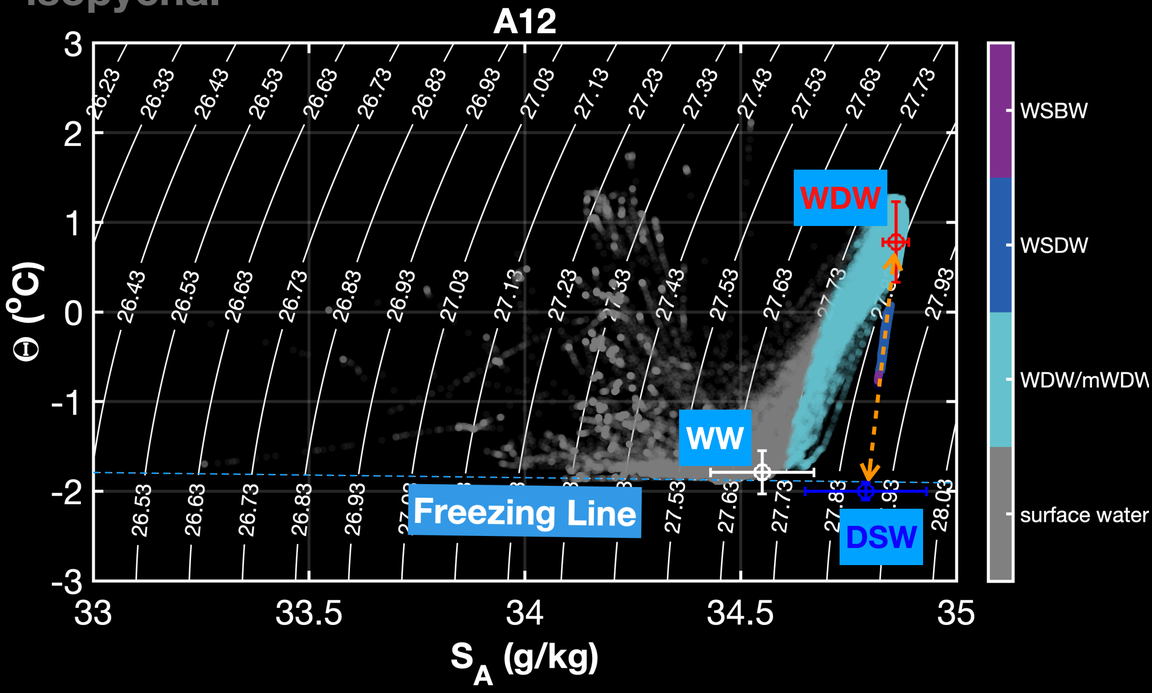
mWDW entrainment

Advection along isopycnal

Diapyncal mixing

Linear reduction of sea ice formation		Ronne+Berkner	FRIS
Residual	CDR	-46.2±11.0%	-44.2±15.1%
	BT	-46.8±11.0%	-44.0±15.3%
	NT	-38.2±11.4%	-40.3±15.0%
SFR	CDR	-43.3±7.6%	-35.8±6.7%
	BT	-42.1±7.3%	-31.6±6.0%
	NT	-34.9±5.8%	-31.2±6.2%

F/E ≡ constant
A+D ≡ constant
-40% of F+E



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Linear reduction of water mass formation	AABW ($\gamma^n \geq 28.37$ kg/m^3)		WSBW ($\gamma^n \geq 28.40$ kg/m^3)	
Hydrographic sections	A12	SR4	A12	SR4
Observation	-28.6±4.4%	-20.7±3.9%	-33.0±4.8%	-34.8±4.1%
Estimation	-33.2±14.2%		-59.6±86.2%	

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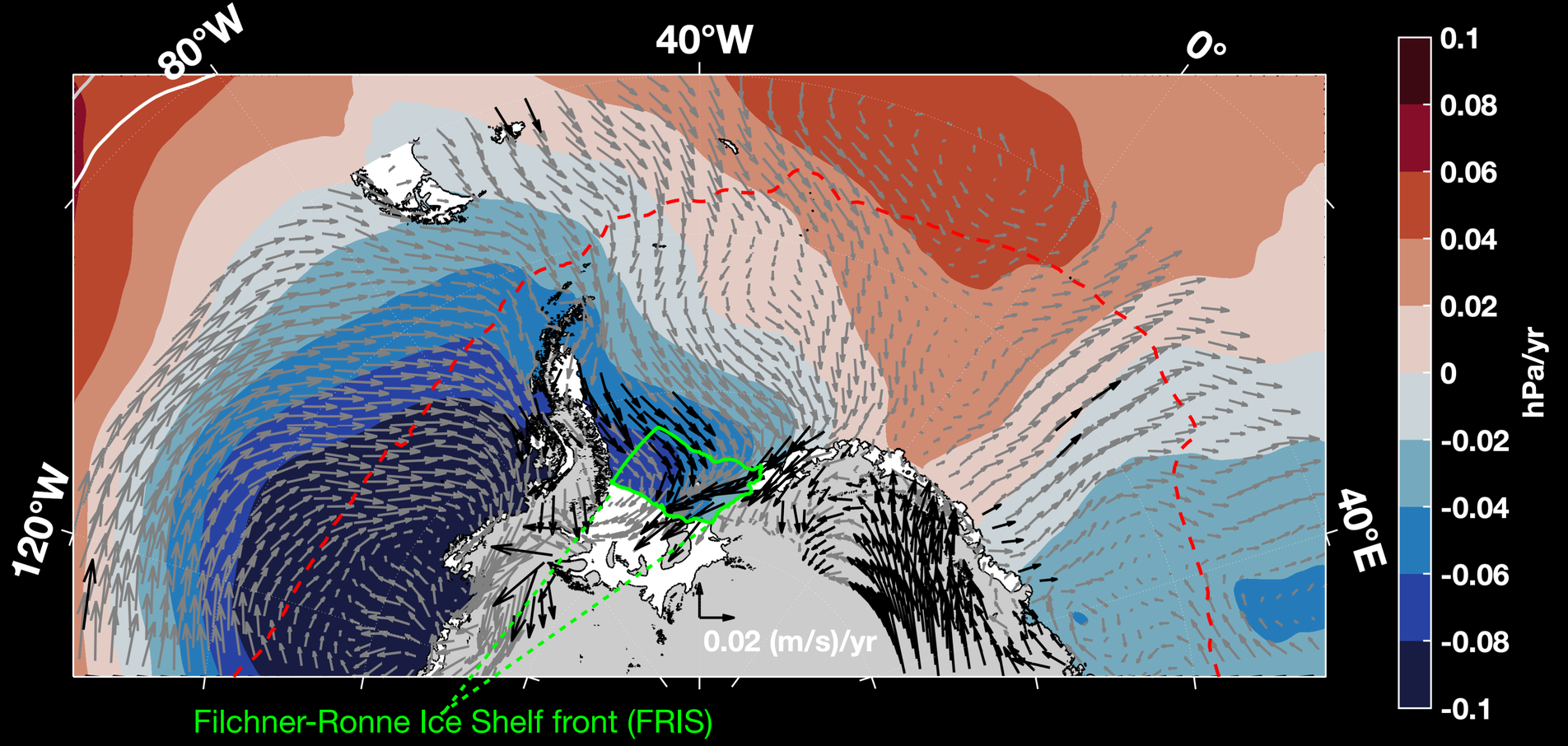

Reanalysis wind vector and mean sea level pressure trend between 1992 and 2020

- ➡ Wide spread **Amundsen Sea Low deepening** since early 1990s
- ➡ Resultant **northernly wind trend** in southern Weddell Sea continental shelf

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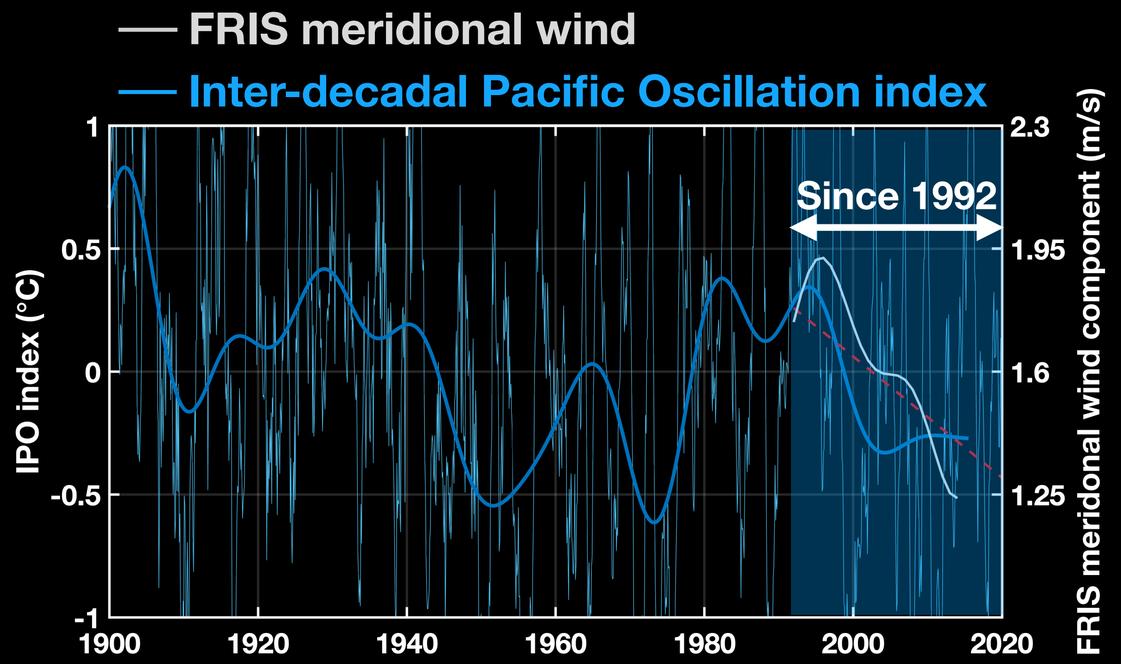

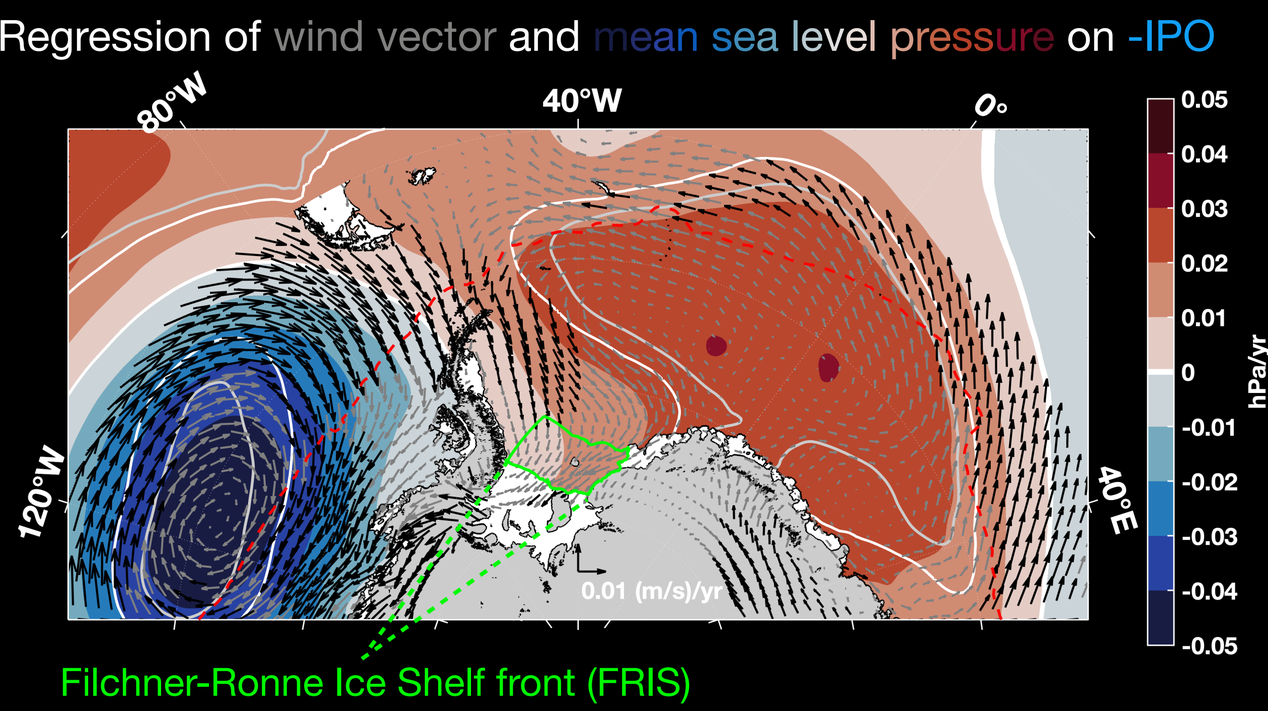

- ***Concurrent trend*** between **IPO** and **FRIS wind**
- Regression of atmospheric fields on **-IPO** ***resembles*** the reanalysis trend —>ASL deepening+filling tendency to the east of Weddell.

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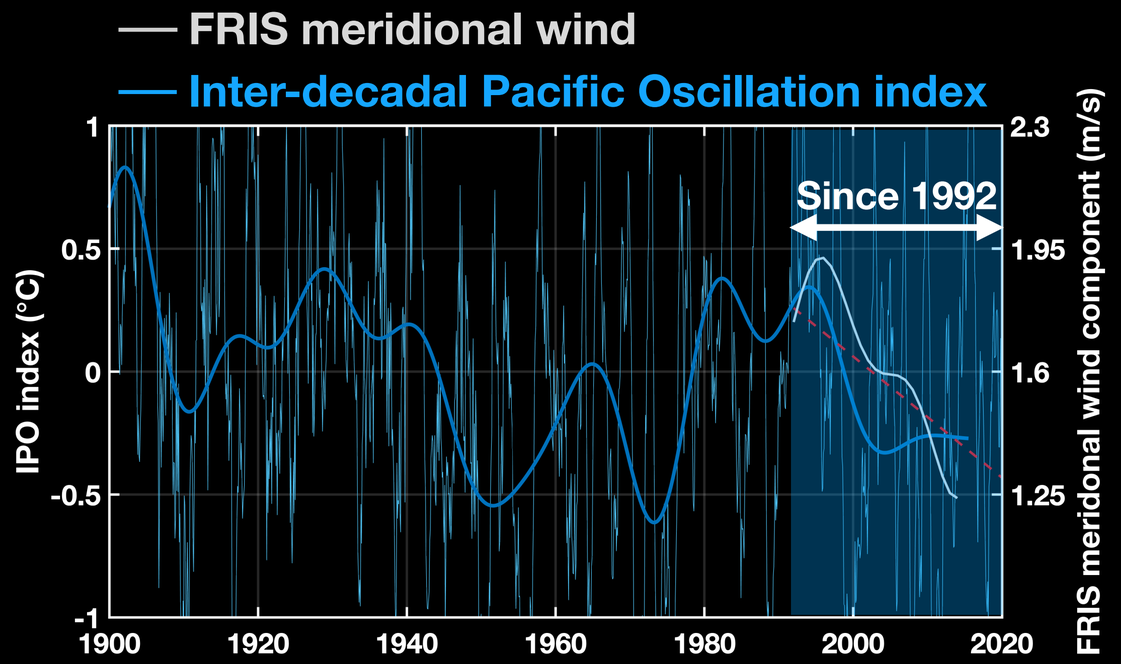

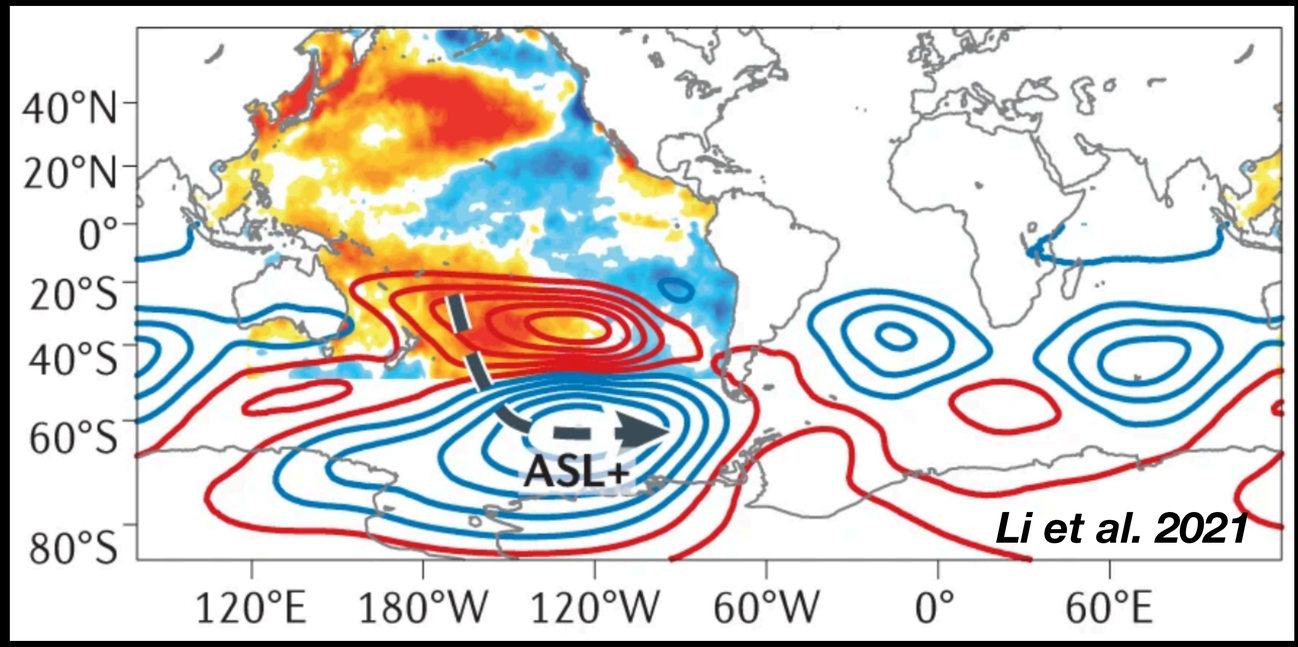

- **IPO- wave train propagates tropical variability toward Antarctica, incl. ASL deepening.**
  - ➡ A **new teleconnection** between ***tropical SST*** variability and ***southern Weddell sea ice/WSBW*** on multi-decadal scale

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To conclude

- A nearly ***30-yr decline*** in WSBW volume (with episodes of recovery)
- concomitant ***isopycnal deepening*** warms deep Weddell Sea rapidly
- ***DSW formation decreased*** in response to ***wind-driven sea ice changes*** on FRIS
- Teleconnection between ***Atlantic-SO abyss*** and ***tropical Pacific***

Zhou, S., Meijers, A.J.S., Meredith, M.P., Abrahamsen, E.P., Holland, P.R., Silvano, A. Sallée,J.-B., Østerhus, S. (2023) Slowdown of Antarctic Bottom Water export driven by climatic wind and sea-ice change. *Nature Climate Change*, **13(7)**, 701–709 (2023).

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