

Manuscript “On the control of the 1 position of the winter sea ice edge by the Antarctic Circumpolar Current.”

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The study discusses the influence of the Antarctic Circumpolar Current (ACC) on the position and dynamics of the winter sea ice edge in the Southern Ocean, highlighting the role of the Polar Front (PF) among various oceanic fronts and different heat transport mechanisms. The definitions of ACC fronts are based on both oceanographic observations and satellite data, which are used to analyze their relationship with the mean location of the sea ice edge. The PF is identified as the best indicator of the ACC's influence on sea ice, due to the lower uncertainty in its position derived from observations and its greater independence from sea ice processes.

It influences sea ice advance and the position of the winter ice edge by modulating heat transport toward high latitudes, both through oceanic processes (via eddy-induced transport) and atmospheric processes (via meridional wind transport).

Through regression models predicting the winter ice edge position using the latitude of the PF, eddy kinetic energy (EKE), and wind velocity, the authors find that PF latitude is the most reliable predictor. Including EKE or winds leads to little or no improvement in predictive skill.

The manuscript is overall well written and clear. The methodology and results are presented in a clear and sufficiently detailed manner.

My only main comment concerns the use of mean wind speed at 60°S, which is often not co-located with the PF or the sea ice edge. This could result in only a partial assessment of the impact of winds on the atmospheric heat transport from the PF to the sea ice.

Minor comments

Line 37. “the sea ice seasonal cycle of sea ice cover” - there is a repetition

Figure 1,3,4. Blue and purple are not an ideal combination for color-blind safe figures. I suggest using a different color combination

Line 71. variability and noise are weaker than at surface

Line 70-81. It is not clear whether the two identification methods are linked or represent two distinct approaches. The paragraph could be rephrased to clarify this point.

Line 210. The PF's position relative to the ice edge is more consistent between regions. However without further evidence, you cannot conclude yet that PF's influence is more robust.

Line 211. The sACCF and the SBdy are close to the winter ice edge in several regions

Line 229-230. “which is systematically located...”- this phrasing is somewhat repetitive

Figure 2. Square brackets denote “units of” in scientific notation: [Depth] m, so it would be more correct to use (m) instead of [m]

Line 251-254. This sentence is not clear, please consider rephrasing for clarity

Line 263-266. The statement may not be fully supported unless the correlation with the distance from the coast or with other factors are also not reported.

Line 291-293. I think the fact that the distance between the front position and the sea ice edge shows a high correlation with latitude better explains the high correlation between front position and sea ice edge latitude, rather than the magnitude of this distance, as mentioned earlier (lines 286–288).

Line 315. It should probably be “stronger northerly winds.” It may also be worth adding a clarification about the sign convention used for the wind direction.

Line 377. more zonal than the fronts

Line 388-390. It should be noted that there is also substantial heat loss in the Indian Ocean sector, despite the PF being located farther north.

Line 391-392. The phrase “the heat extracted from the ocean to the north of the PF, towards the south” is unclear, it should probably be “the heat extracted from the ocean north of the PF, towards the south”

Lines 393–395. Does the fact that in sectors where the PF is farther north it is close to 50°S—and thus the 60°S meridional winds may not be representative—affect the interpretation of the relationship with atmospheric heat transport?

Line 428. Similar to lines 393–395, it might be worth considering a latitude that varies with the PF’s position, to better assess the impact of winds.

Line 501-505. This sentence is too long, please split it to make it more clear.

Line 511. it is also possible that the position

Line 513-516. This sentence is not clear, please consider rephrasing for clarity

Best Regards,
Martina Zapponini