Enhanced air-sea heat fluxes and subduction in an ACC standing meander

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Abbreviated abstract: *Standing meanders along the Antarctic Circumpolar Current (ACC) host strong ocean dynamics and enhance cross-front exchange. Air-sea heat fluxes from finescale products show variability at the scale of meanders and related small-scale processes. We diagnose heat fluxes and water mass subduction along the ACC from 120°E to 165°E in the 1/10° ACCESS-OM2 ocean model forced with JRA55. Preliminary results reveal that a standing meander substantially changes the distribution of heat loss from the ocean and enhances subduction of water below the permanent mixed layer.*

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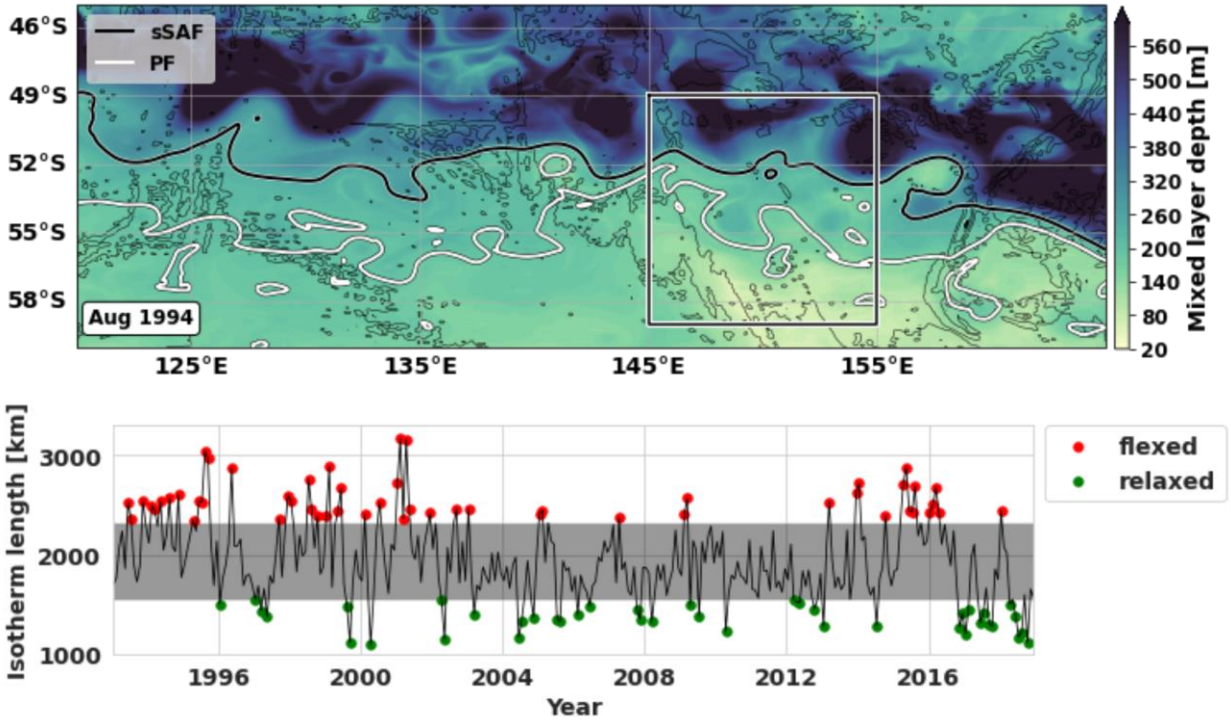
Model outputs and methods

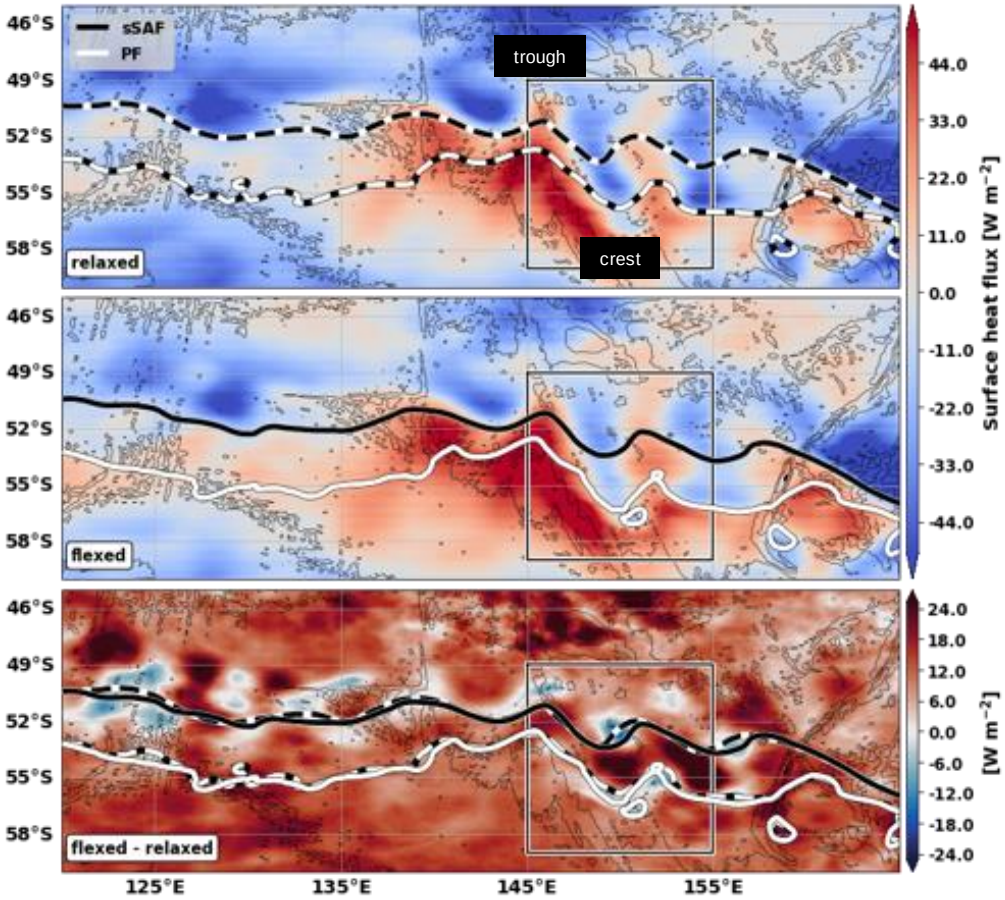


(top) Mixed layer depth output in Aug 1994. The black and white contours represent the south Subantarctic Front (sSAF) and Polar Front (PF), respectively. The box indicates the region of the Macquarie Meander.
(bottom) Length variability of the PF isotherm between 145°E and 155°E from 1993 to 2018. The values outside the gray bar represent the periods of relaxed (green) and flexed (red) composites. The composite regimes are based on the mean and standard deviation of the time series.

- ACCESS-OM2 ocean model forced by the JRA55 atmospheric reanalysis:
  - (a) 26 years (1993—2018);
  - (b) 0.1° resolution;

- The model captures variabilities at the scale of meanders.
  - (a) We track the ACC fronts based on water mass properties;
  - (b) We build composite regimes (flexed and relaxed) based on the length variability of the Polar Front (PF) isotherm in the region of the Macquarie Meander (145°E--155°E) south of Australia.

Results



Surface heat flux composites. (top) relaxed, (middle) flexed, (bottom) difference between the flexed and relaxed composites.

- The flexed PF presents a higher curvature than the relaxed PF. In addition, an eddy is captured in the regime of the flexed PF;

- The meandering region presents a different surface heat flux configuration compared to the almost zonal ACC path upstream the meander. In the Macquarie Meander region, the ACC hosts:
  (a) heating of the ocean at the trough;
  (b) cooling of the ocean at the crest;

- Heat loss by the ocean (i.e., cooling) results in buoyancy loss that causes the deepening of the mixed layer depth (MLD);
  → The lateral induction of fluid below the permanent thermocline (i.e., water subduction; Williams and Meijers, 2019) is intimately linked to the changes in the MLD.
  → The deepening of the MLD might enhance the water subduction at the crest of the meander.

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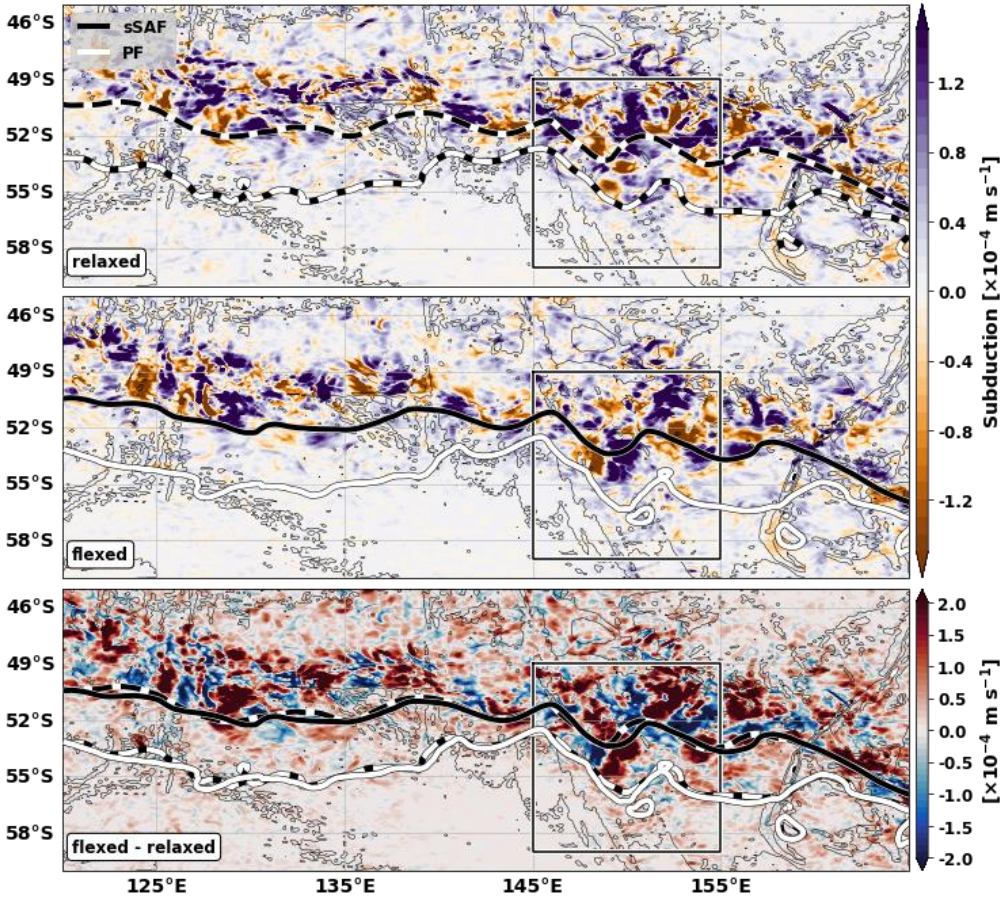
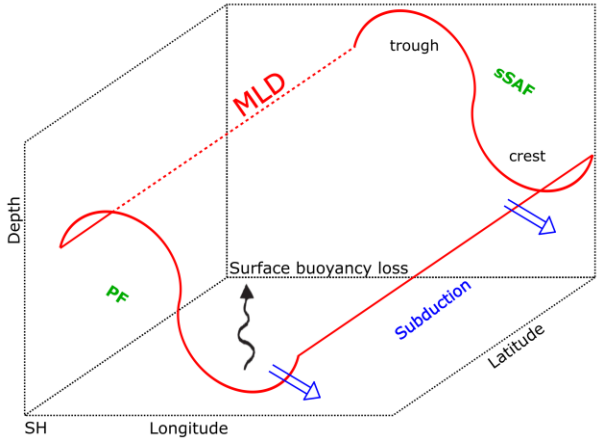
Discussion and conclusions



Water subduction rate composites. (top) relaxed, (middle) flexed, (bottom) difference between the flexed and relaxed composites.

- The subduction rates of water capture the lateral injection of fluid below the permanent thermocline at the crest of the meander (purple colors at ~150°E on the left);
- The subduction rates extend from the SAF to the PF waters, the SAMW and AAIW, at the region of the Macquarie Meander;
- The difference in composites of a relaxed and flexed Polar Front meander show a link between the meander flexing, buoyancy forcing and subduction of water to the ocean interior.



Schematic diagram representing the deepening of the MLD and subduction of water at the crest of the meander.

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