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Surface pathways of the South Atlantic: Revisiting the "cold" and "warm" water routes using observational data

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The relative contributions of the traditional "cold" and "warm" water routes of the South Atlantic (SA) to the Atlantic Meridional Overturning Circulation (AMOC) remain largely unresolved. We contribute to this issue by using observational data to explore water mass pathways feeding into the Benguela Current, which is considered a major component of the AMOC upper limb in the SA. Specifically, we focus on the pathways from the Pacific Ocean via Drake Passage (the "cold" water route) and the Indian Ocean via Agulhas Leakage (the "warm" water route). We employ two observational data sets: (1) surface drifter trajectories from the National Oceanic and Atmospheric Administration's Global Drifter Program, and (2) the OSCAR surface current product. From (1) we analyze the raw drifter trajectories and construct a Markov-Chain, which allows us to calculate the distribution of particles using a probabilistic approach. We use (2) to track Lagrangian particles forward in time from their sources (the Drake Passage and Agulhas Current) and backward in time from the Benguela Current.
For the "cold" water route the majority of particles follow the ACC, while a smaller portion reaches the northern limb of the SA subtropical gyre. Particles released in the Drake Passage also infiltrate the Agulhas Current region and follow internal pathways in the SA. For the "warm" water route, most particles exit through the Agulhas Return Current or remain in the Agulhas region, and a smaller portion leaks into the SA. Observed pathways reveal the potential for strong interactions between the two routes throughout the SA basin, including the Brazil-Malvinas confluence, the subtropical gyre, the Benguela Current, as well as the Agulhas Current region. Results from the backward Markov-Chain and OSCAR fields suggest a sizeable contribution of the "cold" route to the Benguela Current, but show disagreement in their respective magnitudes.