Frontogenesis in the Agulhas Return Current region simulated by a high-resolution CGCM

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Detailed mechanisms for frontogenesis/frontolysis of the sea surface temperature (SST) front in the Agulhas Return Current (ARC) region in the southwestern Indian Ocean are investigated using outputs from a high-resolution coupled general circulation model (CGCM), the Community Earth System Model (CESM; Small et al. 2014), which has good skill in simulating the main features of the SST front and mixed layer depth in the ARC region. The SST front is maintained throughout the year due to approximate balance between frontolysis by surface heat flux and frontogenesis by horizontal advection. Although a southward (northward) cross-isotherm flow on the northern (southern) side of the front is weaker than a strong eastward along-isotherm current in the frontal region, this cross-isotherm confluent flow advects warmer (cooler) temperature toward the SST front north (south) of the front and acts as the dominant frontogenesis mechanism. In addition, stronger (weaker) frontogenesis in austral summer (winter) is attributed to the stronger (weaker) cross-isotherm confluence, which may be linked to seasonal variations of the Agulhas Current, ARC, and Antarctic Circumpolar Current.
On the other hand, the contribution from entrainment is relatively small, because frontolysis by larger (smaller) entrainment velocity on the northern (southern) side opposes frontogenesis by less (more) effective cooling associated with a thicker (thinner) mixed layer and smaller (larger) temperature difference between the mixed layer and entrained water in the northern (southern) region.

Keywords: frontogenesis/frontolysis, Agulhas Return Current, high-resolution coupled general circulation model, horizontal advection, entrainment

