The Role of the Agulhas System in Regional and Global Climate

AGU Chapman Conference: The Agulhas System and Its Role in Changing Ocean Circulation, Climate, and Marine Ecosystems; Stellenbosch, South Africa, 8–12 October 2012

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The AGU Chapman Conference on the Agulhas system was the first held on the African continent. There was a feeling of excitement among participants about the great diversity of ongoing research related to the Agulhas Current system, including its role in global and regional climate, its possible influence on human origins in southern Africa, its link to the Madagascar phytoplankton bloom, and its influence on South Atlantic hurricane development (Catarina) through warming related to Agulhas leakage over the past decades.

The conference was organized into four thematic sessions: the state and dynamics of the Agulhas Current in the present and the geological past; the effects of the current on regional weather, ecosystems, and fisheries; the mechanisms that link the Agulhas to changes in ocean circulation and climate; and its impact on the Atlantic Meridional Overturning Circulation (AMOC) and global climate. The conference was attended by 108 participants from 20 different countries, including 35 from 7 African countries, and 27 Ph.D. students. The conference was opened by Gansen Pillay, vice-president of the National Research Foundation in South Africa (NRF). Participants covered the fields of ocean and climate modeling, physical and biological oceanography, marine ecology, paleoceanography, meteorology, and marine and terrestrial paleoclimatology.

Growing interest in the Agulhas Current is related to its unique position in the world ocean: at the southern tip of the African continent, it abruptly loses its coastal boundary, leaking Indian Ocean waters into the South Atlantic. A portion of this Agulhas leakage is thought to stimulate and stabilize AMOC, while the rest feeds into the Southern Hemisphere "supergyre." Its distribution over these branches of the thermohaline and wind-driven circulation depends on mixing processes in the Cape Basin that are poorly known. Moreover, there is no simple way to measure or determine Agulhas leakage.

Most current climate models were shown to perform poorly in the Agulhas region: the simulated Agulhas separates and retroflects too early, leading to an unrealistically narrow Agulhas Ring corridor in the South Atlantic and too little mixing into AMOC. As a consequence, the characteristic high Atlantic salinities and the "salt advection feedback" are poorly simulated.

There currently is limited observational evidence for the global effects of a variable Agulhas leakage. Studies using paleoproxy data profiles from marine sediment cores have found a link between leakage and glacial-interglacial transitions and notably also show fast, multicentennial timescales in the Agulhas Current. The data suggest that Agulhas leakage maxima plausibly played a role in the reestablishment of a vigorous AMOC during interglacials. An effort to trace the impacts of Agulhas leakage on the changing global climate system at a range of timescales was identified as the next great challenge.

The Agulhas system was shown to have a large effect on marine ecosystems due to its high variability and abundance of mesoscale eddies and dipoles. Eddies affect the distributions of plankton and the largest top predators, the recruitment of small pelagic fish, and connectivity between remote ecosystems. Eddies may also facilitate the northward sardine run against the Agulhas Current flow.

Western boundary current extensions are hot spots for the release of heat into the atmosphere and for uptake of carbon dioxide. The Agulhas hot spot is the most prominent in the Southern Hemisphere, helping to maintain and anchor the storm track that feeds into the westerly Polar Front Jet and the Mascarene High and affecting regional weather patterns, including extreme rainfall events over South Africa.

A major recommendation from the conference is to develop sustained observations of the Agulhas system. The Western Indian Ocean Sustainable Ecosystem Alliance (WIOSEA) could serve as an integrating framework for the cooperation of international and regional scientists toward sustained observations. Further capacity building and training of regional technicians and scientists are essential and could take place through partnerships with the NRF.

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