The Southern Ocean is disproportionately important in influencing the Earth system. It connects the major ocean basins, links the shallow and deep limbs of the overturning circulation, exerts great influence on global biogeochemical and carbon cycles, and is home to many unique and vulnerable species, some of which are commercially exploited. The Southern Ocean is changing, with potentially global impacts. These changes include a warming, freshening, and acidification, with concordant changes in the distribution of marine organisms. However, data coverage in the Southern Ocean remains the sparsest globally, inhibiting our ability to detect, interpret and predict such changes.

This need has led to the design and implementation of a Southern Ocean Observing System (SOOS), sponsored by the Scientific Committee on Antarctic Research (SCAR) and the Scientific Committee on Oceanic Research (SCOR), and endorsed by the Partnership for Observation of the Global Oceans (POGO) and the World Climate Research Programme (WCRP). It addresses six overarching challenges of high scientific and societal relevance (summarised in the Figure):

1. The role of the Southern Ocean in the planet's heat and freshwater balance;
2. The stability of the Southern Ocean overturning circulation;
3. The role of the ocean in the stability of the Antarctic ice sheet and its contribution to sea-level rise;
4. The future and consequences of Southern Ocean carbon uptake;
5. The future of Antarctic sea ice;
6. The impacts of global change on Southern Ocean ecosystems.

Sustained observations of the evolving physical, biogeochemical and biological state of the Southern Ocean are essential to tackle each of these, and the published SOOS Initial Science and Implementation Strategy (available at www.soos.aq) identifies the key variables to be observed and the combination of platforms needed to measure them. These include conventional ship-based techniques and repeat hydrography, autonomous floats and gliders, remote sensing, miniaturised oceanographic sensors on mammals and birds, genomic approaches, and observations of the abundance and distribution of top predators (fish, penguins, seabirds, seals and whales). Work is ongoing to refine the optimal sampling strategy for SOOS, complete its implementation, and refine the 20-year vision such that the future evolution of SOOS can parallel that of the societal drivers and our observational capability. This work is coordinated by the SOOS International Project Office, hosted by the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania, Australia.

Improved understanding of Southern Ocean processes and change are required in order to tackle many of the most pressing and challenging issues faced by society, including climate change, sea-level rise, and the response of marine ecosystems to ocean warming, acidification, and human exploitation. SOOS will provide the sustained observations of the Southern Ocean that are required to achieve this understanding.