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Achievements and legacy of the International Polar Year in the Southern Ocean

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The Southern Ocean was observed in a comprehensive way for the first time during the International Polar Year (IPY). During the 24 months of the IPY, most of the World Ocean Circulation Experiment (WOCE) Southern Ocean sections were completed (this took close to a decade during WOCE); a wide range of biogeochemical measurements were made, including the first full-depth measurements of a variety of trace metals; Argo floats provided broad-scale, year-round measurements of the upper 2000 m of the ice-free ocean; elephant seals collected more than 60,000 temperature and salinity profiles, most of these in the seasonal ice zone in winter; current meter moorings measured major boundary currents and dense water outflows; and a variety of satellite sensors provided circumpolar measurements of ocean and sea ice properties. These measurements have provided new insights into how the Southern Ocean works and its influence on the rest of the globe. Comparison of float data and repeat hydrographic sections to historical data shows that the Southern Ocean is warming at a faster rate and to greater depth than the global ocean average; in situ observations and proxies derived from repeat hydrography and satellite altimetry have shown that the Antarctic Circumpolar Current has on average shifted poleward; and Antarctic Bottom Water is fresher, warmer (in many locations) and less dense than observed in previous decades. Time series from current meter moorings have provided new insights into the strength and variability of dense overflows and the deep boundary currents that make up the deep limb of the Southern Ocean overturning circulation. Iron measurements in the deep Southern Ocean have revealed that mid-ocean ridges are a significant source of iron, and observations of mercury and organic compounds have highlighted the role of the Southern Ocean overturning circulation in regulating exposure of Antarctic biota to contaminants. Biological measurements collected during IPY identified new species and revealed links between the physical environment and biogeographic boundaries. SO IPY demonstrated that a comprehensive, integrated, multi-disciplinary observing system for the Southern Ocean is feasible and powerful. A legacy of the IPY will be a sustained Southern Ocean Observing System (SOOS), providing the observations needed to address societal challenges including climate change, sea-level rise, ocean acidification and sustainable management of marine resources. After extensive consultation, the international community has developed a plan for Southern Ocean observations (Southern Ocean Observing System: Initial Science and Implementation Strategy; www.scar.org/soos) that articulates the rationale and initial design of the SOOS.