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A global Biogeochemical Argo pilot array: Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) profiling floats and results

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The ocean provides critical services to life on the planet, absorbing 93% of the heat from anthropogenic warming and a quarter of human carbon dioxide (CO_2) emissions each year. However, rising ocean temperatures and CO_2 levels also change the marine environment: pH and oxygen levels fall, ocean currents change, and nutrient fluxes and concentrations are shifting, all with large effects on ecosystems and the cycles of oxygen, nitrogen, and carbon throughout the ocean and atmosphere. Observing these biogeochemical (BGC) processes across remote ocean areas with seasonal to interannual resolution has been impractical due to the prohibitive costs associated with ship observations. Yet such observations are essential to understand the natural and perturbed systems.

Profiling floats, proven in the Argo program, with BGC sensors (oxygen, nitrate, pH, bio-optical) provide a transformative solution to this need. BGC profiling floats are capable of observing chemical and biological properties from 2000 m depth to the surface every 10 days for many years. Based on various OSSE and sampling approaches, global coverage can be achieved with 1000 BGC floats contributing to the core T/S Argo array of about 4000.

The U.S. Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program serves as a major basin-scale pilot for such a global array. Its 141 operating BGC floats, building towards an ultimate 200 floats, demonstrate that the major challenges associated with operating a large-scale, robotic network have been overcome, and that there is a substantial user base for the data. Data have been publicly available in near real-time since the start of SOCCOM. Robust protocols for QC, calibration and validation of BGC float data have been developed, based on

GLODAPv2 climatologies and relationships between the observed float variables. Data are being incorporated in BGC state estimation and are being used for comparison/validation of ocean models used for climate. Initial SOCCOM results are already transforming understanding of Southern Ocean biogeochemistry. Annual cycles of air-sea carbon flux are revealing major surprises, including strong outgassing within the Antarctic Circumpolar Current. Annual net community production in all major regimes of the Southern Ocean has been quantified. The broad-scale float profiling has validated NASA's satellite algorithms for POC and chlorophyll in the Southern Ocean. As the international community moves forward towards sustained BGC-Argo deployments, SOCCOM can provide its experience in sensors, floats, deployments, calibration, and data management.