Re: Justification for a two-ship operation for the Southern Ocean Gas Exchange Study

Ocean-atmosphere gas exchange experiments have been conducted in a comprehensive and interdisciplinary process study mode with a wide range of observations in both the ocean and atmosphere. A fundamental operational protocol is that it is necessary for the studies to be performed in a Lagrangian or water-mass following frame of reference. By studying, for the most part, the same water mass makes it possible to properly investigate the biological and physical processes controlling the surface concentrations of the gases.

The Lagrangian water-mass has either been a tagged with drifters, as in GasEx-1998, or a drifter where shear displacement is accounted for, as in GasEx-2001. For a true Lagrangian study, the 1998 approach is desirable as it helps account for the dispersion processes. In a comprehensive ocean-atmosphere gas exchange study, the scientific operations fall into two main classifications of observations. One measurement mode requires quasi-stationary observations in the center of the study region while the other measurement mode requires surveys of a broader extent of the study region and surrounding waters.

The 2-ship measurement modes of operation are complementary. Details of the 2-shipboard operational requirements include:

Ship 1: Center, or fixed, ship in study region.

[1] Air-side flux measurements using meteorological techniques in the marine atmospheric boundary layer. The ship should be stationary or underway at slow speeds (1-2 knots) into the predominant wind. Air-sea momentum, heat, and gas fluxes would be performed by a variety of methods. Methods may include direct covariance, profile flux technique, REA, DEA. Heat fluxes include components from sensible, latent, and long and short wave radiation.

[2] Shallow depth (0-1000 m) concentration measurements of biochemical and physical parameters that influence surface gas concentrations (ADCP, T, S, O_2, nutrients, carbonate system parameters, chlorophyll, and isotopes). This requires continuous CTD-Rosette operations at 3 to 6 hour intervals.

[3] Ship-based remote sensing. This would include measurements such as wave height, wave slope, wave spectral characteristics, wave age, windstress, and wind.

Ship 2: Survey ship and over the side platform operations.

[1] Perform dual-deliberate tracer studies. This requires extensive surveys to delineate the tracer patch and to set the position fixed-ship 1.

[2] Surface gas concentrations (CO_2, halocarbons, DMS, O_2).

[3] Mixed-layer profiles of gases for deliberate tracer and mass balances. This requires shallow CTD measurements of pertinent gases, including the deliberate tracers to determined the losses

due to mixing and dispersion.

[4] Deployment and recovery of drifters and platforms. Implementation of novel drifters and platforms to determined near-surface (air and water) concentration, wind, and momentum profiles as well as surface characterization (turbulence, waves) are anticipated.

[5] Profiling drifter deployments. A broad array of water column profilers will provide full characterization of gas and hydrographic dynamics.

[6] Buoy deployment. To gain better understanding of longer term surface forcing and autonomous surface gas concentration measurements, a buoy deployment with at least 1-year duration is recommended.