Print

Beaufort Gyre Exploration Project: Modeling

While the primary activity of this project is organized around data collection and analyses, some reasonable modeling efforts are needed for better understanding the relationships between different processes. An important aspect of modeling studies is the potential to synthesize the results in terms of a dynamically consistent description of the processes and events. Model results have been used to establish the relationships between changes in the atmospheric, sea ice and oceanic wheels. To efficiently use the resources and to focus on a specific question, we employ a hierarchy of models, ranging from a 2-D model (Proshutinsky and Johnson, 1997), to an idealized 3-D model (Proshutinsky et al., 2002) and a 3-D coupled ice-ocean model (Karcher et al., 2002, see also Arctic Ocean Model Intercomparison web site and the EOS paper by Proshutinsky et al. [2005]). The 2-D model has been used to update the Arctic Ocean Oscillation index (AOO; Proshutinsky and Johnson, 1997) in order to continue analyzing Beaufort Gyre (BG) circulation modes: for comparison with the AO index and to predict the location of the BG center for expedition planning (see Figures 1-5 showing annual surface circulation of the Arctic Ocean from the model results).

In order to test different ideas related to oceanic physics and interactions between sea ice and ocean we use a version of Sirpa Häkkinen's model (Häkkinen, 1993). A similar approach was used by Proshutinsky et al. (2002), where processes of FW accumulation and release in the BG were tested in a rectangular basin with a very simple bathymetry. The development of the three-dimensional fields in time was simulated by Hakkinen and Proshutinsky (2003) with the coupled ocean-sea ice general circulation model forced with realistic atmospheric factors over the last 50 years. We also employ two versions of the NAOSIM (North Atlantic-Arctic Ocean-Sea Ice Model) family of models developed at the Alfred Wegener Institute. High resolution NAOSIM model results are shown in an EOS paper (Proshutinsky et al., 2005). This model provides the best results among all of the AOMIP models.

The ability of the models to synthesize greater aspects of the project depends crucially on the quality of the model results. The analysis of the hindcast simulations include but are not restricted to: detailed heat and FW balance for the BG that includes transports across the boundaries, storage of heat and salt, and local surface fluxes; water mass transformation rates inside the BG; variability of stratification and surface buoyancy fluxes; relationship of convection with the heat release to atmosphere, exchange with boundary currents, and transport rates and properties of water masses; freshwater fluxes to the rest of the Arctic Ocean and its redistribution depending on climate modes.

Figures

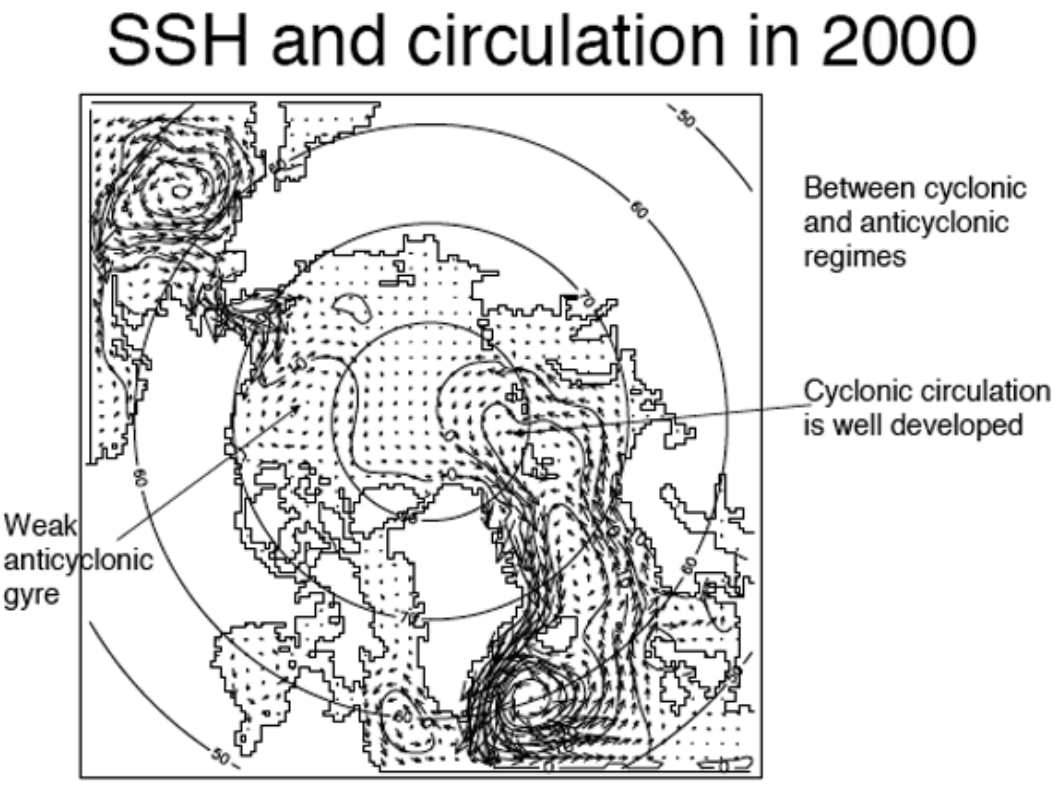

Figure 1. Sea surface heights (cm) and surface sea ice drift and surface water circulation in 2000 based on 2-D coupled ice-ocean model results

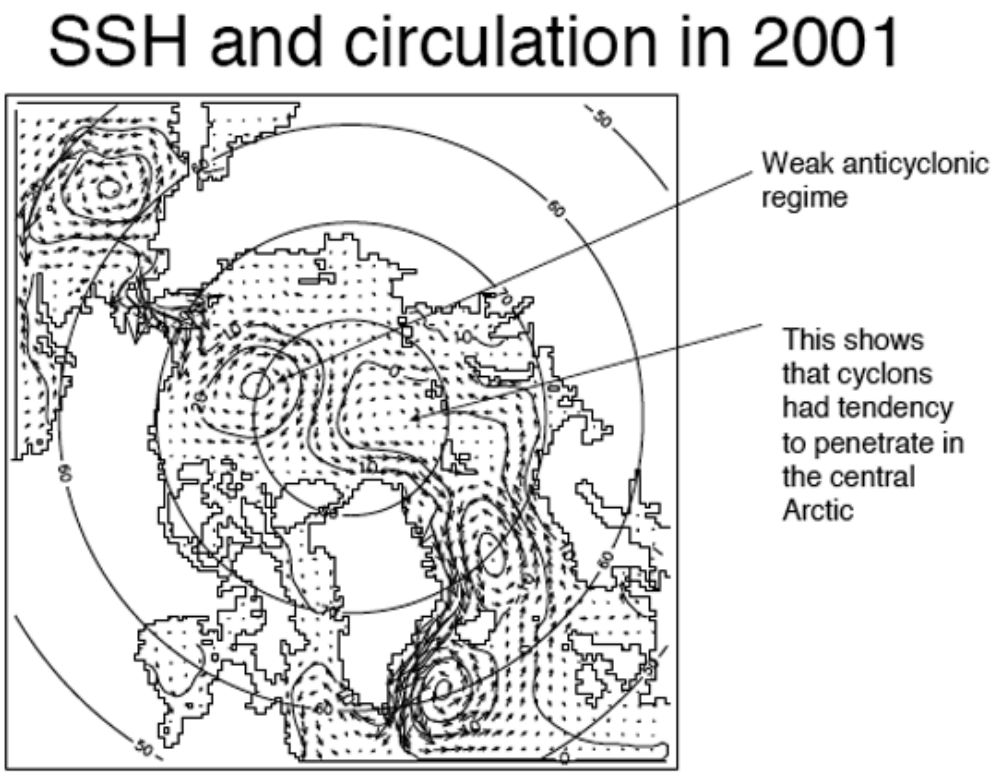

Figure 2. Same as in Figure 1 but for 2001.

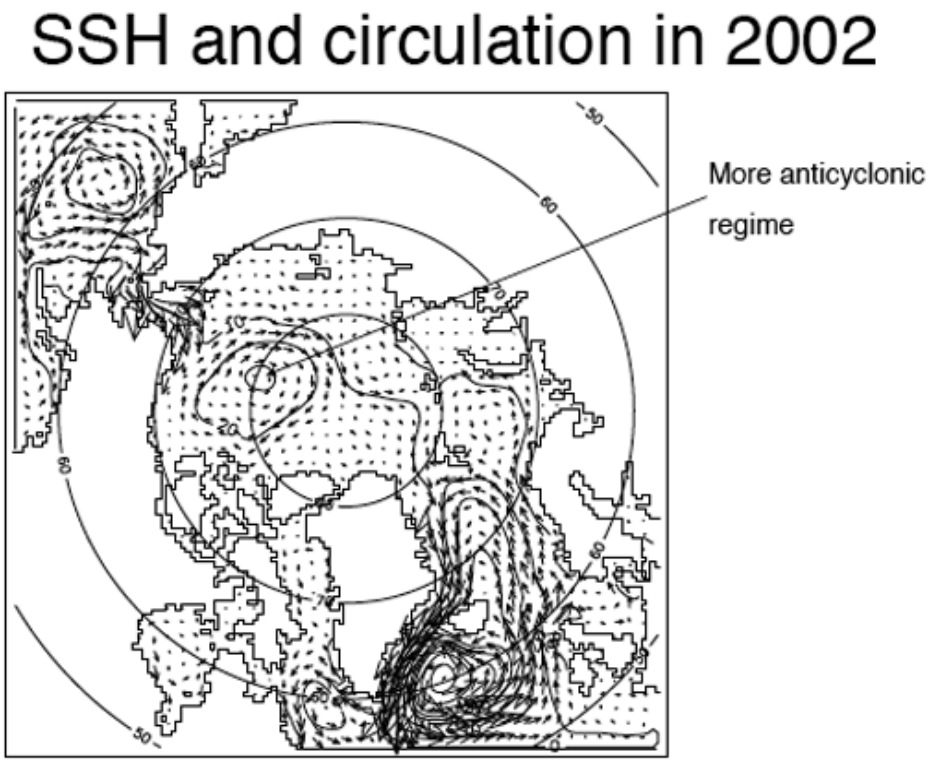

Figure 3. Same as in Figure 1 but for 2002.

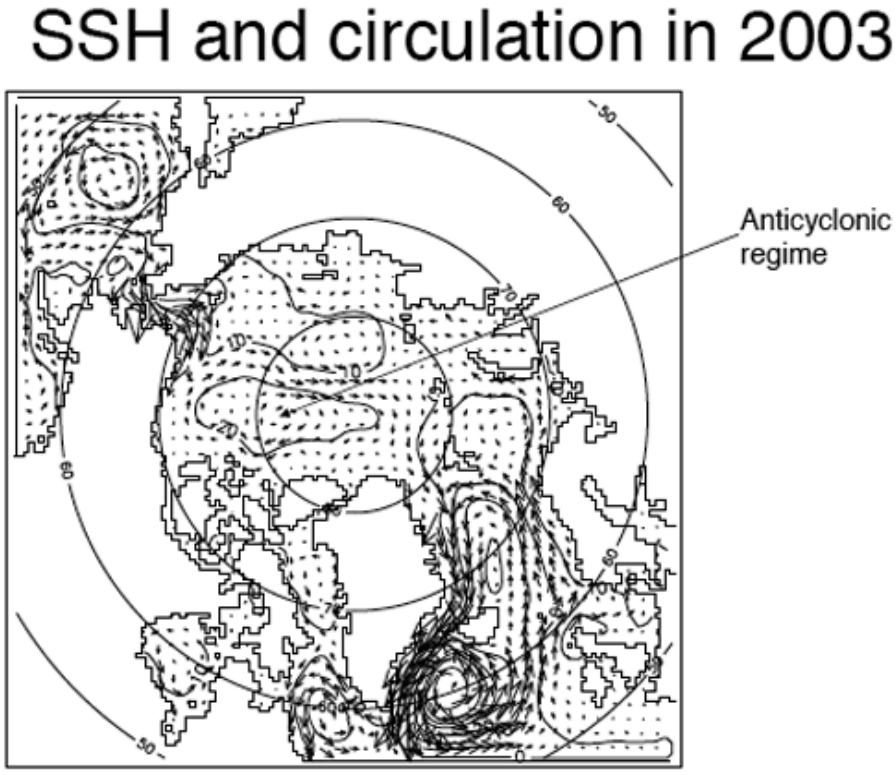

Figure 4. Same as in Figure 1 but for 2003.

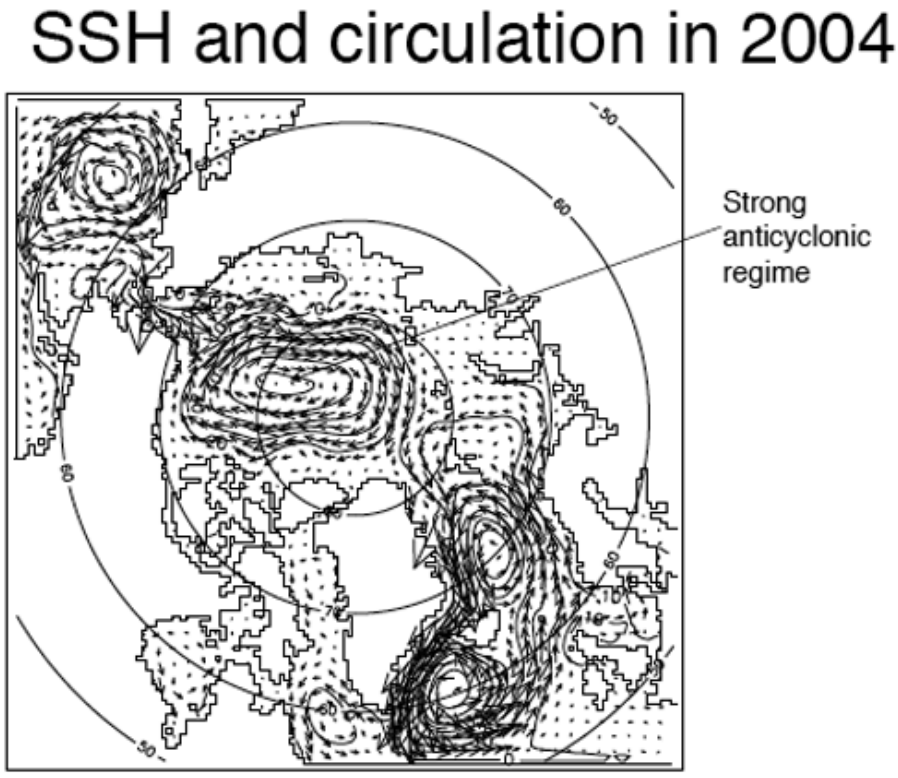

Figure 5. Same as in Figure 1 but for 2004.

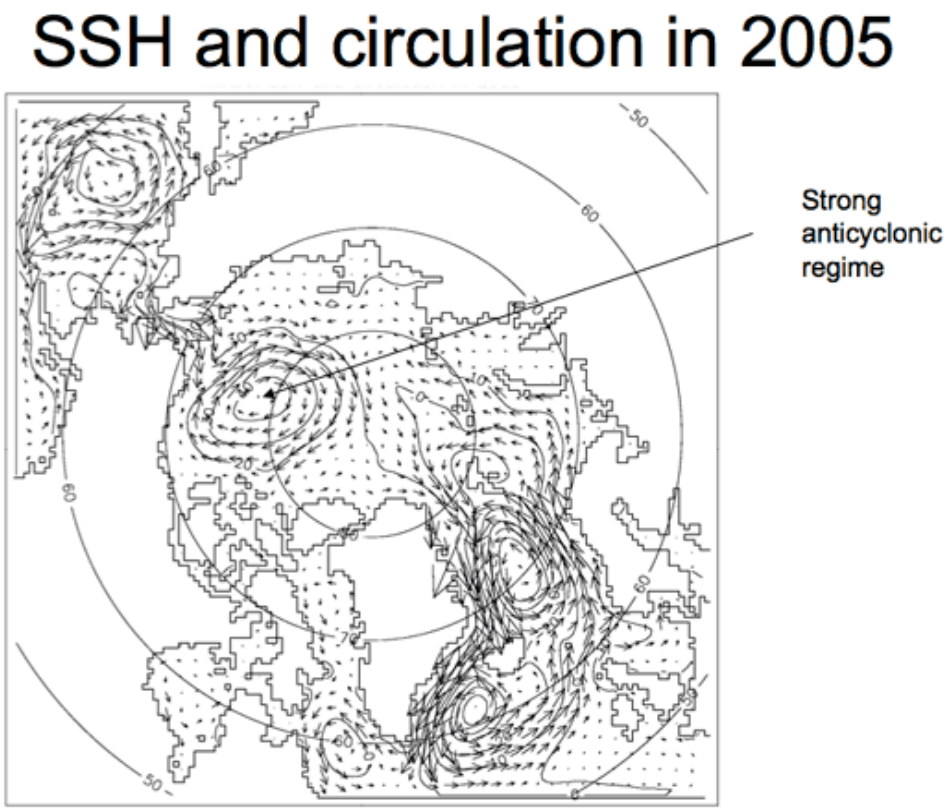

Figure 6. Same as in Figure 1 but for 2005.

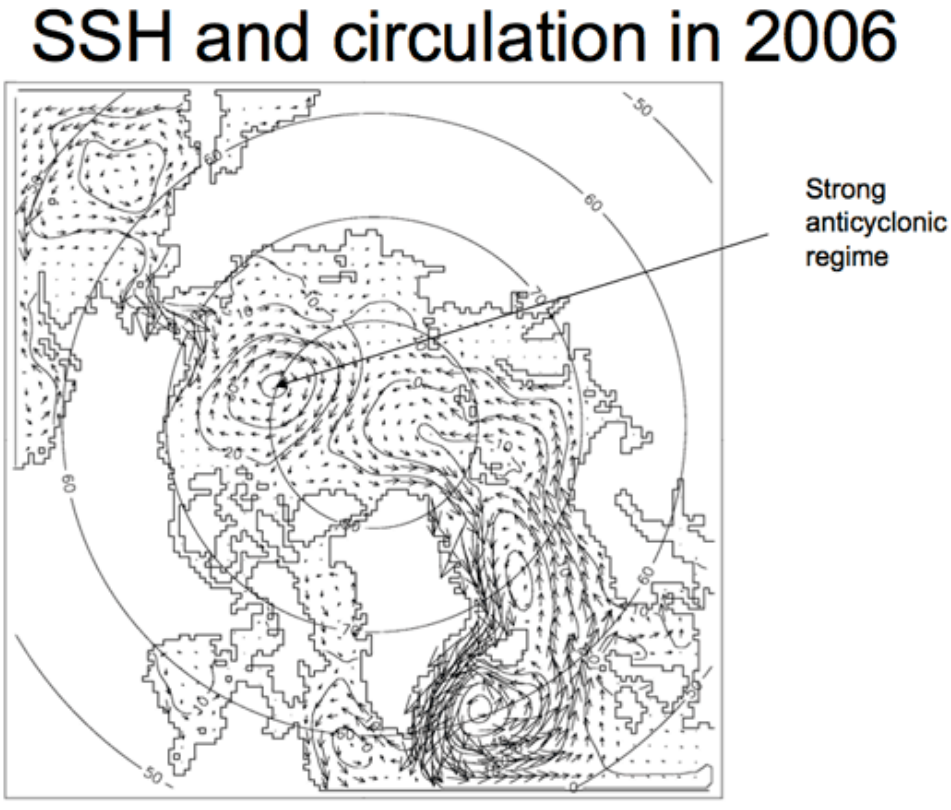

Figure 7. Same as in Figure 1 but for 2006.

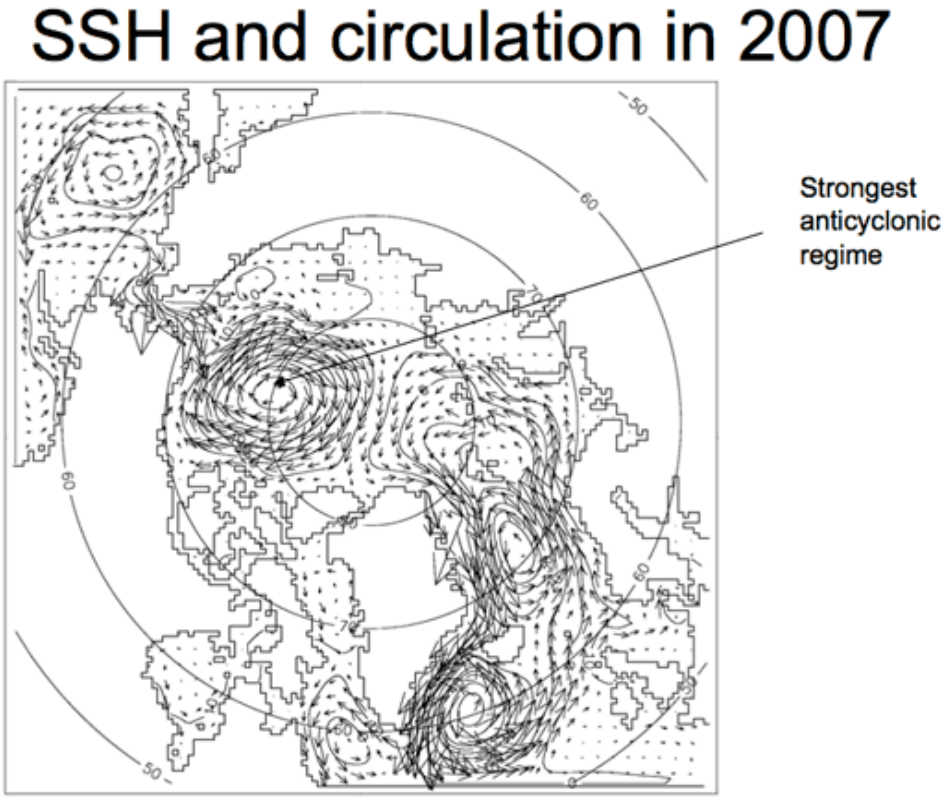

Figure 8. Same as in Figure 1 but for 2007.

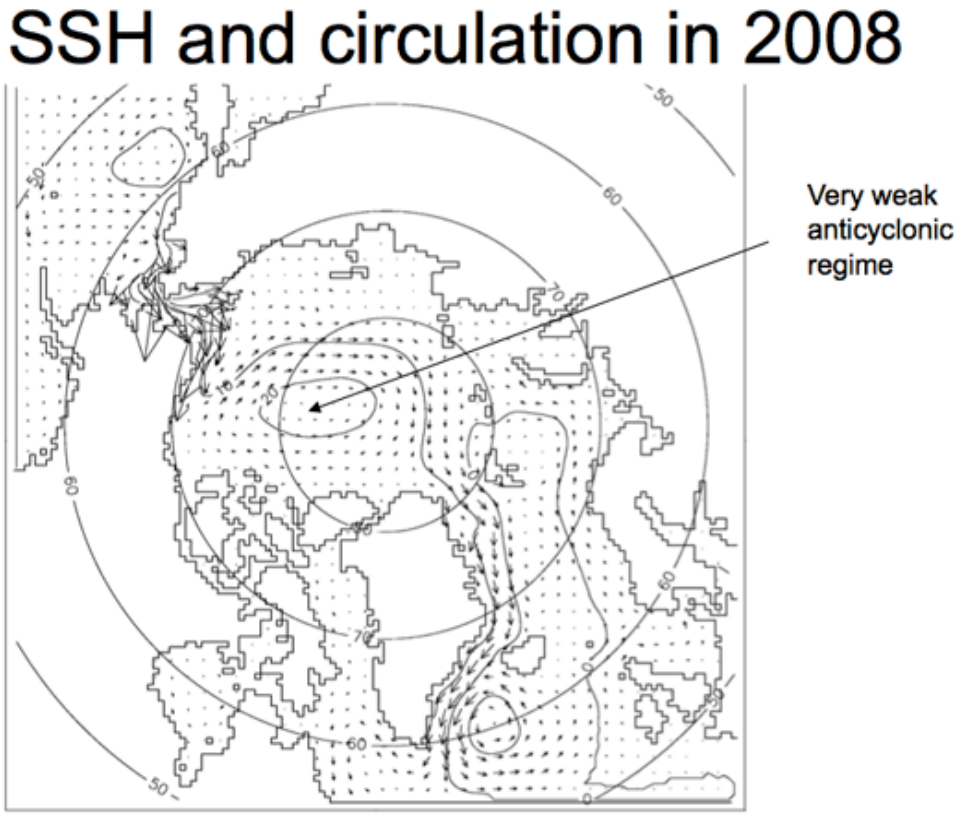

Figure 9. Same as in Figure 1 but for 2008.

References

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