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Response of the Coupled Ocean-Atmosphere System to Greenland Ice Melting

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We investigate the transient response of the global coupled ocean-atmosphere system to enhanced freshwater forcing representative of melting of the Greenland ice sheets. A 50-year long simulation by a coupled atmosphere-ocean general circulation model (CGCM) is compared with another of the same length in which Greenland melting is prescribed. To highlight the importance of coupled atmosphere-ocean processes, the CGCM results are compared with those of two other experiments carried out with the oceanic component of the coupled model (OGCM). In one of these OGCM experiments the prescribed surface fluxes of heat, momentum and freshwater correspond to the unperturbed simulation by the CGCM; in the other experiment Greenland melting is added to the freshwater flux. The responses by the CGCM and OGCM to the Greenland melting have similar patterns in the Atlantic, albeit the former have five times larger amplitudes in sea level anomalies. The CGCM shows likewise stronger variability in all state variables in all ocean basins because the impact of Greenland melting is quickly communicated to all ocean basins via atmospheric bridges. We conclude that the response of the global climate to Greenland ice melting is highly dependent on coupled atmosphere-ocean processes. These lead to reduced latent heat flux into the atmosphere and an associated increase in net freshwater flux into the ocean, especially in the subpolar North Atlantic. The combined result is a stronger response of the coupled system to Greenland ice sheet melting.