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The ECCO Consortium: Assessing deep ocean variability and implications for the observing system

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The need to observe long-term climate signals in the deep ocean, in the presence of background variability associated with eddies, waves and other processes, has been recently recognized. Present in situ measurements provided by the Argo system focus on the upper ocean and provide no data below depths varying from ~1000 to 2000 meters. Other available data (mostly from rare deep moorings and repeat hydrographic sections) are manifestly insufficient to provide comprehensive temporal and spatial characteristics of variability in temperature, salinity and other variables of interest in the deep ocean. In this work, fully 3-dimensional ocean estimates produced by the ECCO consortium are explored to assess characteristics of variability in deep steric height --a variable of considerable interest for quantitatively understanding the relation between sea level, heat content and other important ocean climate parameters. Results are based on monthly-averaged steric height anomalies, vertically integrated over the "unobserved" deep ocean (below ~1800 m). Excluding linear trends, variability in deep steric height is typically 10-20% of that in the upper ocean, but values > 50% are seen in many oceanic regions. Enhanced deep variability occurs in areas of strong eddy energy associated with several western boundary currents and along the Antarctic Circumpolar Current. Deep signals are mostly thermosteric in nature, but important halosteric contributions can occur in the North Atlantic and other basins. Possible inference of deep signals from knowledge of the upper ocean is hampered by less than perfect correlations. Simple regressions of deep on upper ocean steric height series fail to represent the estimated variability. Best determination of deep variability should involve a combination of observing platforms capable of measuring not only temperature and salinity, but complementary fields such as bottom pressure as well.