Can we map the interannual variability of the whole upper Southern Ocean with the current database of hydrographic observations?

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With the advent of Argo floats, it now seems feasible to study the interannual variations of upper ocean hydrographic properties of the historically undersampled Southern Ocean. To do so, scattered hydrographic profiles often first need to be mapped. To investigate biases and errors associated both with the limited space-time distribution of the profiles and with the mapping methods, we colocate the mixed layer depth (MLD) output from a state-of-the-art $1/12°$ DRAKKAR simulation onto the latitude, longitude and date of actual in-situ profiles from 2005 to 2014. We compare the results obtained after remapping using a nearest-neighbor (NN) interpolation and an objective analysis (OA) with different spatio-temporal grid resolutions and decorrelation scales. NN is improved with a coarser resolution. OA performs best with low decorrelation scales, avoiding too strong a smoothing, but returns values over larger areas with large decorrelation scales and low temporal resolution, as more points are available. For all resolutions OA represents better the annual extreme values than NN. Both methods underestimate the seasonal cycle in MLD. MLD biases are lower than 10 m on average but can exceed 250 m locally in winter. We argue that current Argo data should not be mapped to infer decadal trends in MLD, as all methods are unable to reproduce existing trends without creating unrealistic extra ones. We also show that regions of the subtropical Atlantic, Indian and Pacific Oceans, and the whole ice-covered Southern Ocean, still cannot be mapped even by the best method because of the lack of observational data. This article is protected by copyright. All rights reserved.