Salinity and water Cycle: spatial patterns and variability of near-surface salinity gradients from historical CTD, TSG, and Argo data

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Sea surface salinity (SSS) is an important variable that reflects the intensity of the marine hydrological cycle [US CLIVAR Salinity Working group, 2008]. The Aquarius satellite mission will provide, for the first time, both global and continuous observations of SSS with space and time resolution not accessible by other components of the ocean observing system. Among these components, the Argo float array is, perhaps, the most compatible due to its continuous global coverage, yet, Argo measurements are absent above 5 m depth thus leaving the most active near-surface ocean layer unobserved. As a step towards the synergy between the satellite and the sea-based observations, we analyze near-surface salinity gradients in historical data sets. This way, open ocean data of high-resolution CTD profiles collected in the World Ocean Database 2009 are used to characterize vertical salinity gradients. Globally, the mean value and standard deviation of the difference between salinity at 5 m depth level and SSS do not exceed 0.03 psu and 0.2 psu, respectively. At the same time, probability distribution of this difference is strongly skewed towards positive values due to relatively rare events of anomalously low SSS. Using the statistics gained from the analysis of historical CTD casts, the Argo data are then utilized to reconstruct seasonal maps of probability of appearance of a complex vertical structure of salinity in the near-surface layer. The areas of high probability indicate the areas where the Aquarius mission is expected to add fundamentally new information for the climate and ocean research. The struggle between precipitation and vertical mixing, which appears to be responsible for the observed evolution of the complexity of the near-surface salinity structure, is also discussed on a seasonal basis. Horizontal near-surface salinity gradients are studied using high-resolution thermosalinograph (TSG) data, collected by the Global Ocean Surface Underway Data Pilot Project (GOSUD). Wavenumber power density spectra of SSS are then computed to determine spatial decorrelation scales as well as other statistical parameters required (e.g.) for optimal interpolation of the high-resolution SSS data, and to assess errors due to components of variability not resolved by the Aquarius measurements. A particular focus of this study is on the North Atlantic subtropical SSS maximum, where the Salinity Processes in the Upper Ocean Regional Study (SPURS) experiment is about to start.