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Evaluation of Climate Variability of Sea Level from the ESA CCI products and ECMWF ocean reanalyses

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Together with ocean heat content change, sea level rise is the most reliable climate indicator of global warming. Robust climate signals can be derived from sea level changes in the objective analysis of satellite radar altimeter data, as well as in the ocean reanalysis products during the satellite era. The ESA Sea Level Climate Change Initiative (SL_CCI) project provides a stable, homogenized satellite-based sea level product with reduced altimetry errors at climate scales. Climate signals from different versions of SL_CCI product were assessed and verified against other reference sea-level datasets (e.g. mapped SLA data from AVISO), and ECMWF's ocean reanalyses using multi-model approach. The robustness of the sea level temporal variability from SL_CCI and its attribution to physical processes were evaluated using the new ECMWF's Ocean ReAnalysis System 5 (ORAS5), with a generic perturbation scheme and 5 ensemble members. The spatial distribution of uncertainties on sea level trends from SL_CCI product was evaluated against ensemble spreads from ORAS5. An Empirical Orthogonal Function (EOF) analysis show that the amplitude, phase, and spatial patterns of the interannual signals of sea level in the new SL_CCI product are more consistent with the ORAS5 than previous SL_CCI products. A robust SL signals in the Baltic Sea and North Sea as identified from the leading EOF pattern for the North Atlantic can be derived from both SL_CCI product and AVISO MSLAs, and was likely associated with the prevailing zonal wind patterns in the North Atlantic sub-polar regions. The relation between the leading EOF modes of sea-level and climate variability processes was also discussed here.