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Ventilation changes in the Subpolar North Atlantic: Insights from Six Decades of Oxygen Observations and Tracer-Based Age Analysis

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The subpolar North Atlantic assumes a key role in ventilating the ocean's interior as it is a primary site for deep water formation. Dissolved oxygen concentrations exhibit high sensitivity to climate variability and changes due to the interplay between sea-surface temperature fluctuations and ocean stratification. This relationship not only affects the solubility of dissolved oxygen but also modulates its transport from the near-surface ocean to the interior, known as ventilation. We collected sixty years of observations, spanning from 1960 to 2022, from three different datasets: GLODAPV2, WOD18 and BGC-Argo. These data underwent rigorous secondary quality control process, which adjusted biases between GLODAPV2 and WOD18, as well as BGC-Argo to minimize systematic errors. We conducted an in-depth analysis of the long-term changes and interannual variability in dissolved oxygen, apparent oxygen utilization (AOU), oxygen utilization rate (OUR) and water mass ages within the upper 2000 meters of the water column. Our specific focus encompassed the Subpolar Mode Water (SPMW), Intermediate Water (IW) and Labrador Sea Water (LSW). The computation of OUR and water mass ages in particular relied on tracer data such as chlorofluorocarbons (CFCs) and Sulphur hexafluoride (SF_6) to estimate ventilation ages via the Transit Time Distribution (TTD) method. OUR provides insights into local oxygen consumption due to remineralization of organic matter, while the total AOU is the integrated OUR along the pathway of the water parcel. Therefore, identifying these parameters enables to distinguish between the primary drivers behind oxygen variations in the subpolar North Atlantic, namely air-sea gas exchanges, ocean circulation, and marine biology.