EGU22-1761
https://doi.org/10.5194/egusphere-egu22-1761
EGU General Assembly 2022

Connecting the North Atlantic subpolar gyre and the northern European shelf seas: a satellite-based Lagrangian perspective

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Understanding the impact of oceanic climate variability on shelf seas requires knowledge of their water-mass origins and associated pathways. Furthermore, identifying the dominant driving mechanisms responsible for water-mass variability is an important step towards better predictability of shelf sea properties. To determine the link between the large-scale circulation of the subpolar North Atlantic and the North Sea, we adopt a Lagrangian approach based on satellite altimetry. Utilizing the derived velocities, we are able to isolate the changes of water-mass pathways in response to decadal large-scale oceanic variability. In particular, during phases of a strong subpolar gyre we find that water-masses which are transported into the North Sea follow a comparatively direct path along the subpolar gyre, as well as being faster. Subsequently, northern North Sea water-masses originate from further west in the southern and central subpolar North Atlantic. Supportive analysis on high resolution reanalysis data suggests that not only strong gyre regimes but also the transient phase into them are connected to pronounced along-shelf advection. In contrast, phases of a weak subpolar gyre lead to increased water-mass residence times in the north-eastern North Atlantic, prior to entering the North Sea. We conclude that the subpolar gyre strength is a key predictor of inter-annual variability of North Sea water-mass pathways, origin, and properties.