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Mechanisms of North Atlantic and European decadal sea level change during the altimetry era

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Sea level rise poses a major threat to the coastal societies and environment. Global sea-level rise has been observed to accelerate synchronously with, and as a consequence of, anthropogenic global warming. Recent studies show that global mean sea level rise has been accelerating from 1-2 mm/yr before 1990 to unprecedented rates of about 3 mm/yr thereafter. This acceleration is primarily a contribution from ice melting and ocean thermal expansion. On top of the global mean sea level curve, there are key decadal basin-scale acceleration and deceleration periods that typically originate from oceanic climate variability. Decadal-scale North Atlantic Ocean circulation variability, its associated sea-level trends in the in the open ocean, on the European shelves and coasts during the altimetry era are investigated utilizing a combination of satellite altimetry, hydrography and tide gauges.

It is well known that the subpolar gyre has undergone a significant warming, salinification and weakening in its strength during the first 12-year period of satellite altimetry, i.e. 1993-2004. These changes have been typically explained in terms of gyre and meridional overturning circulation changes. Interestingly, since mid-2000s, the subpolar gyre has shown a gradual cooling and hence a recovery in its strength, especially in the past few years. The causes of these changes during the recent decadal cooling are here quantified and, in turn, linked to the European shelf and coastal sea level variability. We find that wind variability plays an important role in driving the dynamic sea level variability on the European shelf and coast. Furthermore, during the North Atlantic cooling period, i.e. the 2005-2016 period, the winds along the eastern boundary are found to have been predominantly from the North and this appears to have influenced the strong upward European coastal sea level trend seen during the North Atlantic warming period (1993-2004). Understanding the mechanisms that produce these connections between large-scale ocean circulation changes and European shelf/coastal sea level is critical for interpreting future decadal regional sea-level trends.