Inter-annual to inter-decadal temperature variability in the benthic layer of the western Black Sea shelf

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Long-term changes in the state of the Bottom Shelf Water (BSW) on the Western shelf of the Black Sea are assessed using analysis of intra- and inter-annual variations of temperature as well as their relations to physical parameters of both shelf and deep-sea waters. First, large data sets of in-situ observations over the 20th century are compiled into high-resolution monthly climatology at different depth levels. Then, the temperature anomalies from the climatic mean are calculated and aggregated into spatial compartments and seasonal bins to reveal temporal evolution of the BSW. For the purpose of this study the BSW is defined as such shelf water body between the seabed and the upper mixed layer (bounded by the σ_θ=14.2 isopycnal) which has limited ability to mix vertically with oxygen-rich surface waters during the warm season (May-November) due to the formation of a seasonal pycnocline. The effects of atmospheric processes at the surface on the BSW are hence suppressed as well as the action of the 'biological pump'. The vertical extent of the near-bottom waters is determined based on energy considerations and the structure of the seasonal pycnocline, whilst the horizontal extent is controlled by the shelf break, where strong along-slope currents hinder exchanges with the deep sea. The BSW is shown to occupy nearly half of the area of the shelf during the summer stratification period. The potential of the BSW to ventilate horizontally during the warm season with the deep-sea waters is assessed using isopycnic analysis of temperature variations. A long-term time series of temperature anomalies in the BSW is constructed from observations during the May-November period for the 2nd half of the 20th century. The results reveal a warm phase in the 1960s/70s, followed by cooling of the BSW during 1980-2001. The transition between the warm and cold periods coincides with a regime shift in the Black Sea ecosystem. While it was confirmed that the memory of winter convection events is well preserved over the following months in the deep sea, the signal of winter cooling in the Bottom Shelf Waters significantly reduces during the warm season. The time series of temperature in the BSW is highly correlated with the temperature of Cold Intermediate Waters in the deep sea thus indicating that the isopycnal exchanges with the deep sea are more important for inter-annual / inter-decadal variability of the BSW on the Western Black Sea shelf than winter convection on the shelf itself.

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