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Changes of surface productivity and ventilation of intermediate waters in the Gulf of Lions (Western Mediterranean Sea) from 133 to 400 Kyr

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A multidisciplinary study involving micropaleontological and geochemical tools was carried out in borehole PRGL 1-4 (Promess1) drilled in the upper slope of the Gulf of Lions with the aim of reconstructing the impact of climate changes on surface and bottom waters between 133 and 400 Kyr. Benthic foraminifer species were grouped by R-mode principal components analysis. We obtained 3 factors that accounted for changes from mesotrophic to eutrophic and oxygenated to dysoxic situations. During warm stages, characterized by high percentages of planktic foraminifer species G. inflata and G. ruber, benthic communities were preferentially mesotrophic owing to the low supply of organic matter from the river and mixed layer as a consequence of the sea level increase and the subsequent separation of Rhône river mouth. We compared our micropaleontological results with C/N ratio of organic carbon (used as a proxy for the source of organic carbon) obtained from a CHN analyzer, and with δ18O isotopes from G. bulloides. Our proxies recorded past climatic variability both at millennial-scale and at astronomical-scale as precession (23 Kyr.) and obliquity (42 Kyr.) parameters. In order to study the relationship between the periodicities that explained most of the variance we used power spectral and cross coherence estimation by Welch method. Our results showed that astronomical parameters mainly controlled both ventilation and productivity processes in the Gulf of Lions. The precession cycle was the most significant regarding ventilation of intermediate waters as shown in spectral estimation of benthic foraminifer oxygenation-related assemblages. These assemblages had significant coherence with C/N ratio and δ18O isotopes at this periodicity corroborating precession forcing. Moreover, C/N ratio had another significant periodicity at 42 Kyr (obliquity) demonstrating the astronomical forcing of productivity in the mixed layer. Although astronomical factors controlled productivity and ventilation in the Gulf of Lions maybe extremely slow sedimentation rates in interglacial stages hided millennial events promoting large scale periodicity.