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Simulation of the mantle and crustal Helium isotope signature in the Mediterranean Sea using a high resolution regional circulation model

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Helium isotopes (3He, 4He) are useful tracers for investigating the deep ocean circulation and for evaluating ocean general circulation models, because helium is a stable and conservative nuclide that does not take part in any chemical or biological processes. Helium in the ocean originates from three different sources: namely, (i) gas dissolution in equilibrium with atmospheric helium, (ii) helium-3 addition by radioactive decay of tritium (called tritiugenic helium), and (iii) injection of helium-3 and helium-4 by the submarine volcanic activity which occurs mainly at plate boundaries, and also addition of helium-4 from the crust and sedimentary cover by α-decay of uranium and thorium contained in various minerals (called terrigenic helium).

Here we present the first simulation of the helium isotope distribution in the whole Mediterranean Sea, using a high resolution model (NEMO-MED12). The simulation was produced by building a simple source function for helium produced by submarine volcanic degassing in the main active areas of the Mediterranean, and by crustal degassing at sea bottom, based on previous estimates of the total flux of helium into the oceans.

In addition to providing constraints on the degassing flux, our work provides information on the variability of the thermohaline circulation and the ventilation of the deep waters to constrain the degree to which the NEMO-MED12 can reproduce correctly the main hydrographic features of the Mediterranean Sea circulation. This study is part of the work carried out to assess the robustness of the NEMO-MED12 model, which will be used to study the evolution of the climate and its effect on the biogeochemical cycles in the Mediterranean Sea, and to improve our ability to predict the future evolution of the Mediterranean Sea under the increasing anthropogenic pressure.