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Connectivity diagnostics in the Mediterranean obtained from Lagrangian Flow Networks; global patterns, sensitivity and robustness

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Lagrangian Flow Network (LFN) is a modeling framework in which geographical sub-areas of the ocean are represented as nodes in a network and are interconnected by links representing the transport of water, substances or propagules (eggs and larvae) by currents. Here we compute for the surface of the whole Mediterranean basin four connectivity metrics derived from LFN that measure retention and exchange processes, thus providing a systematic characterization of propagule dispersal driven by the ocean circulation. Then we assess the sensitivity and robustness of the results with respect to the most relevant parameters: the density of released particles, the node size (spatial-scales of discretization), the Pelagic Larval Duration (PLD) and the modality of spawning. We find a threshold for the number of particles per node that guarantees reliable values for most of the metrics examined, independently of node size. For our setup, this threshold is 100 particles per node. We also find that the size of network nodes has a non-trivial influence on the spatial variability of both exchange and retention metrics. Although the spatio-temporal fluctuations of the circulation affect larval transport in a complex and unpredictable manner, our analyses evidence how specific biological parametrization impact the robustness of connectivity diagnostics. Connectivity estimates for long PLDs are more robust against biological uncertainties (PLD and spawning date) than for short PLDs. Furthermore, our model suggests that for mass-spawners that release propagules over short periods ($\simeq$ 2 to 10 days), daily release must be simulated to properly consider connectivity fluctuations. In contrast, average connectivity estimates for species that spawn repeatedly over longer duration (a few weeks to a few months) remain robust even using longer periodicity (5 to 10 days). Our results give a global view of the surface connectivity of the Mediterranean Sea and have implications for the design of connectivity experiments with particle-tracking models and for evaluating the reliability of their results.