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Alboran jets, gyres and eddies in a 20-year high resolution simulation

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The circulation of the Alboran Sea has long been described as being in a quasi-steady state composed of the Atlantic Jet meandering on the northern bound of two conspicuous gyres: the Western Alboran Gyre and Eastern Alboran Gyre (WAG and EAG). Changes to this 2 gyre flow system (transitions or transient events) are not very well explored yet. Periodic disappearances of the WAG (collapses or migrations) have been reported, but a single event of WAG migration, observed in fall 1996, is described in detail. These studies suggested that WAG is more likely to disappear in winter after drastic changes in the inflow, and that 2-gyre steady states are essentially observed in summer. The transition periods and the occurrence of smaller eddies are episodically referred in the literature but poorly known.

Using a 20 yr 2km resolution Regional Ocean Modeling System simulation of the Gulf of Cadiz-Alboran Sea basins (from the "Inter-basin Exchange in a changing Mediterranean Sea" project MedEX), a classification of the circulation types and mesoscale structures in the Alboran Sea is conducted, characterizing their duration and frequency of occurrence, and temporal evolution.

The 2-gyre quasi-steady state (or blocking situation) is confirmed as the most common flow type in the Alboran (occurring during about 42% of the simulation time) and that it is more frequent in summer. However, periods of double gyre flow in winter are also present although the gyre organization is slightly different and this state is described as a 2-gyre winter type. Long stable periods of a single gyre blocking were also identified, and they occupy about 17% of the 20-year period This single gyre usually constitutes a larger version of the WAG somewhat displaced to the east and occurs all year round although it is more common in winter months.

The remaining time, the Alboran Sea is in relatively fast evolving flow transitions. The transitions were classified into, WAG migrations (when the WAG clearly migrates to the west); the coastal mode (when a weaker inflow circulates along the African Coast), the Gyre merging (when WAG and EAG merge usually to produce a single gyre blocking), and a less clear situation dominated by unusually large cyclones originating on the cut-off of the inter-gyre cyclonic meanders. The occurrences of smaller cyclonic eddies, and their dynamical origin is also described.

The occurrence of the different circulation modes and transitions events is compared with different indexes computed from the model results and observations: WAG and EAG magnitude indexes from model and satellite altimetry, model EKE and inflow time series. As expected, stable periods (2 gyre single gyre blockings) correspond to high WAG/EAG indexes and low EKE values (and correspondingly the inverse is observed during transitions). Inter-annual variability during the 20-year period discussed.