Geostrophic currents in the Mediterranean and Black Seas derived from Argo float profiles

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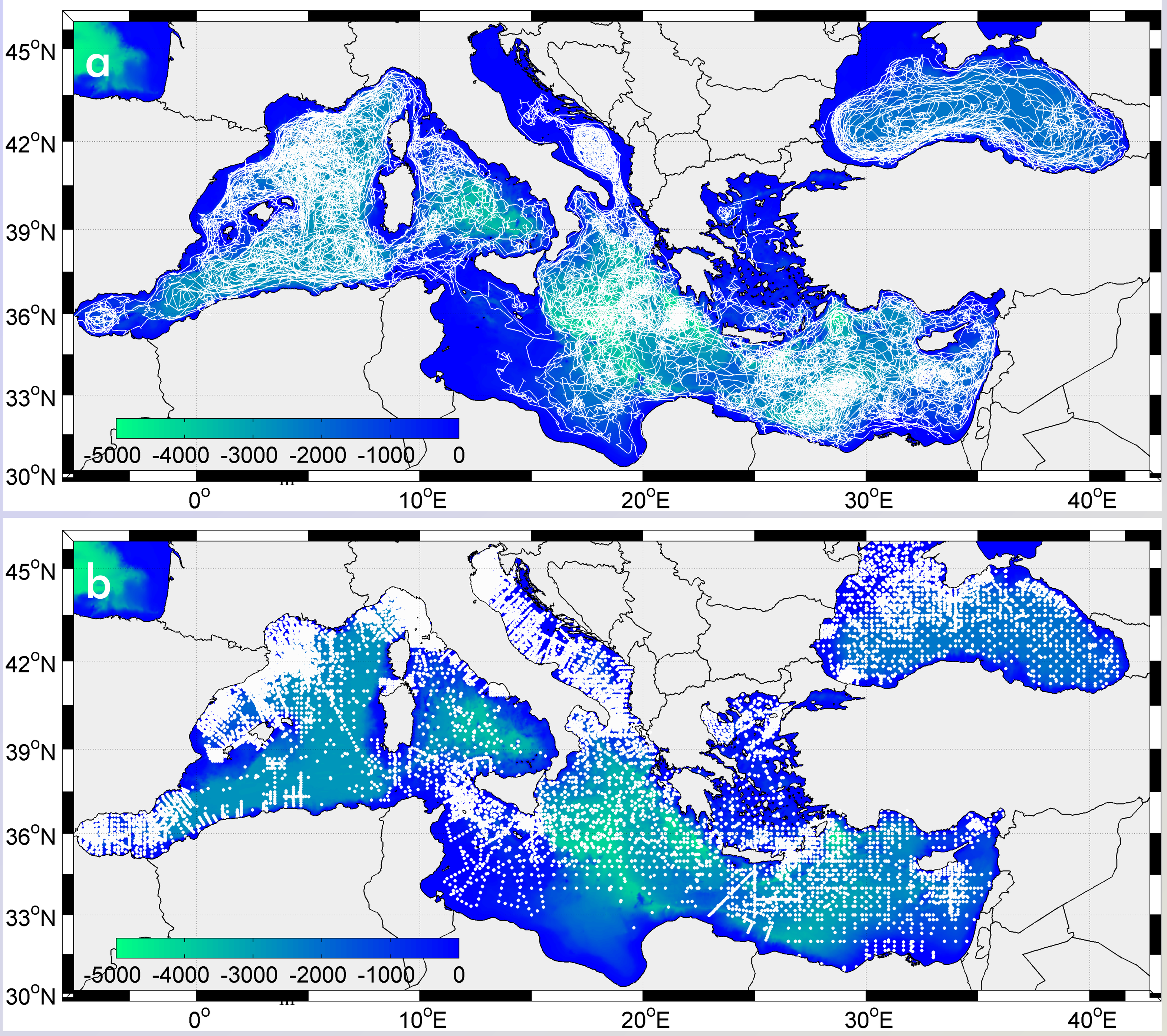

Figure 1. a) Trajectories of the Argo floats in the Mediterranean (2001-2015) and Black (2005-2015) Seas; b) Location of the MEDAR/MEDATLAS CTD stations.

1. Introduction

Temperature and salinity profiles derived from Argo floats (Fig. 1a) are used in conjunction with the MEDAR/MEDATLAS (Fig. 1b) and satellite altimetry data of sea level height, in order to describe the main characteristics of the geostrophic circulation in the Mediterranean and Black Seas.

Hydrographical data were linearly interpolated on standard pressure levels (i.e., [10 20 50 100 200 400 600 800 1000 1200 1400 1600 1800] dbar), then the CTD profiles were organised in pairs according to spatial and temporal criterions.

Altimetry-derived geostrophic currents were interpolated at the mean location and time of each pair of profiles and the geostrophic velocities relative to the surface currents were estimated using the thermal wind equation. These velocities were, therefore, divided in bins of 0.5°x 0.5° and the mean geostrophic velocity in each bin was estimated using a least-square method.

2. Results

In the Western Basin, the Northern Current (NC) extend vertically between the surface and the deep layer (Fig. 2); whereas the cyclonic circulation in the Liguro-Provencal basin involves the surface and the intermediate layers (Figs. 2a, 2b, 2c, 2d).

The Algerian Current (AC) show intense velocities (20-25 cm/s) at the 10 dbar depth (Fig. 2a), whereas it disappears below 200 dbar (Figs. 2d, 2e, 2f); intermediate and deep layers in the Algerian Basin are characterised by the Eastern and Western Algerian Gyres (AG1 and AG2, respectively; Figs. 2c, 2d, 2e, 2f), in agreement with [3].

In the Tyrrhenian Sea currents flow cyclonically above the 400 dbar depth (Figs. 2a, 2b, 2c); the Northern Tyrrhenian Eddy (NTE) is recognizable in the upper and intermediate layer (Figs. 2a, 2b, 2c, 2d, 2e).

In the Eastern Mediterranean the cyclonic signature of the South Adriatic Gyre (SAG) dominates the circulation of the southern Adriatic in the whole water column.

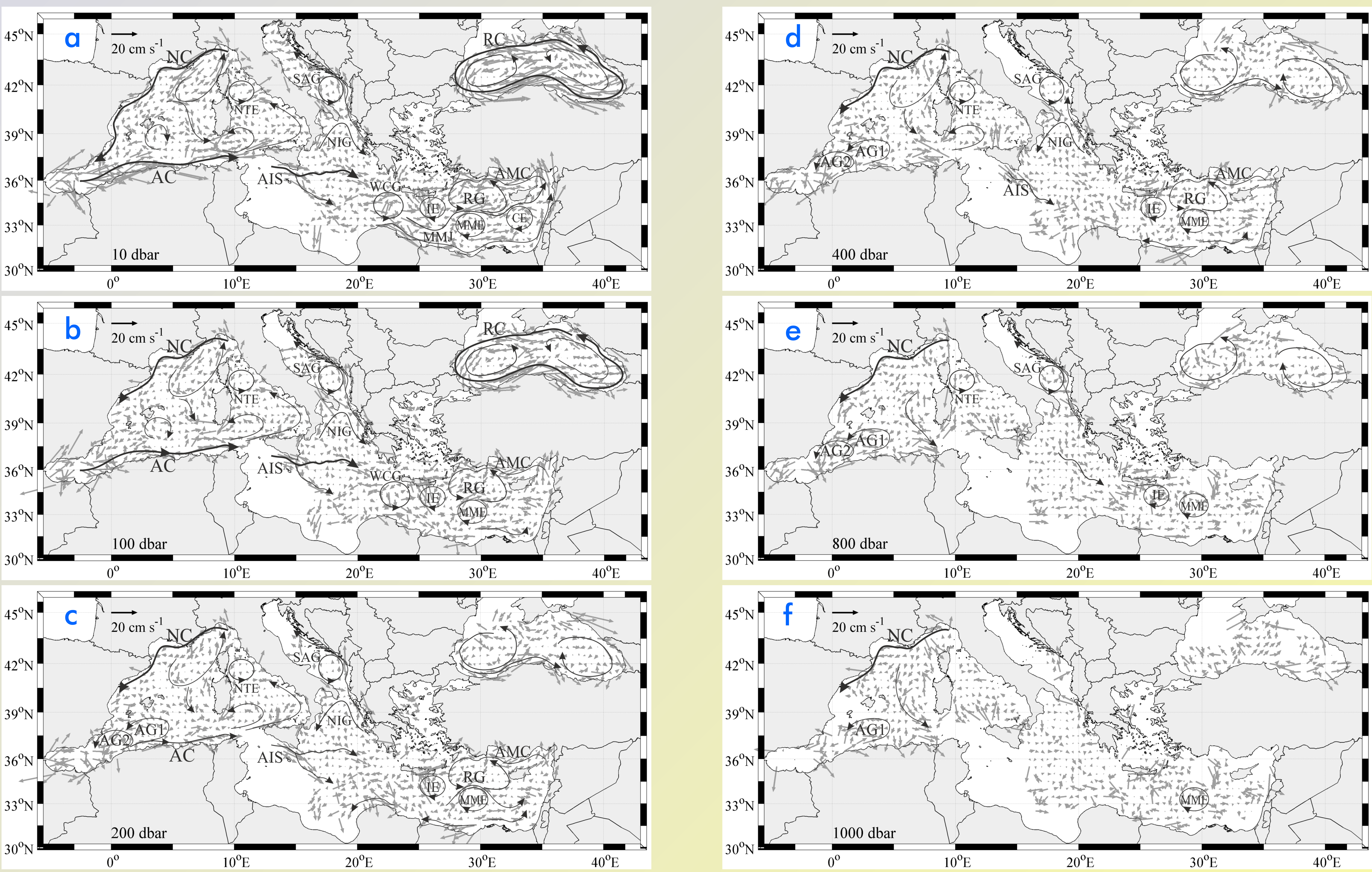

Figure 2. Mean geostrophic currents (gray arrows) in the Mediterranean and Black Seas at a) 10 dbar, b) 100 dbar, c) 200 dbar, d) 400 dbar, e) 800 dbar, f) 1000 dbar. The main currents and circulation features are emphasized with black arrows. The acronyms are defined in the text.

The Northern Ionian Gyre (NIG) shows an anticyclonic pattern in the surface layer (Figs. 2a, 2b) and a cyclonic one in the intermediate layer (Figs. 2c, 2d).

The Atlantic-Ionian Stream (AIS) shows intensities of 15 cm/s between the surface and the 400 dbar depth (Figs. 2a, 2b, 2c, 2d).

In the Levantine basin the Mid Mediterranean Jet (MMJ) and the Rhodes Gyre (RG) are clearly recognizable above the 400 dbar depth (Figs. 2a, 2b, 2c, 2d); the Mersa-Matruh (MME) and the Ierapetra Eddies (IE) show a deeper signature between the surface and 800-1000 dbar depth.

In the Black Sea, the basin-scale cyclonic boundary current (Rim Current- RC) dominates the surface circulation above 100 dbar depth (Figs. 2a, 2b) with typical velocities of 30 cm/s along the southern coast, and of 15-20 cm/s in the north, in agreement with [1] and [2]; in the interior of the basin the geostrophic currents define two cyclonic sub-basin eddies.

The RC is weaker in the intermediate layer (Figs. 2c, 2d) and the eastern sub-basin eddy flows anti-cyclonically, showing a reversal of the intermediate currents with respect to the surface.

The anticyclonic eddy persists between 200 dbar and 800 dbar depths (Figs. 2c, 2d, 2e).

3. Conclusions

The reconstruction of the geostrophic currents using Argo and altimetry data:

- Show the vertical extension of the main circulation features in the Mediterranean and Black Seas;
- Define a reversal of the intermediate currents with respect to the surface:
  - in the eastern basin of the Black Sea;
  - in the Northern Ionian Gyre.

References

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