Extremely high salinity in the water column of the South Adriatic Pit

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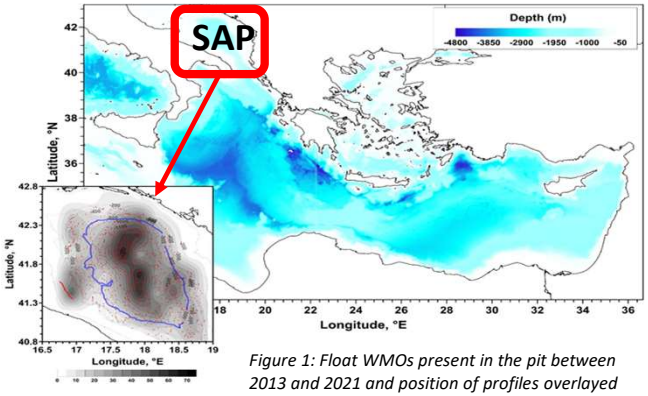


Figure 1: Float WMOs present in the pit between 2013 and 2021 and position of profiles overlayed on the bathymetry.

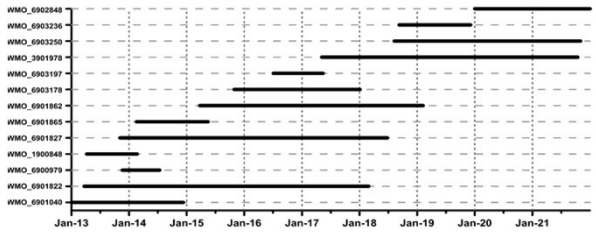


Figure 2: Float WMOs used in the time series.

The South Adriatic Sea is a site of deep-water formation processes and it is undergoing through drastic changes in salinity and temperature in the last years.

This study investigates the causes of the extraordinary increase of salinity and temperature in the Southern Adriatic using multi-platform approach: Argo float and Copernicus products.

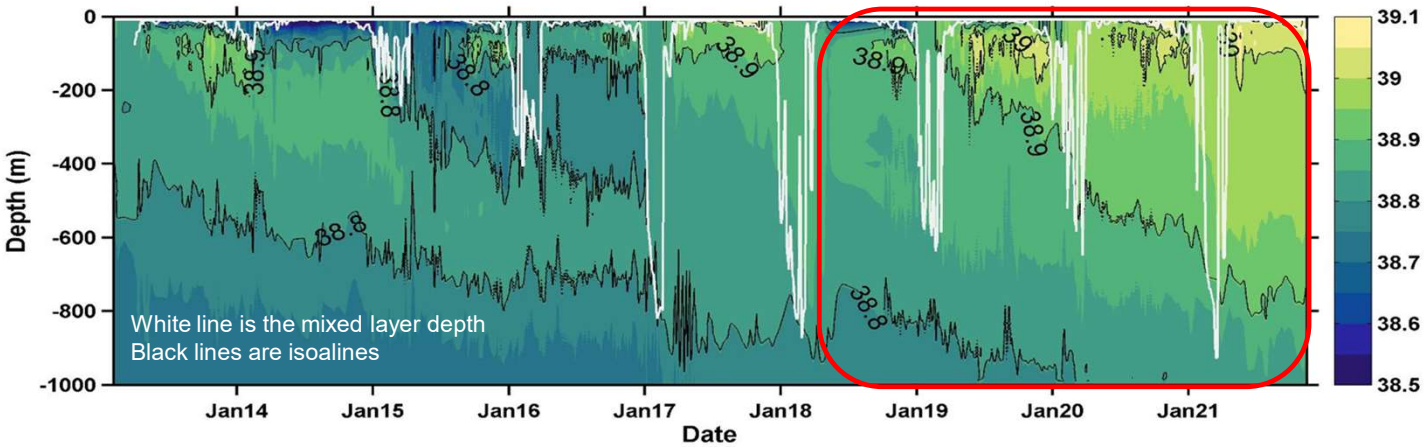


Figure 3: 2013-2021 salinity time series obtained from Argo floats in the South Adriatic Sea.

Argo float 2013-2021 time series in the Southern Adriatic Pit

The time series shows:

- drastic salinification in the subsurface extending into deeper layers, more evident after 2017
- a subsurface water mass (>39) saltier than the Levantine Intermediate Water (LIW usually present between 100-400 m) enters in the South Adriatic from 2019

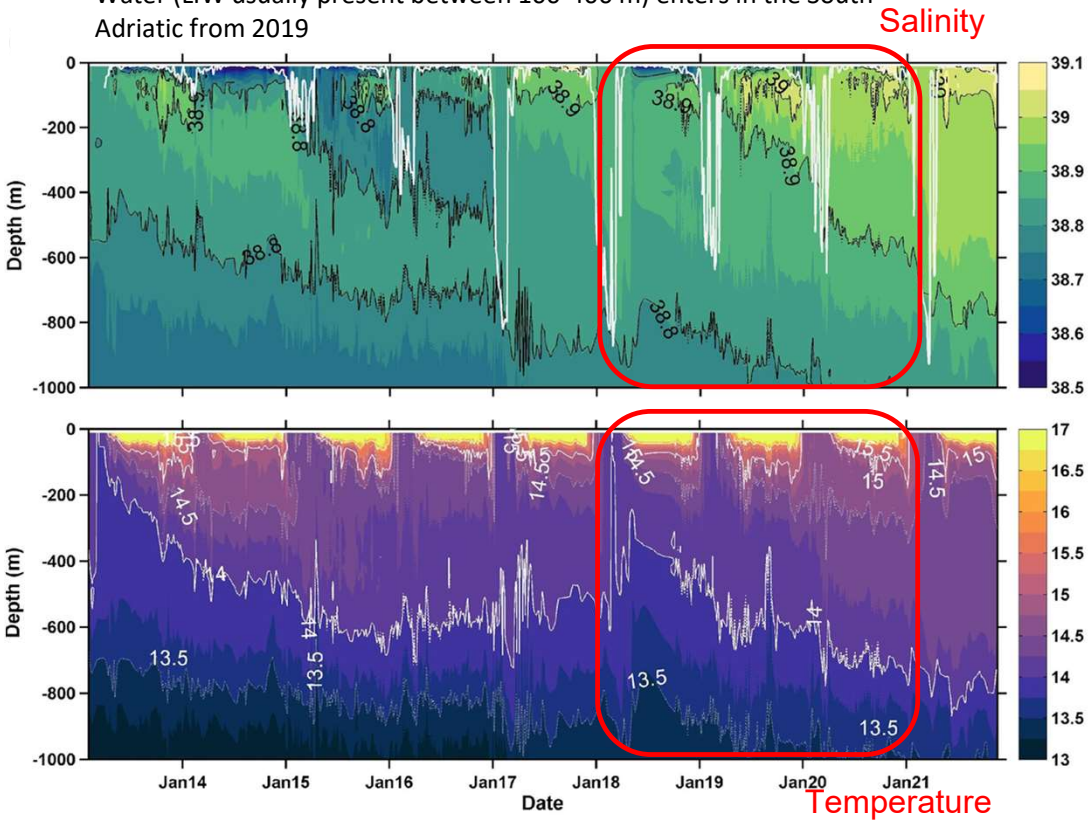


Figure 4: Salinity and temperature time series obtained from Argo floats in the South Adriatic Sea.

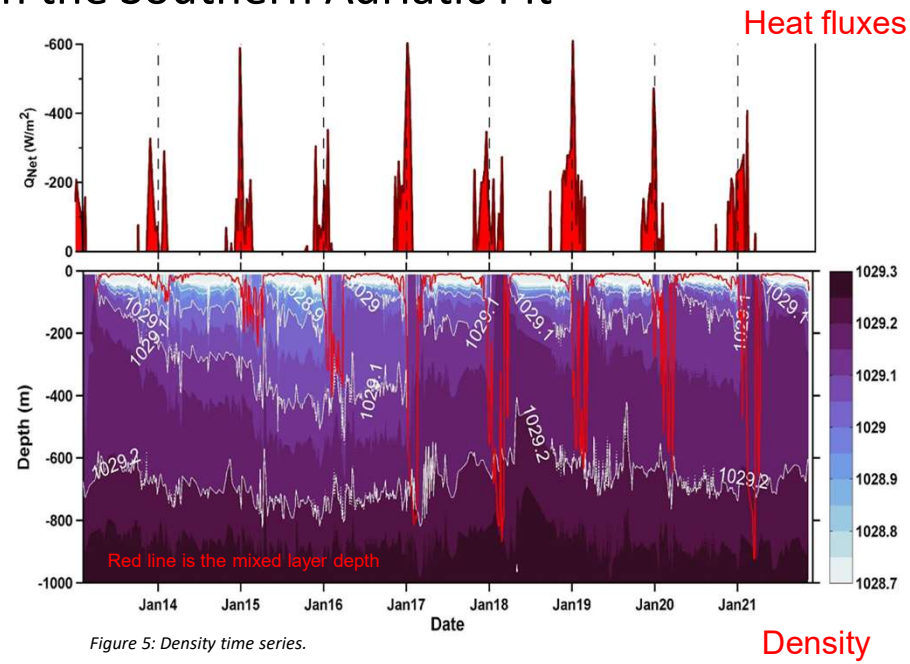


Figure 5: Density time series.

Salinity and temperature distribution are influenced by local weather conditions. Local heat fluxes are not tightly correlated with the intensity of the convection.

Temperature and salinity profiles are derived by 11 Argo floats:

- quality controlled in real-time using a set of predefined tests (Wong et al., 2022)
- different float profiles of the same day are averaged in a daily profile (https://doi.org/10.13120/bxf7-pb83)

Daily surface net heat fluxes are computed in the southern Adriatic (41.6°N- 42.5°N; 17°E-18°E) using the Copernicus Climate ERA5 hourly data on single levels (Copernicus climate data store, https://doi.org/10.24381/cds.adbb2d47). Mixed layer depth is computed following the criteria of de Boyer Montégut et al. (2004); based on two threshold methods: temperature (0.2°C) and σ_θ (0.03 kg/m^3).

Salinity maps

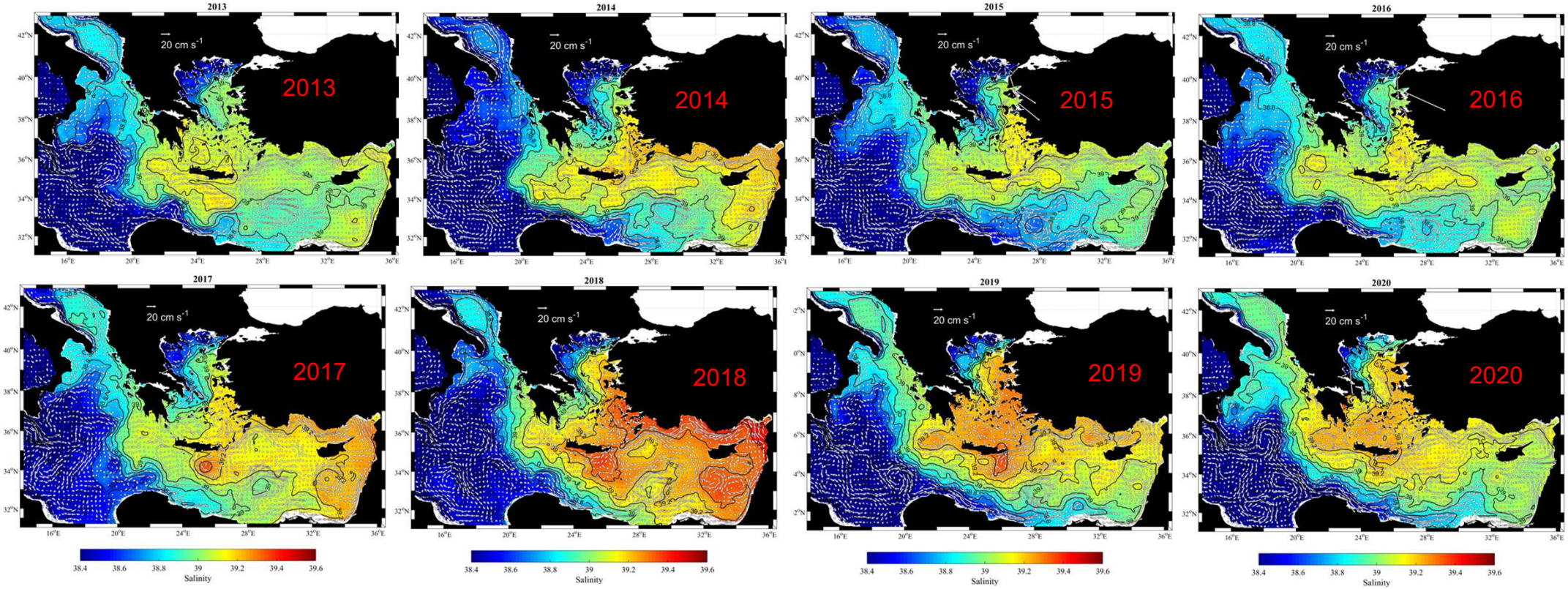


Figure 6: Annual salinity maps with geostrophic current derived from satellite altimetry overlayed for the Eastern Mediterranean Sea.

- Maps of salinity concentration at 50 m show an increase starting from 2017 in the Levantine Basin, and a reduction of low saline Atlantic water in the southern part of the Ionian and Cretan passage is evident.
- In 2018 the Levantine Basin is characterized by the highest salinity recorder in the studied period.
- After 2019 in the Levantine Basin the salinity decreases while in the Aegean Sea the salinity is still quite high covering a wider area of the basin.

Products used:
SEALEVEL_MED_PHY_L4_REP_OBSERVATION_008_051 and CMEMS MEDSEA_MULTIYEAR_PHY_006_004.
The method is descibed in Menna, et al. 2021

Argo float salinity data

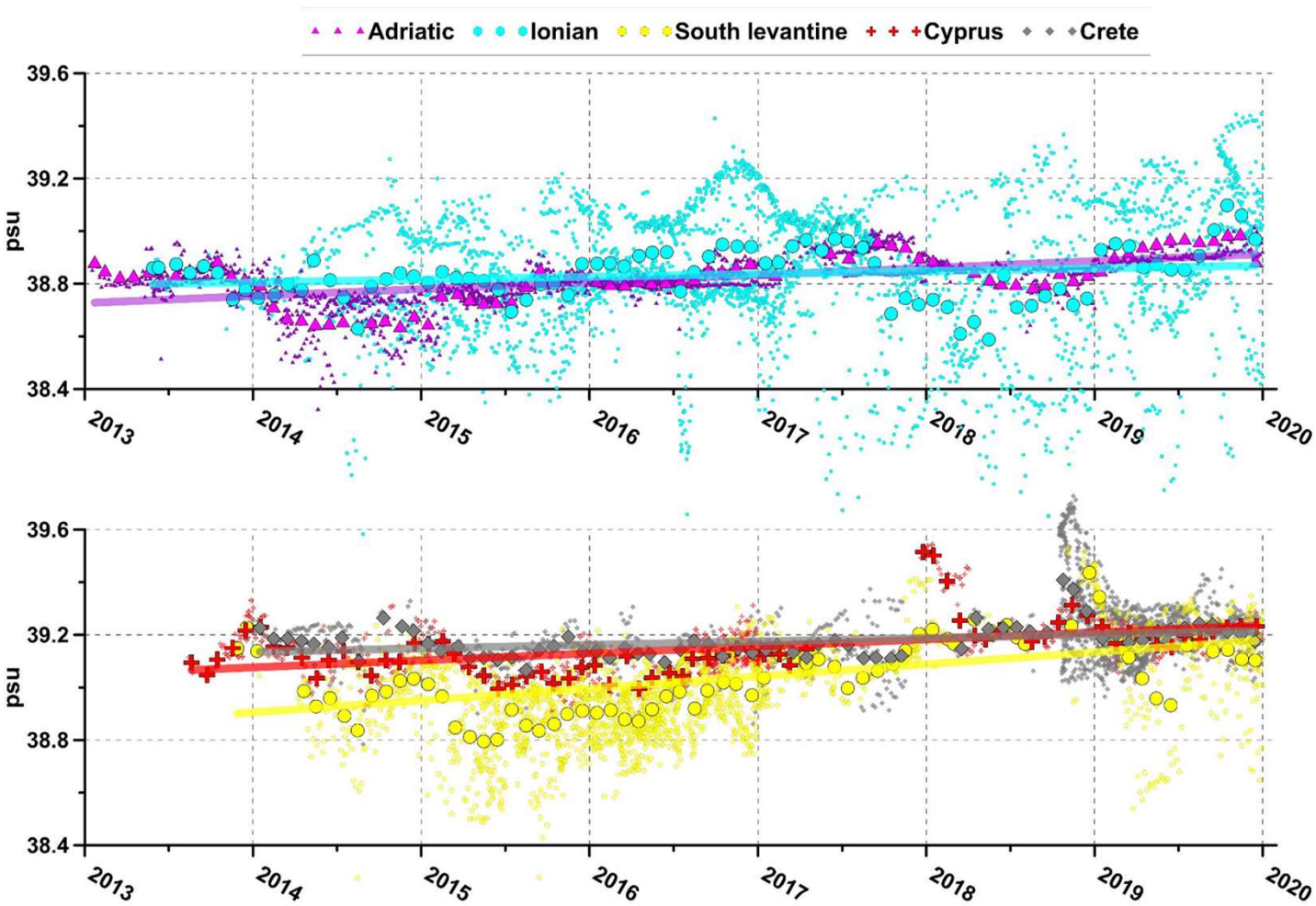


Figure 7: Argo float mean surface salinity integrated on 0-150 m depth. Small symbols are relative to each profile, large symbols refer to monthly salinity means. Symbols are colour coded by regions as shown in figure 8. Trendlines are computed on the monthly means.

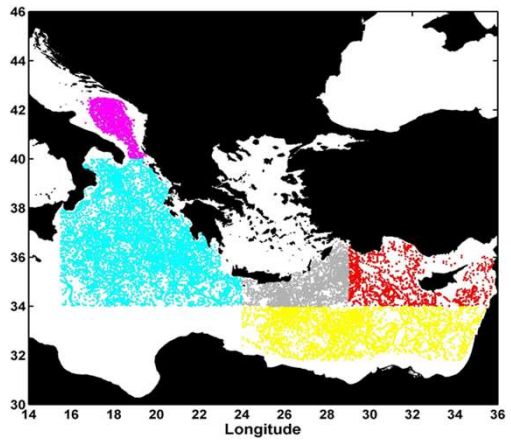


Figure 8: Maps of Argo float profiles in the five regions during 2013 and 2020.

- The five trendlines show an increase of salinity in the top 150 m in all regions.
- The Ionian region shows a wide salinity variability and the trendline a slightly lower increase then the Adriatic Sea.
- The trend in the Levantine Basin and Cyprus area is quite marked.
- The Cretan and Levantine sub-region show a peak of high values in 2019.

Total salt mass transports

- **Kythira and Antikythira**: 2019 to 2020 significant outflow after 2016 and 2017 low outflow
- **Cretan passage**: reduction of exchange between Ionian and Levantine Basin
- **Otranto Strait 0-200 m:** in the studied period, slight increase of salinity modulated by the seasonality
- **Otranto Strait 200-400 m:** after 2017 increase of salty advection probably due to the LIW ingression

The **Otranto Strait** two layers are chosen respectively as indicators of Cretan Intermediate Water (shallower) and Levantine Intermediate water.

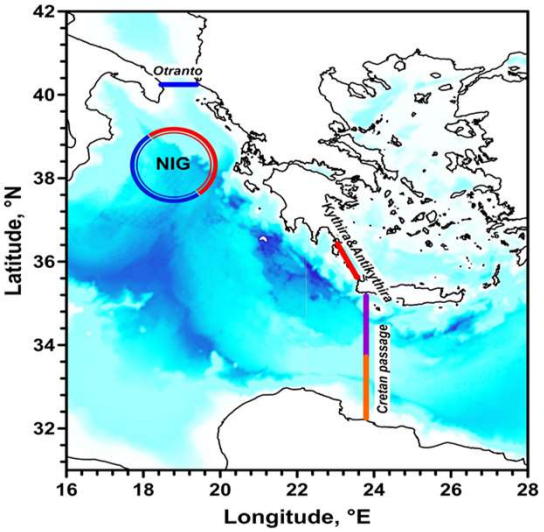
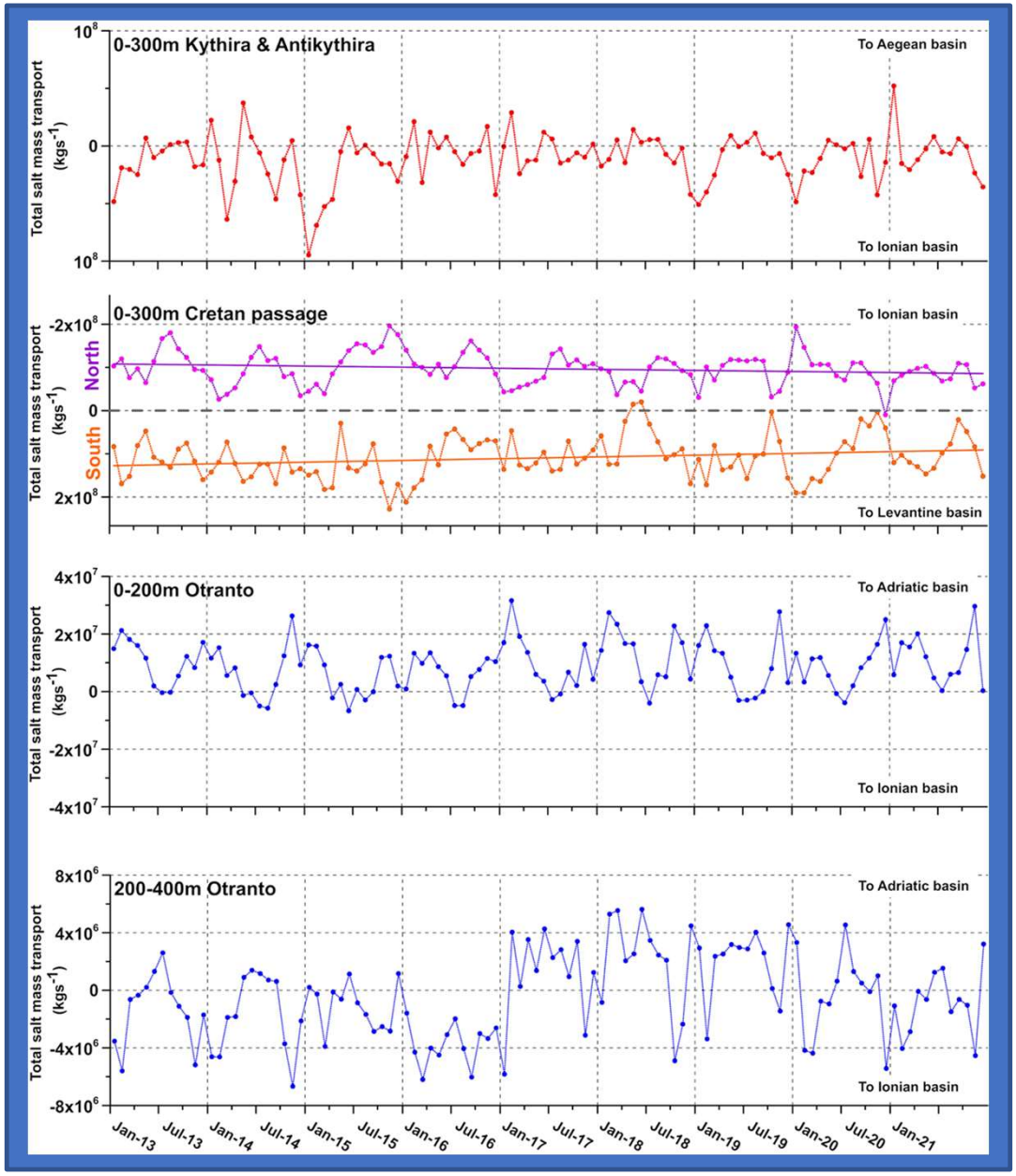


Figure 5: Maps of the central Mediterranean, Straits are indicated with colors

Salt transports through Kythira and Antikythira straits and Cretan Passage of the top 300 m and Otranto Streit split in two layers 0-200 and 200-400m. Monthly data from CMEMS catalogue are used to compute the transport using the Yari et al. 2012 method.



CONCLUSIONS

The large salinity increase in the surface and intermediate layers of the southern Adriatic Sea since 2017 has been observed. From an analysis of multi-platform data the preliminary results are the following:

- Local heat fluxes play a marginal role in salinification, while the advection from the south through the Otranto Strait has a major role;
- Salt transport through the Otranto Strait reveals that:

  Saltwater inputs at the surface follow a seasonal input
  Subsurface salt ingression is more continuous through the years

- The origin of salt increase in the south Adriatic appears due to the advection of very salty subsurface water created in the Levantine Basin during 2018 and of more salty water coming from the Aegean in 2019.
- The increase is visible in the South Adriatic with a time lag of a few years.