ONLINE SUPPORTING MATERIAL

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"**Ultraphytoplankton basin-scale distribution in the eastern Mediterranean Sea in winter: link to hydrodynamism and nutrients**" by Michel Denis, Melilotus Thyssen, Valérie Martin, Beniamino Manca, Francesca Vidussi

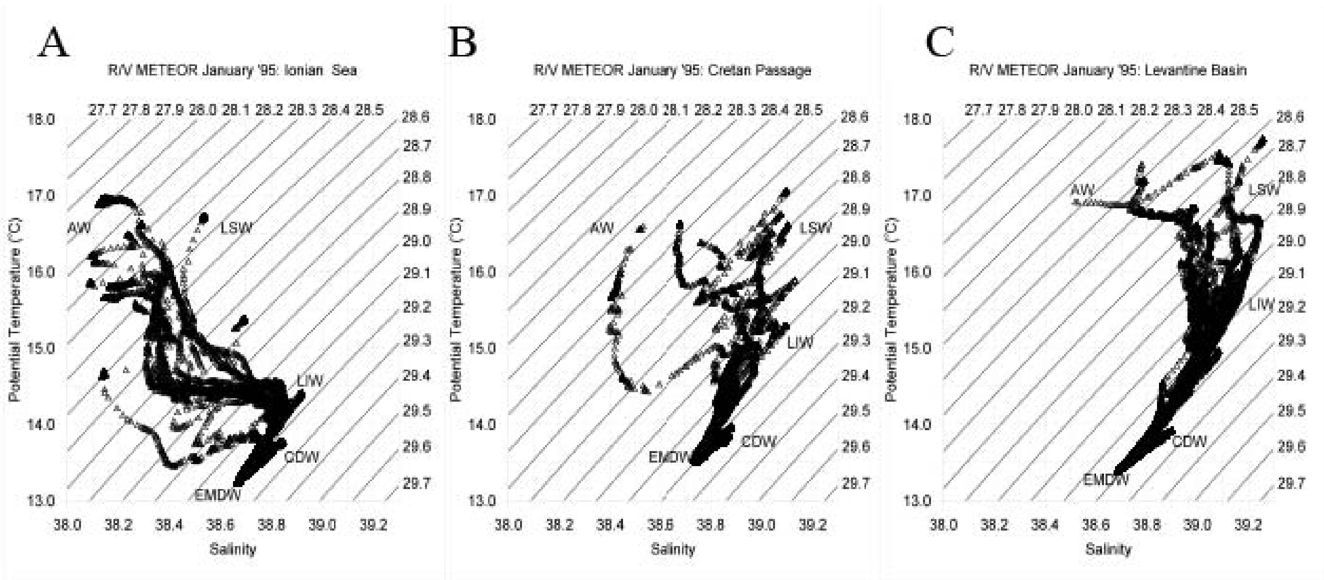

Fig. OSM1: θ/S Diagrams with CTD casts in the (A) Ionian basin (stations 7-14 and 20-29), (B) Cretan Passage (stations 30-34 and 44-51), and (C) in the Levantine basin (stations 52-77). The different water types discussed in the text are indicated by their acronyms. AW: Atlantic water; LIW: Levantine intermediate water; LSW: Levantine surface water; CDW: Cretan deep water; EMDW: eastern Mediterranean deep water.

Low salinity values indicate the AW that intruded into the Ionian basin through the Strait of Sicily, where it was characterized by S ≅ 37.5-38.0 and θ ≅ 15-16°C (not shown). In the Ionian basin (Fig. **OSM1**A), the AW had salinity and temperature values in the range from 38.1 to 38.4 and from 15°C to 17°C, respectively. As it moves eastward, it might be still recognized by low-salinities; in the Cretan Passage (Fig. **OSM1**B), relatively fresh waters were found at the southernmost stations, i.e. at stations 30, 49 and 50, with salinity in the range of 38.4 to 38.8 and above the isopycnal surface 28.8 kg·m^{-3}. This is a clear manifestation of the eastward flow pattern of the AW into the Levantine basin (Fig. **OSM1**C), where it may be still recognised by temperature of about 17°C and salinity in the range of 38.5-38.9, above the isopycnal 28.6 kg·m^{-3}. In the Levantine basin, higher salinities (S > 39.0) at surface indicate Levantine Surface Water (LSW), which results from the excess evaporation over precipitation and from the absence of fresh water from riverine inputs in this region. The LSW flowed westward through the Cretan Passage, where its salinity and temperature values ranged from 38.9 to 39.1 and 16.0°C to 17.0°C, respectively. The isopycnal 28.8 kg·m^{-3} separates the upper mixed layer from the layer below.

A strong halocline appears between the isopycnal surfaces 28.8 and 29.0 kg·m^{-3}, in particular in the Ionian basin, indicating the transition from the AW to the LIW, which is at deeper level, i.e. between 200 and 800 m. The LIW appears in the diagrams as a spur with salinities in the range of 39.2 to 38.8 and temperatures of 16.5°C to 14.5°C as it moves from the Levantine basin to the western Ionian basin.

In the deep layer, i.e. below the 29.17 $kg \cdot m^{-3}$, located at about 1000 m, water mass properties indicated a slow and steady decrease of the temperature and salinity towards the bottom, ascribed primarily to the presence of the EMDW of Adriatic origin; the abrupt changes in temperature and salinity in the very deep layer ($\sigma\theta > 29.2\ kg \cdot m^{-3}$) was due to the presence of the CDW recently overflowed throughout the Cretan Arc Straits into the central region all around the Crete island (Roether et al., 1996).

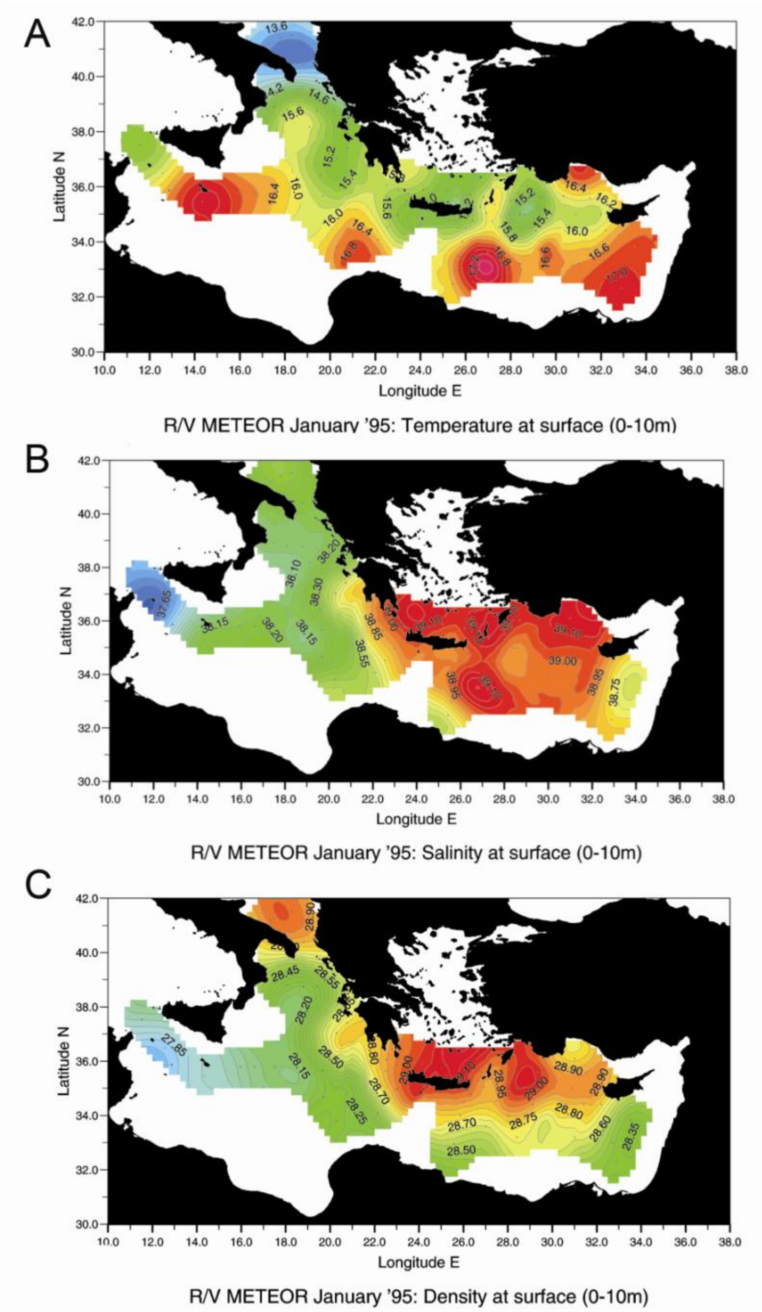

Fig. OSM2: Horizontal distribution of **(A)** temperature, **(B)** salinity and **(C)** density in the surface layer (data averaged over the interval 0–10 m) in January 1995.

The upper dynamics in the Ionian basin was dominated by a meandering current transporting anticyclonically AW into the northern Ionian basin and a strong meridional salinity front that separated AW on the west and LSW on the east (Fig. **OSM2**B). In addition, a sub-surface cyclonic eddy was centred at station 25, offshore the Greek mainland (Fig. **OSM2**C; $\sigma\theta > 28.8$ kg·m^{-3}). Cross tracks of temperature and salinity along the vertical have shown that this eddy was colder and saltier suggesting entrainment of highly saline water from the layer below.

In the Levantine basin, the excess evaporation over precipitation leaded to a large presence of the highly saline LSW, which dominated in the northern part of the Levantine basin and in the Aegean basin (Fig. OSM2B). The principal vein of the AW might be noticed in the south of the Cretan Passage and, getting progressively narrow, definitively entered into the Levantine basin along the African coast. Contrarily to previous situations depicted by Malanotte-Rizzoli et al. (1999) in 1991, when the AW was advected into the Levantine basin between the southern rim of the Rhodes gyre and the northern boundary of the complex Mersa-Matruh/Shikmona anticyclones, in January 1995 the AW was presumably ‘coastally trapped’ in a very narrow band along the African coast. However, the AW has been traced as far as in the eastern Levantine basin and entrapped in the anticyclonic Shikmona gyre (Fig. OSM2B). In spite of the winter season, the surface temperatures were characterized by relative high values (≅ 17°C) throughout the southernmost portion of the eastern Mediterranean Sea, that, in combination with low salinities ($S < 38.80$), created conditions of low density. On the other hand, lower temperatures and higher densities dominated in the northern region enhancing winter-time convection activities and mixing in those regions prone to intermediate and deep water formation. These features may be clearly seen in the horizontal distribution of temperature, salinity and density fields (Fig. OSM2A, B and C, respectively) in the centre of the Rhodes gyre, in the south Aegean basin (Cretan basin) and in the southern Adriatic basin. The coherent westward flow of the LSW from the Levantine basin into the western regions occurred through the northern side of the Cretan Passage and through the Straits of the Cretan Arc. From there the LSW could be found as far as in the eastern Ionian basin.

In the southern Adriatic basin, upon specific hydrographic conditions associated with winter outbreaks of cold and dry continental air from the eastern Europe, just as in other sites of the Mediterranean Sea, convective mixing and water column overturning were able to generate dense waters in the centre of the permanent and topographically controlled cyclonic gyre (Ovchinnikov, 1985). One of the most important prerequisite was the presence of the LIW, which lowers the density gradient in the sub-surface layer, allowing the exposure at surface of higher density water in the interior of the gyre. In January 1995, the winter cooling and subsequent deep convection set the properties of the water masses into the gyre towards rather low temperatures and high densities (Fig. OSM2A and C).

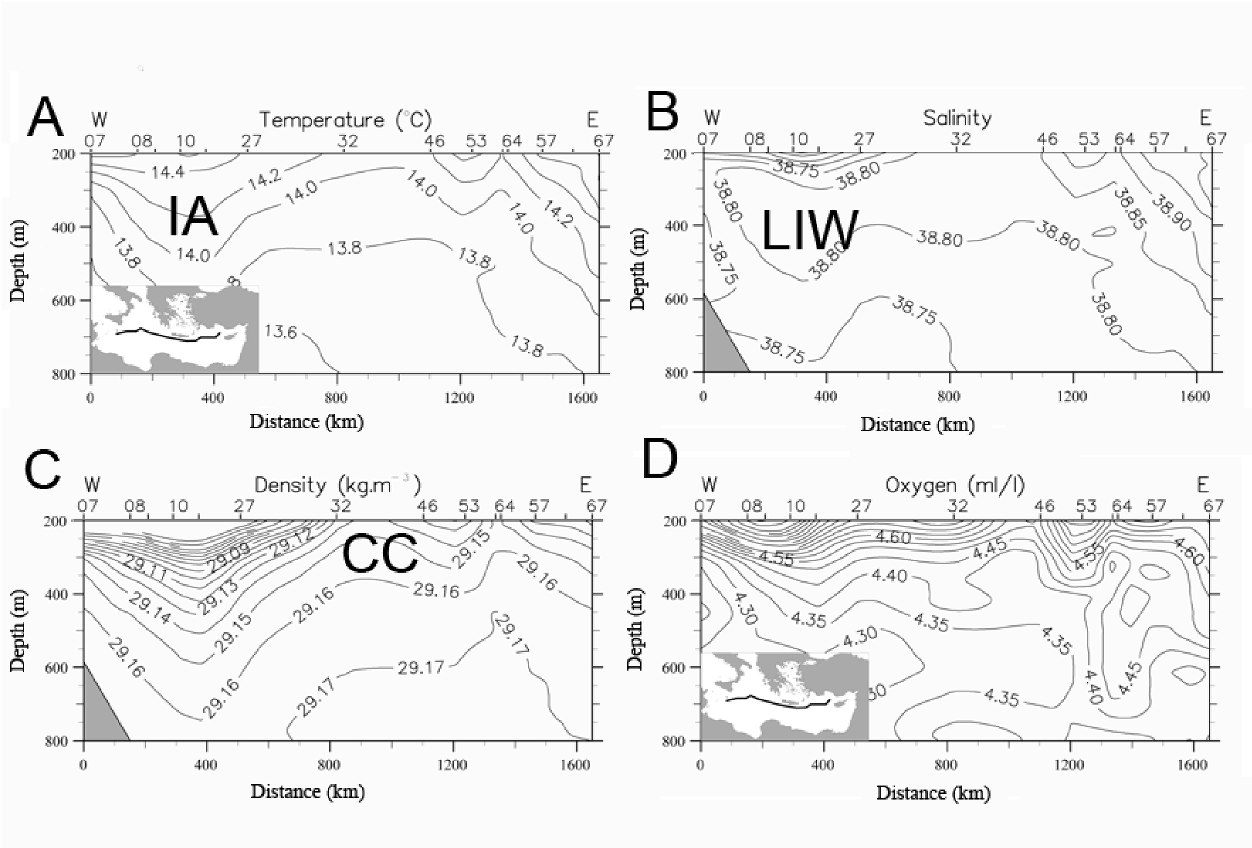

Fig. OSM3: Vertical distribution of (A) temperature, (B) salinity, (C) density, and (D) dissolved oxygen from 200 m down to 800 m along the cross section through the eastern Mediterranean Sea (see inset map) in January 1995. The position of the CTD stations is indicated at the top x axis. The positions of the Ionian Anticyclone (IA), the Cretan Cyclone (CC) and the Rhodes Gyre (RG) are also indicated.

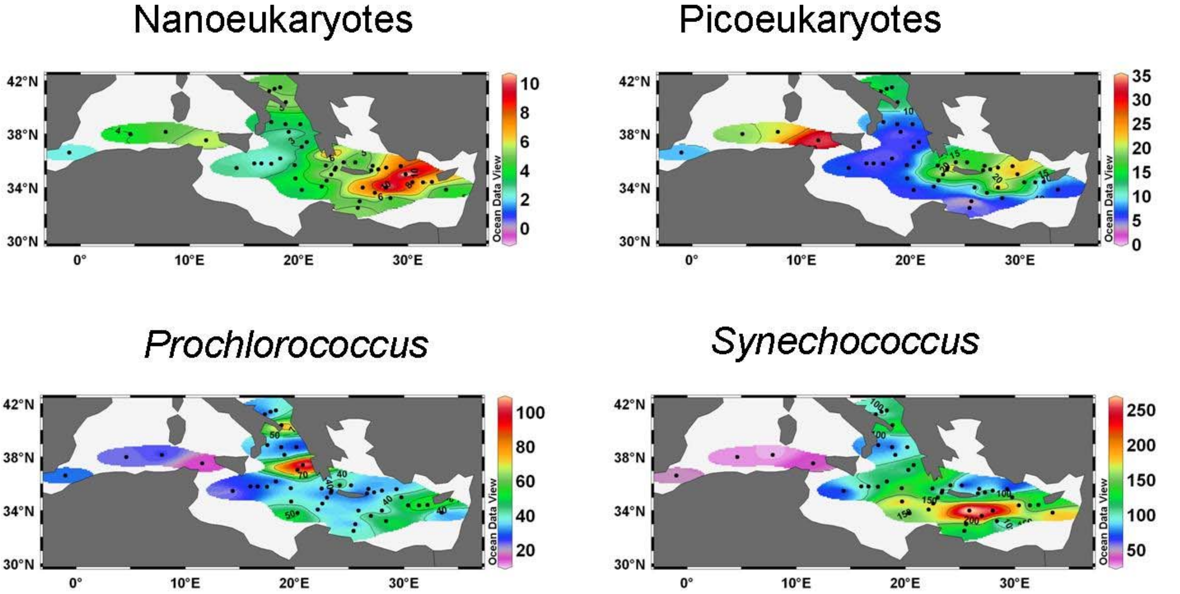

Fig. OSM4: Abundance distribution of ultraphytoplankton integrated between 0 to 200 m in the eastern Mediterranean Sea, namely nanoeukaryotes, picoeukaryotes, *Prochlorococcus* and *Synechococcus*. Values are expressed with, as unit, 10^{10} cells m^{-2}. Dots denote the sampled stations. Note that different abundance scales were used.

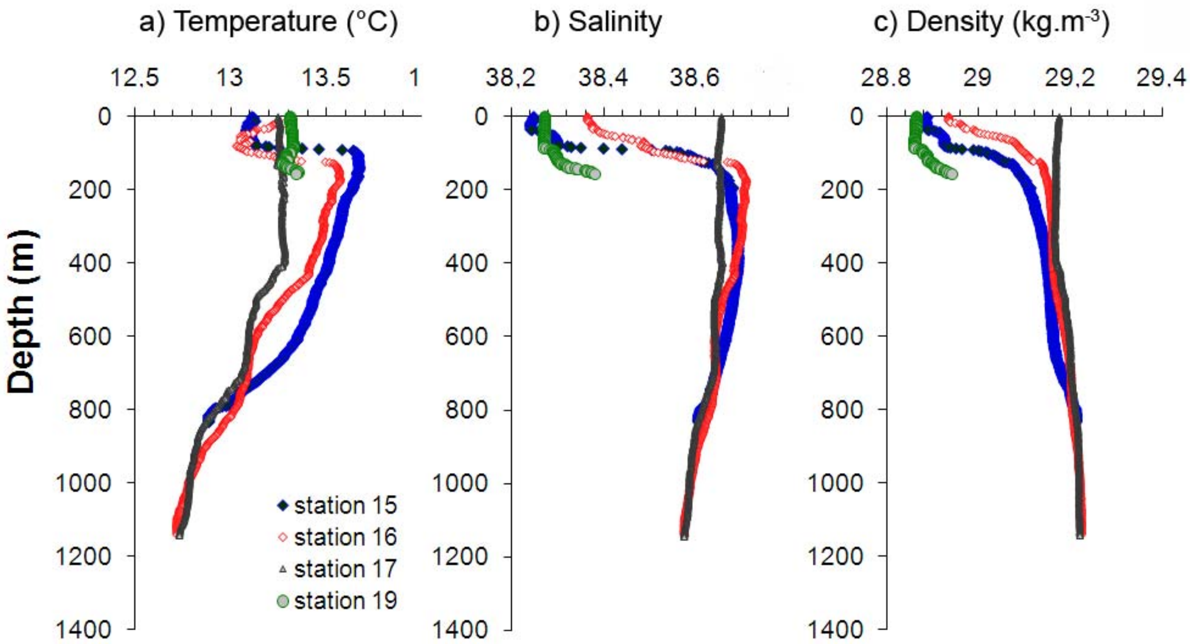

Fig. **OSM5**: Southern Adriatic basin features. Profiles of (A) temperature, (B) salinity, and (C) density excess for the stations located in the southern Adriatic basin and in the Strait of Otranto.

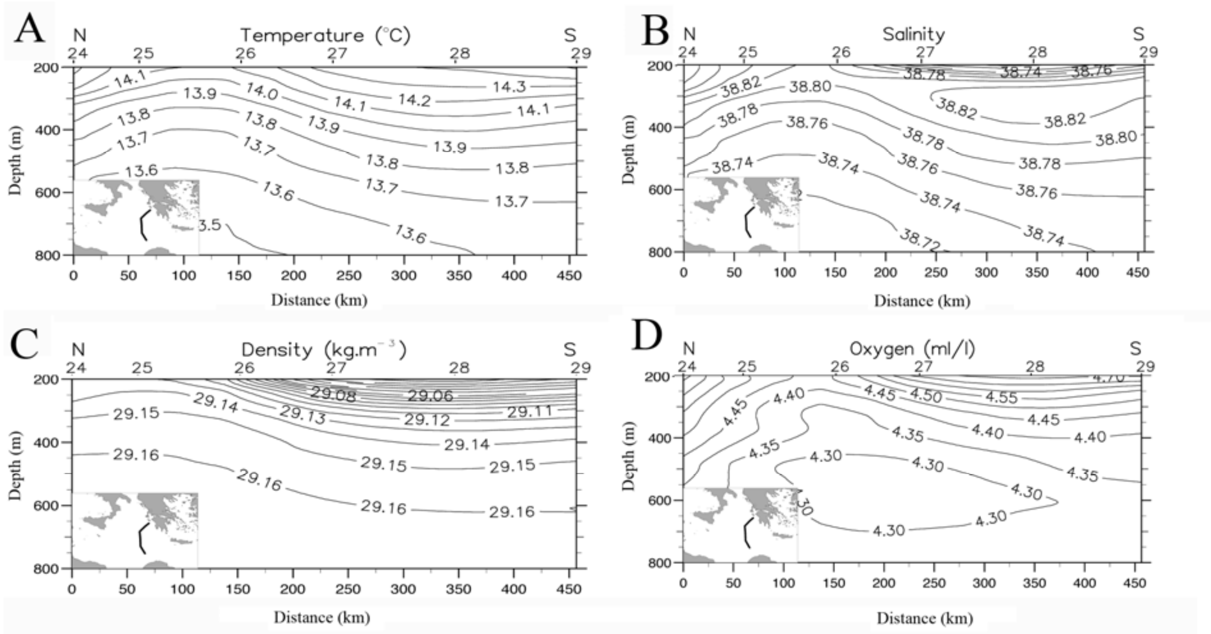

Fig. OSM6: Vertical distribution of (A) temperature, (B) salinity, (C) density and (D) dissolved oxygen along the north-south transect defined by stations 24 to 29. To note the presence of an eddy field establishing a thermohaline front located between stations 25 and 27.

References

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