

THE EASTERN MEDITERRANEAN IN THE 80'S AND IN THE 90'S: THE BIG TRANSITION EMERGED FROM THE POEM-BC OBSERVATIONAL EVIDENCE

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Abstract

The thermohaline circulation of the Eastern Mediterranean underwent a dramatic change between 1987 and 1995. In 1987 the "engine" of the Eastern Mediterranean "conveyor belt" was the convective cell of the Southern Adriatic, while in 1995 the active convective region moved to the Aegean Sea. This change actually started as early as 1991. The phenomenological evidence of the POEM programme shows that in 1987 the source of Levantine Intermediate Water (LIW) mass was the Levantine basin and the bottom water mass was formed in the Southern Adriatic. In 1991 all the intermediate/deep water masses on the horizons $\sigma_t = 29.00$ to 29.18 kg/m^3 were formed inside the Aegean sea, from which they spread out into the entire Eastern Mediterranean through the Cretan Arc Straits.

Key-words: circulation, deep waters, hydrology, Eastern Mediterranean

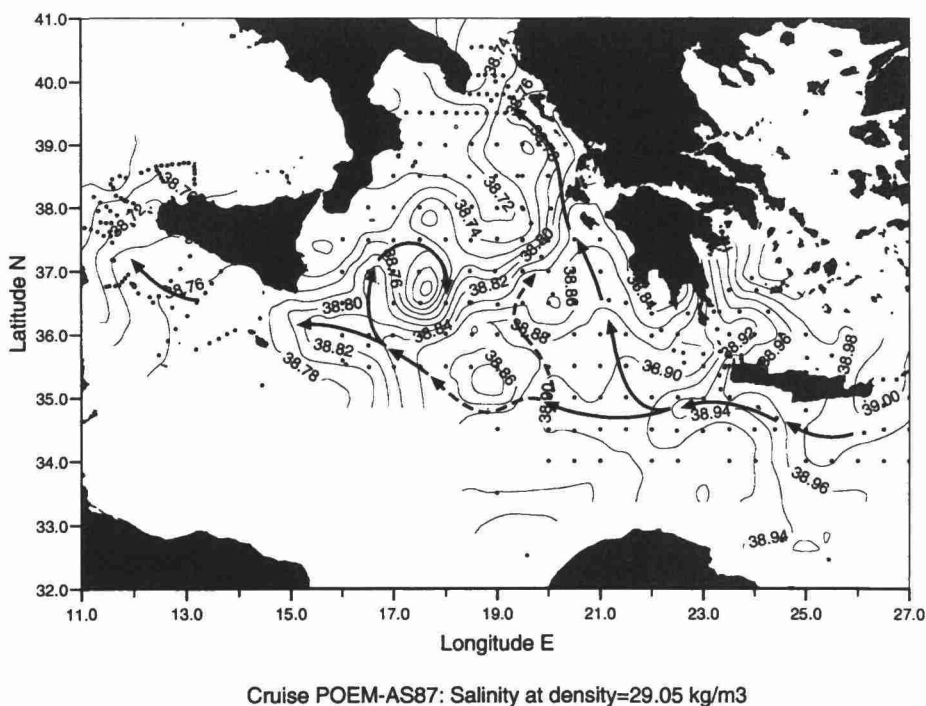
In the last decade the Eastern Mediterranean has been the object of the multinational collaborative programme P.O.E.M. (Physical Oceanography of the Eastern Mediterranean) sponsored by UNESCO, IOC and CIEM. Under this programme a series of general hydrographic surveys was carried out by the R/V of Greece-Israel-Italy and Turkey in the period 1985-1987, culminating in POEM-AS87 in which the German R/V *Meteor* covered the entire Eastern Mediterranean with a basin-wide station network. In 1987 the regular CTD surveys were implemented by a transient-tracer survey (1). The observational dataset collected in these surveys was intercalibrated, pooled and distributed to all the participating scientists in a series of UNESCO sponsored workshops. The joint analyses and interpretation led first to a group paper summarizing the new findings that included extended modeling results (2); second a special issue of Deep-Sea Research was devoted to this POEM-Phase 1 research (3). Recently, the entire POEM-Phase 1 dataset has been revisited for the Ionian sea with an in-depth complete reanalysis that has led to important new findings (4). These include the first detailed definition of the upper thermocline circulation in the Ionian sea, with the discovery of the strong Mid-Ionian Jet (MIJ) crossing the basin interior in north/south direction and then becoming the Mid-Mediterranean Jet (MMJ); and the first definition of the pathways of the intermediate LIW and of the Eastern Mediterranean Deep Water (EMDW).

In 1990 POEM evolved into POEM-BC (Biology and Chemistry) a fully interdisciplinary programme, with the major overall objective of establishing the phenomenology of the 90's for the chemical and biological parameters together with a reassessment of the phenomenology of the physical properties, contrasted to that of the 80's, (POEM-Phase 1). The first interdisciplinary multi-ship general survey of the entire basin was carried out in October 1991, POEM-BC-O91, followed by a more restricted survey in April 1992 (the Ionian basin only) and a final basin-wide survey by the R/V *Meteor* in January 1995, with a second transient tracer network of stations. This was part of the LIWEX experiment aimed to investigate the successive phases of the LIW formation and concentrated in the Northern Levantine region of the Rhodes gyre during the successive months, February through April 1995. The analysis of the *Meteor* cruise, including the transient tracer observations revealed a very important, dramatic change in the deep thermohaline circulation, the Eastern Mediterranean "conveyor belt". Specifically, in 1987 the driving engine of the deep, closed thermohaline cell was the Southern Adriatic, where deep convection leads to the formation of the Adriatic Deep Water (ADW) that exits from the Otranto Straits, becomes EMDW and spreads throughout the eastern Levantine in the bottom layer. General

upwelling to the intermediate transitional layer (below 1,000 m) provides the return pathways to the Southern Adriatic closing the cell (1). In winter 1995 the situation was completely different: the engine of the deep thermohaline circulation was now the Aegean sea, with deep, denser water masses exiting from the Cretan Arc Straits, spreading throughout the entire basin and pushing to the west, while simultaneously lifting, the less dense EMDW of southern Adriatic origin (5).

We present here the first observational evidence that this dramatic change in the Eastern Mediterranean circulation actually started in 1991 and involved not only the deep water mass pathways but the intermediate ones as well, specifically the LIW origin and pathways. This evidence is based on the first joint analysis of the POEM-BC-O91 general survey. This analysis revealed first that the upper thermocline circulation (upper ~250 dbar) was actually extremely similar in the 80's and 90's. Most important the MIJ, emanating from the Atlantic Ionian Stream (AIS) entering the Sicily Straits, is quite strong, crossing the Ionian interior from North to South and surrounding a general anticyclonic region in the Southwestern Ionian both in the 80's and 90's. Recent results based on drifter observations confirm the persistence of the MIJ from the 80's throughout 1995-96 (Poulain, personal communication).

On the other hand, a dramatic change is observed from 1987 to 1991 in all the intermediate and deep water mass pathways. In 1987 the LIW was formed in the proper Levantine basin, entered the Cretan



Cruise POEM-AS87: Salinity at density= 29.05 kg/m^3
Figure 1 - Distribution of salinity at the 29.05 kg/m^3 isopycnal horizon during August-September 1987 survey.