ON THE FUTURE OF THE EASTERN MEDITERRANEAN TRANSIENT

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Abstract

The evolution of the Eastern Mediterranean Transient (EMT) to date has been documented in some detail. Presently, the deep waters are still in a transient state, with salinity distinctly enhanced relative to the classical situation. It is argued that, because of this, of long time scales of deep-water recirculation, and of expected climatic changes, transient conditions in the deep waters will prevail for a long time, with even an uncertain outcome. This contrasts strongly with the quasi-equilibrium situation that prevailed during the pre-EMT era.

Keywords: Eastern Mediterranean, Global Change

While our 1987 Meteor observations confirmed the classical view how the thermohaline system of the Eastern Mediterranean operated [1], the 1995 cruise (both cruises under the POEM umbrella) revealed the entirely disturbed situation [2] now known as the EMT. Dominant EMT features were a T-S inversion in the deep waters and a highly increased salinity over much of the water column, most strongly so below the inversion. A rather steady but far more moderate salinity increase was found also prior to the EMT (Fig. 1). However, T and S were always found to decrease with depth without any positive evidence of an inversion. The evolution after 1995 was further monitored by Meteor cruises in 1999 and 2001. The hydrographic observations (by OGS) together with our own tracer data and much information from other work revealed many remarkable features. One was the Aegean dense-water outflow in 1993 averaging as high as 3 10^6 m^3/s (3 Sv), related to isopycnals being raised by several hundred meters. The density of the Aegean-derived deep waters (referenced to an appropriate isobar) was hardly different from that of the classical Adriatic outflow [3]. Presently the deep waters are still far from an equilibrium state, and how the Eastern Mediterranean's thermohaline circulation will be organized in the long run is an open question.

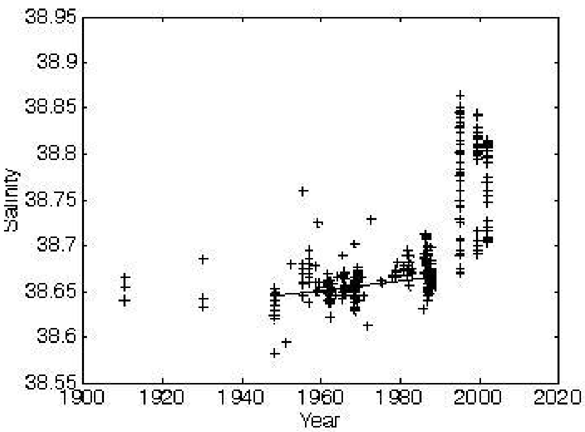

Fig. 1. Eastern Mediterranean salinities below 2000 m depth, 1910 – 2001 (courtesy B. Klein). Much of the scatter in the early data is measurement noise. The straight line is a linear fit to the pre-EMT data since 1948.

In this context, I address a potential paradigm change: During the period from the first observations (1910) up to the 1980s a quasi-equilibrium prevailed, proving to be basically stable against whatever disturbances occurred. The Adriatic acted as the principal deep-water source while the Aegean added to its preconditioning [3]. The deep waters generated formed one coherent cell of lateral spreading and upwelling. This structure was completely disturbed by the EMT (since about 1990), with the Aegean dwarfing the Adriatic as the deep-water source. It appears that the EMT was a unique event, brought about by accidental coincidence of a number of factors. After 1995, decreasing density restricted the Aegean outflow waters to mid-depths, which eventually enabled the Aegean to precondition the Adriatic again. However, a further ingredient is inclusion of upwelling deep waters. As its salinities distinctly exceed the pre-EMT values, the inclusion tends to raise salinity and density of deep waters newly formed. Considering that deep-water transports are governed by minute density differences, it is clear that such changes will modify the depths to which such waters penetrate and also their circulation pathways. The salinity increase has been highest in the Levantine deep waters, so that the effect will be strongest in the Aegean, which might help inducing another Aegean event. Reaching the Adriatic implies a delay on the order of 100 years [4], which, together with varying pathways and assisted by the moderate deep-water volume relative to those of the ocean at large, might induce oscillation. On such time scale, further salinity enhancement will arise from the expected regional decrease in precipitation [5]. I conclude that the deep waters will continue to be transient for a long time, and that even the outcome cannot be predicted with certainty.

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