Interannual variability of dense water formation in the Mediterranean sea

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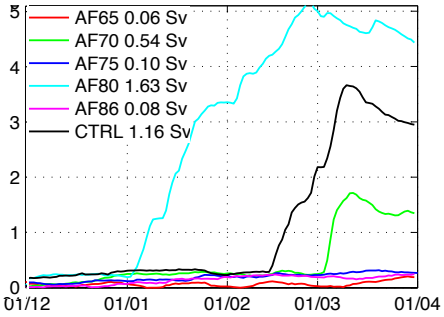
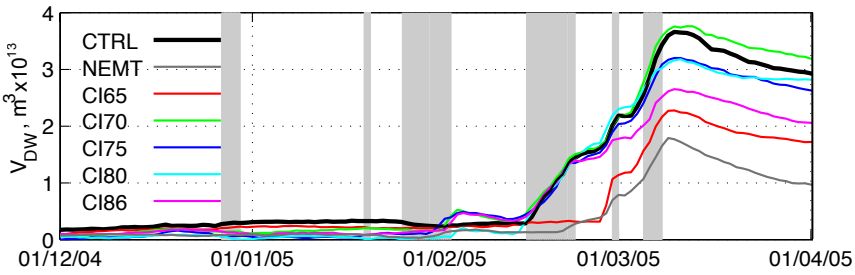
Open-sea convection occurring in the northwestern Mediterranean basin (NWMED) is at the origin of the formation of Western Mediterranean Deep Water (WMDW), one of the main Mediterranean water masses. During winter 2004–2005, a spectacular convection event occurred, observed by several experimental oceanographers. It was associated with an exceptionally large convection area and unusually warm and salty WMDW.

Explanations were proposed tentatively, relating the unusual characteristics of this event to the Eastern Mediterranean Transient (EMT) that occured two decades earlier in the Eastern basin, or to the atmospheric conditions during winter 2004–2005 in the NWMED. They could, however, not be supported until now. Here we used numerical modeling to understand what drove this convection event.



Evolution of dense water volume ($10^{13}m^3$) with initial conditions of autumn 2004 and atmospheric forcing of years 65 to 86 (AF..) and 2004-05 (CTRL)

The control simulation performed with NEMOMED8 for the period 1961–2006 reproduces correctly the long-term evolution of the Mediterranean Sea circulation, the EMT, and the NWMED convection event of 2004–2005. Sensitivity simulations were performed to assess the respective contributions of atmospheric and oceanic conditions to this event. They show that winter buoyancy loss is the major factor driving the intensity of deep convection, and that the initial autumn stratification of the water column is a second order factor. The weakness of the winter buoyancy loss since 1988 in the NWMED prevented strong convection to occur during the 1990s, enabling heat and salt contents to increase in this region. This resulted in the change of WMDW characteristics observed in 2005. The strong buoyancy loss of winter 2004–2005 was responsible for the intensity of the convection observed this winter in terms of depth and volume of newly formed WMDW. The EMT did not fundamentally modify the convection process but potentially doubled this volume by inducing a deepening of the heat and salt maximum that weakened the preconvection stratification.



Evolution of dense water volume ($10^{13}m^3$) with atmospheric conditions of winter 2004-05 and initial conditions of years 65 to 86 (CI..), 2004-05 (CTRL) and not taking EMT into account.

Read more about this study : Herrmann et al. (2010). What induced the exceptional 2005 convection event in the northwestern Mediterranean basin? Answers from a modeling study, J. Geophys. Res., 115, C12051, doi:10.1029/2010JC006162.

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Beuvier et al. (2010). *Modelling the Mediterranean Sea interannual variability over the last 40 years: focus on the Eastern Mediterranean Transient (EMT)*. J. Geophys. Res., 115, C08017, doi:10.1029/2009JC005950

Schroeder et al. (2010). *Abrupt warming and salting of the Western Mediterranean Deep Water:* atmospheric forcings and lateral advection. J. Geophys. Res., 115, C08029, doi:10.1029/2009JC005749

Herrmann et al. (2008). Impact of interannual variability and climate change on dense water cascading in the Gulf of Lions. Continental Shelf Research, 28 (15), 2092-2112, doi:10.1016/j.csr.2008.03.003