Project: 1190
Project title: JPI Oceans / JPI Climate project ROADMAP
Principal investigator: Dr. Daniela Matei
Allocation period: 2026-01-01 to 2026-12-31

Achievements in 2026

The subpolar gyre bridges AMOC variability with European summer heat extremes

In the previous report we indicated that a dipole pattern in North Atlantic sea surface temperature (SST) anomalies (with cold anomalies in the subpolar region; in the following referred to as deltaSST) favours atmospheric conditions leading to extreme summer heat waves over Europe.

In the current allocation period, we have refined the analysis and demonstrated that as deltaSST strengthens, summers tend to exhibit more frequent and persistent European heat waves. In contrast, heat wave intensity is less well captured by deltaSST. These results indicate that deltaSST primarily modulates persistence and recurrence of summer heat waves rather than their peak intensity.

We further identify summers characterized simultaneously by a strong deltaSST and long heat wave duration (referred to as enhanced HW-summers) as well as summers characterized simultaneously by a weak deltaSST and limited heat wave duration (referred to as suppressed HW-summers). Enhanced-HW summers (left panel in Figure 1) are characterized by pronounced subtropical North Atlantic warming co-occurring with strong subpolar cooling, resulting in an intensified thermal contrast. These SST anomalies are accompanied by strengthened surface winds over the northwestern Atlantic and anomalous northward-deflected flow over western Europe. The latter promotes a poleward displacement of the eddy-driven jet, reducing moist-air advection into Europe and favouring dry, persistent summer circulation regimes. In contrast, suppressed-HW summers (middle panel in Figure 1) exhibit substantially weaker subtropical warming and a reduced thermal contrast. These summers are associated with anomalously strong westerly flow over central Europe, favouring enhanced moist-air transport into the continent and reduced heat wave persistence. The difference composite (right panel in Figure 1) highlights the regions where the two circulation states diverge most strongly, with statistically significant warm SST anomalies over the subtropical region, Mediterranean Sea and North Sea during enhanced-HW summers.

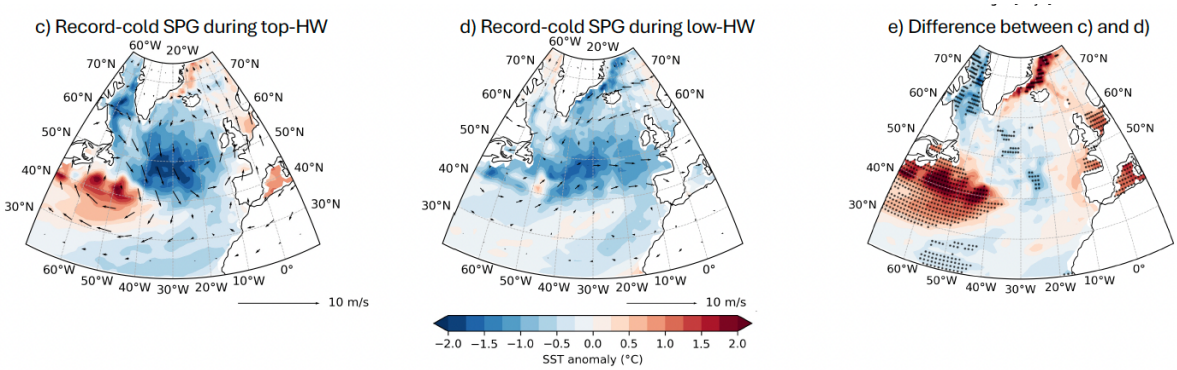


Figure 1: Left panel: Composite map of JJA SST anomalies (shaded contours) and surface wind anomalies (vectors) for enhanced HW-summers. Middle panel: Same as left panel but for suppressed HW-summers. Right panel: Difference between left and middle panel. From: G.

Cerato, K. Lohmann, J. v Hardenberg, K. Bellomo and D. Matei: The Subpolar Gyre bridges AMOC Variability with European Summer Heat Extremes. Submitted to NPJ Climate and Atmospheric Science.

Long-term archiving of ocean-eddy-resolving experiments performed within project bm1190

To fulfill publication requirements and as ocean-eddy-resolving simulations are very costly, the set of ocean-eddy-resolving simulations performed within project bm1190 is currently moved to the long-term archive. This set encompasses the so-called assimilation run 1990 – 2018 (used to initialize hindcast prediction experiments), twenty hindcasts initialized in November 2014 and ten hindcasts initialized in November 2013 as well as multi-year initialization hindcasts initialized every other year between 1992 and 2012 (for bias-correction of 2013/14 hindcasts). As preparation for long-term archiving, the raw data of these experiments need to be retrieved from archive and corrected for double output (stored in tar-files by mistake).

Progress in the long-term archiving of the bm1190 ocean-eddy-resolving experiments has been slower than expected due to personal constraints as well as a change in the archiving software in summer this year, causing unavailability of archive for some time and the need to learn the new software and to adapt the retrieval scripts.

The status at hand-in of this report is that the raw data of the assimilation run have been retrieved from archive, corrected for double output and will be moved to long-term archive by DKRZ staff within the next weeks. Long-term archiving of the raw data from the hindcasts will go on within the next weeks, but will extend into 2027 (see application).