Interannual Variability of the Mediterranean Overflow Water from 2005 to 2016

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BACKGROUND

- The Mediterranean Outflow Water (MOW) is an important contributor to the heat and salt content of the North Atlantic, and has an impact on the variability of the Atlantic Meridional Overturning Circulation (AMOC);
- Oceanic and atmospheric fluctuations such as the North Atlantic Oscillation (NAO) and El Niño-Southern Oscillation (ENSO) have been found to have an important role for the net evaporation and wind pattern over the Mediterranean basin;
- The main objectives are to examine the properties of the MOW and assess the impacts of interannual climate modes (e.g., NAO, ENSO). The interannual variability of the MOW and its driving mechanisms are to be investigated with a dynamically consistent ocean state estimate – ECCO v4.

MAIN CHARACTERISTICS: Between ECCO and Argo

- The performance of ECCO version 4 release 3 in the MOW region was assessed by comparing with multiple OA products.
- ECCO v4 captured the major features of the spatial patterns with similar intensity of the signals and is thus suitable for the purpose of this research.

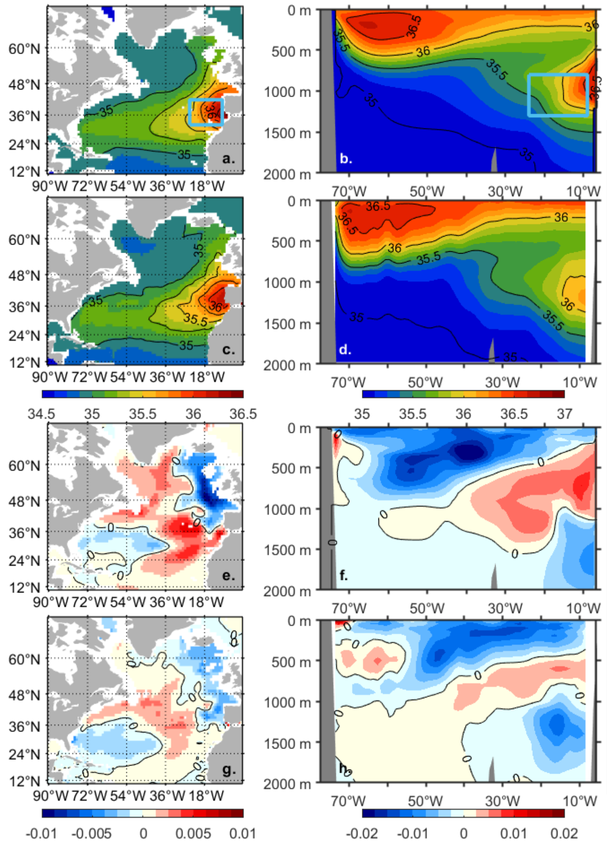


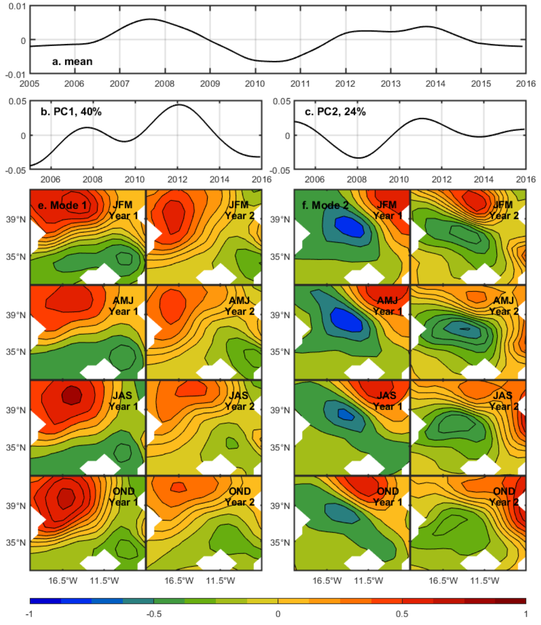
Figure 1. Mean salinity fields and 10-year salinity trends in the North Atlantic and along the 36°N transect. Panel a, b, e & f are from ECCO, and panel c, d, g & h are from Scripps Argo product.

The blue boxes in panel a & b shows the MOW reservoir (10°W, 25°W, 32°N, 42°N, 800-1300 m).

Units for the left and right columns are g/kg and g/kg/year, respectively.

SPATIAL MODES OF VARIABILITY: Cyclostationary EOF Analysis

Figure 2. Mean salinity (detrended) and the two leading CSEOF modes of the MOW. Panel b & c shows the principal components (pc), e & f shows the loading vectors (3-month averaged). (Unit: g/kg)



- The two leading modes together explain more than 64% of the total variance;
- Mode 1 has a distinct North-South pattern, and the cycle of the signal is likely longer than 2 years;
- Mode 2 shows a propagation from the East towards the North within the 2-year nested period.

ANOMALY SALT BUDGET: Change in Circulation vs. Change in Salinity

- The advective salt flux in the MOW region is decomposed into a linear term due to temporal anomalies of the velocity (UaSc) and a linear term due to anomalies in salinity (UcSa);
- Each of the budget terms corresponds to a CSEOF mode, and shows moderate correlation to a climate index, i.e., NAO (mode 1) and ENSO (mode 2), respectively.

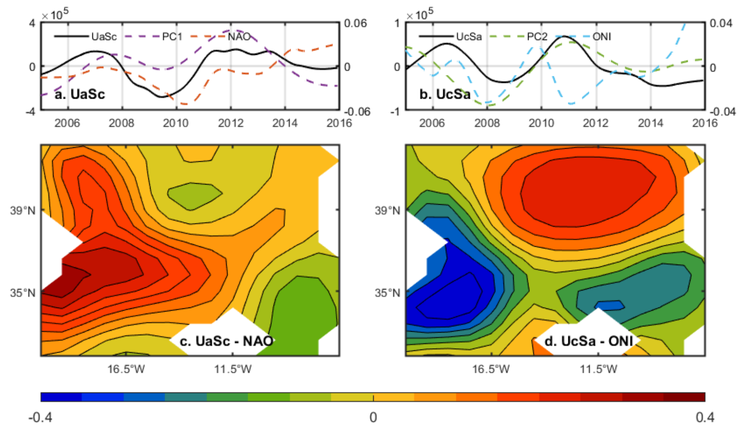


Figure 3. a & b Salt budget terms, PC timeseries and climate indices; c & d Regression maps of the climate indices onto the budget term fields.

FROM SEA SURFACE TO MOW: A Possible Path?

- The upper ocean above the MOW is analyzed as an attempt to find the source of the interannual signal shown in Fig. 2, mode 2;
- Both mode 1 and mode 2 have moderate correlations with ONI(0.54 and 0.35, respectively). PC2 is almost identical to UcSa of MOW, suggesting a possible source of the observed change of salinity influx.

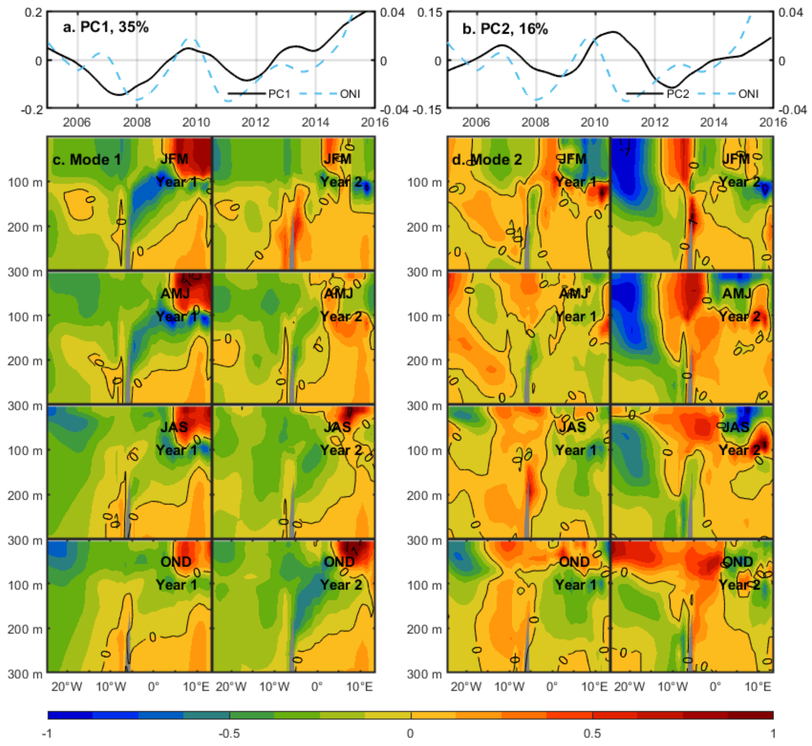


Figure 4. Two leading CSEOF modes over the 36°N transect. Panel a & b shows the PC timesries, c & d shows the loading vectors (3-month averaged).

CONCLUSIONS

- Two distinct modes of variability are found in the MOW salinity field.
- The two modes are driven by two different advection processes, of which the fluctuations are likely associated with ENSO and NAO, respectively.
- The plausible ENSO signal in the deep North Atlantic Ocean showcases remote connections in the different parts and layers of the global ocean.