Regional model estimation of seasonal and interannual variability of circulation and volume transport in the Sicily Channel

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ABSTRACT

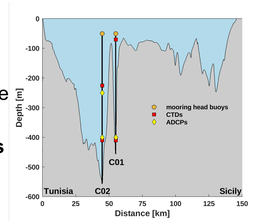
1. WHAT AND WHY

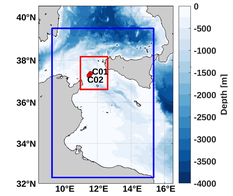
The **Sicily Channel** connects the two major basins of the Mediterranean Sea: the **Western Mediterranean Basin (WMED)** and the **Eastern Mediterranean Basin (EMED)**. The exchanges through this choke point are fundamental for understanding the dynamics and processes regulating the **circulation** of the Mediterranean Sea and the **physical, chemical, and biological characteristics of the water masses in the two basins**.

2. HOW

In situ measurements

- **Two moorings** (C01 and C02), located in the Sicily Channel, managed by the CNR-ISMAR **(red dots)** since **1993**.
- **Current velocities data** were acquired through **ADCPs** since **2010**, allowing the analysis of almost the entire water column.



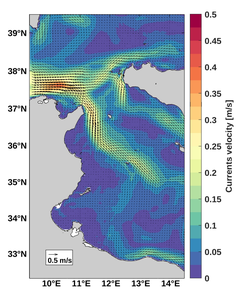


Regional model

- **Regional Ocean Modeling System (ROMS)** used to simulate the period **2010-2019** using a **One-way nesting application**.
- **Parent grid (blue)** has a resolution of **1500 m**; **child grid (red)** has a resolution of **500 m**.

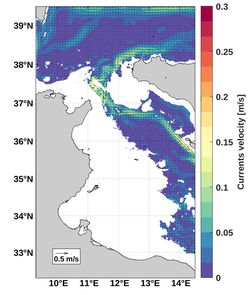
Atmospheric forcings	Boundaries and Initials
ERA5 ECMWF reanalysis	CMEMS Med MFC physical reanalysis

3. CIRCULATION

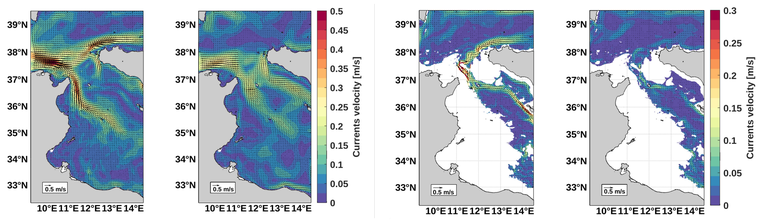


2010 - 2019 mean surface circulation

2010 - 2019 mean 300 m circulation



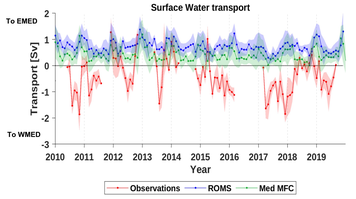
- The **surface circulation** is characterized by a complex series of **permanent dynamics** whose intensity varies between winter and summer periods. The currents intensities variability induces the formation of seasonal mesoscale structures.
- The **intermediate circulation** does not exhibit complex dynamics, and the pathway is **primarily influenced by bathymetric constraints**. The intensity of intermediate currents varies seasonally, with an increase during the winter period and a decrease in the summer period.

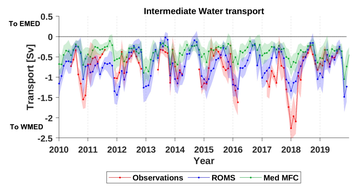


4. VOLUME TRANSPORT

Surface water transport

- **ROMS** simulations show mean eastward transport **(0.73 ± 0.21 Sv)**, as **Med MFC (0.44 ± 0.23 Sv)**. **Observations** show a mean transport of **-0.39 ± 0.63 Sv**.
- Errors induced by horizontal extrapolation in the estimates of in situ observations results in no correlation.
- **Modelled results** show a **low seasonal signal** with transports **peaks during late autumn - early winter period**.



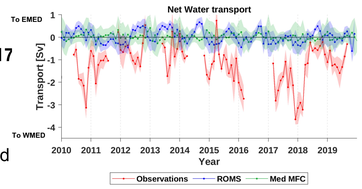


Intermediate water transport

- **Models and observations show a mean westward transport.**
- **High correlation** between modelled and observational results ($R^2 > 0.7$).
- **Strong seasonal signal, with maximum/minimum** westward transport **during winter/summer**.

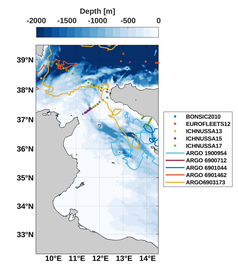
Net water transport

- **ROMS** and **Med MFC** transports show a mean positive net transport (**0.0371 ± 0.27 and 0.0377 ± 0.273 Sv**, respectively). Observation values are strongly influenced by surface water data (mean transport **-1.17 ± 0.83 Sv**)
- **Low correlation** between modelled and observed transports.
- **Seasonal signal** in ROMS simulations. Med MFC and Observations does not show seasonal variability.

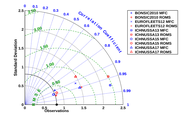


5. MODEL VALIDATION

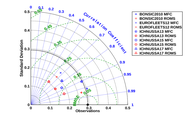
Simulations were compared with the in situ CTDs observations of temperature and salinity and five ARGO profilers.



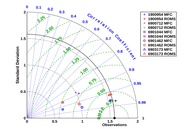
Argo trajectories and CTDs profiles used to perform the model validation

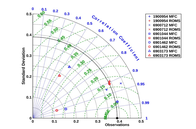


Temperature profiles Taylor Diagrams



Salinity profiles Taylor Diagrams





6. DISCUSSIONS AND CONCLUSIONS

- **The dynamics in the Sicily Channel** are complex and play a crucial role in regulating the exchanges and characteristics of WMED and EMED.
- The **wind component** is the predominant driving force of the surface circulation, which intensifies the currents entering the channel, resulting in increased transport.
- An **integrated approach** could provide a comprehensive solution for studying the area in detail.