MedCORDEX-Baltic Earth-COST Workshop
Mallorca, March, 13 – March,17 2018

The climate change signal for temperature and salinity in the Western Mediterranean Sea in a regionally coupled ocean-atmosphere model

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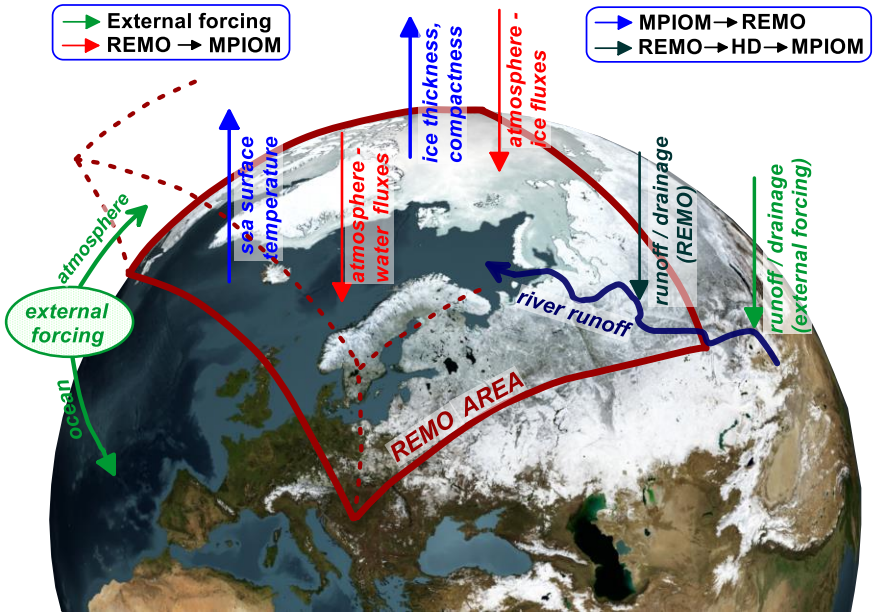
MOTIVATION

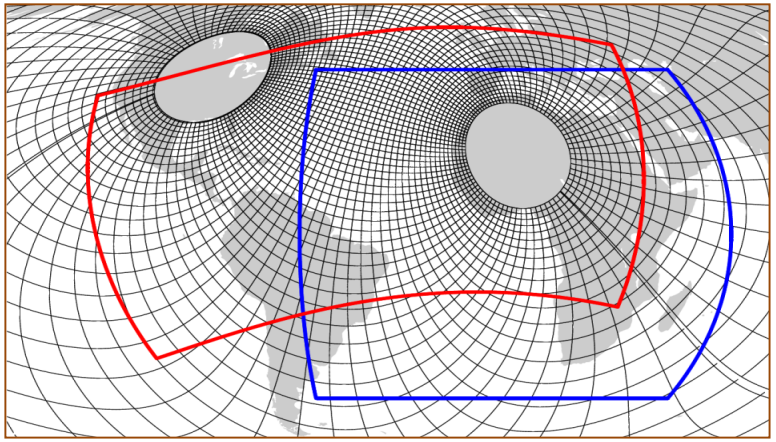
- To validate the ROM model in the Mediterranean
- To identify the impact of climate change on
  - -temperature
  - -salinity
  - -Water exchange

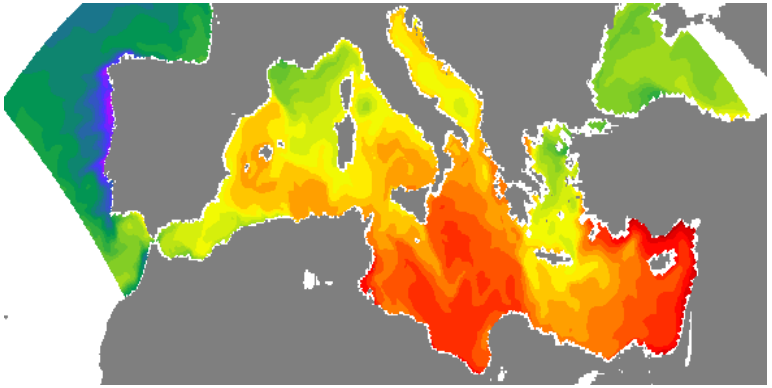
in the RPC8.5 Scenario.

THE REGIONALY COUPLED MODEL ROM

ROM: REMO + MPIOM+HD + HAMOCC

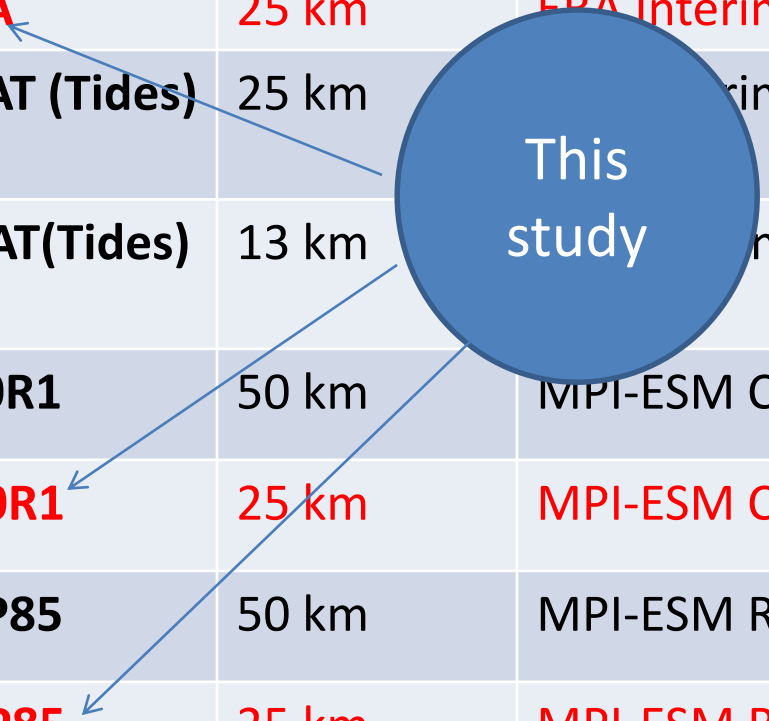




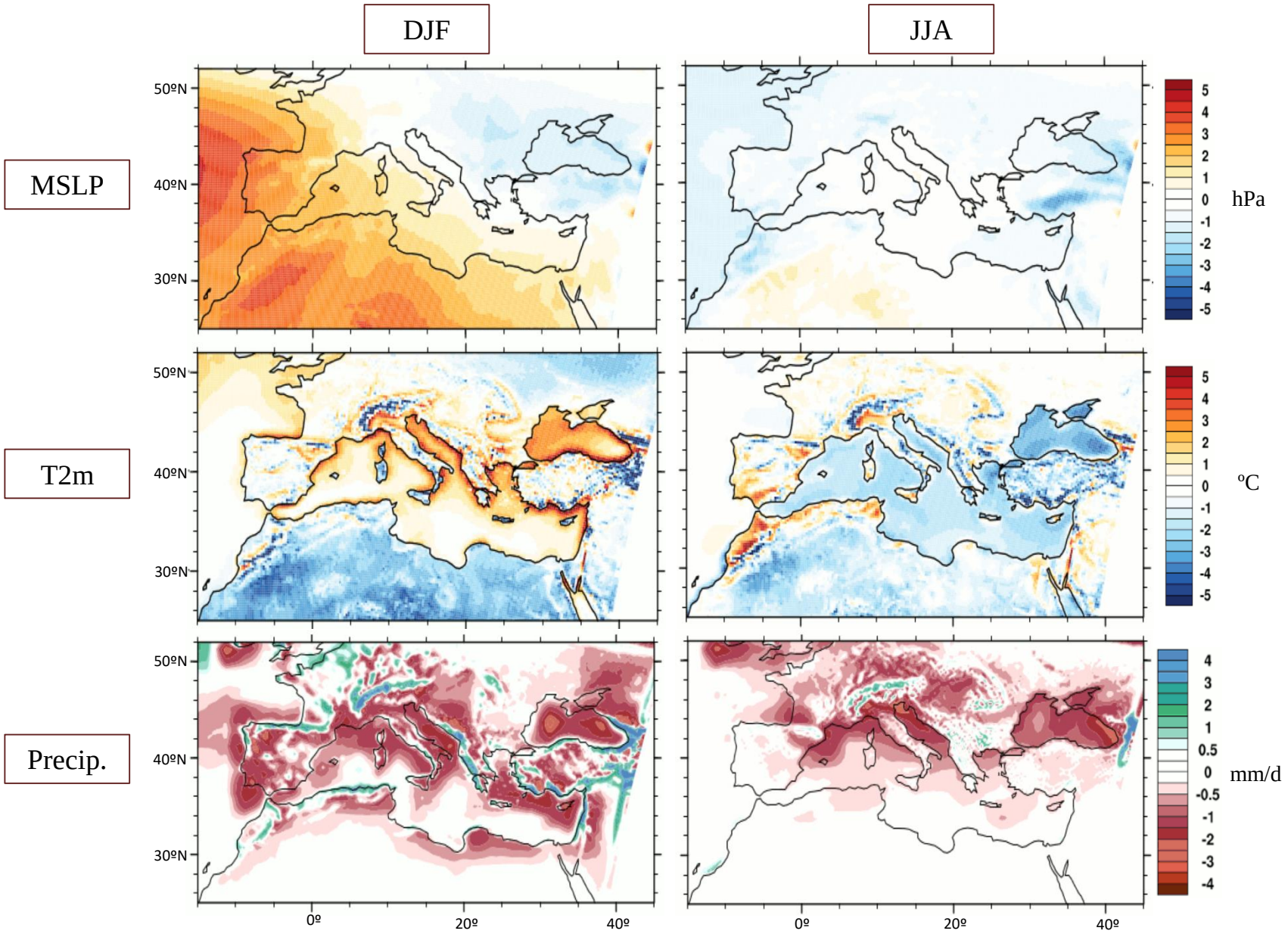


EXPERIMENTS

EXPERIMENT	RESOLUTION	FORCING	PERIOD	COUP.	UNCOUP.
NAT-ERA	50 km	ERA Interim	1980-2012	yes	yes
NAS-ERA	25 km	ERA Interim	1980-2012	yes	yes
NAS-ERAT (Tides)	25 km	ERA Interim	1980-2012	yes	not
NAX-ERAT(Tides)	13 km	ERA Interim	1980-2012	yes	yes
NAT-C20R1	50 km	MPI-ESM C20r1	1950-2005	yes	yes
NAS-C20R1	25 km	MPI-ESM C20r1	1950-2005	yes	yes
NAT-RCP85	50 km	MPI-ESM RCP85	1950-2005	yes	yes
NAS-RCP85	25 km	MPI-ESM RCP85	2006-2099	yes	yes
NAS-RCP45	25 km	MPI-ESM RCP45	2006-2099	yes	yes



PRESENT TIME: ATMOSPHERIC BIASES



PRESENT TIME: SST bias (1980-2012)

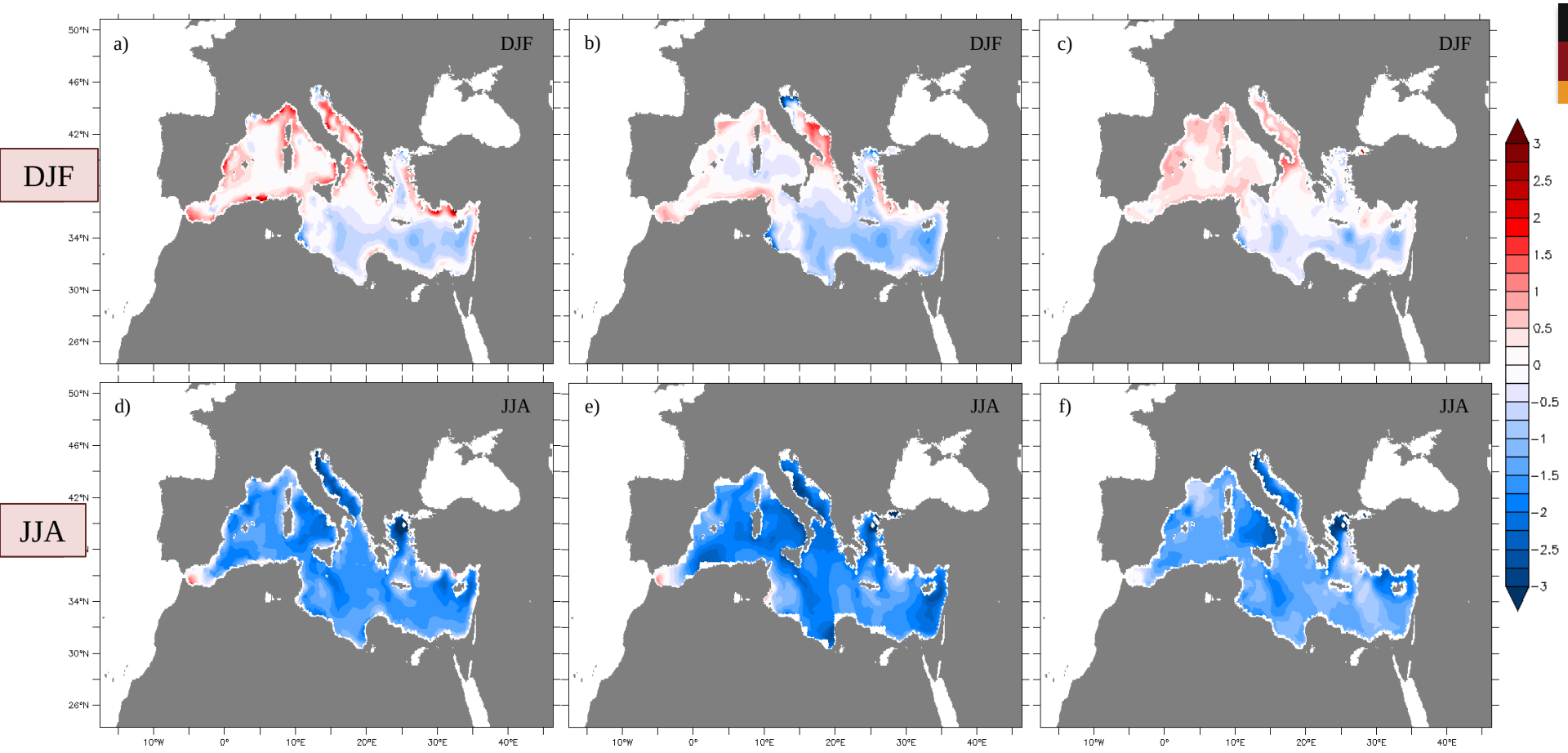
ROM - ERAI

ROM – EN4

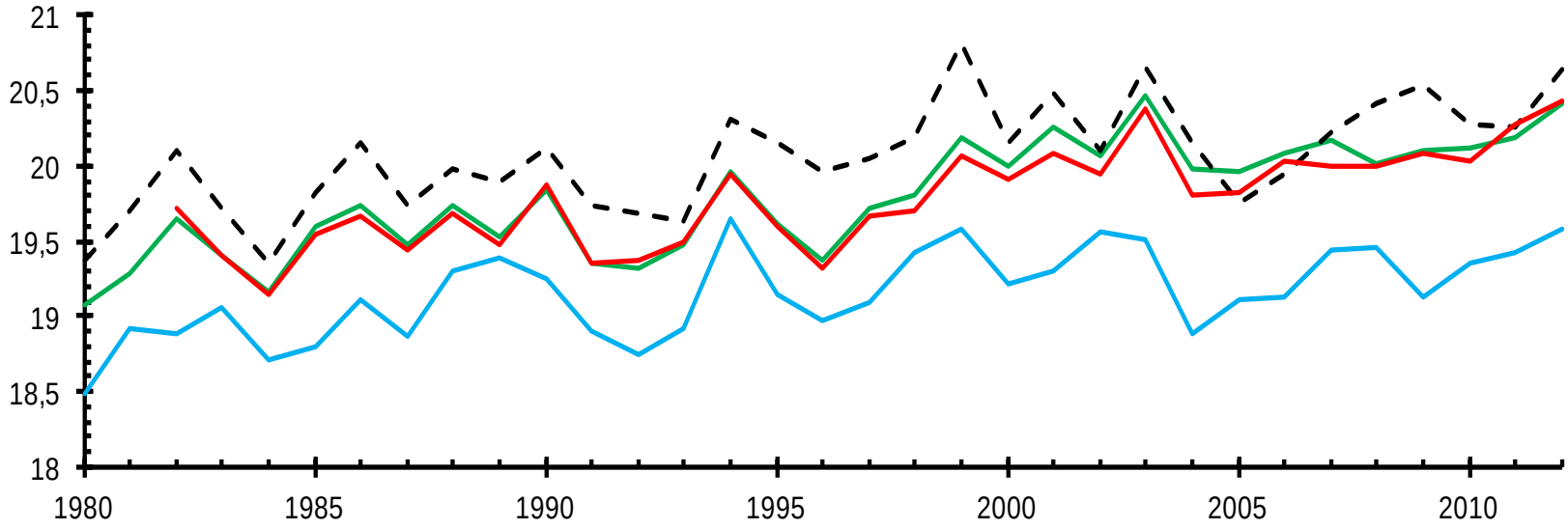
ROM-OISSTV2

DJF

JJA

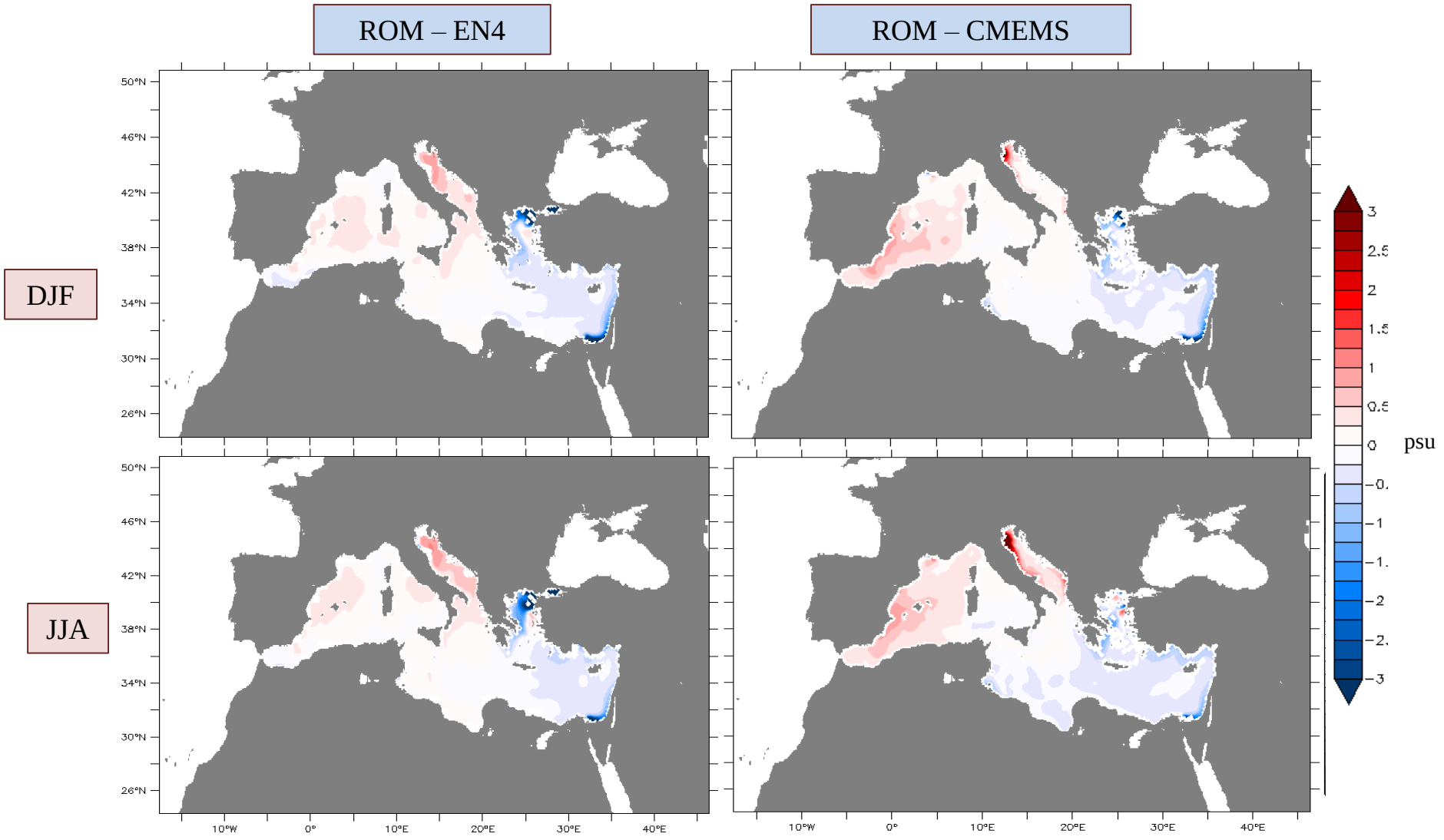


PRESENT TIME: MEAN SST (1980-2012)

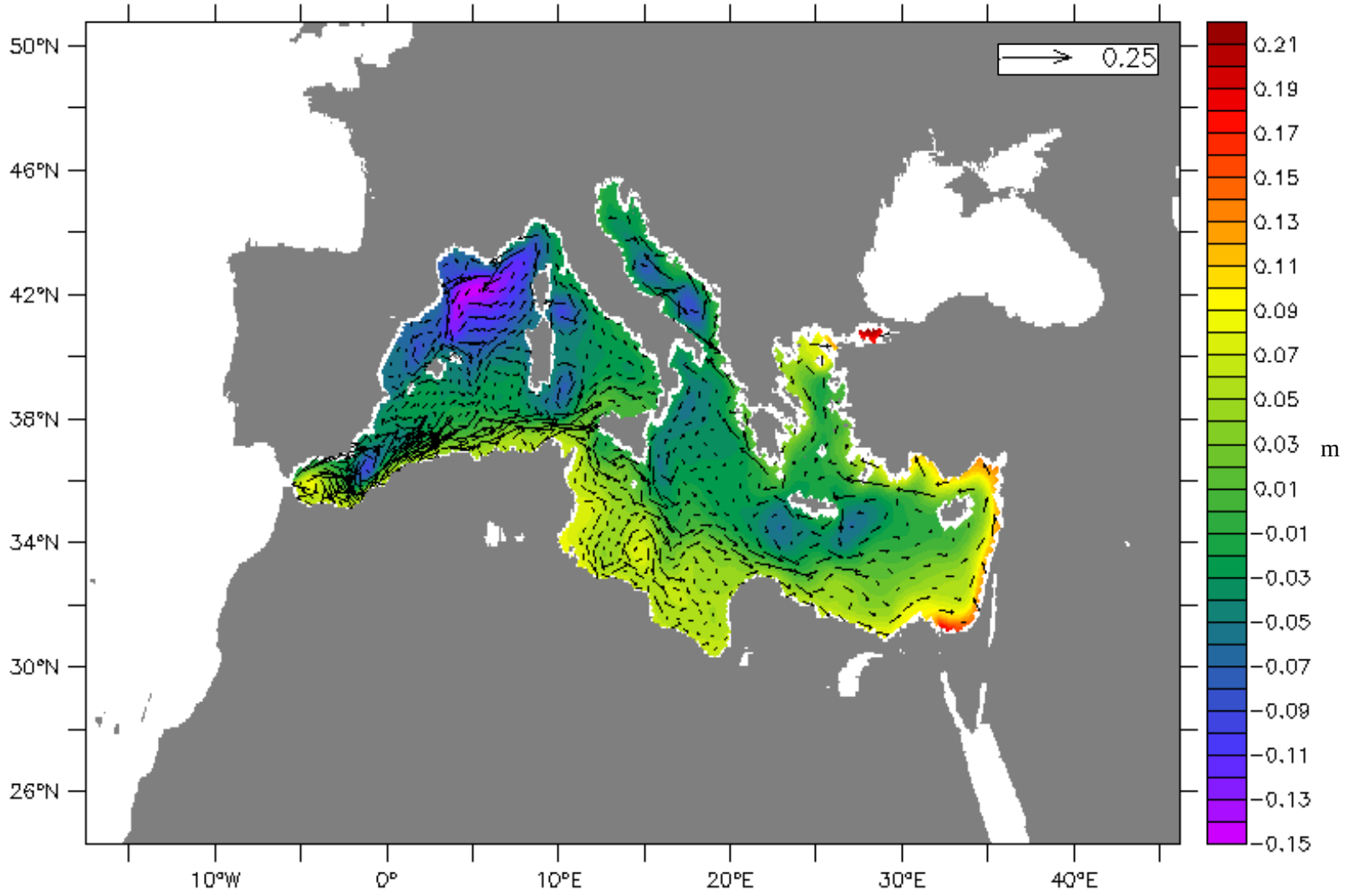


MED Basin	ROM 1880-2012	EN4 1980-2012	ERA_I 1980-2012	ROM 1982-2012	OISST 1982-2012
SST (°C)	19,16	20,06	19,79	19,19	19,78
Correlación		0.96	0.97		0.97

PRESENT TIME: SSS BIAS (1980-2012)



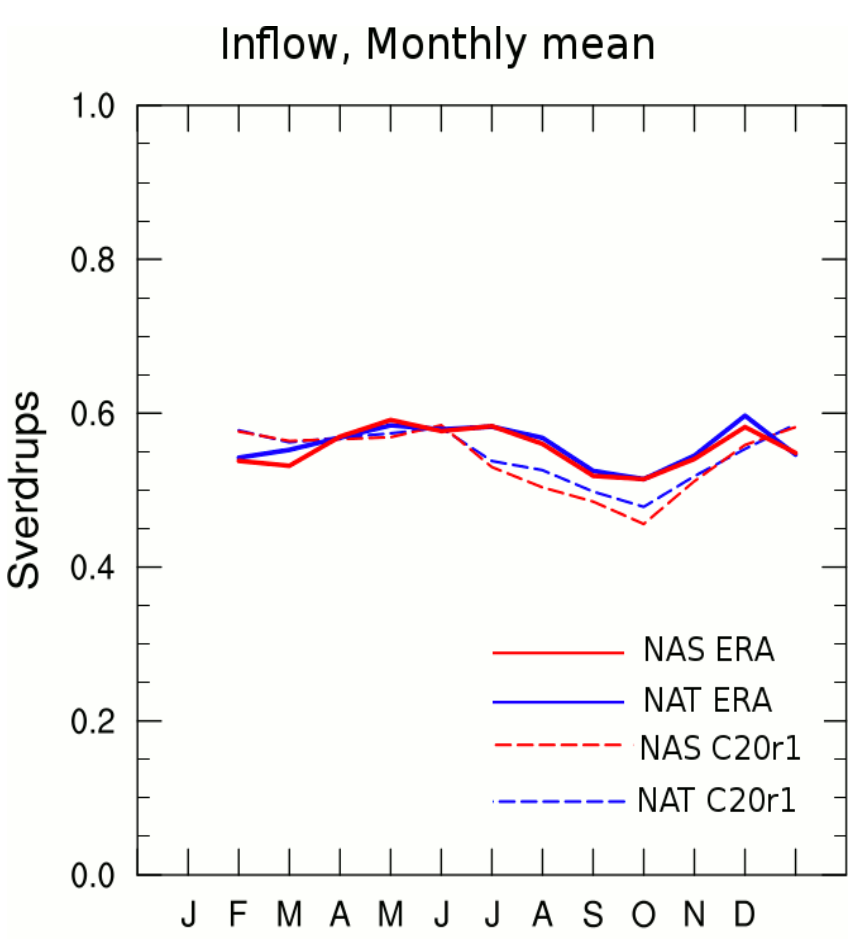
PRESENT TIME: SSH (1980-2012)

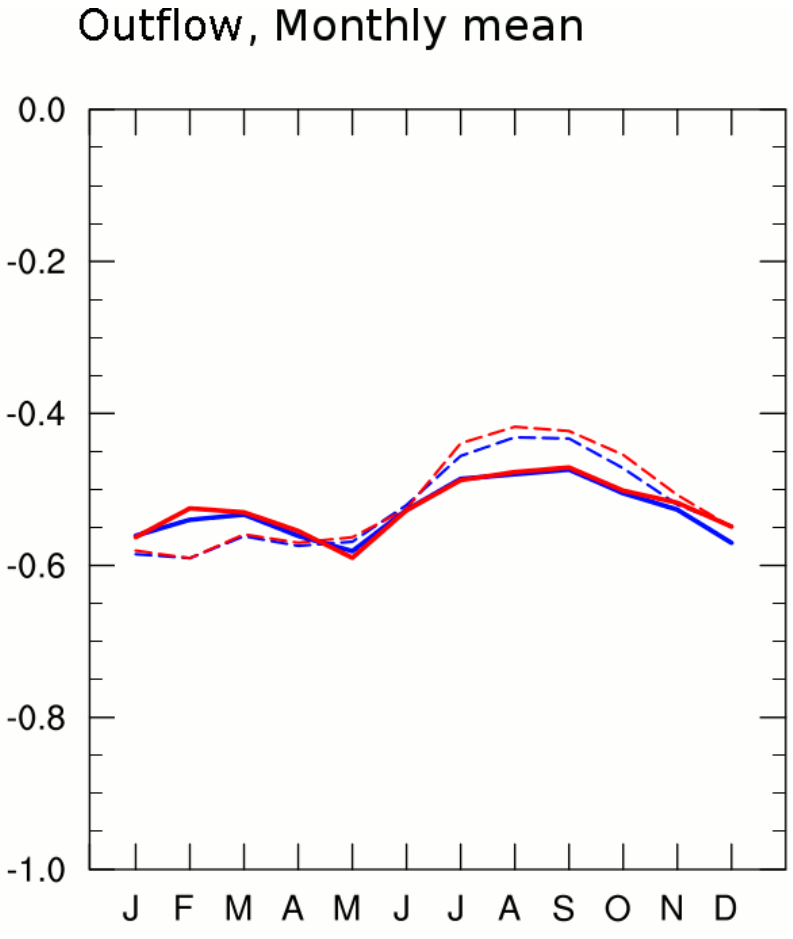


Mass Transport (Gibraltar)

Experiment	In	Out	Total
NAT-ERA	0.559	0.529	0.030
NAS-ERA	0.554	0.524	0.030
NAS-ERA Tides	0.665	0.644	0.021
Estimates (Addlof et al)	0.81±0.05	0.78±0.06	0.04 ±0.04

Present time Gibraltar transport. Seasonality



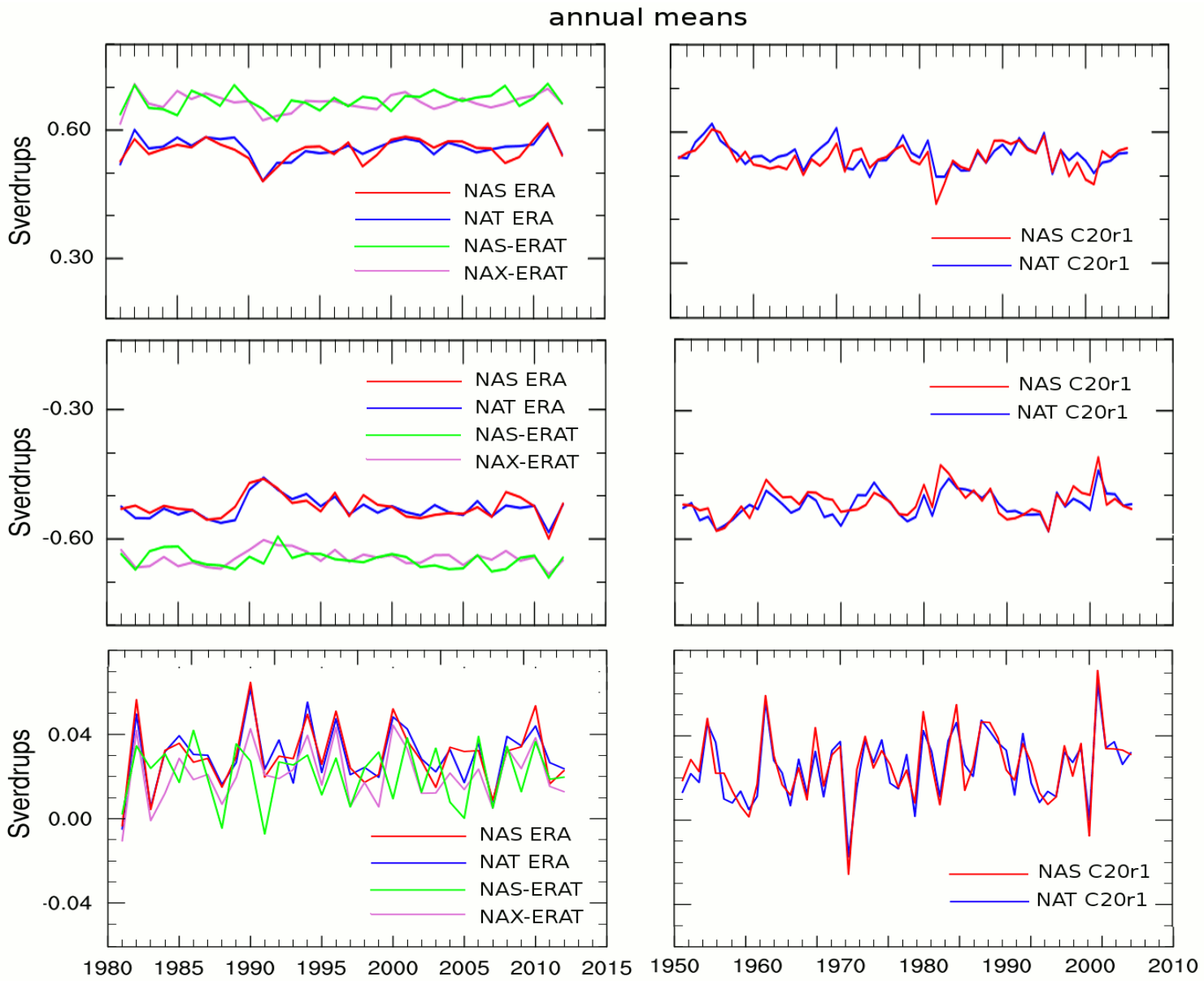


Present time Gibraltar transport. Variability

INFLOW

OUTFLOW

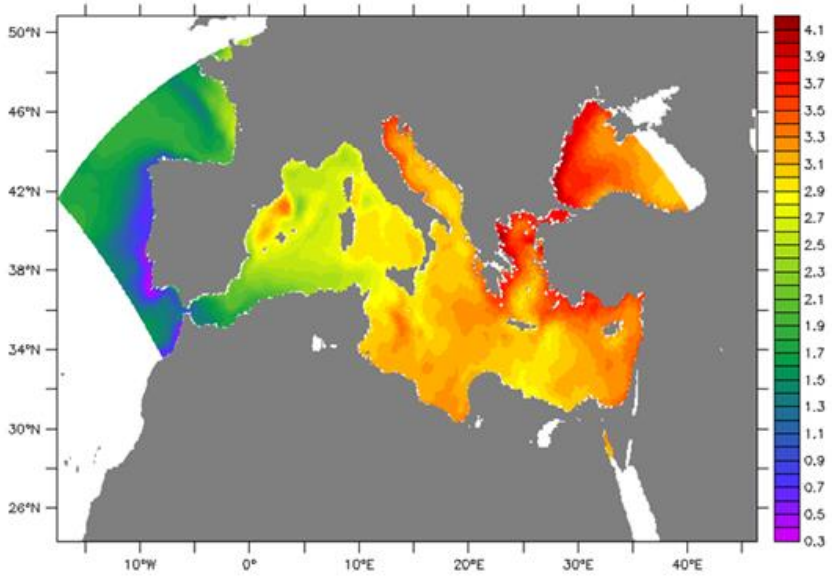
TOTAL



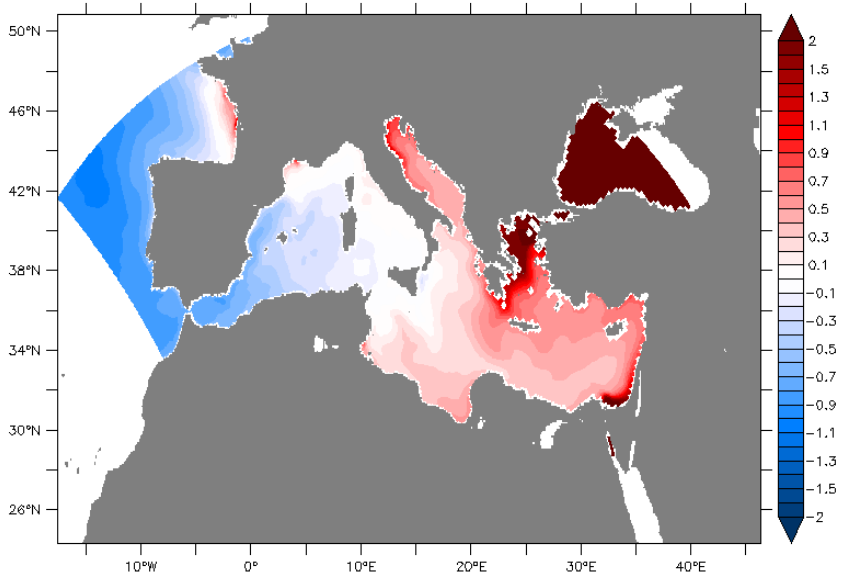
RCP85 SCENARIO: SST and SSS CHANGE

	Escenarios	ΔSST (ºC)	ΔSSS (psu)
ROM (RCP8.5-Ref.)	**RCP 8.5**	+2,82	+0,03
Thorpe y Bigg (2000)	**2XCO$_2$**	+4	-
Somot *et al.*, (2006)	**A2**	+2,50	+0,33
Somot *et al.*, (2008)	**A2**	+2,60	+0,43
Adloff *et al.*, (2015)	**A2**	+2,53	+0,48
(ibid)	**A2-F**	+2,97	+0,69
(ibid)	**A2-ARF**	+2,97	+0,89
(ibid)	**B1-ARF**	+1,73	+0,70

SST

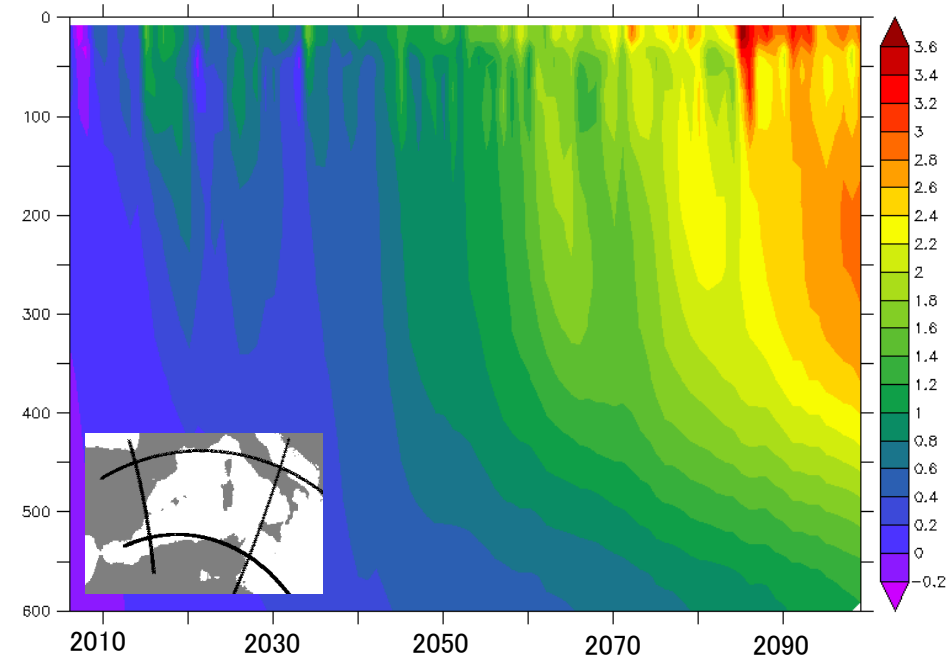


SSS

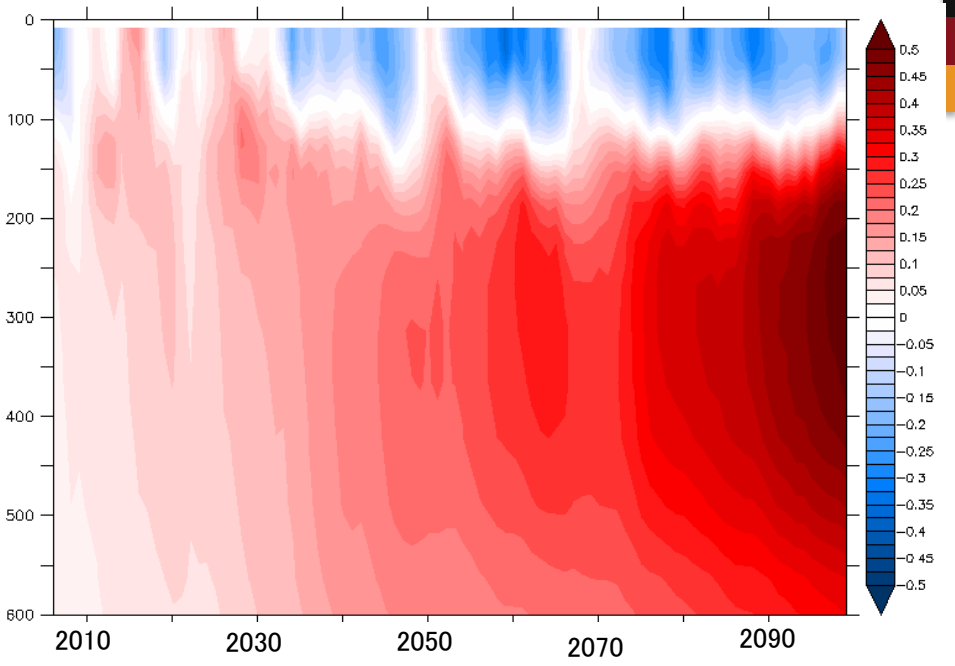


RCP85 SCENARIO: Temp. and Sal. evolution

Western Mediterranean

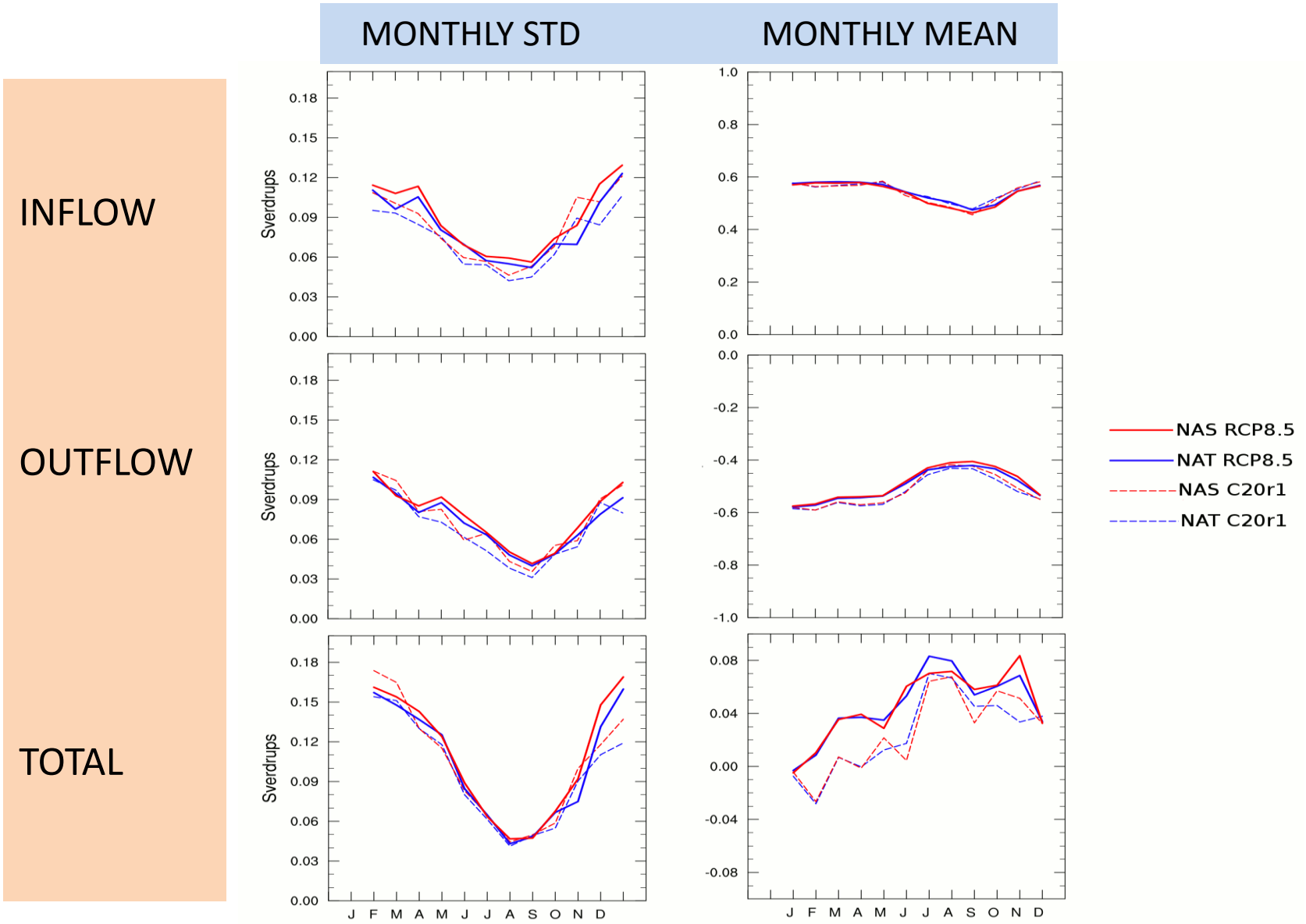


Temperature



Salinity

FUTURE (RCP8.5) GIBRALTAR TRANSPORT

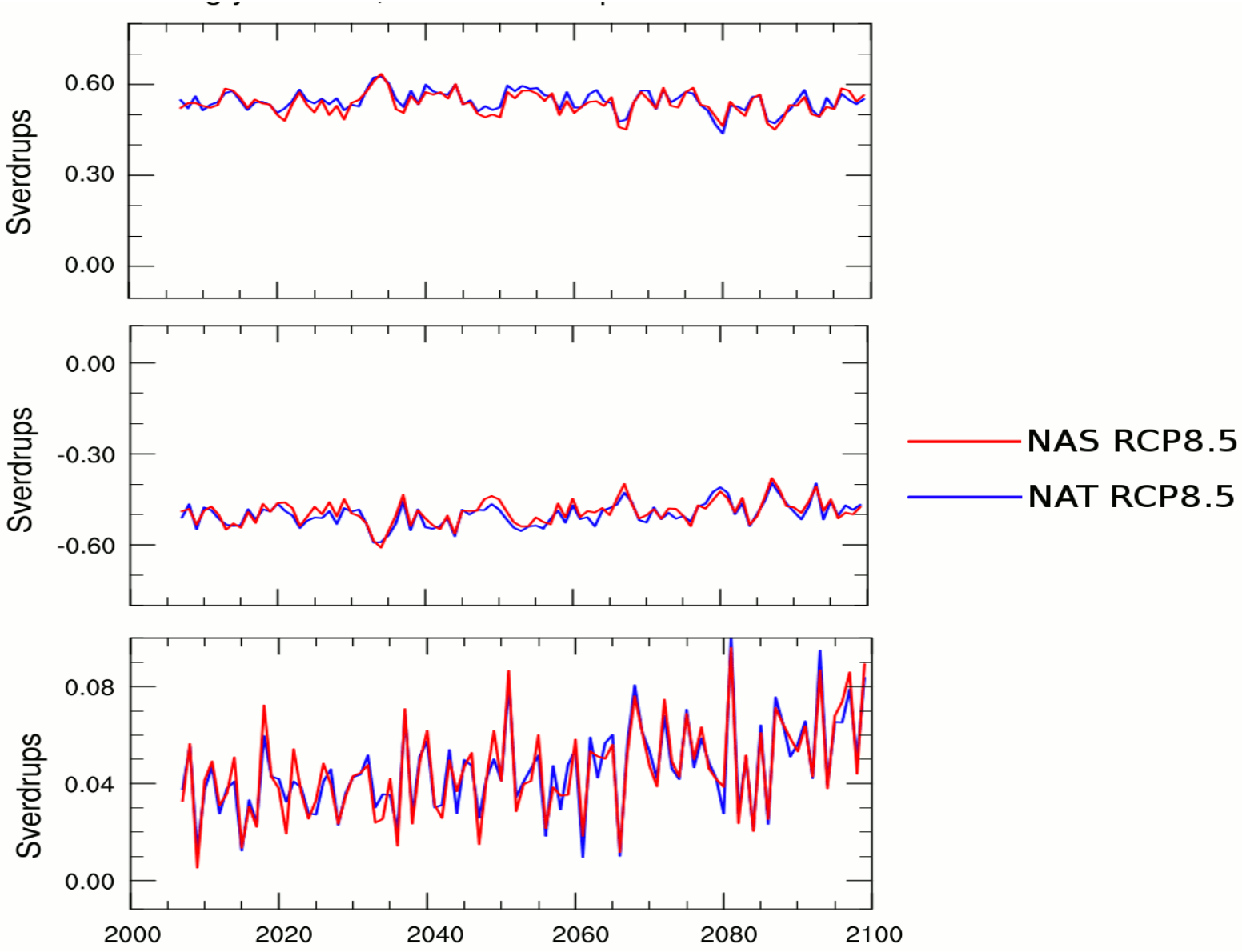


FUTURE (RCP8.5) GIBRALTAR TRANSPORT

INFLOW

OUTFLOW

TOTAL



CONCLUSIONS

- Our regionally coupled model simulates well the present climate in the Mediterranean atmosphere and in the ocean

- ROM provides a physically consistent estimate of the mass fluxes in the straits.

- The warming and salinization causes changes in deep water formation and thermohaline circulation.

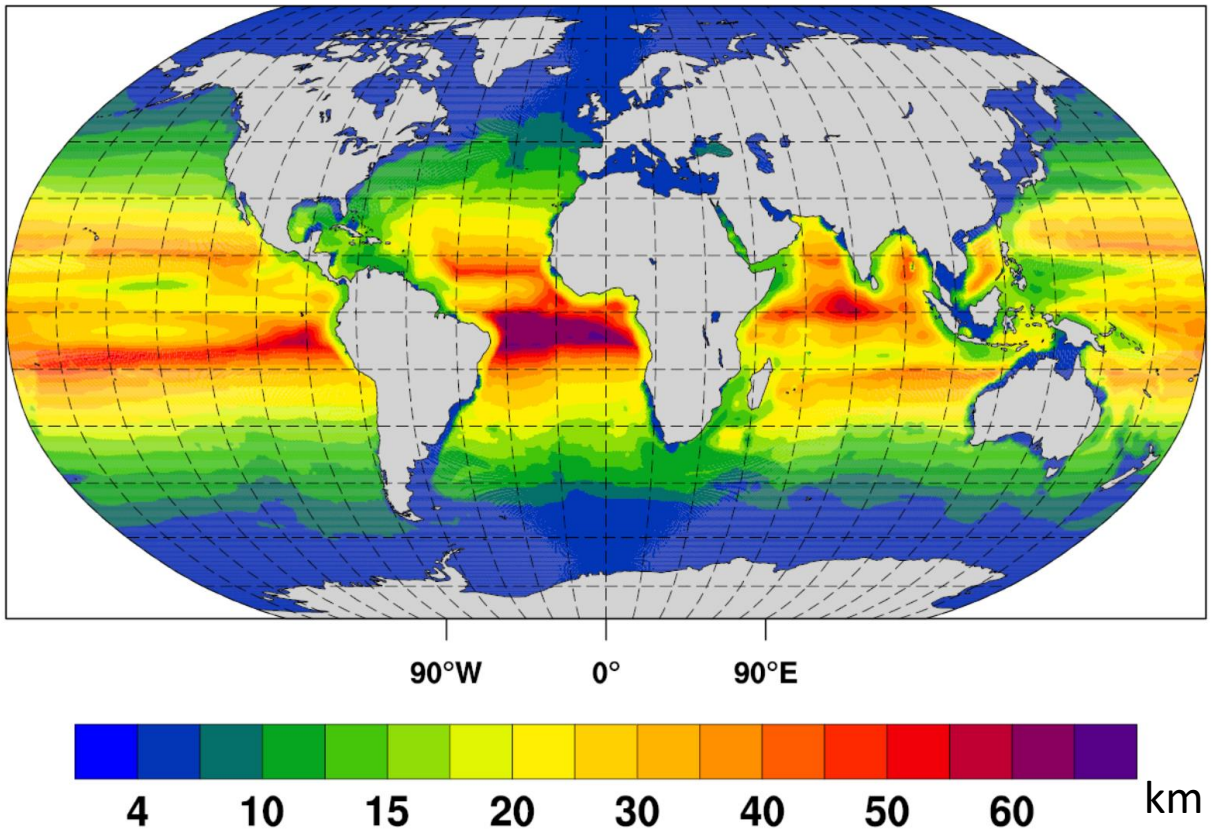
- The pattern of SSS presents a dipole structure: SSS decreases in the W. M. due to NE ATLANTIC influence (the NE Atlantic becomes less salty at surface due to changes in circulation)

- The present time transport through Gibraltar are less than observed estimates and the net inflow in the RCP8.5 scenario increases

Outlook: FESOM 2.0 ocean model

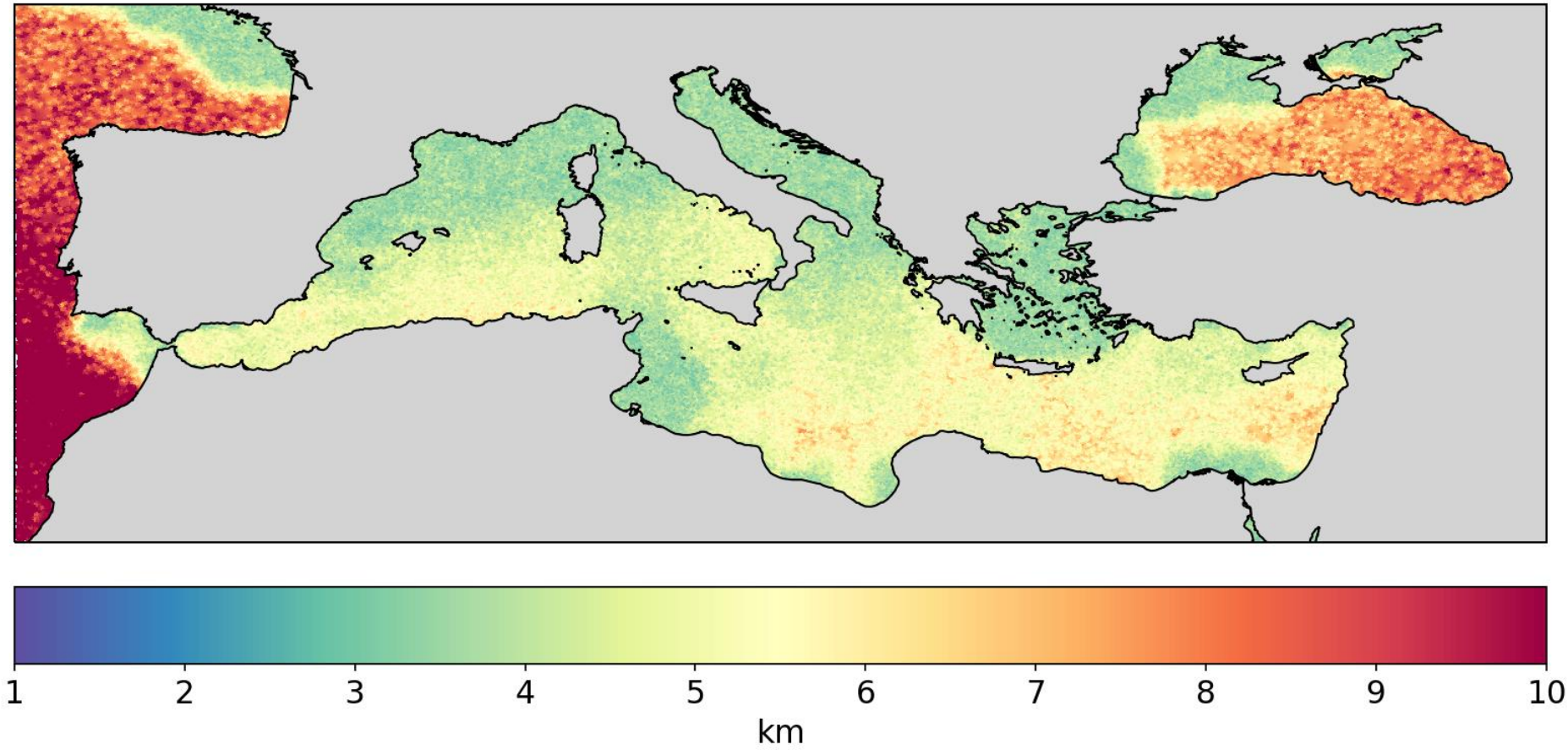
Characteristics:

- Flexible unstructured grid: e.g Rossby Radius resolving (Sein et al, 2017, JAMES)
- Finite volume approach (FESOM 1.* - finite elements)
- Fast: for 5M surface nodes in 1600 cores, 2 years/day, 7200 cores 8 years/day



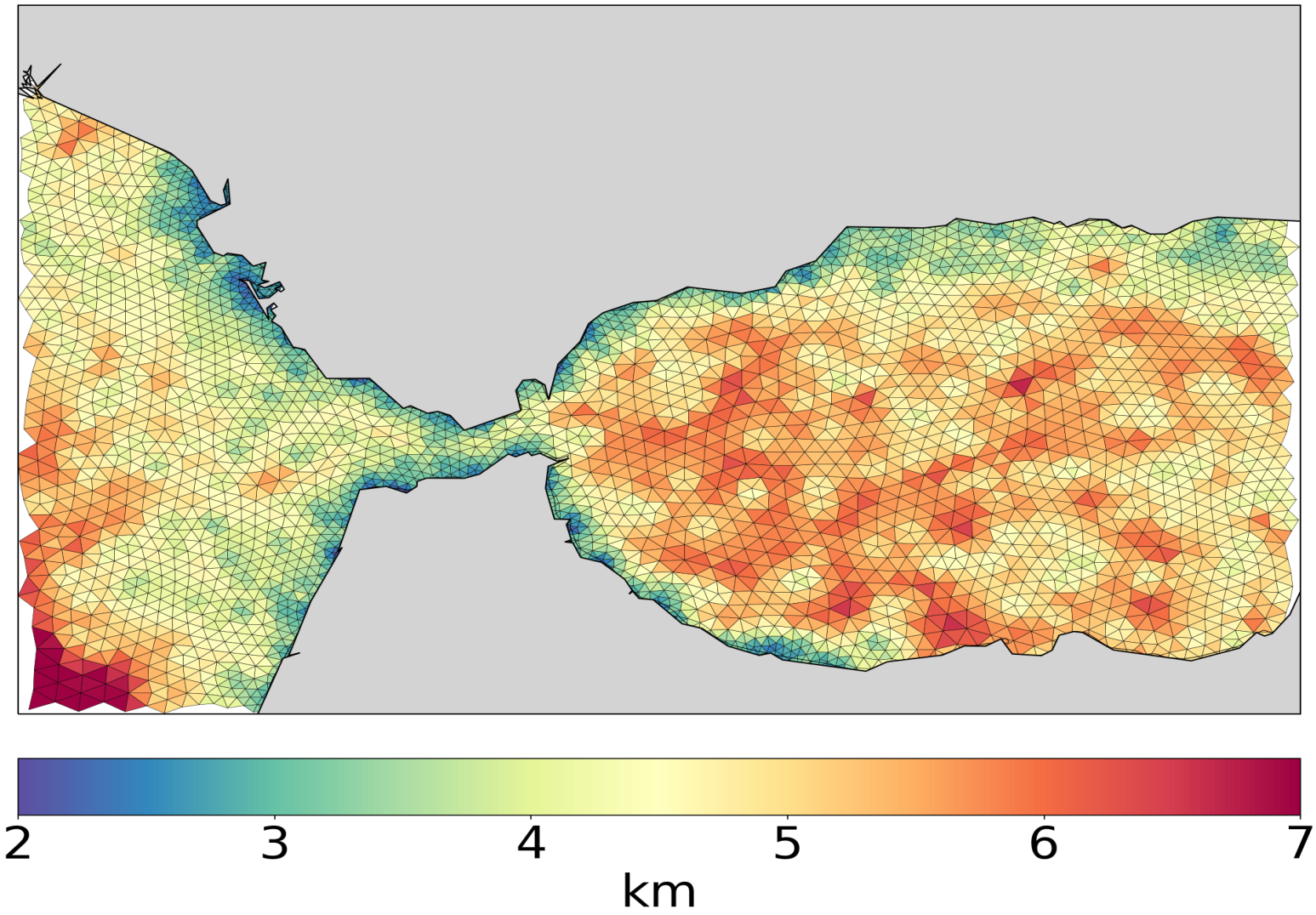
FESOM Frontier mesh (5M surface nodes)
Resolution = Max(Min(0.5*Rossby radius, Ocean variability), 4km)

FESOM V.2: Mediterranean representation



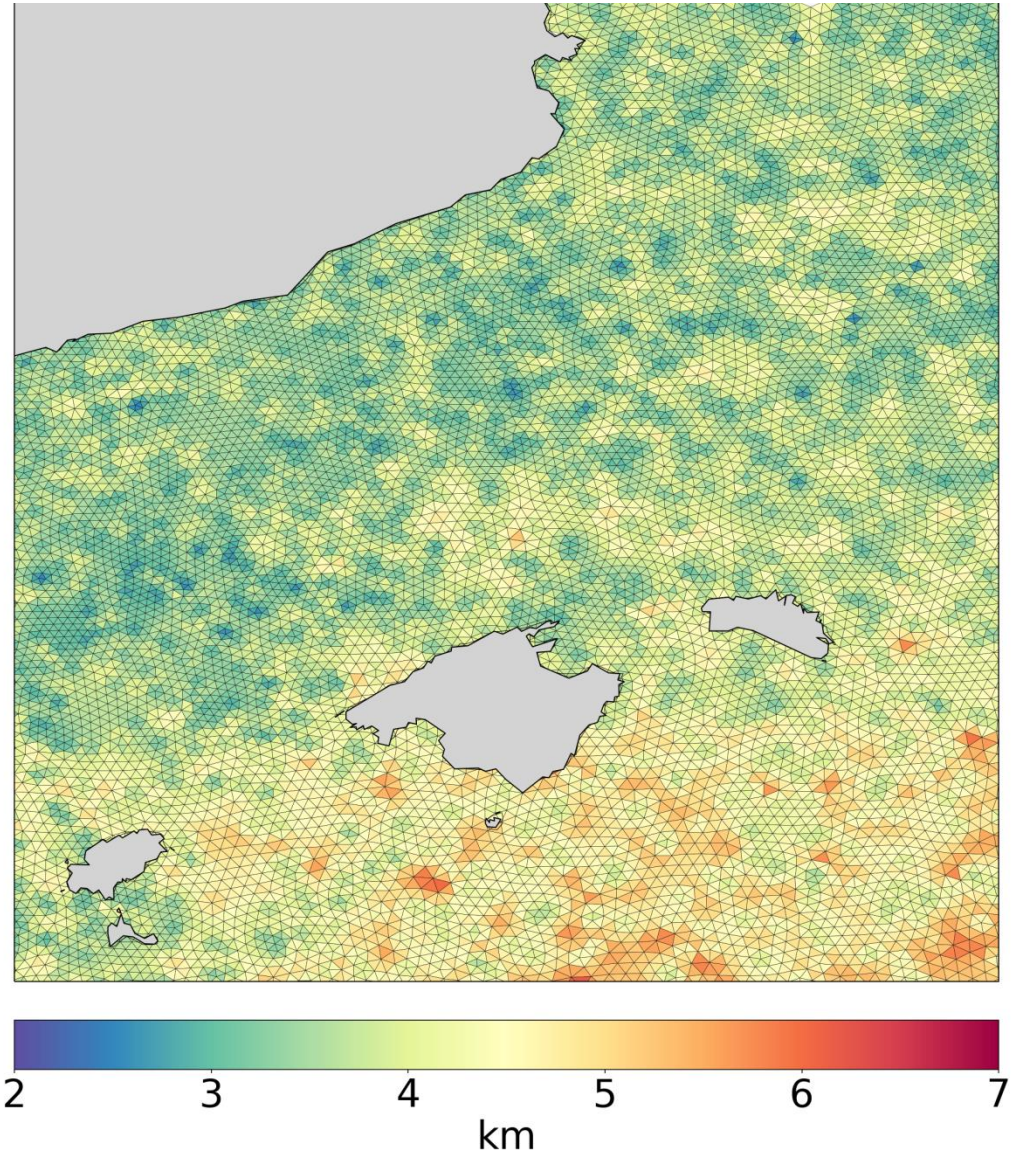
FESOM V.2: Mediterranean representation

Strait of Gibraltart



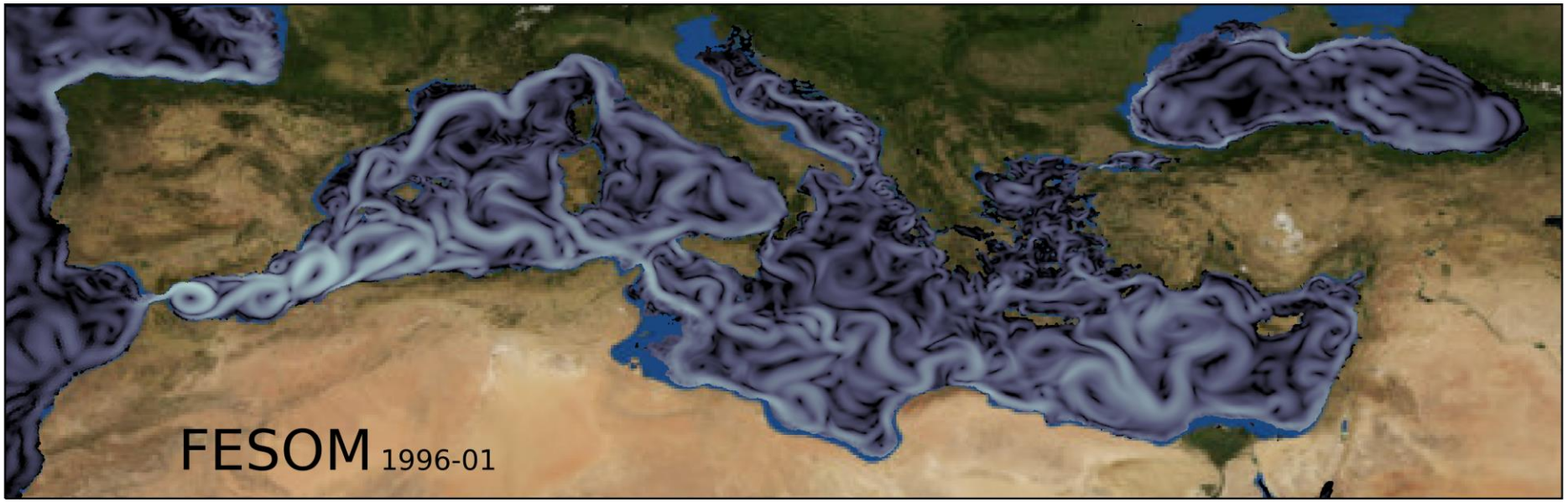
FESOM V.2: Mediterranean representation

Balearic Islands



FESOM V.2: Mediterranean representation

50 m ocean velocity snapshot



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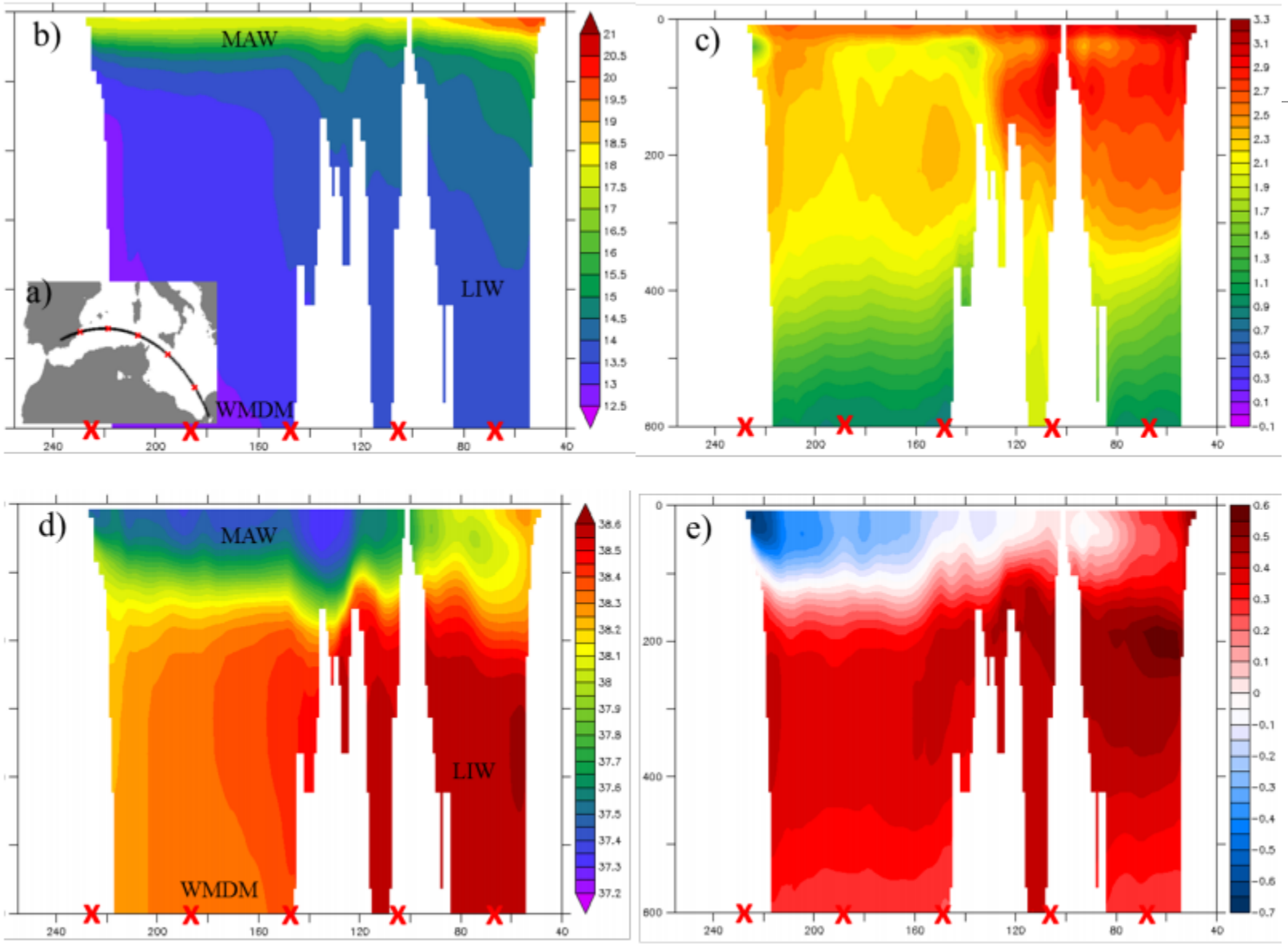

Figura 5. a) Transecto de estudio situado sobre la cuenca occidental. Secciones verticales realizadas a lo largo del transecto, donde el eje vertical representa la profundidad (m) y el eje horizontal los nodos a lo largo del transecto; b) temperatura promedio (ºC) normal climática (1950-1980); c) diferencia de temperatura (ºC) entre 2069-2099 y 1950-1980; d) salinidad promedio (psu) normal climática (1950-1980); c) diferencia de salinidad (psu) entre 2069-2099 y 1950-1980.