Ecosystem functioning: Physical Status

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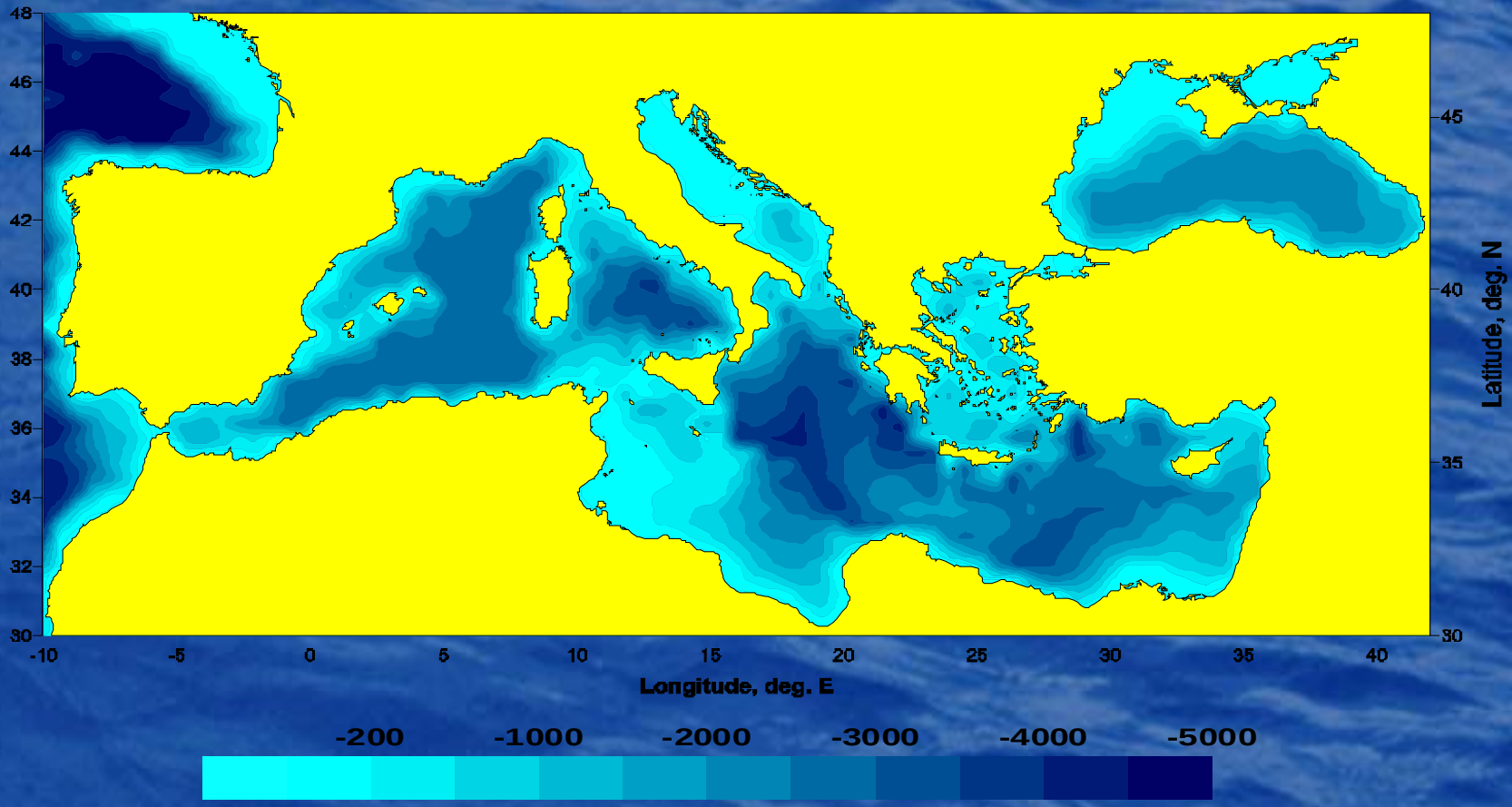
…and the task 2.1 participants

- Basin characteristics
- Air-Sea-Land exchanges
- Thermohaline circulation
- Variability
- Scenarios

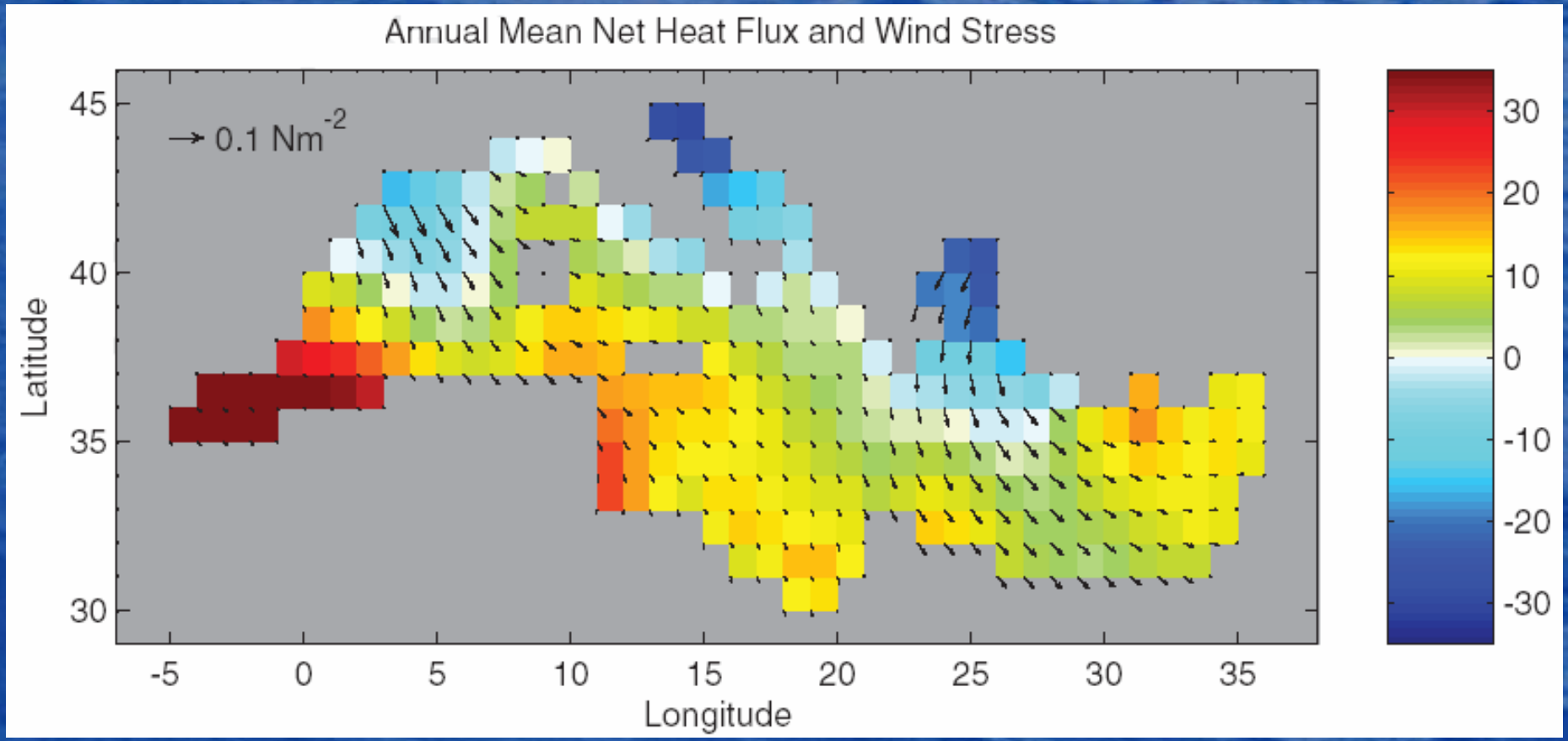
Basin Characteristics



Air-Sea-Land exchanges

- Evaporation (E) exceeds precipitation (P) everywhere
- The riverine input (R) in the Mediterranean is only about 20% of E-P.
- In the Black Sea, R ~ 200-300 % E-P.
- Freshwater budgets:
  - Mediterranean: deficit (~0.04-0.42 Sv)
  - Black Sea: surplus (~0.01 Sv)
- This determines the circulation, deep-water residence times and ecological characteristics of the basins

Air-Sea exchanges



From Tsimplis et al., 2006

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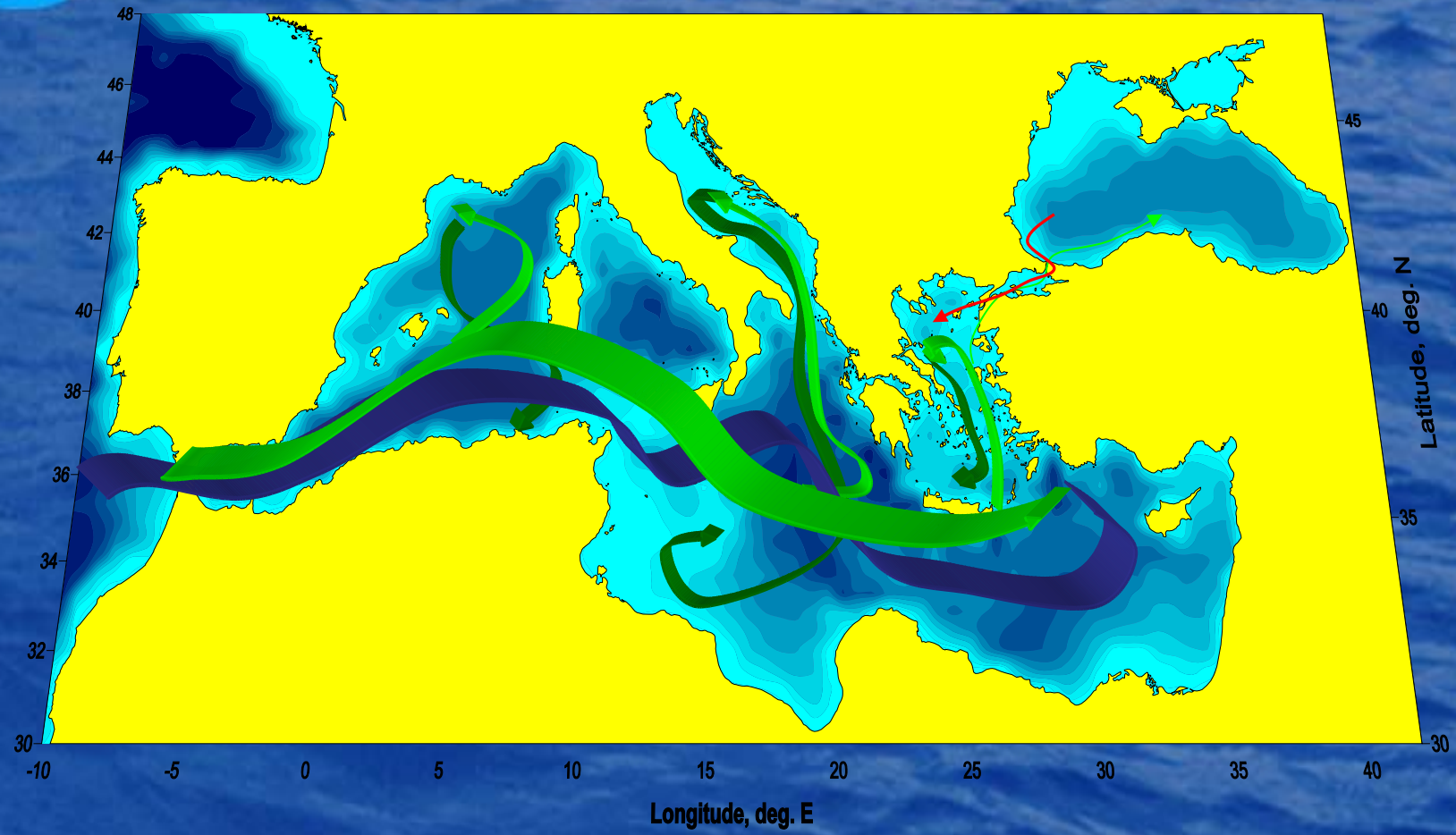
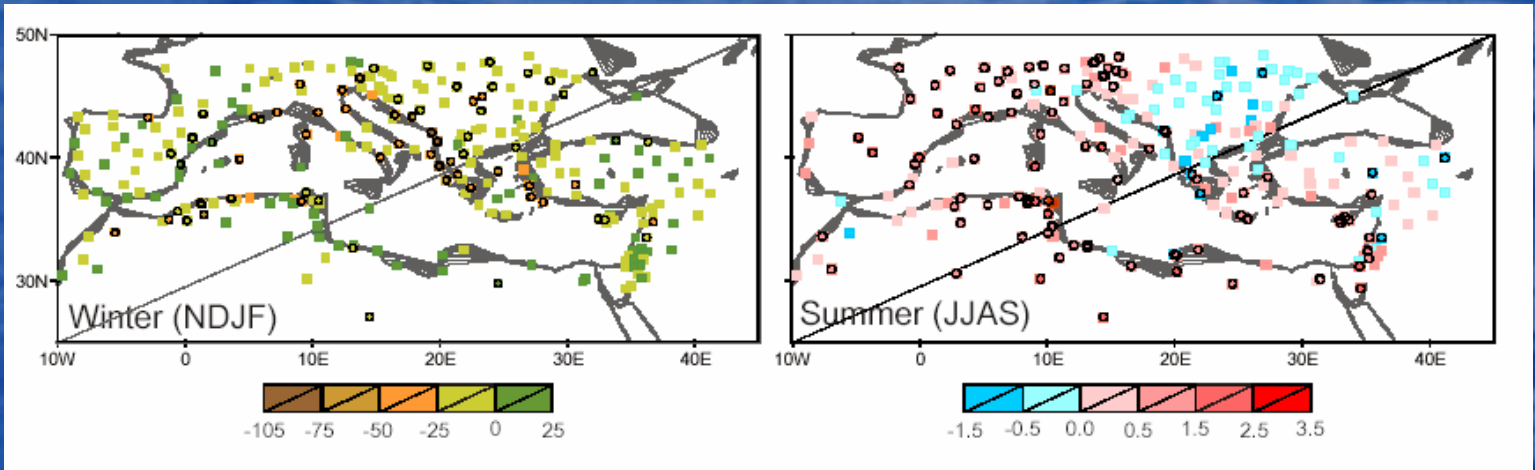
Thermohaline circulation



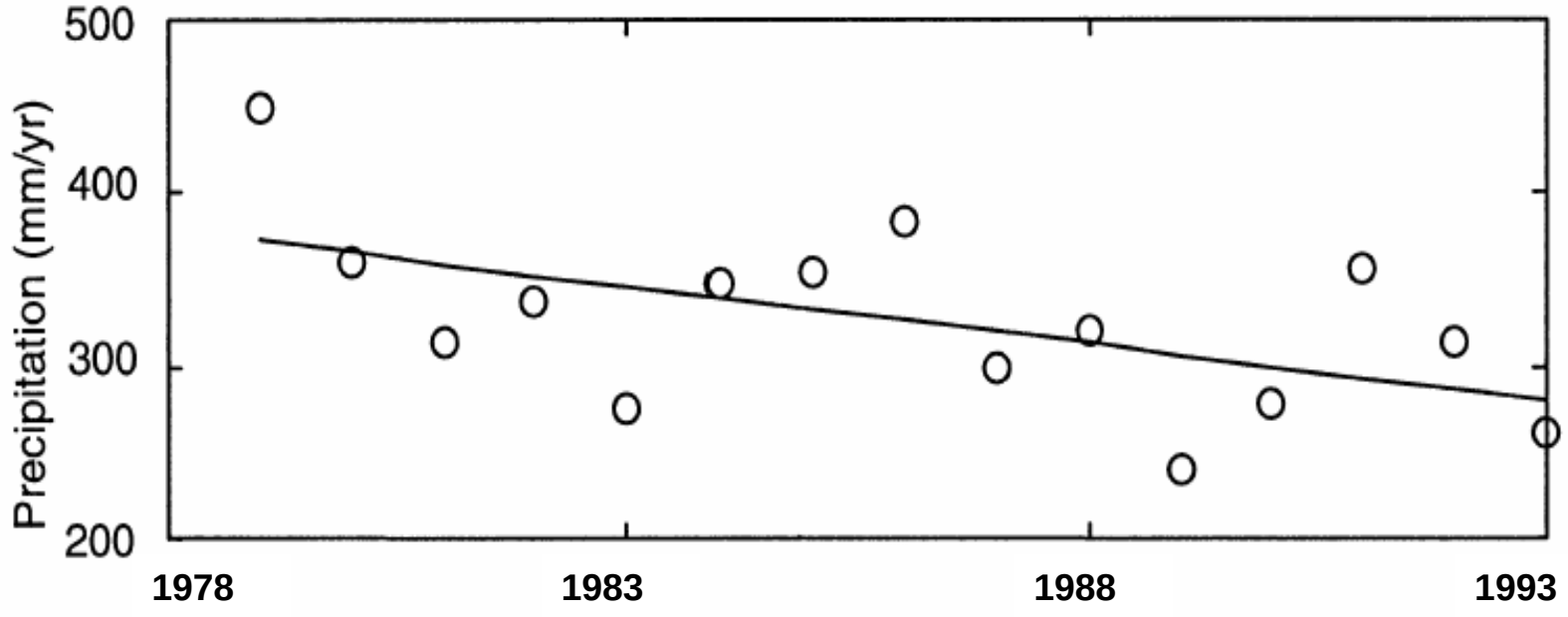
Meteorological variability

Precipitation trends for the 1950 – 1999 period (from Xoplaki, 2002)

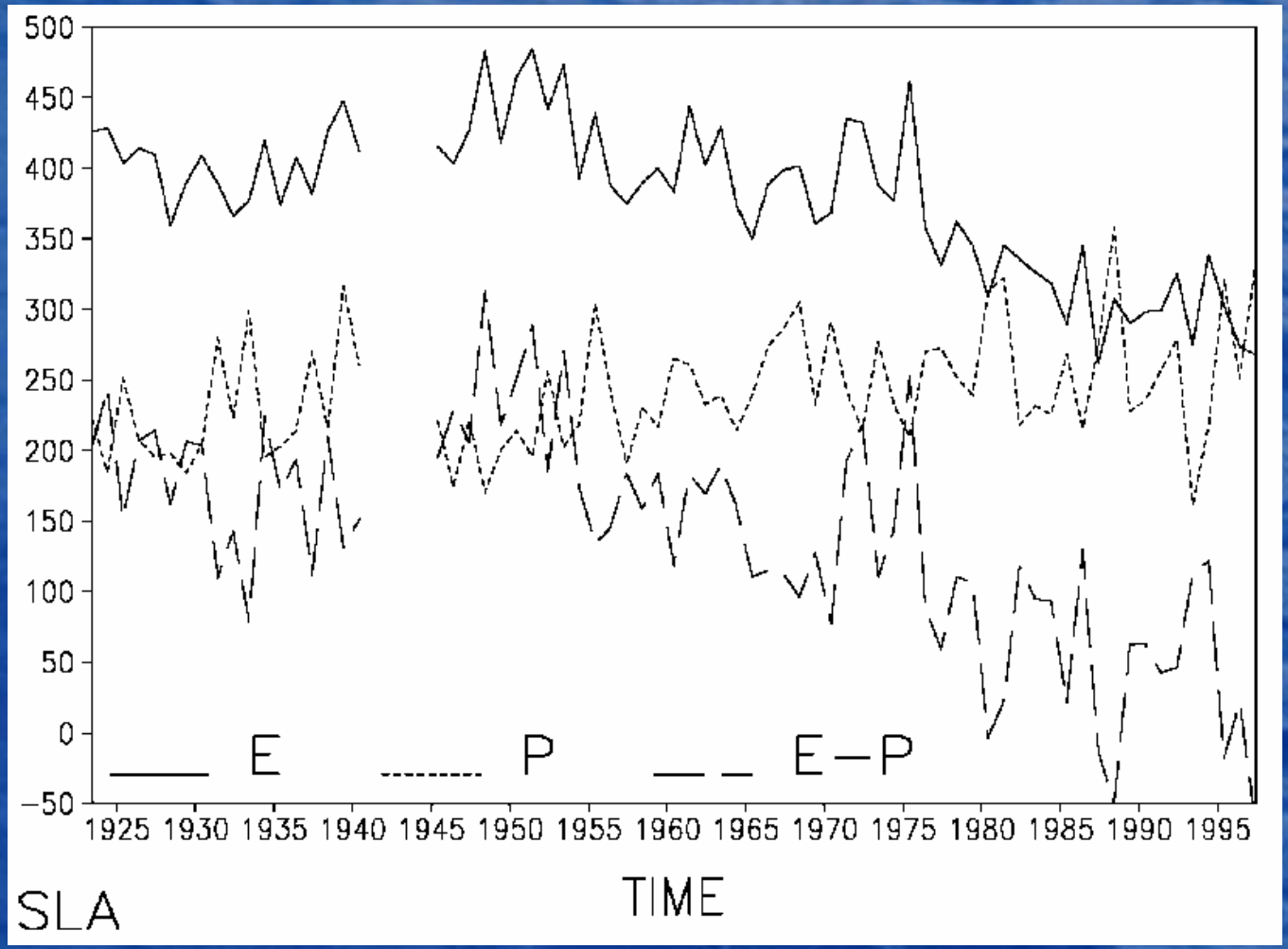


Meteorological variability

Boukthir and Barnier, 2000



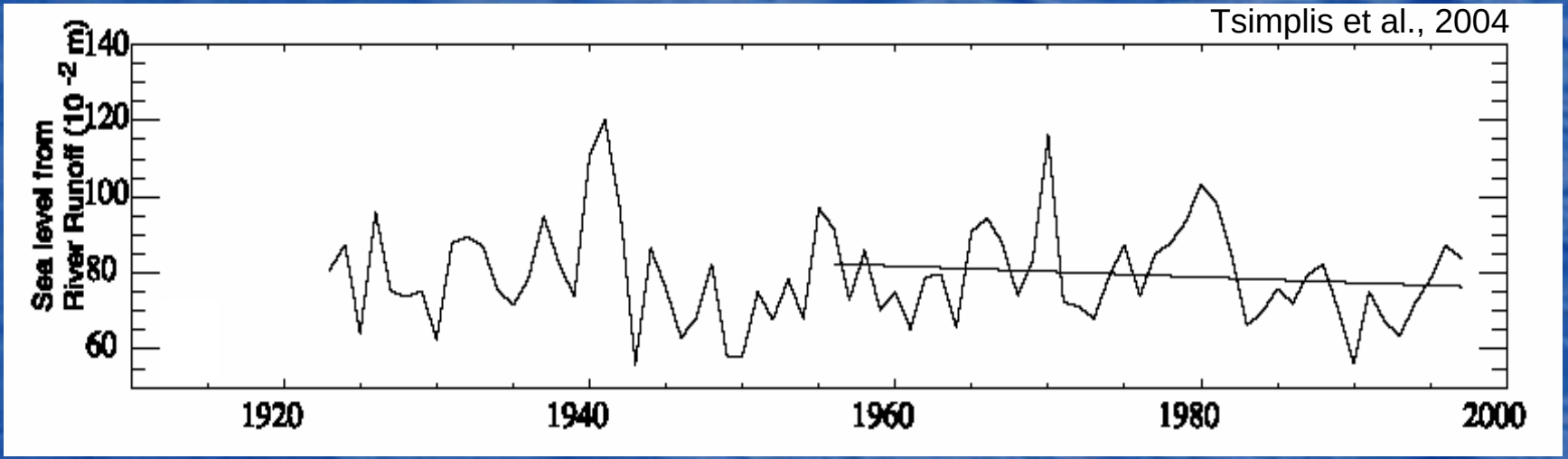
Meteorological variability



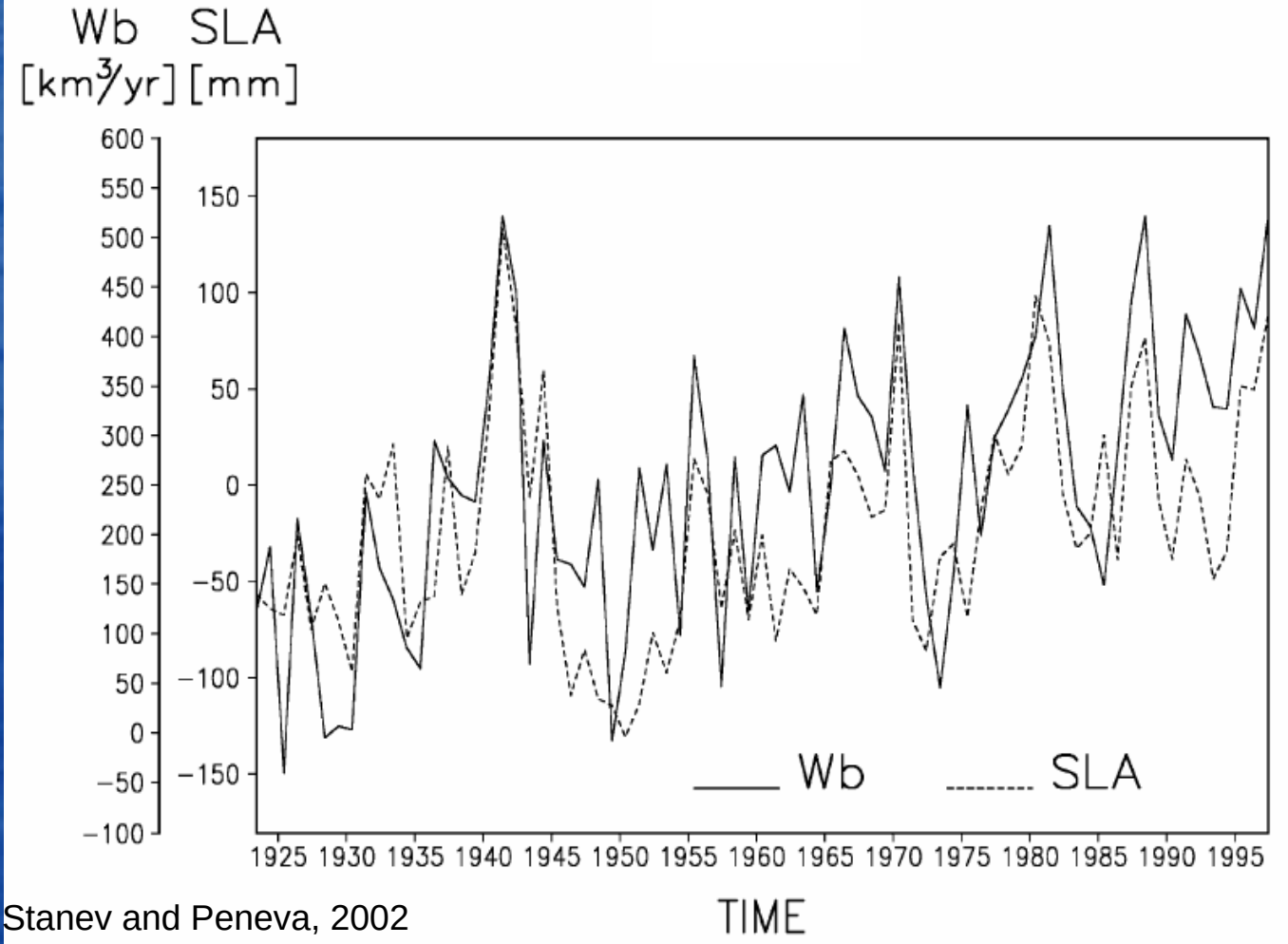
From Stanev and Peneva, 2002

Riverine input

Tsimplis et al., 2004

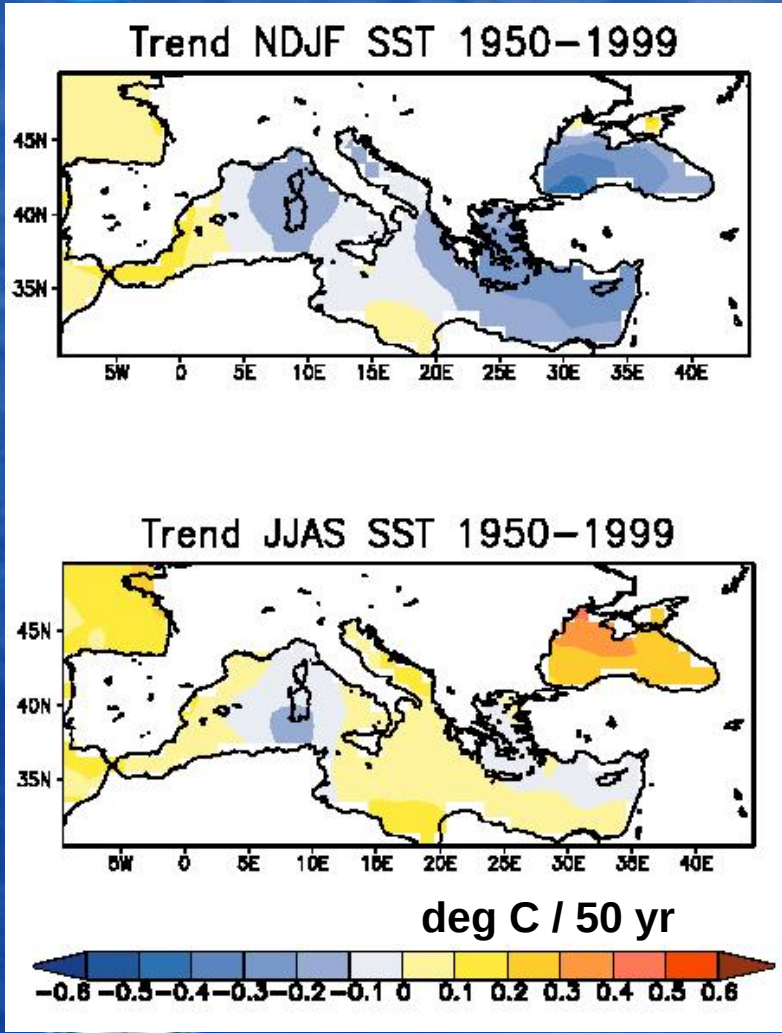


Meteorological variability



Stanev and Peneva, 2002

Meteorological Variability

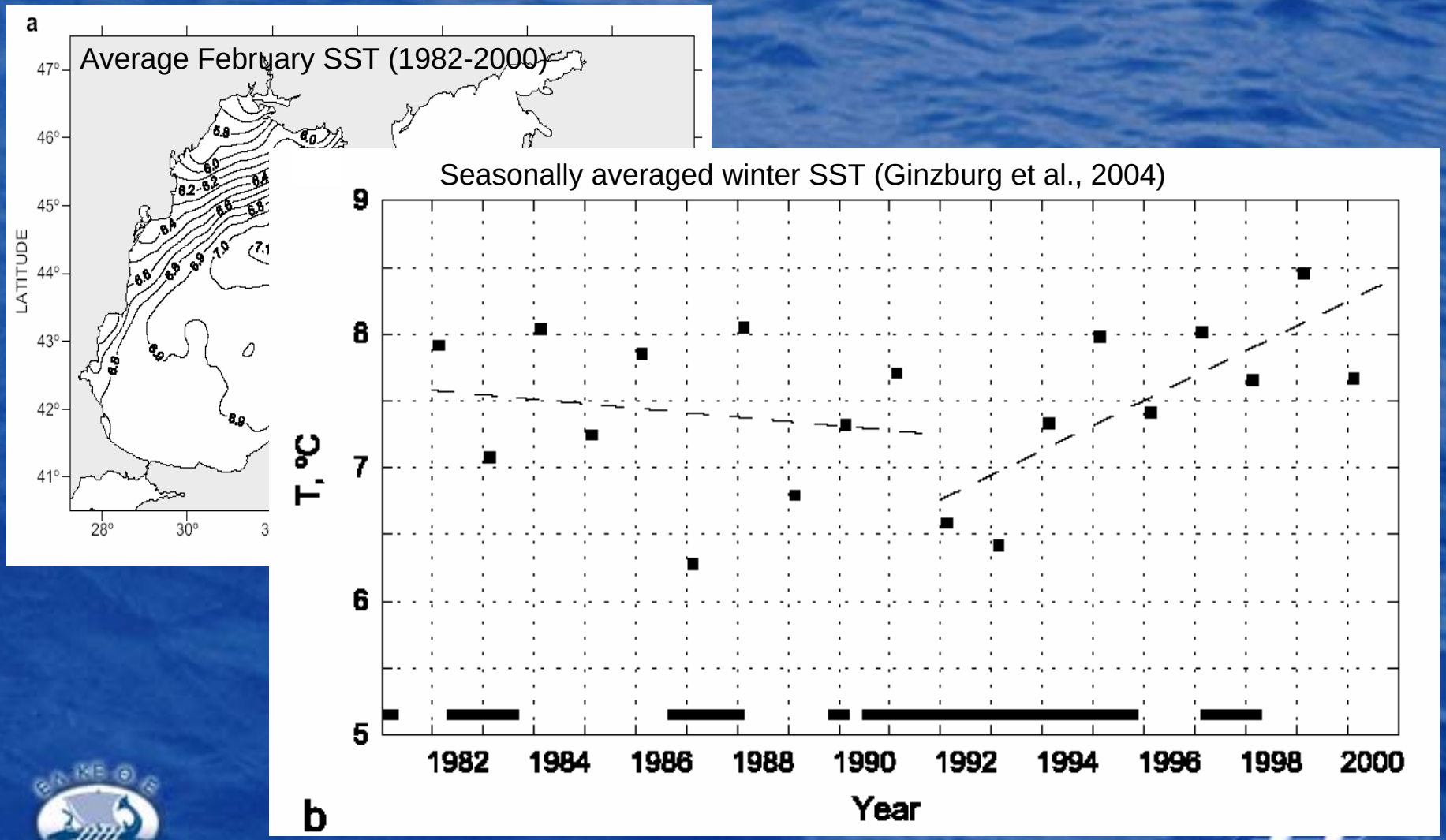


Winter SST trends: warming in the East, cooling in the West

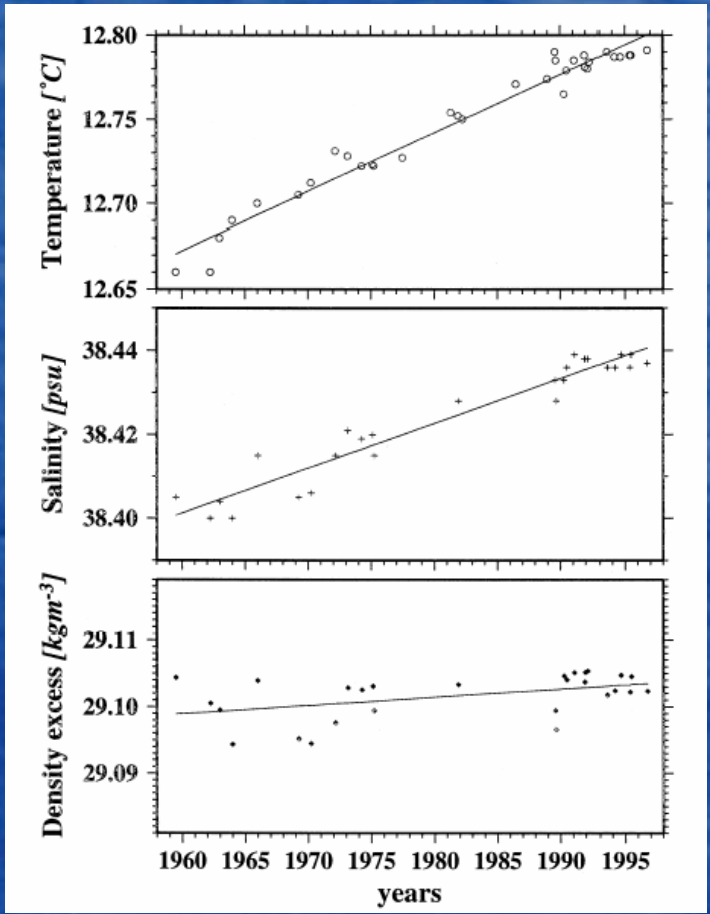
Summer SST trends: warming in East and West

From Xoplaki, 2002

Meteorological variability



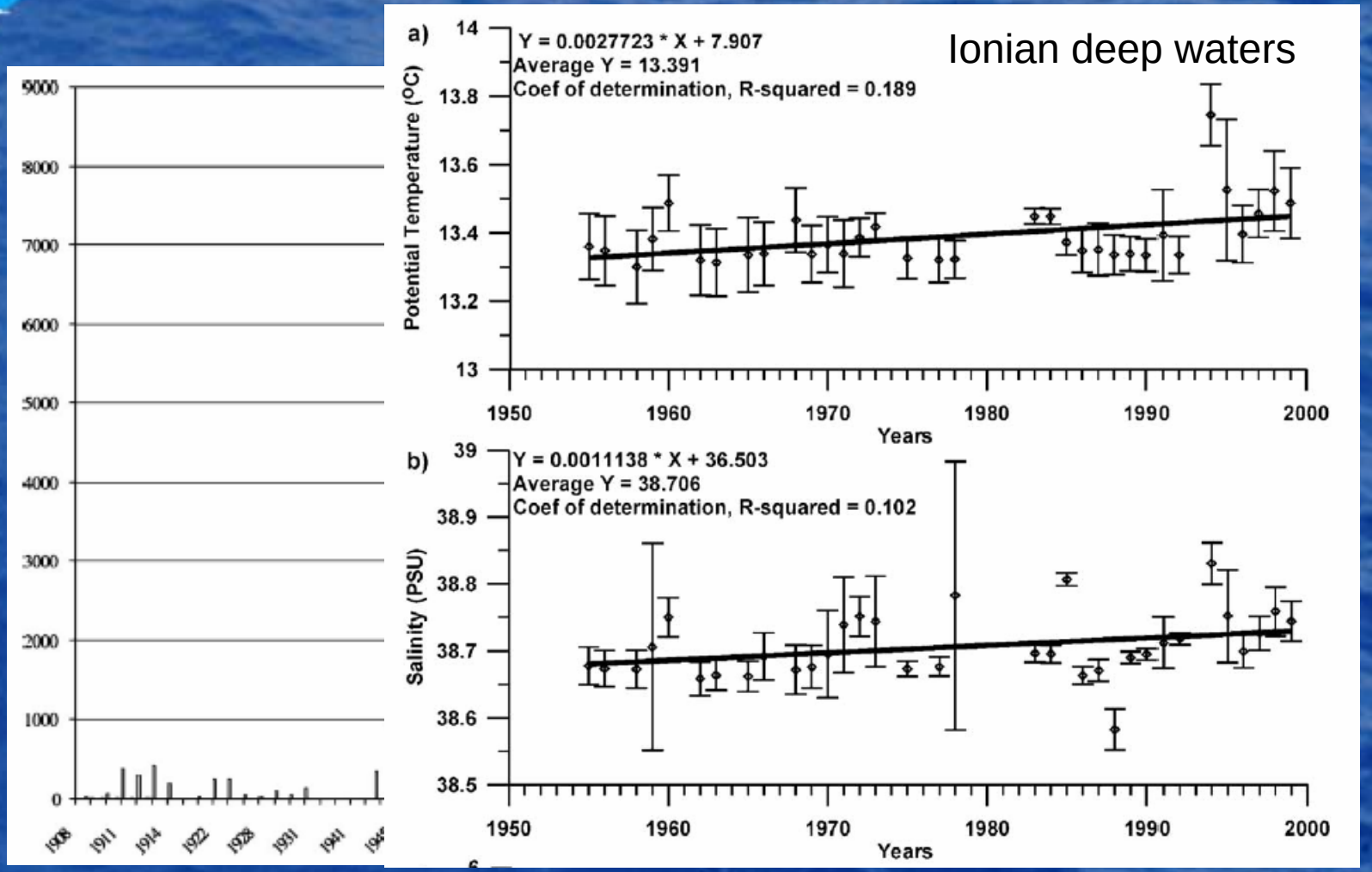
Thermohaline variability (WMed)



Bethoux and Gentili, 1999

- Variability first identified by Lacombe et al (1985)
- Several studies that followed certified that the deep waters are not in steady state (Charnock, 1989; Bethoux et al., 1990).
- Rohling and Bryden (1992) identified similar trends of LIW and the changes to anthropogenic changes (mainly Asswan dam)
- Bethoux and Gentili (1999) added a necessary contribution of reduced freshwater input from Central/Eastern European rivers (Tolmazin, 1985a).
- Damming the Nile river accounts only to about 45% of the salinity increase of WMDW (Skliris and Lascaratos; 2004).
- Damming the river Ebro (Ibanez et al., 1996; Martin and Milliman, 1997)
- Influence of NAO (Krahman and Schott;1998; Tsimplis and Josey, 2001)

Thermohaline variability (EMed)



Ionian deep waters

Manca et al., 2004

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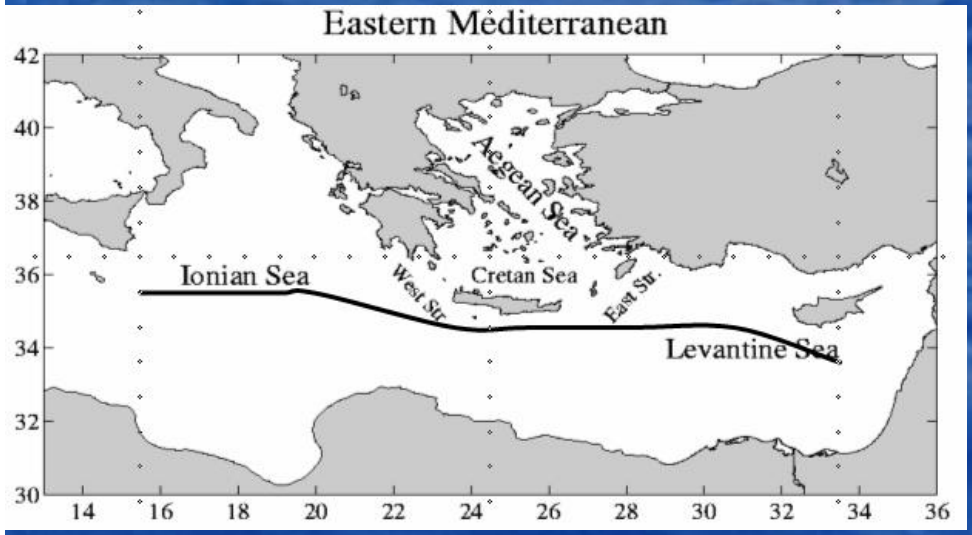
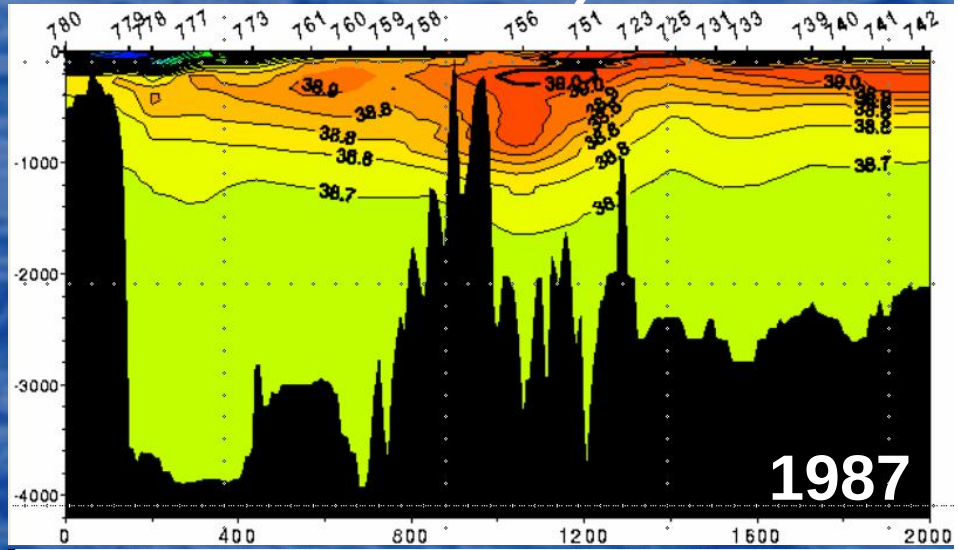
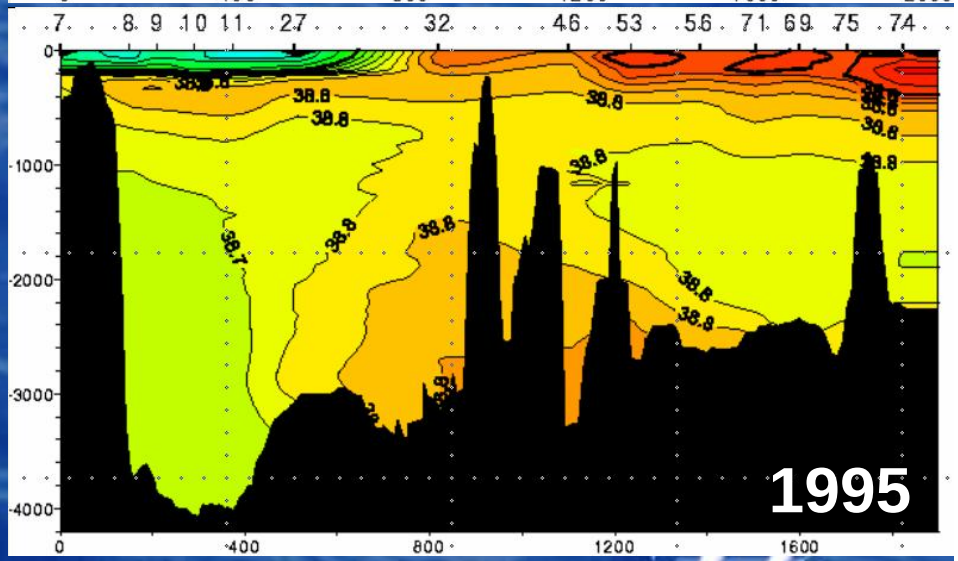
The E.M.T. event

(Eastern Mediterranean Transient)







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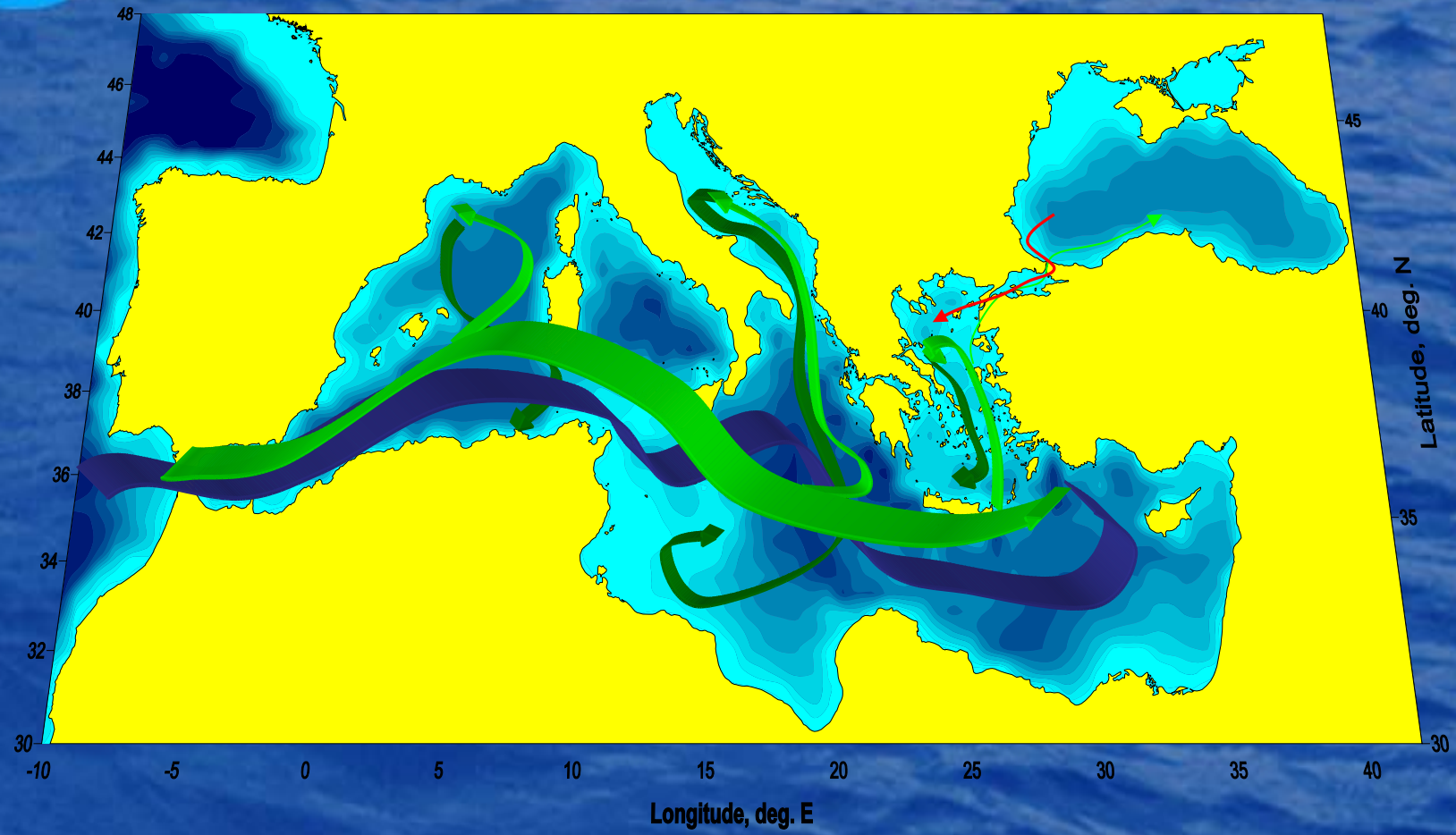
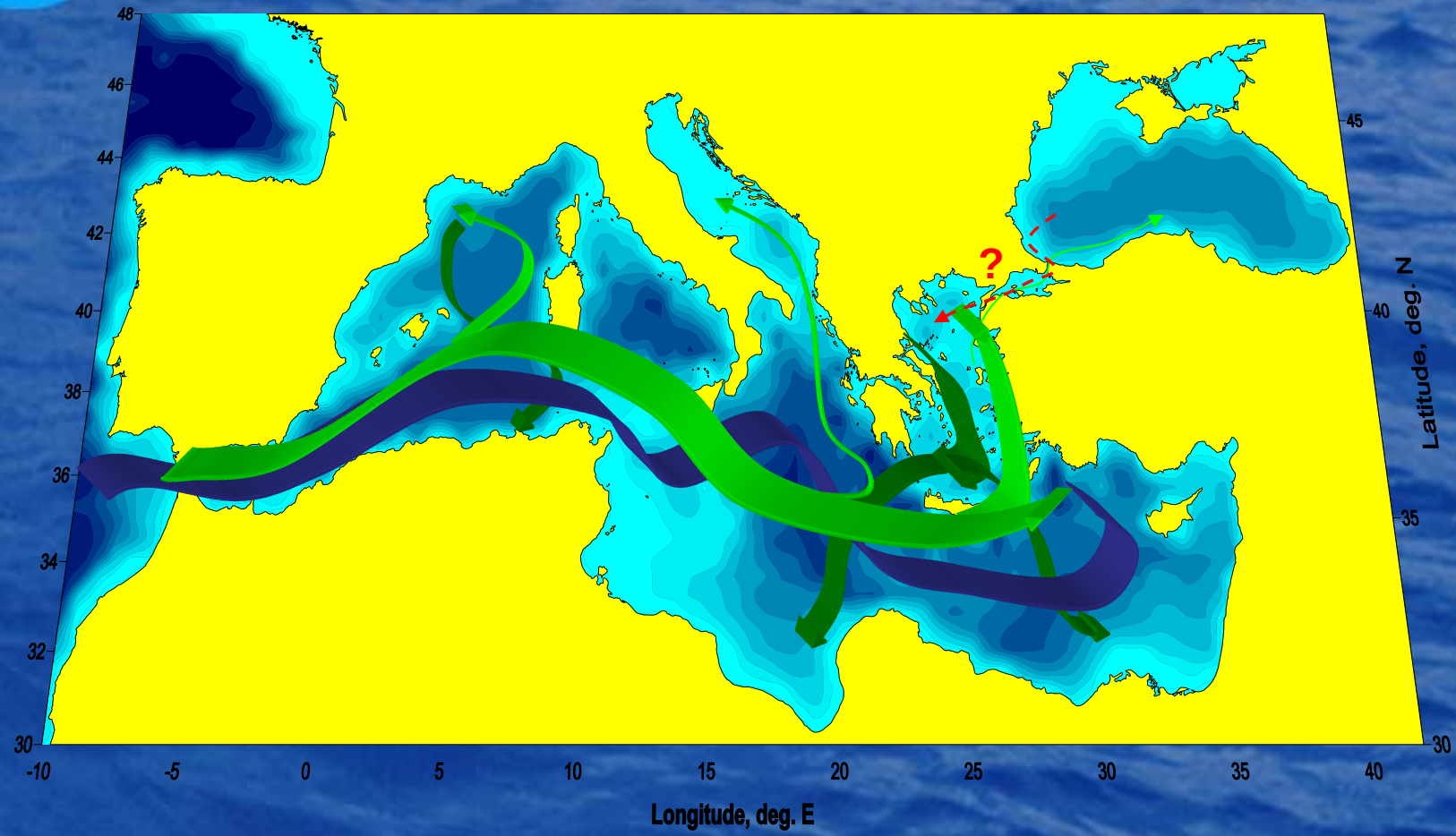
Regular circulation

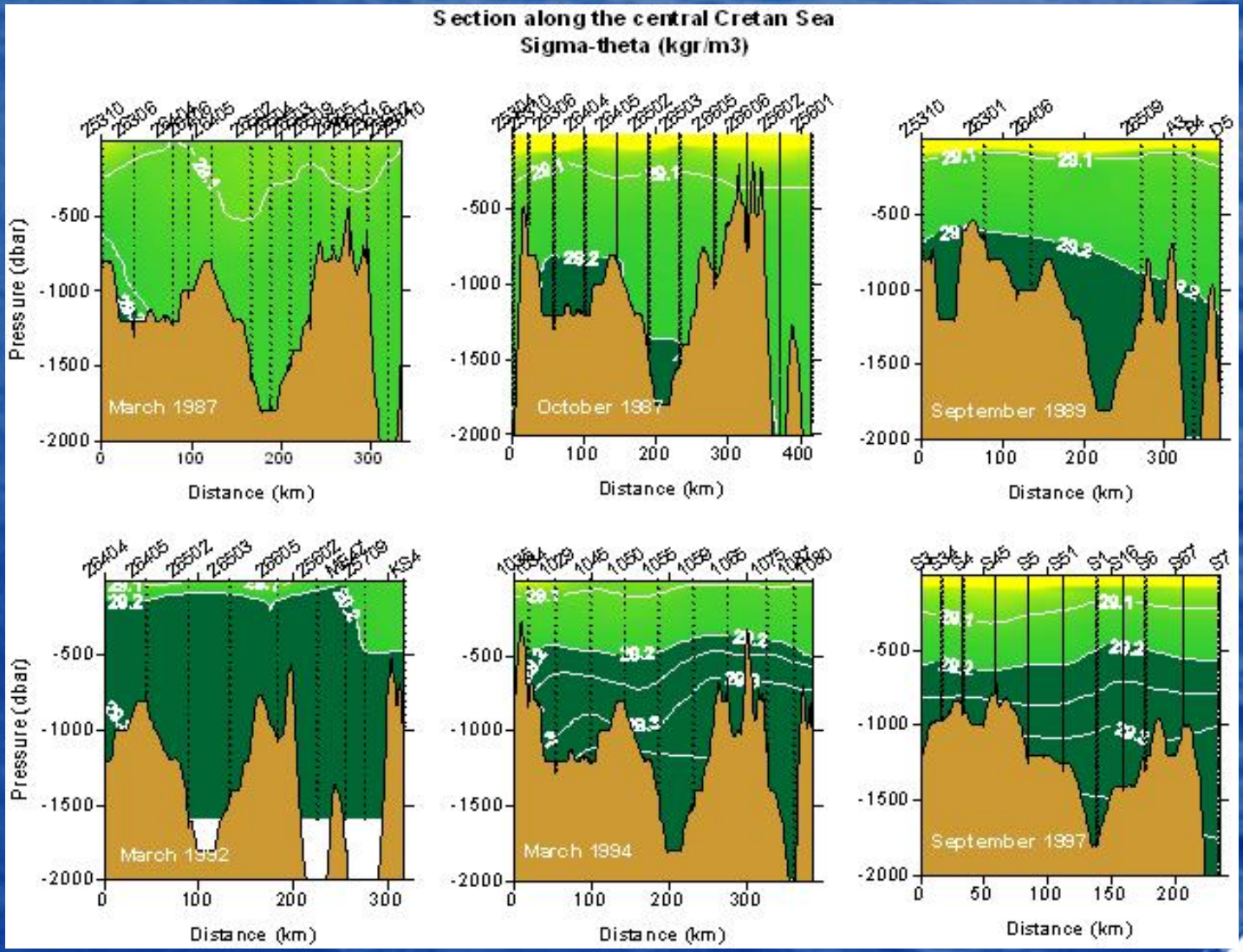


E.M.T. circulation



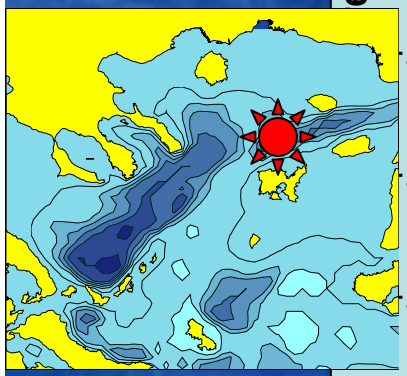
-200 -1000 -2000 -3000 -4000 -5000

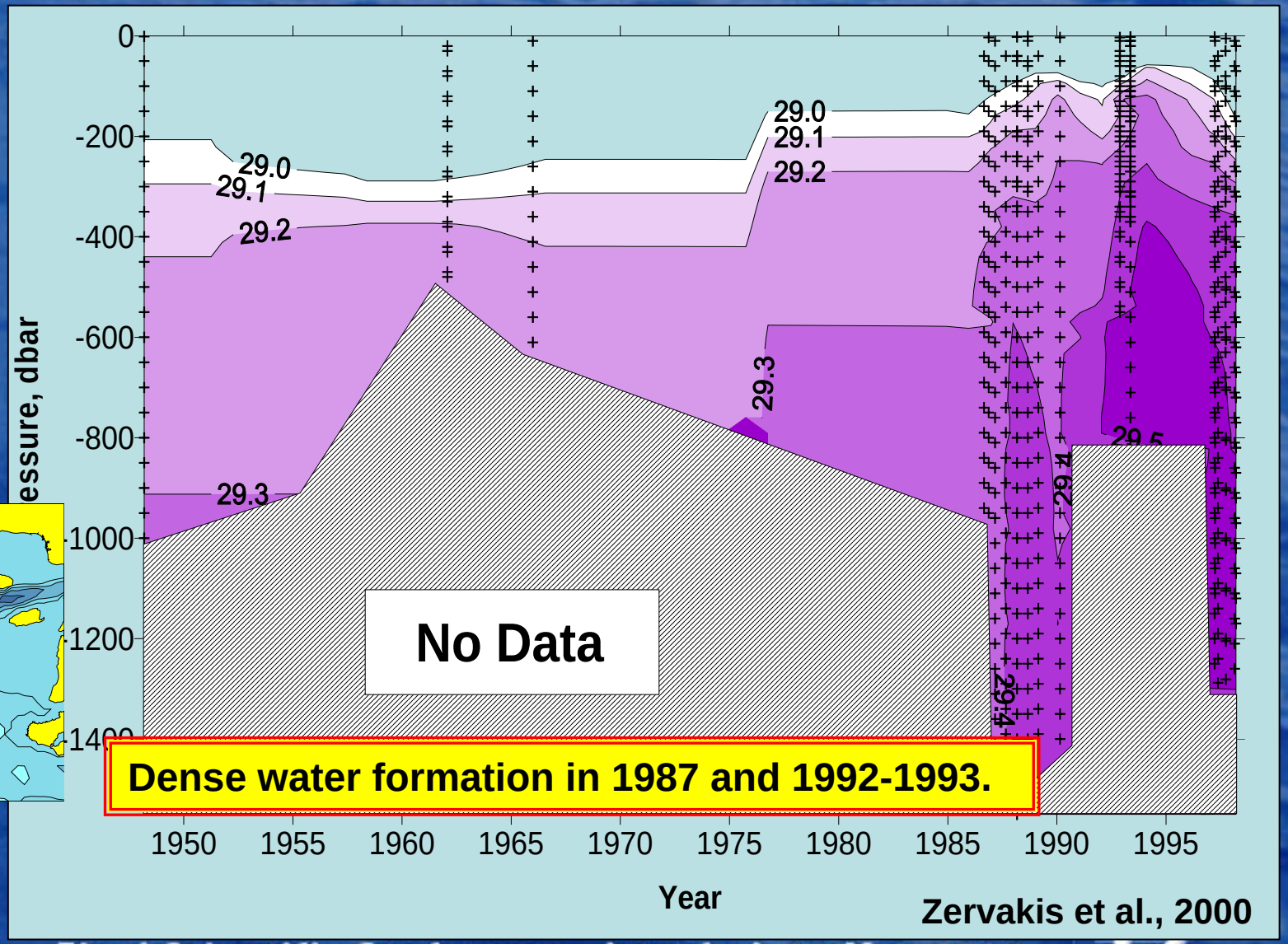
The E.M.T. event



Theocharis et al., 1999

The E.M.T. event





Dense water formation in 1987 and 1992-1993.

Zervakis et al., 2000

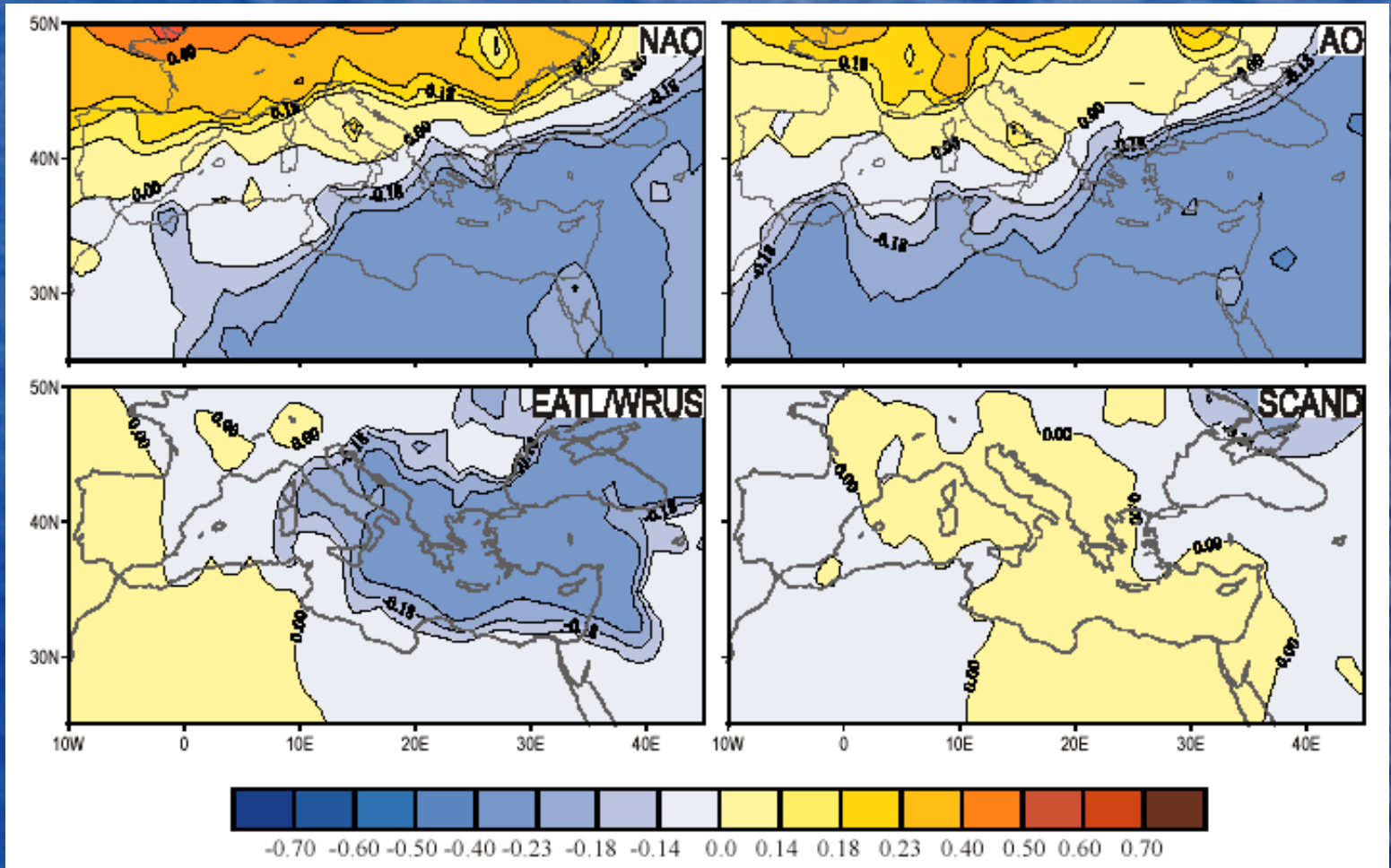
Scenarios for the EMT causes

Observed phenomena:

- Variability of local buoyancy forcing
- Change of wind climatology
- Change of circulation in the Ionian Sea
- Reduction of Black Sea buoyancy input
- Long term anthropogenic changes

The EMT should be a result of a combination of the above.

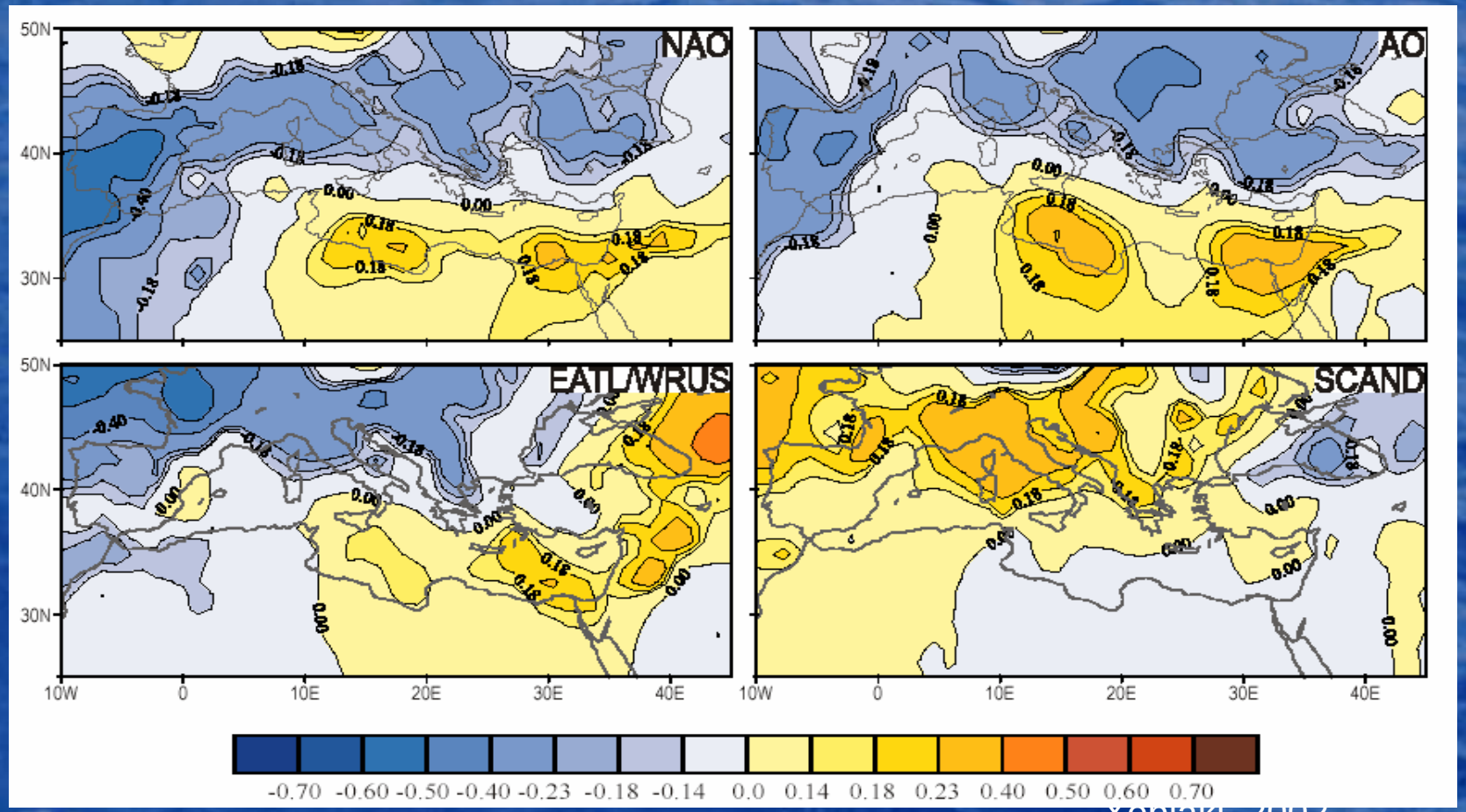
Teleconnections



Xoplaki, 2002

Correlation to winter air temperature

Teleconnections

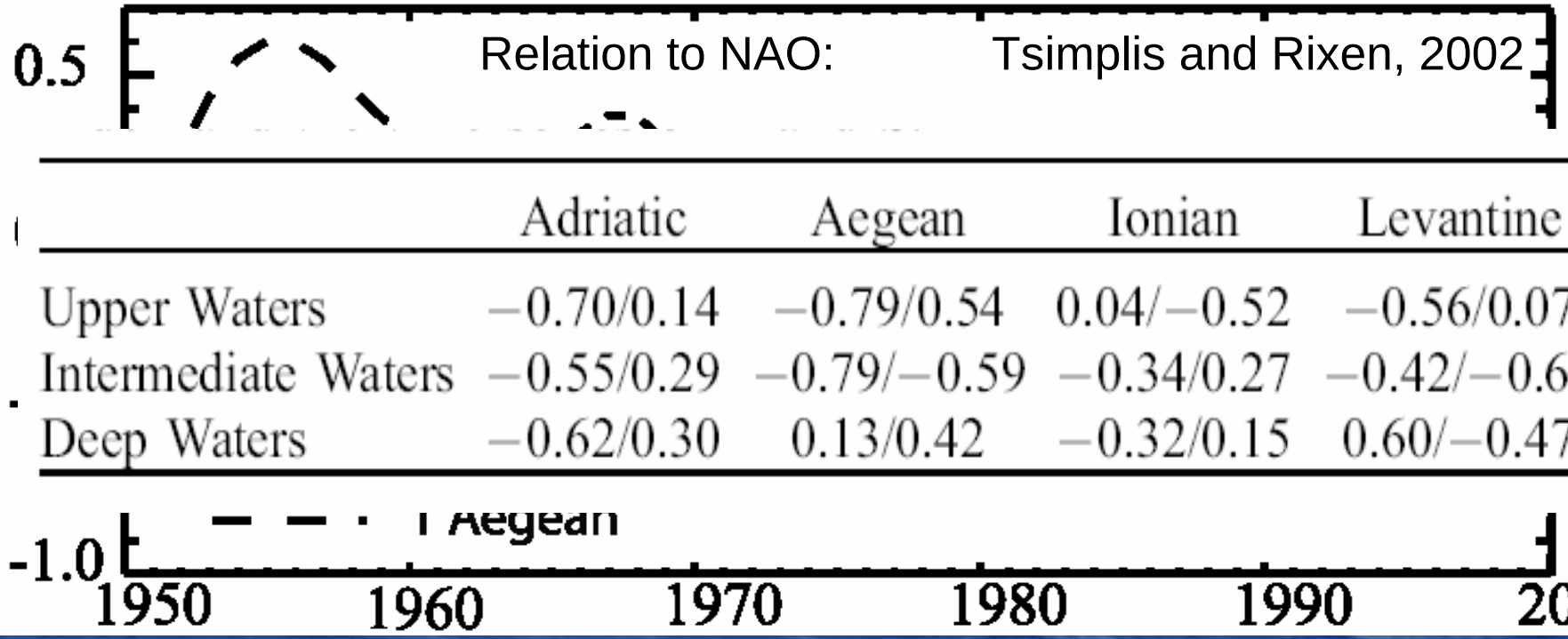


Xoplaki, 2002

Correlation to winter precipitation

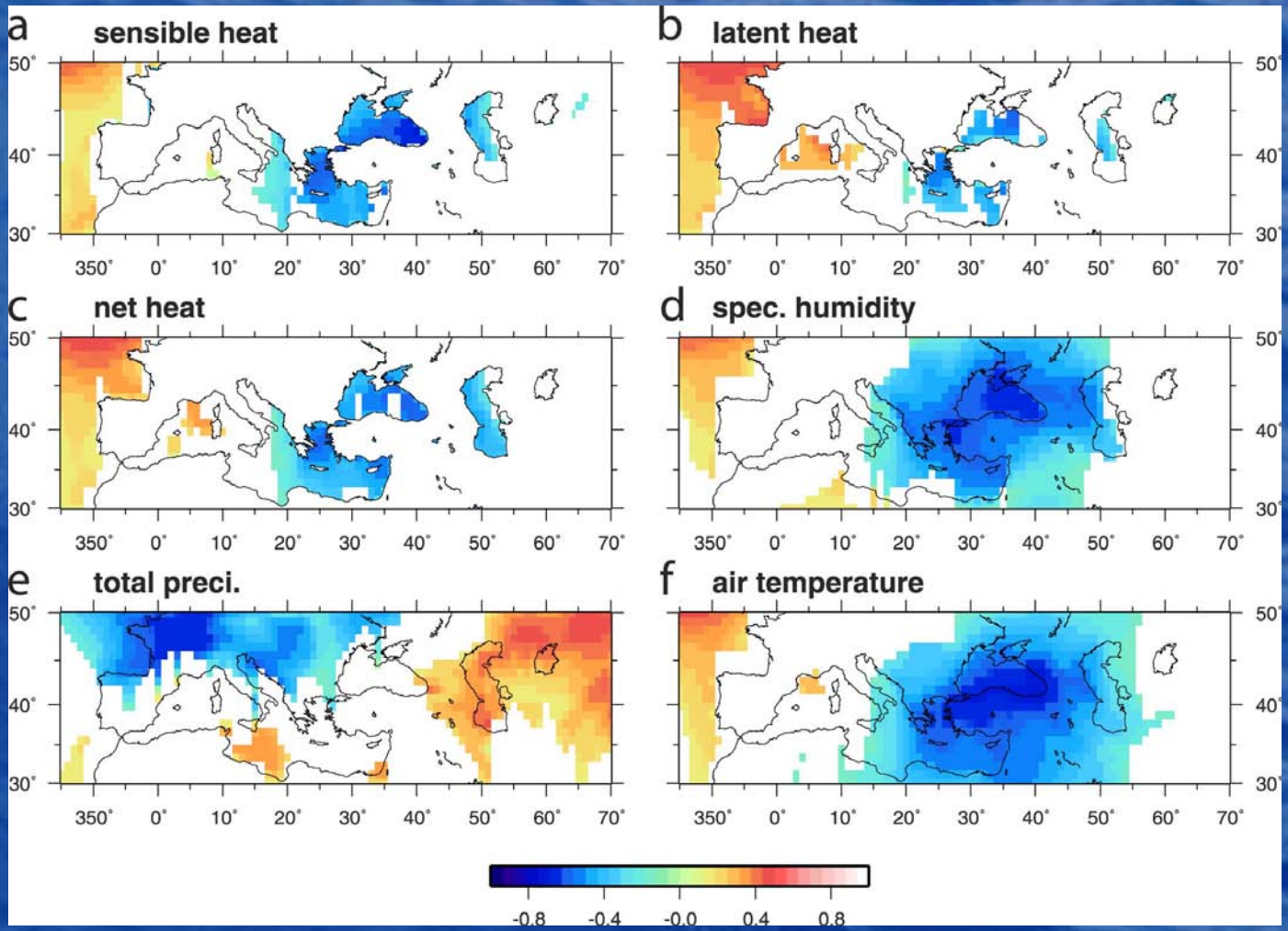
Teleconnections: NAO

Relation to NAO: Tsimplis and Rixen, 2002



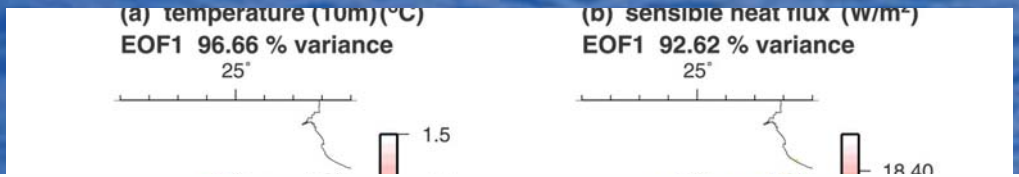
	Adriatic	Aegean	Ionian	Levantine
Upper Waters	−0.70/0.14	−0.79/0.54	0.04/−0.52	−0.56/0.07
Intermediate Waters	−0.55/0.29	−0.79/−0.59	−0.34/0.27	−0.42/−0.68
Deep Waters	−0.62/0.30	0.13/0.42	−0.32/0.15	0.60/−0.47

Teleconnections: NCP (or WRUS)



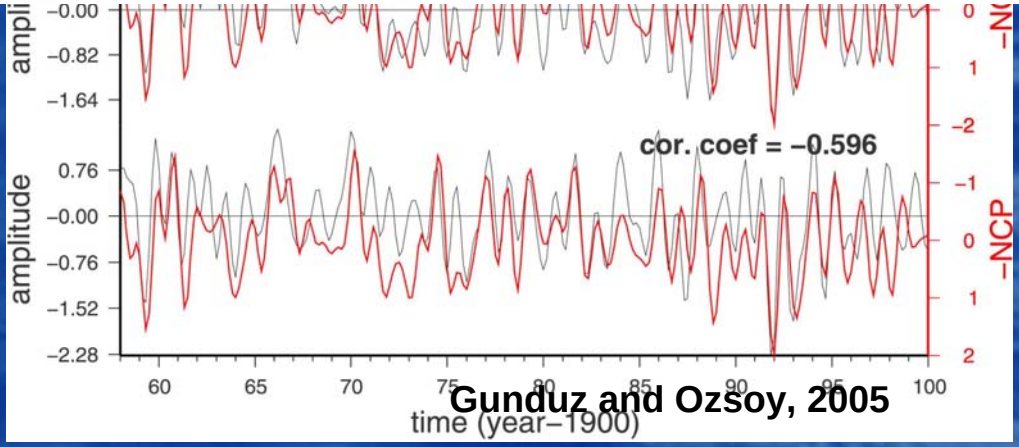
Gunduz and Ozsoy, 2005

Teleconnections: NCP (or WRUS)



	NWM				LVT				ADR				AEG				BLK				CAS			
	ts	eof	m	%	ts	eof	m	%	ts	eof	m	%	ts	eof	m	%	ts	eof	m	%	ts	eof	m	%
T	0.06	−0.52	3	2	−0.16	−0.57	1	93	−0.09	−0.36	2	6	−0.24	−0.63	1	97	−0.27	−0.69	1	95	−0.12	−0.38	1	86
H	0.09	−0.29	3	1	−0.22	−0.54	1	90	−0.11	−0.39	2	7	−0.27	−0.56	1	96	−0.30	−0.67	1	95	−0.15	−0.39	1	82
S	0.17	−0.52	3	3	−0.40	−0.50	1	88	−0.10	0.30	2	11	−0.50	−0.60	1	92	−0.57	−0.67	1	88	−0.30	−0.36	1	79
L	0.27	0.33	1	83	−0.35	−0.42	1	84	−0.04	−0.04	1	84	−0.50	−0.54	1	90	−0.40	−0.57	1	85	−0.21	−0.36	1	75
C	−0.42	−0.58	3	16	0.34	0.34	2	30	−0.22	−0.56	2	19	−0.05	0.63	1	68	0.24	−0.69	2	26	−0.48	−0.61	1	42
D	−0.43	−0.66	1	53	−0.09	−0.43	1	36	0.45	−0.56	1	58	0.55	−0.65	1	54	−0.38	−0.44	1	37	−0.38	0.65	2	22
X	−0.68	−0.70	1	74	−0.05	0.47	3	5	−0.49	−0.46	1	84	−0.60	−0.60	1	82	0.24	−0.57	2	13	0.50	0.52	2	20
Y	0.07	−0.57	3	5	−0.46	0.47	1	72	−0.46	0.51	2	16	−0.65	−0.67	1	89	−0.56	−0.61	1	81	−0.59	−0.61	1	70

[a]Higher correlations are statistically significant according to the students's t test with significance level 0.05. NWM, North Western Mediterranean; LVT, Levantine Sea; ADR, Adriatic Sea; AEG, Aegean Sea; BLK, Black Sea; CAS, Caspian Sea; T, temperature; H, specific humidity; S, sensible heat flux; L, latent heat flux; C, curl of wind stress; D, divergence of wind stress; X, zonal component of wind stress; Y, meridional component of wind stress.



Gunduz and Ozsoy, 2005

Teleconnections and EMT

- Thus, the EMT could be directly forced by a teleconnection.
- The exchange between Black Sea and the Mediterranean still may have played an important role, through the reduction of buoyancy contribution to the North Aegean.
- Massive dense water formation in the North Aegean in 1987 preconditioned the Sea for the second major event, in 1992-1993.
- While the E.M.T. was well recorded regarding physics, the ecosystem response is not as well known.
- Monitoring is crucial