INTERNATIONAL CONFERENCE ON
MOUNTAINS AND CLIMATE CHANGE

CLIMATE CHANGE, IMPACTS AND ADAPTATION IN THE MEDITERRANEAN REGION

Vincenzo Artale
Director, Unità Tecnica Modellistica Energetica Ambientale (UTMEA)
ENEA, CR Casaccia, Rome (Italy)
http://utmea.enea.it/

High Summit
LECCO 2013

Contents

- ✓ Peculiarities of the Mediterranean Region
- ✓ PROTHEUS Regional Earth System
- ✓ Today climate and future climate scenarios
- ✓ Impacts and adaptation in the Mediterranean Region

High Summit
LECCO 2013

Mediterranean climate
(is relevant for global climate studies?)

The Mediterranean is located in a transitional zone where mid-latitude and tropical variability are both important and compete

The northern part of the Mediterranean region presents a Maritime west coastal climate while the southern part is characterized by a Subtropical desert climate

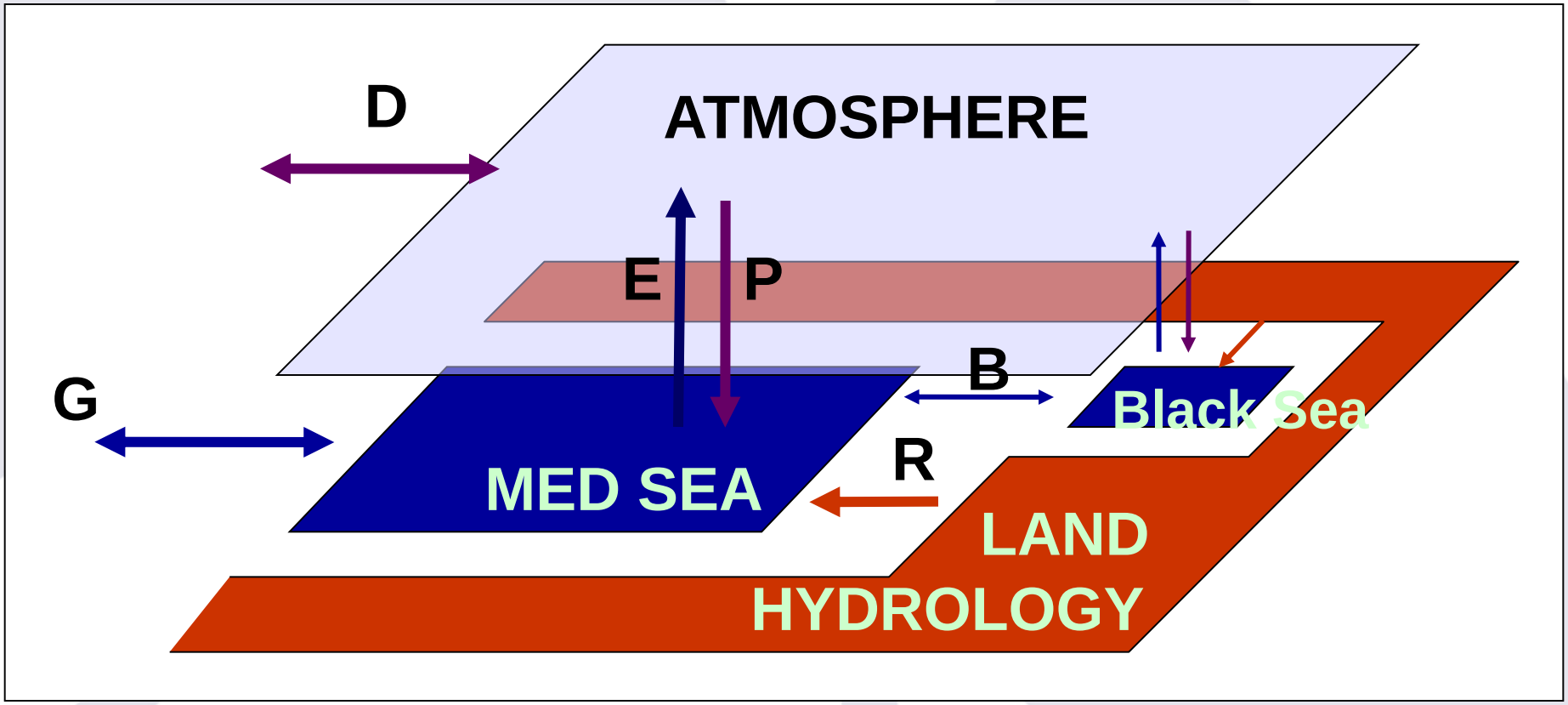
in summer is exposed to South Asian Monsoon and the Siberian high pressure system in winter

The southern part is mostly under the influence of the descending branch of the Hadley cell, while the northern is more linked to NAO and other mid-latitude teleconnections patterns

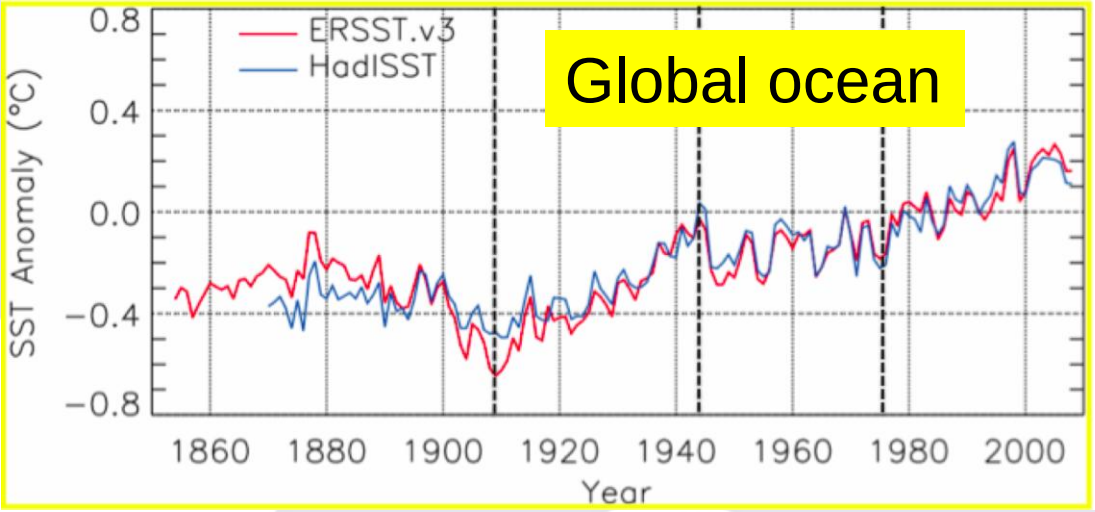
The Mediterranean is a evaporative regions in which the salinity within the water column, including deep water, are changing

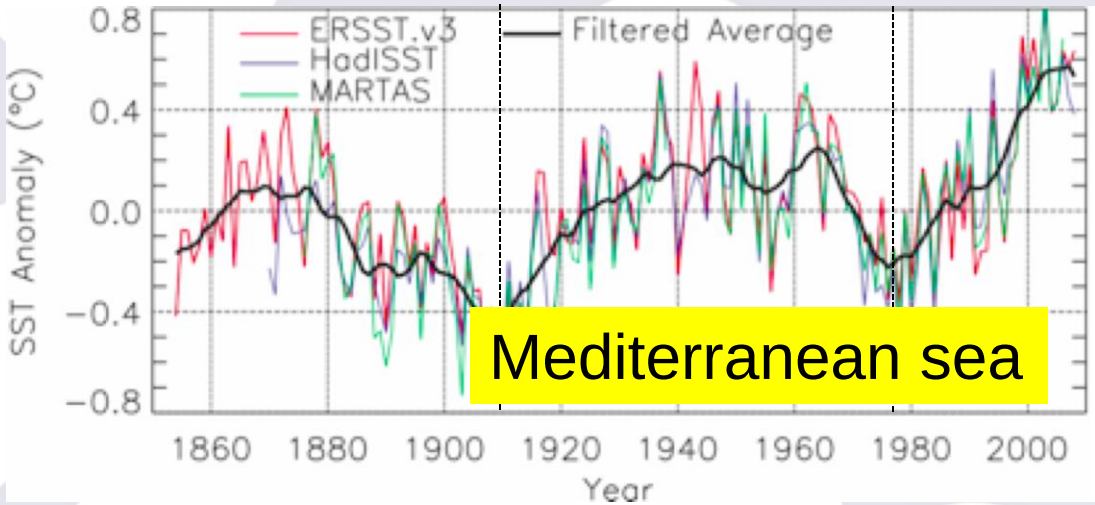
Hydrological cycle

E=-3.20 , P= 1.40, R= 0.30, B= 0.20, G= 1.30 (mm/d)

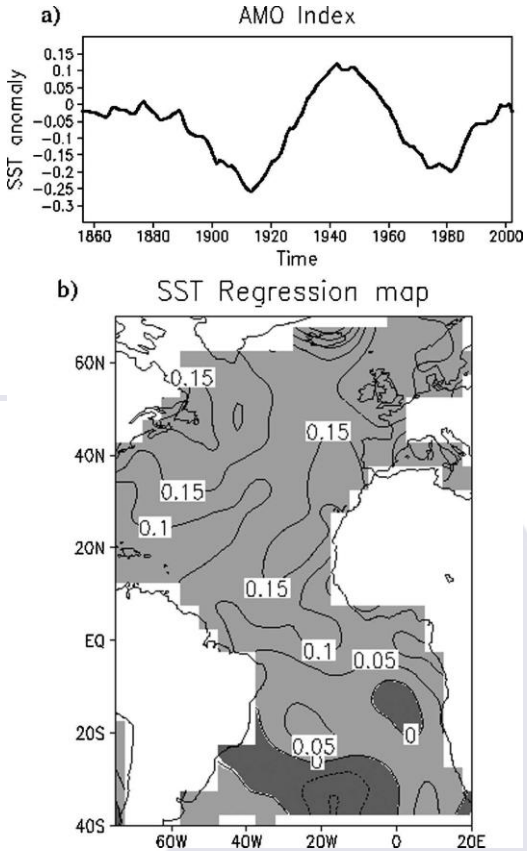


Peculiarities of Mediterranean sea: **SST**





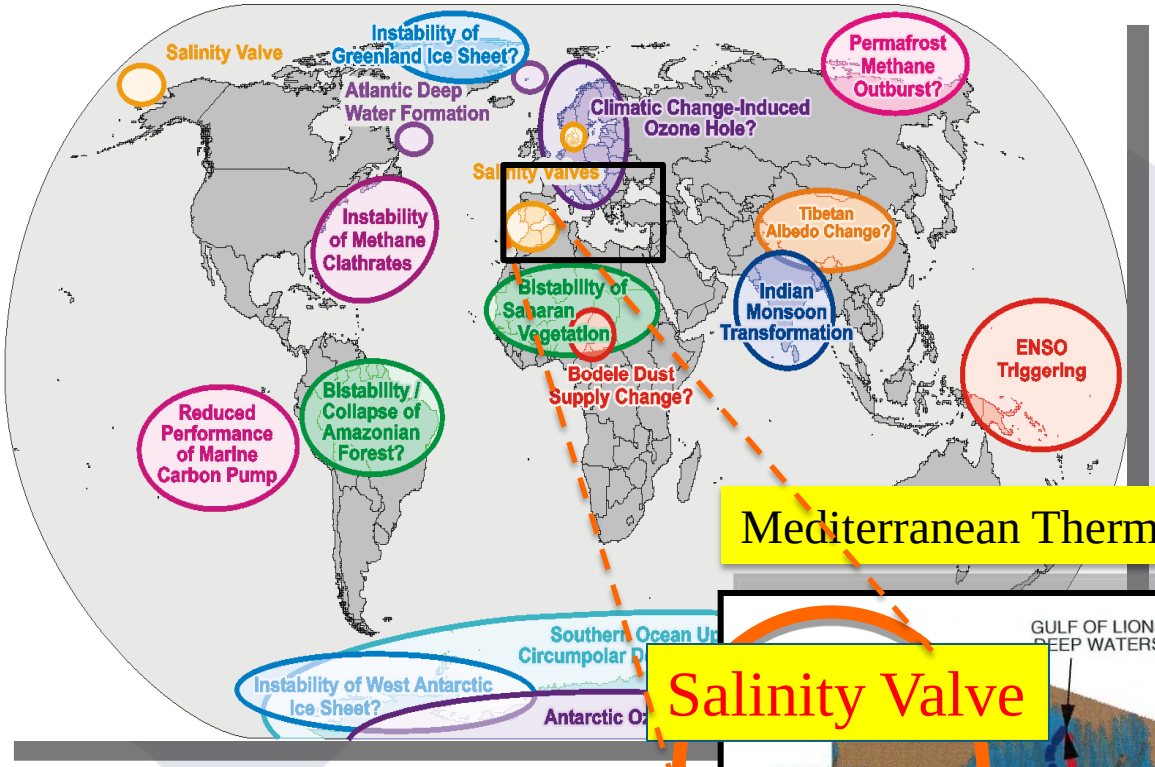
AMO INDEX



Marullo, Artale and Santoleri, J. of Climate, 2011

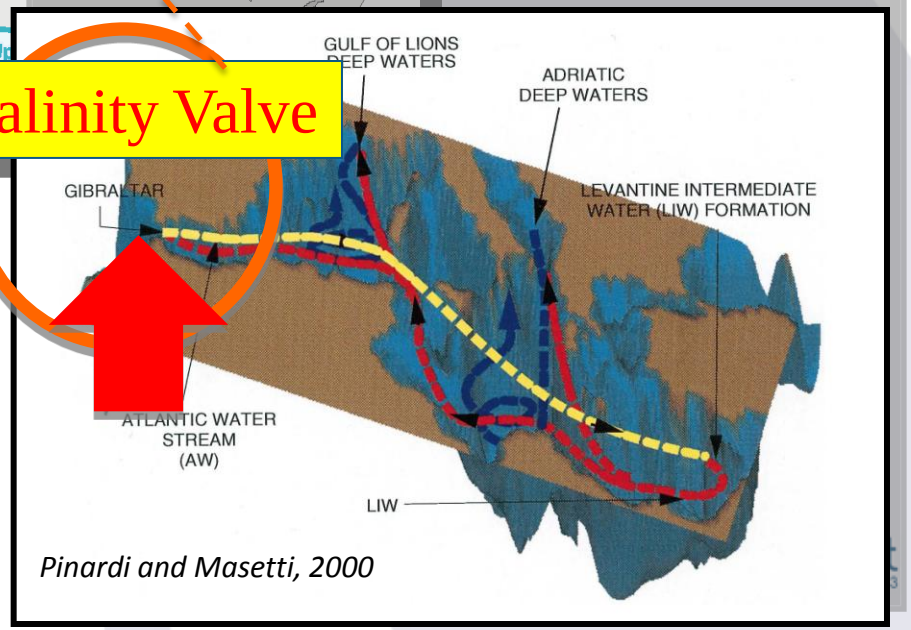
High Summit LECCO 2013

Tipping points in the Earth climate system
(where a small change in forcing causes a qualitative change in their future state)



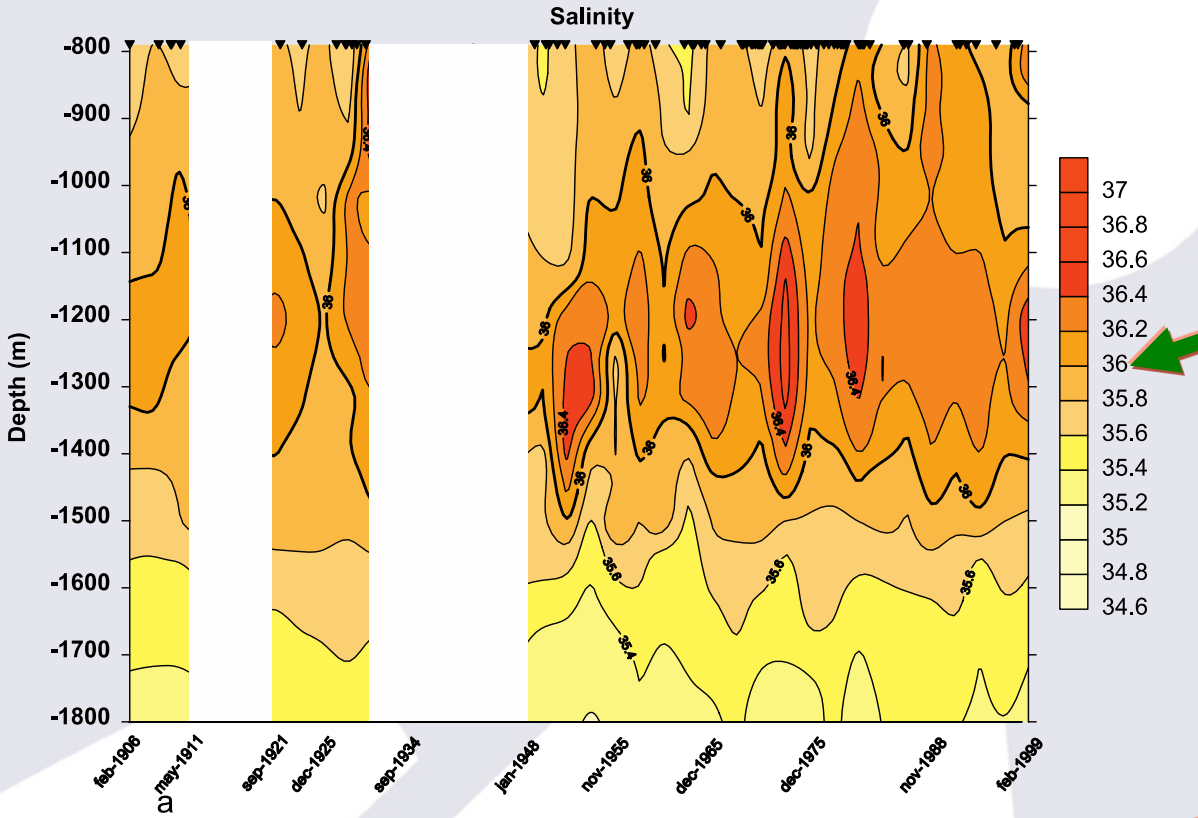
Mediterranean Thermohaline Circulation

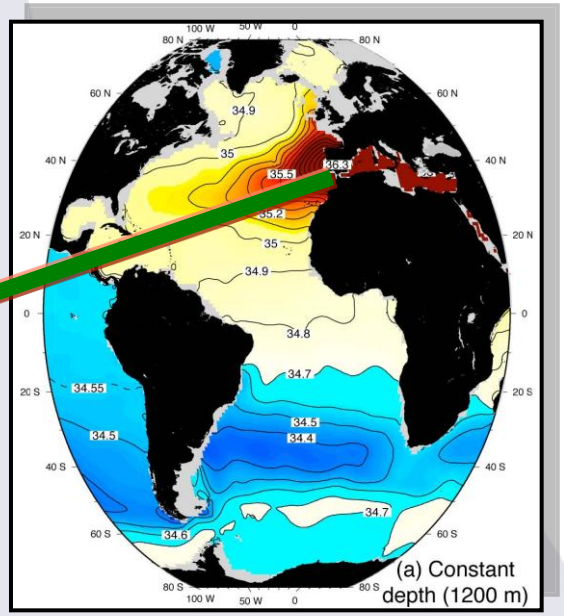
Salinity Valve

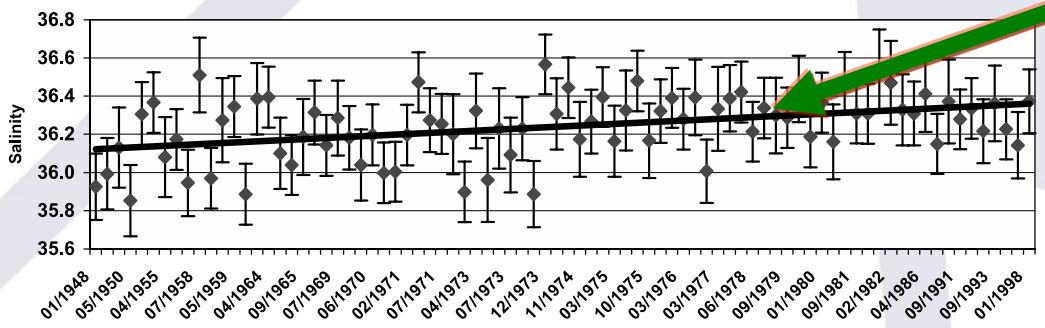


Lenton, T. M. et al., Tipping Elements in the Earth's Climate System. Proceedings of the National Academy of Science 105 (6), 1786 (2008).
Kreigler, E. et al., Imprecise probability assessment of tipping points in the climate system. Proceedings of the National Academy of Science, (2009).

Mediterranean-Atlantic basin interchange: MOW







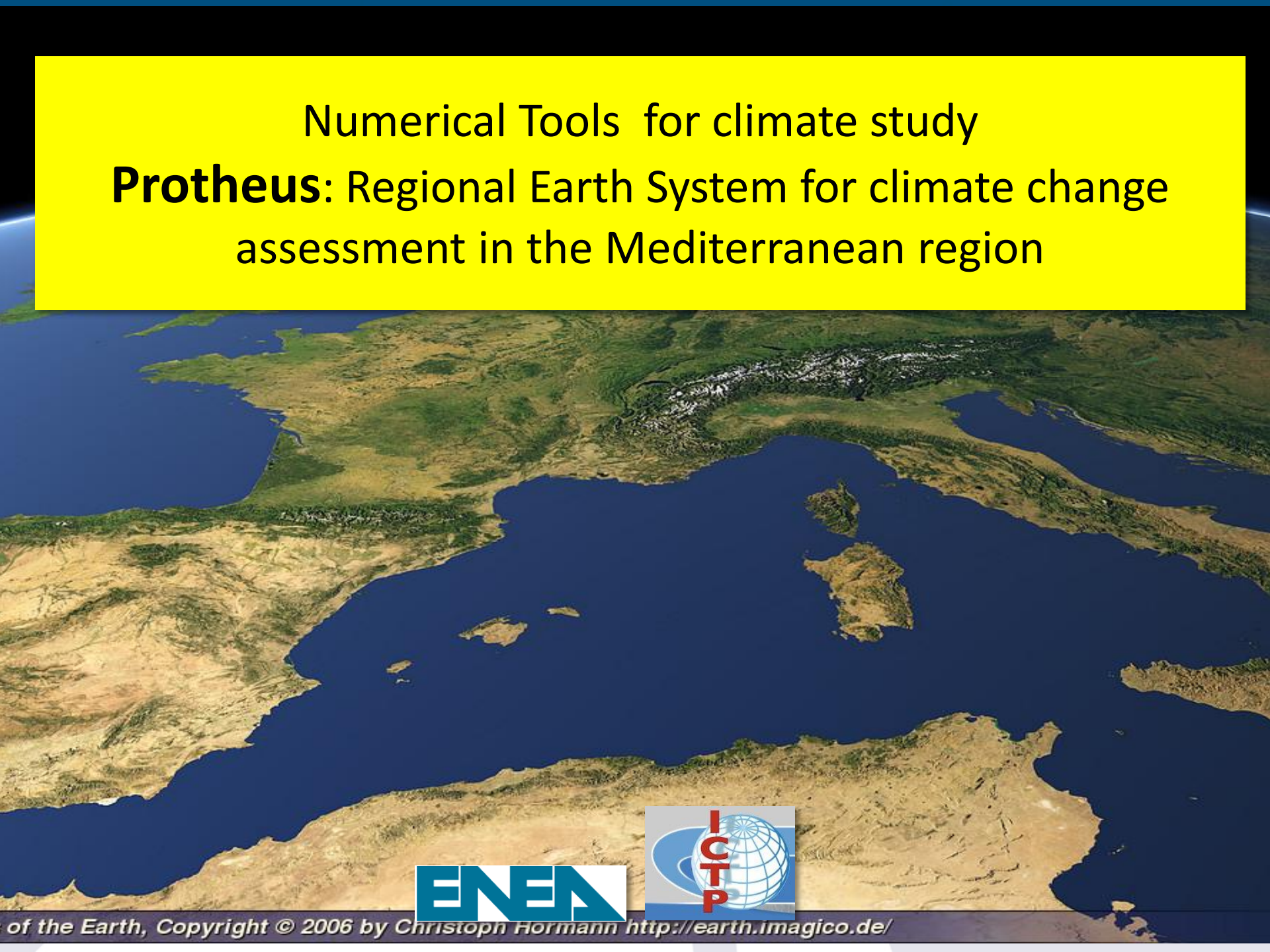
increase of salinity

(Fusco et al., Deep-Sea Res., 2008)

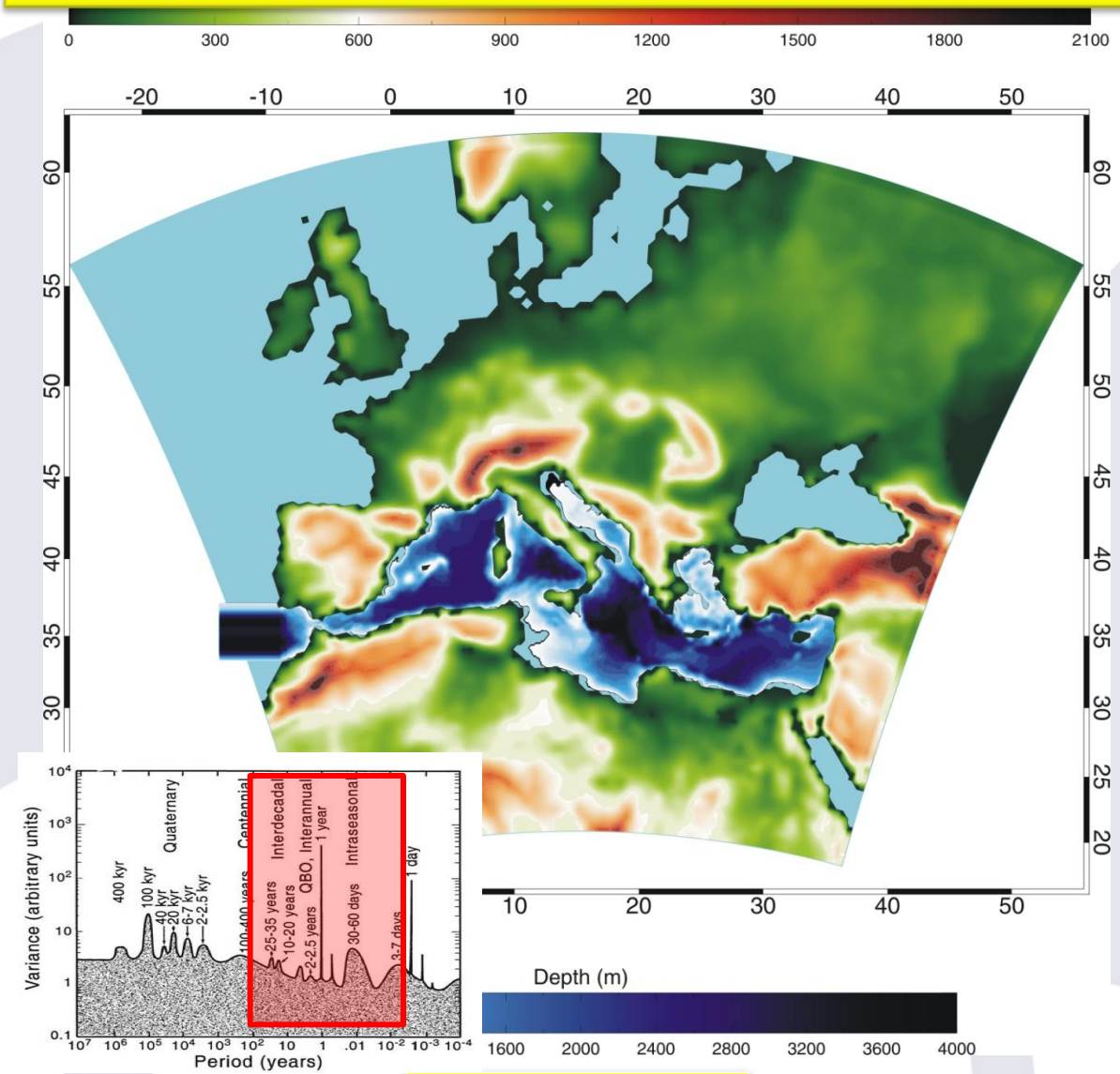
High Summit LECCO 2013

Numerical Tools for climate study

Protheus: Regional Earth System for climate change assessment in the Mediterranean region



ENEA Regional earth system model for the Mediterranean region: PROTHEUS



Model domain

Model components

RegCM3

18 sigma vertical levels

30 Km horizontal resolution

BATS + IRIS

BATS: Biosph.-Atmosph. Transfer Scheme

IRIS: interactive RIvers Scheme

HF-WF-Wind

OASIS 3
Freq. 6h

SST

MedMIT

42 zeta vertical levels (partial cell)

1/8° x 1/8° horizontal resolution

High Summit LECCO 2013

ENEA involvement in projects for Mediterranean climate variability

CLIM-RUN
Climate Local Information in the Mediterranean region Responding to User Needs

Climate Local Information Responding User Needs, Climate Services in EU – Energy and Toursim sectors (ENEA coord)

IMPACT 2C

Quantifying projected impacts under 2° C warming – (HZG Coord., ENEA italian partner)

SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

SPECS will deliver a new generation of climate prediction systems for seasonal-to-decadal time scales, to provide actionable climate information for a wide range of users.

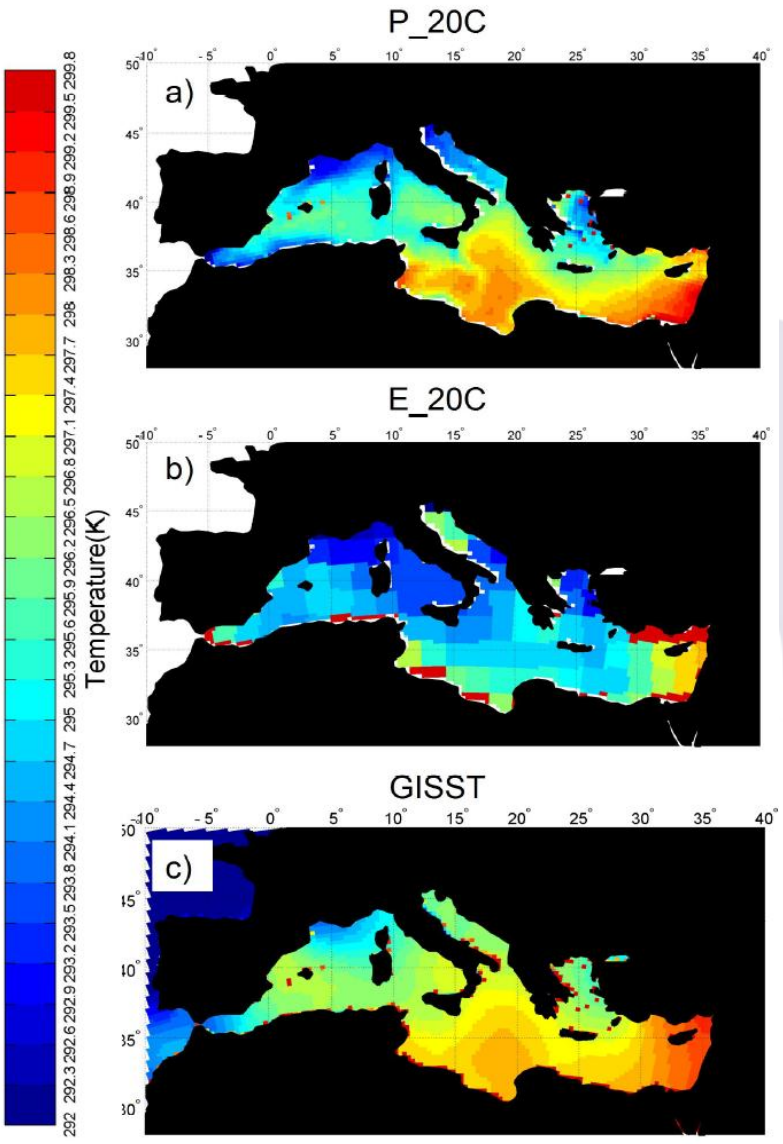
European Provision Of Regional Impacts Assessments on Seasonal and decadal timescales

EUPORIAS

SEVENTH FRAMEWORK PROGRAMME

High Summit
LECCO 2013

PROTHEUS Validation: Sea Surface Temperature (SST)



(Dell'Aquila et al., Climate Research, 2011)

INTERCOMPARISON BETWEEN REGIONAL -GLOBAL MODELING AND OBSERVATION

P_20C: SST (summer) generated by PROTEHUS driven by ECHAM5-MPI/OM at the lateral boundaries.

E_20C: SST (summer) generated by ECHAM5-MPI/OM

GISST: Observed SST (summer), from Rayner et al. 2006

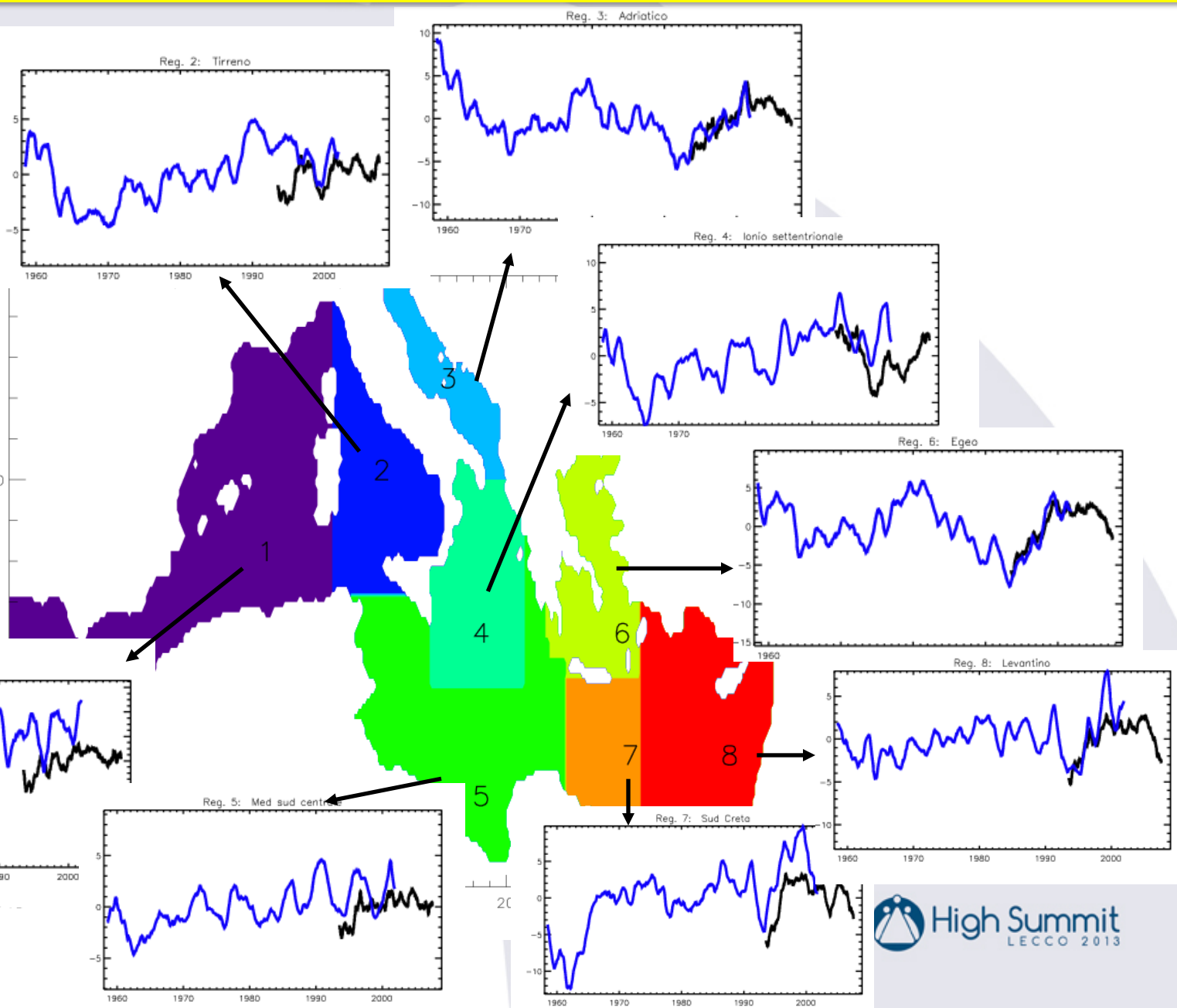
PROTHEUS corrects the large cold bias which affects the global driver

As no data assimilation is performed in the regional simulation, the improved description of the SST seasonal pattern is a pure result of the coupling

High Summit LECCO 2013

PROTHEUS Validation: Sea Level Anomalies (Carillo et al., Climate Dynamics 2012)

Total sea level anomalies for the Mediterranean sub-basins.
Values computed from PROTHEUS ERA40 run (blu line) & altimeter data (black line).

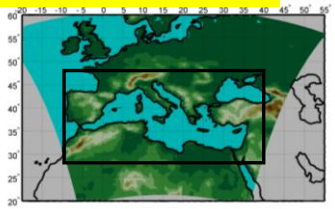


High Summit
LECCO 2013

Scenario Simulations: PROTHEUS driven by ECHAM5-MPIOM (1951-2050)

Global drivers and regional downscaling over land

Dell'Aquila et al
2012, Clim. Res.

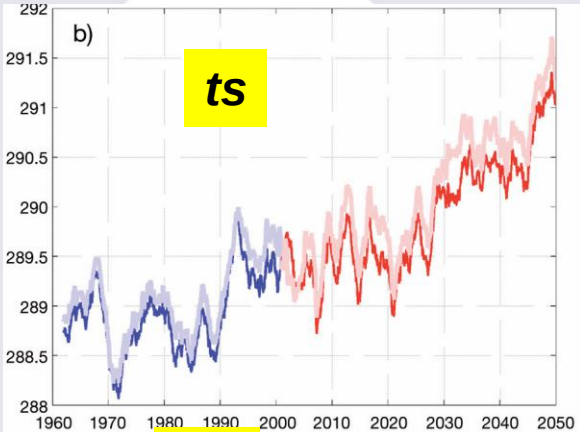


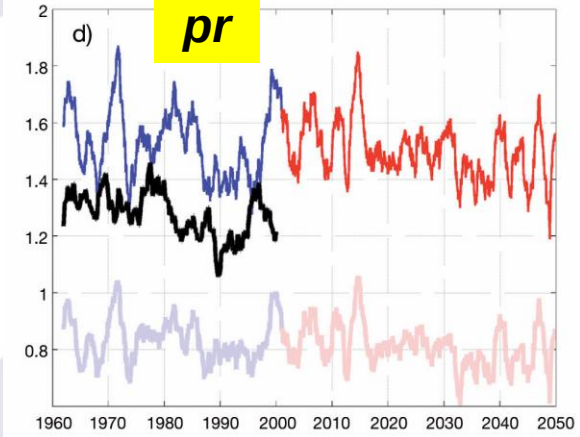
PROTHEUS 20 C
ECHAM5-MPIOM 20C
PROTHEUS A1B
ECHAM5-MPIOM A1B

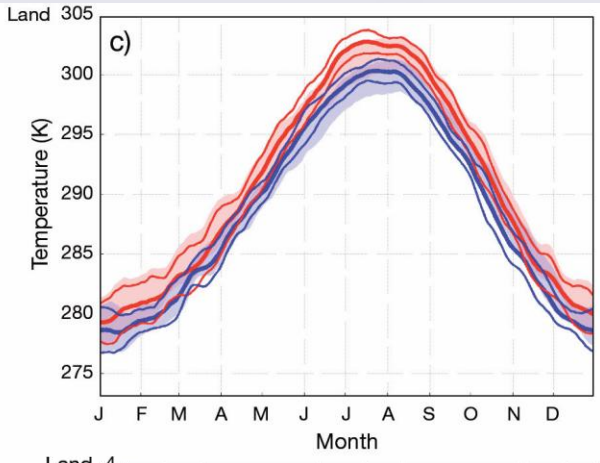
Annual mean

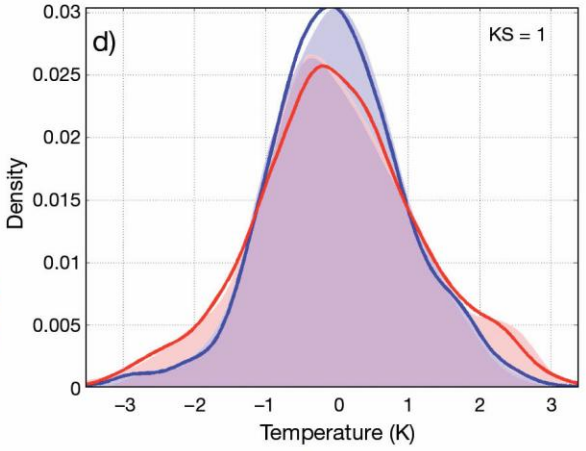
Seasonal cycle

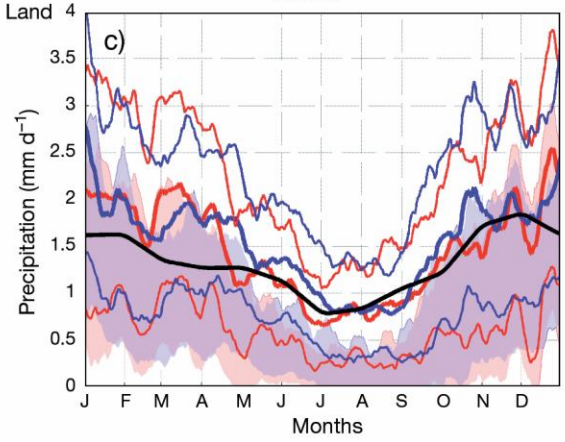
Deviations from Seasonal cycle

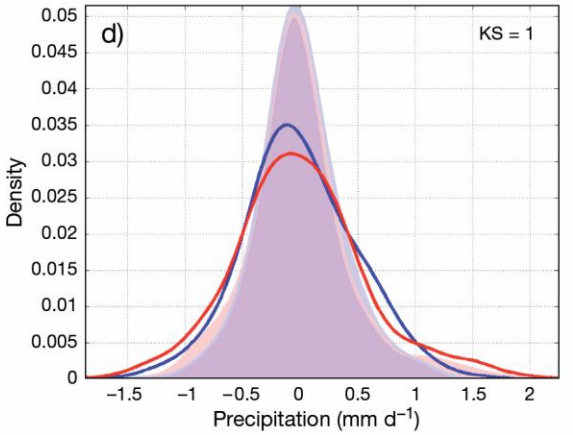






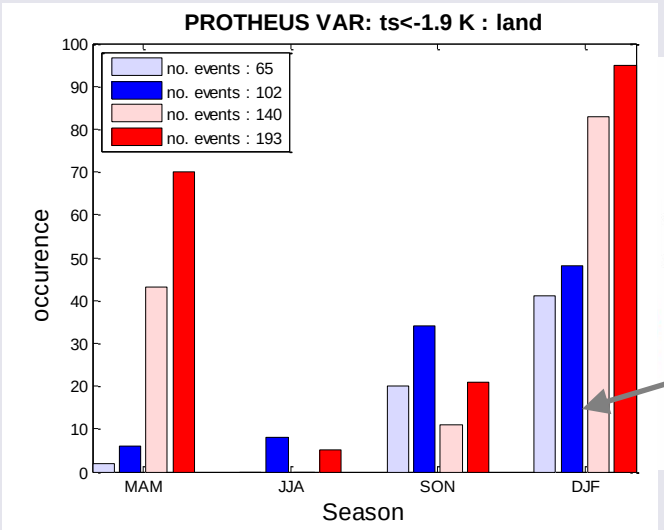




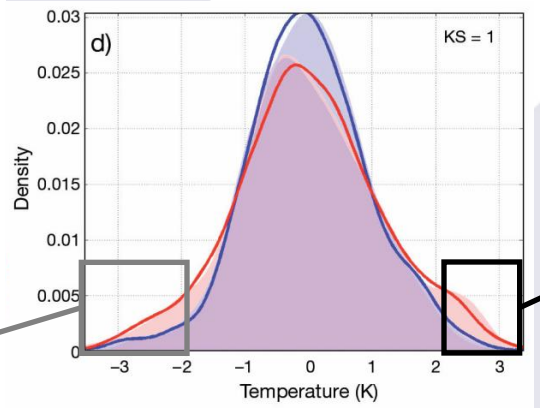


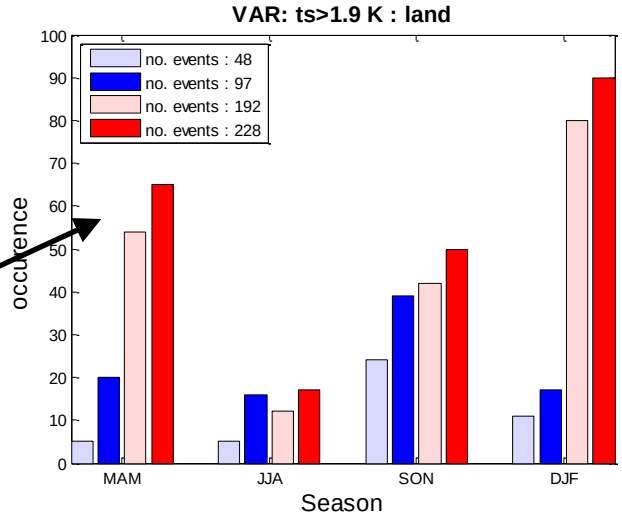
Scenario Simulations: PROTHEUS driven by ECHAM5-MPIOM (1951-2050)

Large anomalies from seasonal cycle (EXTREMES)

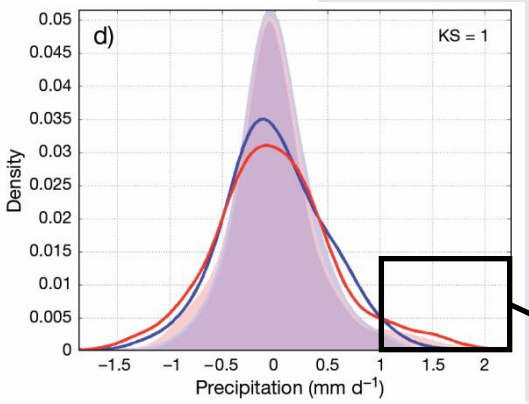


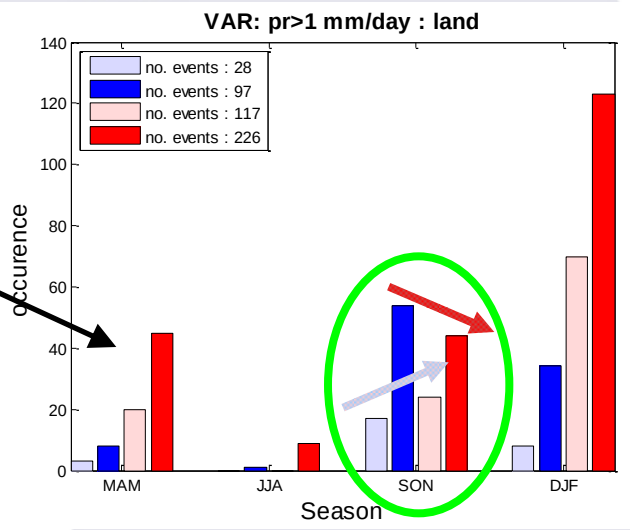
ts

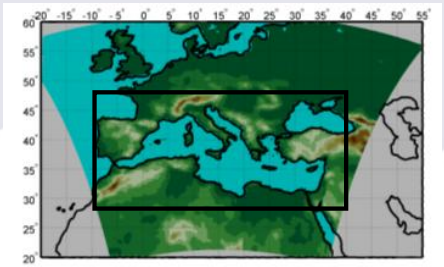




pr







PROTHEUS 20 C

ECHAM5-MPIOM 20C

PROTHEUS A1B

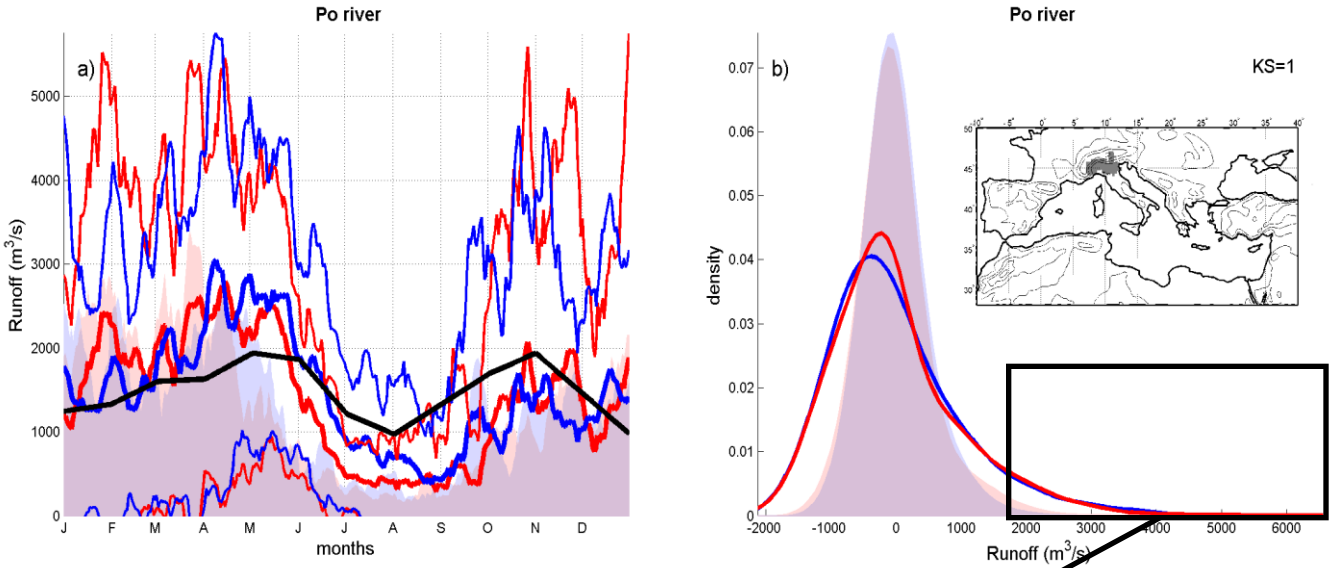
ECHAM5-MPIOM A1B

Dell'Aquila et al 2012, Clim. Res.

Impacts in key sectors

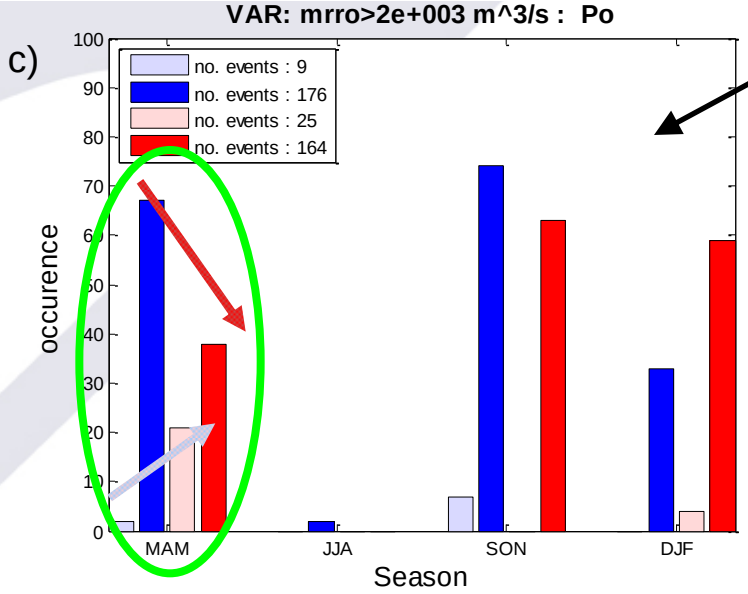
WATER resources

Scenario Simulations: PROTHEUS driven by ECHAM5-MPIOM (1951-2050)



Po River discharge

- PROTHEUS 20 C
- ECHAM5-MPIOM 20C
- PROTHEUS A1B
- ECHAM5-MPIOM A1B

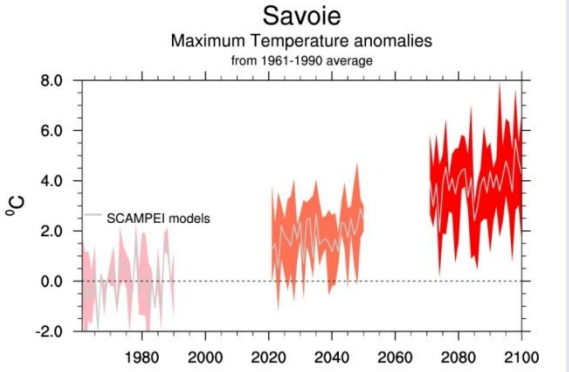


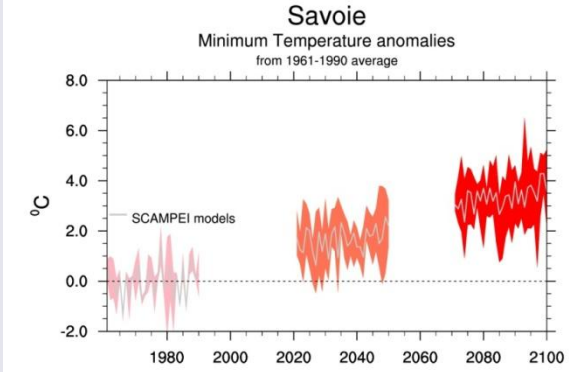
Dell'Aquila et al 2012, Clim. Res.

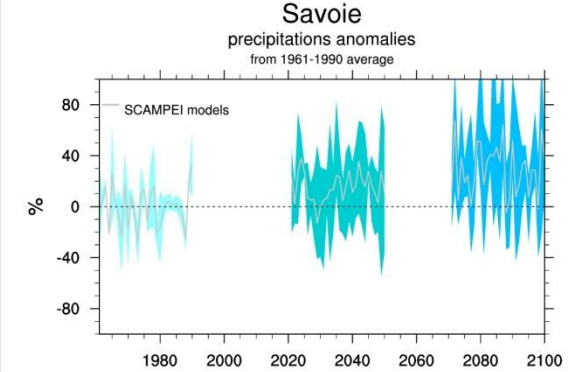
*Total Runoff (surface + drainage) **mrro** integrated over the Po catchment basin. We also report the map of the associated catchment basin (TRIP dataset). The **black line** in the a) panel is the average seasonal cycle of the observed Po discharge in Pontelagoscuro. In c) we report the number of large anomalies of **mrro'** from seasonal cycle for each season*

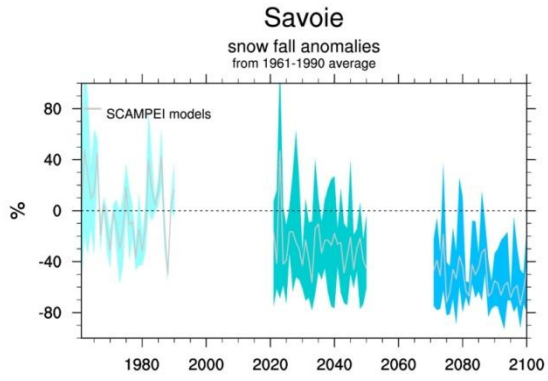
Extremes in the Alps

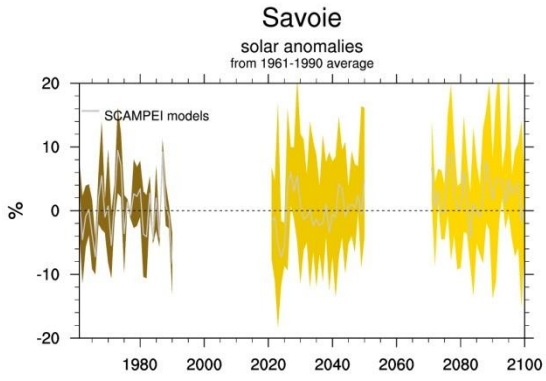
Spring condition : the temperatures are increasing both for the maximum and minimum temperatures. This imply a decrease in the snow fall. The precipitation are increasing. Not significant trend is found for the solar radiation.











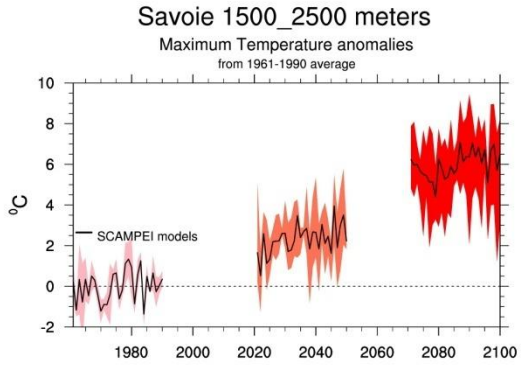
CLIM-RUN

High Summit
LECCO 2013

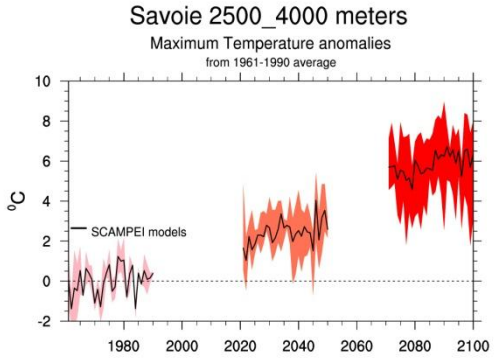
Evolution of temperatures in high mountain areas

Model ensemble mean (black line) for the T°C maximum. The envelop represents the minimum and maximum changes obtained by the different simulations.

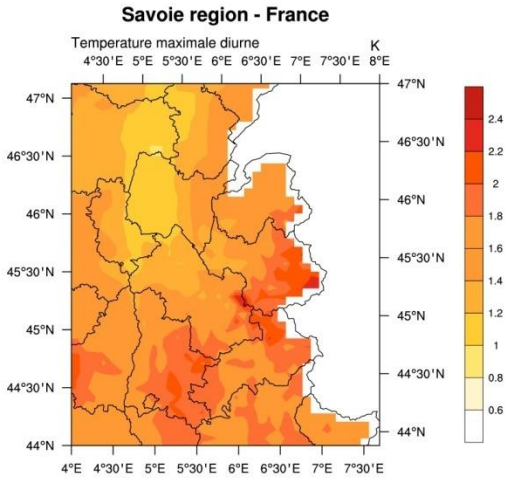
°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.1	2.3	3.7
2071 -2100	3.8	6.0	7.7

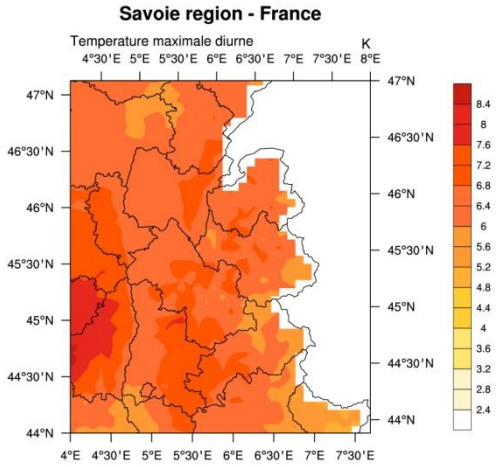


°C	T_{min}	T_{mean}	T_{max}
2021 -2050	1.3	2.4	3.6
2071 -2100	3.8	5.8	7.4



The maximal temperature is increasing in the future for all altitude ranges and models. The increase in stronger by the end of the century. The mean of the model is around +6°C with an uncertainty between +4°C to 8°C. This information can be translated by the stakeholders who are familiar with the local climatic conditions. An raise of 6°C will give a rise of 0 ° C isotherm of about 600 meters.





CLIM-RUN

High Summit LECCO 2013

CONCLUSION

The analysis of the observations and simulation models for the today climate and the future scenarios, in particular for the Mediterranean region, even in the absence of a proper representation of some modes of internal variability of the climate system creating therefore uncertainty about future impacts of climate change, reveals the complexity of the climate system itself, but compared to the preceding analyses emerge with greater consistency tests on the on-going climate change and those who might be most likely in the coming decades.


Thanks for your attention !!