Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile

ECOMONDO
THE GREEN TECHNOLOGY EXPO

Livello del mare lungo le coste italiane per scenari climatici futuri

Rimini - 26 ottobre 2021

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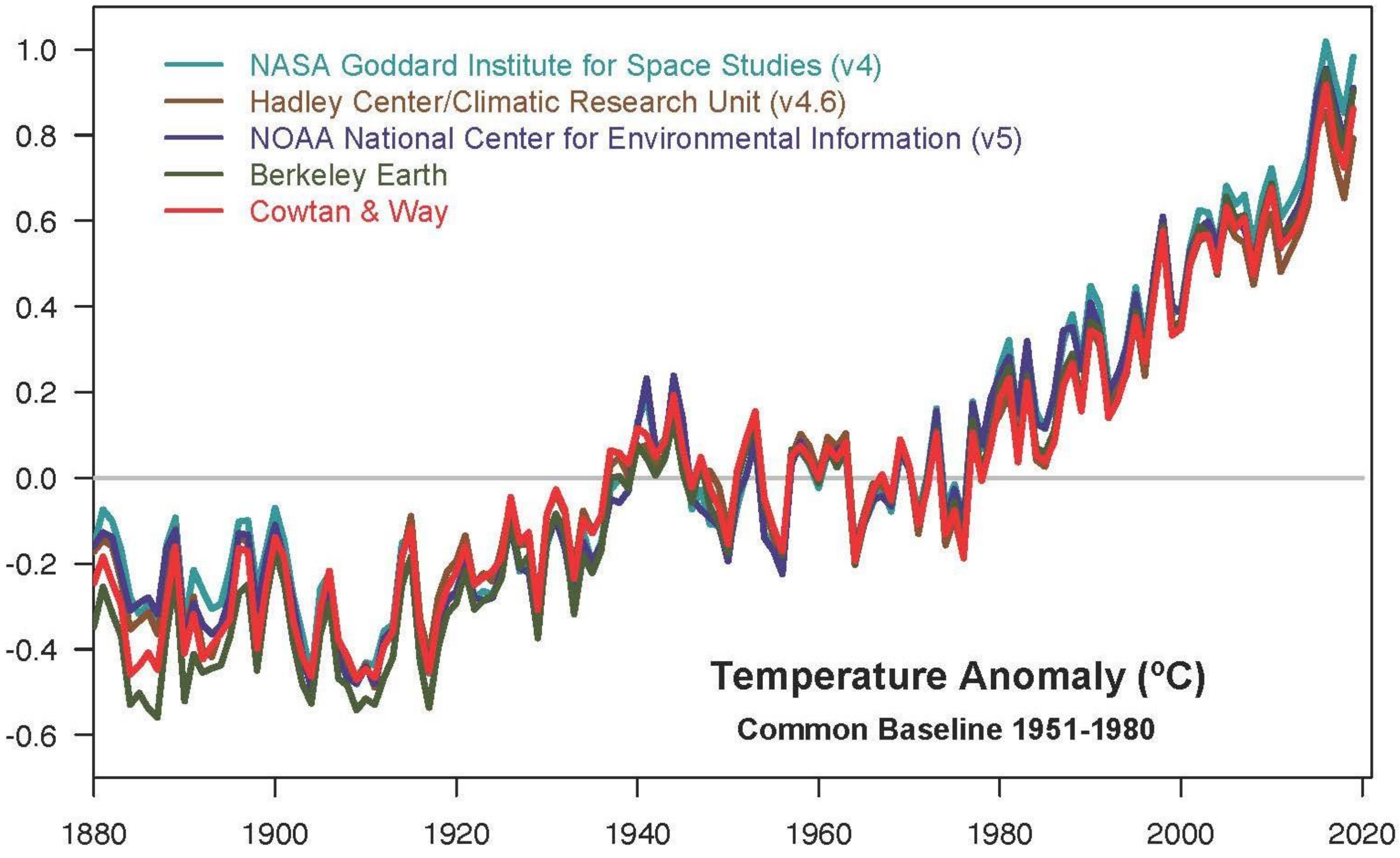
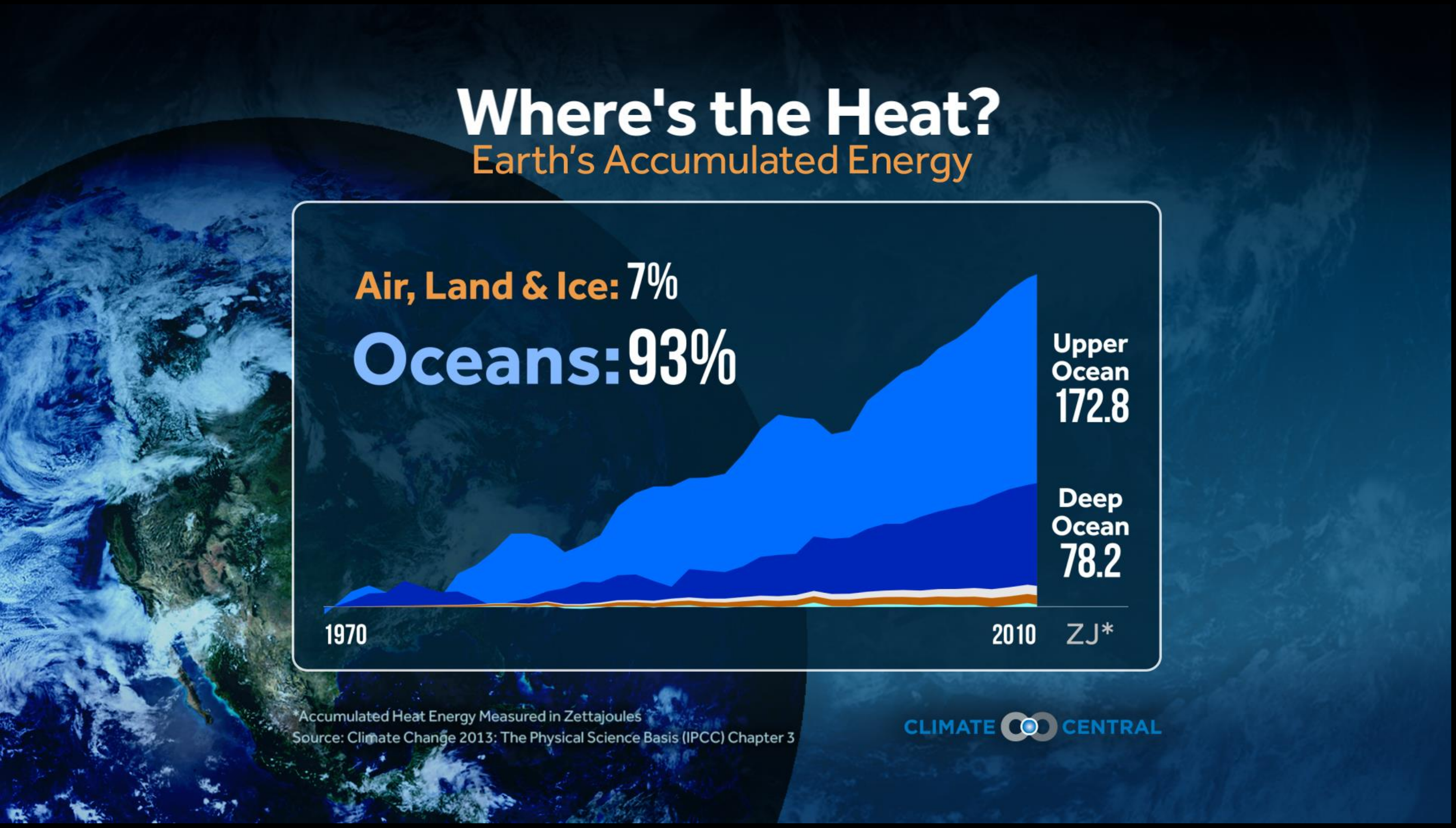
https://impatti.sostenibilita.enea.it/structure/clim

Andamento temperatura globale superficiale

Change in global surface temperature relative to 1951-1980 average temperatures

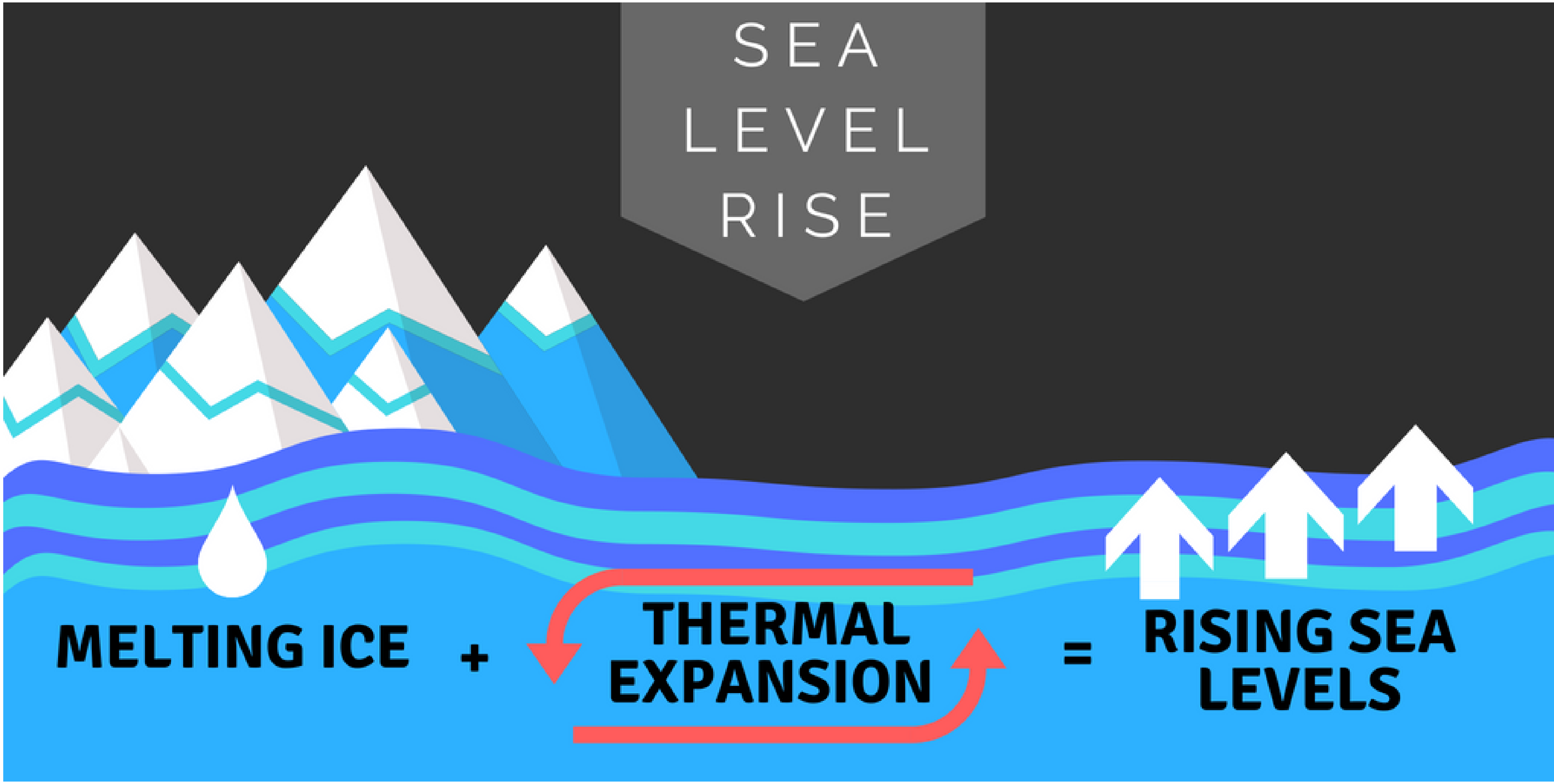


Oceans are getting warmer

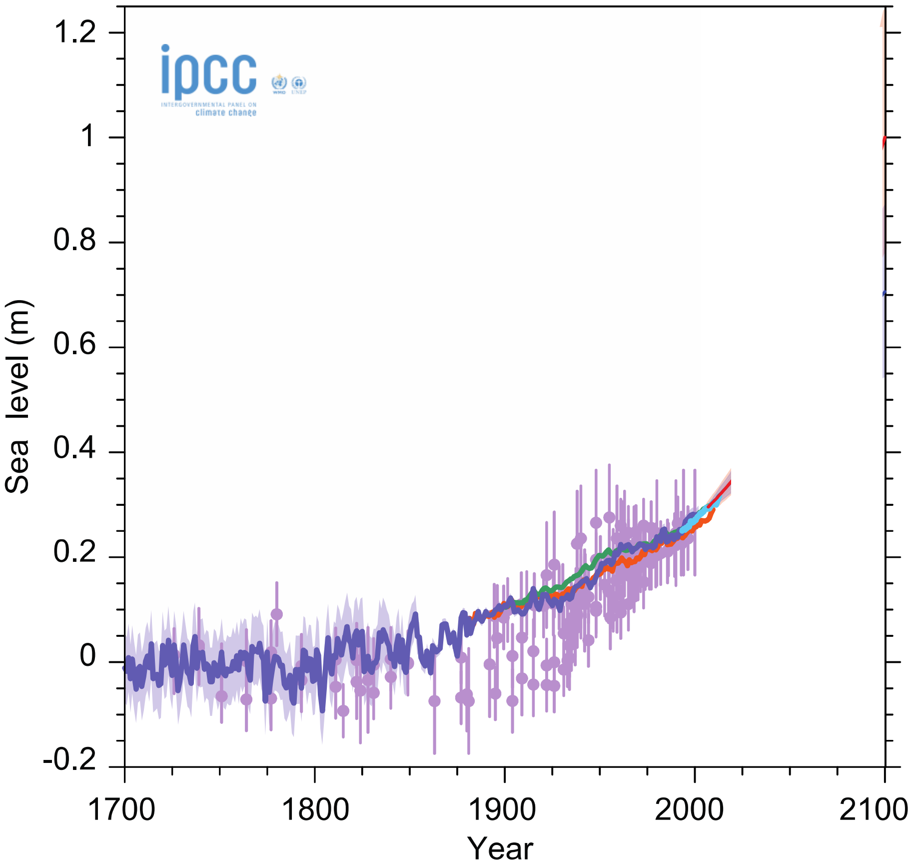


- Most of the heat went into the oceans, not the atmosphere.
- Oceans capture 25% of the CO2 emitted into atmosphere

Causes of Sea Level Rise



Global sea level since 1700



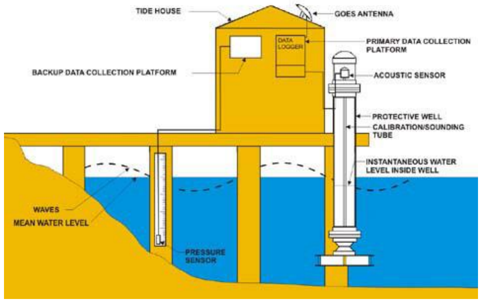
Rate during 1901-1990 was 1.50 ± 0.2 mm yr^{-1}

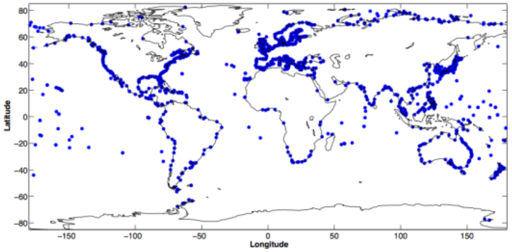
Rate during 1993-2010 was 3.07± 0.37 mm yr^{-1}

Rate during 2005-2017 was **3.50± 0.2 mm yr^{-1}**

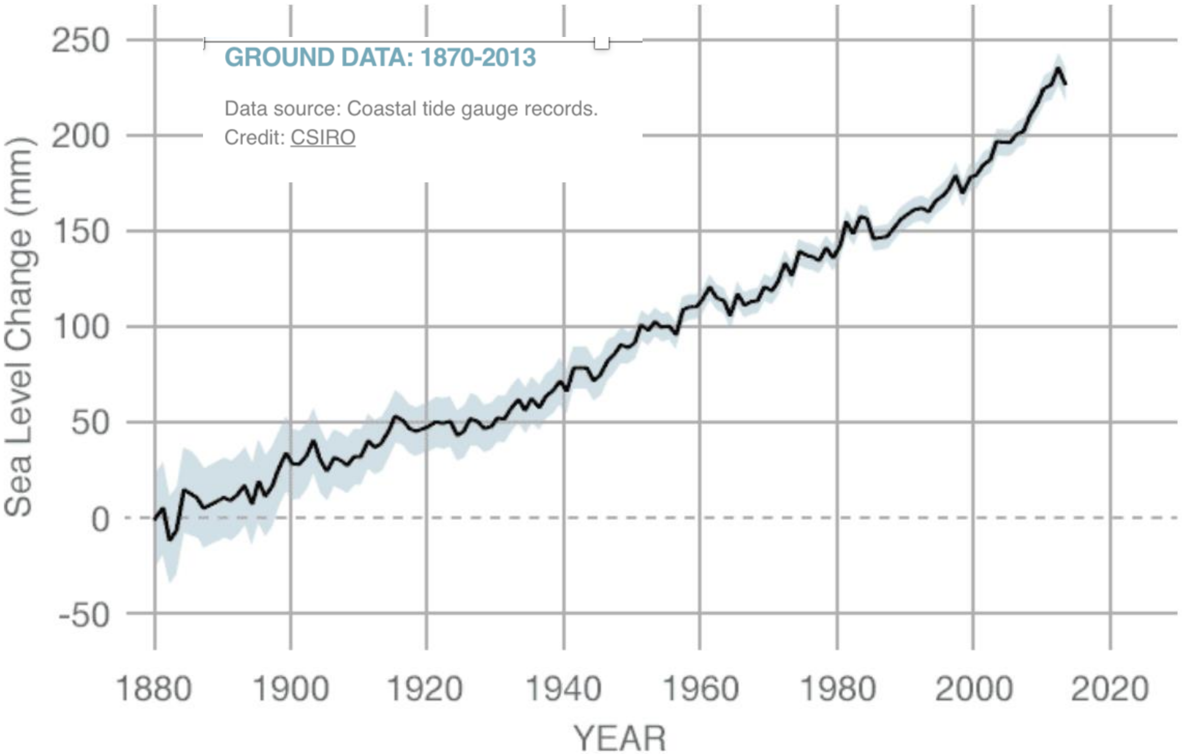
Compilation of paleo sea level data, tide gauge data, altimeter data.

Global sea level since 1880





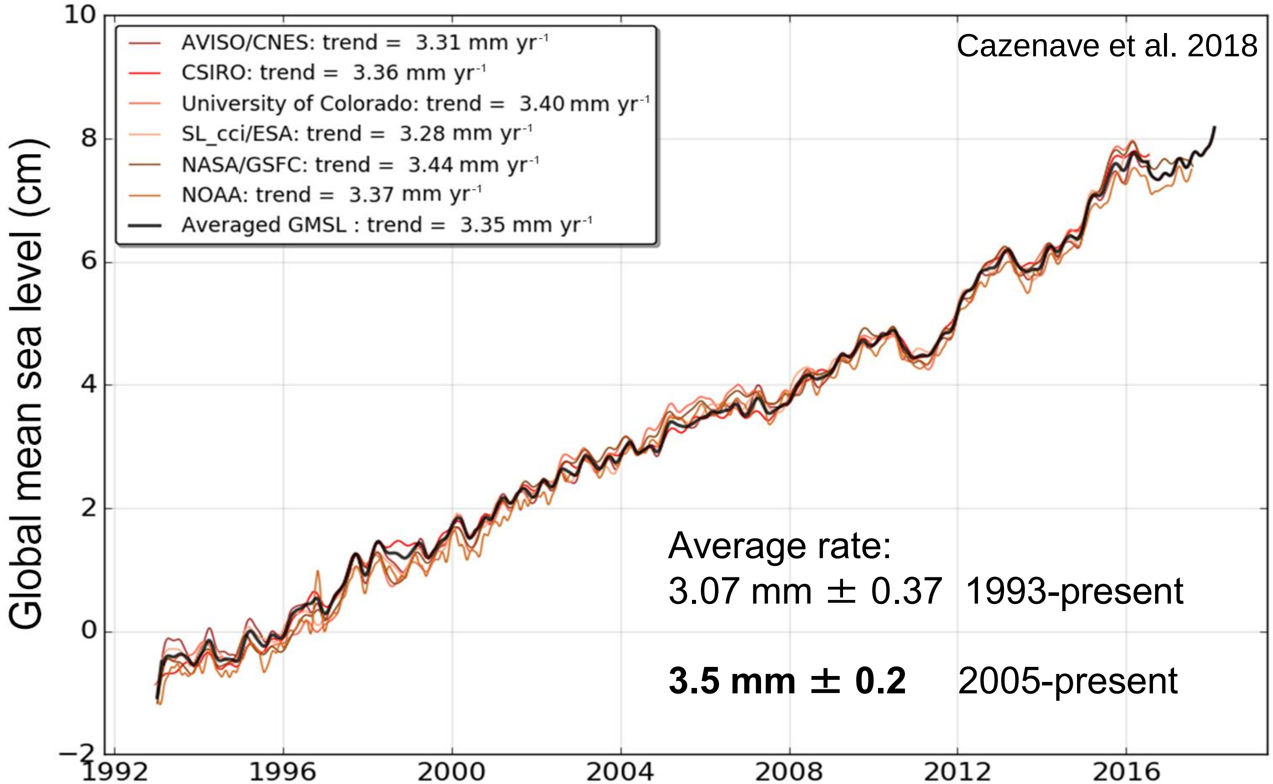
Spatial distribution of the **1420** tide gauges



Change in sea level since 1880 as observed by coastal tide gauge*

About +25 cm from 1880

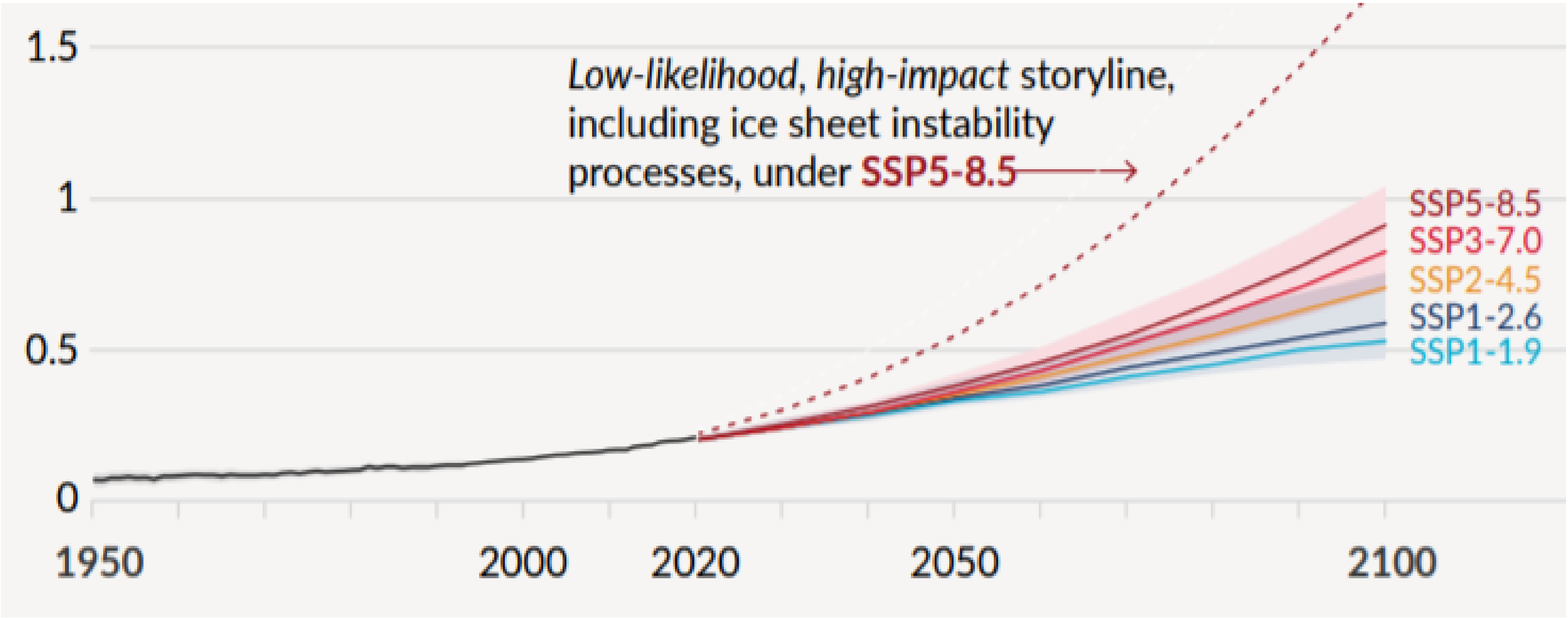
Global sea level since 1993



About **+8.3** cm from 1993

Change in sea level since **1993** as observed by satellites.

Future Scenarios global sea level



AR6 ipcc

INTERGOVERNMENTAL PANEL ON climate change

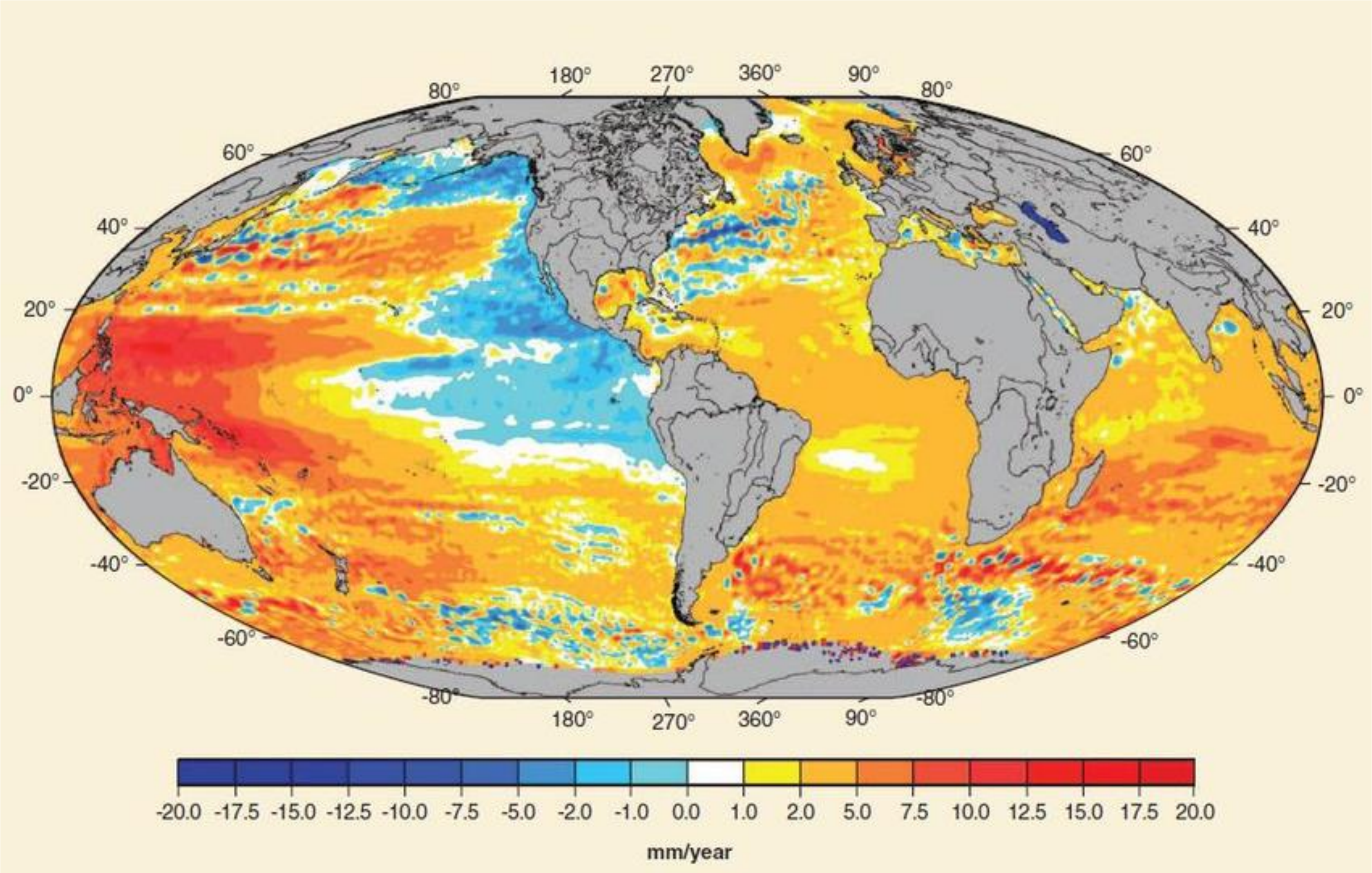
WMO UNEP

SROCC & IPCC AR6 – WGI Chapter 9

*The **SROCC** estimated regional sea-level changes from combinations of the various contributions to sea-level change from **CMIP5** climate model outputs, allowing comparison with satellite altimeter and tide-gauge observations. Closure of the regional sea-level budget is complicated by the fact that **regional sea-level variability is larger than GMSL variability** and there are more processes that need to be considered, such as vertical land movement and ocean dynamical changes.*

*Since **CMIP6** models are of fairly coarse (typically ~100km) resolution, and even the models participating in HighResMIP (near 10km resolution) do not capture all the phenomena that contribute to coastal ocean dynamic sea-level change, there is low confidence in the details of ocean dynamic sea-level change along the coast and in semi-enclosed basins, **like the Mediterranean**, where **coarse models can misrepresent key dynamic processes**.*

Regional Sea Level



Regional sea-level trends from satellite altimetry for the period: **October 1992 to July 2009**

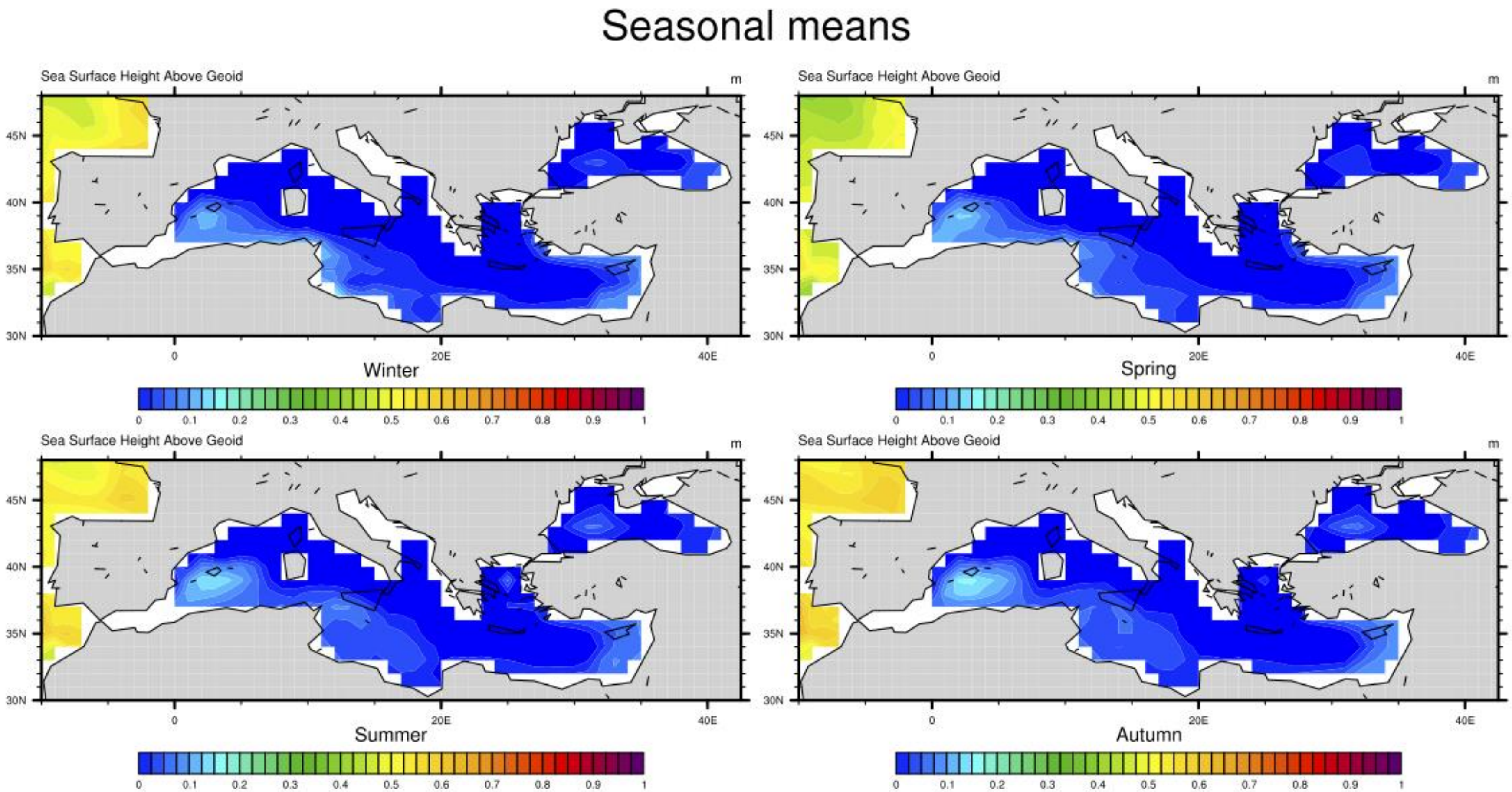
Spatial differences are due to the steric effect. Nicholls & Cazenave, 2010

Causes of R-SLR at Gobal, Regional and Local scale

	G	R	L
Melting Greenland and Antarctica	●	●	○
Melting Glaciers and ice caps	●	●	○
Ocean Thermal expansion	●	●	○
Ocean Circulation	●	●	○
Postglacial rebound, self-attraction and loading	○	●	●
Land Hydrology	○	○	●
Tides, Storm surge, Subsidence	○	○	●

Background geography

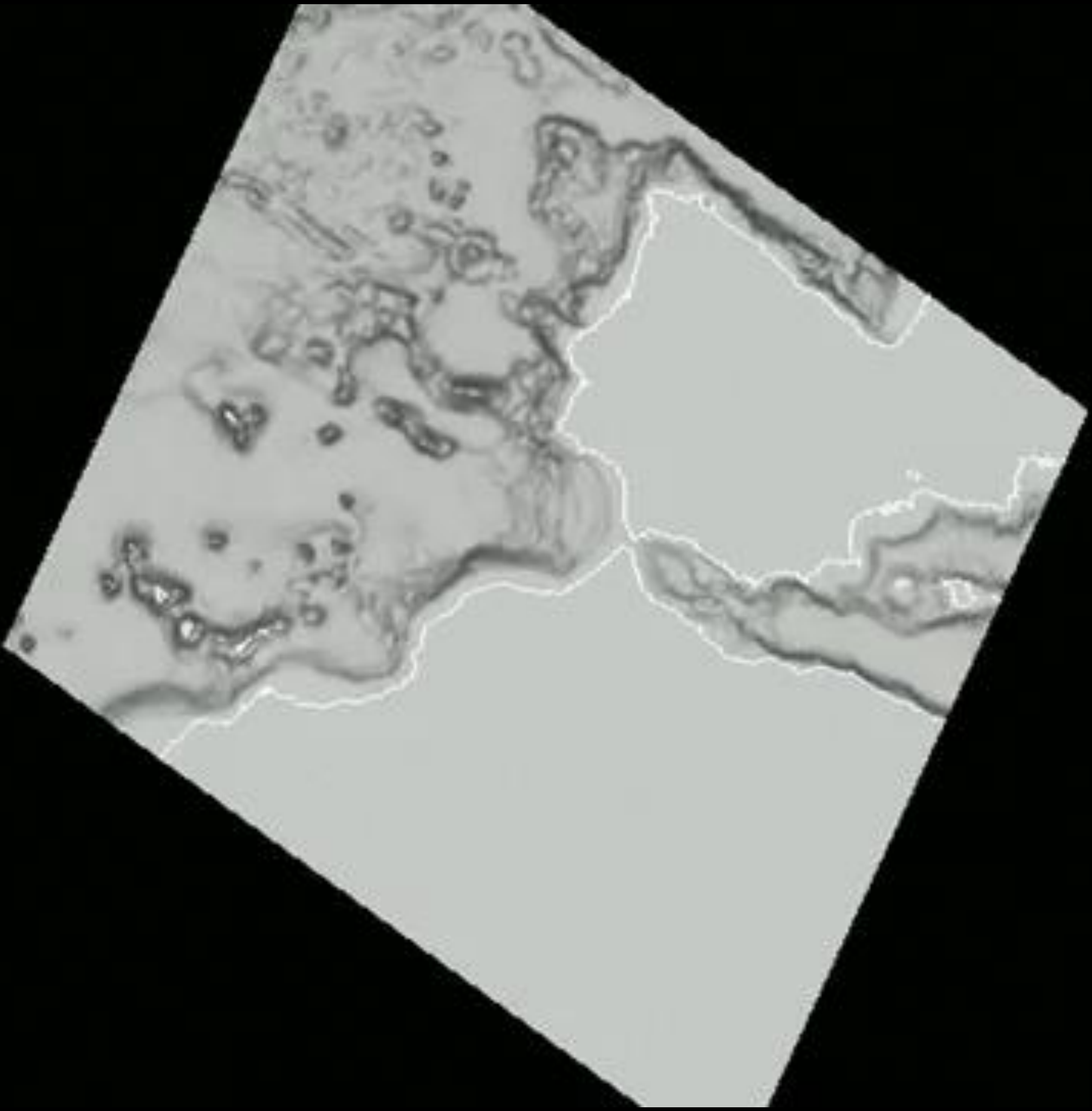
Global climate models: present climate seasonal means



Mediterranean sea level reproduced by CMIP5* global models (present climate)

*Coupled Model Intercomparison Project - https://cmip.llnl.gov/cmip5/

Strait of Gibraltar Background: 3D Bathymetry



Strait of Gibraltar Background

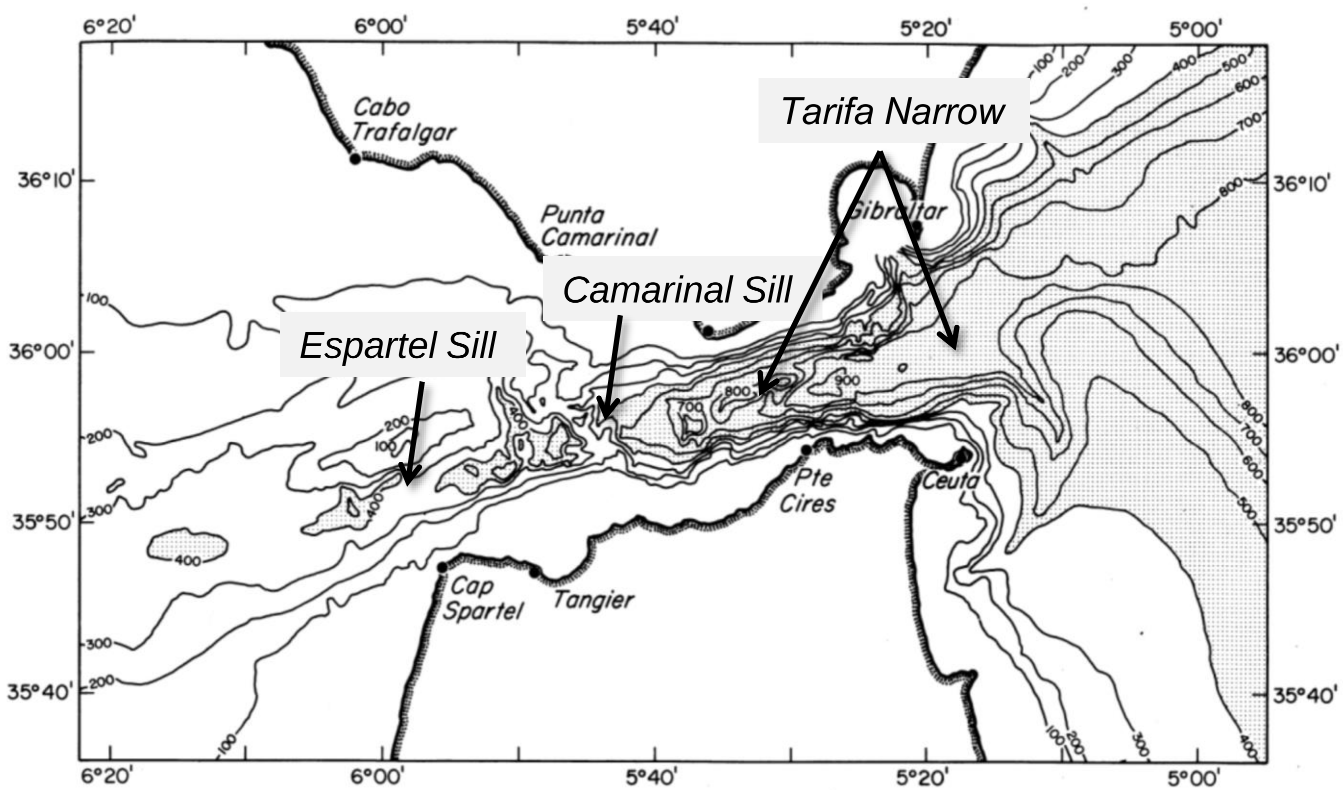


Chart of the Strait of Gibraltar, adapted from Armi & Farmer (1988), showing the principal geographic features referred to in the text.

Areas deeper than 400 m are shaded

Strait of Gibraltar Background: Physics

Strong mixing and entrainment mainly driven by the very intense tides.

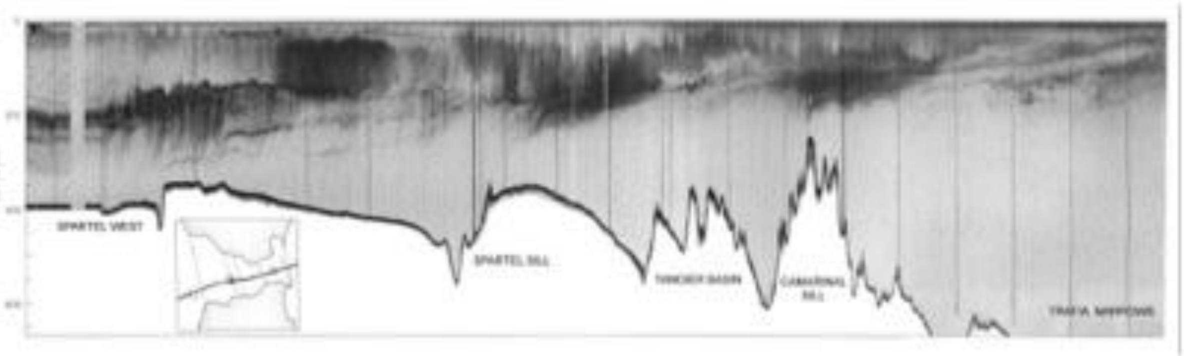


Figure 2. Transect of the Strait [From Armi and Farmer, Farmer and Armi.1988]

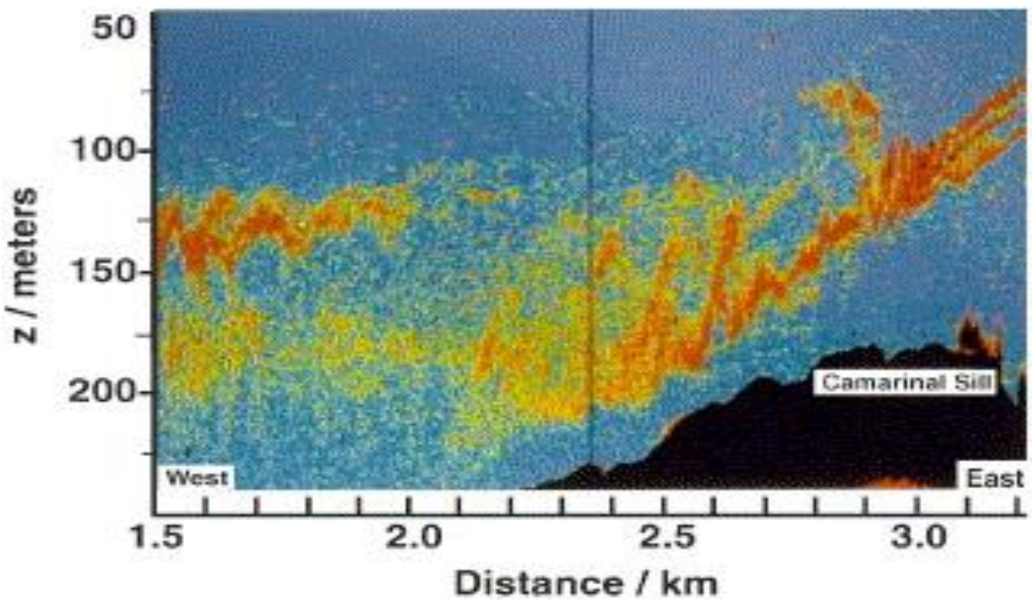
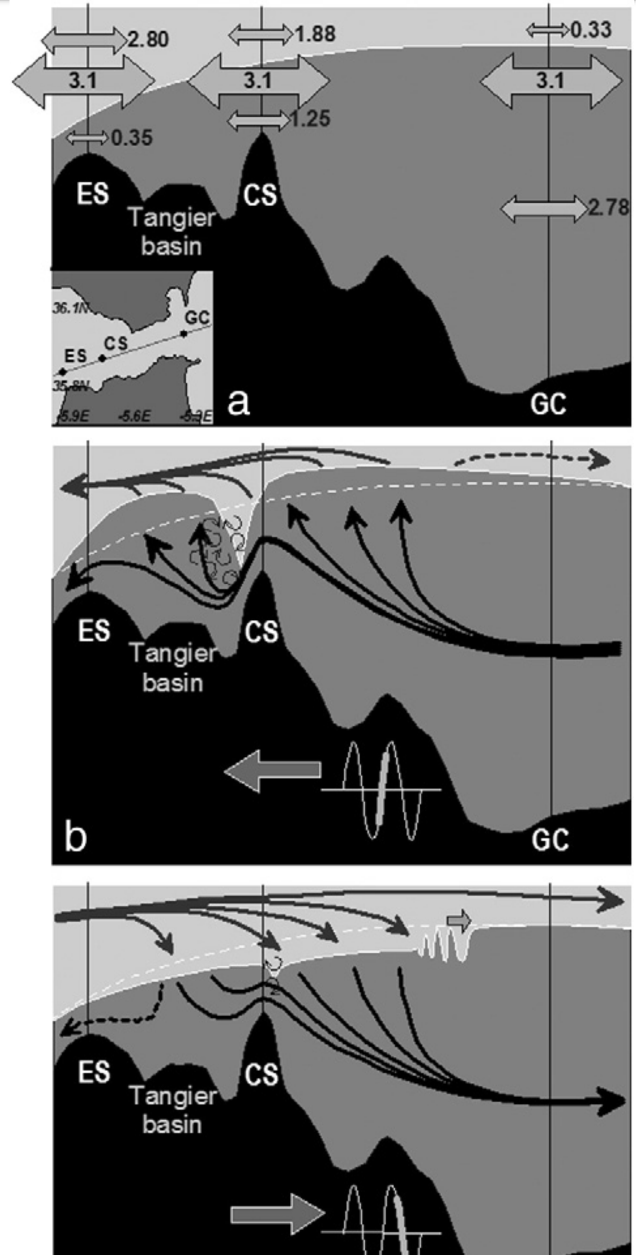
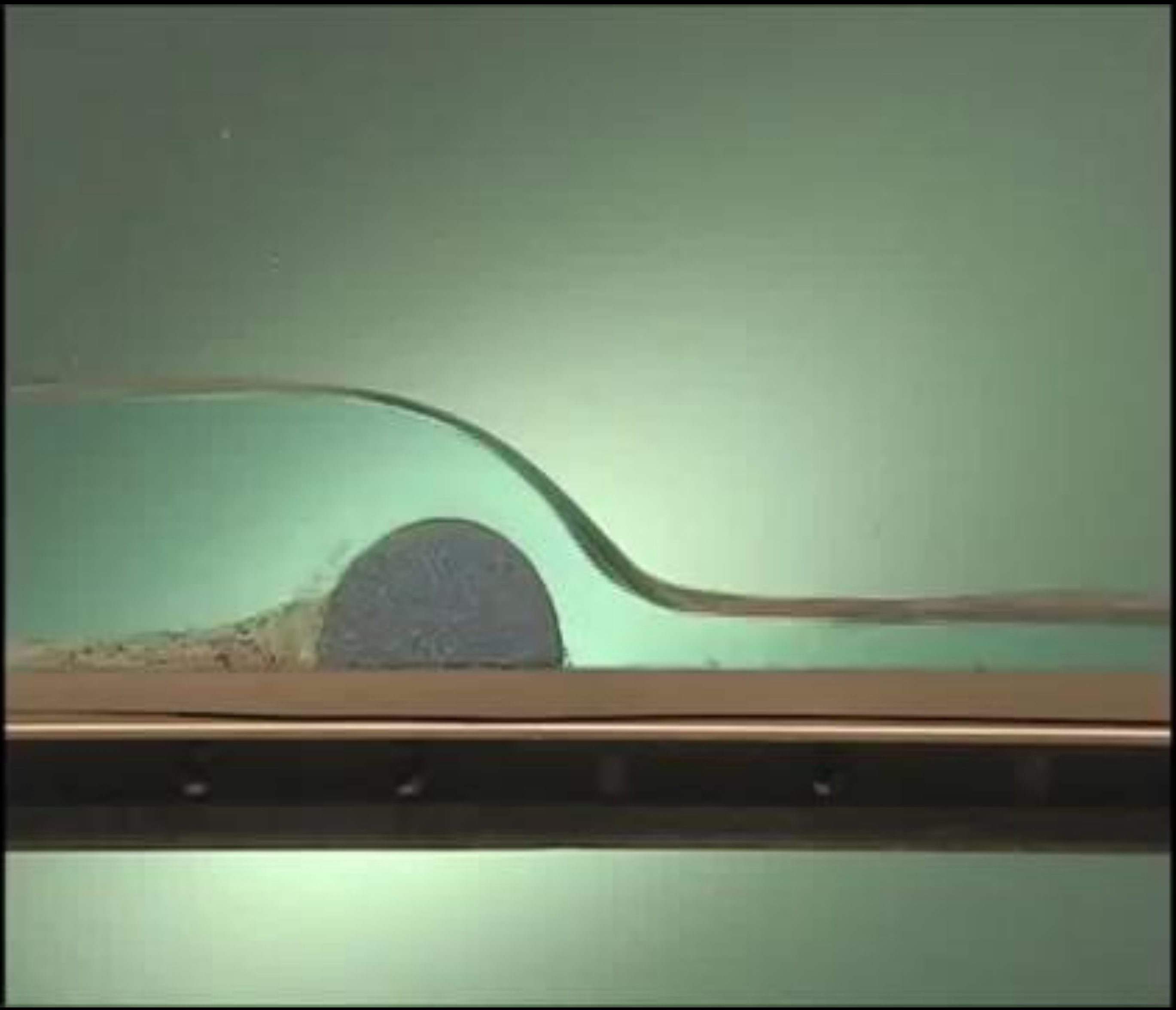


Image of acoustic backscatter during ebb tide over Camarinal Sill in the Strait of Gibraltar (Wesson and Gregg, 1994)

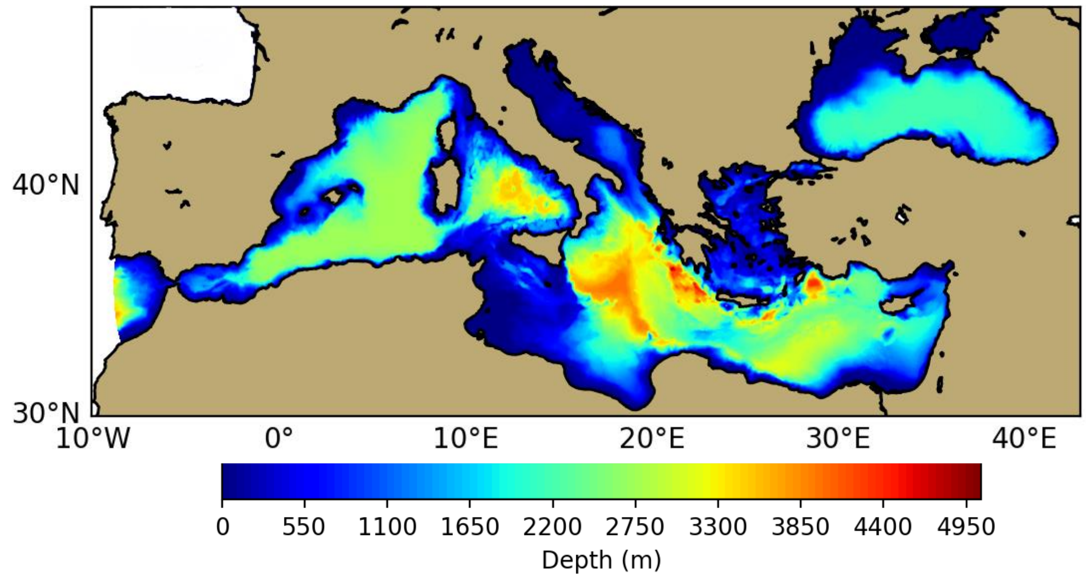


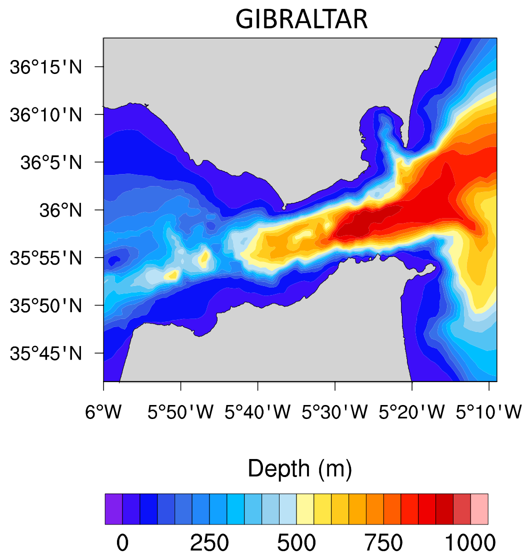
A. Sánchez-Román et al, JGR 2012

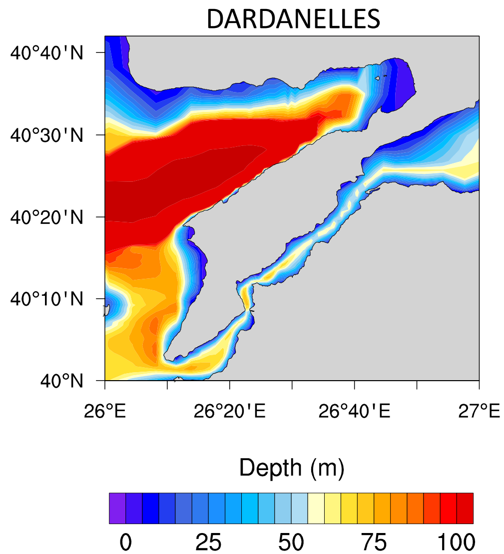
Hydraulics jump: an example

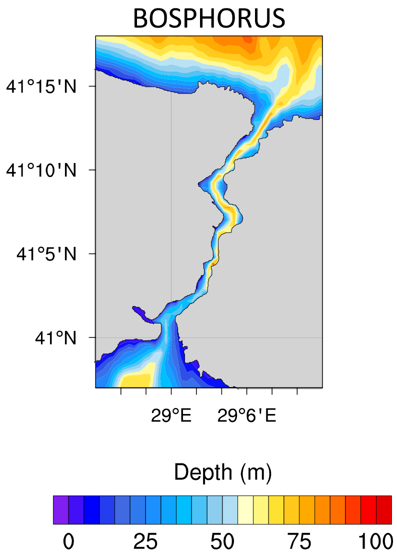


ENEA Climate Model

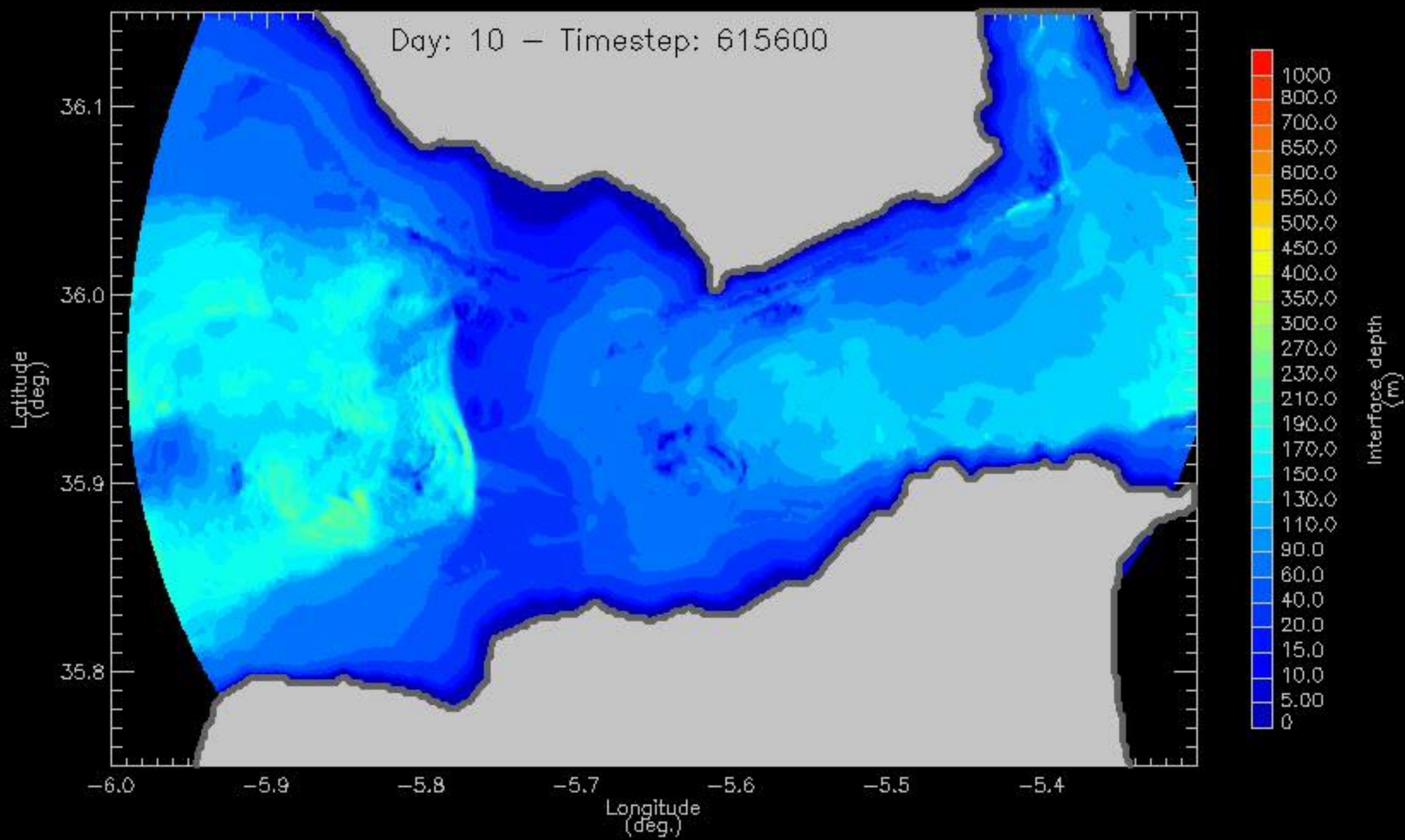




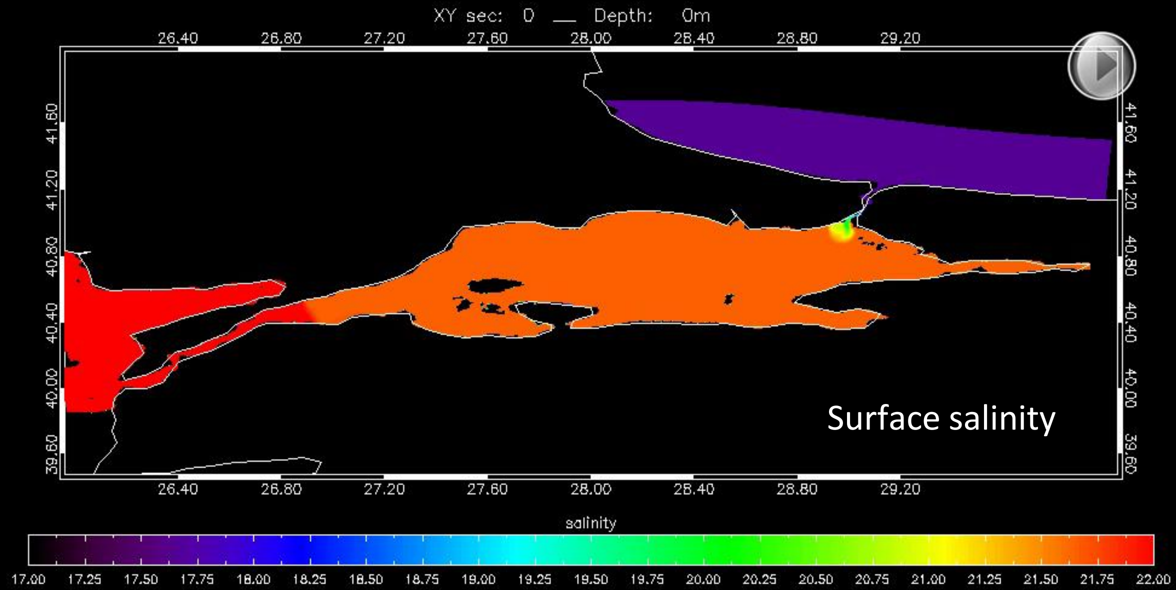




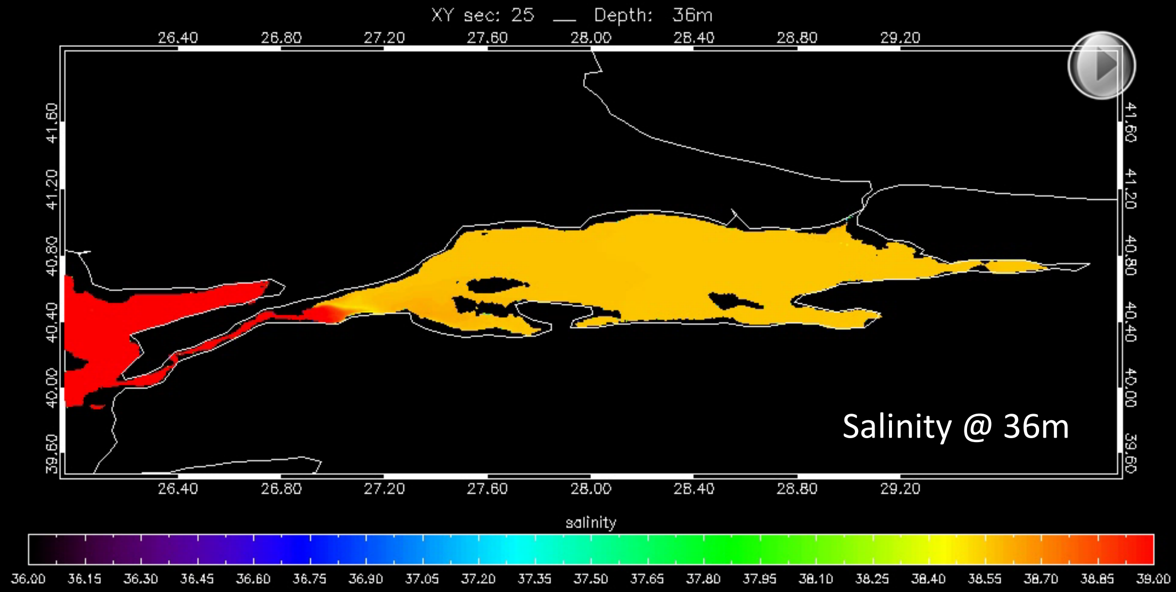
MITgcm model simulation



Interface depth evolution



Forced net barotropic flow 18000 m^3/sec experiment

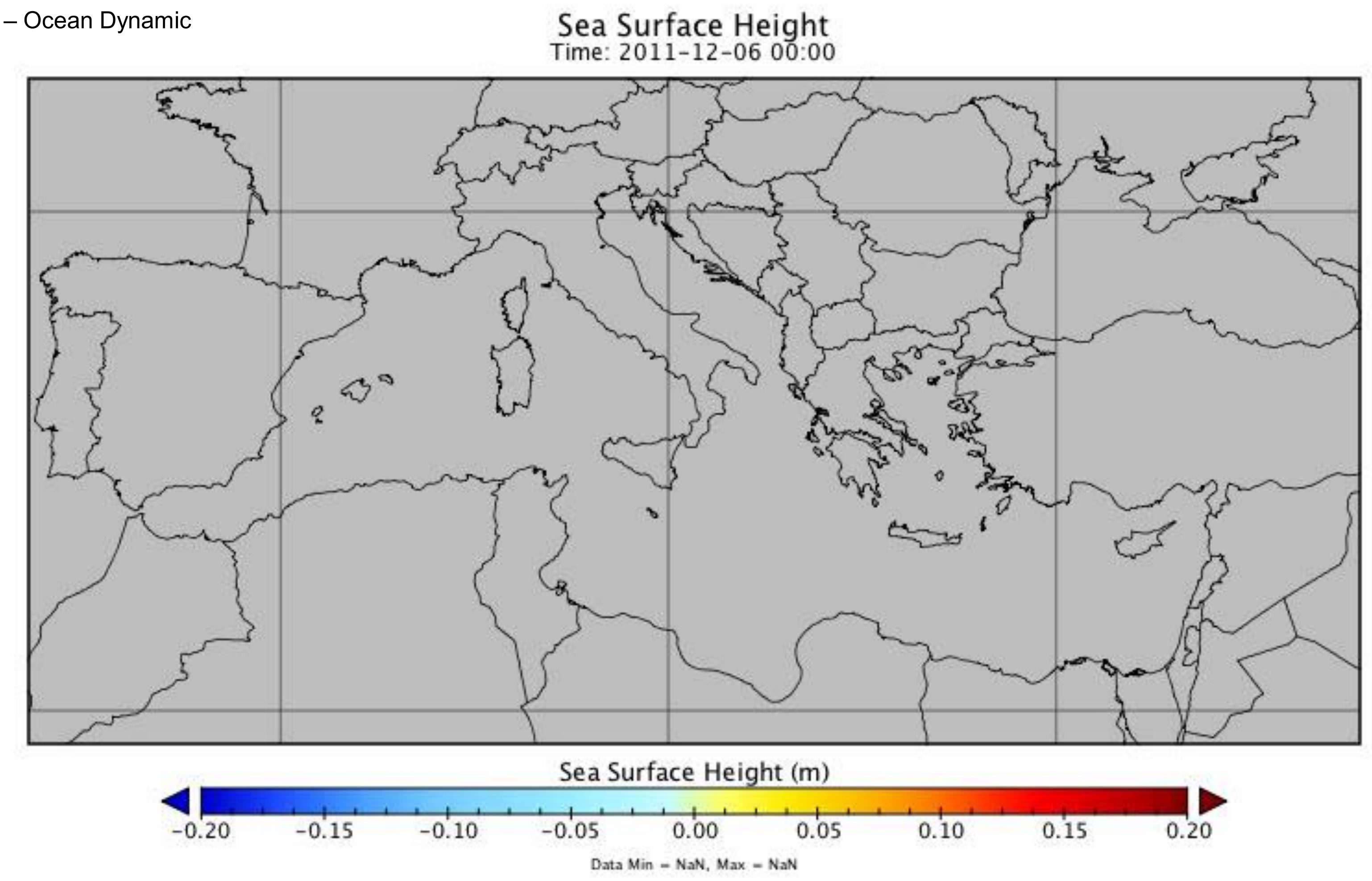


Sannino et al. ODY 2017

Three experiments were conducted to study the sensitivity of the circulation to different net barotropic flows: **5600, 9600, 18000, and 50000** m^3/sec

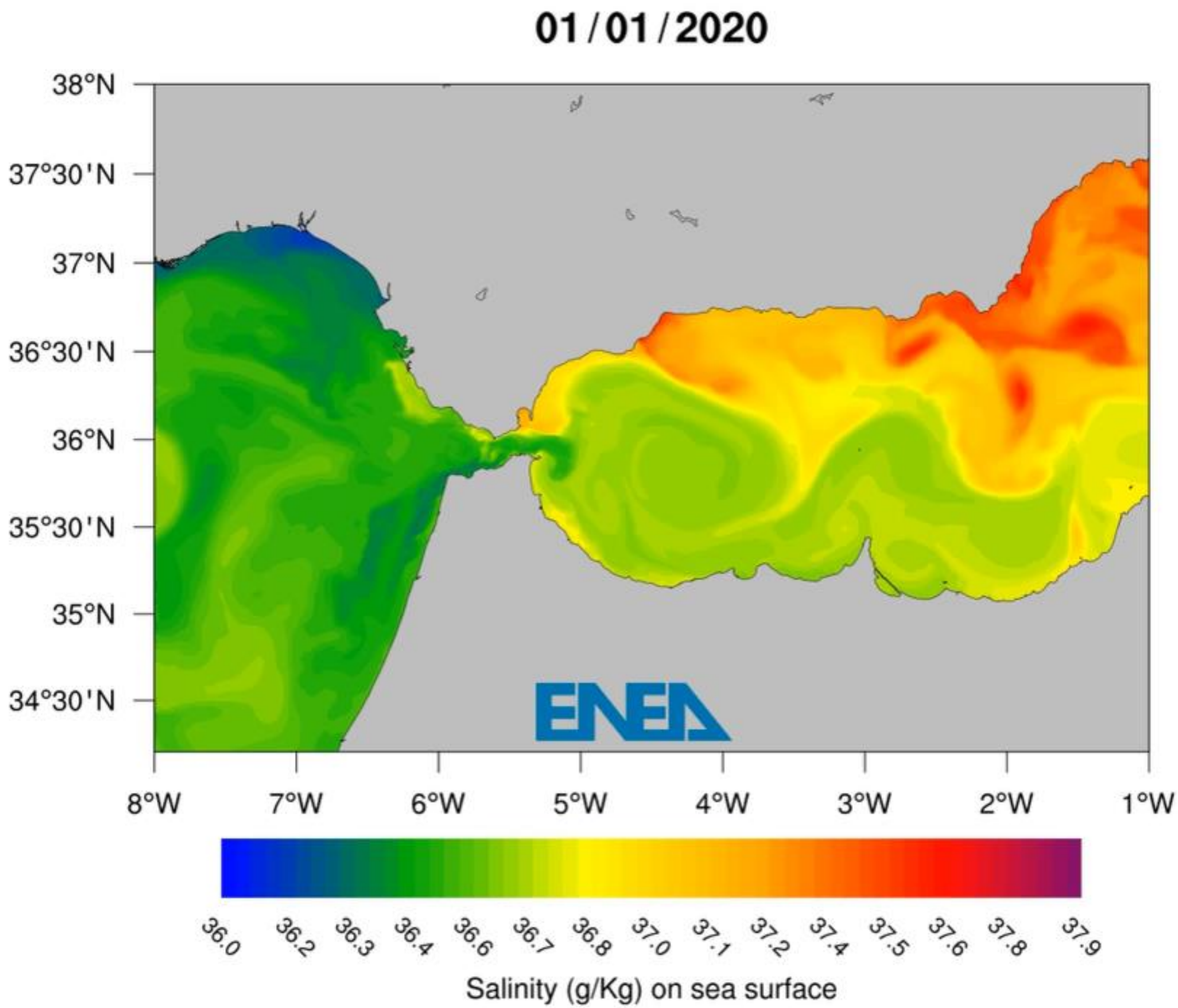
ENEA Climate Model

Palma et al 2019 – Ocean Dynamic



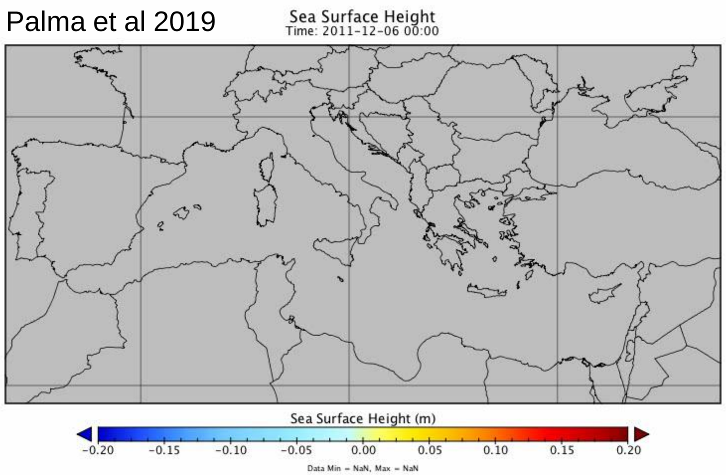
MITgcm – Explicit Tides (M2,S2, K1, O1) – Lateral Tide + Tidal Potential
Average resolution 1/16° (7 Km)
Minimum resolution at Gibraltar (230m) and Turkish Straits (90m)
100 Vertical Levels

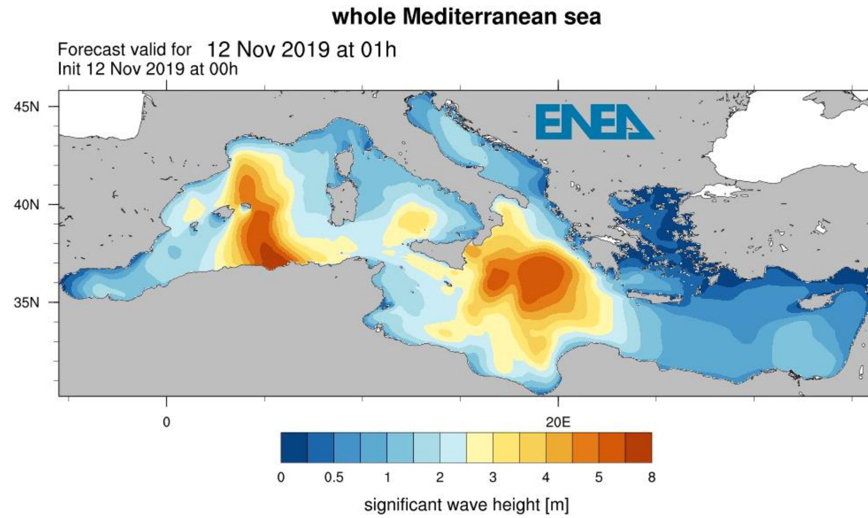
Venice flooded by highest tide in more than 50 years

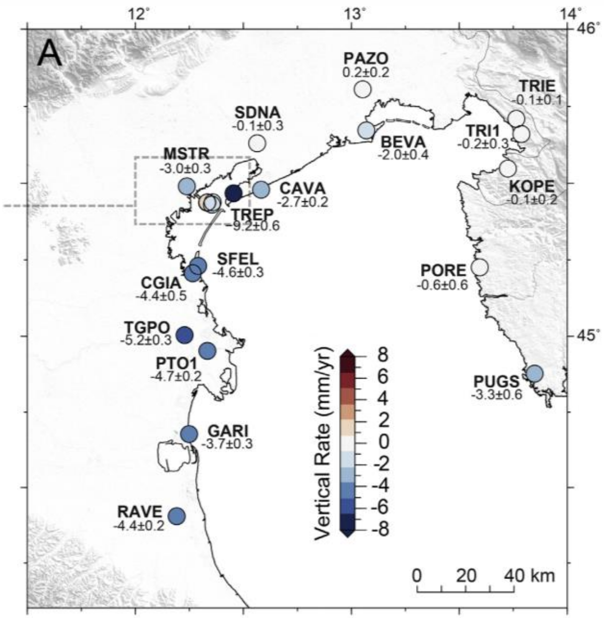


Causes of Sea Level Rise: Tides+Storm Surge+Subsidence

Palma et al 2019



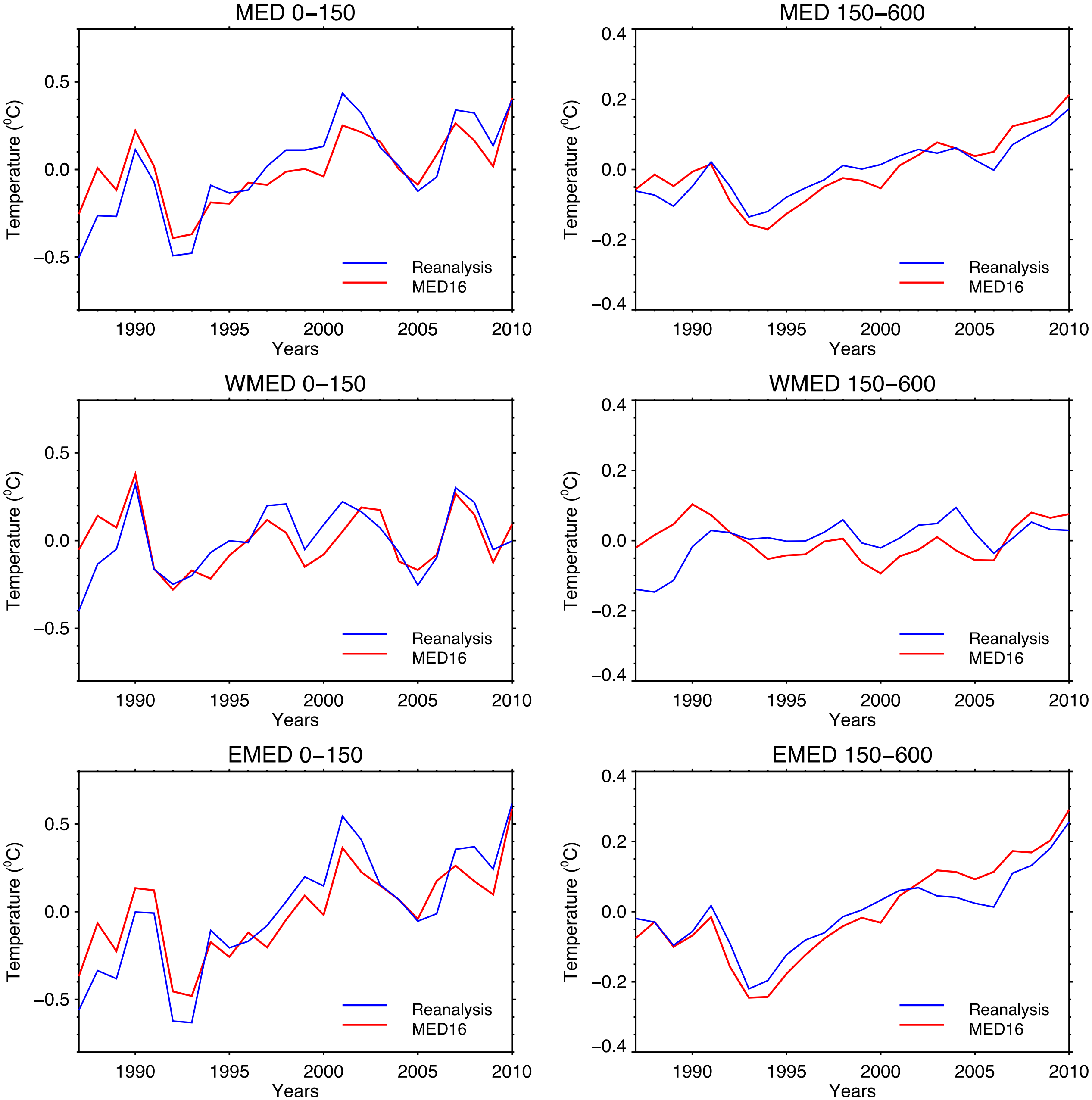




Antonioli et al 2017

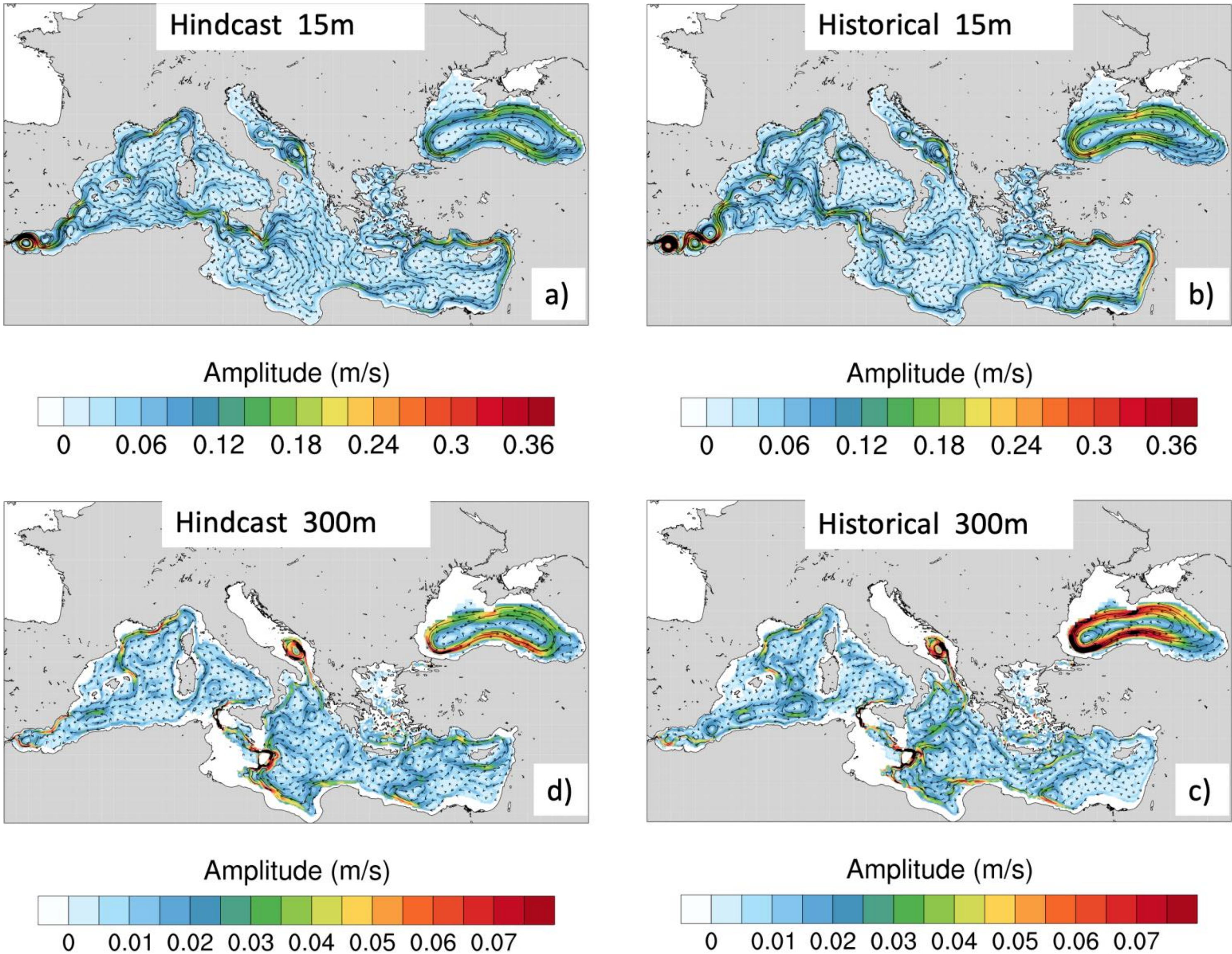
ENEA Climate Model

Reanalysis (blue) and hindcast (red) time series of temperature anomalies ($^\circ$ C ; annual values) for the upper (0-150 m) and intermediate (150-600 m) layers, for the Mediterranean Sea, and the western and eastern sub-basins



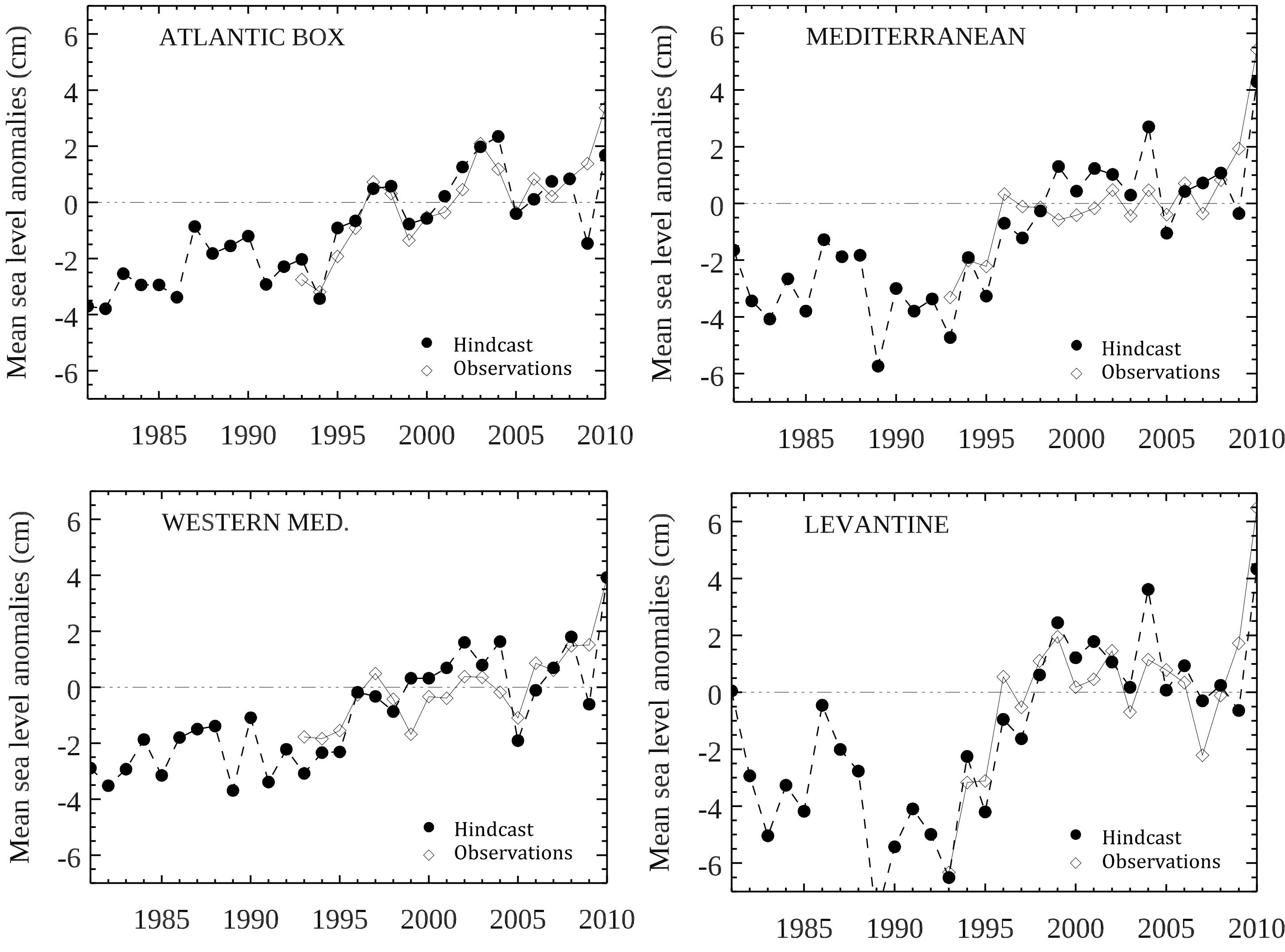
ENEA Climate Model

Surface (15 m of depth) and intermediate (300 m of depth) circulation, averaged over the simulation periods of the hindcast (left panel) and of the historical (right panel) experiments

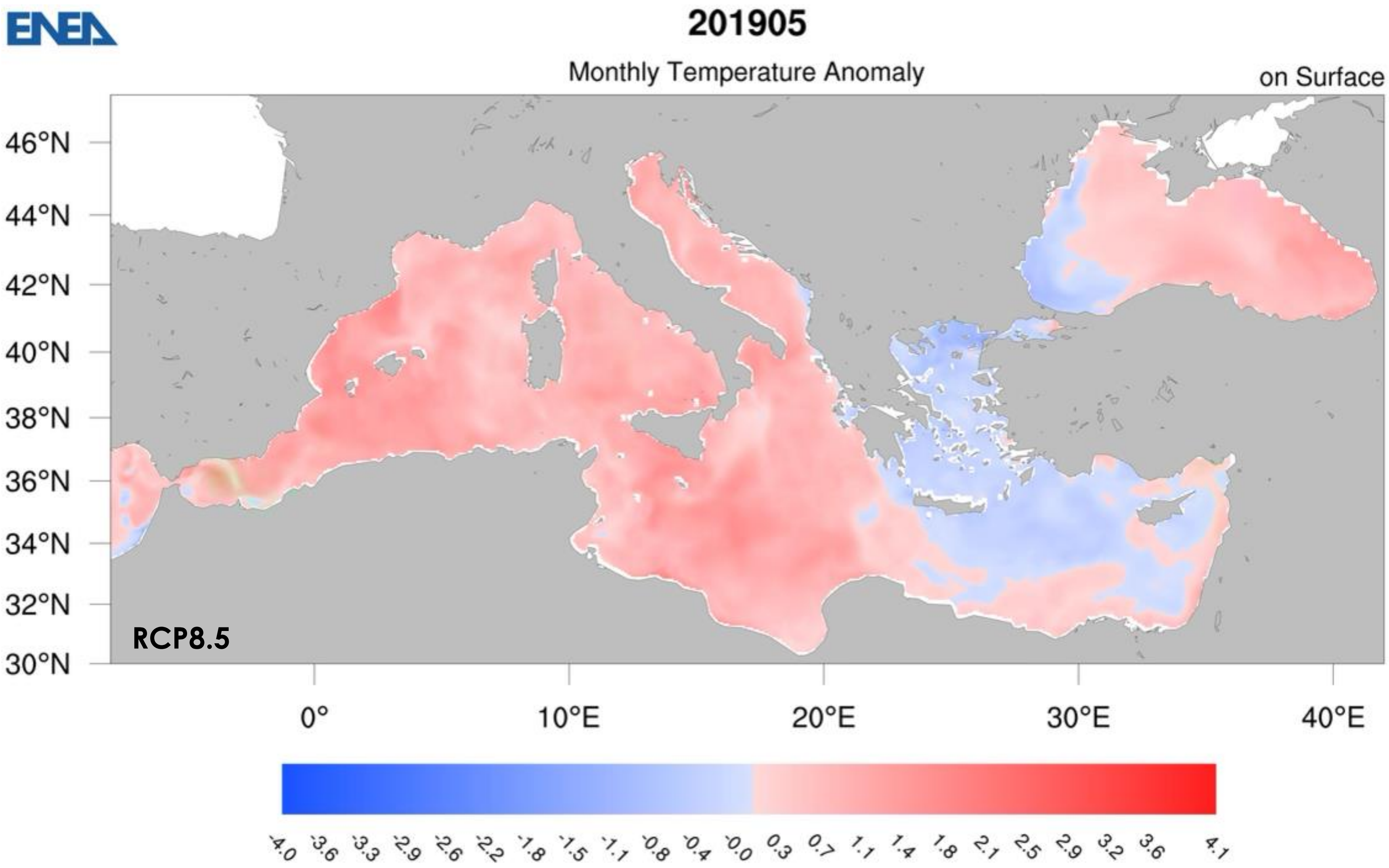


Future (2100) Mediterranean Sea Level

Interannual variability of the sea-level anomaly in different basins: whole Mediterranean (panel a), western and eastern sub-basins (panels b-c). Black dots denote values computed from the hindcast simulation, and diamonds those from the observations

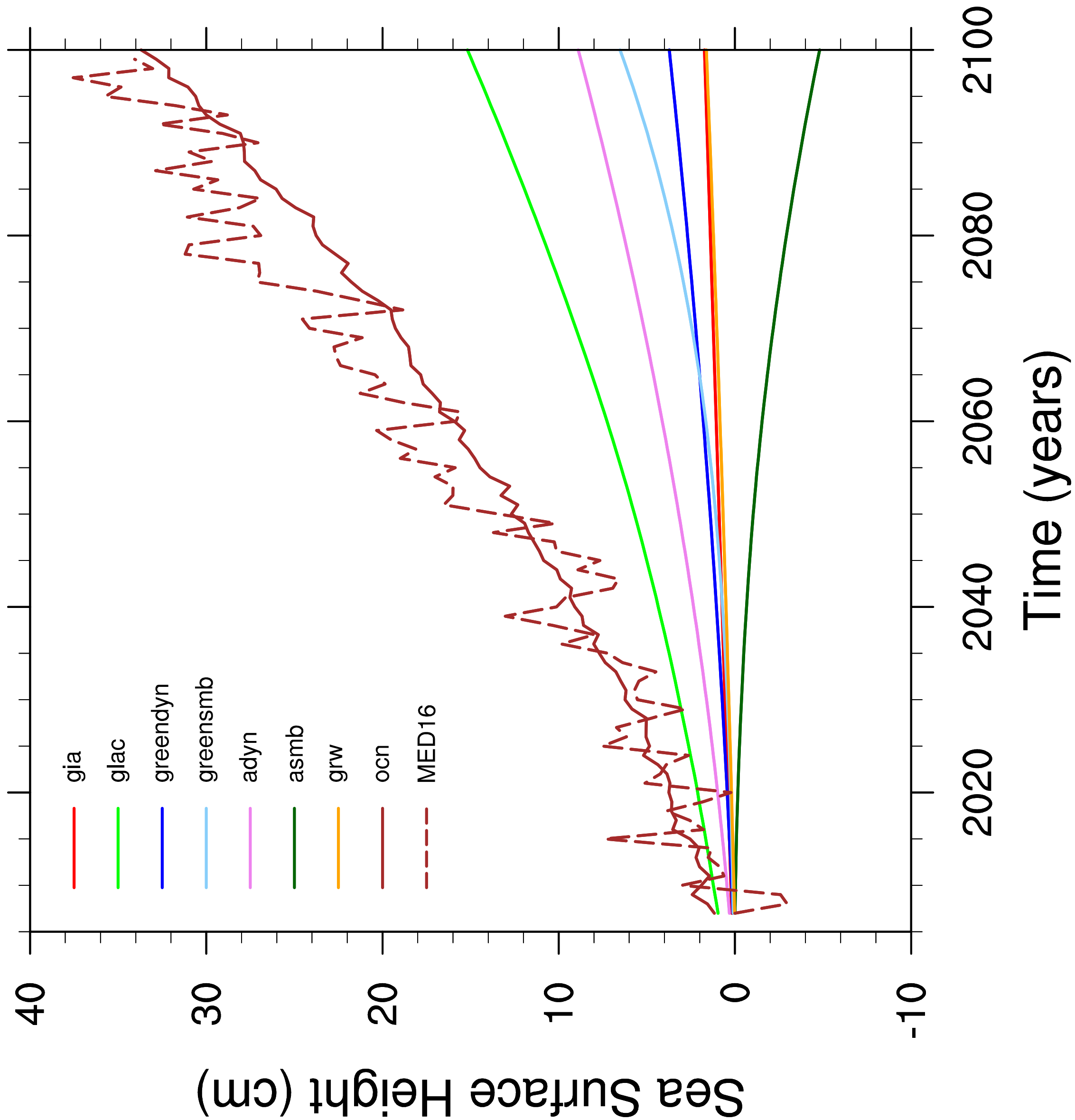


Future (2100) Mediterranean Heat Waves



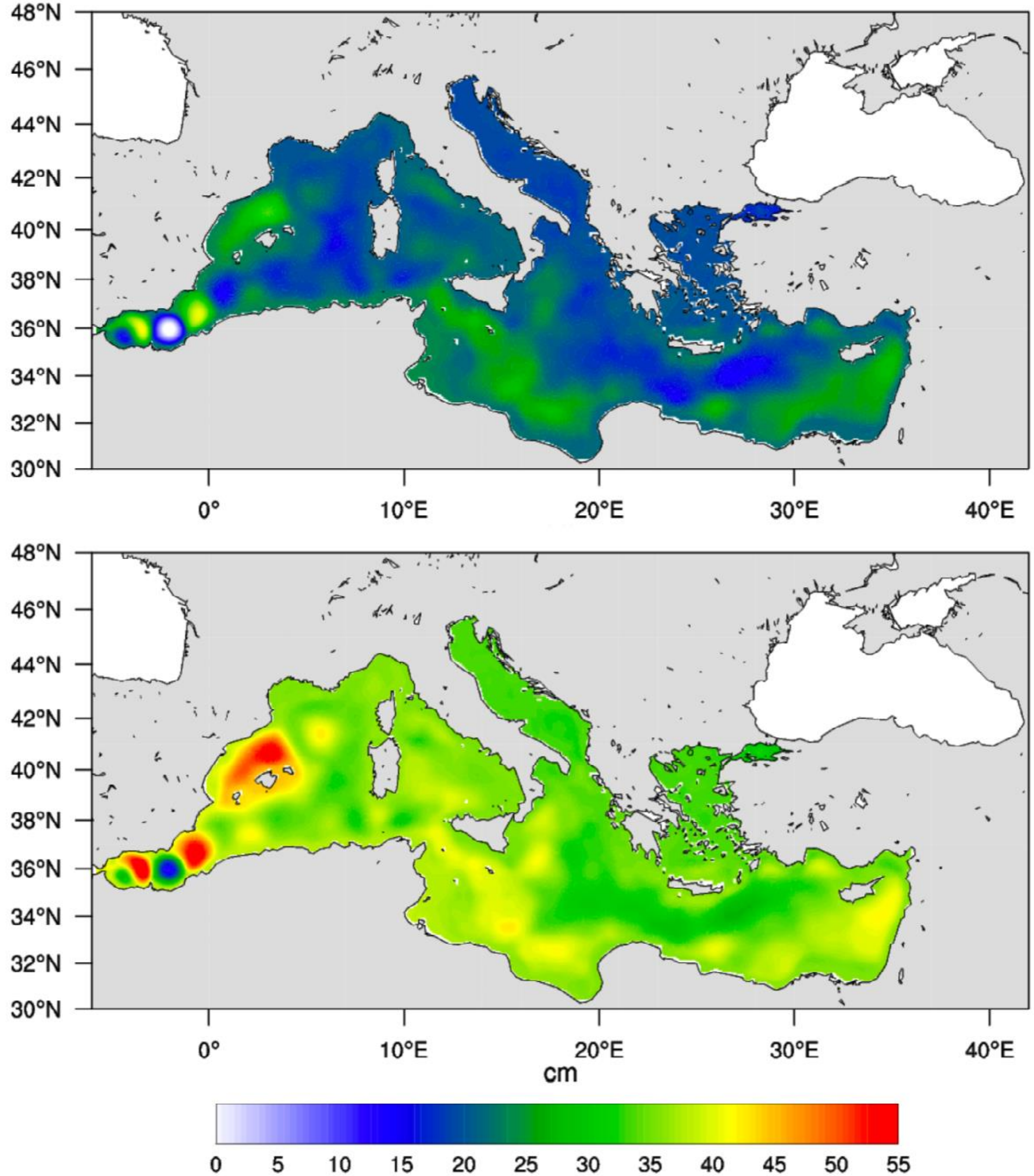
Future (2100) Mediterranean Sea Level

Time evolution of the components contributing to the projected mean sea level in the Mediterranean under the RCP8.5. Solid lines represent the central estimate over available models

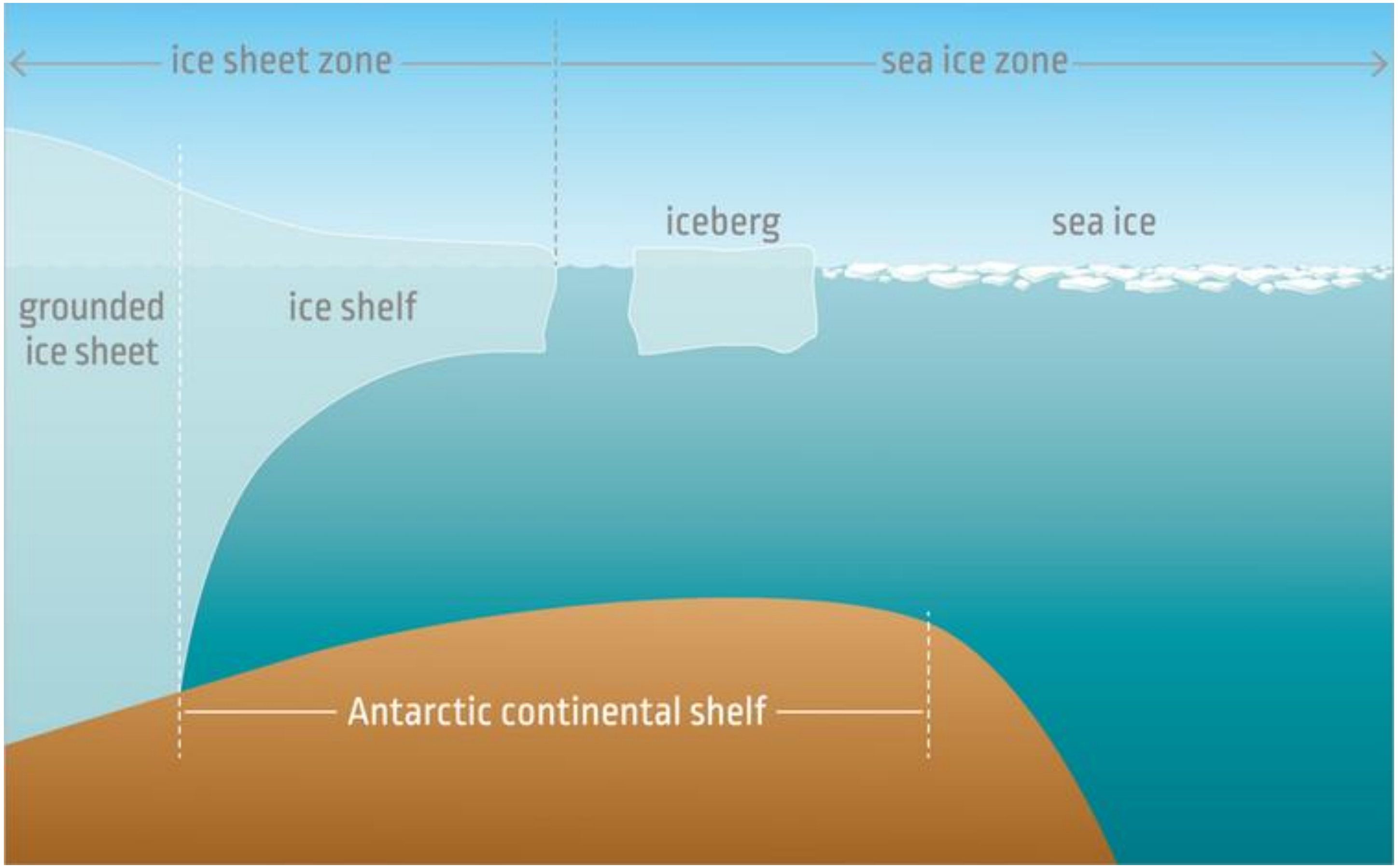


Future (2100) Mediterranean Sea Level

Difference in the MED16 sterodynamic SLC computed over the period 2046-2065 (upper panel) and over the period 2080-2099 (lower panel) relative to the historical period. (scenario rcp 8.5).



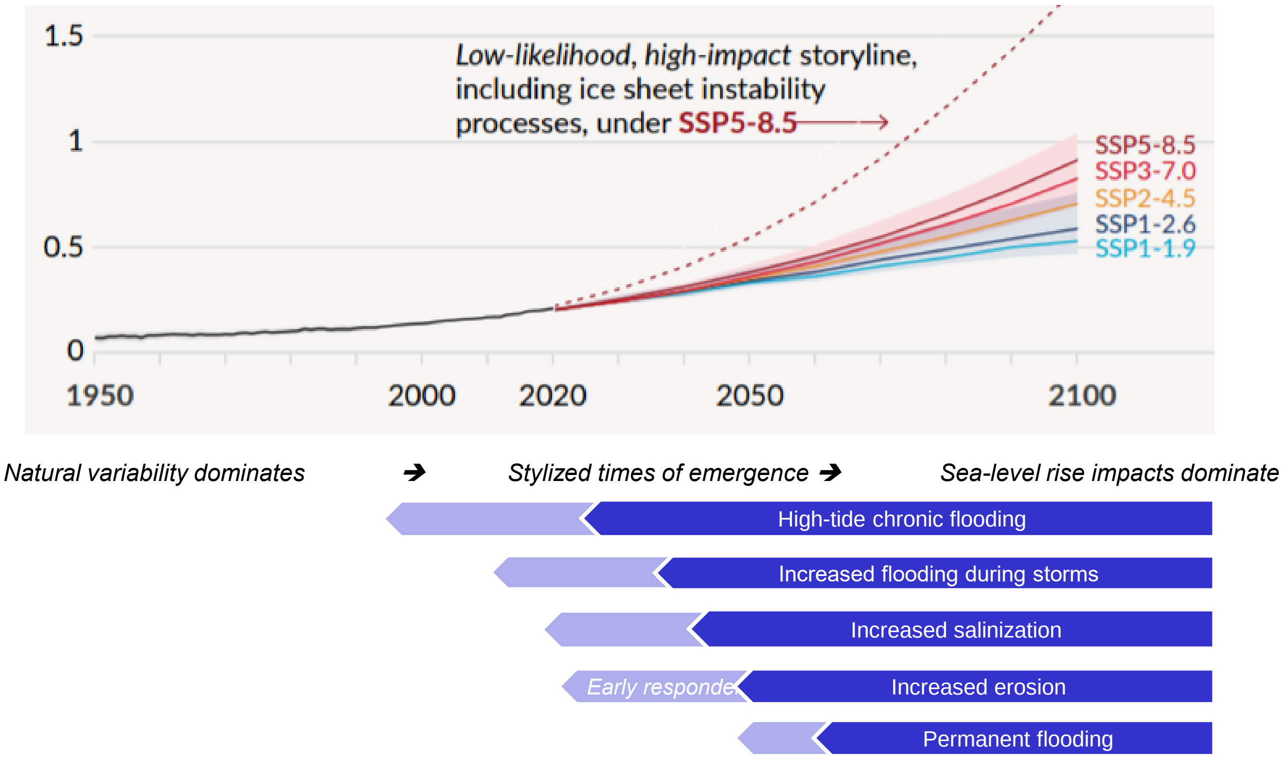
ANTARCTIC STABILITY



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003598.

CoCliCo
coastal climate core services

Why CoCliCo ?



IPCC, AR6 WG1, 2021

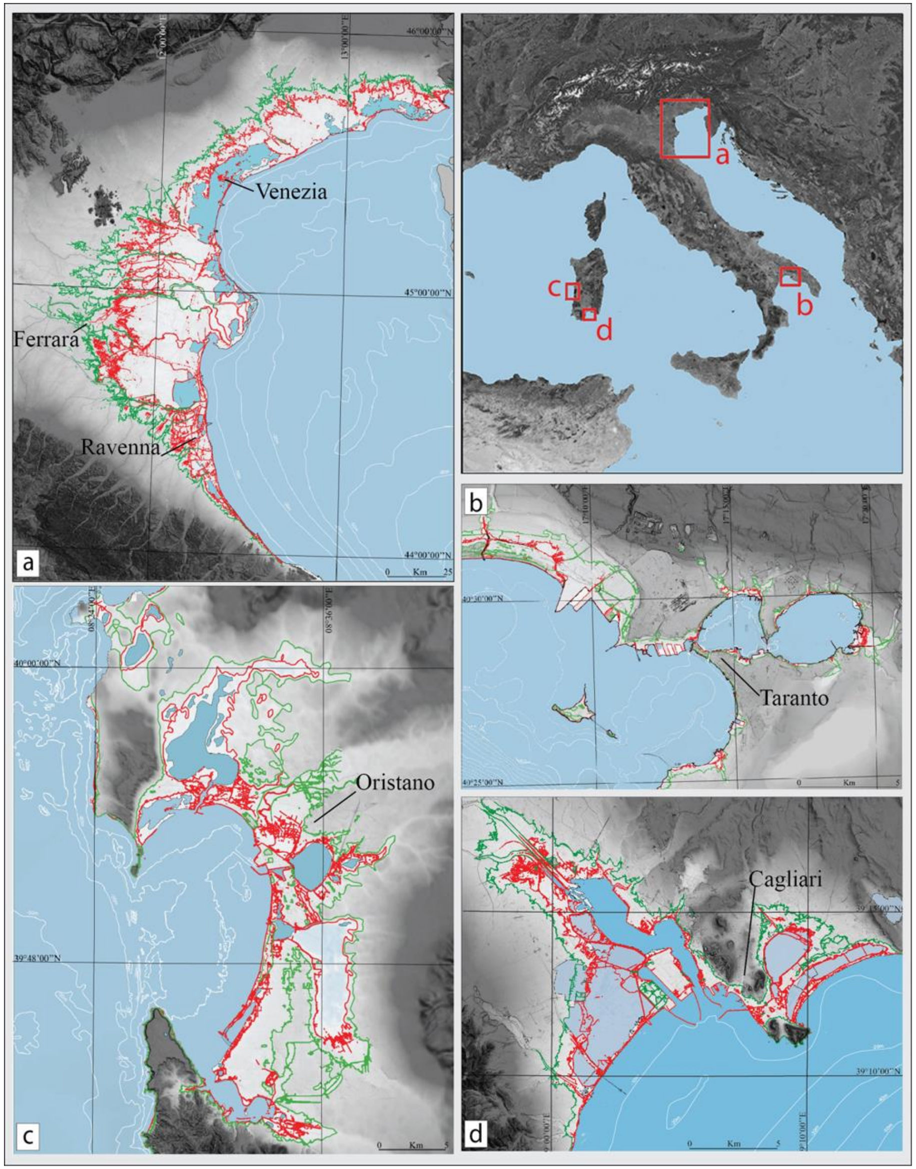
Sea level will rise at least by 0.3 to 0.6m in 2100 and continue rising for centuries.

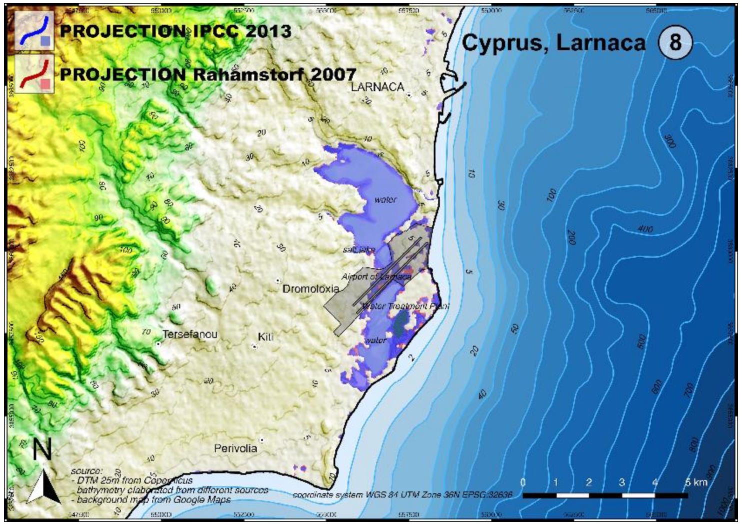
The potential impacts for coastal flooding are a major source of concern for Europe.

The impacts of sea-level rise are starting to emerge from natural variability.

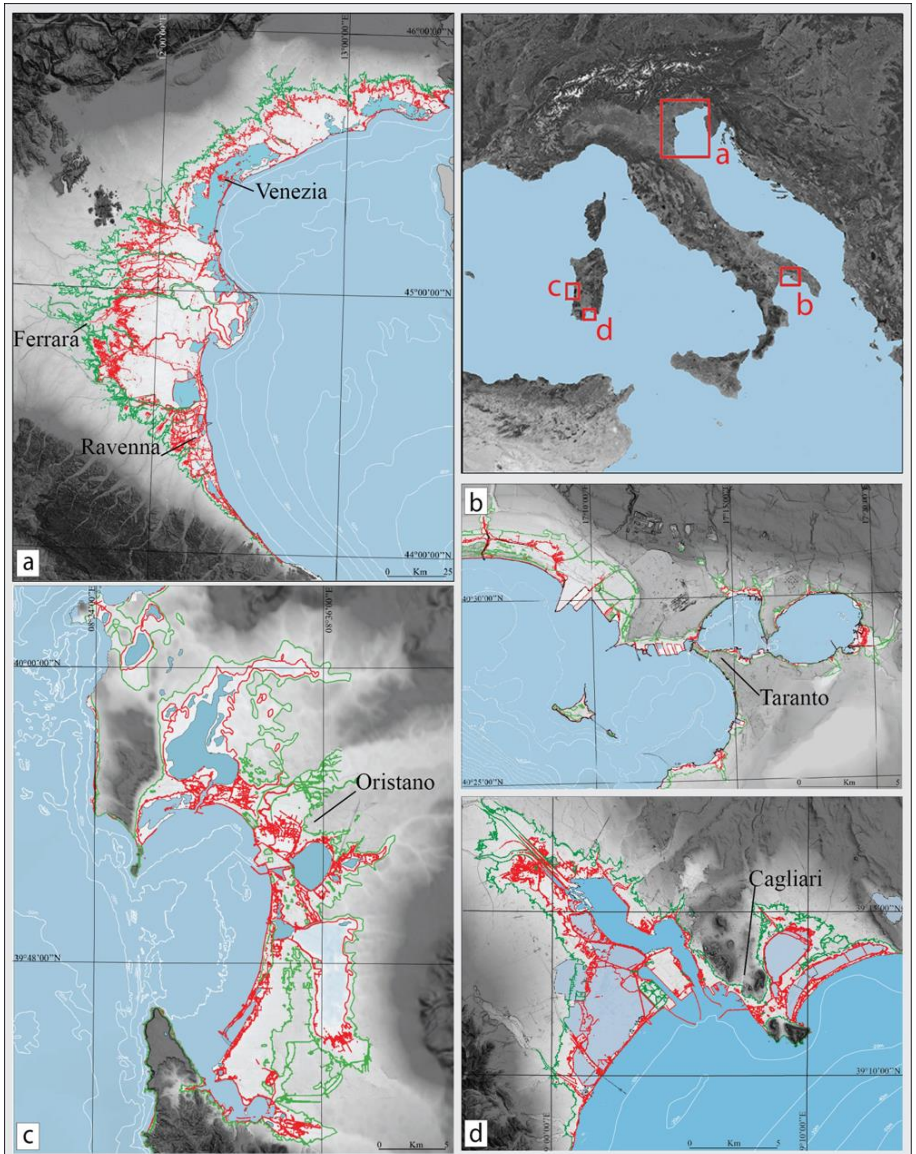
Adaptation is becoming urgent because planning and implementing adaptation often requires decades.

Future (2100) Mediterranean Sea Level





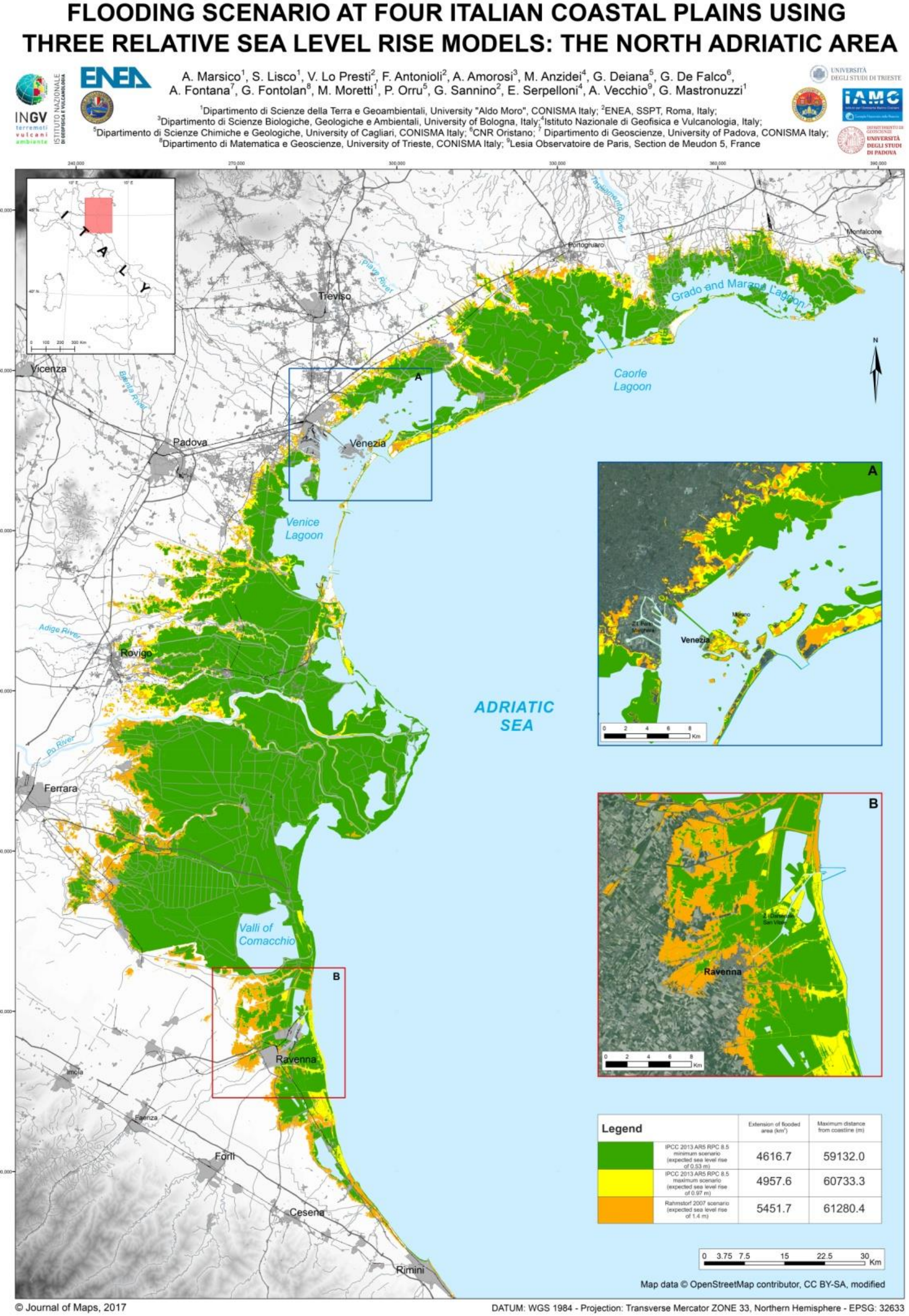
Future (2100) Mediterranean Sea Level

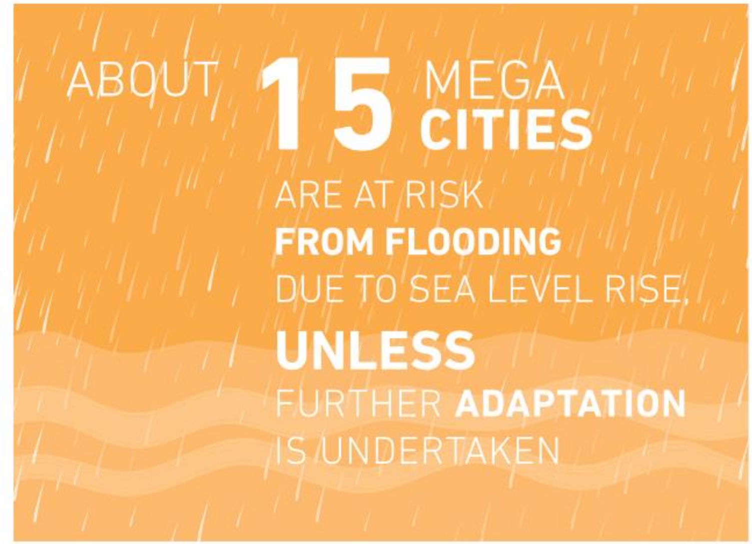


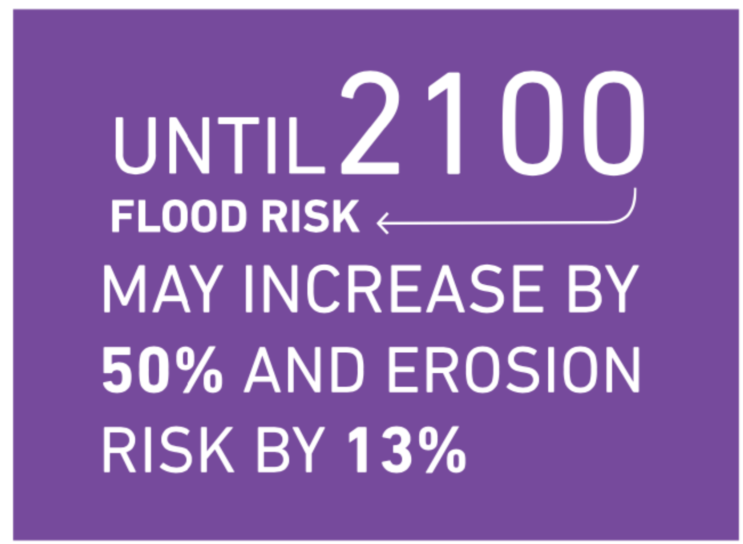
ABOUT **15** MEGA **CITIES**
ARE AT RISK
FROM FLOODING
DUE TO SEA LEVEL RISE,
UNLESS
FURTHER **ADAPTATION**
IS UNDERTAKEN

UNTIL 2100
FLOOD RISK
MAY INCREASE BY
50% AND EROSION
RISK BY **13%**

Future (2100) Mediterranean Sea Level rcp 8.5







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