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

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

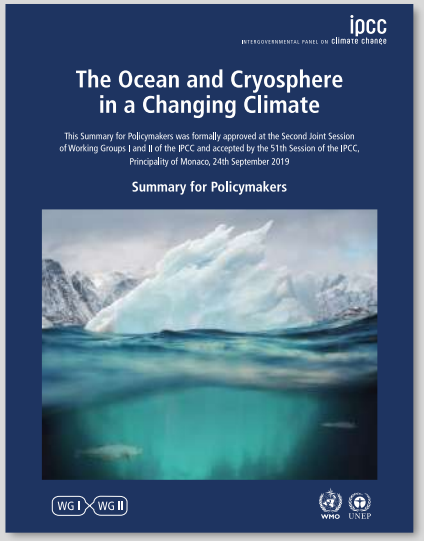
PIANO Clima ROMA

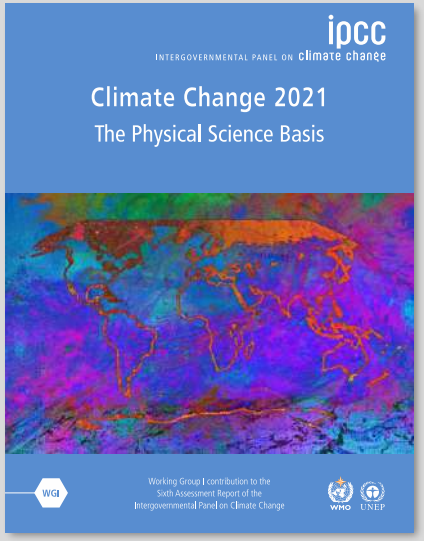
Presentazione della
STRATEGIA DI ADATTAMENTO CLIMATICO DI ROMA CAPITALE

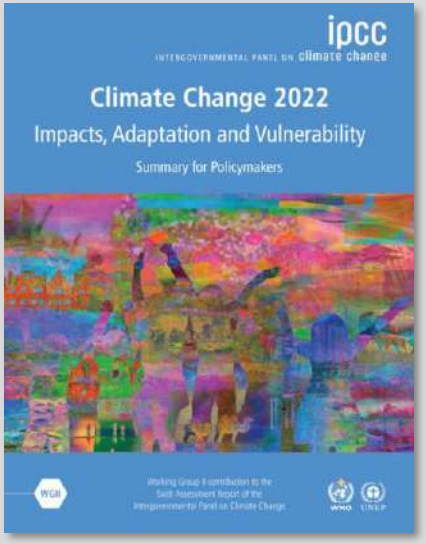
Il litorale costiero in uno scenario di cambiamenti climatici

Roma - 23 gennaio 2024

Gianmaria Sannino (ENEA), Filippo D'Ascola (ISPRA)







I rapporti dell'IPCC sono redatti e rivisti in più tappe, garantendo così obiettività e trasparenza. Ogni 6-7 anni vengono pubblicati dei rapporti di valutazione scientifica approfonditi; il sesto rapporto di valutazione, è stato pubblicato inizialmente nel 2021 e ha fornito la principale base scientifica agli scienziati e ai responsabili politici. Nel 2022 è stato pubblicato il rapporto del WGII sugli impatti, l'adattamento e la vulnerabilità.

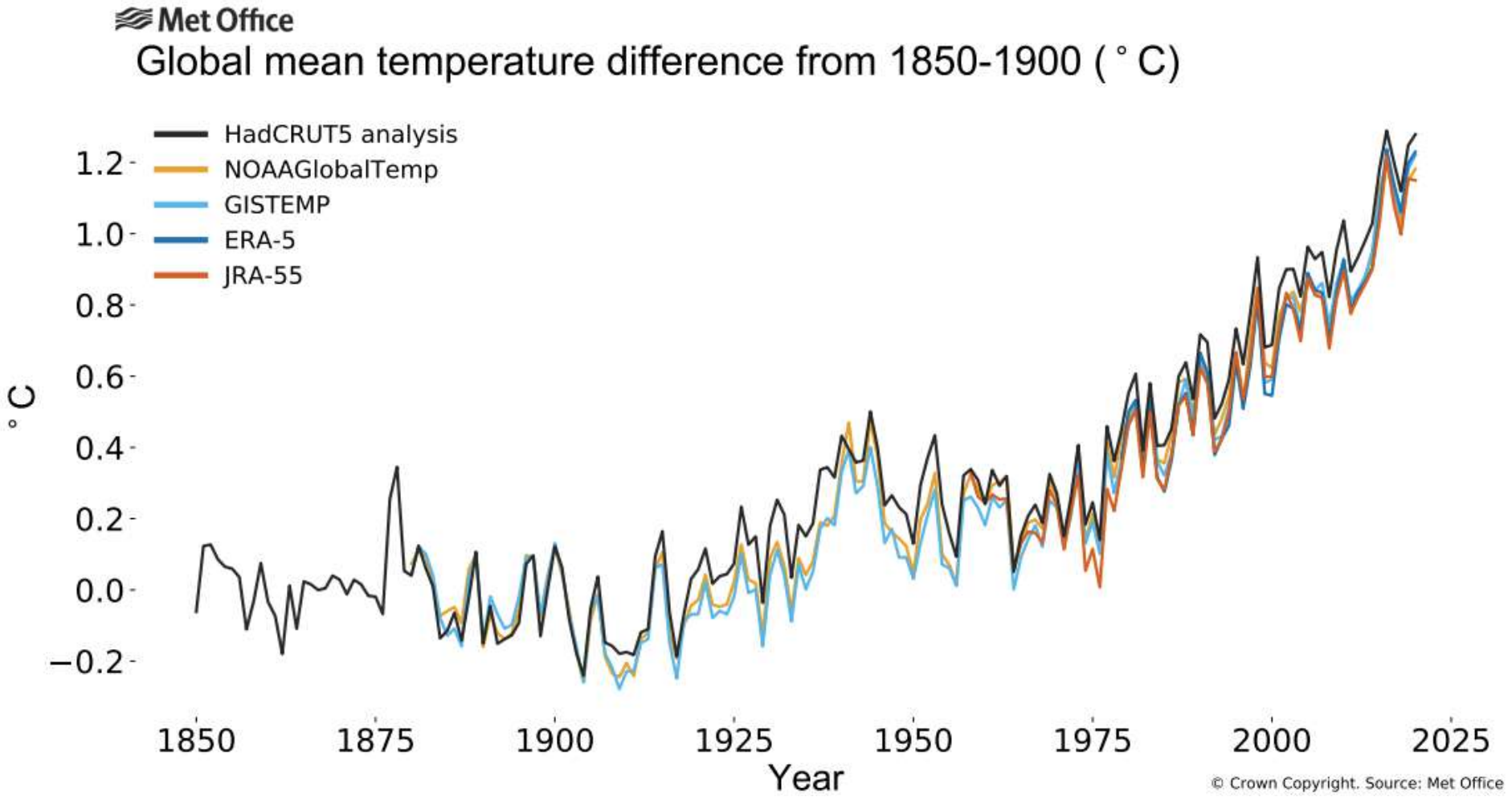
[Credit: NASA]

"I recenti cambiamenti del clima sono diffusi, rapidi, in intensificazione e senza precedenti da migliaia di anni.

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

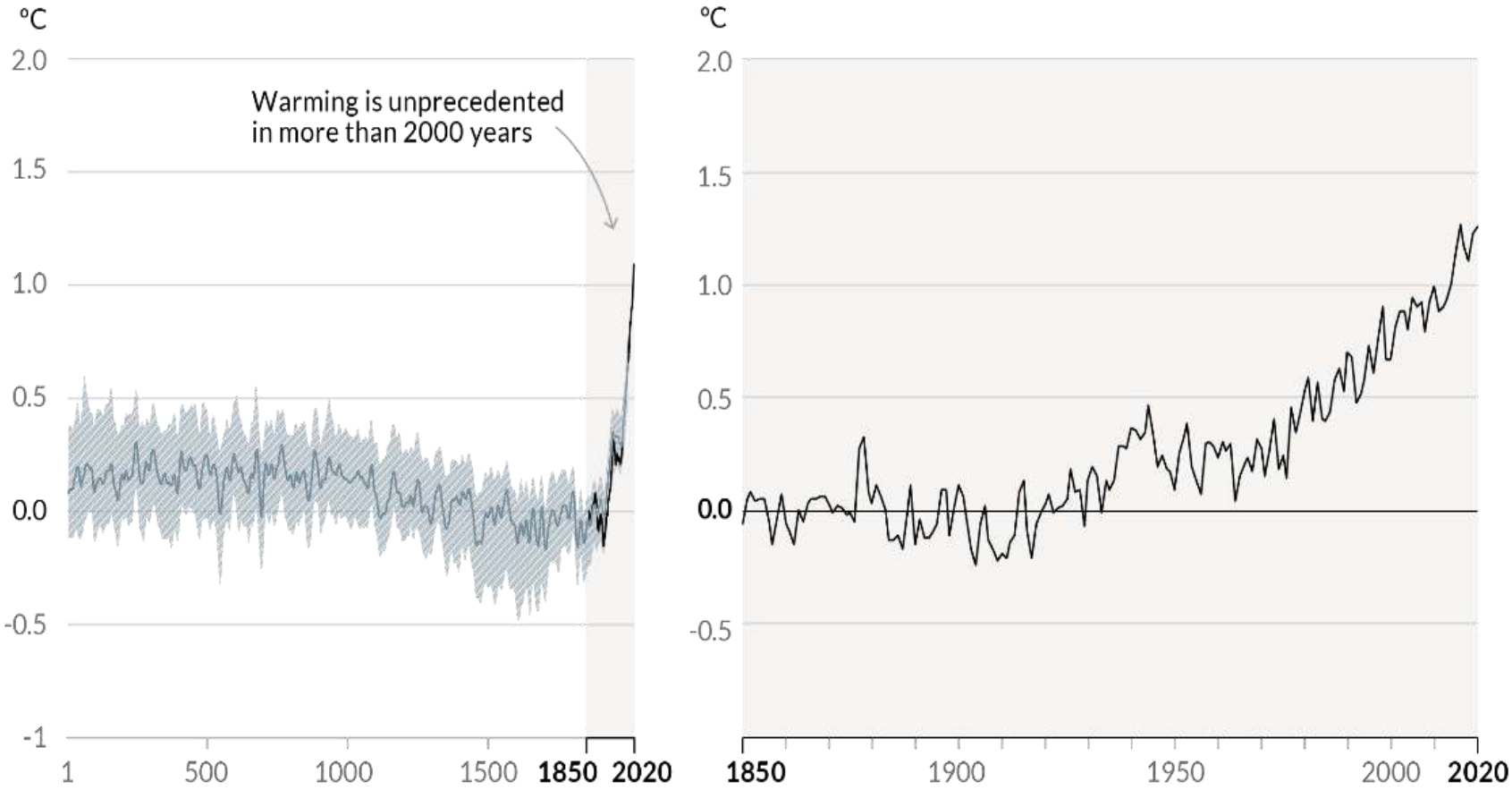
Andamento della temperatura media globale



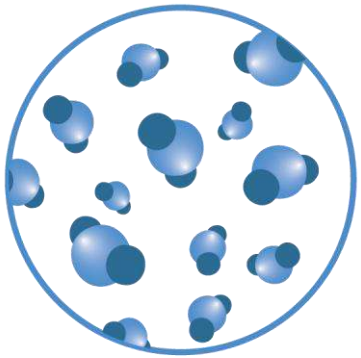
Andamento della temperatura media globale

L'influenza umana ha provocato un riscaldamento ad un ritmo che non ha precedenti almeno negli ultimi 2000 anni

Changes in global surface temperature relative to 1850-1900



Concentrazione
CO_2



la più alta

degli ultimi

2 milioni di anni

Innalzamento
livello del mare

il più rapido

degli ultimi

3000 anni

Estensione
ghiaccio artico

il più basso

degli ultimi

1000 anni

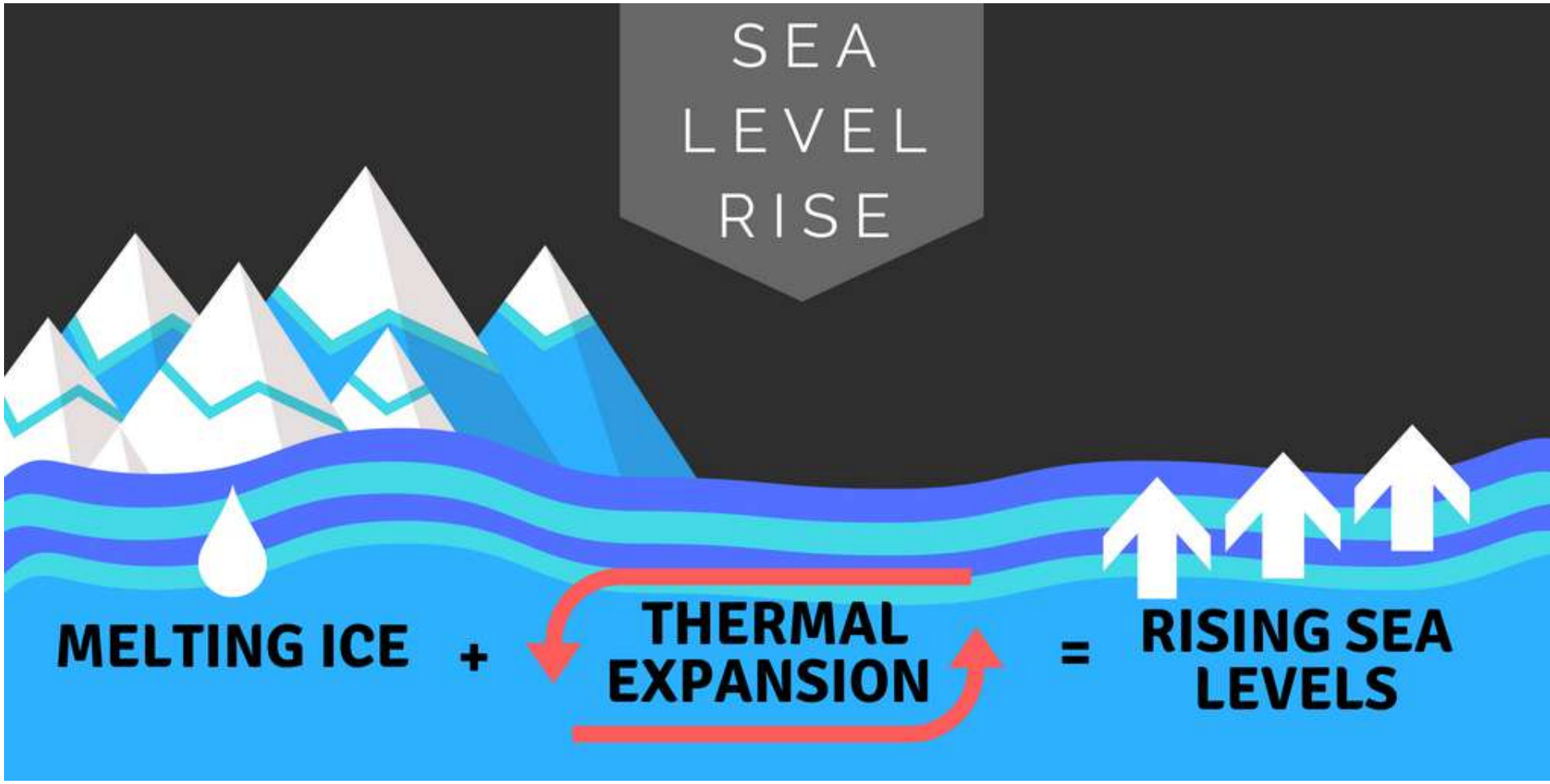
Ritiro
ghiacciai

Senza precedenti

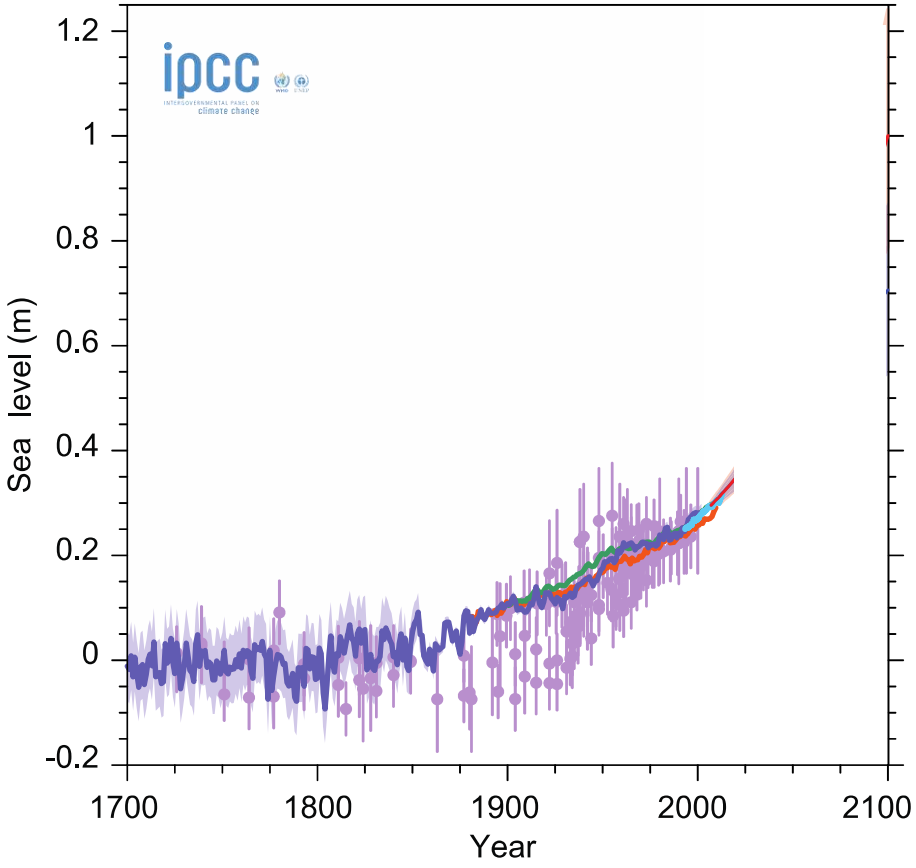
negli ultimi

2000 anni

Cause dell’innalzamento del livello del mare



Andamento del livello del mare globale dal 1700



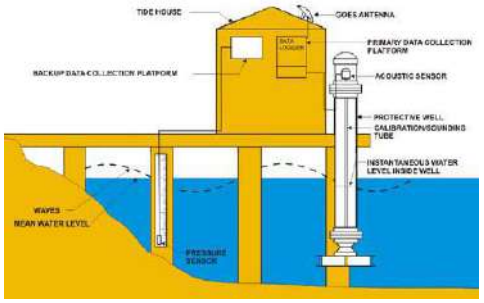
Rate during 1901-1990 was 1.50 ± 0.2 mm yr^{-1}

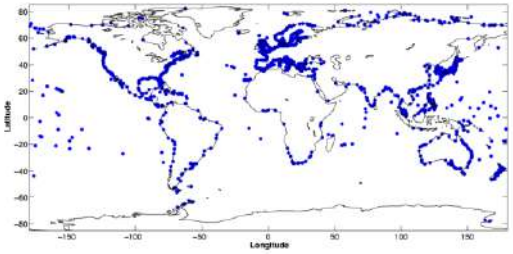
Rate during 1993-2010 was 3.07± 0.37 mm yr^{-1}

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

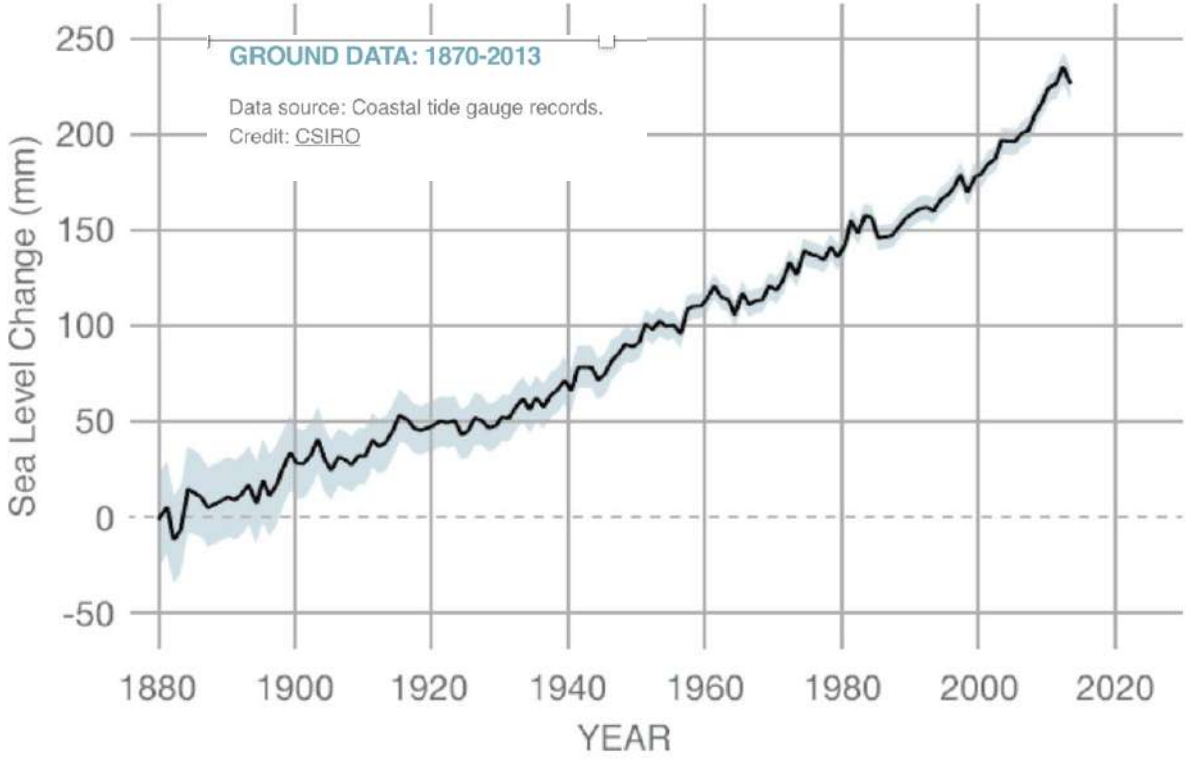
Compilation of paleo sea level data, tide gauge data, altimeter data.

Andamento del livello del mare globale dal 1880





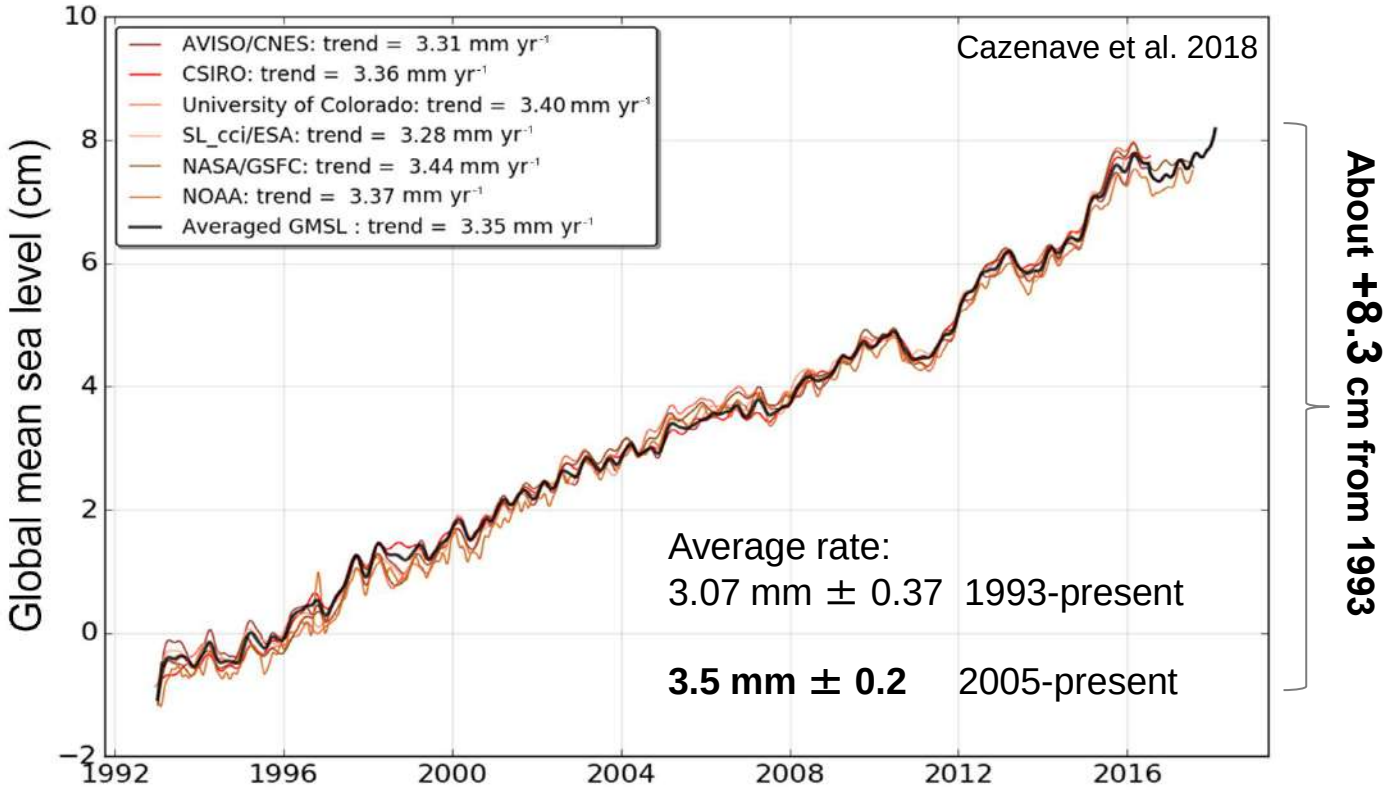
Spatial distribution of the **1420** tide gauges



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

About +25 cm from 1880

Andamento del livello del mare globale dal 1983



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

[Credit: Yoda Adaman | Unsplash]

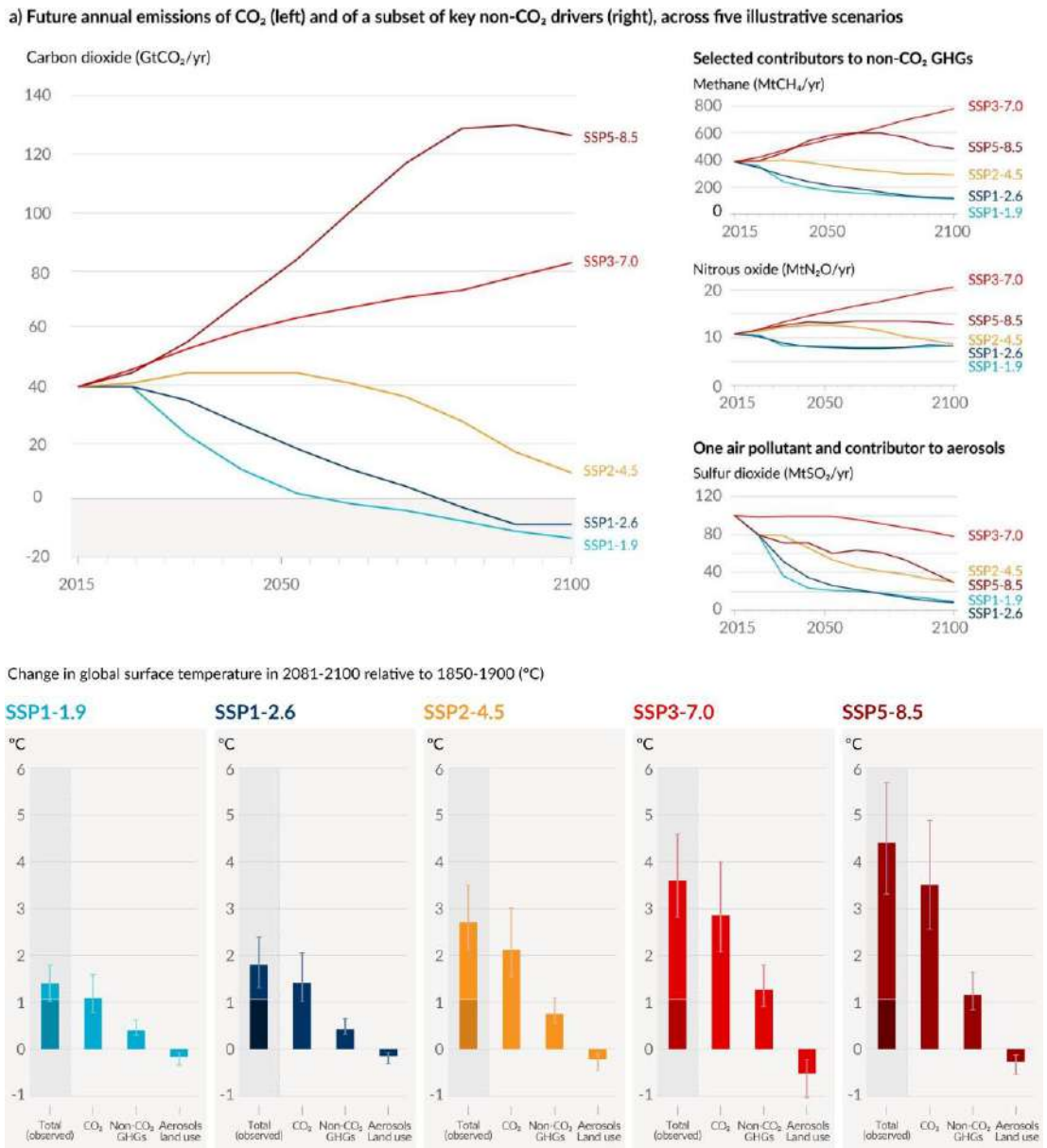
> È indubbio che le attività umane stanno causando il cambiamento climatico, rendendo gli eventi climatici estremi, tra cui le ondate di calore, le piogge intense e la siccità, più frequenti e intense.

Possibili scenari emissivi futuri

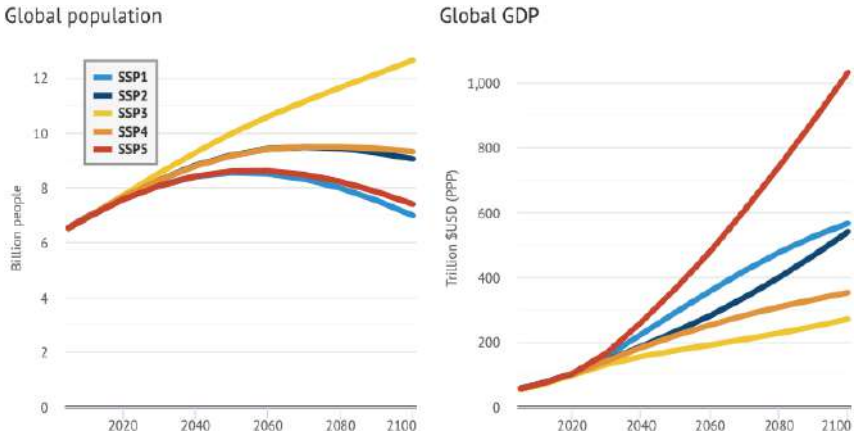
Emissioni antropogeniche dei principali gas e sostanze che contribuiscono al riscaldamento globale e influenzano il cambiamento climatico.

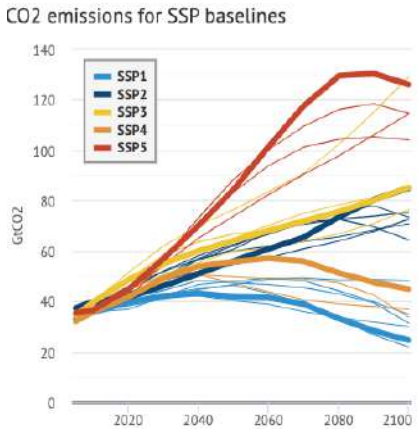
Shared Socioeconomic Pathways

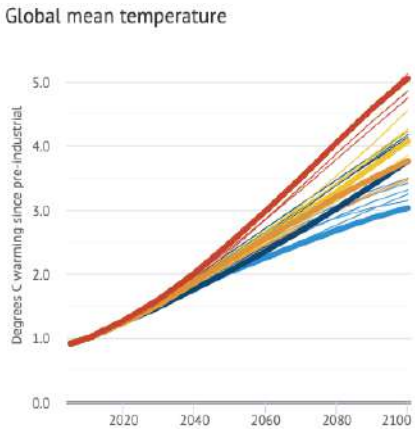
Pannello (a) Emissioni antropiche annuali per il periodo 2015-2100. Sono mostrate le traiettorie delle emissioni di anidride carbonica (CO2) da tutti i settori (GtCO2/anno) (grafico a sinistra) e per un sottoinsieme di tre fattori chiave non-CO2 considerati negli scenari: metano (CH4, MtCH4/anno, grafico in alto a destra); protossido di azoto (N2O, MtN2O/anno, grafico centrale a destra); e anidride solforosa (SO2, MtSO2/anno, grafico in basso a destra, che contribuisce agli aerosol antropogenici nel pannello (b).

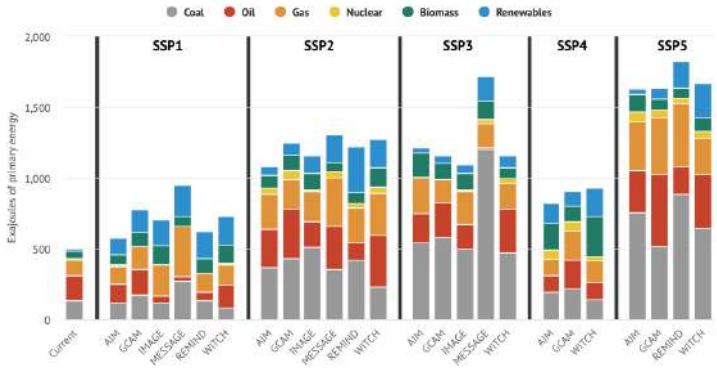


Percorsi socio-economici condivisi









CarbonBrief

SSP1 **Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation)**
The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.

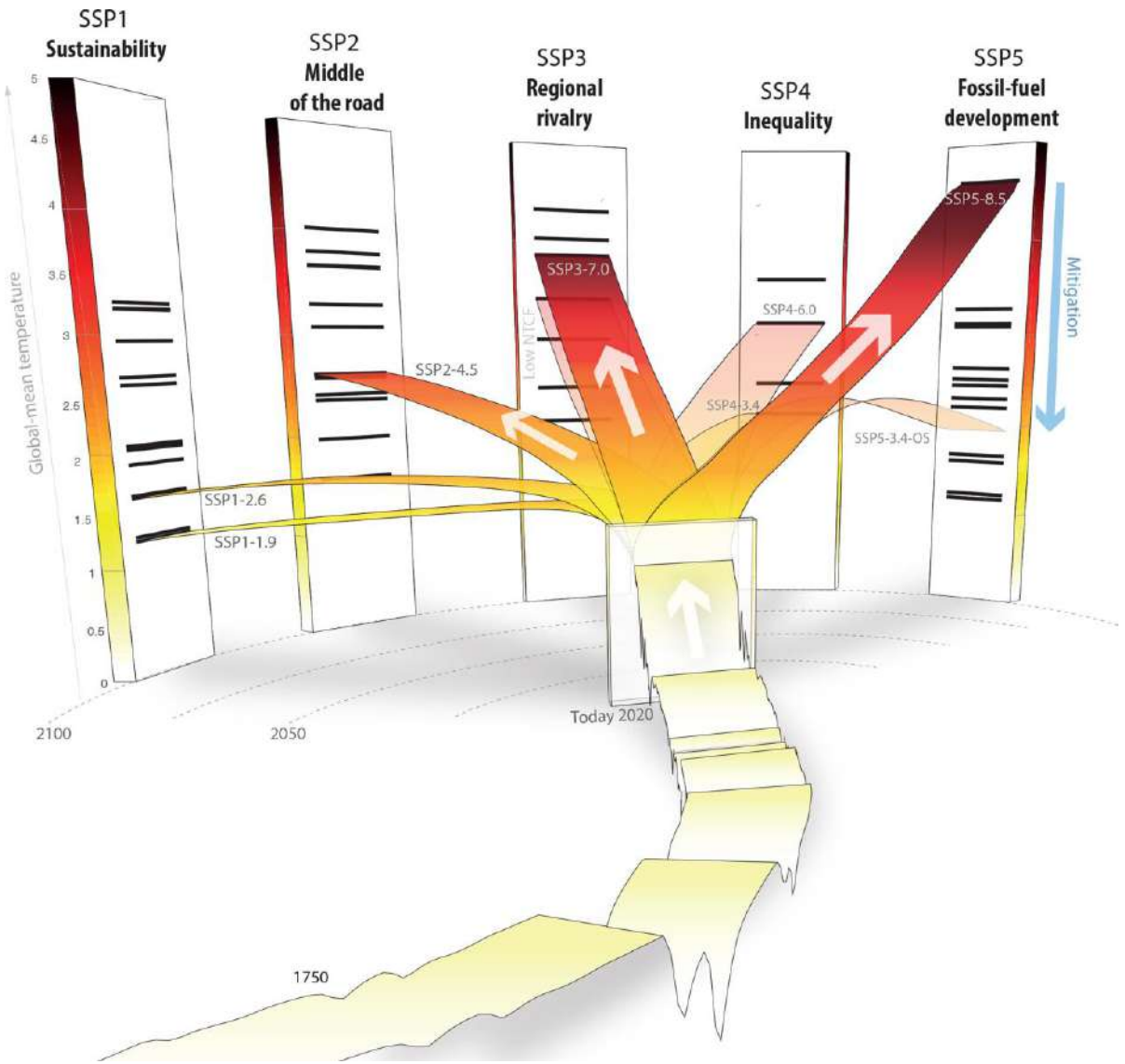
SSP2 **Middle of the Road (Medium challenges to mitigation and adaptation)**
The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.

SSP3 **Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation)**
A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialized and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.

SSP4 **Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation)**
Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally-connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labor intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle and high income areas.

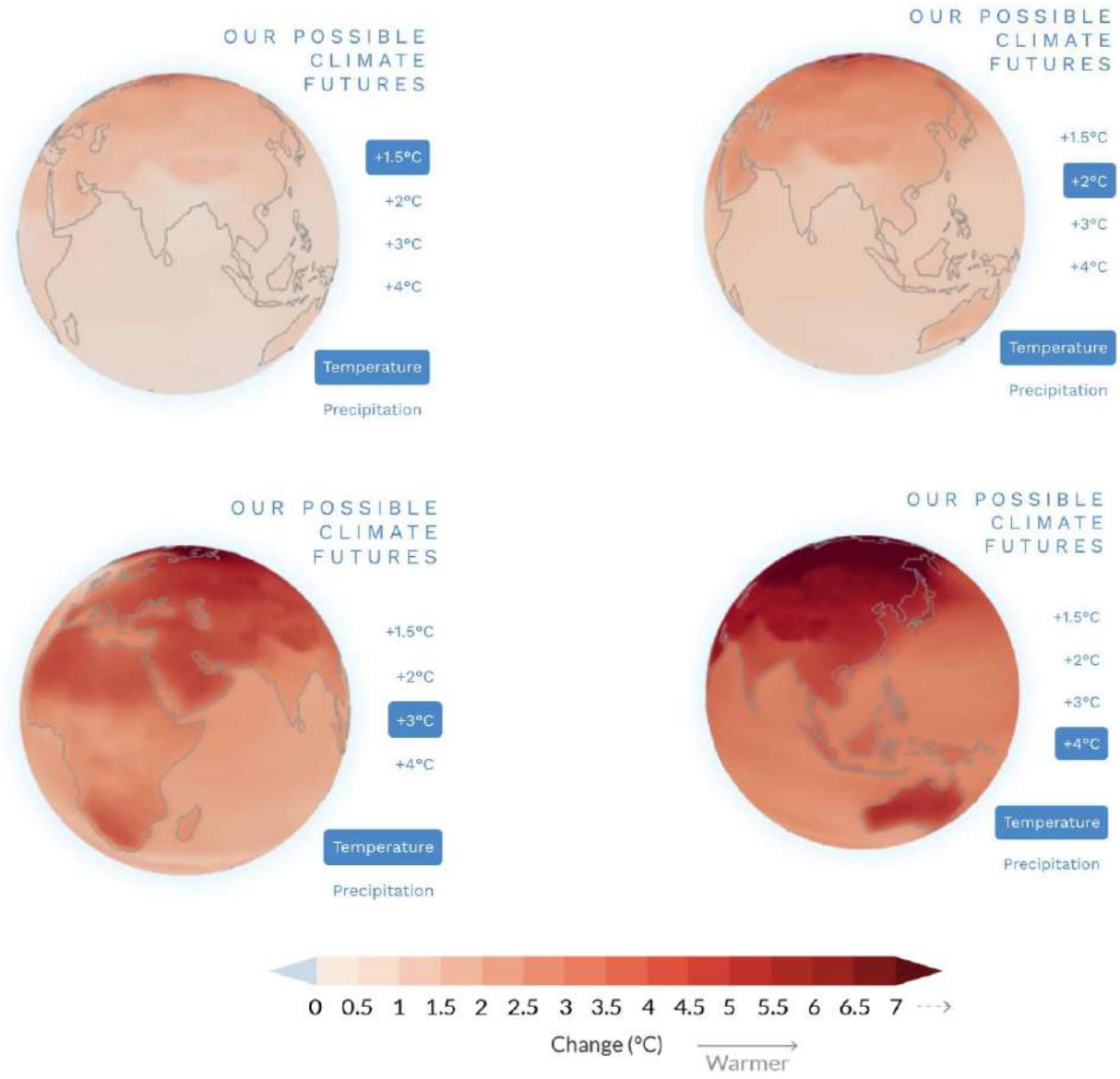
SSP5 **Fossil-fueled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation)**
This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.

Shared Socioeconomic Pathways & Temperature

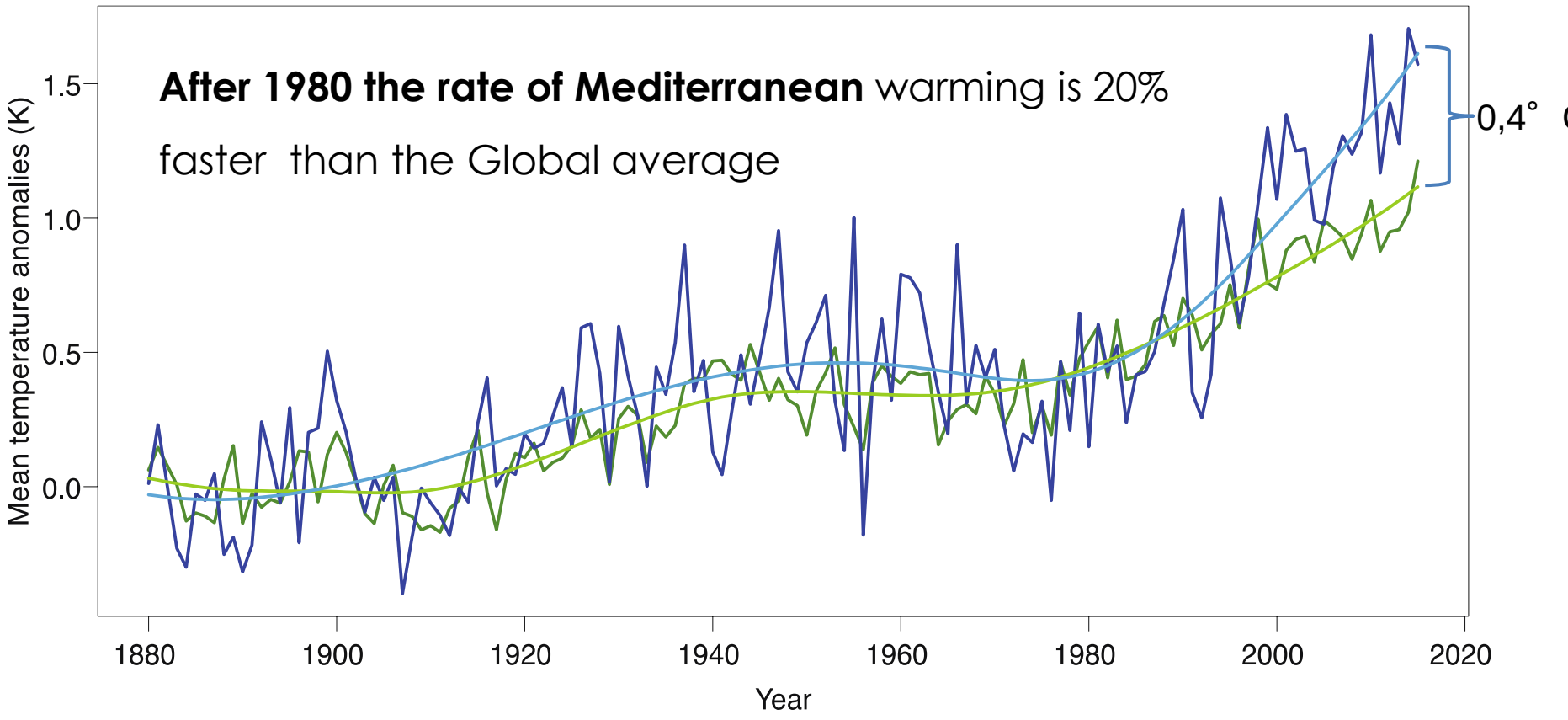


Meinshausen et al, GMD 2020

Scenari: Temperatura superficaile media globale

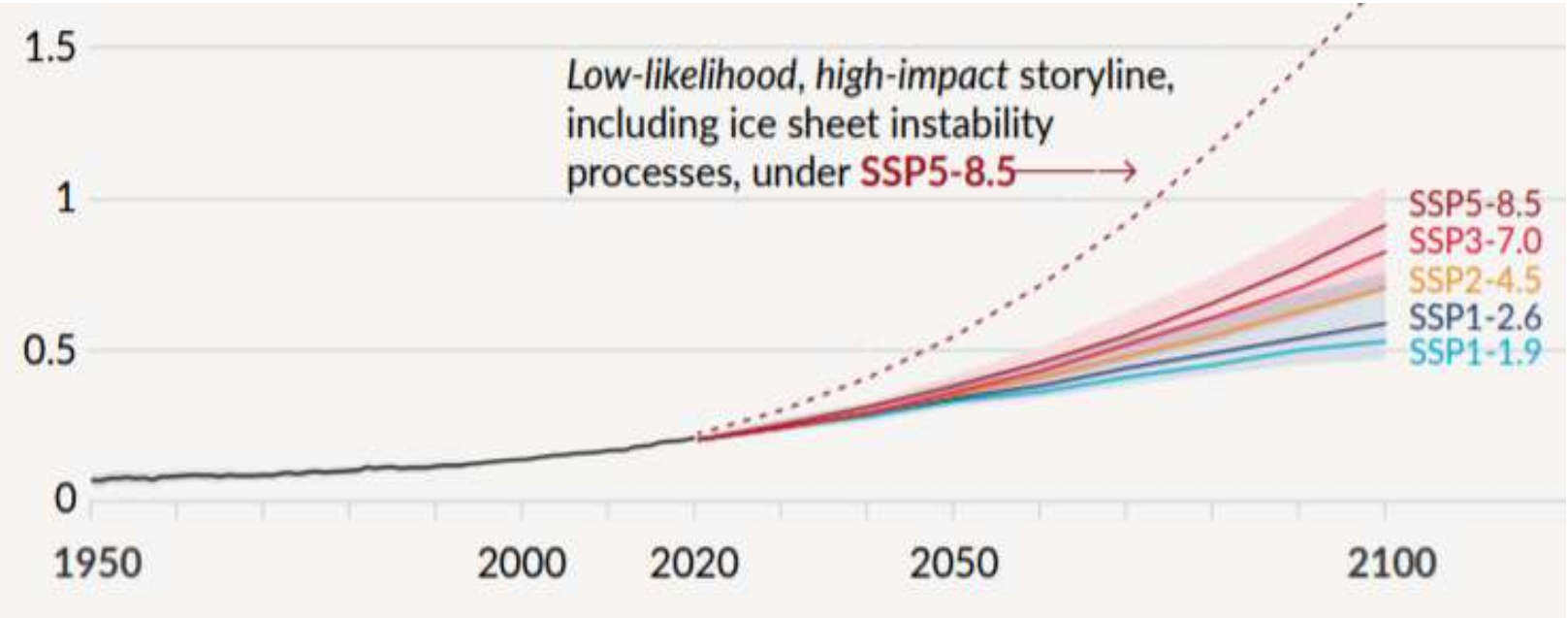


Changes in global vs Mediterranean surface temperature



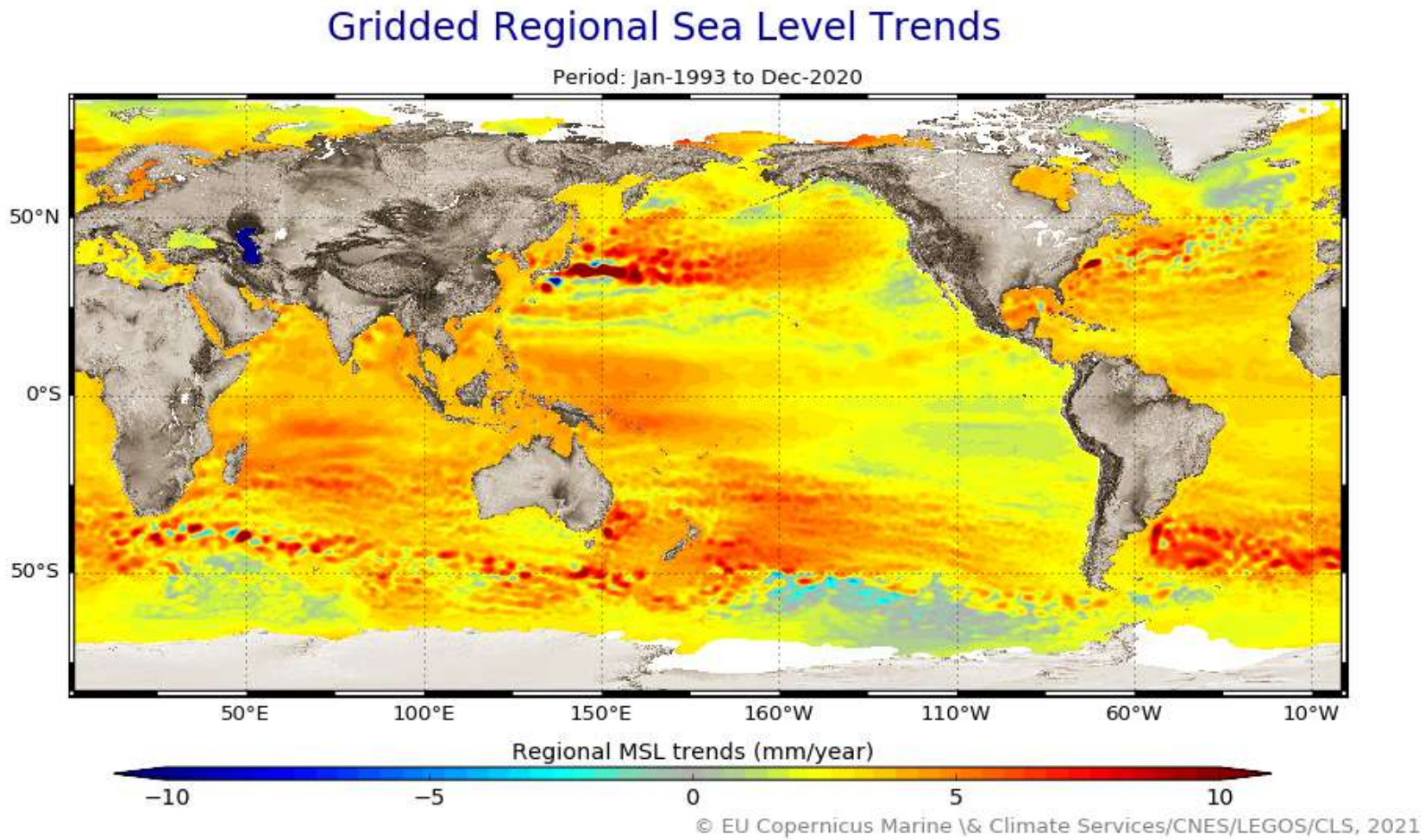
Historic warming of the atmosphere at Global and Mediterranean scale. Annual mean air temperature anomalies are shown with respect to the preindustrial period (**1880–1899).** Adapted by Cramer et al. 2018 (NCC)

Future Scenarios global sea level



AR6 ipcc
INTERGOVERNMENTAL PANEL ON climate change

Regional Sea Level

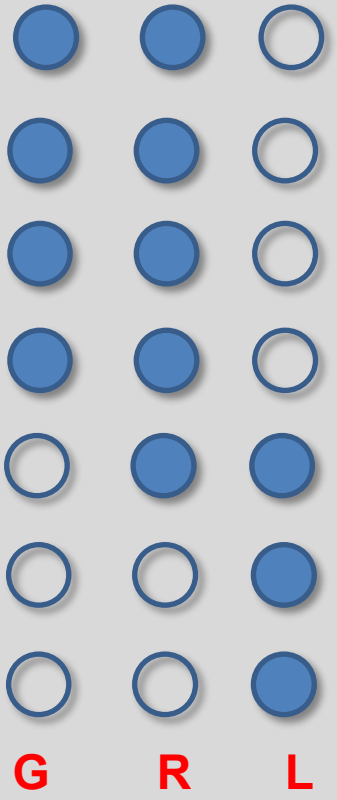


Regional gridded sea level trend over the period 1993-to present (in mm/year) from the multi-mission Ssalto/Duacs data.

The grid resolution is of a 1/4 of a degree.

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

- 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



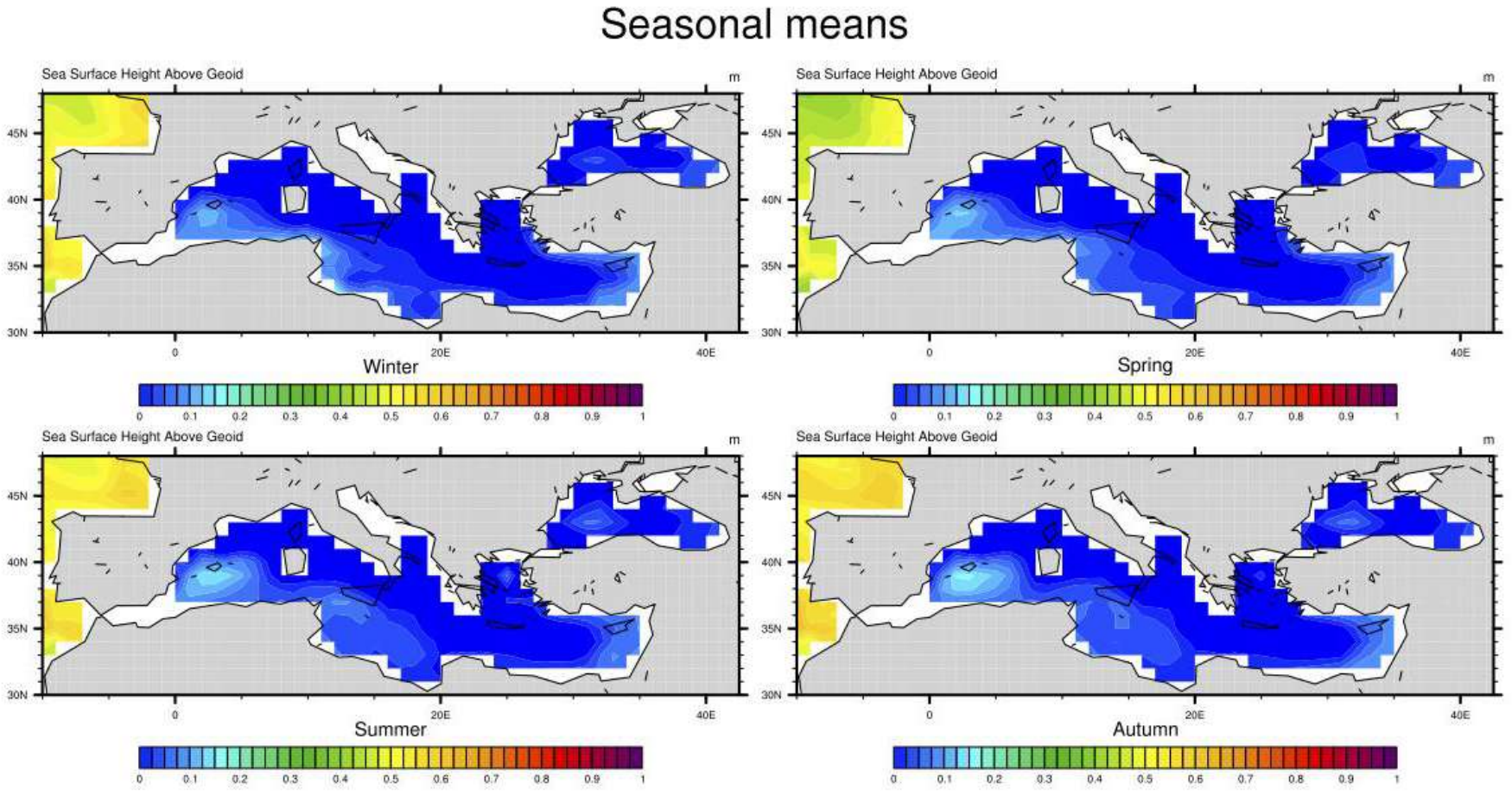
SROCC & IPCC AR6 – WGI Chapter 9

*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**.*

Background geography

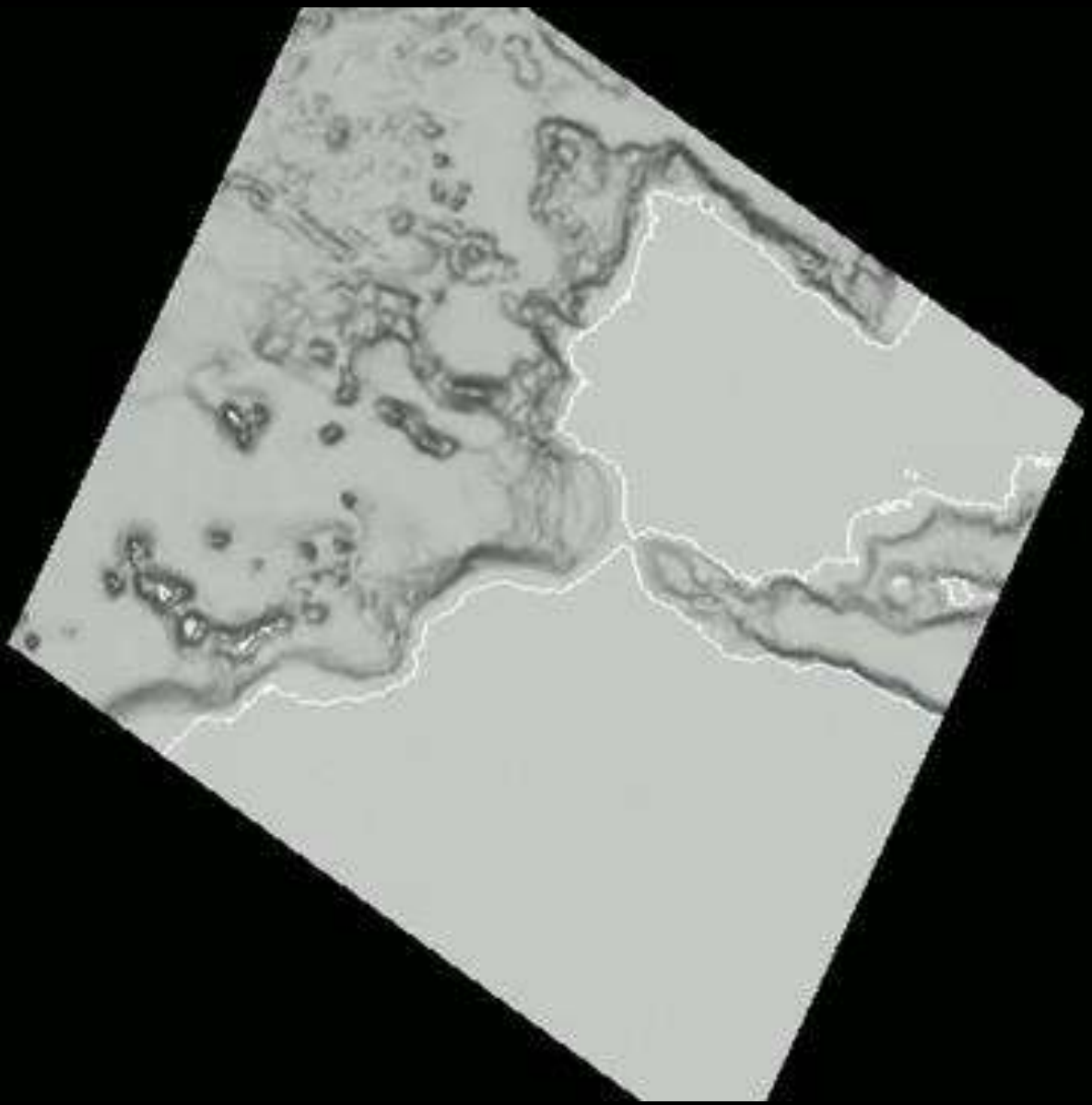
Global climate models: present climate seasonal means



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: Physics

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

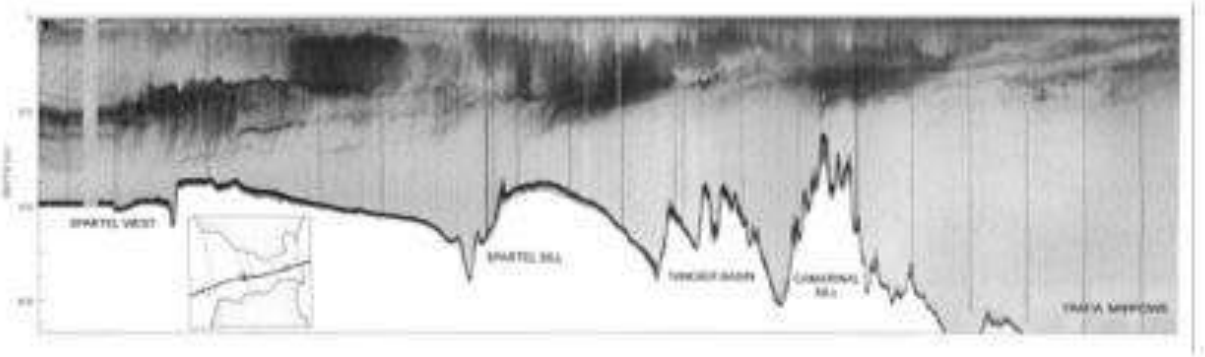


Figure 2. Transect of the Strait [From Armi and Farmer, Farmer and Armi.1988]

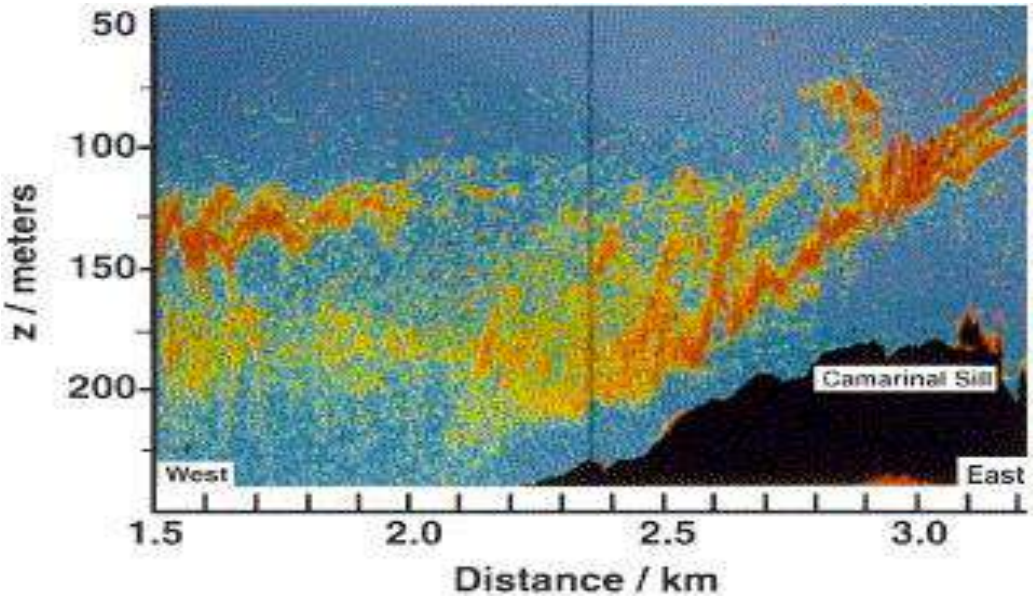
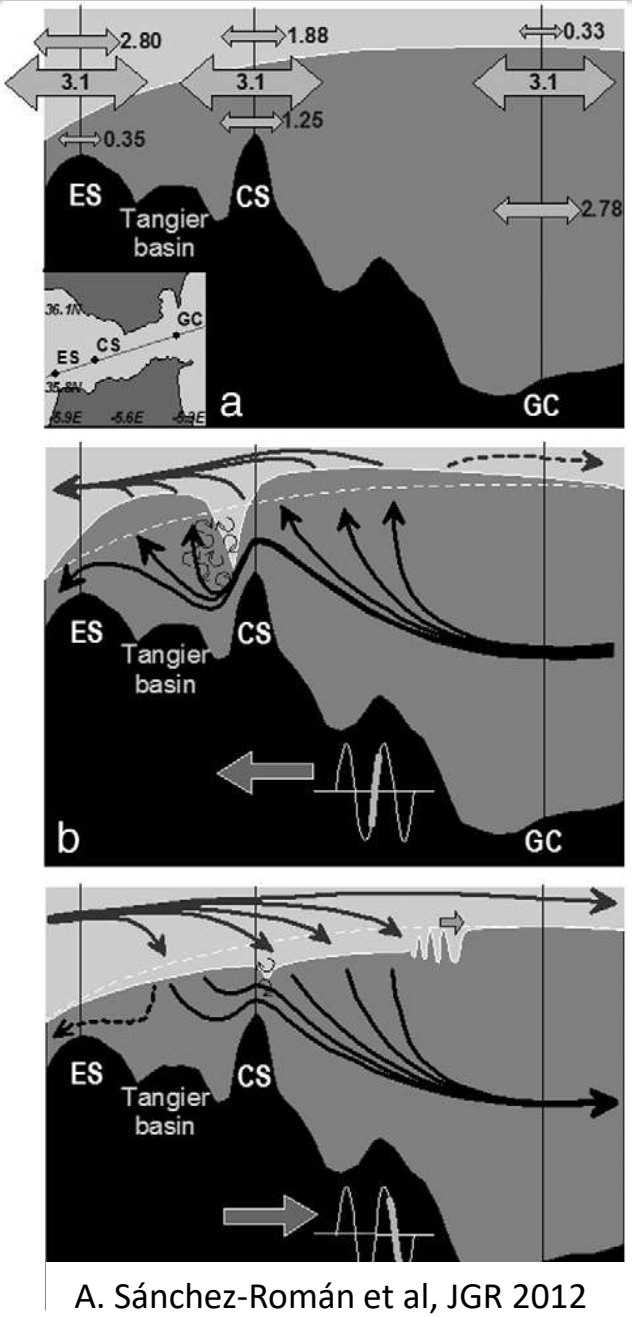
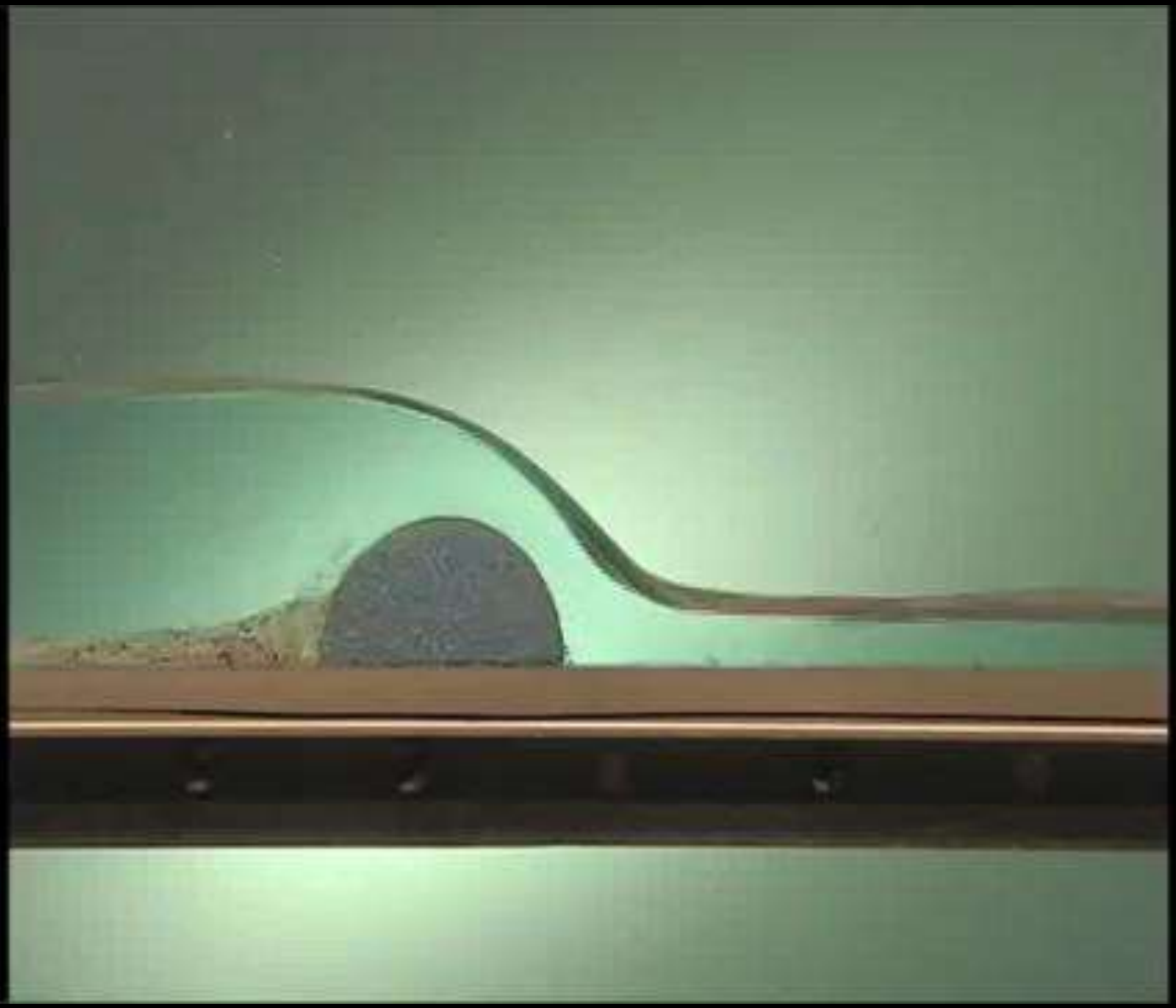


Image of acoustic backscatter during ebb tide over Camarinal Sill in the Strait of Gibraltar (Wesson and Gregg, 1994)



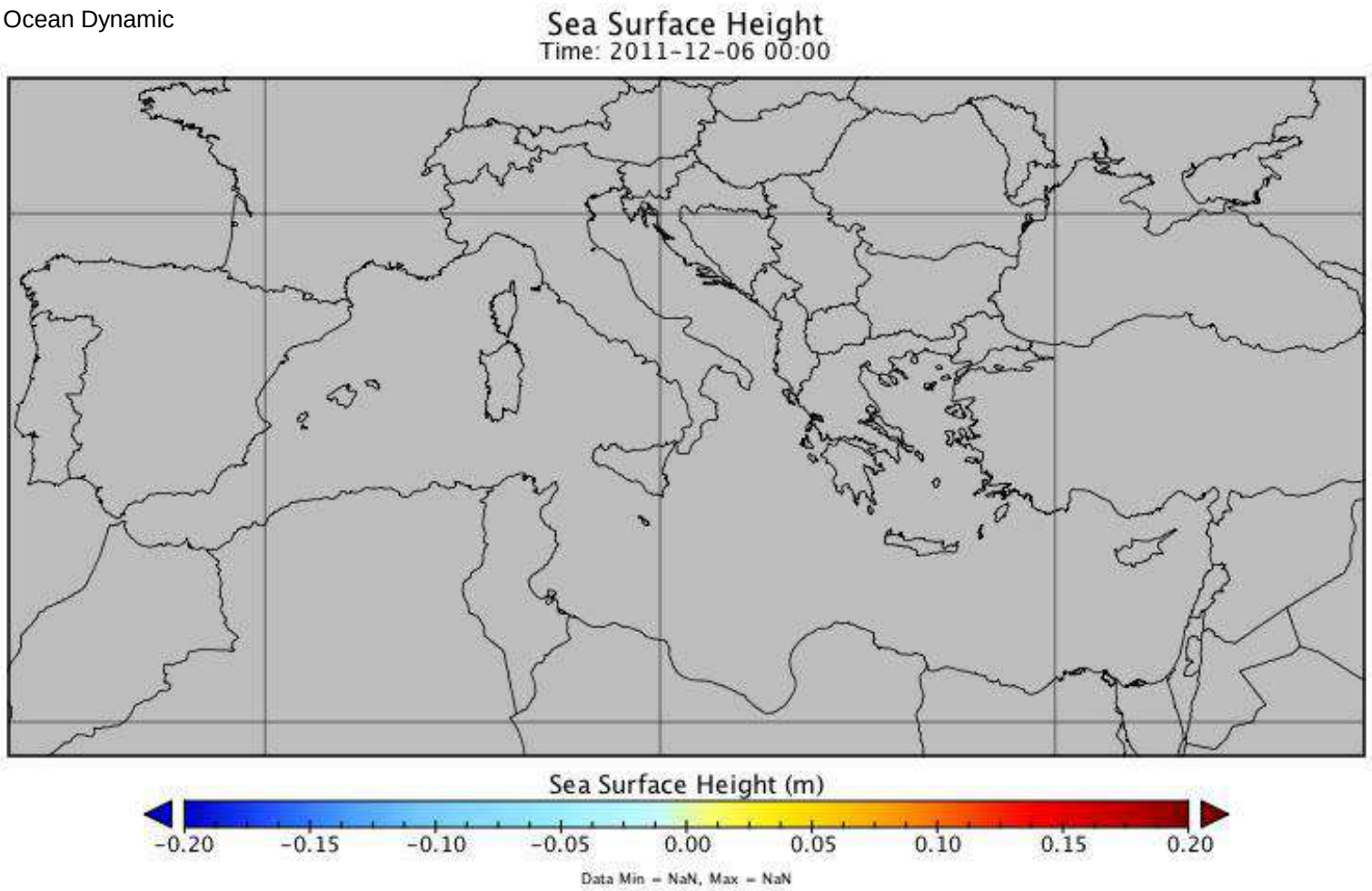
A. Sánchez-Román et al, JGR 2012

Hydraulics jump: an example



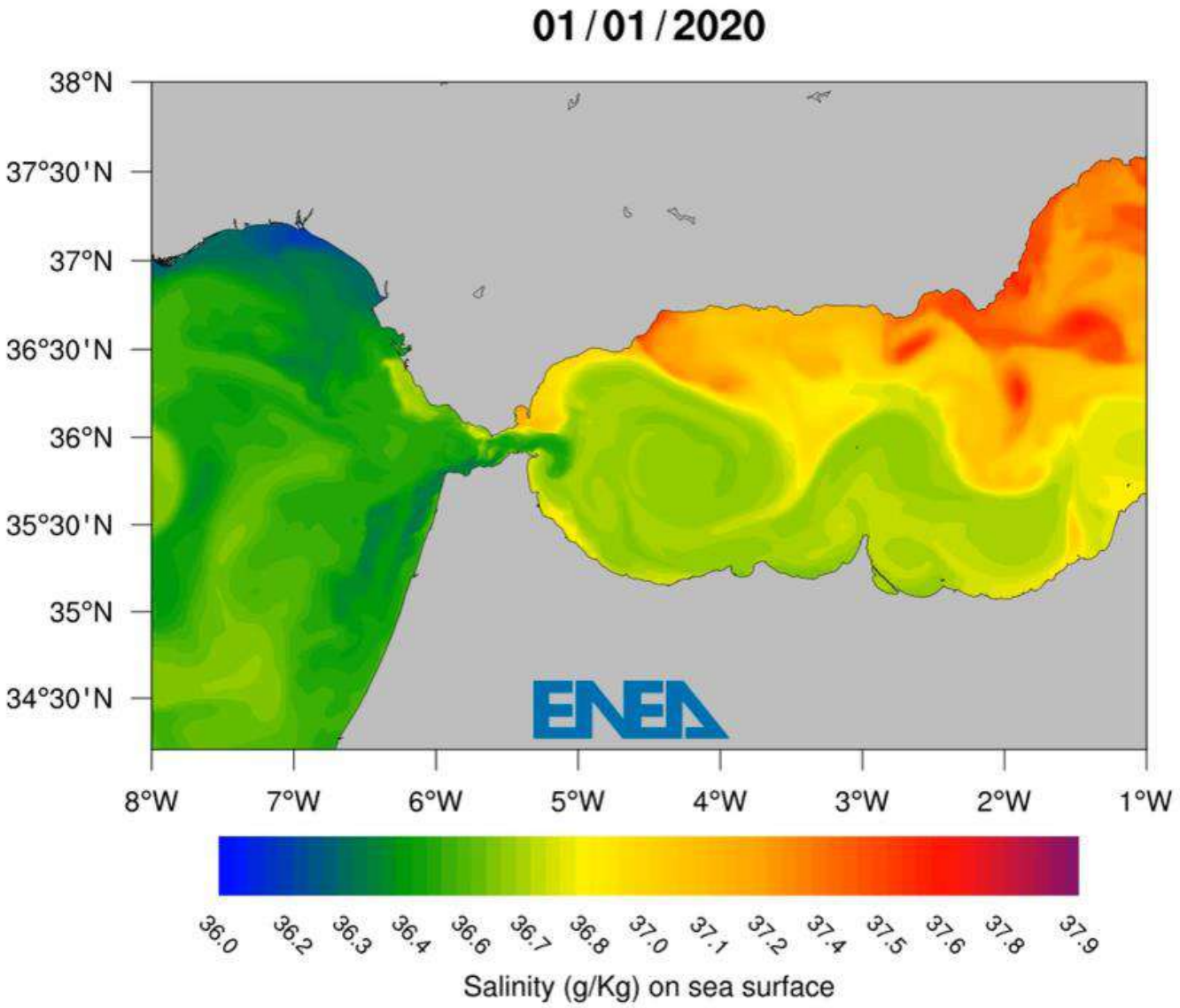
ENEA Climate Model

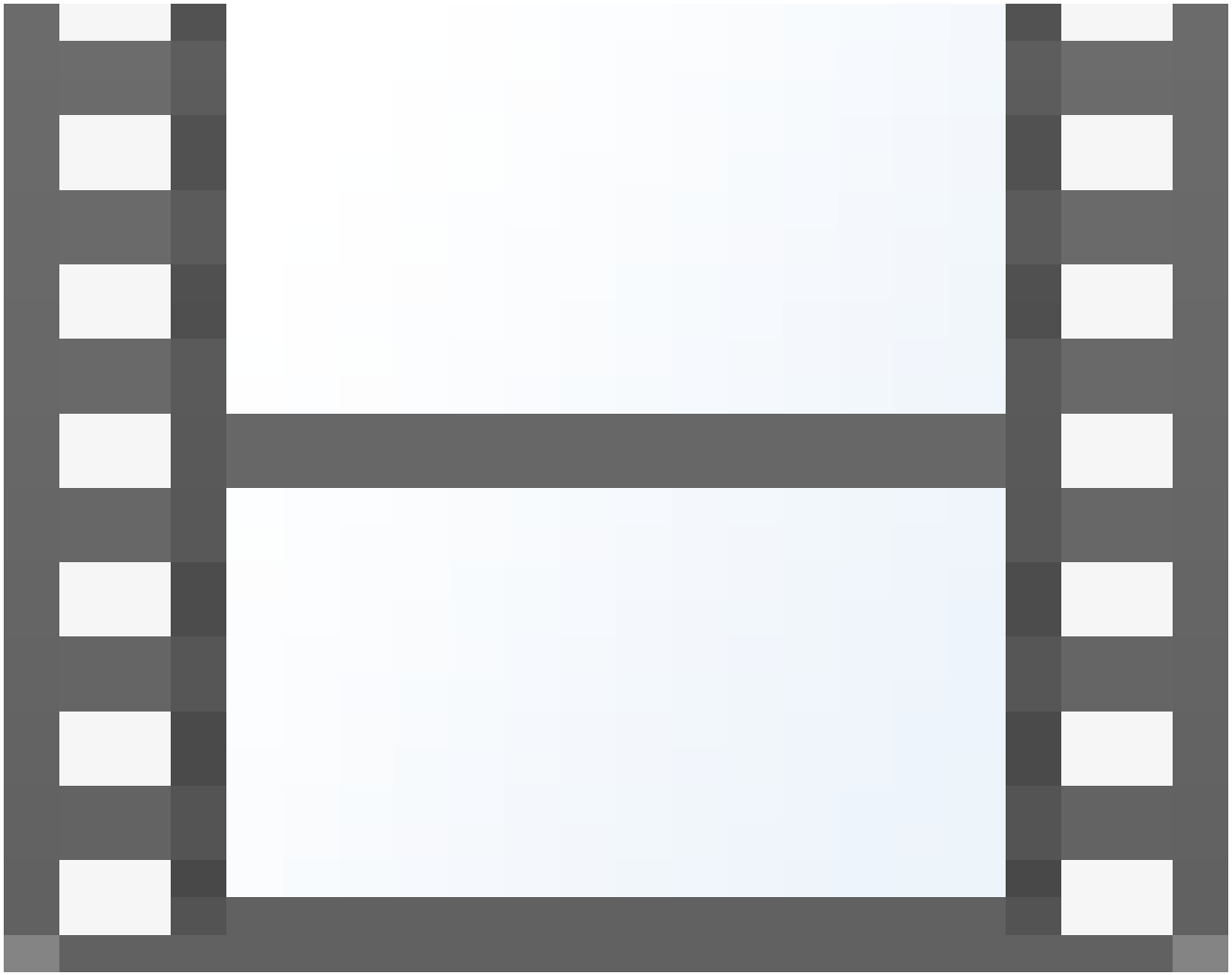
Palma et al 2019 – Ocean Dynamic

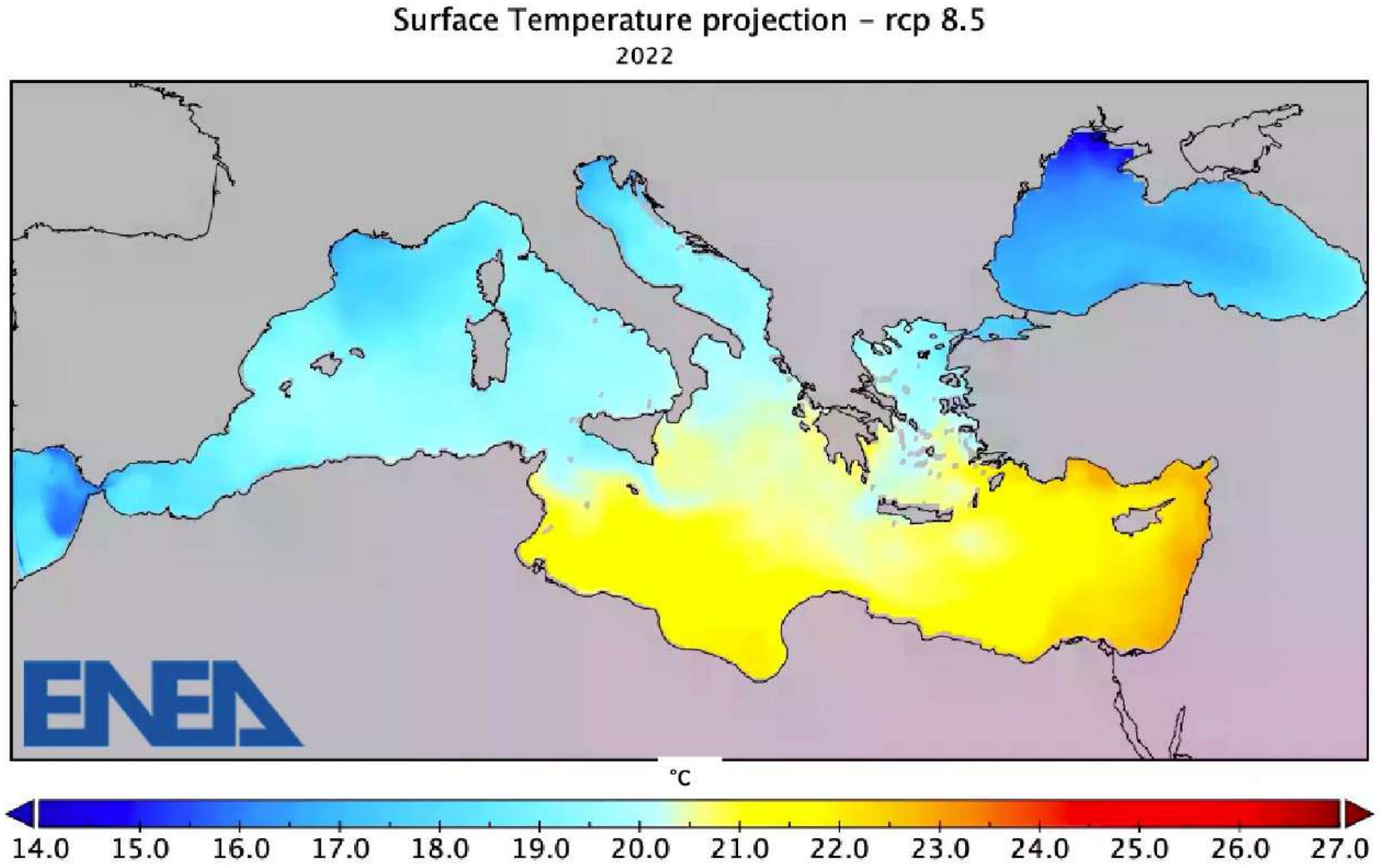


MITgcm – Explicit Tides (M2,S2, K1, O1) – Lateral Tide + Tidal Potential
Average resolution 1/16° (7 Km)
Minimum resolution at Gibraltar (230m) and Turkish Straits (90m)
100 Vertical Levels

Venice flooded by highest tide in more than 50 years



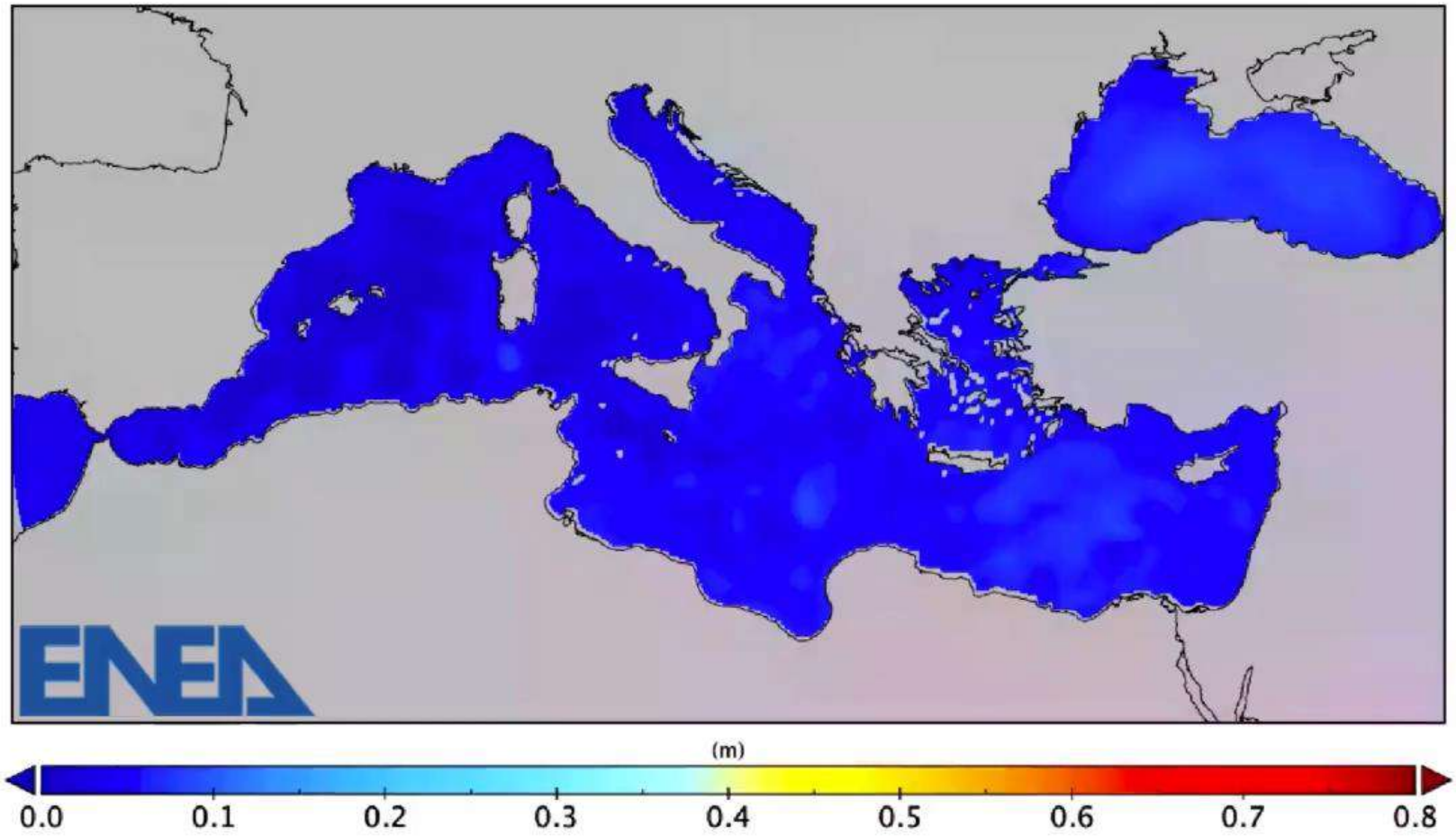




Sannino et al. Clim. Dyn 2022

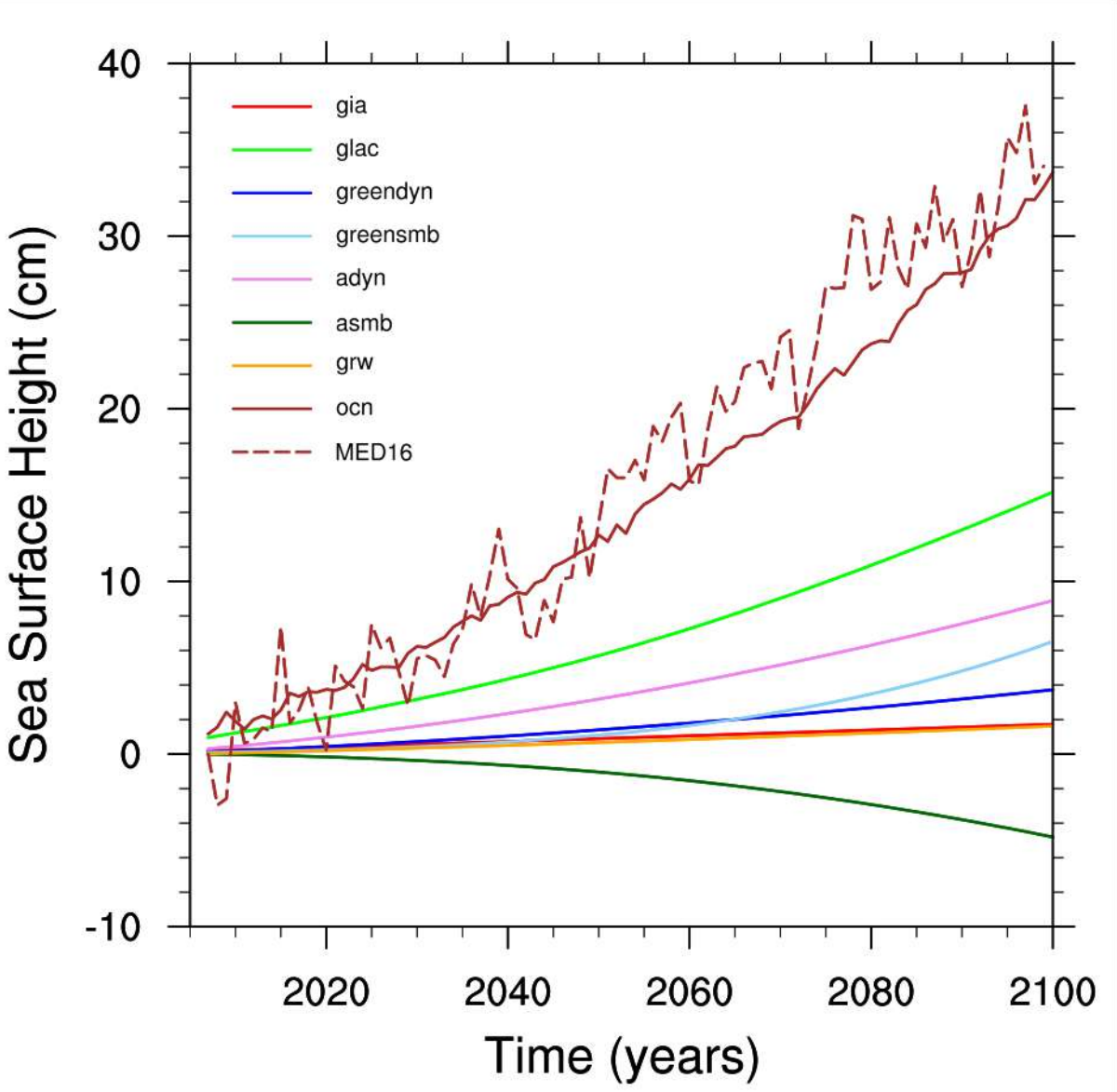
Sea level rise projection – rcp 8.5

2022

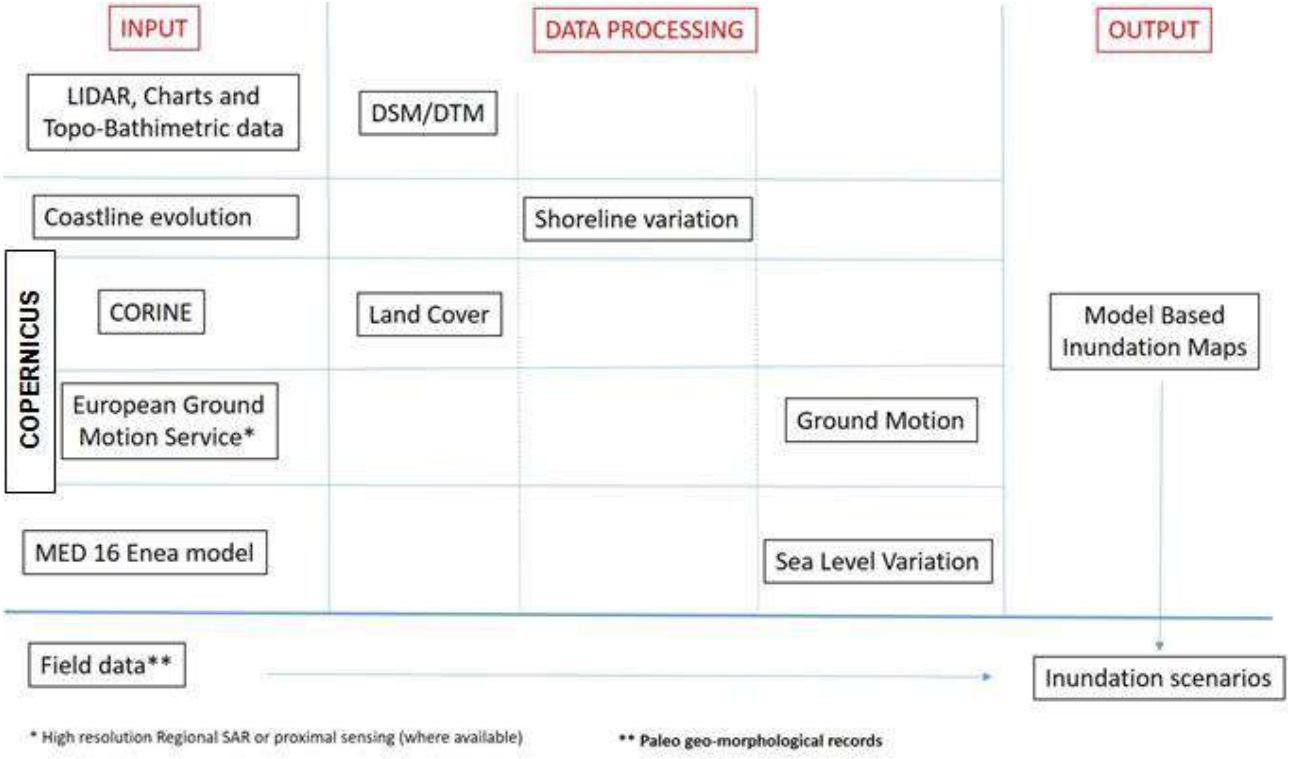


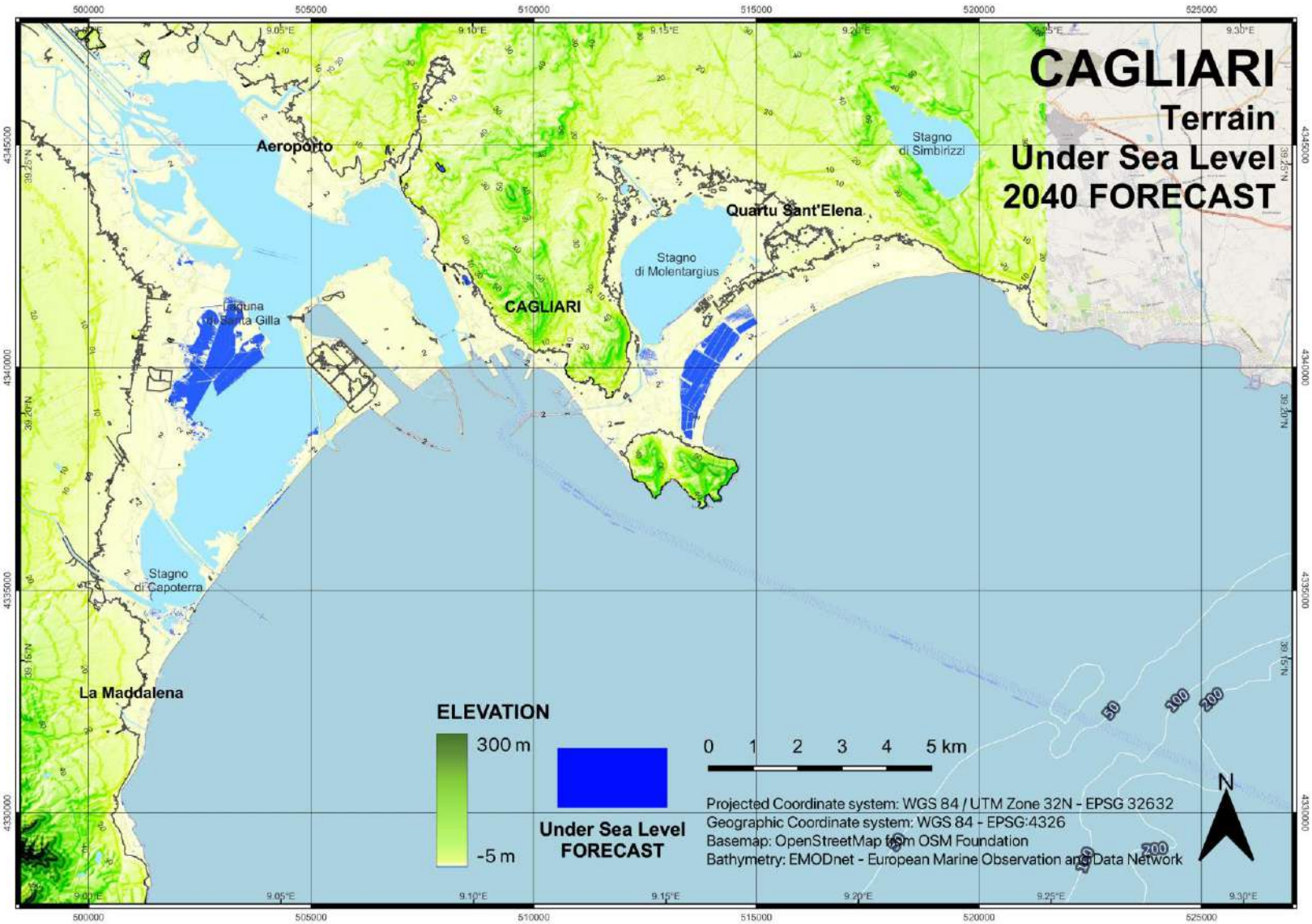
Future (2100) Mediterranean Sea Level

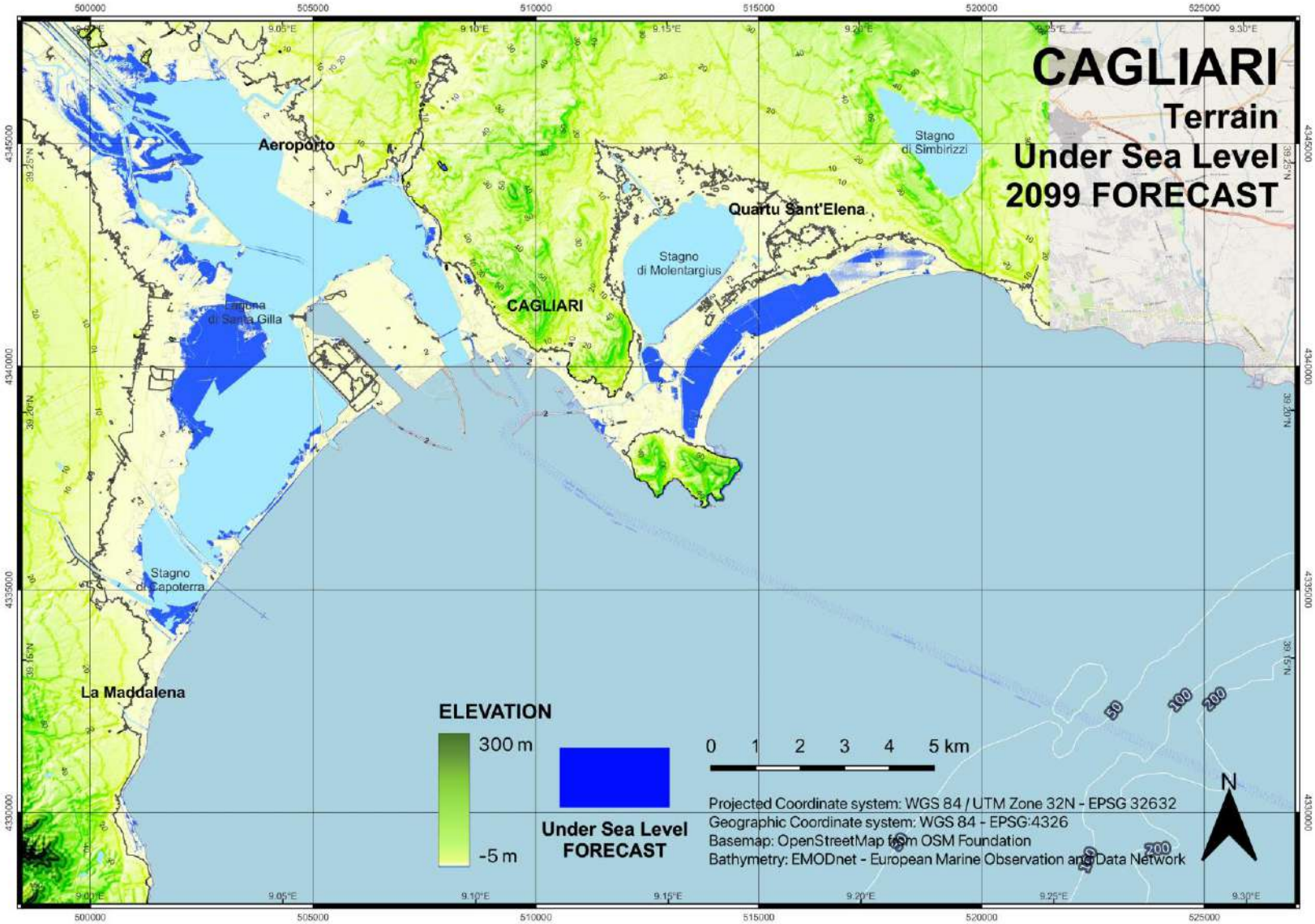
Time evolution of the components contributing to the projected mean sea level in the Mediterranean under the RCP8.5. Solid lines represent the central estimate over available models



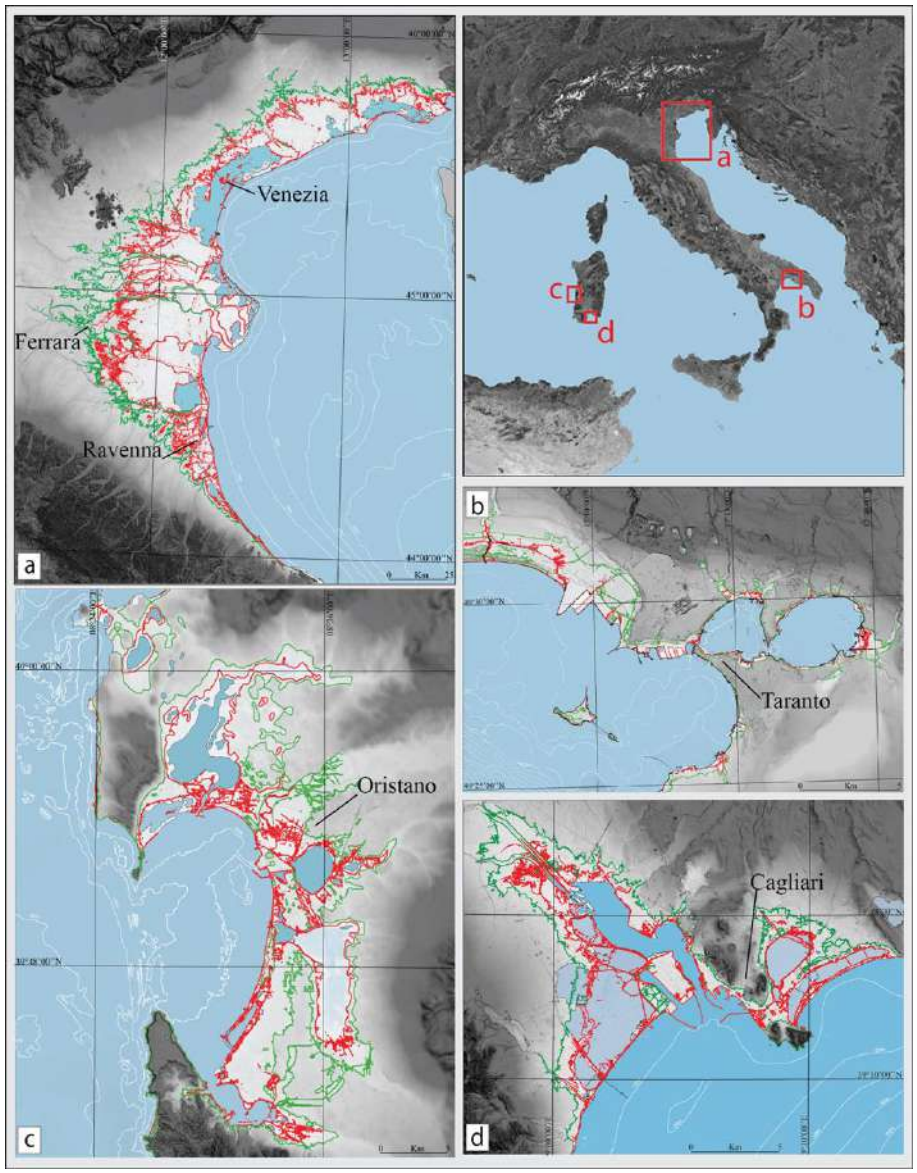
Sannino et al. Clim. Dyn 2022

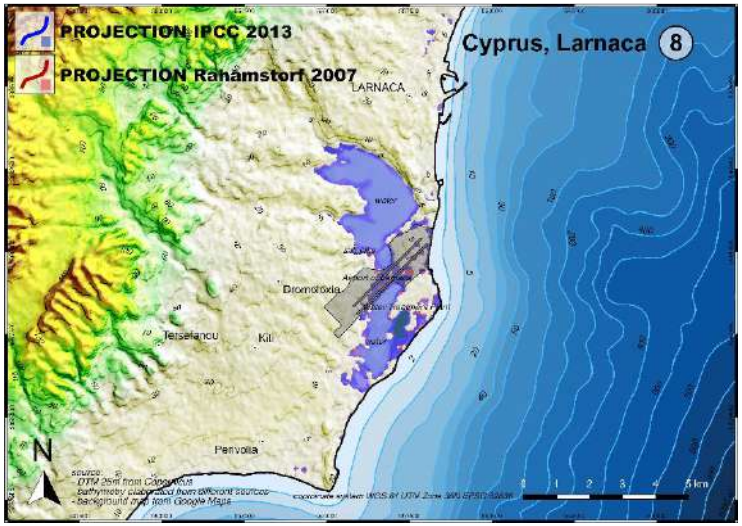

INPUT
DATA PROCESSING
OUTPUT
LIDAR, Charts and Topo-Bathimetric data
DSM/DTM
Coastline evolution
Shoreline variation
COPERNICUS
CORINE
Land Cover
Model Based Inundation Maps
European Ground Motion Service*
Ground Motion
MED 16 Enea model
Sea Level Variation
Field data**
Inundation scenarios
* High resolution Regional SAR or proximal sensing (where available)
** Paleo geo-morphological records


CAGLIARI
Terrain
Under Sea Level
2040 FORECAST
Aeroporto
Stagno
di Simbirizzi
Quartu Sant'Elena
Stagno
di Molentargius
CAGLIARI
Laguna
di Santa Gilla
Stagno
di Capoterra
La Maddalena
ELEVATION
300 m
-5 m
Under Sea Level
FORECAST
0 1 2 3 4 5 km
Projected Coordinate system: WGS 84 / UTM Zone 32N - EPSG 32632
Geographic Coordinate system: WGS 84 - EPSG:4326
Basemap: OpenStreetMap from OSM Foundation
Bathymetry: EMODnet - European Marine Observation and Data Network
N
50
100
200
500
200
500000
505000
510000
515000
520000
525000
4345000
4340000
4335000
4330000
9.00°E
9.05°E
9.10°E
9.15°E
9.20°E
9.25°E
9.30°E
39.25°N
39.20°N
39.15°N

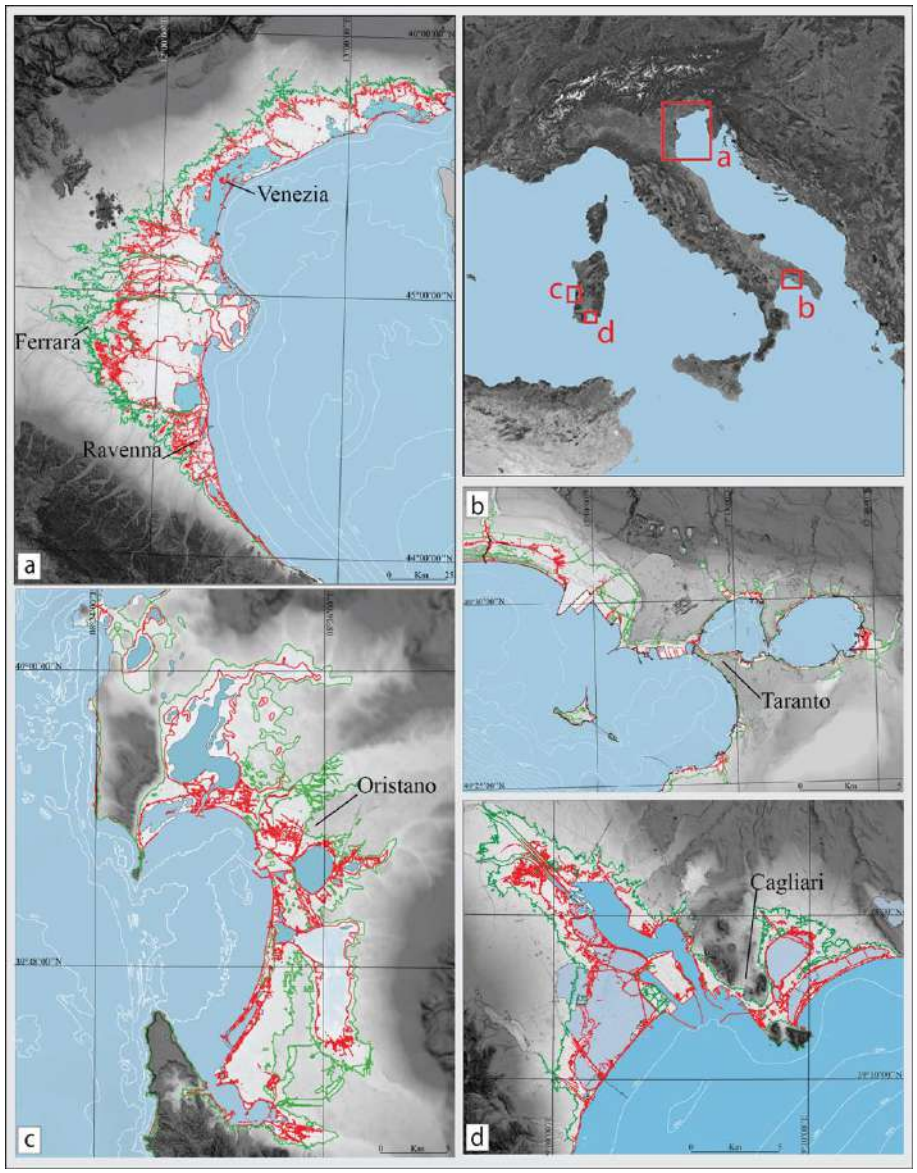

CAGLIARI
Terrain
Under Sea Level
2099 FORECAST
Aeroporto
Stagno di Simbirizzi
Quartu Sant'Elena
Stagno di Molentargius
CAGLIARI
Laguna di Santa Gilla
Stagno di Capoterra
La Maddalena
ELEVATION
300 m
-5 m
Under Sea Level FORECAST
0 1 2 3 4 5 km
N
Projected Coordinate system: WGS 84 / UTM Zone 32N - EPSG 32632
Geographic Coordinate system: WGS 84 - EPSG:4326
Basemap: OpenStreetMap from OSM Foundation
Bathymetry: EMODnet - European Marine Observation and Data Network

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%**

ENEA

FLOODING SCENARIO AT FOUR ITALIAN COASTAL PLAINS USING THREE RELATIVE SEA LEVEL RISE MODELS: THE NORTH ADRIATIC AREA

A. Marsico[1], S. Lisco[1], V. Lo Presti[2], F. Antonioli[2], A. Amorosi[3], M. Anzidei[4], G. Deiana[5], G. De Falco[6], A. Fontana[7], G. Fontolan[3], M. Moretti[1], P. Orru[2], G. Sannino[2], E. Serpelloni[4], A. Vecchio[9], G. Mastronuzzi[1]

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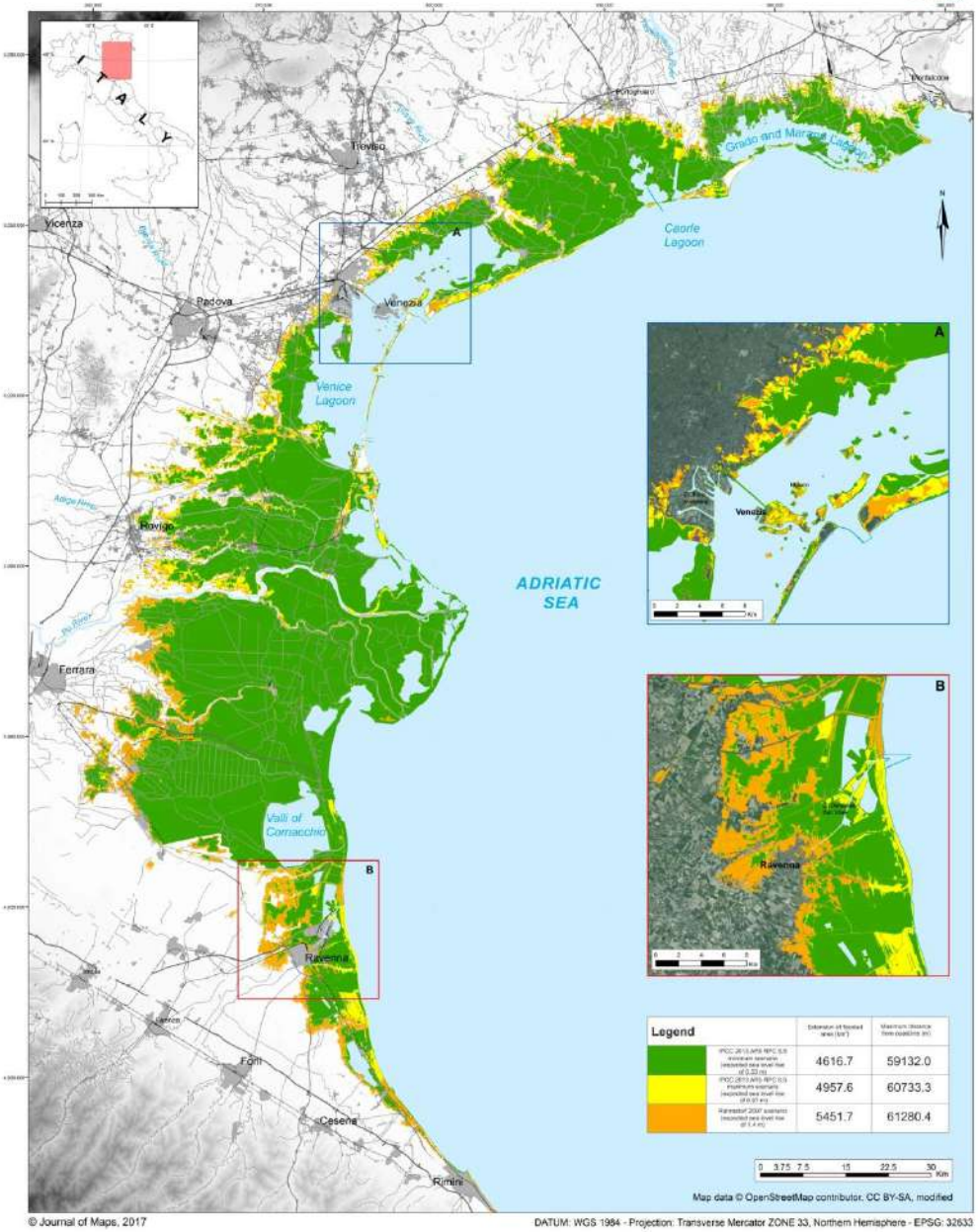

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DATUM: WGS 1984 - Projection: Transverse Mercator ZONE 33, Northern Hemisphere - EPSG: 32633

Future (2100) Mediterranean Sea Level rcp 8.5

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Gianmaria Sannino
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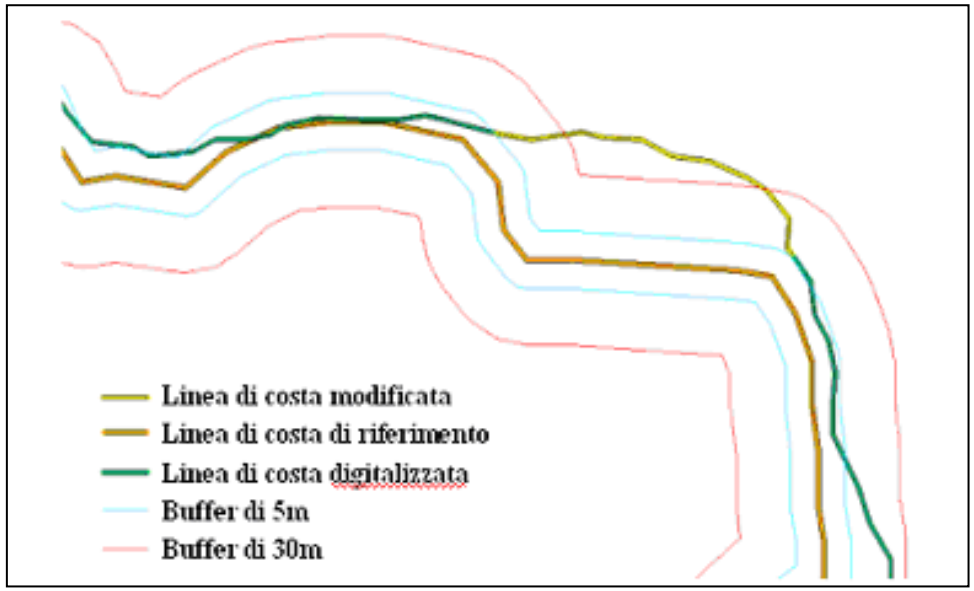
ISPRA: caratterizzazione della costa nazionale

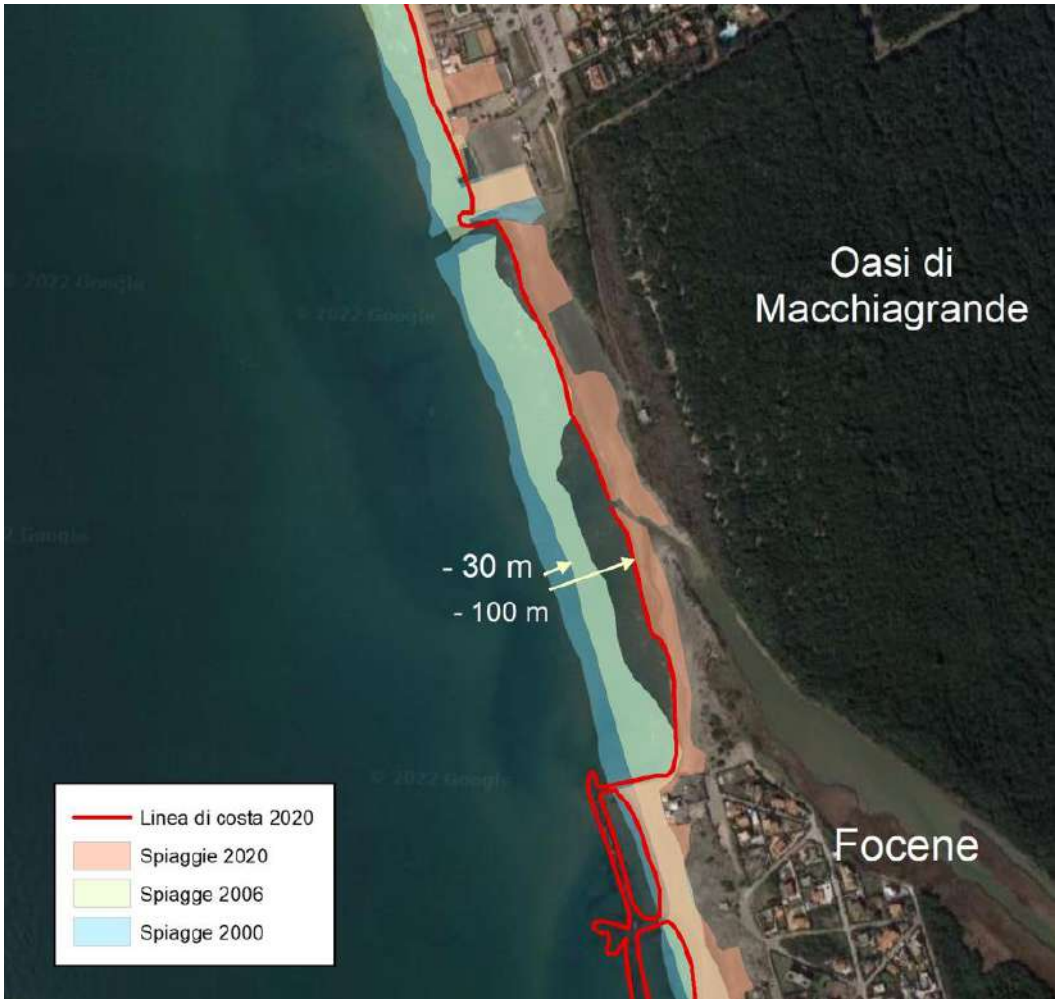
- **Sviluppare e aggiornare** gli strati informativi costieri, comprendenti I vari elementi naturali e antropici e la loro evoluzione nel tempo;
- **Seguire l'evoluzione dell'Earth Observation costiero** sia su progetti nazionali che internazionali



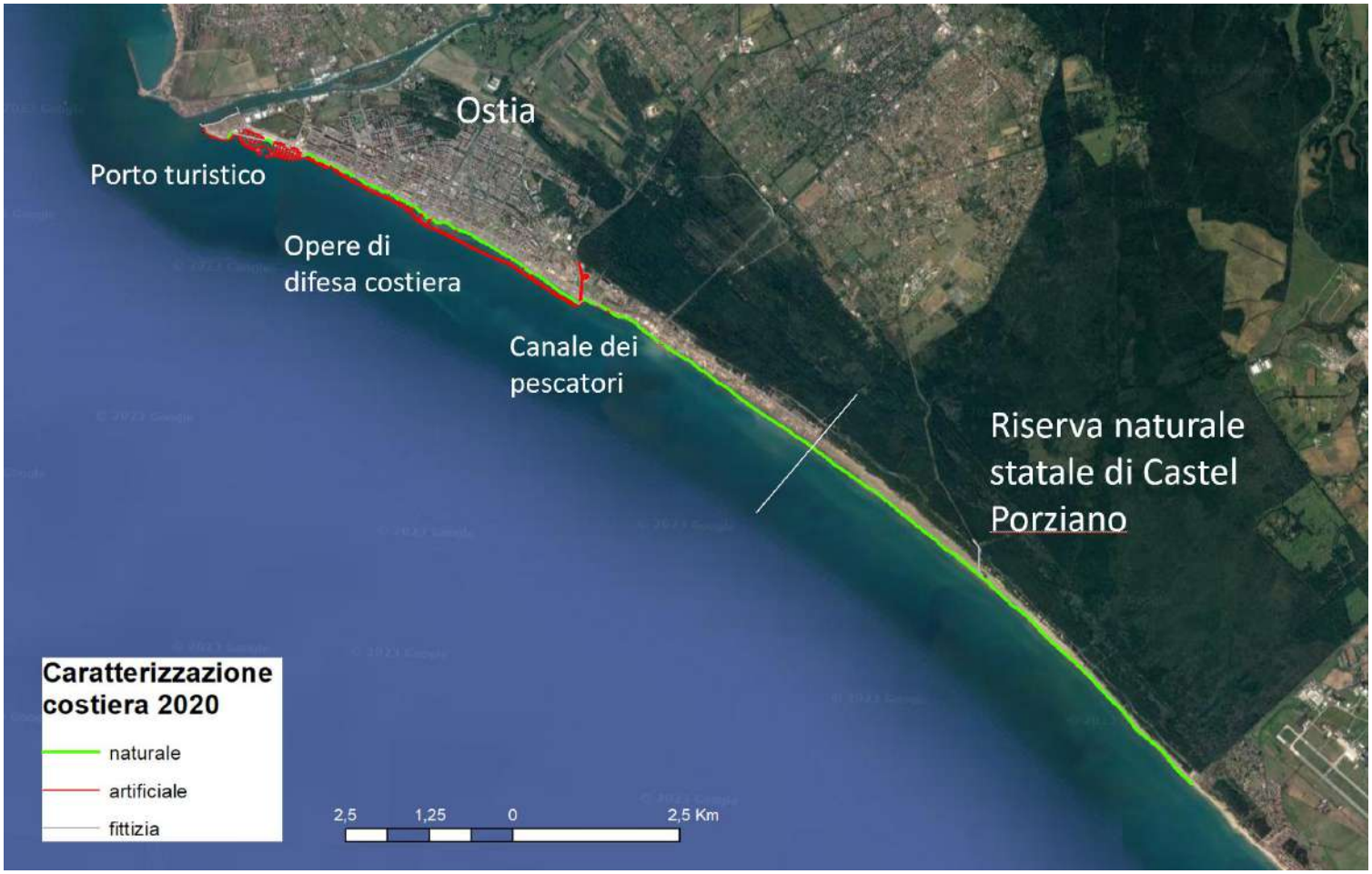
L’assetto costiero nelle coperture GIS

Le serie temporali utilizzate per la caratterizzazione costiera, uniformi e complete:

- **Layer IGM150:** digitalizzazione delle tavolette storiche dell’Istituto Geografico Militare
- **Coperture digitali LC00-LC06-LC20,** comprendenti ciascuna I tre strati**:**
  - Linea di Costa
  - Linea di Retrospiaggia
  - Spiagge



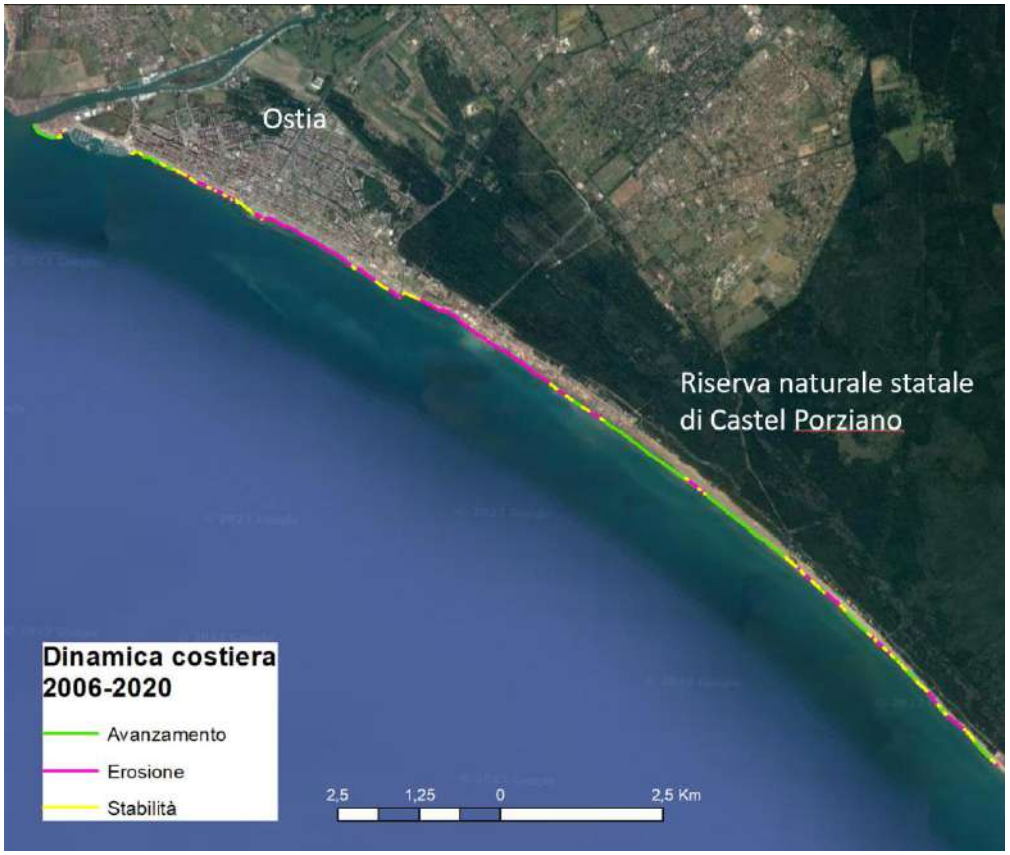
Caratterizzazione generale della costa romana



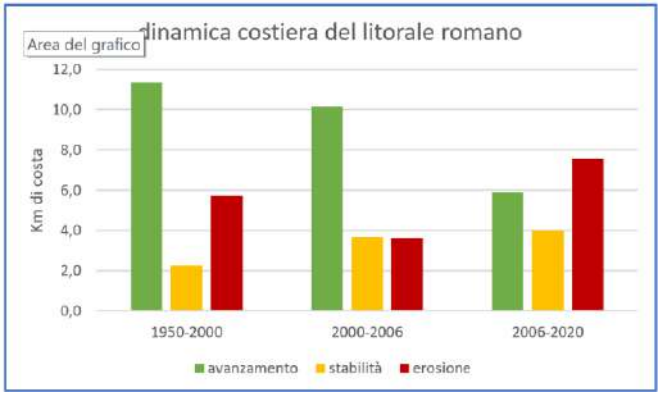
Circa 18 Km di sviluppo complessivo, caratterizzato da due aree principali:

- il litorale di Ostia, molto antropizzato e completamente saturo di stabilimenti, con le opere di difesa costiera, il porto turistico e il Canale dei Pescatori
- il litorale ricadente nella Riserva naturale statale di Castel Porziano, all'opposto, quasi del tutto libero da opere antropiche, con gli ambienti costieri tutelati

La dinamica costiera comunale tra il 1950 e il 2020

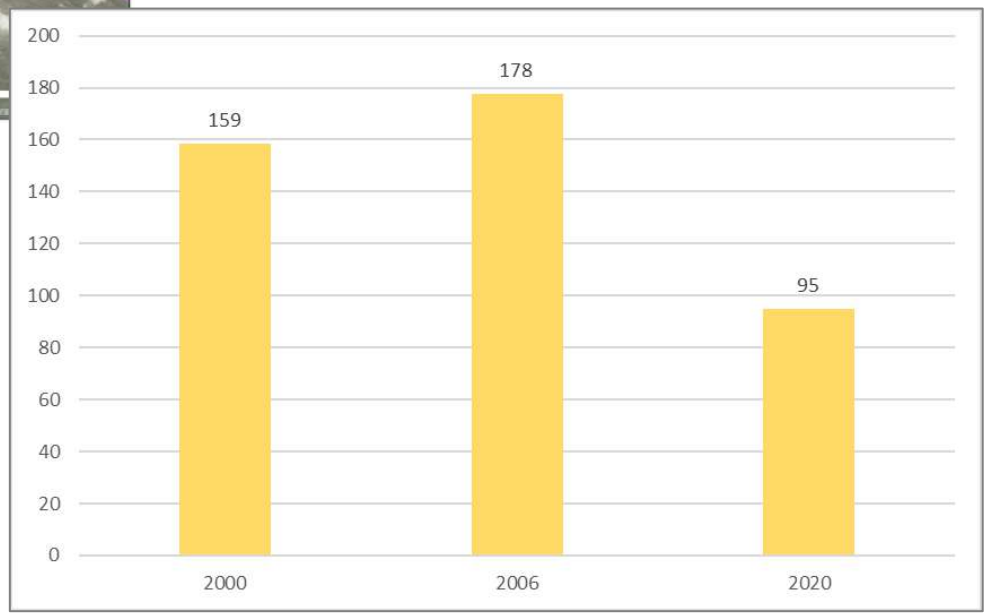


- L’analisi degli ultimi due rilievi ISPRA rileva una condizione di generale stabilità solo nelle aree più occidentali, mentre lungo il litorale di Ostia la costa è per lo più in arretramento, avanzamenti consistenti si registrano nelle aree comprese nella Riserva naturale statale di Castel Porziano
- Nel corso dei decenni, una tendenza generale all’accrescimento delle spiagge si è invertita, nonostante gli interventi di ripascimento effettuati



I valori di superficie delle spiagge

- Dalla costa soggetta a dinamica alla quantificazione dell'avanzamento e dell'erosione
- La questione dello spostamento delle spiagge
- La misura delle superfici nel caso del litorale romano



La superficie complessiva, in ettari, delle spiagge del litorale romano