Smart Control of the Climate Resilience in European Coastal Cities


# Webinar

# From Global to Local scale: Predicting the effects of climate change on coastal cities

Thursday, 18 January 2024
11:00 a.m.- 12:00 p.m. (CET)

CNR ISMAR ISTITUTO DI SCIENZE MARINE

CNR IAS ISTITUTO PER LO STUDIO DEGLI IMPATTI ANTROPICI E SOSTENIBILITÀ IN AMBIENTE MARINO

igg Istituto di Geoscienze e Georisorse

Consiglio Nazionale delle Ricerche
Istituto per la BioEconomia

CONSORZIO LaMMA

ATU

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# Agenda

**11:00 – 11:05:** Welcome & Introduction | Laura De Nale (Euronovia)

**11:05 – 11:15:** From global to local: the SCORE approach to downscaling | Carlo Brandini (LaMMA/CNR)

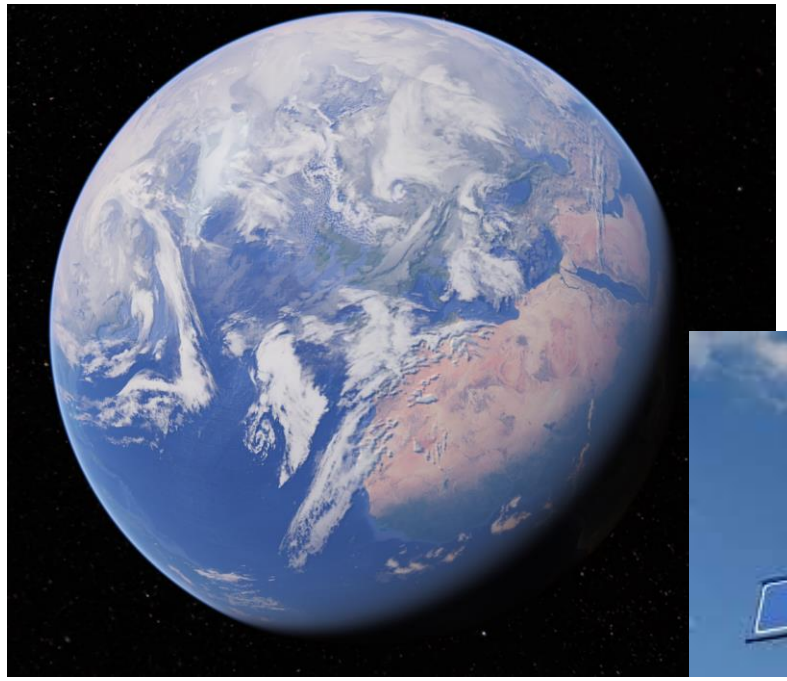
**11:15 – 11:40:** Models for downscaling – step 1 : from global scale to basin and coastal scale | Stefano Taddei, Massimo Perna, Andrea Cucco (LaMMA & CNR)

**11:40 – 11:50:** Preparing modeling scenarios through statistical analysis | Iulia Anton (ATU)

**11:50 – 12:00:** Models for downscaling – step 2 : urban scale or “last mile” downscaling | Michele Bendoni & Carlo Brandini (LaMMA/CNR)

**12.00 – 12.15:** Q&A and closing remarks

# From Global to Local scale : scales



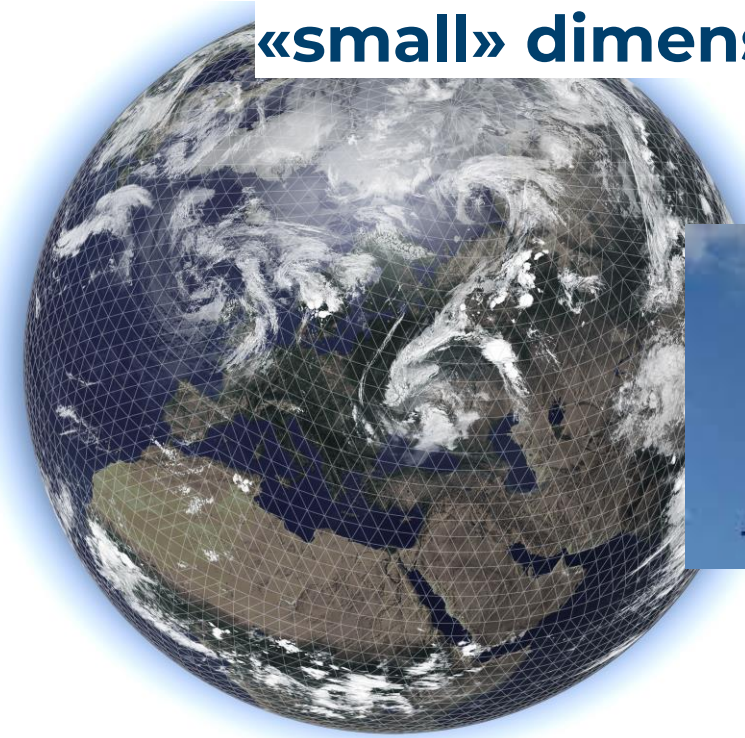

**Global scale**:
the scale of the earth system, of the coupled dynamics between atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere

Typical scale: 1000 km – 50 km

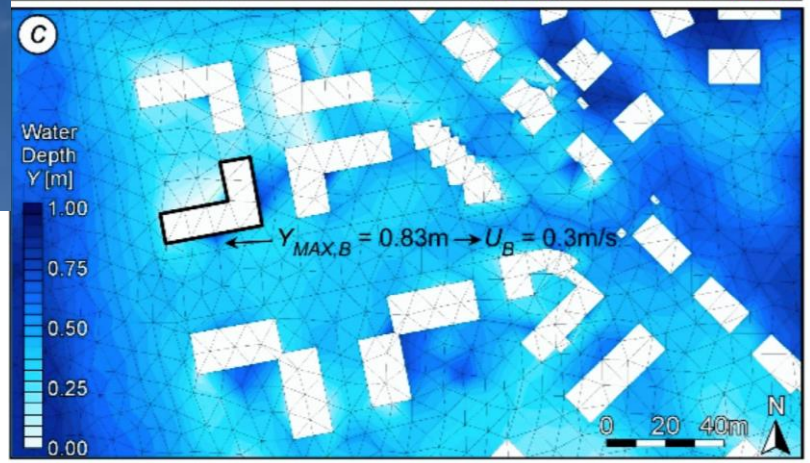
**Local scale:**
the scale of our everyday life AND
The scale at which we evaluate our climate change relience strategies: EbA, financial resilience, etc.

Typical scale: 1 km – 10 m

# From Global to Local scale : the «small» dimensions








In global models, large-scale dynamic features are represented, e.g. the dynamics of air masses or water masses, thus the main winds and currents, areas covered by ice, etc.

- «Eddy resolving» models

In local models we are interested in understanding the effects of urban-scale features, e.g. a flood on an urban district or even on individual buildings

- Urban hydraulics

score

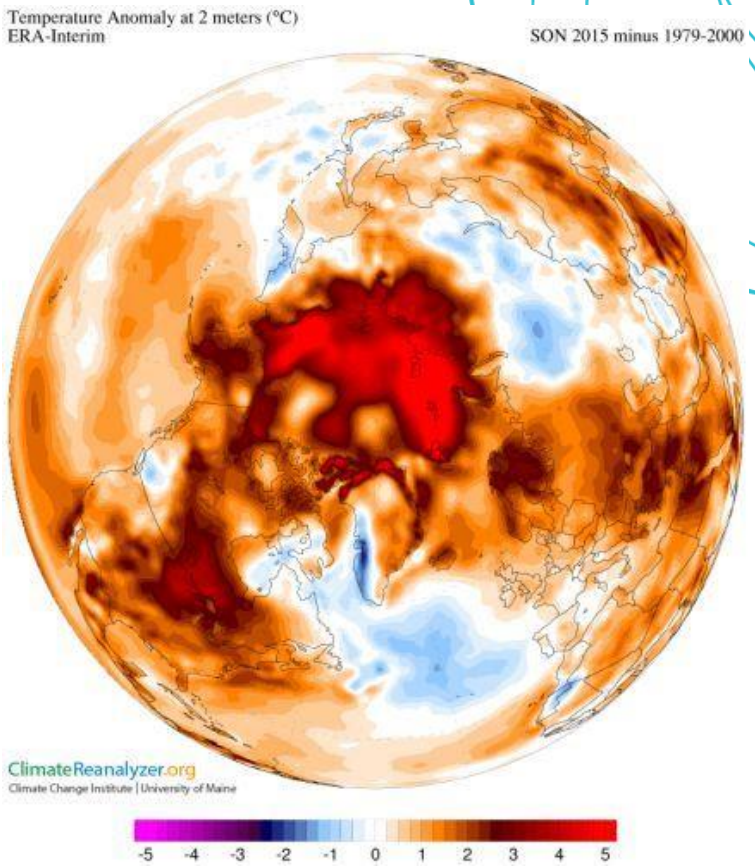
# Global effects of climate change

Hotter temperatures. As greenhouse gas concentrations rise, so does the global surface temperature. ...

More frequent and intense extreme phenomena
Increased drought
More severe storms
Heat waves (atmospheric and marine h.w.)

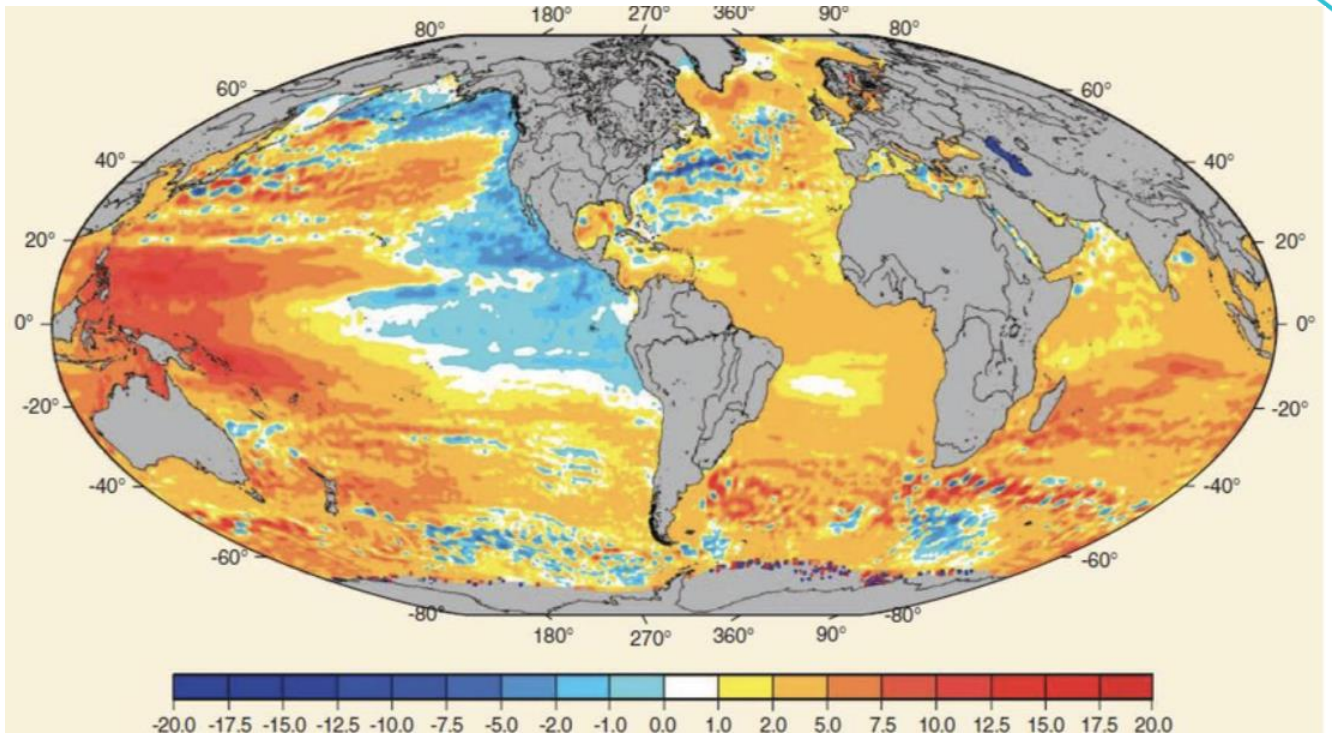
Melting glaciers
A warming rising ocean
Coastal floods

Change in the global circulation of atmosphere and oceas



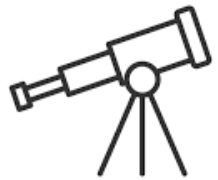
# Global change effects are not uniform on Earth !

Regional trends in sea level rise observed by altimeters (1992-2009) show notable spatial differences due to thermal expansion, isostatism, changes in global circulation.
Other phenomena to take into account that can influence the spatial patterns of SLR are decadal scale oscillations




Observed distribution Sea Level Rise trends
Nicholls & Cazenave, 2010 SCIENCE VOL 328 18 JUNE 2010

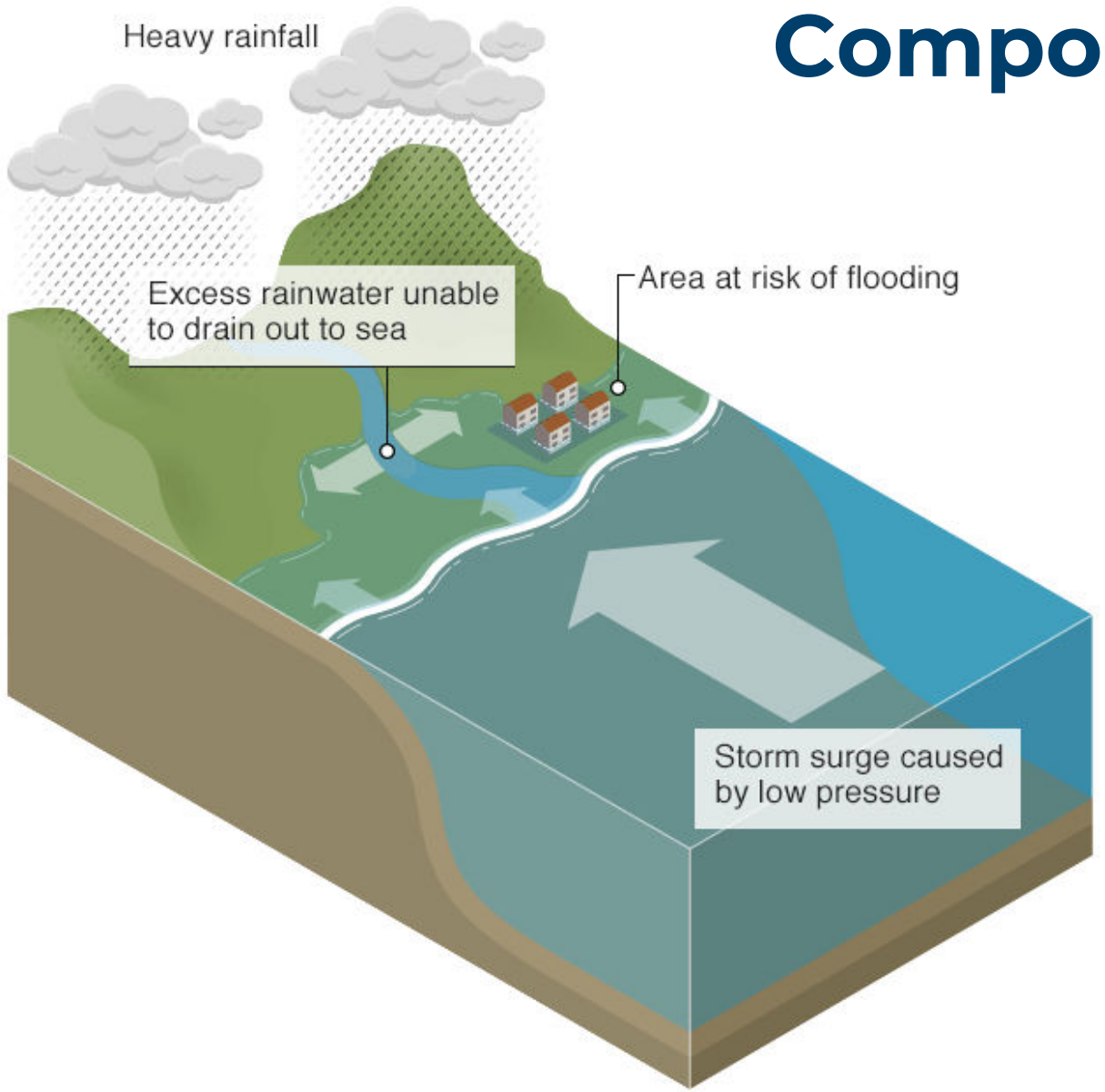
# Downscaling

- **Downscaling** means taking known information at large scales to make predictions at local scales. Downscaling of climate models is an attempt to bridge the gap between global and local effects by nesting local-level data onto large-scale climate models. Generally, climate information comes from global climate models.
- Scaling global models solutions (reanalyses / projections) down to the urban or “last mile” scale is not so trivial: each scale represents particular physical processes and to represent them it is not possible to do in a single step. Models are different….

Global → Regional → Subregional/Shelf/Coastal → Local/Urban

# Compound effects




The effects combine, and often do not act independently of each other. For example, a major atmospheric cyclonic disturbance, or a hurricane, not only causes strong wind, which in turn is associated with an area of low pressure, but is also accompanied by heavy rainfall.

→ there is a need that climate projection data, when applied on an urban scale, take all these coupled effects into account → they must be produced by the same coupled simulation

# How to compute these climate effects?



Waves are very important: they cause coastal disruption and coastal erosion, they contribute to coastal inundation by increasing the sea level along the coast

→ **WAVE MODELS**

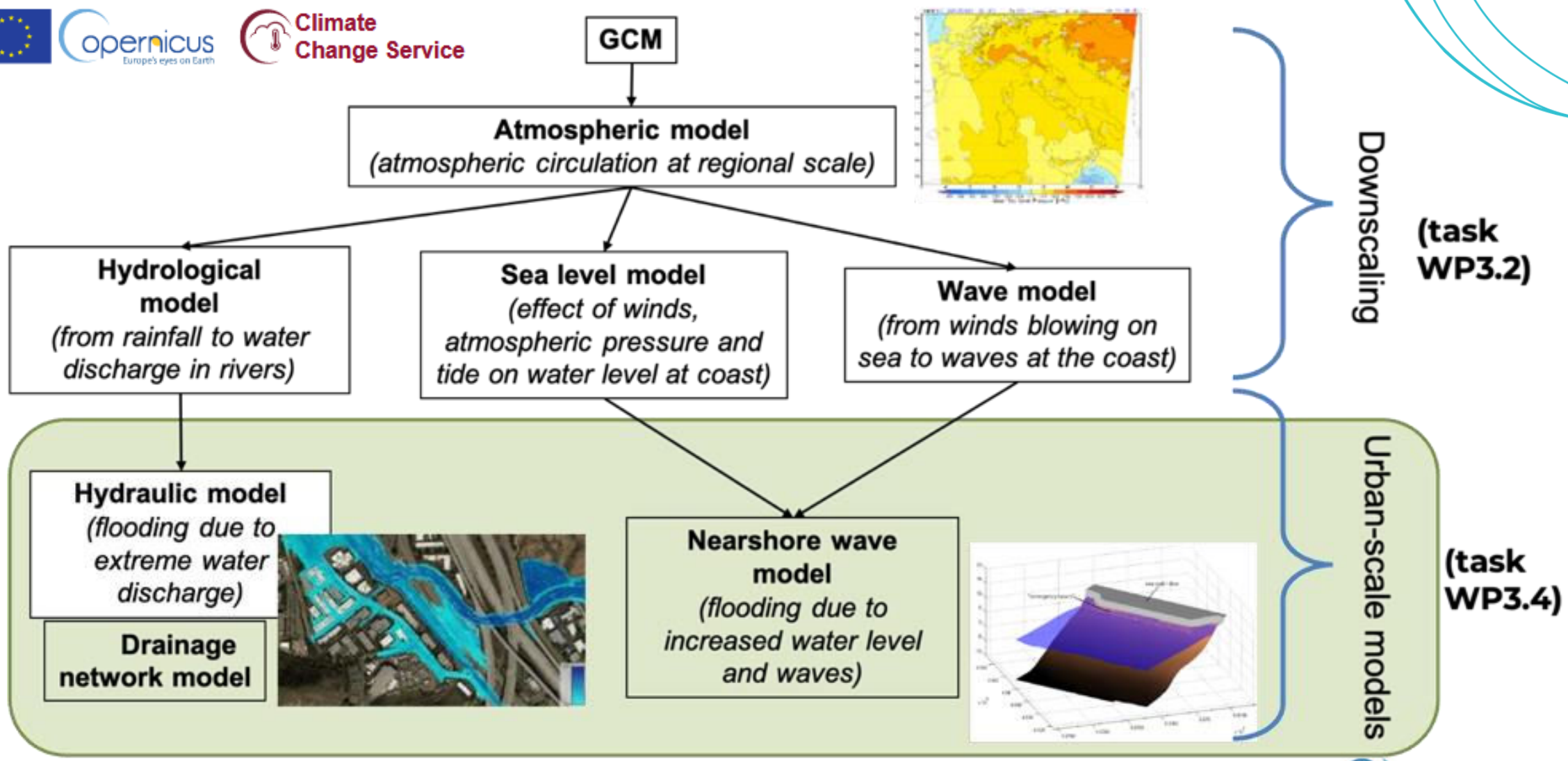
Predicting sea levels along the coast is from a combination of short term (storm surge, tide) and long-term effects (SLR)

→ **HYDRODYNAMIC OCEAN MODELS**

River floods are directly determined by hydrological processes in which rainfall is the main atmospheric forcing

→ **HYDROLOGICAL MODELS**

# 1 From global to local: the SCORE approach to downscaling



# 1 From global to local: the SCORE approach to downscaling

Multiple simulations repeated for different scenarios

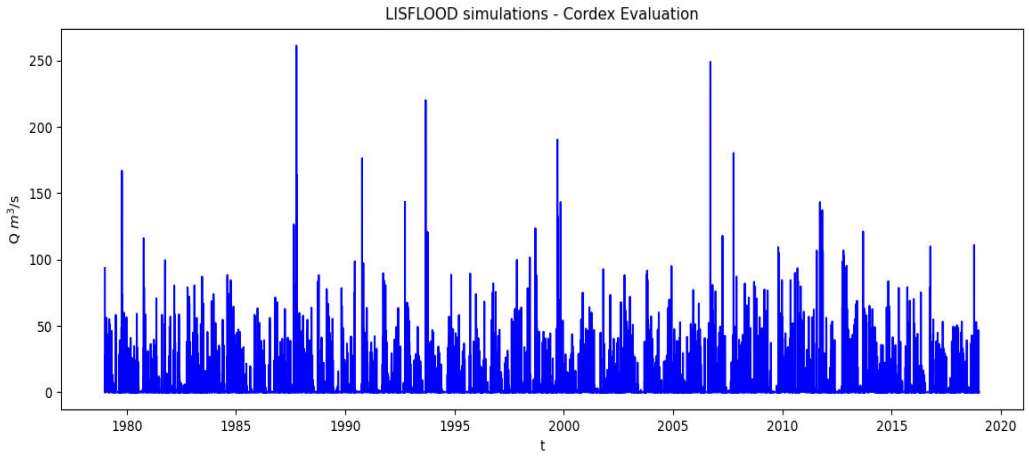
**Modelling Chain**
**Hindcast run**
(1979 -2018)
→ Validation
$P_{t,EVAL}$

**Modelling Chain**
**Historical run**
(1955 -2005)
→ Baseline
$P_{t,HIST}$

**Modelling Chain**
**RCP4.5**
(2006 -2099)
→ Flood maps
$P_{t,RCP45}$

**Modelling Chain**
**RCP8.5**
(2006 -2099)
→ Flood maps
$P_{t,RCP85}$

Time series from downscaling procedure (wave height, water level, river discharge)

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Extreme Value Analysis

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Peak value associated to a return period ($P_{RP}$) to be used fo urban scale models

example: $P_{100}$ corresponds to the flooded area for the return period of 100 years…