ECRA General Assembly 2015

"New knowledge for risk reduction"

25/26 March 2015

Square Brussels Meeting Centre

www.ecra-climate.eu

Sea Level Change and Coastal Impacts Collaborative Programme

Coordinated (from October 2014) by:

Gianmaria Sannino (ENEA) and Jan Even Øie Nilsen (NERSC)

Italian National Agency for New Technologies, Energy and Sustainable Economic Development

Nansen Environmental and Remote Sensing Center (Bergen, Norway)

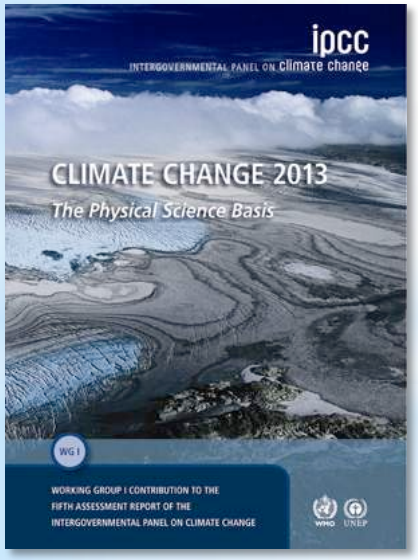
Former co-chairs (since September 2014):
Paolo Ruti (ENEA) and Wilco Hazeleger (KNMI)

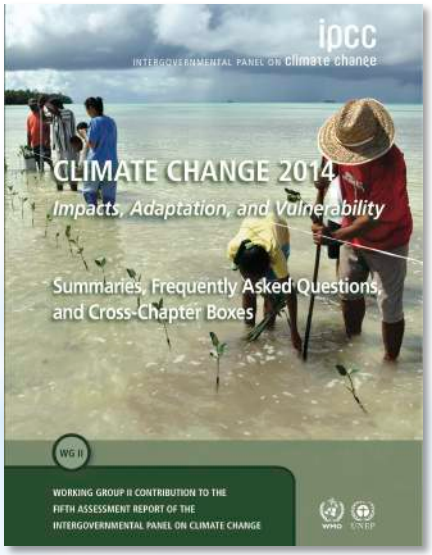
Sea Level Change and Coastal Impacts

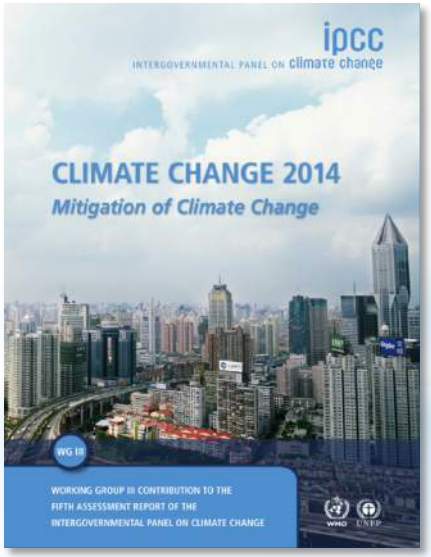
WHY?

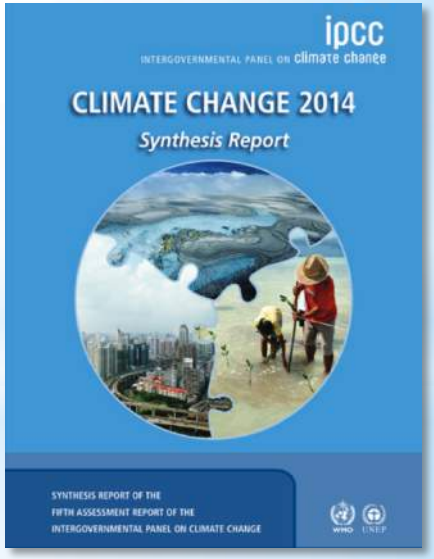
Present-day sea-level rise is a major indicator of climate change (IPCC AR5)

Climate sea level rise and its impact on coastal areas has serious implications on more than 10% of the world population that is currently living in coastal areas less than 10m above sea level (McGranahan et al., *Envir. Urban.* 2007)







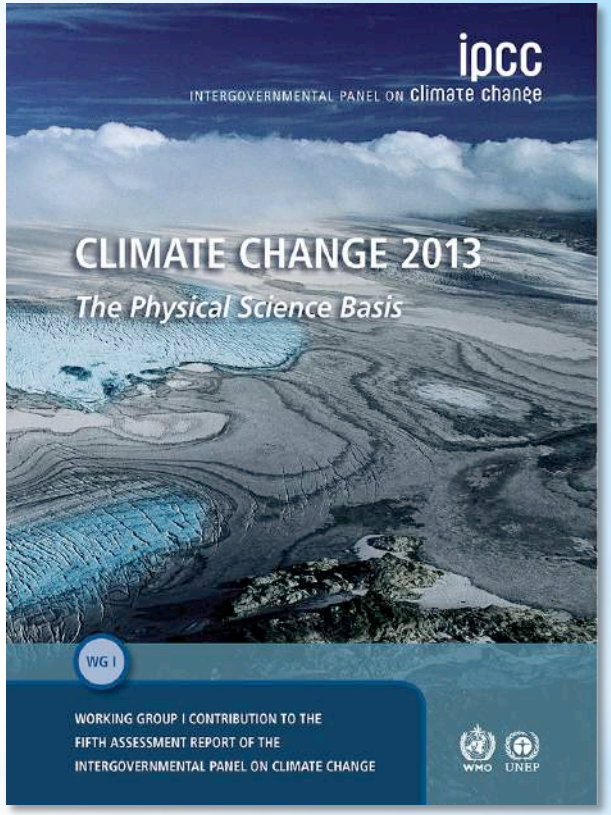


Sea Level Change and Coastal Impacts

WHY?

IPCC Assessment Report 5 (AR5 - **www.ipcc.ch**)

Climate Change 2013 – The physical Science Basis



13

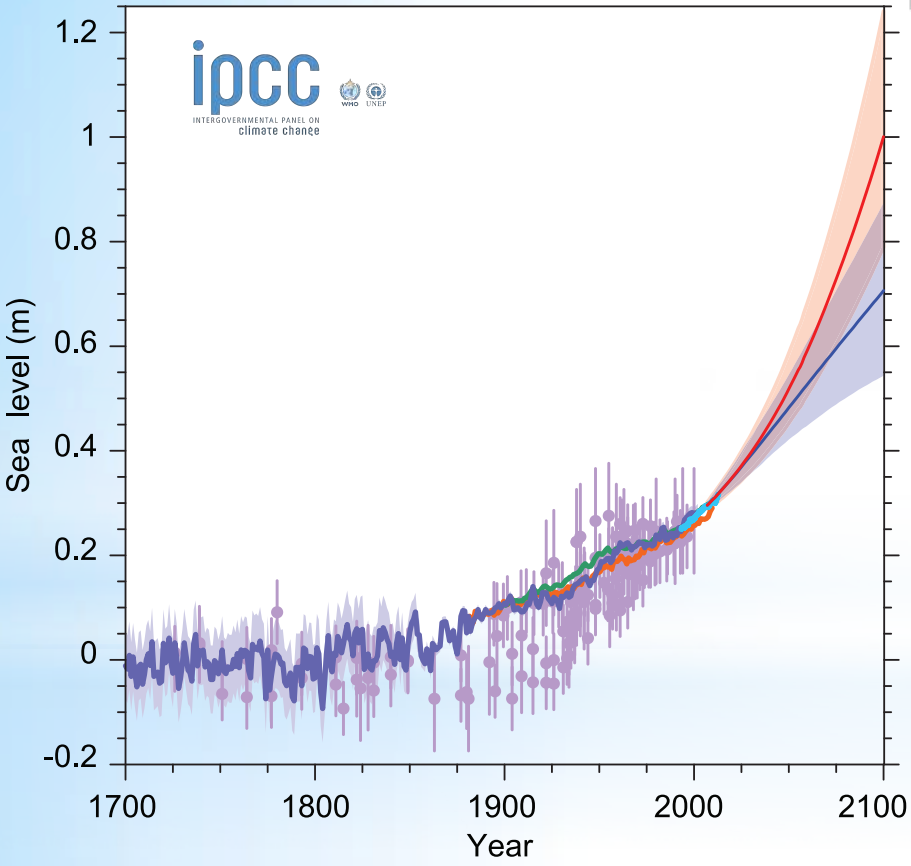
Sea Level Change

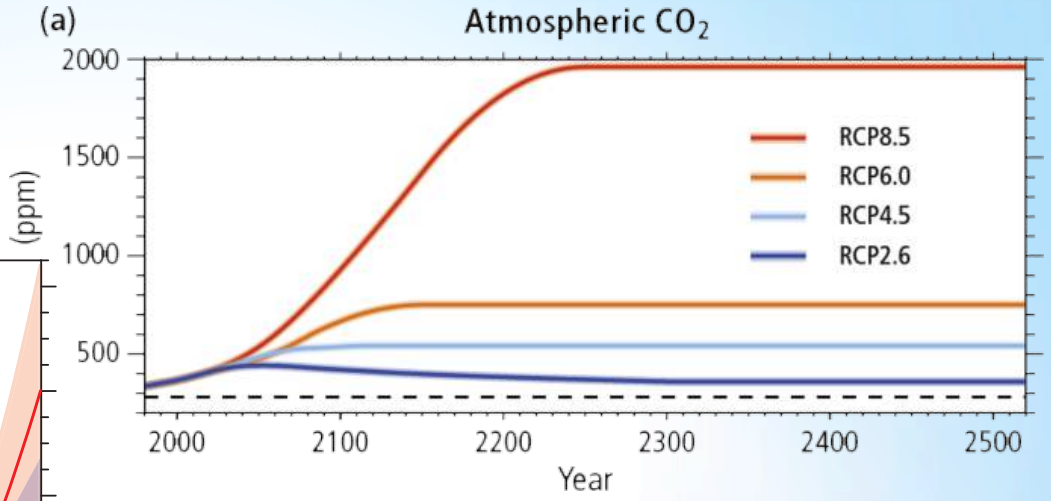
Coordinating Lead Authors:
John A. Church (Australia), Peter U. Clark (USA)

Lead Authors:
Anny Cazenave (France), Jonathan M. Gregory (UK), Svetlana Jevrejeva (UK), Anders Levermann (Germany), Mark A. Merrifield (USA), Glenn A. Milne (Canada), R. Steven Nerem (USA), Patrick D. Nunn (Australia), Antony J. Payne (UK), W. Tad Pfeffer (USA), Detlef Stammer (Germany), Alakkat S. Unnikrishnan (India)

Sea Level Change and Coastal Impacts

WHY?





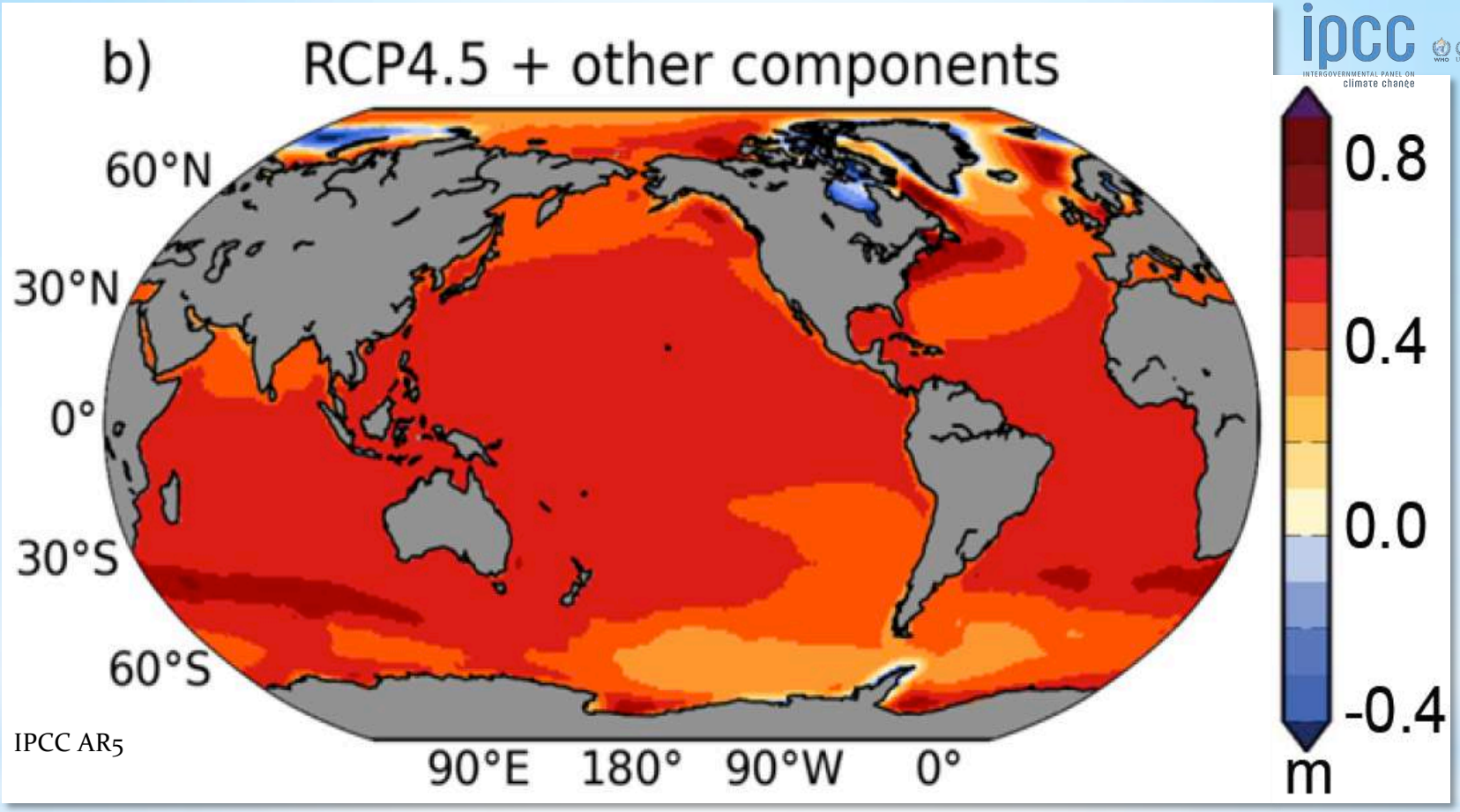
Rate during 1901-1990 was 1.5± 0.2 mm yr^{-1}

Rate during 1993-2010 was 3.2± 0.4 mm yr^{-1}

Mostly due to thermal expansion and land ice melting

Compilation of paleo sea level data, tide gauge data, altimeter data, and central estimates and *likely* ranges for projections of global mean sea level rise for **RCP2.6** (blue) and **RCP8.5** (red) scenarios, all relative to pre-industrial values.

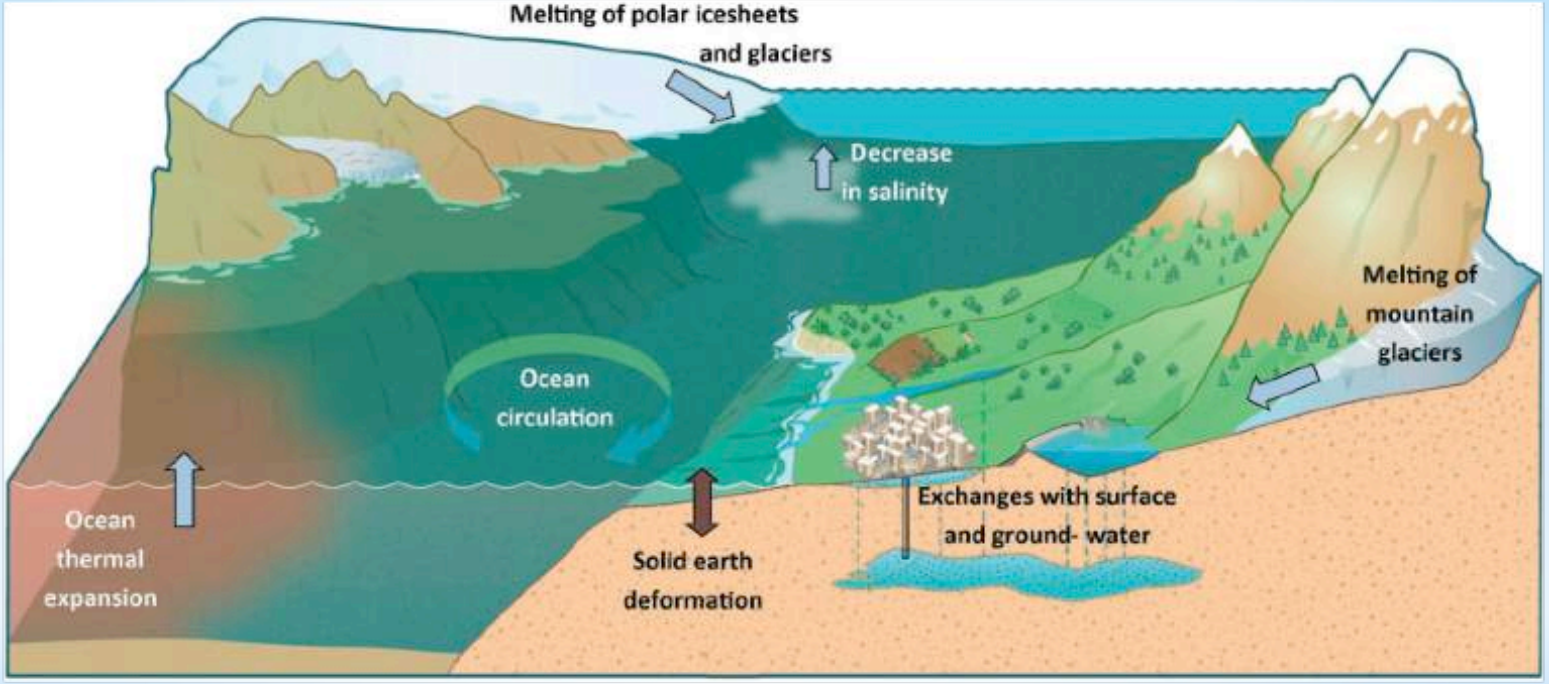
Sea Level Change and Coastal Impacts



Ensemble mean regional relative sea level change (m) evaluated from 21 models of the CMIP5 scenario RCP 4.5, including atmospheric loading, plus **land-ice**, **GIA** and **terrestrial water sources**, between 1986–2005 and 2081–2100. Global mean is 0.48 m, with a total range of -1.74 to +0.71 m.

Sea Level Change and Coastal Impacts

Sketch showing the main factors causing sea level changes



Changes in any one of the components or processes shown will result in a sea level change.

Source: Cazenave, A., and G. Le Cozannet (2013), Sea level rise and its coastal impacts, *Earth's Future*, 2, 15–34.

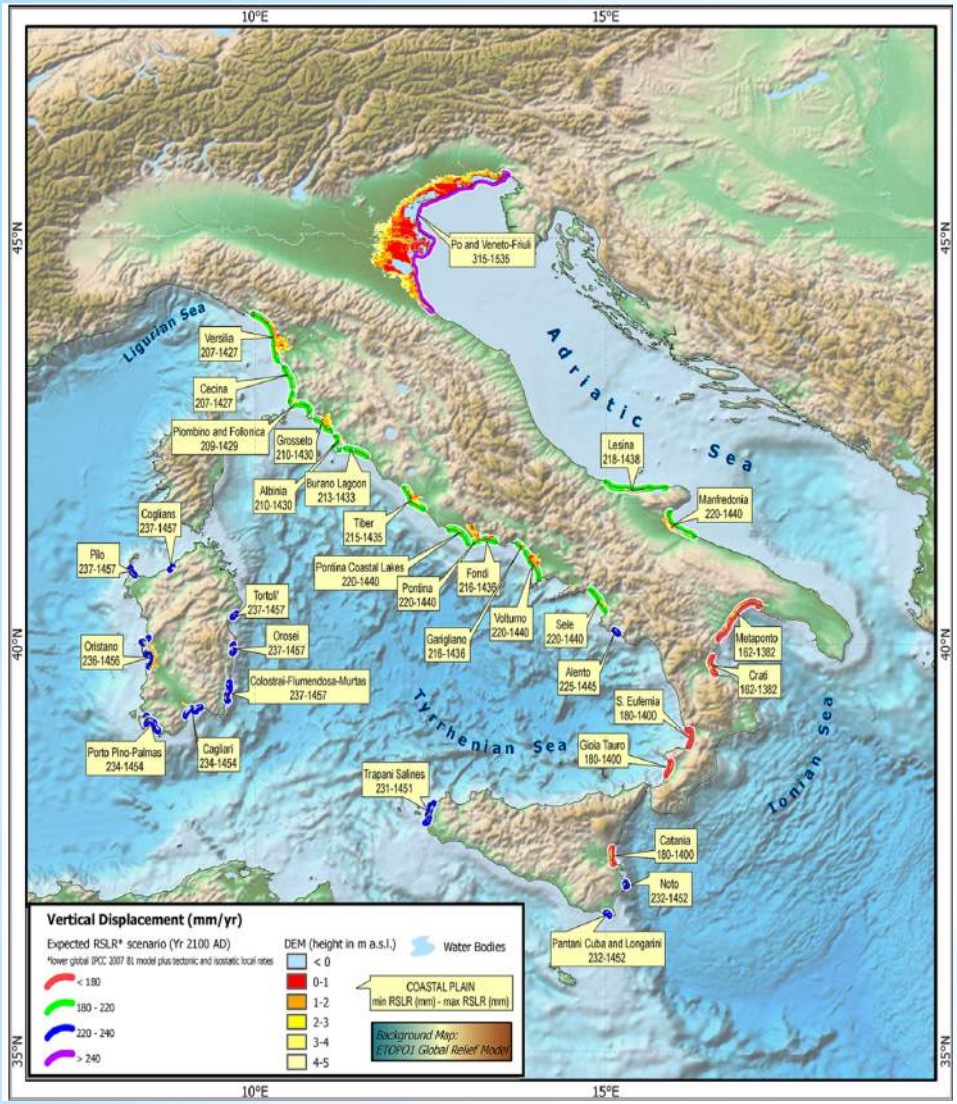
Sea Level Change and Coastal Impacts

Many **coastal regions** in Europe are **vulnerable** to sea level rise and changes in storm surges. Global sea level rise due to raising global temperatures has a non-trivial imprint on the European coasts. In addition changes in atmospheric circulation may affect storm surges in the region.

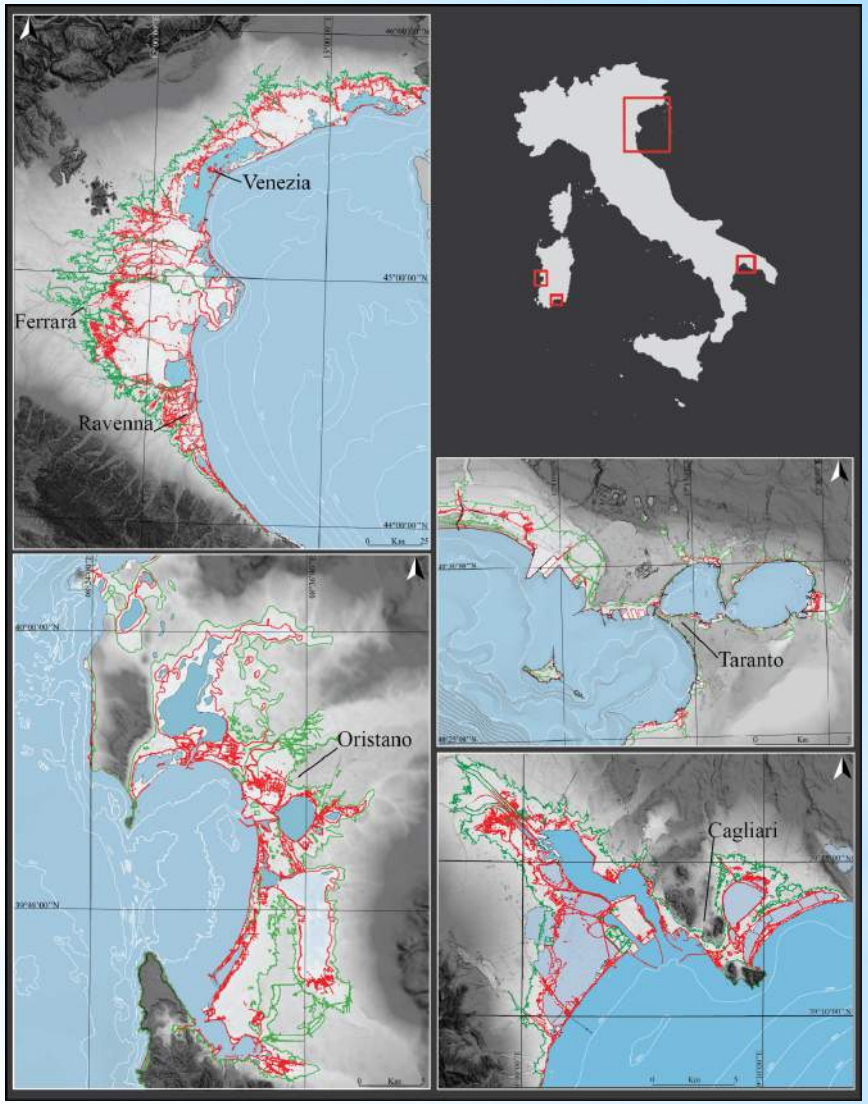
Circeo
(south oRome)

Source:
F. Antonioli
(ENEA)

Sea Level Change and Coastal Impacts

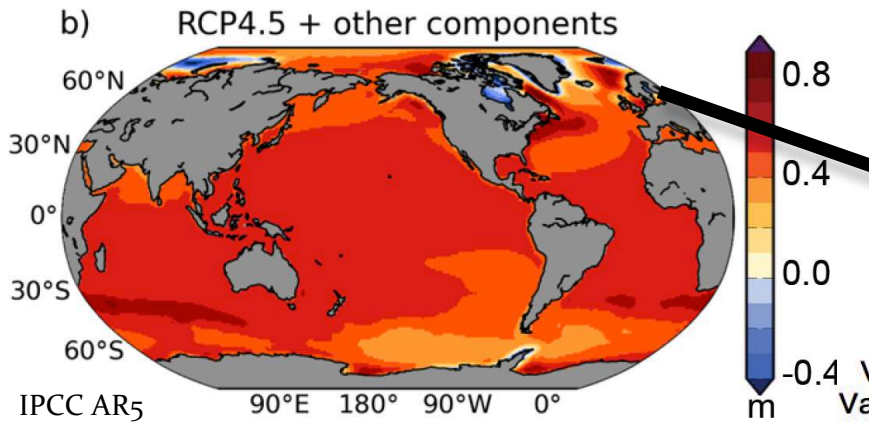


Lambeck et al., 2010

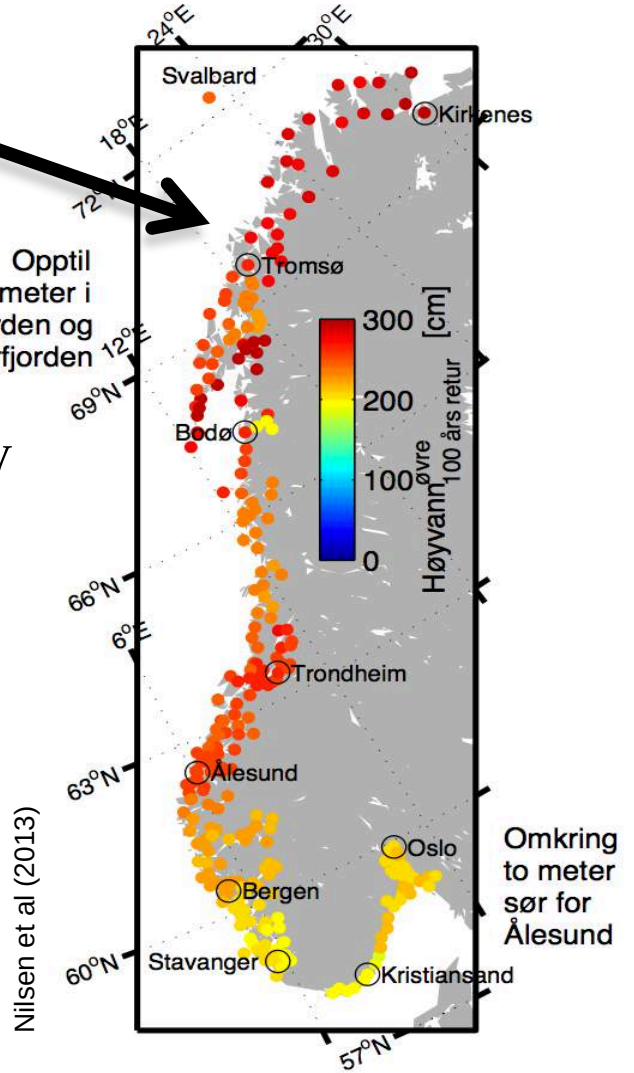


Antonioli et al., 2015

Sea Level Change and Coastal Impacts



SLR - GIA + tide + storm surge



Updated regional sea-level projections for Norway

IPCC AR5 regional projections

+ regional analysis of components

+ updated local land uplift rates

+ tide and storm surge statistics

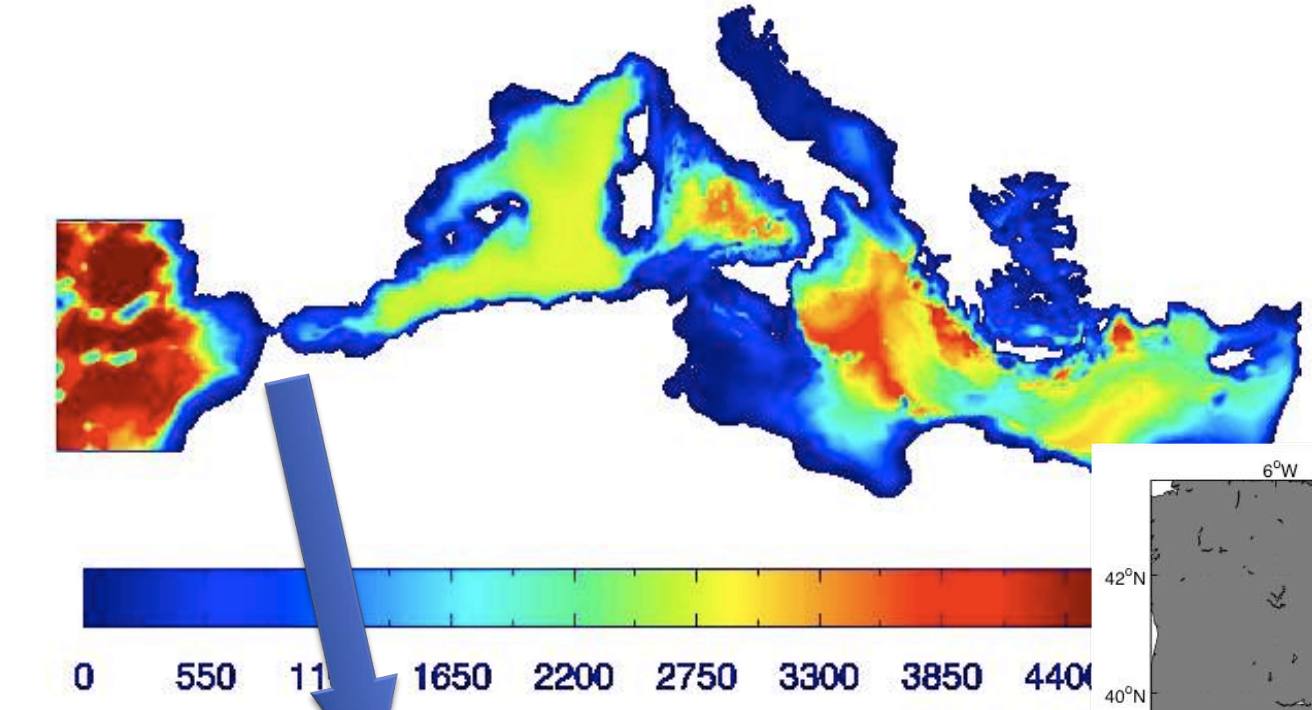
+ relate to map datum

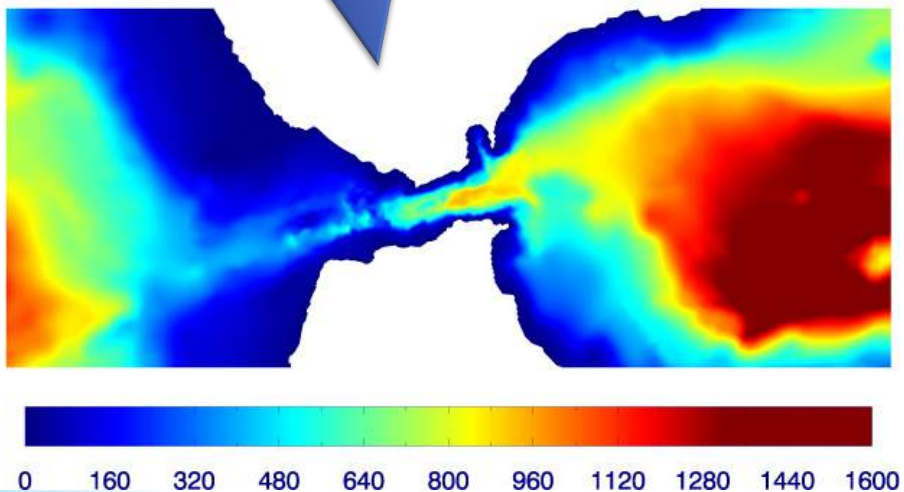
=> Local adaptation to SLR

Source: Jan Even Øie Nilsen (NERSC)

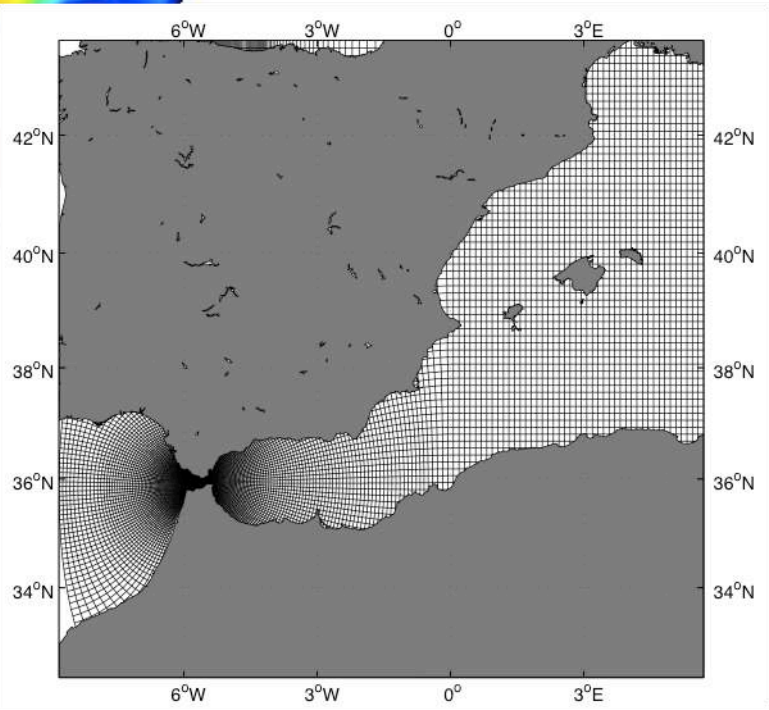
Sea Level Change and Coastal Impacts

Improve regional sea level models

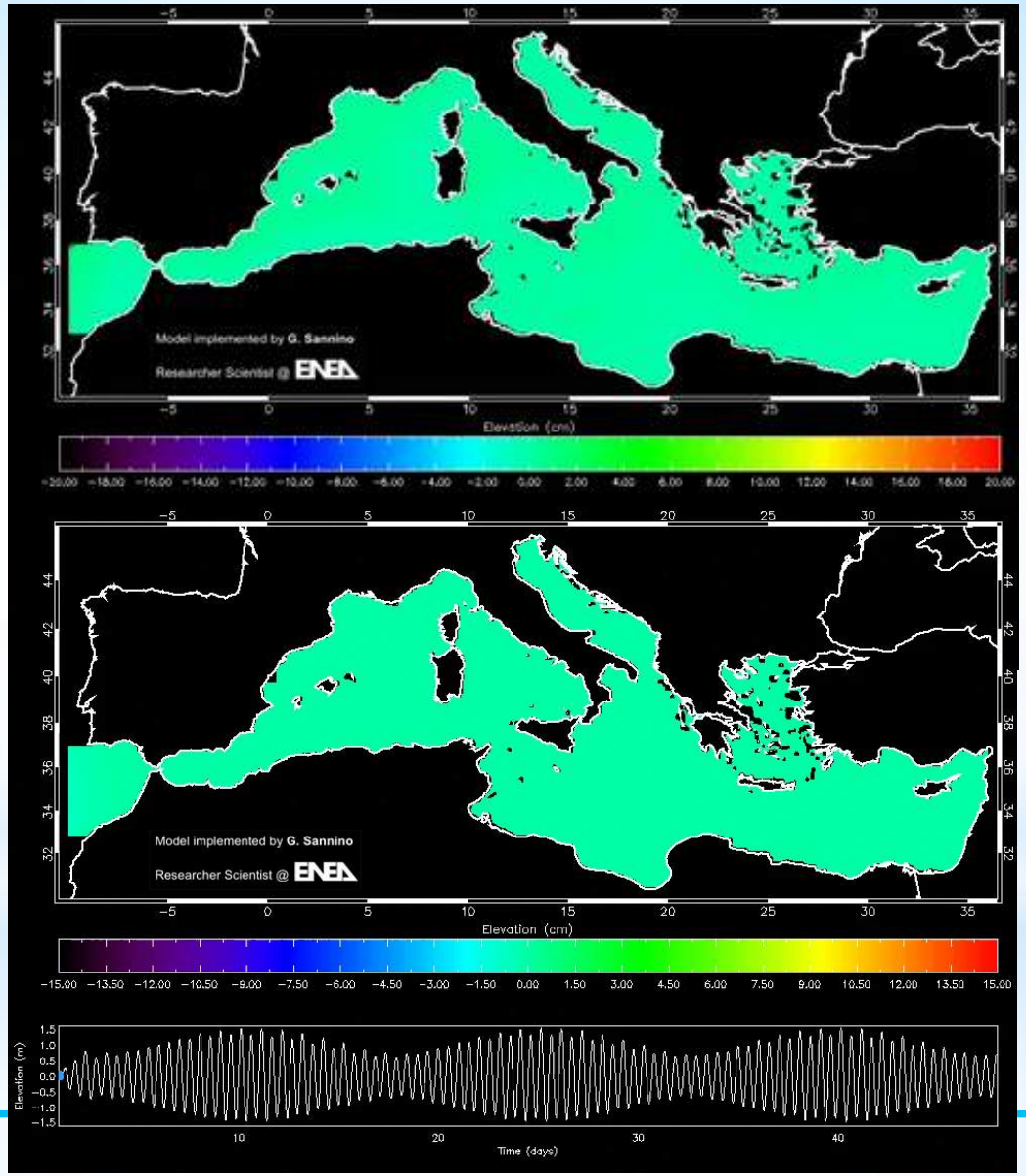




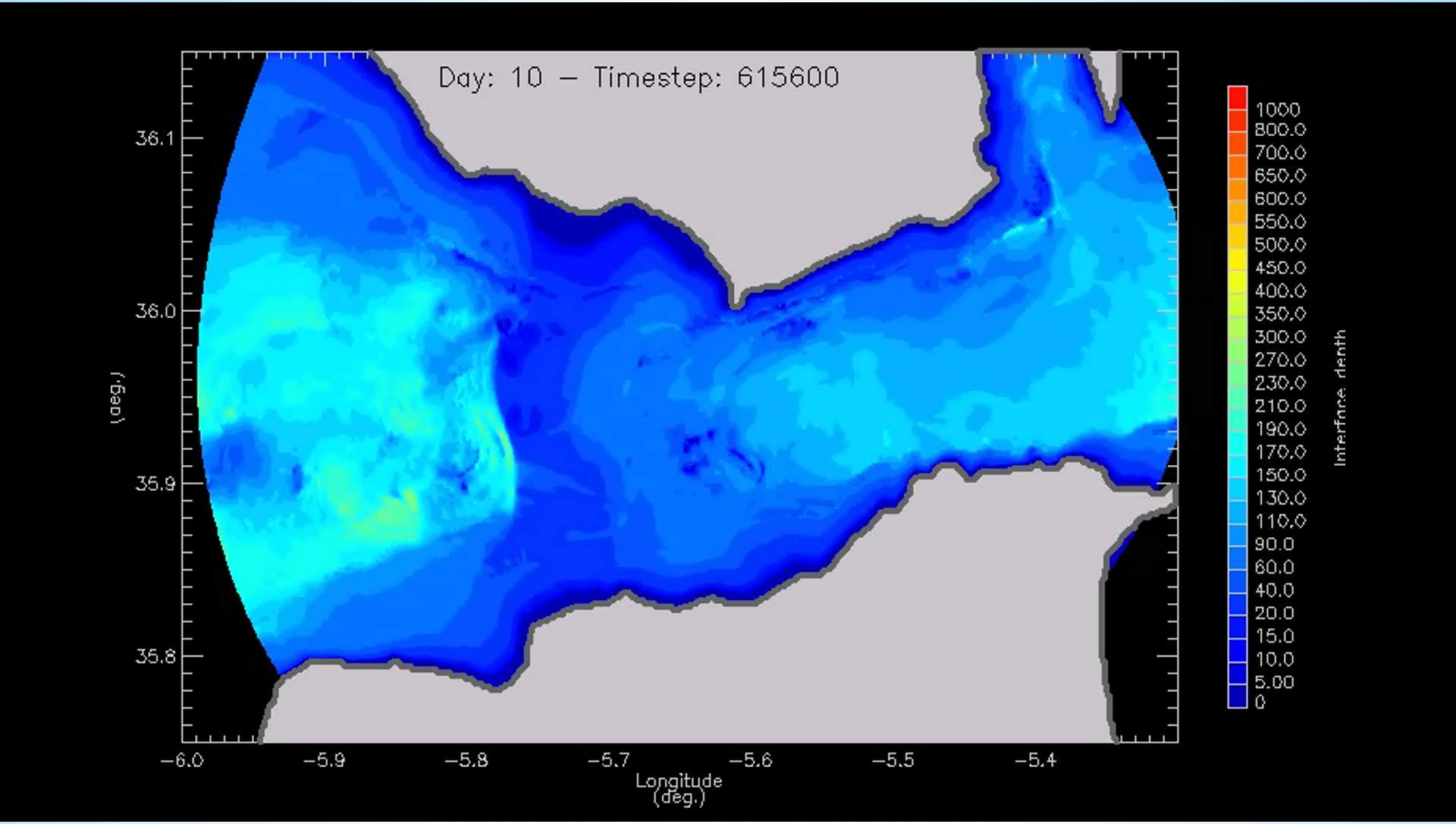
- Variable horizontal resolution (1/16° up to 1/200°)
- 72 vertical levels
- Tidal forcing (main 4 components)
- Surface atmospheric pressure



Sea Level Change and Coastal Impacts

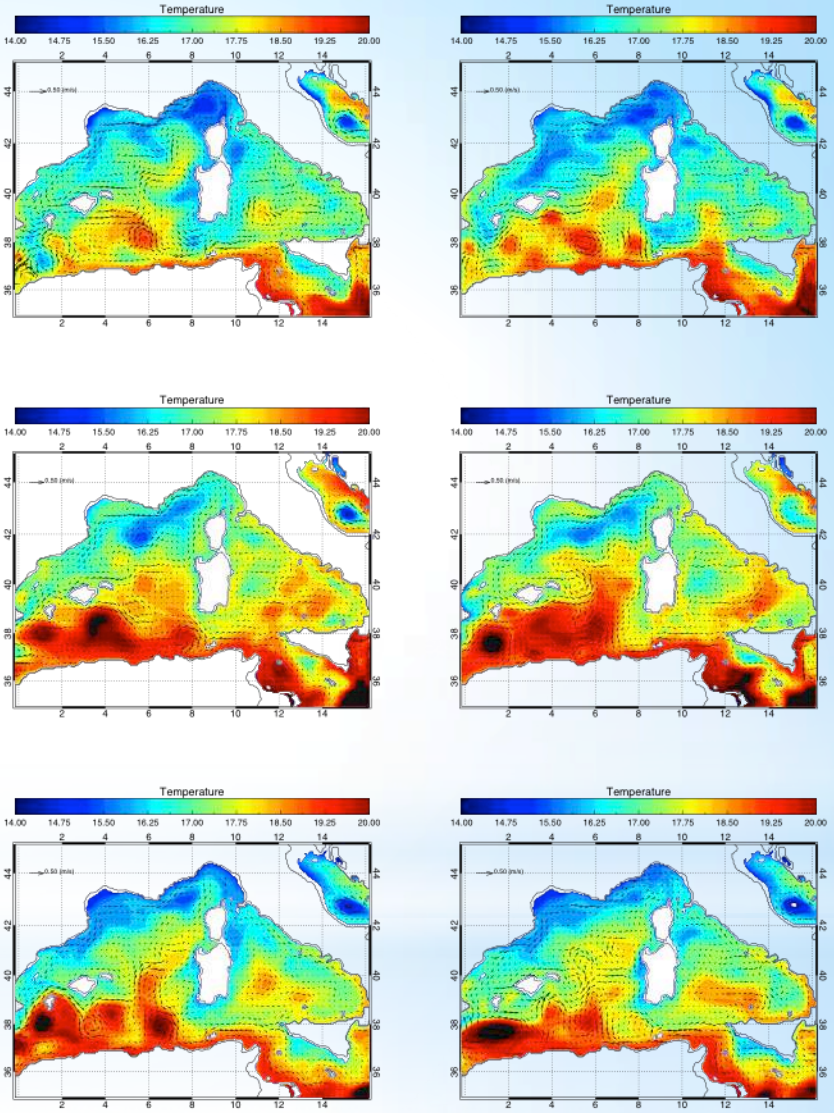


Sea Level Change and Coastal Impacts



Sea Level Change and Coastal Impacts

Improve regional sea level models



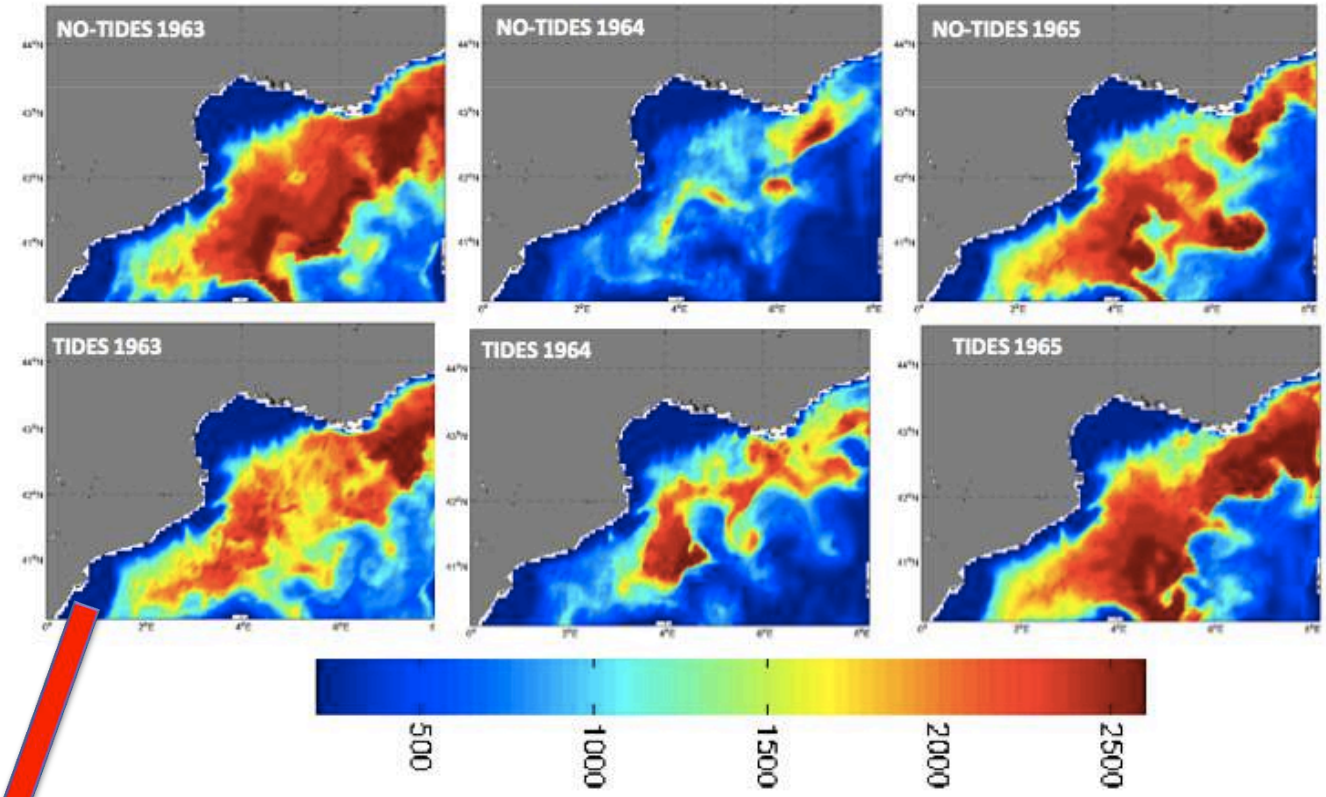
Temperature at 50m time-averaged over the period **October-December 1962** (upper panel) October-December **1963** (middle panel), and October-December **1964** (lower panel). One of three values of velocity are plotted. Left ExpT, right ExpNT

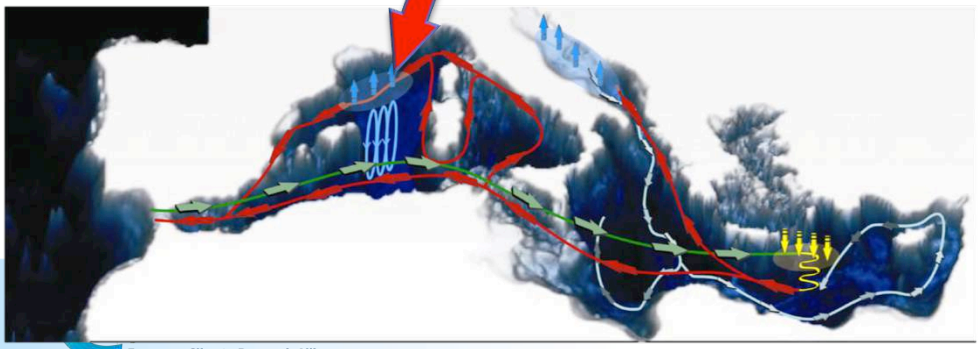
New modeling strategy for the Mediterranean (ENEA)

Sea Level Change and Coastal Impacts

NO-TIDE

TIDE





Improve regional sea level models

Sannino et al 2015. Prog. Ocean

Sea Level Change and Coastal Impacts

Key questions that still need to be addressed in this context are:

1. Has sea level gone up along European coasts and is sea level rise accelerating?
2. What is the interannual to centennial variability?
3. Can we understand and attribute these changes to specific physical processes?
4. How will sea level change in the coming century along European coasts at very local scales?

Sea Level Change and Coastal Impacts

ECRA identified the following challenges to address these key questions:

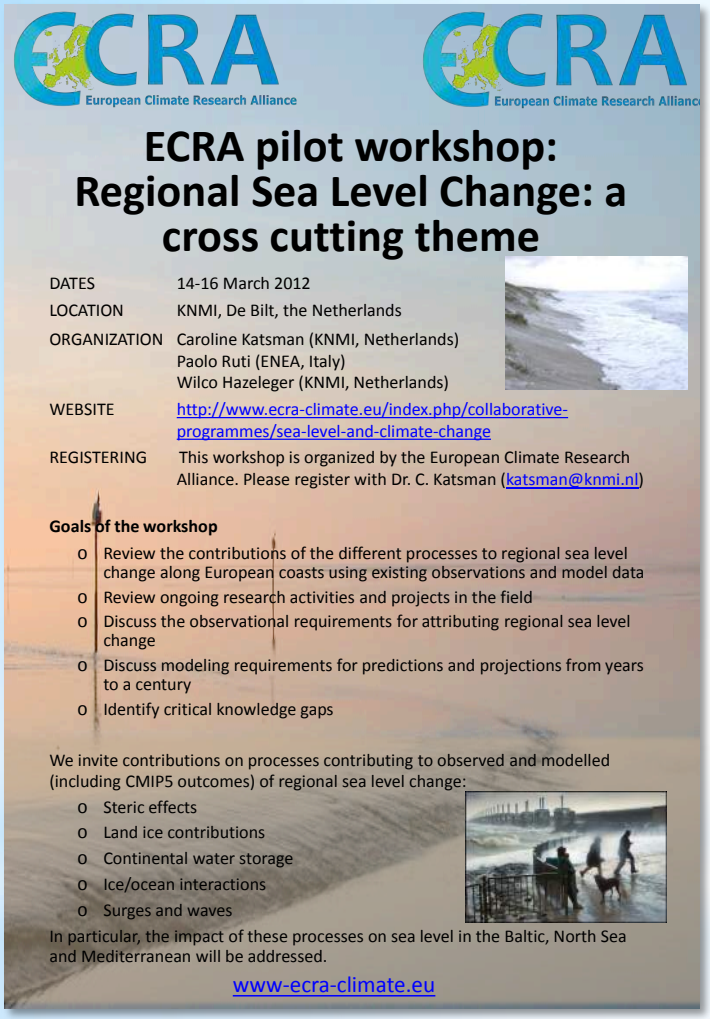
1) Integrate and homogenize observational records of sea level rise, both from in situ tide gauges and remote sensing.

2) Detect and attribute past regional sea level changes along the Baltic, North Sea, Atlantic and Mediterranean coasts to physical causes.

3) Foster modelling activities in order to construct projections of future changes of regional sea level rise and storm surges. Models of regional ocean and atmosphere, tides and land movement are needed to reduce uncertainties in regional sea level projections.

This information and further understanding of geophysical processes will be of paramount importance for impact studies and adaptation policies.

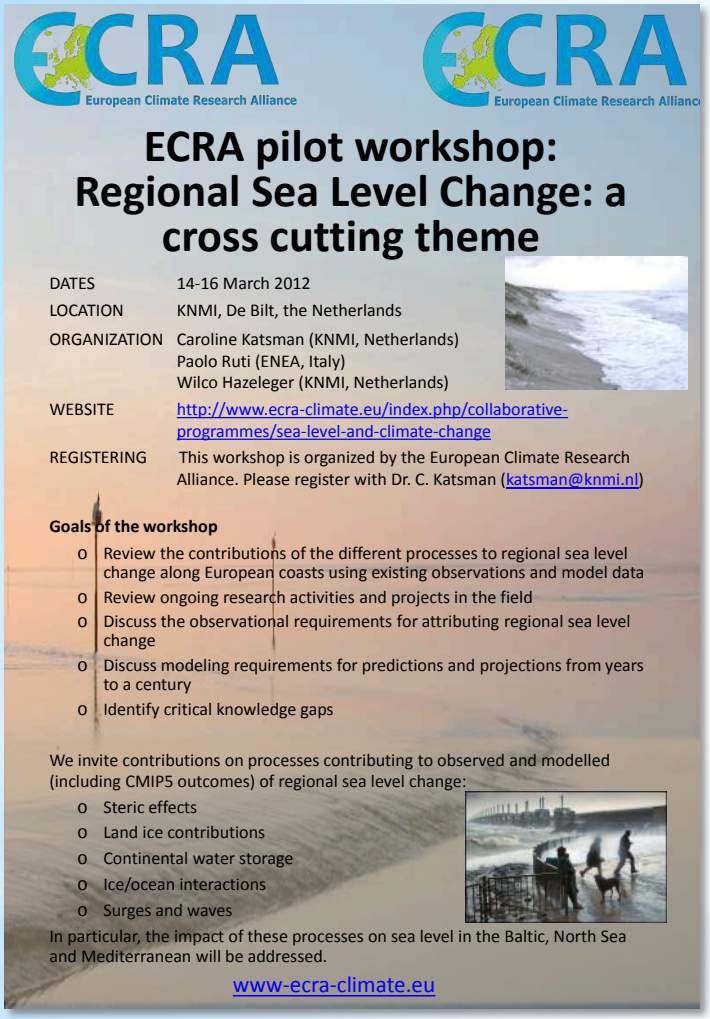
CP initiatives: 2 Workshops organised



Utrecht, March 2012

Hamburg, November 2013

1st Pilot Workshop



Utrecht, March 2012

The goals of the workshop :

- Review the contributions of the different processes to regional sea level rise along European coasts using existing observations and model data
- Review ongoing research activities and projects in the field
- Discuss the observational requirements for attributing regional sea level change
- Discuss modeling requirements for predictions and projections from years to a century
- Identify critical knowledge gaps

2nd Workshop

The 2nd workshop was organized jointly by **WCRP**, **ECRA**, and **CliSAP/CEN** of the University of Hamburg.

CliSAP: Cluster of Excellence Integrated Climate System Analysis and Prediction
CEN: Center for Earth System Research and Sustainability

The goals of the workshop :

- Review regional sea level projections simulated for high-end climate change scenarios as they result mainly from CMPI5 .

Main contributor: Detlef Stammer

Hamburg, November 2013

2nd Workshop

The workshop was organized around 5 topic areas:

1. Projections
2. Processes
3. Data issues
4. Impacts
5. Uncertainties

In addition, a strategy was discussed on how to **further improve** regional sea level **projections** as part of a **CMIP6** effort.

Hamburg, November 2013

2nd Workshop outcome

White Paper

During the workshop it was decided to use the workshop outcome as a basis for a review paper summarizing the state of sea level research, to identify open issues and to state next steps required to make further progress.

Hamburg, November 2013

2nd Workshop outcome

White Paper Structure

1) Introduction

- State of regional sea level research.
- Need for the coastal community to consider high end/upper limit.
- Discussion of what a high end - an upper limit/RCP8.5 is.
- Need to include histograms, have skewed histograms - might lead to a different view of what is high end.

2) Processes underlying observed sea level trends and their representation in climate models

- Consistency between observed and CMIP5 trends consistent.
- Improved approaches to estimate uncertainties of sea level projection

3) Existing Estimates of high-end sea level change scenarios and their limitations

- How we would need to expand methodologies so that the problem of high-end sea level change scenarios can be quantitatively addressed.

4) Information and data sets required to properly address sea level impact questions

- Requirements for an observing system to properly observe sea level change from global to coastal scale.
- Observational requirements to improve our knowledge about land ice changes

5) Suggestions for future studies required to better address the problem of global to regional to local sea level change

Further Steps – 3rd Workshop

Global and regional sea level variability and change

The workshop is organized around 7 topic areas:

1. Paleo Sea Level
2. Vertical Land Movements
3. Mean Sea Level Observations and Processes
4. Modelling Sea Level Changes
5. Sea Level Extremes
6. Coastal Impacts of Sea Level Changes
7. Special session on Mediterranean sea level

Mallorca, June 2015

Further Steps – 3rd Workshop

Global and regional sea level variability and change

ECRA is one of the **sponsors** of the workshop. ECRA Travel student grant sponsored by ECRA

A presentation slot has been reserved to ECRA

Internal ECRA meeting the day before the workshop

Mallorca, June 2015

Further Steps: COST action submission

Title(attempt):
Towards an integrated assessment of European coastal sea level projections at local scale for the 21st century

Preferred COST Domain:
Earth System Science and Environmental Management (ESSEM)