UNCTAD National Workshop Jamaica

30 May – 1 June 2017, Kingston, Jamaica

"Climate Change Impacts and Adaptation for Coastal Transport Infrastructure in Caribbean SIDS"

LISCoAsT – Large Scale Integrated Sea-level and Coastal Assessment Tool: Application for the SIDS (I)

By

Michalis Vousdoukas

European Commission, Joint European Research Centre, Ispra, Italy

LISCoAsT – Large scale Integrated Sea-level and Coastal Assessment Tool: Application for the SIDS

UNCTAD National Workshop Jamaica
"Climate change impacts and adaptation for coastal transport infrastructure in Caribbean SIDS"

Michalis Vousdoukas, Lorenzo Mentaschi, Evangelos Voukouvalas, Luc Feyen

European Commission, Joint Research Centre, Ispra, Italy



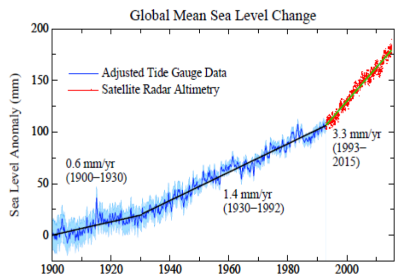
Disaster Risk Management Unit
Directorate E, Joint Research Centre, EC

Activity on river floods:
European/Global Flood Awareness System (EFAS/GLOFAS)
Climate change projections (Alfieri L., Rojas R., Feyen L)

Coastal floods group:
Michalis Vousdoukas, Lorenzo Mentaschi, Evangelos Voukouvalas, Dimitrios Bouziotas, Tomas Montblanc, Georgia Kakoulaki, Francesco Dottori, Luc Feyen

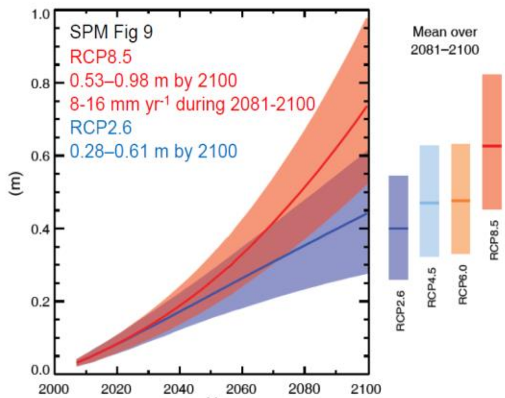


Sea level rise



Hansen ACPD, 2015

- The ocean absorbs >90% of the increase in energy
- Past sea levels under +1.5-2°C were 6-10 m higher than present
- Expansion of sea water per °C of warming is greater at higher temperature and higher pressure



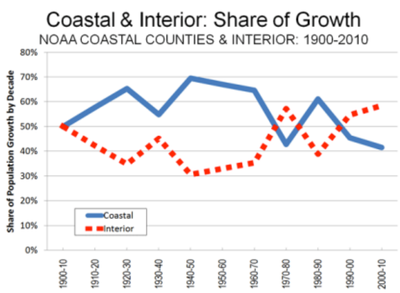
IPCC 2013

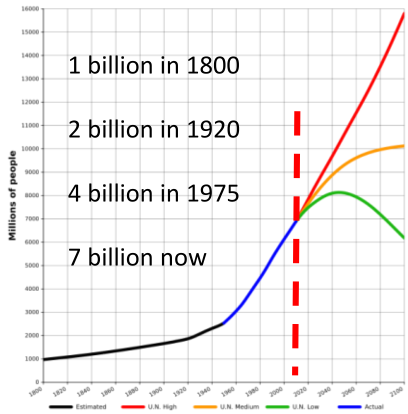
Are SLR, erosion and flooding the problems?

http://www.greekhotel.com/

Population growth

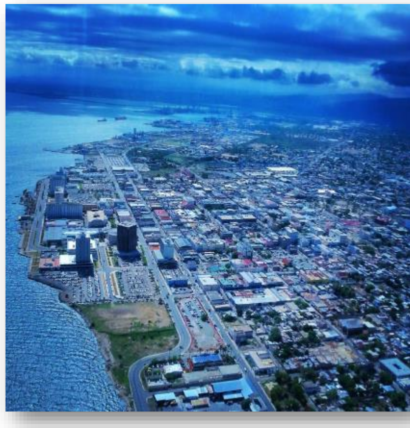
- 44% of global population lives within 100 km of the coast (UN Atlas 2010)
- A great proportion below 10 m elevation
- Population in Jamaica is increasing by 0.2%





UN 2010

Pressure on the coast: Population

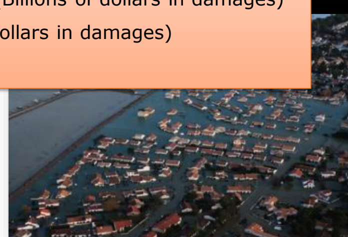


Pressure on the coast: extreme events

Katrina 2005 1400 dead, 108 billion $

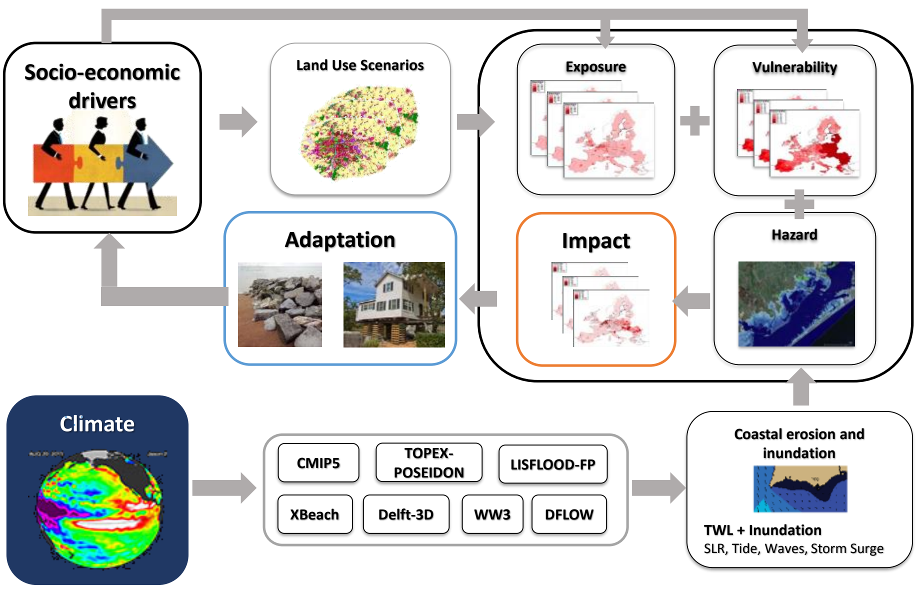
Rita 2005 120 dead, 12 billion $

Sandy 20



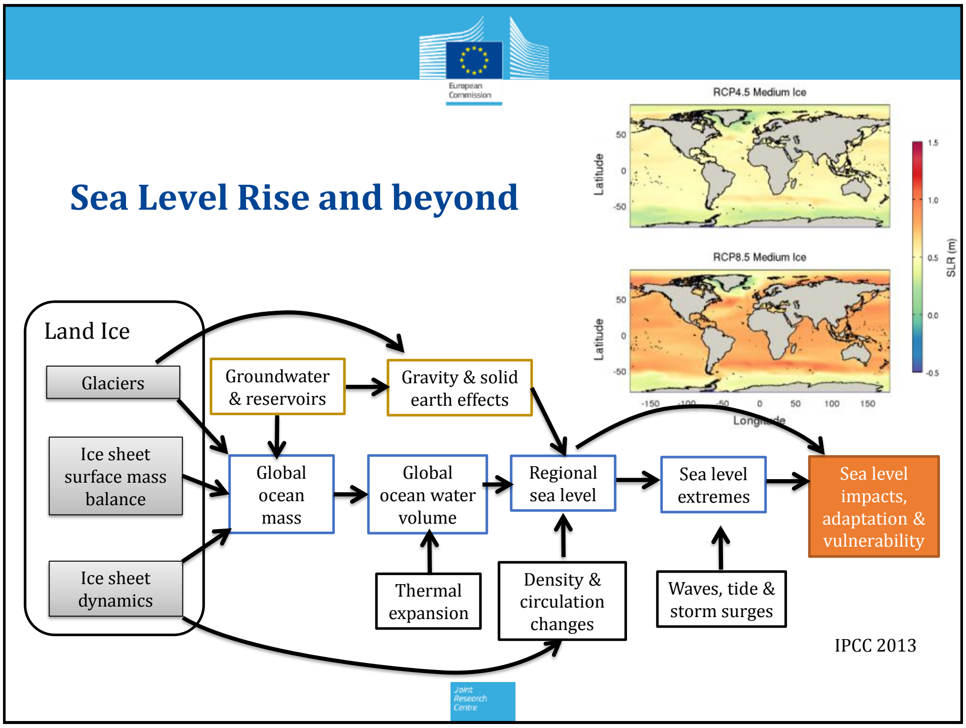
- 1980 Hurricane Allen (8 deaths, J$200 million dollars)
- 1988 Hurricane Gilbert (45 deaths, US$800 million)
- 2004 Hurricane Charley (1 death, $7 million)
- 2004 Hurricane Ivan (17 deaths)
- 2005 Hurricane Dennis and Emily (Billions of dollars in damages)
- 2005 Hurricane Emily (Billions of dollars in damages)
- Nicole 2010 (16 deaths, 240 m $)

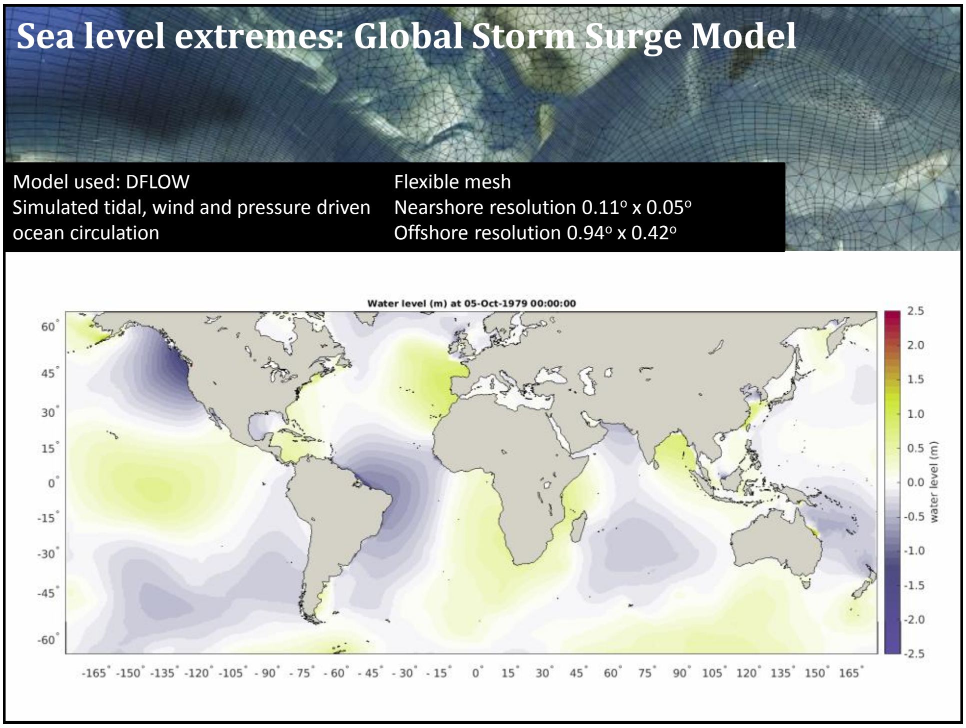
The LISCoAsT approach



The LISCoAsT approach

HAZARD PROJECTIONS


Sea Level Rise and beyond
European Commission
RCP4.5 Medium Ice
RCP8.5 Medium Ice
Latitude
Longitude
SLR (m)
Land Ice
Glaciers
Ice sheet surface mass balance
Ice sheet dynamics
Groundwater & reservoirs
Gravity & solid earth effects
Global ocean mass
Global ocean water volume
Regional sea level
Sea level extremes
Sea level impacts, adaptation & vulnerability
Thermal expansion
Density & circulation changes
Waves, tide & storm surges
IPCC 2013
Joint Research Centre


Sea level extremes: Global Storm Surge Model
Model used: DFLOW
Simulated tidal, wind and pressure driven ocean circulation
Flexible mesh
Nearshore resolution 0.11° x 0.05°
Offshore resolution 0.94° x 0.42°
Water level (m) at 05-Oct-1979 00:00:00
water level (m)

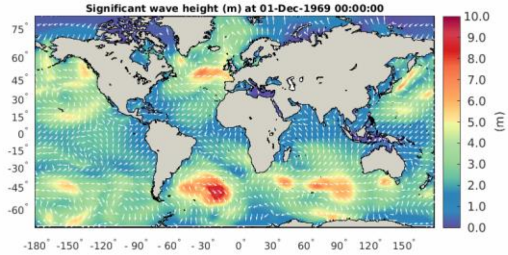
Sea level extremes: Global wave model

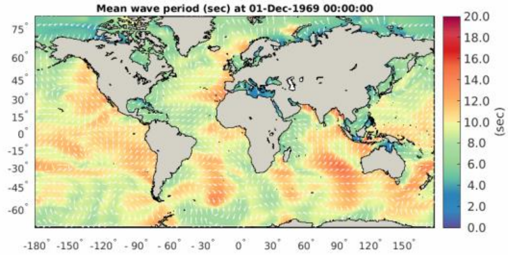
Model used: WaveWatch3 v4.18

Generates waves from wind fields

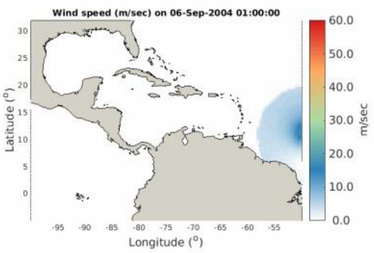
Resolves all wave directions and frequencies

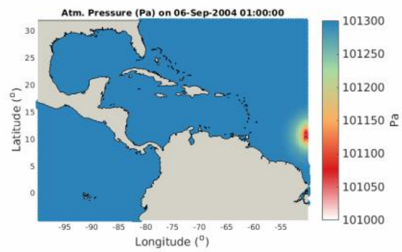
Considers several parameters including temperature, ice concentration

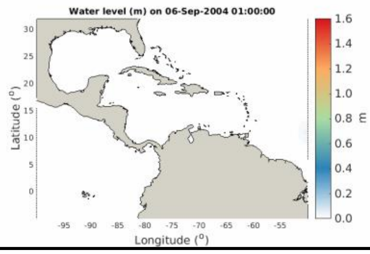




Sea level extremes: Tropical cyclones







European Commission

AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER

10.1002/2016GL072488

Key Points:
- Extreme waves will change along a large portion of the coasts generally increasing in the S. Hemisphere and decreasing in the N. Hemisphere
- The projected changes of extreme waves can be explained with a projected intensification of climatic patterns such as AAO, ENSO, and NAO

Supporting Information:
- Supporting Information S1

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Citation:
Mentaschi, L., M. I. Vousdoukas, E. Voukouvalas, A. Dosio, and L. Feyen

Global changes of extreme coastal wave energy fluxes triggered by intensified teleconnection patterns

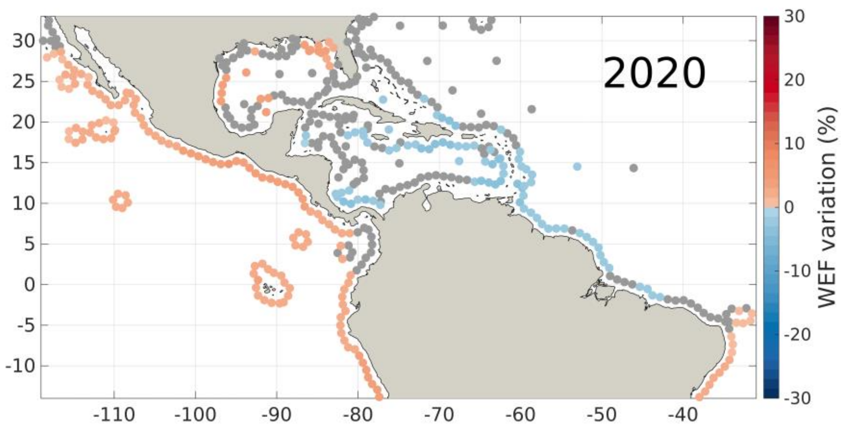
Lorenzo Mentaschi[1], Michalis I. Vousdoukas[1,2], Evangelos Voukouvalas[1], Alessandro Dosio[1], and Luc Feyen[1]

[1]Joint Research Centre, European Commission, Ispra, Italy, [2]Department of Marine Sciences, University of the Aegean, Mitilene, Greece

Abstract In this study we conducted a comprehensive modeling analysis to identify global trends in extreme wave energy flux (WEF) along coastlines in the 21st century under a high emission pathway (Representative Concentration Pathways 8.5). For the end of the century, results show a significant increase up to 30% in 100 year return level WEF for the majority of the coastal areas of the southern temperate zone, while in the Northern Hemisphere large coastal areas are characterized by a significant negative trend. We show that the most significant long-term trends of extreme WEF can be explained by intensification of teleconnection patterns such as the Antarctic Oscillation, El Niño–Southern Oscillation, and North Atlantic Oscillation. The projected changes will have broad implications for ocean engineering applications and disaster risk management. Especially low-lying coastal countries in the Southern Hemisphere will be particularly vulnerable due to the combined effects of projected relative sea level rise and more extreme wave activities.

European Commission

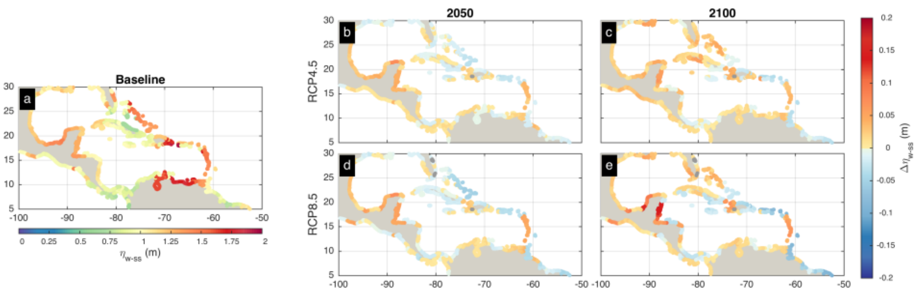
Caribbean TWL projections: Waves



Joint Research Centre

European Commission

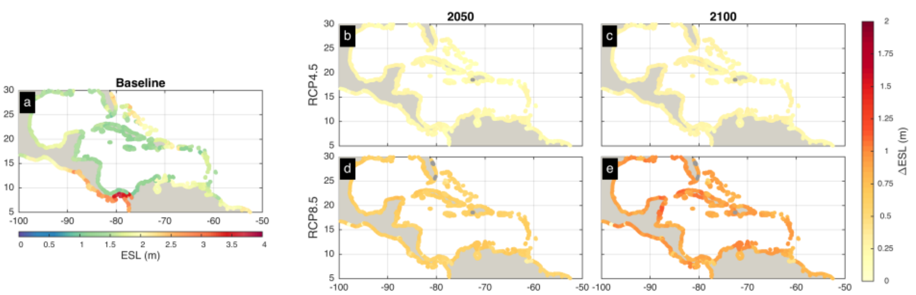
Caribbean TWL projections: Waves and storm surge



Joint Research Centre

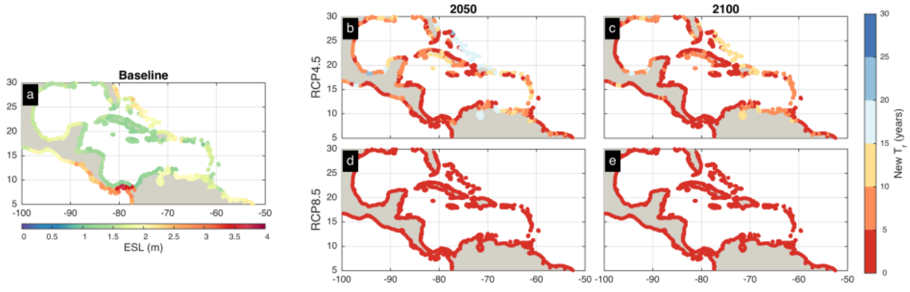
European Commission

Caribbean TWL projections: All components



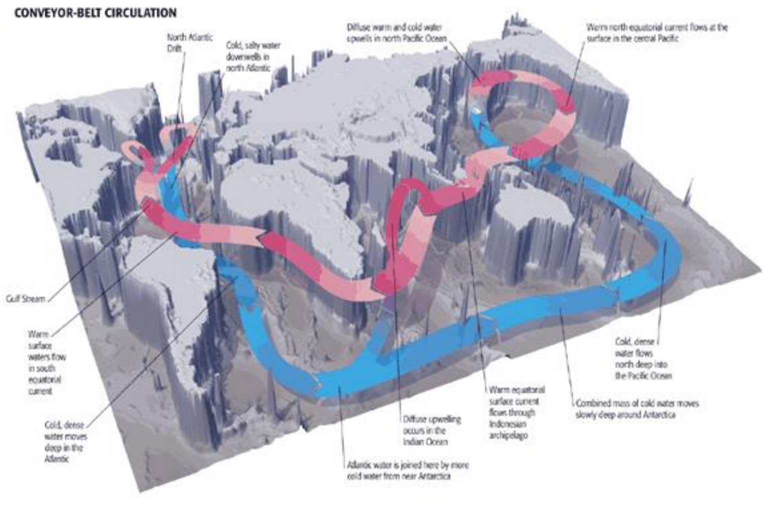
Joint Research Centre

Caribbean TWL projections: Changes in frequency

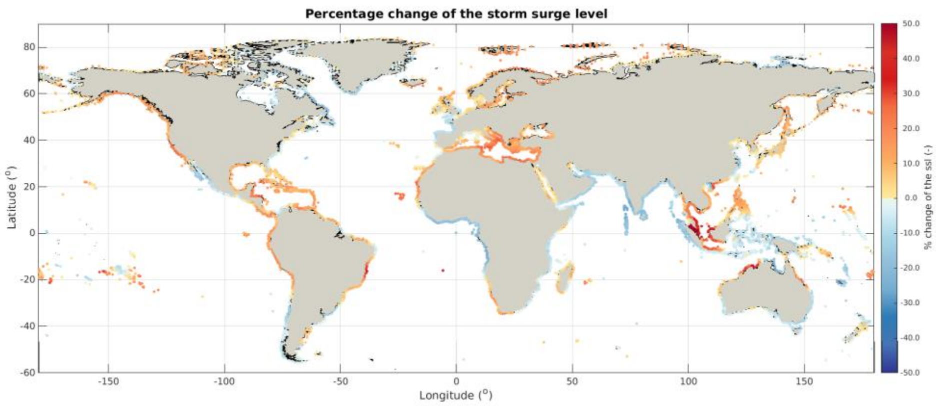


European Commission

Climate tipping points: Thermohaline circulation

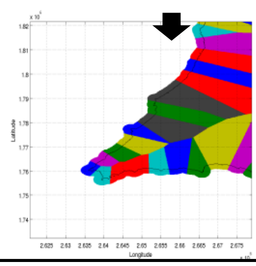


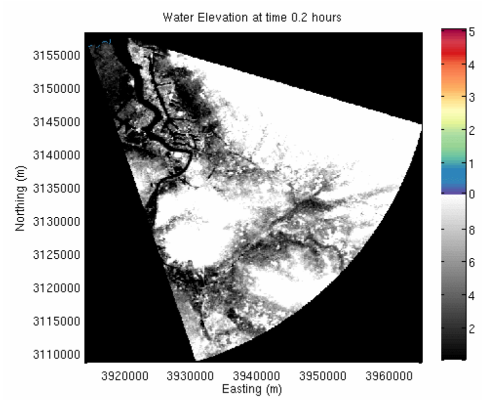
Climate tipping points: Thermohaline circulation



Coastal Inundation on continental scales

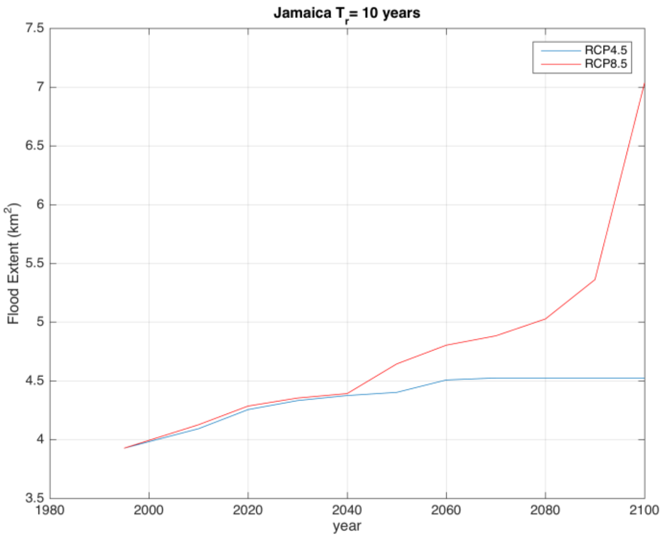
- TWL components estimated every 25 km of coast
- SRTM DEM
- Similarly coastline and all data divided in 25 km long segments, extending 50 km inland





$$\eta_{TWL} = \eta_{MSL} + RSLR + \eta_{tide} + \eta_{stormsurge} + \eta_{wave}$$

Flood extent projections for Jamaica



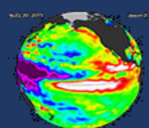


Closing Remarks

SUMMARY AND WORK IN PROGRESS:
METHODOLOGICAL GAPS, IDEAS, CRITICAL QUESTIONS

What is really at stake?

Climate



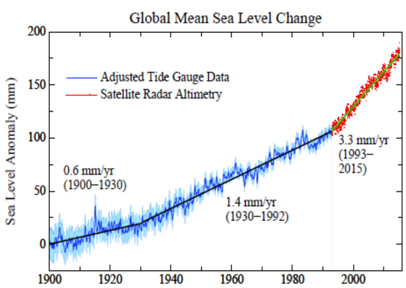
SLR

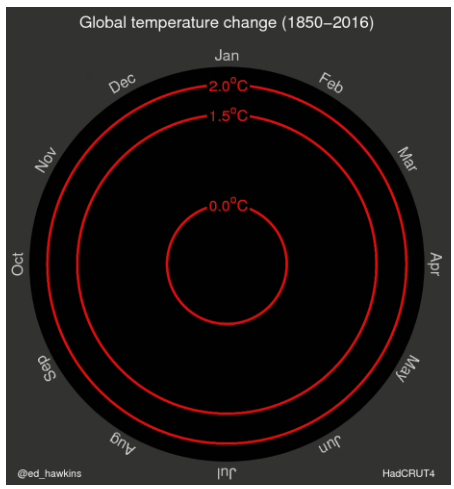
River floods
Heat waves
Cold waves
Draughts
Wildfires
Windstorms
Crops
Fisheries
Coastal floods

Impacts

What is really at stake?

- The ocean absorbs >90% of the increase in energy
- Past sea levels under +1.5-2ºC were 6-10 m higher than present
- Expansion of sea water per ºC of warming is greater at higher temperature and higher pressure





Hawkins, MetOffice, 2016

What is really at stake?

- Projections indicate an order of magnitude increase of direct impacts by the end of the century
- Without considering tipping points
- Without considering indirect impacts
  - Business interruption
  - Ecology
  - Sector interactions
  - Criticality of transport hubs
  - Etc….

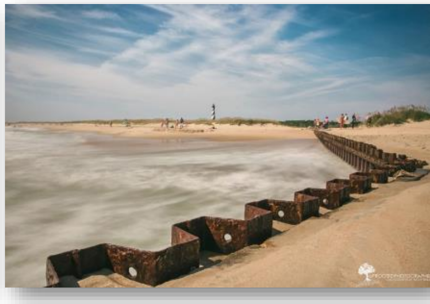
Intangible/indirect impacts

www.wikipedia.org

	Coastline (km)	GDP	Expenses	GDPratio
Jamaica	894	14	0.7599	5.43%
NL	2000	752	1.7	0.23%

Adaptation and social justice

James G. Titus and Michael Craghan (2009)



http://porterbriggs.com/

- Need to acknowledge the challenging nature of coastal adaptation in view of climate change
- Urgency of moving towards the direction of a timely response, taking coordinated and fair measures