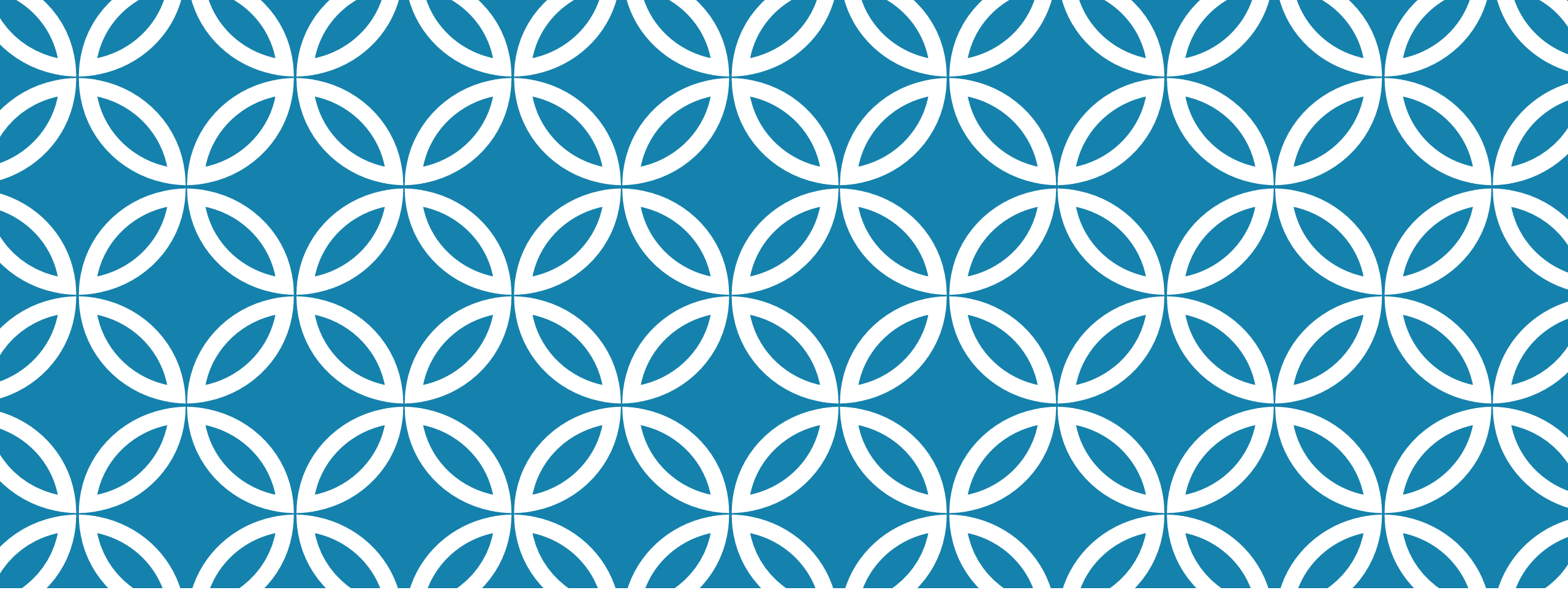
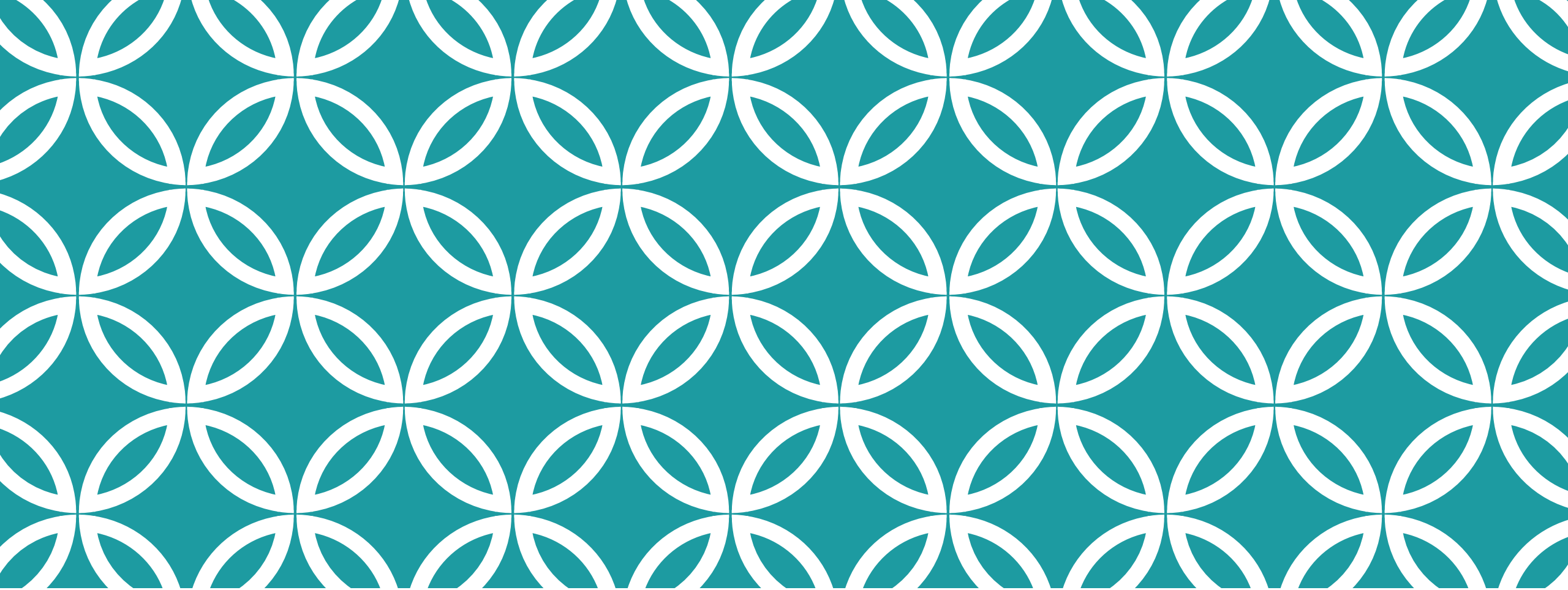


CLIMRISK

MODEL DESCRIPTION AND ILLUSTRATION

CONTENTS

1. Climate module
   - Probabilistic climate change projections
   - Risk measures
2. Damage functions
   - Adjustment of RICE impact functions
   - Persistence of shocks
3. Illustration of CLIMRISK
   - Economic impacts of climate change
   - Multivariate climate-economy risk measures



CLIMRISK CLIMATE MODULE

PROBABILISTIC CLIMATE CHANGE SCENARIOS AND RISK MEASURES

CLIMATE MODULE

Global temperature projections

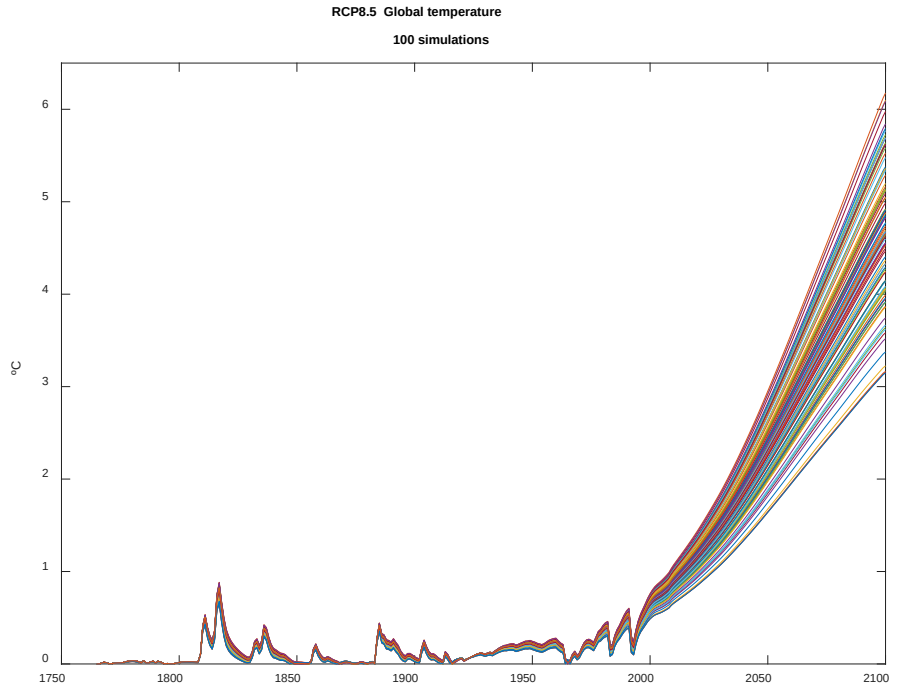
- Version 1: Uses MAGICC runs
- Version 2: Stochastic version of MAGICC (climate sensitivity and carbon cycle models)

Emissions scenarios

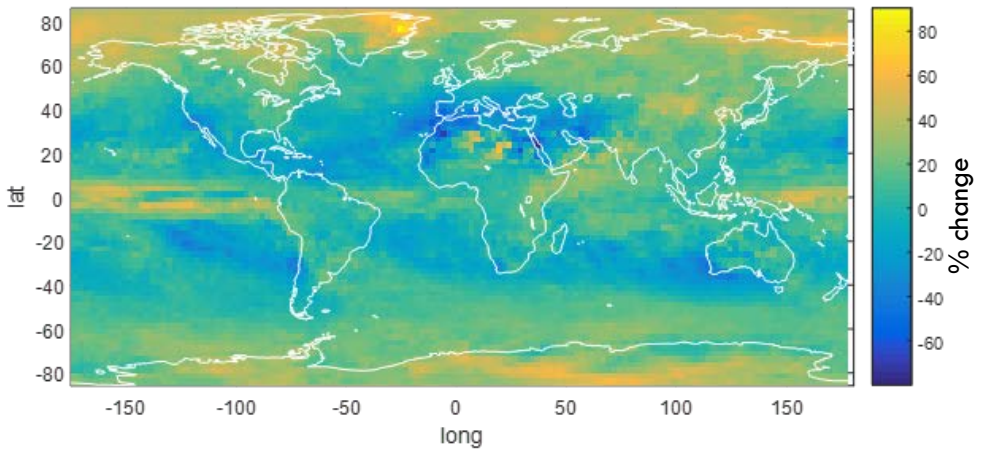
- RCP: RCP8.5, RCP6, RCP4.5
- SRES: A1B, A1FI, A1T, A2, B1, B2
- Policy: INDC, RCP3PD, RCP6 to RCP45, RCP4.5 to RCP3PD, WRE750, WRE650, WRE550, WRE450, WRE350

Regional climate scenarios

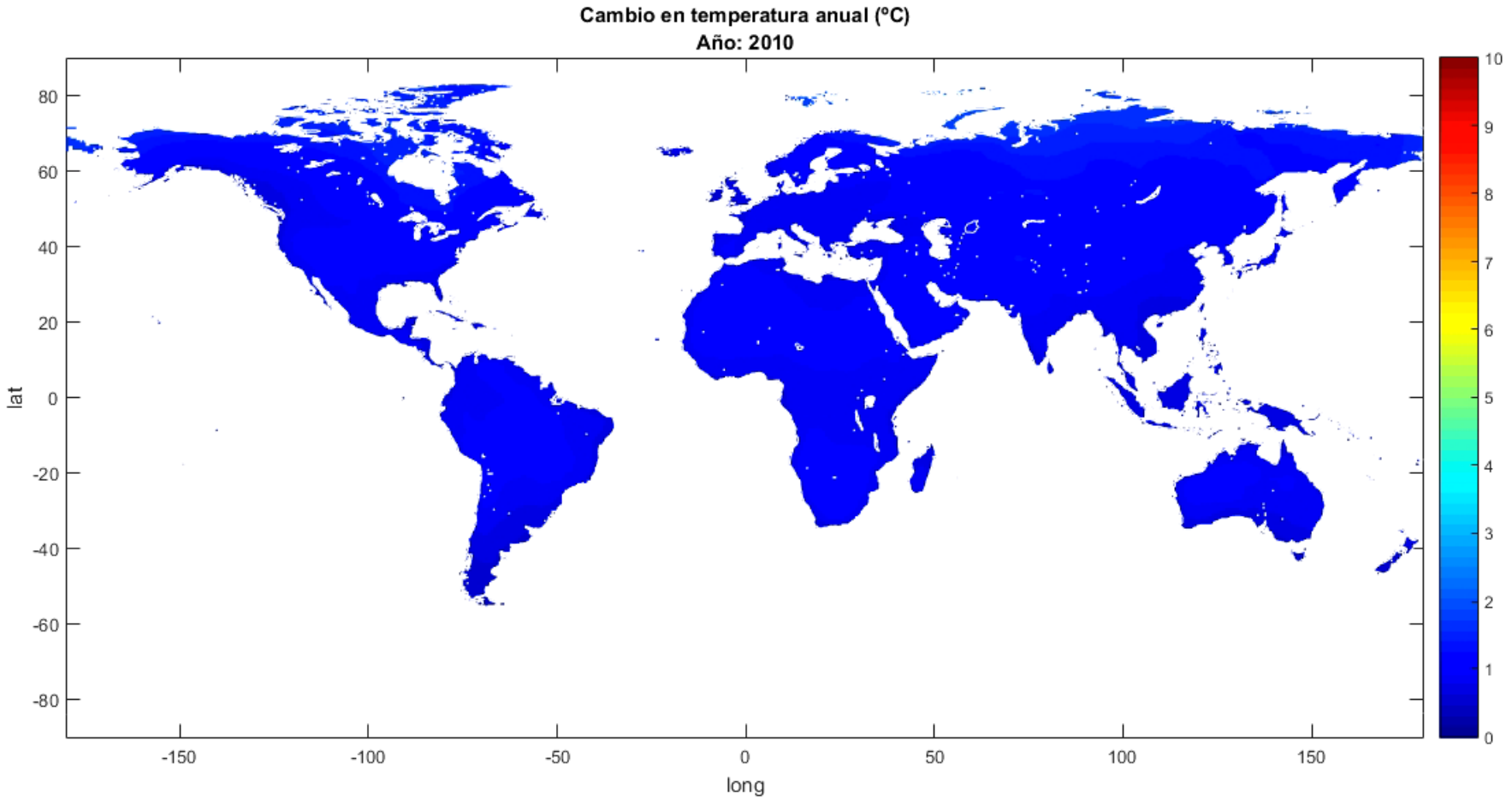
- Based on pattern scaling methods (e.g., Tebaldi y Arblaster, 2014), and stochastic simulation
- Version 1: Pattern scaling from 20 AOGCM CMIP3
- Versión 2: Pattern scaling from 41 AOGCM CMIP5



Median PCP
2100

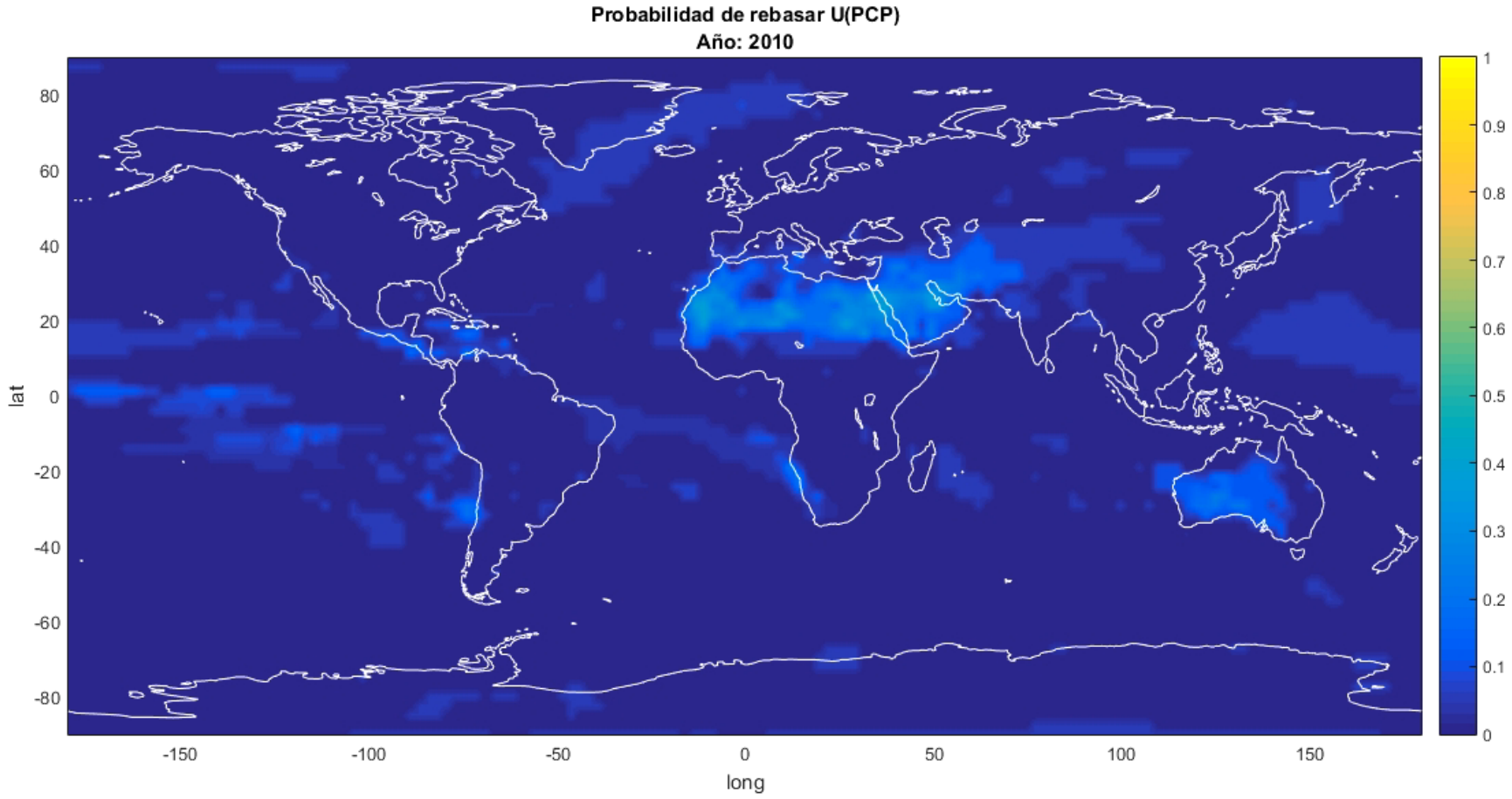


MEDIAN OF ANNUAL TEMPERATURE CHANGE (RCP8.5)

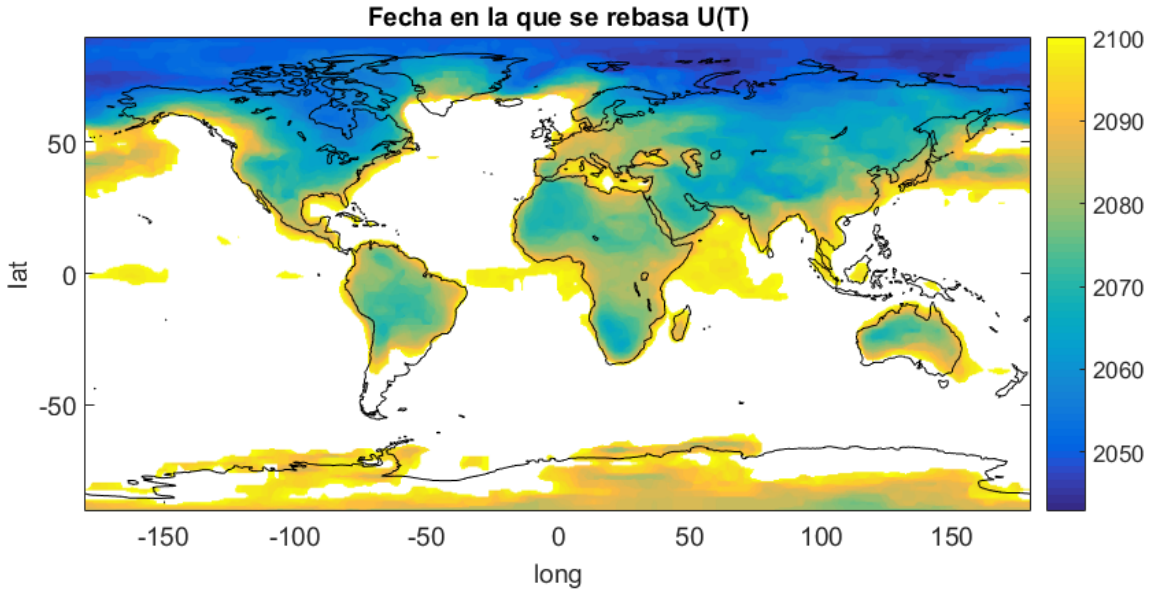


MULTIVARIATE CLIMATE RISK MEASURES:

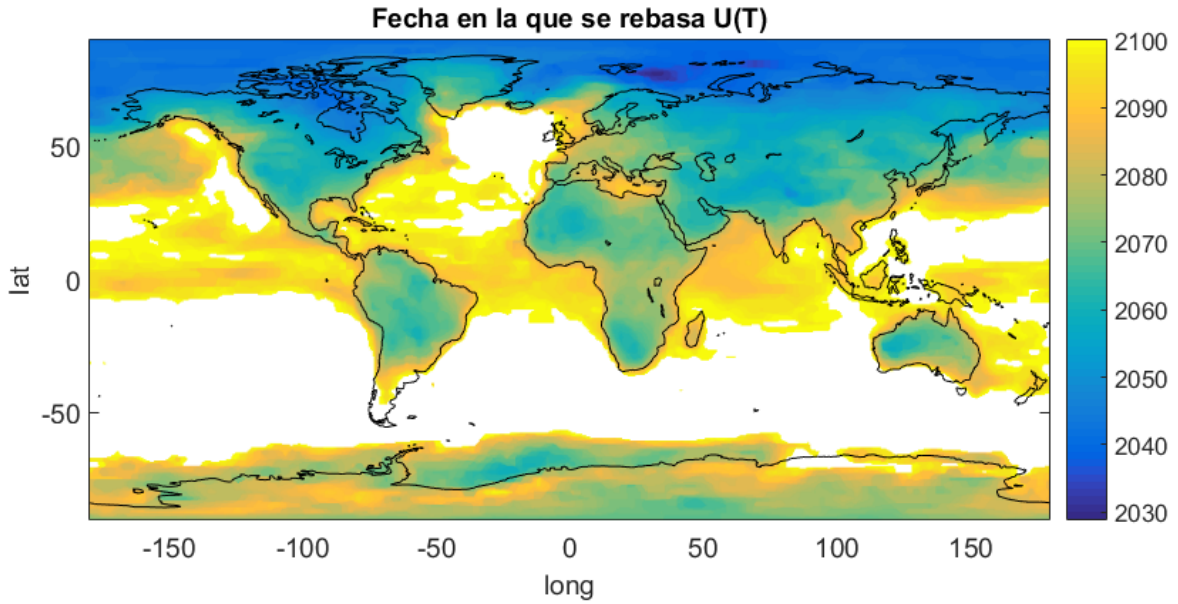
JOINT PROBABILITY OF WARMING LARGER THAN 4ºC AND PCP REDUCTIONS OF MORE THAN 10% (RCP8.5)



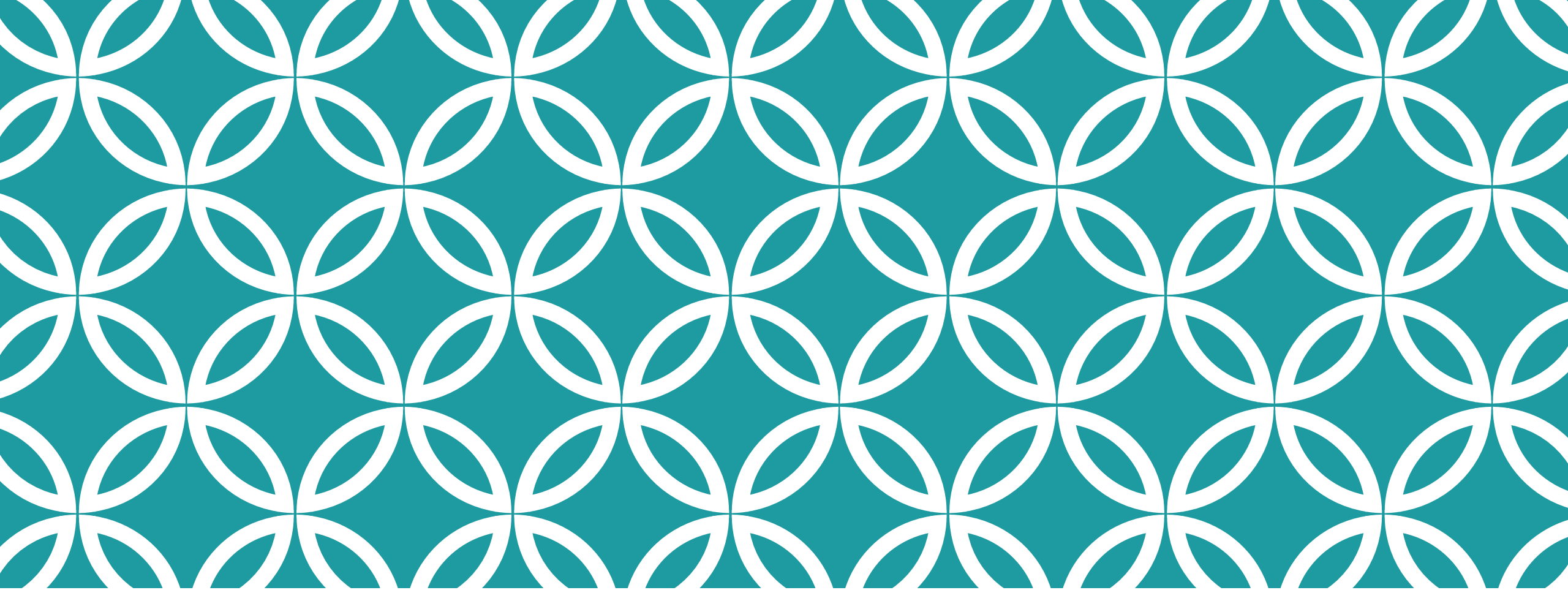
CLIMATE RISK MEASURES:
DATE ESTIMATES FOR GOING OVER A 4ºC WARMING THRESHOLD



Probability 50%



Probability 25%



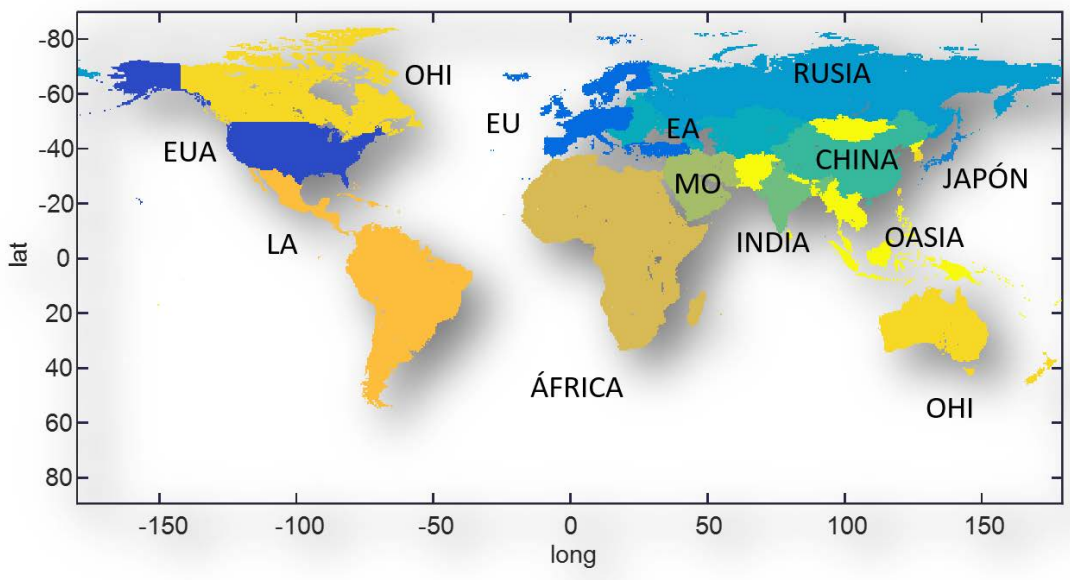
CLIMRISK

DAMAGE FUNCTIONS

DAMAGE FUNCTIONS IN CLIMRISK:
TYPES, REGIONS AND SECTORS

Two sets of damage functions (modified and extended versions of RICE2010) :

1) RICE (Nordhaus and Boyer, 2003)
2) RICE-P including the persistence of climate shocks (Estrada et al., 2015)



Twelve world regions in RICE2010

Sectors and aspects included in the RICE2010 damage functions:

- Agriculture (including CO_2 effect)
- Health (malaria and tropical diseases, dengue and pollution)
- Sea level rise
- Other aspects(forestry, energy, water, construction, fisheries y outdoor recreational activities)
- Human settlements and ecosystems
- Climate catastrophes

MODIFICATION OF RICE2010 DAMAGE FUNCTIONS

Original RICE2010 functions are driven by global temperature change

These functions are modified to be driven by regional temperature changes (0.5°x0.5°) by means of a correction factor $S_{r,t}$

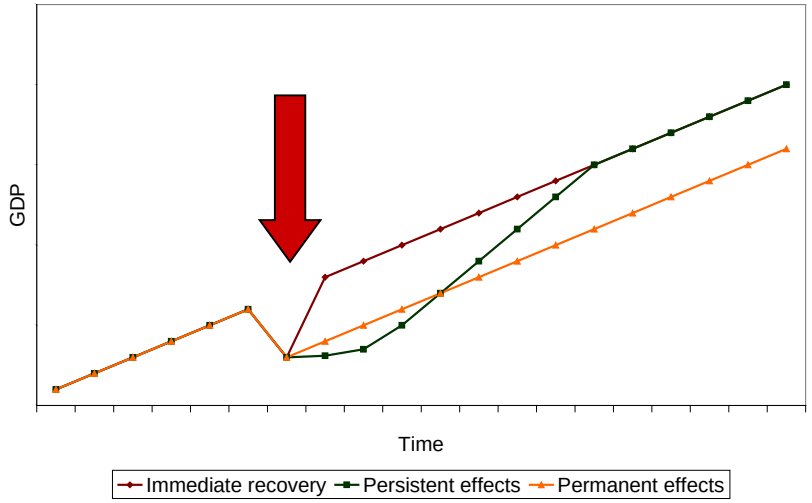
$$I^{S}_{r,t,i,j} = Y_{r,t,i,j} D_{r,t,i,j} S_{r,t}$$

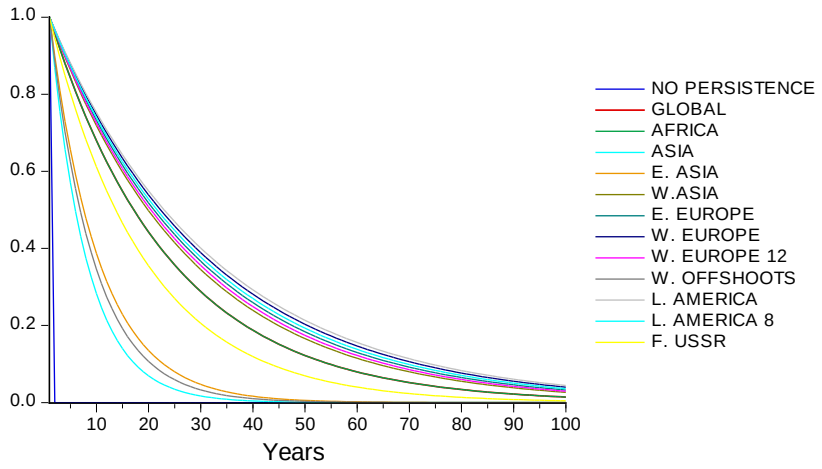
$$S_{r,t} = {I_{r,t}}/{I^{*}_{r,t}}$$

where *r* represents the region; *t* is time; *i,j,* are coordinates within the region *r; Y* is GDP; *D* is the climate change damage (%).

$I^{*}_{r,t}$ is the impacts from region *r* from the modified function and $I_{r,t}$ is the impacts for region r according to the original RICE2010 function.

PERSISTENCE OF SHOCKS IN GDP



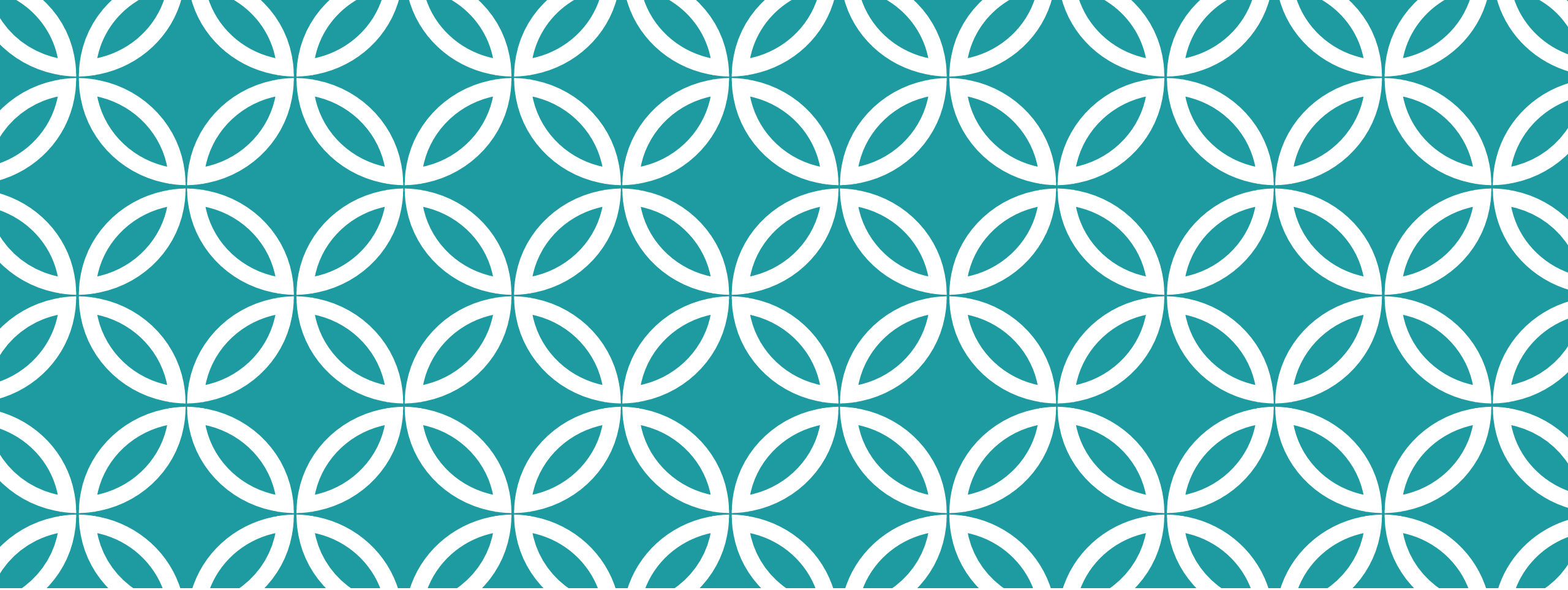


$$I_{r,t} = Y_{r,t} D_{r,t} + \alpha_r I_{r,t-1} \qquad (2)$$

Where $I_{r,t}$, $Y_{r,t}$ are the economic impacts and GDP in region *r* at time *t*, respectively.

The persistence is given by $0 \leq \alpha_r \leq 1$ and is estimated from regional GDP time series.

Estrada F., Tol R.S.J., Gay-Garcia C., 2015. The persistence of shocks in GDP and the estimation of the potential economic costs of climate change. **Environmental Modelling & Software**.

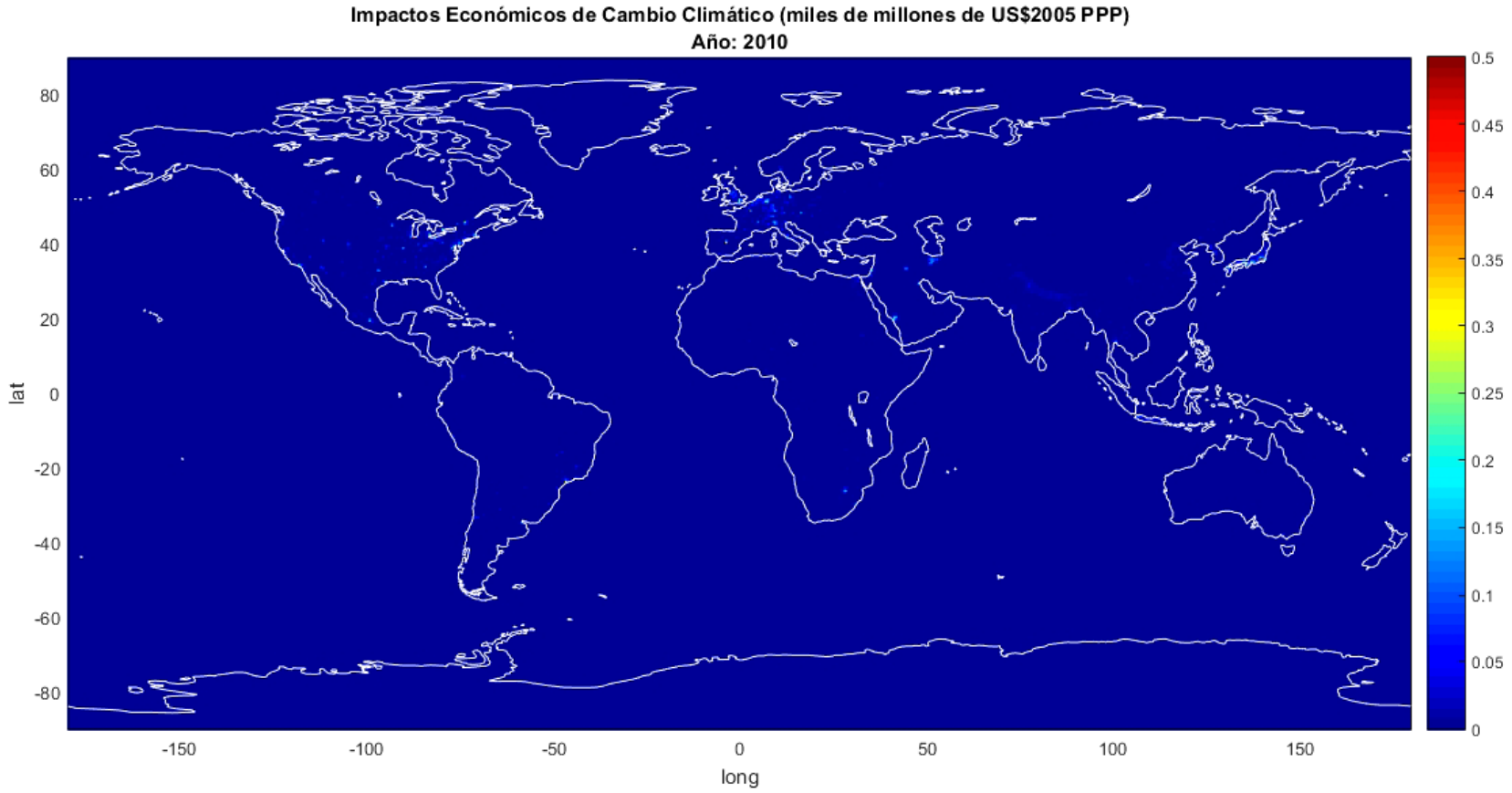


CLIMRISK:

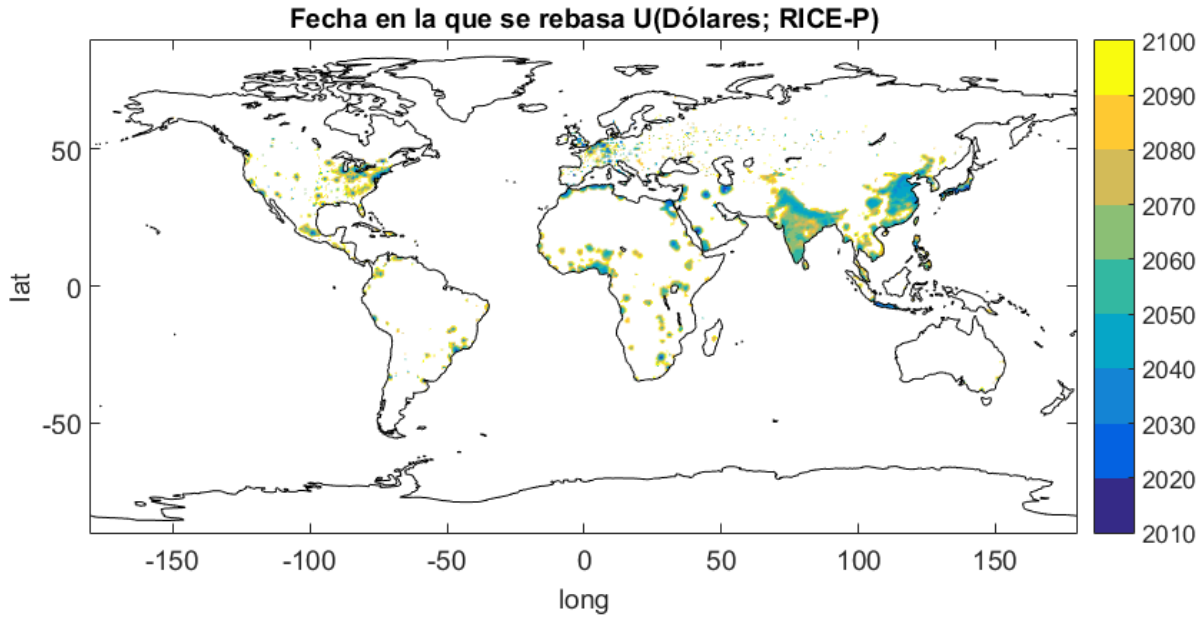
CLIMATE CHANGE EOCNOMIC IMPACTS AND MULTIVARIATE RISK MEASURES

SPATIAL DISTRIBUTION OF ECONOMIC CLIMATE CHANGE IMPACTS (SSP3,RCP8.5, RICE-P)

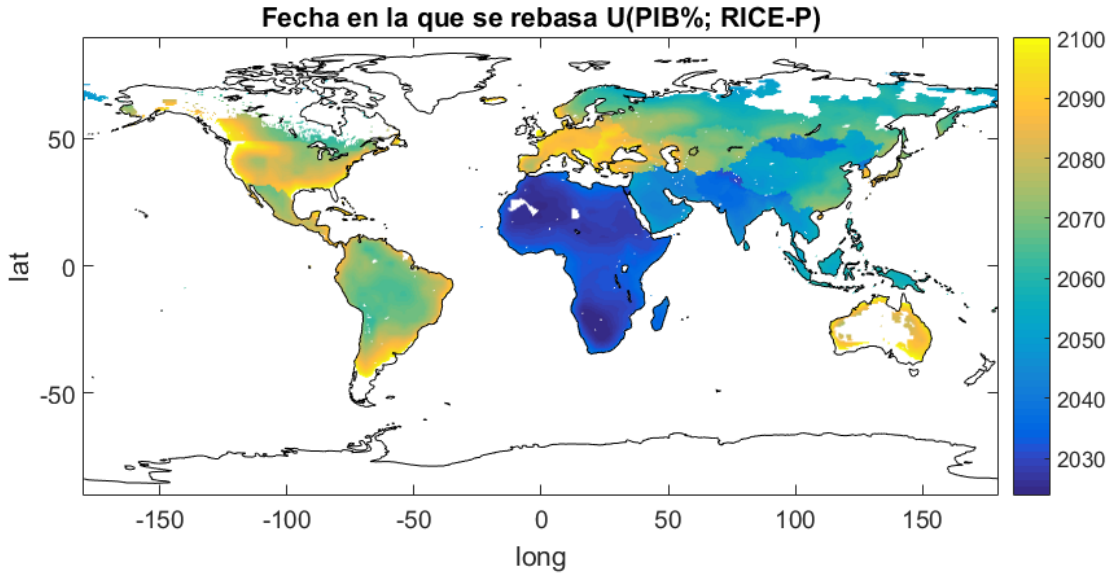
US$2005 BILLION DOLLARS



UNIVARIATE ECONOMIC RISK MEASURES

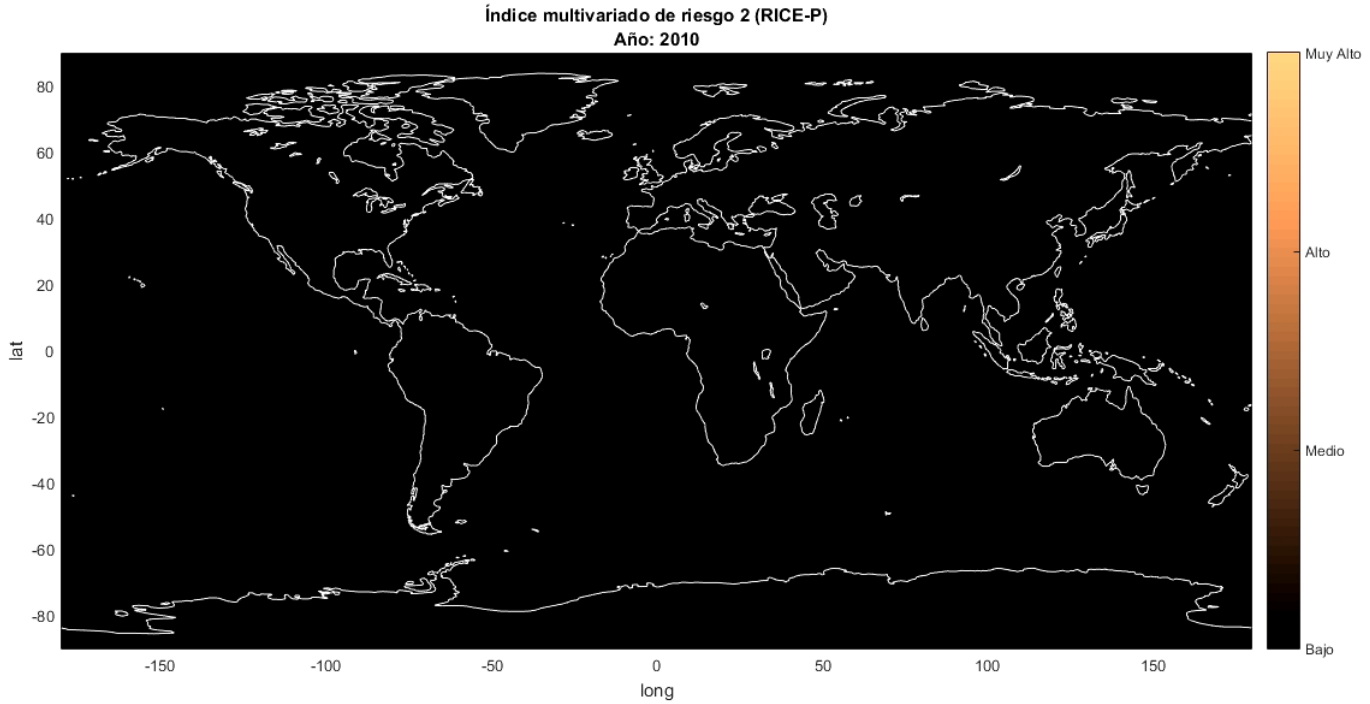


Date impacts > 1 billion US$2005



Date impacts > 5% GDP

MULTIVARIATE CLIMATE/ECONOMIC RISK INDEX



High risk

Low risk

Risk index: warming larger than 4°C; precipitation reductions larger than 10%; economic losses larger than 5% of GDP; losses larger than 1 billion US$2005