Climate Data:
Diagnosis, Prediction and Projection

Paul Bowyer (paul.bowyer@hzg.de)
Climate Service Center Germany (GERICS)

Boram Lee (blee@wmo.int)
World Meteorological Organization (WMO), World Climate Research Programme (WCR

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

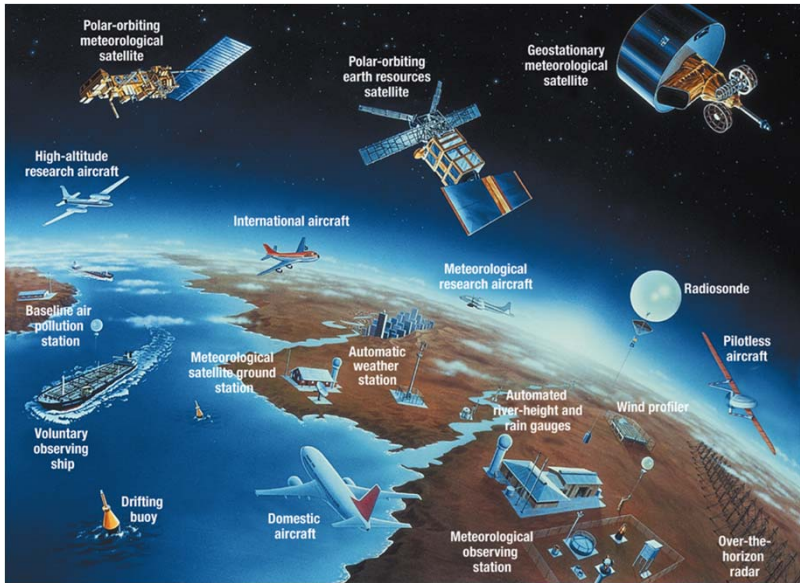
WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

Group of Experts on Climate Change Impacts and Adaptation for Transport Networks and Nodes
(7 June 2018, Geneva, Switzerland)

World Meteorological Organization

- UN Specialized Agency on **weather, climate & water**
- 191 Members, HQ in Geneva
- 2nd oldest UN Agency, since 1873
- Coordinates work of ~5000 national experts from meteorological services, hydrological services and academia

- Co-Founder and host agency of IPCC (1st World Climate Conference)
- Co-Founder of UNFCCC (2nd World Climate Conference)



WMO OMM

WCRP World Climate Research Programme

WMO Strategic Priorities 2017-2023

UN level

- Climate expertise
- Disaster expertise
- El Niño/La Niña
- Partnerships with international organizations

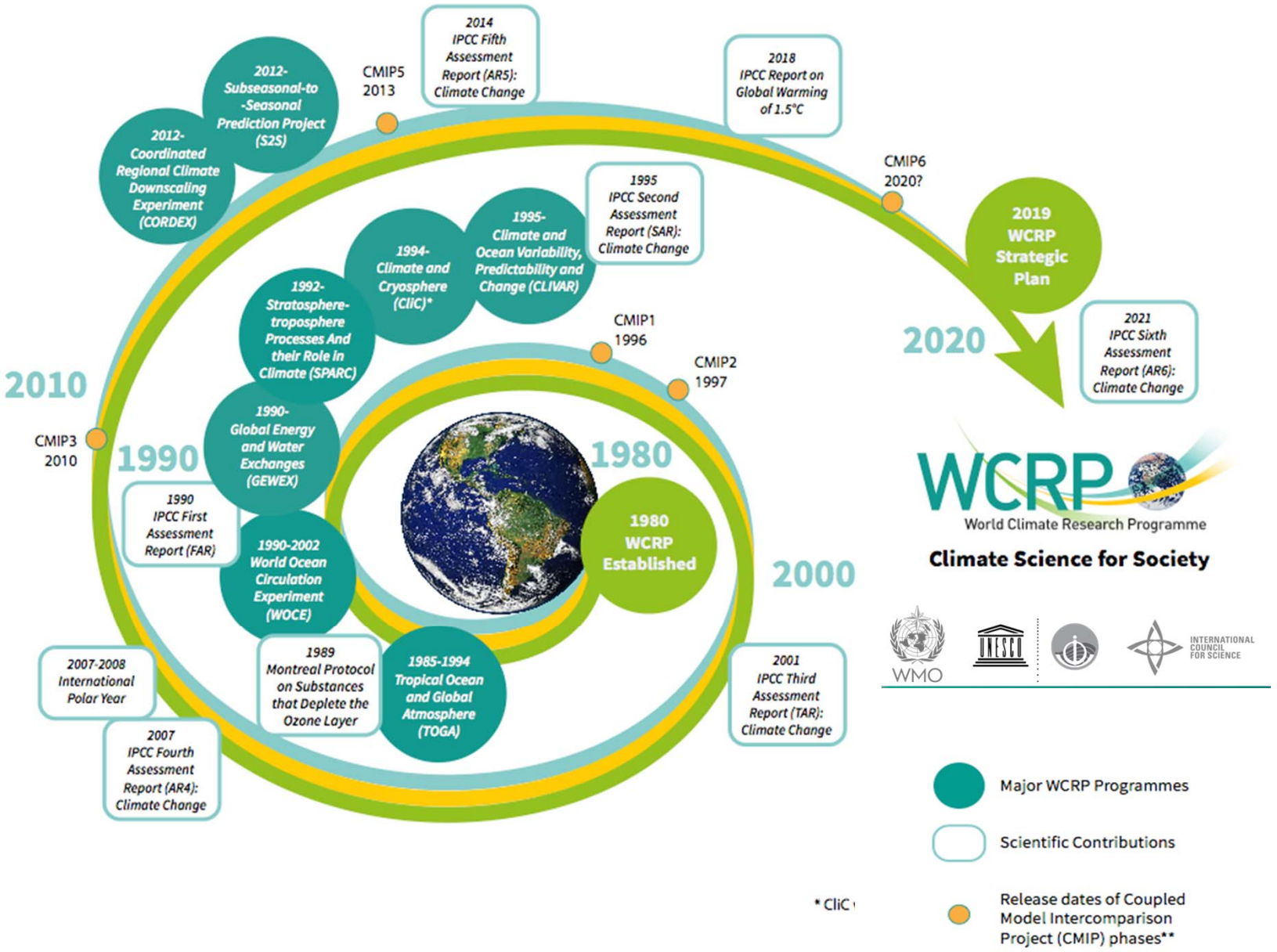
Organizational level

- Public-Private partnership, definition of roles
- Visibility of WMO & NMHS: climate, disasters, water resources

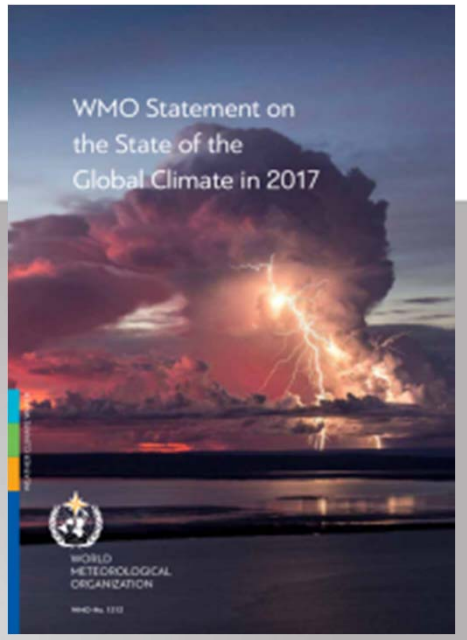
WMO OMM

WCRP World Climate Research Programme

The World Climate Research Programme



WMO: Annual State of Climate



WMO: Annual State of Climate

WMO OMM

WCRP
World Climate Research Programme

WMO: Annual State of Climate

Climate risks, extreme events and related impacts 2017

WEATHER CLIMATE WATER

≈30% OF THE WORLD POPULATION FACE EXTREME HEATWAVES
World Health Organization

+41 MILLION AFFECTED BY FLOODS IN SOUTH ASIA
International Federation of Red Cross and Red Crescent Societies

2ND YEAR OF MAJOR BLEACHING IN THE GREAT BARRIER REEF

MAJOR DESTRUCTION IN THE CARIBBEAN ASSOCIATED WITH SUCCESSIVE HURRICANES

+80% OF FOOD INSECURE PEOPLE LIVE IN NATURAL HAZARD-PRONE AREAS
World Food Programme

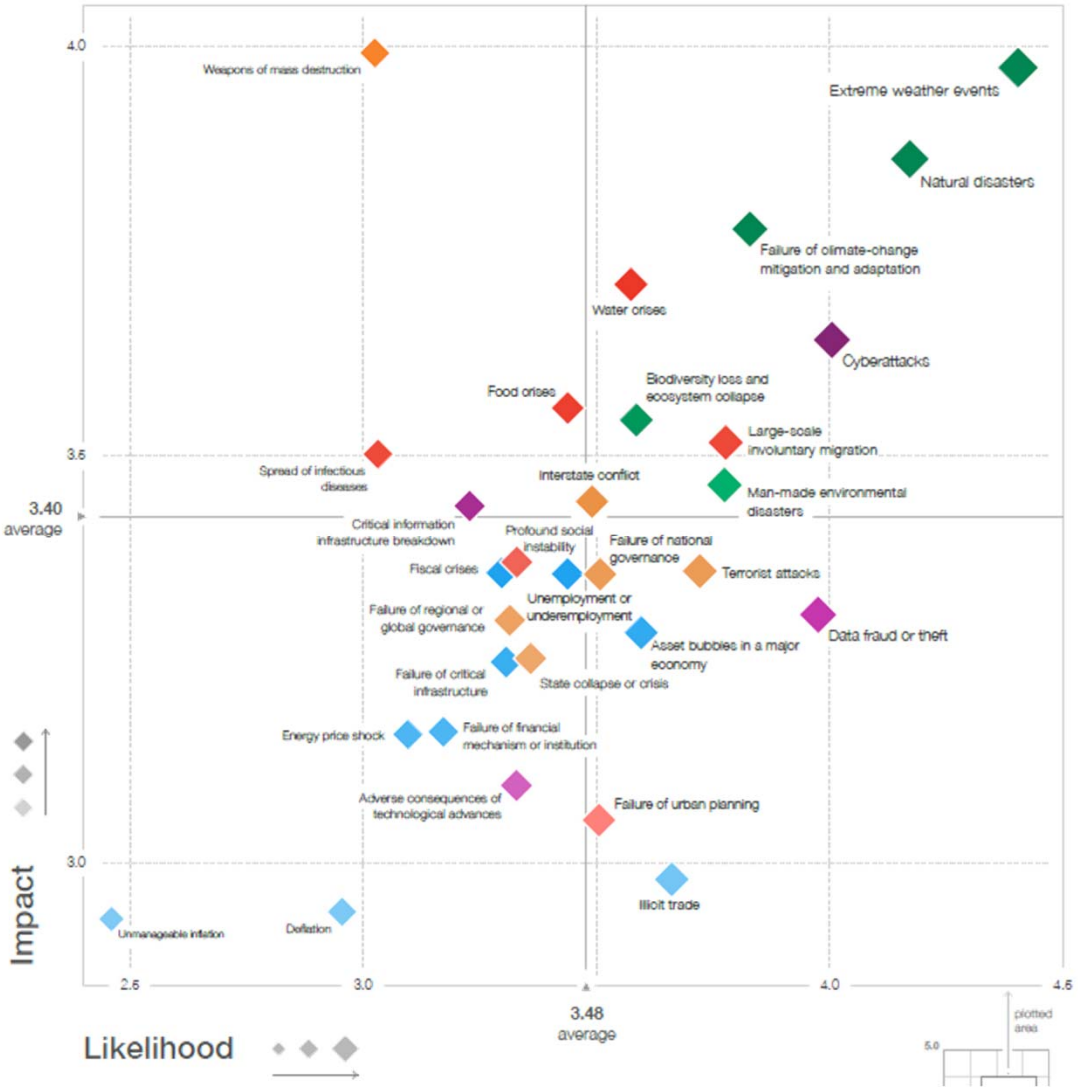
+760,000 DROUGHT & FOOD SECURITY RELATED INTERNAL DISPLACEMENTS IN SOMALIA
Internal Displacement Monitoring Network

EXCEPTIONALLY HEAVY RAINS CONTRIBUTED TO DEADLY LANDSLIDES IN SIERRA LEONE

DESTRUCTIVE WILDFIRES AROUND THE WORLD

WMO

Weather risks are the top economic risks…



- Extreme weather events
- Natural disasters
- Failure of climate-change mitigation and adaptation

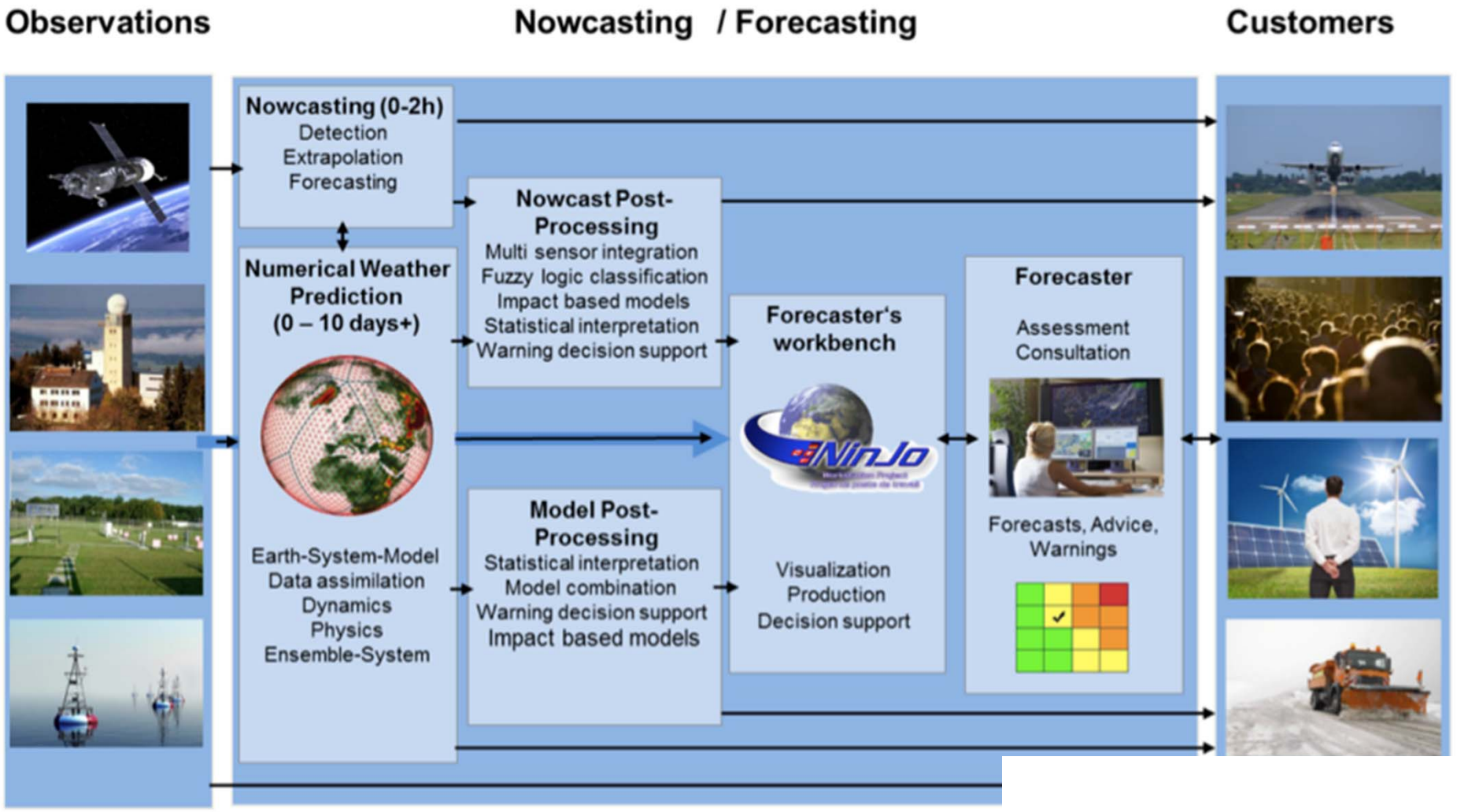
Economic
Societal
Environmental
Technological
Geopolitical

W

WMO OMM

WCRP
World Climate Research Programme

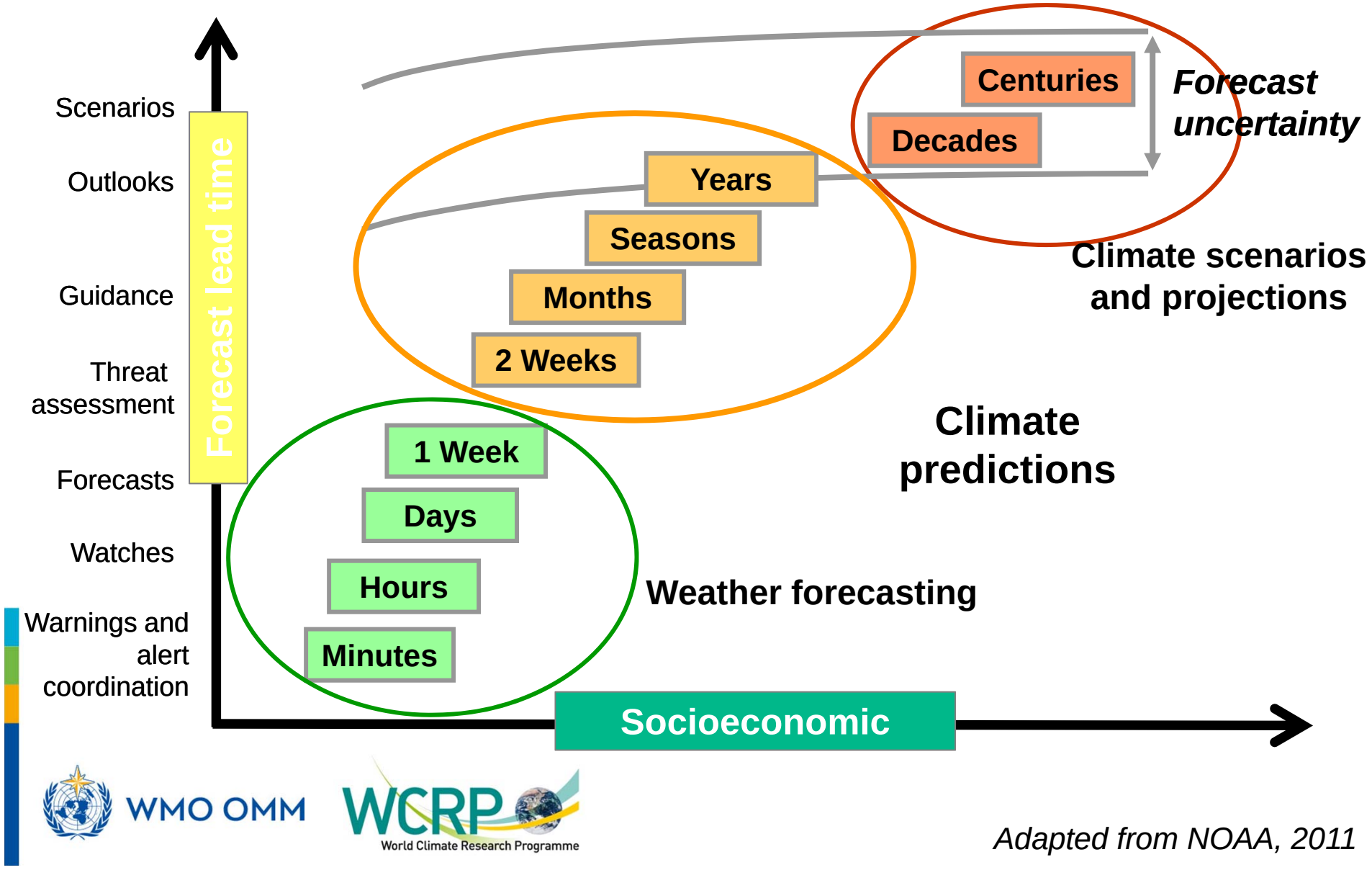
What the weather will be → What (damage) it will do



WMO OMM

WCRP
World Climate Research Programme

Weather to Climate: Seamless Framework



WMO OMM

WCRP World Climate Research Programme

Adapted from NOAA, 2011

Climate information on different spatial scales

1) Global assessments:
Global General Circulation Models,
e.g. ~300 km to ~100 km

2) National or continental scale assessments:
Global General Circulation Models
Regional Climate Models, on e.g. ~50 km

3) Regional (subcontinental) assessment:
Regional Climate Models, on ~50 km to ~10 km

4) Local assessment:
(Non-hydrostatic) Regional Climate Models,
on ~1 km to ~100 m
Statistical downscaling
Combined approaches of dynamic & statistical downscaling

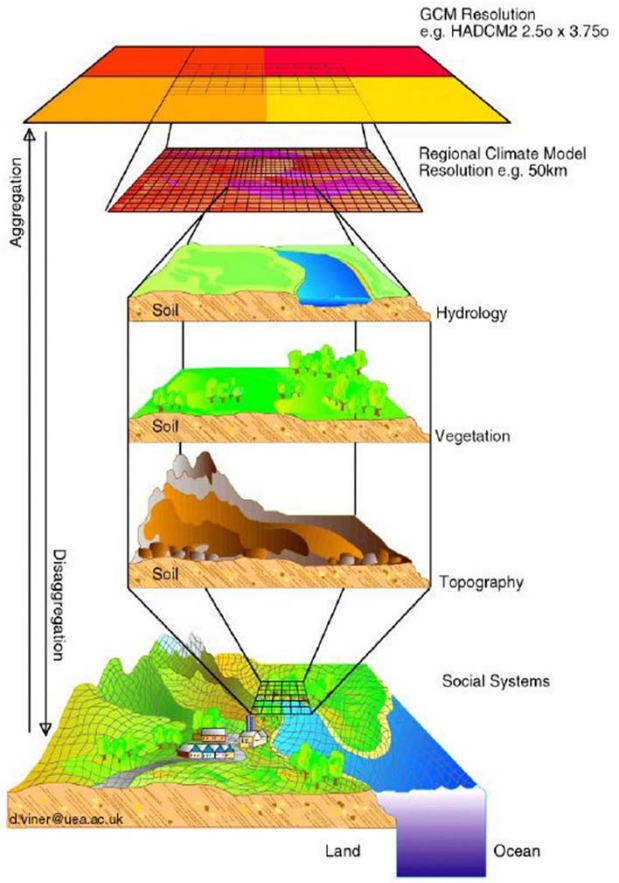


Figure source: David Viner, CRU, University of East Anglia, UK

WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

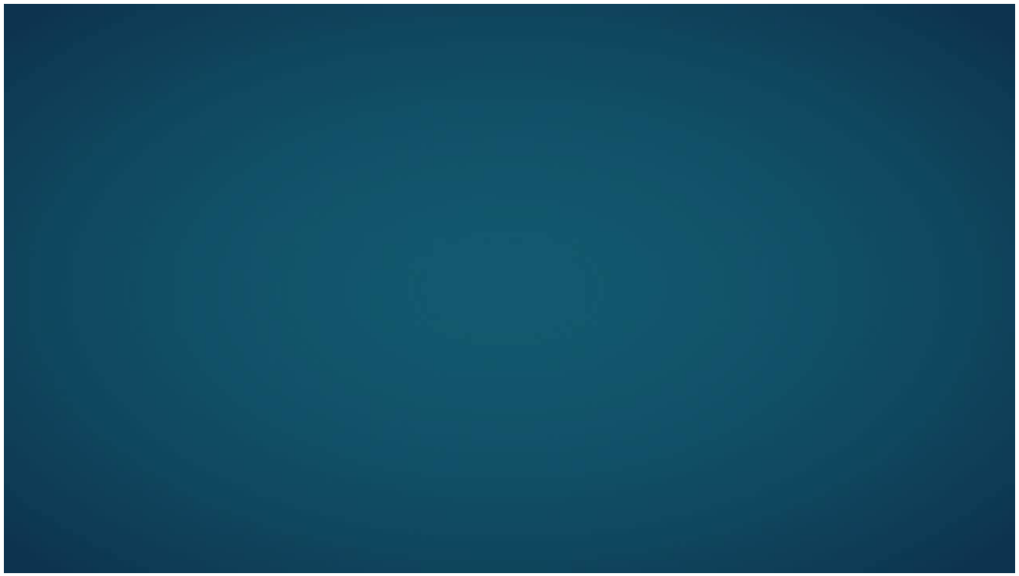
Climate information on different spatial scales

1) Global assessments:

Global General Circulation Models,
e.g. ~300 km to ~100 km

2) National or continental scale assessments:

Global General Circulation Models
Regional Climate Models, on e.g. ~50 km



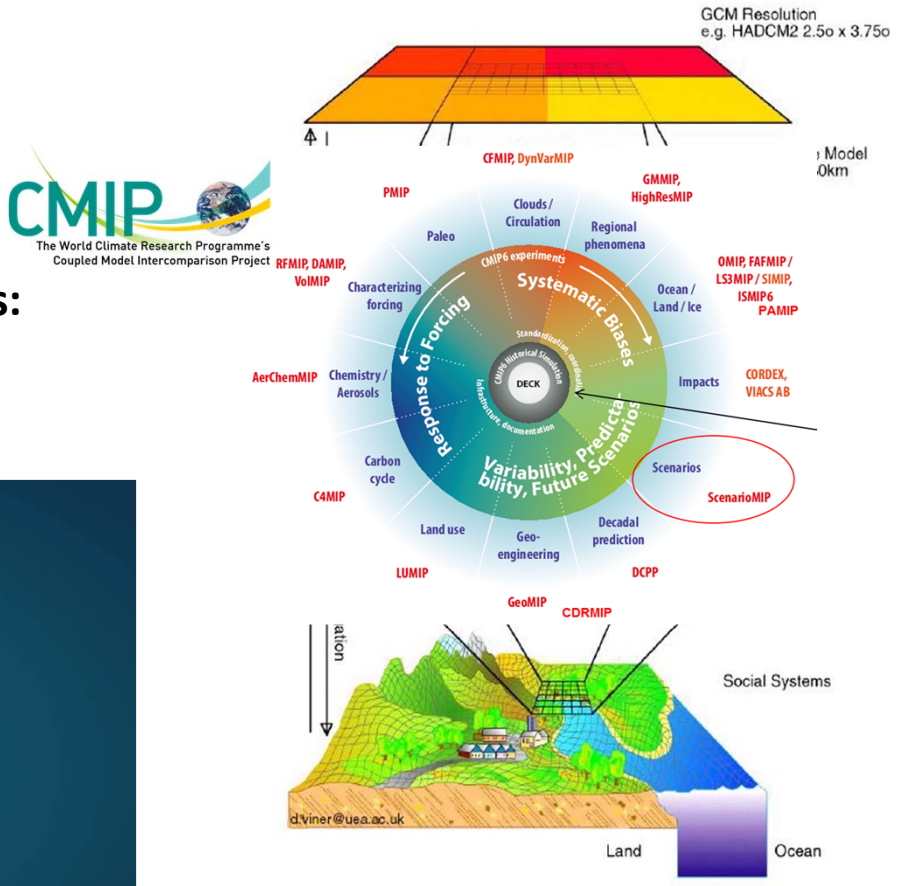


Figure source: David Viner,
CRU, University of East Anglia, UK

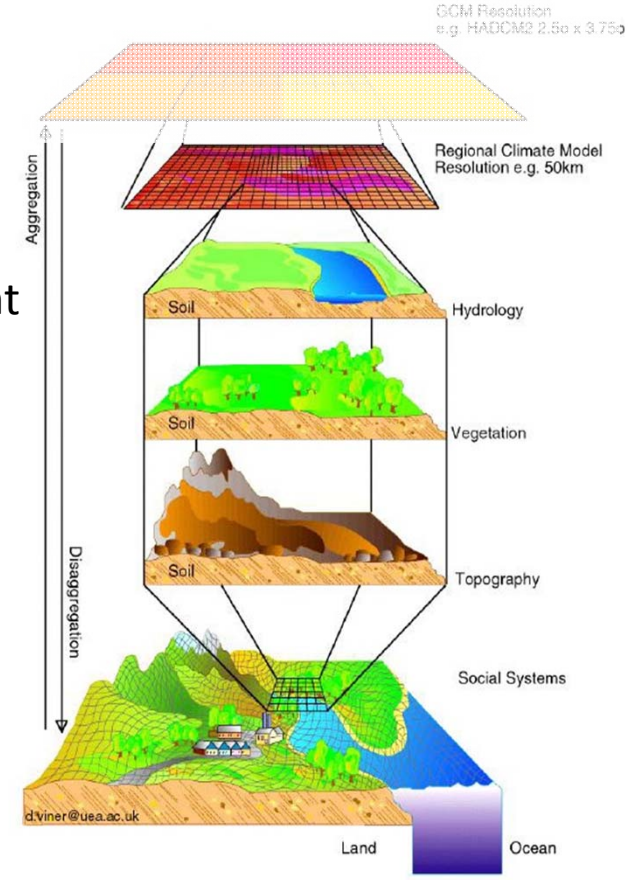
WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Climate information on different spatial scales

The Coordinated Regional Climate Downscaling Experiment



3) Regional (subcontinental) assessment:

Regional Climate Models, on ~50 km to ~10 km

4) Local assessment:

(Non-hydrostatic) Regional Climate Models,
on ~1 km to ~100 m
Statistical downscaling
Combined approaches of dynamic & statistical downscaling

Figure source: David Viner, CRU, University of East Anglia, UK

WMO OMM

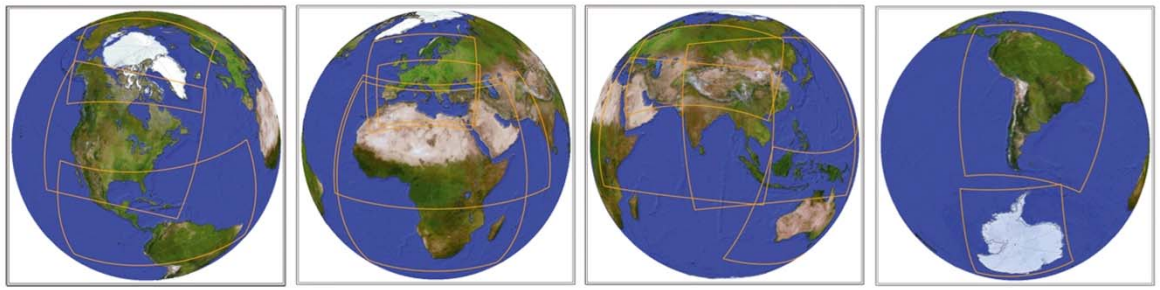
World Climate Research Programme

GERICS Climate Service Center Germany

Climate information on different spatial scales

The Coordinated Regional Climate Downscaling Experiment

- 14 domains or areas where simulations are available
- Number of simulations varies regionally, and by RCP
- Data are available



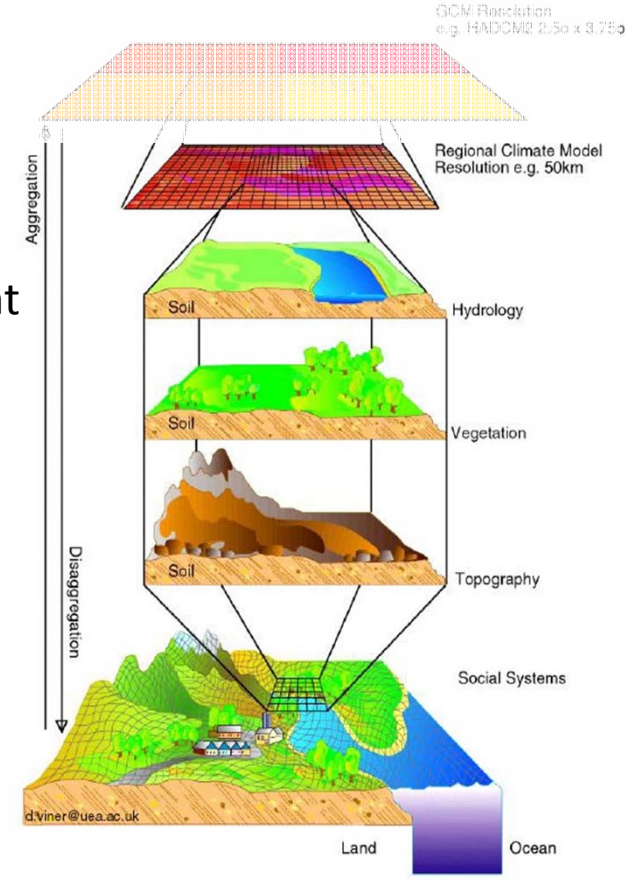


Figure source: David Viner, CRU, University of East Anglia, UK

WMO OMM

World Climate Research Programme

GERICS Climate Service Center Germany

Climate information on different spatial scales

CORDEX Coordinated Output for Regional Evaluations (CORE)

- Standardized set of simulations for most CORDEX domains to serve as a basis for further downscaling
- CMIP5 downscaled for RCPs 2.6 and 8.5, CMIP5 1970-2100
- Minimum 3 GCMs; high-, low– and midrange
- Some institutions/RCMs run globally, others regionally, ESD contribution
- CORE Atlas based on 25 km resolution

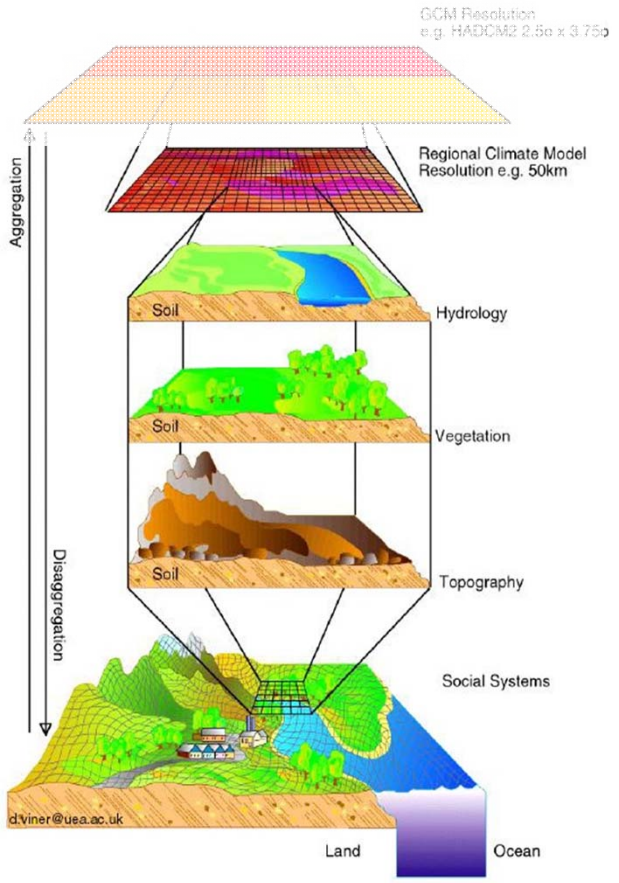


Figure source: David Viner, CRU, University of East Anglia, UK

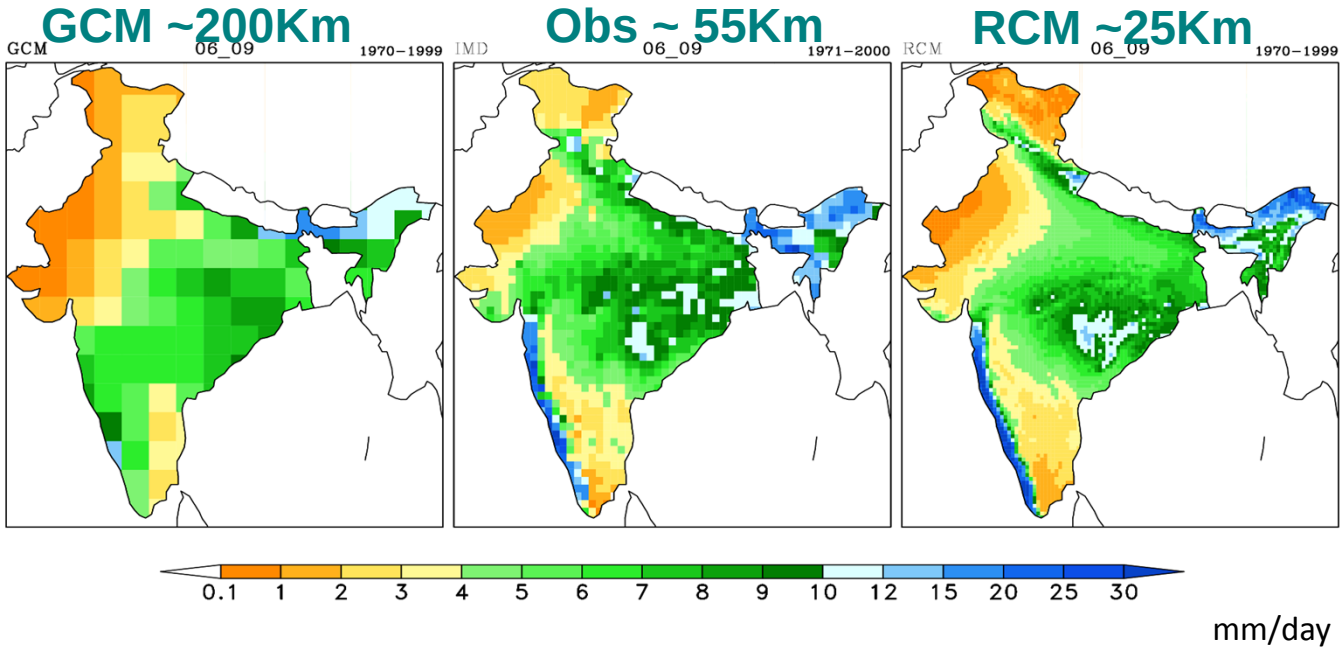
WMO OMM

World Climate Research Programme

GERICS Climate Service Center Germany

GCM, RCM, observation differences

Monsoon precipitation JJAS



More realistic monsoon precipitation in RCM simulations
(mean of 3 RCMs driven by 2 GCMs, 1970-1999)
Source: *Pankaj Kumar, High Noon Project, MPI-M*

WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Provided Climate Data

As the first-step demonstration to cover the whole UNECE region:

Global Climate Model (GCM, ~200km resolution) data relating to 9 relevant climate variables and indices for transport structure

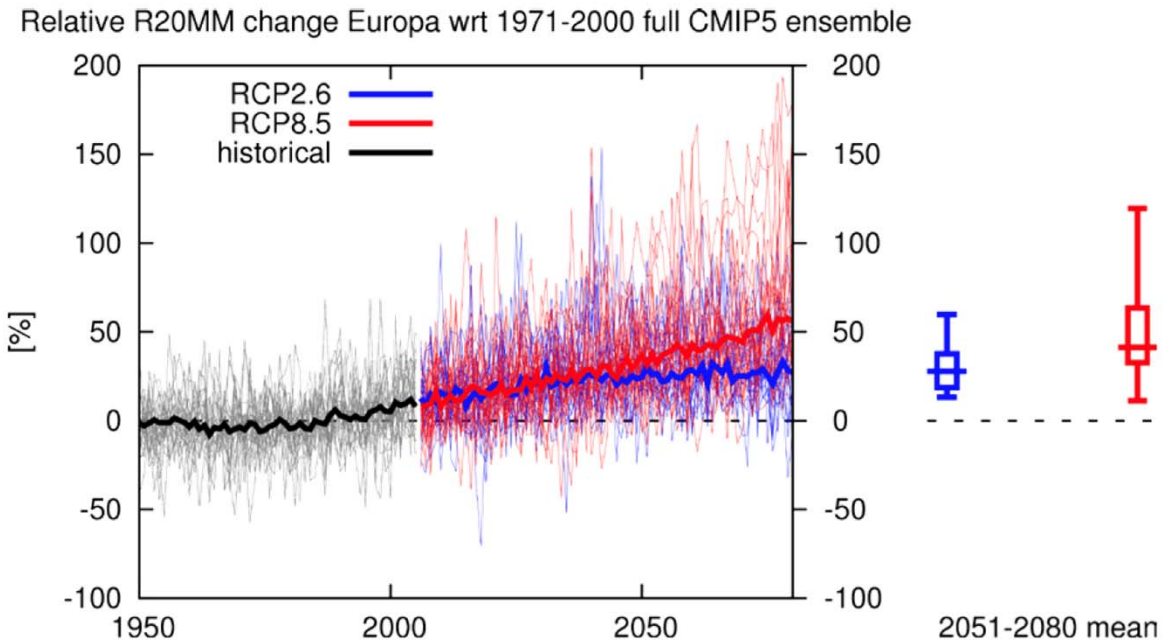
- Annual precipitation (pr)
- Annual maximum temperature (Tasmax)
- Annual maximum consecutive 5 day precipitation (rx5day)
- Annual count of days when precipitation is greater than 10 mm (r10mm)
- Annual count of days when precipitation is greater than 20mm (r20mm)
- % of days when daily maximum temperature is greater than the 90th percentile in the baseline reference period (1971-2000) (tx90p)
- % of days when daily maximum temperature is less than the 10th percentile in the baseline (tx10p)
- % of days when daily minimum temperature is greater than the 90th percentile in the baseline (tn90p). Calculated on an annual basis.
- % of days when daily minimum temperature is less than the 10th percentile in the baseline (tn10p). Calculated on an annual basis.

Provided Climate Data

For a period of 2051-2080, from a reference time period of 1971-2000

From 2 emissions scenarios within the CMIP5 ensemble

- RCP 2.6 (major reduction in greenhouse gas emissions), and
- RCP 8.5 ('business as usual')



WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Thank you

blee@wmo.int
paul.bowyer@hzg.de

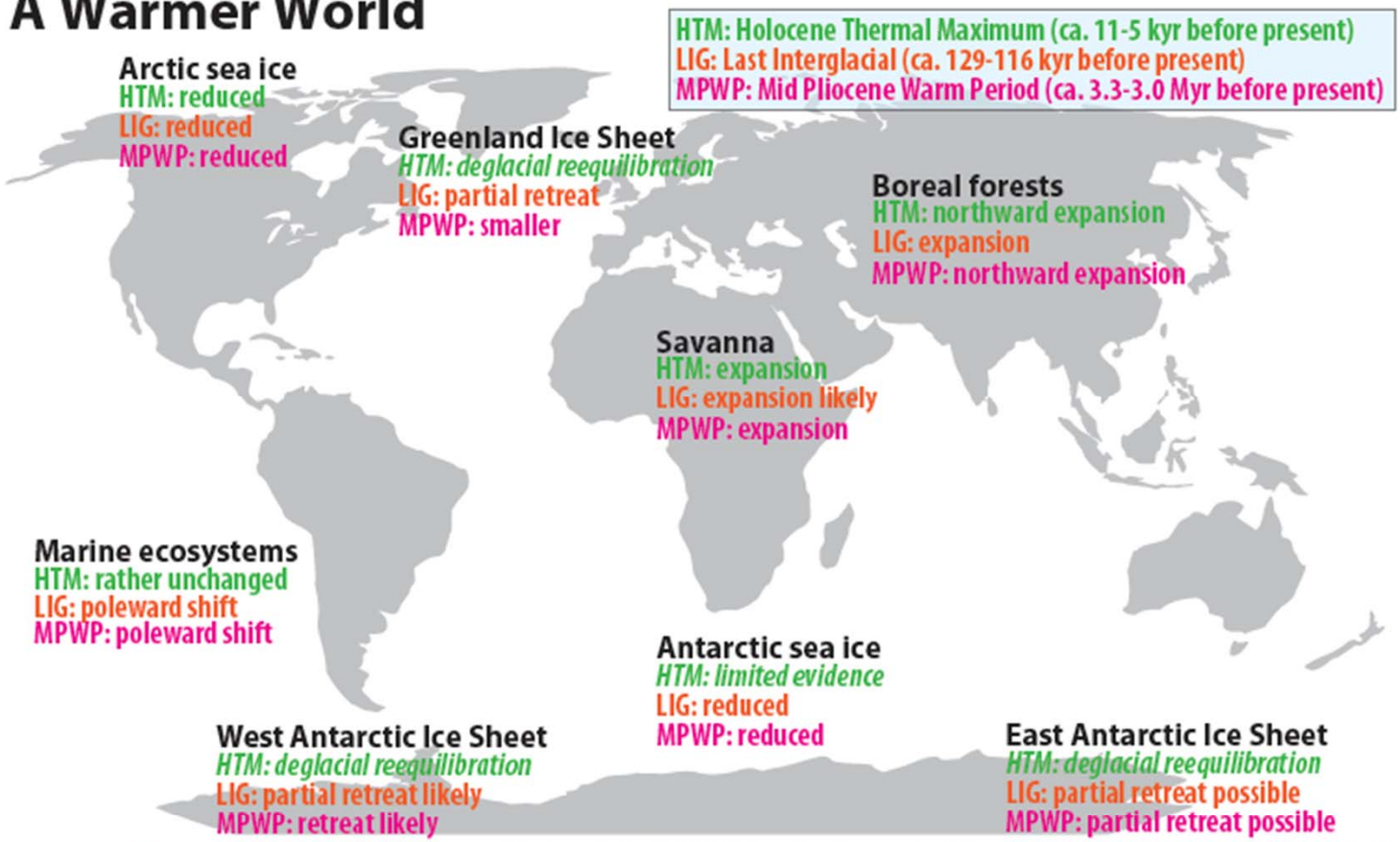
WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Spare slides

A Warmer World



Reference: Fischer et al., (2018). Paleoclimate constraints on a future warmer world (submitted).

PAGES
PAST GLOBAL CHANGES

The PAGES (Past Global Changes) project is an international effort to coordinate and promote past global change research. It is a Global Research Project of Future Earth and a scientific partner of WCRP.

WMO OMM

WCRP
World Climate Research Programme

GERICS
Climate Service Center
Germany

The World Climate Research Programme

The Next Decade

WCRP Coordinates international climate research to develop, share and apply the climate knowledge that contributes to societal well-being.

Science for Understanding

Science for Impact

WMO OMM

WCRP World Climate Research Programme

The New World Climate Research Programme

Fundamental science is needed improve understanding. Understanding prepares society for the challenges we cannot foresee.

Imbalances in the fluxes of energy, water, carbon and other climate-relevant compounds

Understanding and pushing limi to predictability of the clima system

Understanding and predicting sensitivities of climate stress

…

WMO OMM

WCRP World Climate Research Programme

The New World Climate Research Programme

Scientific partnerships across science communities are critical:

Capacity and infrastructure development

Consistent support for critical work e.g. CMIP

Wider partnerships – social sciences, governments, industry, civil society – are critical for climate science to service society.

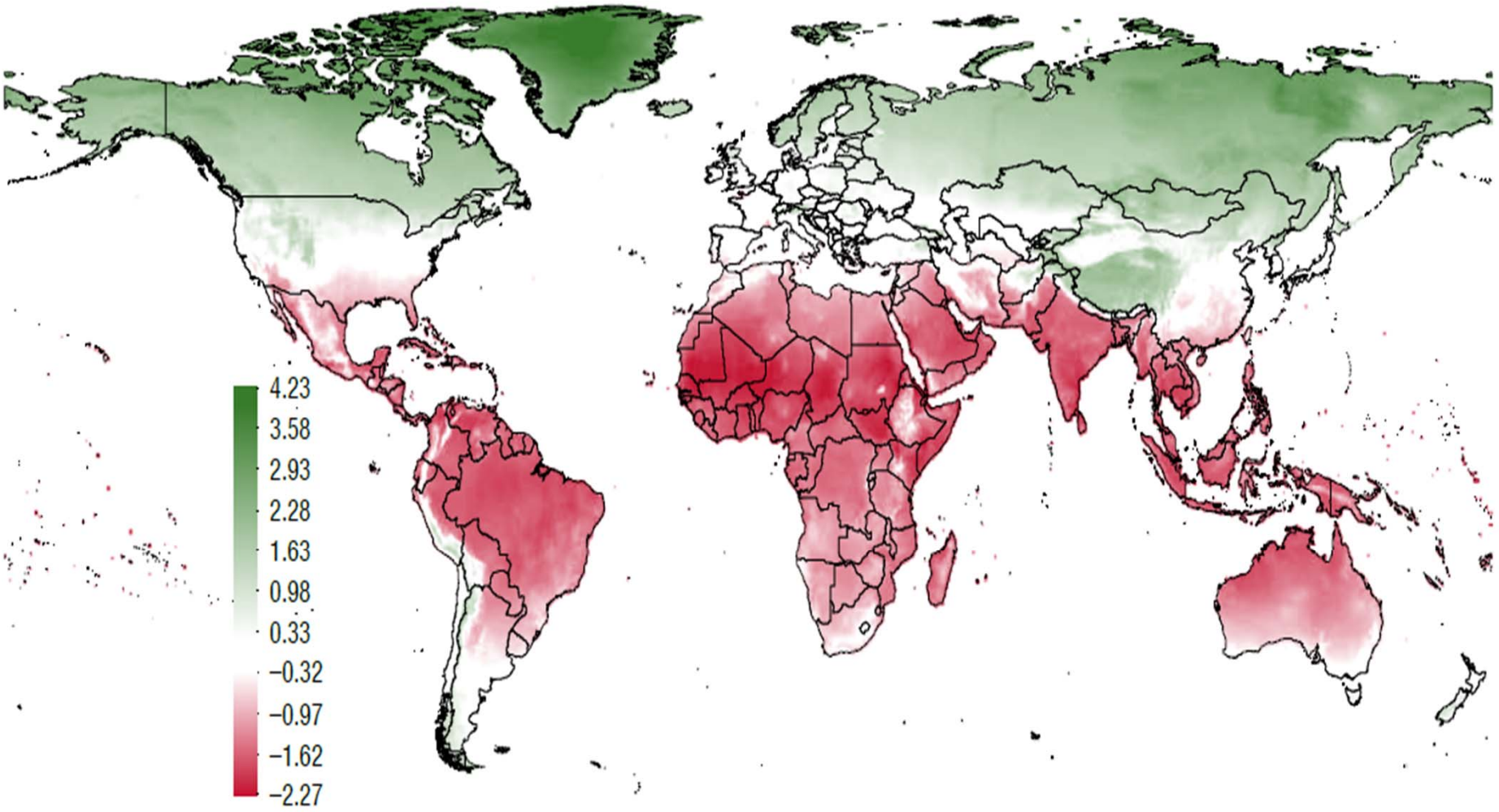
Co-production of knowledge, co-design of solutions

Connecting global to local scales for adaptation

WMO OMM

WCRP World Climate Research Programme

Effect of 1° C temperature increase on per capita output



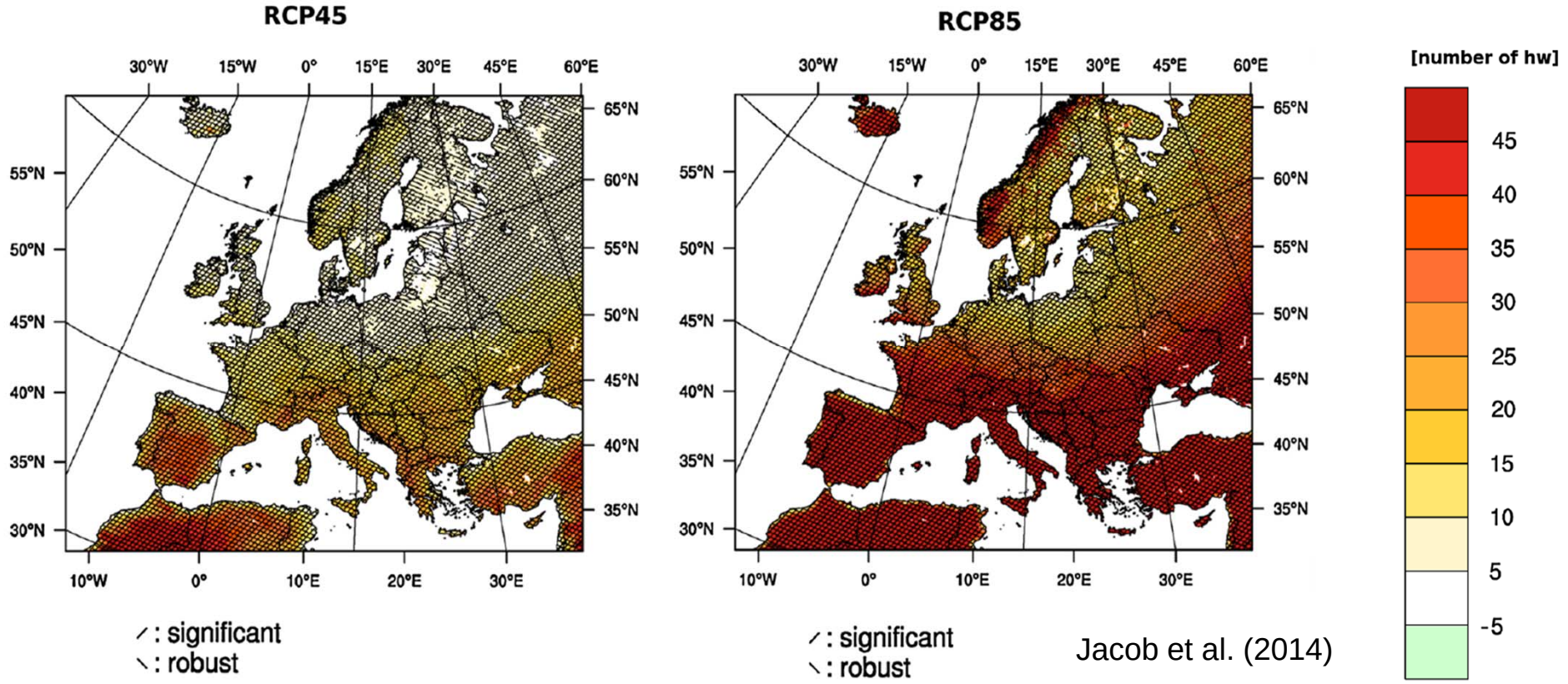
WMO OMM

WCRP
World Climate Research Programme

GERICS
Climate Service Center
Germany

Projected change in heat waves

Projected changes of heat waves 2071–2100 vs. 1971–2000



Jacob et al. (2014)

- Increase in number of heat waves in southern Europe in both RCPs

Heat waves:
Periods of more than 3 consecutive days exceeding the 99th percentile of the daily maximum temperature of the May to September season for the control period (1971–2000).

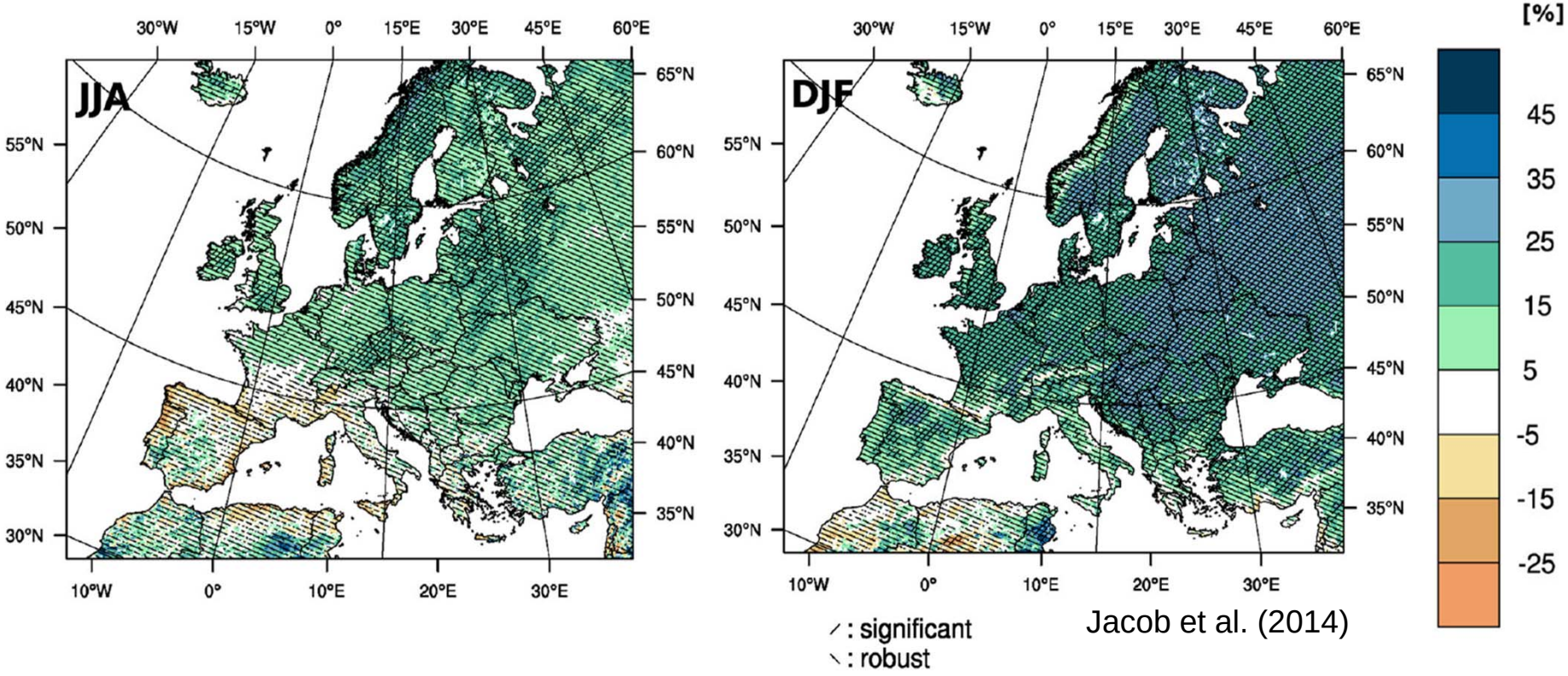
WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Projected change in heavy precipitation

RCP8.5: Projected changes of heavy precipitation 2071–2100 vs. 1971–2000



Jacob et al. (2014)

- Up to 45 % increase in large areas in winter in Northern and Eastern Europe
- No decrease besides isolated regions in Southern Europe (mostly along coastlines)

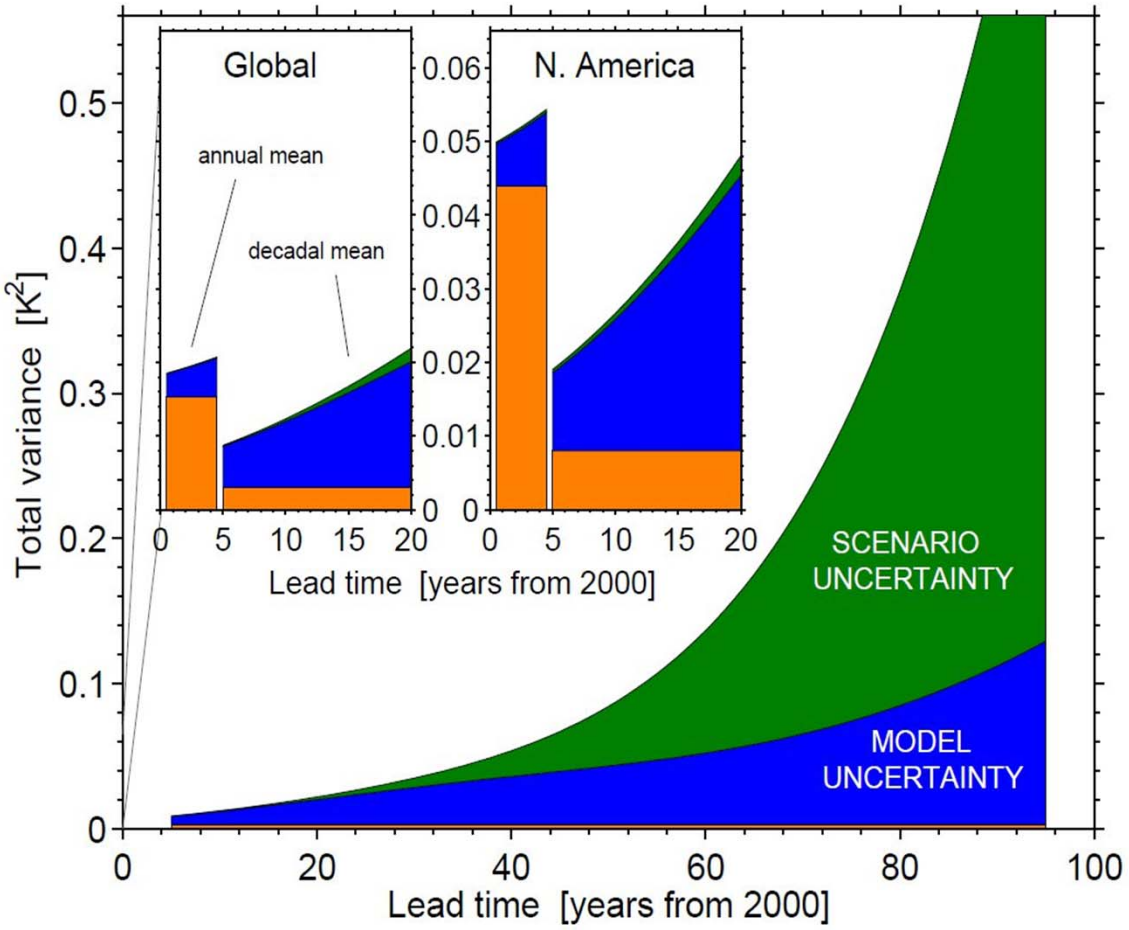
Heavy precipitation: 95th percentile of daily precipitation (only days with precipitation 1 mm/day are considered)

WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Sources of uncertainty in climate model projections



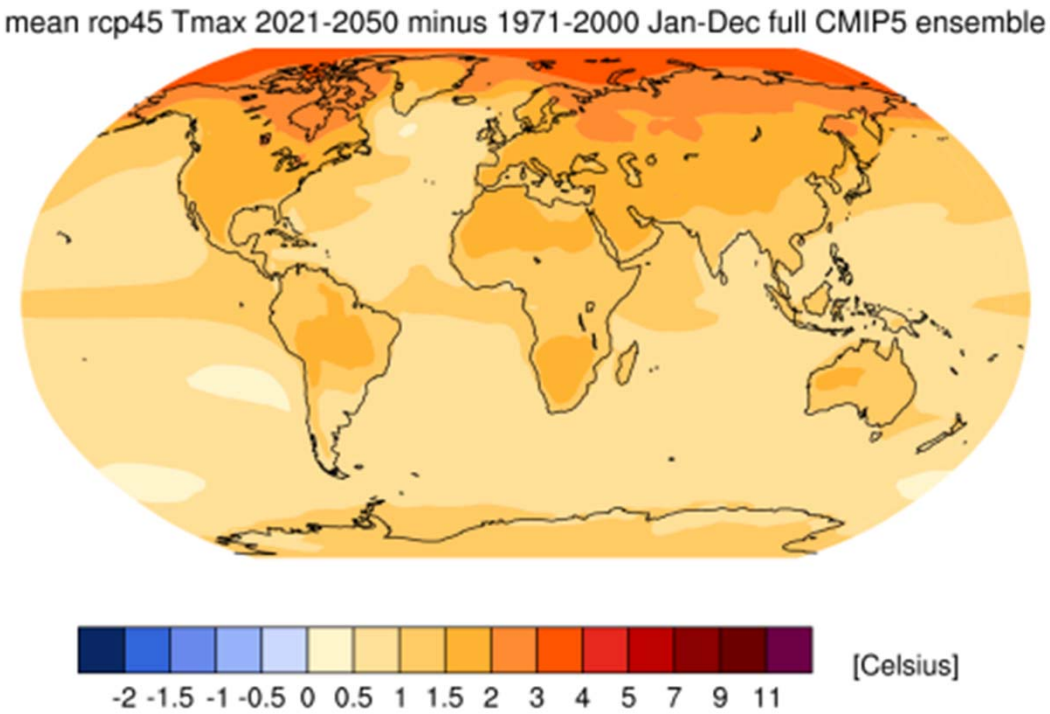
Source: Hawkins & Sutton 2009

WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in annual maximum temperature

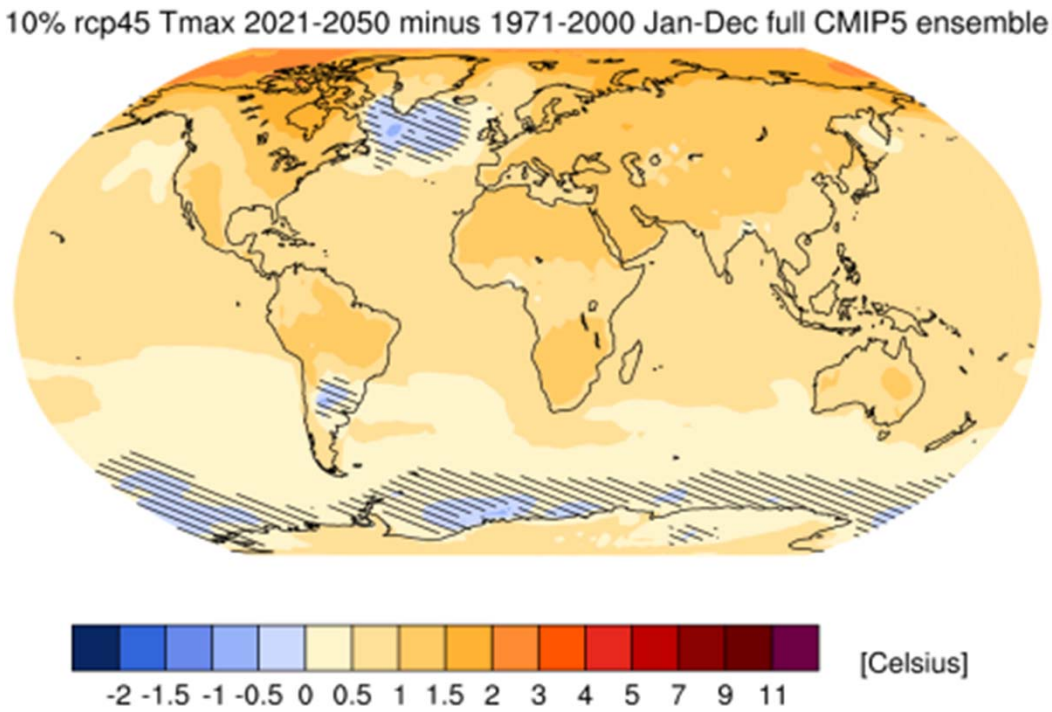


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in annual maximum temperature

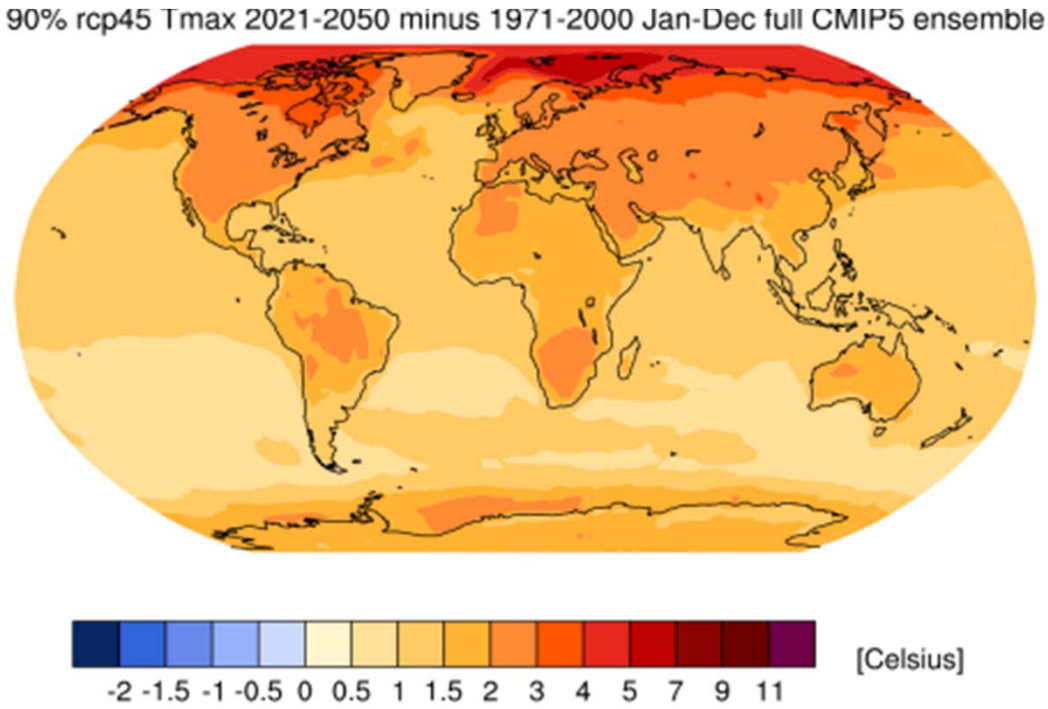


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in annual maximum temperature

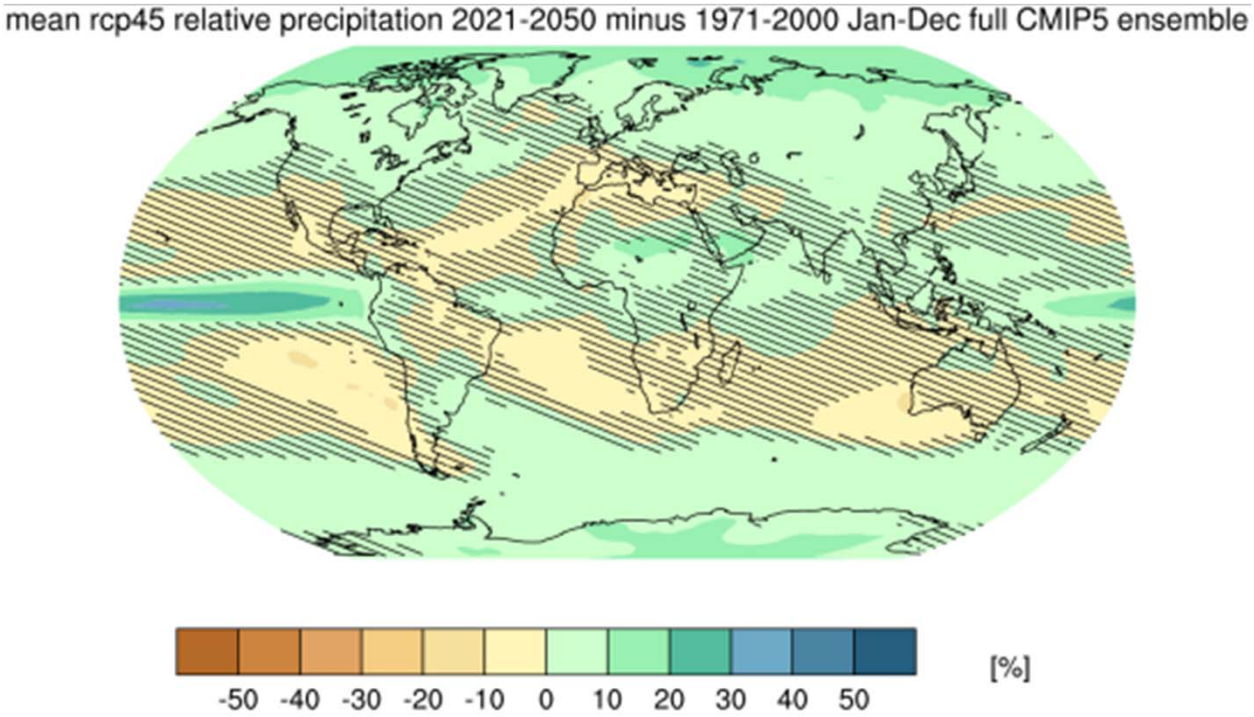


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in annual precipitation

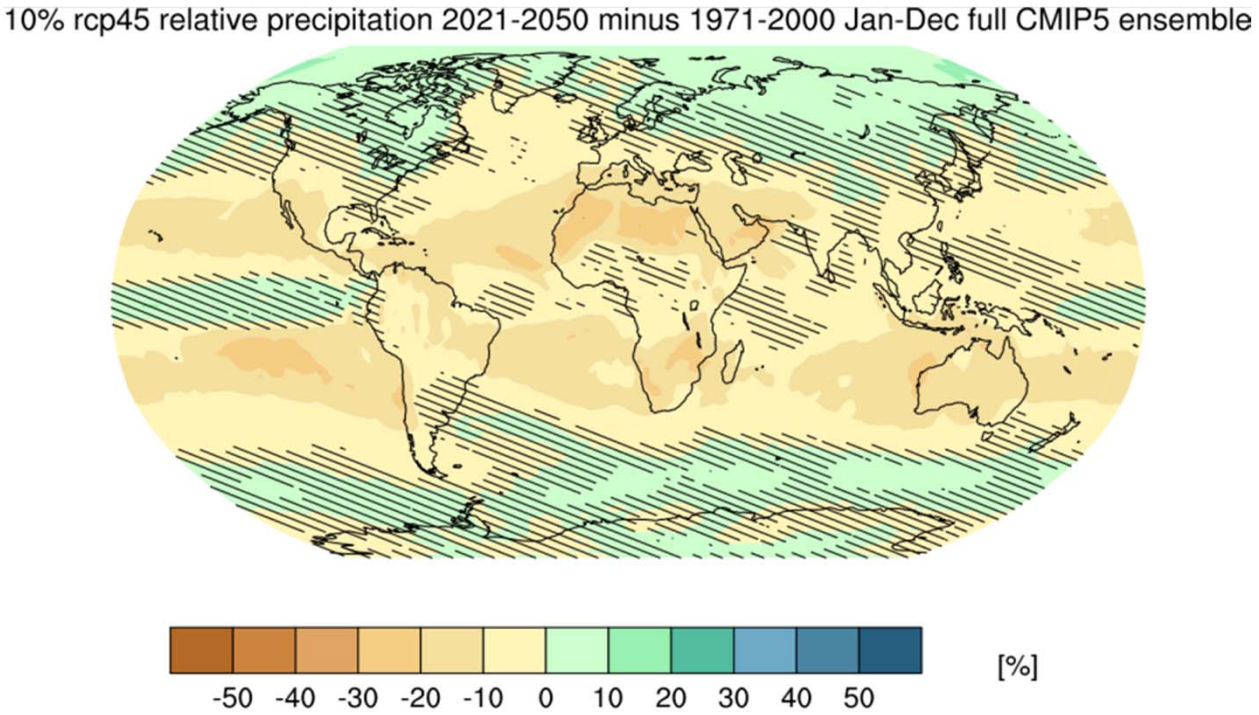


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in annual precipitation

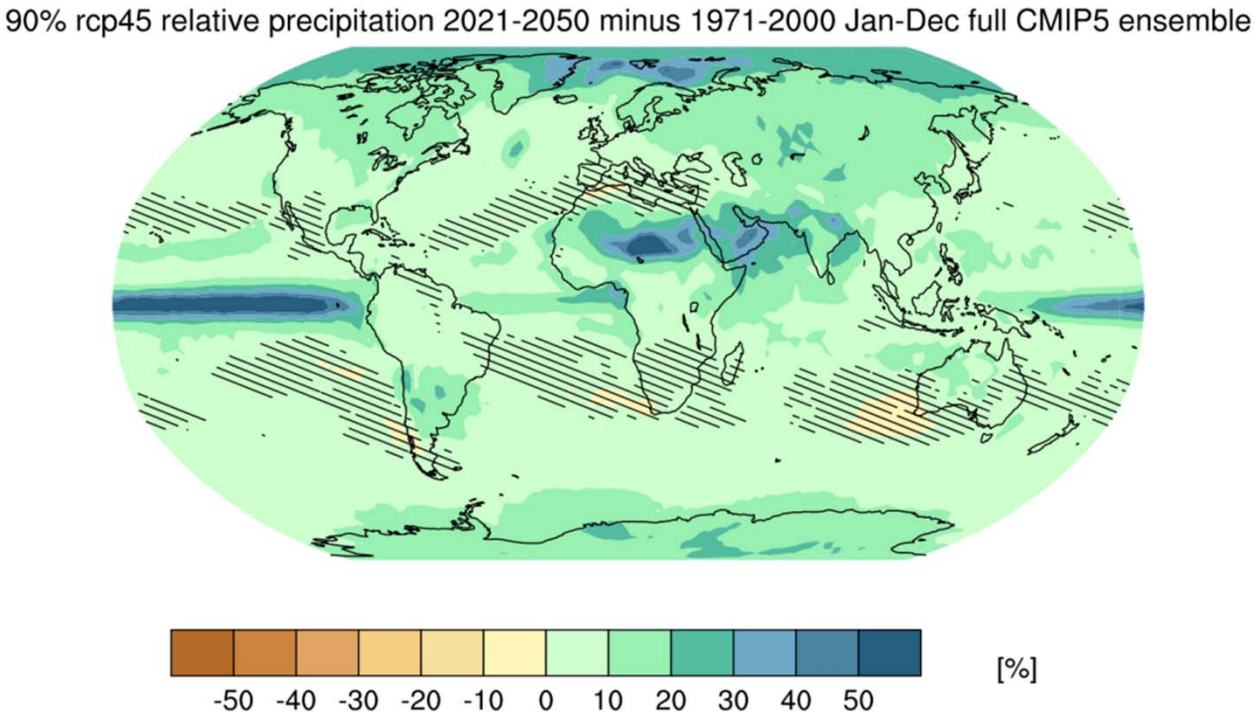


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in annual precipitation

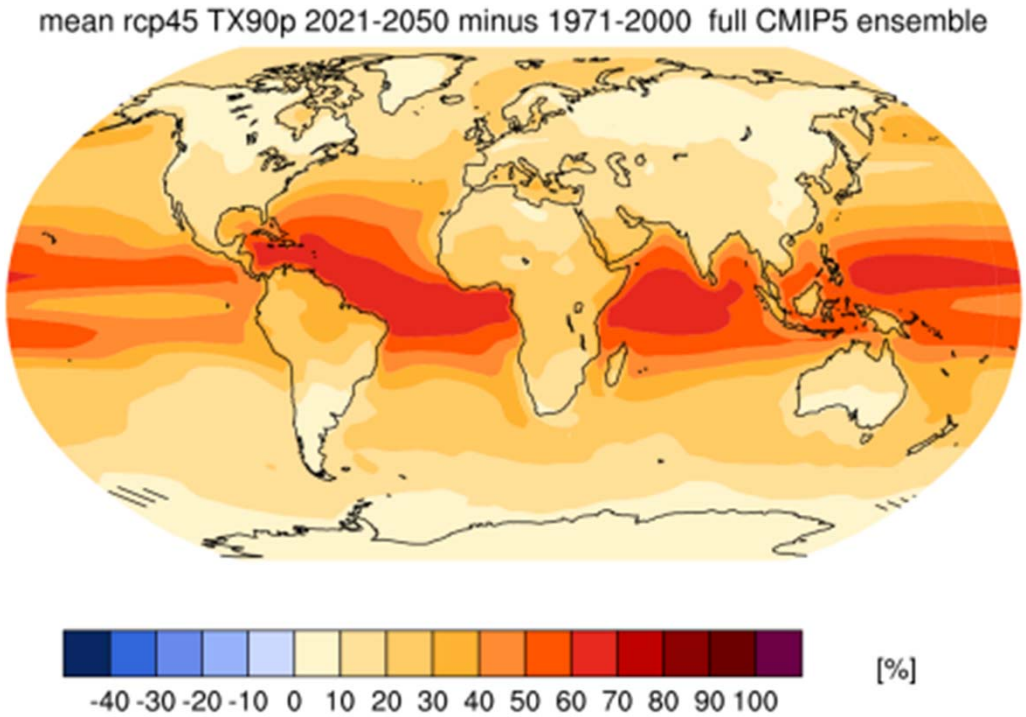


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in % of days when maximum temperature is greater than the 90th percentile

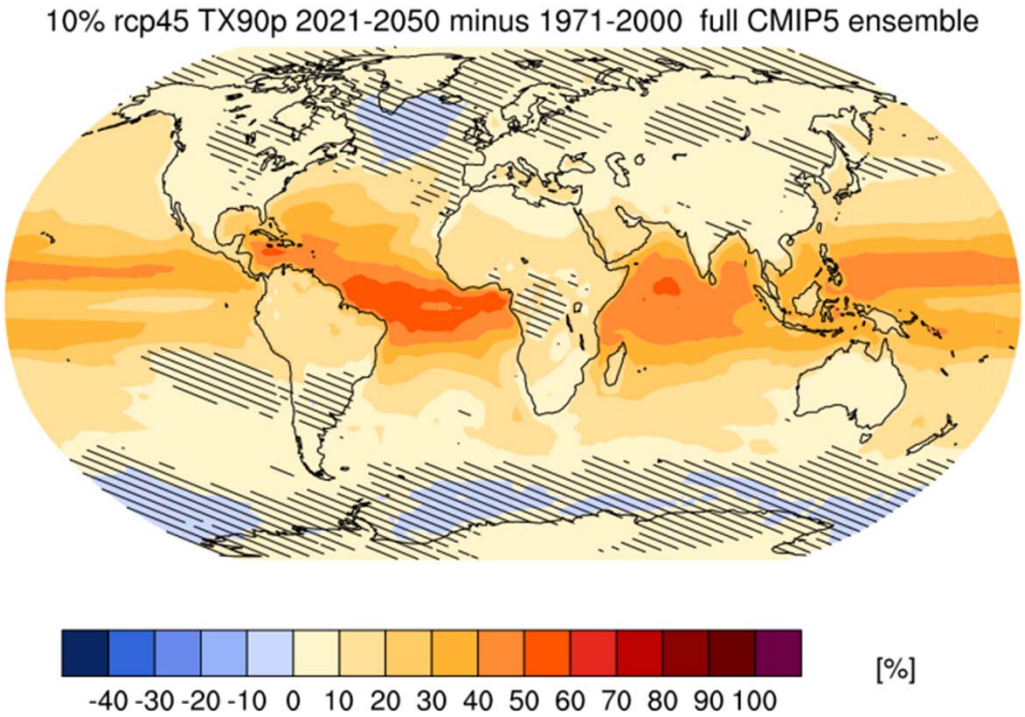


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in % of days when maximum temperature is greater than the 90th percentile

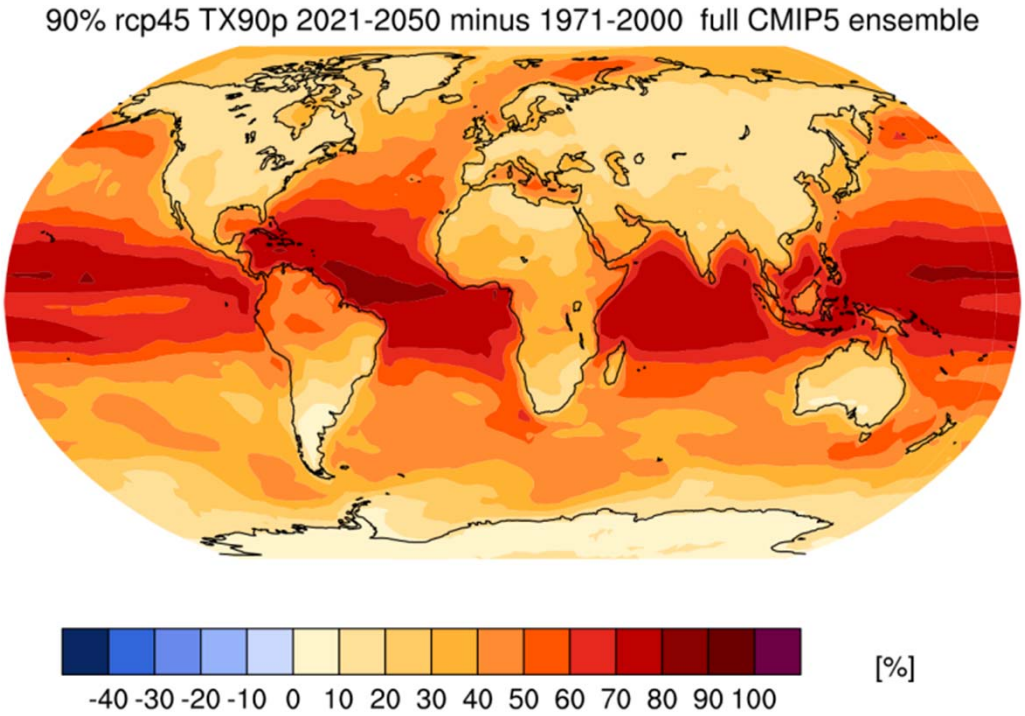


WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

GCM analysis: change in % of days when maximum temperature is greater than the 90th percentile



WMO OMM

WCRP World Climate Research Programme

GERICS Climate Service Center Germany

Acknowledgement

The GCM maps were produced using the KNMI Climate Change Atlas

https://climexp.knmi.nl/plot_atlas_form.py

Thanks to Geert Jan van Oldenborgh, KNMI.