WORLD CLIMATE RESEARCH PROGRAMME

"Our Climate Future: Impacts and risks"

WCRP
World Climate Research Programme

Dr Mike Sparrow, Head World Climate Research Division, WMO

(thanks to many including Detlef Stammer, Helen Cleugh, Tianjun Zhou, Tim Naish, Ted Shepherd, Michel Rixen, Irene Lake, Roberta Boscolo, Christoph Heinze, Heiko Gölzer, Beatriz Balino, Mareike Heckl …)

WORLD METEOROLOGICAL ORGANIZATION

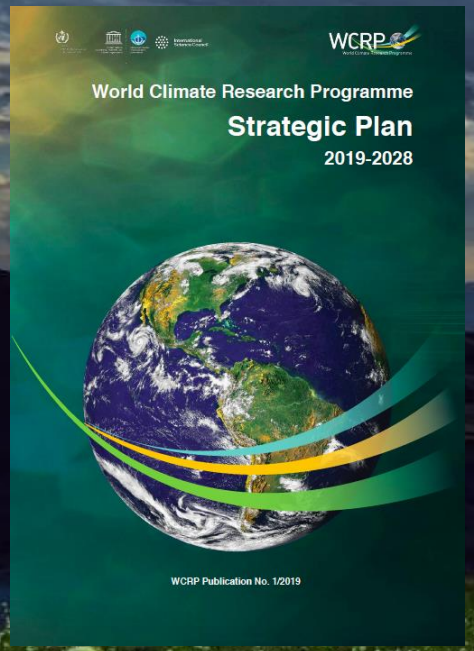
United Nations Educational, Scientific and Cultural Organization

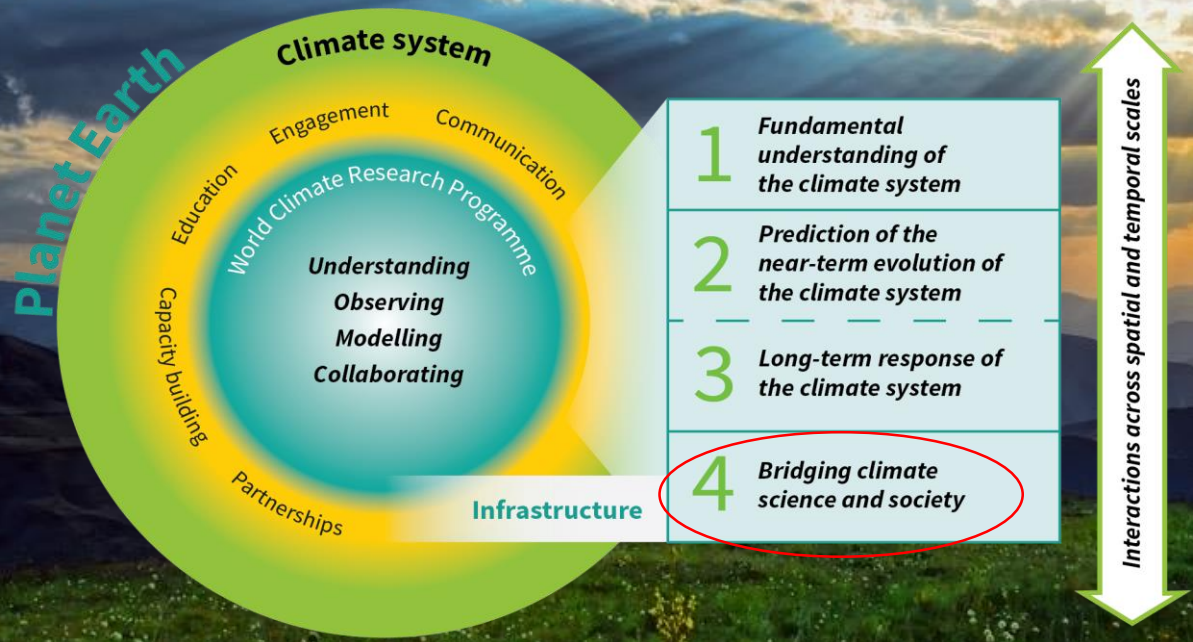
Intergovernmental Oceanographic Commission

International Science Council

Introduction

The **World Climate Research Programme (WCRP)** leads the way in addressing frontier scientific questions related to the coupled climate system — questions that are too large and too complex to be tackled by a single nation, agency or scientific discipline.



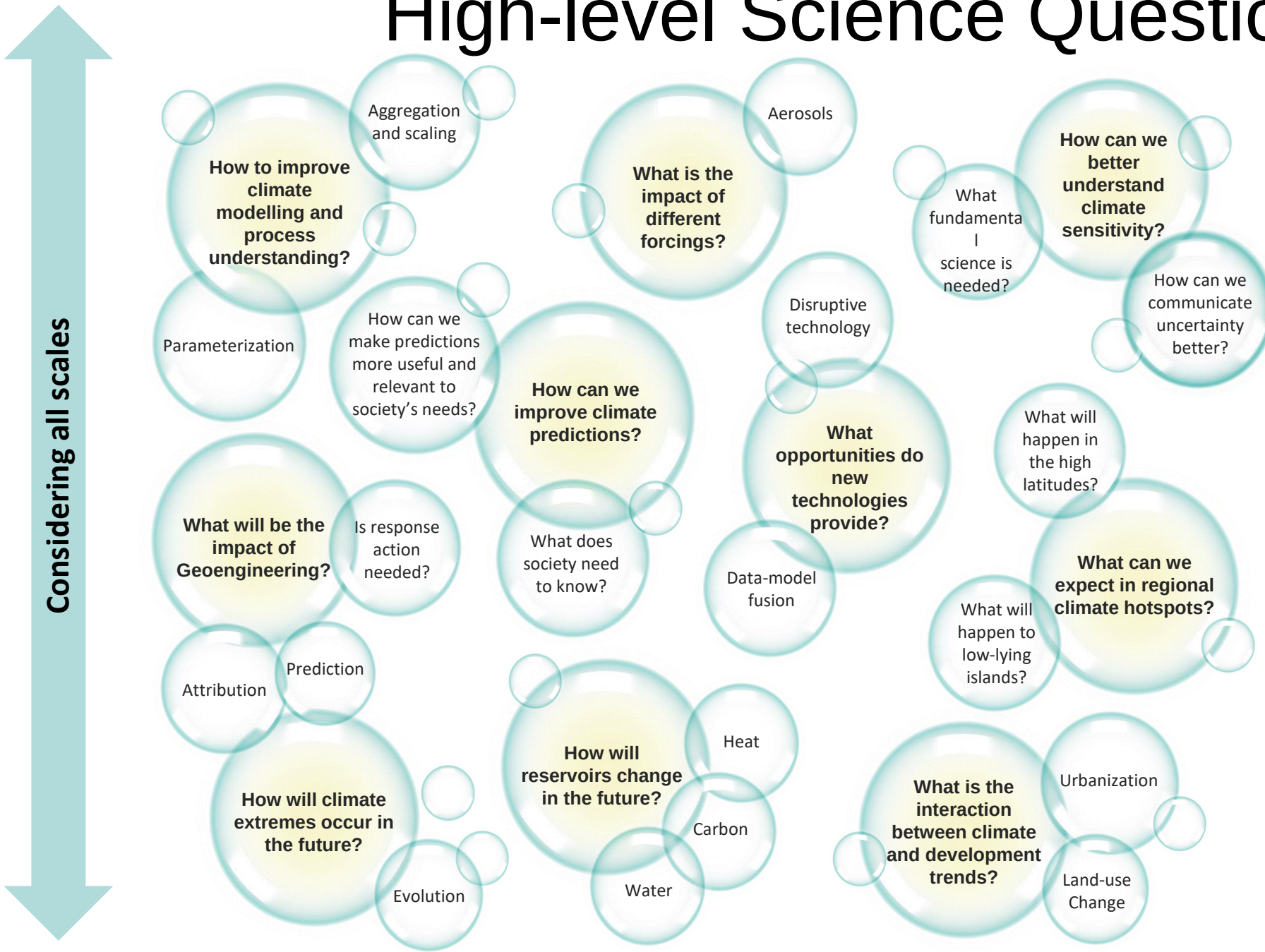


United Nations
Climate Change

SUSTAINABLE DEVELOPMENT GOALS

Sendai Framework
for Disaster Risk Reduction
2015 - 2030

High-level Science Questions



WCRP World Climate Research Programme

WORLD METEOROLOGICAL ORGANIZATION · United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission · International Science Council

futureearth research for global sustainability

WWRP WORLD WEATHER RESEARCH PROGRAMME

WMO · GAW

GCOS

WMO · IOC · International Science Council · UN environment

International Science Council SCOR Scientific Committee on Oceanic Research

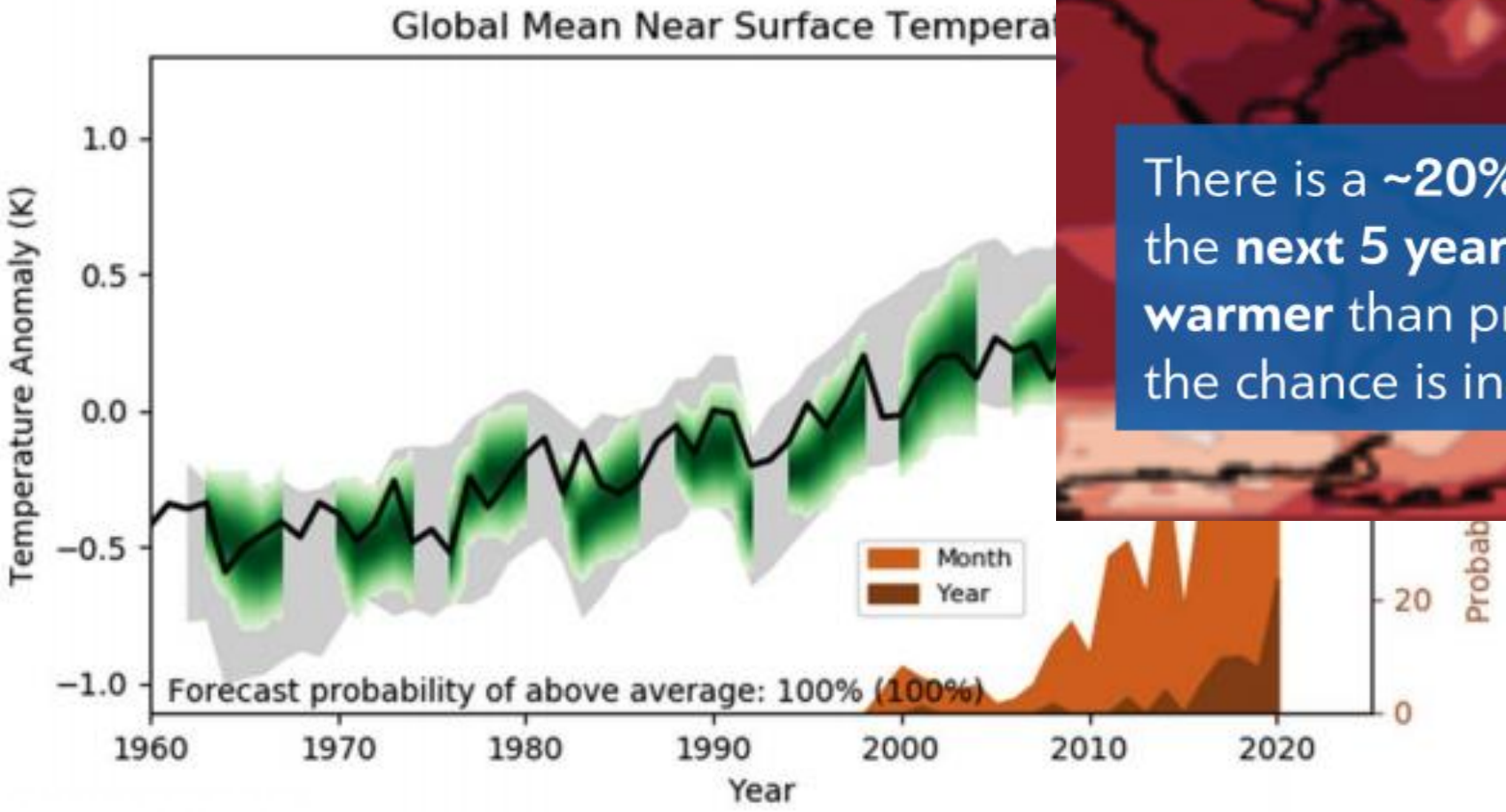
START

SCAR The International Council for Science Scientific Committee on Antarctic Research

YOUNG EARTH SYSTEM SCIENTISTS community

BELMONT FORUM

Science for Society e.g. Annual to Decadal Outlook



WORLD METEOROLOGICAL ORGANIZATION

WMO Lead Center for Annual to Decadal Climate Update, 2020
Hosted at the UK Met Office

WCRP
World Climate Research Programme

Science for Society e.g. FOCUS-Africa

Full-value chain Optimized Climate User-centric Services for southern Africa

The main objective of ***FOCUS-Africa*** is to demonstrate the full value chain of climate services in the SADC region

HydroMet data → Climate science knowledge → Decision support tools → Science-based Innovation

Sectors:

- Food Security
- Water
- Energy
- Infrastructure

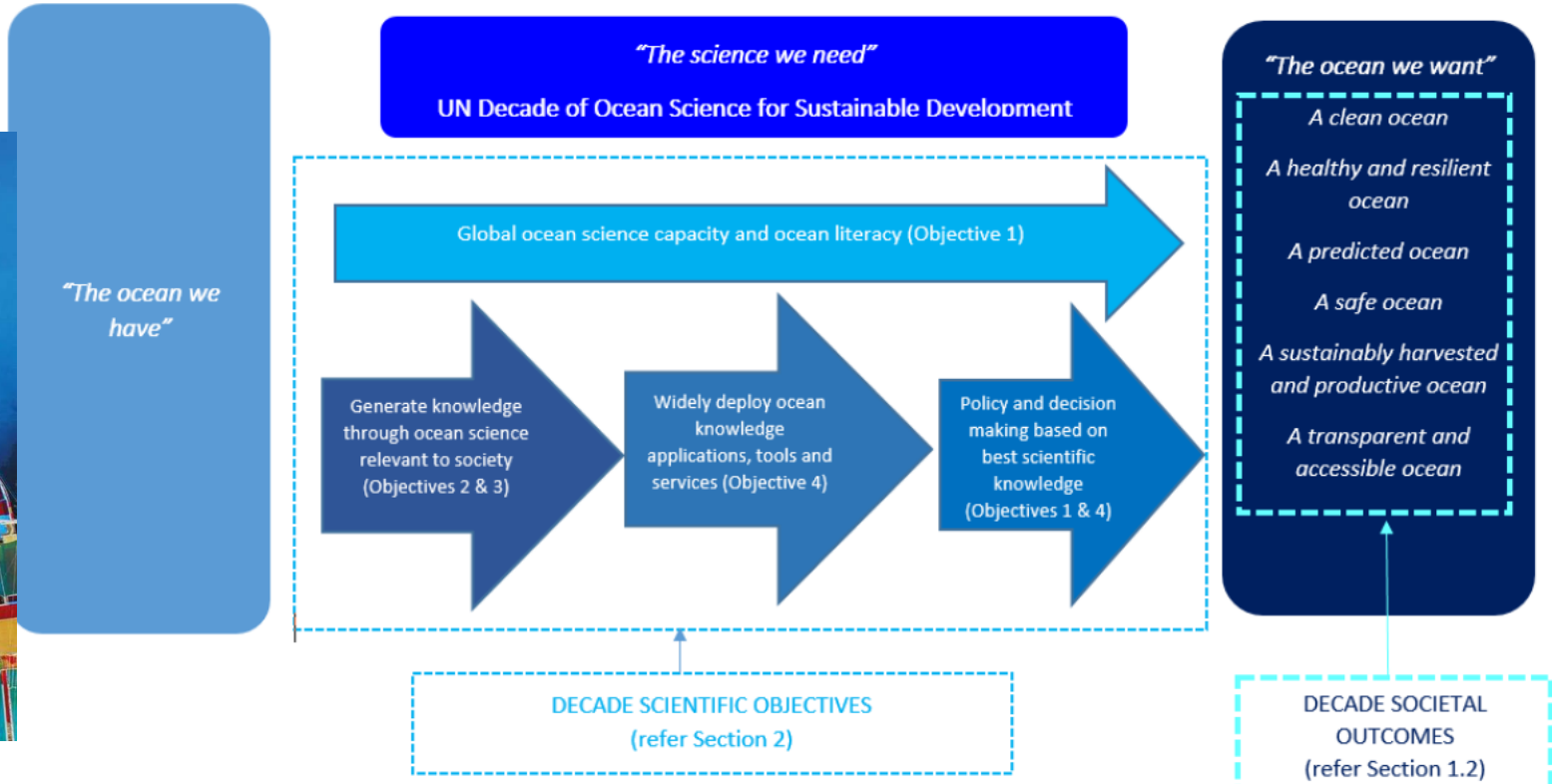
Start Date : 1st September 2020

Duration: 4 years

Contact: rboscolo@wmo.int

http://focus-africaproject.eu/

Science for Society e.g. UN Ocean Decade



United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

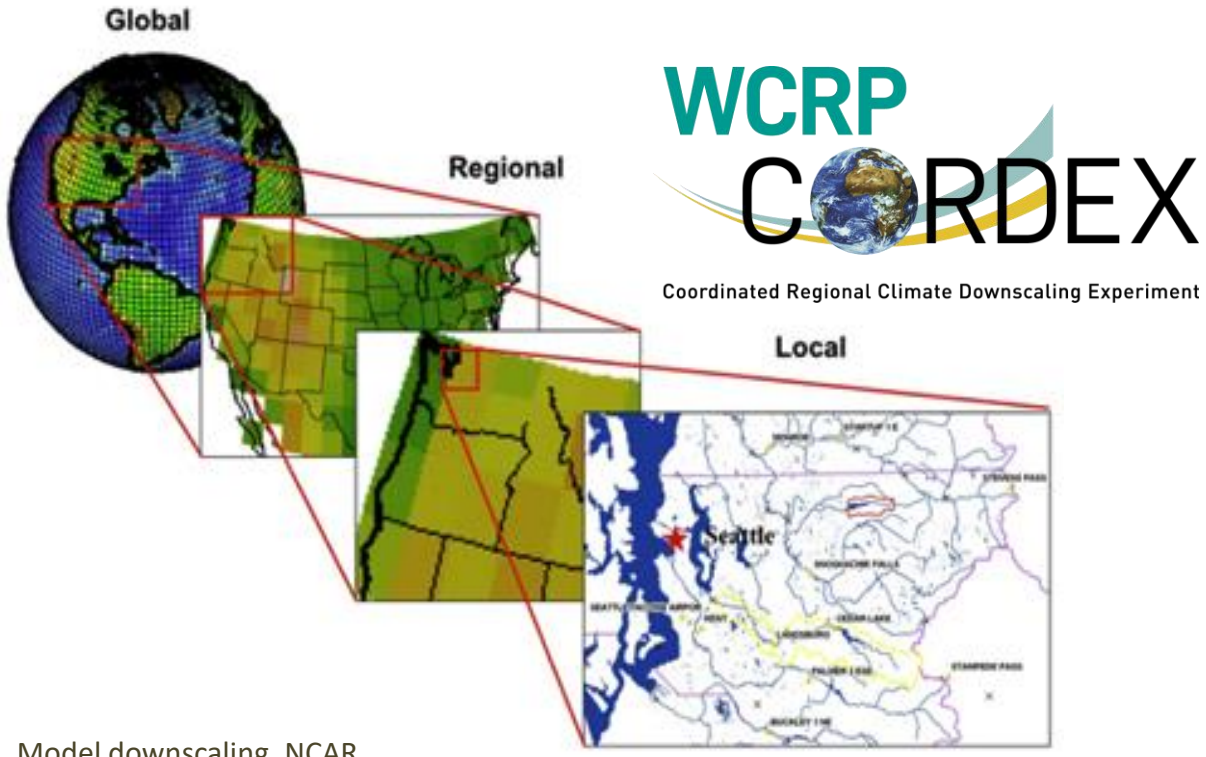
United Nations Decade of Ocean Science for Sustainable Development 2021 - 2030

https://oceandecade.org/

CLIVAR

The “new” WCRP…

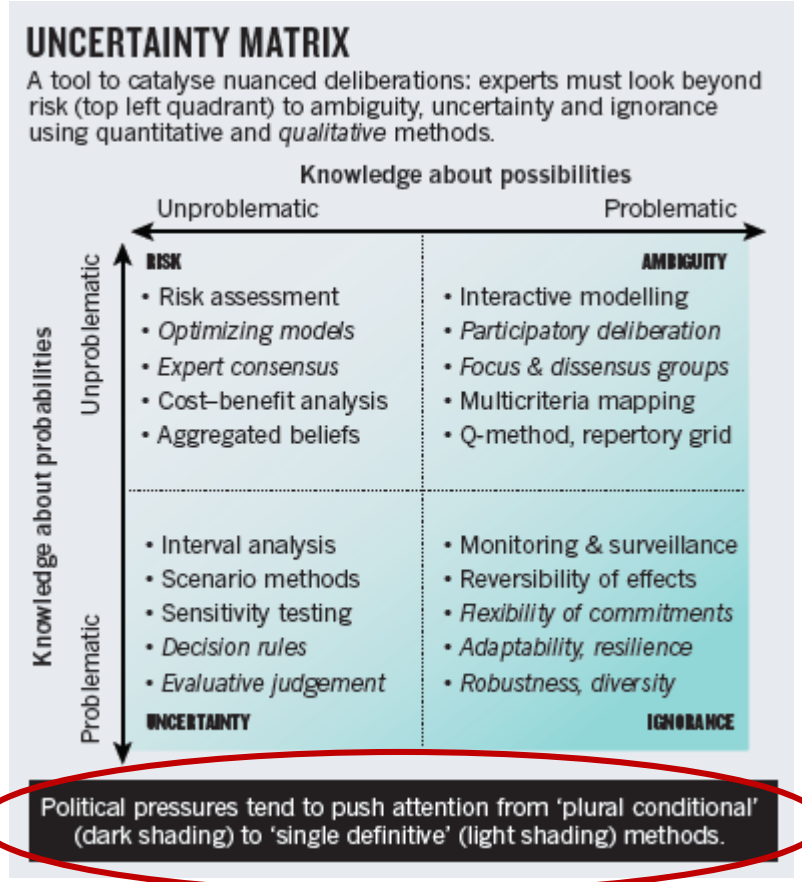
1. There is an increased need and expectation for robust and useful regional and local climate information
2. Climate change is a problem in risk assessment and risk management. This requires a meaningful measure of both the likelihood and impact of specific events over different time scales.



WCRP CORDEX

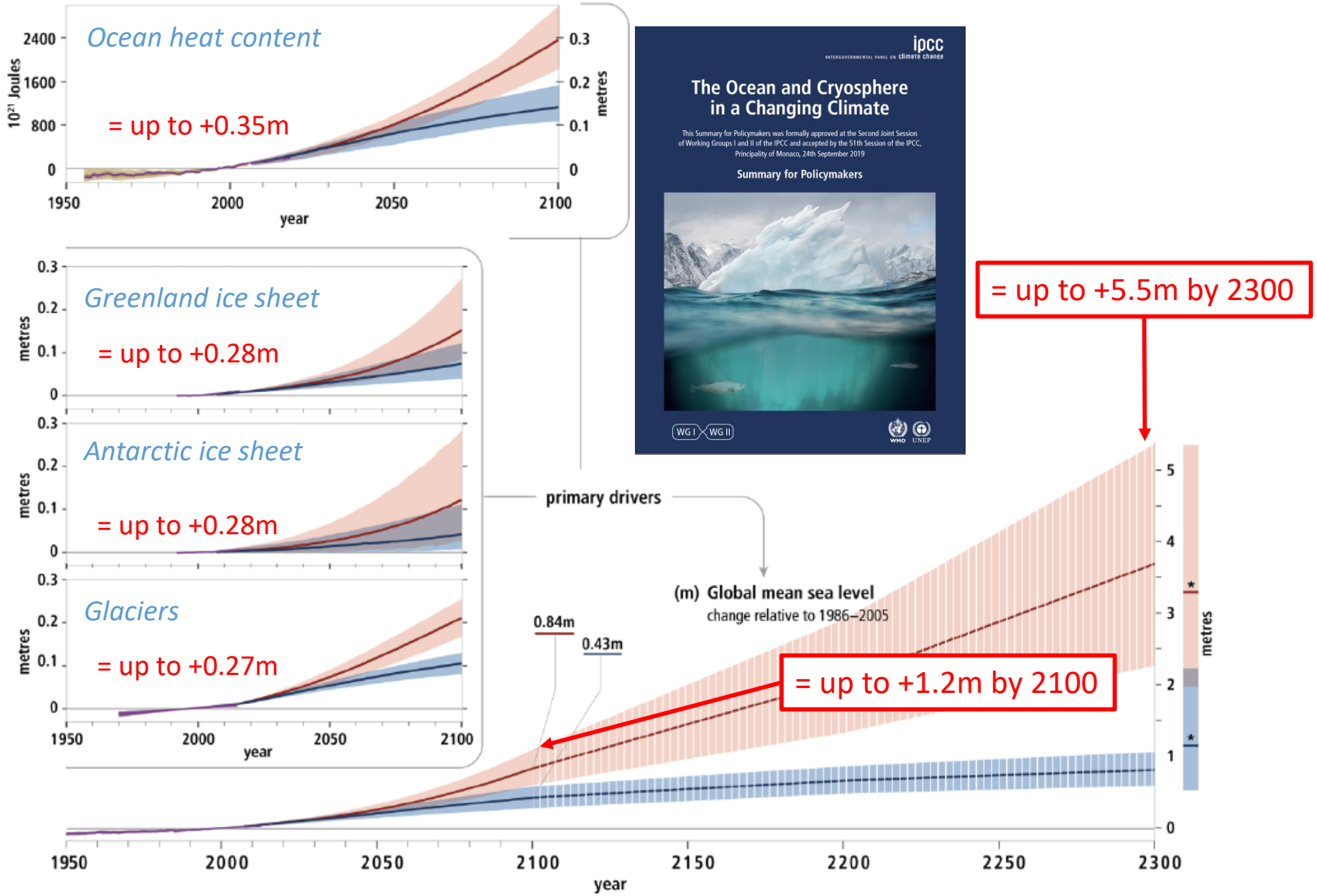
Coordinated Regional Climate Downscaling Experiment

Model downscaling. NCAR
Andrew Wood

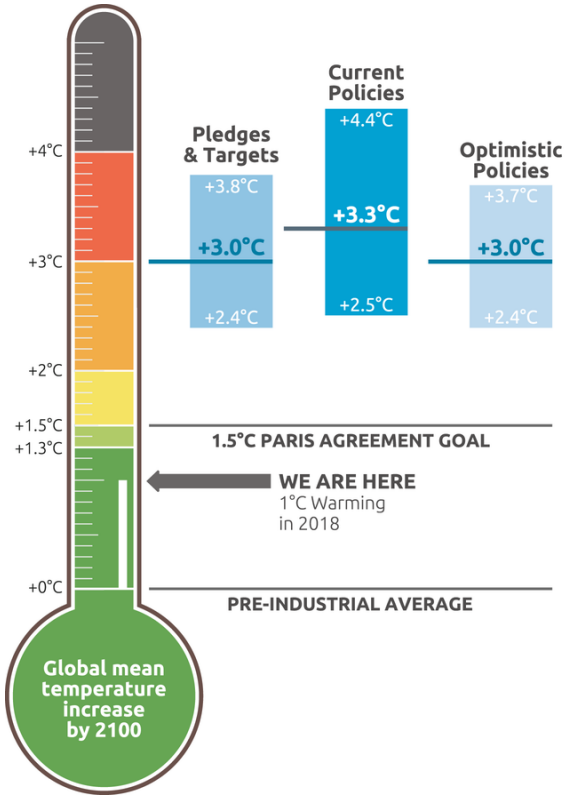


Stirling (2010 Nature)

Some examples: Latest IPCC “likely” (66%) global sea-level projections - SROCC



Is there a threshold for irreversible loss of marine-based ice sheet sectors?



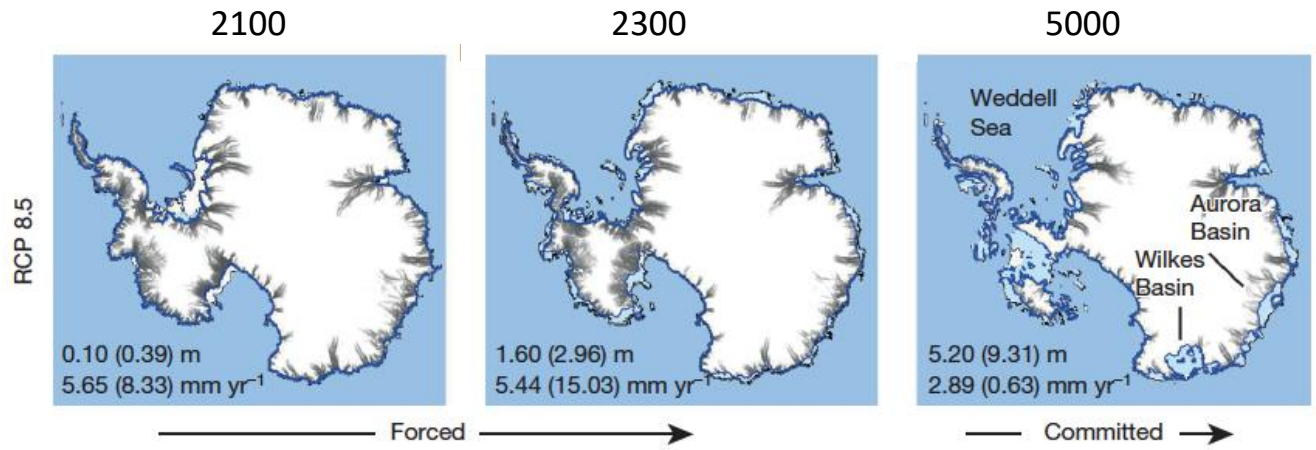
- *1.5 degrees C in 10-15 years*
- *2 degrees C in 20-25 years*

Climate Action Tracker

CAT warming projections

Global temperature increase by 2100

December 2018 Update



Golledge et al. (2015) Nature

ISMIP6

Ice Sheet Model Intercomparison Project for CMIP6

nature climate change — REVIEW ARTICLE

https://doi.org/10.1038/s41558-018-0305-8

The Greenland and Antarctic ice sheets under 1.5 °C global warming

Frank Pattyn[1*], Catherine Ritz[2], Edward Hanna[3], Xylar Asay-Davis[4,5], Rob DeConto[6], Gaël Durand[2], Lionel Favier[1,2], Xavier Fettweis[7], Heiko Goelzer[1,8], Nicholas R. Golledge[9,10], Peter Kuipers Munneke[8], Jan T. M. Lenaerts[11], Sophie Nowicki[12], Antony J. Payne[13], Alexander Robinson[14], Hélène Seroussi[15], Luke D. Trusel[16] and Michiel van den Broeke[8]

LETTER

doi:10.1038/nature15706

The multi-millennial Antarctic commitment to future sea-level rise

N. R. Golledge[1,2], D. E. Kowalewski[3], T. R. Naish[1,2], R. H. Levy[2], C. J. Fogwill[4] & E. G. W. Gasson[5]

ARTICLE

doi:10.1038/nature17145

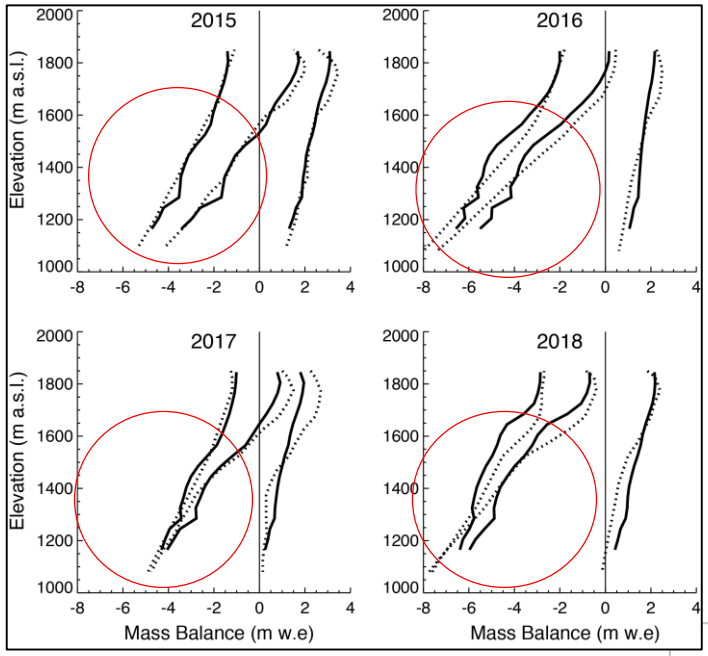
Contribution of Antarctica to past and future sea-level rise

Robert M. DeConto[1] & David Pollard[2]

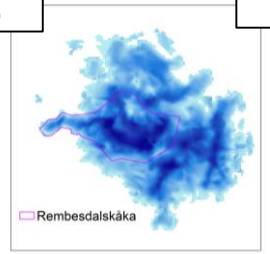
WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment

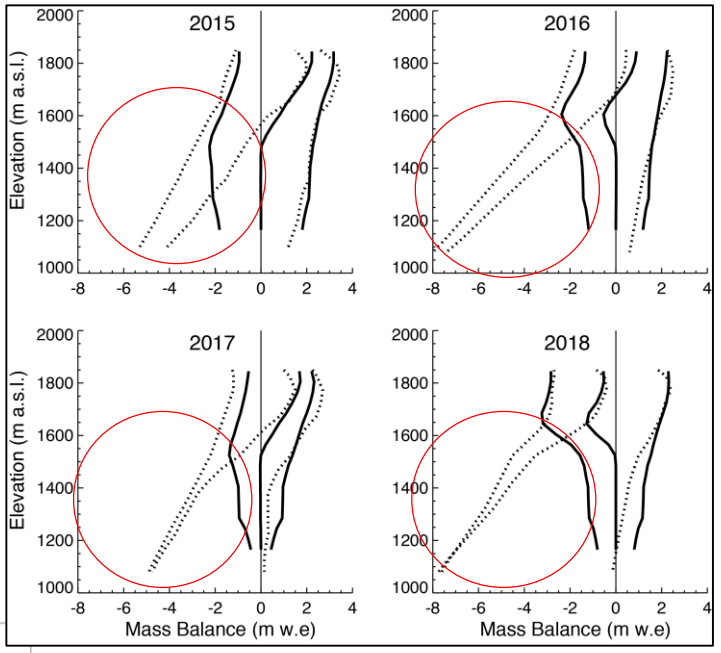
Impacts of GHGs on ice sheets, glaciers etc.

Example: Incorporating interactive glaciers into high-res regional models improves representation of surface mass balance and hydrological processes



With Glacier Module

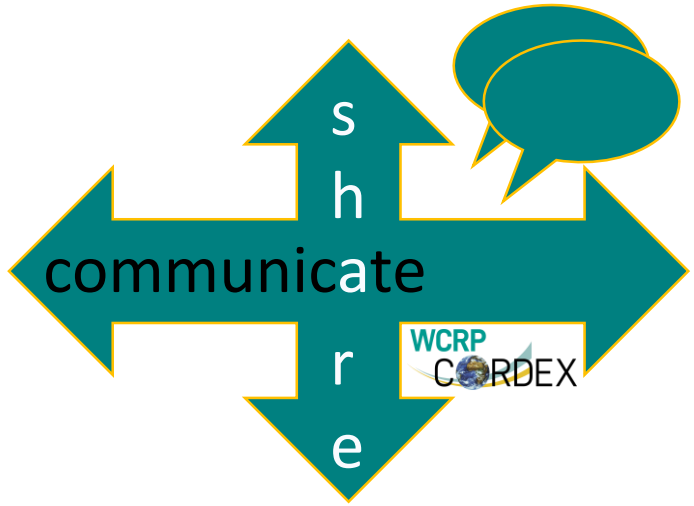




Without Glacier Module

Model
Observations

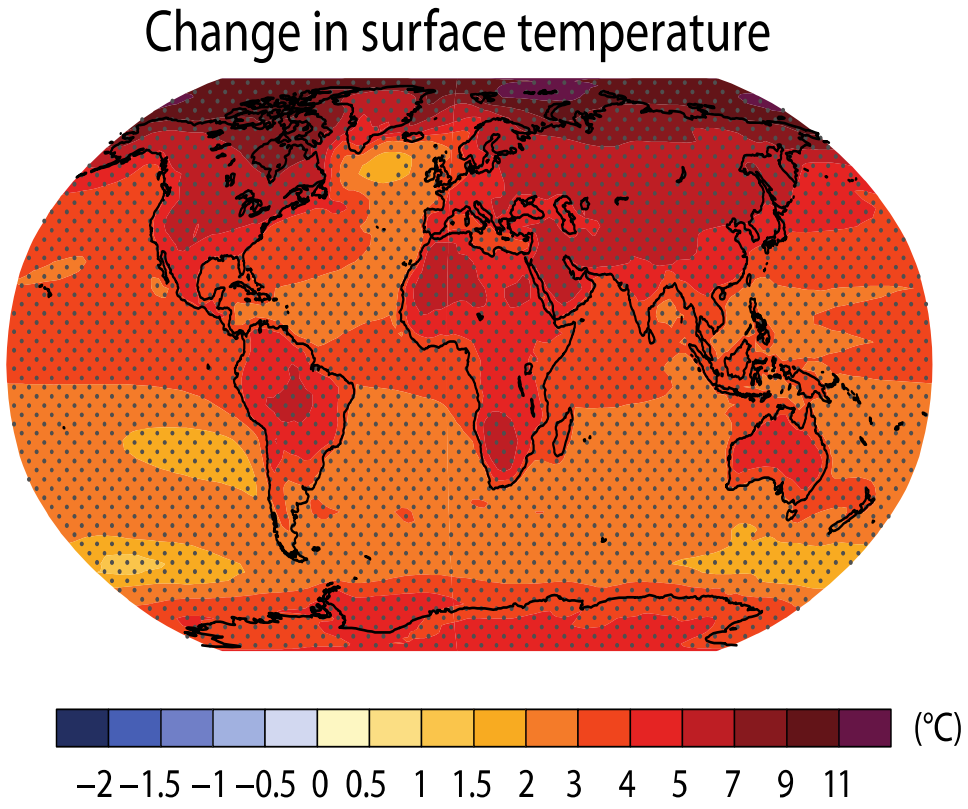
(Eidhammer, et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-119, 2020.)



Each region has its own possibilities and limitations that needs to be considered:

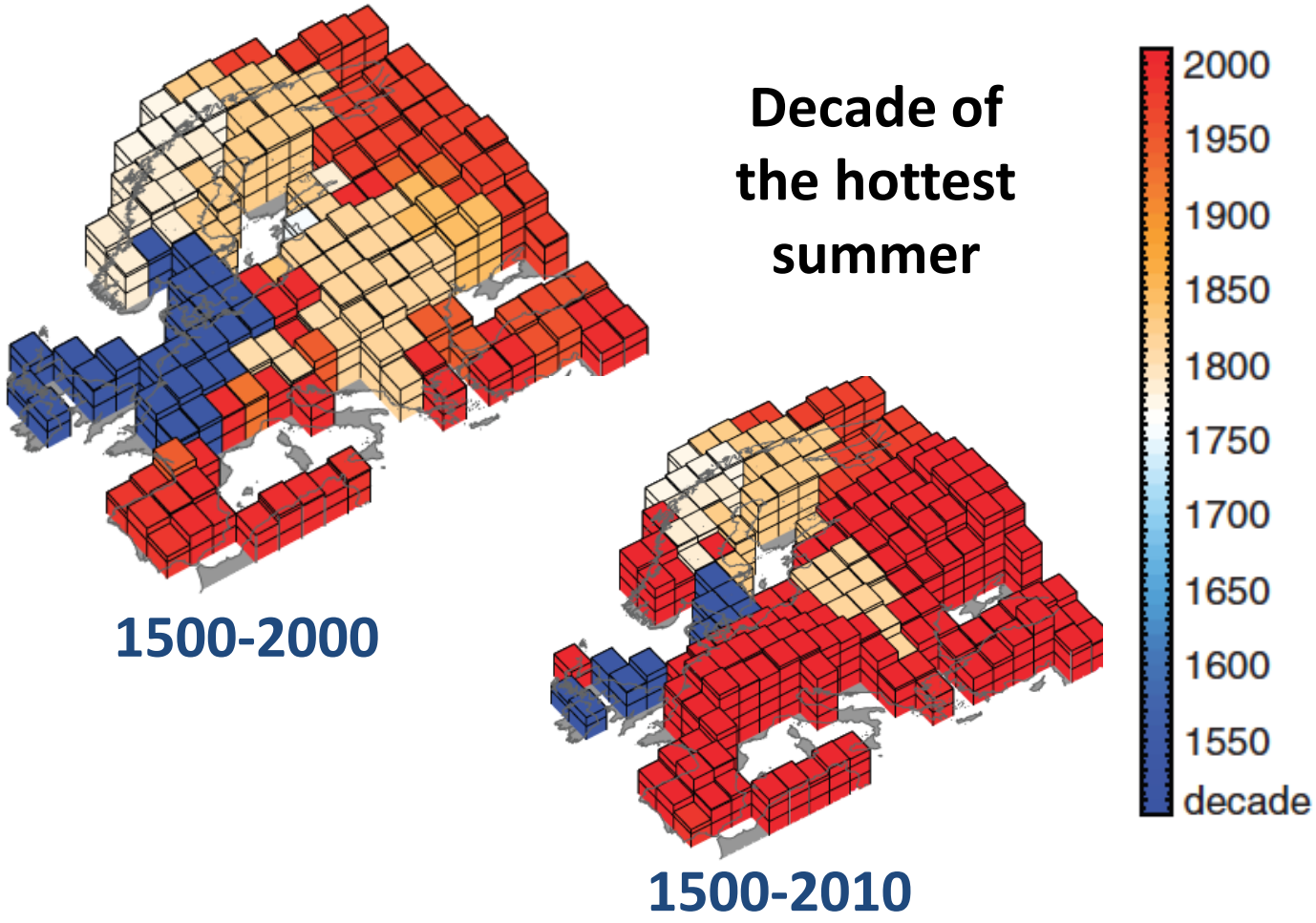
- Internet accessibility
- Bandwidth
- Technical limitations
- Restrictions within countries/regions
- Etc.

- **It's going to get hotter!**
- Projected changes by end of century under RCP8.5, with 4°C of global warming (stippling indicates robustness in sign)



IPCC AR5 WGI (2013)

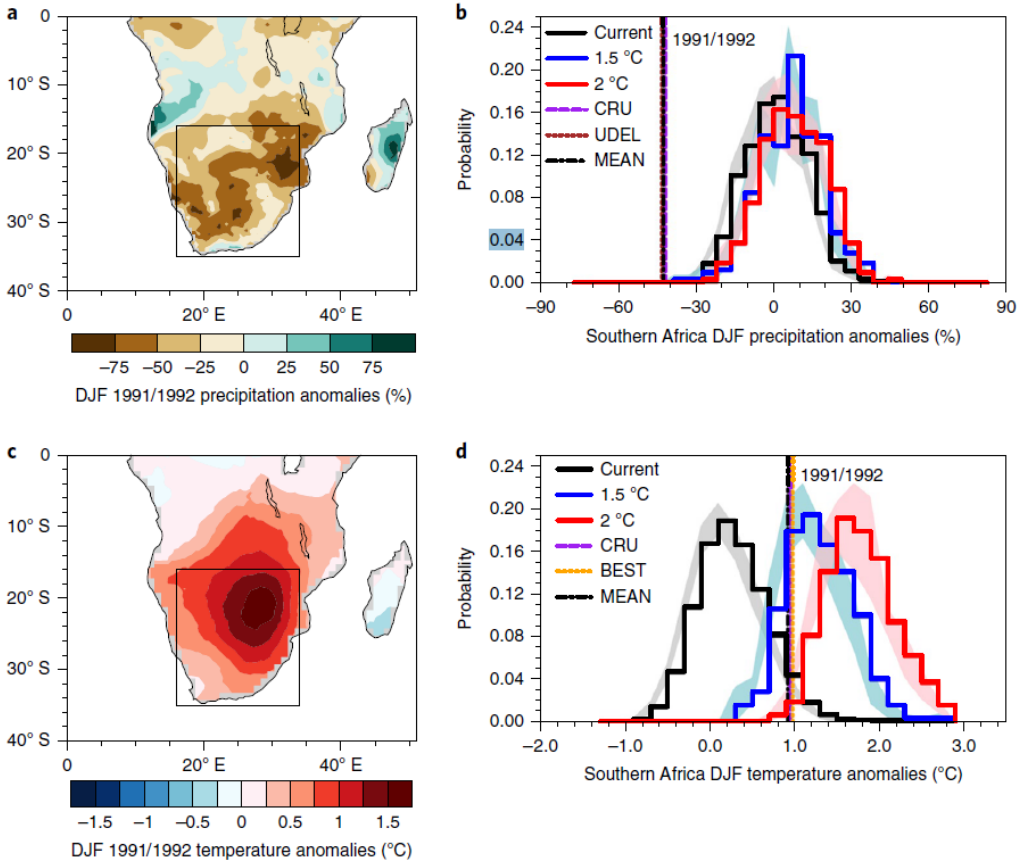
- Adding ten years to a 500-year record **completely redrew the temperature record map of Europe** (and that was 10 years ago)



Barriopedro et al. (2011 Science)

Example: Drought risk in Southern Africa increases from 1.5 to 2° C global warming

1991/92 DJF drought over southern Africa



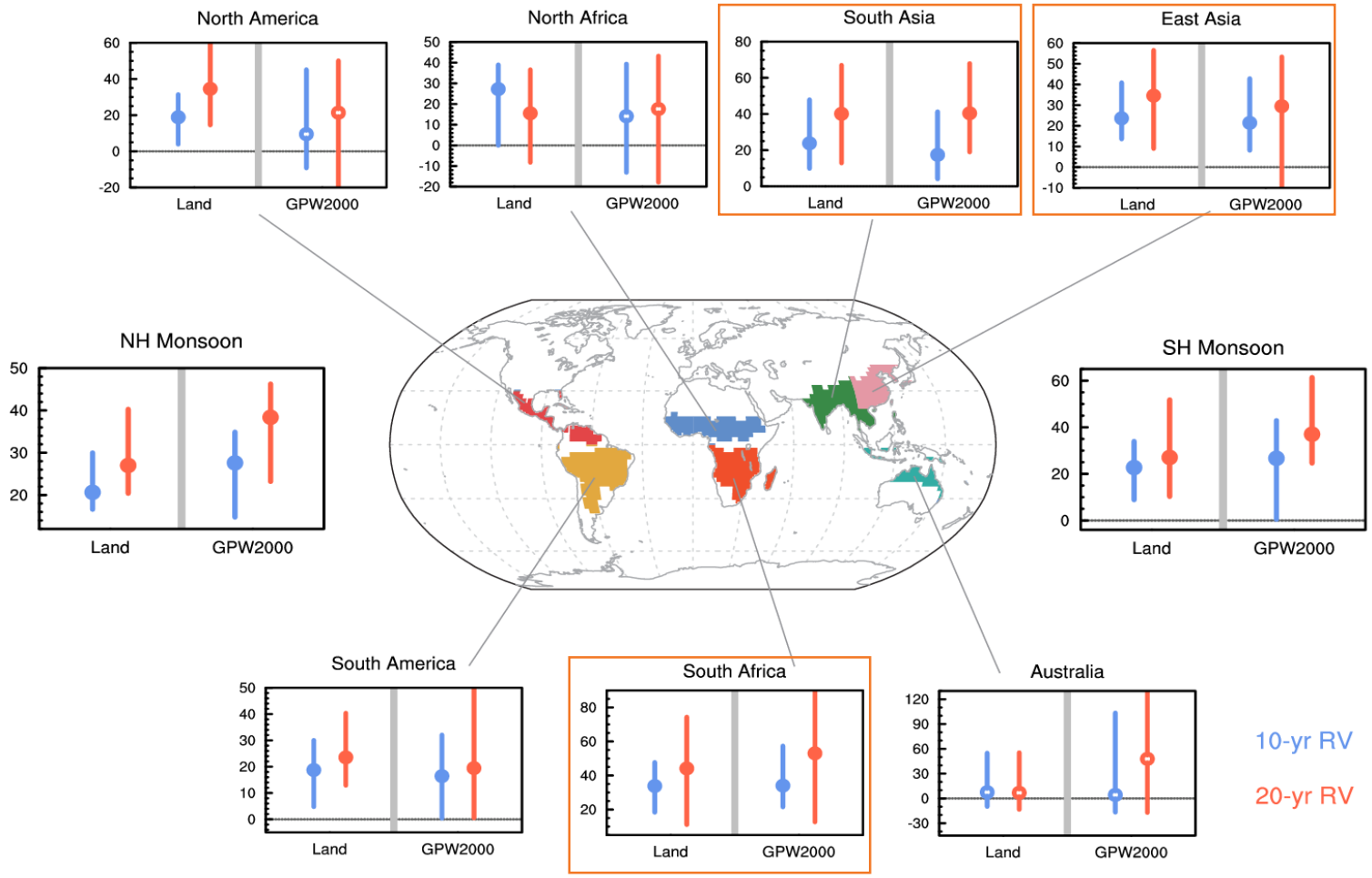
- **Extreme low precipitation**
  - projected to be rare in future scenarios

- **Extreme high temperature**
  - 1.5°C: 74% (70%-78%)
  - 2°C: 98% (97%-100%)

Regardless of the insignificant precipitation change projected, excessive warming alone might increase the probability of similar droughts occurring in a warmer world

Nangombe S., Tianjun Zhou*, Wenxia Zhang, et al. Record-breaking climate extremes in Africa under stabilized 1.5C and 2C global warming scenarios. *Nature Climate Change* (2018)

Example: Extreme precipitation risks in global monsoon regions: from 1.5° C to 2° C global warming



Regional hotspots: South African, South Asian, and East Asian monsoon regions will be affected most by the 0.5° C additional warming.

Zhang W., T. Zhou*, L. Zou, L. Zhang, X. Chen, 2018: Reduced exposure to extreme precipitation by 0.5° C less warming for global land monsoon regions . ***Nature Communications*** 9, Article number: 3153 (2018).

Proposed Lighthouse Activities

Earth System Change	To design, and take major steps toward delivery of, an integrated capability for quantitative observation, explanation, early warning and prediction of Earth System Change on global and **regional** scales, with a focus on multi-annual to decadal timescales.
My Climate Risk	To develop a new framework for assessing and explaining **regional climate risk** to deliver climate information that is meaningful at the **local scale**.
Safe Landing Climates	To explore the routes to climate-safe landing 'spaces' for human and natural systems, on multi-decadal to centennial timescales; connecting climate, Earth system and socio-economic sciences. Explore present-to-future "pathways" for achievement of key SDGs.
Digital Earths	To develop a digital and dynamic representation of the Earth system, optimally blending models and observations, to enable an exploration of past, present and possible futures of the Earth system.
WCRP Academy	To establish one or more targeted capacity exchange climate programmes, working with one or more of the other lighthouses and established climate education providers, including universities.

https://www.wcrp-climate.org/wcrp-ip-overview

Consultation and Co-design

In the coming months WCRP will be consulting with the global community on its strategy, new activities and proposed new structure.

Create new “homes” for modelling and observations and for regional climate information for society.

Lighthouse Activities and other core research activities will be co-designed with our community and partners to ensure that the outcomes meet the urgent needs of society.

United Nations
Climate Change

SUSTAINABLE DEVELOPMENT GOALS

Sendai Framework
for Disaster Risk Reduction
2015 - 2030

ADDITIONAL/BACKUP SLIDES

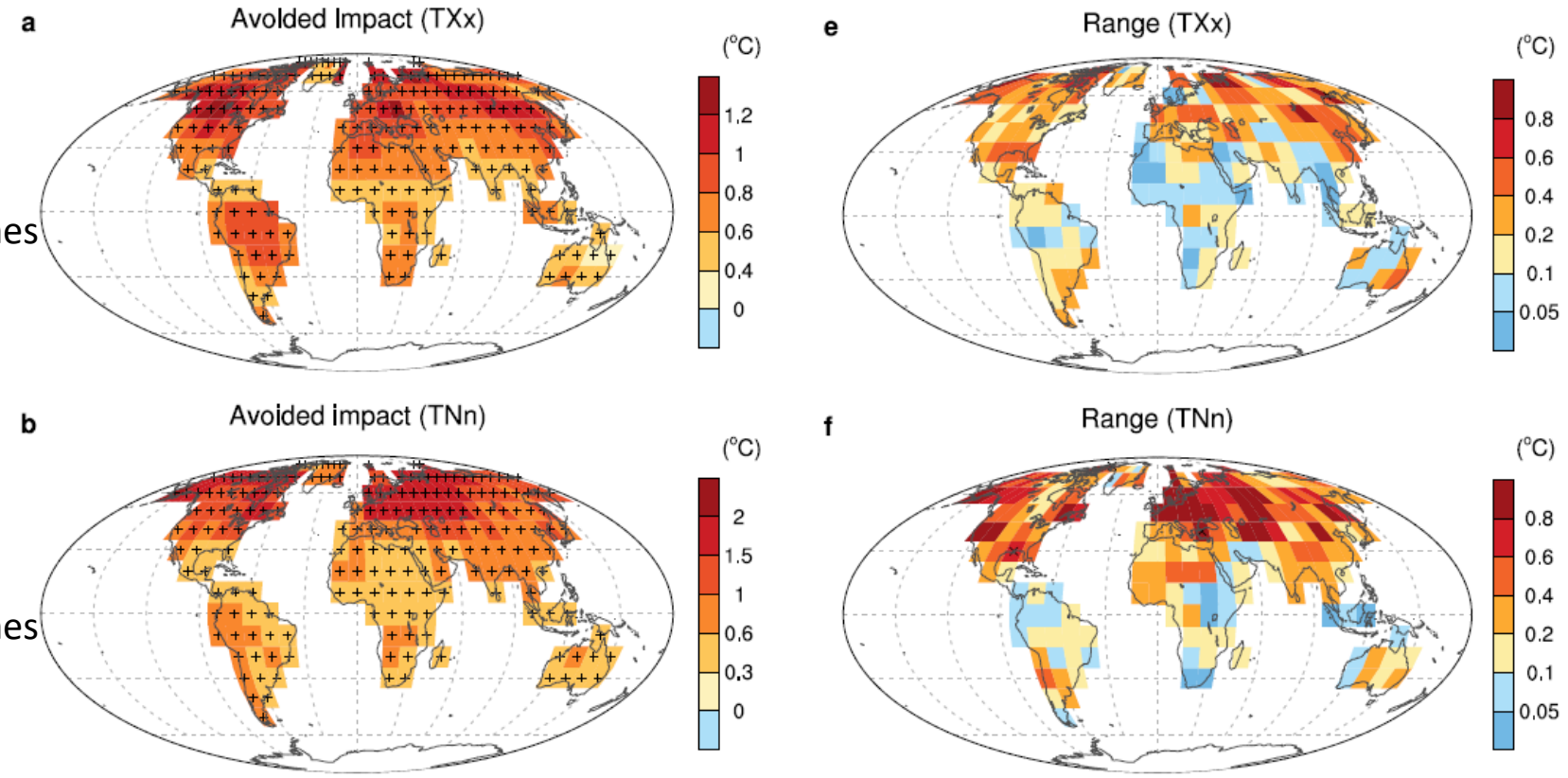
Extreme climate risk map and methodological uncertainty

Risk map:
from 1.5° C to 2° C global warming

Methodological uncertainty
from modeling strategies

Hot extremes

Cold extremes



Extreme temperature risks increase fast in northern high latitudes, but with large methodological uncertainty

Zhang and Zhou, The uncertainty of reduced impacts of 0.5°C less global warming on climate extremes arising from modeling strategy. 2020, Earth's Future, in revision

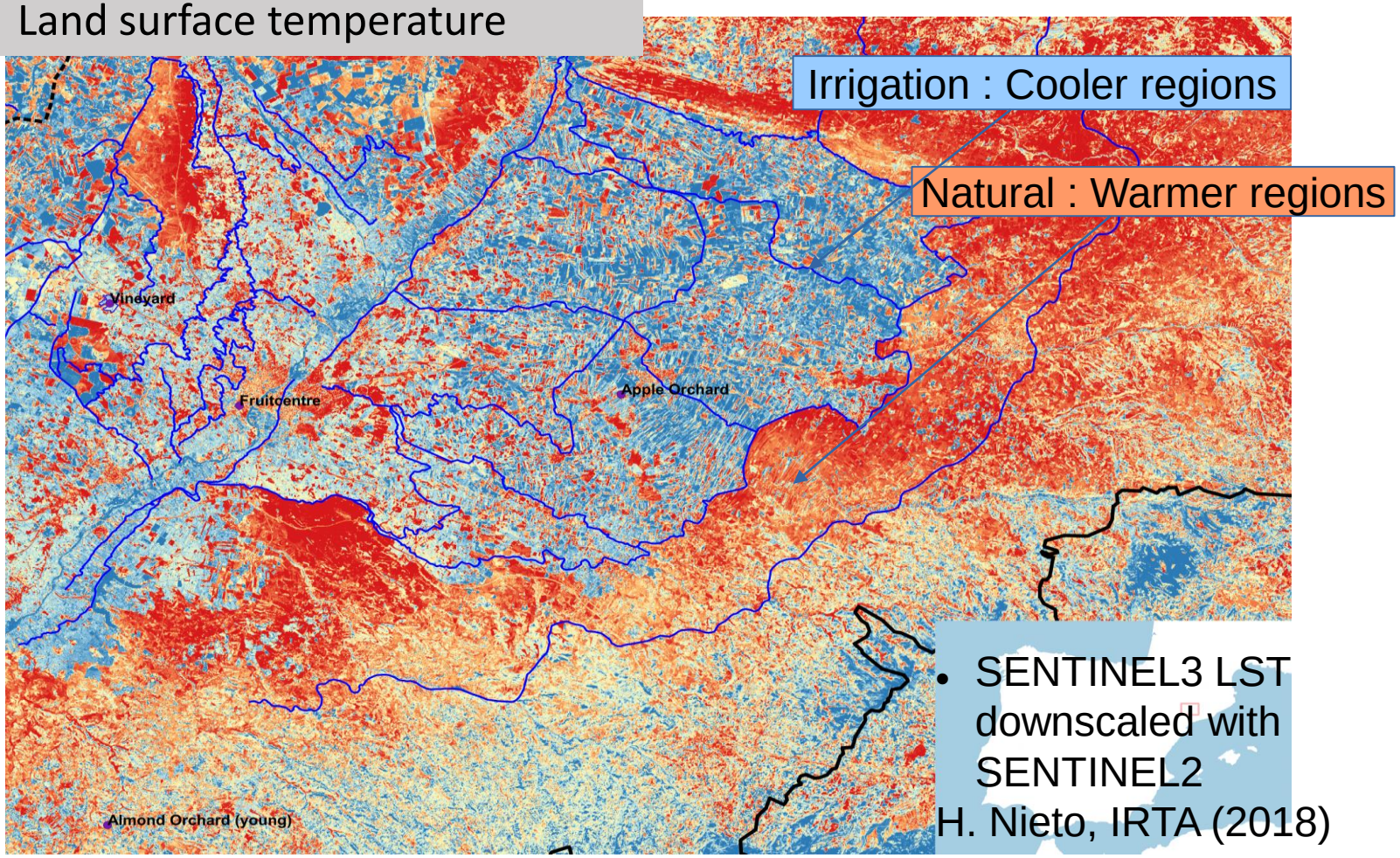
High resolution land surface modelling

- As we go towards the scales of CPM, the surface/atmosphere are no longer local.
- Lateral water transports contribute significantly to evaporation.
- Human land and & water usage modify atmosphere surface interactions :
  - Humans create contrasts
  - Humans decide when evaporation should maximize
- Human water management directly interacts with climate change. Warming modifies water demands.
- Including human land & water management makes our predictions also more relevant to society

Toward integrating human water management into models

To better understand the role of irrigation on surface/atmosphere interactions a field campaign is planned in Northern Spain (LIAISE)

Land surface temperature

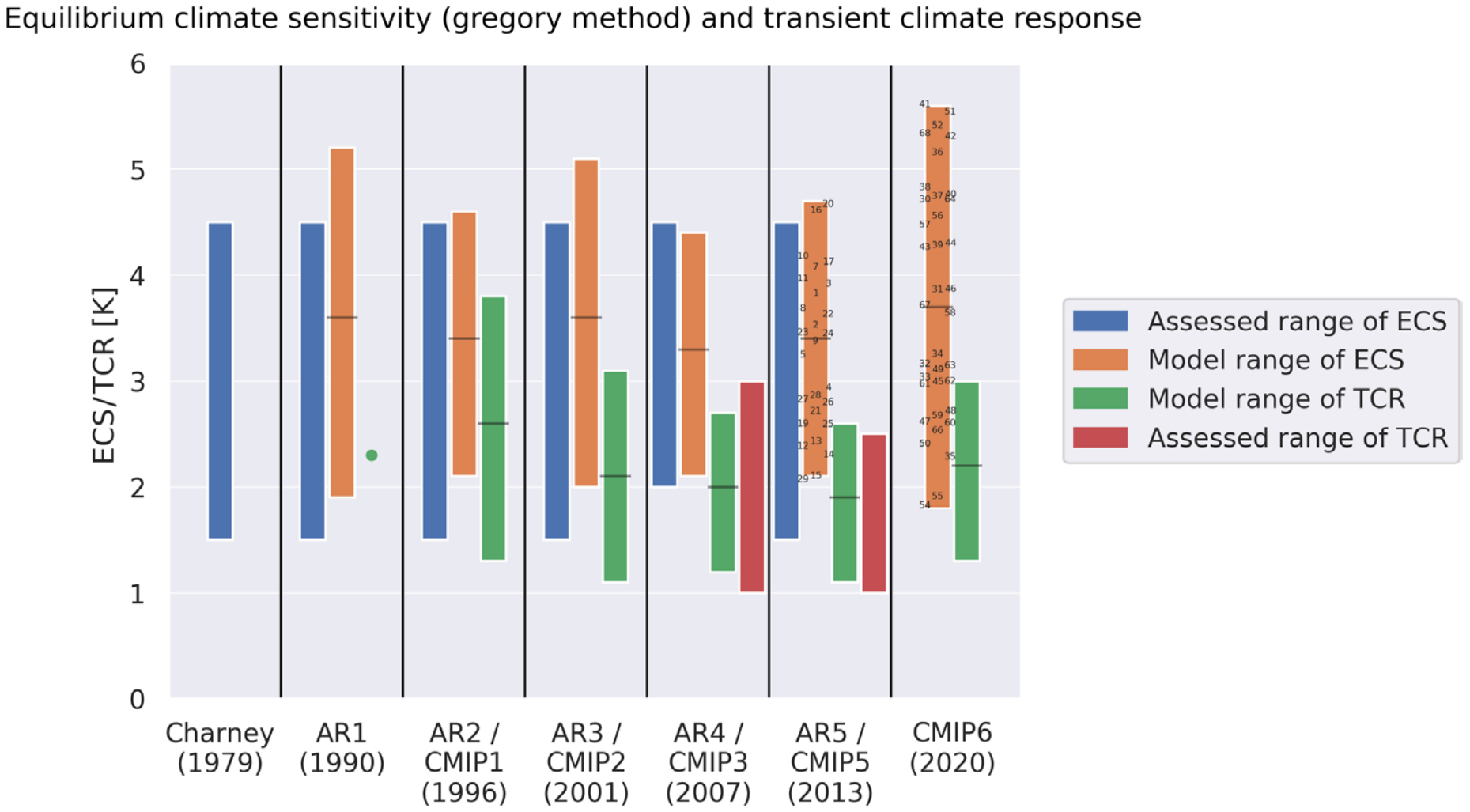


- SENTINEL3 LST downscaled with SENTINEL2

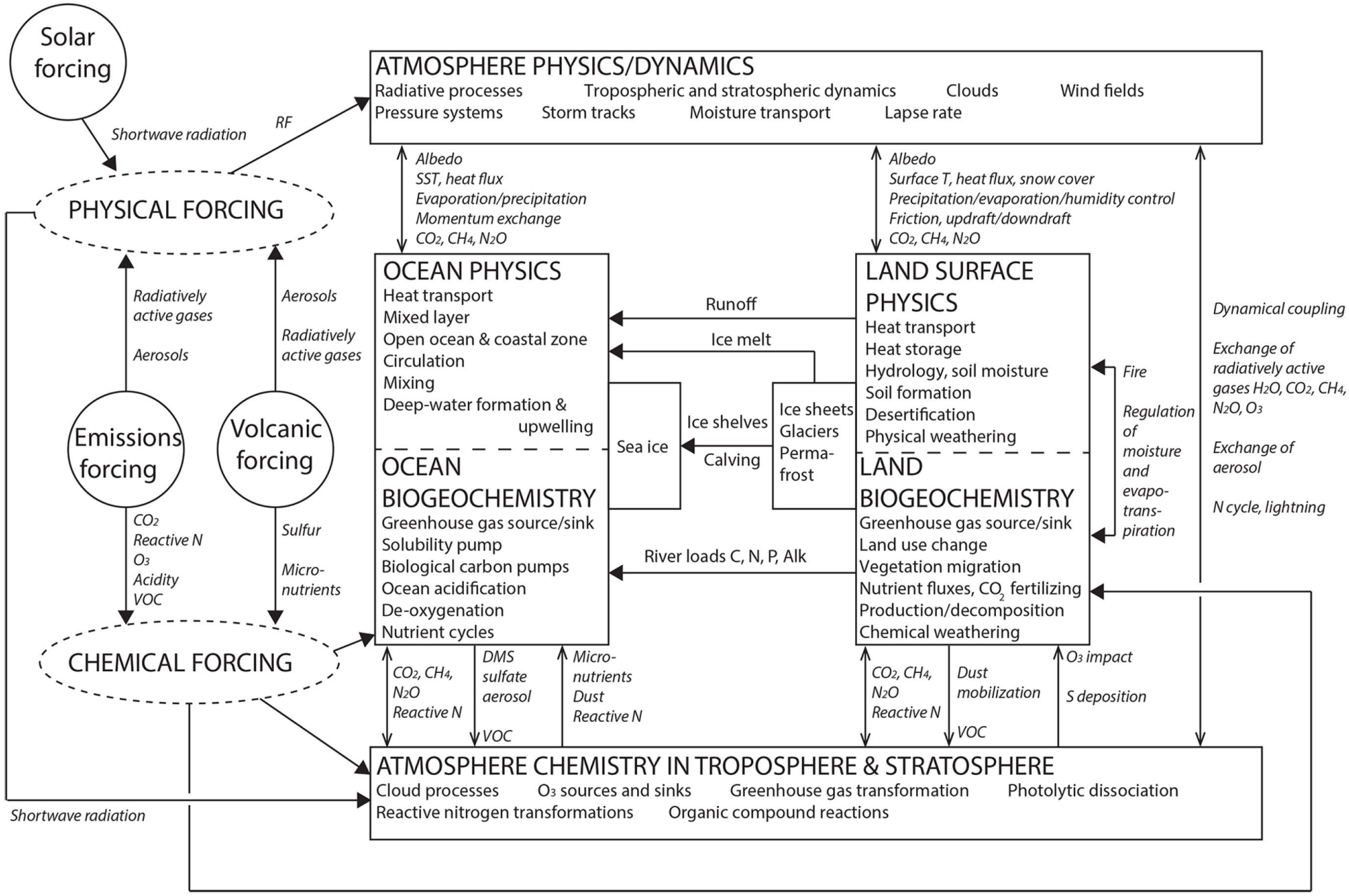
H. Nieto, IRTA (2018)

Simulating water usage and water demands in regional Earth system model will be key in making them more relevant to society.

CMIP Equilibrium Climate Sensitivity



Meehl et al., Sci. Adv. 2020



The **Earth system** as an extension of the physical climate system.

["Bretherton diagram" drawn anew with modifications, extensions, and simplifications, following the idea of Bretherton (1985)]

Heinze et al., Earth Syst. Dynam., 10, 379–452, 2019 https://doi.org/10.5194/esd-10-379-2019

Increased Wind Shear over the North Atlantic

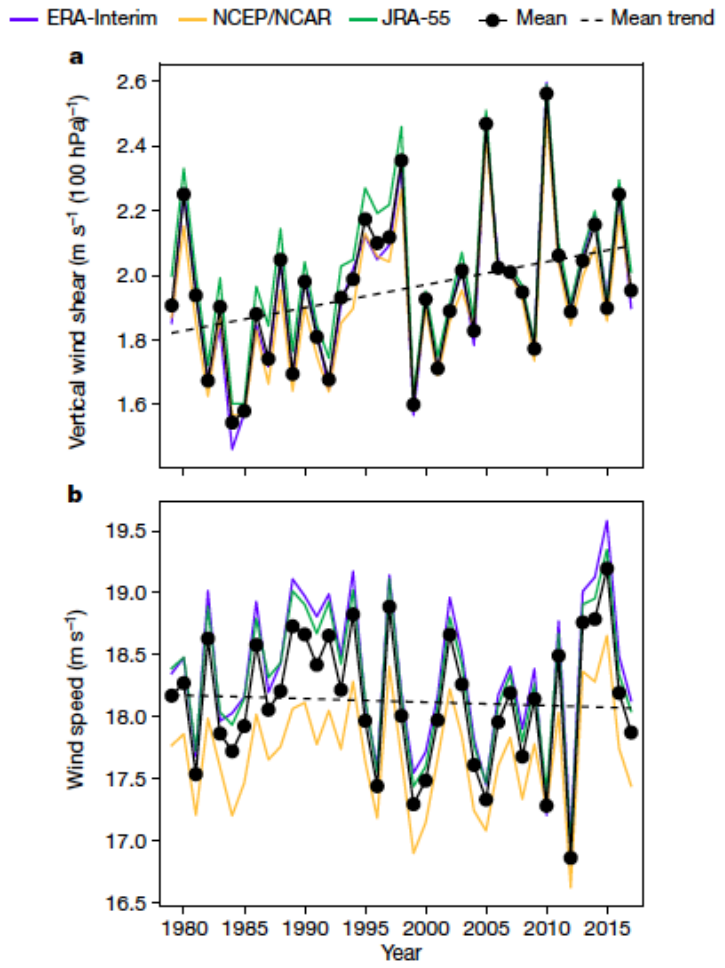
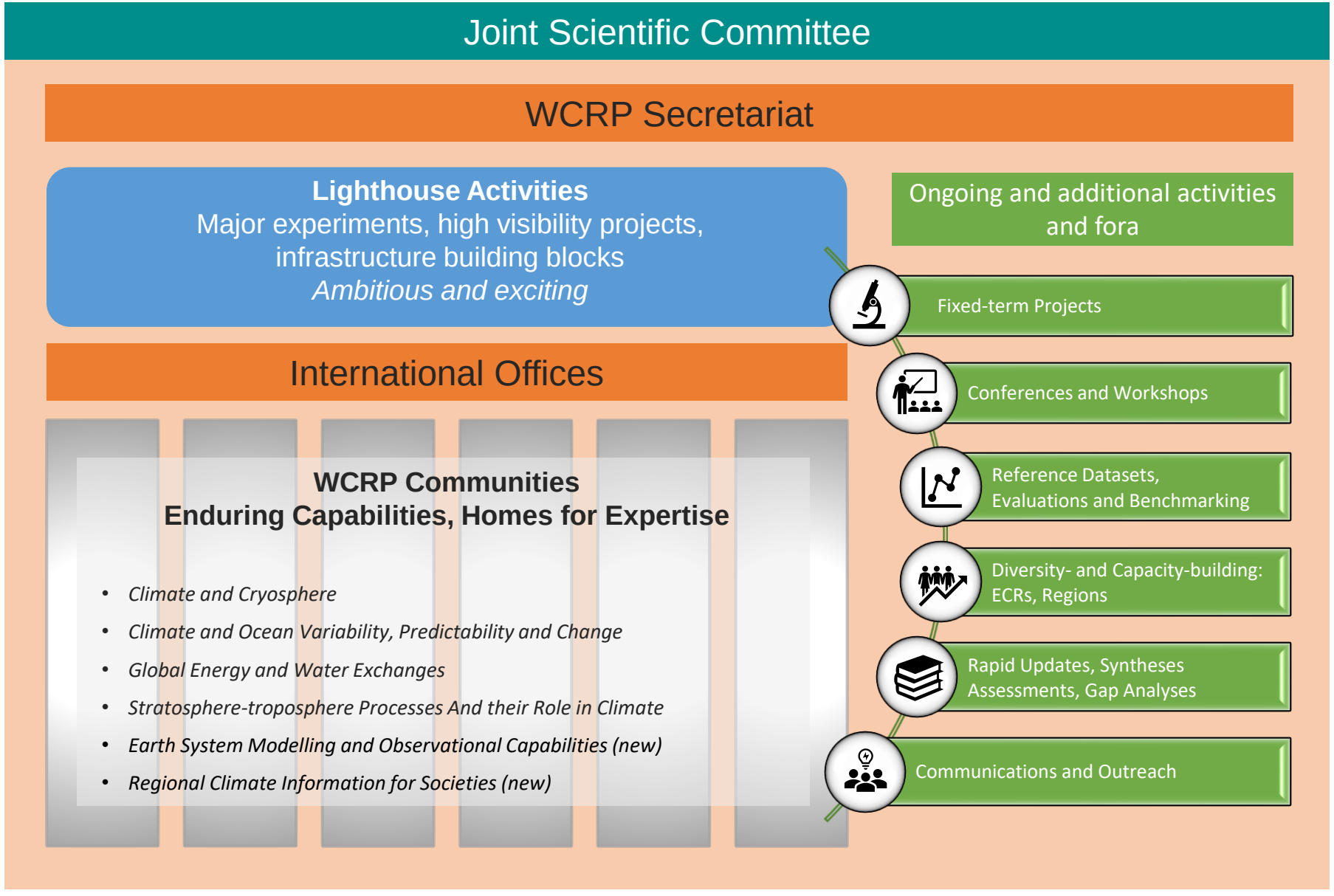


Fig. 3 | Time series of annual-mean wind characteristics in the North Atlantic at 250 hPa over the period 1979–2017. a, Vertical shear in the zonal wind. **b**, Zonal wind speed. Data are presented from the ERA-Interim, NCEP/NCAR and JRA-55 reanalysis datasets. Also shown are the mean of the three reanalysis datasets and the linear trend in the mean.

Climate models predict changes in the latitudinal temperature gradient. By the thermal wind equation, this should be accompanied by changes in the vertical wind shear. Reanalyses show such a change in wind shear over the North Atlantic at aircraft flight levels. This, in turn, will likely lead to increased clear-air turbulence at flight levels in that region. Note that, while little change is seen in the zonal wind speed over the period 1979-2017, increases in the vertical shear of the zonal wind are seen (Lee, Williams and Frame, 2019, Nature, **572**, 639-642, doi.org/10.1038/s41586-019-1465-z)


Joint Scientific Committee
WCRP Secretariat
Lighthouse Activities
Major experiments, high visibility projects, infrastructure building blocks
Ambitious and exciting
International Offices
WCRP Communities
Enduring Capabilities, Homes for Expertise
Climate and Cryosphere
Climate and Ocean Variability, Predictability and Change
Global Energy and Water Exchanges
Stratosphere-troposphere Processes And their Role in Climate
Earth System Modelling and Observational Capabilities (new)
Regional Climate Information for Societies (new)
Ongoing and additional activities and fora
Fixed-term Projects
Conferences and Workshops
Reference Datasets, Evaluations and Benchmarking
Diversity- and Capacity-building: ECRs, Regions
Rapid Updates, Syntheses Assessments, Gap Analyses
Communications and Outreach