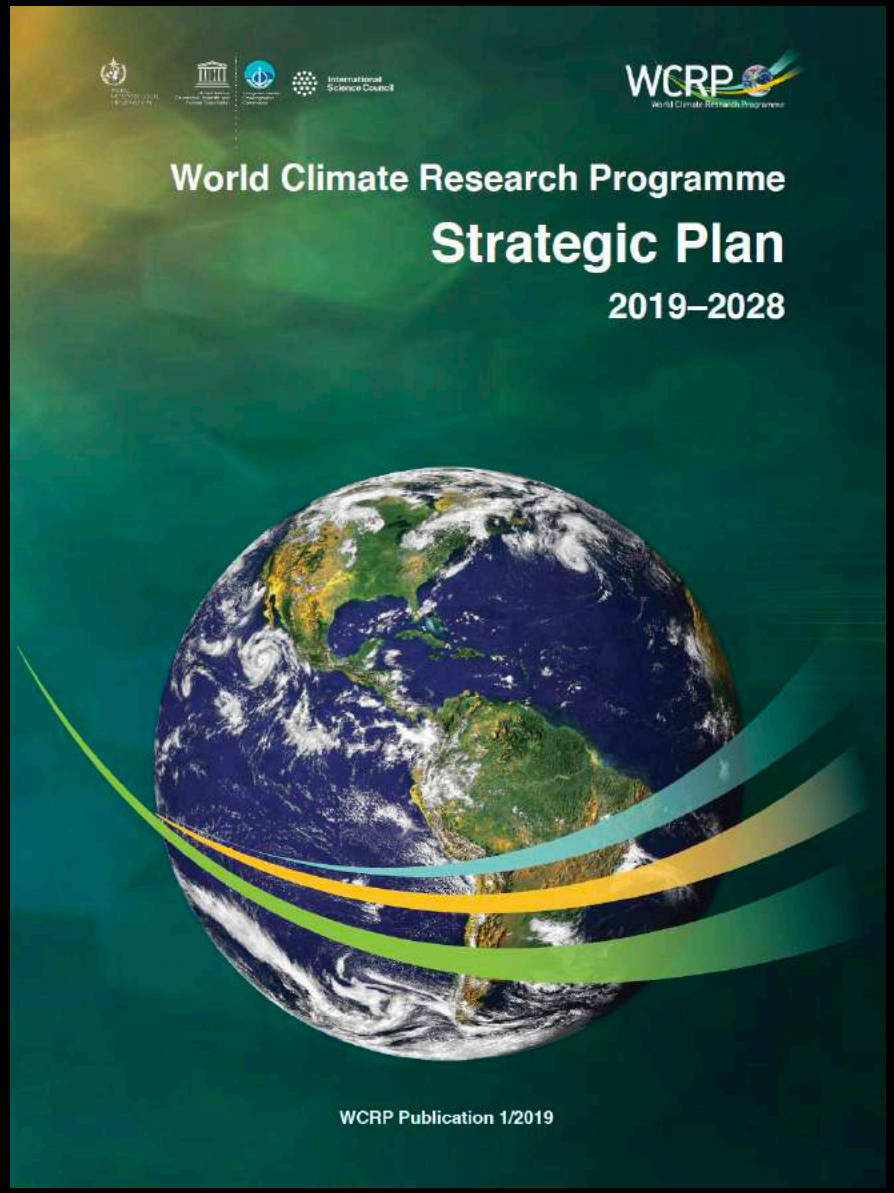
WCRP: QUESTIONS FOR THE NEXT 10 YEARS

GUY P. BRASSEUR

THANKS TO JOCHEM MAROTZKE, BJORN STEVENS, DETLEF STAMMER, DANIELA JACOB AND MANY OTHERS FOR THEIR INPUT.



THE SOCIETAL CONTEXT

- The emissions of greenhouse gases continue to increase:
  - The Paris agreement specifies legally binding targets (2^0C and, if possible, 1.5^0C), but current national contributions to emission reductions point to a world warming larger than 3^0C. We may go to 4^0C…..
- The first impacts of climate change appeared earlier than predicted:
  - Melting of the Arctic and removal of ice in the western Antarctic
  - Frequency of wildfires (California, Australia)
  - Intensity of hurricanes and typhoons
  - Loss of biodiversity, destruction of coral, multiplication of bugs

Example of Climate IMPACT: the Permafrost in danger

The northern permafrost region stores 1672 Pg C, nearly 90% of it in perennially frozen soil. This is about double the amount of carbon in the atmosphere

Tarnocai et al. 2009

Photo: Edward A.G. Schuur

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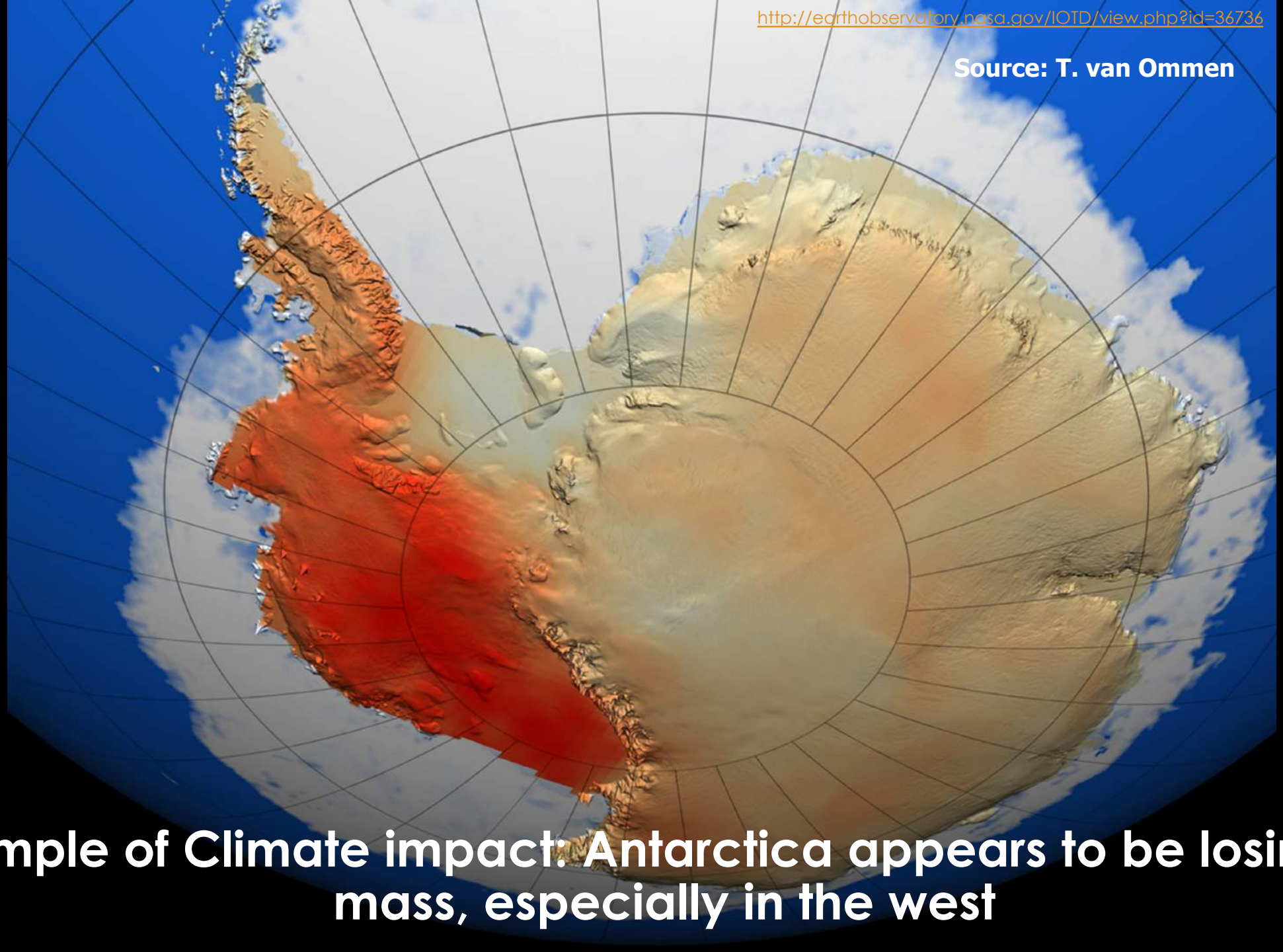
Source:International Permafrost Association, 1998.
Circumpolar Active-Layer Permafrost System (CAPS), version 1.0.



Example of Climate impact: Antarctica appears to be losing ice mass, especially in the west

WHAT HAS WCRP BROUGHT TO THE TABLE OF DECISION-MAKERS ?

- THE EARTH IS WARMING AND WILL CONTINUE TO GET WARMER
- MOST OF THE WARMING IS CAUSED BY HUMAN ACTIVITIES.
- THE CONSEQUENCES WILL BE GLOBAL AND REGIONAL. THEY WILL BE SEVERE: POLAR MELTING, RISING SEA-LEVEL, MORE EXTREME EVENTS, IMPACTS ON THE BIOSPHERE AND ON THE ECONOMY.
- THUS: THE DECISION OF REDUCING EMISSIONS IS NOT ROOTED IN THE LACK OF KNOWLEDGE, BUT IN THE POLITICAL PROCESS.

The Pioneers

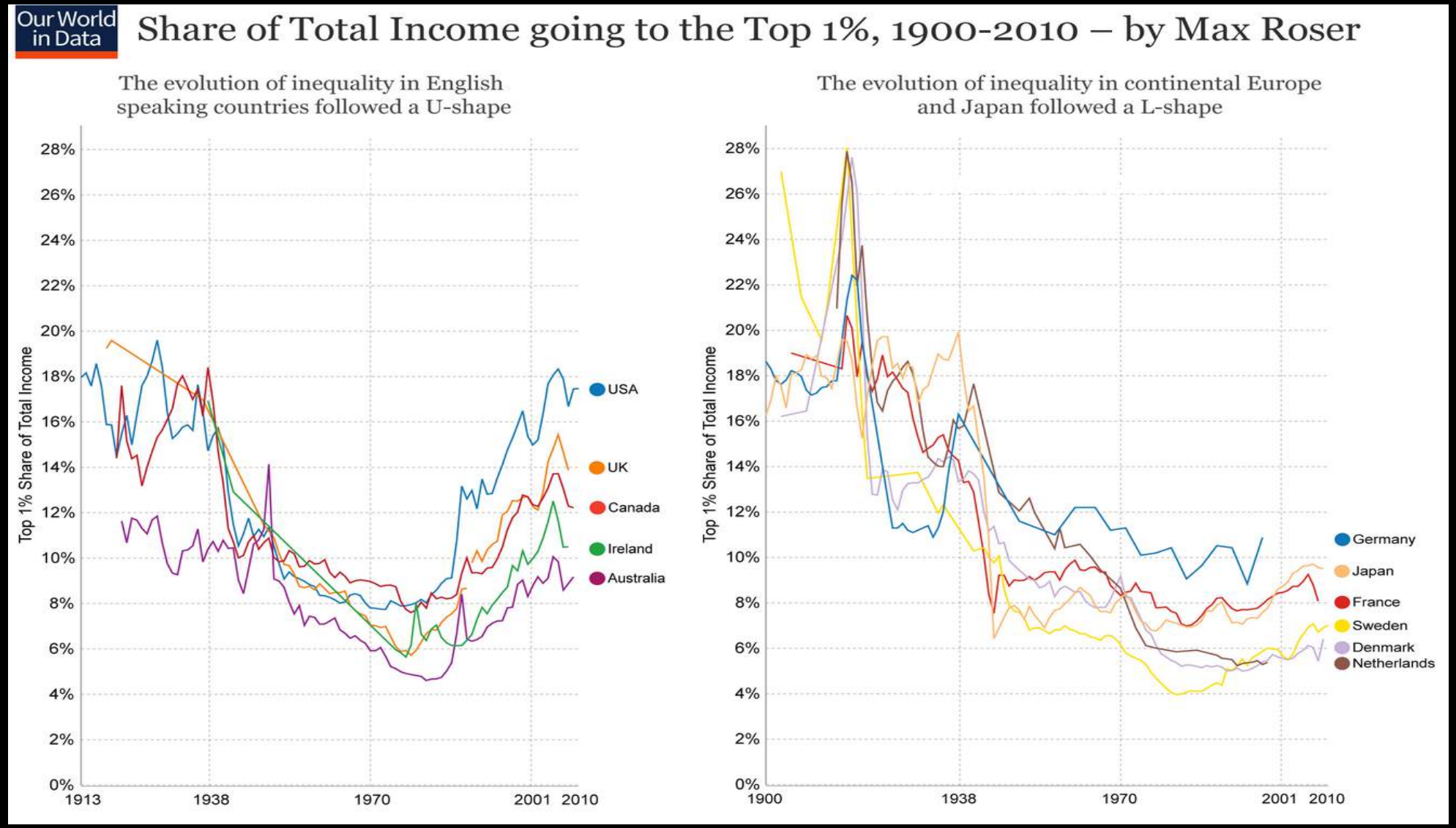
BERT BOLIN (FIRST IPCC CHAIR),
JOHN HOUGHTON (WCRP CHAIR 1982-84),
JOSEPH SMAGORINSKI (FIRST WCRP CHAIR 1980-81) AND
PIERRE MOREL (FIRST DIRECTOR OF WCRP);
BO DOӦS (SECRETARY OF THE GARP SCIENTIFIC COMMITTEE)
JOHN MASON (WCRP CHAIR 1985-88)

THE POLITICAL CONTEXT HAS ALSO CHANGED

- THE POLITICAL CONTEXT HAS CHANGED DRAMATICALLY WITH TWO DOMINATING POLES REPLACING THE TRADITIONAL PARTIES:
  - POPULIST MOVEMENT
  - ECOLOGICAL MOVEMENT
- PROFOUND RELATED QUESTIONS REMAIN ABOUT THE FUTURE OF THE WORLD:
  - THE FUTURE OF THE EUROPEAN UNION,
  - THE RELATIONS BETWEEN RUSSIA, ASIA AND THE WESTERN WORLD,
  - THE ROLE OF AFRICA, THE MIGRATION QUESTIONS,
  - INCREASING INEQUALITIES IN SOCIETY


THE ECONOMY
BY KILLING
LIFE
=INSANITY!
FOLLOW THE SCIENCE
LET US HAVE A FUTURE
OURS
TELL THE TRUTH
LOSING NEMO
THERE IS NO PLANET B
We Shouldn't Have to do This But Here we are Begging you To Protect Your
WHAT I STAND FOR IS WHAT I STAND ON!
THE OCEAN IS RISING AND SO ARE WE
DON'T BE A FOSSIL FOOL
WHY DO WE
ONE LOVE
ONE STRUGGLE
DO WE REALLY NEED ANOTHER SIGN
SAVE THE EARTH
RESPECT EXISTENCE OR EXPECT RESISTANCE
CLIMATE CHANGE STRIKE 2019
NOT THIS CLIMATE
STOP FRACKING WITH MOTHER EARTH
YOU'LL DIE OF OLD AGE
WE'LL DIE OF
BURN

Evolution of Income Equality

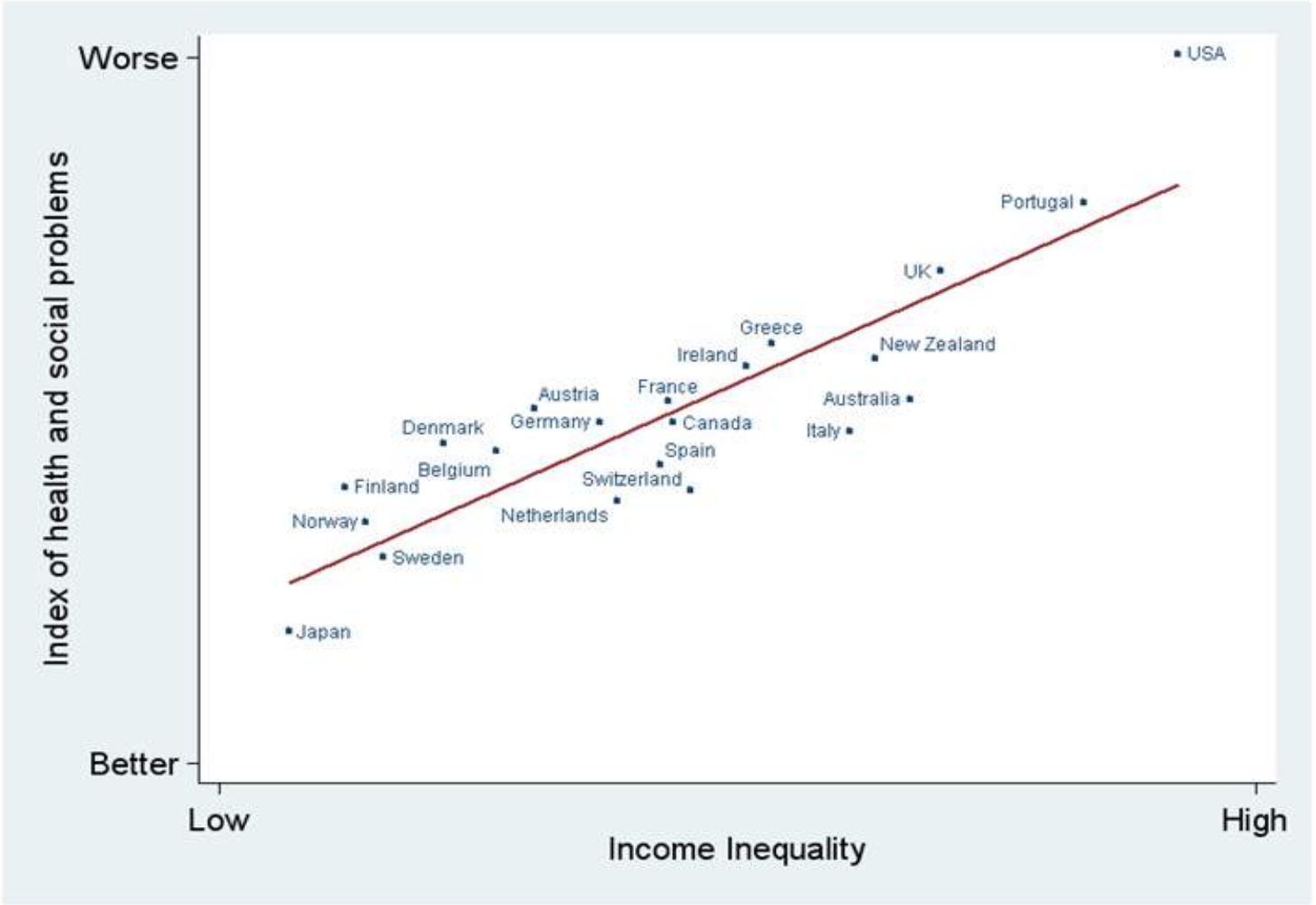


Source: S. van der Leeuw

Health and Social Problems are Worse in More Unequal Countries

Index of:

- Life expectancy
- Math & Literacy
- Infant mortality
- Homicides
- Imprisonment
- Teenage births
- Trust
- Obesity
- Mental illness – incl. drug & alcohol addiction
- Social mobility



Source: Wilkinson & Pickett, The Spirit Level (2009)

www.equalitytrust.org.uk

The Equality Trust

Pickett and Wilkinson 2015

THE ROLE OF SCIENTIFIC KNOWLEDGE IN THE POLITICAL PROCESS:

- LONG-TERM: THE PARIS AGREEMENT WOULD NOT HAVE TAKEN PLACE WITHOUT INPUT FROM THE SCIENCE (ROLE OF WCRP).
- SEVERAL SCIENTIFIC QUESTIONS REGARDING THE LONG-TERM EVOLUTION OF THE EARTH SYSTEM REMAIN OPEN.
  - FEEDBACKS BETWEEN THE BIOGEOCHEMICAL AND CLIMATE SYSTEMS
  - FEEDBACKS BETWEEN THE HYDROLOGICAL AND CLIMATE SYSTEMS
  - FUTURE STORAGE OF CARBON BY THE OCEAN AND THE CONTINENTAL BIOSPHERE.
  - IRREVERSIBILITY OF CLIMATE CHANGE

THE ROLE OF SCIENTIFIC KNOWLEDGE IN THE POLITICAL PROCESS:

- SHORT-TERM: FOR ECONOMIC SECTORS, SCIENTIFIC KNOWLEDGE REPRESENTS ONLY ONE INPUT AMONG MANY IN THE DECISION PROCESS. MANY QUESTIONS ARE POSED BY THESE SECTORS:
  - IMPROVING SEASONAL TO DECADAL PREDICTION OF WEATHER AND THE HYDROLOGICAL CYCLE.
  - PROVIDING MORE INFORMATION AT THE REGIONAL SCALE.

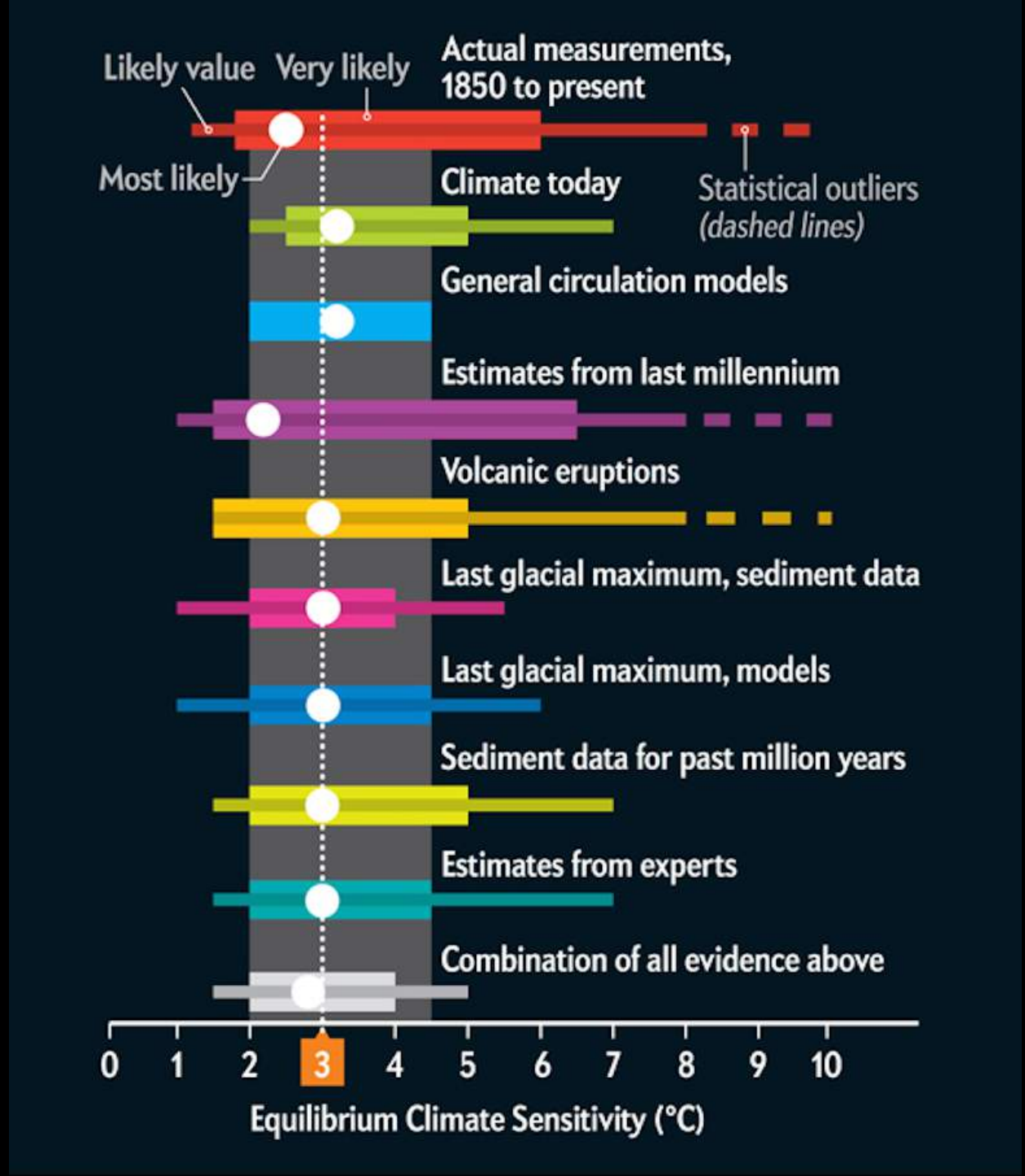
In this context, what are the questions that the community should address?

What should be the role of **WCRP** in the next 10 years?

.WHAT SCIENTIFIC KNOWLEDGE SHOULD BE PROVIDED BY WCRP TO SUPPORT THE POLITICAL PROCESS?

- Question 1: How sensitive is climate to GHG emissions, and which emissions are compatible with the Paris's targets?
- We need to reduce the uncertainty in the climate sensitivity (2-5 ^{0}C).
- We need to better understand the evolving fluxes in the carbon cycle: and to determine where anthropogenic carbon goes.
- We need to better assess the budget of short-lived climate forcers such as methane and ozone.
- Strategic Plan: WCRP should enable an integrated and fundamental understanding of the multi-scale physical and biogeochemical processes that determine the evolution of climate and hence of the socio-economic system.

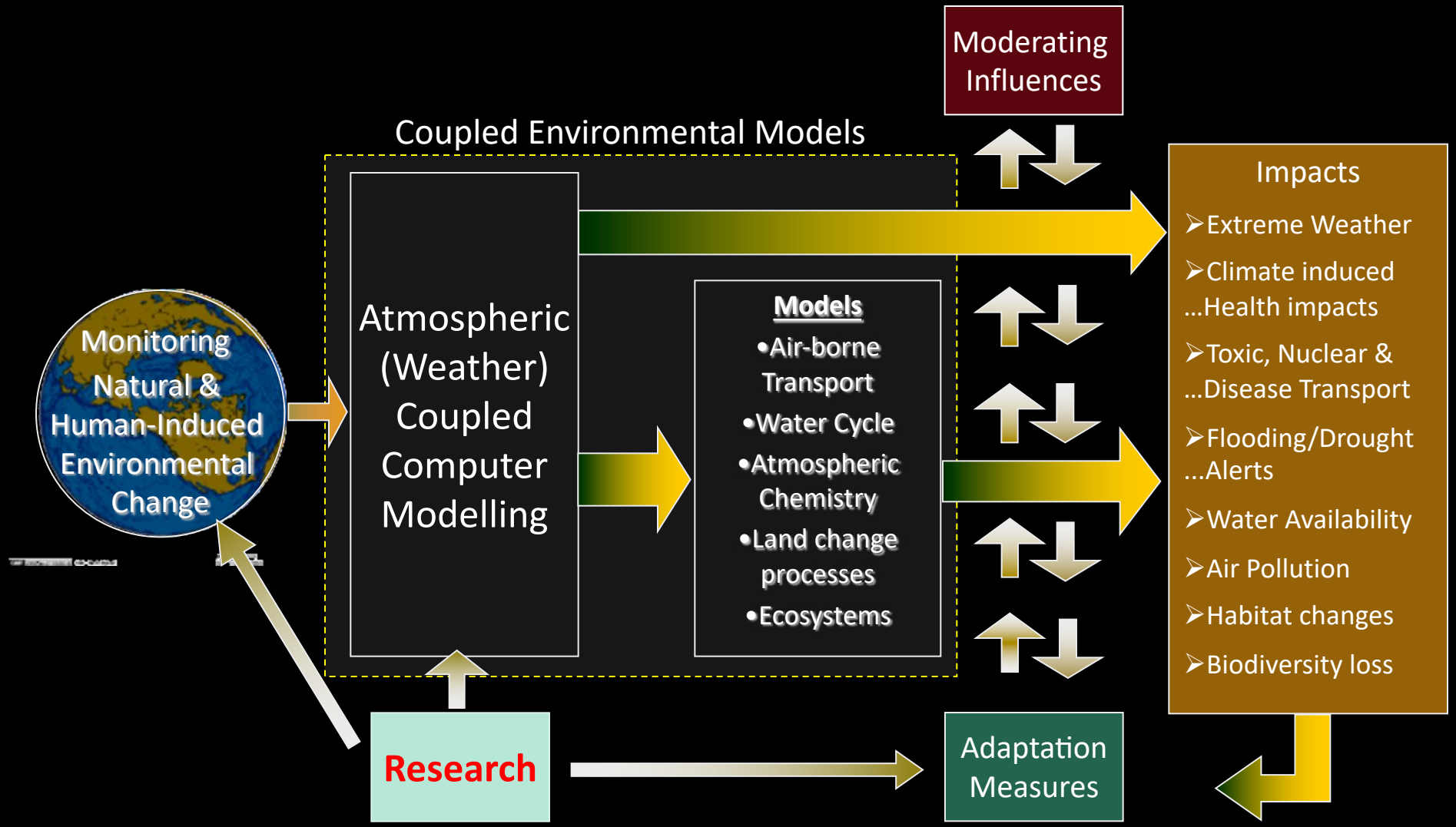
EQUILIBRIUM CLIMATE SENSITIVITY



WHAT SCIENTIFIC KNOWLEDGE SHOULD BE PROVIDED BY WCRP TO SUPPORT THE POLITICAL PROCESS?

- Question 2: How can we better manage the effects of climate variability and short-term changes?
- How will climate change affect weather in different regions of the world?
- How will climate change and variability affect the biosphere and hydrosphere including food productivity?
- Which strategy should we develop to make rapid progress in our skills to predict the evolution of the Earth system on seasonal to decadal scales?
- Strategic Plan: WCRP should push the frontiers of predictions for sub-seasonal to decadal timescales across the different components of the climate/Earth system at the global and regional scales.

OVERARCHING RESEARCH NEED: IMPROVE PREDICTION CAPABILITIES VIA INCORPORATING/INTEGRATING COMPOSITION, WEATHER AND CLIMATE



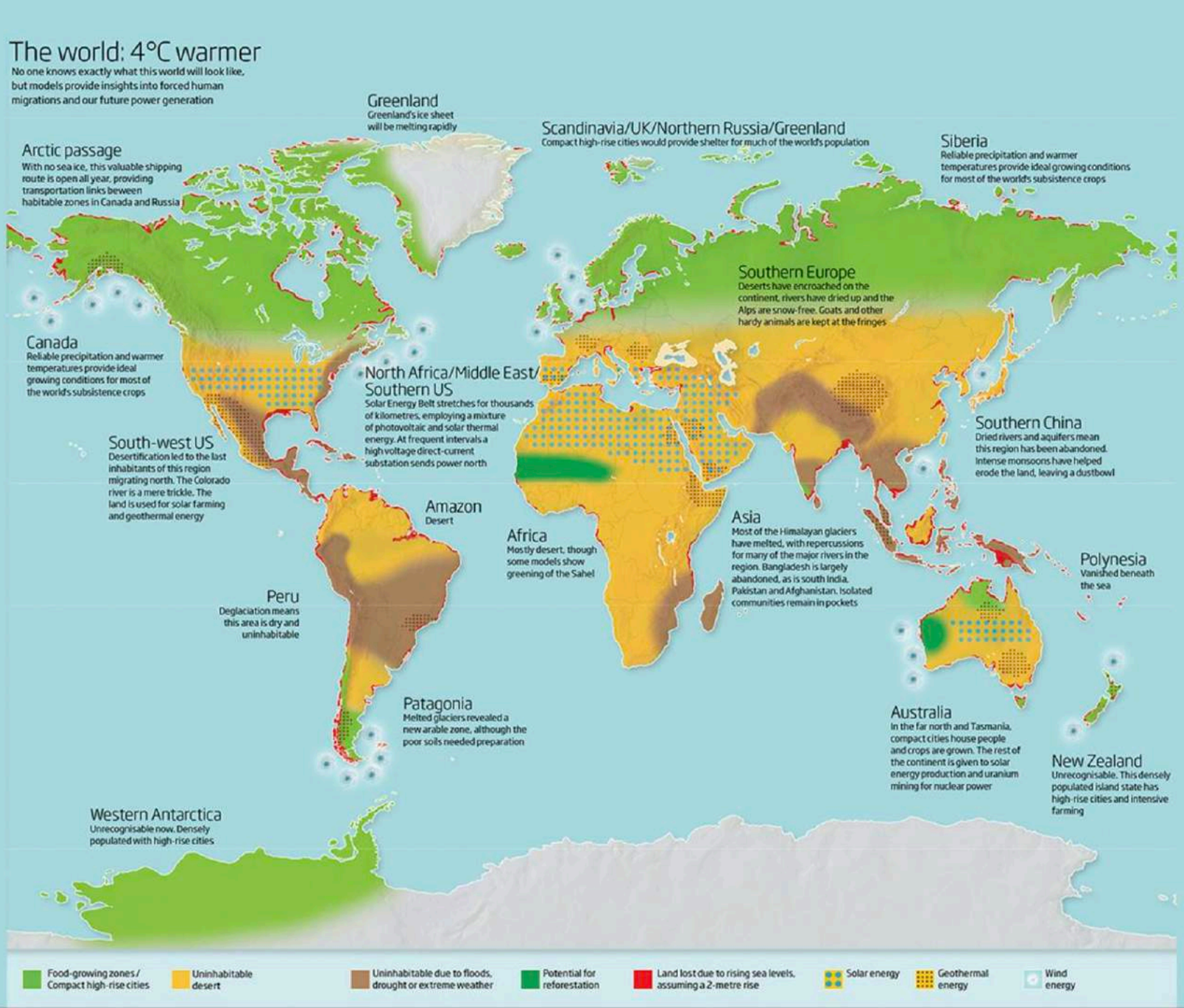
Across Relevant Temporal and Spatial Scales

From Greg Carmichael

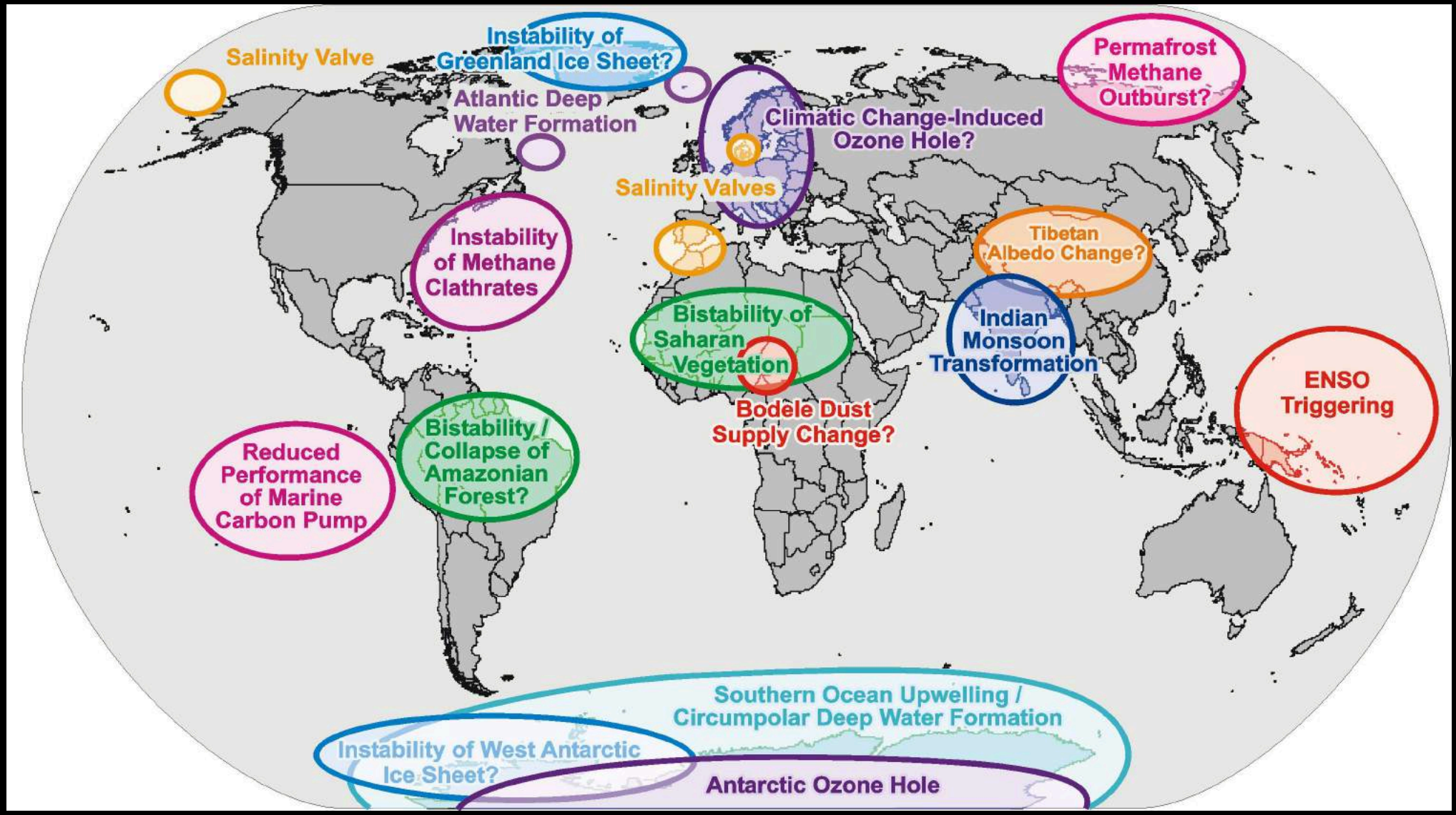
WHAT SCIENTIFIC KNOWLEDGE SHOULD BE PROVIDED BY WCRP TO SUPPORT THE POLITICAL PROCESS?

- QUESTION 3: WHAT WILL BE THE CONSEQUENCES OF A (PLAUSIBLE) WARMING LARGER THAN REQUIRED BY THE PARIS' AGREEMENTS (3, 5 OR 7 ^{0}C)?
- HOW WILL A WORLD RESPOND TO A 5 ^{0}C WARMING?
- WHICH REGIONS OF THE WORLD ARE LIKELY TO BECOME INHABITABLE?
- WILL TIPPING POINT(S) BE CROSSED WITH IRREVERSIBLE AND DRAMATIC ENVIRONMENTAL AND ECONOMIC CONSEQUENCES?
- WHAT FUTURE IS POSSIBLE? (PLAUSIBLE SOCIAL ECONOMIC WORLD UNDER CLIMATE CHANGE)
- WHAT WOULD BE THE IMPACT OF CLIMATE INTERVENTION?
- STRATEGIC PLAN: WCRP SHOULD FACILITATE THE DEVELOPMENT OF A NEW GENERATION OF COUPLED EARTH SYSTEM MODELS THAT EXPLICIT REPRESENT GLOBAL STORMS, DEEP CONVECTION OCEAN EDDIES AND LAND-ATMOSPHERE INTERACTIONS (1 KM) AND PROVIDE RELIABLE INFORMATION WITH RELIABLE REGIONAL PRECISION.

The World under a 4^{0}C warming

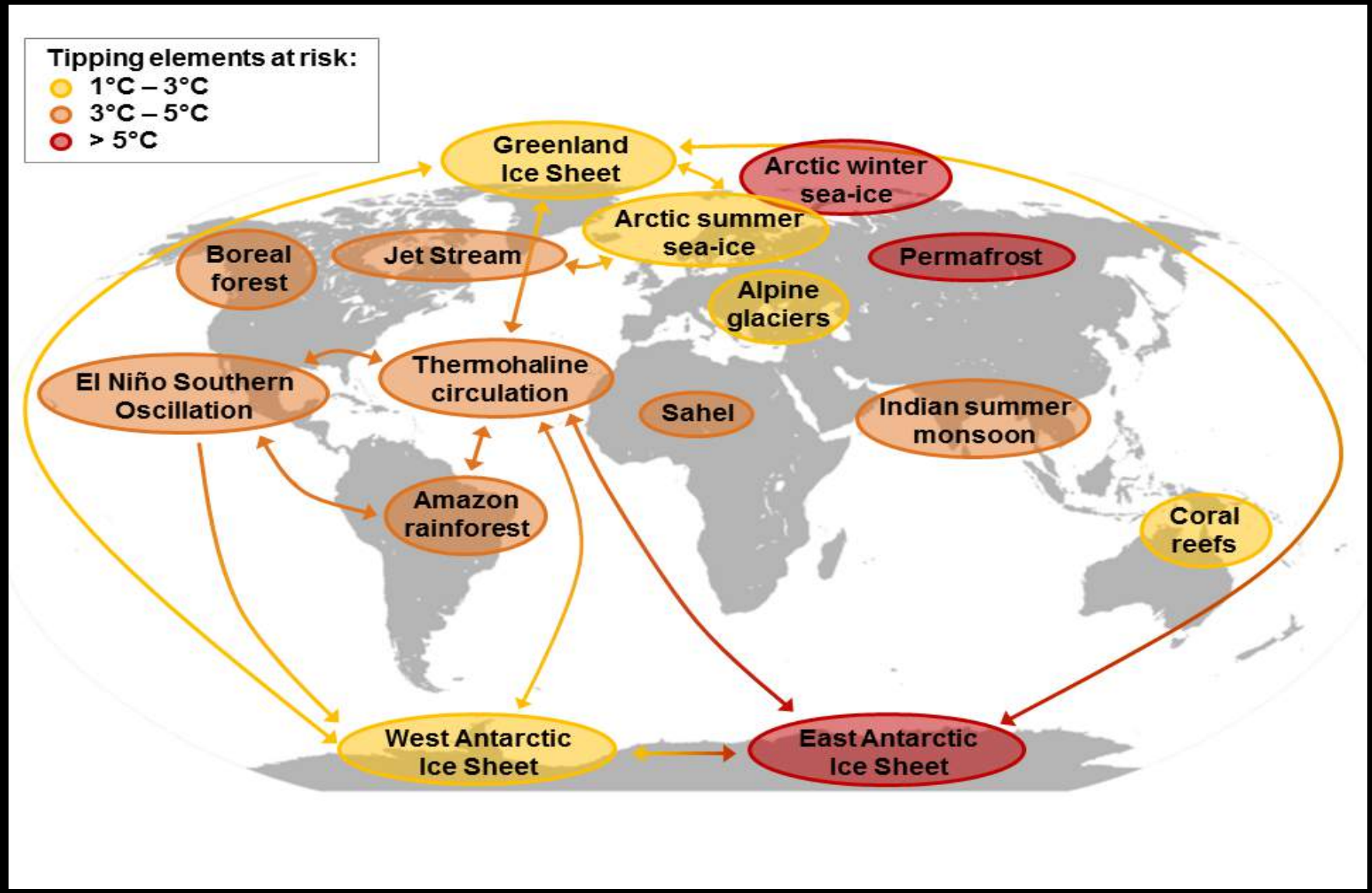


Tipping Elements in the Earth System



Schellnhuber, after Lenton et al, PNAS, 2008

Tipping Cascades



Source: J. Donges and R. Winkelmann in Steffen et al. 2018

WCRP WILL SUPPORT THE DEVELOPMENT OF SOLUTIONS TO THE CLIMATE CRISIS

- Climate Change is a global problem, but the solutions required integrated information at the regional and even local scale.
- WCRP Must engage with different communities, which should use reliable scientific information towards integrated solutions to the climate crisis.
- The solutions are not only a matter of environmental policy. They involve economic and technological aspects (engineering) as well as individual behavior.
- Climate science cannot be isolated from social, economic and cultural aspects. Need to link with other research programs.
- WCRP should share decision-relevant information and knowledge (two-way dialogue) to these different heterogeneous groups including climate services in their efforts to develop solutions to the climate crisis.

CLIMATE RESEARCH: IS IT SOCIETALLY RELEVANT OR IS IT A FASCINATING SUBJECT?

- NOW THAT GOVERNMENTS HAVE RECOGNIZED THE NEED TO RESPOND TO THE CLIMATE CRISIS, CAN WE STILL CONVINCE THEM THAT OUR FUNDAMENTAL RESEARCH IS OF IMMEDIATE SOCIETAL IMPORTANCE?
- TODAY, THE FOCUS AND THE MONEY ARE ON THE IMPLEMENTATION OF SOLUTIONS
- SHOULD WE NOT CONVINCE THE DECISION-MAKERS THAT THE FUNDAMENTAL UNDERSTANDING THE DYNAMICS OF THE EARTH SYSTEM IS JUST AN INTELLECTUALLY FASCINATING TOPIC JUST LIKE FUNDAMENTAL RESEARCH IN PHYSICS, ASTRONOMY, ETC.?

A CERN-LIKE CENTER FOR CLIMATE STUDIES?

- YES, BUT TO DO WHAT?
- NCAR, FOR EXAMPLE, IS DESIGNED AS A COMMUNITY CENTER TO TACKLE PROBLEMS THAT ARE BROADER THAN WHAT A SINGLE UNIVERSITY CAN DO.
- BUT, NCAR HAS NOT CONVINCED GOVERNMENTS THAT THEIR RESEARCH IS SO FASCINATING THAT FUNDING SHOULD INCREASING.
- WE NEED TO PROPOSE SOME NEW FASCINATING AND CHALLENGING TOPICS THAT MOBILIZE THE COMMUNITY, CREATE AND COMMUNICATE ENTHUSIASM AND CONVINCE FUNDING AGENCIES.

THE PATH FORWARD FOR WCRP

1. WCRP must be at the intellectual forefront not only by facilitating existing initiatives but also by proposing new and challenging studies to be conducted in an international framework. This is the topic of the present meeting.

2. Scientific research has to support society and hence must structure itself to provide the scientific knowledge to stakeholders. But, it must also communicate fascination about some fundamental issues.

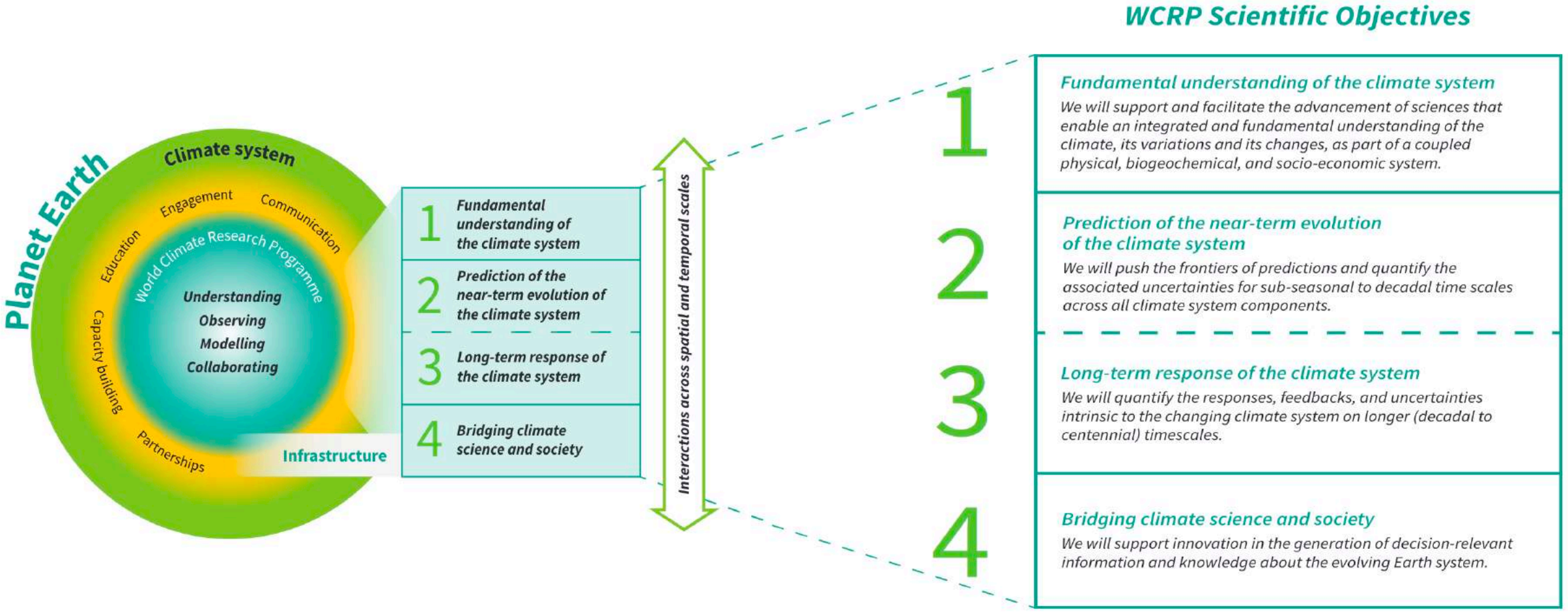
3. The solution to the climate crisis requires knowledge that goes beyond the physical climate question. The link between fundamental science and the response to the climate crisis requires an Earth system approach.

4. The coming decade will see an evolution towards open- and citizen science in most disciplines. WCRP must respond to this evolution, which will allow citizen to become actors in implementing solutions to the climate crisis.

AN IDEA FOR WCRP

- Organize around 2028 (together with other programs) an international Earth system Year with intensive observational and modeling activities to investigate the complexity of planetary dynamics
- (from very interdisciplinary point of views, accounting for multi-scale interactive processes and feedbacks between the components of the Earth System)

THANK YOU


Planet Earth
Climate system
Engagement
Communication
Education
World Climate Research Programme
Understanding
Observing
Modelling
Collaborating
Capacity building
Partnerships
Infrastructure
1 Fundamental understanding of the climate system
2 Prediction of the near-term evolution of the climate system
3 Long-term response of the climate system
4 Bridging climate science and society
Interactions across spatial and temporal scales
WCRP Scientific Objectives
1
Fundamental understanding of the climate system
We will support and facilitate the advancement of sciences that enable an integrated and fundamental understanding of the climate, its variations and its changes, as part of a coupled physical, biogeochemical, and socio-economic system.
2
Prediction of the near-term evolution of the climate system
We will push the frontiers of predictions and quantify the associated uncertainties for sub-seasonal to decadal time scales across all climate system components.
3
Long-term response of the climate system
We will quantify the responses, feedbacks, and uncertainties intrinsic to the changing climate system on longer (decadal to centennial) timescales.
4
Bridging climate science and society
We will support innovation in the generation of decision-relevant information and knowledge about the evolving Earth system.