WORLD CLIMATE RESEARCH PROGRAMME

Detlef Stammer
January 2020
GEWEX SSC, Pasadena

WMO

INTERNATIONAL COUNCIL FOR SCIENCE

WCRP
World Climate Research Programme

2019 JSC

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40 years ago ....

- The **World Climate Research Programme** was established 1980 after a major climate conference concluding that humans are able to affect the climate, but that **precise scientific knowledge was needed to understand the nature and consequences of this disturbance**.

- The conference recommended **international research to improve scientific knowledge of climate** and to use this knowledge to "**predict and prevent possible human-induced climate change** that could affect the well-being of humanity".

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Since then …

- WMO and ICSU (now ISC) formalized the creation of the World Climate Programme in 1980. 1993 the International Oceanographic Commission (IOC) of UNESCO became a third official co-sponsor.

- **WCRP became** a component of of the World Climate Programme, coordinates international climate research, and today as much as before provides a **reference framework for both individual researchers and national funding agencies**.

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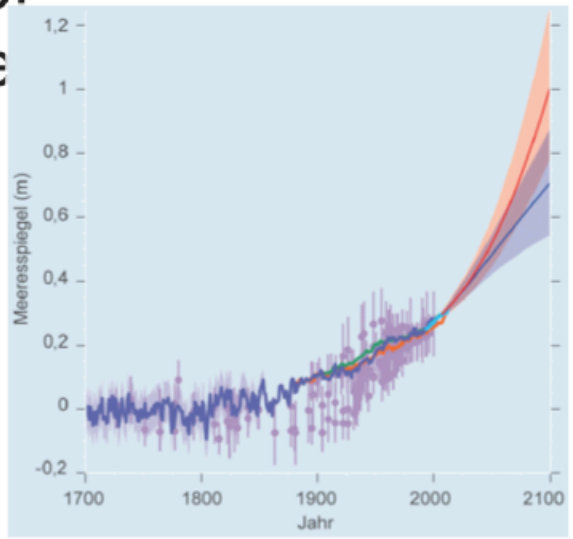
WCRP's Initital Mission

Until recently WCRP's mission was to facilitate the analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to socie



The two overarching objectives were:

- to determine the **predictability of climate**;

and

- to determine the **effect of human activities** on climate

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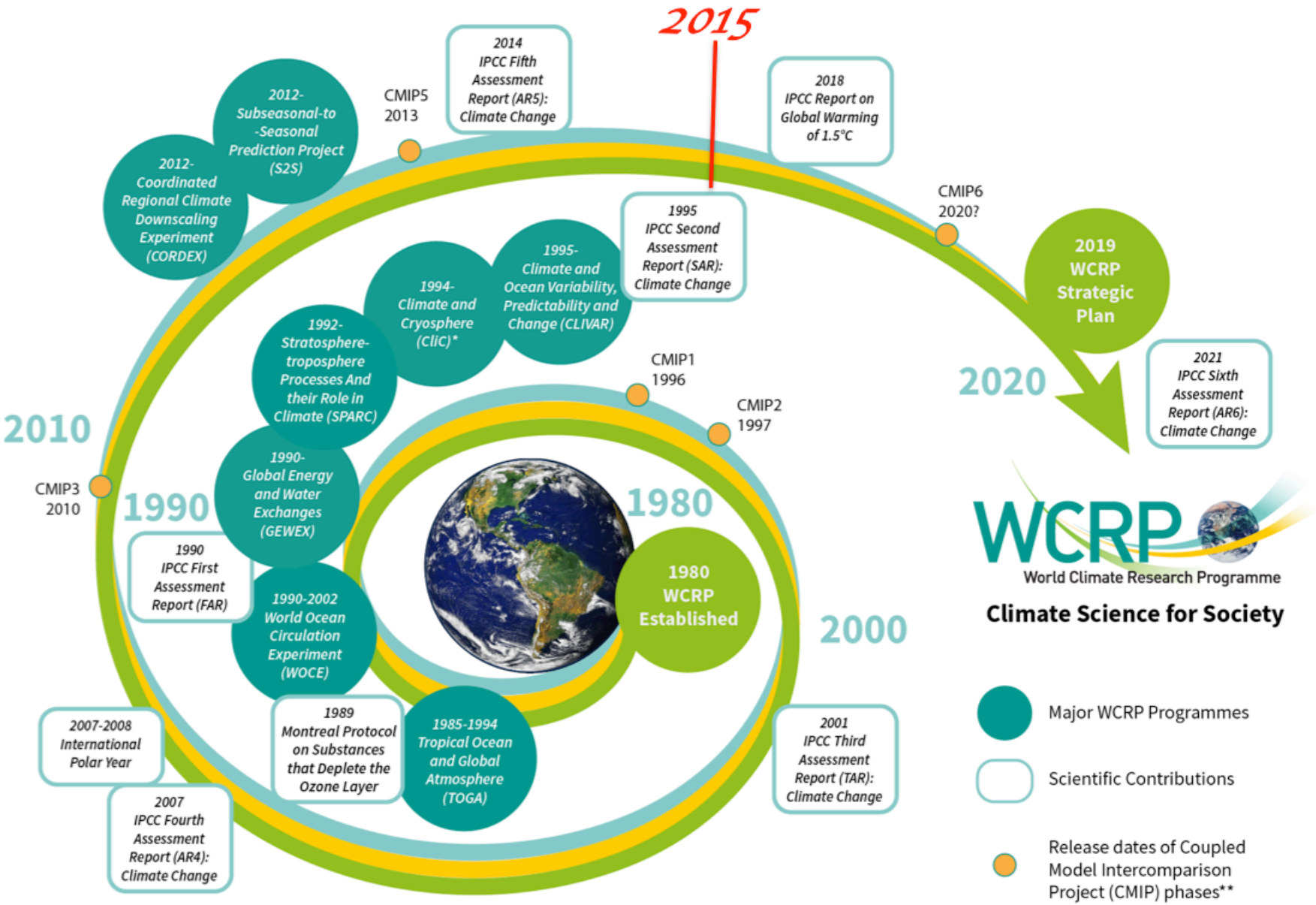

* CliC was formerly the Arctic Climate System Study (ACSYS)
** There was no CMIP4

JOINT SCIENTIFIC COMMITTEE (JSC)

WCRP MODELLING ADVISORY COUNCIL (WMAC)

WCRP DATA ADVISORY COUNCIL (WDAC)

WORKING GROUPS ON:

- COUPLED MODELLING (WGCM)
- NUMERICAL EXPERIMENTATION (WGNE)
- SUBSEASONAL TO INTERDECADAL PREDICTION (WGSIP)
- REGIONAL CLIMATE (WGRC)

CRYOSPHERE-CLIMATE

OCEAN-ATMOSPHERE

LAND-ATMOSPHERE

TROPOSPHERE-STRATOSPHERE

REGIONAL CLIMATE DOWNSCALING

GRAND CHALLENGES

- CLOUDS, CIRCULATION AND CLIMATE SENSITIVITY
- NEAR-TERM CLIMATE PREDICTION
- REGIONAL SEA-LEVEL CHANGE AND COASTAL IMPACTS
- MELTING ICE AND GLOBAL CONSEQUENCES
- CARBON FEEDBACKS IN THE CLIMATE SYSTEM
- WATER FOR THE FOOD BASKETS OF THE WORLD
- WEATHER AND CLIMATE EXTREMES

JOINT PLANNING STAFF (JPS)

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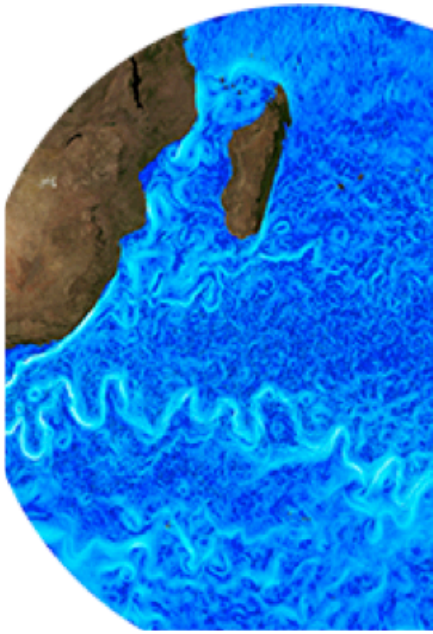
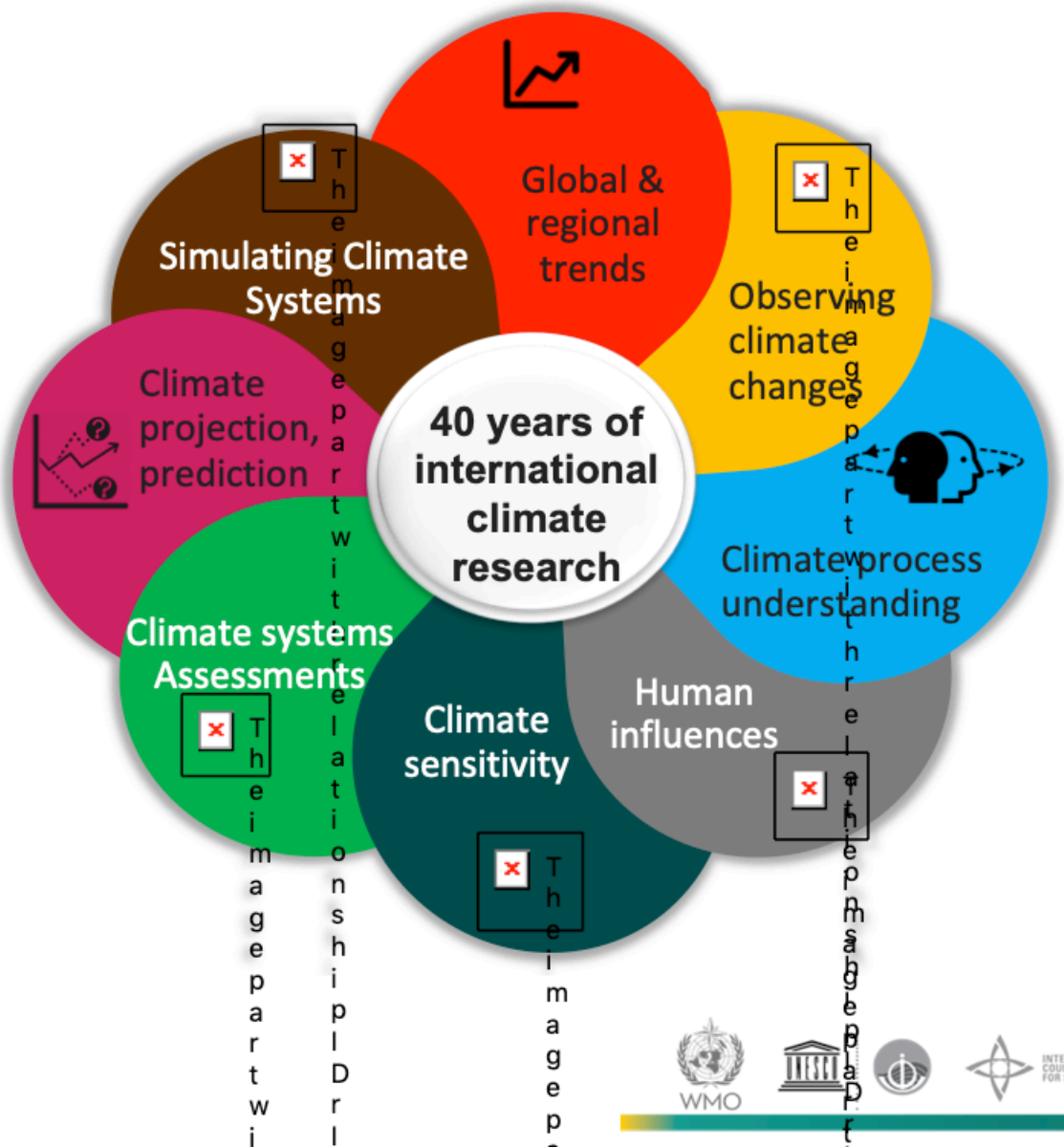
World Climate Research Programme

40 yrs of Major Achievments

- Build initially around existing initiatives WOCE, TOGA,
- WCRP fundamentally advances our **understanding of the climate system**,
- helped the **development of spatial and *in situ* observing systems**, climate data processing and assimilation methods
- improved computational facilities and **enabled extraordinary developments of numerical coupled climate models**, which established the the basis for ongoing climate politics.



40 yrs of Major Achievments



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2015: A Landmark Year

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

- Over 190 countries signed up to reduce emissions, with the target to stay within a 2ºC world.

UN World Conference on
Disaster Risk Reduction
2015 Sendai Japan

- 15-year agreement for the substantial reduction of disaster risk and losses in lives, livelihoods and health.

- 2030 agenda with 17 goals to end poverty and hunger, improve health and education, making cities more sustainable, combating climate change, and protecting oceans and forests.

Understanding and Quantifying Weather and Climate Risk are at the Core of these Actions

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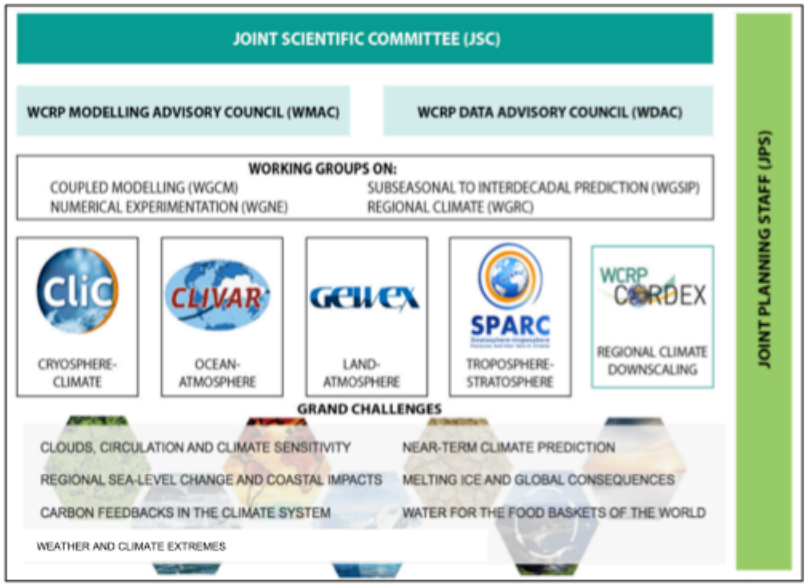
WCRP Review 2018



Unwieldy, complex and confusing.

Core Projects stuck in the past?

Where is whole system approach?

Where is next generation model development?

Where is the pathway to climate services?

Where is climate change?

CURRENT STRUCTURE IS NOT THE STRUCTURE FOR THE FUTURE

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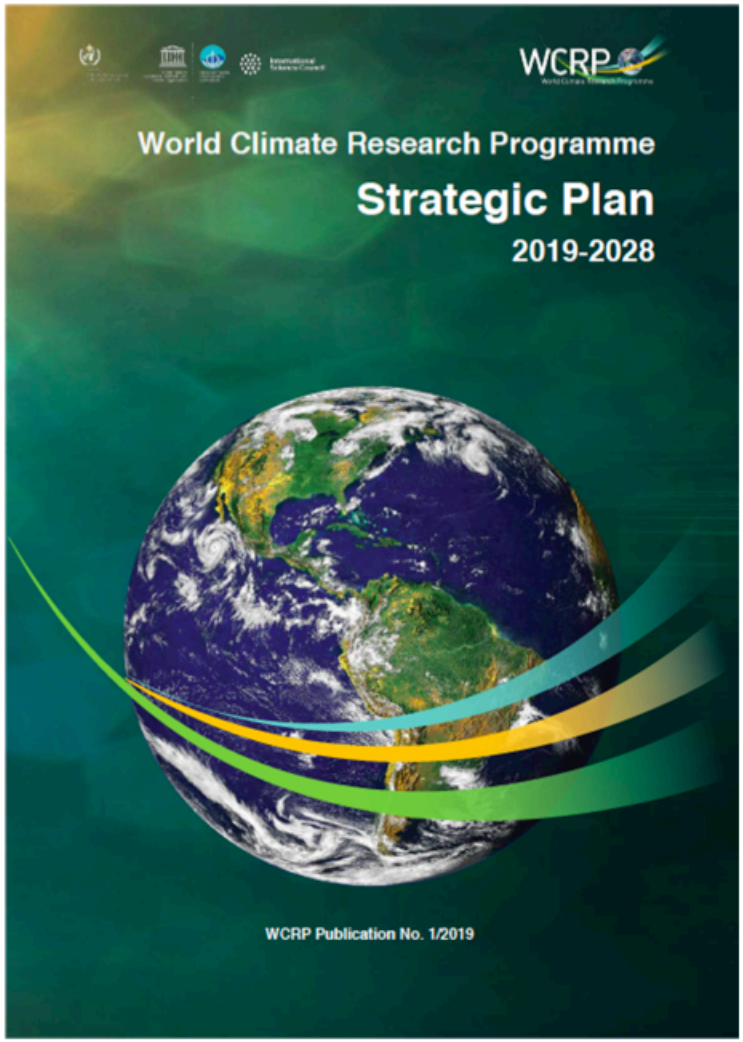
The Future of WCRP



The New Strategic Plan of WCRP

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The Future of the World Climate Research Program

The Vision

A world that uses sound, relevant, and timely climate science to ensure a more resilient present and sustainable future for humankind.

The Mission

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

www.wcrp-climate.org/wcrp-sp

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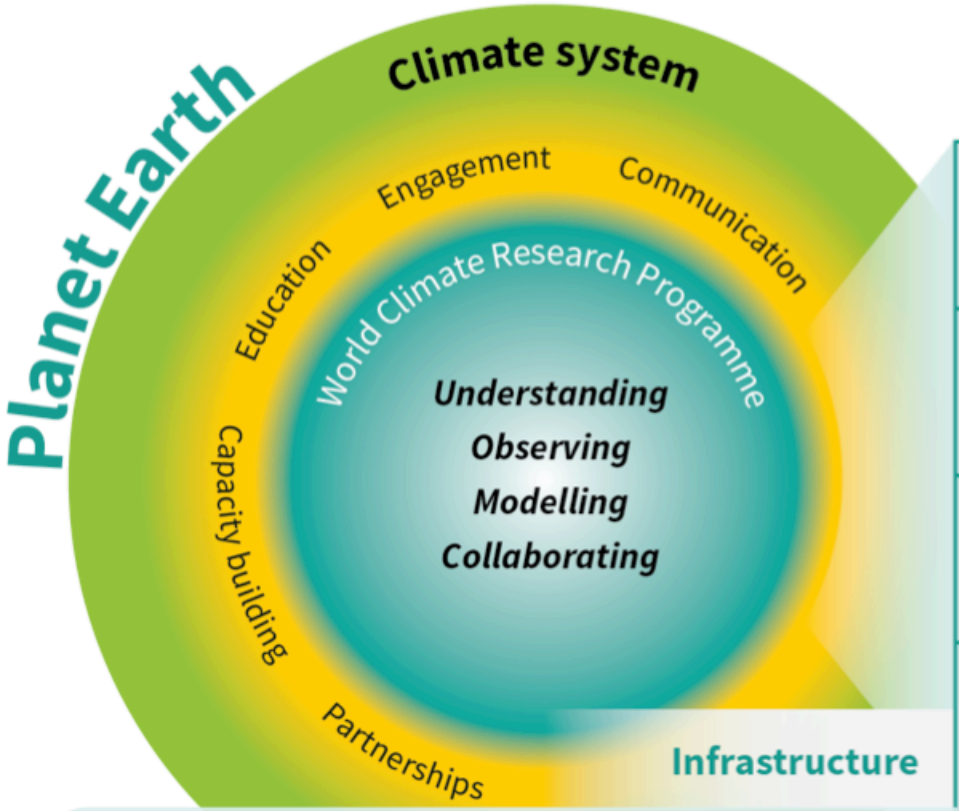
WCRP Strategic Plan: Overview



Scientific Objectives

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

- A hierarchy of simulation tools
- Sustained observations and reference data sets
- Need for open access
- High-end computing and data management

www.wcrp-climate.org/wcrp-sp

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Scientific Objectives

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.

Emphases:

- **Climate dynamics**: past and future global and regional changes in oceanic and atmospheric circulations
- **Reservoirs and flows**: radiative, hydrologic, cryospheric and biogeochemical changes to the reservoirs and flows of energy, water, carbon, and other climate-relevant compounds

Scientific Objectives

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

Fundamental science is needed for the generation and delivery of decision-relevant information and knowledge

circulations

- **Reservoirs and flows**: radiative, hydrologic, cryospheric and biogeochemical changes to the reservoirs and flows of energy, water, carbon, and other climate-relevant compounds

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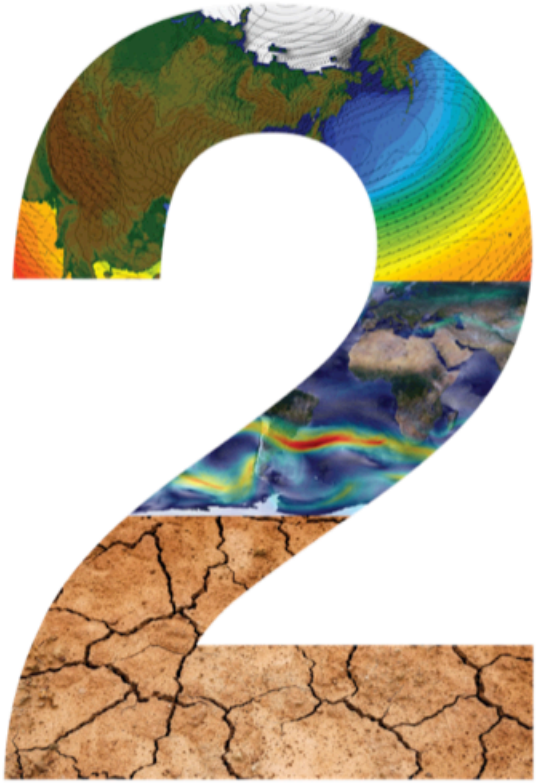
Scientific Objectives

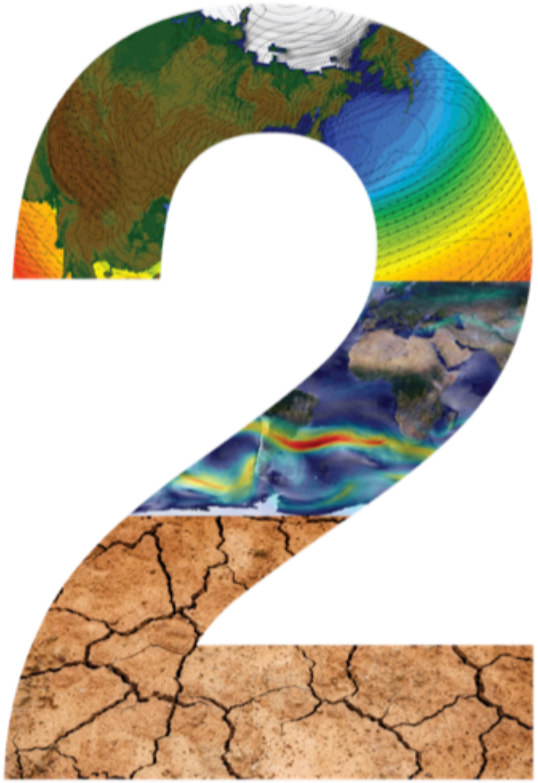


We will push the frontiers of predictions and quantify the associated uncertainties for sub-seasonal to decadal time scales across all climate system components.

Emphases:

- **Advancing prediction capabilities** of component systems and their coupling: Deterministic, statistical and machine learning approaches. Data assimilation, complex networks, and ensemble generation
- **Predicting extreme events**: regional climate hotspots and potential for crossing thresholds. Interactions between fast and slow extremes

Scientific Objectives



We will push the frontiers of predictions and quantify the associated uncertainties for sub-

Need for Actionable climate information:

Salient and credible information on current and future states of climate, on required timescale and spatial range

- **Predicting extreme events**: regional climate hotspots and potential for crossing thresholds. Interactions between fast and slow extremes

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Scientific Objectives

We will quantify the responses, feedbacks, and uncertainties intrinsic to the changing climate system on longer (decadal to centennial) timescales.

Emphasis:

- **Simulation capabilities:** Development of integrated models that account for the slowly varying interactions and highly non-linear processes. Representation of the complex interactions between aquifers, vegetation and soil carbon, permafrost, glaciers, and ice sheets, and human activities

Scientific Objectives

We will quantify the responses, feedbacks, and uncertainties intrinsic to the changing climate system on longer (decadal to centennial)

Need for a better understanding of the long-term response, including climate sensitivity

varying interactions and highly non-linear processes. Representation of the complex interactions between aquifers, vegetation and soil carbon, permafrost, glaciers, and ice sheets, and human activities

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Scientific Objectives

We will support innovation in the generation and delivery of decision-relevant information and knowledge about the evolving Earth system.

Emphases:

- **Interactions with social systems**: Social processes and emergent behaviour in the Earth System. Interactions and feedbacks between climatic and socioeconomic systems
- **Engaging with society**: Actionable climate information, scientific assessments, educational approaches and public communication strategies

Scientific Objectives

Resilient society and sustainable future require collaborative efforts with multi-sectoral actors in all regions of the globe.

Whole value chain for Research – Services – Decisions – Benefits

Co-production of knowledge, co-design of solutions

Connecting global to local scales for adaptation

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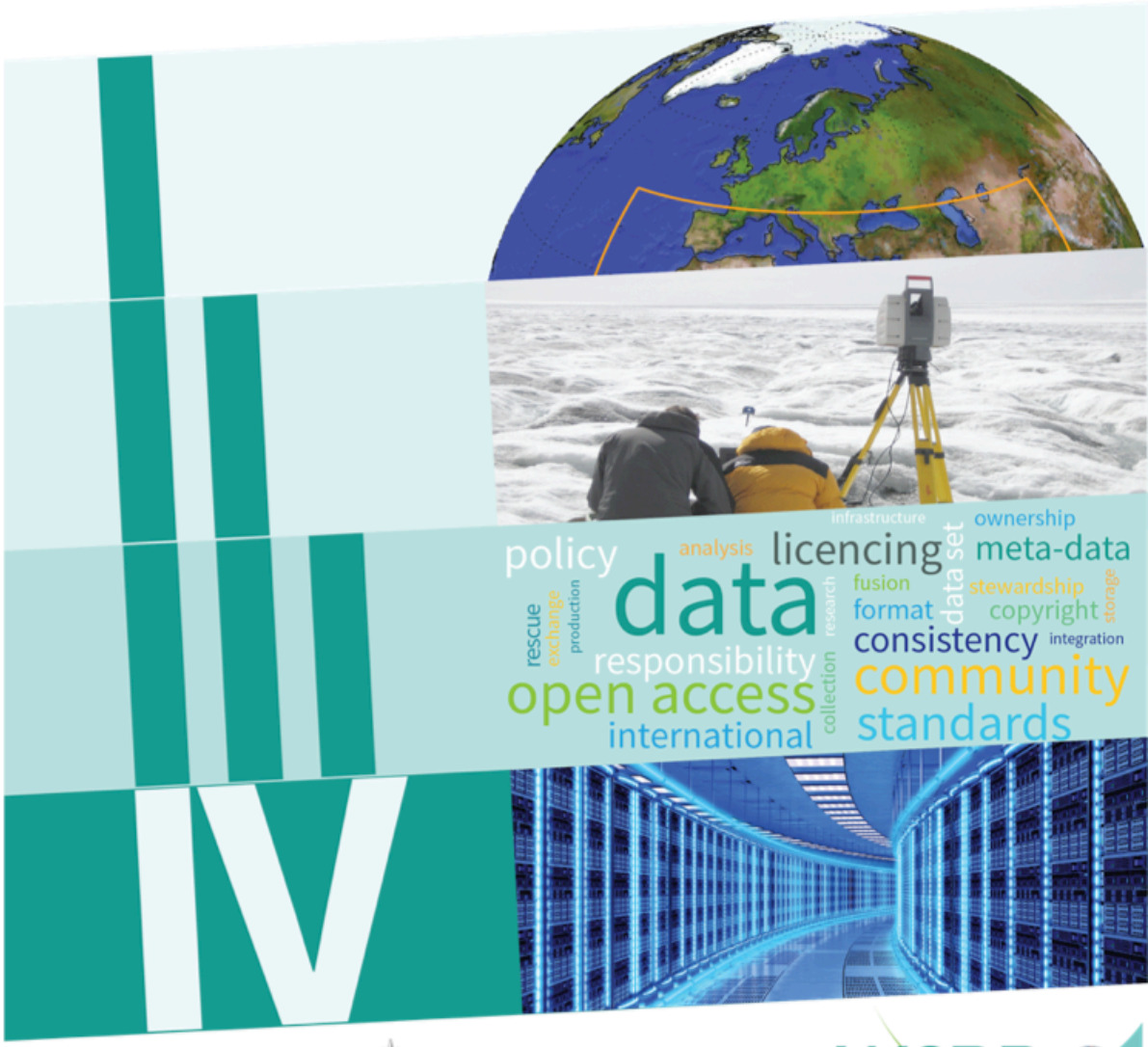
Critical Infrastructure

I. A hierarchy of simulation tools
II. Sustained observations and reference data sets
III. Need for open access
IV. High-end computing and data management



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Critical Infrastructure

I. Continuous support for fundamental climate research, and enabling infrastructure, is essential

II. to link science to action.

- Consistent support for critical work (CMIP)
- Co-commitment and investment across

III. nations, disciplines and societal sectors

- Embracing diversity, demanding equality, and

IV. building capacity for the future

data management

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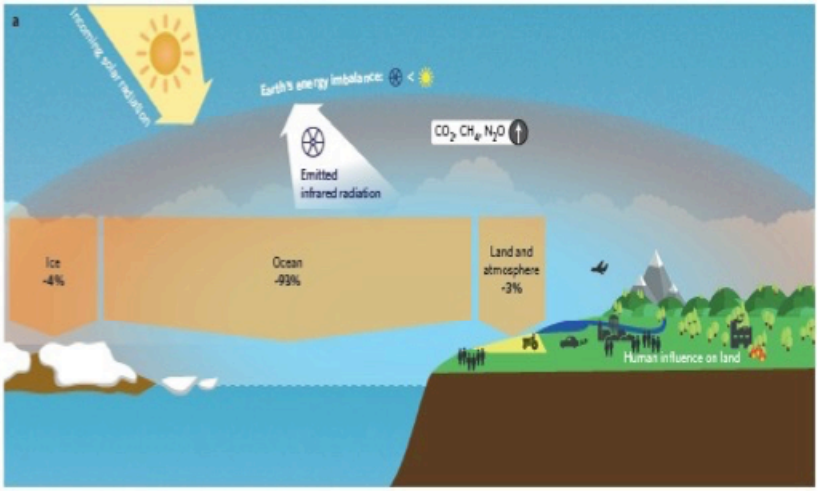
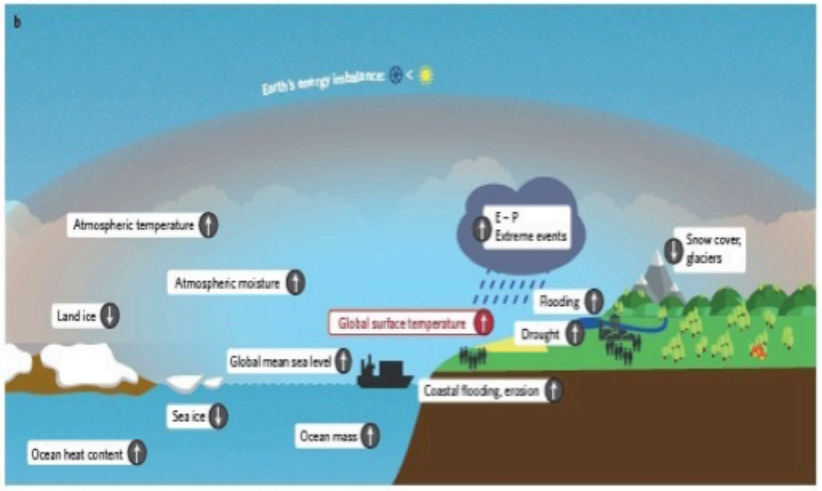
An integrated approach to Climate Science
Example: Earth's Energy Imbalance





Absolute Value

Quantification & uncertainty assessment

Toward sustained & extended global climate observing systems

Inventory

Toward improved consistency for global budget constraint [Ocean, Land, Cryosphere, Atmosphere]

Assess energy stored in the Earth system

Implications

Temporal and spatial variation of EEI & key forcing processes

Global climate observations (in situ, remote sensing)

Reanalysis systems, Climate models

CLIVAR GEWEX SPARC Stratosphere-troposphere Processes And their Role in Climate clic

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Roadmap

Initial planning and conceptualizing

Implementation and Transition Meeting and 40th Session of the Joint Scientific Committee (JSC-40)

May 2019

Consolidation:
- Landscape discussion
- Partner and stakeholder consultation
- Funder and sponsor consolidation

Set up WCRP Task Teams on modelling, data and regional activities

AGU: Community consultation of WCRP Framework
December 2019

"High-level Science Questions and Flag Ship" Workshop
February/ March 2020

"Elements and Structure" Workshop:
March/April 2020

Phase I: Approval of WCRP Implementation Plan:
- High-level science questions and flagship product
- Elements of new WCRP
- Collaboration landscape and interfaces to partners
- Governance
- Financial plan

JSC-41 **May 2020**

- Request from Sponsors for approval of plan
- Writing of WCRP Implementation Plan
- Community and agency outreach, including fundraising

Agreement on final Implementation Plan
(JSC-43)

April 2022

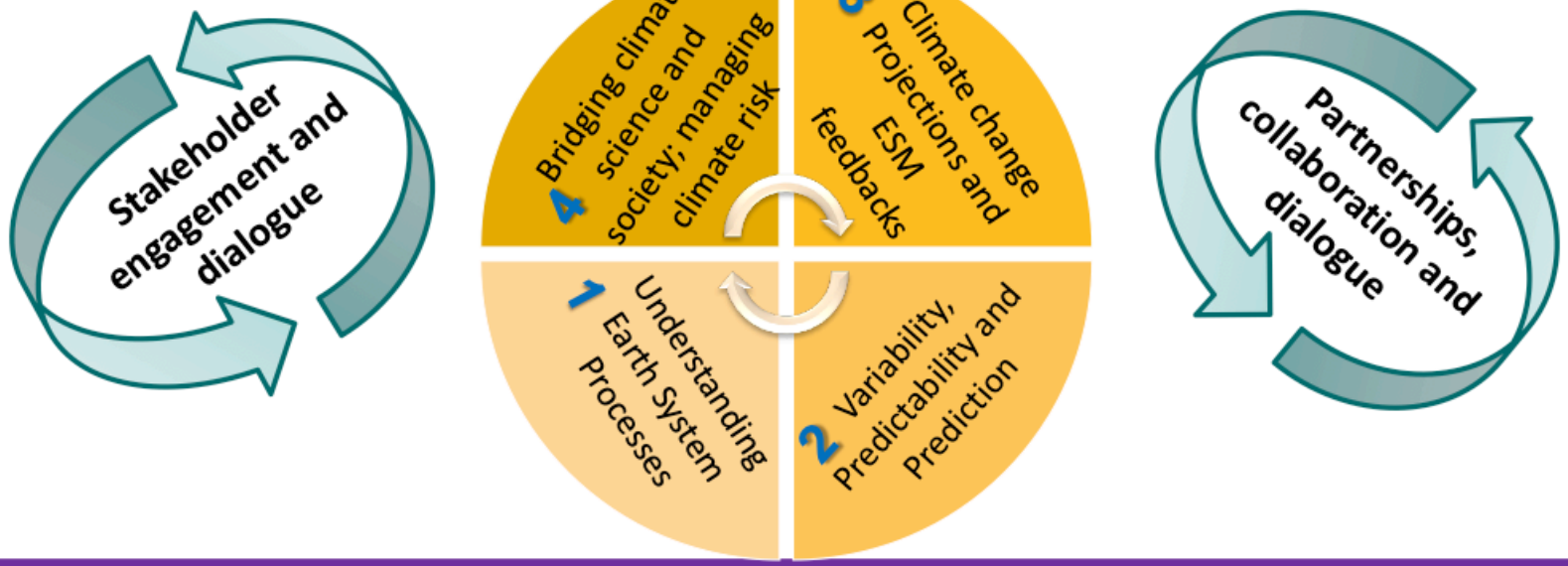
Synthesis of core activities

Transition

Phase II and beginning of transition
(JSC-42)
April 2021

WCRP Mission: to coordinate and facilitate international climate research to develop, share, and apply the climate knowledge that contributes to societal well-being

[Partnerships] Links to sustained observing systems (e.g. GCOS)



Science Questions: Relevance, Innovation, Discovery, Integration

Function: Integration across Earth System (Local to Regional to Global)

Earth System Model Development| Observing system innovation and evaluation| Model – Data fusion
Fora and services for Capacity development, Education, Community building

Function: Infrastructure

Simulation tools| Seamless data| Sustained obs.| High-end comp.; data storage & management|
Platforms for open access, data sharing, collaboration

Climate System Elements

Function: Enduring capability and Link to science communities

Water, Energy, Composition, Dynamics, (Biosphere)
Ocean, Atmosphere, Cryosphere, Land

Global and Regional

[Partnerships] Coordinated Model Experiments and Assessments | Production | Evaluation

Path toward Implementation

The transition from our current functioning WCRP into a new WCRP requires:

- A transparent «bottom-up» approach involving the entire community
- Identifying high-level Science goals; and the key actions required to reach them and to ensure strong “buy-in” from the community
- Identifying those Elements of a new WCRP that are required to put the WCRP Strategic Plan into action, including:
  - structures, milestones, deliverables, resources, measures of success, risk assessment

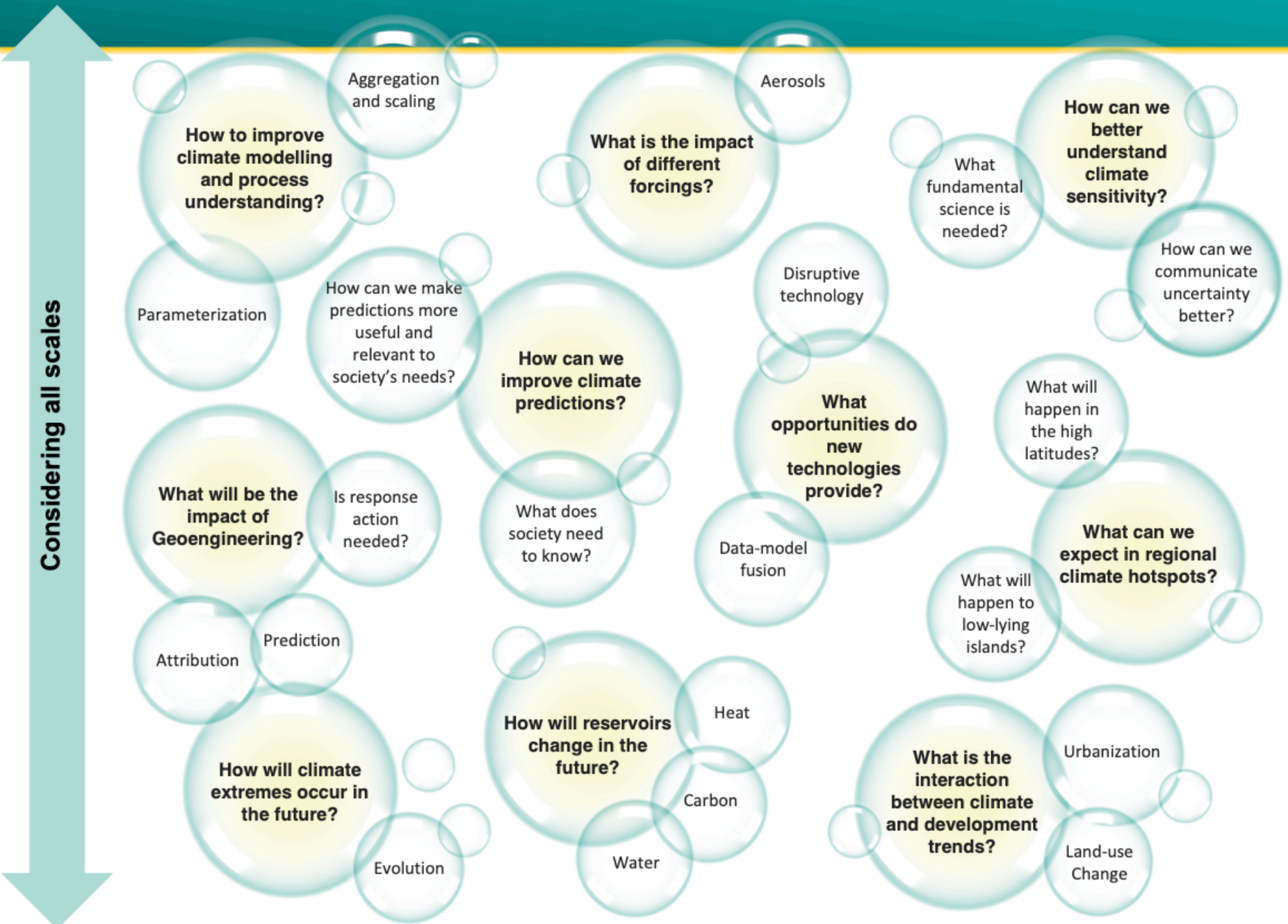
Community Consultation

- Task Teams on Regional Activities, Modelling and Data
- Consultation with funding agencies
- Interaction with WWRP/GAW and other partners
- Integration into new WMO, ISC, IOC
- Interaction with Future Earth and Belmont Forum: Landscape discussion

Next Steps

- February 24- 26, 2020: WCRP High-level Science Questions and Flagship Workshop, Hamburg
- March 2020: WCRP Elements and Structure Workshop, Washington, DC

High-level Science Questions are central



Implementation Plan Elements

Research Projects

- Lifecycle (start and end) with a clear timeline and deliverables
- Joint and co-designed with Partners outside WCRP
- Deliver to Strategic Plan Objectives
- WCRP attributes: Integration; Scale; Relevance; Climate Change; Discovery and Innovation

Jointly through dialogue and co-design

Enduring capability - people: Climate System Elements Infrastructure and Integration

Conferences, Workshops, WCRP Forum

Projects and fora to engage and empower ECRs; and regional partners: part of the WCRP family

Regular Syntheses, Assessments, Gap Analyses Rapid Assessments and Reports

Reference data sets (observed, modelled)

Evaluations, Inter-comparisons, Benchmarking, Standards

Coordination

Educational services and activities

Stakeholder engagement and outreach

Capacity building and communication

Implementation Plan: Roadmap

May/June 2020:

JSC-41: Approval of WCRP Implementation Plan:

- High-level science questions and flagship product
- Elements of the new WCRP
- Collaboration landscape and interfaces to partners
- Governance
- Financial plan

After JSC-41:

- Request from Sponsors for approval of plan
- Writing of WCRP Implementation Plan
- Community and agency outreach, including fundraising

Strategy for what will come

- Bottom-up, community design of new WCRP and consultation
- Evolution, not revolution
- Smooth transition without interruption into better WCRP that is fit for the challenges ahead.

2 year subsequent transition phase to murph into the new structure.

Implementation Plan: Draft Structure

1. Introduction
2. The WCRP Strategy: Vision, Mission and Objectives
3. Engagement
4. Framework
5. Partnerships
   - Identifying key partners
   - Co-designing science questions
   - Identifying common infrastructure
   - Clarifying their role in the Strategy
   - Reaffirming current, and building new
6. Implementation
   - Transition Plan
   - Schedule: Gantt chart, milestones, deliverables
7. Measures of success
8. Risks and contingencies

Phase I
(by 2020)

Phase II
(by 2022)

Fully consultative development

Will include:

- Support functions (including support offices)
- External governance: sponsors, Joint Scientific Committee, Governing Board, Joint Planning Staff (Secretariat)
- Internal structure and governance
- Resources, budgets, finance management

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WCRP Science Week at AGU

Purpose of the Week

- Celebrating 40 years of WCRP in service to society
- Thank the community for its loyalty
- Entrain the next generation scientists
- **Discuss and plan with you WCRP's future**

40th Anniversary

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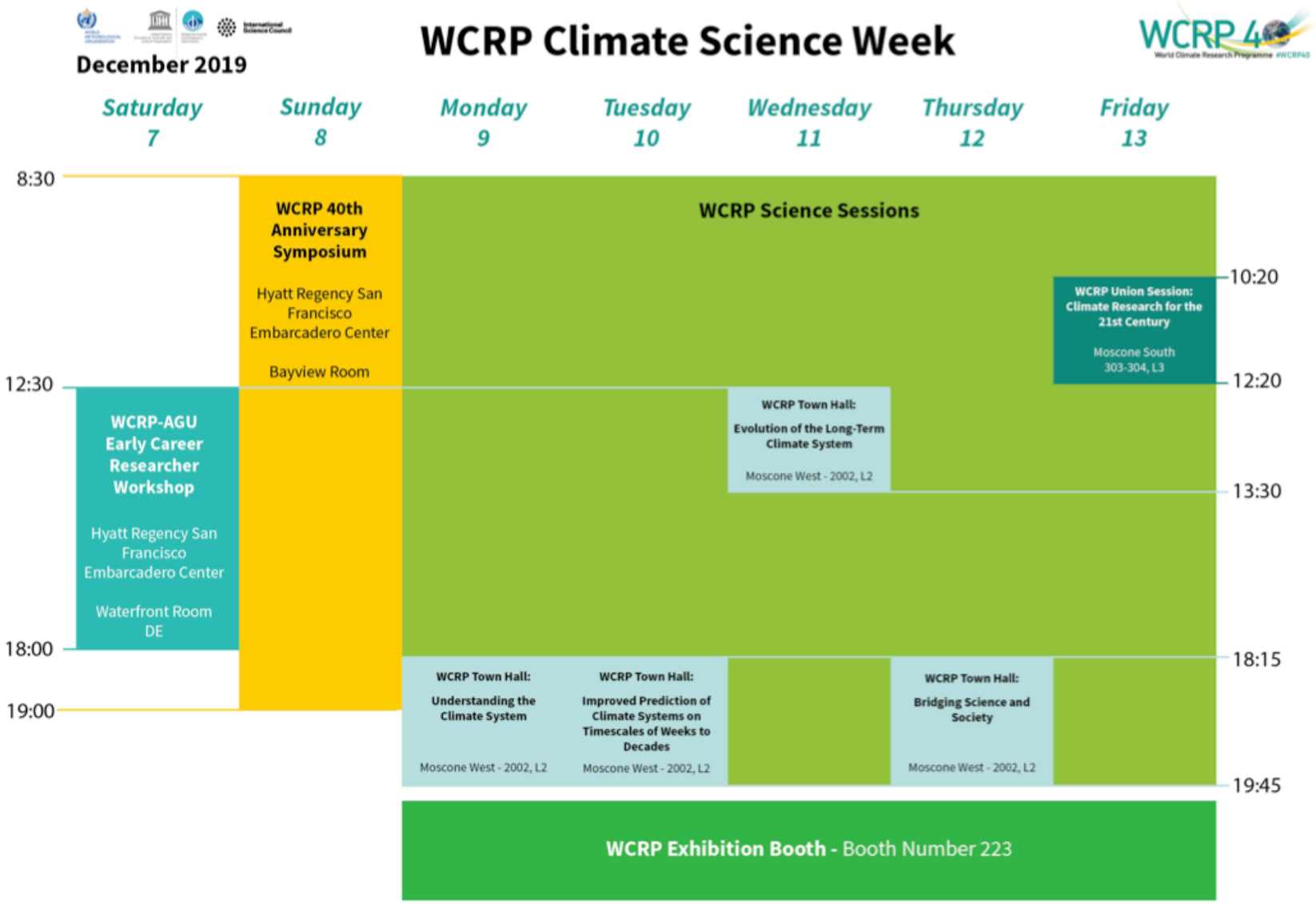
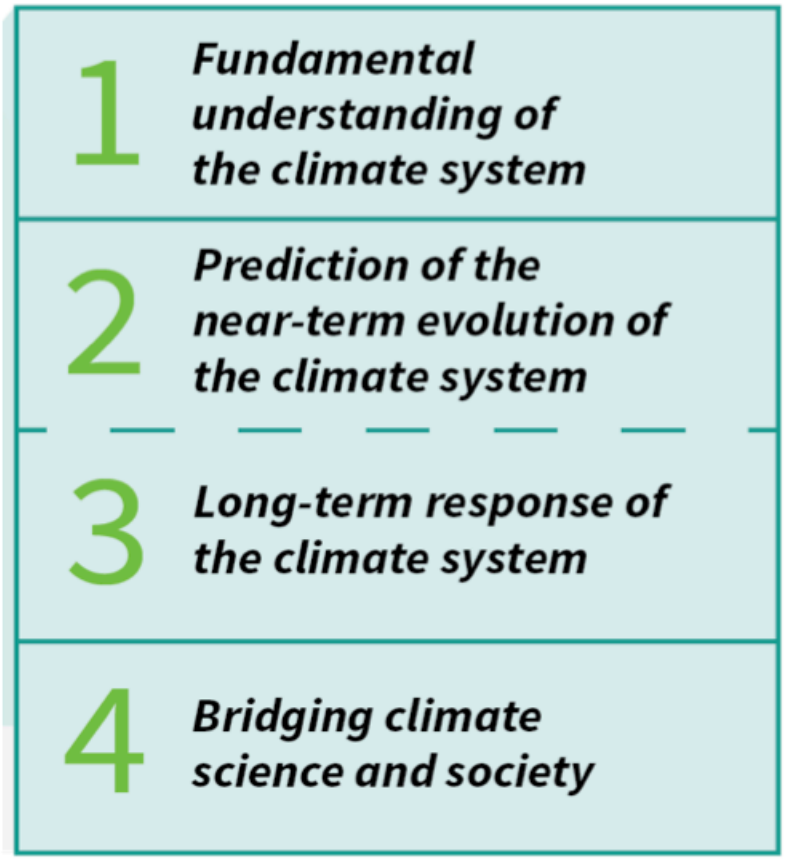
Climate Science Week: Series of events



Town Halls – key messages

4 Town Halls – each addressing a Science Objective from the WCRP Strategy



WCRP 4
World Climate Research Programme #WCRP40

AGU100 ADVANCING EARTH AND SPACE SCIENCE

WCRP CLIMATE SCIENCE WEEK

AGU FALL MEETING, 7–13 DECEMBER 2019

Union Session

Audience participation at: **www.sli.do**

#WCRP40

Town Halls – synthesising some key messages

A. Starting with foundational climate science challenges:

1. **Model accuracy** – addressing [diagnosing and resolving] "stubborn" biases and systematic errors; addressing uncertainty [ensembles, storylines ...]
   - Can't yet forecast precipitation at weather, seasonal and climate change timescales
2. **Climate sensitivity** – understanding, constraining and reducing range [NB key role for paleo climate science here]
3. Science and model frameworks to answer questions about **impacts and consequences of geoengineering**
4. Better understand and quantify the **evolving carbon cycle** (where does the carbon go?) and **budget of short-lived climate forcers** (e.g. methane and ozone)
5. **Atmospheric-based carbon assessments:** brings transparency & rigour to inventory-based methods; forecasts and projections of physical climate AND BGC
6. **Credible and skilful regional to local scale climate information**
   - Seamless across past, present and future
   - Addressing weather and climate extremes
   - Will need to represent urban areas
   - Accessible and useful for risk assessments and decision support systems

Town Halls – synthesising some key messages

B. Moving to Impacts and Solutions:

7. How will climate change affect:
   - Weather in different regions of the world?
   - Ecosystems and food productivity?
   - Air quality?
8. What does a 4 degree, 5 degree, 7 degree world look like?
   - Which regions of the world are likely to become un-inhabitable?
   - Thresholds, tipping points and surprises – with irreversible and dramatic environmental and economic consequences?
9. Pathways, from now to post 2100 [*need to clarify this one*]
10. What are the questions, experiments, flagship programs that can only be done by a **World Climate Research Programme**?

Town Halls – synthesising some key messages

C. Climate Science Capability - Infrastructure:

1. **Observing Systems remain fundamentally important**:
   - Critical for Near-term prediction (initialization and data assimilation); Process understanding; and Parameter estimation [Model – Data Fusion]
   - New technologies need to be explored, developed and deployed
   - Critical importance of ocean observations (but don't forget land and air!)
2. **Climate Models**
   - Addressing model accuracy issues (see science challenges)
   - Earth System Models: Feedbacks; incl. Human systems; Regional ESMs
   - Regional models: credible approaches for simulating regional climates; statistical downscaling; building higher resolution models – process representation; greater skill?
   - Exploit ML/AI (and digital technologies generally): "data driven science"
   - Seamless prediction?
   - Trade-off between Resolution and complexity; Ensemble size and diversity
   - Choosing the right model for the problem
   - A model hierarchy

Town Halls – synthesising some key messages

C. Climate Science Capability – Infrastructure *cont*:

3. **High Performance Computing and Data**: a real challenge facing us now!
4. **CMIP is one of WCRP's most successful initiatives/products**
   - Securing its future so that it meets both scientific and operational (IPCC, Climate Services) needs
   - Whilst also being sustainable into the future
   - Better advertising our successes?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World Climate Research Programme
World Climate Research Programme (WCRP)
The JSC looks forward to a continuous joint journey with the WCRP family.
WORLD METEOROLOGICAL ORGANIZATION
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
International Science Council