



# WORLD CLIMATE RESEARCH PROGRAMME

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Boulder CO, USA



ICSU  
International Council for Science



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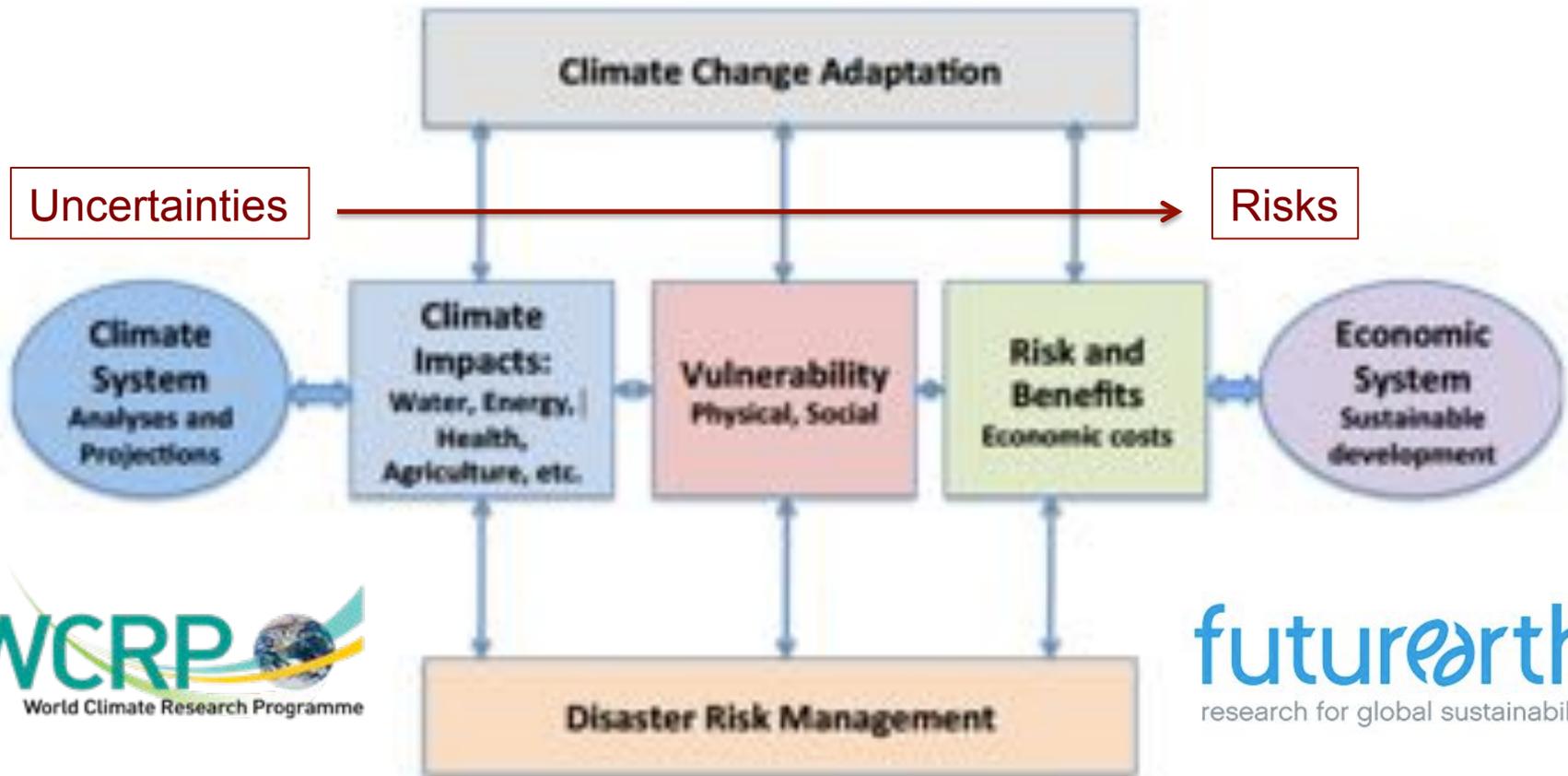
# CLIMATE CHANGE

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## REDUCING AND MANAGING RISKS

# The Science in Support of Risk Management

## Building a Resilient Society



# History of WCRP

- WCRP was established in 1980 under the joint sponsorship of the International **Council for Science** (ICSU) and the **World Meteorological Organization** (WMO). In 1993, The **Intergovernmental Oceanographic Commission** (IOC) of UNESCO became a sponsor as well.

# WCRP's mission....

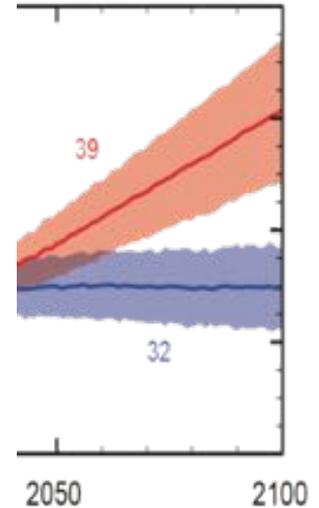
... is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society.

*The two overarching objectives of the WCRP are:*

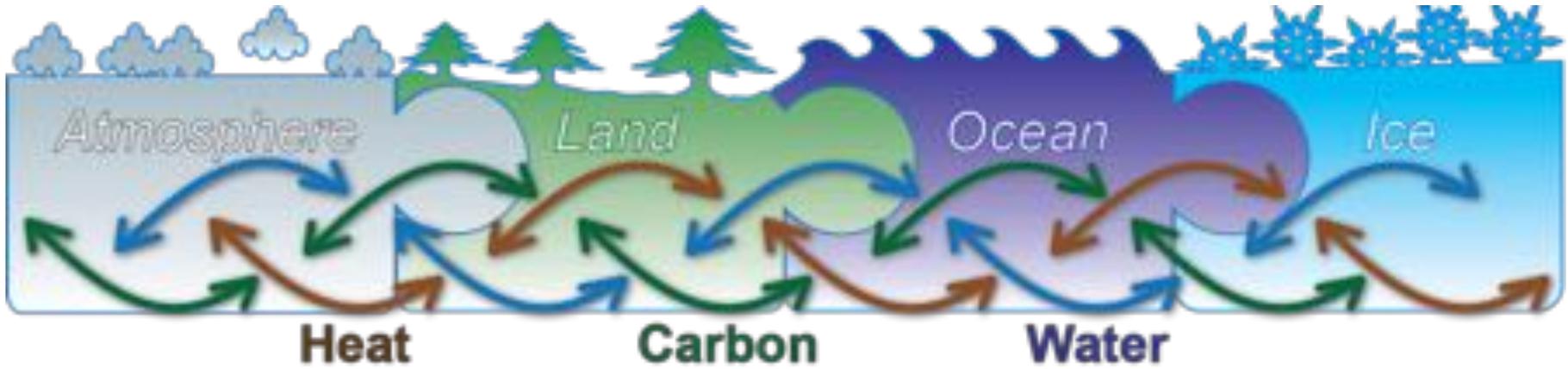
to determine the predictability of climate

to determine the effect of human activities on climate

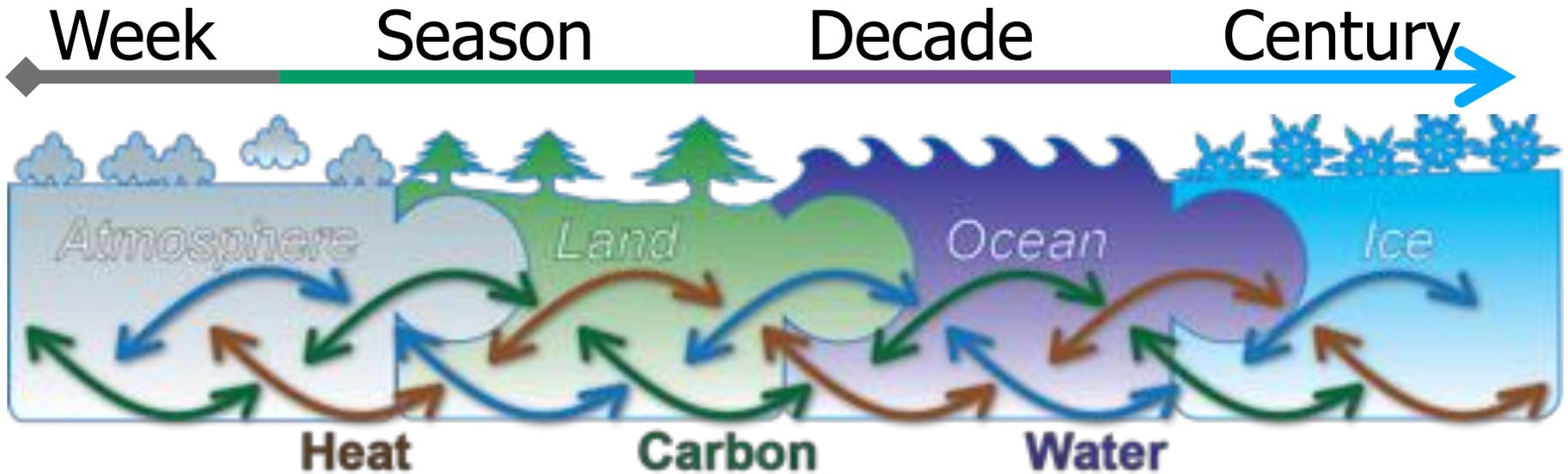
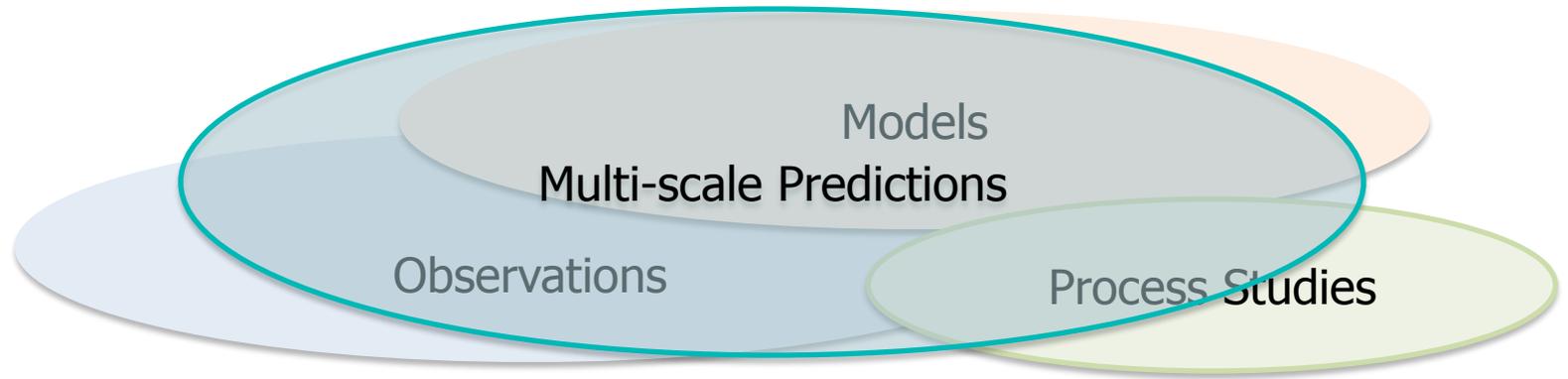
# Role of WCRP



Week      Season      Decade      Century



# Role of WCRP



# WCRP Structure

Joint Scientific Committee

Joint Planning Staff

Modeling Advisory Council

Data Advisory Council

**Working Groups on:** Coupled Modeling (WGCM), Numerical Experiment (WGNE), Regional Climate (WGRC), Seasonal to Interannual Prediction (WGSIP)

**cliC**

Cryosphere-  
Climate



**CLIVAR**

Ocean-  
Atmosphere



**GEWEX**

Land-  
Atmosphere



**SPARC**

Troposphere -  
Stratosphere





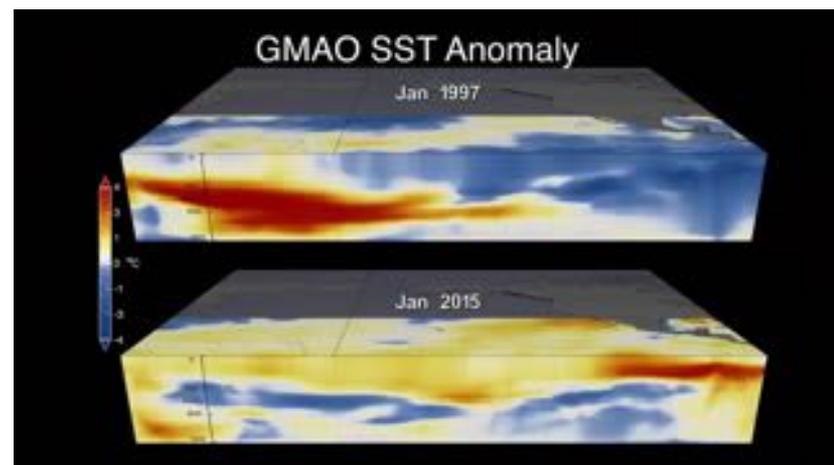
# CLIVAR

*Climate and Ocean: Variability, Predictability and Change*

to understand the dynamics, the interaction, and the predictability of the coupled ocean-atmosphere system

## *Research Foci:*

- **Decadal variability and predictability** of ocean and climate variability
- Marine **biophysical interactions** and dynamics of upwelling systems
- **Regional Sea Level Change** and Coastal Impacts
- Consistency between planetary energy balance and **ocean heat storage**
- **ENSO** in a changing climate
- Intraseasonal, seasonal and interannual variability and **predictability of monsoon systems**



*El Niño comparison 1997 vs. 2015, NASA Visualization Lab*

# An Impressive CLIVAR Conference in Qingdao



# An Impressive CLIVAR Conference in Qingdao

- The Climate System is highly variable, and the ocean plays a key role in this variability
- Multi-scale climate variability with possibly surprises (ocean dynamics, decadal oscillations, extreme events, carbon uptake, etc.) has major impacts on society (weather, food chain, seasonal-to-decadal cycles, etc.) and its understanding is a major scientific challenge.
- Small-scales and their interactions with larger scales are important and poorly documented. Building resilience requires a regional approach for climate research.
- There is a major intellectual potential (including a new generation of motivated scientists) and excellent research facilities to address these pressing issues.
- New research directions initiated by CLIVAR and implemented by the international community will enhance our observation potential and modeling capability to address new frontier questions.



**SPARC**  
Stratosphere-troposphere  
Processes And their Role in Climate

# SPARC

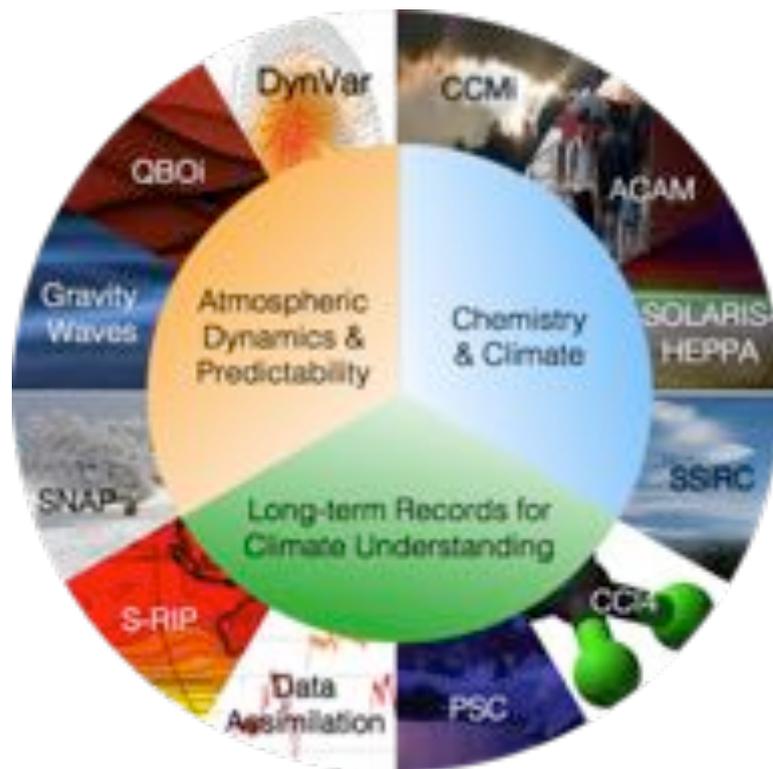
Stratosphere-troposphere Processes And their Role in Climate



coordinating international efforts to bring knowledge of the atmosphere to bear on issues regarding climate variability and prediction

## Themes:

- Climate variability and change and its impact on the atmosphere
- Ozone
- Atmospheric chemistry and aerosols
- Polar atmospheric processes



ICSU  
International Council for Science



→ Understanding the changing cryosphere and its climate connections

## *Four main aims for the upcoming future:*

1. Improved understanding and quantification of the **role of the cryosphere in the global climate system**, its variability and change.
2. Improved utilization of **cryospheric observations** as indicators of global and regional climate change.
3. Improved understanding of the physical, chemical and other **processes** that govern behavior of the cryosphere, and the **representation of these processes in Earth System Models**.
4. Improved ability to make **quantitative predictions and projections** of the cryosphere in a changing climate.



NASA visualization Lab

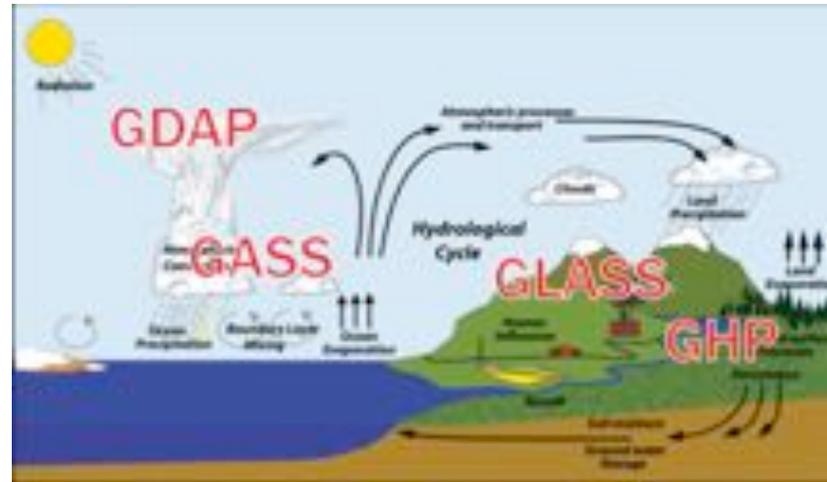


focuses on the atmospheric, terrestrial, radiative, hydrological, coupled processes, and interactions that determine the global and regional hydrological cycle, radiation and energy transitions, and their involvement in climate change.

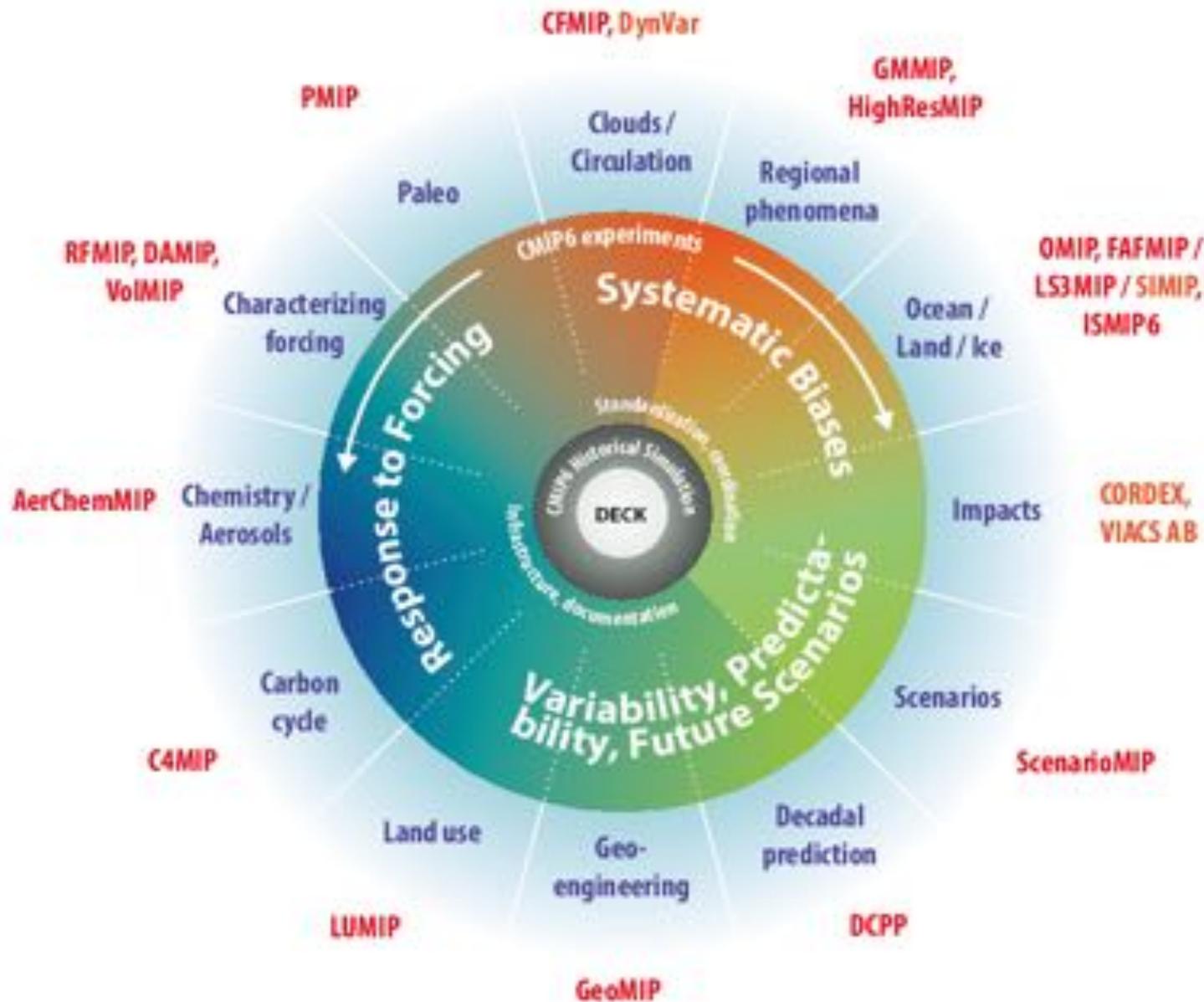
*Focus areas:*

- Water and Energy Cycles and Processes
- Observations and Predictions of Precipitation
- Global Water Resource Systems
- Changes in Climate and Weather Extremes

GEWEX panels:

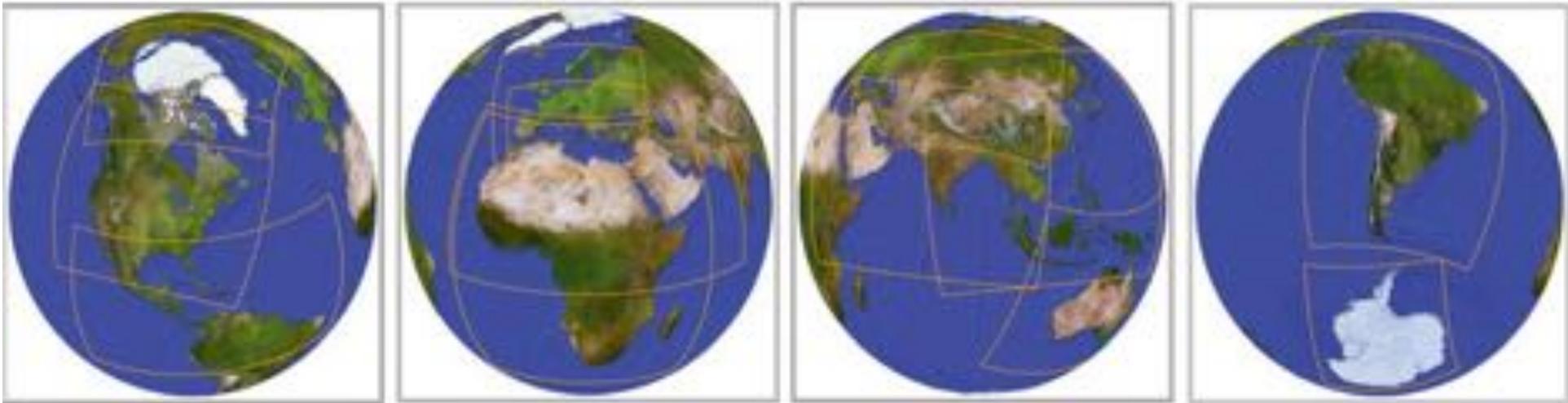


# 21 CMIP6-Endorsed MIPs



# CORDEX

COrdinated DOWnscaling EXperiment



**CORDEX advances and coordinates the science and application of regional climate downscaling through global partnerships.**



# CORDEX

*COordinated Regional climate Downscaling Experiment*



to advance and coordinate the science and application of regional climate downscaling through global partnerships

## *Main aims:*

To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.

To evaluate and improve regional climate downscaling models and techniques

To produce coordinated sets of regional downscaled projections worldwide

To foster communication and knowledge exchange with users of regional climate information



# WCRP Structure

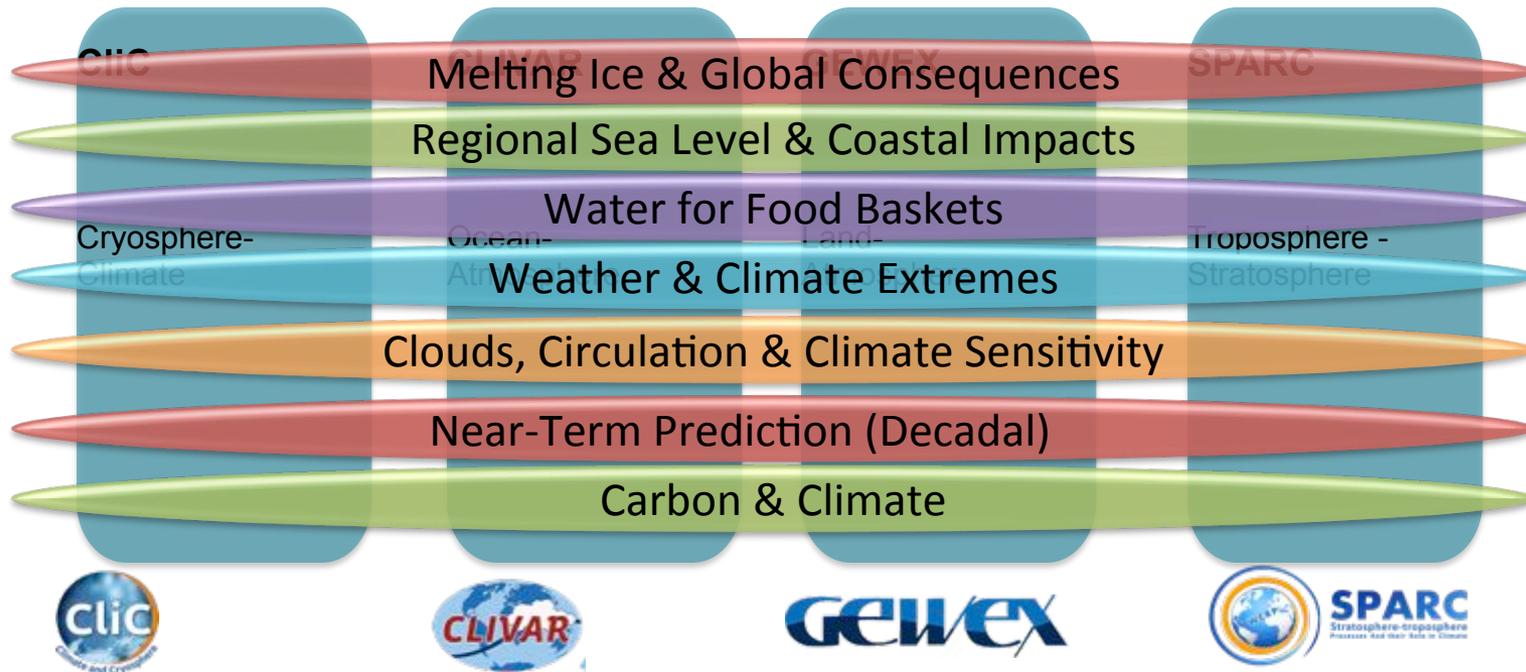
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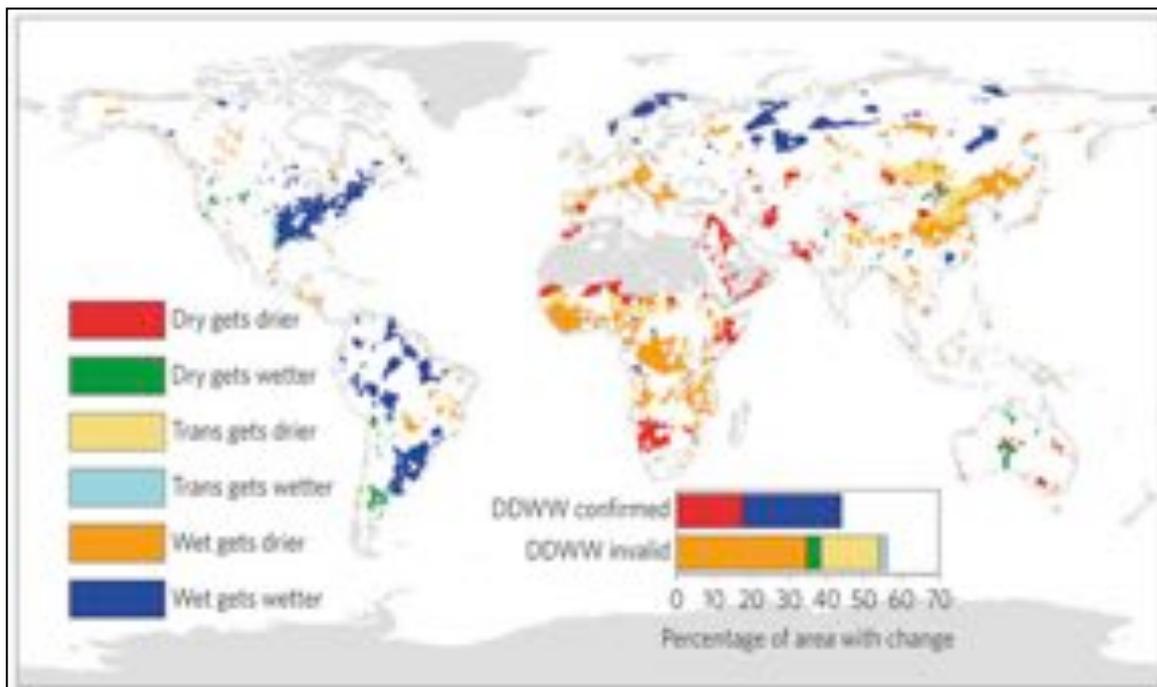
# MELTING ICE and GLOBAL CONSEQUENCES



Snow and ice are seen as bright blue, while vegetation appears green and bedrock brown. Gray stripes on the glacier surface represent rocky debris. NASA visualization Lab

How will melting ice respond to, and feedback on, the climate response to increasing greenhouse gases, and what will the impacts be on:

- *Permafrost and the Global Carbon Cycle*
- *Ice Sheets*
- *Glaciers*
- *Rising Sea Level*
- *Sea Ice and Snow interaction*



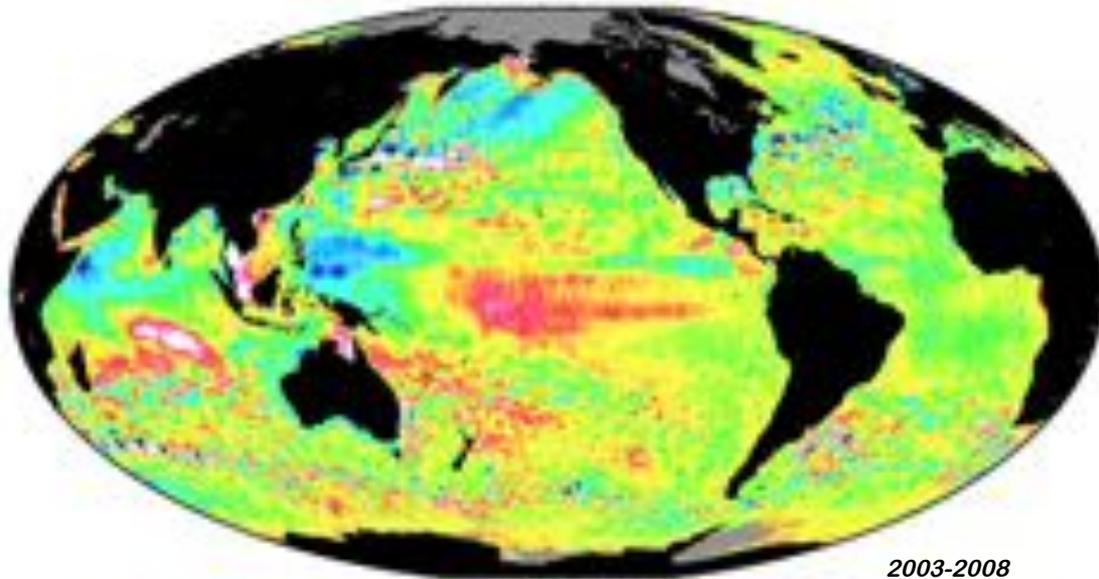
*Greve et al. 2015*

How can we better understand and predict precipitation variability and changes?

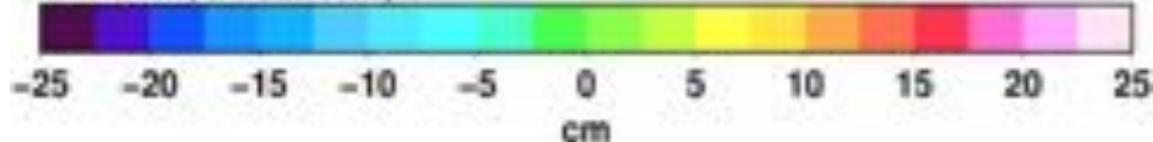
How do changes in land surface and hydrology influence past and future changes in water availability and security?

## Sea surface height anomalies

20030101 to 20030115



NOAA Laboratory for Satellite Altimetry



What are the main causes of contemporary regional sea level variability and change?

What is the degree of decadal variability in sea surface height observations and in forecasts?



# WEATHER and CLIMATE EXTREMES



**document**

**understand**

**attribute**

**simulate**

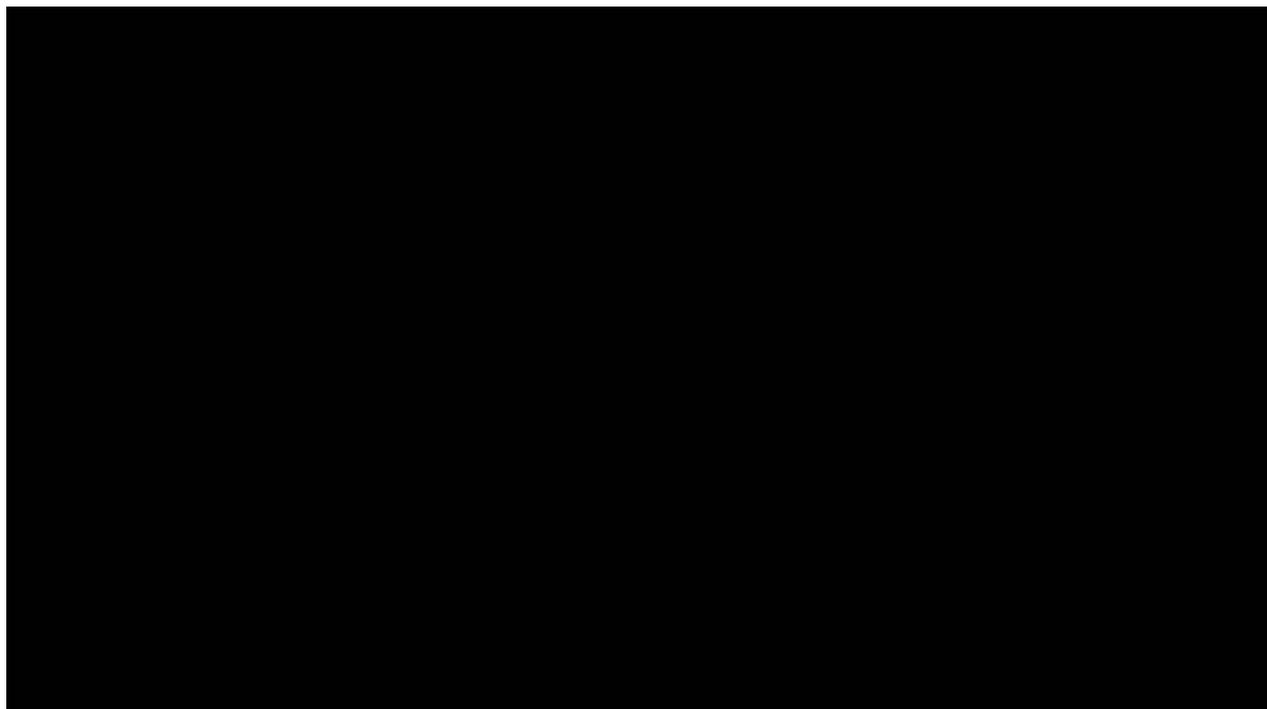


Are changes in the frequency and intensity of extremes predictable at seasonal to decadal scale? And how can society best use such forecasts?

What do we understand about the interactions between large-scale drivers and regional-scale land-surface feedbacks that affect extremes?



# CLOUDS, CIRCULATION and CLIMATE SENSITIVITY



How will clouds and circulation respond to global warming or other forcings?

How do clouds couple to circulations in the present climate?

*Wind vectors and monthly average CO<sub>2</sub> concentrations in 2003. High CO<sub>2</sub> concentrations of ~385 ppm are in red, low CO<sub>2</sub>, about ~360 ppm, is blue. NASA Visualization Lab*



# NEAR-TERM CLIMATE PREDICTION

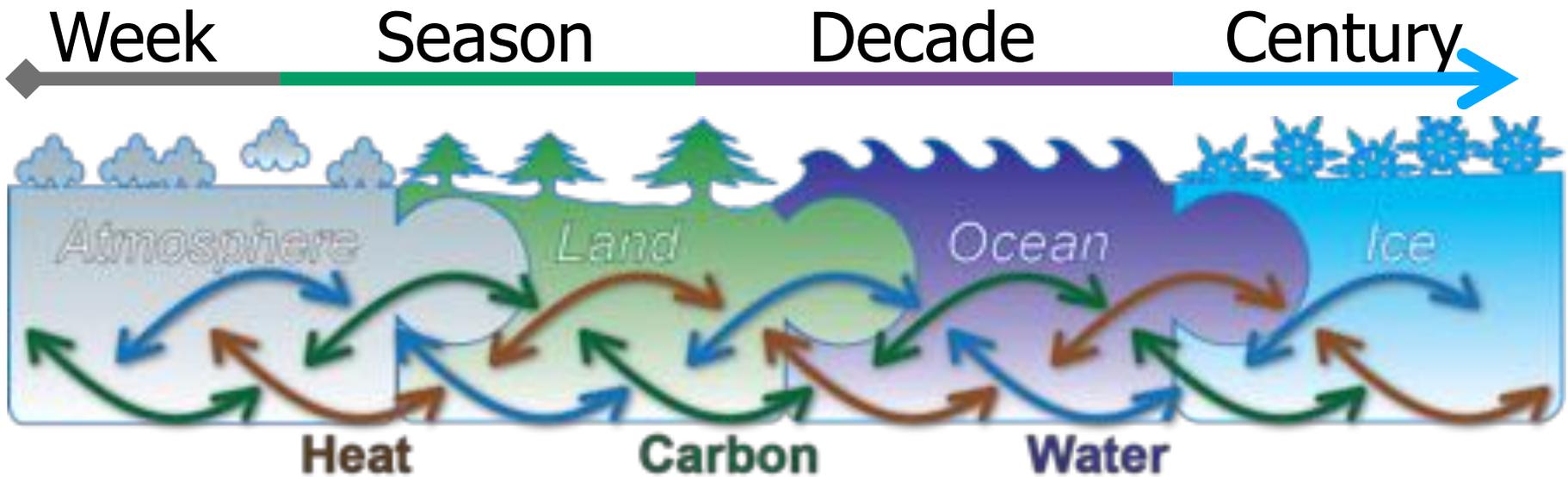
- To improve the quality of initialized decadal climate information and prediction
- To collect, collate, and synthesize the prediction output and tailor information to form the basis of a service that addresses stakeholders' needs
- To develop processes to assess and communicate the degree of confidence and uncertainty in the predictions

# CARBON and CLIMATE

- What biological and abiological processes drive and control land and ocean carbon uptake?
- Can and will carbon feedbacks amplify climate changes during the 21<sup>st</sup> century?
- How will highly vulnerable land and ocean carbon reservoirs respond to a warming climate, to climate extremes and to abrupt changes?

*Where does the carbon go?*

# The Seven Grand Challenges of WCRP



# Post COP-21 Science

- COP-21: A major political achievement, based in large part on the knowledge provided by the scientific community.
- A major success for *our* scientific community

After decades of active investigations (e.g., WCRP) and the efforts to communicate the findings (e.g., IPCC):

1. The science is now *widely accepted*: All key nations accept the concept of human-induced climate change, even if some large uncertainties remain.
2. The focus of the research must *evolve* from “making the case” for “greenhouse warming” to the development and dissemination of regional information needed to minimize risks and to build resilience.

# A Shift in the Research Emphasis

The immediate challenge for political and economic leaders is to create the conditions for the sustainable development of the planet (UN Sustainable Development Goals)

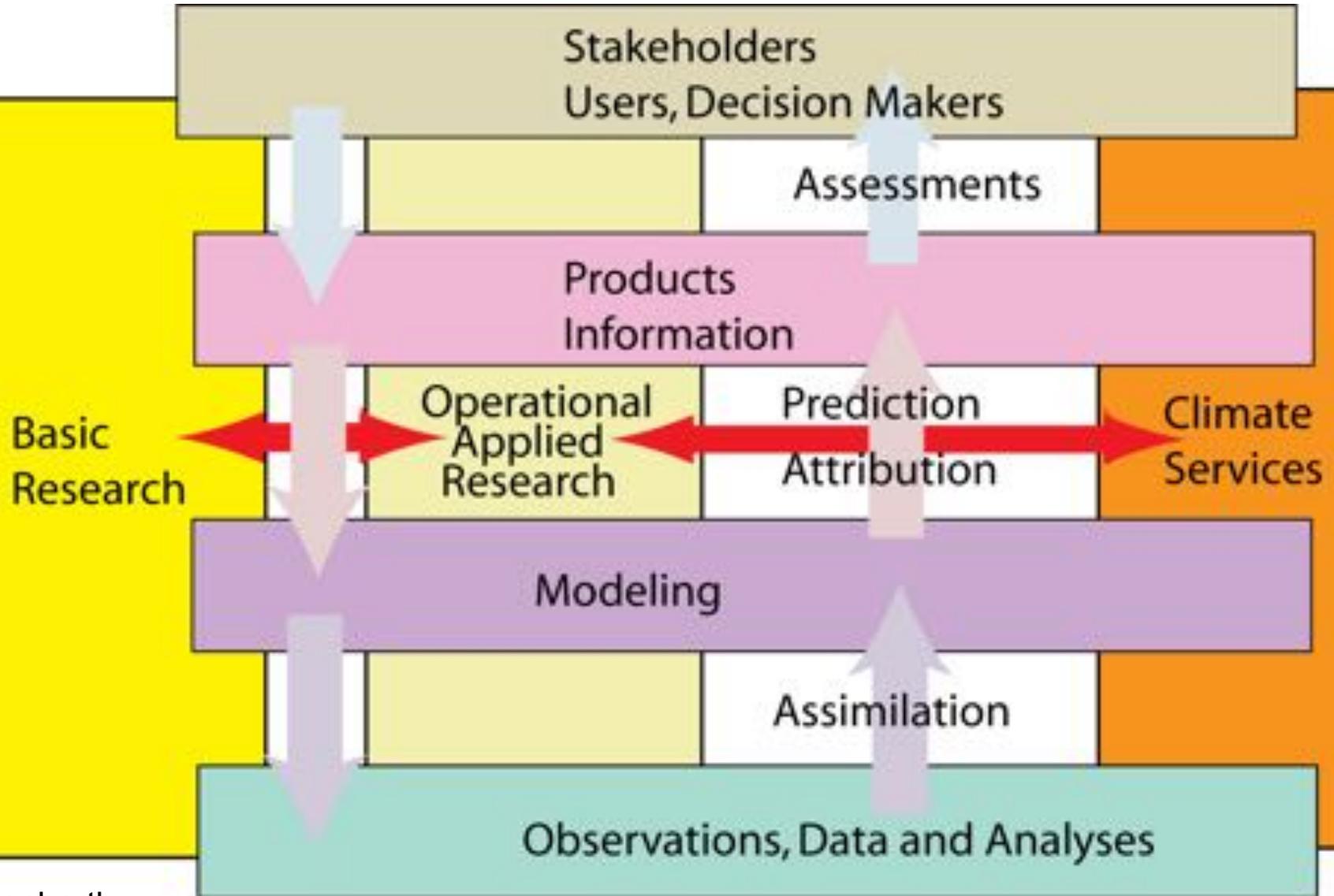
Goal 13: *“Take urgent action to combat climate change and its impacts”*

Ensuring sustainable development requires that we understand the processes that govern the multi-scale variability and changes associated with the dynamical Earth system.

It also requires the development of a “smart” end-to-end information system based on

- a strong fundamental research component (basic research, high resolution ocean-land-atmosphere observation system, advanced Earth System models with regional predicting capability, process studies)
- a translation system that integrates knowledge from different disciplines, addresses questions from different actors and supports boundary organizations (climate services, GFCS, IPCC, Future Earth, etc.).

# Towards a Smart End-to-End Climate Information System



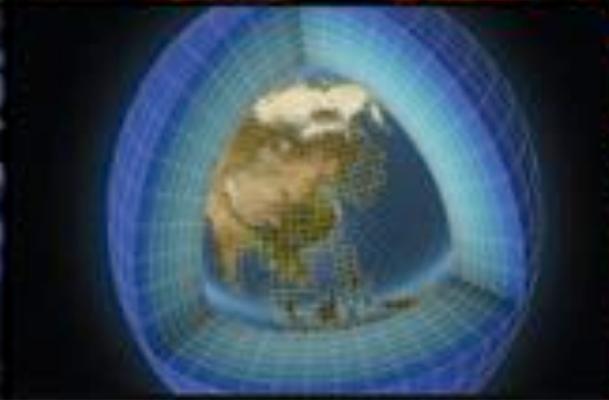
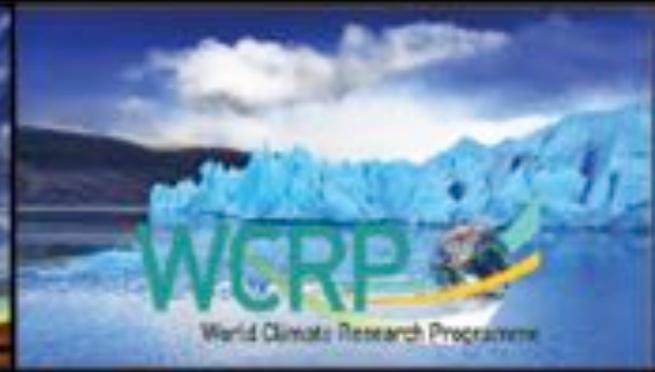
# A Shift in the Research Emphasis and in the Message to Society

We need therefore to recalibrate the message that we are giving to the outside world.

Time is mature

- to start develop a new perspective for WCRP that responds to the societal challenges of the next decades, and puts more emphasis on regional aspects, on natural variability, and on possible surprises.
- to redefine a challenging vision for the future of the Programme.

This should be initiated soon and be launched at the occasion of a large WCRP Open Science Conference that will celebrate the 40<sup>th</sup> anniversary of the Programme in 2020.



# WORLD CLIMATE RESEARCH PROGRAMME

*Thank You*

