

# WORLD CLIMATE RESEARCH PROGRAMME

## Current and Future Priorities for Climate Research

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*WCRP*

*24 November 2016*

*Budapest, Hungary*



**ICSU**  
International Council for Science

# 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.

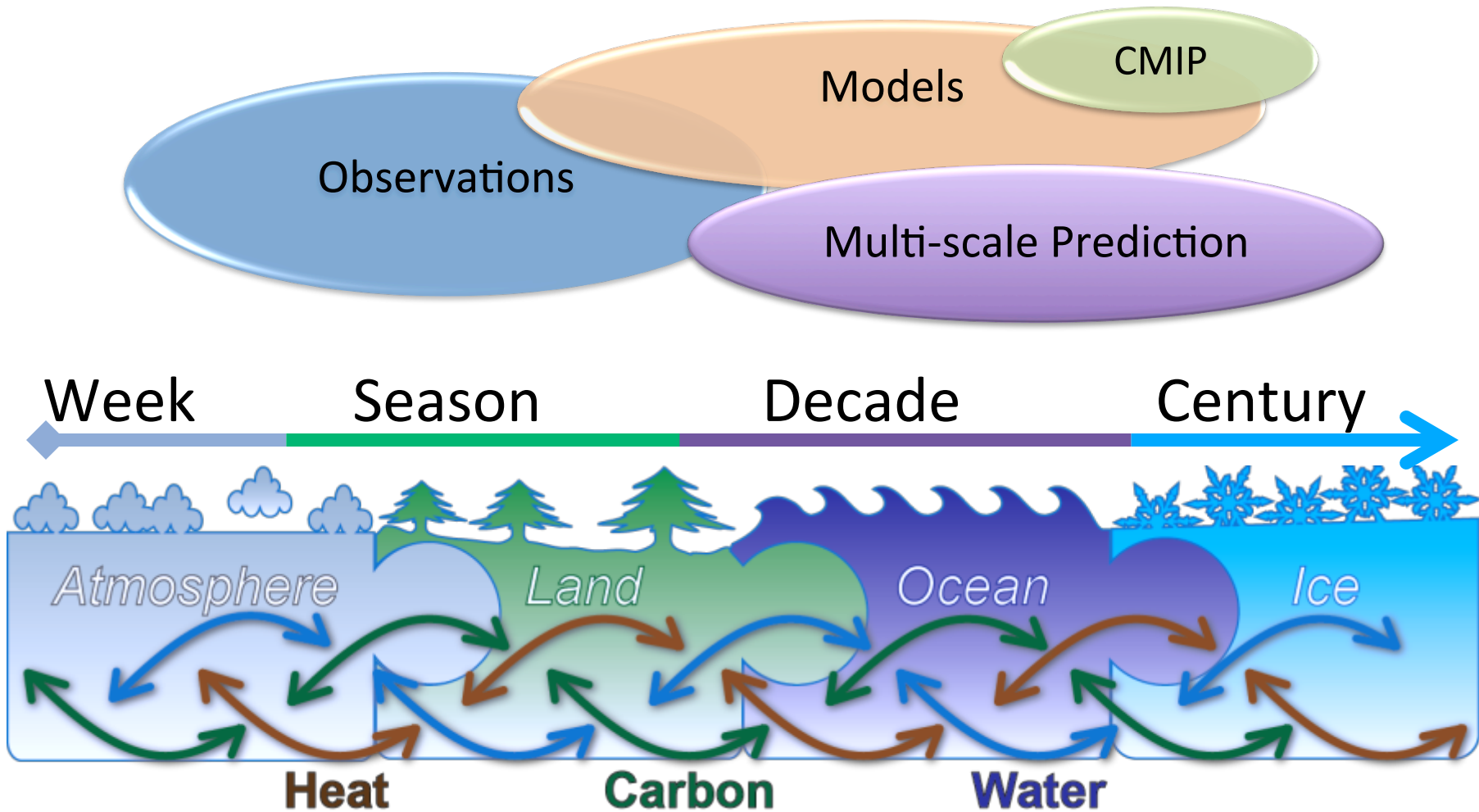
*The two overarching objectives of WCRP are:*

to determine the predictability of climate

to determine the effect of human activities on climate



# Role of WCRP



# Post COP-21 Science

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

*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 information for regions** needed to minimize risks and to build resilience.

a strong fundamental  
research component

integrating  
interdisciplinary knowledge



# A future of WCRP: thinking out of box...

***Three primary questions*** in defining key topics confronting the research community:

(WCRP “out of box” workshop, June 2016)

- **Where will the carbon go?**
- **How will weather vary with climate?**
- **How will climate change impact the habitability of our planet and its regions?**



# WCRP Structure

Joint Scientific Committee

Joint Planning Staff

Modeling Advisory Council

Data Advisory Council

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

**cliC**

Cryosphere



**CLIVAR**

Ocean-  
Atmosphere



**GEWEX**

Land-  
Atmosphere



**SPARC**

Troposphere -  
Stratosphere



**CORDEX**

Regional  
Climate  
Downscaling



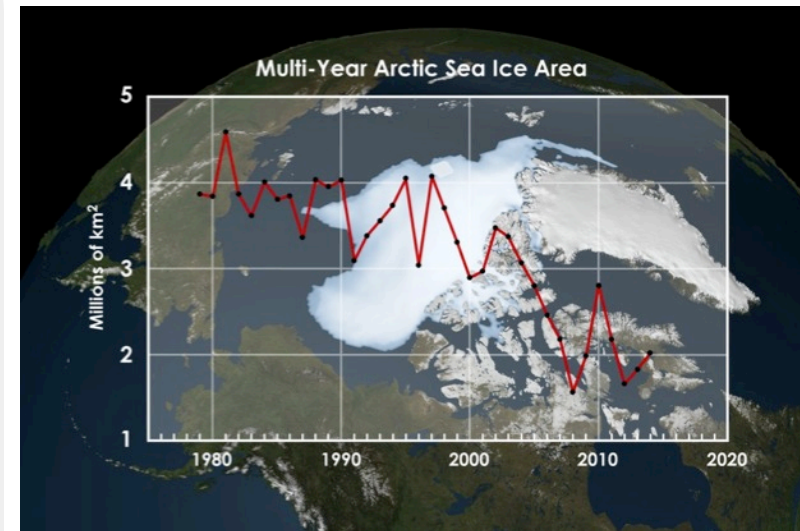




Understanding the changing cryosphere and its climate connections

*Overarching research needs guiding CliC activities:*

- Improved understanding and quantification of the **role of the cryosphere in the global climate system**, its variability and change
- Improved utilization of **cryospheric observations** as indicators of global and regional climate change
- 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**
- Improved ability to make **quantitative predictions and projections** of the cryosphere in a changing climate



NASA visualization Lab



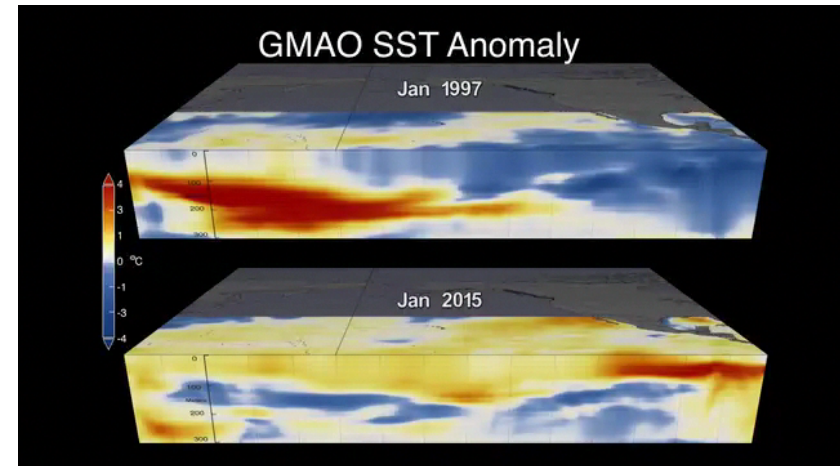
# CLIVAR

Climate and Ocean: Variability, Predictability and Change

→ Understanding 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 Nino comparison 1997 vs. 2015, NASA Visualization Lab*



# GEWEX

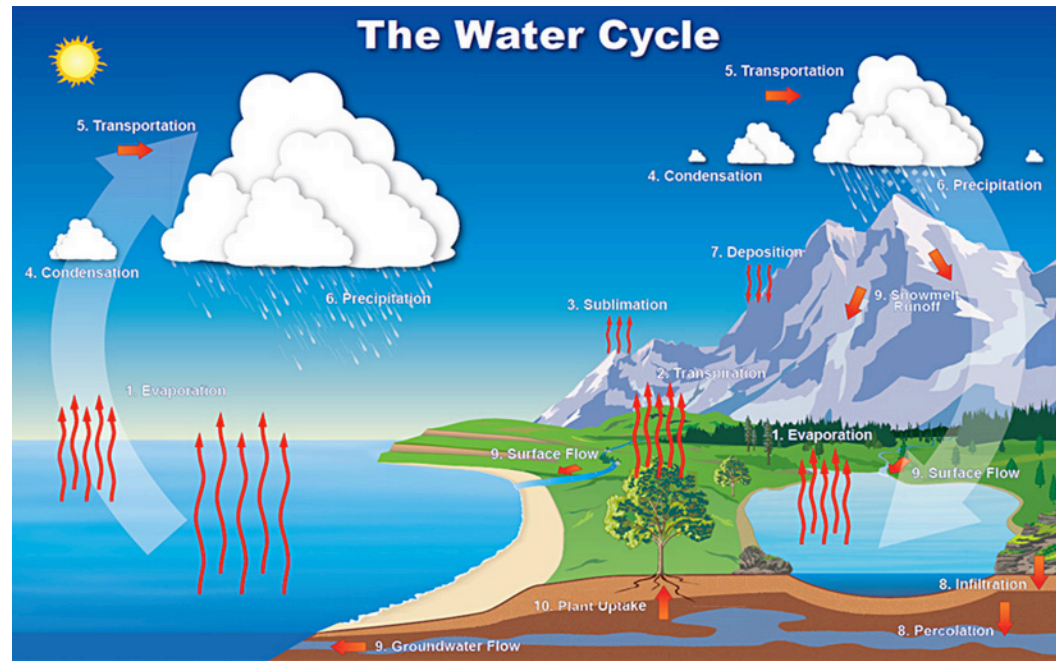


## Global Energy and Water Cycle Exchanges

Understanding Earth's water cycle and energy fluxes at the surface and in the atmosphere

### GEWEX science questions:

- Observations and predictions of **precipitation**
- Global **water resources** systems (land use and hydrology)
- Changes in **extremes** (esp. droughts, flood, heat waves)
- **Water and energy** cycles and processes



**GEWEX Panels:** Global Land/Atmosphere System Study (GLASS), Global Atmospheric System Studies (GASS), Hydroclimatology Panel (GHP), GEWEX Data and Assessments Panel (GDAP)



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

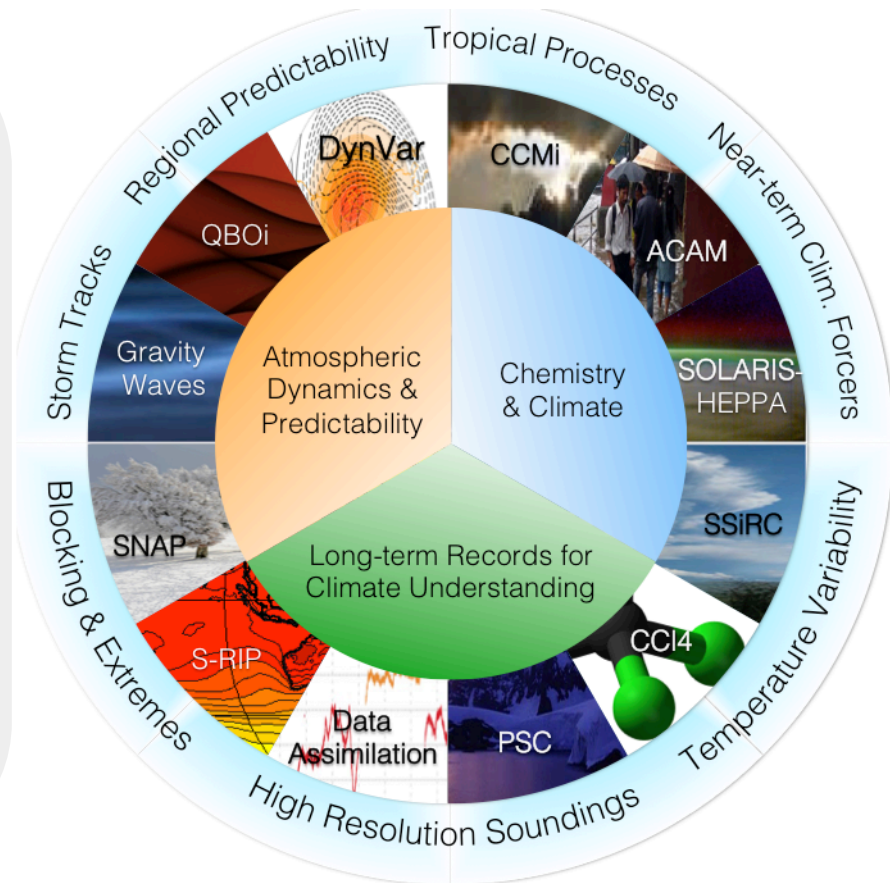
# SPARC

## Stratosphere-troposphere Processes And their Roles in Climate

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

### Themes:

- **Atmospheric Dynamics and Predictability**  
climate variability, near-term climate predictions, stratosphere-troposphere interactions
- **Chemistry and Climate**  
coupling of climate-dynamical-radiative processes, gas emissions
- **Long-term records for Climate Understanding**  
construction, analysis, and interpretation of long-term climate records

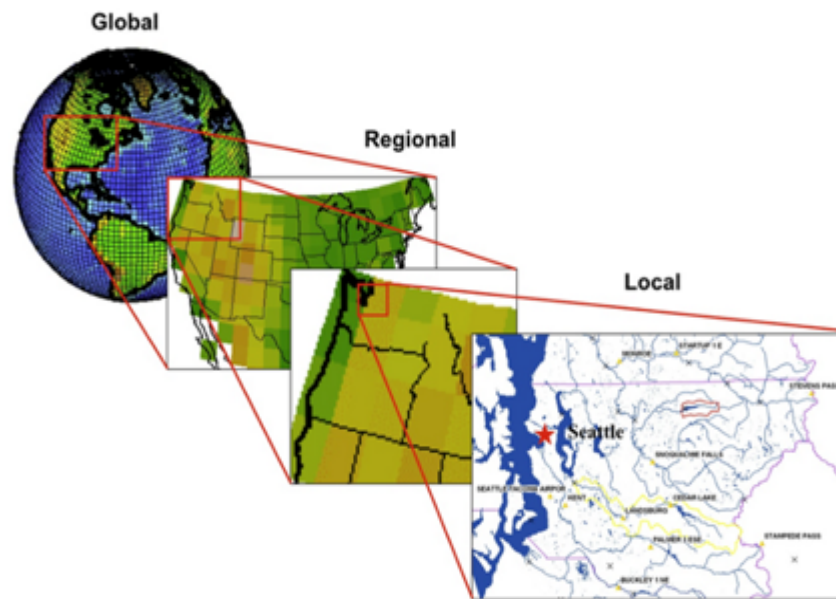




➔ Advancing the science and application of regional climate downscaling, for improved regional climate information

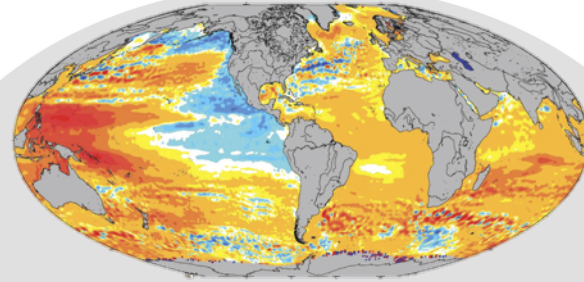
### *CORDEX scientific challenges:*

- **Added value** of downscaling, scales, bias and uncertainties, user-oriented metrics
- Understanding and simulating **human elements**, e.g. land use, urban development, climate and coastal cities
- Coordination of regional **coupled modeling**
- Precipitation, e.g. convective systems, monsoon
- Local wind systems





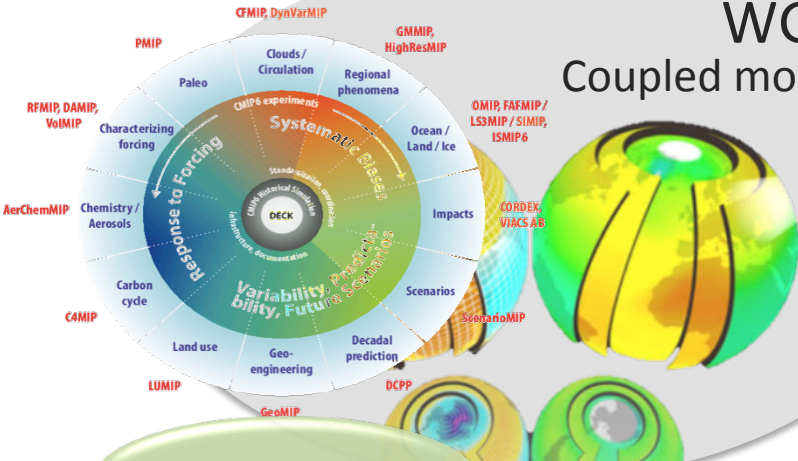
Numerical Experimentation  
WGNE



-20 0 20  
Regional sea level rise (mm/yr)

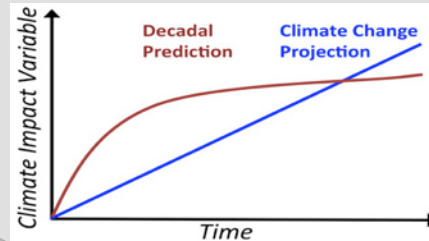
Regional Climate  
WGRC

WGCM  
Coupled modeling



CMIP

WGSIP  
Subseasonal to Interdecadal  
Prediction



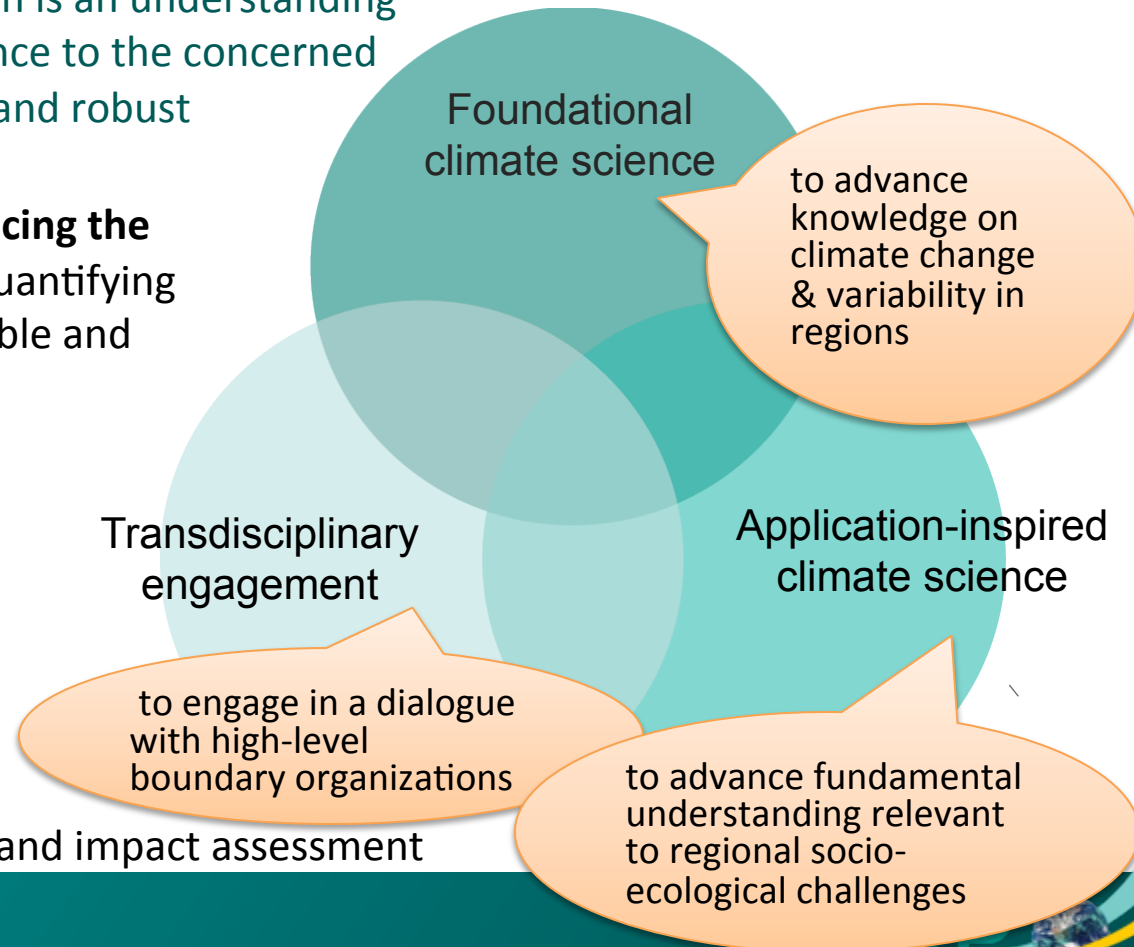


# A scope for WCRP regional activities

- WCRP focuses on facilitating **creation of reliable climate information for regions**, from climate data of verified sources based on observations, assessments and predictive models.

**Information ≠ data:** information is an understanding that builds messages of relevance to the concerned users that are backed by clear and robust physical analyses

- WCRP's focus remains on **enhancing the scientific basis** for identifying, quantifying and delivering high quality, reliable and accessible climate information.
- WCRP recognizes the **substantial gaps in climate data** to be ready to produce climate information in need, particularly of different regions.
- WCRP **works with partners** contributing to climate services and impact assessment



# WCRP in the global community



World Meteorological Organisation



ICSU

International Council for Science



GAW



Sub-Seasonal to Seasonal  
Prediction Project



GLOBAL CLIMATE OBSERVING SYSTEM

ipcc



UNEP



futureearth

PAGES  
PAST GLOBAL CHANGES



ICSU

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# WCRP Grand Science Challenges



Regional Sea Level & Coastal Impacts



Water for Food Baskets



Melting Ice & Global Consequences



Near-Term Prediction



Clouds, Circulation & Climate Sensitivity



Climate & Carbon



Weather & Climate Extremes

**focused**  
**measurable**  
**innovative**  
**collaborative**



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# Melting Ice



*Columbia Glacier, Alaska*

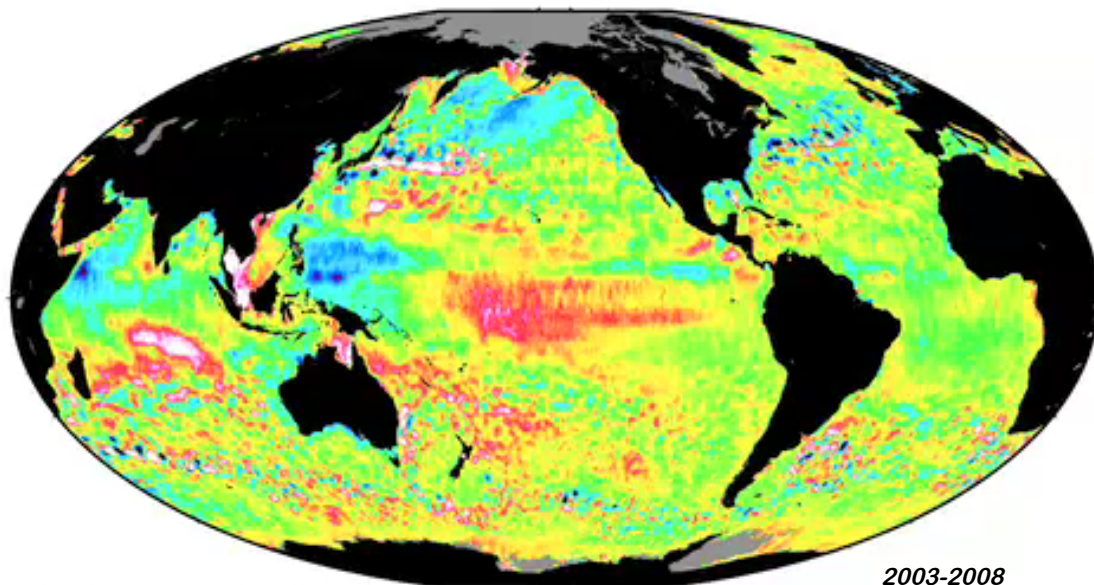
*Snow and ice are seen as bright blue, while vegetation appears green and bedrock brown. Gray stripes on the glacier surface represent rocky debris. NASA visualization Lab*

How will melting ice respond to, and feedback on, climate change and what will the impacts be on:

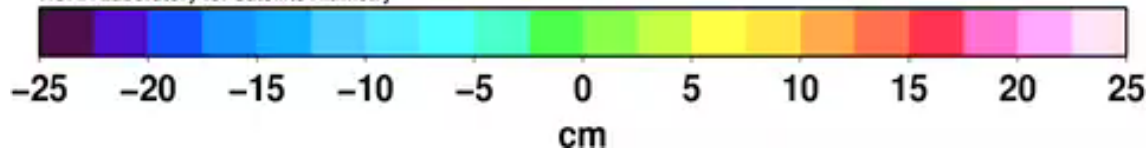
- *Permafrost and the global carbon cycle*
- *Ice sheets*
- *Glaciers*
- *Rising sea level*
- *Sea ice and snow interaction*

## 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?





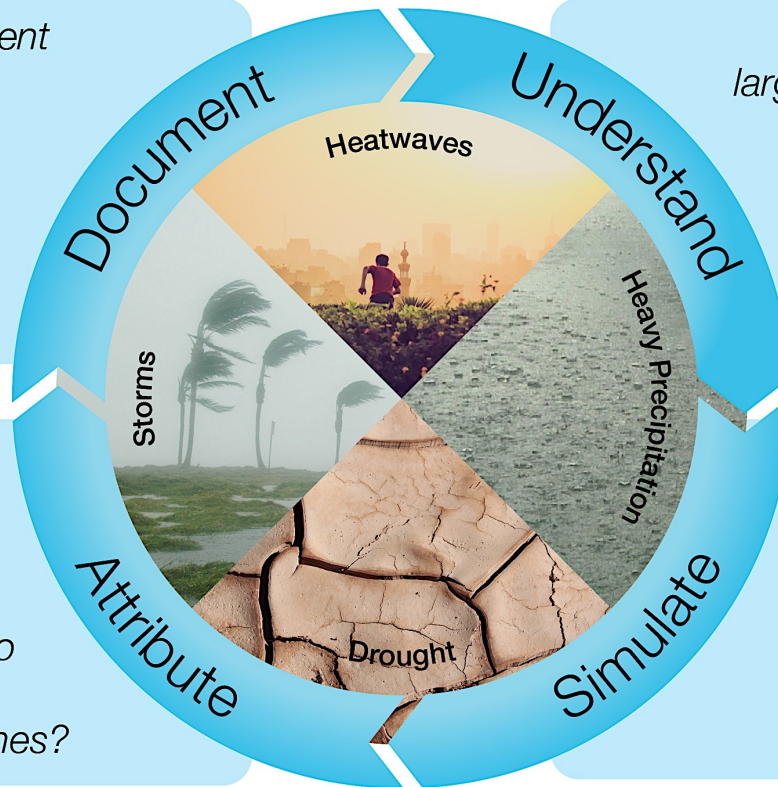
# Weather & Climate Extremes

*Are existing observations sufficient to underpin the assessment of extremes?*

*What are the relative roles of large-scale, regional and local scale processes, as well as their interactions, for the formation of extremes?*

*What are the contributors to observed extreme events and to changes in the frequency and intensity of the observed extremes?*

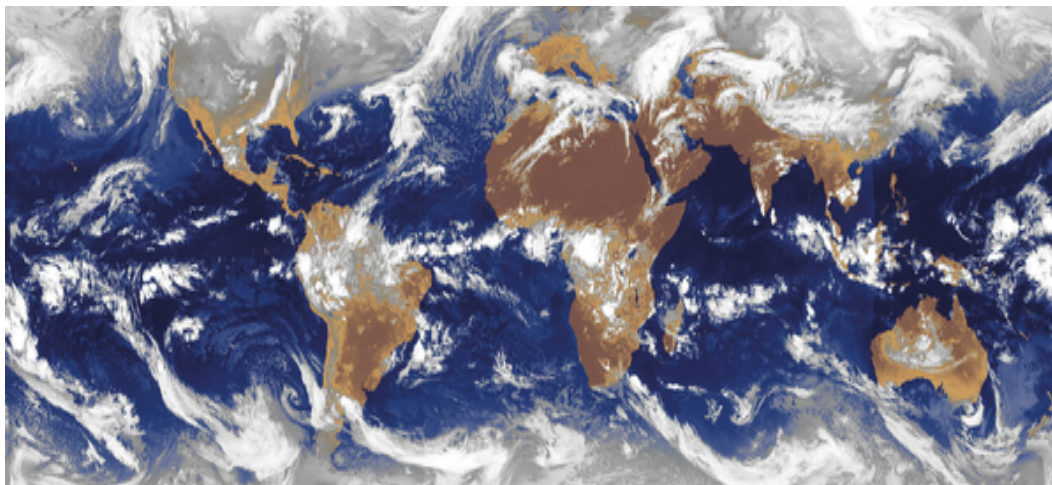
*Are models able to reliably simulate extremes and their changes, and how can this be evaluated and improved?*







# Clouds, Circulation & Climate Sensitivity

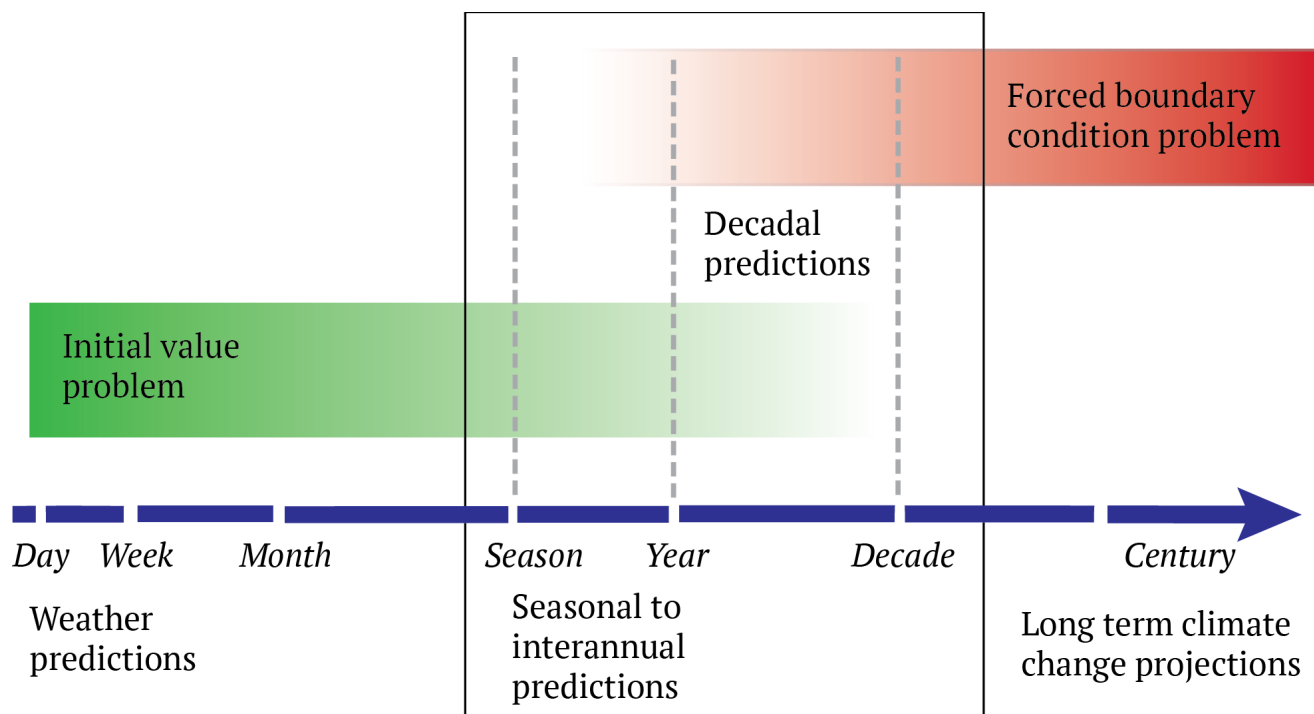


How will clouds and circulation respond to global warming or other forcings?

How do clouds couple to circulations in the present climate?



# Near Term (decadal) Prediction

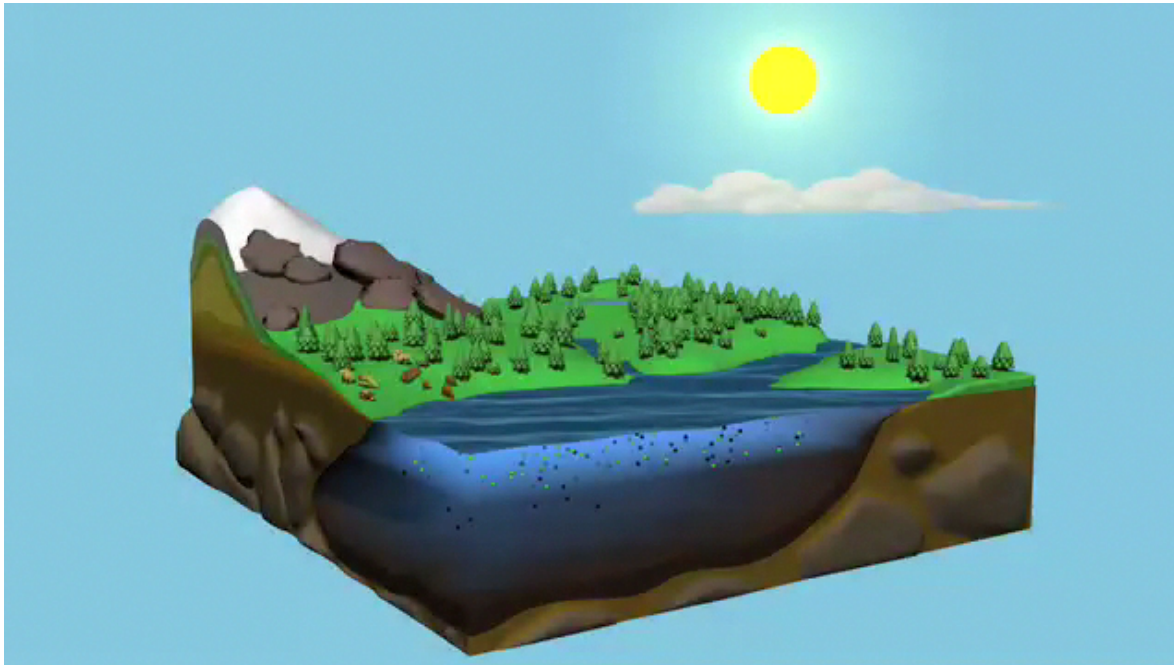


How can we enhance the understanding of sources of decadal predictability?

How can we serve decadal prediction information as is already done for seasonal prediction?



# Climate & Carbon



*A conceptual animation illustrating the various parts of the Carbon cycle. Purple arrows indicate the uptake of Carbon; yellow arrows the release of Carbon. NASA/Goddard Space Flight Center/UMBC.*

What are the drivers of land and ocean carbon sinks?

What is the potential for amplification of climate change over the 21st century via climate-biogeochemical feedbacks?

How do greenhouse gases fluxes from highly vulnerable carbon reservoirs respond to changing climate?





# Water for Food Baskets

*“Reliable access to sufficient quantities of affordable, nutritious food to maintain healthy, active lives.” – 1996 World Food Summit*

Four main dimensions of **food security**;

- **Availability** – Supply of food as determined by production, stock level and net trade
- **Access** - Affected by income, expenditure, markets and prices
- **Utilisation** – Nutritional status of what we produce
- **Stability** – Inadequate access to food on periodic basis



# Water for Food Baskets

## Key questions



*How will a warming world affect the available fresh water resources globally, the human interactions with these water resources, as well as their value to society?*

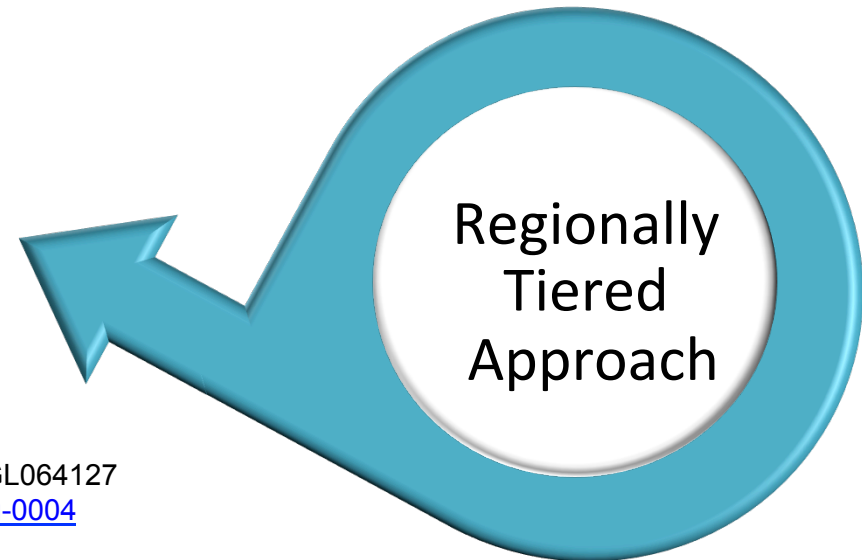
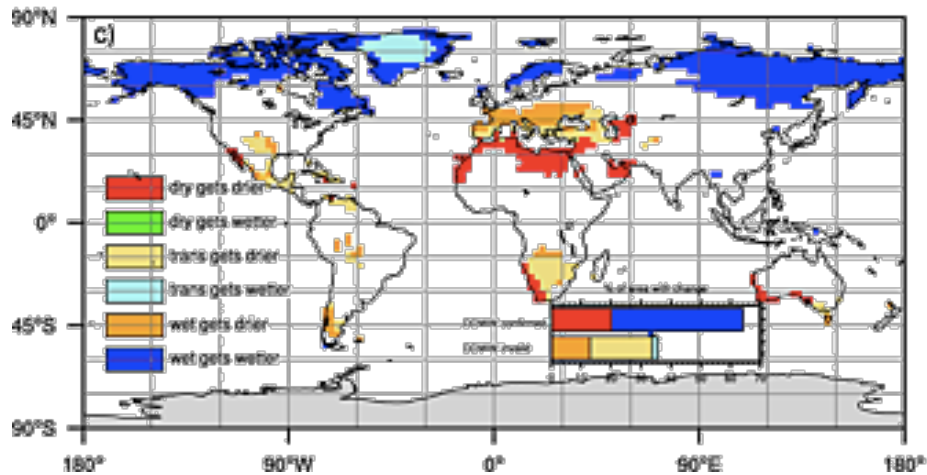
*How does this translate specifically to the food basket regions of the world?*

\*Within the context of the World Climate Research Programme the focus will be on **the geophysical processes and the anthropogenic influences** on these processes



# Water for Food Baskets

## Methodology



**Geophysical Research Letters**

[Volume 42, Issue 13](#), pages 5493-5499, 4 JUL 2015 DOI: 10.1002/2015GL064127

<http://onlinelibrary.wiley.com/doi/10.1002/2015GL064127/full#grl53101-fig-0004>

Focus on major food producing regions of the world  
in the context of climatic change

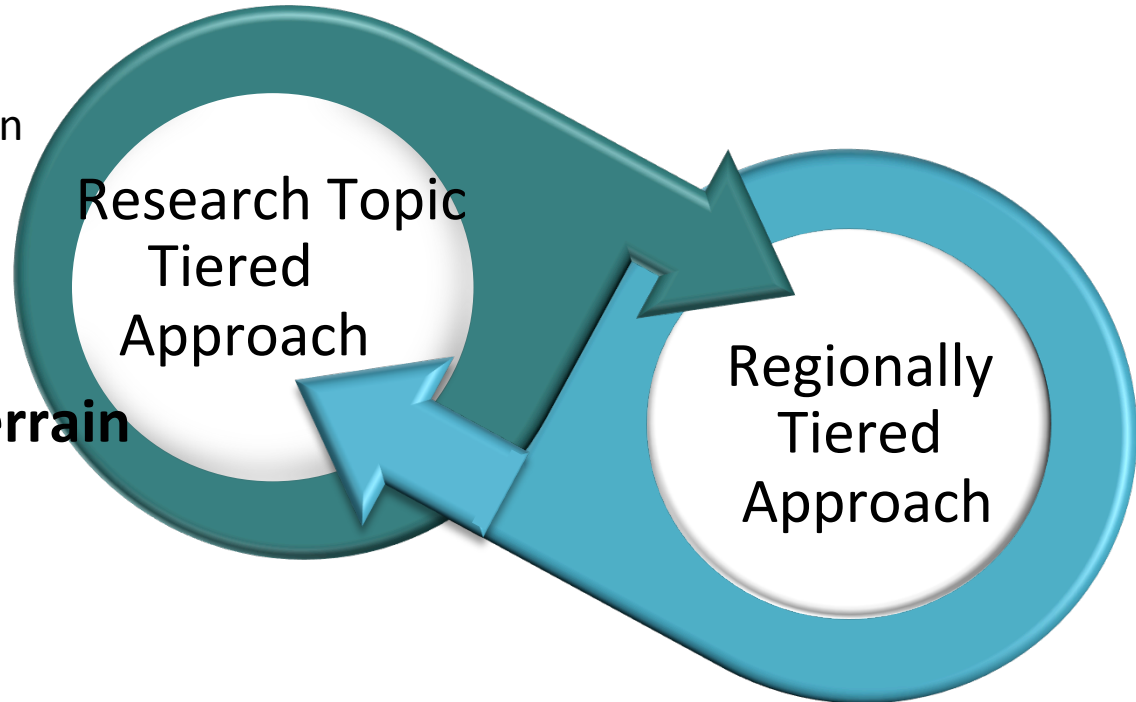




# Water for Food Baskets

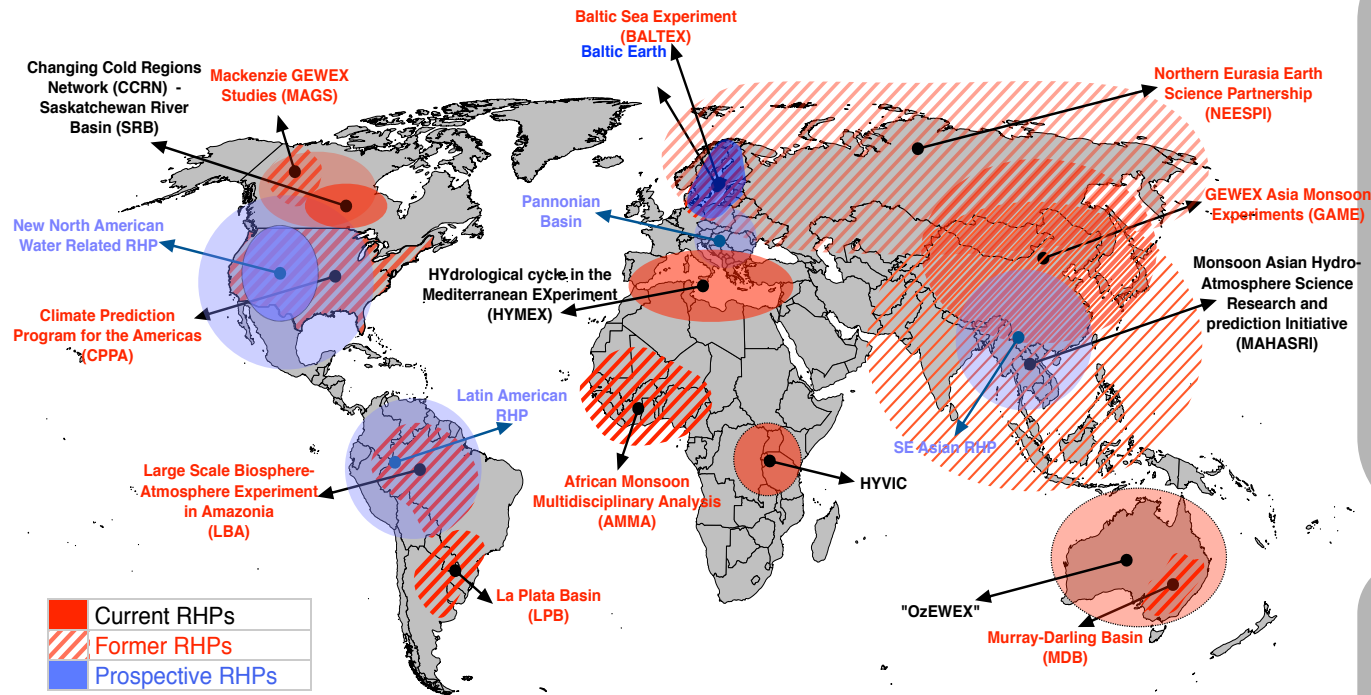
## Methodology

- Human Dimension  
(including water management in large scale models)
- High Resolution  
Convection Permitting  
Modeling / **Complex Terrain**
- Representation of land use effects on regional and global climate
- Build upon Existing Efforts within and beyond WCRP  
(UNESCO IHP, HYDROMET Services, iLEAPS, etc.)





# Water for Food Baskets



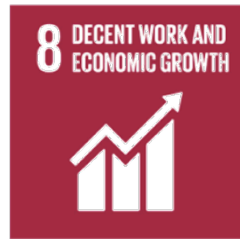
How will a warming world affect the available fresh water resources globally? (Focus on the geophysical processes and the anthropogenic influences on these processes)

How does this translate specifically to the food basket regions of the world?



# Water for Food Baskets

## Links with SDGs





# Thank You



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<http://wcrp-climate.org>

