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
Role of WCRP

IMPROVED UNDERSTANDING & PREDICTION

MODELLING
DATA
OBSERVATIONS

INFORMATION & SERVICES
ASSESSMENTS

SEASON
ICE
OCEAN
DECADE
WCRP Structure

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)

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
- UNDERSTANDING AND PREDICTING WEATHER AND CLIMATE EXTREMES
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
Long term objectives:
- Identify ocean and coupled climate processes that are critical for global and regional climate variability and change
- Identify temporal and spatial scales of climate predictability
- Quantify constrains on climate sensitivity, air-sea exchange and Earth’s energy budget / ocean heat content
- Quantify regional impacts of climate change in sea level, cryosphere and water cycle
- Quantify past/present/future ocean role in heat and CO₂ uptake and links between climate and ocean ecosystems
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

GlobaLand/Atmosphere System Study (GLASS), Global Atmospheric System Studies (GASS), GEWEX Hydroclimatology Panel (GHP), GEWEX Data And Assessments Panel (GDAP). Modified from NASA Earth Observatory.
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

Global CO2 fluxes. Nasa Earth Observatory
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

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

- Regional sea level change and coastal impacts
- Understanding and predicting weather and climate extremes
- Clouds, circulation and climate sensitivity
- Near-term climate prediction
- Water for the food baskets of the world
- Carbon feedbacks in the climate system
- Melting ice and global consequences
Melting Ice

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

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
Regional Sea Level Change

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

How predictable is sea level on a regional scale and how can we improve the predictability?

What is the contribution of land ice to near-future sea level rise?
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?
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?

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

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

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

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

How do clouds couple to circulations in the present climate?
Near Term 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?
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?

A conceptual illustration of the carbon cycle. NASA Earth Observatory.
To serve as a focal point for all observational and data matters across the programme

- **Promote open data policies**, protocols and standards across the programme
- **Recommend best practices** for ECV data set development and assessments
- **Coordinate reanalysis intercomparison efforts**
- Promote and publish observational and reanalysis data sets to support climate modeling
- Coordinate flux research and promote development of associated data sets
- Review adequacy of observations and data assimilation techniques
- Sponsor **International Data Prize**
To coordinate high-level aspects of modelling across WCRP, and act as a single entry point for all WCRP modelling activities

- **Review modelling issues** and advise the JSC on strategic matters
- **Promote seamless approaches** across timescales and towards Earth System Models
- Organization of Model Development Schools
- Develop model development training material
- **WCRP-WWRP International Prize for Model Development**
Working groups

- Numerical Experimentation
  - WGNE
- Regional Climate
  - WGRC
- Coupled modeling
  - WGCM
- Subseasonal to Interdecadal Prediction
  - WGSIP

Regional sea level rise (mm/yr)
WGRC Working Group on Regional Climate

Prioritize and coordinate regional climate research within WCRP

- Regular **assessment** of regional activities across WCRP

- **Guidance on the development**, implementation and progress of regional climate projects to emphasize the role of those activities as scientific **contributions to climate services**

- **Facilitating and promoting regional activities** that advance research and capacity development

---

Indian Ocean sea surface temperature anomalies, relative to 1961-90 average. Bureau of Meteorology, Author provided.
Principal aims and activities:

• Developing a programme of *numerical experimentation* for climate variability and predictability over a range of time scales, with an emphasis on *assessing and improving predictions*

• Evaluating data assimilation, model initialization and forecasting procedures for *initialized climate predictions*
fostering the development of atmospheric circulation models for use in weather prediction and climate studies on all time scales

Objectives are achieved through:

• Identification of **systematic errors** common to many models.

• Sharing **diagnostic tools and techniques** to get to the root of the error.

• Sharing knowledge around **sensitivity of errors to model formulation** (parametrizations, dynamical core, etc.).

• Work with other groups (e.g. GASS & GLASS) to **develop solutions**.
To foster the development and review of coupled climate models

- Organisation of *model intercomparison projects*

- *Enhancing understanding* natural climate variability and predictability on decadal to centennial time scales

- *Enhancing predicting* the response of the climate system to changes in natural and anthropogenic forcing
CMIP is a project of WCRP’s Working Group on Coupled Modeling (WGCM)

CMIP has led to an improved understanding of past, present and future climate change and variability in a multi-model framework.

CMIP defines common experiment protocols, forcings and output.

21 CMIP6-Endorsed MIPs
Sub-Seasonal to Seasonal Prediction (S2S)

The S2S Database, hosted by ECMWF & CMA, contains 10 models.

**Improving forecast skill and understanding on the sub-seasonal to seasonal timescale** (2 weeks to a season) with special emphasis on high-impact weather events.

**Promote the initiative’s uptake** by operational centres and exploitation by the applications community.

**Expertise from weather and climate research communities** and link to Global Framework for Climate Services.

- Teleconnections
- Madden-Julian Oscillation
- Monsoons
- Africa
- Extremes

**Verification and Products**
- Research Issues
  - Predictability
  - Teleconnection
  - O-A Coupling
  - Scale interactions
  - Physical processes
- Modelling Issues
  - Initialisation
  - Ensemble generation
  - Resolution
  - O-A Coupling
  - Systematic errors
  - Multi-model combination
- Needs & Applications
  - Liaison with SERA (Working Group on Societal and Economic Research Applications)

**S2S Database**

[Image showing Sub-Seasonal to Seasonal Prediction Project]

[Website: http://s2sprediction.net]
POLAR CHALLENGE

CONTEXT
The cryosphere plays a fundamental role in the climate system. We need much better monitoring and prediction capabilities for the polar regions.

CHALLENGES AND OPPORTUNITIES
Polar observations are expensive, risky and sparse. We can expand AUVs’ endurance, navigation and communication capabilities to operate under the sea ice.

VISION
A cost-effective, sustainable and autonomous polar ocean monitoring system to drive a new era for climate research and services.

Be the first to complete a 2000 km continuous mission with an Autonomous Underwater Vehicle (AUV) under the sea ice.

500K €
Compete for the Prize!
Become a co-sponsor!
www.wcrp-climate.org/polarchallenge
Capacity development

- Empower **long-term achievements** in climate research, promoting current and **future leadership** in climate research
- Stimulating **opportunities** corresponding to **specific regional requirements**

Early career researchers’ perspective on future challenges:

- WCRP-JNU Training school on Monsoon Variability (Jan ’17)
- CRC-CORDEX ECS side event (May ’16)
- CLIVAR ECS Symposium (Sept ’16)
- CLIVAR ECS Poster Competition (Sept ’16)
Arctic freshwater is expanding and changing

- Arctic freshwater domain expanded, both for the oceans and land
- New freshwater regimes developed
- An un-quantified moisture flux detected, due to the loss of Arctic freshwater ice cover
- Increase of the benefits of freshwater-based resource activities
WCRP science findings
Ocean warming & impacts on hurricanes and rainfall

Change in Ocean Temperature in North Atlantic
Predicting the warming event in 1990s

Initialised predictions
Uninitialised predictions
Measurements

Hurricanes
Predictions
Measurements

Rainfall
Models
Observations

Initialised decadal predictions for ocean warming show good skill

Higher predictability for hurricanes than for rainfall
Disagreement between reported (bottom-up) and calculated (top-down) CCl₄ emissions since 1999

Multi-disciplinary activity using innovative analysis techniques and new observations

Total lifetime of CCl₄ updated

New emissions estimates (reported + unreported inadvertent industrial emissions) agree within the uncertainty range

Policy Relevant: Direct response to stakeholder needs (Parties to the Montreal Protocol)
WCRP in the global community

World Meteorological Organisation
UNESCO
IOC
ICSU
International Council for Science

GAW
WWRP
WCRP
World Climate Research Programme
PAGES
PAST GLOBAL CHANGES
GFCS
GCGS
IPCC
CC
UNEP

START

global change System for Analysis, Research & Training

WMO
IOC
ICSU
International Council for Science
Thank You
WORLD CLIMATE RESEARCH PROGRAMME

Name – WCRP
Date etc.