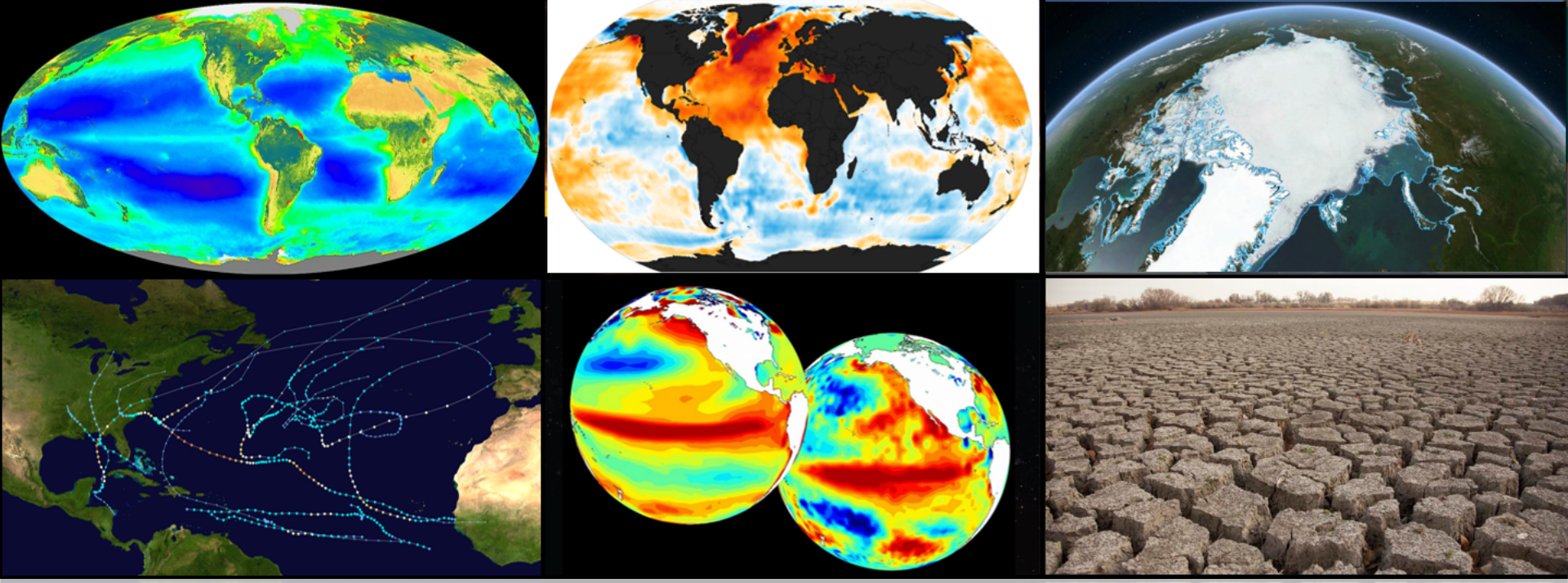

# WGSIP, DCPP and GC-NTCP

## 40th Session of the WCRP Joint Scientific Committee

*Doug Smith, WGSIP co-chair*

*May 2019*

*Geneva, Switzerland*

WORLD METEOROLOGICAL ORGANIZATION

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Science Council

WCRP World Climate Research Programme

# 2 Prediction of the near-term evolution of the climate system

## Our Goal

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

This goal supports the capacity of Earth system scientists to engage with society in the context of climate changes in the decade ahead. Furthermore, the goal focuses attention on societally relevant outcomes such as meteorological, oceanic and hydrological extremes, including compound events. Achieving the goal requires an ability to quantify uncertainties, limits, and capacities of prediction systems. It requires advances in the foundational mathematics of predictability of the climate as a system and of components of that system. At the same time, this objective provides many opportunities for the development of new scientific knowledge regarding the whole Earth system.

# Our Scientific Emphases

## Simulation capabilities

Advances in the simulation of component systems and their coupling remain of paramount importance. Improvements are critically required in representations of the water, carbon and energy cycles, of clouds and precipitation, oceanic eddies and waves, sea ice dynamics and river flows. Rigorous and systematic verification is essential to evaluating the fidelity of these simulations. These advances will require innovative science – deterministic, statistical and machine learning approaches; advanced model-data fusion methods including data assimilation techniques; and ensemble generation methods. We will collaborate with partner programs to advance coupled model initialization techniques.

## Predicting extreme events

Climate change and variability influence the frequency and intensity of extreme events, in ways that affect the environment and society. To improve our predictive skills, climate research will determine the processes responsible for the existence of regional climate hotspots, as well as the potential for crossing thresholds and manifesting surprises. The ways in which the non-stationarity of the Earth system interacts with "fast" (such as hurricanes) and "slow" (such as droughts) extremes will be a key focus.

# Links to the WCRP Strategic and Implementation Plans

- Primary WGSIP/DCPP/GC-NTCP links are with Objective 2, *Prediction of the near-term evolution of the climate system*
  - high-frequency hindcast data across earth system components from DCPP + possible sub-annual MIP will enable predictability & skill assessment for meteorological, oceanic and hydrological extremes
  - verification against specific observed events (not possible for simulations/ projections) points to model successes & errors
  - rigorous verification requires high-quality observations
- Potential capacities also to address other Objectives:
  - 1 *"Understanding"*
    - unprecedented extremes in hindcasts → new climate dynamics insights
    - annual to decadal forecasts of energy, water, and carbon flows could enhance their understanding

# 1 Fundamental understanding of the climate system

## Our Goal

*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.*

Coupled natural processes are fundamental to understanding, for example, variations in atmospheric and oceanic circulations; fluctuations and change in temperatures, salinities and precipitation; the trajectories of regional and global sea level rise; the ways in which extreme events are manifest in a non-stationary climate; the cycling of carbon and other chemical species between atmosphere, land and ocean; the dynamical, radiative and chemical interactions from the uppermost layers of the atmosphere to the deep oceans; and the evolution of regional climates. Closing the energy, water and carbon budgets of these systems is integral to observing, assessing and simulating climate change and variability, regionally and globally. Research focusing on laboratory science, instrument development, field experiments, paleoclimate proxy analyses, remote sensing technologies, and model innovation substantially contributes to the understanding of processes and mechanisms in every component of the climate system.

# Our Scientific Emphases

## Climate dynamics

In order to better understand the past evolution of climate and to anticipate future changes, we will improve our understanding of the drivers that lead to global and regional changes in oceanic and atmospheric circulations. The profound nonlinearities of these systems continue to present critical emerging questions at a range of scales.

## Reservoirs and flows

The mechanisms responsible for radiative, hydrologic, cryospheric and biogeochemical changes determine our ability to quantify the reservoirs and flows of energy, water, carbon, and other climate-relevant compounds. We will advance this quantification, within and between the sub-systems of the Earth system, as an important check on our evolving understanding.

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# 3 Future evolution of the climate system

## Our Goal

*We will quantify the responses, feedbacks and uncertainties intrinsic to the changing climate system on longer timescales.*

A fundamental scientific understanding of non-linear processes and internal variability, and of system sensitivities to imposed forcing, such as fossil-fuel emissions, land use change, volcanic eruptions, and solar variability, can inform improved climate projections and scenarios. Moreover, developing ideas on emergent constraints in the system promises useful information on longer time horizons. Reducing uncertainty in model projections will provide salient information for climate change on these timeframes. This goal has the potential to support the consideration of longer-term mitigation and adaptation alternatives.

# Our Scientific Emphasis

## Simulation capabilities

The ongoing development of integrated Earth system models that account for the slowly varying interactions and highly non-linear processes will underpin scenarios of the long-term evolution of the climate system. Many significant challenges remain in our ability to make these projections, including for example the detailed representation of complex interactions between aquifers, vegetation and soil carbon, or between permafrost, glaciers, and ice-sheets. To advance support of climate services, progress will be further enhanced in dynamical and statistical downscaling tools to better represent regional and extreme phenomena.

*Future projections of the climate system require approaches that recognize the limits of prediction of the system and that effectively convey associated uncertainties.*

# Links to the WCRP Strategic and Implementation Plans

- 3 *"Future evolution"*
  - verified decadal hindcasts could improve understanding of influences of external forcing (especially solar, volcanoes and anthropogenic aerosols) on climate evolution
  - development of seamless information out to projection time scales
- 4 *Bridging climate science and society* – continue developing collaborative links, providing information on emerging predictive capabilities to WMO operations and associated Expert Team

- Suggestions for implementation plan:
  - large-scale meeting (akin to 2017 pan-WCRP modelling meeting) addressing each objective of Strategic Plan (also modelling, obs?)
  - for Objective 2, would involve WGSIP, DCPP, GC-NTCP, S2S + core project expertise aligned with prediction aspects of ocean, land, cryosphere, stratosphere…
  - chairs would report back to and iterate with JSC

# 4 Bridging climate science and society

## Our Goal

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

Collaborative research involving the natural sciences and the social and economic sciences is continuing to blossom, leading to rapid advances in answering complex questions associated with the dynamics of the Earth system. In particular, partnerships with programs within and beyond Future Earth will support the refinement of risk management and disaster response, economic and infrastructure planning, public communication and education, as well as adaptation and mitigation strategies.

# Links to the WCRP Strategic and Implementation Plans

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# Emerging issues

- Viability of pilot sub-annual prediction MIP aligned with CMIP6 DCPP will require rapid engagement with and approval by CMIP panel
- In terms of future structure and functioning of WCRP relating to prediction, could have much better coordination and leveraging of expertise between prediction-centric groups and prediction elements of core projects, some GC (e.g. Carbon, Extremes), and CORDEX
- A pan-WCRP prediction meeting in ~2020 would jump start such coordination and accelerate strategic plan implementation relating to prediction