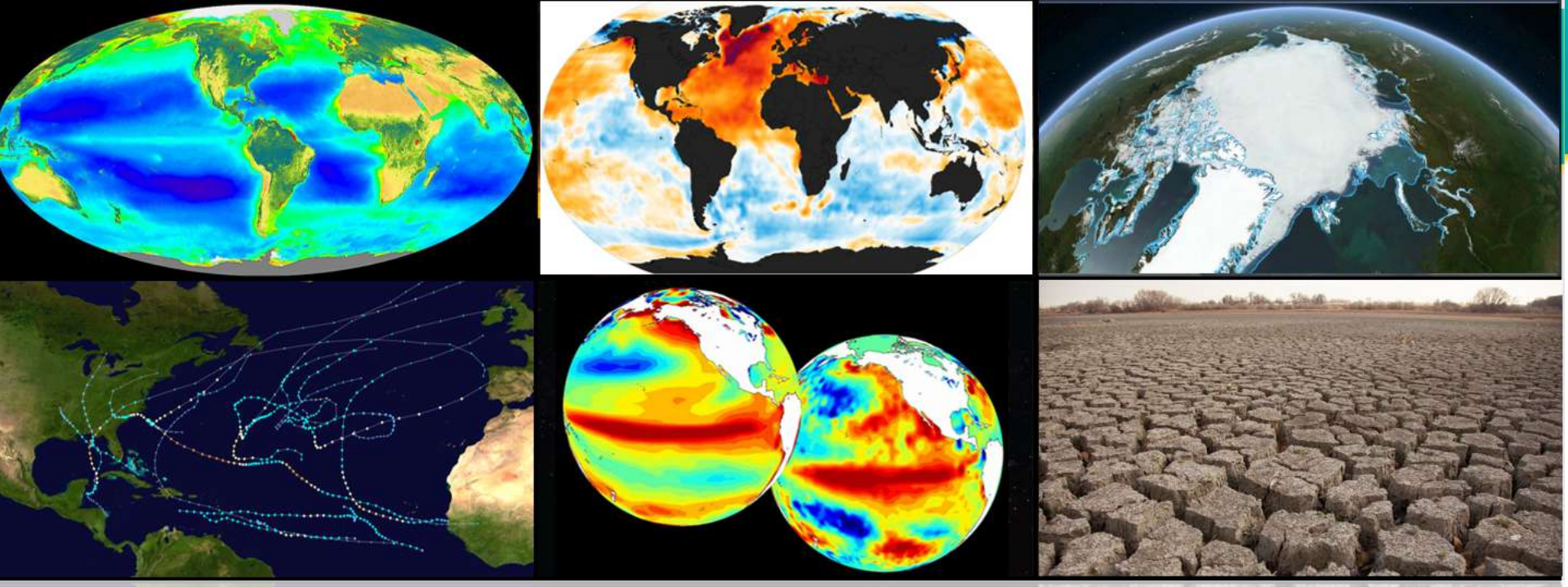


WGSIP/DCPP

41st Session of the WCRP Joint Scientific Committee

Bill Merryfield (presenting), Doug Smith, WGSIP co-chairs
Wolfgang Müller, Stephen Yeager, DCPP co-chairs

May 2020
Online

WORLD METEOROLOGICAL ORGANIZATION
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
International Science Council
WCRP World Climate Research Programme

Progress and achievements - WGSIP

- A synthesis of the Sep 2018 S2S / S2D conferences has been published

BAMS

Current and emerging developments in subseasonal to decadal prediction

- WMO in process of publishing *"Guidance on Operational Objective Practices for Seasonal Forecasting"* co-authored & reviewed by WGSIP (delayed by pandemic)

- WGSIP 21 held May-June 2019 in Moscow
  - New cycle of WGSIP projects for 2019-2024 formulated
  - Capacity building: WGSIP co-organized and gave lectures & lab sessions for International Young Scientists School and Conference CITES-2019 → ~40 students from Russia + CIS countries

WORLD METEOROLOGICAL ORGANIZATION

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Science Council

WCRP
World Climate Research Programme

Progress and achievements - WGSIP

New WGSIP Projects

I. **Prediction Capabilities** – assess existing capabilities across Earth system, emphasizing high-impact phenomena and knowledge gaps

a) Monsoon prediction – Asian and Global, prospective collaborations with CLIVAR Monsoon Panel, GEWEX/Asia-PEX, GMMIP

b) Ocean prediction – initial focus on sea surface height and mixed-layer depth, prospective collaborations with S2S and Copernicus

c) Temperature trends – evaluate representation of temperature trends, impacts of trend biases on forecast quality

II. **Risks of Extremes** – predictability of extremes, quantify risks of extremes (including unprecedented extremes) in current climate; prospective collaborations with GC-Extremes, S2S

III. **Information for Decision Making (I4D)** – review and intercompare methods for calibration and combination of forecasts across time scales, contribute capacity building & guidance to operational community; prospective collaborations with WMO, S2S etc.

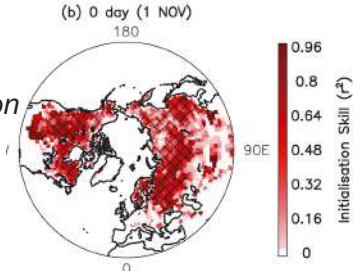
Detailed project information in additional slides

Progress and achievements - WGSIP

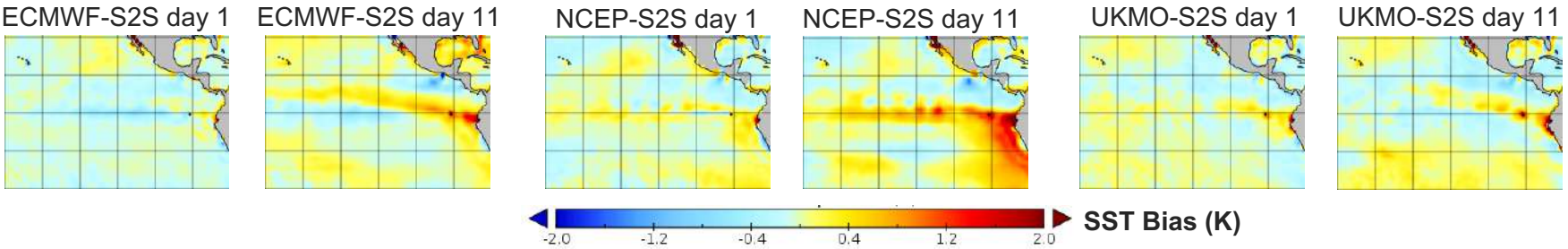
Ongoing WGSIP Projects

2014-2019 cycle

Snow initialization skill in NorCPM



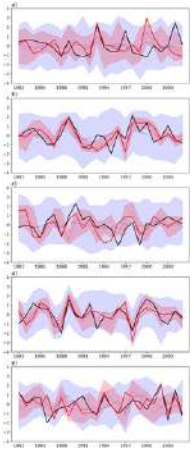
- **SNOWGLACE** (snow initialization)
  - paper on snow initialization impacts published in JGR S2S issue
  - reanalyses shown to overestimate snow cover & depth in Tibetan Plateau
- **LRFTIP** (shocks and drift)
  - evaluating development of model systematic errors in >40 subseasonal, seasonal and decadal systems for overview paper
  - database used by EU APPLICATE project to study model biases

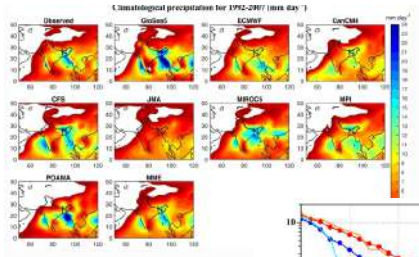


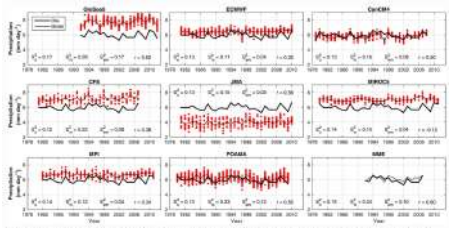
- **Teleconnections**
  - published CHFP-based paper on tropical rainfall predictions and associated teleconnections

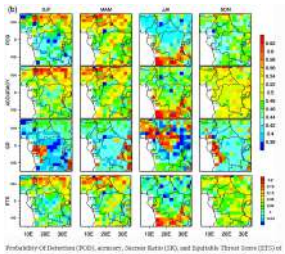
Progress and achievements - CHFP

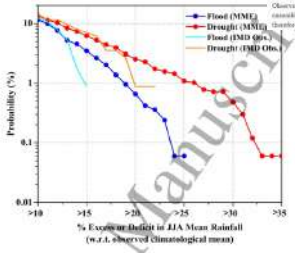
- Efforts to widen awareness of CHFP database (hindcasts from 27 systems and counting) appear to be taking hold → increasing numbers of publications (≥6 in 2019-20)

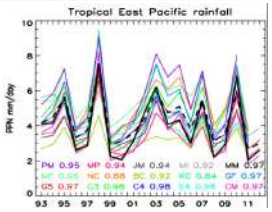


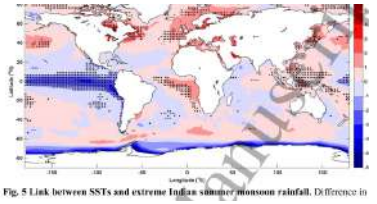








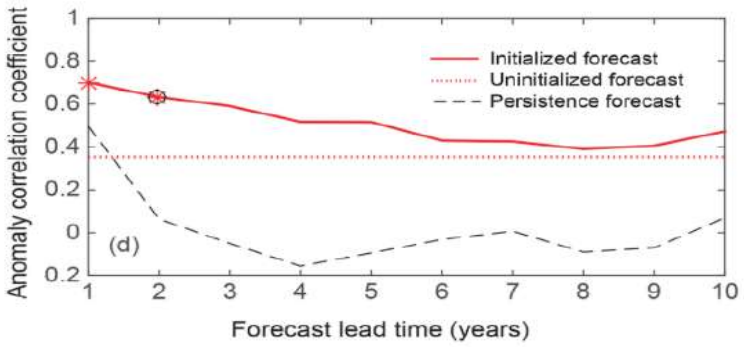




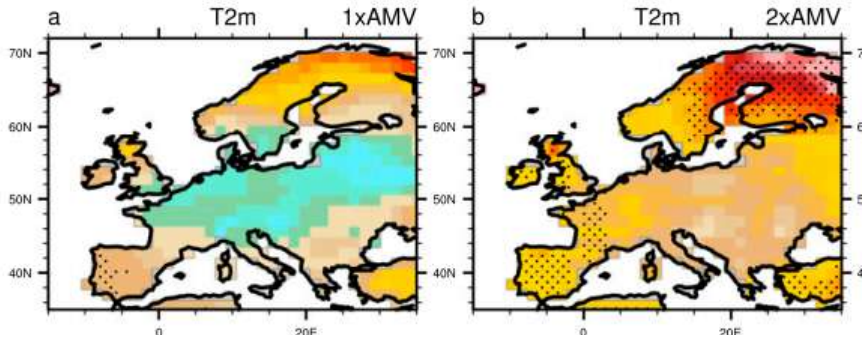
- WMO IPET-OPSLS Expert Team has agreed for past/present/future seasonal hindcasts from consenting Global Producing Centres to be archived in CHFP
- This will enable comprehensive tracking of seasonal forecast performance through time as advocated in TPOS 2020 2nd report
- Feeding new WGSIP projects

Progress and achievements DCPP

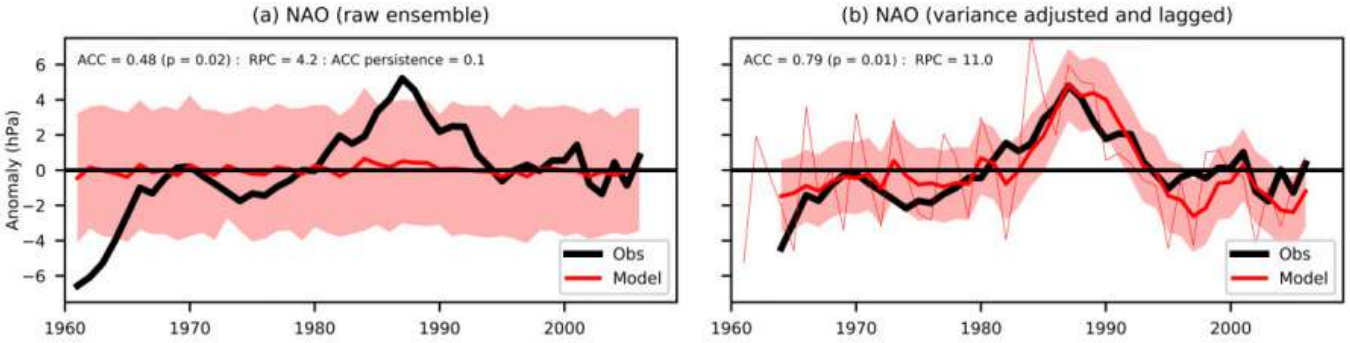
Skilful predictions of ocean carbon uptake (detrended)



Non-linear impact of AMV on Europe



- New panel with improved diversity (geographical, gender, expertise).
- CMIP6 DCPP hindcasts and targeted predictability, mechanism and case study simulations have been completed by numerous modelling groups
- Skilful predictions of carbon uptake
- Improved understanding of climate impacts of AMV
- Skilful predictions of NAO, but models severely underestimate the predictable signal



Skilful predictions of North Atlantic Oscillation are possible with very large multi-model ensemble, but signal is 10 times too small in models

Lovenduski et al 2019, Qasmi et al 2020, Smith et al 2020

Future plans - WGSIP

WCRP Workshop on Extremes in Climate Prediction Ensembles (ExCPEns)

APCC APEC CLIMATE CENTER

Subseasonal · Seasonal · Annual to Decadal · Multi-decadal

Hosted by APEC Climate Center (APCC) | 26-28 October 2020, Busan, Korea

Organized by

- WCRP Working Group on Subseasonal to Interdecadal Prediction (WGSIP)
- WCRP Grand Challenge on Weather and Climate Extremes
- WWRP/WCRP Subseasonal to Seasonal Prediction Project (S2S)

→ APN funding applied for to support participation by scientists from developing Asian countries (esp. ECS)

→ Held in conjunction with WGSIP 22

→ *Decision soon on whether to solicit abstracts or postpone*

APN
ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH

WORLD METEOROLOGICAL ORGANIZATION · United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission · International Science Council

WCRP World Climate Research Programme

Future plans - WGSIP

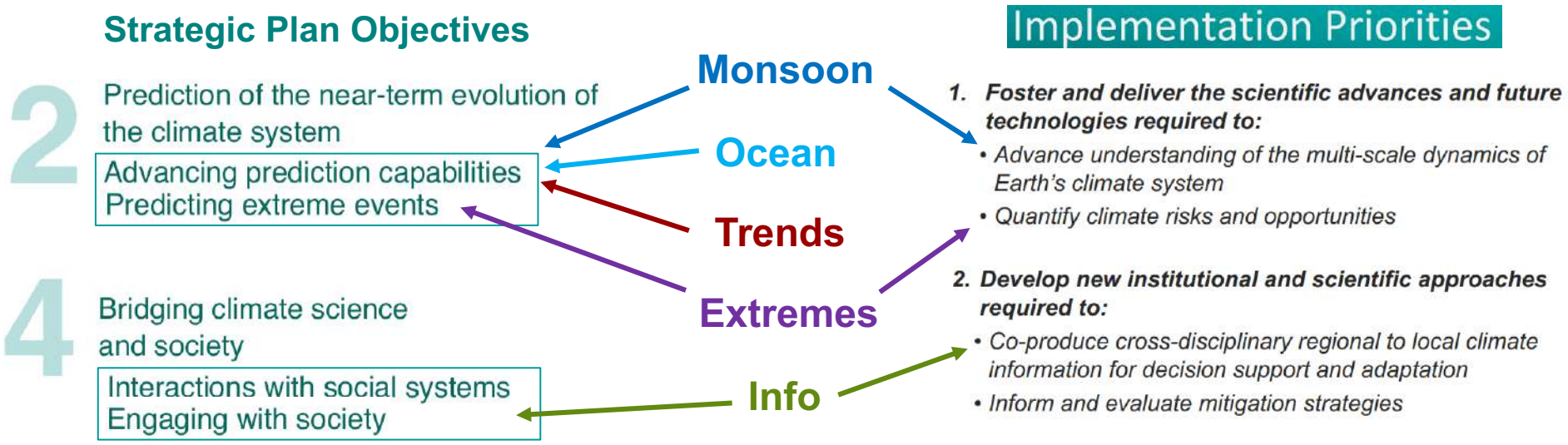
- New WGSIP projects: carry forward new project work plans, updating and extending after 2021, while pursuing collaborations with WCRP and external groups
- CHFP: develop software “pipeline” to ingest WMO GPC hindcasts, explore migration to ESGF node
- Use enhanced CHFP to assess progression of seasonal forecasting skill over time
- Continue to co-schedule school or workshop with each WGSIP session

Future plans - DCPP

- Engagement with emerging multi-institutional "Year 2" prediction effort within the US with 4x/year initialization
- Forecasts of opportunity with volcanic forcing (once there is a major volcano; DCPP “on standby”)
- Multi-model intercomparisons from CMIP6 ensemble (North Atlantic study underway)
- Encourage additional contributions to DCPP component C (pacemaker, volcanic forcing expts, “cheap” compared to component A hindcasts)

Links to the WCRP Strategic and Implementation Plans

- The new cycle of WGSIP projects was formulated to address Strategic Plan Objectives, and align well with Implementation Priorities as well:



- A central science issue, that *models underestimate predictability and forced response of atmospheric circulation* by up to an order of magnitude e.g. in the North Atlantic region is fundamentally a modeling issue that will require coordinated efforts to understand and solve.

Emerging issues

- **Membership**
  - WGSIP's subseasonal to interdecadal remit requires broad expertise and GPC representation, cross-membership with S2S, IPET-OPSLS etc.
  - This is challenging with 13 members (11 in 2019-2020)
  - Requesting 14 members in 2020-21, ideally longer
- **Research to Operations (R2O) / Operations to Research (O2R)**
  - WGSIP and WMO IPET-OPSLS co-chairs currently operate as informal task team to facilitate R2O & O2R
  - Would be advantageous to formalize, modestly increase size of task team
- **Coordinating and adding value to modeling experiments**
  - Much potential added value lost due to fragmentation of research initiatives*
  - Could be addressed by leveraging CMIP protocols and ESGF data access for climate prediction experiments, using DCPP protocols as a starting point
- **WCRP Climate Prediction Summit?**
  - Much could be achieved by a joint working meeting involving WGSIP, DCPP, GC-NCTP, S2S, IPET-OPSLS and core project representatives in 2021 or 2022
  - Objectives would include sharing approaches and results of research initiatives, formulating strategies for research and climate services development

* see additional slides

Additional Slides

WGSIP Monsoon Project

Long-Range Forecasts of Monsoons (LRFM)
(A component of the WGSIP Prediction Capability Project)
Yuhei Takaya and Hongli Ren*, Leads

The purpose of the WGSIP Initiative LRFM is to make a systematic evaluation and inter-model comparison of long-range forecasts of the monsoons.

Two themes: "**Asian monsoon (AM)**" and "**Global Monsoon (GM)**"

Expected outcomes of the AM theme:

→ Better understanding of processes and mechanisms responsible for the seasonal predictability of AM
→ New diagnostic ways to describe the model performance of seasonal predictions of AM
→ Identification of key aspects to further improve the seasonal prediction skill of AM to facilitate the model development at modeling centers
→ Provision of the systematic assessment of the prediction skill in latest and past seasonal prediction systems, to infer progress and prospects of the Asian monsoon seasonal predictions

Expected outcomes of the GM theme :

→ Evaluation of the performance of dynamical models in the seasonal prediction of the GM index and GM precipitation patterns.
→ Evaluation of the performance of dynamical prediction models in representing the impact patterns of the main factors of ocean forcing on the GM and precipitation.
→ Understanding of main mechanism aspects responsible for the seasonal predictability of the GM index or GM precipitation.

*WGSIP 21 invited expert

WGSIP Monsoon Project

The monsoon is a fundamental annual climate variation and fluctuates in various time scales.

Asian Monsoon

The Asian monsoon is the most dominant regional monsoon, which is strongly influenced by the atmosphere-land-ocean interactions in a region with complex geography (coastlines and terrains). The long-range forecast of the Asian monsoon had been a challenge for climate modeling. Although the model development is still in an incipient stage and its skill is still far from satisfactory, recent progress of climate modeling enables to generate meaningful predictions up to a season ahead. Better understanding of the dominant variability modes and processes controlling them reveals the predictable variability of the Asian monsoon. The dominant variability modes play a major role in modulating the Asian summer monsoon and are considered to give rise to the seasonal predictability.

Global Monsoon

Several regions worldwide are dominated by a monsoon-like cycle of rainy and dry seasons. The concept of the global monsoon (GM) has been developed to refer these features in a holistic view, originally in the climate change research, but this concept can also be extendedly applicable in the context of the climate prediction. Prior studies have examined the features, changes, and ocean forcing of the GM-related precipitation. Because the GM is the fundamental and drastic feature in climate system, it is crucial to represent the GM features well in the dynamical models. Better representation of the GM in dynamical models is expected to bring with the improved seasonal forecasts.

WGSIP Ocean Prediction Project

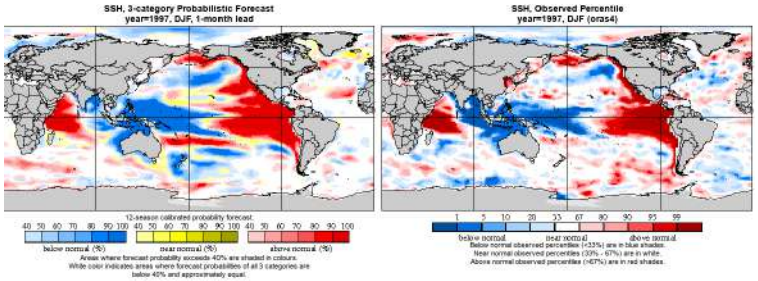
Johanna Baehr and Bill Merryfield, Leads

The oceans are a relatively predictable Earth system component, yet there has been relatively little attention to forecasting ocean variables beyond SST.

This project is addressing this gap by systematically evaluating ocean predictions across time scales for multiple initialized climate prediction systems.

Initial efforts are focusing on two ocean variables that are relatively well observed, provide important diagnostics of modeled ocean behavior, and have potential societal impacts:

- **Sea surface height (SSH)**
  - Known to he relatively predictable
  - Significant societal impacts (SSH anomalies of up to several 10s of cm are driven by ENSO)



- **Mixed-layer depth (MLD)**
  - Significant ecological impacts
  - Influences atmosphere-ocean interactions and hence performance of prediction models

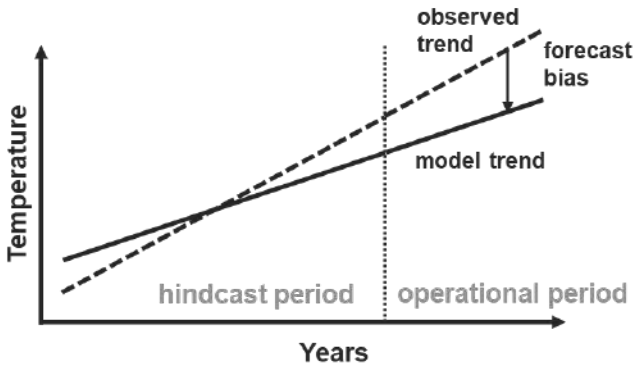
Because the oceans are relatively sparsely observed, an important additional element is to **explore optimal choices or combinations of observational datasets** for verification.

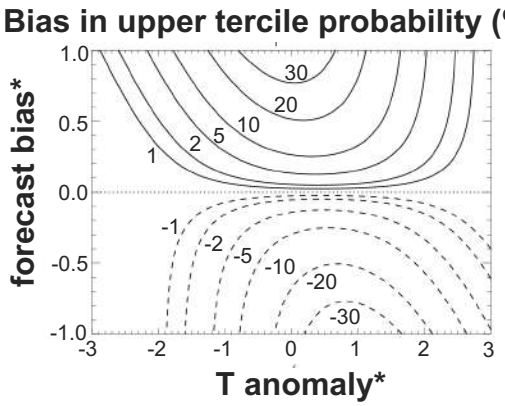
WGSIP Temp Trend Prediction Project

Bill Merryfield, Lead

Climate prediction models stem both from NWP and climate simulation models. Differing treatments of radiative forcings, as well as differing initialization methodologies, may cause long-term temperature trends to deviate from what is observed.

A consequence of misrepresented temperature trends is that prediction systems may systematically over- or underestimate temperatures in operational forecasts, even after mean biases during the hindcast period have been removed:





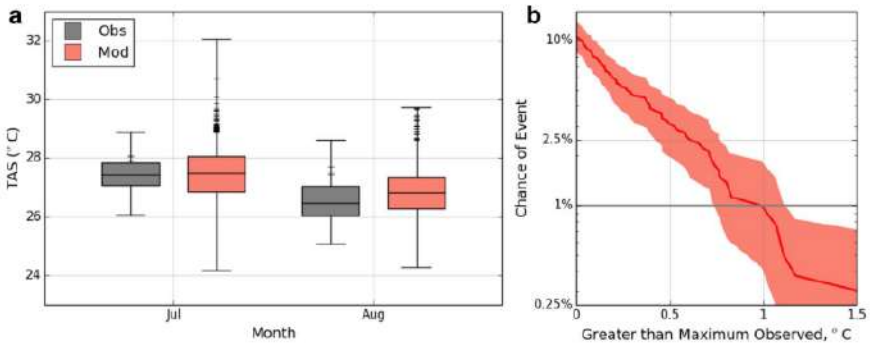
*in units of standard deviations of the forecast distribution

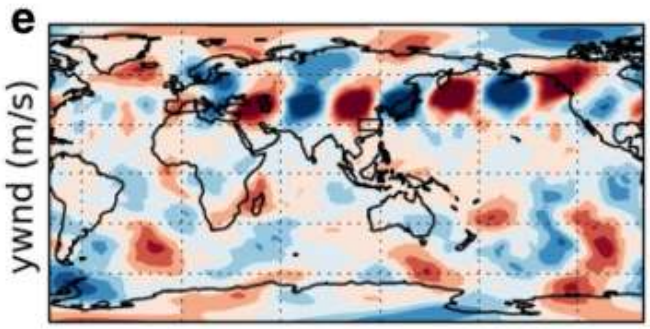
In light of limited previous attention to this issue, this project is

- assessing the representation of temperature trends across several generations of prediction systems (initial results indicate mean trend errors of ± 0.2°C/decade over land are not uncommon)
- estimating impacts of trend errors on operational forecasts
- examining possible reasons for incorrect trends with a view toward informing prediction system development

WGSIP Risks of Extremes Project

Doug Smith and Hongli Ren*, Leads





UNSEEN (UNprecedented Simulated Extremes using Ensembles)
Models provide multiple realisations of dynamically plausible events allowing the risks of extremes, including unprecedented events, to be quantified more accurately than is possible from the limited observations. Associated dynamics can also be explored.
→ ***7 papers and counting***

Example shows "Silk Road" pattern influence on south-east China temperature (Thompson et al 2018). Other applications include UK rainfall, Indian monsoon, and crop yields.

*WGSIP 21 invited expert

- Assess the predictability of extremes
- Quantify the risks of extremes in the current climate using large ensembles of initialised model simulations
- Investigate the dynamics associated with extremes
- Addresses objectives 1 (Fundamental understanding of the climate system) and 2 (Prediction of the near-term evolution of the climate system) of the WCRP Strategic Plan.

WGSIP I4D Project

Information for Decision Making (I4D)

Ángel Muñoz* and Lauriane Batté, Leads

This WGSIP project on climate forecast information for decision making is tackling several research-to-operations issues faced by the climate prediction community.

In doing so, the project is aligned with the WCRP Strategic Plan objective 4.2 “Engaging with society”.

Components and research foci:

1) Assessment and improvement of calibration and ensemble techniques: how can imperfect model forecasts be translated into useful, reliable and comprehensive products?
   - Review paper on existing methodologies
   - Intercomparison of calibration and multi-model ensemble techniques
   - Web site at IRI including index of repositories for calibration code used at different institutions
2) Combination of forecasts across time scales
   - Explore ways to combine seasonal and subseasonal forecasts to increase skill and provide complementary information
   - Explore methodologies for seamless verification across time scales
3) Capacity building and guidance for the operational community
   - Organize training schools/workshops
   - Provide guidance and tools for the operational community regarding (1) and (2)

*WGSIP 21 invited expert

Existing climate prediction landscape

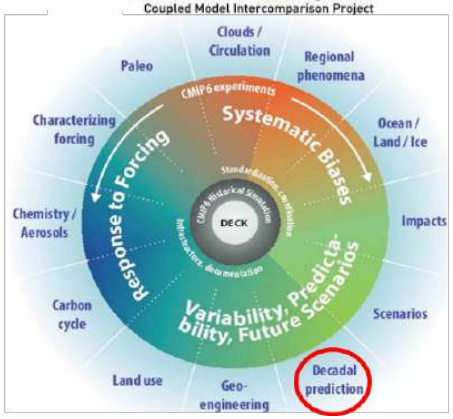
Research

WCRP World Climate Research Programme

Subseasonal-to-Seasonal S2S Prediction Project

The Climate-system Historical Forecast Project at Centro de Investigaciones del Mar y la Atmosfera

CMIP The World Climate Research Programme's Coupled Model Intercomparison Project



Decadal Climate Prediction Project

GLACE-2 LFMIP-Pobs LRFTIP

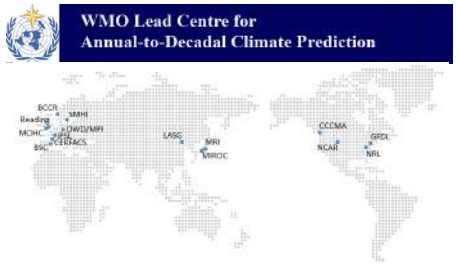
WGSIP and other WCRP subprojects

SNOWGLACE LS4P Strat-HFP Ice-HFP

Operations

WORLD METEOROLOGICAL ORGANIZATION

WMO subseasonal under development



2 weeks month season year decade

Subseasonal *Seasonal* *Annual to Decadal*

Existing climate prediction landscape

A fragmented landscape

Research

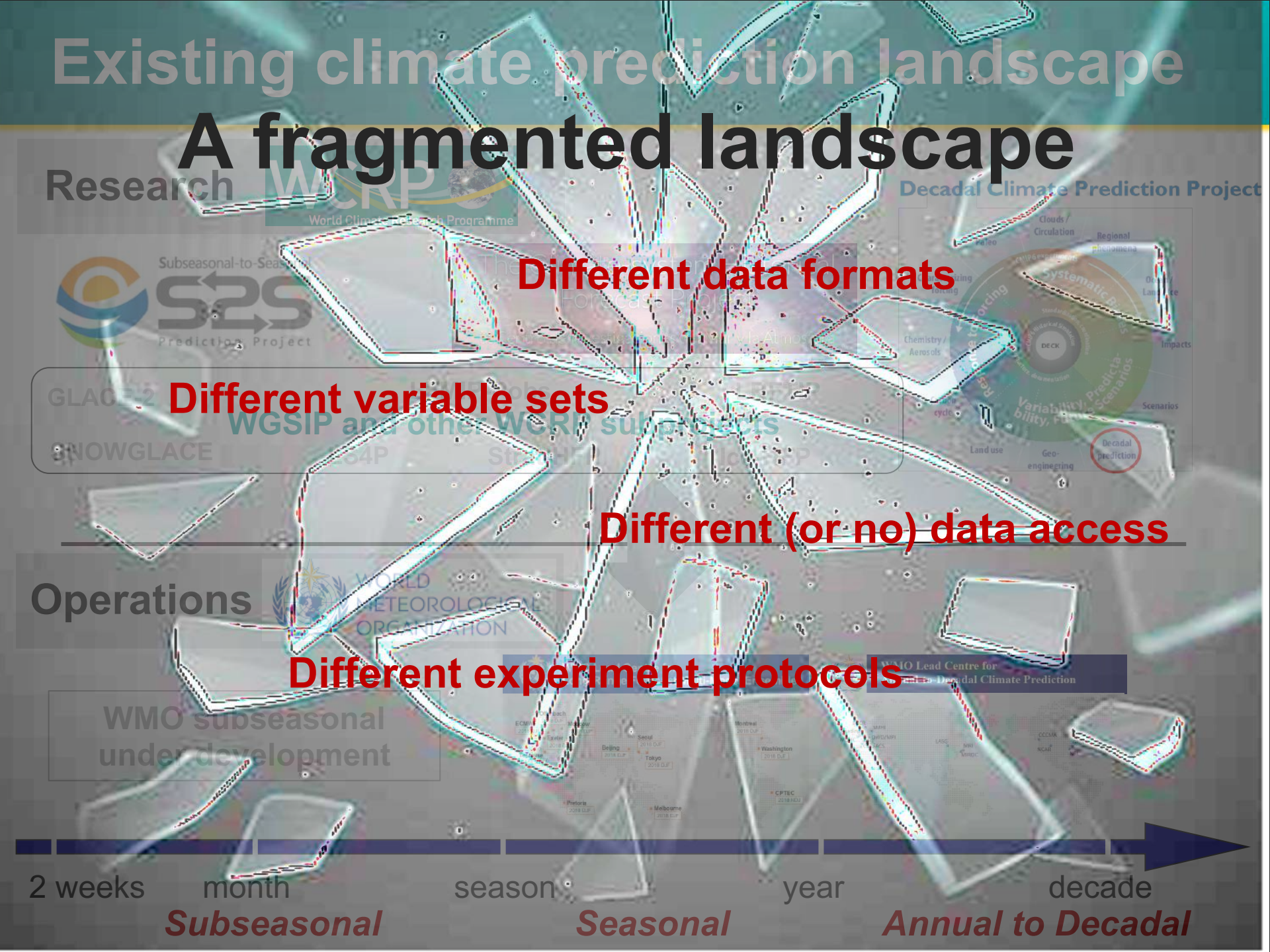
Operations

Different data formats

Different variable sets

Different (or no) data access

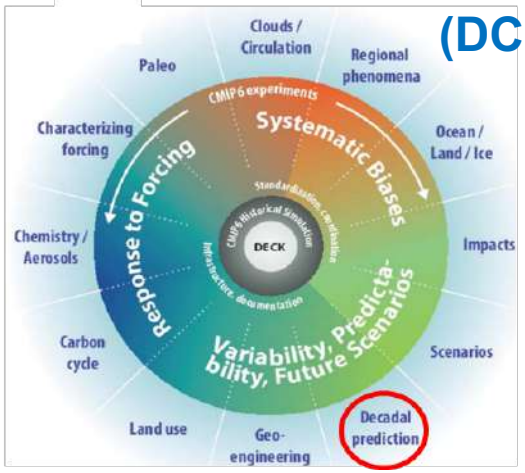
Different experiment protocols



A way forward via CMIP & ESGF

- Future climate prediction projects adopt same data standards as DCPP (DCPP a “foothold”)
- Would not be a major burden for most research centres because they are following these standards anyway for CMIP
- Likely advantages:
  - reduced duplications of effort meeting different design criteria
  - more centres likely to participate
  - uniform data access
  - more stable data legacy, potential for value added
- Incentives for current non-CMIP operational centres to participate

Decadal Climate Prediction Project (DCPP)



ESGF