WORLD CLIMATE RESEARCH PROGRAMME

Lighthouse Activity on Explaining and Predicting Earth System Change

June 2021

Co-chairs:
Rowan Sutton, NCAS & U. Reading, U.K.
Kirsten Findell, GFDL, U.S.A.

WMO UNESCO INTERNATIONAL COUNCIL FOR SCIENCE WCRP World Climate Research Programme

Contact

If you wish to get in contact regarding this activity, please email:

Nico Caltabiano: avazcaltabiano@wmo.int

or

Narelle van der Wel: nvanderwel@wmo.int

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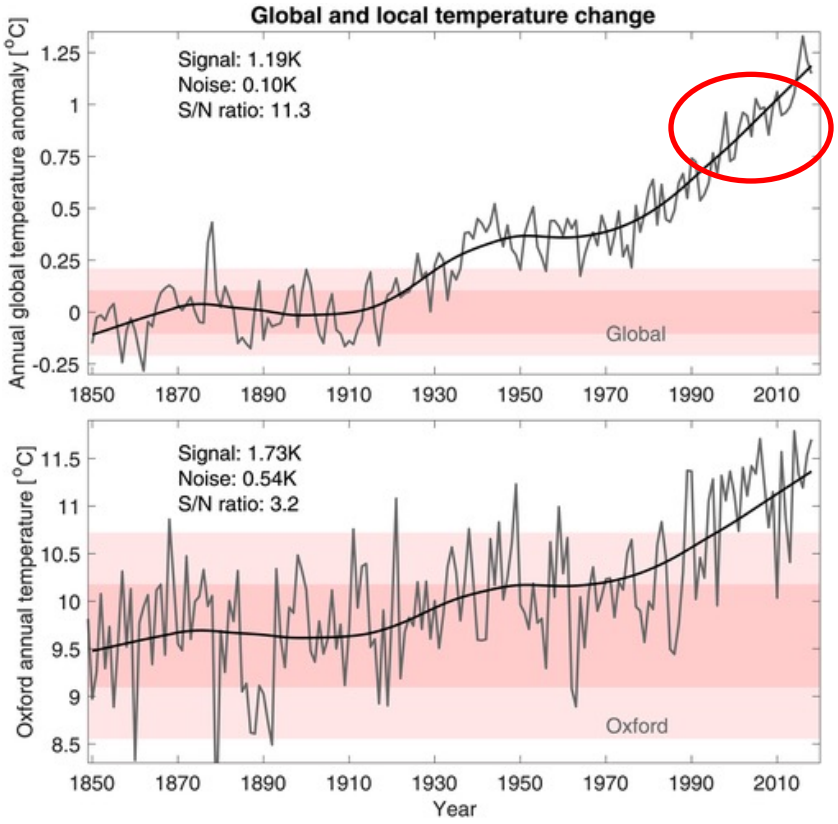
The signal of anthropogenic climate change is emerging progressively from the background of natural variability.

Emergence is seen on multi-annual and longer timescales and is becoming ever more apparent on smaller spatial scales and in a greater range of variables.

Yet capabilities for quantitative explanation and prediction of changes on these timescales are exceedingly primitive (e.g. “hiatus”)

We are particularly poor at explaining changes in dynamical variables, e.g. atmosphere and ocean circulation.



Hawkins et al, GRL, *Observed emergence of the climate change signal: from the familiar to the unknown*, 2020

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Motivation

- The formulation of robust policies for mitigation of, and adaptation to, climate change requires quantitative understanding of how and why specific changes are unfolding in the Earth system.
- Quantitative process-based explanation (attribution) of observed changes is essential for quantifying current risks and fundamental to confidence in climate predictions and projections.

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Overarching objective

- ***To design, and take major steps toward delivery of, an integrated capability for quantitative observation, explanation, early warning and prediction of Earth System Change on <u>global and regional scales</u> and <u>multi-annual to decadal timescales.</u>***

Changes in ocean and atmosphere circulation a specific focus – key issue for adaptation.

Headline output: quantitative explanation of Earth System change

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

EMBARGO 1400 CET (1300 GMT) WEDNESDAY 2 DECEMBER 2020

State of the Global Climate in 2020

WORLD METEOROLOGICAL ORGANIZATION
Commission for Basic Systems / Commission for Climatology

Global Annual to Decadal Climate Update

Target years: 2019 and 2019-2023 TRIAL PHASE

Executive Summary

This update presents a summary of annual to decadal predictions from WMO designated Global Producing Centres and non-designated contributing centres for the period 2019-2023. Latest predictions suggest that:

- Annual global temperature is likely to be at least 1°C warmer than preindustrial levels in each of the coming 5 years
- There is a small but growing chance (~10%) that one of the next 5 years will be at least 1.5°C warmer than preindustrial levels

These headline reports currently include virtually no information on the attribution/explanation of multiannual to decadal changes in the Earth System

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Headline output: quantification of current and future weather and climate hazards

- *Where can specific hazards occur?*
- *How are hazard locations and other properties modulated by natural variability on interannual to decadal timescales, and how predictable are these modulations?*
- *How has climate change affected the distribution and other properties of specific hazards and what further changes should we anticipate?*

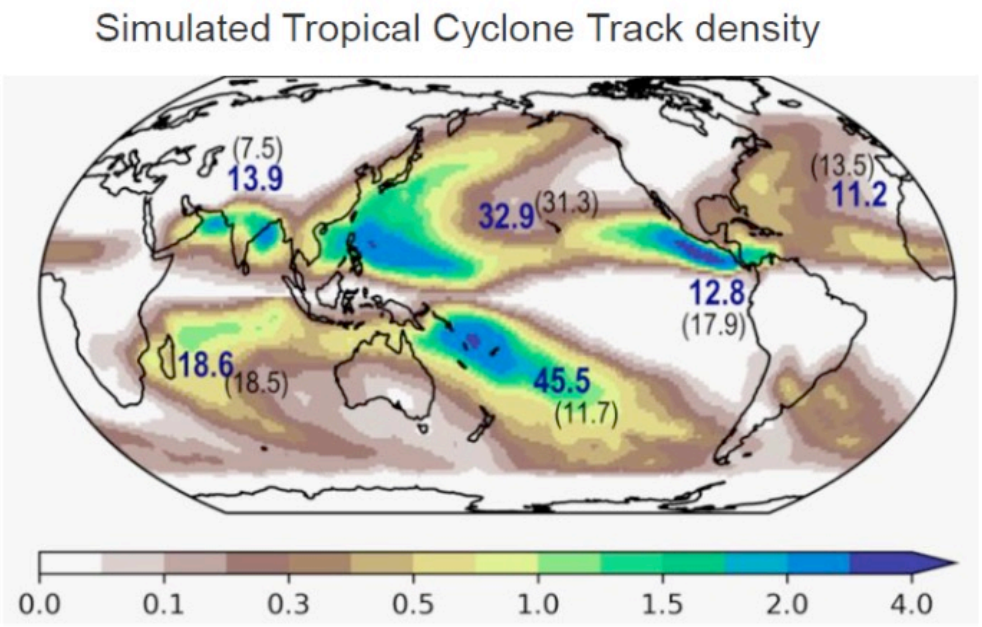

Figure from Pier Luigi Vidale

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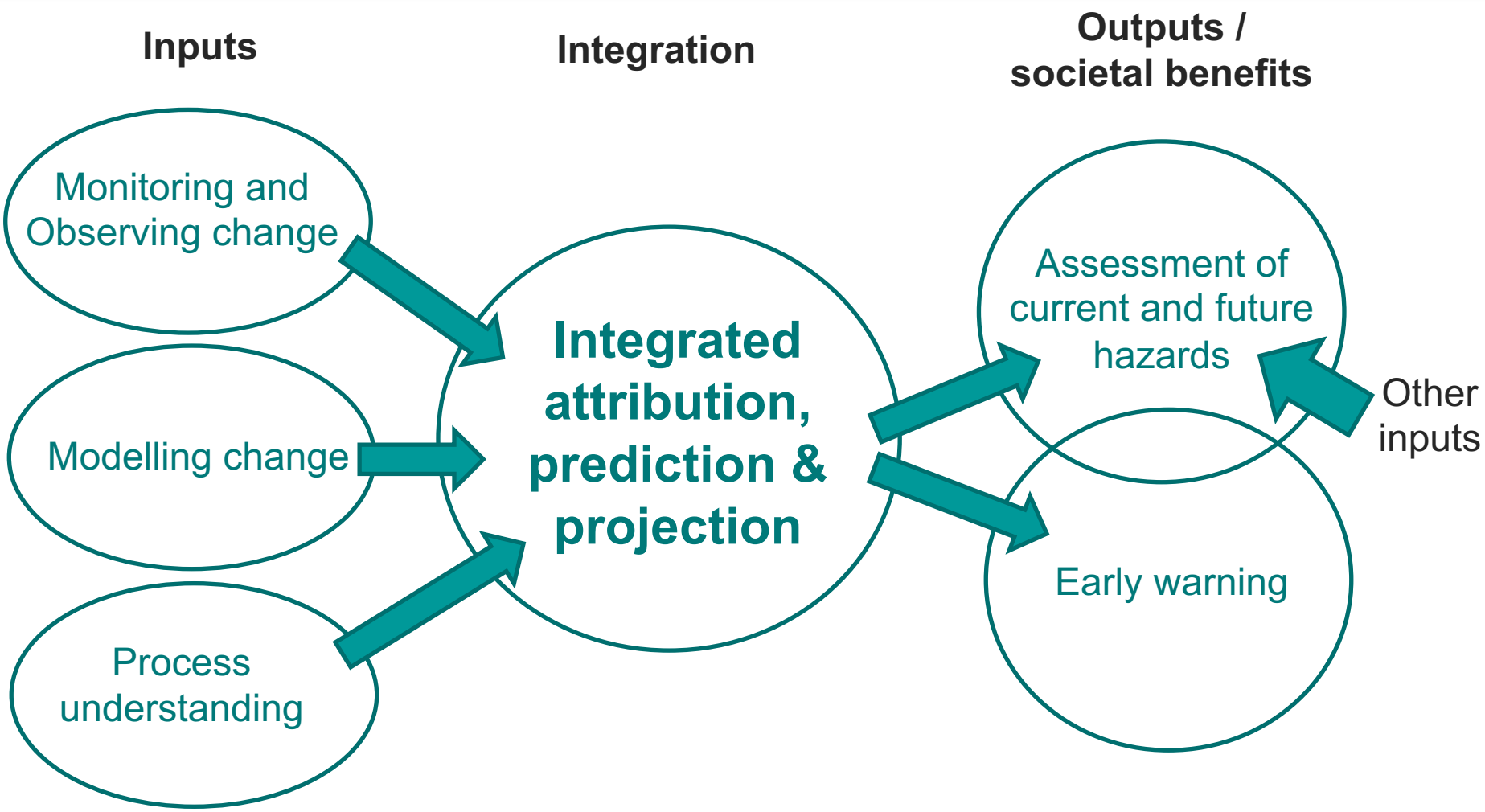

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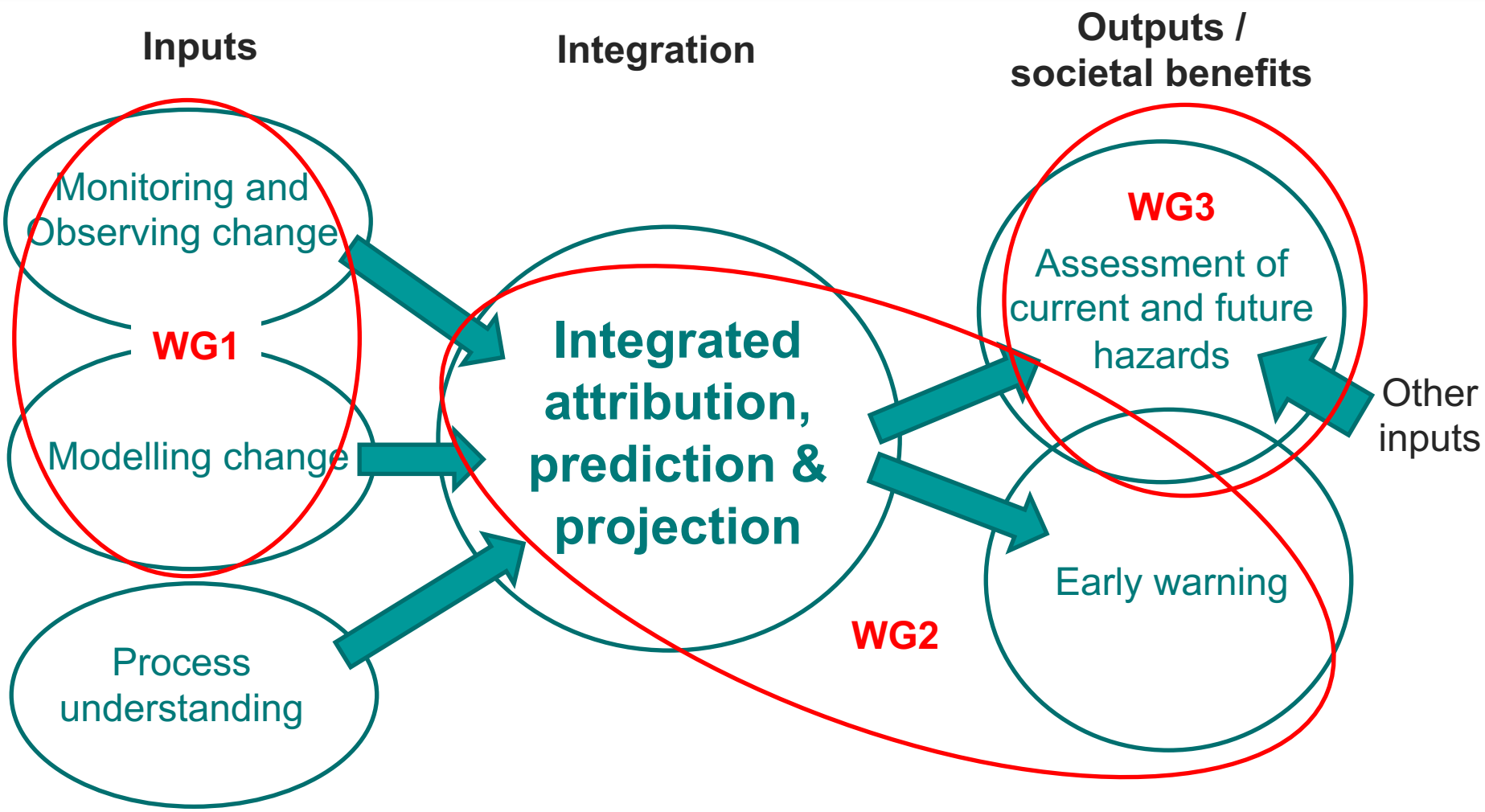

Some emerging priorities

WG1: Monitoring and modelling Earth System Change

- Case studies
- Convergence between climate modelling and Earth system DA & reanalysis
- Uncertainty quantification & observing system design
- Innovation in model development

WG2: Integrated attribution, prediction, projection and early warning

- Need for *large ensembles with single forcings* to advance attribution and explore potential nonlinearities. Collaboration with DAMIP and SMILE communities.
- Circulation change (including "signal-to-noise paradox")
- Case studies
- Contribute to WMO State of Global Report & Global Annual to Decadal Climate Update

WG3: Assessment of Current and Future hazards

- Focus here on classes of events rather than individual events
- Understanding the natural and anthropogenic drivers of changing hazards in different regions
- Need for large ensembles *and* high resolution
- Extending "event attribution" methodologies
- Collaboration with My Climate Risk & RifS

WCRP workshop on attribution of multi-annual to decadal changes in the climate system

Format: virtual workshop (free registration and attendance)

When: 22-24 September 2021 **Abstract submission deadline:** 30 June 2021

The aim of this workshop is to document current research, identify challenges, and explore potential pathways towards building an operational capability to attribute multi-annual to decadal changes in the climate system on global-to-regional scales. Key areas to be addressed include:

- To what extent is the observing system adequate for the task and how best to use the observations
- Approaches to assess the roles of internal variability and external factors including greenhouse gases, aerosols, solar variations, volcanic eruptions, ozone, land use etc
- To what extent are models adequate for the task and how to account for model errors, including underestimated signals
- To what extent responses to different forcings add linearly
- Analysis of physical processes
- Linking large scale circulation to regional weather and climate hazards
- Steps needed to build an operational capability

https://wcrp-epesc.sciencesconf.org/