RIfS
Regional Information for Society

RIfS Science Plan, v2

2022-2026

Enhancing the scientific value of regional climate information in policy and decision contexts

WCRP Publication No.: ?/2025

WCRP World Climate Research Programme

unesco

International Science Council

Bibliographic Information
The RIfS Science Plan should be cited as:

RIfS, 2025. Regional Information for Society (RIfS) Science Plan, version 2 (2022-2026), WCRP Publication ?/2025 ; Online; 17 pp.

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Authorship and publisher's notice
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Preface

WCRP Core Projects are enduring research communities. The Regional Information for Society (RIfS), while one of the newer WCRP Core Projects, serves as a home for the the Coordinated Regional Climate Downscaling Experiment (CORDEX), which has a 15 year history in this domain, and builds upon other longstanding communities of practice across the WCRP.

The RIfS Science plan should be read as a living document that is meant to be flexible and responsive to the rapidly evolving context of societies response to climate change. As such, the "big picture" framing is the important focus, and the implementation of the detailed foci will be adaptable in terms of priority as a function of the region, resources, and societal application.

This version is adapted from the draft Science and Implementation Plan prepared by the Interim Coordination Group and approved by the WCRP Joint Scientific Committee (JSC) in April 2022. Because these are still early days for RIfS, we plan to update it again in 2026, with the expectation that our early experiences will inform the next phase.

The RIfS Scientific Steering Group (SSG) was formalized in 2023, with its first annual meeting over several days in early October 2023, just after the International Project Office (IPO) was established with the hiring of its inaugural director.

It should be recognized that partnerships and collaborative opportunities, both internal to WCRP and externally, will continue to evolve through discussions and meetings. It should also be noted that the internal relationships and structure within RIfS is still expanding, and as collaborations mature, this plan will be updated again to reflect a deliberate and sustainable approach to growing this program.

MISSION

Regional Information for Society (RIfS) builds understanding, develops, coordinates and enhances collaboration among scientists, decision makers and society to amplify the scientific value of regional climate information in policy and decision contexts.

VISION

RIfS envisions a world where deepened systemic understanding and integration of different knowledge systems enhances the value of climate science for stakeholders in policy and adaptation decisions.

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Context

The need for robust regional climate information, where the term robust is applied to denote information that is both scientifically defensible and contributes to reducing the risk exposure of decision consequences in society, is becoming more urgent as the effects of climate change are felt in regions around the world. This is a crucial moment, in which sectors across society are of necessity rapidly seeking to implement measures to manage their climate risk(s).

The ability to take informed and responsible actions is undermined by the limited progress that has been made in developing defensibly robust information as understood by decision makers accountable for consequences. This is due to ; (i) gaps in understanding certain aspects of the physical climate response, (ii) the inadequacy in how to deal with non-congruent or even contradictory data and (iii) challenges in aligning information with decision contexts. Together these factors can have large regional planning implications. The absence of any agreed way to assess the robustness of climate information compounds the challenge to responsibly implement actions, and opens the door to potential maladaptation.

At the same time, new data and information products continue to proliferate, including new emerging high-resolution and downscaled climate data products, as well as emerging machine learning-based approaches. These are made available through multiple avenues of varied completeness and accessibility, where the data may be easily inferred as actionable information by decision makers.

Transparency about the design and limitations of modelling experiments, data production, analyses and information construction is urgently required to better enable all actors to align information production and adoption with the contexts of policy and decision-makers.

When experts engage in a process of distillation and partner with stakeholders in co-production, it is possible to develop robust and decision-relevant information about physical climate risks. However, it is usually a complicated, labour intensive, process, that may not be readily scalable and often produces a unique solution for a particular context which limits transferability of lessons learned. Sharing these experiences more transparently (the successes *and* failures) across regions can help researchers offer greater value over time.

RIfS brings together the top-down and bottom-up approaches to the production of regional information for society, with its scientific pillars in state-of-the-art regional modelling (CORDEX) and monitoring and understanding of emerging climate extremes (GEP), along with new activities centred on robust information, responsible data use, and partnerships around regional exemplars of information co-production to empower decision-makers at the local scale with context aligned information.

About RIfS

Who we are

The Regional Information for Society (RIfS) Core Project is a global community of experts who seek to understand, develop, and enhance the effective flow of relevant information among scientists, decision makers and society to develop policy-relevant climate research. RIfS is one of the Core Projects of the World Climate Research Program (WCRP, www.wcrp-climate.org).

What we do

RIfS coordinates, facilitates, and implements targeted research on regional climate information and the internally and externally forced climate variability and change at the regional scale. RIfS develops connections with stakeholder communities to understand how the contextual realities of policy and decisions can better inform the development and delivery of regional climate information . This understanding is used to strategically inform new research foci, and to enhance the construction, communication, and adoption of climate information by society.

How we work

RIfS accomplishes its mission by bringing together scientists and stakeholders from around the world to share experiences and build community collaboration around improving regional information about climate variability and change. The work of RIfS is governed by its Scientific Steering Group (SSG), which identifies gaps, sets priorities, and develops new activities in partnership with the activities that form RIfS' scientific pillars (see Section 5). RIfS is supported by an International Project Office (IPO) which is the main point of contact for RIfS (www.wcrp-rifs.org).

Defining our terms

Regional

The term “Regional” is used here loosely to refer to a variety of scales from continental to hyper-local. The spatial scale of interest is highly dependent on the societal context and problem for which the information is required; a decision scale.

Information

The term “Information” notably differs from data, in implying an ability to interpret and move towards actionable knowledge.

Society

The term “Society” is used here in a limited definition to prioritize the focus on the two key communities of users of climate information: first, those directly involved with policy and decision making and the impact research community; second, the climate services community who are also a type of user, but of more primary climate data, including environment/environmental services.

Context

The term “context” is used in this document to refer to the context in which the climate information is used (e.g. a city planners decision context, or a water resource manager’s context). This may include the broader aspects of values, culture, operations, institutions, policy frameworks, governance, etc.

Robust

The term robust, as applied to regional climate information, refers both to information that is scientifically defensible and suitable to inform a decision context. For the decision maker(s) who is/are accountable for the consequences of actions, ‘robust’ refers to that climate information which assists in reducing their risk exposure when responding to projected impacts. We recognize there are other uses of the term in the WCRP community, for example referring to scientific robustness, confidence, uncertainty, or fitness-for-purpose.

Climate Literacy

We define “climate literacy” as comprehending enough about another community to engage with the right questions and not be presumptive, whether coming from the scientific research or decision-maker perspective.

RIfS Science Goals

The overarching ambition of RIfS is to facilitate and catalyse new targeted research related to the provision of actionable information about climate variability and change in support of adaptation and mitigation that draws on the best available science. RIfS uses the application context to inform research on aspects of understanding the climate system, the collation and/or generation of relevant data, the construction of actionable information informed by the context, and the communication, engagement and partnership with policy and decision makers and relevant stakeholders.

To link climate science and society with context relevant climate information, we identify three overarching science challenges, each of which is addressed by a set of RIfS' research objectives.

1) How to optimally identify, understand, and model climate processes and their interactions which are most critical to manage the socio-ecological risks at decision scales within regions.

- Improved understanding of the fundamental mechanisms and drivers of regional climate change and regional climate variability.
- Improved understanding of the changes in weather and climate extremes (including compound extremes) and their attribution.
- Improved articulation of the climate relationship between regions and the large-scale climate mechanisms and their interactions across scales.
- Advanced understanding of predictive skill of drivers of regional climate in the context of regional vulnerability.

2) How to optimally integrate multiple lines of evidence from physical understanding, observations, and data from dynamical and statistical regional and global models to inform society's climate information needs.

- Improved approaches and methodologies for reconciling and integrating multiple lines of evidence for climate change prediction and projections at the relevant societal scales.
- Construction of regional climate information relevant to the decision context and impacts, including a specific focus on extreme events.
- Quantification of the temporal and spatial scales of skillful climate prediction and projection and the associated added value of available statistical and dynamical modelling systems contributing toward actionable climate information.
- Assessment and evaluation of the skill, uncertainty and limits of tools for developing regional climate prediction and projection information products, including extreme events.

3) How to best undertake engagement between stakeholders and the science community in different regional contexts to maximize the information benefit for the stakeholder and ensure that the application context is integrated into the design and execution of relevant climate research.

- Assessment and development of approaches for effective engagement between the research community and society stakeholders and the Climate Services communities.
- Improved research designs that incorporate stakeholder context to advance the responsible and pragmatic uptake of climate information in a heterogeneous landscape of values and cultural priorities.
- Enhanced methods for co-production with stakeholders on the context-relevant construction, communication and adoption of actionable information.
- Develop approaches to better integrate and assess the connections across the pathways linking data production, information construction, knowledge development, and wisdom in adaptation.

The RIfS Interim Coordinating Group (ICG), when tasked with establishing the initial framing for RIfS, identified even more specific research gaps that RIfS could address, organized into four inter-related and co-dependent clusters. Appendix A describes these clusters and their priority scientific questions, as a guide for the RIfS SSG when developing and considering new activity proposals.

Implementation

RIfS will promote, design, and implement research activities to enhance the beneficial value of climate science for society leveraging all relevant foci within WCRP, and especially the two scientific pillars of CORDEX and GEP. It is explicitly recognized that some objectives of RIfS have overlap with other Core Projects. In such cases, RIfS will seek to be complementary, collaborative, and not duplicate other efforts.

Structure and Organization

Implementation of activities in support of the science plan will be the responsibility of the SSG. The SSG engages in ongoing discussions with other components of the WCRP, exploring collaboration and how best to complement their activities.

RIfS has two major components which function as scientific pillars that complement additional foundations beyond RIfS, and which strengthen the physical science basis for robust regional climate information:

1. The Coordinated Regional Climate Downscaling Experiment (CORDEX)
2. The Global Extremes Platform (GEP)

Each of these scientific pillar activities operates autonomously with the oversight of the RIfS SSG, who approve the membership of their top-level governing bodies. Each of the pillar activities has its own project office (in the case of CORDEX) or

support unit (for GEP). The RIfS IPO interfaces directly with the staff at these offices to aid in coordination and collaboration across activities.

In addition to CORDEX and GEP, the RIfS SSG creates working groups and task teams to address the science gaps outlined in this document.

- A Working Group coordinates activities over the long term on a broad research area of importance to RIfS, and may create Task Teams to address particular needs of the Working Group.
- A Task Team works over a limited period of time to address a specific, targeted issue or project, usually with a narrower scope than a Working Group.

Working groups and task teams fall under two categories: cross-cutting thematic activities, and region-specific collaborations and exemplars. Figure 1 shows the initial groups established by the RIfS SSG, with room for others to emerge depending on the needs of the community.

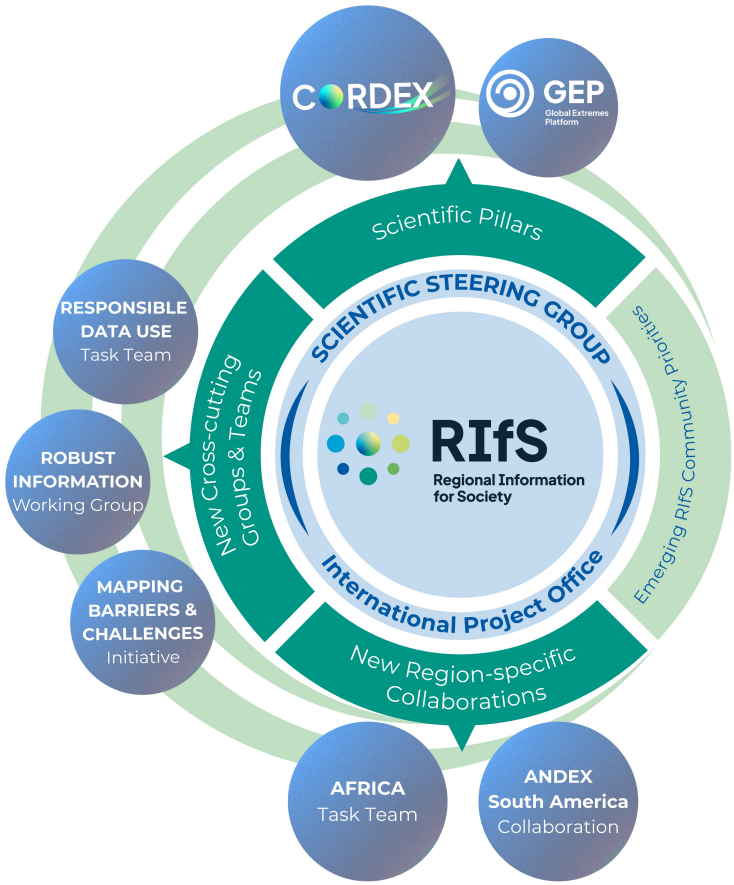

Figure 1 An illustration of RIfS' current internal structure (as of April, 2025), with room for growth depending on emerging community priorities.

In addition to showing the types of activities under RIfS, Figure 1 highlights the complementary roles of the RIfS SSG and the RIfS IPO.

The SSG provides the intellectual framing and insight to oversee and steer RIfS activities and represents the wider community involved in these types of activities. The SSG activities are guided by the RIfS stated vision, and objectives, including evolving these as needed to be responsive to a changing knowledge landscape.

The RIfS IPO supports and provides advice to the SSG and implements SSG decisions. The IPO works in close cooperation with the RIfS co-chairs, SSG members, the WCRP leadership, and the WCRP Secretariat in Geneva. The IPO has Ex Officio representation on the RIfS SSG, and where needed on subsidiary groups as established by the SSG.

Table 1 elaborates how the SSG and IPO work together to achieve RIfS' mission. The SSG co-chairs and the RIfS IPO director work closely together, and participate in WCRP-wide leadership coordination, as is the case for all WCRP Core Projects.

Table 1. Roles and responsibilites within the RIfS organizational structure.

Scientific Steering Group (SSG)	International Project Office (IPO)
Oversee and steer RIfS activities	Strategic development, project support, and coordination
• Determine thematic priorities • Approve scientific pillar top-level governing bodies, working group and task force membership • Conceive, design, develop, contribute to, and advance structured RIfS activities and programs • Collaborate in the development of white papers and other publications as relevant • Promote the work of RIfS within their own networks and wider community • Ensure that all relevant stakeholder points of view are represented throughout RIfS' activities • Engage in donor opportunitites to source and develop additional funding streams for targeted activities.	• Interface with everyone to foster potential collaborations • Maintain an overarching view of all RIfS projects to ensure alignment with goals and objectives • Bring forward activity proposals to enact SSG priorities • Provide project infrastructure (e.g. website, shared documents, internal communications) • Provide project support (e.g. coordinating and facilitating meetings, notes and minutes, drafting reports and white papers) • Develop external communication with multiple audiences, and advise activities on communications • Contribute to acquiring, and manage, funds for activities • In special cases, supervise research efforts in support of priority activities

Monitoring, Evaluation, and Learning

During the period covered in this plan, RIfS leadership will continue to evolve policies and procedures in other documents for approval by the RIfS SSG. These are expected to include 1. Procedures for establishing new activities, 2. General terms of reference for activities under RIfS, 3. Reporting templates for activities, and 4. Procedures for analysis and learning from previous activities.

The periodic meetings of the SSG, and especially the annual SSG meeting and JSC reporting, will be opportunities to reflect on progress, assess weaknesses and strengths, and build collective knowledge of lessons based on experience. This will grow the projects experiential knowledge to guide new developments and correct past weaknesses.

Indicative key partnerships

Our activities integrate with those under other WCRP Core Projects, Lighthouse Activities, and initiatives. Our impact is augmented through partnerships with relevant external research projects and organizations engaged in regional climate research, and with the broader climate services community.

Note that the descriptions below are not intended to be comprehensive but rather illustrative of the depth and breadth of intended partnerships.

Within WCRP

The following key partnerships have been identified within WCRP, organized in terms of the clusters described in Appendix A.

Cluster #1: Regional climate and projections

Core projects:

- Earth System Modelling and Observations (ESMO)
- Global Energy and Water Exchanges (GEWEX)
- Climate and Cryosphere (CliC)

Lighthouse activities:

- Safe Landing Climates
- Digital Earths
- Explaining and Predicting Earth System Change (EPESC)
- My climate Risk

Cluster #2: Sub-seasonal to Decadal predictability

Core projects:

- Stratosphere-troposphere Processes And their Role in Climate (SPARC)
- Climate and Ocean Variability, Predictability and Change (CLIVAR)
- Global Energy and Water Exchanges (GEWEX)
- Earth System Modelling and Observations (ESMO)
- Climate and Cryosphere (CliC)

Lighthouse activities:

- Digital Earths
- Explaining and Predicting Earth System Change (EPESC)

Cluster #3: Weather and climate extremes

Core projects:

- ESMO
- Climate and Ocean Variability, Predictability and Change (CLIVAR)
- GEWEX

Lighthouse activities:

- My Climate Risk
- Digital Earths
- Explaining and Predicting Earth System Change (EPESC)

Cluster #4: Communication and Societal Engagement

Core collaborations for this activity are the subsidiary actions within all Core Projects and Lighthouse Activities that involve some measure of societal engagement. Additionally the Academy offers a special role in building literacy and experiential capacity on the complexity facing scientists when engaging policy and decision maker communities. In particular, partnering with the Academy is central to building a new generation of scientists with a comprehension and literacy for being in partnership with stakeholders.

Cluster #4 warrants further explanation as the concepts and realities of this focus are not a strength of the traditional WCRP communities. The "literacy" gap is substantial. In it's latest Strategic Plan[1], the WCRP as a whole has embraced "bridging climate science and society" as one of four Science Objectives. We note thus that the communication, partnership, and engagement with society is cross-cutting across and dependent on the full spectrum of RIfS activities and collaborative partnerships - learning from and building on the societal link is central to and the essence of RIfS' purpose and existence.

The scope and resources of a typical WCRP core project are both finite and dwarfed by the scale of society's knowledge needs and heterogeneity of contexts, cultures, and risk exposure. Moreover, RIfS is a research action, not a climate service. Consequently, given the cross-cutting nature of this cluster's focus this creates an imperative to be targeted, innovative, and intentionally focused on choke points that undermine or constrain the value of WCRP's collective science for society.

To achieve this requires RIfS to step into unorthodox arenas (compared to WCRP norms) and includes issues of ethics, values, perceptions, social science, and even the philosophy and science of information, all of which have burgeoning science communities that need to be entrained[2].

[1] https://www.wcrp-climate.org/wcrp-sp

[2] At the time of revising this science plan, the RIfS 2024 Expert Meeting is a clear example of the innovation required to engage with the broader and trans-disciplinary community to inform and establish direction and momentum on RIfS actions. (https://www.wcrp-rifs.org/wp-content/uploads/2025/04/Workshop-Report.pdf)

External to WCRP

- Climate service partnerships (GFCS) and individual providers (GERICS, RISAs (USA), Ouranos, etc).
- VIA (vulnerability, impacts, adaption), risk/resilience research community (including commercial services).
- Future Earth (Risk-KAN)
- WMO´s WWRP-SERA & HiWEATHER
- START
- Interamerican Institute for Global Change Research (IAI)
- ECRA, ClimatEurope, Copernicus, ICNet Global (https://theicnet.org/).

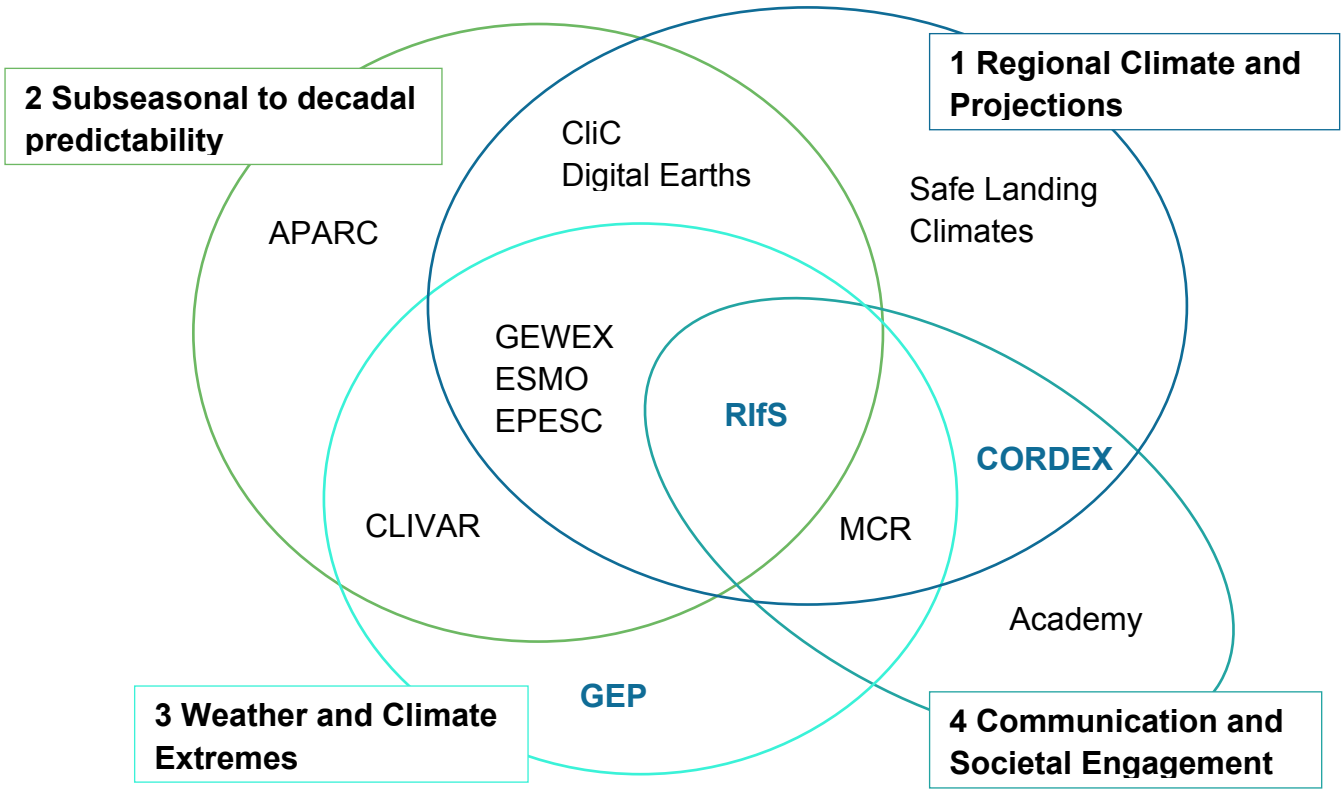

Figure 2. illustrating how the RIfS science profile is positioned for partnerships with both the regional activities of the Lighthouse Activities, and complementary and collaborative with the remaining Core Projects of the WCRP.

Expected outcomes

The RIfS SSG will continuously identify gaps and launch new activities in a deliberate and sustainable manner, as needed, based on the Science goals described earlier, with particular considerations on advancing global North-South equity.

These steps may include:

1. Creating new working groups or task teams to address gaps identified under the Science goals, and in Appendix A.
2. Establishing partnerships inside and outside of WCRP, such as the potential collaborators listed above.
3. Building a presence in the community, gathering case studies, generating publications, and developing trainings and other materials with collaborators.
4. Earning a position of leadership and building community consensus around better practices to co-develop robust climate information that is used by decision-makers.
5. Conceiving, developing, and administering new funding for targeted regional transdisciplinary collaboration.

A new Science plan for the next 5-10 years, starting in 2026, will be developed in wide consultation with the growing RIfS community, to further elaborate the science objectives and implementation strategy.

Appendix A

A.1 Research clusters

The RIfS scope spans a broad range of overlapping and mutually informing research themes, that range from core modelling to the social dimensions of information communication and adoption in society. RIfS groups these into four complementary clusters which necessarily overlap with each drawing on the science and expertise of the others. Notably, the understanding that comes from engagement with society is explicitly threaded through all four clusters.

The four clusters are:

I. Regional climate understanding for climate projections (multi-decadal)
II. Regional climate understanding for predictions (seasonal to decadal)
III. Weather and climate extremes
IV. Communication and Societal Engagement

From the perspective of climate information for society, many of the science questions about climate prediction and projection are common across the timescales. Consequently, there is significant overlap in science questions between Clusters 1 and 2, yet also questions unique to each time scale.

Cluster 1 addresses climate change projections that are forced by external drivers (e.g. enhanced greenhouse gas concentrations) contingent on human socio-economic activity. Of special note is the Coordinated Regional Downscaling Experiment (CORDEX) leading activities within cluster 1.

Cluster 2 addresses sub-seasonal to decadal predictability and is largely forced by internal climate processes (e.g. atmospheric ocean, and troposphere-stratosphere coupling). Cluster 2 seeks to advance understanding of the predictability and drivers of regional climate's variability on seasonal to decadal time scales and for this works in collaboration with leadership in other WCRP core projects.

In outlining the science questions for clusters 1 and 2, we recognize the benefits from collaboration between these communities to learn from and contribute to each other's endeavours. Consequently, for clusters 1 and 2 the key science questions are presented first as those common to both clusters, followed by the science questions that are more specific to the time scales of each cluster.

Cluster 3 builds upon and integrates multiple activities on weather and climate extremes across WCRP and contributes to improved understanding of the changes in weather and climate extremes (including compound extremes) and their attribution. Of special note is the Global Extremes Platform (GEP) leading activities of this cluster within RIfS.

Cluster 4 is explicit about bridging with society and emphasizes the partnership with stakeholders. Necessarily cluster 4 draws upon the knowledge in clusters 1-3, while also informing the activities and knowledge production of clusters 1-3.

A.2 Priority research questions and actions in each cluster

Clusters 1 and 2: Regional climate understanding for projections and predictions *SCIENCE QUESTIONS IN COMMON TO BOTH PREDICTION AND PROJECTION TIME SCALES*

There is significant benefit in research collaboration between the communities focused on

climate prediction and those on climate projections and to allow each community to benefit from the insights of the other. From the RIfS perspective the following are the primary questions and actions in common to cluster 1 and cluster 2:

1. What are the knowledge gaps, uncertainties, opportunities for improved regional climate prediction/projection across climate time scales?

Our goal is to evolve improved metrics to evaluate climate model simulations and advance the process understanding of model behaviour in ways that explicitly incorporate stakeholder needs and that can readily be communicated beyond the climate science research community.

- Identify knowledge gaps needed to improve representation of key regional processes and scales in modelling systems.
- Develop new approaches to efficiently identify aspects of regional climate that are most relevant to key socioeconomic sectors and systems, and what are the drivers of regional predictability (e.g., regional climate features, teleconnections, external forcings) of those features
- Advance methods to seamlessly assess and communicate uncertainty across the range of time scales and different model products/ensembles from forecasts of sub-seasonal, seasonal to decadal predictions and projections.
- Assess/qualify the reliability and uncertainty of predictions/projections for derivative parameters relevant to stakeholders, such as compound variable impacts, or of values derived from multiple variables in the models such as heat stress, storm surge, runoff, etc.
- Develop methods to better communicate model skill as time and space scales in a simple/understandable way to stakeholders without using difficult to interpret, overly technical language and metrics.

2. What model complexity is required to usefully represent regional climates and change?

- Contribute to development of good practice to optimally select for a given application's context which model systems to use in developing regional climate predictions and projections of their future changes.
- Relate climate system complexity to the key issues of coupling between components of the climate system, the coupling between global and regional models and questions of physical consistency, missing or under-represented components and drivers, and sources of uncertainty.

3. How to reconcile and integrate multiple lines of evidence in providing regional climate information?

- Assess the current status of guidance and good practice for the selection of models, tools, frameworks, and protocols in constructing climate information across regions and the diversity of application contexts.
- Evaluate the range of lines of evidence and assess their relative added value in context of applications.
- Implement new activities to evolve good practice guidance based on evidence from real world experiences.
- Understand the reasons for differences/similarities/contradictions in climatology, variability, and extremes on local to regional scales among different data sources, and better explain the implications for regional climate information.

- Use the understanding of the regionally relevant multi-scale drivers of climate variability and change to reconcile the differences of data sources and so improve the signal-to-noise ratio of the regional information (including the role of temporal and spatial resolution along the model chain e.g. global, regional to impact model).
- Quantify the limits to regional climate information in geographic regions where observations, monitoring, and modelling infrastructure are limited, and develop strategies to overcome these limitations.

SCIENCE QUESTION PRIMARILY FOR CLUSTER 1: THE CLIMATE PROJECTION TIME SCALE

4. How can the foundations for impact-relevant regional climate projections be enhanced?

- Develop better approaches to determine the added value from a dynamical or statistical downscaling model to provide context relevant actionable information.
- Develop methods to determine the optimal combination of modelling techniques for a given context.
- Evaluate and improve bias-adjustment methods for regional applications.
- Construct new approaches to represent and convey uncertainties inherent in the different data sources to enhance the signal-to-noise ratio and so better inform regional decision making.
- Develop new dialogue communities to improve the feedback from new regional understanding into model development and experiment design that improves the representation of critical climate phenomena and processes important to regional impacts and regional climate change.

A more detailed science plan for CORDEX (as of May 2021) can be found here.

SCIENCE QUESTION PRIMARILY FOR CLUSTER 2, THE CLIMATE PREDICTION TIME SCALE

5. What are the primary sources and drivers of predictability and predictive skill across climate timescales?

- Facilitate optimal methods to build multi-model ensembles for sub-seasonal forecasts given the short processing time and very different creation methods
- Identify what aspects of internal variability need to be reproduced for teleconnections and thus regional information to be valid
- Advance and optimally reconcile the scales and metrics of greatest predictability with the scales and metrics most relevant for stakeholders.
- Identify knowledge gaps that need to be closed to separate stochastic internal variability from forced changes at regional scale and to discern the primary natural and anthropogenic drivers of regional climate change and variability.
- Contribute to advancing observation-based and model-based approaches and work to better integrate these to advance our knowledge and improve confidence for predictions and projections of regional climates.
- Provide guidance on how to best select prediction models/systems when the constraints of an operational climate service preclude processing of very large ensembles.
- Enhance stakeholder relevant verification measures of model forecast projections.

Cluster 3: Weather and climate extremes

Weather and climate extremes have a strong impact on society. Extremes are tackled in various ways across different WCRP activities, yet our ability to deliver effective and timely information on extremes at the global and regional level to inform society needs to be improved. Not all tools are equally skillful in representing extreme events. Evaluation of models in terms of extremes is challenging due to sparsity of data in some regions and due to poorer sampling than mean climate in all regions, hence evaluation needs to consider multiple approaches. Moreover, different extreme events have different impacts on different sectors and regions. Therefore, there is a clear need to better identify the character of extreme events that are most relevant for different regions and sectors to advance our predictive capability and better project the climate change impact on extremes. This cluster of activities focuses on coordinating efforts to improve the quantification and characterization of a wide range of extreme conditions and understanding the causes. Note the term extremes is used herein as inclusive of compound events, modal shifts in regional climate, exceedance of socio-ecological climate thresholds, and low frequency – high impact events in the contemporary and possible future climate states.

The Global Extremes Platform (GEP) is a key contributor to activities within this cluster. It will contribute to improving the ways of delivering science, information, and data concerning extremes in a well-synthesized format and to integrate outputs on extremes across WCRP, therefore, contributing to the scientific objectives of this cluster.

Necessarily the cluster will work in close collaboration with Cluster 4 on stakeholder engagement and bring the specific knowledge about extremes to Cluster 4's foci.

Specific science questions:

6. How can we best communicate the nature of extreme events that most strongly threaten socio ecological systems in different regions of the world?
    - Develop a web portal to provide a clear picture of the current status of research and attribution capabilities concerning weather and climate extremes.
    - Develop a database of key atmospheric hazards in the contemporary climate.
    - Develop and apply new metrics for the detection and characterization of extreme events in the contemporary climate. This work will leverage past activities (e.g. Expert Teams on Climate Change Detection and indices, and Sector-specific Climate Indices (ETCCDI and ET SCI) and integrate with the on-going work of WMO's Expert Team on Climate Information for Decision-Making.
    - Evolve scientific understanding of multiple stressors or hazards that occur concurrently or sequentially.
7. How can we best deliver timely and useful information regarding the future evolution of these events?
    - Facilitate structure dialogue around communication on extremes within and external to WCRP.
8. How can we best develop methods to attribute change in probability of observed extreme events?
    - Facilitate systematic evaluation of reliability of extreme event attribution across events and regions; and evaluate methods and tools to do so. This activity connects to the lighthouse activity my climate risk and explaining and predicting earth system change yet with a distinct focus on event attribution for regions.

9. How can we best develop methods for mitigation verification from the perspective of changes in weather and climate extremes?
    - Develop and evaluate improved model approaches to simulation of extremes under global climate change, and develop methods for early detection of impacts of emission reduction on extremes.

Cluster 4: Communication and Societal Engagement

This cluster area centres around understanding and enhancing the communication flows between the climate science community and the breadth of society that has a need for climate information. The activities are dependent on the knowledge from clusters 1-3, and expressly supports and informs their work. Activities within cluster 4 seek to advance the understanding of how societal context and climate information are best integrated, articulated and disseminated between the communities of climate research, climate services, and society, and so enhance the climate resilience of society. This recognizes there is no singular or static solution due to the global heterogeneity of the regional community's context, risk exposure, cultures and values, and adaptation needs. The cluster works in close partnership with the climate services community to better understand how to assess and integrate the context and information needs, and so enhance the approaches to the construction and communication of relevant regional context and climate information.

The goal is to improve understanding of knowledge exchange between climate scientists and key actors engaged in communication through climate services, and key stakeholders in climate sensitive socio-economic sectors (e.g. agriculture, or energy) and social systems (e.g. cities).

Two key elements frame the research: research on connecting with society (as opposed to RIfS being a climate service) and establishing a dialogue and functional partnerships with those operationally engaged with bridging science and society or representing key decision and policy communities (e.g. city or national government, regional or trans-border water resource management, or transnational organisations such as the World Bank). This component of RIfS focuses on understanding the dialogue with society and does not imply RIfS is engaging as an operational climate service. Rather, RIfS seeks to understand, explore, test, and evolve good practice and so better enable WCRP internal and external interactions.

The specific science goals are:

10. How can we better understand the dynamics and evolving landscape of climate information services, users and usage?

    Our goal is to advance methods to optimally design and communicate physical climate information products that are of maximal value to society, and to learn from society the diversity of contextual constraints and needs to better inform climate research. Priority actions within this framing include:
    - Understand how to assess user context and incorporate this into the design and communication of information.
    - Evaluate the type and attributes of information which are of priority for the range of actors using and/or needing climate information.
    - Assess the skill, capacity, and constraints to achieve the desired knowledge products (to be further defined), and develop strategic actions to work past these limitations.
    - Learn from how actors in different sectors (e.g. water resource planning, policy

development, early warning, etc.) or those managing social systems (e.g city governance) experience the access to, limitations of, and applicability of current knowledge products (resolution, scales, attributes of relevance, etc), and use this knowledge to better evolve the climate information products.

- Understand how actors in society perceive, assess, understand and interpret skill (skill, robustness, trustworthiness) and uncertainty/confidence in the climate information they are able to access.
- Use the evolving understanding of the actors in society and develop strategic plans (including partnerships with relevant Lighthouse activities) to develop capacity in the user communities, and how to better reframe the knowledge products to meet the user understanding and capacity.
- Build a knowledge base of the relation between characteristics of information versus characteristics of perceptions and assessment of information quality and the characteristics of the provider/source (trust and authority), and through this help evolve good practice guidance and identify critical capacity development needs.

11. <u>How can we enable improved understanding of, and advance the dialogue with stakeholders?</u>

Our goal is to advance and inform approaches to engage with the diversity of actors using climate information noting the heterogeneity of socio-economic, political, cultural, and development contexts. Three core research actions are key to achieving this goal: Develop exemplars from real world actions that demonstrate key lessons of examples of good and bad practices in bridging the gap between climate information and society for different types of actors and contexts and distil the principles to guide further activities. Characterize high value approaches that are most effective and appropriate for engaging with different types of actors, contexts and information needs, including approaches to communication/visualization, co-production, and trans-disciplinary research.

- Enhance the capacity of the science community to better access, understand, and comprehend user-contexts, and through this facilitate the construction and communication of climate information to be better aligned with the users needs, and deepen the user capacity to assess the fit-for-purpose value of the information products.
- Develop approaches in monitoring and evaluating adaptation measures, drawing on concepts of the AR6 WG2 report. (SSG to explore potential partnership with the My Climate Risk lighthouse to address this)