JSC-47
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Overarching content/goal: *To provide an update on progress made during the last year, and to identify issues etc. in advance of the JSC meeting. This will allow more discussion and less reporting at the JSC meeting itself.*

Update report for the WCRP Joint Scientific Committee

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Digital Earth Lighthouse Activity

1. Key highlights since the last JSC meeting (May 2025)

Over the past year, the Digital Earth Lighthouse Activity (DE-LHA) has consolidated its role as a cross-cutting WCRP initiative advancing integrated, interactive Earth system information frameworks. Activities have focused on three pillars: km-scale modeling, model–data fusion leveraging AI/ML, and integration of human systems.

Governance has been strengthened through a restructured management approach, with new working group leadership selected via an open, globally inclusive process. This has improved representation and positioned the activity for broader community engagement and input.

We are re-visioning the km-scale working group to be broader than model development for kilometer scale models. A more specific model development activity is to be iterated with ESMO and their Working Group on Numerical Experimentation (WGNE) and Working Group on Coupled Modelling (WGCM). That discussion is ongoing.

Key achievements include the 2025 global km-scale modeling hackathon (~700 participants, 5 continents), which significantly advanced collaborative analysis workflows and democratized access to high-resolution climate data. Initial outputs include an overview paper (accepted), technical documentation (paper in draft from), and multiple ongoing scientific publications from the hundreds of participants.

We also continued an active kilometer-scale modeling seminar series, and transitioned this to a new set of co-leads. We also have a few other activities coming to 'fruition' soon, such as a review of km-scale Land-Atmosphere Interactions (which involves a lot of GEWEX-GLASS expertise as well).

Progress in AI-enabled climate science has accelerated, including coordinated activities in machine learning for data assimilation and model development. Currently 'weather generators' can emulate a general circulation weather model, but are not 'climate models'. The digital earth lighthouse is trying to advance that science in the next year with some coordinated meetings.

Strategic alignment with WWRP and WCRP core projects has been strengthened in many areas, but could continue to grow. We are trying to make sure activities are linked to relevant core projects (e.g. link km-scale work to CORDEX regional km-scale work).

Urban Digital Twin efforts have expanded, demonstrating clear societal relevance by linking high-resolution climate information with urban-scale applications and decision-making contexts. These activities contribute directly to climate services, enhancing accessibility, usability, and relevance of climate information, particularly in support of adaptation and resilience. We are looking for other ways to add value and incorporate new methods of including physical systems. The new working group members will hopefully help with this.

2. Future Plans and priorities

Over the next year, priorities include scaling km-scale modeling collaborations, advancing AI/ML integration, and strengthening Urban Digital Twin applications. The Lighthouse will play an important role in a 2026 km-scale modeling summit, to be held in Hamburg in July. A international AI/ML climate modeling meeting, is planned for November 2026.

Looking ahead, another planned 2027 global km-scale hackathon will expand participation and scientific scope, with a stronger emphasis on Global South engagement. We next intend to make it easier for a broad spectrum of users and smaller modeling groups to participate and contribute data, with more cloud-forward data sets, and a more robust technical stack. We also will explore a broader distribution of nodes.

Efforts will also focus on embedding Digital Earth approaches across WCRP activities and advancing coupled human–Earth system modelling. This comes through continued collaboration with core activities in the domain space (e.g. process teams with GASS, GLASS, APARC, etc.)

Funding strategies will prioritize targeted support for coordination, infrastructure, and inclusive participation: we will reserve scarce resources for targeted travel support, while trying to leverage ‘strategic partnerships’ (non-WCRP efforts and projects). We aim to continue to thrive on a very small budget. We have gotten some key support from core project IPOs, for example from ESMO for the hackathon.

3. Suggestions, Issues or Challenges

Key challenges include limited dedicated funding, coordination across WCRP structures, and the rapidly evolving landscape of climate AI. There is a need for clearer prioritization and alignment to maximize impact and avoid duplication.

Engagement across regions with respect to AI and high resolution modeling remains uneven, with barriers related to culture, resources and technical capacity. Addressing these will be critical to ensuring equitable global participation. In some countries there is more focus on impacts and decision-making, and less on specific modeling. Also, in some countries, there is strong respect+reliance on large institutional approaches, while some other countries want to break with tradition

As we see greater AI adoption in climate science, we need to make sure that it is distributed more broadly. The hackathon process is one mechanism for that.

Guidance from the JSC is sought on strengthening cross-cutting coordination. What connections are we missing or not exploiting? It still is a bit of a challenge to coordinate across the WCRP: lots of good conversations, but everyone is stretched, so we often do not get traction. Should the lack of traction for activities (e.g. a km-scale convective process team) indicate there is simply no interest? Or have we not identified the right people and structures (likely a bit of both).

Finding the right approaches and methods in the 'beyond the physical system' area has been a struggle. There is a lot going on, but in very specialized communities. Maybe we need better guidance on whom to approach? Urban Digital Twins does seem to be an important and active community. We think there is potential for km-scale water and hydrology, but have not connected with it yet. Is this because it is not sufficiently coordinated, or because we don't know the right people?

We are happy to engage in shaping WCRP's strategic role in AI for climate science, and need to make sure our efforts are complementary with other activities in this area.

4. Any other points

Digital Earth represents a transformative capability for WCRP, enabling integrated, accessible, and actionable climate information systems. Sustained support and strategic alignment will be essential to realize its full potential. We also are targeting alignment with other activities so we can transition our work into them. For example, technical advances for the hackathon could be adopted by CMIP for 'low resolution / large ensembles' climate modelling.

We have done a good job of being effective with limited budgets. We don't have an IPO, which makes more work for the co-chairs. But support from the WCRP secretariat has been excellent (thanks Maureen!) and very helpful.

Alignment with funded projects (where the community is going anyway) and key strategic partners has been important in working without resources. Success indicates that we are on the right track in several areas. So there are some general lessons for the WCRP in being successful with limited funds.

Obviously, success depends on identifying capable and engaged people, and we have many of these. We shall continue to try to find more.