CMIP7 Data Request: co-created guidance for the production of CMIP7 data [v1.2.2.5]

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Abstract. This paper outlines the scope, development and publication of data requirements for a set of reference climate simulations, and describes the methodology used to gather and synthesise them into a cohesive 'Data Request' usable by data producers. The simulations supported by this Data Request comprise the initial phase of the next upgrade of research activities under the World Climate Research Programme (WCRP). Dunne et al. (2025) set out the scientific scope and objectives of the Assessment Fast Track and its role in initiating the current phase of the Coupled Model Intercomparison Project, CMIP7 – a key part of the next WCRP activity upgrade.

Building on the successes of past CMIP phases which have supported an ever-expanding scope of work, the Data Request Task Team reached out to new communities to enhance engagement in CMIP. A transparent and community-led approach was adopted, where domain experts from the CMIP community were recruited into five teams by domain called 'Thematic Author Teams' to co-create data requirements through wide consultation. This paper describes the process of gathering data requirements in the initial phase of CMIP7, along with the structure of the CMIP7 Data Request itself.

Version 1.2.2.5 of the CMIP7 Data Request (DR7) covers the data production requirements for i) control simulations of the past climate (both distant and recent), ii) key sensitivity experiments focusing on critical aspects of climate and model behaviour, and iii) a range of future climate scenarios. It consists of a relational database that maps climate variables to

reference experiments according to scientific objectives, with associated metadata to enable data production and tools to allow interoperability and content exploration.

The usage of climate models and CMIP data is broadening from its origins in scientific study of the physical environment to support the analysis of climate impacts, and planning for an ever-increasing portfolio of adaptation and mitigation measures. To support this growing scope, DR7 introduces a new organising component, Opportunities, to support transparent mapping between variables and experiments. The 46 Opportunities in DR7 represent the key community-driven use cases across CMIP data users – each describing why its combination of variables and experiments is important and how they contribute to impact, providing both scientific justification and technical requirements.

It is challenging to represent the needs of the rapidly expanding CMIP community and user base while respecting the capacity limitations of CMIP data production. DR7 addresses this through a process of wide stakeholder engagement centred around an open consultation and community co-creation, while prioritising stakeholder representation and diversity. Innovations in interactive web tools and enhanced WCRP support through the CMIP IPO and Task Teams were also critical to the process of developing data requirements in collaboration with the community.

1 Introduction

1.1 Data Request concept and objectives

The Coupled Model Intercomparison Project (CMIP) Data Request specifies data requirements for a vast range of climate model analysis and evaluation activities on decadal to centennial timescales, which come together under the expanding umbrella of the CMIP framework – a flagship activity of the global climate modelling community (Durack et al., 2025a). As the Data Request concept has evolved, the following mission statement emerged following CMIP6 in Juckes (2020):

- Develop and maintain a registry of defined Physical Parameters appropriate for the analysis of climate simulations and exchange of climate model output (building from previous CMIP Data Requests);
- Develop and maintain a registry of file metadata specifications to facilitate interoperable exchange of climate model output; and
- Support WCRP-endorsed model intercomparison projects (such as CMIP) by facilitating the specification of output requirements for climate model intercomparison and evaluation efforts.

For CMIP7, Dunne et al. (2025) have identified a set of experiments to support prioritisation of resource allocation by modelling centres called the Assessment Fast Track (AFT), which includes key simulations such as the DECK and future scenarios. CMIP7 experiment design, simulation and analysis does and will continue to extend beyond the AFT scope and timeline; a key factor in ensuring the Data Request meets the needs of the diverse CMIP community.

This paper describes the scope and ambition of the CMIP7 Data Request development activity, which culminated with the publication of version 1.2.2.5 of the CMIP7 Data Request. We designate the collection of published artefacts that constitute

v1.2.2.5 as 'DR7', and the developmental activity that facilitated DR7's creation and release as 'DR7-dev'. The timing of DR7-dev was guided by decisions and expectations of the 7th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR7) timeline as discussed at the 60th session of the IPCC (IPCC, 2024)[1].

DR7 contains data requirements for the following parts of CMIP7: i) data from AFT simulations intended to support the IPCC AR7 and later assessments, ii) data from AFT simulations which may act as control runs for subsequent research and model evaluation work, and iii) data from CMIP7-era experiments that are not in the AFT, but whose organising MIPs are on timelines similar to the AFT and who opted to contribute to DR7.

DR7-dev can be thought of in terms of three distinct pieces: a) community engagement and input, b) creating and managing the DR7 content, and c) developing flexible tools for users. All these activities need to be supported by documentation and communication.

Community engagement has been thoroughly revised in DR7-dev to address several issues encountered in the CMIP6 Data Request, especially the need to provide greater clarity about the scientific requirements that underpin requests for resource-intensive data production. This extensive community engagement activity not only gathered requirements, but also promoted and supported in-depth discussions spanning data user groups and data producers, in order to achieve a realistic consolidated request. The DR7 content includes full technical metadata required to define the variables requested and the experiments from which they are requested, along with rich contextual information that explains who is requesting the data and the scientific justification for the request.

Many DR7 variables are only requested from a small number of experiments, or for very specialised analyses that some modelling centres may elect not to support. Following feedback after CMIP6, the information about why variables are being requested has been expanded, made more accessible, and subjected to more thorough guidance, review and harmonisation. The overall size of DR7 is similar to the CMIP6 Data Request (DR6) – the large increase in the number of DR variables requested from simulations (from $\sim$30 at its inception to $\sim$2000 in DR6) has not occurred in CMIP7. However, the introduction of DR Opportunities into DR7 is intended to make it more accessible to users by reducing the complexity of the mapping between variables and experiments (see Section 5).

To further support usability, DR7 introduced a *Core* request containing a relatively small number ($\sim$130) of highest-priority variables that are requested from all experiments (see Section 3.2). These variables were adopted from Juckes et al. (2025, ESM-BCVs) with minor adjustments (such as change of pressure level values), and are represented as the DR Opportunity "Baseline Climate Variables for Earth System Modelling" and the Priority Level "Core".

The tools supporting access to the CMIP7 Data Request represent a reformulation of the python library introduced in CMIP6 for data production workflows and a cloud-supported accessible database to support collaboration and content exploration which replaces the static web pages provided for CMIP6[2]. See the *code and data availability* statement on page 37 and the DR7 v1.2.2.5 release page on the CMIP website[3].

[1] https://www.ipcc.ch/site/assets/uploads/2024/08/FINAL_REPT_P-60.pdf [accessed 3 March 2026]

[2] https://w3id.org/cmip6dr/browse.html [accessed 12 March 2026]

[3] https://wcrp-cmip.org/cmip7-data-request-v1-2-2-3/ [accessed 12 March 2026]

1.2 Role of the Data Request in the CMIP and climate science community

The Data Request development activity (DR7-dev) sits within the broader range of CMIP7 science engagement and coordination activities described by Dunne et al. (2025). The CMIP7 Assessment Fast Track (AFT) is a series of 58 high-priority experiments selected by the CMIP Panel[4]. These experiments are expected to underpin the most critical evaluations of Working Group I of the IPCC 7th Assessment Report (AR7 WGI). Thus, the primary scope of DR7-dev is the creation and consolidation of a set of requirements for the data needed to evaluate and assess the CMIP7 AFT experiments, with the timeline set according to those anticipated by CMIP and IPCC.

However, CMIP7 is a much broader activity than supporting the current IPCC cycle. There will be extensive use of data from DECK and AFT experiments beyond IPCC AR7, along with the many non-AFT experiments which are being developed by Community MIPs. This community of CMIP data users participated in DR7-dev primarily through the Thematic Author Teams and wider consultation (described in Section 4, with specific communities listed in Table 1), and included representation from WCRP activities such as CORDEX, most registered Community MIPs, and those working on climate impacts, adaptation and mitigation (e.g. fisheries, human health, and energy). Thanks to the active participation of the CMIP and climate community throughout DR7-dev, the Data Request can provide ongoing utility to the CMIP community throughout and beyond the CMIP7 cycle.

The CMIP Data Request is developed in close consultation with modelling centres to ensure that variables in the request can be feasibly generated and archived. The variables list always represents an inclusive collective ambition and while not all requested variables make it into the final archive, the vast majority do (see Juckes et al., 2025). Through its role in determining the contents of the final CMIP archive of each phase, the Data Request is a direct reflection of the scope of scientific exploration that can be supported by each phase of CMIP. The intention with DR7 was to maximise the usefulness of the final CMIP7 archive for both scientific research and climate-informed decision-making.

The DR7 community engagement process involved two parallel harmonisation processes, leading to a well-structured technical document specifying the request and a shared understanding of the scientific objectives, technical limitations and systemic challenges across the many parties engaged in the process.

Firstly, there is harmonisation of expectations on scientific scope, data volumes and production timelines. Achieving a good understanding of expectations across many communities was led by the Thematic Author Teams (also called DR Themes, see Section 4.2), and is primarily represented in DR7 by 46 'Opportunities', each describing a logical mapping of experiments and variables against specific scientific requirements set through community consultation. Each Opportunity description conveys why this combination of variables and experiments is important and how they contribute to impact, proving clear rationale to data producers and users.

Secondly, there is harmonisation of technical language used to specify the request clearly and consistently. This involves use of external standards (in particular the CF Conventions), implementing emerging standards and protocols from other elements

[4]https://wcrp-cmip.org/cmip-phases/cmip7/fast-track/ [accessed 12 March 2026]

of the CMIP process (such as the Controlled Vocabularies Task Team), and common approaches developed between the Data Request Task Team (DR-TT) and the Thematic Author Teams.

The expansive consultation undertaken reflects a shift in priority for the DR-TT. The CMIP6 Data Request allowed for a robust technical foundation for DR7, however the major shift for CMIP7 was the greatly improved process and expanded ambition of community engagement, allowing for a much more accessible and transparent Data Request than in previous CMIP phases.

During the data production phase of CMIP7, DR7 has a primary purpose of delivering information to data production teams in modelling centres, as did DR6. It also brings the community of scientists and users who are preparing to analyse CMIP data into the conversation early, providing them with detailed information about the expected data and scientific objectives they are intended to support. After CMIP data production for IPCC AR7, DR7 will continue to provide contextual information for CMIP data users about the intended use of DR variables. Adoption and adaption by the MIP community when defining new MIPs and experiments is also expected and encouraged, as has happened in past CMIP cycles.

1.3 Outline of this paper

In this paper, we detail the developmental journey and final delivery of the CMIP7 Data Request, covering:

- the history of the CMIP Data Request, and the requirements for CMIP7 that emerged during CMIP6 and in the lead up to CMIP7 (Section 2),
- the formation and early designs of the DR-TT, including the strategic approach approved by the CMIP Panel in 2023 (Section 3),
- interfaces with CMIP, and the methodology and outcomes of the community engagement undertaken via the Thematic Author Team process initiated in 2024 (Section 4), and
- a description of the technical structure, assets and versioned releases of the CMIP7 Data Request (DR7), with v1.0 released in November 2024 and v1.2.2.5 described here released in July 2026 (Section 5).
- a discussion of the broader DR context and intentions, summary statistics from DR7, reflections and lessons learned, and future recommendations (Section 6).
- a glossary of all acronyms used in this paper (Appendix A).

2 Evolution of the CMIP Data Request

2.1 History of CMIP and the Data Request

The first phase of the Coupled Model Intercomparison Project was established in the mid 1990s to investigate through Global Coupled Models (GCMs) simulations the mean climate and climate variability under constant present-day conditions (Meehl

et al., 1997). This was closely followed by a second iteration, dubbed CMIP2, which addressed the time-evolving climate system response to specific CO2 levels and trends by accounting for about 25 different models (Meehl et al., 2005). In both phases, model outcomes for ∼30 climate variables (monthly and annual) were centrally collected by the Program for Climate Model Diagnosis and Intercomparison (PCMDI) and made available to the scientific community through aggregated compressed data archives.

In the early 2000s, a coordinated set of 12 experiments was identified within the CMIP3 exercise to assess the twentieth-century and future climate conditions, with a further extended set of 143 high-priority climate variables at increasing frequencies requested from 23 GCMs (Meehl et al., 2007; Durack et al., 2025a). Development of the NetCDF Climate and Forecast Metadata Conventions (Eaton et al., 2025) and similar software libraries enabled the creation of a uniform data structure to further support model intercomparison, and enable wider applications of the archive.

After an extensive community consultation on the major gaps in understanding past and future climate changes (Hibbard et al., 2007), the CMIP5 moved towards coupled climate-carbon cycle investigation with the introduction of Earth System Models (ESMs). In this phase, data production accounted for 986 physical and biogeochemical variables from ∼120 experiments (Taylor et al., 2012b). CMIP5 models outputs were formatted in a common way through an expanded Data Request (known at the time as the "standard model output"; Taylor et al., 2012a), while the sharing of large data volumes was realised through a distributed data system handled by either modelling or data centres under the open source platform Earth System Grid Federation (ESGF; Cinquini et al., 2014).

With the growing complexity of global-scale coupled climate-carbon models and increasing interest in multi-variable multi-model analyses, the community-led Model Intercomparison Projects (MIPs) of the most recent CMIP cycle (CMIP6) fuelled the development of a greatly expanded Data Request. 2,063 Earth system variables were requested from 322 experiments through a relational mapping guided by the scientific objectives of the climate research community, as expressed primarily through experiment protocols (Durack et al., 2025a).

The developers of the CMIP6 Data Request (DR6) confronted the challenge of gathering requirements from a greatly expanded community (Eyring et al., 2016) while maintaining and advancing the level of data standardisation needed by the data providers, archive managers, and data users (Juckes et al., 2020). DR6 drew on input from 23 participating Model Intercomparison Projects (MIPs), each of which published their own peer reviewed description of their data requirements. Technical standardisation was enhanced by moving the request into a database with a formal metadata structure, creating a python library to enable automated processing and interrogation of the request, and by exploiting the CMIP6 Data Reference Syntax (Taylor et al., 2018), and Controlled Vocabularies (Durack et al., 2025b, Section 4.2).

The CMIP activity has led the way in shaping climate model archives and data delivery systems throughout the past three decades. It has enabled the exploitation of coupled modelling data products by a wide array of socioeconomic and scientific communities, and set many global standards for high-quality public scientific data. For a comprehensive review on the Coupled Model Intercomparison Project's scientific foundations and technological evolution, refer to Durack et al. (2025a).

2.2 CF Conventions and the CMIP Data Request

The CF metadata conventions are a community standard designed to promote the processing and sharing of NetCDF files (Eaton et al., 2025). The CF conventions define metadata that provide a definitive description of what the data in each variable represents, and the spatial and temporal properties of the data. The CF conventions include three controlled vocabularies: the standard name table, which defines strings that identify physical quantities; the area type table, which defines strings to identify surface characteristics; and the standardised region names, which defines strings to identify geographical areas that have complex boundaries and can't readily be defined using latitude and longitude coordinates.

First published in 2006 for gridded climate and forecast model data, CF is maintained by an active community and has expanded to other geoscience domains, including observations and those with irregular grids and parameters. The CF community maintains a website[5], while community discussions take place within the CF GitHub organisation[6].

CMIP requires modelling centres to publish their data in CF compliant NetCDF format (CF-NetCDF), and the CF community has long been a key stakeholder of the CMIP DR, and vice-versa (Juckes et al., 2020). The increasing complexity of climate models brings increases in the number of physical processes represented – for example, CMIP6 led to the introduction of 340 new standard names. Before CMIP7, each MIP was responsible for requesting new standard names, sometimes leading to multiple proposals for similar terms. CF community rules require each new vocabulary term to be individually proposed, discussed and agreed before it can be published, and the large number of proposals arising from CMIP places considerable pressure on those moderating CF discussions. A lack of direct CF representation within CMIP hampered communications between the two communities, slowing the addition of new vocabulary terms and increasing burden on CF moderators.

CF Conventions were integrated even further into the Data Request development process, as discussed in Section 4.5.

2.3 Requirements for the CMIP7 Data Request

2.3.1 CMIP6 community survey

A community-wide CMIP6 survey was conducted by the CMIP IPO in March 2022[7] and summarised in O'Rourke (2024). It sought to capture the CMIP6 experiences of both providers and users and included dedicated questions on the CMIP6 Data Request.

The responses clearly indicated the value of the Data Request to the community and that the Data Request principles (i.e., a formalised, processable way to pre-define the model outputs published to CMIP) should be preserved going forward. CMIP6 was seen as a large step forward in terms of available variables that support the intercomparison of models, with a high level of satisfaction with the list of variables included in the archive. Those expressing dissatisfaction felt there were too many priority 1 variables; however, there were also many comments suggesting important variables were missing (particularly ocean variables) and highlighting the need for increased temporal resolution to support impact studies and dynamical downscaling.

[5]https://cfconventions.org/ [accessed 12 March 2026]

[6]https://github.com/cf-convention [accessed 12 March 2026]

[7]https://wcrp-cmip.org/cmip6/cmip6-community-survey/ [accessed 17/12/2025]

Suggestions that the Data Request could focus on a small set of common climate variables for core DECK, historical and scenarios simulations led to the creation of the Baseline Climate Variables (Juckes et al., 2025).

Areas of suggested improvement focused around: reducing the complexity of the request; limiting the number of versions and updates; better coordination of experiments and Data Requests between MIPs and the modelling centres; and delivering a stable request with a clearer timetable, deadlines and earlier availability than in CMIP6.

2.3.2 The need for technical continuity and re-design

The CMIP6 community survey results demonstrated that the technical structure underpinning the Data Request (the schema, vocabulary and python tools) is beneficial to modelling centres, and that changes to the technical structure would likely cause problems for those working on technical implementation in research institutions.

In tension with the need for technical continuity is the demand for clearer justification of resource requests, due to the complexity of managing petabyte-scale data. The new infrastructure must provide more transparent metrics to handle the computational, storage, and personnel resources needed for sustaining the climate data catalogues. Furthermore, the system must actively support decision-making processes within modelling centres. This requires providing actionable insights, such as usage statistics and priority indicators, to guide the strategic allocation of the available resources.

Ultimately, all these requirements feed into the final goal: to improve the accessibility and understandability of the Data Request content. Simplifying the inherently complex process of identifying and retrieving CMIP variables for specific purposes can enable the data in the CMIP7 archive to support a broader community of scientific and policy analysts.

Through community-led Opportunities, which map variables to known use cases, data users can more easily align the available model output with their specific scientific objectives. This addresses the challenge of communicating the rationale behind the mapping between variables, experiments, and science objectives – a challenge recognised as a limit of DR6 – making DR7 more useful to the CMIP community.

2.3.3 The need for co-creation with the CMIP community

The benefits of co-development in information technology have long been recognised (e.g., Deck and Strom, 2002), but can mean different things to different people. In the terminology of Fleming et al. (2023), the approach used in DR7-dev included aspects of co-design (setting joint goals), co-development (collaboratively identifying a shared solution) and co-delivery (working together to complete the project) – for DR7-dev we refer to this as 'co-creation'. The common element that separates co-development from other models of collaboration is joint participation at the level of individual tasks, ensuring that different teams are interacting through multiple staffed roles.

Initially, the co-creation approach was guided by immediate technical concerns identified through community feedback, including the ability to: provide detailed feedback on draft content, browse content in a supportive and intuitive interface, read content directly from an interoperable file, and interact with content programmatically through a transparent yet flexible python interface (the Data Request Technical Implementation Sub-Group (TISG) was created to support technical use of DR7).

As the process evolved into DR content creation and review, deeper community consultation was required. In CMIP6, data requirements were provided from endorsed MIPs directly to the DR developers with little co-development, a strategy that would fall short when scaling data production toward the needs of a growing and diverse community of users. A controlled and facilitated process of broad consultation and co-creation was required to engage deeply with the entire CMIP community. The Thematic Author Teams were created and supported in response to this requirement (see Section 4.2).

The benefits of co-creation, however, come at a cost. Multiple institutions need voluntarily allocate staff time (often requiring key staff with critical skills) to CMIP activities that are designed to serve the international common good, and where decisions are typically made outside the normal lines of institutional oversight. This limits the capacity of the community to dedicate time to CMIP tasks, and is dependent on institutions understanding the value of contributing their own resources to CMIP activities.

3 Development of the CMIP7 Data Request

3.1 Data Request Task Team

The evolution of the Data Request community (i.e., those responsible for delivering DR7 to the CMIP community) between CMIP6 and CMIP7 has been part of a broader shift in CMIP design toward a more community-driven approach, a major new component being the CMIP Task Teams[8].

These teams were recruited from the CMIP community in an open process led by subject matter experts, supported by the newly created CMIP IPO[9] and guided by the CMIP Panel and WCRP ESMO Infrastructure Panel (WIP[10]. The DR-TT was created in late 2022 with a starting membership of around 19 individuals representing diverse communities[11].

In 2023, the DR-TT conducted initial scoping and planning and defined a strategic approach (see next subsection), endorsed by the CMIP Panel (Dingley et al., 2023), followed by a methodological approach (see Sections 4 and 5). From this planning, the Technical Implementation Sub-Group (DR-TISG) was initiated within the DR-TT, whose first meeting took place on 10 May 2024. In 2024, the Thematic Author Teams were launched (see Section 4.2) (Dingley et al., 2024), with community engagement and feedback continuing into 2025 to facilitate improvements to early DR7 releases (see Section 5.2 for more details on DR7 version releases).

3.2 Strategic approach

During the conception and planning phase of DR7-dev, a strategic approach was designed by the DR-TT that aimed to clarify the purpose and scope of the Data Request activity, and provide a framework for its creation. This culminated in an approved Gateway 1 request to the CMIP Panel in July 2023 which detailed the intended strategic approach of the DR-TT.

[8]https://wcrp-cmip.org/cmip7-task-teams/ [accessed 12 March 2026]
[9]https://wcrp-cmip.org/project-office/ [accessed 12 March 2026]
[10]https://wcrp-cmip.org/cmip-governance/wip/ [accessed 12 March 2026]
[11]https://wcrp-cmip.org/cmip7-task-teams/data-request/ [accessed 12 March 2026]

In this strategic approach, the main Data Request content (variable definitions and the mapping of variables onto experiments) was separated into three categories: *Core*, *Harmonised* and *Unharmonised*; each with a different design methodology, and role in the official Data Request release. These are illustrated and summarised in Figure 1, which was prepared at the time of the Gateway 1 request.

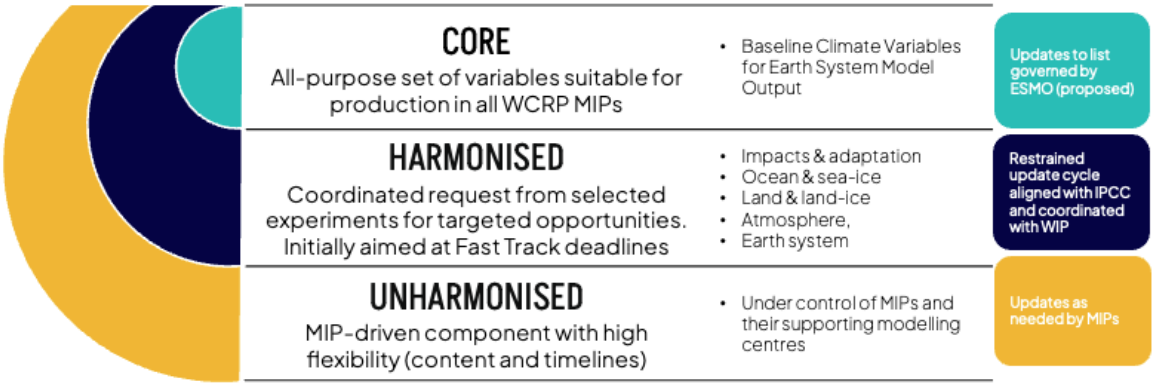

Figure 1. The strategic approach to the CMIP7 Data Request, as developed in a community discussion led by the DR-TT and approved by the CMIP Panel in July 2023. The *Core* is based on the ESM-BCVs, the *Harmonised* component consists of the majority of the work described in this paper, and the *Unharmonised* component is a planned future phase of the CMIP7 Data Request.

3.2.1 Core

The *Core* component reflects the work done by the ESM-BCVs author team to define a list of "variables which have high utility for the evaluation and exploitation of climate simulations" (Juckes et al., 2025). These variables are vital to provide a foundational level of completeness and usability in the CMIP7 Data Archive for the most common use cases.

This list of 135 ESM-BCVs has been adopted as the *Core* of the DR7. 97 of these are classified as having low or medium data volumes, and will be requested from all CMIP7 experiments and ensemble members. The additional 38 high-volume variables (28 daily and 10 sub-daily) will be requested only where there is clear justification for the additional resources required, and for a subset of ensemble members and simulation period. The *Core* component is represented technically in the DR7 by the DR Opportunity "Baseline Climate Variables for Earth System Modelling".

3.2.2 Harmonised

The *Harmonised* component refers to the bulk of the work required to produce a cohesive and functional Data Request that supports the scientific objectives of the AFT, including release in time to allow modelling centres to publish data in time for use in IPCC AR7 related analyses. Beyond this immediate requirement to help deliver the DR7 in support of the AFT, the DR-TT intended to produce a Data Request that meets the diverse needs of the wider CMIP community who are working to the

anticipated IPCC AR7 timelines and/or will rely on data from AFT experiments (including user communities such as impact modelling and climate services).

Harmonisation refers to the process of identifying and leveraging as many cross-linkages as possible among MIPs, with the purpose of keeping the volume of CMIP7 data to a minimum. This process is key to the CMIP Data Request, both in terms of interoperability between experiments, and minimising pressures on modelling centres, infrastructure providers, data users, and the environment. The harmonisation process is one of editorial oversight, community and stakeholder engagement, and technical development of the Data Request. This harmonisation was performed through the Thematic Author Team process and public consultations, and supported by DR-TT Theme liaisons, a Cross-Thematic Working Group, and the CMIP IPO (see Section 4 for more information on the roles in DR7-dev and the harmonisation process).

The *Harmonised* component is represented technically in the DR7 through: i) all Opportunities, Variable Groups and Experiment Groups, ii) new Physical Parameters, Variables and Structures that were not in the DR6, and iii) changes to imported DR6 content. See a simplified schema of DR7 in Section 5.1.

3.2.3 Unharmonised

The *Unharmonised* component is an anticipated future activity that will facilitate MIPs and other community activities to exploit the CMIP Data Request without being restricted by the deadlines and engagement requirements of the harmonisation process. It is envisioned to consist of an à la carte system that will allow users to create Opportunities, propose new variables, and construct bespoke Data Requests in an agile and flexible manner, rather than going through the administratively heavy harmonisation process needed for the CMIP7 AFT. The specifics of this component are still unclear, as it will depend heavily on available resources and the level of community interest and engagement after delivery of the DR7; see Section 6.4 for *Unharmonised* recommendations.

3.2.4 July 2023 CMIP Panel decision on strategic approach

Quoted directly from the CMIP Panel governance decision log (Decision ID 09)[12].

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1. Approve that there be both a fully harmonised component and an unharmonised component to the CMIP7 Data Request.
2. Approve that the unharmonised component is flexible, allowing MIPs to add content subject only to transparent technical compliance requirements.
3. Approve that the harmonised component is controlled to ensure consistency and reusability, avoid duplication, and enhance interoperabilty.
4. Approve in principle the following elements of the harmonised component: (a) it will provide a coherent and version controlled request aligned with the IPCC timeline under discussion of a start in 2025 (early production mid 2025), and (b) it will meet the quality control requirements of the modelling centres in the run up to the IPCC timeline.

[12]https://airtable.com/shrIAHOuVw8ktdoe1 [accessed 12 March 2026] (CMIP Extended Panel, Decision ID 09)

5. Approve that the Data Request core will adopt the WCRP baseline variables.
6. Approve in principle that the harmonised variable list be created via topic themed papers developed through an IPO-coordinated process inspired by the baseline variables process.

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4 CMIP interfaces and community engagement

4.1 Key people, things and interactions

DR7-dev depended on many sources of information and support in the CMIP ecosystem. As illustrated in Figure 2, DR7 primarily relies on information from two major sources: those under the governance of the CMIP Panel (including other CMIP Task Teams) and those from the wider climate community via the DR community engagement part of DR7-dev. We note these groups are not clearly delineated, but overlap in many ways – Figure 2 is for illustration purposes and is from the perspective of the DR-TT, rather than a holistic view of the CMIP ecosystem.

The *CMIP7 Data Request* box in Figure 2 can be understood to encompass the DR-TT and sub-groups therein (such as the Technical Implementation Sub-group), along with the DR7 content, and all supporting tools and documentation including this paper and Data Request entries to the WCRP-CMIP Zenodo repository[13]. The technical structure of the DR7 is detailed in Section 5.

From *CMIP Governance*, the CMIP7 Data Request relied on experiment specifications from the AFT and MIPs, the ESM-BCVs (the *Core* component of the DR7), CMOR tables and metadata standards, as well as support from the CMIP Panel and IPO. CMIP task teams were required to regularly report and update the CMIP Panel on progress, any issues that may result in delayed delivery, and approval for key strategic decisions and community engagements. Key Task Teams with which the DR had interactions include the Controlled Vocabularies (CVs) Task Team to ensure the Data Request was compatible with the CMIP7 CVs and the intended WCRP Variable Registry, and the Model Benchmarking Task Team to ensure that variables in the CMIP7 AFT Rapid Evaluation Framework (REF; Hoffman et al., 2025) were included in their own Opportunity.

Interactions with the *CMIP & Climate Community* (a broad group of stakeholders ranging from non-CMIP WCRP activities and MIPs to individual researchers and downstream users of CMIP data) were managed through the process of *Harmonisation and Community Co-creation*, which included the Thematic Author Teams and their Steering Groups, all content co-creation, and reviewing by the CMIP community through open consultation.

The primary use of the DR7 is as input into the *Modelling and Data Production* pipeline where CMIP7 simulations are performed and data produced. The most common tools and workflows for producing CMIP data are CMOR[14] (and tools that rely on CMOR) and XIOS[15] / dr2xml[16] (used for certain models and model components). Engagement with technical repre-

[13] https://zenodo.org/communities/wcrp-cmip/ [accessed 12 March 2026]
[14] https://cmor.llnl.gov/ [accessed 12 March 2026]
[15] https://ipsl.pages.in2p3.fr/projets/xios-projects/xios/ [accessed 3 August 2026]
[16] https://dr2xml.readthedocs.io/en/v3.2_doc/ [accessed 31 March 2026]

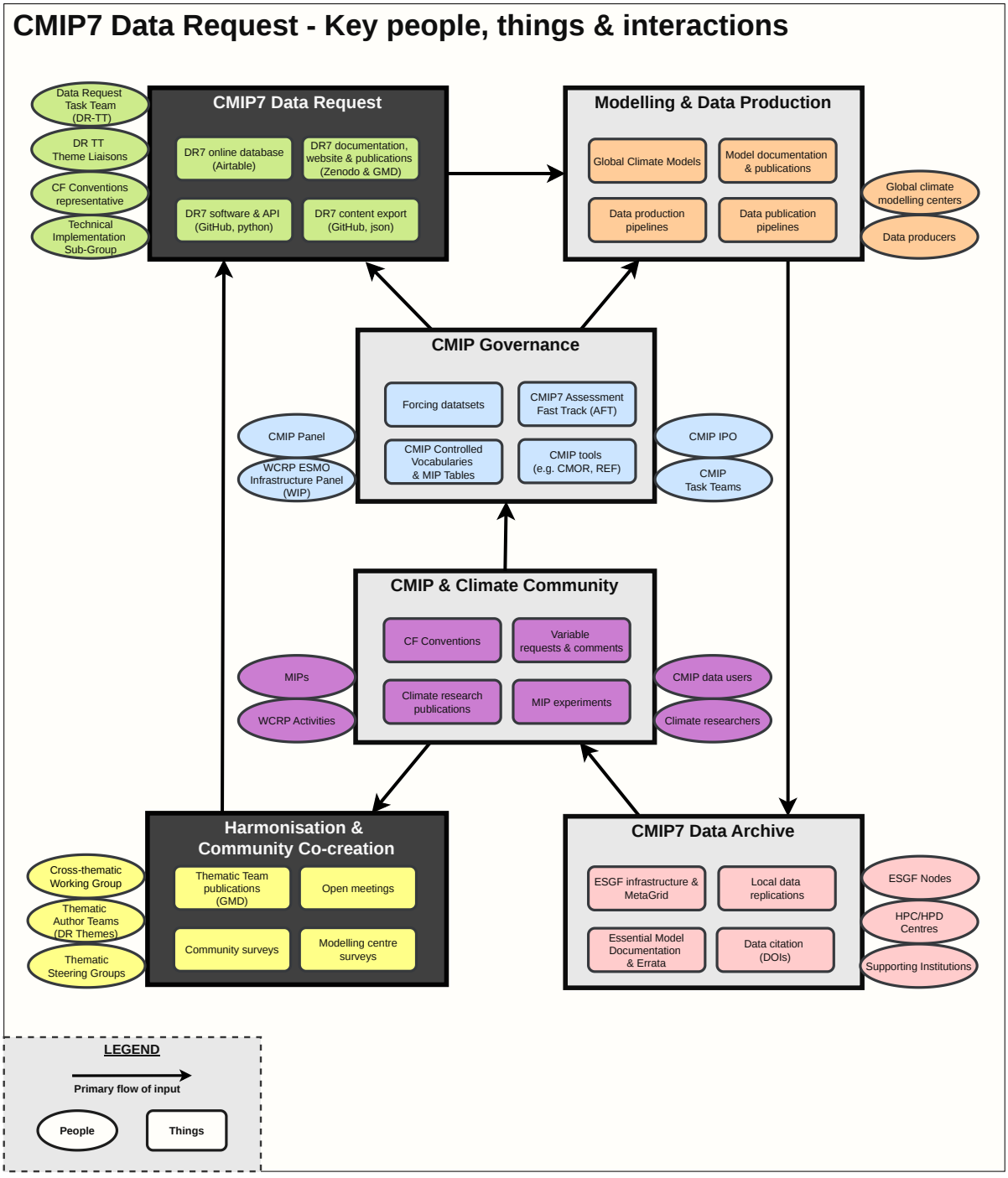

Figure 2. Illustration of the key input flows in the development and delivery of the CMIP7 Data Request. There are six main categories (large rectangles) of 'people' (formal or informal groups and organisations; ovals) and 'things' (assets and activities; curved rectangles), each representing a key function in relation to the Data Request. The arrows between categories indicate the primary mode of interaction and input (for example, DR7 delivers primarily to Modelling and Data Production, though information flows both directions).

sentatives of each modelling centre took the form of bespoke spreadsheets allowing for specific Variable and/or Opportunity review, and requests for updates on CMIP7 readiness and intended experiment production, which helped to guide the decisions of the Thematic Author Teams.

The overarching purpose of the DR7 is to enable the creation of a *CMIP7 Data Archive* that is as useful as possible for the diverse objectives of CMIP data users. This includes the ESGF catalogue, local replications of CMIP7 data by ESGF nodes or other data centres, the citation metadata (i.e. DOIs) of published datasets, the institutions that support the CMIP infrastructure and the documentation that facilitate an understanding of the data (including model description papers and the Essential Model Documentation; Hassell et al. 2025).

4.2 Thematic Author Teams

The requirement for the DR7 to be co-created alongside the CMIP community, and to ensure sufficient coverage of scientific requirements from all downstream users of CMIP data, prompted the initiation of a set of Thematic Author Teams (called 'DR Themes' in the DR7 database), separated by science domain. Each team consisted of community representatives from domain-related MIPs, modelling centres, data users, and related community activities and stakeholders.

While the division of the CMIP community into distinct themes was not trivial, five themes were identified: Atmosphere, Earth System, Impacts and Adaptation, Land and Land-Ice, and Ocean and Sea-Ice. The remit of each theme is summarised in Table 1, including which activities were invited to join the theme and citations to their respective publications. For each theme, a small number of climate science activity groups were invited to join the relevant Thematic Steering Group, whose role was to guide and support the initial setup of the Thematic Author Teams, including application reviews. Authors were recruited to the DR Themes via a series of open calls held between October 2023 to March 2024[17]. Each theme was recruited to cover a wide range of CMIP-relevant activities, career stages, genders, and geographical representation.

Finally, to ensure harmonisation across groups, and to allow for decisions to be made on matters which impact multiple themes, a Cross-Thematic Working Group was formed. Initially, this group was comprised of Steering Group members from each theme and DR-TT liaisons. However, as the process evolved, all DR Theme members were eventually invited to join cross-thematic meetings for discussion and decision making.

The successful convening of the DR Themes was achieved in great part due to the following improvements in CMIP governance and digital ways of working: i) the critical administrative support and facilitation from the CMIP IPO, ii) the use of teleconferencing instead of email exchanges for group discussions and complex issue resolution, and iii) the use of a cloud-hosted database (Airtable) to display content and facilitate collaboration and consultation.

Table 1: Summaries and citations for the five Thematic Author Teams (DR Themes). In columns 4 and 5, communities are relevant Community MIPs and WCRP activities, while for Impacts and Adaptation column 5 also includes industry sectors. The papers listed in column 6 are the main outputs of the DR Themes, and contain full details of each Theme's DR7 Opportunities.

[17] e.g., I&A: https://wcrp-cmip.org/cmip7-data-request-call-for-impacts-and-adaptation-realm-paper-co-authors/ [accessed 12 March 2026]

Theme	**Recruitment dates** [DD-MM-YYYY]	**Remit**	**Communities invited to join Steering Group** (*accepted invitation)	**Communities represented in theme**	**Output paper**
Atmosphere	13-2-2024 – 8-3-2024	Physical atmosphere, clouds, and aerosol analysis.	APARC, GEWEX, RFMIP*, CFMIP*, DAMIP*, AerChemMIP*, DCPP, GCOS-AOPC, RAMIP	RFMIP, CFMIP, DAMIP, DynVarMIP, AerChemMIP, GeoMIP, Rapid Evaluation Framework	Dingley et al. (2026)
Earth System	13-2-2024 – 8-3-2024	Earth system, biogeochemistry, cycles, and feedbacks.	GEWEX, ESMO, C4MIP*, GeoMIP*, PMIP*, DAMIP*, TIPMIP*, SLC*	C4MIP, GeoMIP, PMIP, DAMIP, TIPMIP, SLC, FishMIP, VolMIP	McPartland et al. (2026)
Impacts and Adaptation	25-10-2023 – 30-11-2023	Downscaling (dynamical and statistical), impact and adaptation modelling and assessments, and developing climate services.	CORDEX*, VIACS-AB*	Climate Services, Agriculture, Cities, Fisheries, Human Health, Infrastructure, Marine Fisheries, Terrestrial and Freshwater Ecosystems, Peace and Socioeconomic Development, Water Resources, Energy	Ruane et al. (2025)
Land and Land-Ice	13-2-2024 – 8-3-2024	Physical land and land-ice analysis.	GEWEX, CliC*, PMIP, LUMIP*, ISMIP*	CliC, GEWEX, PMIP, GlacierMIP, TIPMIP, RCMIP, FireMIP, GCOS-TOPC	Li et al. (2026)
Ocean and Sea-Ice	2-2-2024 – 1-3-2024	Physical ocean and sea-ice analysis.	OMDP*, OMIP*, SIMIP, PMIP, CLIVAR, CliC, GCOS-OOPC	OMDP, SIMIP, OMIP, PMIP, CLIVAR, CliC, HighResMIP, ESMO	Fox-Kemper et al. (2026)

4.3 Open community consultation process and phases

Consultation with the wider scientific community was managed via the Thematic Author Teams, with additional opportunities for input from those not involved with the author teams. The author team members consulted widely using their own scientific

networks to curate the DR7. Each theme conducted their own engagement, for details see Table 1 and the individual theme papers (Dingley et al., 2026; McPartland et al., 2026; Ruane et al., 2025; Li et al., 2026; Fox-Kemper et al., 2026).

Wider consultation with CMIP stakeholders was organised in three phases. The first phase ran between 5 August 2024 and 18 October 2024. The goal in this first phase was to gather community requirements for the CMIP7 Assessment Fast Track, via early lists of Opportunities, Variable Groups, and DR7 Variables. Any of these items could be proposed by a thematic group or wider community members. Towards the end of the consultation phase, the Cross-Thematic Working Group reviewed all submissions and proposed a number of Opportunity merges to simplify the request wherever possible. Phase 1 culminated with the release of v1.0beta of DR7 to MIPs and modelling centres, followed shortly by v1.0 of the DR7 on 22 November 2024.

The second phase of consultation was launched shortly after the release of v1.0 on 6 December 2024. The goal of the second phase of consultation was to aim for v1.1 of the CMIP7 Data Request to be stable enough for modelling centres to begin configuring their workflows, particularly for the piControl and historical experiments. Additionally, the DR-TT sought to understand how different centres will prioritise different Opportunities. During this consultation, feedback on v1.0 was requested from MIPs, Modelling Centres, and other coordinated community activities to review the Data Request content in v1.0. Feedback was gathered via Airtable forms (for the wider community) and summary spreadsheets (for modelling centres and MIPs). Based on this feedback, and further thematic work, the next version of the Data Request, v1.1 was released on 30 January 2025.

The third and final phase of consultation was launched in tandem with the v1.1 release on 30 January 2024 and closed on 17th March 2024. The overarching goal for the third phase was to ensure that v1.2 of the CMIP7 Data Request was stable and complete, to allow modelling centres to start running CMIP7 simulations. During this phase, MIPs and modelling centres were still welcome to provide any feedback through Airtable forms and updated spreadsheets of the v1.1 content. Additionally, a systematic variable review was performed by the Data Request Task Team, DR Themes and the CVs Task Team to improve clarity and consistency of technical variable definitions.

Due to the complexity of this third consultation phase, v1.2 (which was originally planned to be the final release) was instead released with multiple subsequent technical updates with the most recent version being v1.2.2.5. The bulk of the requested content in these releases remained stable, but some minor updates were made to the technical metadata (e.g., cell methods and dimensions) to enhance compatibility between the Data Request and the planned Variable Registry being developed by the CVs Task Team (see Section 5.5). DR7 versions are detailed in Section 5.2.

In all phases of consultation, details of how to contribute were shared across the CMIP mailing lists, reaching over 1500 stakeholders with an interest in CMIP data from academia, industry, the third sector, and governments. Information was also released via the CMIP website, in emails and in the WCRP-CMIP Zenodo collection (such as the public guidance and supporting information for consultation participants; Turner et al., 2024). Additionally, the DR-TT held a number of drop-in sessions to explain the consultation process, the Data Request structure, and the tools which are available to the community to interact with the request.

4.4 Key cross-theme discussions and decisions

Following submission of proposed content for DR7 in Airtable (Opportunities, Variable Groups, DR7 Variables, and Physical Parameters), DR Themes and the Cross-Thematic Working Group conducted a significant amount of review and consolidation work during each stage of public consultation. Alongside the content review, systematic technical reviews of variable metadata were performed by the DR and CVs Task Teams.

At the end of the first phase on public consultation, a cross-thematic sprint was held. During this, all Opportunity submissions were reviewed by the Cross-Thematic Working Group and a number of Opportunity merges were proposed. These proposals were sent back to thematic groups to implement with the help of the Opportunity proposers. Some merges were simpler than others, and were completed in time for the v1.0 release. Others were more complex and involved discussions across a wide range of activities and so were not implemented until later releases. Details of these Opportunities reviews and merges can be found in the DR Theme publications (see Table 1).

Some key cross-cutting definitions that emerged from these cross-thematic sprint and subsequent discussions are listed below.

4.4.1 Prioritisation

The DR-TT required that Opportunity proposers define the priority of their requested variables to help modelling groups collectively produce a more complete data archive than would occur if each modelling centre independently determined its own variable prioritisation.

Each Opportunity proposer faced the challenge of reconciling comprehensiveness with practicality. On one hand, each Opportunity addresses a set of scientific questions requiring a comprehensive collection of variables for investigation. On the other hand, there are pragmatic and logistical limitations to what modelling groups can reasonably be expected to provide. The latter are dependent on both the computational and human resources that modelling centres are willing to dedicate to CMIP. Cognisant of these competing constraints, Opportunity proposers were tasked with determining the priority level of their respective Variable Group requests.

The definitions of the four Variable Group Priority Levels agreed by the Cross-Thematic Working Group during a meeting on 12 November 2024 are:

1. **Core**: Top priority, reserved for variables selected for inclusion in the Baseline Climate Variables. These variables should be produced for all experiments.
2. **High**: These variables support the core objectives of the Opportunity. These are required to make the Opportunity viable.
3. **Medium**: These variables deliver extra information that can enable people to go further and push the scientific boundaries further.
4. **Low**: These variables help to fill gaps and are more speculative. This is information that will be useful if it is available, bearing in mind modelling centres may have data on tape that they could output. This priority level can also be used for

data that has prior agreement to be produced by particular modelling centres, so it is not expected by additional centres unless they wish to participate.

Such prioritisation of variable groups was intended to produce a targeted and relatively lightweight Data Request, while giving modelling centres the flexibility to contribute data at a level appropriate to their interest in individual Opportunities.

4.4.2 Time Subsets

In CMIP6, a large number of time subsets were requested, where data would just be produced for a short time period of the full experiment. For example, the three-hourly surface temperature might only be requested for three years of a particular experiment, to reduce data volumes. During the CMIP6-era, these were called 'time slices', but were renamed 'Time Subset' in DR7 to avoid confusion with the 'time slice' experimental protocol commonly used by the composition-climate community.

Additionally, in CMIP7, the DR-TT had a vision to simplify the number of Time Subsets requested. Following consultation with modelling centres, it was identified that many modelling centres either ignore the Time Subset request and instead produce the variable for the full experiment, or do not produce the variable at all. This is due to the additional complexity and work it takes to output a variable for only a short period of an experiment. Therefore, the DR-TT proposed that only the highest volume Opportunities should request Time Subsets, while other Opportunities were encouraged not to unless necessary. This led to five ($\sim$10.5%) Opportunities requesting Time Subsets. This decision was made in the cross-thematic meeting on 16 January 2025.

4.4.3 Pressure levels

Similarly to time subsets, the range of pressure levels requested for 3D atmospheric variables was extensive in CMIP6. The Atmosphere Theme was requested to review this and decide if any harmonisation was possible. Following extensive discussion, they presented a proposal to move all daily and monthly variables requested on *plev7h* and *plev8* to *plev19* to make 3D data easier for modelling centres to produce. This decision was finalised in the cross-thematic meeting on 12 November 2024. Full details on this decision can be found in the Atmosphere paper (Dingley et al., 2026).

4.4.4 Albedo

There was significant discussion around whether the CMIP7 Data Request should include requests for albedo. Reasons included the fact that it is a quantity which can be calculated via radiative fluxes, while albedo is often not well defined within Earth System Models. However, a number of communities, particularly in the Ocean and Sea-Ice theme, raised examples of specific requirements for requesting albedo, such as the albedo of sea-ice covered surface, which is a GCOS Essential Climate Variable (WMO et al., 2025). Ultimately, it was decided to allow requests for albedo in such exceptional cases; however, such variables should be well justified and explicitly defined. This decision was made during the cross-thematic meeting on 12 November 2024.

4.5 Continued integration with CF Conventions

For CMIP7, the integration between the CMIP and CF community processes were significantly improved upon (see Section 2.2 for background). For the first time, training on the CF Conventions was provided for the DR-TT and DR Themes by a representative of CF in the DR-TT (Pamment, 2024). Additionally, direct links were made in the suite of consultation tools that allowed for transparent connections between newly proposed DR variables and associated CF standard name proposals. This resulted in robust engagement between the CMIP and CF communities, and facilitated harmonisation among DR-initiated CF proposals. DR7-dev led to proposals for 103 new standard names, five new area types and two new standardised regions. These improvements in workflow efficiency allowed the DR-TT to meet the challenging timetable of the AFT.

The processes established for DR7 should continue to be implemented into the future of the Data Request, including the provision of CF training and direct links between the DR and CF communities. This is particularly important given that the CF conventions are in wide use across the science sector, and the CF community must balance the needs of CMIP modelling groups alongside those of other research activities with which CF interfaces.

5 DR7 structure and technical implementation

5.1 A simplified schema

A simplified technical schema of the DR7 database is illustrated in Figure 3, with each item referring to a DR7 database category (definitions given below). The bottom section under the dotted line refers to the part of the database that contains DR7 Variable construction and descriptions, while the top section refers to the mapping of DR7 Variables to Experiments via Opportunities (which provide scientific scope and justification). This mapping section saw the largest changes in terms of structure from DR6 to DR7. In particular, the introduction of Opportunities greatly simplified the way in which variables map to experiments. Previously this mapping was managed by several database items that were not readily visible to users (see Figure 3 in Juckes et al. 2020), while the DR7 Opportunity component is now the primary user-facing index of the Data Request.

DR7 Variables have a strong basis in DR6, which were imported into Airtable and formed the initial variable dataset that was then further developed through harmonisation and community engagement activities (see Section 4). The construction of DR7 Variables are largely the same as in DR7, with minor changes made to variables during importation that were informed from DR6 user feedback described in Section 2 – e.g., renaming database items, removing redundant database components (most notably the component 'Structure'), and the addition of Branded Variable labels and names (see Section 5.5). Further minor changes and additions to the Variable structures and definitions were managed via the DR Themes, which also saw the creation of Opportunities and related mapping. Externally defined database items include CF Standard Names[18] and CMIP Controlled Vocabularies managed by the CVs Task Team[19].

[18] https://cfconventions.org/Data/cf-standard-names/current/build/cf-standard-name-table.html [accessed 12 March 2026]

[19] CMIP7 CVs: https://github.com/WCRP-CMIP/CMIP7-CVs [accessed 12 March 2026]

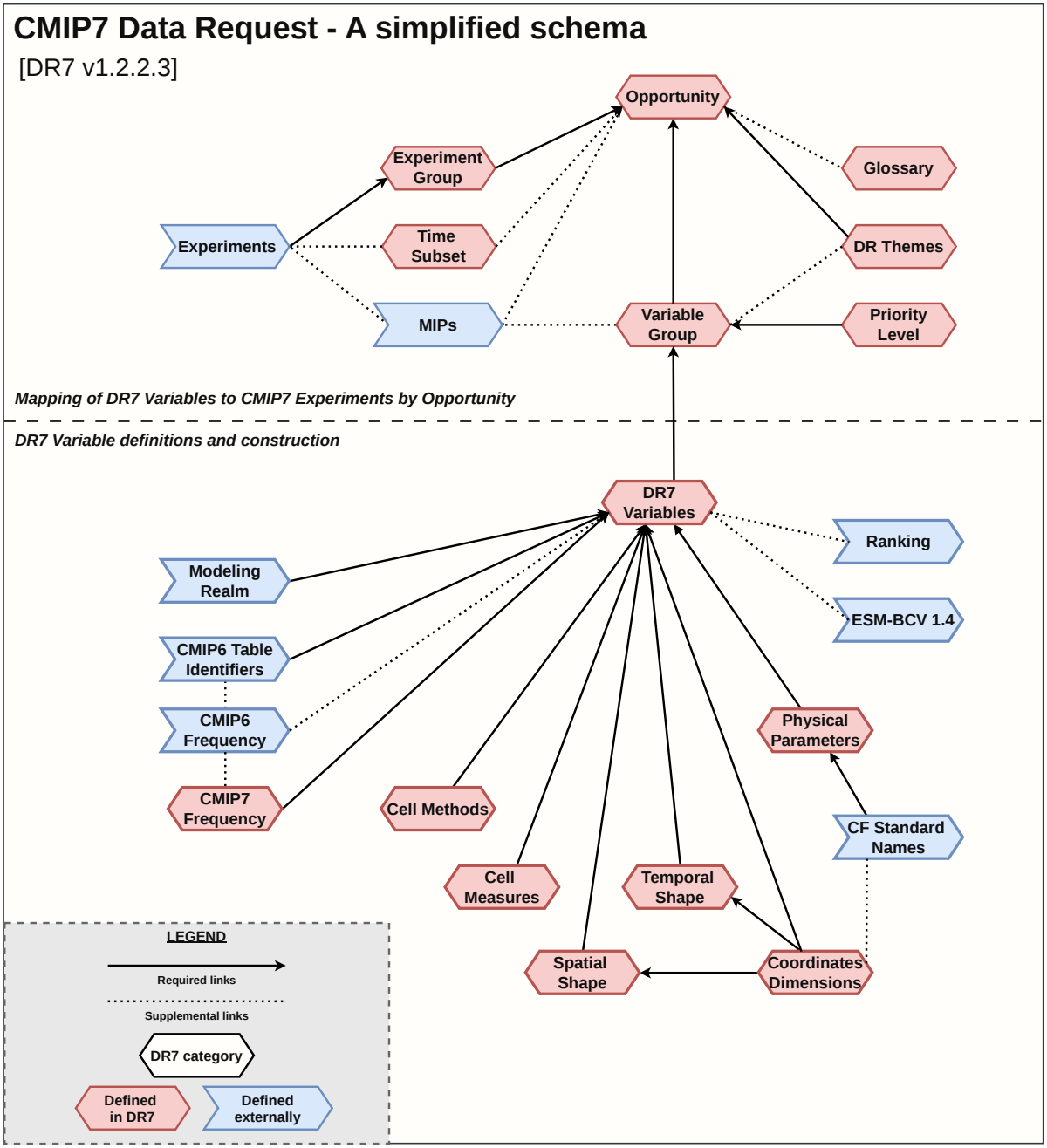

Figure 3. A simplified technical schema of the CMIP7 Data Request, showing key database categories and their relative dependencies. Categories that are defined internally to the Data Request are red hexagons, while categories that are defined externally to the DR7 are blue chevrons. Arrows indicate required database links, while dotted lines indicate supplemental database links.

5.1.1 Schema definitions

Physical Parameters: Physical quantities known to be modelled/parametrised in GCMs or derivable from GCM output. Each requires a CF Standard Name, Title and Units. Known as MIP Variables in CMIP6 (Juckes et al., 2020).

DR7 Variables: Specifications that prescribe the construction of GCM output variables as submitted to CMIP7 via the ESGF. Each Variable is a combination of a Physical Parameter, Spatial and Temporal Shapes, Frequency, and Cell Methods and Measures, along with additional metadata to support technical implementation (e.g., Processing Note). Compound names for DR7 Variables are provided using both the CMIP6-era and CMIP7-era constructions (see Section 5.5). Known in CMIP6 as CMOR Variables.

Experiments: CMIP7-era experiments, as defined in Dunne et al. (2025). The list of experiments primarily consists of the CMIP7 AFT, but also includes non-AFT experiments that were included at the request of MIPs who are on activity timelines similar to the AFT.

Experiment group: A non-exclusive grouping of experiments (e.g., *fast_track*, *deck*, *scenarios*, etc.). Experiments can belong to more than one group.

Variable group: A non-exclusive grouping of CMIP variables (e.g. monthly baseline variables). DR7 Variables can belong to more than one group.

Opportunity: An intended use-case/justification for one or multiple variable groups. Opportunities are linked to relevant experiment groups. Identifying Opportunities helps to provide a structure to map variables against requirements. Each Opportunity description will convey why this combination of variables and experiments is important and how they contribute to impact.

MIPs: Model Intercomparison Project. In the CVs, MIPS are referred to as 'Activities'. In the DR7, MIPs that were engaged are linked with Opportunities and Variable Groups. Opportunities have classified by MIPs as 'High priority' or 'Lower priority', while Variable Groups are designated as 'owned by' or 'of interest to' included MIPs.

DR Themes: The five Thematic Author Teams, described in Section 4.2, with topic areas: Atmosphere, Earth System, Impacts and Adaptation, Land and Land-Ice, and Ocean and Sea-Ice. In DR7, all Opportunities are designated a 'Lead Theme' and 'tagged' with related Themes.

Priority Level: Prioritisation given to variable groups (see Section 4.4.1).

Time Subset: Time subsets are used in some cases where diagnostics are required only for a subset of the years of an experiment.

Modeling Realm: A string that indicates the high level modelling component which is particularly relevant. Note that sometimes a variable will be equally (or almost equally relevant) to two or more realms, in which case a primary realm is assigned as the first listed and other relevant realms follow in a space separated list.

CMIP7 Frequency: The periodicity of time steps to be archived.

CMIP6 Table Identifiers: Used to organise DR6 Variables. The structure of the MIP tables has evolved as the request has expanded through CMIP phases and are included in DR7 for provenance because they were a key component of DR6 Variable names. Imported to DR7 from DR6, or equivalently the CMIP6 CMOR tables[20].

CMIP6 Frequency: In DR6, frequencies were applied to variables via CMIP6 Table Identifiers, for which frequency was an attribute. CMIP7 Frequency is now its own category, and CMIP6 Frequency is included in DR7 for provenance.

Spatial Shape: Records of spatial dimension profiles, and an integer specifying the number of vertical levels, if specified (a boolean level flag is set to true if the number of vertical levels is specified).

Temporal Shape: Records for temporal dimensions with additional metadata.

Cell Methods: Encoding of computational sampling/aggregation methods recommended for each Variable (for example, time: mean where sea, indicating that the value should be an average over the requested time step, and only where sea is present). The contents of this element follows syntactical rules set out in the CF Conventions.

Cell Measures: Either specifies the parent grid on which a Variable is requested, by grid-cell area Variable (e.g. *areacella*, the atmospheric grid), or provides optional directives to data producers. If a directive, the two options are: –MODEL or –OPT. –MODEL indicates that the data should be provided at the cell locations used for that variable in the model code (e.g. cell vertices). –OPT indicates that the data may be provided either on the cell centres or on the cell boundaries (not used in v1.2.2.5, but present in previous versions and CMOR). The value of the *cell_measures* attribute written to data files must correspond to an ESGF-published variable providing the area of each grid cell (this external variable must be provided by data producers alongside the primary variable it serves).

Coordinates & Dimensions: A registry of all spatial and temporal dimensions (e.g. latitude) and model coordinates (e.g. pressure levels) used to specify Variable construction.

CF Standard Names: Names of physical quantities as specified in the CF Conventions Standard Names table for the description of gridded data from climate and forecast models (see Section **??**

Ranking: A numerical assessment of the relative popularity of CMIP6 Variables in terms of publication to, and download from, the ESGF. The Thematic Author Teams utilised Ranking to support decision-making. See ESM-BCV 1.4, whose process was adopted for DR7.

ESM-BCV 1.4: Baseline Climate Variables for Earth System Modelling, version 1.4 (final published version; Juckes et al., 2025)

Glossary: A maintained list of key definitions relevant to DR7.

5.2 Release cycle and version management

From the CMIP6 community survey (see Section 2.3), the DR-TT received strong feedback from the community on the need for greater stability and transparency in the release process, with a reduced number of releases. The advantages of a rapid

[20]https://github.com/PCMDI/cmip6-cmor-tables [accessed 12 March 2026]

release cycle enabling corrections and updates to be shared as soon as possible were expressed by the WIP, and the four-part semantic versioning scheme (described below) was designed to allow for fine-grain updates when needed. Initial planning, following community discussion at the ESMO/WGCM meeting in Hamburg, March 2024, envisioned a sequence of three major production-ready releases starting in September 2024.

Planning throughout DR7-dev operated on the principle of delivering in time to meet projected community timelines, particularly those related to the AFT. As release dates approached, it was necessary to review both the projected community deadlines and the progress on all development activities delivering to the release.

For all DR7 versions released up until July 2025, DR7-dev activities were taking longer than initially planned, mainly due to factors such as systematic reviews of DR content by domain experts, feedbacks from DR7-API development, and complex discussions with other Task Teams and the WIP. However, releases were completed on or close to the initially planned dates to meet commitments and permit wide dissemination of completed work, while remaining transparent about the revised community timelines and the status of DR7-dev. This delay was not too critical, as most modelling centres also experienced delays to their production schedules, as determined through modelling centre surveys conducted as part of the community consultation (see Section 4.3). For these reasons, more releases were required than initially intended, however releasing DR7 versions while development continued allowed for higher-quality community feedback and final delivered product.

The co-design of data structures created the need for a joint decision process around each release, particularly where these interact with parallel developments of archive infrastructure which will be used to publish and disseminate CMIP7 data. For DR7 versions 1.0, 1.1 and 1.2, release date targets were set by the DR-TT are shared with DR Themes, the CMIP Panel and WIP, and relevant Task Teams, and consolidating content and feedback. The process typically involved several online meetings to talk through priorities in different thematic areas. Major developments over these first three versions were largely focused on constructing and reviewing Opportunity descriptions through community consultation, with DR Themes establishing and beginning to harmonise Opportunity variable lists.

Following the release of v1.2, reviews by the WIP and CVs Task Team resulted in a large number of change requests covering both technical and scientific issues. The review process for maintenance and patch releases was altered and streamlined – issues were assigned to appropriate experts (sourced from DR Themes, CMIP Task Teams and the WIP) and addressed asynchronously. Final decisions on modifications to be included in each release were made jointly by the DR-TT co-chairs and the CMIP IPO. Most changes made to DR7 post-v1.2 were at the metadata level, such as clarifying variable descriptions, correcting errors and inconsistencies, and small changes to Opportunity variable lists.

Version 1.2.2 coincided with critical deadlines for three modelling centres, with the Data Request being used for CMIP7 data production from v1.2.2 onward.

Table 2 summarises all DR7 version release, while full release notes are available on the CMIP7 DR webpage[21] and in the WCRP-CMIP Zenodo publication repository[22]. Version control of DR7 Content comprised a four-part semantic versioning scheme (major, minor, maintenance, patch):

[21] https://wcrp-cmip.org/cmip-phases/cmip7/cmip7-data-request/ [accessed 13 March 2026]

[22] https://zenodo.org/communities/wcrp-cmip/ [accessed 12 March 2026]

1. **Major**: v1.x.y.z for the CMIP7 AFT.
2. **Minor**: Three versions (v1.0, v1.1, v1.2) of the AFT Data Request. There was a significant evolution in content over these versions, but they provided information for modelling centres to begin configuring AFT workflows. This fixed timetable of three releases was established based on feedback from modelling centres on the need to reduce the frequency of
595 significant DR releases.
3. **Maintenance**: Potentially disruptive changes mandated by the CMIP panel or WIP were published as maintenance revisions, distinct from planned content updates and non-disruptive patches. Beginning with v1.2.1.
4. **Patch**: Non-disruptive fixes for technical errors or inconsistencies (e.g., spelling corrections and clarifying descriptions). Beginning with v1.2.2.1.

Table 2: Schedule of DR7 version releases. Full release notes for each DR version are linked from the CMIP7 DR webpage, and published to the WCRP-CMIP Zenodo (see text for details and links).

Date [DD-MM-YYYY]	**Version**	**Comment**
09-10-2024	1.0alpha	Originally scheduled as a full release in September, this alpha version allowed community to start interacting with new Data Request structure and platforms. Content was only illustrative at this stage.
21-10-2024	1.0beta	Early community engagement continued, feedback spreadsheet circulated to modelling centres. MIP tagging of Opportunities and Variable Groups.
22-11-2024	1.0	This first release contained significant gaps, but the content reflected the scope of community requirements. v1.0 launch event: CMIP Data Request Task Team (2024).
30-01-2025	1.1	Continued refinement of content to reflect community requirements. BCVs updated, and use of time subsets (previously called time slices) reduced.
01-04-2025	1.2	Finalised scope of community requirements for CMIP7 AFT. Experiments outside AFT added. v1.2 launch event: CMIP Data Request Task Team (2025)
26-04-2025	1.2.1	Variable changes from CMIP6 flagged, technical updates to some variables. Provisional Branded Variable names added.
25-07-2025	1.2.2	DR7 Variables requested for 30S-90S listed separately in Variables table, technical updates to some variables.
26-09-2025	1.2.2.1	Deprecated due to errors (not suitable for production). Superseded by v1.2.2.2.
30-09-2025	1.2.2.2	Several technical inconsistencies resolved. Branded Variable names finalised and was the first DR version used to generate CMIP7 CMOR tables.
18-12-2025	1.2.2.3	Finalised ScenarioMIP experiment names, minor technical updates to some variables.
05-06-2026	1.2.2.4	Two new C4MIP variables and minor technical updates to some variables.

17-07-2026	1.2.2.5	Experiment name error in v1.2.2.4 corrected, new PMIP experiment 'eocene-5x', new variable 'zhalf' and minor technical updates to some variables and coordinates.

5.3 Interactive tools for creating and exploring content (Airtable)

Airtable, a cloud-hosted collaborative database service, was selected early in the design process for hosting the CMIP7 Data Request content. Several factors were taken into account for this choice, largely in relation to the functionality of Airtable, including:

i. its relational database features, allowing items in different tables to be linked together and in turn simplifying the amount of metadata required in each individual table,

ii. accessibility functions such as filtering, grouping, and sorting, including via public web views,

iii. interoperability with common formats such as csv and xml/xlsx,

iv. the ability for content to be added by non-registered users via input forms linked directly to specific records,

v. flexible versioning capabilities, and

vi Airtable already being in use by the CMIP IPO, therefore allowing the IPO staff to provide technical support.

The DR7 Airtable database[23] was initially configured by importing the CMIP6 Data Request and transforming it to make use of the relational database features. CMIP7 DR content (Opportunities, Variable Groups, Experiment Groups, and new variables and Physical Parameters) was proposed by the community using Airtable forms, and where wider discussion across DR Themes was required GitHub issues were created[24]. Thematic Author Teams also collaborated in self-driven ways, including the use of tailored spreadsheets and cloud-based workspaces.

Versioned DR releases were created by freezing the Data Request content and providing a read-only Airtable link, allowing the frozen content to be explored by the public online using Airtable's viewing and filtering capabilities.

Additionally, the content of each Data Request release was exported to JSON format and archived as versioned releases in the CMIP Data Request GitHub organisation[25] and Zenodo (Anstey et al., 2026). It is strongly recommended that users do not interact directly with the exported JSON file that stores the content of a DR release. Although JSON is a text-based format and can be read in any standard text editor, the structure of this file is not designed to be human-readable because it preserves the relational database schema and internal links exported from the Airtable cloud database. Direct use will likely be error-prone, which could lead to inconsistent data outputs across models in the ESGF archive. Instead, the Data Request Python API enables programmatic access to the Data Request content (see next section).

[23] v1.2.2.5: https://bit.ly/CMIP7-DReq-v1_2_2_5 (latest: https://bit.ly/CMIP7-DReq-latest)

[24] https://github.com/CMIP-Data-Request/Harmonised-Public-Consultation [accessed 12 March 2026]

[25] https://github.com/CMIP-Data-Request/CMIP7_DReq_Content

A web viewer of the DR content JSON exports has also been developed to maximise accessibility. The open-source DR Webview[26] can be used to explore the content in a similar way to Airtable but has less functionality due to its simpler design. It is hosted in a GitHub repository alongside the software and context exports under the CMIP Data Request GitHub organisation[27].

5.4 Python tools for programmatic use (DR7 API)

In addition to the Airtable database, a Python software package was developed to enable programmatic access to the Data Request to support integration into data production workflows at modelling centres. The Application Programming Interface (API) for the CMIP7 Data Request (DR7 API)[28] provides some functionality for this purpose, allowing users to query and explore the DR using scripts and command-line utilities (Anstey et al., 2025). The JSON export of DR content provides the input to the DR7 API. The DR content and software are maintained in separate GitHub repositories. When installing the software, versions of the content export file are automatically downloaded and cached locally on the user's system, facilitating offline workflows. See the *code and data availability* statement on page 37 for further links.

The software provides functionality for exploring, querying, and utilising the downloaded Data Request content, and has supported DR7 releases from v1.0 onward. Software versions are not tied to specific Data Request releases – they are separate from the versioning of the DR content exports. DR7 releases v1.0 to v1.2.2 were followed by corresponding software release with the same version string. After v1.2.2, however, API software versions were decoupled from the main DR7 releases and published independently according to user needs and development progression. Post-v1.2.2 DR7 API software versions use the standard three-part semantic versioning (major, minor, patch), as distinct from the four-part scheme used for the Data Request (see next Section).

Functionalities provided by the software include:

- Generation of machine-readable lists of requested variables for each CMIP7 experiment.
- Customization of provided lists based on chosen Opportunities.
- Prioritization of requested variables based on chosen Opportunities.

These illustrate one of the key uses of the software, which is to allow modellers to easily combine information from multiple Opportunities into experiment-specific lists of variables that can be used in data production. Manually combining information from numerous Opportunities would be time-consuming, tedious, and error-prone (and hence could lead to inconsistencies across model outputs archived on ESGF), but is automated with the DR7 API. Further functionalities provided by the software include:

- Provision of metadata for variables, including parameters used in CMOR tables (e.g., cell_methods) as well as parameters from the Data Request schema (see Section 5.1).

[26] https://cmip-data-request.github.io/cmip7-dreq-webview/ [accessed 12 March 2026]
[27] https://github.com/CMIP-Data-Request [accessed 12 March 2026]
[28] https://github.com/CMIP-Data-Request/CMIP7_DReq_software

- Identification of variables using their CMIP7-era compound names (utilising Branded Variable names) as well as their CMIP6-era compound names, to help modellers maintain continuity with CMIP6-era workflows. A configuration parameter is available to specify which era of name is primarily used to identify variables in software outputs. Note that the filenames and directories in CMIP7-compliant data use CMIP7-era names – see the CMIP7 Global Attributes (Taylor et al., 2025).
- Comparison of variable metadata between DR7 versions or with CMIP6 variables to identify any changes in variable definitions.
- Customizable volume estimates to inform data production decisions.

As a community software package, users who wish to add functionality to the package are encouraged to do so by forking the software and submitting merge requests on GitHub. Modellers are encouraged to contribute additional tools and functionality to the package especially if they may be of benefit to other data producers. Data analysts may also find the software useful to understand the scientific justifications of variable selections, and estimate which variables are expected to be published to CMIP7. Contributions designed specifically to support analysis are also welcome.

5.5 Controlled Vocabularies, Branded Variables and DR7 compound names

The Data Request is a key part of defining the requirements for the CMIP data and has connections to information held in other parts of the infrastructure that are needed to support data delivery and publication. Another prominent component is the CMIP Controlled Vocabularies (CVs)[29] where core metadata are recorded, such as experiment and model identifiers along with allowed values for fields including modelling realms, frequencies and geographical regions – these are key inputs to DR7 (see the schema in Section 5.1). When producing data for a given experiment, modelling groups will identify required variables for a specified experiment from the Data Request and include appropriate metadata in agreement with the CVs.

A new naming system for variables, referred to as 'Branded Variables', has been developed for use in CMIP7 and subsequent WCRP projects. This system retains familiar short variable names from earlier CMIP phases, which identify Physical Parameters in DR7, and adds to these a 'Branded suffix' composed of four labels that describe the spatio-temporal sampling of the variable. Branded Variable names were not originally part of the DR7 schema (Figure 3) but subsequently were included as additional DR7 Variable metadata attributes (early DR7 releases did not include Branded names, see Table 2). Branded Variables and DR7 Variables are not exactly equivalent because Branded Variables do not specify a frequency or region – hence every Data Request variable has a corresponding Branded Variable, but some Branded Variables correspond to more than one Data Request variable.

Since many users remain familiar with the CMIP6-era compound names (e.g., *Amon.tas*), and data production workflows may depend on them, DR7 specifies both CMIP6-era and CMIP7-era compound names for every DR7 Variable. CMIP6 compound names contain CMIP6 MIP Table and Physical Parameter name in the construction {*table id*}.*physical parameter name*. CMIP7 compound names contain Realm, Physical Parameter name, Branded suffix, CMIP7 Frequency and Region in the

[29] https://github.com/WCRP-CMIP/CMIP7-CVs [accessed 12 March 2026]

construction *realm.physical parameter name.branded suffix.frequency.region*. Monthly atmospheric surface temperature for example has the CMIP6 and CMIP7 compound names of *Amon.tas* and *atmos.tas.tavg-h2m-hxy-u.mon.glb*, respectively. For new DR7 Variables, appropriate CMIP6 Table Identifiers were chosen by proposers to enable backward compatibility.

The decision to implement the concept of Branded Variable names represents a disruption from CMIP6 that was agreed upon by CMIP decision-making bodies following discussion within the various Task Teams. The rationale is to provide a unique, non-ambiguous and self-explanatory variable identifier that includes structural components. Branded Variable names are also a pivotal element in the CMIP ecosystem, as it provides key access to the CMIP7 CVs via EsgVoc[30] – a WCRP vocabulary server developed for CMIP7, used in the new CMIP7 QA/QC system[31] and in the workflows of some modelling centres.

The inclusion of Branded names in DR7 was necessary to provide metadata specified in the CMIP7 Global Attributes (i.e., Branded names are part of the CMIP7 CVs; Taylor et al., 2025). Additionally, the intended creation of a WCRP Variable Registry is expected to include Branded Variable names and definitions for use across WCRP activities[32] (e.g., CMIP, input4MIPs, obs4MIPs, etc.). Further information about development of the WCRP Variable Registry will be made available via the CMIP7 guidance pages[33].

5.6 Summary statistics

In Table 3, we present the number of unique items across the DR7 categories in v1.2.2.5 (see the schema in Section 5.1), compared to those in DR6 v01.00.31 (Juckes et al., 2020).

While there has been only a marginal decrease in the total number of Physical Parameters and DR Variables (8.6% and 4.6% reduction, respectively), many DR6 Variables were not carried into DR7 – 183 Physical Parameters and 530 DR Variables are new to DR7 (15.7% and 26.9%, respectively). This demonstrates a significant evolution of DR content, with additions across all Modeling Realms and most Opportunities. The significant reduction in Experiments is reflective of the DR7-dev timeline, and it would be expected to grow to a similar number throughout the rest of CMIP7 if the *Unharmonised* Data Request is enabled (see 6.4).

In DR6, Objectives were linked to Request Variable Groups and Experiment Groups, of which there were significantly more than in DR7, however this mapping was overhauled under the Opportunity scheme, reducing the granularity of this mapping to facilitate greater understandability. Additionally, some DR7 categories were applied in DR6 as attributes (Modeling Realm, Frequency, and Cell Methods and Cell Measures), however their structure and use are identical in DR7 – the upgrade from 'attribute' to 'category' was to raise visibility of these important metadata factors, with the vocabulary of terms more explicit and accessible to users.

DR Themes and the Glossary are new categories in DR7, while the Ranking and ESM-BCV 1.4 represent developments between CMIP6 and CMIP7 that are described in Juckes et al. (2025), and which were adopted into DR7.

[30] https://pypi.org/project/esgvoc/ [accessed 31 March 2026]

[31] https://github.com/ESGF/cc-plugin-wcrp [accessed 31 March 2026]

[32] https://airtable.com/appYNLuWqAgzLbhSq/shrIAHOuVw8ktdoe1 [accessed 12 March 2026] (WIP Panel, Decision ID 59)

[33] https://wcrp-cmip.github.io/cmip7-guidance/docs/CMIP7/ [accessed 13 March 2026]

Table 3: Comparison of summary statistics by category/attribute from DR7 (v1.2.2.5) to DR6 (v01.00.31) – see text for details. Externally defined categories/attributes are asterisked. Categories with unmodified titles are indicated with "=" in column 4. Five categories are new in DR7.

DR7 category (*externally defined)	**# items in DR7**	**# items in DR6**	**Corresponding DR6 category/attribute**	**Comments**
Physical Parameters	1163	1272	MIP Variables	
DR Variables	1968	2063	CMOR Variables	
Experiments*	98	294	=	
Experiment group	31	76	=	Usage modified.
Variable group	188	248	Request Variable Group	Usage modified.
Opportunity	46	90	Objectives	Linked to MIPs in DR6, DR Themes in DR7; usage modified to have far more descriptive content and harmonised usage.
MIPs*	54	29	=	Usage modified – DR7 now also lists MIPs which have not requested any data.
DR Themes	5			
Priority Level	4	3	Default Priority	Definition modified.
Time Subset	39	33	Time Slice	Usage modified.
Modeling Realm*	8	8	=	
CMIP7 Frequency	9			
CMIP6 Frequency*	20	16	Frequency	The 16 functional items are unmodified, but 4 are duplicated in DR7 v1.2.2.5.
CMIP6 Table Identifiers*	49	44	MIP Tables	5 new MIP Tables created in DR7, however only 3hrPt is linked to any Variables.
Spatial Shape	38	33	=	
Temporal Shape	7	5	=	
Cell Methods	125	61	=	Extra detail added in CMIP7 cell methods strings.
Cell Measures	8	7	=	"area: areacellr" added in DR7 for river models.

Coordinates & Dimensions	115	107	Grids	
		220	Structure	Aggregated Shape and Grid attributes in DR6. Deprecated in DR7.
CF Standard Names*	861	4292	=	DR6 imported all CF standard names; DR7 only imported used names

6 Discussion

6.1 Supporting model analysis and scientific investigation through data quality

CMIP data now underpins a massive and growing array of scientific, governmental and political activities (Ju et al., 2025). Because this data is being used to make highly impactful decisions at all scales of research and society, it is subject to ongoing scrutiny – the quality of this data must meet the expectations of users and support the integrity of their analysis and data science pipelines.

Data quality in the context of CMIP is not just about the scientific quality of the output from individual models, but also the consistency and usability of the CMIP archive across models and experiments and the matching of published model output to community needs and expectations. In other words, the data needs to meet a high level of FAIR (Findable, Accessible, Interoperable and Reusable; Wilkinson et al., 2016) – CMIP data is most impactful when the metadata is rich, model intercomparison is efficient, a wide variety of use cases are enabled, and ingestion into scientific and decision-making pipelines is supported and transparent.

Through the IPCC process and the UNFCCC Conference of Parties, the CMIP projections and the conclusions drawn from them feed into governmental decision-making processes in all member states of the United Nations. Most organisations, at all scales, that are making climate-informed decisions ultimately draw from CMIP (whether directly or indirectly, such as through the CORDEX[34] regional downscaling intercomparison activity; Lake et al. 2017), from local councils to regional intergovernmental partnerships. For example, the Victorian State Government and local councils rely on CMIP-derived data to inform climate adaptation policy and projects – the Victorian Climate Futures[35] tool was created through the dynamical downscaling of CMIP5 and CMIP6 data (Rafter et al., 2019; Round et al., 2024).

Spending effort up-front to enable the creation of high-quality data delivers great impact at the end of the science pipeline (Mons, 2020). This is almost universally accepted as a general principle, but there are often reservations around specific up-front actions (e.g., Hughes et al., 2023). The CMIP Data Request has the ambition of enabling the production of high-quality climate model data by consolidating user requirements from across a broad community into a concise set of guidance and technical specifications for use by CMIP modelling centres and data producers.

[34]https://cordex.org/ [accessed 13 March 2026]

[35]https://vicfutureclimatetool.indraweb.io/ [accessed 13 March 2026]

CMIP can only achieve its goals if community engagement and consultation is enabled and prioritised. The challenge is to ensure that the expanding scopes of scientific analysis of, and public interest in, CMIP can be accommodated, while at the same time enhancing the level of internal consistency to support greater automation of workflows. Further tensions include resource limitations (both in terms of labour and computational and data infrastructure), the growing size and complexity of climate models and their components (such as the inclusion of wave modelling in CMIP7), and expected IPCC timelines that are often both short and uncertain. The community engagement activities built into the development of the CMIP7 Data Request were an attempt to meet and resolve these challenges and tensions.

6.2 A Theory of Change model

'Theory of Change' is a logic model commonly applied to social programs[36] in which the context, intended actions and deliverable assets are outlined, and are connected logically to the behavioural changes and/or sociological impacts that are intended by the program (Weiss et al., 1995).

A Theory of Change model was developed by the DR-TT to support planning and decision-making, ensuring that actions align to the overarching purpose and helping to maintain awareness of key high-level dependencies. It is provided here in Figure 4 to help facilitate an understanding of the DR7 context and methodology, highlighting the intended outcomes and impacts. Notable features in Figure 4 discussed elsewhere include the diversity of organisational inputs into the DR-TT and community engagement, and the various components of DR7 and their dependencies.

While the primary outcome of DR7-dev is to facilitate the production of CMIP7 data by modelling centres, the wide range of outcomes facilitated by a robust DR (such as informed decision-making and shared community knowledge) demonstrate that the technical solution is just part of what makes the CMIP Data Request a highly valuable activity. Community co-creation of DR content that is aligned with the infrastructure and strategic goals of CMIP and WCRP is how the DR7 ultimately feeds into many of the impacts sought by CMIP as a whole, including broad utilisation of the CMIP data archive across science and policy.

6.3 Reflections and lessons learned

The CMIP7 Data Request contains both stable elements (such as DR Variable descriptions and metadata) which have been produced consistently over many CMIP eras, and more innovative elements (such as Opportunities and DR Themes) that have been designed to address persistent challenges that limit the utility of the Data Request. Such challenges include accessibility limitations due to technical complexity, ad-hoc version release schedules, and the difficulty of conducting a community-wide consultation that is strategic, inclusive and transparent.

Past CMIP Data Requests provided a firm basis for DR7-dev. CMIP5 saw the development of variable descriptions and metadata attributes (known as the "standard model output" list) that remain largely consistent today. The CMIP6 Data Request (DR6) introduced the mapping of variables to experiments according to the requirements of science team, increased accessibility to DR content through online and programmatic tools, and enabled provenance tracing of DR items across CMIP phases.

[36] https://www.theoryofchange.org/what-is-theory-of-change/ [accessed 13 March 2026]

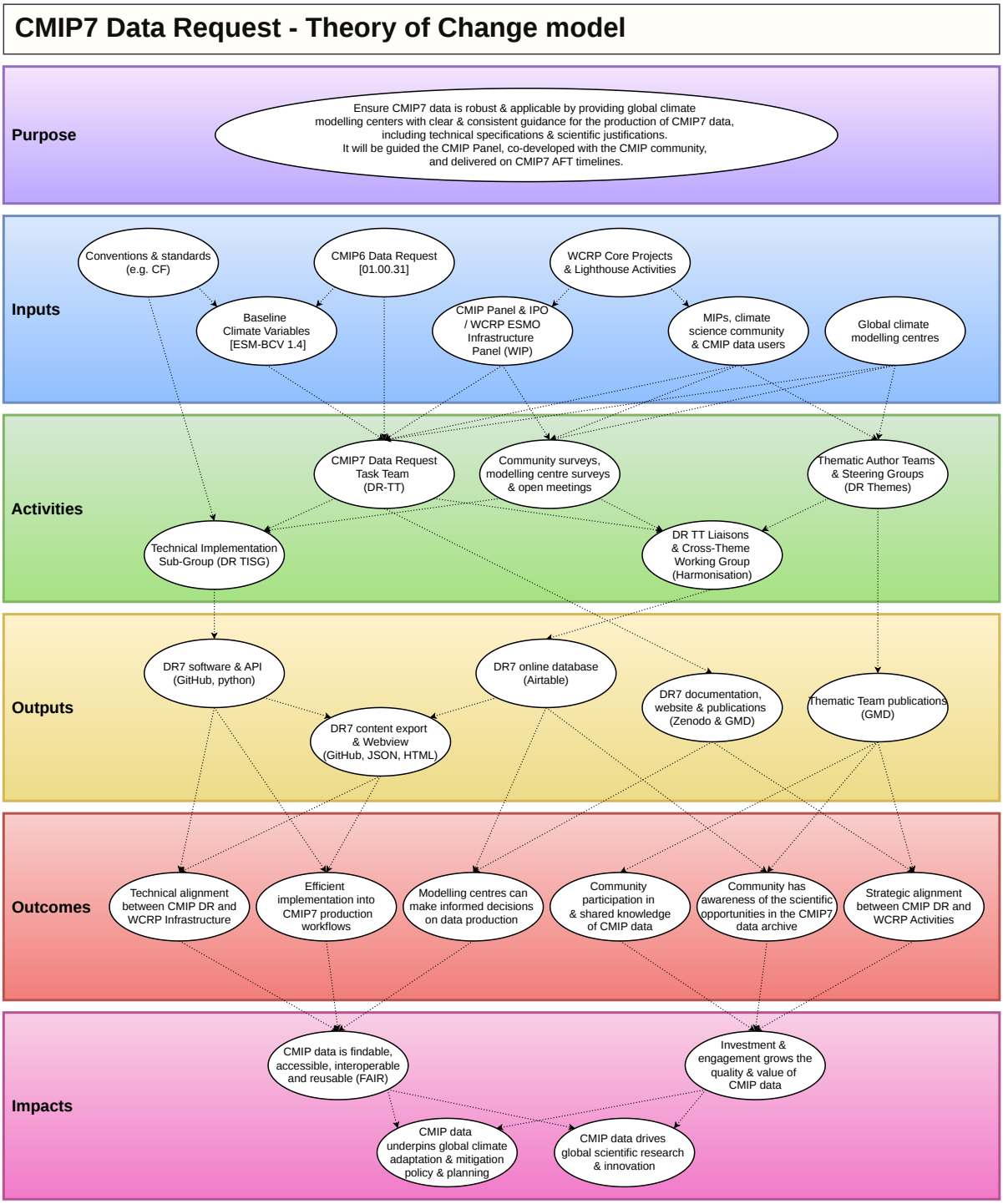

Figure 4. A Theory of Change model for the CMIP7 Data Request, with a top-level purpose statement and items (ovals) in five categories: inputs, activities, outputs, outcomes and impacts. These items and the arrows connecting them illustrate causation (i.e., how the intended impacts of the Data Request are affected through action).

These are foundational to the ability of modelling centres to create CMIP data by ensuring the efficient adaptation of data production workflows over time, thereby minimising disruption to climate modelling teams. The intercomparison of data from different CMIP phases is also dependent on the clear provenance and traceability of DR variables.

DR7 involved modest changes to the mapping of variables to experiments through the introduction of Opportunities, however it was the enhanced community engagement that led to a substantial enhancement in the content and the information it provides to explain and justify data requests. The adoption of new technologies, in-line with community expectations to utilise contemporary technical solutions, led to a more open and sustainable activity. These include the use of Airtable for the direct creation of content by DR Themes, and the DR Python API which was developed in an open GitHub repository in collaboration with the user community. We acknowledge the long history of the Data Request and those who built a firm foundation for the work of the DR-TT and the future of the CMIP Data Request (see Section 2).

The Thematic Author Team process, a foundational component of DR7-dev, was critical to success, and represents a significant step change in how the Data Request is created and communicated (see Section 4.2). In particular, the DR Themes enabled greater transparency and thoroughness in harmonising requirements from disparate science teams and user groups. The community co-creation of DR content, enabled by the DR Themes, ensures that the CMIP7 Data Request accurately reflects the needs of data users, and encourages a culture where the knowledge of data requirements (and how to gather and synthesise them) is not restricted to individual experts but shared among those in the CMIP community. This will contribute greatly to the ongoing utility of CMIP data and the capacity of the community to develop tailored data requests for future model intercomparison activities. We acknowledge the incredibly large effort required by the Thematic Author Teams, without whom community representation and co-creation could not have been possible.

The main challenge to effective community-wide consultation was the complex administrative burden, especially when considering the strong dependency on voluntary contributions from institutions and professionals. The main impact was in limiting the richness of the collected feedback due to short time-frames on requests for information and feedback, which can be addressed through continuous improvement of governance-level coordination and clarity. We acknowledge the vital role of the CMIP IPO in supporting both the administration of DR7-dev and the technical development of DR7.

The operational nature of CMIP, combined with its dependence on coordinated community effort, produces an environment where strategy and delivery are often concurrent across a complex and ever-moving program of work. In this situation, the separation between governance and product delivery are often unclear, resulting in developmental delays due to ongoing strategic changes in related activities (e.g. the inception of the CVs Task Team in early 2025, after DR7 v1.0 had been released).

A significant challenge faced throughout DR7-dev was in the separation of responsibilities over different parts of CMIP infrastructure, and there were persistent barriers to finding clarity. These barriers existed at both the technical level – such as with the inclusion of Branded Variable names – and governance level – such as understanding the implications of community co-creation on the wider CMIP data publication workflow for which planning and development is ongoing (including CVs, ESGF, CMOR, EsgVoc, CMIP7 QA/QC, and WCRP Variable Register). There were also differing interpretations of the boundaries between governance and technical levels. We acknowledge the integral support and partnership of the CMIP Panel, the WCRP ESMO Infrastructure Panel (WIP), and the CVs and Model Benchmarking Task Teams.

With the ownership and management of the various components of CMIP being subject to social and institutional dynamics (an inevitability for such activities requiring significant international cooperation), continued access to published DR versions and sector-wide collaboration are at risk. The sustainable continuation of CMIP infrastructure requires clear chains of governance and transparent joint decision-making processes (especially where dependencies are complex).

6.4 Legacy and sustainment of the Data Request

While the primary scope of DR7 is to facilitate CMIP7 AFT data production, the design of the Data Request Task Team's approach considered the evolving and future needs of CMIP and the climate modelling communities beyond the AFT. Some of these needs were able to be met in DR7, especially when Community MIPs were able to engage with the Data Request due to compatible timelines (those in the DR7 category 'MIPs').

Future developments by Community MIPs, including those MIPs already engaged with the DR and those on longer timelines, will constitute the *Unharmonised* component of the Data Request (see Section 3.2). We leave this component purposefully under-defined to allow for emerging requirements to be prioritised, but have built adaptable frameworks and tools with the aim of easing future Data Request creation.

By structuring DR7 into modular Opportunities, it is amenable to the addition of new Opportunities, with the DR7 API allowing users to combine future requests with the present request. Moreover, by engaging deeply with the climate science community and ensuring that ownership over individual Opportunities remains with the CMIP community via DR Themes, global capability in creating new Data Requests for future CMIP phases and other community-driven intercomparison activities has significantly evolved. This improves the longevity of Data Request assets and the coordinated activity required for its development.

The most critical prerequisite for the sustainment of the Data Request beyond the AFT and CMIP7 is clear ownership, governance, and change control over specific DR assets and objectives, especially when delivering to the CMIP operational environment. The DR has historically been carried forward by individual committed scientists with affiliative support, while in CMIP7 DR management has moved into a more formal governance structure (see Section 4). This should be carried forward as the Data Request enters the *Unharmonised* phase described in Section 3.2. While the *Unharmonised* component of the DR could be developed by the MIP community without centralised coordination from CMIP governance, it would maximise the usefulness of tailored CMIP7-era community requests and the likelihood of the successful development of a CMIP8 Data Request if there is a need.

By maintaining the DR7 throughout the CMIP7 cycle and beyond (with updates and user support), and ensuring perpetual public access to DR7 content for long-term validation and provenance, the Data Request can remain as a foundational and valuable piece of CMIP infrastructure. With continued (or increased) community engagement, WCRP prioritisation and institutional investment, the Data Request can support the growth of CMIP's international impact into the future by ensuring that the CMIP data archive adequately serves the needs of all users and stakeholders.

7 Conclusions

In this paper we described the strategy, implementation and delivery of the CMIP7 Data Request, in which data requirements for CMIP7-era reference climate simulations were gathered and harmonised into a coherent relational database. It is a key input into the next upgrade of WCRP activities, which includes CMIP7 and its initial phase outlined by the Assessment Fast Track (Dunne et al., 2025). DR7 enables data production workflows through controlled metadata, while containing clear scientific and resource justifications to inform decision-making.

The CMIP Data Request has seen an evolution from a flat list of key variables developed by individual experts, into a large relational database with content owned by community and assets managed through CMIP governance. The *Core* and *Harmonised* strategic components of the CMIP7 Data Request (see Section 3.2) comprise the current release (v1.2.2.5), where the aim was to provide a set of CMIP data requirements with a high level of internal consistency and clarity of scientific justification. This was achieved through the consultation and harmonisation efforts undertaken by the DR-TT and Thematic Author Teams with the support of the CMIP IPO (see Section 4), and delivered to the community in the form of an interactive database and programmatic tools (see Section 5).

Developing and delivering the Data Request (or any part of CMIP) is a challenging endeavour, with a vast user community and stakeholder network. We have made our best attempt to address all feedback and adapt our approach where possible. The content of the DR7 is as representative of the needs of the whole CMIP community as was feasible under the constraints of IPCC AR7 and AFT timelines. The Data Request is intrinsically granular in its nature and has a foundational role in the creation of a robust CMIP data archive. This necessitates ongoing technical evolution, mentorship and capability development, continuity in the ownership of assets and content, resourcing of distributed community effort, and advocacy at the institutional and international scale.

The success of the Data Request is irrevocably reliant on voluntary contributions from the community – ranging from climate modellers to industry professionals and government policymakers. However, this is also the source of its true value and greatest impact, and we envisage that the transformation of the Data Request into a community-owned and community-driven resource will continue. As climate research and data user communities evolve, engaging with this broadening audience will continue to be both a necessity and a privilege for those who will carry the CMIP Data Request forward.

Appendix A: Glossary of Acronyms

30S-90S: The area bound between 30° South and 90° South

AerChemMIP: Aerosols and Chemistry Model Intercomparison Project

AFT: CMIP7 Assessment Fast Track

APARC: Atmospheric Processes And their Role in Climate (WCRP Core Project)

AR7: Seventh Assessment Report of the IPCC

AR7 WGI: Working Group One of the IPCC AR7

C4MIP: Coupled Climate–Carbon Cycle Model Intercomparison Project

CF Conventions: Climate and Forecast metadata conventions

CFMIP: Cloud Feedback Model Intercomparison Project

CliC: Climate and Cryosphere (WCRP Core Project)

CLIVAR: Climate and Ocean Variability, Predictability and Change (WCRP Core Project)

CMIP: Coupled Model Intercomparison Project (WCRP project)

CMIP IPO: CMIP International Project Office

CMOR: Climate Model Output Rewriter (CMIP-related software)

CORDEX: Coordinated Regional Downscaling Experiment (WCRP project)

CV: Controlled Vocabulary

DAMIP: Detection and Attribution Model Intercomparion Project

DCPP: Decadal Climate Prediction Project (WCRP project)

DECK: Diagnostic, Evaluation and Characterization of Klima (base set of CMIP experiments)

DOI: Digital Object Identifier

DR Themes: Data Request Thematic Author Teams

dr2xml: A package for translating a CMIP Data Request to XIOS file

DR7: CMIP7 Data Request

DR7-API: DR7 Application Programming Interface

DR7-dev: DR7 development activity

DRS: Data Reference Syntax

DR-TISG: Data Request Technical Implementation Sub-Group

DR-TT: Data Request Task Team

DynVarMIP: Dynamics and Variability Model Intercomparison Project

EMD: Essential Model Documentation (CMIP7 component)

ESGF: Earth System Grid Federation (WCRP infrastructure)

EsgVoc: a Python library for using WCRP CVs

ESM: Earth System Model

ESM-BCVs: Baseline Climate Variables for Earth System Modelling (Juckes et al., 2025)

ESMO: Earth System Modelling and Observations (WCRP Core Project)

FAIR: Findable, Accessible, Interoperable and Reusable (data sharing framework)

FireMIP: Fire Model Intercomparison Project

FishMIP: Fisheries and Marine Ecosystem Model Intercomparison Project

GCM: General Circulation Model (or Global Climate Model)

GCOS: Global Climate Observing System

GCOS ECVs: GCOS Essential Climate Variables

GCOS-AOPC: GCOS Atmospheric Observation Panel for Climate

GCOS-OOPC: GCOS Ocean Observations Physics and Climate Panel

GCOS-TOPC: GCOS Terrestrial Observation Panel for Climate

GeoMIP: Geoengineering Model Intercomparison Project

GEWEX: Global Energy and Water Exchanges (WCRP Core Project)

GlacierMIP: Glacier Model Intercomparison Project

HighResMIP: High Resolution Model Intercomparison Project

input4MIPs: Input datasets for Model Intercomparison Projects

IPCC: Intergovernmental Panel on Climate Change

ISMIP: Ice Sheet Model Intercomparison Project

JSON: JavaScript Object Notation

LUMIP: Land Use Model Intercomparison Project

MIP: Model Intercomparison Project

NetCDF: Network Common Data Form

obs4MIPs: Observations for Model Intercomparison Projects

OMDP: Ocean Model Development Panel (CLIVAR panel)

OMIP: Ocean Model Intercomparison Project

PMIP: Paleoclimate Modeling Intercomparison Project

QA/QC: Quality Assurance and Quality Control

RAMIP: Regional Aerosol Model Intercomparison Project

RCMIP: Reduced Complexity Model Intercomparison Project

REF: Rapid Evaluation Framework (CMIP component)

RFMIP: Radiative Forcing Model Intercomparison Project

ScenarioMIP: Scenario Model Intercomparison Project

SLC: Safe Landing Climates (WCRP Lighthouse Activity)

SIMIP: Sea-Ice Model Intercomparison Project

TIPMIP: Tipping Points Modelling Intercomparison Project

UNFCCC: United Nations Framework Convention on Climate Change

VIACS-AB: Vulnerability, Impacts, Adaptation, and Climate Services Advisory Board

VolMIP: Volcanic Forcings Model Intercomparison Project

WCRP: World Climate Research Programme

WIP: WCRP ESMO Infrastructure Panel

XIOS: XML Input Output Server (CMIP-related software)

Code and data availability. The DR7 v1.2.2.5 Content Export is published in Zenodo at https://doi.org/10.5281/zenodo.21412336 (Anstey et al., 2026). The DR7 Python API v1.4 is published in Zenodo at https://doi.org/10.5281/zenodo.17993659 (Anstey et al., 2025).

Author contributions. CRediT[37] attributions (initials in authorship order). Conceptualization: CM, MJ, JA, BD, CP, GR, MPM, TL, AP, MS, MK, TB, CK, BT & MM. Methodology: CM, MJ, JA, BD, CP, GR, MPM, TL, AP, MS, MK, TB, CK, EO & BT. Supervision: CM, MJ & JA. Data curation: CM, MJ, BD, AP & EO. Validation: CM, MJ, JA, BD, CP, GR, MPM, TL, AP, MS, MK, TB, CK, EO, DE & MM. Software: JA, GR, MPM, MS, DE & MM. Visualization: CM, BD & BT. Project administration: BD, EO & BT. Resources: BD, EO, BT & DE. Writing – original draft: CM, MJ, JA, BD, CP, GR, MPM, TL, AP, EO & MM. Writing – review & editing: CM, MJ, JA, BD, TL, AP, MS & EO.

Competing interests. JA and MM are co-chairs, and MJ an emeritus member, of the WCRP ESMO Infrastructure Panel (WIP). BD, EO, BT and DE are employees of HE Space Ltd which delivers the CMIP IPO service to the European Space Agency. At least one of the (co-)authors is a member of the editorial board of Geoscientific Model Development.

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[37] Hosseini et al. (2026)

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