

**Climate Services:**

**Principles, requirements, and guidelines**

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## Foreword

Human caused climate change will continue to increase risks to human and natural systems in all regions of the world unless international efforts are made to greatly reduce the amount of greenhouse gases (GHG) in the earth's atmosphere. As natural climate patterns continue to change, society will want more timely and reliable climate services to help them gain an understanding of climate risks, developing and implementing meaningful responses to those risks and associated vulnerabilities, and for guidance on how to take advantage of related opportunities. This standard has been drafted to help climate service users and providers of climate services to ensure robust climate change decision making.

The working definition for the term “climate services” in this standard was agreed by consensus with the project delivery team and wider stakeholder consultation as follows:

“Climate services involve the production, translation, transfer, and use of climate knowledge and information in climate-informed decision making”

The following benefits of standardisation are recognised:

1. A standard builds **CONFIDENCE** and **TRUST** in the services that are being provided and can be used
2. A standard will encourage climate service providers to improve the **QUALITY** of their services, by striving for demonstrable good practice
3. A standard will improve the **TRANSPARENCY** of climate service products and procedures
4. A standard will increase the **ACCOUNTABILITY** of climate service providers
5. A standard provides a **BENCHMARK** for climate services, aiming to reduce the prevalence or use of services which do not meet this standard
6. A standard can help **CONNECT** decisions and their implementation with the most appropriate climate services and/or products
7. A standard can **SUPPORT PROVIDERS** who are not comfortable offering a user-requested climate service, though could offer alternatives that better align with the standard principles
8. A standard can support **ETHICAL** considerations such as equitable access and integrity of climate services

Climate services have the potential to provide considerable support to human and planetary security by significantly improving climate-informed decision-making processes. When delivered and used appropriately, climate services can therefore enhance societal benefits, reduce social deficits and reduce climate related losses. If delivered and used ineffectively providers of climate services run the very real risk of contributing to poor decision-making, some of which could have harmful consequences for decades to come. It is critical therefore that climate service providers deliver a service that is regarded by climate service users as being robust, reliable, credible, understandable, meaningful, and honest.

In this document, the following verbal forms are used:

- ‘shall’ indicates a requirement;
- ‘should’ indicates a recommendation;
- ‘may’ indicates a permission;
- ‘can’ indicates a possibility or a capability.

## I Introduction

Climate service providers can use this standard to deliver services to an industry-recognised benchmark level of quality that meets the needs of climate service users. Quality benchmarks will apply across different service offerings, and climate service providers may seek accreditation to certify their climate services to meet the requirements of this standard.

Whilst the implementation of the standard is targeted at climate service providers, the existence of the standard, and its application, is important to users in building trust and confidence. The standard supports the climate service user in appreciating, understanding, and evaluating climate services. Users of climate services can also use the standard to inform terms of relevance and appropriateness for their intended use.

Application of this standard requires iterative interaction with climate service users and includes guidance on how best to do this in a way that accommodates climate service users' needs, perspective, and experience.

The standard recognises that climate service users' needs are not static. Climate service user needs continually change, progress, regress and evolve as organisations, their staff, their decisions, and their actions change. New information, policy, legislation, and experience levels change. Knowledge and available data are continually and periodically changing as are the technology for presenting and using them. Climate service providers have a responsibility for making climate service users aware of those changes and their implications in terms of decision-making processes. Climate service providers must understand how and when to adapt their services to continually meet the requirements of intended climate service users, and must demonstrate that they understand how and when to adjust their services to meet the evolving needs of the climate service user.

While the emphasis and responsibility of meeting the standard sits with the climate service provider, the standard is designed to be used in a way that ensures there is an iterative learning and improvement interface engaging climate service providers and climate service users. It is not expected that a climate service user would intend to be accredited in this standard. However, climate service users are likely to find this standard useful in helping them identify climate service providers that are most appropriate to them. For example, it is useful for climate service users to have an appreciation of the range or complexity of services they might need and use this to assist in selecting climate service providers that are able to meet their needs.

Climate services are not just provided by climate modelling organisations or organisations which collect and manage meteorological observations. Climate services are also provided by consultants and other types of organisations who use data and information from climate and other organisations and transform it into different types of tailored information for specific purposes or integrate it into decision making frameworks. For example, some organisations provide climate services more relevant to specific decisions and their implementation, such as those that support adaptive management and transformative adaptation approaches.

A climate services user organisation starting out on understanding its climate risk and developing responses to a changing climate requires very different support compared with one which has a lot of experience, technical capacity and resources. More advanced organisations tend to need more in-depth data and may need more involved support. Many climate service user organisations are learning about how best to respond to climate risks and will require climate services appropriate for their needs. Some organisations will choose to undertake analysis, engagement, strategic planning, etc. which may require more complex and sophisticated climate services. Climate service users may not always be aware of the particular data, information or knowledge they require. Hence the nature and scope of the data and information, and level of support required are context

specific and will need to be discussed with the climate service user, and the climate service provider must be able to align the service with the requirements and capabilities of the climate service user.

Consideration of the specific service requirements could lead to a climate service user seeking complementary services from more than one climate service provider. This could occur when a single climate service provider is not able to provide the full spectrum of perspectives, expertise, networks, or support services required at an appropriate standard. This standard can apply in such situations where climate services are provided by multiple climate service providers.

## 2 Scope

This standard applies to any organisation, of any size and type, and in any sector that provides climate services as related to products, activities and services intended to support and improve climate-informed decision-making and implementation. These services encompass those supporting adaptation and resilience to weather and climate variability to longer-term climate-informed decision-making. It can also be used by climate service users to assist with selecting and using services that are available from climate service providers.

It sets out an assurance framework for climate services so that:

- a) Providers of climate services can demonstrate that they are capable of delivering services to a recognised benchmark level of quality and provide services meeting or exceeding that benchmark; and,
- b) Users of climate services can be confident that climate service providers have attained the requisite level of quality and understand the nature and scope of the services being offered commensurate with their expectations, needs and capabilities.

Whilst intended for climate service providers in the United Kingdom, users of the standard may choose to apply or use the provisions of this standard as a basis for developing an appropriate standard in other geographic areas.

Commercial considerations, such as affordability of services, or value for money, are not considered in this standard. It is the responsibility of the climate service provider and climate service user to reach a mutual agreement that clearly identifies critical aspects of the service (quality, usability, limitations and uncertainties) and its deliverability (e.g., pace and affordability). It is also the responsibility of the climate service provider to be transparent about such considerations.

*NOTE: Organisations can be both providers and users of climate services depending upon their relative position in the value chain when carrying out a particular activity.*

### 2.1 Normative references

Normative references are documents which are cited in the text in such a way that some or all of their content constitutes requirements of the document. There are currently no normative references in this document.

## 3 Principles

### General

The principles are the basis for the technical parts in this standard: the main body of the standard that starts with Clause 5. They have been used as a guide to draft the standard and can be useful for guiding the development and use of climate services and for those using this standard where this document does not provide specific requirements for all situations. These principles provide guidance for decisions that need to be made in as yet unknown or in unanticipated circumstances. The principles are not requirements.

### Agility

Agility relates to climate service providers using iterative processes to learn and improve climate services when climate service user needs have changed and require different types of data, information, knowledge, and support. It also relates to an ability to inform and test different, new and evolving services and products as they emerge into the market. Climate service providers have

a responsibility to inform climate service users of new knowledge, data and information that could improve their decision-making and implementation processes.

### **Collaboration**

Climate service providers and climate service users engage in co-development and co-evaluation of services. By collaborating they ensure the quality and usability of services provided is commensurate with the complexity of the climate services user's needs, aptitude and capability of their decision-makers and decision-making processes, along with the complexity and timelines of the systems involved.

### **Flexibility**

Organisations continually review, respond, and adapt to new conditions, information, methods and solutions as they emerge. Examples might be changing user needs, changes to regulation, availability of new climate science, data and information, and integration of additional perspectives and contexts.

### **Integration**

Organisations recognise that climate services should be designed and developed so they can be integrated with other data and information that are required to inform decision-making and implementation processes.

### **Learning**

Processes of action and reflection are adopted so that climate services continue to evolve in a direction that reflects the experiences and perspectives of those involved in delivering and using climate services and the evolving nature and scope of use of climate services. This will inform decision-making processes. Note that learning from negative experiences is just as important as learning from positive ones.

### **Traceability**

Records are kept and continually updated for all sources of data, information and knowledge, their provenance and how they were produced, and the rationale behind their selection.

### **Transparency**

Transparency promotes trust. Organisations work in a culture of openness, achieving comprehensible and appropriate exchanges between climate service providers and climate service users. For example, discussions about data, information and knowledge are credible reflecting uncertainties and limitations and do not sensationalise or under- or over-exaggerate their quality or usability. In developing and providing services, concepts are all described honestly such as those underlying uncertainty, value judgements that are used, principles of practice, and methodologies involved.

## **4 Terms and definitions**

### **Climate services**

Products and services that involve the production, translation, transfer, and use of climate knowledge and information in climate-informed decision making.

[SOURCE: IPCC AR5]

### **Climate service provider**

The organisation providing climate services.

### **Climate service user**

The organisation, or part thereof, that is using, and may be making decisions with, the climate services from a climate service provider. The climate service provider can be internal within the organisation or external to the climate services user.

### **Climate-informed decision**

Climate relevant decisions that have appropriately considered the outputs of a climate service.

### **Adaptation to climate change**

(also, 'climate change adaptation')

Process of adjustment to actual or expected climate and its effects.

*Note 1 to entry: In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities.*

*Note 2 to entry: In some natural systems, human intervention can facilitate adjustment to expected climate and its effects.*

[SOURCE: IPCC, 2014]

### **Adaptive capacity**

Ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

[SOURCE: ISO 14090:2019]

### **Adaptive management**

Process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change.

### **Emission Pathways**

Modelled trajectories of global human-caused emissions into the future

[SOURCE: IPCC, 2018]

### **Timeframe**

Timescale of services in scope of the lifetime of actions. This also applies to all climate service user actions such as concept and design of adaptation and resilience measures, through implementation, maintenance, and end-of-life.

*Note to entry: See definitions for Long-range; Seasonal to multi-year.*

### **Seasonal to multi-year**

Timeframe of approximately three months (seasonal), to annual, and periods of multiple years up to twenty years.

### **Long-range**

Timeframe lasting twenty years or longer.

### **Observation**

Data relating to one or more parameters, such as meteorological observations of temperature from a single location. Earth observations may be collected by surface-based equipment (e.g. thermometer) or remote sensing (e.g. weather radar, rawinsonde - for upper air measurements - or satellites).



## Capability

The level of experience and competence an organisation has in using or providing climate information to inform decision-making and the implementation of actions.

## Interested parties

Person or organisation that can affect, be affected by, perceive itself to be affected by, or be expected to implement a decision or activity. These include those that are either directly or indirectly impacted.

*Note 1 to entry: To “perceive itself to be affected” means the perception has been made known to the organisation.*

*Note 2 to entry: Examples are customers, communities, suppliers, regulators, non-governmental organisations, investors, employees and academia.*

[SOURCE: ISO 14001:2015, 3.1.6 modified]

## 5 External and Internal Climate Services

Climate service providers may also be users of data and information that they themselves provide. As such, climate services may be provided internally by an organisation to its own users. Alternatively, an organisation may seek/ require climate services from outside of their organisation (external). Competent experts shall be engaged in developing and delivering climate services, whether climate services are sourced externally or internally.

## 6 Alignment Between Climate Service Provider and Climate Service User

The climate service provider should ensure that the service provided remains closely aligned with the climate service user’s ability to understand what to do with the information, and the complexity (or simplicity) of the decisions that need to be informed.

The climate services provider shall ensure services are easily accessible and understandable to the intended climate service users. Resource constraints of climate service users should be taken into consideration when designing services.

The climate service provider may provide services for commercial gain.

## 7 Assessing Climate Service User Needs

In assessing the climate service user’s needs the climate service provider shall establish:

- Decisions that climate service users are making that the service is intended to inform;
- The climate service user's decision-making and implementation processes;
- The format of the information needed;
- The frequency of updates needed and on what basis;
- Temporal resolutions beyond timeframe e.g. annual data breakdown over the timeframe;
- The geographical location and spatial resolution needed;
- Which climate services are needed by the climate service user to meet their data and information needs. This includes understanding the variables, metrics and indicators required;
- Whether the climate service provider can deliver in a manner that demonstrates added value to the user: the data and information consistent with the climate service users' needs and capacities, and any strengths and limitations of their offering (including relevant timeframes, locations and availability of data and information); and,

- The climate service user's capability to undertake climate-informed decisions and their implementation.

Capability considerations should include:

- Organisations that are just beginning to consider climate variability and changes without any prior knowledge of the topic;
- Organisations beginning work on climate variability and change, which have developed some responses to climate change, but which need to consider a broader/fuller range of responses;
- Organisations which are beginning to consider climate change across most of their climate-sensitive decisions;
- Advanced organisations who are experimenting with new ways to use data, information, and knowledge to enhance their climate-related decisions, climate change resilience or adaptive capacity, and take advantage of opportunities.

This provides a basis for collaboratively co-designing and co-developing the services to be provided, to enable learning and to ensure the services developed are tailored to meet the requirements of climate service users with respect to climate-informed decision-making. It also ensures that climate services are consistent with climate services users' needs and capabilities.

The climate services that a climate service user requires are particular to a given organisation, their needs with respect to climate-informed decision-making, and the policy and legislative environment in which they are operating. This includes using the data, information or knowledge provided.

Due to the inherent complexities and resource requirements needed to develop responses to climate, the climate service user is responsible for communicating as accurately as possible their specific data, information, and knowledge requirements.

*Note: The climate service user's needs may not always be apparent to themselves.*

Climate service providers shall not make false claims to climate service users about how effective their service is in meeting the climate service user's needs. The climate service provider should suggest alternative services where their service is not the most appropriate that they are aware of. The cost of alternatives may be conveyed in this communication to assist the climate service user in understanding the cost and benefits of their options commensurate to their resources.

*NOTE: The climate service provider can assume that the following information provided by the climate service user represents their needs and capacities:*

- *the intended use and objective for the information provided;*
- *the requirements they have for integrating this information with other information and implementation processes;*
- *the timeframe under consideration;*
- *the risk appetite;*
- *the tolerance / approach for management of uncertainty;*
- *the capability of the organisation to make climate-informed decisions;*
- *the complexity of the climate-informed decisions for which the service is being used. For example, the number of interdependencies with other data sets and decisions, or the length of decision lifespans involved.*

## 8 Data Sources

### 8.1 General

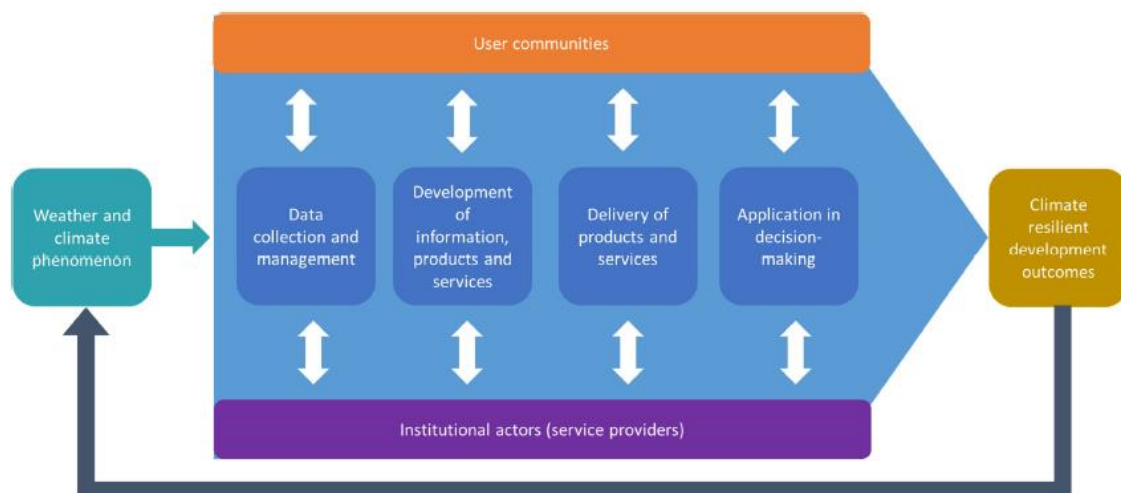
There are increasing levels of processing that make data and other forms of learning progress from raw data to information, and from information to relevant, usable, legitimate, and credible knowledge.

The ultimate goal of climate services is the delivery of relevant, usable, legitimate and credible 'knowledge' that can support action in a demonstrable value-added manner. Climate service providers can undertake some or all of the steps that translate basic climate data into information, knowledge and action.

The types of data and information that climate service users use can include:

- Basic climate data;
- Services related to delivery of digitized climate data, which may include data presented in mapped format, requiring expert climate and data processing knowledge for further use;
- Climate data or related information that is interpretable by climate service users competent in their own field with the aid of external support from climate experts;
- Climate data or related information that is readily integrated into decision-making and implementation processes by climate service users competent in their own field without external support;
- Information derived from processed climate data that can be understood by non-experts, e.g., via tables and charts.

Figure 1 illustrates a concept showing different stages of data, information and knowledge and climate resilient outcomes as a value chain. Providers and users of climate services can interface across any part of the value chain, but the types of support provided at each interface can be different depending upon climate service user needs and climate service provider capabilities.



**Figure 1. Concept diagram illustrating the 'value chain' for climate services** (image adapted from the World Bank's *E-Platform on Weather and Climate Services for Resilient Development: A Guide for Practitioners and Policy Makers* (<https://olc.worldbank.org/content/e-platform-weather-and-climate-services-resilient-development-guide-practitioners-and-poli-2>))

Climate service providers shall ensure data and information are accompanied by adequate advice as to how it is or is not intended to be used. These details should be co-developed by working with climate service users to validate their utility and added value ensuring that they include the

necessary details of the data used, its provenance, suitability, completeness, associated uncertainty and the methodologies used to produce it.

Climate service providers shall make their data, information, or knowledge available such that it is relevant, usable, legitimate, credible, and consistent with enabling the targeted decision making and implementation by the intended climate service user. One set of principles is known as FAIR<sup>1</sup> (Findable, Accessible, Interoperable, and Reusable by people and computers) and climate service providers should aim to incorporate the principles of FAIR.

To achieve FAIR services, climate service providers should ensure alignment with Spatial Data Infrastructure (SDI) approaches in situations where location-based information is part of the services being provided. Concepts outlined in the United Nations Committee of Experts on Global Geospatial Information Management's Integrated Geospatial Information Framework<sup>2</sup> offer a good summary of SDI approaches.

FAIR principles can be extended to cloud computing environments to ensure interoperability of data and processes between cloud computing systems. The European Space Agency's Earth Observation Exploitation Platform Common Architecture<sup>3</sup> provides a common framework for working with earth observation data consistently between different platforms.

## 9 Timeframes

### 9.1 Aligning Timeframes to Climate Service User's Needs

The climate service provider should work in collaboration with the climate service user to determine which timeframes are most relevant to the climate service user's needs. Within decision-making and implementation processes, timeframes are one of the most important indicators of whether a climate service meets a climate service user's needs. Not all users will require the same types of data, information, and knowledge.

In recognition of this complexity, the climate service provider should align its services to the climate service user's actionable timeframe: how much the climate change risks they face are likely to change over the life of the climate service user's identified decisions and actions.

Timeframe is context specific and descriptions should include one or more of the following:

- Current/ past timeframes;
- Seasonal/ multi-year timeframes;
- Long-range timeframes.

### 9.2 Timeframes of adaptation decisions and actions

Planning and implementation activities cover multiple timeframes. These can include:

- Decisions and action timeframes of less than five years requiring current and historical climate data and information, including trends, to ensure the climate service user is up to date with current weather patterns and extremes and their respective impacts. These types of data and information tend to be relatively easily understood by climate service users.

*Note: Many organisations are unaware that they have been relying upon weather and climate data that do not reflect current climatic conditions and their trends.*

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<sup>1</sup> <https://www.go-fair.org/fair-principles/>

<sup>2</sup> <https://ggim.un.org/IGIF/>

<sup>3</sup> <https://eoepca.org/>

- Decisions and action timeframes of between 5 and 20 years requiring current and historic climate data as well as future climate change projections and information. This latter type of information requires experience in interpretation or translation into relevant, usable and legitimate information and in integrating it with other non-climate information that is part of decision-making and implementation processes.
- Decisions and actions of between 20 and 50 years requiring significant support in interpreting climate projections and scenarios depending on the capability of the climate service user to understand the data and information provided. This data and information is likely to have impacts and levels of uncertainty that require a high level of specialist expertise to identify and translate those uncertainties so that they can be effectively integrated into decision-making and implementation processes.
- Decisions and actions lasting over 50 years likely to require the capacity to manage significant levels of uncertainty and will require high levels of expertise to interpret climate services for this timescale. The capability and technical capacity of the climate service user organisation becomes increasingly important here, as the climate service provider, either internal or external, will also have to communicate this data and information in various ways to different target audiences. Detailed data and information used by technical experts in the user group is more likely to be co-developed with the climate service provider and to be accompanied with more generic, high-level and usable messaging of the complex data and information.

Climate service providers should provide detailed information at the correct timeframe, with longer-term trends being expressed in appropriate (relevant and usable) terms.

## **I0 Communicating Uncertainty**

Climate service providers shall:

- Include appropriate descriptions of uncertainties considering the capacity and intended actions of the climate service user;
- Co-design with the climate service user the information on uncertainty to be included with the intention of describing the uncertainty as clearly as possible and in terms that are relevant and usable (as well as credible) to the climate service user's decision-making. For example, emphasising the implications in relation to the expected use case.

Uncertainties may derive from, for example, uncertainty about future emissions pathways (e.g. socio-political trends regionally and globally-influencing GHG emissions), technical issues (e.g. unclear thresholds), structural uncertainty (e.g. inherent design attributes in methodologies, tools and software), knowledge uncertainty (e.g. gaps in scientific knowledge about climate systems), or parameter uncertainty (e.g. limitations of modelling).

*Note: This may mean that climate service providers need to perform additional analysis in order to characterise uncertainty beyond what the climate service user thinks they need and to translate the information to ensure relevance and usability.*

## **I I Methods and Approaches**

### **I I.1 Co-development**

Climate services shall be co-developed between the climate service user and the climate service provider.

Climate service providers shall tailor their offer of services to the level appropriate for the climate service user considering the requirements and recommendations as set out in prior sections 6, 7, 8, 9 and 10.

*Note: Climate services that are offered too high above or too low beneath the climate service user's capability to interpret and use the data and information are of little to no value from the perspective of the user.*

The provision of data, information or knowledge is an iterative process that begins with understanding the climate service users' needs from the outset; a process that enables the products and services to evolve as the climate service user's needs and capacities evolve. The outcome of this evolution can be the provision of different climate services. Where contractual obligations prevent ongoing iterations (e.g. once a contract has been agreed), the climate service provider may recommend more appropriate climate services to the climate service user.

The iterative knowledge exchange process can identify when the climate service user's needs change, or when there has been a change in the data, information or knowledge previously provided or when the climate service can be improved to better inform their decision-making and implementation processes.

The number of iterations, and the time between periodic reviews can be determined collaboratively between climate service users and climate service providers (e.g., with an agreed value proposition).

The process should include more general feedback from the climate service user to the climate service provider, to enable continuous improvement of the service. This includes improvements to the information, the guidance that accompanies it, and the associated data/ information (for example metadata).

### **I I.2 Documentary evidence**

Climate service providers shall evidence their assessment of the climate service user's needs by documenting:

- The working and results of the assessment processes that are used to decide on the appropriate data, information, or knowledge (timeframe and capability), including any assumptions made during the assessment processes.
- The details of staff involved in the assessment processes including their roles, responsibilities, qualifications, skills, and experience.
- The basis for the decisions taken in relation to the needs, capacities and contexts of the intended climate service user(s) and to the related state of the science.
- The details and results of the co-development of the value proposition.
- The date and expected use case, together with details of data to be integrated with the information provided through the climate service (for example: temporal / spatial resolutions);

- The nature and scope of collaboration / engagement involving the climate service user or user group across the design, development and evaluation processes.

This evidence shall be shared with the climate service user and shall be sufficient to support auditing procedures (see Clause 13.5). This should include documentary evidence of the process by which the information that is needed is created.

## 12 Accessibility

Climate service providers shall communicate and appropriately translate the service offered to the service users and user groups so as to enhance relevance and usability.

Climate service providers shall follow accessibility legislation, including access for those with disabilities such as colour-blindness or avoiding content that cannot be navigated using a keyboard.

Charts, graphs, and maps shall be assessed for ambiguity and potential for misinterpretation by users of different capabilities.

Climate service providers shall ensure their services do not cause nor exacerbate inequities.

Climate service providers shall consider additional dimensions of accessibility when providing services – such as approachability, acceptability, availability, affordability, and appropriateness – and accommodate these where necessary.

Guidance on additional dimensions of accessibility:

- **Approachability** - climate service providers should make their services known across social or geographical contexts. Communications and outreach to service users and user groups is relevant and usable. Exclusionary, manipulative, careless, or confusing language is avoided. The use of jargon should be kept to a minimum, offering meaningful interpretation where jargon is unavoidable, to make the services more approachable.
- **Acceptability** - climate service providers should ensure their services respond to the unique needs of different climate service users and user groups, such as those belonging to racialized, socioeconomically disadvantaged, and/or other marginalized and vulnerable populations. Since different service users and user groups are informed by different worldviews and norms (e.g., technocentric versus ecocentric, economic outcomes versus social outcomes), the nature of the service shall meet their needs and definitions of appropriateness.
- **Availability** - climate service providers should offer services in manners that can be reached. This can include facility characteristics (e.g., building accessibility), geographic characteristics (e.g., distribution, transit availability), modes of delivery (e.g., virtual consultations) and flexibility of meeting times.
- **Affordability** - climate service providers should consider initial and ongoing direct costs, indirect costs, and lost opportunity costs to service users and user groups when pricing, designing, and providing their services.
- **Appropriateness** - climate service providers should provide timely, effective services that meet the needs of the intended service users and user groups. For example, services offered address current and future capacity and resources to implement and maintain the suggested solutions, reflect goals and worldviews, allow for engagement and co-development, etc.

## **13 Benchmarking**

### **13.1 Purpose of benchmarking**

Climate service providers who can demonstrate their offerings meet this standard in an auditable way can support the climate service user in selecting the service that best suits their requirements. Climate service users can commission climate services with confidence that the services offered will match their needs, the climate service provider having been verified as able to supply these services to the quality levels set out in this standard.

*Note ISO 19011 Guidelines for auditing management systems - provides principles on integrity, presentation, due professional care, confidentiality, independent verification, evidence-based approaches and risk-based approaches to undertaking audits.*




## Annex A (Informative)

### Worked Example 1 – Environment Agency flood risk allowances for climate change

This worked example has been prepared by JBA, Climate Sense, with review and support from the Environment Agency. Details of the climate service can be found here: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Standard section	Clause within standard	Compliance type	How service complies with the standard
5. External and Internal Climate Services	Competent experts <b>shall</b> be used to develop climate services, whether climate services are sourced externally or internally.	Requirement	<p>Allowances have been developed by competent persons within the Environment Agency and based on trusted science from UKCP18 and commissioned research such as from UKCEH and Met Office/Newcastle University to derive allowances for sea level rise, peak river flow and peak rainfall. .</p> <p>Allowances are updated and monitored by the same team that developed them.</p>
6. Alignment Between Provider and User	The climate service provider should ensure that the service provided remains closely aligned with the climate service user’s ability to understand what to do with the information, and the complexity (or simplicity) of the decisions that need to be informed.	Recommendation	<p>Care has been taken to ensure the information provided is understandable by the target audience (e.g. developers, local planning authorities, flood risk management authorities and consultants working for these organisations), for example:</p> <p>“Climate change allowances are predictions of anticipated change for:</p> <ul style="list-style-type: none"> <li>• peak river flow</li> <li>• peak rainfall intensity</li> <li>• sea level rise</li> <li>• offshore wind speed and extreme wave height</li> </ul> <p>To increase resilience to flooding and coastal change, you should make allowances for climate change in your flood risk assessment.</p> <p>There are allowances for different climate scenarios over different epochs, or periods of time, over the coming century. They include figures for extreme climate change scenarios.”</p> <p>The guidance provides simple allowances (% uplifts in flow or rainfall intensity or mm increase in annual sea level rise) that can be applied to flood risk assessments and an explanation of which allowances to use based on the development type and lifetime.</p>

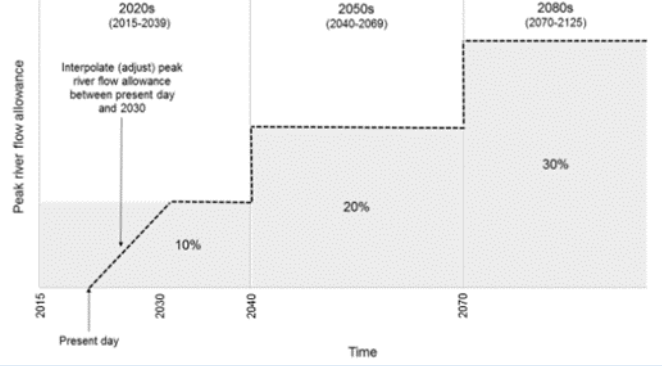
Standard section	Clause within standard	Compliance type	How service complies with the standard
	The climate services provider shall ensure services are easily accessible and understandable to the intended climate service users.	Requirement	<p>We have also provided briefings to explain how the allowances relate to future climate change scenario (4oC by 2100).</p> <p>As above, considerable care has been taken to ensure the information provided is understandable by the target audience (e.g. developers, flood risk management authorities and consultants working for these organisations), for example:          “This guidance is for:</p> <ul style="list-style-type: none"> <li>• local planning authorities preparing strategic flood risk assessments</li> <li>• developers and their agents preparing flood risk assessments for planning applications, and development consent orders for nationally significant infrastructure projects</li> </ul> <p>Making allowances for climate change in your flood risk assessment will help minimise vulnerability and provide resilience to flooding and coastal change.”</p> <p>The guidance provides simple allowances (% uplifts in flow or rainfall intensity or mm increase in annual sea level rise) that can be applied to flood risk assessments and an explanation of which allowances to use based on the development type and lifetime. This means they are easy for flood risk modellers to use and simple for local authorities and developers to check if the right allowance has been used.</p>
	Resource constraints of climate service users should be taken into consideration when designing services.	Recommendation	<p>The following aspects demonstrate constraints of users have been taken into account:</p> <ol style="list-style-type: none"> <li>i) Language used is non-technical as far as possible and so accessible to assumed audience</li> <li>ii) There is a practical and low-effort approach to uncertainty management – using a ‘central’ and ‘upper end’ estimate for peak rainfall and a central, higher central and upper end allowance for peak river flows</li> <li>iii) There are links to maps of peak river flow allowances by catchment to make accessing the allowances easy</li> </ol>
	<p>In assessing the climate service user’s needs the climate service provider shall establish:</p> <ul style="list-style-type: none"> <li>• Decisions that climate service users are making that the service is intended to inform;</li> <li>• The climate service user's decision-making and implementation processes;</li> </ul>	Requirement	<p>Providing formats that are specific to areas such as management catchments:</p>

Standard section	Clause within standard	Compliance type	How service complies with the standard
	<ul style="list-style-type: none"> <li>• The format of the information needed;</li> <li>• The frequency of updates needed and on what basis;</li> <li>• Temporal resolutions beyond timeframe e.g. annual data breakdown over the timeframe;</li> <li>• The geographical location and spatial resolution needed;</li> <li>• Which climate services are needed by the climate service user to meet their data and information needs. This includes understanding the variables, metrics and indicators required;</li> <li>• Whether the climate service provider can deliver in a manner that demonstrates added value to the user: the data and information consistent with the climate service users' needs and capacities, and any strengths and limitations of their offering (including relevant timeframes, locations and availability of data and information); and,</li> <li>• The climate service user's capability to undertake climate-informed decisions and their implementation.</li> </ul>		 <p>Allowances are based on projections to specific time slices (decades or multiple decades). These are adequate for user needs.</p> <p>Geographical location is well covered through map or description of regions affected by different allowance values. Forthcoming peak rainfall allowances changes will be location specific, rather than generic for all England.</p> <p>Metrics and variables are well understood by the service provider:</p> <ul style="list-style-type: none"> <li>• Peak flow and rainfall allowances are a percentage increase to be applied to the FEH design storm or hydrograph for different future time periods</li> <li>• Sea level rise allowances are in millimetres for different future time periods</li> <li>• offshore wind speed and extreme wave height allowances are percentages to apply in simulation models for different future time periods</li> </ul> <p>Efforts are made to show the target audience is understood by helping the audience access the right information for different user needs, e.g.:</p> <ul style="list-style-type: none"> <li>• “Assess both the central and higher central allowances for strategic flood risk assessments.</li> <li>• In flood zones 2 or 3a for: <ul style="list-style-type: none"> <li>• essential infrastructure – use the higher central allowance</li> <li>• highly vulnerable – use central allowance (development should not be permitted in flood zone 3a)</li> <li>• more vulnerable – use the central allowance</li> <li>• less vulnerable – use the central allowance</li> </ul> </li> </ul>

Standard section	Clause within standard	Compliance type	How service complies with the standard
			<ul style="list-style-type: none"> <li>• water compatible – use the central allowance</li> </ul> <p>In flood zone 3b for:</p> <ul style="list-style-type: none"> <li>• essential infrastructure – use the higher central allowance</li> <li>• highly vulnerable – development should not be permitted</li> <li>• more vulnerable – development should not be permitted</li> <li>• less vulnerable – development should not be permitted</li> <li>• water compatible – use the central allowance”</li> </ul>
	<p>Climate service providers shall not make false claims to climate service users about how effective their service is in meeting the climate service user’s needs. The climate service provider should suggest alternative services where their service is not the most appropriate that they are aware of. The cost of alternatives may be conveyed in this communication to assist the climate service user in understanding the cost and benefits of their options commensurate to their resources.</p>	Requirement	<p>No evidence that false claims are made and all allowance values are drawn from UKCPI8 or related, peer reviewed research.</p>
	<p>The climate service provider <b>should</b> suggest alternative services where their service is not the most appropriate that they are aware of.</p>	Recommendation	<p>In this service it is not appropriate to suggest alternative services since England needs to have one set of allowances for flood risk and multiple services providing different values would lead to confusion.</p>
	<p>Capability considerations should include: Organisations that are just beginning to consider climate variability and changes without any prior knowledge of the topic;</p> <ul style="list-style-type: none"> <li>• Organisations beginning work on climate variability and change, which have developed some responses to climate change, but which need to consider a broader/fuller range of responses;</li> <li>• Organisations which are beginning to consider climate change across most of their climate-sensitive decisions;</li> </ul>	Requirement	<p>The service indicates at the start who its audience is: “This guidance is for:</p> <ul style="list-style-type: none"> <li>• local planning authorities preparing strategic flood risk assessments</li> <li>• developers and their agents preparing flood risk assessments for planning applications, and development consent orders for nationally significant infrastructure projects”</li> </ul> <p>The allowances have been produced such that they understandable and can be implemented by this user group.</p> <p>The guidance is written following Government Digital Service writing style requirements that ensure it is clear and understandable for the intended audience.</p>

Standard section	Clause within standard	Compliance type	How service complies with the standard
	<ul style="list-style-type: none"> <li>Advanced organisations who are experimenting with new ways to use data, information, and knowledge to enhance their climate-related decisions, climate change resilience or adaptive capacity, and take advantage of opportunities.</li> </ul>		
	The climate service provider should suggest alternative services where their service is not the most appropriate that they are aware of.	Recommendation	N/A
	These details should be co-developed by working with climate service users to validate their utility and added value ensuring that they include the necessary details of the data used, its provenance, suitability, completeness, associated uncertainty and the methodologies used to produce it.	Recommendation	<p>We are aware that this service has been co-developed by its user community as the Environment Agency has consulted and worked with hydrologists, engineers and planners in developing these allowances. It may be useful for the service to clarify that it has been co-developed through years of consultation and iterations.</p> <p>When the EA update the guidance they explain in supporting briefings who they have consulted with. The EA always consult with customers groups – e.g. they did a workshop in Dec 2019 to explore the peak river flow update options with LPAs and consultants and we consulted with Lead Local Flood Authorities (they are responsible for surface water flooding and drainage) when updating the Peak Rainfall allowances. This consultation has informed the EA’s approach to providing allowances, responding to feedback to keep the allowances as simple as possible.</p>
	Climate service providers shall make their data, information, or knowledge available such that it is relevant, usable, legitimate, credible, and consistent with enabling the targeted decision making and implementation by the intended climate service user.	Requirement	<p>The guidance is written following Government Digital Service writing style requirements that ensure it is clear and understandable for the intended audience.</p> <p>Clear, appropriate language is used in the service. An example is:  “When to use climate change allowances  The Environment Agency uses climate change allowances when they provide advice on flood risk assessments and strategic flood risk assessments.  Exceptions – when it might be appropriate to use other data or allowances  There may be circumstances where local evidence supports using other data or allowances. For example, the impact of climate change on peak river flow may not be the same for all rivers in a management catchment.  The Environment Agency may want to check how and why you used other data in your plans and proposals.”</p>

Standard section	Clause within standard	Compliance type	How service complies with the standard																														
<p>9. Timeframes</p>	<p>The climate service provider should work in collaboration with the climate service user to determine which timeframes are most relevant to the climate service user's needs.</p>	<p>Recommendation</p>	<p>For all allowances (fluvial flow, peak rainfall, sea level rise) there are allowances provided for the timeframe that is applicable to users. For example, for peak rainfall:</p> <p>Table 2: sea level allowances by river basin district for each epoch in mm for each year (based on a 1981 to 2000 baseline) – the total sea level rise for each epoch is in brackets</p> <table border="1" data-bbox="1137 327 1664 571"> <thead> <tr> <th>Area of England</th> <th>Allowance</th> <th>2000 to 2035 (mm)</th> <th>2036 to 2065 (mm)</th> <th>2066 to 2095 (mm)</th> <th>2096 to 2125 (mm)</th> <th>Cumulative rise 2000 to 2125 (metres)</th> </tr> </thead> <tbody> <tr> <td>Anglian</td> <td>Higher central</td> <td>5.8 (203)</td> <td>8.7 (261)</td> <td>11.6 (348)</td> <td>13 (390)</td> <td>1.20</td> </tr> </tbody> </table> <p>The allowances are applied based on the lifetime of the development so in using them they should be considered resilient to CC for its lifetime.</p> <p>Users of flood risk allowances are concerned with a range of future planning horizons from present day (2022), 2030 and on to 2125 or beyond for sea level rise. This climate service provides allowances for these future dates and indicates which baseline date is being used so that it can be used for any year of interest.</p> <p>Timeframes for the allowances are clearly stated in each of the allowance types (fluvial flow, peak rainfall, sea level rise), e.g.:</p> <div data-bbox="1137 917 1556 1177"> <p><b>East Devon Management Catchment peak river flow allowances</b></p> <table border="1"> <thead> <tr> <th></th> <th>Central</th> <th>Higher</th> <th>Upper</th> </tr> </thead> <tbody> <tr> <td>2020s</td> <td>16%</td> <td>22%</td> <td>34%</td> </tr> <tr> <td>2050s</td> <td>24%</td> <td>33%</td> <td>55%</td> </tr> <tr> <td>2080s</td> <td>46%</td> <td>61%</td> <td>96%</td> </tr> </tbody> </table> </div> <p>Timeframes have been provided  User capability has also been considered  Ease of use diagrams such as the one below help communicate the way to apply the allowances:</p>	Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)	Anglian	Higher central	5.8 (203)	8.7 (261)	11.6 (348)	13 (390)	1.20		Central	Higher	Upper	2020s	16%	22%	34%	2050s	24%	33%	55%	2080s	46%	61%	96%
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Standard section	Clause within standard	Compliance type	How service complies with the standard
			
	<p>In recognition of this complexity, the climate service provider should align its services to the climate service user’s actionable timeframe: how much the climate change risks they face are likely to change over the life of the climate service user’s identified decisions and actions.</p>	Requirement	<p>The service indicates at the start who its audience is:          “This guidance is for:</p> <ul style="list-style-type: none"> <li>• local planning authorities preparing strategic flood risk assessments</li> <li>• developers and their agents preparing flood risk assessments for planning applications, and development consent orders for nationally significant infrastructure projects”</li> </ul> <p>The allowances have been produced such that they understandable and can be implemented by this user group.</p>
	<p>Timeframe is context specific and descriptions should include one or more of the following:</p> <ul style="list-style-type: none"> <li>• Current/ past timeframes;</li> <li>• Seasonal/ multi-year timeframes;</li> <li>• Long-range timeframes.</li> </ul>	Recommendation	<p>Long-range timeframes are used. The service is clear on the timeframes for which the allowances apply.</p>
<p>10. Communicating Uncertainty</p>	<p>Climate service providers <b>shall</b>:          Include detailed descriptions of uncertainty that are appropriate to the capacity and intended actions of the user.</p>	Requirement	<p>Uncertainty in the climate model projections giving rise to the allowances is managed through using two, three or four possible allowance values, referring to these in user-friendly terminology, such as ‘central’ or ‘upper end’. This text shows how peak flow allowances uncertainty is managed:          “The range of allowances is based on percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flow fall below it, and half fall above it.          The:</p> <ul style="list-style-type: none"> <li>• central allowance is based on the 50th percentile</li> </ul>

Standard section	Clause within standard	Compliance type	How service complies with the standard																				
			<ul style="list-style-type: none"> <li>• higher central allowance is based on the 70th percentile</li> <li>• upper end allowance is based on the 95th percentile”</li> </ul> <p>Users are then given guidance as to which allowance value to use from the uncertainty range, in which the higher the vulnerability, the higher the allowance estimate to use. For example:  “essential infrastructure – use the higher central allowance  highly vulnerable – use central allowance (development should not be permitted in flood zone 3a)  more vulnerable – use the central allowance”</p>																				
	<p>Climate service providers <b>shall</b>:</p> <ul style="list-style-type: none"> <li>• Co-design with the climate service user the information on uncertainty to be included with the intention of describing the uncertainty as clearly as possible and in terms that are relevant and usable (as well as credible) to the climate service user's decision-making. For example, emphasising the implications in relation to the expected use case.</li> </ul>	Requirement	<p>Climate uncertainty sizes (magnitudes) are captured in the range of allowance estimates provided, as shown in the example below for sea level rise allowances in one area (Anglian):</p> <table border="1" data-bbox="1137 639 1720 866"> <thead> <tr> <th>Area of England</th> <th>Allowance</th> <th>2000 to 2035 (mm)</th> <th>2036 to 2065 (mm)</th> <th>2066 to 2095 (mm)</th> <th>2096 to 2125 (mm)</th> <th>Cumulative rise 2000 to 2125 (metres)</th> </tr> </thead> <tbody> <tr> <td>Anglian</td> <td>Higher central</td> <td>5.8 (203)</td> <td>8.7 (261)</td> <td>11.6 (348)</td> <td>13 (390)</td> <td>1.20</td> </tr> <tr> <td>Anglian</td> <td>Upper end</td> <td>7 (245)</td> <td>11.3 (339)</td> <td>15.8 (474)</td> <td>18.1 (543)</td> <td>1.60</td> </tr> </tbody> </table> <p>The sources of uncertainty (e.g. natural variability, structural model uncertainty, SRES uncertainty) are not described. It could be appropriate for the service to link to a document that describes uncertainty sources should users wish to have more information on why there are ranges of allowances for each time period and not just one value provided.</p> <p>However, a supporting Q+A document is available to EA staff that provides answers to a range of questions, including uncertainty. There are used to answer customer questions, which can be submitted via a link of the gov.uk page or to area teams. The EA also take opportunities to present to climate service users about the allowances and educate them on where they came from and sharing explanations in briefings and slide packs.</p> <p>Government Digital Services publishing requirements are strict about what the EA can publish and hence not possible to put these documents on gov.uk. EA also have to be mindful that climate service users may find this information confusing, thus providing it on a needs basis feels the best way to share additional explanatory information.</p>	Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)	Anglian	Higher central	5.8 (203)	8.7 (261)	11.6 (348)	13 (390)	1.20	Anglian	Upper end	7 (245)	11.3 (339)	15.8 (474)	18.1 (543)
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<b>11. Methods and Approaches (11.1 Co-development)</b>	Climate services shall be co-developed between the climate service user and the climate service provider.	Requirement	We are aware that this service has been co-developed by its user community as the Environment Agency has consulted and worked with hydrologists, engineers and planners in																				



Standard section	Clause within standard	Compliance type	How service complies with the standard
			<p>developing these allowances. It may be useful for the service to clarify that it has been co-developed through years of consultation and iterations.</p> <p>In the case of this service, the users are not dictating when they need changes; rather the science has improved since the first allowances in 2006 and this has resulted in research that has improved the allowances: improved by making more specific to local changes, and using new estimates of change, for example, in peak rainfall estimates from convection-permitting climate modelling.</p> <p>Updates to the allowances are driven by changes to the science; however, the EA respond to climate service user feedback by iteratively updating how the guidance explains how to apply the climate change allowances so they are easy for climate service users to use.</p>
	Climate service providers shall tailor their offer of services to the level appropriate for the climate service user considering the requirements and recommendations as set out in prior sections 6, 7, 8, 9 and 10.	Requirement	<p>There is evidence this is considered throughout by the use of language (non-technical, though appropriately detailed for the intended user group), the use of tables of allowance data as well as map-based tools that provide an additional, easy to use method for obtaining the values, and clear information on how to use higher allowances for more vulnerable developments.</p> <p>Legitimacy: the service indicates allowances have been based on percentiles from UKCP18 data, and hyperlinks UKCP18 to the UKCP18 web page, for the peak river flow and sea level rise allowances. It does not state the origin of the peak rainfall allowances (though we are aware these will be updated in 2022 and are likely to detail the origin of the values used.)</p>
	The process should include more general feedback from the climate service user to the climate service provider, to enable continuous improvement of the service.	Recommendation	Updates are made when new science indicates it should be. When the EA do this they alert climate service users that the update is being made and provide transitional guidance to ensure updates don't have a big impact on users and their development proposals.
<b>11. Methods and Approaches (11.2 Documentary evidence)</b>	<p>Climate service providers shall evidence their assessment of the climate service user's needs by documenting:</p> <ul style="list-style-type: none"> <li>The working and results of the assessment processes that are used to decide on the appropriate data, information, or knowledge (timeframe and capability), including any assumptions made during the assessment processes.</li> </ul>	Requirement	<p>The EA ran events with climate service users (LPAs, Consultants, Govt depts) in:</p> <ul style="list-style-type: none"> <li>2015 ahead of 2016 publication of the guidance (transitioning from Govt ownership of the climate change allowances).</li> <li>2018 to get feedback on how the 2016 allowances guidance was working ahead of UKCP18 being published.</li> <li>2019 to get feedback on how to use peak river flow research (based on UKCP18) to update the allowances.</li> </ul>

Standard section	Clause within standard	Compliance type	How service complies with the standard
	<ul style="list-style-type: none"> <li>The details of staff involved in the assessment processes including their roles, responsibilities, qualifications, skills, and experience.</li> <li>The basis for the decisions taken in relation to the needs, capacities and contexts of the intended climate service user(s) and to the related state of the science.</li> <li>The details and results of the co-development of the value proposition.</li> <li>The date and expected use case, together with details of data to be integrated with the information provided through the climate service (for example: temporal / spatial resolutions);</li> <li>The nature and scope of collaboration / engagement involving the climate service user or user group across the design, development and evaluation processes.</li> </ul>		<ul style="list-style-type: none"> <li>During Dec 2021-March 2022 we held a series of meetings with representatives of LLFAs and flood risk consultants (via ASA and CIRIA SusDrain) to explore how to use peak rainfall research (based on UKCP Local) to update the allowances.</li> </ul> <p>The EA also respond to climate service user feedback submitted via the feedback button on the guidance</p>
	This evidence shall be shared with the climate service user and shall be sufficient to support auditing procedures (see Clause 13.5).	Requirement	See above - compliant
	This should include documentary evidence of the process by which the information that is needed is created.	Recommendation	See above - compliant
<b>12. Accessibility</b>	Climate service providers shall communicate and appropriately translate the service offered to the service users and user groups so as to enhance relevance and usability.	Requirement	Met through evidence of addressing user need

Standard section	Clause within standard	Compliance type	How service complies with the standard
	Climate service providers shall communicate and appropriately translate the service offered to the service users and user groups so as to enhance relevance and usability.	Requirement	
	Charts, graphs, and maps shall be assessed for ambiguity and potential for misinterpretation by users of different capabilities.	Requirement	
	Climate service providers shall ensure their services do not cause nor exacerbate inequities.	Requirement	
	Climate service providers shall consider additional dimensions of accessibility when providing services – such as approachability, acceptability, availability, affordability, and appropriateness – and accommodate these where necessary.	Requirement	

## Annex B

### (Informative)

### Worked Example 2 – UK Water Industry Research (UKWIR) RED-UP climate change perturbation tool

This climate service was funded by UK Water Industry Research (UKWIR).

Standard section	Clause within standard	Compliance type	How service complies with the standard
5. External and Internal Climate Services	Competent experts <b>shall</b> be used to develop climate services, whether climate services are sourced externally or internally.	Requirement	RED-UP (the climate service) has been developed by two Chartered Meteorologists and by Sewer Modelling experts, including leading members of the CIWEM Urban Drainage Group. The staff are highly competent in the understanding of climate science, hydrometeorology and use of UKCPI8 projection data.
6. Alignment Between Provider and User	The climate service provider should ensure that the service provided remains closely aligned with the climate service user’s ability to understand what to do with the information, and the complexity (or simplicity) of the decisions that need to be informed.	Recommendation	<p>Users have been involved in co-developing the service. The service originated in 2014 in the first UKWIR commission (17/CL/10/17) and since the outset and service design it has engaged with users: the two UKWIR projects in which this service have been developed have established Project Steering Groups, made up of industry experts representing all the major UK water and sewerage companies (WaSCs). These groups have provided informed comment on the need for the service, the problems the industry are facing that need to be solved by the service and the desired ‘look and feel’ of the service such that it is easy to use and informative. Additionally: of the service such that it is easy to use and informative. Additionally:</p> <ul style="list-style-type: none"> <li>• A User Guide has been developed to accompany the service to make it easier to use</li> <li>• A questionnaire was put to all WaSCs to consulta on some key choices for the service, thereby allowing a wide range of user requirements to be understood and addressed.</li> </ul> <p>The service is freely available to all members of UKWIR (which includes all target users). The service is downloadable from the UKWIR website.</p>
	The climate services provider shall ensure services are easily accessible and understandable to the intended climate service users.	Requirement	
	Resource constraints of climate service users should be taken into consideration when designing services.	Recommendation	
7. Assessing User Needs	<p>In assessing the climate service user’s needs the climate service provider shall establish:</p> <ul style="list-style-type: none"> <li>• Decisions that climate service users are making that the service is intended to inform;</li> </ul>	Requirement	Timeframes for which the service provides outputs have been developed through both user need (the requirements of the urban drainage community, e.g. Drainage and Wastewater Management Plans – DWMPs) and time horizons of the UKCPI8 outputs – 2021-2040 and 2061-2080. The key industry date of 2050 sits between the two UKCPI8 output examples and so the service uses the two UKCPI8 output horizons to derive estimates from the mid-point between these two time horizons (2050).

Standard section	Clause within standard	Compliance type	How service complies with the standard
	<ul style="list-style-type: none"> <li>• The climate service user's decision-making and implementation processes;</li> <li>• The format of the information needed;</li> <li>• The frequency of updates needed and on what basis;</li> <li>• Temporal resolutions beyond timeframe e.g. annual data breakdown over the timeframe;</li> <li>• The geographical location and spatial resolution needed;</li> <li>• Which climate services are needed by the climate service user to meet their data and information needs. This includes understanding the variables, metrics and indicators required;</li> <li>• Whether the climate service provider can deliver in a manner that demonstrates added value to the user: the data and information consistent with the climate service users' needs and capacities, and any strengths and limitations of their offering (including relevant timeframes, locations and availability of data and information); and,</li> </ul> <p>The climate service user's capability to undertake climate-informed decisions and their implementation.</p> <p>Climate service providers shall not make false claims to climate service users about how effective their service is in meeting the climate service user's needs. The climate service provider should suggest alternative</p>	Requirement	<p>The output timeframes were discussed with users and agreed at a workshop in September 2019.</p> <p>The format of the information required is in the format of a RED file (rainfall event data file) that is used by the industry standard software provider for sewer modelling software. This requirement was understood at the start of the service design process and was an important element of the co-design of the service with the user. If the service had not been aware of how the outputs of the service would be used in another modelling package, significant re-engineering would have been required. Co-design, co-development and co-testing of the service have all been undertaken.</p> <p>Update frequency is driven by either:</p> <ul style="list-style-type: none"> <li>• A step change in climate modelling science meaning that the climate service output information is considered to be sufficiently inaccurate because of new climate science to warrant an update, or</li> <li>• A step change in the requirement for the format of the service output</li> </ul> <p>There are mechanisms for UKWIR (the service funder) to be informed of such step changes through its members and to initiate a service update.</p> <p>The service is for future projections to 2070 at 1- or 2-minute temporal resolution.</p> <p>The climate service provider has determined that the data and information needed to develop it are available and has developed computer programming code to extract the data and analyse it as volumes are huge (8 TB of data). Data used are freely available UKCP Local 2.2km resolution data.</p> <p>In this situation there are no known alternatives to this service for perturbing rainfall time series to be representative of future climate conditions in the UK. The only alternative is to use UKCP Local data directly, but this has a number of downsides: it is hourly resolution and users need 2-minute resolution so disaggregation would be needed which introduces new uncertainties; the UKCP Local model output has an acknowledged 'wet bias' meaning that rainfall estimates may be over-estimated</p>

Standard section	Clause within standard	Compliance type	How service complies with the standard
	<p>services where their service is not the most appropriate that they are aware of. The cost of alternatives may be conveyed in this communication to assist the climate service user in understanding the cost and benefits of their options commensurate to their resources.</p>		<p>(this bias is eliminated to some degree by the RED-UP approach that uses change in the model output (anomalies) to inform the perturbation); users place trust in perturbing observed rainfall time series over use of entirely synthetic model output.</p>
	<p>Capability considerations should include:</p> <ul style="list-style-type: none"> <li>• Organisations that are just beginning to consider climate variability and changes without any prior knowledge of the topic;</li> <li>• Organisations beginning work on climate variability and change, which have developed some responses to climate change, but which need to consider a broader/fuller range of responses;</li> <li>• Organisations which are beginning to consider climate change across most of their climate-sensitive decisions;</li> <li>• Advanced organisations who are experimenting with new ways to use data, information, and knowledge to enhance their climate-related decisions, climate change resilience or adaptive capacity, and take advantage of opportunities.</li> </ul>		<p>All language used is designed to be understood by intended users. This includes the User Guide and the Guidance report. An example of appropriate language and terminology from the User Guide is:</p> <div data-bbox="1043 576 1955 911" style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <p><b>3 Quick-start — How do I Perturb a RED File?</b></p> <p>This section provides a basic step by step guide through the perturbation process using default settings. See other sections of this guide for more detail on each stage of the process and explanations of the options available.</p> <ol style="list-style-type: none"> <li>1. <b>Start tool:</b> Double-click on the tool executable to start the software: PerturbationTool.exe. <i>Note: you could set up a shortcut on your desktop for this file to provide quick access to the tool.</i></li> <li>2. <b>Select file to analyse:</b> The interface will start by prompting you to specify the RED file you want to analyse. A pop-up window will be displayed in front of the main interface:</li> </ol> </div> <p>Users who are involved in the co-production of this service have reviewed the User Guide and commented on any areas requiring greater clarity.</p>
	<p>The climate service provider should suggest alternative services where their service is not the most appropriate that they are aware of.</p>		<p>N/A</p>

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8. Data Sources	Climate service providers shall ensure data and information are accompanied by adequate advice as to how it is or is not intended to be used.	Requirement	The service (RED-UP) is detailed in the project's Technical Report and Guidance. These two documents provide supporting information around the use of the service to allow users to make informed decisions based on its output.
	These details should be co-developed by working with climate service users to validate their utility and added value ensuring that they include the necessary details of the data used, its provenance, suitability, completeness, associated uncertainty, and the methodologies used to produce it.	Recommendation	Users who are involved in the co-production of this service have reviewed the User Guide and commented on any areas requiring greater clarity.
	Climate service providers shall make their data, information, or knowledge available such that it is relevant, usable, legitimate, credible, and consistent with enabling the targeted decision making and implementation by the intended climate service user.	Requirement	<p>The latest version of this service (v3) allows users to derive climate information specific to their location, defined by UK WaSC boundaries. The users were consulted on this plan and are in agreement with it. This is a significant improvement over the prior versions of the service (v1 and v2) that used much smaller and less representative spatial areas from which to provide output.</p> <ul style="list-style-type: none"> <li>• Previous RED-UP used 90 1.5km<sup>2</sup> climate cells, one simulation only, one future epoch</li> <li>• New RED-UP using all UK land cells (2.2km), 12 simulations, two future epochs (5,500 times more data)</li> </ul> <p>This service is believed to be the first in the world of its type for deriving rainfall perturbations anywhere nationally using a convective permitting climate model.</p>
9. Timeframes	The climate service provider should work in collaboration with the climate service user to determine which timeframes are most relevant to the climate service user's needs.	Requirement	The service was first produced in 2017. Version 3 of the service is being produced in 2022 and provides significant advantages over its predecessor (detailed above). This periodicity of improvement is aligned with user need and the water industry asset management programme (AMP) that runs on a 5-year cycle. Future versions will align to this cycle where possible while being driven by step change improvements in the climate science.
	In recognition of this complexity, the climate service provider should align its services to the climate service user's actionable timeframe: how much the climate change risks they face are likely to change over the life of the climate service user's identified decisions and actions.	Requirement	The service was first produced in 2017. Version 3 of the service is being produced in 2022 and provides significant advantages over its predecessor (detailed above). This periodicity of improvement is aligned with user need and the water industry asset management programme (AMP) that runs on a 5-year cycle. Future versions will align to this cycle where possible while being driven by step change improvements in the climate science.

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	<p>Timeframe is context specific and descriptions should include one or more of the following:</p> <ul style="list-style-type: none"> <li>• Current/ past timeframes;</li> <li>• Seasonal/ multi-year timeframes;</li> <li>• Long-range timeframes.</li> </ul>	Recommendation	Long-range and current / past timeframes are used in the service.
10. Communicat ing Uncertainty	Climate service providers <b>shall:</b> Include detailed descriptions of uncertainty that are appropriate to the capacity and intended actions of the user.	Requirement	<p>The Technical Report and Guidance accompanying the climate service make clear the levels of uncertainty in the service outputs. For example:</p> <ol style="list-style-type: none"> <li>1. V3 of the service is now much better at capturing uncertainty as it is using 5,500 times more climate data to derive the change estimates</li> <li>2. UKCP Local uses only one Relative Concentration Pathway (RCP8.5) and therefore there is acknowledged uncertainty that other greenhouse gas emission pathways could occur and result in different changes to rainfall. Methods to manage this uncertainty are detailed in the reports.</li> </ol> <p>There are uncertainties related to the quality and record length of the input rainfall data that will affect the quality of the perturbed output data.</p>
11. Methods and approaches	Climate service providers <b>shall:</b> <ul style="list-style-type: none"> <li>• Co-design with the climate service user the information on uncertainty to be included with the intention of describing the uncertainty as clearly as possible and in terms that are relevant and usable (as well as credible) to the climate service user's decision-making. For example, emphasising the implications in relation to the expected use case.</li> </ul>	Requirement	<p>The Technical Report and Guidance accompanying the climate service make clear the levels of uncertainty in the service outputs. For example:</p> <ol style="list-style-type: none"> <li>1. V3 of the service is now much better at capturing uncertainty as it is using 5,500 times more climate data to derive the change estimates</li> <li>2. UKCP Local uses only one Relative Concentration Pathway (RCP8.5) and therefore there is acknowledged uncertainty that other greenhouse gas emission pathways could occur and result in different changes to rainfall. Methods to manage this uncertainty are detailed in the reports.</li> <li>3. There are uncertainties related to the quality and record length of the input rainfall data that will affect the quality of the perturbed output data.</li> </ol> <p>This service has been fully co-designed, co-developed, co-tested by the user and provider (as detailed above)</p> <p>The service was first produced in 2017. Version 3 of the service is being produced in 2022 and provides significant advantages over its predecessor (detailed above). This periodicity of improvement is aligned with user need and the water industry asset management programme (AMP) that runs on a 5-year cycle. Future versions will align to this cycle where possible while being driven by step change improvements in the climate science.</p>



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			<p>The Technical Report and Guidance accompanying the climate service make clear the levels of uncertainty in the service outputs. For example:</p> <ol style="list-style-type: none"> <li>1. V3 of the service is now much better at capturing uncertainty as it is using 5,500 times more climate data to derive the change estimates</li> <li>2. UKCP Local uses only one Relative Concentration Pathway (RCP8.5) and therefore there is acknowledged uncertainty that other greenhouse gas emission pathways could occur and result in different changes to rainfall. Methods to manage this uncertainty are detailed in the reports.</li> </ol> <p>There are uncertainties related to the quality and record length of the input rainfall data that will affect the quality of the perturbed output data.</p> <p>The Technical Report and Guidance accompanying the climate service make clear the levels of uncertainty in the service outputs. For example:</p> <ol style="list-style-type: none"> <li>1. V3 of the service is now much better at capturing uncertainty as it is using 15,000 times more climate data to derive the change estimates</li> <li>2. UKCP Local uses only one Relative Concentration Pathway (RCP8.5) and therefore there is acknowledged uncertainty that other greenhouse gas emission pathways could occur and result in different changes to rainfall. Methods to manage this uncertainty are detailed in the reports.</li> <li>3. There are uncertainties related to the quality and record length of the input rainfall data that will affect the quality of the perturbed output data.</li> <li>4. This service has been fully co-designed, co-developed, co-tested by the user and provider (as detailed above)</li> </ol>
	Climate service providers shall tailor their offer of services to the level appropriate for the climate service user considering the requirements and recommendations as set out in prior sections 6, 7, 8, 9 and 10.	Requirement	Staff developing the service and their credentials and qualifications were subject to a proposal submitted for review by the client (UKWIR) who appointed the service provider based on these staff's credentials. In the Technical Report and Guidance accompanying the service, all staff involved in the development of the service are listed at the start of the reports, including a statement of their role in the development of the service.

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	The process should include more general feedback from the climate service user to the climate service provider, to enable continuous improvement of the service.	Requirement	These needs and capacities of intended users were documented in a ‘Scoping Report’ that set out how the service would be developed. This included the results of a user consultation survey gaining consensus on some outstanding questions related to how the service would be developed. This document was signed off and remains as a record for detailing how the service would be developed to address users’ needs.
12. Accessibility	Climate service providers shall communicate and appropriately translate the service offered to the service users and user groups so as to enhance relevance and usability.	Requirement	These needs and capacities of intended users were documented in a ‘Scoping Report’ that set out how the service would be developed. This included the results of a user consultation survey gaining consensus on some outstanding questions related to how the service would be developed. This document was signed off and remains as a record for detailing how the service would be developed to address users’ needs.
	Climate service providers shall communicate and appropriately translate the service offered to the service users and user groups so as to enhance relevance and usability.	Requirement	Care has been taken to avoid such language and the co-development and co-testing of the service allow for changes to any confusing language. Care has been taken to avoid such language and the co-development and co-testing of the service allow for changes to any confusing language.
	Charts, graphs, and maps shall be assessed for ambiguity and potential for misinterpretation by users of different capabilities.	Requirement	The service has gone through extensive peer review within the service development team and this is recorded in email review evidence. As part of the co-development process, the service is being ‘beta tested’ by WaSCs to check that it is working adequately, easily understandable and producing meaningful results from which to make long term investment decisions.
	Climate service providers shall ensure their services do not cause nor exacerbate inequities.	Requirement	Charts, graphs, and maps are included in the Technical Report and Guidance accompanying the climate service – all have been checked to ensure avoidance of ambiguity and potential for misinterpretation by users of different capabilities. Checking carried out by wide range of users and across development team.
	Climate service providers shall consider additional dimensions of accessibility when providing services – such as approachability, acceptability, availability, affordability, and appropriateness – and accommodate these where necessary.	Requirement	The Technical Report and Guidance accompanying the climate service are produced as drafts for review by the Project Steering Group made up of many of the UK WaSCs and this process acts as an external accreditation for the service. The Technical Report and Guidance accompanying the climate service detail that they have been reviewed and finalised (signed off) by external peer reviewers – WaSC members of the project steering group.

## Bibliography

The WMO produces many technical specifications and standards for observing, presenting and quality assurance of weather and climate data. These are relevant to this standard and a selection is offered below:

WMO (2008) Guide to Meteorological Instruments and Methods of Observation WMO No. 8  
<https://www.weather.gov/media/epz/mesonet/CWOP-WMO8.pdf>

WMO No. 8 Preliminary edition (2020) Guide to Meteorological Instruments and Methods of Observation WMO No. 8 <https://community.wmo.int/activity-areas/imop/wmo-no.8/Preliminary-2020-Edition>

WMO (2018) Guide to Climatological Practices: WMO No. 100 -  
[https://library.wmo.int/index.php?lvl=notice\\_display&id=5668#.YBP0pC2IITY](https://library.wmo.int/index.php?lvl=notice_display&id=5668#.YBP0pC2IITY)

WMO (2018) WMO Guidelines on Quality Management in Climate Services WMO-No. 1221 -  
[https://library.wmo.int/index.php?lvl=notice\\_display&id=20652#.X-9ZIS2IITY](https://library.wmo.int/index.php?lvl=notice_display&id=20652#.X-9ZIS2IITY)

WMO (2014) WMO Strategy for Service Delivery and its Implementation Plan: WMO-No. 1129 -  
[http://www.wmo.int/pages/prog/amp/pwsp/documents/WMO-SSD-1129\\_en.pdf](http://www.wmo.int/pages/prog/amp/pwsp/documents/WMO-SSD-1129_en.pdf)

### ISO 9001 Quality Management Systems

Adams, Peter & Eitland, Erika & Hewitson, Bruce & Vaughan, Catherine & Wilby, Robert & Zebiak, Stephen. (2015). Toward an ethical framework for climate services. 10.13140/RG.2.1.1029.0645.  
<https://public.wmo.int/en/resources/bulletin/call-ethical-framework-climate-services>

Findlater, K., Webber, S., Kandlikar, M. et al. Climate services promise better decisions but mainly focus on better data. *Nat. Clim. Chang.* 11, 731–737 (2021). <https://doi.org/10.1038/s41558-021-01125-3>

IPCC, 2018: Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Available at:  
[https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15\\_Full\\_Report\\_High\\_Res.pdf](https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf)

Wilby, R. (2017). *Climate Change in Practice: Topics for Discussion with Group Exercises*. Cambridge: Cambridge University Press. <http://dx.doi.org/10.1017/9781316534588>

Visscher, K. et al., 2020: Matching supply and demand: A typology of climate services. *Climate Services*, 17, 100136, doi:10.1016/j.cliser.2019.100136. Available at:  
[https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15\\_Full\\_Report\\_High\\_Res.pdf](https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf)

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