

# Climate Services Information System

## Technical Reference Document

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## EXECUTIVE SUMMARY

Climate services provide scientifically-based climate information in a way that enhances users' knowledge and understanding about the impacts of climate on their decisions and actions. The Climate Services Information System (CSIS) is the principal mechanism through which information about climate – past, present and future – is archived, analyzed, modeled, exchanged and processed. The CSIS is the "operational core" of the Global Framework for Climate Services (GFCS), which is the United Nations' led initiative, spearheaded by WMO, to guide the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors.

The CSIS is organized as a three-level network arrangement of global, regional and national enablers, which carry out consistent CSIS functions at the global, regional and national levels respectively, covering the entire time continuum from historic past (centuries) to the future. Key categories of required input for CSIS are:

- Observational data
- Model data from operational model runs
- Research findings
- Best practises for tailoring information to end users

The CSIS major enablers include WMO Climate Services Toolkit, WMO Global Producing Centers, WMO Regional Climate Centres, National Meteorological and Hydrological Services, Regional and National Climate Outlook Forums, the World Data System, and WMO Climate Services Network. CSIS creates an organized and effective network of enablers, partners, and users, where every member contributes their information in a timely accurate and effective manner.

The CSIS capacity development includes human resource, infrastructural, procedural, and institutional capacities. The CSIS capacity development mainly focuses on the following targets:

- The development and sustained operation of formalized and interoperable structures and mechanisms at global, regional and national levels;
- A comprehensive catalogue of available and upcoming climate services created at different hierarchical levels;
- Climate service capacity development of the CSIS national and regional elements and the effective use of global and regional inputs in national level CSIS operations including products and services for climate-informed decisions in social economic sectors such as agriculture, water resources, energy, human health, and disaster risk response and mitigation.

CSIS partnership and engagement strategy goals focus on developing climate services Coverage, Accuracy, Relevancy, and Efficiency (CARE) – the essential qualities for advancing GFCS implementation. These attributes of climate services quality can be evaluated and measured on regular bases to track progress in CSIS implementation processes at national, regional and global levels.

## INTRODUCTION

The document strives to provide a high-level reference for the Climate Services Information System's (CSIS) basic technical functions and their interlinkages, largely to be integrated into basic WMO infrastructure by expanding the portfolios of WIGOS, WIS and GDPFS. Therefore, the document provides a rather WMO-centric view; it is intended, however, to provide flexibility to add relevant activities of GFCS partner organizations.

Targeted readers comprise climate services infrastructure experts and managers as well as climate services subject matter experts.

The document identifies and characterizes CSIS key enablers and postulates CSIS operating principles. Aspects of CSIS stakeholder coordination, climate service capacity development and CSIS development and maintenance are discussed to provide a comprehensive picture of the nature of CSIS.

## DEFINITIONS

Climate service is a timely production and delivery of useful climate data, information, and knowledge to decision makers.<sup>1</sup> Climate services provide scientifically-based climate information in a way that enhances users' knowledge and understanding about the impacts of climate on their decisions and actions. Such services require appropriate engagement along with an effective access mechanism and must respond to user needs<sup>2</sup>.

The term "climate information system" means a systematic approach for coordinating the development, archiving, and use of such climate information by decision makers, with defined roles for federal agencies and nonfederal entities such as academic institutions. A climate information system coherently organizes different types of climate information and facilitates technical assistance to help decision makers understand how to integrate climate information into their planning processes<sup>3</sup>.

## GLOBAL FRAMEWORK FOR CLIMATE SERVICES (GFCS)

The international community established the Global Framework for Climate Services (GFCS) to promote operational climate services at the national and regional levels. This intergovernmental partnership is supported by the United Nations and other international organizations with diverse, cross-cutting mandates. It is overseen by the Intergovernmental Board on Climate Services, which reports to the World Meteorological Congress. The Framework's contribution to climate change adaptation and resilience has been recognized by the Parties to the United Nations Framework Convention.

GFCS provides a worldwide mechanism for coordinated actions to enhance the quality, quantity and application of climate services in order to enable better management of the risks of climate variability and change and adaptation to climate change, through the

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<sup>1</sup> 2001, US Board for Atmospheric Science and Climate, A Climate Services Vision First steps toward the Future. National Academy Press Washington DC. P.84

<sup>2</sup> Global Framework for Climate Services definition of Climate Services Information System ([http://www.wmo.int/gfcs/what\\_are\\_climate\\_weather\\_services](http://www.wmo.int/gfcs/what_are_climate_weather_services))

<sup>3</sup> US Government Accountability Office, 2015 A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information. US Government Accountability Office 16-37 Washington DC 53 pp.

development and incorporation of science-based climate information and prediction into planning, policy, and practice on the global, regional, and national scales.

GFCS comprises of five pillars: Observations and Monitoring pillar, and Research, Modelling and Prediction pillar that both provide essential input for the CSIS pillar. The information generated by the CSIS pillar will be directly available to end users as well as to the User Interface Platform pillar as intermediary. The Capacity Development pillar is cross-cutting to develop the capacity of Members to contribute and benefit from GFCS.

### **CLIMATE SERVICES INFORMATION SYSTEM (CSIS)**

The Climate Services Information System (CSIS) is the principal GFCS mechanism through which information about climate – past, present and future – is archived, analyzed, modeled, exchanged and processed. The CSIS is the "operational core" of the GFCS. It produces and delivers integrated, authoritative climate information -consistent across time and space-through operational mechanisms, technical standards, communication and authentication.

World Meteorological Congress in 2011, based on outcome of World Climate Conference 3 and follow up activities, decided (Resolution 17 (Cg-XVI)) to establish a Climate Services Information System with global, regional and national entities providing operational climate information, including data, monitoring and prediction products within the GFCS. It further decided, that (i) CSIS operations shall adhere to the WMO Technical Regulations and should generate, as needed, new Technical Regulations pertinent to the advancement of operational climate services; (ii) the implementation of CSIS should be guided by the Commission for Climatology; (iii) the core operational CSIS products should be standardized in terms of production, presentation, delivery and verification; (iv) CSIS will promote consensus-based approaches to facilitate common understanding and user appreciation of uncertainties through, inter alia, Climate Outlook Forums; and (v) CSIS should be guided by the long-term vision of providing an authoritative source.

The underpinning WMO policy for the international exchange of climate data and products in support of GFCS has been implemented by Resolution 60 of the seventeenth World Meteorological Congress (2015). Through this Resolution, Congress decided -among others- that the GFCS relevant data and products from the WMO World Data Centres, Global Producing Centres for Long-range Forecasting, WMO Regional Climate Centres, Regional Climate Outlook Fora and the ICSU World Data System, as well as from the framework of the GCOS Essential Climate Variables (ECV; Atmospheric, Oceanic and Terrestrial), will constitute an essential contribution to the Framework and therefore should be made accessible among Members, in particular through the GFCS CSIS, on a free and unrestricted basis.

## CSIS FUNCTIONS

### CSIS USERS AND UTILITY

CSIS is envisioned to provide an integrated platform for advancing international climate services through accelerated information exchange on new science and technologies, shared data and products, tools, and best practises for service delivery to end-users and partners. In addition, CSIS implementation will foster climate services capacity development among WMO members.

Main users of CSIS are the NMHSs from WMO member countries. NMHSs will use CSIS resources and technical support, largely provided by RCCs, to apply global and regional climate community-shared knowledge, data, products, and tools in climate services at their country level to support local governments and industries in making climate-sensitive decisions. The following user scenarios illustrate functions of CSIS.

*User scenario 1: A NMHS in a country with frequent droughts needs to support national agriculture. The NMHS, facilitated through the GFCS Helpdesk and the relevant RCC, can use CSIS guidance including software, data, and tools for developing scientific information such as drought monitoring and outlook products to guide agricultural preparation, response, and adaptation associated with drought, lack of precipitation, soil moisture deficiency, and other hydrologic and societal impacts. In this scenario the NMHS develops and delivers a Drought Early Warning System (EWS) in support of national agriculture.*

*User scenario 2: A NMHS is asked by a ministry to develop national climate change scenarios for the country in order to guide national climate adaptation planning activities. Facilitated by the CSIS resources, the NMHS can download software to facilitate the development of climate change scenarios for their country. CMIP (Coupled Model Intercomparison Experiment) and CORDEX (Coordinated Regional Climate Downscaling Experiment) resources will be identified for boundary and background conditions; CSIS training opportunities are provided to develop capacities in human resources. Eventually, a set of national climate change scenarios will be delivered to the ministry and comparison to global and regional climate change scenarios is provided. This scenario shows how CSIS information can be utilized for national development and planning efforts.*

*User story 3: A NMHS is approached by its country's largest university to identify data sources for a study on Arctic sea ice and its interactions with global climate patterns. Facilitated by the CSIS Climate Services Toolkit (CST), the NMHS can identify relevant data sets and familiarise with the terms of its usage. Drawing on expertise of the respective WMO Regional Climate Centre (RCC) and using CST resources and training support, the NMHS will facilitate the data download to enable research for this task. This scenario is an example of how CSIS can help with national research advances and promote development of observing system at a country level.*

### ORGANIZATION OF THE CSIS

The CSIS is organized as a three-level network arrangement of global, regional and national enablers, which carry out consistent CSIS functions at the global, regional and national levels, respectively, covering the entire time continuum from historic past (centuries) to the future (decades to centuries).

## GOVERNANCE

Guided by the WMO Commission for Climatology the CSIS implementation and initial development is coordinated through the WMO Secretariat, CLPA Branch, backed by national GFCS and CSIS focal points as well as appropriate expert- and task teams, inter-commissional where needed. A close coordination with partners such as GFCS underpins the governance. A proposal for a future governance model to steer CSIS operations will be developed in due time; natural key players will be WMO/CCI and partners on the global level, WMO Regional Associations and partners on the regional level and NMHSs and partners at the national level.

## FUNCTIONS OF THE CSIS

The functions of CSIS shall include:

Core functions:

- (a) Climate data services including climate data rescue, climate data management and archiving, climate data exchange and generation of climate-relevant data sets;
- (b) Climate monitoring services including climate analyses and diagnostics, generation of climatologies and implementation of climate watch systems to advise on expected or ongoing climate anomalies with potential adverse impacts on societies;
- (c) Climate prediction services including seasonal and intraseasonal forecasts with information on uncertainties and comprehensive verification information;
- (d) Climate projection services including projections and validation information;
- (e) Generation of user-targeted climate information services based on a) to d) above.

Support functions:

- (f) Quality assurance procedures for all information provided;
- (g) Long-term storage of CSIS data and products;
- (h) Maintenance of a continuously updated catalogue of data and products stored in the system;
- (i) Information exchange between CSIS enablers;
- (j) Online access to all CSIS data, products and services including methodology information, product descriptions and user guidance;
- (k) Ongoing service improvements based on continuous and regular stakeholder engagement and feedback mechanisms;
- (l) Effective communication of CSIS services;
- (m) Capacity development.

Appendix 1 specifies the above functions for global, regional, and national levels in greater details by converting it into products and services.

## CSIS OPERATING PRINCIPLES

A key feature of CSIS is basic consistency in climate information provision across time and space scales. This feature translates into cascading processes and operations from global through regional to national (and local) levels and vice-versa, reflecting the geographical and time scale interdependencies of the climate system.

Appendix 2 lists reference guidelines regarding recommended practices to which CSIS operations should adhere. By further developing these recommended practices into consistent standard practices, including through the High-quality Global Data Management Framework on Climate (HQ-GDMFC)(cf. <http://www.wmo.int/pages/prog/wcp/ccl/opace/opace1/documents/HQ-GDMFC-CONOPS-VER2.5-31Mars2016-1.pdf>), CSIS operations will produce largely time and space consistent information.

## CSIS INPUT

Key categories of required input for CSIS are:

- i) Observational data\* delivered by WIGOS with coordination contribution from GCOS and GFCS Observation and Monitoring pillar;
- ii) Model data\*<sup>4</sup> from operational model runs including NWP and Long-range forecasting as well as from climate projections and re-analyses with coordination contribution from GFCS Research, Modelling and Prediction pillar;
- iii) Research findings and results in terms of data, tools, products, expertise and methodology delivered from the international research community with coordination contribution from GFCS Research, Modelling and Prediction pillar;
- iv) Best practices for tailoring climate information for the end users from GFCS priority areas such as health, agriculture, energy, water resources, and disaster risk reduction;
- v) Continuous engagement with climate information users from the GFCS priority sectors<sup>5</sup>, formulation their needs, and translation of these needs to service requirements.

Close CSIS interaction with stakeholders from the above categories is needed in terms of requirements as well as interfaces management.

## CSIS PROCESSING, EXCHANGE, AND OUTPUT

CSIS operations will be based on up-to-date science and will benefit from a close interaction with the research community to efficiently convert new research findings into operations.

The exchange of information within CSIS as well as CSIS information delivery to users including the GFCS User Interface Platform will largely be facilitated by the next generation WMO Information System (WIS 2.0). Appendix 2, attachment 2.1 specifies requirements for CSIS information to be discoverable and exchangeable through WIS.

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<sup>4</sup> Note re i) and ii): Observational and model data need to be quality controlled and aggregated, stored and archived in order to be fit for purpose. Relevant data management procedures include metadata management in order to generate traceable data sets. Data aggregation may include averaging, extremes identification, gridding and homogenisation. Climate data management is ideally facilitated by a modern Climate Data Management System (CDMS).

<sup>5</sup> GFCS priority sectors include agriculture and food security, human health, water resources, energy, and natural disaster risk reduction.

CSIS production processes are closely aligned to the WMO Global Data Processing and Forecasting System (GDPFS) with the aim of a future integration of GDPFS-relevant CSIS arrangements and operations into a seamless GDPFS.

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## **KEY ENABLERS**

The following chapter focusses on initial key enablers and will be broadened at a later stage to include other enablers. A key characteristic of the key enablers listed below is that they form the basic skeleton of CSIS, jointly covering all CSIS functions for global, regional and national geographical scales across all time scales from historic data to future climate change projections (cf. Appendix 1). CSIS key enablers follow agreed upon practices and procedures ensuring basic consistency of information across the above geographical and time scales, thereby facilitating cascading production processes. The functions of the CSIS key enablers will be coordinated accordingly.

## **CLIMATE SERVICES TOOLKIT**

WMO GFCS Climate Services Toolkit (CST) is a suite of guidance, procedures and instructions, data, software and online tools, training resources, and examples for enabling climate services at global, regional, and national levels. Appendix 3 provides further details in CST components and utility.

CST provides an operational CSIS functions to share new tools, procedures and instructions, information, methods, and training material, thereby enabling all CSIS providers and users to take advantage of research and development advances. CST facilitates the production, communication, and application of climate information products. CST enables more countries to develop their national products, and so encourage improved data sharing, and foster the interaction and shared learning between information providers through the development of a common set of skills. CST ensures the climate information and products developed for and provided to end-users is relevant, reliable, useable, consistent (through time and across regions) and of high quality. And finally, CST will reduce the need for expensive capacity building through availability of training resources and make training workshops more focused, tangible, and efficient in imparting the operational skills.

## **CSIS RELEVANT INSTITUTIONS**

### *WMO GLOBAL PRODUCING CENTRES*

WMO Global Producing Centres for Long-range Forecasts (GPC LRF) are Centres that provide a defined list of operational global climate products including comprehensive verification information, where appropriate, based on fixed production cycles and times of issuance, accessible through GPC WebSites and/or disseminated through WIS and/or the Internet.

GPCs LFR constitute a core operational capability of the CSIS climate prediction function, providing global-scale operational climate predictions from one month to two years, focusing particularly on the seasonal timescale, including comprehensive verification information.

GPCs ADCP constitute a complementary core operational capability of the CSIS climate prediction function, providing global-scale operational climate predictions from years to a decade, including comprehensive verification information.

Lead Centres are attached to both above categories of GPCs.

### *WMO REGIONAL CLIMATE CENTRES*

WMO Regional Climate Centres (RCC) are Centres of Excellence, that create regional products including long-range forecasts in operational mode that support regional and national activities and thereby strengthen capacity of WMO Members in a given region to deliver the best climate services to national users.

RCCs serve as the CSIS stewards at the regional level by producing operational climate monitoring and prediction products, facilitating climate data services, and conducting regional and in-country training activities. RCCs take advantage of CST and support countries to effectively use its resources for advancing regional and national climate services. RCCs facilitate climate services network and play an instrumental role in the organization of Regional Climate Outlook Forums.

#### *NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES*

National Meteorological and Hydrological Services (NMHSs) own and operate most of the infrastructure that is needed for providing the weather, climate, water and related environmental services for the protection of life and property, economic planning and development, and for the sustainable exploitation and management of natural resources.

NMHSs constitute the core enablers at national level, carrying out or contributing to large parts of national CSIS functions.

#### *CLIMATE SERVICES NETWORK*

By developing CSIS following a phased approach, interfaces to further important climate service providers will be defined and implemented. Examples of such entities are the International Research Institute for Climate and Society (IRI), Copernicus<sup>6</sup> and others.

### **CSIS RELEVANT ACTIVITIES**

#### *REGIONAL CLIMATE OUTLOOK FORUMS*

Regional Climate Outlook Forums (RCOF) bring together national, regional and international climate experts, on an operational basis, to produce regional climate outlooks based on input from NMHSs, regional institutions, Regional Climate Centres and global producers of climate predictions. RCOFs are also used to address climate change information.

The core concept of all RCOFs remains the same: delivering consensus-based, user-relevant climate outlook products in real time through regional cooperation and partnership. However, since national and regional capacities are varied and, in some cases, are inadequate to face the task individually, the implementation mechanisms of RCOFs in different regions have been tailored to meet the local conditions. By bringing together countries having common climatological characteristics, the forums ensure consistency in the access to and interpretation of climate information. Through interaction with sectoral users, extension agencies and policymakers, RCOFs assess the likely implications of the outlooks on the most pertinent socio-economic sectors in a given region and explore the ways in which use could be made of these outlooks.

#### *NATIONAL CLIMATE OUTLOOK FORUMS*

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<sup>6</sup> **Copernicus** is a European Union Programme aimed at developing European information services based on satellite Earth Observation and in situ (non-space) data.

Same as Regional Climate Outlook Forums but at national level; bringing national providers and users of climate services together.

### *ICSU WORLD DATA SYSTEM*

The World Data System (WDS) promotes long-term stewardship of, and universal and equitable access to, quality-assured scientific data and data services, products, and information across a range of disciplines in the natural and social sciences, and the humanities. ICSU-WDS facilitates scientific research under the ICSU umbrella by coordinating and supporting trusted scientific data services for the provision, use, and preservation of relevant datasets, while strengthening their links with the research community.

WDS provides access to a large range of climate-relevant data, thereby feeding the CSIS climate data function.

It is planned to define, in close partnership with ICSU WDS dedicated GPCs for global climate data.

### *GLOBAL SEASONAL CLIMATE UPDATE*

The GSCU summarises the current status (monitoring) and the expected future behaviour (prediction) of major general circulation features and large-scale oceanic anomalies around the globe (e.g., ENSO, North Atlantic Oscillation, Indian Ocean Dipole, etc.) and to discuss briefly its likely impacts on continental-scale temperature and precipitation patterns. The GSCU is proposed to be designed, and thereby standardised, in a way that allows for comparing qualitatively the climate monitoring results of the current issue with the respective climate outlook issued in the previous issue.

GSCUs are expected to be used primarily by Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and NMHSs in order to elaborate regional and national climate updates, and also by global user communities as well as the general public.

### *COUPLED MODEL INTERCOMPARISON EXPERIMENT*

The Coupled Model Intercomparison Experiment (CMIP) is a largely research-oriented standard experimental framework for designing experiments with and studying the output of coupled atmosphere-ocean general circulation models. This facilitates assessment of the strengths and weaknesses of climate models which can enhance and focus the development of future models. CMIP5 (formally: Coupled Model Intercomparison Project Phase 5) is the most current and extensive of the CMIPs. It is defined by experiment suites divided into three categories: (I) Decadal Hindcasts and Predictions simulations; (II) "long-term" simulations; and (III) "atmosphere-only" (prescribed SST) simulations for especially computationally-demanding models, thereby providing projections of future climate change on two time scales, near term (out to about 2035) and long term (out to 2100 and beyond). CMIP phases model run data are archived using a common naming system for files, directories, metadata and URLs to facilitate its use.

CMIP provides model run data to underpin the development of global climate projections and scenarios and conveying uncertainties, thereby largely contributing to the CSIS climate data services and climate projection services functions.

It is planned to define, in close partnership with IPCC/CMIP dedicated GPCs for global climate projections.

#### *COORDINATED REGIONAL CLIMATE DOWNSCALING EXPERIMENT*

The Coordinated Regional Climate Downscaling Experiment (CORDEX) is a World Climate Research Programme framework to evaluate regional climate model performance through a set of experiments aiming at producing regional climate projections.

CORDEX provides model run data to underpin the development of regional climate projections and scenarios and conveying uncertainties, thereby largely contributing to the CSIS climate data services and climate projection services functions.

It is planned to extend RCC capabilities for climate change projections in close partnership with CORDEX communities.

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## MATRIX OF KEY ENABLERS

Table 1 Matrix of key enablers for CSIS and CST development and implementation.

Key enablers	Climate data services function	Climate monitoring services function	Climate prediction services function	Climate projection services function	User-targeted climate information function	Support functions
<b>Global scale</b>						
<b>GPC LRF</b>	<b>x</b>		<b>x</b>			<b>x</b>
<b>GPC ADCP</b>	<b>x</b>		<b>x</b>			<b>x</b>
<b>GCSU</b>		<b>x</b>	<b>x</b>			<b>n/a</b>
<b>ICSU WDS*</b>	<b>x</b>					<b>x</b>
<b>(IPCC/CMIP)*</b>	<b>x</b>			<b>x</b>		<b>x</b>
<b>Regional scale</b>						
<b>RCC</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>(x)</b>	<b>x</b>	<b>x</b>
<b>RCOF</b>		<b>(x)</b>	<b>x</b>	<b>(x)</b>	<b>x</b>	<b>n/a</b>
<b>(CORDEX)*</b>	<b>x</b>			<b>x</b>		<b>x</b>
<b>National scale</b>						
<b>NCOF</b>		<b>(x)</b>	<b>x</b>	<b>(x)</b>	<b>x</b>	<b>n/a</b>
<b>NMHS</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>

\* ICSU WDS, IPCC/CMIP and CORDEX represent important international capabilities regarding global data services to underpin the development of global and regional climate projection services. It is planned to define, in close partnership with the above, dedicated CSIS/GDPFS entities to introduce relevant capabilities into CSIS/GDPFS, e.g. by considering introducing GPCs for global climate data services as well as for global climate monitoring and for global climate projections. On regional and national levels, RCCs and NMHSs are expected to extend their current capabilities to cover all CSIS functions.

## COORDINATION AND ENGAGEMENT OF CSIS PARTNERS AND STAKEHOLDERS

In addition to enablers described in section 3, CSIS stakeholders comprise of climate services partners and users. Partners include subject matter experts, who contribute their intellectual expertise, data sets, and tools for sharing among members of international climate services community. Partners represent experts in physical, social, and economic sciences as well as members of international institutions and professional societies. End users are groups and individuals who rely on climate information for their business and life decisions. Users include governments, economic sectors, industries, and citizens. Coordination among enablers and partners at global, regional and national levels can advance climate services potential. Clarity in understanding user needs and their feedback on availability, coverage, and quality of existing climate information improves climate service usability.

CSIS creates an organized and effective network of enablers, partners, and users, where every member contributes their information as well as its interpretation and implication for the end user in a timely, accurate, and effective manner. Climate services starts with user needs that should be translated into services requirements. Requirements should have regular review and clarification. The requirements drive production of climate product suite including components such as climatology, monitoring of climatological events (e.g., ENSO, drought, temperature trends, precipitation variations, etc.), predictions (weekly hazard assessments, monthly and 3-month temperature and precipitation outlooks, etc.), and projection (centennial variation of temperature, precipitation, runoff variation as a result of various scenarios in emission of green-house gases), and tailored climate information to specific end-users (e.g., cooling and heating degree days for energy sector, heat waves for health, drought information for agriculture, runoff indices for water resources, flooding return periods for community predation to severe flood impacts).

The climate products are developed and delivered to the end-users using various forms of communication including newsletters, web sites, targeted engagement with news media, and social media. Users need to have an outlet to provide their feedback to the existing climate services providers and request additional needs. Such outlets can be periodic surveys, workshops, user forums, participation in community planning events, etc. Such information “push – pull” model in relationship between climate services enablers, partners, and users proves very effective for maintaining climate services relevancy to user needs.

CSIS will work together with User Interface Platform (UIP), another GFCS implementation component, to map out ways and means for ensuring effective delivery and uptake of user-relevant climate services in the areas of informing policy and decision-making in climate-sensitive regions. In essence, CSIS is the operational facility catering to all the climate information needs of the UIP. It also receives feedback that it uses to improve its products and services. CSIS will work towards establishing mechanisms to facilitate ongoing connections between climate service users and providers. The following specific actions can foster user engagement and feedback mechanism:

- Facilitating user participation in national climate forums (e.g., NCOFs, working groups, etc.);

- Developing a comprehensive framework for climate services at the national level. Mechanisms such as the NCOFs/NCFs mentioned above can serve as integral components of the activities within such a national framework;
- Promoting the single window weather and climate service concept within the NMHSs to assist users in accessing weather and climate information they require in a seamless manner.

At a global scale CSIS will benefit from GFCS Partnership Advisory Committee that serves as GFCS stakeholder engagement mechanism and consists of UN and other international organizations representing climate-sensitive sectors such as agriculture and food security, water resources, human health, energy, and disaster risk reduction.

CSIS partnership and engagement strategy goals focus on developing climate services **Coverage, Accuracy, Relevancy, and Efficiency (CARE)** – the essential qualities for advancing GFCS implementation. The CARE qualities can be explained in the following terms:

- **Coverage** is CSIS implementation at global, regional, and national levels
  - Global coverage of climate services is facilitated through engagement with GPCs, GFCS PAC members
  - Regional coverage of CSIS is fostered through RCC activities including production of regional climate products, organization of Regional Climate Outlook Forums, training events, and periodic information disseminations
  - National coverage is promoted through services provided by the NMHSs including engagement with users, developing national network of partners, operational release of climate products and information, maintaining existing and developing new capabilities for climate services delivery, organization of National Climate Outlook Forums, etc.
- **Accuracy** is the degree to which the climate services products conform to their correct value or a scientific standard. This quality is achieved through continuous and systematic engagement with professional experts on components, data, tools, research advances, education, training and outreach modules, etc. Work of CCI ETs and coordination with GFCS pillars on OBS and RMP fosters advancement of this CSIS quality. Accuracy can be evaluated in terms of
  - Verification skill of climate products
  - New scientific methods and/ or technologies incorporated in the operational routines of climate services provision
- **Relevancy** to users is the condition of climate services usability for climate-informed decisions. Development climate services relevancy to users is fostered by incorporating social and economic sciences on climate information use, engagement with end-users, and user benefits. CSIS relies greatly on its partnership with the GFCS pillar on UIP. Climate services relevancy can be evaluated using
  - Methods of social and economic sciences

- Mechanism for user engagement and feedback
- Communication of probabilistic information and conveying uncertainty
- **Efficiency** is the ability to develop and deliver climate services with a minimum expenditure of time and effort. To expedite information sharing CST prototype has been put together and is currently being tested at a country level. Efficiency can be evaluated in terms of
  - Ease of climate information understanding
  - Timeliness of information services for decision support

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## CLIMATE SERVICES CAPACITY DEVELOPMENT

Climate services capacity development mainly focuses on the following targets:

- The development and sustained operation of formalized and interoperable structures and mechanisms at global, regional and national levels;
- A comprehensive catalogue of available and upcoming climate services created at different hierarchical levels viz. Nations, Regional Associations and Global;
- Climate service capacity development of the CSIS national and regional elements and the effective use of global and regional inputs in national level CSIS operations including products and services for climate-informed decisions in social economic sectors such as agriculture, water resources, energy, human health, and disaster risk response and mitigation.

CSIS capacity development activities are stratified according to attributes defined by GFCS IP Annex on Capacity Development: Infrastructural capacity, procedural capacity, institutional capacity, and human resource capacity.

### INFRASTRUCTURAL CAPACITY

Infrastructural capacity is enabling access to the resources that are needed to implement infrastructure to generate, archive, quality control, communicate, exchange and use climate data and decision-relevant information and products. In support of developing this aspect of climate services capacity, CST identified, cataloged, and linked from online portal access to available climate data, products, and tools. RCCs are working to improve use of GPC products at regional and country levels and develop value added service at country level. In addition,

### PROCEDURAL CAPACITY

Procedural capacity covers the following aspects:

- Guidance material on how to organize National Climate (Outlook) Forums should also be produced to commence standardizing these processes and attain comparability of quality across the world.
- Best practices on how to present, and the media on how to use these products, should be enhanced, i.e. through two-way media training.

### INSTITUTIONAL CAPACITY

Institutional capacities to do climate services cover:

- Policy, Legislative, and Regulatory Frameworks
- Administrative Framework
- Funding and Resource Management
- Mechanisms for Follow Up, Monitoring and Assessment
- Role of RCCs and other stakeholders in Capacity Development

*Add more detail to the latter three capacities based on the Guidelines for NMHSs on Capacity Development for Climate Services (under preparation)*

## HUMAN RESOURCE CAPACITY

Human resource capacity is equipping individuals with the knowledge, skills and training to enable them to generate, communicate and use decision-relevant climate information. Human resource in NMHSs is good in providing weather information, but for climate services, with exception of few countries it is either not available or satisfactory in the countries. Developing human resource capacity, CSIS focuses on the WMO Competencies for Provision of Climate Services.<sup>7</sup>

1. Create and Manage Climate Data Sets
2. Derive Products From Climate Data
3. Create and/or Interpret Climate Forecasts and Projections
4. Ensure Quality of Climate Information and Services
5. Communicate Climatological Information with Users

It is important to create an ongoing learning community of service providers, users, stakeholders, scientists and trainers to maximize the effectiveness of the training activities. In addition to developing and maintaining a registry of training resources, this community would require fora for exchanges and collaborations. The training event must rely on educational professionals from universities and services practitioners from WMO Regional Training Centres and RCCs.

CST Training section organized available online training resources using these competencies. This section has been developed in coordination with the WMO CCI expert team on education and training (ET-ETR). ET-ETR developed the following recommendations for climate services training:

- Training must be oriented toward application of learning in operational settings. Even background knowledge should be taught in the context of its application.
- A variety of learning solutions are required to meet training needs due to the wide scope of climate services and large differences in the existing knowledge and skills of NMS personnel. A combination of formal, semi-formal and informal training is recommended.
- Learning solutions that can reach a wider audience are critical due to financial and time constraints of the NMSs and their personnel. Solutions such as e-learning components and in-country training by roving training teams have a large potential to reach many people.
- Training events will include three phases: pre-event activities to prepare learners with prerequisite knowledge (and to identify those not prepared or over-prepared), the core learning activities (including opportunities for application and assessment/feedback), and post-event follow up activities (including implementation support and impacts assessment).
- Training should be offered using standardized learning outcomes, tools and materials to assure minimum global services and allow shared development. When possible the training should occur in the native language of the trainees.

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<sup>7</sup> <http://www.wmo.int/pages/prog/dra/etrp/documents/CompetenciesforProvisionofClimateServices.pdf>

- The standard training packages need to be customizable to address local capabilities and needs. Training that assumes and is prepared to facilitate later customization is more highly valued.
- All training events should include a component on communication skills and introduce quality management processes.
- The standard learning outcomes identified when further developing the competency framework and training for climate services will be reviewed for contributing to the potential creation of a climate services Basic Instruction Package.

RCCs serve as a principal mechanism to conduct regional and in-country training events. RCOFs serve as a venue to build capacity in climate services at regional and national levels. RCCs select CST resources appropriate for their regions and foster application of the resources in individual countries.

### **CAPACITY DEVELOPMENT ENABLERS**

CST serves as a resource for capacity developed at regional and national levels. CST provides WMO recommended guidance for climate services development. Climate data and tools for climate data management, analysis, monitoring, predictions, and projections are available for use by RCC and NMHSs. CST training section is organized according to WMO recommendation on Competencies for Provision of Climate Services listed above with help and support by RCCs, which will play a critical role in delivering training events at regional and in-country levels. Currently it provides links to distance learning training modules and residence and online training events available in climate services community. Currently most of the training resources are in English with selected available in French and Spanish. As CST will mature, all resources shall be available in all WMO official languages.

CSIS steps for capacity development include regional partnership and networking as outlined in chapter 4.

WMO RCCs have a mandatory function on capacity development, specifically targeted at NMHSs in their area of responsibility. RCOFs develop capacities of NMHSs and national and regional partners to interpret and understand as well as to generate long-range forecasts. NCOFs develop capacities of national users to access and understand climate information.

## CSIS FURTHER DEVELOPMENT AND MAINTENANCE

### FURTHER DEVELOPMENT

Further development of CSIS operations should be planned and implemented in a phased approach considering its system character. CSIS should reach out to wider scientific community for information exchange through peer-reviewed publications, brochures, fact sheets, and scientific and partnership targeted meetings and professional societies.

### ASPECTS OF CST DEVELOPMENT

CST resources shall be updated annually. The CST updates includes revision of all links as well as addressing user feedback that is collected routinely through CST online survey. CST is a continuously evolving online resource. Although CST prototype is presently available online ([www.wmo.int/cst](http://www.wmo.int/cst)), several immediate issues are planned for implementation including the following tasks:

- Complete coordination of and cross-reference to resources of the service delivery section and GFCS Help Desk;
- Improve CST Data section by incorporating most advanced innovations available in the CDMSs;
- Strengthen collaboration with RMP to expedite transition from research to CST and therefore climate services operation conducted at RCCs and NMHSs;
- Incorporate CST target user feedback from initial testing;
- Provide user-defined organization of online resources;
- Integrate climate products generation procedures and relevant guidance;
- Develop selection criteria for CST resources;
- Discover and integrate potential qualified resources that have been omitted from the initial CST implementation;<sup>8</sup>
- Provide CST resources on electronic devices upon country request.

CST will reach its mature state when it will:

- Refer to tools that are compliant with standards and can be labeled as “WMO recommended”;
- Be WIS-compliant;
- Complete integration with currently under development GFCS Help Desk;
- Provide seamlessness and transparency of the CST data and tools;
- Implement learning progressions to achieve professional competencies referred in chapter 5;
- Make available CST capabilities at global, regional, and national levels;
- Share efficiently new advances in research and development International climate services community;
- Provide support the end-users of climate services in a timely, accurate, and competent formats;
- Be translated in all WMO languages.

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<sup>8</sup> CST original implementation included resources that have been identified by WMO reports from CCI expert team meetings or referenced from WMO and GFCS publications.

## *ASPECTS OF REGIONAL CLIMATE SERVICES PARTNERSHIPS DEVELOPMENT*

Presently many regions do not have sufficient partnerships and networks for CSIS implementation. Working closely with UIP, CSIS implementation shall establish (where applicable), strengthen and sustain regional partnerships for enhancing the capacities of CSIS structures (especially Regional Climate Centres) and their linkages to NMHSs in their respective domains of responsibility. This activity, through regional partnerships and networks, aims to establish forums for sharing expertise and experiences among professionals including on how to improve communication and achieve a consistent approach in addressing climate-related hazards. The regional partnerships for capacity development will be built upon and expanded from existing regional and national partnerships for severe weather forecasting and warning services. The activities will also be aligned with the development of the future integrated and seamless WMO GDPFS. Expected outputs include regional frameworks for CSIS implementation, RCC/RSMC workshops, climate watch systems, regional management team meetings, regional collaborative platforms, and regional stakeholder engagement.

## *ASPECTS OF CLIMATE DATA MANAGEMENT SYSTEMS DEVELOPMENT*

Almost 80 Member countries presently have insufficient basic climate data management capabilities. CSIS goal in this is to significantly improve climate service provision at national, regional and global levels and climate services relevancy to decision support GFCS priority sectors. The activities shall focus on:

- CDMS implementation at country level;
- Ensure basic maintenance and evolution of existing open-source CDMSs used by WMO Members; and
- Develop the architecture for and implement a future a single reference open-source CDMS.

Anticipated results of CSIS implementation in this area include consistent national, regional and global climate data sets and related data products and services.

## **CSIS MAINTENANCE**

The following principles have to be considered in order to maintain CSIS:

- Keep abreast of the evolution of observing system(s) including WIGOS, information system(s) including WIS and productions systems including GDPFS. Define and update relevant CSIS requirements. Update relevant CSIS practices and interfaces.
- Implement a CSIS Rolling Requirements Review including its documentation. Perform regular CSIS performance reviews.
- Regularly coordinate operations including production cycles of key enablers to ensure a consistent basic CSIS information package that facilitates cascading processes
- Keep abreast with technological advances. Implement technology updates in a coordinated manner and ensure migration of all CSIS stored and archived information
- Implement a continuous research to operations model.

## CSIS PERFORMANCE MATRIX

Attributes of climate services quality (cf. section 4 above) can be evaluated and measured on a regular bases to track progress in CSIS implementation. The Table 1 provides examples of performance measures that can be employed for each attribute of climate service quality:

Table 2. Examples of performance matrix for CSIS implementation

Attribute	Performance measures
<b>Coverage</b>	<ul style="list-style-type: none"> <li>Number of global applications of climate</li> <li>Number of RCCs uses of CST</li> <li>Number of climate service examples on country level</li> <li>Number of CSIS outreach materials available in all WMO languages</li> </ul>
<b>Accuracy</b>	<ul style="list-style-type: none"> <li>Average skill of climate products</li> <li>Number of new technologies/tools/methods shared through CST</li> </ul>
<b>Relevancy to end users</b>	<ul style="list-style-type: none"> <li>Number of CST user reports on climate information use for decision support</li> <li>Number of climate services products and /or tools for sectoral applications</li> <li>Number of user targeted workshops</li> </ul>
<b>Efficiency and Timeliness</b>	<ul style="list-style-type: none"> <li>Number of CST users</li> <li>Average level of CST usefulness as estimated by CST feedback survey</li> </ul>

## GLOSSARY OF ACRONYMS

CARE	Coverage, Accuracy, Relevancy and Efficiency	IP (GFCS)	Implementation Plan
CCI	WMO Commission for Climatology	IPCC	Intergovernmental Panel on Climate Change
CDMS	Climate Data Management System	IRI	International Research Institute for Climate and Society
CLIMAT	WMO format for routine monthly data exchange	LC-LRFMME	Lead Center for LRF Multi-Model-Ensembles
CLIMAT TEMP	Historic WMO format for routine monthly data exchange of upper air observations (obsolete)	LRF	Long-range forecasting
CLPA Branch	Climate Prediction and Adaptation Branch in the WMO Secretariat	n/a	Not applicable
CMIP	Coupled Model Intercomparison Experiment	NCMP	(Defined set of six) National Climate Monitoring Products
COPERNICUS	Name of a European programme developing European and global information services	NCOF	National Climate Outlook Forum
CORDEX	Coordinated Regional Climate Downscaling Experiment	NMHS	National Meteorological and Hydrological Service
CSIS	Climate Services Information System	OBS (GFCS)	Observational and Monitoring pillar of GFCS
CST	Climate Services Toolkit	PAC (GFCS)	Policy Advisory Committee
ENSO	El Nino Southern Oscillation	RCC	WMO Regional Climate Centre
ET (CCI)	Expert Team	RCOF	Regional Climate Outlook Forum
ETR (ET)	Education and Training	RMP (GFCS)	Research, Modelling and Prediction pillar of GFCS
FAQ	Frequently Asked Questions	RSMC	Regional Specialized Meteorological Center
GCOS	Global Climate Observing System	SST	Sea Surface Temperature
GDPFS	WMO Global Data Processing and Forecasting System	Tmax	(Daily) maximum temperature
GFCS	Global Framework for Climate Services	Tmin	(Daily) Minimum temperature
GPC	Global Producing Centre	SME	Subject Matter Experts
GCP ADCP		UIP (GFCS)	User Interface Platform of GFCS
GPC LRF	GPC for Long-range Forecasting	URL	Uniform Resource Locator
GSCU	Global Seasonal Climate Update	WDS	World Data Center
ICSU	International Council for Science	WIGOS	WMO Integrated Observing System
I-DARE	International Data Rescue Portal	WIS	WMO Information System
		WMO	World Meteorological Organization
		WMO-TD	WMO Technical Document

**List of references (to be completed)**

*[GFCS IP]*

*[Manuals and Guides on GDPFS, WIGOS and WIS]*

*[Guide to climatological practices]*

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## APPENDIX 1 PRODUCTS AND SERVICES OF THE CSIS AT NATIONAL, REGIONAL AND GLOBAL LEVELS

*Note: The below listed products and services are largely coordinated in terms of climate variables targeted; periods of analyses and predictions, where appropriate; cascading production cycles as well as basic scientific methods applied.*

Core function	Global level (ICSU WDS/future GPC on climate data)	Regional level (WMO RCCs)	National level (NMHSs, CST)
Climate data services	<p>Gridded global datasets based on homogeneous station data and oceanographic, satellite and model data where appropriate (at least daily data of mean temperature, Tmin, Tmax, and precipitation as well as monthly SST); time series as long as possible</p> <p>Climate database, archiving and dissemination services</p> <p>Support to regional and national climate database, archiving and dissemination services as well as data rescue activities</p> <p>Exchange of data as required and agreed for national, regional and global CSIS operations</p>	<p>Gridded regional datasets based on homogeneous station data and oceanographic, satellite and model data where appropriate (at least daily data of mean temperature, Tmin, Tmax, and precipitation); time series as long as possible</p> <p>Climate database, archiving and dissemination services</p> <p>Support to national climate database, archiving and dissemination services as well as national data rescue activities</p> <p>Exchange of data as required and agreed for national, regional and global CSIS operations</p>	<p>Historical homogenised national station datasets and real-time data in digital form (at least daily data of mean temperature, Tmin, Tmax, and precipitation), time series as long as possible, using as much of the instrumental record as possible while retaining the original observational and metadata</p> <p>Climate database, archiving and dissemination services</p> <p>Data rescue</p> <p>Exchange of data as required and agreed for regional and global CSIS operations</p>

Core function	Global level (future GPC on climate monitoring, GSCU)	Regional level (WMO RCCs, RCOFs)	National level (NMHSs, NCOFs, CST)
Climate monitoring services	<p>Perform climate diagnostics incl. analysis of climate variability, change and extremes (including monthly and annual bulletins) considering the NCMP concept</p> <p>Historical reference climatologies (currently at least 1961-90 and 1981-2010)</p> <p>Global climate watch systems, such as Global Seasonal Climate Updates (GSCU), El Nino/La Nina</p>	<p>Perform climate diagnostics incl. analysis of climate variability, change and extremes (including monthly and annual bulletins) considering the NCMP concept</p> <p>Historical reference climatologies (currently at least 1961-90 and 1981-2010)</p> <p>Climate Watch system implementation and provision of climate watch guidance information for national advisories</p>	<p>Perform climate diagnostics incl. analysis of climate variability, change and extremes (including monthly and annual bulletins) considering the NCMP concept</p> <p>Historical reference climatologies (currently at least 1961-90 and 1981-2010)</p> <p>Climate Watch implementation and advisories</p>

	Update etc		
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Core function	Global level (GPCs LRF and ADCP, GSCU)	Regional level (RCCs, RCOFs)	National level (NMHSs, NCOFs, CST)
Climate prediction services	<p>Provision of global seasonal and intraseasonal forecasts (1 to 4 months –refer to GPC criteria), including information on uncertainties</p> <p>Provision of multi-model ensemble outputs, such as LC-LRFMME</p> <p>Global climate watch systems, such as Global Seasonal Climate Updates (GSCU), El Nino/La Nina Update etc</p> <p><b>(Capture GPC ADCP!)</b></p> <p>Comprehensive verification of past forecasts and real-time assessment</p>	<p>Provision of regional seasonal and intraseasonal predictions where skill permits (1 to 4 months –refer to GPC criteria) considering global-/national scale information and including communication of the relevant climatological context as well as information on uncertainties</p> <p>Building of consensus statements, e.g. through RCOFs, teleconferences etc.</p> <p>Comprehensive verification of past forecasts and real-time assessment</p>	<p>Provision of national seasonal and intraseasonal predictions where skill permits (1 to 4 months – refer to GPC criteria) considering global-/regional scale information and including communication of the relevant climatological context as well as information on uncertainties</p> <p>Comprehensive verification of past forecasts and real-time assessment</p>

Core function	Global level (IPCC/CMIP, future GPCs for climate change projection)	Regional level (WMO RCCs, CORDEX, RCOFs)	National level (NMHSs, NCOFs, CST)
Climate projection services	<p>Provision of global projections in close collaboration with IPCC/CMIP including information on uncertainties</p> <p>Validation of model simulations of observed climate</p>	<p>Provision of regional projections in close collaboration with CORDEX considering communication of the relevant climatological context as well as information on uncertainties</p> <p>Validation of model simulations of observed climate</p>	<p>Provision of national information on climate change projections considering communication of the relevant climatological context as well as information on uncertainties</p> <p>Validation of model simulations of observed climate</p>

Core function	Global level	Regional level	National level
User-targeted climate information services	<p>Examples of user targeted products:</p> <p>Bulletins, assessments, statements targeted at specific sectors;</p> <p>Risk and vulnerability maps;</p> <p>Predictions of Monsoon onset, breaks, bursts and cessation, heat wave predictions in collaboration with UIP;</p> <p>Information on variability and change in climate extremes as well as significant weather events etc.;</p> <p>Forums, workshops, press releases etc.</p>		

Support functions	Global level	Regional level	National level
QA, guidance, storage, communication and feedback	<p>Online access to, quality assurance and long-term storage of, products and services incl. methodology information, product catalogue and descriptions and user guidance</p> <p>Effective communication</p> <p>User feedback mechanisms</p>		
Capacity development	Capacity development of national and regional capabilities including training, knowledge transfer, technological transfer etc.	Capacity development of national capabilities including training, knowledge transfer, technological transfer etc.	Training for practitioners, providers and users

## APPENDIX 2. RECOMMENDED PRACTISES FOR CSIS FUNCTIONS

### To be completed

*Note: All of the below practices can be accessed through CST, Guidance section.*

#### CLIMATE DATA SERVICES

Data rescue	<p>Data rescue activities should follow a well organised process of preserving original documents, image original media and digitize (key) data. Data rescue needs and activities should be reflected in the international data rescue portal I-DARE. The below guidelines describe modern best practices for climate data rescue</p> <p><b>WMO 2016: Guidelines on best practices for climate data rescue. WMO-No. 1182</b></p>
Climate data management	<p>The below document defines climate data management systems (CDMS), describe the functions, classifies functions into mandatory, recommended and optional and discusses CDMS implementation aspects. CDMSs used at NMHSs should adhere to these specifications, thereby underpinning</p> <p><b>WMO 2014: WMO Climate Data Management Systems (CDMS) specifications. WMO-No. 1131</b></p> <p>The below guidance note provides recommendations on how to minimise adverse impacts of the transition from conventional to automatic observations on time series data</p> <p><b>WMO 2017: Guidance note: Challenges in the transition from conventional to automatic meteorological observing networks for long-term climate records. In print</b></p>
World Weather Records	<p>The below guidelines guide the global collection of monthly mean climate data collected and published annually</p> <p><b>WMO 2017: Guidelines for the submission of the World Weather Records 2011+. WMO-No. 1186</b></p>
Calculation of climate normals	<p>The below guidelines discusses calculation methods for generating climate normals including climatological standard normals</p> <p><b>WMO 2017: Calculation of climate normal. In print</b></p>
CLIMAT (monthly exchange of monthly climate data)	<p>Monthly climate-relevant data from meteorological observing stations are globally exchanged following the below guidance</p> <p><b>WMO 2009: Handbook on CLIMAT and CLIMAT TEMP Reporting. WMO/TD-No. 1188</b> <i>Note: CLIMAT TEMP submission has been discontinued</i></p>
Time series homogenisation	<p>The importance of metadata for climate data management and data use is discussed as well as strategies and methods for time series homogenisation</p> <p><b>WMO 2003: Guidelines on climate metadata and homogenisation. WMO-TD No. 1186</b> <i>Note: An updated Guide on homogenisation is under development</i></p>

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CLIMATE MONITORING SERVICES

Climate monitoring products	The document defines six national climate monitoring products recommended for production by all WMO Members to inform regional and global climate assessments.  <b>WMO 2017: Guidelines on generating a defined set of national climate monitoring products. WMO-No. 1204.</b>
Climate Watch	Advisories on climate anomalies with potential adverse effects on societies  <b>WMO 2005: Guidelines on climate watches. WMO-TD. No. 1269</b>
Climate extremes analysis	[short description]  <b>WMO 2009: Guidelines on analysis of extremes in a changing climate in support of informed decisions for adaptation</b>

CLIMATE PREDICTION SERVICES


CLIMATE PROJECTION SERVICES


USER-TARGETED CLIMATE INFORMATION


## OVERARCHING ASPECTS AND OTHER FUNCTIONS

Climate practices	<p><i>The document provides the single-ource high-level reference of climatological practices for WMO community</i></p> <p><b>WMO 2016: Guide to climatological practices. WMO-No. 100</b></p>
Quality management	<p><i>These documents describe the quality management framework implemented by WMO.</i></p> <p><b>WMO 2011: Technical Regulations, Basic documents No 2, Volume IV: Quality Management. WMO-No. 49</b></p> <p><b>WMO 2013: Guide to the implementation of a quality management system for National Meteorological and Hydrological Services. WMO-No. 1100</b></p>
Information exchange (WMO Information System, WIS)	<p>The WMO Information System (WIS) is the single coordinated global infrastructure responsible for the telecommunications and data management functions. WIS provides an integrated approach suitable for all WMO Programmes to meet the requirements for routine collection and automated dissemination of data and products, as well as data discovery, access and retrieval services for all weather, climate, water and related data produced by centres and Member countries in the framework of any WMO Programme.</p> <p><b>WMO 2015: Manual on the WMO Information System. WMO-No. 1060</b></p> <p><b>WMO 2015: Guide to WMO Information System. WMO-No. 1061</b></p>

## Appendix 2, attachment 2.1 Requirements for CSIS information to be discoverable and exchangeable through WIS

All CSIS data and products shall be registered under WIS. A common file naming convention needs to be agreed to make sure that CSIS products can be easily discovered. Moreover, easy detection of similar products from CSIS entities (e.g. LRF products for a given forecast period from GPCs LRF, RCC products etc) should be facilitated by the file naming convention in order to allow users to compare and decide on the most appropriate product for the intended purpose. *[To be update upon clarification of WIS 2.0 specifications and further development of WMO information management]*

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## APPENDIX 3. CST RESOURCE CATALOGUE AND GENERAL USER GUIDANCE

CST portal ([www.wmo-int/cst](http://www.wmo-int/cst)) has been developed under auspice of the WMO CCL technical experts.

### COMPONENTS

CST ([www.wmo-int/cst](http://www.wmo-int/cst)) is an online portal that consists of four main functions:

- Access to *Guidance* and *Training*
- Producing Climate Products including climate *Data* and *Tools*
- *Service Delivery*
- Support including *Help Desk* and *User Forum*

#### Guidance

Function *Guidance* links to subset of WMO Climate Services Guidance documents. It provides recommendations for best practices organized by the scopes of the GFCS pillars:

- Observations and Monitoring
- Research, Modelling And Predictions
- Climate Services Information System
- Capacity Development
- User Interface Platform

#### Training

Function Training has been organized according to WMO recommendation on Competencies for Provision of Climate Services. It links to available distance learning modules and residence courses offered by the international climate services community. The online courses are currently available in English, although selected courses are available in Spanish and French.

#### Climate Data

Selection of *Climate Data* provides access to datasets available in public domain and is based on four user-specified characteristics:

- *Climate Element* – Temperature , Precipitation, Sea Surface Temperature
- *Data type* – Instrumental, Reanalysis, Current Conditions, Prediction, Projections
- *Spatial Scale* – Global, Regional, National
- *Temporal Scale* – Daily, Weekly, Monthly, Seasonal, Decadal

#### Tools

Section Tools links to downloadable software or online tools using the following categories of climate services:

- Managing Data & Products
- Analysing and Monitoring Data & Products
- Predictions
- Projections
- Verification and Quality Management

## Services Delivery

Section on Services Delivery is currently under development in coordination with GFCS Help Desk. Initial plan to include information on:

- Case studies of user-targeted climate information applications in GFCS priority areas (health, agriculture, energy, water resources, and disaster risk reduction)
- Best practices for climate information communication
- Tools to engage partners and users

## Support

The CST *Support* function includes:

- *CST User Forum* to facilitate CST utility – shown now
- *Help Desk* including Frequently Asked Questions and Answers (*FAQ&A*), option to *Contact Experts* on various climate services topics, understand **Terminology**, and complete *Evaluation Survey* to improve CST capabilities

## **CST UTILITY**

CST intended target audience is staff of NMHSs and RCCs developing and delivering climate services to the end-users. An example of CST utility for a new services development can be summarized in the following steps:

1. Identify a need for new services (for example, climate guidance for energy sector at 3 month into the future) and translate it to service requirement (seasonal heating and cooling degree day outlooks)
2. Refers to CST guidance sections for existing WMO standard in such service development
3. Obtain CST training to develop personal competency of how to derive products from data and create climate products
4. Select climate data and tools needed for development seasonal outlooks (in this example, seasonal average temperature distribution, with temperature conversion to heating and cooling degree days)
5. Follow CST resources on service delivery
6. Obtain CST help, if needed, throughout entire process above
7. Provide feedback through CST evaluation survey