

Guidelines for the Assessment of Competencies for Provision of Climate Services

2022 edition

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WMO-No. 1285

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PREFACE

The Strategic Plan adopted by the World Meteorological Congress at its eighteenth session (Cg-18), in June 2019, sets the directions and priorities to guide the activities of WMO from 2020 to 2023 — and looking ahead to 2030 — to enable all Members to improve their information, products and services. The Plan recognizes the demand for actionable, accessible and authoritative science-based information to address the increasing threats of extreme weather and the urgency of climate action for resilience, mitigation and adaptation, as well as the need to reduce the growing capacity gap in infrastructure and services by making use of rapid advancements in science and technology and innovative partnerships.

This aspiration is highlighted in Strategic Goal 4 of the Plan, which reads as follows:

Close the capacity gap on weather, climate, hydrological and related environmental services: Enhancing service delivery capacity of developing countries to ensure availability of essential information and services needed by governments, economic sectors and citizens.

The Strategic Plan calls for WMO to develop and sustain the core competencies and expertise required for effective service delivery through education and training programmes focused on standards and recommendations. Competency frameworks are also considered essential for the establishment of a quality management system in the implementation of the WMO technical programmes. The present publication, which focuses on competencies in climate services, complements two other WMO publications published in recent years, namely: the [Guide to Competency](#) (WMO-No. 1205), and the [Compendium of WMO Competency Frameworks](#) (WMO-No. 1209). These three publications offer implementation guidance to Members, particularly in the areas of framework development, competency assessment of staff members and training design. While the high-level competencies have been published in the [Technical Regulations](#) (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, no single location was available for consulting the competencies for the provision of climate services in full detail.

The work on the present publication was initiated by the Commission for Climatology (CCI) Expert Team on Education and Training, but subsequently, it was transferred to the Expert Team on Capacity Development for Climate Services and Communications of the Standing Committee on Climate Services (SC-CLI), a subsidiary of the Commission for Weather, Climate, Water and Related Environmental Services and Applications (SERCOM).

We expect these Guidelines will aid Members and the WMO Secretariat in the implementation of the WMO competency frameworks for the improvement of the provision of climate services. I wish to thank the authors, experts and contributors to this publication.



Ian Lisk
President of SERCOM

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INTRODUCTION

The *WMO Strategic Plan 2020–2023* (WMO-No. 1225) envisions a world in 2030 where all nations, especially the most vulnerable, are more resilient to the socioeconomic consequences of extreme weather, climate, water and other environmental events; and underpin their sustainable development through the best possible services, whether over land, at sea or in the air. This cannot be achieved without a comprehensive plan to develop the capacities of Members, including their human capacities. WMO Long-Term Goal 4 foresees enhancing their capabilities and, more precisely, indicates that this has to be achieved by strengthening “core competencies” and expertise.

One of the purposes of WMO, as laid down in its Convention, is to promote the standardization of meteorological and related observations, including those that are applied to climatological studies and practices. Provision of climate services requires competencies for the transformation of climate data (including in situ, remotely-sensed, reanalysis and model output data) into climate products and services. Such services require professionals at the managerial level, trainers, information technology (IT) specialists, communicators and administrators, and those specifically involved in the delivery of climate services. The WMO Executive Council, at its sixty-eighth session (EC-68) in 2016, approved the competency framework for the provision of climate services¹ to help National Meteorological and Hydrological Services (NMHSs) and other institutions to deliver high-quality climate services in compliance with WMO standards and regulations, specifically those defined by the Standing Committee on Climate Services (SC-CLI) and the Global Framework for Climate Services (GFCS). WMO Technical Regulations and Guides describe in more detail the practices, procedures and specifications that Members are expected to follow or implement in establishing and conducting their arrangements in compliance with the Technical Regulations, and in otherwise developing their meteorological and climatological services. As stated in the *Technical Regulations* (WMO-No 49), in a given institution, the list of the competencies to be met and the associated performance criteria are determined by the infrastructural and human capacity of the institution. The competencies falling in the areas of quality of climate information and services as well as communication of climatological information to users are considered cross-cutting and should be met, at least at basic levels, by all institutions providing climate services.

The WMO competency framework for the provision of climate services is conditioned by:

- (a) The organizational mandate, mission and priorities, and stakeholder requirements;
- (b) The way in which internal and external personnel are engaged in the provision of climate services;
- (c) The available resources and capabilities (financial, human, infrastructural and technical);
- (d) National and institutional legislation and rules, organizational structures, policies and procedures;
- (e) WMO guidelines, policies and procedures for climate data and products;
- (f) The dominant weather and climate influences and extremes experienced;
- (g) Basic knowledge of user needs and requirements.

The present publication expands the top-level competency statements and performance criteria (published in *Technical Regulations* (WMO-No 49), Vol. I) to a third level, learning outcomes, and uses them as the baseline for a suggested competency assessment process (CAP). The CAP is based on the WMO *Guide to Competency* (WMO-No 1205) and the WMO *Guidelines for Trainers in*

¹ Resolution 5 (EC-68) – Competencies for provision of climate services, https://library.wmo.int/doc_num.php?explnum_id=3166.

- Retrieve climate data from sources inside and outside the organization, and organize, store and document them;
- List different sources of sectorial data inside and outside the organization, including local, regional and global networks;
- Retrieve sectorial data from sources inside and outside the organization, and organize, store and document them;
- Prepare climate and sectorial data sets for own usage, considering the necessary spatial and temporal coverage;
- Demonstrate knowledge of descriptive statistics and their adaptation to climate analysis, including measures of centrality and dispersion, data centring and standardization;
- Visualize the data analysis by producing figures, diagrams, numeric and graphic summaries, such as scatterplots and box plots;
- Represent climate data and climate indices time series and test them for temporal changes, including significance analysis;
- Demonstrate knowledge of inferential and multivariate statistics, including hypothesis testing, fitting and exploiting probability distributions, correlation and regression models, principal component analysis and clustering methods;
- Demonstrate knowledge of geostatistics, especially the techniques involved in data interpolation (for example, kriging);
- Demonstrate computer literacy and the ability to use and adapt commercial and specifically designed software, including image treatment software, statistical packages, climate data management systems, graphical and geographical information system packages, and specific packages for the generation of climate indices (RClimdex, Climpact) and other climate products;
- Explain the meaning and applications of widely used climate indices, such as those included in the RClimdex and Climpact packages;
- Make use of climate data, climate indices, other climate-related information and sectorial data to derive climate products;
- Create synthesis reports, including textual, graphical and cartographic information to convert climate products into climate services and communicate them to users.

1.3 **Competency 3: Create and interpret climate forecasts, climate projections and model output**

Competency description

Climate data, climate data products and the output of climate models are used to create sub-seasonal and seasonal climate forecasts and future climate projections.

Performance criteria

- 3.1 Locate, select and retrieve climate forecasts and the output of climate models generated by Regional Climate Centres, Global Producing Centres and other institutions;
- 3.2 Create sub-seasonal, seasonal and longer-scale forecast products;

- Create products from models relevant to end-user needs such as climate means, indices specific to each sector, box plots, drought analysis, climate trends and climate extremes.

1.4 **Competency 4: Ensure the quality of climate information and services**

Competency description

Climate information and services are defined and routinely updated. Best practices are followed and guidelines and quality management procedures for climate information are established and routinely maintained. Monitoring processes for climate services are documented and used in quality control activities.

Performance criteria

- 4.1 Define and apply quality management procedures for climate services;
- 4.2 Recruit competent personnel and design the organization workforce to develop and deliver climate services;
- 4.3 Ensure that the institution meets the competency framework at its infrastructural capacity level and has a strategy for sustainable capabilities;
- 4.4 Provide training to personnel so that they can fulfil their job requirements and expand their capabilities;
- 4.5 Conduct refresher courses at regular intervals to update knowledge;
- 4.6 Define and implement a catalogue of climate data sets, products and services to meet user requirements at the national and regional level;
- 4.7 Monitor the functions of climate services, including validation of data, products and services;
- 4.8 Evaluate the impact and benefits of climate services for customers, by gathering customers' comments, suggestions and complaints;
- 4.9 Make decisions about service improvement based on evaluation results;
- 4.10 Build partnerships with science and service providers and end-user stakeholders to improve products and service delivery.

Learning outcomes

- Describe WMO, national and other standard and recommended practices for climate services, including competency frameworks;
- List quality management principles, practices and procedures;
- Apply quality management procedures;
- Demonstrate ability to work with varied technical knowledge and methodologies across a multidisciplinary team required to deliver climate services;
- Identify education and training systems for developing knowledge and skills for climate services;

- List the main climate-sensitive socioeconomic sectors and key climatic issues of the area of study;
- Express the impact of climate on the different sectors of economic activity and key social and geopolitical issues in the area of study and give examples;
- Explain the concepts of impact, risk, vulnerability, adaptation capacity and uncertainty associated with climate, climate variability and climate change;
- Select among the available climate products those suitable to explain the impact of climate on the sectors of economic activity, and on social and geopolitical key issues;
- Develop a plan for communicating with climate information users, adapting it to the cultural environment and educational characteristics of each user;
- Make use of appropriate channels of communication, including management of social media and liaison with media agents;
- Carry out a survey of users' needs in terms of climatological information and revise it based on users' input;
- Find out from users how they use climate information to ascertain whether it has to be revised or whether they need assistance in using it;
- Formulate climatological information in a language that is both scientifically sound and adapted to the expected users;
- Integrate the communication of uncertainty and risk in the delivery of climate information;
- Develop a system to evaluate the effectiveness of climate information;
- Assess the effectiveness of climate information exchange with users in accordance with established evaluation plans;
- Recommend improvements for the climate information process.

2. **FOUR-STAGE COMPETENCY ASSESSMENT PROCESS**

When implementing a competency framework, organizations should first review and adapt the second-level information (performance criteria) to meet their specific circumstances, taking into account institutional structures and responsibilities, technology, staffing, service levels, and weather, water and climate phenomena that impact the country or area of responsibility. The support of upper-level management is essential to ensure the successful implementation and ongoing management of the competency framework.

Organizations audited by international regulatory bodies may be called upon to report their level of implementation of relevant competency frameworks. Implementation through each stage should be documented, as appropriate, according to the organization's quality management system (QMS).

The competency framework for the provision of climate services adopted at EC-68 constitutes a reference for WMO Members. Its implementation by each organization should consist of the following four stages, as described in the [Guide to Competency](#) (WMO-No. 1205):

- Stage 0: Awareness of the competency framework;
- Stage 1: Adaptation and adoption of the competency framework;

2.3 **Stage 2: Establishment of a competency assessment process**

Competency assessment, which is conducted to determine if someone can perform the job to the level of skill and knowledge required, is a critical element in implementing competency requirements. Whether an individual is competent can be known after he or she has completed an assessment that verifies whether all aspects of the competency can be applied in an operational context. This assessment may involve a variety of assessment methods. Then, it is necessary to define job roles and their associated competencies to be able to assess them.

Competency-based assessment is defined as a process with the following characteristics:

- It is based on standards that describe the competency levels;
- Standards include competence criteria that provide details regarding the operational work and have to be correlated to the job position;
- The assessment is individual; there is no comparison among workers;
- It provides a judgment for the assessed workers: competent or not yet competent;
- It is done, preferably, in real working situations – based on direct observation or simulations;
- It is an ongoing process rather than a snapshot;
- It is not directly related to the completion of specific training;
- It includes the recognition of competencies acquired as a result of work experience;
- It plays an important role in the development of skills and abilities for the person being assessed;
- It is repeatable and fair.

Steps for developing a competency assessment plan

The following steps could be followed to develop a competency assessment plan:

1. Identify the second-level and third-level competencies for the job roles; add any specific ones if necessary based on local conditions;
2. Determine the tools which will be used to assess each of the competencies identified;
3. Describe how the tools will be applied;
4. Determine who will do the assessments;
5. Plan the schedule for when the tool will be applied and how long will it take;
6. Communicate the plan to management or government administration;
7. Identify any competencies which will require a new or different assessment tool;
8. Describe how records of results will be kept, for example in the form of updatable assessment matrices.

3. **EXAMPLES OF APPLICATION OF THE ASSESSMENT PROCESS**

In this chapter, we use a fictional CSP to show how these guidelines could be used. Our CSP belongs to Category 1: Basic capacity as described in the GFCS and would like to attain Category 2: Essential capacity. It will have to follow the steps described below.

3.1 **Categories of climate service providers**

Capacity Development for Climate Services (WMO-No. 1247) explains the four categories of climate service providers – Basic, Essential, Full and Advanced – and contains a description of the capacity needed to achieve each level. Table 1, reproduced from p. 5 of *Capacity Development for Climate Services* (WMO-No. 1247), contains a detailed description of those categories.

Members can self-assess their category using the WMO [Checklist for Climate Services Implementation](#). This checklist is designed to be used by NMHSs to self-assess progress with respect to the implementation of climate services and identify areas where support is needed. The checklist refers to the country-focused results-based framework for WMO contribution to the GFCS approved by EC-68.² The checklist consists of “YES/NO” self-assessments to evaluate the degree to which actions have been taken or outputs generated. These actions or outputs are listed under the four levels.

² *Executive Council – Sixty-eighth session: Abridged final report with resolutions and decisions* (WMO-No. 1168), pp. 82–92.

Table 1. Categories of climate services providers

<i>Level of service</i>	<i>Weather services</i>	<i>Climate services</i>	<i>Hydrology services</i>	<i>Description of capacity needed to achieve service level</i>
Category 1: Basic	Weather observations Weather data management Interaction with users of weather data and products	Climate observations Climate data management Interaction with users of weather data and products	Hydrological observations Hydrological data management Interaction with users of hydrology data and products	A small network of quality-controlled observations Basic data-processing, archiving and communication systems Little or no backup/offsite storage or contingency options Staff: observers and some meteorologists trained to Basic Instruction Package (BIP) No 24/7 operation Rudimentary quality management system No research and development
Category 2: Essential	Medium-range (synoptic scale) forecasts and warnings Established links with media and disaster risk reduction (DRR) communities	Seasonal climate outlooks Climate monitoring	Hydrological data products for design and operation of water supply structures Water level and flow monitoring Short-term flow forecasts (low flows) Flood forecasting	Able to take and integrate observations from other parties Well-established protocols for emergencies, backup of data and minimum offsite facilities Staff: observers and meteorologists trained to BIP standards 24/7 operation Well-established quality management system Able to access most numerical weather prediction data/products from other centres Small research and development unit Some partnerships as junior members
Category 3: Full	Specialized weather products for a wide range of sectors Well integrated into DRR communities and mature links with media	Specialized climate products Decadal climate prediction Long-term climate projections	Seasonal streamflow outlooks Specialized hydrology products	Advanced observation equipment Ability to run its own numerical prediction suite Research and development unit Well-educated/trained staff Own training group Developed library and information services Active partnerships with NMHSs taking a leading role
Category 4: Advanced	Customized weather products Weather application tools	Customized climate products Climate application tools	Customized hydrology products Hydrology application tools	Advanced observations Leading research and development team Well-developed education and training unit

Box 2. Example job description

Department: Climate Services

Job title: Climatologist Reports to Head of Climate Services

Tasks: Quality control, homogenization and calculation of indices (Competency 1, “Create and manage climate data sets”; Competency 2, “Derive products from climate data”)

The employee must be able to meet the following performance criteria:

Performance criterion 1.4: Apply quality control processes to climate data and resulting time series

- Explain the concepts of climate time series quality and homogeneity and the causes of quality problems and inhomogeneities.
- Demonstrate computer literacy and the ability to use and adapt commercial and specifically designed software, including office suites, statistical packages, graphical packages and specific quality control packages.
- Apply statistical concepts associated with quality control issues, namely descriptive statistics, hypothesis testing, probability distributions, correlation, regression models and multivariate statistics.
- Apply quality control techniques and evaluate the quality of a climate data network after gathering documentary, statistical and graphical evidence.

Performance criterion 1.5: Assess climate data homogeneity and adjust inhomogeneous time series

- Explain the concepts of climate time series quality and homogeneity and the causes of quality problems and inhomogeneities.
- Demonstrate computer literacy and the ability to use and adapt commercial and specifically designed software, including office suites, statistical packages, graphical packages and specific homogenization packages.
- Apply statistical concepts associated with homogeneity problems, namely descriptive statistics, hypothesis testing, probability distributions, correlation, regression models and multivariate statistics.
- Apply homogenization techniques and evaluate the homogeneity of a climate data network after gathering documentary, statistical and graphical evidence.

Performance criterion 2.3: Compute climate indices for the monitoring of climate change, climate variability and climate extremes

- Explain the meaning and applications of widely used climate indices, such as those included in the Climact package.
- Demonstrate computer literacy and the ability to use and adapt commercial and specifically designed software, including office suites and specific packages for the generation of indices such as Climact.
- Represent climate data and climate indices time series and test them for temporal changes, including significance analysis.

Each job role needs a table like this one. It is necessary to ensure that all the competencies required to meet the requirements of the organization are covered by one or more job roles. A matrix crossing job roles with requested competencies will help to identify whether all the competencies are attributed to a job role.

The concept “sufficient” implies that, through the gathered evidence, there is no doubt whether the candidate is competent or not. For instance, attending a workshop where the candidate is exposed to the meaning and applications of Climpact indices implies some degree of training, and may be sufficient to create competence, but it is not certain that after a training opportunity a person is capable of performing the job at the required level.

“Current” relates to the need to assess individuals on recent and up-to-date skills. An extreme but illustrative example would be a skilled programmer who has not kept up to date since the days of punched cards. In today’s environment, that person would still be very knowledgeable, but not effective and, therefore not competent without a refresher course.

Finally, authenticity refers to the importance of ensuring that the evaluation focuses on the actual work of each candidate. If the evidence being gathered is, for example, the state of the existing quality-controlled database, the assessor should monitor that the work being evaluated has been performed by the candidate.

Step 3: Describe how tools will be applied

To assess competency, three kinds of evidence can be used:

- (1) Direct (direct observation, oral questioning, demonstration of specific skills, video captures);
- (2) Indirect (assessment of qualities of a final product, review of previous work, written tests of underpinning knowledge, verification statistics);
- (3) Third-party (testimonials from employers/peers/customers, reports from supervisors, self-assessment, examples of work documents or reports).

Some institutions take a 360°-approach to the gathering of evidence, where a supervisor, two peers and a junior to the candidate form a panel to conduct the assessment. This approach ensures that the candidate is seen from different perspectives.

An assessment matrix is used to assess a set of competencies, performance criteria or learning outcomes. The rows represent the items assessed and the columns the evidence gathered. The most direct approach is to simply tick those cells which represent accomplishments and complete the assessment with an assessment report. Table 2 shows an example of an assessment matrix for the role described in Box 2.

Table 2 provides different options to assess each learning outcome required. Offering more than one option is aligned with the properties of a good CAP outlined in the previous paragraphs. The assessment will consist of certifying a predetermined number of pieces of evidence for each item, allowing customization to the needs of each candidate.

Note that the last column – Portfolio of evidence – is suitable for all criteria and consists in the submission by a staff member of previous work.

scheduling should be fair to the candidates and should not conflict with the normal day-to-day tasks of each individual (candidates, trainers, assessors) and with the collective functioning of the organization.

3.4 **Example for Stage 3: Completion of the competency assessment and planning of competency-oriented training to fill the identified competency gaps**

Once all the evidence has been collected and assessed, it is necessary to revisit Table 2 and each assessment matrix.

4. **SUGGESTED ASSESSMENT MATRICES AND ASSESSMENT TOOLS FOR THE COMPETENCY FRAMEWORK FOR THE PROVISION OF CLIMATE SERVICES**

The previous sections provided general guidance on how to structure a CAP. This chapter provides assessment tools for the five top-level competencies and their associated performance criteria. Implicitly, these assessment tools monitor that the candidate has achieved the learning outcomes which are relevant to each performance criterion, as described in Chapter 2. As an example, an assessment tool for the performance criterion Collect and store climate data and metadata in relational databases should look at the general capabilities for Competency 1, “Create and manage climate data sets”:

- Explain the workflow of climate data-set management and creation, including the successive application of data rescue, quality control, homogenization and integration into a climate database management system;
- Characterize the climate of the area of study and describe its variability and recent changes;
- Identify climatological similarities and differences across the area of study, relate them to climate-controlling factors and explain them using a climate classification.

It should also look at those specific to this performance criterion:

- Design a database of climate data and metadata using a climate data management system, including raw, quality controlled and homogenized records;
- Construct tables and queries to serve specific purposes for climate data analysis.

Table 2 offered guidance on how to combine different pieces of evidence for the assessment of a particular job role. The subsections of this chapter contain one table for each top-level competency statement, suggesting a series of specific assessment tools. In most cases, they rely on structured activities or on questioning of the candidate and intend to offer a model for the design of specific assessment tools. They are not by any means mandatory in their application, but instead offer guidance to those involved in designing CAPs and are meant to be modified and adapted. In many cases, the assessment can be performed even more efficiently by direct observation of real work, by third-party feedback (for example, documentation from the previous employer or supervisor) or by evidence gathered in the candidate’s portfolio (for example, diplomas from official degrees or training activities, journal papers or reports).

The last subsection of this chapter includes a few examples of assessment tools that have been developed.

The evaluators may want to create their own altered data and adapt this exercise to the specific software and quality control procedures run in their institutions.

The exercise is presented as follows:

- Download Rclimindex-extraQC.R and its documentation from <http://www.c3.urv.cat/softdata.php> and follow the instructions to upload the code.
- Download the series provided by the evaluators and save them on your computer in a folder named rclimindex_raw.
- Run the quality control routines on five of the series listed in stations.txt. Document the decisions taken using a log table, including the nature of the problem detected, the solution adopted and reasoning for it, and the statistical principles involved in the test which helped you to detect the problematic value.
- Deliver the quality-controlled series renamed as QC*.txt and placed it in a new folder called rclimindex_qc.

The candidate will **demonstrate, besides** the possession of learning outcomes 1.4b and 1.4c, the ability to:

- (a) Install, manage and run specific software;
- (b) Use office suites to produce a report contributing to the indirect evaluation of learning outcome 1.Gd.

Tool 5Ga.

Evaluates the ability to “List the main climate-sensitive socioeconomic sectors and key climatic issues of the area of study”.

The candidate is presented with a list of sectors and geopolitical issues and is asked to select those most germane to the region of study.

Tool 5Gb.

Evaluates the ability to “Explain the concepts of impact, risk, vulnerability, adaptation capacity and uncertainty associated with climate, climate variability and climate change”.

The candidate writes (or delivers orally) short definitions of these concepts. These are compared with United Nations, WMO or GFCS definitions.

Tools 5.1 through 5.4

Generally, these tools evaluate the candidate’s ability to demonstrate the learning outcomes within Competency 5. They are focused upon conditions in the area of focus. They generally take the shape of the conceptual design, or practical application of, plans to engage users in the ways defined in the learning outcomes. They are evaluated for coherence, practicability, communicability to colleagues (whether colleagues of similar skill would be able to adapt their practice with reasonable effort).

There is a specific exception: Tool 5.2b is dependent upon the completion and acceptance of Tool 5.2a.

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