WORLD CLIMATE PROGRAMME

WORLD CLIMATE SERVICES PROGRAMME

COMMISSION FOR CLIMATOLOGY
TASK TEAM ON
CLIPS EVOLUTION

FINAL REPORT

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The **World Climate Programme (WCP)** implemented by WMO in conjunction with other international organizations consists of the following major components:

- World Climate Research Programme (WCRP)
- Global Climate Observing System (GCOS)
- World Climate Services Programme (WCSP)

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NOTE

Definitions

Climate Service:
The provision of one or more climate products or advice in such a way as to assist decision-making by individuals or organizations.

National Climate Services (NCS):
Those services that, through a collaborative network of entities under a National Framework for Climate Services, create and provide authoritative, credible, usable and dependable science-based climate information and advice that is of value to government institutions, socio-economic sectors and the broader community.

National Climate Centre (NCC):
An officially mandated entity that has responsibility for the national climate record and for operational climate information products that constitute the essential climate science inputs to the National Climate Services.

National Framework for Climate Services (NFCS):
A coordinating mechanism enabling the development and delivery of climate services required at national and local levels.

A. National Framework for Climate Services

There is need in each country for a "National Framework for Climate Services" (NFCS), which is similar to the Global Framework for Climate Services (GFCS), except that the NFCS involves practicalities and specifics for the actual delivery of services at the national level, and for coordination with regional and global components of the GFCS. The most important aspect of the national framework is effective coordination at the national level to ensure the climate services are authoritative, credible and dependable, and used to inform better decision-making by the end users.

The NFCS would involve the key national institutions collecting and compiling climate observations and other climate-related datasets, institutions undertaking relevant research, and organizations providing tailored information products and expert advice. If a country has a National Climate Centre then this would most likely be central to a national framework and its outputs will form the core of the nation's climate services. The National Meteorological Service will be involved in at least some of the activities and will be part of this national framework, and in many cases may house the National Climate Centre. The NFCS might involve regional and global centres.

In this document the functions required of a National Climate Service are described, possible roles of a National Climate Centre and of the National Meteorological Service are explored, and some coordinating mechanisms for the National Framework are suggested.

A.1. National Climate Services

There are a minimum set of climate service activities that need to be operating at the national level, without which it will be difficult to provide effective regional and global support. The minimum function for a National Climate Service would require the ability to provide climate data and a capacity to deliver operational products. Another key function is the capability to support users in the interpretation of these products (see Table below for a more detailed list of basic activities). While the management of the observing system and of the national climate data, together with the issuance of official warnings, are necessarily in-country activities, the generation of operational products could be conducted by regional and global centres if capacity is lacking. However, national expertise to support users in the interpretation, and possibly translation, of these products would still be essential.

At an intermediate level of climate service provision, all standard information products are either generated nationally or regional and global products are downscaled to national level. There is meaningful input into regional activities such as the Regional Climate Outlook Forums. The intermediate National Climate Service is proactive in identifying user needs, whereas a basic NCS takes less initiative in reaching out to the users, rather responding to users that approach it. In advanced services, tailored information products can be developed in response to specific user requirements, and there is greater expertise to work with different users to identify these specialized requirements.

National Climate Service Functions

Basic

User-Interaction

Meet requests for a minimum set of climate data and information products
Field questions about climate information products
Provide advice on the use of basic climate information
Get feedback on the usefulness of the information and services provided

Climate Information Generation

Disseminate a minimum set of climate products based on historical climate data
Disseminate a minimum set of climate products based on current climate conditions
Disseminate predictions from RCCs and/or global centres, and enable verification of these predictions by RCCs

Research

None

Observations

Maintain a database of quality controlled climate observations on a minimum set of climate variables

Capacity Building

None

Intermediate

Basic climate services, plus:

User-Interaction

Meet requests for an extended set of climate data and information products

Identify user requirements for climate information products
Provide advice on interpretation and use of climate information products

Climate Information Generation
Disseminate an extended set of climate products based on climate data
Operate climate watch programmes and disseminate early warnings
Develop a minimum set of climate prediction products (where there is predictability) with verification information
Add value from national perspectives to the products received from RCCs and / or global centres

Research
Identify predictability at different timescales

Observations
Maintain a database of quality controlled climate observations on an extended set of climate variables

Capacity Building
Build user awareness about the uses and limitations of climate information, including data, predictions, and model outputs

Advanced

Intermediate climate services, plus:

User-Interaction
Identify needs for specialized climate products to meet the needs of major sectors

Climate Information Generation
Provide climate information and products to cover all the elements of climate risk management, from risk identification, risk assessment, planning and prevention, services for response and recovery from hazards, information relevant to climate variability and change, and information and advice related to adaptation
Provide specialized climate products

Research
Develop specialized climate products
Conduct scientific research, e.g. to improve the usefulness of the climate information to users (perhaps through improving skill, communication, development of tools and techniques, impacts, risk management)

Observations
Maintain a database of quality controlled climate observations on specialized climate variables

Capacity Building
Build societal awareness to climate issues, including climate change

As a simple summary, national climate services at all levels should be able to provide access to quality-controlled national climate data as well as advice to users about the use of these climate data. The distinctions between different levels of climate service provision are instead more importantly definable in terms of the ability to meet the specific needs of climate information users: a basic climate service has only the ability to disseminate and

support a minimum set of climate information products; an intermediate service is able to support this minimum set, and an additional set of standard products; an advanced service, however, can identify and develop new tailored products.

A.2. Functions of National Climate Centres

The National Climate Centre is the national provider of climate data and operational climate products that enable a National Climate Service to serve its users' needs. Although, in most cases, the data and operational functions are likely to be provided by a single organization, that is not necessarily the case. National Climate Centre functions should include the following minimum required functions (some of these functions are not climate services per se, but, as per the definition of the NCC's role, are necessary for climate services to operate, and need to be coordinated under a framework for climate services):

1) Data collection
    a) Operate and maintain an adequate national observing system.
2) Data management
    a) Conduct data management, including quality assurance and quality control.
    b) Maintain data archives.
    c) Compile basic statistics of climate parameters, including climatological normals and statistics of extremes.
3) Data provision and exchange
    a) Provide data services.
    b) Contribute climate observations and metadata to WIS.
    c) Exchange historical as well as real-time observations for use at Regional Climate Centres (RCCs).
4) Monitoring
    a) Conduct climate system monitoring, diagnostics of climate anomalies, and hazard monitoring.
    b) Provide climate watch products and disseminate early warnings, where appropriate.
5) Predictions
    a) Provide climate predictions on timescales where there is useful (in terms of the user needs) predictability, potentially ranging from intra-seasonal to inter-annual. (Since century-scale projections are not operational products these may be provided by separate organizations.)
    b) Provide relevant verification information for predictions.
6) International collaboration
    a) Participate in regional and global GFCS processes such as RCOFs and the CSIS focal point network.
    b) Meet international standards in data and information products.

The minimum set of functions described above effectively covers the Climate Services Information System, and Observations and Monitoring, and part of the Prediction

components of the Global Framework for Climate Services, as implemented nationally. The Research and Modelling components are likely to be covered to varying extents by the National Climate Centre, although rarely exclusively since universities and other research institutes are likely to be able to make important contributions. Some aspects of the User-Interface Platform are also likely to be provided by the National Climate Centre, such as the hosting of National Climate Outlook Forums, although it is only in well-resourced centres that there is likely to be sufficient experience in service provision for the Centre to take a leading role in the UIP.

More detailed information on the functions of a National Climate Centre are provided in the *WMO Guide to Climatological Practices*; the *Guide* provides a list of additional recommended functions.

A.3. Role of the National Framework for Climate Services

The National Framework for Climate Services is the national coordinating mechanism for facilitating the development and delivery of climate services. It will form part of the GFCS, and will accordingly link to the global and regional components of the Framework. The GFCS identifies five components that need to be adequately resourced for the effective delivery of climate services. These components are:

1. *User Interface Platform* (UIP)
   Provides a means for users, user representatives, climate researchers and climate service providers to interact, thereby maximizing the usefulness of climate services and helping develop new and improved applications of climate information.

2. *Climate Services Information System* (CSIS)
   Protects and distributes climate data and information according to the needs of users and according to the procedures agreed by governments and other data providers.

3. *Observations and Monitoring*
   Ensures that the historical and real-time climate observations necessary to meet the needs of climate services are generated.

4. *Research, Modelling and Prediction*
   Assesses and promotes the needs of climate services within research agendas.

5. *Capacity Building*
   Supports systematic development of the necessary institutions, infrastructure and human resources to provide effective climate services.

It is not necessarily the case that the National Framework for Climate Services will draw exclusively, or even primarily, upon national activities for all five components of the GFCS, and may rely to varying degrees upon regional and global inputs, but it will need to be responsible for ensuring that the necessary inputs are available, that national components are sufficiently resourced, and that all components are coordinated effectively.

A.4. Possible structures and coordinating mechanisms

The NMS is ideally suited to take on the role as host of the National Climate Centre, or at some of the functions of a distributed Centre, because:

- The NMS has relevant experience from providing weather services that could be leveraged off for delivering climate services.
- Many NMSs have a mandated responsibility, often with a legislative basis, in delivering weather services and collecting observations. This mandate often defines standards that must be adhered to, competencies of staff, and quality of products, all of which would be required of a National Climate Centre. To extend this mandate to cover aspects of a climate service is a natural step, whilst to establish a separate entity requires many new structures to be established.
- NMSs are part of WMO's infrastructure and adhere to related worldwide standards and procedure.
- In most cases the NMS is the holder of the national climate data archive.
- The NMS has a history of providing authoritative, credible, usable, dependable, sustainable services.
- Many users do not distinguish between weather and climate and may well benefit from only needing to get their information from a single agency to have their needs met.

However, the extent to which NMS's are well-suited for coordinating the National Climate Services is a more open question, depending upon existing capacity to conduct climate services (as distinct from their capacity to provide the data and operational functions of the National Climate Centre), and to coordinate various inputs from other sources. The role of the NMS in the National Framework for Climate Services is therefore much more likely to vary from country to country. In this section a number of structures for defining different roles of the NMS are considered. Other structures are possible, but only those that are most likely to be considered seriously are discussed here. Each country is encouraged to identify a structure that fits with its national preferences.

Structure 1: The NMS is mandated, and resourced, by the nation to be the National Climate Centre. The NMS also coordinates the National Climate Service, drawing together the other key national institutions. The NMS would coordinate the development and delivery of the nation's climate services with national universities, and other institutes who provide the necessary expertise, capacity and capability to enable effective delivery of the necessary services. In some instances this may involve international collaboration.

Structure 2: The National Climate Centre is not part of the NMS, but part of a different organization, established outside of the NMS, that already successfully provides climate-related functions. The National Climate Centre coordinates the National Climate Service, drawing together the other key national institutions, including the NMS. The National Climate Centre would coordinate the nation's climate services with national universities, and other institutes, including the NMS if the NMS has relevant expertise, capacity or capability.

Structure 3: The National Climate Centre is formed from the NMS and an additional organization that already successfully provides climate-related functions. The National Climate Centre coordinates the National Climate Service, drawing together other key national institutions, if any.

The above structures might include organizations from overseas as part of the National Climate Service if necessary.

Determining which structure is most appropriate depends to some extent on what function the national government wishes the NMS to play in coordinating, developing and delivering climate services within the country. Where successful climate service functions have been established outside of the NMS, there may be no need to change the arrangements; however if this is not the case then there are advantages in the NMS becoming the home of a climate service function, as discussed above.

A.5. Capabilities of National Meteorological Services to Contribute to National Climate Services

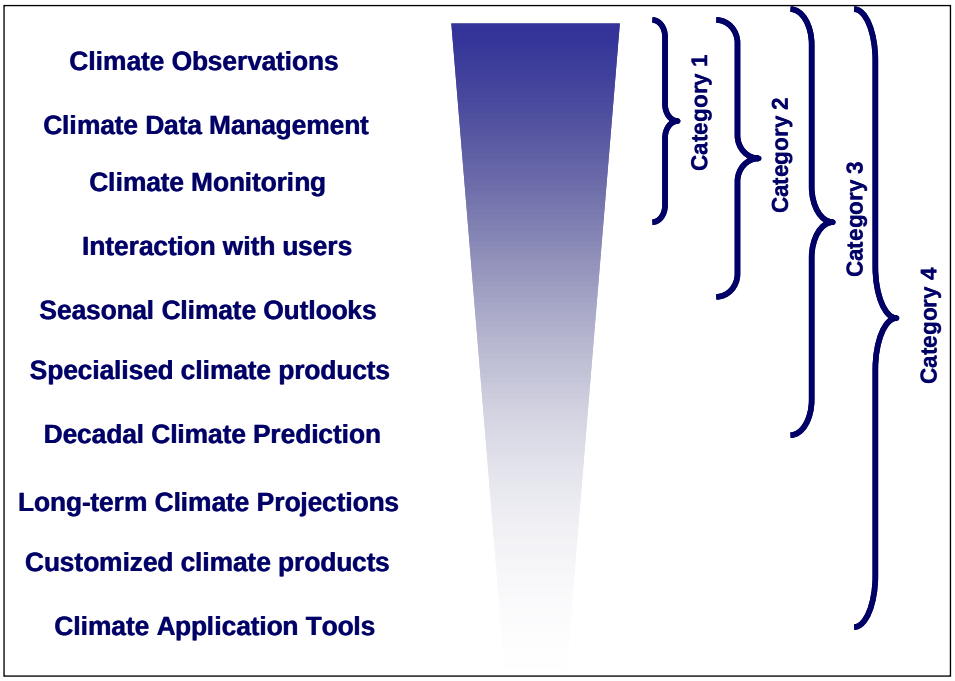
Within a National Framework for Climate Services, each NMS has to play its role depending on its strengths, capacities and capabilities and given mandates. The competence/capability of a NMS to engage in climate services will depend on their capacity to provide climate data, converting them into reasonable and usable information and products as well as developing decision support and decision making tools to convert the information based on the application of knowledge, so generated, into tools for decision making. While all efforts have to be made to improve the level of services provided by a NMS, it has to be recognized that a NMS, guided by the constraints of human, technical and financial resources may decide to make use of the regional or regional centres of excellence for getting services beyond its own capacity. The level of services provided by NMSs can be categorized as follows:

Category 1 NMSs: Providing basic climate services

Category 2 NMSs: Providing essential climate services;

Category 3 NMSs: Providing full climate services; and

Category 4 NMSs: Providing advanced climate services.



Category 1: Basic climate services

Functions of Category 1 NMSs capability include design, operation and maintenance of national observing systems; data management including QA/QC; development and maintenance of data archives; climate monitoring; oversight on climate standards; climate diagnostics and climate analysis; climate assessment; dissemination via a variety of media of climate products based on the data; participation in regional climate outlook forums and some interaction with users, to meet requests and gather feedback. All NMSs should be able to perform the basic functions of national climate centres. Optimally, staff in Category 1 NMSs should be proficient in climate statistics, homogeneity testing techniques and quality assurance techniques, etc.

Category 2: Essential climate services

Category 2 NMSs, in addition to performing all the basic functions of a national climate centre, should have the capacity to develop and/or provide monthly and longer climate predictions including seasonal climate outlooks, both statistical and model-based; should be able to conduct or participate in regional and national climate outlook forums; should interact with users in various sectors to identify their requirements for, provide advice on climate information and products; and should get feedback on the usefulness and effectiveness of the information and services provided. Category-2 NMSs would add value from national perspectives to the products received from RCCs and in some cases GPCs, conduct climate watch programmes and disseminate early warnings. Staff in category 2 NMSs should be proficient in development and interpretation of climate prediction products, and in assisting users in uptake of these products.

Climate service providers not only need to strengthen the production, availability, and delivery of climate information and products, but also need to work closely with users in various sectors either directly or through 'boundary organisations' to ensure their most effective application. In many instances efficiency and cost effectiveness may lie in collaborating with organizations that already have a close relationship with end-users within various sectors such as some intermediates or "boundary organizations", that is, organizations that already have a level of expertise in both sectoral and climate issues, rather than to have the NMS develop the sectoral relationships and client understandings directly with end-users on their own.

Category 3: Full climate services

In addition to the functions discharged by Category 2 NMSs, the Category 3 NMSs would have the capacity to develop and/or provide specialized climate products to meet the needs of major sectors and should be able to downscale long-term climate projections as well as develop and/or interpret decadal climate prediction (as and when available). Category 3 NMSs would meet the requirements for climate information and products to cover all the elements of Climate Risk Management, from risk identification, risk assessment, planning and prevention, services for response and recovery from hazards, information relevant to climate variability and change, and information and advice related to adaptation. They would serve to build societal awareness to climate change issues, and provide information relevant to policy development and National Action Plans. Staff in Category 3 NMSs will

require special knowledge in risk assessment, risk management and may have knowledge of financial tools for risk transfer.

Category 4: Advanced climate services

In addition to the functions discharged by Category 2 NMSs and the Category 3 NMSs, the Category 4 NMSs have certain in-house research capacities, and would be able to run Global and regional Climate Models. They would be able to work with sector-based research teams to assist them in developing applications models (e.g. to combine climate and agriculture information and produce food security products), and to develop software and product suites for customized climate products. Staff in category 4 NMSs will have modelling and statistical expertise, in a multi-disciplinary context, and will be able to downscale global scale information to regional and national levels. They would also be required to receive and respond to user requirements for new products.

A.6. Some outstanding issues

There are standards for weather services that have evolved over many years, but is there a similar, sufficient, set of standards for climate services? If not, how will these be set? Is a quality framework needed for National Climate Centres and National Climate Services? If so, how would this be developed and applied?

There could be benefits for funders, for example those related to adaptation funds, to require climate service providers to attain certain standards, and perhaps have an accreditation system.

How will countries resource their National Climate Centre and National Climate Service, particularly countries that currently have very little, if any, resource for climate-related activities?

B. The role of CLIPS

B.1. Priority Activities for CLIPS

With the forthcoming implementation of the Global Framework for Climate Services, a primary task of the CLIPS Program should be to help build the capacity for the implementation of the Climate Services Information System (CSIS). Given that the CLIPS Program is scheduled to expire in 2015, while the likely implementation of the GFCS is imminent, the building of capacity at the national level in all countries is an unrealistic short-term goal, and so the focus should be upon ensuring that the RCCs are in a position to support the national climate services under their purview, and are able to eventually build those national capacities.

To support the implementation of the CSIS the CLIPS Program needs to:

1. *Define a minimum set of climate products expected of the CSIS*

   To-date CLIPS has given priority to the development of seasonal forecast products. Although there is evidence for skill in these forecasts, there are also some demonstrated systematic errors, and so priority should be given to providing verification information along with the forecasts. More attention should also be

given to monitoring and historical products, especially for areas with minimal seasonal predictability.

2. *Establish expertise at the RCCs to ensure that the minimum set of climate products are produced regionally and are made available to each country*

   The provision of climate information products by the RCC does need to be balanced against the need for ownership of those products by the NMS. On the one hand, it is important to ensure that the RCCs are providing a supporting and enabling role rather than a duplicative, redundant, or even competitive role; on the other hand, it is important to ensure that the NMSs are tailoring and adding value to the RCC (and GPC) products, rather than simply reproducing the same product at the national scale.

3. *Define and make available a Climate Services Toolkit to provide the software technology to produce, at the least, the minimum set of climate product*s

   The definition, purpose, and scope of a Climate Services Toolkit together with standards, certification procedure, and a list of some potential candidate tools are discussed below.

4. *Establish expertise at the RCCs to provide regional training in the Climate Services Toolkit*

   Expertise needs to be established at the RCCs in the most important components of the Climate Services Toolkit, not only to use these tools for generating the minimum set of climate products, but also to act as resource persons for supporting NMSs in the use of the tools.

5. *Support the RCCs and NMSs in the identification, design and implementation of new climate information products*

   The climate products of the CSIS are meant to provide the information that the User-Interface Platform (UIP) can use to tailor new products for end users. Some consideration should be given to the development of a minimum set of CSIS products that have maximum potential for tailoring, as distinct from developing products that are designed to be maximally useful to the end-user. However, because the UIP is poorly developed in much of the world, and given that the RCCs and NMSs are likely to play at least some role in the UIP, the building of capacity in the principles of tailoring of information should be given high priority.

Success in these areas will require consideration of the objectives of the CLIPS Training Program, as well as redesign of the Focal Points network.

B.2. CLIPS Training Programmes

To-date CLIPS training programs have been targeted primarily at addressing a general lack of training in climatological concepts and practices of staff at National Meteorological Services. Many NMSs do not have a formal climate program or division, and yet are starting to take on some climate service functions. The CLIPS Focal Point training program has provided introductory training to staff from most Member countries, although in some cases these staff members no longer work for the NMS or have transitioned to different duties. Until

basic climatological concepts are an integral component of meteorological training programmes, there will continue to be a need for similar training opportunities in basic concepts. To avoid an ongoing need to repeat such training under the GFCS, an important legacy of the CLIPS program would be a core curriculum of online or electronic training resources. This core curriculum need not cover absolutely everything in the current CLIPS curriculum, but should provide the expertise to interpret the minimum set of climate products expected (whether produced or just distributed from a RCC or a global centre) from a National Climate Centre.

Competency in the topics covered by this core curriculum could form the basis for participation in subsequent training activities. Measuring such competency could be logistically difficult, but, while far from ideal, requiring the answering of a few multiple-choice test questions would be easy to implement, and would be at least partially effective. A register could be kept of those who have completed the test so that repeated testing is not necessary.

It seems unrealistic to expect that the core curriculum will be developed based on voluntary contributions, and it would be difficult to coordinate a consistent set of materials by collating directly from the materials used in prior workshops. Instead the option of consulting the COMET® Program, or similar, should be considered. The NOAA Climate Services Division also has an extensive set of training materials that could be used.

Once the core curriculum is in place, there will be an important need for skills training in the production of the minimum set of climate products, including predictions and verification information. The proposed skills training is largely hands-on, in contrast to the more theoretical content of the basic training in climatological concepts of past CLIPS workshops, and would need to draw upon the most important components of the Climate Services Toolkit. It is recommended that these training workshops be linked to activities such as the pre-RCOF workshops, for the following reasons:

1. Participants at the pre-RCOF workshops are specifically designated to work on the production of an operational product, and so are likely to have, or to be expected to acquire, at least some knowledge in climatological practices;

2. The training workshops could be used to introduce experimental new products that could then be discussed with the user communities participating in the RCOF to receive feedback, and to demonstrate clearer responses to user requests at past RCOFs;

3. There are significant savings, in both finance and logistics, in not having to organize dedicated workshops.

The Climate Services Toolkit will need to include adequate training materials. An additional important CLIPS activity would be to ensure that these training materials are available.

B.3. Focal Point Networks

There is a need for a network of national Climate Services Information System (CSIS) Focal Points, to facilitate communication between national, regional and global components of the Framework. The national Focal Points would likely play an important role in communication with the User-Interface Platform, Research and Modelling, Data and Observations, and

Capacity Building components of the GFCS in addition to being hosted by the national CSIS (typically, but not necessarily, the National Climate Centre).

The CLIPS Focal Point network has been only partially successful in trying to play a similar role to that intended for the CSIS Focal Points, but would need to be re-defined in order to address identified weaknesses in the CLIPS Focal Point network. Specifically, this network has been insufficiently active, with roles poorly defined, or at least poorly recognized and implemented. A clear problem has been a lack of commitment to the importance of a Focal Point network, resulting in failure to update designated Focal Points, and to poor commit to the designated Focal Point functions.

The creation of a successful Focal Point network requires the following:

1. Linking of Focal Point designation to specific positions at the NMSs rather than to individuals. To facilitate the maintenance of a Focal Point contact list, it is suggested that NMSs be requested to establish a generic email account rather than providing individual's addresses.

2. Recognition that the network must service and facilitate the Focal Point's responsibilities rather than add to them. Thus:

    a. Tasks such as reporting need to be eliminated or kept to an absolute minimum, and when reporting is necessary it should not be onerous (for example, by completion of an online form rather than by requesting written submissions) and should have clearly identifiable objectives with direct benefits to the reporters;

    b. The Focal Point network may have different functions in different countries, depending upon the NMS's climate services capacity;

    c. Definitions should be constrained to only a limited range of Focal Point functions that specifically address networking needs rather than extending to a more comprehensive set of functions of climate service personnel (the current list of CLIPS Focal Point responsibilities, for example, despite acknowledgement of national variations, is far too extensive for realistic adoption).

3. Recognition that the Focal Point may not be the only or even primary target for capacity building initiatives. In most cases the Focal Point is likely to be linked to a more senior and managerial role in the NMS, whereas capacity building efforts may need to be directed to more junior staff.

B.4. Climate Services Toolkit

The implementation of climate services is likely to impose considerable demands upon service providers, including upon National Meteorological Services (NMSs) regardless of the extent of their role in national climate service provision. In any realistic scenario, the availability of additional resources for climate service provision is inevitably going to fall short of the ideal requirements to meet the new demands. One partial solution to this problem is to make available a suite of tools that can be used by climate service providers and users to facilitate the production, communication, and application of climate

information products. However, to avoid the possibility of a proliferation of inconsistent, and possibly sub-standard, tools, there is a need to implement a set of standards, and to establish a certification process for new tools. The objective in this document is to define the purpose of such a Climate Services Toolkit (CST), to outline a set of standards, and to propose a certification process.

Definition

A climate information and prediction services toolbox or toolkit consists of a set of bespoke software products (including data management, data analysis, and prediction packages), and accompanying training modules, that are specifically designed to support the generation and use of climate information and prediction products that meet user needs. Although essential resources, interpreted products (e.g., the WMO El Niño / La Niña Update and the NOAA NCDC State of the Climate reports) are not considered part of the Toolkit.

Need

There are numerous reasons for developing a Climate Services Toolkit:

1. Promote the implementation of best practices in all countries. The toolkit would enable end-users to gain access to high-quality climate information, and would provide access to resource-poor service providers to access state-of-the-science datasets and analytical procedures.

2. Enable service providers to generate climate information and predictions efficiently, thus enabling the production of information that would otherwise have been unfeasible because of constraints on personnel time, or freeing up personnel time to work on other tasks. Increases in efficiency can enable more frequent product updates and/or generation of new products.

3. Simplify the learning curve required to use data management and analysis tools by the provision of bespoke software products that have clear and tailored functionalities.

4. Reduce the need for extensive capacity building to generate and use new climate information products that are possibly based on sophisticated analytical procedures, whilst recognizing the need for sufficient expertise to interpret the products.

5. Promote standardization of methods of producing and presenting climate information products within (and, to the extent that is possible, across) regions. Standardization is helpful for a number of reasons:

    a. To increase the consistency of information in neighbouring areas, thus facilitating the building of consensus for generating regional products, and reducing the chances of confusing end users through provision of conflicting information;

    b. To facilitate interaction and shared learning between information providers through the development of a common set of skills.

Scope

The Climate Services Toolkit is designed to ensure exchange of data and operational products, but a comprehensive toolkit should target different users including Meteorological Services staff, researchers, decision makers, and end-users. The various components of the Toolkit should include:

1. Data management tools – including:

    a. A data portal for access to and analysis of observations and GCM outputs (e.g., access to global sea-surface temperature data for empirical prediction schemes, to GCM outputs for statistical and dynamical downscaling, to reanalysis products for diagnostics studies);

    b. A database management tool for quality control and simple manipulation of data (e.g., calculation of climatologies, monthly and seasonal averages and frequencies);

    c. A climate analysis tool for diagnostic analyses (e.g., teleconnection studies, composite analyses, trend detection).

2. Climate monitoring tools – for calculation of anomalies, percentiles, return periods.

3. Forecasting, downscaling and verification tools - for statistical and MOS models, and with flexibility to interface to impacts models.

All tools should have visualization capabilities to present data, analytical results, and predictions in publication-quality formats.

Standards

In order for products to be included in a toolkit, a set of standards for documentation, design, and support will be required. Demonstration that the following standards have been met will be required for certification:

1. Documented best practices – to ensure that tools are based upon refereed scientific principles and recognized methodologies.

2. Accompanying manuals – to enable users of the tools to gain an understanding of how the tools work and thus reduce the potential for the tools to become “black boxes”.

3. Accompanying training materials and training programs – to enable users of the tools to gain proficiency, and to fully understand their functionality, and correction interpretation.

4. Support – to ensure that climate information meets quality control standards, the tools would not only have to be designed to implement best-practices, but the users

of the tools need to have the expertise to use the tools properly. The tools would therefore need to provide:

   a. Certified training programs (workshops, and remote-learning) to provide users with the competency to apply the tools effectively;

   b. Mechanisms for receiving answers to questions about the tool's proper use and interpretation (whether through a help desk, or a FAQ page, for example), for reporting bugs, and for providing suggestions for future enhancements.

5. Sustainability – to provide guarantees of on-going maintenance of the tools so that they are not made obsolete by developments in computer systems, any bugs are fixed, and new features are introduced in response to identified needs.

6. Visualization capabilities - to present data, analytical results, and predictions in publication-quality formats. Given that many, if not most, climate information products are likely to be distributed in graphical format, and given that most analytical procedures will require some form of data visualization, the implementation of high-quality graphical functionality is an important component of a tool. The following graphics functionalities will therefore need to be implemented:

   a. ability to save images in standard formats (for example, JPEG, postscript);

   b. ability to produce images in colour, and in grey-scale;

   c. some ability to edit images to meet user specifications;

   d. consideration of colour-blind users in the definitions of colour palettes.

   Alternatively, the ability to save data and results so that the user can create their own images in other software, should be a possibility.

7. Accessibility – the tools should be easily available from the Internet and/or available on request upon a portable electronic medium.

The following are a set of recommended standards, but are not required for certification:

1. Multilingual user interfaces – to allow the user of the tools to operate them in their native, or a familiar, language.

2. Portability – to minimize potential problems arising from restricting the operation of tools to specific, or to a small subset of, computers and operating systems.

3. Scalability – to ensure that tools can be used on computers with a wide range of power and by personnel with varying levels of technical skill, without becoming ponderous and difficult to use, on the one hand, or limiting and trivially simple on the other hand.

4. Free software or freeware – to ensure that countries are not denied access to technologies on the basis of insufficient resources.

5. Offline or minimal bandwidth – given the sometimes severely restricted Internet access in some countries the ability to run analyses offline is a distinct advantage, while software that necessarily require Internet access (e.g., data portals) should have a light bandwidth option to avoid unnecessary download of webpage content.

6. Easy-to-use – although impossible to define objectively, the tools should be designed so that the learning curve for the user is not unduly steep.

7. Certification of trainers – although the tool developer is initially likely to play a primary, and possibly exclusive, role in conducting training programs, in the longer-term Regional Climate Centres (RCCs) are likely to be well-placed to provide support and training for the tools. The establishment of a certified program for training-of-trainers is encouraged.

Certification Procedure

When a software developer wishes to certify a product as a component of the Climate Services Toolkit, the following steps are recommended:

Step 1: The tool developer will contact the WMO Permanent Representative (PR) of the country in which it is situated to express its intent to have the software designated as a component of the Toolkit. The letter of intent should provide a brief description of the software's purpose, and should indicate how each of the minimum standards is met, and the extent to which any of the recommended standards are adhered to.

Step 2: The PR will inform the President of CCl, with a copy to the President of CBS and the Secretary General, of the intent expressed by the tool developer.

Step 3: The President of CCl will contact an evaluation group to evaluate whether the tool meets the minimum standards, and will feedback to the PR if further evidence, development, or guarantees are required.

Step 4: Upon successful designation, the President of CCl will contact WMO Members to advise them of the availability of the tool.

Potential Candidate Tools

It is suggested that a draft prototype Toolkit be made available on electronic media. This demonstration product could include some standard public domain datasets, including monthly sea-surface temperatures, some reanalysis fields, global gridded observational data, some GPC model outputs, together with a selection of some possible candidate tools. There is a wide range of tools already in use by climate service providers. The extent to which these products meet the minimum standards would need to be assessed, but at this stage

the demonstration product is meant only to provide any illustration of what the Toolkit might look like, and would not be meant as an endorsement of any particular product. The following list provides a few examples of some of the more widely used tools; the list is not meant to be exhaustive.

1. Data management tools:
    a. Data portal (e.g., ClimatView[1]; IRI Data Library[2]; NOAA's Weather and Climate Toolkit[3]);
    b. Database management (e.g., ClimSoft[4], CliSys[5]);
    c. Climate analysis (e.g., Climate Explorer[6]).
2. Climate monitoring (CMT[7]).
3. Forecasting, downscaling and verification (Clik[8]; CPT[9]; PRECIS[10], SCOPIC[11]).

C. Proposals and Recommendations

- All countries are encouraged to create a National Framework for Climate Services to coordinate the development and provision of climate services within their country. The aim of the National Climate Service is to create a source of consistent and authoritative climate information within the country to foster better decision-making by the end users.

- Such a framework will involve the key national institutions collecting and compiling climate observations and other climate-related datasets, undertaking relevant research, producing and interpreting climate forecasts and projections, and providing tailored information products and expert advice. The National Meteorological Service (NMS) will be involved to varying degrees (depending on the range of activities of the NMS) in some or all of these activities and will be part of this national framework. In some cases international collaboration may also be appropriate, for example if capacity needs building.

- All countries are encouraged to create a **National Climate Centre**, an organization nationally mandated to have the responsibility for providing climate information and standardised products. The National Climate Centre would be part of this framework, perhaps central to it, and its outputs will be essential for the nation's climate services.

[1] http://ds.data.jma.go.jp/gmd/tcc/climatview/
[2] http://iridl.ldeo.columbia.edu/http://iri.columbia.edu/
[3] http://www.ncdc.noaa.gov/oa/wct/
[4] http://www.ssc.rdg.ac.uk/climsoft/
[5] http://www.mfi.fr/en/clisys-the-management-tool-for-all-climate-data-fiche-produit.php
[6] http://climexp.knmi.nl/start.cgi
[7] Under development by NOAA CPC.
[8] http://clik.apcc21.net/
[9] http://iri.columbia.edu/climate/tools/cpt/
[10] http://www.metoffice.gov.uk/precis/
[11] http://www.bom.gov.au/climate/pi-cpp/scopic.shtml

- If a country has a National Climate Centre then this would most likely be central to a national framework and its outputs will form the core of the nation's climate services. The NMS will be involved in some of the activities and will be part of this national framework.

- One organization within each country should be the **coordinator** of the National Climate Service. This coordination should ensure the consistency and quality of information and services, efficiently utilise the skills and resources within the country (i.e. avoid unnecessary duplication), and adopt best practices.

- The choice of the coordinating organization will vary from country to country. The organization needs to have the ability, and authority, to bring together all of the relevant institutions to enable the provision of authoritative, credible, usable, dependable, sustainable climate services. The NMS will in many countries be *well* placed to do this often having the ability and authority to do so, but it is for each country to decide which organization is *best* placed.

- Define a minimum set of climate information products, covering historical, monitoring, prediction and verification information, that are expected of the CSIS.

- Define a minimum set of climate services expected of the NMS in its role in the UIP.

- Outline the needs for, and implement a program of, training-of-trainers for core RCC staff to identify and support needs of NMSs in the provision of these minimum sets of climate products and services.

- Identify a primary set of Climate Service Toolkit contents.

- Create a draft prototype Toolkit from a selection of commonly-used climate datasets and the primary set of software tools that can be freely distributed on electronic media, or links to tools that are available only online.

- Conduct a program of training-of-trainers for core RCC staff in these tools.

- Establish a national Focal Point network for CSIS.

ANNEX

CCl Task Team on CLIPS Evolution

Task-Team Members

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Terms of Reference

Develop and provide to the CCl Management Group for further action the following:

1. A set of overall functions of National Climate Centres (NCCs) to coordinate national-level technical activities for basic climate data, diagnostics, climate system monitoring, and in many cases long-range forecasts (LRF), to help alignment with the core products and services of Global Producing Centres of Long Range Forecasts (GPCs) and Regional Climate Centres (RCCs)/RCC Networks;
2. A concept note on National Climate Services (NCSs), including proposals for a range of possible structures and coordination mechanisms and clear definitions of climate services, from the perspectives of national programmes, and services to users, ensuring due flexibility around the proposed roles and responsibilities of NCSs and NCCs according to national capabilities and priorities;
3. An outline for a climate information and prediction services toolbox;
4. Review of the past experiences with the CLIPS Focal Point network, and development of a new Climate Services Information System (CSIS) Focal Point network along with their Terms of Reference;
5. A draft action plan for the transition of CLIPS into the upcoming GFCS; and
6. Task-Team lead to inform the OPACE co-chairs that the task is finished and that the Team can be dissolved.