Report to the 33rd session of the Subsidiary Body for
Scientific and Technological Advice

A Framework for Terrestrial Climate-Related Observations and The Development of Standards for the Terrestrial Essential Climate Variables:

Proposed Workplan

Condensed Version (CV)

September 2010

Submitted by the Secretariat of the
Global Terrestrial Observing System
on behalf of its Sponsors
(FAO, ICSU, UNEP, UNESCO, WMO)

GTOS - 78

Table of Content:

Executive Summary

In 2009, the SBSTA "*encouraged the GTOS secretariat and the GTOS sponsoring agencies to implement the framework …for the preparation of guidance materials, standards and reporting guidelines for terrestrial observing systems for climate, and associated data and products",* proposed as a joint effort of the GTOS Sponsors and the International Organization for Standardization (ISO); and to "*elaborate a workplan for developing observational standards and protocols for the 13 terrestrial ECVs assessed*".

The workplan presented in this report consists of two main phases, the implementation of the organizational Framework and the standardization of individual Essential Climate Variables (ECVs). The proposed workplan is consistent with SBSTA decisions on this matter and with results of previous discussions among the UN agencies and the ISO. While most of the standard development work under the Framework will be carried out by technical bodies and experts, the overall effort requires substantial logistical, management and administrative support. The establishment of the Framework and coordination through the proposed JSG Secretariat has been estimated to require approximately US$970,000 annually until 2015 when the bulk of the standards should be completed. This estimate assumes that ISO members and other participants will fund the costs of their participation, consistently with the current ISO practice.

It is concluded that:

1. Sufficient information and technical resources are available to undertake the development of standards for priority ECVs to be addressed during the initial period, while progress continues to be made in other cases where standardization is less urgent.
2. The standardization should focus on *in situ* observation methods but since the resulting data will in many cases (~45-82% of ECV 'Observables') be used for the preparation of satellite-based information products, the needs of the latter must be built into the initial standards where feasible.
3. The specific issues and questions meriting standardization differ substantially among ECVs. Consequently, although a common architecture for the standards is desirable and should be defined at the outset, the standards development must address ECV- specific issues such as those identified in this report.
4. Significant financial resources are required if the Framework is to succeed in producing effective standards within the proposed time frame.

The following recommendations are made:

1. That SBSTA endorse this workplan, in present form or modified as appropriate.
2. That SBSTA requests:
    a) GTOS and its Sponsors together with ISO to implement the workplan.
    b) Parties to respond to the financial requirements of the standardization framework and to resource GTOS Secretariat to implement the workplan.
    c) Space agencies and the scientific community to continue developing capabilities for observing and delivering integrated terrestrial ECV information products from *in situ* and satellite data.
    d) GTOS report on the progress at the 35th session of the SBSTA.

1. Introduction and objectives

Reliable assessment of global and regional environmental changes - both natural and human-induced - requires systematic, sustained observations. The need for consistent and comprehensive global observations is particularly critical in case of climate change, due to the climate system affecting the environment and the society at all scales, from local to global. While such need exists in all three parts of the global system (atmosphere, oceans, land), it continues to be least satisfied for the land component. This problem was first articulated by the Global Climate Observing System in preparing its implementation plan (GCOS, 2003, 2004). Among others, the GCOS identified a need for *"a mechanism for establishing standards, regulatory material and guidelines for terrestrial observing systems"*. In its second adequacy report, GCOS (2003) also identified essential climate variables for atmospheric, oceanic and terrestrial domains *"that are both currently feasible for global implementation and have high impact with respect to the UNFCCC and IPCC requirements"*.

The deficiencies in land observations have subsequently been recognized by the Subsidiary Body on Scientific and Technological Advice (SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC). The SBSTA therefore requested (Decision 11/CP.9; UNFCCC, 2003) that the sponsoring agencies of the Global Terrestrial Observing System (GTOS) take action "*to develop a framework for the preparation of guidance materials, standards and reporting guidelines for terrestrial observing systems for climate, and associated data and products"*. At its 23rd session SBSTA "*also called on the GTOS secretariat to assess the status of the development of standards for each of the essential climate variables in the terrestrial domain*" (SBSTA, 2006, p. 16).

The above SBSTA requests initiated a series of actions by the GTOS and responses by the SBSTA (refer to SBSTA (2009a) for details). Based on these developments, the GTOS submitted a report (SBSTA, 2009a) summarizing steps taken to date, and then presenting (i) an approach to developing the Framework requested in SBSTA Decision 11/CP.9, and (ii) a status of the standards for the Essential Climate Variables (ECVs) in the terrestrial domain.

At its 30th session, the SBSTA (SBSTA, 2009b) "*welcomed the proposal contained in the updated progress report for a joint terrestrial framework mechanism between relevant agencies of the United Nations and the International Organization for Standardization, and encouraged the GTOS secretariat and the GTOS sponsoring agencies to implement the framework. The SBSTA also invited the GTOS secretariat and the GTOS sponsoring agencies to elaborate a workplan for developing observational standards and protocols for the 13 terrestrial ECVs assessed. It invited the GTOS secretariat to report on the results of the implementation of the framework and its elaboration of the workplan at SBSTA 33.*"

The present report contains a workplan for developing observational standards and protocols for the terrestrial ECVs which covers both aspects of the SBSTA's (2009b) request. While this report is focused on the needs of the UNFCCC it should be noted that the ECVs are also relevant to other UN Conventions (Biodiversity, Desertification), and in a broader context may be thus termed 'Essential Terrestrial Variables'. Consequently, results of an ECV standardization

process should have substantial impacts beyond climate- related issues, at both global and national levels. The term ‘standard’ is used throughout this document for brevity to represents guidance materials, standards and reporting guidelines.

2. Proposed workplan

The workplan outlined below addresses a) implementation of the Framework necessary for the development of ECV standards; and b) standardization issues for individual ECVs.

2.1 Organizational aspects

The 2009 report (SBSTA, 2009a) proposed an organizational structure which, in a modified form, is the basis for the planned implementation as described below.

Figure 1 shows the overall setting within which the ECV standardization will take place:

- The UNFCCC/SBSTA is the principal client for the desired standards but other UN organizations are also involved, both as participants in the development and as beneficiaries of the completed standards. It should be emphasized that the FCCC Parties are also a major beneficiary of the proposed standardization.
- The working tasks will be considered by the Joint Steering Group (JSG), a new entity established to consider and approve the plan of work, to coordinate the development of ECV standards, and to deal with numerous overarching or other issues that may arise. The JSG is inter-agency group external to the ISO's technical structure. It reports to the sponsoring UN organizations as well as to the ISO Technical Management Board (TMB).
- The development of standards will be carried out by Joint Working Groups (JWGs). JWGs and their terms of reference will be established by the JSG. Principal JWG tasks will be the preparation of Draft International Standards (DIS), Final DIS (FDIS), or other document formats as decided by the JSG. JWG membership will include appropriate representation of ISO Technical Committees, of UN organizations and their programs, and of other specialist bodies such as international scientific programs or projects.

Steps to be taken toward establishment of the JSG and JWGs are described in section 3.

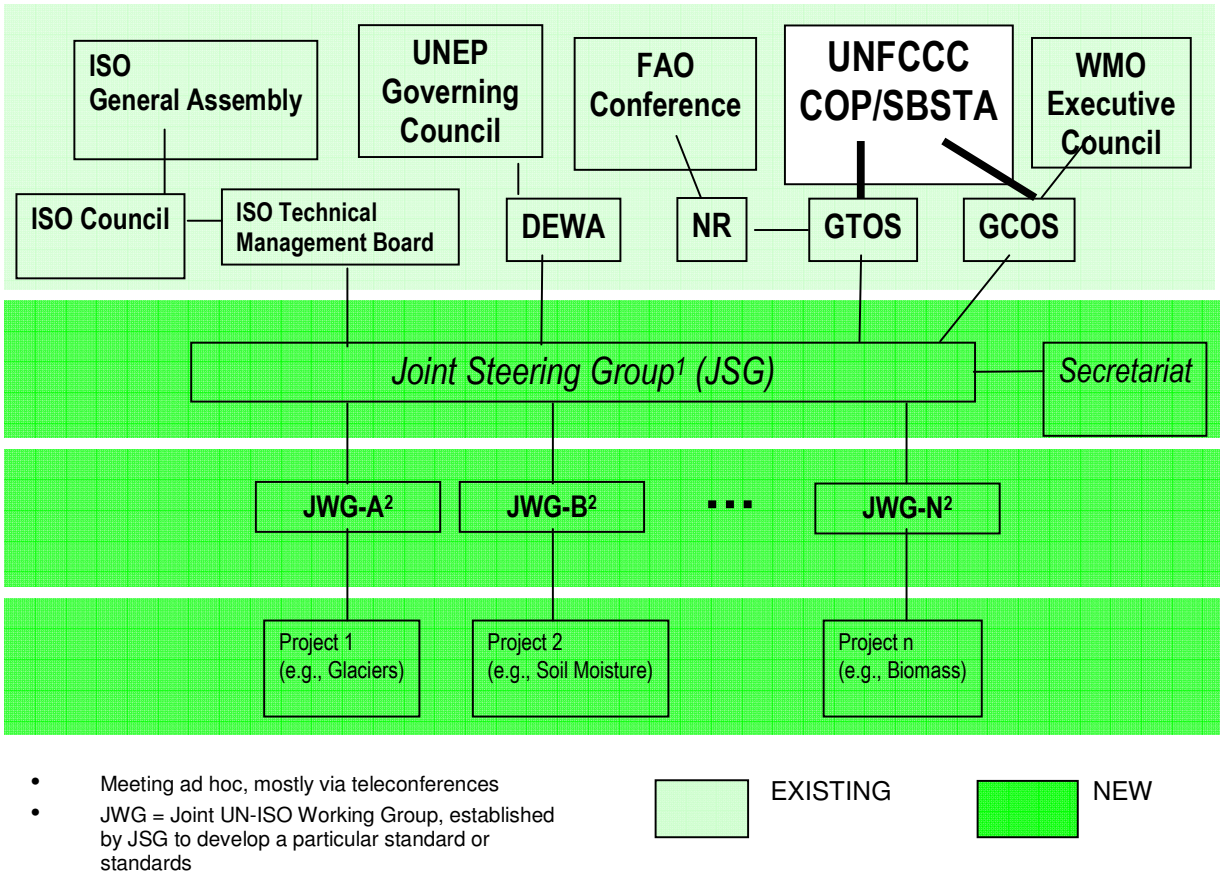
2.2 ECV standardization

2.2.1 Standardization process

The preparation of international standards is fundamentally a consensus- building process. For the resulting ECV standards to be applicable at national and sub-national levels as well as internationally this process requires the identification, evaluation of options, and resolution of various technical and practical issues.

The International Organization for Standardization (ISO) is the world's largest developer and publisher of International Standards (IS). A non-governmental organization with national standards institutes of 159 countries as members, the ISO forms a bridge between the public and private sectors, enabling a consensus to be reached on solutions that meet the requirements of business as well as the broader needs of society.

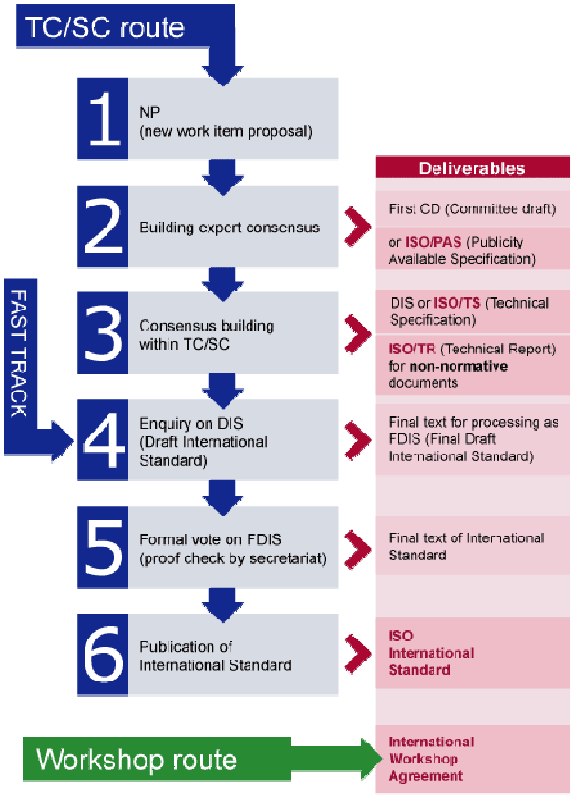
Figure 1. Organizational arrangement for the Framework: existing and new components.



Over the years, the ISO elaborated and refined the process of developing effective international standards that is capable of resolving the attendant complexities. Three standardization options are employed (Figure 2): the nominal (Technical Committee, TC) route, Fast track route, and Workshop route. Among the three, the TC route is the most effective in building consensus but also the lengthiest (the development of one standard typically takes several years). The Workshop route is the fastest but the resulting product (International Workshop Agreement) is less effective. The Fast track option is both relatively rapid, produces full international standards, and will be able to take advantage of the expertise available through ISO TCs.

For UNFCCC/SBSTA purposes and to maximize the usefulness of data collected for tracking climate change evolution and impacts, rapid progress toward ECV standardization is an essential requirement. Therefore, the Fast track (and Workshop) routes are to be strongly preferred. The Fast track option bypasses initial steps involved in a) building consensus on the need for an international standard, and b) achieving consensus on the technical aspects of the standard (Figure 2). Where consensus has not yet been achieved on technical issues but there is urgent need to have a standard in place, the Workshop route should be considered as an approach that produces an interim solution. The joint UN-ISO character of the JSG and its position outside the ISO technical structure will also facilitate use of the most efficient and effective route among the

Figure 2. ISO procedure for standards development: options and main phases.



existing ISO options. These ISO mechanisms also enable countries to contribute expertise and financial resources to accelerate the process and ensure its effectiveness.

Essential Climate Variables (ECV) are environmental parameters considered to be the most important for understanding, detecting, monitoring, and assessing the impact of climate change. As such, the list of variables can be expected to evolve. For the terrestrial domain, the initial list consisted of 13 variables (GCOS, 2004). Soil moisture was recognized as an emerging ECV in 2004 and added since (SBSTA, 2009c), and Soil Carbon and Terrestrial biodiversity and habitat properties were proposed as candidate ECVs in 2009 (SBSTA, 2009c). This plan addresses 14 ECVs for which have been considered for standardization so far, namely: Albedo, Biomass, FAPAR, Fire disturbance, Glaciers, Ground water, LAI, Lake levels and reservoir storage, Land cover, Permafrost, River discharge, Snow cover, Soil moisture, Water use.

2.2.2 Considerations and factors

The workplan must reflect both the need for ECV standards and the availability of knowledge, experience and expertise that together will determine if a standard may be successfully and promptly completed. The large number of ECVs and the urgency in developing standards are important factors and constraints for the workplan. Given the large number of ECVs and the finite resources available for this work, the development process needs to be sequential, and it

should begin with important ECVs that are 'ripe' for standardization. However the urgency of the requirement for standardization means that several standards need to be under development at any one time.

In developing a plan for standardizing individual ECVs, a key challenge will be to identify the specific issues a standard must address. Given that the goal of this process is to track the evolution and impacts of climate change in the terrestrial domain, the most important questions concern the extent/ coverage, characteristics/ quality, consistency (including compatibility), and availability/ accessibility of the observations (and information on these attributes) for individual ECVs.

Although the issue of standardization initially arose in the context of *in situ* observations, many terrestrial ECVs require use of satellite data (GTOS, 2010). Thus ideally, the ECV standards should encompass both *in situ* and satellite data. However, a good portion of the satellite- based techniques is at an experimental stage, variously focusing on product validation, algorithm development, or sensor development.

The desired number of deliverables from each ECV standardization project and the scope of each are also an important consideration. ISO experience has shown that the preparation and approval of a complex, comprehensive standard is more difficult and lengthier than of several simpler standards addressing components of the problem.

The status of standardization for individual ECVs was previously described at several levels of detail, including GTOS reports to SBSTA (refer to SBSTA (2009a) for the list), reports by the Global Climate Observing System (SBSTA, 2009c), and detailed reports prepared by the GTOS for individual ECVs (available at http://www.fao.org/gtos/pubs.html). In preparing this workplan, the previously collected information was used to identify critical issues that need to be addressed during the standardization process. Specifically, for each ECV a brief summary was provided of:

- Importance and urgency;
- Readiness and feasibility;
- Available documentation (to use in drafting the standards);
- Existing expertise (specialized scientific/ technical groups, committees).

A brief summary under these headings is provided for each ECV in the full report (GTOS, 2010).

2.2.2.1 Prioritization

Given the large number of terrestrial ECVs and the finite resources available for standardization, prioritization is a key step and a way to maximize effectiveness of the process. In preparing this workplan, individual terrestrial variables were therefore assessed using two types of criteria:

a) Urgency and importance:
   - How critical (in relative terms) is the need for a standard becoming available during the next 2-4 years?
   - Are some standards, guides or similar documents in place which can serve in the interim?

- Are only few groups/ organizations involved who are already collaborating/ sharing methodologies (thus lessening the urgency for a standard)?

b) Readiness and feasibility:
   - Has the observation methodology developed sufficiently to enable definition of an international standard? In relation to the Fast track route as the preferred option (section 2.2.1) this question can be rephrased as, does sufficient documentation exist upon which a Draft International Standard could be built?
   - Are there candidate groups for providing technical expertise in the development of a standard?

Based on information available for individual ECVs the resulting relative ratings were summarized. Using this and other supporting information (SBSTA (2009a) and references provided there), the 14 ECVs were placed into three priority tiers:

Tier 1: High priority: ECV ready for standardization to begin now;
Tier 2: Medium priority: standardization to begin in ~3 years;
Tier 3: Low priority: standardization to begin after ~3-4 years.

Tier 1 is further divided into two groups on the basis of urgency, i.e. existence of documentation and/ or of ongoing collaboration through which convergence to standard approaches is already evolving.

The resulting ECV groups are as follows (refer to Table 1 of GTOS, 2010 for further details):

Tier 1 (High (H) – Medium (M) urgency, H-M readiness):
Tier 1a = initial set: 5 ECVs:
- ECV Biomass
- ECV Glaciers and Ice Caps
- ECV Land Cover
- ECV Permafrost
- ECV Soil Moisture

Tier 1b = coincident with *Tier 1a* (provided resources are available):
- ECV Leaf Area Index
- ECV River Discharge

Tier 2 (M-Low (L) urgency, H-M readiness):
- ECV Albedo
- ECV Fraction of Absorbed Photosynthetically Active Radiation
- ECV Snow Cover

Tier 3 (L urgency or L readiness):
- ECV Fire Disturbance
- ECV Lake Levels and Reservoir Storage
- ECV Ground Water
- ECV Water Use.

The above analysis implies that the first five variables (ECV Biomass, ECV Glaciers and Ice Caps, ECV Land Cover, ECV Soil Moisture, and ECV Permafrost) should form the initial standardization cohort. If sufficient resources are available, this cohort should be expanded by adding ECV Leaf Area Index and ECV River Discharge.

2.2.2.2 Satellite vs. *in situ* observations

The descriptions of individual ECVs (GTOS, 2010) show that in most cases, an ECV encompasses several different types of observations. These may differ in kind as well as spatial and/ or temporal attributes. Thus, the ECVs are in reality compound variables for which one or more observables need to be obtained. The term "Observable" is used here to distinguish these specific measurements from their respective ECVs. Spatially, the various *in situ* observables may or may not be taken at exactly the same spot on the ground; and they may be expressed as a point (a site possibly with several sub-sites), a line, or a polygon (a boundary delineating a homogenous patch). To various degrees, the ECVs require *in situ* and satellite- based observables, the latter typically derived using gridded spatial coverage.

Table 1 provides a preliminary analysis of this aspect, including required observables by ECV, the relative contributions of *in situ* and satellite data, and (for satellite techniques) the relative importance (compared to *in situ*) as well as the current status of development. The 14 ECVs considered in this workplan represent 38 different observables. Using *in situ* techniques, roughly 23 (60%) are taken as point measurements, 14 (37%) as polygons, and one (glacier front variation) as a line (it should be noted that the numbers depend somewhat on the measurement technique, e.g. some 'point' measurements may actually be taken along a line). Regarding the relative importance of *in situ* and satellite observations, satellite data are a primary data source for the final ECV product in 17 cases (45%) and play supporting role in 14 (37%). Seven observables (18%) rely on *in situ* observations alone, and will likely continue so for the foreseeable future because most of these measurements are concerned with subsurface properties. A number of the satellite approaches are under active development.

The analysis shown in Table 1 indicates that standards for *in situ* observations must in most cases consider, and respond to, the needs of satellite- based information products. This need not dampen the progress in standardization for those observables, even where satellite- based methods or algorithms are still under development. The reason is that the requirements for *in situ* observations (in support of satellite- based products preparation) are quite well understood for most of the ECVs concerned.

The last column of Table 1 indicates the typical present suppliers of *in situ* observables, either actual or potential. The 'coverage' is neither global nor uniform, and so the designation should be taken as indicative rather than definitive. [For example, national biomass inventories contain information on above ground forest biomass, not other forest biomass pools and no other vegetation types. Nevertheless, national monitoring programs (as opposed to science projects) were listed in Table 1 as the likely source because if such *in situ* observations were to be routinely provided, they would have to be collected by national agencies.] Table 1 does indicate

Table 1. Characteristics of specific observables for terrestrial ECVs.

ECV	In situ observations			Role of satellite data[1]	Source of in situ observations[2]
	Specific observation type needed	**Spatial dimension**	**Exactly co-located in situ?**		
BIOMASS	Above-ground biomass (all living biomass above the soil)	Point	Yes	Supporting (upscaling via land cover); Primary under development	NMP[2]
	Below-ground biomass (all living biomass of live roots)	Point		Supporting (upscaling via land cover)	
	Dead mass (all non-living woody biomass not contained in the litter)	Point		Supporting (upscaling via land cover)	
	Litter (all non-living biomass above the mineral or organic soil)	Point		Supporting (upscaling via land cover)	
GLACIERS .	Glacierized area	Polygon	Yes	Primary	NMP/SP[2]
	Specific mass balance	Polygon		Supporting (under development)	
	Glacier front variation	Line		Primary	
LAND COVER	Land cover type/ category	Patch/ Polygon	Yes	Primary	NMP
	Land cover attribute (e.g., fraction of tree canopy cover)	Patch/ Polygon		Primary	
	Change in land cover type/category or attribute(s)	Patches/ Polygon		Primary	
PERMAFROST	Thermal state of permafrost	Point	Yes	None	NMP/SP

	Active-layer thickness	Point		None	
	Permafrost areal extent	Polygon	No	Supporting (via land cover properties)	
	Seasonally frozen ground	Polygon		Primary	
SOIL MOISTURE	Profile moisture distribution	Point	No	None	NMP/SP
	Landscape moisture distribution	Areal distribution		Primary (under development)	
LAI	Total leaf area	Patch/Site	Yes	Primary	SP
	Canopy clumping index	Patch/ Site		Supporting (via land cover, multiangular observations)	
RIVER DISCHARGE	Velocity of water	Point	Yes	None	NMP
	Riverbed profile	Point		None	
ALBEDO	Direct, diffuse and total incoming solar radiation	Point	Yes	Primary	SP
	Reflected radiation	Point		Primary	
FAPAR	PAR measurements above & below canopy	Patch/ Site	Yes	Primary	SP
SNOW COVER	Snow depth	Point	Yes	Supporting (under development)	NMP
	Snow water equivalent	Point		Supporting (under development)	
	Snow cover extent	Polygon	No	Primary	
	Snow cover duration	Polygon		Primary	
FIRE DISTURBANCE	Active fires	Polygon	Yes	Primary	NMP/SP
	Radiated power	Polygon		Primary	
	Total burned area	Polygon		Primary	
GROUND	Groundwater	Point		Supporting	NMP

WATER	level		Yes	(gravity missions, under development)	
	Recharge and discharge	Point		Supporting (gravity missions, under development)	
	Well level	Point		Supporting (gravity missions, under development)	
	Water quality	Point		None	
LAKE LEVELS and RESERVOIR STORAGE	Lake- specific area-volume curve	Site	Yes	Supporting (area measurement)	NMP
	Water level	Point		Supporting (under development)	
WATER USE	Area of irrigated land	Polygon	No	Primary	NMP
	Amount of water used for irrigation	Point		None	

NOTES:

1) Describes the role of satellite data in preparing the final information product for that observation over the spatial domain of interest (global, regional):
   Primary: final product is prepared using satellite measurements as primary source, with *in situ* observations providing quantifying/ validation information.
   Supporting: final product relies on *in situ* observations, with satellite supporting upscaling to areal coverage.
   Note that some satellite techniques are presently under development, including experimental satellite missions that have been launched.
2) A likely source of *in situ* observations:
   NMP = national monitoring program (agencies presently collect such data, at least in some countries);
   SP= science programs and projects (existing programs/ projects collect such observations; continuity uncertain). Some scientific observations and resulting networks may be eventually transformed into ongoing monitoring programs (this has been the case in ocean observations).
   Where both modes are indicated: both types of organizations currently collect such data (or potentially could do so in the future).

that both NMPs and SPs play important roles in providing *in situ* observations. Depending on the ECV, one or both of these are presently the main supplier of such data. This situation may be expected to continue into the future, as operational observing systems evolve fairly gradually.

In terms of standardization, an important implication of the last column in Table 1 is that where the *in situ* data are collected through national monitoring programs, the procedures are more likely to differ among countries (compared to science programs which tend to be more coordinated). Furthermore, they are likely embedded in existing national protocols, thus complicating the development of an acceptable international standard. One solution to this challenge has been demonstrated by ISO Technical Committee 211 which, in preparing a standard for land cover, focused on the development of a common meta-language as a tool to formalize the meaning of any existing land cover classification/legend. Given current data collection programs and practices, the NMP/SP issue may also be important for the following ECVs: Biomass, River Discharge, Snow Cover, Fire Disturbance, Ground Water, Water Use.

2.2.3 ECV- specific issues

As evident from the previous sections, the 14 terrestrial ECVs differ substantially in various aspects relevant to standardization. To make the process efficient and the resulting standards effective, the most important aspects need to be identified and addressed during the standard development process. These will not only differ among ECVs, but are also likely to change over time (e.g., as *in situ* and satellite measurement techniques evolve).

As a step in this direction and to develop a workplan that would reflect the needs of individual ECVs, the following items were addressed for each ECV:

(a) Key issues and questions to be resolved in a standardization process; and
(b) Suggested action within the UN-ISO Framework.

The remainder of this section contains results for part (b) only (Suggested actions); issues for part (a) are itemized in GTOS (2010).

a) Tier 1

ECV Biomass

1. Establish a JWG to develop an ISO International Standard for obtaining and reporting biomass information for climate- related purposes.
2. Continue the development and validation of satellite- based biomass measurement methods and products.

ECV Glacier and Ice Caps

Establish a JWG to develop an ISO International Standard for obtaining and reporting glacier and ice caps observations for climate- related purposes.

ECV Land Cover

1. Complete the preparation of ISO international standards for land cover (currently underway).
2. Assess the current feasibility of standardizing fractional land cover products using Fast track or Workshop ISO mechanisms.

ECV Permafrost

Establish a JWG to develop an ISO International Standard or an ISO Guide for making and reporting permafrost observations for climate- related purposes.

ECV Soil Moisture

Organize an international workshop(s) to complete an ISO Workshop Agreement on the preparation and reporting of site- and landscape- level soil moisture information.

ECV Leaf Area Index (LAI)

Define an ISO International Standard or an ISO Guide encompassing: making LAI measurements *in situ*, the preparation of satellite- based products making use of *in situ* data, and reporting LAI information for climate change- related purposes (all subject to the availability of resources).

ECV River Discharge

Establish a JWG to prepare an ISO International Standard for climate- related purposes that will bring together and build upon existing standards and guides.

b) Tier 2

ECV Albedo

1. Establish and ad hoc group to evaluate the urgency and feasibility of completing an ISO international standard for albedo products generated from *in situ* and satellite data; and to recommend a plan of action (section 3.2.1).
2. If appropriate and subject to the availability of resources, implement the plan.

ECV Fraction of Absorbed Photosynthetically Active Radiation

Establish an ad hoc expert group to prepare a proposal and a timetable for completing an ISO Guide for FAPAR information products for climate- related purposes, including an outline of the proposed standard and a timetable that encompasses *in situ* and satellite- based observations.

ECV Snow Cover

1. Establish and ad hoc group to evaluate the urgency of completing an ISO International Standard for snow cover products that are based on *in situ* and satellite data; and to recommend a plan of action (refer to section 3.2.1).
2. If appropriate and subject to the availability of resources, implement the plan.

c) Tier 3

ECV Fire Disturbance

1. Establish and ad hoc group to (i) evaluate the urgency and feasibility of completing an ISO Guide or Workshop Agreement for *in situ* fire disturbance information and for the preparation of satellite- based products using both types of observations; and (ii) recommend a plan of action (section 3.2.1).
2. If appropriate and subject to the availability of resources, implement the plan.
3. Continue the development of techniques for quantifying fire radiated power and the definition of validation protocols.

ECV Ground Water

Establish an ad hoc group to: (i) analyze the adequacy of existing standards and guides for climate- related purposes; and (ii) if appropriate, develop a plan of action (section 3.2.1).

ECV Lake Levels and Reservoir Storage

Establish an ad hoc expert group to: (i) analyze the adequacy of existing standards and guides for climate- related purposes; and (ii) if appropriate, develop a plan of action (section 3.2.1).

ECV Water Use

Standardization action should be deferred pending developments in AQUASTAT.

3. Implementation

The overall implementation involves two phases: implementation of the organizational Framework, followed by the development of ECV standards within this Framework.

3.1 Framework implementation

The foundations for the Framework are SBSTA's endorsement of the GTOS 2009 proposal (SBSTA, 2009a) and a Memorandum of Understanding (MOU) between the GTOS Sponsors and the ISO. A draft MOU has been completed and is ready for signature, conditional upon SBSTA's endorsement of this workplan. The MOU defines the Framework organization and operation at a high level, and the details provided in the current report are consistent with it.

It is envisioned that the following steps will be required to implement the Framework, assuming SBSTA's endorsement of this report and its recommendations:

- MOU signing by the GTOS Sponsors (FAO, ICSU, UNEP, UNESCO, WMO) and the ISO;
- Establishment of the Joint Steering Group (JSG), including and specifying a consistent way to represent GTOS Sponsors;
- Adoption of the JSG terms of reference, nomination of its members, and establishment of the JSG Secretariat;
- Establishment of a resource and support mechanism for the JSG, including the Secretariat.
- Adoption of workplan by the JSG (based on this report and after modifications as required).

Once the workplan is adopted the stage will be set for the development of ECV standards.

3.2 ECV Standards

The overall approach consists of:

- Adopting a common format/ architecture for the ECV standards (section 3.2.1) and an overall plan for sequencing the standards development work;
- Specifying the content and a strategy for standards development based on proposals of the approach to be adopted for each ECV (section 3.2.2); and
- Executing the approved proposals, tracking progress and modifying the developmental strategy as appropriate.

3.2.1 Common format

The various ECV standards to be developed are intended to be used for a common purpose, supporting the needs of the UNFCCC. Collectively, they also describe one domain, the terrestrial component of the Earth environment. It is therefore desirable that the individual standards share a general structure and conform to a common 'look-and-feel'. The definition of such common architecture is a task for the JSG and should precede the preparation of ECV- specific proposals.

Existing ISO standards of similar type should be used and modified as necessary to better match the needs of the ECVs.

3.2.2 ECV- specific proposals

Given the complexities and differences among the terrestrial ECVs, the standardization process needs to be carefully designed to match the various ECV- specific issues. Therefore, individual proposals need to be prepared and reviewed before the standards development work begins. The proposals should build on the discussion presented in this report by exploring in detail the issues raised (and others relevant to a particular ECV) so that a standard is properly focused, covers the important aspects, and can be completed efficiently and in timely manner. It is suggested that proposals for ECV standardization employ a common table of content and be limited to no more than ~3-4 pages. The proposed main headings are: Objectives; Scope; Applicable existing standards, guides and other sources; and Approach to implementation. GTOS (2010) contains the complete table of content for these proposals.

The above table of content should be finalized and approved by the JSG. The proposals for ECV standardization should then be prepared by ECV coordinators within the GTOS, with contributions by experts familiar with ISO standards development.

3.2.3 Standards development, approval and endorsement

Considering the differences among ECVs and the need for various types of input and expertise, it is proposed that a Joint Working Group (JWG) be established for each ECV to be standardized. The terms of reference for the JWG would be tailored to the needs of that ECV. They would be based on the general JWG Terms of Reference, supplemented or modified as appropriate to ensure the ECV- specific issues are dealt with. The ECV- specific JWG, its terms of reference, membership and reporting should be specified by the JSG following the consideration and approval of the ECV proposal (section 3.2.2). The actual development and approval process will follow procedures and practices of the ISO (SBSTA, 2009a; GTOS, 2010).

The approved standards will be presented by the GTOS and its Sponsors to the UNFCCC/SBSTA for endorsement as ‘meeting the requirements of the UNFCCC’. They will be published and made available in a way consistent with the UN-ISO Memorandum of Understanding, and maintained using ISO procedures and practices.

3.3 Tasks and timetable

Following the UNFCCC/SBSTA decision regarding this proposed workplan, the next priority actions are the establishment of the JSG and the finalizing the format for developing ECV-specific proposals for standardization. Immediately after (and possibly overlapping in time with JSG deliberations) ECV coordinators would start the preparation of specific proposals for Tier 1 (or 1a only, section 2.2.2.1) ECVs. The completed proposals will be submitted to the JSG for consideration and approval, after which the JSG will take steps to establish the required JWGs

and to implement the proposed standardization for the selected ECVs. Once the above actions are underway, an analysis and preparations for standardizing other ECVs may proceed in parallel or delayed mode.

Table 2 contains a more list of actions in the end-to-end ECV standards development/ endorsement process and the actors responsible for completing these actions. Tasks 4-7 are to be undertaken for each ECV Tier, and tasks 8a through 8h for each ECV. According to ISO procedures, individual standards are regularly reviewed and updated as appropriate. This review and update function is also provided for in the implementation (Table 2).

Table 2. Summary of actions and groups/ leads responsible for implementation

Task	**Action led/ by**
1. Signing MOU	ISO, GTOS Sponsors
2. Creation of JSG, appointment of Chair, establishment of JSG Secretariat	ISO, GTOS Sponsors
3. Development of common format/ architecture for ECV standards	JSG
4. Finalizing, approving and issuing request for proposals re initial ECV standards development	JSG
5. Preparation of proposals for ECV standard development	ECV Coordinators/ GTOS
6. Finalizing and approving ECV standard preparation procedures, including JWG terms of reference and operating procedures	JSG
7. Evaluating received proposals for ECV standards preparation, and finalizing program of work for the initial series of ECVs	JSG
8. For each ECV selected:	
a) Establishment of the JWG	JSG
b) Completing preparation of the ECV standard document[1] for voting	JWG
c) Submission of the DIS to voting ('Enquiry')	ISO Secretariat
d) Revision of DIS and preparation of the Final DIS (FDIS)	JWG
e) Formal voting on FDIS	ISO Secretariat
f) Endorsement of FDIS	SBSTA, GTOS Sponsors
g) Publication of IS	ISO
h) Periodic review and revision of IS	JSG on the advice of ECV Science Leads/GTOS
9. Prepare proposals for Tier 2 and later Tier 3 ECVs (in parallel)	As above
10. Repeat steps 5. through 8., adjusting priorities and procedures as appropriate	As above

NOTE:
1) Assumed to be Draft International Standard (DIS); the steps may differ depending on the form of the standard document.

An approximate timetable for the Tier 1a ECVs is as follows, assuming SBSTA's approval of this workplan in November 2010:

2011:
- Signing UN-ISO MOU
- JSG establishment
- Preparation of ECV proposals for priority ECVs
- JSG decision on initial standards to be developed, establishment of JWGs, JWG work begins

2012-2015:
- Development, approvals and publication of ECV standards for priority ECVs
- Preparation of proposals for other ECVs
- JSG decisions on other standards to be developed, establishment of appropriate JWGs, JWG work underway.

At this point it is difficult to estimate when the bulk of the ECV standards will have been completed. The speed and efficiency involved in the initial set will provide an indication of the degree of complexity and thus likely duration of each standard development task. The level of financial and human resources will also play a key role in determining the overall time requirement.

3.4 Resources for implementation

While most of the standard development work under the Framework will be carried out by technical bodies and experts, the overall effort requires substantial logistical, management and administrative support.

Previous experience shows that the development of effective international standards requires substantial support for coordination activities. Contributions to drafts of working documents, project management, and organization and execution of meetings are among the functions of an ISO Technical Committee Secretariat (ISO, 2008). For the terrestrial ECVs, the task is further complicated by the precedent- setting establishment of the Framework structure, the thematic diversity of the needed standardization documents, and by the need to develop and publish the standards over a short time period so that the harmonization of global terrestrial observations may proceed as expeditiously as possible. These circumstances imply a high degree of administrative activities over the next few years.

Within ISO, each TC has a Secretariat maintained by a willing ISO member. The proposed JSG Secretariat will require a higher initial - and similar ongoing - level of support. A more detailed analysis has shown that approximately US$970,000 will be required annually for the establishment of the framework and for ECVs development, until 2015 when the bulk of the standards should be completed. This estimate assumes that (i) the participation of country representatives and other TC members will be funded by ISO member countries following the

current practice; (ii) UN agencies or other organizations (e.g., international scientific organizations) that wish to contribute to developing a standard will fund their representatives; and (iii) the overhead administrative cost of the proposed Fast track route will be much reduced compared to the standard TC route. Additional funds may also be required to support the participation of developing countries and to enhance the level of activities of the most directly implicated ISO Technical Committees.

4. Conclusions and Recommendations

This report analyzes issues involved in standardizing Essential Climate Variables in the terrestrial domain to prepare a workplan for the development of such standards within a Framework endorsed by the UNFCCC/ SBSTA. The proposed workplan consists of two main phases, the implementation of an overall organizational Framework and the standardization of individual ECVs. The overall approach as well as specific tasks for each phase have been elaborated, and a timetable described. The proposed workplan is consistent with SBSTA decisions on this topic and with results of previous discussions among UN agencies and the ISO.

It is concluded that:

1. Sufficient information and technical resources are available to undertake the development of standards for ECVs to be addressed during the initial period, while progress continues to be made in other cases where standardization is less urgent.
2. The standardization should focus on *in situ* observation methods but since the resulting data will in many cases (~45-82% of the ECV observables) be used for the preparation of satellite- based information products, the needs of the latter must be built into the initial standards where feasible.
3. The specific issues and questions meriting standardization differ substantially among ECVs. Consequently, although a common architecture for the standards is desirable and should be defined at the outset, the standards development must address ECV- specific issues such as identified in this report.
4. Significant human and financial resources are required if the Framework is to succeed in producing effective standards within the proposed time frame.

The following recommendations are made:

1. That SBSTA endorse this workplan, in present form or modified as appropriate.
2. That SBSTA requests:
    a) GTOS and its Sponsors together with the ISO to implement the workplan.
    b) Parties to respond to the financial requirements of the standardization framework and to resource GTOS Secretariat to implement the workplan.
    c) Space agencies and the scientific community to continue developing capabilities for observing and delivering integrated terrestrial ECV information products from *in situ* and satellite data.
    d) GTOS report on the progress at the 35th session of the SBSTA.

5. References

GCOS. 2003. The Second Report on the Adequacy of the Global Observing System for Climate in support of he UNFCCC. Report GCOS – 82 (WMO/TD No. 1143). 74p.

GCOS. 2004. Implementation Plan for the Global Observing System for Climate in support of the UNFCCC. Report GCOS – 92 (WMO/TD No. 1219). 136p.

GTOS. 2010. A Framework for Terrestrial Climate-Related Observations and The Development of Standards for the Terrestrial Essential Climate Variables: Proposed Workplan. Complete Report (of which this Summary report is a condensed version), submitted to SBSTA, October-November 2010. 48p.

ISO. 2008. ISO/IEC Directives, Part 1. Procedures for the technical work. 6th edition, International Organization for Standardization. 76p.

SBSTA. 2006. Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-third session, held at Montreal from 28 November to 6 December 2005. Report FCCC/SBSTA/2005/10. 33p.

SBSTA. 2009a. Assessment of the status of the development of standards for essential climate variables in the terrestrial domain and development of a framework for climate-related terrestrial observations: Update on progress. Report CCC/SBSTA/2009/MISC.8, Subsidiary Body for Scientific and Technological Advice, Thirtieth session, Item 6 of the provisional agenda, Research and systematic observation, Revised submission from the secretariat of the Global Terrestrial Observing System, Bonn 1–10 June 2009. 86p.

SBSTA. 2009b. Report of the Subsidiary Body for Scientific and Technological Advice on its thirtieth session, held in Bonn from 1 to 10 June 2009. Report FCCC/SBSTA/2009/3, 5 August 2009. 31p.

SBSTA. 2009c. The Global Climate Observing System implementation plan: a provisional update including provisional cost estimates. Report FCCC/SBSTA/2009/MISC.12, Subsidiary Body for Scientific and Technological Advice, Thirtieth session, Item 6 of the provisional agenda, Research and systematic observation, Submission from the secretariat of the Global Climate Observing System, Copenhagen, 7–18 December 2009. 156p.

UNFCCC. 2003. Report of the Conference of the Parties on its Ninth Session, held at Milan from 1 to 12 December 2003. Part Two: Action Taken by the Conference of the Parties at its Ninth Session. 65p.

6. Acronyms

DIS	Draft International Standard
ECV	Essential Climate Variables
FAO	Food and Agriculture Organization
FDIS	Final Draft International Standard
GTOS	Global Terrestrial Observing System
HWRP	Hydrology and Water Resources Program
ICSU	International Council for Science
ISO	International Organization for Standardization
JSG	Joint Steering Group
JWG	Joint Working Group
LAI	Leaf Area Index
MOU	Memorandum of Understanding
NMP	National Monitoring Programme
SBSTA	Subsidiary Body for Scientific and Technological Advice
SP	Science Programme
TC	Technical Committee
TMB	Technical Management Board (of ISO)
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
WMO	World Meteorological Organization