INTRODUCTION

by Han Dolman, John Latham and Reuben Sessa

The 2007 IPCC assessment unequivocally states that humans have significantly changed the composition of the atmosphere and that, as a result, our climate is changing. To be able to attribute the causes of climate change, analyse the potential impacts, evaluate the adaptation options and enable characterization of extreme events such as floods, droughts and heat waves, globally consistent sets of observational data are needed. Without such baseline data it will not be possible develop the products needed by policy and other stakeholders.

The climate observing system in the terrestrial domain is, however, still poorly developed, while at the same time there is increasing significance being placed on terrestrial data for impact, adaptation and mitigation activities. The precise quantification of the rate of climate change also remains important to determine whether feedback or amplification mechanisms, in which the terrestrial surface plays an important role, are operating within the climate system.

The Global Terrestrial Observing System (GTOS) is supporting its Sponsors (FAO, UNEP, WMO, UNESCO, ICSU) and the broader stakeholder community to address issues of climate change and climate variability, especially with regard to its effects on food security, the environment and sustainable development. The GTOS Secretariat, with the assistance of its Panels, is also supporting the observational requirements of the UNFCCC. In particular it is developing possible mechanisms for a terrestrial framework and assisting the implementation of the 13 terrestrial Essential Climate Variables (ECVs), including the assessment of the status of available standards. These terrestrial, with oceanic and atmospheric, ECVs were originally identified in the implementation plan developed by GCOS and its partners as the observations that are currently feasible for global implementation and have a high impact on the requirements of the UNFCCC and other stakeholders. These activities are also recognized as an official task of the Global Earth Observation System of Systems (GEOSS).

GTOS liaises with relevant research and operational communities to identify measurable terrestrial properties and attributes that control the physical, biological and chemical processes affecting climate. Through its Secretariat and its Panels, especially TOPC (a joint panel of GTOS and GCOS), GTOS is playing an important role towards improving the understanding of the terrestrial components of the climate system, the causes of change to this system and the consequences in terms of impact, adaptation and mitigation. An important role is also played in regards to international coordination; supporting the *in situ* Global Terrestrial Networks undertaking the observations; determining the requirements of stakeholders; and assessing the available methodologies and standards which are required.

The establishment of both independent bottom-up data sets of ECVs and data sets required for calibration and validation of Earth Observation data is an important activity of the networks. Only harmonized,

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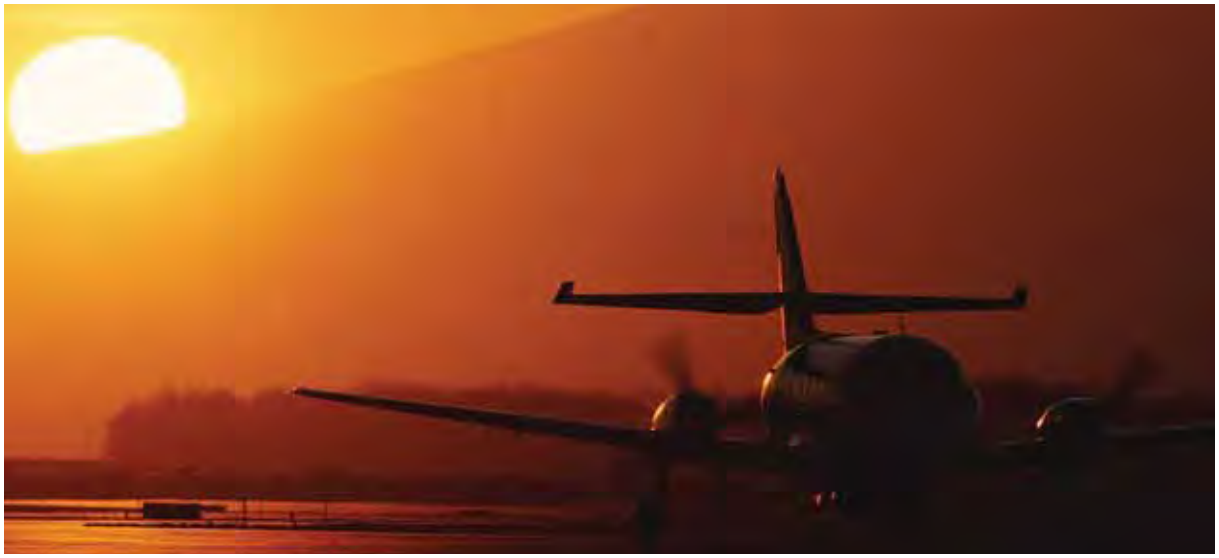

consistent data sets provide the multi-user community, which includes the UNFCCC, countries and other organizations dealing with elements of global change, such as desertification, with the high quality global data sets required to achieve their purpose.

The international space agencies, through the Committee for Earth Observation Satellites (CEOS), have agreed to provide multi-decadal climate products covering the terrestrial, oceanic and atmospheric domains. Internationally agreed validation protocols and benchmarks are, however, not always available for terrestrial climate variables. GTOS and its science Panels are collaborating with the CEOS' Working Group on Calibration and Validation to establish such protocols and benchmarks.

However, despite the demonstrated importance of the terrestrial climate variables and the work that is ongoing, there are still important gaps in satellite and especially *in situ* observations, and these need to be filled and resolved. These concern, for example, the apparently ever decreasing number of stations measuring river discharge, and the scarcity of suitable networks observing permafrost. A further challenge is to ensure continuity in cryospheric observations, some of which were only initiated under the International Polar Year. The hydrological variables in the terrestrial domain also require attention, especially those relating to soil moisture (which is a key variable linking the atmospheric and terrestrial branches of the hydrological cycle) and groundwater (as a declining and often overexploited resource for fresh water). In addition, the terrestrial variables that play a role in the carbon cycle need to be monitored in a comparable way to the other terrestrial ECVs. TOPC will work closely with the Terrestrial Carbon Observation Panel of GTOS to achieve this. The importance of these observations and some of the activities, gaps, concerns and funding requirements have been highlighted in this report.

Responding to new and changing requirements of the UNFCCC and other conventions, as well as the needs of international treaties and agreements, GTOS and GCOS will assess the adequacy of current *in situ* and remote sensing observations, and review and suggest new terrestrial ECVs that are strongly needed to determine transient change, adaptation, impact and mitigation. The GTOS Secretariat and its technical Panels, especially TOPC, will continue to play a fundamental role in this process, emphasizing the need for consistent, harmonized observation of key terrestrial variables.

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