CGMS

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OUTCOME OF THE WCRP OBSERVATION AND ASSIMILATION PANEL (WOAP) WORKSHOP ON EVALUATION OF SATELLITE RELATED GLOBAL CLIMATE DATASETS

In response to CGMS Recommendation R38.03

Under the auspices of the World Climate Research Programme (WCRP) Observation and Assimilation Panel (WOAP), a workshop was hosted by the European Space Agency (ESA) in Frascati, Italy on 18-20 April 2011 to prepare a technical report on the evaluation of global climate datasets; eight satellite-related Essential Climate Variables (ECVs) were considered. The datasets covered the atmospheric, ocean and terrestrial domains of GCOS and they were at different stages of maturity.

As a basis for detailed consideration of global climate datasets, the utility of these datasets was first summarised and it was concluded that global climate datasets are vital components of climate science.

From consideration of the evaluated ECV datasets, it is concluded that special attention needs to be given to some issues; in particular: observing strategies for ECVs, reprocessing of FCDRs, atmospheric correction for satellite retrievals, independent expert-group assessment of datasets, indices of maturity and uncertainty, interdependence of variables and long-term homogeneity of datasets.

CGMS is invited to note the outcome of this workshop, in particular in the context of the development of an architecture for climate monitoring from space.

Outcome of the WCRP Observation and Assimilation Panel (WOAP) Workshop on Evaluation of Satellite Related Global Climate Datasets

1 INTRODUCTION

Under the auspices of the World Climate Research Programme (WCRP) Observation and Assimilation Panel (WOAP), a workshop was hosted by the European Space Agency (ESA) in Frascati, Italy on 18-20 April 2011 to prepare a technical report on the evaluation of global climate datasets; eight satellite-related Essential Climate Variables (ECVs) were considered. The datasets covered the atmospheric, ocean and terrestrial domains of GCOS and they were at different stages of maturity.

As a basis for detailed consideration of global climate datasets, the utility of these datasets was first summarised and it was concluded that global climate datasets are vital components of climate science, supporting activities such as:

Monitoring of climate variability and change on a range of time scales,
Monitoring of forcing of the climate system,
Prediction of climate variability and change,
Attribution of causes of climate change,
Characterisation of extreme climate events.

Global climate datasets relating to the eight selected ECVs were evaluated against the GCOS Guidelines of Dataset Generation, which promote a rigorous process for the development and evaluation of global datasets. That process should ensure that the quality, utility and accessibility of datasets are adequate for the identified applications. It is recognised that different datasets may be fit for different purposes.

To provide a consistent framework for the workshop evaluations, the status of each dataset was entered in an inventory that itemises the evaluation elements of the GCOS Guidelines. The establishment and maintenance of such an inventory at a site, such as the NOAA Global Observing Systems Information Centre (GOSIC), will provide a consistent and accessible source of information on global climate datasets. The admission of new datasets into the inventory is expected to be managed by the GCOS Panels.

The inventory of global ECV datasets will be a resource for users of climate observations to identify and locate data for their particular applications. It will also be of value to producers of datasets in providing a consistent evaluation of strengths and weaknesses, and hence a means for determining priorities for further development. Inspection of inventory components can also highlight the vulnerability of specific ECVs to potential gaps in satellite instruments; for example, the risk of continuity of microwave radiometers with low-frequency channels may impact on the global SST record.

2 EVALUATION OF GLOBAL DATA SETS

The eight ECVs selected for evaluation were:

Atmospheric domain:	Cloud properties Surface radiation
Oceanic domain:	Sea ice Sea-surface temperature (SST) Surface winds
Terrestrial domain:	Soil moisture Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) Snow cover

For cloud properties, the EUMETSAT Cloud Retrieval Evaluation Workshop (CREW) and the GEWEX Cloud Assessment were considered. These assessments are interesting to compare as the CREW activity was focused mainly on Level 2 data, while the GEWEX activity assessed various physical properties of long-term global cloud (Level 3) datasets. For surface radiation, the GEWEX Radiative Flux Assessment was discussed. Key messages from all these assessments are that formal evaluation is a major task and that dedicated resources need to be allocated to that task.

For SST, datasets developed through the Group for High Resolution SST (GHRSST) were evaluated. Questions remain about how best to exploit the mix of *in situ* platforms available for quality control and evaluation of GHRSST SST products.

For surface winds, there was a focus on scatterometer estimates of the surface wind field. It was found that a concerted effort is needed to support appropriate calibration, evaluation and reprocessing activities on surface winds.

For sea ice, several composite datasets have been assessed, and there have been some inter-comparisons. However, the nature and sources of the differences have not been fully documented.

For soil moisture, Level 2 datasets based on active and passive satellite instruments were evaluated. It is seen that reprocessing of a number of fundamental climate data records (FCDRs) and comparison of existing climate datasets and their associated algorithms would help ensure the consistency and quality of global climate datasets.

For FAPAR, the earlier assessment carried out by GTOS was seen to provide adequate documentation for that ECV, but resources are needed to support work on reference sites for *in situ* evaluation. It was noted that land cover classification is an important aspect of modelling used to derive FAPAR, and a consistent approach to the detection of land cover change would help ensure consistency across a range of terrestrial ECVs.

For snow, satellite-based estimates of snow-covered area are routinely prepared. Snow water equivalent, snow depth and snow wetness products are also available. The impacts of vegetation cover, wet snow and complex terrain can limit the accuracy of global climate datasets for snow.

3 CONCLUSIONS

From consideration of the evaluation of the ECV datasets, it is concluded that special attention needs to be given to some common issues; in particular:

Observing strategies for ECVs
Reprocessing of FCDRs
Atmospheric correction for satellite retrievals
Independent expert-group assessment of datasets
Indices of maturity and uncertainty
Interdependence of variables
Long-term homogeneity of datasets.

Conclusions on each of these issues are summarised below.

The global climate observing system under development has two major components: complementary data provided by both the satellite constellation and the global *in situ* networks in the atmosphere, the ocean, on land and on ice. While satellites can generally provide global coverage, they cannot measure all the variables of interest and they often are not designed to provide data with long-term stability and homogeneity. The *in situ* networks can be used for Calibration/Validation of satellite data, and they are vital for the measurement of variables, such as surface air temperature and sub-surface ocean properties, that cannot be measured from satellites. These global systems are supplemented by reference sites ('super-sites'), which provide detailed point measurements of several variables in specific climatic zones. Observations from these sites can provide anchor points for global climate datasets, as well as yielding information on the processes controlling the budgets of water, energy and chemical species. All three components of the global observing system are needed to ensure the quality and comprehensiveness of global climate datasets.

Space agencies are encouraged to give sustained attention to activities that ensure the accuracy and consistency of observational datasets from satellites used to derive ECV products. As calibration methods improve there will be a periodic need to reprocess FCDRs and the ECV products that depend on them. It is vital for these activities to be continued and expanded to meet the full range of user requirements. The international activities of GSICS and SCOPE-CM and the climate reprocessing activities of ESA and NASA are important initiatives supporting these needs.

Many surface variables require the removal of atmospheric effects on radiances measured by satellite instruments, and so atmospheric correction is a common procedure for climate datasets. These corrections use a range of ancillary data in somewhat different ways for different ECV datasets. While the corrections are statistically based, there is little scope to develop an agreed consistent approach.

However, research aimed at the development of an agreed forward model for the calculation of retrievals should lead to greater consistency among ECV datasets.

All producers of climate datasets carry out self-assessment of the utility and uncertainties of the products. However, independent expert-group assessments of the datasets associated with ECVs markedly enhance the utility and encourage improvements of individual datasets. This process is time-consuming and needs to be properly resourced in the future, in order to confirm the commitment of agencies to transparency and quality in the generation of global climate datasets. International independent assessments are seen as an important mechanism to enhance and promote the utility and application of these datasets. For example, it would be timely to commence a coordinated international assessment process for global Level 2 soil moisture datasets, with a view to expanding the scope and depth as scientific progress is made.

In order to promote an effective dialogue between users and producers of global climate datasets, an agreed lexicon based on the maturity index will be used in the ECV inventory to articulate the relative strengths and weaknesses of datasets for specific applications. More work is required to develop agreed metrics of uncertainty in global datasets that transparently account for the many sources of error in generating a global climate dataset from satellite-based measurements.

Many ECVs represent a number of physical variables and so it is appropriate to account for their interdependence when generating datasets for each variable. Moreover a group of variables is often constrained by physical processes, such as the conservation of energy or water. Such constraints should be used in the generation of the individual datasets, and they can also be used in the evaluation of datasets. To maximise the benefits of accounting for the interdependence of variables, it is often desirable for agencies to coordinate the reprocessing of their datasets.

The specific variables associated with an ECV can evolve with advances in scientific knowledge and instrumentation, and such changes need to be accounted for to assure the long-term record of ECVs. For example, the products being generated by the Group for High Resolution SST (GHRSST) have enhanced the quality and reproducibility of global SST datasets, but work is required to ensure that the climate record can be extended consistently back in time as well as forward; that is, the long-term homogeneity of global climate datasets must be maintained.

The workshop brought together experts from across the geographical domains and found that, while there are specific issues associated with ECVs for each domain, there are many commonalities in the development and evaluation of global climate datasets across domains. Further international cooperation will lead to enhancements in the quality, utility and accessibility of global climate datasets, which WCRP is promoting and supporting under its mandate.

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