CGMS XXXII NOAA-WP-11
Prepared by: NOAA
Agenda Item: D.3

PROCESSING OF SATELLITE DATA FROM FUNCTIONAL SATELLITES

This paper responds to Action 30.09, which reads: In view of the increasing use and importance of operational meteorological satellite data for climate research and monitoring, CGMS is invited i) to consider a review of current practice of satellite operators with regard to the climate monitoring principles from satellites, and ii) to provide pertinent reports at CGMS XXXI meeting.

REVIEW OF CURRENT APPLICATION OF CLIMATE MONITORING PRINCIPLES FROM SATELLITES

1 INTRODUCTION

The purpose of this paper is to provide a qualifying statement to what extent NOAA adheres already to the GCOS Climate Monitoring Principles (CMPs). Section 2 lists the CMPs relevant to satellite observations and provides an item-by-item response highlighting open issues. The open issues should be discussed within Working Group II at CGMS XXXI.

2 THE GCOS CLIMATE MONITORING PRINCIPLES AND CURRENT ADHERENCE BY EUMETSAT

Long-term data sets from operational meteorological satellite are increasingly used for studies of the variability of climate quantities. As these satellites have been designed for weather applications rather than climate they typically lack adequate instrument characterisation, calibration accuracy and orbit stability amongst other problems. Operational satellite systems are, however, in principle very suitable for climate observations because the operational satellite programmes have a long-term commitment.

In order to foster the usefulness of current and future observing systems for climate applications an effort has been made to formulate 'Climate Monitoring Principles (CMPs)' as firm guidance that should be adhered to. The effort was initiated by Dr. T. Karl of NOAA/NESDIS. CGMS XXX discussed and amended the CMPs relevant to satellite observations and WMO EC–LIV endorsed the CMPs.

In the following the ten CMPs referring to satellite observations are recalled (in italic). The original numbering, i.e. from 11 through 20 is kept because CMPs 1 to 10 refer to in-situ observing systems. An item-by-item response concerning the current adherence by NOAA follows the corresponding CMP.

Satellite Climate Monitoring Principles:

Furthermore, satellite systems for monitoring climate need to:

- *(a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system; and*
- *(b) Take steps to sample the earth system in such a way that climate-relevant (diurnal, seasonal, and long-term inter-annual) changes can be resolved.*

Thus satellite systems for climate monitoring should adhere to the following specific principles:

11. Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained.

The much more stable orbits for the POES system began with NOAA-16 and will continue through NOAA-N' are having a positive impact on our climate products.
The current and future requirements for POES orbit stability are:
POES – Orbit shall be maintained such that the nodal crossing time is maintained to within ± 30 minutes over the lifetime of the mission.
NPOESS - Orbit shall be maintained such that the nodal crossing time is maintained to within ± 10 minutes over the lifetime of the mission.
Orbit stability is not an issue for the geostationary satellites since precise pointing and stability have always been a requirement (to provide feature tracking for winds).

12. *Overlapping observations should be ensured for a period sufficient to determine inter-satellite biases.*

The POES mission objective is to provide an uninterrupted flow of global environmental information to meet operational requirements. This requires that we maintain two satellites on orbit, morning and afternoon, so that we always have one operational satellite. This allows for continuous coverage while we replace failed satellites, which can often take a year or more. Given the relatively short design life of the POES satellites (i.e., 3 years) and the use of two distinct orbits, our "launch-on-failure" strategy gives us the best service from our satellites.

NOAA's policy for geostationary satellites is to maintain a spare in orbit at all times, allowing for a swap upon failure strategy.

13. *Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured.*

NOAA endeavours to meet this need within budgetary constraints. NOAA is working with NASA to ensure an overlap and continuity of EOS observations by supporting the joint NPOESS Preparatory Program (NPP). NOAA is also supporting the Initial Joint Polar System partnering with EUMETSAT to continue the morning polar mission. NOAA's existing policy of having a geostationary backup satellite in orbit at all times satisfies this requirement for the geostationary mission.

14. *Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured.*

NOAA maintains rigorous pre-launch calibration and qualification of all space hardware per requirements for the current POES and GOES. Details on the calibration of individual instruments are available and are being continuously updated by NOAA scientists and engineers. A comprehensive approach was recently adopted as a result of a NOAA workshop with the U.S. National Institute of Standards and Technology (NIST) in the fall of 2002. Results of this workshop are being used by NOAA to produce a long-term plan for calibration of all NOAA instruments against a national metrology standard.

15. *On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored.*

NOAA performs on-board calibration of all current instruments as per requirements and engineering standards available at instrument procurement. NOAA is currently

working on a Unified Monitoring System to improve climate monitoring and make those data available to the archive.

16. *Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate.*

NOAA is currently engaged with the United States National Academy of Sciences in a process to define priority climate products including organization, generation and stewardship, and sustaining a climate data record generation program. A National Academies Report and a NOAA implementation plan on this subject will be issued in 2004.

17. *Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained.*

NOAA is currently developing the Comprehensive Large-Array data Stewardship System (CLASS) to provide free, web-based access to data and metadata for all past, current, and future satellite data.

18. *Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on de-commissioned satellites.*

NESDIS does not decommission satellites that have useful instruments still working, as long as resources are available to monitor them and process the data from them. At this time our limit appears to be six POES satellites. For those satellites which are not our primary morning or afternoon assets, we command and monitor them for health any safety once a day to once a week and collect data from them once a day to 4 times per day depending on which instruments are still working. In this respect, we not only meet the real-time or near-real-time needs of the operational users but also attempt to meet the needs of those users (e.g., climate) who do not have a strict timeliness requirement for the data.

19. *Complementary in-situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation.*

NOAA is producing a comprehensive assessment of its observing system architecture and has formed an observing system council to ensure integration of all NOAA systems. More specifically, NOAA's climate goal funds activities of the Global Climate Observing System to provide in situ baseline observations.

20. *Random errors and time-dependent biases in satellite observations and derived products should be identified.*

NOAA's work with the U.S. National Academies has identified the production of fundamental climate data records (FCDRs), records which identify and correct both random errors and time-dependent biases, as a critical element of NOAA's proposed scientific data stewardship program to generate operational climate data records. NOAA currently funds a number of investigations aimed at documenting such errors and biases and will be producing annual reports on these efforts starting in FY04.

3 CONCLUDING SUMMARY

WG II is invited to take note of the current adherence of EUMETSAT to CMPs and comment as appropriate. WG II is also invited to foster the continuation of the CGMS inter-calibration efforts to include other channels than the IR and WV that are currently considered. Finally it is recalled that a Satellite Application Facility (SAF) on Climate Monitoring has nearly completed its development phase and will provide products for climate applications in the future. A meeting between the CM SAF and GCOS is planned for May 2004.