JOINT CGMS-CEOS SIDE EVENT ON THE OCCASION OF THE CGMS-44TH PLENARY SESSION

SUMMARY REPORT: NON-METEOROLOGICAL APPLICATIONS FOR NEXT GENERATION GEOSTATIONARY SATELLITES

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SUMMARY REPORT: NON-METEOROLOGICAL APPLICATIONS FOR NEXT GENERATION GEOSTATIONARY SATELLITES

A BACKGROUND AND SCOPE

Under its CEOS chairmanship, the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), has initiated a study on non-meteorological applications for the next generation of meteorological geostationary satellites for completion by end October 2016.

In order to coordinate the CEOS study with CGMS, and to take into account already ongoing or planned future activities by CGMS agencies in this field, the CGMS Secretariat initiated a joint CGMS/CEOS side-event on the occasion of CGMS-44.

CSIRO presented the related CEOS concept/study and state of affairs. Relevant CGMS agencies presented their undertakings in the provision of "non-meteorological" applications resulting from both existing and planned use of their current and future meteorological satellites. Examples of global/international coordination mechanisms used by CGMS members in this field were also presented.

B SIDE EVENT INTRODUCTION

The CGMS Secretariat introduced the side-event and outlined the Agenda and welcomed the CEOS initiative on non-meteorological applications for next generation satellites, whilst emphasising the need to build on already existing capacities and already ongoing activities. Therefore, the joint event was necessary in order to ensure that all relevant players have the same level of understanding of the current and future capabilities of the current and new geostationary meteorological satellite systems.

C CEOS CONCEPT/STUDY

The CEOS concept/study, initiated by CSIRO as Chair for CEOS for 2016, on *non-meteorological applications for next generation geostationary satellites*, was then introduced by CSIRO. In particular, the need to draw upon existing expertise and capacity from CEOS Working Groups and Virtual Constellations, as well as member agency experts were emphasised. The study was triggered by the capabilities now demonstrated with the AHI (Himawari-8/JMA) and ABI (GEOS-R) instruments, with similar spectral capabilities to the MODIS instruments flying on Aqua and Terra in a polar orbit. The new geostationary imagers combine the spectral capabilities of the polar system with the temporal capabilities of geostationary satellites, providing a model for the next generation global geostationary meteorological satellite constellation. The next generation of advanced geostationary (GEO) meteorological capabilities provide new opportunities for the exploitation of the high temporal-frequency data for "non traditional meteorological" applications as well. Additionally, due to the similar observational capabilities of the geostationary imagers there is an opportunity for leveraging/combining GEO and LEO capabilities for non-met applications.

To pursue documenting these non-meteorological capabilities, a Task Team co-chaired by CSIRO, BoM, EUMETSAT and NOAA was established and is supported by 14 other CEOS Agencies (CNES, CSA, DLR, EC, ESA, GA, JAXA, JMA, KARI, NASA, NSMC-CMA, UKSA, USGS, WMO).

The study will result in a report to be tabled at the November 1, 2016 CEOS Plenary, that provides comprehensive and pragmatic guidance to CEOS on new opportunities arising from next generation geostationary satellites and from GEO-LEO synergies.

CSIRO further introduced the outline of the foreseen report with some examples of application areas and, in conclusion, the main expected outcomes of the study were highlighted:

1. Trends and outlook for geostationary Earth observation satellite capabilities – Catalogue of CEOS/CGMS agency missions, instruments, measurements, data volumes etc.;

2. Inventory of relevant non-met applications and review of initiatives being undertaken by CEOS and related agencies – atmosphere, land and ocean (build on Japan-Australia bilateral effort initiated in 2015);

3. Benefits of synergistic use of GEO-LEO systems;

4. Identification of key opportunities and benefits to CEOS and CGMS agencies as well as challenges; and

5. ***Recommendations for the way forward*** tactically and strategically for CEOS and its agencies; links and collaborations with CGMS.

D EUMETSAT NETWORK OF SATELLITE APPLICATION FACILITIES

To demonstrate the current capabilities in Europe, EUMETSAT introduced its Network of Satellite Application Facilities (SAF) for the Sustained Development and Operations of Products from Satellite data. Currently eight SAFs exist, covering the following application areas: Climate Monitoring (CM SAF), Support to Operational Hydrology and Water Management (H SAF), Land Surface Analysis (Land SAF), Support to Nowcasting and Very Short Range Forecasting (NWC SAF), Numerical Weather Prediction (NWP SAF), Ozone and Atmospheric Chemistry Monitoring (O3M SAF), Radio Occultation Meteorology (ROM SAF) and Ocean and Sea Ice (OSI SAF).

The SAFs are a part of the EUMETSAT application ground segment, providing operational products and services to users on specialised topics and themes. They complement production of standard meteorological products at EUMETSAT Secretariat and are located at Weather Services in EUMETSAT Member and Cooperating States. The goal of the SAFs is to provide operational products that embrace:

- Continuity of product provision
- Continuity of product improvements
- Continuity of quality monitoring
- Committed user services
- Validation and review before official release/launch
- Complete documentation of products, algorithms, validation results

After the introduction, three SAFs - the OSI, CM and Land SAF - were introduced in more detail.

OSI SAF:

The OSI SAF presentation noted in particular that the geostationary satellites have a unique capability for observing ocean surface dynamics at small space and time scales in the low and mid latitudes. The EUMETSAT Ocean and Sea Ice SAF (OSI SAF) processes in near real-time GOES-East and MSG full disk data to provide hourly Sea Surface Temperature (SST) as well as radiative fluxes at the ocean surface. Cloud detection is a key step in the SST processing, and relyies on the cloud mask from the Nowcasting SAF software package. Compared with drifting buoys SST measurements, MSG-derived SSTs in both day and night conditions exhibit a similar accuracy as other operational SST products derived from polar orbiting satellites.

MSG-derived SSTs have been extensively used to study the diurnal cycle of the ocean skin surface temperature, which is a key variable in ocean/atmosphere interactions. Diurnal variations up to 4-5 K are commonly observed, and areas of strong diurnal warming are usually organised as small scale elongated structures, where surface winds are very low. The comparison between MSG-derived and drifting buoy SSTs, measured at a depth of about 20 cm, shows that when diurnal warming occurs, there is on average a 2 to 3 hour time lag between the start of satellite (skin) and buoy (20 cm) temperature increase in the morning.

The OSI SAF has been working on the reprocessing of MSG-derived SSTs since 2004, in order to deliver a consistent time series of hourly SST products. It is also preparing for the next generation of GOES and Meteosat satellites. Future OSI SAF SST and radiative fluxes will benefit from the improved time and space resolution, as well as from the new spectral bands of the FCI and ABI imagers.

CM SAF:

The CM SAF produces a large set of climate data records. These also include non-meteorological applications like solar energy and sunshine monitoring as well as aerosol data records. Some of these records include data from the Meteosat First Generation satellites.

LAND SAF:

The Land SAF product portfolio includes the vegetation parameters, water stress products and also products to detect wild fires and determine their radiative power.

Other SAFs:

Finally, the participants were encouraged to go to the SAF web pages that give a detailed overview of all products. Specifically for the Land SAF of interest are various vegetation related products like fractional vegetation cover.

E CGMS MEMBER ACTIVITIES

The following CGMS members presented relevant aspects of their non-meteorological applications activities:

JMA:

JMA introduced Himawari-8/AHI. Himawari-9 was launched on 7 July 2015 and onboard is the Advanced Himawari Imager (AHI), an instantiation of the Advanced Baseline Imager (ABI) developed for GOES-R. AHI provides observations in 3 VIS, 3 NIR and 10 IR bands. The full disk observing cycle is

10 minutes, rapid scanning can be performed with 2.5 minutes/30-second intervals. AHI will provide significant improvements over the previous generation Japanese geostationary satellites, in particular in addition to meteorological applications, for monitoring land and ocean surfaces. The product capabilities include e.g. SST, snow cover, surface emissivity and albedo, fire detection, vegetation mapping, aerosol and volcanic ash detection.

JAXA:

JAXA introduced the polar orbiting GOSAT-series. These satellites are dedicated to greenhouse gases and the first satellite was launched 2009 with a follow-on foreseen in 2017. The GOSAT flies the TANSO-FTS spectrometer and the TANSO-CAI imager. JAXA regularly reprocesses the data in order to get consistent and the best possible data records, e.g. global monthly mean CO2 and CH4 maps.

CMA:

CMA presented the FY-2 and FY-4 geostationary satellite series. FY-2 is today used for some non-meteorological applications, like grassland fire or drought monitoring, however, with FY-4, planned for launch towards the end of 2016, significantly improved capabilities will emerge. Today, several new algorithms and products are under development (using Himawari-8 data as a proxy) in anticipation of the new FY-4 data, including aerosol and heavy pollution monitoring and looking at synergies with polar orbiting data. In general, the capabilities of the FY-4 imager are very similar to those of the ABI-type instruments and the EUMETSAT MTG FCI imager.

KMA:

KMA then proceeded to present its next generation geostationary satellite GK-2A, which will host also host an ABI like instrument, AKI (Advanced Kompsat Imager) with similar capabilities to that of AHI. GK-2A is currently foreseen for launch in 2018. KMA also make use of Himawari-8 data for the development of products from the next generation satellite, including products for drought monitoring, flooding, forest fire detection, aerosol density/height and volcanic ash.

NOAA:

Finally, NOAA introduced its GOES-R satellite that is scheduled for launch in the last quarter of 2016. GOES-R carries the ABI instrument and the derived product suite is similar to that of AHI and AKI. The presentation particularly noted the improved high temporal resolution and the ability for more cloud free observation that result in better product availability and with precise measurements of the diurnal cycle. In addition, the fixed observation geometry provides consistent measurements. In addition to the baseline capabilities NOAA is also exploring the possibilities to derive information on flood/standing water, ice cover, sea and lake ice, snow depth (over plains) amongst others.

All the Agency reports demonstrated a mature level of readiness for deriving products for non-meteorological applications at the very start of the new programmes. In addition, several innovations are also under preparation.

F GSICS

EUMETSAT then introduced the GSICS activities. Space-based observations required for weather and climate applications rely on multiple satellite missions from different agencies around the world. To be reliable and interoperable, these different sources must be precisely calibrated with similar methods and common references. Poor or inhomogeneous calibration would result in degraded performance. GSICS members are collaborating to develop and apply “best practices” for state-of-the-art and homogeneous calibration. GSICS provides references, tools and guidelines, for prelaunch characterisation, instrument performance monitoring, anomaly resolution, comparison of sensors, and correction if necessary.

The benefits of GSICS can be summarised as follows:

- **Satellite operators benefit from participating in GSICS**
  - Sharing development effort and sharing resources (calibration references, datasets, software tools)
  - Capacity building in sharing best practices (for instrument monitoring, traceability, sensor comparison and correction)

- **Satellite data users benefit from GSICS**
  - Calibration is improved
  - Corrections available to align to a common reference
  - Assessments, reports, for better understanding
  - Algorithms enabling to reprocess data records
  - Improved and consistent calibration across the different agencies builds confidence on reliability of each other’s data
  - Interoperability increases the benefit of data exchange

The presentation also provided concrete examples of improved calibration, more efficient check-out of satellites as well as improved geophysical products.

G SCOPE-CM

Finally, EUMETSAT also introduced the SCOPE-CM activities. SCOPE-CM is the Sustained, Co-Ordinated Processing of Environmental Satellite Data for Climate Monitoring. The aim of SCOPE-CM is to enable a network of facilities ensuring continuous and sustained provision of high-quality Climate Data Records (CDRs) from satellite observations. The foundation of SCOPE-CM is the network of relevant space agencies and other organisations with the aim to develop extend and preserve the capabilities and skills of generating and re-generating CDRs. SCOPE-CM is a coordinated international network to produce CDRs from multi-agency mission data in operational environment addressing GCOS requirements and involves:

- Operational Satellite operators: NOAA, JMA, CMA, EUMETSAT

- Stakeholder: WMO Space Programme, GCOS, CEOS, GEO, CGMS/GSICS, WCRP/GEWEX, ESA (observer)

The presentation also included some examples of products generated by the project, including a global surface albedo product derived through collaborative and distributed processing of high volume data.

In summary, the new generation geostationary satellites provide the following benefits:

- High temporal resolution
- Full Disk image frequency of Geo-satellite can be up to every 5 minutes

- Better Vegetation Measurement (daily instantaneous measurement)
- More cloud free observation results in better product availability
- Cloud or cloud contamination is a major issue in land data production since most of land measurements rely on visible and infrared channels Examples: flood development, surface energy balance
- Precise Diurnal Cycle Measurements
- Diurnal variation (such as LST) can only be detected from Geo-satellite
- Fixed observation geometry provides consistent measurements
- Reduced uncertainty due to anisotropic surface
- Enterprise Products: Blended GEO with LEO satellite measurements

H DISCUSSION

In the subsequent discussion, WMO raised the following points:

1. WMO greatly appreciated the progress and many new products showed at the side event. These demonstrated that the new geostationary satellites have a great potential to be used in many new application areas, like climate monitoring, renewable energy, health, etc. beyond the traditional applications of weather by GEO satellites in the past. This is due to the greatly enhanced capability of the new generation of geostationary meteorological satellites, with more channels (16), greatly improved resolutions and more frequent observing cycles;

2. WMO believed that the new generation of geostationary meteorological satellites will contribute more to disaster risk reduction (DRR) activities, by taking advantages of greatly improved resolutions (0.5-1KM, which is the similar resolution with LEO satellites instruments AVHRR, etc), and more frequent observing cycles (especially 2.5 minutes for regional scale), which can observe both the phenomena and process (over advantage of LEO which can only see the phenomena as a snapshot). The targets should including fires, floods, volcanic ash, extreme convection systems, etc.; and

3. WMO further strongly encouraged the further development with more value-added products from the new generation of GEO Satellites together with many mixed data resources (for example the NOAA's plans to merge GEO+LEO observations for integrated products) for more application areas. Like data utilisation in NWPs which assimilated many datasets for improving forecasting performance, the satellite community should also try its best to use as many needed data sources as possible for improving the quality of products (not like the traditional approach of mainly generating products based on ONE instrument).

In addition, WMO interprets that meteorology should include at least weather, and climate and the side event showed many new climate products (which are not appropriate to link to non-meteorological applications). Therefore, it was suggested that in future similar activities should instead of NMA be considered as 'Expanding GEO satellites application areas'.

The CGMS Secretariat noted that for this particular initiative it would be better not to restrict it by adding a label to it. Meteorology and climate correspond to more today than previously and it is important to consider all aspects of the full Earth system of which non-meteorological applications are an integral part.

The Group on Earth Observation tries to support the activities through the Societal Benefit Areas (SBAs). This may well go beyond meteorological applications and it is important to know how to reach out to these SBA communities.

Furthermore, it was noted that big data, data management, interoperability and data and product distribution are key issues that need to be addressed in the future.

Finally, CSIRO expected that as the data and products become available from the new generation satellites further opportunities will emerge, and during this first study we will probably just scratch the surface of the overall capabilities of the new generation geostationary satellites.

I CONCLUSIONS

In addition to confirming the importance of non-meteorological applications, the following conclusions were drawn from the presentations and discussions and provided as guidance by CGMS to CSIRO for executing the study. It was recommended that CSIRO and CEOS:

1) Ensure that there is no overlap or duplication with existing or planned non-meteorological applications already foreseen by CGMS space agencies;
2) Take into account global/international coordination mechanisms and initiatives such as GSICS and SCOPE-CM (and others as necessary);
3) Promote the use of such existing mechanisms to further develop activities that might result from the report, rather than duplicating such mechanisms;
4) Take into account that several applications (related to e.g. climate) cannot be considered as non-meteorological applications ;
5) Build upon the existing applications, knowledge and plans by the CGMS community in order to provide added value with new and complementary applications; and
6) Interface with the CGMS Secretariat as necessary.

CSIRO confirmed it would distribute the final study report to CGMS once available.

J AGENDA, PRESENTATIONS, LIST OF PARTICIPANTS

The agenda and presentations are available at http://cgms.eumetsat.int/views/agendas.xhtml (please select Agenda, CGMS-44, and the side-event tab).

CSIRO study concept: http://ceos.org/document_management/Meetings/Plenary/29/Documents-For-Decision/38a_Non-met-Applications-v2-0.pdf

The list of participants is provided in the Annex.

ANNEX: List of participants

ANNEX: LIST OF PARTICIPANTS

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