INTRODUCTION TO THE COMS METEOROLOGICAL DATA PROCESSING SYSTEM

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ABSTRACT:

Communication, Ocean, and Meteorological Satellite (COMS) to be launched in year 2008 will be the first Korean multi-purpose geostationary satellite aiming at three major missions, i.e.: communication, ocean, and meteorological applications. The development of systems for the meteorological mission sponsored by the Korea Meteorological Administration (KMA) consists of payloads, ground system, and data processing system. The program called COMS Meteorological Data Processing System (CMDPS) has been initiated for the development of data processing system. The primary objective of CMDPS is to derive the level-2 environmental products from geo-located and calibrated level 1.5 COMS data. Preliminary design for the level-2 data processing system consists of 16 baseline products and will be refined by end of 3rd project year. Also considered for the development are the necessary initial information such as land use and digital elevation map, algorithms for the vicarious calibration and procedures for the calibration monitoring, and radiative transfer model. Here, we briefly introduce the overall development strategy, flow chart for the intended baseline products, a few preliminary algorithm results and future plans.

KEY WORDS: COMS, Meteorological Data Processing, and Development Plan

1. INTRODUCTION

1.1 Background

COMS (Communication, Ocean, and Meteorological Satellite) program formally started from in September 2003 is one of program for the "Long Term National Space Development Plan" of the Korean government. One of the main mission objectives of COMS is the operational meteorological application with a dedicated mission payload. To support the operational meteorological application, COMS program includes the development of COMS meteorological data production system (CMDPS).

The major function of CMDPS is the derivation of the baseline meteorological parameters from the calibrated and geo-located level 1.5 data. The planned preliminary baseline products consist of 16 parameters such as the analysis of special weather phenomena such as the yellow sand event in addition to the standard derived products from the current geostationary data. Additional function of CMDPS includes the development of calibration monitoring, upgrade, and validation mechanism of the baseline products.

CMDPS will be integrated to the operational data processing system, which will be used for the operational processing of the raw data, product generation, dissemination, archiving, and so on in real time. Here, we briefly introduce the overall development strategy, flow chart for the intended baseline products, a few preliminary algorithm results and future plans.

1.2 Development structure

A number of meteorological products will be extracted from the geo-located and calibrated level 1.5 data. The general principle shall be adopted for all meteorological products that, subject to technical constraints (e.g., dissemination channel capacity), all of the derived products shall be disseminated, together with full quality control information via the COMS operational data processing system, which will be installed at the data processing center.

Figure 1 shows an overall flow diagram of milestones for the CMDPS development. The conceptual design for the overall development strategy and plan including algorithm design for the products was prepared in the first project year. The conceptual design is based on the algorithm development strategy, annual progress, integration strategy, implementation of CMDPS in the operational system, and finally preparation for the operation.

Currently the prototype S/W module for each product is under development and will be prepared by the end of the 3rd project year (April 2006). With the algorithm development, two other activities, interface design and sensor calibration scheme, are under development. The prototype S/W module will be standardized and optimized and will be integrated in the 4th project year. Overall test will be performed in the 5th project year followed by the preparation of the operation in the last year. For the performance test, a special assessment data, which may include both the theoretical radiance and actual observation data, will be prepared. The theoretical radiance will be prepared by using the radiative transfer model, simulated and observed meteorological input fields, and sensor characteristics. For the actual observation data we will choose a well calibrated, used, and validated satellite data.

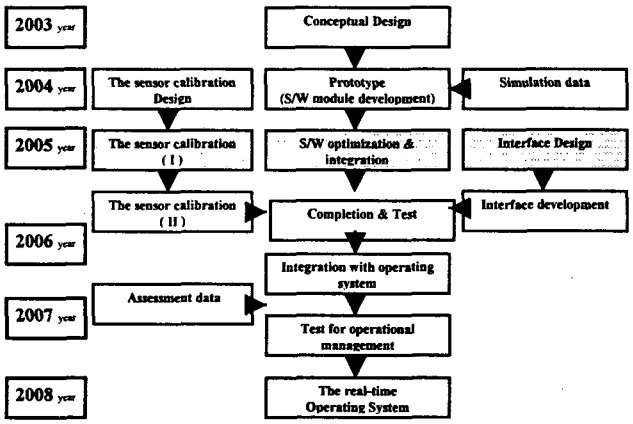

Figure 1. Milestones for the CMDPS development.

2. CONTENTS

2.1 Meteorological payload

The meteorological payload is a scanning spectrometer which measures earth radiated and reflected up-welling radiances at 5 separated wavelength bands (channels), 1 visible and 4 infrared wavelength region, as shown in Table 1.

Table 1. Observation bands of the meteorological payload

Channel	Central Wavelength (㎛)	Wavelength (㎛)
VIS	0.675	0.55 – 0.80
SWIR	3.75	3.5 – 4.0
WV	6.75	6.5 – 7.0
IR 1	10.8	10.3 – 11.3
IR 2	12.0	11.5 – 12.5

The field of view of the meteorological payload covers full disk frame. Required acquisition time for the full disk frame shall be less than 27 minutes including the blackbody calibration for IR channels. The scanning mechanism will be acquired by a gimbal which scans separate E-W and N-S with the same mechanical scan speed. With the gimbal, the meteorological payload is able to point anywhere within the mechanical limit of the scanner and provides flexible observation frame and frequencies.

Understanding of the mechanical and optical characteristics of the meteorological payload is essential to understand the characteristics of the sensor-measured data. For this, a full size mock-up model has been prepared

2.2 Baseline Products

With the finalization of the payload specification, the baseline products defined during the conceptual design has been modified in 2004. The current baseline products consist of 16 products, which can be categorized as scene analysis, surface information, cloud information, water vapor information, environmental information, and atmospheric motion vectors.

Figure 2 shows the overall flow chart for the 16 baseline products. The production chains area aligned by consideration of many factors such as the necessary input data, its outputs, and interactions among each algorithm, priority of production sequence, time requirements, and stable operation of the system. However, it should be noted that the order could be modified with finer adjustment and priority of products.

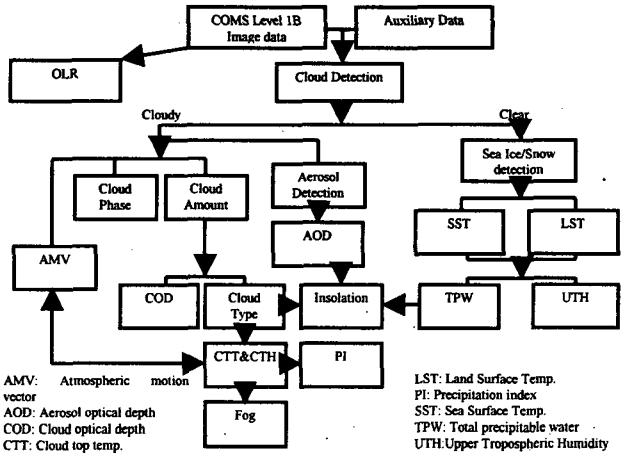

Figure 2. Flow chart of the baseline products of COMS meteorological payloads for the normal observation mode.

The very beginning of the production chain is the scene analysis, which has main purpose of cloud screening, snow/sea ice detection, and possibly land use information. For the information such as land use is not derived from COMS, although it plays an important role in CMDPS. Thus, we are going to prepare these information off line through various lines such as from other satellites, in situ

measurement, and so on. The results from the scene analysis play key role in the determination of product type, whether it is a cloudy or clear sky product, and all the necessary basic information for the consequent products. Also, accuracy of the scene analysis affects on the accuracy of all of the products and the accuracy and quality information of the scene analysis will be provided.

The baseline products can be divided into two types, cloudy and clear products. The cloudy products include parameters such as cloud information including cloud phase, cloud top pressure and temperature, cloud amount, cloud motion vector, cloud type including ISCCP (International Satellite Cloud Classification Project) type classification and fog, rain rate. The clear products are such as the surface temperatures of sea and land, water vapor information. The aerosol products, detection and optical depth, will be derived from the cloudy pixel although it is categorized as the environmental products.

With the progress of the prototype S/W development, the character of each baseline products becomes clear. For example, the objective and automatic derivation of the snow/ice information with the five channel data of the meteorological payload is not an easy task. Derivation of the cloud optical depth for clouds having larger than 20 will include a large uncertainty. Thus, in depths review process to re-characterize and possibly re-define the baseline products between the end user and developer are under going.

As mentioned earlier, the payload is capable of fast limited coverage operation for the monitoring of severe weather events. During this kind of special observation operation, the CMDPS does not produce all of the baseline products, instead it produces severe weather related parameters such as the cloud information including the precipitation rate, cloud top temperature, and cloud phase.

2.3 Sensor Calibration

The sensor calibration scheme will perform the overall monitoring, validation, and update of the calibration process prepared during the ground system development. The calibration coefficients for the payload obtained at ground before the launch is subject to vary after the launch into the space due to many factors. Thus, during the normal operation the characteristics of instrument need to be monitored to insure the high quality observation data.

In case of infrared channels, there will be onboard reference calibrator, a blackbody, which can be used for the real time adjustment of the calibration coefficients. However, there will be no absolute reference for the visible channel. Thus after the launch of satellite, the validation and update of the calibration algorithm and coefficients if necessary are done at the ground with the measured radiance values.

The basic approach for the ground process is based on the comparison of the COMS data with the reference data such as the well calibrated other satellite data, in situ observation, and theoretically calculated data. This ground processing is especially important for the VIS channel, which does not have the onboard calibrator. Thus, for the VIS channel, we will use the satellite to satellite approach, comparison with the theoretically calculated radiance, albedo monitor, star sense data, and other available approaches for both monitoring and update.

For the IR channels, comparison with the collocated other satellite and theoretical radiance will be used mainly for the monitoring purpose. For the near-real time monitoring, comparison with the model-simulated radiance will be used. For this purpose, a fast radiative transfer model is required and will be developed based on the current fast forward model such as RTTOV. The fast radiative transfer model will also be used for the CMDPS which requires the theoretical clear and cloudy sky radiances in its production chain.

3. SUMMARY

The COMS meteorological data processing system(CMDPS) has been successfully developed in phase with the initial conceptual design. Once it is fully developed and integrated into the operational system, it will produce the defined baseline products, which will be used for various application areas. The important characteristics of CMDPS are to have a stable, fast, accurate, easy to maintain. The calibration algorithm will ensure the high quality of raw observation data by monitoring, validating, and updating the calibration characteristics. Finally, for a better use of derived products, a validation strategy for the baseline products will be established in near future.

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