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# CMA update on Space Weather Activities


Executive summary

The paper describes the recent space weather activities of CMA in associated with the space weather observation, forecast and services.

CMA has performed the orbit cross-calibration for relativistic electron (> 2 MeV) observations in the drift shell Lm coordinate and got the systematic deviation between the FY4A and GEOS' observations.

As the one of the regional space weather information centres designated by ICAO, China/Russian Federation consortium is working on the cooperation mechanisms, data sharing, product processing and other issues to ensure space weather services support for aviation safety. NMSC/CMA also has developed the aviation space weather information service system to meet demand of ICAO on the space weather information.

CMA also participates in the Phase II of the Chinese Meridian Space Weather Monitoring Project (Meridian Project) which has kicked off on July. 2019. Phase II of the Meridian Project will has the observation capability covering all spheres of the solar-terrestrial system, including solar surface, interplanetary space, magnetosphere, ionosphere, and atmosphere.


Action/Recommendation proposed: none

# CMA Update on Space Weather Activities

## 1 INTRODUCTION

The National Center for Space Weather (NCSW) was established in 2002 as part of the responsibility of the National Satellite Meteorology Center of CMA, and began to provide space weather operational service on July 1, 2004. NCSW has preliminarily developed a complete operational system covering space weather monitor, forecast, and service.

CMA/NCSW is the nation's official source of space weather forecasts, and capable of providing the space weather information in support of international civil aviation. Since 2012, the routine space weather products based on the NOAA scales (Radio blackouts, Solar radiation storm, and Geomagnetic storm) have been provided to aviation industry via the Aviation Meteorological Center of Air Traffic Management Bureau of Civil Aviation Administration of China.

## 2 ON-ORBIT CROSS-CALIBRATION FOR RELATIVISTIC ELECTRON OBSERVATIONS FROM FY-4A AND GOES-13

The on-orbit cross-calibration for relativistic electron (> 2 MeV) observations from FY-4A and GOES-13 are performed. In this work, only the observations obtained under very quiet geomagnetic conditions (Kp < 2) are adopted to ensure that the objects of study are the radiation belt particles, which are stably captured by the geomagnetic field. According to the Liouville theorem, which states that the phase space density will be conserved on the same phase space coordinates, the phase space density of the stably geomagnetically trapped particle will be the same on the same three adiabatic invariants (μ, J and $L^*$). The observations investigated from both FY-4A and GOES are of the same energy (> 2 MeV) and pitch angle approximately, since they are both from the instruments facing to east or west. Therefore, their two corresponding invariants (μ and J) are the same approximately. Then the Liouville theorem can be simplified as that the electron fluxes observed by the two satellites will be the same on the same Lm-shell and the electron fluxes observed by the two satellites are compared on the Lm-shell coordinate. The systematic deviation between the two satellites' relativistic electronic observations can be obtained. According to this result, the data assimilation is carried out, and the results show that the system deviation can be removed well. This work provides the new methods for on-orbit cross-calibration for the electronic observations on geosynchronous orbit.

## 3 CHINA-RUSSIAN CONSORTIUM IN SUPPORT OF INTERNATIONAL AIR NAVIGATION

As cross-polar traffic increases, the aviation industry is becoming more aware of the impacts space weather can have on operations. The mutual cooperation agreement on the support the international aviation of space weather service between the National Satellite Meteorological center(CMA) and the Institute of Applied Geophysics(IAG, Roshydromet) was signed on June 08, 2018, and served as the basis for creating the China/Russian Federation consortium of the International Civil Aviation Organization(ICAO) regional space weather center. In December 2018, the international Civil Aviation Organization (ICAO) designated 3 global space weather information service providers and 2 regional centres. China/Russian Federation consortium was designated as one of the regional centres. In 2019, the specialists of IAG twice visited NMSC and held detailed discussions on cooperation mechanisms, data sharing, product processing and other issues to ensure space weather services support for aviation safety.

To enhance the capacity building, NMSC has developed the aviation space weather information service system to meet demand of ICAO on the space weather information. The new system introduces the ionospheric TEC model based on spherical harmonic and generalized trigonometric series functions to calculate the global TEC Real Time Maps, imports the Ionospheric data assimilation model by use of the kalman filter to provide 3D electron density throughout the china ionosphere region and update the warning program for aviation radiation dose exposure. NMSC also plan to develop a low-cost dosimeter sensor to monitor the radiation dose for the air travel.

## 4 PHASE II OF THE CHINESE MERIDIAN PROJECT

The Chinese Meridian Space Weather Monitoring Project (Meridian Project) is a ground-based geospace monitoring chain in China which. It consists of 15 ground-based observation stations located roughly along 120°E longitude and 30°N latitude. Construction of the project started in January 2008 and completed in December 2012.

A major upgrade to the current Meridian Project has been approved by China's National Development and Reform Commission. The construction has started up in the July of 2019. Phase II of the Meridian Project will add to the current project two observatory chains, one along 100°E and another along 40°N. Together with the current 120°E and 30°N chains, a two-cross network configuration will be formed to cover nearly the whole territory of China in a sense of monitoring medium scale phenomena, and distances between adjacent stations will be as small as 100km in some critical regions. Also, a series of solar-interplanetary monitoring instruments will be added to constitute a complete observation capability that covers all spheres of the solar-terrestrial system, including solar surface, interplanetary space, magnetosphere, ionosphere, and atmosphere. Altogether, about 200 new instruments will be deployed or built, and the number of stations will increase from 15 to 31.