



Impact of space environment on spacecraft and mitigation measures

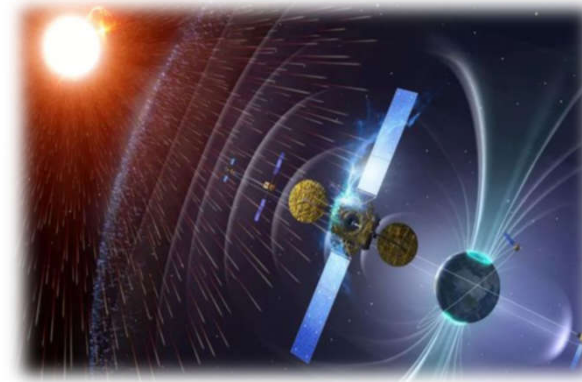
**Beijing Institute of Tracking and Telecommunications Technology
(BITTT)**

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Introduction

- ❖ **Space is more and more crowded as a large number of spacecraft and debris in orbit**
- ❖ **Disastrous space weather often causes satellite anomaly even failure**



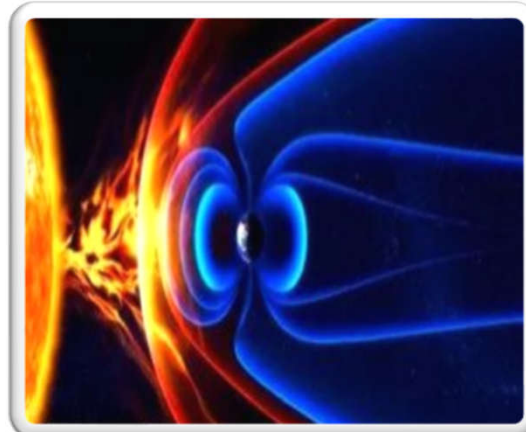
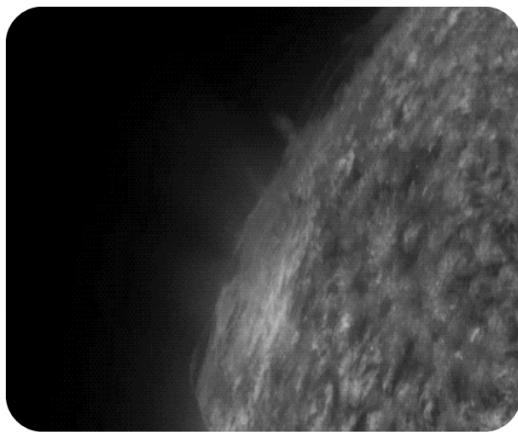
- ❖ **International cooperations promote the sustainable utilization of outer space**



Deteriorating space environment

❖ Significant impact of space weather

- Solar storms affect near earth space through three rounds of strikes
- Spacecraft anomaly may caused by single particle, charge discharge, total dose, etc.
- Solar storms often induce the functional failures of spacecraft components, and even lead to total failure(permanent loss of mission)





Deteriorating space environment

❖ Significant impact of space weather

- Large flares, strong magnetic storms, intense radiation and other events lead to frequent failures of on-orbit satellites
- The deployment of giant commercial satellites constellations increases the challenge of space environmental protection

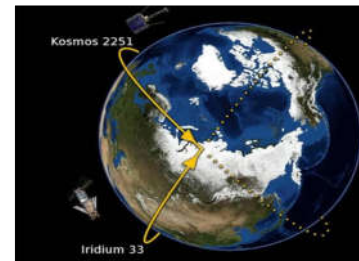
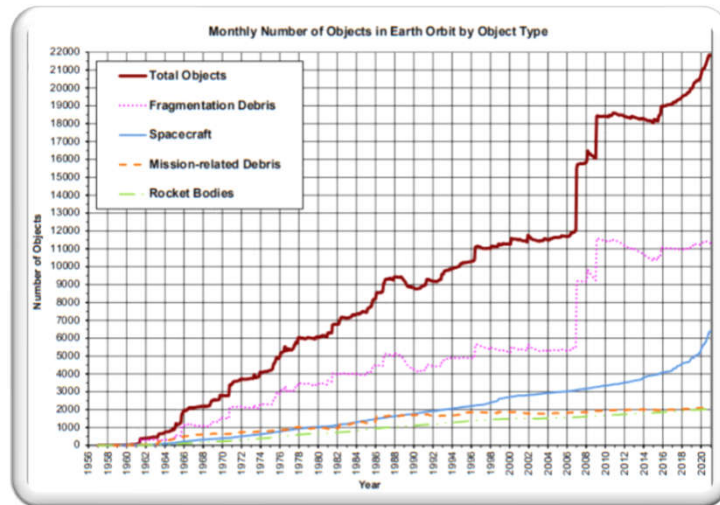




Deteriorating space environment

❖ Increasing number of space debris

- Space debris seriously threaten the safety of spacecraft
- Many incidents such as breaking-up, explosion, collision etc. have occurred
- There are more than 900,000 space objects larger than 1cm
- The density of debris in low-Earth orbit will reach a critical value in decades theoretically

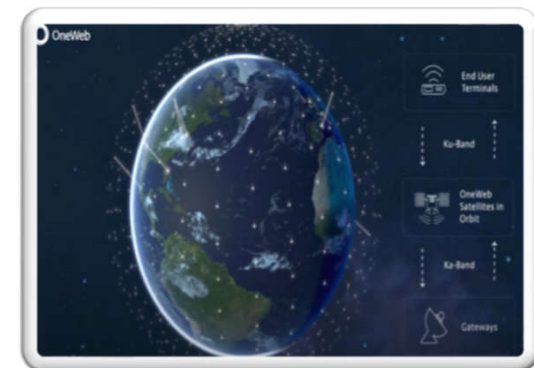




Deteriorating space environment

❖ Environmental burden with huge constellations

- Several giant constellation programs have been proposed and being carried out
- Coordination of orbit and spectrum resources will be more difficult
- Frequent orbital maneuvers of satellites will increase the risk of collision
- Serious space environment events will lead to orbital anomaly of satellites

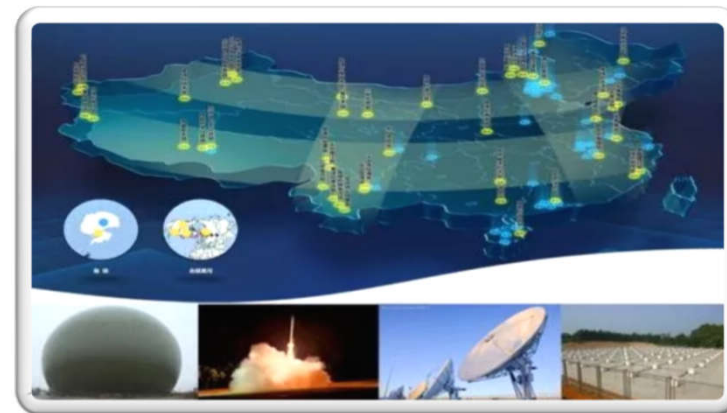




Environmental risks reduction

❖ Reduce the impact of space weather

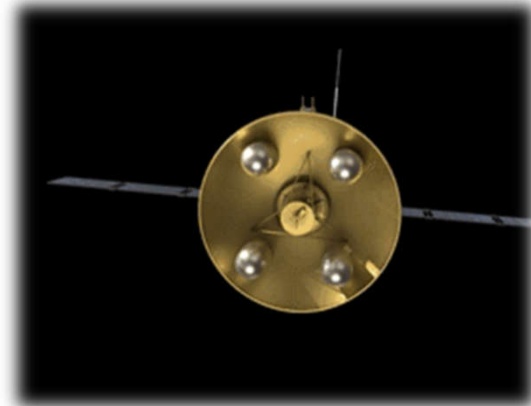
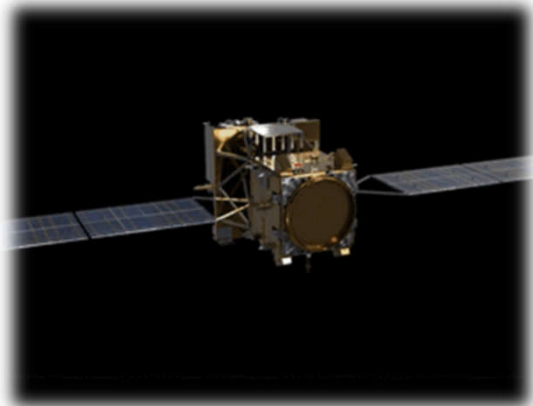
- China has developed a space weather monitoring and early warning system
- Supported by the monitoring data of Fengyun satellites, Beidou satellites, Meridian Program etc.
- Provides monitoring and early warning of solar proton events, high-energy electron storms and other events





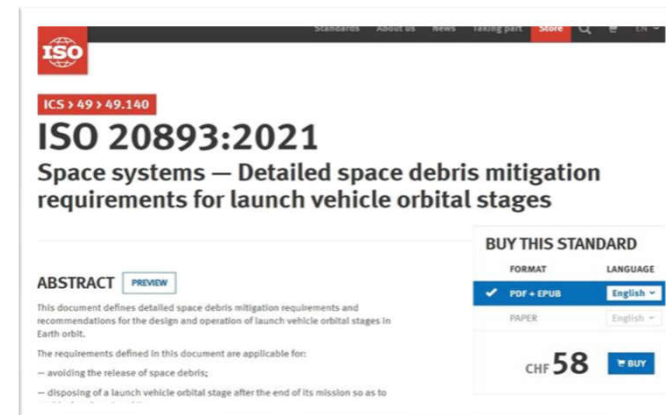
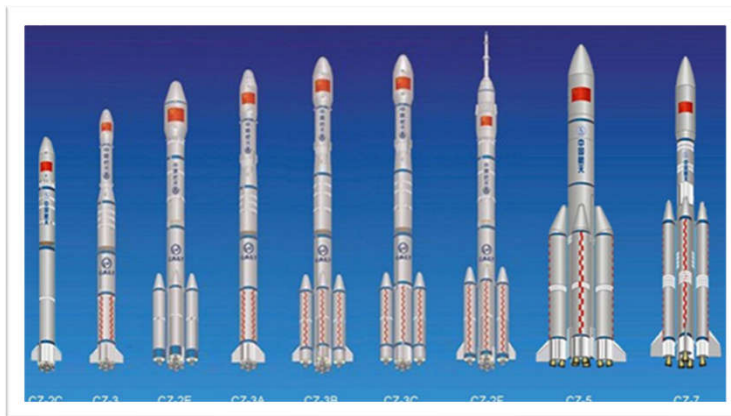
❖ Reduce the impact of space weather

- Evaluated the impact of strong solar flares to eliminate the launching risk in Tianzhou mission
- Lowers Failure rate of Beidou satellites caused by space environment significantly
- Promotes the construction of satellites such as ASO-S and SMILE
- Undertakes the work of International Space Environment Services (ISES)



❖ Promote space debris mitigation

- The administrative measures for space debris mitigation and protection issued in 2009, revised in 2015
- Regulates China's space launch and the development of micro-satellites
- Passivation disposal for the upper stage of rockets in service
- ISO officially released Standards 20893:2021 about debris mitigation proposed by China in 2021

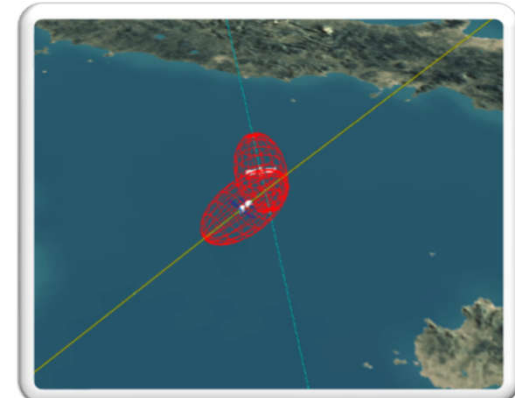




Environmental risks reduction

❖ Improve collision management measures

- Enacts laws and policies to proper control the licensing of launch
- The space debris mitigation fulfilment system was designed and implemented
- Disposed multiple events of satellite collision warning effectively
- Participating in international cooperation of space debris observation and collision warning





Environmental risks reduction

❖ Participate in international cooperation

- Active participation in works of COPUOS
- Bilateral or multilateral dialogues of space security and collision avoidance cooperation
- Participating in international joint observation and scientific research under the framework of IADC

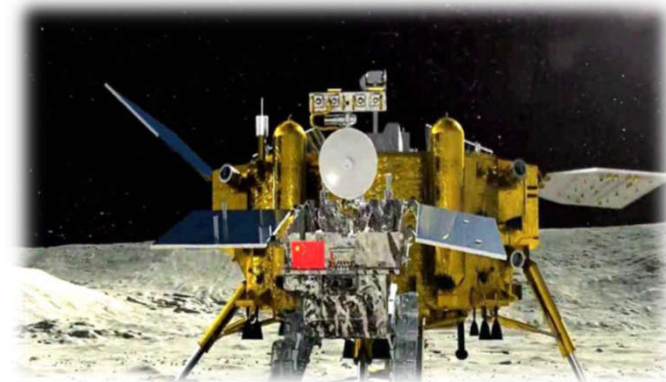
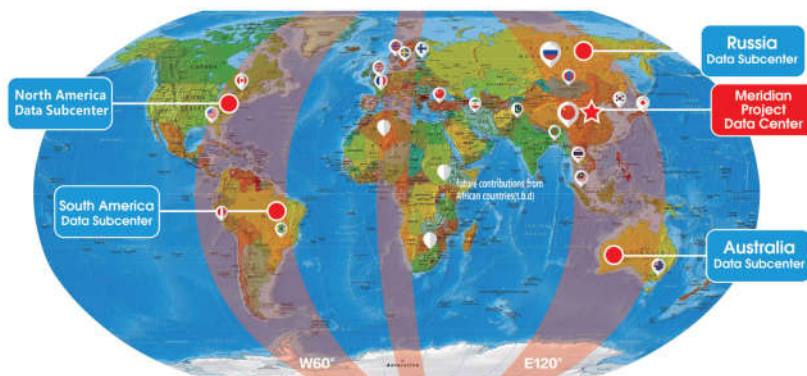




Environmental risks reduction

❖ Participate in international cooperation

- Undertakes service missions of international space environment organizations such as ISES, IPT-SWeISS , etc.
- Construction of the International Space Weather Meridian Circle Program
- Completed joint environmental exploration in Chang'e-4 mission (carrying loads from 4 countries)

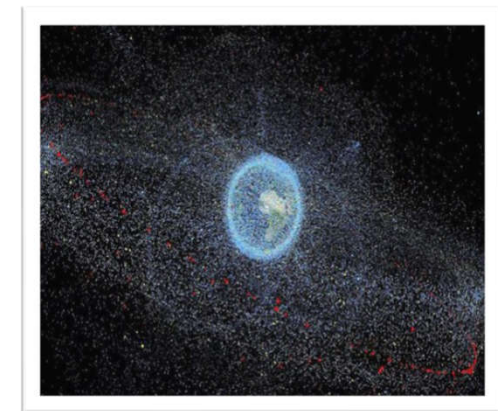
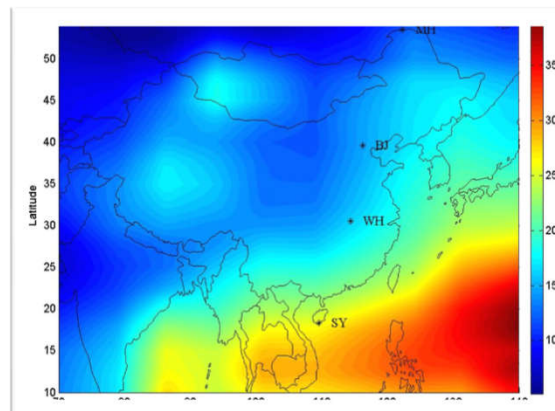
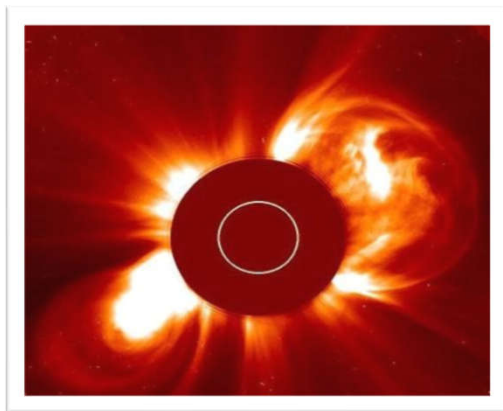




International Cooperation

❖ Expand space environment data sharing

- Expands the scope and content of global public service products
- Promotes space-based monitoring cooperation and data sharing of space environment
- Researches on technologies such as space weather forecasting, space debris environment modeling, etc.
- Motivates the global utilization of basic data of space environment

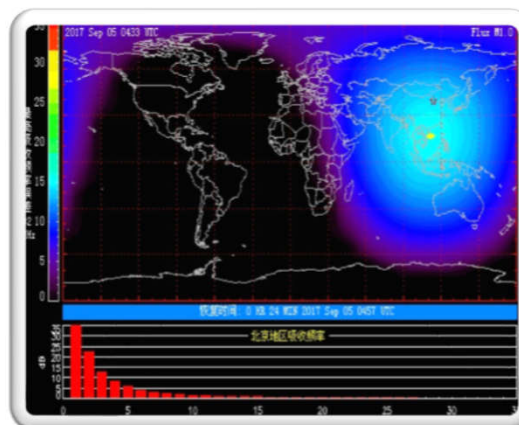
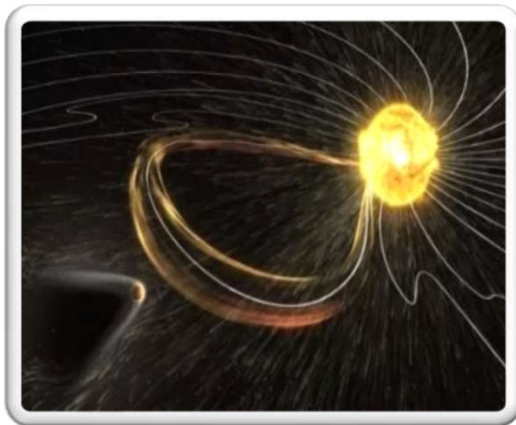




International Cooperation

❖ Promote joint action on space environmental events

- Develops global service guidelines, standards, coordination mechanism and disposal process for disastrous space environmental events
- Announces and acts on space environmental risks, guarantee the safety of on-orbit satellites





International Cooperation

❖ Improve regulations of space collision management

- Refines the current guidelines of space debris mitigation in terms of policies, laws, and services
- Formulates implementation methods in line with national conditions
- Enhances the effectiveness of the implementation of proposed guidelines and initiatives





Thanks

