

# Enhancing Global Cooperation for Space Environment Modeling and Data

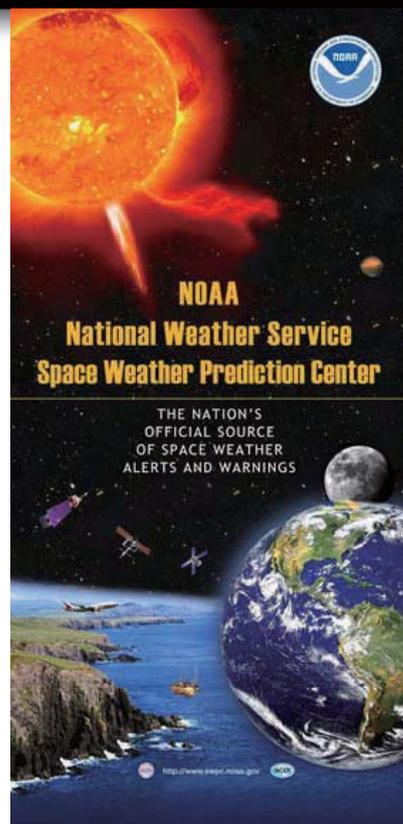


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## Outline

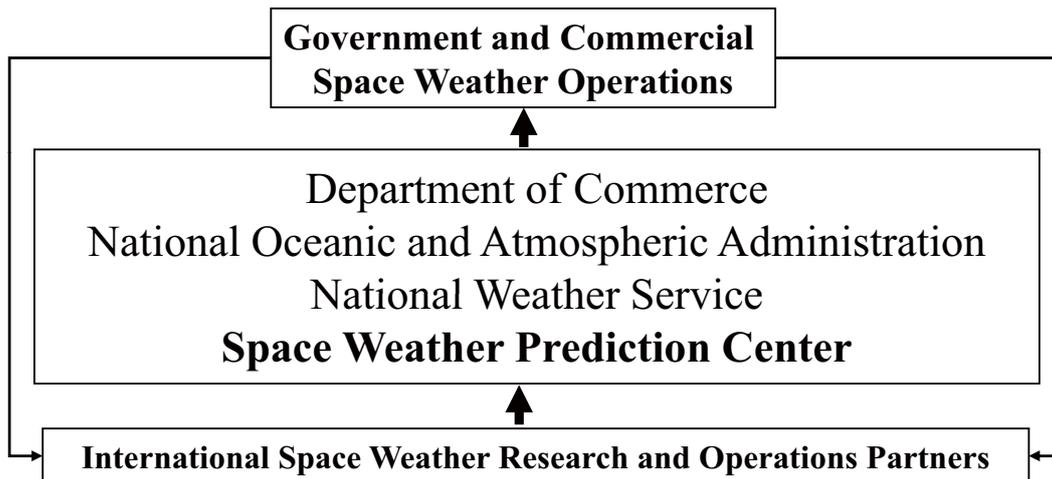
- Space Weather Customer Growth
- Highest Priority Service Areas
- Focus on Prediction – Future Plans
- 宇宙基本法
- International Collaboration on Space Weather Applications





# Space Weather Prediction Center

Mission: To deliver space weather products and services that meet the evolving needs of the nation



# Space is Critical to the World's Economy and Security

## • Space Systems

- We increasingly depend on our space infrastructure
- World satellite industry revenues in 2007: >\$100 billion

## • Aviation

- Polar route use – from no flights in 1998 to ~8,000 flights in 2008 – space weather is a major concern
- The Next Generation Air Transportation System will depend on GPS

## • GPS

- Single biggest source of error is space weather
- Strong growth in applications – surveying, drilling, precision agriculture, navigation, aviation

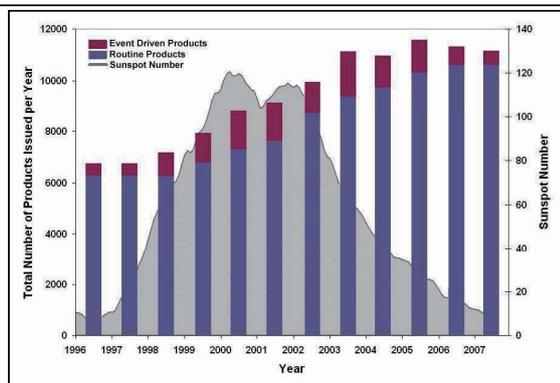
## • Electric Utilities

- Potential for significant disruption of service with \$Billion consequences





## Constant Growth in Customer Demand



### Every Month:

- 400,000 Unique Customers
- 50,000,000 File Transfers
- 120 Countries Represented
- 67,500,000 Hits
- 0.3 TBytes of Data Downloaded



## Space Weather Product Categories

### Product timeliness:

- Long lead-time forecasts (1 to > 3 days)
- Short-term warnings (notice of imminent storm)
- Alerts and Specifications (current conditions)

### Space Weather Category:

- X-ray flares
- Solar energetic particle events
- Geomagnetic storms
- Ionospheric disturbances
- Radiation belt enhancements
- Neutral density disturbances



# Major Problems in Space Weather

- **Solar Flares**
  - When will an active region erupt, and what will the consequences be?
  
- **Solar Energetic Particles and Radiation Belts**
  - If an active region erupts, will energetic particles arrive?
  
- **Geomagnetic Activity**
  - When and where will large magnetic field disturbances occur?
  
- **Ionospheric Disturbances**
  - When and where will electron density variations occur?



# Status of Current Space Weather Products

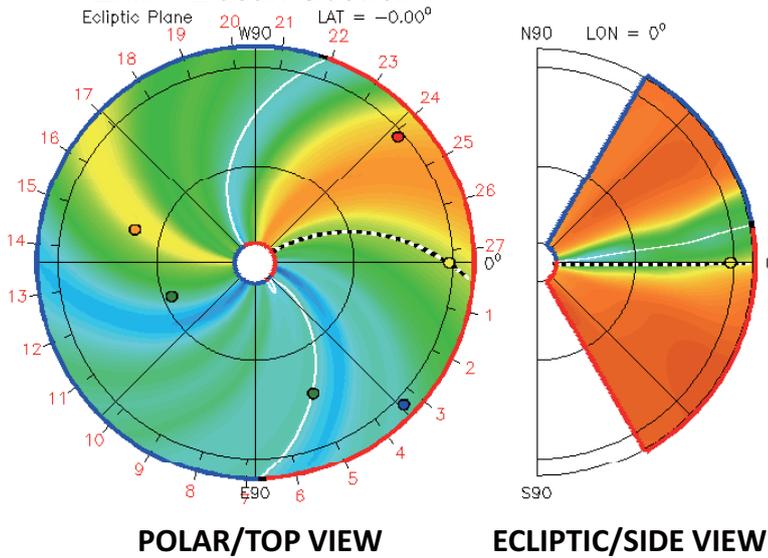
	Long-Term Forecast (1- >3 days)	Short-Term Forecasts and Warnings (<1 day)	Nowcasts and Alerts
Flare Products	M-flare and X-flare Probabilities	M-flare and X-flare Probabilities	X-ray Flux – Global and Regional
Energetic Particle Products	Proton and Electron Radiation Probabilities	Proton and Electron Radiation Probabilities	Proton and Electron Radiation – Global and Regional
Geomag Activity Products	Geomagnetic Storm Probabilities	Geomagnetic Storm Probabilities – Global and Regional	Geomagnetic Activity – Global and Regional
Iono and Atmo Products	Ionospheric Disturbance Probabilities	Ionospheric Disturbance Probabilities – Global and Regional	Ionospheric Disturbances – Global and Regional

# Prediction of Solar Disturbances

Predict the onset and strength of large geomagnetic storms:

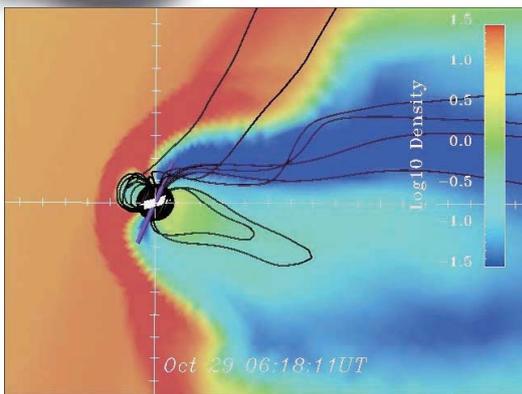
- 3 – 4 days in advance

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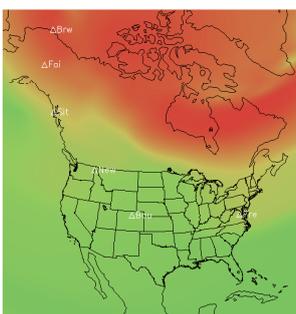


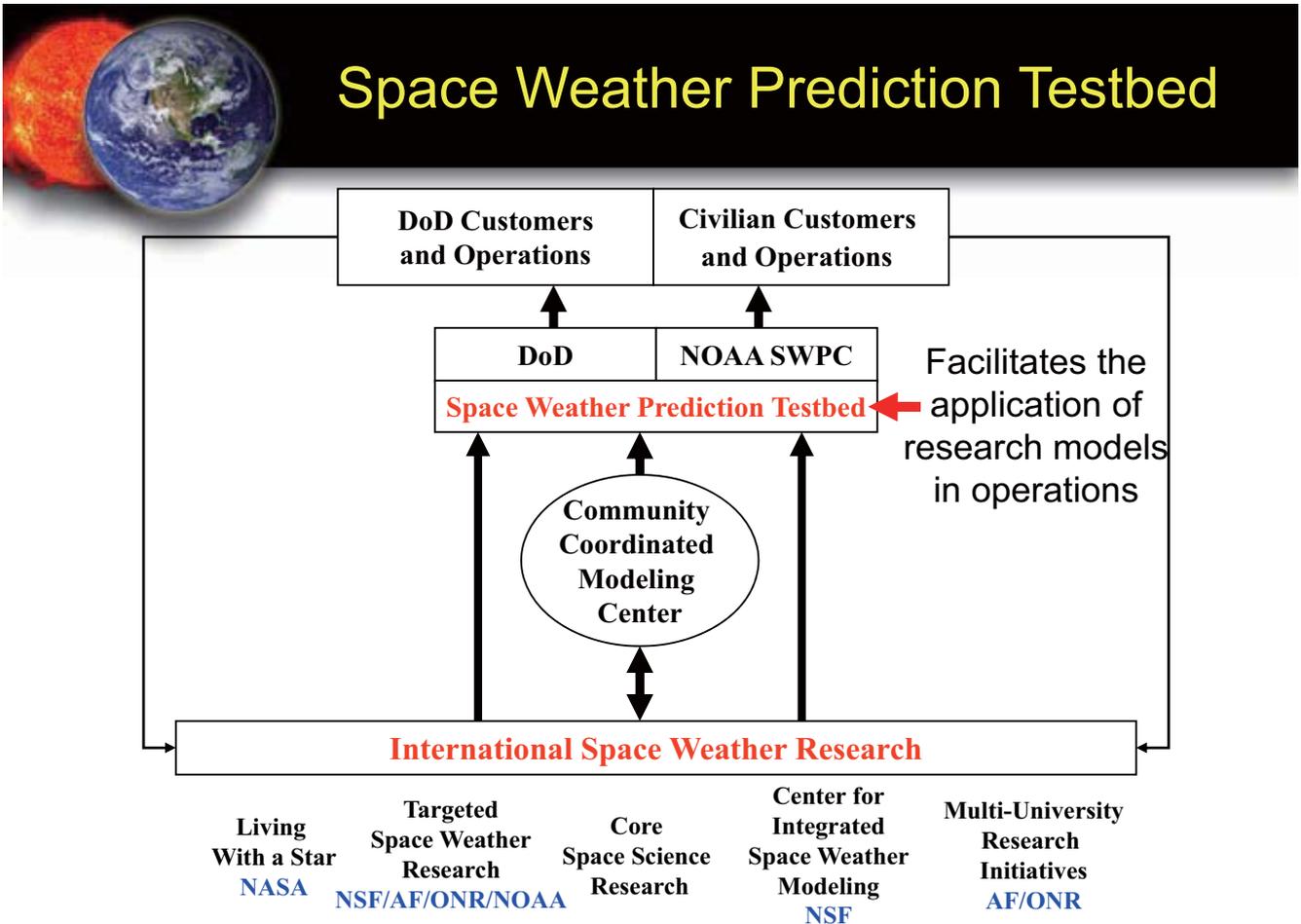
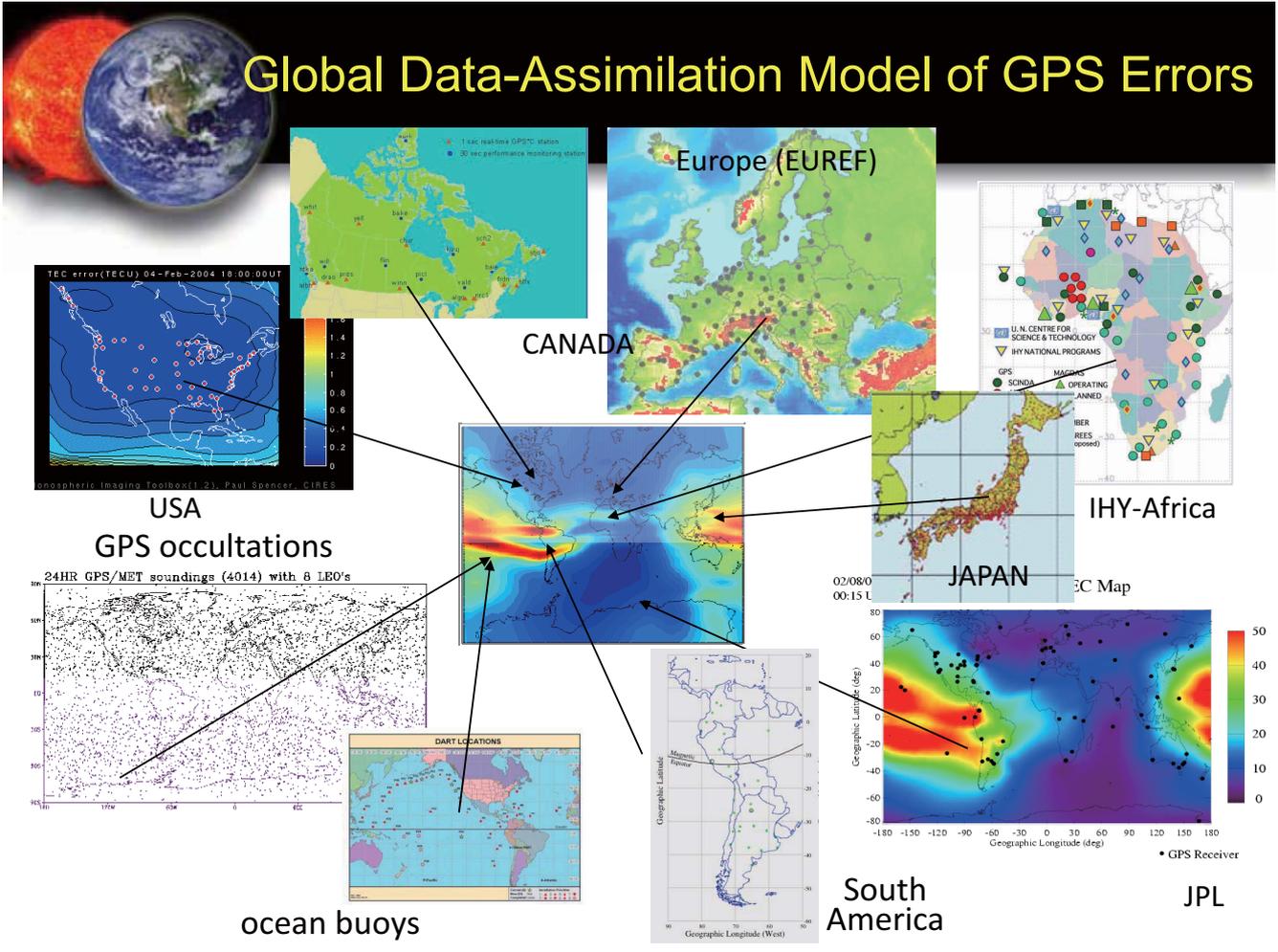
- Predict background solar wind
- Predict propagation of Coronal Mass Ejections
- Requires accurate measurement of solar photospheric magnetic field

# Magnetosphere, Ionosphere, Atmosphere Disturbance Prediction



- Predict the response of the magnetosphere 3 to 4 days in advance
- Focus on 3 – 4 day prediction for large events (CMEs)
- Focus on ~1-hour prediction using solar wind measurements
- Provide regional forecasts

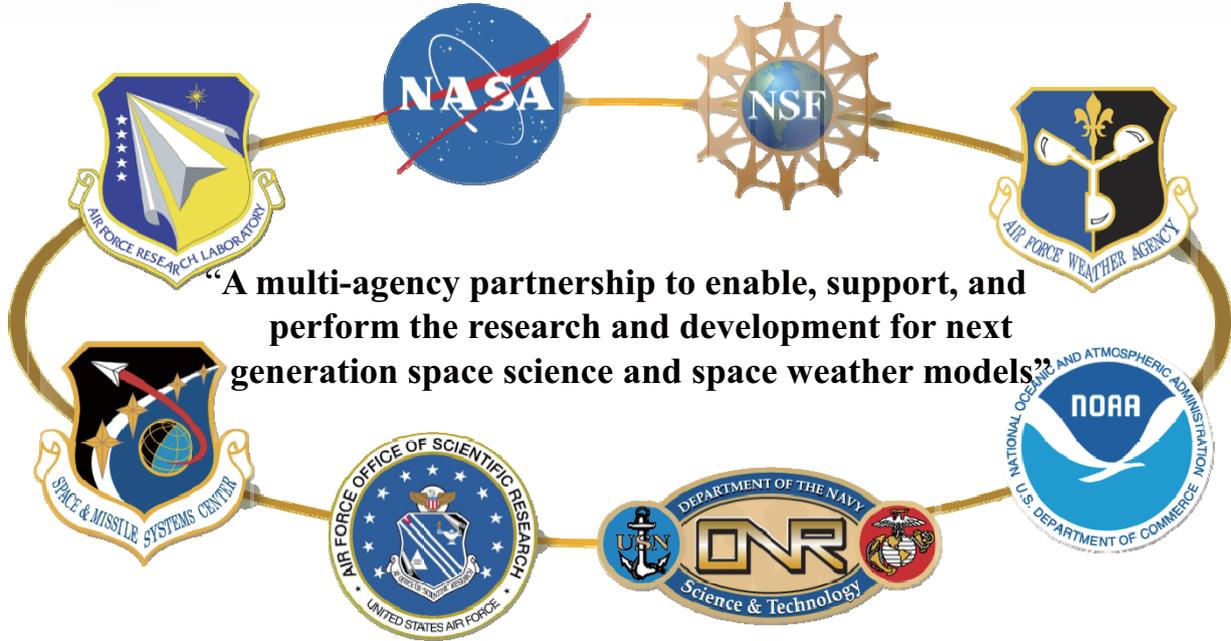






# Space Weather Partnerships

## National Space Weather Program



# International Partnerships

- **International Space Environment Service**
  - 12 Regional Warning Centers around the Globe
  - In discussion with World Meteorological Organization

Brazil (INPE):  
- Soon to be a member

South Africa (IMT):  
- Now a member



South Korea:  
- Applied for membership



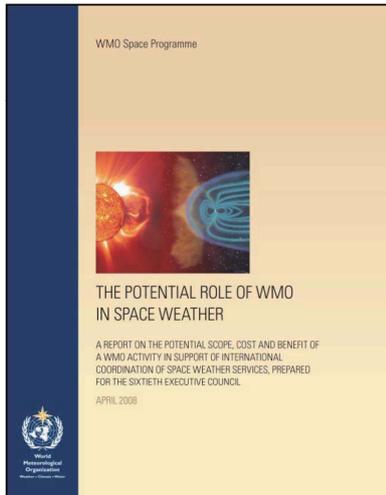


## Space Weather in the United Nations



World Meteorological Organization (WMO)

60<sup>th</sup> Session of the WMO Executive Council in Geneva, June 2008:



***“...the Council fully endorsed the principle of WMO activities in support of international coordination in Space Weather.”***

WMO Members with Space Weather within National Meteorology Services:  
Australia, China, Finland, Russia, U.S.



## Space Weather in the United Nations

Space Weather is a matter of importance for several agencies in the United Nations:

International Civil Aviation Organization (ICAO)

International Telecommunications Union (ITU)

International Maritime Organization (IMO)

UN Committee on Peaceful Use of Outer Space (COPUOS)



## 宇宙基本法

- 宇宙の平和的利用
- 国民生活の向上等
- 産業の振興
- 人類社会の発展
- 国際協力等の推進
- 環境への配慮



## Need for International Collaboration

- Space is a critical component of our economic and security infrastructure
- Our global assets are all impacted by the same space weather disturbances
- We all need the same information about space
- Space is too vast and complex for any single nation to continuously monitor or predict



## Research Collaborations are Strong

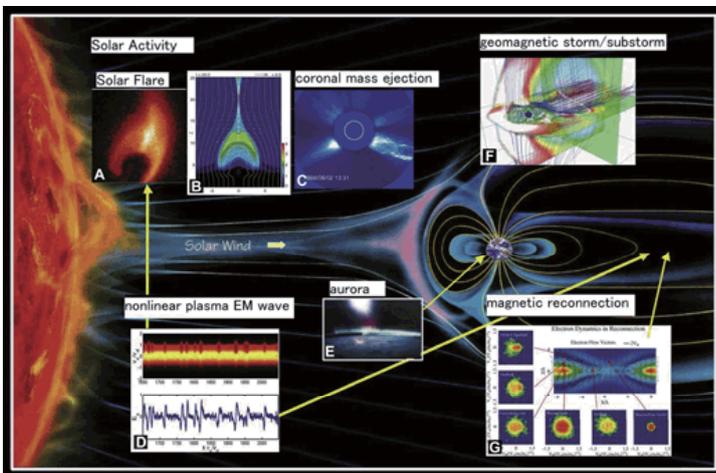
- International Satellite Programs
- Space- and Ground-based Data Sharing
- Solar-Terrestrial Theory and Modeling

However:

- Research activities are transient – Economic and Security needs continue and expand
- Focus is not on commercial and government needs

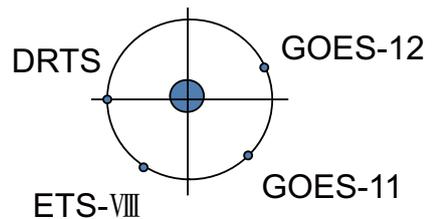


## Complementary Models and Data



Shibata and Kamide, 2007

JAXA and NOAA  
Geosynchronous Satellites



T. Goka



## Elements of a Focused Activity

- Determine international needs for space weather information
  - Global and Regional
- Identify the current and planned data sources
- Quantify the current level of space weather models
- Develop a plan for coordinated space weather research and observations

Focus on applications



## Summary

- Space is growing in importance for our economy and our security
- International cooperation is essential, and collaborative networks have been established
- Active research is occurring; however, there are significant gaps in our capabilities
- Japan's new Space Law could enable new partnerships
- International collaboration on space weather applications is needed – with a coordinated plan among the agencies