



# Real-time Space Weather Forecasts Via ASTRA's Phone Apps

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# Introduction to ASTRA

- Atmospheric & Space Technology Research Associates
- Specializing in Solar-Terrestrial research and applications
- Current and recent customers:
  - Los Alamos National Laboratory
  - AFRL
  - AFOSR
  - ONR
  - NRL
  - NASA
  - NSF
  - JHU-APL
  - Aerospace Corp.
  - Various universities

❖ **Science**

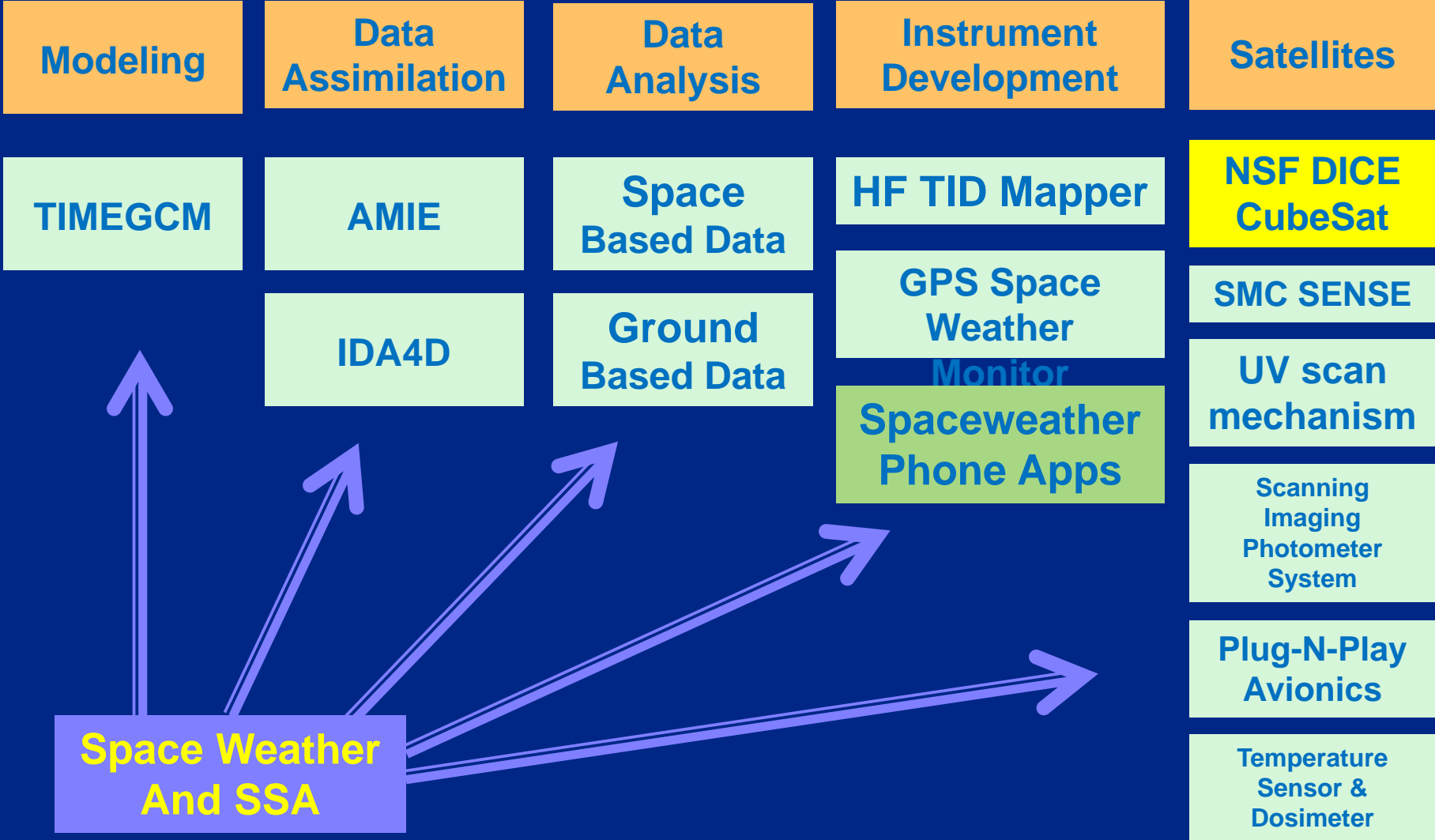
❖ **Technology**

❖ **Applications**

**Bringing It All Together**



# ASTRA Core Competencies





# Experience: Transition of TIMEGCM

Thermosphere Ionosphere Mesosphere Electrodynamics GCM

Modeling

Data  
Assimilation

Data  
Analysis

TIMEGCM

AMIE

Space  
Based  
Data

Ground  
Based  
Data

ACE solar wind

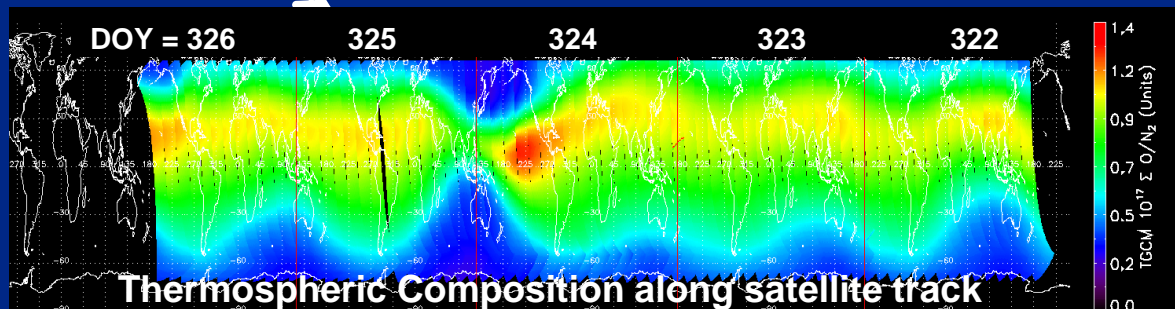
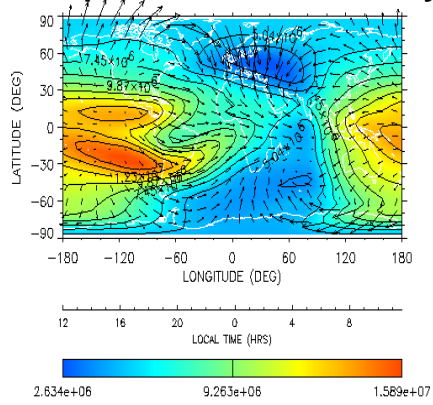
DMSP

UV-  
Spectrograph

magnetometers

SuperDARN

Ionospheric Electron Density





# Experience: Transition of AMIE

## Assimilative Mapping of Ionospheric Electrodynamics

Modeling

Data  
Assimilation

Data  
Analysis

Space  
Based  
Data

ACE solar wind

DMSP

UV-  
Spectrograph

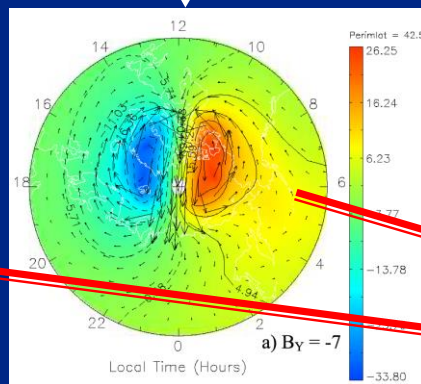
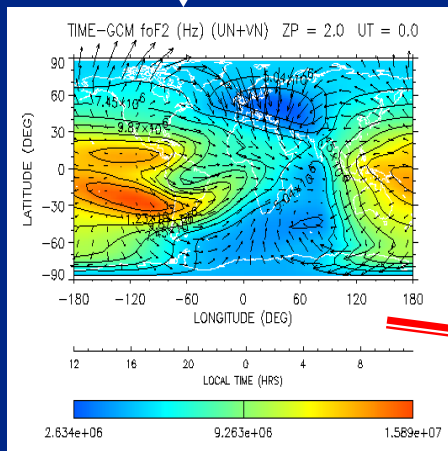
Ground  
Based  
Data

magnetometers

SuperDARN

TIMEGCM

AMIE



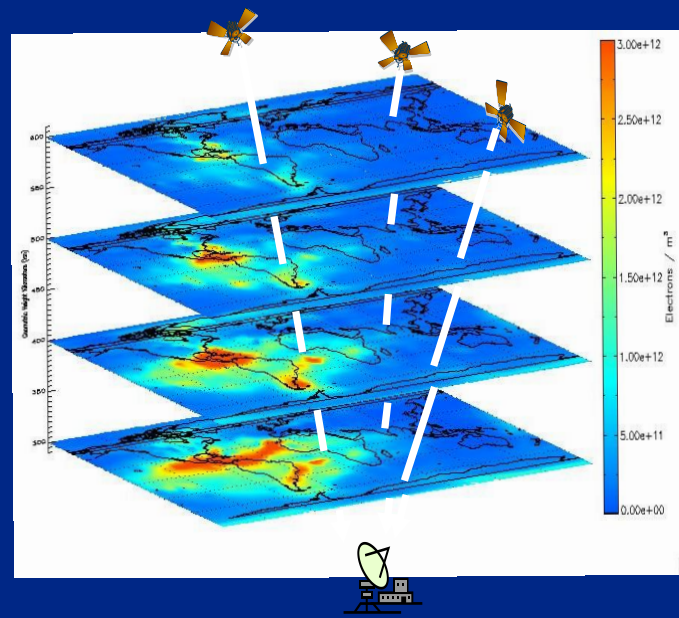
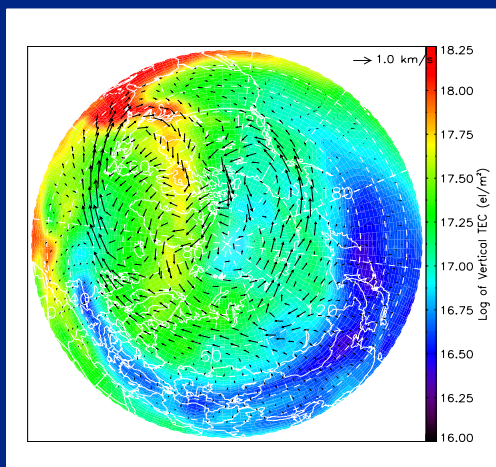
android  
market



[www.astraspace.net](http://www.astraspace.net)

# Transition Issues

- Disciplined code management (version #, efficiency)
- Computer system development (speed)
- Dynamic time-step allocation (affects run time)
- Model resolution (affects run time)
- Storage of model output (23 TB/yr or 108 GB/yr)
- Graphical Output





# Transition Issues for Assimilation Models:

- Ensuring input data stream
- How to identify and deal with missing data
- How to identify and deal with “bad” data
- What situations can cause code to malfunction
- Quality control on output



# Problem: Dynamic Time Step Allocation for Realtime GCM

Timestep →	Depends on Potdf (kV)		
	<80	80-120	>120
	60s	30s	15s

TIMEGCM - Run Time for 5 min run			
Timestep →	15s	30s	60s
	440s	220s	110s
Parallelized /MPI →	260s	130s	65s



# Problem: Storage of Model Output

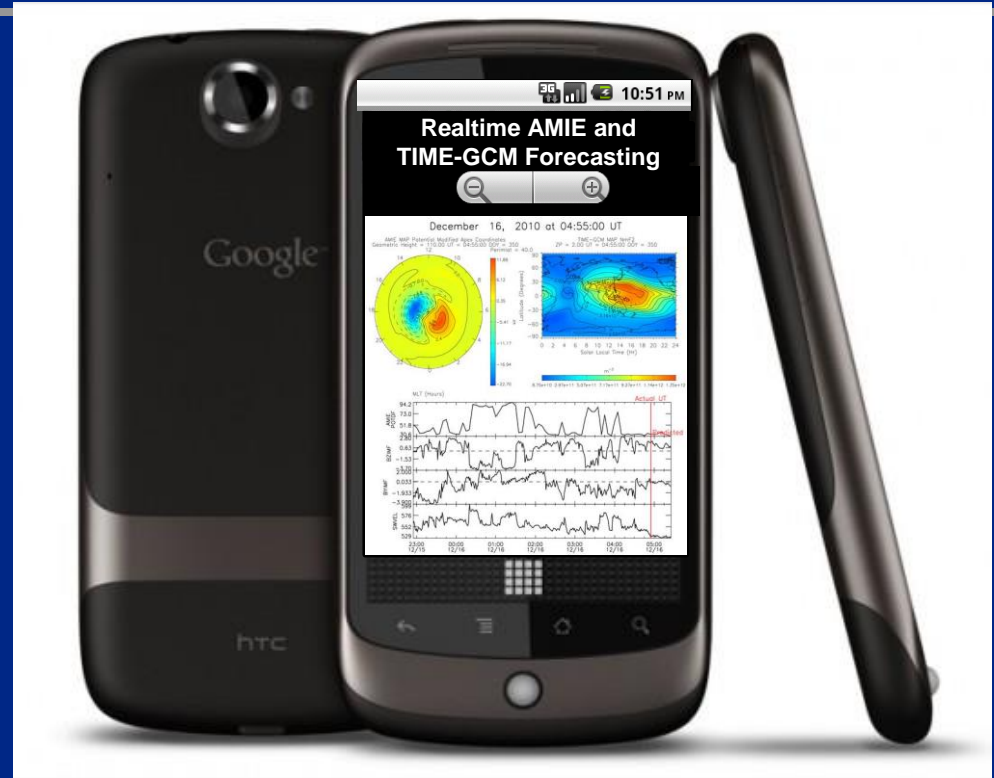
Saving Interval	Size/step	Steps/day	Size/day	Size/year
Regular 5-min	113 MB	*576	65 GB	<b>23 TB</b>
Trimmed 5-min	113 MB	*288	32.5 GB	11,900 GB
1-hour	113 MB	24	2.7 GB	990 GB
1-day primary, 1-hour secondary	**12.375 MB	24	297 MB	<b>108 GB</b>

\* Due to the way GCM saves its output, and the way it must be run for a real-time system, every time is saved twice (duplicated), hence 576 times per day on a 5 minute cadence before trimming.

\*\* The histories take up 8 MB per secondary, and 105 MB per primary, the effective size/hour is calculated as  $8 + (105/24) = 12.375$  MB.



# AMIE and TIMEGCM Models *on the ASTRA Space Weather App!*



Get Realtime AMIE and TIME-GCM Model data on your mobile phone with the **Astra Space Weather App**.

Use barcode scanner application on your phone and scan the QR code on the right to download from Google Marketplace now!



# Challenges for Presenting Large Amounts of Data on Smartphone Devices

- **Bandwidth**
  - Unpredictable speeds for download of data can produce poor experience for the end users
- **Functionality**
  - Different hardware manufacturers provide different features impacting the experience of the end user
    - » Viewable screen size
    - » Multi-touch screens
    - » Wi-Fi or 3G connections
- **Source Data**
  - Realtime phone applications rely on the availability of the datasets and models every time it is requested by the end user.



# ASTRA is prepared to address these challenges!

- **Bandwidth**

- Our development team is encouraged and rewarded for bandwidth reduction providing continual improvement to performance and low-bandwidth operations of our applications.
- Some examples include:
  - » High resolution zoom by downloading only high resolutions of viewable screen through image slicing techniques
  - » Video streaming
  - » Changes to functionality when low-bandwidth connections are detected.
  - » On-device caching of static data

- **Functionality**

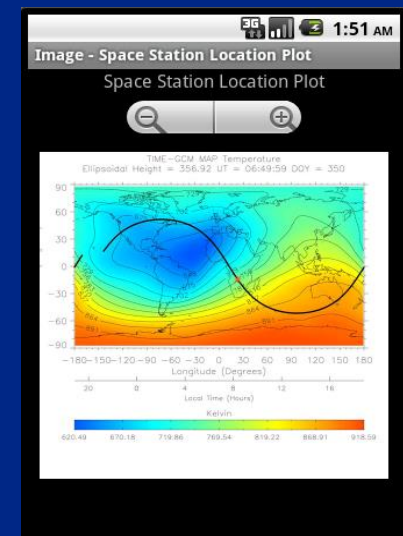
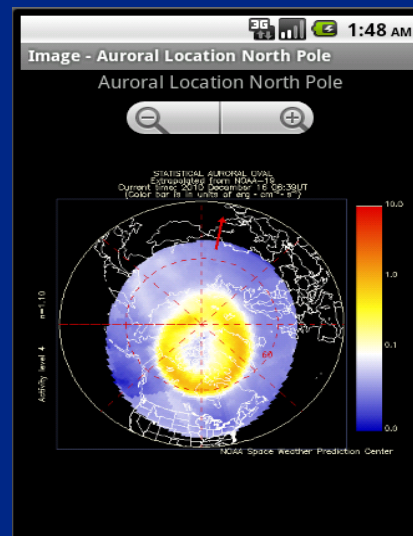
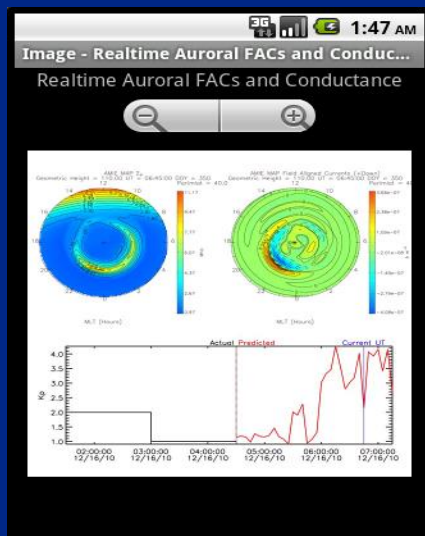
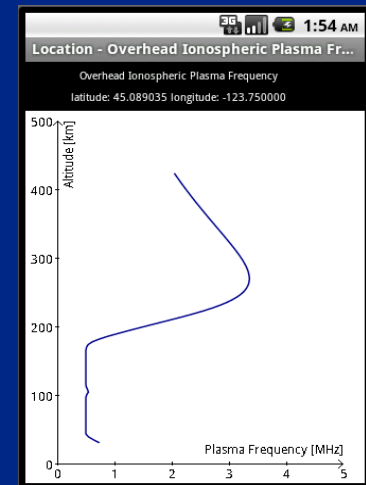
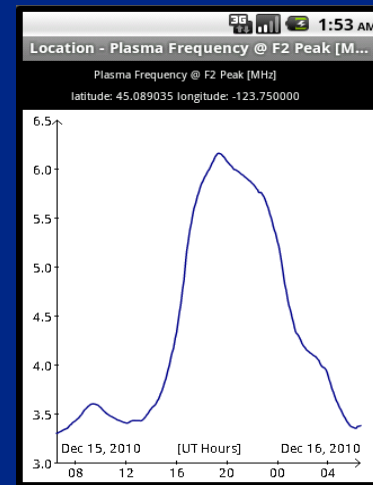
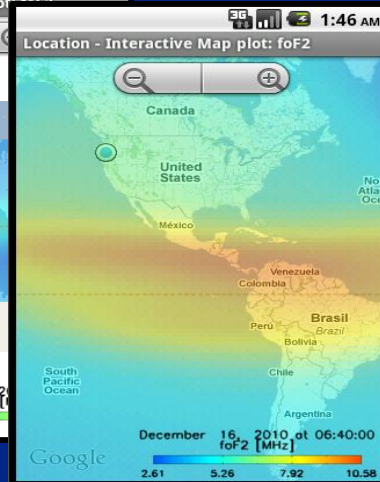
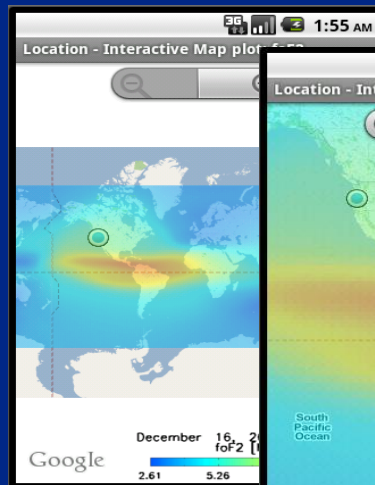
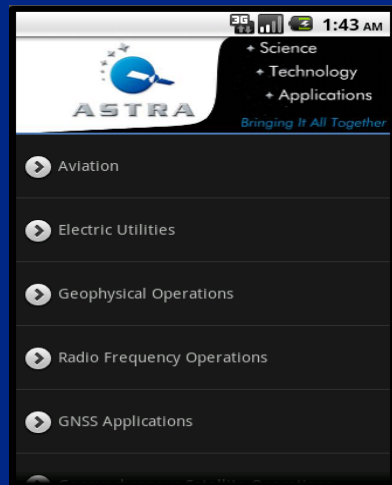
- Large and small screen format design and testing
- Support on-screen zoom and multi-touch zoom
- Testing on multiple devices and multiple operating system version to ensure cross-device compatibility

- **Source Data**

- Application data served up by Amazon S3 and Cloud Front systems for high availability
- Ability to use “remembered” data and notify the user that realtime data will be used once available.



# A LOOK INTO ASTRA Space Weather App





# ASTRA SpaceWeather App

**13,482 downloads!**

**In 17 countries**

- **United States**
- **Canada**
- **Brazil**
- **United Kingdom**
- **China**
- **Puerto Rico**
- **Qatar**
- **Ethiopia**
- **Spain**
- **Germany**
- **Australia**
- **Netherlands**
- **Ireland**
- **Austria**
- **Poland**
- **France**

**From our Customers:**



*An excellent app -- amazing array of satellite images/aerospace data all in one place. Thank you!!*



*Cool real time images of sun and space weather. You must have this app. Go space physicists!*



*Great way to keep a look out for solar storms!*



*Great for ham radio*



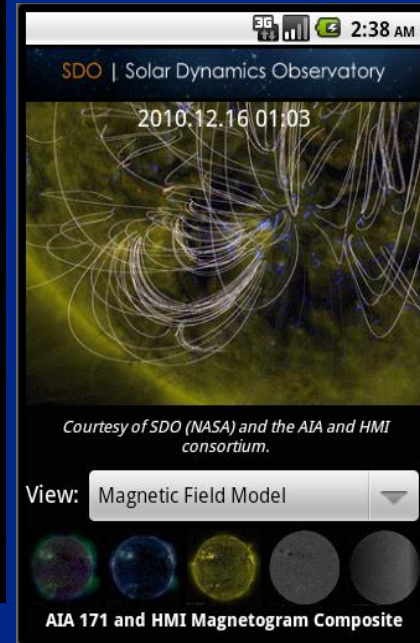
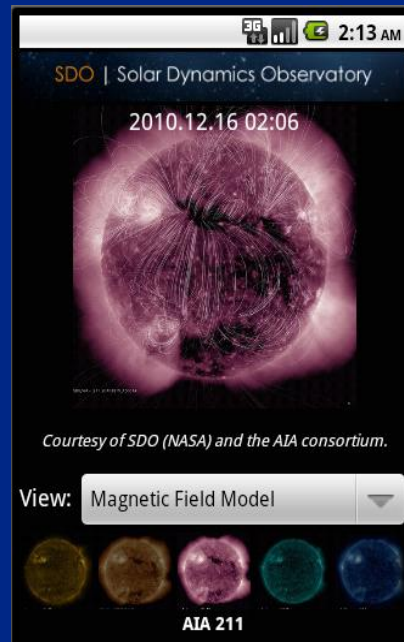
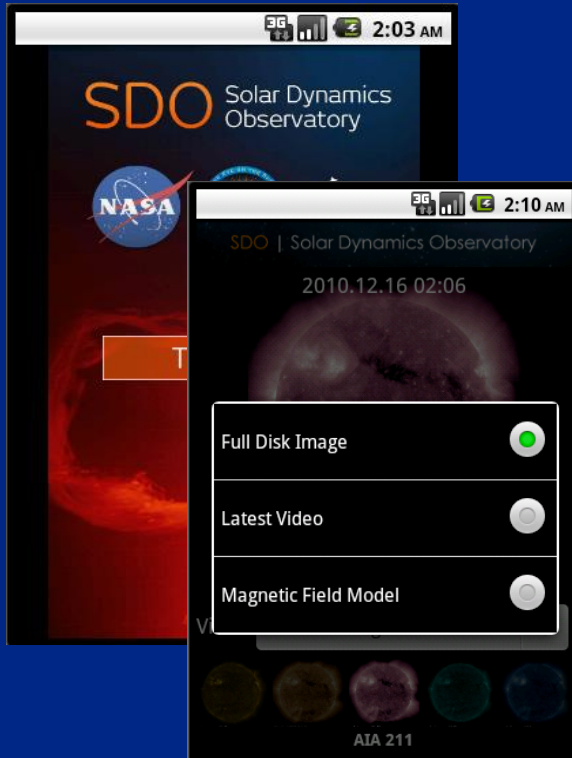
# A LOOK INTO Solar Dynamics Observatory App







# A LOOK INTO Solar Dynamics Observatory App







# NASA / ASTRA SDO App

## 2,491 downloads!

### In 10 countries

- *United States*
- *United Kingdom*
- *Spain*
- *Germany*
- *Netherlands*
- *Italy*
- *Canada*
- *France*
- *Australia*
- *Russia*

**From our Customers:**



*Super collection d'images pour analyser le soleil.*



*Totally awesome!*

*Better than a paid app I had!*



*Fantastic and all images are current! Images are up to date and is working flawlessly ...*



*This is one of my favorite apps. Updates pictures everyday and the videos are awesome...*



# CONCLUSIONS – Part 1

- 1) Realtime Space Weather Available on Smart Phones**
- 2) ASTRA Apps available on Android for 18 mo**
- 3) ASTRA Apps being used worldwide**
- 4) Available on iPhone next month**
- 5) Apps can be tailored for specific users**

**We're Hiring!**



# CONCLUSIONS – Part 2

## From our Customers:



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