Providing Space Weather Services from Data to Forecasts

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ESA Space Weather Workshop
Noordwijk, The Netherlands
December 18, 2002

Outline

- New Customers – Europe and U.S. – of Space Weather Services
- Necessary Data
- Necessary Models
- Desired Products
- Other New Data
- Summary

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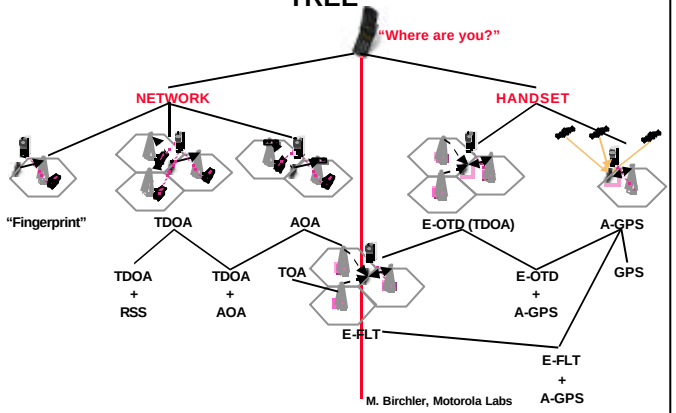
E911 Wireless Services (E112 in Europe)

Federal Communications Commission

The wireless E911 program is divided into two parts - Phase I and Phase II. Phase I requires carriers, upon appropriate request by a local Public Safety Answering Point (PSAP), to report the telephone number of a wireless 911 caller and the location of the antenna that received the call.

Phase II requires wireless carriers to provide far more precise location information, within 50 to 100 meters in most cases.

E911 LOCATION SOLUTION "FAMILY TREE"



U.S. Cell Phone Usage

- **For the year ending December 2000**
  - **Generated over $52.5 billion in revenues**
  - **Increased subscribership from 86.0 to 109.5 million, change of 28%**
  - **Increased nationwide penetration rate (total subscribers/total population) to 39% (vs. 62.5% in Europe)**

(Source: Federal Communications Commission Report FCC 01-192, July 17, 2001)

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E911 Phase 2 Mandates

- **Providers have to meet a schedule of E911 Phase 2 compliance, imposed by the FCC**
- **For example, for *Verizon Wireless***
  - **March 31, '03** — **50% of new handsets nationwide must be A-GPS capable.**
  - **December 31, '03** — **100% of new handsets nationwide must be A-GPS capable.**
  - **December 31, '05** — **95% of all customer handsets in service nationwide must be A-GPS capable.**
- **AT&T, Cingular, Nextel, and Sprint have similar deadlines**

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BBC NEWS

Transport Bill gets moving

The government wants to reduce traffic jams

Controversial plans to introduce congestion charges on motorists and the part privatisation of the air traffic control system have been published by the Deputy Prime Minister John Prescott.

BBC December 1, 1999

German Truck-Toll Plan Advances

GPS World
October 7, 2002

A plan to implement a $7.7-billion automatic road-tolling system for commercial truckers in Germany is moving ahead following the Federal Cartel Office's rejection of a contract appeal by an unsuccessful competitor. **The Toll Collect system uses GPS-equipped on-board units to measure truck movements along roads.**

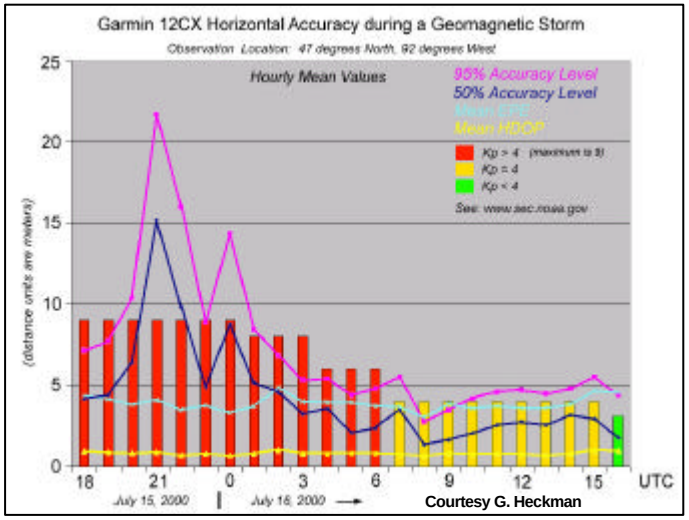
ETC.de, a consortium comprised of Daimler-Chrysler, Deutsche Telekom and French toll-road operator Cofiroute, will offer the service, scheduled to begin next year. Daimler-Chrysler and Deutsche Telekom each own 45 percent of the winning group and Cofiroute has 10 percent.

German Truck-Toll Plan, cont.

The system, **mandated for use by trucks of more than 12 tons**, is expected **to generate some $3.4 billion per year** (based on a fee of about 24 cents per mile), which will be used for improvements to the German transportation system.

Once a Toll Collect–equipped vehicle begins to move, **the GPS receiver automatically identifies the road on which the vehicle is traveling**. As soon as the truck enters a toll road, the onboard unit uses the truck's data (number of axles and emissions class) and the number of kilometers driven to calculate the tolls. A wireless communications link transmits the distances traveled by vehicles to the Toll Collect Center. The center then arranges payment of the toll with the shipping company.

"Since the system functions completely automatically, the driver can concentrate fully on the road," says Michael Rummel, managing director of mobility management at Daimler-Chrysler Services. **"The positioning function of the navigation system is so precise that the unit can accurately and easily determine whether a truck is on a toll highway or a parallel toll-free road,"** adds Rummel.



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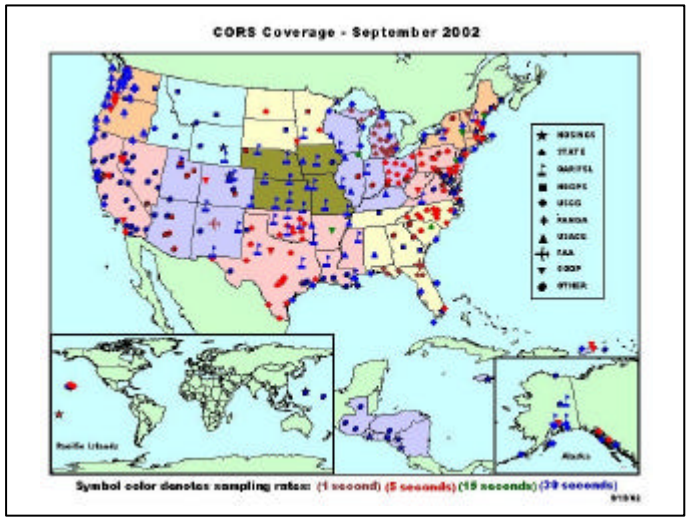
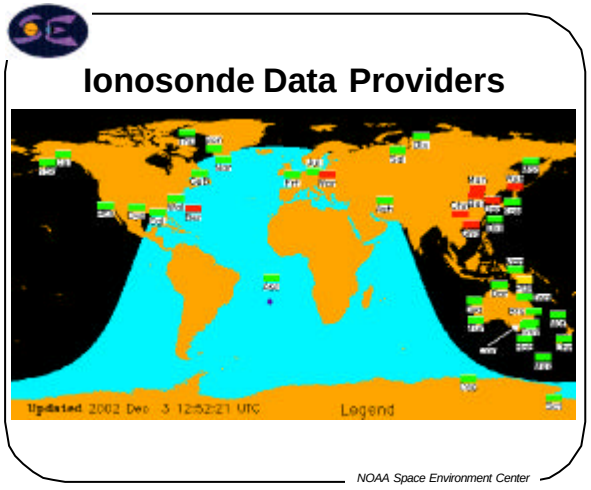


European IGS Network

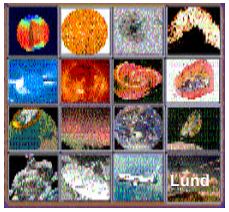


International Space Environment Service (ISES)

SIDC

RWC Belgium World Data Center for the Sunspot Index

Brussels



RWC - Sweden

ESTEC RESEARCH & TECHNOLOGY CENTRE FOR THE EUROPEAN SPACE AGENCY

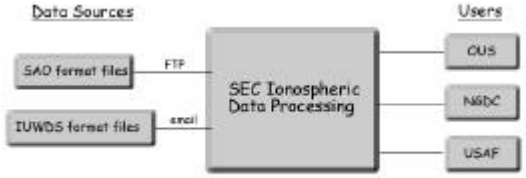
RWC - Russia

RWC - Poland

RWC – Czech Republic

ARWC - Toulouse

Ionosonde Data



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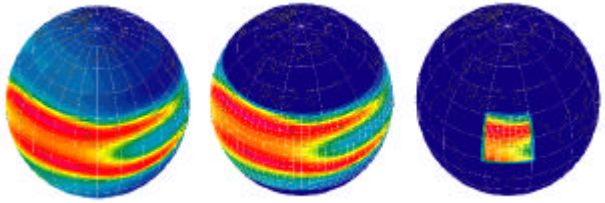
Global Assimilation of Ionospheric Measurements

GAIM uses a Physics-Based Ionosphere-Plasmasphere Model as a Basis for Assimilating a Diverse Set of Real-Time (or Near Real-Time) Measurements. GAIM will Provide Both Specifications and Forecasts on a Global, Regional, or Local Grid.



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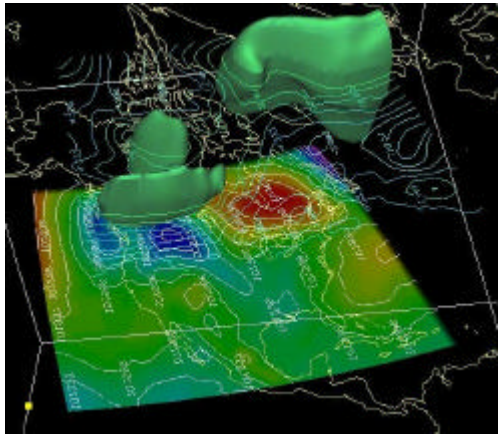
Gridded Data, 3D Wind Speed and Surface Pressure



Courtesy UCAR

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Data and Imagery

- One of the greatest changes in recent times is the availability of crucial data
- The internet has allowed these data to be of use to forecasters
- New data streams ready to follow
- The incorporation of the new data and imagery will mark another leap in predictions

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ACE and SOHO have revolutionized forecasting

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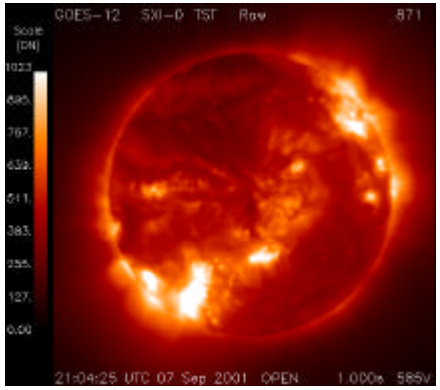
Solar X-Ray Imager
April 2003



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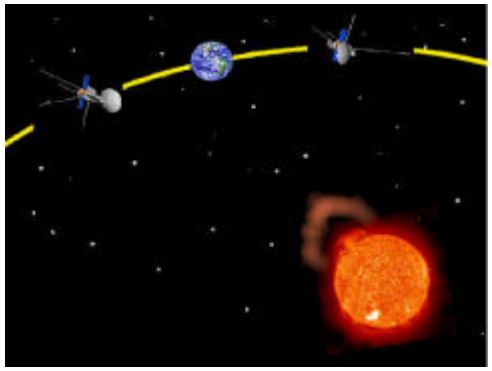
NASA Stereo Mission

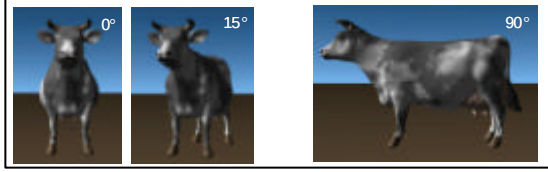


Stereoscopy and 3D Reconstruction

Qualitative and quantitative 3D information from two views.

Stereoscopy or 3D reconstruction from moderate separation angles.

Additional 3D information from larger angles.



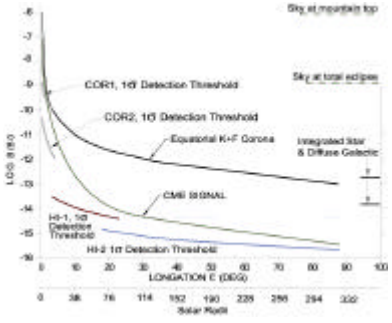
Courtesy S. Plunkett

Why Multiple "Coronagraphs"?

Each coronagraph is designed to operate in a small height regime.

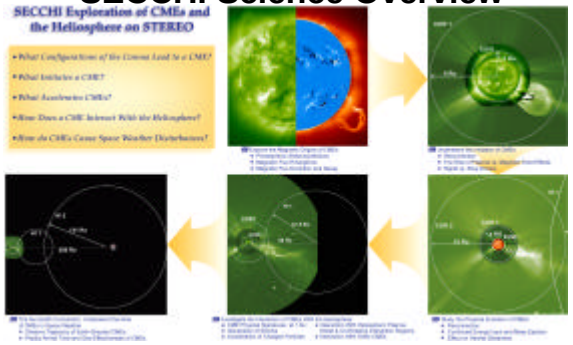
This makes the problem of observing the corona over many orders of magnitude tractable.

Shown are the 1 sigma CME detection threshold compared to the coronal brightness.



Courtesy S. Plunkett

SECCHI Science Overview



Courtesy S. Plunkett

SECCHI Instrument Suite

EUVI: Extreme Ultraviolet Imager
- Narrow band (multi-layers) Ritchey-Chretien Telescope

COR1: Coronagraph for Inner Corona
- Internally occulted visible light Lyot Coronagraph

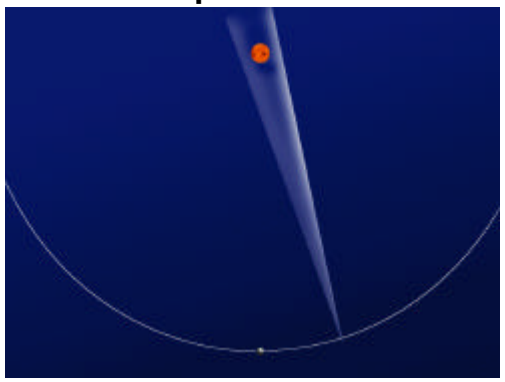
COR2: Coronagraph for Outer Corona
- Externally occulted visible light Lyot Coronagraph

HI-1: Heliospheric Imager for Extended Corona
- Externally occulted visible light Coronagraph

HI-2: Heliospheric Imager for Inner Heliosphere
- Externally occulted visible light Coronagraph

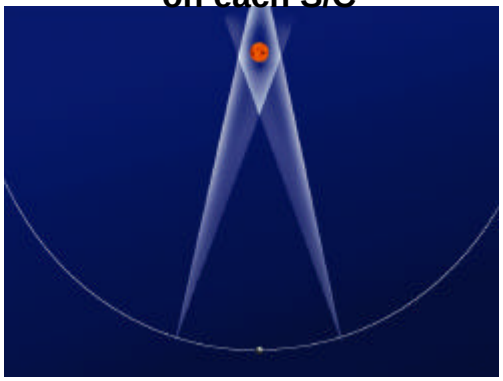
Courtesy S. Plunkett

COR View from Single STEREO Spacecraft



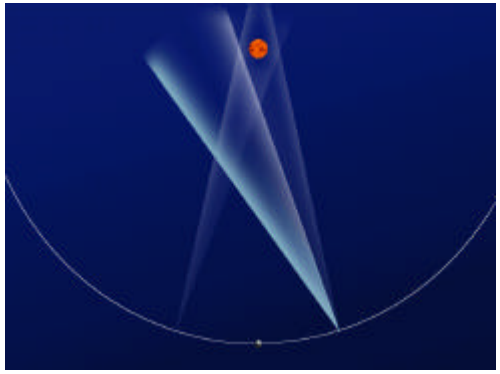
Courtesy S. Plunkett

Region of Overlap from CORs on each S/C



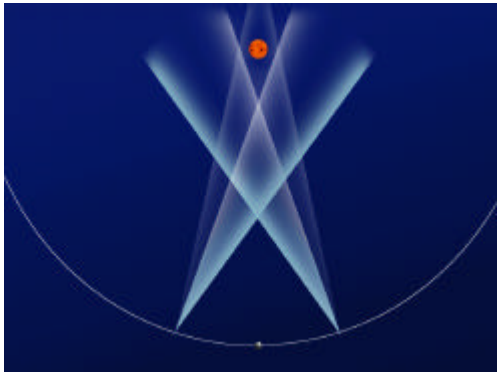
Courtesy S. Plunkett

HI-1 View from STEREO-Ahead



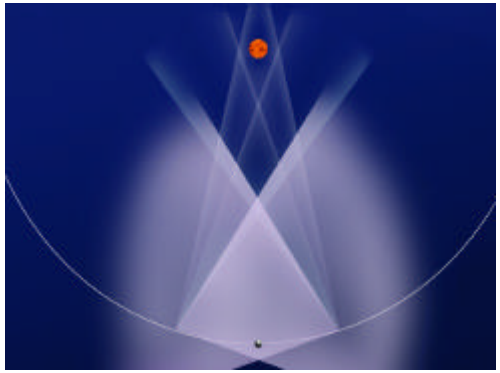
Courtesy S. Plunkett

Overlap from HI-1 and CORs



Courtesy S. Plunkett

HI-2 Overlap Region



Courtesy S. Plunkett

SECCHI Major Science Objectives

What is the 3D structure of coronal loops, streamers, and large-scale coronal features?

What configurations of the corona lead to a CME?

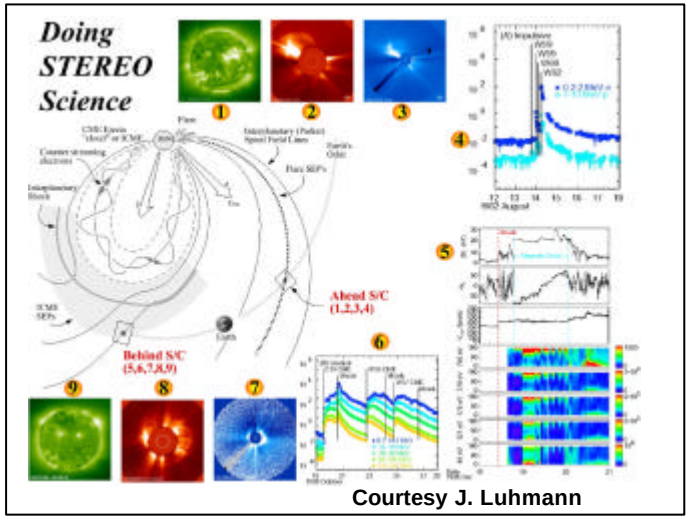
What processes initiate and accelerate CMEs?

What is the 3D structure of CMEs?

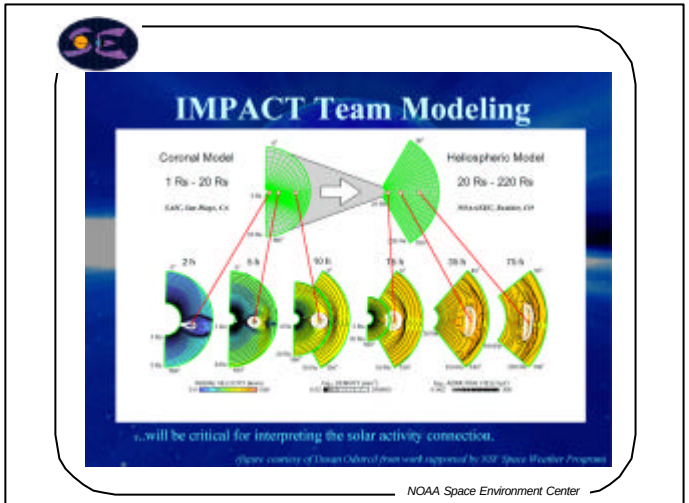
How do CMEs interact with heliospheric structures?

How do CMEs cause space weather disturbances?

Courtesy S. Plunkett



Courtesy J. Luhmann



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Future Missions

- GOES N+(SXI, EUV, particles, ...), 2004
- NPOESS (GPSOS, SESS,....), 2009
- Geostorms (B, plasma, particles), tbd
- SMEI (wlc), late 2002
- STEREO (2 spacecraft; euv, wlc, plasma, particles, radio), late 2005
- LWS SDO (magnetic, wlc, euv), 2007
- LWS Geospace (particles, B, ...), 2008
- LWS Sentinels (B, plasma, particles), tbd
- Solar-B (magnetograph,UV/EUV), 2005
- SOLIS (vector magnetograph), 2002

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Customer Needs

Priority	Model	Customer	Impact	Lead Time
1	Solar Energetic Particle Forecast	Airlines Satellite Launch Manned Space Flight	Solar Energetic Particles	5-12 hours 12 hours 5 days
2	Relativistic Electron Forecast	Manned Space Flight	Radiation Belt Electrons	5 days
2	Regional Geomagnetic Forecast/Specification	Electric Power Airlines	Geomagnetic Activity	Various, function of skill
3	Ionospheric Disturbance Forecast/Specification	GPS	TEC and Scintillation	1 day
3	Ap Prediction	Various	Geomagnetic Activity	1-3, 7, and 27 days
4	Dst Prediction	Various	Geomagnetic Activity	Storm onset, max, and end

Onsager, Singer, and Kunches, 2002

Summary

- **New user applications coming**
- **The capability exists in Europe to:**
  - **Acquire necessary data**
  - **Model the environment**
  - **Specify and forecast conditions**
  - **Distribute the appropriate products**
- **This paradigm may be further extended using additional new data (i.e., STEREO SECCHI and IMPACT)**

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