Space Weather - The operational need

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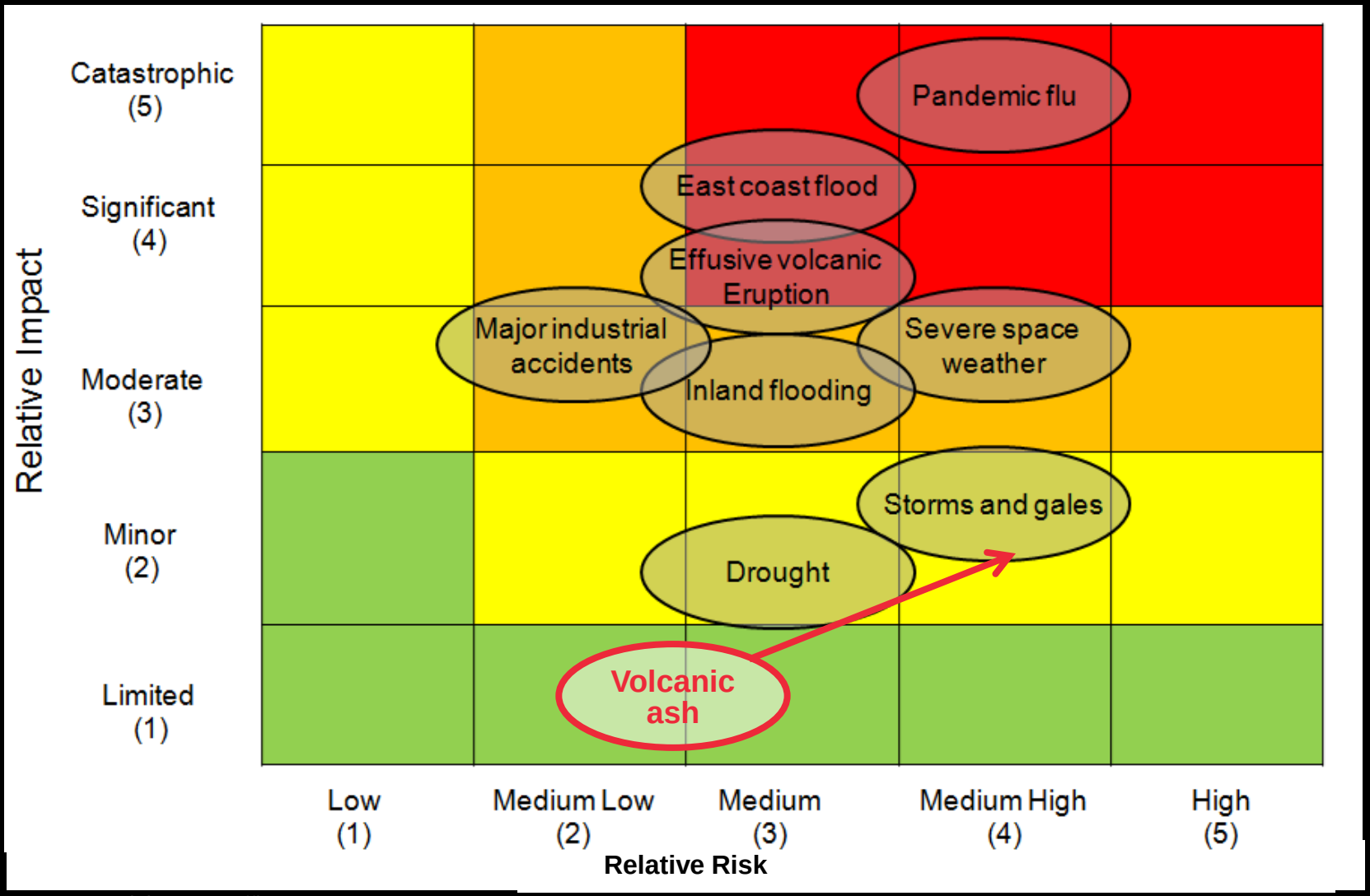
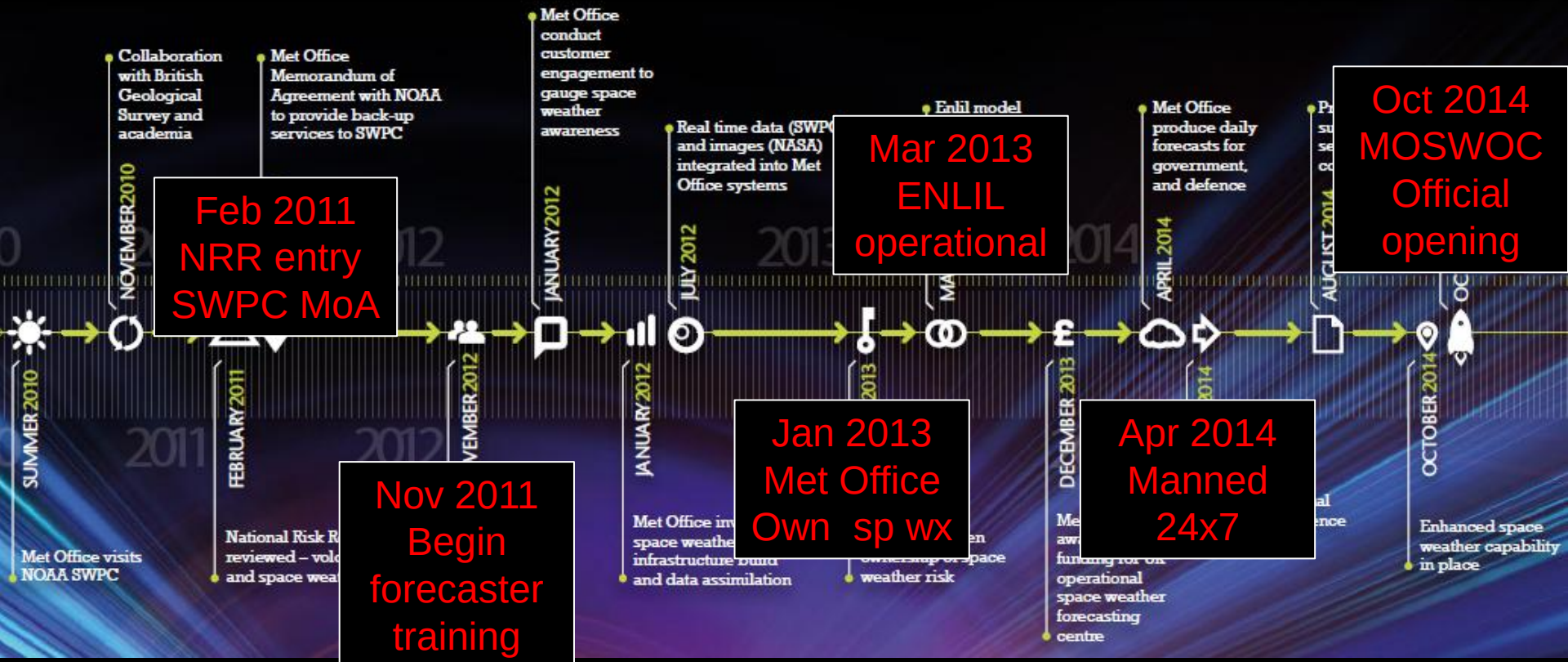
Met Office

Background



Met Office

A space weather journey through time



Met Office Space Weather Operations Centre (MOSWOC)

Key Challenges

- CME arrival accuracy
  - Initial forecast
  - Forecast update
- Bz prediction or early measurement (sub-L1)
- Early identification of ‘concerning’ active region
- Radiation environment at aviation altitude
- SEP prediction
- Regional geomagnetic storm prediction

The priority need

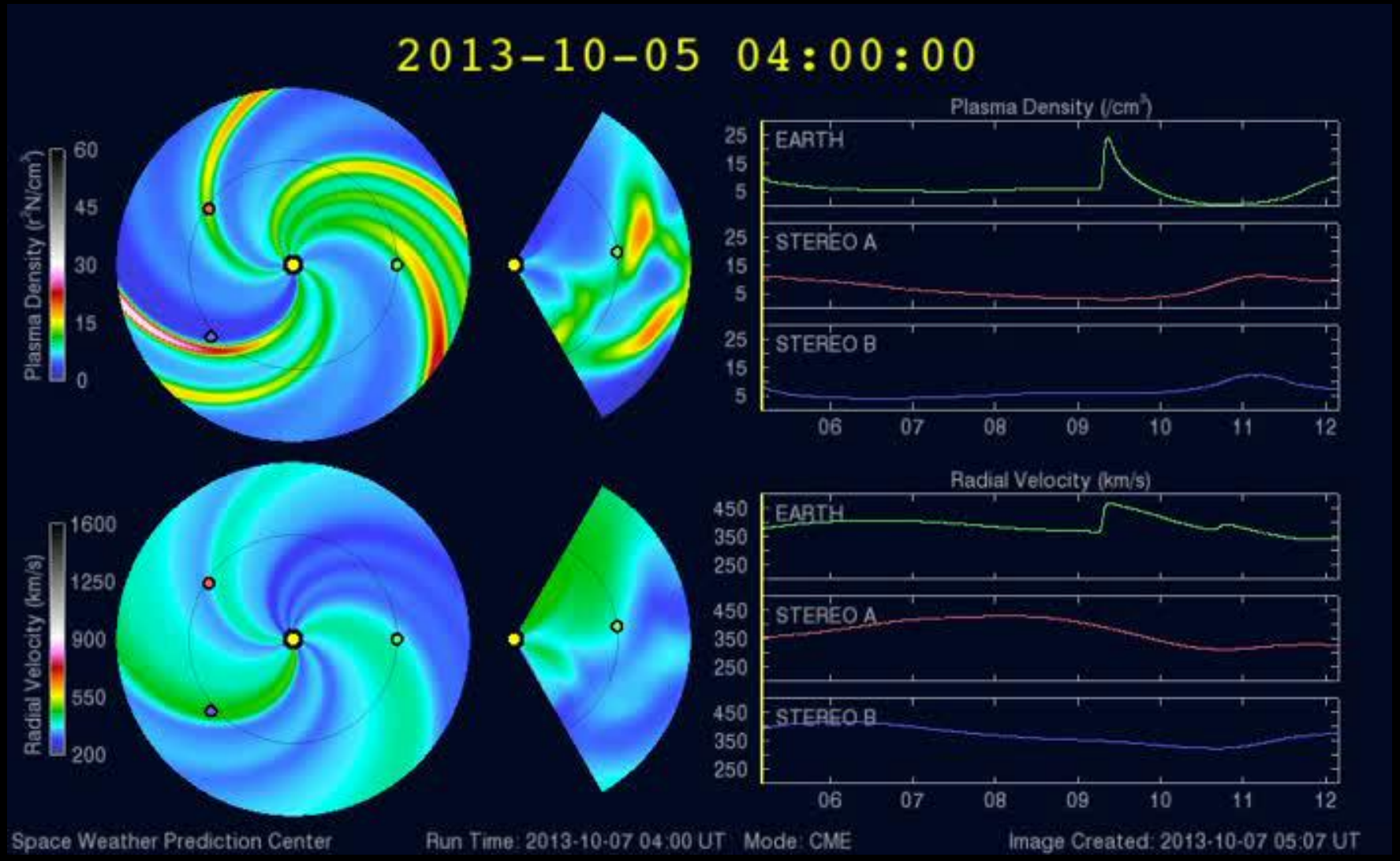
1. Accurate CME arrival time prediction
   i. Improved initial CME forecast arrival time
   ii. Update forecast arrival
2. Earlier ‘concerning’ AR identification

L1 & L5 operating in tandem

&

Operationally reliable

CME arrival prediction WSA ENLIL

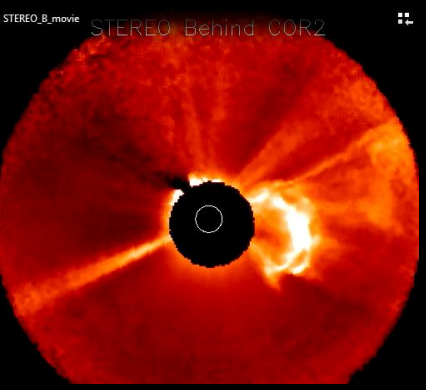


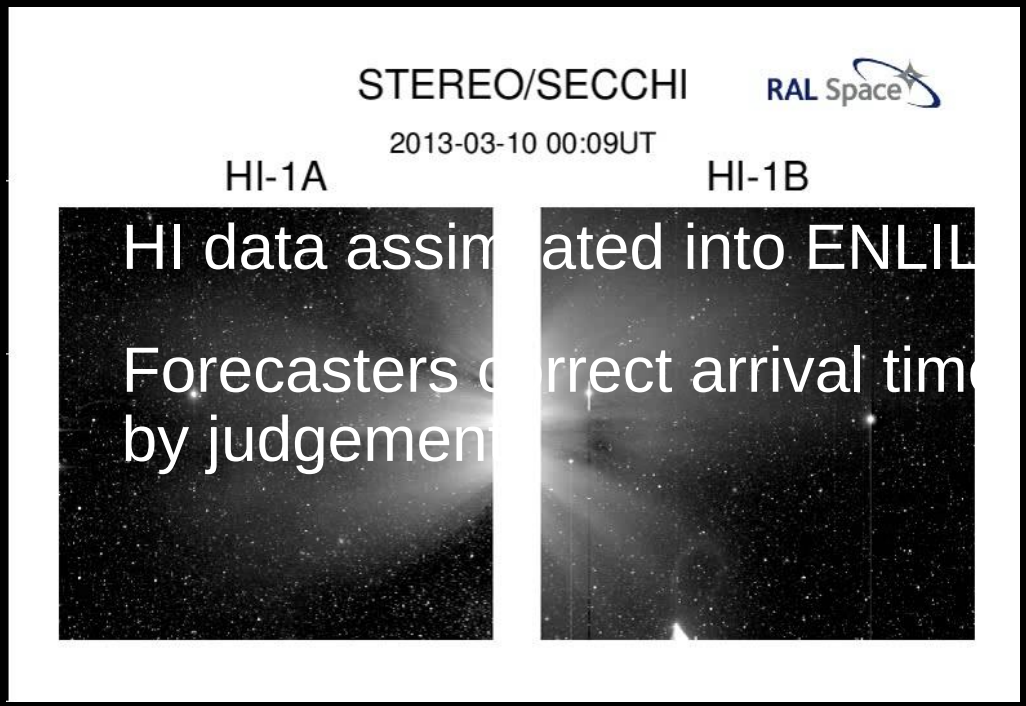
Initial CME forecast

- During ‘STEREO age’ CME accuracy ±7 hrs
- Without STEREO ±12 hrs ?

- Improved CME parameterisation
  - Coronagraph head-on & side-on views
- Improved background heliospheric field
  - Improved inner boundary
  - Magnetic structures towards the east limb

Update forecast arrival





Benefits of L_1 & L_5

Issue	L1	L5
CME detection	✓	✓
CME parameterisation	✓	✓
Constrain background solar wind	Not for Earth directed	✓
CME arrival forecast update	Not for Earth directed	✓ (HI)
Early AR detection	4/5 days	8/9 days
SEP onset	~0 lead time	✓(short lead time)
Other:		
Non-CME Kp prediction	✓ (short lead time)	✓ (esp HSS)

The political need

- Space weather is a medium-high risk
- Yet we have lower capability than 3 years ago
- Sir Mark Walport is aware
- Pre-election – UK Ministers were aware
- Multi-national solution to take to our governments

Priority needs for L5 instruments / parameters

1. Coronagraph
2. Heliospheric Imager
3. Magnetograph
4. In-situ
    - Magnetometer
    - Plasma (speed & density)
    - Energetic particles
- Continuous 24/7 data availability for all instruments

Thank you – pass on to Tom

NOAA L1 Solar Wind Requirements

Magnetic field vector measurements

a. At least one vector measurement per minute (Bx, By, Bz)
b. Must deliver data in GSM coordinates in real time
c. Range: 0.1 to 100 nT for each component (along positive or negative axis)
d. 0.1 nT relative accuracy with 2.0 nT absolute accuracy

Plasma Ion Measurement

a. At least one measurement of the solar wind velocity vector (Vx, Vy, Vz), average ion temperature, and ion density moments every minute
b. Must deliver data in GSM coordinates in real time
c. Velocity range 200 to 1500-km/sec with 5% relative accuracy
d. Temperature range: 40,000 to 2,000,000 K with 20% relative accuracy
e. Density range: 1 to 100 cm-3, with 20% absolute accuracy

Characterization of Low Energy ION Particle population

a. At least one set complete set of measurements every 5 minutes
b. At least 4 different differential flux channels covering the energy range from 50 keV to 1 MeV
c. Relative accuracy of 20 %

Data must be delivered to the NOAA Space Weather Prediction Center at Boulder, CO

Conceptual Solar Wind Sensor Characteristics

Magnetometer

Established heritage on deep space missions
Nominal range +/- 256 nT full scale, 12-bit resolution per axis, 0.0625 nT digital resolution per sample
0.1 nT relative accuracy and 2.0 nT absolute accuracy
Mass 1 kg, power 1 W, data rate ~300 bps

Plasmas Ion (Faraday Cup Design)

Electrostatic analyzer (ESA) with energy range from 100 cV -22 keV
One instrument covers entire range
Two heads for 3 axis stabilized design, one head for a spinner
Heritage on many spaceflight missions
Energy range and accuracy well within heritage sensors
Mass 3.5 kg; power 4.0 Watts, data rate ~600 bps per unit

Low Energy Ion Particle Population

Mass 2.2 kg, power 3 W, data rate ~500 bps

4. Common power and data unit

NOAA L1 Coronagraph Requirements

Pointing Knowledge - The line of sight pointing knowledge shall be 25 arc-secs, (Goal: 12.5 arc-secs). The direction of solar north shall be known to within 1° (Goal: 0.5°). Data must be of useable quality during all levels and types of disturbed space weather

Field of View - The field of view (FOV) shall be an annulus, centered on the Sun. The inner radius of the annulus shall be 3.7 Rsun. The outer radius of the annulus shall be at least 17Rsun.

Point Response - the image spatial resolution shall be 50 arc-secs. This requirement shall be met at the radius which is the average of the inner and outer radii of the FOV.

Absolute Accuracy - The data shall be calibrated to an absolute accuracy of 25%.

Data Cadence - The sensor shall be capable of achieving a cadence of at least one full-FOV image at least every 15 min. The sensor shall be capable of meeting the requirements with an exposure time of less than 15 seconds.

Data Latency - Data latency shall not exceed 15 minutes (delivery to NOAA/SWPC)

Conceptual CME Sensor Characteristics

Mass: 17 kg

Dimensions:

1. 517 X 175 mm cylinder
2. 680 X 130 mm cylinder

Power ~ 12 W

Field of View alternatives:

1 - 4.5 degrees (4-17 solar radii) coronagraph

0.75 - 5 degrees (3-20 solar radii) coronagraph