# SWIMMR

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Met Office

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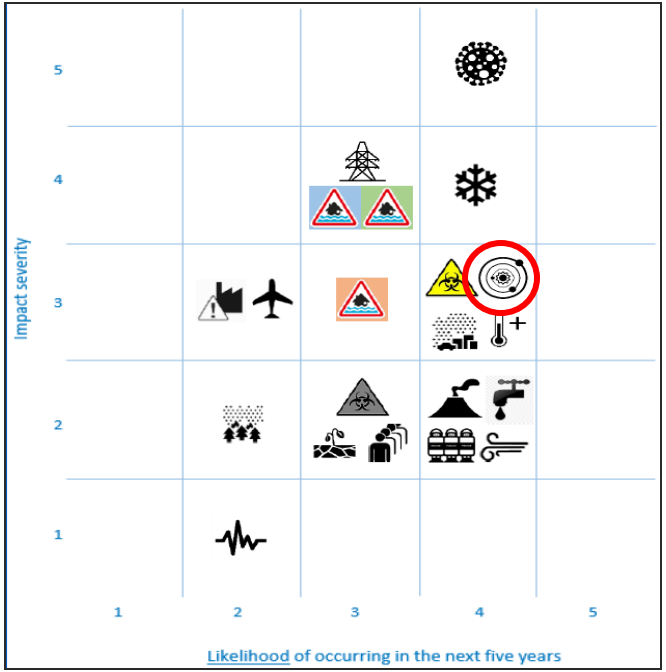


# Met Office Space Weather Operations Centre (MOSWOC)

- Fully integrated within Met Office Operations Centre
- National capability supporting;
  - Government, military & critical sectors
- 1 dedicated forecaster on duty 24/7
  - Mutual back-up with Volcanic Ash Advisory Centre position
- One of only 3 24/7 manned centres globally

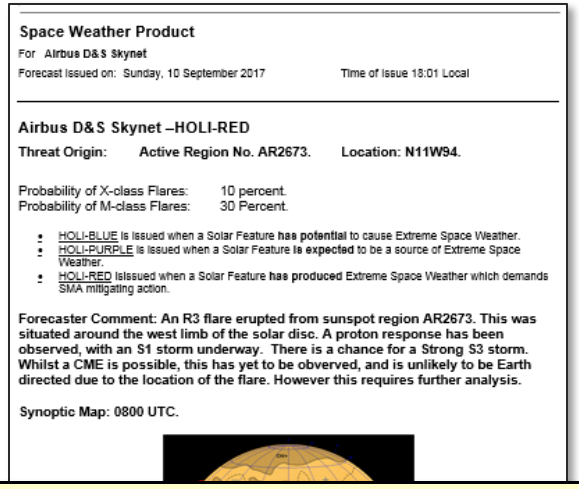
# Growing user base
(number & criticality)

**Existing users**

- Government & CNI operators
  - E.g. National Grid, satellite operators, CAA, etc
- UK military Skynet secure communications satellites

**New /developing users**

- UK Space Operation Centre (SpOC / NSpOC)
- ICAO Global Space Weather Centre
- UK spaceport
- UK satellite constellations



**Space Weather Product**

For **Airbus D&S Skynet**

Forecast issued on: Sunday, 10 September 2017 Time of Issue 18:01 Local

**Airbus D&S Skynet –HOLI-RED**

**Threat Origin:** **Active Region No. AR2673.** **Location: N11W94.**

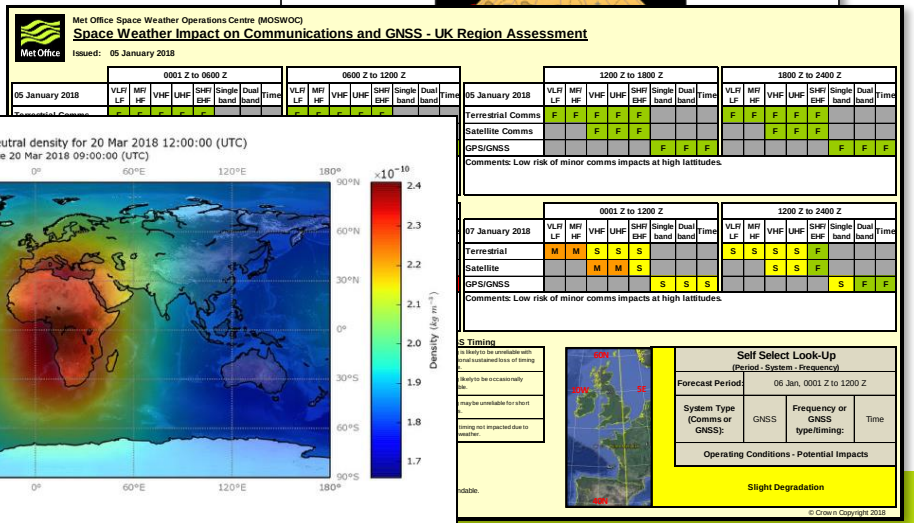
Probability of X-class Flares: 10 percent.
Probability of M-class Flares: 30 Percent.

- HOLI-BLUE is issued when a Solar Feature **has potential** to cause Extreme Space Weather.
- HOLI-PURPLE is issued when a Solar Feature **is expected** to be a source of Extreme Space Weather.
- HOLI-RED isissued when a Solar Feature **has produced** Extreme Space Weather which demands SMA mitigating action.

**Forecaster Comment: An R3 flare erupted from sunspot region AR2673. This was situated around the west limb of the solar disc. A proton response has been observed, with an S1 storm underway. There is a chance for a Strong S3 storm. Whilst a CME is possible, this has yet to be obverved, and is unlikely to be Earth directed due to the location of the flare. However this requires further analysis.**

**Synoptic Map: 0800 UTC.**





Met Office Space Weather Operations Centre (MOSWOC)

**Space Weather Impact on Communications and GNSS - UK Region Assessment**

Issued: 05 January 2018

| 05 January 2018 | 0001 Z to 0600 Z | | | | | | | | 0600 Z to 1200 Z | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VLF LF | MF HF | VHF | UHF | SHF EHF | Single band | Dual band | Time | VLF LF | MF HF | VHF | UHF | SHF EHF | Single band | Dual band | Time |
| Terrestrial Comms | F | F | F | F | F | | | | F | F | F | F | F | | | |

| 05 January 2018 | 1200 Z to 1800 Z | | | | | | | | 1800 Z to 2400 Z | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VLF LF | MF HF | VHF | UHF | SHF EHF | Single band | Dual band | Time | VLF LF | MF HF | VHF | UHF | SHF EHF | Single band | Dual band | Time |
| Terrestrial Comms | F | F | F | F | F | | | | F | F | F | F | F | | | |
| Satellite Comms | | | F | F | F | | | | | | F | F | F | | | |
| GPS/GNSS | | | | | | F | F | F | | | | | | F | F | F |

Comments: Low risk of minor comms impacts at high lattitudes.

| 07 January 2018 | 0001 Z to 1200 Z | | | | | | | | 1200 Z to 2400 Z | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VLF LF | MF HF | VHF | UHF | SHF EHF | Single band | Dual band | Time | VLF LF | MF HF | VHF | UHF | SHF EHF | Single band | Dual band | Time |
| Terrestrial | M | M | S | S | S | | | | S | S | S | S | F | | | |
| Satellite | | | M | M | S | | | | | | S | S | F | | | |
| GPS/GNSS | | | | | | S | S | S | | | | | | S | F | F |

Comments: Low risk of minor comms impacts at high lattitudes.

S Timing

Self Select Look-Up
(Period - System - Frequency)

Forecast Period: 06 Jan, 0001 Z to 1200 Z

System Type (Comms or GNSS): | GNSS | Frequency or GNSS type/timing: | Time

Operating Conditions - Potential Impacts

Slight Degradation



Met Office

200 km Atmospheric neutral density for 20 Mar 2018 12:00:00 (UTC)
at reference date 20 Mar 2018 09:00:00 (UTC)

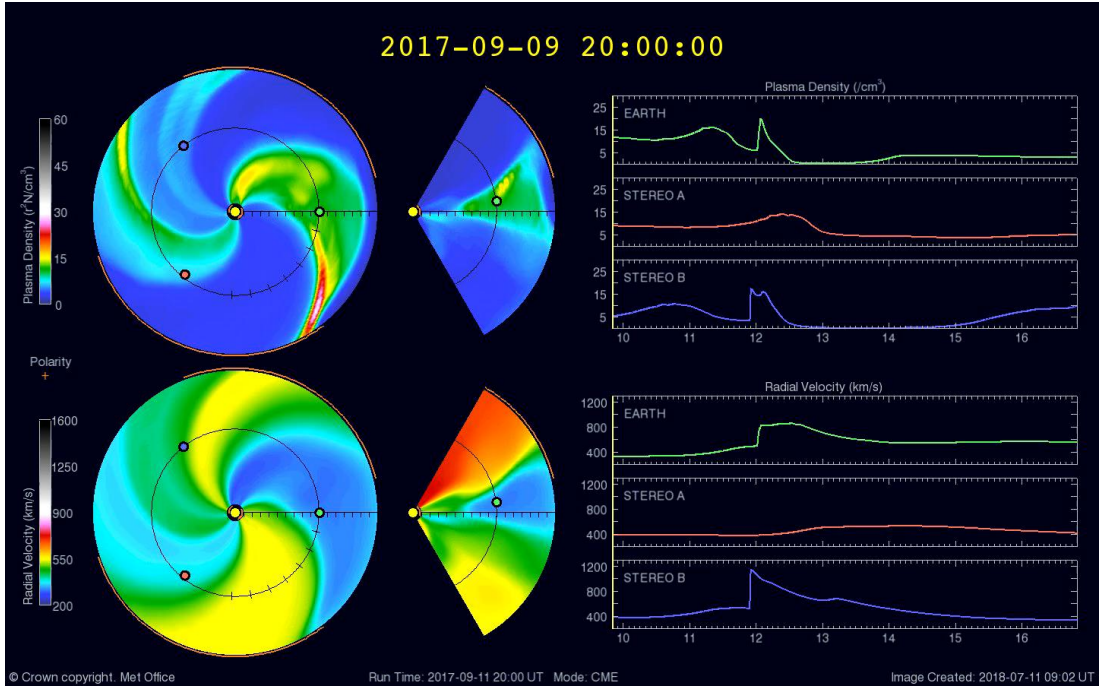
Met Office

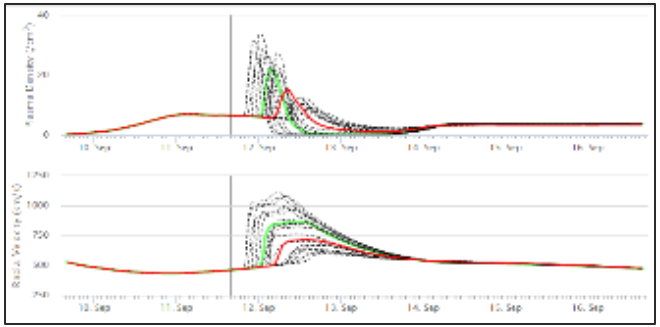
# Motivation for SWIMMR

# Motivation

- MOSWOC created by importing SWPC capability
- No UK space weather research programme results in continued dependence on US
- Lack of diversity in models
- Cost if transitioning research into operations is expensive

# CME / Geomagnetic focus



# Why SWIMMR?

1. Fill capability gaps (now & future)
   - Radiation effects
   - Ionospheric impacts – navigation & communications
   - Atmospheric density (orbit determination & collision risk)
   - Geoelectric field modelling
2. Utilise UK knowledge & capability
   - Showcase UK science
   - Create diversity in forecast solutions
3. Reduce the research-to-operations gap

Doesn't have to be UK model – nice
Does need thorough UK understanding & ability to adapt

# Radiation effects

- No real-time UK monitoring capability
  - Ground based
  - Aviation altitudes (no global capability)
  - Satellite based (no sovereign capability for future UK spacecraft)
- Modelling
  - Need improved satellite radiation nowcasts & forecasts
    - Not just environment but likely effects
    - Provide better / more useful services
    - GEO / MEO / LEO – along specific orbits
    - Electrons & protons
  - Need hindcast/nowcast (forecast?) for aviation altitudes
    - Advise airlines, CAA & DfT
    - Be able to alert threshold breaches
  - Risk to ground based systems
    - E.g. autonomous vehicles

# Ionospheric effects

- MOSWOC modelling very limited
- Impacts on HF comms remain important
  - Military & aviation
- GNSS becoming increasingly important (P, N & T)
  - Blackett Review etc
  - Support ‘useful’ services for users e.g.
  - Nowcasts & forecasts of scintillation
  - ‘system’ level predictions for aircraft approach & landing

# Space weather effects on satellite drag

- Why?
  - UK sovereign launch capability
  - Rise of the mega-constellations
  - Space security / Space Surveillance & Tracking
- Don’t want a drag / orbit prediction model
- Improved space weather input for existing orbit prediction models
- Improved orbit prediction / collision risk estimates
- Ideally close synergy with ionospheric model

# Geoelectric field modelling

- Nowcasts & forecasts of geoelectric field across UK
- GIC predictions
  - High voltage power grid
  - Gas pipelines
  - Rail network
- UK sub-surface electric conductivity model (utilising MT etc)
- ‘coupling’ of geomagnetic & geoelectric models & data

# Sun to L1

- Better CME arrival predictions
  - WSA-ENLIL with cone – big code with no data assimilation
  - Smaller/lighter code offer benefits?
  - Coping with difficult situations 2nd fast CME
- Better predictions of the evolution of the solar wind
  - Improved timing / characterisation of SIRs
  - Evolution of solar wind post CME arrival
  - Realistic evolution to enable coupling of models

# Research to Operations infrastructure

- It's difficult & expensive
- Barrier to bringing UK capability into use
  - Easier to follow the US
- You're better placed to do it than we are
  - Greater understanding & can spot bad results
- Joint effort – let's have a joint capability
- Create a cloud-based infrastructure that mimics operational capability – easily accessible by scientists, Met Office & IT developers alike

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