Eurocontrol Space Weather Activities

Space Weather Workshop, Boulder, CO – April 2012

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EUROCONTROL: Who are we?

European Organisation for the Safety of Air Navigation

EUROCONTROL:

- 39 members states
- 4 sites: Brussels (HQ), Luxembourg, Maastricht, Bretigny (Paris)
- 2200 staff members

Air Traffic Management in Europe:

- 600 sectors
- 16000 Air Traffic Controller
- 36000 Support staff

Eurocontrol: who are we?

European Organisation for the Safety of Air Navigation

- Directorate Single Sky:
  - Support to regulation
  - Support on safety (EASA)
  - Civil-military coordination
  - Implementation planning at State level

Rules

- Directorate Network Management:
  - Deliver the EUROCONTROL pan-European network functi
  - Exercise the iction
  - Contribute to the achi performance

Operational/Coordination

Space Weather

- Directorate SESAR and Research:
  - Contribute to SESAR program as committed
  - Ensure effective research and development to prepare future traffic growth

Space Weather

R&D

Eurocontrol space weather activity

1. SESAR WP 15.3.4: Space Weather impact on GNSS based application
   - 1.1 Ionosphere monitoring campaign
   - 1.2 Ionosphere impact modeling
   - 1.3 Mitigations evaluations

2. Space weather within the European Aviation Crisis Coordination Cell (EACCC)

3. Following / Supporting space weather at international level (ICAO, WMO, EASA, ESA…)

1. SW impact on GNSS based operation

1.1.1 Ionosphere monitoring campaign

Bibliography → Past event characterization

Ionosphere Monitoring → Current Solar Cycle event characterization

Ionosphere Monitoring → Archive (RINEX format)

- Report 1: Sept 2011
- Report 2: Sept 2012
- Report 3: Sept 2013

Phase 2

- Report 4: Sept 2014
- Report 5: Sept 2015

Phase 3

Past event characterization + Current Solar Cycle event characterization → Realistic Ionosphere scenarios

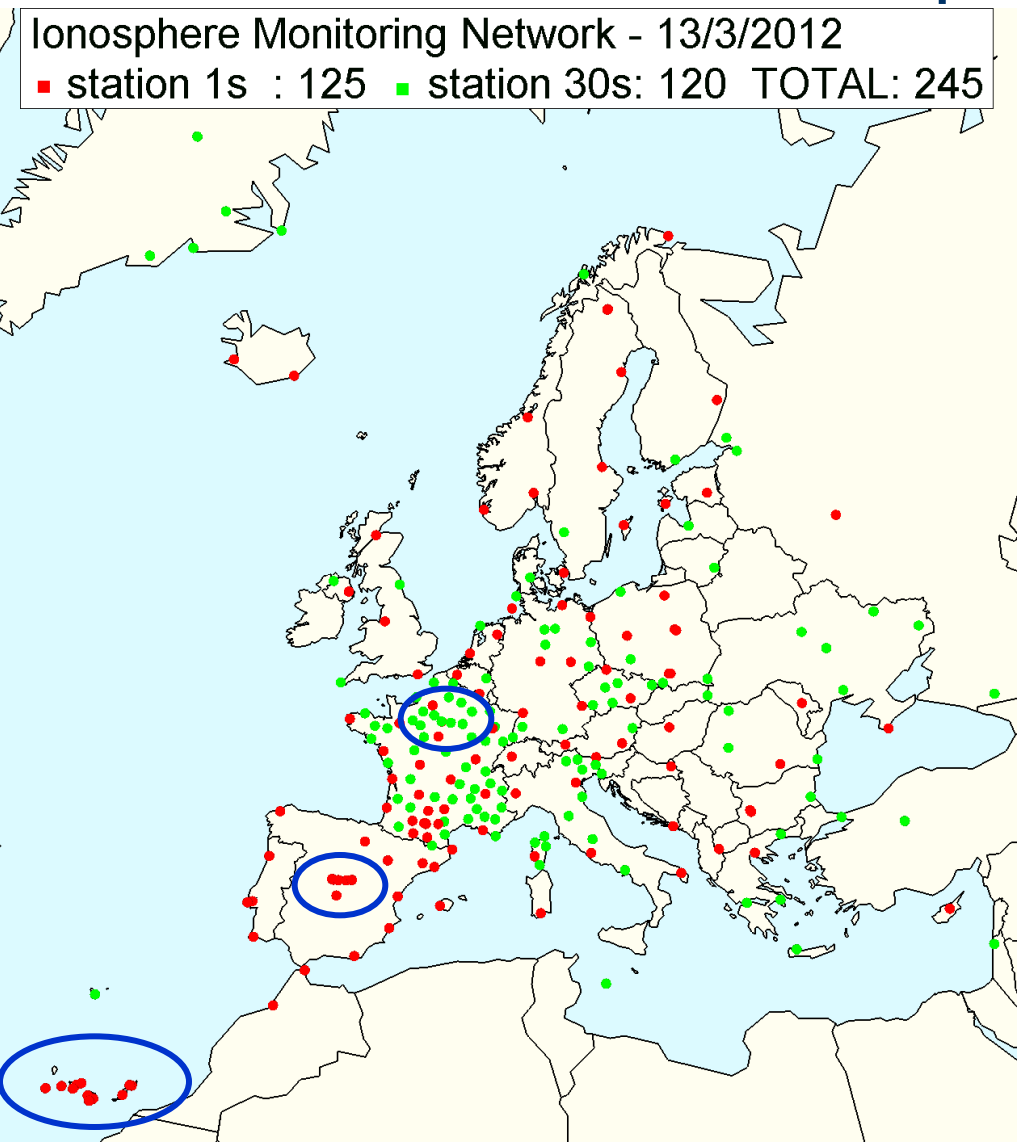
1.1.2 Ionosphere impact modeling

Realistic Ionosphere scenarios → GNSS receiver simulator → Impact at receiver level → Operational requirement and simulation → Impact at service level

- Preliminary report - high level simulation definition : July 2011
- Intermediate report - detailled simulation definition: May 2012
- Final report – simulation results: Sept 2013

Phase 2: Sept 2011 – Oct 2013

1.1 Ionosphere monitoring campaign



Monitoring network:

- Operational since July 2011
- Average 2012: 230 stations (min 169 max 262)
- 3 high density cluster for GBAS purposes (Canary Island, Madrid, Paris)

Daily products:

- Key parameters
- Vertical TEC map (every 15 min)
- TEC spatial gradients maps (every 15min)
- L2 missing maps (every 15 min)
- ROTI maps (every 15 min)

Event analysis:

- 22 Oct 2011 (worst EGNOS degradation)
- 24-25 Oct 2011 (worst WAAS degradation)
- March 2012 event

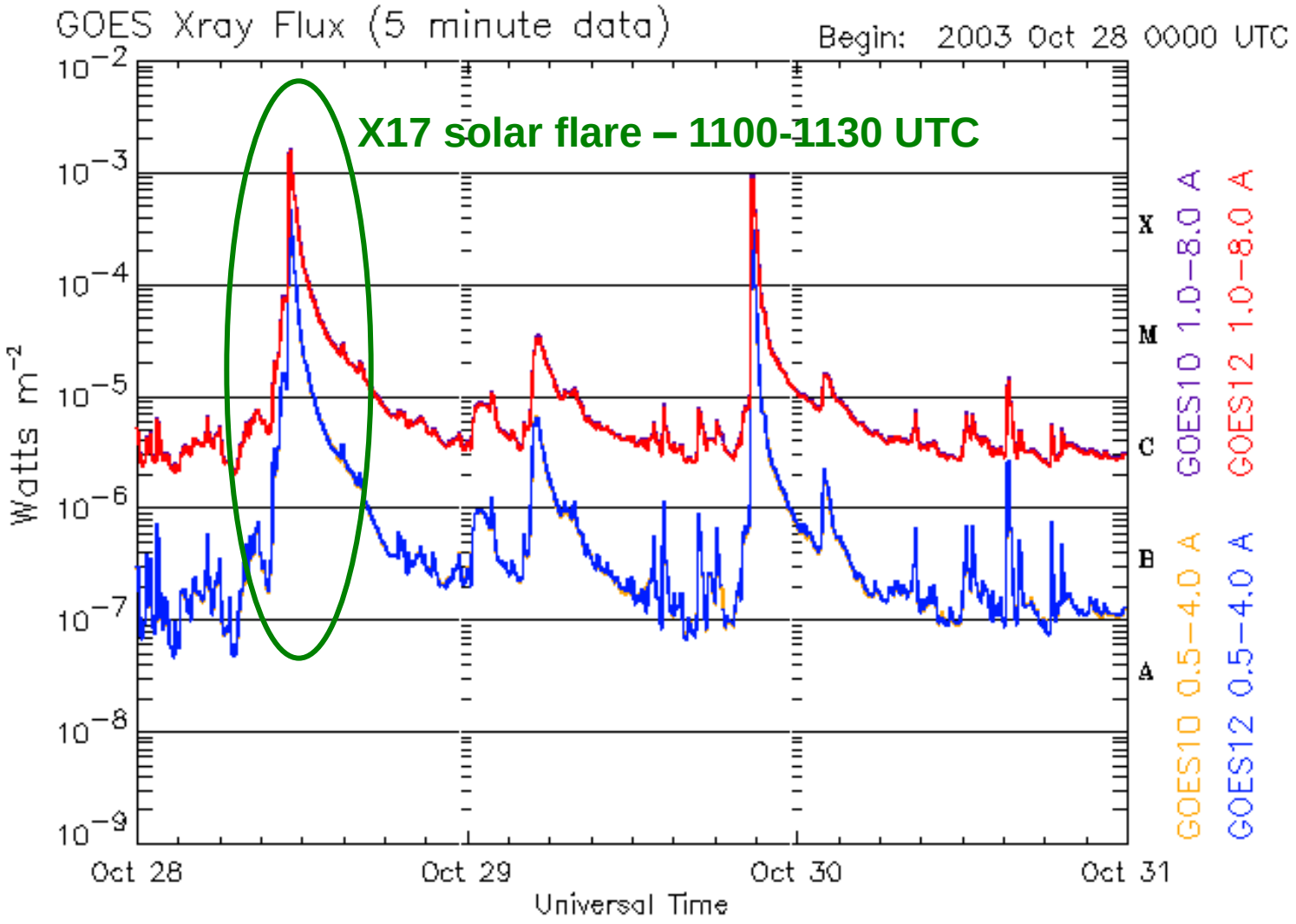
1.1 Ionosphere scenarios

The following ionosphere disturbances will be considered:

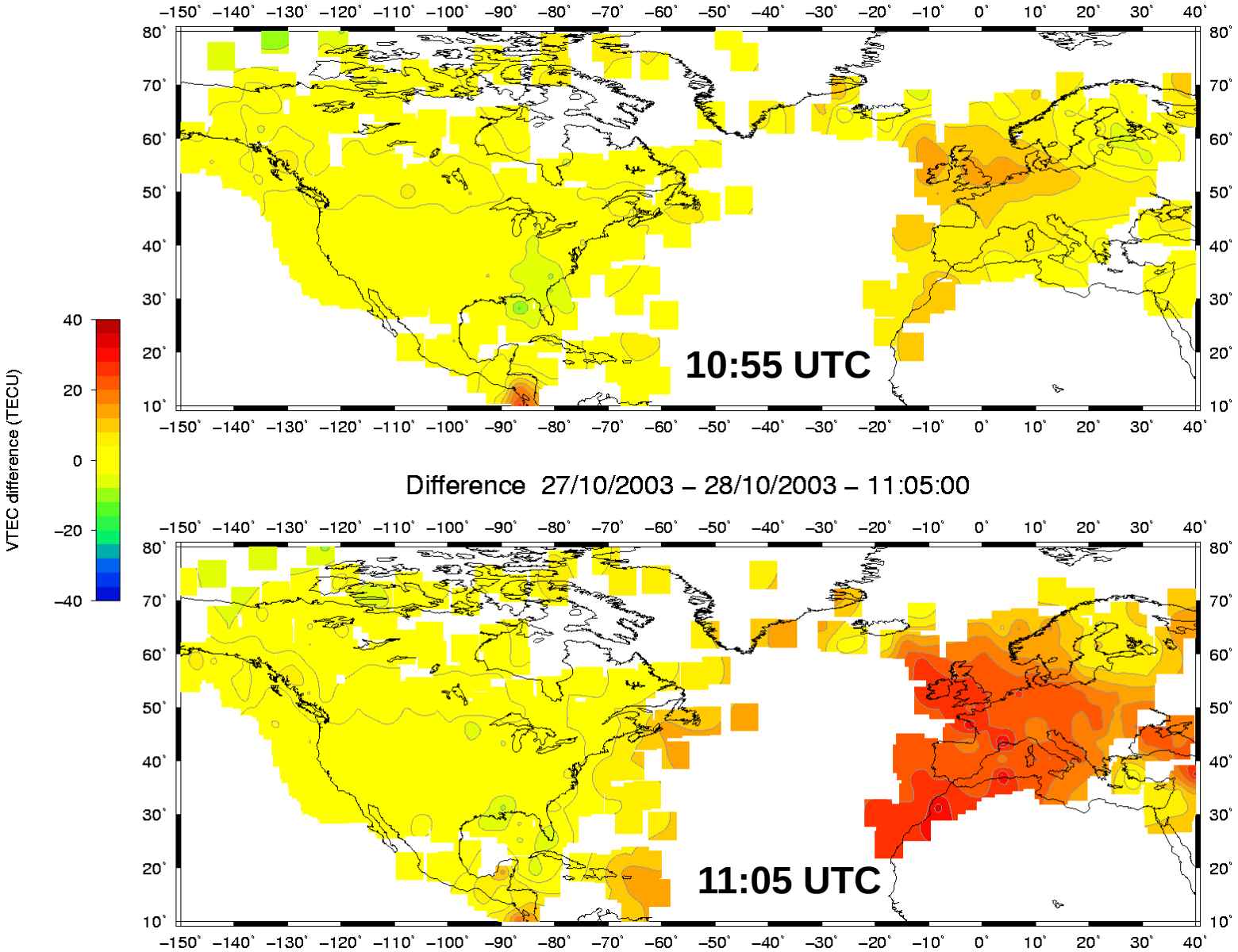
- **Ionosphere delay due to Coronal Mass Ejection:** large scale event which include some local large VTEC gradients. Time scale: from hours to days. Ex: Oct/Nov 2003.
- **Ionosphere delay due to X flare:** large scale with sharp VTEC temporal increase. Time scale: few min. Ex:
- **Ionosphere scintillation due to Equatorial anomaly:** regional scale event (low latitude). Time scale: several hours after sunset.
- **Ionosphere scintillation due to Auroral activity:** regional scale event (high latitude). Time scale: several hours during day and night.

Under definition

1.1 Ionosphere scenarios



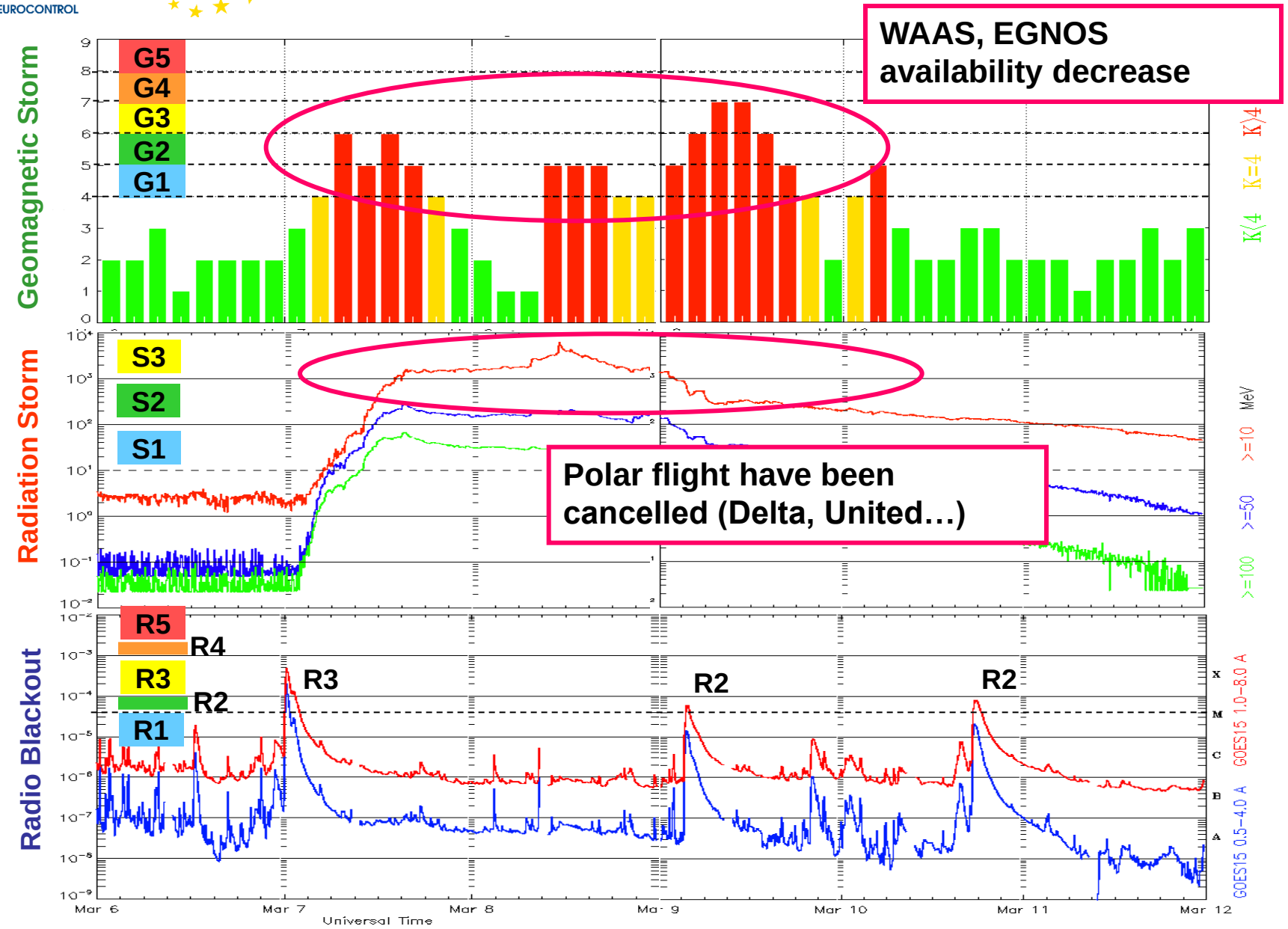
1.1 Ionosphere scenarios



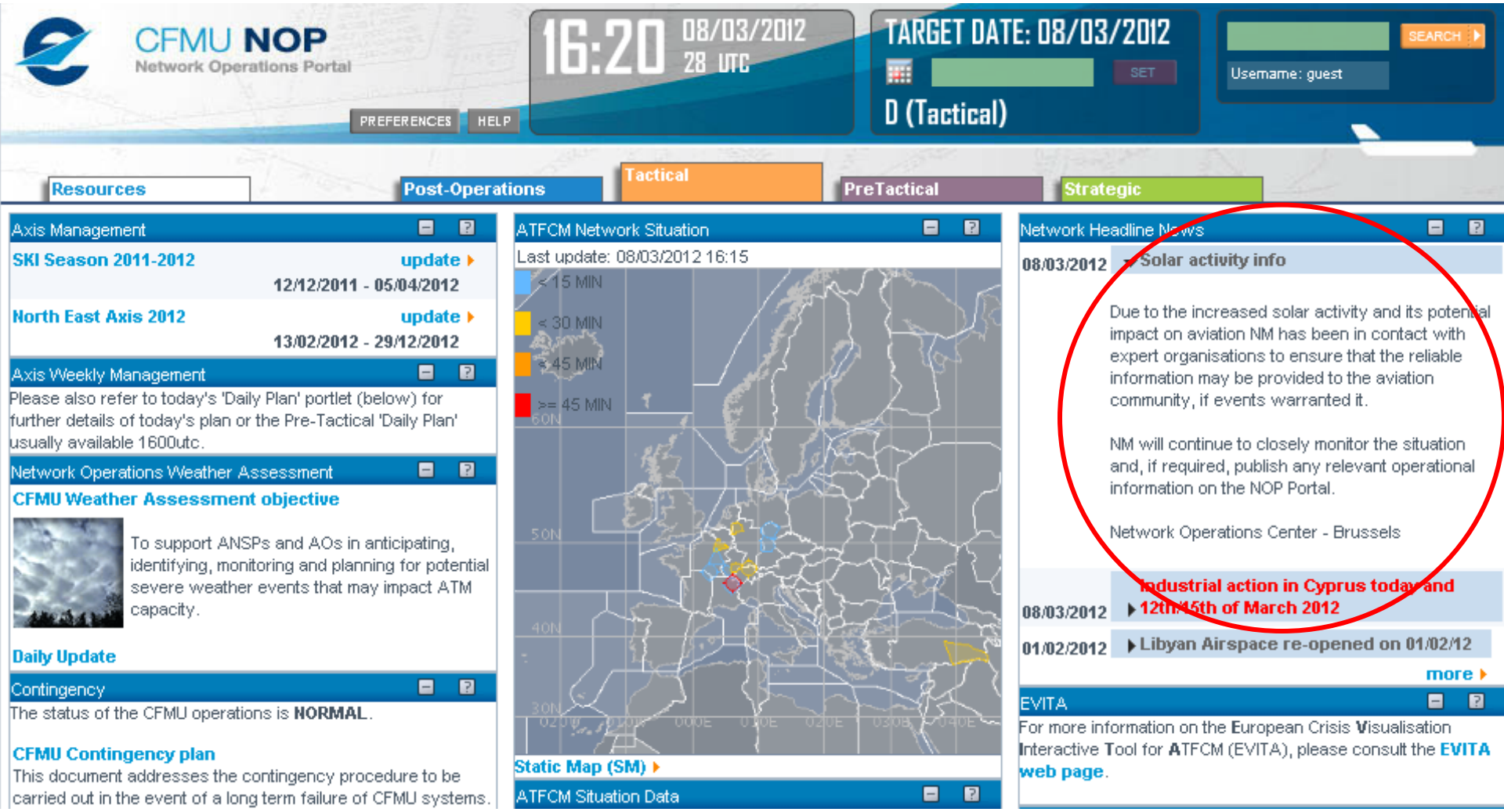
2. Space Weather within EACCC

- The European Aviation Crisis Coordination Cell (EACCC) has identified space weather as a potential threat to the European Network
- Coordination between Eurocontrol and space weather agencies and experts have been set up (ESA, NOAA…)
- In case of significant space weather event, information will be made available to the aviation community through the Network Operations Portal (see following slide on March event)

2. Example of March 2012 event



2. NOP portal on March 2012 event



3. Space Weather at international level

- **Concept of Operations:**

  IAVWOPSG has drafted a Concept of Operations (CONOPS) for International Space Weather information in Support of Aviation Operations (Sept 2011). Comments are expected for 2012.

  Once agreed, Space Weather services shall be formalize in the form of a Standard and Recommended Practice (SARP) that will be added to Annex III.

- **Space weather educational material:**
  - EASA has drafted a Safety Information Bulletin on the space weather and its effect on the aviation
  - Eurocontrol is writing a SKYBRARY article on the space weather impact on aviation

3. Space Weather at international level

- **<u>Space weather impact on GNSS:</u>**

  NOAA scale only measured the level of geomagnetic storm. However, the link between geomagnetic storm and ionosphere storm is not straightforward. Do we need a Ionosphere disturbance scale?

  Aviation needs: forecast on GNSS availability

- **<u>Effect of radiation on health and system:</u>**
  - Health: A regulation is already in place today.
  - System: EASA has drafted a Safety Information Bulletin on the effect of cosmic and solar radiation on the on board system

- **<u>Space weather impact on radio communication</u>**
  - Impact on HF is already quite well known
  - Potential impact on satellite communication
  - May VHF be impacted? No record of VHF impact so far.

  Aviation needs: better assess the SW impact on VHF.

Questions ?

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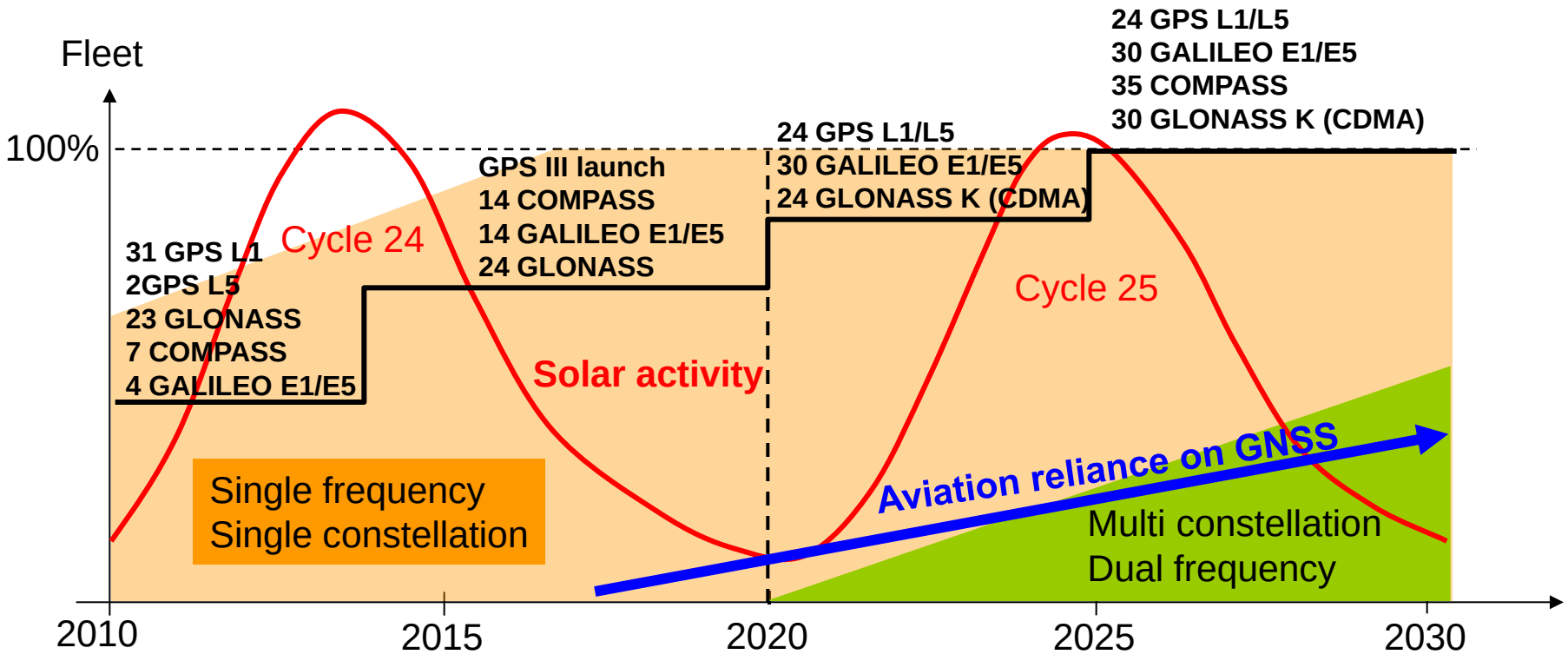
Back up slides

GNSS roadmap and fleet equipment



- Dual constellation (or more), dual frequency SIS will be operational from 2020
- But fleet will not be equipped for the 25 solar cycle (2022-2027)

⇒ **Scaling the ionosphere impact during cycle 24 is required to decide on the appropriate operational mitigations for cycle 25.**