Status overview of the European scatterometer activities

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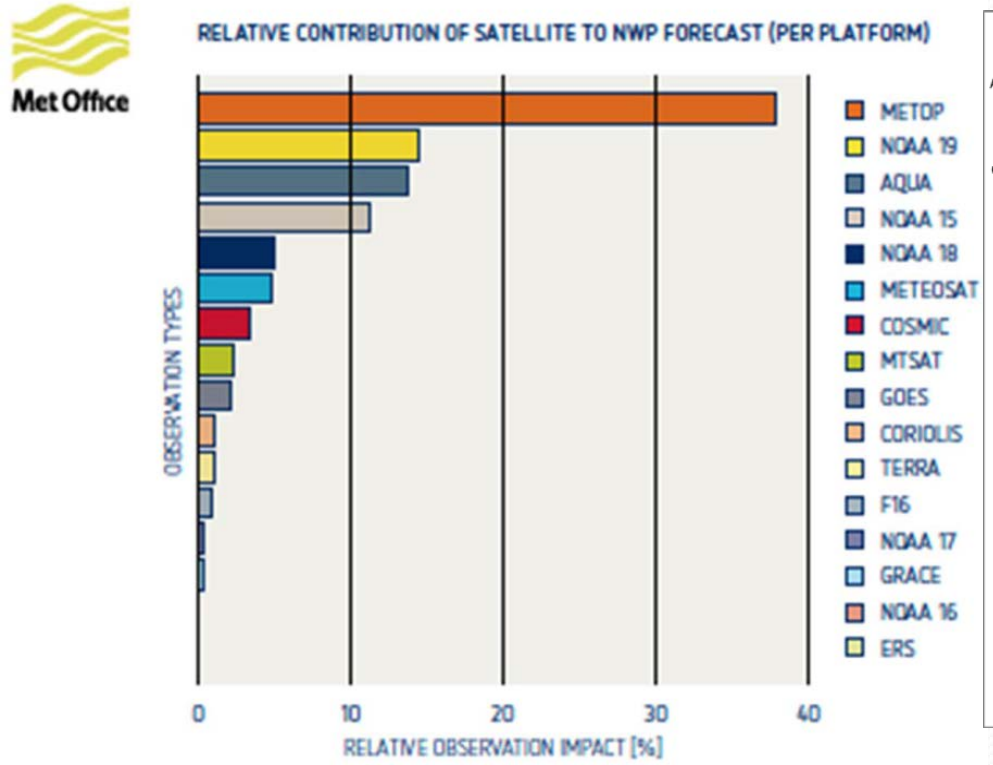
Outline

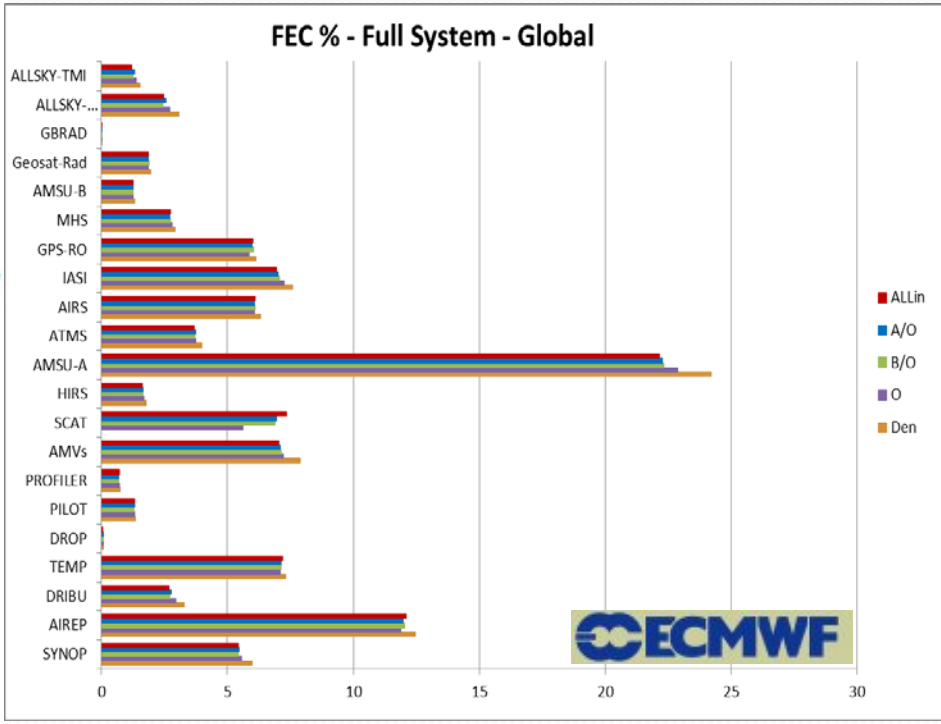
- Overview and objectives of European scatterometer programs
- MetOp/EPS – the ASCAT mission
  - Status of operations
  - Evolution of the current products and services
  - ASCAT-A re-processing status
- MetOp/EPS Second Generation – the SCA mission
  - Payload capability
  - Development status and schedule
  - Not just a 'follow-on'

MetOp/EPS and -SG Objectives

- To provide sustainable operational observations and measurements from polar orbit for numerical weather prediction and climate monitoring in the 2006 to 2040 timeframe.
- To complement the NOAA 'early morning' Low Earth Orbit systems with a 'mid morning' set of satellites (Joint Polar System)
- In addition, to provide services to atmospheric chemistry, operational oceanography and hydrology.
- With respect to the first generation of MetOp/EPS, the Second Generation of satellites will
  - Ensure continuity of essential operational meteorological observations from polar orbit, without a gap
  - Improve accuracy and resolution
  - Add new capability

MetOp/EPS and -SG Objectives





Relative contributions of various satellites to NWP forecast from a 2012 Met Office study

ECMWF Forecast Error Contribution (FEC) is a measure (%) of the variation of the forecast error (as defined through the dry energy norm) due to the assimilated observations – measure of the impact of the observations on the short-range forecast (24 hours)

Overview of Europe Scatterometer missions

- C-band fan-beam scatterometers flying on board MetOp/EPS (3 instruments) and planned for their Second Generation satellites (nominally 3 instruments, to be formally confirmed by EUMETSAT in 2014)
- All in sun-synchronous polar orbit, altitude 832 km, mean local solar time 09:30 (descending node), repeat cycle 29 days.
- ASCAT-A (2006-…) and ASCAT–B (2012-…) on MetOp/EPS in dual operations. ASCAT-C planned for launch in October 2018
- MetOp/EPS-SG consists of two series of satellites: “SAT-A” and “SAT-B” and target 21 years of operations. The scatterometer instruments SCA are in SAT-B, the first one planned for launch in 2023

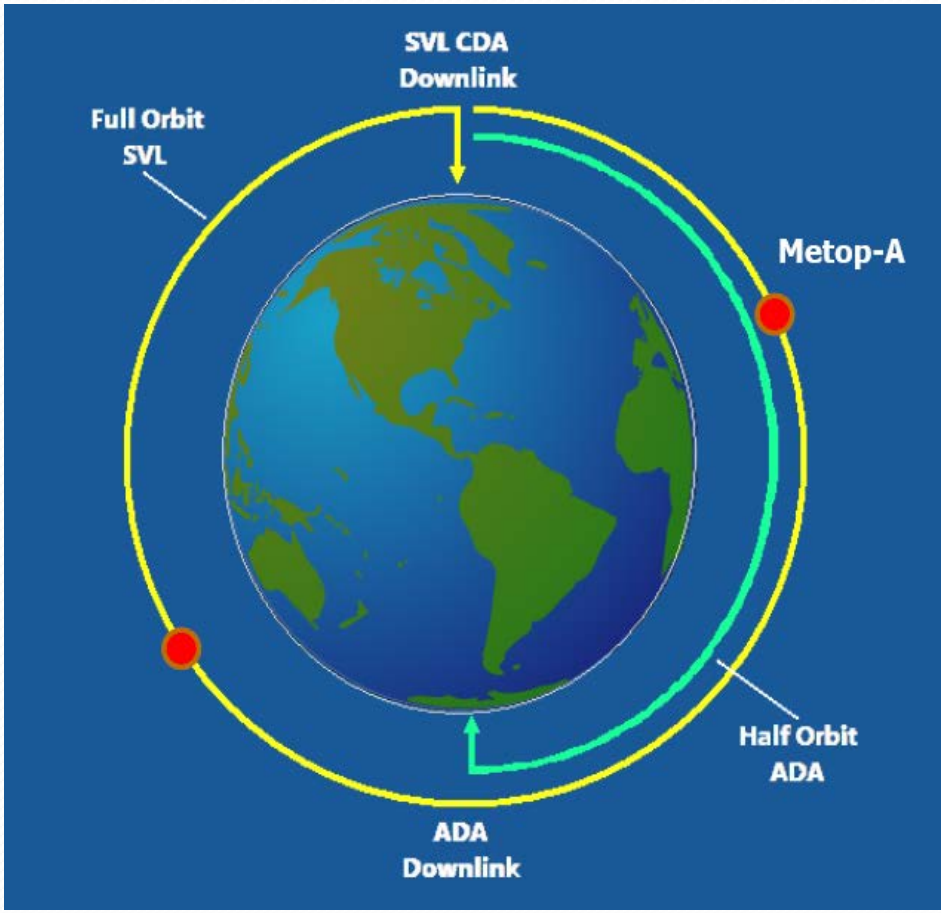
Metop/EPS -A/B dual operations

Data acquisition:

- Svalbard: 14 orbits per satellite on same data acquisition station
- McMurdo: 14 half-orbits for primary mission

Data timeliness:

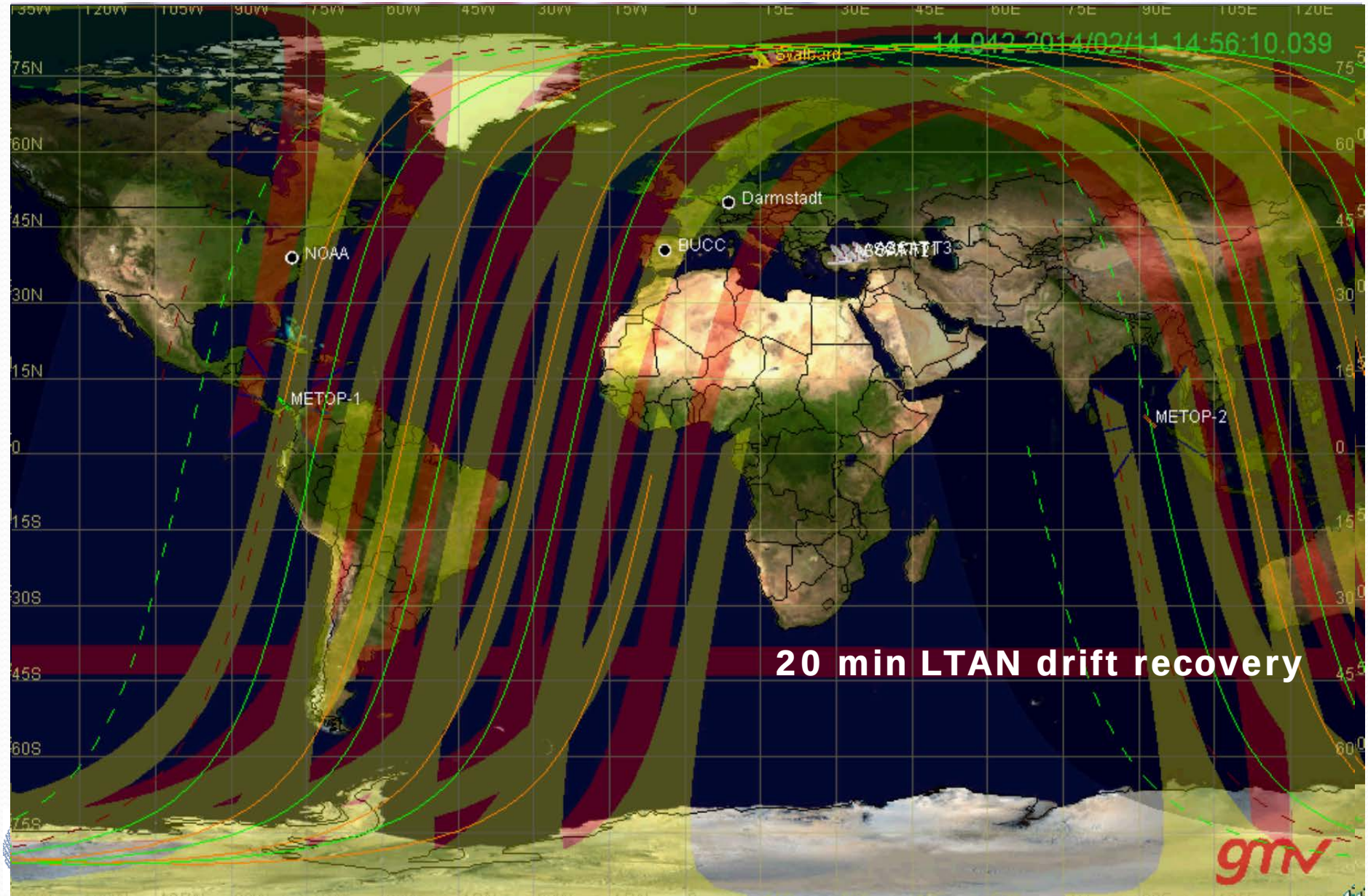
- ASCAT-B ~ 80 min
- ASCAT-A ~ 120 min



Evolution of MetOp/EPS operations

- Drivers:
  - Maintain as long as possible MetOp A/B tandem operations, up to MetOp-C start of operations (>12 years for MetOp-A!)
    - Single stations operations
    - Optimal coverage for applications
  - Save enough fuel to de-orbit MetOp-A in compliance with space debris mitigation guidelines (re-entry < 25 years)
- Schedule
  - 2015 (October): MetOp/EPS-A last orbit inclination maintenance manoeuvre -> dead-band (2 min) guaranteed for 18 months
  - 2017 - … LTAN drift phase of up to 30 min, where ground track will be maintained. Life extension possible by increasing orbit phase through moving to another 'leg' of same ground track (several options).
  - 2018-2019 : MetOp-C launch and Commissioning
  - MetOp-A EndOfLife activities, end of 2019

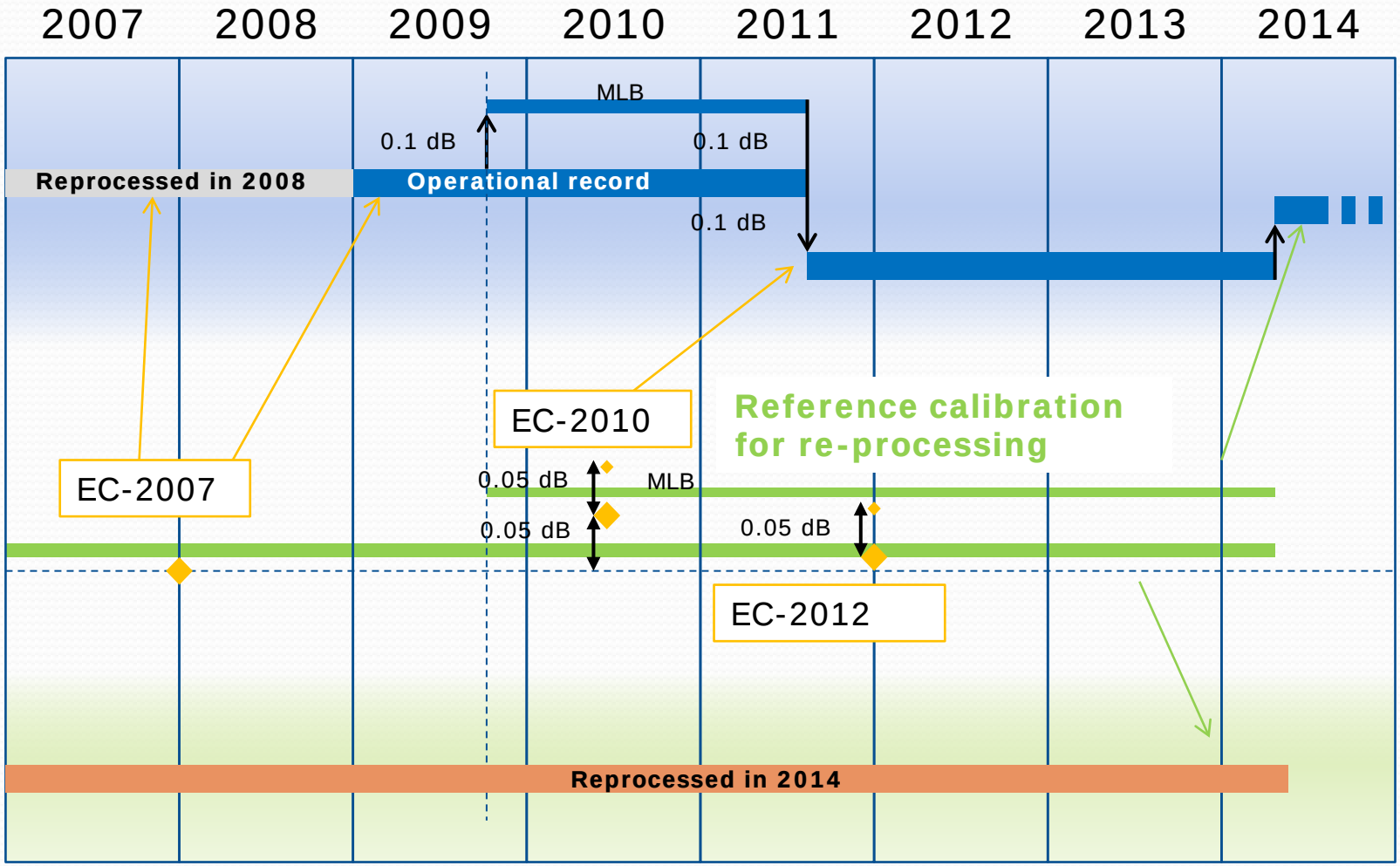
Evolution of Metop/EPS -A/B dual operations



Outlook of ASCAT mission and services

- 2014 - Release of the first ASCAT-A re-processed data set: NRCS, winds (by the OSI SAF) and soil moisture (in cooperation with the Hydrology SAF)
- 2014-2015 – Technical and scientific improvements to ASCAT data services:
  - consolidation of product catalogue;
  - optimisation of NRCS data re-sampling for ocean and land;
  - real-time processing of backscatter calibration factors
- 2016 : Ground segment hardware upgrade in preparation for receiving a third MetOp/EPS mission
- 2017 : Addition and operations preparation of ASCAT-C processing chain
- 2018-2019: ASCAT-C Commissioning and start of operations
- 2019: ASCAT-A discontinuation, ASCAT-A/B re-processing??

ASCAT-A data record - Re-processing



See for more details on the data set and validation results, poster by C. Anderson

MetOp/EPS-SG Payload capability

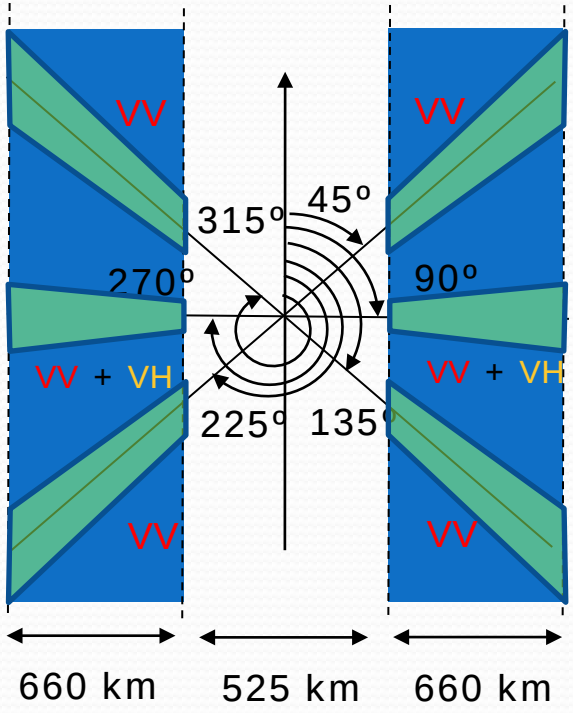
- **New instruments**
  - MWI: precipitation monitoring, sea ice extent information
  - ICI: monitor clouds and cloud ice particles
  - METimage: 14 more channels, 4 x better spatial resolution
  - 3MI: atmospheric aerosol monitoring
- **Improved instruments**
  - IASI-NG: 2 x better spectral resolution and NEΔT
  - MWS: 4 more channels, improved spatial resolution and NEΔT
  - SCA: 2 x better spatial resolution, slightly extended swath, cross-pol measurements
  - RO: GPS and Galileo, so 2 x number of occultations
  - Sentinel-5: more bands, increased spectral range, better spatial resolution

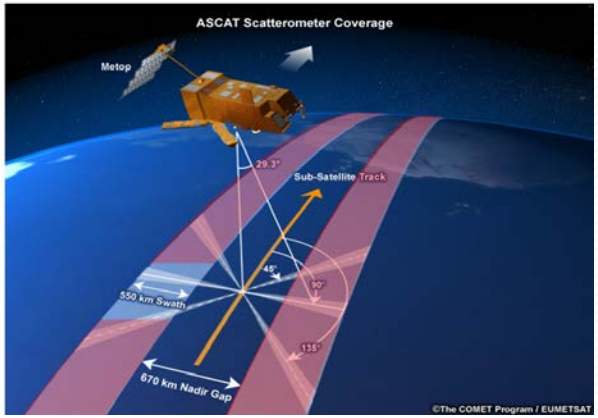
MetOp/EPS-SG Space Segment Status

- **Phase O** - mission analysis and requirements identification:
  - parallel, competitive industrial studies performed in period March 2008 to April 2010
- **Phase A/B1** - feasibility and preliminary definition:
  - parallel, competitive industrial studies performed in period January 2011 to July 2013
- **Instrument Bridging phase** - bridging activity between instrument selection in March 2013 and start of Phase B2 under satellite Prime
- **Phase B2/C/D** - detailed definition, qualification and production:
  - Invitation To Tender (ITT) was issued by ESA in September 2013
  - ESA's Industry Policy Committee on 10-11 April 2014, Kick-off expected in May 2014
  - Combined SRR in September 2014 and combined PDR by Q3 2015
- **MetOp-SG Launches :** First **SAT-A** by 2021, first **SAT-B (with SCA)** 18 months after

SCA overview

- C-band scatterometer SCA has heritage from ASCAT on MetOp (frequency band, geometry) with
  - slightly improved coverage
  - Improved resolution (two times ASCAT's)
  - Additional information (HV measurement, residual doppler)
- Instrument Prime: Open ITT to be released before summer 2014.
- Two different concepts are under investigation: simultaneous / non-simultaneous reception of V and H-polarisations





See for more details presentation by F. Fois and J.J.W. Wilson

SCA critical/open areas

- Critical technology/pre-developments
  - Highly stable antenna technology for SCA
  - Vacuum tube HPA technology (due to obsolescence of the ERS-1/2 technology)
  - Switch matrix element
- Open areas
  - Selection of central frequency due to ground-based radars and future RLAN development

See for more details presentation by F. Fois and J.J.W. Wilson

Summary and conclusions

- Europe is committed to the **continuity of the operational scatterometer services** started by the MetOp/EPS ASCAT mission with a Second Generation instrument series SCA, covering operations into the 2040 time frame. ASCAT and SCA are built on the ERS scatterometer heritage, which provide a C-band NRCS record started in 1991
- It is intended to maintain **tandem operations of ASCAT-A/B** until the commissioning of ASCAT-C. In order to comply with the space debris mitigation guidelines, MetOp/EPS-A will be de-commissioned and moved to an EndOfLife orbit in 2019
- A **re-processed NRCS record from ASCAT-A** will be released this summer and its analysis shows a very stable instrument (see poster from C. Anderson)
- The **preparations for the MetOp/EPS-SG** are currently in phase B2. It is expected to kick-off the SCA development at the end of 2014 (see presentation by F.Fois and J.J.W.Wilson)
- **SCA improved capability with respect to ASCAT** includes improved resolution, increased coverage and an additional polarization to improve the measurement of high winds

Full ASCAT-A backscatter operational data record to date

- ✓ Reprocessed data 2007 –> 2008
- ✓ Operational data 2009 Jan –> June
- ✓ Operational data 2009 July –> August (fast NTG)
- ✓ Operational data 2009 Sept –> now (dynamic NTG and non- frozen eccentricity orbit)
- ✓ Sept 2009 -> Change in Mid Left Beam calibration: increase of 0.1 dB over all incidence angles
- ✓ August 2011 -> EC_2010 and compensation for the MLB calibration change
- ✓ June 2013 -> Slight change in Level 1B spatial averaging grid and product format change
- ✓ March 2014 -> Backscatter calibration change to continue the calibration model used in the re-processing

Other events influencing the consistency of the data record

- ✓ Manoeuvre record

ASCAT L1b reprocessing product specifications

Record type: ASCAT-A NRCS FCDR, input to ERA-CLIM reanalysis

Format: EPS Native (v12.0), BUFR and netCDF4 (Classic model)

Spatial coverage: Global (ocean and land), sampling:

- ASCA_SZR on 12.5km, ASCA_SZO on 25 km spacing swath grid
- ASCAT_SZF on measurement sampling pattern (i.e. full resolution)

Temporal: Continuous, full ASCAT-A mission: 01.2007– 06.2013, full data dumps

Target Accuracy:

- Absolute and inter-beam: 0.1 dB
- Relative (w.r.t inc angle): p2p variations of antenna patterns within 0.1 dB

Target Precision: radiometric resolution 4%

Target Stability: 0.1 dB over 5 years

Absolute calibration based on the transponders, validation over natural targets

SCA specifications

- Scatterometer specifications: ASCAT versus SCA

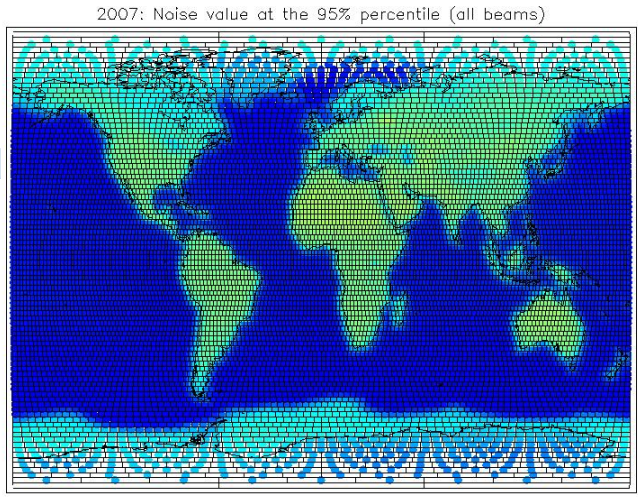
Parameter	ASCAT	SCA
Frequency	5.3 GHz	
Polarisation	VV for all beams	VV for all beams + VH for Mid-beams
Azimuth views	45°, 90° and 135° w.r.t. satellite track	
Min. incidence	25°	20° [G]
Horizontal resolution	Nom: $(50\ km)^2$ High res.: $(25 - 35\ km)^2$	Nom: $(25\ km)^2$ [G] High res.: $(17 - 22\ km)^2$
Horizontal sampling	Nom: $(25\ km)^2$ High res.: $(12.5\ km)^2$	Nom: $(12.5\ km)^2$ [G] High res.: $(6.25\ km)^2$
Radiometric resolution	≤ 3 % for $\theta_i \leq 25°$ at 4 m/s cross-wind (VV) $\leq (0.175 \times \theta_i - 1.375)$ % for $\theta_i > 25°$ at 4 m/s cross-wind (VV)	
Coverage	97 % in 48 hrs.	99 % in 48 hrs. [G]

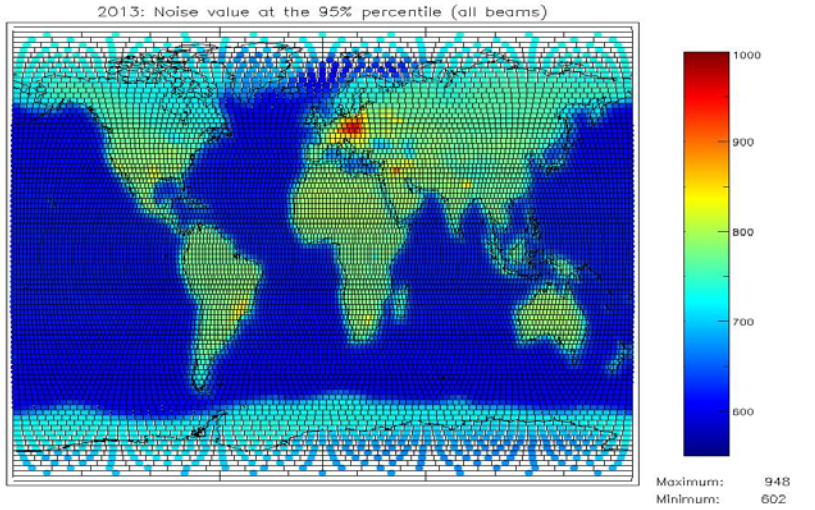
ASCAT-A - RFI analysis

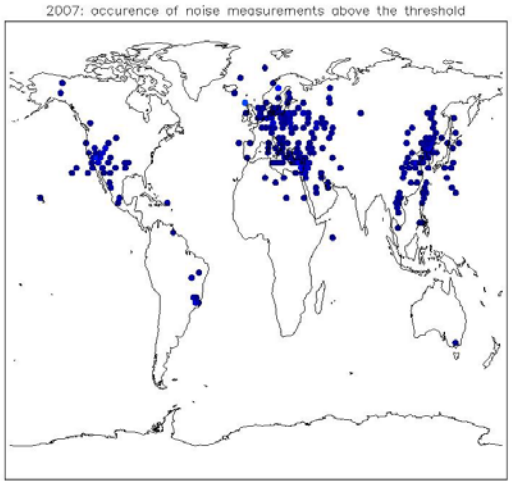
Background noise

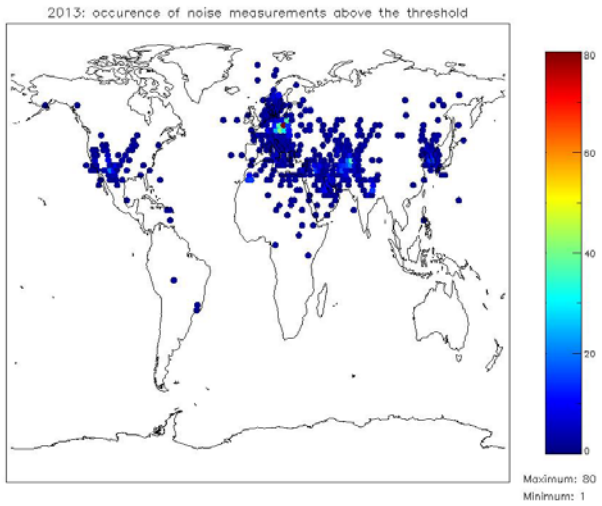
2007

Noise outliers









2013