EARS: A user-driven Regional Data Service

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Additional Data Services

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LITHUANIA
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SLOVAK REPUBLIC
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SWITZERLAND
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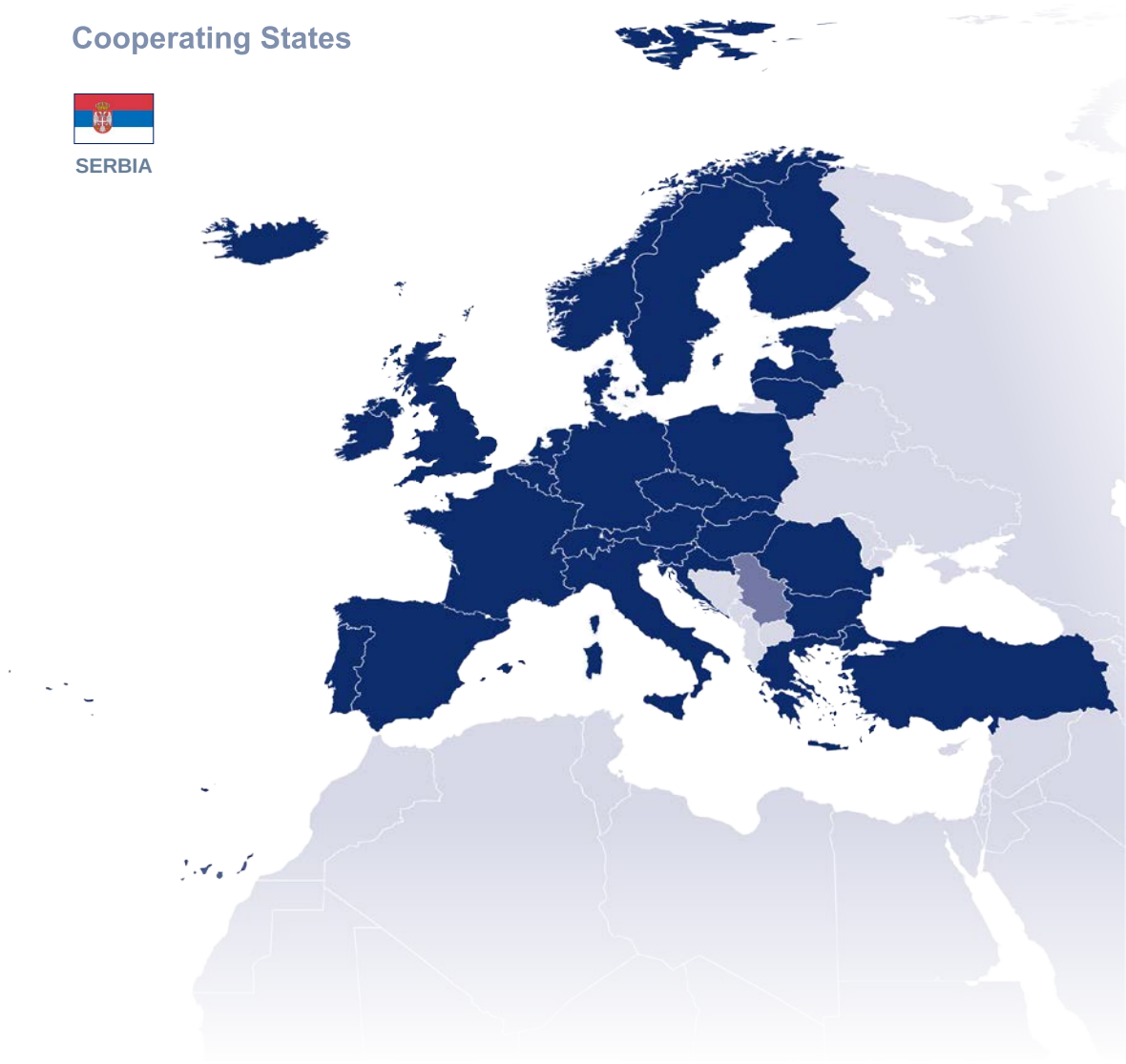
Cooperating States

SERBIA



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Overview

1. What is EARS?
2. What do the users want?
3. How does EARS work?
4. How do we check that we still do what the users need?
5. How will EARS evolve?

What is EARS?

Eumetsat Advanced Retransmission Service is:

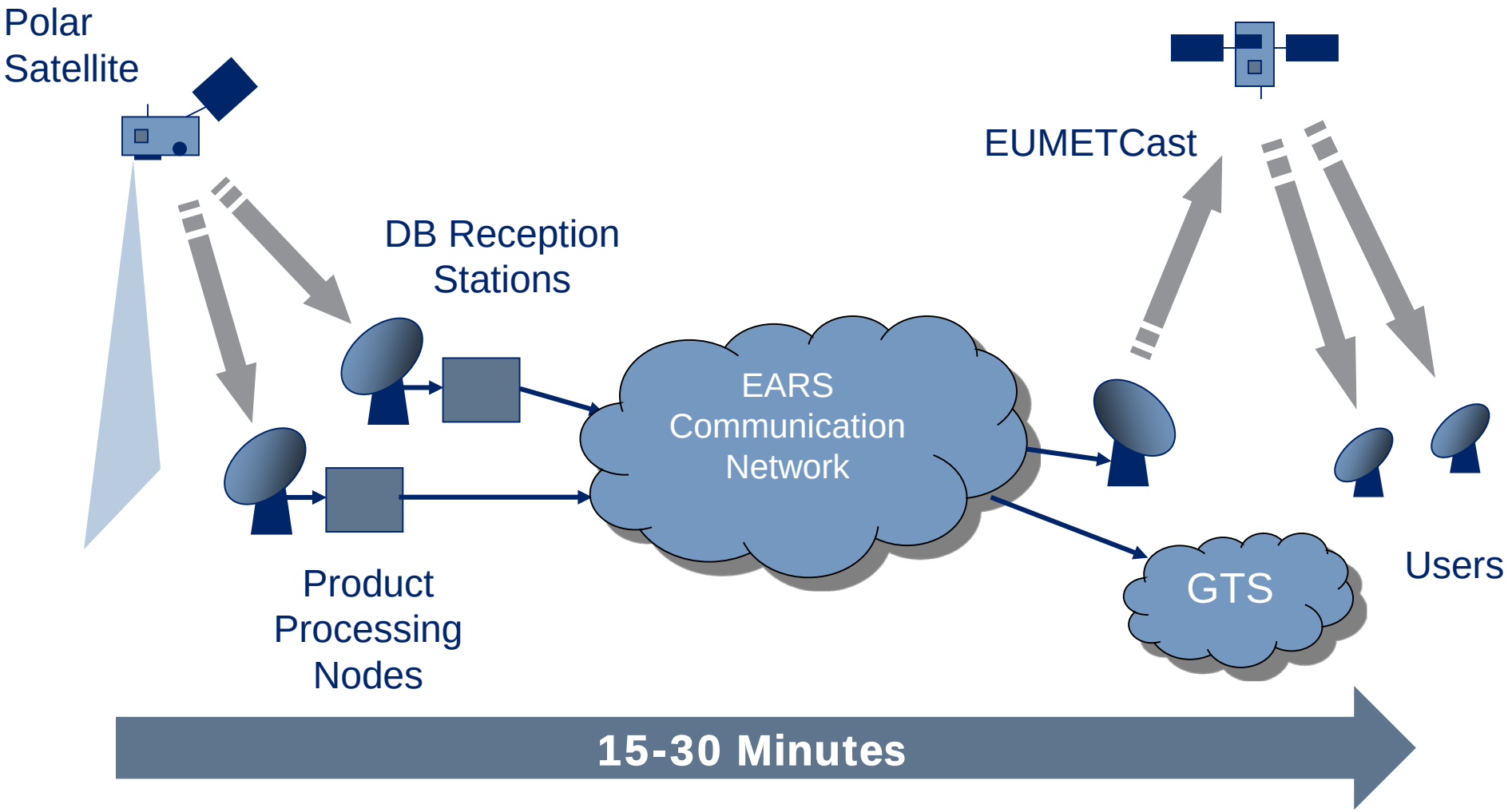
- The **Regional** Data Service of EUMETSAT
- EUMETSAT's contribution to **DBNet**
- Based on **direct broadcast** from polar orbiting satellites
- Applies local processing **software** packages from the satellite operators (AAPP, RT-STPS, CSPP, FY3-PP, PPS, ASCAT-PPF)
- Provides **L1/SDR** and an limited set of **L2 data**.
- Using EUMETSAT **infrastructure** (antennas, network, processing hardware, ...) and infrastructure from partner organisations and commercial partners.
- Serves two major **user** groups: NWP and nowcasting
- Data are **distributed** via EUMETCast and GTS

What do the users want Regional Services ?

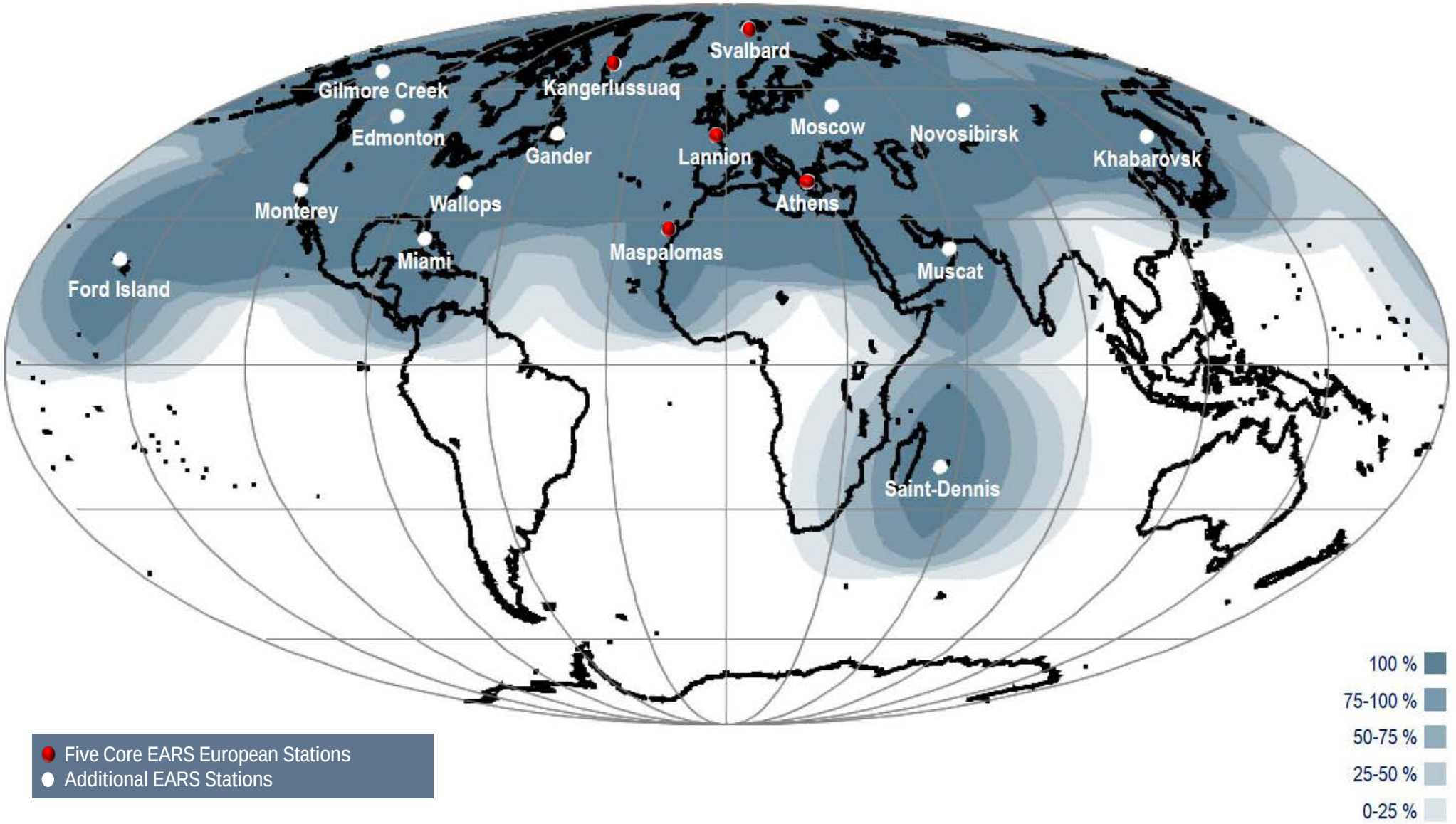
User requirements defined by EUMETSAT member states:

	NWP, Regional Modelling	Nowcasting
Data Types	MW+IR sounder L1/SDR data Scatterometer L1+L2 data (MW imager data TBC)	VIS+NIR+IR Imager data Cloud products Atmospheric profiles
Coverage	Northern Hemisphere (together with DBNet)	Europe, North Polar Region, and North Atlantic
Availability	>90%	>95%
Timeliness	<30 minutes	<15 minutes
Quality	Consistent with global data	Sufficient to create L2 data
Cost	Affordable	Affordable

How does the EARS System work?



The EARS Ground Station Network



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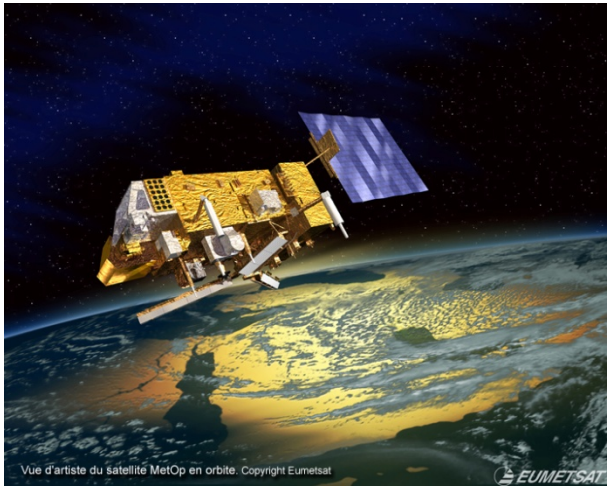
The EARS Satellite Network



METOP-A
METOP-B

S-NPP

~~**NOAA-15**~~
NOAA-18
NOAA-19

FY-3C

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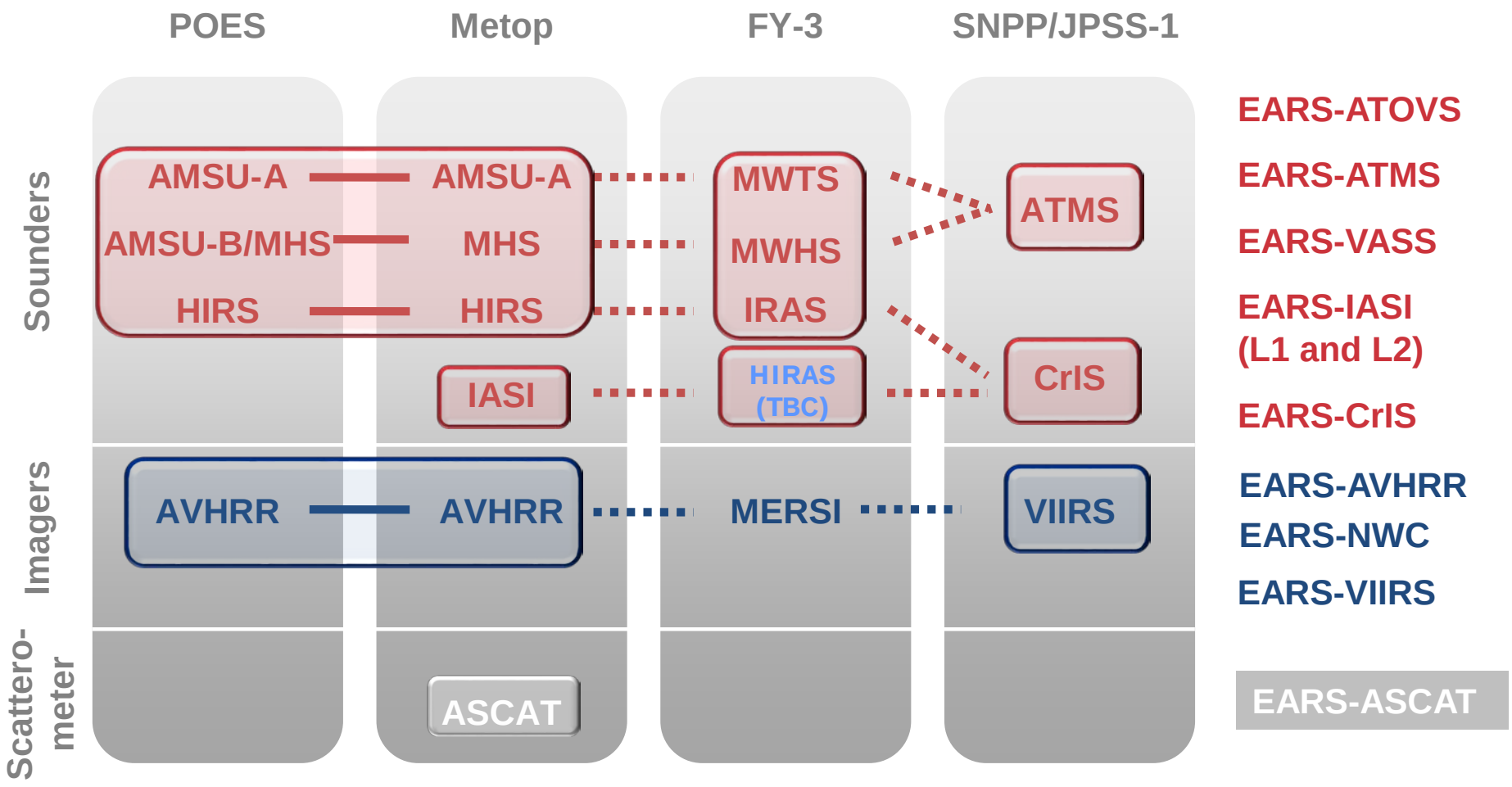
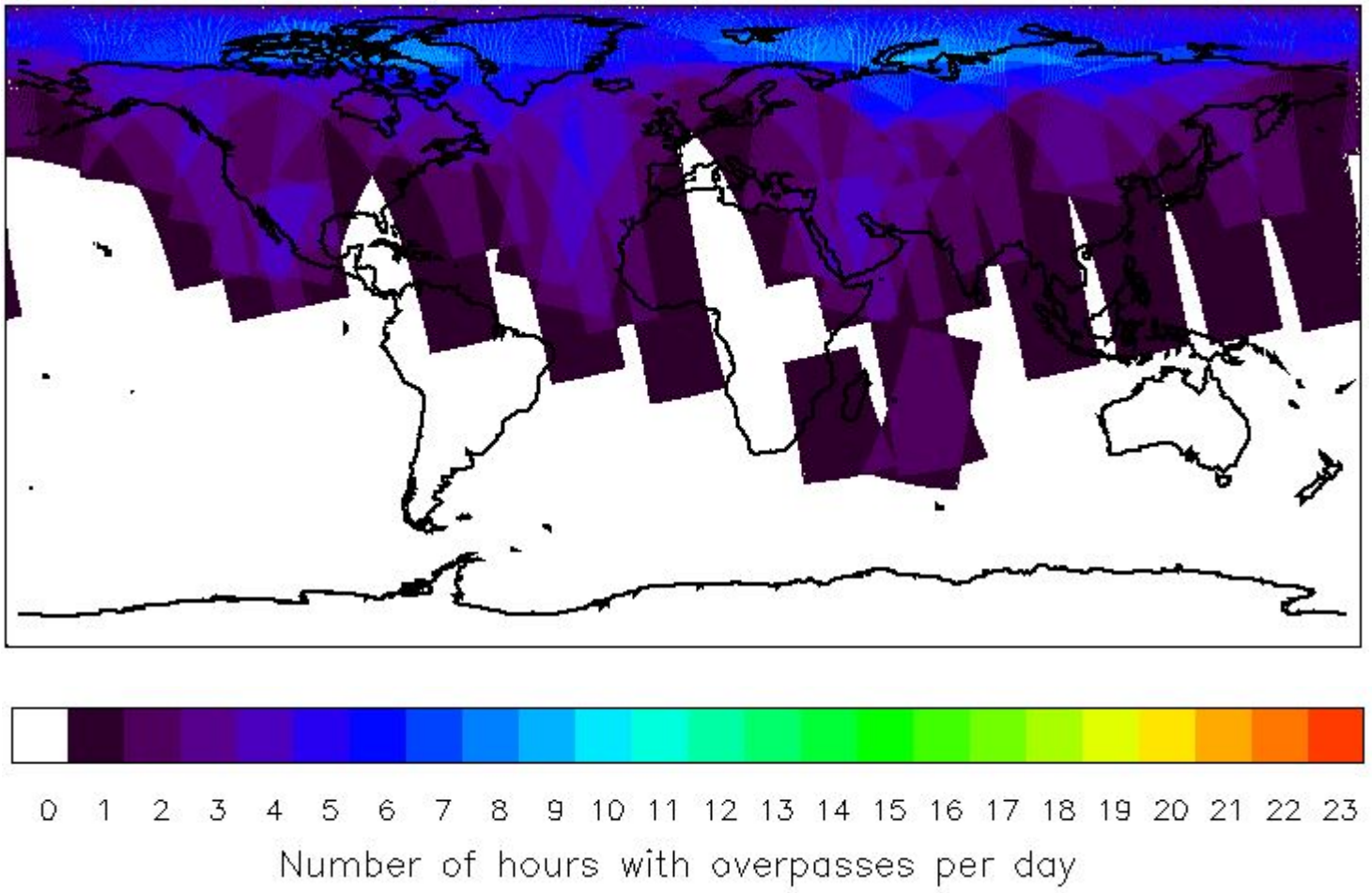
The EARS Instruments and Services



http://www.eumetsat.int/website/home/Data/RegionalDataServiceEARS/index.html

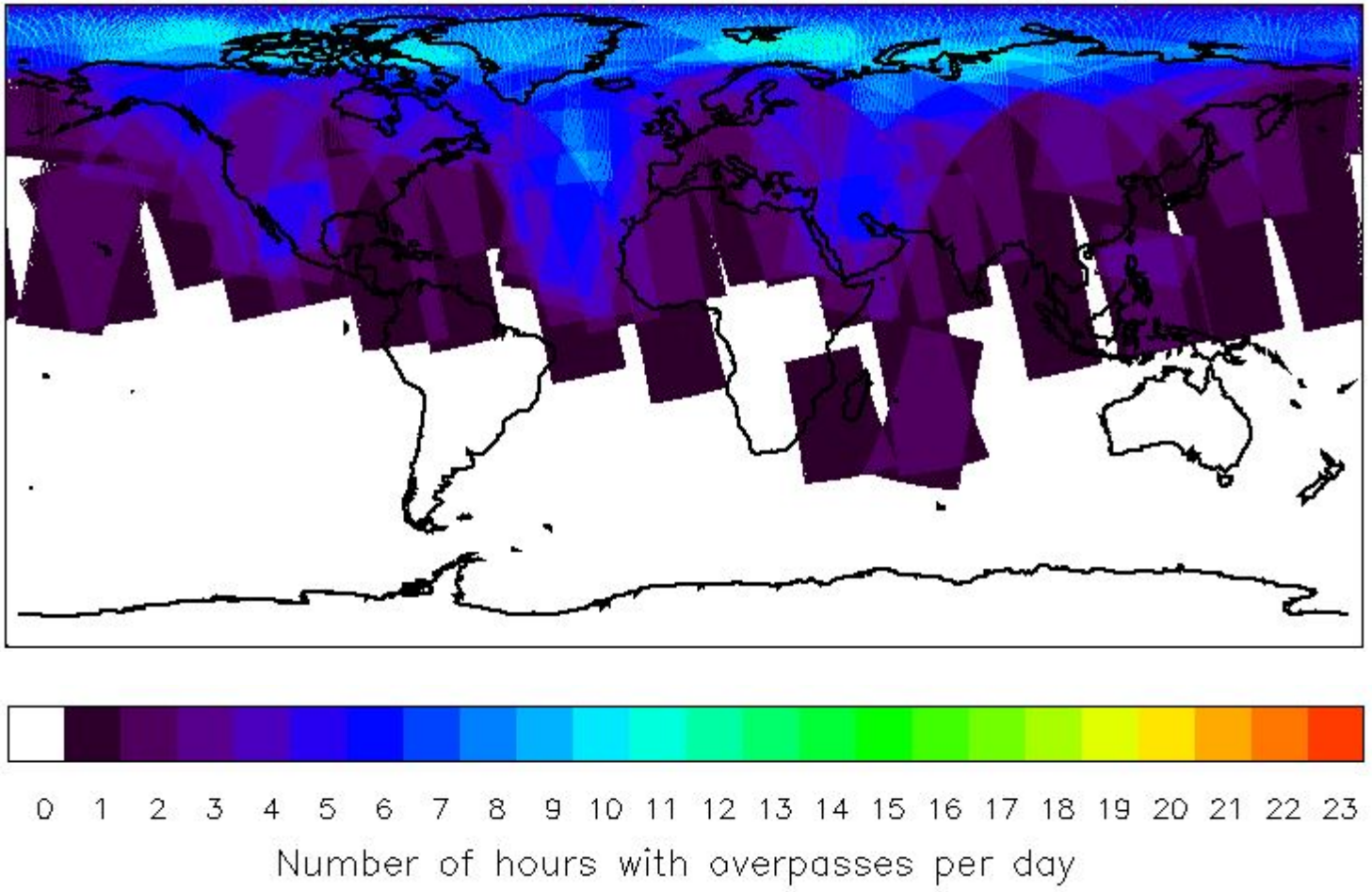
EARS coverage, MW sounder

Only Metop (A/B), mid-morning orbit



EARS+DBNRT coverage, MW sounder

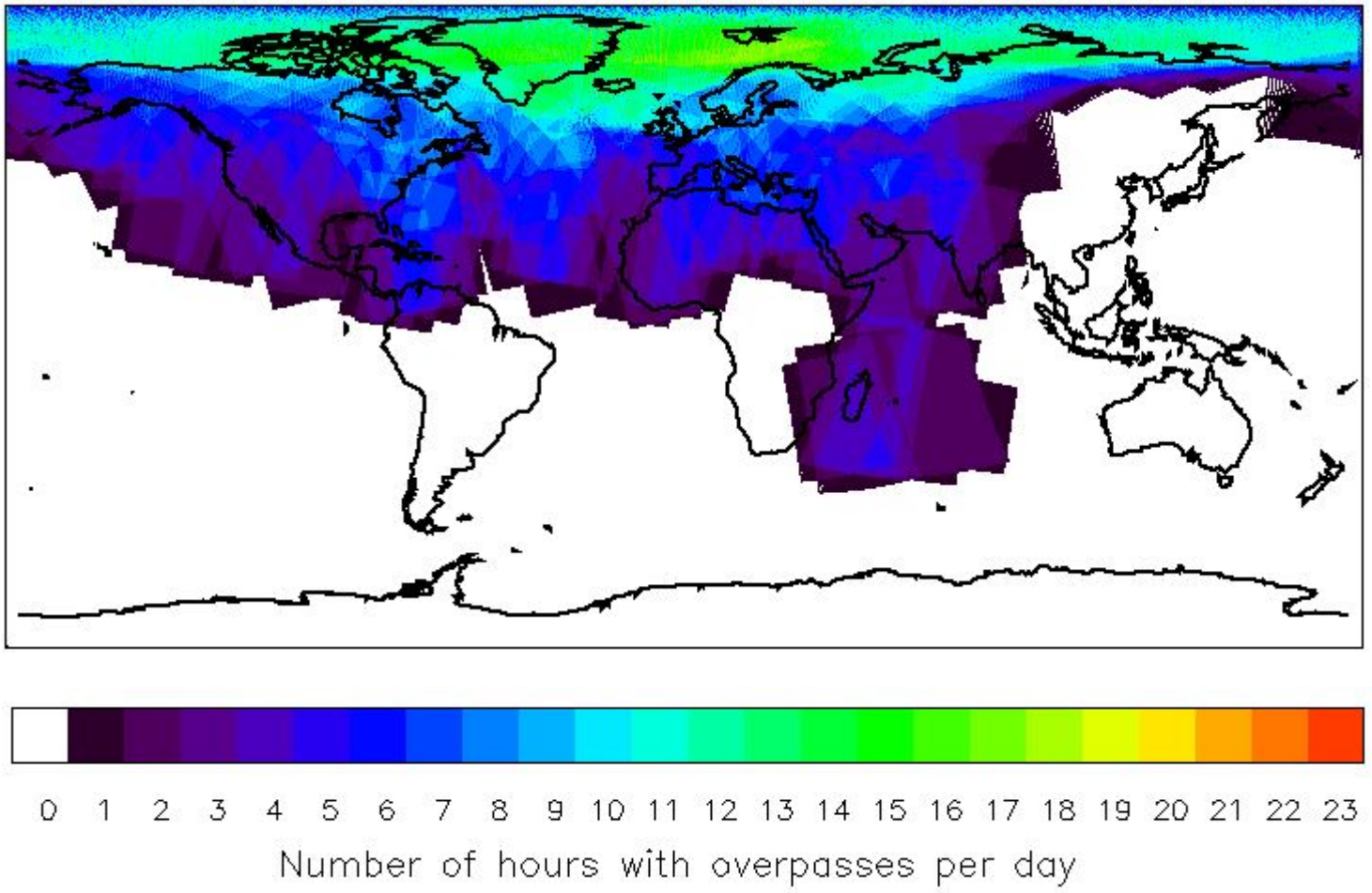
Metop (A/B) + S-NPP
(mid-morning + afternoon orbit)



EARS+DBNRT coverage, MW sounder

Metop (A/B) + S-NPP+NOAA (18/19)

mid-morning + afternoon (S-NPP+N19) + terminator orbit* (N18)



***Note: N-18 is drifting but FY-3E will be permanently in the terminator orbit**

How do we check that we do what the users asked for ?

Automated service monitoring

- **Availability and Timeliness:** Check of actual availabilty and timeliness against expected values. SMART monitoring.

- **Quality:** Comparing produced data regularly with validated global data from the original provider NWP-SAF: https://nwpsaf.eu/site/monitoring/dbnet/dbnet-atms/

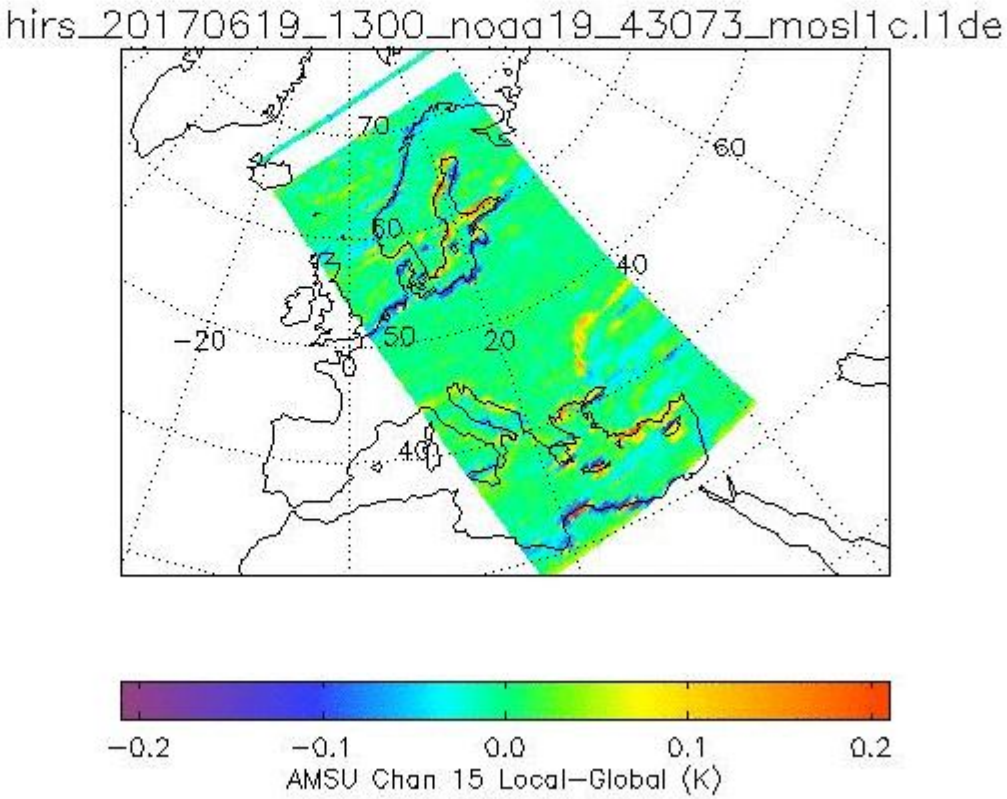
SMART monitoring

EARS - Controller ASCAT : Total Duration [24 hours] / End [0 hours from now]

Start	End	Schedule	Satellite	Station	X-Band/HRPT L0	EUMETSAT RTS	ASCAT L1	To KNMI	L2 To EUMETCast	User Station	Timeliness
171-04:02:28	171-04:33:34	171-03:59:35	metopa	sva	171-04:33:10	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	48m35.293s
171-04:06:27	171-04:17:47	171-04:07:50	metopb	std	171-04:17:37	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	15m10.787s
171-04:38:35	171-04:51:43	171-04:39:09	metopa	mus	171-04:43:08	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	25m00.461s
171-04:50:19	171-05:05:03	171-04:51:18	metopa	std	171-05:05:16	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	25m35.527s
171-05:16:40	171-05:29:20	171-05:16:40	metopb	sva	171-05:18:44	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	23m30.671s
171-05:31:43	171-05:47:01	171-05:31:43	metopb	mus	171-05:35:59	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	27m07.772s
171-05:43:59	171-05:59:18	171-05:44:55	metopb	std	171-05:59:44	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	23m03.805s
171-05:45:39	171-06:16:45	171-05:42:02	metopa	sva	171-06:14:52	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	47m50.935s
171-06:17:51	171-06:32:35	171-06:19:03	metopa	mus	171-06:22:20	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	23m03.882s
171-06:19:10	171-06:25:28	171-06:19:10	metopa	ath	171-06:22:13	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	13m52.946s
171-06:31:06	171-06:44:19	171-06:32:14	metopa	std	171-06:44:21	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	21m50.965s
171-06:58:06	171-07:12:13	171-06:58:06	metopb	sva	171-07:00:04	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	24m21.142s
171-07:04:03	171-07:19:17	171-07:04:04	metopb	mos	171-07:08:06	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	25m10.331s
171-07:12:24	171-07:23:21	171-07:12:24	metopb	ath	171-07:15:40	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	19m32.341s
171-07:13:15	171-07:24:28	171-07:13:15	metopb	mus	171-07:18:10	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	17m59.349s
171-07:28:07	171-07:59:13	171-07:23:52	metopa	sva	171-07:58:24	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	51m55.502s
171-07:58:00	171-08:10:24	171-07:58:00	metopa	ath		0 of 1	0 of 1	0 of 1	0 of 2	0 of 2	
171-08:39:07	171-08:54:12	171-08:39:07	metopb	sva	171-08:41:08	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	25m19.876s
171-08:44:20	171-08:59:06	171-08:44:21	metopb	mos	171-08:50:15	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	21m02.865s
171-08:48:31	171-09:01:56	171-08:49:42	metopb	lan	171-08:51:26	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	22m21.886s
171-08:52:16	171-09:04:12	171-08:52:16	metopb	ath	171-08:56:02	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	19m23.951s
171-08:57:47	171-09:05:22	171-08:57:47	metopb	mas	171-09:01:14	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	14m49.893s
171-09:09:40	171-09:40:46	171-09:05:04	metopa	sva	171-09:40:05	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	51m04.252s
171-09:34:08	171-09:49:13	171-09:38:02	metopa	lan	171-09:39:20	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	21m02.150s
171-09:39:37	171-09:48:34	171-09:39:37	metopa	ath	171-09:42:44	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	17m28.138s
171-09:41:09	171-09:54:45	171-09:41:09	metopa	mas	171-09:45:12	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	20m09.316s
171-10:19:48	171-10:35:17	171-10:19:48	metopb	sva	171-10:21:48	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	27m20.397s
171-10:24:44	171-10:36:15	171-10:24:45	metopb	mos	171-10:29:36	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	23m43.418s
171-10:25:13	171-10:35:36	171-10:25:12	metopb	kan	171-10:29:35	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	20m32.398s
171-10:28:13	171-10:43:35	171-10:29:10	metopb	lan	171-11:31:50	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	1h18m54.789s
171-10:34:31	171-10:49:52	171-10:34:31	metopb	mas	171-10:38:39	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	24m24.468s
171-10:50:22	171-11:21:28	171-10:45:41	metopa	sva	171-11:20:30	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	48m32.998s
171-11:14:25	171-11:28:54	171-11:19:23	metopa	lan	171-11:43:13	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	37m41.830s
171-11:20:43	171-11:35:21	171-11:20:43	metopa	mas	171-11:24:55	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	19m09.720s
171-12:00:11	171-12:15:39	171-12:00:11	metopb	sva	171-12:02:12	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	26m45.986s
171-12:05:29	171-12:19:45	171-12:05:29	metopb	kan	171-12:09:26	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	23m48.005s
171-12:08:58	171-12:21:19	171-12:10:11	metopb	lan	171-12:11:30	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	23m53.027s
171-12:11:14	171-12:24:33	171-12:11:10	metopb	gan	171-12:28:15	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	26m25.064s
171-12:16:02	171-12:27:12	171-12:16:02	metopb	mas	171-12:20:18	1 of 1	1 of 1	1 of 1	2 of 2	2 of 2	17m05.504s
171-12:30:31	171-13:01:37	171-12:25:53	metopa	sva	171-13:00:16	1 of 1	0 of 1	0 of 1	0 of 2	0 of 2	
171-12:55:39	171-13:04:44	171-13:01:53	metopa	lan		0 of 1	0 of 1	0 of 1	0 of 2	0 of 2	

Quality monitoring by NWP-SAF

Satellite	Station	Display	Day	Time of day
NOAA-19	[E] Moscow	AMSU Channel 15	Latest	AM



How to check that the service still meets the user's needs ?

Operations Reports:

- Regional Services Operations Reports are yearly prepared and presented to stakeholders.

Help-Desk statistics:

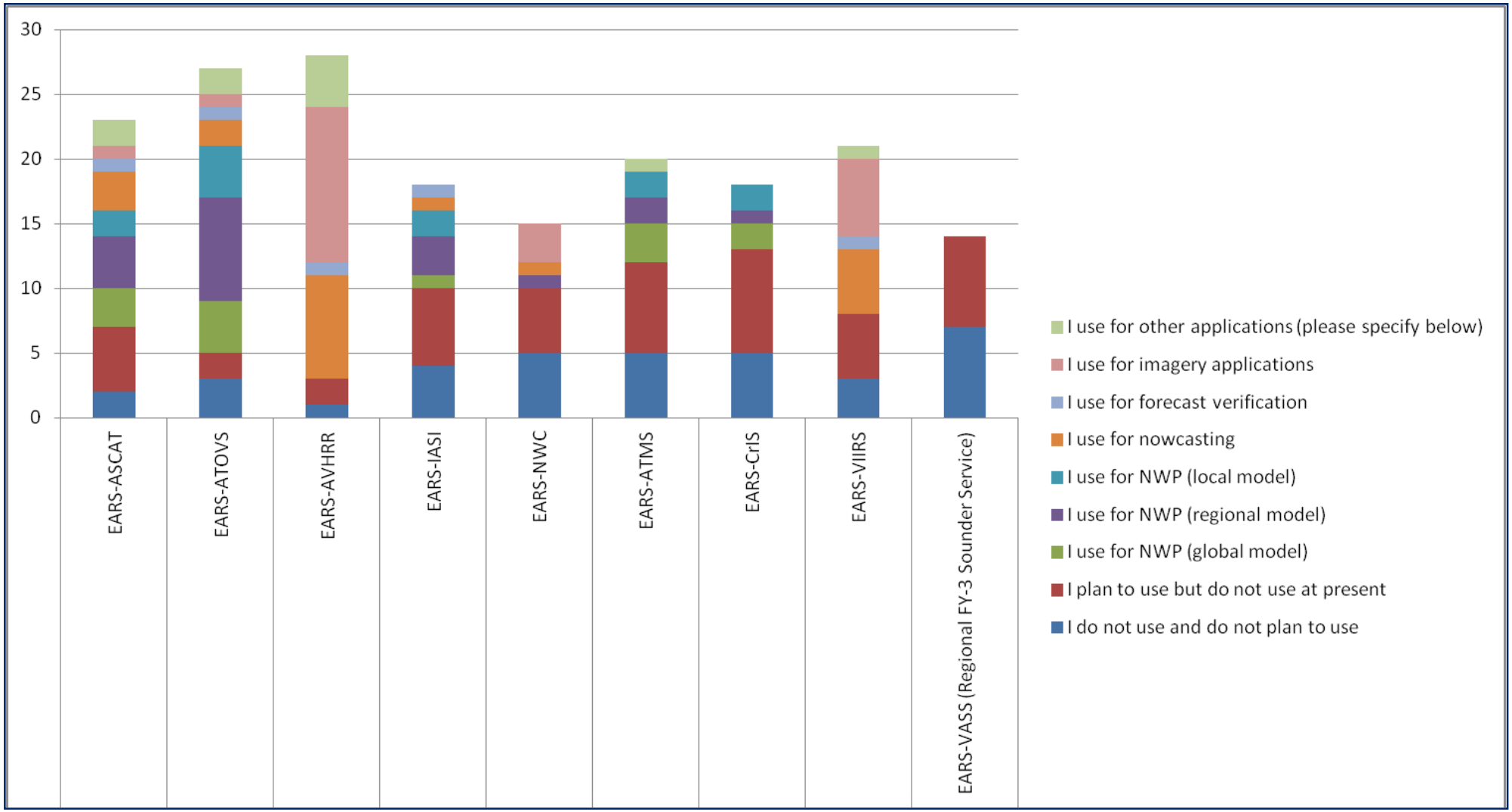
- Questions to the user service Help-Desk are logged an checked for persistent problems.

EUMETSAT users surveys:

- Regularly surveys on product usage are performed. The last survey, covering Metop Global Data and EARS Regional Services, was issued to Member States' NMHSs on 6 July 2016 and closed at the end of August 2016.

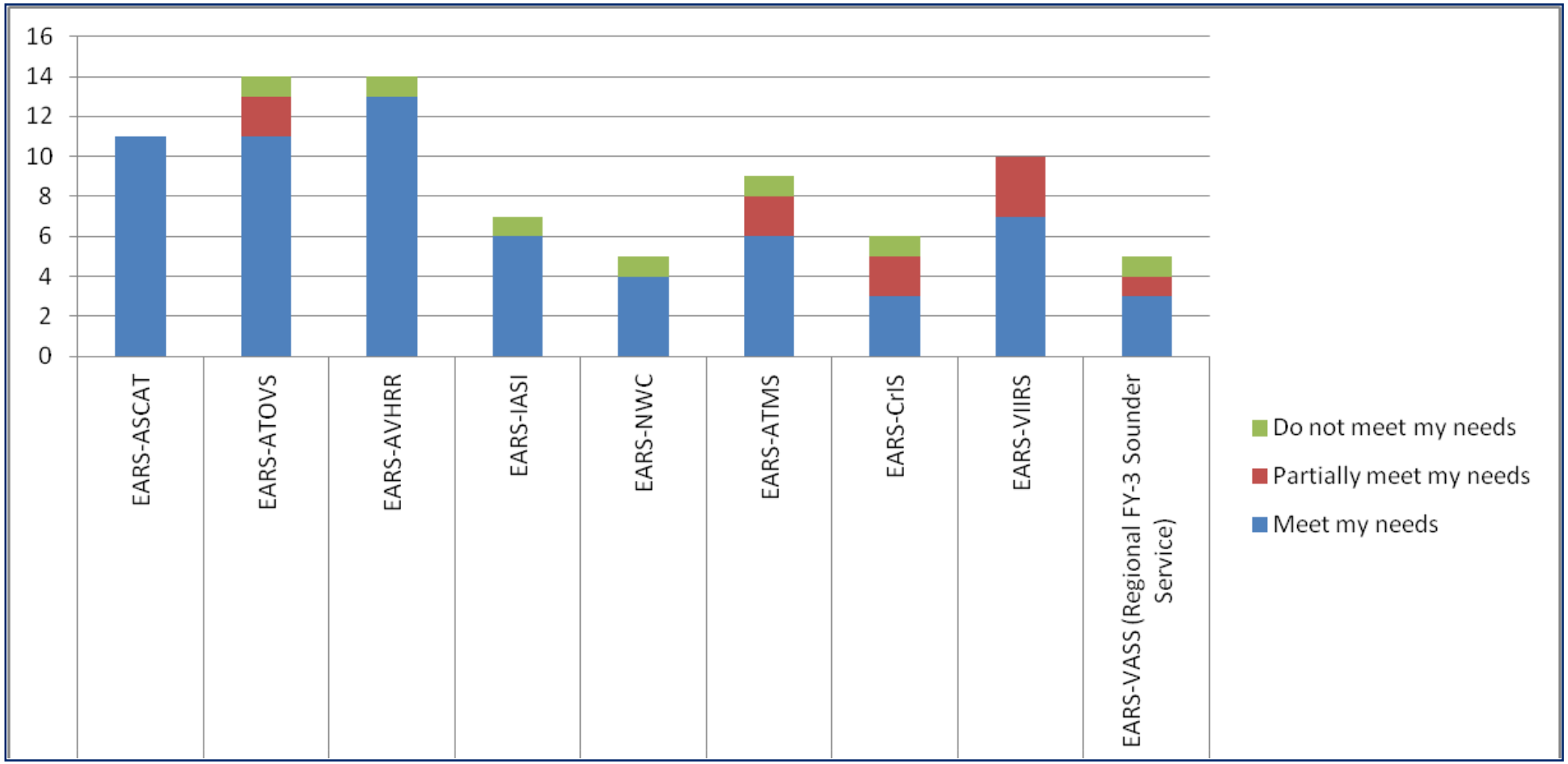
User survey: Usage of EARS Regional Data

Q5: Please indicate your use of the following EARS regional data



User Survey: Usage of EARS Regional Data

Q6: Do the EARS regional data you currently use meet your needs?



How will EARS evolve?

- Moving from re-active to active service design (not using what is available but first checking what is needed).

- Considering:
  - Future satellites,
  - DB method: L-band or X-band (incl. polarisation),
  - Evolution and obsolescence of hardware,
  - Evolution of networks,
  - Consistency with other ground-segment developments at EUMETSAT, especially for EPS-SG (synergies),
  - New distribution mechanisms,
  - Cost.

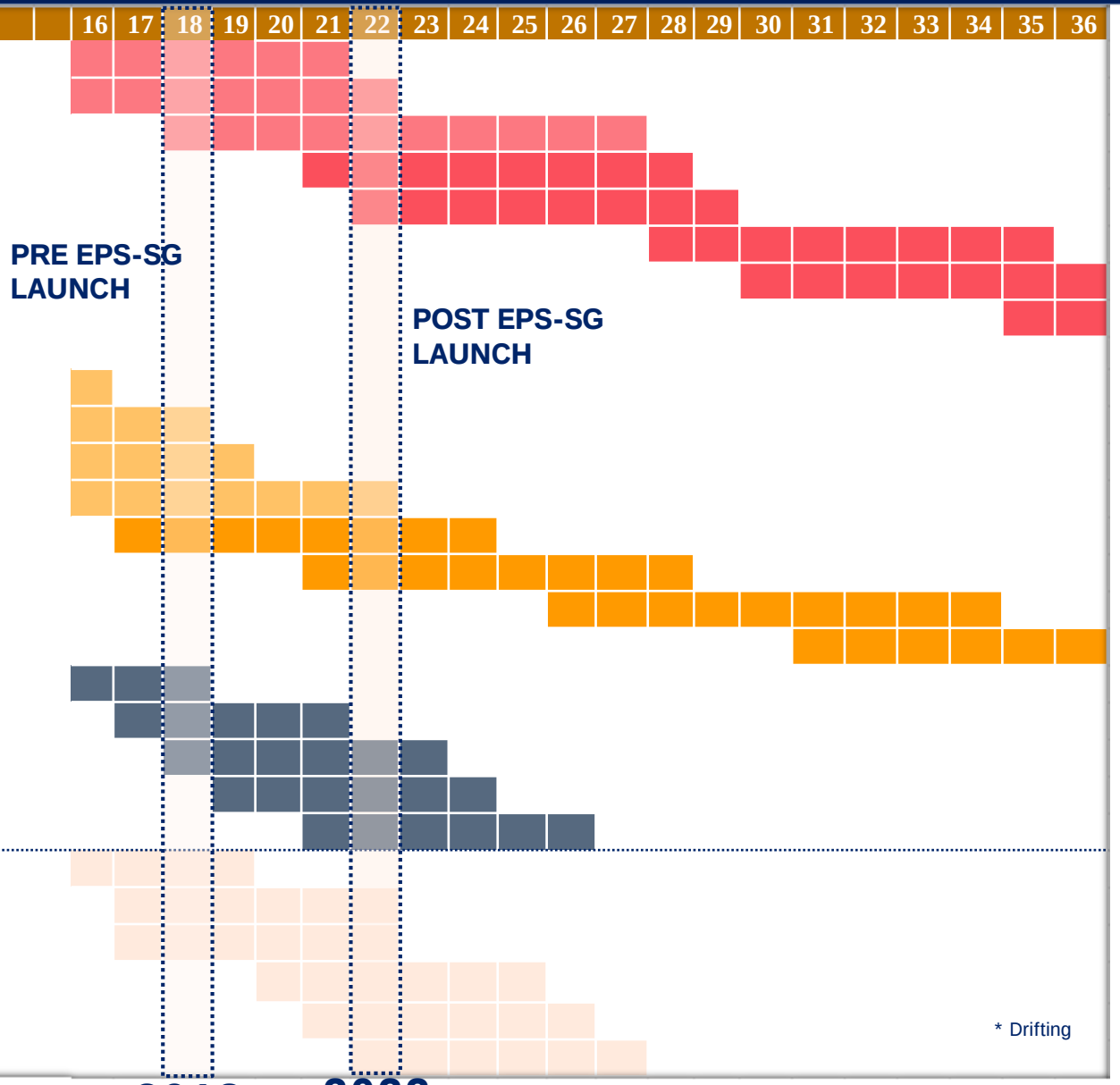
Why an Antenna Capacity Analysis?

- **Acquiring 100% of the total broadcasted data is possible but not realistic/affordable**. Sites covering polar regions (Svalbard and Kangerlussuaq) would need as many antennas as satellite altitudes being flown. At Svalbard, for example, these would be about 6 antennas in 2018. However, all satellites in conjunction are rare events, so this would lead to under utilization of resources;

- **A trade-off between the number of available antennas (costs) and the total satellite coverage provided (benefits) is required**.

Satellites to be supported

Satellite	Lifetime	ECT
Metop-A	2006-2021	09:30 desc *
Metop-B	2012-2018	09:30 desc
Metop-C	2018-2024	09:30 desc
SG-1A	2021-2028	09:30 desc
SG-1B	2022 - 2029	09:30 desc
SG-2A	2028-2035	09:30 desc
SG-2B	2030 - 2037	09:30 desc
SG-3A	2035-2042	09:30 desc
SG-3B	2036 - 2043	09:30 desc
NOAA-15	1998-2016	05:38 desc *
NOAA-18	2005-2016	05:30 desc *
NOAA-19	2009-2016	14:20 asc *
SNPP	2011-2016	13:30 asc
JPSS-1	2017-2024	13:30 asc
JPSS-2	2021-2028	13:30 asc
JPSS-3	2026-2033	13:30 asc
JPSS-4	2031-2038	13:30 asc
FY-3C	2013-2018	10:20 desc
FY-3D	2017-2022	14:00 asc
FY-3E	2018-2023	06:00 desc
FY-3F	2019-2024	10:00 desc
FY-3G	2021-2026	14:00 asc
Meteor-M N2	2014-2019	21:14 asc
Meteor-M N2-1	2017-2022	15:00 asc
Meteor-M N2-2	2017-2022	09:00 desc
Meteor-M N2-3	2020-2025	15:00 desc
Meteor-M N2-4	2021-2026	09:00 desc
Meteor-M N2-5	2022-2027	15:00 desc



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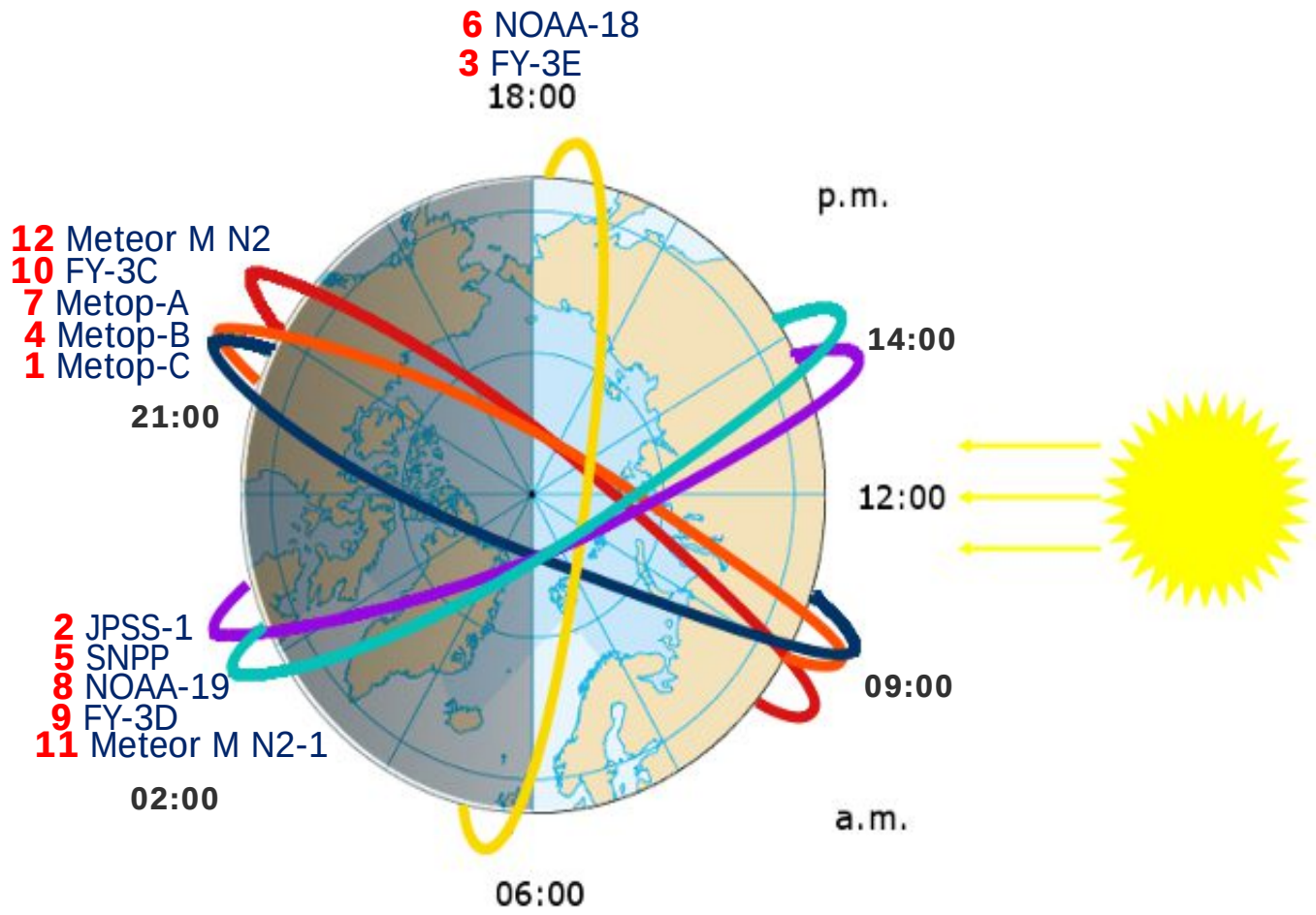
Acquisition Priorities Pre EPS-SG Launch Scenario (2018)



Capacity Analysis Scenarios

	SATELLITES	STATIONS
Scenario I Pre EPS-SG Launch (2018)	Metop-C JPSS-1 FY-3E Metop-B SNPP NOAA-18 Metop-A NOAA-19 FY-3D FY-3C Met-M N2-2 Met-M N2-1	Athens Maspalomas Kangerlussu Svalbard Lannion

	SATELLITES	STATIONS
Scenario II Post EPS-SG Launch (2022)	SG1B SG1A JPSS-2 FY-3E Metop-C JPSS-1 Metop-B FY-3G NPP FY-3F Met-M N2-5 Met-M N2-4	Athens Maspalomas Kangerlussu Svalbard Lannion Santa Maria

Capacity Analysis Tool

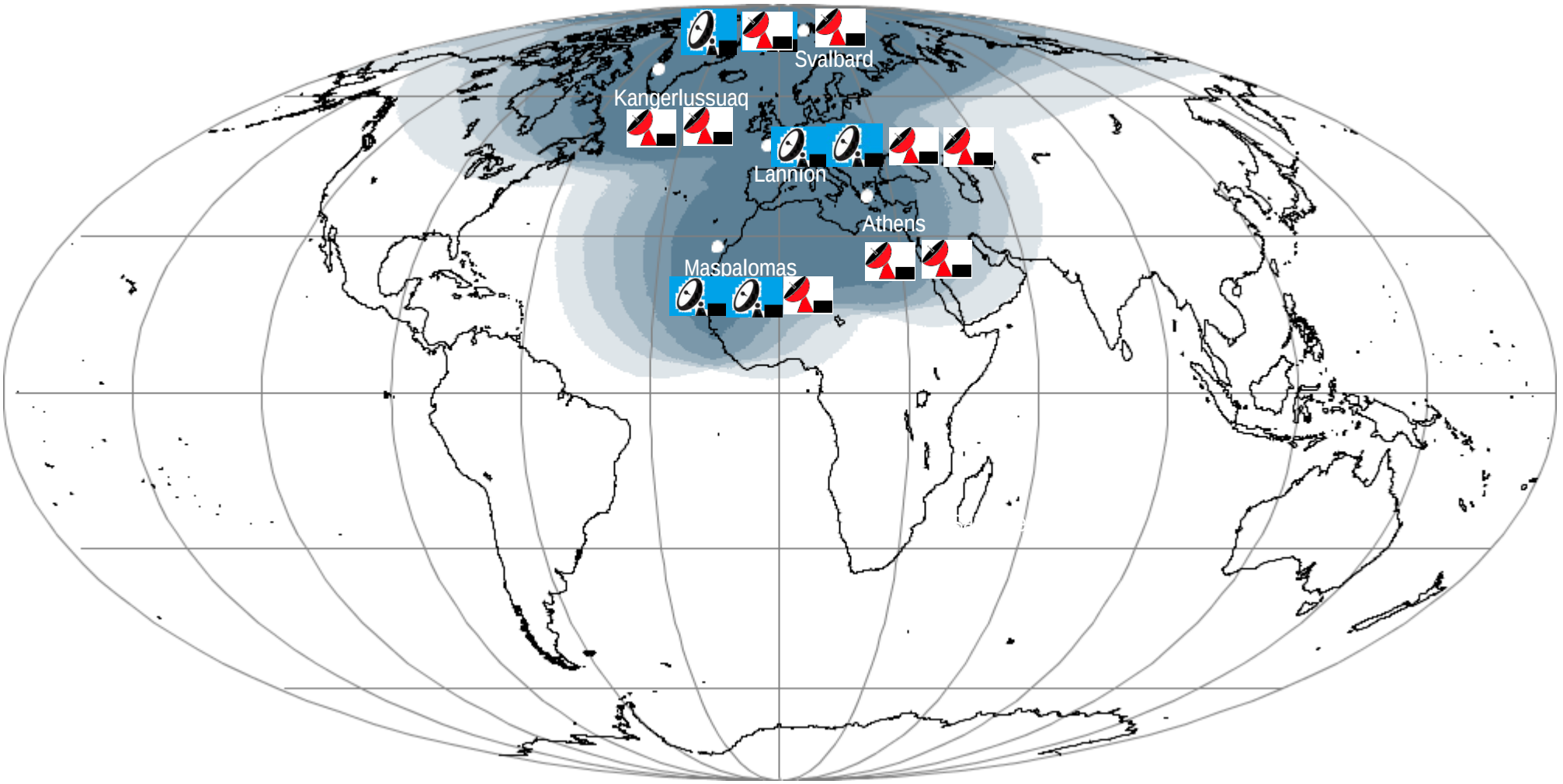
- **We have developed capacity analysis tools which provide results of coverage/availability for any given scenario defined by a set of satellites with assigned scheduling priorities and the on-ground infrastructure available**.
  Those tools allow us to assess the coverage provided by the existing EARS infrastructure to future satellite sets expected to be operational in the different timeframes. Potential upgrades to the existing infrastructure can be measured in terms of coverage improvement.

- **The Capacity Analysis results are used to find the best strategy for the EARS infrastructure evolution.** To asses readiness of a certain infrastructure configuration to support a set of satellites, not only the coverage provided in nominal circumstances will be taken into account, but as well the coverage that the infrastructure would provide in case of a degraded scenario (resilience to failure).

Additional Considerations for the determining the necessary infrastructure

- **Per site redundancy is mandatory to ensure resilience to failure for sustaining the operational services (minimum of 2 antennas per site)**
- **Although the overall system has a certain level of redundancy provided by station coverage overlaps, many regions (even inside European Users' zone of interest) are only covered by a single station .**
- **The infrastructure has to evolve from L/LX towards a LX-Band solution.** All future missions are X based but L based missions will still be operational for a number of years beyond 2018.
- **The evolutions needs to take due consideration of the needs for data locally at the station**
- **100% of EPS-SG data shall be received**

Overview of Infrastructure Baseline & Evolutions



L-Band Reception System : Antenna + FEP

LX-Band Reception System : Antenna + FEP

Azores Station to be added for the 2022 Scenario
Include ongoing obsolescence removal in Athens and Kangerlussuaq
Svalbard CDAs considered L-band since only support Metops

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Readiness status of Infrastructure Baseline and benefits of planned Evolutions (system level, nominal scenario)

P	2018 Satellite Set	Baseline	Evolving: Svalbard :(L ⇢ LX) & Lannion :(New LX)
1	Metop-C	100%	100%
2	JPSS-1	100%	100%
3	FY-3E	92.60%	99.6%
4	Metop-B	99.70%	99.8%
5	SNPP	94.20%	99.7%
6	NOAA-18	98.00%	93.8%
7	Metop-A	98.20%	99.6%
8	NOAA-19	93.00%	92.1%
9	FY-3D	75.40%	88.1%
10	FY-3C	62.90%	78.3%
11	Met N2-2	66.50%	76.3%
12	Met N2-1	62.50%	75.7%
	WM (all)	92.6%	95.6%
	WM (F6)	97.6%	99.0%
	WM (-MN)	**94.9%**	**97.2%**

P	2022 Satellite Set	Baseline	Evolving: Svalbard :(L ⇢ LX) & Lannion :(New LX)
1	SG1B	100%	100.00%
2	SG1A	100%	100.00%
3	JPSS-2	90.60%	100.00%
4	FY-3E	85.10%	95.20%
5	Metop-C	99.60%	99.60%
6	JPSS-1	82.50%	94.80%
7	Metop-B	99.40%	99.40%
8	FY-3G	70.60%	88.10%
9	NPP	77.60%	91.60%
10	FY-3F	62.30%	83.20%
11	MetN2-5	53.70%	71.80%
12	MetN2-4	50.80%	67.50%
	WM (all)	86.9	94.6
	W M (F6)	93.2%	98.4%
	W M (-MN)	**89.7%**	**96.6%**

< 95% > 95%

Summary

- EARS provides data based on user requirements
- Requirements need regular re-evaluation
- EARS infrastructure has to evolve to cover also future missions and growing demand for data volume (e.g. more hyper-spectral sounder channels) and data types (e.g. MW-imager data)
- Processing software has to stay in line with global processing and should be available for all instruments that are part of the DB services.