EUCOS – OSE studies for an upper-air network redesign

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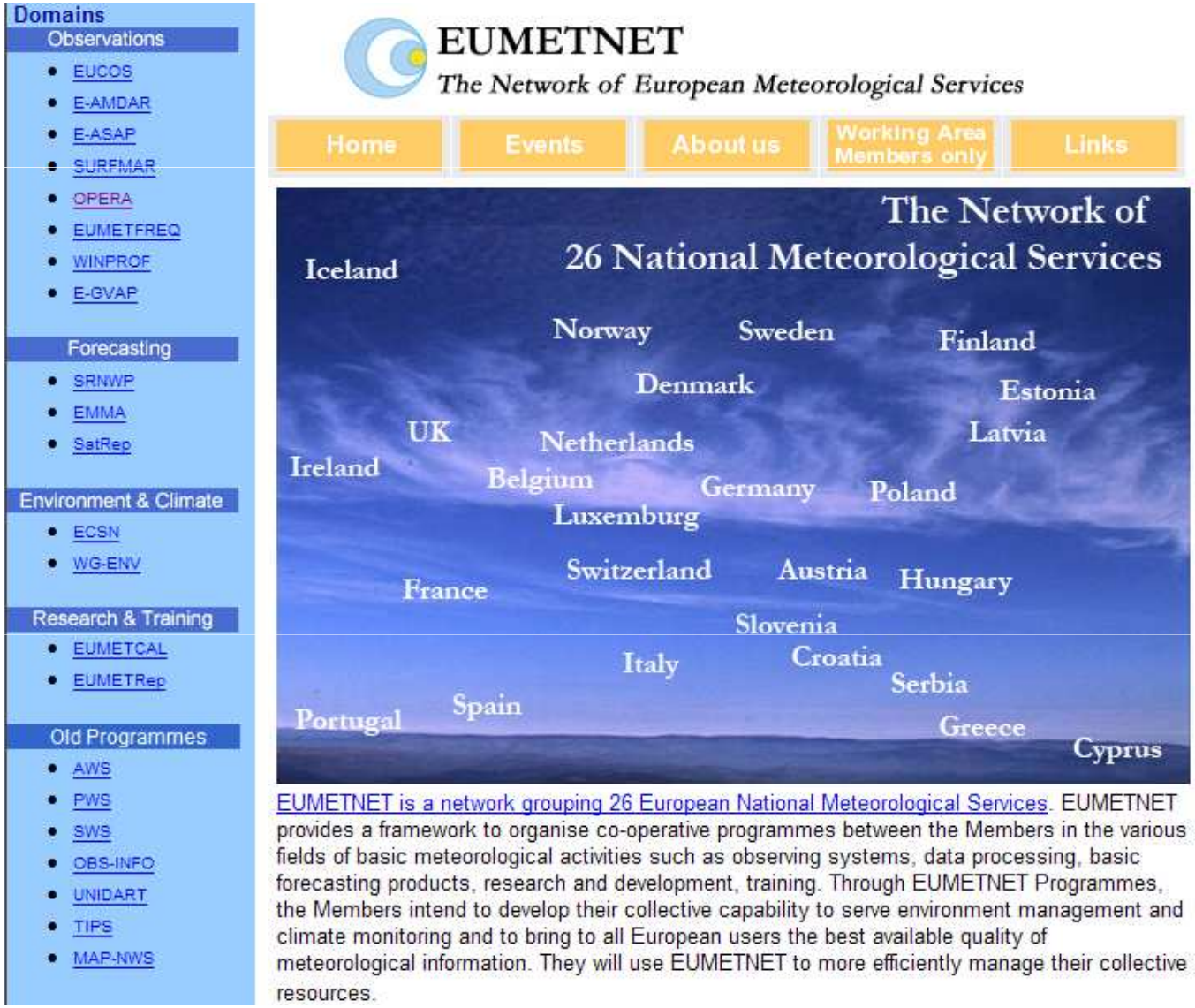
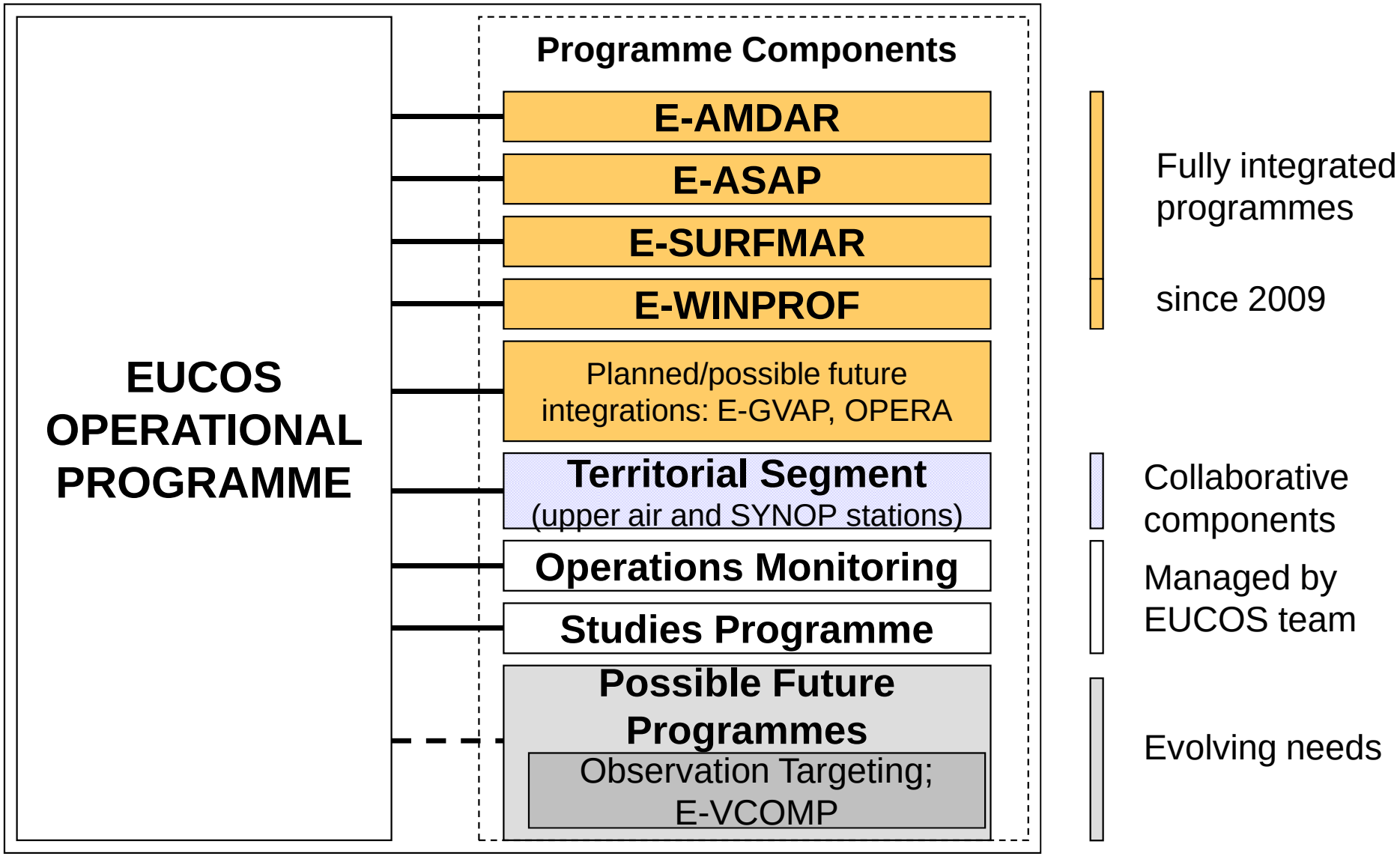
About EIG EUMETNET and EUCOS



About EIG EUMETNET and EUCOS



EUCOS Information System (www.eucos.net)

EUCOS objectives

- Monitor and control the EUMETNET composite observing system (EUCOS) performance
- Design and coordinate the evolution of the ground based EUCOS to be optimized at European scale with a view to improve short range forecast over Europe without increasing the overall cost
- Support the evolution of EUCOS through a studies programme

The current EUCOS network

- All European ships of the Automated Ship Aerological Programme (currently 18 ships)
- All measurements from European commercial aircraft (AMDAR)
- Selected moored buoys and all European drifting buoys
- European Voluntary Observing Ships
- Selected European radiosonde stations (incl. Ekofisk)
- Selected European synoptic weather stations
- Selected European wind profilers (+ wind profiles derived from weather radar data)

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Monitoring: EUCOS network performance 2009

2009 Network	Data availability	Timeliness HH+50 (Radiosondes: TEMP AB)	Timeliness HH+100 (Radiosondes: TEMP CD)	Achieving 100 hPa	Achieving 50 hPa	Individual targets subprogrammes
Surface stations	Target: 95% 95%	Target: 90% 98%	Target: 95% 99%	---	---	---
Radiosonde stations	Target: 95% 90%	Target: 75% 76%	Target: 95% 95%	Target: 97% 96%	Target: 95% 91%	---
ASAP units	Annual target: 4453 obs 4544 obs (equals 102%)	Target: 75% 85%	Target: 95% 95%	Target: 90% 91%	Target: 75% 82%	Loss rate Target: max. 20% 15%
Ocean platforms Average LDWR Ekofisk	Target: 95% 85% 86% 85%	Target: 75% 91% 92% 87%	Target: 95% 96% 96% 97%	Target: 95% 97% 98% 96%	Target: 90% 92% 95% 87%	---
E-AMDAR	Annual target:* 12 Mio. obs 16,379,675 (equals 136%)	Target: 90% 95%	Target: 95% 98%	---	---	*Profile distribution* daily profiles Target: 780 886 daily airports Target: 140 121
Moored buoys	Target: 90% 88%	Target: 90% 75%	Target: 95% 96%	---	---	---
Drifting buoys	Target: 88% 97%	Target: 70% 67%	Target: 85% 87%	---	---	---
Automated VOS ships	Daily avg target: 1,000 997 (equals 99.7%)	Target: 90% 91%	Target: 95% 97%	---	---	---
Conventional VOS ships	Daily avg target: 250 293 (equals 117%)	Target: 90% 78%	Target: 95% 95%	---	---	---
E-WINPROF Wind profiler	Target: 85% 90%	Timeliness HH+60 Target: 85% 84%		---	---	---
Weather radars	Target: 85% 78%	Target: 85% 95%		---	---	---

. The AMDAR target bases on an annual target of 12 Mio. messages. The 2009 performance displays the AMDAR observations **including additional data e.g. DWD, Met Office and Météo France sub-3-hourly data.**

target achieved
<10% below target
=>10% below target

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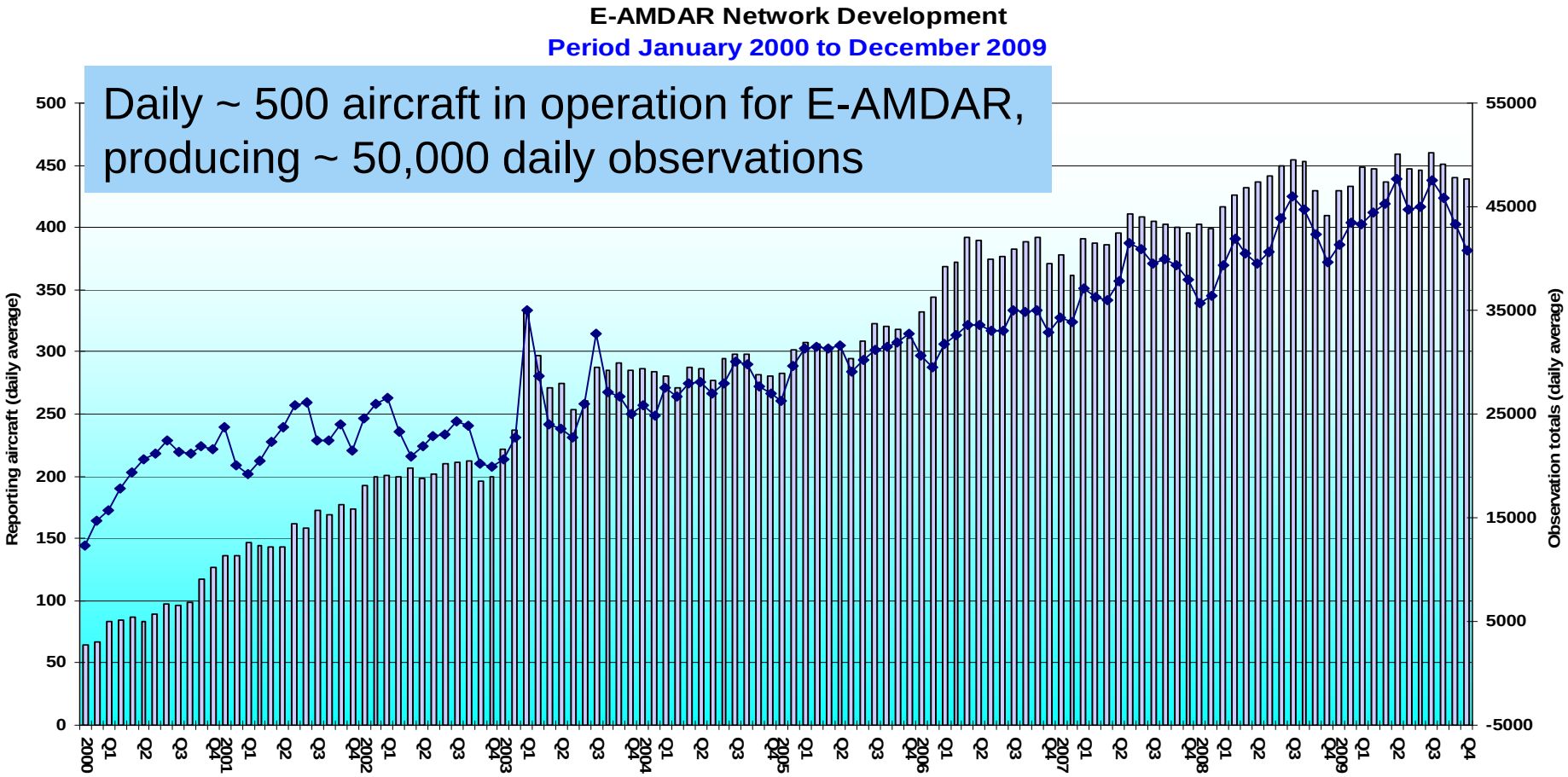
Monitoring: EUCOS network performance 2009

2009 Network	Temperature RMSE	Wind Mean Vector	Specific Humidity Error dq/q*	O-B-Geopotential	Pressure RMSE
Surface stations	**Target: 1 K** **1.69 K**	**Target: 5.0 m/s** **2.59 m/s**	**Target: 10%** **8.27%**	---	**Target: 1 hPa** **0.74 hPa**
Radiosonde stations	**Target: 1 K** **1.09 K**	**Target: 5.0 m/s** **4.65 m/s**	**Target: 10%** **12.08%**	**Target: 65 m** **24.06 m**	---
ASAP units	**Target: 1 K** **1.11 K**	**Target: 5.0 m/s** **4.05 m/s**	**Target: 10%** **12.02%**	**Target: 65 m** **20.53 m**	---
Ocean platforms	**Target: 1 K**	**Target: 5.0 m/s**	**Target: 10%**	**Target: 65 m**	
Average	**0.98 K**	**3.47 m/s**	**12.43%**	**21.25 m**	---
LDWR	0.93 K	3.38 m/s	11.84%	20.61 m	
Ekofisk	1.02 K	3.56 m/s	13.01%	21.88 m	
E-AMDAR	**Target: 1.5 K** **1.04 K**	**Target: 5.0 m/s** **4.13 m/s**	**Target: 10%** **not provided yet**	---	---
Moored buoys	**Target: 1 K** **0.96 K**	**Target: 5.0 m/s** **3.89 m/s**	**Target: 10%** **7.51%**	---	**Target: 1 hPa** **0.85 hPa**
Drifting buoys	---	---	---	---	**Target: 1 hPa** **0.84 hPa**
VOS ships	**Target: 2 K**	**Target: 5.0 m/s**	**Target: 15%**		**Target: 1 hPa**
Automated	**1.40 K**	**3.74 m/s**	**7.24%**	---	**0.87 hPa**
Conventional	**1.47 K**	**4.90 m/s**	**10.00%**		**1.33 hPa**
Wind profiler **E-WINPROF**	---	**Target: 5.0 m/s** **4.44 m/s**	---	---	---
Weather radars **E-WINPROF**	---	**Target: 5.0 m/s** **51.02 m/s**	---	---	---

EUCOS target achieved
within WMO target
below WMO target

Comparison of observations against COSMO-EU short-range forecasts

E-AMDAR

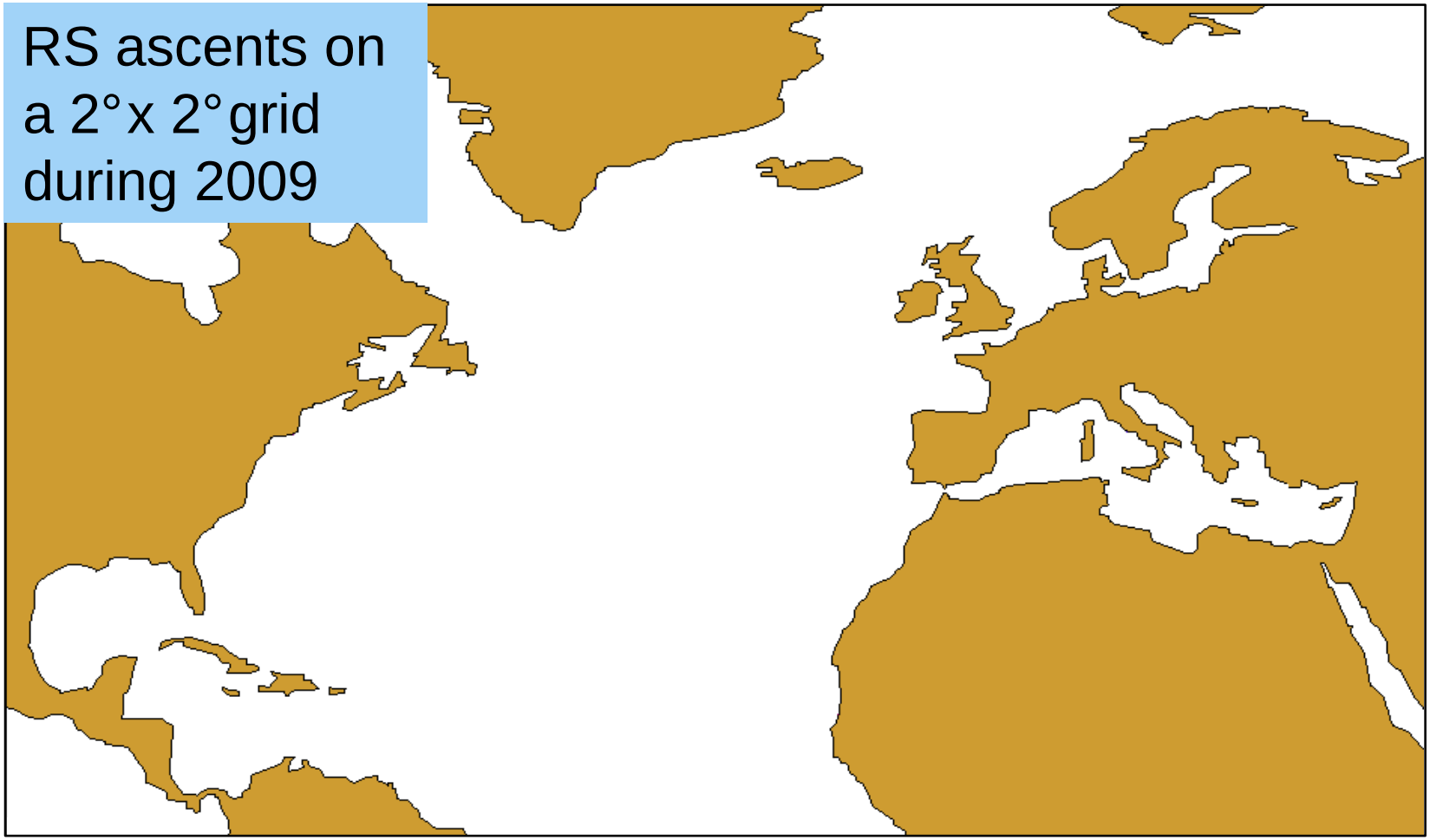


Important current activity:

Extended E-AMDAR humidity trial: Installation of 6 + 6 water vapour sensors onboard E-AMDAR aircraft during 2011/2012, monitoring of performance, OSEs required before further rollout

E-ASAP

RS ascents on a 2°x 2°grid during 2009



Bulletins per grid point

3 5 8 10 14 18 22 28 35 45 55

Important current activity:

Replacement of INMARSAT-C by IRIDIUM satellite transmission systems (thus enabling transmission of binary data: 20 sec BUFR).

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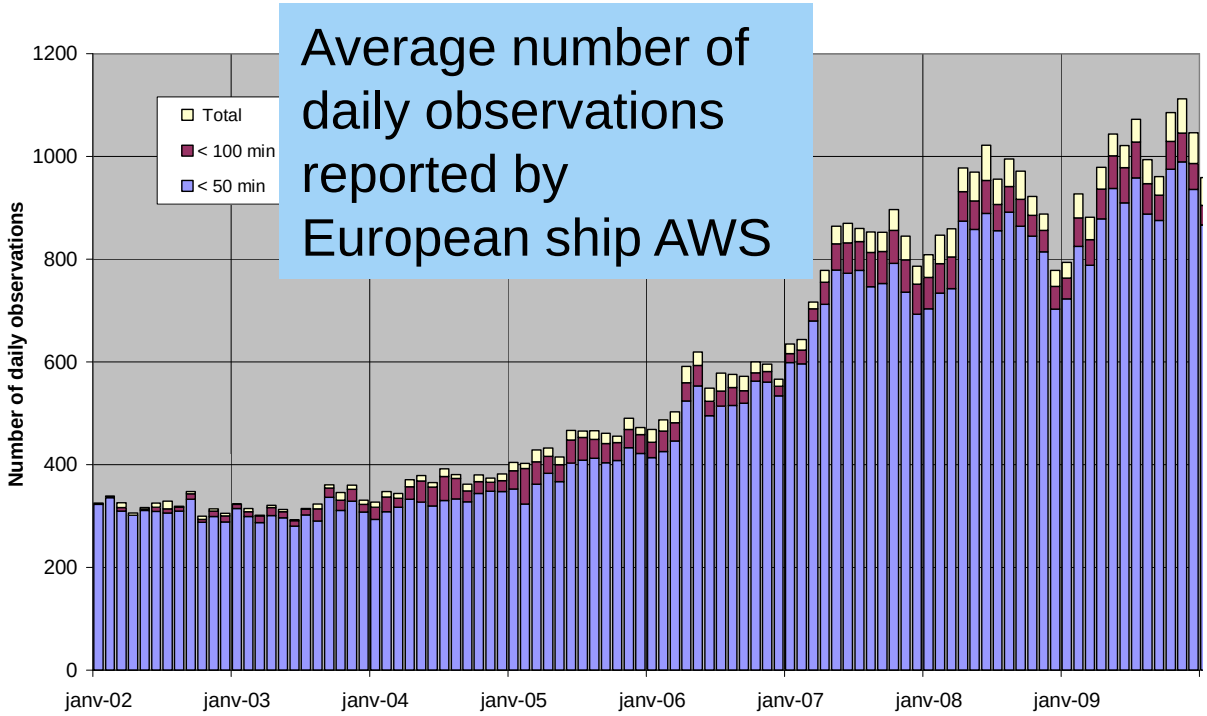
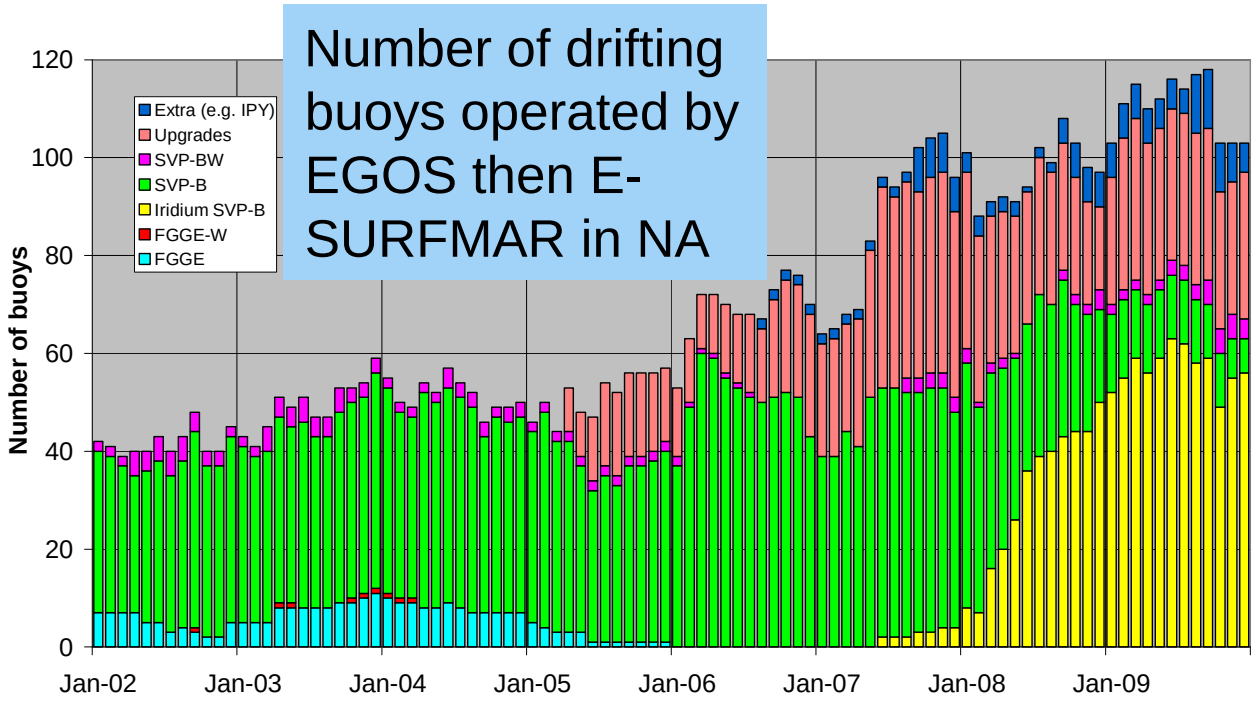
E-SURFMAR





Important current activity:
Paving the way for a common procurement of automatic weather stations for ships (S-AWS) by EUMETNET members.

E-WINPROF

Wind profilers, which reach a certain level of quality and availability

+

Weather Radar Wind Profiles (WRWP) from about 100 sites which reach certain quality

Important current activity: Formation of a technical support/ expert team in order to facilitate co-operation between Members.

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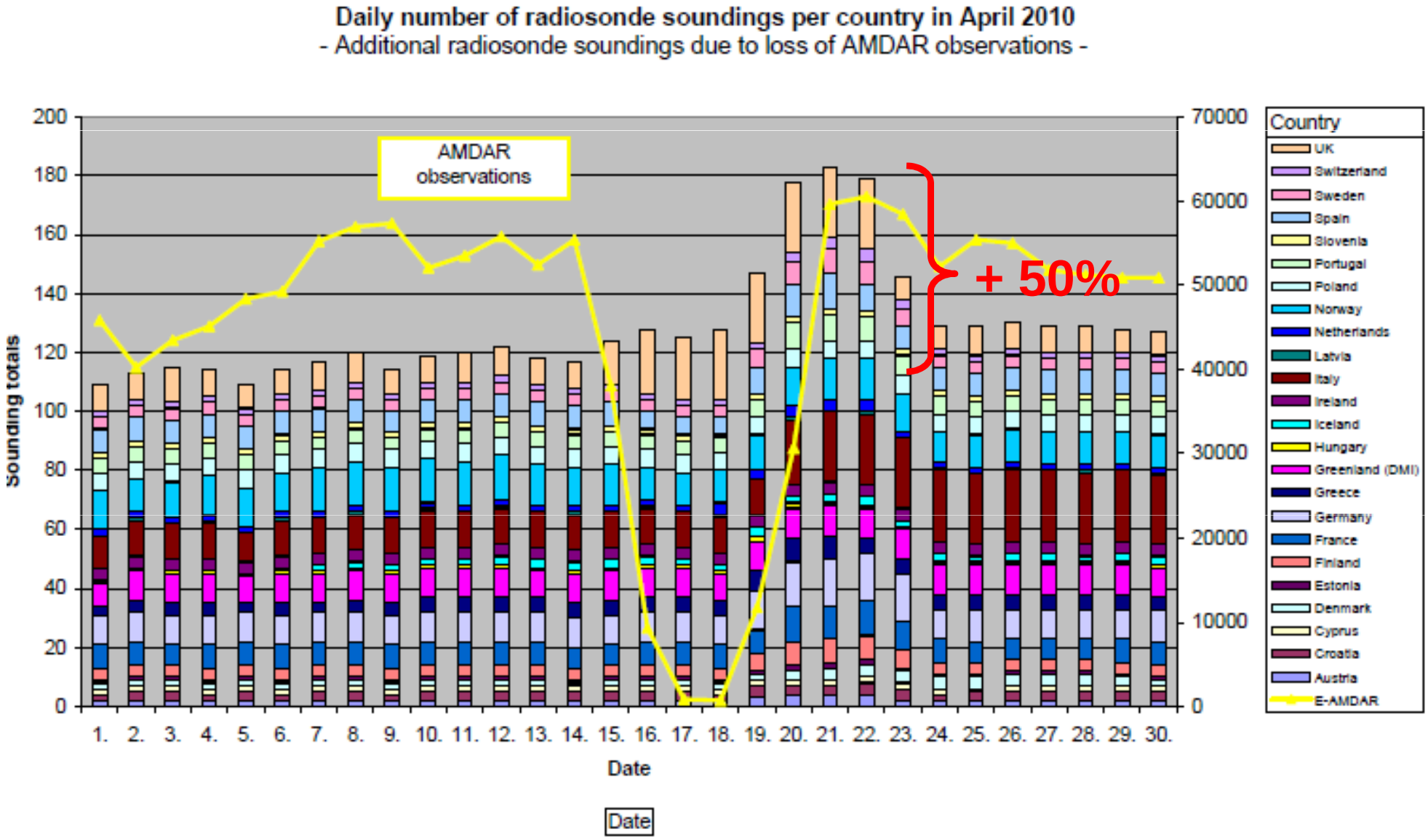
Impact of the volcanic ash cloud on conventional observing systems



EUCOS upper-air network redesign – Motivation

- The EUCOS upper-air network required a redesign because:
  - Of the need to take into account the significant evolution of the E-AMDAR network;
  - Members were not able to install the proposed EUCOS radiosonde network design with 4 ascents per day at most of the sites;
  - Results from the Space Terrestrial Studies are available with recommendations for the network design;
  - Data assimilation of NWP models has improved significantly with advanced capability to make use of high time resolution data.

EUCOS upper-air network redesign – Setup

- **Scenario no 1: Baseline:**
  All current satellite observations used in NWP (radiances, cloud-drift winds, scatt winds) + GUAN radiosonde network + GSN + hourly buoys (no ship data);

- **Scenario no 2: Control:**
  All currently available data in the EUCOS area.

EUCOS upper-air network redesign – Setup

- **Scenario no 3a:**
  Experiment with horizontal spacing of 100 km for profiles. Control "–" those land-based radiosondes which are beyond a network with 100 km horizontal spacing, thereby replacing radiosonde sites with AMDAR data if 3-hourly AMDAR measurements are available at those locations

- **Scenario no 3b:**
  The same as for 3a but keeping 0 UTC radiosonde ascents at those sites which are replaced in scenario 3a because of the vicinity to an airport

EUCOS upper-air network redesign – Setup

- **Scenario no 4:**
  Experiment with horizontal spacing of 250 km for profiles from radiosondes and aircraft; all other settings like those of scenario 3a.

- **Scenario no 5:**
  Experiment with horizontal spacing of 500 km for profiles from radiosondes and aircraft; all other settings like those of scenario 3a.

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OSE scenarios - summary

no	scenario description	# EUMETNET radiosondes		# airports
		non GUAN	**total**	
1	BASELINE	0	**13**	**0**
2	BASELINE + all available data in EUCOS area	80	**93**	**58**
3	BASELINE + 100km spaced RS + all airports	50	**63**	**58**
4	BASELINE + 250km spaced (RS + airports)	33	**46**	**40**
5	BASELINE + 500km spaced (RS +airports)	10	**23**	**~ 20**

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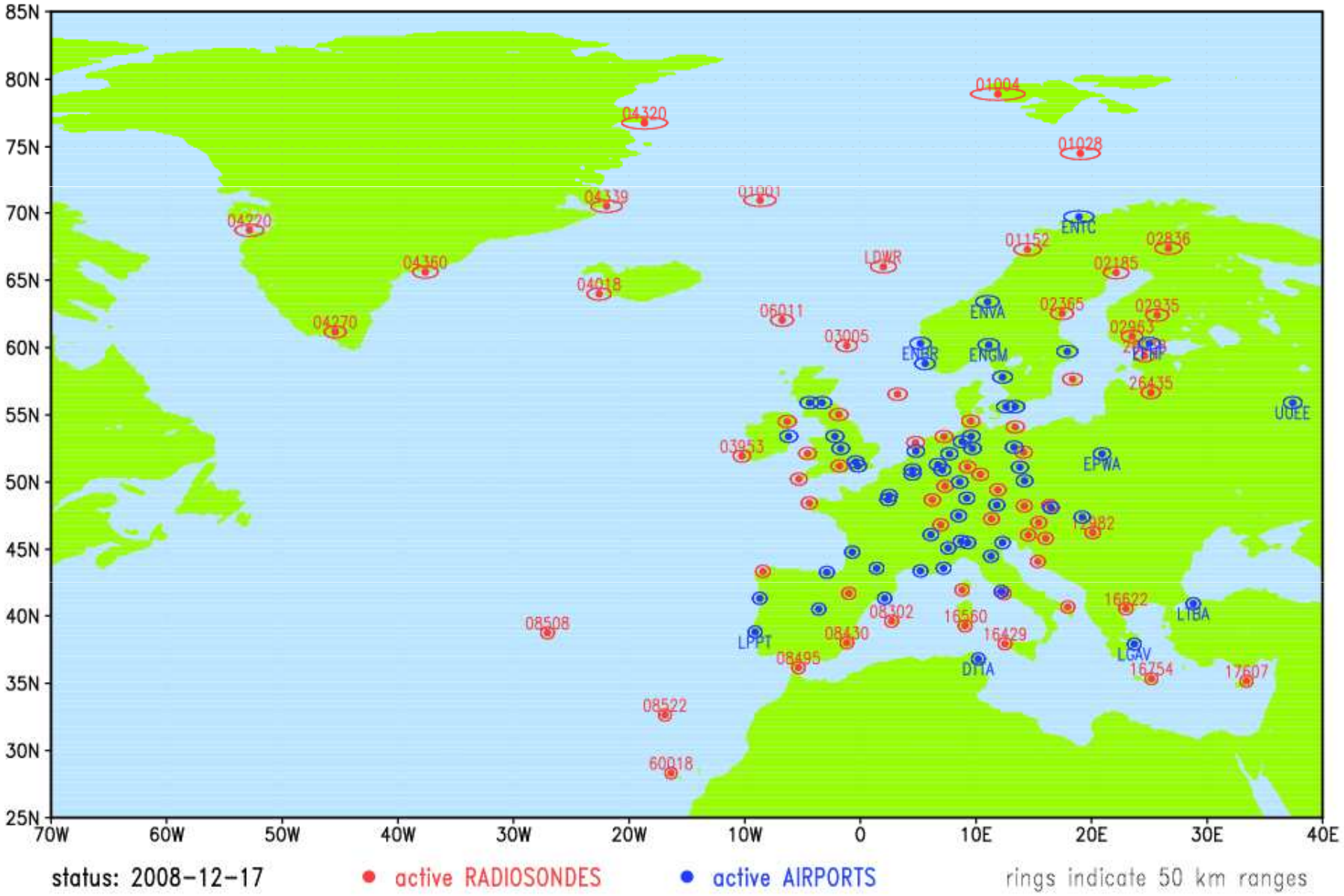
Example map for Scenario no 3a:

all active radiosondes and 3-hourly airports



EUCOS upper-air network redesign – Setup

- Periods: Winter: 15th Dec 2006 – 31st Jan 2007,
  Summer: 1st Jun 2007 – 15th Jul 2007

- Participants:
  - **ECMWF** CY35R2 of IFS (operational in 2009),
    T511 (40km horiz. res.), 91 vert. levels, 4D-Var
    2 runs daily: 0 and 12 UTC, range 4 days
  - **OMSZ** ALADIN/HU (cy30), LAM domain: Central Europe,
    8 km horiz. res., 49 vert. levels, LBC: from ECMWF, local data assimilation: upper air: 3D-Var, surface: OI,
    2 runs daily: 0 UTC, range 54 hours,
    6 UTC, range 48 hours

EUCOS upper-air network redesign – Setup

- Participants:
  - **HIRLAM**(SMHI, Icelandic Met. Service, KNMI, met.no)

    Winter period: HIRLAM, LAM domain: NA + Europe, 0.15°horiz. res., 60 vert. levels, LBC from ECMWF, 4D-Var, 4 runs daily, range 48 hours

    Summer period:
    - HIRLAM, LAM domain: Europe, 0.10°horiz. res., 60 vert. levels, LBC from ECMWF, 4D-Var, 4 runs daily, range 48 hours
    - HARMONIE, LAM domain: Norway, 0.04°horiz. res., 60 vert. levels, LBC from HIRLAM, 3D-Var, 1 run daily: 0 UTC, range 24 hours

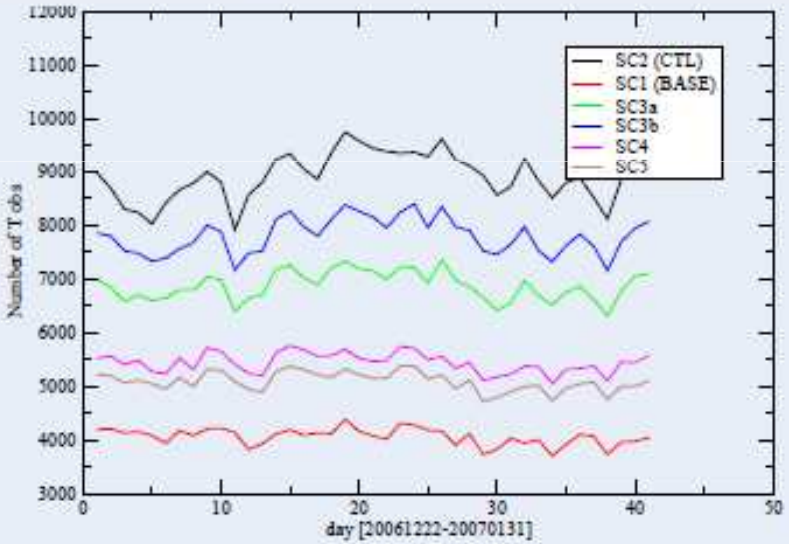
ECMWF: Cross-checking the experiment setup

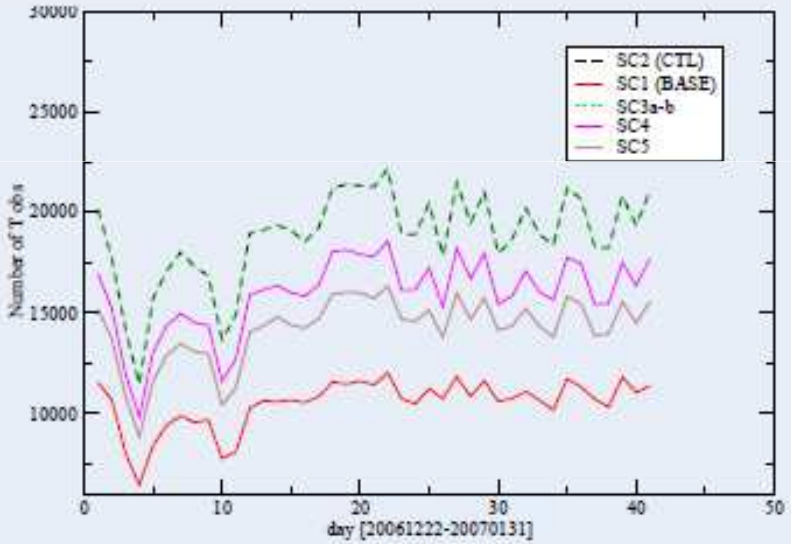
ECMWF

Observation usage scenarios (cont.)

IMPORTANT: observation usage outside Europe is exactly the same in all scenarios, even in the baseline

Daily assimilated *radiosonde temperatures(left)* and *aircraft temperatures (right)* over Europe





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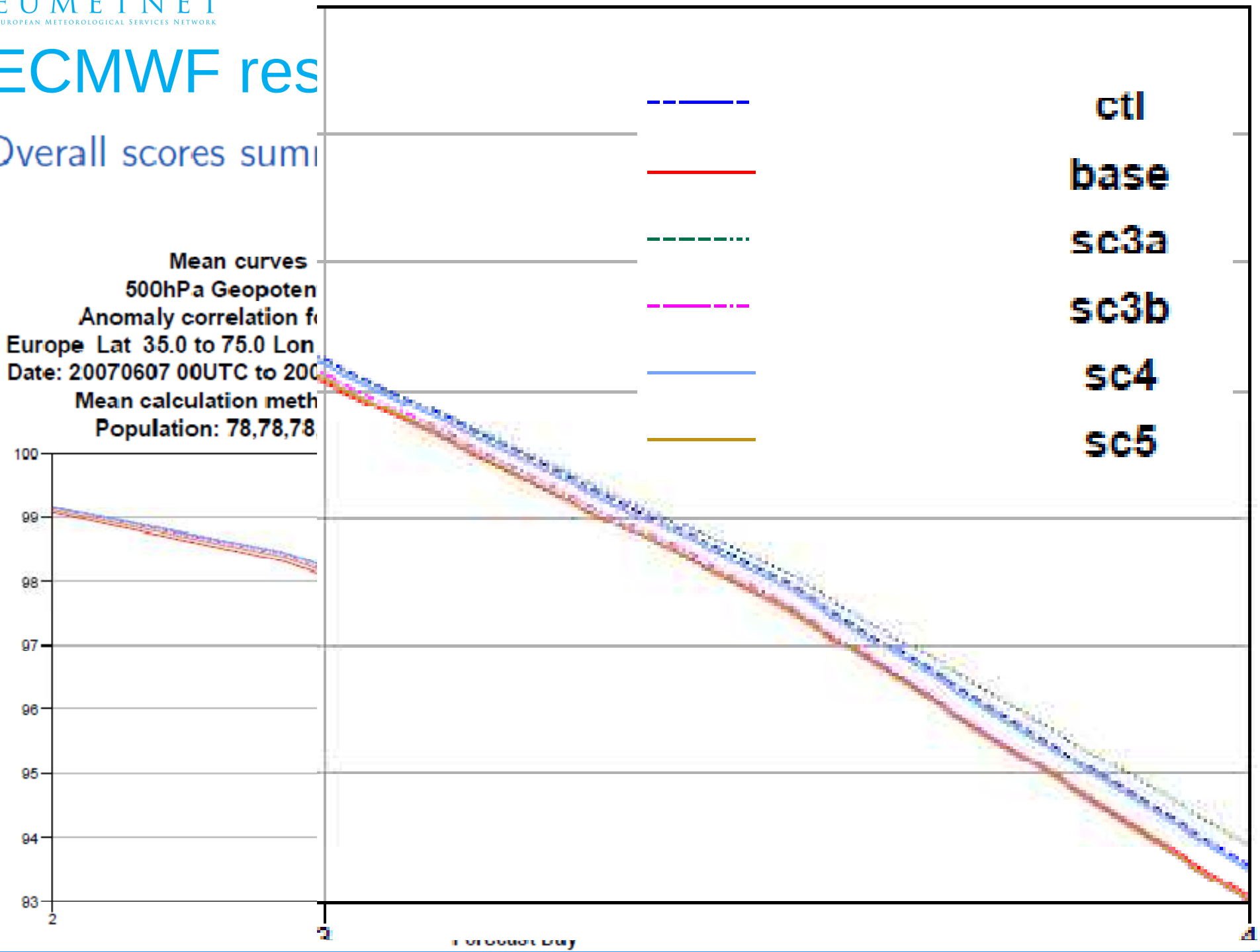
ECMWF res

Overall scores sum

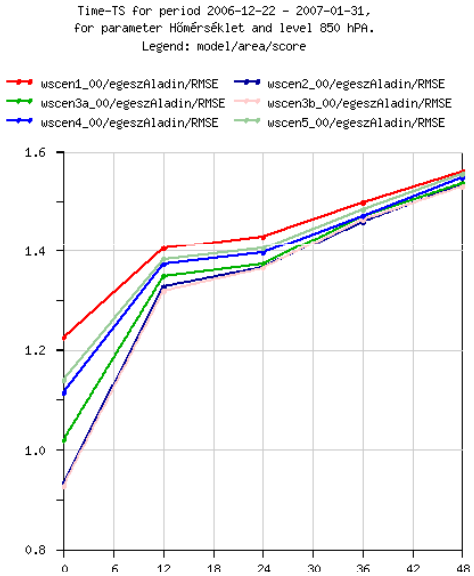


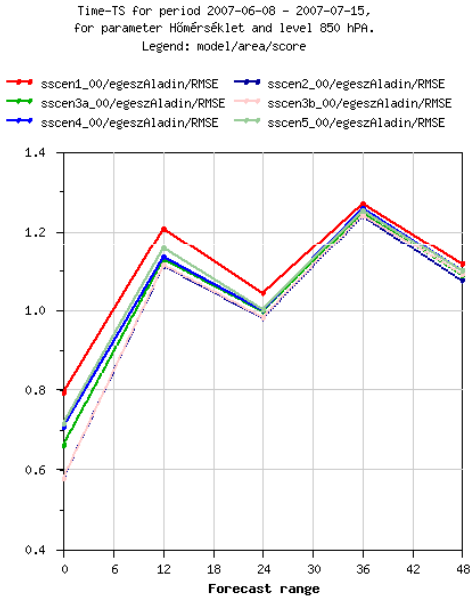
OMSZ: Overall results

winter

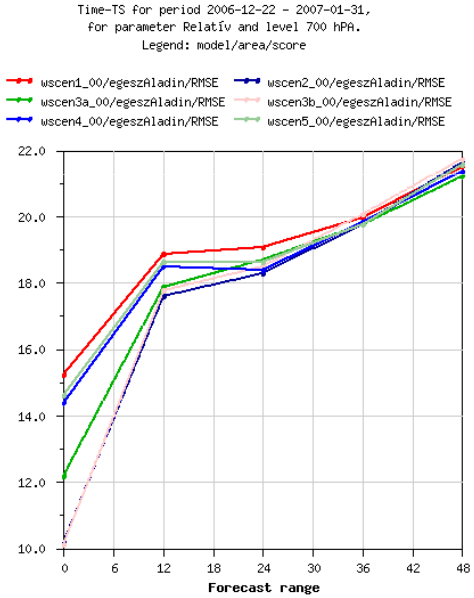
summer

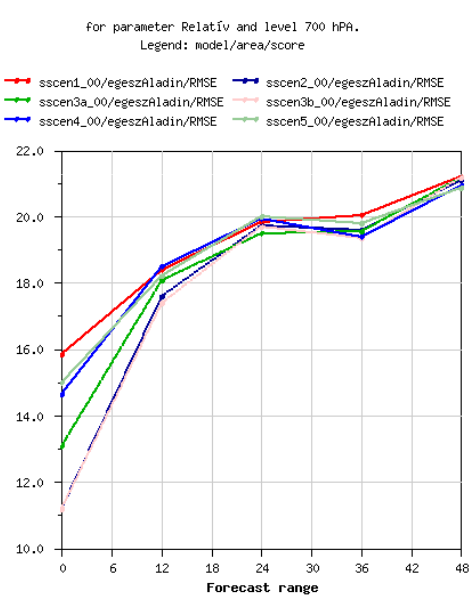
T850



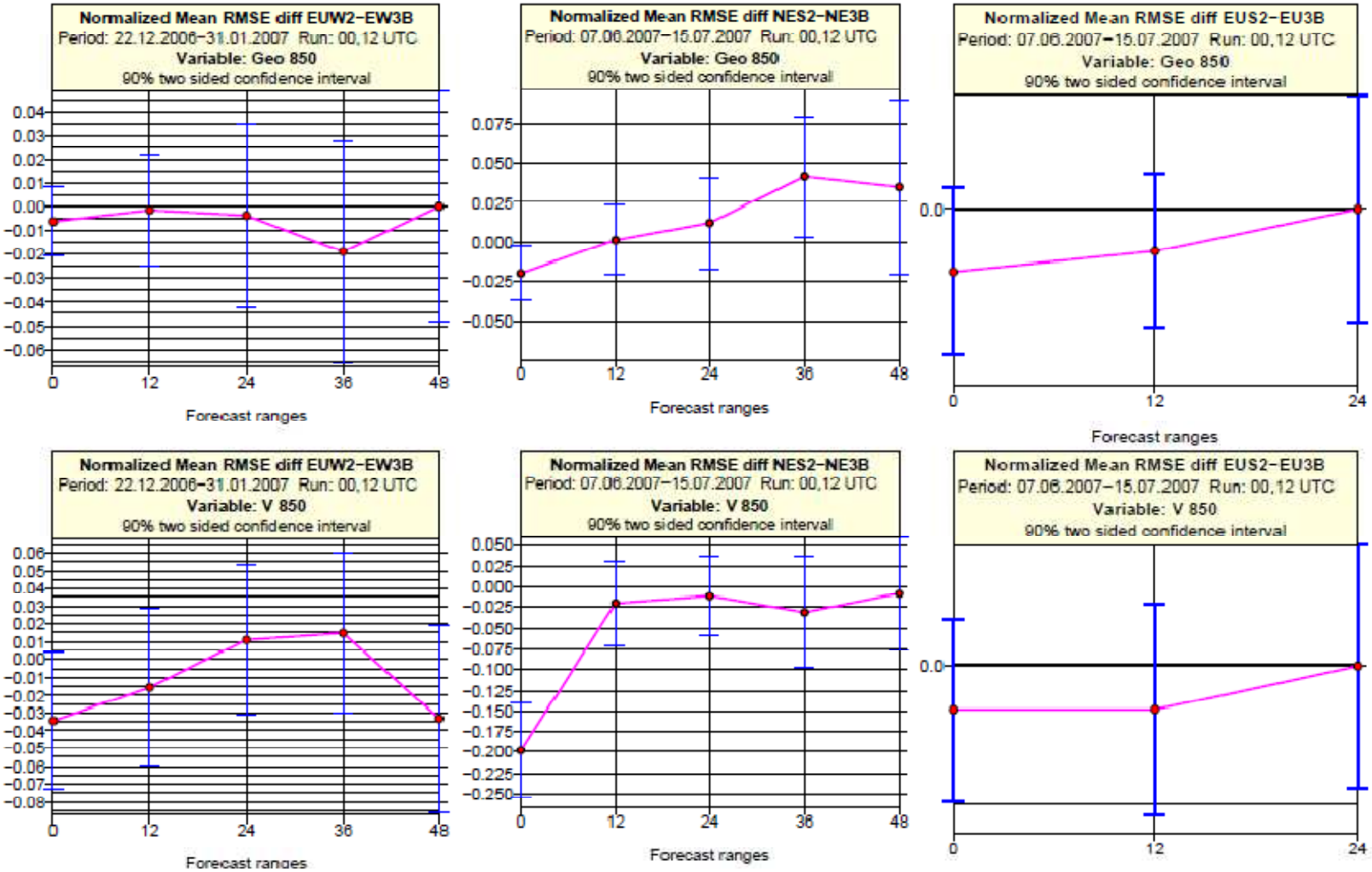


RHU700



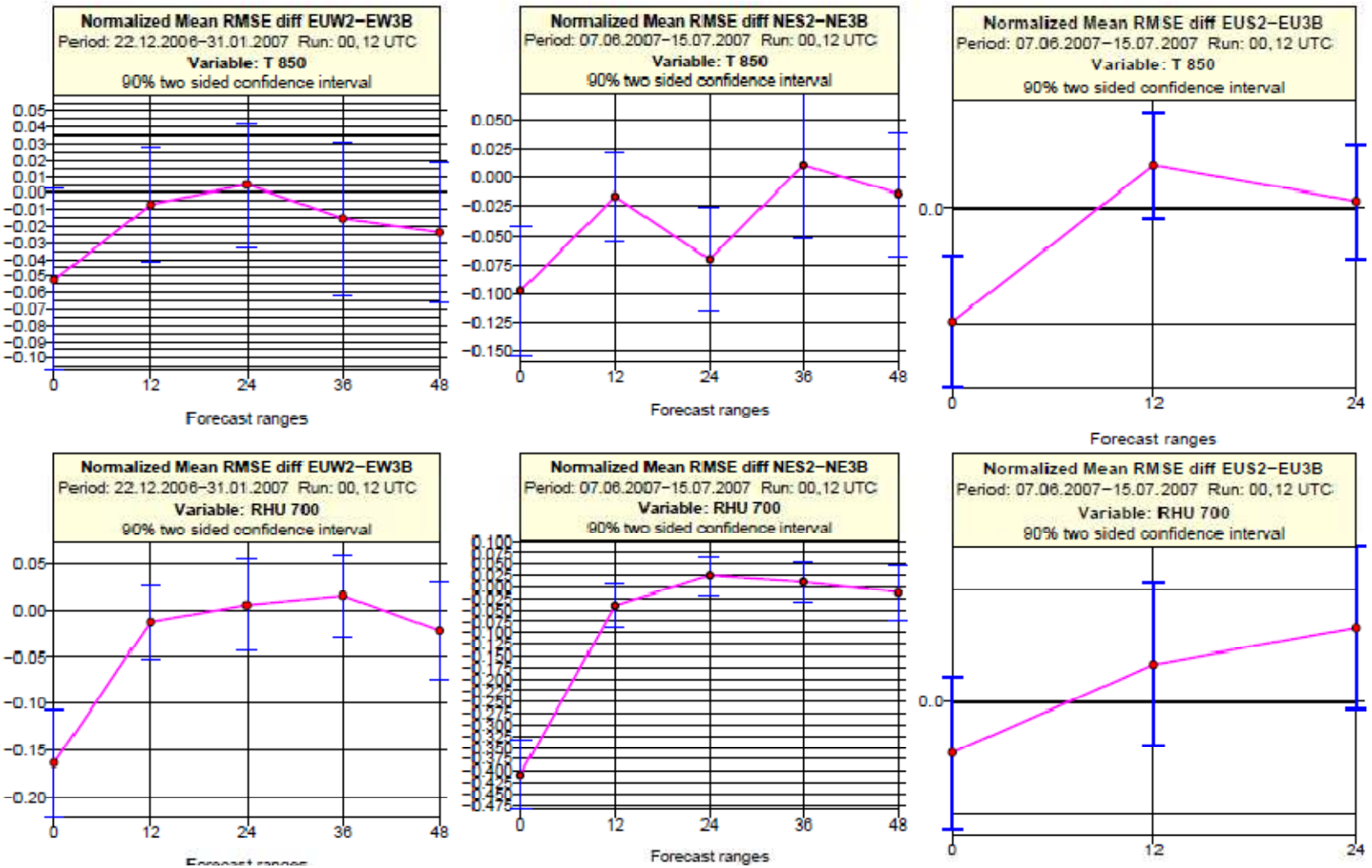


HIRLAM: Scen 3b versus Sc2



Normalized mean RMS differences over Europe between control (Sc2) and scenario Sc3b for the winter period with HIRLAM (left), for the summer period with HIRLAM (middle) and with HARMONIE (right) and for the parameters 850hPa height: first row; 850 hPa vector wind: second row.
Vertical bars represent significance at the 90 percent confidence level.

HIRLAM: Scen 3b versus Sc2



Normalized mean RMS differences over Europe between control (Sc2) and scenario Sc3b for the winter period with HIRLAM (left), for the summer period with HIRLAM (middle) and with HARMONIE (right) and for the parameters 850 hPa temperature: third row; 700 hPa relative humidity: fourth row. Vertical bars represent significance at the 90 percent confidence level.

ECMWF: overall results table

850hPa temperature, 700hPa relative humidity and 500hPa geopotential height forecast error increase (in %) for selected denial experiments.

Forecast length	Baseline	Sc3a	Sc3b	Sc4	Sc5
Winter:					
T850+12 hours	+8	0	0	+2	+2
T850+24 hours	+4	0	0	0	+1
T850+48 hours	0	0	0	0	0
T850+60 hours	0	0	0	0	0
RH700+12 hours	+10	+1	0	+2	+4
RH700+24 hours	+5	0	0	+1	+1
RH700+48 hours	+1	0	0	0	0
RH700+60 hours	+1	0	0	0	0
Z500+12 hours	+3	0	0	0	+1
Z500+24 hours	+2	0	0	+1	+1
Z500+48 hours	+1	0	0	0	0
Z500+60 hours	0	0	-1	0	0

OMSZ: overall results table

Scenario	Initial time	WINTER			SUMMER			**"SCORE" ON SCENARIO**
		T_{850}	RH_{700}	Z_{500}	T_{850}	RH_{700}	Z_{500}	
Baseline (Sc1)	00 UTC	12	12	12	12	06	12	**114**
	06 UTC	18	06	06	06	06	06	
Sc3a	00 UTC	12	00	12	00	00	00	**48**
	06 UTC	06	06	06	00	06	00	
Sc3b	00 UTC	00	-12	-24	00	00	00	**-36**
	06 UTC	00	00	00	00	00	00	
Sc4	00 UTC	12	12	12	6	30	12	**126**
	06 UTC	18	12	06	00	06	00	
Sc5	00 UTC	12	12	12	12	30	12	**150**
	06 UTC	18	18	06	06	06	06	
"SCORE" ON VARIABLES		**108**	**66**	**44**	**42**	**90**	**48**	
"SCORE" ON SEASONS		**218**			**180**			
"SCORE" ON INITIAL TIME		**228** (00 UTC)			**174** (06 UTC)			

Table 1: The integration ranges, up to when the impact of the given scenario is significantly negative with respect to the control (sc2) for 850 hPa temperature, 700 hPa relative humidity and 500 hPa geopotential for summer and winter for the 00 UTC and 06 UTC integrations. The bold face lines/column summarise the obtained ranges into a cumulative indicator, which gives and overall assessment of the given aspect.

HIRLAM: overall results table

Winter runs results:

850 hPa temperature, 700 hPa relative humidity and 500 hPa geopotential height RMS error increase (in %) for selected denial experiments

Forecast length	Baseline	Sc3a	Sc3b	Sc4	SC5
Winter HIRLAM:					
T850+12h	+5	-1	0	+2	+2
T850 | 24h	| 1	-4	0	-5	| 1
T850 | 48h	| 5	| 2	| 2	-1	| 2
RH700+12h	+1	+5	+1	+2	+1
RH700+24h	+2	0	0	-1	+2
RH700+48h	+5	+3	+2	0	+2
Z500+12h	+6	+1	0	+2	+2
Z500+24h	+7	-1	+1	+1	+4
Z500+48h	+5	0	+1	+3	+2

HIRLAM: overall results table

Summer runs results:

850 hPa temperature, 700 hPa relative humidity and 500 hPa geopotential height

RMS error increase (in %) for selected denial experiments

European domain:

Summer HIRLAM:					
T850+12h	+12	+2	+2	+4	+5
T850+24h	+12	+6	+7	+10	+10
T850+48h	+2	+1	0	+1	+3
RH700+12h	+6	+4	+4	+1	+4
RH700+24h	+5	0	-2	0	+5
RH700+48h	+3	0	0	+3	+1
Z500+12h	+1	-1	-2	0	-3
Z500+24h	+6	-2	+1	+3	+3
Z500+48h	+3	0	-1	+6	+5

Norwegian mesoscale domain:

Summer HARMONIE:					
T850+12h	+5	+1	-2	0	+3
T850+24h	+3	0	0	+2	+4
RH700+12h	+6	0	-2	0	+1
RH700+24h	+2	-6	-3	-1	-4
Z500+12h	+4	-6	-1	+3	-1
Z500+24h	+5	-1	0	+4	+2

EUCOS UANR – E-SAT conclusions

- The OSE studies concerning the EUCOS upper-air network redesign (UANR) were conducted with the **global model** of ECMWF and the limited area models of OMSZ and several HIRLAM members. **In general** the experiments show **similar results**.

- In agreement with the previous Space-Terrestrial study the **baseline scenario** shows a significant and the **strongest reduction in forecast skill**.

- Scenarios 3a and 3b which **removed radiosonde sites collocated to 3-hourly visited E-AMDAR airports** show **almost no degradation in forecast skill**. Results from OMSZ' regional model show better results for a scenario where 0 UTC radiosonde observations –in vicinity to airports- are kept.

EUCOS UANR – E-SAT conclusions

- **Further thinning** of upper-air observations to **250 km or 500 km spacing** show a **significant degradation** of forecast skill for most parameters, and for summer and winter periods.

- When **thinning radiosonde observations** the parameter **most negatively affected** is relative **humidity** in lower troposphere.

- **Biases** are observed **between radiosonde and AMDAR temperature** measurements. More investigations are needed to correct biases of AMDAR observations.

EUCOS UANR – E-SAT recommendations

- A **collocation** of operational **radiosonde** observations and 3-hourly **AMDAR profile** measurements **should be avoided**. Scenario 3b is recommended for implementation.

- Humidity information in the lower troposphere should not be degraded, **E-SAT** therefore **recommends to improve** the **coverage** of lower tropospheric **moisture observations**.

- E-SAT recommends to work towards a **horizontally more homogeneous distribution of upper-air observing sites**.

EUCOS UANR – proposal after consultation with the Programme Board for Observations (heads of OBS departments)

- Definition of a combined radiosonde and E-AMDAR network comprising of
  - 90 operational radiosondes of EUMETNET members
  - 40 airports – visited 3-hourly by E-AMDAR aircraft

- EUCOS recommends
  - to fill gaps in the European upper-air network where the average distance of profiles still exceeds 100 km;
  - to work towards a denser network of humidity profile measurements in the lower troposphere.

EUCOS UANR – proposal after consultation with the Programme Board for Observations (heads of OBS departments)

- As long as aircraft do not provide operational humidity measurements recommendation for 2 radiosonde launches per day even if E-AMDAR measurements are available at airports in the vicinity

  Therefore:
  EUCOS currently pushes installation of humidity sensors onboard E-AMDAR aircraft

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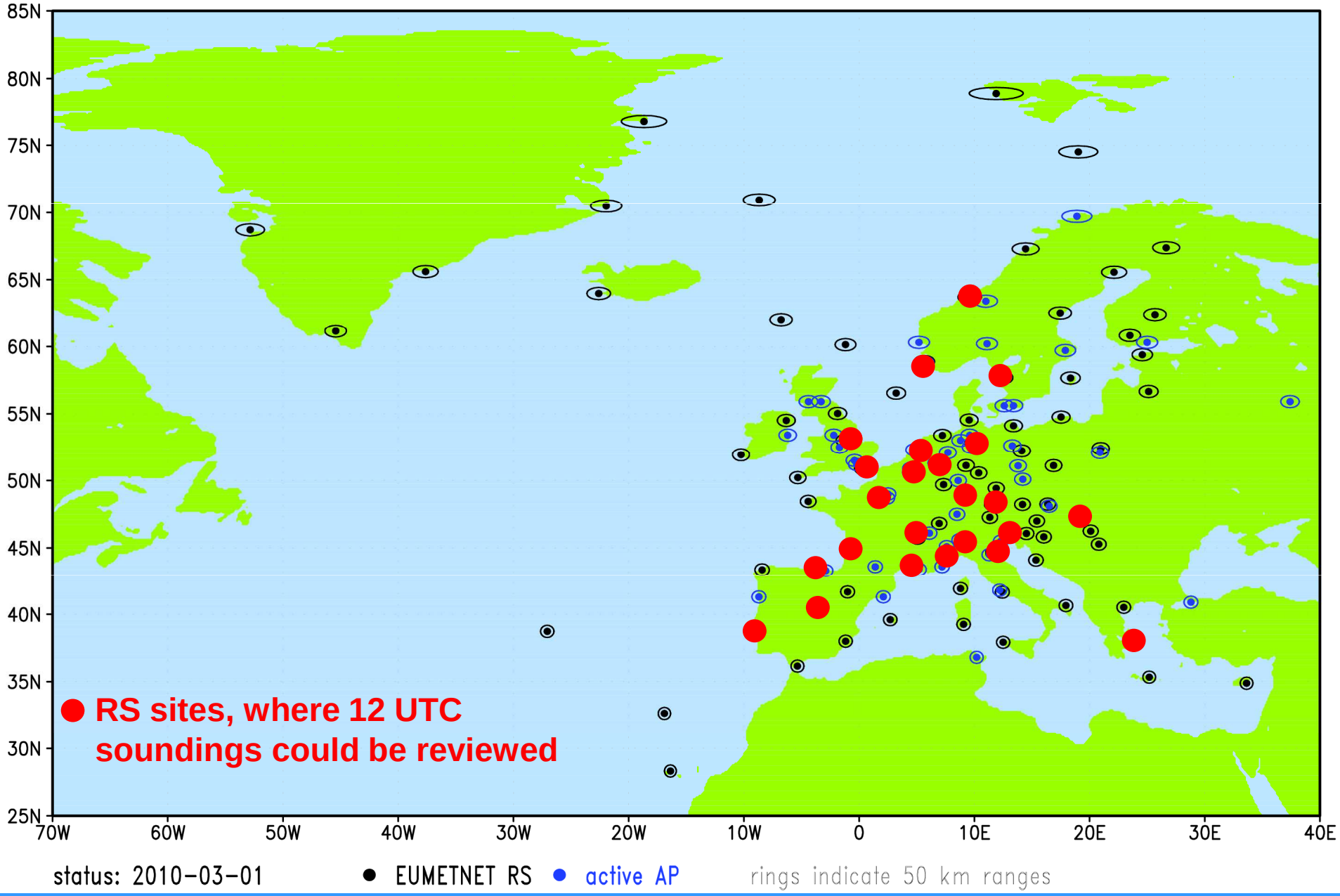
EUCOS UANR 2010 - proposal



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Questions and comments?

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