General Observational Developments – Topic 3: In-situ observations

WMO, CAS, THORPEX ICSC, DAOS Working Group
Meeting 5, Madison, Wisconsin, USA, 19th and 20th September 2012

Stefan Klink (EUCOS Programme Manager)
with contributions from
Tom Keenan (BoM) and 3rd parties and
Bertrand Calpini (President of CIMO, MeteoSwiss)

Acknowledgements:
Programme Managers of the EUMETNET Obs Programmes

Content

- Developments in AMDAR, ASAP, GVAP, wind profiler, LIDAR, surface marine networks:
  - –EUMETNET and EUCOS
  - –AMDAR, ASAP, E-GVAP, E-PROFILE, E-SURFMAR
  - –BUFR migration
  - –EUMETNET Observation Programme studies
- Summary of radar related (incl. EUMETNET OPERA) activities (T. Keenan)
- Remote-sensing and new technologies (B. Calpini)
- Capacity-building (B. Calpini)
- Radiosoundings

About EIG EUMETNET and EUCOS

EIG EUMETNET is a grouping of 29 European National Meteorological Services

that provides a framework to organise co-operative programmes between its Members in the various fields of basic meteorological activities.

These activities include observing systems, data processing, basic forecasting products, research and development and training.

EUCOS / Obs. Programme Management objectives

- Ensure integrated management for agreed components such as E-ASAP, E-AMDAR, E-SURFMAR and E-WINPROF (E-PROFILE) plus E-GVAP and OPERA from 2013 onwards
- 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

AMDAR

[information taken from 'ET-AIR-3 and AMDAR Panel-14/Doc. 3.2' (2011), submitted by the WMO Secretariat and AMDAR Panel Chairman (Dean Lockett)]

- Following countries and organisations maintain operational AMDAR programmes: Australia, Canada, China, E-AMDAR, Hong Kong (China), Japan, New Zealand, Republic of Korea, South Africa, United States;
- 31 airlines, comprised of over 2800 aircraft, provide AMDAR observations;
- Developments over 2011 have meant that the global AMDAR Programme now provides an average of between 250,000 and 300,000 upper air observations per day in support of the WMO WWW Programme;

AMDAR

[information taken from 'ET-AIR-3 and AMDAR Panel-14/Doc. 3.2' (2011), submitted by the WMO Secretariat and AMDAR Panel Chairman (Dean Lockett)]

- Sharp rise in global observation totals (250,0000 to 300,000) occurred in spring 2011 when 110 Alaska Airlines B737 aircraft were added to the US AMDAR (MDCRS) Programme;
- Managerially: AMDAR Panel and ET-AIR continue to work towards the full integration of the AMDAR Programme into the WMO WWW Programme;
- Development of the new AMDAR BUFR template has progressed;
- A Mexican regional AMDAR workshop was held in November 2011;

AMDAR

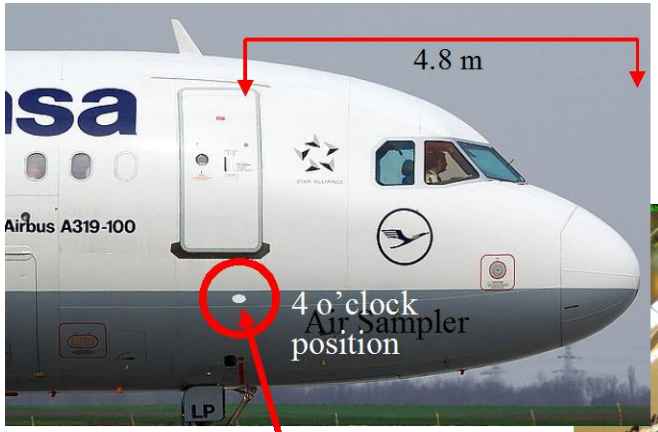
[information taken from 'ET-AIR-3 and AMDAR Panel-14/Doc. 3.2' (2011), submitted by the WMO Secretariat and AMDAR Panel Chairman (Dean Lockett)]

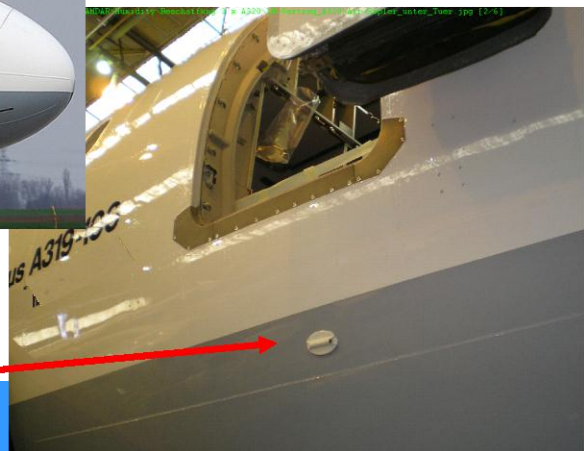
- Work has progressed on the update of the ARINC 620 meteorological report specification towards a version 5, incorporating many necessary improvements;
- South African AMDAR data quality and GTS output improved significantly due to improved data processing (downlink from aircraft to ground);
- First data became available on the route between Australia and Antarctica (southern hemisphere summer);
- First flight testing of AMDAR software commenced on a B737 of Air Vanuatu (southwest Pacific).

The E-AMDAR Humidity Trial

- Commercial aircraft measurements complement but could also partly replace traditional radiosonde soundings;
- EUMETNET STAC is currently working on a business case for a further roll-out of aircraft humidity sensors;

- 3 WVSS-II sensors currently tested on commercial aircraft, one on research aircraft
- 6 further WVSS-II sensors will be installed in 2013





ASAP

[input from ASAP report at SOT-VI meeting 2011, author: Rudolf Krockauer, chairperson ASAP Task Team]

Regular ASAP fleets:

- European E-ASAP
  - 18 Ships under the umbrella of the European Meteorological Network EUMETNET,
  - 85% are container ships in line service,
  - Sounding area: North Atlantic (>90%).
- Japanese ASAP ships
  - 5 governmental research ships, reduced to 2 ships in 2010
  - Sounding area: mainly North Pacific.

plus

- Some independent research vessels which transmit their data to the GTS.

Distribution of gobal ASAP soundings 2010

[input from ASAP report at SOT-VI meeting 2011, author: Rudolf Krockauer, chairperson ASAP Task Team]

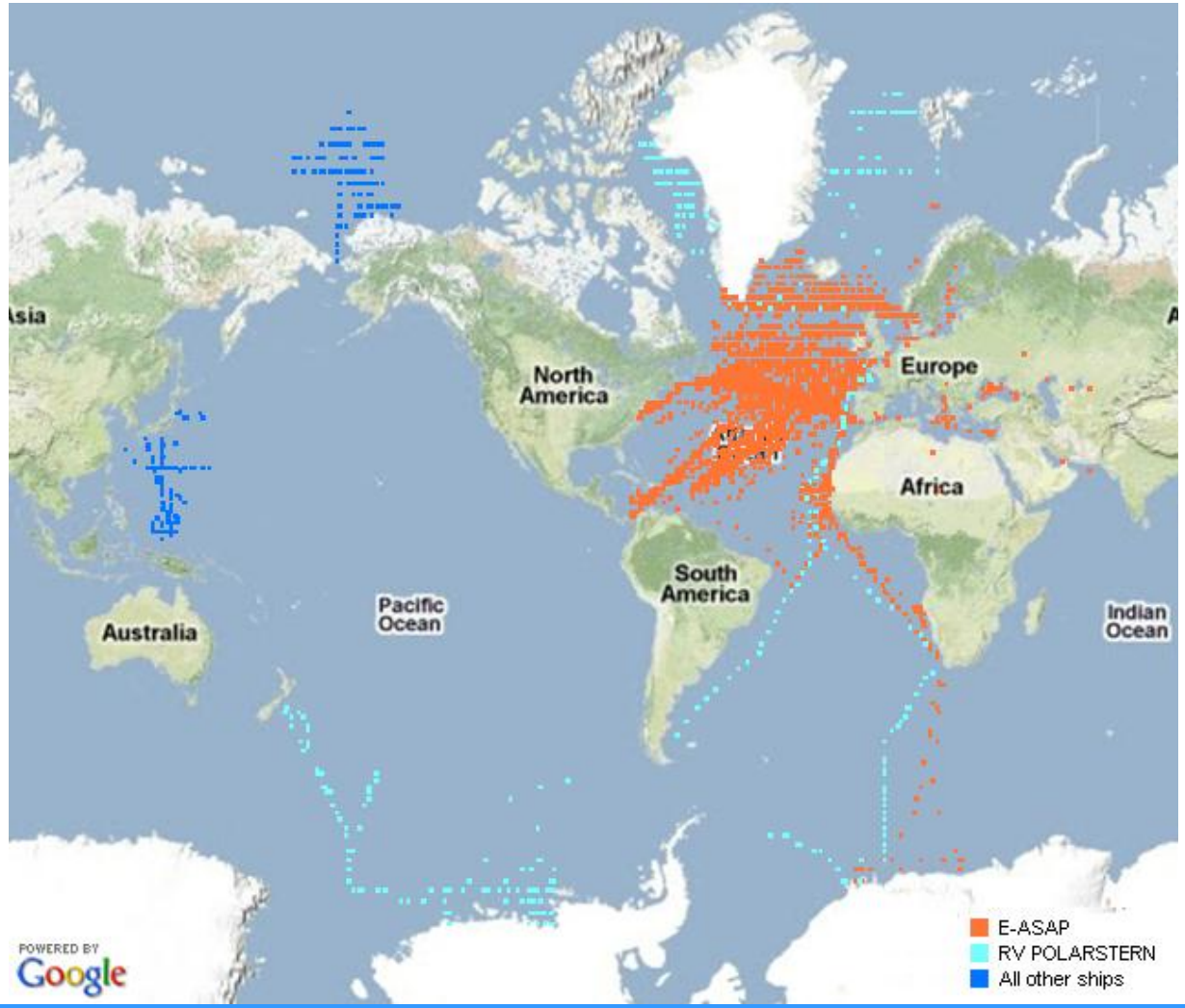
<u>6011 Snd. on the GTS</u>

82% E-ASAP fleet

7% RV Polarstern

11% All other (mainly 2 Japanese ships)

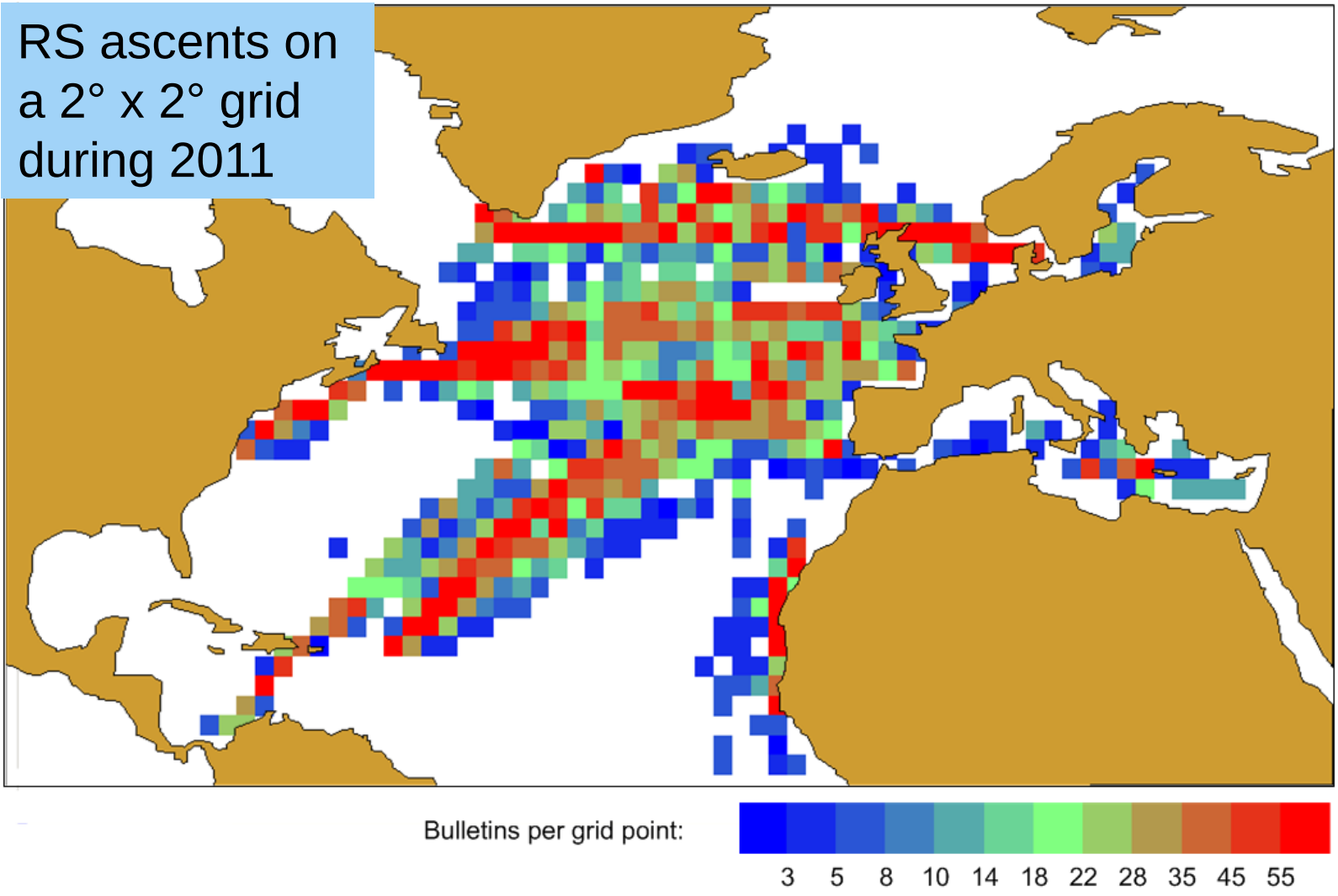
Note: Soundings over East Europe are due to longitude errors



E-ASAP

E-ASAP: sounding distributions 2011

RS ascents on a 2° x 2° grid during 2011



E-SURFMAR

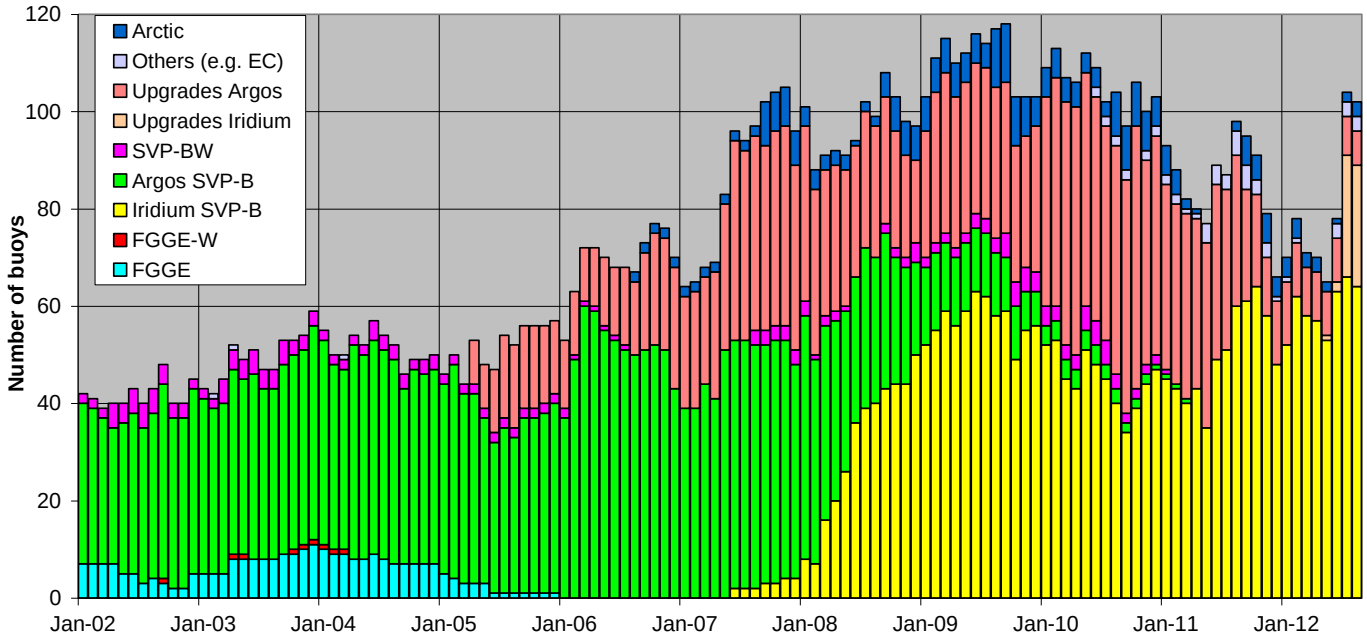
Conventional VOS
(National fleets)

Shipborne AWS
(National and EUCOS fleets)

Moored buoys
(National networks)

Drifting buoys
(EUCOS network)

E-SURFMAR Drifting Buoys



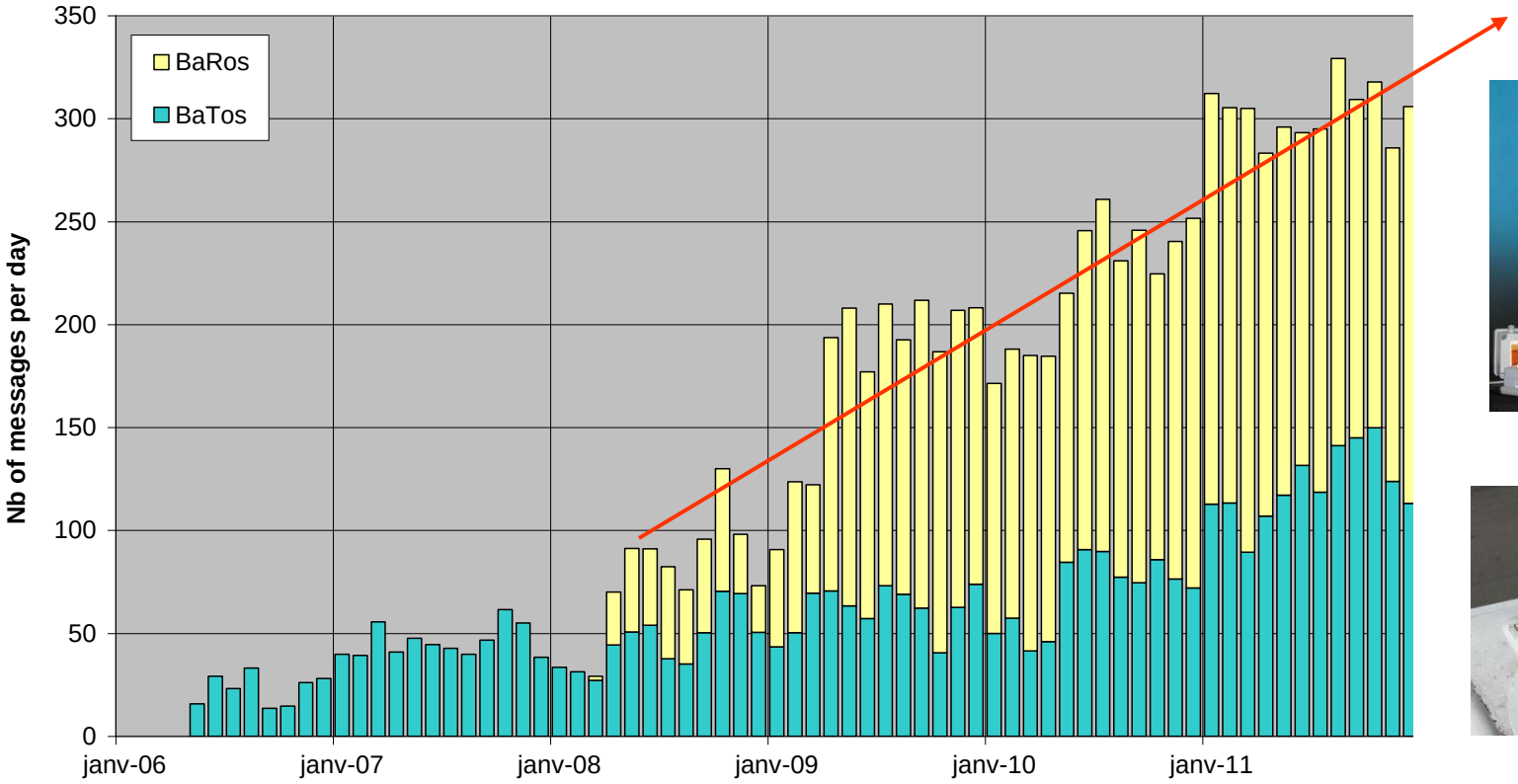
The number of operating buoys significantly dropped in 2011. This was mainly due to a decrease in lifetime of Iridium buoys deployed in 2010-2011.

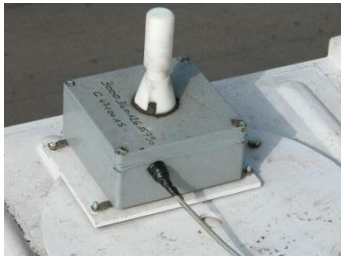
Since June 2012 the number of operating buoys has been increasing again.

Problems with short buoy lifetimes seem having been fixed.

The E-SURFMAR design study (2004) recommended 175 drifting buoys.

E-SURFMAR AWS Fleet





Total number of SLP observations carried out by E-SURFMAR S-AWS per day

Wind profilers

[input provided by V. Lehmann E-WINPROF TAG member]

- Global perspective:
  - CMA: currently in the process of setting up a network of approx. 350 wind profilers (mixture of UHF and L-band);
  - JMA: has recently installed two more wind profilers (L-band) north and south of the Fukushima nuclear power plant, total number of systems: 33;
  - NOAA: having problems in financing operation and modernisation of its UHF network;
  - Sout Korea: small network of approx. 5 L-band systems;

Wind profilers

[input provided by V. Lehmann E-WINPROF TAG member]

- Global perspective continued:
  - BoM: operating several profilers in Australia;
  - Canada: 10 systems in Ontario operated by University of Western Ontario;
  - EUMETNET: see next slide.

EUMETNET
EUROPEAN METEOROLOGICAL SERVICES NETWORK

Wind Profilers

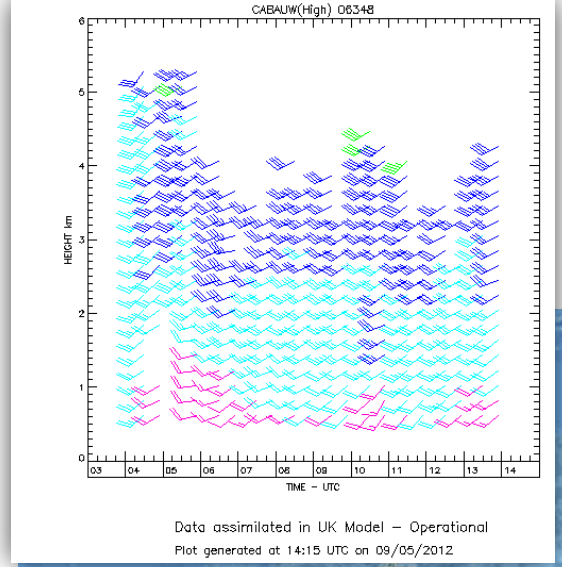
- 19 operational WPs
- 10 non-operational WPs
- Incl. 4 Czech WP in pre-operational status since November 2011
- WPs provide wind profiles every 30 minutes

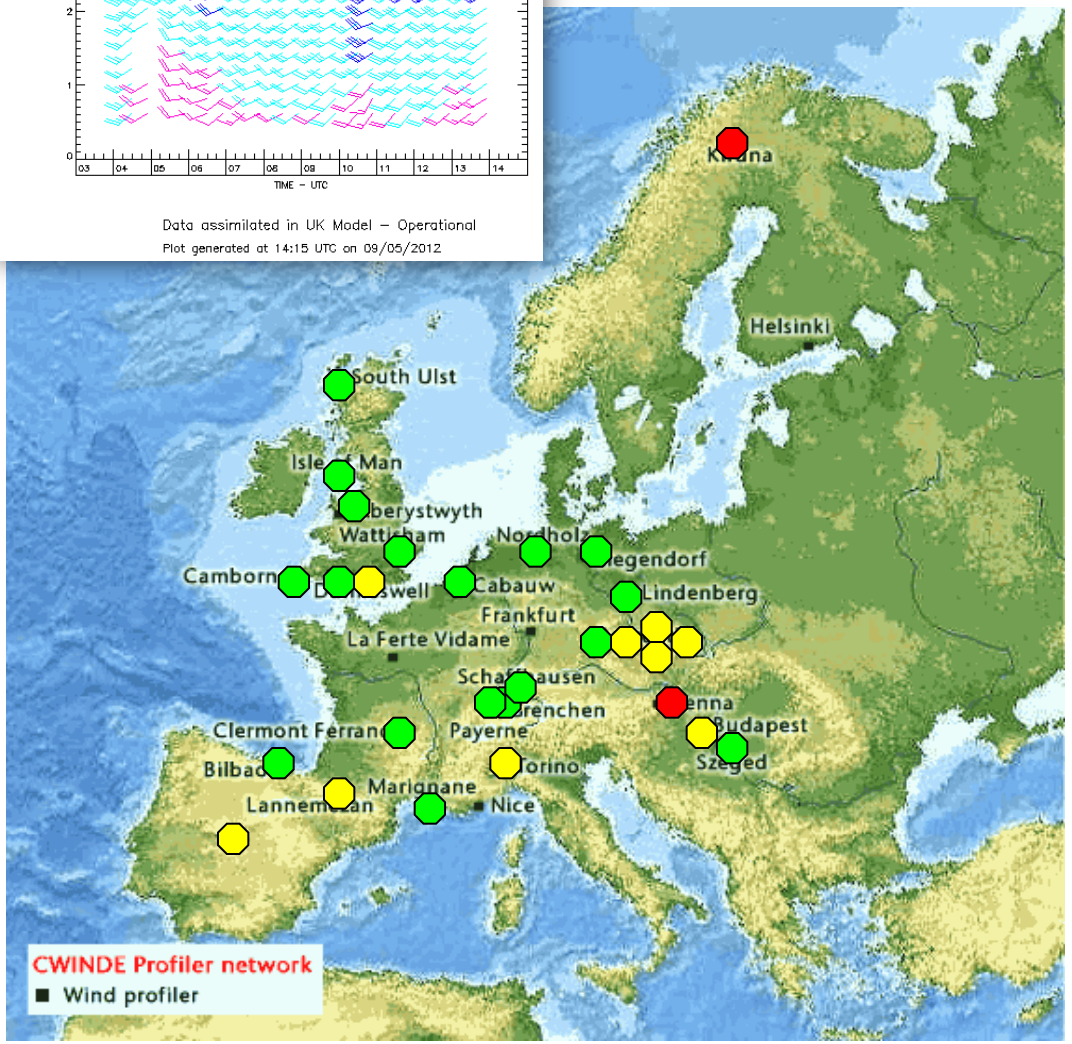
Classification

Green - Operational

Yellow - Quality good but timeliness/ support issues.

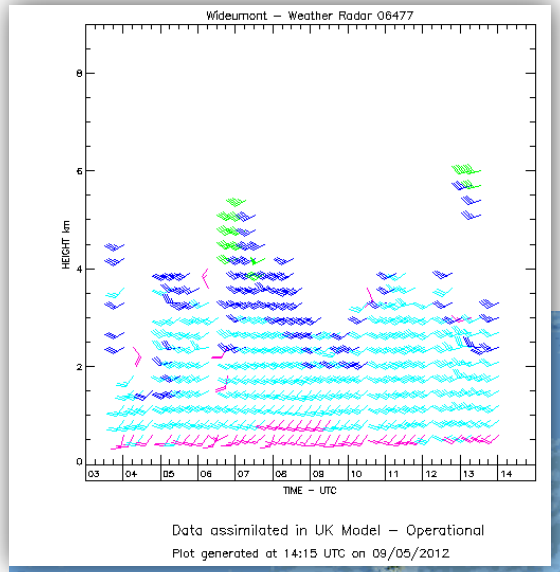
Red - Data Quality poor

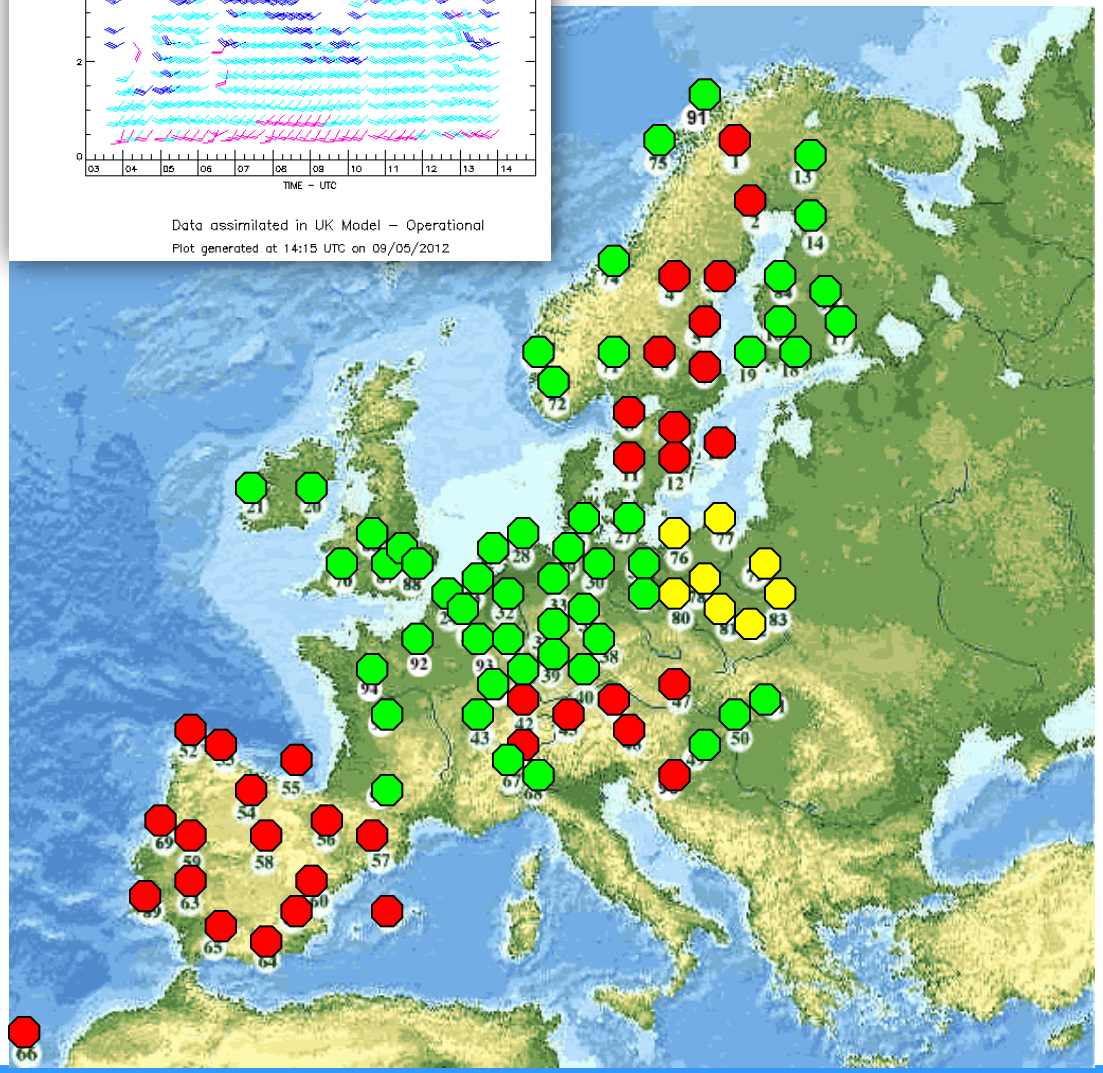




Weather Radars

- 52 operational WRWPs
- 49 non-operational WRWPs
- Depending on the system WRWPs provide VAD wind profiles every 5 to 15 minutes





Classification

Green - Operational

Yellow - Quality good but timeliness/ support issues.

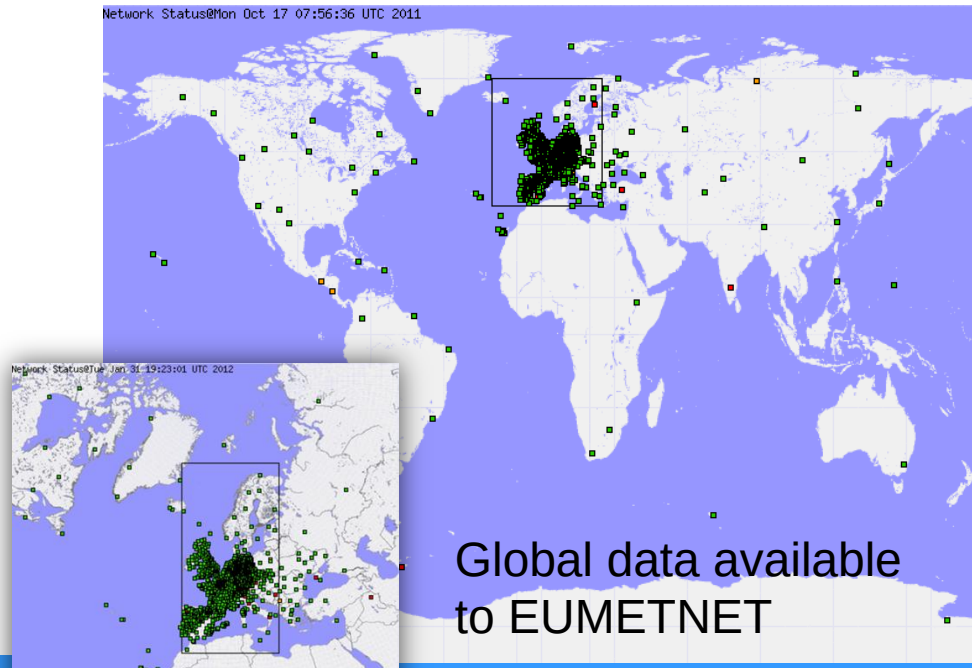
Red - Data Quality poor

E-GVAP:

- The objective of the E-GVAP Programme is to provide EUMETNET partners with European GPS delay and water vapour measurements for operational meteorology. This is done in close collaboration with the geodetic community in Europe.

- Currently data from more than 400 GPS sites are being send hourly to a common ftp-server at the UK Met Office. The data is mainly intended and used for scientific purposes.

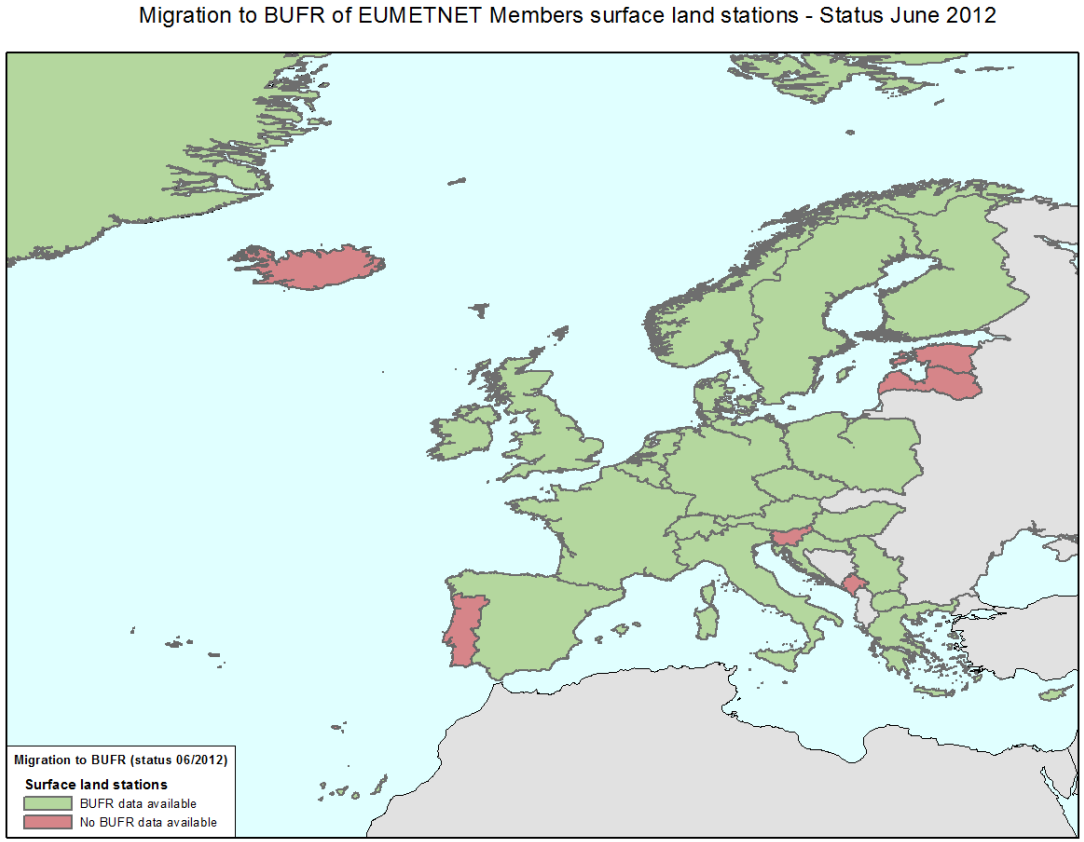
- Implementation of ground based GPS data in operational NWP and nowcasting has certain requirements regarding quality, homogeneity, stability, actions to take in case of problems, extent of observation network.



Global data available to EUMETNET

Monitoring BUFR migration - surface land stations

- 23 out of 29 EUMETNET Members (79%) provided 'SYNOP' data in BUFR format in June 2012 *(still missing: Estonia, Iceland, Latvia, Montenegro, Portugal, Slovenia)*



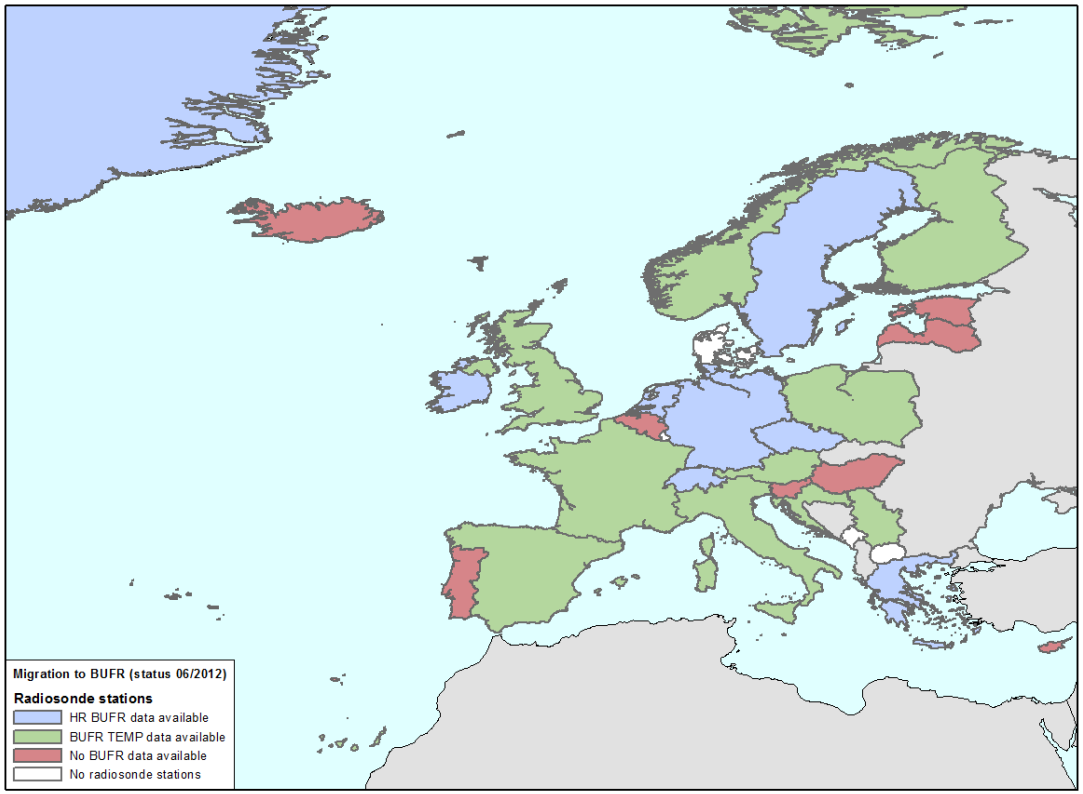
Monitoring BUFR migration - radiosonde stations

- 16 out of 26 EUMETNET Members (62%) provided radiosonde 'TEMP' data in BUFR format in June 2012. *(still missing: Belgium, Cyprus, Estonia, Iceland, Latvia, Montenegro, Portugal, Slovenia)*

- 6 of these 16 EUMETNET Members additionally provided HR BUFR data on an operational basis.

- Denmark and Greece provide HR BUFR data only.

Migration to BUFR of EUMETNET Members radiosonde stations - Status June 2012



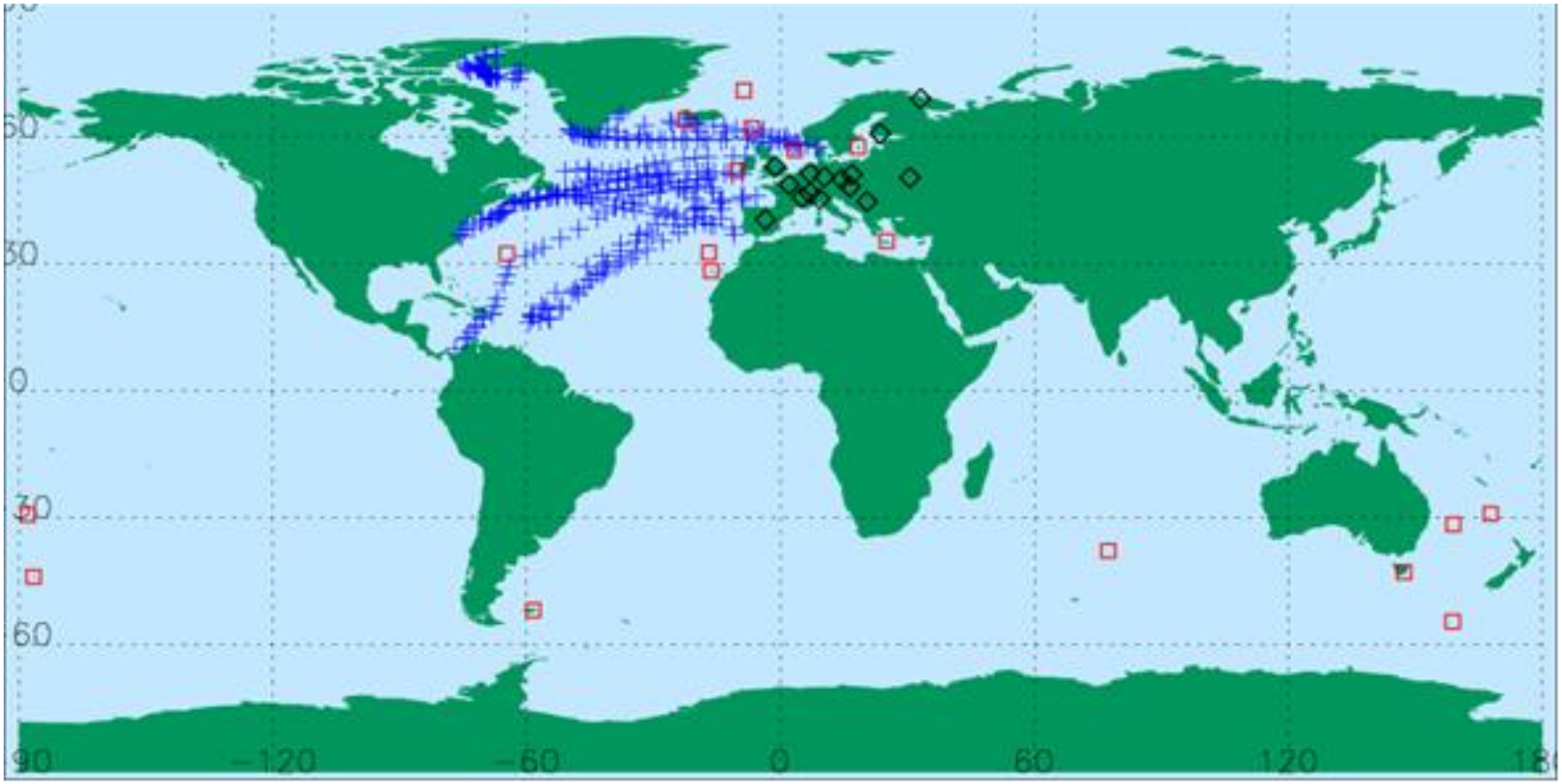
E-ASAP impact study

"The Adjoint-based Observation Impact of ASAP Radiosondes",

Richard Marriott, UK Met Office (7th Nov 2011)

- Model version: operational version at the Met Office during the period 16 Mar - 20 Jul 2011
- Trial period: 18Z 22nd Aug until 18Z 13th Sept 2010
- Impacts of three groups of radiosondes are being assessed:
  - E-ASAP sondes
  - control-group of continental "inland" sondes
  - control-group of "remote" island-based sondes

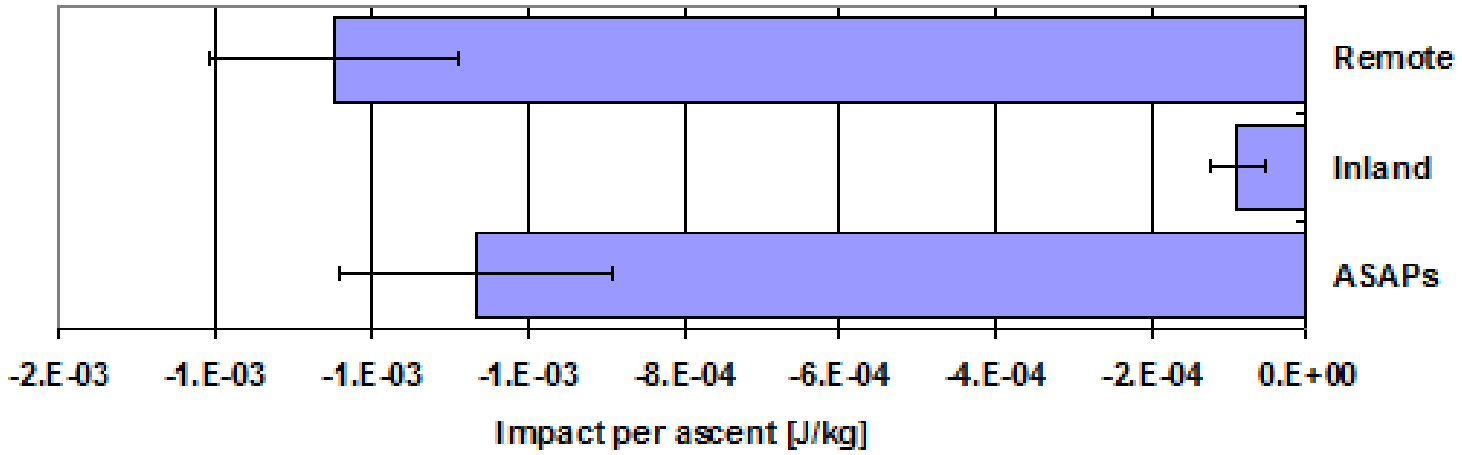
E-ASAP impact study



Locations of ascents throughout the period 18Z 22nd Aug – 18Z 13th Sept 2010.
Blue crosses: E-ASAP, red squares: remote islands, black diamonds: inland sondes.

E-ASAP impact study

- During the period there were 340/560/598 ascents for the E-ASAP/Inland/Remote groups,
- E-ASAP sondes had the second largest mean impact per ascent



The average observation impacts per ascent for the three groups.
Error bars give an approximation to the standard error of the mean ($\sigma/\sqrt{N}$).

EUCOS upper-air network redesign – 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**.

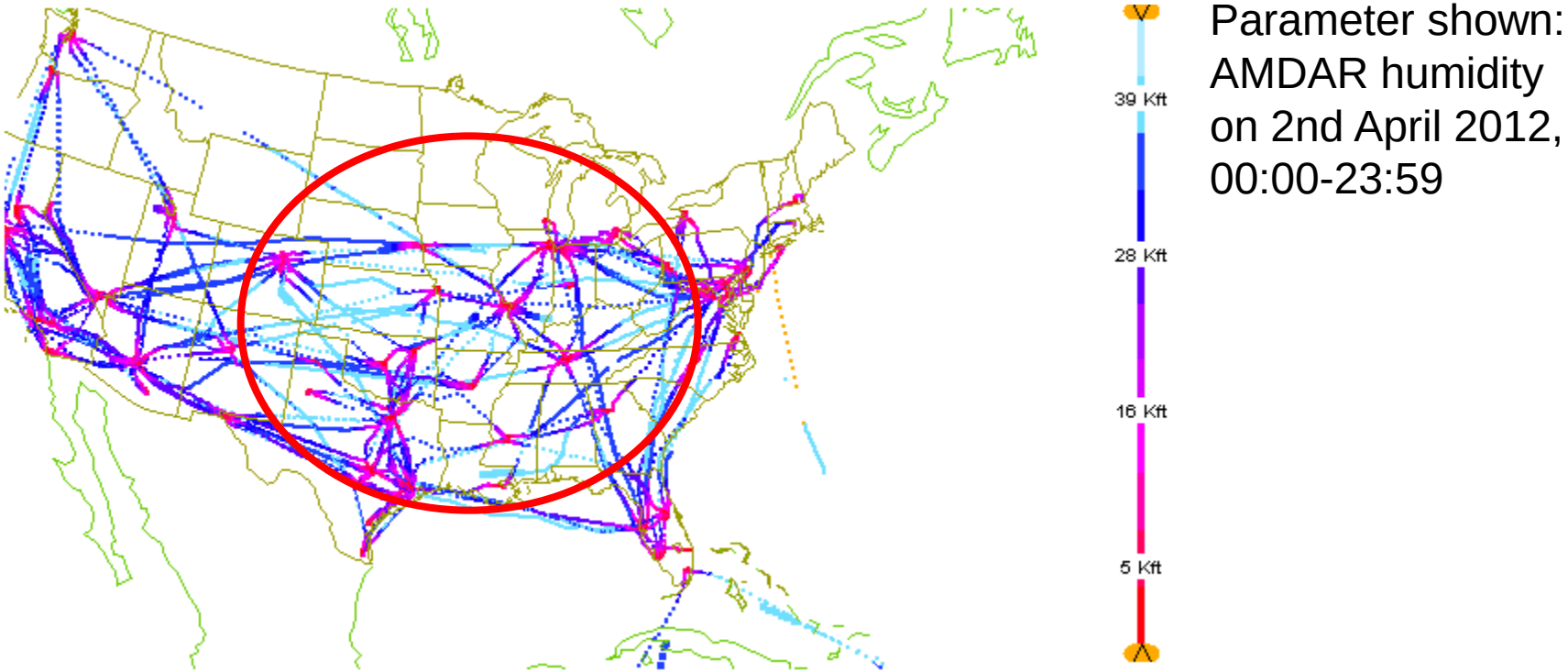
Envisaged AMDAR q / TAMDAR study - Motivation

Key questions:

1. Does it make sense to further invest money into procurement of more WVSS-II humidity sensors to be installed on commercial aircraft which belong to the E-AMDAR programme?
2. Is TAMDAR an alternative to E-AMDAR observations or is it complementary to E-AMDAR?
3. In case WVSS-II or TAMDAR sensors prove to have a beneficial impact on NWP forecast skill, how many sensors should be installed?

US AMDAR humidity coverage

US Midwest



Parameter shown: AMDAR humidity on 2nd April 2012, 00:00-23:59

Picture taken from NOAA AMDAR webpage

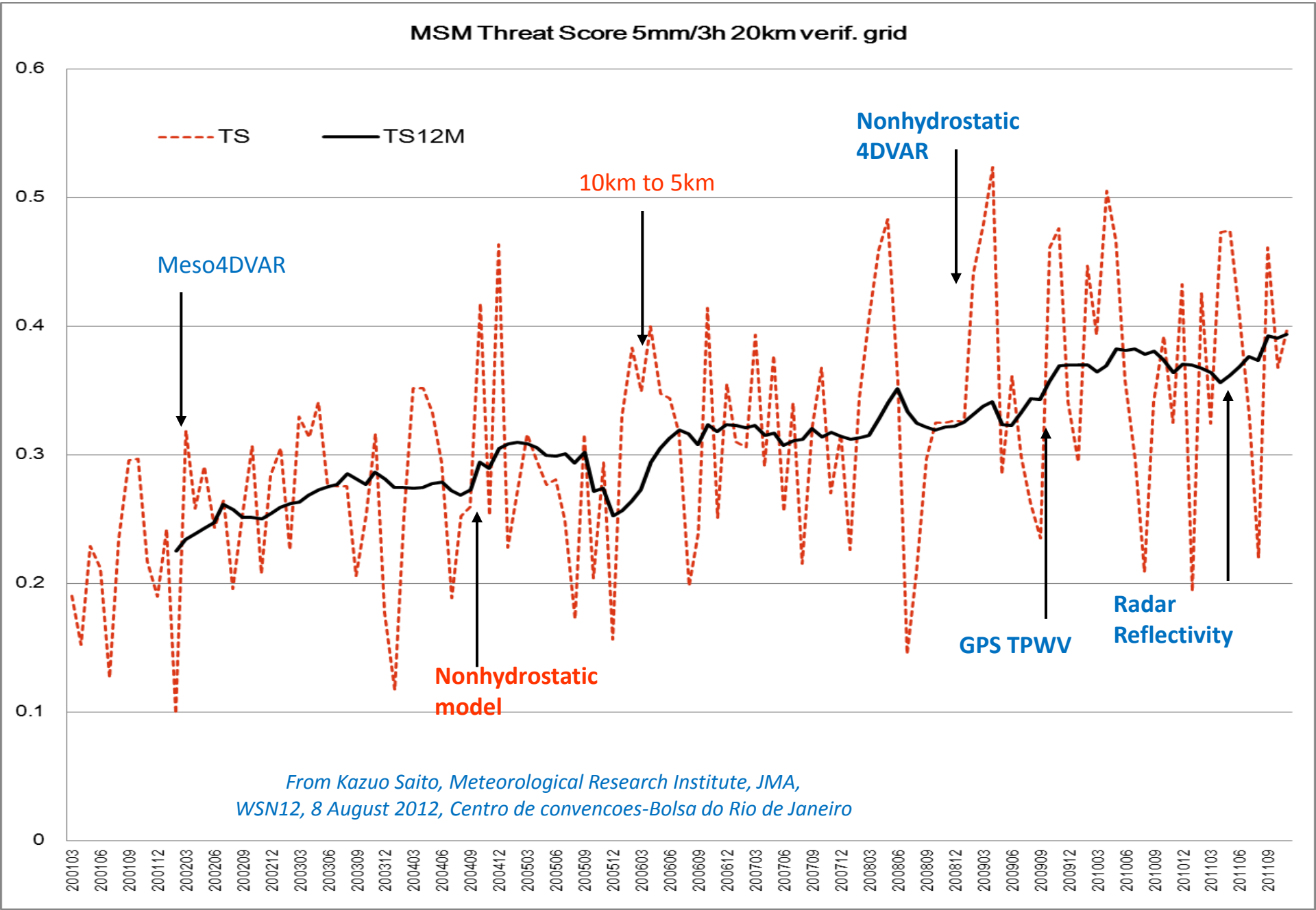
WWRP THORPEX DAOS-WG

Madison 19-20 September 2012

Summary of radar related activities

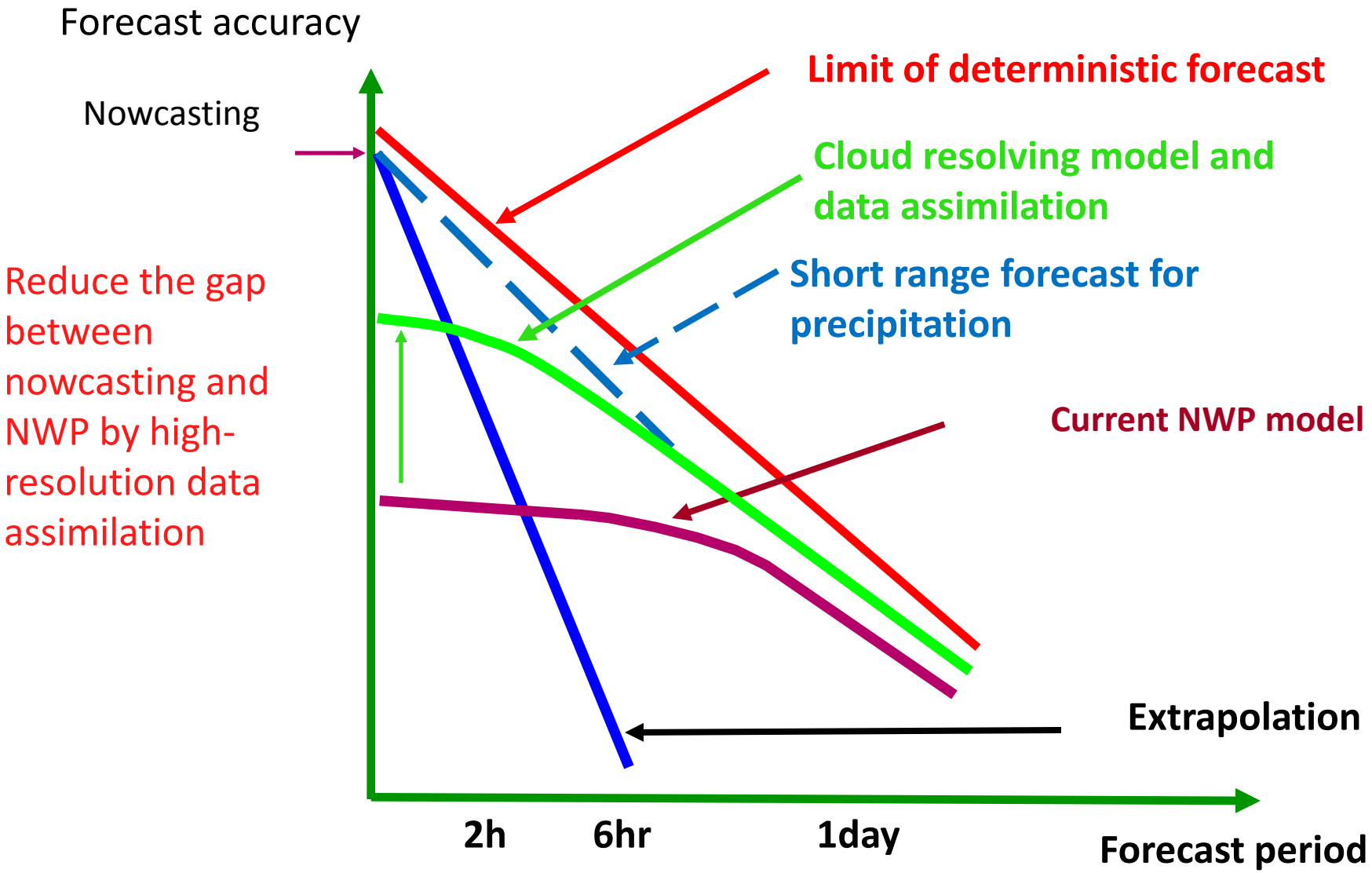
- Drivers for Radar Information in NWP
  - Gains in very short range forecasting (WSN12)
  - Medium terms gains discussed previously
- Facilitating International Radar Data Exchange
  - WMO Workshop on Regional & Global Exchange of Weather Radar Data, 28-30 November 2012
  - APEC Research Center for Typhoon and Society (ACTS) in Asia (see http://www.apectyphoon.org/front/bin/home.phtml)
- WMO Radar Data Quality Control-RQQI

Threat score of MSM Mar.2001-Nov.2011 (FT=0-15)



From Kazuo Saito, Meteorological Research Institute, JMA,
WSN12, 8 August 2012, Centro de convencoes-Bolsa do Rio de Janeiro

Approaches to predict local heavy rain (2)



Reduce the gap between nowcasting and NWP by high-resolution data assimilation

From Kazuo Saito, Meteorological Research Institute, JMA,
WSN12, 8 August 2012, Centro de convencoes-Bolsa do Rio de Janeiro

WMO and the CBS Workshop on Regional & Global Exchange of Weather Radar Data

Aims:

1. Define weather radar data to be exchanged at regional and global levels;
2. Propose formats and frequency of exchange of those data; and;
3. Agree the next steps needed to enable the regional and global exchange of these data.

Facilitated under Action G48 of the new EGOS-IP (Ver13.06):

Define weather radar data to be exchanged at regional and global levels, propose frequency of exchange of those data and develop a weather radar data processing framework, in concert with development of products based on national, regional, global requirements.

CBS (leading the action), CIMO, CHy in coordination with NMSs/NMHSs, agencies operating weather radars, in collaboration with RAs.

Hosted by WMO Expert Team on Surface-based Remotely-Sensed Observations at Exeter, UK, November, 2012.

Objectives: WMO Workshop on Regional & Global Exchange of Weather Radar Data

- Review the current and likely future requirements for regional and global weather radar data exchange, period of consideration 2012 to 2025;
- Review the current extent and operational status of regional and global data exchange being undertaken;
- Review alternative regional and global data exchange models in operation in other observing system areas;
- Improve community understanding of the range of Weather Radar Network operators and their respective relationships with WMO Members;
- Identify current and likely future constraints on regional and global data exchange from Weather Radar Network operators. Areas of constraint could include: Data Ownership; Data Policy; Data Volumes; Data Quality;
- Recommend data model(s) for regional and global weather radar data exchange based on an improved understanding of requirements, capabilities and constraints;
- Recommend pilot study cases for regional and global weather radar data exchange using recommended data model(s) to demonstrate how constraints could be overcome

Workshop Deliverables

- A consolidated set of current and future data requirements for the regional and global weather radar data exchange;
- A recommended set of data models to be used for Weather Radar Data Exchange;
- A plan for a pilot study/studies to demonstrate the methodology for sustained operational regional and global data exchange;
- A series of next steps actions to facilitate the regional and global exchange of Weather Radar Data

Workshop Participants

- Global NWP Centre Representative(s)
- Regional NWP Centre Representative(s)
- Climate Monitoring Community Representative(s)
- CHy Representative
- CIMO RQQI Project Representative
- THORPEX Representative(?)
- RA Representatives and Members where Wx Radar Data Exchange between members is currently occurring, there is ambition for exchange to begin and where no plans are currently in place
- WMO Weather Radar Metadata Database Representative
- EUMETNET OPERA Representative
- BALTRAD Representative
- WMO WIS Representative
- CBS/ISS/ET-DRC Representative
- Satellite data exchange service provider(s)
- Other significant data exchange community representatives
- HMEI representative

Regional Radar Exchange-Developments in Asia

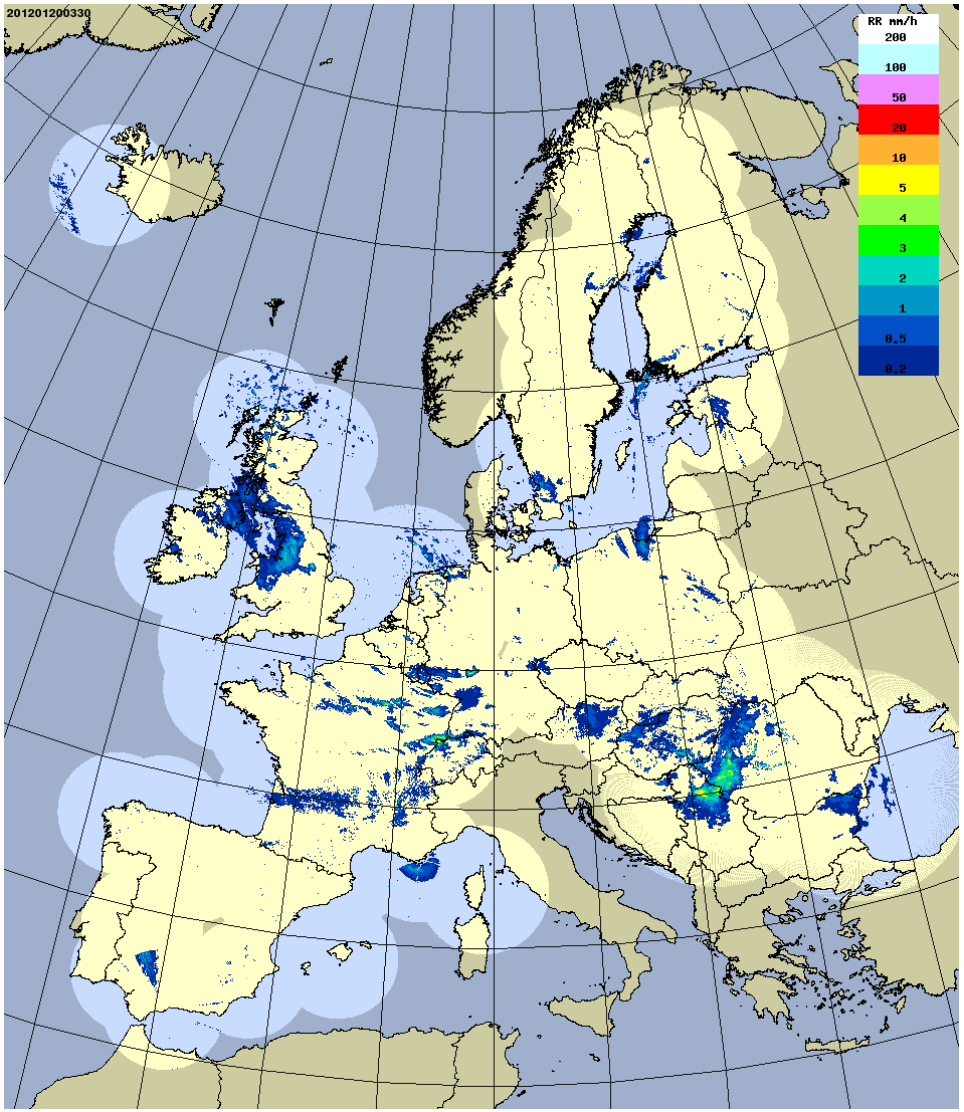
- APEC Research Center for Typhoon and Society (ACTS) meeting (– see http://www.apectyphoon.org/) considered potential for exchange of radar data in Asia.
- Yu-Chieng Liou (ACTS) at the 2012 APEC Typhoon and Prediction and Hazard and Mitigation Symposium presented a paper at the advocating improved exchange of radar information within Asia
- Targeting use in data assimilation with outcomes in precipitation forecasting and overall early warning.
- This activity is planned to be taken up as part of ACTS under the auspices of APEC and potential countries to be involved include China, Taiwan, Korea and Japan.
- Key contacts are Dr Jong-Dao Ben Jou (jouben@apectyphoon.org) and Dr Yu-Ching Liou (tyliou@apectyphoon.org).

ACTS Activities

- ACTS has made a formal proposal to APEC 43rd Industrial Science and Technology Working Group meeting held at Taipei, August (21-23). The title of the proposal is " Asia-Pacific Weather Radar Data Application Promotion Project for Landfall Typhoons". The proposal has been approved by the working group and will be executed in a self-funded base.
- Immediate Activities being undertaken
  - Sept. 26-28, at Fuzhou, China, Workshop on Cross-(Taiwan)Strait Cooperative Severe Weather Research Project. The exchange of radar data across strait is one of the subject to be discussed. The discussion will be probably starting with selected cases.
  - October 4-5, at Manila Philippines, meeting with PAGASA/DOST to discuss the possible way of radar data exchange. The Tembin typhoon will be probably the first case to demonstrate the importance of this cooperation.
  - Early Nov, at Tokyo Japan, meeting with JMA people, the possible usage of Okinawa radar in future collaboration of typhoon warning. Prof. H Yamada is helping us to arrange the meeting.
- ACTS are also designing a survey and try to identify the current inventory radar systems we have in the Asia-Pacific region as the base information for future radar network.
- Contribution to WMO Workshop on Regional & Global Exchange of Weather Radar Data, 28-30 November 2012 -THORPEX DAOS Support(?)
- First systematic approach to radar exchange in a region notable for its HIW. Needs WMO encouragement and support (DOAS WG-role of THORPEX Regional committee?)

OPERA:

- Operational phase started in June 2011
- Three composites defined:
  - maximum reflectivity,
  - rain intensity and
  - rain accumulation (1 hr).

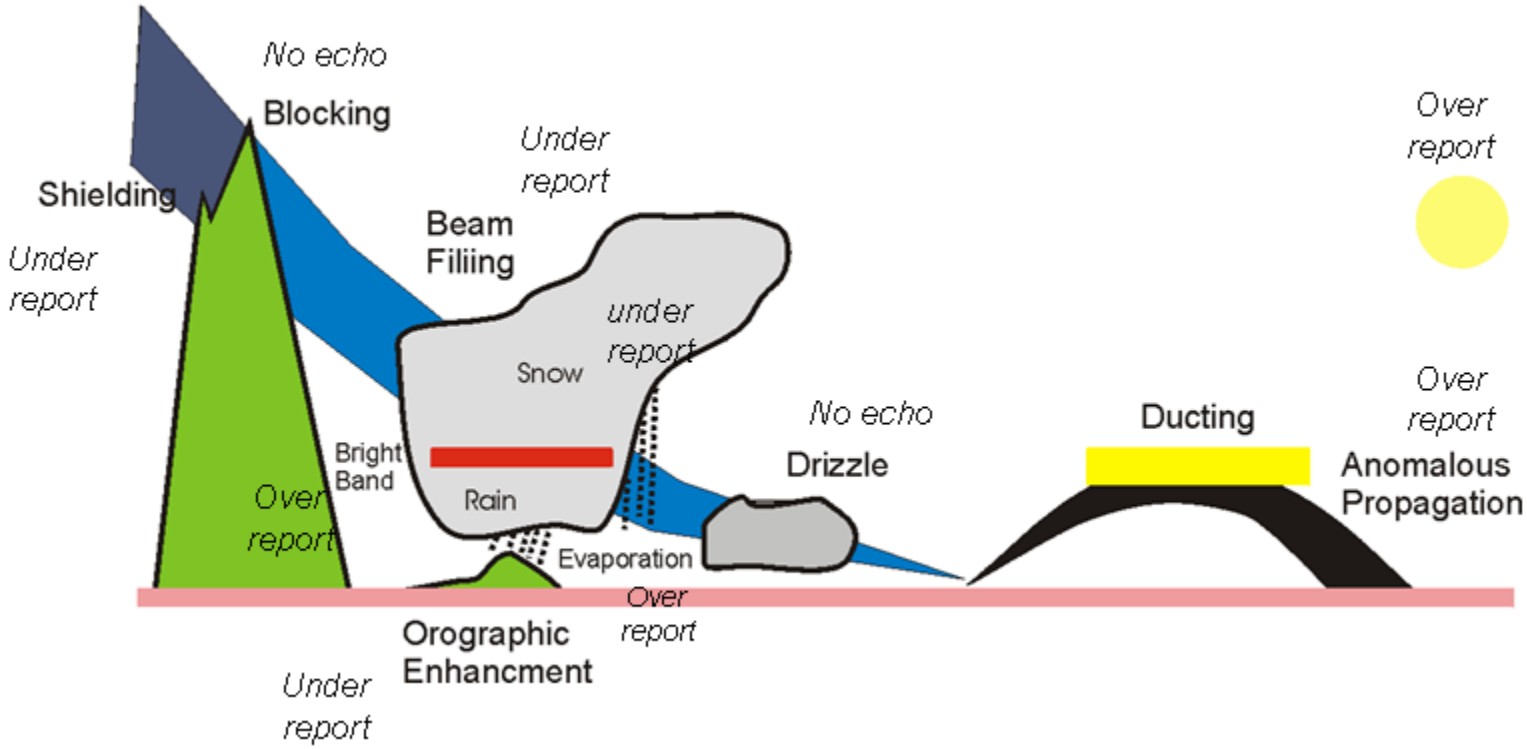


WMO Radar Quality Control Quantitative Precipitation Estimation Inter-comparison (RQQI) Project

Goals:

- Undertake systematic inter-comparison and validation of radar QC algorithms evaluated under a variety of environmental conditions for QPE, nowcasting, NWP and climate applications.
- Provide guidance to WMO members on quality control processes employed in radar quality control algorithms.
- Characterize and assess errors involved in radar quality control algorithms.
- Report on algorithms employed in radar QC.

RQQI Radar QC Issues



RQQI

Project Deliverables

- Intercomparison data sets
- Standard data quality metrics.
- Intercomparison Workshops
- Workshop summary reports.
- Reports/publications on best techniques and best practices for radar QC and QPE.
- Recommendations for global implementations
- Training workshops

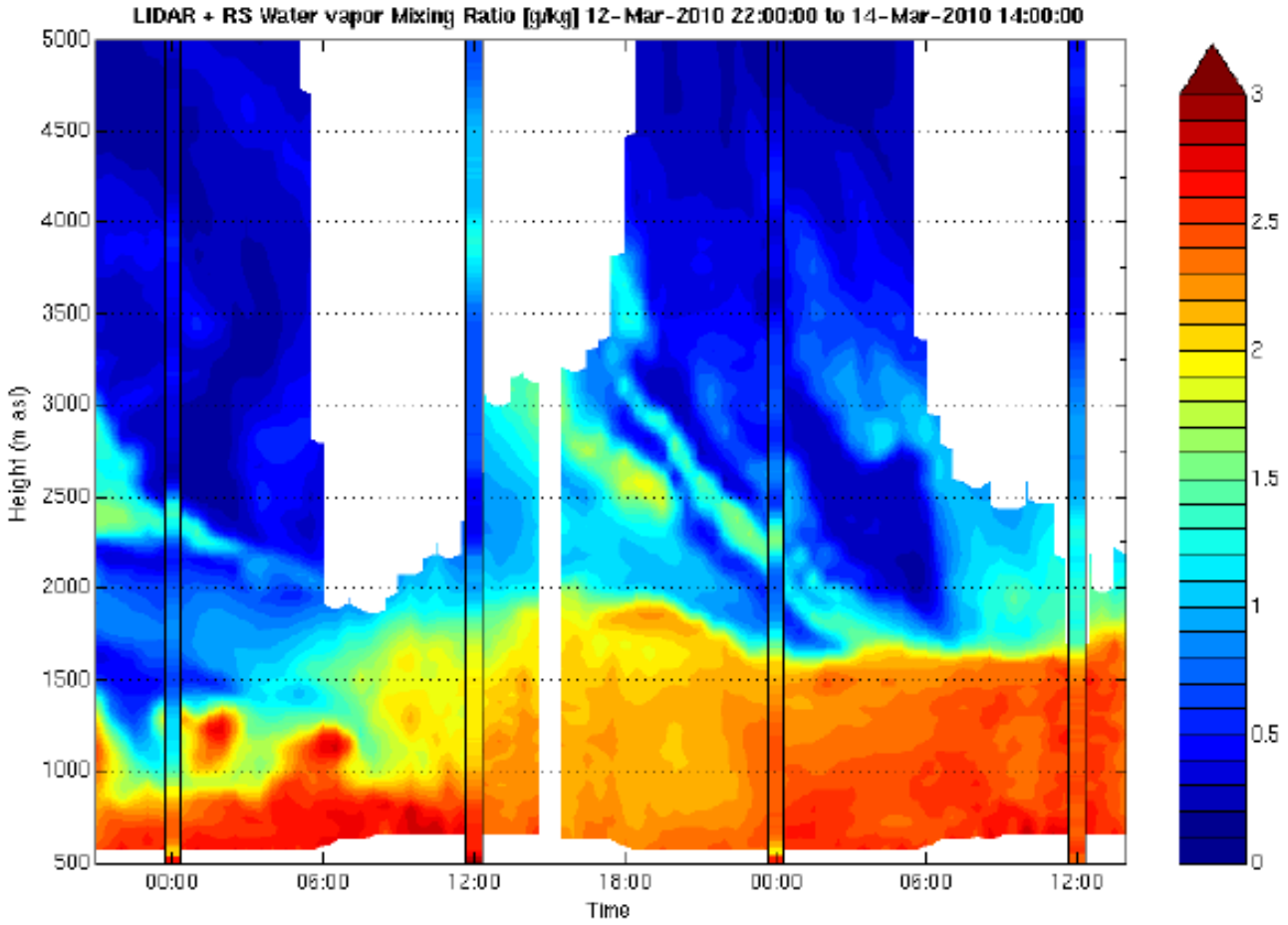
RQQI Project Team

- Paul Joe (chair)* Canada, Environment Canada
- Liping Liu* China, Chinese Meterological Agency
- Yoshihisa Kimata Japan, Japan Meteorological Agency
- Alan Seed Australia, Bureau of Meteorology
- Estelle de Coning South Africa, South African Weather Service
- Vincenzo Levizzani Italy, WCRP/WGPRN
- Daniel Michelson* Sweden, Swedish Meteorological Hydrological Institute
- Daniel Sempere-Torres Spain/Expert, GRAHI
- Nicholas Gaussiat UK/UKMO-OPERA HUB
- Tim Crum USA/ NOAA-ROC
- John Hubbert* USA/Expert, NCAR
- Roberto Calheiros Brazil, IPMET

Testbeds and Leadcenters

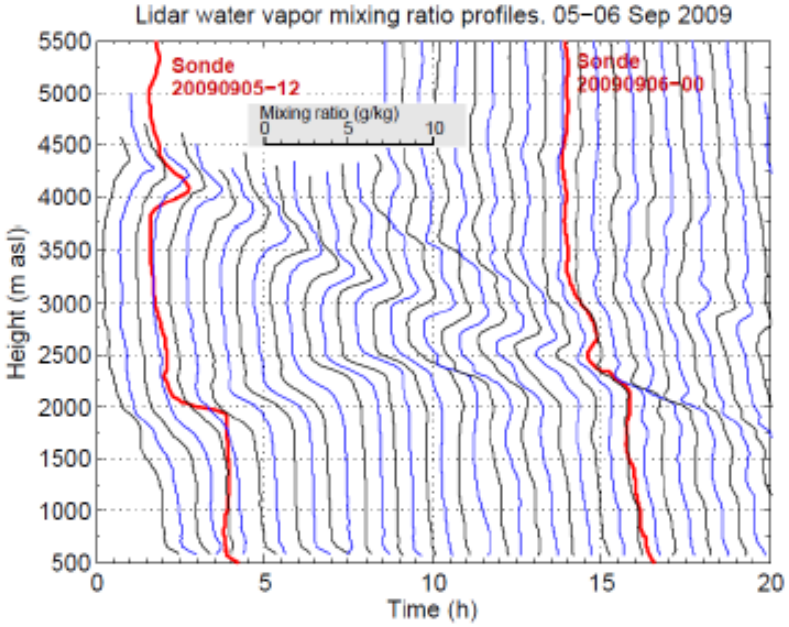
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

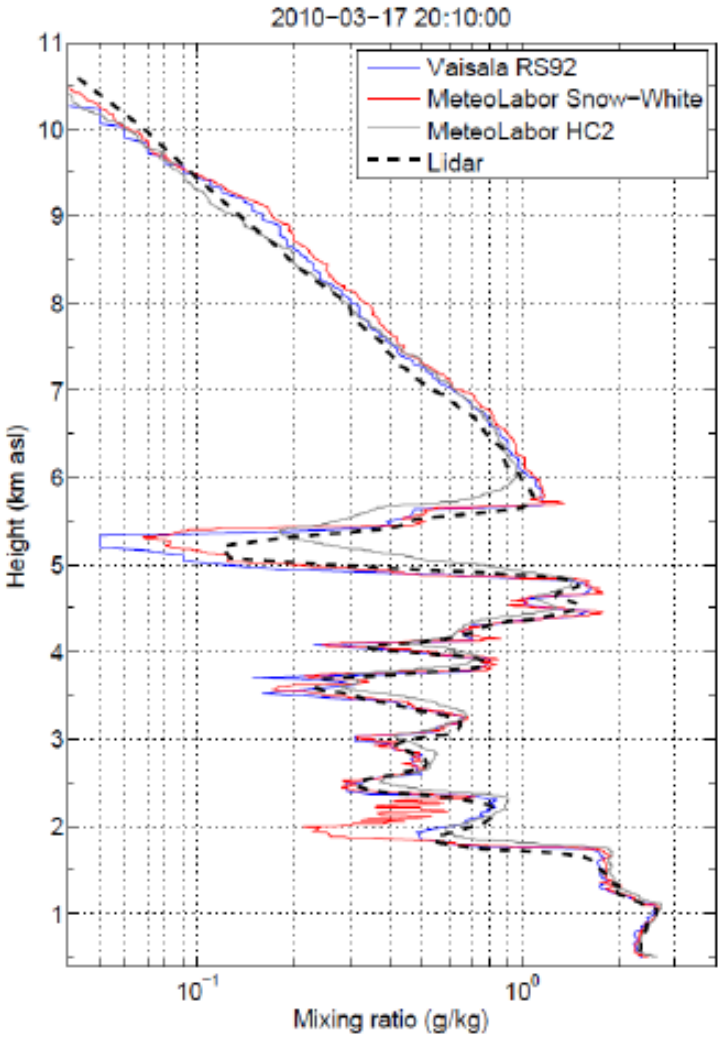
Swiss Confederation



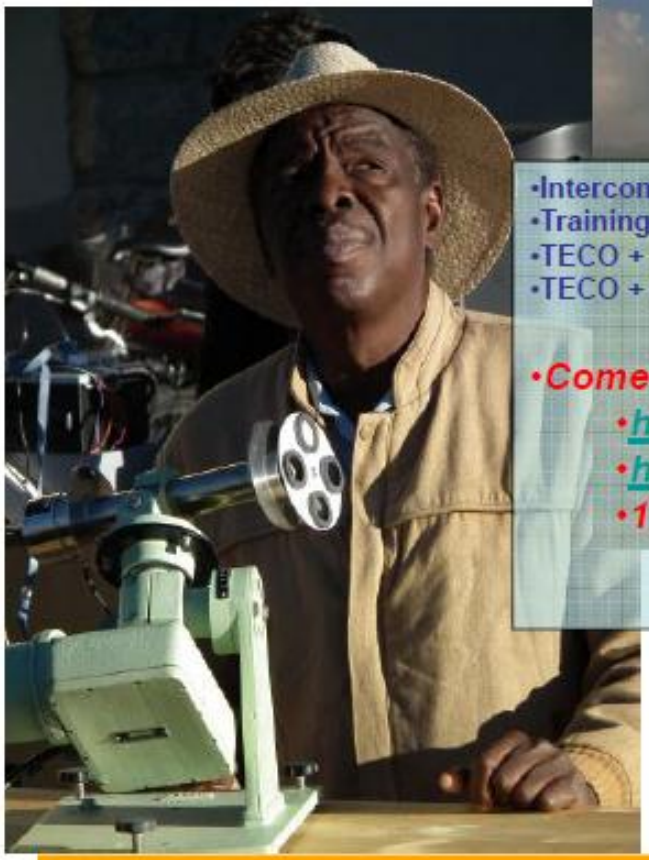
Calibration …

- Calibration against frost point hygrometer (Snow White)
- Daily intercomparison with regular sounding for data quality check





Capacity Building



- Intercomparisons
- Training workshops
- TECO + METEOREX 2008 St Petersburg
- TECO + METEOREX 2010 Helsinki

- ***Come to the next CIMO TECO 2012 , see***
  - ***http://www.meteorologicaltechnologyworldexpo.com***
  - ***http://www.wmo.int/pages/prog/www/IMOP/meetings.html***
  - ***16-18 October 2012, Bruxelles Belgium***

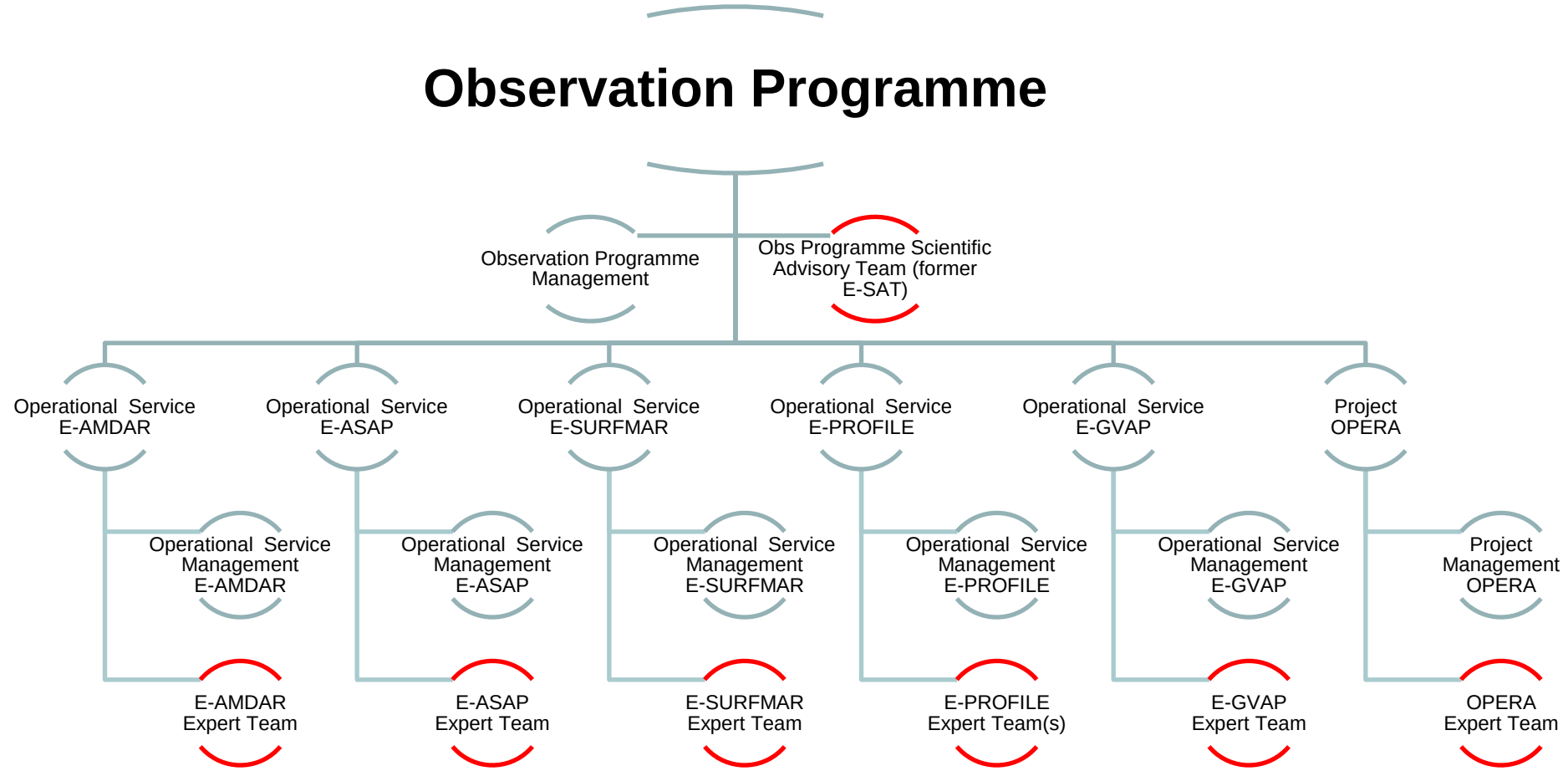
Issues of HR BUFR radiosonde data

- Discussion started at the E-SAT Meeting in April on the decoding of HR BUFR data:
  - A EUMETNET Member using the EMOSLIB BUFR decoding software of ECMWF was not able to decode several HR radiosonde BUFR data of January and February
  - DWD using its own BUFR decoding software was able to decode the data
  - Recently no further problems discovered with European data
- Further it was identified that the available radiosonde formats and transmitted time intervals differ depending on the manufacturer
  - In general 1s raw data are measured by all radiosondes
  - Vaisala calculates smoothed edited data in the ground system (to remove the swing of the sonde), Modem provides 1s data
  - Vaisala extracts mandatory levels from the 1s raw data but the significant levels are interpolated over the configured time period (land stations: 2s, E-ASAP: 20s)

EUMETNET
European Meteorological Services Network

Questions and comments?

Observation Programme structure



EUMETNET Observation Programme Outlook 2013 - 2017

- Take also into account the requirements from global and kilometre-scale NWP and Climate;
- Further harmonisation of obs data monitoring;
- Despite the budget reduction (approx. 5-10% for E-AMDAR, E-ASAP, E-SURFMAR and radiosonde compensations)
  - Try to keep the good coverage of E-ASAP soundings;
  - Try to maintain the excellent coverage of slp measurements delivered by E-SURFMAR and try to search for possibilities how to deploy more drifting buoys in the most northern part of the NA;

EUMETNET Observation Programme Outlook 2013 - 2017

  - Try to retain the good spatial and temporal coverage of E-AMDAR observations in most parts of the EUCOS area of interest and to further improve coverage e.g. over the Iberian Peninsula, Eastern Europe and Scandinavia;
- Revise the EUCOS targets, especially for data timeliness and accuracy and geographical coverage, in order to take into account requirements from Forecasting and Climate and updated needs from NWP;
- Foster the OPERA developments in order to be able to produce quantitatively usable 2D radar products and to exchange single site 3D volume data (reflectivity, Doppler winds) by the end of the programme phase;

EUMETNET Observation Programme Outlook 2013 - 2017

- Extend the remit of the E-PROFILE (former E-WINPROF) Operational Service with the aim to include Lidar/Ceilometer observations for the main purpose of volcanic ash monitoring.

European E-ASAP

Examples of E-ASAP ships:

ATLANTIC CONCERT in Hamburg, Germany

DUBLIN EXPRESS in Hamburg, Germany

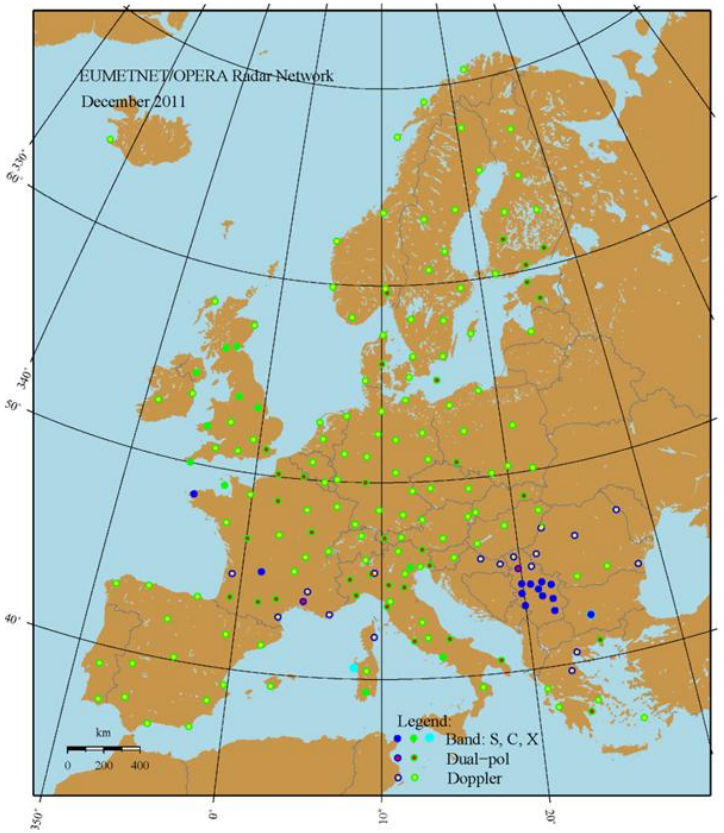
EUMETNET
EUROPEAN METEOROLOGICAL SERVICES NETWORK

E-ASAP fleet April 2012

No	Station	Ship name	Operating area	Vessel
1	ASEU01	Maria S. Merian	Research vessel, mainly Atlantic	Research
2	ASEU02	Liverpool Express	North Europe – Chile	Merchant
3	ASEU03	Mississauga Express	Western Mediterranean – Montreal	Merchant
4	ASEU04		idle	
5	ASEU05	Atlantic Companion	North Europe – East coast US	Merchant
6	ASEU06	Atlantic Conveyor	North Europe – East coast US	Merchant
7	ASDE01	Atlantic Compass	North Europe – East coast US	Merchant
8	ASDE02	Meteor	Research vessel, worldwide	Research
9	ASDE03	Atlantic Concert	North Europe – East coast US	Merchant
10	ASDE04	Dublin Express	North Europe – Chile	Merchant
11	ASDK01	Irena/ Naja/ Mary/ Arina/ Nuka Arctica	Denmark – West coast Greenland	Merchant
12	ASDK02		Denmark – West coast Greenland	Merchant
13	ASDK3		Denmark – West coast Greenland	Merchant
14	ASFR1	Fort Saint Louis	North West Europe – French West Indies	Merchant
15	ASFR2	Fort Saint Pierre	North West Europe – French West Indies	Merchant
16	ASFR3	Fort Saint Georges	North West Europe – French West Indies	Merchant
17	ASFR4	Fort Sainte Marie	North West Europe – French West Indies	Merchant
18	ASES01	Esperanza del Mar	Off Mauretania and Canary Islands	Hospital
19	4089	Egilsstadir	Airport Egilsstaðir (NE Iceland)	Land

OPERA:

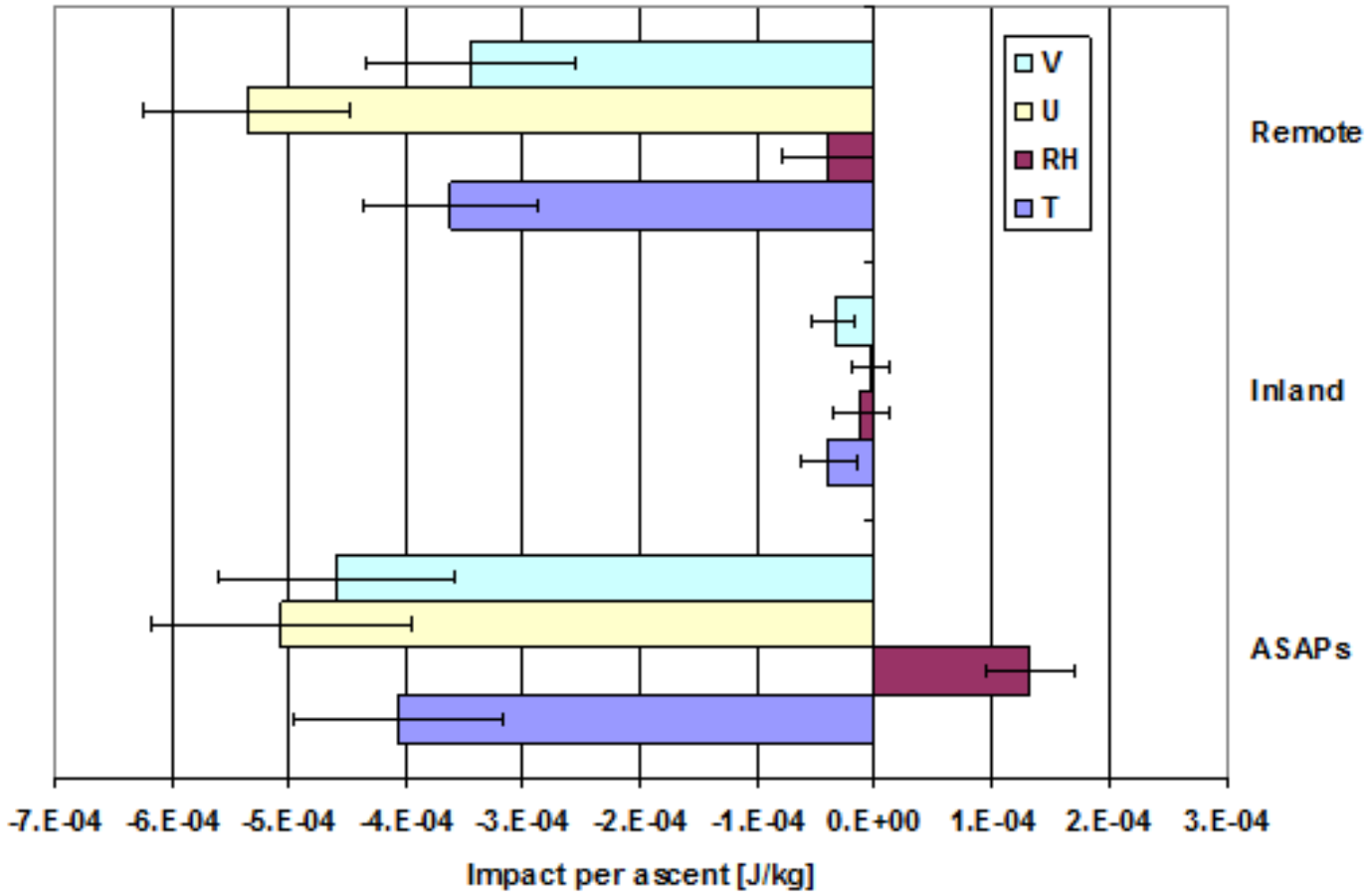
The fundamental objective of OPERA is to provide a European platform wherein expertise on operationally-oriented weather radar issues is exchanged.



The main central tasks of OPERA are:

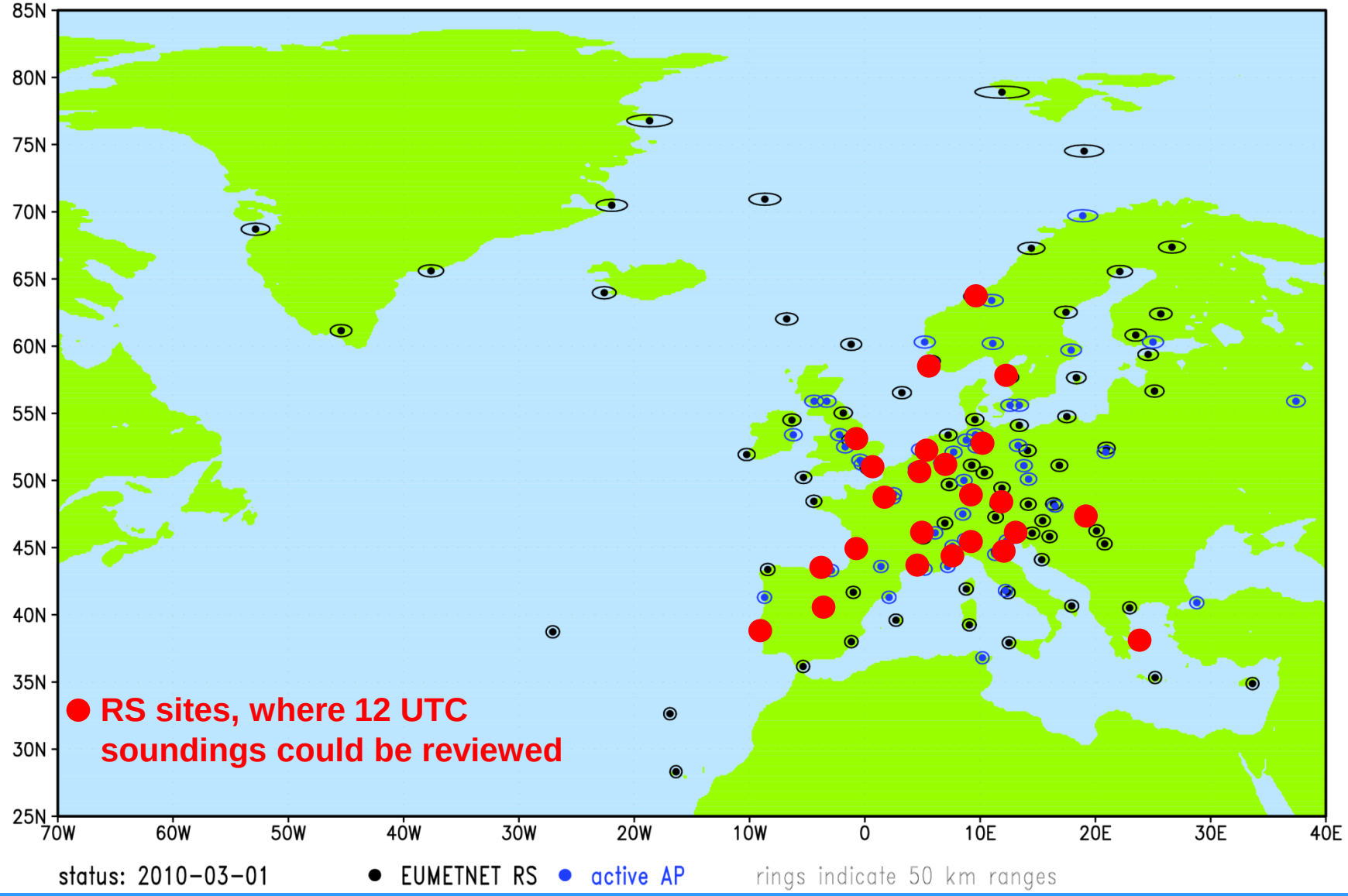
- To work to increase the exchange and harmonization of weather radar data and products throughout Europe.
- To carry out studies to collect best experiences of the members on weather radars.
- To work on understanding and describing radar data quality, in support of the increased quantitative use of data.
- To support European applications of weather radar data through the establishment of a Data Hub function where harmonized products from the European Weather Radar Network are generated and managed.
- To develop the OPERA data information model (ODIM), and the software to encode and decode radar data in BUFR and HDF5 formats.

E-ASAP impact study



The average observation impacts per ascent for the three groups separated by variable. Error bars give an approximation to the standard error of the mean ($\sigma/\sqrt{N}$).

EUCOS UANR 2010 - proposal



Contact Details

Stefan Klink
EUCOS Programme Manager
GIE/EIG EUMETNET

EUCOS Programme Manager
Deutscher Wetterdienst
Frankfurter Str. 135
63067 Offenbach

Tel: + 49 69 8062 4492
Fax: + 49 69 800 863 410
Email: stefan.klink@dwd.de
Web: www.eumetnet.eu

GIE EUMETNET Secretariat
c/o L'Institut Royal Météorologique de Belgique
Avenue Circulaire 3
1180 Bruxelles, Belgique

Tel: +32 (0)2 373 05 18
Fax: +32 (0)2 890 98 58
Email: info@eumetnet.eu
Web: www.eumetnet.eu