



World Meteorological Organization

Weather • Climate • Water

ECMWF-WWRP/THORPEX Workshop on polar prediction
(Reading, UK, 24-27 June 2013)

WMO observing systems in polar areas and the transition to the WMO Integrated Global Observing System

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Outline

1. WMO Polar activities
2. Status on observing systems in polar areas
3. Observing System Design and Evolution



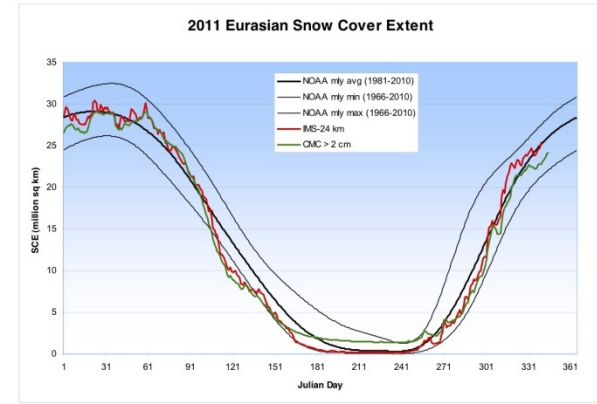
1. WMO Polar Activities

- Currently undertaken in the framework of
 - Global Observing System (GOS)
 - WMO Space Programme
 - Regional Basic Synoptic Network (RBSN)
 - Regional Basic Climatological Network (RBCN)
 - AMDAR Programme
 - Antarctic Observing Network (AntON)
 - International Arctic Buoy Programme (IABP)
 - WCRP-SCOR International Programme for Antarctic Buoys (IPAB)
 - Global Atmosphere Watch (GAW)
 - Global Cryosphere Watch (GCW)
 - Cryonet
 - WMO-IOC-UNP-ICSU Global Climate Observing System (GCOS)
 - GCOS Surface Network (GSN)
 - GCOS Upper Air Network (GUAN)



OBSERVATION AND MONITORING

Critical Elements of the "Watch"



- operating in remote, data sparse regions
- **CryoNet** – reference, super sites – develop consortium of sustained, ground-based international **multi-disciplinary observatories, strengthening collaboration**
- **Contributing to an optimized cryosphere observing system using in-situ and satellite systems**
- **Developing value added long-term standardized observational data and products to address systems science and policy questions, initialize and validate model and satellite derived cryospheric outputs**
- **comprehensive, coordinated cost-effective, sustainable system of observations & information**



Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS)

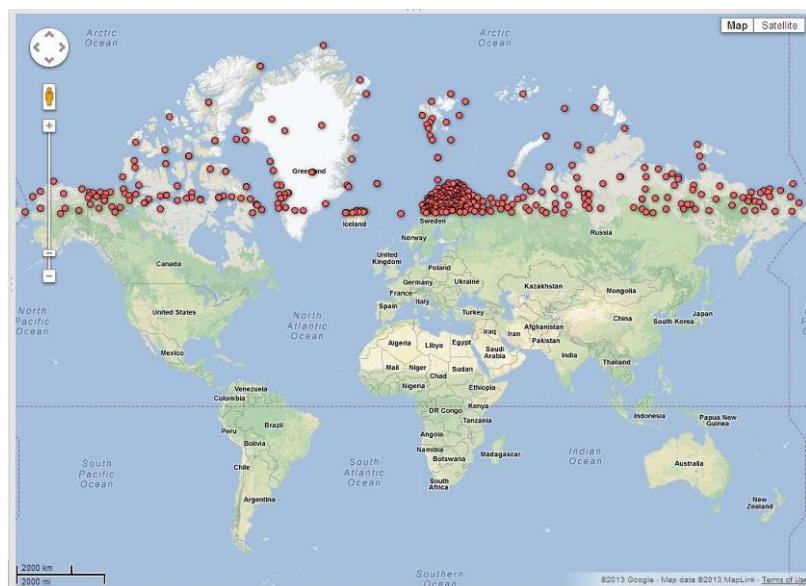
- EC-PORS promotes and coordinates activities of WMO programmes that are carried out in the Antarctic and Arctic regions by WMO Members, including the Antarctic Observing Network (AntON – established by Cg-16)
- The Panel interfaces with all WMO programmes as well as other related programmes throughout the world, meeting global needs and requirements for meteorological, climatological and hydrological observations, research and services in the Polar Regions.
- EC-PORS is guiding the development of the Global Cryosphere Watch (GCW)



2. Status on observing systems in polar areas



Global Observing System (GOS) - countries operating stations in the Antarctic and north of the Arctic Circle (66°N)

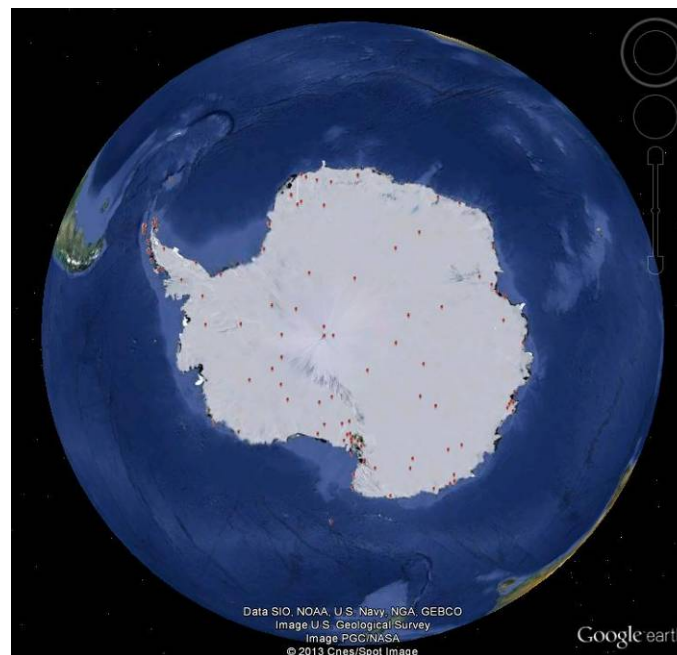


The number of synoptic stations operating in the Arctic 402 surface and 35 upper-air (Volume A) of which:

- 126 stations in the RBSN, report SYNOP
- 29 stations in the RBSN, report TEMP
- 88 stations in the RBCN, report CLIMAT

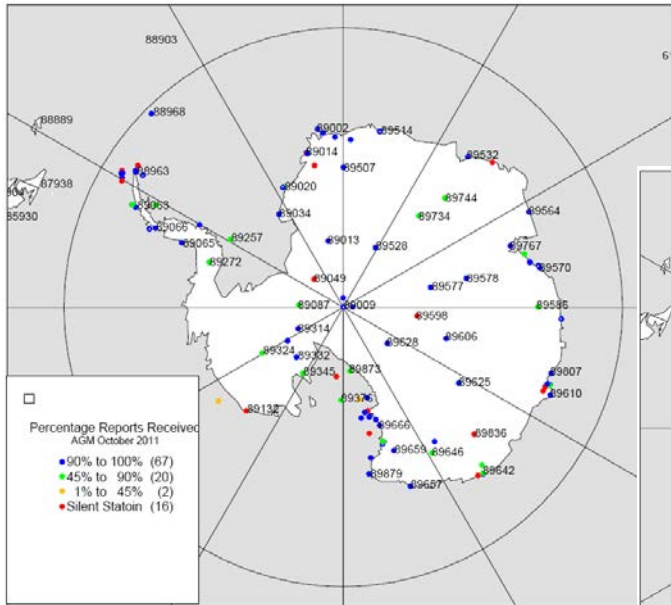
The number of synoptic stations operating in the Antarctic 120 surface and 15 upper-air (Volume A) of which:

- 105 stations in the AntON - report both SYNOP and CLIMAT.
- 15 upper-air stations in the AntON - report TEMP

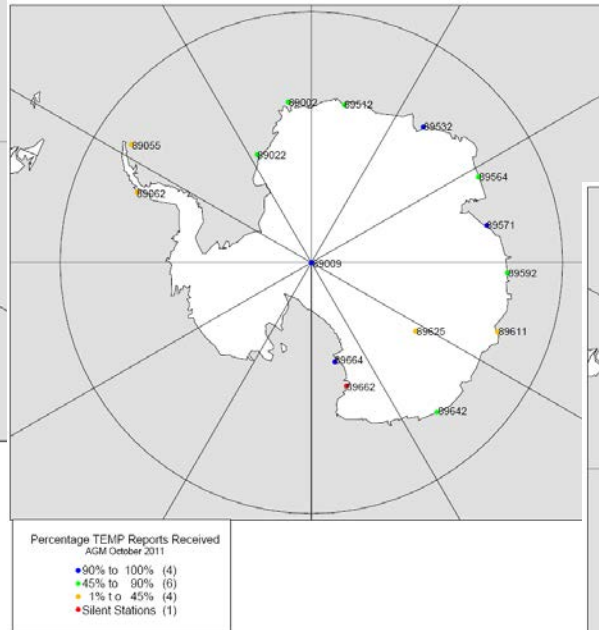


Antarctic Observing Network (AntON) – Performance Monitoring

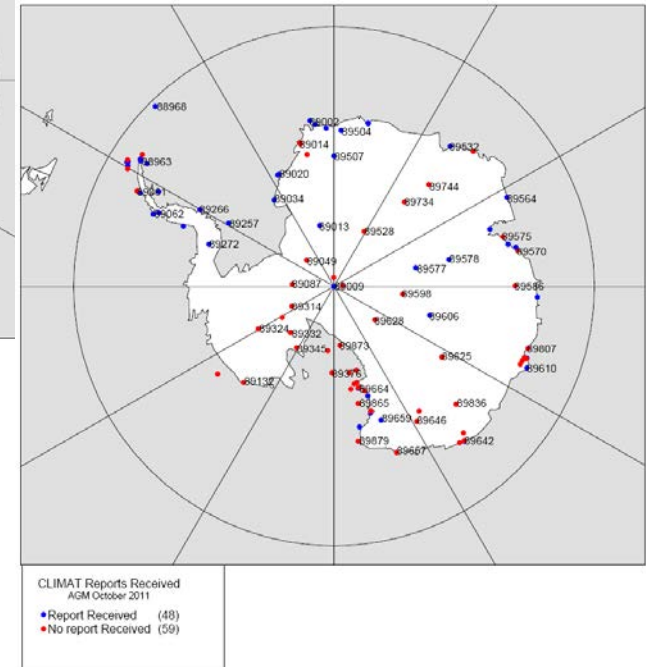
(SYNOP)



(TEMP)

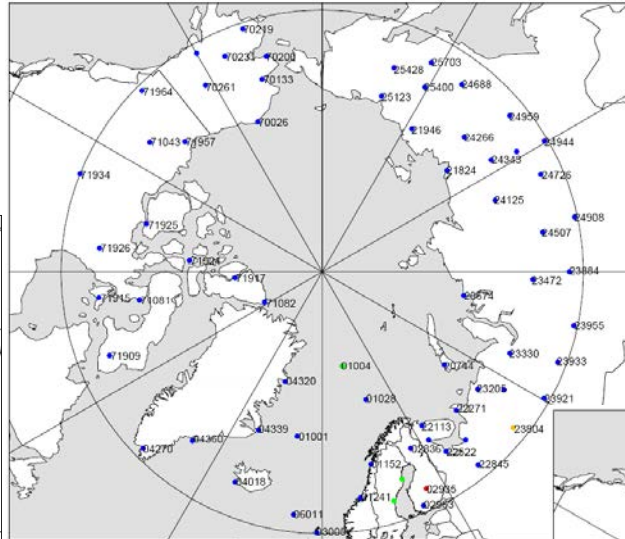


(CLIMAT)



RBSN/RBCN - north of the Arctic Circle (66°N) – Performance Monitoring

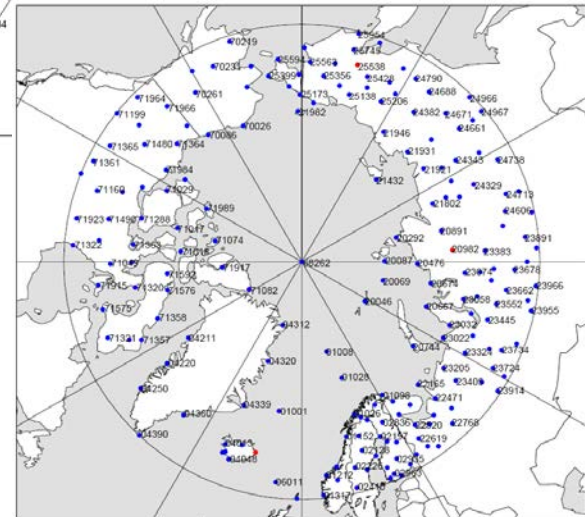
(TEMP)



Percentage TEMP reports received
AGM October 2011

- 90% to 100% (64)
- 45% to 90% (3)
- 1% to 45% (1)
- Silent Stations (1)

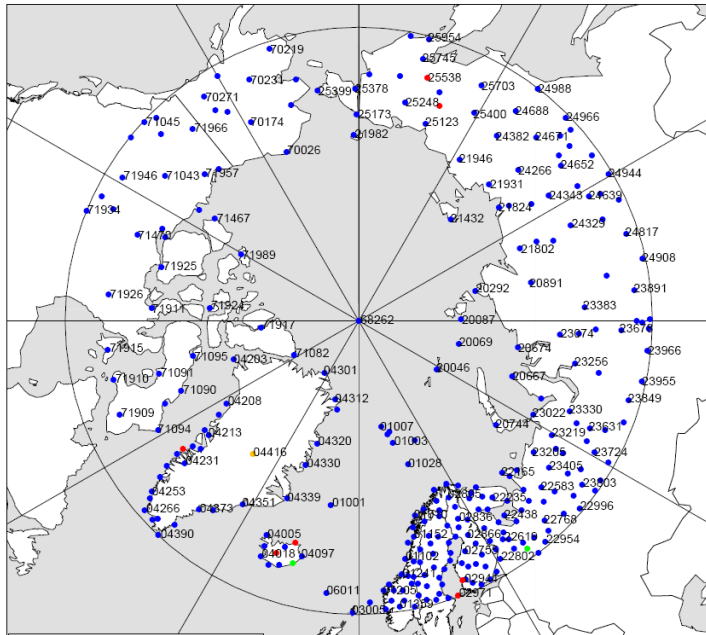
(CLIMAT)



CLIMAT Reports received
AGM October 2011

- Report Received (195)
- No report received (6)

(SYNOP)



Percentage SYNOP Reports Received
AGM October 2011

- 90% to 100% (281)
- 45% to 90% (2)
- 1% to 45% (1)
- Silent Stations (7)



GAW Stations – Arctic (65N – 90N)

GAWSIS 2.2

gaw.empa.ch/gawsis/StationList.asp

Map Satellite Hybrid

GAW Global
 GAW Regional
 GAW Contributing
 Other

© MeteoSwiss

WMO RA / Country	Station	GAWID	Station Type	Operating Status	Coordinates (m a.s.l.)	Elevation
II - Asia						
Russian Federation	Dikson Island	DXO	Regional	intermittent operation	73.50°N 80.23°E	18
Russian Federation	Heiss Island	HED	Regional	closed	80.62°N 58.10°E	20
Russian Federation	Igarka	IGY	Regional	closed	67.47°N 86.57°E	20
Russian Federation	Kotelnyj Island	KOT	Regional	full operation	76.00°N 137.9°E	5
Russian Federation	Olenok	OLN	Regional	full operation	68.50°N 112.4°E	127
Russian Federation	Salekhard	SKD	Contributing	full operation	67.50°N 67.50°E	419
Russian Federation	Tiksi	TIK	Regional	full operation	71.59°N 128.9°E	8
Russian Federation	Turukhansk	TRH	Regional	full operation	65.78°N 87.90°E	38
Russian Federation	Zhigansk	ZHI	Contributing	full operation	67.20°N 123.4°E	50
IV - North/Central America						
Canada	Alert	ALT	Global	full operation	82.50°N 62.34°W	210
Canada	Eureka	EUK	Regional	full operation	80.05°N 86.42°W	610
Canada	Inuvik		Regional (prospective)	full operation	68.32°N 133.5°W	113
Canada	Mould Bay	MBC	Regional	closed	76.25°N 119.3°W	58
Canada	Resolute	RSL	Regional	full operation	74.72°N 94.98°W	64
Greenland	Station Nord		Regional	full operation	81.60°N 16.66°W	24
United States	Barrow (AK)	BRW	Global	full operation	71.32°N 156.6°W	11
United States	Poker Flat (AK)	POK	Regional	full operation	65.12°N 147.5°W	204
VI - Europe						
Denmark	Scoresbysund	SCB	Contributing	full operation	70.48°N 21.97°W	10
Denmark	Site J	GRL	Regional	closed	66.50°N 46.20°W	2030
Denmark	Sondrestrom	SST	Regional	full operation	66.99°N 50.95°W	150
Denmark	Thule	THU	Regional	full operation	76.52°N 68.77°W	200
Finland	Hailuoto	HLO	Contributing	full operation	65.00°N 24.68°E	4
Finland	Matorova	MAT	Global	full operation	68.00°N 24.24°E	340
Finland	Oulanka	OUX	Regional	full operation	66.32°N 29.40°E	310
Finland	Pallas	PAL	Global	full operation	67.97°N 24.12°E	560
Finland	Sodankylä	SDK	Global	full operation	67.36°N 26.63°E	180
Finland	Värriö		Regional	full operation	67.76°N 29.61°E	400
Greenland	Summit	SUM	Regional	full operation	72.58°N 38.48°W	3238
Norway	Andoya	ARR	Contributing	full operation	69.28°N 16.01°E	360
Norway	Bjørnøya	BJN	Contributing	closed	74.50°N 19.02°E	20
Norway	Hornsund (Svalbard)	HRN	Regional	closed	77.00°N 15.55°E	11
Norway	Jergul	JGL	Regional	closed	69.40°N 24.60°E	255
Norway	Longyearbyen	LYB	Regional	closed	78.22°N 15.57°E	0
Norway	Murchison Bay	MUB	Regional	closed	80.00°N 18.00°E	-1
Norway	Ny Ålesund	NYA	Global	full operation	78.92°N 11.92°E	0
Norway	Svanvik	SVV	Contributing	closed	69.45°N 30.03°E	30
Norway	Tromsø	TRK	Regional	closed	69.65°N 18.95°E	100
Norway	Tustervatn	TUV	Regional	full operation	65.83°N 13.92°E	439
Norway	Zeppelin Mountain (Ny Ålesund)	ZEP	Global	full operation	78.91°N 11.89°E	474
Russian Federation	Janiskoski	JNS	Regional	full operation	68.93°N 28.85°E	118
Russian Federation	Murmansk	MRM	Regional	full operation	68.97°N 33.05°E	46
Russian Federation	Pechora	PCH	Regional	full operation	65.20°N 57.17°E	56
Russian Federation	Terberka	TER	Regional	full operation	69.20°N 35.10°E	40
Sweden	Esränge	ESR	Regional	closed	67.88°N 21.07°E	475
Sweden	Kiruna	KIR	Contributing	full operation	67.84°N 20.41°E	424
Sweden	Luleå	LUL	Regional	full operation	65.54°N 22.11°E	32
Sweden	Tarfala	TLA	Regional	full operation	67.91°N 18.61°E	1144
United States	Ocean Station M	STM	Regional	full operation	66.00°N 2.00°E	4

GAW Stations – Antarctic (60S – 90S)

GAW 2.2

gaw.empa.ch/gawsis/StationList.asp

by QA/SAC Switzerland

GAW SIS
STATION INFORMATION SYSTEM

- Find Information
- Edit/Add Information
- Provide Feed-back

Home Advanced Search Edit/Add Information Register a New Station Feed-back FAQs & Glossary About

Stations matching criteria (total: 37)

WMO RA / Country	Station	GAWID	Station Type	Operating Status	Coordinates (m a.s.l.)	Elevation
VII - Antarctica						
Argentina	Belgrano II	BLG	Regional	full operation	77.88°S 34.63°W	255
Argentina	Doctor Sobral	DSB	Regional	closed	81.07°S 40.50°W	100
Argentina	Jubany	JBN	Regional	full operation	62.24°S 58.67°W	15
Argentina	Marambio	MBI	Regional	full operation	64.24°S 56.62°W	198
Argentina	San Martin	SMT	Regional	full operation	68.13°S 67.10°W	30
Australia	Casey	CYA	Regional	full operation	66.28°S 110.5°E	51
Australia	Davis	DAS	Regional	full operation	68.58°S 77.47°E	15
Australia	Law Dome	LAD	Regional	unknown	66.73°S 112.8°E	1390
Australia	Mawson	MAA	Regional	unknown	67.60°S 62.87°E	20
Australia	Wilkes	WKS	Regional	closed	66.25°S 110.5°E	12
Belgium	Base King Baudoin	KBK	Regional	closed	70.43°S 24.32°E	38
Belgium	Princess Elisabeth station	PES	Regional	intermittent operation	71.95°S 23.35°E	1350
Chile	Marsh (King George Island)	MKG	Regional	closed	62.18°S 58.30°W	20
China	Zhong Shan	ZOS	Contributing	full operation	69.37°S 76.37°E	71
France	Concordia, Dôme C	DCC	Contributing	full operation	75.10°S 123.3°E	3233
France	Dumont d'Urville	DDU	Regional	full operation	66.66°S 140.0°E	40
Germany	Neumayer	NMY	Global	full operation	70.67°S 8.27°W	42
India	Maitri	MTR	Regional	full operation	70.46°S 11.45°E	330
Japan	Mizuno	MZH	Contributing	closed	70.70°S 44.30°E	2230
Japan	Syowa	SYO	Regional	full operation	69.00°S 39.58°E	21
Korea, R. of	King Sejong	KSG	Regional	full operation	62.22°S 58.78°W	0
New Zealand	Arrival Heights	ARH	Regional	full operation	77.83°S 166.7°E	184
New Zealand	Hallett	HAL	Regional	closed	72.32°S 170.2°E	5
New Zealand	Scott Base	SBS	Regional	full operation	77.85°S 166.8°E	16
Russian Federation	Mirny	MIR	Regional	closed	66.55°S 93.00°E	30
Russian Federation	Novolazarevskaya-Forster	NLZ	Regional	closed	70.77°S 11.87°E	110
Russian Federation	Vostok	VST	Regional	closed	78.27°S 106.5°E	-1
Ukraine	Faraday-Vernadsky	FAD	Regional	full operation	65.25°S 64.26°W	10
United Kingdom	Argentine Islands	ARI	Regional	full operation	65.25°S 64.27°W	10
United Kingdom	Halley	HBA	Global	full operation	75.62°S 26.18°W	30
United Kingdom	Rothera	ROT	Contributing	full operation	67.57°S 68.12°W	30
United States	Byrd	BYR	Regional	closed	80.03°S 119.5°W	1528
United States	Little America	LAM	Regional	closed	78.00°S 162.0°W	44
United States	McMurdo	MCM	Regional	full operation	77.85°S 166.7°E	11
United States	Palmer Station	PSA	Regional	full operation	64.77°S 64.05°W	10
United States	South Pole	SPO	Global	full operation	90.00°S 24.80°W	2841
Uruguay	Artigas	ART	Regional	full operation	62.18°S 58.90°W	10

New Search

EMPA
Materials Science & Technology

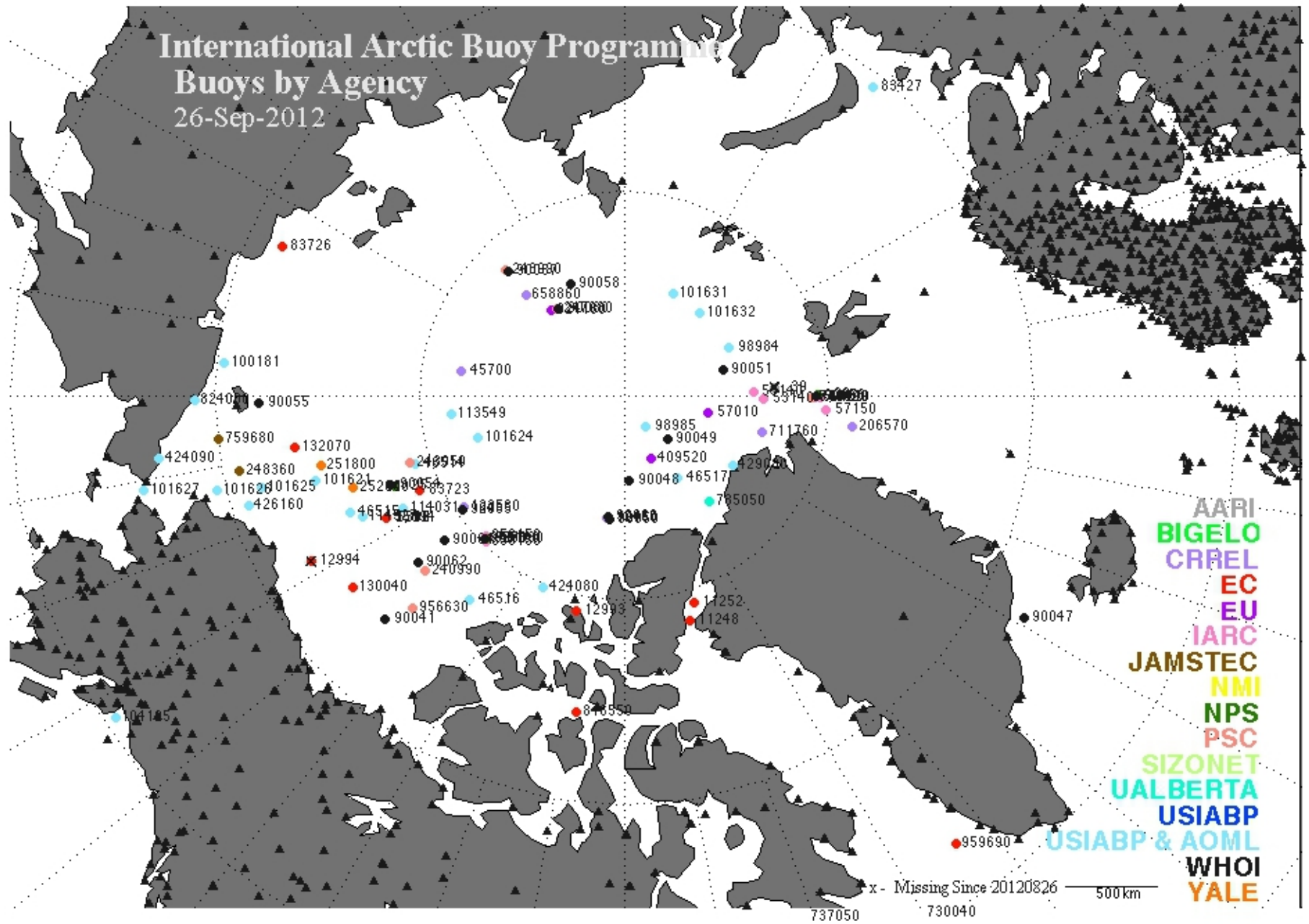
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Home Affairs EDIA
Federal Office of Meteorology and Climatology MeteoSwiss

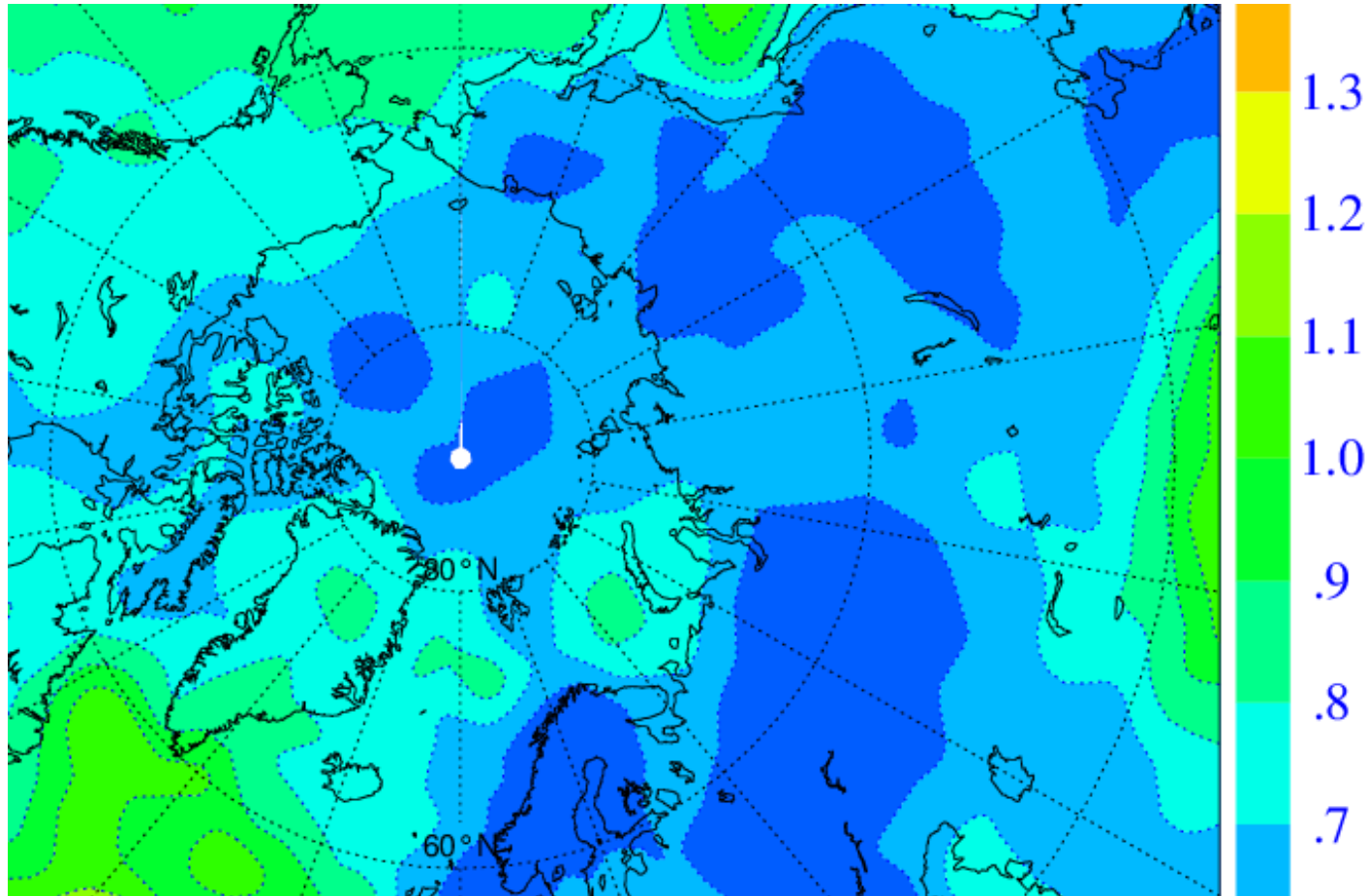
International Arctic Buoy Program

Buoys by Agency

26-Sep-2012



Surface pressure analysis uncertainty
Spread in an ensemble of data assimilations (EDA),
Massimo Bonavita (ECMWF)



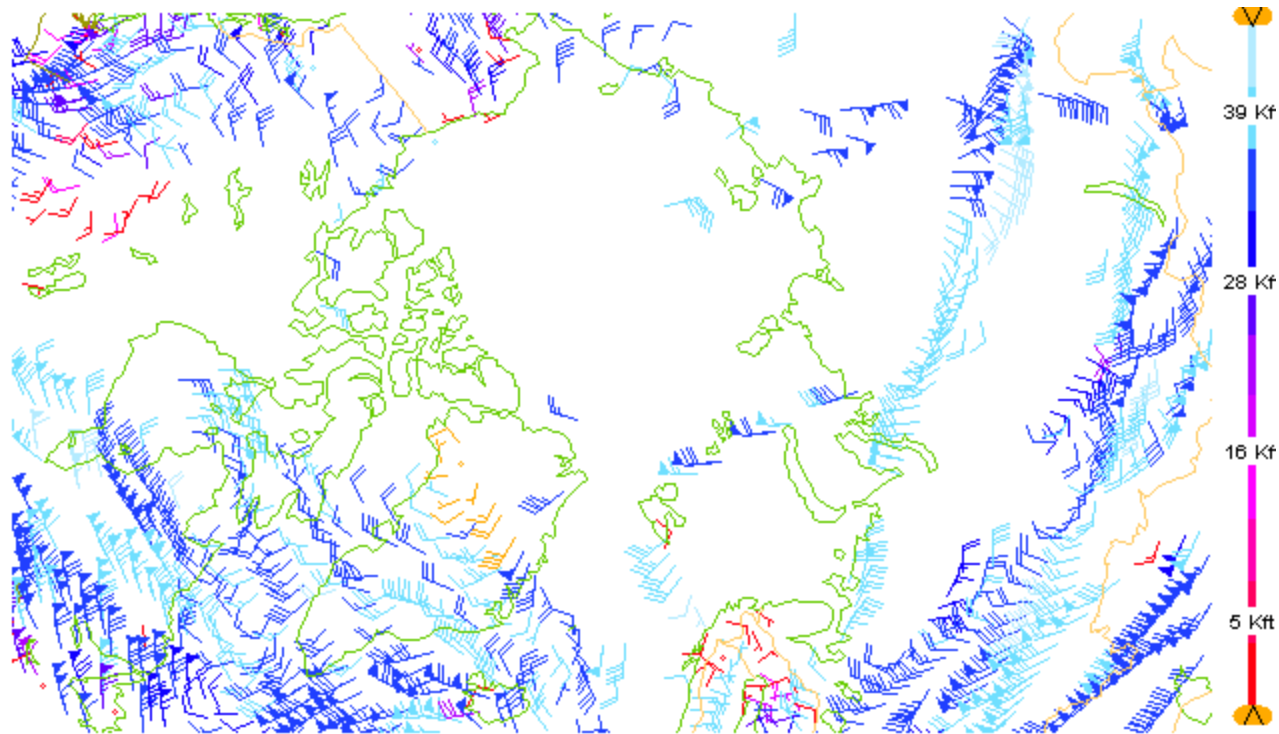
Comparison between ECMWF and UK Met Office analysis

Standard deviation at z500



AMDAR Observations over Arctic Region.

Courtesy of NOAA ESRL/GSD - <http://amdar.noaa.gov/>

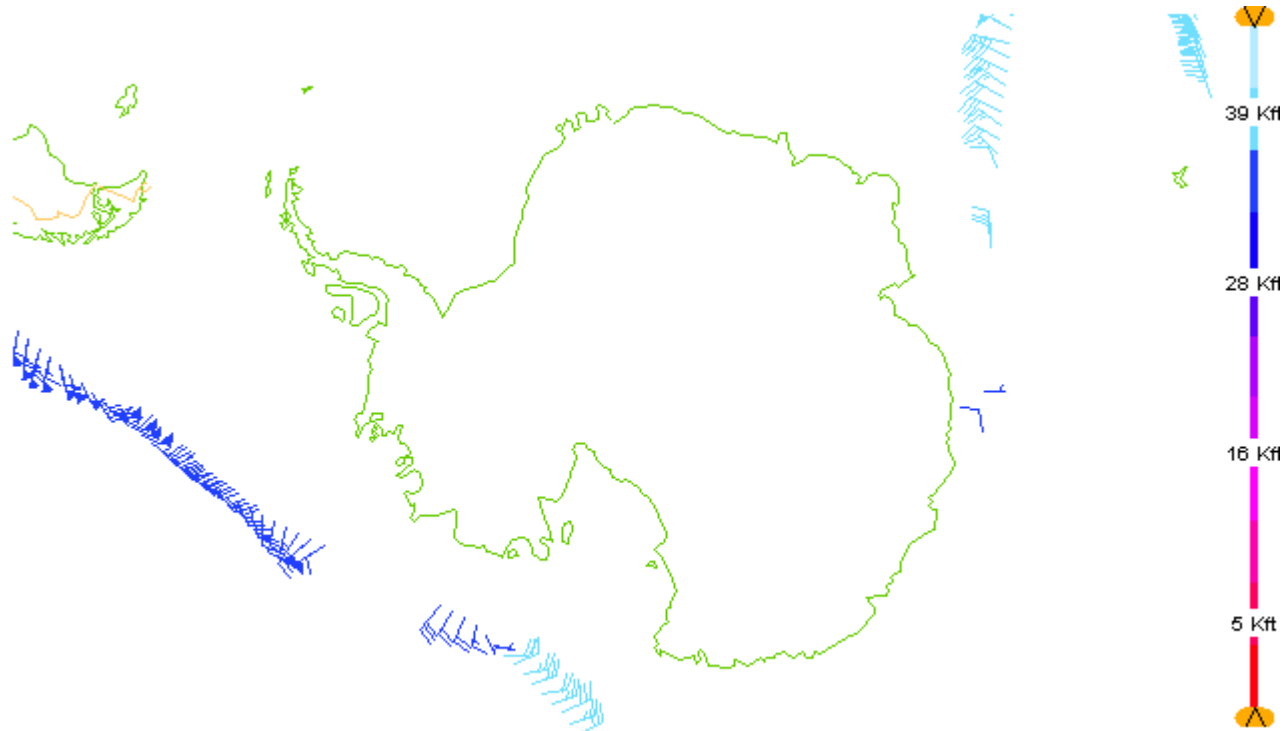


22-May-2013 11:00:00 -- 23-May-2013 11:04:00 (424373 obs loaded, 36433 in range, 1185 shown)



AMDAR Observations over Antarctic Region.

Courtesy of NOAA ESRL/GSD - <http://amdar.noaa.gov/>



22-May-2013 11:00:00 -- 23-May-2013 11:14:00 (426920 obs loaded, 115 in range, 115 shown)



4. Observing System Design and Evolution

<http://www.wmo.int/egos>

- WMO Rolling Review of Requirements (RRR)
 - Addressing the requirements for all WMO applications
 - Initiated through the WMO Space Programme in cooperation with CEOS
 - Commission for Basic Systems (CBS) in charge of RRR
 - Inter Programme Expert Team on the Observing System Design and Evolution (IPET-OSDE)
 - Chairperson, John Eyre, UK Metoffice



Rolling Review of Requirements (RRR) and Evolution of Global Observing Systems

Long term vision of global observing systems

Application Areas

User requirements

Observing Systems Capabilities
(OSCAR)

Critical review

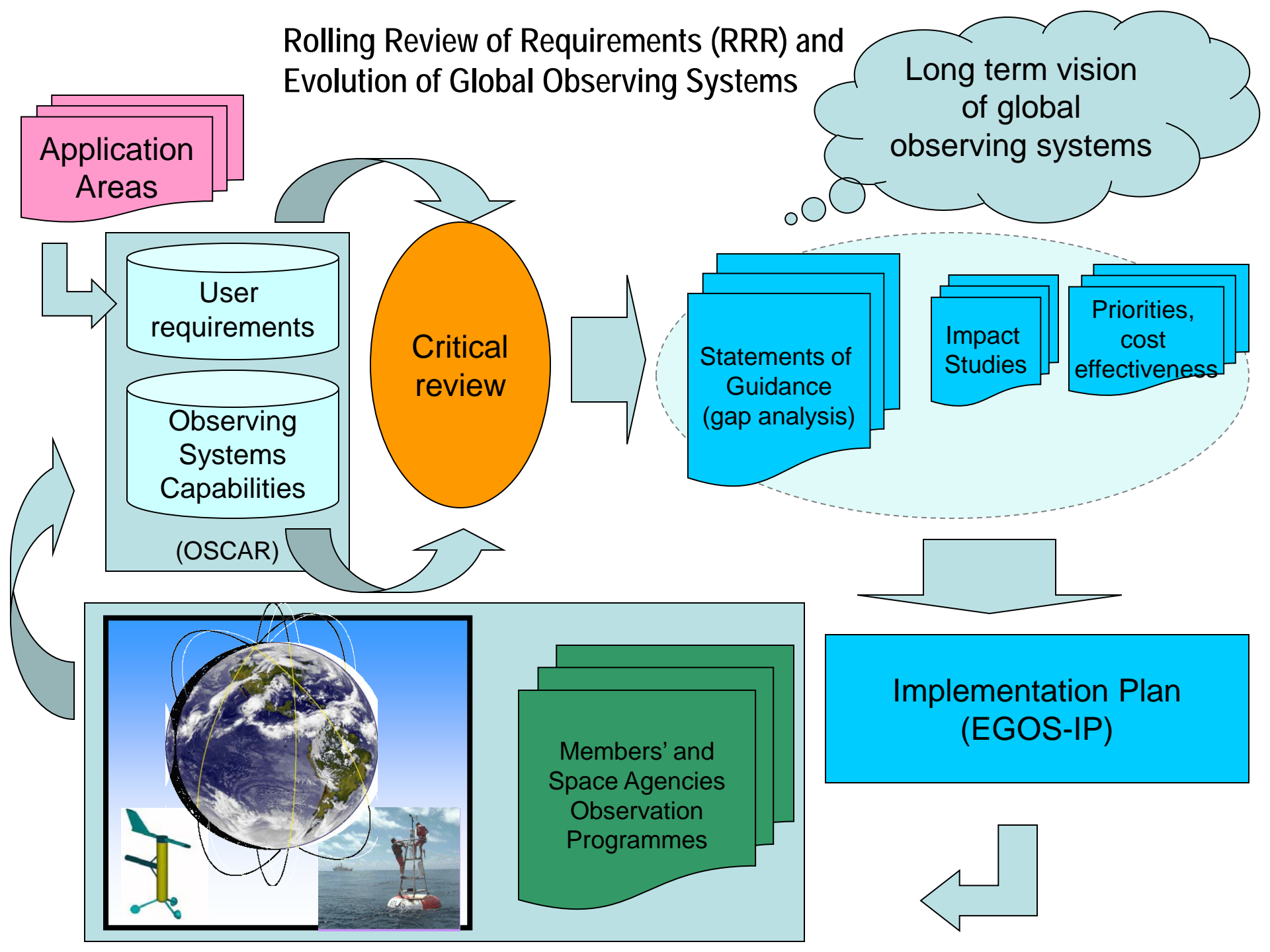
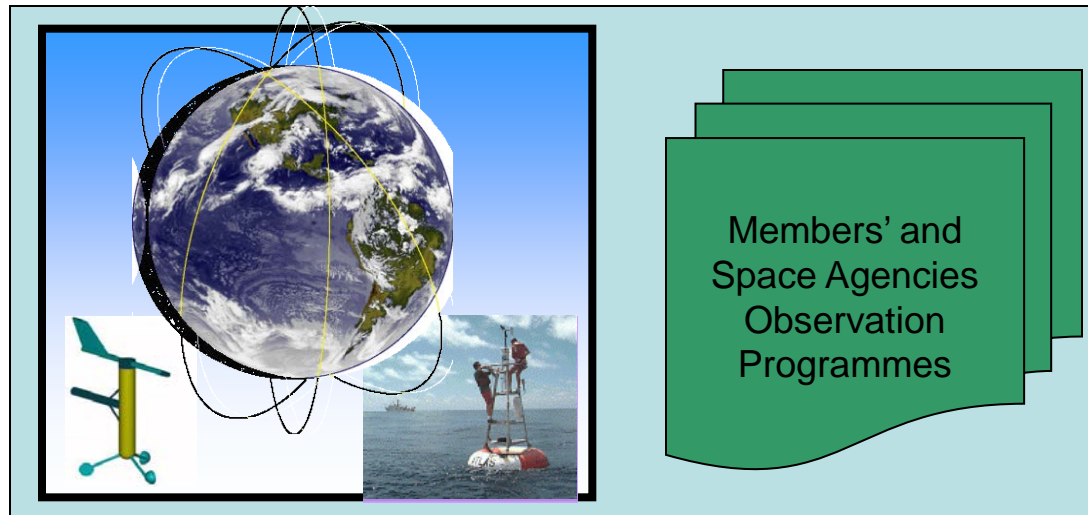
Statements of Guidance
(gap analysis)

Impact Studies

Priorities, cost effectiveness

Implementation Plan
(EGOS-IP)

Members' and Space Agencies
Observation Programmes



WMO Application areas in RRR

1. Global Numerical Weather Prediction (NWP)
 2. High Resolution NWP (HRNWP)
 3. Nowcasting and Very Short Range Forecasting (NVSRF)
 4. Seasonal to Inter-annual Forecasts (SIAF)
 5. Aeronautical Meteorology (CAeM)
 6. Atmospheric Chemistry (CAS)
 7. Ocean Applications (JCOMM)
 8. Agricultural Meteorology (CAgM)
 9. Hydrology (CHy)
 10. Climate Monitoring (GCOS)
 11. Climate Applications (other aspects – CCI)
 12. Space Weather
- Cross cutting (or under discussion)
 - **Global Cryosphere Watch (GCW)**
 - Global Framework for Climate Services (GFCS)
 - Obsolete: Synoptic Meteorology (merged into Nowcasting & VSRF)



User requirements database

<http://www.wmo.int/oscar>

The screenshot shows a web browser window displaying the WMO Observing Requirements Database. The browser's address bar shows the URL <http://www.wmo-sat.info/db/>. The page header includes the WMO logo and the text "WMO Observing Requirements Database" with a "Login" button. Below the header is a navigation bar with "Home" and "Consult Tables" links, and a search box labeled "Quick Search...".

The main content area features a "WELCOME TO THE WMO OBSERVING REQUIREMENTS DATABASE" section with a "Hide" link. The text explains that the database is the official repository for requirements for observation of physical variables in support of WMO Programmes and Co-sponsored Programmes. It mentions the **Rolling Requirements Review (RRR)** process overseen by the **Expert Team on Evolution of Global Observing Systems (ET-EGOS)** of CBS. A link to [More information](#) is provided.

The text further states that the database is open for consultation and provides three options to explore it: **Option 1 (Quick Search)** and **Option 3 (Consult Tables)**. It notes that editing is only possible by designated focal points after login.

Helpful tips are provided: green arrows indicate that symbols (like a question mark) indicate help on a specific item or form field, and acronyms with a dashed underline (e.g., **HR resolution**) can be revealed by hovering the mouse over them. A link to the [Help Section](#) is also provided for more detailed explanations and a User Manual for Download.

At the bottom, there are three main options for user interaction:

- Option 1: Quick Search**: A search box with the placeholder text "Click and start typing..." and a help icon.
- Option 2: Filter**: A section with three dropdown menus for "Theme", "Application Area", and "Layer", each with a help icon. Below the dropdowns are two buttons: "Display Requirements" and "Display Variables".
- Option 3: Consult Tables**: A list of links: [List of Variables](#), [List of Requirements](#), [Themes \(with Variables\)](#), [Application Areas](#), [List of Layers](#), [List of Domains](#), and [List of Organizations](#).

Global NWP Requirements (example)

Id	Variable	Layer	App Area	Uncert Goal	Uncert Thresh	HR Goal	HR Thresh	VR Goal	VR Thresh	OC Goal	OC Thresh	Avail Goal	Avail Thresh
244	Accumulated precipitation (over 24 h)	2D	Global NWP	0.5 mm	5 mm	10 km	100 km	N/A	N/A	60 min	12 h	24 h	30 d
245	Aerosol column burden	TC	Global NWP	10 %	50 %	15 km	250 km	N/A	N/A	60 min	24 h	6 min	6 h
246	Aerosol mass mixing ratio	HS&M	Global NWP	10 %	50 %	15 km	250 km	km	km	60 min	24 h	6 min	6 h
247	Aerosol mass mixing ratio	HT	Global NWP	10 %	50 %	15 km	250 km	km	km	60 min	24 h	6 min	6 h
248	Aerosol mass mixing ratio	LS	Global NWP	10 %	50 %	15 km	250 km	0.2 km	3 km	60 min	24 h	6 min	6 h
249	Aerosol mass mixing ratio	LT	Global NWP	10 %	50 %	15 km	250 km	0.2 km	3 km	60 min	24 h	6 min	6 h
250	Air pressure (at surface)	Over land	Global NWP	0.5 hPa	1 hPa	15 km	500 km	N/A	N/A	60 min	12 h	6 min	6 h
251	Air pressure (at surface)	Over sea	Global NWP	0.5 hPa	1 hPa	15 km	500 km	N/A	N/A	60 min	12 h	6 min	6 h
252	Air specific humidity (at surface)	Surface	Global NWP	2 %	10 %	15 km	250 km	N/A	N/A	60 min	12 h	6 min	6 h
253	Air temperature (at surface)	Surface	Global NWP	0.5 K	2 K	15 km	250 km	N/A	N/A	60 min	12 h	6 min	6 h
254	Atmospheric temperature	HS&M	Global NWP	0.5 K	5 K	50 km	500 km	km	km	60 min	24 h	6 min	6 h
255	Atmospheric temperature	HT	Global NWP	0.5 K	3 K	15 km	500 km	km	km	60 min	24 h	6 min	6 h
256	Atmospheric temperature	LS	Global NWP	0.5 K	3 K	15 km	500 km	km	km	60 min	24 h	6 min	6 h

Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)

<http://www.wmo.int/pages/prog/www/OSY/gos-vision.html#egos-ip>

- Responding to the [Vision of the GOS in 2025](#) and WGOS, GFCS, and Polar Application needs
- Synthesis of all [Statements of Guidance](#) for all WMO Applications
- Includes guidelines and recommended actions to WMO Members to stimulate cost-effective evolution of observing systems
- Wide community review 2011 - 2012
- Reviewed & Approved by CBS-15 in Sept. 2012
- Approved by EC-65 in June 2013



Examples of Actions from the EGOS-IP

- **G55**: Increase ice buoy data coverage on the northern polar cap through a regular deployment of new drifters
- **S13**: Ensure the orbit coordination for all core meteorological missions in LEO orbit, in order to optimize temporal and spatial coverage, while maintaining some orbit redundancy. The LEO missions should include at least 3 operational sun-synchronous polar orbiting satellites with ECT equal to 13:30, 17:30 and 21:30 (local time).
- **S19**: Implement a water vapour channel (e.g. 6.7 μm) on the imager of all core meteorological polar-orbiting satellites to facilitate the derivation of polar winds from water vapour motion.
- **S35**: Plan and design a demonstration mission with visible/infra-red instruments onboard a HEO satellite with a highly elliptical orbit and a high inclination over the equator, in order to target a polar area. The aim is to obtain the same environmental observations with a quality similar to those obtained from GEO satellites.



Observing System Design

- Workshop on OSD planned in Geneva, 12-14 November 2013
 - Propose observing system design principles
 - Design principles for single technology observing systems
 - Design principles for composite observing systems
 - Capacity Development issues
 - e.g. quantify the benefits or potential benefits of different network densities for the driving application, using OSEs and OSSEs
 - Do cost-benefit analysis and work out how many can be afforded
 - Take account of other constraints: political, needs of secondary applications, etc.
 - Look at the potential for achieving synergies, and possible collaborations
 - Implement the affordable density





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Thank you for your attention

3. WIGOS Implementation

- Resolution 50 (Cg-16) – Implementation of WIGOS
- ...
- Considering *“the importance of WIGOS to the development and implementation of the Global Framework for Climate Services (GFCS) and the Global Cryosphere Watch (GCW)”*
- ...
- Recognizing that *“WIGOS will enable the evolution and integration of the observing system components of WMO and enhance collaboration with its partner organizations and programmes”*
- ... *“that WIGOS will enable WMO Members to better respond to natural hazards, improve environmental monitoring, and adapt to climate change and man-made environmental impacts, especially in developing and least developed countries”*
- ... *“that WIGOS will lead to cost-effectiveness and enhanced observing capabilities of Members”*
- ...
- Decides *“to implement WIGOS and that implementation activities will be undertaken during the next financial period as one of the major efforts of the Organization with the goal that WIGOS should become operational from 2016 onwards”*



WIGOS Framework Implementation Plan

- Key activity areas

1. Management of WIGOS Implementation
2. Collaboration with the WMO co-sponsored observing systems and international partner organizations and programmes
3. Design, planning and optimized evolution of WIGOS and its regional, sub-regional and national component observing systems
4. Observing System Operation and Maintenance
5. Quality Management (QM)
6. Standardization, System Interoperability and Data Compatibility
7. The WIGOS Operational Information Resource (WIR)
8. Data discovery, delivery and archival
9. Capacity development
10. Communications and outreach



WIGOS Framework Implementation

KAA#3 - Design, planning and optimized evolution of WIGOS and its regional, sub-regional and national component observing systems

- WIP is about integration of observing systems
- EGOS-IP is about optimized evolution of observing systems

KAA#7 - The WIGOS Operational Information Resource (WIR)

- Web portal – www.wmo.int/wigos/wir
- “Standardization of Observations” Reference Tool (SORT)
- Observing Systems Capability Analysis and Review Tool (OSCAR)
 - www.wmo.int/oscar
 - Observational User Requirements (operational)
 - Space-based observing system capabilities (operational)
 - Surface-based observing system capabilities (under development)

