World Meteorological Organization

Working together in weather, climate and water

WMO Integrated Global Observing System

Our Planet's Future Hub
for Weather, Climate, Water and Environment Observations

--CIMO/WIGOS Exploratory Workshop

Langen, Germany, 3-5 December 2014

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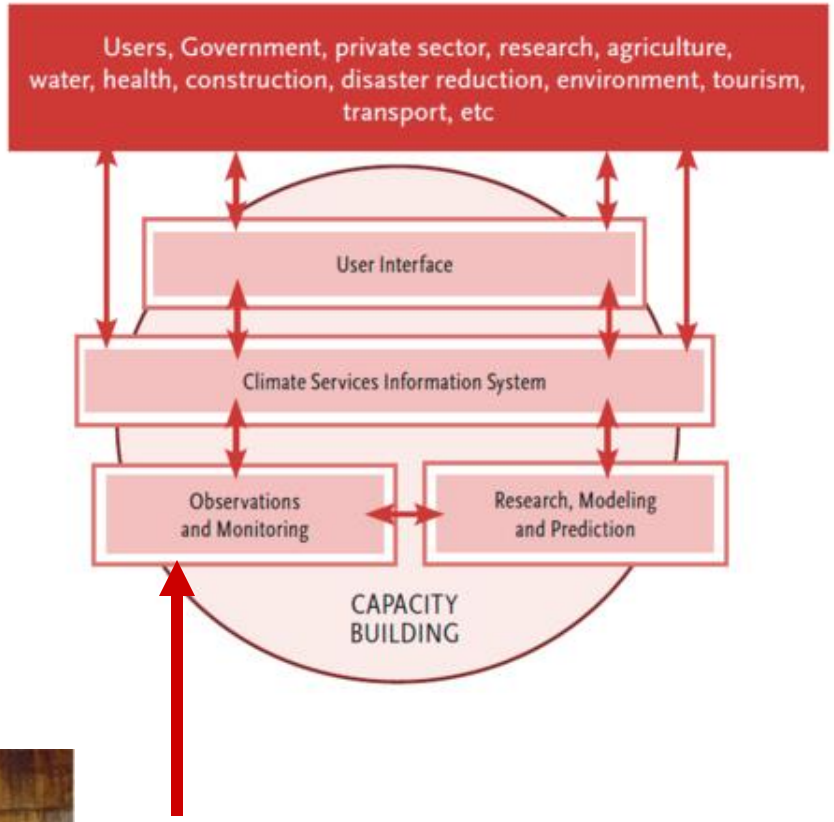
www.wmo.int/pages/prog/www/wigos/

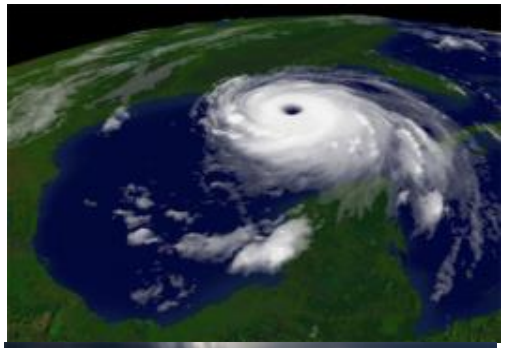
Outline

- Background: WIGOS Vision and Congress/EC Decisions
- WIGOS Key Activity Areas on Observational Quality Matters
- Some Considerations and examples
- Suggestions & Summary

WMO Cg-16 Decisions on key priorities for 2012-2015

- ✓ Global Framework for Climate Services (GFCS)
- ✓ Capacity building
- ✓ WIGOS/WIS
- ✓ Disaster Risk Reduction
- ✓ Aeronautical meteorology





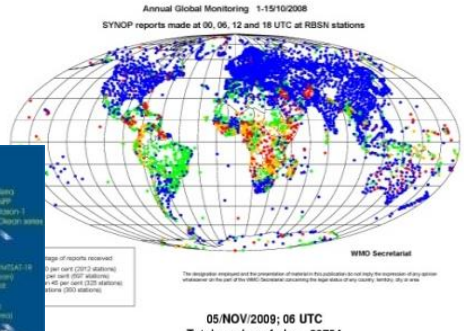
WIGOS Vision and Congress Decisions/Guidance

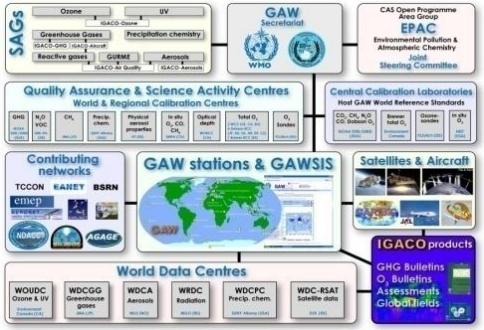
- The Sixteenth World Meteorological Congress decided that **enhanced integration of the WMO observing systems** should be pursued as **a strategic objective of WMO** and identified this as a major expected result of the WMO Strategic Plan.
- Congress request Executive Council:
    - **Monitor, guide & support the implementation of WIGOS;**
    - **Establish an Inter-Commission Coordination Group on WIGOS (ICG-WIGOS);**
- WIGOS VISION calls for**:**
  - **An integrated, coordinated and comprehensive observing system** to satisfy, in a **cost-effective and sustained manner**, the evolving observing requirements of Members in delivering their **weather, climate, water and related environmental services**.
- Furthermore, WIGOS will provide a framework for enabling the integration and **optimized evolution** of WMO observing systems, and of WMO's contribution to co-sponsored systems.

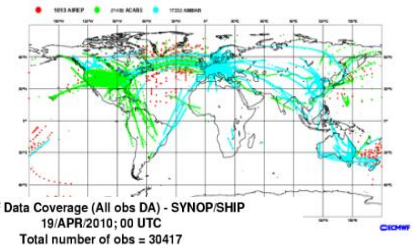
WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

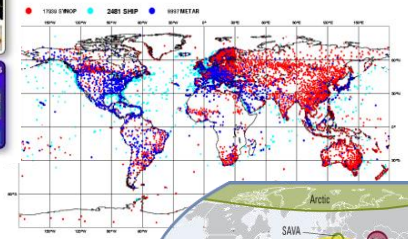
WMO Global Observing Systems

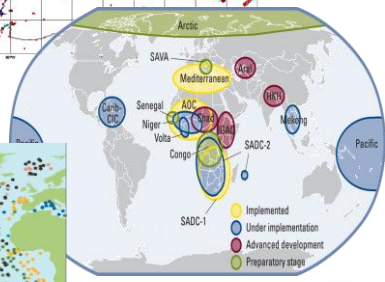
- Global Observing Systems (WWW/GOS)
  - RBSN, RBCN (>10,000 stations,1,000 upper-air)
  - AMDAR (39754/day)
  - Ship & Marine obs (30417/day)
  - Surface-based remote sensing(radars)
  - Meso-scale networks
- WMO Space Programme
- Global Atmospheric Watch (GAW)
- World Hydrological Cycle Observing System (WHYCOS)
- WMO Co-sponsored Observing Systems
  - GCOS, GOOS, GTOS

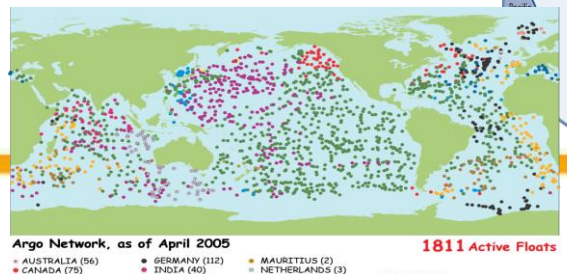










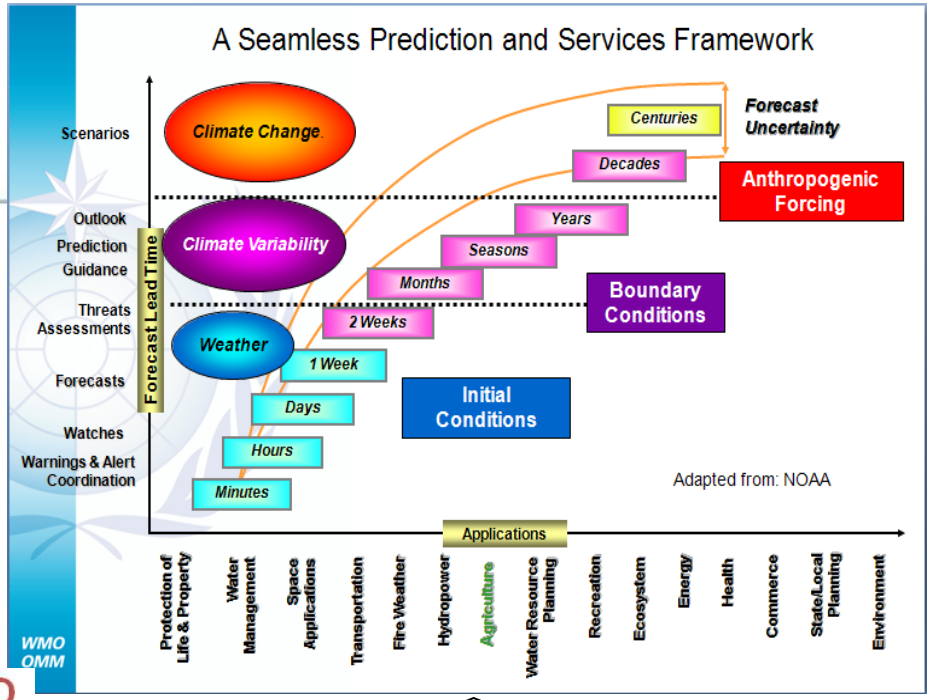


WIGOS: A future observing framework for WMO by integrating observing components

Cg-16 (2011) decided to Implement WIGOS

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

The whole is more than the sum of the parts—Aristotle



WIGOS: A future observing framework for WMO

Need an Integrated Global Observing System to meet all requirements in a cost – effective manner

Outline

- Background: WIGOS Vision and Congress/EC Decisions
- **WIGOS Key Activity Areas on Observational Quality Matters**
- Some Considerations and examples
- Suggestions & Summary

EC 64 (2012) approved WIGOS Framework Implementation Plan (Global plan)

CONTENTS

1. Introduction and Background
2. Key Activity Areas for WIGOS Implementation
3. Project Management
4. Implementation
5. Resources
6. Risk Management
7. Outlook

Annexes

KEY ACTIVITY AREAS

1) Management of WIGOS implementation (EC, RAs, TCs, ICG)
2) Collaboration with WMO and co-sponsored observing systems
3) Design, planning and optimized evolution
4) Integrated Observing System operation and maintenance
5) Integrated Quality Management
6) Standardization, system interoperability and data compatibility
7) The WIGOS Operational Information Resource
8) Data and metadata management, delivery and archival
9) Capacity development
10) Communication and outreach

WIGOS Framework Implementation Plan

Key Activity Area 5: Integrated quality management

Develop WIGOS **Quality Management guidance, mechanism, practices and procedures** to include monitoring	2014	ICG-WIGOS TT-WIGOS QM TCs
Examination of **current quality management practices** being used by WMO observing programmes.	2014	ICG-WIGOS TT-WIGOS QM

WIGOS Framework Implementation Plan

Key Activity Area 6: Standardization, system interoperability and data compatibility

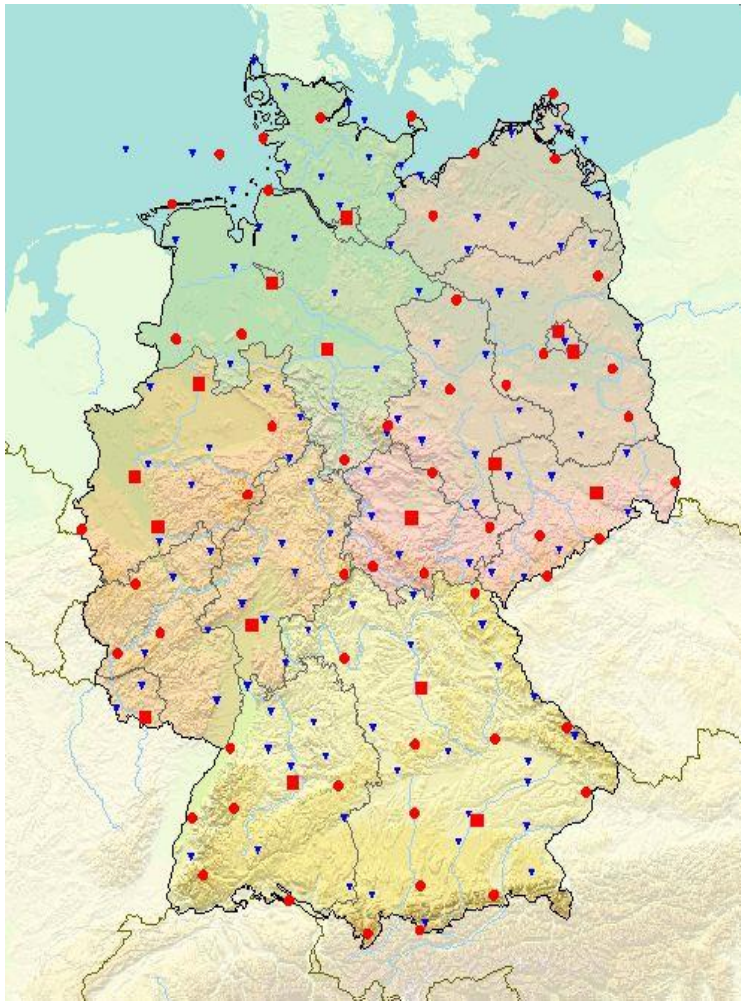
Develop **guidance for WIGOS standards and document the implemented standards**, including best practices, procedures on instruments, methods of observations, data products, etc.	2014	TCs WIGOS PO
Develop and maintain the **Standardization, Operational and RRR databases**.	Cg-17	ICG-WIGOS

One of the major WIGOS achievements – more observations

Cases: Germany, China, Africa (Côte d'Ivoire & Taniasina)

Stations operated by Deutscher Wetterdienst (main stations)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



➔ **4 Regional Oberserving Network Groups**
Hamburg, Potsdam, Offenbach, Munich

➔ **68 Stations with professional Observers**,
38 occupied 00-24 UTC, 30 only daytime
48 measuring radioactivity (air+precipitation)
28 RBSN Stations
12 Climate Reference (conventional Equipment)
4 GSN-Stations (GCOS)
1 GUAN Station
1 GAW Station

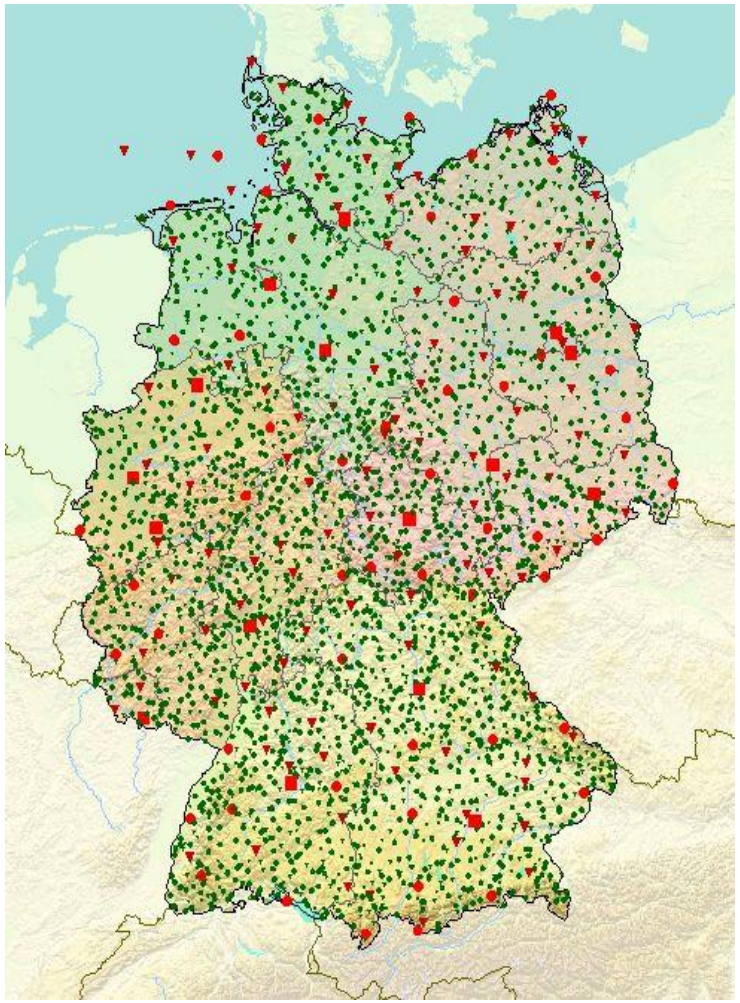
➔ **112 Automated Weather Stations** with full equipment

➔ **17 Weather Radar Stations**

➔ **9 Aerological Stations (4 autolaunchers, 1 ozone)**

➔ **4 Wind Profilers**

Additional Stations operated by DWD and Partners



➔ **1787 Voluntary Stations (climate; wind; precip)**, **1367 reporting online** (24/1 reports per day)

Ship-based:

➔ **844 Voluntary Observing Ships (VOS)**

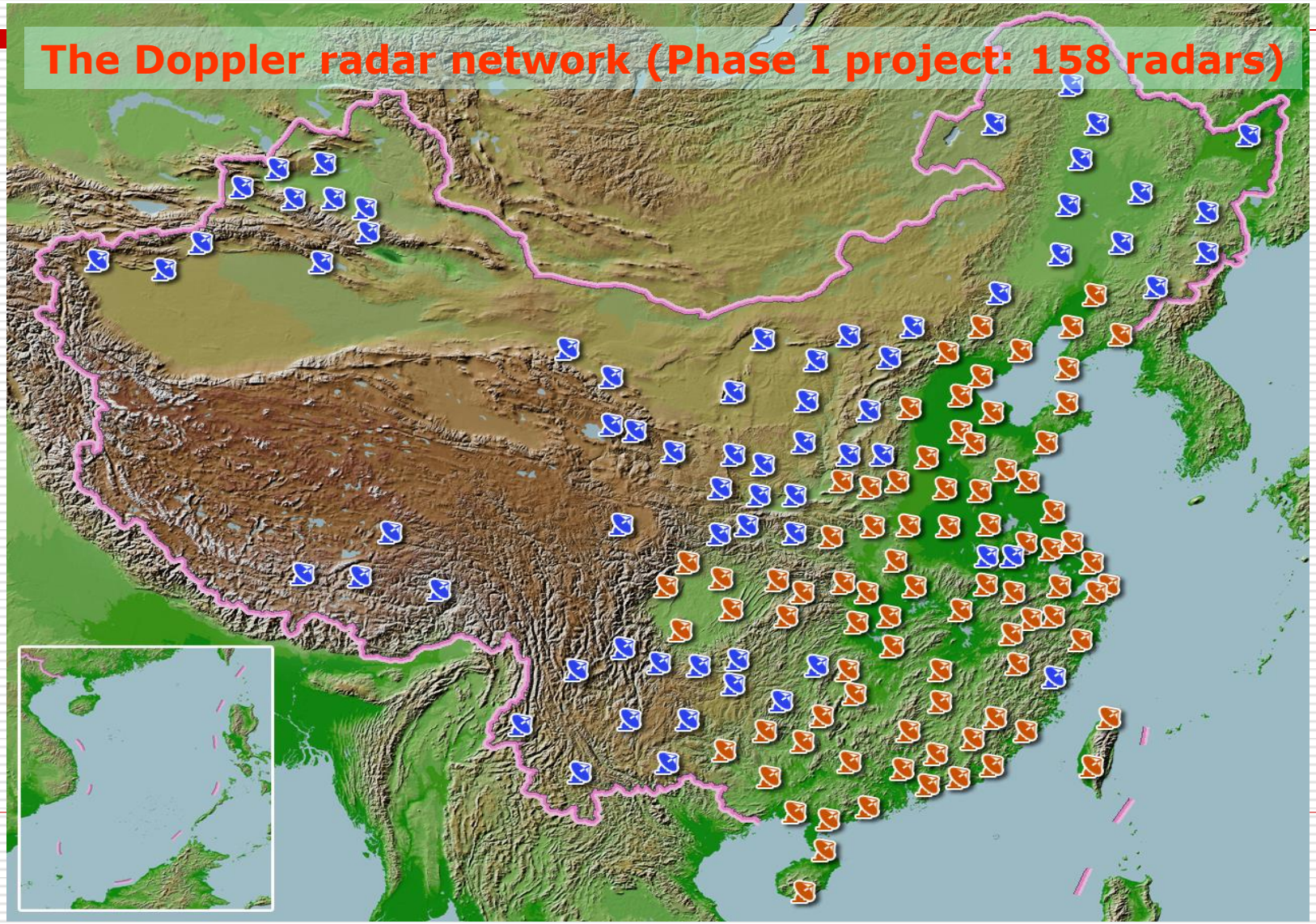
➔ **19 Ship (AWS)** (24 reports/day)

Last but not least …:

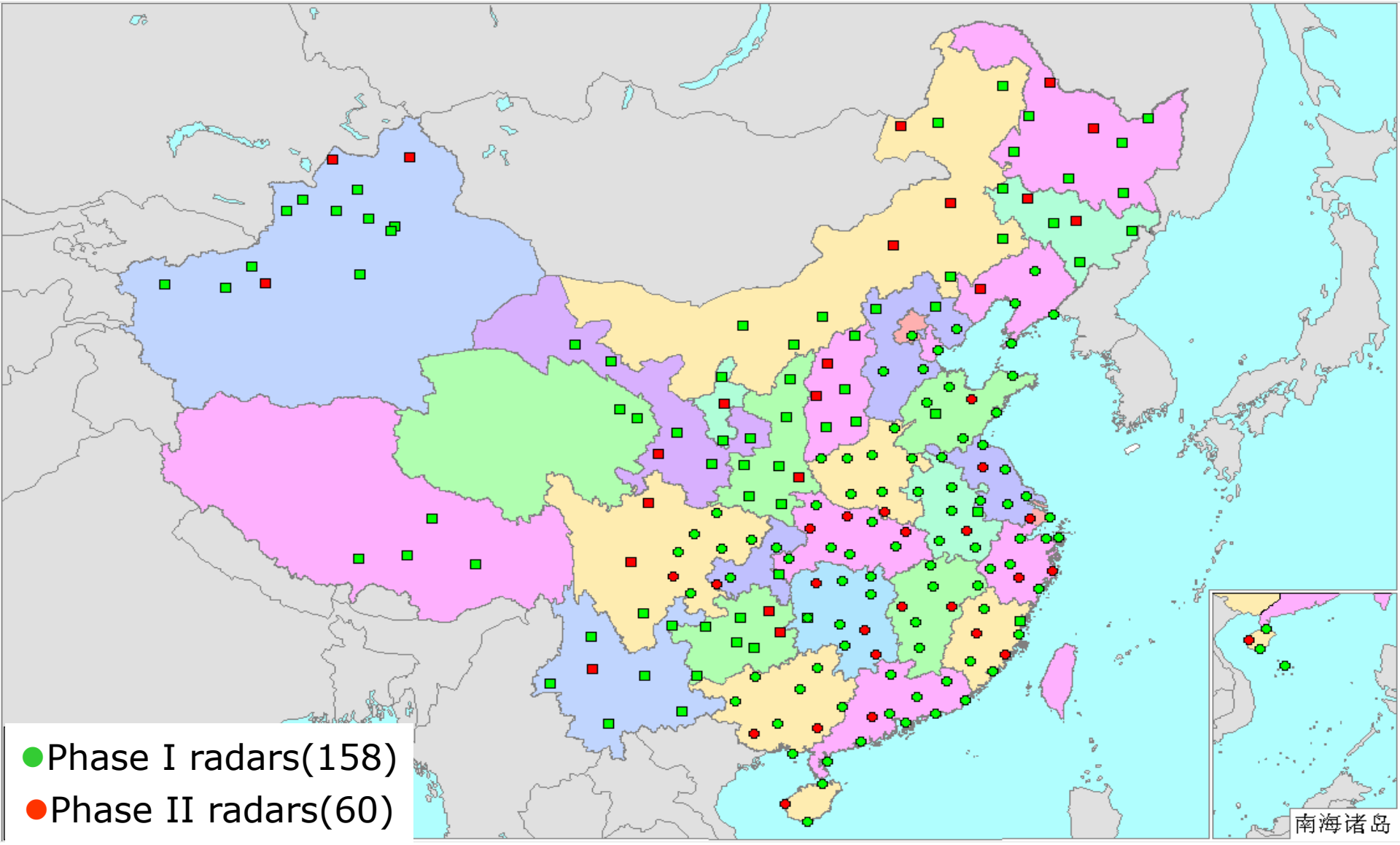
➔ **1304 Phenological** Stations (observing plants)

➔ **1500** (approx) **Partner stations** (motorways, fed.states, wind energy, (nuclear) power-plants, university, military)

The top priority of optimization to synoptic observing network is to extend Radar network. **In order to monitor severe weather CMA planed to supplement Doppler Radar. It is vital for China to have a completely coverage to convective region.**

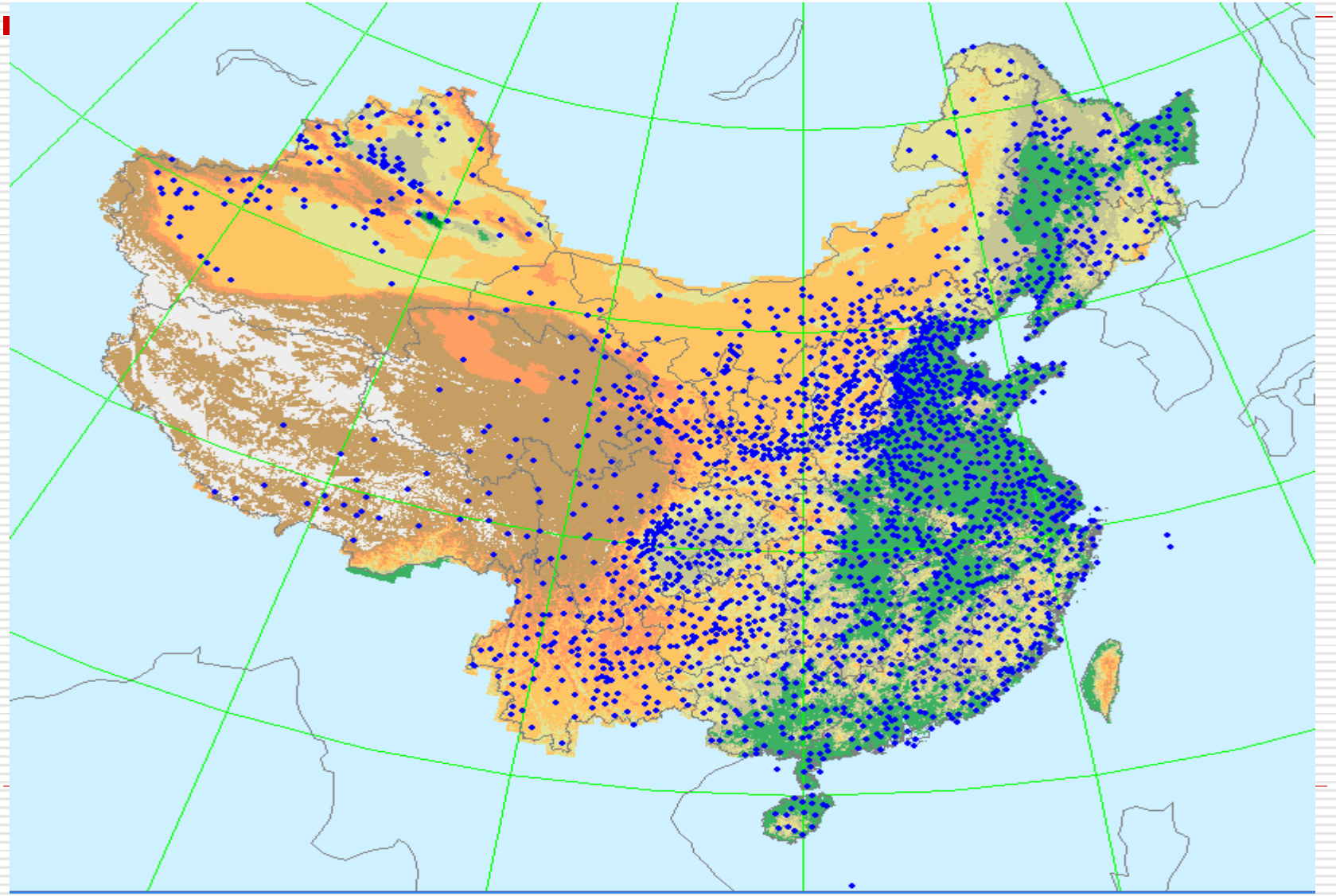


We plan to supplement Doppler radars to 218 from 158. This project has been approved. Target: 1) Enlarging coverage, 2) filling data gap, 3) backuping in key area such as Metropolis, convective region, Coastal area, populated, economic developed, etc.



Secondly priority of optimization to synoptic observing network is to increase the synoptic stations (level 1, hourly observations) from 530 to 900 with the help of automation technology. Most of newly upgraded stations are located in western area (Tibet-plateau).

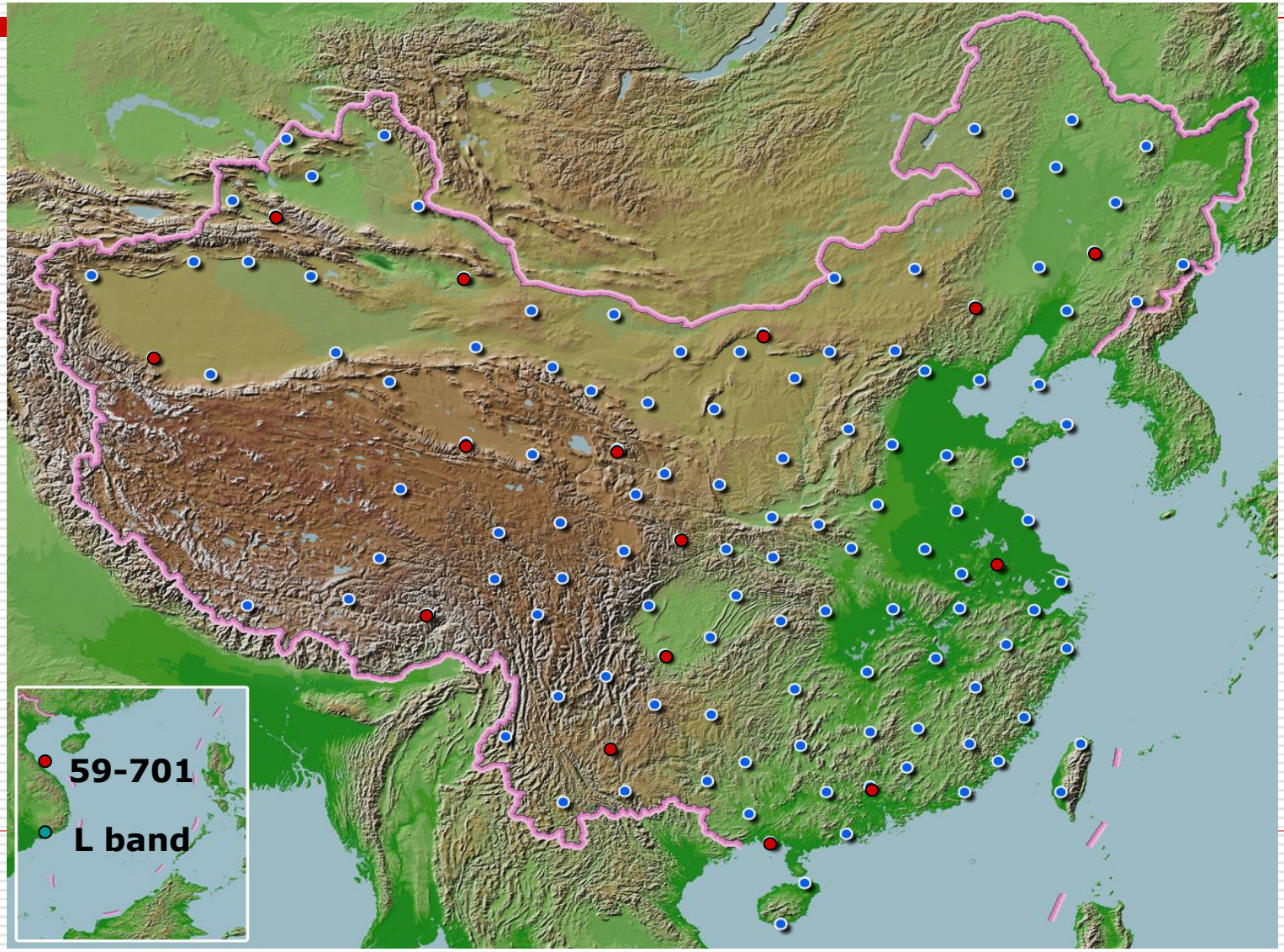
Optimization to meso-scale observing network is to deploy AWSs by higher spatial and temporal observation in key area such as populated, economic developed and/or disaster frequently happened regions. Today there are more than 40000 AWS deployed in China. These are mainly surface AWS with rainfall, wind, temperature, pressure, humidity.



The third priority is to upgrade upper-air sounding network with apparent improvement in measurement accuracy and data delivery.

1) 100 sounding system upgraded to L band, new radiosonde

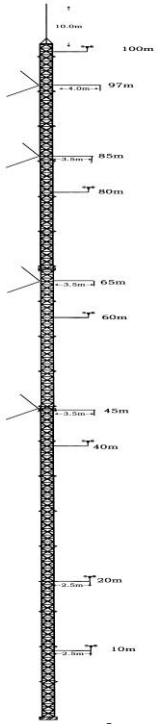
2) The rest 20 system will be upgraded before 2011.



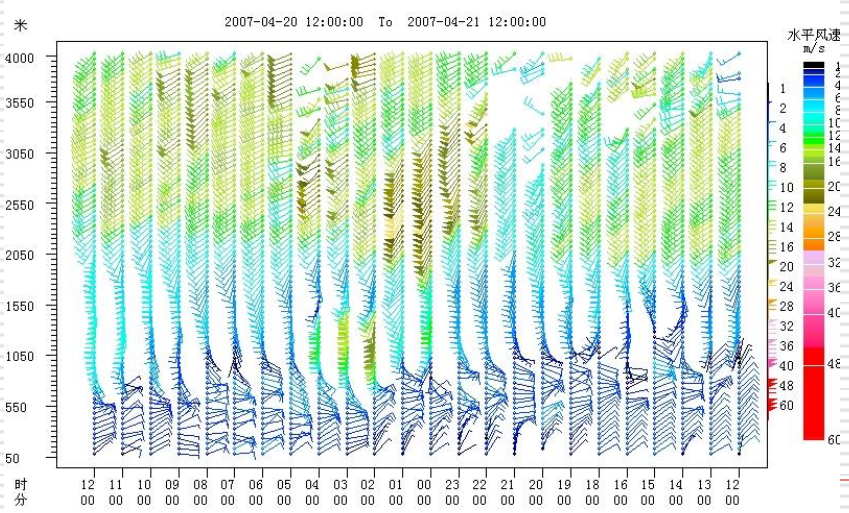
Some of the instruments at coastal climate observatory

Boundary Wind profile

Visibility

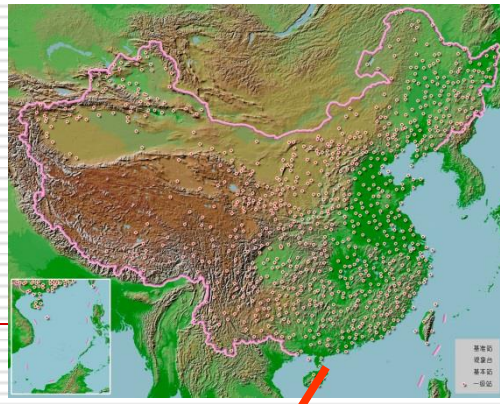


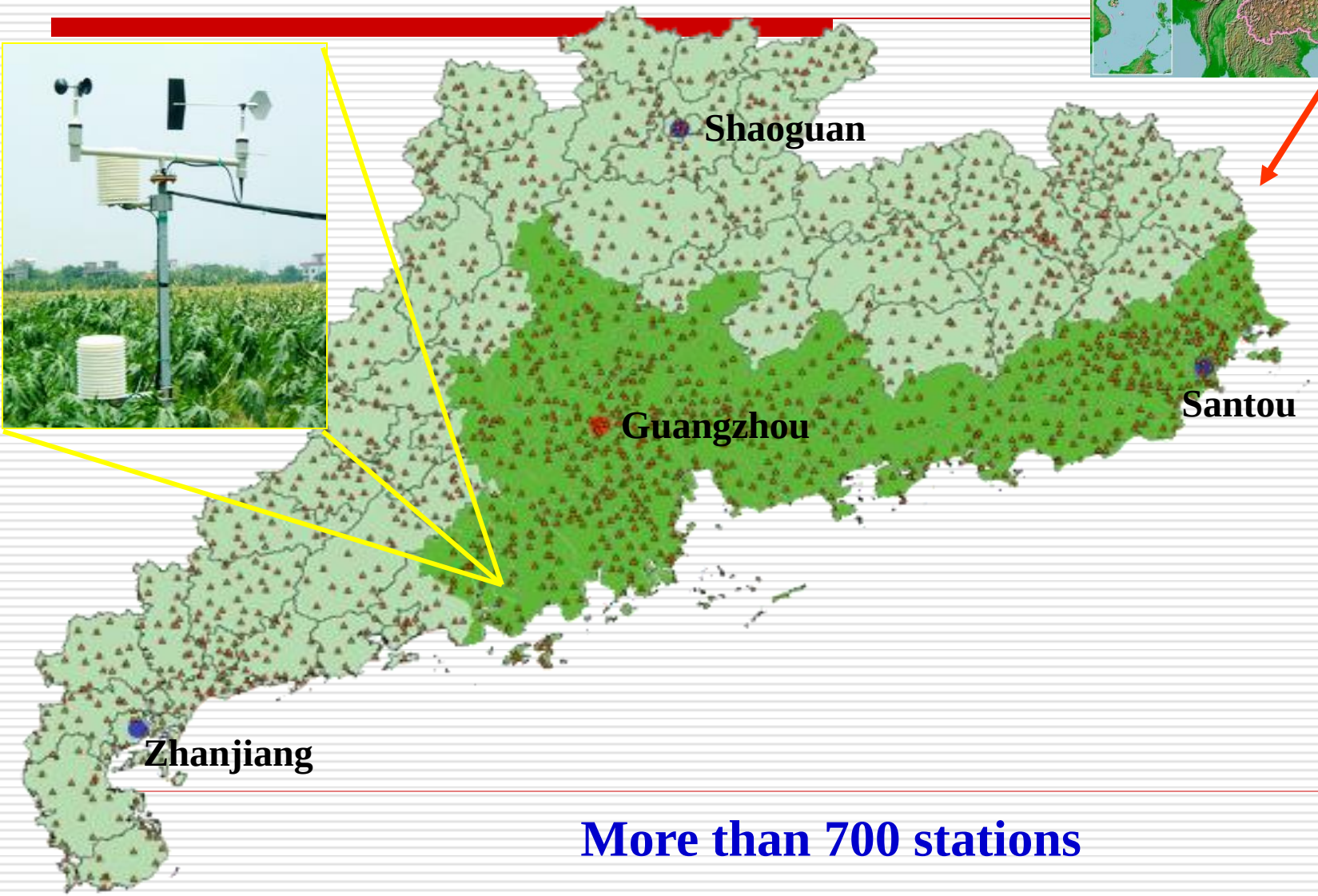
Grade



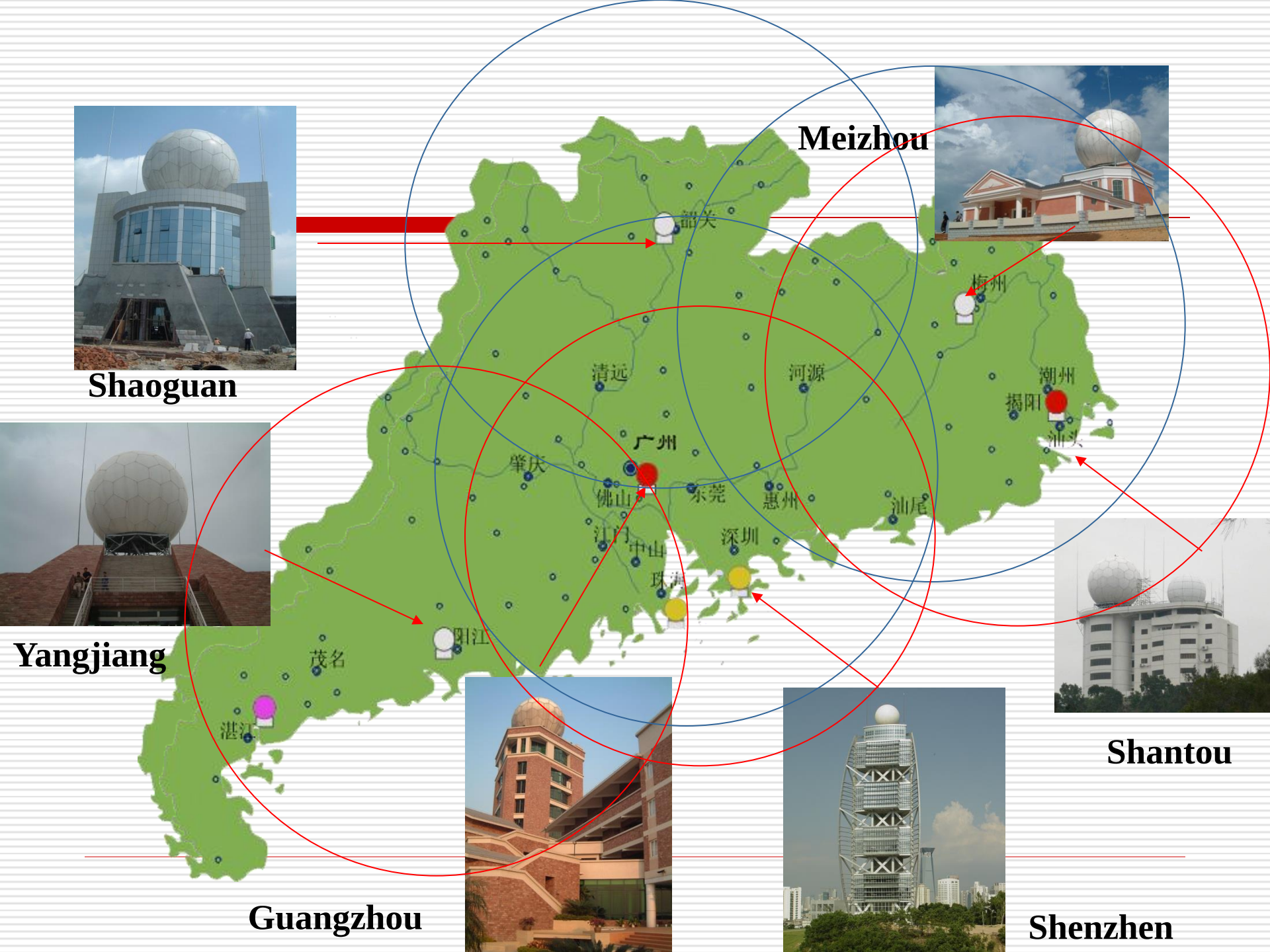
Optimization of GAW network: **Established 6 regional atmospheric watch stations. So currently the GAW network consists 7 stations, one GAW plus six regional atmospheric watch stations. They are an integrated component of CCOS.**

Example: Regional AWS network in Guangdong with more than 700 AWSs. The measured data are sent up to local meteorological bureau and CMA every 10 minutes. These data are both very helpful to shorter-range weather forecast and to the warning, services, etc.



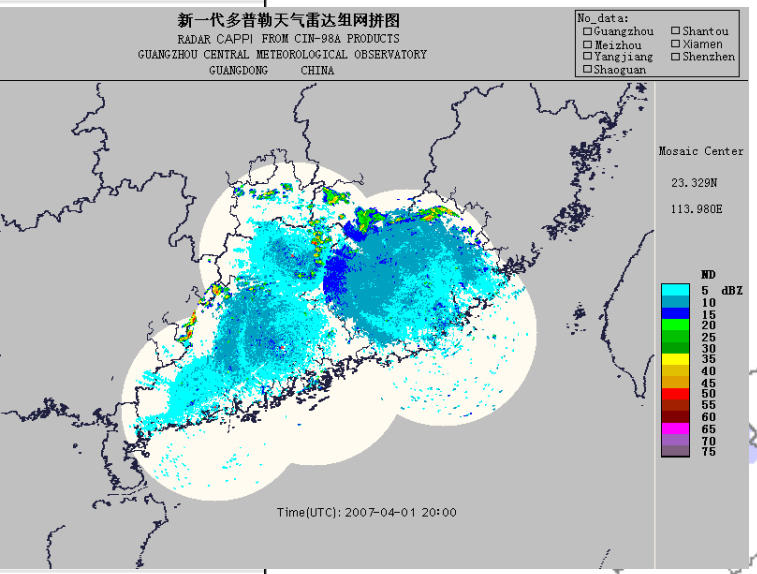


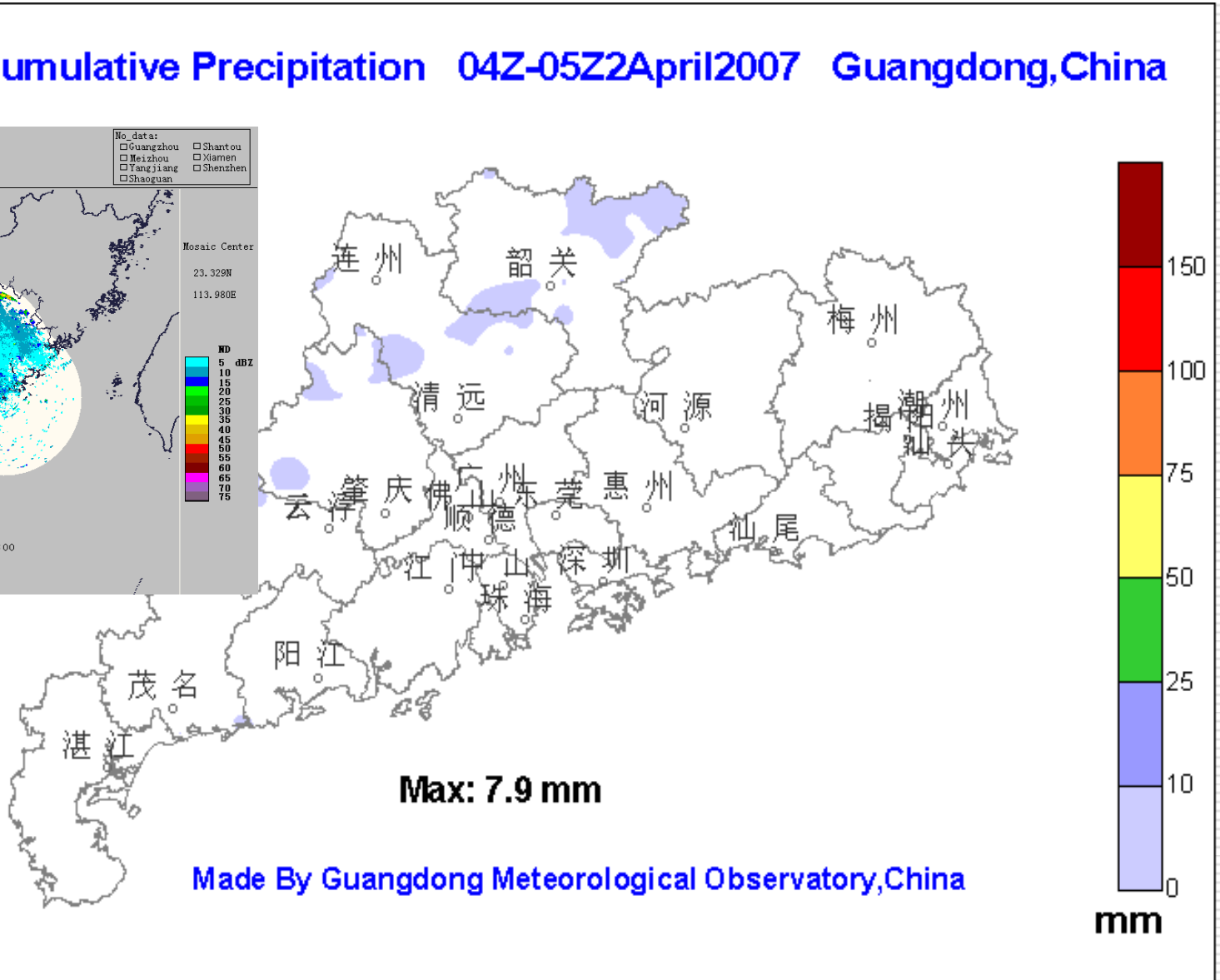
More than 700 stations


Meizhou
Shaoguan
Yangjiang
Shantou
Guangzhou
Shenzhen
韶关
梅州
清远
河源
潮州
揭阳
汕头
广州
肇庆
佛山
东莞
惠州
汕尾
江门
中山
深圳
珠海
阳江
茂名
湛江

Data utilization: **The AWS's data are calibrated with Doppler radar data.**

1) improving forecasting; 2) real time warning; 3) satellite rainfall algorithm development, CAL/VAL; 4) information services to the local information networks (citizen, farmers, etc).

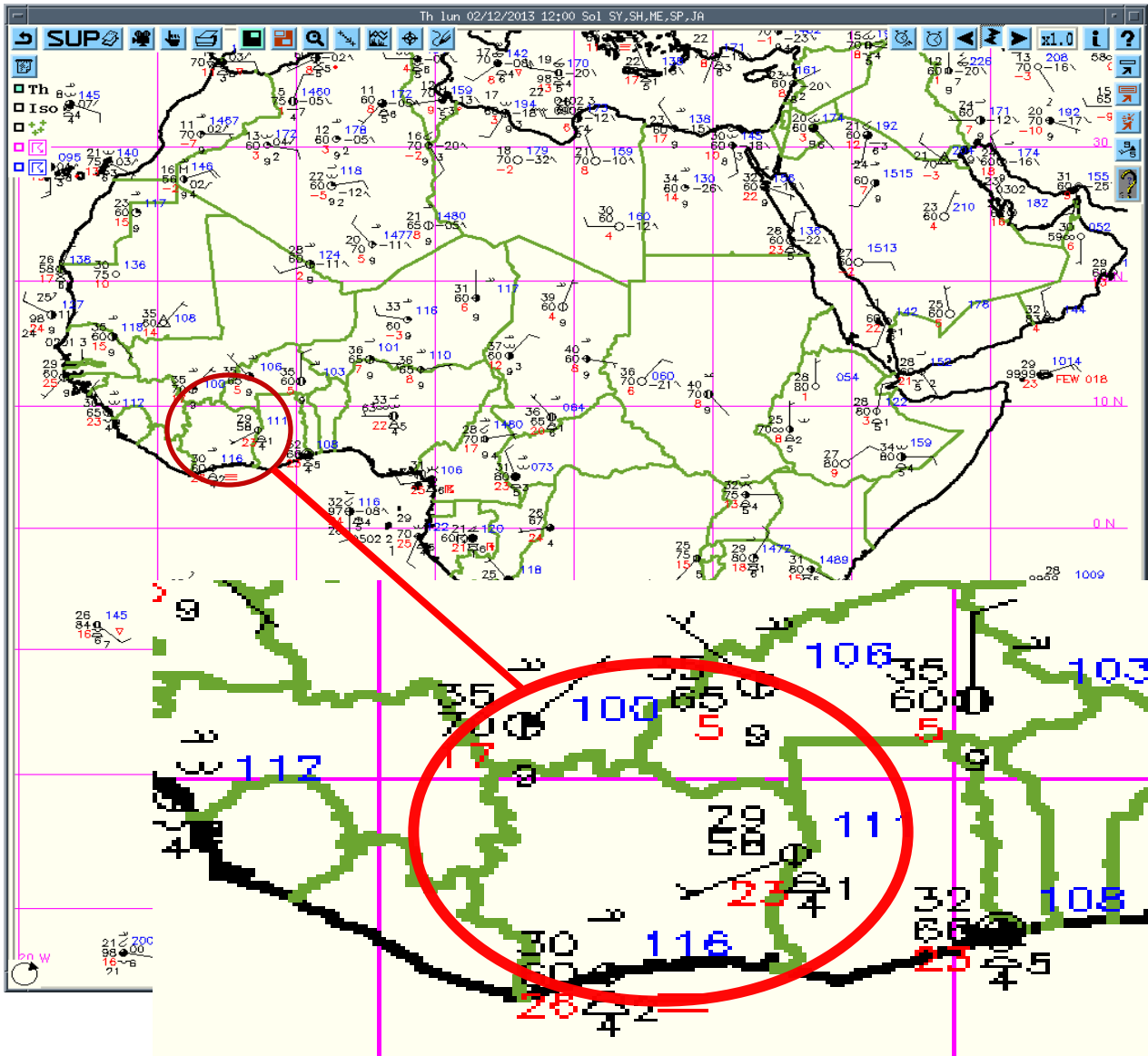




1. Introdution : Côte d'Ivoire
Geographical location

. Côte d'Ivoire is in west Africa

bordered in the north by Mali and Burkina Faso, in the west by Guinea and Liberia, in the east by Ghana and in the south by Atlantic ocean

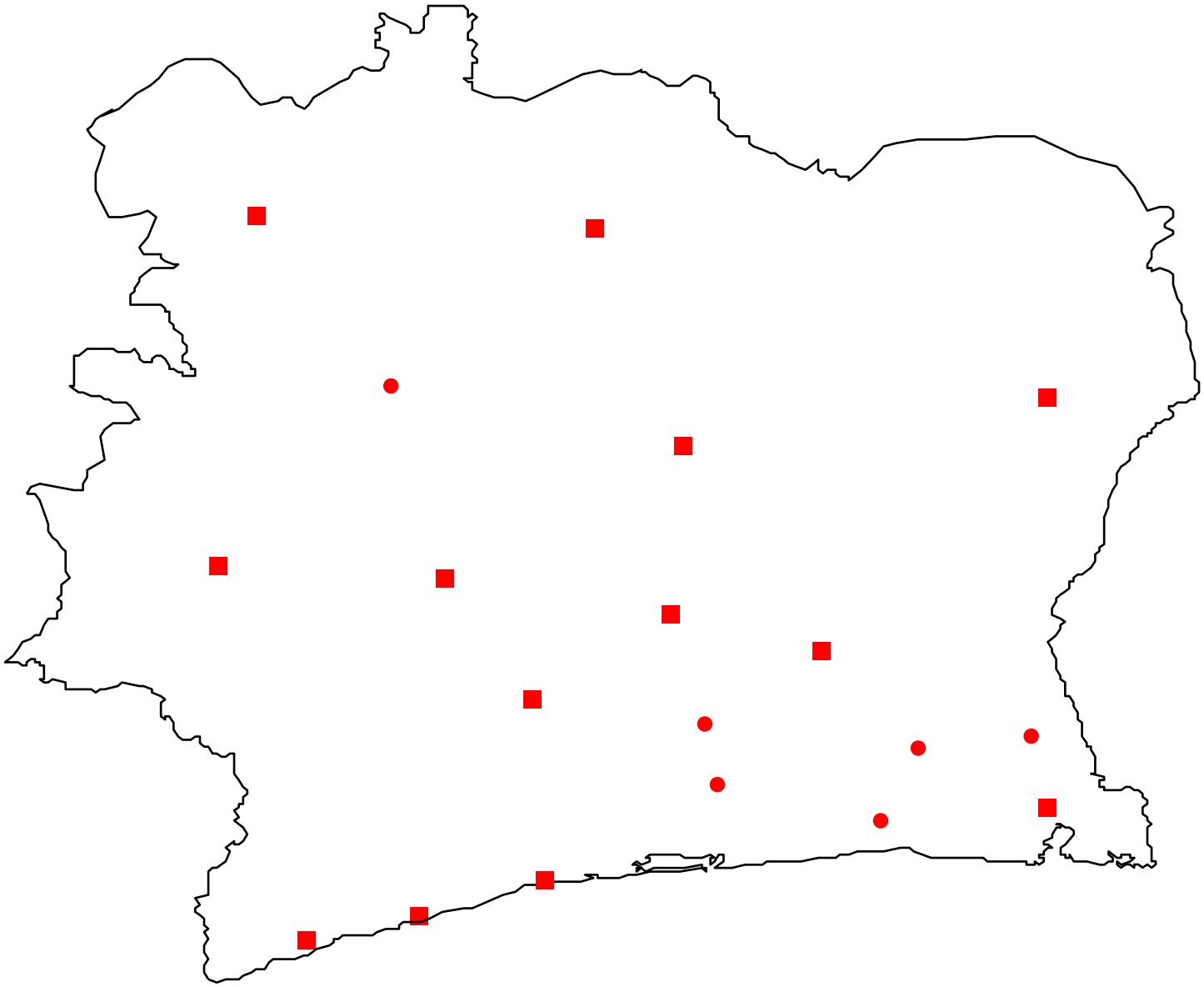


2. CMS observation Network

Type de stations	QTE	Automatic OR Manual	operational	silent
SYNOPTIC	13	2 new AWS 11 Manual	11	2
CLIMATOLOGICAL	6	Manuel	2	4
RAINFALL	183	Manuel	77	106

2. CMS observation Network

- synoptic
- climatology



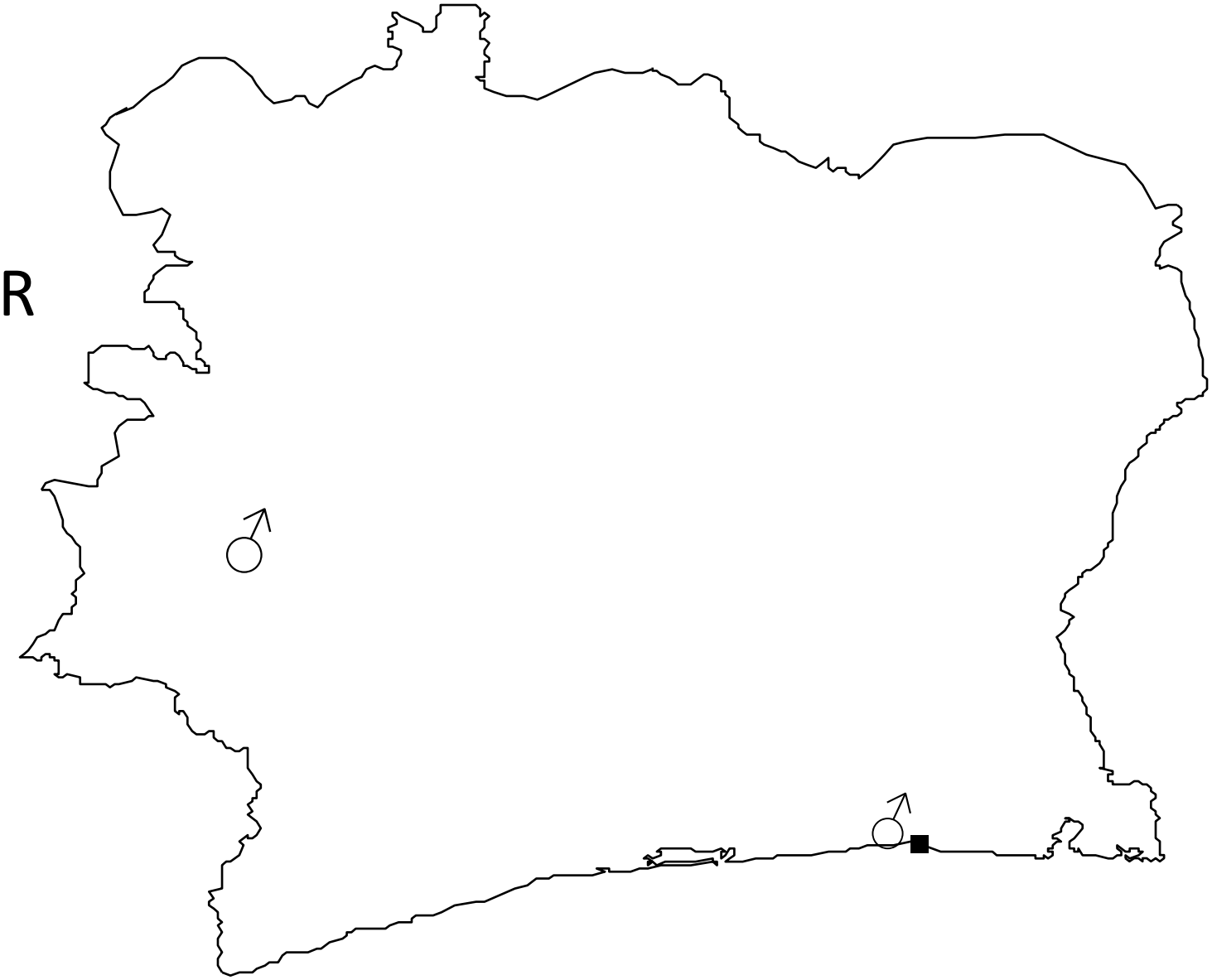
3.2 information on partners station

Key patners	domains	Station qty	Station position card
ASECNA	Synoptic, upper air	1 AWS, 2 upper air	ok
CNRA	Agromet, rainfall	27 agromet	ok
ANADER	agrometeoroly	Not yet answer	
CRO	oceanology	9 topograpgy level, 2 sea surface temp, 1 maregraphy,1 laboratory	ok
IHH	hydrology	173 hydrology	ok
CIAPOL	air and water quality	85 (salinity, temperature,)	no
MINISTRY AGRI	agrometerology	1 sattilite image for agriculture	no
MINISTRY ENV	environment	Not yet answer	

3.2.1 Partners 1: **ASECNA**

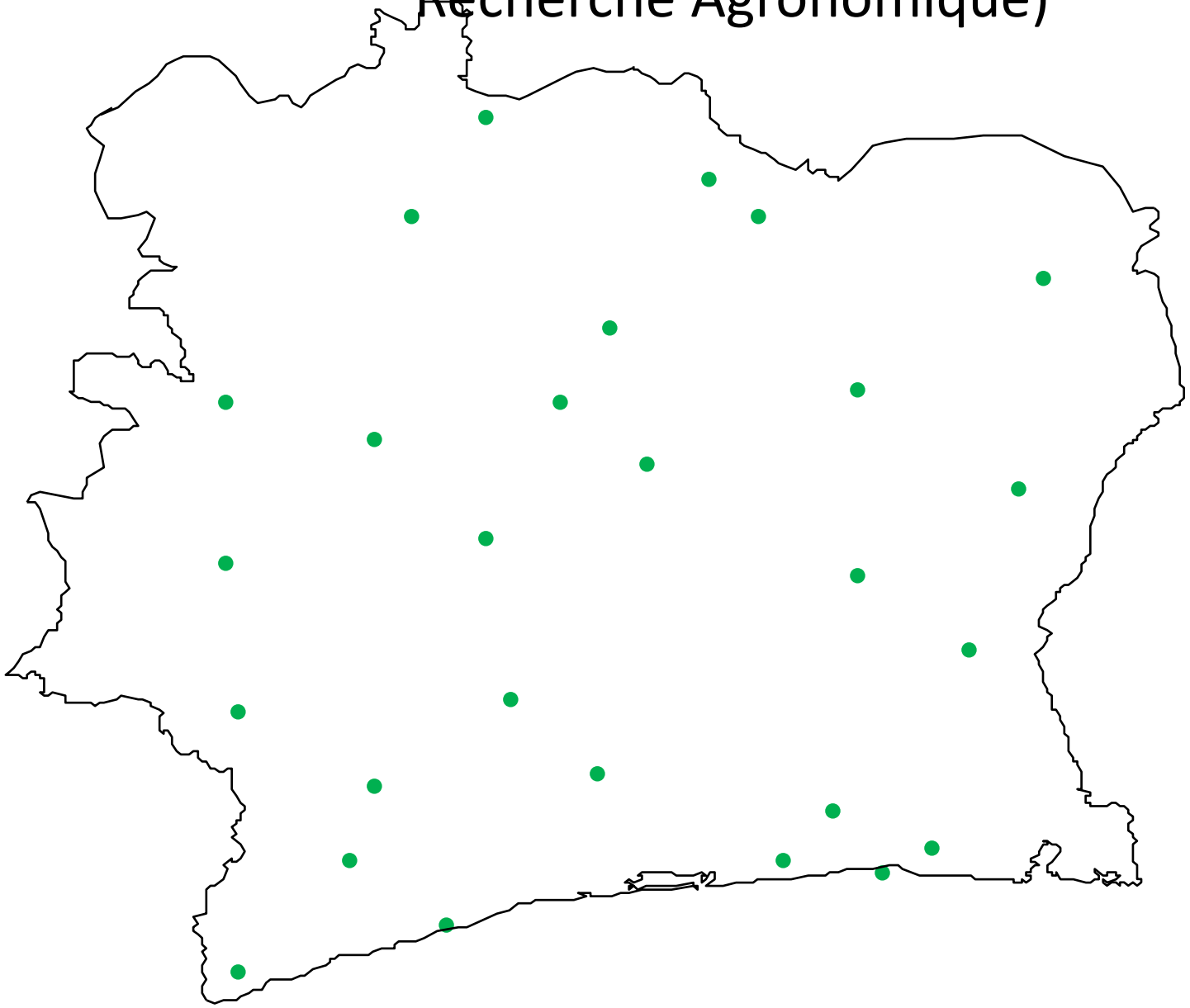
♂ UPPER AIR

- **SYNOPTIC**



3.2.2 Partners 2 : **CNRA (**Centre National de Recherche Agronomique)

- **agromet**

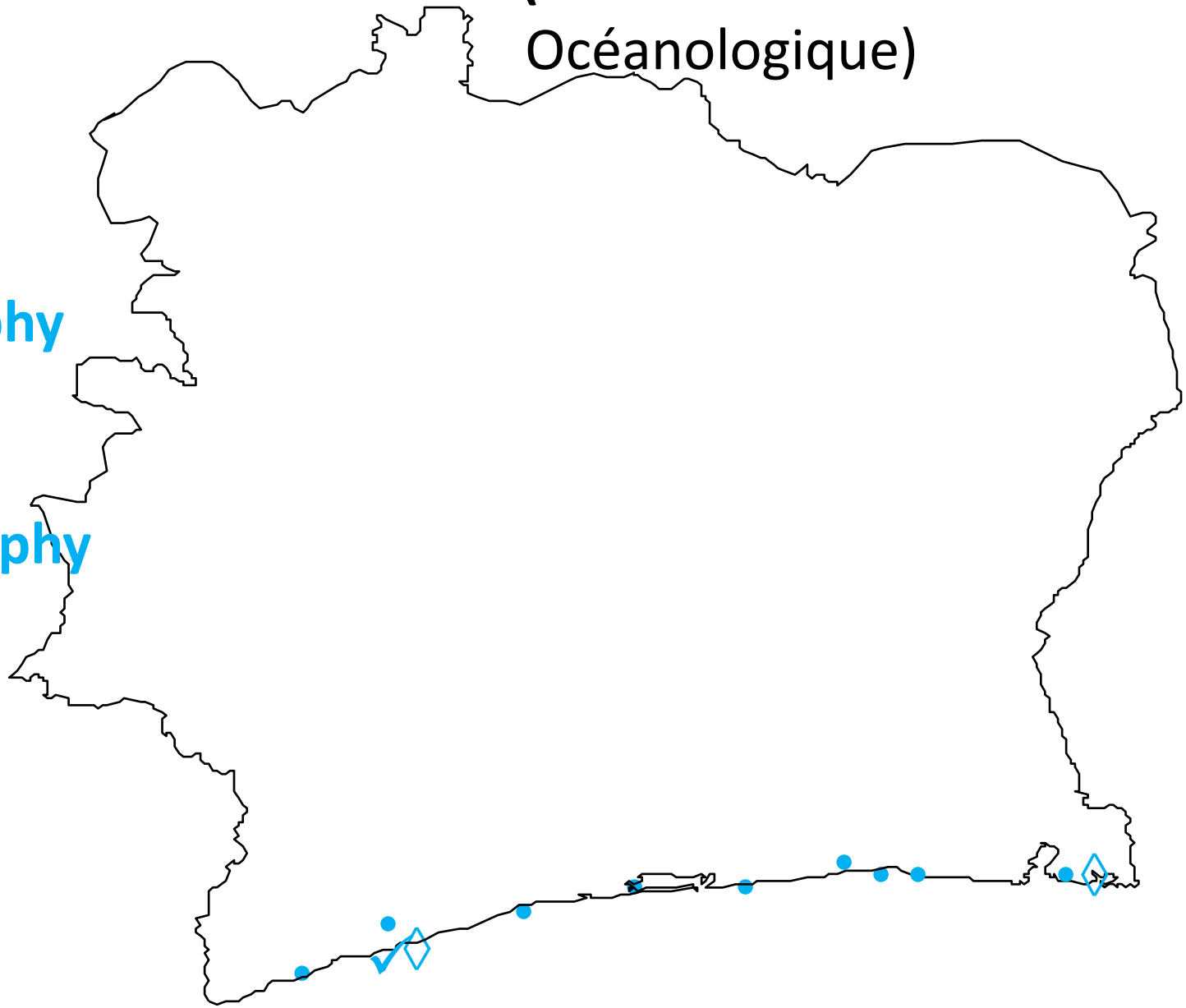


3.2.2 Partners 3 : **CRO(**Centre de Recherche Océanologique)

- **topography**

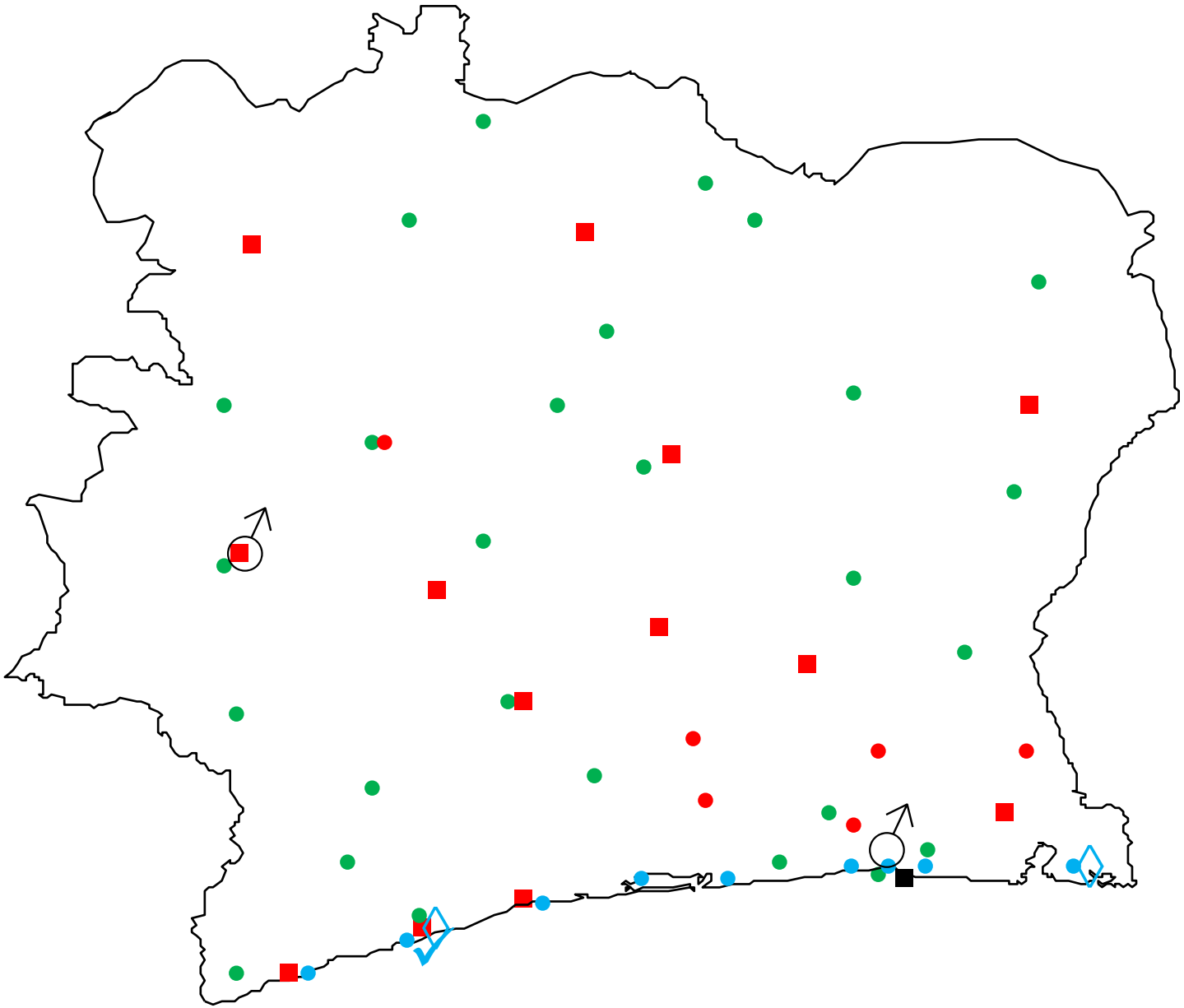
◊ **SST**

✓ **maregraphy**



Togother we will have

CMS
ASECNA
CNRA
CRO



3.4 other partners identified

Station owners

- CIDT
- IVOIRE COTON
- FHB University
- NA University
- Water resource Direction
- SAPH
- Abidjan Hasbourg
- San pedro Hasbourg

Data user who can help CMS

- National program of Climate change (PNCC)
- RCC
- BNETD
- Electricity company
- Water distrution company
- PETROCI
- FIRCA

Location

Mediterranean Sea
Atlantic
Ocean
Indian
Ocean
www.theworldatlas.net

UGANDA
KENYA
RWANDA
LAKE VICTORIA
SERENGETI
Ngoro Ngoro
MT. KILI-MANJARO
Burundi
Lake Manyara
ARUSHA
Tarangire
Pemba
TANZANIA
Zanzibar
Lake Tanganyika
RUNGWA & RUAHA
DAR ES SALAAM
Mafia
SELOUS GAME RESERVE
INDIAN OCEAN
ZAMBIA
Lake Malawi
MALAWI
MOZAMBIQUE

WIGOS

2.0 TMA OBSERVATION NETWORK Current

TYPE OF OBSERVATION STATIONS	AMOUNT
SYNOPTIC STATIONS	28
AWS	14
AGRO-METEOROLOGICAL	13
CLIMATOLOGICAL	61
RAINFALL	2056
UPPER AIR	4
MARINE OBSERVATIONS DRIFTERS RECENTLY DEPLOYED	4
METEOROLOGICAL RADARS	2

TMA WIGOS IMPLEMENTATION PLAN

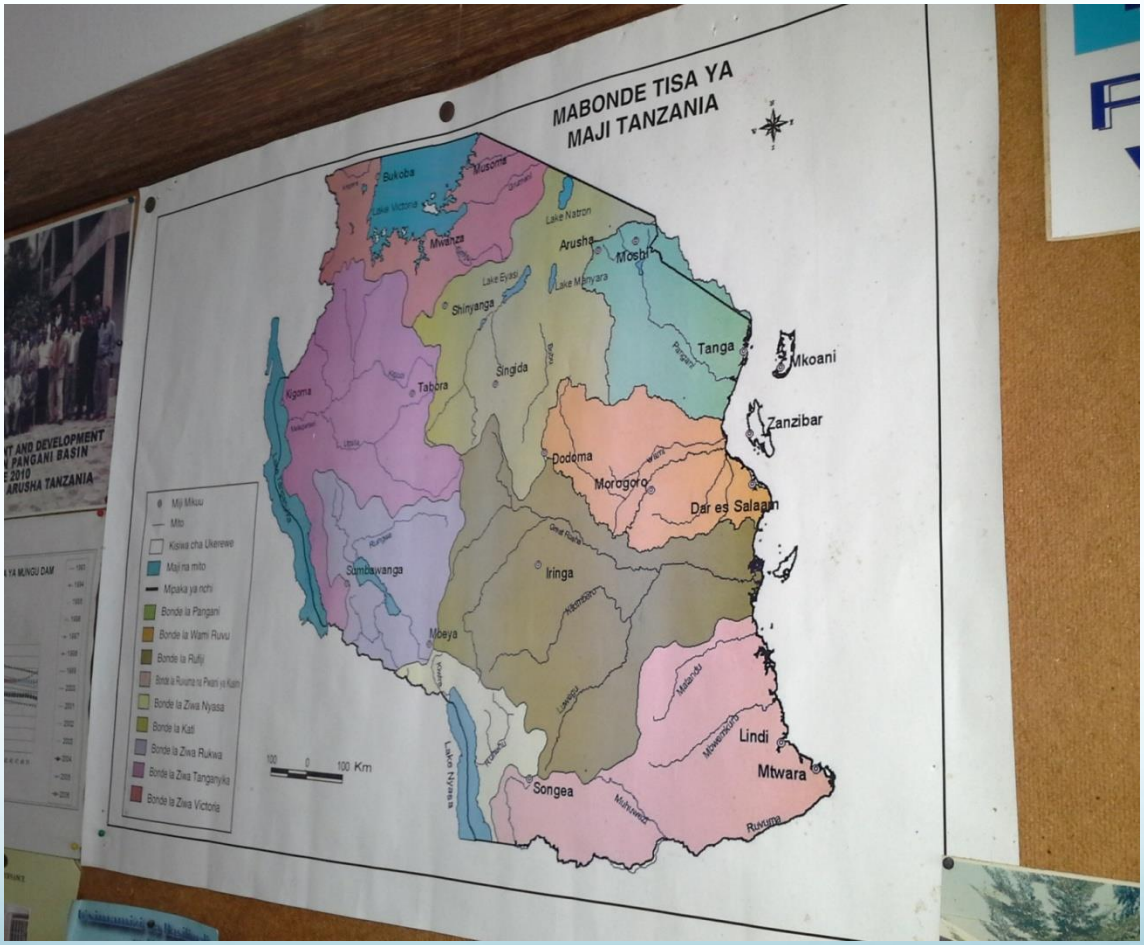
TMA in Large farms and Agricultural Research Institutes

Agromet research-seriani-Arusha

Farmers in green houses

WIGOS

TMA in the Water Basins



TMA at Water Basins

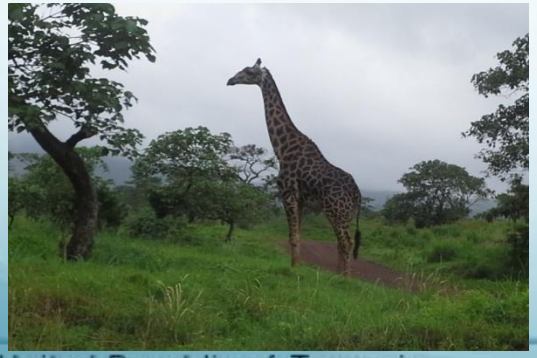
Synoptic station and AWS owned by Pangani water basin-Tengeru **Arusha**

Source:TMA

WIGOS

TMA in the National Parks

Rainfall station-Arusha national Park



Rainfall station-Manyara national park

WIGOS

TMA in the National Parks

WIGOS

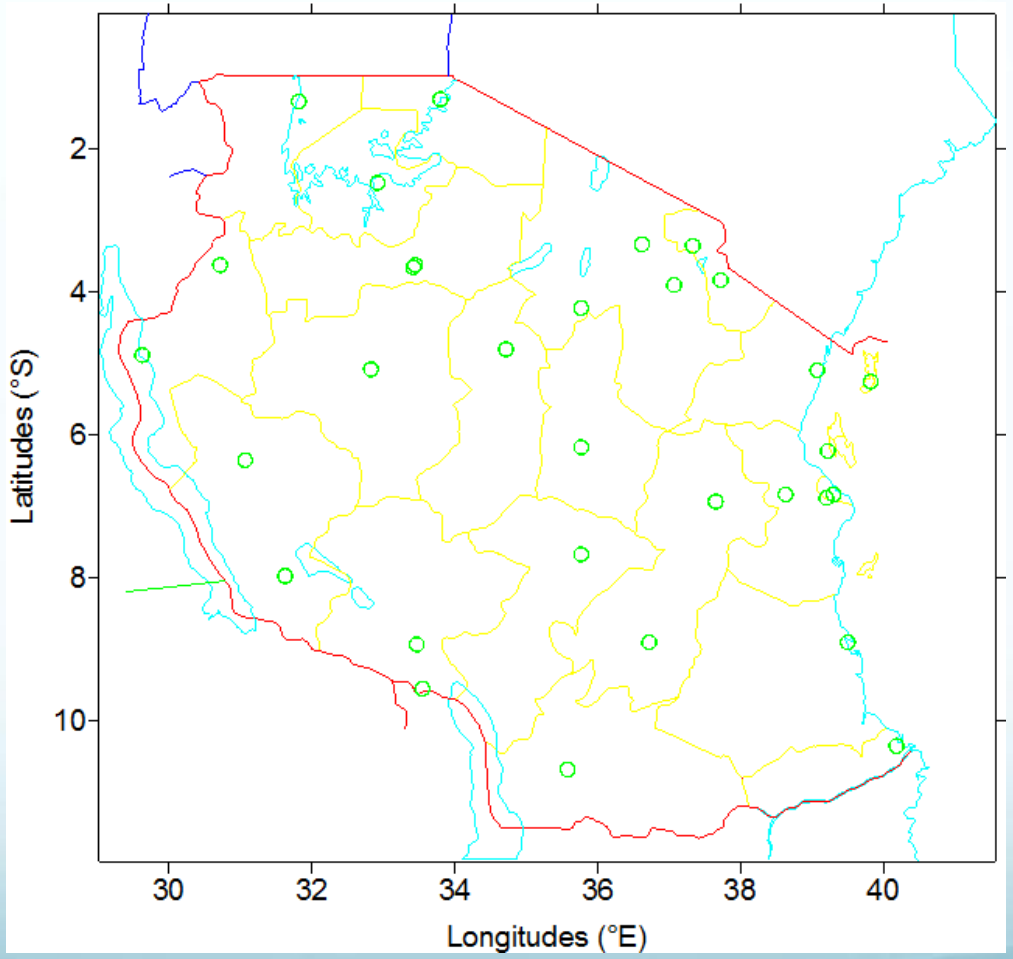
IDENTIFIED NETWORK OF OBSERVATION SYSTEMS OUTSIDE TMA

Current

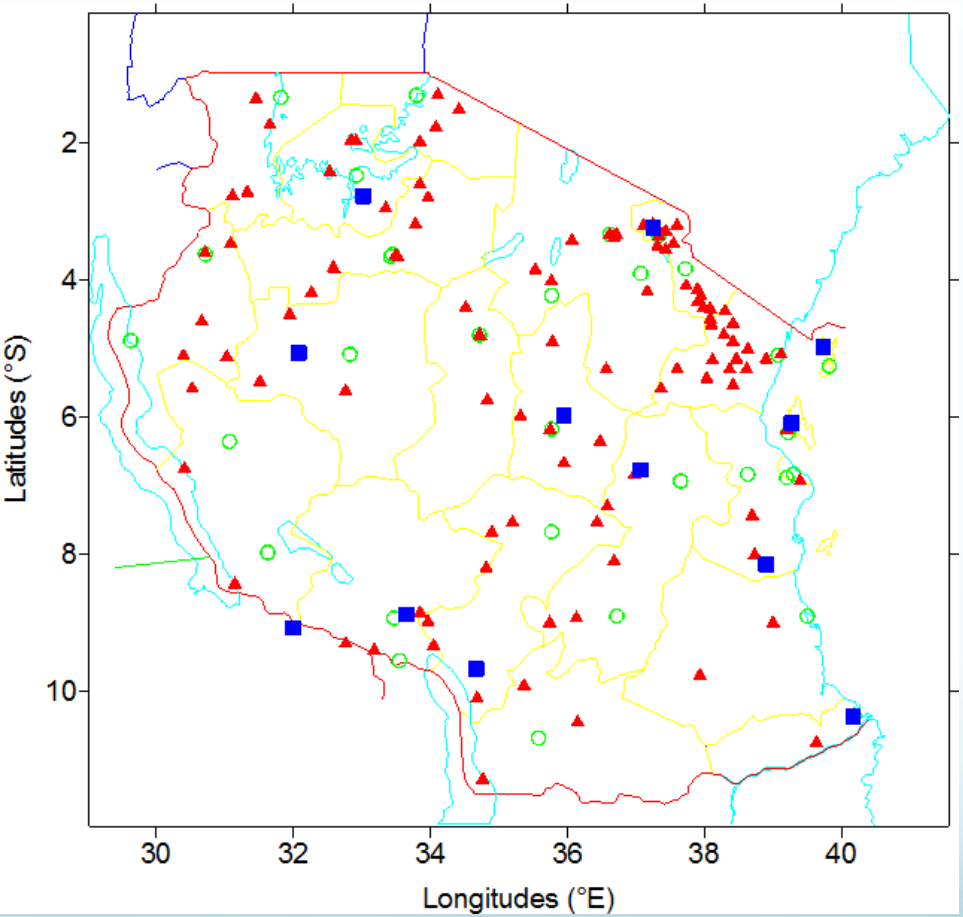
STAKEHOLDERS	STATIONS
MINISTRY OF WATER (9 WATER BASINS)	•AWS •Surface manned synoptic stations •Rainfall stations
TANZANIA NATIONAL PARKS	
FLOWER AND FRUIT FARMS	
RESEARCH INSTITUTIONS	
OIL COMPANIES (STATOIL,PETROBRAS	

WIGOS

TMA Current Synoptic Stations

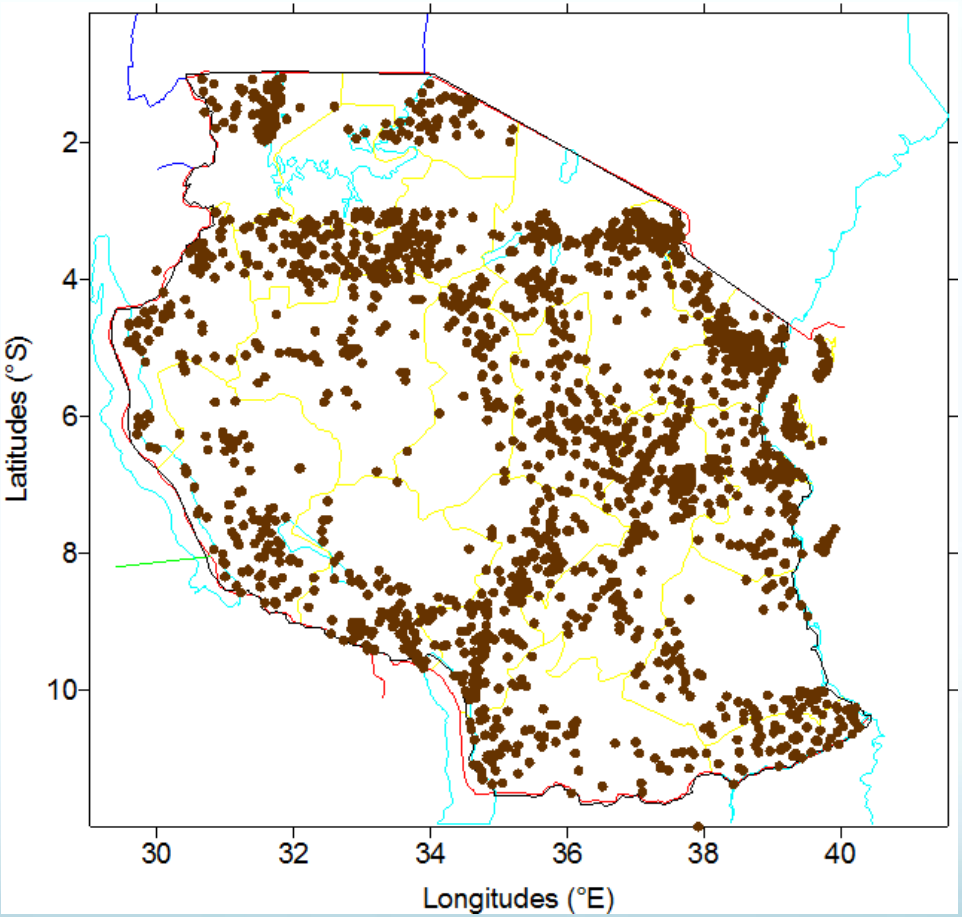


TMA Current Synoptic+Agromet+Water Basins Stations



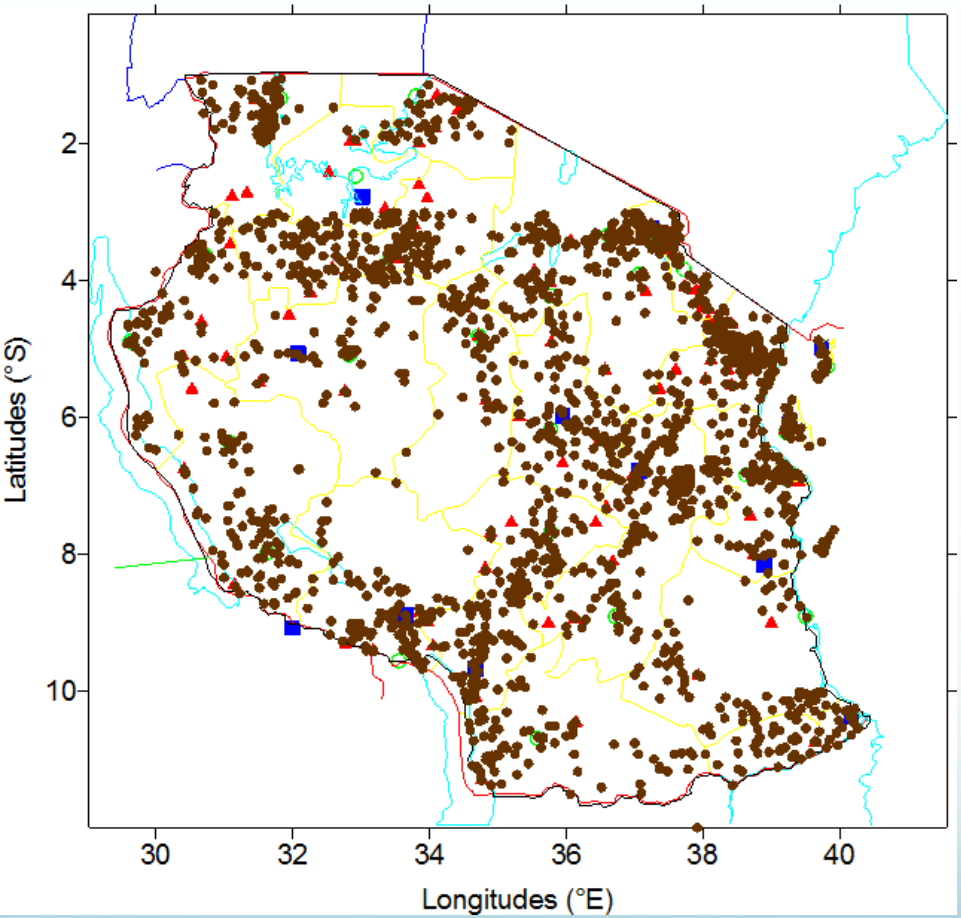
WIGOS

Tanzania Rainfall Stations



WIGOS

Projected integrated network of stations



What are the major concerns about the observing quality

WIGOS

4.0 CHALLENGES-

Gaps identified from stakeholders

Lack of qualified personnel to manage the observation stations

Non conformity to WMO standards of instrumentations and observations from stakeholders

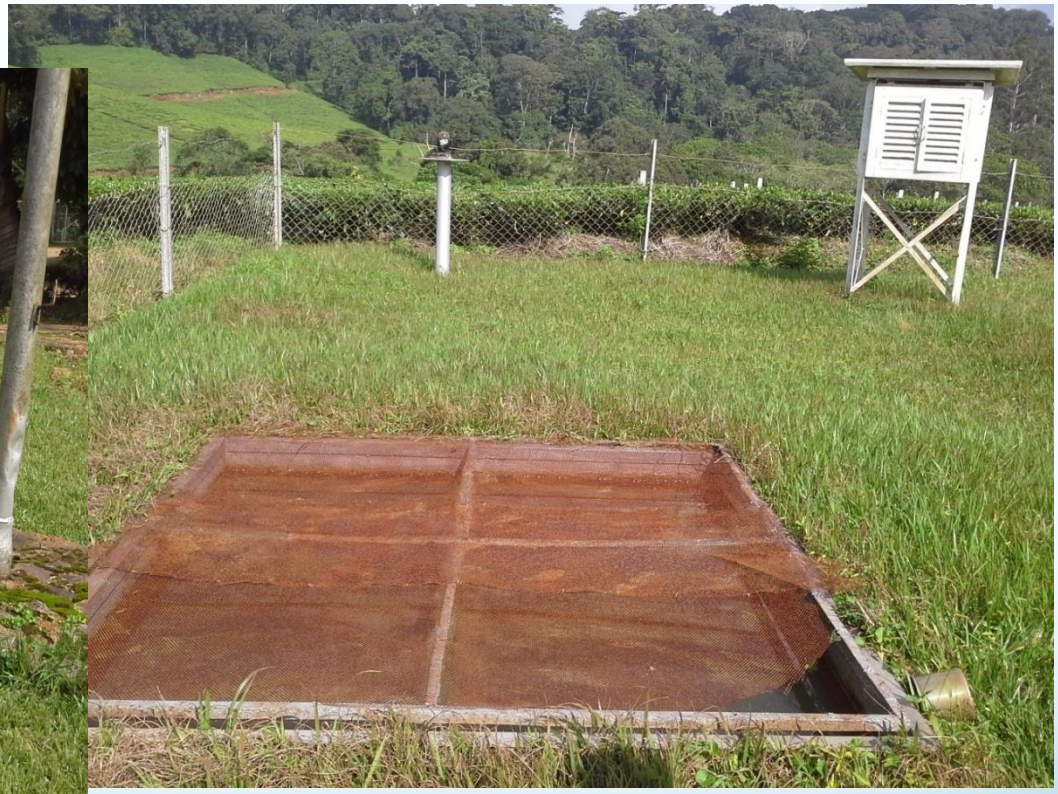
WHY WIGOS FOR TMA FINDINGS

Need of technical support to service and maintain the stations

Thirsty for meteorological, Weather observation knowledge and data sharing, this will easy the MoUs processes

WHY WIGOS FOR TMA

CHALLENGES



CHALLENGES …

Stevenson screen –wrong

Source:TMA-kili flora

Evaporation pan-wrong

WIGOS

CHALLENGES

Potential risks

- Wrong observation data from other players due to improper installation of instruments, low quality instruments and inappropriate observation skills

Outline

- Background: WIGOS Vision and Congress/EC Decisions
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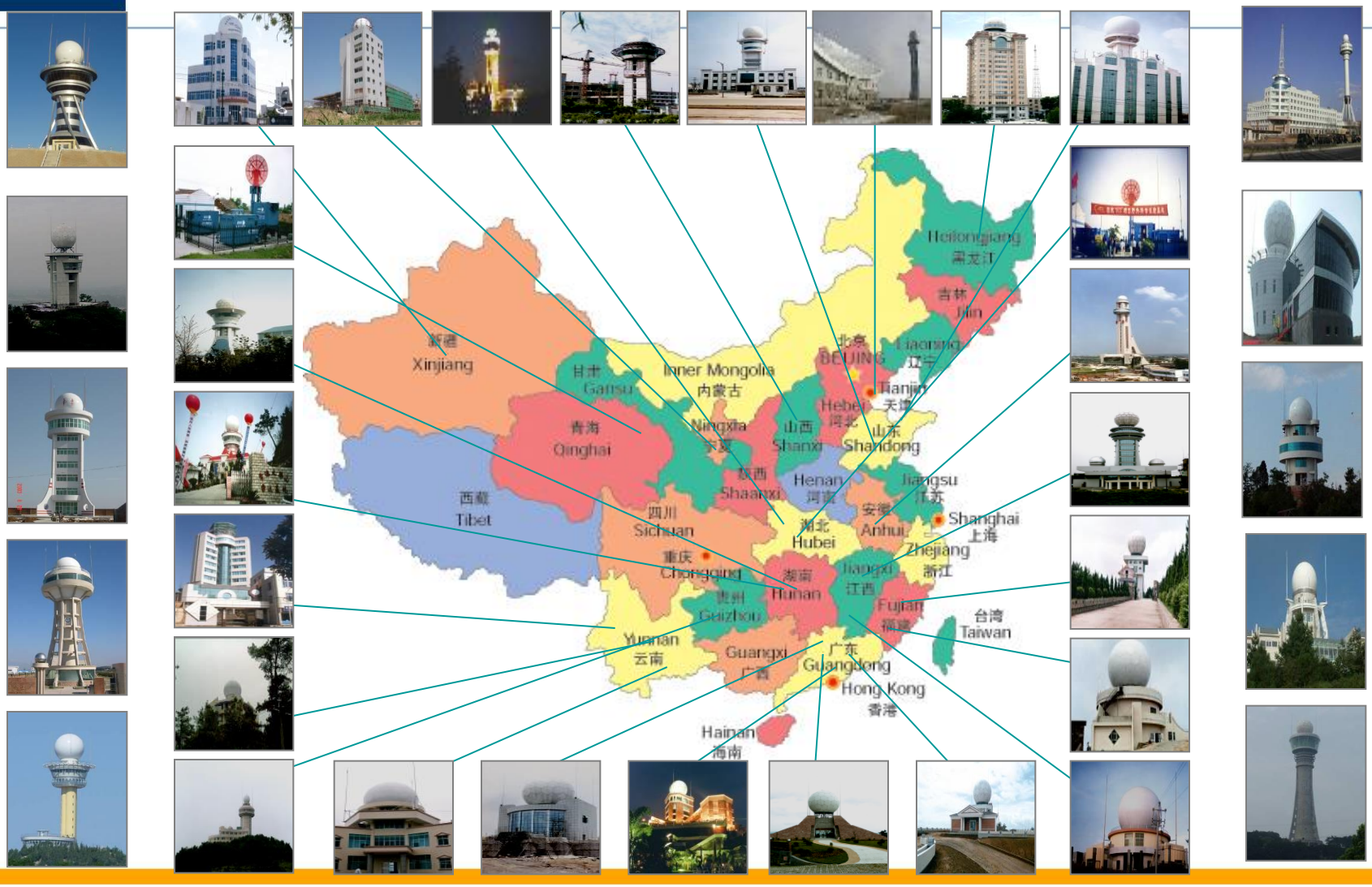
- **Some Considerations and examples**
- Suggestions & Summary

A real case in China

The established Radars played key role in improving warning and disaster reduction



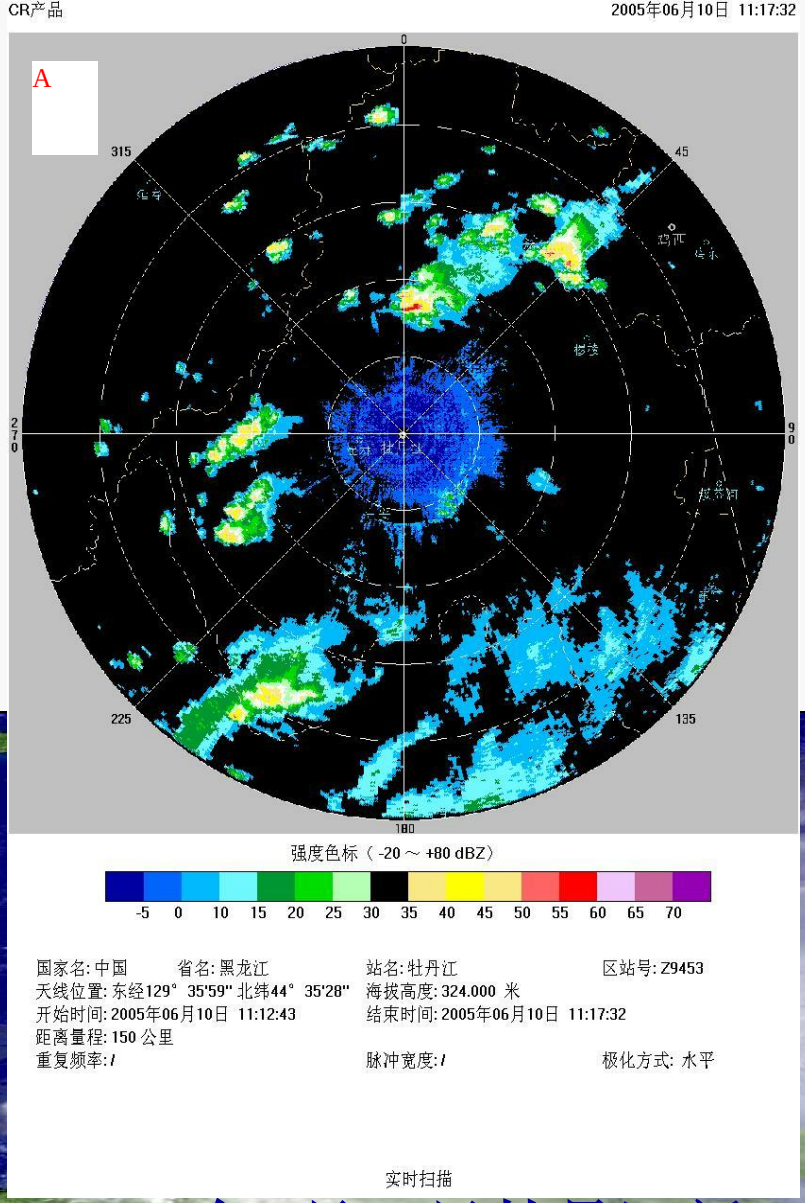
ShaLan County Regional Storm Disaster, June 10, 2005

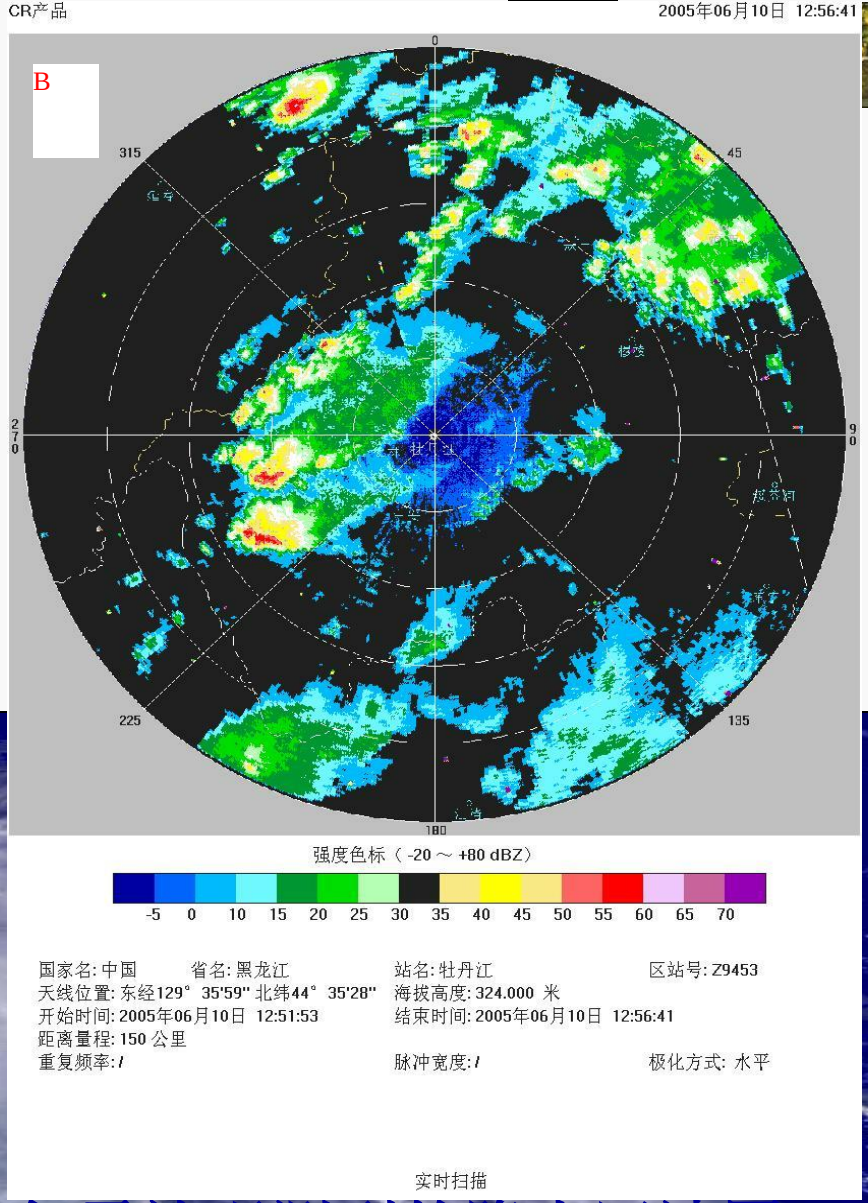
黑龙江沙兰镇山洪灾害

World Bank Group

- The storm from 12:50-15:30, June 10 2005 produced heavy rainfall and the average basin rainfall reached 123.2mm
- The rainfall-induced flash flood casued 117 death toll (most are school students), and direct economic lose 120 million RMB

Accurate real time monitoring and timely early warnings of sereve weather based upon weather radars are critical !



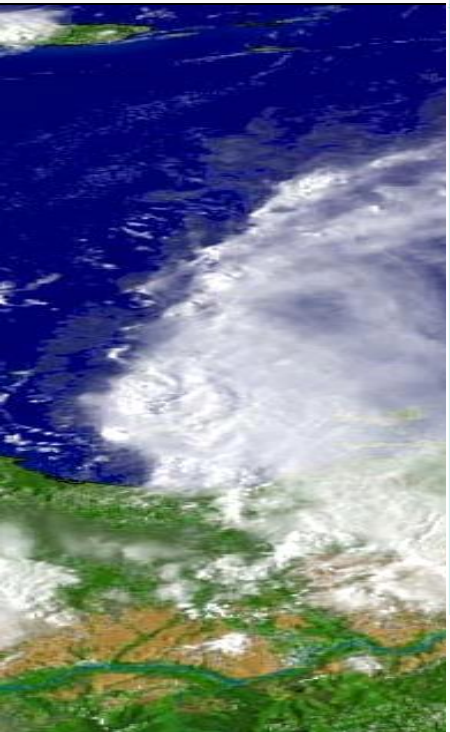


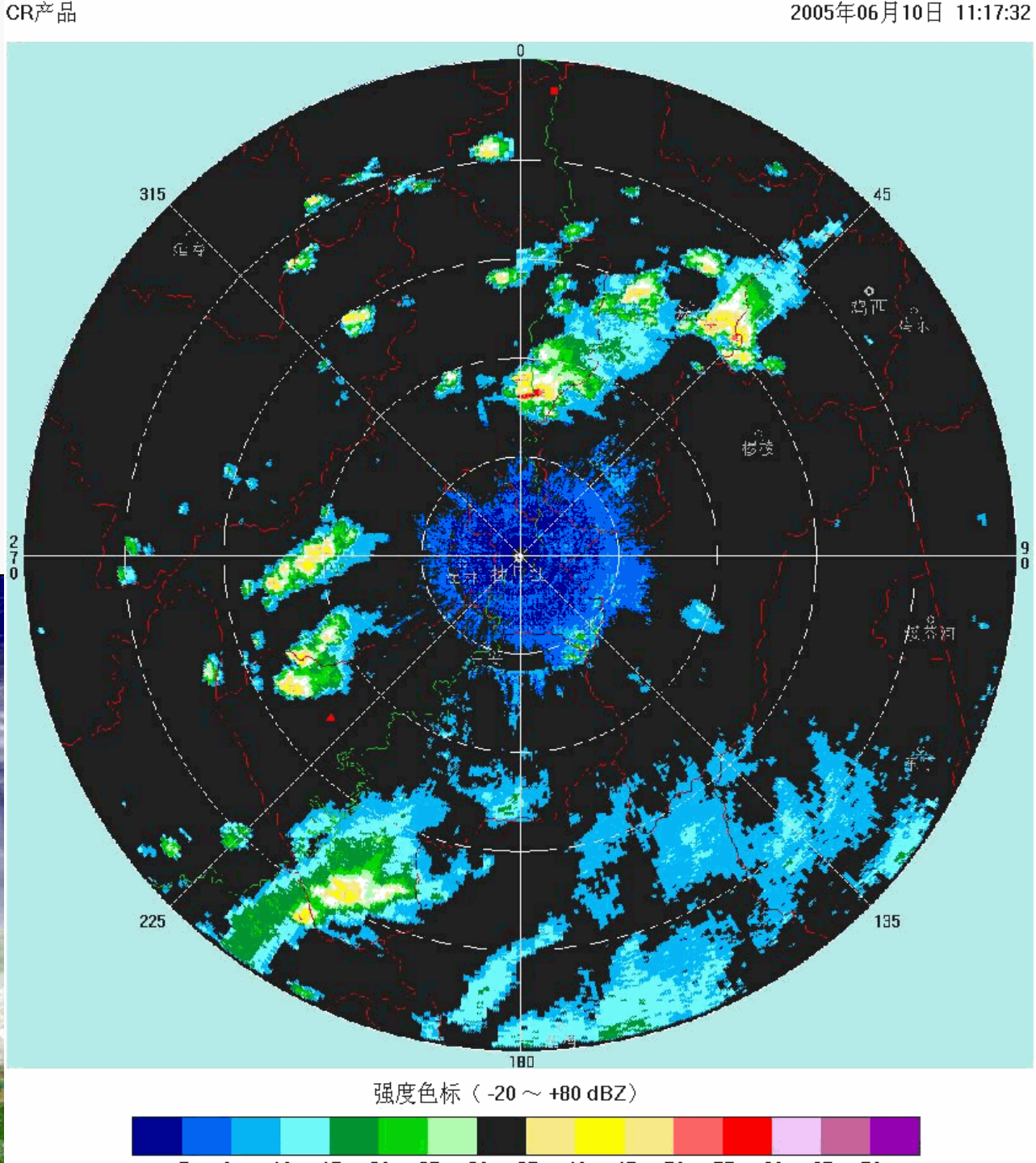
2005年6月10日牡丹江新一代天气雷达观测到的降水回波图

A表示：2005年6月10日11时17分的组合反射率因子

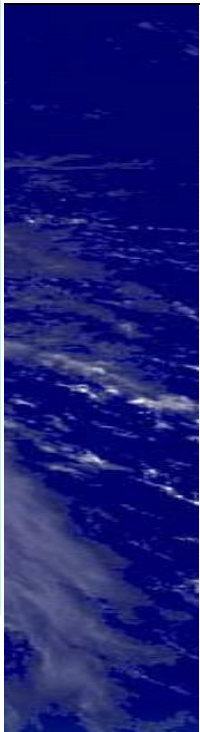
B：表示2005年6月10日12时56分的组合反射率因子

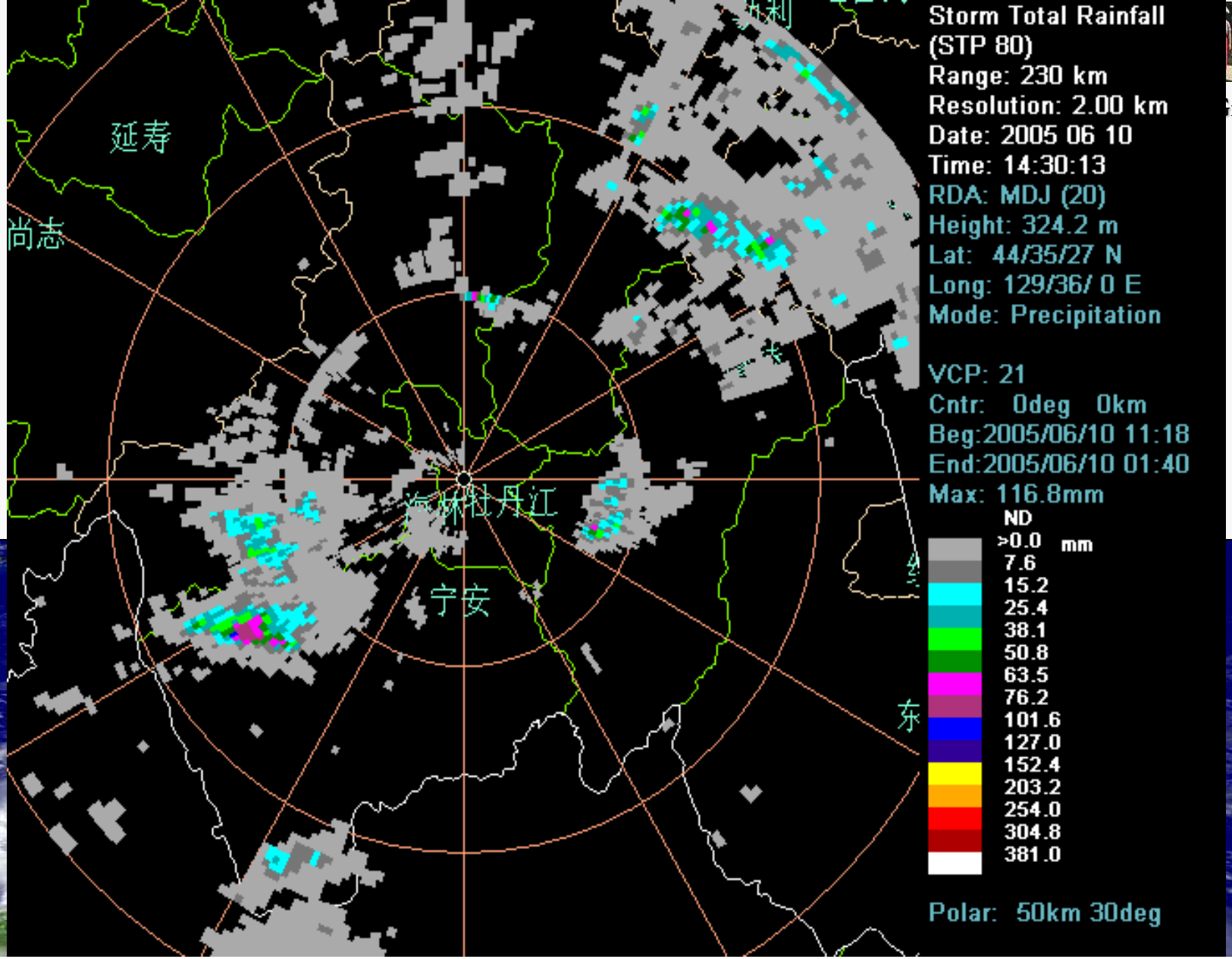
通过牡丹江雷达可以捕捉到中小尺度雷暴信息





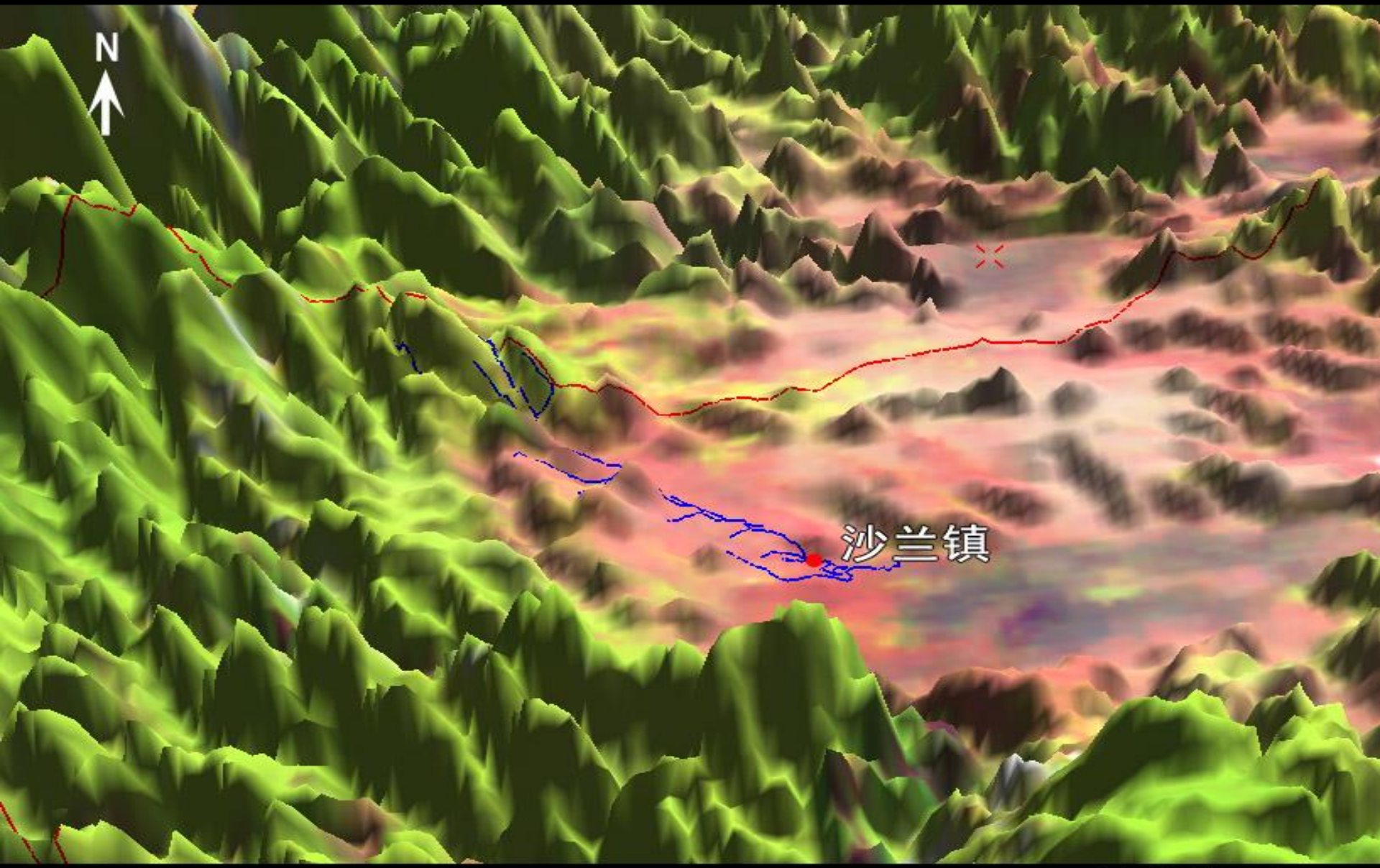
k Group





Accumulated total rainfall distribution from radar measurement 11:17—14:30, June 10th, 2005

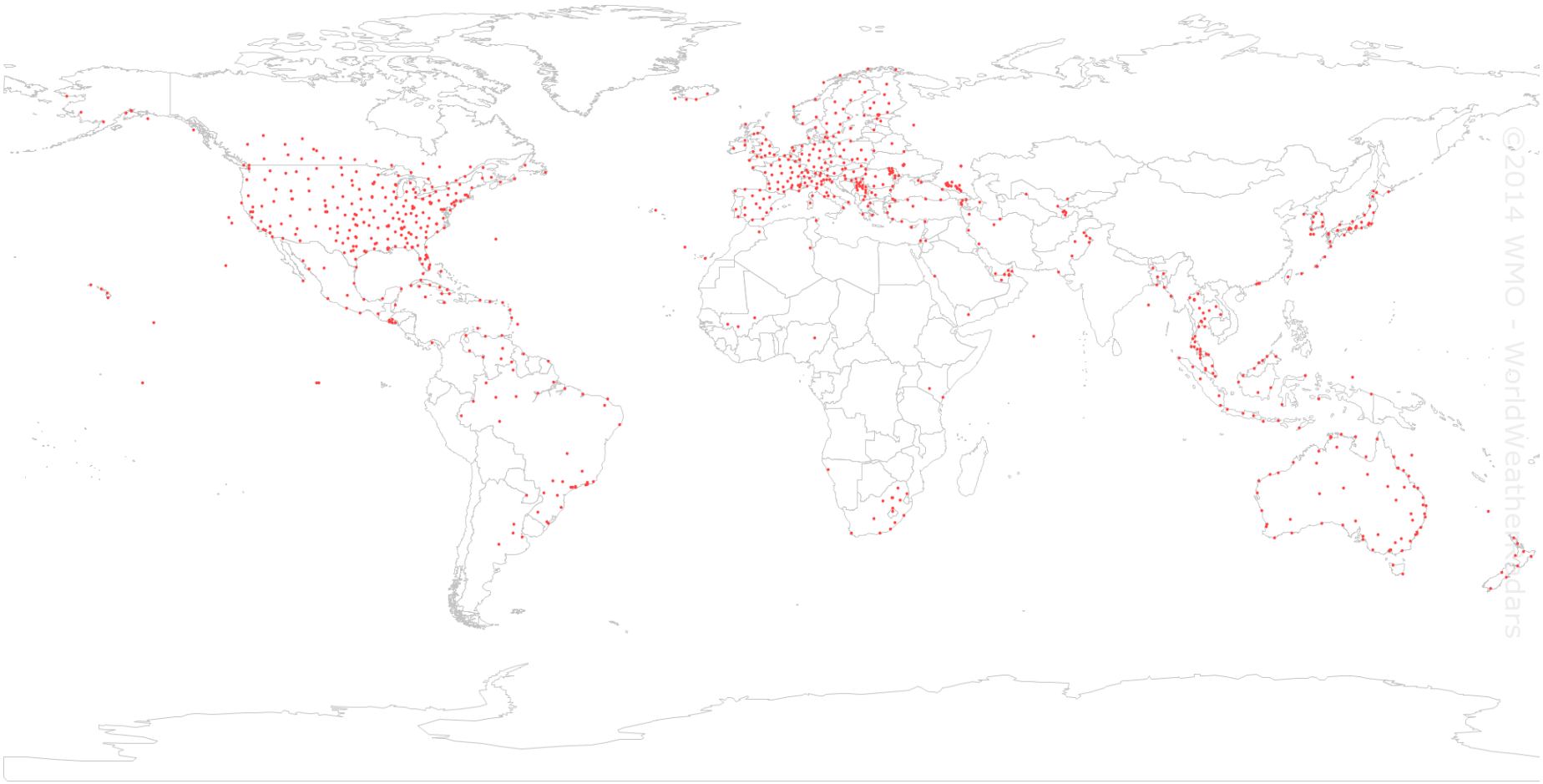
黑龙江省宁安市沙兰镇三维地形影像图



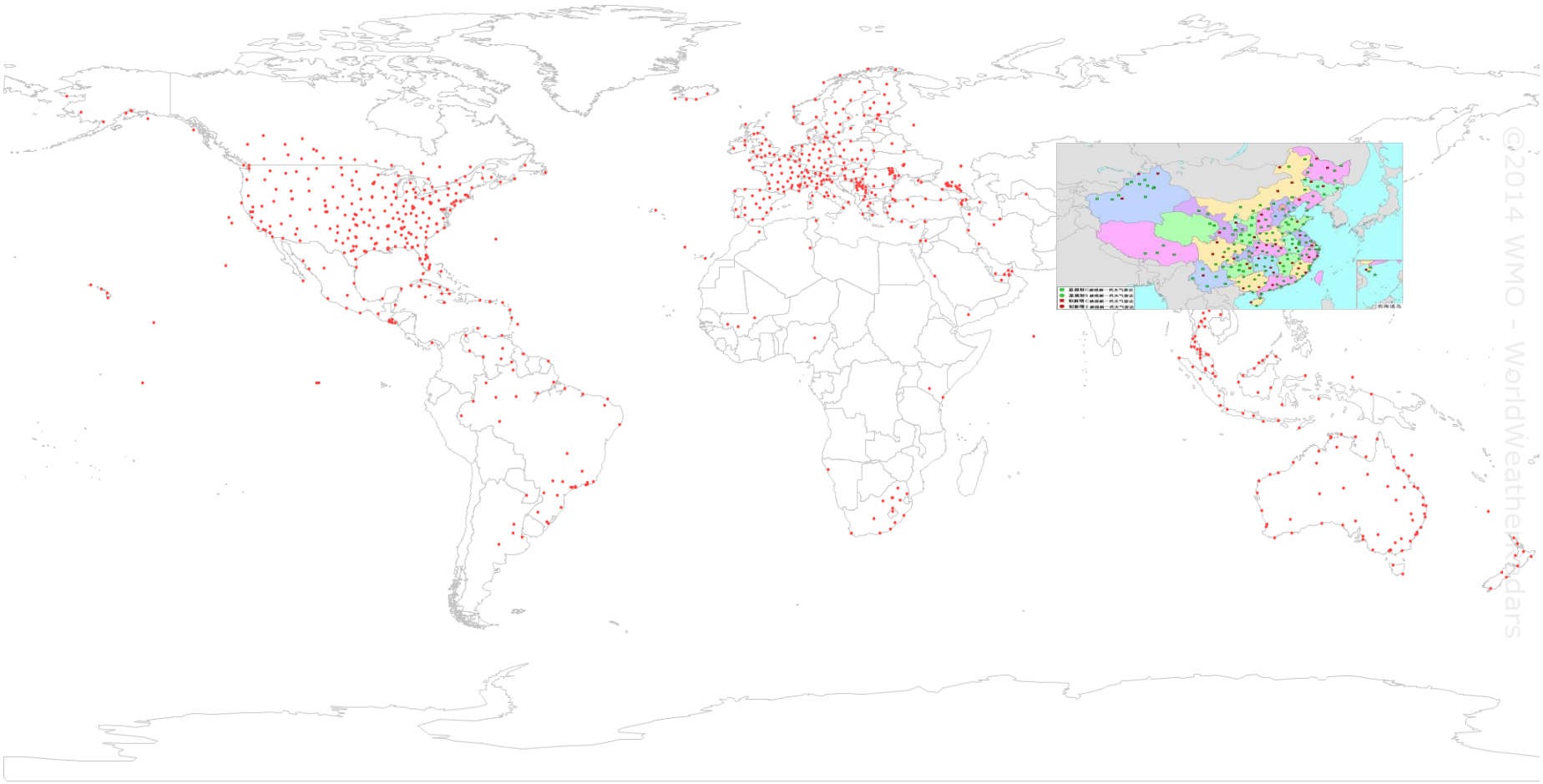
河流　县界　城镇

中国气象局
国家卫星气象中心

Global Weather Radar Development



Global Weather Radar Development



In total rough estimation global weather radars account to 1000+

- WMO Radar Database managed by Turkish Meteorological Service (TMS)
  - Current databse statistics: 835 radars (without China)
  - Add China Radars (216) makes 1051 Dopplar Radars
  - Thousands of small Radars (X band, etc) and Radars outside of NMHSs
- A typical Dopplar Radar costs 2M USD, then total cost 2 Billion USD+

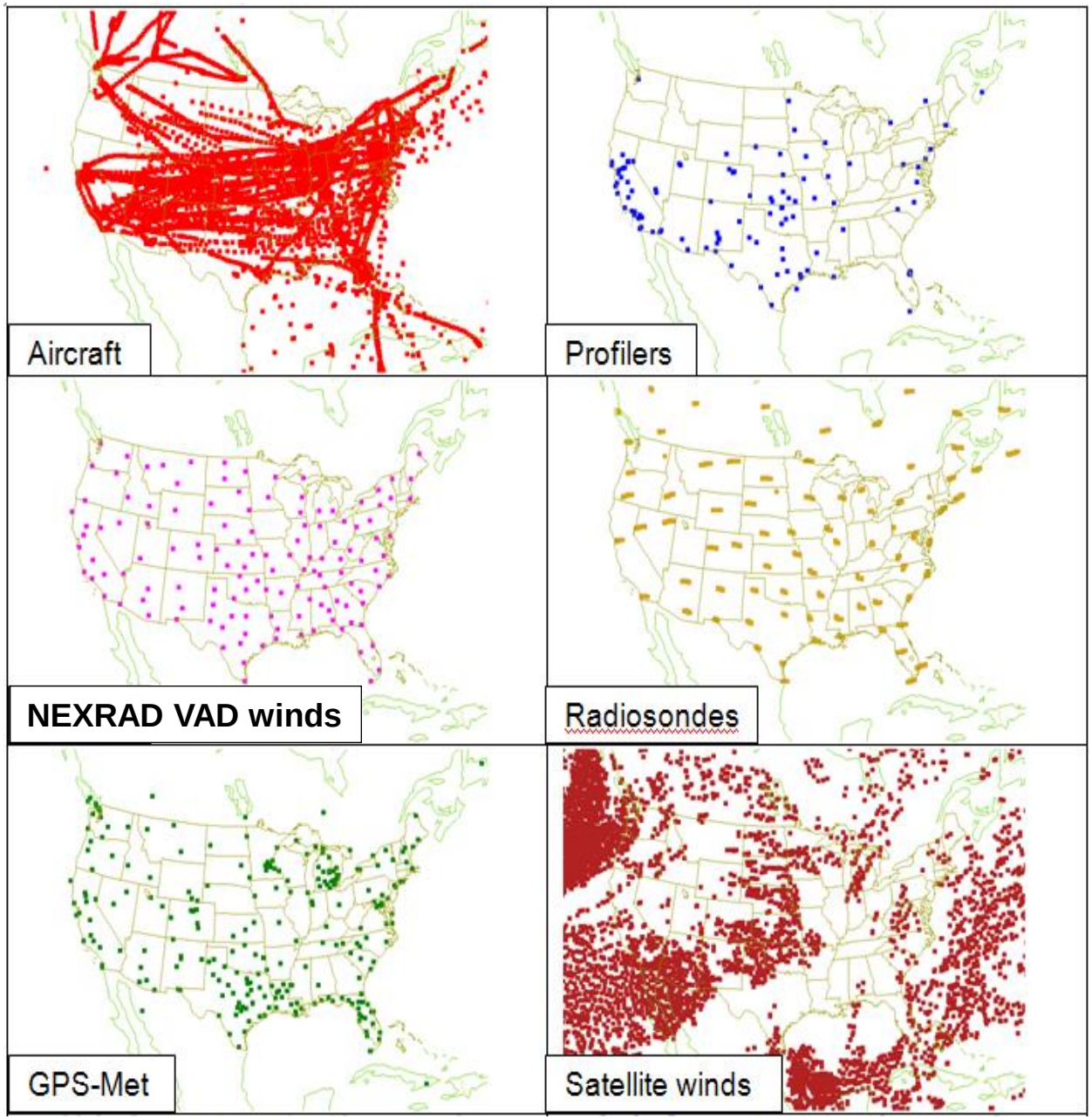
A quality index for radar data
OPERA deliverable OPERA_2010_03

- The compositing of radar data is one of the most important uses for quality indices: the indices can be used to compare the quality of radar data in areas where there is coverage from more than one radar and decide which data to use.
- Radar data is increasingly being assimilated into numerical weather prediction (NWP) and hydrological models. The associated quality information is important for the successful and efficient use of radar data in these models.
- Quality indices can also be used as a visual tool to aid interpretation of the radar data as done in France and increasingly, quality information is being requested by hydrologists using radar data for water management and flood risk.

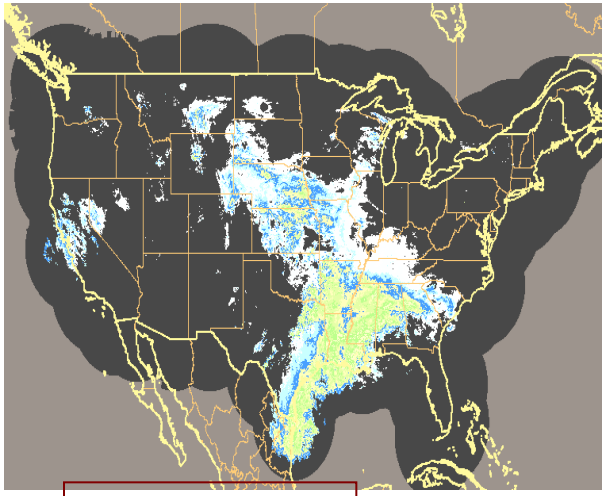
Conclusions II

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- *AMVs important contribution to the global observation system*
- *Impact of AMVs stronger in summer period than in winter*
- *Impact is high on the Southern Hemisphere and Tropics and smaller on the Northern Hemisphere*
- *Strong impact of polar AMVs over the southern polar regions*
- *Positive Impact of scatterometer data in summer hurricane period and also in the limited area model*
- *Positive impact of radar rain rates up to 6 hours*
- *General positive impact of GPS ZTD IWV data used (especially in assimilation) in COSMO in summer, still problems in winter*
- *VAD winds show only small positive impacts but need a careful data selection (data quality is very mixed)*



Observations assimilated in hourly update models (RUC, Rapid Refresh)



Radar reflectivity

Doppler radial winds

6 radars currently providing radial winds

(plans to upgrade whole network by 2015)

4 currently assimilated operationally

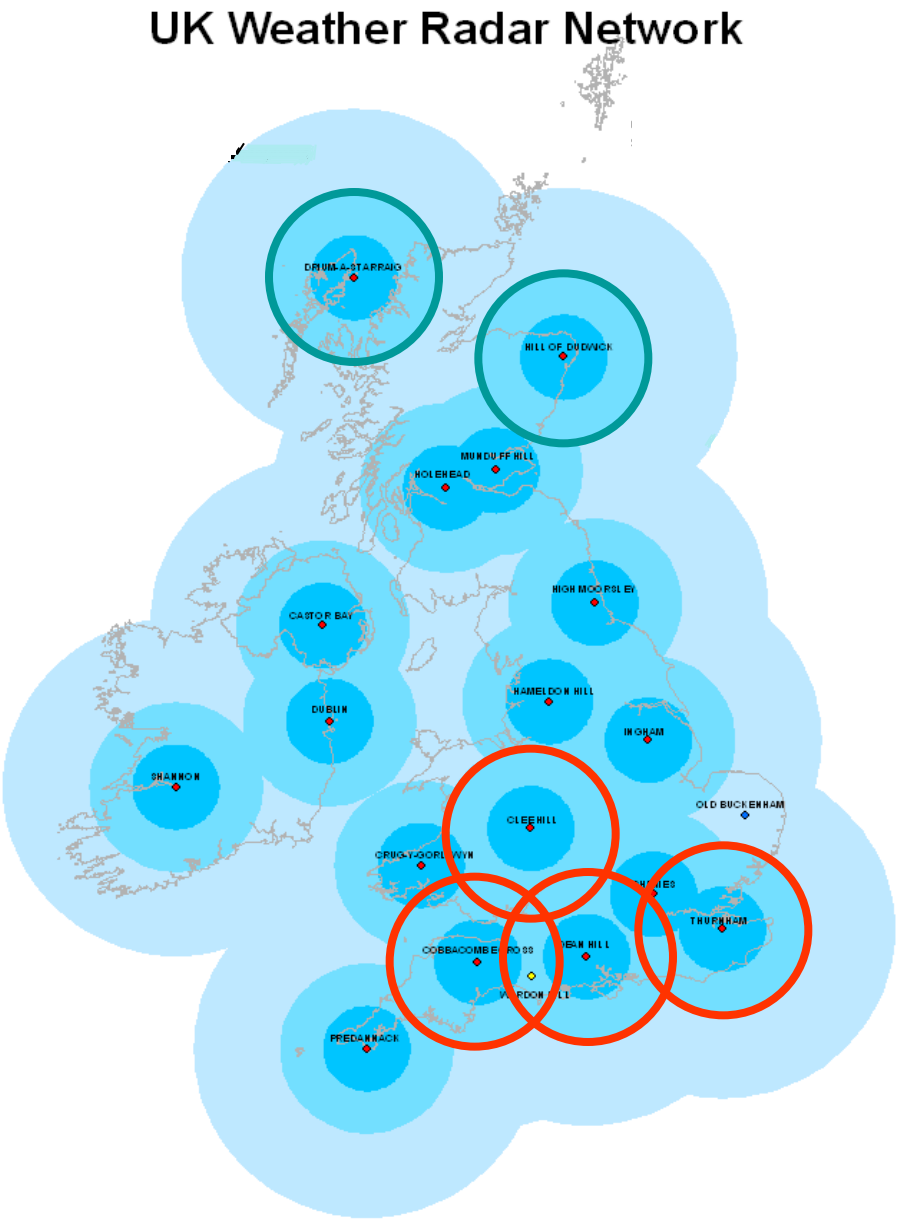
obs within 100 km radius

elevations between 1° and 9°

1° azimuthal, 600 m radial

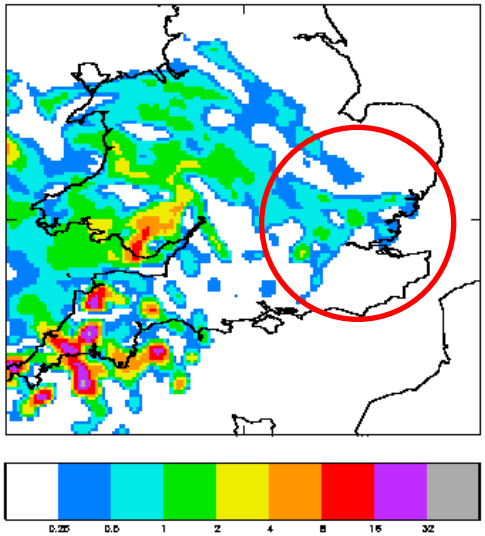
available every 5 minutes

assimilated every 3 hours

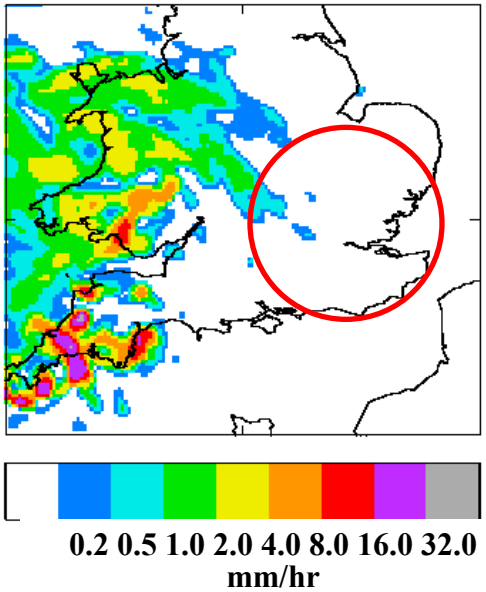


Individual case where rainfall location is seen to be improved

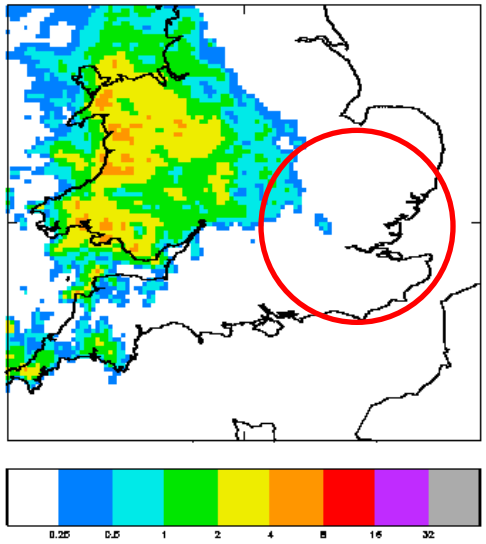
CNTL



CNTL + radial winds



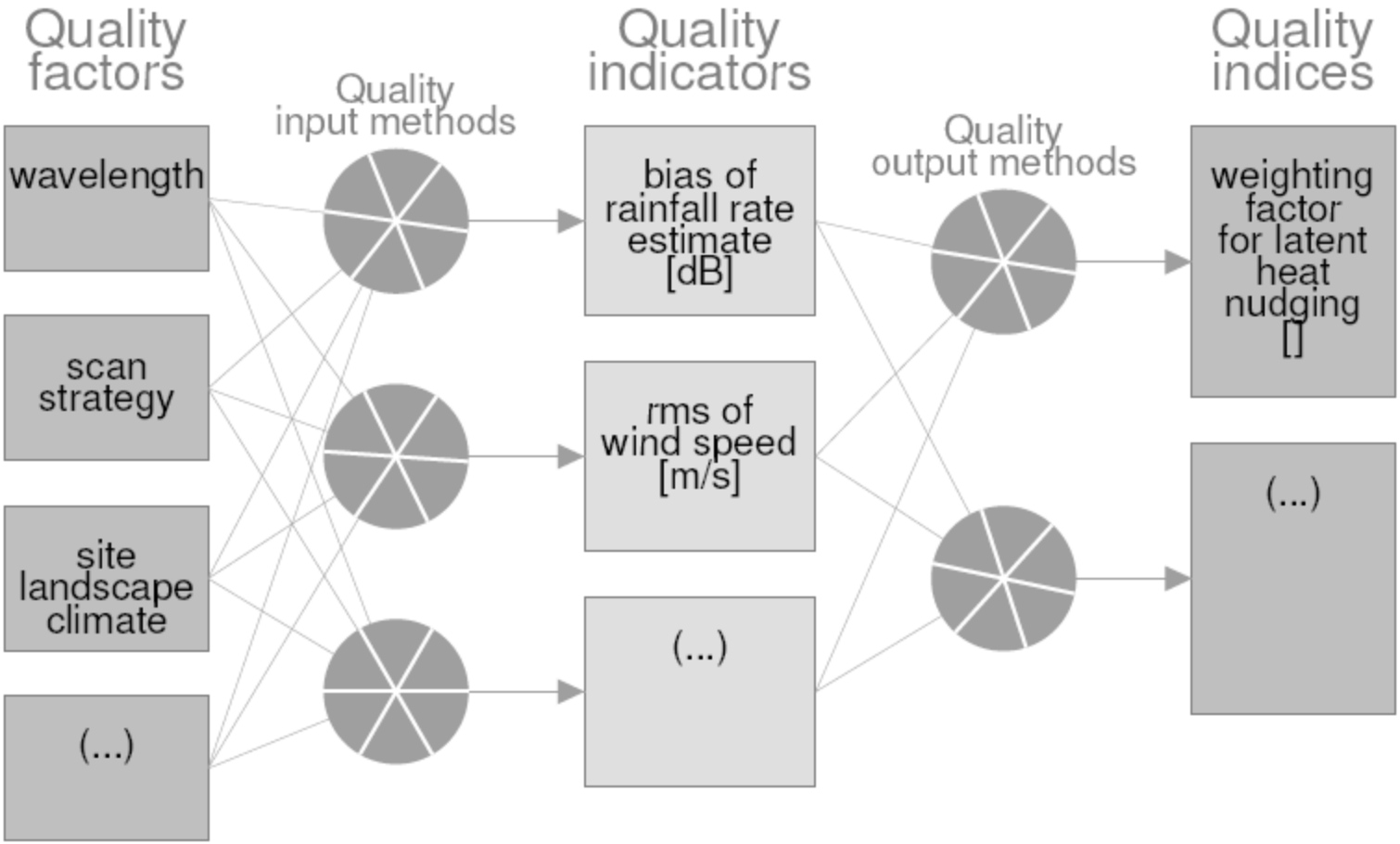
Radar



T+4

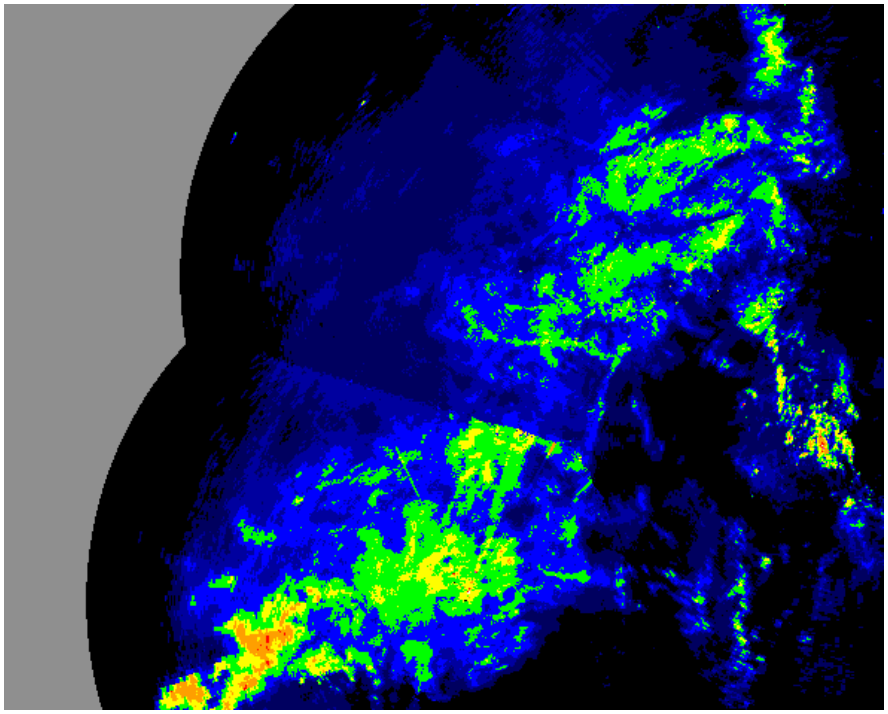
Helen Buttery

Schematic diagram of quality framework for generating a quality index (taken from Holleman et al (2006)).

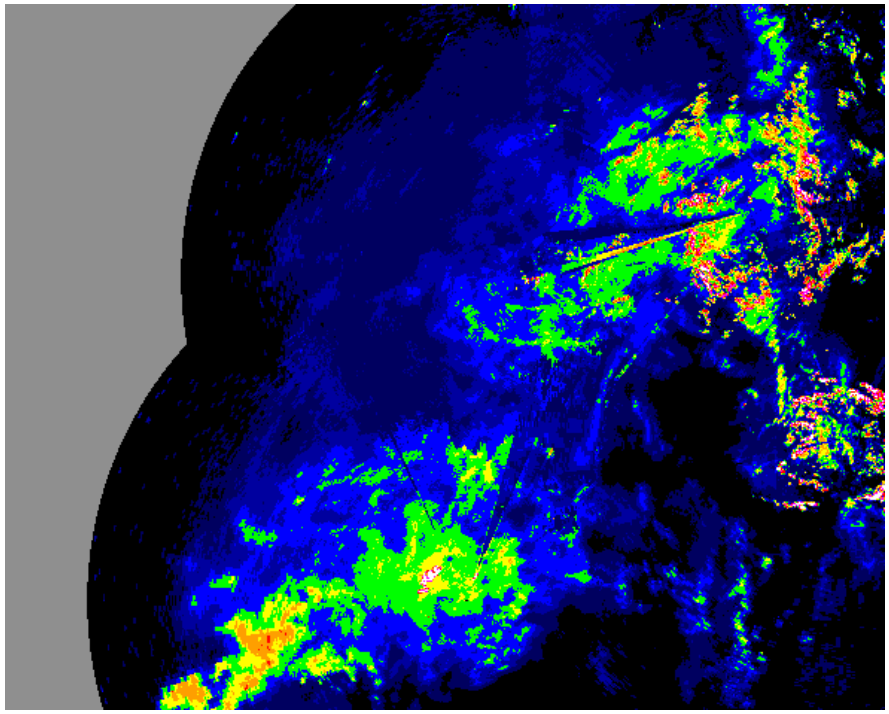


The major improvement seen by using the level 1 quality index compared to the one used by UK Met Office, is the elimination of the discontinuities associated with the lines of equal beam height between radars

UK composite



Level 1 composite.



Outline

- Background: WIGOS Vision and Congress/EC Decisions
- WIGOS Key Activity Areas on Observational Quality Matters
- Some Considerations and examples
- **Suggestions & Summary**

Consideration I

- **Greater efforts should be made to motivate Members to implement CIMO Guide, PART III: QUALITY ASSURANCE AND MANAGEMENT OF OBSERVING SYSTEMS**
- **THE ISO 9000 FAMILY**
  - **ISO 9000: Quality management systems – Fundamentals and vocabulary**
  - **ISO 9001: Quality management systems – Requirements**
  - **ISO 9004: Quality management systems – Guidelines for performance improvements**
  - **ISO 19011: Guidelines for quality and/or environmental management systems auditing**
- **ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories**
- **ISO/IEC 20000: Information technology – Service management**
- **WMO Quality Management Framework**

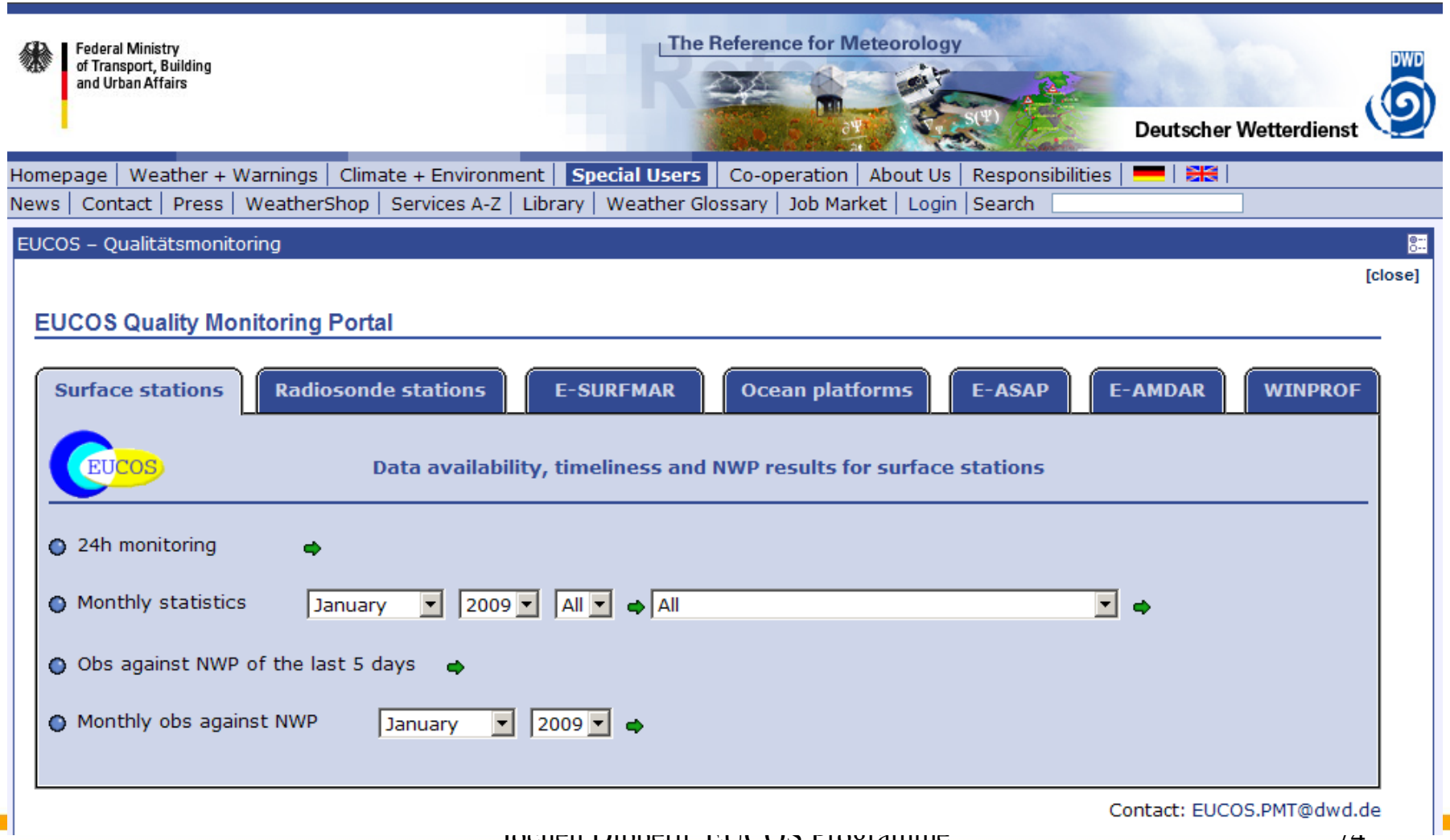
Consideration I (cont.)

- **The section 1.6: FACTORS AFFECTING DATA QUALITY included almost all the factors, which give a high level guidance for data quality management and controls.**
  - **More examples should be cited from surface remote sensing technologies in the future updates, i.e. the quality management and control should be end-to-end system from user requirements to the end observational products (to meteorological variables)**
- **The current Guide 1.7 QUALITY ASSURANCE (QUALITY CONTROL): Only covers :**
  - **1.7.1 Surface data**
  - **1.7.2 Upper-air data**
  - **The surface remote sensing part should be developed for the future update of the chapter.**

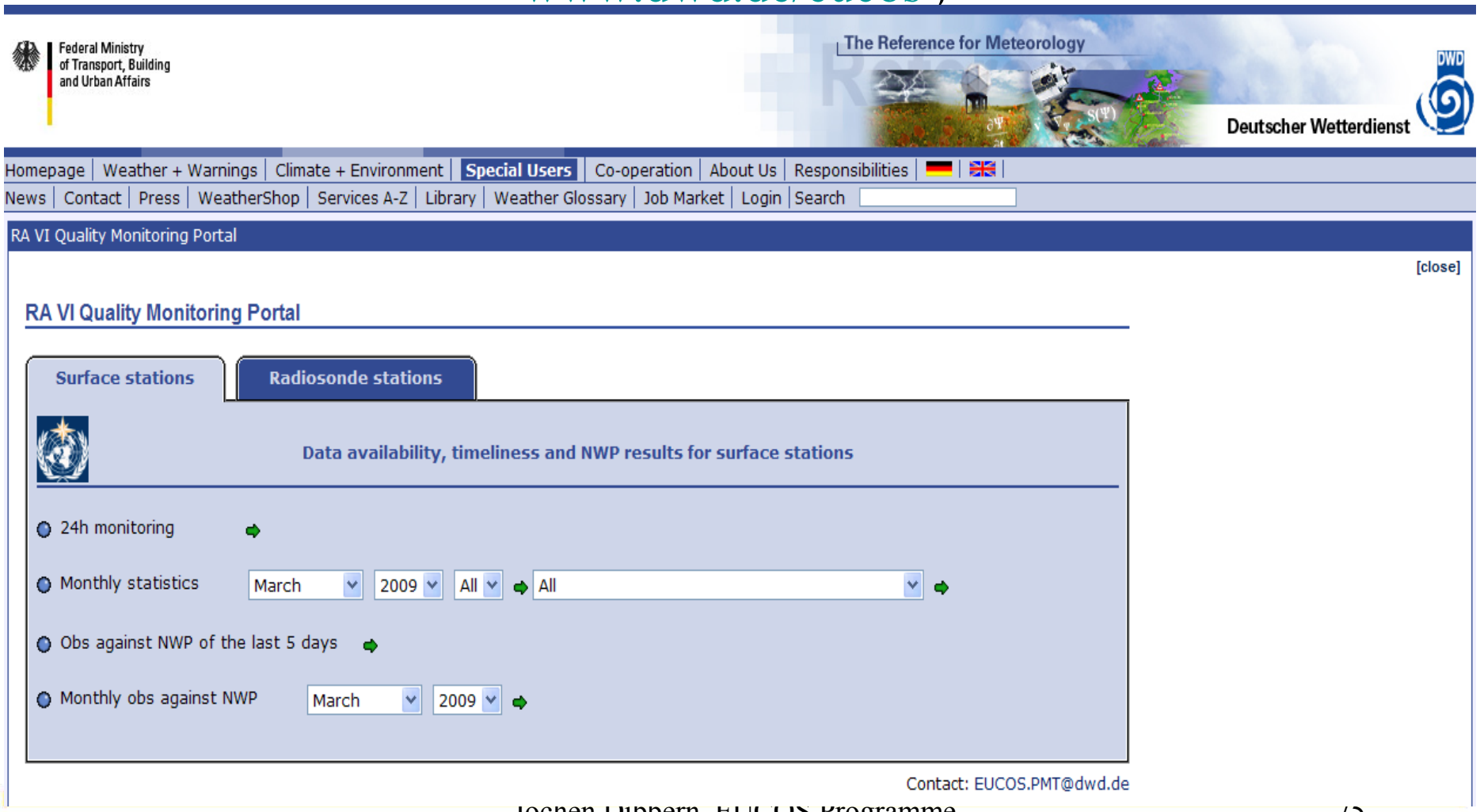
Consideration II: CIMO should motivate & support Members to establish national observing network performance monitoring system, as an important CIMO/WIGOS activity

- CIMO Guide Part III: Chapter I: 1.8 **Performance monitoring**
  - The management of a network, or of a station, is greatly strengthened by keeping continuous records of performance, typically on a daily and monthly schedule.
  - The objective of performance monitoring is to review continually the quality of field stations and of each observing system, such as for pressure measurement, or the radiosonde network. (add radars, wind profilers)
  - Implement & Document all the WIGOS metadata for tracebility and re-processing (esp. for climate app)

EUCOS Quality Monitoring Portal



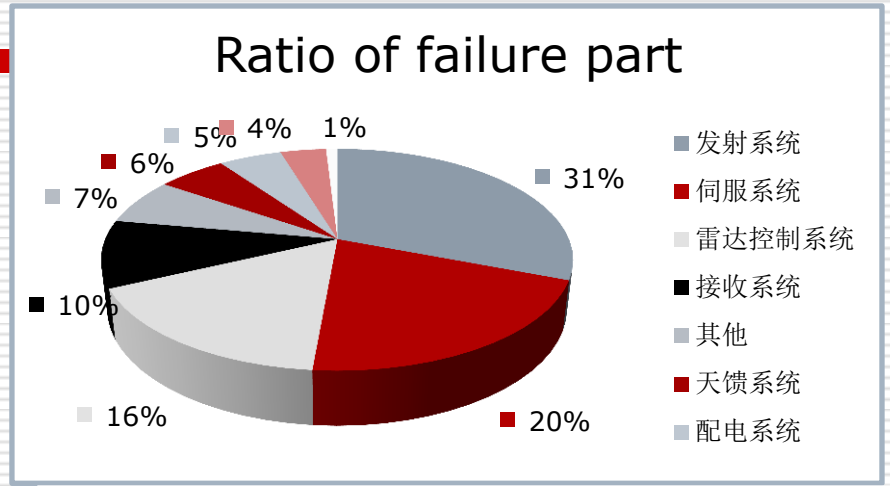
EUCOS QM for RA-VI stations (www.dwd.de/eucos)

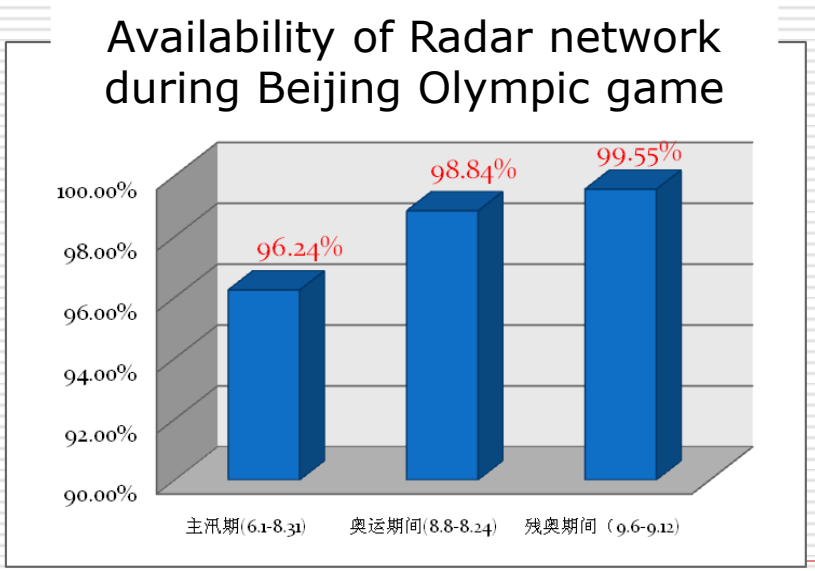


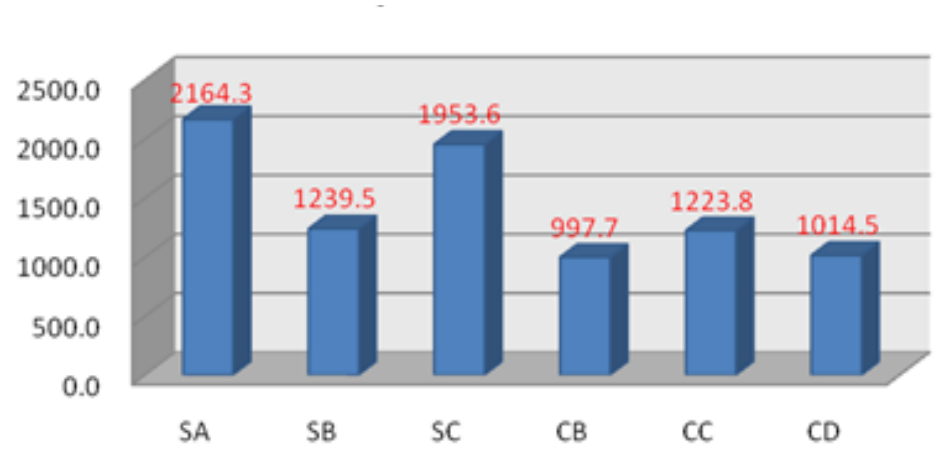
Maintenance and Monitoring Assistance

- **Real time on-line monitoring of performances**
- **Remote video trouble-shooting**
- **Guide to replace spare parts**

Doppler Radar availability improved obviously

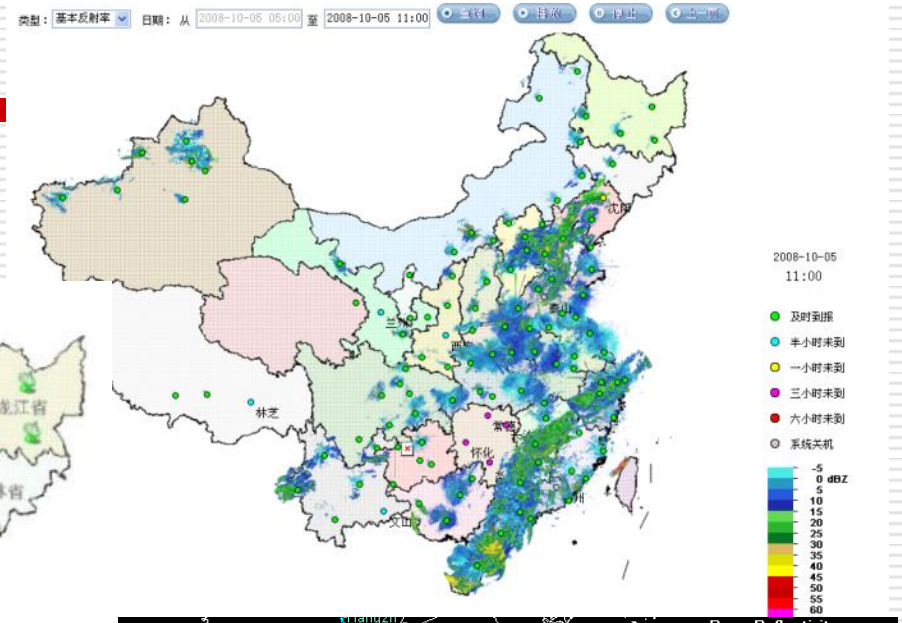


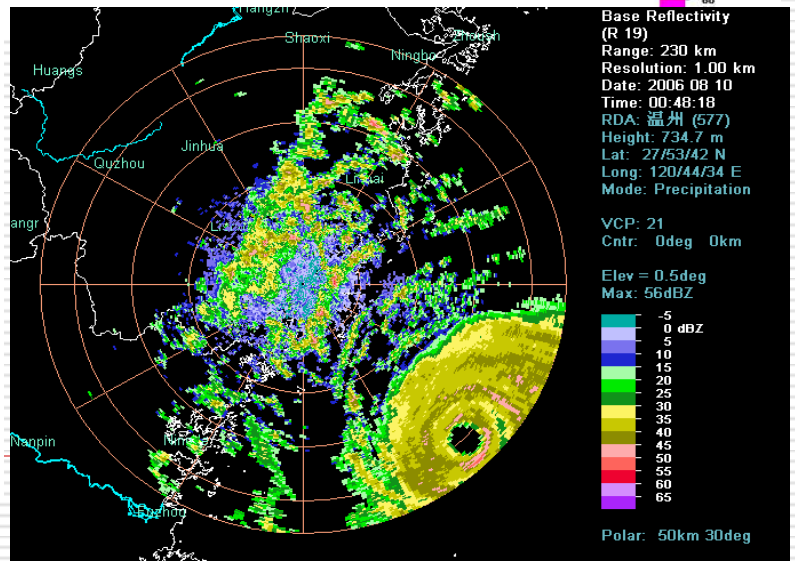




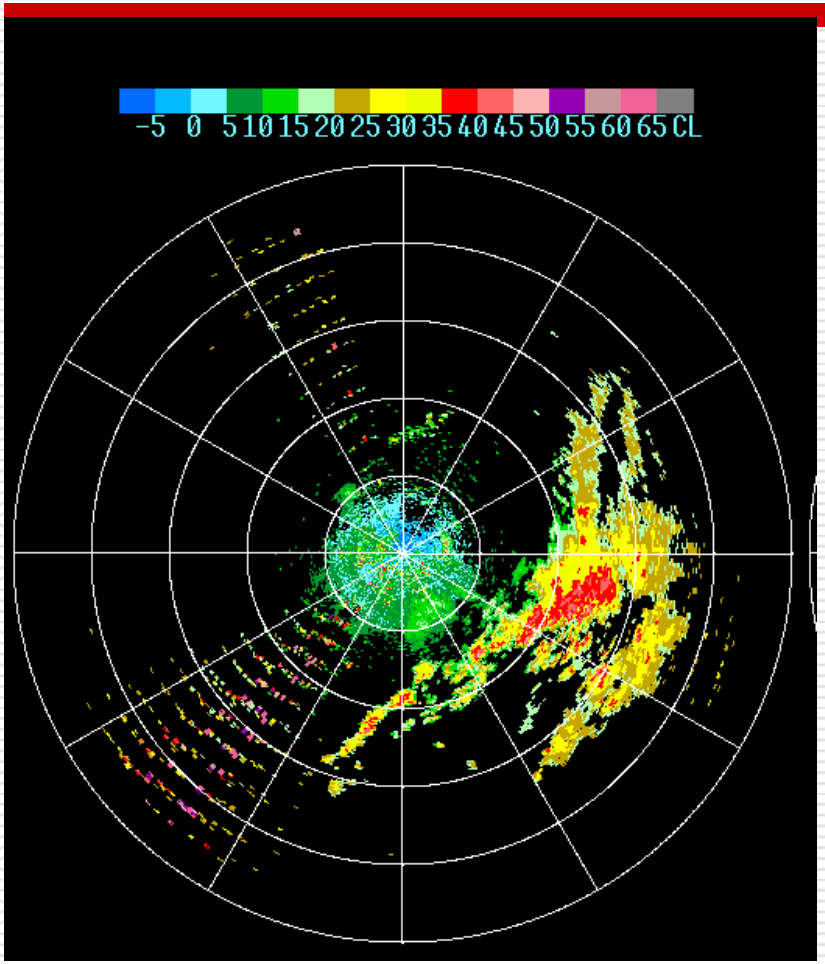
How ASOM make quality controlling on Doppler radar data?

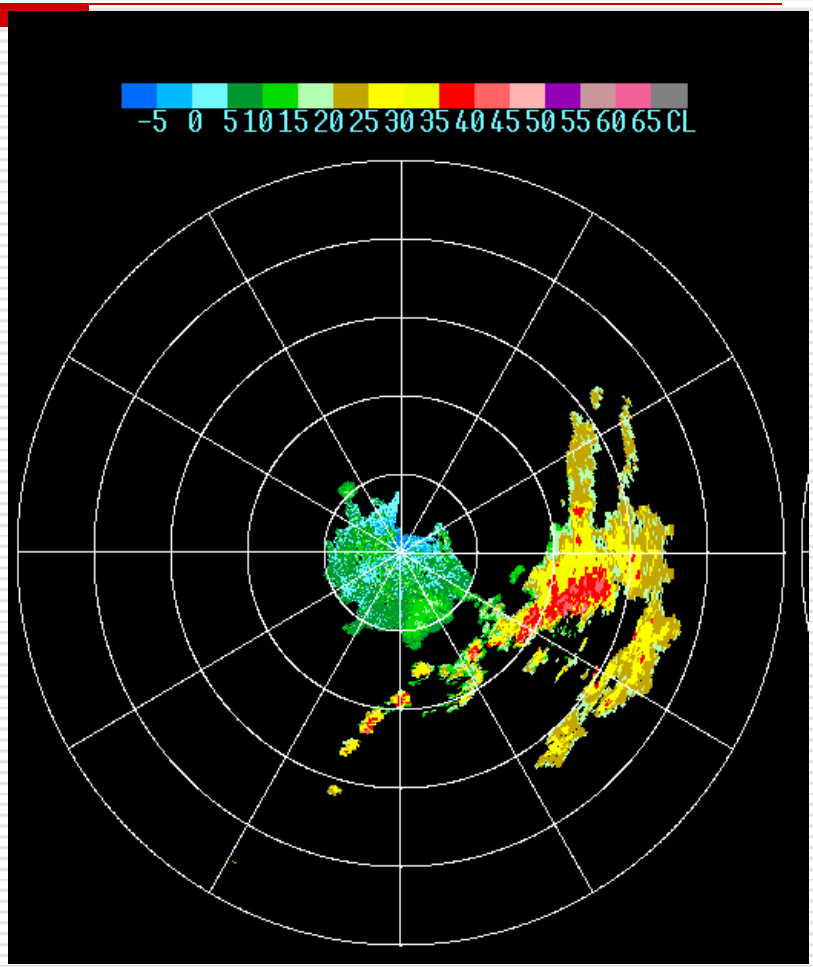
Inter-radar calibration





Example: quality control on radar data



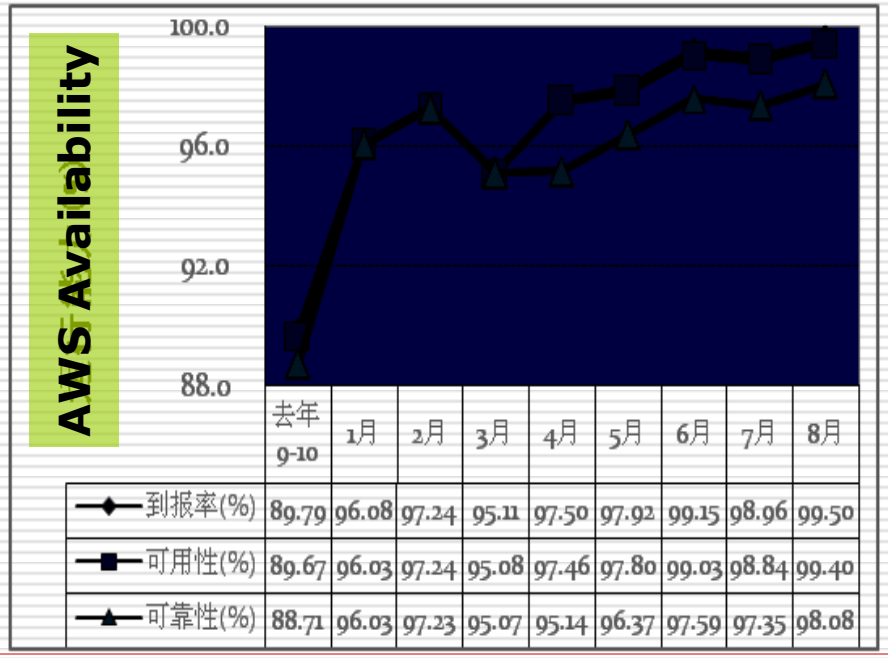


Before Q.C

after Q.C

Conventional data availability improved obviously

- AWS data availability increased up to 99.40%
- Operation time of Radar network increased up to 98.00%
- Radar data availability increased up to 98.50%



	去年 9-10	1月	2月	3月	4月	5月	6月	7月	8月
到报率(%)	89.79	96.08	97.24	95.11	97.50	97.92	99.15	98.96	99.50
可用性(%)	89.67	96.03	97.24	95.08	97.46	97.80	99.03	98.84	99.40
可靠性(%)	88.71	96.03	97.23	95.07	95.14	96.37	97.59	97.35	98.08

Consideration III: ACCREDITATION OF LABORATORIES (for Radars)

- CIMO should encourage the establishment of Laboratories (at national for countries has more than 10+ radars, and regional levels) for remote sensing equipments (mainly radars, lightning sensors, etc)
- In case of necessary, carry out the accreditation and certificate processes.

Consideration IV: More efforts on standardization of observational products generations (esp. RS)

- **Terms of Reference of CIMO (WMO Basic Document)**
  - The Commission shall be responsible for matters relating to international standardization, compatibility and sustainability of instruments and methods of observation of meteorological, climatological, hydrological, marine, and related **geophysical and environmental variables.**
  - This shall include in particular: (a) Respond to the requirements for standardized and compatible observations, including data content, quality, metadata and observational product generation;
- **From raw data to value-added products will greatly promote the value of observations, and also promote cost-benefits of Radar investiment. Certainly the products quality management & traceability will be a huge task and challenge !**

We are not alone !: GEOSS & QA4EO request

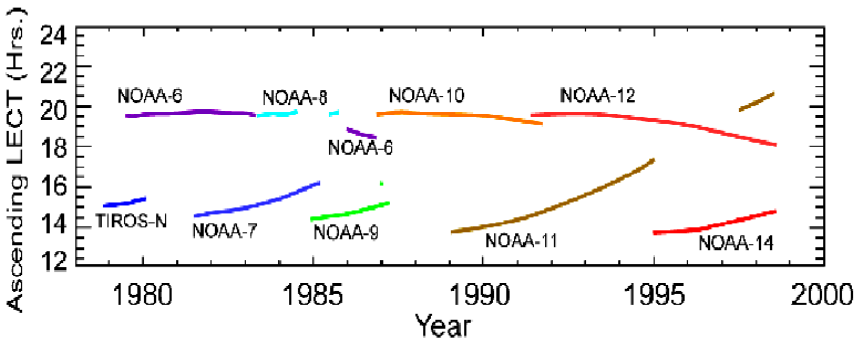
- ***Data and derived products shall have associated with them an indicator of quality to enable users to assess their suitability for*** ***particular applications, i.e., their "fitness for purpose".***
- The guiding principle for data quality within the QA4EO framework is that:
- ***All data and derived products must have associated with them a Quality Indicator (QI) based on documented quantitative assessment of its traceability to community agreed (ideally tied to SI) reference standards.***

Consideration IV: More efforts on standardization of observational products generations (esp. RS, Cont.)

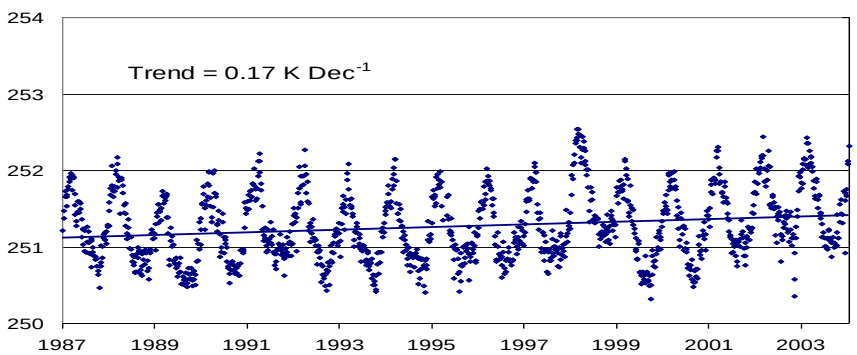
- The full benefits of all observations are realized only when the essential infrastructure, in addition to the hardware segment, such as data processing, quality control and products generation, full sectors wide applications, and trained personnel, is in place.
- Therefore balanced investment of observing systems for fully motivated applications (model, monitoring of weather, climate, environments) is essential. The end-to-end quality performance feedback will further improve the observing system!

WMO Global surface networks with long-term records provide validation/integration base for Space climate monitoring

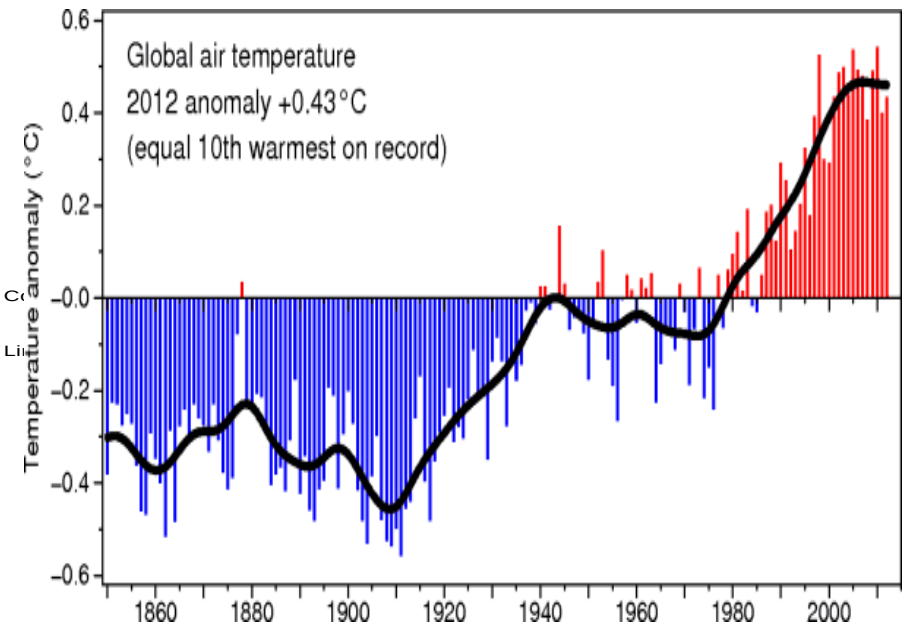
Figure 5



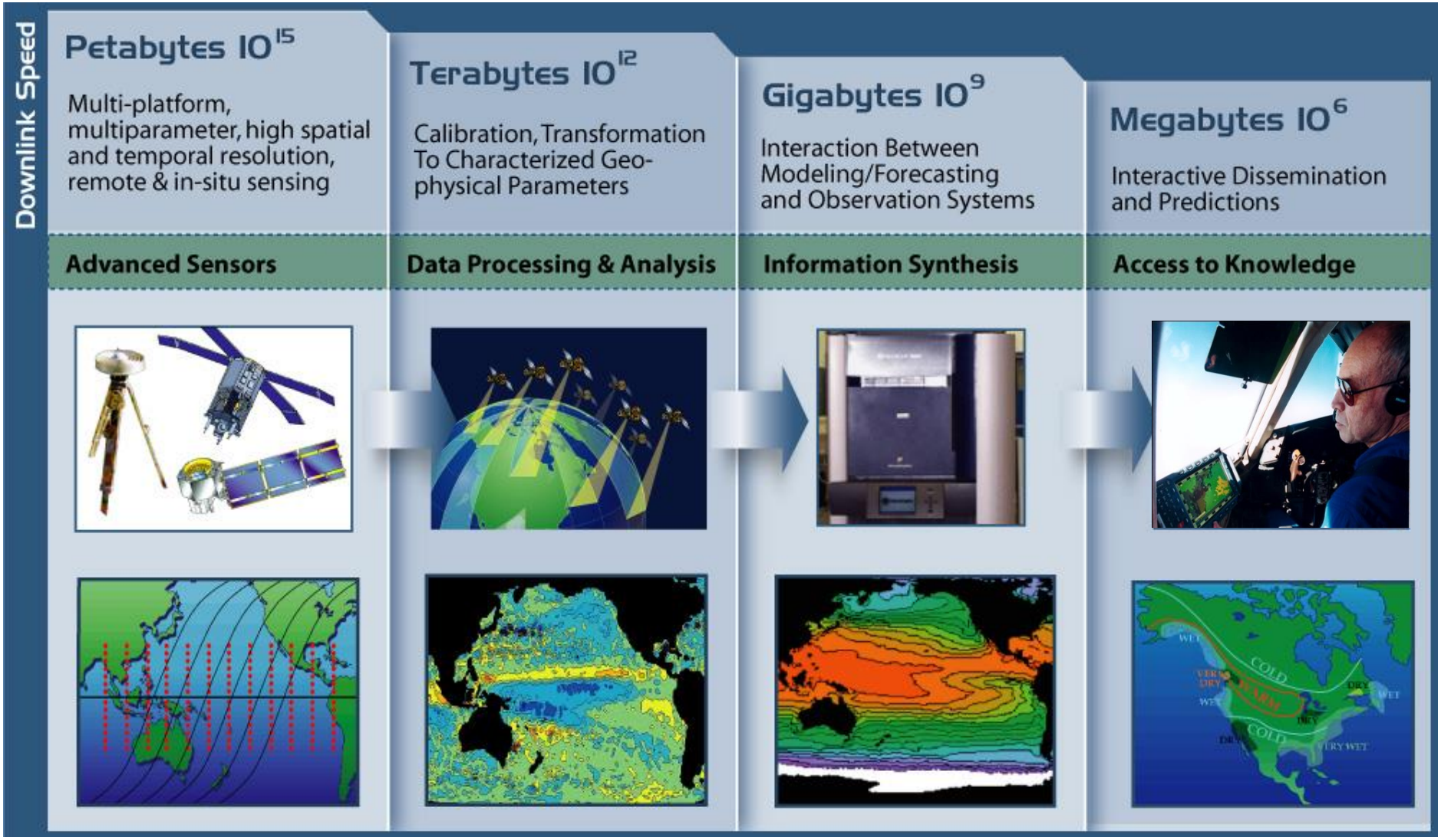
Local equatorial crossing time for NOAA satellites show the long-term drift (from Wentz, 2002).



Longest surface T instruments measurements (>140 years)
Against 30 years average (1961-1990)

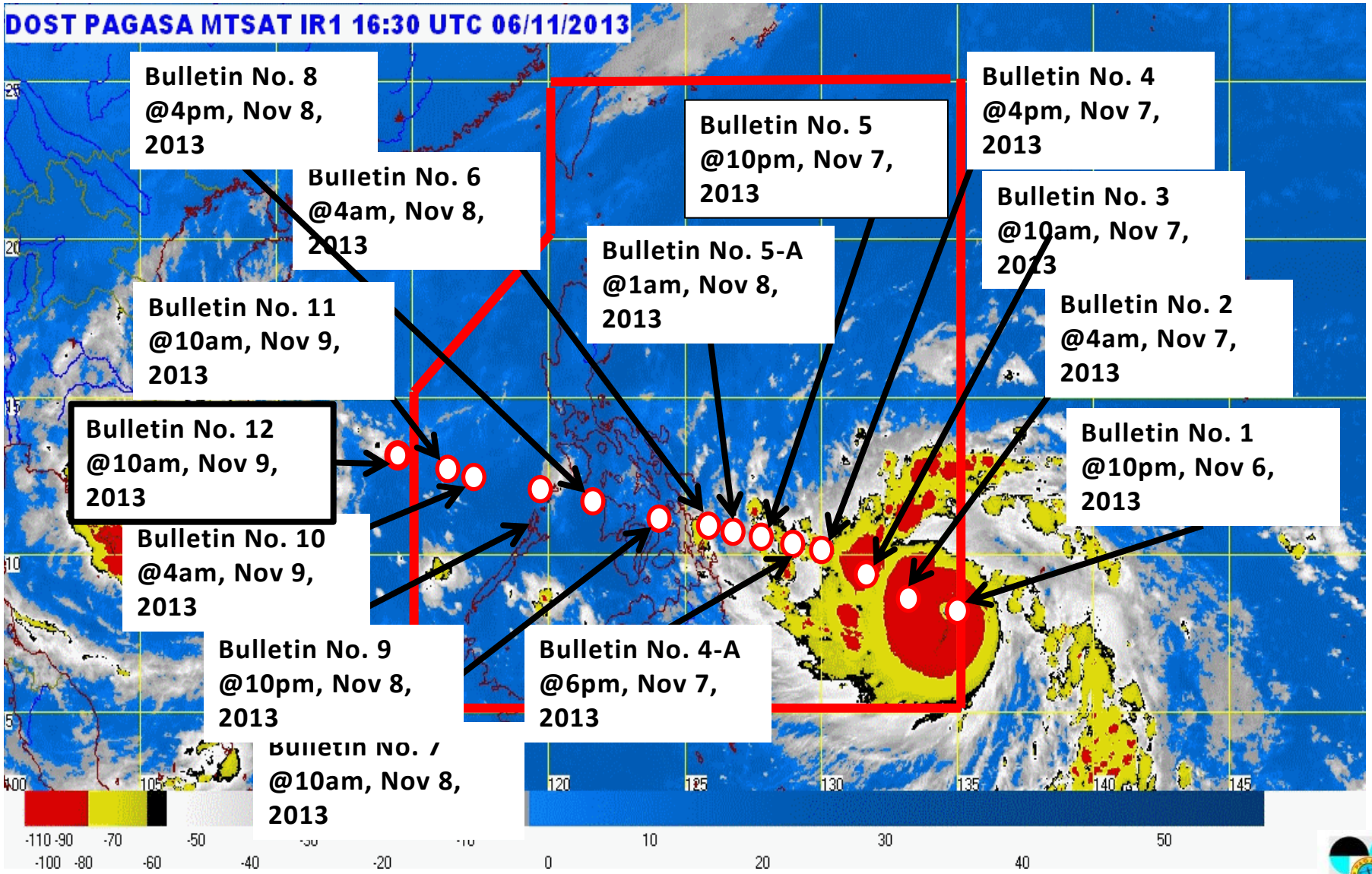


Technical Challenge: Turning Observations into Knowledgable Products & Information



TYPHOON YOLANDA (HAIYAN)- a slide from PAGASA

November 6 – November 10, 2013



The GFCS initial priority areas

Provide challenges & opportunities for new partnership to address new observational requirements via user communities

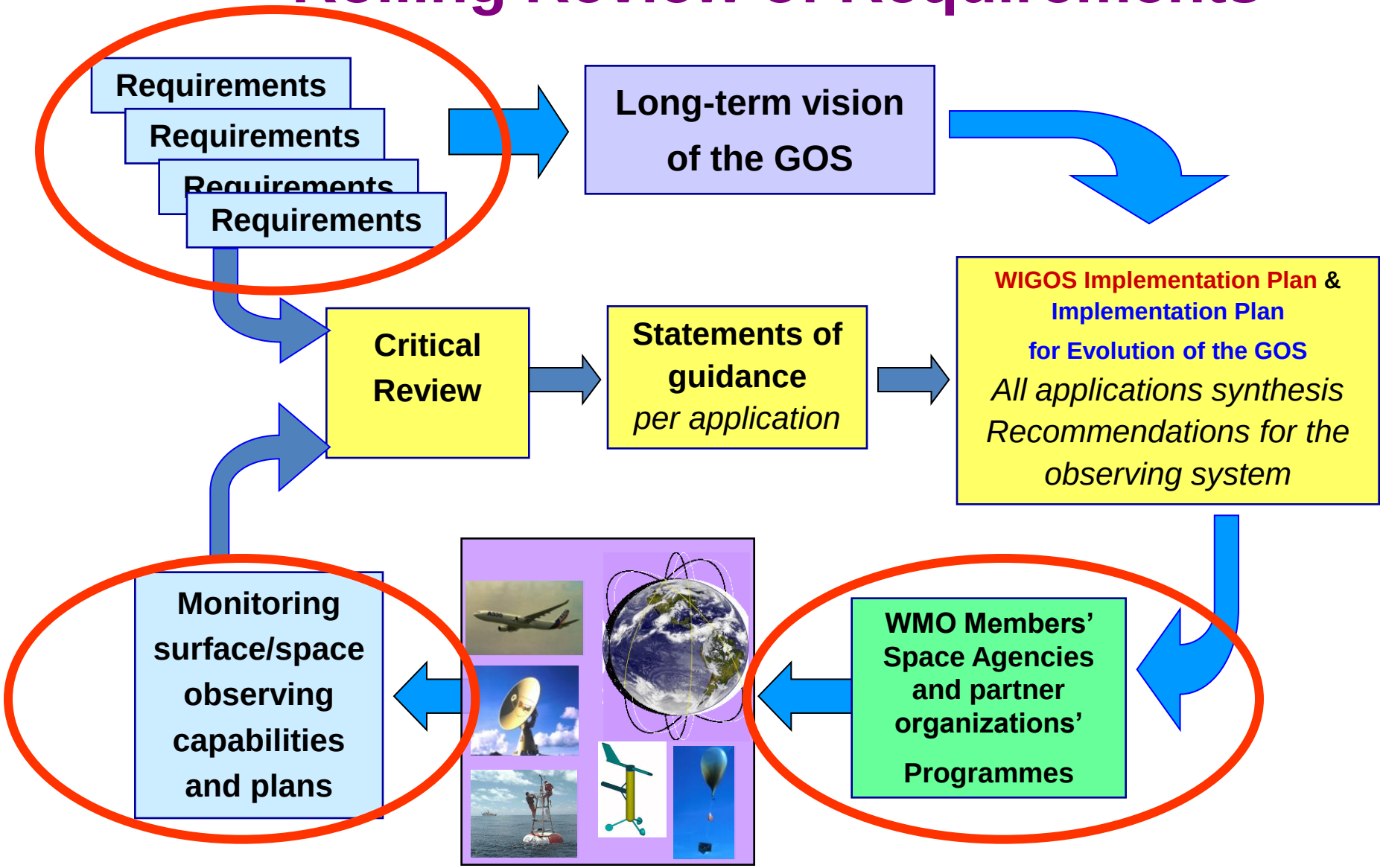
Agriculture

Water

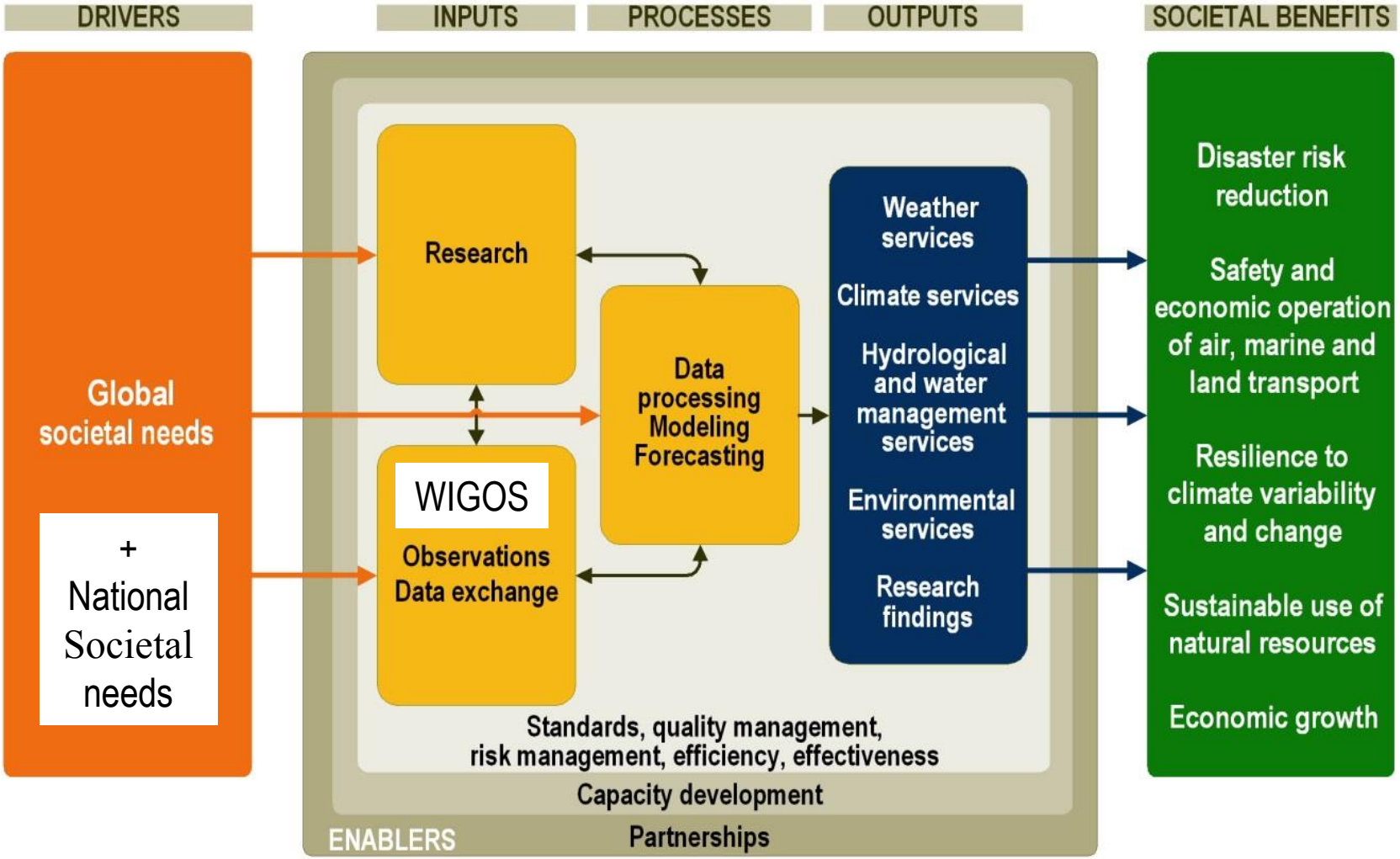
Health

Disaster Risk Reduction

WMO Standard Practice:
Rolling Review of Requirements



WIGOS: Integral part of NMHS and key enabler of their value proposition



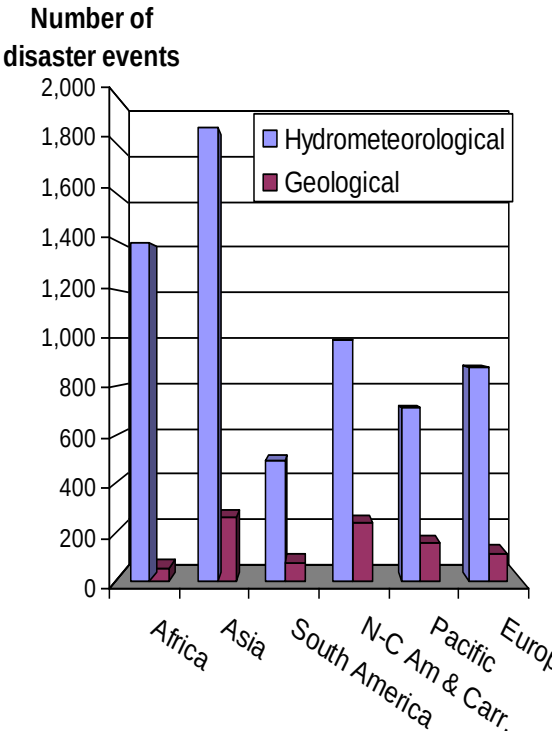
WIGOS Pre-operational Phase (2016-2019)

- Back to the basic principle of WIGOS → WIGOS is an integrated, comprehensive, and coordinated system
- Build on core contributions from CBS (ICT-IOS, EGOS-IP, network design) & CIMO (eg standards & quality)
- Focus on core differentiating aspects of WIGOS
  - Integrated governance and management
  - Integrated information
  - Integrated regulatory practice
  - **Integrated data and products quality & monitoring**

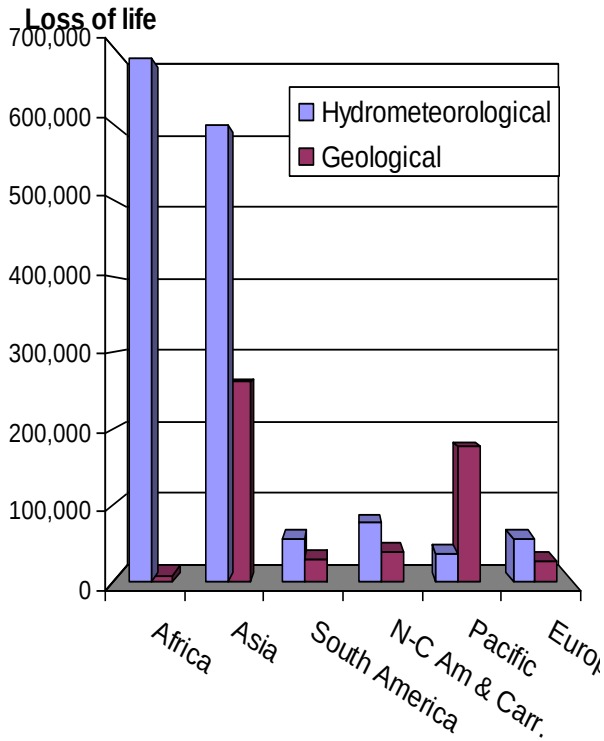
→ ***This is one of the most important piority area: Establishment of WIGOS Monitoring System (for both data availability and quality) through Global Operational Centers and WMO centralized information system (Dec.10-12, 2014, first workshop, Geneva)***

→ Integrated utilisation, for more efficient & effective outcomes

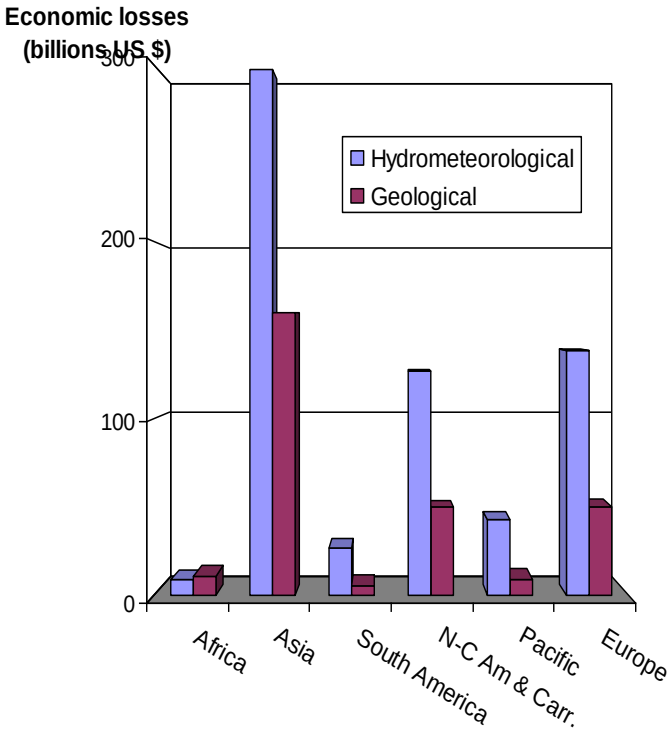
Regional Distribution of Number of Disasters, Casualties and Economic losses Caused by natural hazards (1980-2007)



Number of events



Loss of life



Economic Losses

Source: EM-DAT: The OFDA/CRED International Disaster Database - Université Catholique de Louvain - Brussels - Belgiumc