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THE DEVELOPMENT OF OPERATIONAL METEOROLOGY AND CHALLENGES FOR THE FUTURE

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Evolution to revolution

Mid 20th century advances in science and technology

- Radars
- Telecommunications
- Computers
- Numerical modelling of atmospheric processes

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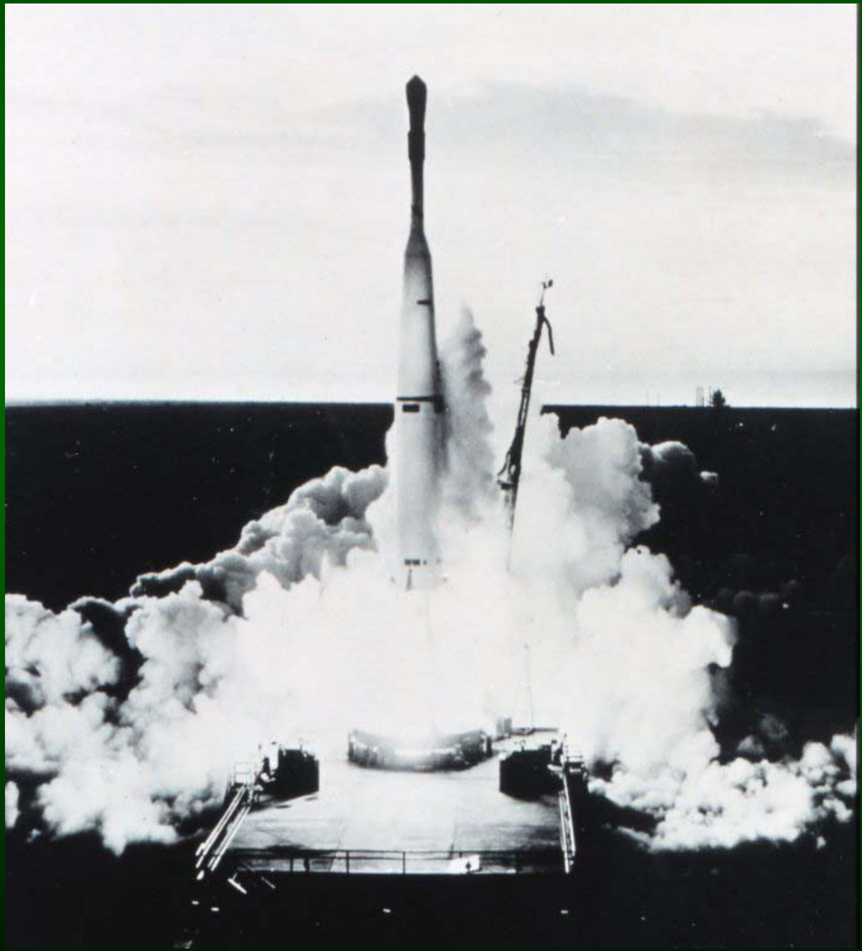
On April 1, 1960 the first U.S. weather satellite (TIROS-1) launched from Cape Canaveral, FL

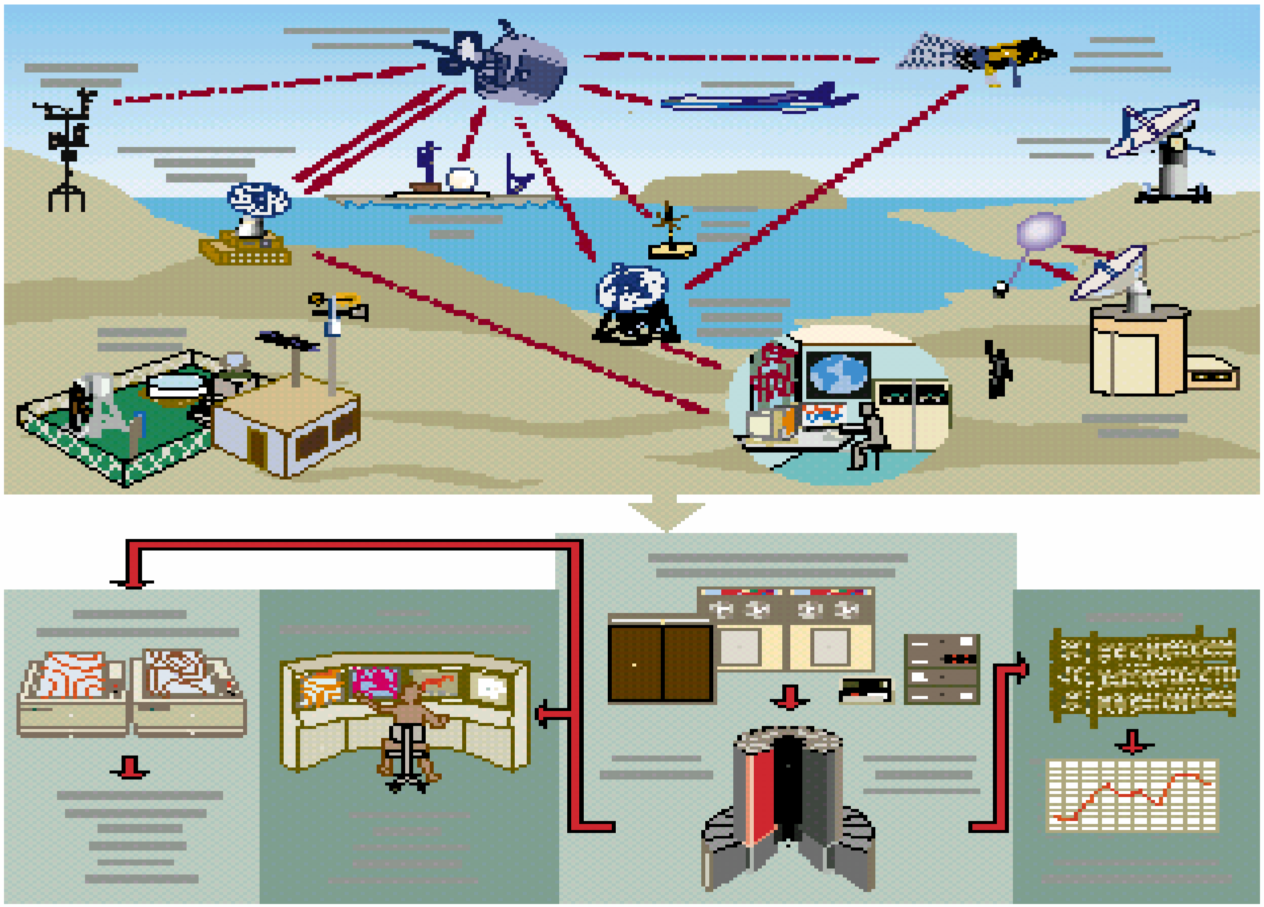
SATELLITES AND THE WWW

UN Resolution for "international co-operation in the peaceful uses of outer space" adopted 20 December 1961

- **Satellites offered substantial opportunities for improvements in meteorological services**
- ***UNGA called on WMO to lead a study and report on recommendations***
- **Report delivered in June 1962: *"First report on the advancement of atmospheric sciences and their application in the light of developments in outer space"***
- ***Birth of WMO's World Weather Watch***



WWW – Basic Components


The World Weather Watch and the operations of a NMS

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Global Atmospheric Research Programme

- GARP crucial to development of the WWW
- Main aim to extend range, scope and accuracy of weather forecasts
- Many field experiments using new and innovative observing systems

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WMO Voluntary Cooperation Programme

- WWW implemented by individual Members according to means and within the agreed plan
- Role of individual NMHS critical to success of WWW
- Implementation of extra-territorial areas based on voluntary participation of Member countries
- To assist those with limited means, VCP established

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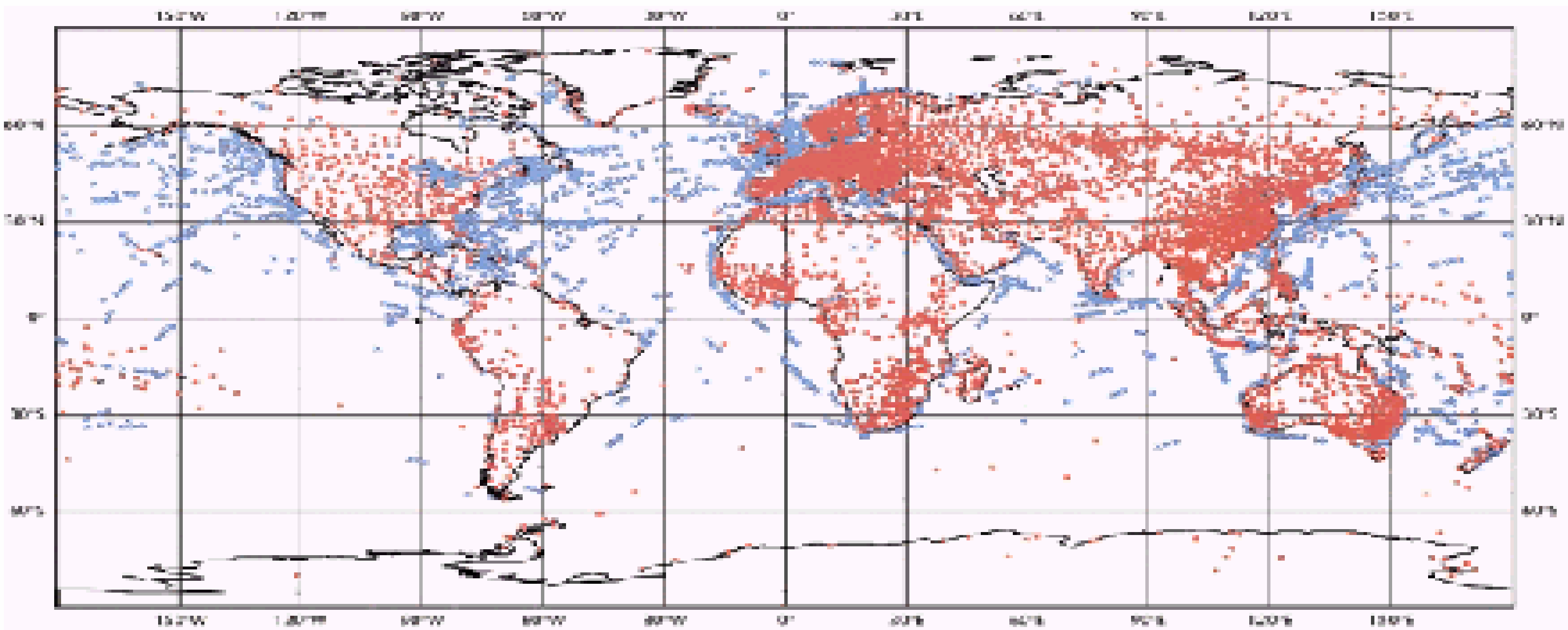
Surface Monitoring Networks



Typical daily coverage of surface observations made at meteorological stations (red) and from ships (blue)

GOS includes 10 000 surface and 1 000 upper air stations; 700 buoys, weather radars, 7 300 ships and 3 000 aircraft.

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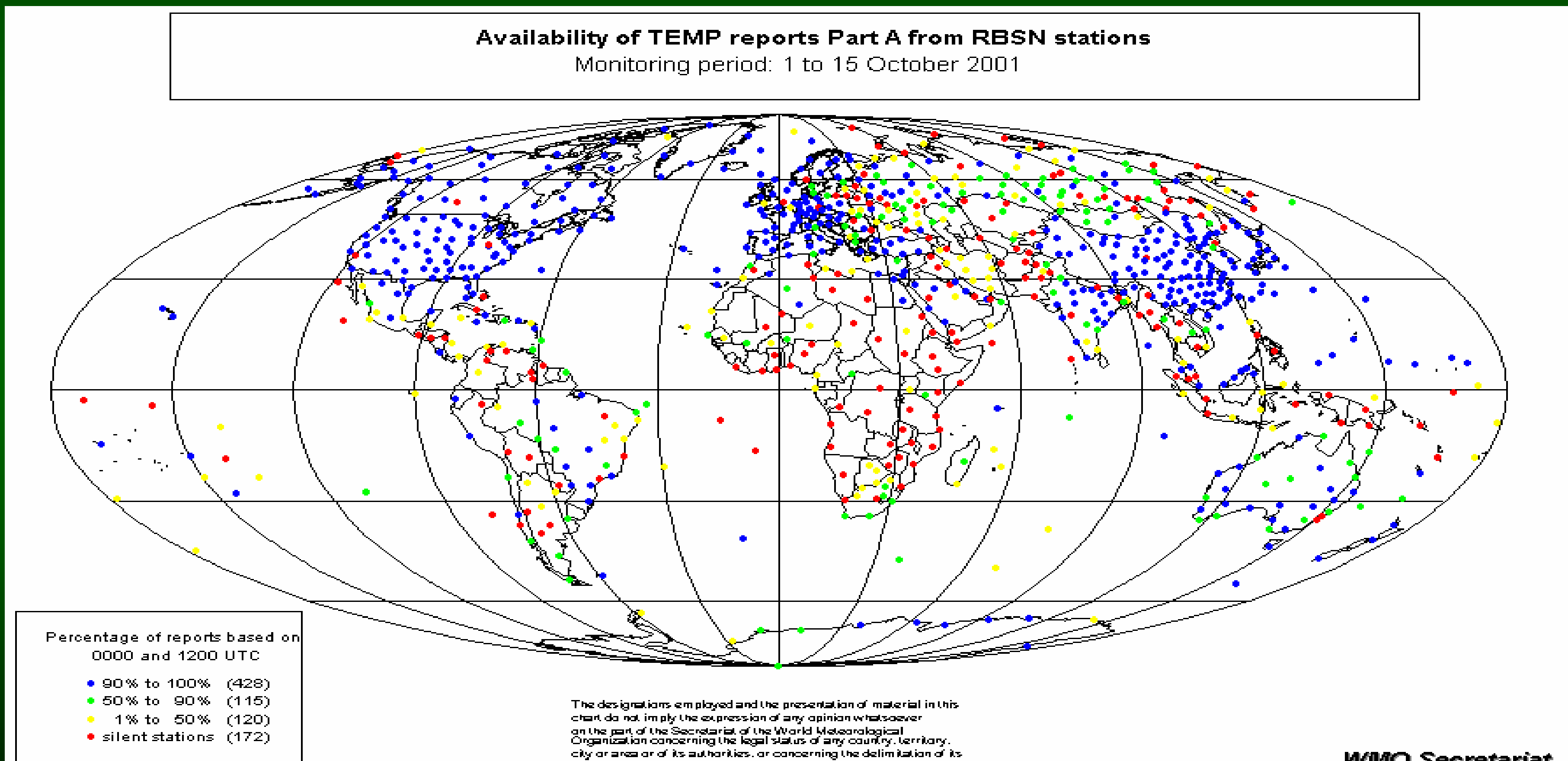
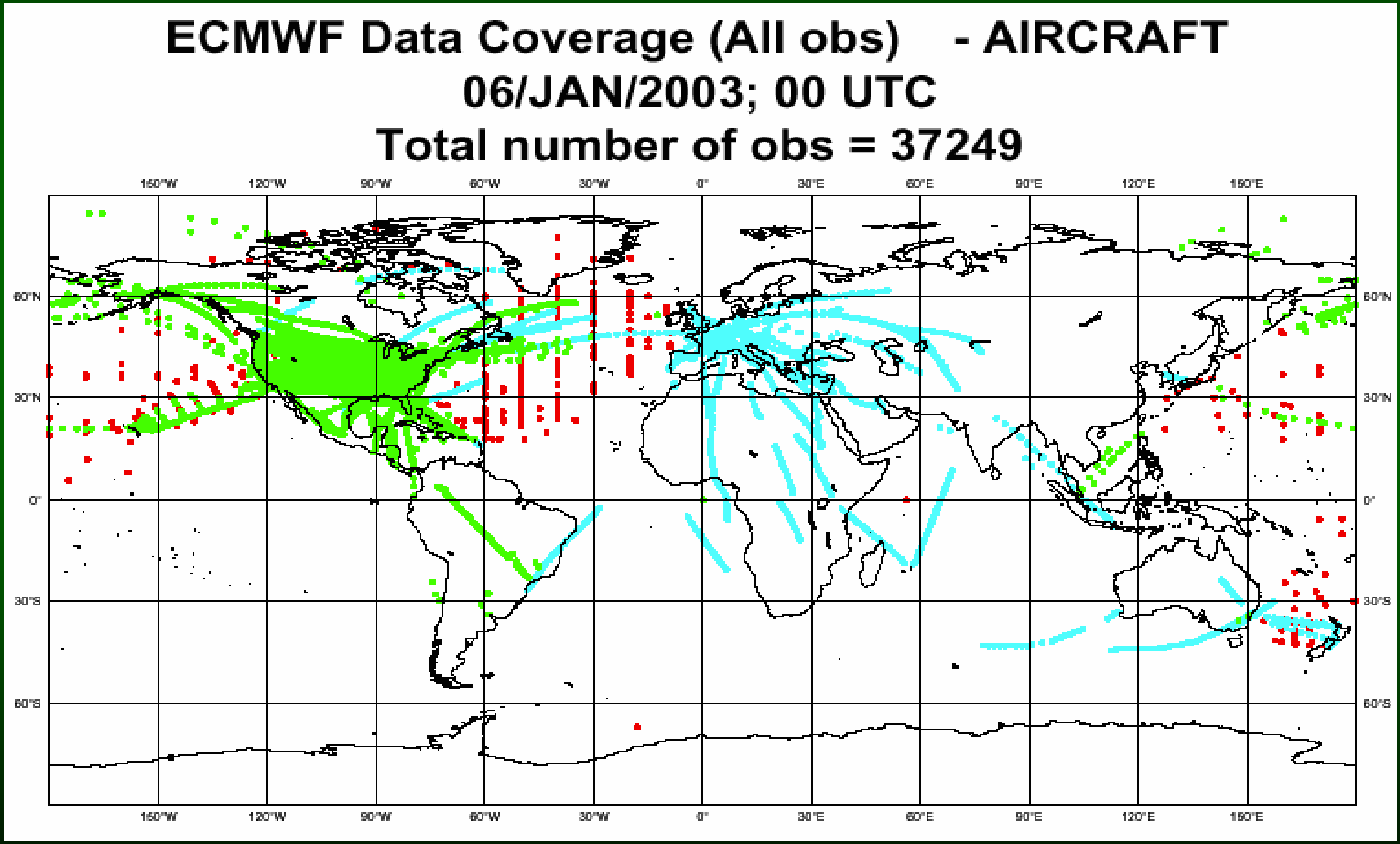
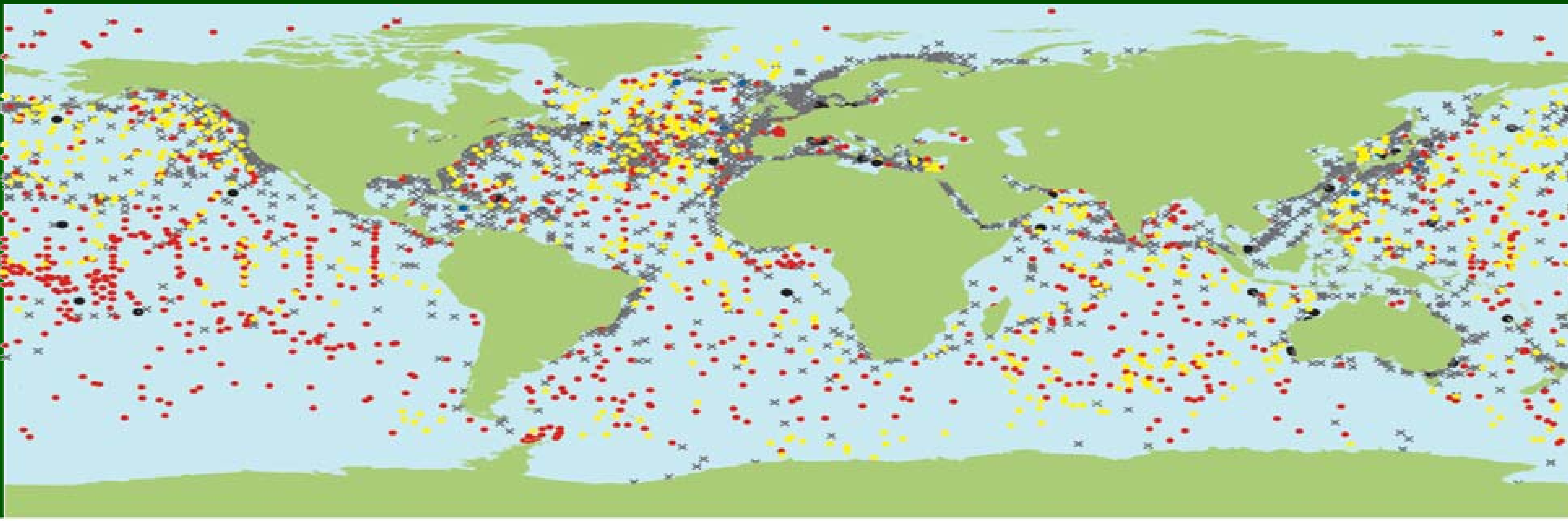
TEMP Reports



Aircraft observations



Status of the in situ marine observing network in early 2003



In situ marine observing platforms, February 2003
(platforms reporting on GTS, last position during the month)

- ● BATHY (mainly XBTs)
- ● BUOY (drifting & moored buoys)
- × SHIP (mainly VOS ships, some moorings)
- ● TEMP-SHIP (ASAP)
- ● TESAC (mainly Argo floats)
- ● TRACKOB (mainly TSG)

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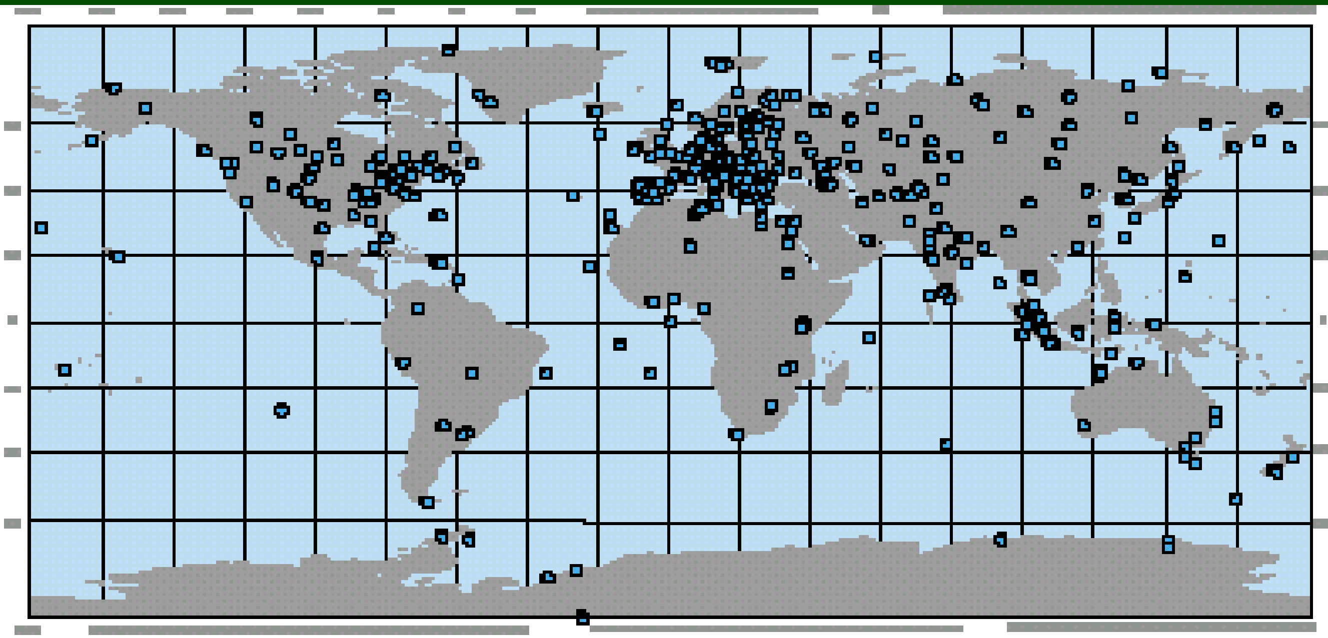
GAW Monitoring Network
Atmospheric chemistry



- 22 Global and over 200 Regional GAW stations in more than 60 countries
- Operated by NMHSs and research/academic institutions, GAW measures CO_2, O_3, other GHGs, air pollutants, etc. Also uses satellites
- GAW provides improved understanding of atmospheric composition (human-induced climate change relationship) essential for research institutions, governments, IPCC, FCCC and Ozone Convention/Protocol

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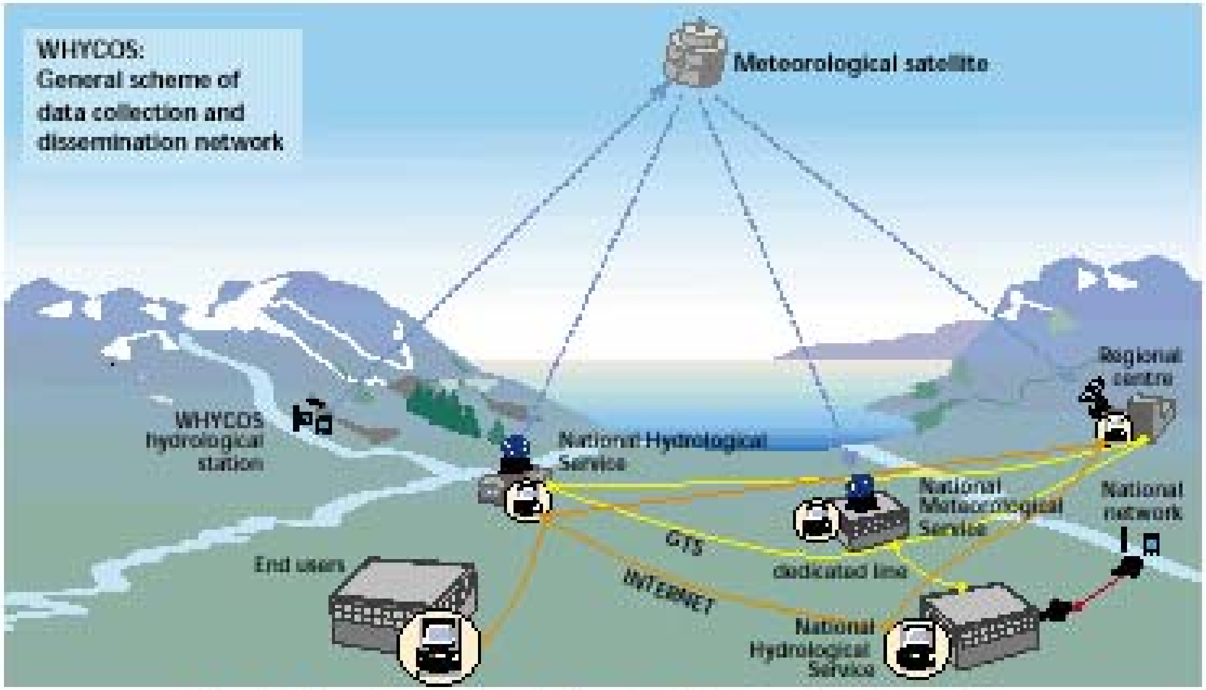
Hydrological Monitoring Network (WHYCOS)



World Hydrological Cycle Observing System

- Hydrological data (river basin runoff, evaporation, ground water, etc.) may provide early warning signal of climate change.
- WHYCOS (MED-HYCOS, etc.) — increased exchange of hydrological data for climate studies.

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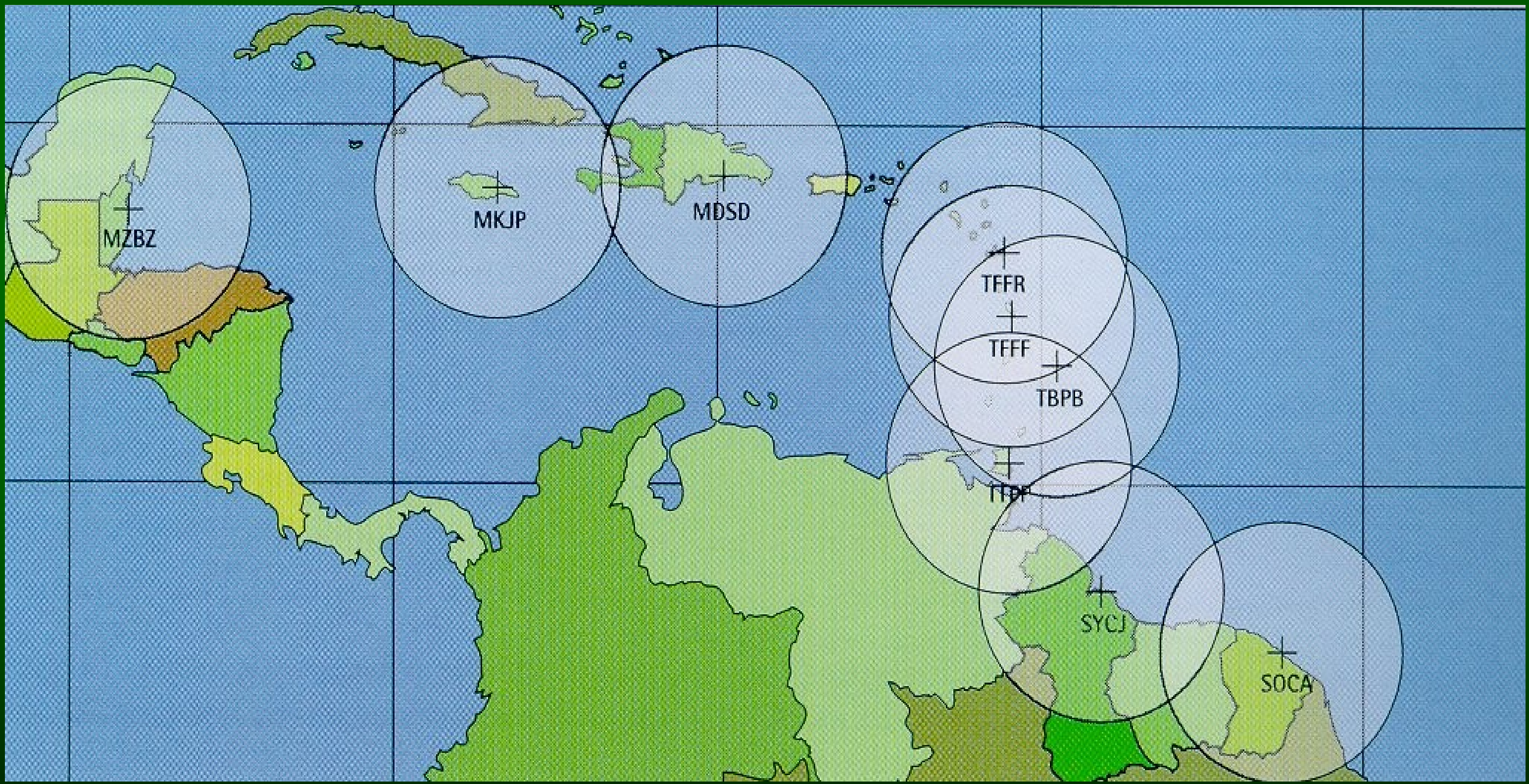
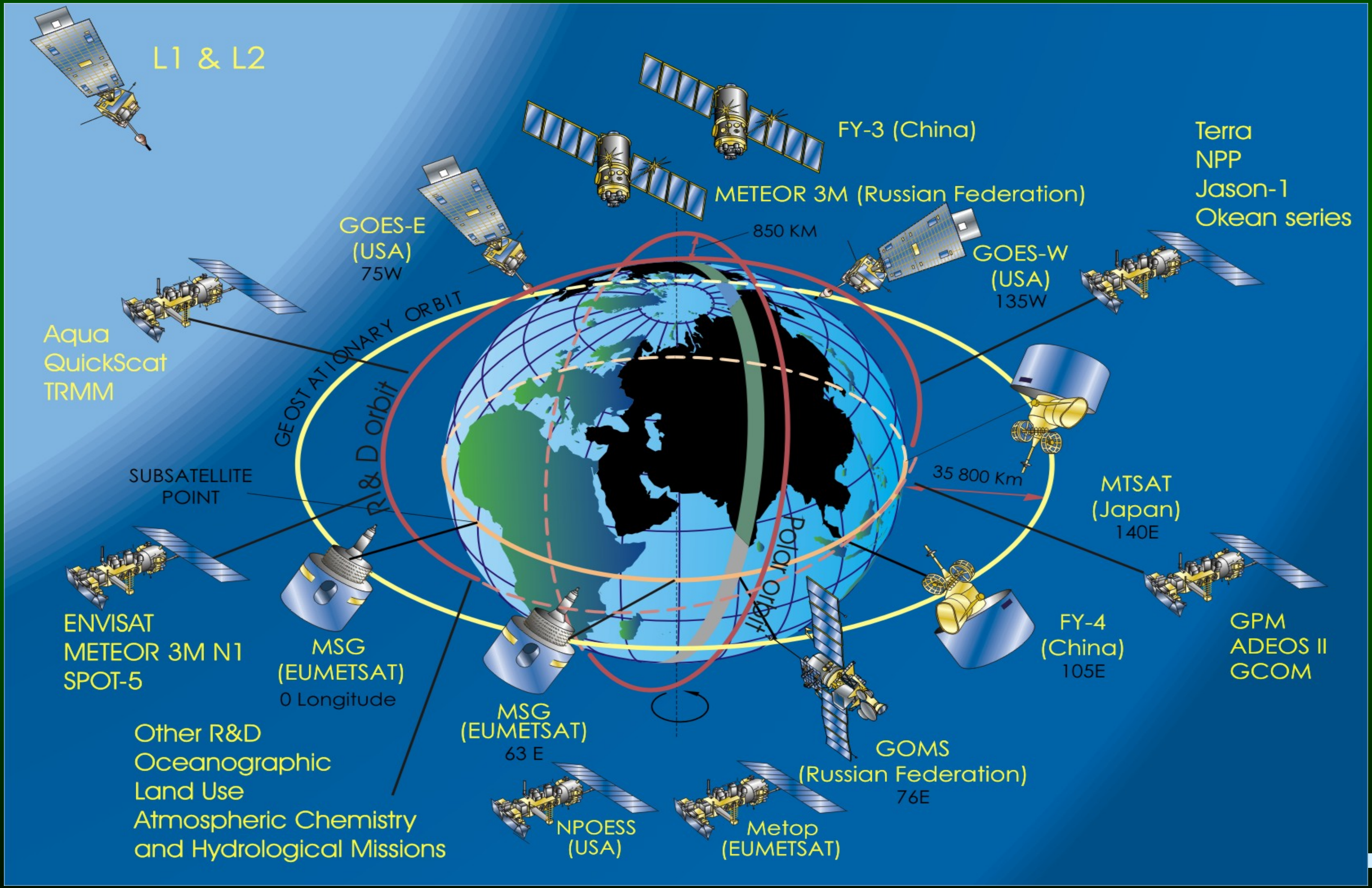
Radar networks

Example:

Carribean radar network



WMO space-based component of the Global Observing System (2004)



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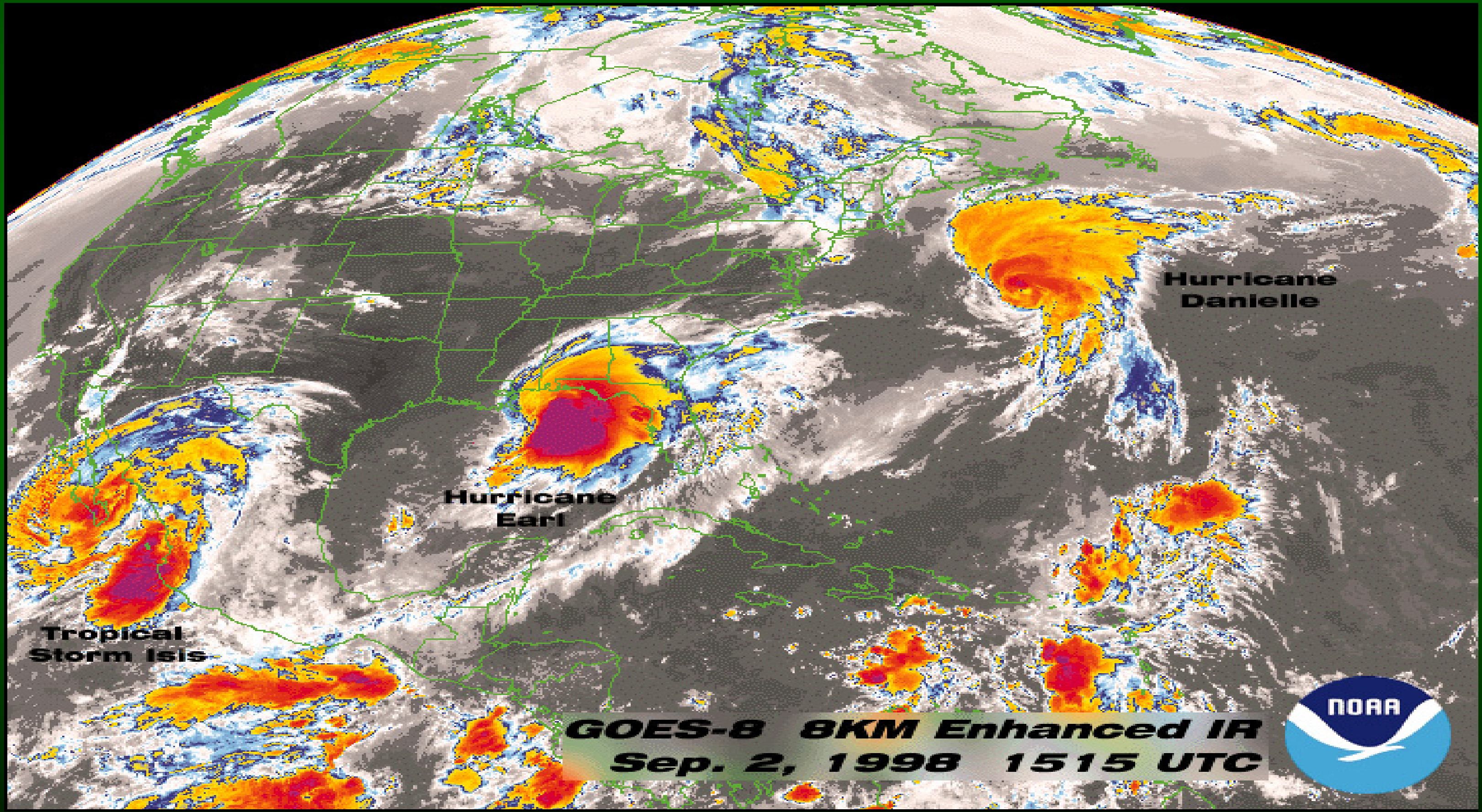
Monitoring tropical storms and hurricanes



(from NOAA)

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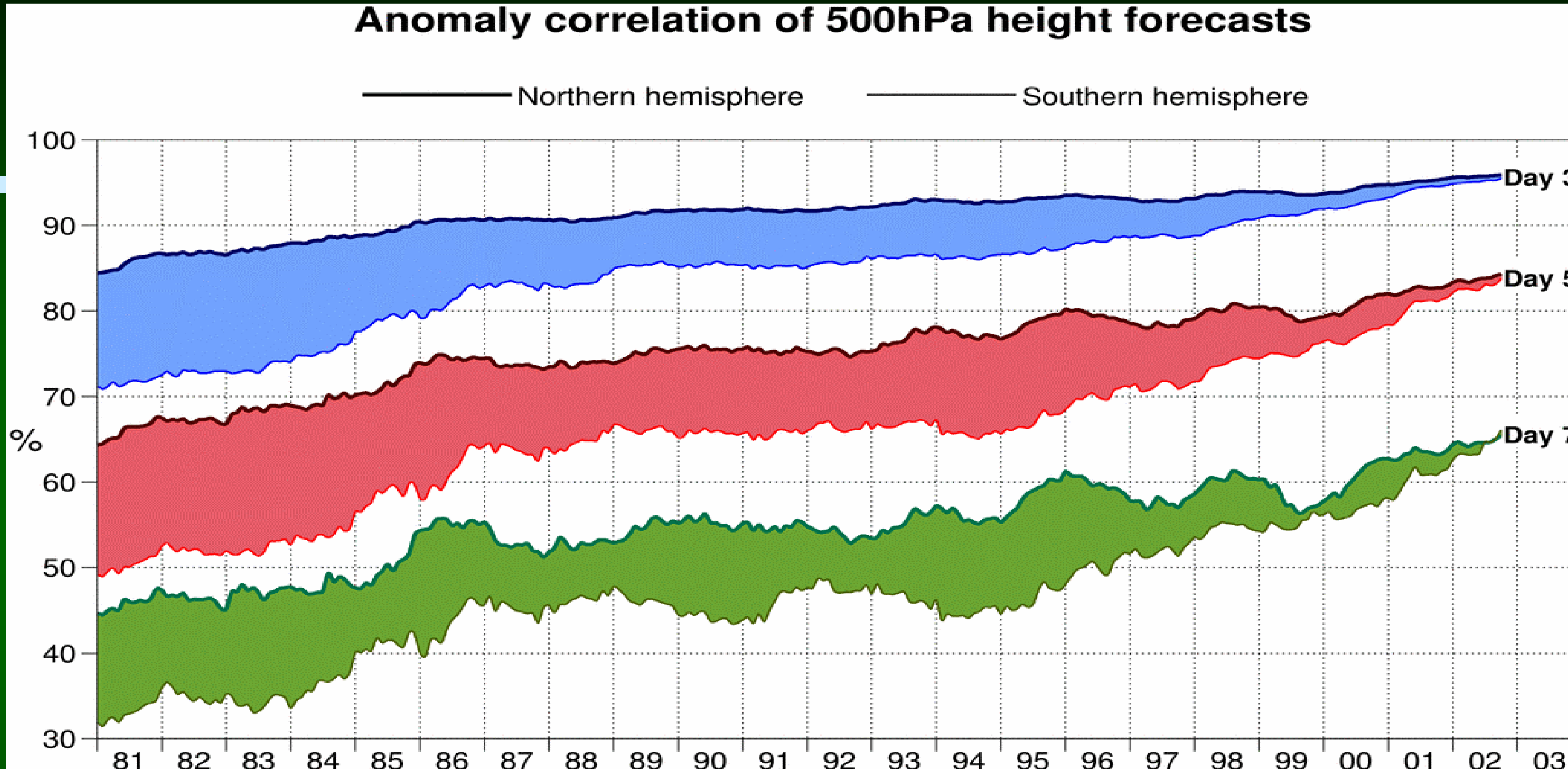

Anomaly correlation coefficients of 3-, 5- and 7-day ECMWF 500hPa height forecasts, for the extratropical northern and southern hemispheres, plotted in the form of annual running means of monthly-mean scores for the period January 1981 to September 2002. Values plotted for a particular month are averages over that month and the 11 preceding months.

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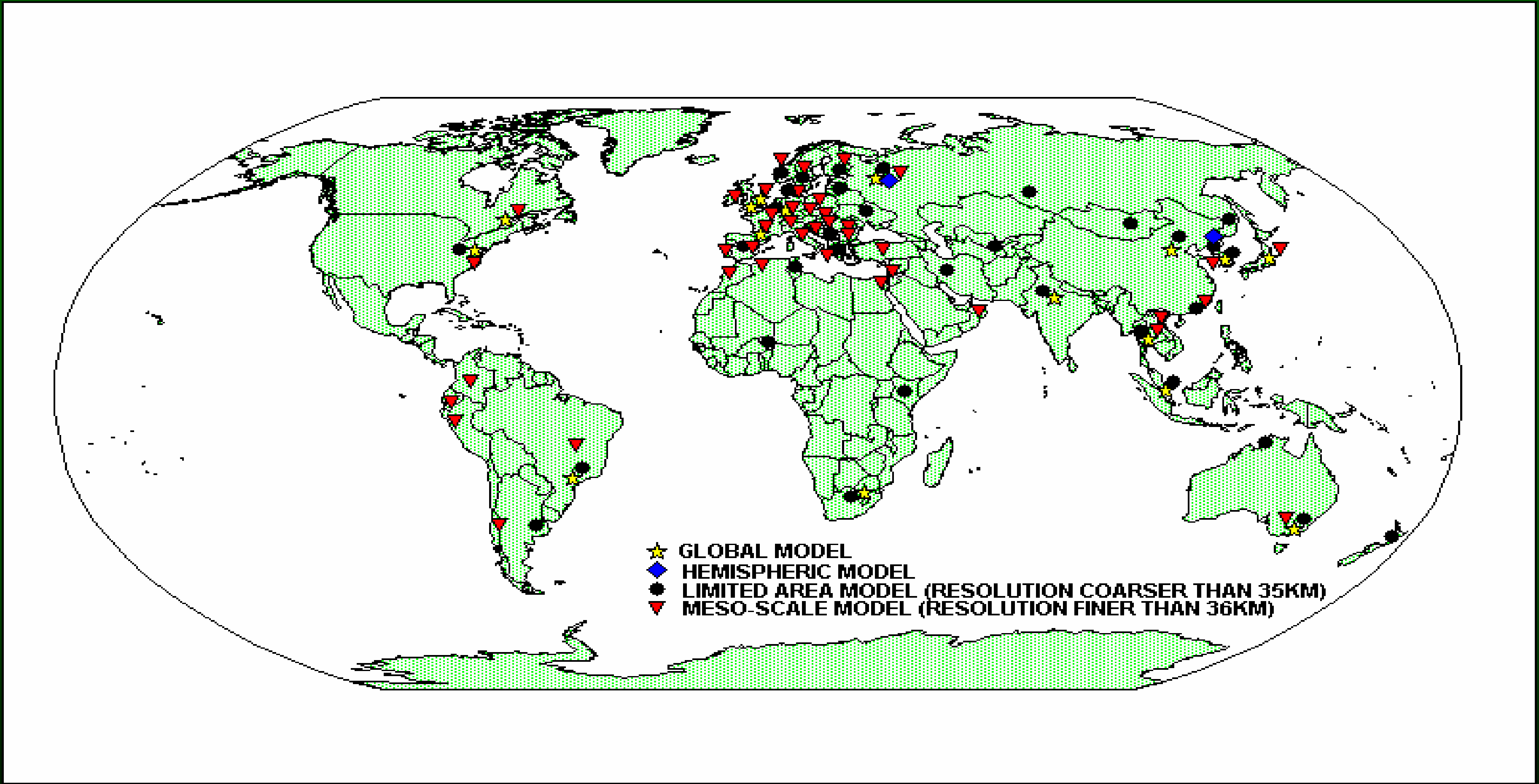
GDP(F)S CENTRES RUNNING MODELS



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Recent Developments and Future Prospects

- New scientific and technological developments
- New requirements and challenges
- Modernization of the global meteorological system

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Requirements for a New Observing System

- New and expanding requirements posed by an increasing range of applications, eg. climate & climate change studies, environmental protection, ...
- New technological developments – avionics, radar, new satellite sensors, Argo floats, use of GPS, targeted observations, ...
- Advanced data assimilation techniques
- Need for cost-efficiency and greater integration

Redesign of the GOS

- *Impact of changes to the GOS in the next decades is likely to be massive*. Radically new approaches to science, data handling, product development, training and utilization are required. Need for strategies for *anticipating and evaluating changes to the GOS*.
- *Future contributing observing systems* (space-based, remote sensed and in situ) *to be considered in an integrated way*, together with other observing systems – GAW, WHYCOS, GOOS, GCOS. Composite system, with *most cost effective mix* of system components and techniques.
- Vision for the WMO GOS in 2015 and beyond

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WMO Space Programme

- **WMO EC agreed to establish a WMO Space Programme as a matter of priority**
- ***Scope, goals and objectives respond to the considerable growth in the utilisation of environmental satellite data, products and services* within the expanded space-based component of the WMO Global Observing System**
- **Guiding principles: *optimisation of the space-based system*, use of existing WMO structures and *integration* with other types of observations**

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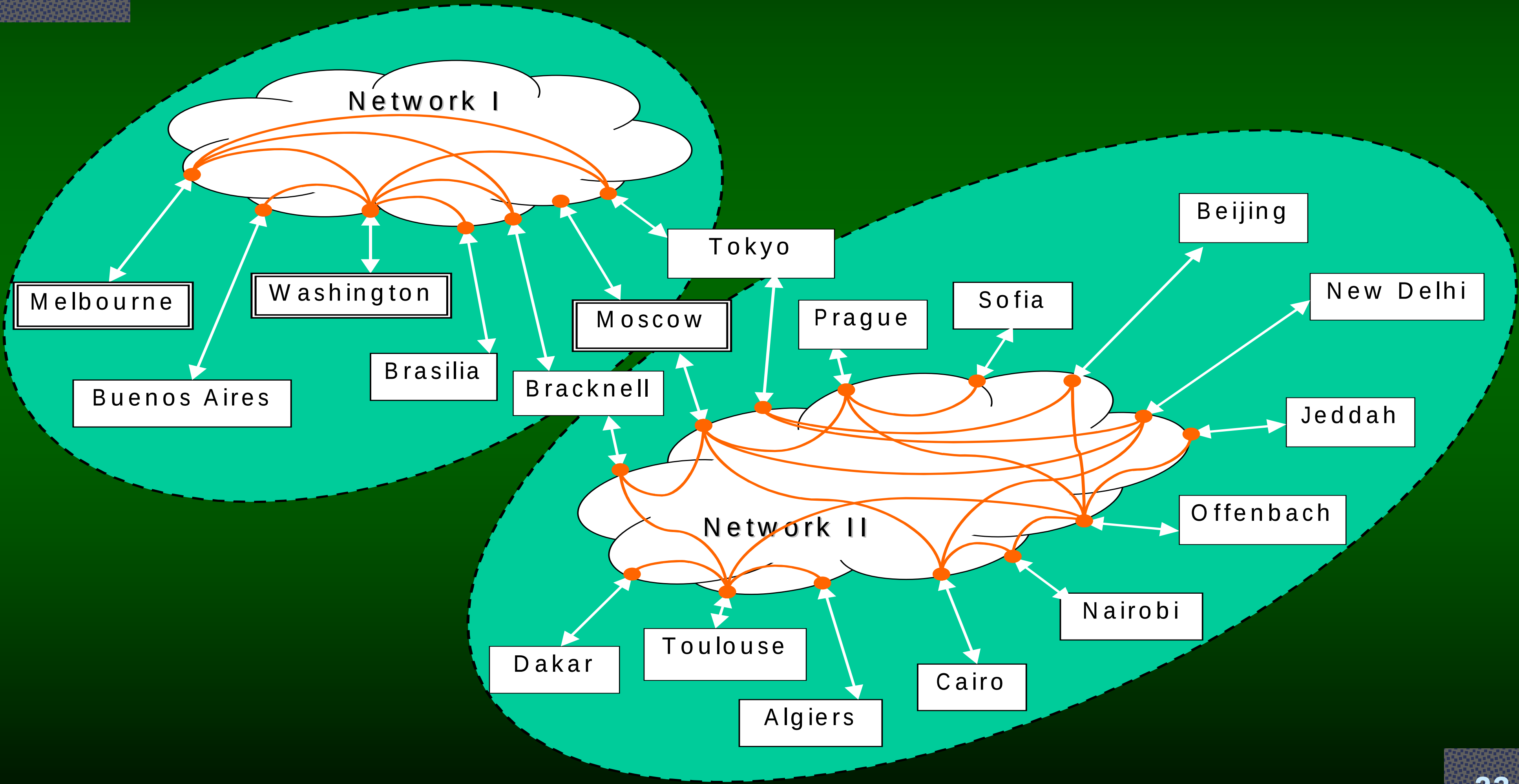
New Information exchange system

Communication techniques and protocols

- Rapid migration to the Transmission Control Protocol/ Internet Protocol (TCP/IP) as a WMO standard over the GTS
- Implementation of File Transfer (FTP), and adoption of a WWW file naming convention facilitating a smooth transition
- Guidance for complementary use of the Internet, minimizing operational risks (E-mail, Virtual Private Networks)

GTS: The Improved MTN



Future WMO Information System

Integrated approach to meeting both real- and non-real-time requirements of *all* WMO Programmes for:

- routine collection of observed data
- dissemination of scheduled products ("*push*")
- ad-hoc non-routine applications ("*pull*")

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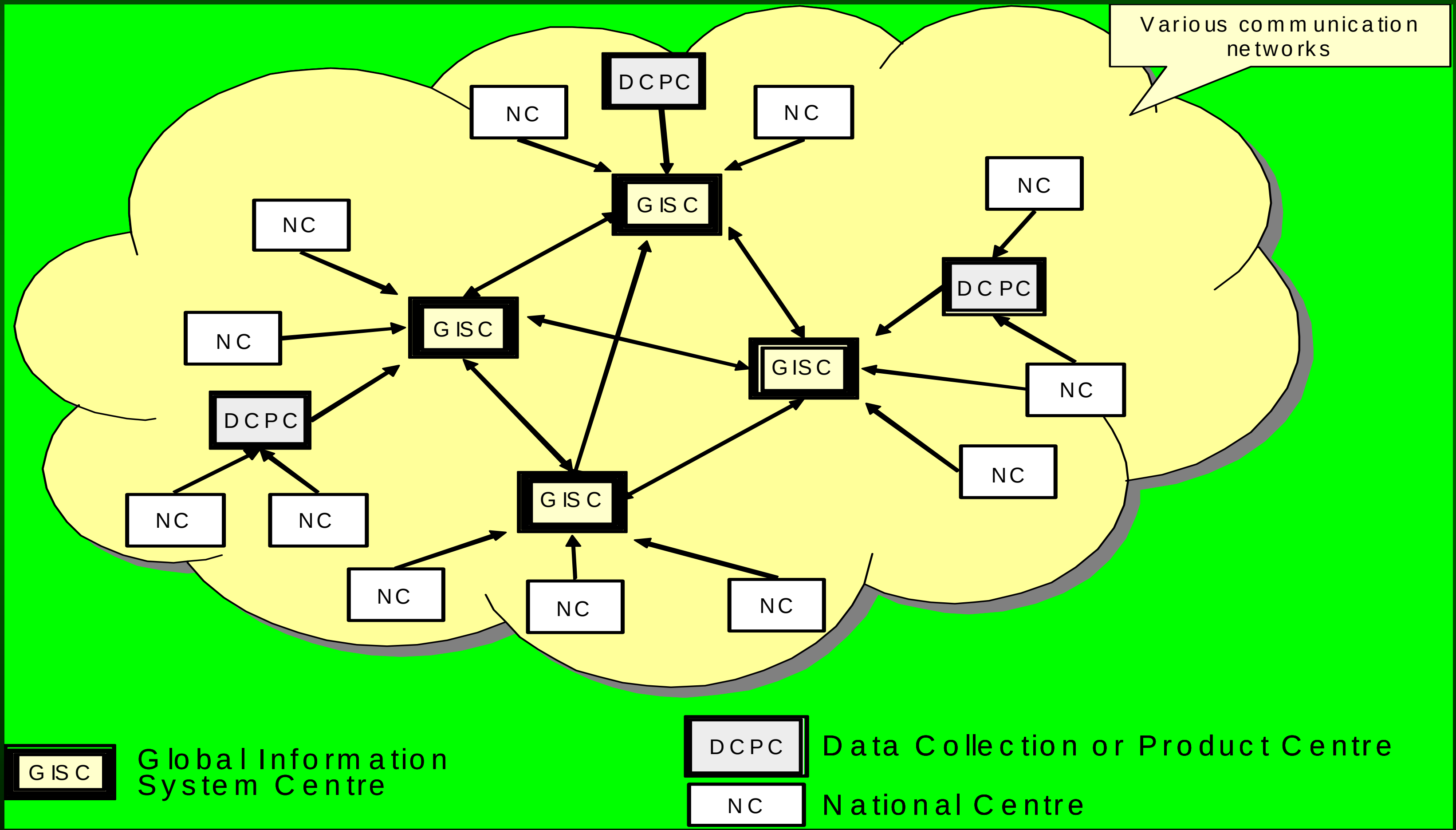
Future WMO Information System Information collection data flow



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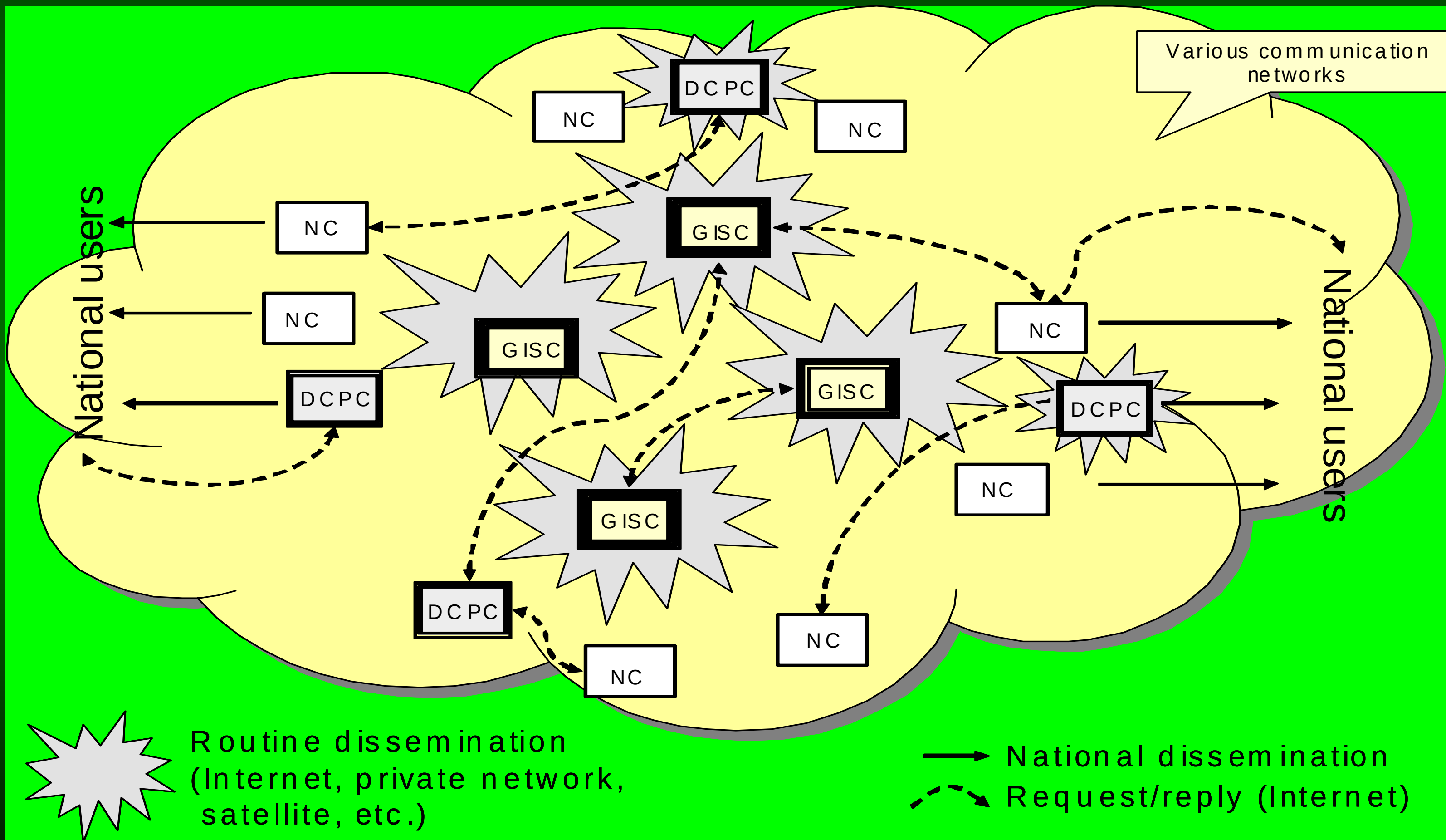
Future WMO Information System
Information distribution



Weather and Climate Prediction

- **Advances in NWP**
- **Advances in data assimilation**
- **Forecast accuracy greatly improved at all ranges**
- **THORPEX – interactive forecast systems**
- **Ensemble prediction systems**

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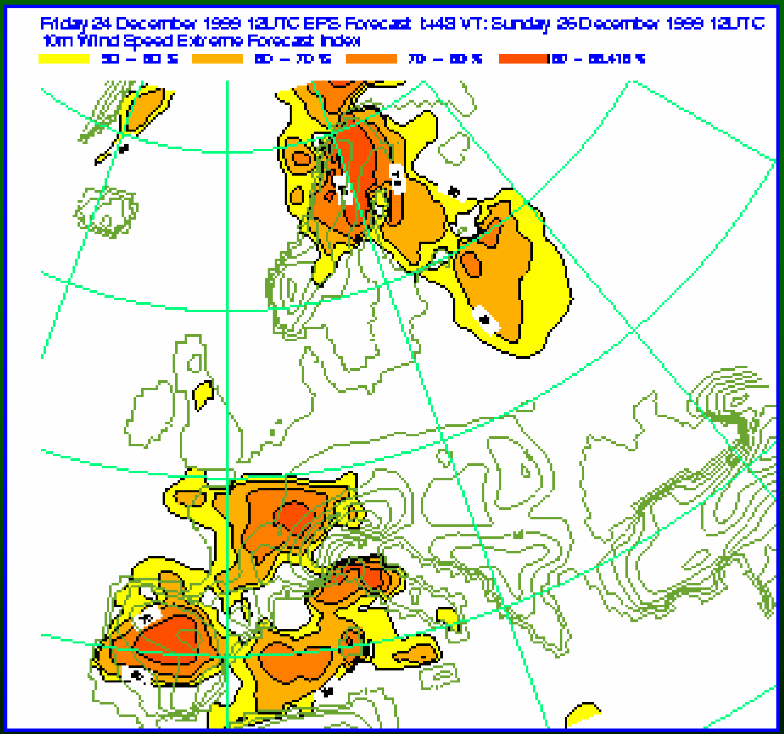
Ensemble Prediction Systems (EPS)

- **Ensemble Prediction Systems (EPS) have the potential to benefit forecasting services in all geographical areas and many applications.**
- **In particular for high impact weather and seasonal prediction and applications in environmental prediction, hydrological modelling and environmental emergency response by *providing probabilistic forecasts for specific environmental variables dependent on atmospheric drivers.***

EPS PRODUCTS

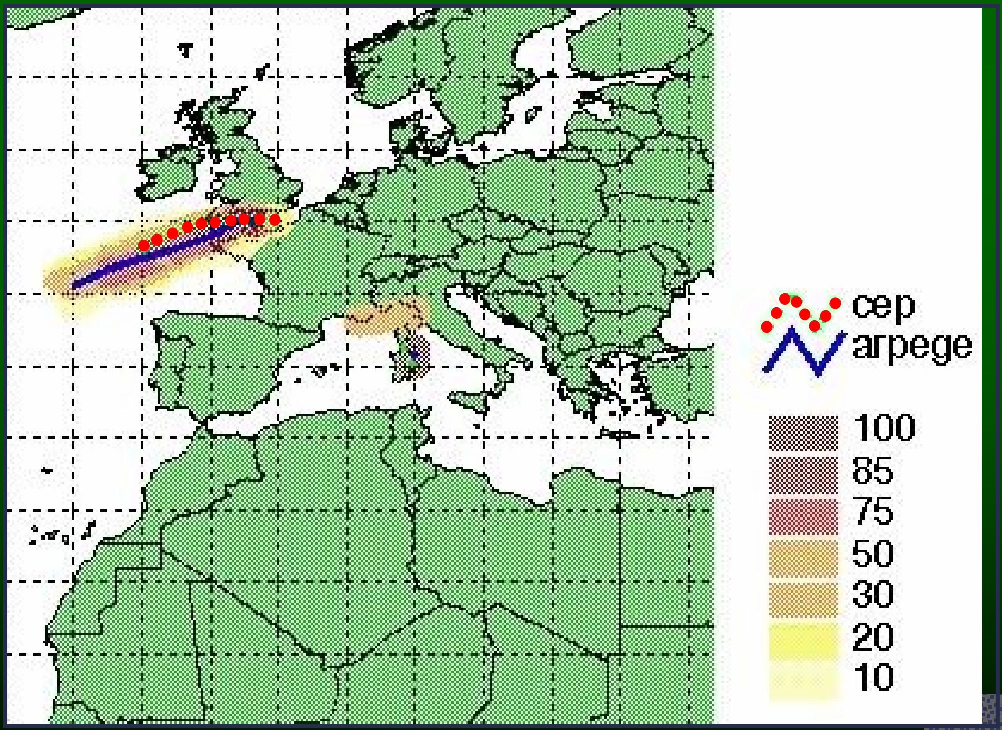
**Extreme Forecast Index
for wind speed 48 h ahead**

For 26/12/1999 12 UTC



**Probability of trajectories of pressure lows
(MSLP < 990 hPa)**

48 h Forecast based on 12/10/2002 00 UTC



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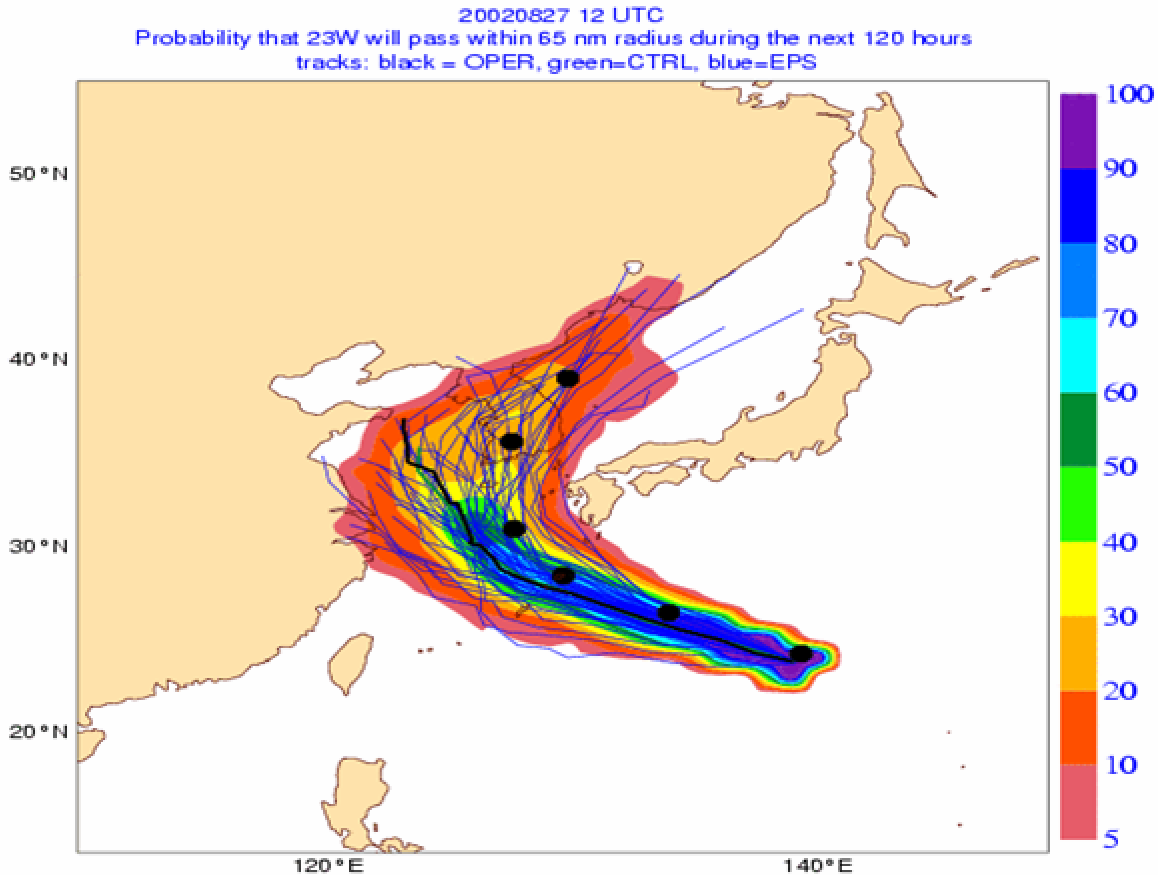
Application of EPS to Typhoon forecasting



Strike probability (within 65 nm) of Typhoon Rusa over the next 120 hours.

Starting time of the forecast is 27 August 2002 12 UTC.

Full dots give the observed position over the period 27 August to 1 September 2002

(from ECMWF)

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Medium to Long-Range Forecasting

- Further advances in data assimilation
- THORPEX
- Application of coupled ocean-atmosphere models and EPS
- Climate variability and predictability – CLIVAR
- ENSO
- International Polar Year 2007-2008

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New Era in Operational Meteorology

- Greater demands on operational system
- Increasing sensitivity / vulnerability of world economy to hydro-meteorological factors
- Cost-efficiency imperative
- Need to increase awareness of applications and benefits of meteorological services

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Environmental Protection and Sustainable Development

- Global responsibilities
- WMO contributions in many areas – global change, pollution, floods, droughts, mitigation of high-impact weather events
- Need for cross-programme, integrated approach

WMO Programme for Disaster prevention and mitigation

- Increasing impact of severe weather
- Emphasis on prevention and risk management
- Early warnings
- Climate related events

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Disaster prevention and mitigation

Need for a more integrated approach at

National level

- Role of national meteorological or hydrological services
- Cooperation across disciplines and agencies
- links with civil society
- importance of partnership with medias

International level

- between IGOs and NGOs concerned

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Bridging the Gap

- Globalisation of meteorological systems and dependence on sophisticated technology creating gap between “haves” and “have-nots”
- Capacity building, education and training, transfer of technology
- Need for more partnerships
- Enhance capability of NHMS to assimilate information from major centres and generate value added products

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Conclusions (1): need for cooperation

The need for cooperation is stronger than ever at:

- **National level**
- **Subregional level**
- **Regional level**
- **Global level**

Across many actors:

- **NMHSs, NHSs**
- **Academic community**
- **Development partners**
- **Government & private sector**
- **Medias**
- **Civil society**

In multiple domains:

- **observations**
- **communications**
- **data processing (incl NWP)**
- **disaster prevention**
- **…**

And *across disciplines*

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Conclusions (2): need for cooperation

- *Bruxelles 1853 to Bruxelles 2003:*
- *The motivations that brought our predecessors here together 150 years ago are as compelling as they were then.*
- *The need for international cooperation is greater than ever.*
- *WMO is ready to to play its full rôle*

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Thank you

Merci