The Redesign and Evolution of the Global Observing System

An Excerpt from the Report of the Chair Open Program Area Group on Integrated Observing Systems

James F.W. Purdom

Chair, OPAG-IOS

This is a power point presentation. The movies in the presentation are included as AVI files and may need to be re-linked on your system.


A composite space and ground based observing system

OPAG IOS Items Reported On

- Activitiy Reports for ET's
  - ET: Observational Data Requirements and Redesign of the Global Observing System
  - ET: Satellite System Utilization and Products
  - ET: Requirements and Representation of Data from Automatic Weather Stations

- Activities of the Rapporteurs
  - Scientific Evaluation of OSEs and OSSEs
  - GCOS Matters
  - AMDAR Matters
  - GOS-related regulatory material
    - Manual and Guide on the Global Observing System (WMO-No. 544 and WMO-No. 488)
    - Improvements to Weather Reporting (WMO-No. 9), Vol. A

- Regional Aspects of the GOS

Observational data requirements and redesign of the Global Observing System

Chair: W.P. Menzel

5.1.2 “focus of activity”

- The update of users requirements and observing system capabilities in ten application areas, including the RRR and the corresponding Statements of Guidance

- The review of several Observing System Experiments (OSEs) that tested possible re-configurations of the GOS and the Third WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction (March 2004)

- 5.1.3: Draft Implementation Plan for the Evolution of the Space- and Surface-Based Sub-Systems of the GOS

"Observing System Experiments (OSEs) that tested possible re-configurations of the GOS"

In Section 5 of "Draft Implementation Plan …"

+ hourly versus 6 hourly surface pressure
– denial of radiosonde data globally above the tropopause
+ information content of the Siberian radiosonde network
+ AMDAR data over Africa
+ tropical radiosonde data
+ three LEO AMSU-like sounders
+ AIRS data
+ better than 3 hourly ascent descent AMDAR data.
+ polar winds from MODIS water vapor imagery

Implementation Coordination Team
OPAG IOS

RA I: Mr. Saloum, Co-chair

RA II: Mr. Chen

RA III: Mr. Plaza

RA IV: Mr. Stolz

RA V: Mr. Iroi

RA V: Mr. Maridet

RA VI: Mr. Douglas

CAeM: Mr. Grooters

ET Chairs & Rapporteurs

Chair: J.F.W. Purdom

Annex to paragraph 5.1.3 of the general summary

IMPLEMENTATION PLAN FOR EVOLUTION* OF SPACE AND GROUND-BASED SUB-SYSTEMS OF THE GOS

(September 2004)

*CBS requested a draft implementation plan for the redesign of the GOS. However, the timeframe under consideration and realities of changes led to the substitution of the word evolution in place of redesign

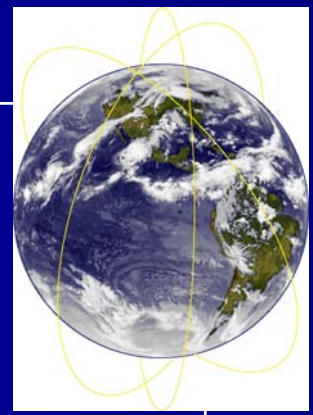
IMPLEMENTATION PLAN FOR EVOLUTION SPACE AND GROUND-BASED SUB-SYSTEMS OF THE GOS (September 2004)

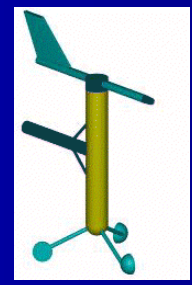
- 1 Introduction
- 2 Recommendations for the Evolution of the GOS
- 3 Implementation Plan for Evolution of the GOS
- 4 Consideration for Evolution of the GOS in Developing Countries
- 5 Specific OSEs carried out to assess possible reconfiguration of the GOS
- 6 Dates of Update for Statements of Guidance

1.2c “basis for the implementation plan” Continuity and Improvement of Service

Candidate Observing Systems

- The future GOS should build upon existing components, both surface and space based, and capitalize on existing and new observing technologies not presently incorporated or fully exploited
- Each incremental addition to the GOS should be reflected in better data, products and services from the NMHSs






1.2d “basis for the implementation plan” Impact and need for strategies

- The impact of the changes to the GOS in the next decades will be so massive that **new revolutionary approaches** for science, data handling, product development, training, and utilization would be required

- There is an **urgent need** to study comprehensive strategies for anticipating and evaluating changes to the GOS

2. Recommendations for the Evolution of the GOS

- **Evolution of the GOS**
  - **47 recommendations**
    - **final report of CBS/IOS/ICT (6-10 September 2004).**
- **Recommendations reflected:**

- **Statements of guidance in 10 application areas**
- **Results from regional programmes such as COSNA, EUCOS and NAOS**
- **Conclusions from the Toulouse (2000) and Alpbach (2004) Workshop on Impact of Various Observing Systems on NWP**
- **Numerous OSEs**

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Third WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction

Co-chairs: Jean Pailleux, METEO-FRANCE and Horst Böttger, ECMWF

Third WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction

- **Session 1: Global Forecast Impact Studies**
- **Session 2: Regional Aspects of Impact Studies**
- **Session 3: Observation Targeting Studies and Observation Network Design Studies**
- **Session 4: Workshop Conclusions**

http://www.wmo.int/web/www/GOS/Alpbach2004/Agenda-index.html

Third WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction

- **Workshop conclusions and recommendations**
  - **Interaction between NWP centers, data providers and users**
  - **Observational data requirements**
  - **Proposals for future studies**

http://www.wmo.int/web/www/GOS/Alpbach2004/Agenda-index.html

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3. Implementation Plan for Evolution of the GOS

3.1 Recommendations for the Evolution of the Space-Based Sub-system of the GOS

3.2 Recommendations for the Evolution of the Surface-Based Sub-system of the GOS

3.3 Additional High Priority Recommendations for the Evolution of the GOS

*Recommendations are followed by a 1) Comment and/or Progress statement; 2) Next Action; and, 3) Schedule.

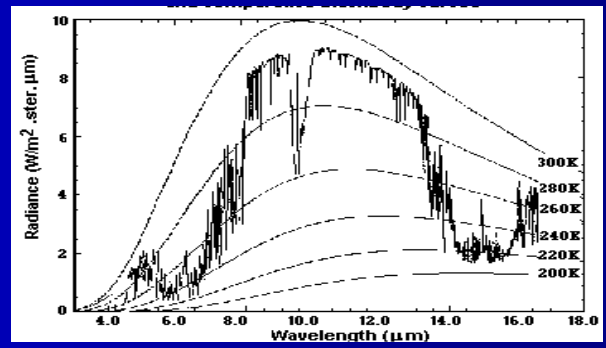
**Next actions and schedules are anticipated milestones.

3.Observational Data Requirements and Redesign of the Global Observing System (6.1.18)

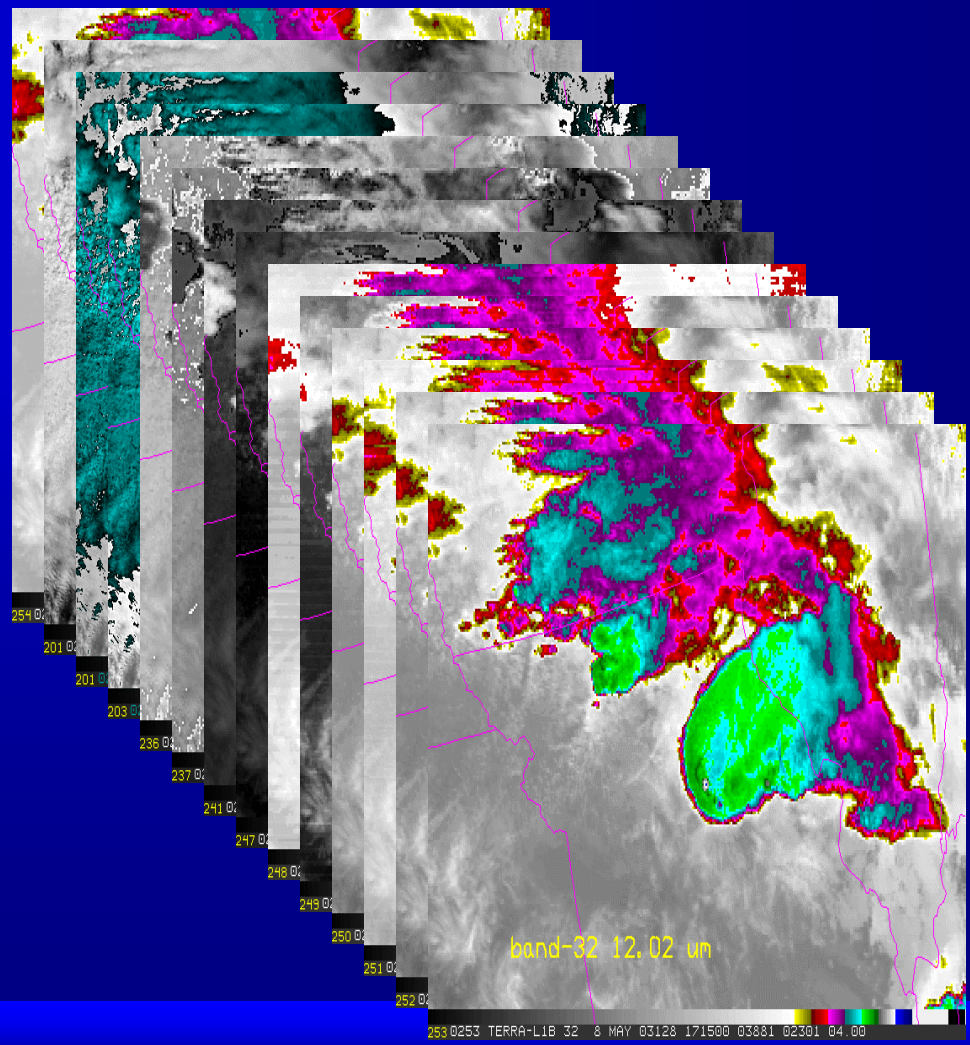
- **Evolution of the GOS**
  - 20 recommendations for the space based component
    - 9 for operational
    - 11 for R&D
    - Based on KNOWN plans of operational and R&D space agencies

- **Rigorous calibration of remotely-sensed radiances**
- Improved spatial, spectral, temporal resolutions and radiometric accuracies
- Singled out for their importance to the GOS
  - wind profiling
  - global precipitation measurement

3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

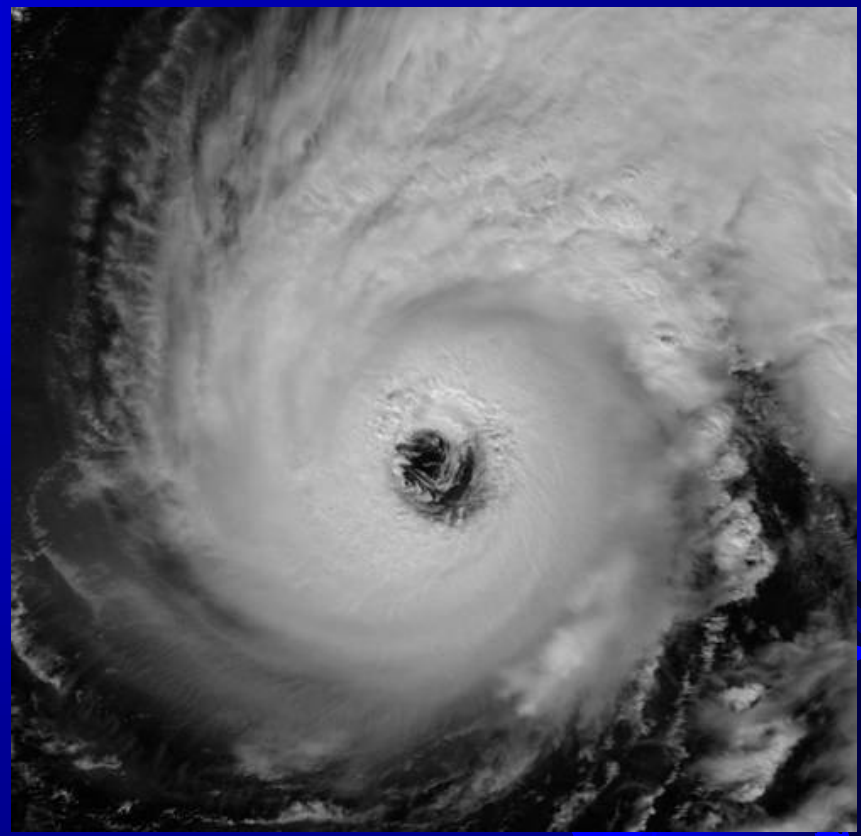


S1. Calibration - There should be more common spectral bands on GEO and LEO sensors to facilitate inter-comparison and calibration adjustments; globally distributed GEO sensors should be routinely inter-calibrated using a given LEO sensor and a succession of LEO sensors in a given orbit (even with out the benefit of overlap) should be routinely inter-calibrated with a given GEO sensor.



3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

S2. GEO Imagers - Imagers of future geostationary satellites should have improved spatial and temporal resolution (appropriate to the phenomena being observed), in particular for those spectral bands relevant for depiction of rapidly developing small-scale events and retrieval of wind information.



MODIS 500 meter visible imagery

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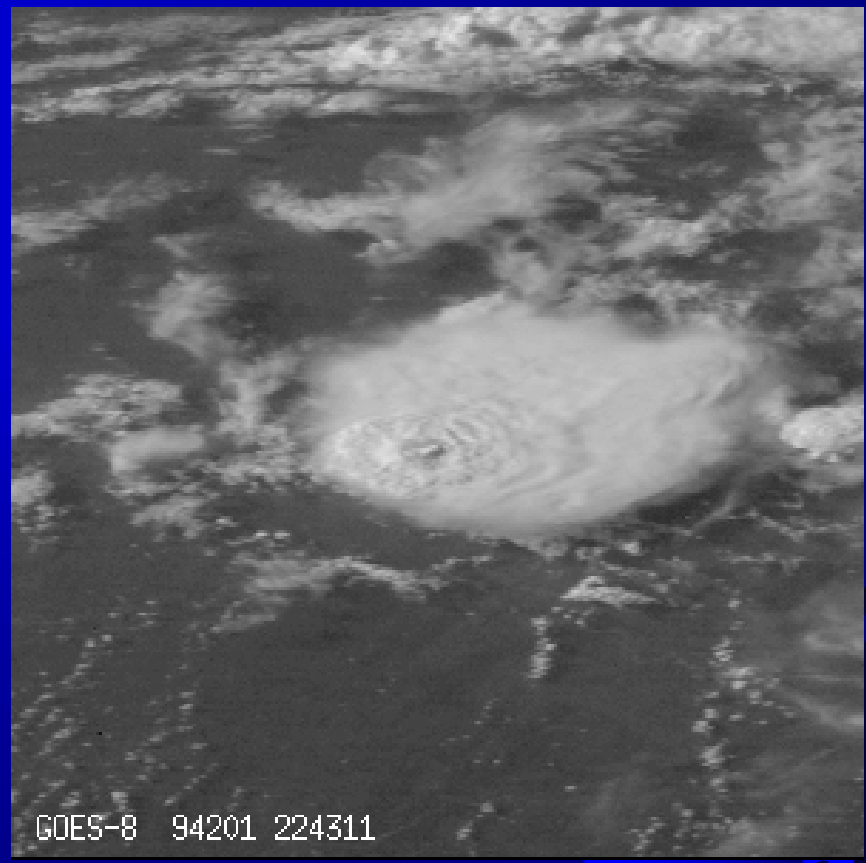

GOES 1-minute rapid scan imagery

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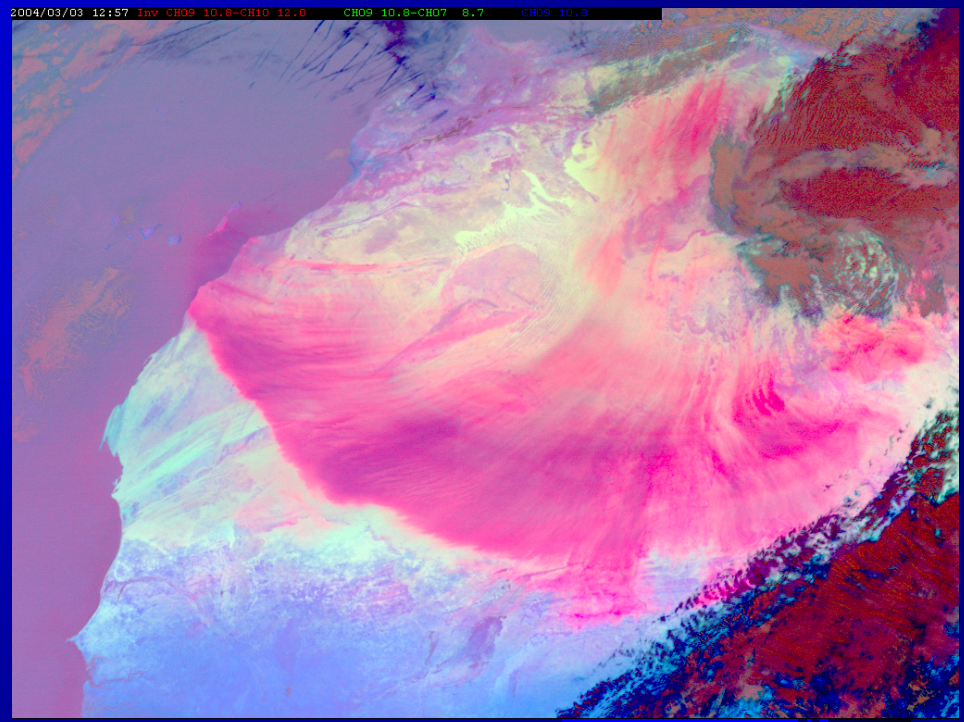
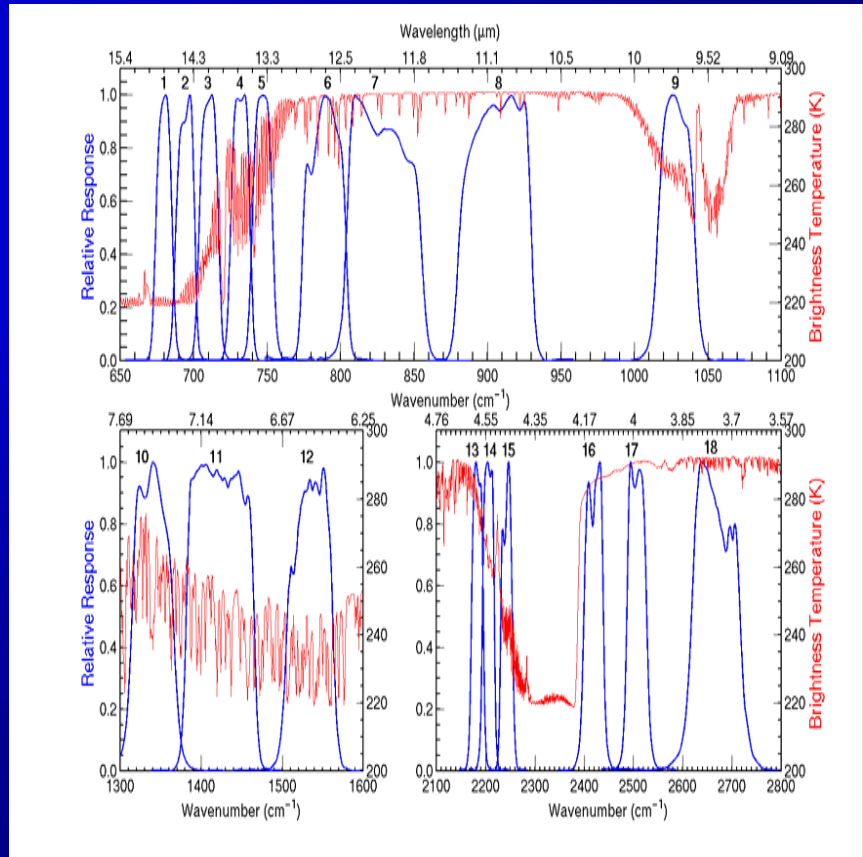


METEOSAT-8 (MSG) combined channel IR dust storm imagery example

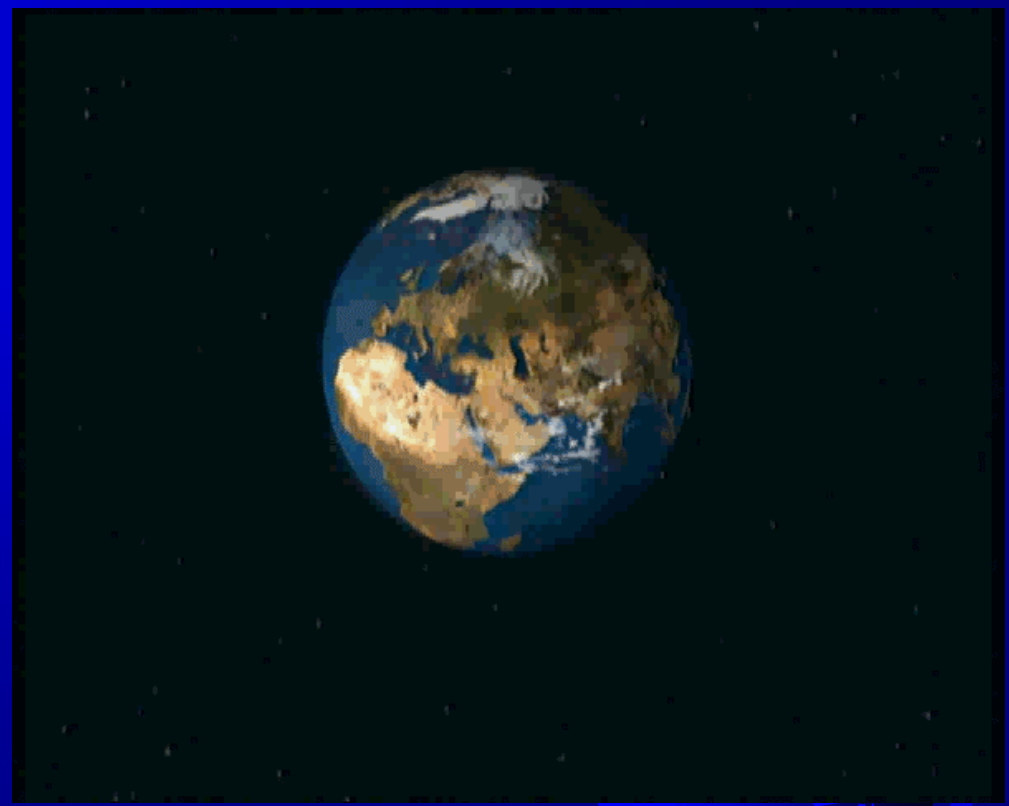
3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

S3. GEO Sounders - All meteorological geostationary satellites should be equipped with hyper-spectral infrared sensors for frequent temperature/humidity sounding as well as tracer wind profiling with adequately high resolution (horizontal, vertical and time).



3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

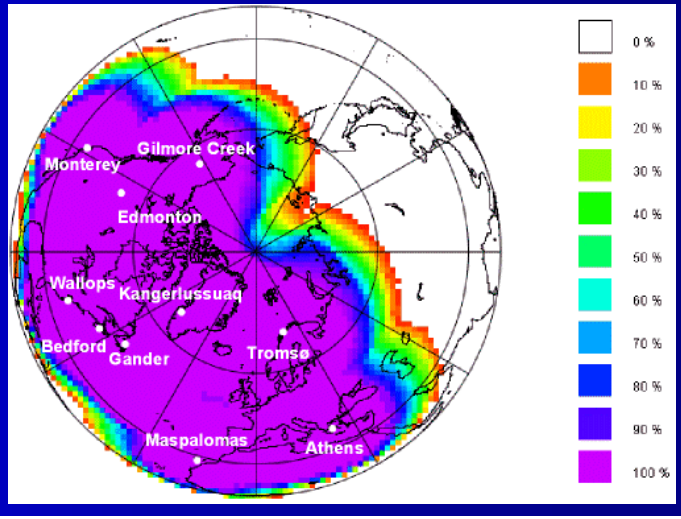
S4. GEO Imagers and Sounders - To maximize the information available from the geo satellite systems, they should be placed "nominally" at a 60-degree sub-point separation across the equatorial belt. This will provide global coverage without serious loss of spatial resolution … provides for a more substantial backup capability should one satellite fail. In particular, continuity of coverage over the Indian Ocean region is of concern.

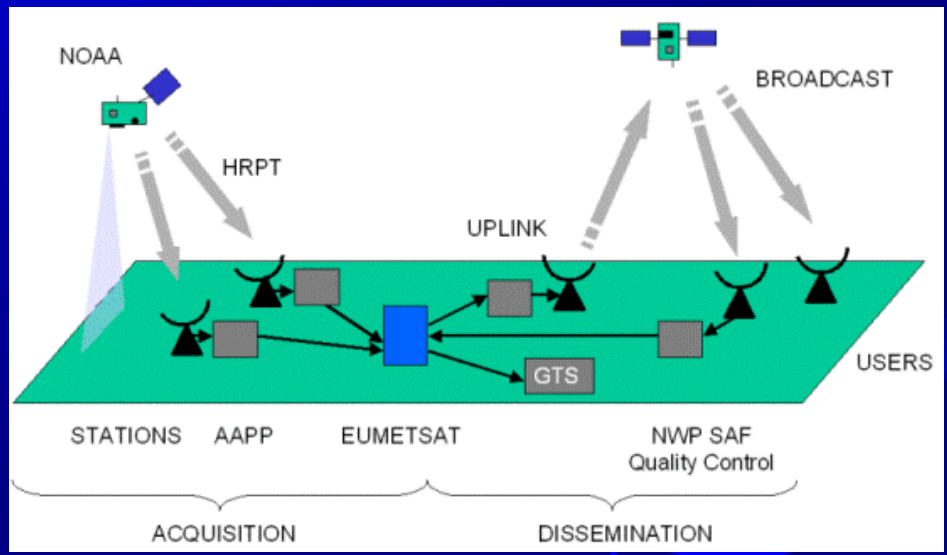


3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

S5. LEO data timeliness - More timely data are needed. Improved communication and processing systems should be explored to meet the timeliness requirements in some applications areas (e.g. Regional NWP).

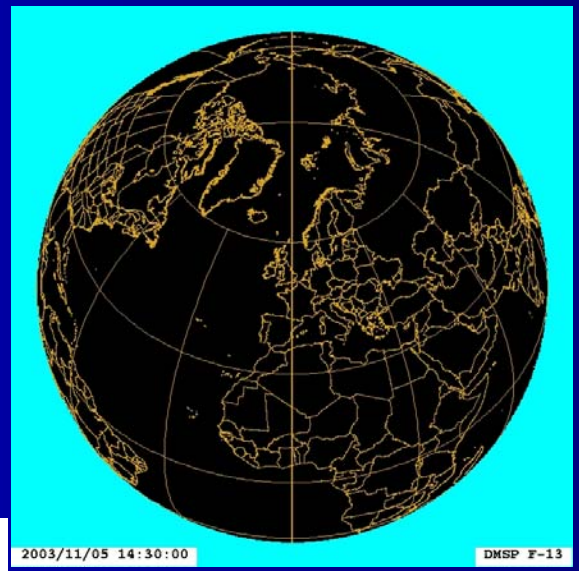
Plan for IGDDS with goal of global ATOVS retransmission service by mid-2006

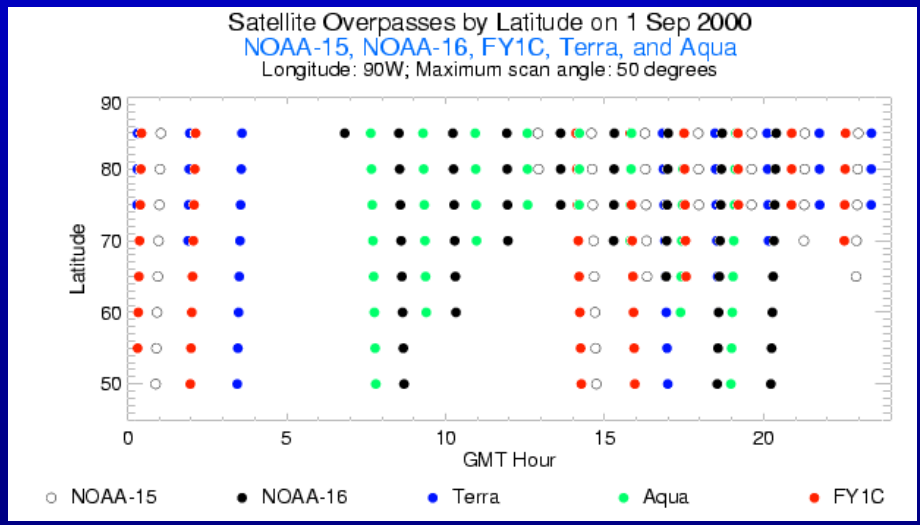




3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

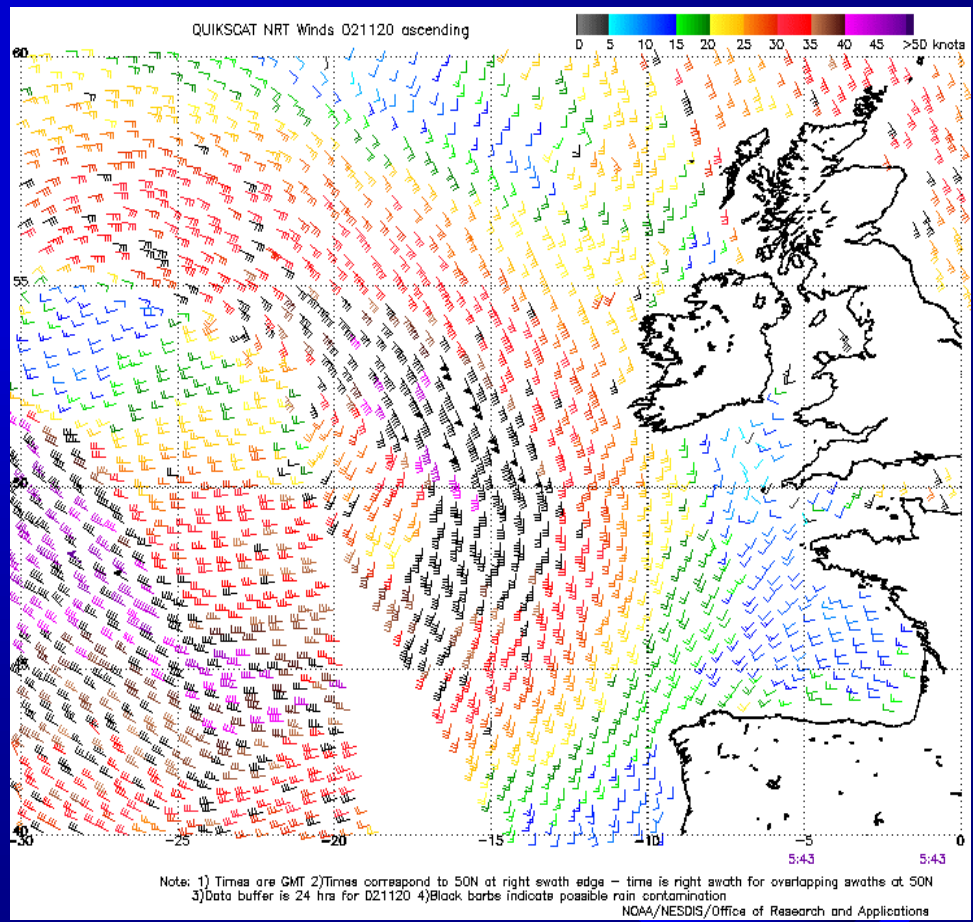
S6. LEO temporal coverage - Coordination of orbits for LEO missions is necessary to optimize temporal coverage while maintaining some orbit redundancy.





3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

S7. LEO Sea Surface Wind - Sea-surface wind data from R&D satellites should continue to be made available for operational use; 6-hourly coverage is required. In the NPOESS and METOP era, sea surface wind should be observed in a fully operational framework. Therefore it is urgent to assess whether the multi-polarisation passive MW radiometry is competitive with scatterometry.

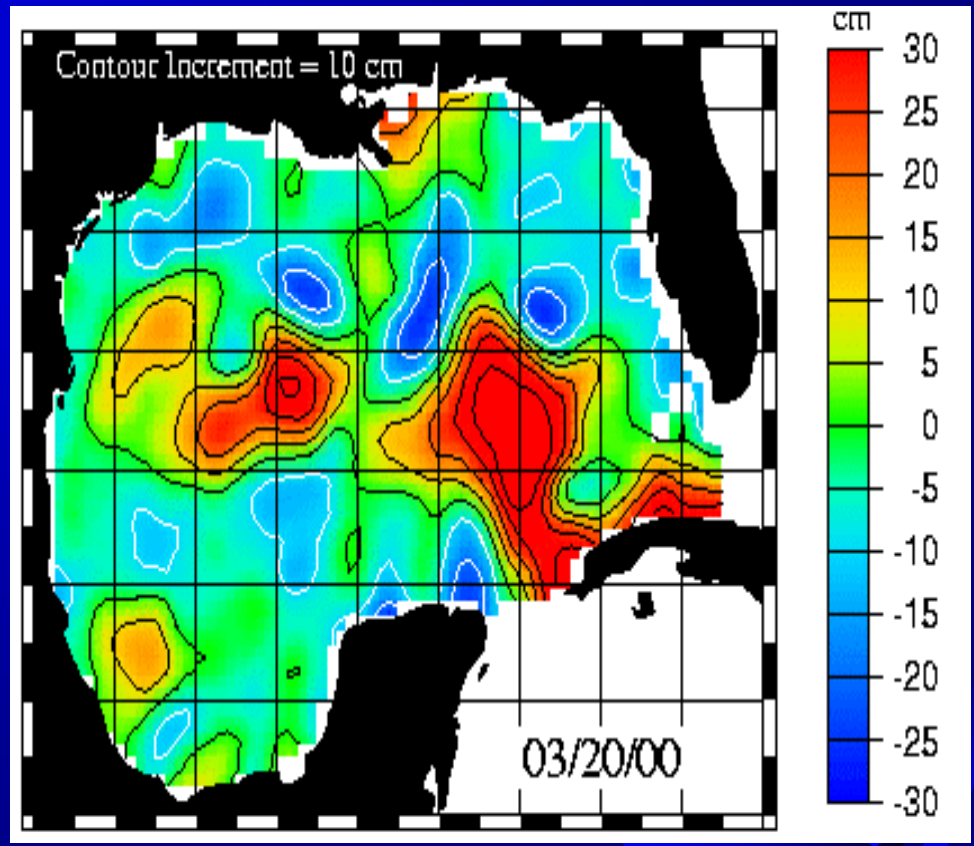


3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

S8. LEO Altimeter - Missions for ocean topography should become an integral part of the operational system.

Progress: Agreement has been reached to proceed with JASON-2.

Schedule: Plans for operational follow-on should be reported at CGMS in 2006.



3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS

S9. LEO Earth Radiation Budget - Continuity of ERB type global measurements for climate records requires immediate planning to maintain broad-band radiometers on at least one LEO satellite.

Comment: There are no current plans for ERB-like measurements after Aqua. There are also concerns about the continuity of absolute measurements of incoming solar radiation.

3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS (R&D)

S10. Leo Doppler Winds

S11. GPM

S12. RO-Sounders

S13. GEO Sub-mm

S14. LEO MW

S15. LEO SAR

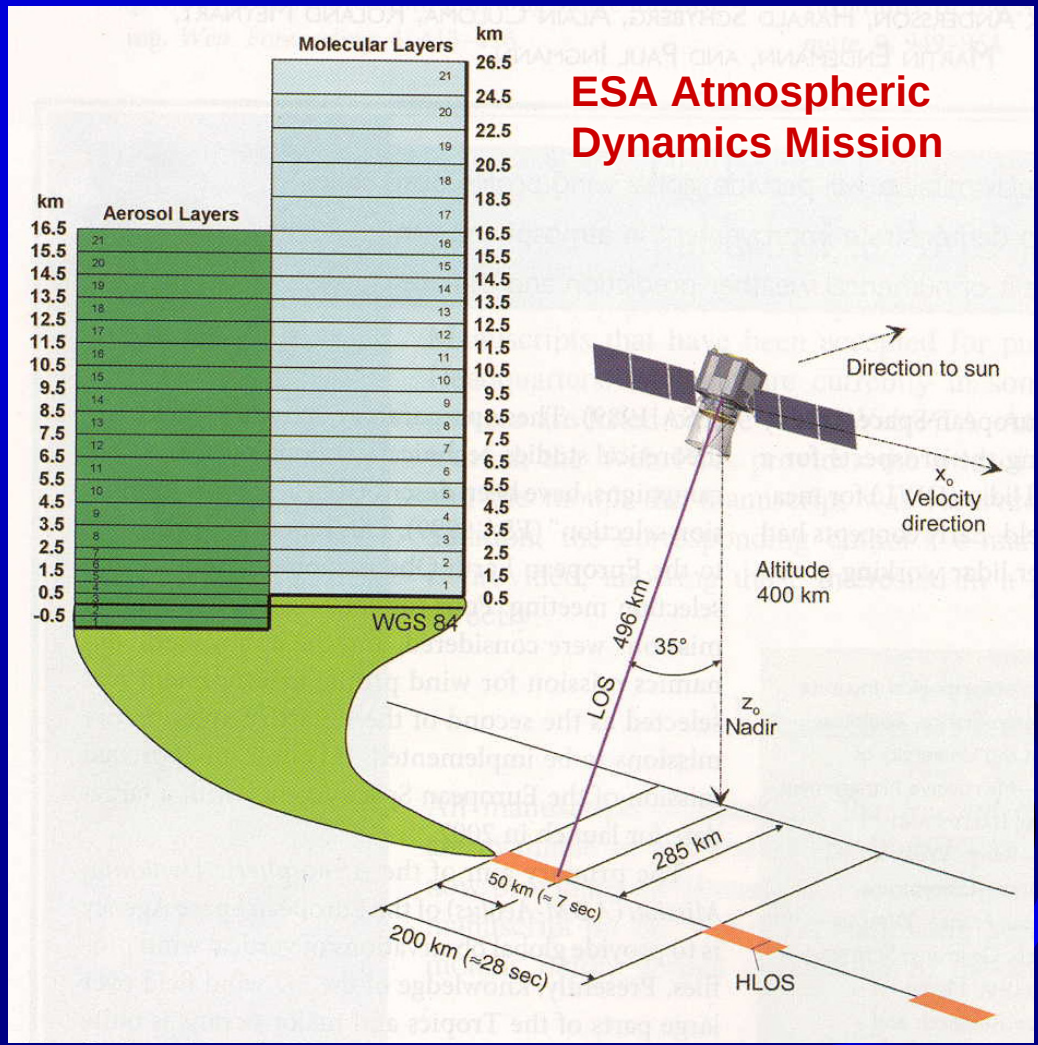
S16. LEO Aerosol

S17. Cloud Lidar

S18. LEO Far IR

S19. Limb Sounders

S20. Active Water Vapor Sensing



3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS (R&D)

S10. Leo Doppler Winds

S11. Global Precip. Mission

S12. RO-Sounders

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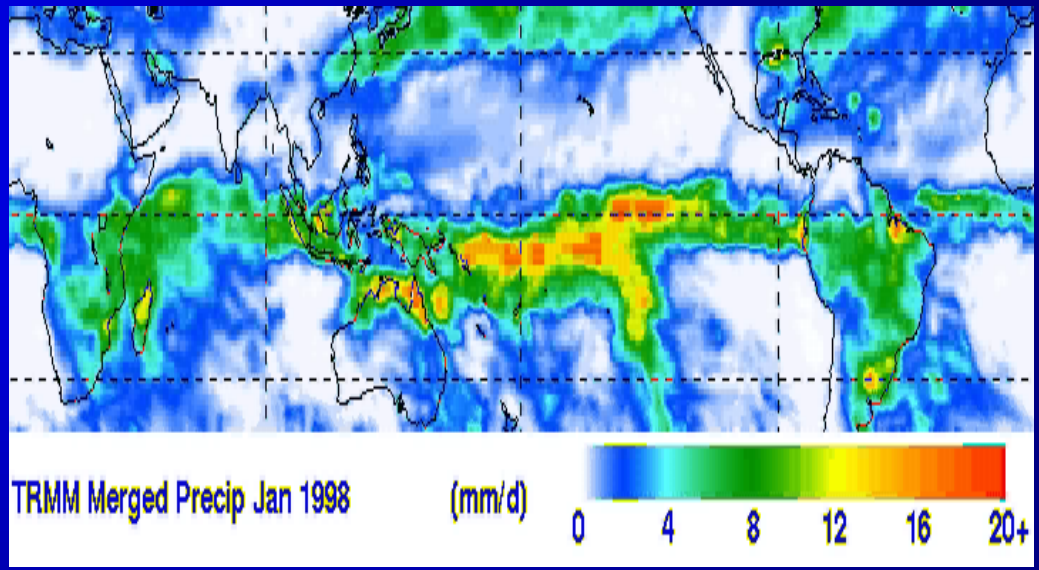

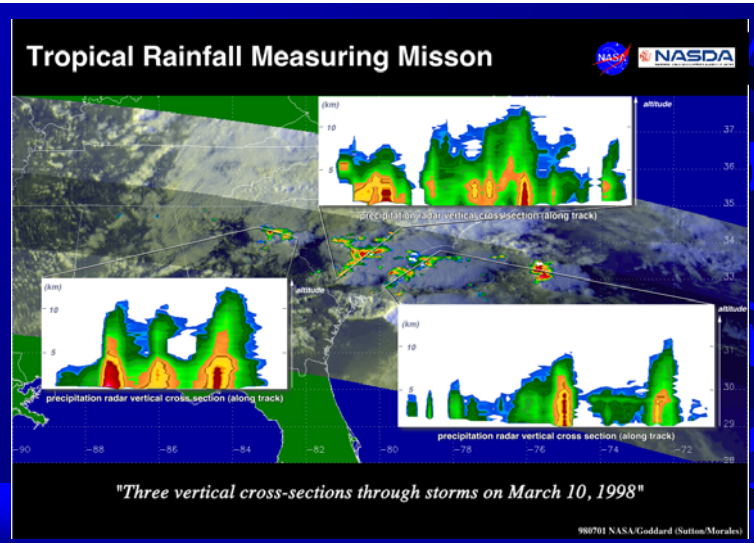

PROGRESS, NEXT ACTION, SCHEDULE

3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS (R&D)

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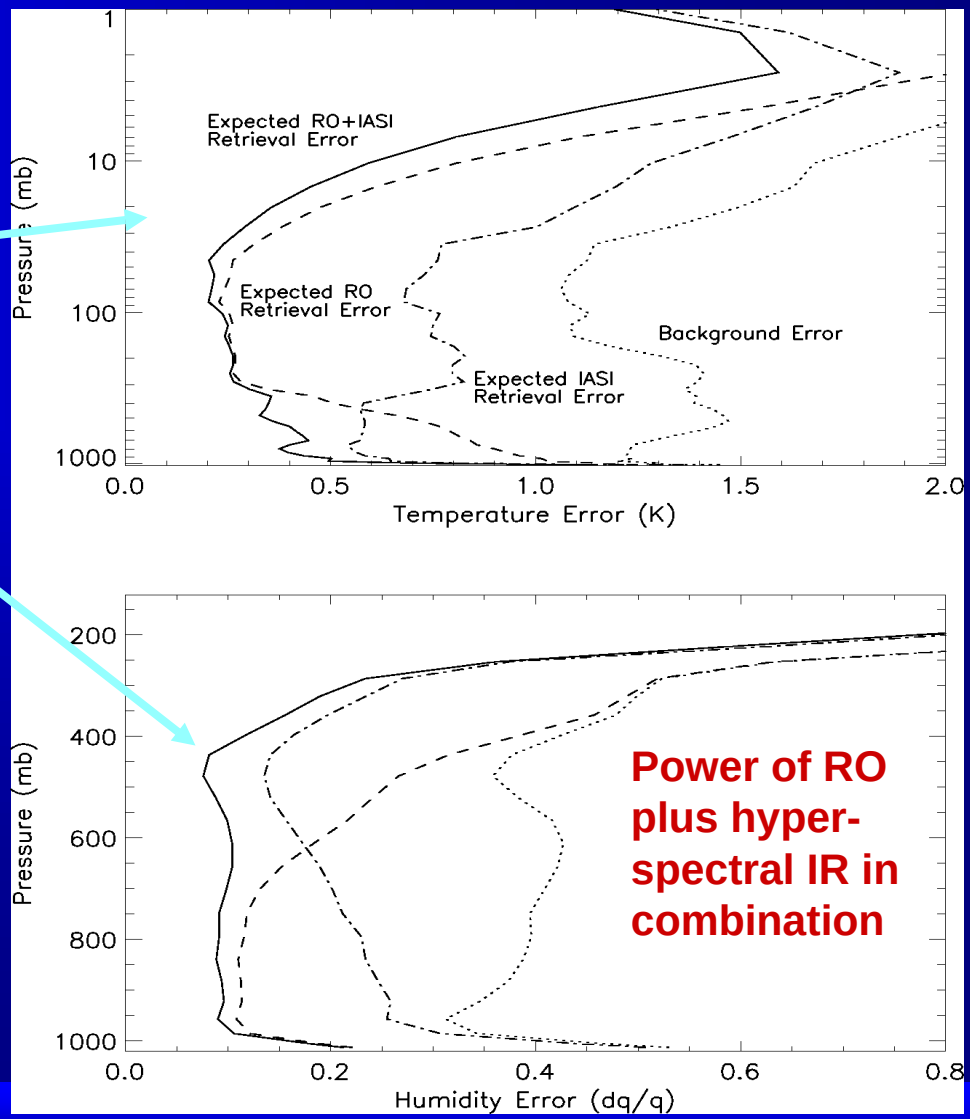

COMMENT, PROGRESS, NEXT ACTION

3.1 Recommendations for the evolution of the Space-Based Sub-system of GOS (R&D)

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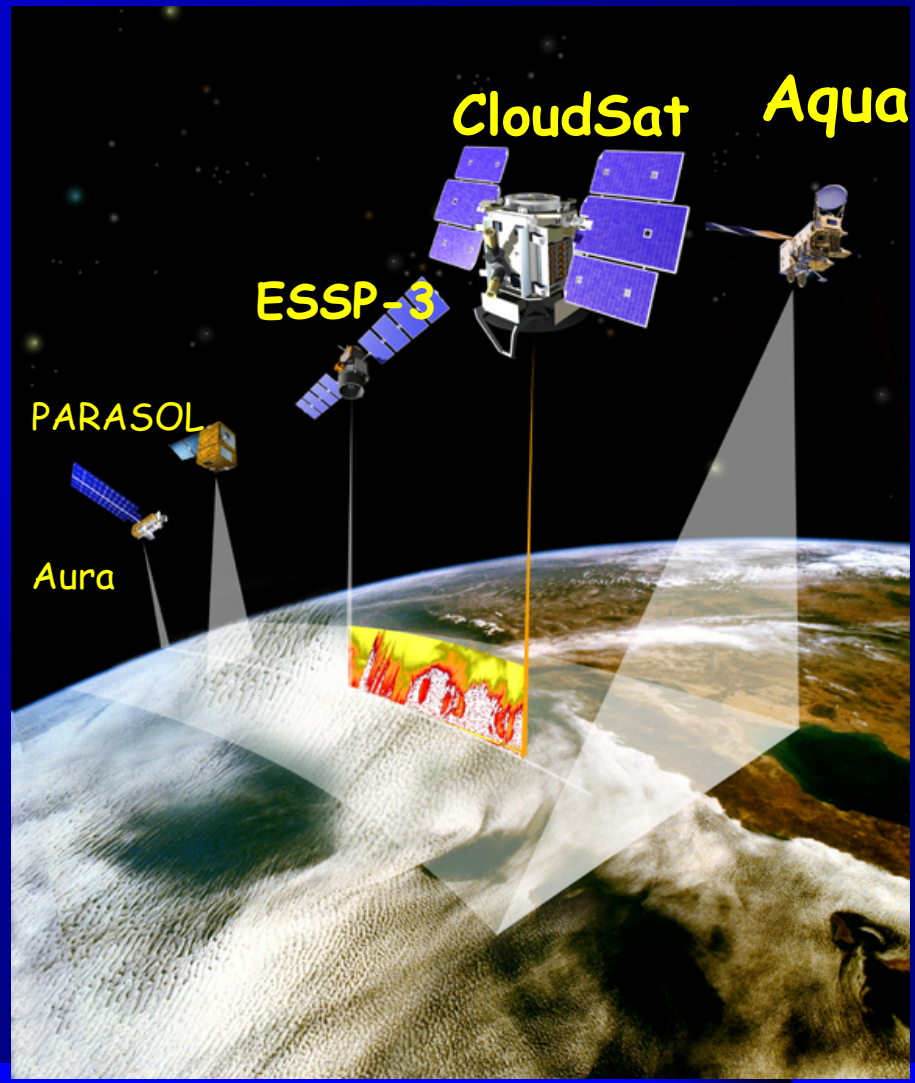
** WMO/IUGG International Aerosol-Precipitation Science Assessment Group (IAPSAG)



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S13. Precipitation estimation and cloud properties - IGeoLab
S14. Ocean salinity and soil moisture - SMOS and OCE
S15. Ocean wave spectra, sea ice and land cover (high res. Ocean winds)
S18. Water vapor and ice clouds
S19. Stratospheric temperature and chemistry
S20. High vertical resolution profiles of water vapor

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

- 22 recommendations for the surface based component covered the areas below
  - Data coverage, distribution and coding
  - Broader use of ground based and in situ observations
  - Targeted observations
  - Optimized rawinsonde distribution and launches
  - AMDAR
  - Atmospheric moisture measurements
  - Improved ocean observing
  - New observing technologies

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G1.Distribution

Based on OSE/OSSE (Section 5)

Observations made with high temporal frequency should be distributed globally at least hourly.

High resolution radar
Soil Temperature and moisture
Wave rider buoys

Observational data that are useful for meteorological applications at other NMHSs should be exchanged internationally.

Requests: WMO Members summarize the data available in their regions and strive to make these data available via WMO real time or near-real-time information systems, whenever feasible.

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G2. Documentation - All observational data sources should be accompanied by good documentation including metadata, QC, and monitoring.

Next Actions: (1) WMO Secretariat to draft a letter to Members (NWP centers) requesting report of specific problems inhibiting effective use of available data; (2) ET review responses; (3) Based on analysis information should become accessible through a centralized WMO web page (late 2005).

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G3. Timeliness and Completeness

There should be a timely distribution of radiosonde observations with all observation points included in the message. Appropriate coding standards should be used to assure that the content of the original measurements, sufficient to meet the user requirements, is retained during transmission.

- **Not just mandatory levels**
- **Together with the time and the position of each data point; information on instrument calibration prior to launch, and information on sensor type and sub-sensor type.**
- **Full vertical resolution**

- **Based on OSE demonstrations**

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G4. Baseline system - Provide comprehensive and uniform coverage with at least 12-hour frequency of temperature, wind, and moisture profiles over mid-latitude continental areas and coastal regions. In tropical regions the wind profile information is particularly important.

The radiosonde and PILOT network still plays an important role in meeting these requirements (NWP OSE Workshop, Alpbach 2004).

Linkage between CBS, CAS's THORPEX, and the International Polar Year should give guidance for polar data sparse region.

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G5. Stratospheric observations - Requirements for a stratospheric global observing system should be refined. The need for radiosonde, radiance, wind, and humidity data should be documented, noting the availability and required density of existing data sources, including GPS sounders, MODIS winds, and other satellite data.

NWP OSE Workshop (Alpbach, 2004), suggested that OSE results on the usefulness of stratospheric observations should be consolidated.

It also noted that the **COSMIC satellite mission likely will provide a substantial enhancement to the stratospheric observing system**.

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G6. Ozone Sondes - Near real-time distribution of ozone sonde data is required for calibration and validation of newly launched instruments and for potential use in NWP.

Secretariat to inform Members of this requirement and request Members to inform WMO of their implementation plans (November 2005).

NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G7. **Targeted Observations** - Observation targeting to improve the observation coverage in data sensitive areas for NWP should be transferred into operations once the methodology has matured. … The operational framework for providing information on the sensitive areas and responding to such information needs to be developed.

The proof of the observation targeting concept was given by US Weather Service in the northeastern Pacific winter storms and land-falling hurricane situations.

THORPEX has declared observation targeting a core research activity in its implementation plan

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G8. RAOBs - Optimize the distribution and the launch times of the rawinsonde sub-system

(allowing flexible operation while preserving the GUAN network and taking into consideration regional climate requirements of the RBCN).

Examples include avoiding duplication of Automated Ship-borne Aerological Program (ASAP) soundings whenever ships are near a fixed rawinsonde site

- **Frees resources for observations at critical times) and optimizing rawinsonde launches to meet the local forecasting requirements. This recommendation is supported by information from the EUCOS Studies.**
- **Observation targeting requires a flexible observing practice. THORPEX has included this concept in their considerations.**

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G9. AMDAR technology should provide more ascent/descent profiles, with improved vertical resolution, where vertical profile data from radiosondes and pilot balloons are sparse as well as into times that are currently not well observed such as 2300 to 0500 local times.

- **This recommendation is supported by information from the Toulouse report, ECMWF northern hemisphere AMDAR impact study and various OSEs**

Programme Items	2005-2006	2008	2010
Operational programmes (Australia, E-AMDAR*, New Zealand, USA, South Africa)	Expanding	Stable	stable
Emerging programmes (Hong Kong China, Saudi Arabia, Japan, Canada, Central-western Africa)	Expanding	expanding/stable	stable
Developing programmes (Chili, Argentina, UAE, Rep. of Korea, China)	first data	expanding	stable
Planned programmes (Eastern-central Europe#, Russian Federation, Oman, Egypt, Morocco, Kenya, Pakistan, India, Iran, Israel, Libya))		first data	expanding
Development software and technologies	work in progress	operational	stable
Humidity/water vapour sensors	operational trials	expanding	operational
Targeted data	Partly operational	expanding	expanding
Optimisation systems	Partly operational	expanding	expanding
Data monitoring, QC and data exchange	Ongoing	Ongoing	ongoing
Awareness and training	Ongoing	Ongoing	stable
Development of operational forecasting tools	in progress	operational	operational

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G10. Transmission of AMDAR reports - Optimize the transmission of AMDAR reports taking into account, en route coverage in data-sparse regions, vertical resolution of ascent/descent reports, and targeting related to the weather situation.

- **This recommendation is supported by information from the Toulouse and Alpbach NWP OSE Workshop reports, ECMWF northern hemisphere AMDAR impact study**

AMDAR coverage is both possible and sorely needed in several currently data-sparse regions, especially Africa and South America, Canadian arctic, northern Asia and most of the world's oceans. Members in the Regions must assume responsibility of implementation.

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

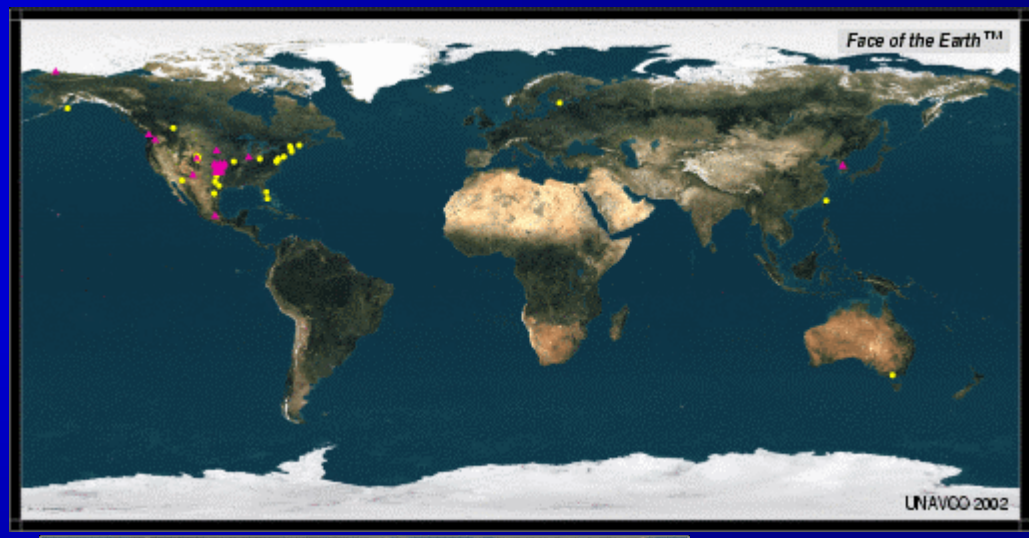
G11. Humidity sensors on AMDAR - Further development and testing of water vapour sensing systems is strongly encouraged to supplement the temperature and wind reports from AMDAR. [This recommendation is supported by information from the Toulouse and Alpbach NWP OSE Workshop reports]

G12. TAMDAR & AFIRS - To expand ascent/descent profile coverage to regional airports, the development of TAMDAR, and use of AFIRS should be monitored with a view towards operational use.

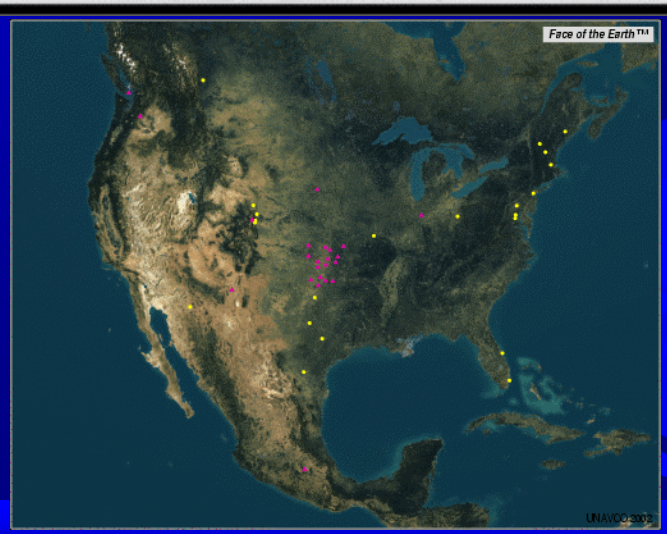
***First data from TAMDAR and AFIRS are expected in late 2004**

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G13. Ground GPS - Develop further the capability of ground-based GPS systems for the inference of vertically integrated moisture with an eye toward operational implementation.



Standardize Ground based GPS processing (Zenith Total Delay and Precipitable Water, priority for ZTD) to provide more consistent data sets. Data should be exchanged globally



COMMENT, NEXT ACTION

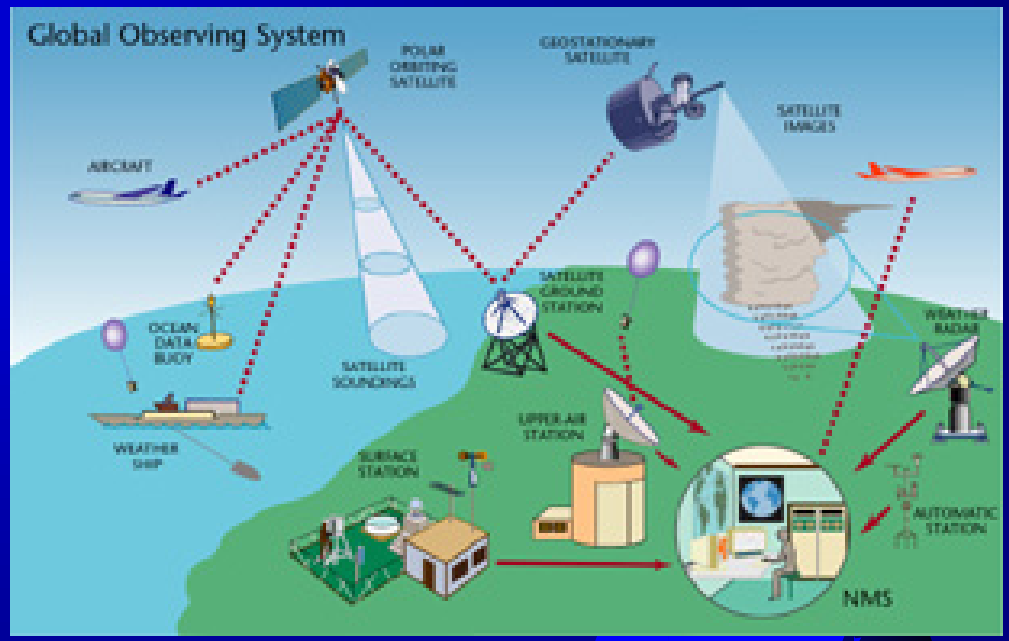
3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G14. More profiles over oceans - Increase the availability of high vertical resolution temperature, humidity, and wind profiles over the oceans. Consider as options ASAP and dropsondes by designated aircraft.

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G15. Telecommunications - Expected increase in spatial and temporal resolution of *in situ* marine observing platforms … and the need for network management, the bandwidth of existing telecommunication systems should be increased (in both directions) or new relevant satellite telecommunications facilities should be established for timely collection and distribution.



* The JCOMM Operations Plan provides background for actions in this area.

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G16. Tropical moorings - For both NWP (wind) and climate variability/climate change (sub-surface temperature profiles), the tropical mooring array should be extended into the tropical Indian Ocean at resolution consistent with that presently achieved in the tropical Pacific and Atlantic Oceans.

*** The JCOMM Operations Plan provides background for actions in this area.**

NEXT ACTION

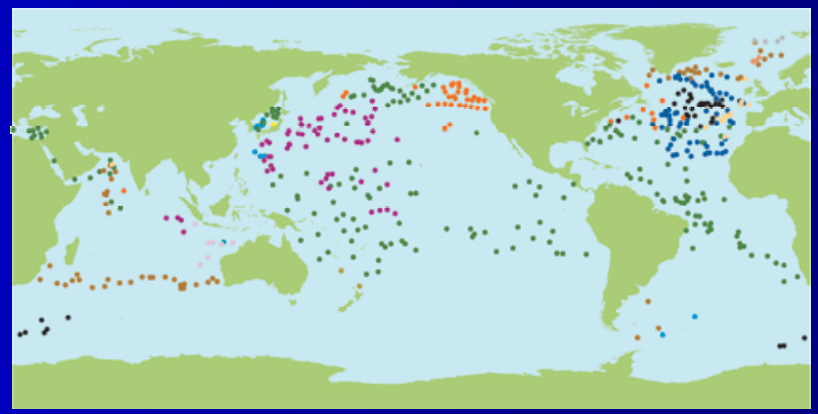
3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

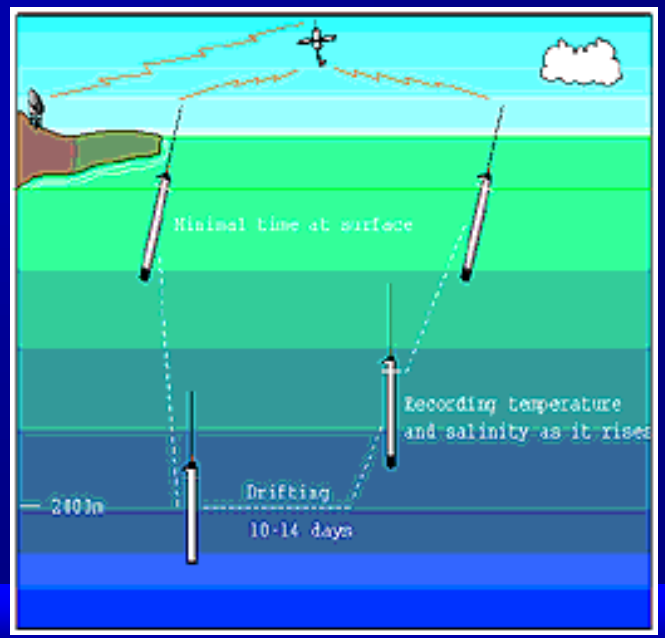
G17. Drifting buoys - Adequate coverage of wind and surface pressure observations from drifting buoys in the Southern Ocean in areas between 40S and the Antarctic Circle should be assured using an adequate mix of SVPB (surface pressure) and WOTAN technology (surface wind). The pressure observations are a valuable complement to the high-density surface winds provided by satellite.

COMMENT, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G18. XBT and Argo – For Ocean Weather Forecasting purposes, improve timely delivery and distribute high vertical resolution data for sub-surface temperature & salinity profile data from XBTs and Argo floats.





***The JCOMM Operations Plan provides background for actions in this area.**

NOTE, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

- **G19. Ice buoys - For NWP purposes, coverage of ice buoys should be increased (500 km horizontal resolution is recommended) to provide surface air pressure and surface wind data.**

*** The JCOMM Operations Plan provides background for actions in this area.**

NOTE, NEXT ACTION

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G20. More profiles in Tropics - Temperature, wind and if possible humidity profile measurements (from radiosondes, Pilots, and aircraft) should be enhanced in the tropical belt, in particular over Africa and tropical America.

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G21. Automatic Weather Station

(a) Coordinated planning that includes:

- **Appropriate codes and reporting standards,**
- **Global standard for quality management and the collection / sharing of metadata, and**
- **Expanded range of measured parameters;**

(b) Exact time of observation, as distinct from a notional time or time period, should be reported.

3.2 Recommendations for the evolution of the Surface-Based Sub-system of GOS

G22. New systems - In the context of THORPEX, the feasibility of new systems should be demonstrated as much as possible.

These possible operational sub-systems include but are not limited to:

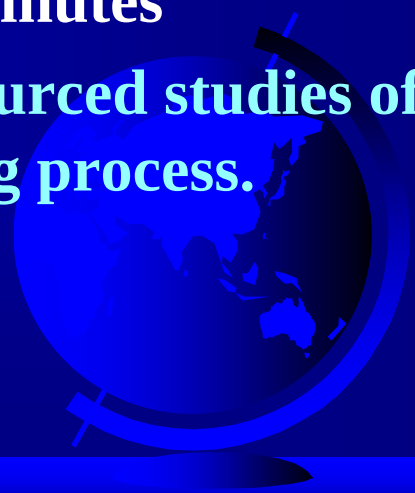
- ground based interferometers and radiometers (e.g. microwave) that could provide continuous vertical profiles of temperature and humidity in selected areas;
- Unmanned Aeronautical Vehicles (UAVs);
- High altitude balloons;
- Lidars.

3.3 Additional High Priority Recommendations for the evolution of the GOS

Interactions between NWP centers, data providers and users

- **N1. New data types - NWP centers should receive early information about and experience with new data types**
- **N2. Data from research satellites – R&D satellite data should be made available in a timely fashion**
- **N3. Timely data delivery – Data processing and delivery systems should strive to meet NWP requirements of 30 minutes**
- **O1. Observing System Study - Support well-resourced studies of re-designed observing systems. This is an ongoing process.**

COMMENTS and NEXT ACTIONS



3.3 Additional High Priority Recommendations for the evolution of the GOS

Interactions between NWP centers, data providers and users

- **T1. Training and information exchange for GOS Utilization –** **Support for sustained training must be realized as a primary means to assist WMO Members towards full exploitation of surface-based and satellite-based sub-systems of the GOS. Training must address data access, data use, and training of trainers. Networks for information exchange toward improved utilization of the GOS must be encouraged.**

4. Considerations for Evolution of the GOS in Developing Countries

- 4.1 Consideration must be given to many applications areas, including human forecasting. In developing countries must address : (a) public infrastructure; (b) expertise and training needs; and (c) funding for equipment, consumables, spare parts, manpower, etc.

- 4.2 Evolution must take into account upgrading, restoring, substitution and capacity building (especially in the use of new technologies), considering the user and data production and data use.

- 4.3 Identify observing systems that are less dependent on local infrastructure. A minimum set of reliable RAOBs is required as a backbone to the GUAN and RBCN.

4. Considerations for Evolution of the GOS in Developing Countries

- **4.4 Explore the role of developing countries in THORPEX through regional associations**

- **4.5 Capacity building in some countries needs further attention. Projects such as PUMA should be expanded to include other data types for routine application (synoptic, aviation, nowcasting).**

- **4.6 Highest priority should go to: (a) maintaining the RBSN and RBCN, noting that GSN and GUAN stations are part of the RBSN; and (b) to rehabilitate observing sites in critical locations.**

4. 7 General recommendations should be taken into account when addressing the evolution of the GOS in developing countries

- Identify and prioritize if additional funding available
- Evaluate field experiments over data sparse areas
- Role of automated versus manned stations
- Role of AMDAR ascent/descent data; RAOB network still plays an important role in human forecasting;
- Adhere to GCOS Climate Monitoring Principles
- Telecommunications should be looked at as a priority
- Prioritize most pressing needs for VCP or other funding
- High priority should be given by the region and secretariat to maintain a minimum RAOB network with acceptable performance within data challenged regions.

5. Specific OSEs carried out to assess possible reconfigurations of the GOS

- In the development a global approach to redesign of the GOS, the Expert Team (ET) kept under permanent review the impact assessments studies being conducted by NWP centers under regional programs such as COSNA, EUCOS and NAOS. The ET found that findings of COSNA, EUCOS and NAOS as well as conclusions and recommendations of the Toulouse and Alpbach Workshops on Impact of Various Observing Systems on NWP provided essential input to the redesign process of the GOS.

- The ET strongly supported workshop recommendation that **impact studies should be carried out for a sufficiently long period, preferably in each of four seasons and that the statistical significance of the results should be established.**

5. Specific OSEs carried out to assess possible reconfigurations of the GOS

Impact of …

5.1 hourly versus 6 hourly surface pressure

5.2 denial of radiosonde data globally above the tropopause

5.3 information content of the Siberian radiosonde network

5.4 AMDAR data over Africa

5.5 tropical radiosonde data

5.6 three LEO AMSU-like sounders

5.7 AIRS data

5.8 better than 3 hourly ascent descent AMDAR data

5.9 polar winds from MODIS water vapor imagery

** Addressed in ET ODRRGOS Section of Report

Implementation Plan For Evolution Of Space and Surface-Based Sub-Systems Of The GOS

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