Requirements for the improvement of climate observation

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Chair, Steering Committee for the Global Climate Observing System

GCOS sponsored by WMO UNESCO IOC UNEP ICSU International Council for Science

The scope of the global observing system for climate

The observations
- what is measured, how, where
- how measurement is sustained
- how change in instrumentation is managed

Data transmission
- what is transmitted, with what time delay, in what numeric code

Data management
- archiving and providing access to raw and processed data

Data records and products
- recovering and recalibrating past data
- forming extended records for particular types of measurement
- converting these data records into products suitable for general use (gridding, gap-filling, merging , …)

with multiple contributing international arrangements, for observations of atmosphere, ocean and land

WMO UNESCO/IOC

WIGOS WMO Integrated Global Observing System

The Global Ocean Observing System GOOS

GTOS Global Terrestrial Observing System

WCRP World Climate Research Programme

CEOS

CGMS

GEO

Some characteristics of the global observing system for climate

Observations typically do not serve only climate purposes

- weather monitoring and forecasting
- tsunami and storm-surge detection
- land-use monitoring
- …

and are often funded primarily for purposes other than climate

- although improving capability for short-term forecasting is one adaptive response to a change in climate that increases vulnerability to severe weather

Observations may be from ground-based, airborne or satellite systems

- with satellite systems funded by single nations or groups of nations, making observations with near-global coverage
- with observations made from commercial aircraft flying internationally

Observations may be made over national territory or the open ocean

- or in maritime Exclusive Economic Zones

Some costs of the global observing system for climate

Submission of USA to SBI 35:

- US$ 760M on satellite-based “climate” sensors in 2010
- US$ 140M on *in situ* platforms in 2010

Sample costs of missions relevant to weather and climate

- next-generation US operational polar orbiter ~US$ 1B per year*
- next-generation European operational geostationary system ~US$ 220M per year*
- ECMWF routinely assimilates data from more than 50 instruments deployed on Chinese, European, Japanese and US satellites

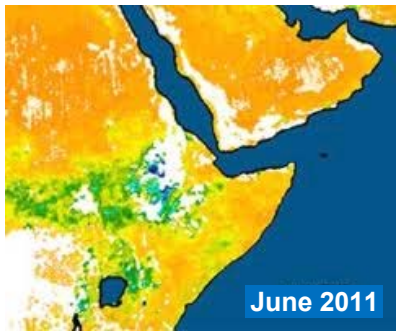
Expenditure by a few nations on satellite systems far exceeds costs of ground-based networks

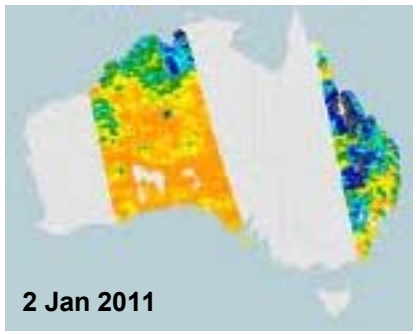
Yet many of the key variables for adaptation cannot be measured well from space

*Source: Report of High-Level Taskforce for the GFCS

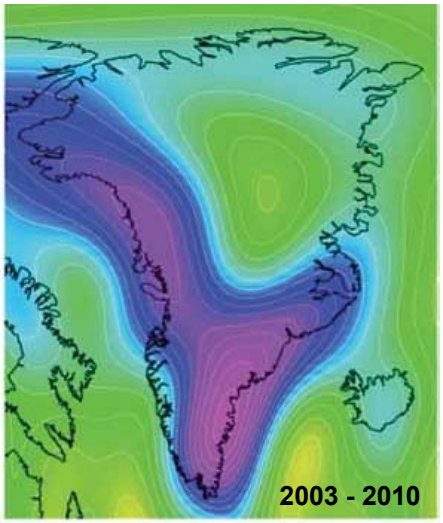
Emerging types of monitoring from space

Examples from European, Japanese and US agencies

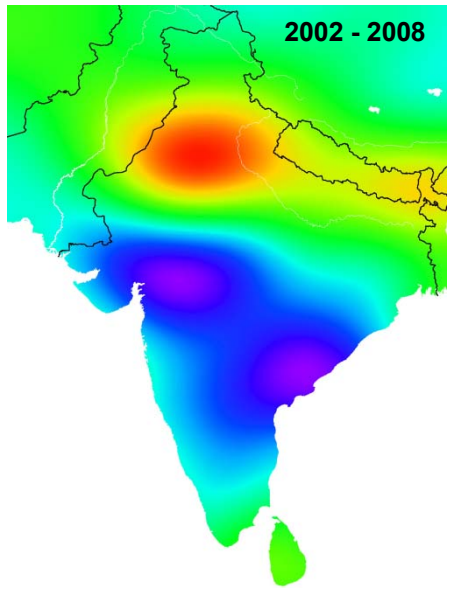


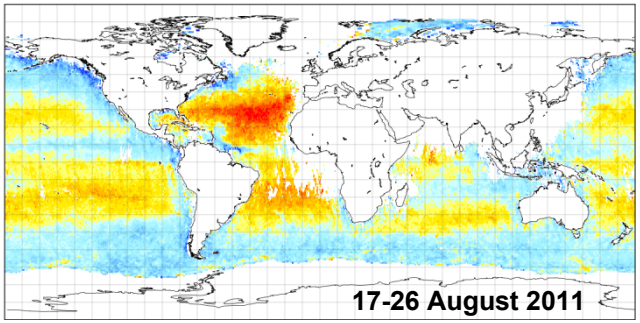


Surface soil moisture from ESA's SMOS mission

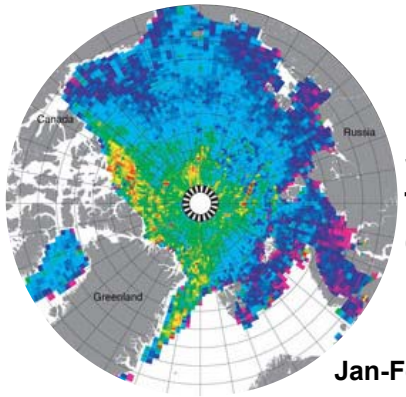


Multi-year change in mass of ice and ground water from NASA's GRACE mission





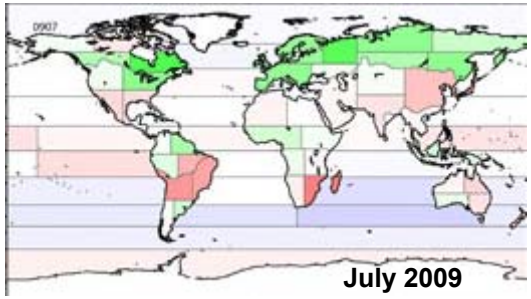
Sea surface salinity from SMOS



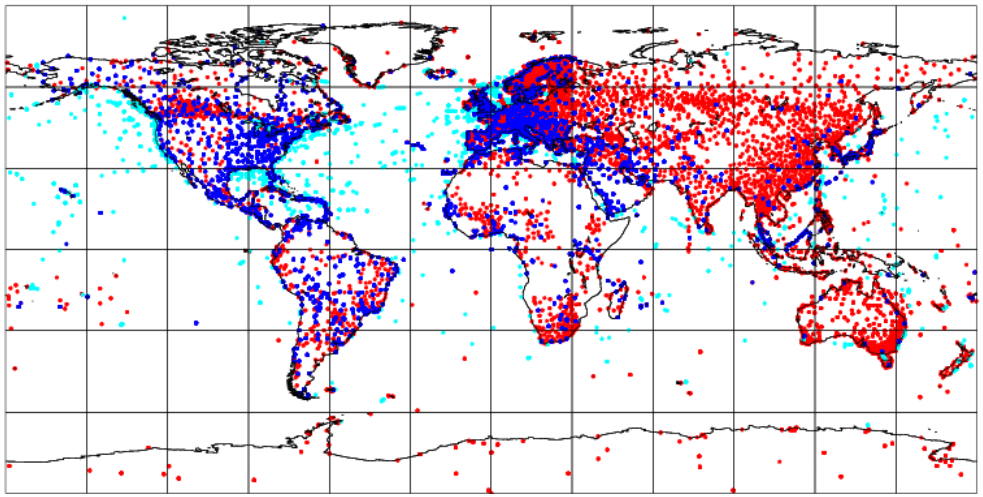
Sea-ice thickness from ESA's CryoSat mission

Jan-Feb 2011

Surface flux of CO_2 from surface measurements and JAXA's GOSAT mission



Surface weather network coverage



Red: Conventional synoptic met reports from land stations
Blue: Reports mostly from airports received in aviation code
Cyan: Reports from ships

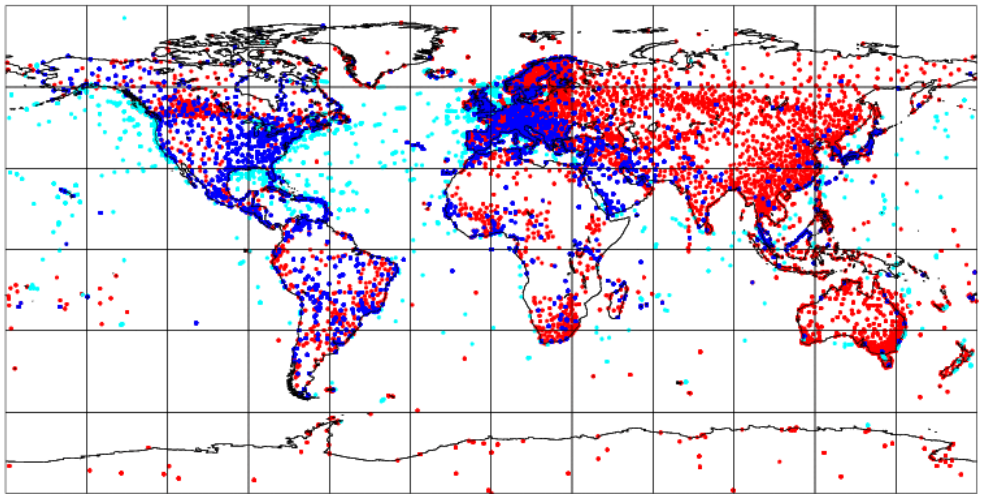
Locations of 35010 surface weather observations received by ECMWF 0900-1500 UTC 14 November 2011

Africa	**57%**
South America	**65%**
SW Pacific	**73%**
North and Central America, Caribbean	**82%**
Asia	**89%**
Europe	**97%**

Percentages of weather reports received by monitoring centres from WMO Regional Basic Synoptic Network

July 2010-April 2011

Surface weather network coverage



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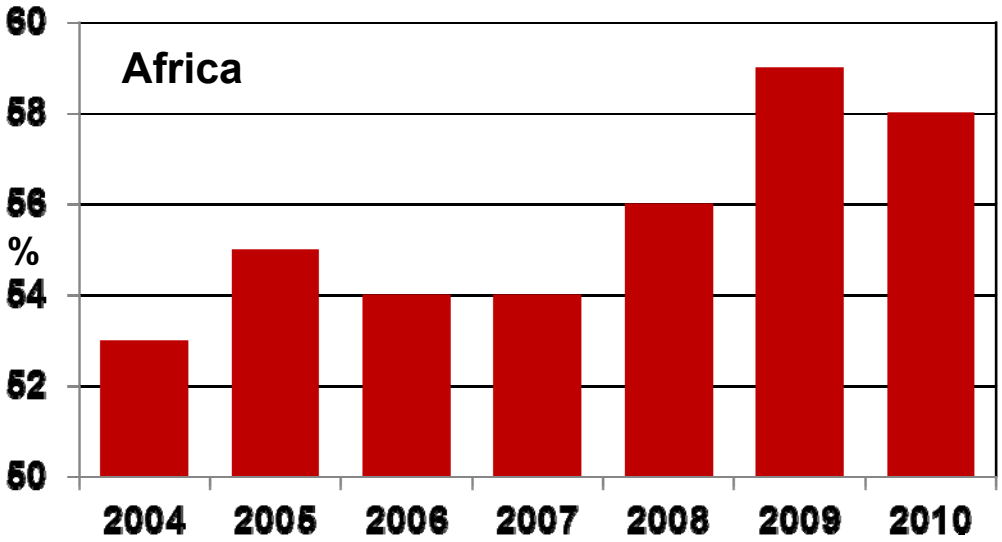
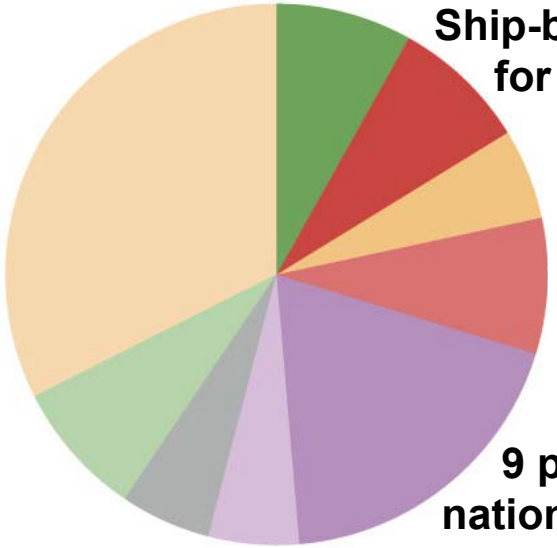


Percentages of weather reports received by monitoring centres from WMO Regional Basic Synoptic Network

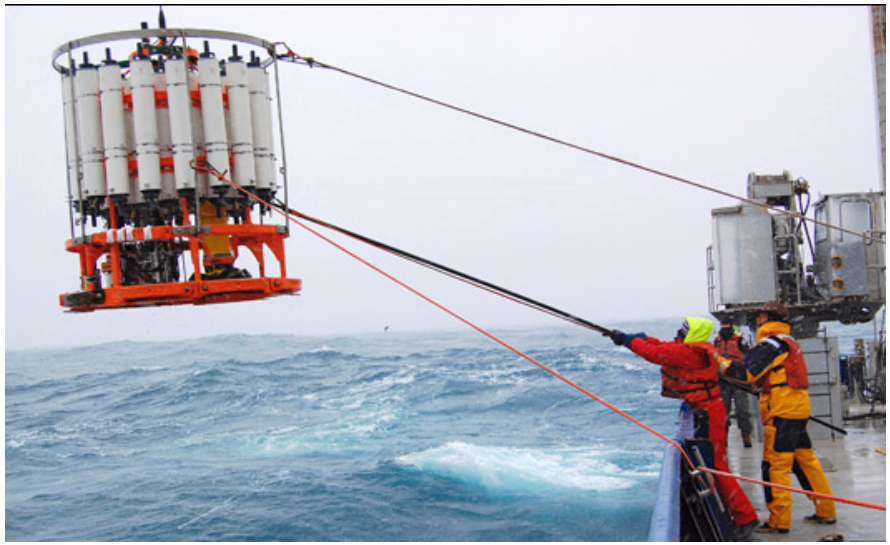
Africa: Octobers from 2004 to 2010

National participation in components of the ocean observing system



Ship-based surveying for carbon inventory

9 participating nations in 2009



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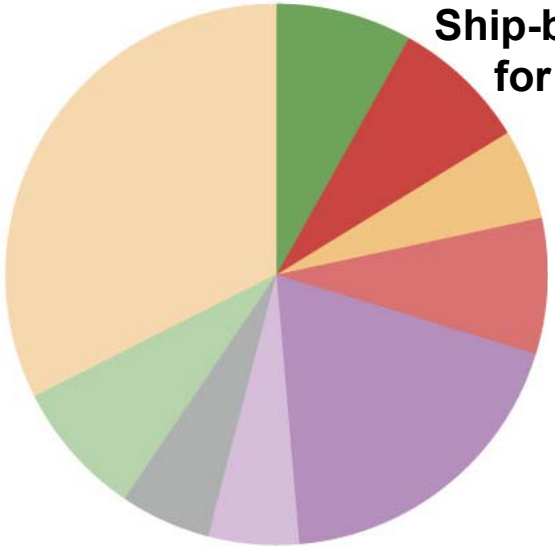

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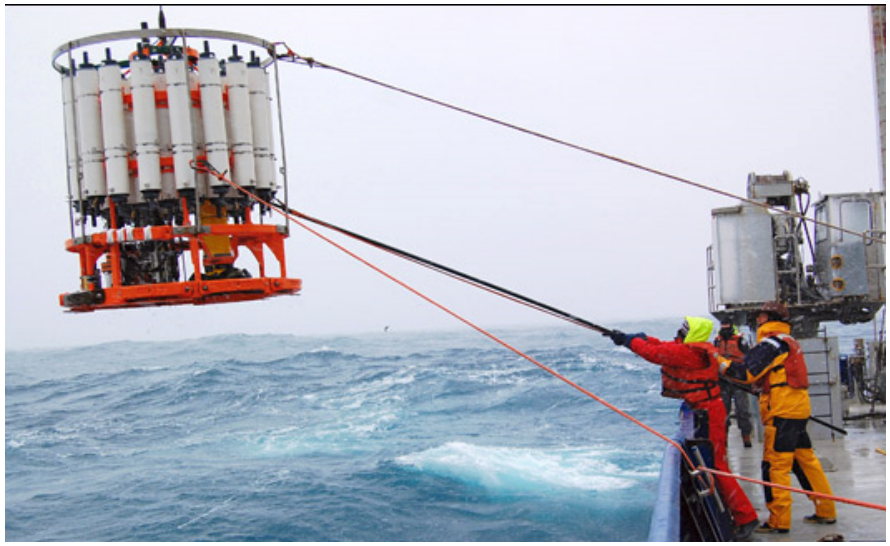
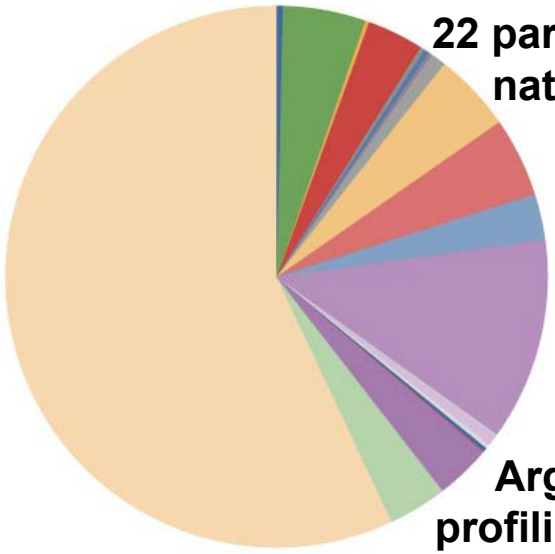
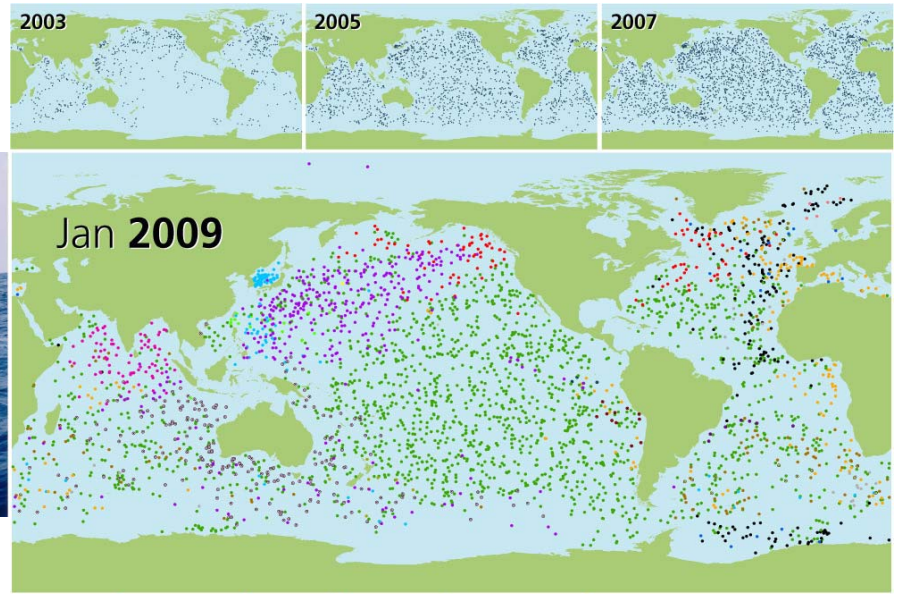




22 participating nations in Jan 2009

Argo profiling floats



National participation in components of the ocean observing system

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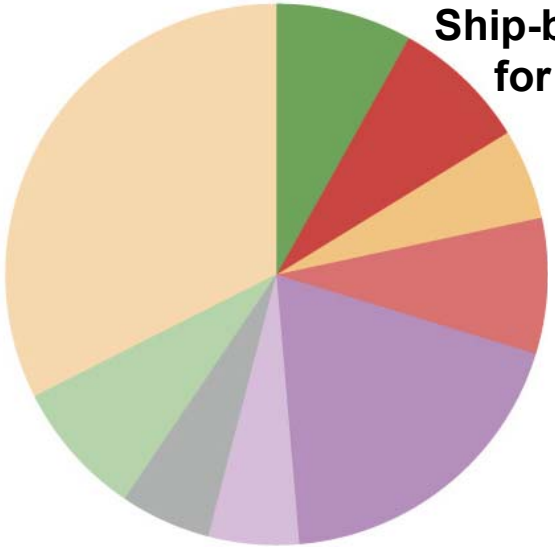
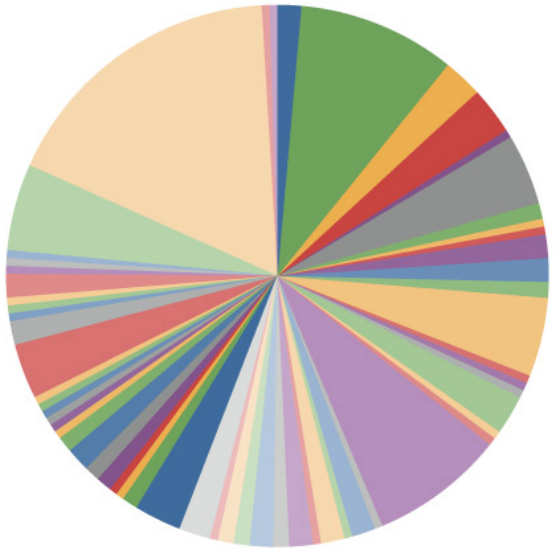
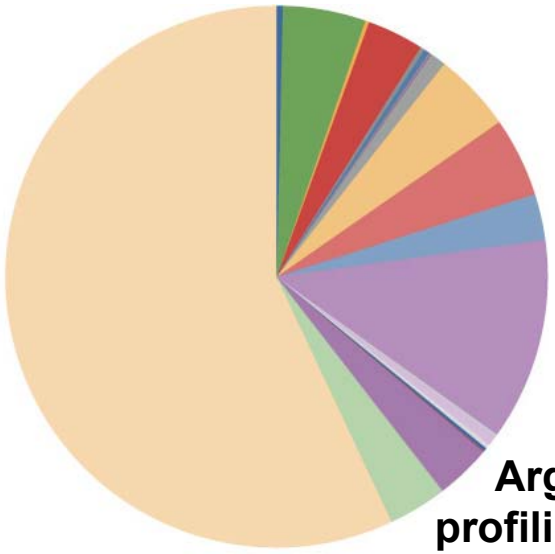




Tide gauges with fast delivery of data



Argo profiling floats

ARG AUS BRA CAN CPV CHL CHN COK CRI DJI ECU EUR FSM FJI FRA DEU GHA HKG IND IDN IRL ISR

JPN KEN KIR MYS MDV MNP MHL MUS MEX MOZ MMR NRU NLD NZL NOR OMN PAK PLW PAN PNG PER PHL

PRT RUS STP SEN SYC SGP SLB ZAF KOR ESP LKA SWE TZA THA TGO TON TUV GBR USA VUT VNM

What mechanisms support developing countries directly?

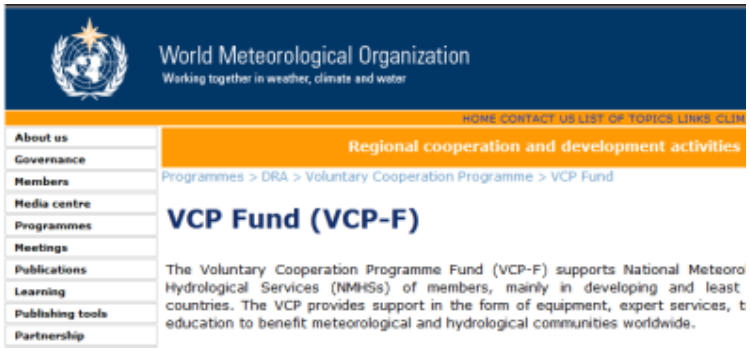
Support is provided through:

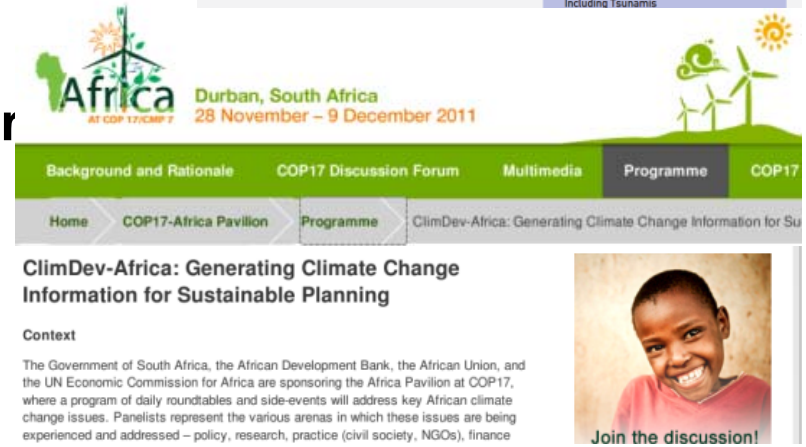
- bi-lateral arrangements between countries
- initiatives of UN agencies with responsibilities for component observing systems
- GCOS Cooperation Mechanism
- Other mechanisms, for example as we will hear about later in this session

Hard to quantify overall level of funding

Slow progress is being made, but support for capacity building is still far from meeting needs

ClimDev-Africa initiative offers prospect of a significant step forward





The GCOS Cooperation Mechanism and regional development

GCOS Cooperation Mechanism

- advises on and implements technical revitalization for key baseline stations
- made possible by donations under the mechanism
- recent projects include:

surface weather stations in Angola, Armenia, Madagascar and Uruguay

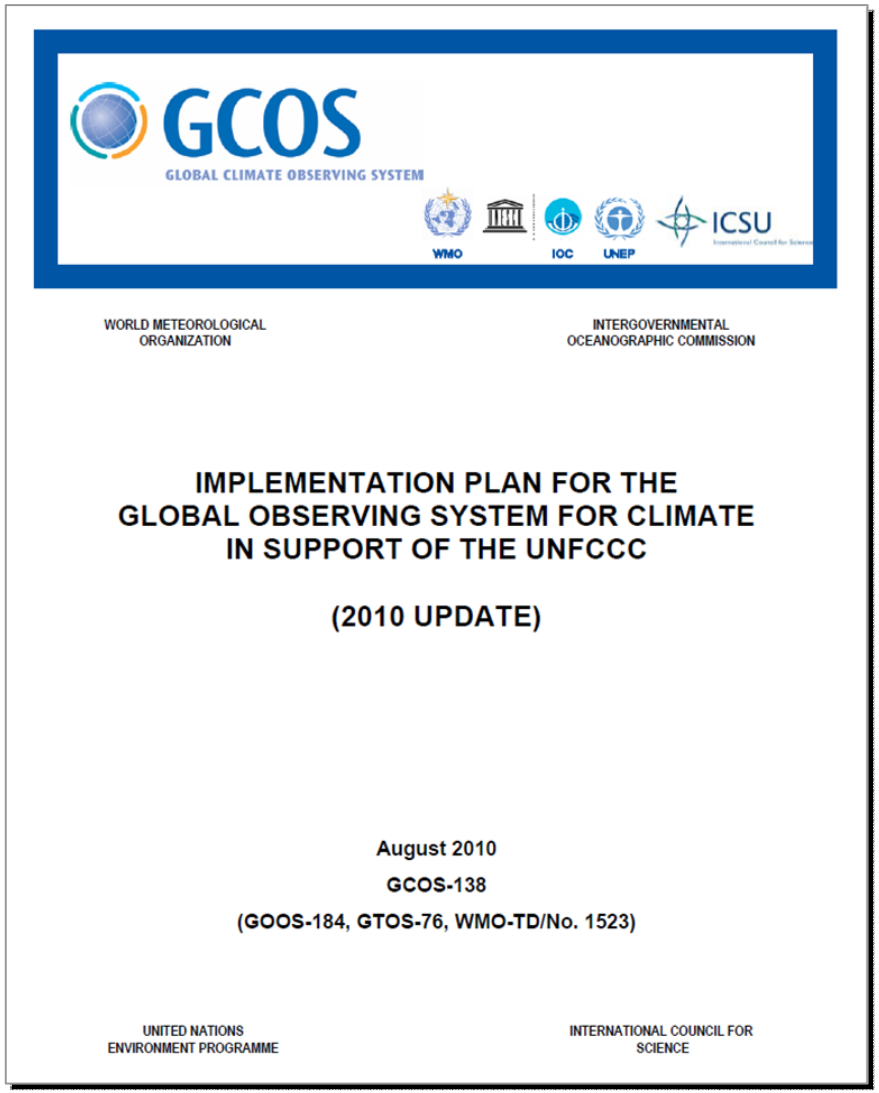
upper-air (radiosonde) stations in Mauritius, Tanzania and Zimbabwe

- support for some oceanic and terrestrial measurements is under consideration
- small (~ US$ 0.5M per annum) but focused

Regional development

- action plans were developed by GCOS regional workshops held 2000-2006
- ClimDev-Africa developed as a broader initiative following a joint GCOS/UNECA workshop to consider the action plans for Africa
- implementation of plans has been insufficient, and they now need updating

Where are the observing-system requirements specified?


GCOS

GLOBAL CLIMATE OBSERVING SYSTEM

WMO IOC UNEP ICSU

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE IN SUPPORT OF THE UNFCCC

(2010 UPDATE)

August 2010

GCOS-138

(GOOS-184, GTOS-76, WMO-TD/No. 1523)

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL COUNCIL FOR SCIENCE

2010 GCOS Implementation Plan

- builds on the assessment of progress 2004-2008
- was prepared by a workshop and expert team, and finalized after open review
- identifies 138 verifiable and costed actions

UNFCCC SBSTA in Cancún

- welcomed plan and urged Parties to work towards its fulfilment
- invited the SBI to consider funding needs
- encouraged a cycle of evaluation, reporting and requirement-setting

What are the additional costs?

For satellite missions, datasets and products, for the benefit of all countries	**~ US$ 1000M per year**
For *in situ* observation of the open ocean, for the benefit of all countries	**~ US$ 400M per year**
For enhancements undertaken in the national territories of Annex-I countries	**~ US$ 500M per year**
For enhancements undertaken in the national territories of non-Annex-I countries	**~ US$ 600M per year**

Includes some costs that are currently being met, but not on an operational basis

~ US$ 70M per year of satellite and open-ocean observation is by non-Annex-I countries

Enhancements in Annex-I countries include operation of global data centres and generation of global data products such as from reanalysis

Main additional annual cost items (US$) for non-Annex-I countries

Basic meteorological stations for surface measurements	~ 200M
Telecommunications; data recovery, archiving and exchange	~ 100M
Observations of marine habitats and terrestrial ecosystems	~ 70M
Sites making reference-quality observations	~ 50M
Proxy data (timing of events, tree rings, lake sediments, …)	~ 30M
River gauges	~ 15M
Glacier monitoring	~ 15M
Baseline radiosonde (balloon) network	~ 15M

In conclusion

- Progress is being made within existing resources and mechanisms, but not in ensuring long-term continuity for several important observing systems, and not in commitment to some innovation
- Support for capacity building is moreover far from meeting needs
- GCOS estimates US$ 2.5B per year to be the full requirement for additional sustained spending on climate observation
- This includes US$ 600M per year for observing system improvement in developing countries, much of it in least developed countries and small island developing states
- US$ 600M is around 10% of current annual expenditure on observation