Status of the Global Observing System for Climate

A GCOS Report, October 2015

Adrian Simmons

Former Chair, Steering Committee for GCOS

Consultant, Copernicus Climate Change Service
European Centre for Medium-Range Weather Forecasts

Why did we do it?

To fulfil a responsibility of the GCOS Programme to its sponsors

"to review and assess the development and implementation of the components of the [global climate observing system] and report to the sponsoring organizations, and to the participating agencies as required"

To respond to an invitation from UNFCCC SBSTA (Cancún, 2010)

"to report on progress made in the implementation of the 2010 … plan … [and] to review, in broad consultation with relevant partners, the adequacy of observing systems for climate"

GCOS is sponsored by WMO, UNESCO, IOC, UNEP, ICSU

GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

Why did we do it?

To document the progress and current status of the global observing system for climate, and thereby establish a sound basis for identifying the actions required to improve the system

From a public-review comment on the report:

"[Observation of land surface temperatures from space] provides an important complement to [observation of] air temperatures, ***especially as [the] number of meteorological stations continue[s] to decline****."*

From the re-worded conclusion of the report:

"There have been ***improvements in coverage*** *for a number of longer established in situ networks,* ***including the main meteorological networks****. The* ***quality of measurements*** *has also shown* ***improvement****."*

What was the background to the UNFCCC invitation?

Notions of *Principal Observations* or *Key Variables* date to the 1990s

– in a US National Research Council report, and in GCOS plans

GCOS published its First Adequacy Report in 1998

– in response to a request from parties to the UNFCCC

GCOS published its Second Adequacy Report in 2003

– introducing the *Essential Climate Variables* (ECVs)

This led to a 2004 Implementation Plan (and 2006 Satellite Supplement)

– setting out the actions required, stemming from Adequacy Report

GCOS then published: a Progress Report in 2009

a revised Implementation Plan in 2010

a revised Satellite Supplement in 2011

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What did we provide in the report?

The background to the report itself

An introduction to climate observation

An account of the current status and established planning of the main contributing observing systems and networks, and of related product generation and assessment, and data management

Accounts of the importance and observational status of each of the 51 ECVs listed in the 2010 Implementation Plan

Reviews of each of the 138 actions set out in the 2010 Plan

Key conclusions and discussions that point to some of the areas to be followed up in preparing a new Implementation Plan

Who did it?

Authors

- **General material and Atmosphere:** Adrian Simmons, with Simon Eggleston and Tim Oakley
- **Ocean:** Mark Bourassa, Toshio Suga, Katy Hill and others
- **Land:** Simon Eggleston, with Adrian Simmons and others

Input and first review

- Members of the GCOS Panels and invited experts

Public review

- Around 40 people contributed 400 comments; responses were led by Adrian Simmons supported by Gilles Sommeria and others

Final review by GCOS Steering Committee and GCOS Director

- Primarily influencing the summary and conclusions

Some of ways in which progress and current status were assessed

By gathering information from panel members and other experts

Name of ECV	Air temperature
Subsidiary variables	**Not applicable** Subsidiary types: Marine Air Temperature, Land Surface Air Temperature, Land Surface Temperature, Ice Surface Temperature, Lake Surface Temperature Subsidiary variables: Average temperature, maximum temperature, minimum temperature, diurnal temperature range, seasonal cycle
~~Supplementary~~ Supporting **measured variables**	IR and Microwave radiances~~, particularly over the oceans~~
ECV Group membership	energy cycle Agriculture (growing conditions, heat and cold indices, planning (e.g. suitable climate conditions for wine-growing), sensitivity analyses, etc) Health (e.g. heatwaves – heat stress, changes in extremes, species migration, outside work tolerances).
Applications	Climate monitoring, detection and attribution, climate services Surface fluxes Service provision and guidance through e.g. climatologies, as above.
Phenomena and indices	Surface temperatures constitute several of the CCI ETCCDI Climdex indices. Frost frequency Heatwave indices, heating/cooling degree days, extremes (e.g., 95%ile), changes in frost frequency
Uncertainties identified by IPCC	Uncertainties, as quantified in HadCRUT4 are extensively used in AR5. Even though understanding of uncertainties is arguably most advanced for surface temperatures there remain issues over potential completeness noted by IPCC and explicit in the lack of inclusion of independent estimates within the uncertainty bounds of HadCRUT4. These uncertainties do not preclude an assessment that the surface temperatures have increased on multidecadal timescales. Hence this warming was made as a statement of fact with no attendant uncertainty language construct.

Peter Thorne
The review paper by Chris Merchant et al. (caveat emptor) could be used here to update this entry holistically … http://www.geosci-instrum-method-data-syst.net/2/305/2013/gi-2-305-2013.html

Indeed you could leverage earthtemp folks to really make sure this reflects a community view.

Adrian Simmons
Blue: Peter's input

Red tracked changes: Will

Peter Thorne
That seems odd. In reality there are several different air temperatures / surface temperatures and several subsidiary variables.

guest01
Clarification text needed

guest01
Move to application

Template for the proposed nomination of an Essential Ocean Variable (EOV)

EOV Information	
Name of EOV	Carbonate System
Sub-Variables	DIC, Total Alkalinity, pCO2 and pH (at least 2 of 4)
Derived Products	Saturation state (aragonite, calcite), dissolved carbonate ion concentration, air-sea flux of CO_2, anthropogenic carbon, change in total carbon.
Supporting variables	Temperature, salinity, wind speed, atm. XCO_2, barometric pressure, oxygen, nutrients, calcium concentration, transient tracers.
Contact/Lead Expert(s)	IOCCP

Some of ways in which progress and current status were assessed

By evaluating responses to actions from the 2010 Implementation Plan

Action A2: Obtain further progress in the systematic international exchange of … hourly SYNOP reports and monthly CLIMAT reports ...

Action A3: Ensure sustained operation of surface meteorological stations addressing national and sub-national needs … implement additional stations where necessary ...

Action C13: Collect, digitize and analyse … historical … data records … and submit to International Data Centres

By evaluating network performance and data-centre holdings

Examining holdings of the recognised international data centres, including the lead archive centre for GCOS (NOAA NCEI)

Examining ECMWF data holdings from near-real-time data flows and collections for reanalysis, and comparing them with NCEI and other data-centre holdings

Availability of synoptic and monthly surface meteorological data

Amounts of synoptic data held by ECMWF and monthly data held by NCEI are higher for more-recent years

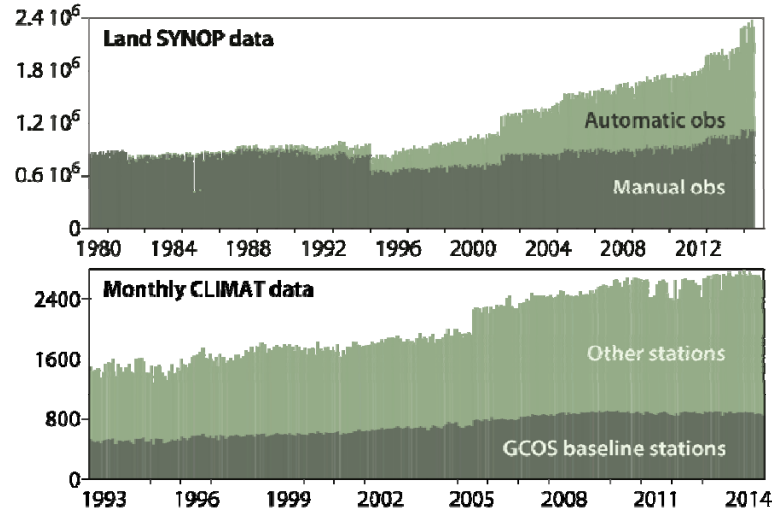
Increases for synoptic data have occurred in both station numbers and reporting frequency

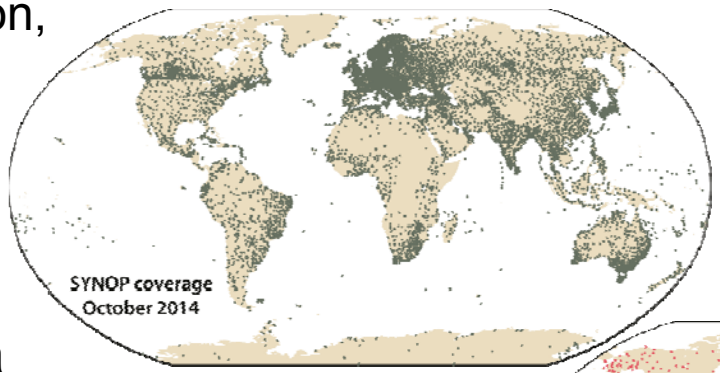
Coverage limitations may be due to limited international data transmission, not lack of measurement

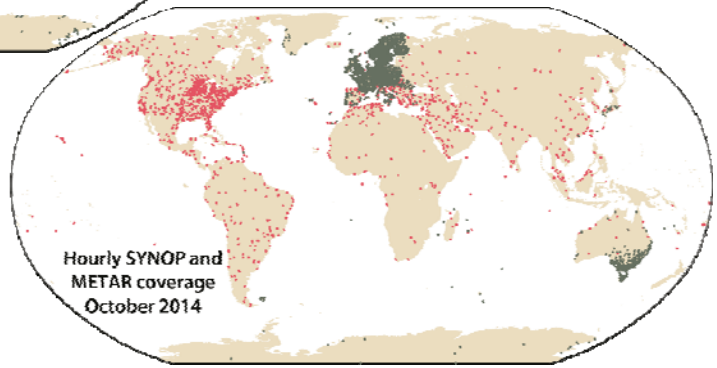
But some gaps persist over time and across variables

More-widespread hourly data are provided in less-precise airport code

There is now some regional transmission of hourly precipitation from synoptic stations

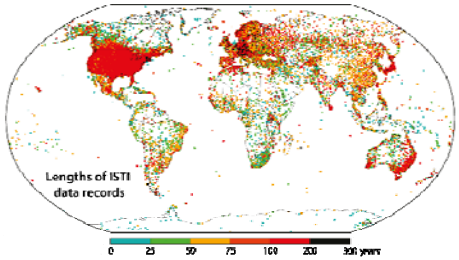


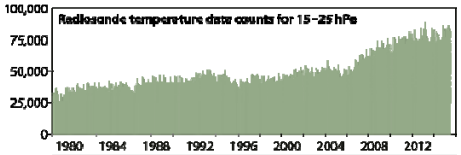


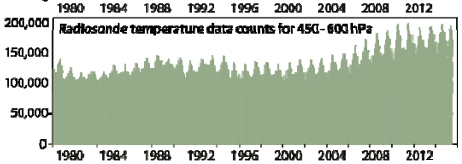


And much more on the networks and archives for atmospheric data

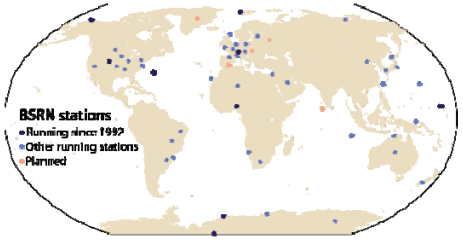
There is progress in recovery/sharing of older data, but scope for more to be done, including archive improvements





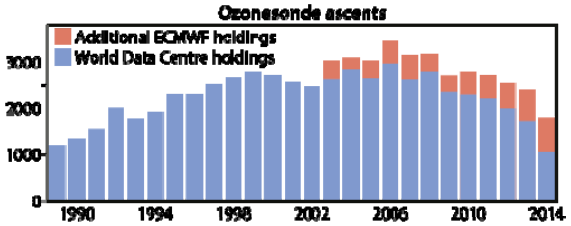


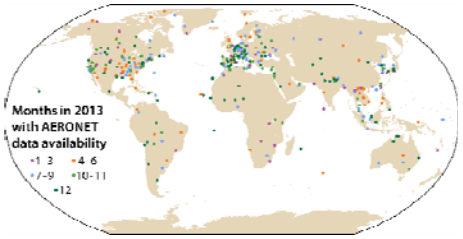
Radiosonde data counts and coverage have improved



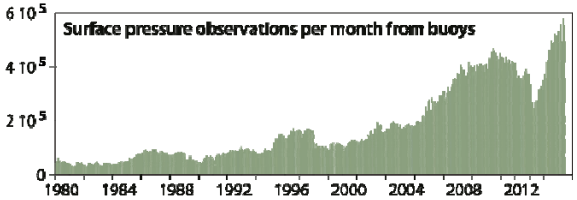
Good global coverage tends to be lacking for reference and baseline networks

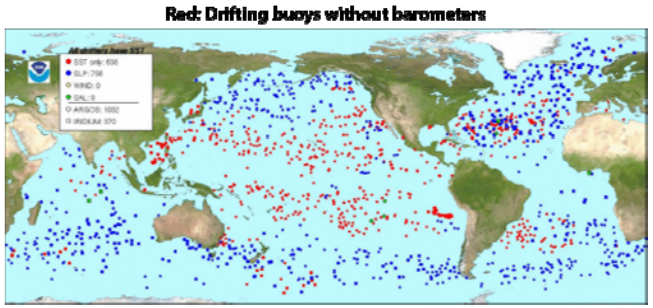
Observing systems for atmospheric composition pose some particular challenges

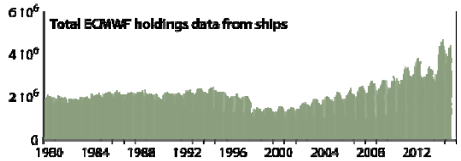


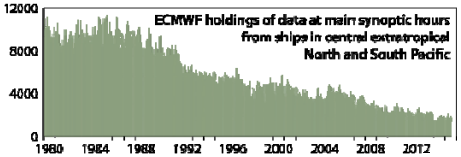


Mixed picture for marine meteorological measurements









Some of ways in which progress and current status were assessed

By gathering information from panel members and other experts

By evaluating responses to actions from 2010 GCOS Implementation Plan

By evaluating network performance and data-centre holdings

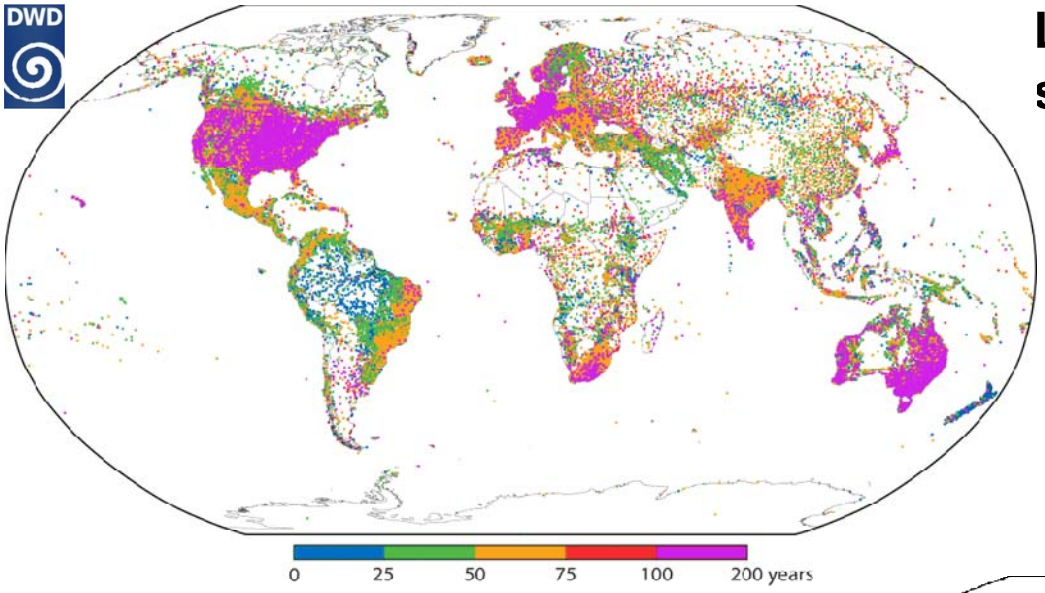
By relating to key uncertainties identified in IPCC AR5

> "Confidence in global precipitation change over land is low prior to 1951 and medium afterwards because of data incompleteness."

By drawing on conclusions of workshops and symposia, and national communications to the UNFCCC

By accumulating evidence of improvements in observational quality

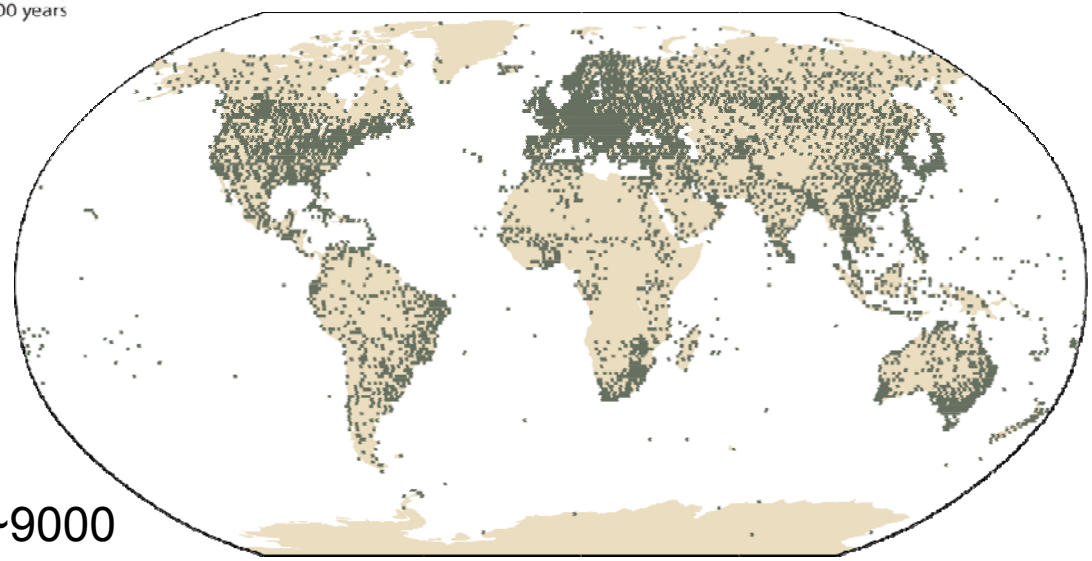
Station distributions for monthly products of the Global Precipitation Climatology Centre



Lengths of record for ~75000 stations in GPCC database

Increase in station numbers over 7 years is 35-40% before1950s, and ~60% in 1970s

Many data are supplied only after several years



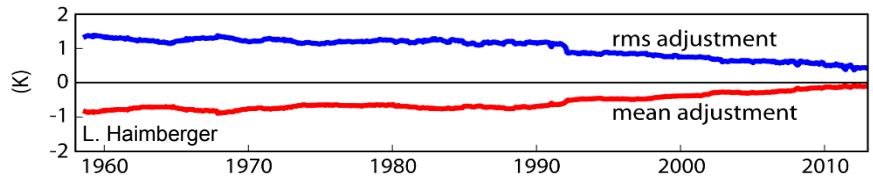
Locations providing daily or monthly data on the GTS for October 2014

Increase over 7 years is ~20%

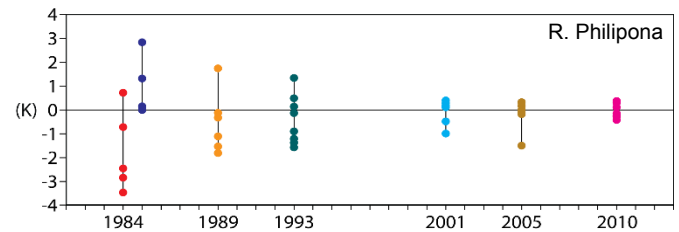
Number of stations is currently ~9000

Improvements over time in observations

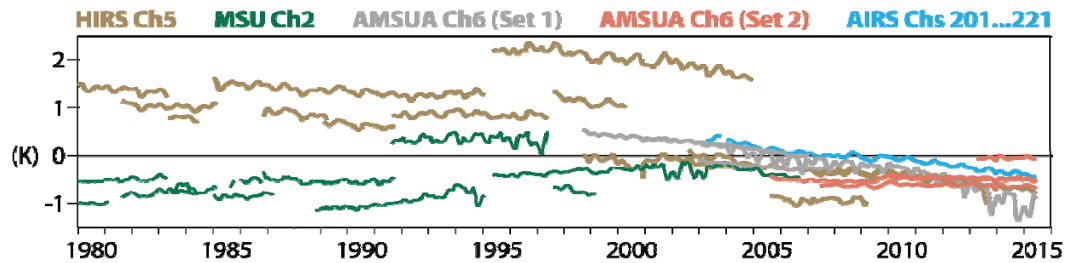
Smaller estimated radiosonde biases



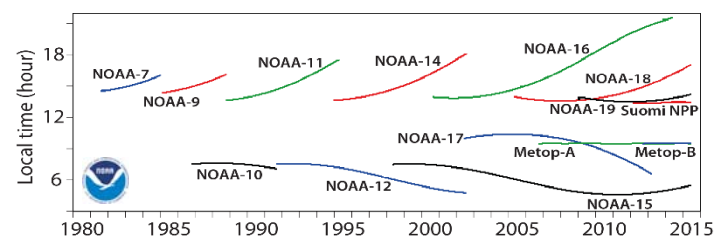
Smaller spread among data from different types of radiosonde from WMO comparisons



Smaller estimated biases in soundings from satellites



Much smaller drift in equatorial crossing times for "sun-synchronous" satellites



And better fits of observations to data assimilation background fields
better reporting codes for some meteorological obs (eventually …)

Some of ways in which progress and current status were assessed

By gathering information from panel members and other experts

By evaluating responses to actions from 2010 GCOS Implementation Plan

By evaluating network performance and data-centre holdings

By relating to key uncertainties identified in IPCC AR5

By drawing on workshops, symposia and national communications to UNFCCC

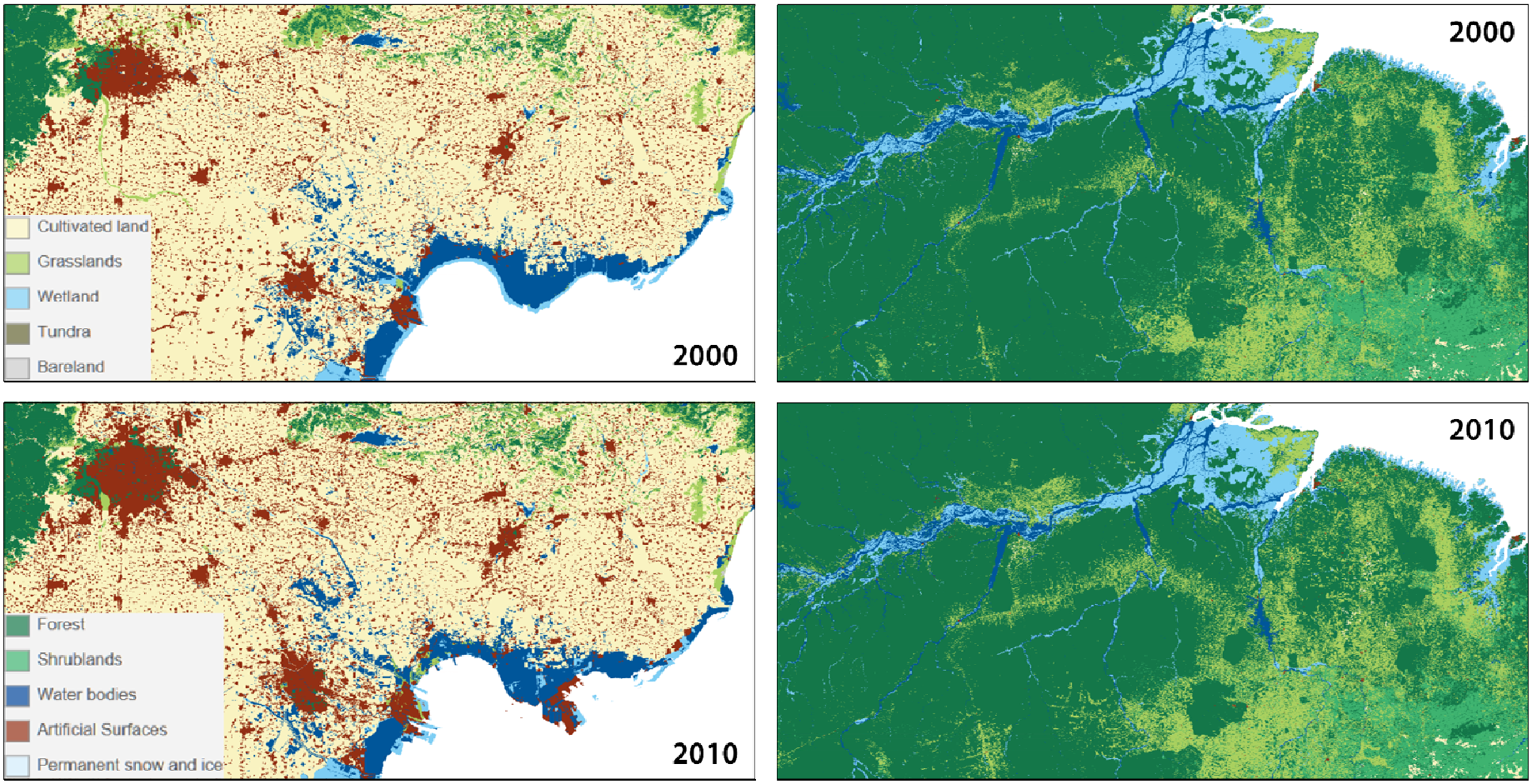
By accumulating evidence of improvements in observational quality

By showing availability of data products using providers' visualization tools

By reviewing the plans of data providers

Action T28: Generate global land cover maps based on 10-30m imagery every 5 years

GlobeLand30: 30m land-cover data for 2000 and 2010 produced by China from US Landsat images

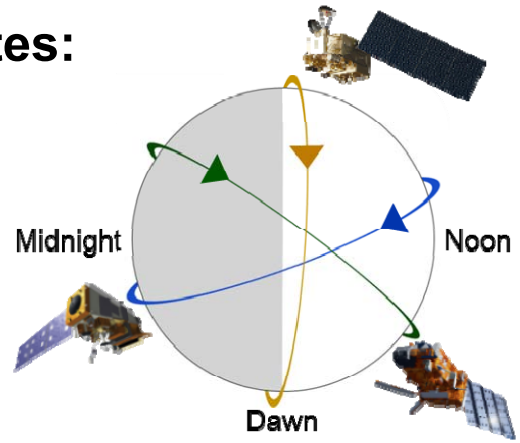


A 30m product for forests has been produced by Univ. Maryland, and a 30m product for surface water by the JRC. The ESA CCI 300m product has more categories.

Evolution of the space-based observing system

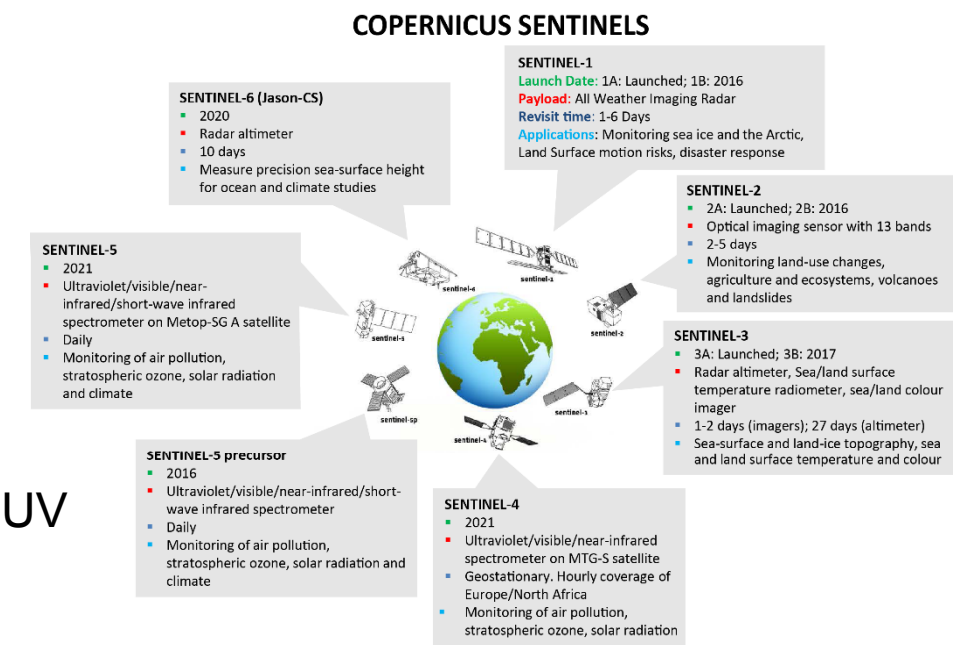
Operational meteorological satellites:

- new providers from polar orbit



Copernicus Sentinels put other types of observation on an operational footing:

- for atmosphere, ocean and land
- for environmental monitoring as well as climate
- with accompanying services



Some issues over continuity:

- limb emission measurement
- SST measurement in the MW
- GNSS radio occultation
- scatterometry from afternoon orbit
- solar irradiance, total and variations in UV
- …

Some other conclusions of the report

The operation and development of the Argo array is a highlight

Other new networks have been established for several ECVs in recent years

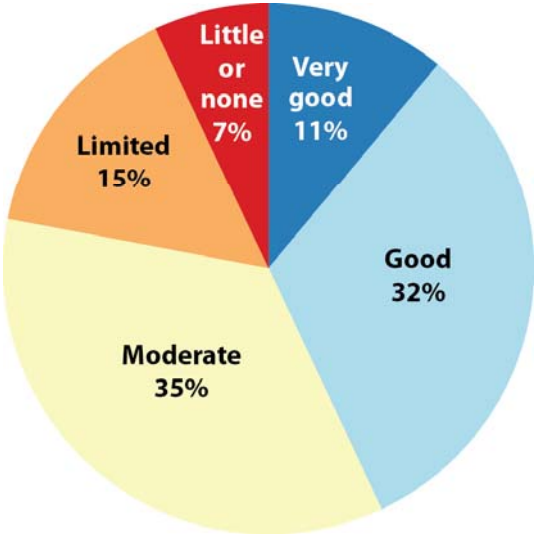
Reprocessing of data and generation of data products, for individual ECVs and from reanalysis, continues to improve and expand; opportunities include recovery of data from early satellite missions

Access to data is improving, but still an issue

Capacity development continues to fall far short of what is needed to fill critical network gaps

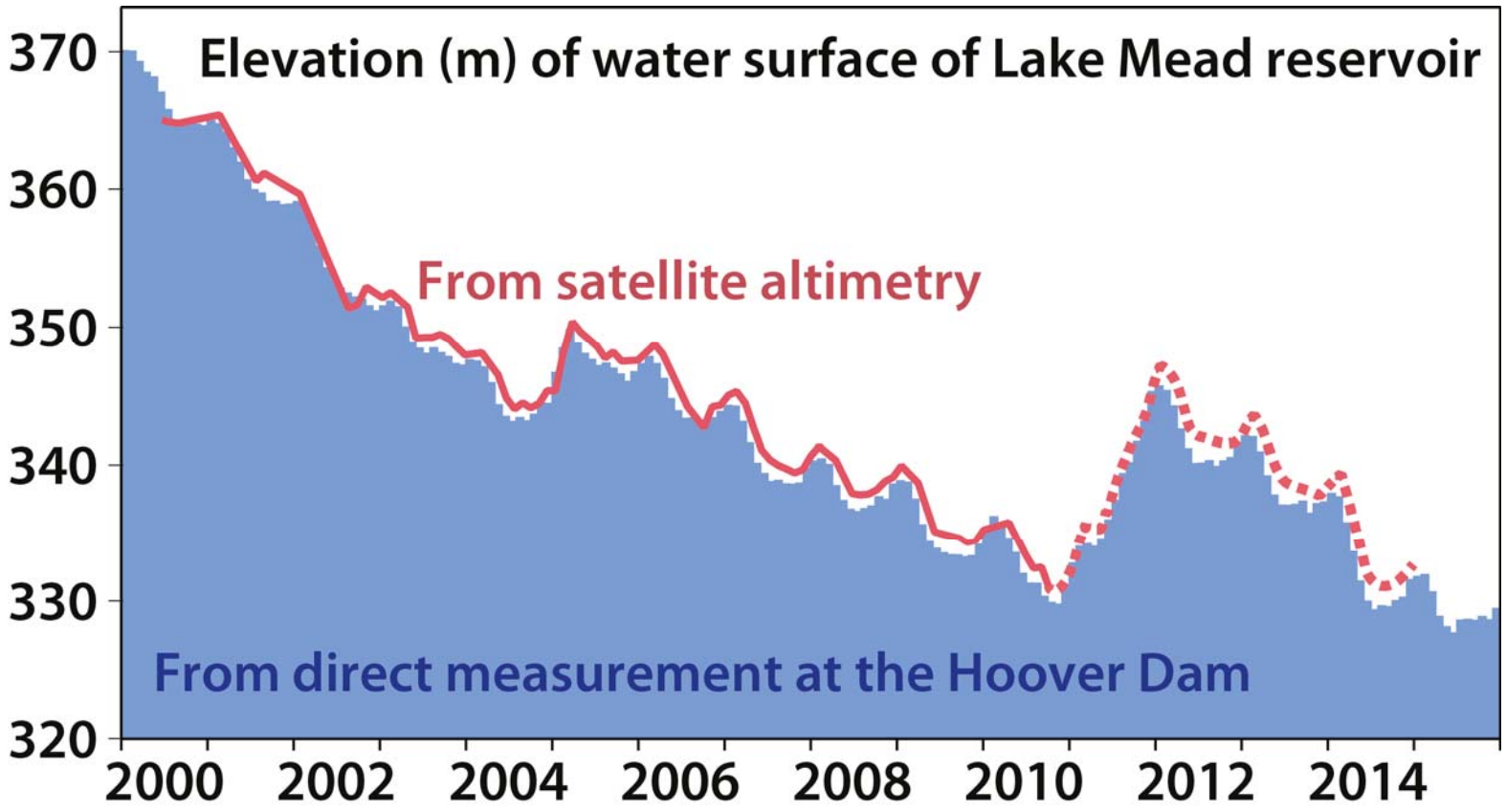
Sustaining activities initiated with short-term research funding is another recurrent issue

International organisation has been strengthened for atmosphere and ocean, but the lead sponsor has not supported the Global Terrestrial Observing System for several years



Assessed progress of 138 IP-10 Actions

After the report was published …



Satellite altimetry from ~~LEGOS~~ THEIA HYDROWEB site (Crétaux *et al*., 2011)

In situ measurements from US Bureau of Reclamation website (not available from International Data Centre for Hydrology of Lakes and Reservoirs)

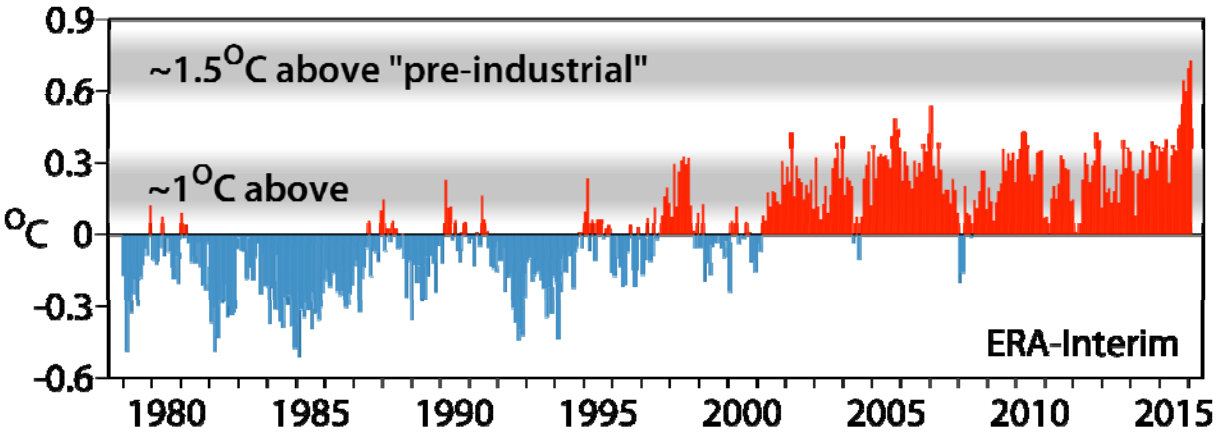
After the report was published …

Launch of Jason-3
17 January 2016
(and return of 1st stage rocket)

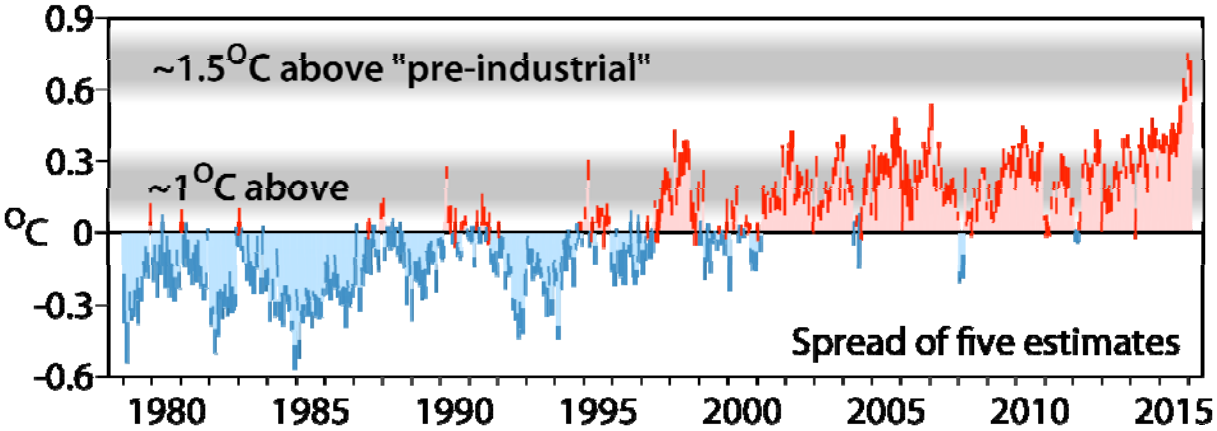
Launch of Sentinel-3A
16 February 2016

After the report was published …

Section 4.3.1: Sub-decadal variability among different analyses remains quite substantial, but there is general agreement among the analyses produced in close to real time that the warmth of the global atmosphere during the current El Niño event is exceptional



Monthly ERA-Interim global-mean surface air temperature anomalies relative to 1981-2010



Spread of ERA-Interim, JRA-55, GISTEMP, HadCRUT4 median and NOAAGlobalTemp