

# Essential Climate Variables and the GCOS Assessment Process

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- cover a wide range of atmospheric, oceanic and terrestrial variables
- are made *in situ* and remotely sensed, to varying degrees and levels of maturity
- need to be complemented by socio-economic and ecosystem data
- may serve several purposes and be used repeatedly over many years
- may be used most effectively only after many years, in originally unforeseen ways
- are prone to biases and changes in instrument and coverage
- may be processed and re-processed, and integrated in various types of product
- are subject to a diverse set of institutional arrangements

## Notions of “Principal Observations” and “Key Variables” emerged in the 1990s

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

## GCOS published its First Adequacy Report in 1998

- addressed to the Parties to the UNFCCC
- following a request by the UNFCCC COP 3 in 1997 addressed to SBSTA, for a report produced in consultation with the IPCC

## GCOS published its Second Adequacy Report in 2003

- under the endorsement by SBSTA of its preparation
- addressed to the Parties to the UNFCCC
- introducing the “Essential Climate Variables” (ECVs)

**ECVs are either specific variables or groups of closely-related variables:**

<p><b>Atmospheric</b></p>	<p><b>Surface:</b> Air temperature, wind speed and direction, water vapour, pressure, precipitation, surface radiation budget</p> <p><b>Upper-air:</b> Temperature, wind speed and direction, water vapour, cloud properties, earth radiation budget (including solar irradiance)</p> <p><b>Composition:</b> Carbon dioxide, methane, and other long-lived greenhouse gases, ozone and aerosol, supported by their precursors</p>
<p><b>Oceanic</b></p>	<p><b>Surface:</b> Sea-surface temperature, sea-surface salinity, sea level, sea state, sea ice, surface current, ocean colour, carbon dioxide partial pressure, ocean acidity, phytoplankton</p> <p><b>Sub-surface:</b> Temperature, salinity, current, nutrients, carbon dioxide partial pressure, ocean acidity, oxygen, tracers</p>
<p><b>Terrestrial</b></p>	<p>River discharge, water use, groundwater, lakes, snow cover, glaciers and ice caps, ice sheets, permafrost, albedo, land cover (including vegetation type), fraction of absorbed photosynthetically active radiation, leaf area index, above-ground biomass, soil carbon, fire disturbance, soil moisture</p>

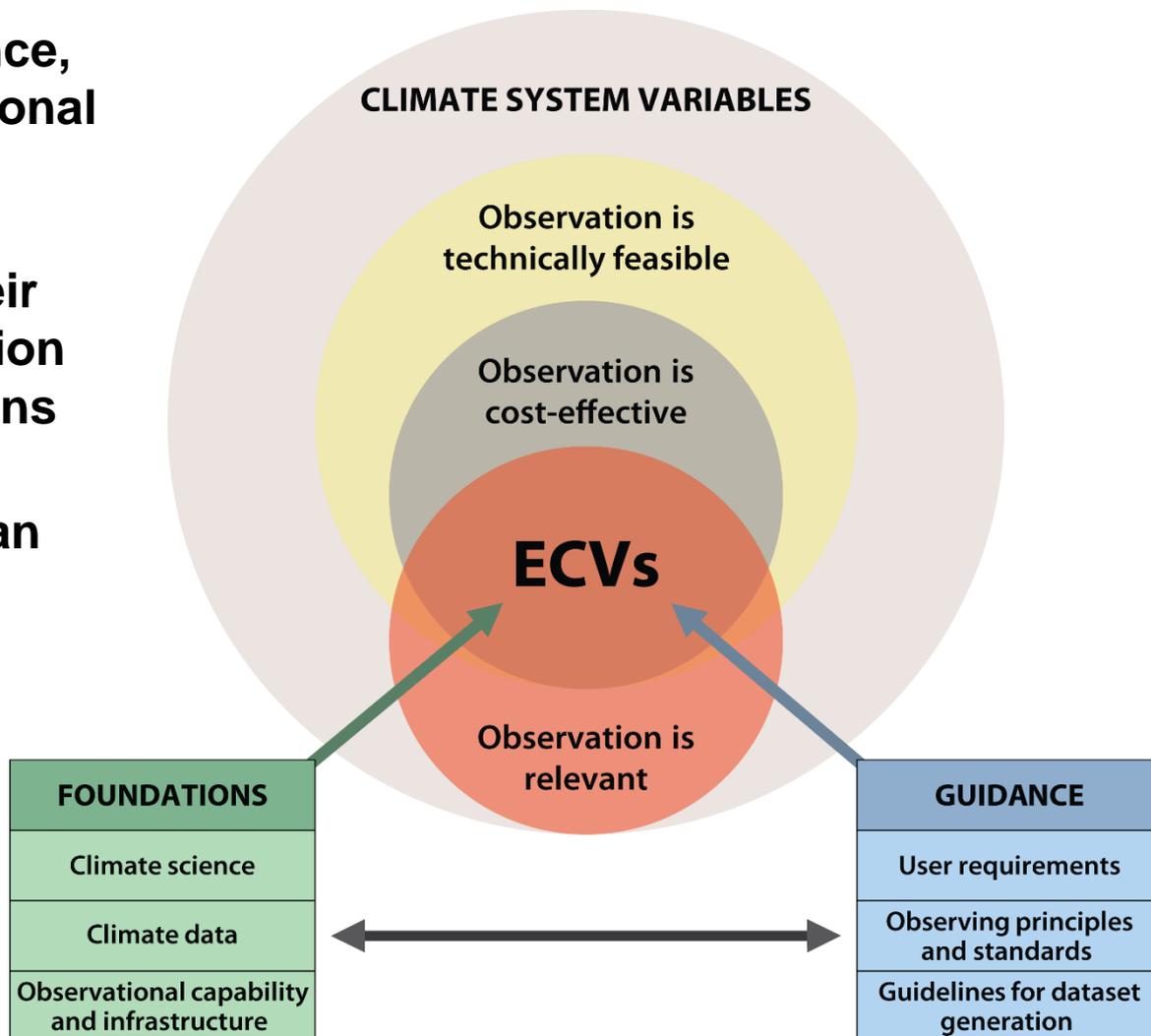
# The ECVs are more than a list of variables

**They build on existing science, data holdings and observational infrastructure**

**Guidance is provided on their observation, and the formation of products from observations**

**They provide one basis for an organised assessment of capabilities and needs**

**Organisation could be by observing network, physical/chemical cycle or societal benefit area**



## Following the Second Adequacy Report in 2003, GCOS produced:

- an Implementation Plan in 2004
- a Supplement to the Plan in 2006 on requirements for satellite-based data products
- a Progress Report in 2009
- an updated Implementation Plan in 2010
- an updated Satellite Supplement in 2011

## UNFCCC/SBSTA, in welcoming the 2010 Implementation Plan:

- urged Parties to work towards full implementation
- invited a subsequent progress report and encouraged a review of adequacy, on a timetable to be proposed by GCOS

## UNFCCC/SBSTA welcomed the timetable proposed by GCOS in 2012

- for a Status Report in 2015 and a new Implementation Plan in 2016

**The ECV list was first published in 2003 in the Second Adequacy Report**

**The list was updated a little in the 2010 Implementation Plan**

- revising some wording, naming ocean acidity and ice sheets explicitly
- adding ocean oxygen content, soil moisture and precursors for O<sub>3</sub> and aerosols
- not adding land-surface temperature
- and including supplementary notes stating that:
  - “ecosystems are characterised, *inter alia*, by a range of biodiversity and habitat properties that are at present too complex to define as an ECV, mainly due to the large variability of scales, the absence of universally-accepted indicators and non-systematic data collection.”
  - “because of the importance of ecosystem changes to the goals of the UNFCCC, such long-term and collocated measurements are recognised in this Plan as ‘Essential Ecosystem Records’.”

**The list may be updated again in the 2016 Implementation Plan**

***IPCC 5<sup>th</sup> Assessment Report, and this workshop***

***National reporting to UNFCCC on systematic observation***

GCOS workshops on observations for adaptation and mitigation

WCRP Open Science Conference and Workshops

Eumetsat/WCRP Climate Symposium

COSPAR roadmap report on observations and integrated Earth-system science

WMO (GFCS, WIGOS), IOC (GOOS) and post-2015 GEO planning

Ongoing CEOS/CGMS/WMO initiatives (Architecture, Inventory of datasets)

Other assessments of requirements (GEO, ESA Climate Change Initiative)

Assessments by GCOS panels and dedicated workshops

Open reviews

### **Copernicus Workshop on Climate Observation Requirements**

- to be held at ECMWF, from 29 June to 2 July 2015
- with focus on the observational content of the Copernicus “Climate Data Store”
- and likely to consider:
  - climate data records from satellites
  - collections of *in situ* climate observations
  - gridded ECV products derived from observations
  - input observations for (and feedback from) model-assisted reanalyses

### **GCOS Conference on “Global Climate Observations, the Road to the Future”**

- expected to be held in Amsterdam, from 24 to 26 February 2016
- in part to consider a draft of the new Implementation Plan
- with preparations led by Han Dolman

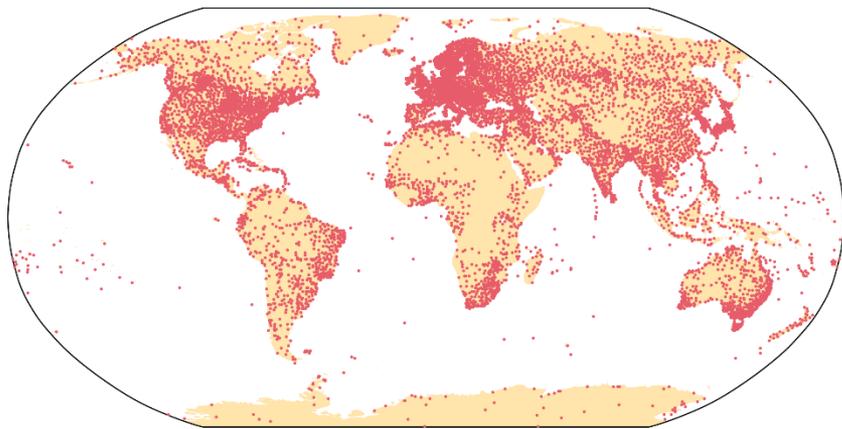
## By evaluating responses to actions from 2010 Implementation Plan

- 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

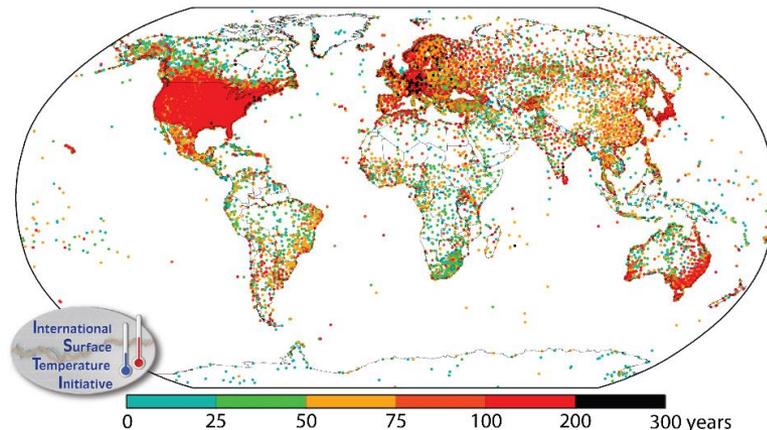
## By evaluating network performance and data-centre holdings

# Coverage by *in situ* surface measurement

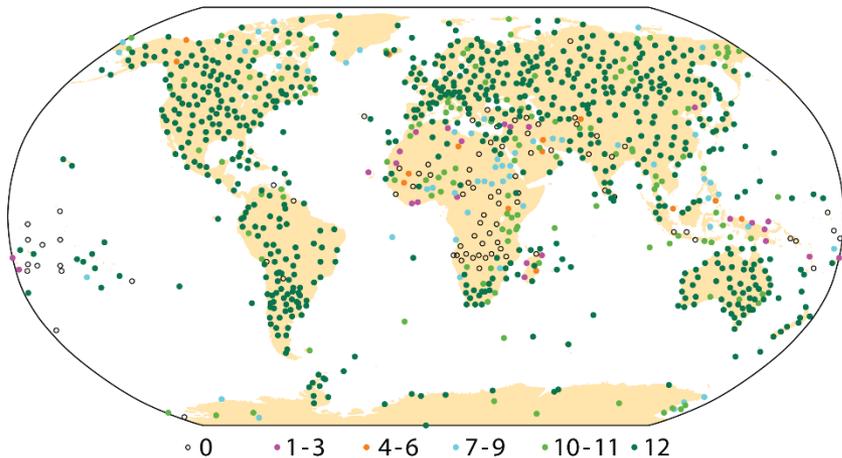
Stations providing surface data at least once per day as received operationally by ECMWF in October 2014



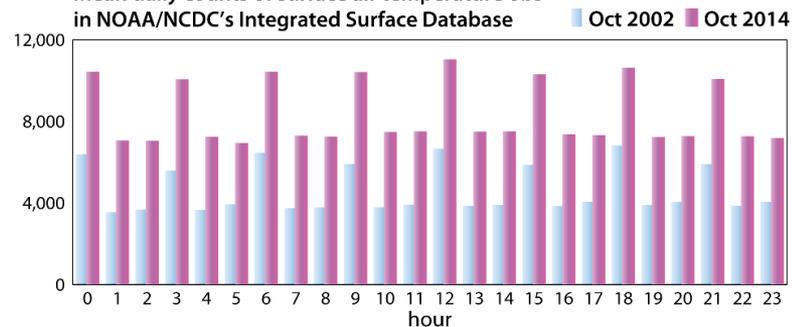
Lengths of monthly surface air temperature records for >32000 stations



Number of monthly CLIMAT reports from GCOS Surface Network held by NOAA/NCDC for 2013



Mean daily counts of surface air temperature obs in NOAA/NCDC's Integrated Surface Database

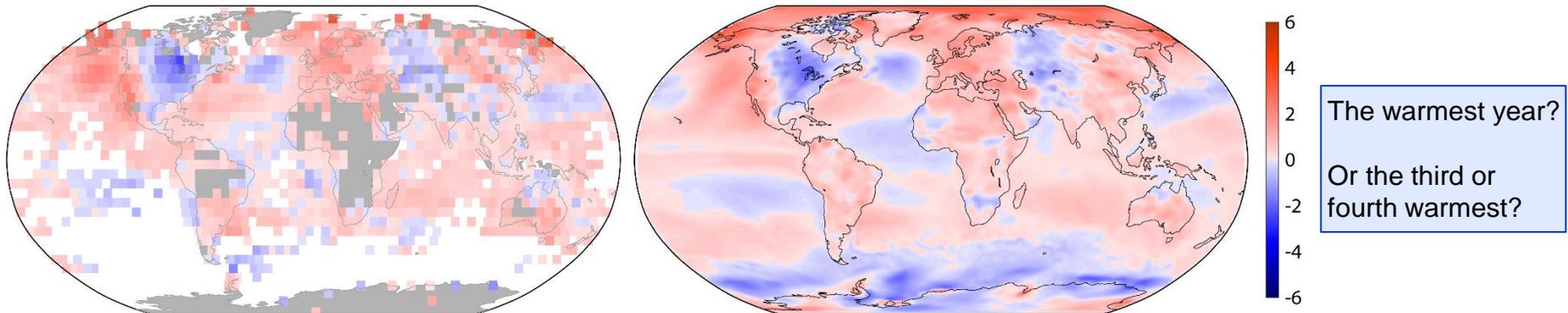


An improving situation, but gaps and lack of local resolution remain

AR5 WGII 13.2.1 notes need for sub-monthly rather than monthly/seasonal/yearly data

# Gap-filling and local resolution are required

HadCRUT4      Two-metre temperature (K) for 2014 relative to 1981-2010      ERA-Interim



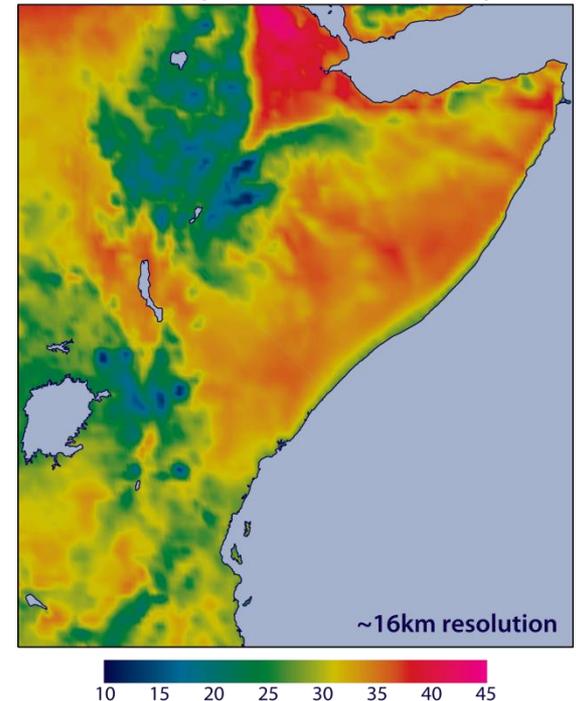
Model-assisted products are gap-free and may be constrained by many types of satellite and *in situ* data

Products with 10km or finer resolution are feasible from global weather prediction analyses and from regional or downscaled global reanalysis

There is need for complementary enhancement of *in situ* observation where gaps are large, or where fine resolution is especially important for decisions on adaptation

AR5 WGII 21.6 notes the “research need” for gridded products

ECMWF 2m temperature (K) 12UTC 24 Sept 2014



By evaluating responses to actions from 2010 Implementation Plan

By evaluating network performance and data-centre holdings

## By relating to key uncertainties identified in IPCC AR5

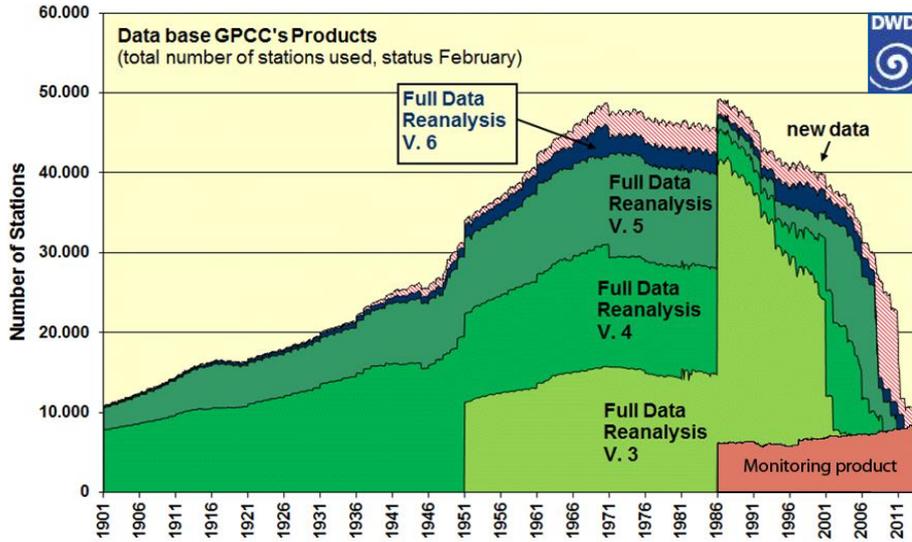
WG I: “Confidence in global precipitation change over land is low prior to 1951 and medium afterwards because of data incompleteness.”

WG II: Notes observational records do not allow determination of century-scale precipitation trends for most areas of Africa and Asia

## By relating to issues raised by the World Climate Research Programme

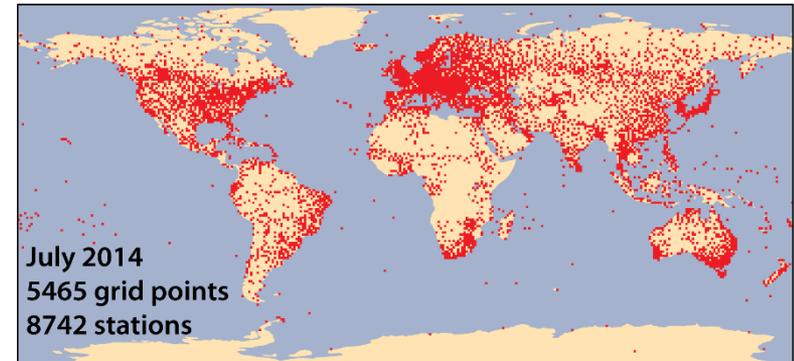
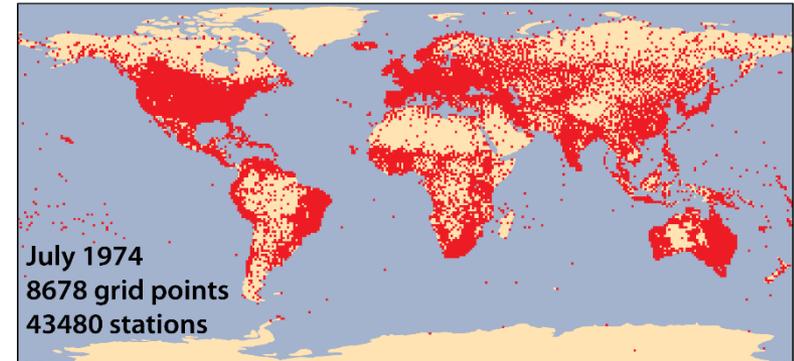
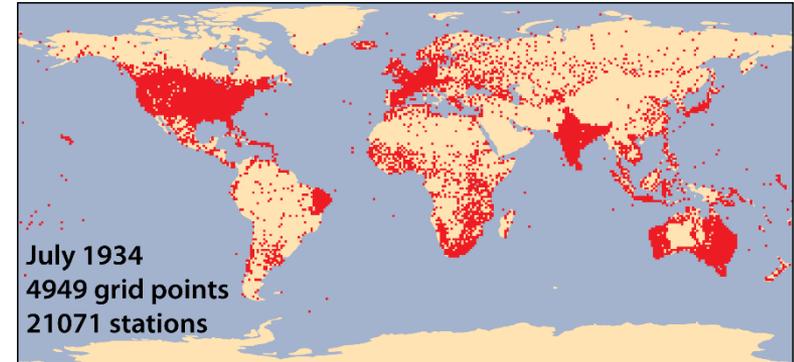
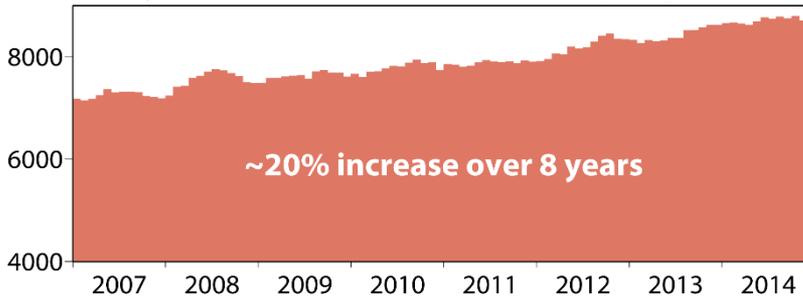
“Over the last few decades, *in situ* observations of land surface hydrological variables, such as streamflow, rainfall and snow, have generally been in decline.”

*From discussion of the WCRP Grand Challenge on Water Availability*



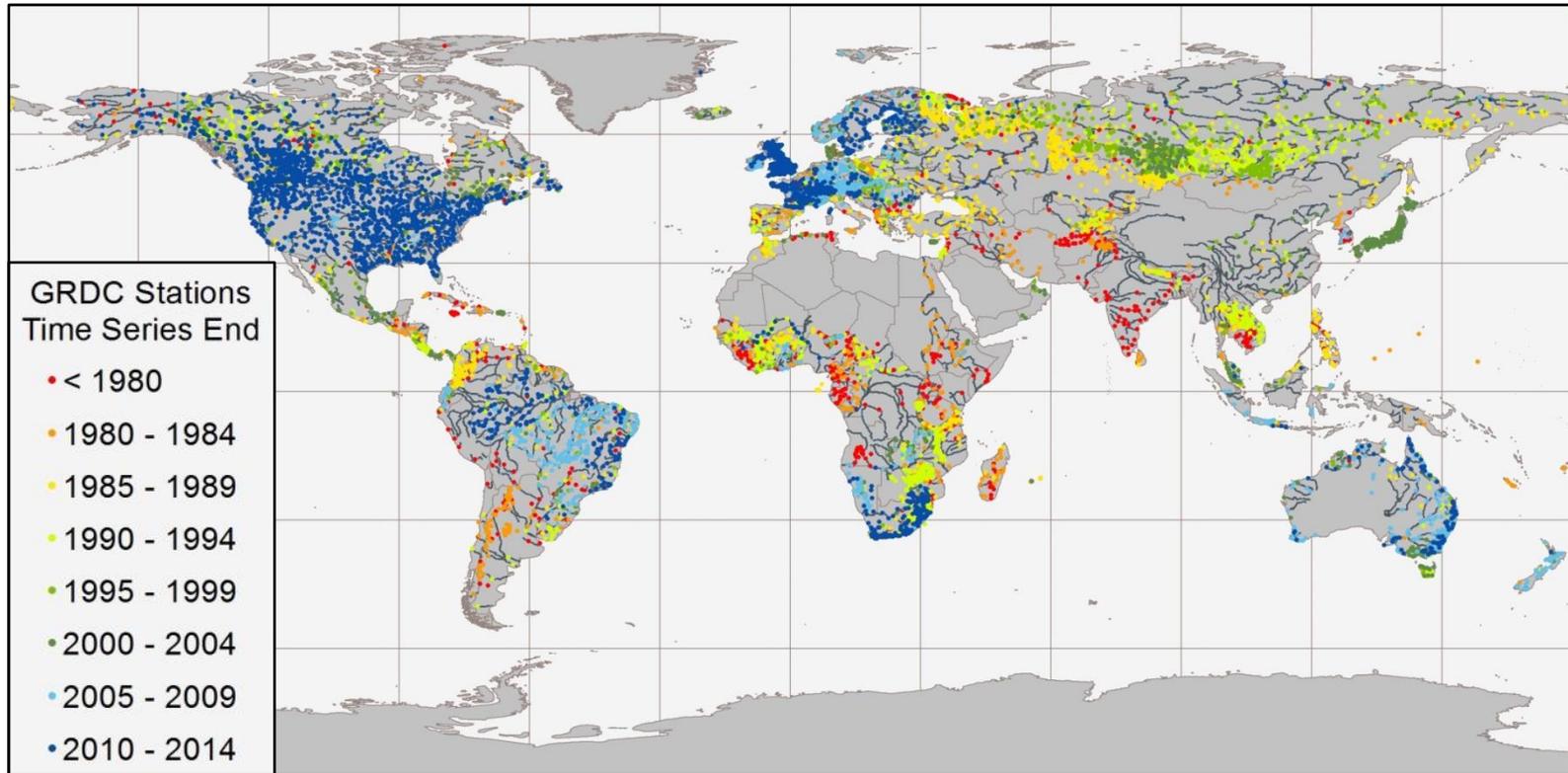
What is the scope to recover more data from before 1951?

Monthly station count for SYNOP/CLIMAT GTS precipitation data



1°x1° grid boxes with one or more stations used in a monthly GPCP product

# River discharge: locations and latest years in Global Runoff Data Centre holdings



9009 GRDC stations with monthly data, incl. data derived from daily data (Status: 24 June 2014)  
Koblenz: Global Runoff Data Centre, 2014.



WMO Congress in 2015 will consider a draft resolution covering exchange of streamflow and other climate data

## **Operational meteorological satellite programmes and related missions are in generally good shape**

- with new contributors such as China and India
- compensating for vulnerability to failure of platforms or key instruments

## **Copernicus programme places many other types of environmental observation on an operational basis**

- first satellite of six multi-satellite Sentinel missions was launched in 2014
- includes supporting monitoring and forecasting services, and has open data policy

## **Various issues related to continuity of other types of observation**

- continuity for quite well-established types of measurement?
- continuity or intermittent enhanced missions for specific R&D purposes?
- what next for measurements that are emerging or may emerge as important?
- how serious is the absence of a reference mission?

## Action C22

**Action:** Develop and publish guidelines for undertaking observational studies in support of impact assessments and to ensure that data policies facilitate the exchange and archiving of all impact-relevant observational data.

**Who:** IPCC TGICA, GTOS and IGBP.

**Time-Frame:** 2011.

**Performance Indicator:** Guideline published.

**Annual Cost Implications:** <1M US\$ (10% in non-Annex-I Parties).

## Action C23

**Action:** Encourage recognition by scientific funding bodies of the need to consider guidelines for the conduct of observational impact studies, and encourage the definition of new impact-related ECVs.

**Who:** Parties and ICSU

**Time-Frame:** 2011 (Achieve improved recognition).

**Performance Indicator:** Availability of supporting data; proposals for new ECVs.

**Annual Cost Implications:** 1-10M US\$ (50% in non-Annex-I Parties).

## **Does the concept of the ECVs and the working of the assessment process remain appropriate, fit-for-purpose, relevant, useful, ...?**

- How can they be improved, or have you a radically different approach to propose?
- Should impact-related ECVs be included?

## **Has there been progress on Actions C22 and C23 of the 2010 Implementation Plan or on “Essential Ecosystem Records”?**

- Do such actions and the “EER” concept need to be restated in the 2016 plan?
- Are there specific proposals for impact-related ECVs?

## **What are your perceptions of the current state of climate observation and related products and services?**

- Where, from your perspective, is progress being made?
- Where, from your perspective, is progress not being made?
- What do you see as the priorities for improvement?