

The ERA-CLIM project

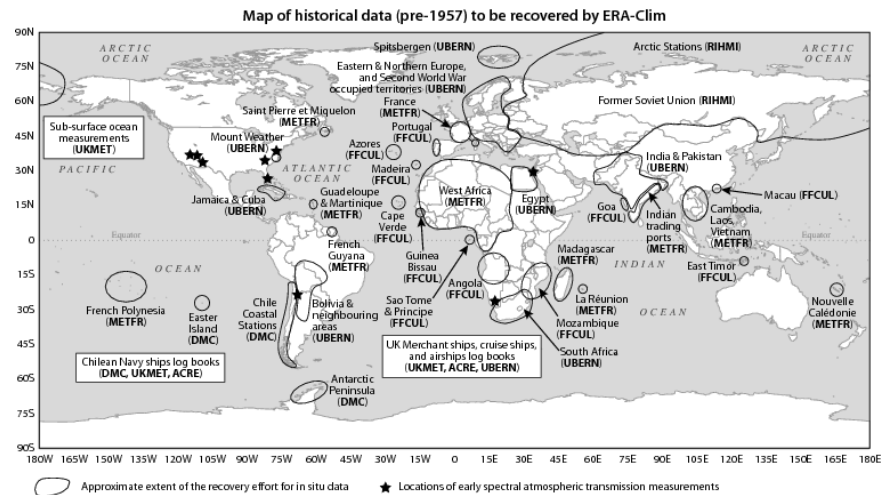
European Reanalysis of Global Climate Observations

Hans Hersbach

ECMWF reanalysis group: Dick Dee, Paul Poli, Carole Peubey, Cristian Codorean, Paul Berrisford, Roger Brugge, Hitoshi Sato, David Tan

Overview

- ERA-CLIM concept and objectives
- Overview of reanalysis at ECMWF
- Rationale behind reanalyses
- ERA-CLIM in more detail
- Concluding remarks



ERA-CLIM

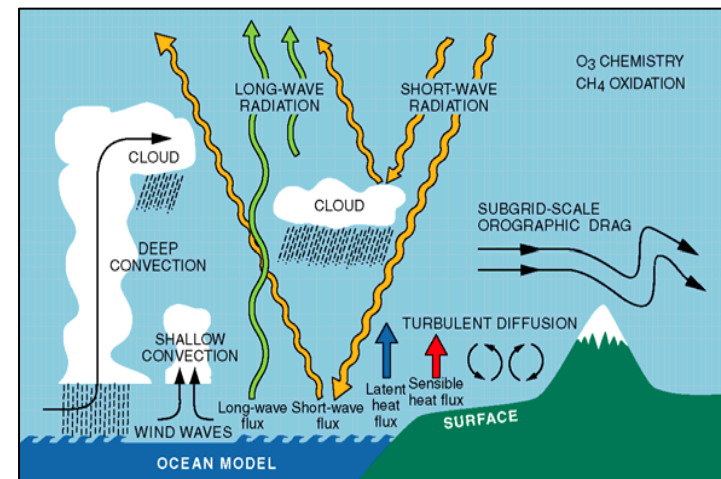
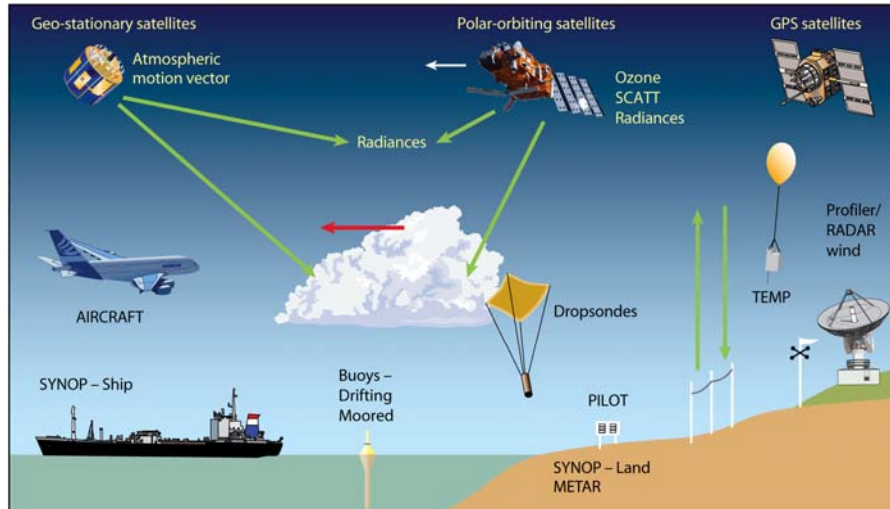
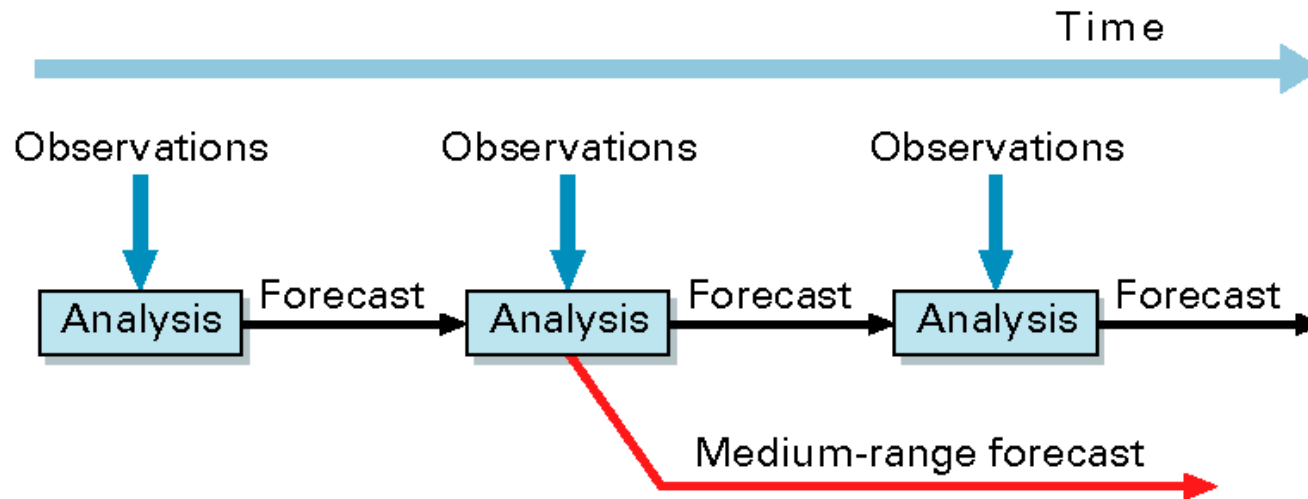
European Reanalysis of Global Climate Observations

A three-year FP7 EU-funded collaborative research project

Integration and improvement of the 20C instrumental record

- Concerted effort in **data recovery**
 - mainly **pre-1957 upper-air** data, and **surface data in sparsely observed areas**
 - and preparation of input **satellite data** sets for reanalysis
- The collection of all data into a newly developed **Observation Feedback Archive (OFA)**
- An ambitious set of **pilot reanalyses** based on these archives to provide incremental:
 - quality assessment, improvement of consistency, bias estimates where possible,
 - information on inter-calibration between overlapping data sets,
 - address challenges in data poor areas in the first decades of the 20th century,
 - and to prepare for the **next comprehensive ERA** reanalysis.
- **Open data access** to all input observations + reanalysis products + quality feedback
- **Partners:** Met Office, Météo-France, EUMETSAT, Un.Vienna, Un.Bern, Un.Lisbon, RIHMI-WDC (Russia), DMC (Chile), ECMWF

ECMWF core activity: Global numerical weather prediction



ERA – ECMWF Reanalysis of atmosphere, land surface and ocean waves



ERA-15:	1979 – 1993
ERA-40:	1957 – 2001
ERA-Interim:	1989 onwards

ERA-CLIM:

European Reanalysis of Global
Climate Observations

An EU FP7 project to *prepare*
the next ECMWF reanalysis

Includes **ERA-20C**

Access to reanalysis data at www.ecmwf.int/research/era

Public data server:
~6000 registered users

Data products are
updated monthly

Full resolution data
expected June 2011

Climate change
monitoring tools in
development

ERA-interim paper:
*Dee, Uppala, Simmons, Poli
et. al, QJRMS, April 2011*

The screenshot shows the ERA-Interim website interface. On the left, there are two vertical navigation menus. The top menu, titled 'Research', includes links for Demeter, ERA, IFS, Monthly Forecasting, Seasonal, SMDA, and Physical Aspects. The bottom menu, titled 'Areas', includes links for Reanalysis at ECMWF, ERA-Interim, ERA-40, ERA-15, and Publications. The main content area is titled 'ERA Areas' and has a sub-header 'Climate monitoring' with tabs for ERA Interim, ERA-40, ERA-15, and Publications. The main text describes ERA-Interim as the latest ECMWF global atmospheric reanalysis, available from MARS or the ECMWF Data Server. It mentions a two-month delay for updates and provides a link to frequently asked questions. A green box highlights 'Product availability as of 7 April 2011: ERA-Interim data are now available for dates from 1 January 1989 to 31 January 2011.' Below this, there is a section for 'NEW: Climate monitoring products' featuring a time series plot of global 2m-temperature anomalies and a description of the data. The bottom of the page mentions support for reanalysis activities at ECMWF.

- ERA-Interim reanalysis is continuing near real-time

Rationale behind reanalysis

Reanalysis:

- provides a proper framework for integrating and reconciling diverse sources of information about recent and present climate,
- combines observations with model information to produce a physically and dynamically coherent record of geophysical parameters.

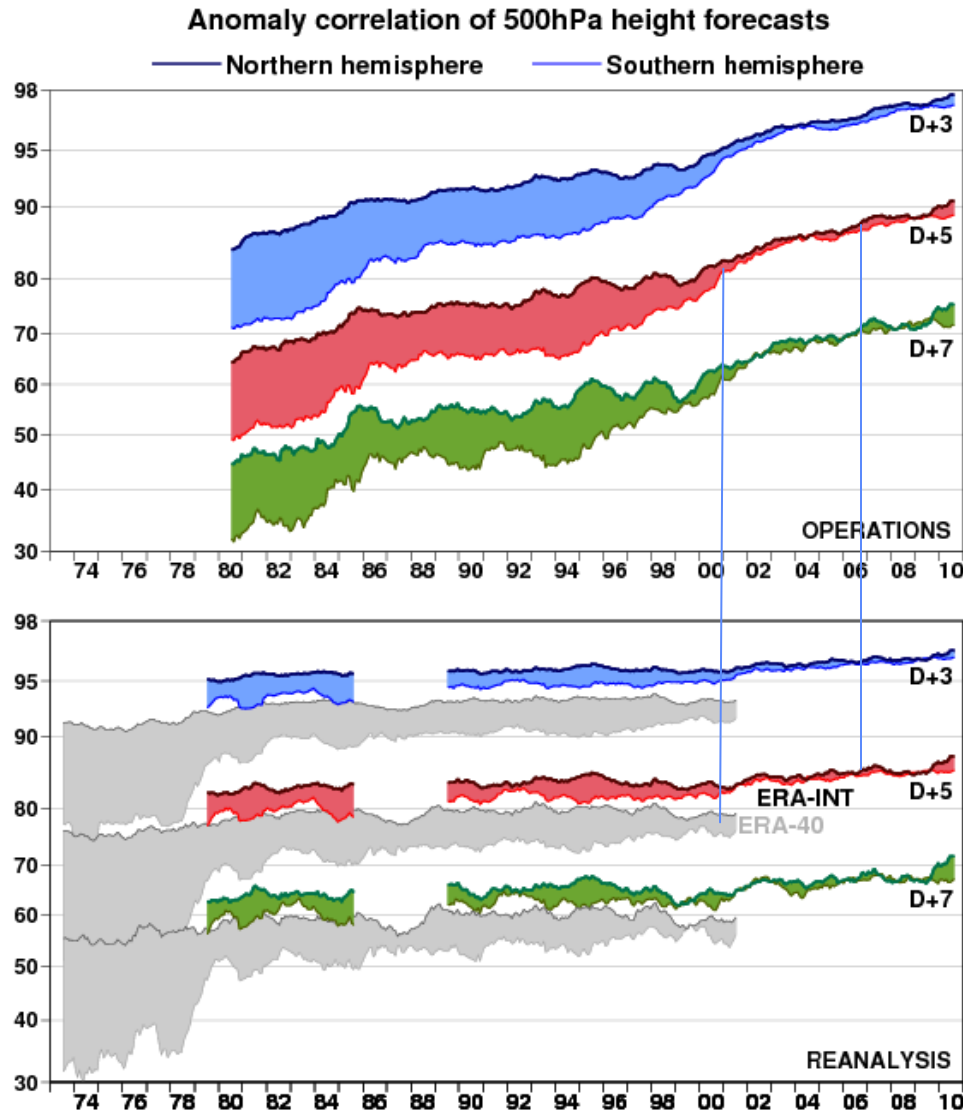
Reanalysis aims to minimize spurious long-term trends by:

- using (in contrast to operational NWP) the same assimilation and forecast system throughout improvements in skill reflect improvements in the observing system,
- consistency checks between data sets and providing bias estimates, where possible.

Applications:

- verification and diagnosis of other NWP models
- Input to other models (e.g., tracer models)
- Providing climatologies
- Assessment of inter-consistency between observing systems
- Study for climate trends, improving
- Resource for climate services
-

Atmospheric reanalysis: ERA-Interim



ECMWF forecasts: 1980 – 2010

Changes in skill are due to:

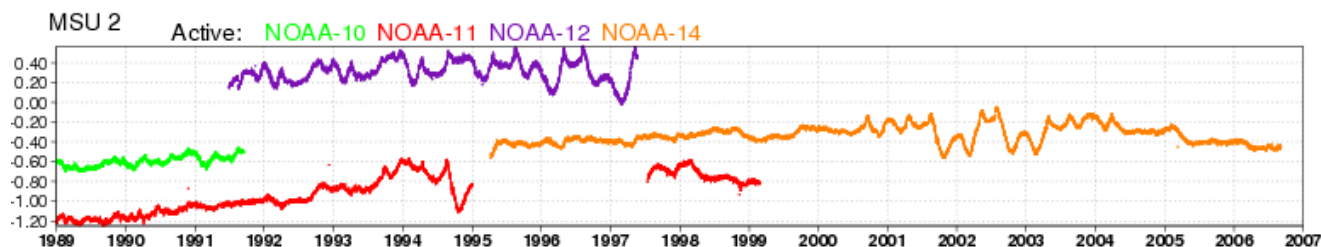
- improvements in modelling and data assimilation
- evolution of the observing system
- atmospheric predictability

ERA-Interim: 1979 – 2010

- uses a 2006 forecast system
- **ERA-40** used a 2001 system
- re-forecasts of more uniform quality
- improvements in modelling and data assimilation outweigh improvements in the observing system

Consistency between data sets: variational bias correction

MSU Ch2 radiance (provides information on tropospheric temperature):
bias [K] as estimated by ERA-Interim,
confirms inter-instrumental biases in the literature



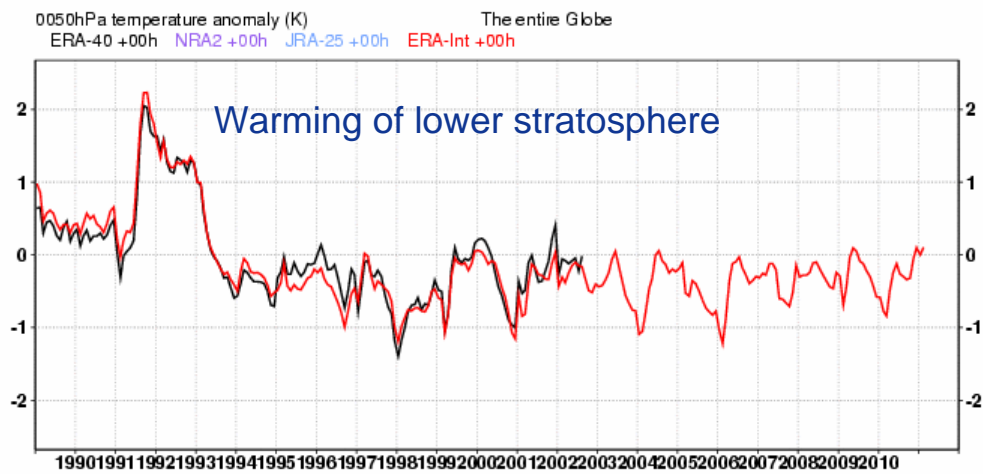
Pinatubo 1991: effect on average global temperature

Although the effect of stratospheric volcanic sulphate was not accounted for :

ERA-Interim signals a correct change in global temperature, supported by:

- the extensive global observing system

ERA-Interim variational bias correction in HIRS water-vapour radiances counter-balance aerosol effect on the radiative transfer mode which was missed in ERA-40



The ERA-CLIM project in more detail

European Reanalysis of Global Climate Observations

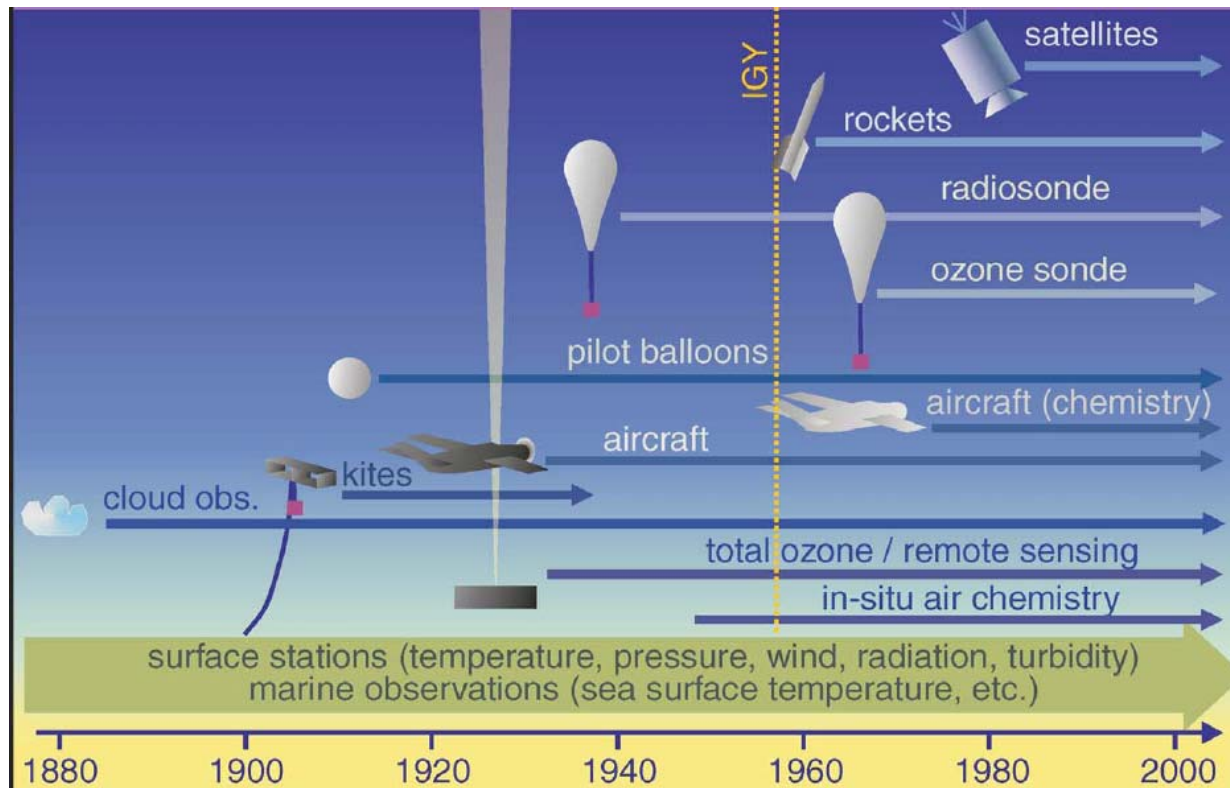
Partners: Met Office, Météo-France, EUMETSAT, Un.Vienna, Un.Bern, Un.Lisbon, RIHMI-WDC (Russia), DMC (Chile), ECMWF

ERA-CLIM is composed of four thematic work packages:

- Development of the observational record for the early 20th century (WPI)
 - Existing data sets (CHUAN, ISPD, ICOADS, ...)
 - Data recovery
- Preparation/collection of (re-processed) satellite observations (WP2)
- Boundary conditions and forcing data (WP2)
 - SST and Sea ice: HadISST2 (*see presentation by John Kennedy, Nick Rayner*)
 - CMIP5 forcing for radiation and surface parametrization
- Development of an Observation Feedback Archive (OFA) (WP3)
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- Assessment and reduction of data uncertainties (WP4)

Building on the 20th century observational network

- Surface data has been available throughout, but initially sparsely distributed
- The **International Geophysical Year (IGY)** marked the start of the extension of the global radiosonde network and data exchange
- The satellite era revolutionized upper-air and stratospheric coverage and general coverage in the southern hemisphere



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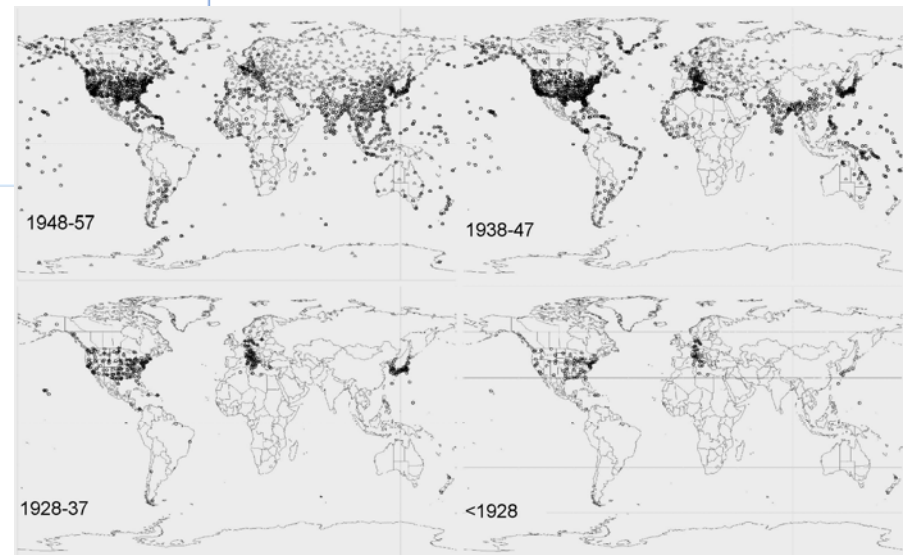
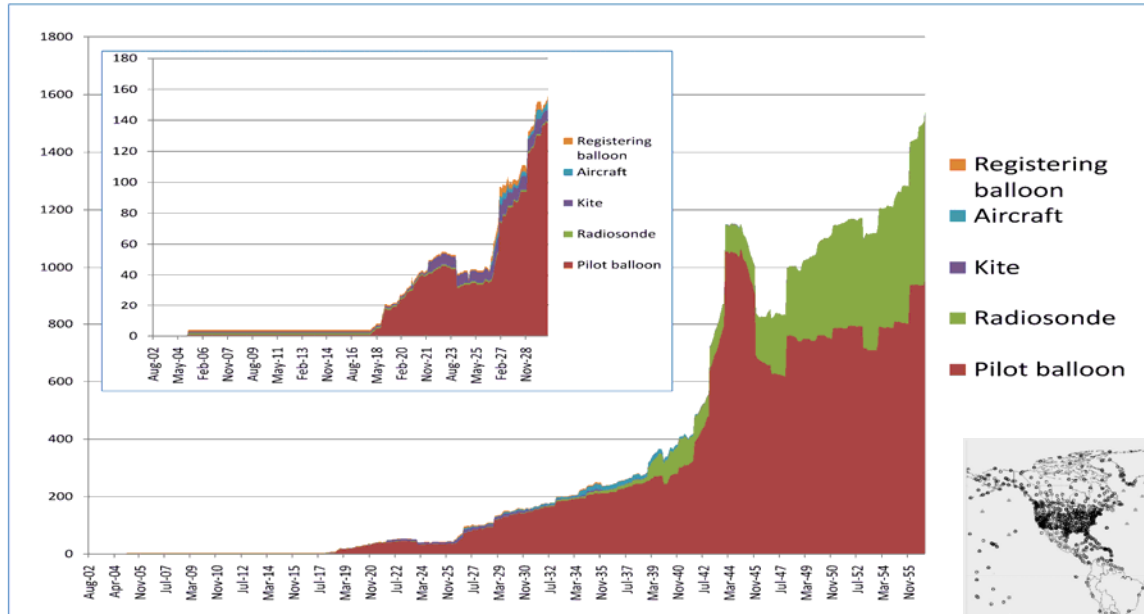
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The CHUAN data set

Comprehensive Historical Upper-Air Network (Stickler et. al. 2009)

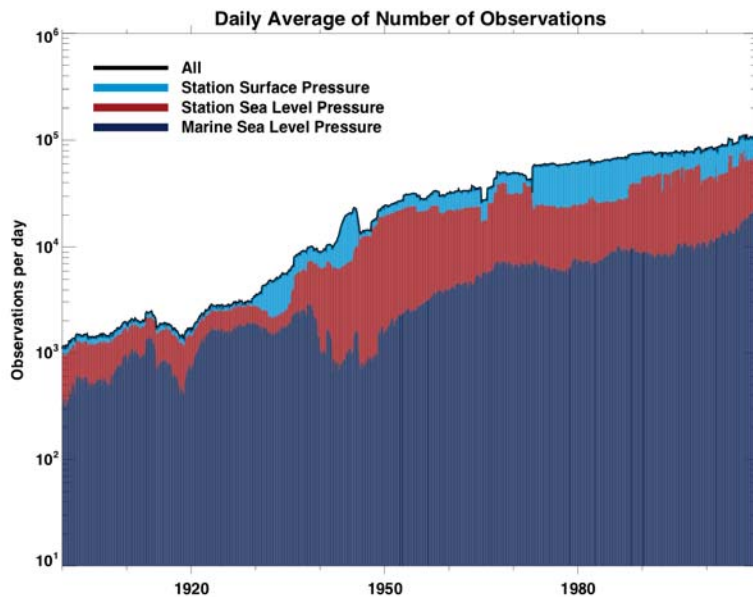


Compiled by University of Bern

- 12.6 million profiles prior to 1958
- 5.3 million prior to 1948
- geopotential height, T, wind, humidity
- to be extended within ERA-CLIM

The ISPD data set

*International Surface Pressure Data bank
(Version 2.2)*

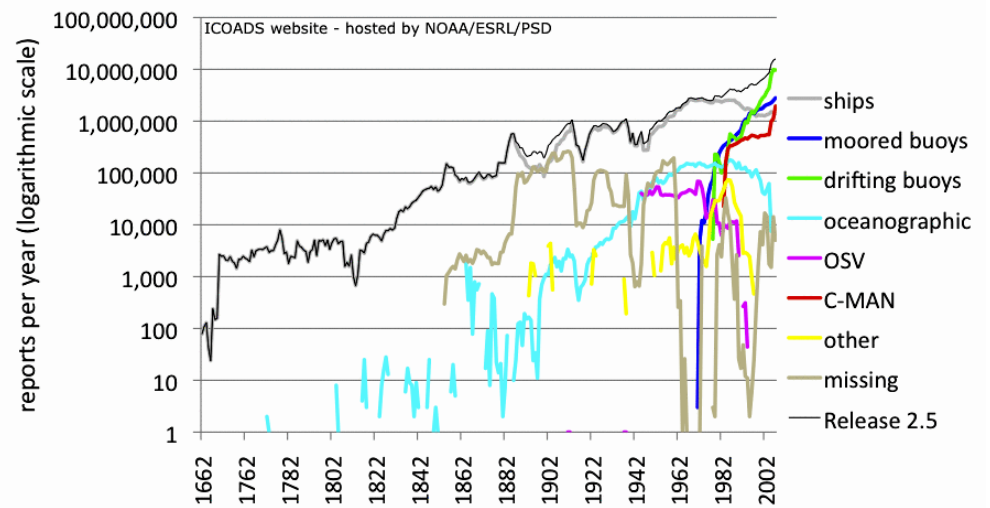


Courtesy :20th Century Reanalysis Project (NOAA/CIRES)

- surface pressure and MSLP
- Includes ICOADS data
- first data set being imported into OFA

The ICOADS data set

*International Comprehensive
Ocean-Atmosphere Data Set*



Courtesy: **ICOADS**

- ERA-CLIM will use MSLP, wind, T2m, Rh2m
- 2nd data set being imported into OFA

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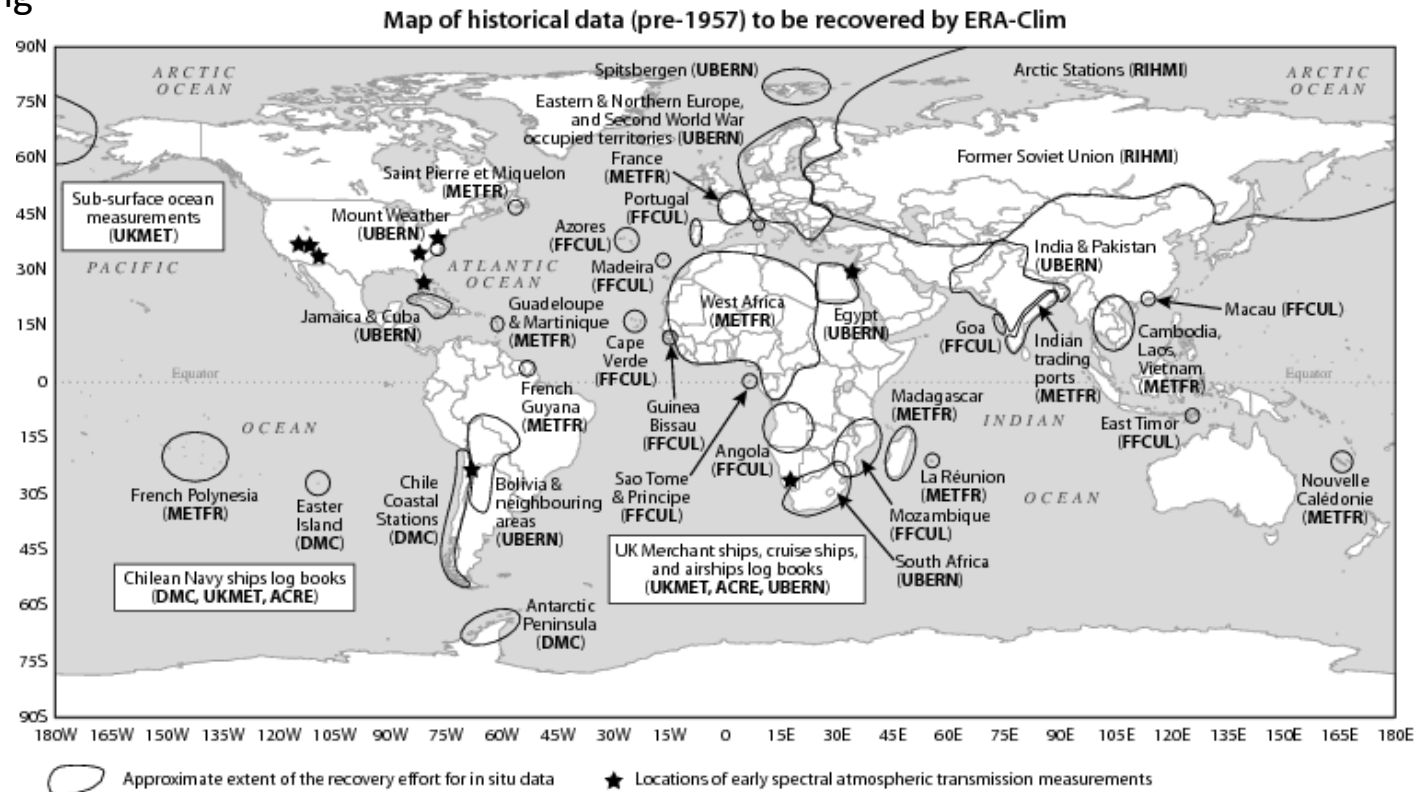
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ERA-CLIM data recovery and digitization

Focus on pre-1957 meteorological data in sensitive regions

Contributions from Met Office/ACRE, Météo-France, Un.Vienna, Un.Bern, Un.Lisbon, RIHMI-WDC (Russia), DMC (Chile)

- Inventories of original paper copies, digitizing tools
- Imaging and digitizing
- Quality control



The ERA-CLIM project in more detail

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CMIP5 forcing for radiation and surface parametrization

Besides boundary conditions at the ocean surface (SST and Sea ice), an atmospheric model relies on a number of input fields, that relate to:

- Radiation

- Solar forcing: total solar irradiance
- Greenhouse gases: CO₂, CH₄, N₂O, CFC-11, CFC-12, ...
- Ozone: is prognostic variable, but *prescribed* inside radiation scheme
- Tropospheric aerosols: sulphate, black carbon, organic, dust, sea salt
- Stratospheric volcanic aerosols: sulphate, dust
- Albedo

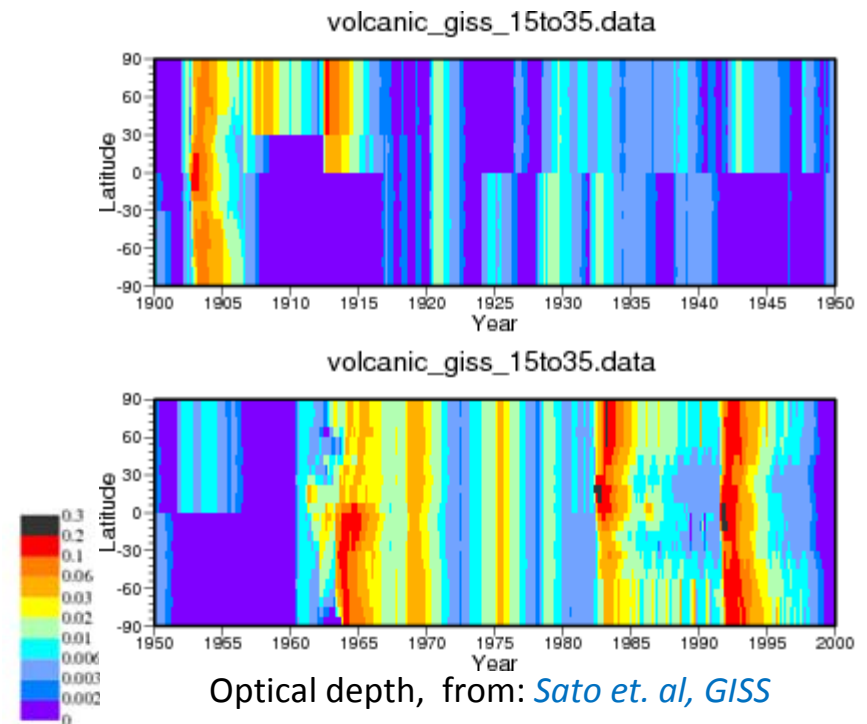
- Surface parametrization

- Vegetation type and cover, LAI,...

- At ECMWF these quantities are prescribed,

but have evolved during the 20th century

- ✓ Incorporate CMIP5-recommended forcing data



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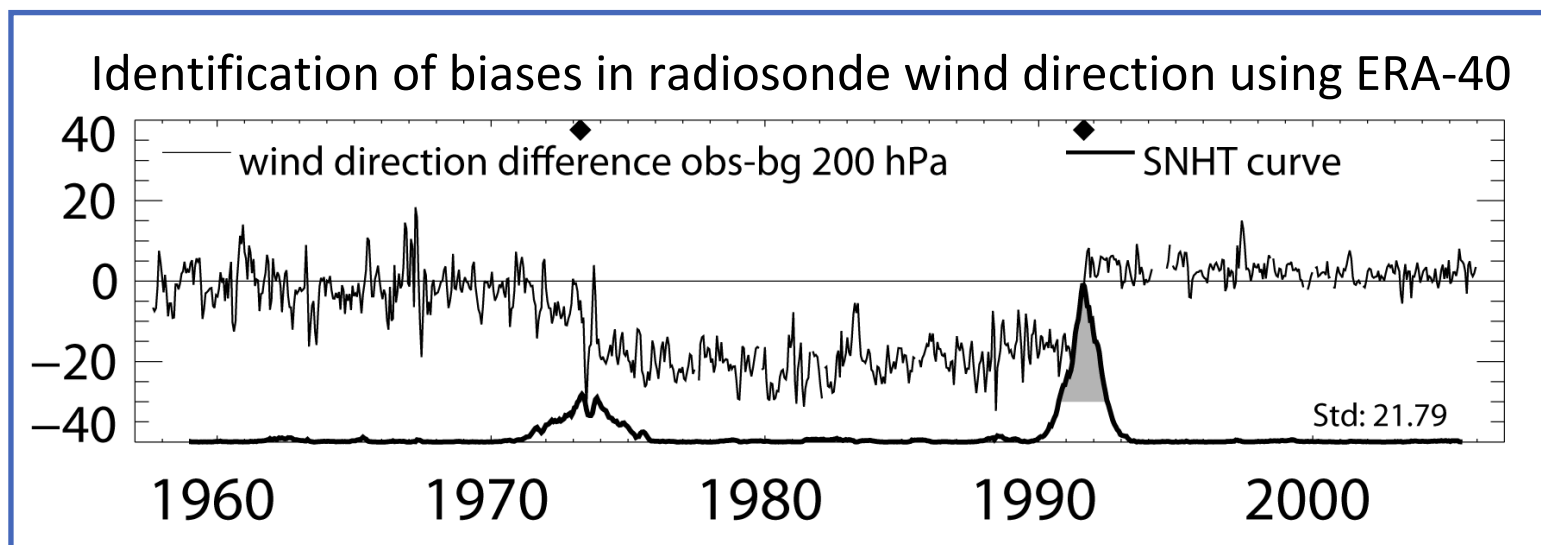
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The observation feedback archive (OFA)

- All data will be placed in a uniform format based on ODB
- Model feedback information is added
 - easy to extract (from MARS archive, query language)
 - easy to use (ODB, NetCDF, ASCII supported)

Model feedback provides powerful information on:

- data quality
 - consistency between various data sets
 - evolving systematic errors
- Accessible via a web interface



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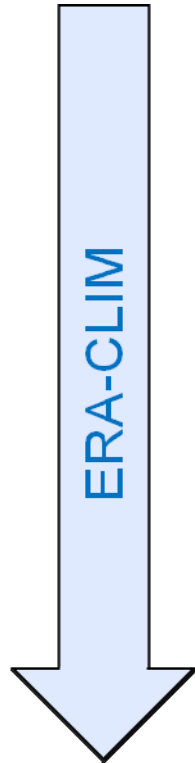
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ERA-CLIM pilot reanalyses

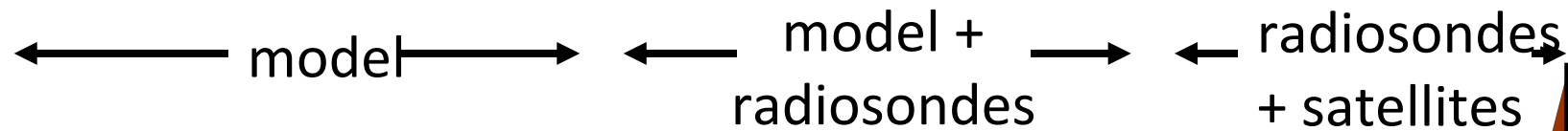


	What	Period	Resolution	Ens	Vol
ERA-Int	Interim reanalysis	1989-NRT	T255L60	1	33 Tb
ERA-20CM	AMIP ensemble	1900-2011	T159L91	10	
ERA-20C	EDA using sfc obs only	1900-2011	T159L91	10	655 Tb
ERA-20C LAND	Land surface using ERA-P1	1900-2011	T799	1	77 Tb
ERA- PRESAT	Reanalysis using all obs	2 early decades	T159L91	10	180 Tb
ERA-SAT	To replace ERA-Interim	1979-NRT	T511L91	1	234 Tb
ERA-?	20 th -century reanalysis	1900-NRT	T511L91	1	1062 Tb

Concluding remarks

- All new ERA products to be freely available from now on
 - ERA-Interim full-resolution data server going live soon
- The ERA-CLIM project is a FP7-EU funded project running from 2011-2013.
- A large effort is being made in data recovery and digitization :
 - **pre-1957 upper-air** data, and **surface observations in sparsely observed areas**
 - this effort will contribute to the existing ICOADS and CHUAN data sets
- ERA-CLIM will use **HadISST2** (*see presentation by John Kennedy*)
- All observations will be held in a newly developed observation feedback archive
- Some requirements from reanalysis
 - Data set versioning and source identification
 - Traceability of individual observations (duplicates,...)
 - ERA needs multivariate sub-daily observations
 - Any available information on quality
 - Open data policy

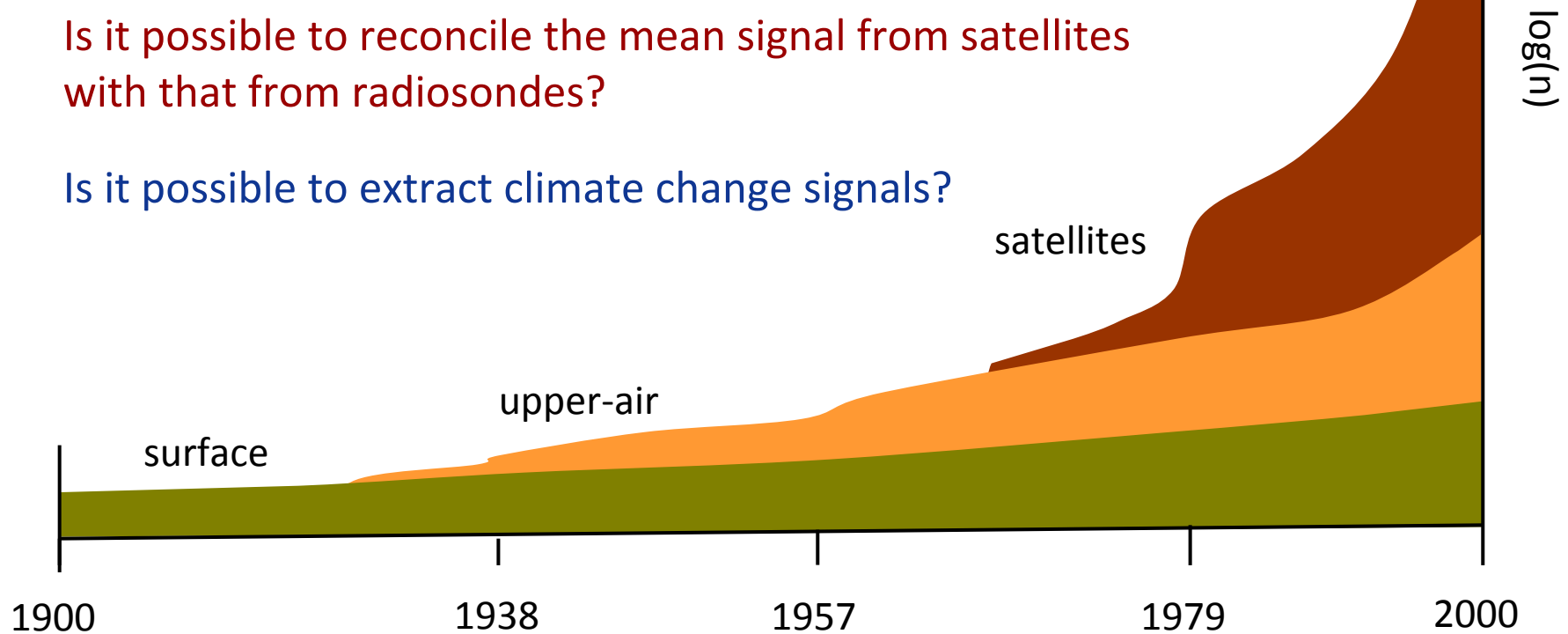
Tropospheric mean temperatures controlled by:



Accurate trend estimates require consistency among the major components of the observing system

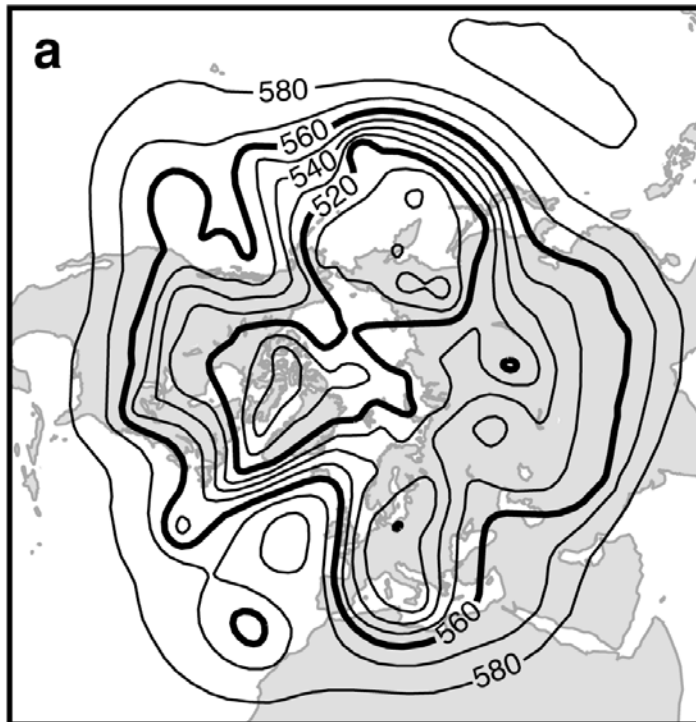
Is it possible to reconcile the mean signal from satellites with that from radiosondes?

Is it possible to extract climate change signals?

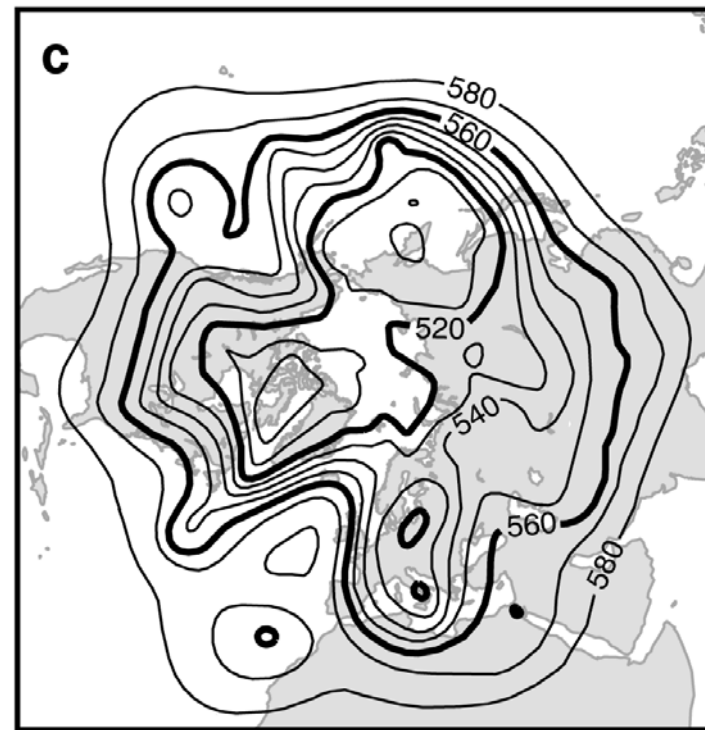


What we can do with sparse observations:

4D-Var analysis of the **500hPa geopotential height** surface
0 UTC, 15 February 2005



using all available
observations



using **surface pressure**
observations only