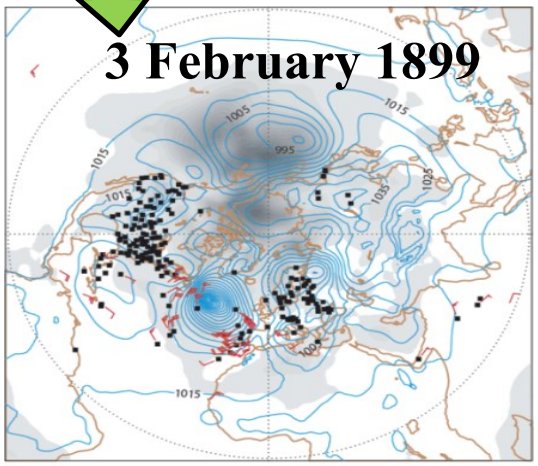
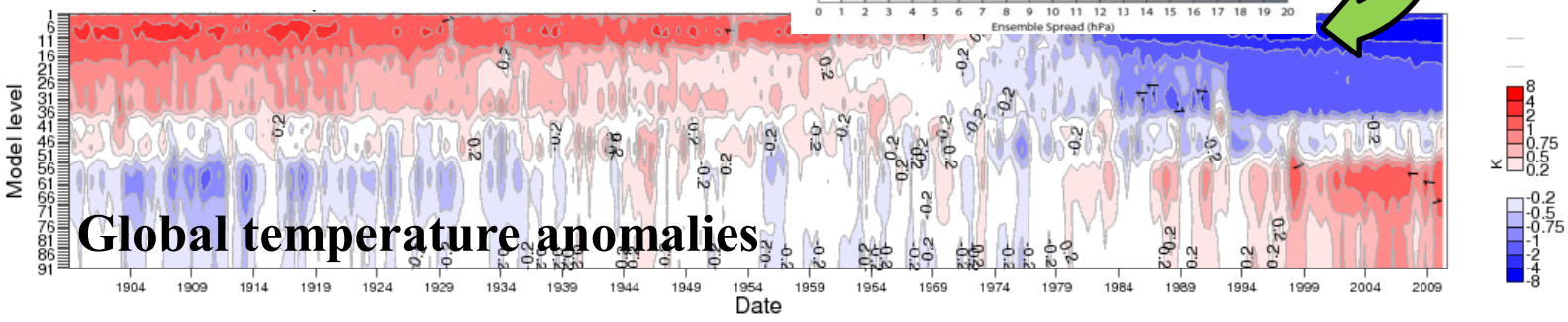
The usage of feedback information in the ERA-20C reanalysis

Hans Hersbach, Paul Poli, Dick Dee and reanalysis team

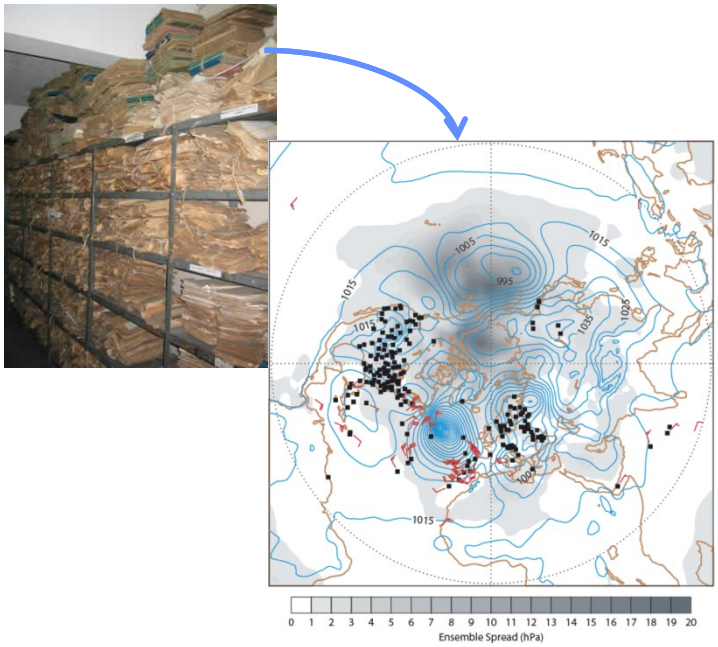




The ERA-CLIM project

EU FP7 funded

Goal: Preparing input observations, model data, and data assimilation systems for a global atmospheric reanalysis of the 20th century



Main components:

1. **Data rescue** efforts (in-situ surface, upper-air)
2. **Atmospheric boundary conditions** (SST, sea ice), forcing data (solar, ozone, aerosols), satellite reprocessing
3. Conducting a number of **20th century pilot reanalyses**
4. Use of **reanalysis feedback** to improve the data record
5. Provide **access** to reanalysis data and observation quality information

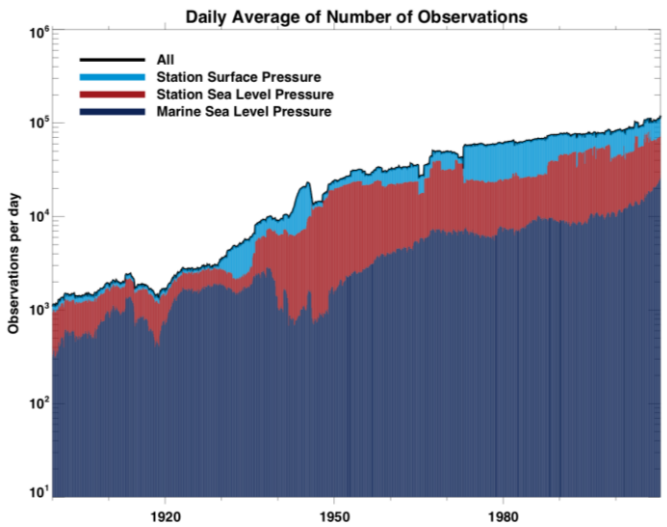
The ERA-20C pilot reanalysis

Inspired on the NOAA/CIRES 20CR reanalysis

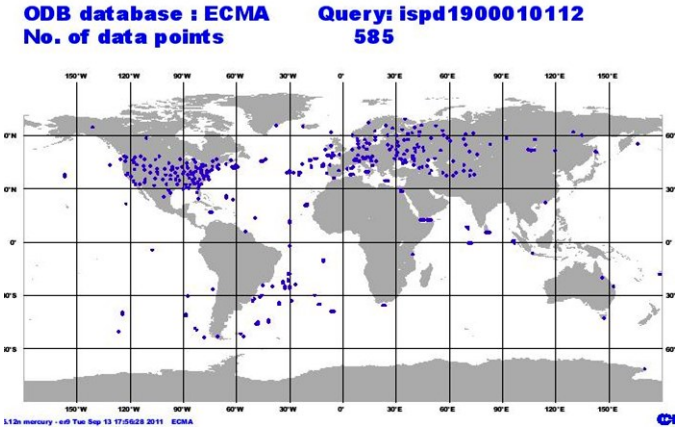
- ✓ **1899 - 2010**
- ✓ **Usage of synoptic pressure and wind** from **ICOADS** and **ISPD** (~1.5 Billion obs)
- ✓ **Variational bias correction for pressure observations**
  - based on ***break-point*** analysis from **20CR** feedback information
  - minimize the dependency between reanalyses.
- ✓ CMIP5 forcing and HadISST2 SST and sea-ice forcing

The ISPD data bank

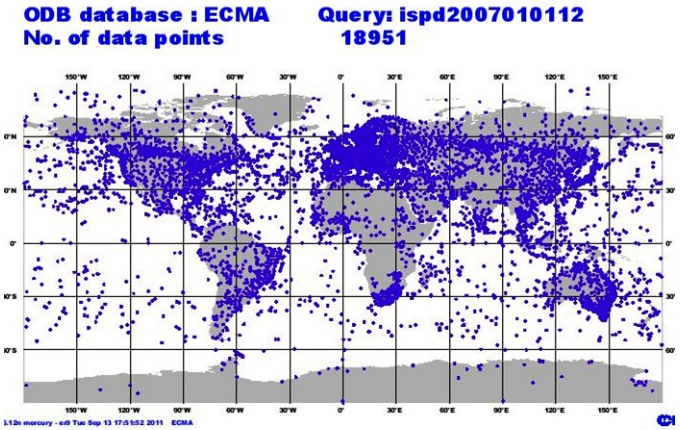
International Surface Pressure Data bank (Version 2.2)



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



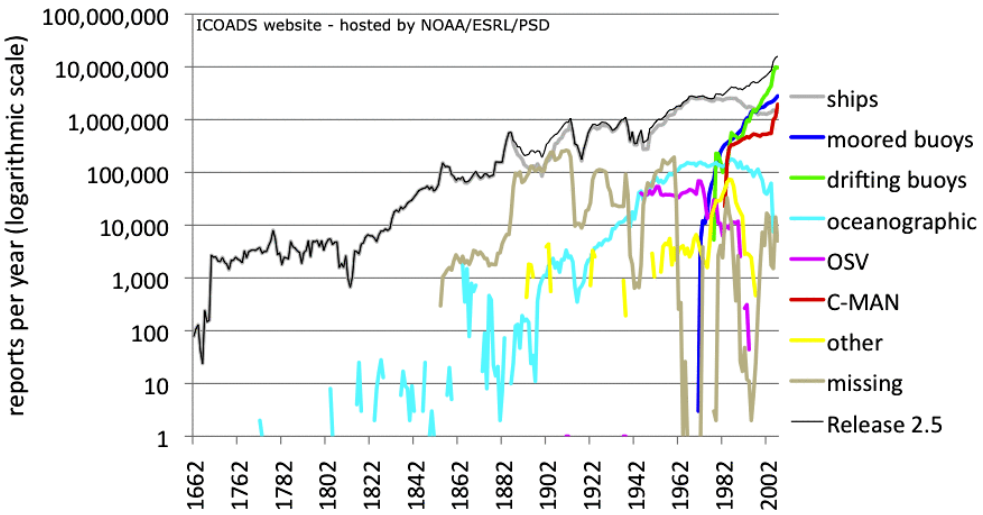
The observation network has evolved quite a bit



- surface pressure and MSLP
- 1.4 Billion observations from 1768 – 2008
- Many collections
- Contains feedback info from ***20CR***
- ***We used Version 3.2.6; created our feedback from off-line collocation 20CR***

The ICOADS data set (R2.5.1)

International Comprehensive Ocean-Atmosphere Data Set



Courtesy: ICOADS, Scott Woodruff

- 350 million reports, 1662-2011;
- MSLP, Pressure tendency, wind, T2m, WBT, Dew point T, SST, ocean wave height, period, present/past weather, visibility, clouds, …
- MSLP already in ISPD
- Many collections (DECKS)
- No feedback information in ICOADS; but we perform an offline collocation with **20CR**, instead.

Importing of ISPD and ICOADS into ODB-2 and MARS

From native format (hdf5, IMMA) using dedicated programs.

Mapping of information is the most non-trivial part.

Introduction of some new ODB-2 columns to facilitate stratification.

- **Source**: ISPD 3.2.6, ICOADS 2.5.1
- **Collection identifier**: each source assembled data records from various origins. For example, collection number 761 in ICOADS 2.5.1 contains
  "Japanese Whaling Ship Data (CDMP/MIT digitization)"
- **Unique identifier**: each source has its own way of defining this variable. It is usually a number which needs to be used along with something else (observation date and time for example)
- **Timeseries_index**: added by us, allows later to pull out easily a single station time-series, across the entire observation feedback archive

Need for platform tracking

In situ network: bias depends on history of a specific platform/station.

- ISPD and ICOADS contain more than **1 Million** platforms (mostly SHIPS)
- distinguished by ***station id*** or ***call sign***:

The top 4 consists of **ICOADS** data for which no information on call sign is available

statid	collection_id	Nobs	First date, lat, lon				Last date, lat, lon			
????????	000104	24,227,426	19520101	219900	57.90	345.80	20021216	129900	11.50	81.49
????????	000105	9,857,296	18000204	169900	-51.50	302.50	19741211	099900	59.60	1.50
SHIP	000104	3,389,093	19700101	009900	71.20	35.10	20061231	189900	-35.50	138.20
MASKSTID	000105	1,331,515	20071201	009900	83.00	97.60	20081231	239900	60.60	3.70

Need to find a way to split such platforms/stations: timeseries index

- ✓ For each call signs, start with one subgroup
- ✓ Create new subgroup if an observation had to move by more than 50 m/s
- ✓ However, allow for minimal distance of 200 km.

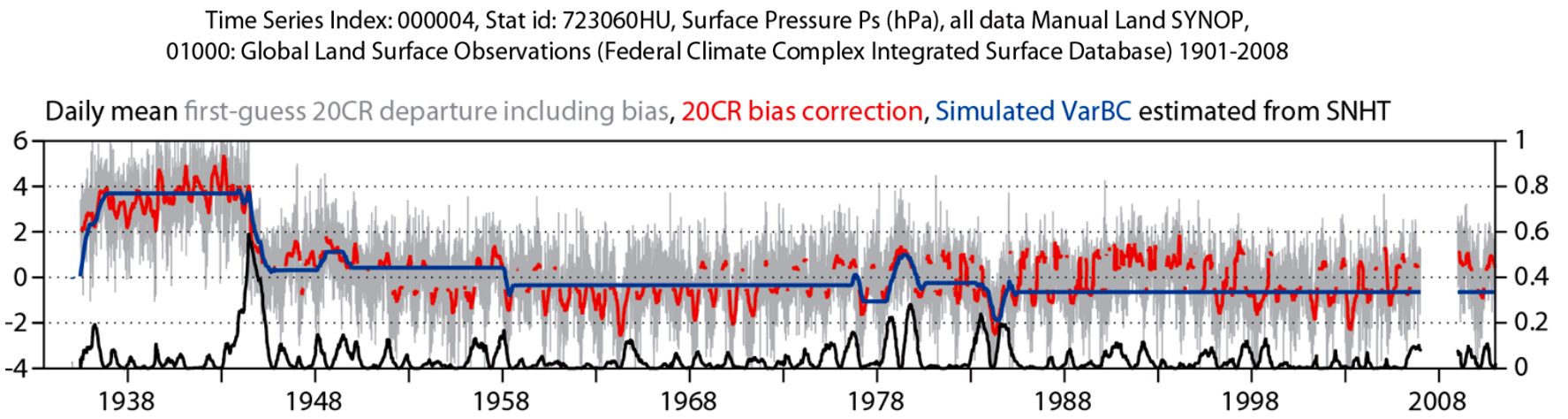
Variational BC using break-point analysis

Perform VarBC on platform level

- Has to be rigid; otherwise the signal is taken away from the observations

Build on feedback information from 20CR (ISPD *and* ICOADS)

- detect break points in advance, create quantity: ***bias volatility*** (=normalized SNHT)



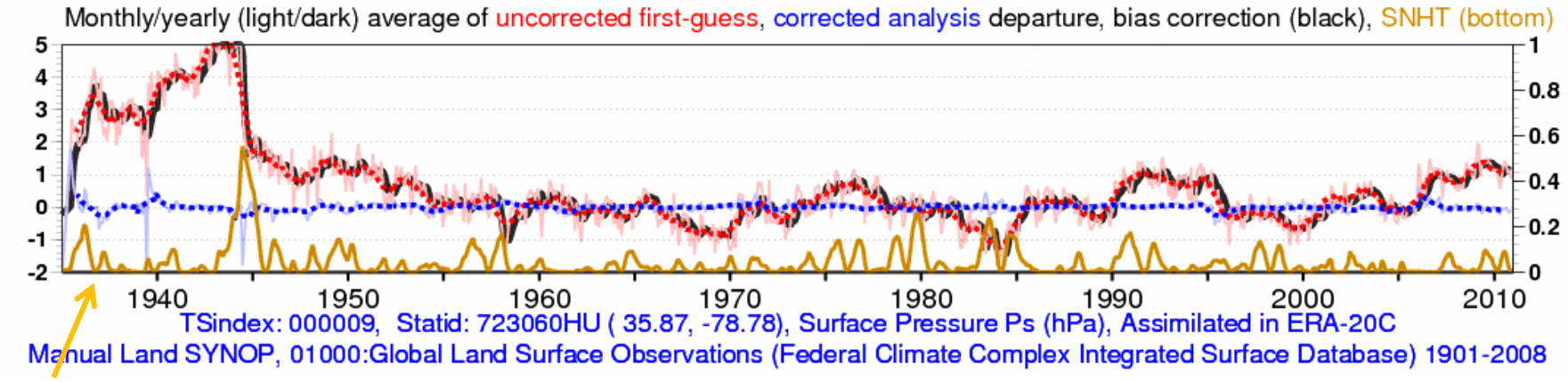
Standard Normal Homogeneity Test (SNHT)

- Used e.g., by ***Haimberger (2005)*** for homogenization of radiosonde data
- Expresses the difference in long-term average departures ***before*** and ***after*** an observation.

- Let the response time of **VarBC** depend on the history of the ***bias volatility***

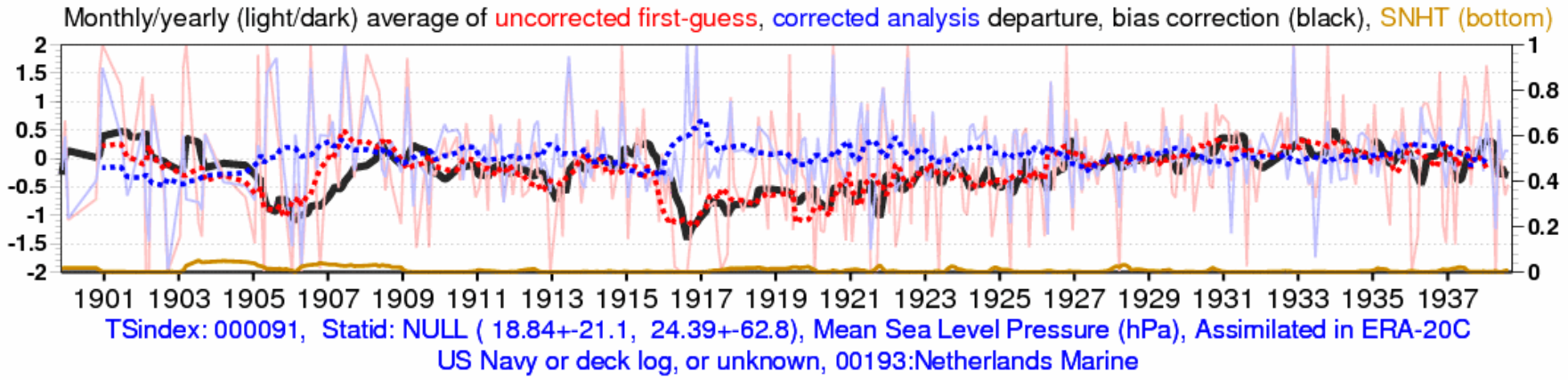
Applied VarBC in ERA-20C

Raleigh-Durham International Airport (NC)



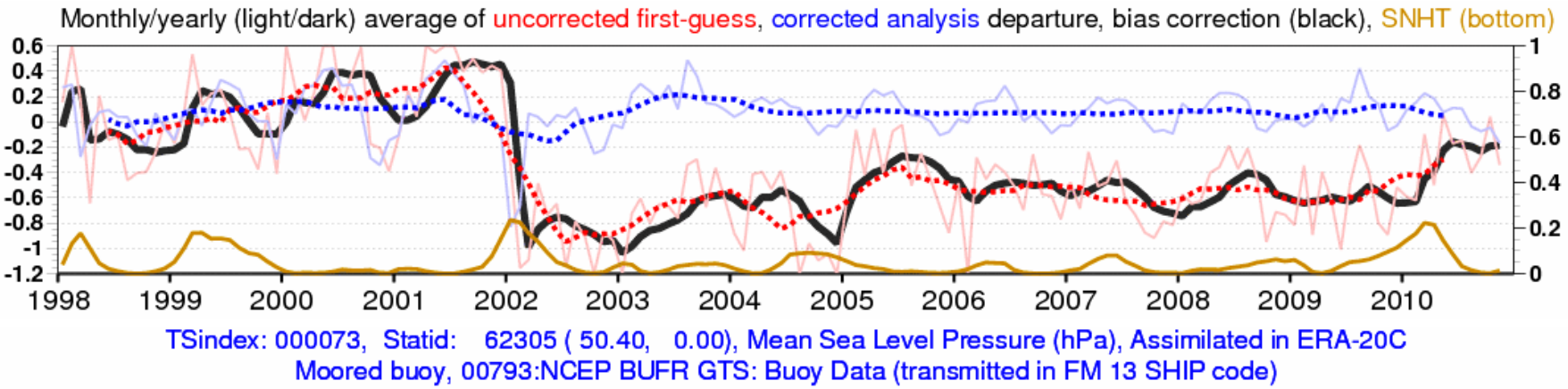
From 20CR

Unknown SHIP

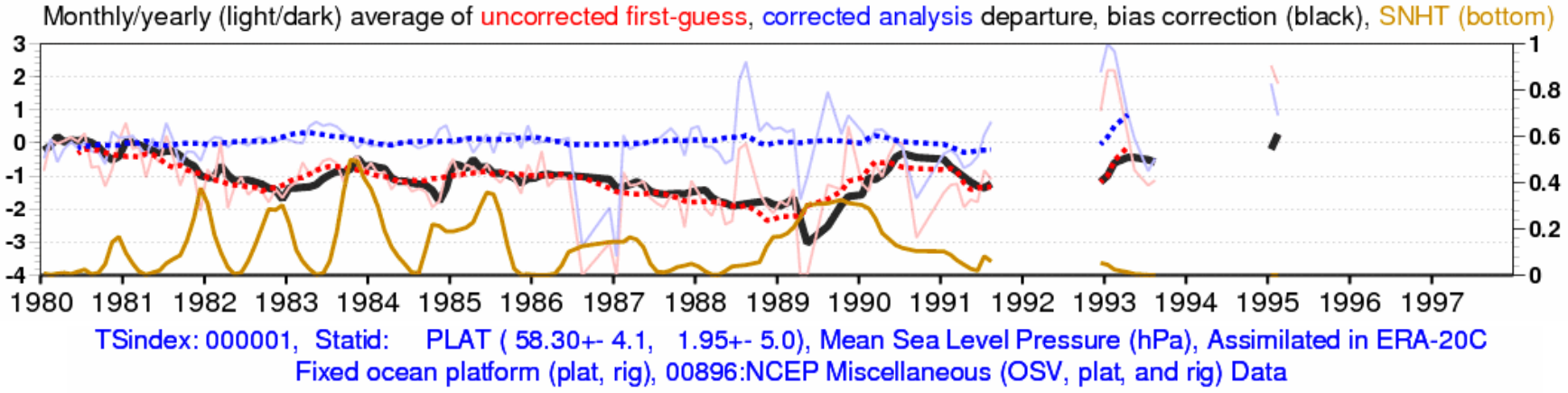


Applied VarBC in ERA-20C

Moored Buoy



Platforms and Rigs

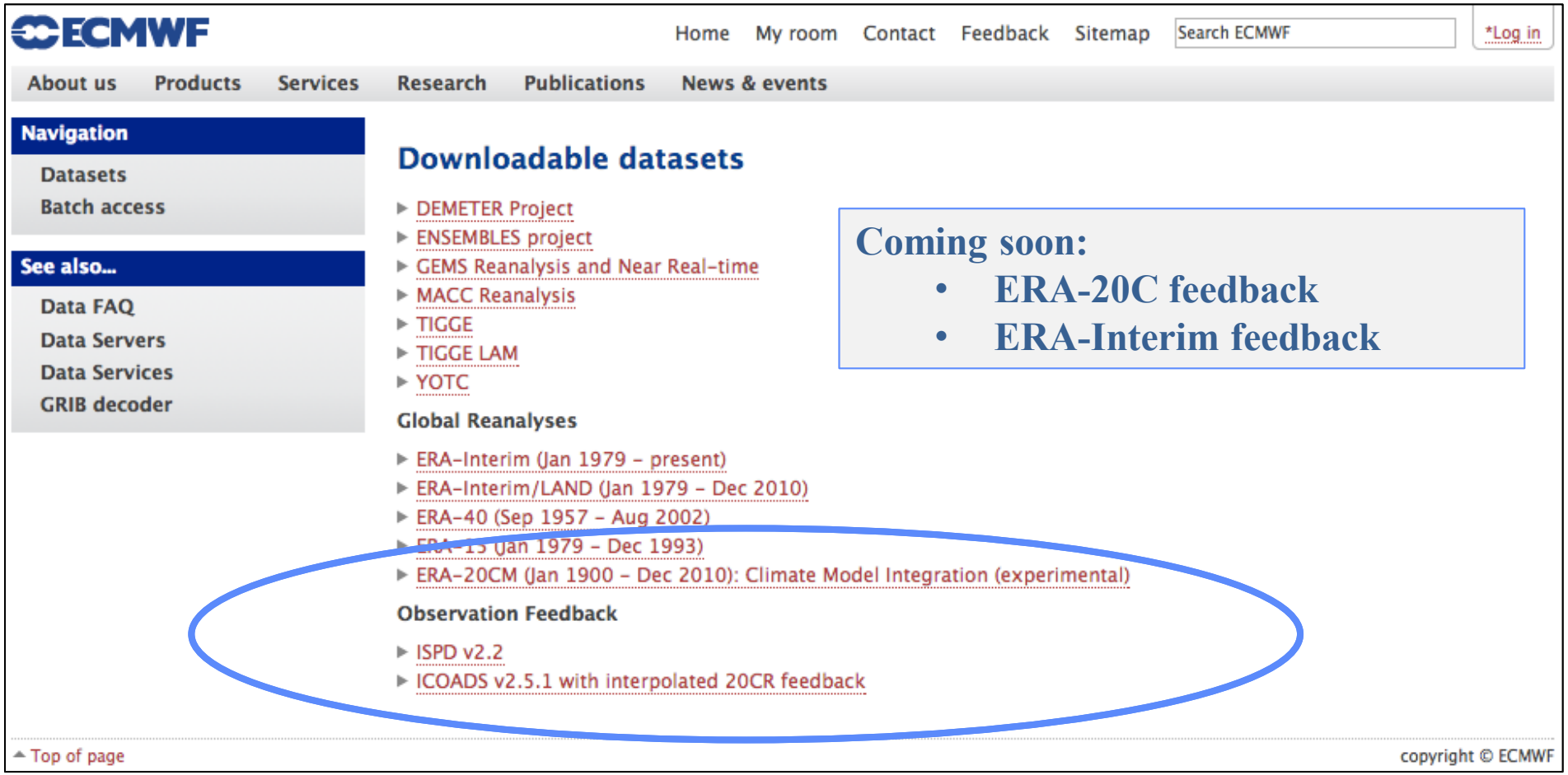


Access to reanalysis data and observation quality information

Observation feedback archive (OFA)

- Based on data format used at ECMWF: **ODB**
  - ✓ One row per observation, not per report
  - ✓ Is, therefore, flexible
- On ECMWF data server
- Contains ***valuable* feedback** information:
  Quality control, model departures, bias estimates, traceability,…

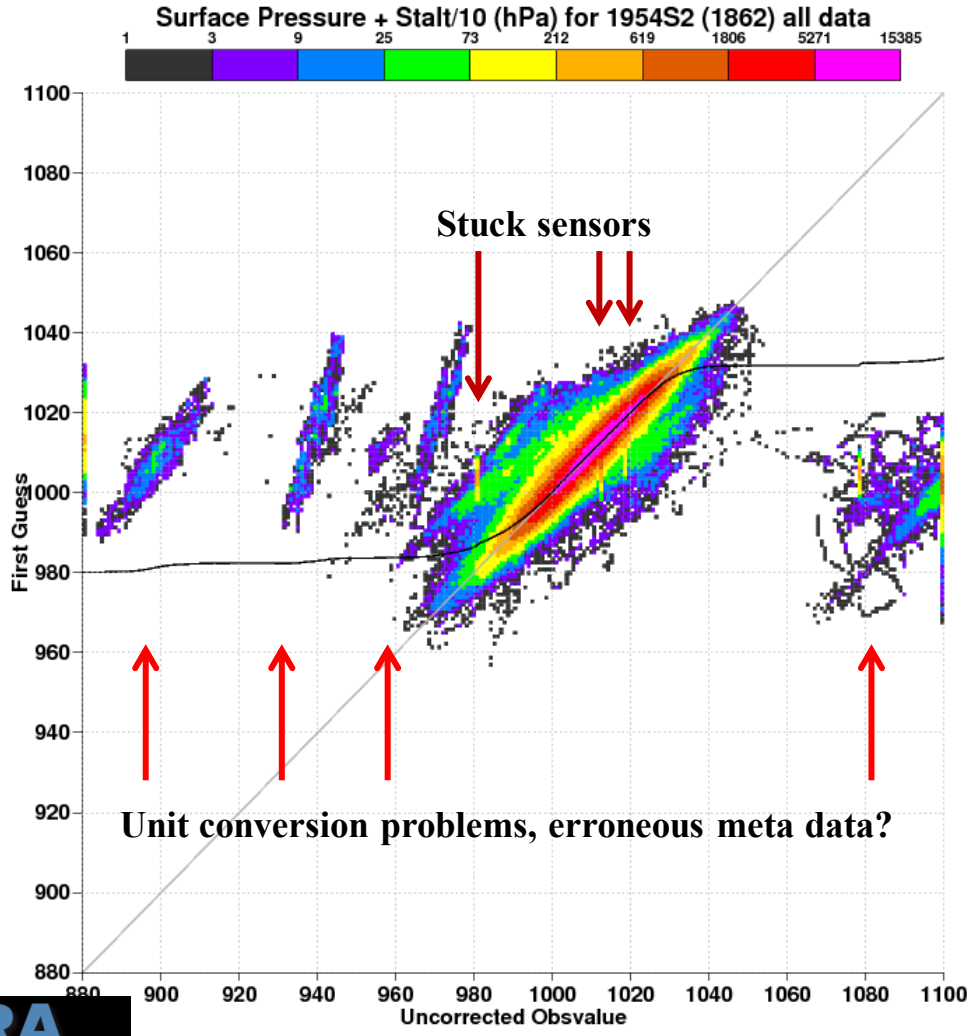
Data server at http://apps.ecmwf.int/datasets/



Coming soon:

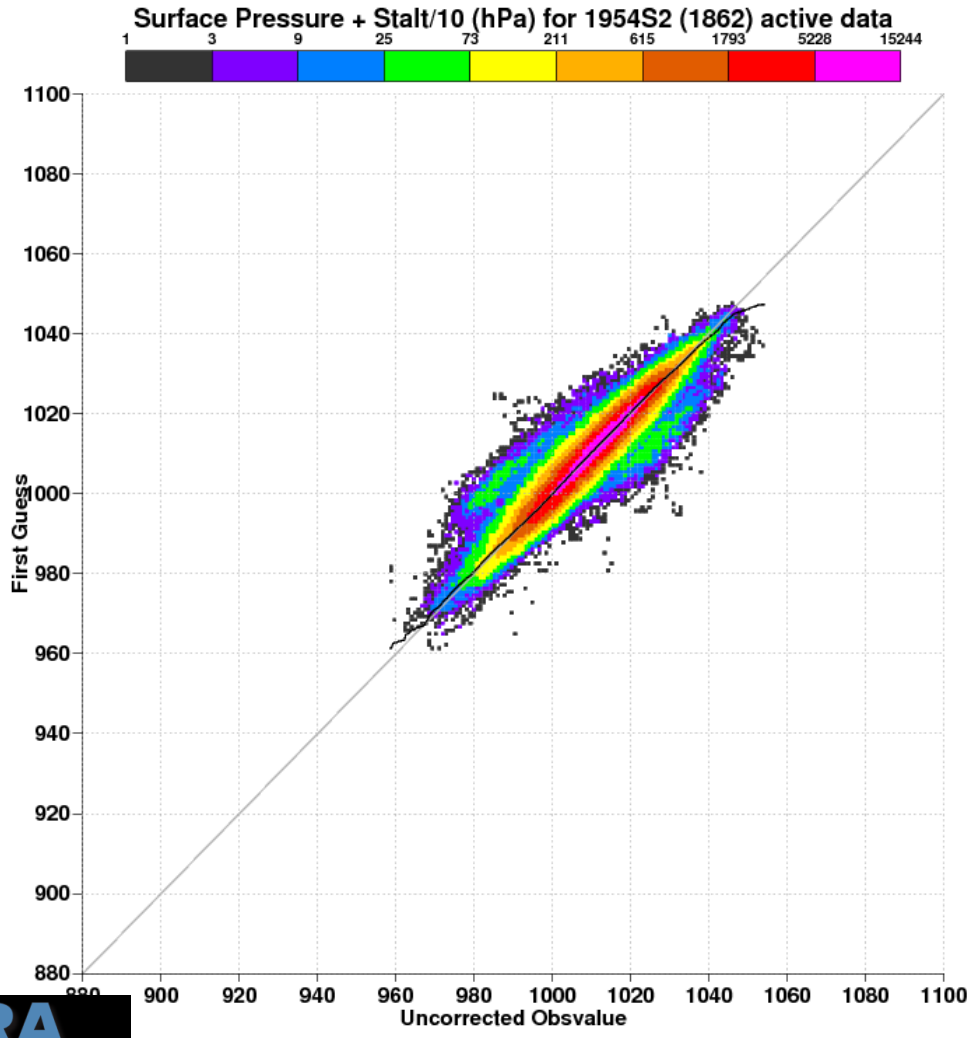
- **ERA-20C feedback**
- **ERA-Interim feedback**

Feedback: Quality control **ERA-20C *all data***



Number of collocations:		1989418
Y-X Mean, stdv:	-0.003	15.675
X Mean, stdv:	1010.623	17.344
Y Mean, stdv:	1010.620	9.379

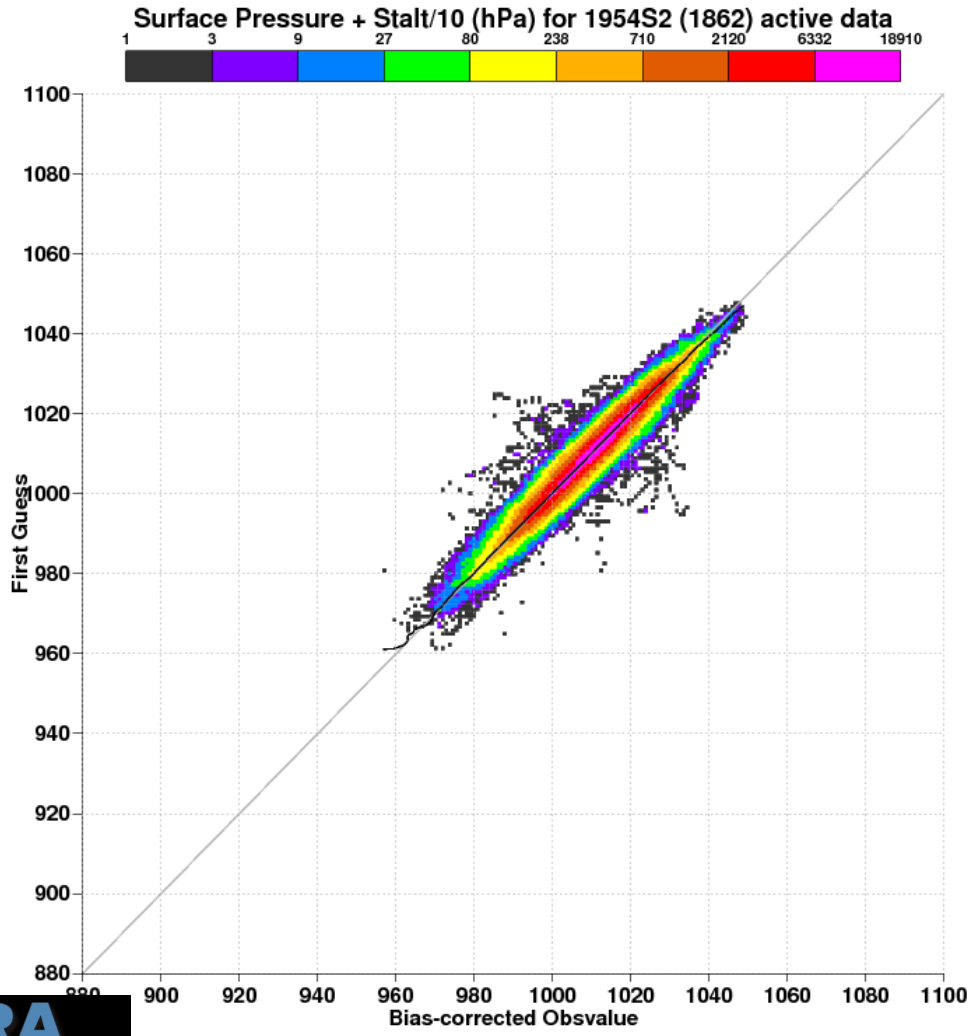
Feedback: Quality control **ERA-20C** ***after screening***



Number of collocations:		1910905
Y-X Mean, stdv:	0.261	2.652
X Mean, stdv:	1010.466	9.303
Y Mean, stdv:	1010.728	9.364

Feedback: Quality control

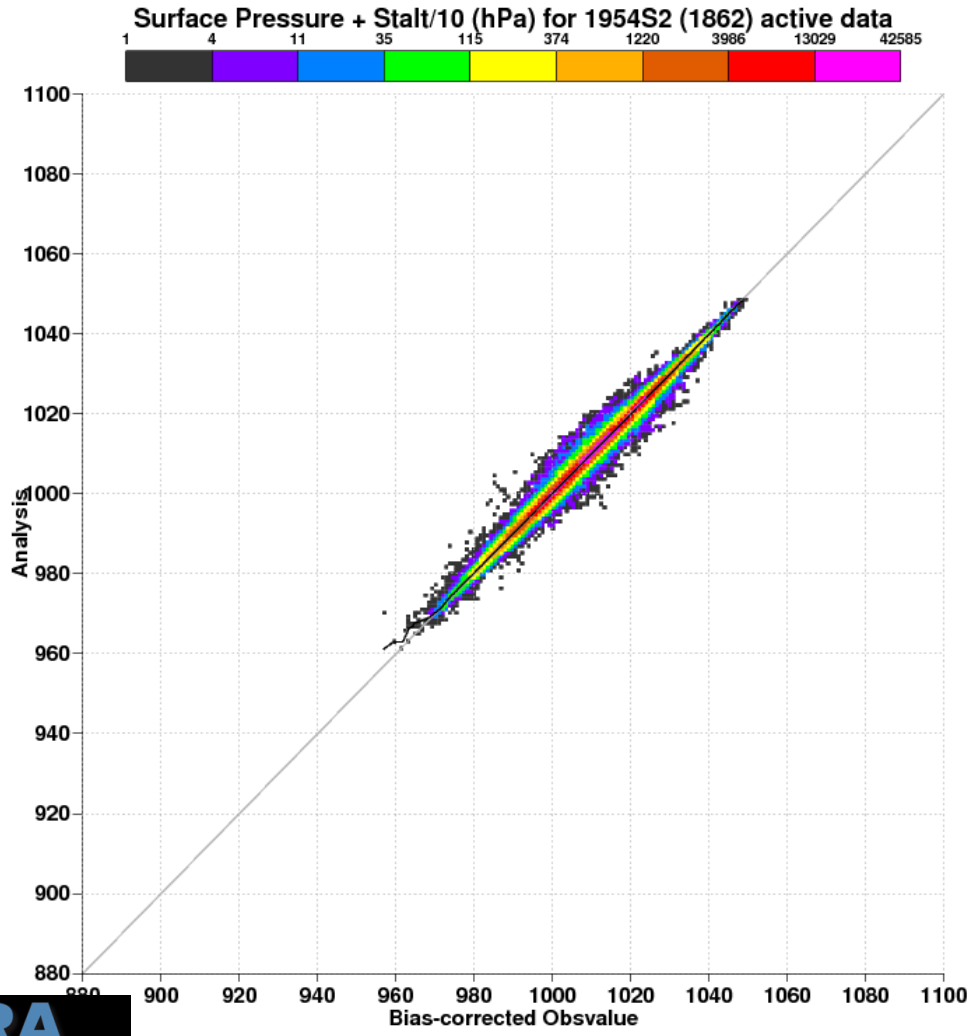
ERA-20C *Bias Correction*



Number of collocations:	1910905	
Y-X Mean, stdv:	0.172	2.001
X Mean, stdv:	1010.556	9.388
Y Mean, stdv:	1010.728	9.364

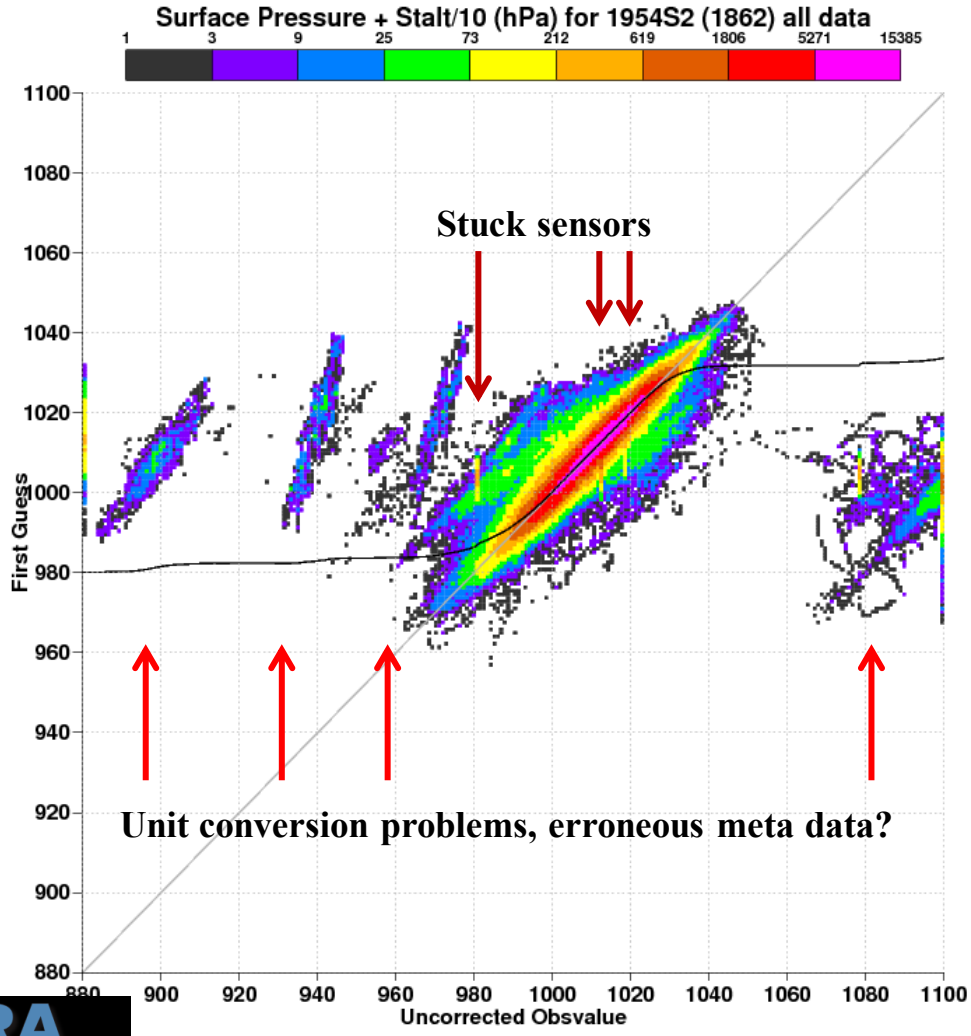
Feedback: Quality control

ERA-20C *after assimilation*



Number of collocations:	1910905	
Y-X Mean, stdv:	-0.008	0.752
X Mean, stdv:	1010.556	9.388
Y Mean, stdv:	1010.547	9.329

Feedback: Quality control **ERA-20C *all data***

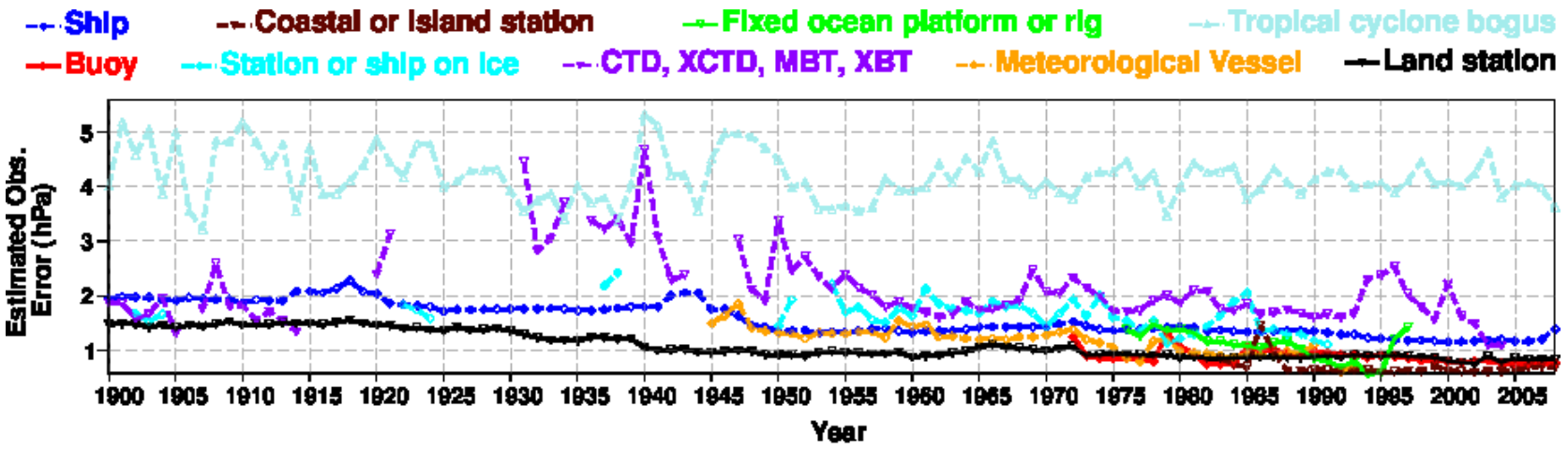


Number of collocations:		1989418
Y-X Mean, stdv:	-0.003	15.675
X Mean, stdv:	1010.623	17.344
Y Mean, stdv:	1010.620	9.379

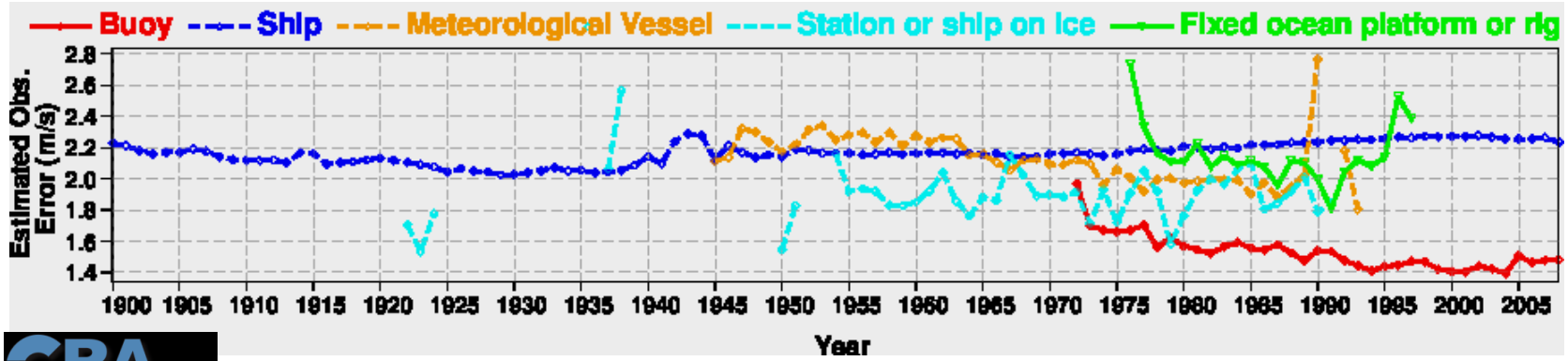
Feedback: estimates on observation error *(Desrosier et. al)*

from (model-obs) departure statistics

Pressure



Wind



Final remarks

Method of VarBC using Break point analysis appears rather robust

- **the dependency on previous reanalysis (20CR) is minimized**

Feedback information contains important information on the observations:

- **Detection of erroneous data or meta data**
- **Bias and random error estimates**

During ERA-CLIM some odb-2 (diagnostic) tools have been created:

- command-line utility for **density plot** between any columns from any ODB-2 file (as shown in this presentation)
- Command-line utility for **animations** from any set of ODB-2 files