

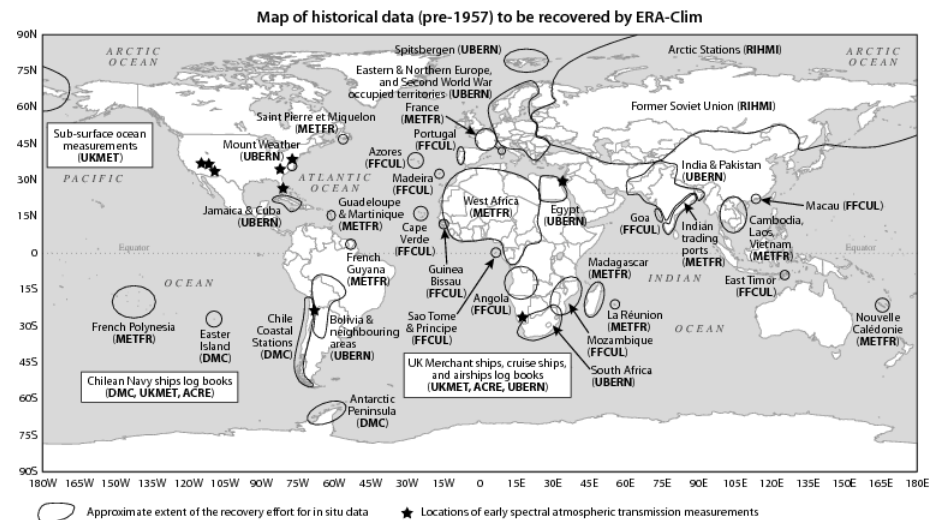
Observations and forcing data for the ERA-CLIM project

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ECMWF

Overview

- ERA-CLIM
- Forcing data
- Observation data banks
- Final remarks



ERA-CLIM

European Reanalysis of Global Climate Observations

A three-year FP7 EU-funded project (2011-2013)

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 reprocessed **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
 - to prepare for the **next comprehensive ERA** reanalysis.
- **Partners:** Met Office, Météo-France, EUMETSAT, Un.Vienna, Un.Bern, Un.Lisbon, RIHMI-WDC (Russia), DMC (Chile), ECMWF

ERA-CLIM pilot reanalyses



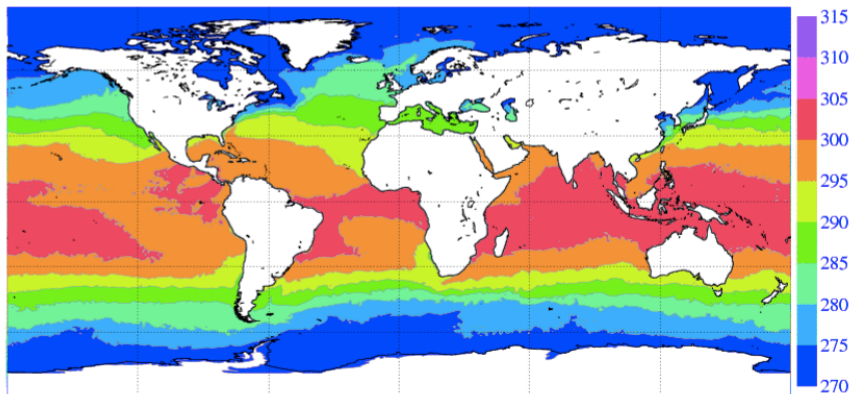
	What	Period	Resolution	Ens
ERA-Int	Interim reanalysis	1979-NRT	T255L60	1
ERA-20CM	AMIP ensemble	1900-2011	T159L91	10
ERA-20C	EDA using sfc obs only	1900-2011	T159L91	10
ERA-20C LAND	Land surface using ERA-P1	1900-2011	T799	1
ERA- PRESAT	Reanalysis using all obs	2 early decades	T159L91	10
ERA-SAT	To replace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

- The first pilot reanalysis using observations (**ERA-20C**) focuses on *surface observations*
- A proper *long-term evolution* of *forcing fields* is important for all pilot reanalyses

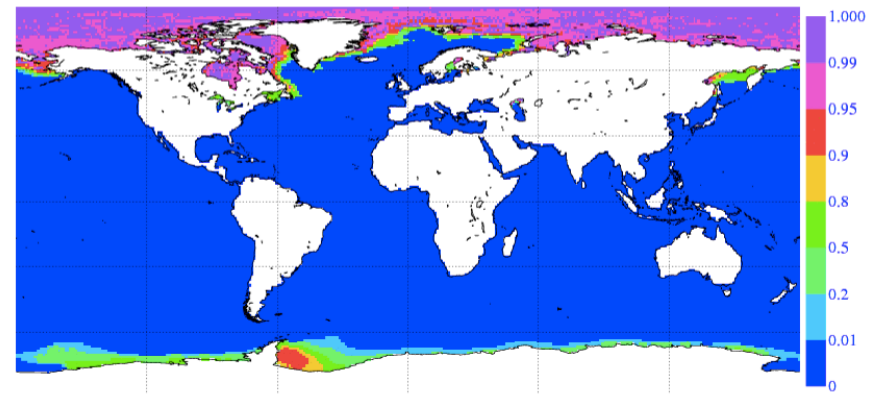
Boundary conditions and forcing data

Sea-surface temperature and sea-ice cover from HadISST2

Sea surface temperature (139), 5 March 1899, HadISST2
MEAN: 291.09 MAX: 304.92 MIN: 271.35



Sea-ice cover (31), 5 March 1899, HadISST2
MEAN: 0.045 MAX: 1 MIN: 0

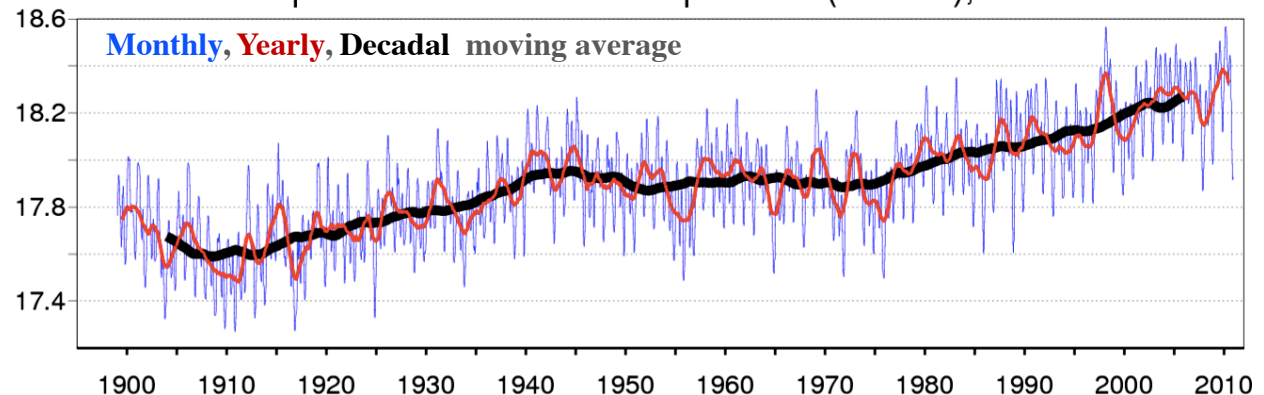


Produced by the *Hadley Centre* (follow-up of HadISST1, *Rayner et al. 2003*)

- **1899-2010**, 0.25-degree gridded daily fields
- Data: in situ ICOADS, Met Office database, AVHRR pathfinder (1985-2007), ATSR2 and AATSR (1995-2011)
- **Ensemble**: 10 equally likely realizations; spread largest in
 - data void areas
 - dynamically active areas



HadISST2 prelim. Sea Surface Temperature (Celsius), Area=GLOBE



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 and surface parametrization:

- ✓ **Solar forcing:** total solar irradiance (constant)
- ✓ **Greenhouse gases:** CO₂, CH₄, N₂O, CFC-11, CFC-12, ... (seasonal, GEMS reanalysis; global trends GISS)
- ✓ **Ozone:** is prognostic variable, but *prescribed* inside the ECMWF radiation scheme (seasonal, GEMS reanalysis)
- ✓ **Tropospheric aerosols:** sulphate, black carbon, organic, dust, sea salt (seasonal fields, Tegen et. al., 1997)
- ✓ **Stratospheric volcanic aerosols:** sulphate, dust (time independent profile, Tanre et. al. 1984)
- **Albedo** (seasonal fields from MODIS, Schaaf et.al. 2002)
- **Vegetation type and cover** (time independent GLCC)
- **LAI** (seasonal MODIS)

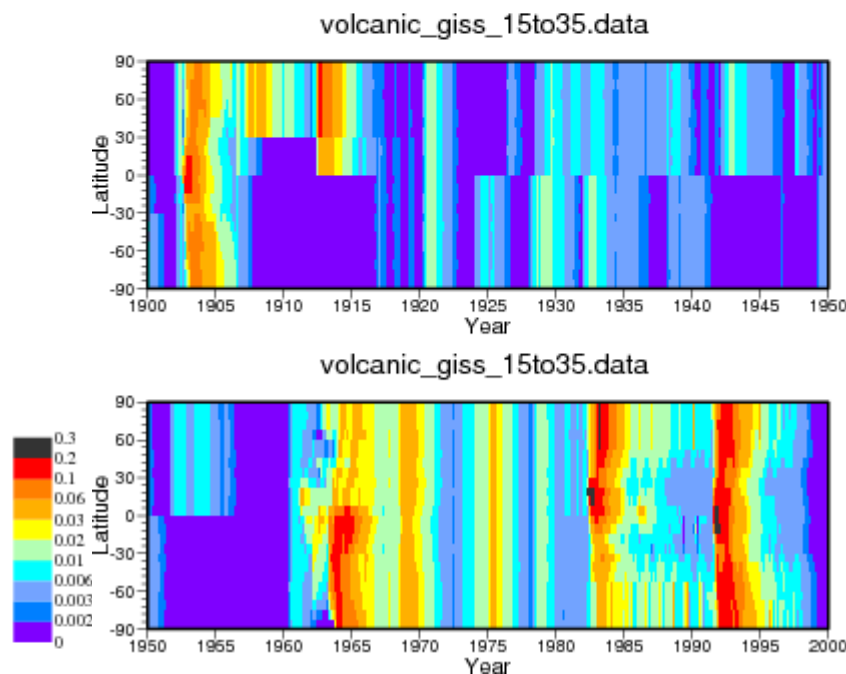
Enable CMIP5 forcing (1850-2100)
to prescribe 20th-century evolution:

✓ Now in place in latest model cycle (switches)

- ✓ Ozone, use code from EC-EARTH
- ✓ Tropospheric aerosols: sulphate only
- ✓ Volcanic sulphate

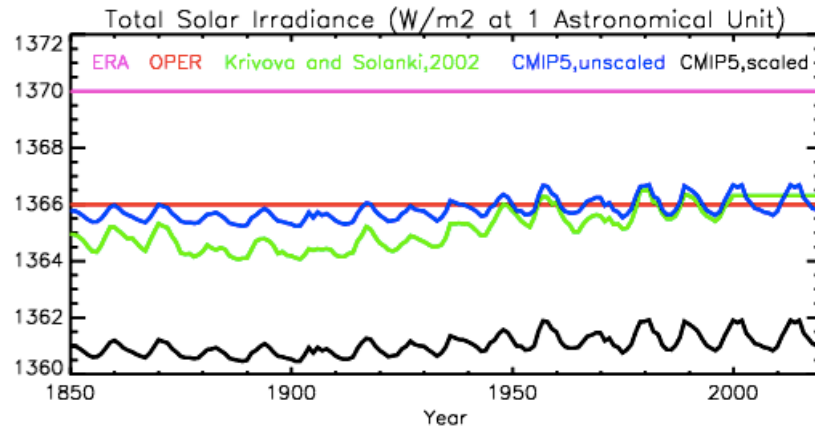
➤ Flexible interface

❖ Some possible issues



Optical depth, from: [Sato et. al, GISS](#)

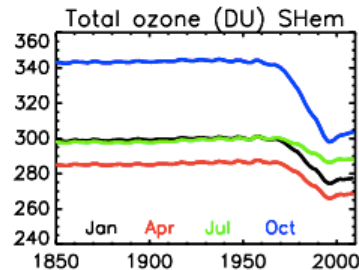
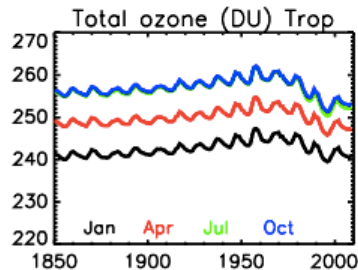
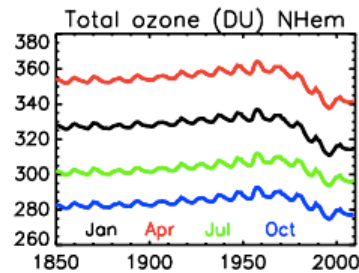
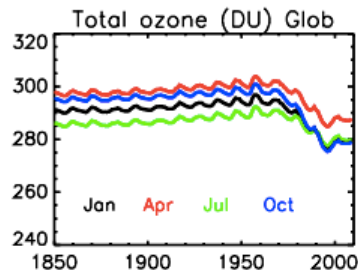
Total solar irradiance



One global number for all frequencies, which can evolve over time (solar cycles).

- **ECMWF operations:** 1366 W/m², constant in time
- **CMIP5:** (*Lean et. al. 2005*)
 - prepared for ECMWF seasonal forecasting **system-4** ; adopts the **TIM** rescaling (0.9965)
 - **EC-EARTH** retains the original **PMOD** scaling

Ozone as used in the radiation scheme



SPARC

ECMWF model: based on GEMS 2006 reanalysis

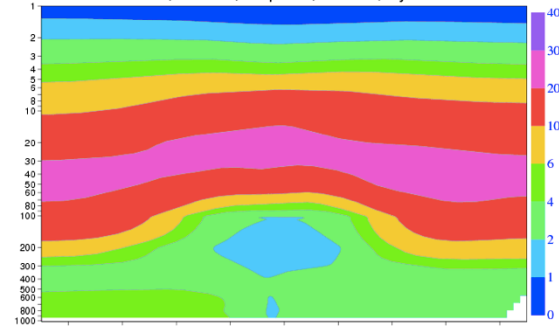
- monthly zonally-averaged fields
- no long-term evolution

CMIP5: AC&C/SPARC (*Cionni et al. 2011*)

- monthly 3D-fields; 1850-2009+RCP projections
- For later 20th century decades:
 - decline of total column ozone
 - higher tropospheric values over industrialized countries

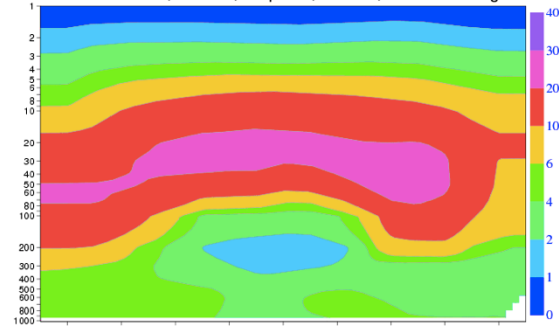
There are some differences for recent period

Ozone Partial Pressure (mPa) , 15 October 2000, 00 UTC (fn7s)
DU: Glob 286, NH 289, Trop 263, SH 305, Cy37r3 Default



Based on GEMS

Ozone Partial Pressure (mPa) , 15 October 2000, 00 UTC (fn94)
DU: Glob 285, NH 289, Trop 265, SH 301, CMIP5 Forcing



Based on SPARC

Impact study: based on 4-member 13 month AMIP runs, T159 L91, Aug 2000-2001

(downwards positive) total ----- net effect -----

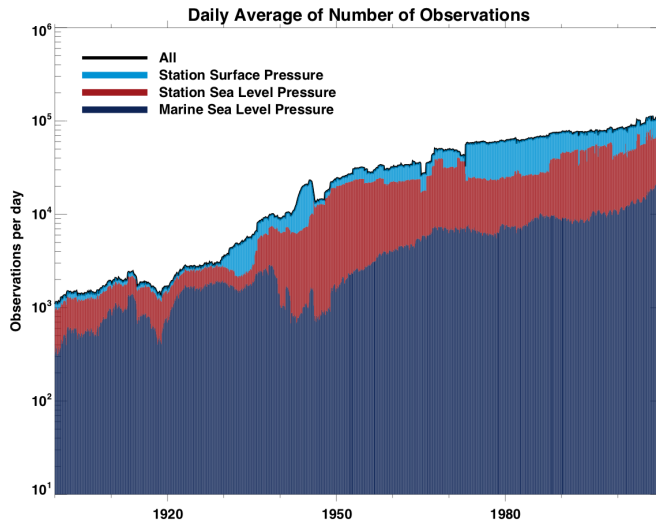
Parameter	Unit	Control	CMIP5 All	CMIP5 Solar	CMIP5 GHG's	CMIP5 Ozone	CMIP5 Trop S	CMIP5 Volc S
Top solar radiation	W/m ²	238.3	0.45	-0.81	0.00	0.02	0.14	1.09
Top thermal radiation	W/m ²	-240.8	-0.52	0.14	-0.29	0.18	-0.05	-0.41
TOA total net flux	W/m ²	-2.5	-0.07	-0.67	-0.29	0.20	0.09	0.68
Surface solar radiation	W/m ²	161.3	-0.36	-0.55	0.04	-0.05	-0.29	0.50
Surface thermal radiation	W/m ²	-59.4	-0.12	-0.03	-0.21	0.13	-0.07	0.00
Surface sensible heat flux	W/m ²	-18.8	0.10	0.00	-0.00	-0.02	0.16	0.00
Surface latent heat flux	W/m ²	-83.6	0.22	-0.15	-0.12	0.12	0.24	0.13
Surface total net flux	W/m ²	-0.5	-0.16	-0.73	-0.29	0.18	0.04	0.63

- Control AMIP loses some energy, rather than gaining
 - ❖ but within 'acceptable limits' (*ERA-Interim: -1.2 W/m², ERA-40: -7.5 W/m²*)
 - ❖ **TIM** scaling makes it slightly worse
 - ❖ Results may not be statistically significant and may depend on period and resolution
- impact of various options is modest
- for volcanic sulphate impact may be largest

**Ingestion of existing
observation data banks
into the
observation feedback archive**

The ISPD data bank

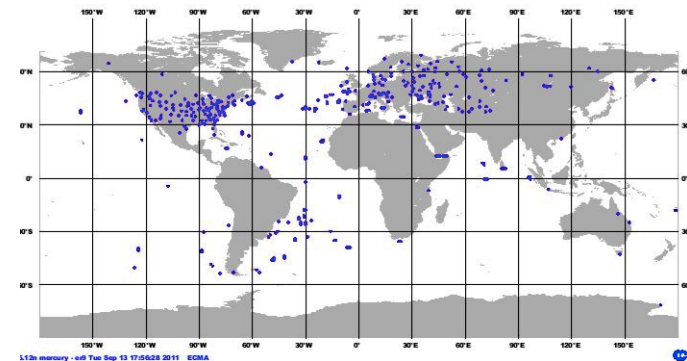
International Surface Pressure Data bank (Version 2.2)



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

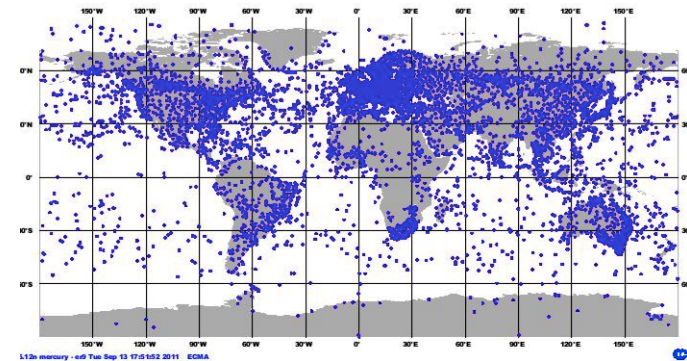
- surface pressure and MSLP
- 1.4 Billion observations from 1768 – 2008
- Many collections
- Contains feedback info from **20CR**

ODB database : ECMA Query: ispd1900010112
No. of data points 585



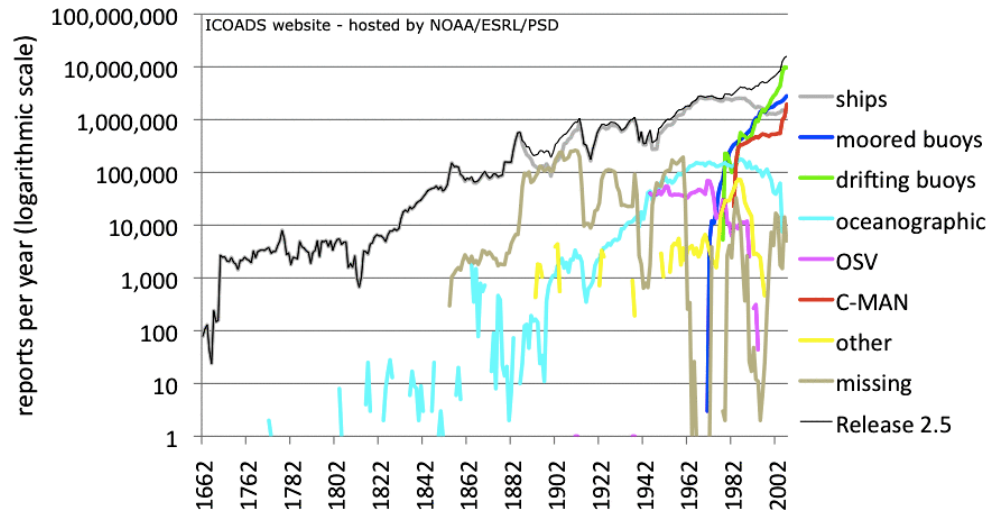
The observation network has evolved quite a bit

ODB database : ECMA Query: ispd2007010112
No. of data points 18951



The ICOADS data set (R2.5)

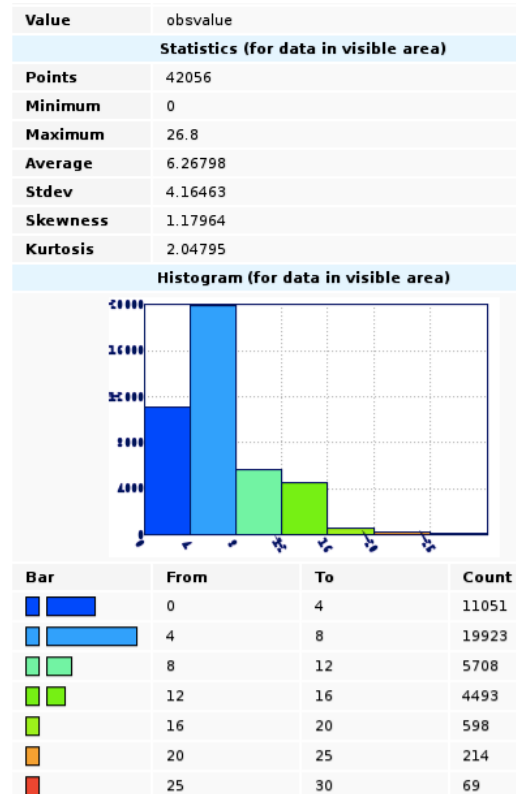
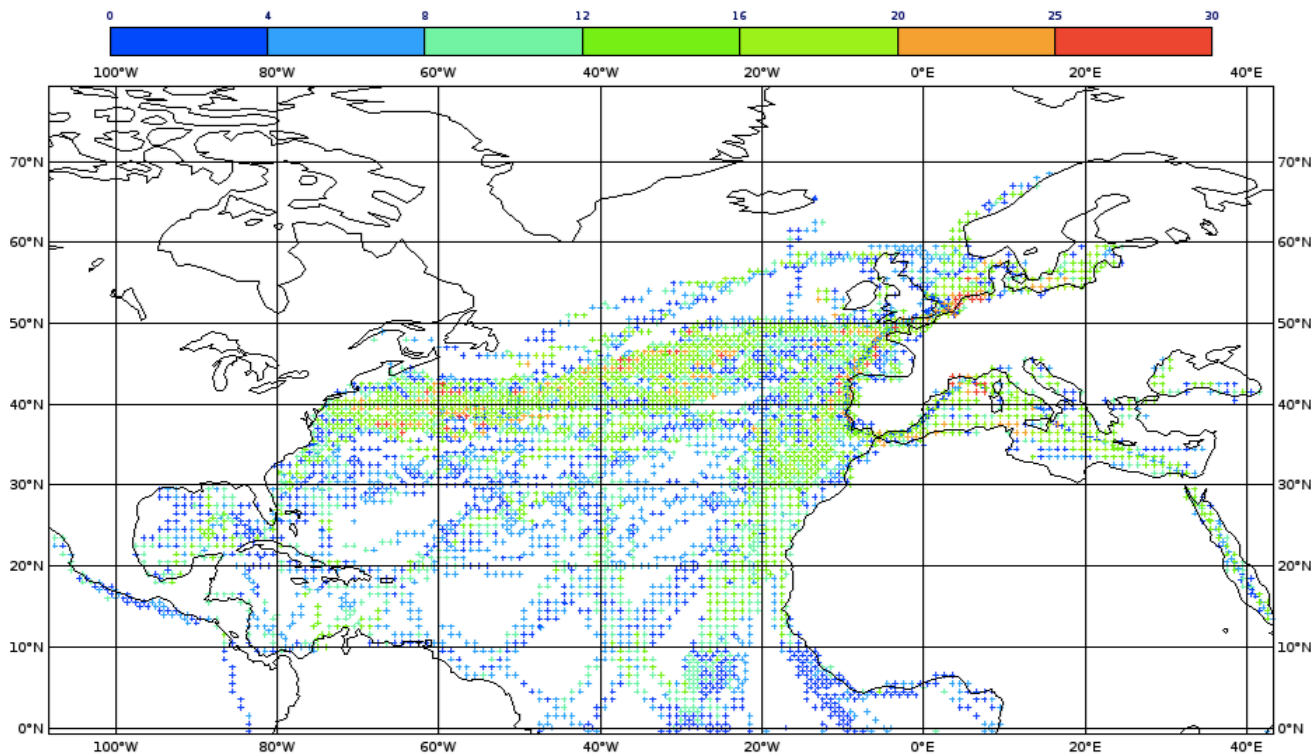
International Comprehensive Ocean-Atmosphere Data Set



Courtesy: [ICOADS](#), [Scott Woodruff](#)

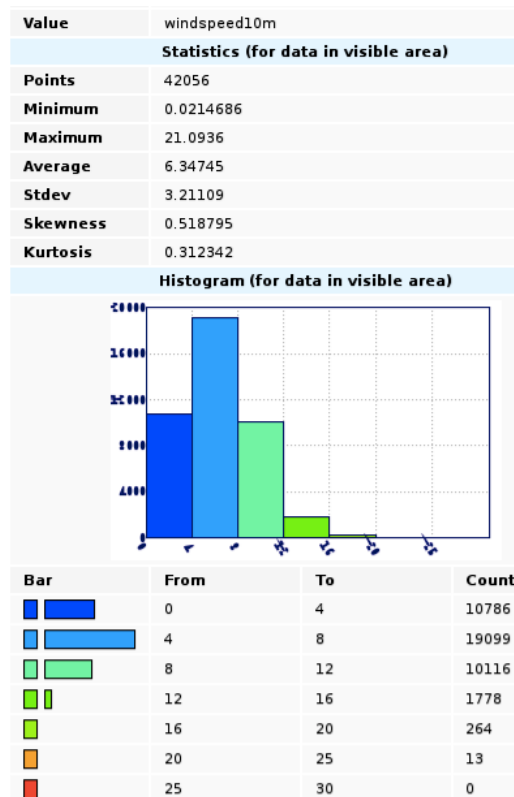
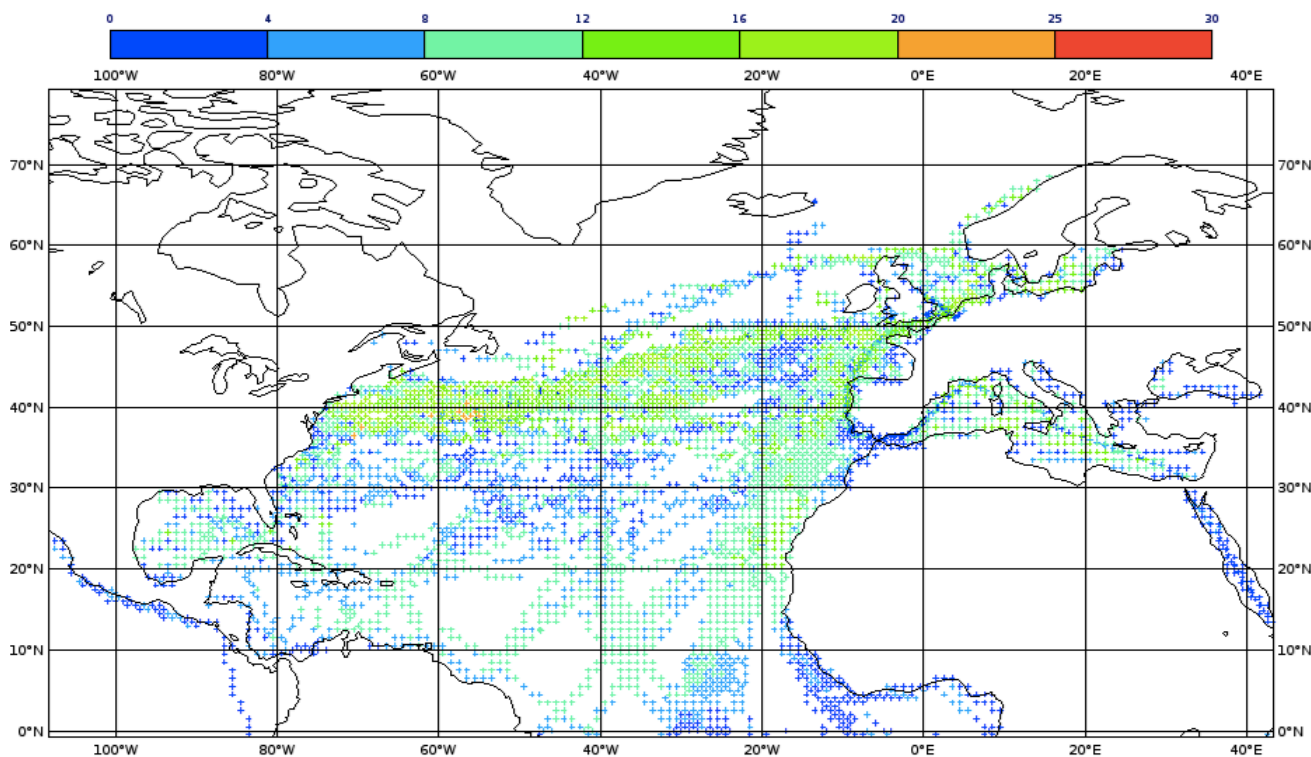
- 350 million reports, 1662-2011;
- MSLP, Pressure tendency, wind, T2m, WBT, Dew point T, SST, ocean wave height, period, present/past weather, visibility, clouds, ...
- MSLP already in ISPD
- Many collections (DECKS)
- No feedback information in ICOADS; but we perform an offline collocation with [20CR](#),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

ICOADS wind speed, April 1912



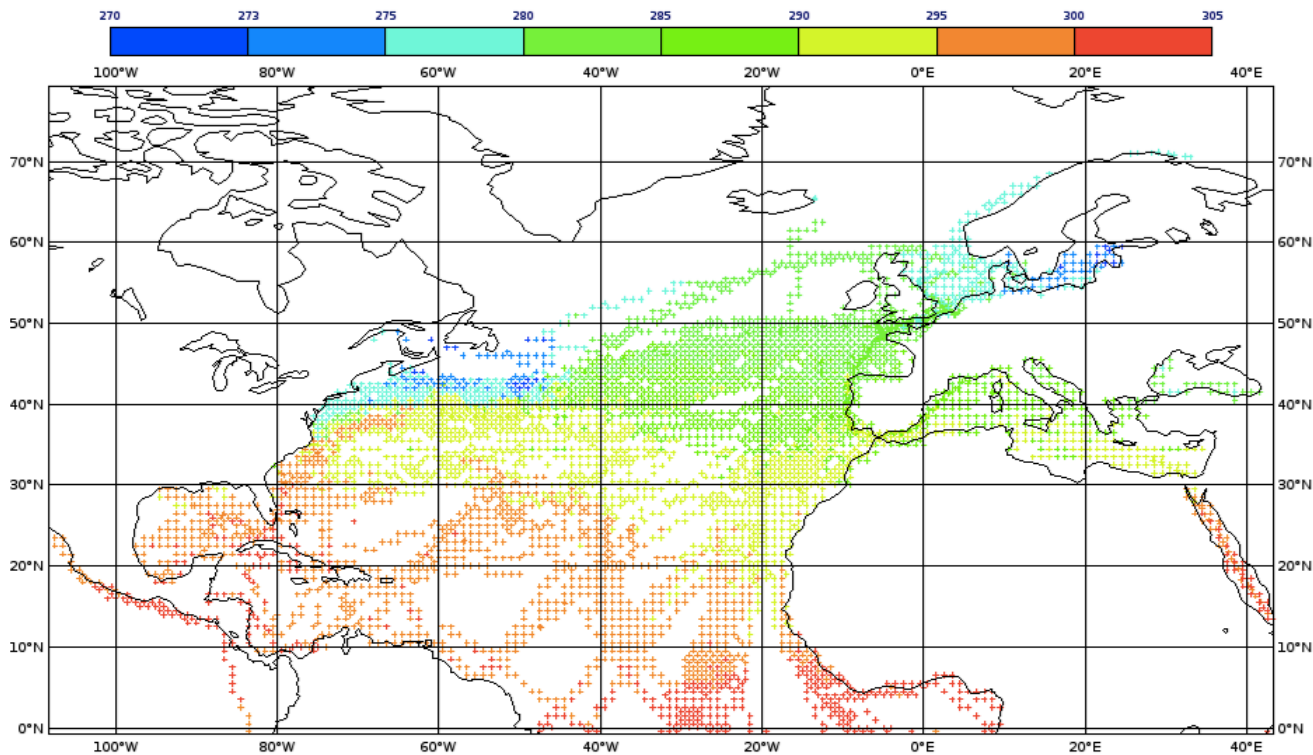
- Wind speed at observation height
- QC subject to enhanced trimming

20CR collocated first-guess '10m' wind speed



- Wind speed at observation height
- QC subject to enhanced trimming
- Interpolated from 0.995 sigma level to 10m, using a logarithmic wind profile

ICOADS SST, April 1912

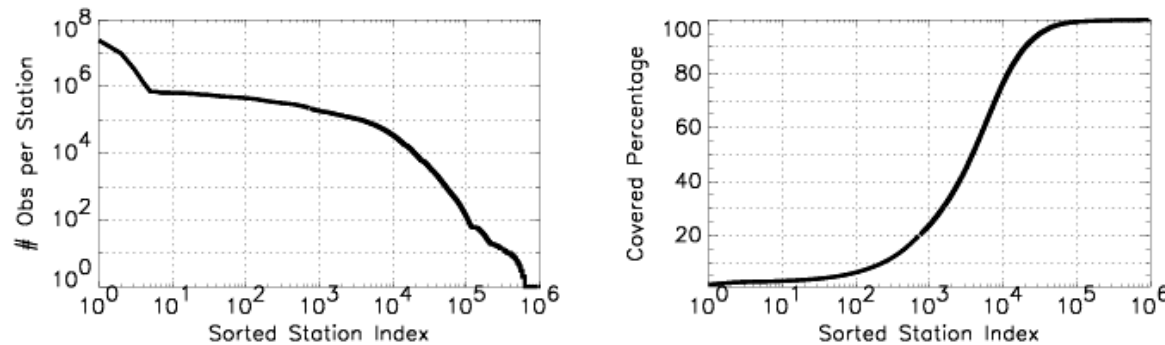


➤ ICOADS contains many geophysical parameters.

Some challenges; an example for ISPD

Interpretation of (meta)data into a unified OFA structure, e.g., station identifier

- Inconsistent formatting (e.g., upper/lower case), suspect names (A, ///, @&\#!!, ...)
- After QC (as far as possible), 1.2 million station identifiers remain
- There are 52,321 statid's which have 1,000 or more observations.
Together these cover 97.9% of all observations.



- The top 4 consists of ICOADS data for which no information on station id is available

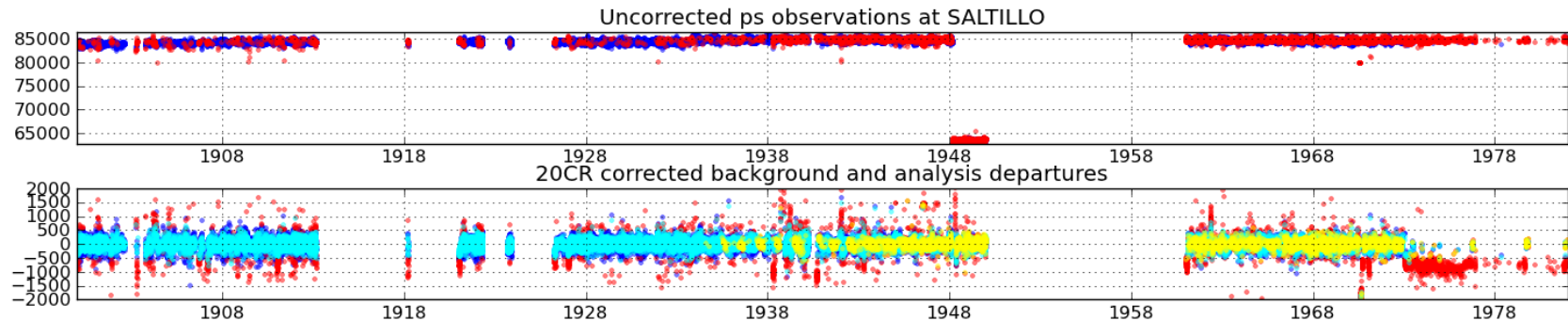
statid	collection_id	Nobs	First date, lat, lon				Last date, lat, lon			
????????	000104	24,227,426	19520101	219900	57.90	345.80	20021216	129900	11.50	81.49
????????	000105	9,857,296	18000204	169900	-51.50	302.50	19741211	099900	59.60	1.50
SHIP	000104	3,389,093	19700101	009900	71.20	35.10	20061231	189900	-35.50	138.20
MASKSTID	000105	1,331,515	20071201	009900	83.00	97.60	20081231	239900	60.60	3.70
725280UR	001000	705,254	19291216	160000	42.93	281.27	20061231	235400	42.93	281.28
725720RZ	001000	698,027	19300206	070000	40.77	248.03	20061231	235600	40.78	248.05
JAKARTA0	004001	653,766	18651231	180000	-6.18	106.83	19411231	230000	-6.18	106.83

Buffalo International
Salt lake City International
Jakarta Observatory

The importance of proper station identifiers and Feedback info (*e.g., from 20CR in ISPD*)

Allows for time-series analysis:

- Connects individual observations
- Variational bias correction per station
- Break-point analysis



Final remarks

- The **AMIP** ensemble is being integrated; the first pilot reanalysis **ERA-20C** is to be started soon
- These use 20th-century evolution of boundary conditions and forcing:
 - ✓ SST and sea ice from **HadISST2**
 - ✓ Radiation: **CMIP5** forcing
 - e.g., model now knows about **Pinatubo** (1991); should improve TOA fluxes
 - Expect improved assimilation of **MSU** microwave (channel 4)
 - VarBC on **HIRS** infrared still essential
 - (radiative transfer model does **not** know about Pinatubo, so far)
- **ICOADS** and **ISPD** are *essential* data sets; they need to be well maintained, regularly updated.
- Translation into a uniform **OFA** structure of heterogeneous sources is non-trivial
- First **OFA's** to be available soon.
- Each **pilot reanalysis** will create its own OFA
- Identification and amount of stations to be assessed/monitored is challenging
- **Reanalysis** explores the *historical ocean/atmosphere* with *state-of-the-art* methods and tools.

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

