Global historic in situ upper air data for climate change research

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Summary

Project task:

➢comprehensive homogenization of the global upper air dataset, which consists of observed time series (T, Wind, RH, SH) coming from radiosondes and tracked balloons (1905 onward).

Method:

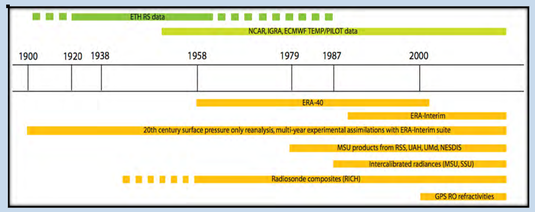
✧development of an unified automatic homogenization system that analyzes and adjusts upper air temperature, wind and humidity dataset together, using background forecasts from reanalysis as reference.

Scientific goals:

❖improvement in climate knowledge, monitoring and forecast;

❖homogenized data as input for reanalysis.

Data coverage & Input data



The radiosonde/balloon archives are:

❖ ERA-40 (1957-2002), ERA-INTERIM (1979-2011) raw data with departures, provided by ECMWF.

❖ CHUAN (1904-2008) altitude/pressure level data, often at asynoptic times, provided by Bern University.

The raw data have been interpolated & merged to obtain a global and homogeneous archive. Merging rules:

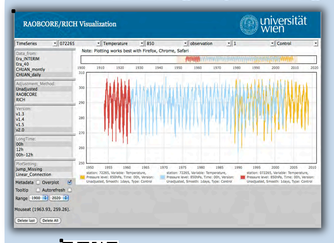
- **Lat**, **Lon** and **Alt** must be the same (± tolerance) in the source archives;
- **Data priority:** (1) => ERA-Int, (2) => ERA-40, (3) => CHUAN
- **Spikes:** if departures(day,pres,time) > 4• an_dep(press) => obs dropped out.

The global background forecast archives are:

❖ ERA-40 (1957-2002), ERA-INTERIM (1979-2011) both provided by ECMWF;

❖ 20th Century Reanalyses (1900-2011, uses only surface data, provided by NOAA).

The time series VIEWER



A web based (Javascript) viewer has been developed. It allows to visualize and compare different time series easily and quickly: observation, analysis and first guess departures at different times and pressure levels are available.

Temperature:

St: 010393 -> long t.s. 1905

St: 004018, 061641 breaks

Wind Speed

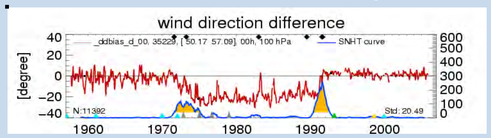
St: 016716 -> @200hPa breaks

Try it:

Homogenization: remove artificial breaks and trends

Starting point is the automatic homogenization method for upper air data called RAdiosone OBservation COrrection using REanalyses

RAOBCORE
- advantages
  - daily data
  - BG weakly dependent from OBS
- drawback
  - BG are satellite data dependent (biased)



These trends:

❖ have non-climatic reasons;

❖ are due to improvements or changes in observation practice;

Radiosonde and tracked balloon observations need homogenization

RAOBCORE v2.0

Temperature t.s. are tested with 20CR as reference.

The 20th Century Reanalysis:

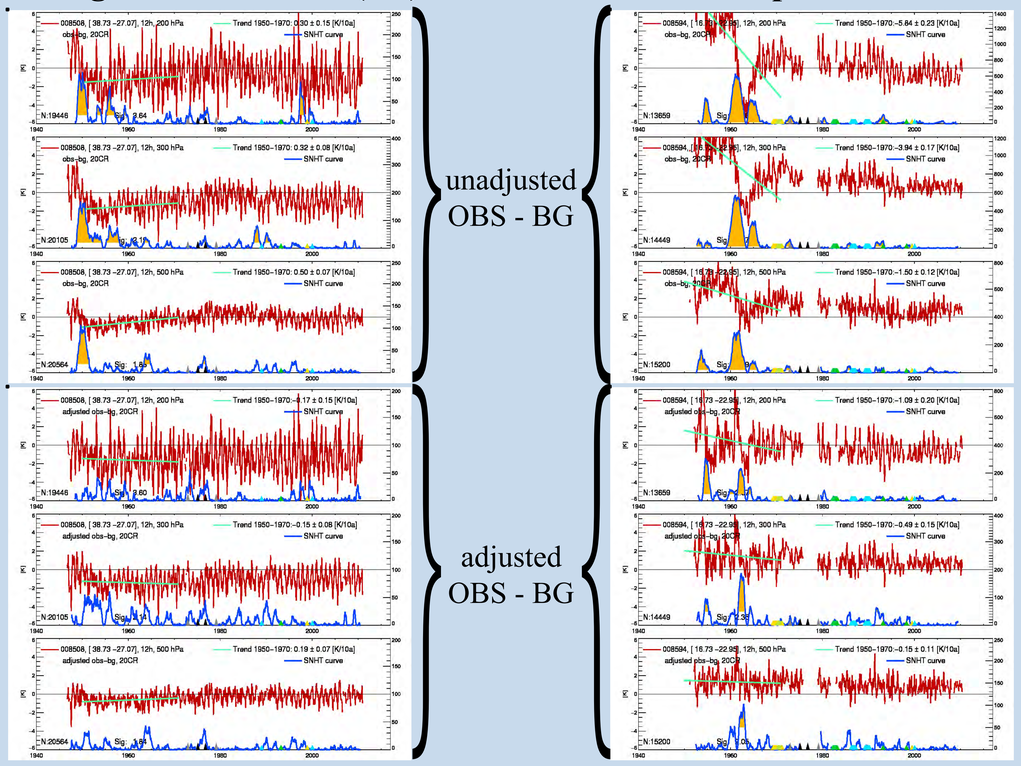
❖dependents only on surface pressure and SST data:
references are totally independent from the analysed data;

❖is quite smooth since it is an ensemble mean:
it may suffer in the detection of fast phenomena;

❖shows high variance, especially at the high pressure levels:
the departures may be noisy and rather large;

❖Evidences warm and cold pools to respect ERA-40/Int:
they may introduce shifts in the corrected time series

RAOBCORE 2.0: homogenization back to 1940s

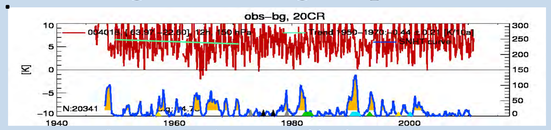


The time series look well homogenized

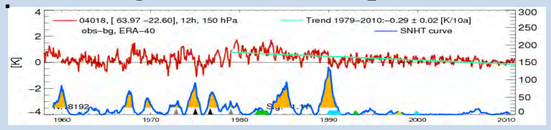
Break size reduced of factor 2, but still spurious spikes

Keflavik (Island)

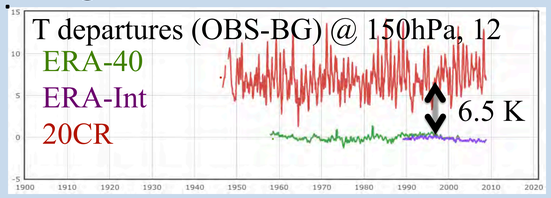
using 20CR: large departures



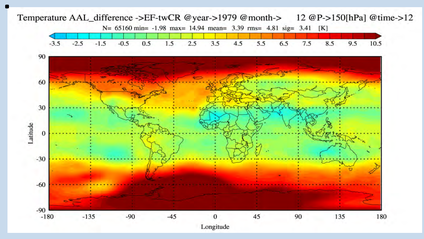
using ERA: small departures



strong offset between 20CR and ERA



ERA40 – 20CR: Global differences



RAOBCORE 2.0: next improvements:

➢ extend the homogenization method for simultaneous analysis of Temperature, Wind & Humidity;

➢ the impact of different background forecasts (20Century Reanalysis, ERA-Int and ERA-40) time series needs to be investigated further;

➢ improve the algorithm for break point detection and correction (from fixed length temporal window to dynamic temporal window, penalized maximums likelihood methods (*Caussinus and Mestre 2004* and *Hadzimustafic 2010*)).

References

Haimberger, L., 2007: Homogenization of radiosonde temperature time series using innovation statistics. J. Climate 20, 1377-1403..

Haimberger, L., C. Gruber, S. Sperka, and C. Tavolato, 2008: Homogenization of the global radiosonde temperature and wind dataset using innovation statistics