Global historic in situ upper air data for climate change research

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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.

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(pres) => obs dropped out.

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 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: Wind Speed
St: 010393 -> long t.s. 1905 St: 016716 -> @200hPa breaks
St: 004018, 061641 breaks

Homogenization: remove artificial breaks and trends
Starting point is the automatic homogenization method for upper air data called RADiosonde OBservatioCOrrection 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;
- spikes:
  - if departures(day,pres,time) > 4
  - an_dep(press) => obs dropped out.

The time series look well homogenized

RAOBCORE v2.0: homogenization back to 1940s

Angra do Heroismo (PT)
Cape Verde
Keilavik (Island)

unadjusted OBS - BG
adjusted OBS - BG

The time series look well homogenized

Break size reduced of factor 2, but still spurious spikes

ERA40 – 20CR: Global differences

ERA-Int
ERA-40

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)).

RAOBCORE 2.0: homogenization back to 1940s

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

References