Reliability of the last century data for paleoclimate model testing and calibration

Elisa Palazzi
Jost von Hardenberg, Antonello Provenzale
ISAC-CNR
Torino

Climate variability in Italy during the last two millennia – Italy 2k
December, 1-2, 2014, Roma

Data and Paleoclimate

- Among the many periods of relevance in paleoclimate, **the last two millennia** play an important role

  - Availability of widespread, **high-resolution,** precisely dated **proxy data**
  - Assessment of the potential uniqueness of recent and projected climate changes

- Reconstruction of past changes from proxy data, based on indirect climate indicators, have to be calibrated and validated against **instrumental records** during common intervals of overlap.

Data and Paleoclimate

Instrumental data:

- are available for the last 100-150. More regionally-limited data (e.g., for Europe) are available back to the early 18th century

- include measurements of surface temperature, sea level pressure, precipitation (including drought indices), sea ice extents, winds and humidity estimates.

- **are by far the most reliable of all available climate data, but they are not free from severe uncertainties.**

Data and Paleoclimate

It is important to assess the strengths and shortcomings of the various last-century climate data since they can be used as a benchmark to test the paleoclimate models over the most recent time-period window, as well as for calibration purposes.

Outline

- Outline of the available **historical** climate datasets
- The main issues of the various dataset kinds and examples (globally and regionally from mountain areas)
- Datasets for Europe/Italy (Greater Alpine Region)
- Concluding remarks

Historical Climate data sets

In-situ stations

- Characterization of the local conditions
- Long temporal coverage

- Unevenly distributed (horizontally and vertically)
- Urban warming biases in the thermometer-based obs., underestimation of solid precipitation by rain gauges
- Statistical methods extract information from the relatively complete post-1950 measurements to interpolate earlier missing data (stationarity assumption)

Surface air temperature measurements are available for **parts of Europe and North America back to the early 18th century**. Many of the European series have been extensively **homogenized** in a number of recent studies.

Historical Climate data sets

Interpolated (gridded) datasets

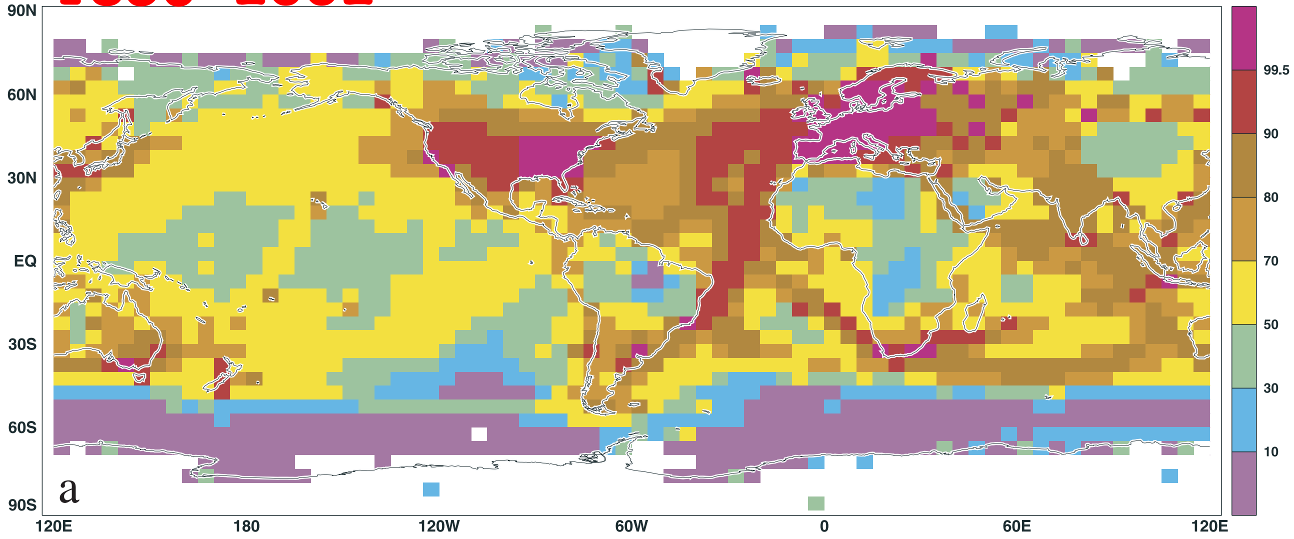
- Long temporal coverage
- Gridding: reduces biases arising from the irregular station distribution; is essential for the analysis of regional trends

- Poor spatial coverage and high sparseness constitute a potential source of uncertainty when interpolating grid point values from the nearest few available stations.
- Precipitation: For short averaging time scales the spatial intermittency of precipitation represents a major source of uncertainty for these approaches; underestimation of total precipitation (snow)

Historical Climate data sets

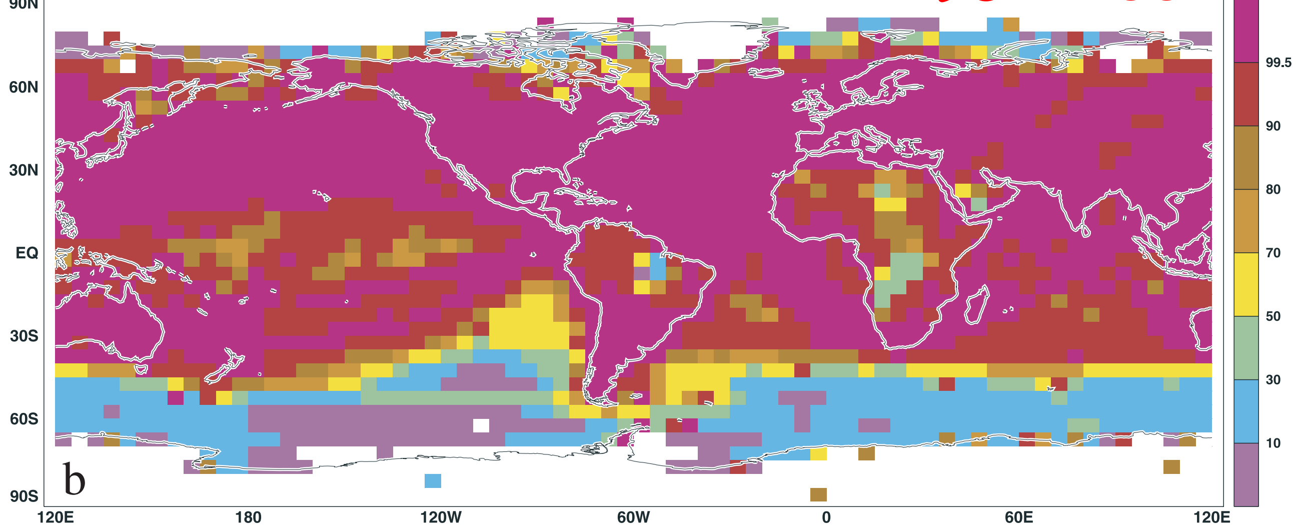
Gridded data sets – Issues

1856-2002



Percent coverage of the CRU dataset (5°x5°) in two different periods

1951-2002

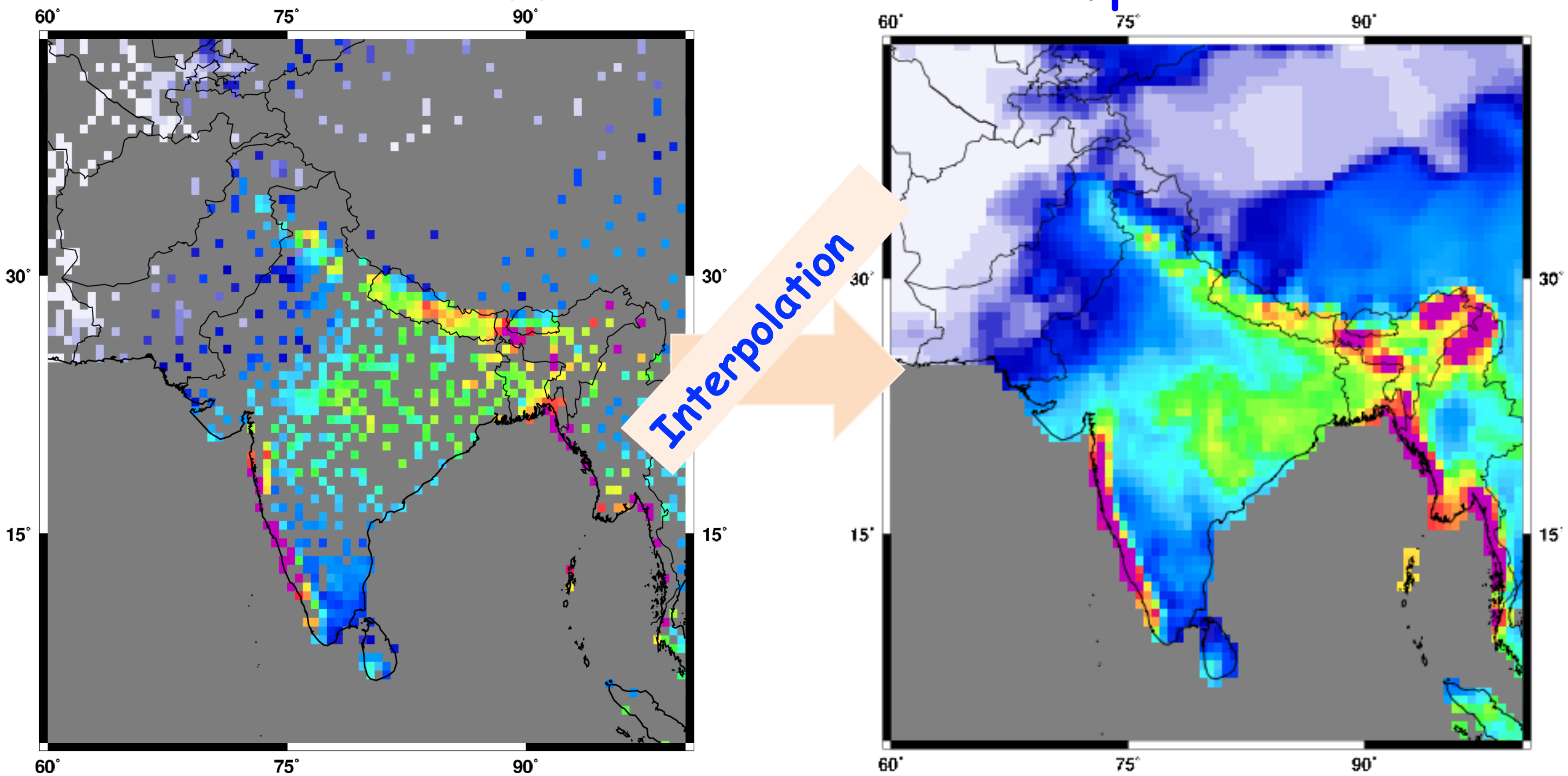


Reviews of Geophysics
[Volume 42, Issue 2,](#)
RG2002, DOI:
10.1029/2003RG000143

Historical Climate data sets

Gridded data sets – Issues

HKKH REGION as an example

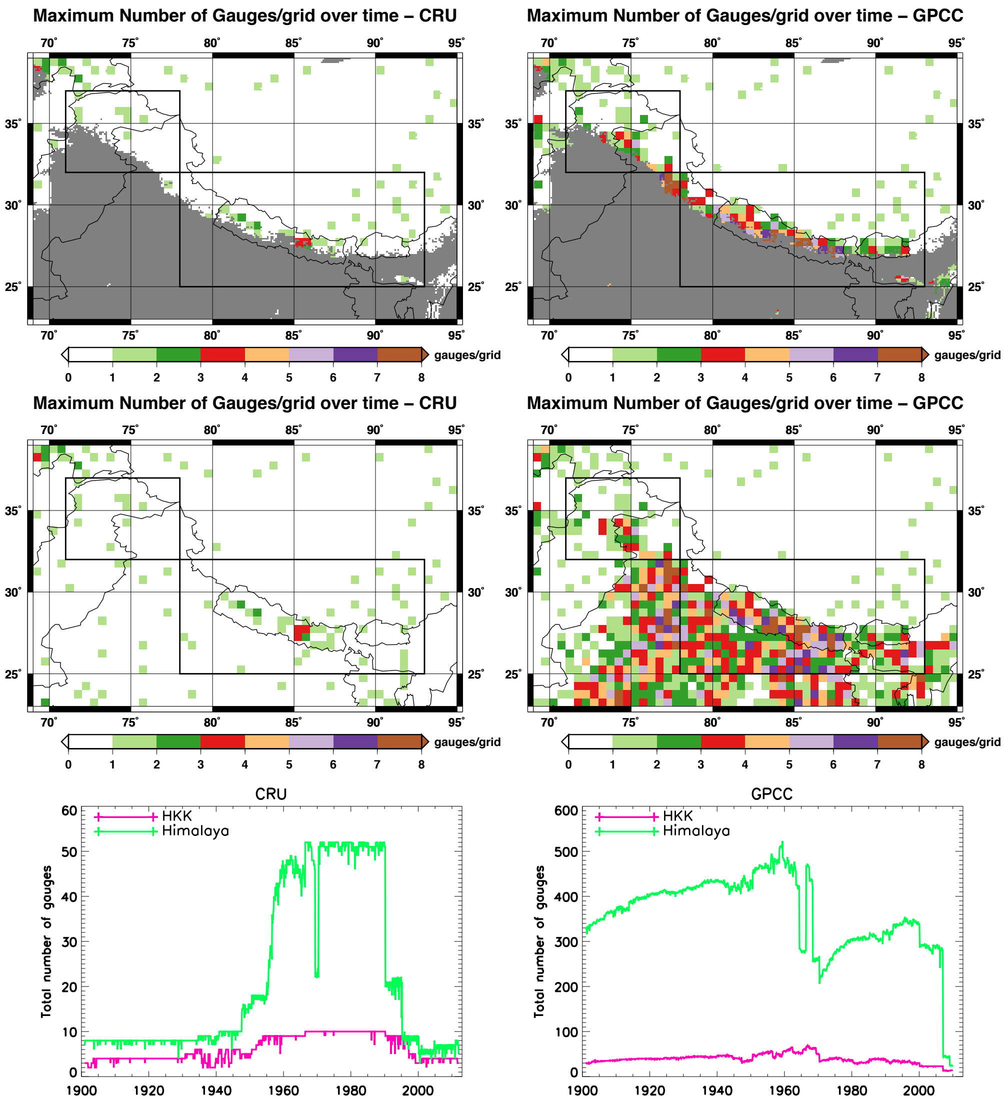


GPCC raw → GPCC interpolated and regularly gridded

Historical Climate data sets

Gridded data sets – Issues

HKKH REGION as an example



Maximum number of gauges/pixel in the period 1901-2013. Elevation > 1000 m a.s.l.

Maximum number of gauges/pixel in the period 1901-2013.

Evolution of the total number of gauges in the HKK and Himalaya

Historical Climate data sets

Satellite Data

- Spatially-complete coverage of precipitation estimates

- They do not extend back beyond the 1970s and as such are not yet suitable for assessing long-term trends and performing climatological studies.

- Precipitation: Problems in measuring snow accurately

Historical Climate data sets

Reanalysis data

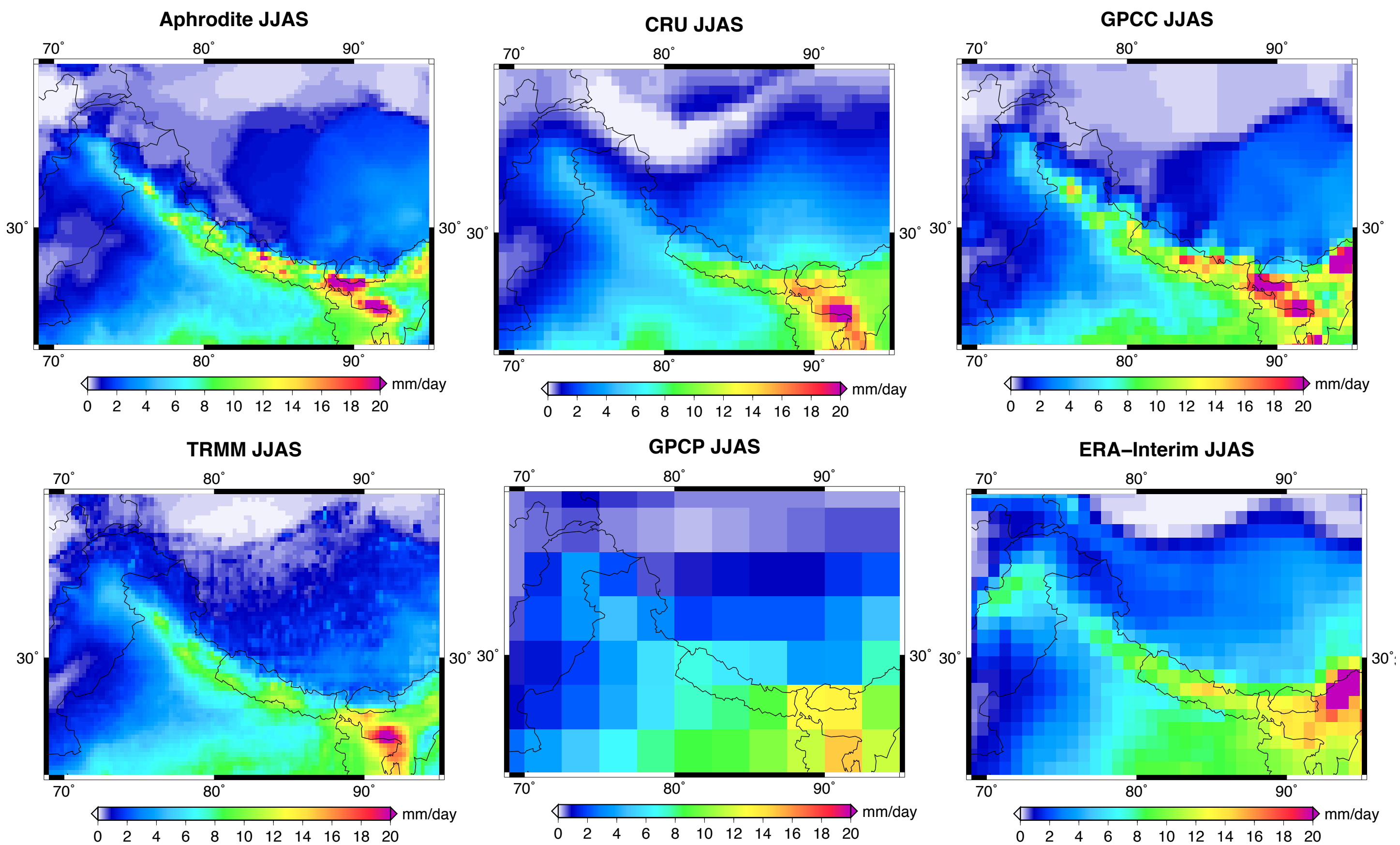
- Global & continuos data
- Precipitation: they do account for total precipitation (rainfall plus snow).

- Climate trends obtained from reanalyses should be regarded with caution, since continuous changes in the observing systems and biases in both observations and models can introduce spurious variability and trends into reanalysis output

Data sets – Issues

HKKH REGION as an example

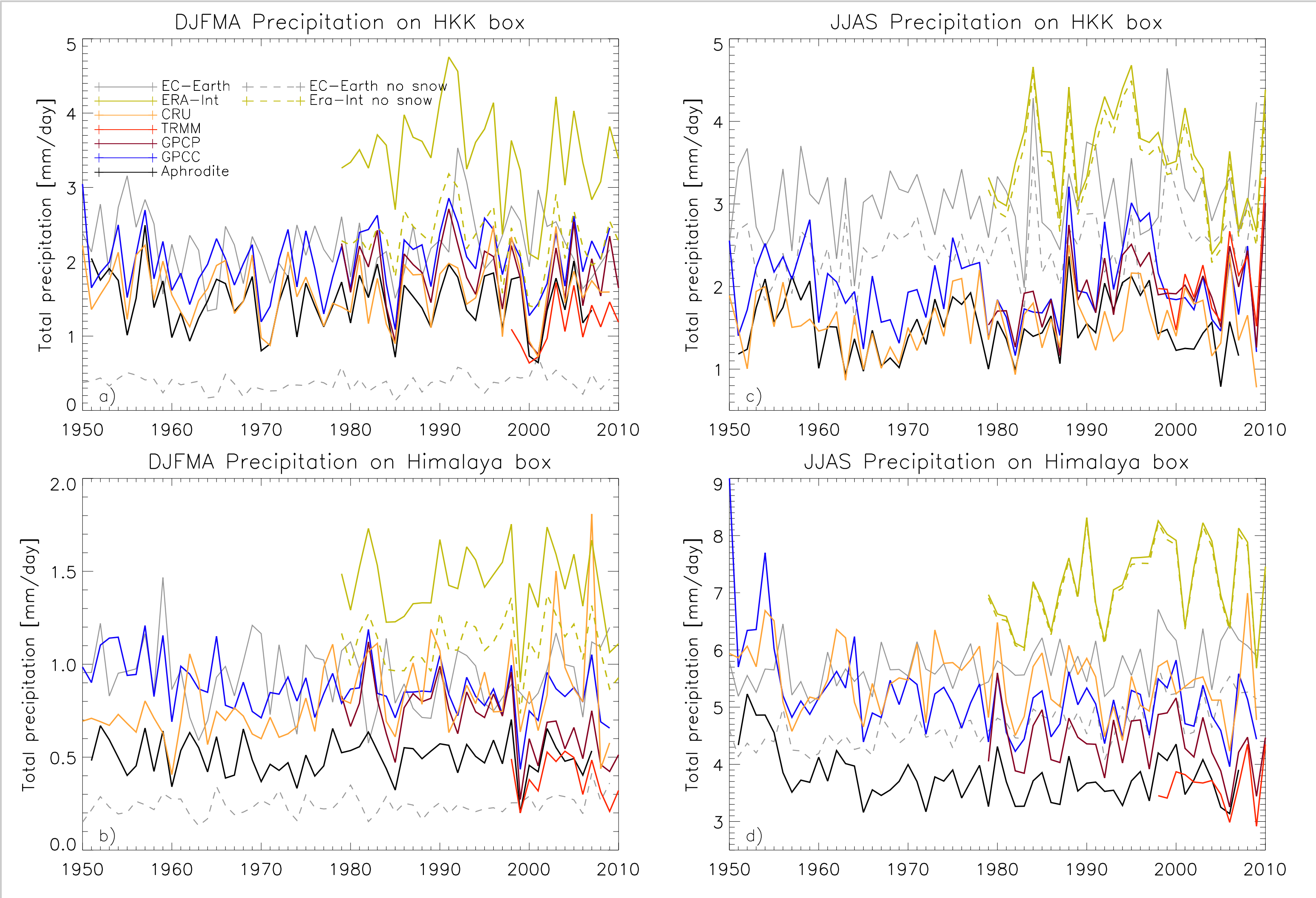
Summer precipitation (JJAS), Multiannual average 1998-2007



Palazzi, E., J. von Hardenberg, and A. Provenzale. 2013. Precipitation in the Hindu-Kush Karakoram Himalaya: Observations and future scenarios, J. Geophys. Res. Atmos., 118, 85–100, doi: 10.1029/2012JD018697

Data sets – Issues

HKKH REGION as an example



Palazzi, E., J. von Hardenberg, and A. Provenzale. 2013. Precipitation in the Hindu-Kush Karakoram Himalaya: Observations and future scenarios, J. Geophys. Res. Atmos., 118, 85–100, doi: 10.1029/2012JD018697

Climate data sets – Europe

E-OBS v9.0

- Daily data set based on ECA&D (http://eca.knmi.nl/)
- Available from 1950 to 2013
- Originally developed as part of the ENSEMBLES project (EU-FP6)
- Maintained and elaborated as part of the EURO4M project (EU-FP7).

- Spatial resolution: **0.25°, 0.50°**
- Spatial Coverage: 25°N-75°N x 40°W-75°E
- Variables: Daily mean temperature, daily minimum temperature, daily maximum temperature, daily precipitation sum, daily averaged sea level pressure (PP).

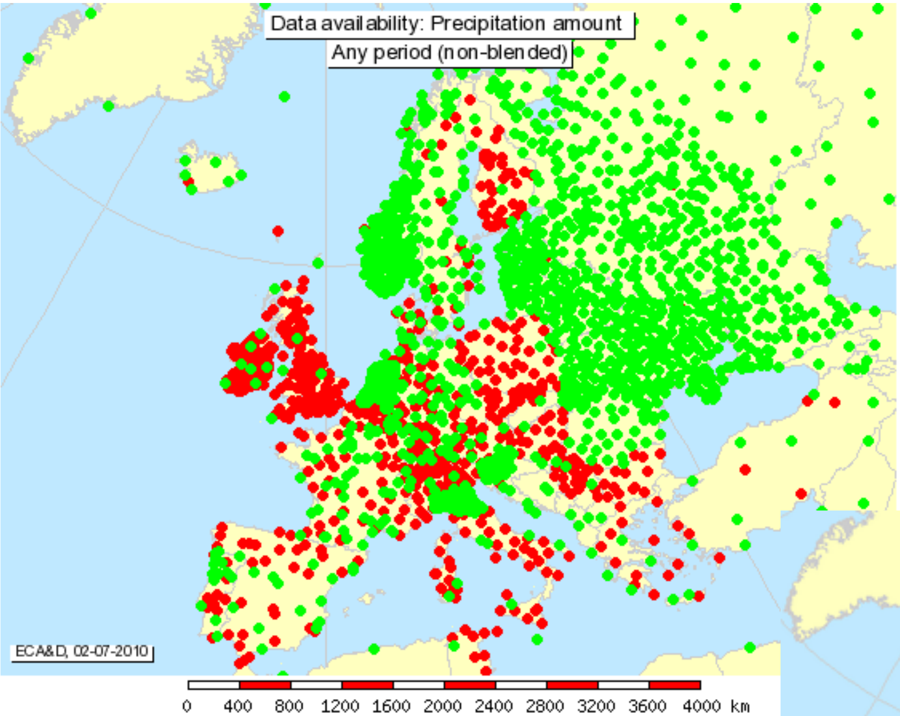
The data files are in compressed NetCDF format

http://www.ecad.eu/download/ensembles/download.php

Gridded data + underlying station data

Climate data sets - Europe

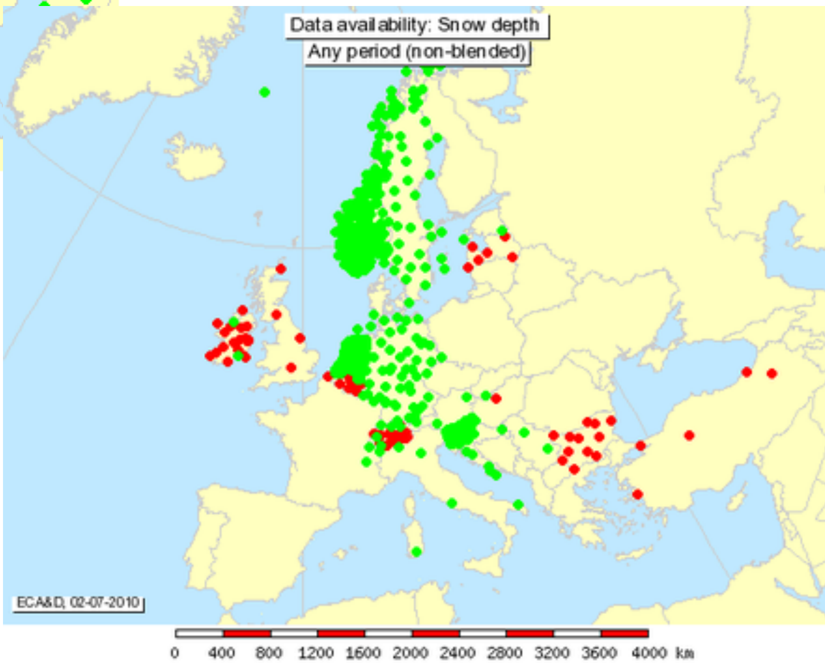
E-OBS v9.0 - Stations



Precipitation

Data availability maps
(public = downloadable)

- **Public data**
- **Non-public data**



Data availability maps
(public = downloadable)

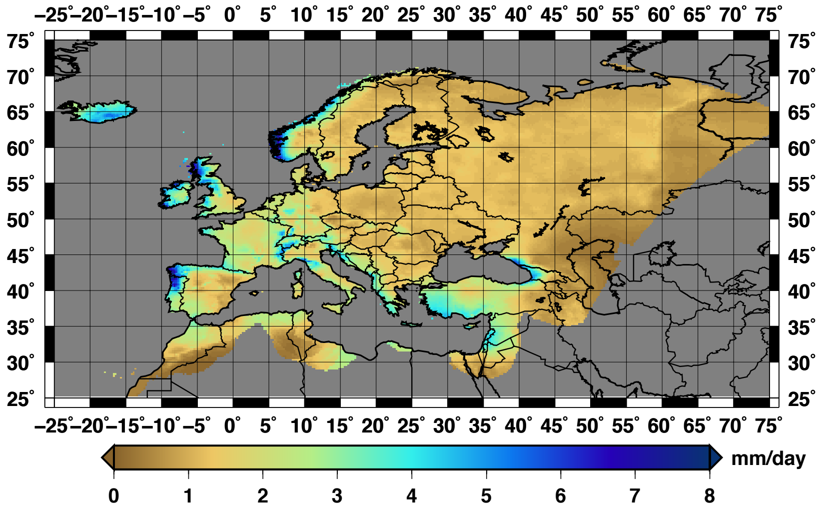
- **Public data**
- **Non-public data**

Snow Depth

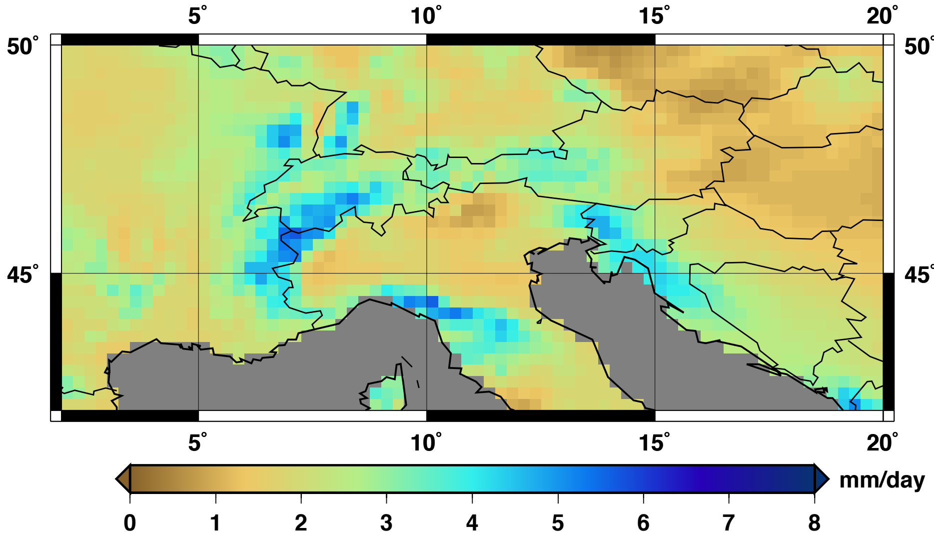
Climate data sets - Europe

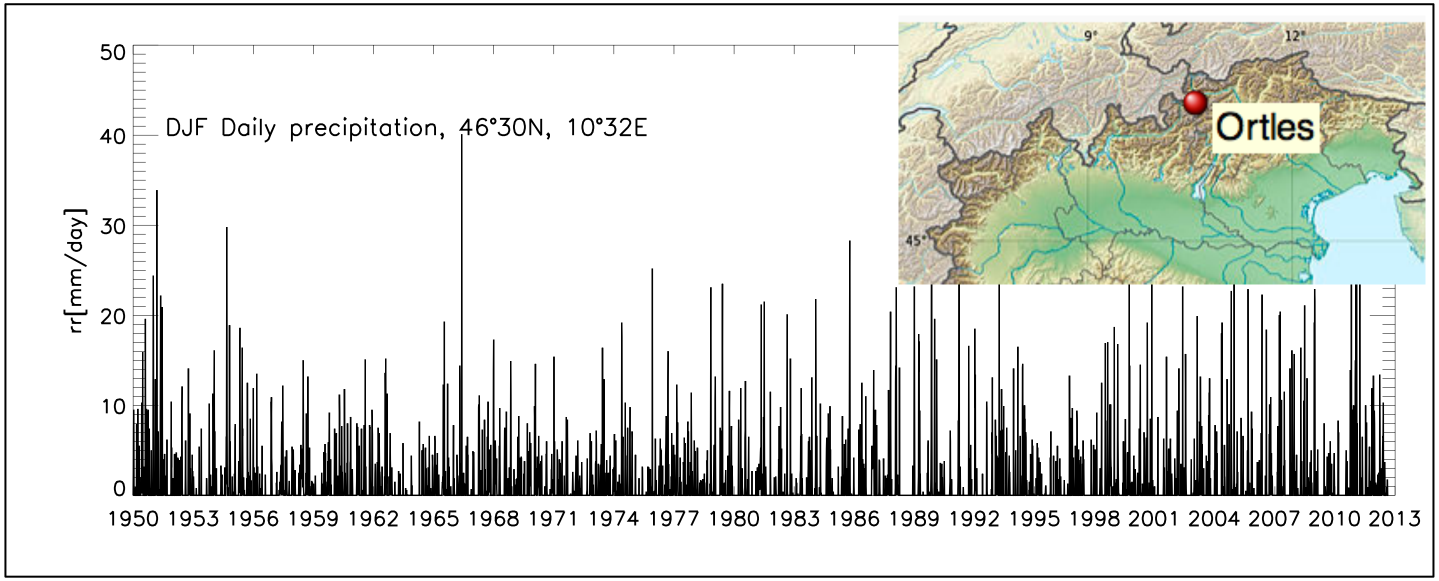
E-OBS v9.0 - PRECIPITATION

E–Obs DJF average (1950–2013)



E–Obs DJF average (1950–2013)





Climate data sets – Greater Alpine Region (GAR)

4-19°E, 43-49°N, 0-3500m asl

1. **EURO4M-APGD** (The Alpine precipitation grid dataset, MeteoSwiss, EURO4M FP7)

2. **HISTALP** (HISTORICAL INSTRUMENTAL CLIMATOLOGICAL SURFACE TIME SERIES OF THE GREATER ALPINE REGION)

3. **Alp-Imp Project** (Alpine Climate Data, mostly based on HISTALP)

Climate data sets – Greater Alpine Region (GAR)

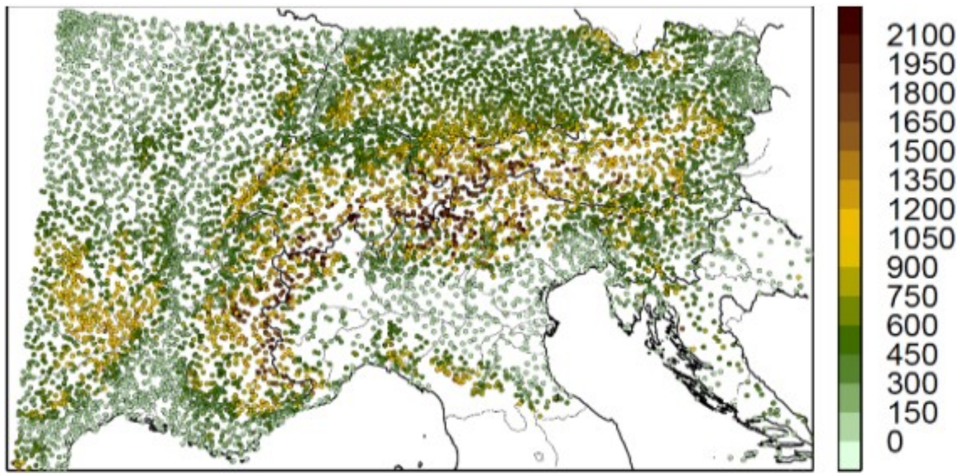
4-19°E, 43-49°N, 0-3500m asl

1. **EURO4M-APGD (The Alpine precipitation grid dataset, MeteoSwiss, EURO4M FP7)**

- Gridded daily **precipitation (Rainfall + SWE)**, based on measurements at high-resolution rain-gauge networks (more than 8500 stations from Austria, Croatia, France, Germany, Italy, Slovenia and Switzerland)

- Period: Jan.-Dec., 1971-2008.

- Effective resolution: 10-20 km



http://www.meteoswiss.admin.ch/web/en/services/data_portal/gridded_datasets/alpineprecip.html

Climate data sets – Greater Alpine Region (GAR)

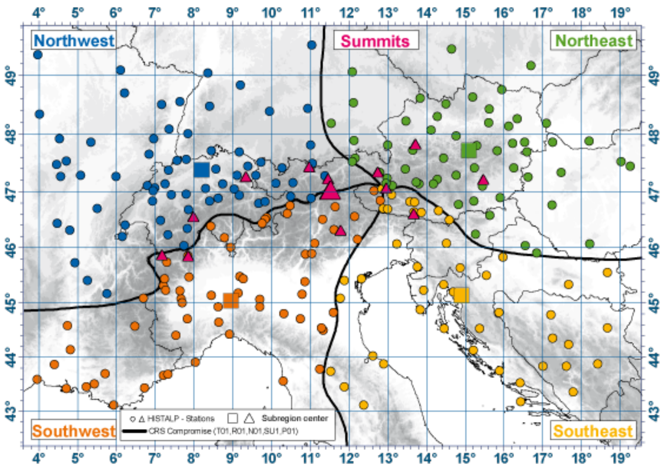
4-19°E, 43-49°N, 0-3500m asl

2. HISTALP (HISTORICAL INSTRUMENTAL CLIMATOLOGICAL SURFACE TIME SERIES OF THE GREATER ALPINE REGION)

- Monthly homogenised **temperature**, **pressure**, **precipitation**, **sunshine** and **cloudiness records** for the GAR

- The longest temperature and air pressure series extend back to **1760**, precipitation to **1800**, cloudiness to the **1840s** and sunshine to the **1880s**.

GRID - MODE DATA	STATION - MODE DATA
CRSM Files coarse resolution subregional means	
1x1 degree gridfiles	Homogenised Series
5x5 minutes gridfiles	



http://www.zamg.ac.at/histalp/datasets.php

Concluding remarks

Instrumental climate records → based on **direct** observations, but not free from uncertainties

- Instrumental errors
- Sparseness of in-situ station data
- Under-representations of many areas
- Reconstruction of Incomplete Station Series (Blending vs non-blending data)
- Propagation of uncertainties into the gridded datasets (interpolation)

Usefulness of instrumental data for paleo studies → comparison of historical instrumental data with proxy-based reconstructions is useful for calibrating proxy records and testing paleoclimate models over the most recent time-window

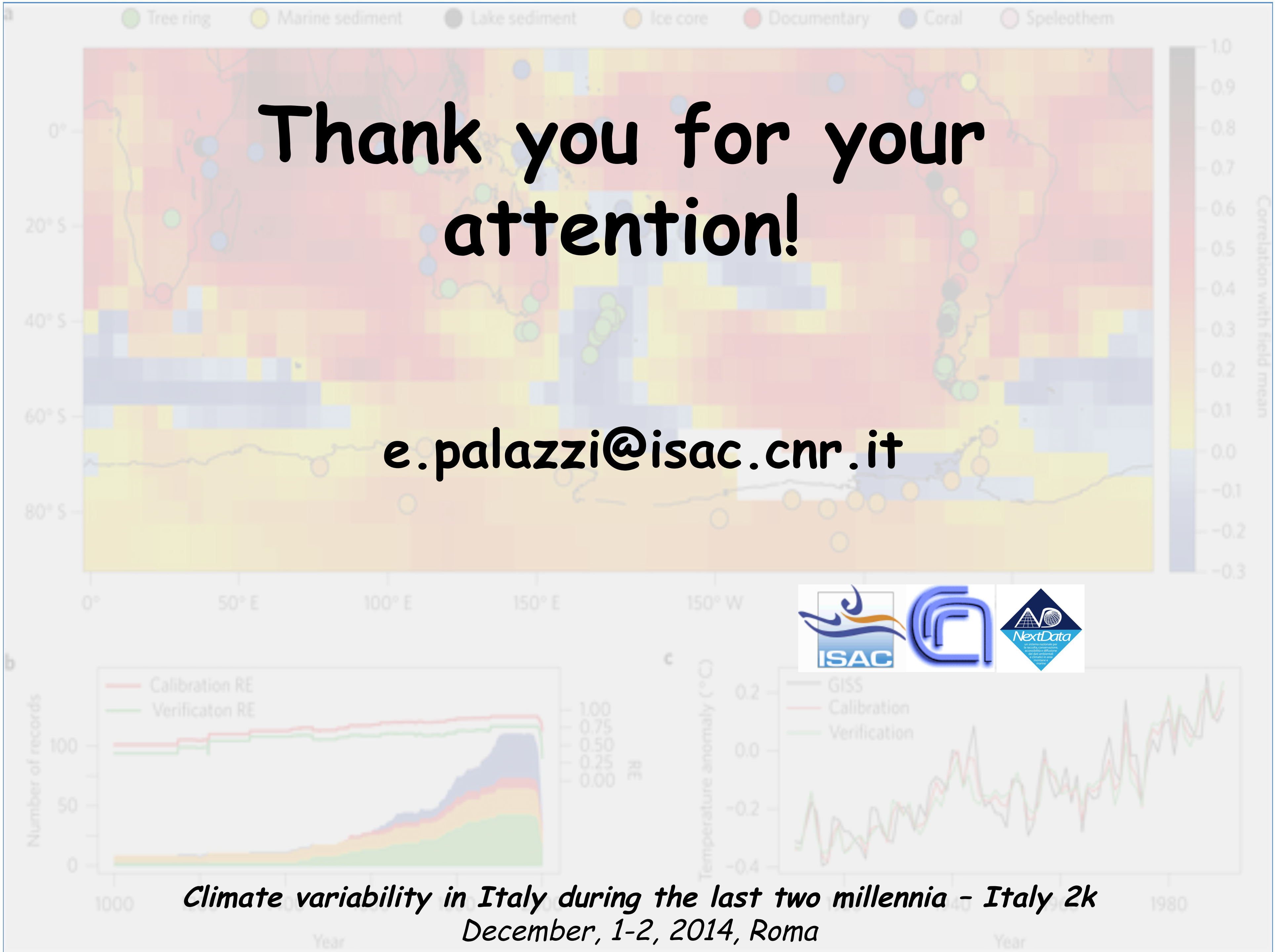
Concluding remarks

It is therefore important to correctly quantify the uncertainties of the instrumental data before their application in paleoclimate studies.

Given the uncertainties in these data and in the proxy-data

- Conclusions for specific regions where both high-res proxies and instrumental dare are sparse can be more uncertain than "global" conclusions

- Conclusions for surface temperature can be considered to be more robust than for precipitation/drought fields



Thank you for your attention!

e.palazzi@isac.cnr.it