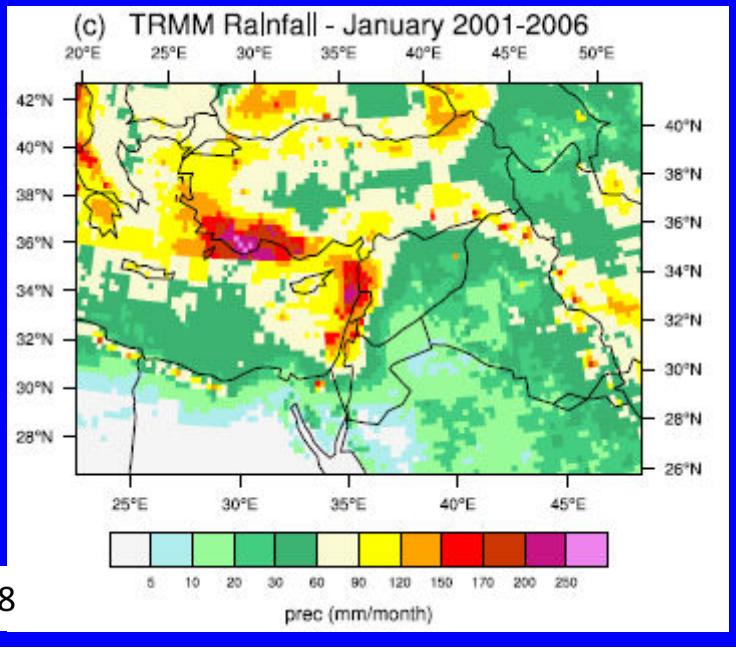
High-resolution forecasts of seasonal precipitation in the south-eastern Mediterranean: **analogues downscaling of global forecasts**

Dorita Rostkier-Edelstein
NCAR, Boulder, CO;
and
P. Kunin, Y. Liu, W. Wu, M. Ge, G. Descombes, T. Hopson, and A. Givati

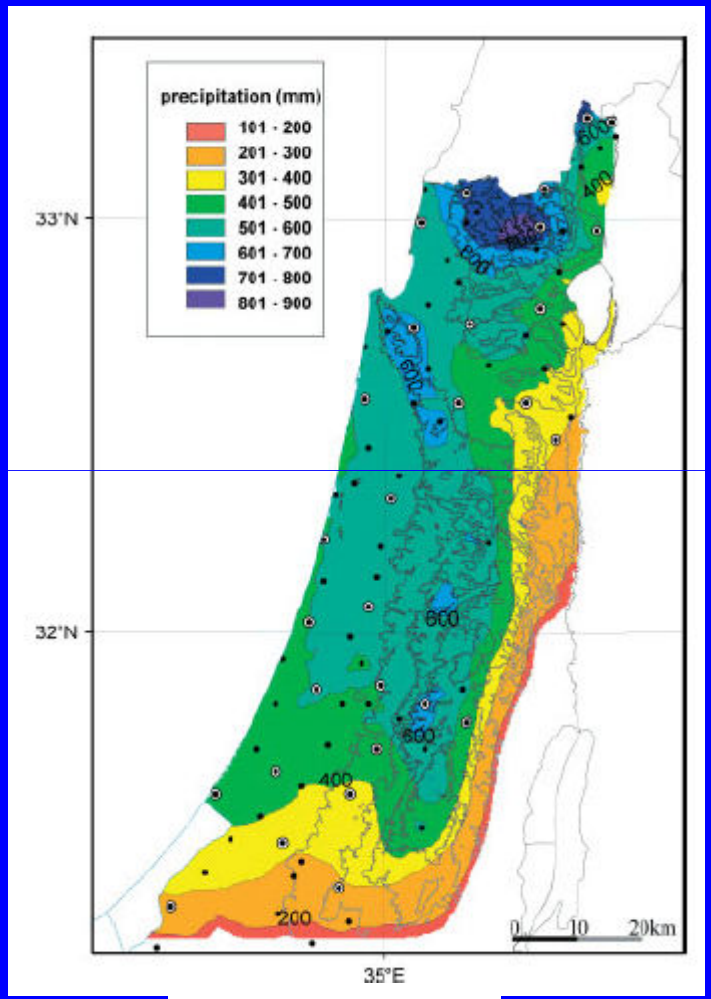
Motivation

- Planning the use of water resources in advance is one of the most important missions in the semi-arid Eastern Mediterranean region.

- Relevant areas are characterized by complex topography, land use and coast-lines that lead to steep spatial gradients in the observed seasonal precipitation.



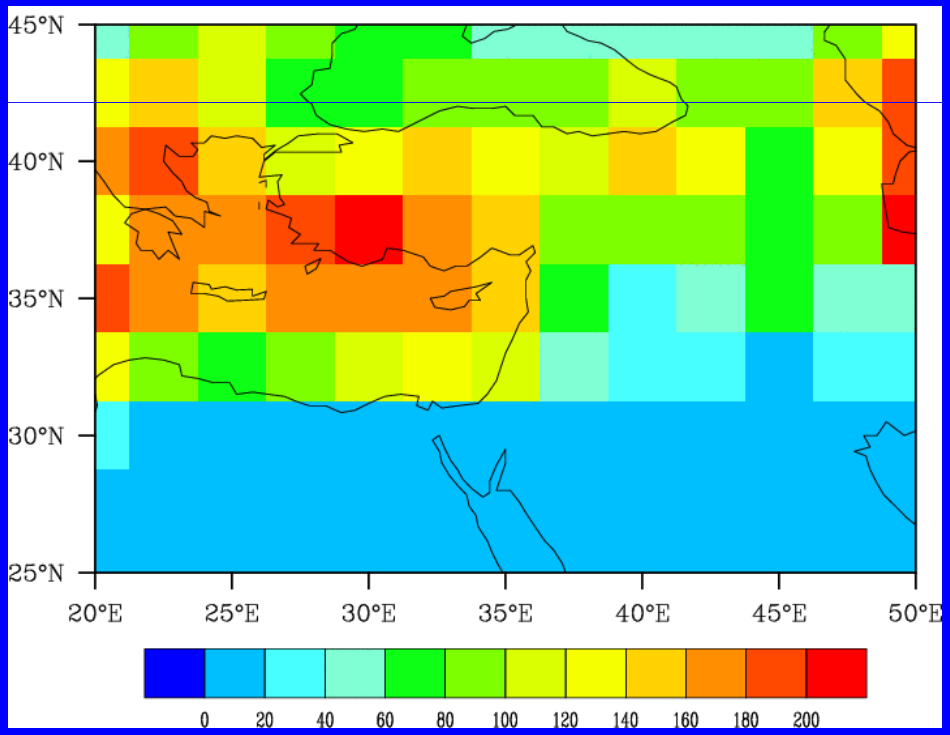
Hahmann et al., 2008



Saaroni et al., 2008

Motivation, ctd.

- Global seasonal forecasts provide partial and incomplete information about the expected precipitation amounts due to their coarse spatial resolution.



A typical CFS1.0-ensemble mean precipitation-rate forecast map zoomed into the Middle East

(issued on October 2009 shows a forecast for January 2010).

Climatology background

- **Precipitation season:**
  - September to May.
  - The most significant amounts→ **December-January-February (DJF),** and are associated with **Eastern Mediterranean (EM) cyclones**.

- **EM cyclones classification:**

  By Alpert *et al.* (2004), according to their minima intensity and geographic location.

- **Correlation between types of EM cyclones and local precipitation:**

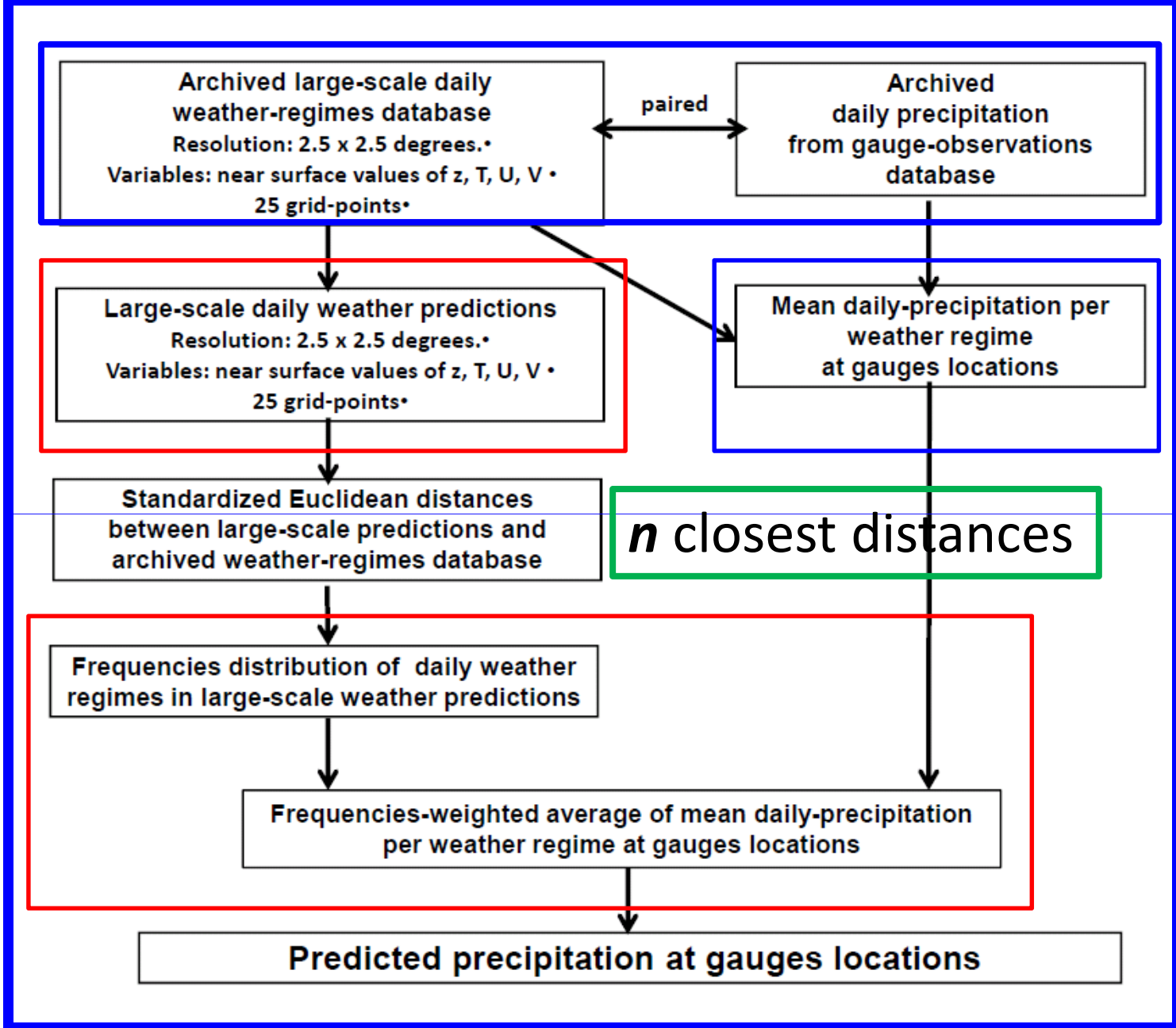
  Saaroni et al. (2010): strong correlation between spatial gradients in observed precipitation and
  - the preferred tracks followed by the cyclones,
  - their intensity,
  - and their interaction with the local topography and complex coastlines

- **Precipitation inter-seasonal variability**:

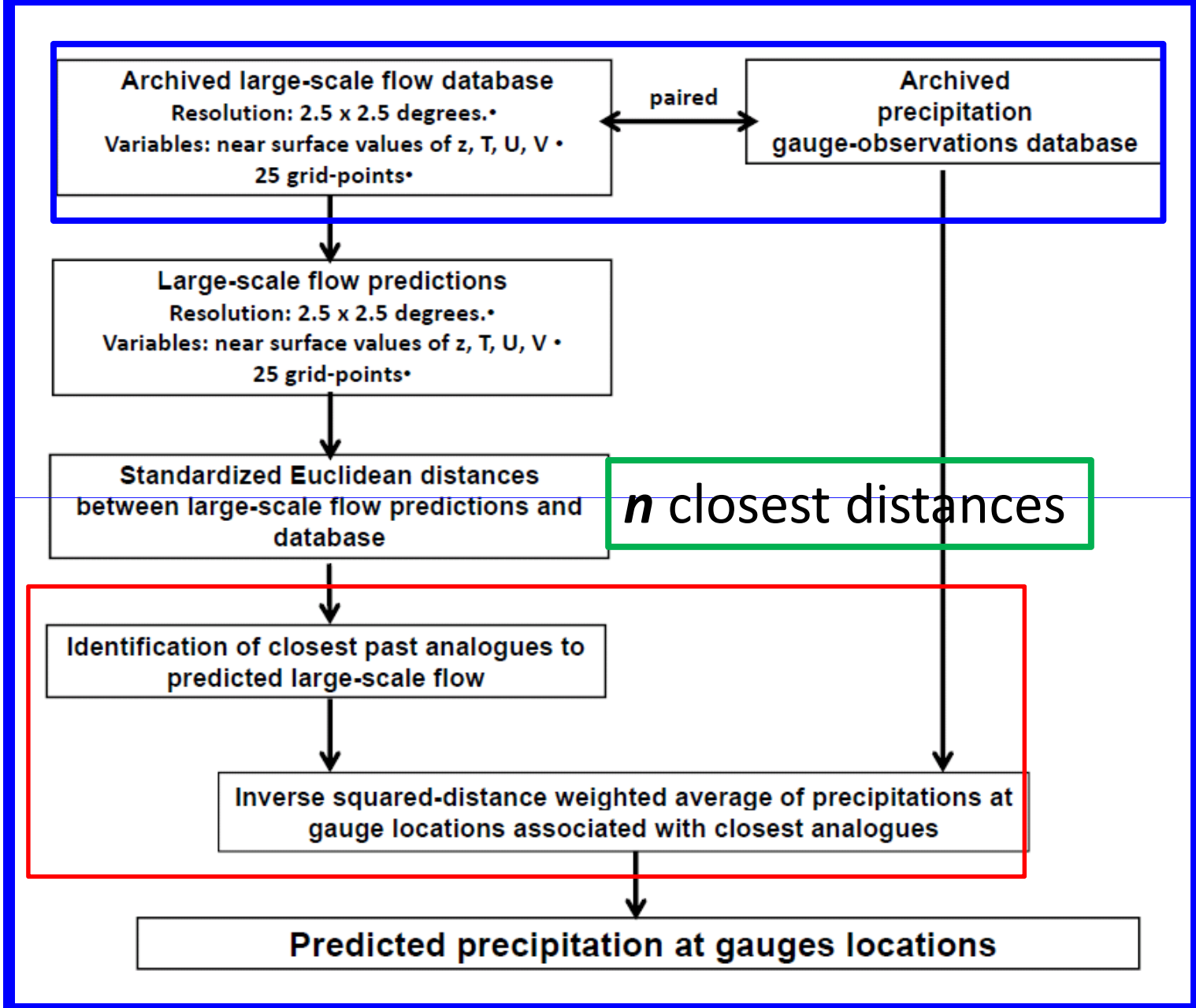
  a result of the frequency of the various types of EM cyclones that varies from season to season.

Method

- Statistical downscaling is based upon statistical links between large(r)-scale weather and observed local-scale weather.
- It is computationally inexpensive, and we are interested in an operational tool that can be run on a desktop/laptop computer.
- Our algorithms are based on the relationship between the large-scale flow associated with the EM cyclones and the spatial distribution of precipitation at pre-determined gauge stations.

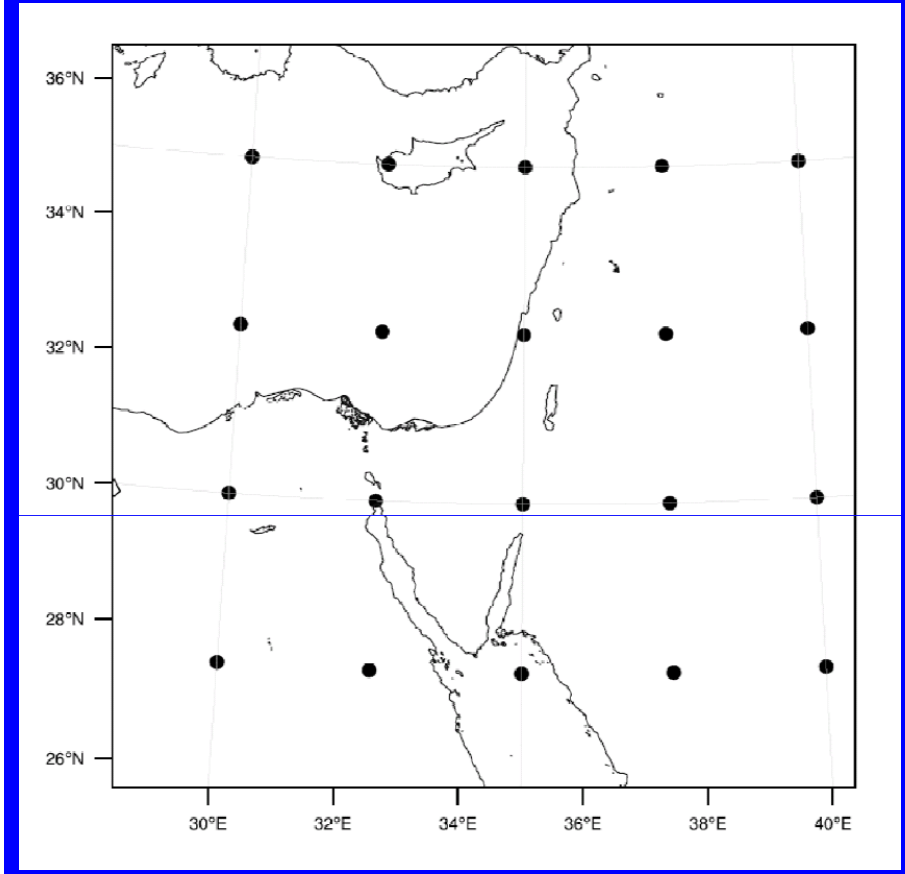


Weather-***R***egimes ***D***ownscaling (***WRD***) algorithm



Analogues ***D***ownscaling (***AD***) algorithm

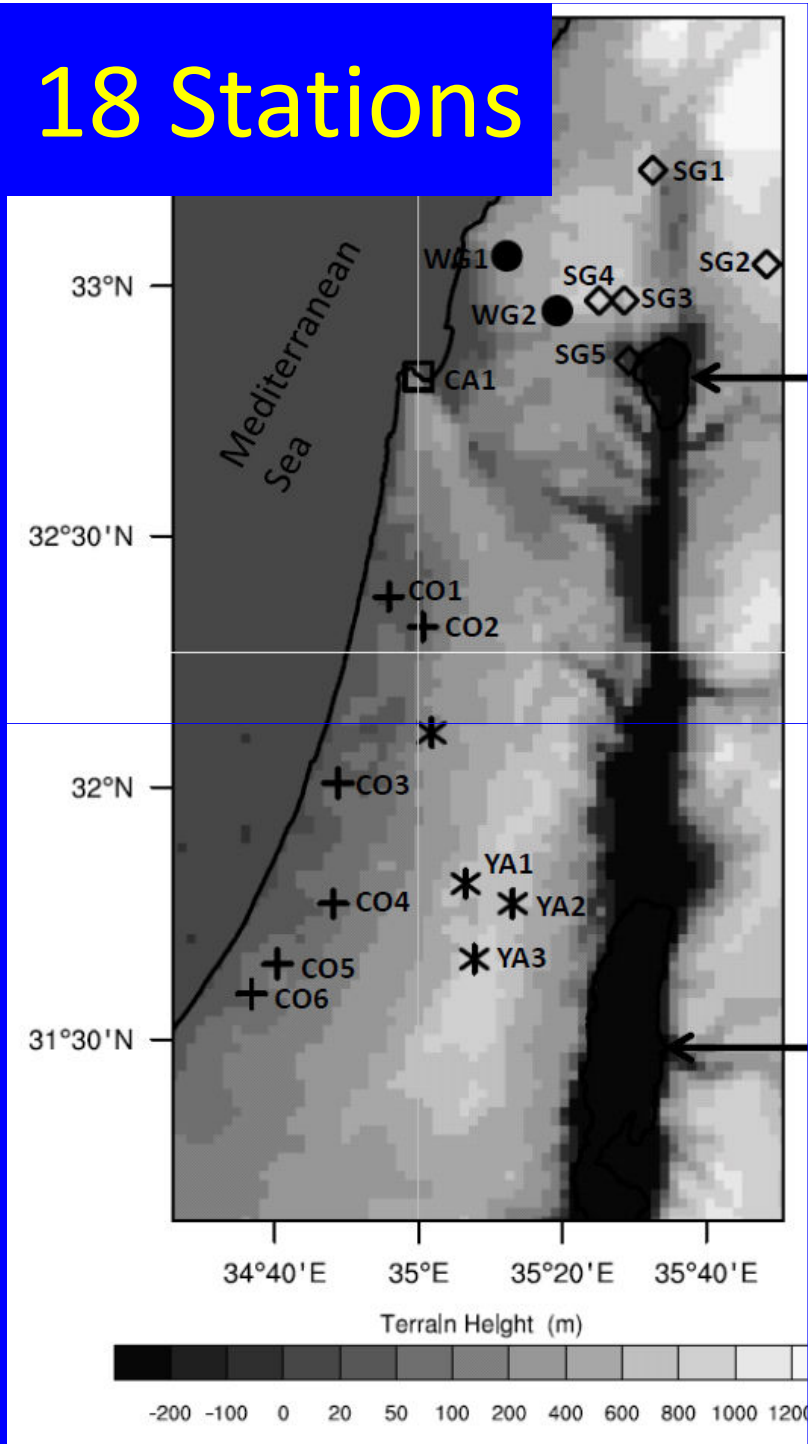
Large scale flow



25 grid points used individually to calculate the standardized Euclidean distances

(rather than considering spatial-averaged values over these 25 grid points)

18 Stations



Validation

- We validate the methods using ***N***CEP/***N***CAR ***R***eanalyses (**NNR**): "perfect large-scale flow" to test the accuracy of the assumptions in the algorithms.

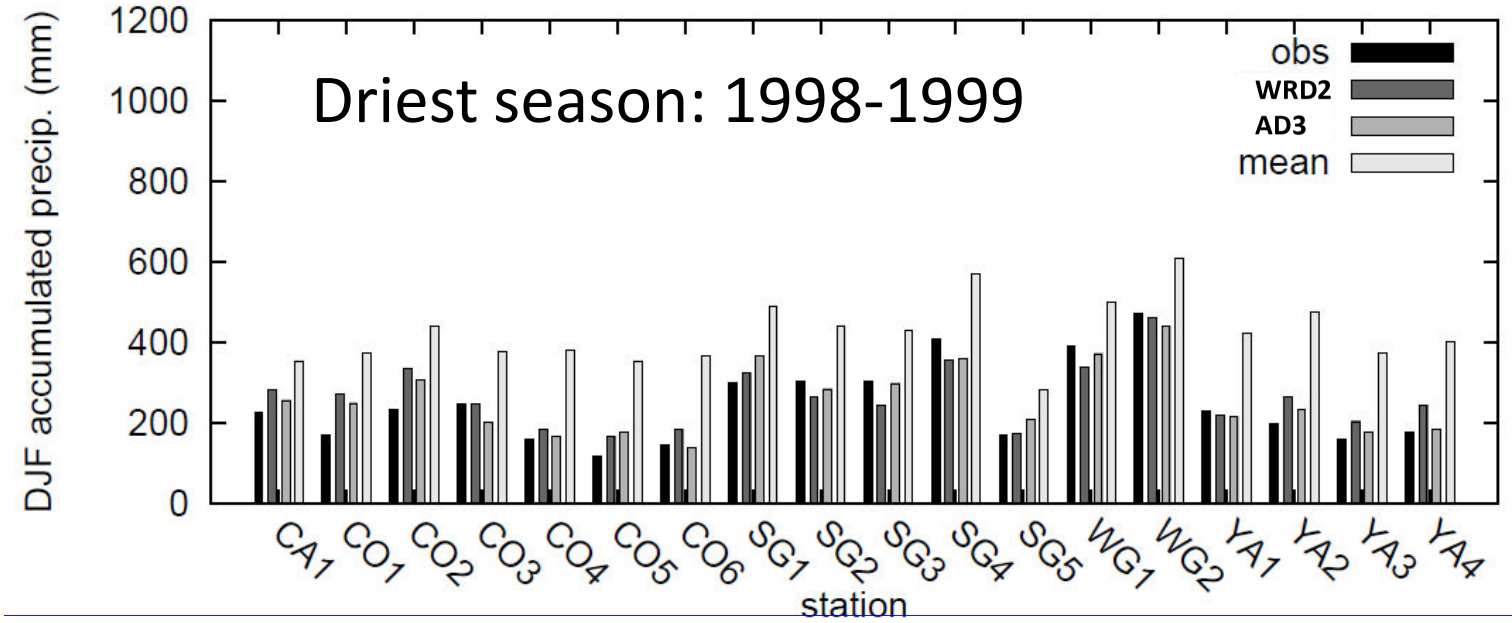
- 18 DJF seasons (1991-2008) are the reference set (reanalyses and their corresponding precipitation at each station).

- 21-27 DFJ seasons (between 1981 and 2008) were downscaled.

  (The downscaled year is excluded from the reference set if it falls in the reference period)

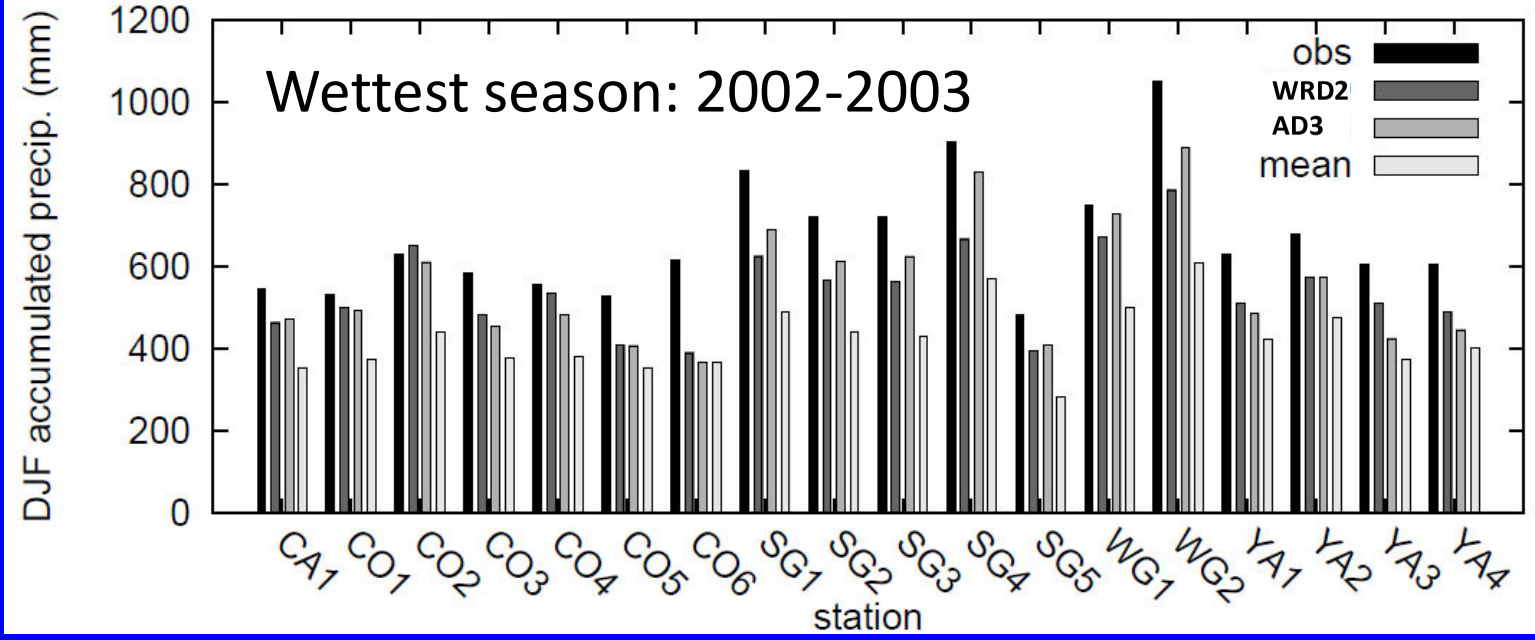
- The validation was designed to provide skill information that is useful to water resources managers.

Validation: Results



Correct reproduction of:

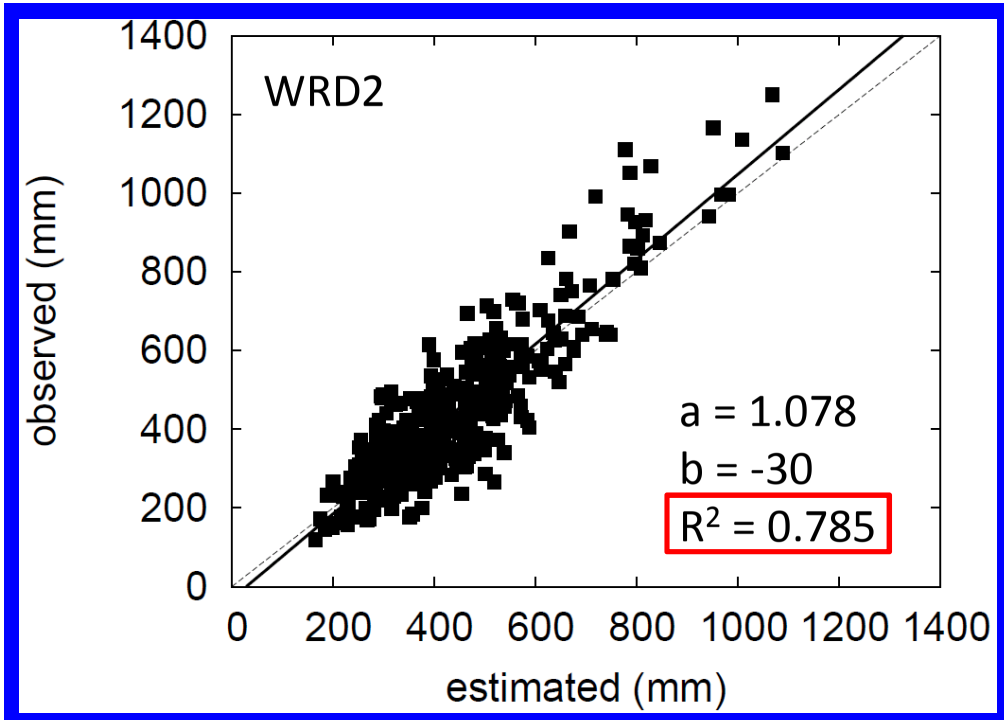
- All stations **below climo** mean
- Gradients between stations

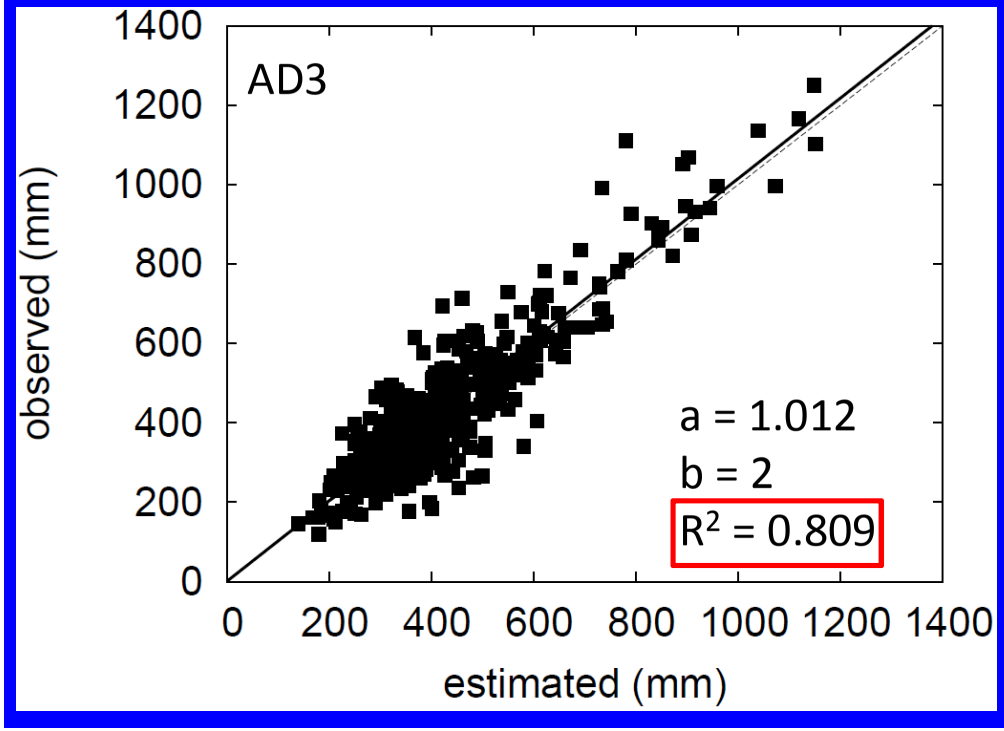


Correct reproduction of:

- All stations **above climo** mean
- Gradients between stations

Some advantage to AD3





Validation: Results

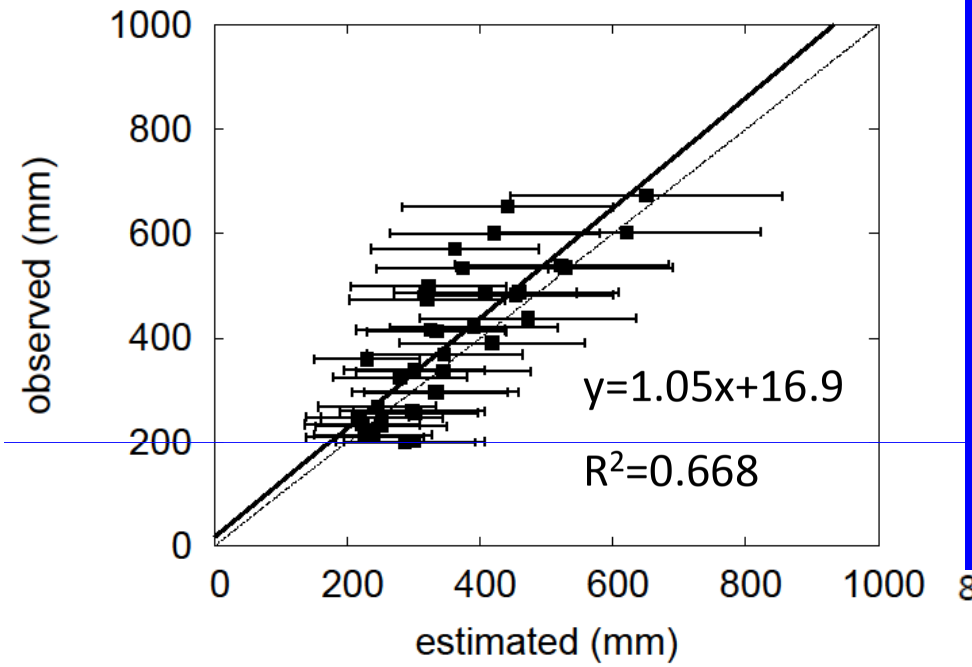
Linear relationship between downscaled and observed seasonal precipitation:

Observations = *a* * estimated + *b*

- Good linear agreement, some advantage of the AD3 method.
- Both methods explain ~80% of the observed variance.
- WRD2: larger underestimation of upper tail and overestimation of lower tail → weather-regimes mean daily-precipitation may be a poor estimate of the tails of the distribution.

Downscaling of ***seasonal CFS1.0 ensemble***: DJF, AN3

CFS1.0 initialized in October, 2009-2010 and 2010-2011 DJF precipitation

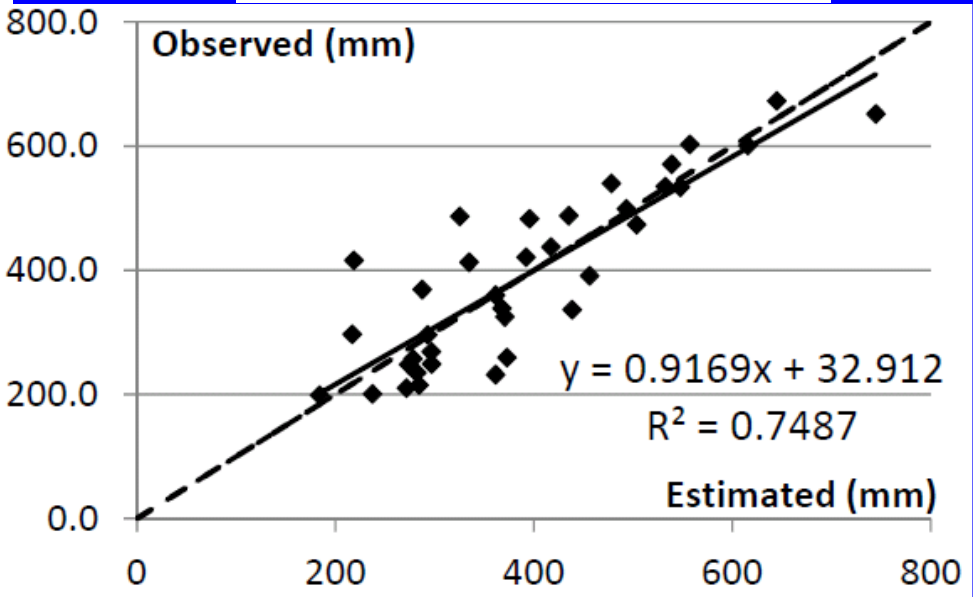


Error bars show ensemble spread is a function of the mean-precipitation amounts:

larger uncertainty found for the larger mean values.

- Good agreement, very similar to that using NNR as large-scale input.
- Regression explains 67% of the variance, somewhat lower than that explained when using NNR.

Same, but downscaled NNR



Summary

- I presented two statistical downscaling methods for precipitation at pre-determined stations, based on daily large-scale past analogues and their correlation with past daily local precipitation.

- The methods were validated at 18 stations using large-scale input from NCEP/NCAR reanalyses.

- Validation results proved good deterministic skill, good reproduction of observed inter-annual and spatial variability.
- Good probabilistic skill to (not) exceed precipitation thresholds as compared to climatology (not shown here).

- After validation the method was used to downscale 2 seasons of the operational CFS1.0-ensemble seasonal forecasts. The verification shows good agreement too.

Further work

- **Further improvement of the algorithms is possible by:**
  - Refinement of the weather-regimes classification or the identification of past analogues.
  - More sophisticate determination of minimum distances (e.g. Mahalanobis)
  - Estimations of the precipitation associated with weather-regimes and of its uncertainty could be improved by re-sampling events within the weather regimes.
- **The algorithms may be extended to downscale other variables:** e.g. temperature and winds, and provide valuable information to meteorology-dependent applications such as wind energy seasonal predictions.

Thanks