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

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NCAR, IIBR, LSRI, IHS

Introduction

- The seasonal precipitation patterns over the eastern Mediterranean show large spatial gradients over a relatively small geographical area due to:
  (a) large scale factors: the preferred tracks followed by the extra-tropical cyclones and their intensity
  (b) mesoscale factors: the local complex terrain, coastlines, and heterogeneous land properties
- **Monitoring and prediction of the seasonal precipitation** over this region are critical for estimating the amount of water that flows into water reservoirs during the rainy season.
- Global seasonal forecasts provide partial and incomplete information about the expected precipitation amounts due to their coarse spatial resolution of ~200 km grid-size.
- More accurate and useful forecasts require finer spatial resolution on the scale of a few kilometers.

Purpose

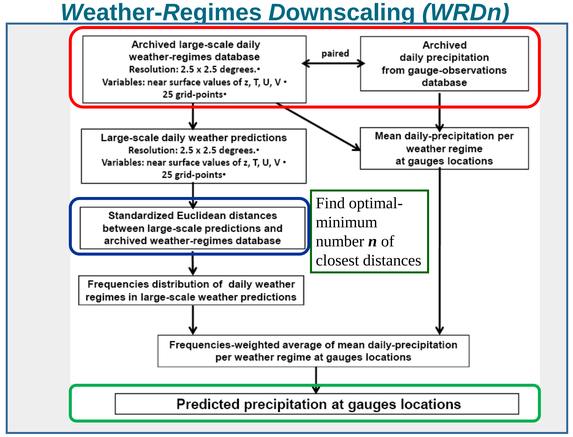
- We present ***two statistical-downscaling methods*** to estimate seasonal precipitation at pre-determined stations that rely on:
  - The atmospheric synoptic-scale flow.
  - A technique to find past-analogue synoptic-weather patterns
  - The connection between those synoptic scale weather scenarios and the local precipitation.
- **Method 1**: ***W*eather-*R*egimes *D*ownscaling (*WRD*)** - uses a classification of the large-scale weather patterns into 19 regimes as defined by Alpert *et al*. (2004).
- **Method 2: *A*nalogues *D*ownscaling (*AD*)** - identifies closest past analogues without grouping the weather events into defined regimes.

Summary of results and conclusions

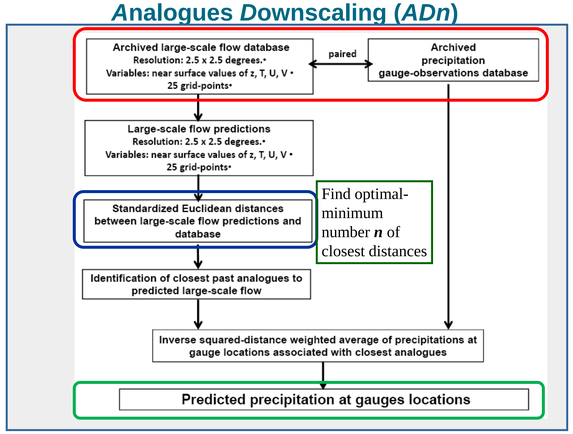
- **Verification of the methods using NCEP/NCAR reanalyses** and past precipitation observations at 18 selected stations proved:
  - **Good deterministic skill** as measured by the linear correlation between predicted and observed seasonal precipitation amounts.
  - **Good probabilistic skill** to exceed the upper tercile of the observed climatology, as assessed by the Brier skill score, its decomposition into reliability and resolution terms and by the area under the relative operating curve.
  - **Reproduction of the observed inter-annual and spatial variability.**
- **Similar skill** was obtained **when downscaling *CFS1.0 seasonal-ensemble forecasts***.

Methods

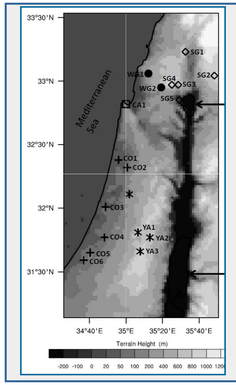
Weather-Regimes Downscaling (WRDn)



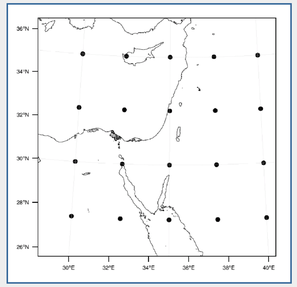
Analogues Downscaling (ADn)



18 gauge stations



Synoptic flow sampling

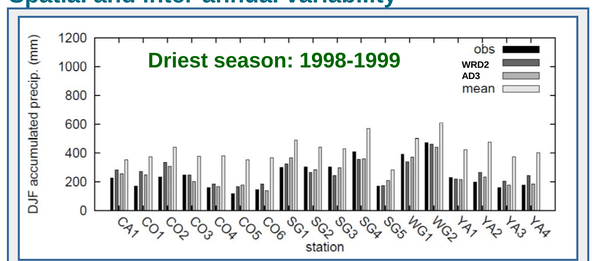


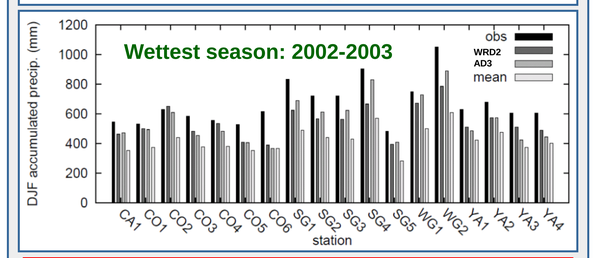
25 grid points used individually to calculate the standardized Euclidean distances

Verification results Downscaling NCEP/NCAR reanalysis

- **"Perfect synoptic flow" assumption at lead-time of interest**, to test the accuracy of the assumptions in the algorithms (real global forecast will add uncertainty).
- 18 December-January-February (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.

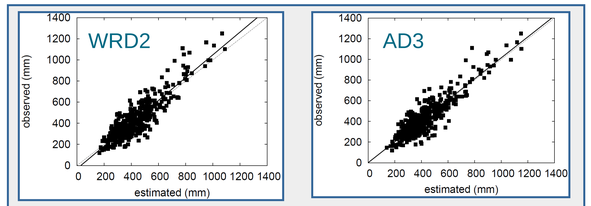
Spatial and inter-annual variability





- **Correct reproduction of:**
  - Exceedance (not exceedance) of climatological mean.
  - Gradients between stations.
- **Some advantage to AD3 method.**

Linear relationship between downscaled and observed seasonal precipitation



slope = 1.078
intercept = -30
R^2 = 0.785

- **Good linear agreement.**
- **Some advantage to AD3 method.**

slope = 1.012
intercept = 2
R^2 = 0.809

Verification results, continued.

Downscaling NCEP/NCAR reanalysis

Probability of exceeding the upper tercile of the observed climatology compared to climatological forecast

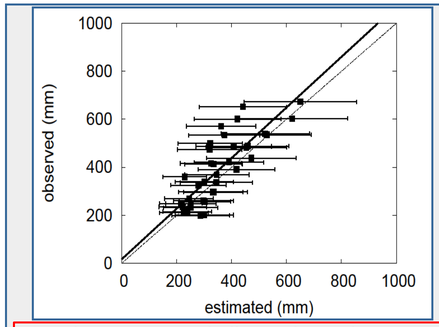
BSS = (resolution – reliability)/uncertainty

	WRD2	AD3	Perfect	No skill
Brier Skill Score (BSS)	0.4	0.4	1	≤ 0
Reliability	0.01	0.01	0	
Resolution	0.1	0.1	Uncertainty (observations distribution)	≤ reliability
Area under the relative operating curve	0.81	0.81	1	≤ 0.5

Both methods are capable of improving climatological forecasts of exceeding the upper tercile of the observed precipitation climatology.

Downscaling CFS1.0-ensemble seasonal forecast

- CFS1.0-ensemble initialized in October 2009 and 2010, 4 ensemble members per day.
- Downscaling of 2009-2010 and 2010-2011 DJF precipitation using ***AD3*** method.



slope = 1.05
intercept = 16.9
R^2 = 0.668

- Good agreement, similar to that using reanalysis.
- Explains 67% of the variance: lower than that explained using reanalysis for the same period (not shown here) → **real global seasonal forecasts add uncertainty**.
- Error bars show downscaled ensemble spread is a function of the mean-precipitation amounts: **larger uncertainty found for the larger mean values**