Towards a high-resolution climatography of seasonal precipitation over the south-eastern Mediterranean

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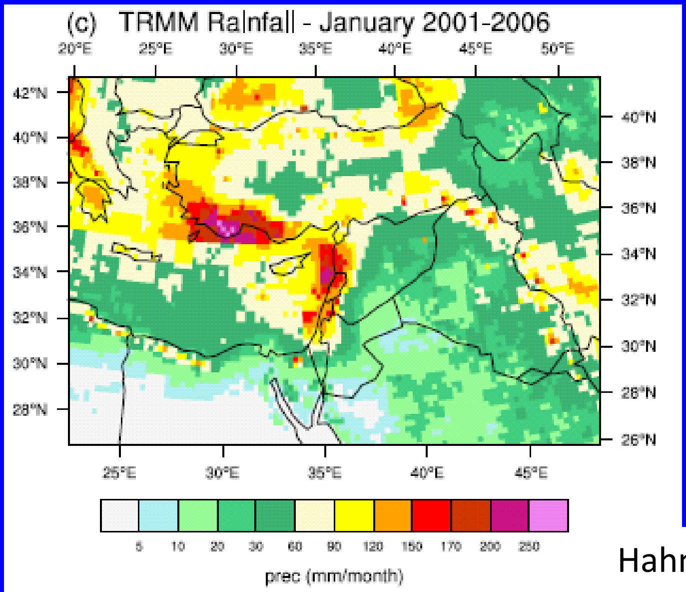
Motivation

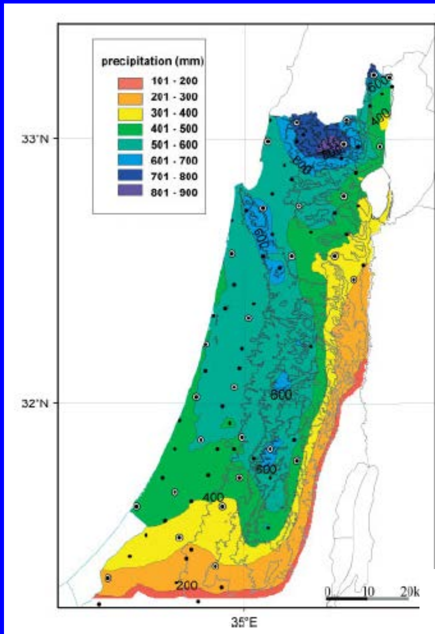
The precipitation over the south-eastern Mediterranean occurs during the transition and cold seasons and shows **large spatial gradients** over a relatively small geographical area, due to:

– **large scale factors:** the preferred tracks followed by the extra-tropical cyclones and their intensity

– **mesoscale factors:** the interaction of the cyclones with the local complex terrain, coastlines, and heterogeneous land properties



Hahmann et al., 2008



Saaroni et al., 2008

Motivation, cont.

- **Monitoring and prediction of the seasonal precipitation *are critical*** for estimating the amount of water that flows into the reservoirs in a semi-arid region.

- **Observations are essential.**

- **Observational spatial and temporal gaps** result from
  - uneven distribution of the observational network and
  - instruments failure.

Our aim

- Fill temporal and spatial gaps in past precipitation observations

- Improve statistical downscaling* of global seasonal forecasts using modeled past seasonal precipitation at a high horizontal resolution regular grid.

*See poster: Attendance Thu, 11 Apr, 17:30–19:00 /
Blue Posters B702, EGU2013-4
High-resolution forecasts of seasonal precipitation in the eastern Mediterranean: analogues downscaling of global forecasts, Dorita Rostkier-Edelstein et *al*.

Method:

Dynamical downscaling:

Has proven an effective approach
in estimating and reconstructing
high-resolution **<u>regional climatographies</u>***
in areas where observations are sparse.

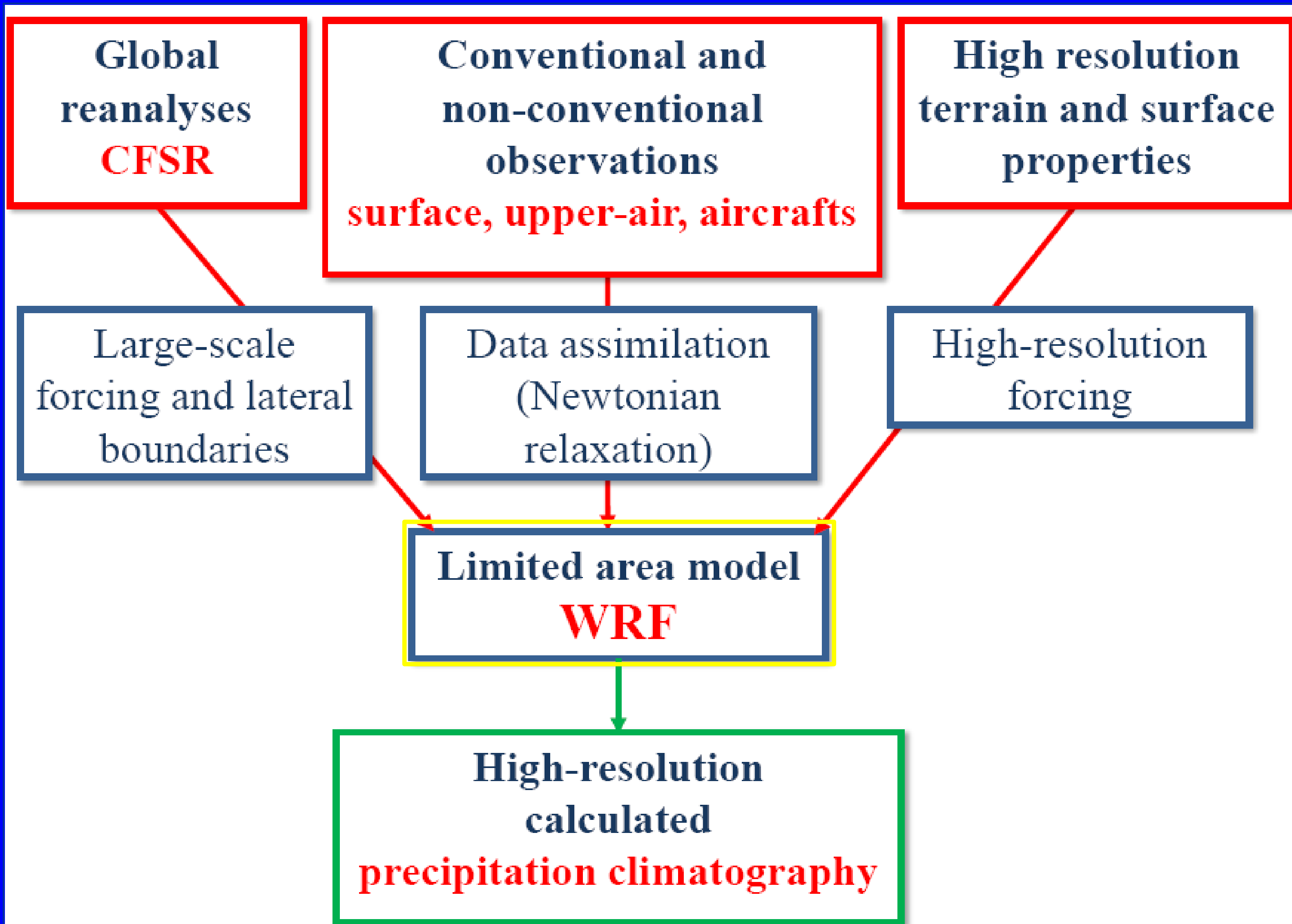
e.g. Hahmann, *et al*., 2008, Hahmann, *et al*., 2010 and Rife, *et al*., 2010.

(*climatography: a description of the climate based on an interpretation of a series of observations/simulations in contrast to the term climatology, which is the study of climate)

Method

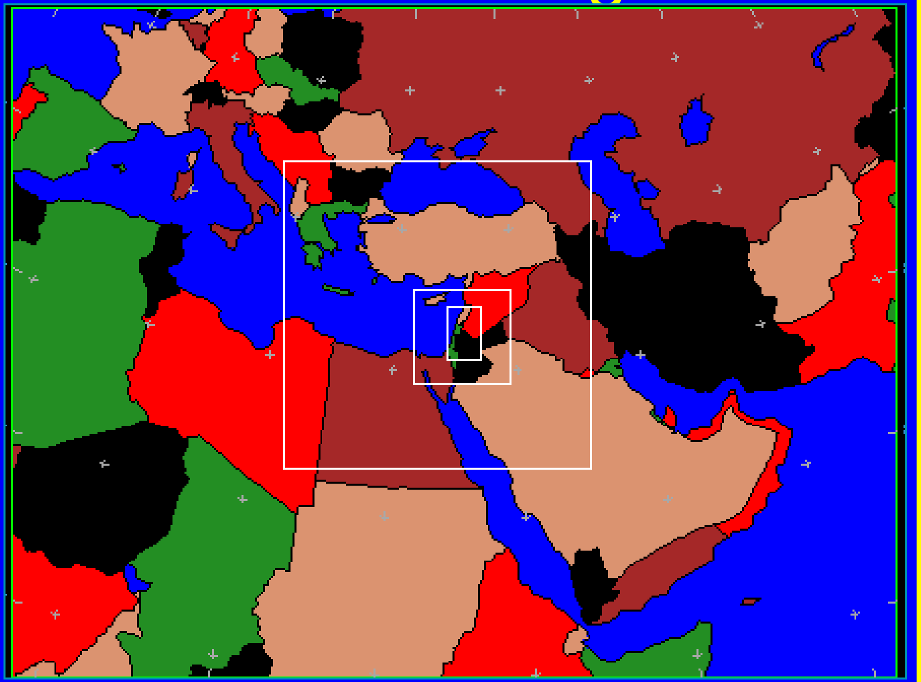
NCAR-RAL/WRF-FDDA dynamical downscaling system

(FDDA: Four Dimensional Data Assimilation)



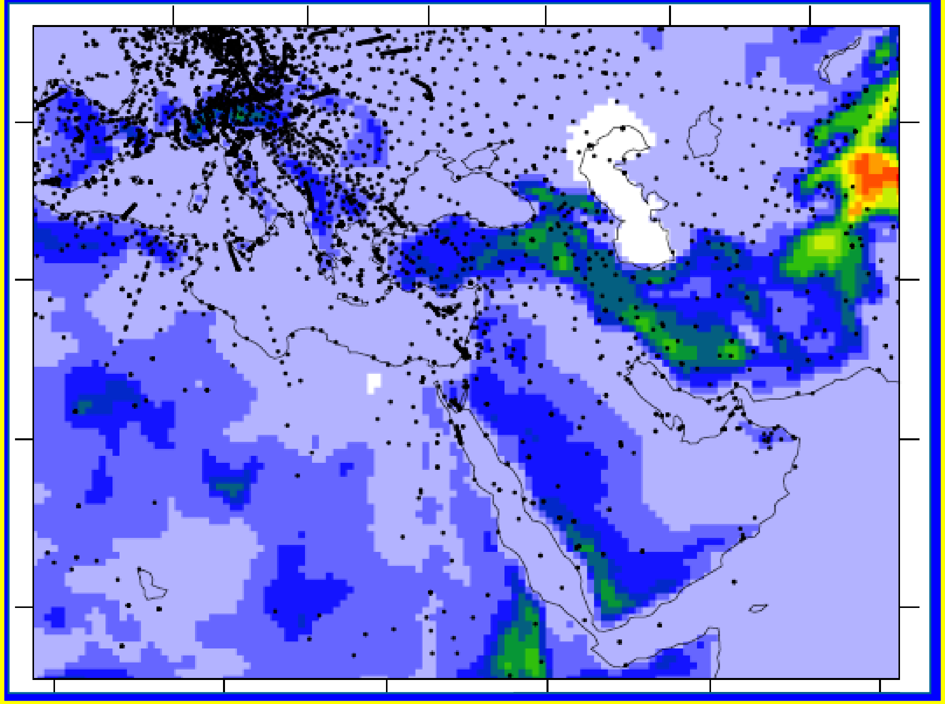
Method: Application to the region of interest

WRF-FDDA configuration



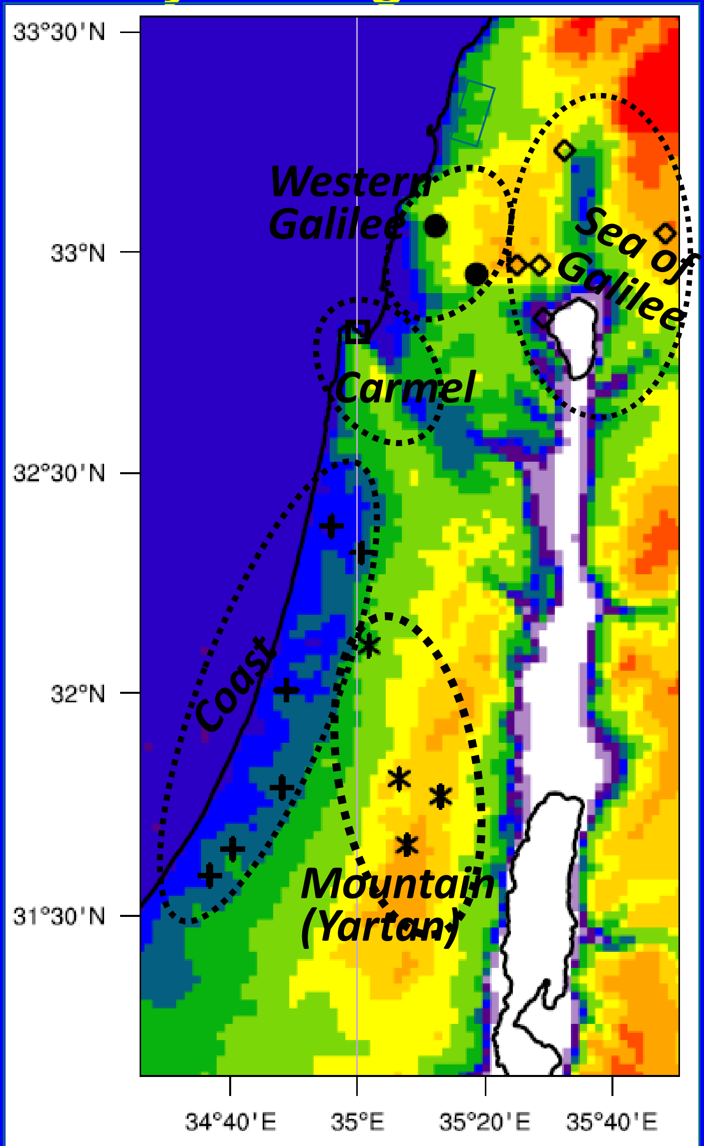
- 4 nested domains at 54, 18, 6 and 2 km grid spacing
- 37 vertical levels, 12 within the lowest 1 km
- Model top at 50 hPa.
- IC/LBC: NCEP's CFSR (0.5 degree)
- SST: 1/12th-degree RTGSST.

Snapshot of the spatial distribution of assimilated observations.



Verification strategy

18 reliable rain gauges
at 5 hydrological basins



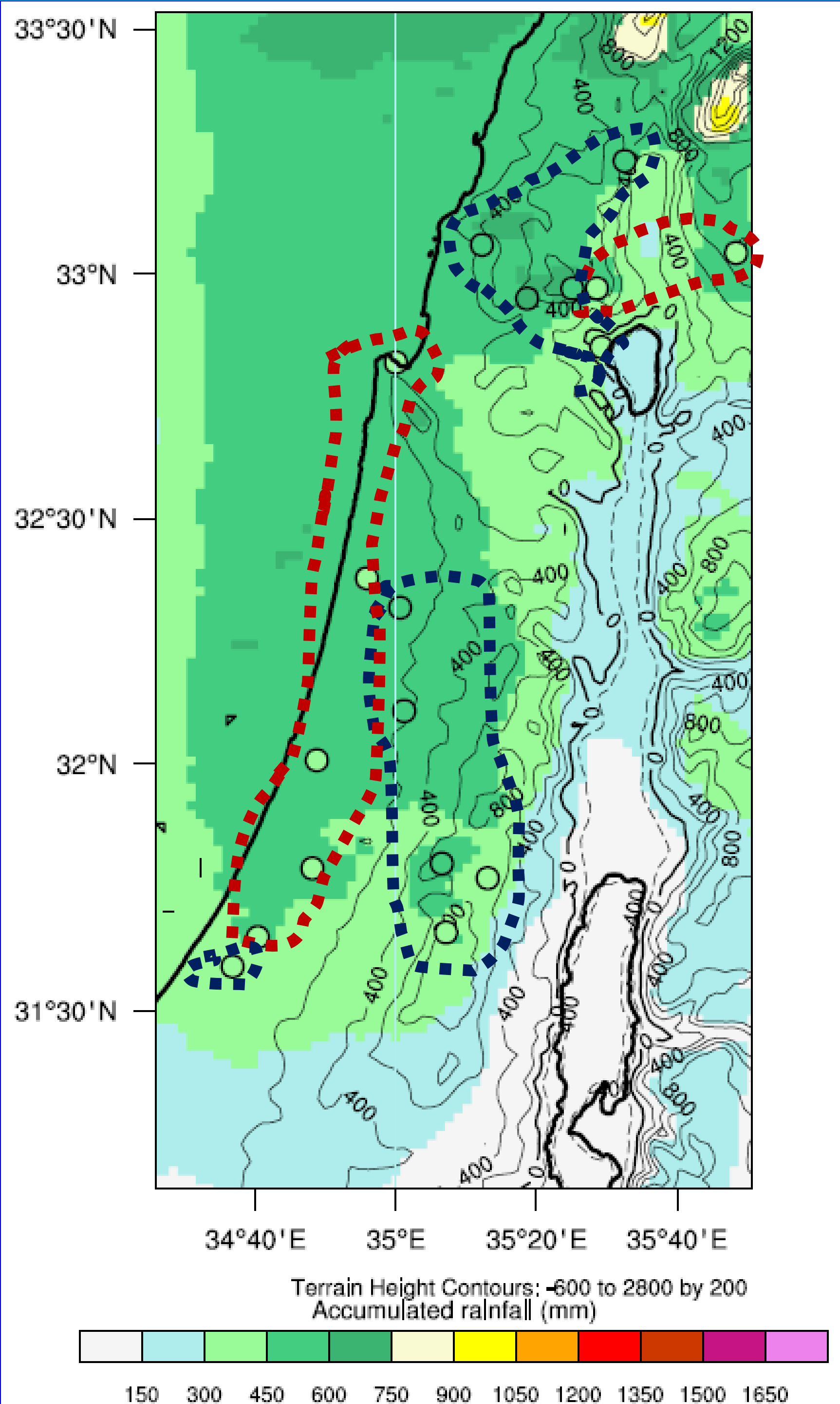
7 seasons

<u>December-January February (DJF):</u>

- 2008-2009
- 2007-2008
- 2006-2007
- 2005-2006
- 2004-2005
- <u>1998-1999 - dry extreme</u>
- <u>1991-1992 - wet extreme</u>

Results:

Multi-season mean spatial variability: 7-seasons mean



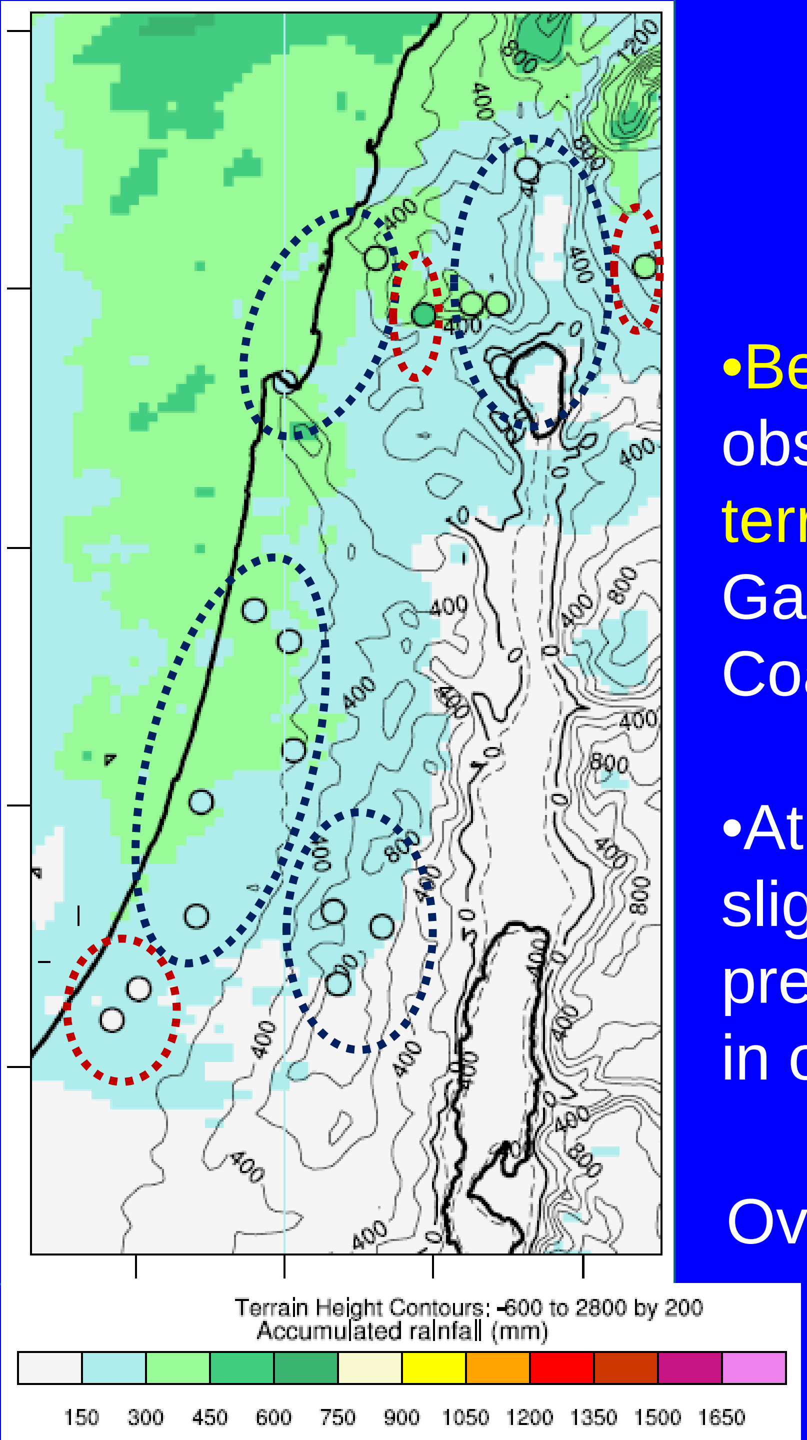
•Good reproduction at all wetter locations, and at some drier locations, in particular over complex terrain.

•Overestimation by one category in our scale at most stations along the Coast-Carmel basins, and at two sites in the Sea of Galilee basin.

•Correct category may be shifted as little as one or two grid-points.

•Best agreement in general over complex terrain: benefit of high-resolution lower-boundary forcing in the dynamical downscaling process.

•Possibly need for better SST data to further improve coastal precipitation.



Results:

Inter-season variability
Driest DJF, 1998-1999

- Best agreement between model and observations in basins with complex terrain: Western Galilee, Carmel, Sea of Galilee, and Yartan; and most of flat Coast.

- At some stations the model tends to slightly overestimate the observed precipitation (no more than one category in our scale).

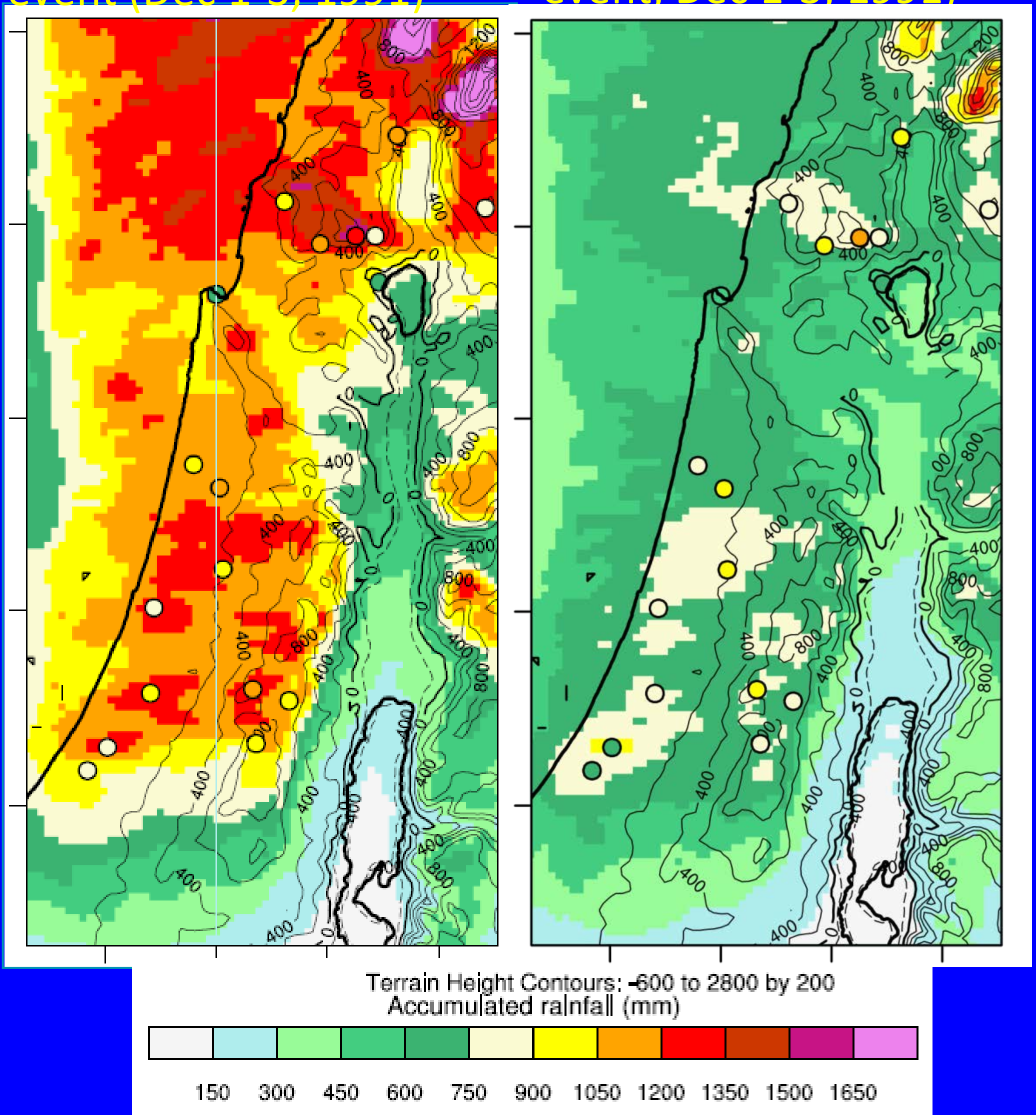
Overall, the driest simulated season, 1998-1999, was fairly well reproduced by the model.

Results: Inter-season variability

Wettest DJF, 91-92

Including rainiest 3-days event (Dec 1-3, 1991)

Excluding rainiest 3-days event, Dec 1-3, 1991)



- One of the wettest recorded seasons.
- Nov 28th - Dec 4th 1991: the rainiest spell recorded in 45 years.
- The difference between the figures illustrates the intensity of the event.
- Agreement between model and observations improved by excluding the rare event.
- Further tuning of the model for rare events is needed.

Results:

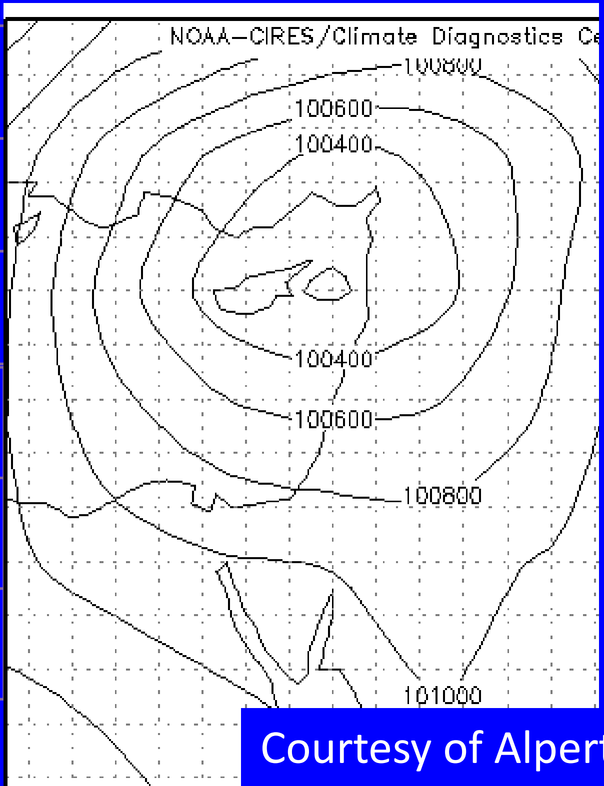
Skill as function of weather regime

•Correct reproduction of the seasonal precipitation at high spatial resolution is mainly conditioned to correct simulation of the extra-tropical cyclones by the downscaling technique.

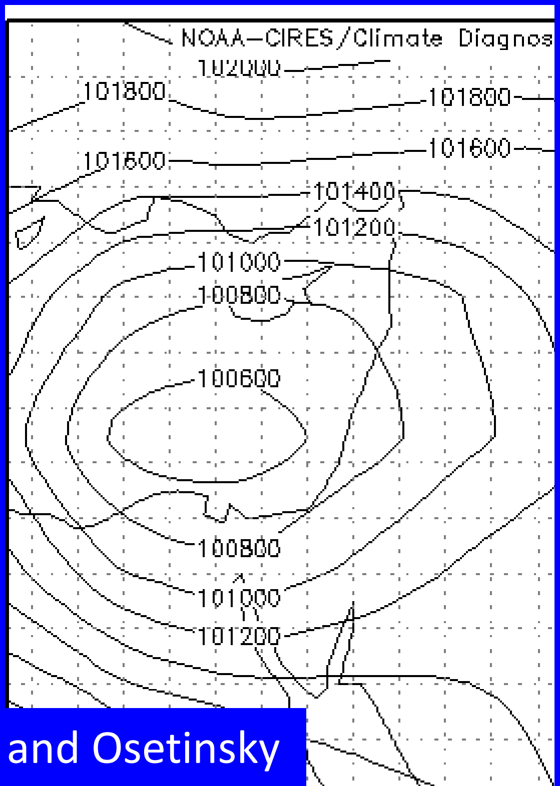
•Alpert, et *al.* (2004) classified the extra-tropical cyclones into 7 classes using a semi-objective method, 6 of which were identified in our seasons.

Low to the East (Deep) , LED
Low to the South (Deep), LSD
Low to the North (Deep), LND
Low to West, LW
Low to the North (Shallow), LNS
Low to the East (Shallow), LES

LND



LSD

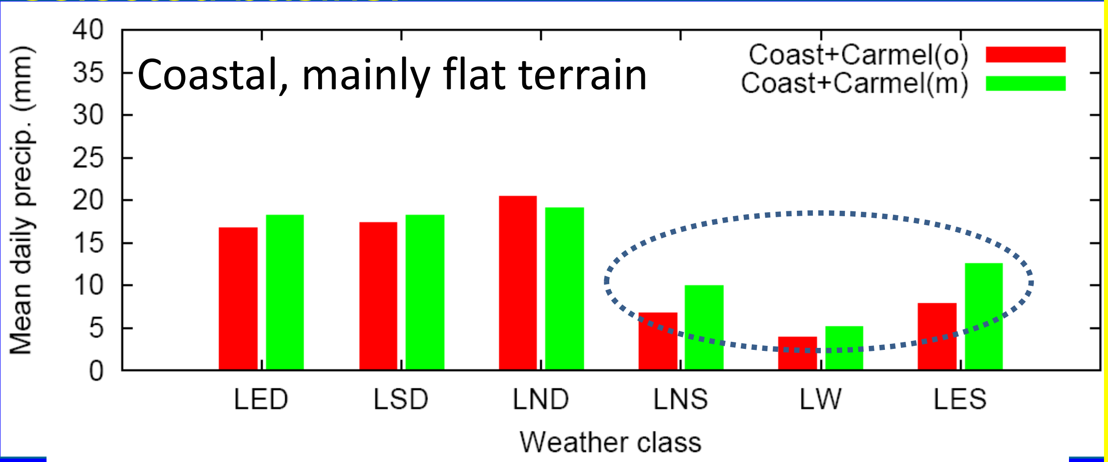


Courtesy of Alpert and Osetinsky

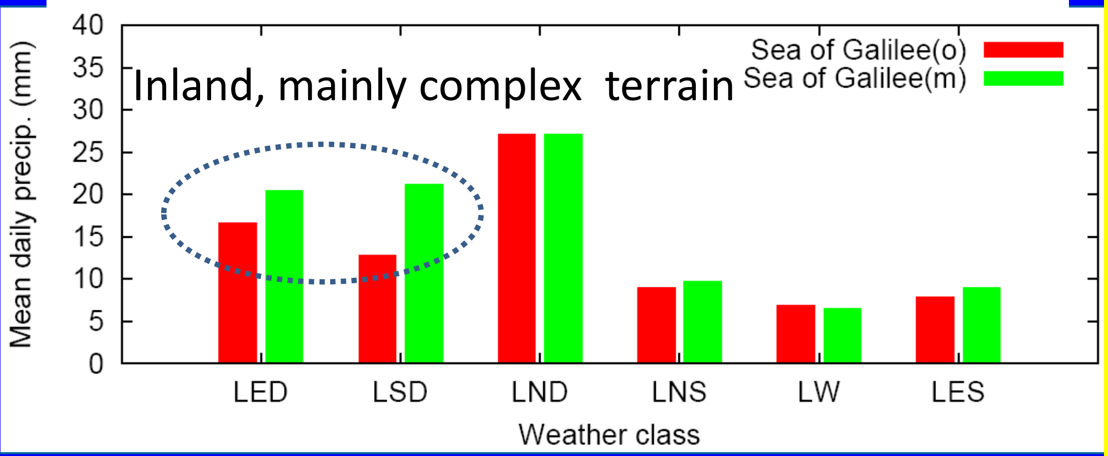
Results:

Skill as function of weather regime

Mean-daily precipitation for the different cyclone types averaged over the gauges at selected basins.



Red left: observations Green right: model.



Positive model biases for:

- shallow cyclones at coastal flat terrain
- deep cyclones at complex terrain.

Possible causes:

- High resolution terrain in the model plays a more significant role under weaker synoptic conditions.
- Under stronger synoptic flow the validity of the simulations rely more on the veracity of the large-scale.
- SST, that strongly determines precipitation in the coastal region, may not be accurate enough.
- Positive precipitation bias in WRF is known…

Summary and conclusions

- WRF-FDDA reproduced fairly well the spatial and inter-annual variability of the seasonal precipitation.
- Best agreement between model and observations is found over complex terrain, illustrating the benefit of the high-resolution lower-boundary forcing in the dynamical downscaling process.
- Some biases were observed over coastal flat terrain, dominated by large scale forcing and suggesting the need for better representation of SST.
- The model exhibited limitations in reproducing rare events, suggesting the need of further model tuning.
- Weather-regimes verification: biases are larger at coastal-flat areas under shallow-cyclonic conditions; deep-cyclonic conditions lead to more significant biases in complex-terrain regions.
- The weather-regimes dependent information may be used for further calibration of the downscaled precipitation.

Thanks

Reference:
Rostkier-Edelstein et al., *International Journal of Climatology.* Accepted with revisions.