Dynamical regionalization evaluation for a tropical area.

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Abstract:
To evaluate the capacities of two regional models, RegCM and WRF were forced with ERA-INTERIM Reanalysis and CNRM global model, with a temporal resolution of six hours and spatial resolution of 50 Km. for the historical period 2007-2012. Comparisons between the regional models were made applied to the northern and southern Mexican zones. We analyzed the interannual variability, the annual and seasonal cycles, by applying root mean square error, mean absolute error, standard deviation, temporal correlation and annual cycles.

Rationale: Due to its geographic location, orography and the effects of adjacent seas, Mexico has a great variety of climates, during summer and autumn, the meteorological events that affect the area, are associated with tropical dynamics (tropical waves, hurricanes and mesoscale convective systems mainly), while during winter the meteorological events are associated with extratropical dynamics (cold fronts). The local response associated with regional atmospheric dynamics is also influenced by low frequency processes, such as seasonal, annual, interannual and decadal fluctuations, contributing to the variability and climate change. The reproduction of these complex dynamics by models is a big issue.
The General Circulation Models (MCG) are a useful tool to contribute to the understanding of the global circulation, its resolution is adequate to describe global circulation patterns, however, it is insufficient to describe local processes, such as the effects of abrupt orography or small-scale atmospheric processes within 100 km. A dynamical reduction of scale is required, using regional models at higher spatial resolutions.

Goal:
To identify how well the models RegCM and WRF reproduce the regional climate using several parameterizations for both the northern and southern regions of Mexico,

Goal (Cont.)
we perfomed numerical experiments by forcing the regional models with Era-Interim and the global model CNRM-CM5 (one of the best performance in the area).

Methodology:
Numerical simulations of 5 years (2007-2012) with different parameterizations (WRF and RegCM models) (Table 1) were performed for the period 2007-2012, forcing both models with the Reanalysis ERA-INTERIM and the CNRM-CM5 model.

Configurations		WRF forced with ERA-INTERIM	REGCM forced with ERA-INTERIM
Domain		North America. Centered in México (14°S - 48°N, 60°W - 140°W)	North America. Centered in México (14°S - 48°N, 60°W - 140°W)
Resolution	Horizontal	50 km (174X149)	50 km (167X111)
	Vertical	28 levels. Top: 100 hPa	18 levels. Top: 100 hPa
Relaxation zone (km)		10 grid points	12 grid points
Parameterizations	**Radiation**	**RRTMG**	**CCSM**
	Surface	**Noah**	**BATS**
	PBL	**YSU**	**Holstag**
	Cumulus	**ARAKAWA (ARAKAWA) BETTS-MILLER (BETTS) GRELL-DEVENYI (GRELL-D) GRELL-FREITAS (GRELL-F) KAIN-FRITSCH (KAIN-F) KAIN-FRITSCH-CUMULUS POTENTIAL (KF-CUP) OLD KAIN-FRITSCH (OLD-KF) OLD GFS SIMPLIFIED ARAKAWA-SCHUBERT (SAS) NEW SIMPLIFIED ARAKAWA-SCHUBERT (SAS-HERF) TIEDTKE (TIEDTKE)**	**EMANUEL EMANUEL (EMA-EMA) EMANUEL GRELL (EMA-GRELL) GRELL EMANUEL (GRELL-EMA) GRELL GRELL (GRELL-GRELL)**
	SST	**Updated/daily**	**Updated/daily**

Methodology (cont)
An analysis of the performance of each parameterization was carried out using comparisons of spatial averages (north and south zones) using the following metrics: standard deviation, mean square error, mean absolute error, correlation, standard deviation and annual cycle, analyzing the seasonal precipitation and surface temperature.

R E S U L T S

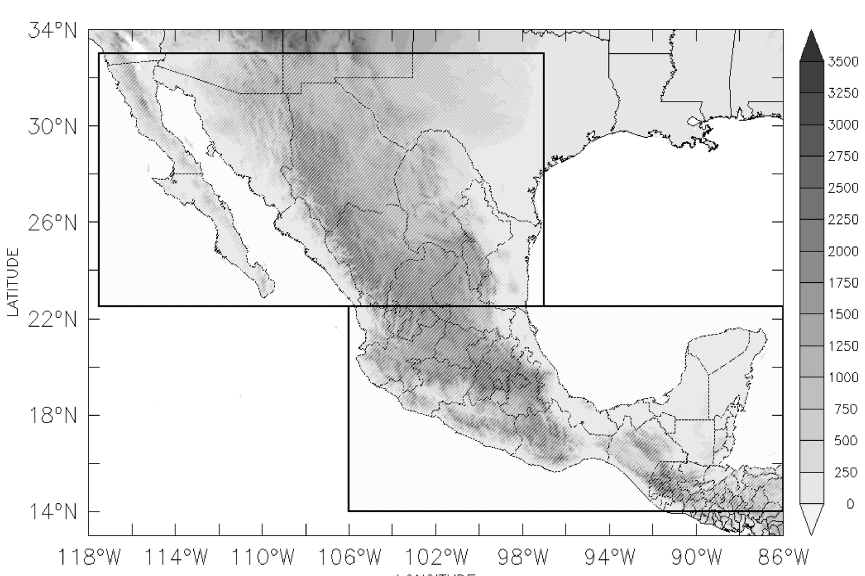

Fig 1. Areas analyzed: northern and southern Mexico.

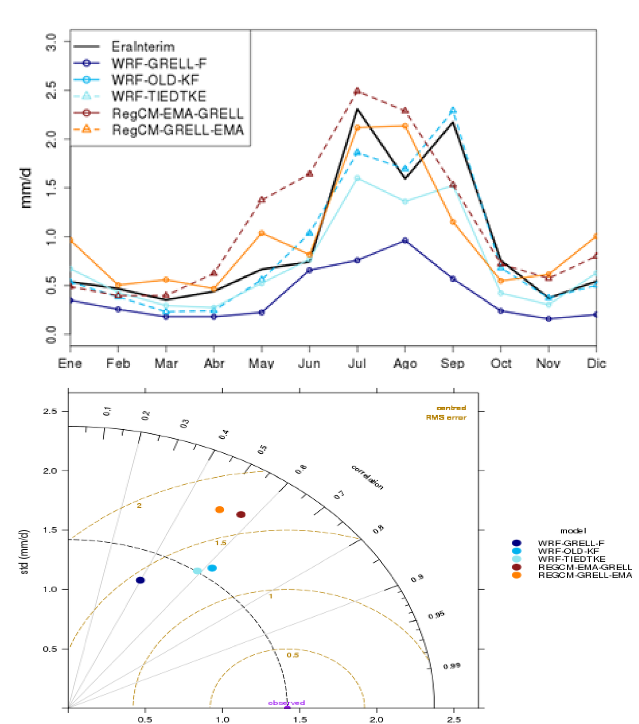

Fig 2. Annual cycle and Taylor diagram for precipitation. WRF and RegCM forced by ERA. Northern region.

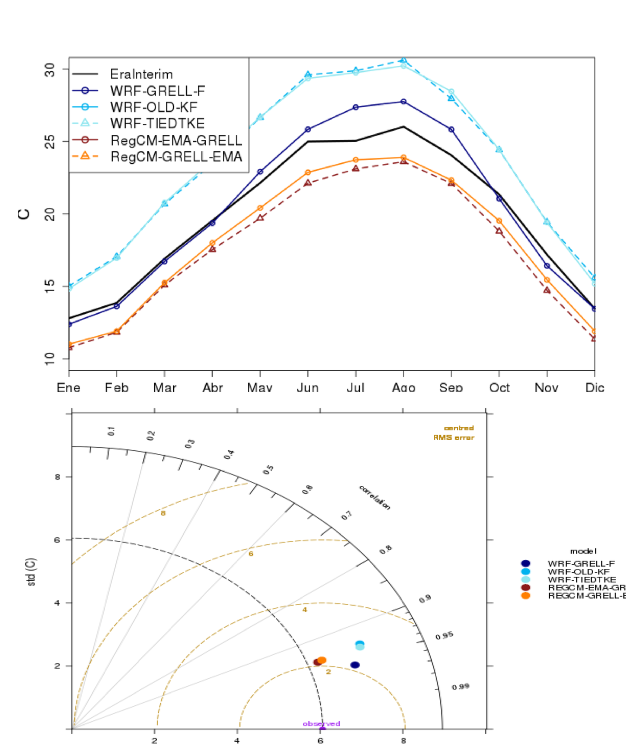

Fig 3. Annual cycle and Taylor diagram for surface temperature. WRF and RegCM forced by ERA. Northern region.

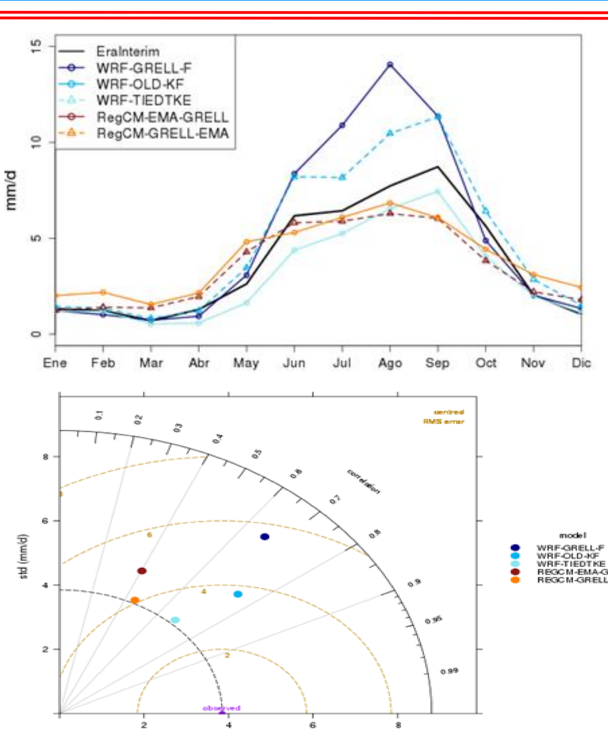

Fig 4. Annual cycle and Taylor diagram for precipitation. WRF and RegCM forced by ERA. Southern region.

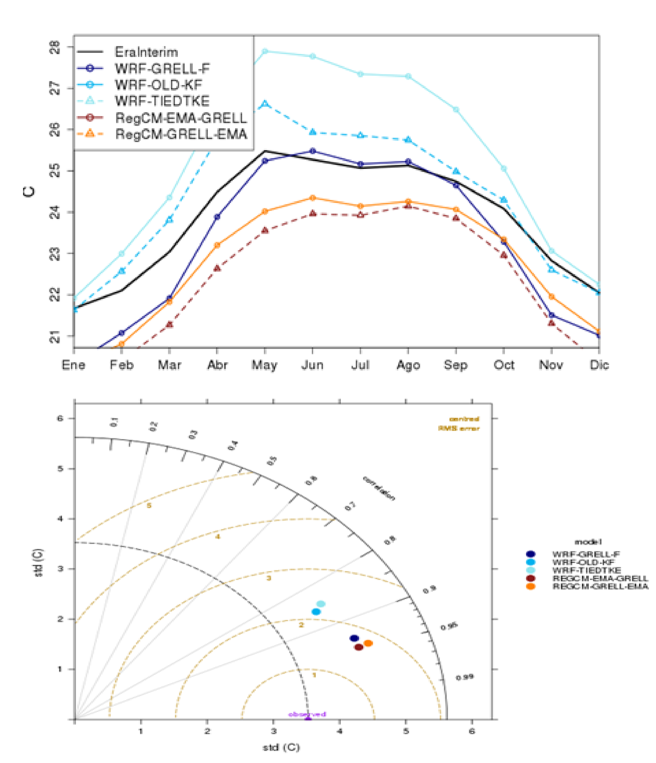

Fig 5. Annual cycle and Taylor diagram for surface temperature. WRF and RegCM forced by ERA. Southern region.

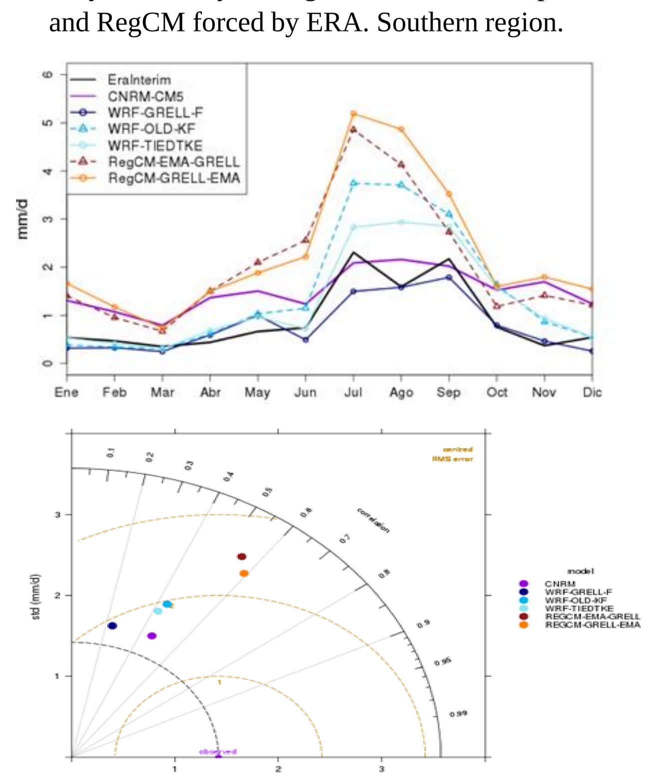

Fig 6. Annual cycle and Taylor diagram for precipitation. WRF and RegCM forced by CNRM-CM5. Northern region.

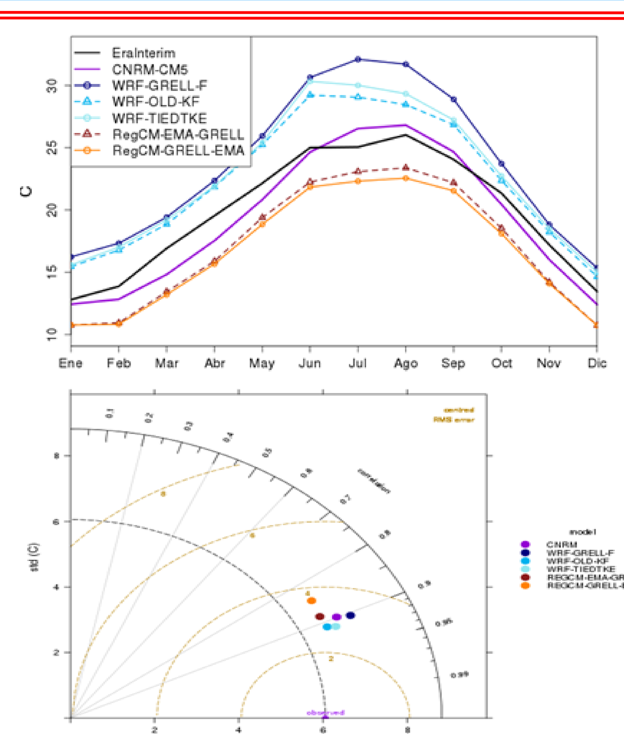

Fig 7. Annual cycle and Taylor diagram for surface temperature. WRF and RegCM forced by CNRM-CM5. Northern region.

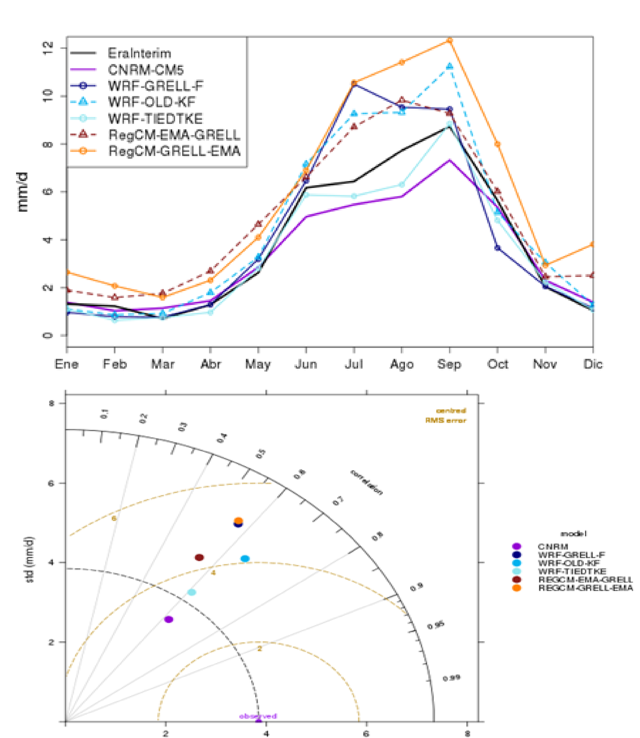

Fig 8. Annual cycle and Taylor diagram for precipitation. WRF and RegCM forced by CNRM-CM5. Southern region.

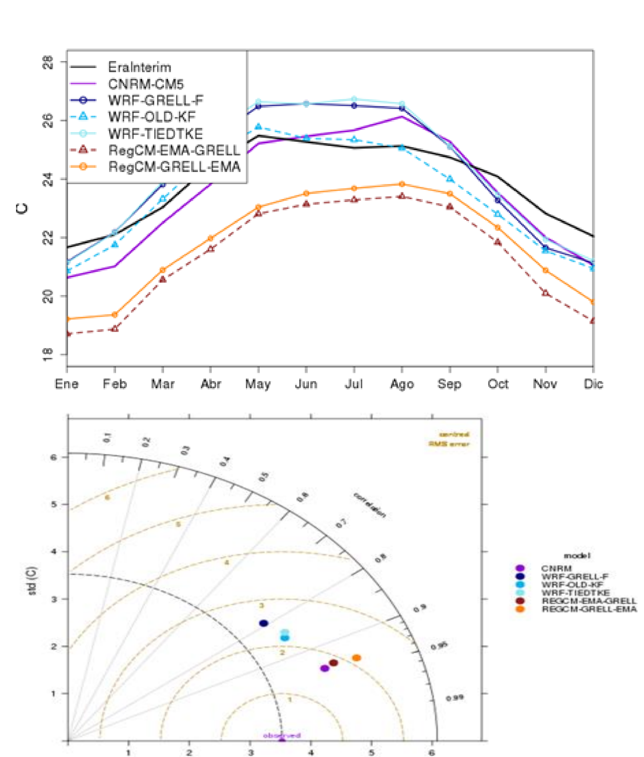

Fig 9. Annual cycle and Taylor diagram for surface temperature. WRF and RegCM forced by CNRM-CM5. Southern region.

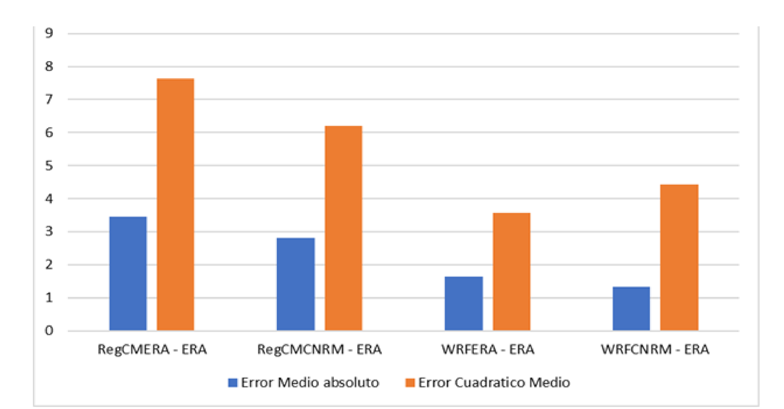

Fig 10. Mean absolute error (blue), root mean square error (orange). Precipitation. Northern region.

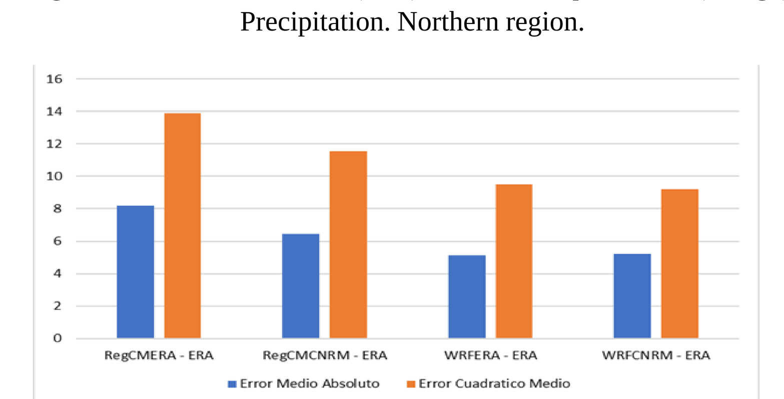

Fig 11. Mean absolute error (blue), root mean square error (orange). Precipitation. Southern region.

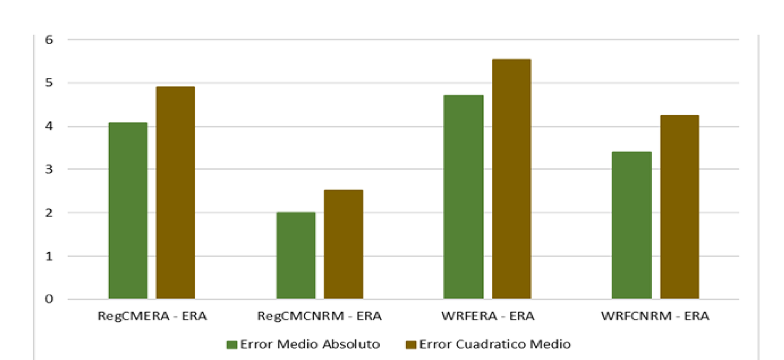

Fig 12. Mean absolute error (green), root mean square error (brown). Surface temperature. Northern region.

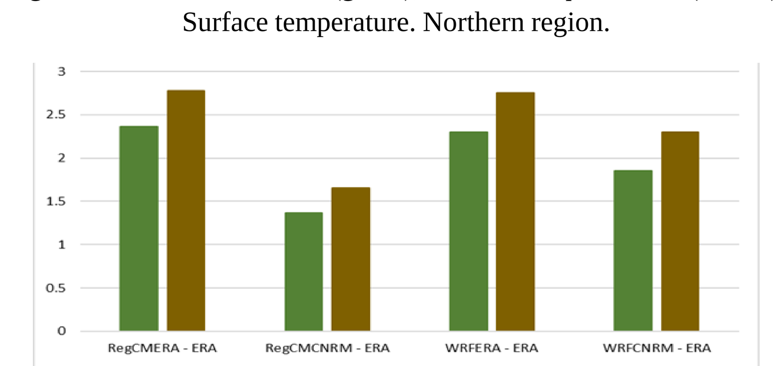

Fig 13. Mean absolute error (green), root mean square error (brown). Surface temperature. Southern region.

Remarks
For the temporal distribution in the northern zone, the configuration with the lowest performance in precipitation is the WRF model with Grell-F, underestimating the annual cycle, and the best approximation is TIEDKE. On the other hand, the RegCM configuration with the lowest performance is Emanuel over continent and Grell over ocean, while the best is Grell over continent and Emanuel over ocean.

The correlations of both models are similar, having greater standard deviation RegCM. For the surface temperature, the configuration with the lowest performance in WRF is TIEDKE. OLD-K overestimates the temperature for the annual cycle. For the RegCM configurations, the lowest performance is Grell over continent and Emanuel over ocean, while the best is Emanuel over continent and Grell over ocean. The correlations have similar values for both models: greater than 0.9, in both configurations of RegCM the correlation is similar: 0.95 with equal standard deviation, the highest correlation identified is WRF with Grell-F. This indicates that the temperature is best reproduced with respect to precipitation, both by the WRF model and RegCM.
For the southern zone, the temporal distribution of precipitation shows that the configuration with the lowest performance in WRF is Grell-F, overestimating the precipitation for the annual cycle, the best parameterization is TIEDKE. For RegCM it was observed that both configurations (Emanuel over continent and Grell over ocean and vice versa) are similar in the annual cycle, with a small underestimation between June and October. Regarding correlations, it is observed a large dispersion in both models, being the configuration of WRF with greater standard deviation Grell-F, the combinations of all configurations of WRF have the greatest correlation for precipitation in the southern zone. For the surface temperature, all the WRF configurations overestimate, except Grell-F, which is the best configuration. For the RegCM model, in its two configurations, the temperature is underestimated, being the best Grell over continent and Emanuel over ocean. In general, all configurations of both models qualitatively reproduce the temporal behavior. We observed that the lowest correlation is associated to the combinations of WRF: Grell-F and Old-K. On the other hand, the highest correlation, with 0.95, is associated to RegCM in its two combinations: Grell over continent and Emanuel over ocean and vice versa. Also in the southern zone, the surface temperature is best reproduced with respect to the precipitation, using both Models.

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