

A 3-D comparison of WRF forecasts with observations during the RHUBC-II campaign

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Motivation

The Atacama Desert in Chile is a region that has been studied relatively little and meteorological observations are scarce. Several astronomical observatories operating there need accurate forecasts.

The **RHUBC-II** campaign was held at Cerro Toco (altitude – 5322 m) from August to October 2009. It provides a great opportunity to assess WRF (Weather Research & Forecasting) model forecasts over this region.

WRF configuration

Two model configurations (**Sim1** and **Sim2**) were used.

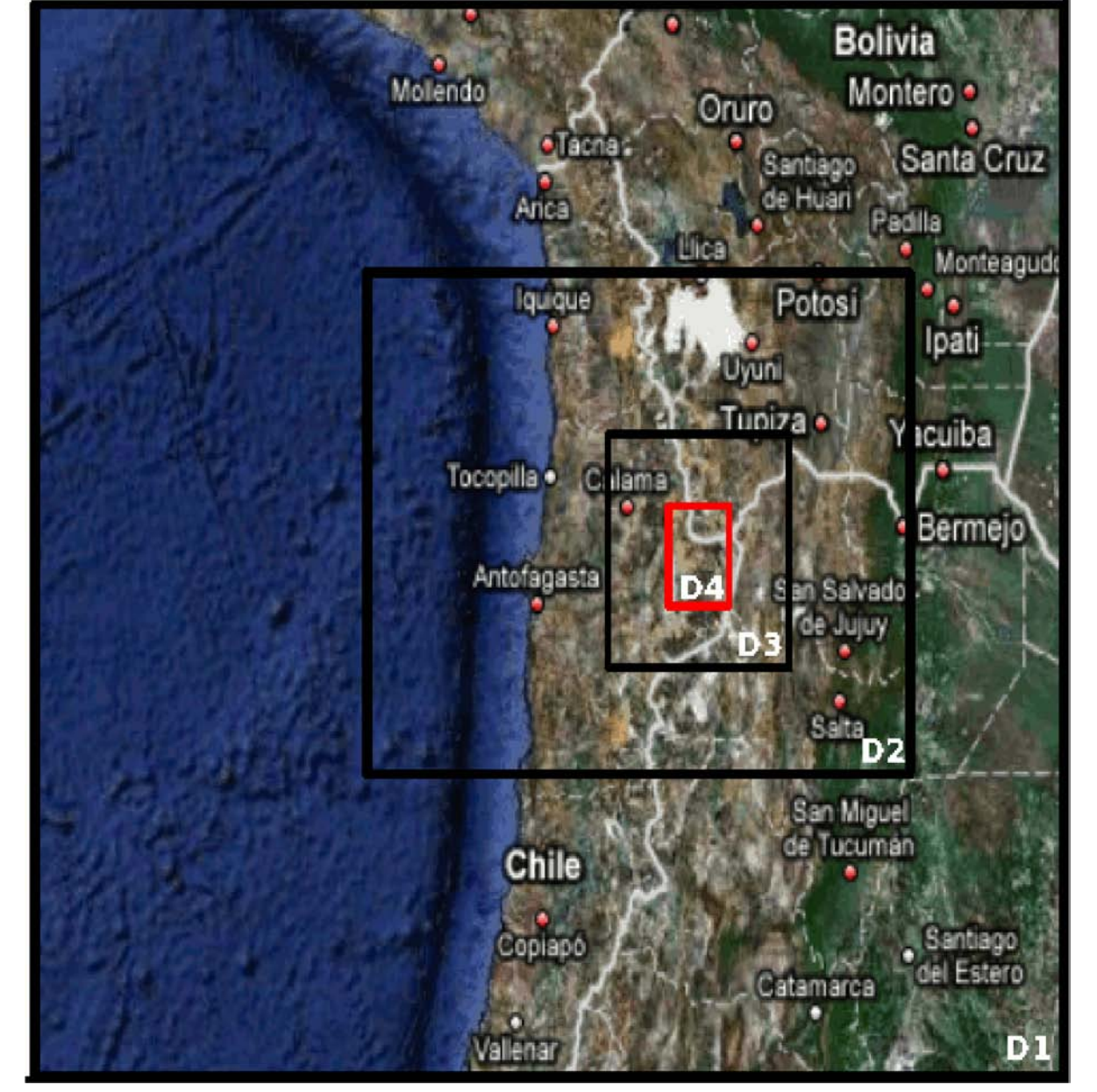


Fig. 1: Four nested domains were used in WRF simulations.

Initial and boundary conditions: GFS forecasts 1° x 1°. Simulations started every day at **12UTC**. 72 h run. Only **D4** is used in the analysis.

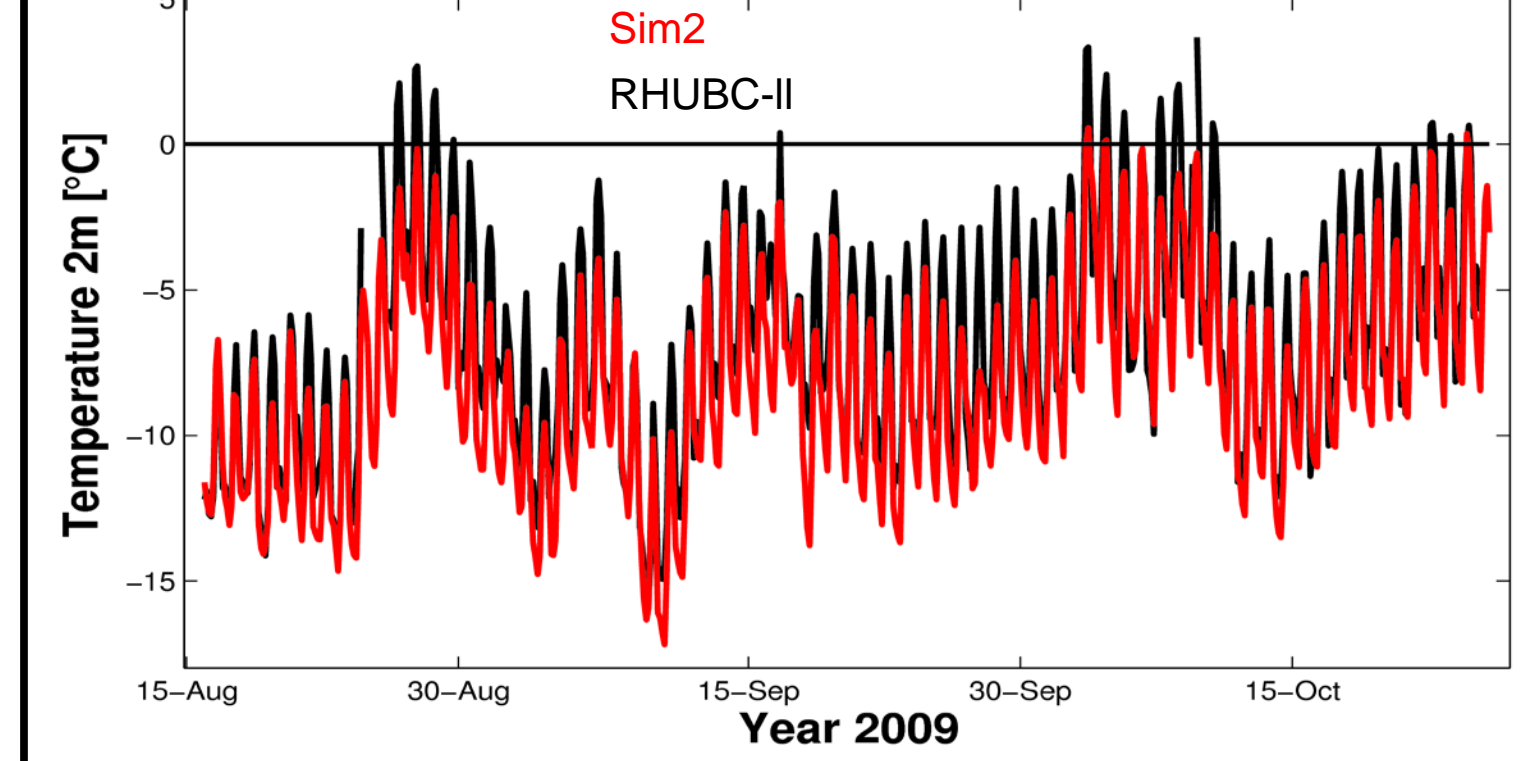
Domains	Nx	Ny	Grid space [km]	Area [km ²]
D1	70	53	27	1890 x 1431
D2	82	93	9	738 x 657
D3	97	97	3	291 x 291
D4	112	112	1	112 x 112

WRF	Sim1	Sim2
Microphysics	WRF Single-Moment 3-class	
Cumulus	Kain-Fritsch	
LW Radiation	RRTM	
SW Radiation	Dudhia	
PBL	Eta scheme: MYJ	
Surface Layer	Eta similarity	
Land surface	5-layer thermal diffusion	Noah LSM
Land-use data	USGS 5-min (~9 km)	MODIS 30 sec. (~1km)

Observations

RHUBC-II Surface Variables • Temp. 2m • qv 2m	Radiosondes • Temperature • Dew Point • RH • PWV	CloudSat Vertical profiles • Cloud water • Ice water	TRMM Vertical profiles • Cloud water • Ice water
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Results



Figs. 2: Temporal evolution of 2m temp. for observations and Sim2.

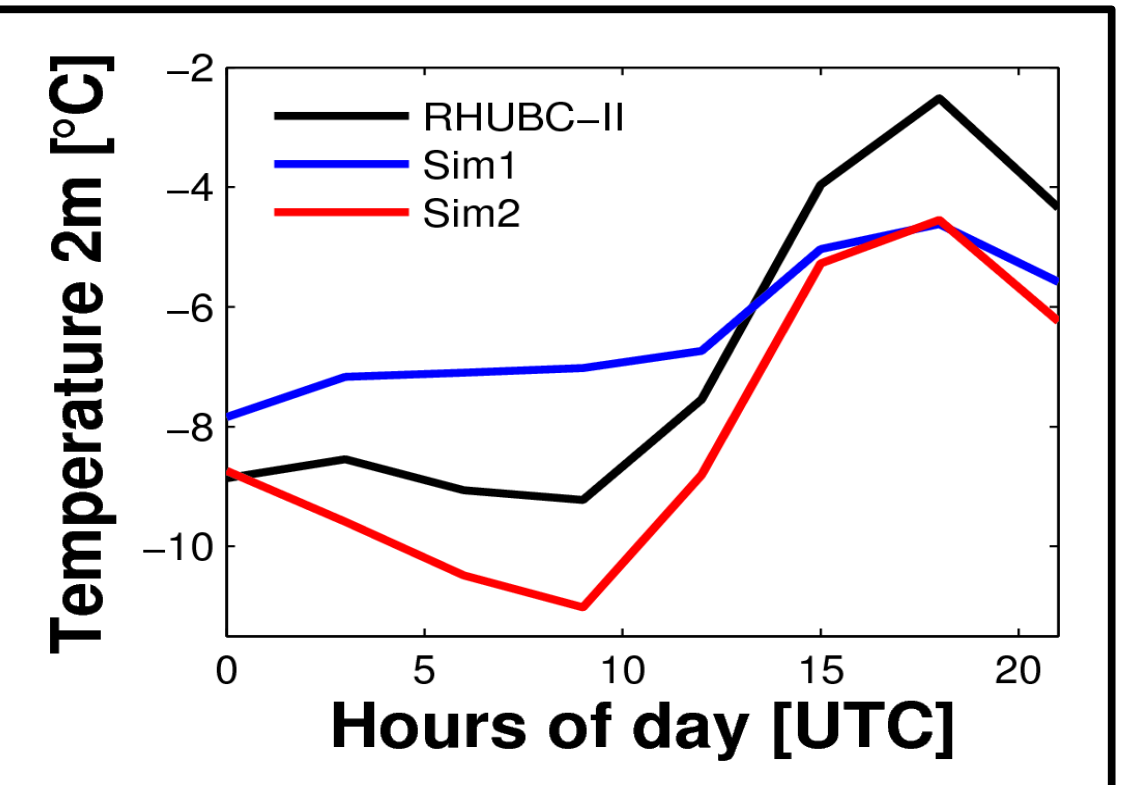


Fig. 3: Mean diurnal cycle of 2m temp. Observations and simulations.

WRF	RMSE [°C]	Mean Bias [°C]
Sim1	2.0	0.3
Sim2	1.9	-1.4

Both simulations reproduce reasonably well the day-to-day variations in 2m temperature. Sim1 underestimates the diurnal cycle. Sim2 shows a negative bias.

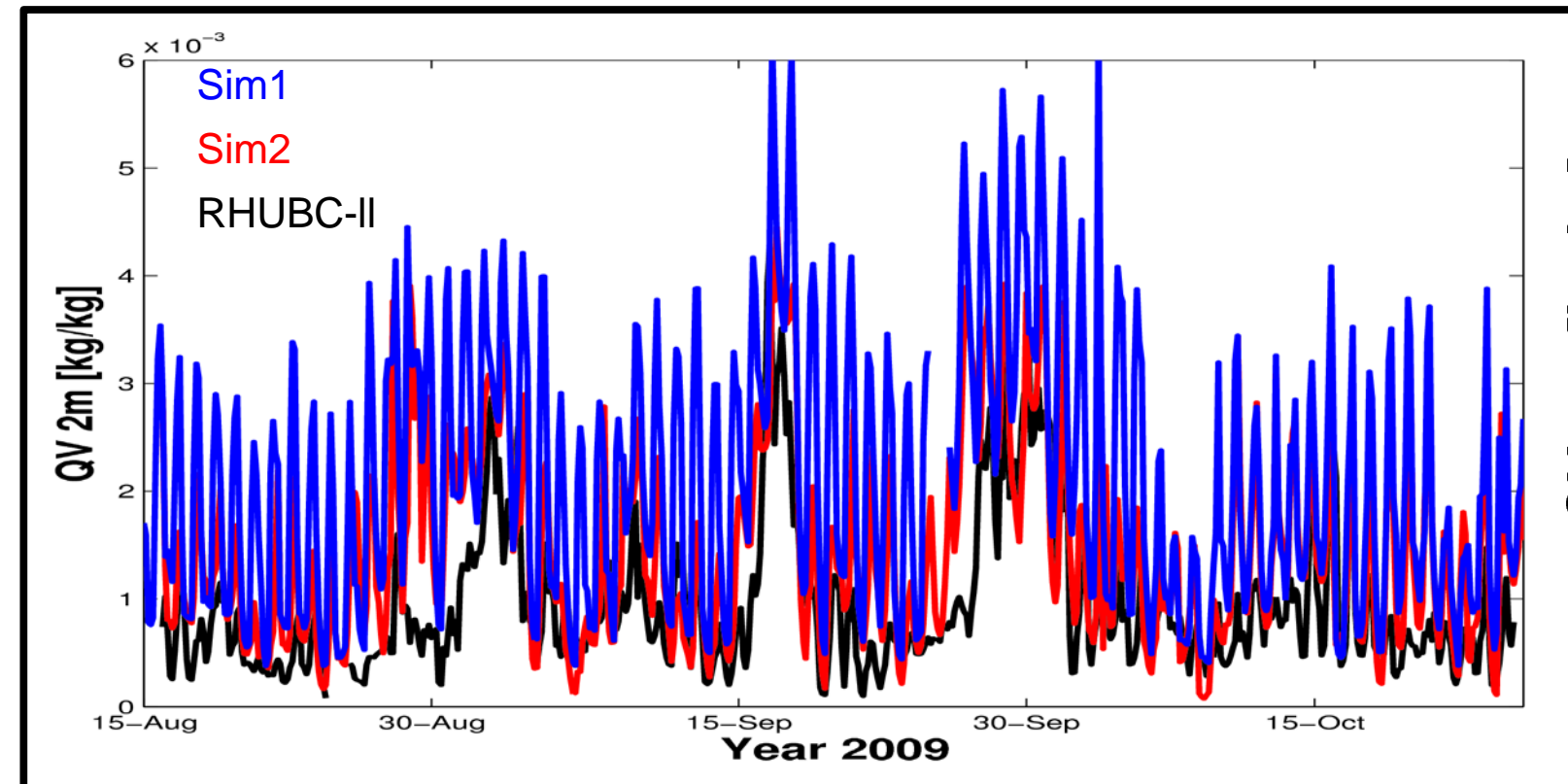


Fig. 4: Temporal evolution of 2m qv for observations, Sim1 and Sim2.

Is the improvement in 2m qv related to the initial conditions or to the new configuration?

WRF	RMSE [kg/kg]	Mean Bias [kg/kg]
Sim1	1.6×10^{-3}	1.2×10^{-3}
Sim2	0.9×10^{-3}	0.5×10^{-3}

The new configuration causes better results!!!

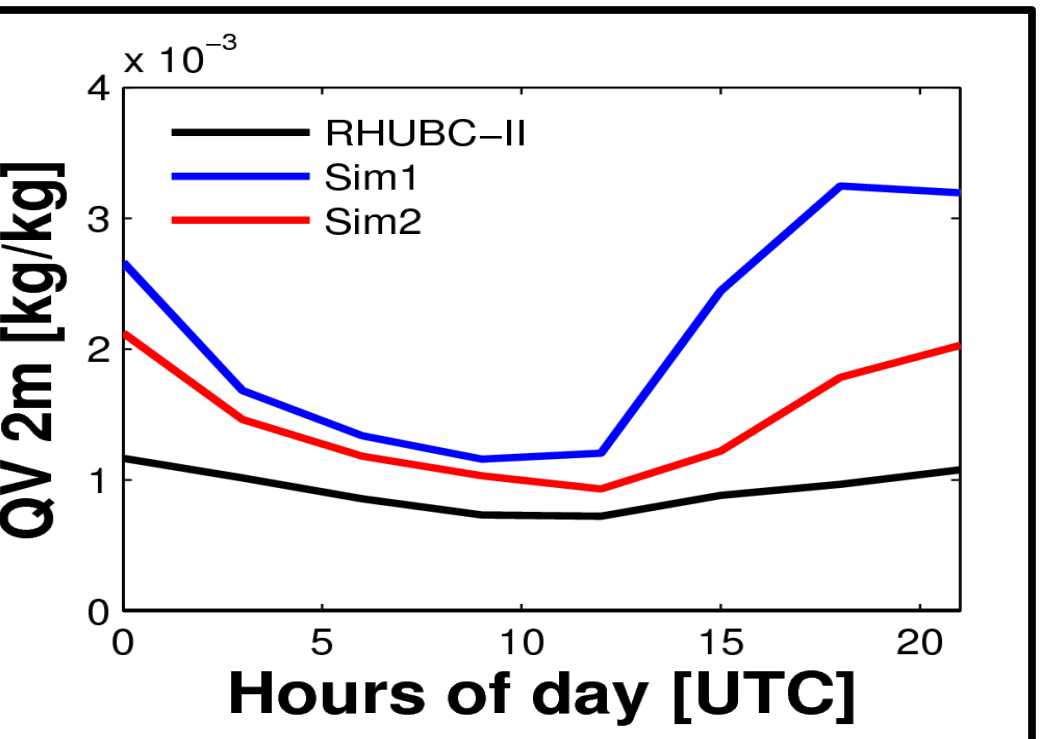


Fig. 5: Mean diurnal cycle of 2m qv. RMSE = 0.6×10^{-3} kg/kg

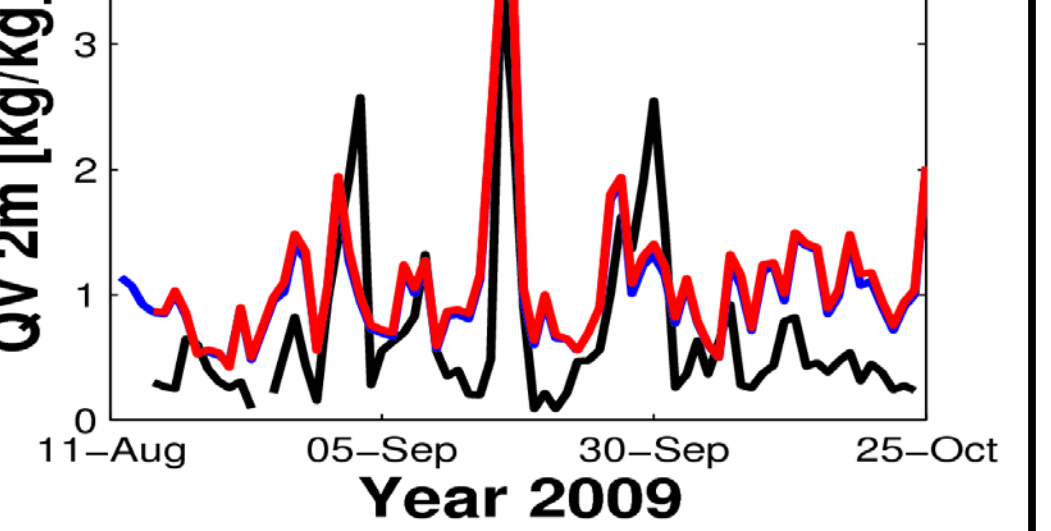


Fig. 6: Initial conditions: Temporal evolution of 2m qv.

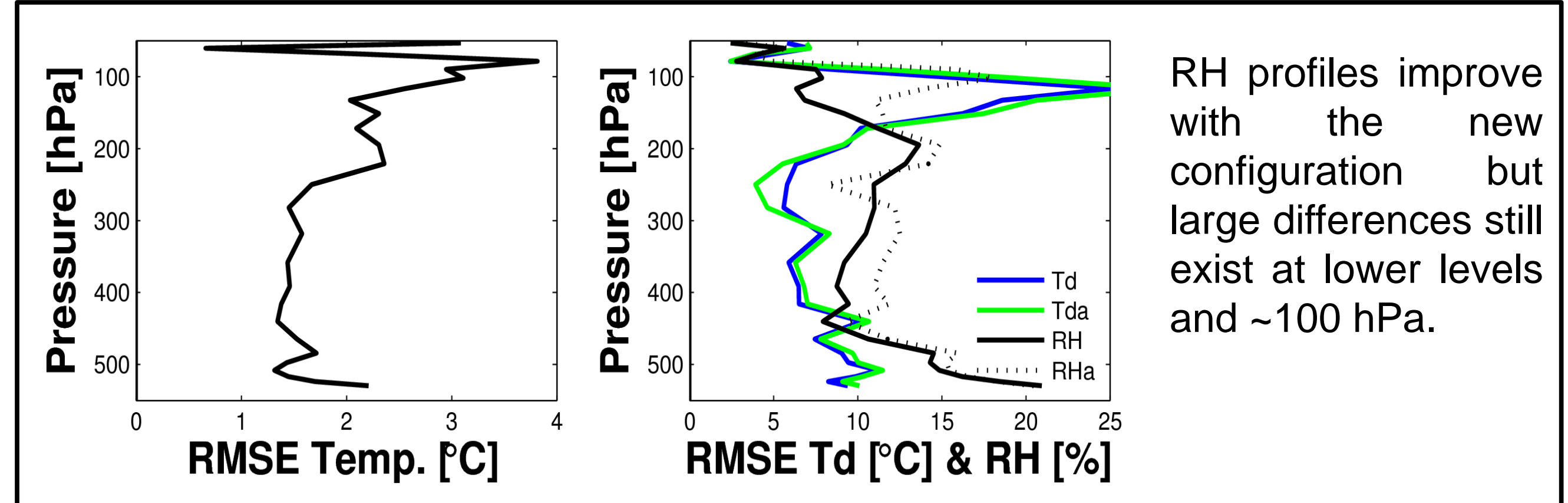


Fig. 7: RMSE variation with height for Temp., dew-point and RH between sondes and Sim2.

RH profiles improve with the new configuration but large differences still exist at lower levels and ~100 hPa.

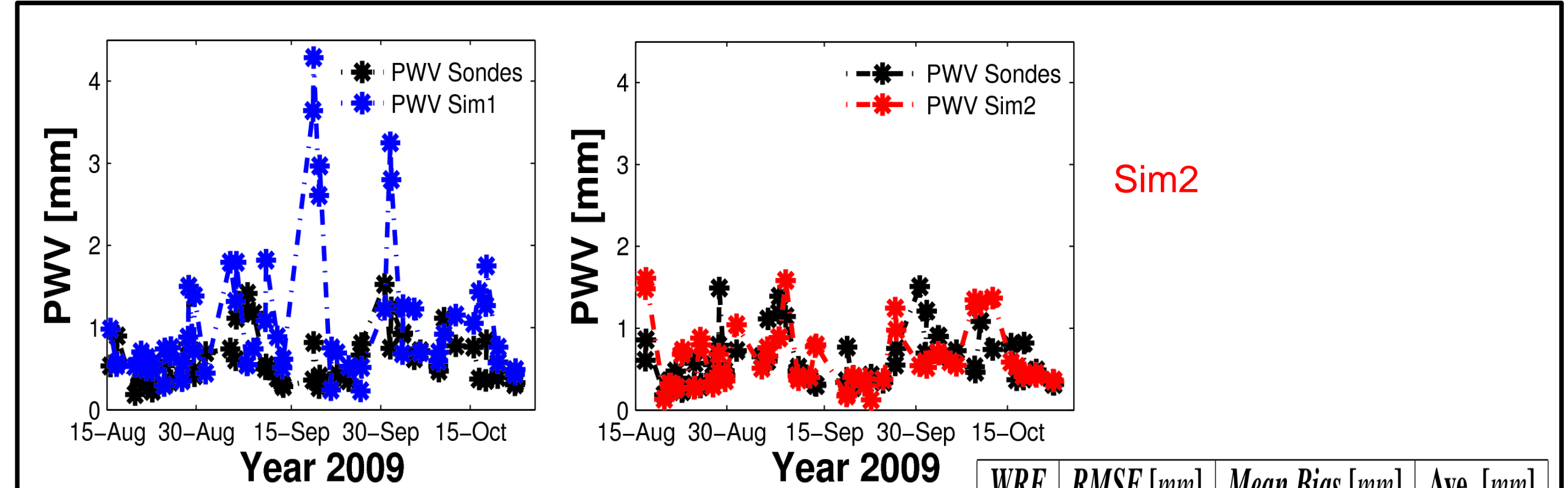
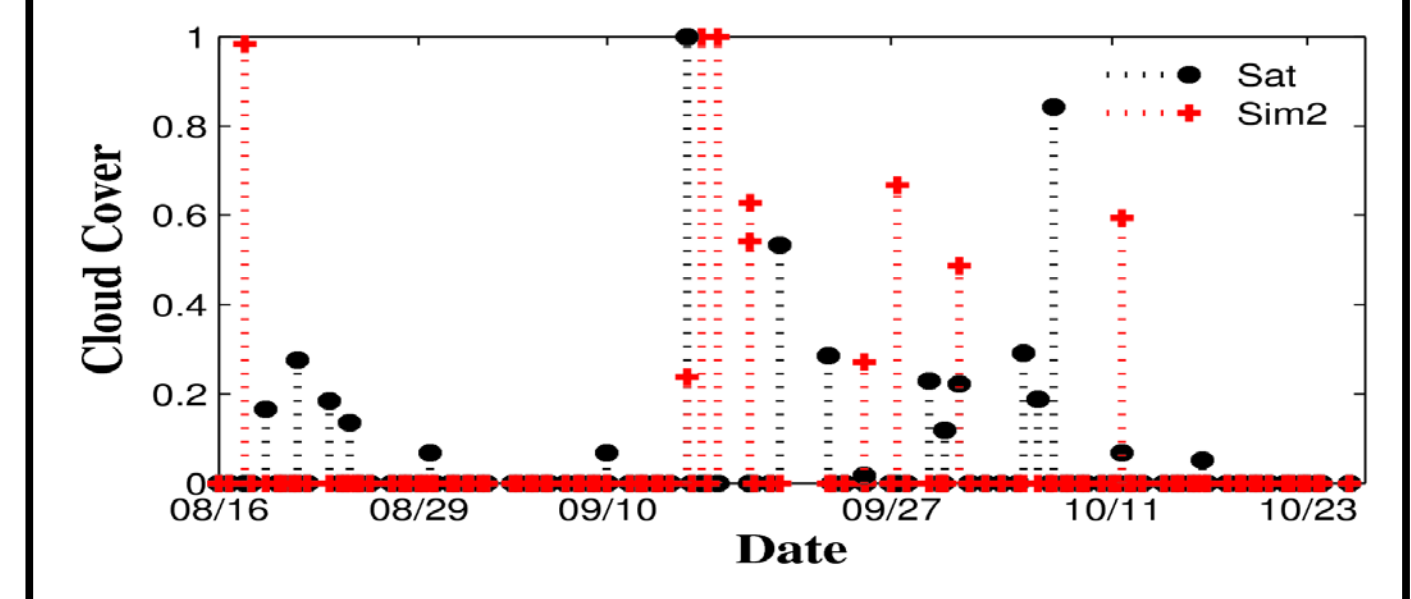
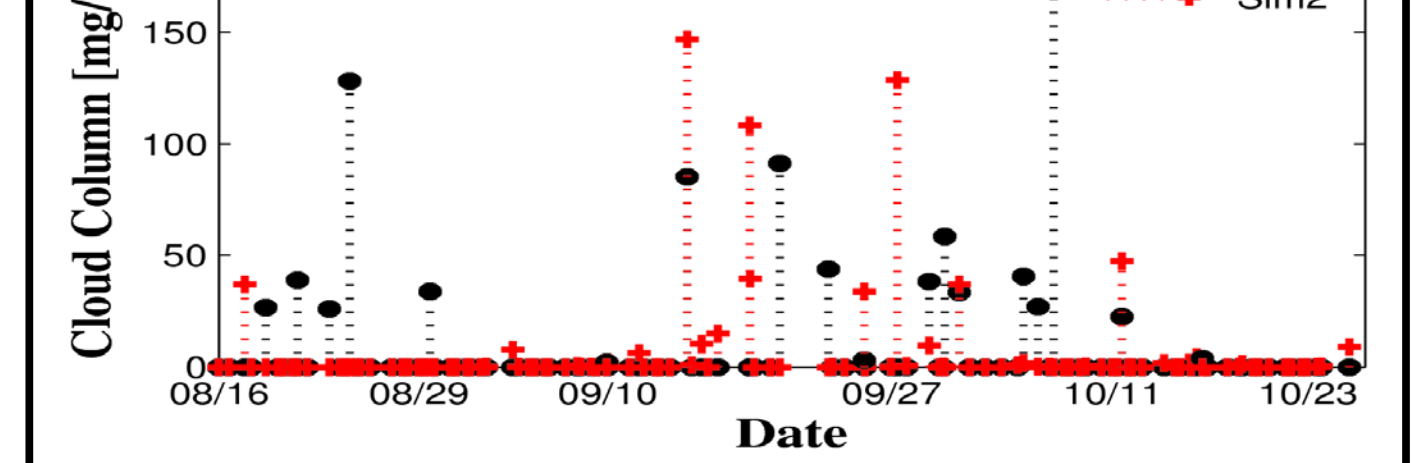


Fig. 8: PWV calculated from radiosondes and simulations. PWV average in Sondes = 0.6 mm !!!!

WRF	RMSE [mm]	Mean Bias [mm]	Ave. [mm]
Sim1	1.0	0.4	1.1
Sim2	0.4	0.02	0.6



Cloud cover and cloud column averaged over D4.



Cloud cover and cloud column averaged over D4.

More skill predicting days without clouds than days with clouds. WRF seems to produce less clouds but more liquid water content.

Conclusions

- Noah-LSM and the new land-use file notably improve the near-surface humidity.
- A large negative bias is introduced in the near-surface temperature.
- RH profiles and PWV improve in Sim2 but still large differences remain.
- WRF underestimates the presence of clouds in the region.

Acknowledgements

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