WRF SURFACE AND UPPER AIR VALIDATION OVER CENTRAL CHILE DURING LA NIÑA-EL NIÑO TRANSITION

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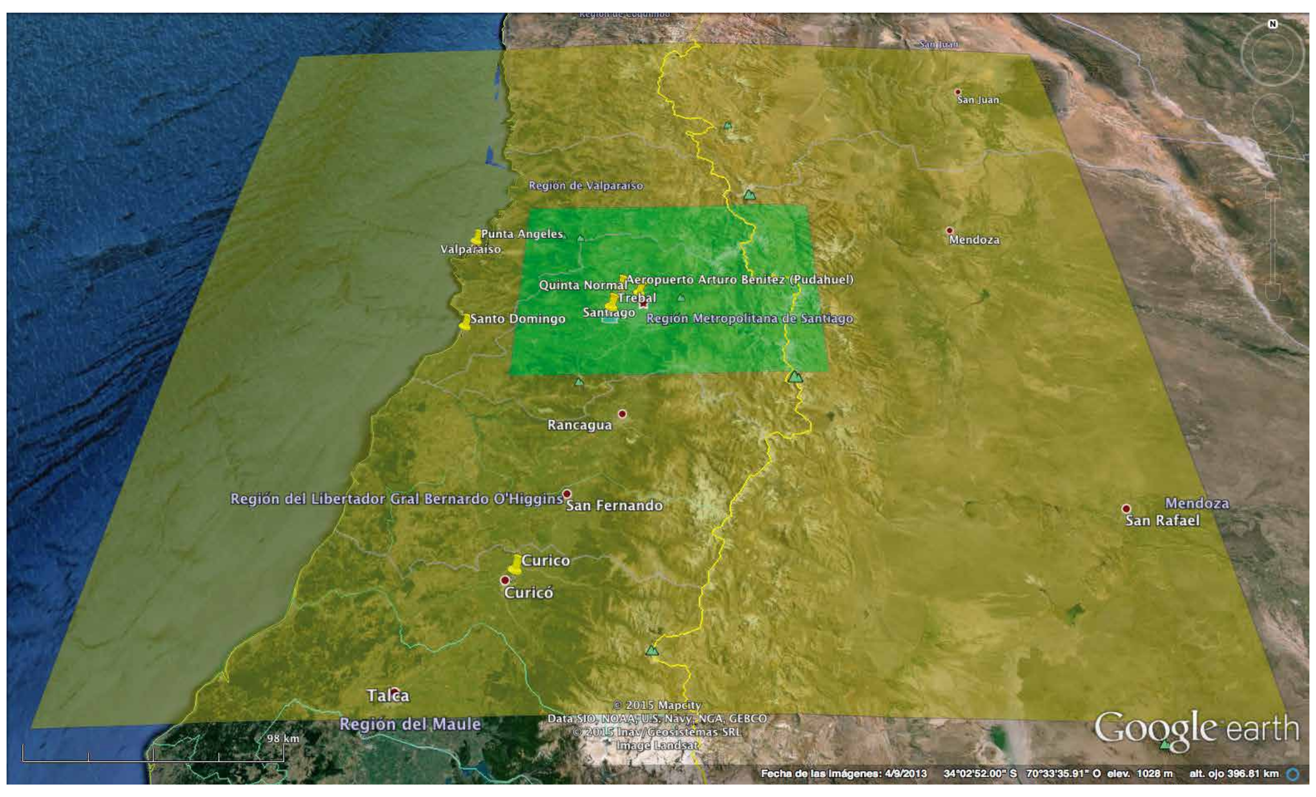
CONCLUSIONS

Both ENSO (El Niño Southern Oscillation) and topographic conditions of Central Chile provide a singular influence to the meteorological conditions over this region; which also affect to the PBL structure. In this work, WRF model validation at PBL over Central Chile was done during the El Niño-La Niña transition period, covering the whole 2009 year. About surface temperature, a positive bias in coastal model results was observed, especially during cold sea surface episodes along La Niña period; this result can be related to the overestimation of surface heat flux using YSU PBL scheme and 5-layer thermal diffusion soil model, combined to the sea breeze effect. In fact, inland sites model results show an underestimation of surface temperature. Better results were achieved for surface wind speed, with similar statistics in both El Niño and La Niña periods.

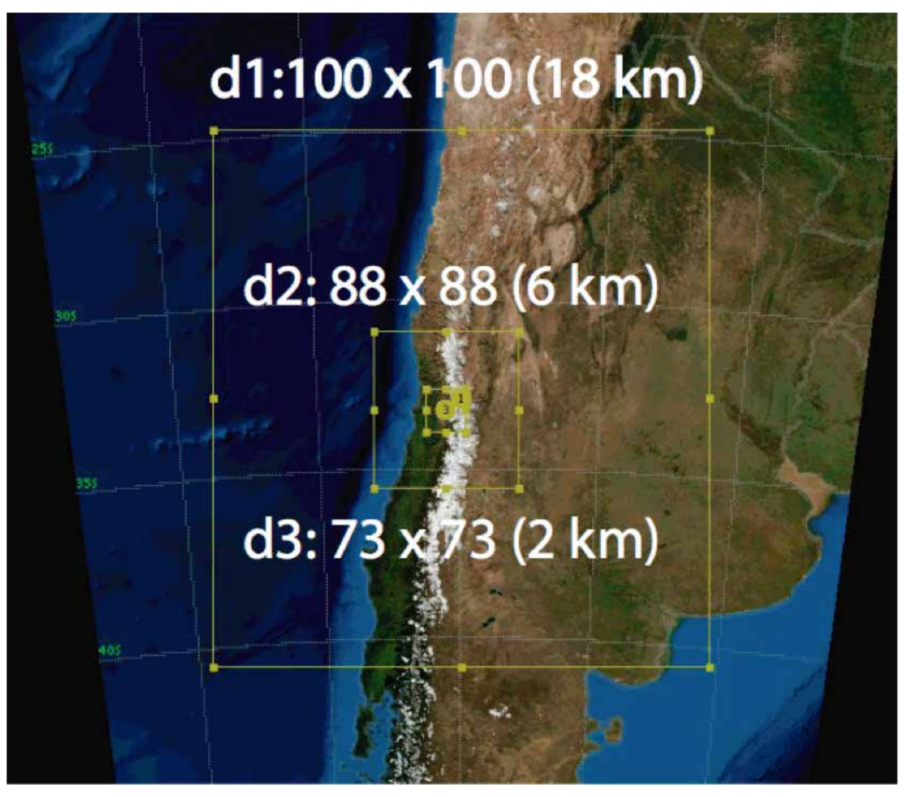
Specific conditions over Central Chile are favorable to low PBL height periods, producing poor air quality events over Santiago de Chile. Therefore, validation of PBL height calculated by WRF model was done along June 2009 period when air quality warnings were announced in that city. PBL height estimations from LIDAR observations are comparable to WRF model predictions, showing the capability of this model to represent this PBL parameter; only some differences arise when surface temperature bias is higher. Also, PBL estimations from synoptic rawinsonde datasets were done but, because of the low number of observations at the PBL, these estimations are not realistic. As synoptic rawinsondes are launched everyday all over the world, it should be highly recommended to increase these rawinsondes vertical resolution at the lowest layer, so they can be applied not only as synoptic observations, but also as PBL observations closely related to poor air quality episodes.

STUDY AREA AND EVALUATION PERIOD

The study area covers 150x150 km2 over Central Chile, around Santiago de Chile (33º 27'S 70º40'W), centered in the Metropolitan Region inside the Central Valley, surrounded on the east by the Andes Mountains with altitudes over 4000 asl-m, on the west by the Coastal Range over 1500 asl-m, and hilly chains partially blocking the north and south faces (Figure 1a). In this work, we apply the WRF meteorological model for an annual 2009 simulation using three telescoping one-way nested grids (Figure 1b) with a maximum 2x2 km2 horizontal resolution in the innermost grid.



(a)



(b)

Figure 1. Study area: (a) Location and physical geography of the D2 and D3 WRF simulation domains, also with the location of the meteorological surface stations and the upper-air site at Santo Domingo; (b) WRF nested domains.

About the WRF model settings selected, they include: Kain-Fritsch cumulus scheme (outer and medium domain), WSM 3-class microphysics scheme, RRTM longwave and Dudhia shortwave radiation schemes, and a 5-layer soil model. About PBL physics, Yonsei University-Pleim-Chang (YSU) scheme was applied. NCEP reanalysis fields supplied initial and boundary conditions.

Table 1. Sea surface temperature, 3 months running mean (Huang et al., 2015).

	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2009	-0.8	-0.7	-0.4	-0.1	0.2	0.4	0.5	0.6	0.7	1.0	1.2	1.3

To validate upper air model performance, two different approaches were considered: (a) Observations from Santo Domingo synoptic rawinsonde launched twice daily near the coast (Figure 1a: D site) were used to estimate PBLH by means of the bulk Richardson number (Holtslag and van Ulden, 1983; González et al., 2015); this approach is very feasible, as almost every National Meteorological Office provides these data. (b) Estimation of PBLH from an algorithm based on aerosol concentration measurements provided by a ceilometer installed at inner Santiago de Chile; these PBLH estimations were supplied by Muñoz et al. (2010).

RESULTS

Station	BIAS (ºC)	Gross Error	IOA (ºC)	RMSE (ºC)	BIAS (ºC)	Gross Error	IOA (ºC)	RMSE (ºC)
A Tre	1.73	3.87	0.53	4.69	1.43	4.57	0.81	5.30
B Pud	1.57	2.83	0.92	3.68	-0.75	2.39	0.93	3.04
C QN	0.85	2.14	0.95	2.82	-1.22	2.11	0.95	2.74
D Sto	2.70	2.92	0.81	3.47	1.89	2.25	0.85	2.80
E Cur	1.02	2.88	0.90	3.65	-0.06	2.11	0.94	2.67
F Pta	1.97	2.49	0.61	2.98	1.09	2.08	0.65	2.56

Table 2. Statistics for 2-m temperature: blue cells corresponds to January-June and red cells to July-December.

Station	BIAS ($m\ s^{-1}$)	Gross Error	IOA ($m\ s^{-1}$)	RMSE ($m\ s^{-1}$)	BIAS ($m\ s^{-1}$)	Gross Error	IOA ($m\ s^{-1}$)	RMSE ($m\ s^{-1}$)
A Tre	0.63	1.46	0.44	1.94	0.53	1.67	0.61	2.06
B Pud	-0.35	1.19	0.83	1.58	-0.51	1.44	0.69	1.96
C QN	0.86	1.00	0.77	1.19	0.65	0.92	0.69	1.14
D Sto	1.11	1.48	0.74	1.89	0.93	1.50	0.80	1.93
E Cur	-0.54	1.18	0.74	1.45	-0.81	1.30	0.68	1.65
F Pta	2.44	3.00	0.51	3.69	2.99	3.47	0.59	4.19

Table 3. Statistics for 10-m wind speed: blue cells corresponds to January-June and red cells to July-December.

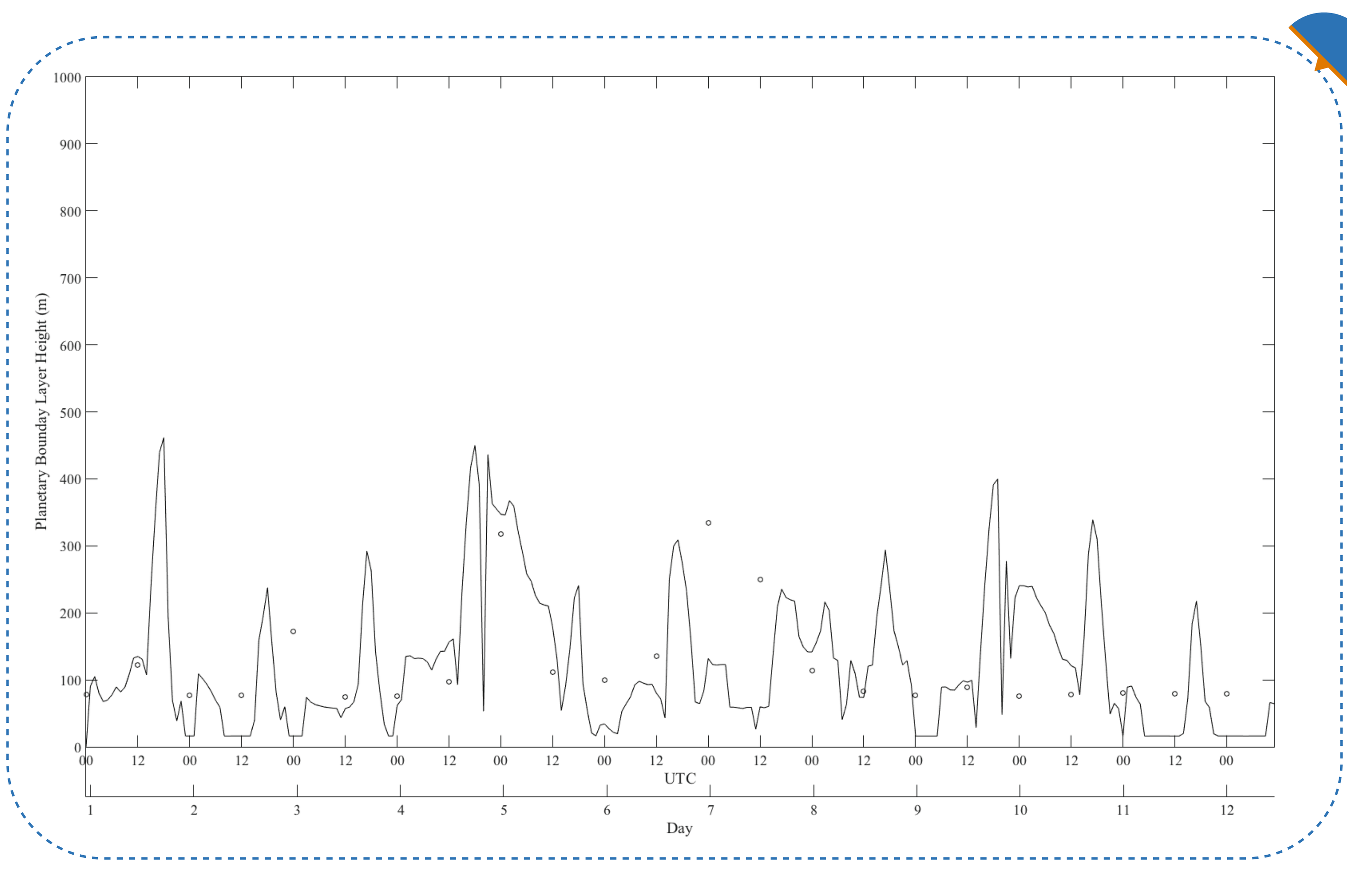


Figure 3. Evolution of the planetary boundary layer height along 1-12 June: (-) WRF, (o) rawinsonde.

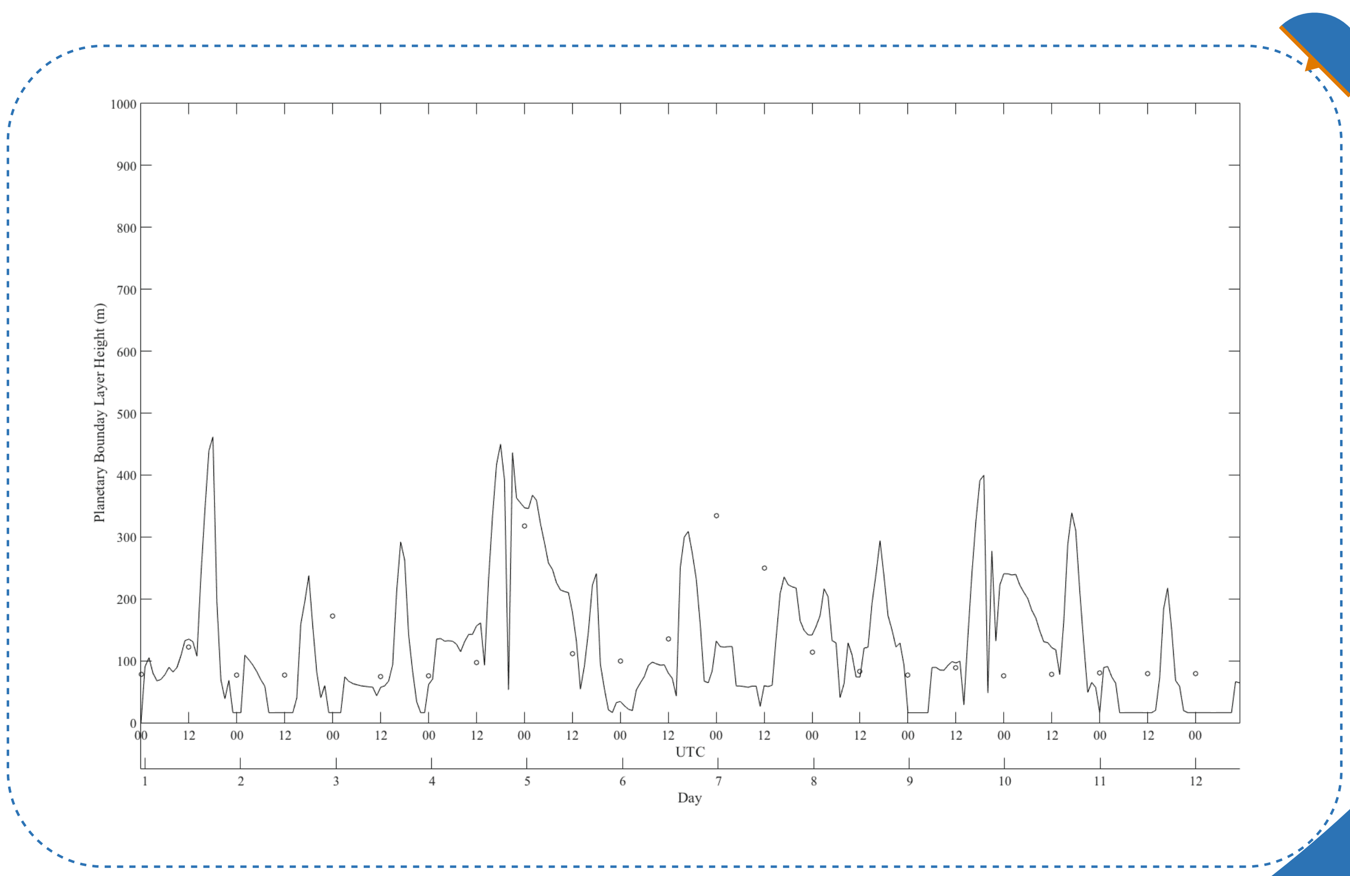


Figure 4. Evolution of the planetary boundary layer height along June 2009: (-) WRF, (o) ceilometer.

Contact Information

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