

Validation of WRF model during O₃ episodes in an Atlantic coastal

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Abstract

in the northwest region of the Iberian Peninsula (IP)

the Yonsei University (YSU) scheme; Asymmetric Convective Model (ACM2) is more suitable for temperature, and Mellor-Yamada Nakanishi and Niino Level 2.5 PBL (MYNN) are better for wind speed.

Introduction

Zhang and Zheng, 2004; Akylas et al., 2006; Pérez et al., 2006; Mao et al., 2006; Borge et al., 2008; de Meij et al., 2009; Lin et al., 2009

Methodology

Three high ozone episodes in the NW coast of Iberian Peninsula (IP) were selected (14-23 July 2002, 16-24 March 2003 and 09-22 September 2003), with hourly maximum SOC exceeding 140 g/m^3 . July and September ozone episodes show the most common synoptic pressure pattern associated with high ozone episodes in the NW IP, “High pressures over the Atlantic ocean and Europe”, whereas March episode was produced under unusual synoptic conditions for ozone episodes, the “British-Scandinavian anticyclone” (Saavedra, 2010). Air pollution data from five air quality sites located in this region were considered to identify the episodes (Saavedra et al., 2012) and meteorological data from 10 surface meteorological stations were considered to analysis the local weather conditions and to validate the WRF model.

- The present study applies the WRF version 3.2 (Skamarock et al., 2008), configured with either 29 or 30 vertical layers (depending on the PBL parameterization tested), and three one-way nested domains with horizontal resolutions of 27, 9 and 3 km (Borrego et al., 2012). Other selected model settings include the Kain-Fritsch cumulus scheme (outer and medium domain), WSM 3-class microphysics scheme, a RRTM longwave and Dudhia shortwave radiation scheme; a 5-layer soil model (except with ACM2 Pleim-Xiu PBL scheme, with Pleim-Xiu soil model) was usually applied.

Initial and boundary conditions were provided by NCEP GFS analysis data, at a horizontal resolution of $1^\circ \times 1^\circ$ every 3-hours. Elevation and land cover data were provided by the USGS digital terrain model (USGS, 2008). Four different PBL schemes were tested: Yonsei University scheme (YSU), Mellor-Yamada-Janjic (MYJ), Mellor-Yamada Nakanishi and Niino Level 2.5 PBL (MYNN), and Asymmetric Convective Model (ACM2).

Results and concluding remarks

Considering RMSE and MAGE, the more suitable parameterizations for temperature during these typical high-O₃ episodes are ACM2 and YSU. Unlike temperature, the best results for wind speed are achieved by MYNN scheme, closely followed by YSU scheme. Therefore, YSU PBL scheme can be recommended to simulate high-O₃ episodes in this study area as a compromise between temperature and wind speed performance.

Table 1.

PBL	14-23 July 02			16-24 March 03			9-22 September 03		
	MB	MAGE	RMSE	MB	MAGE	RMSE	MB	MAGE	RMSE
ACM2	0.238	1.643	2.238	0.424	1.919	2.420	-0.182	1.719	2.249
MYJ	-0.428	1.824	2.411	-1.201	2.276	2.832	-0.982	2.217	2.823
MYNN	-0.819	1.887	2.451	-1.456	2.300	2.860	-1.325	2.263	2.890
YSU	0.679	1.748	2.496	-0.363	1.937	2.427	-0.272	1.914	2.516

Table 2.

PBL	14-23 July 02			16-24 March 03			9-22 September 03		
	MB	MAGE	RMSE	MB	MAGE	RMSE	MB	MAGE	RMSE
ACM2	-0.499	1.587	2.150	1.055	2.039	2.532	0.328	1.561	1.970
MYJ	-0.107	1.438	1.907	1.273	1.998	2.498	0.638	1.640	2.099
MYNN	-0.722	1.546	2.114	0.481	1.684	2.088	0.128	1.511	1.941
YSU	-0.512	1.484	2.032	0.815	1.789	2.232	0.347	1.551	1.979

Differences in the July episode statistics respect to the others may be due to the lack of meteorological data during this episode, so less meteorological stations were used for validation. The comparison of time series (not shown) drives to ACM2 as the best scheme to simulate daily maximum temperatures with clear sky; on the other hand, systematic overestimation of low winds using ACM2 and, also, MYJ schemes, is observed.

Following the benchmarks proposed by Emery (2001), ACM2 is a suitable parameterization related to temperature for all episodes, whereas YSU is

only adequate for the March and September episodes, and MYJ for the July episode. MYNN does not satisfy the goals for any period. About wind speed, ACM2, MYNN and YSU meet the benchmark goals for the September episode, and MYJ for the July period.

Acknowledgments

References