COUPLING WRF AND CALMET MODELS: EVALUATION DURING 15-DAY CASE STUDY IN A CARIBBEAN BAY, CUBA

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ABSTRACT

CALMET meteorological model is evaluated during a typical dry season period in a coastal domain at the Caribbean region, using four different CALMET input datasets. Evaluation was focused in terms of surface wind and temperature modeling performance. As input data, Weather Research and Forecast model (WRF) results are combined to meteorological measurements from different sites. CALMET results statistics (both relative and absolute) are calculated over sites not used as input data providers. Relative wind speed statistics values are high, due to the weak winds along the study period. However, absolute statistics are better. Also, a significant improvement in both wind speed and temperature statistics, both relative and absolute, is observed as more sites provide input data.

CASE STUDY: JAGUA BAY, CUBA

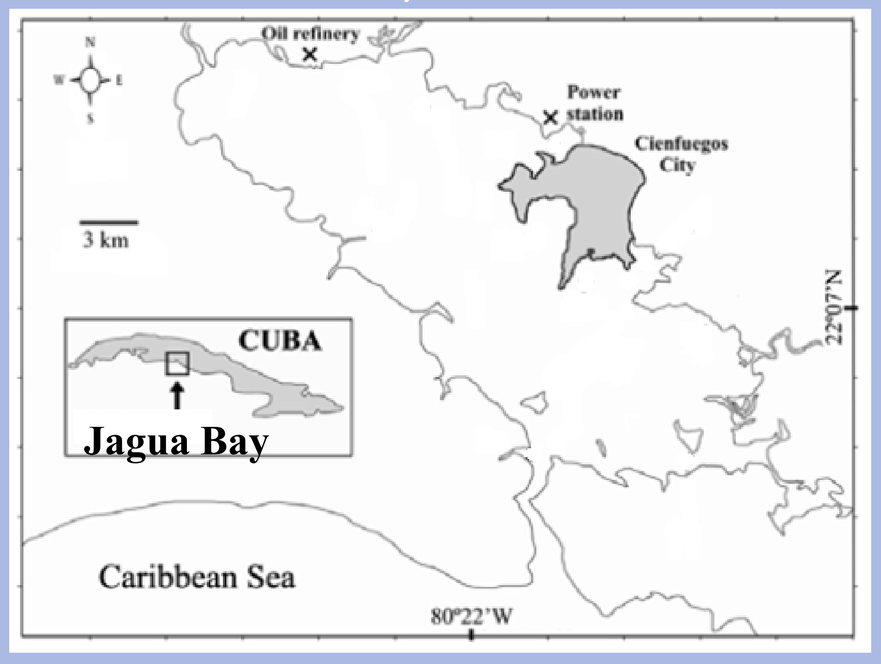

Figure 1. Jagua Bay at the central southern coast of Cuba, with its potential main air pollution sources.

Jagua Bay (Fig. 1) is a semi-enclosed Bay located in the southern central part of Cuba, with a surface area of 90 km^2. Over there, expansion of an oil industrial complex is expected, close to Cienfuegos city and also a close touristic region (Rancho Luna). The two main industrial air pollution sources are an oil refinery and a power station.

In order to check the capability of CALMET model to provide accurate meteorological input to CALPUFF dispersion model for regulatory purposes, high resolution meteorological simulations (Fig. 2) along a typical dry season 15 days period are tested, using different input datasets. The selected period covers from 02 January 2010 - 05 UTC to 16 January 2010 - 05 UTC, in the typical dry season, with weak winds (2.6 m·s^{-1}) and moderate temperatures (17.0 ºC).

MODELS AND METHODS

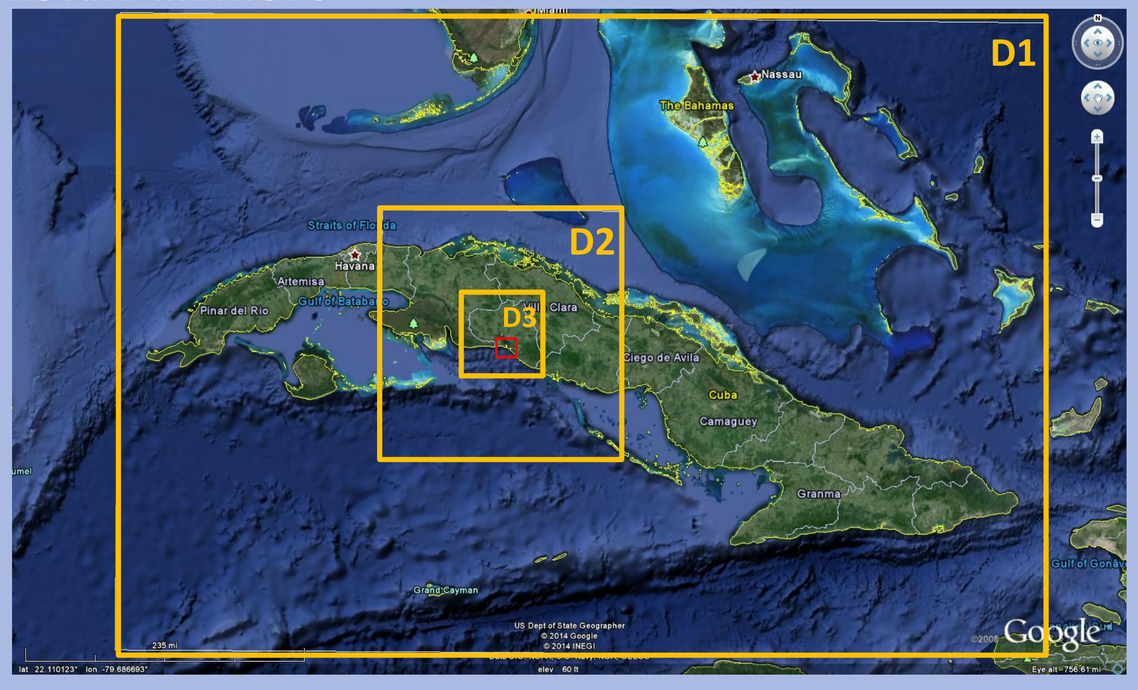

Figure 3. Nested WRF simulation domains (resolution: D1: 27x27 km^2; D2: 9x9 km^2; D3: 3x3 km^2), to provide meteorological inputs to CALMET model domain (□; 1x1 km^2 resolution).

METEOROLOGICAL MODELS CONFIGURATIONS

WRF MODEL	CALMET MODEL
•Three domains (Fig. 3) one-way nesting •Microphysics: WMS-5, WRF Single-Moment 5-class •Cumulus: Grell-Devenyi ensemble •Short wave radiation: D1: RRTMG; D2 & D3: Dudhia •Long wave radiation: D1: RRTMG; D2 & D3: RRTM •Surface layer: MM5 similarity •Land surface: 5-layer thermal diffusion •PBL: Yong Sei University (YSU) •Input: GFS 1º analysis	•Horizontal resolution: 1x1 km^2. •10 vertical layers: (top-face, agl-m): 20, 40, 80, 160, 320, 640, 1200, 2000, 3000, and 4000. • Default CALMET interpolation and parameterization options

RESULTS

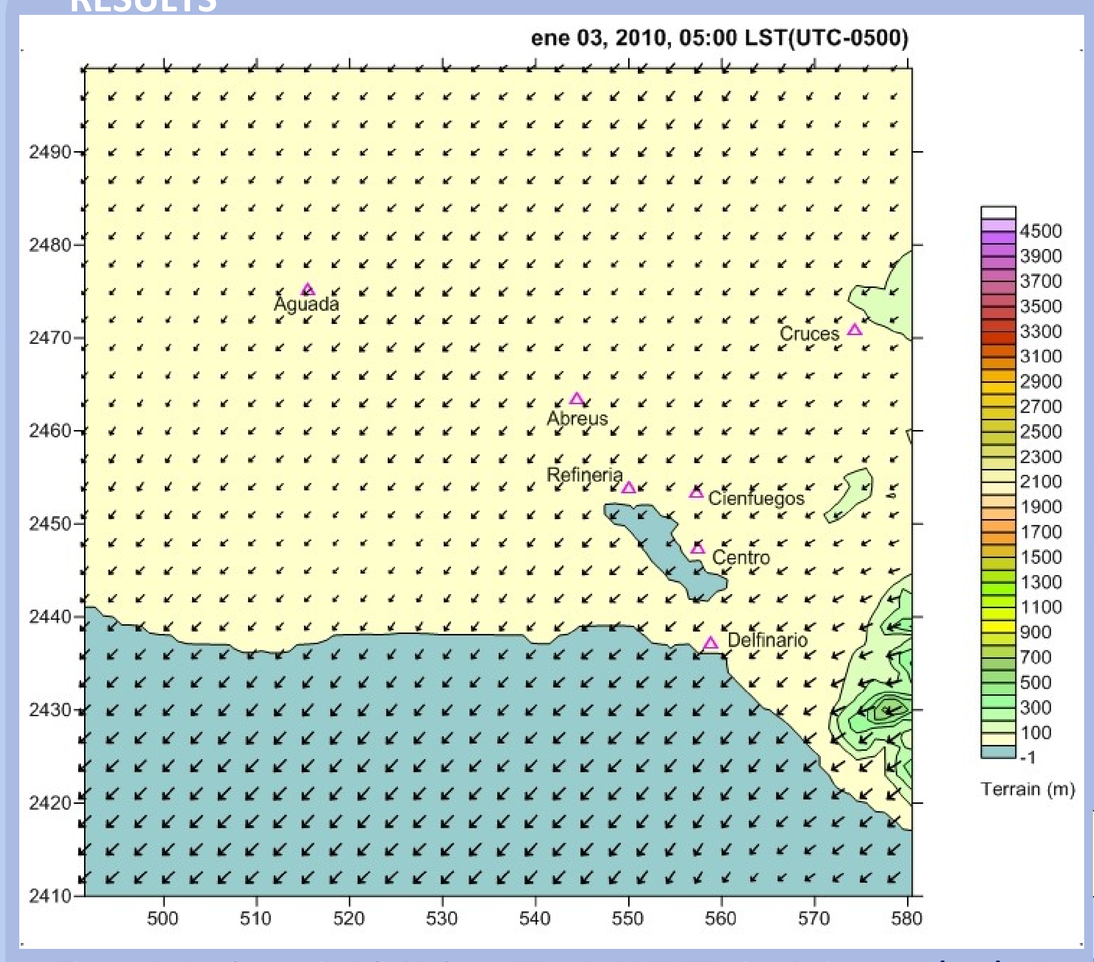

Figure 2. Surface wind field from Met_1 CALMET simulation at 3/Jan/2010 05LST over Jagua Bay, and location of 7 surface meteorological sites applied.

CALMET SIMULATIONS

Simulation	Meteorological inputs	Input dataset sites	Check dataset sites
Met_1	WRF results	-	7 sites (all)
Met_2	WRF results and 2 sites	Cienfuegos, Aguada	Centro, Delfinario, Refinería, Cruces, Abreus
Met_3	WRF results and 4 sites	Cienfuegos, Aguada, Delfinario, Cruces	Centro, Refinería, Abreus
Met_4	WRF results and 5 sites	Cienfuegos, Aguada, Delfinario, Cruces, Abreus	Centro, Refinería

STATISTICS

Wind size (m·s^{-1})	MB	MNBE (%)	MFB (%)	MAGE	MNGE (%)	NME (%)	NMB (%)	RMSE
Met_1	2,516	2554,485	84,383	2,674	2558,273	123,818	116,523	3,039
Met_2	1,203	770,687	47,395	1,835	788,922	79,462	52,101	2,214
Met_3	0,577	746,365	31,332	1,514	772,896	62,775	23,941	1,851
Met_4	-0,345	9,791	-9,369	1,082	50,123	36,114	-11,499	1,353
Temp. (ºC)	**MB**	**MNBE (%)**	**MFB (%)**	**MAGE**	**MNGE (%)**	**NME (%)**	**NMB(%)**	**RMSE**
Met_1	1,391	12,412	9,880	2,267	16,631	13,351	8,194	2,932
Met_4	-0,139	-0,301	-0,866	1,288	8,033	7,486	-0,806	1,650

CONCLUSIONS

CALMET diagnostic wind model nested to a WRF model simulation was tested over a Caribbean coastal region, Jagua Bay, in order to check its capability to represent wind and temperature patterns along a dry season period. Also, different surface measurements datasets jointly to WRF results were applied as either CALMET input.. Compared to the different available surface data CALMET simulation with only WRF results provide good wind and temperature relative statistics, but absolute wind statistics are too high; the typical weak winds during this dry season period are not favorable to achieve better results. As more surface measurements are applied as CALMET input, better statistics were obtained; taking into account that none of the input data were used as checking data in the model evaluation; even though the limited number of available sites.

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