

A COMPARISON OF DIFFERENT WRF-CALMET SIMULATIONS AGAINST SURFACE AND PBL RAWINSONDE DATA

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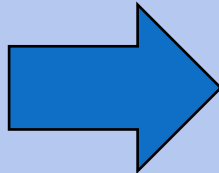


Overview

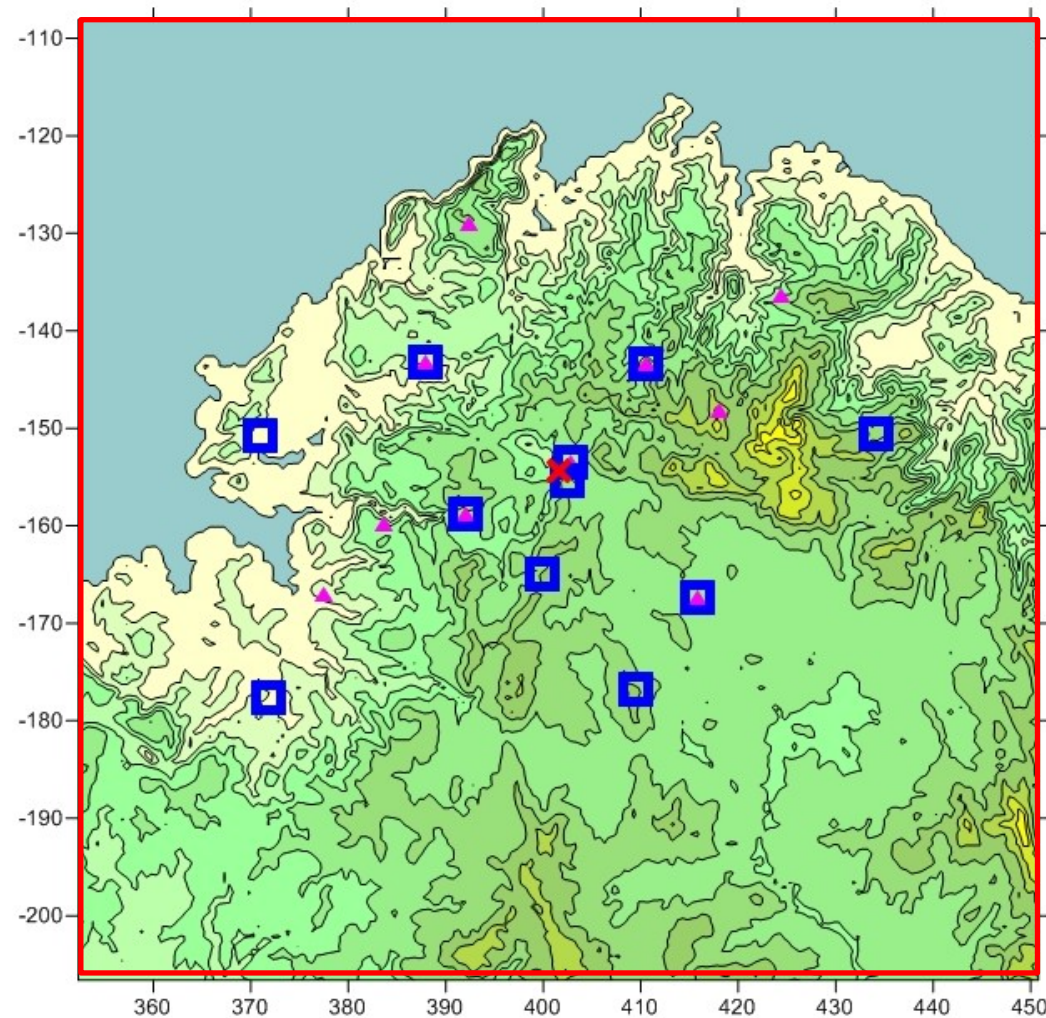
- **Meteorological modelling for local large plume dispersion simulation**
- **Study area and validation periods**
- **WRF model settings**
- **CALMET model simulations**
- **Models validation**
 - **Surface sites**
 - **Upper-air (rawinsonde data)**
- **Concluding remarks**

Meteorological modeling for plume dispersion

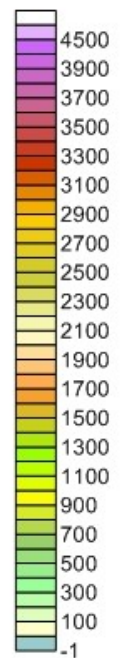
- Meteorological models vs / & measurements datasets
- Prognostic model: Settings
- The need of coupling high resolution diagnostic model
- Meteorological models validation, both surface and upper-air

WRF model  **CALMET model**

Study area and validation periods



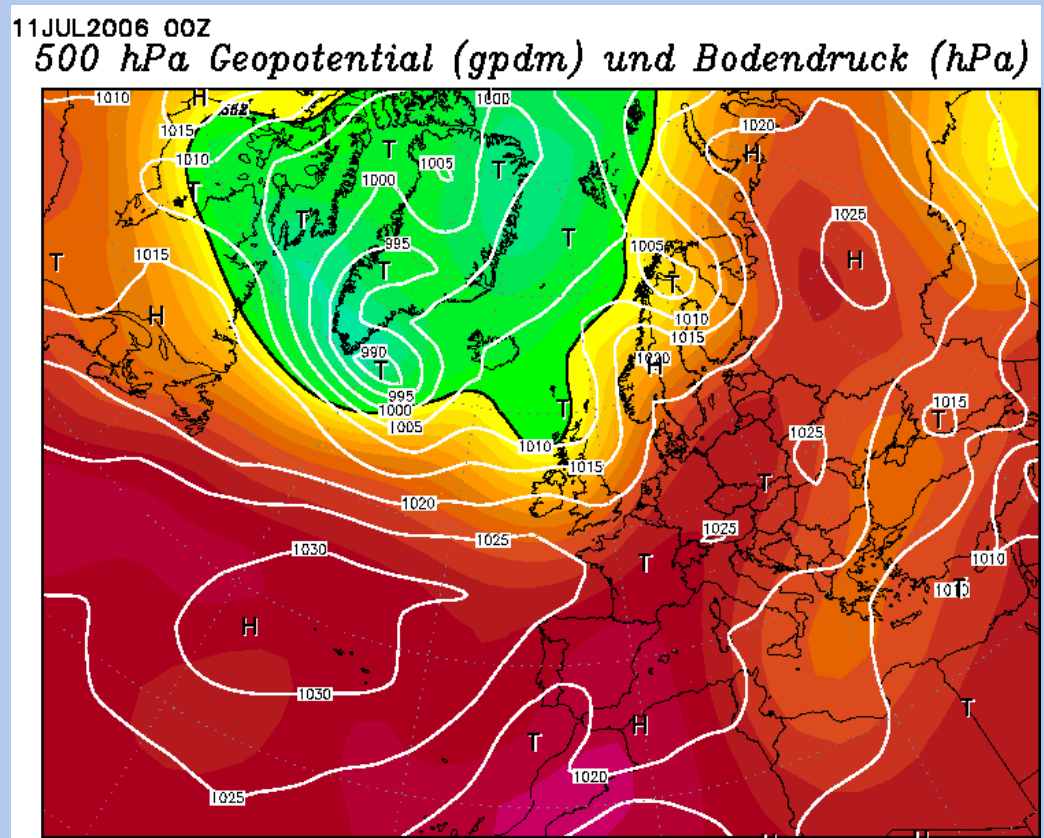
- x As Pontes Power Plant stack
- ▲ Air quality stations
- Meteorological stations



Period	Peak hourly SO ₂ glc (µg/m ³)
13-15 July 2005	304
01-03 June 2006	324
09-11 July 2006	174

Validation periods

- High Pressure over Atlantic and Europe (HPAE)
- Dry periods
- Clear skies
- Solar radiation
- Moderate winds
- Sea breezes



WRF model

D1 – 27 x 27 km²

D2 – 9 x 9 km²

D3 – 3 x 3 km²

One-way nesting

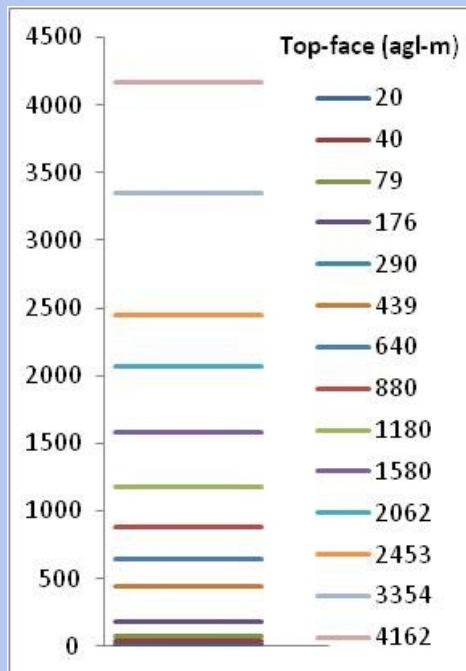
WRF SETTINGS

- 30 vertical layers up to 100 hPa (max. 5 in the PBL)
- Cumulus: Kain-Fritsch (D1 and D2)
- Microphysics: WMS-3
- Short wave radiation: Dudhia
- Long wave radiation: RRTM
- Surface layer: MM5 similarity
- Land surface: 5-layer soil model
- **PBL: Yong Sei University**
- Input: GFS 1^o analysis
- USGS topography and land use

CALMET model

CALMET SETTINGS

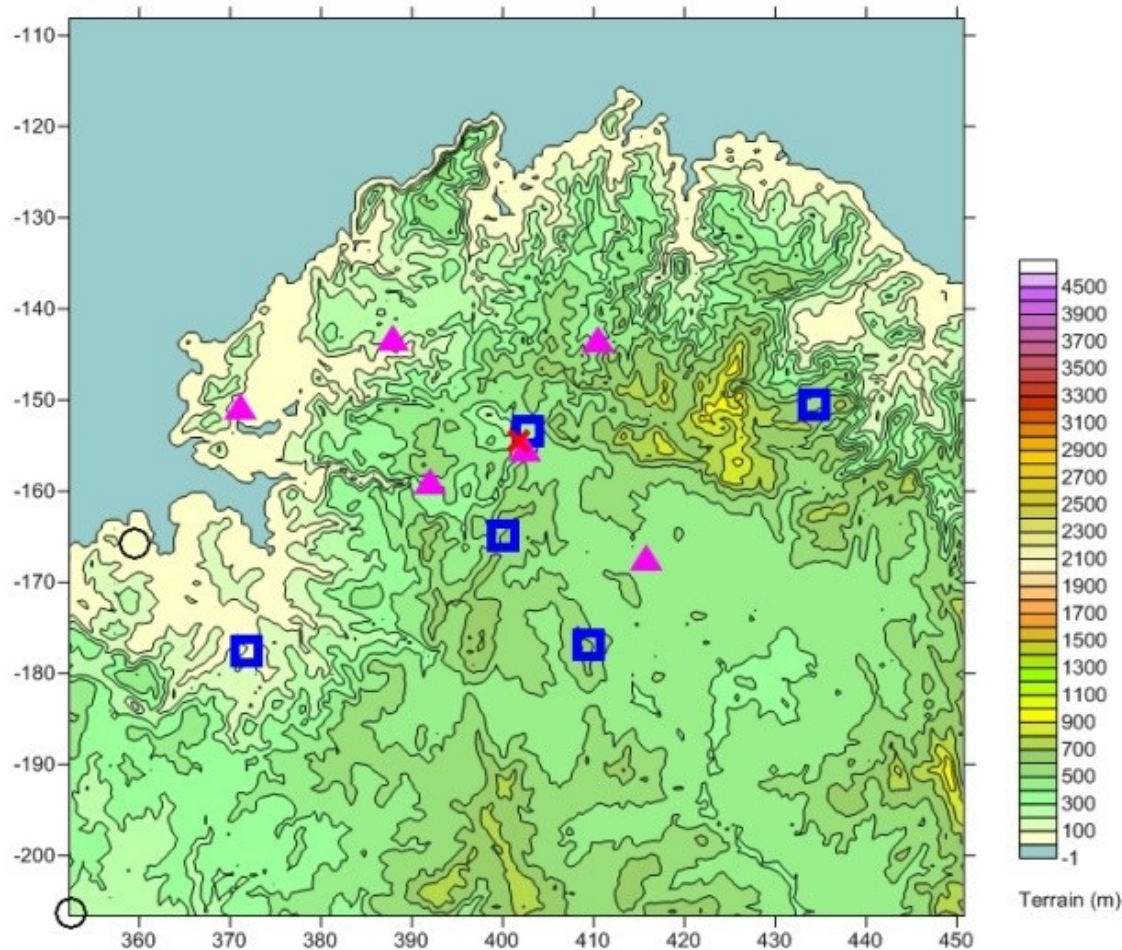
- Default options
- Different horizontal resolutions
- 14 vertical levels



WRF / CALMET Simulations

	CALMET met. inputs and grids
Group 1 (against 11 sites)	
Best WRF	-
Cm-1/3km	WRF results only, 1 km grid resolution
Cm-0.5/3km	WRF results only, 0.5 km grid resolution
Cm-0.2/3km	WRF results only, 0.2 km grid resolution
Group 2 (against 5 sites)	
Cm(S+U)	Data from 11 (all) surface and 2 upper-air sites
Cm(W+S6)	WRF results and 6 surface sites
Cm(Sw+Uw)	WRF results (as measurements), 6 surface and two upper-air sites
Cm(S6+U)	Data from 6 surface and 2 upper-air sites

Models validation - Surface sites



X As Pontes Power Plant

▲ Surface sites for input

□ Surface sites for validation

○ Upper-air sites

Models validation - RMSE at surface sites

CALMET Simulations	RMSE, wind speed (m·s ⁻¹)				RMSE, temperature (°C)			
	P1	P2	P3	Mean	P1	P2	P3	Mean
Group 1 (against 11 sites)								
Best WRF	1.574	2.582	1.968	2.041	3.635	1.879	2.522	2.679
Cm-1/3km	1.495	2.550	1.946	1.997	3.753	2.305	3.092	3.050
Cm-0.5/3km	1.498	2.510	1.919	1.976	3.755	2.293	3.083	3.044
Cm-0.2/3km	1.499	2.527	1.914	1.980	3.763	2.285	3.081	3.043
Group 2 (against 5 sites)								
Cm(S+U) (REF.)	0.048	0.061	0.054	0,054	0.650	0.050	0.732	0,477
Cm(W+S6)	0.493	0.610	0.682	0,595	3.480	1.944	2.687	2,704
Cm(Sw+Uw)	1.463	2.245	2.250	1,986	3.577	3.374	2.825	3,259
Cm(S6+U)	1.412	2.491	2.622	2,175	1.416	2.870	2.369	2,218

PBL depth validation - Schemes

Modelling

WRF

Max. 6 PBL levels

Yong Sei Univ. (YSU)
(Hong and Lim, 2006)

CALMET

14 PBL levels

Overland

(Holstlad and van Ulden, 1983)

Overwater

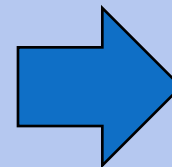
(Scire et al, 2001)

Upper-air measurements

PBL depth estimation (Vogelezang et al, 1996)

$$Rib(z) = \frac{gz}{\theta_{v0}} \left(\frac{\theta_{vz} - \theta_{v0}}{u_z^2 + v_z^2} \right)$$

$$Rib(z) = 0.25, 0.5$$

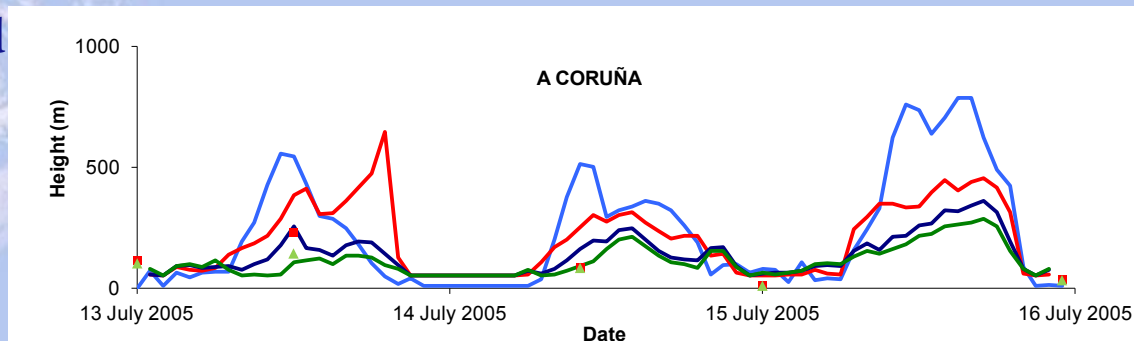


$$h = z$$

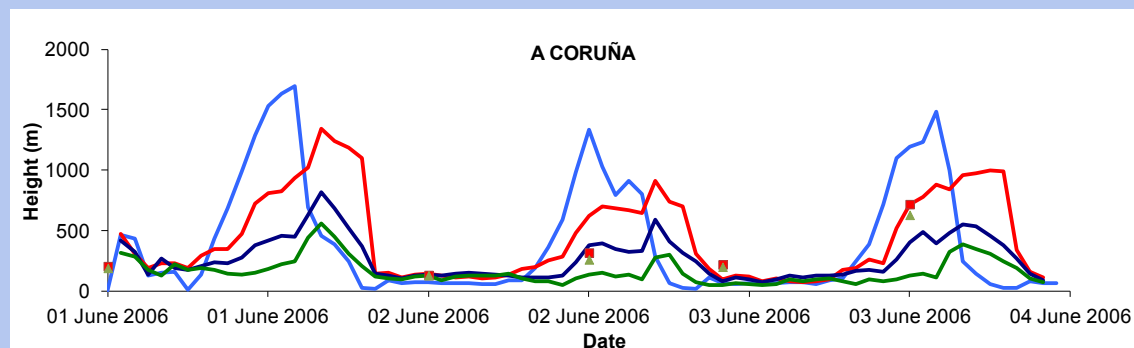
Models validation - PBL depth

Validation period

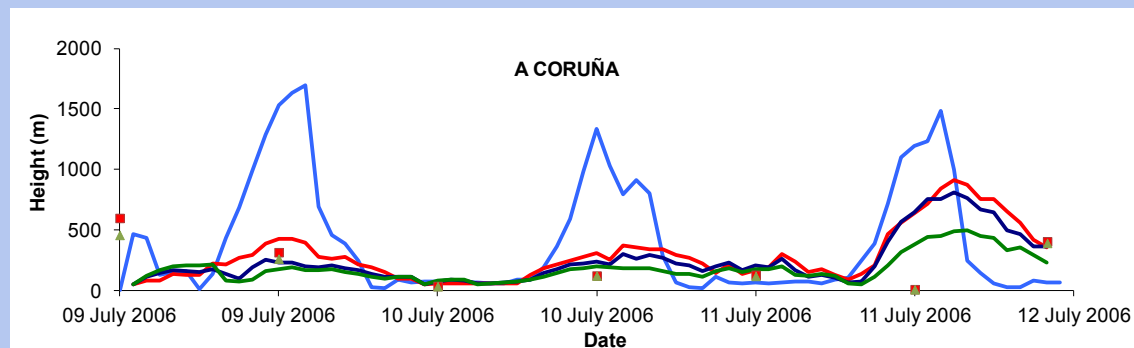
P₁
13-15 July 2005



P₂
01-03 June 2006



P₃
09-11 July 2006



PBL depth model
vs.
A Coruña
rawinsonde
coastal site data
(AEMET)

— WRF ■ OBS-RS-TPV ▲ OBS-RS-TP — Cm-1/3km — Cm-0.5/3km — Cm-0.2/3km

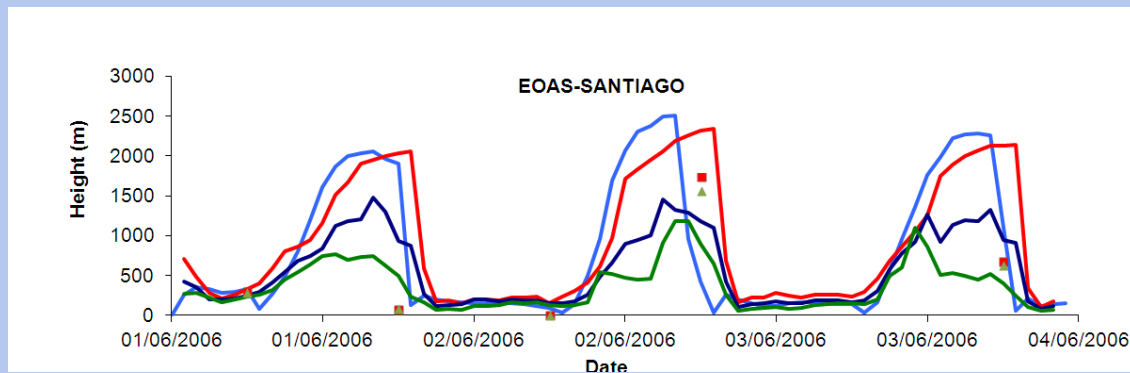
Models validation - PBL depth

Validation period

P₁
13-15 July 2005

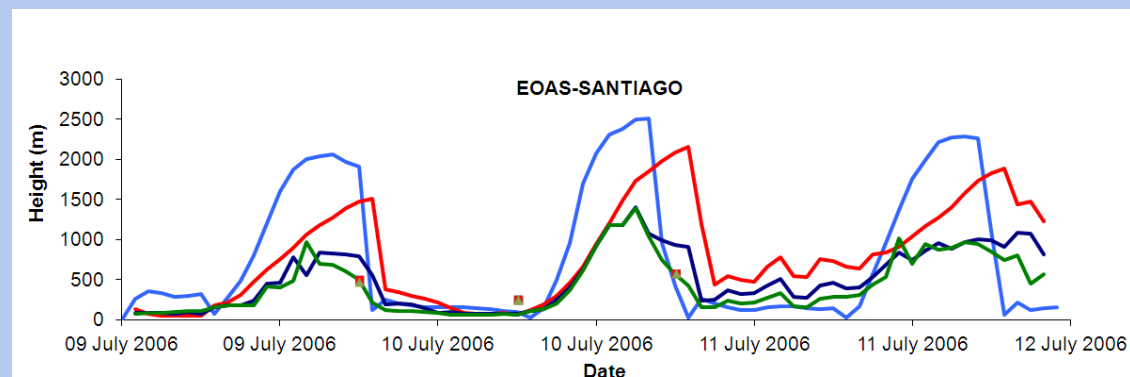
Rawinsonde was not operated

P₂
01-03 June 2006



PBL depth model
vs.
EOAS-Santiago
rawinsonde
in-land site data
(MeteoGalicia)

P₃
09-11 July 2006



— WRF ■ OBS-RS-TPV ▲ OBS-RS-TP — Cm-1/3km — Cm-0.5/3km — Cm-0.2/3km

Concluding remarks

WRF / CALMET Simulations		EVALUATION		
	Meteorological inputs and grids	Surface wind	Surface temp.	PBL depth
Group 1 (against 11 sites)				
Best WRF	-	-	Best G1	Worse
Cm-1/3km	WRF results only, 1 km grid resolution	-	-	Better
Cm-0.5/3km	WRF results only, 0.5 km grid resolution	Best G1	-	Best G1
Cm-0.2/3km	WRF results only, 0.2 km grid resolution	-	-	Best G1
Group 2 (against 5 sites)				
Cm(S+U)	Data from 11 (all) surface and 2 upper-air sites	Max. Agr.	Max. Agr.	-
Cm(W+S6)	WRF results and 6 surface sites	Best G2	-	As best G1
Cm(Sw+Uw)	WRF results (as measurements), 6 surface and two upper-air sites	-	-	-
Cm(S6+U)	Data from 6 surface and 2 upper-air sites	-	Best G2	-

Concluding remarks

- ✓ Better surface wind and PBL depth results were obtained using WRF output and surface sites measurements as CALMET meteorological input
- ✓ Better surface temperature was obtained using both surface and upper-air measurements as CALMET meteorological input
- ✓ Also, when measurements are not applied, better surface temperature is directly provided by WRF: **Improving CALMET temperature interpolation?**
- ✓ During clear sky periods, PBL depth provided by CALMET (14 layers in PBL) is better than YSU PBL depth (up to 6 layers in PBL): **Testing YSU PBL depth scheme in CALMET? Testing YSU PBL in WRF with higher PBL vertical and horizontal resolutions? Computational time?**



A COMPARISON OF DIFFERENT WRF-CALMET SIMULATIONS AGAINST SURFACE AND PBL RAWINSONDE DATA

*THANK YOU FOR YOUR
ATTENTION*

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