Modelling of summer photochemistry and winter aerosol in Grenoble urban area in the French Alps

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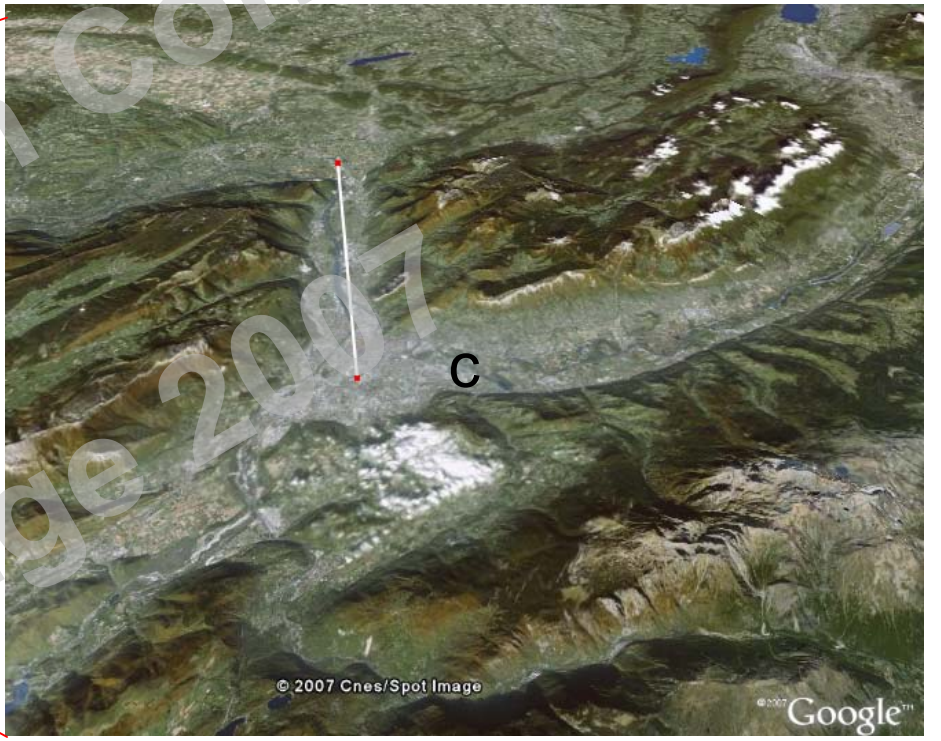
- complex atmosphere dynamics (ex. Grenoble)
- numerical models (PREVALP chain of models)
- summer photochemistry (2003 heat wave)
- winter aerosol episode (february 2005)
- conclusions

Chaxel's thesis on http://tel.archives-ouvertes.fr/

urban area in the Alps :

introduction

a typical example : the Grenoble area



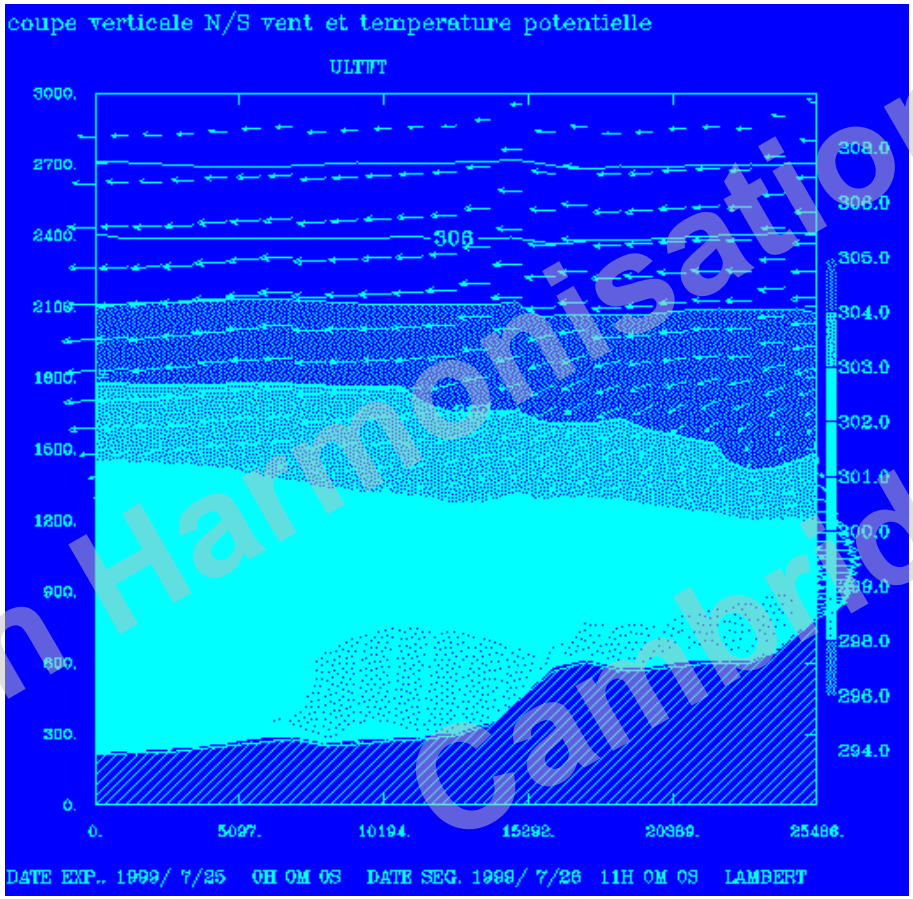
grenoble :
- 400 000 inhabitants
- emissions : road traffic, biogenics

valley :
mountains heights : 1200 to 2400 m above bottom level

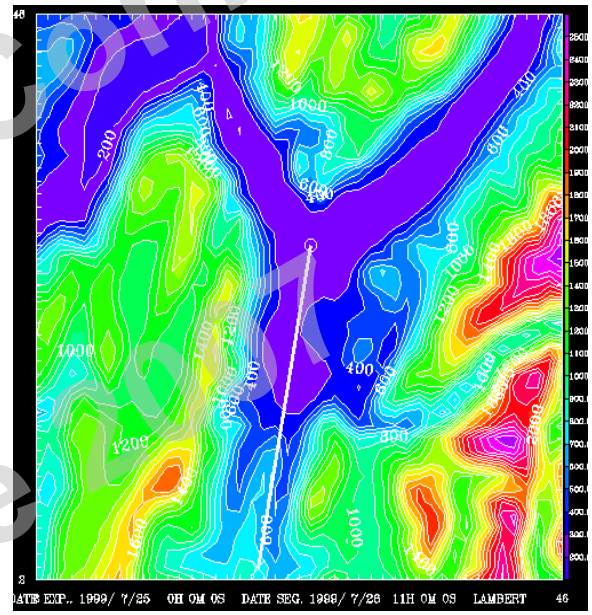
Grenoble summer episodes (simulations and GRENOPHOT field campaign) in :
Couach et al, 2003, Atmos. Chem. Phys, 3
Couach et al. 2004, .Atmos. Env., 38

complex wind/temperature pattern

introduction



vertical cross section : 11:00 to 15:00 UTC

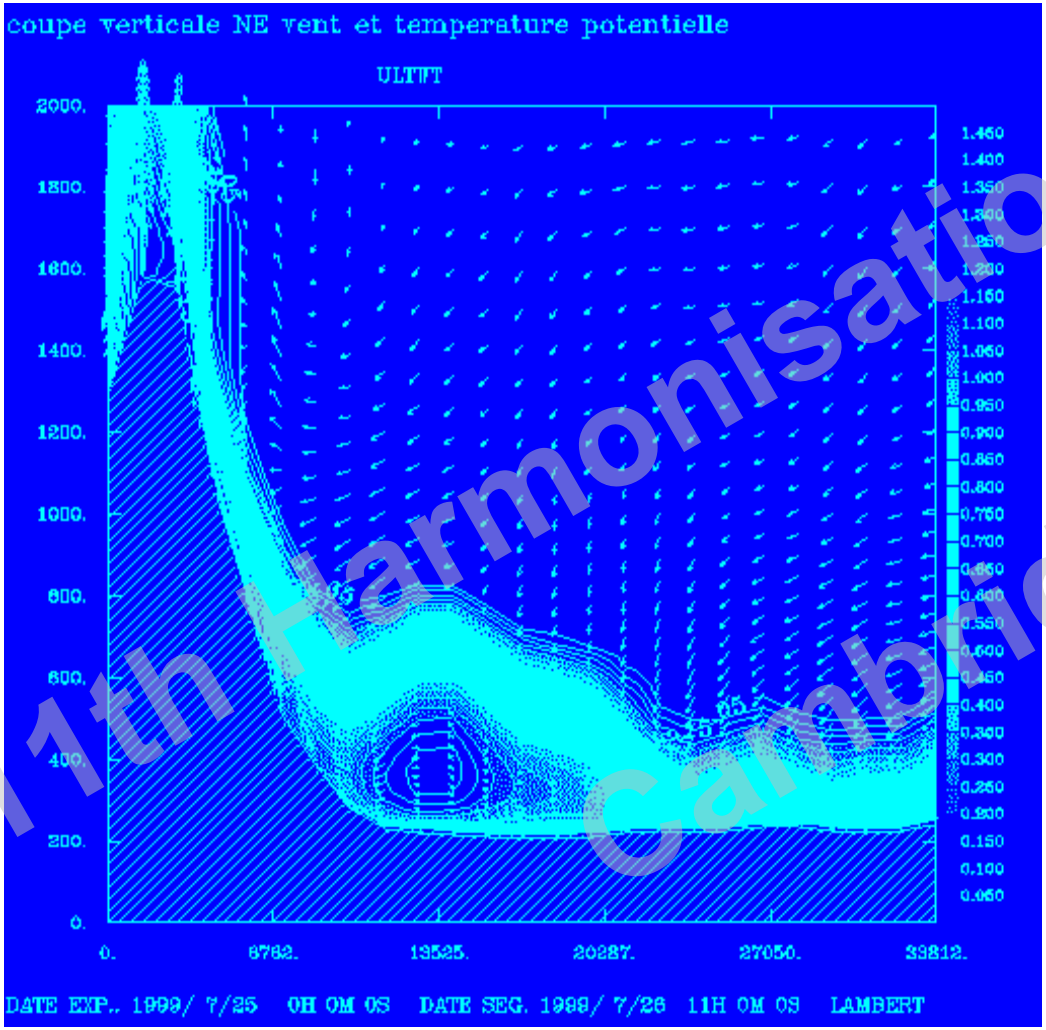


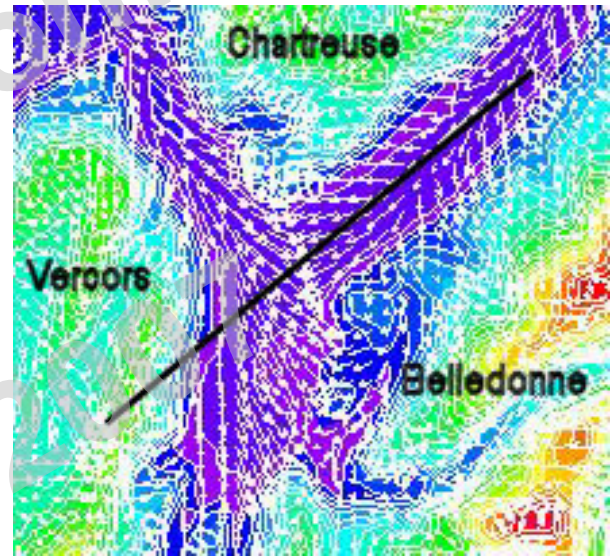
wind and potential temperature in the southern branch

computed with Meso-nH
Claeyman & Chollet
on july 25th, 1999

complex wind, mixing pattern

introduction





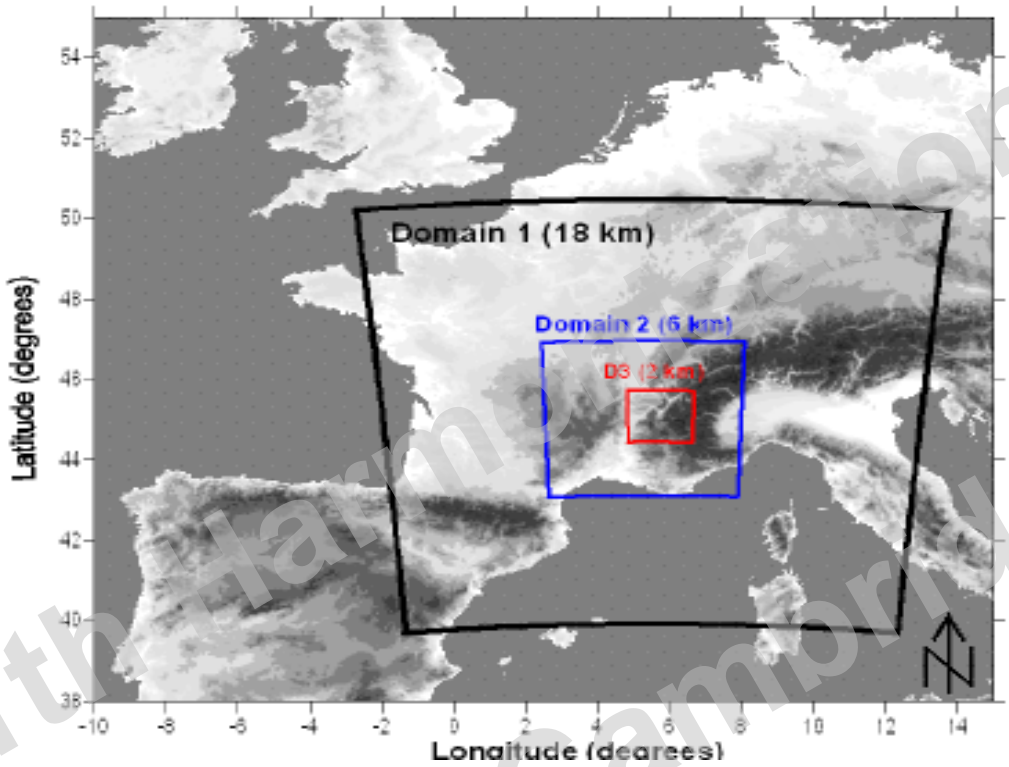
wind and subgrid turbulent kinetic energy

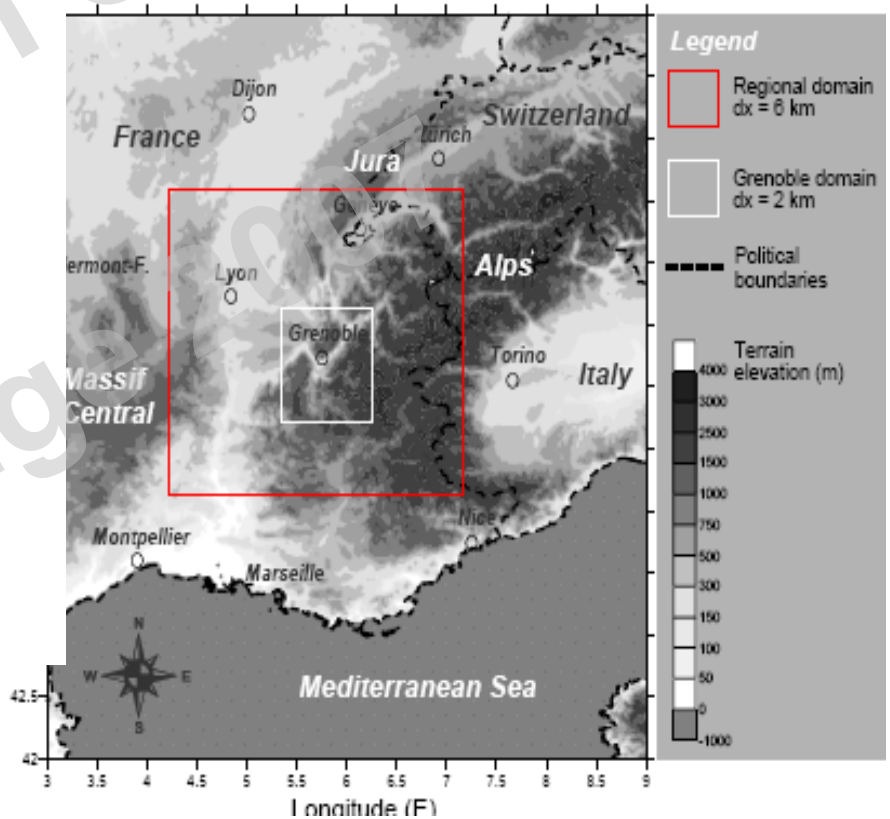
vertical cross section
from 11:00 UTC to 00:00 UTC

computed with Meso-nH
Claeyman & Chollet
on july 25th, 1999

computational domains

model

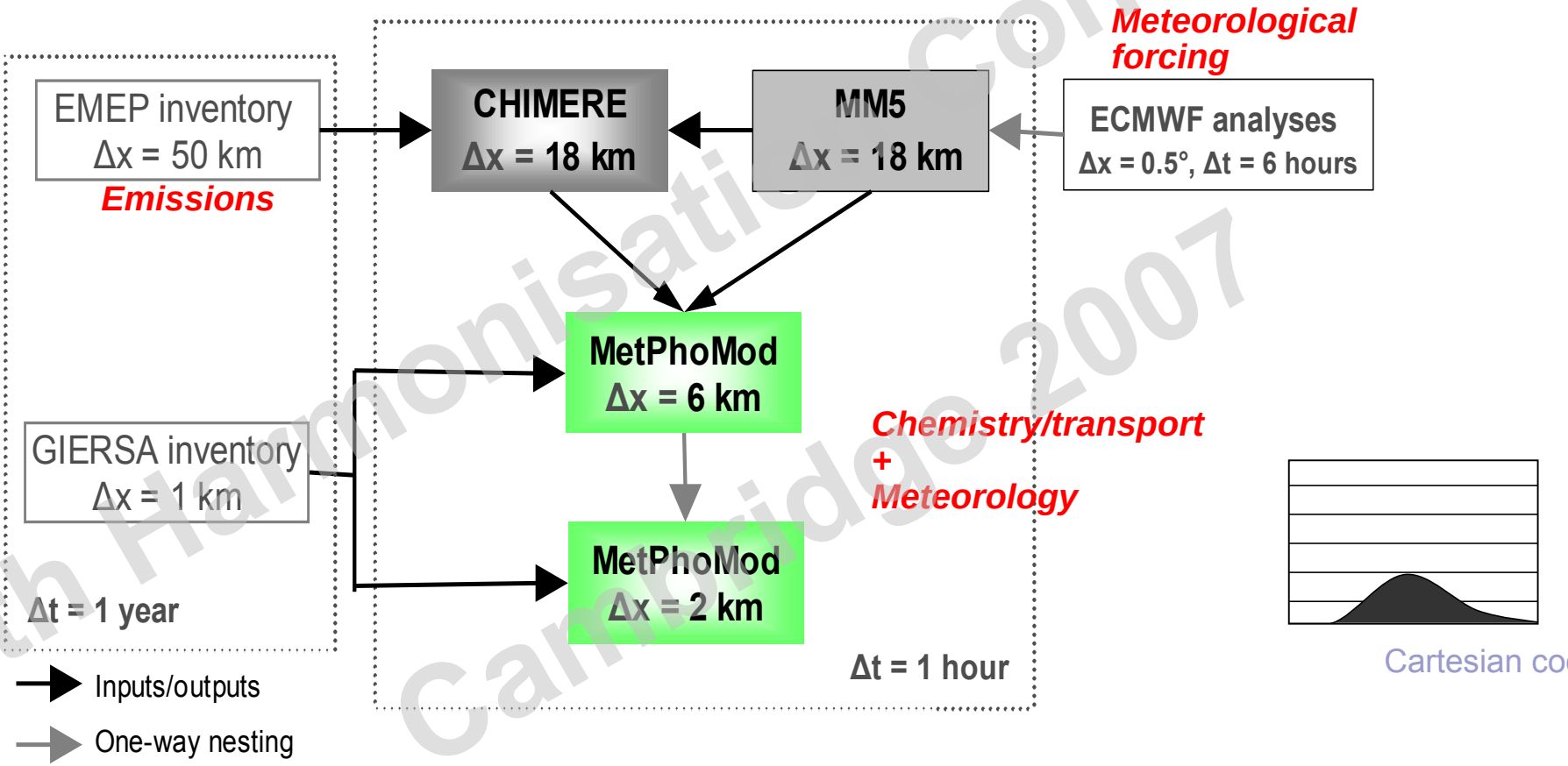




- domain nesting
- dynamics and (gas) chemistry

PREVALP Modelling chain

model



MetPhoMod : Perego, 1993 *Meteorol. Atmos.Phys, 70*
CHIMERE : Vautard et al., 2001, *Atmos. Environ., 35*
MM5 : Grell et al., ,1995

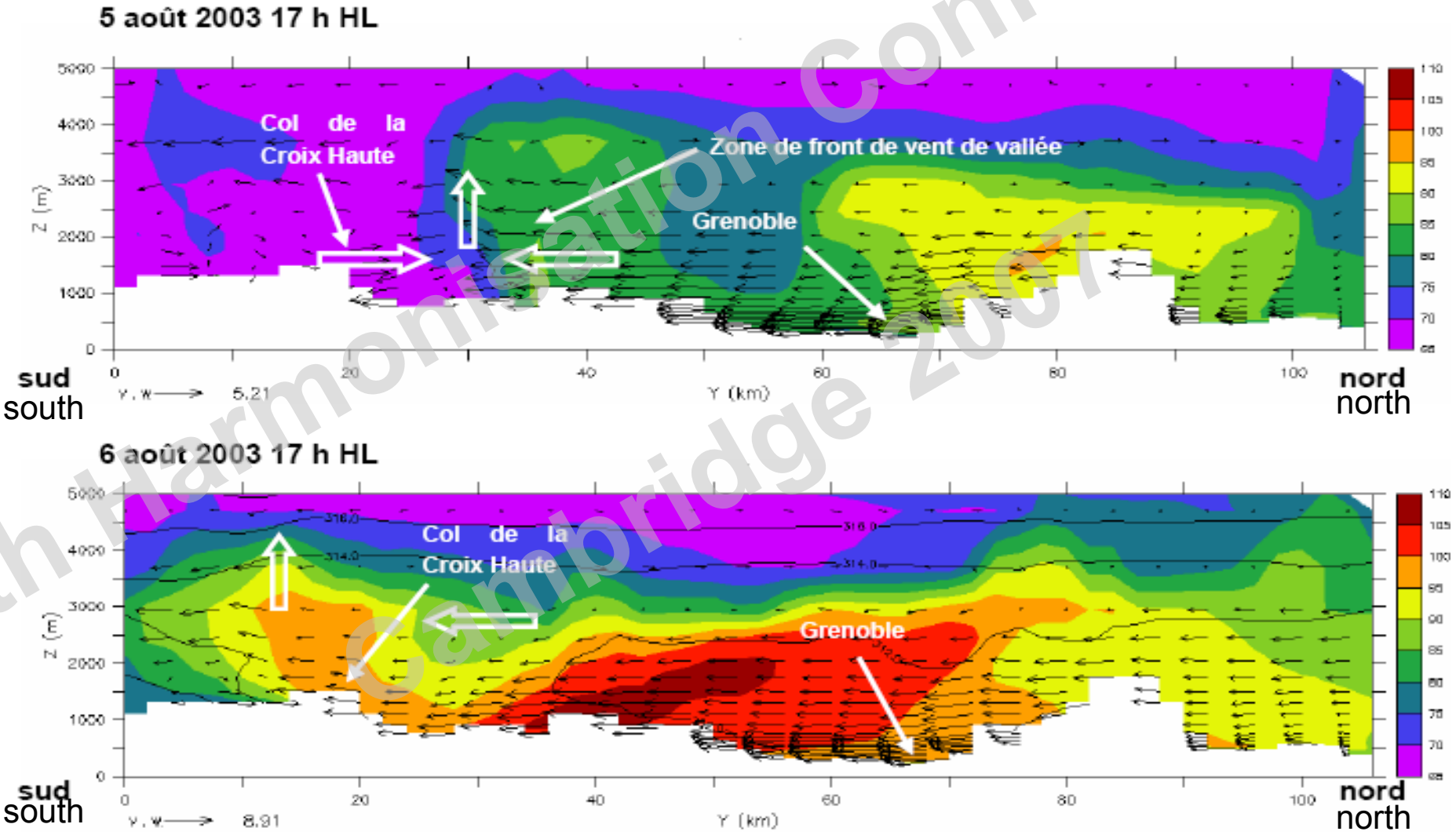
numerical code for chemistry

model

	CHIMERE	Metphomod
Couplage avec dynamique	*offline*	*online*
Résolution horizontale	18 km, 6 km and 2 km	6 km et 2 km
Coordonnées verticales	hybrid sigma	rectangulaire
Mécanisme chimique	MELCHIOR 2 (44 espèces dont 22 COVNM, 120 réactions) [*Derognat*, 1998]	RACM (73 espèces dont 32 COVNM, 216 réactions) [*Stockwell, Kirchner, Kuhn, and Seefeld*, 1997]
Nombre de niveaux	8	24
Toit de modèle	500 hPa	9000 m amsl (≈350 hPa)
Algoritme de transport	PPM [*Colella and Woodward*, 1984]	PPM [*Clappier*, 1998]
Schéma de diffusion verticale	k-diffusion [*Troen and Mahrt*, 1986]	k-ε [*Apsley and Castro*, 1997]
Dry deposition scheme	[*Wesely*, 1989]	[*Wesely*, 1989]
Microphysique	effect of cloud water on radiation	no cloud effects
Technique d'imbrication	one-way	one-way
Emissions	Au sol seulement	Au sol et en altitude (sources ponctuelles)

ozone & wind : 5- 6 august 2003

summer



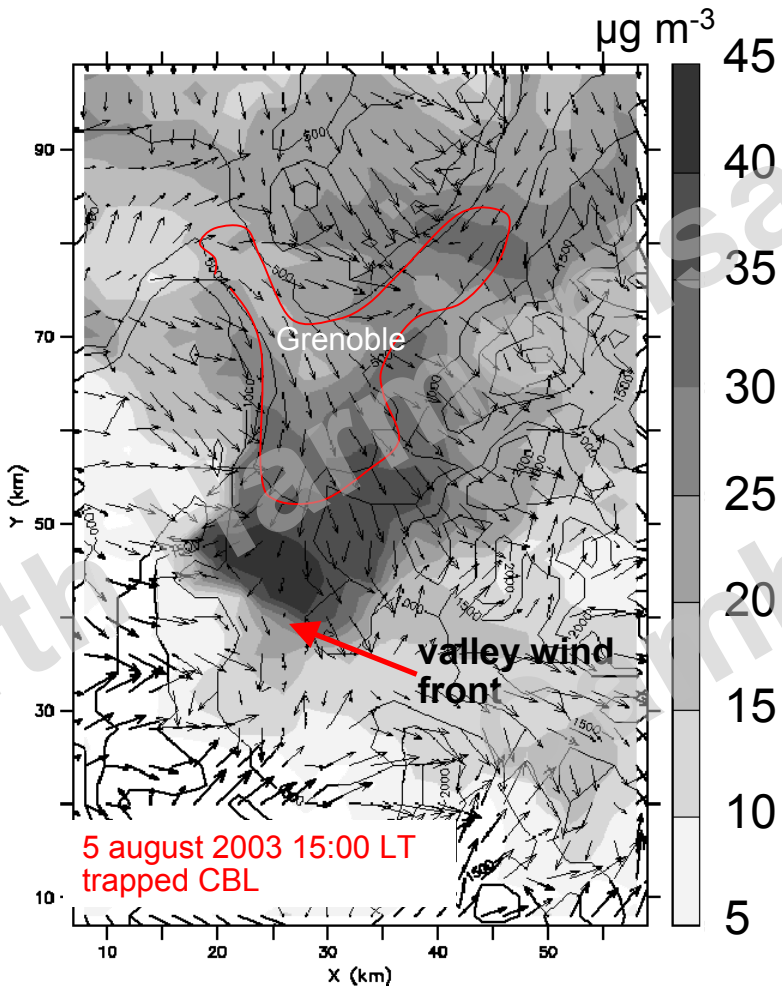
local production of ozone

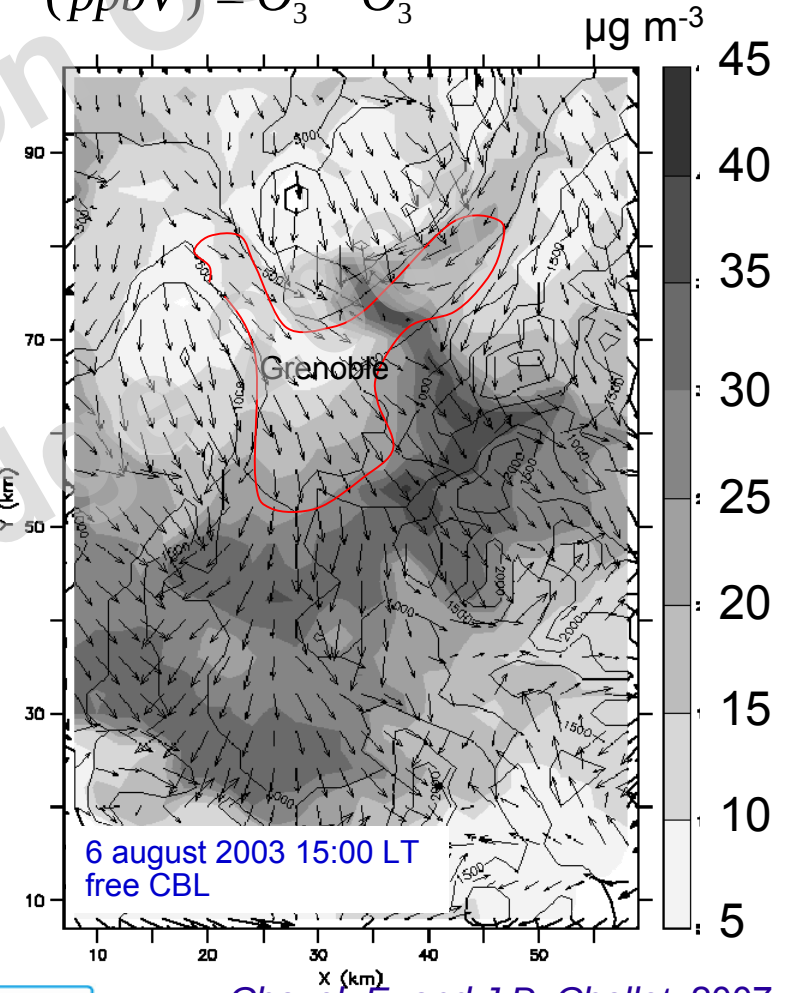
summer

total ozone

ozone from boundary conditions

$$pO3^{loc}\,(ppbV) = O_3 - O_3^{R}$$





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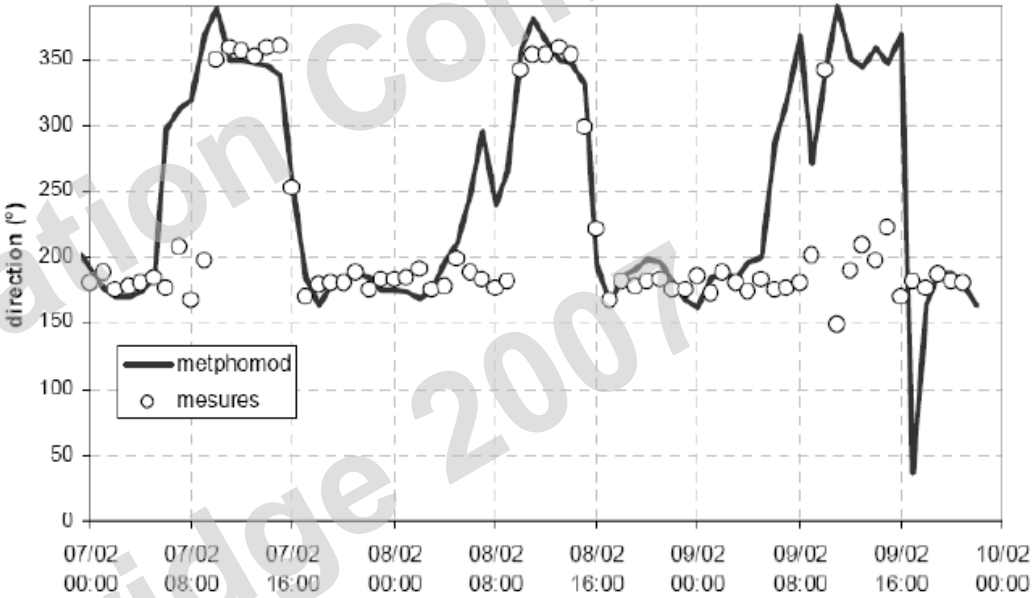
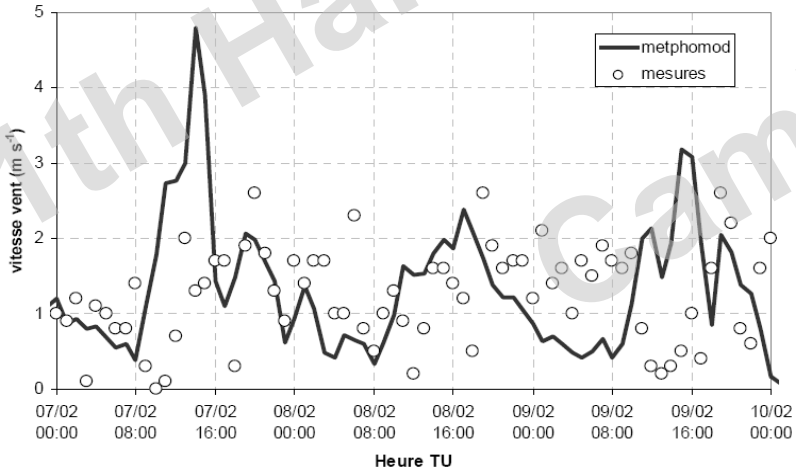
Chaxel, E. and J.P. Chollet, 2007, UAQ2007, Cyprus

model/measurement : February 2005

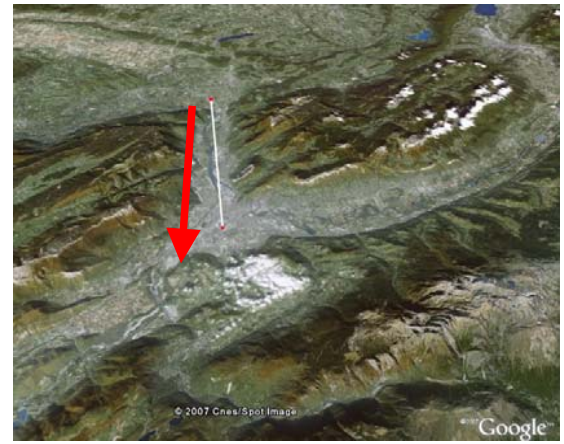
winter



wind direction

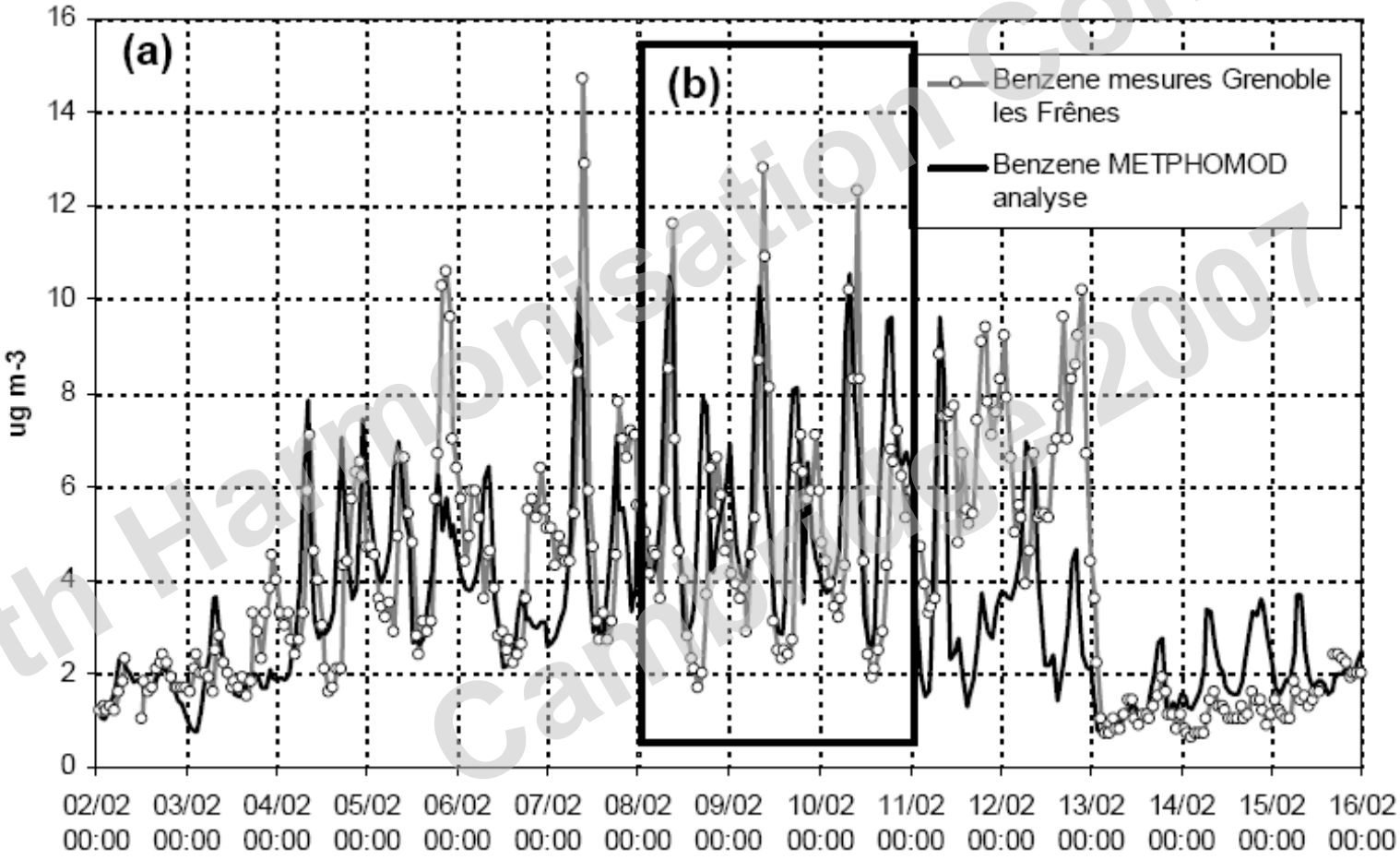


wind force



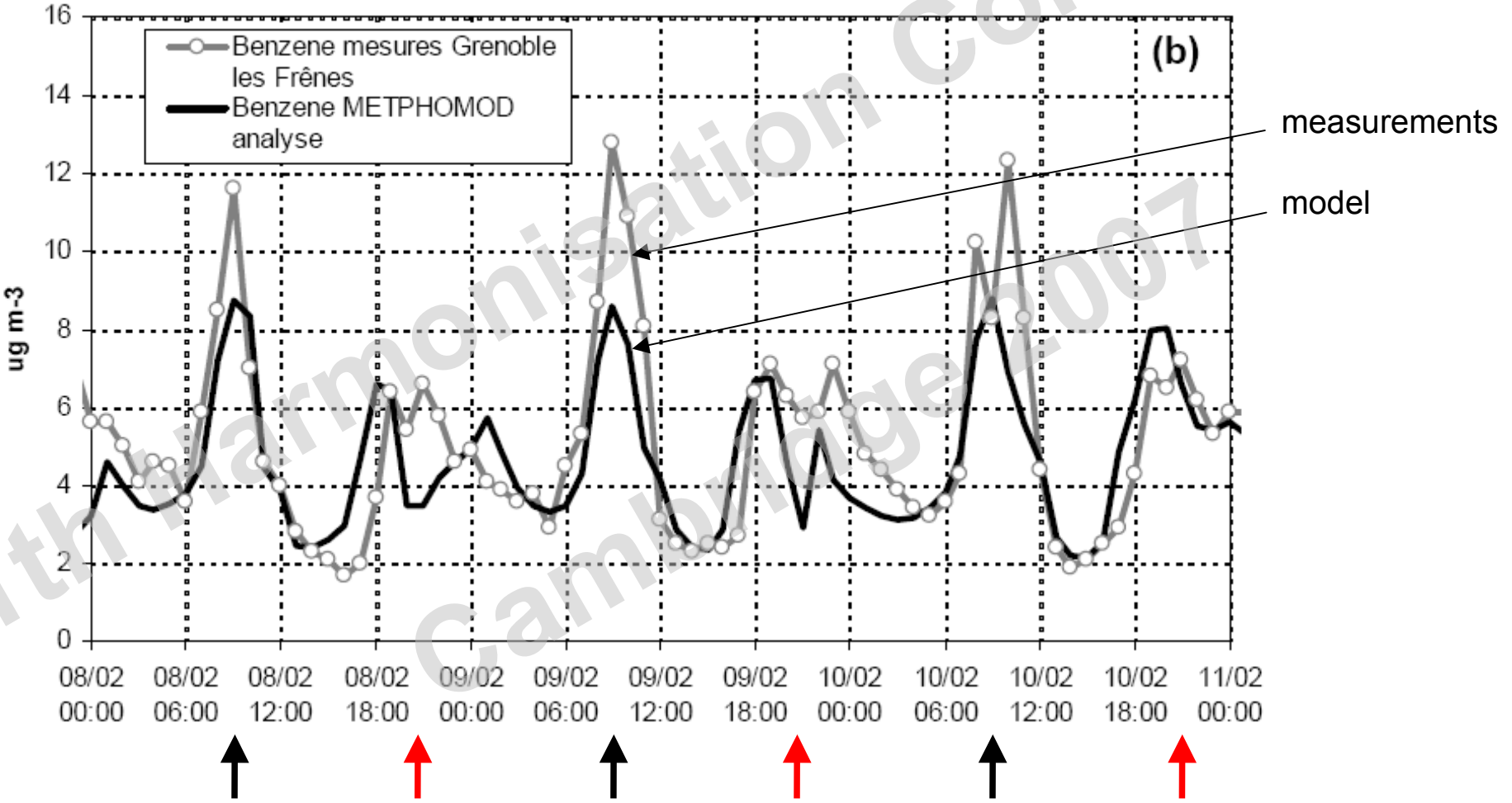
benzene : 2 to 16 February 2005

winter



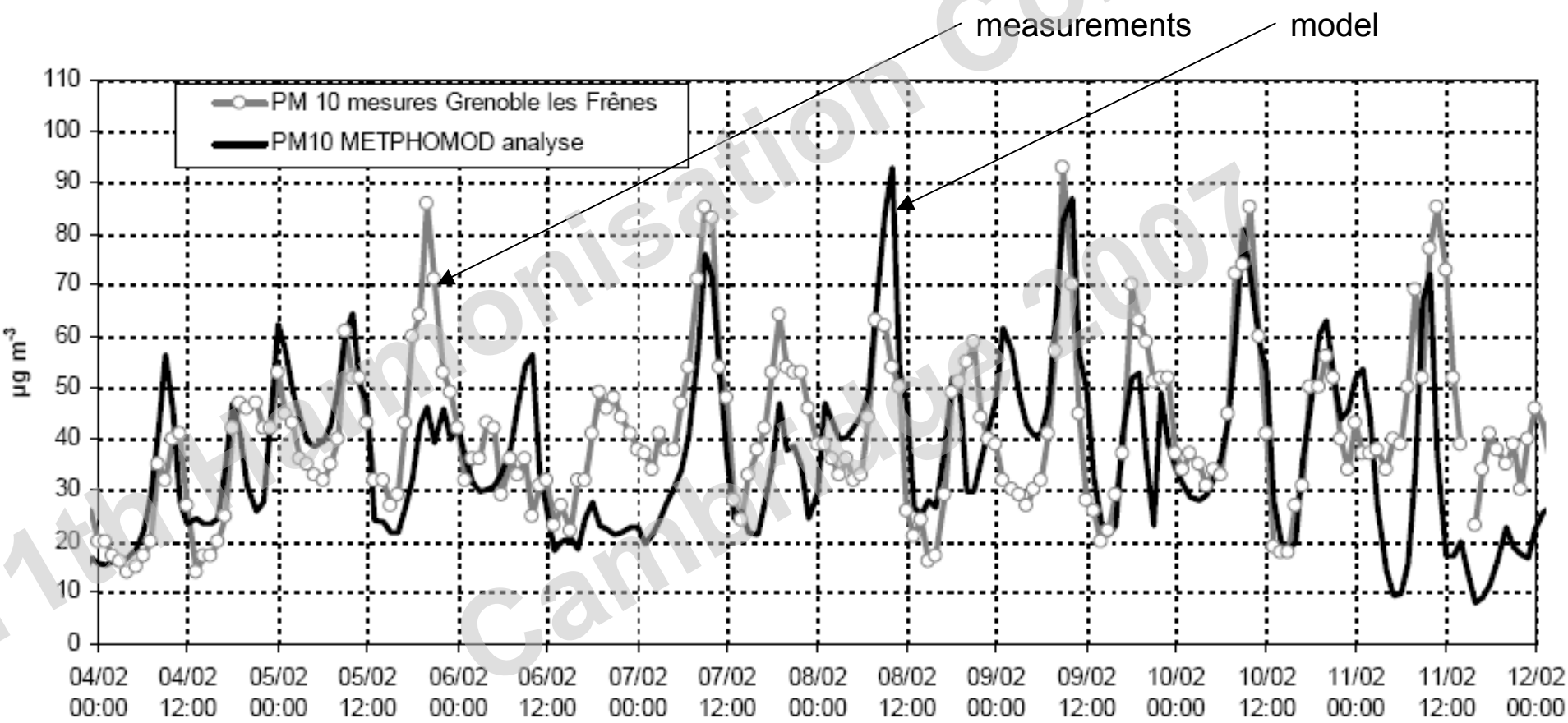
benzene : focus on 6 to 11 February 2005

winter



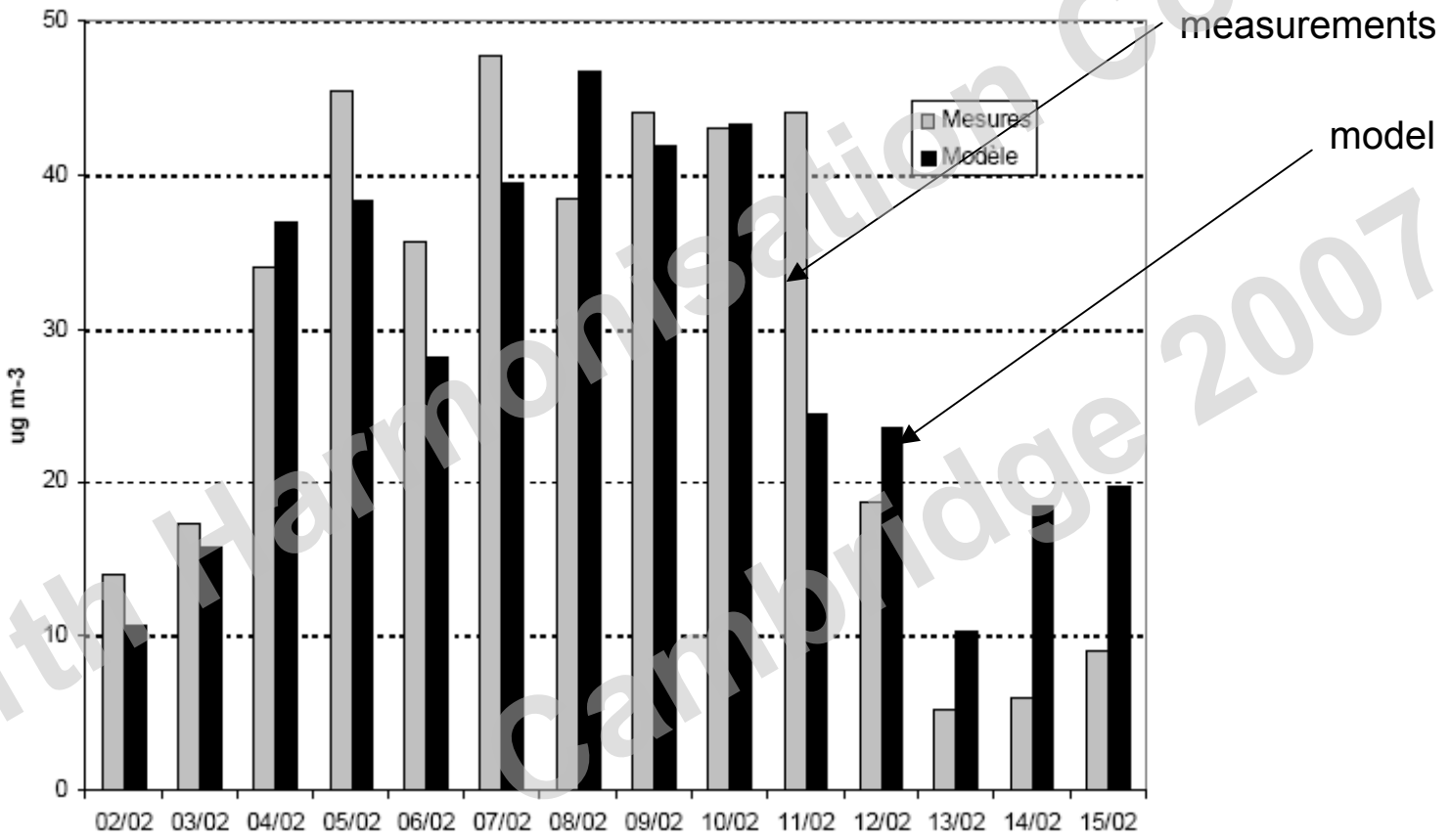
PM10 : February 2005

winter



PM10 :daily averaged concentration

winter

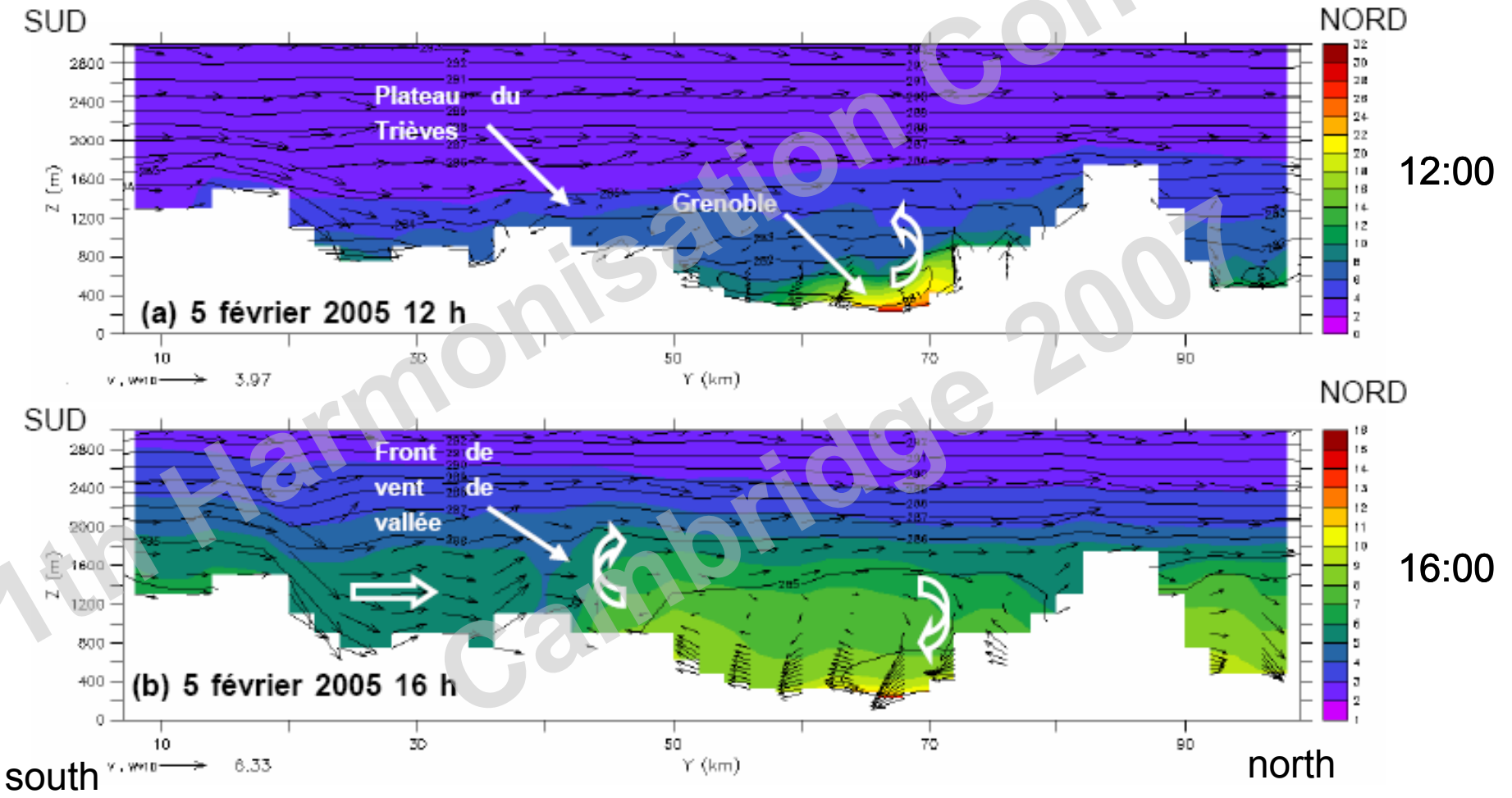


measurements

model

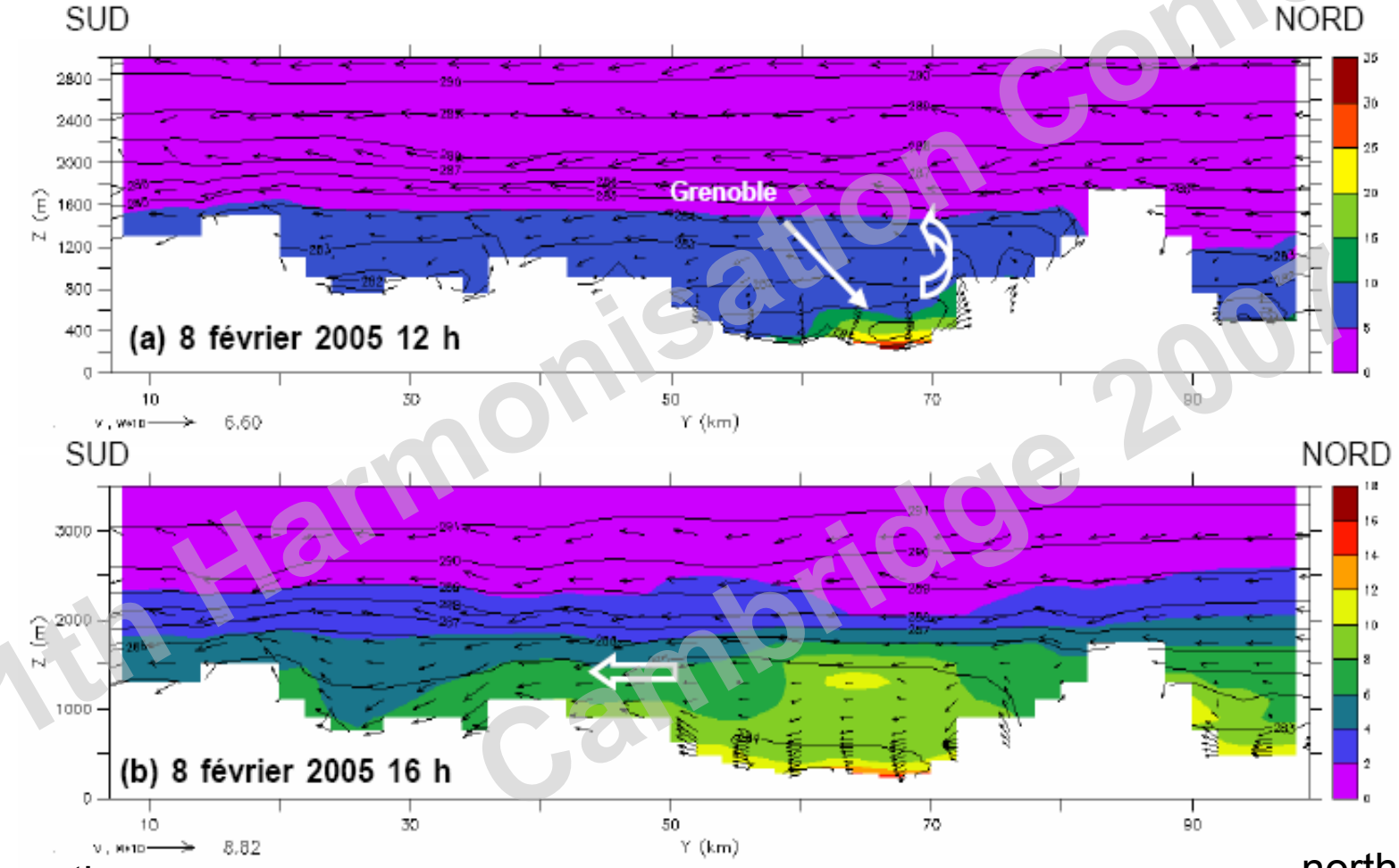
wind & PM10 : 5 February 2005

winter



wind & PM10 : 8 February 2005

winter



12:00

16:00

south

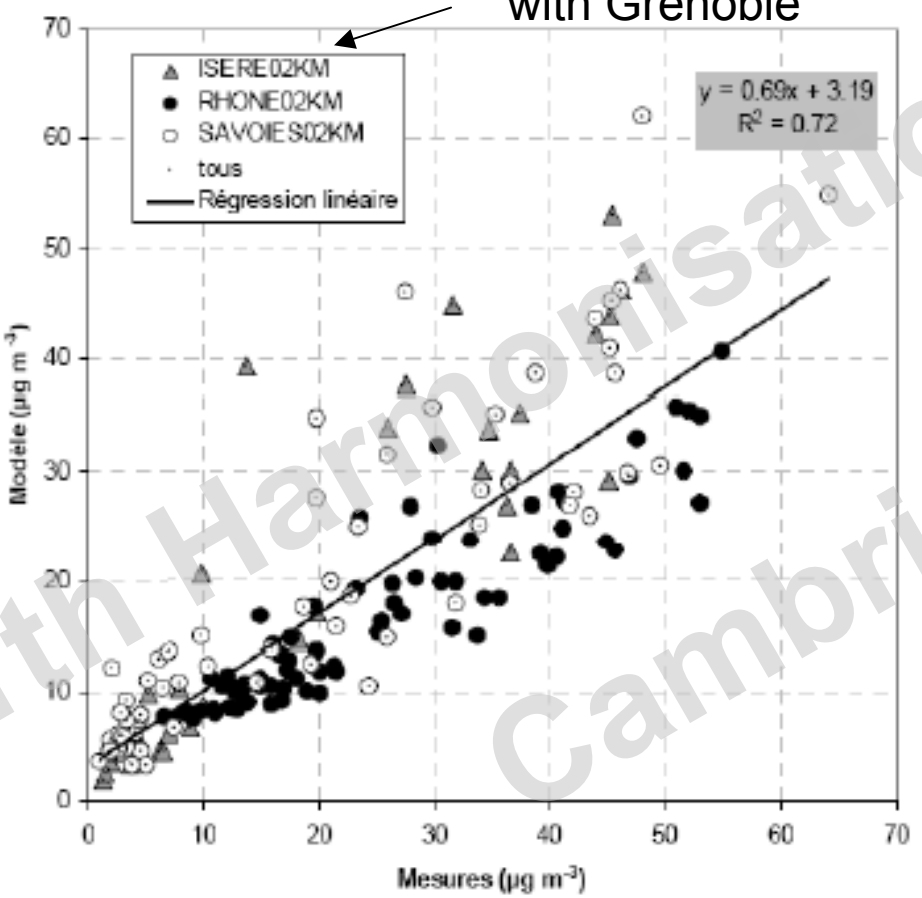
north

model/experiments comparisons (passive tube campaign : February 2005)

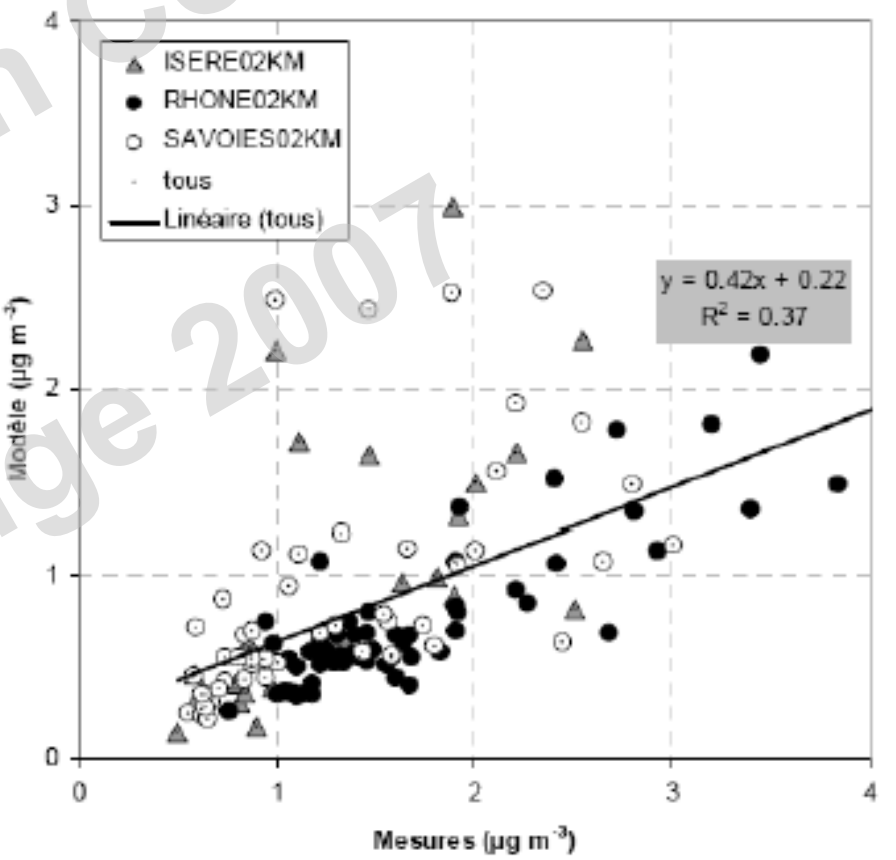
winter

NO2

with Grenoble



benzene



benzene in mountainous area (Isere, Savoie) : deposition to be improved ?

conclusions & prospects

- PREVALP chain of models currently in use for forecast and scenarios in Grenoble (operated by ASCOPARG-GIERSA)
- in summer, 30 to 40% of ozone production is local ; various regimes : trapped BL, free BL,..
- in winter, PM10 as passive tracer : various regimes (synoptic wind, slope wind,..)
- *to be improved :* emission-deposition (e.g. benzene in winter), PM from regional scales
- *prospects : finer grid (down to 300m) and urban canopy, study(in time,space) of regime transitions, local meteo fields to drive smaller scale models (streets,..)*