Evaluation of an operational “ensemble prediction system” for ozone concentrations over Belgium using the CTM Chimere

A. Delcloo[a] and O. Brasseur[b]

[a]Royal Meteorological Insitute, Uccle, Belgium B-1180

[b]Belgian Interregional Environment Agency, Brussels, Belgium B-1210

Overview

- Chimere at RMI
- Evaluation of an operational Ensemble Prediction System for ozone
- OUTLOOK

Ozone, UV and aerosol group

- Observations:
- Total ozone column
- Ozone profiles
- UV spectral measurements and UV-index
- Aerosol Optical depth in the UV

- Modelling:
- Radiative Transfer in the UV
- Chemical Transport Model to study ozone and other minor constituents in the troposphere

Ozone, UV and aerosol group

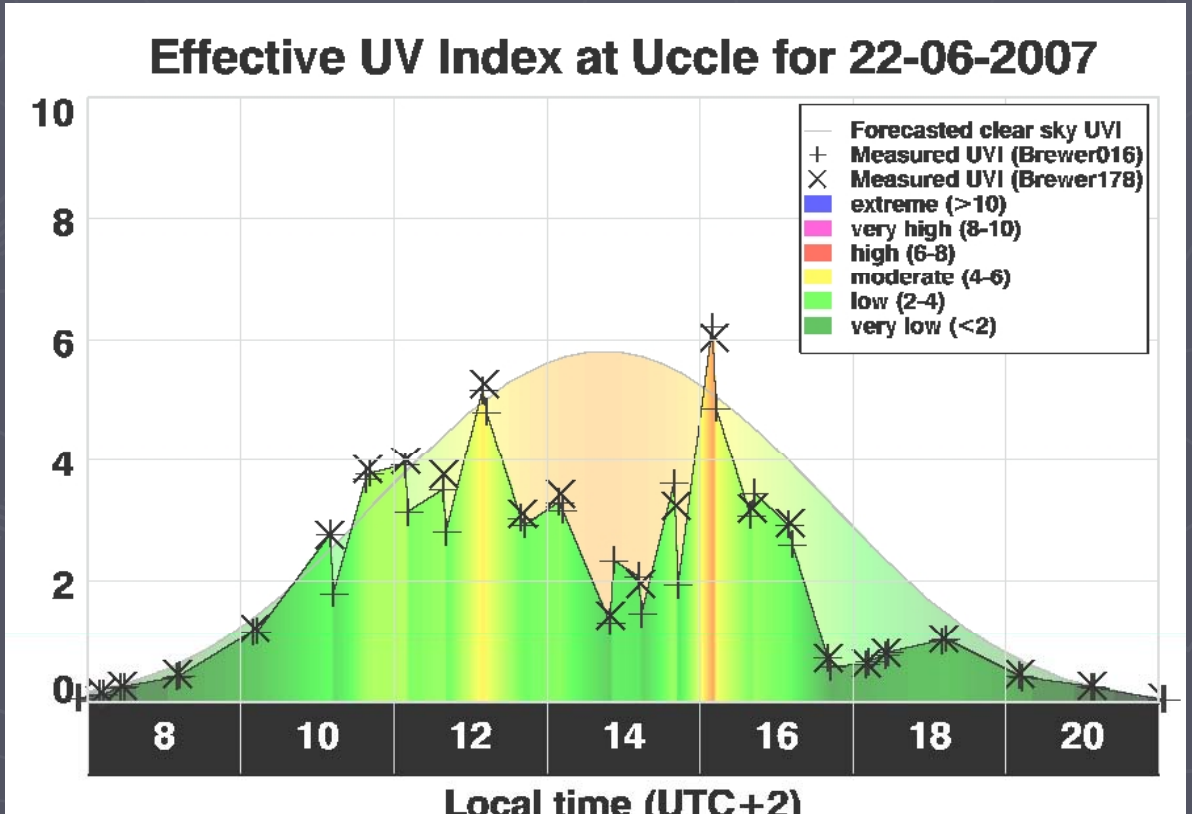
- Ozone column, UV spectra & AOD (daily observations)
  - UV spectrophotometers:
    - Dobson since 1971
    - Brewer single monochromator since 1983
    - Brewer double monochromator since 2001

Ozone, UV and aerosol group

- Ozone profiles
  - Balloon soundings
  - Brewer-Mast sondes 1969-1997
  - Z-ECC-sondes since April 1997
  - 3 x week: Mo-We-Fri

Ozone, UV and aerosol group

- UV Modelling
  - Radiative transfer for UV-index forecast



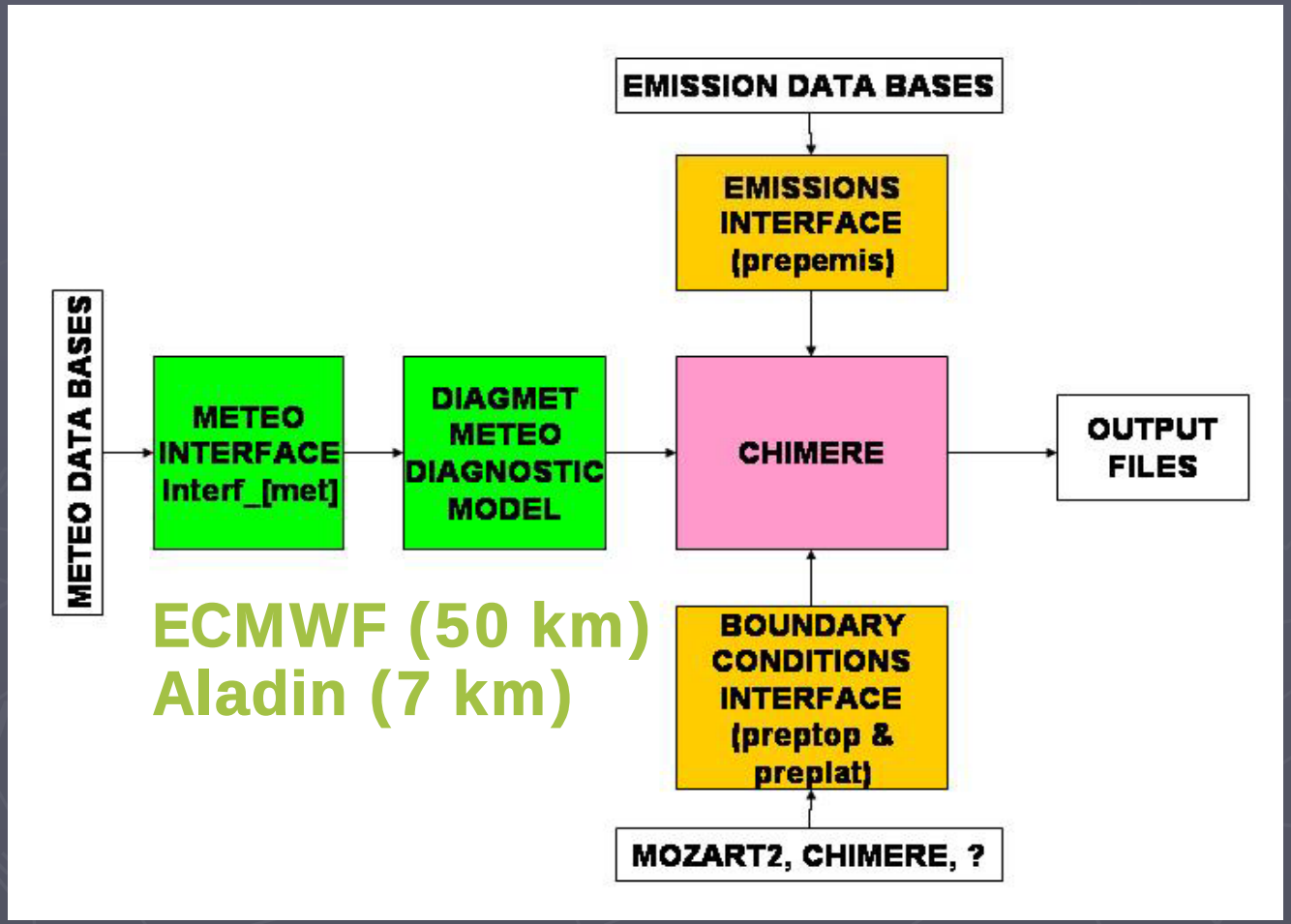
Ozone, UV and aerosol group

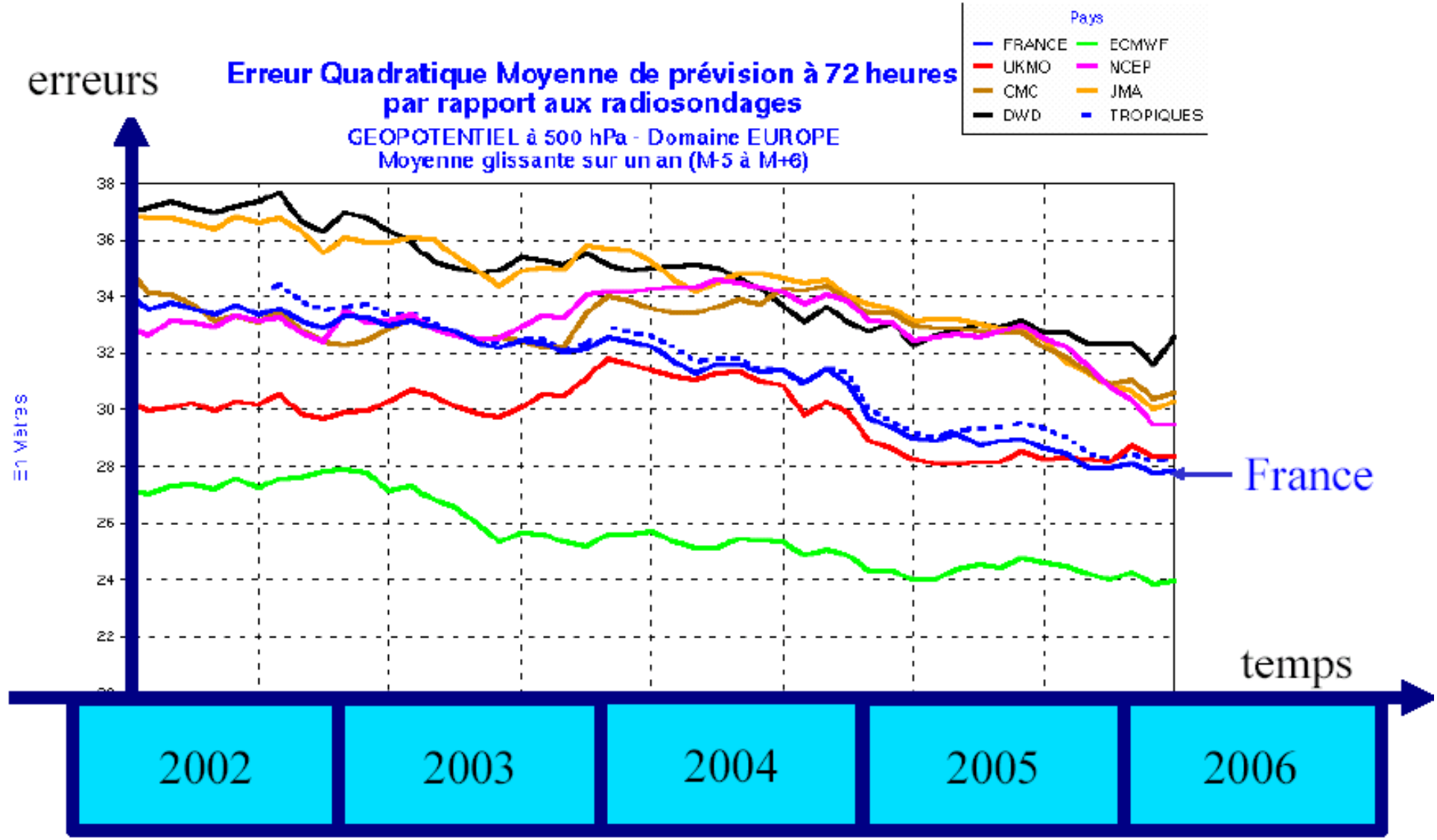
- Chemical Transport Modelling
  - CHIMERE coupled to ECMWF
  - Research topics:
    - exploitation of ozone (profile) observations
    - link between meteorology and air-pollution
    - assimilation of ozone observations
    - Coupling to Aladin (7 km)

Chimere

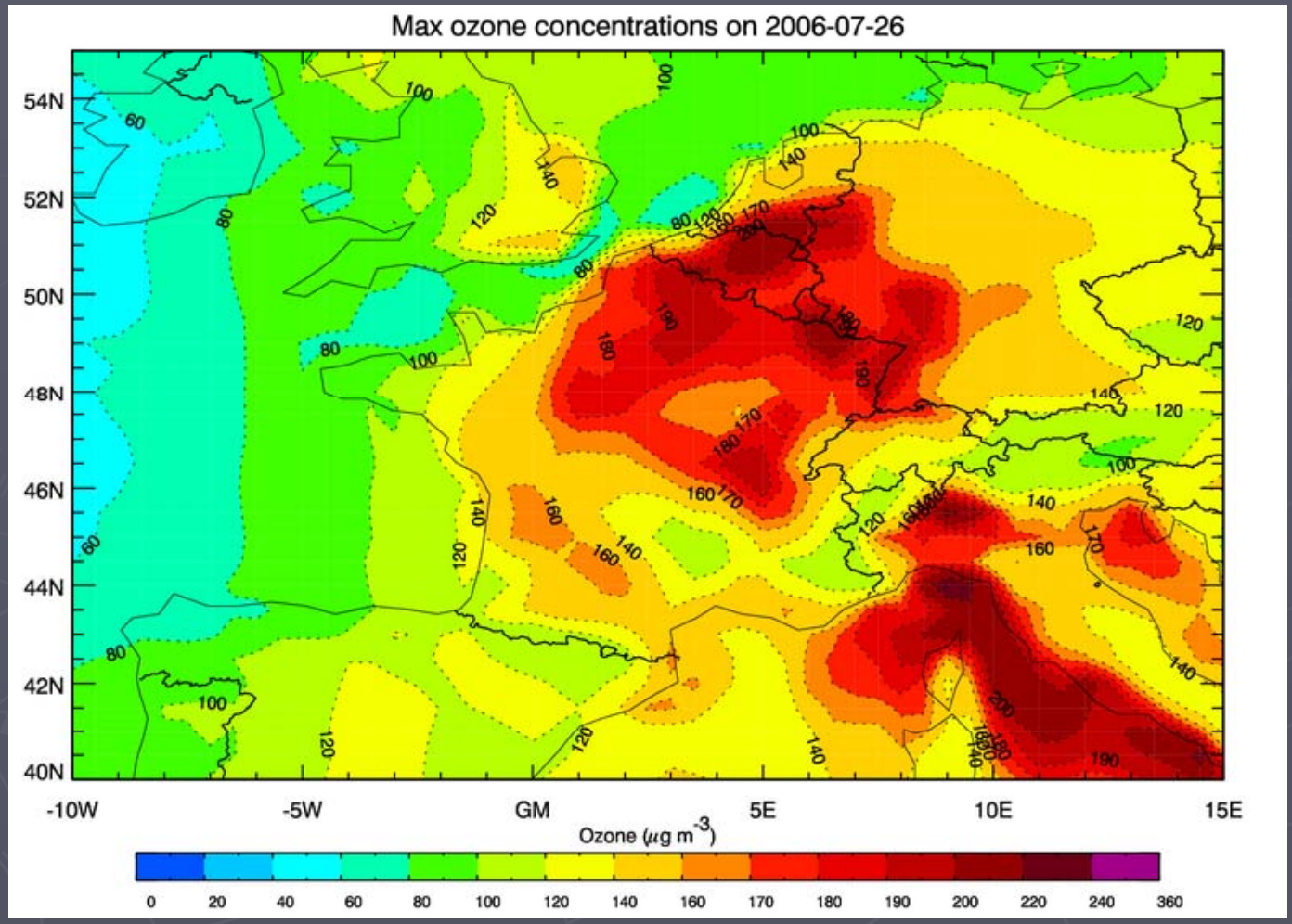
- Resolution 50 km ($0.5\ ^{0}$)
- Emissions: EMEP (2002)
- Domain: Europe (CONT 3)
- Levels (8, until 500 hPa (5.5 km))
- Parallel version (Melchior 2)
- ECMWF data set (0.5^{0})
- 57’ for 6 days forecast with 4 CPU’s

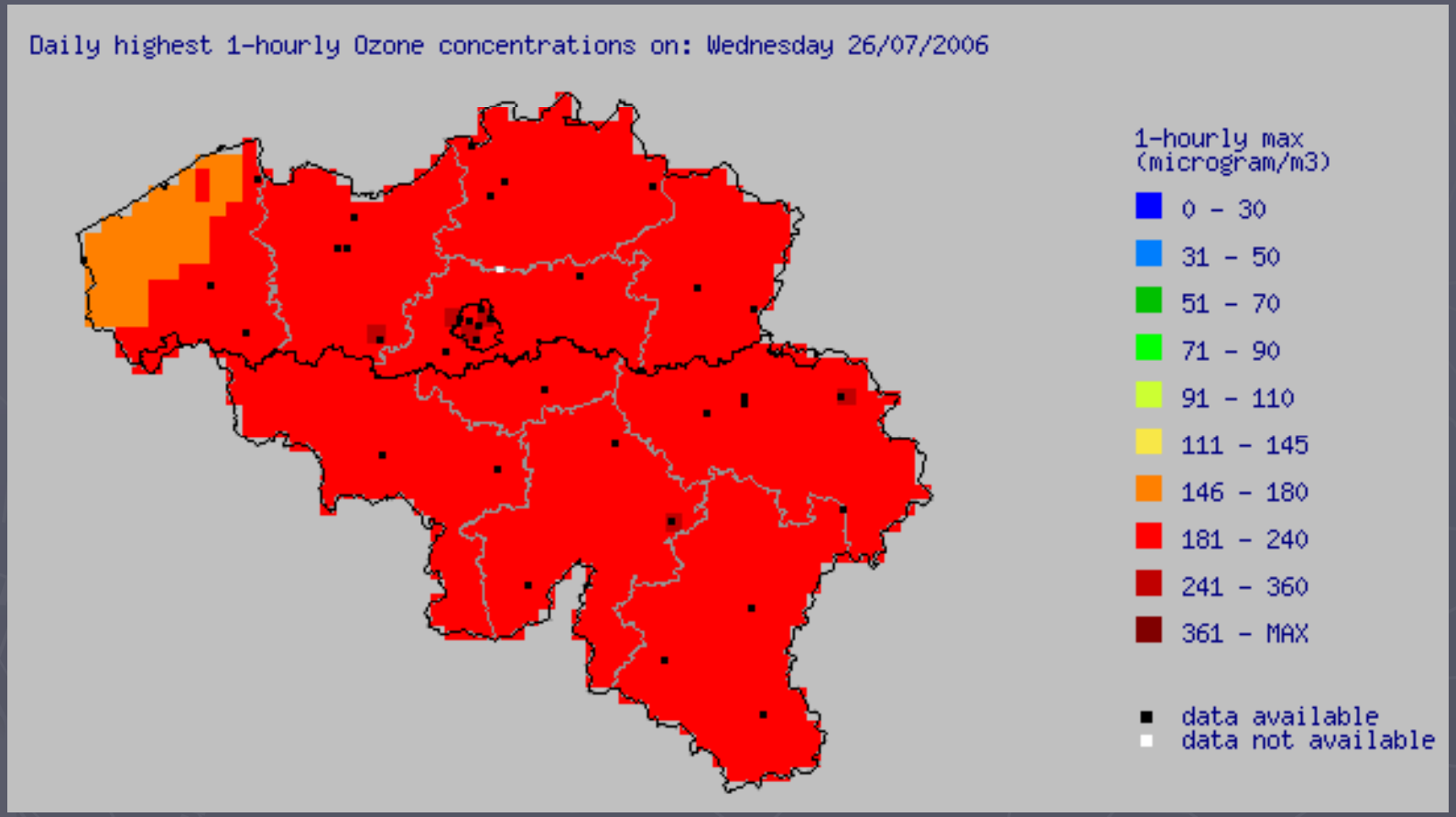
General scheme




erreurs
Erreur Quadratique Moyenne de prévision à 72 heures
par rapport aux radiosondages
GEOPOTENTIEL à 500 hPa - Domaine EUROPE
Moyenne glissante sur un an (M-5 à M+6)
Pays
FRANCE
ECMWF
UKMO
NCEP
CMC
JMA
DWD
TROPIQUES
En Mètres
38
36
34
32
30
28
26
24
22
France
temps
2002
2003
2004
2005
2006

Ozone heatwave July 2006

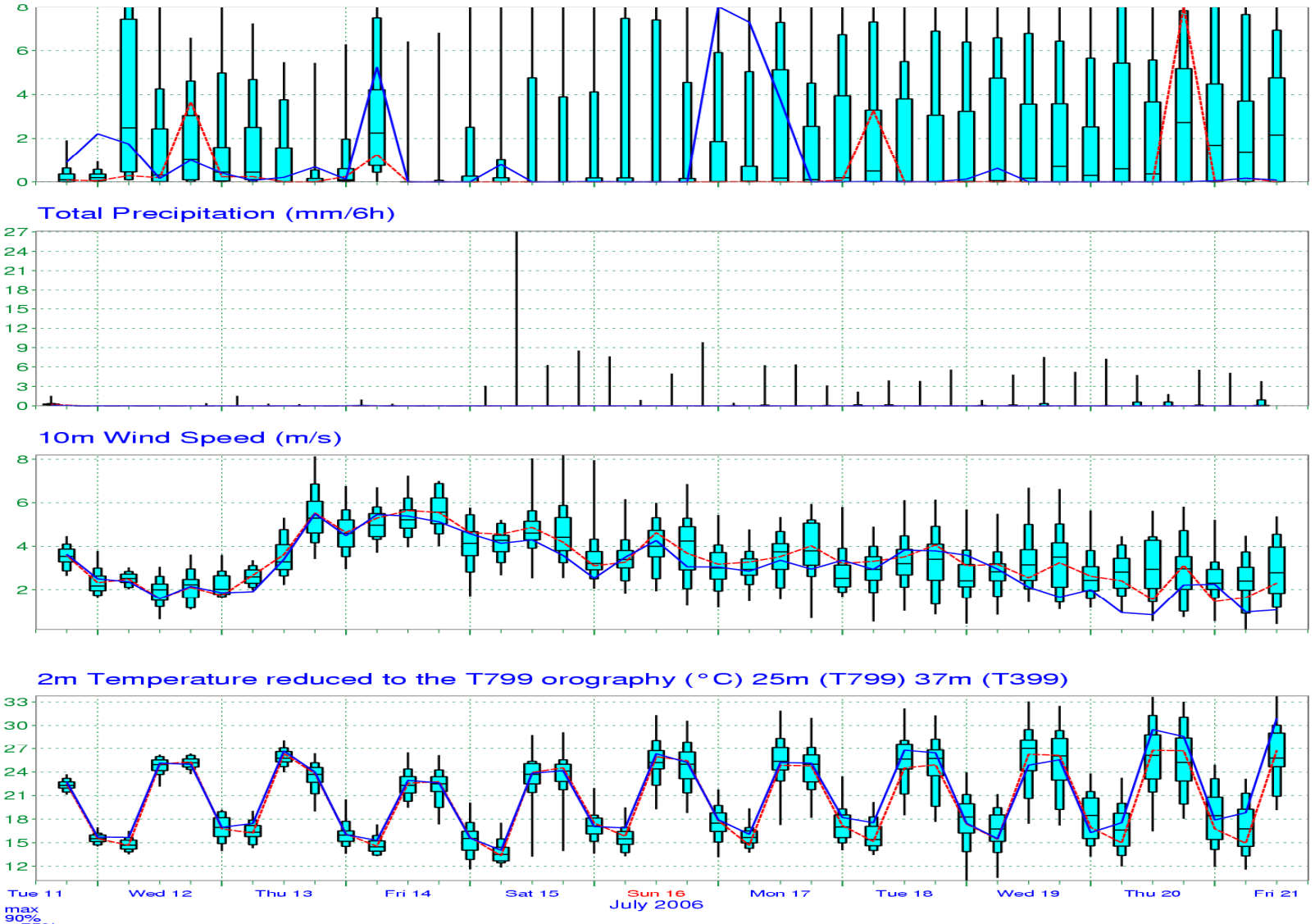



Daily highest 1-hourly Ozone concentrations on: Wednesday 26/07/2006
1-hourly max
(microgram/m3)
0 - 30
31 - 50
51 - 70
71 - 90
91 - 110
111 - 145
146 - 180
181 - 240
241 - 360
361 - MAX
data available
data not available

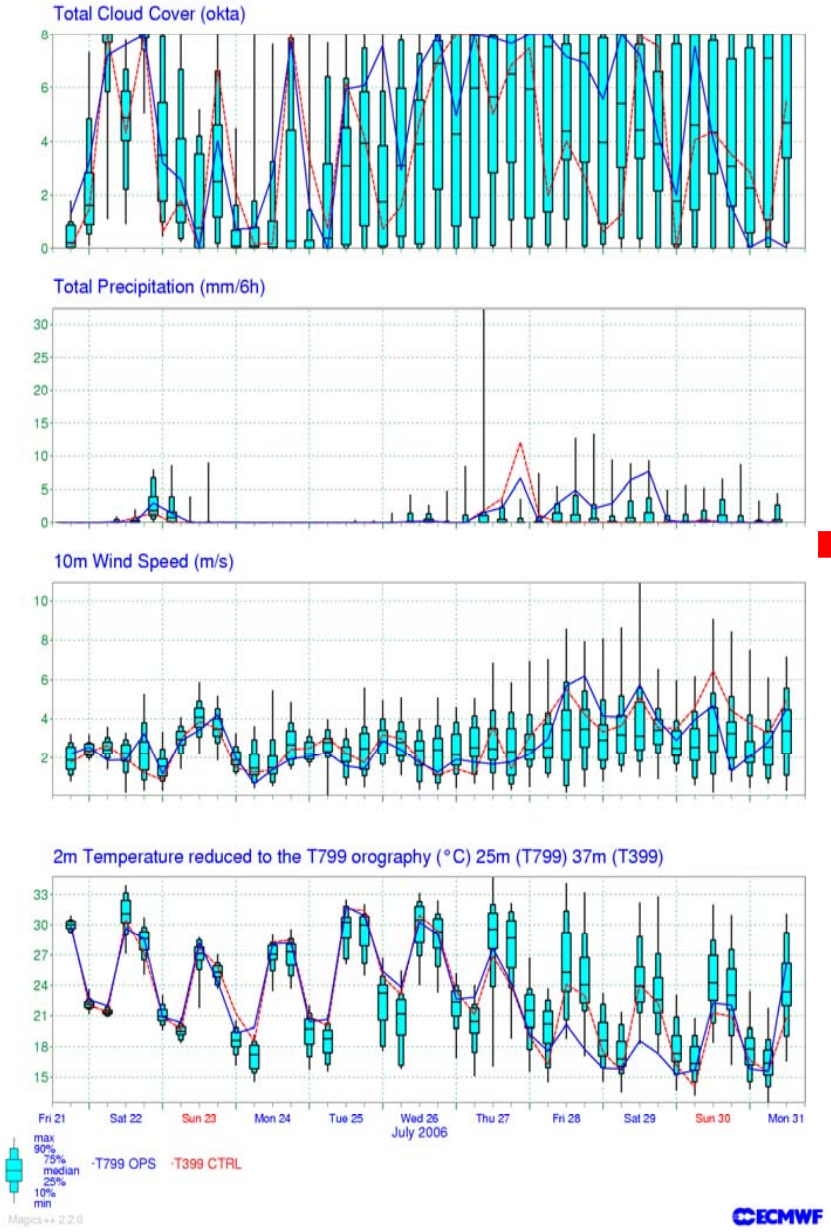
Overview

- Chimere at RMI…
- Evaluation of an operational Ensemble Prediction System for ozone
- OUTLOOK

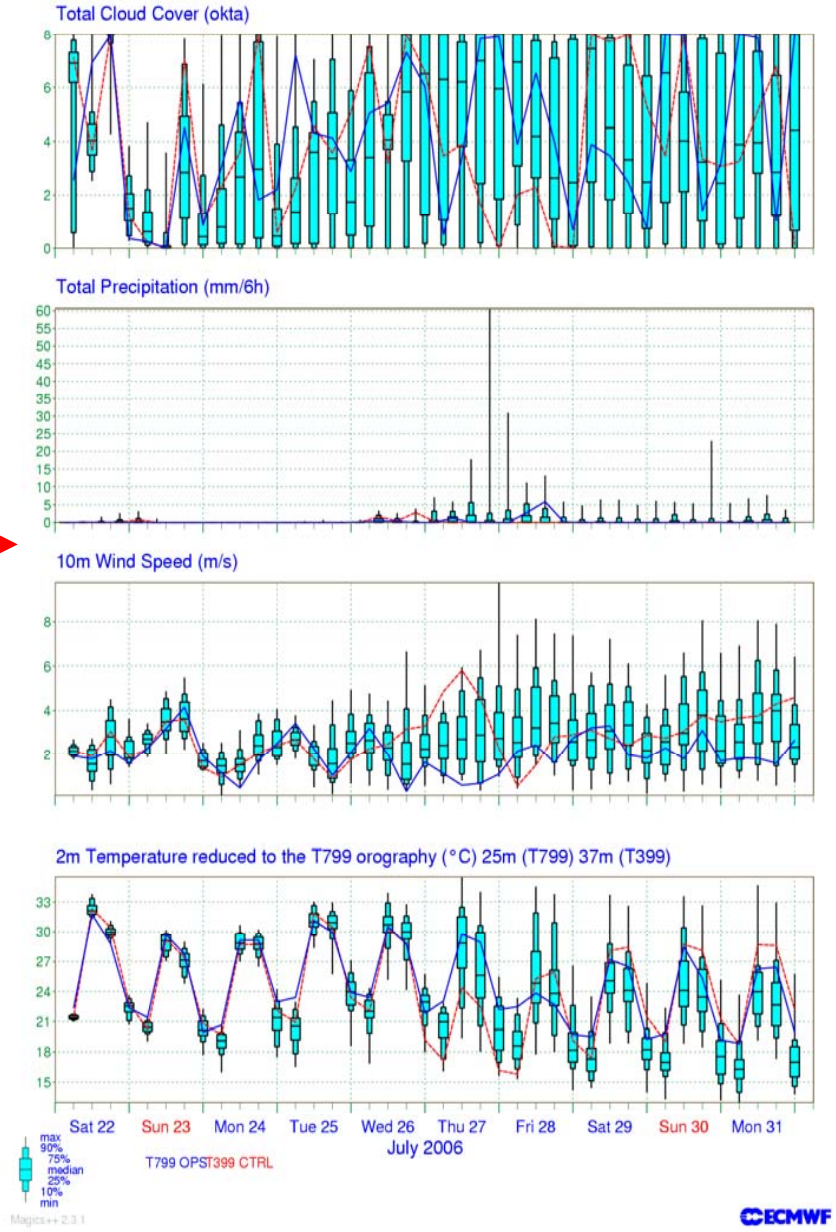
EPS Meteogram
Brussel 51.01°N 4.67°E
Deterministic Forecast and EPS Distribution Tuesday 11 July 2006 12 UTC



EPS Meteogram
Brussel 51.01°N 4.67°E
Deterministic Forecast and EPS Distribution Friday 21 July 2006 12 UTC



EPS Meteogram
(6.01347e-154 m) 51.01°N 4.67°E
Deterministic Forecast and EPS Distribution Saturday 22 July 2006 00 UTC



Ensemble

- Perturbation of 4 parameters
- Cloud cover (0 or 1) (CLO, CL1), +50% (Cp5), -50% (Cm5)
- Temperature (+2 ºC (Tp2), +4 ºC (Tp4), -2 ºC (Tm2), -4 ºC (Tm4))
- Wind speed (-1 m/s (Wm1), -2 m/s (Wm2), +1 m/s (Wp1), +2 m/s (Wp2))
- Emissions (-50 %(EM1), +50% (EM2), +100 %(EM3))

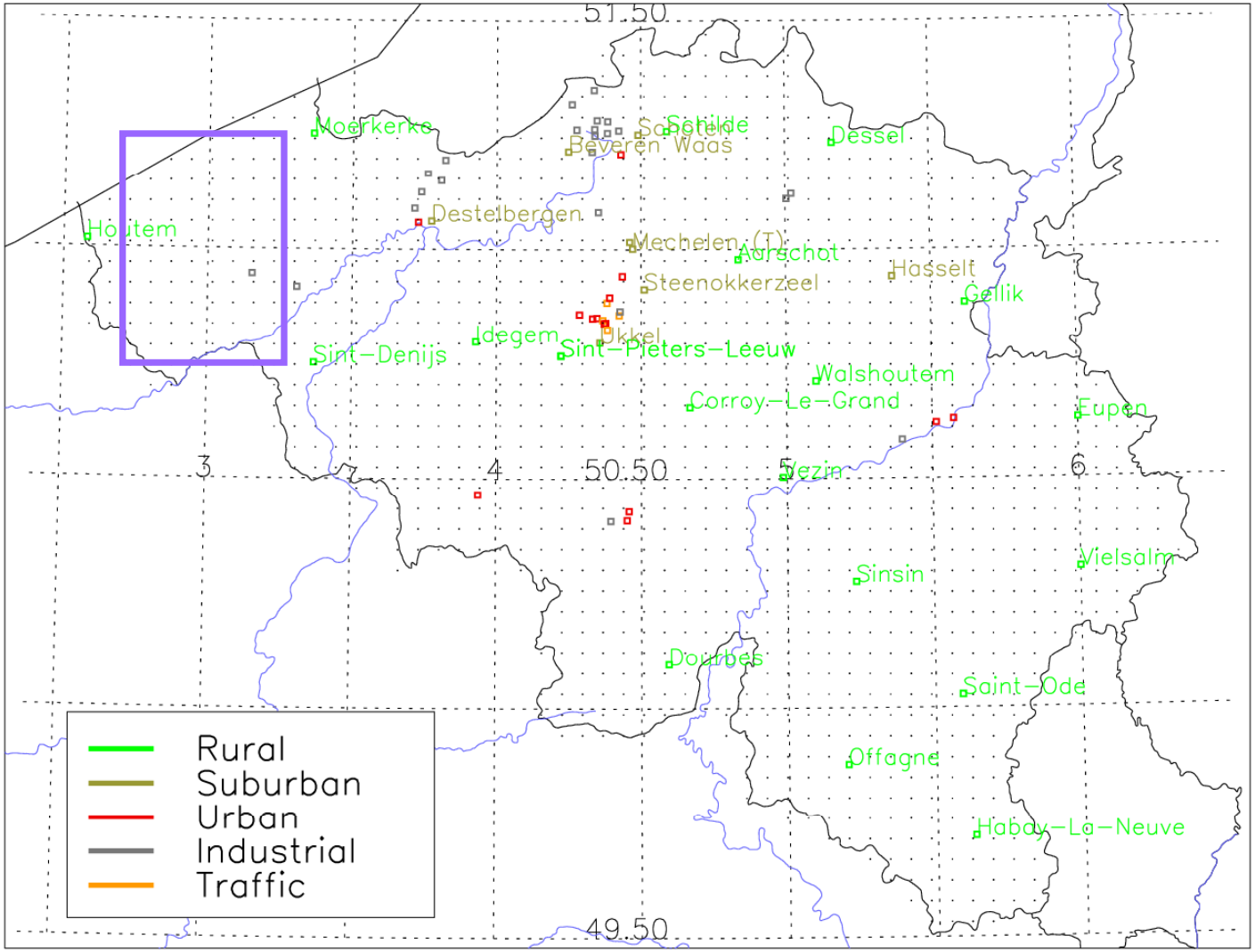
Ensemble scheme

Observations

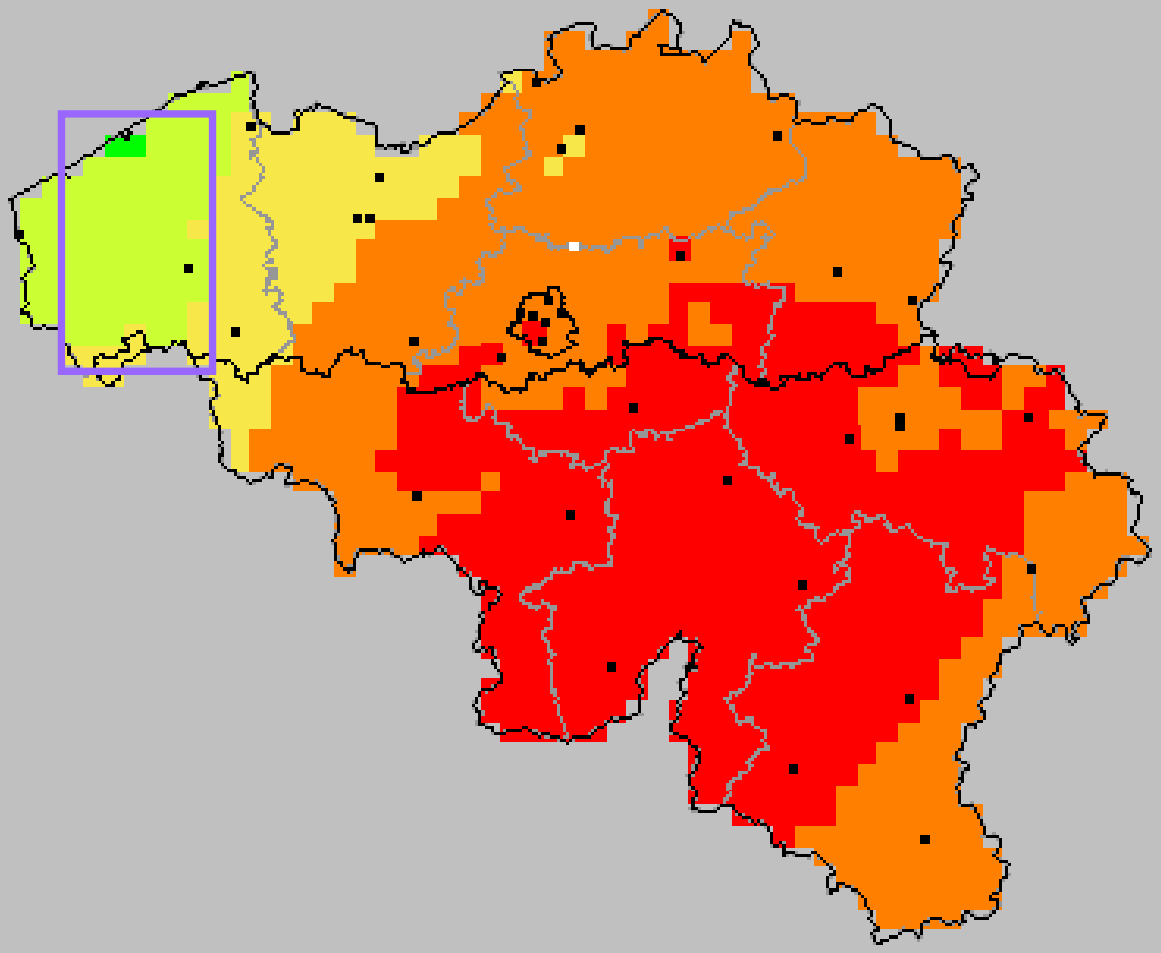
- Delivered by IRCEL-CELINE (Belgian Interregional Environment Agency, representing VMM, Ministère de la Région wallonne and Leefmilieu Brussel)

- Using an interpolation model, i.e. RIO algorithme (Hooyberghs et al., 2006)

Ozone surface stations



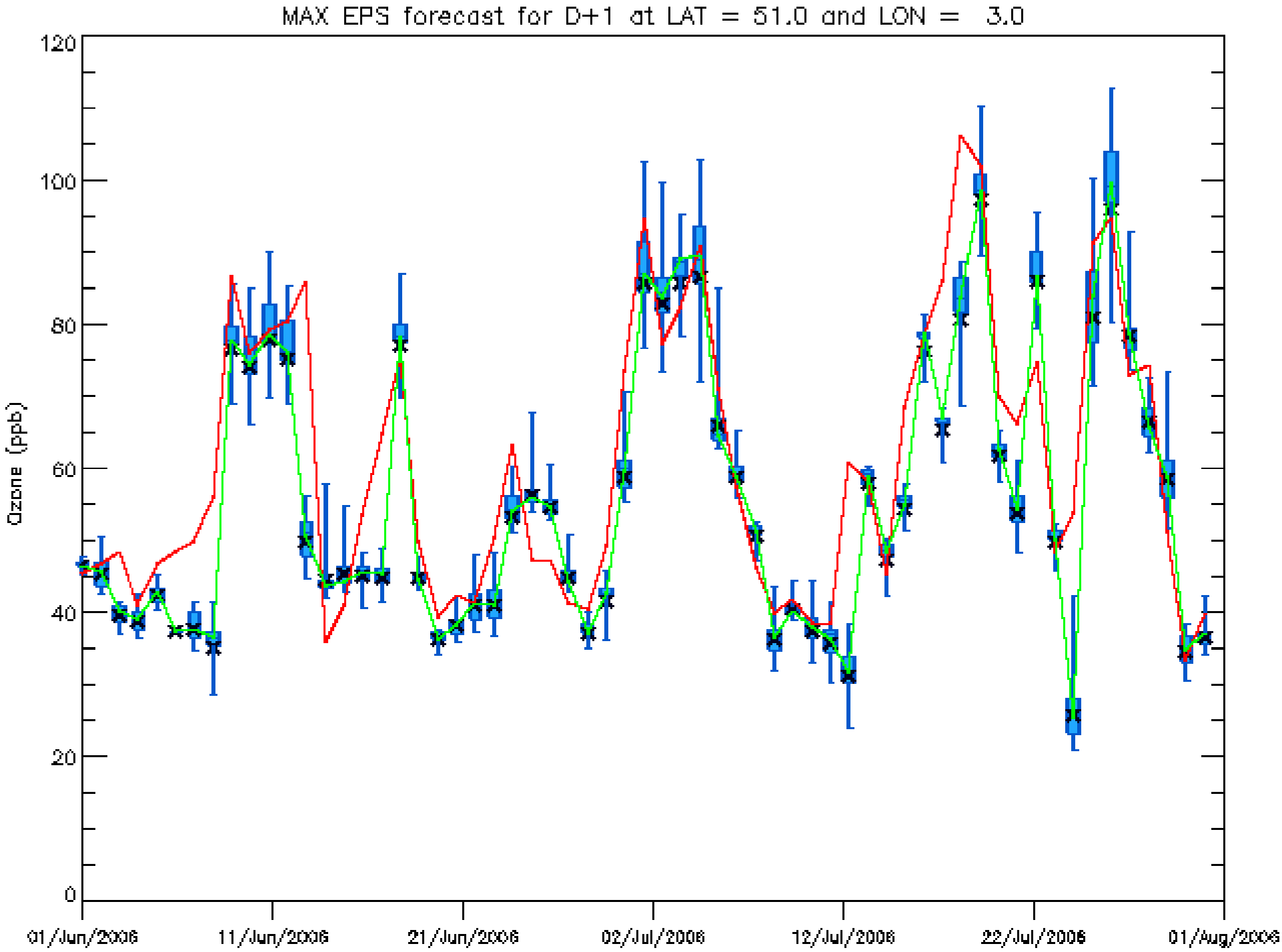
Daily highest 1-hourly Ozone concentrations on: Thursday 13/07/2006

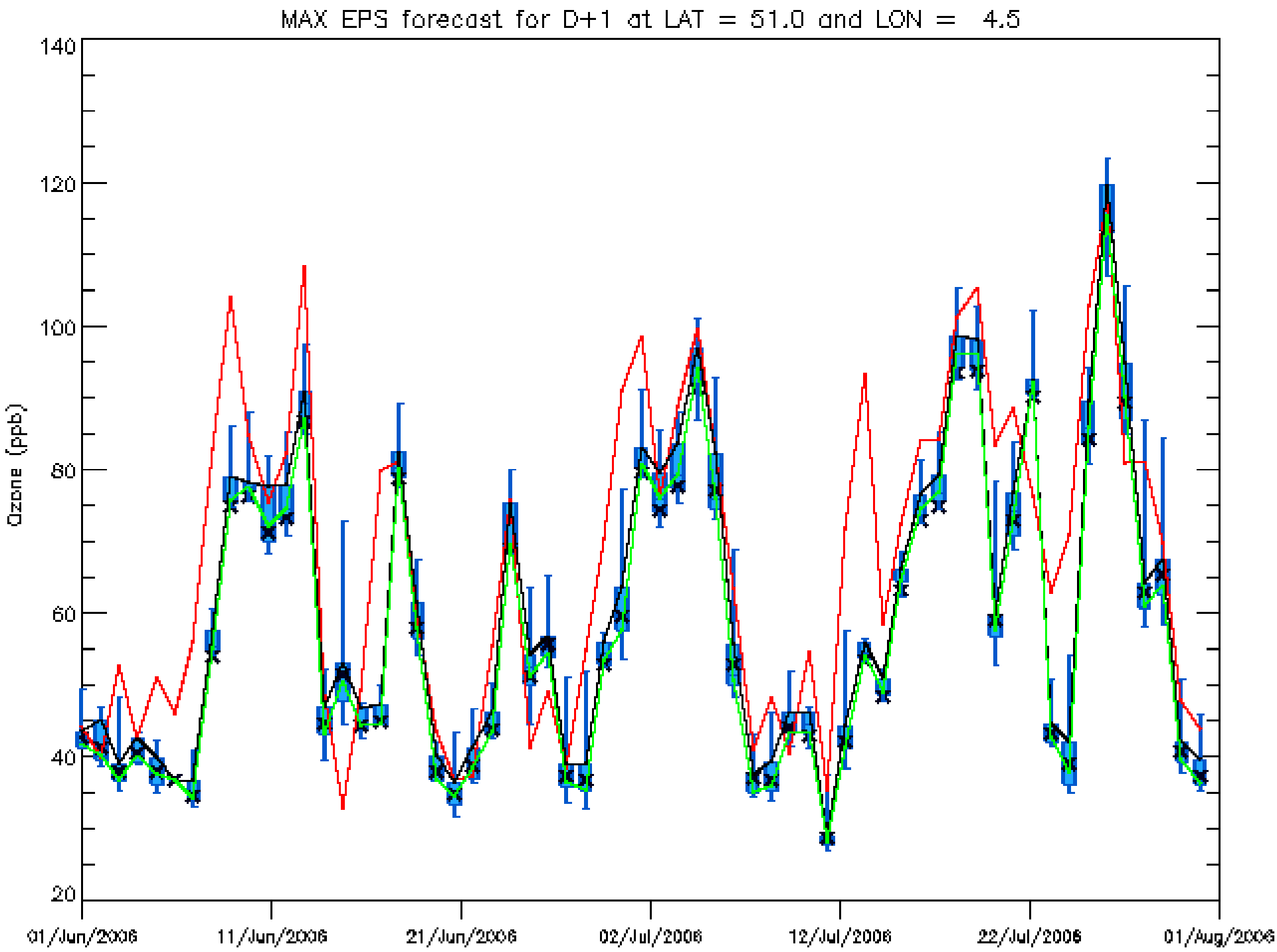


1-hourly max
(microgram/m3)

- 0 - 30
- 31 - 50
- 51 - 70
- 71 - 90
- 91 - 110
- 111 - 145
- 146 - 180
- 181 - 240
- 241 - 360
- 361 - MAX

- data available
- data not available


MAX EPS forecast for D+1 at LAT = 51.0 and LON = 3.0
Ozone (ppb)
120
100
80
60
40
20
0
01/Jun/2006
11/Jun/2006
21/Jun/2006
02/Jul/2006
12/Jul/2006
22/Jul/2006
01/Aug/2006


MAX EPS forecast for D+1 at LAT = 51.0 and LON = 4.5
Ozone (ppb)
140
120
100
80
60
40
20
01/Jun/2006
11/Jun/2006
21/Jun/2006
02/Jul/2006
12/Jul/2006
22/Jul/2006
01/Aug/2006

Evaluation

Table 1. Bias (ppb), correlation and rmse (ppb) for the time period 01/06/2006 - 31/07/2006 are shown for some grid points with respect to the RIO-observations

LAT	LON	CL0	CL1	Cm5	Cp5	STD	Tm2	Tm4	Tp2	Tp4	Wm1	Wm2	Wp1	Wp2	EM1	EM2	EM3
51.0	5.0	-0.2	-25.3	-5.3	-8.7	-7.5	-7.6	-8.2	-7.0	-4.6	-7.0	-6.5	-7.9	-8.3	-10.0	-6.4	-6.1
		0.78	0.66	0.84	0.86	0.85	0.85	0.85	0.87	0.87	0.85	0.85	0.86	0.86	0.84	0.85	0.84
		13.9	30.1	13.1	14.3	13.7	13.7	14.2	13.2	12.3	13.6	13.5	13.8	13.9	15.5	14.2	16.0
51.0	3.0	0.6	-18.4	-3.1	-5.4	-4.5	-4.0	-4.0	-6.3	-4.2	-4.6	-4.7	-4.5	-4.6	-5.7	-4.7	-5.4
		0.82	0.56	0.86	0.87	0.87	0.86	0.86	0.82	0.85	0.87	0.87	0.86	0.86	0.87	0.86	0.85
		11.4	24.1	10.4	11.0	10.7	10.4	10.6	12.6	11.3	10.7	10.8	10.7	10.9	11.0	12.0	13.8
50.5	6.0	-0.3	-16.9	-4.2	-7.0	-6.0	-6.1	-6.8	-3.4	0.1	-5.1	-4.3	-6.5	-6.6	-9.9	-3.4	-1.6
		0.66	0.60	0.72	0.73	0.73	0.72	0.72	0.75	0.76	0.74	0.74	0.73	0.73	0.70	0.73	0.72
		13.9	22.1	13.5	14.4	14.0	13.9	14.1	13.0	13.0	13.5	13.0	14.1	14.2	16.0	14.0	15.4
51.0	4.5	-2.3	-27.9	-7.9	-11.4	-10.2	-9.0	-9.2	-8.8	-6.7	-9.8	-9.5	-10.4	-10.6	-11.0	-10.8	-12.0
		0.80	0.65	0.85	0.85	0.85	0.86	0.86	0.87	0.87	0.85	0.85	0.85	0.85	0.85	0.83	0.82
		13.9	32.8	14.4	16.6	15.6	14.5	14.8	14.4	13.6	15.4	15.3	15.8	15.8	16.3	17.4	19.8

Results...

- Chimere has a high negative bias for this particular time period (summer 2006).
- Reducing the cloud cover reduces the bias significantly and for some grid points also the rmse, but the correlation declines.
- Parameter *Tp4* shows for some grid points significantly better scores for bias, correlation and rmse, compared with the standard run (*STD*) of Chimere.
- emission scenarios (VOC and NO_x) are not showing important changes for modelling ozone.

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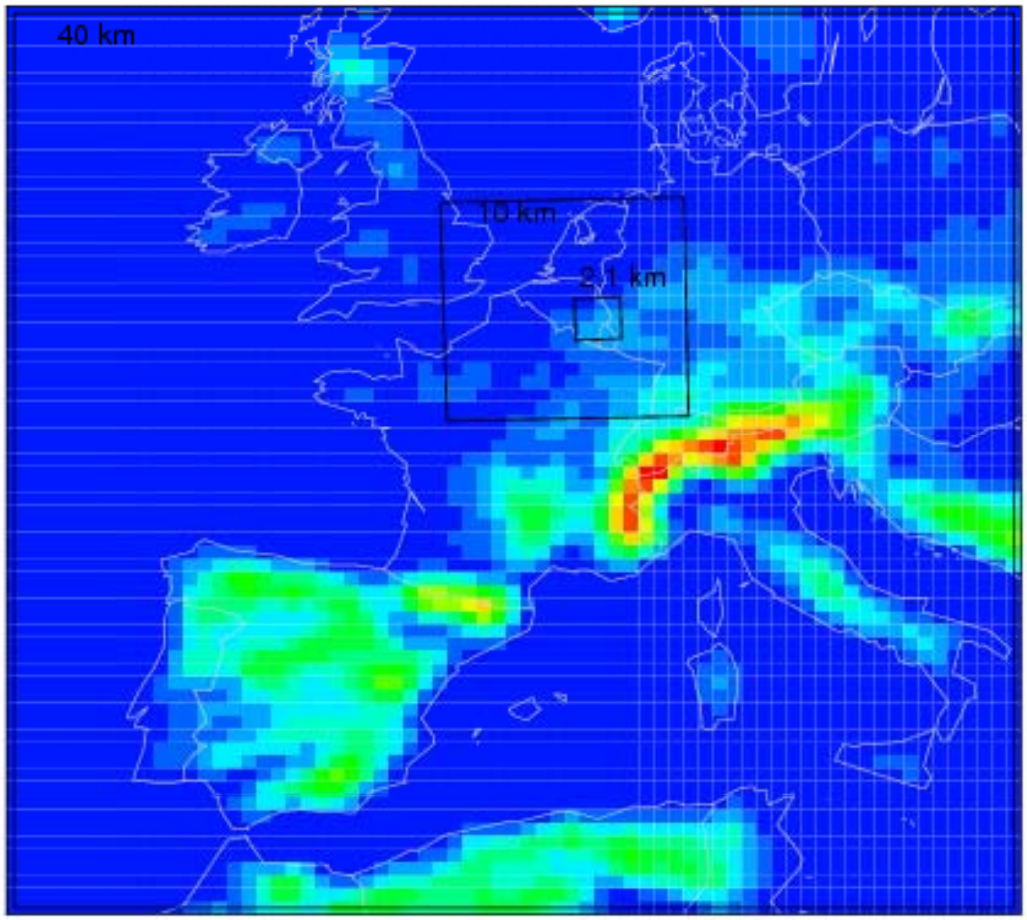
Downscaling the ERA-40 re-analysis A 10 km climatology for Belgium

- Purpose: wind climatology for Belgium
- ERA-40, resolution = 120 km → 40 km
- We have a complete 43 year dataset at a resolution of 10 km for Belgium
- Dynamical adaptation to 2 km possible
- Input to feed CTM's...

ERA–40 downscaling domains



Questions ?