

Ozone modeling over Italy: a sensitivity analysis to precursors using BOLCHEM air quality model

Mihaela Mircea¹, Massimo D'Isidoro¹, Alberto Maurizi¹, Maria Gabriella Villani¹, Andrea Buzzi¹, Sandro Fuzzi¹, Francesco Tampieri¹
Gabriele Zanini², Fabio Monforti², Lina Vitale²

¹*Istituto di Scienze dell'Atmosfera e del Clima, CNR, Bologna, Italy*

²*ENEA, Italian Agency for New Technologies, Energy and the Environment, Via Martiri di Monte Sole 4, 40129 Bologna, Italy*

Objectives

- **to investigate the sensitivity of ozone concentration to the reduction of NO_x and VOC for few periods during the years 1999 and 2003 over the whole Italy**
- **to asses the relative importance of precursors in reducing the ozone levels identifying the regions of Italy where local emissions strategies could not be effective**

Photochemical mechanisms

CB-IV (Gery et al., 1989) : lumped-structure condensed mechanism

-85 reactions and 30 chemical species

-organics are grouped according to bond type (for example, as carbon single bonds, carbon double bounds or carbonyl bounds)

-organic species are treated explicitly (e.g. formaldehyde, ethene, isoprene), represented by carbon bond (PAR – single bonded one carbon atom, OLE –two carbon atoms) or molecular (TOL and XYL aromatic hydrocarbons) surrogates according with their chemistry or importance in the environment.

SAPRC90 (Carter, 1990) : lumped-molecular condensed mechanism

-131 reactions with 35 chemical species

-calculate the kinetic and mechanistic parameters for lumped species in the mechanism created for representative emissions profile (mole-weighted approach)

-organics species are treated explicitly (e.g. formaldehyde, acetaldehyde, etc) or represented by molecules as alkane, alkenes, aromatics, etc.

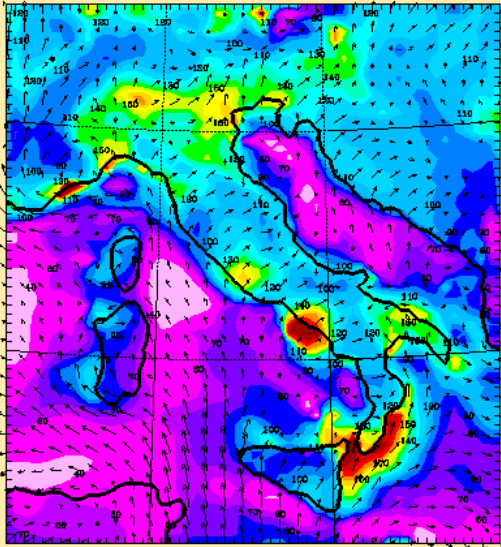
Base case

NOx reduced(-35%)

VOC reduced(-35%)

O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

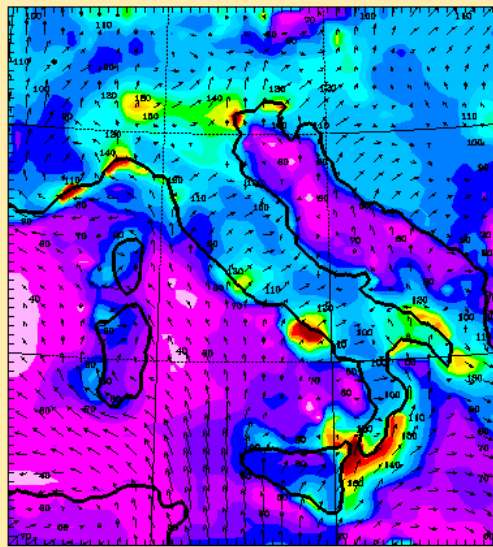
INITIAL DATE 05/08/1999 0000 UTC
FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
INTERVAL -0.257



BOLCHEM MODEL ISAC-CNR, BOLOGNA
CB4+SD2

O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

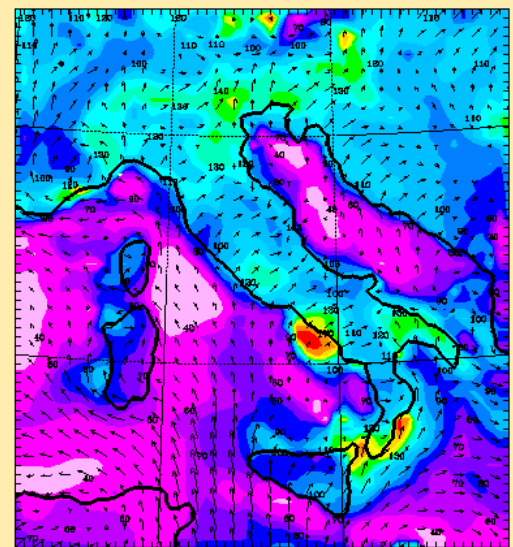
INITIAL DATE 05/08/1999 0000 UTC
FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
INTERVAL 0.00



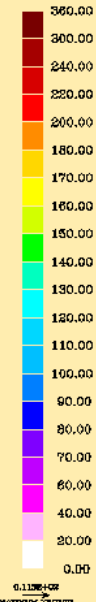
BOLCHEM MODEL ISAC-CNR, BOLOGNA
CB4+SD2

O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

INITIAL DATE 05/08/1999 0000 UTC
FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
INTERVAL 0.00

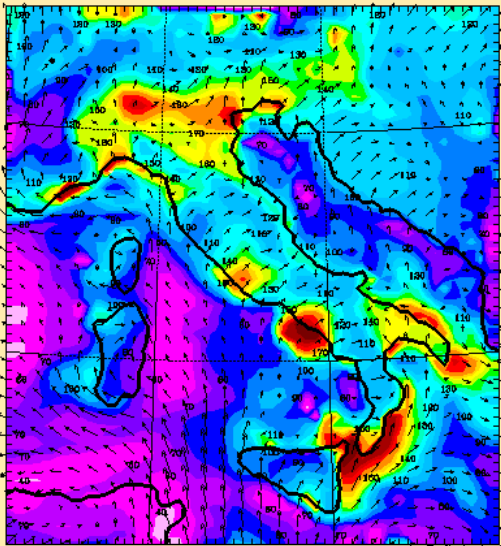


BOLCHEM MODEL ISAC-CNR, BOLOGNA
CB4+SD2



O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

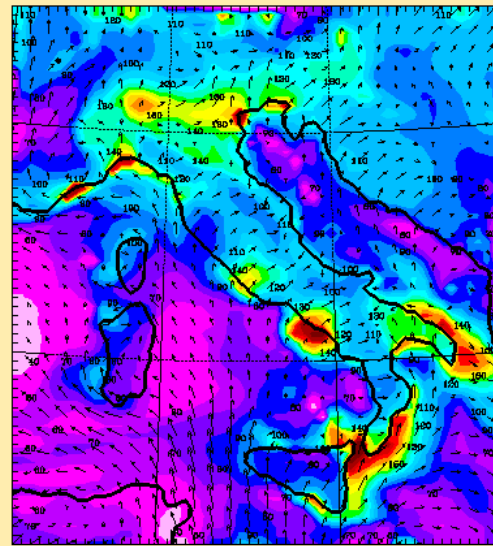
INITIAL DATE 05/08/1999 0000 UTC
FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
INTERVAL -0.257



BOLCHEM MODEL ISAC-CNR, BOLOGNA
SAPRC-90

O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

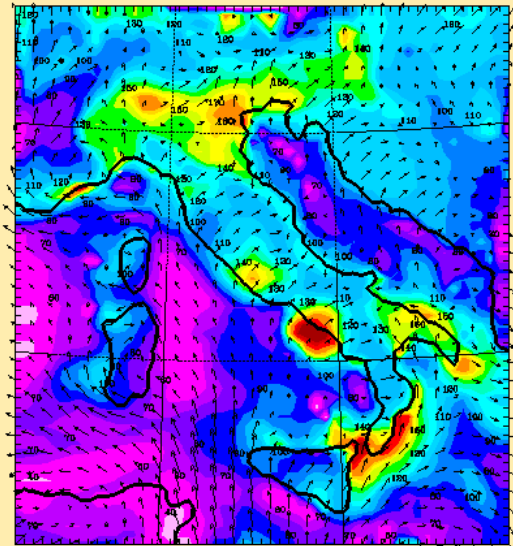
INITIAL DATE 05/08/1999 0000 UTC
FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
INTERVAL 0.00



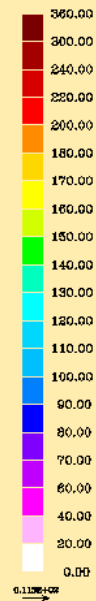
BOLCHEM MODEL ISAC-CNR, BOLOGNA
SAPRC-90

O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

INITIAL DATE 05/08/1999 0000 UTC
FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
INTERVAL 0.00



BOLCHEM MODEL ISAC-CNR, BOLOGNA
SAPRC-90

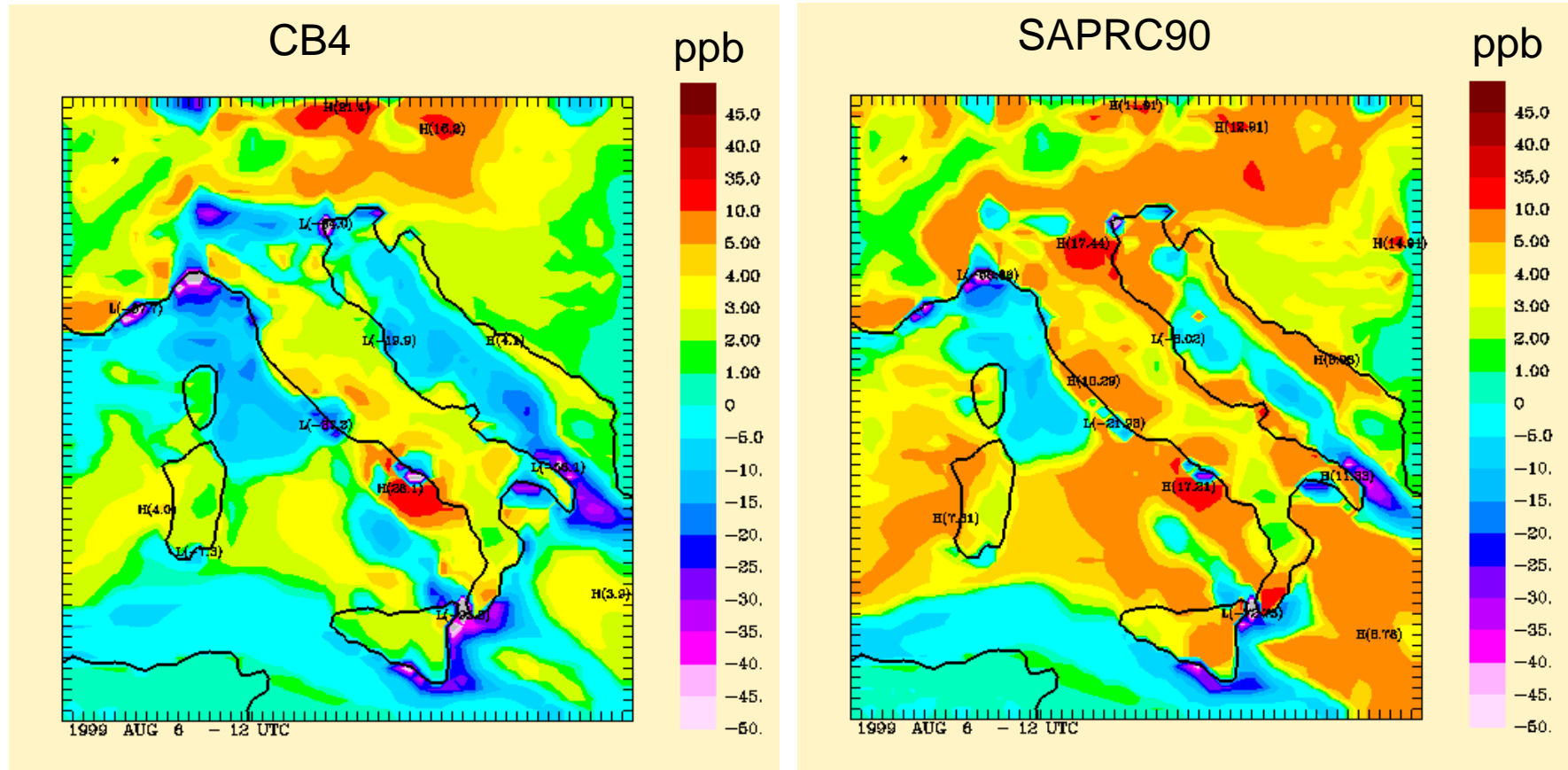


Chemical regimes over Italy

Differences in ozone concentrations: $\Delta O_3 = O_3(65\%VOC) - O_3(65\%NO_x)$

$\Delta O_3 > 0$ NO_x limited area

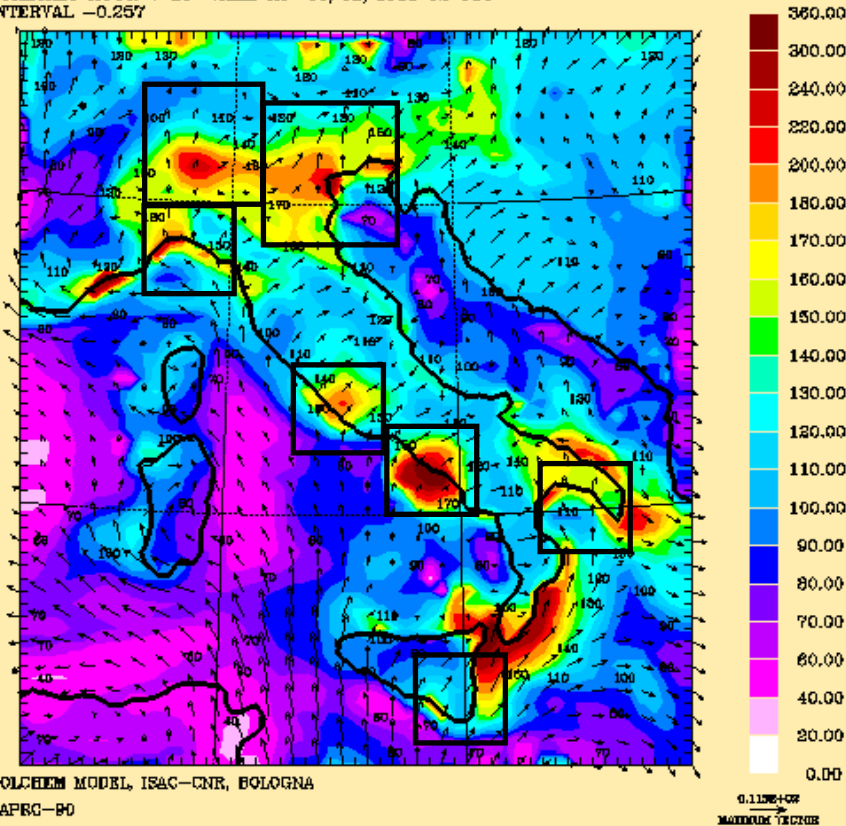
$\Delta O_3 < 0$ VOC limited area



Areas selected for the analysis

O3 LIVELLO BOLCHEM 1 (MICROGR/M3)

INITIAL DATE 06/08/1999 0000 UTC
 FORECAST HOUR + 36 VALID AT 06/08/1999 12 UTC
 INTERVAL -0.257



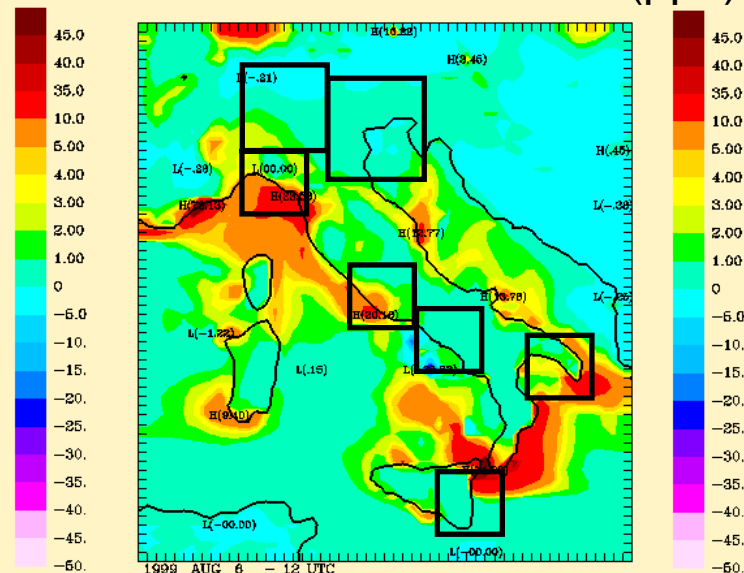
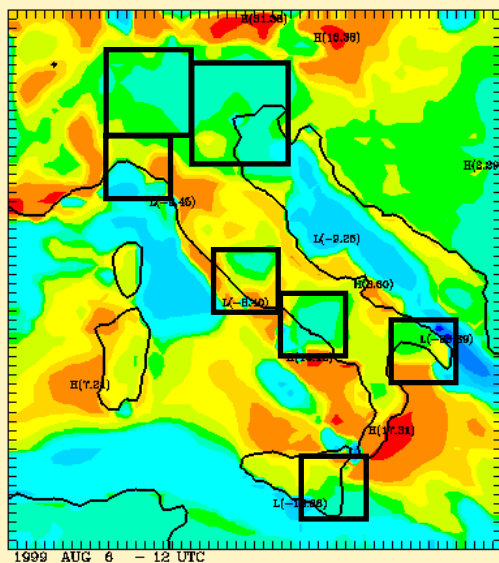
Center of the area	Lat	Lon	Size (km X km)
Milano	45°28'	9°10'	160x160
Genova	44°25'	8°54'	80x80
Venezia	45°26'	12°19'	240x240
Roma	41°54'	12°28'	80x80
Napoli	40°51'	14°16'	80x80
Taranto	40°25'	17°14'	80x80
Pachino	36°15'	15°05'	100x100

NOx reduced(-35%)

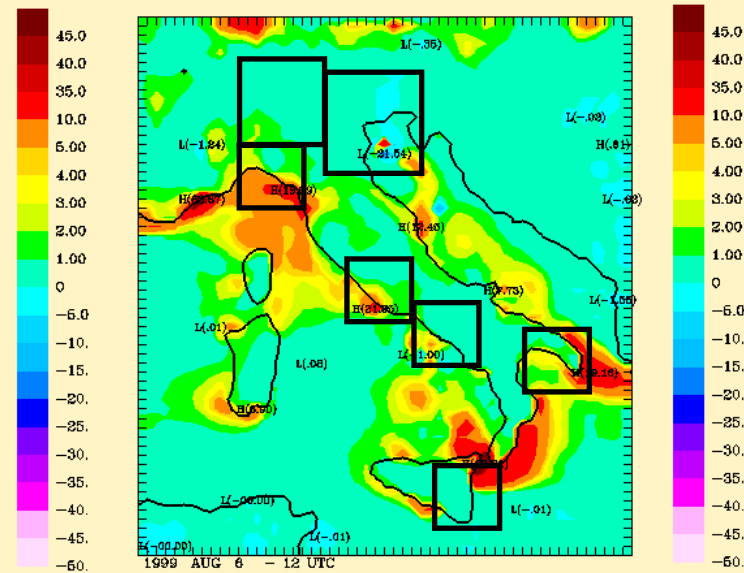
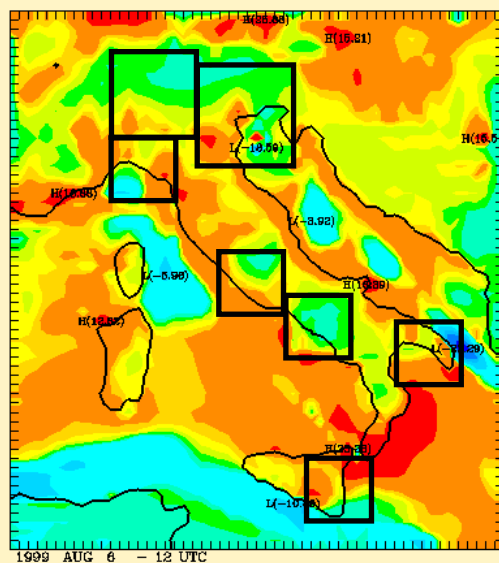
VOC reduced(-35%)

CB4

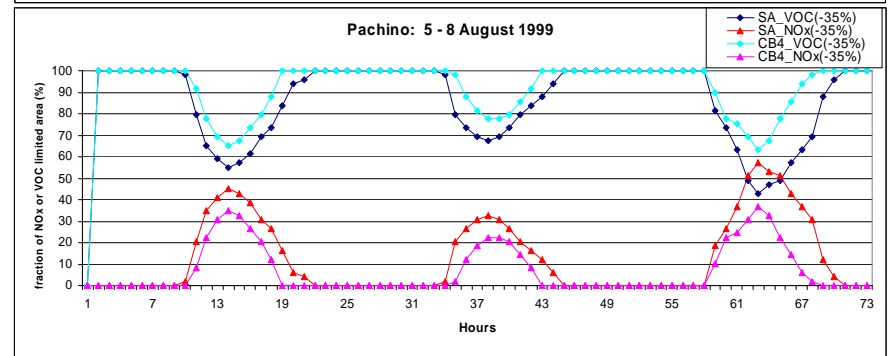
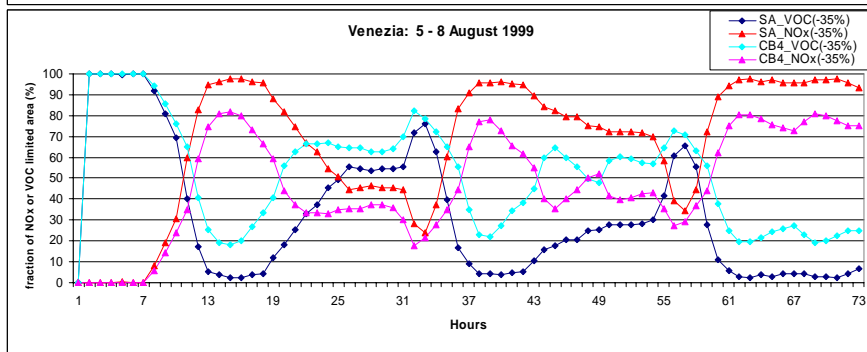
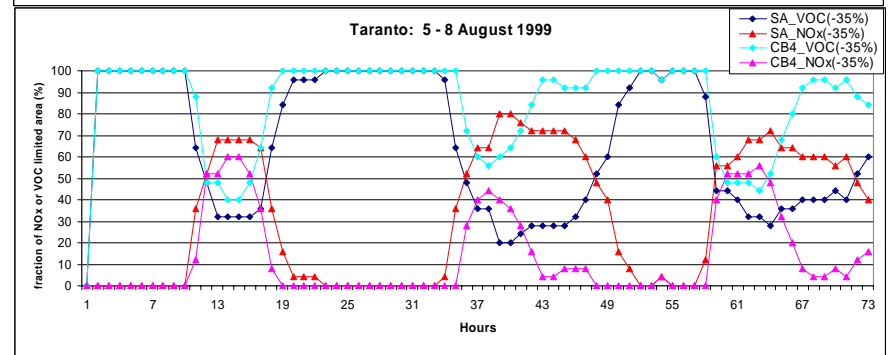
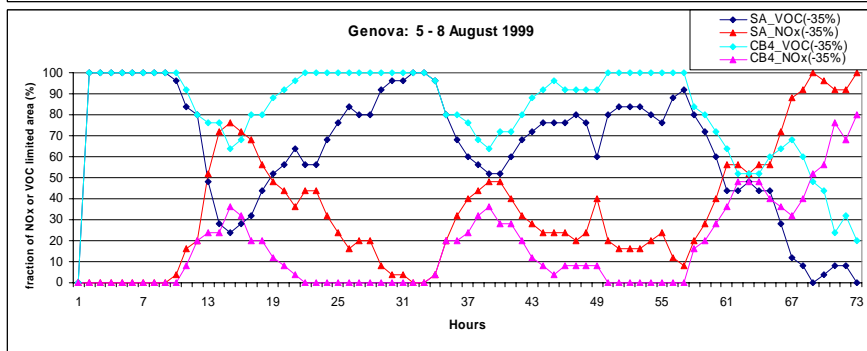
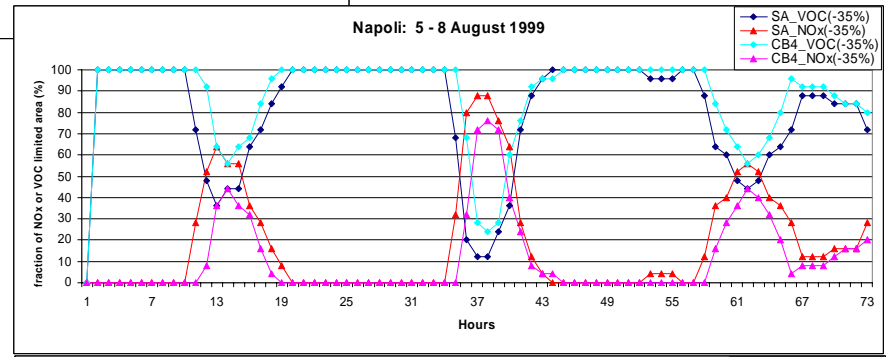
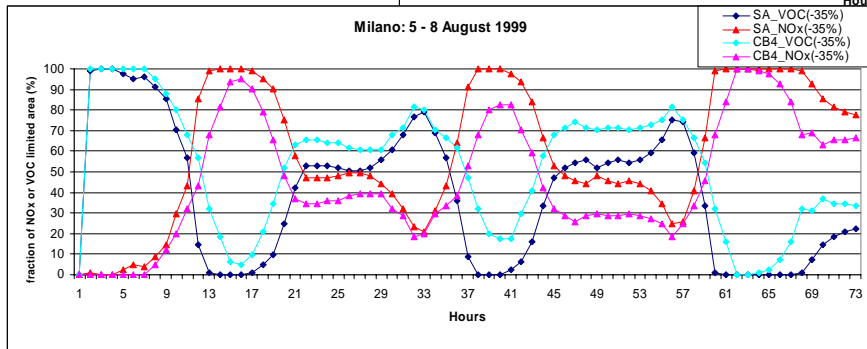
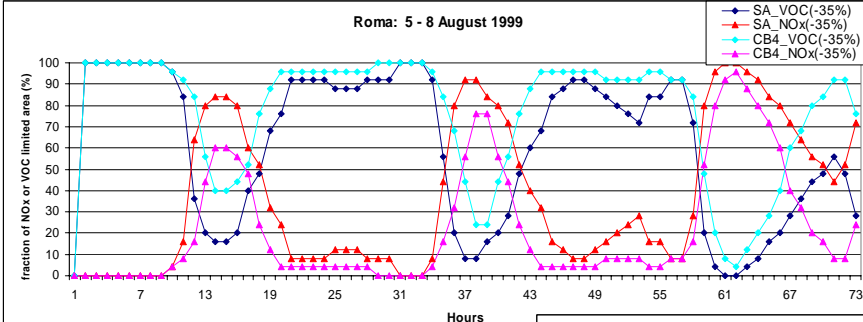
ΔO_3 (ppb)



SAPRC90

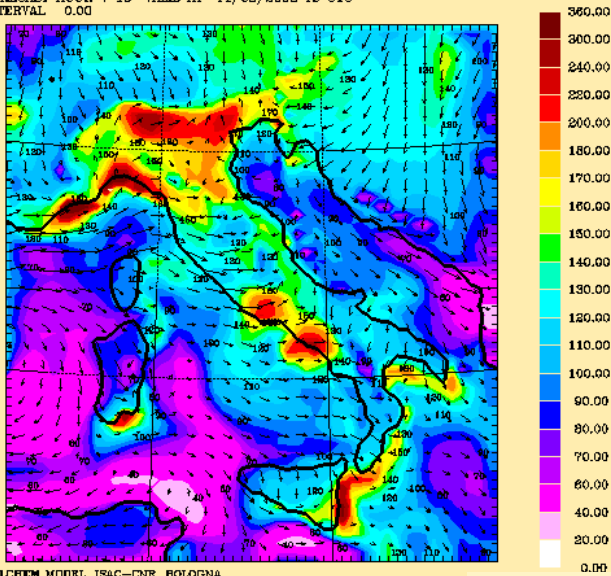


ΔO_3 =local-global reduction.

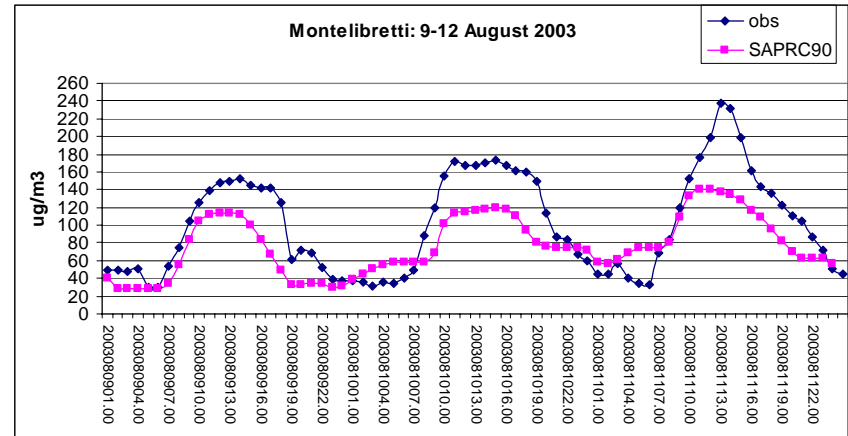


Extreme summer 2003

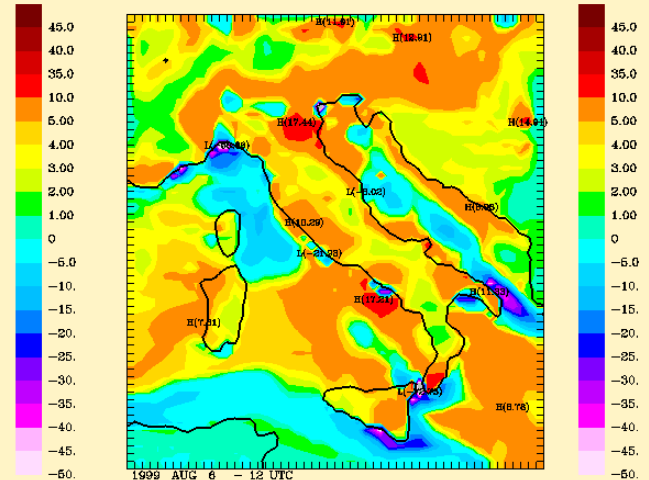
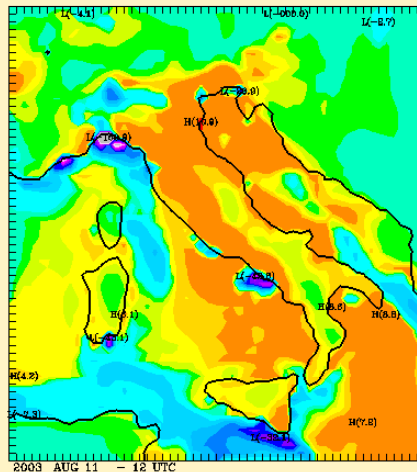
O3 LIVELLO BOLCHEM 1 (MICROGR/M3)
 INITIAL DATE 11/08/2003 0000 UTC
 FORECAST HOUR + 15 VALID AT 11/08/2003 15 UTC
 INTERVAL 0.00



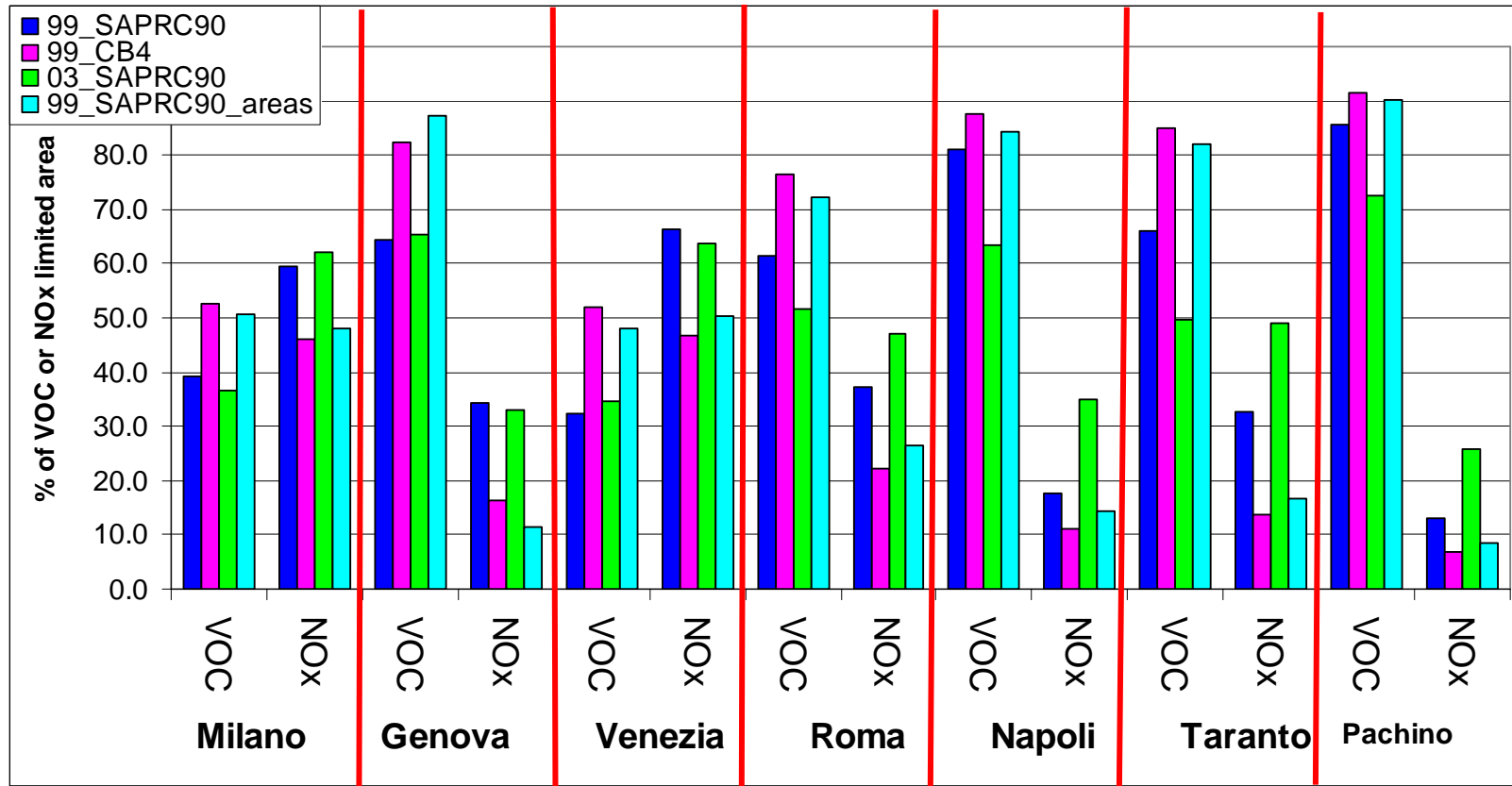
BOLCHEM MODEL, ISAC-CNR, BOLOGNA
 SAPRC-00



$$\Delta O_3 = O_3(65\%VOC) - O_3(65\%NO_x)$$

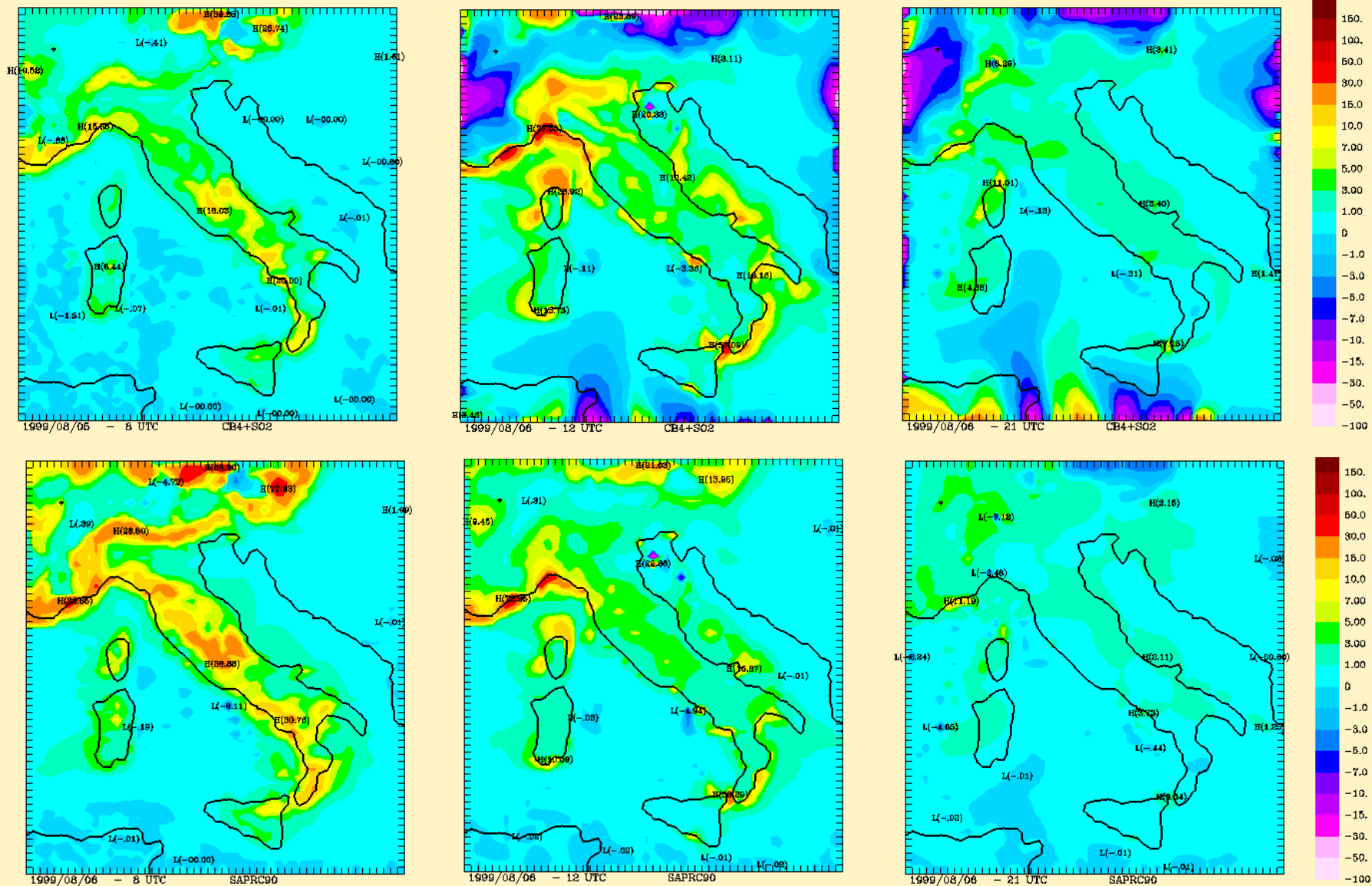


Fraction of VOC or NOx limited area



O3 increase due to the increase in isoprene emissions

ppb



Preliminary conclusions

- The differences in the predicted ozone concentrations due to the photochemical mechanisms are comparable to those obtained by reducing the emissions of NO_x or VOC
- The distribution and the “intensity” (differences in ozone concentration) of VOC or NO_x limited areas depend on the photochemical mechanism. For example, in the same meteorological and environmental conditions, a region can be VOC or NO_x sensitive according with the photochemical mechanism used.
- The local reduction of VOC was efficient for Milano and Venice areas. In the other regions, significant increase in ozone concentration was observed by reducing locally both the NO_x or VOC emissions.
- The increase of isoprene leads to substantial increase in the concentration of ozone at some locations (up to 25%), therefore, the uncertainties in isoprene emissions can bias the air quality design.

ACKNOWLEDGEMENTS

- GEMS and ACCENT: EU-projects
- ICTP Programme for Training and Research in Italian Laboratories”, Trieste, Italy