Biogenic Emissions Impact On The Atmospheric Composition In Bulgaria

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Objectives:

- To construct statistically significant ensemble of atmospheric chemical composition state for Bulgaria – "atmospheric composition climate";

- To study the atmospheric pollution transport and transformation processes (accounting also for heterogeneous chemistry and the importance of aerosols for air quality and climate) from urban to local to regional scales;

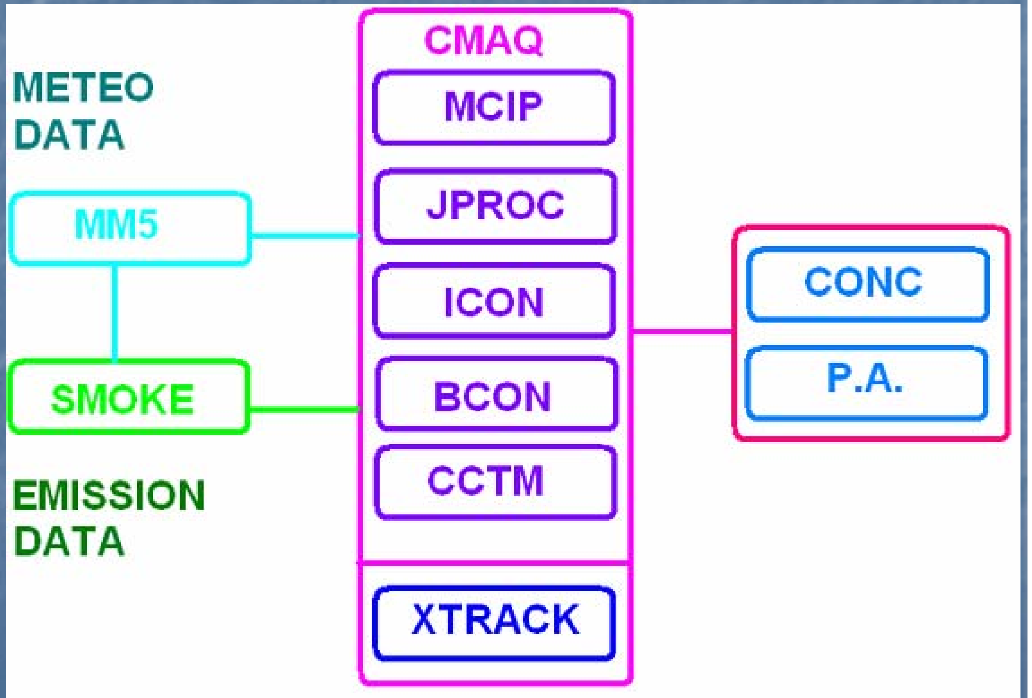
- To provide high quality robust assessments of the air quality and its origin – basis for formation of pollution mitigation strategies

Modeling tools - US EPA Models-3 System:

MM5 - the 5th generation PSU/NCAR Meso-meteorological Model MM5 (Dudhia, 1993, Grell et al., 1994) used as meteorological pre-processor. This model is pretty often replaced by the next generation model WRF (Shamarock et al., 2007);

SMOKE - the Sparse Matrix Operator Kernel Emissions Modelling System (CEP, 2003) – the emission pre-processor of Models-3 system. SMOKE currently supports BEIS (***Biogenic Emissions Inventory System***) mechanism, versions 3.13

CMAQ - the Community Multiscale Air Quality System being the Chemical Transport Model (CTM) of the system. A chlorine chemical mechanism has been added to CMAQ based on Tanaka et al. (2003);



Methodology – data

Data:

Meteorological data – NCAR 1ºx1º

Emission data – TNO with 0.25ºx0.125º in 10 SNAP categories

The calculations are made for 8 years from 2000 to 2007 for 2 scenarios: with all the emissions and with excluded biogenic emissions

The relative contributions of the biogenic emissions were calculated for each day of this 8 year period and then by averaging the typical fields of relative contribution of biogenic emissions to each of the compound surface concentrations were calculated for the 4 seasons and annually.

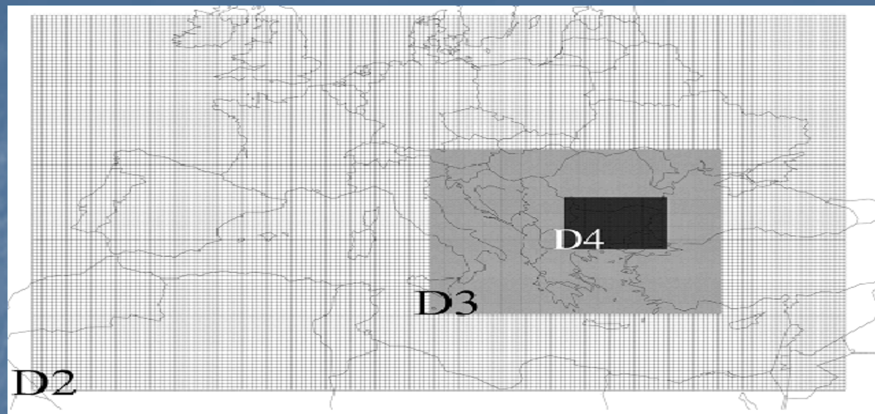
Number of output variables from CCTM is 78

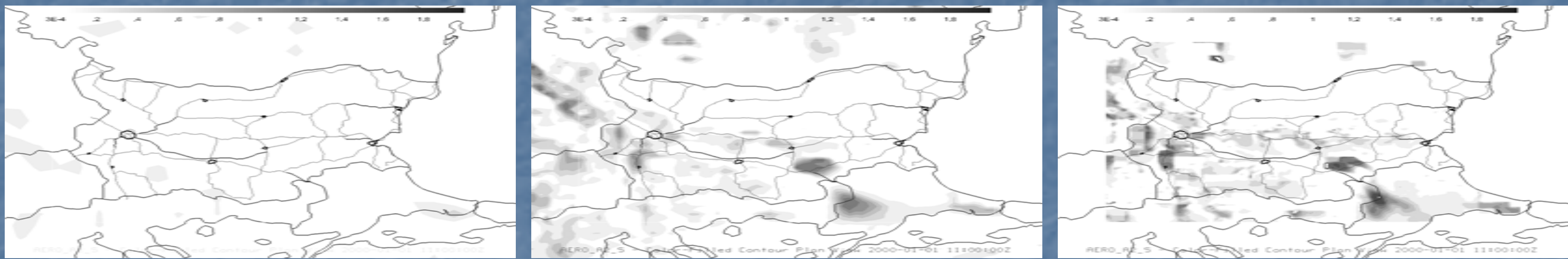
XTRACT – gives the output from 1st σ-level and reduce the output variables from CCTM to 43

Processors - 3day run	8	16
MM5 – 27 sigma vertical levels		
HDD(input & output)	4GB	-
Computational time	6h 40min	-
CMAQ – 15 sigma vertical levels		
HDD(input & output)	25.05GB	25.05GB
Computational time	13h 30min	8h 00min
XTRACT – 1 sigma vertical level		
HDD(input & output)		6GB
Computational time		+1h

Methodology – domains, nesting, downscaling

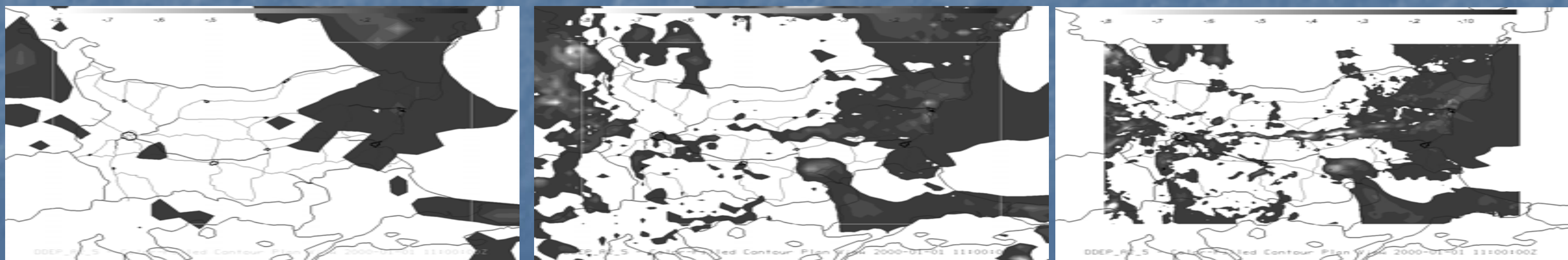
	D1	D2	D3	D4
MM5 (km) 2 way nesting	81	27	9	3
CMAQ (km)		27	9	3
Grid dimensions		166X115	178x151	190x140





(a) (b) (c)

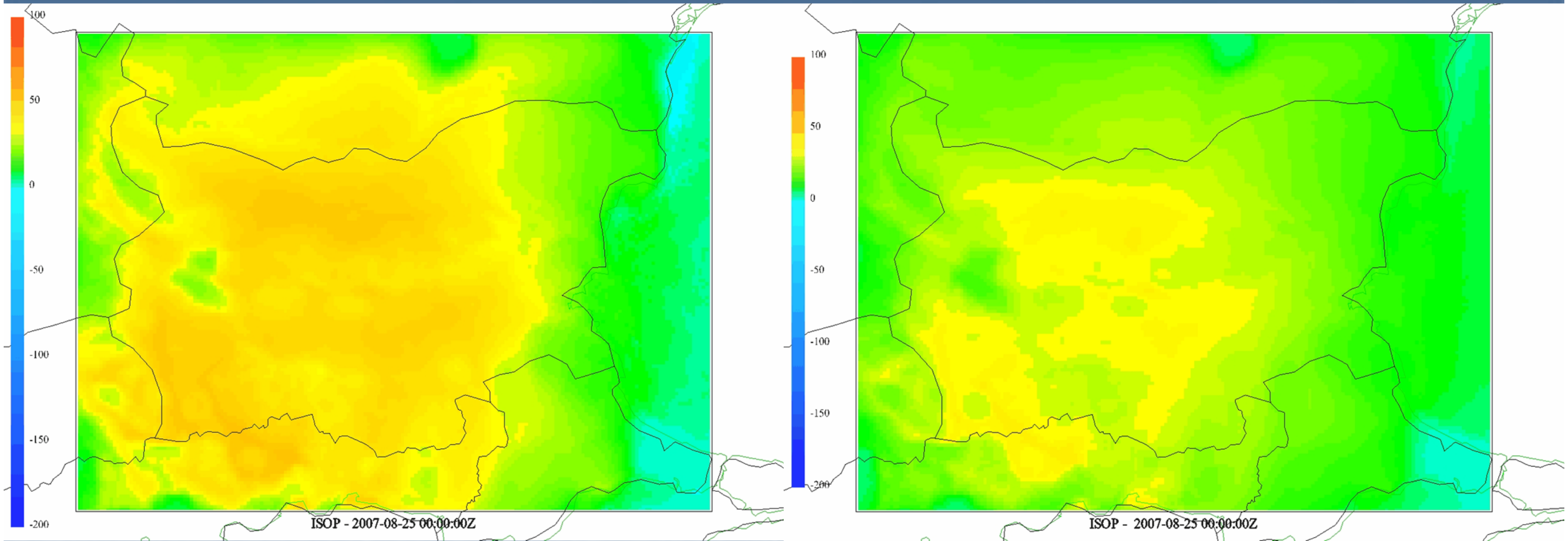
Fields of the hourly contribution of aerosol processes to the PM 2.5 formation [μg/(m ^{3}.hour)] calculated by the second D2 (a), D3 (b) and D4 (c) nesting steps, 01.01.2000, 11:00 UTC



(a) (b) (c)

Fields of the hourly contribution of dry deposition to the PM 2.5 formation [μg/(m ^{3}.hour)] calculated by the second D2 (a), D3 (b) and D4 (c) nesting steps, 01.01.2000, 11:00 UTC

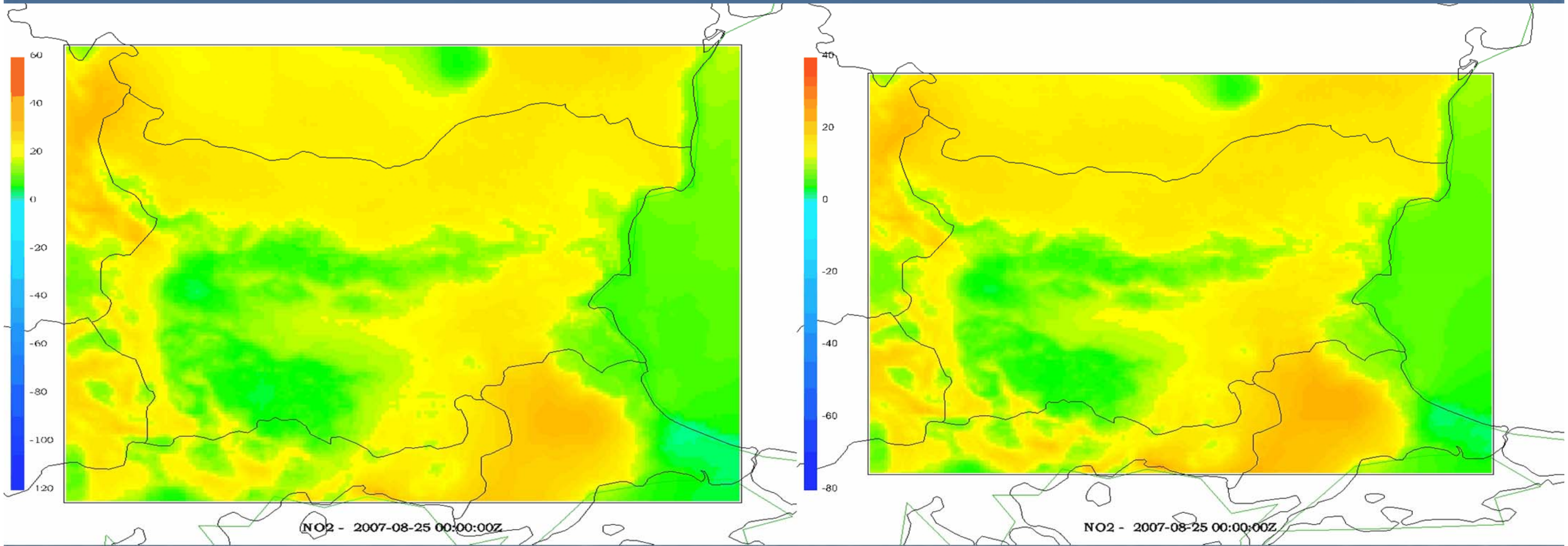
Contribution of Biogenic emission to the formation of Isoprene in 1-st σ-level for typical summer day and annual averaged.



The contribution during the day is near 100% over land

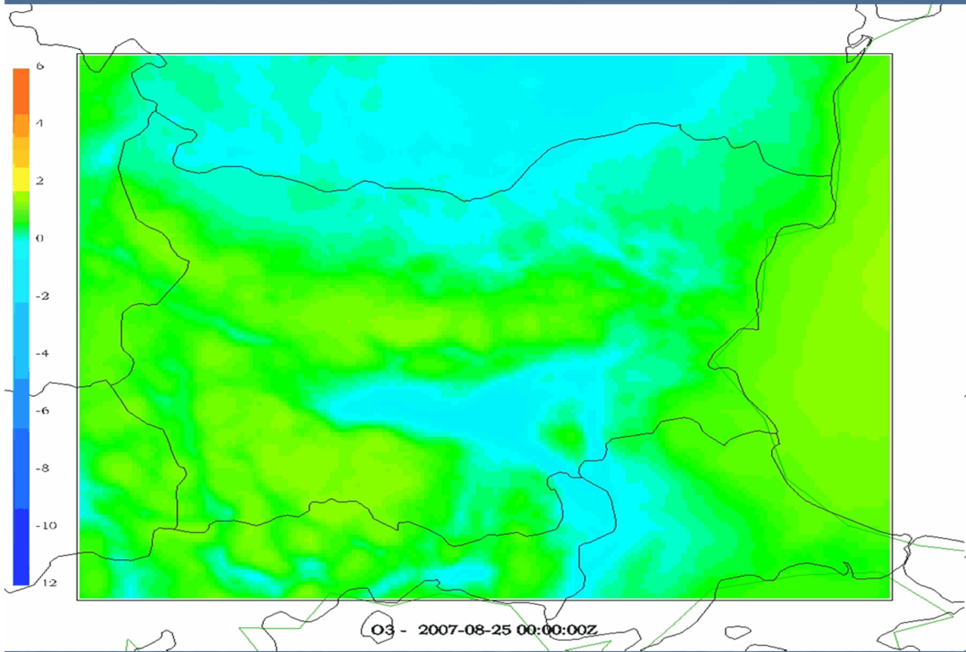
The annual contribution of biogenic emissions is quite similar to the summer case.

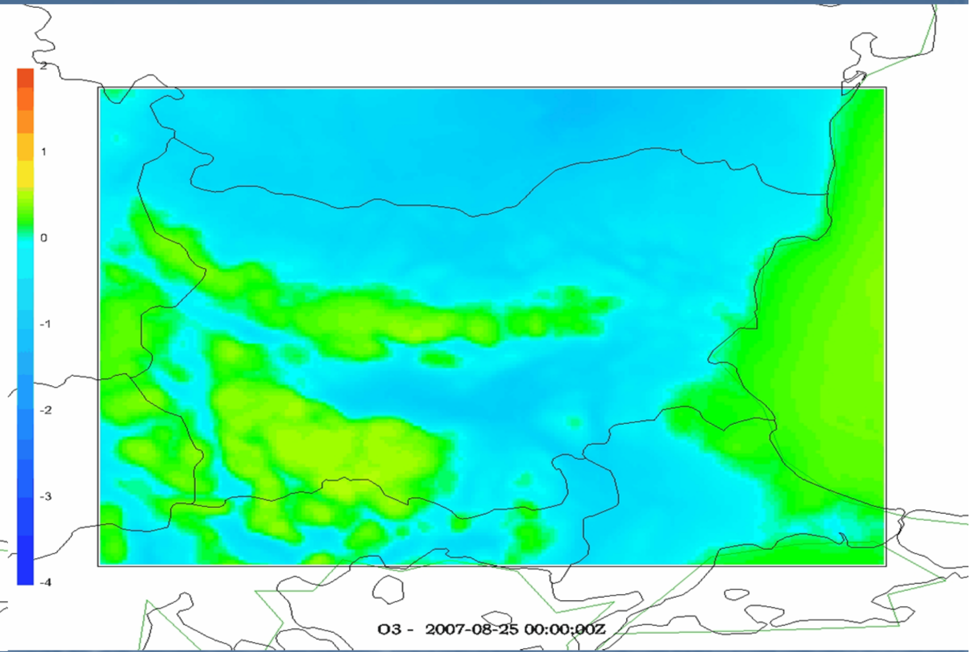
Contribution of Biogenic emission to the formation of NO_2 in 1-st σ-level for typical summer day and annual averaged.



Annual contributions of biogenic emissions are, much smaller than the one for summer

Contribution of Biogenic emission to the formation of Ozone in 1-st σ-level for typical summer day and annual averaged.

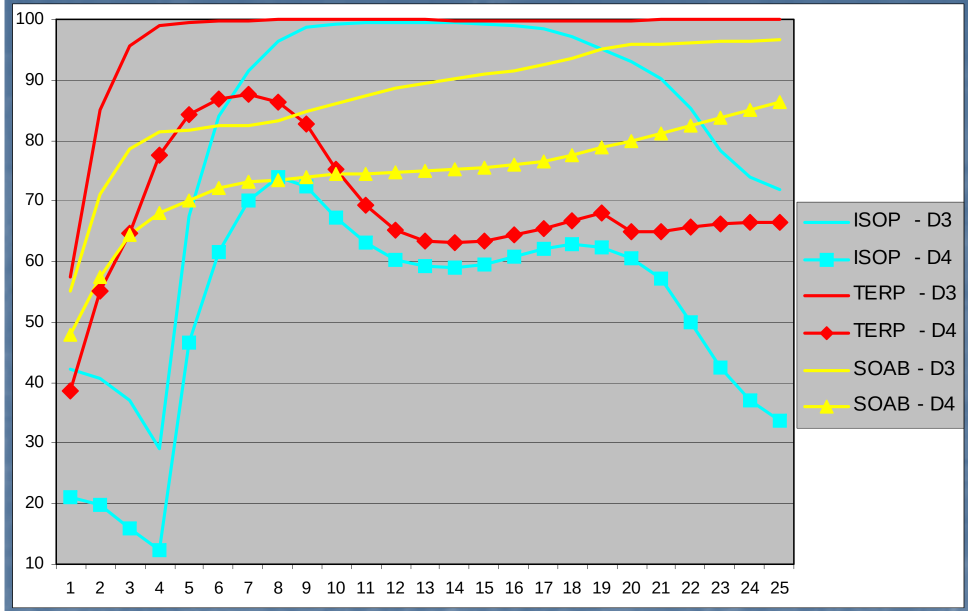


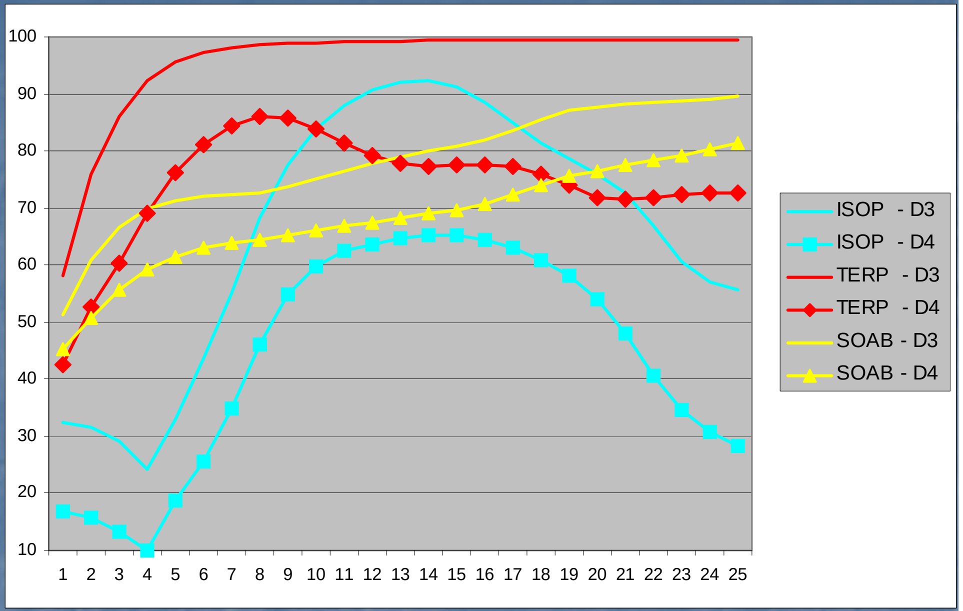


The contribution of biogenic emission to the formation of O3 is small.

This is probably due to the fact the NOx concentrations in the region are relatively small and are the limitation factor for O3 formation.

Contribution of Biogenic emission averaged over the territory of Bulgaria in D3 and D4 for ISOP, TERP and SOAB– typical summer day and annual averaged.

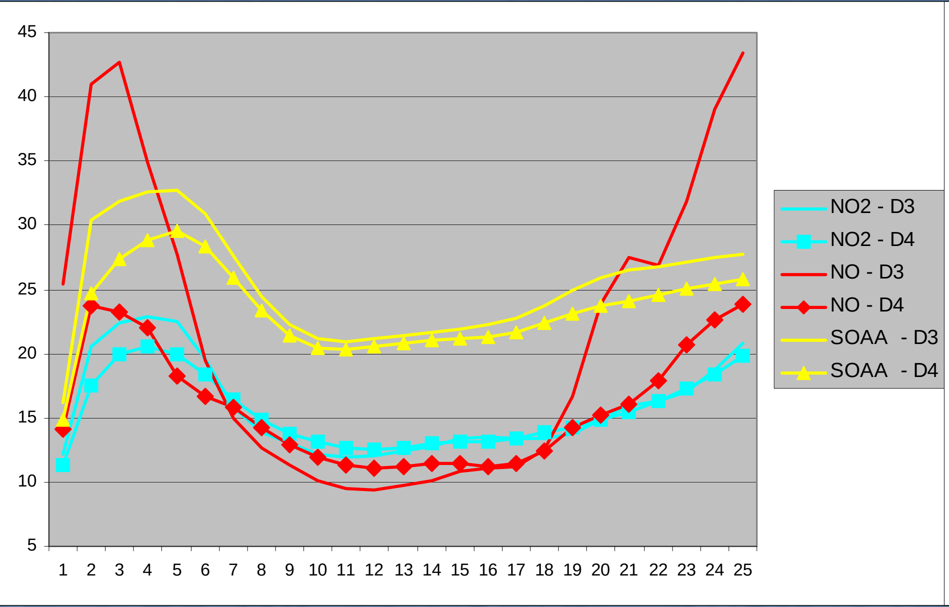


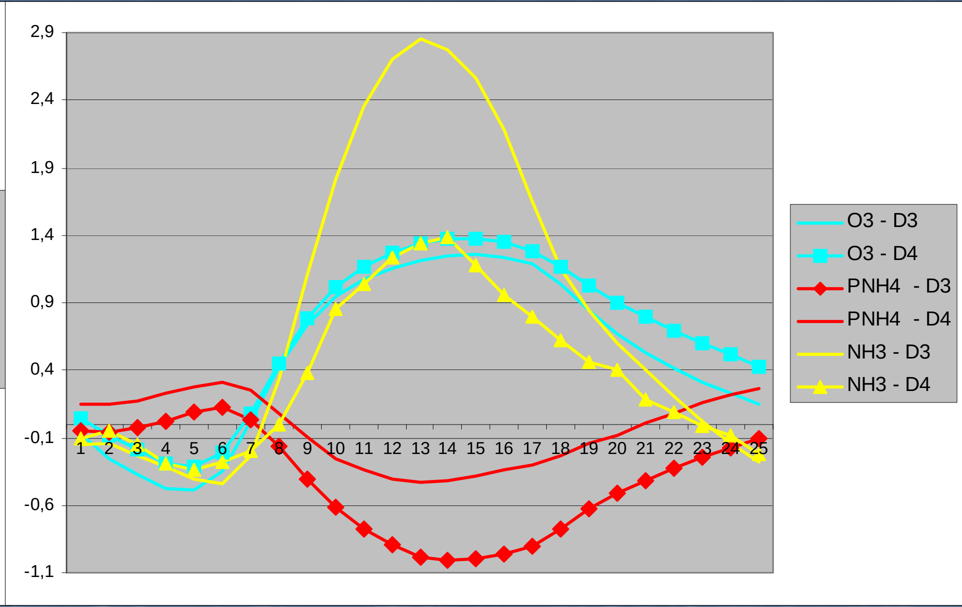


On the diagrams it could be seen that the role of the spatial resolution is not negligible – there could be significant quantitative differences between the contributions, calculated in D3 and D4 and the difference is bigger when the contribution is bigger.

Some quite obvious qualitative differences can be seen for example the contribution to Terpene concentrations, calculated in D3 reaches a 100% plateau early in the morning, while the behaviour in D4 is different – it reaches a maximum in 6-7 (summer) o'clock in the morning and then decreases.

Contribution of Biogenic emission averaged over the territory of Bulgaria in D3 and D4 annual averaged.





On the diagram for NO2, NO and SOAA it could be seen that the contribution have good manifested diurnal course and the contribution is appear as a sink during the day

On the diagram for O3, PNH4 (aerosol ammonium) and NH3 (ammonia) it could be seen that the contribution have good manifested diurnal course and also anti-correlation between O3 and NH3 with PNH4

Conclusions:

-The numerical experiments showed that the biogenic emission contribution to ozone levels in Bulgaria is rather small. This is probably due to the fact that the NOx concentrations in the region are relatively small and are the limitation factor for ozone formation.

- The numerical experiments performed produced a huge volume of information, which have to be carefully analyzed and generalized so that some final conclusions could be made.

- The obtained ensemble of numerical simulation results is large enough to allow statistical treatment – calculating not only concentration and biogenic contribution mean fields, but also standard deviations, skewness, etc. with their dominant temporal modes (seasonal and/or diurnal variations).

Future work:

-To track the main pathways and processes witch form the atmospheric composition in different spatial/temporal scales;

- To provide high quality robust assessments of the air quality and to conclude witch sources and processes are most important for the formation of atmospheric composition;

- To formulate short term and strategic measures for improving the air quality.

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