SOME STATISTICAL EVALUATIONS OF NUMERICALLY OBTAINED ATMOSPHERIC COMPOSITION FIELDS IN BULGARIA

Georgi Gadzhev(1), Kostadin Ganev(1), Maria Prodanova(2), Dimiter Syrakov(2), Nikolay Miloshev(1)

1) National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, Sofia, Bulgaria

2) National Institute of Meteorology and Hydrology, Bulgarian Academy of Sciences, Sofia, Bulgaria

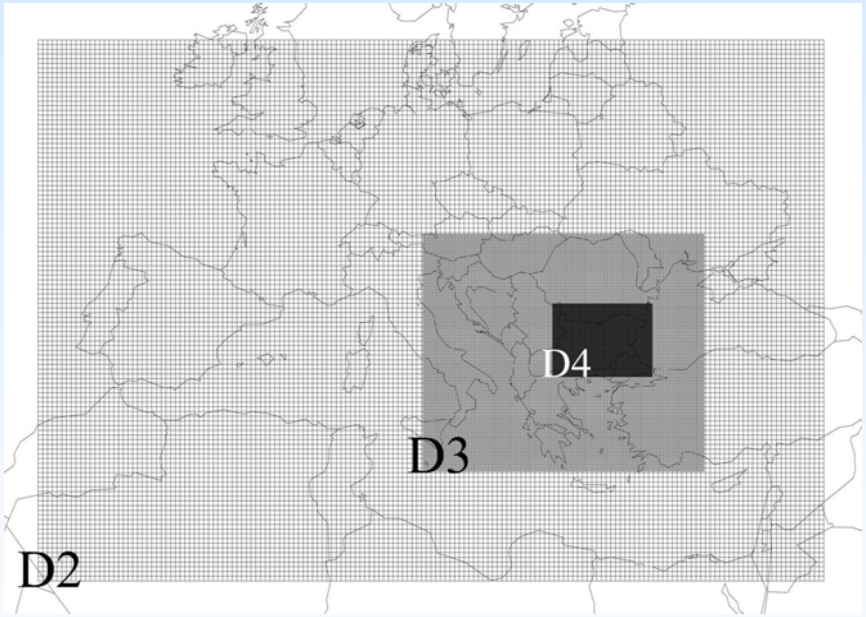
Numerical Study of the Atmospheric Composition Climate in Bulgaria – objectives:

- Statistically representative ensemble of the atmospheric composition status of the Balkan Peninsula and the country – “atmospheric composition climate”;
- Accounting for the two way interactions of the different (urban-to-local-to-regional) scales ;
- Tracking and characterizing the main pathways and processes that lead to atmospheric composition formation in different scales ;
- Providing high quality scientifically robust assessments of the air quality and its origin – basis for formulation of air pollution mitigation strategies.

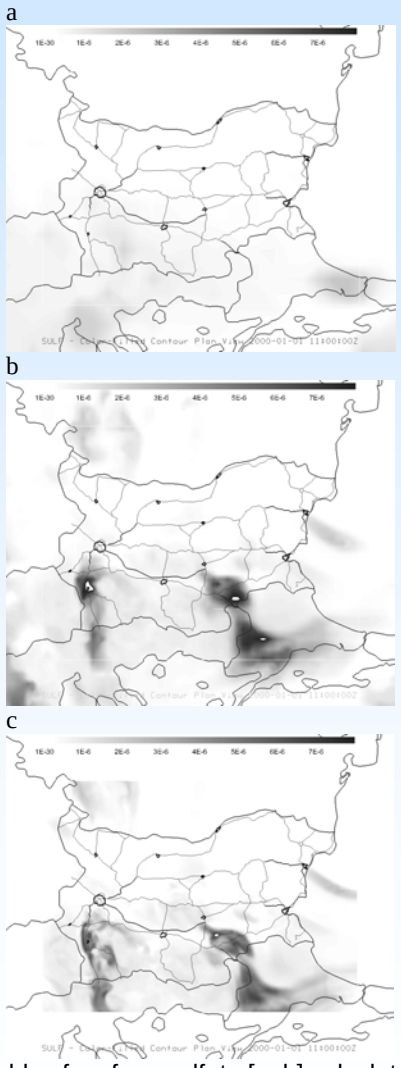
Modeling tools – US EPA Models-3 System:

- 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);
- 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);
- 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

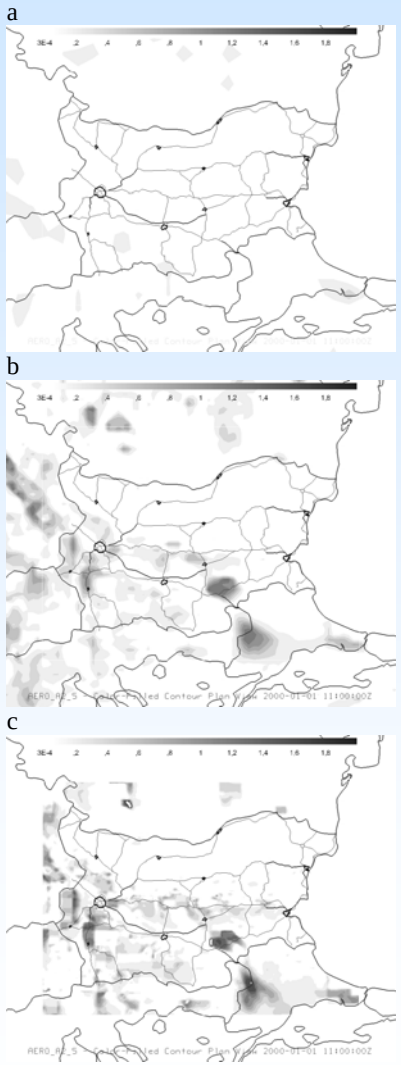
Numerical Study of the Atmospheric Composition Climate in Bulgaria : domains & “nesting”



The three inner computational domains produced by TERRAIN

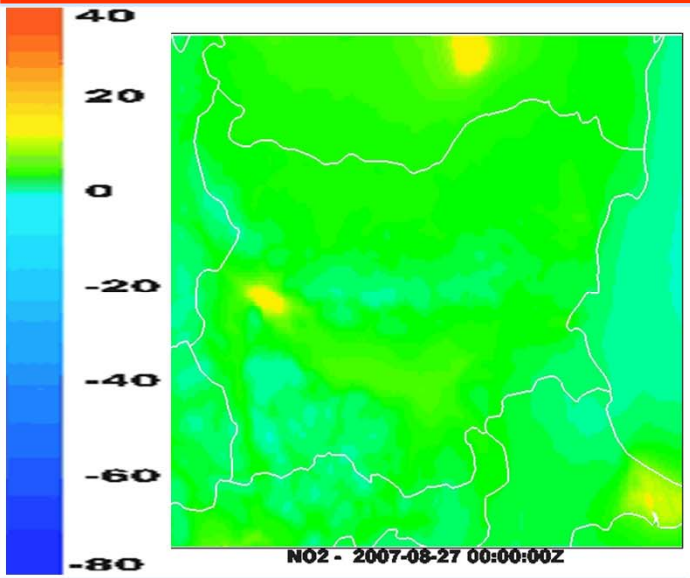


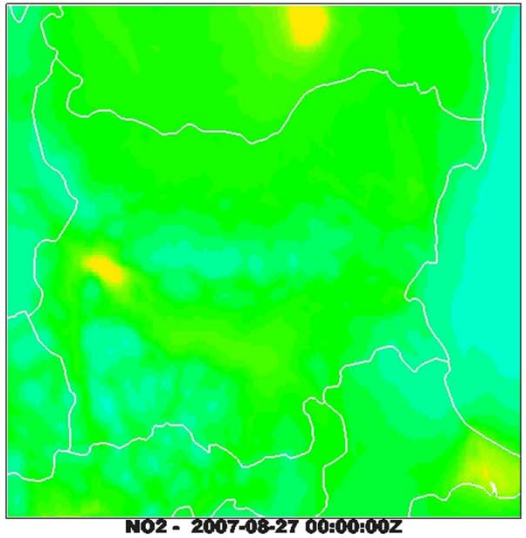
Fields of surface sulfate [ppb] calculated by the second D2 (a), D3 (b) and D4 (c) nesting steps, 01.01.2000, 11:00 UTC



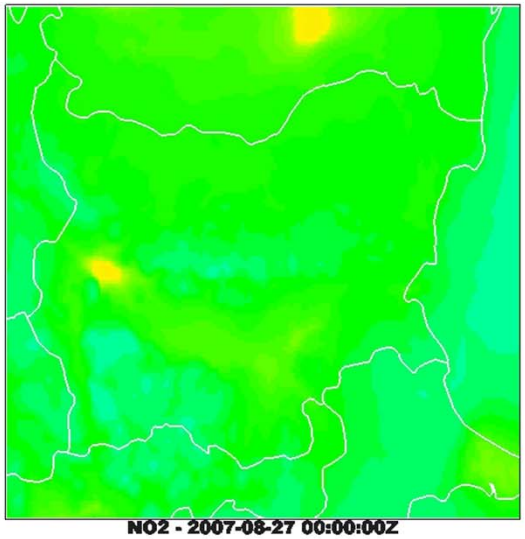
Fields of the hourly contribution of aerosol processes to the PM2.5 formation [μg/(m^3.hour)] calculated by the second D2 (a), D3 (b) and D4 (c) nesting steps, 01.01.2000, 11:00 UTC

Numerical Study of the Atmospheric Composition Climate in Bulgaria : averaged concentrations





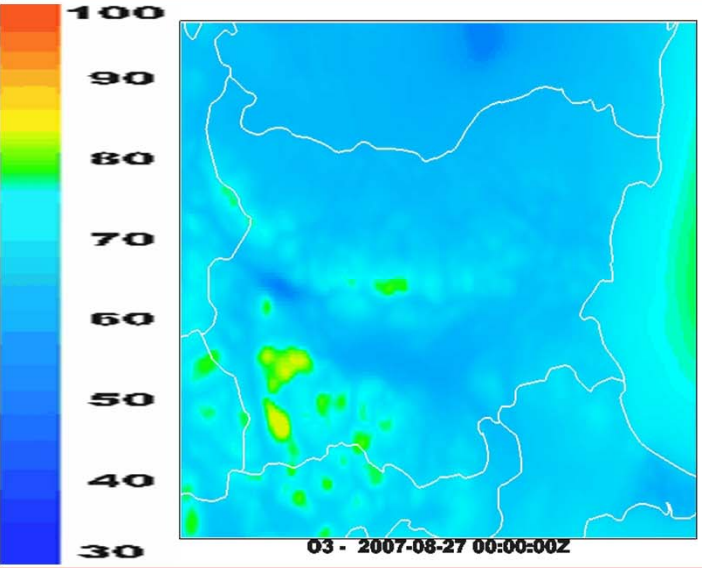
NO2

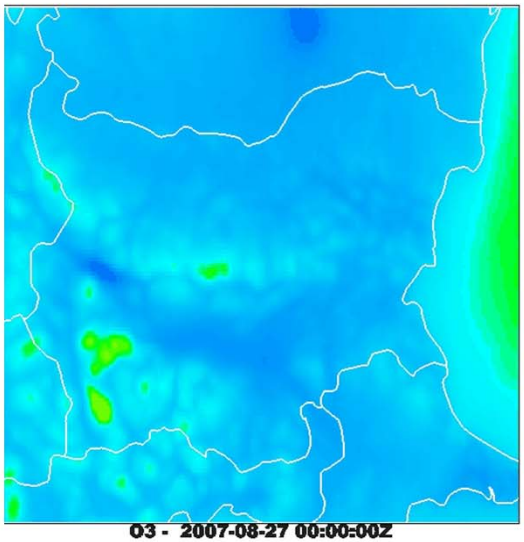


Annual

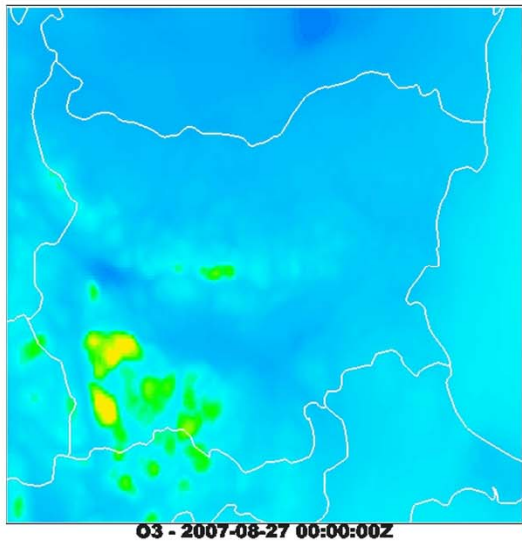
Summer

Winter

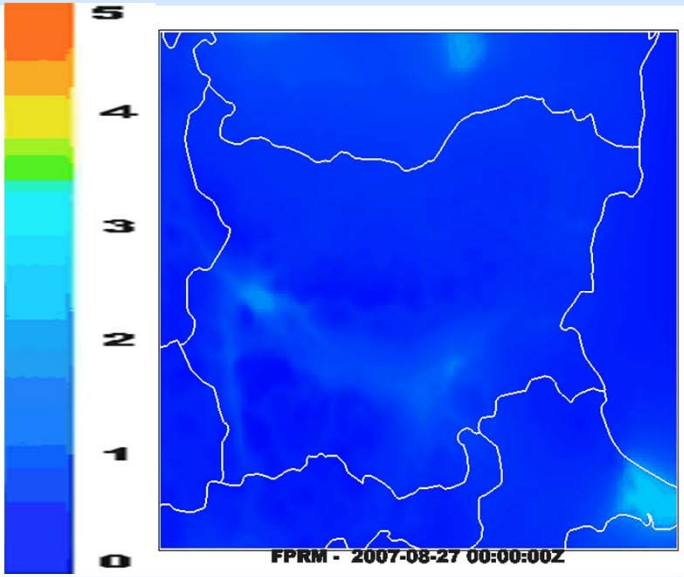


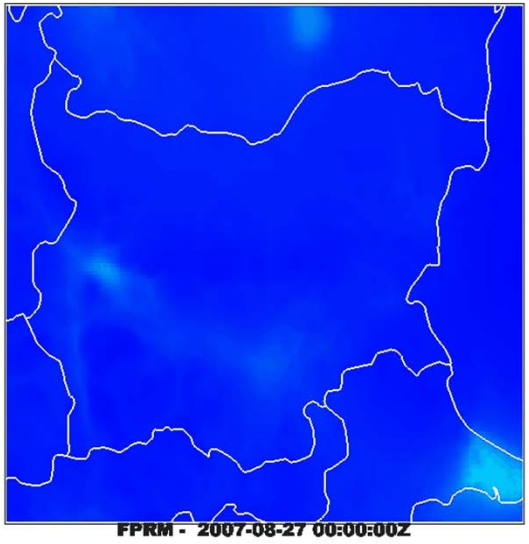


O3

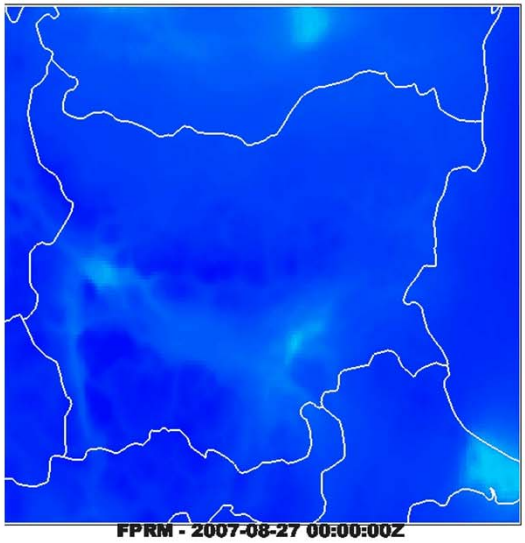


Numerical Study of the Atmospheric Composition Climate in Bulgaria : averaged concentrations





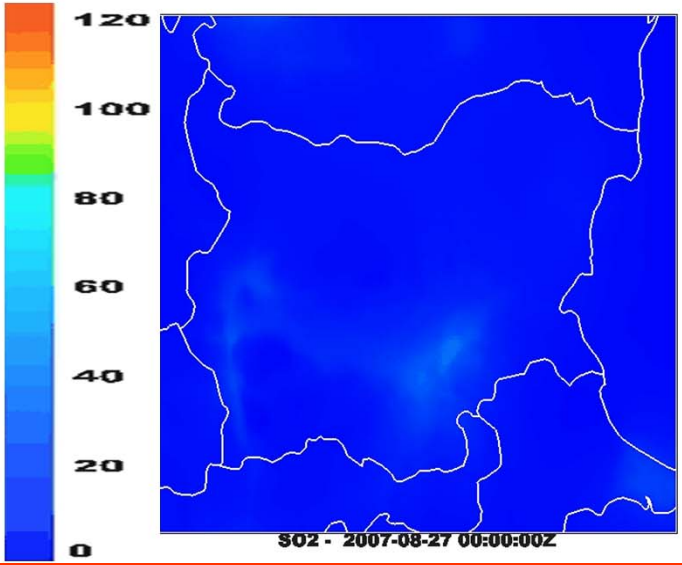
FPRM

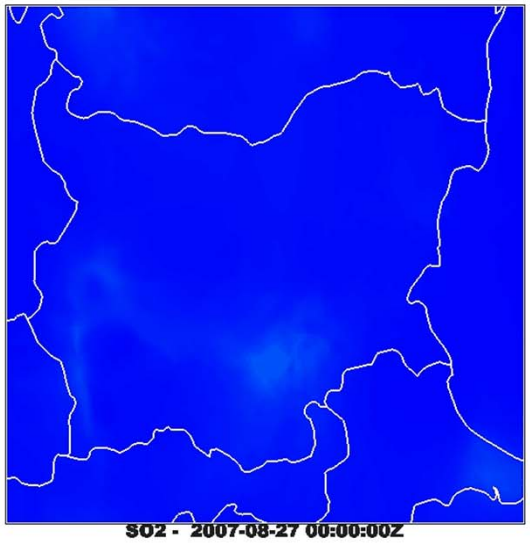


Annual

Summer

Winter





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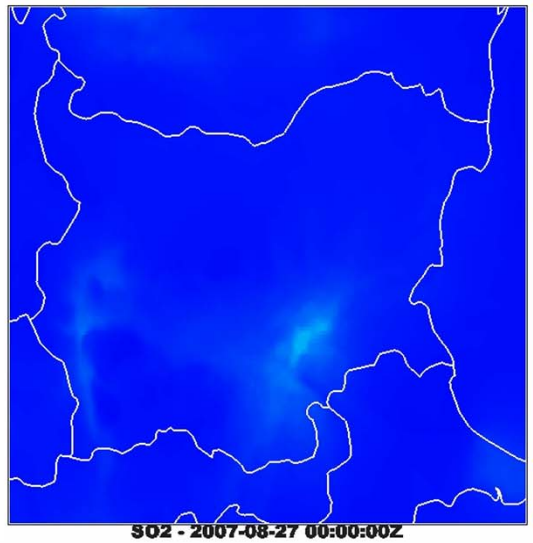
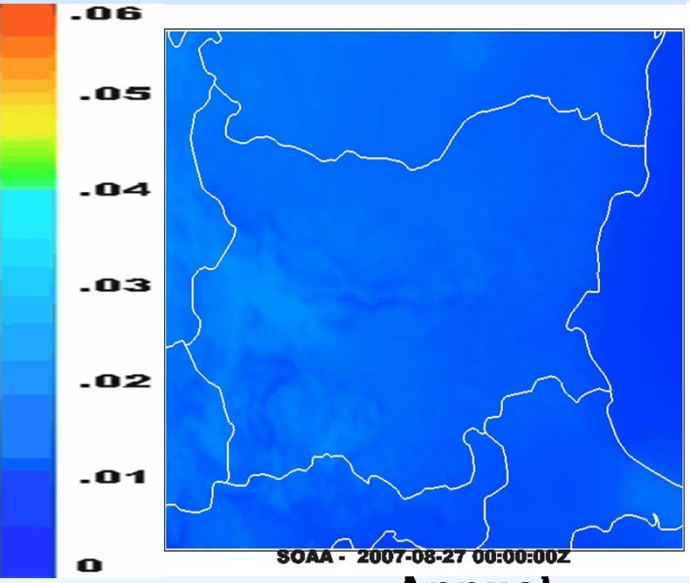
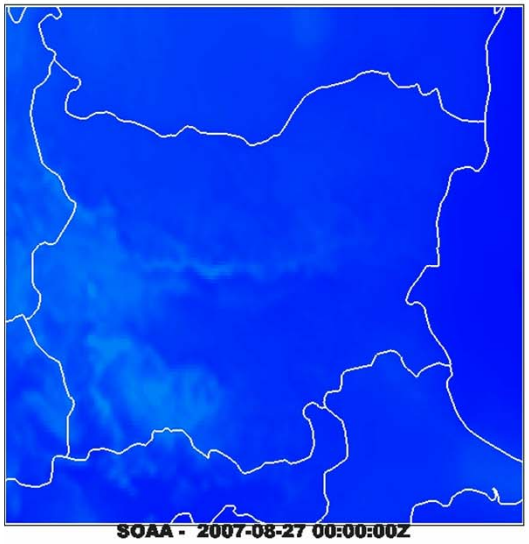


Numerical Study of the Atmospheric Composition Climate in Bulgaria : averaged concentrations

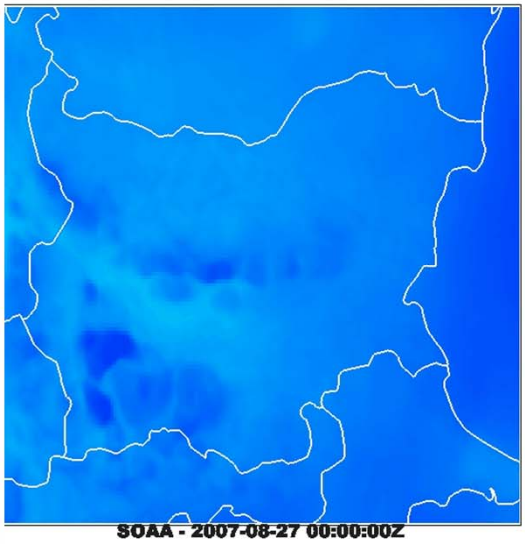


Annual

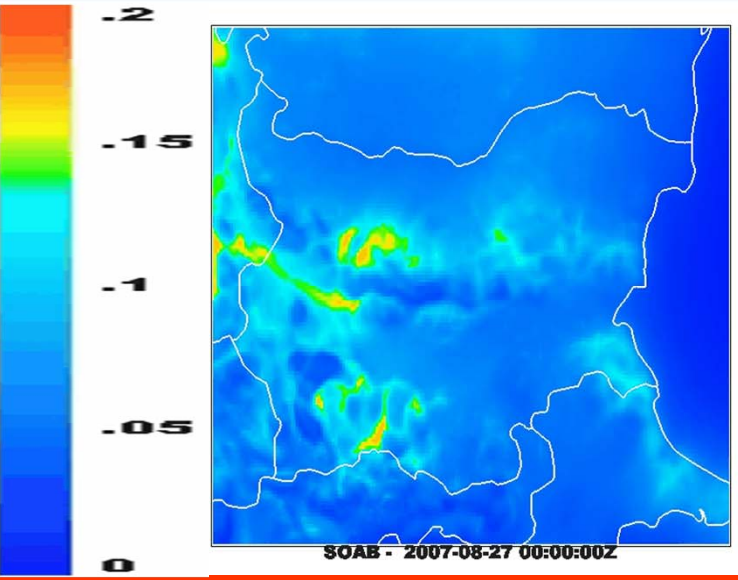


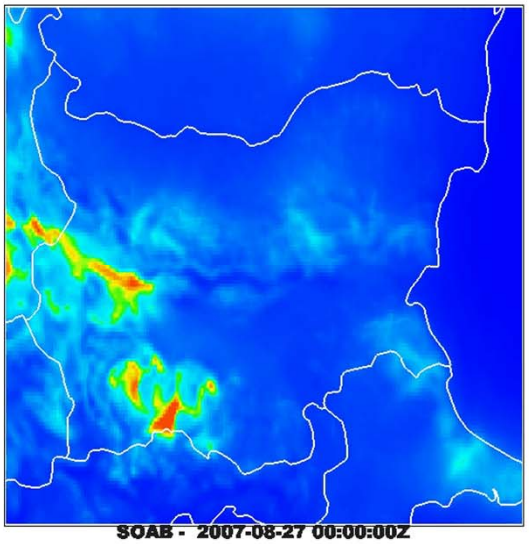
Summer

SOAA

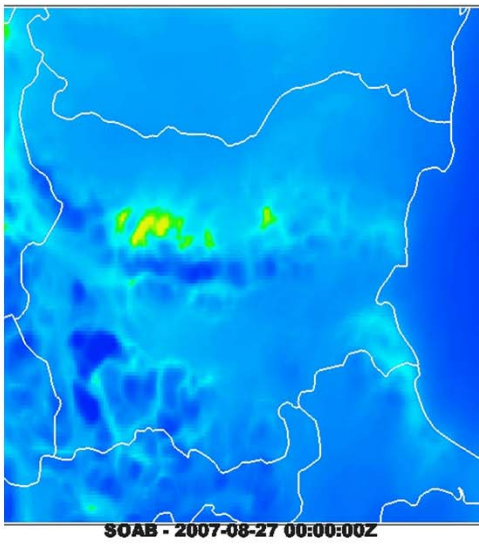


Winter

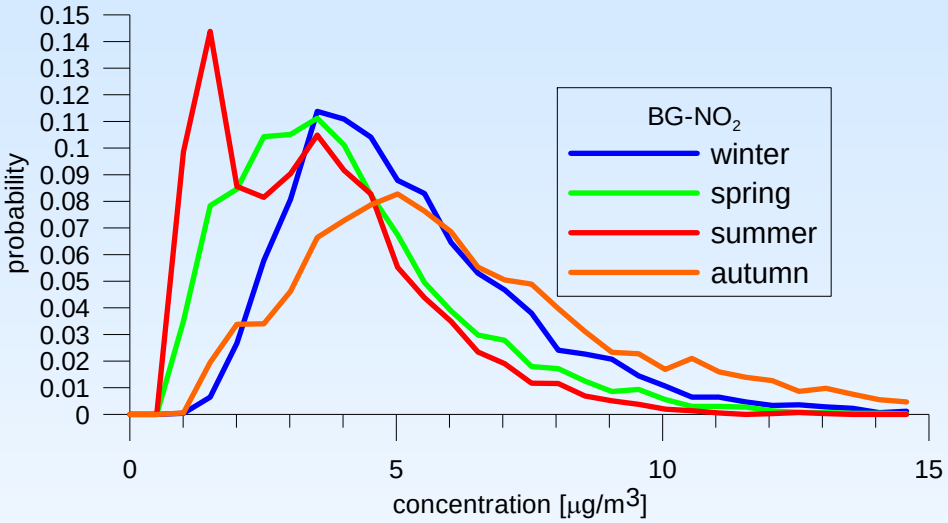


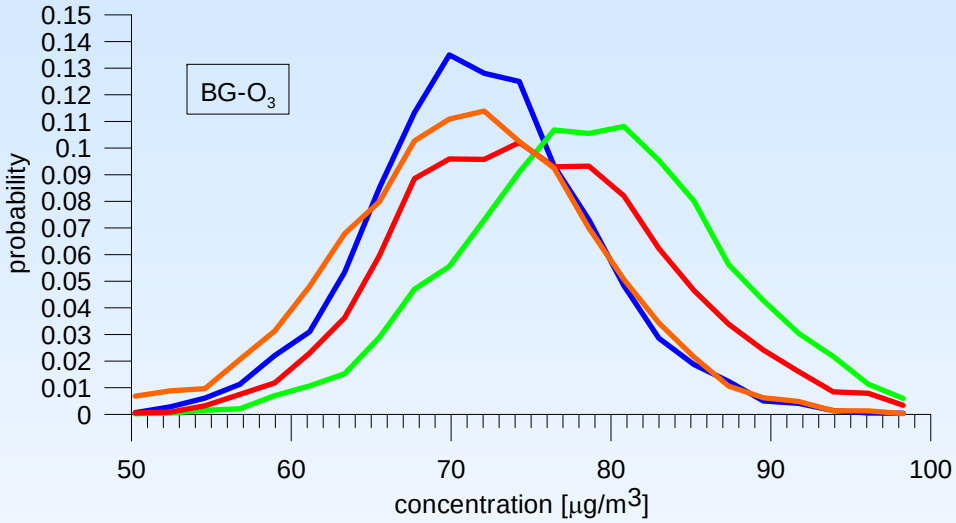


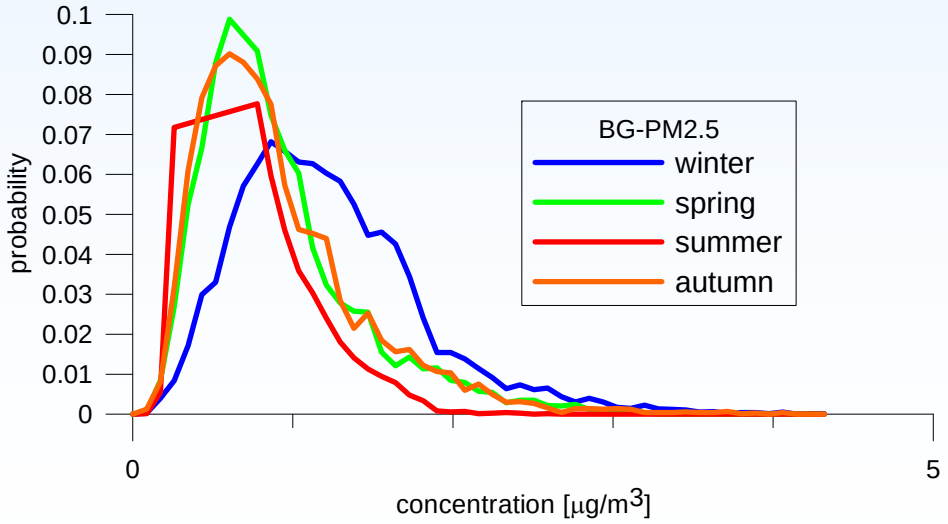
SOAB

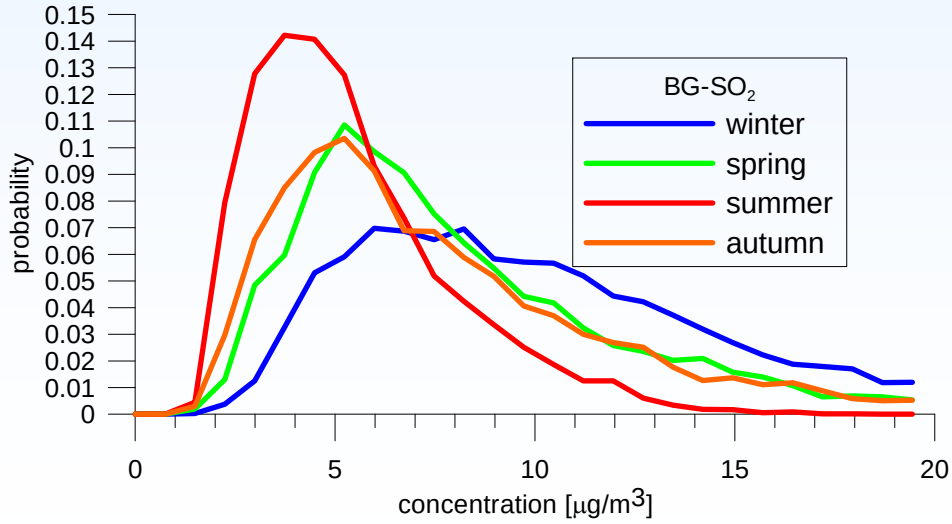


Numerical Study of the Atmospheric Composition Climate in Bulgaria : seasonal variations of concentration probability density for Bulgaria

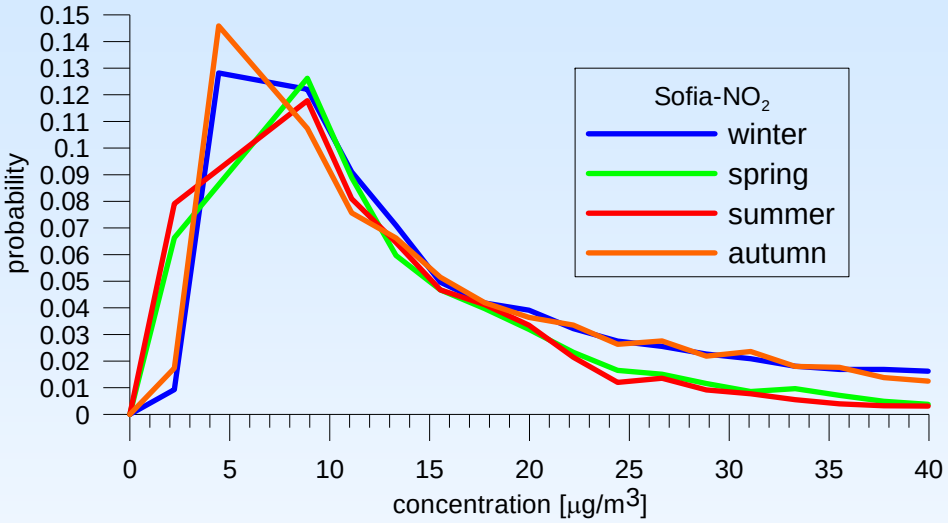


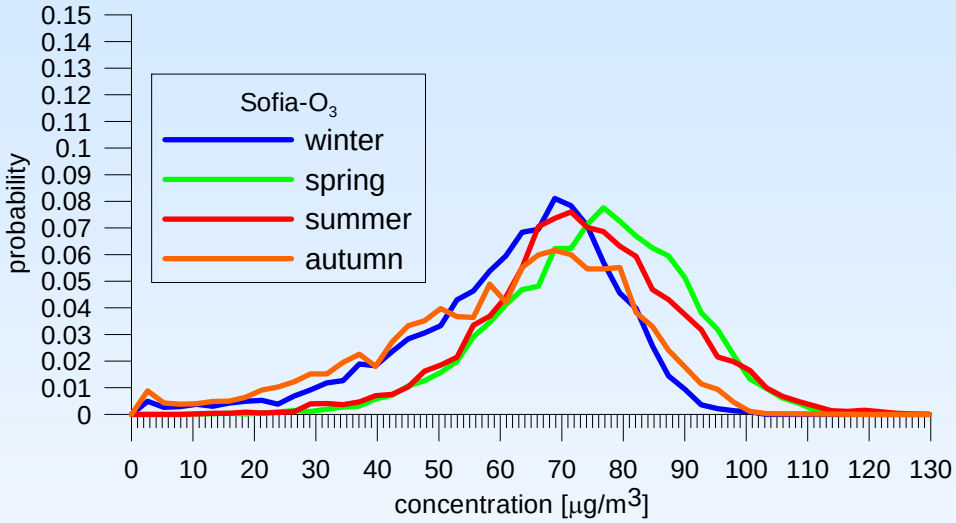


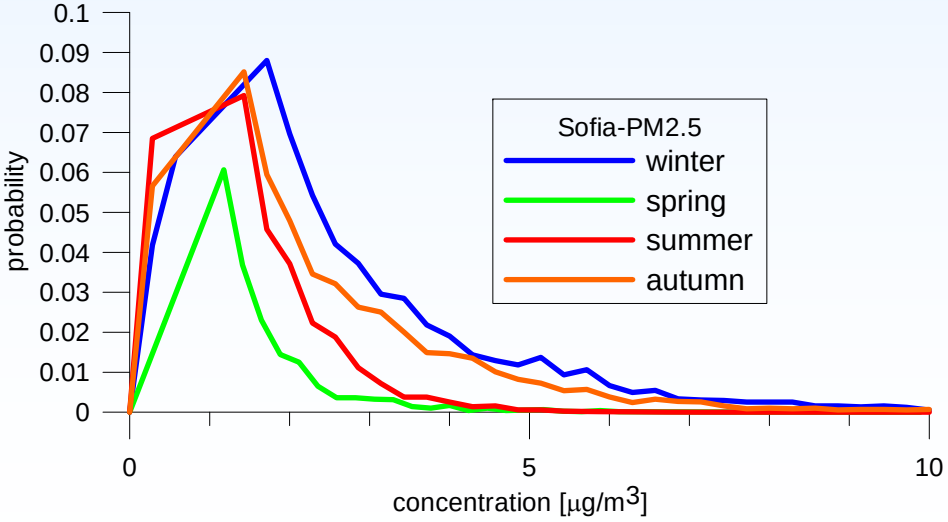


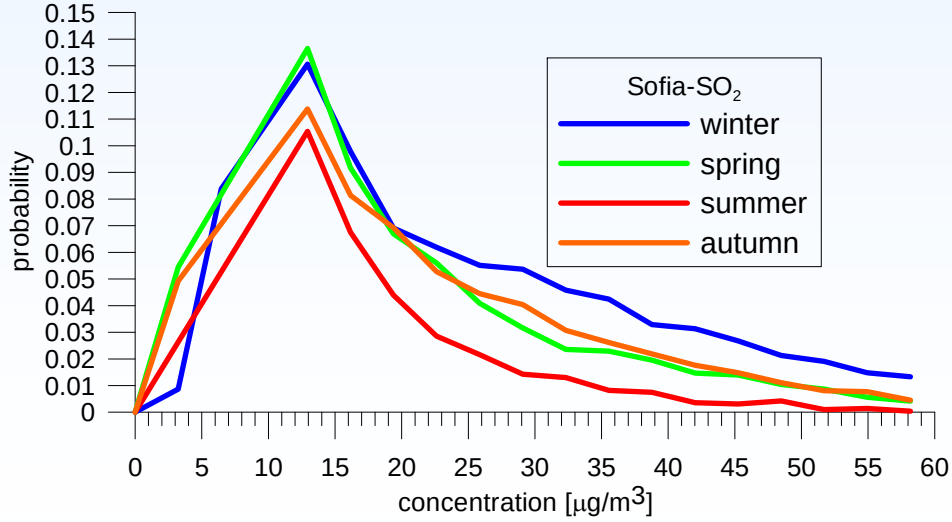


Numerical Study of the Atmospheric Composition Climate in Bulgaria : seasonal variations of concentration probability density for Sofia

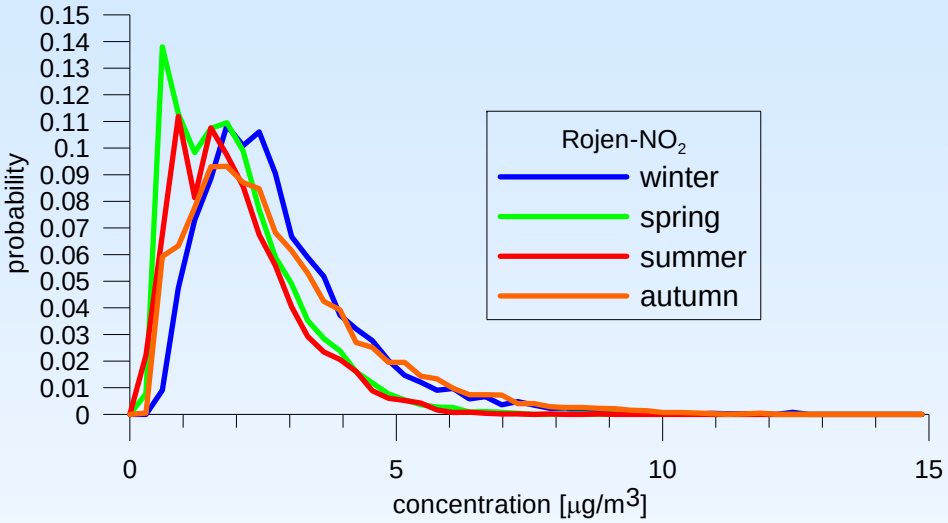


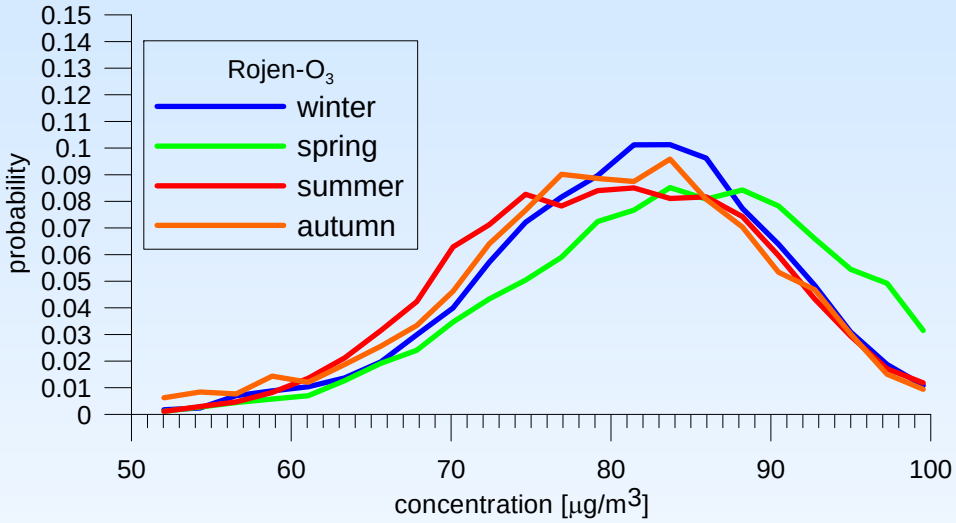


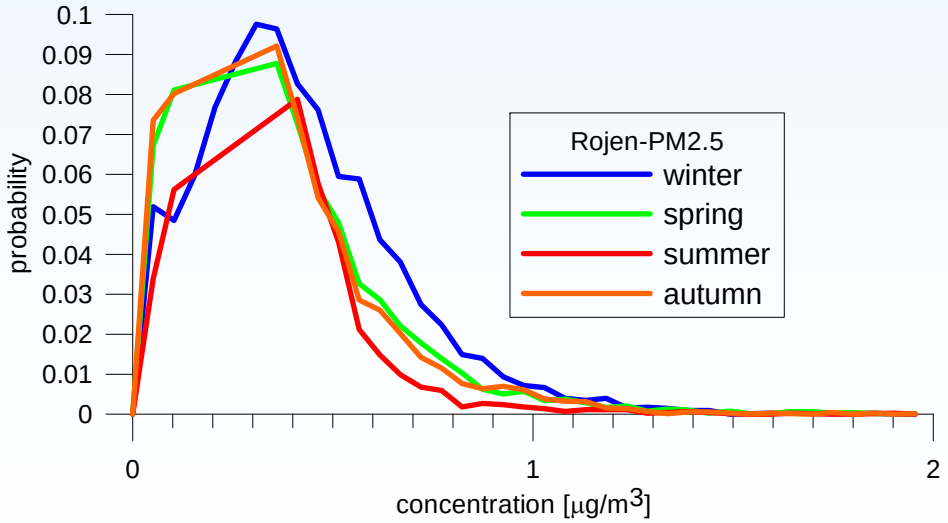


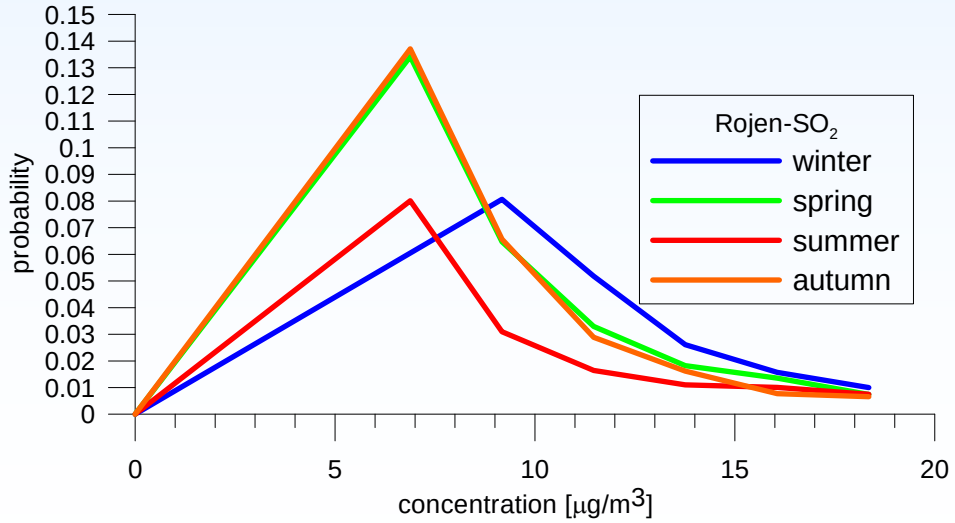


Numerical Study of the Atmospheric Composition Climate in Bulgaria : seasonal variations of concentration probability density for Rojen

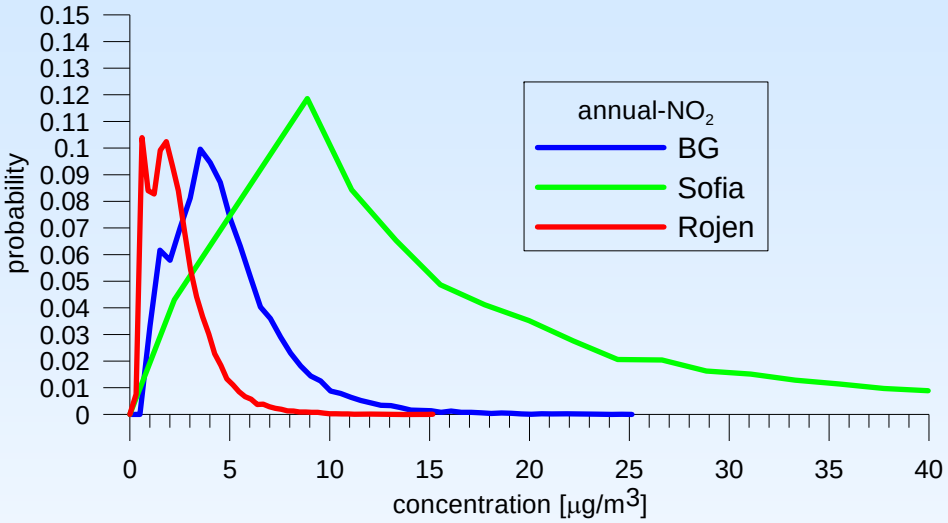


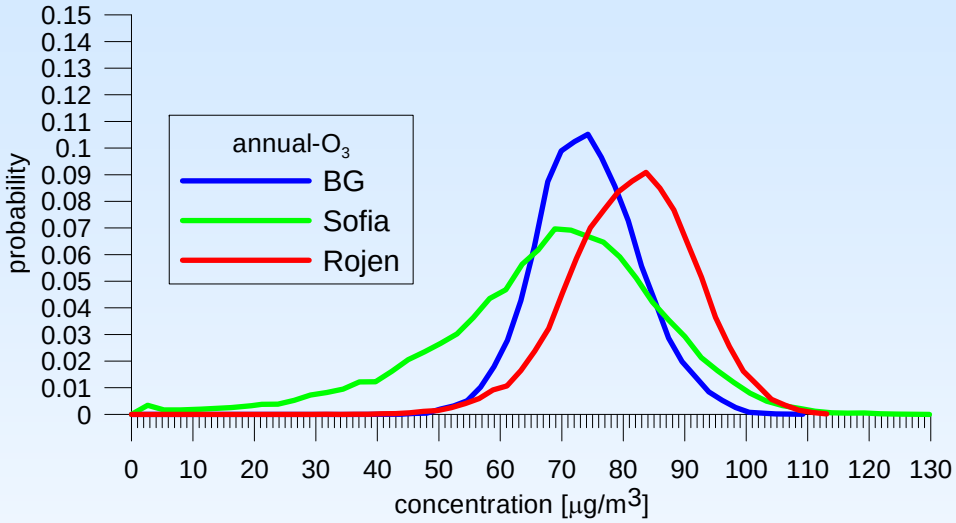


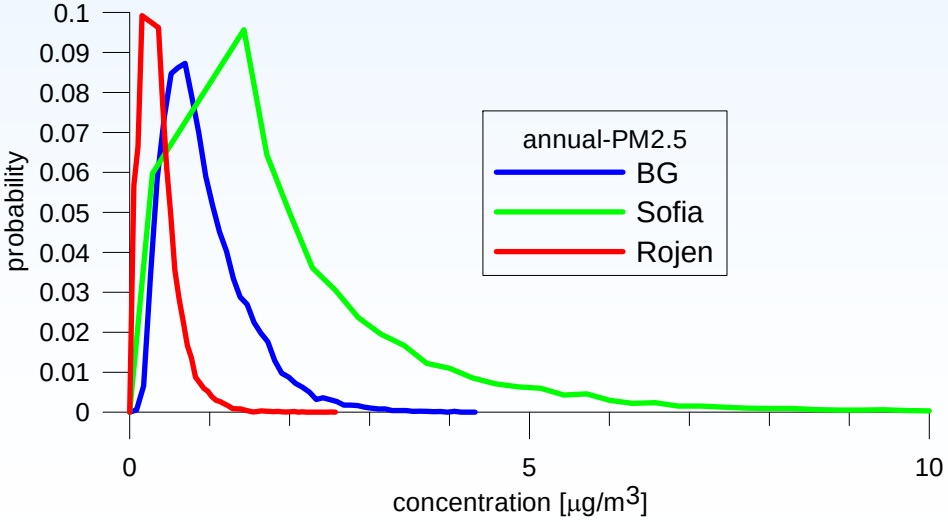


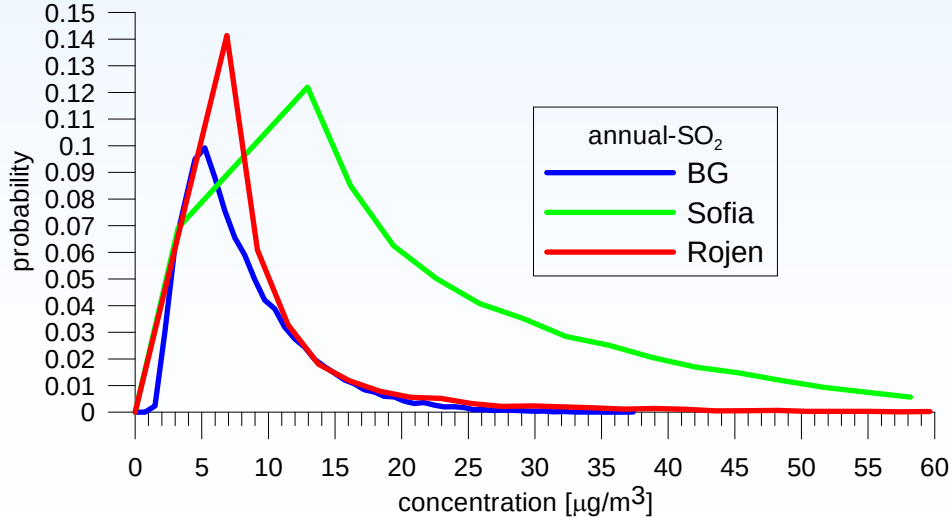


Numerical Study of the Atmospheric Composition Climate in Bulgaria : spatial variations of annual concentration probability density

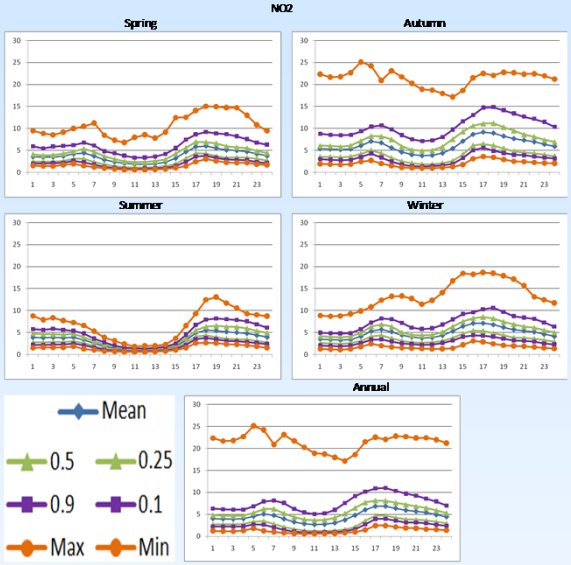


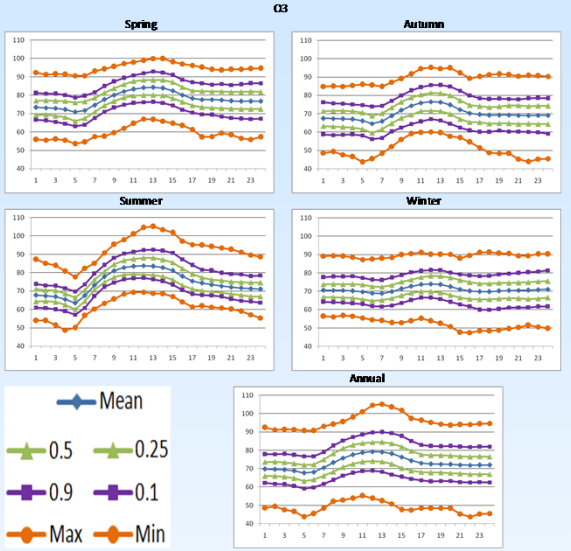


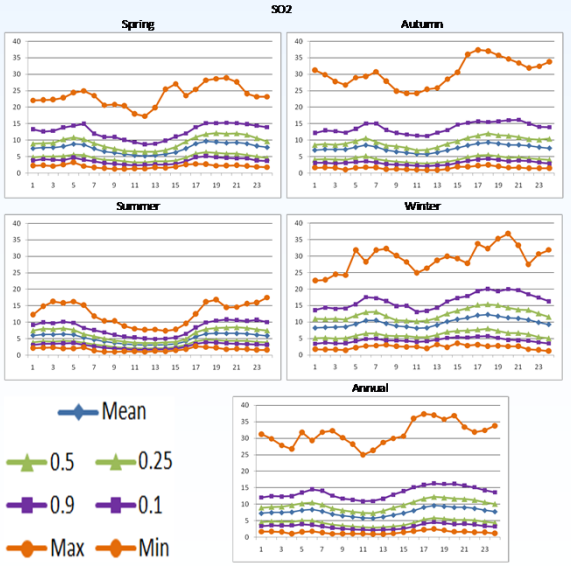


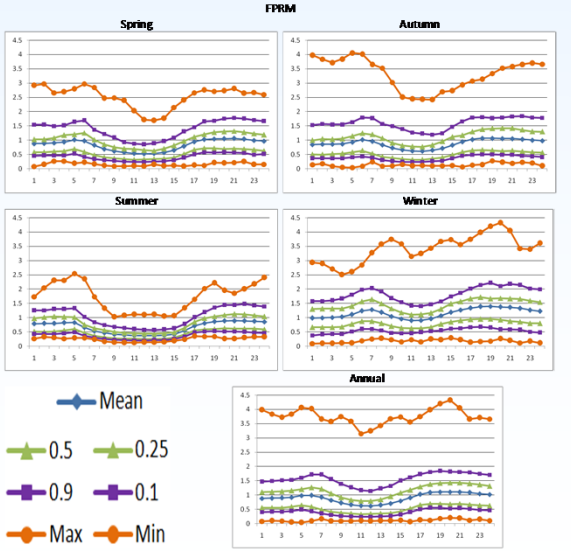


Numerical Study of the Atmospheric Composition in Bulgaria : diurnal/seasonal variations of averaged over Bulgaria concentrations

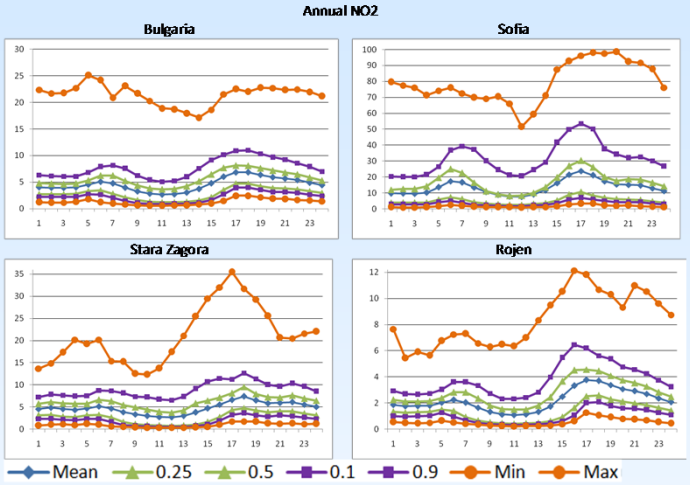


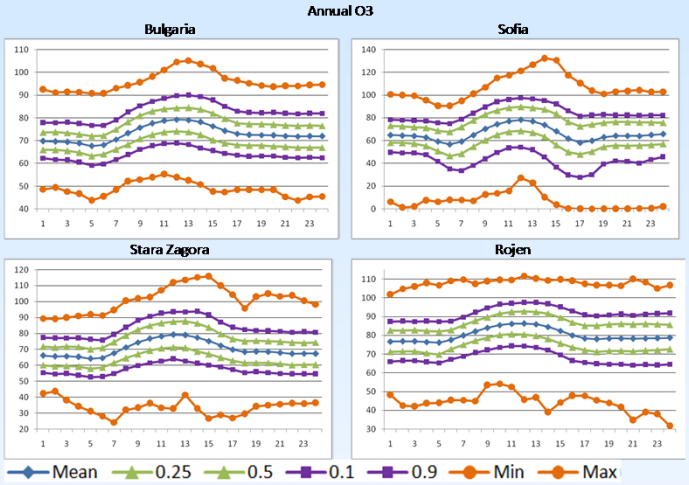


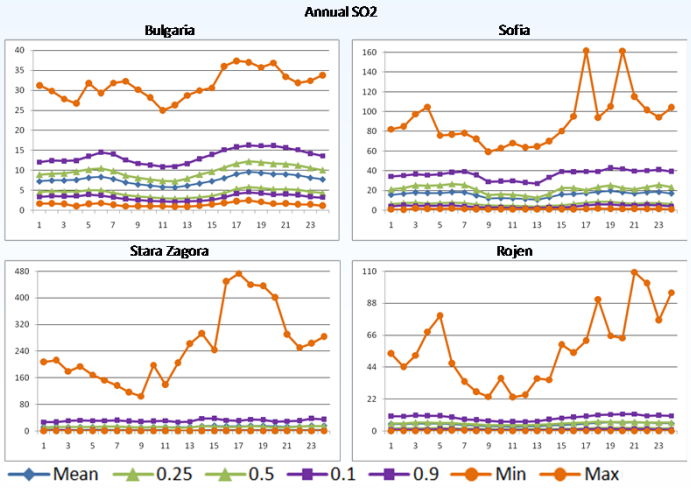


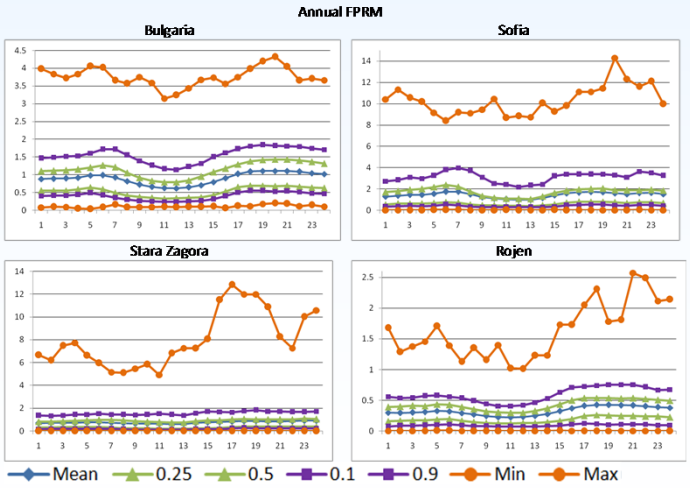


Numerical Study of the Atmospheric Composition in Bulgaria : diurnal and spatial concentration variations



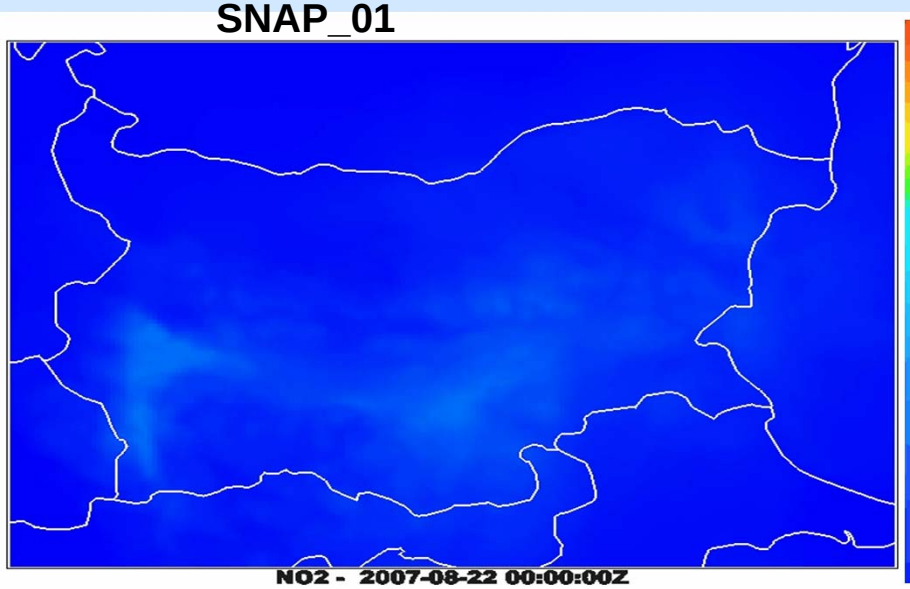


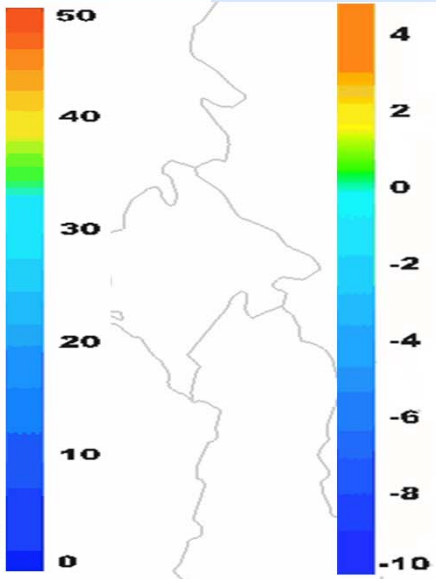




Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions for NO2

SNAP_01





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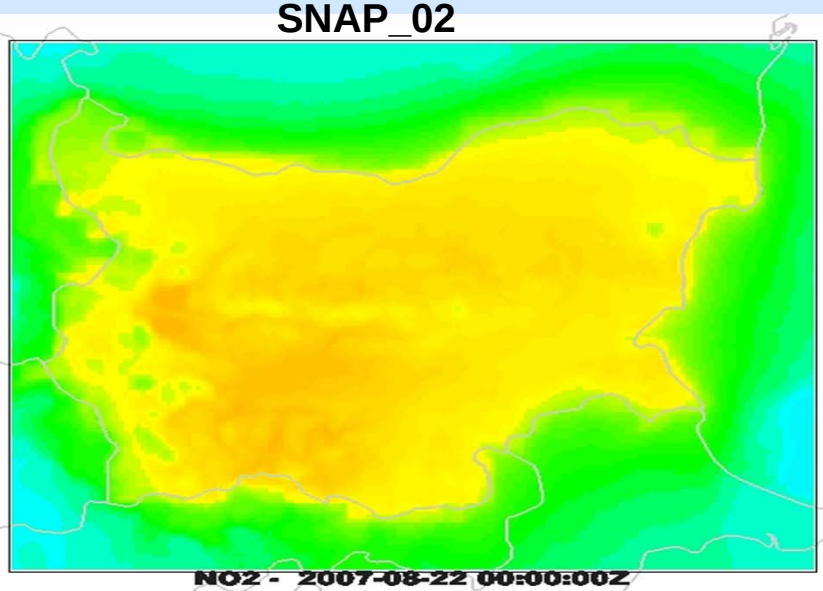
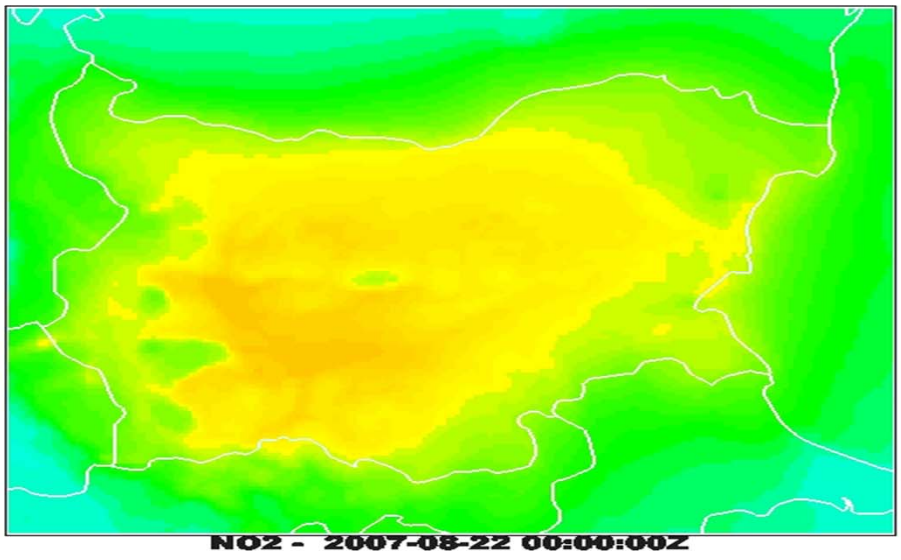
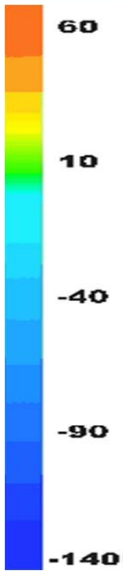
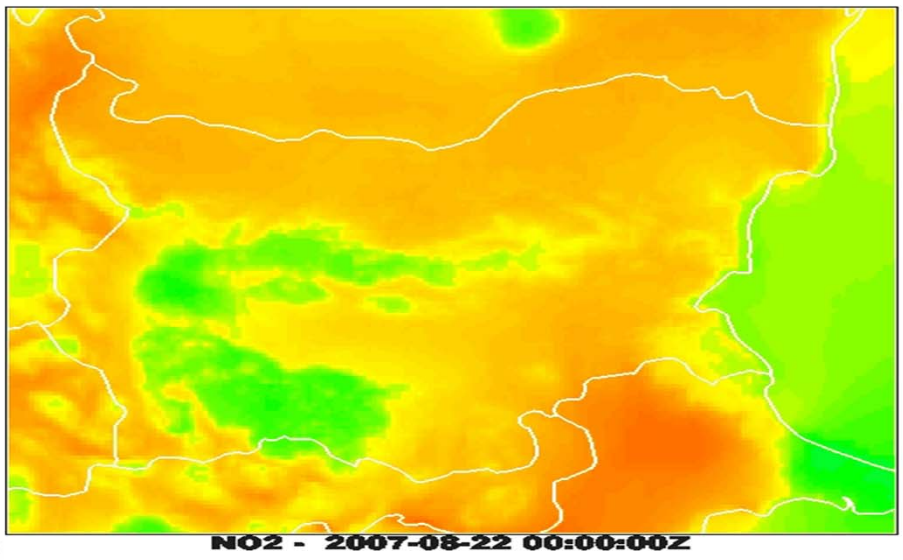


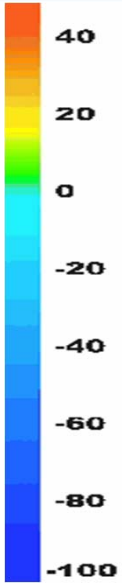
SNAP_07





Biogenic





Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions for SO2

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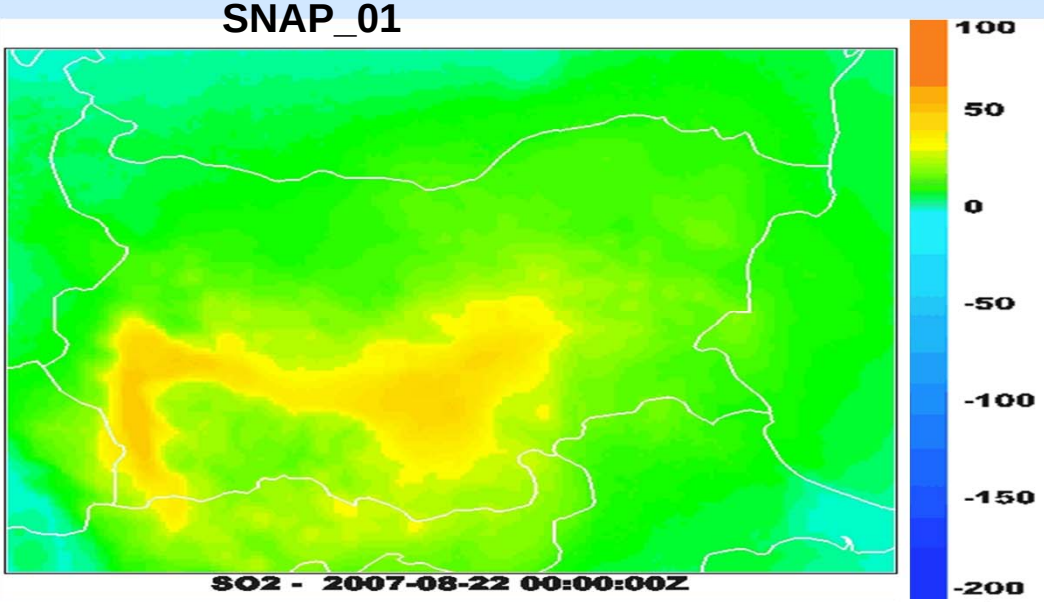

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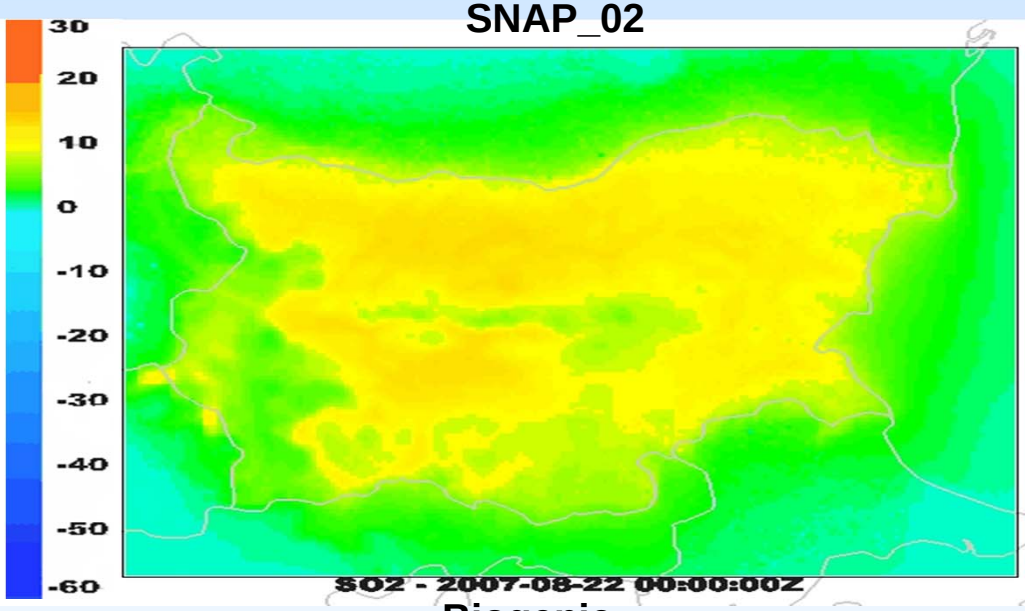

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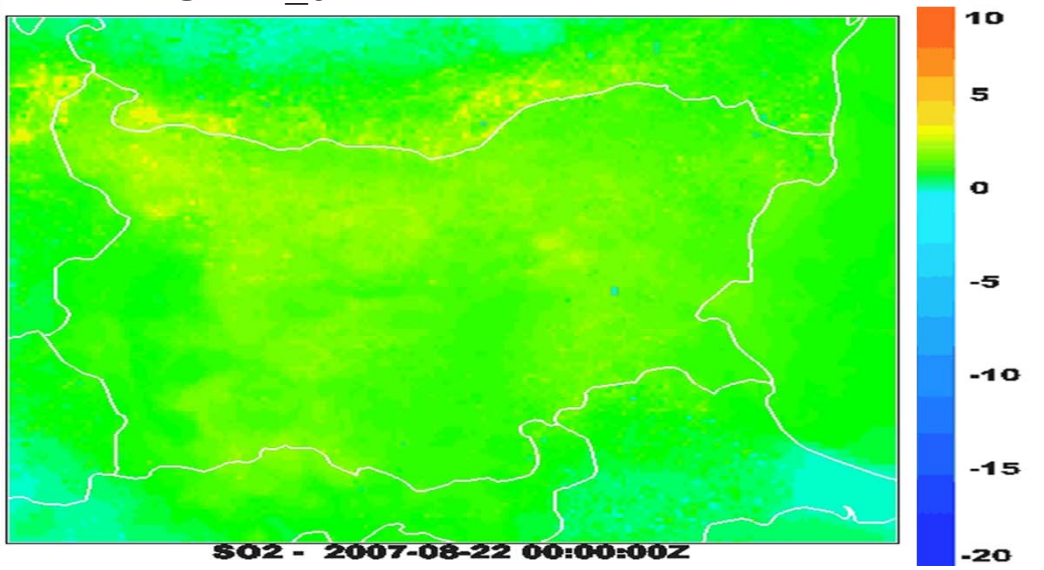

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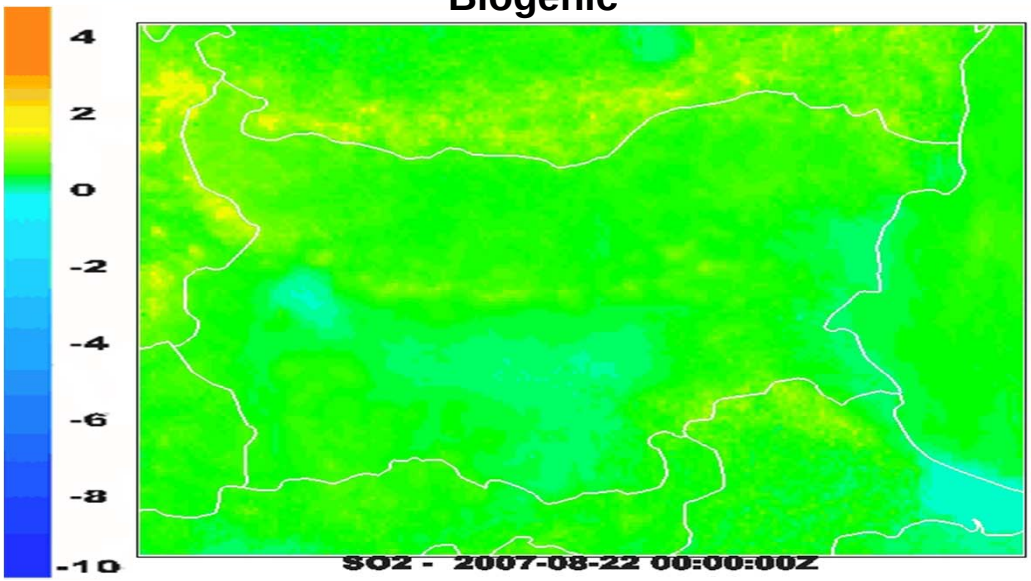

Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions for O3

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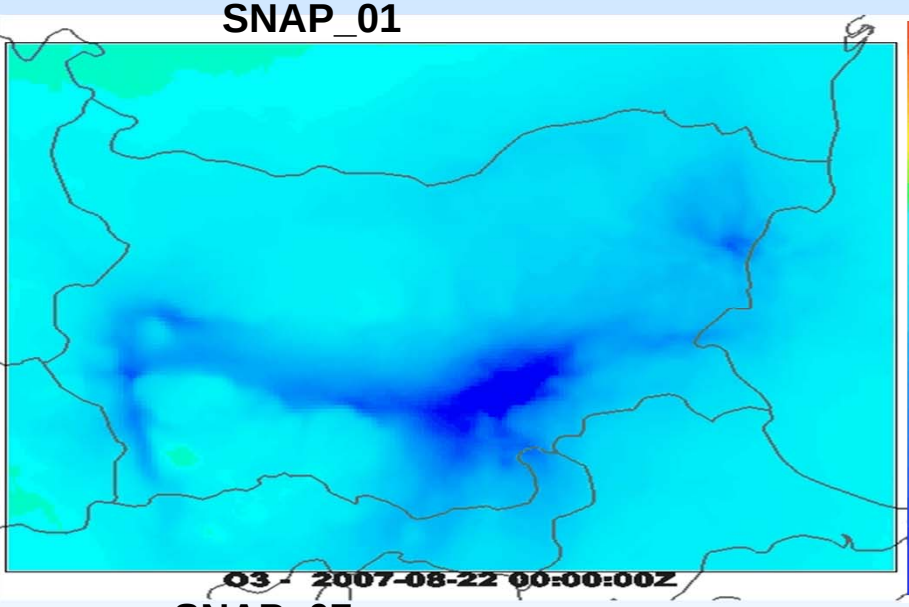

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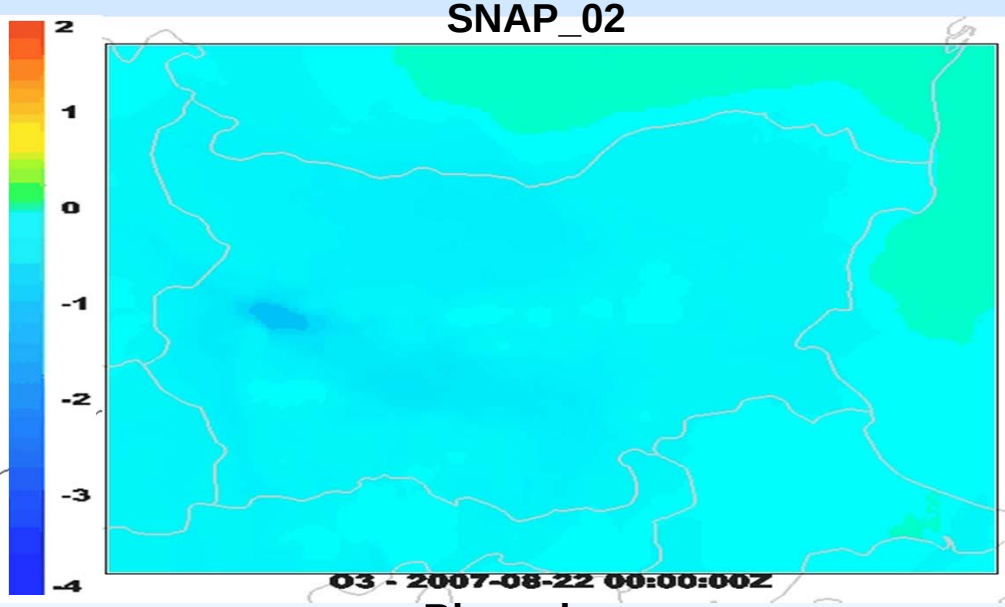

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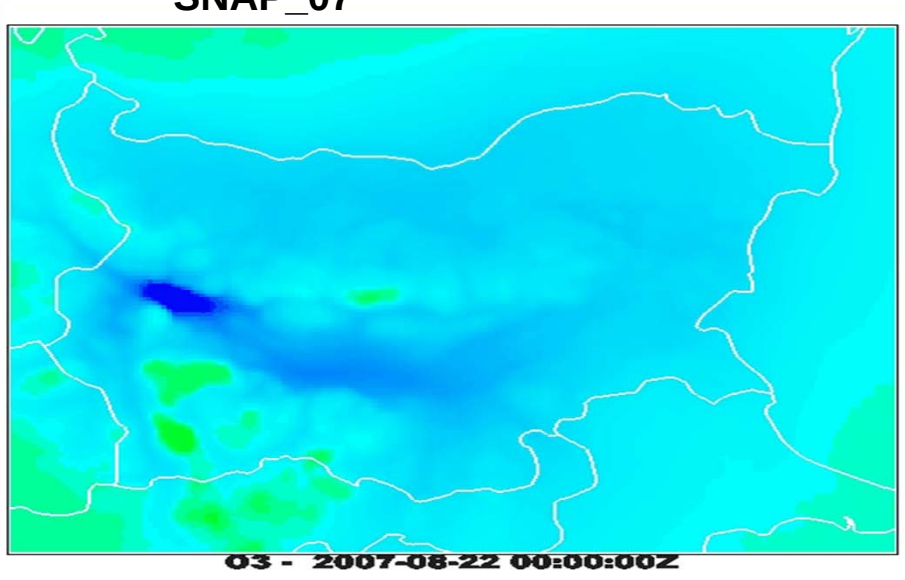

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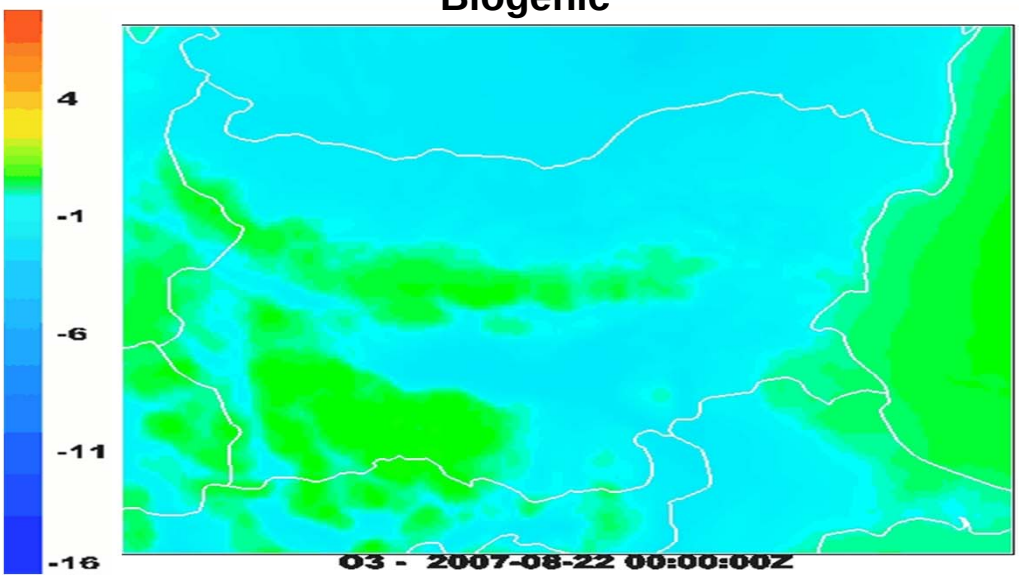

Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions for FPRM

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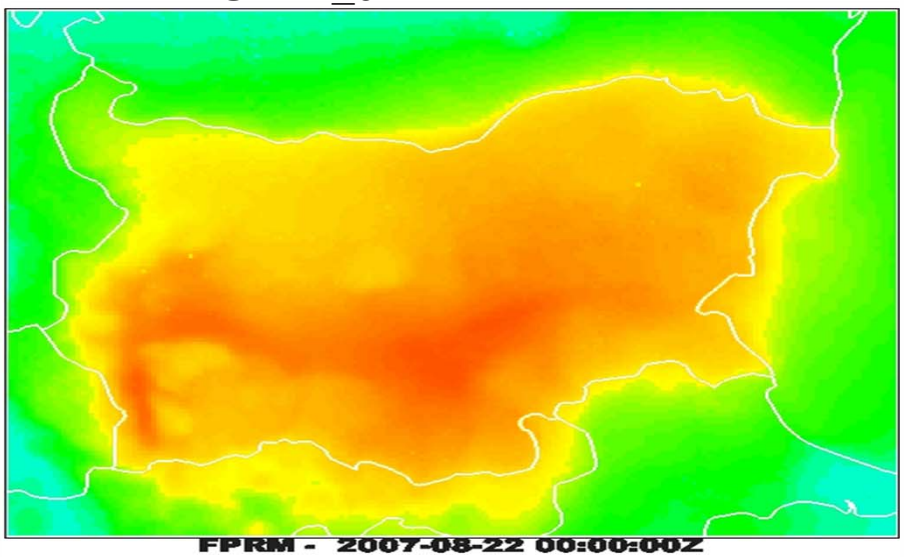

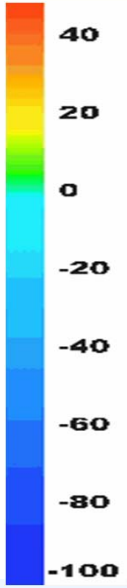

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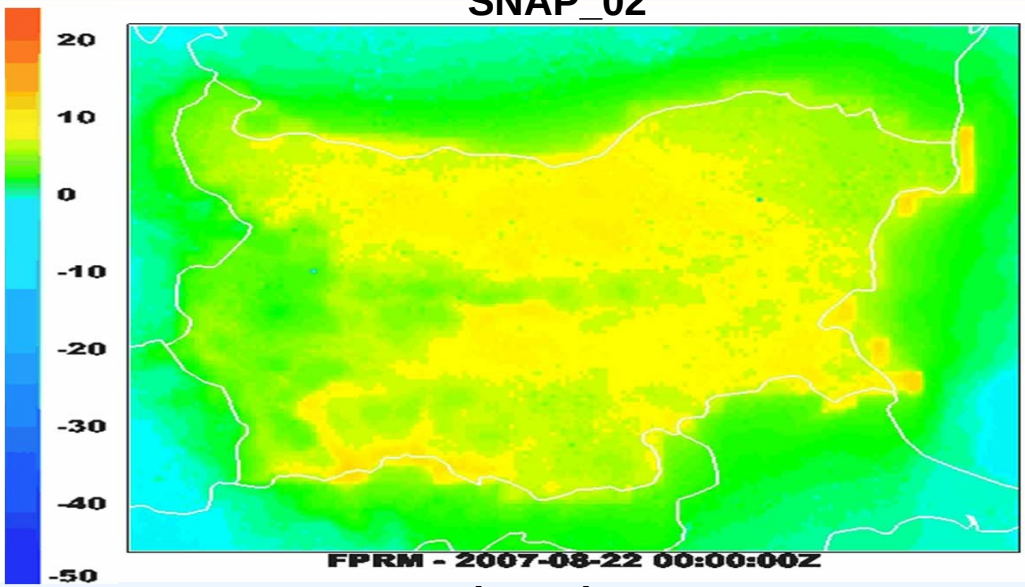

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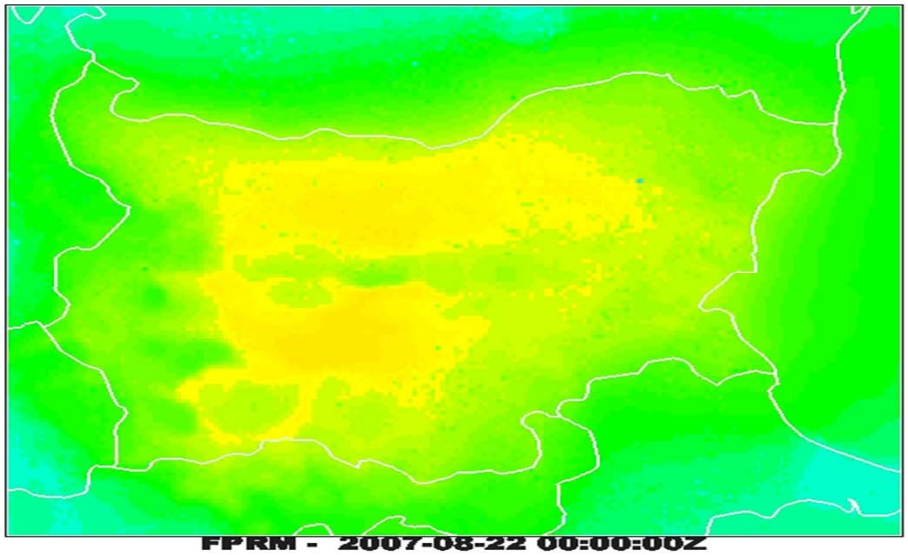

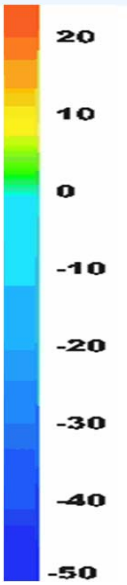

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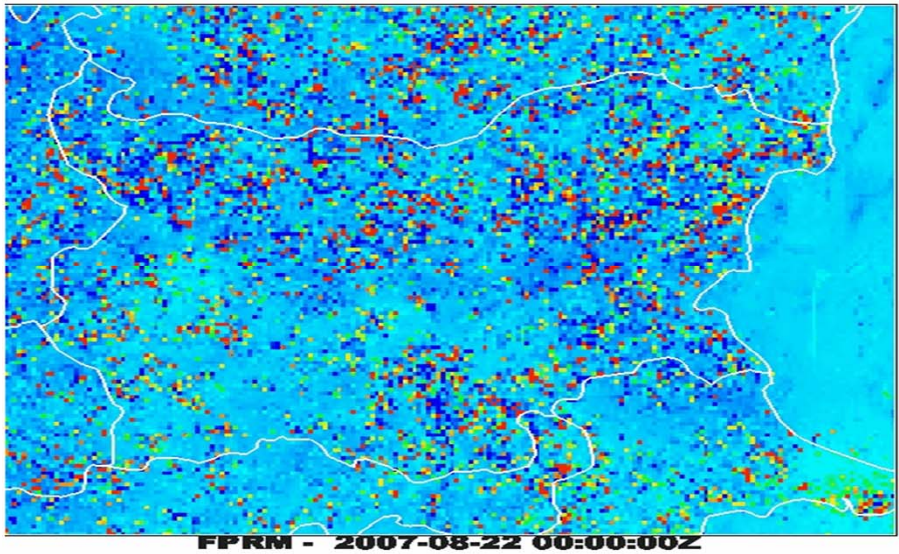
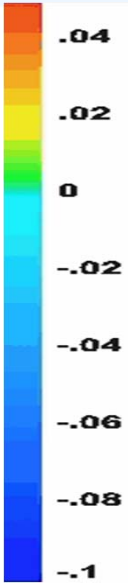
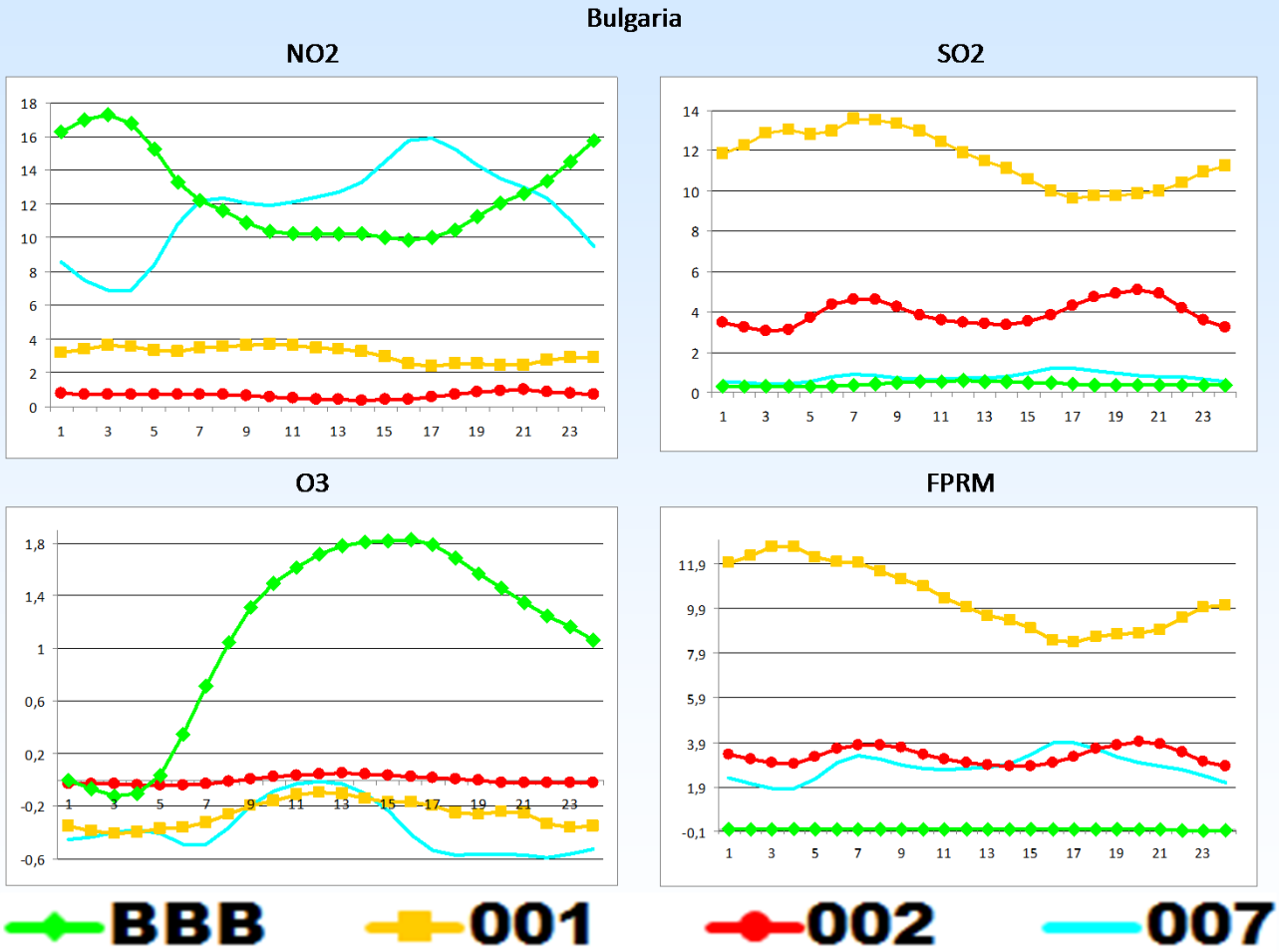
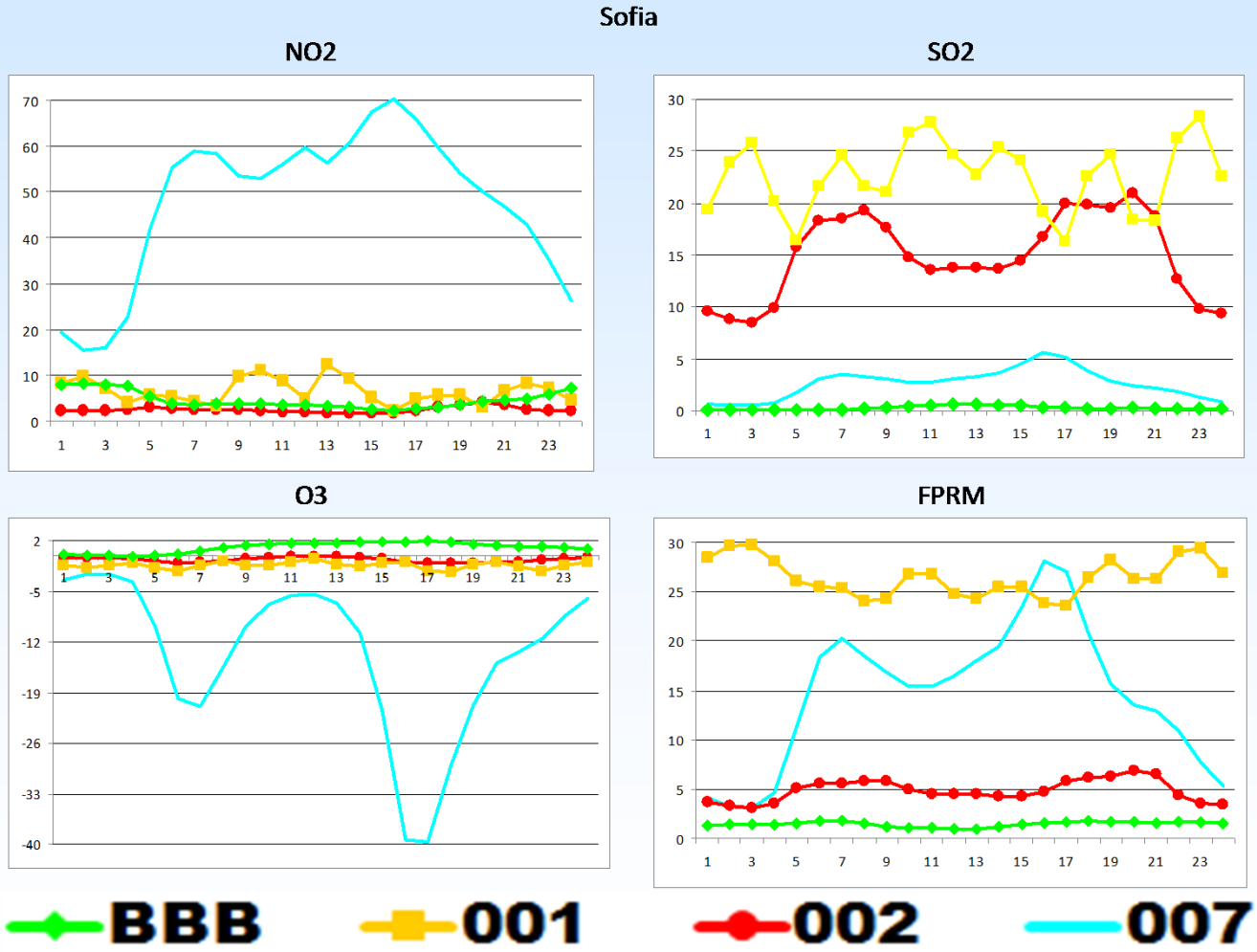




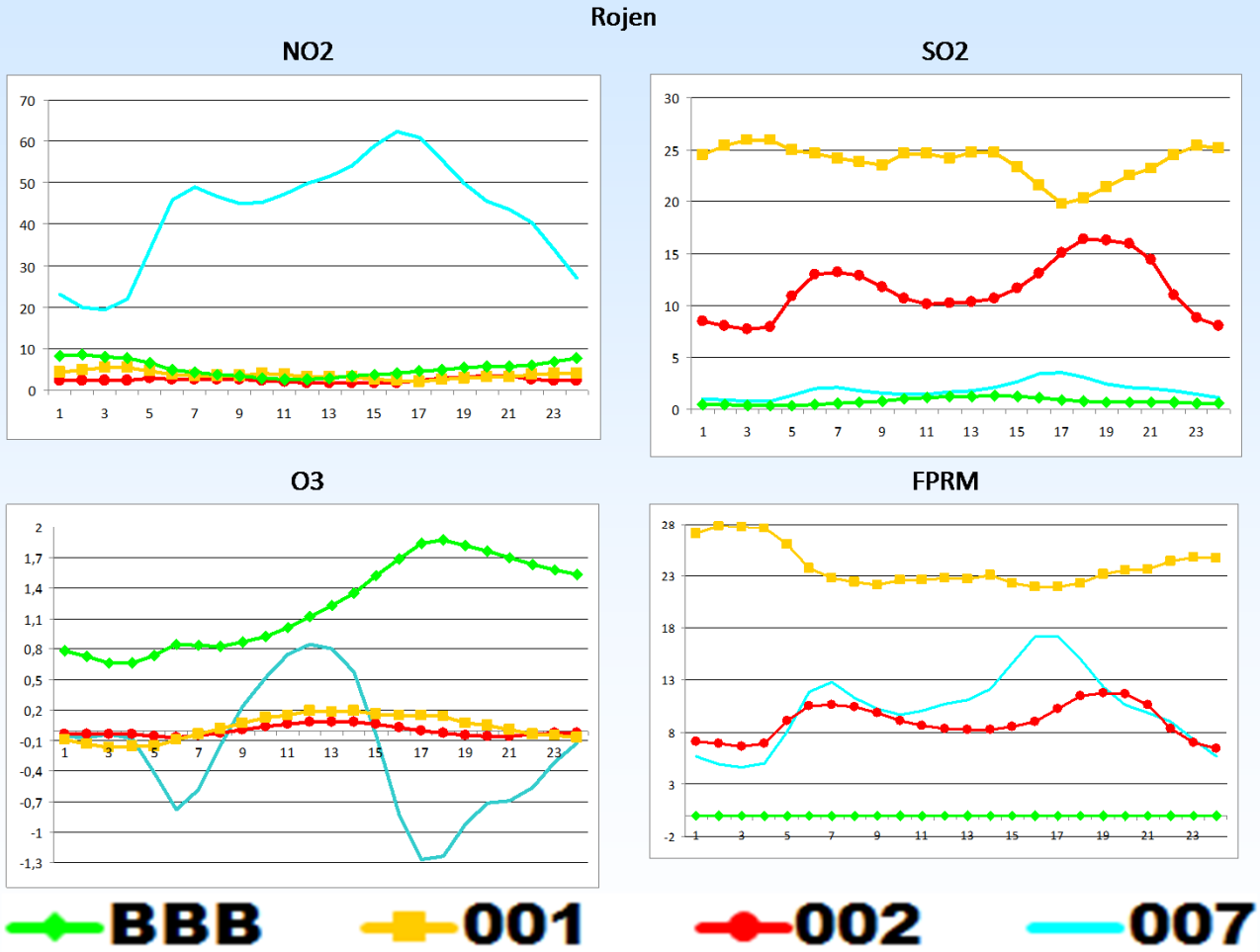
Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions averaged for Bulgaria



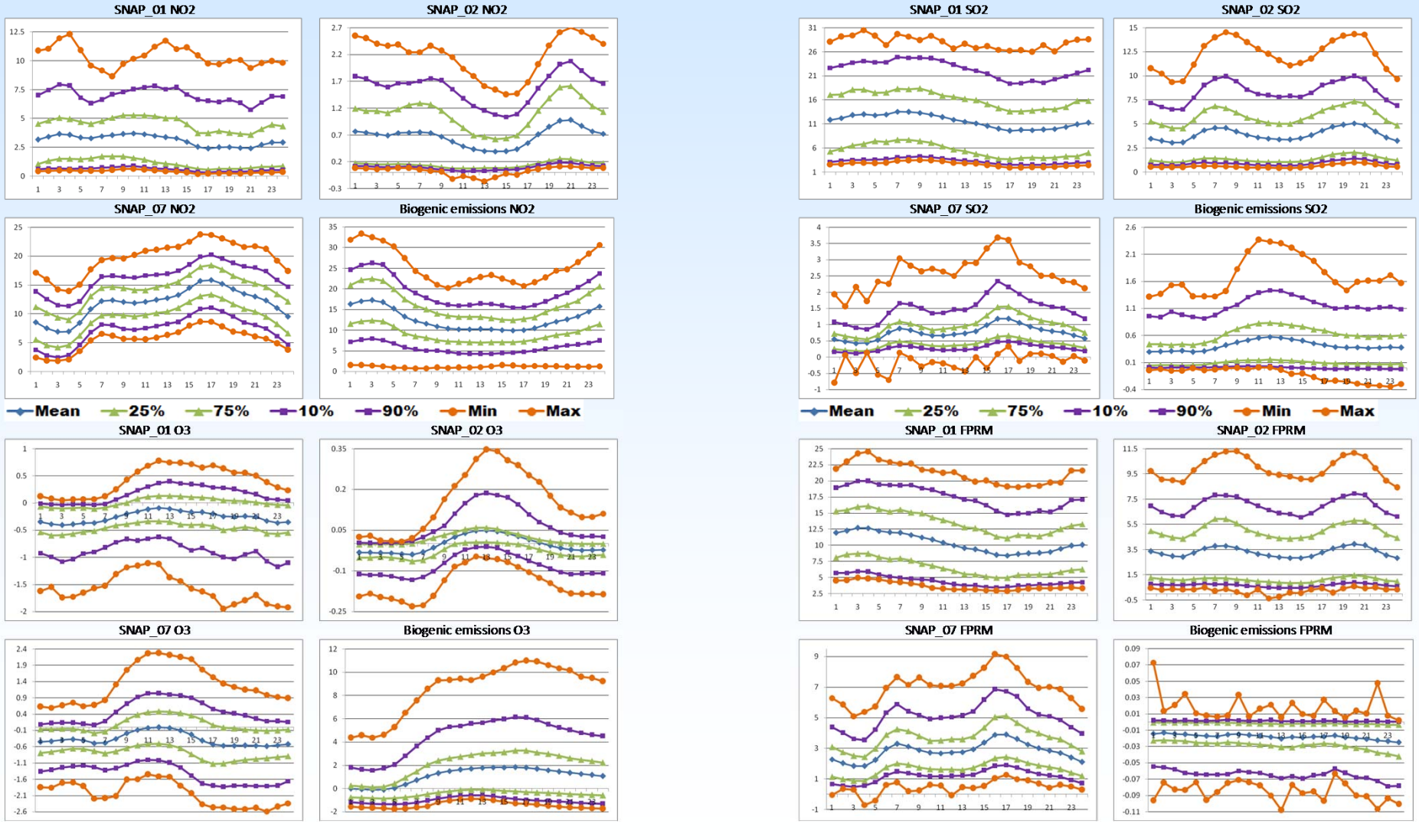
Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions for Sofia



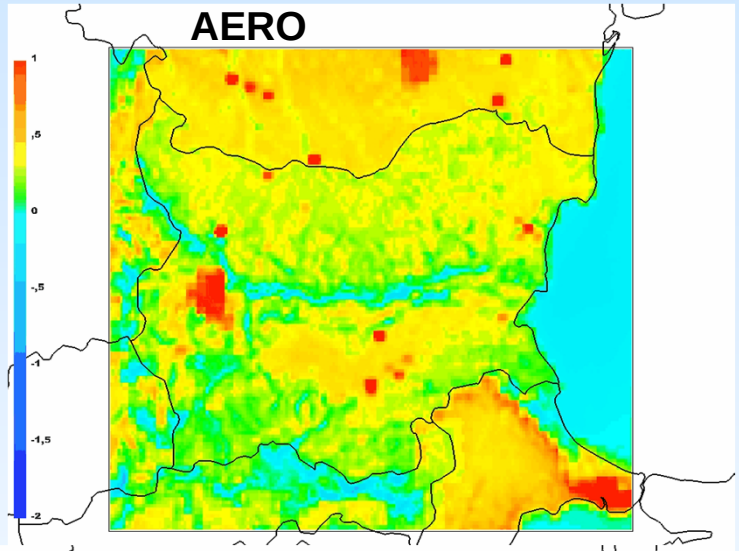
Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions for Rojen

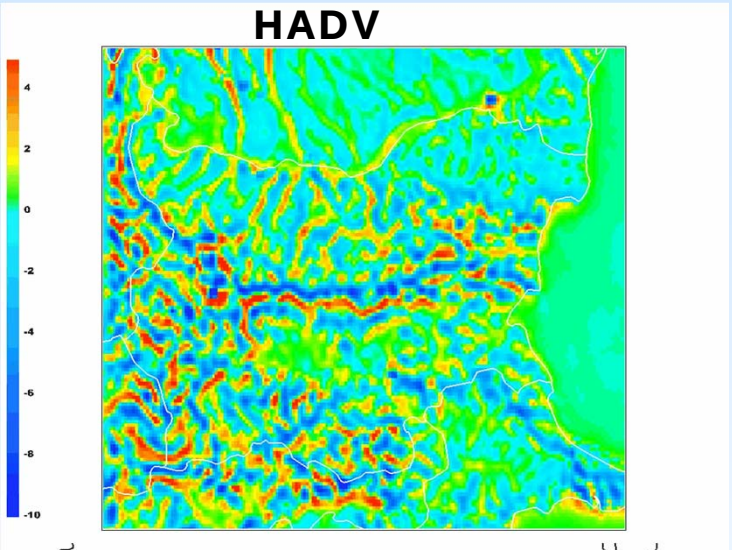


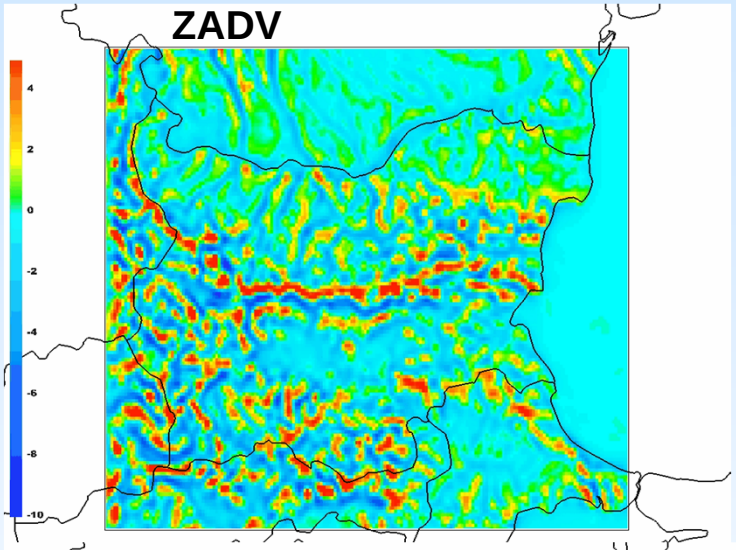
Numerical Study of the Atmospheric Composition in Bulgaria : annual SNAP contributions averaged for Bulgaria

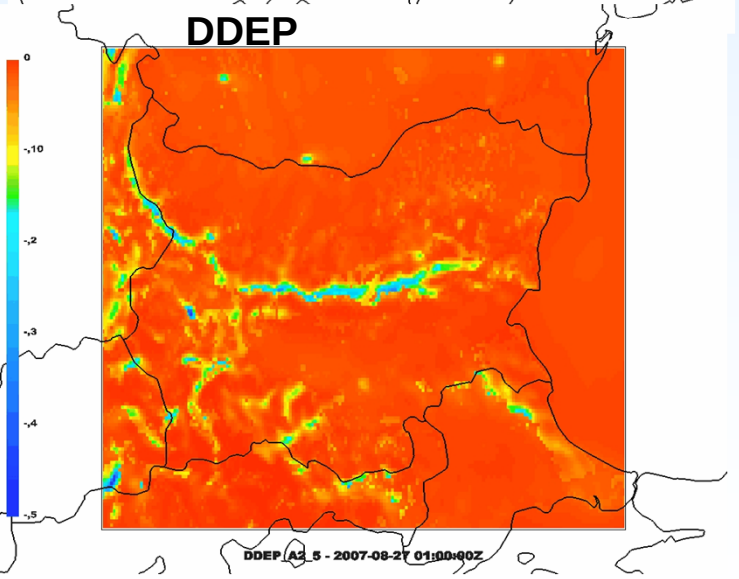


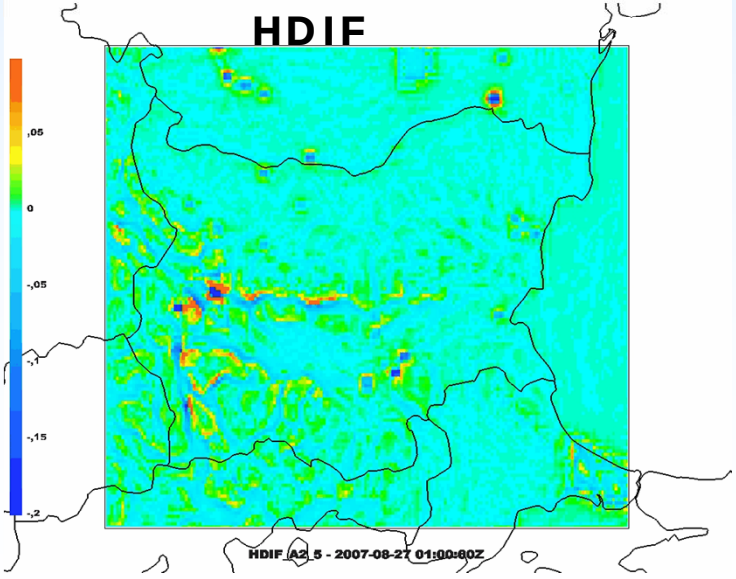
Numerical Study of the Atmospheric Composition in Bulgaria : process contribution to hourly change of PM2.5

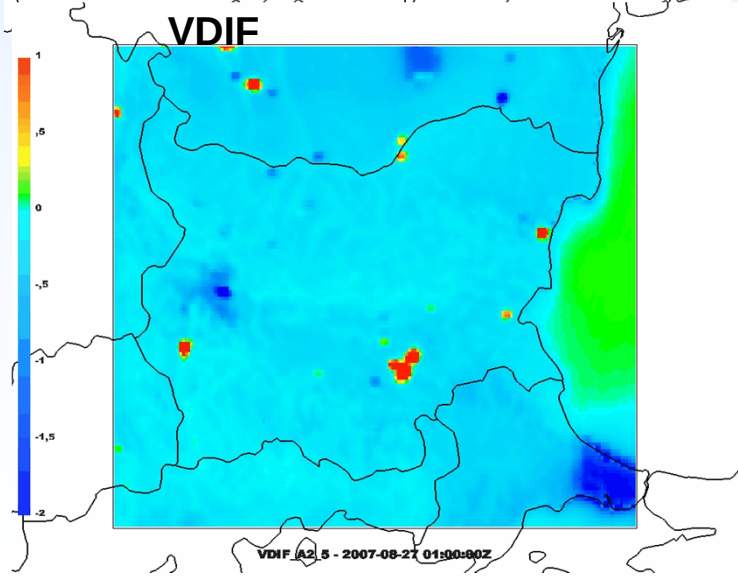












Numerical Study of the Atmospheric Composition in Bulgaria : process contribution to hourly change of SO2

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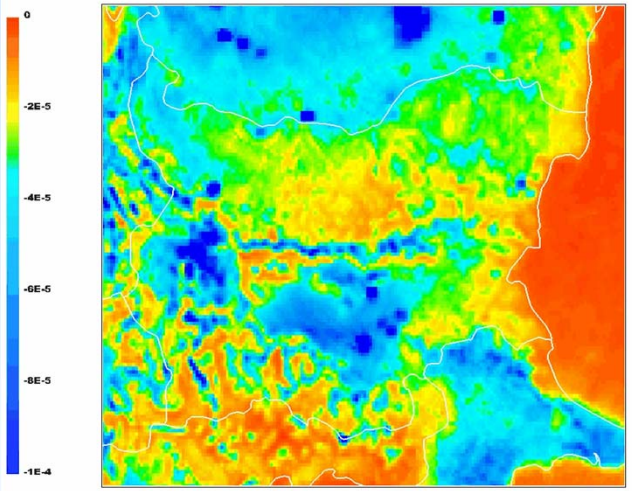

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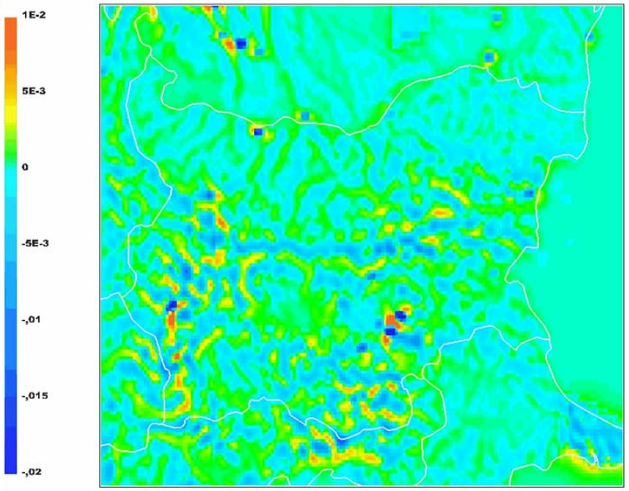

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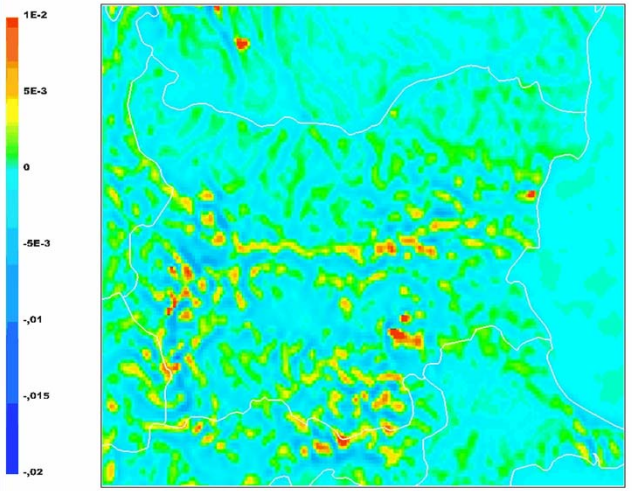

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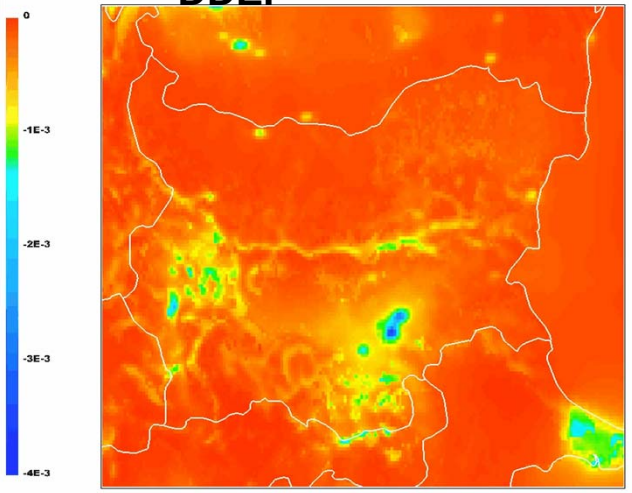

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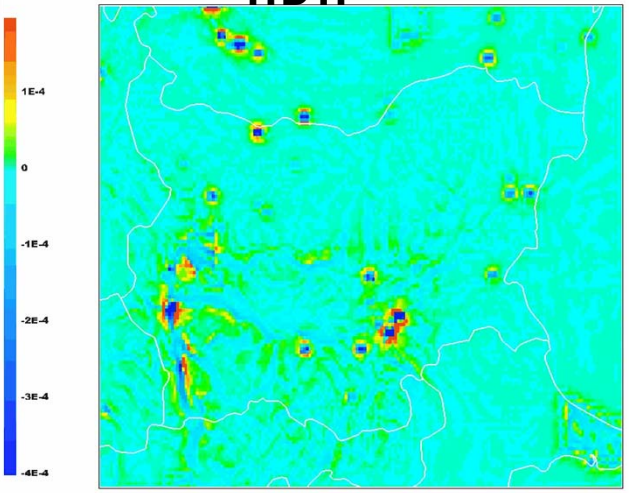

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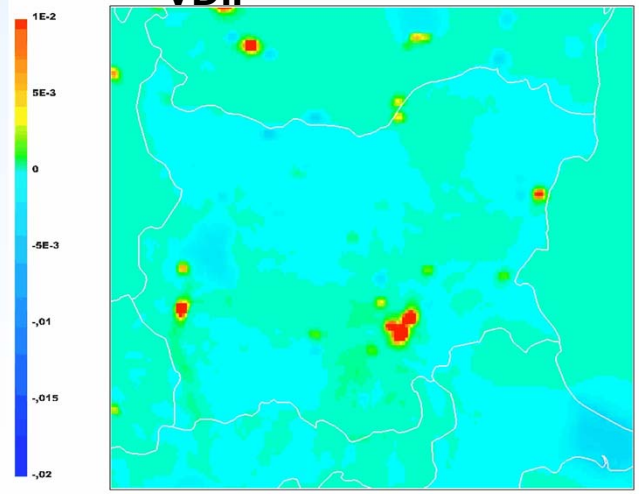

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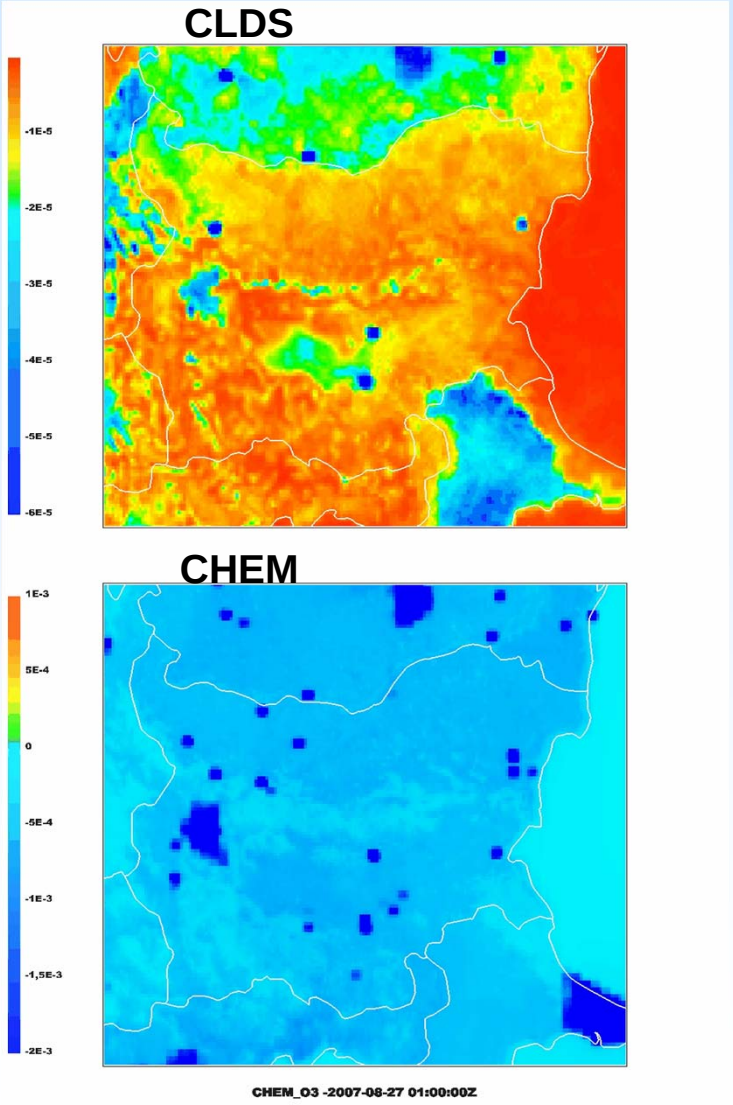
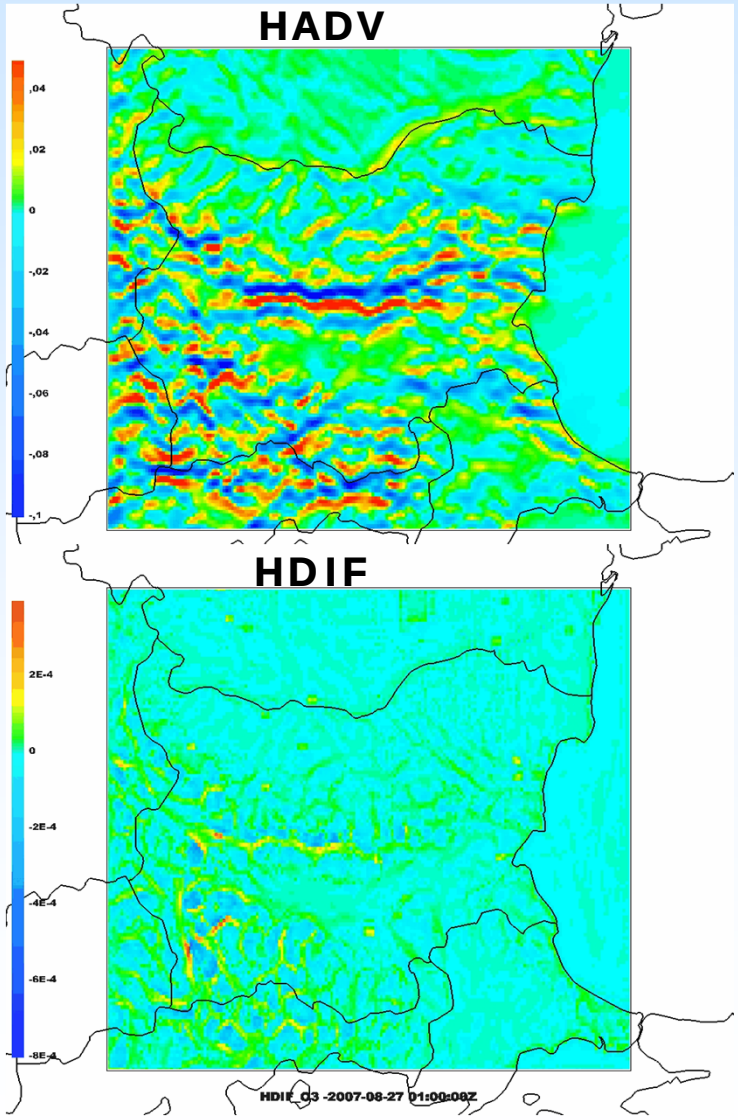
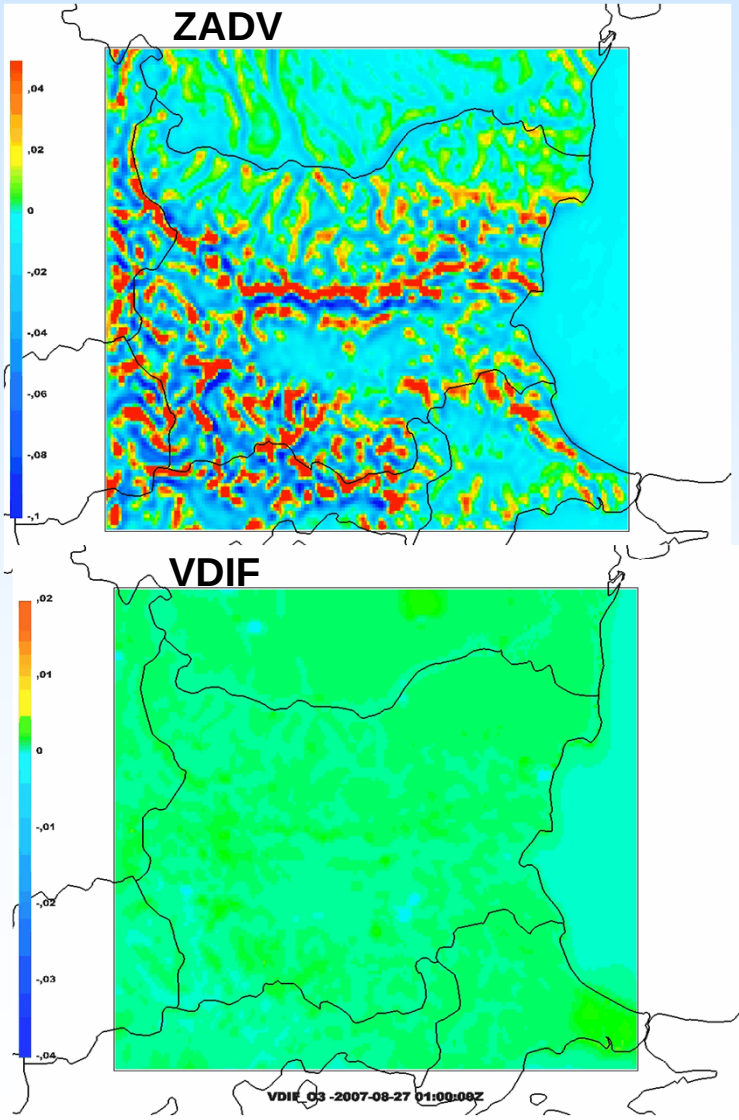
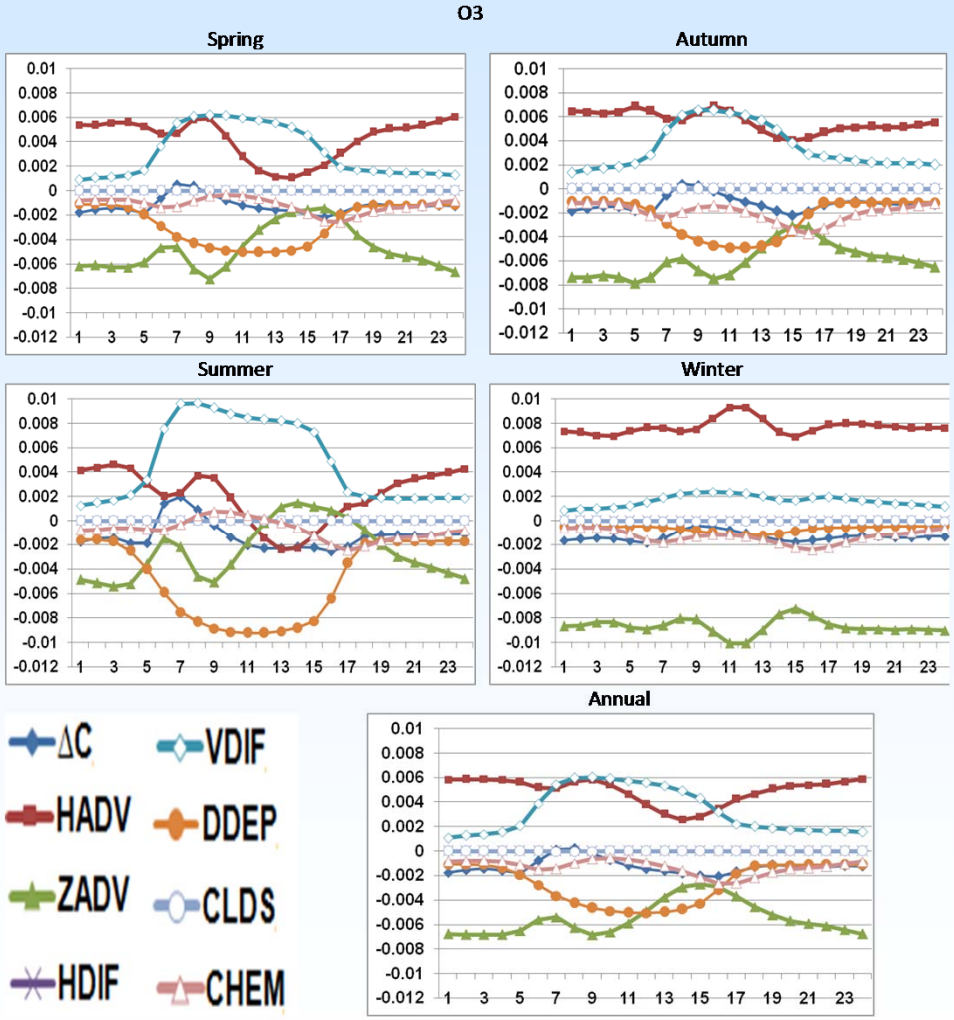
Numerical Study of the Atmospheric Composition in Bulgaria : process contribution to hourly change of O3

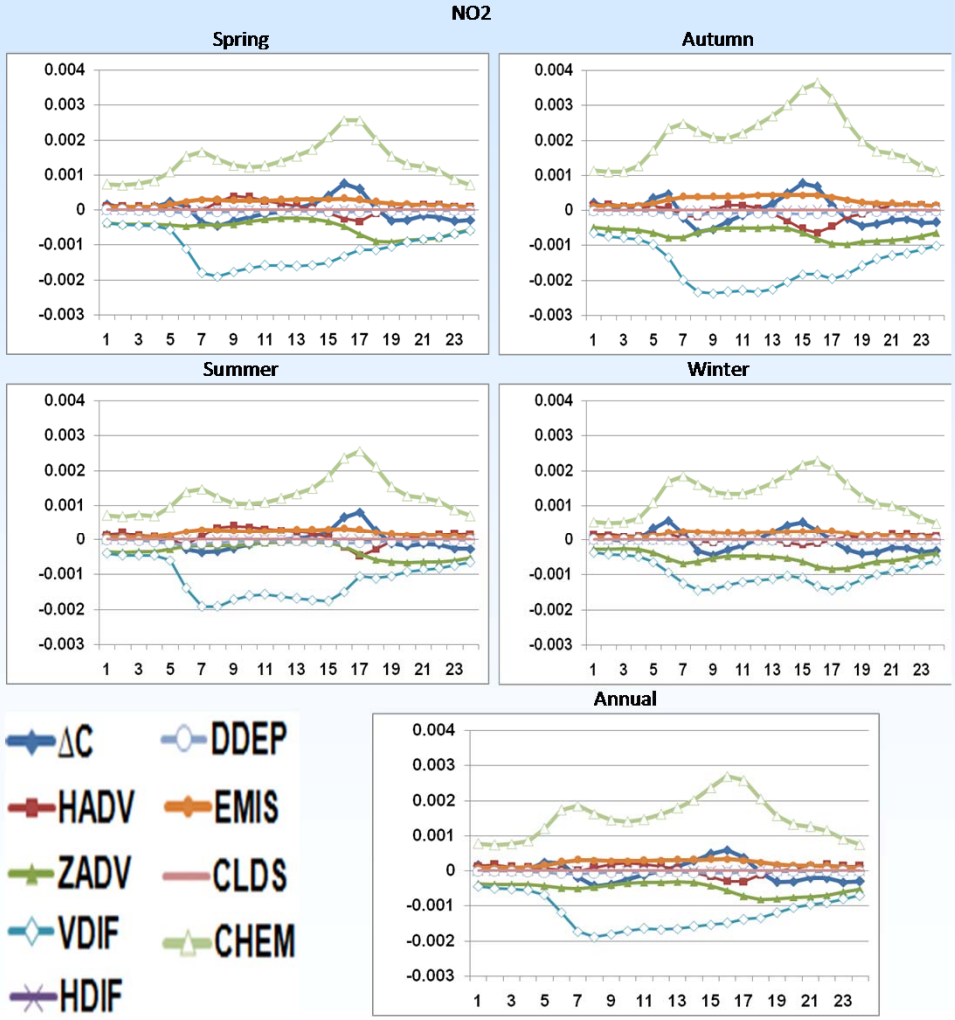




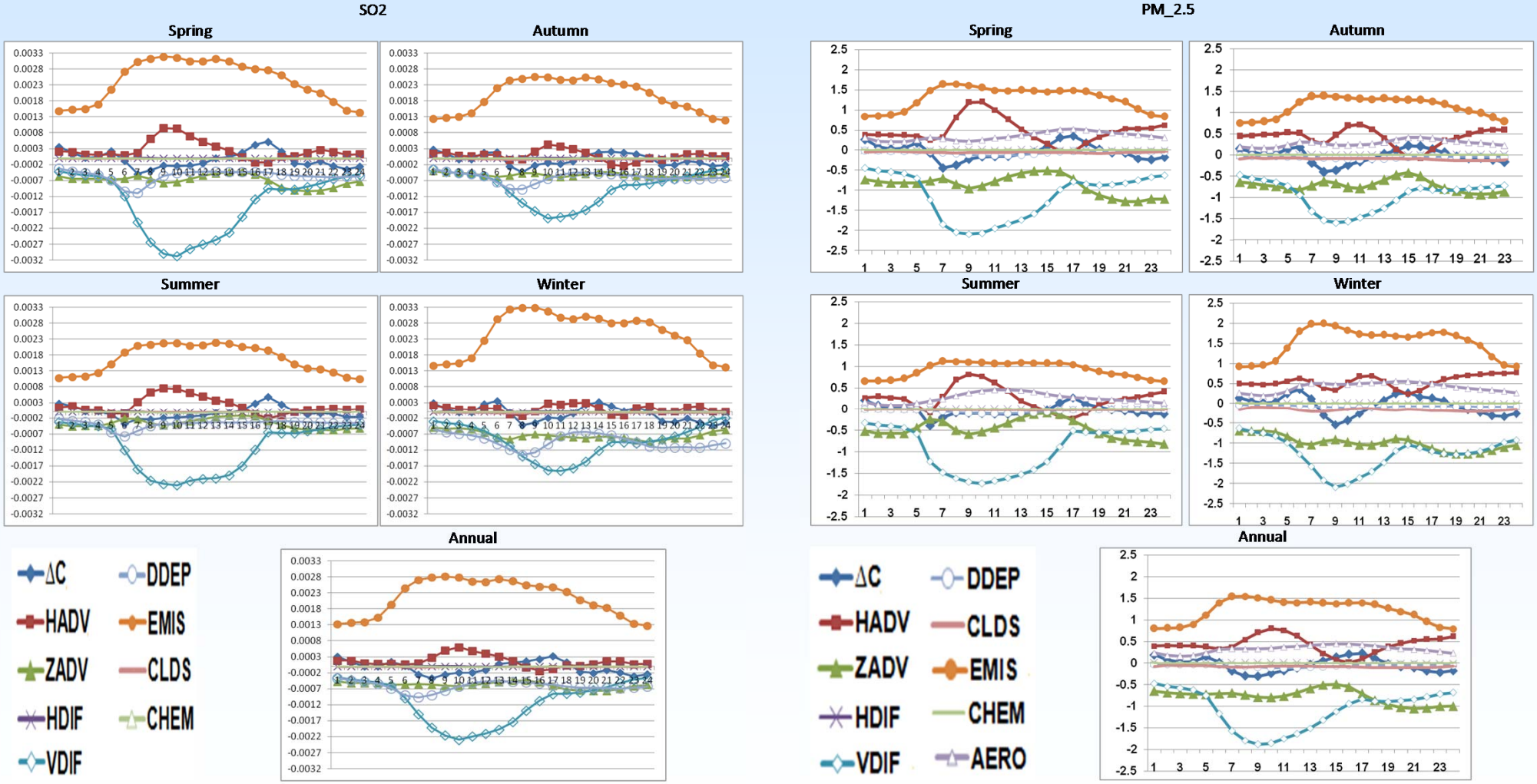


Numerical Study of the Atmospheric Composition in Bulgaria : seasonal variations of process contribution

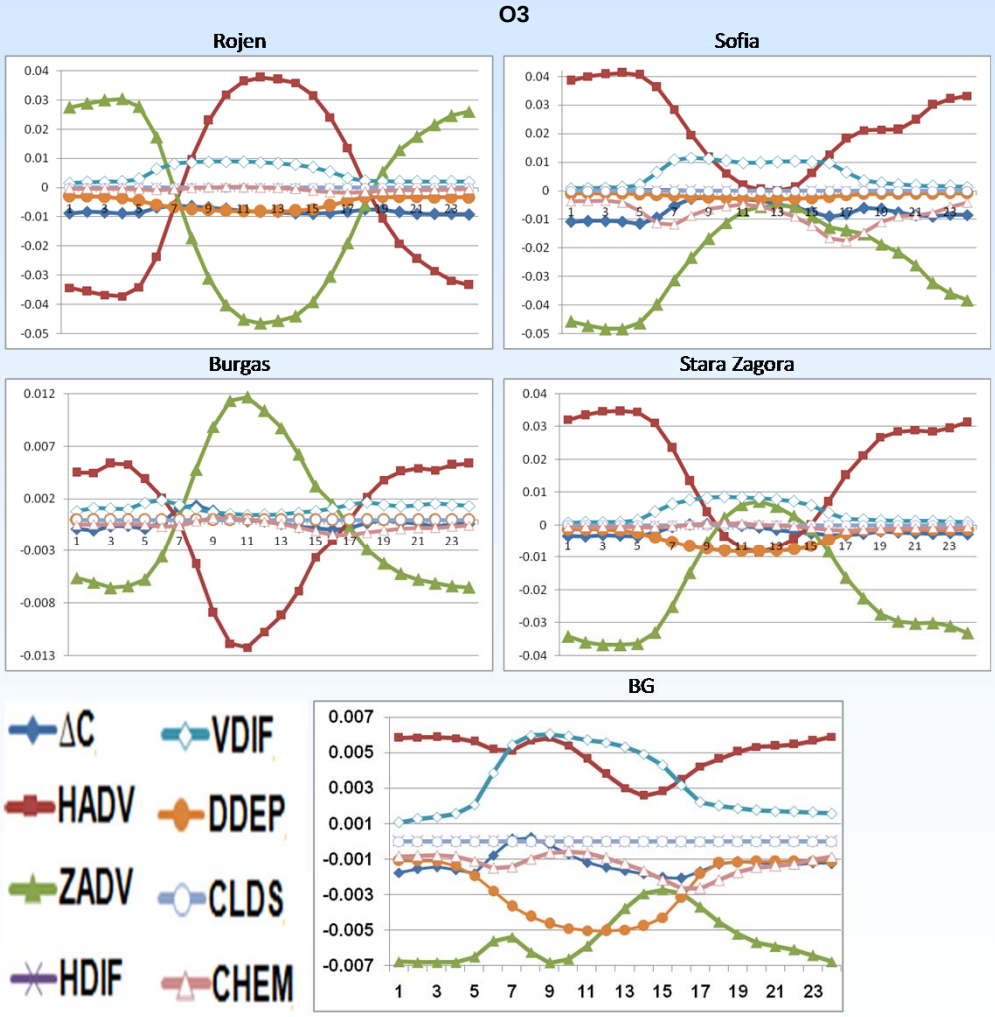


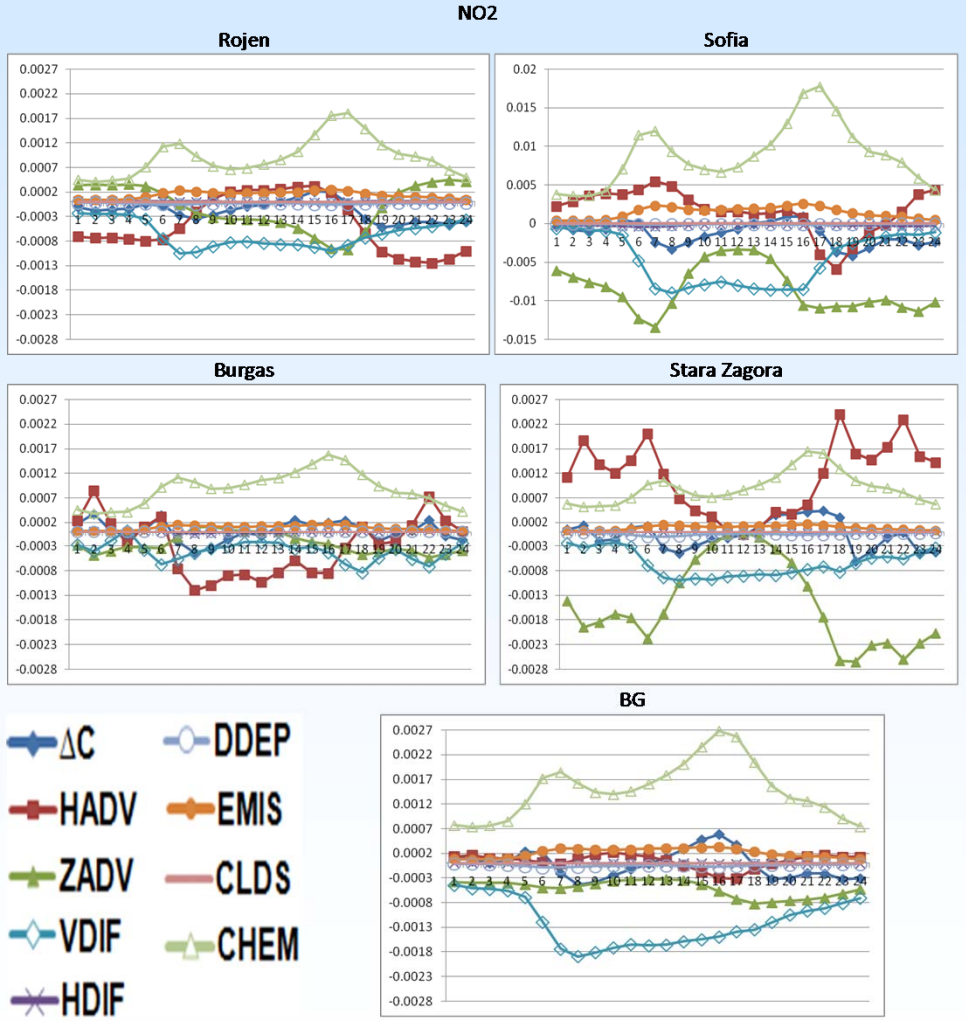


Numerical Study of the Atmospheric Composition in Bulgaria : seasonal variations of process contribution



Numerical Study of the Atmospheric Composition in Bulgaria : geographical variations of process contribution

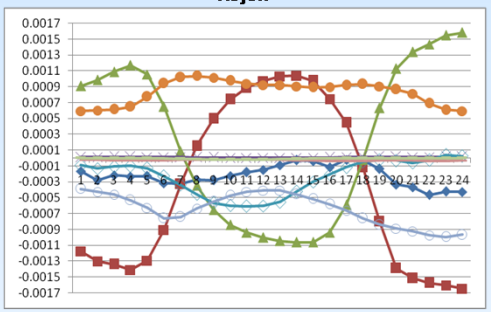




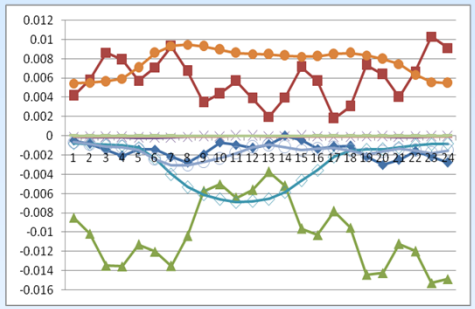
Numerical Study of the Atmospheric Composition in Bulgaria : geographical variations of process contribution

SO2

Rojen



Sofia



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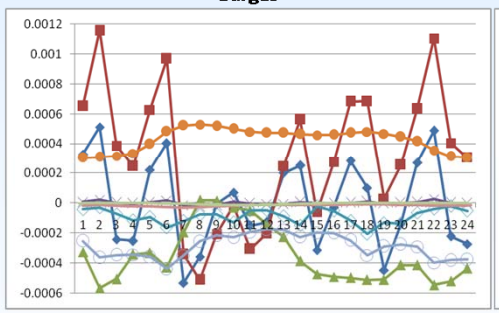
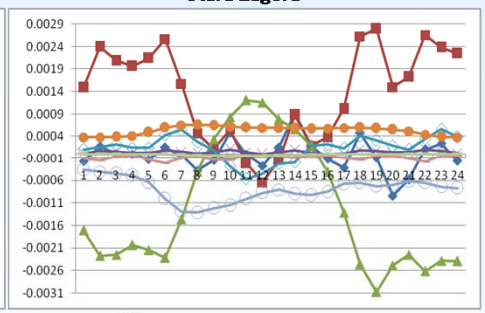


Stara Zagora



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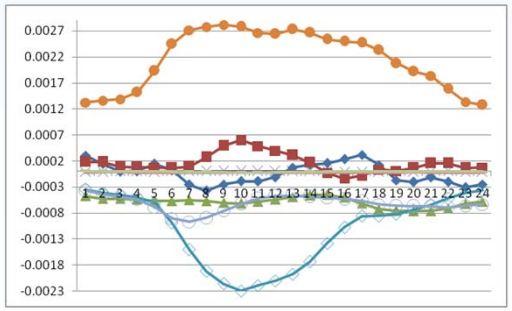
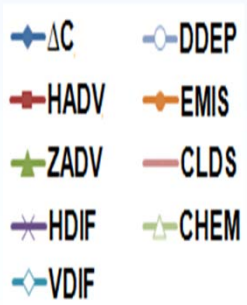
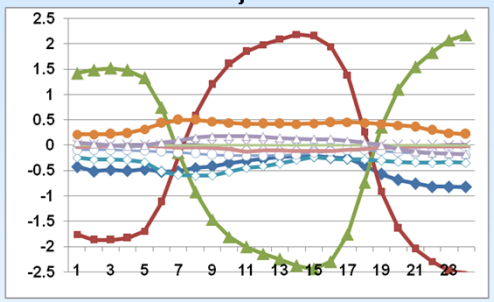


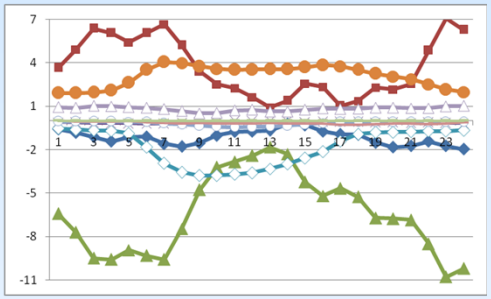


PM2.5

Rojen



Sofia



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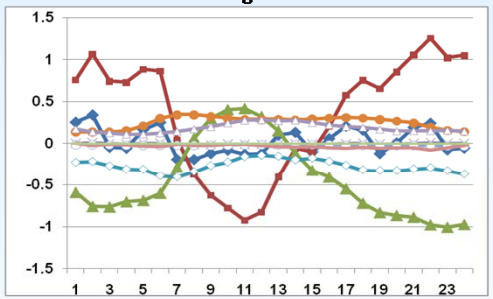
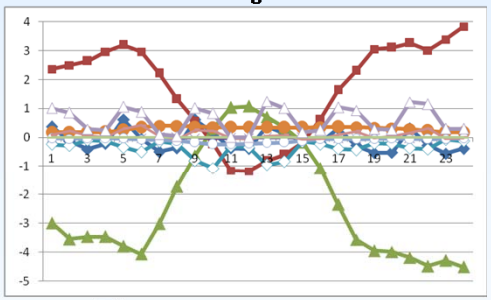


Stara Zagora



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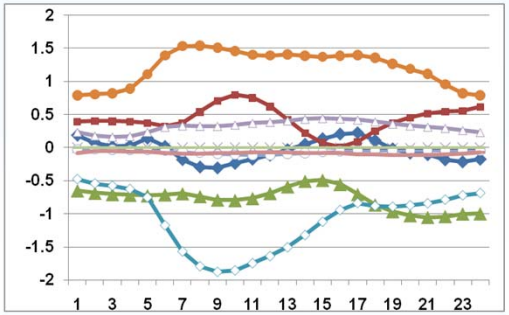

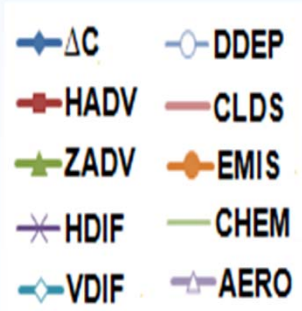

Numerical Study of the Atmospheric Composition in Bulgaria : completed / future tasks

- ***Completed:*** Extensive simulations were carried out and a atmospheric composition data base was created with 3 km horizontal resolution (5 emission scenarios);
- ***Completed:*** Statistical evaluations of the ensemble (probability distribution density, dispersion, skewness, etc.);
- ***Pending:*** Downscaling the simulations to 1 km distribution for selected regions (probably Sofia);
- ***Pending:*** Additional estimations: Air Quality and Discomfort Indexes;