ABSTRACTS

of the scientific publications submitted by Assoc. Prof. Dr. Emilia Venkova Georgieva for participation in the competition for academic position „Professor“ in professional field 4.4. Earth Sciences (scientific specialty Meteorology), at group „Air pollution modelling“, Department of Meteorology, National Institute of Meteorology and Hydrology, announced in State Gazette No.103 of 10.12.2021

Group/№	Type of publication, authors, title, publisher, doi /ISBN/ISSN, abstract
	Publications in group B (Bulgarian version “B”)
1.	Georgieva E., Syrakov D., Atanassov D., Spassova T., Dimitrova M., Prodanova M., Veleva B., Kirova H., Neykova N., Neykova R., Hristova E., Petrov A. (2021) Use of Satellite Data for Air Pollution Modelling in Bulgaria. *Earth.* 2(3), 586-604. https://doi.org/10.3390/earth2030034 Air pollution continues to be of concern for Bulgarian cities, mainly due to particulate matter of aerodynamic diameter smaller than 10 μm (PM10). There is public and expert interest in the improvement of two operational air quality modelling systems: the Bulgarian Chemical Weather Forecast System (BgCWFS) and the Local Air Quality Management System (LAQMS) for the city of Plovdiv. The aim of the study is to investigate the effects of satellite data assimilation in BgCWFS on surface concentrations over Bulgaria (resolution 9 km), to downscale BgCWFS output to LAQMS (resolution 250 m), and to examine effects on PM10 in Plovdiv. Data from the Global Ozone Monitoring Experiment-2 (GOME-2) (MetOP satellites) for aerosols, nitrogen dioxide (NO2), and sulphur dioxide (SO2) were assimilated in BgCWFS using objective analysis. Simulation experiments with and without satellite data were conducted for a summer and a winter month. The comparison to surface observations in the country showed improvement of results when using satellite data, especially in the summer due to mineral dust events captured by satellites. The decrease in the normalized mean bias (NMB) over the two months was 43% (PM10) and 73% (SO2). The LAQMS estimated background contributions to PM10 in the city as 32%. The absolute NMB by LAQMS decreased by 38%.
2.	Oruc I., Georgieva E., Hristova E., Velchev K., Goksel D., Akkoyunlu B.O. (2021) Wet Deposition in the Cross-Border Region between Turkey and Bulgaria: Chemical Analysis in View of Cyclone Paths. *Bull Environ Contam Toxicol* 106 (5), 812–818, https://doi.org/10.1007/s00128-021-03210-x The aim of this work is to study precipitation chemistry in the cross-border region between Turkey and Bulgaria, situated on the south-eastern part of the Balkan Peninsula. A total of 115 wet deposition samples were collected and analysed for pH values and major ions (Na^+, Mg^{2+}, Ca^{2+}, K^+, NH_4^+, Cl^-, NO_3^-, and SO_4^{2-}) throughout the summer and autumn seasons of 2014. The enrichment factor analysis and non-sea salt estimates were conducted to determine the possible sources of ions in the wet deposition for the sampling period. The trajectories of the cyclones affecting the area during the study period were also analysed by separating them in different groups. The minimum, average and maximum pH values for the first group of cyclones (CG1) are 4.30, 6.04, 7.40, and 4.00, 6.14, 7.43 for the second group cyclones (CG2), respectively. The non-sea salt fractions of the K^+ ion were found to be 0.94 in CG1 and 0.90 in CG2. Also, the Mg^{2+} ion in CG1 and CG2 is 44% and 60% of the sea salt source.
3.	Georgieva E., Hristova E., Syrakov D., Prodanova M., Batchvarova E. (2018) Preliminary Evaluation of CMAQ Modelled Wet Deposition of Sulphur and Nitrogen

	over Bulgaria, *Int. J. of Environ. and Pollution*, 64, (1/3), 161-177. doi: 10.1504/IJEP.2018.099158 Wet depositions of sulphur and nitrogen over Bulgaria have been simulated by the WRF-CMAQ system for the period from March to June 2016. Precipitation amounts have been overestimated – the average NMB is 44% for the country and 70% for Sofia. Precipitation chemistry data from Sofia have been used for the estimation of observed sulphur and nitrogen depositions – 602 $mg.m^{-2}$, and 528 $mg.m^{-2}$, respectively. Modelled wet depositions show overestimation, more significant for sulphur deposition (NMB 87%). Precipitation adjustment has been applied as post-processing to model wet depositions. The correction led to decrease in NMB for S wet deposition (9%), while N-monthly depositions were in general underestimated. Possible effects of long-range transport for Sofia have been discussed for two selected periods of a few days.
4.	Monteiro A., Durka P., Flandorfer C., Georgieva E., Gueirreiro C., Kushta J., Malherbe L., Maiheu B., Miranda A.I., Santos G., Stocker J., Trimpeneers E., Tognet F., Stortini M., Wesseling J., Janssen S., Thunis Ph. (2018) Strengths and weaknesses of the FAIRMODE benchmarking methodology for the evaluation of air quality models, *Air quality, atmosphere and health*, 11, 373-383, doi: 10.1007/s11869-018-0554-8 The Forum of Air Quality Modelling in Europe (FAIRMODE) was launched in 2007 to bring together air quality modellers and users in order to promote and support the harmonised use of models by EU Member States, with emphasis on model application under the European Air Quality Directive. In this context, a methodology for evaluating air quality model applications has been developed. This paper presents an analysis of the strengths and weaknesses of the FAIRMODE benchmarking approach, based on users' feedback. European wide, regional and urban scale model applications, developed by different research groups over Europe, have been taken into account. The analysis is focused on the main pollutants under the Air Quality Directive, namely PM_{10}, NO_2 and O_3. The different case studies are described and analysed with respect to the methodologies applied for model evaluation and quality assurance. This model evaluation intercomparison demonstrates the potential of a harmonised evaluation and benchmarking methodology. A SWOT analysis of the FAIRMODE benchmarking approach is performed based on feedback from users of the tool. This analysis helps to identify the main advantages and value of this model evaluation benchmarking approach compared with other methodologies, in addition to highlighting requirements for future development.
5.	Syrakov D., Prodanova E., Georgieva E., Etropolska I., Slavov K. (2016) Simulation of European air quality by WRF–CMAQ models using AQMEII-2 infrastructure, *Journal of Computational and Applied Mathematics*, 293, 232-245, ISSN 0377-0427, doi:10.1016/j.cam.2015.01.032 The air quality modelling system WRF–CMAQ was applied to the European domain for the year 2010 in the frame of the Air Quality Model Evaluation International Initiative (AQMEII), Phase 2. The model system was set up for a domain of 5000 × 5000 km^2 size with horizontal resolution of 25km. The emissions at European level were available through AQMEII and further processed in a way to feed the chemistry transport model CMAQ. The meso-meteorological model WRF was driven by NCEP GFS data with 1°×1° resolution. The chemical boundary conditions were extracted from MACC global simulation data. Model performance was investigated by means of AQMEII-2 web based evaluation platform and the monitoring data gathered for this activity. A preliminary model evaluation for ozone, nitrogen dioxide and particulate matter was conducted. The statistical analysis was based on comparison between simulated and observed concentrations at different type of surface stations in the EU wide domain (rural, urban, suburban), as well as for selected four cities. Model performance was characterized by overestimation for ozone and underestimation for the

	other pollutants. The relative statistical indicators were discussed also in view of recently published performance criteria.
6.	Syrakov D., Prodanova M., Georgieva E. (2015) Performance of the Bulgarian WRF-CMAQ modelling system for three subdomains in Europe, *Física de la Tierra*,27,137-153,ISSN:0214-4557, doi: 10.5209/rev_FITE.2015.v27.51197 The air quality modelling system WRF-CMAQ running at the National Institute of Meteorology and Hydrology (NIMH) in Sofia was applied to the European domain for the year 2010 in the frame of the Air Quality Model Evaluation International Initiative (AQMEII), Phase 2. The model system was set up for a domain of 5000x5000 km^2 size with horizontal resolution of 25 km. The models' options used and the emission input are briefly outlined. The model performance was investigated based on graphical plots and statistical indexes obtained by the web-based model evaluation platform ENSEMBLE. A preliminary operational model evaluation for ozone and particulate matter was conducted, comparing simulated and observed concentrations at ground level in three sub-domains of Europe. The analysis shows model overestimation for ozone and model underestimation for particulate matter. The best statistical indicators are for ozone concentrations during summer, when comparing data for EMEP stations in the EU domain. The worse results are for PM10 winter concentration in the region of the Balkan countries.
7.	Georgieva E., Syrakov D., Prodanova M., Etropolska I., Slavov K. (2015) Evaluating the performance of WRF-CMAQ air quality modelling system in Bulgaria by means of the DELTA tool, *Int. J. of Environ and Pollution*, 57, 272 – 284, doi:10.1504/IJEP.2015.074512 Model evaluation is performed based on comparison of simulated and observed air pollution concentrations at 25 background stations of the Bulgarian national air quality monitoring network for the year 2013. The DELTA software package, developed within the forum for air quality modelling in Europe – FAIRMODE, is used to analyse model results focusing on maximum daily eight-hour mean ozone (O_3) concentrations, hourly nitrogen dioxide (NO_2) and daily particulate matter (PM_{10}) concentrations. Ozone is overestimated by 38%, minimum daily values are overestimated by a factor of 3. NO_2 and PM_{10} are underestimated by a factor of, respectively, 4 and (5 to 9). The main DELTA model quality objective is respected at 26% of the stations for ozone, 58% of the stations for NO_2, and nowhere for PM_{10}. The best model performance is for ozone at rural sites during summer. Possible ways for improvement of model results are discussed.
8.	Miglietta M.M., Thunis P., Pederzoli A., Georgieva E., Bessagnet B., Terrenoire E., Colette A. (2012) Evaluation of WRF model performances in different European regions with the DELTA-FAIRMODE evaluation tool, *Int. J. of Environ. and Pollution*, 50, 83-97. doi:10.1504/IJEP.2012.051183 051183 One-year (2006) WRF model simulations performed at a European scale and ECMWF-IFS forecasts are compared with 10 m wind speed and 2 m temperature observations from around 1,200 surface stations. A statistical evaluation on the modelled meteorological fields is performed using the DELTA software, developed in the framework of FAIRMODE, the forum for air quality modellers relevant to the application of the European Air Quality Directive. In terms of wind speed, ECMWF forecasts are pretty good over most of the domain, while WRF model simulations are less skilful, e.g., they show a larger bias and RMSE. Regarding 2 m temperature, performance criteria are better satisfied by both modelling systems. Finally, the models' statistics are exemplified in a couple of specific areas: near Berlin, one of the urban areas showing a better model performance, and in the Alpine region, where the model skill is very poor.

9.	Pederzoli A., Thunis Ph., Georgieva E., Borge R., Carruthers D., Pernigotti D. (2012) Performance criteria for the benchmarking of air quality model regulatory applications: the TARGET approach, *Int. J. of Environ and Pollution*, 50, 175-189. doi:10.1504/IJEP.2012.051191 The definition of appropriate performance criteria is one of the key issues for the benchmarking of air quality models in regulatory applications. As part of the FAIRMODE benchmarking activities (Thunis et al., 2010), suitable criteria for air quality modelling in the frame of the EU air quality directive (AQD) 2008 are proposed and tested. The suggested approach builds on the target indicator (Jolliff et al., 2009) as support to the relative directive error, the current official statistical parameter as defined in the AQD (EEA, 2011), for quantitatively estimating model performances in air quality modelling applications. This study describes the advantages of using the target compared to the actual limitations of RDE and addresses the main links between the target and some 'traditional' statistical indicators (MFB, R, FAC2, σ). It also describes the application of this methodology to NO2, O3 and PM10 concentrations on three different model-observations datasets. Among these datasets two focus on the urban areas of Madrid and London and include modelled results provided by the air quality models CMAQ and ADMS-Urban for years 2007 and 2008 respectively. One other dataset (POMI) covering the Po valley and including multiple model results has also been tested for year 2005.
10.	Thunis P., Georgieva E., Pederzoli A. (2012) A tool to evaluate air quality model performances in regulatory applications, *Environmental Modelling & Software*, 38, 220-230. https://doi.org/10.1016/j.envsoft.2012.06.005 This paper describes the details of the DELTA Tool and Benchmarking service for air quality models, recently developed in the framework of FAIRMODE (Forum for Air Quality Modelling in Europe). One of the main objectives of the FAIRMODE activities is the development of a procedure for the evaluation and benchmarking of air quality modelling applications for regulatory purposes. The DELTA Tool is a specific software which provides summary statistics (i.e. BIAS, RMSE, correlation coefficient) as well as scatterplots, time series plots, Taylor, Target and other diagrams providing an overview of the quality of model results with respect to monitored data. Moreover, the benchmarking service implemented in DELTA produces summary reports containing performance indicators related to a given model application in the frame of the EU Air Quality Directive (AQD, 2008). This work describes the structure of the DELTA tool and template for reporting model performances. Some examples of application are also briefly presented.
11.	Pernigotti D., Georgieva E., Thunis P., Bessagnet B (2012) Impact of meteorology on air quality modelling over the Po valley in northern Italy, *Atmospheric Environment*, 51, 303-310. doi:10.1016/j.atmosenv.2011.12.059 A series of sensitivity tests has been performed using both a mesoscale meteorological model (MM5) and a chemical transport model (CHIMERE) to better understand the reasons why all models underestimate particulate matter concentrations in the Po valley in winter. Different options are explored to nudge meteorological observations from regulatory networks into MM5 in order to improve model performances, especially during the low wind speed regimes frequently present in this area. The sensitivity of the CHIMERE modelled particulate matter concentrations to these different meteorological inputs are then evaluated for the January 2005 time period. A further analysis of the CHIMERE model results revealed the need of improving the parametrization of the in-cloud scavenging and vertical diffusivity schemes; such modifications are relevant especially when the model is applied under mist, fog and low stratus conditions, which frequently occur in the Po valley during winter. The sensitivity of modelled particulate matter concentrations to turbulence parameters, wind, temperature and cloud liquid

	water content in one of the most polluted and complex areas in Europe is finally discussed.
	Publications in group G7 (Bulgarian version "Г7")
1.	Velchev K., Georgieva E. (2022) Ground level ozone at the southern Bulgarian Black Sea coast for a typical summer month, In: Baiba Rivza (Ed.) *Proceedings of the 21-st Intern Scientific GEoConference on Earth and Planetary Sciences (SGEM2021*), 14-22.08.2021, Albena, Bulgaria, ISSN 1314-2704 pp. 391-398. doi: 10.5593/sgem2021/4.1/s19.50 Ground level ozone (O_3) is a photochemical pollutant with harmful effects on human health, vegetation and ecosystems. The focus of this work are ozone data measured at the synoptic station Ahtopol, a rural site at the southern Bulgarian Black Sea coast. The surrounding area is without big anthropogenic sources of air pollution, rich in biodiversity and protected zones by NATURA2000. From our summer campaigns data collected during the last years, we have selected for analysis July 2018 – a summer month with well-expressed breeze circulations and diurnal ozone cycle. 1-hourly O_3 concentrations are in the range from 10-15 μgm^{-3} to 120-140 μgm^{-3}. The monthly mean values at Ahtopol are 66.5 μgm^{-3}, with a maximum daily 8-h averaged concentrations of 107.1 μgm^{-3}. These values are higher than at the 2 regulatory urban air quality stations located at the coast 70-90 km northward of Ahtopol – Burgas (monthly mean 65.8 μgm^{-3}) and Nessebar (monthly mean 59.3 μgm^{-3}). We discuss the time evolution of O_3 and meteorological parameters (wind, temperature) at Ahtopol during the month and analyse the mean diurnal ozone cycle at the three sites. Values above 90 μgm^{-3} in Ahtopol extent from 11:00 to 16:00 LT and are linked to well-developed breeze circulation with winds from the sea at about 4-5 ms^{-1}. The maximum daily 8-h averaged ozone concentrations has highest value of 107.15 μgm^{-3}, and for four days in middle of the month is above the 100 μgm^{-3} guideline value of the World Health Organization with regard to negative impact of ozone on human health. Limit EU values at the three coastal sites were not exceeded.
2.	Georgieva E., Kirova H., Hristova E. (2022) Atmospheric dry depositions in the southern Bulgarian Black Sea coastal area during summer. In: Baiba Rivza (Ed.*) Proceedings of the 21-st Intern Scientific GEoConference on Earth and Planetary Sciences (SGEM2021*), 14-22.08.2021, Albena, Bulgaria, ISSN 1314-2704 pp. 303-310. doi: 10.5593/sgem2021/4.1/s19.39 The southern part of the Bulgarian Black Sea coast is characterized by numerous nature protected areas with high biodiversity, picturesque seashore landscapes and small villages that attract many tourists in summer. Despite the fact that the region is distant to big emission sources of anthropogenic pollution, air pollution and deposition can be significant for specific pollutants and seasons [1-2]. The main goal is to discuss recent data for dry depositions of oxidized nitrogen, reduced nitrogen and sulphur for the months of June, July and August of 2018, based both on field campaigns data and modelling results. The chemical analysis of atmospheric dry deposition samples, collected on monthly basis at the synoptic station Ahtopol, indicate prevalence of the chloride anion - 29% in July and 49% in August. Other abundant elements are sulphates, with share of 23% (July) and 8% (August), and nitrates – respectively 16% and 12%. The observational data are discussed in comparison to results of the EMEP MSC-W chemical transport model [3], applied by the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe for assessment of European air pollution policy. The modelled dry depositions at Ahtopol for the three summer months have highest values in August: oxidised nitrogen deposition 14.5 mgm^{-2}, reduced nitrogen deposition 10.9 mgm^{-2} and sulphur deposition 9.3 mgm^{-2}. The highest underestimation by the model is for the sulphur deposition in August – 60%, while the highest overestimation, by a factor of about 4, is for the reduced

	nitrogen in August. Some comparison to data from other campaigns and from the literature is also provided.
3.	Syrakov D., Prodanova M., Georgieva E. (2021) Effects of Satellite Data Assimilation in Air Quality Modelling in Bulgaria. In: Dobrinkova N., Gadzhev G. (eds) Environmental Protection and Disaster Risks. EnviroRISK 2020. *Studies in Systems, Decision and Control*, 361, 3-18. Springer, Cham. https://doi.org/10.1007/978-3-030-70190-1_1 The operational Bulgarian Chemical Weather Forecast System (BgCWFS) was modified and applied for assimilation of satellite retrieved atmospheric chemistry parameters - Aerosol Optical Depth (AOD) and columnar values of NO_2 and SO_2. The work outlines the methodology based on calculation of correction factors between model estimated and assimilated satellite derived parameters. Simulations by two versions of the system were performed for two months (August 2017 and February 2019) for all 5 domains of BgCWFS. The first version, *mod-run*, is without satellite data assimilation, the second one, *sat-run* assimilates satellite data. The effects of the assimilation is demonstrated for different pollutants analysing the difference between the results of the two versions on particular days in different model domains and as domain mean values for the Balkan Peninsula and for Bulgaria. The domain mean monthly particulate matter concentrations increase by more than 100% in summer and by about 50% in winter. The increase in the domain mean monthly SO_2 concentrations is about 110% in summer and 130% in winter.
4.	Kirova H., Neykova N., Georgieva E. (2021) Performance of Operational Chemical Transport Models for Particulate Matter Concentrations in Bulgaria. In: Dobrinkova N., Gadzhev G. (eds) Environmental Protection and Disaster Risks. EnviroRISK 2020. *Studies in Systems, Decision and Control*, vol 361,107-122, Springer, Cham. https://doi.org/10.1007/978-3-030-70190-1_8 The main objective of this study is to evaluate the performance of some well-known and widely used operational air quality modelling systems (EMEP-MSC-W, and the models at the Copernicus Atmosphere Monitoring Service (CAMS)) for simulations of ground-level particulate matter in Bulgaria. The analysis is focused on two months—a summer one (August 2017) and a winter one (February 2019). The comparison of models to observations from regular air quality background stations is based on statistical indicators and various plots (box plots, kernel density estimations, and scatter plots). The EMEP and CAMS regional models underestimate the observed concentrations, on average by about 50% for PM_{10} and by about 22% for $PM_{2.5}$. These models perform better at a rural remote (mountain) site than at urban background stations indicating that the outputs of the models could be used for indicative values of PM background concentrations. The model inter-comparison consists of an analysis of the spatial distribution of monthly mean concentrations and values for domain averaged model concentrations. The CAMS global model simulates in summer different spatial distribution due to the assimilation of satellite data providing information for dust storms and wildfires.
5.	Georgieva E., Hristova E., Veleva B. (2021) Precipitation Chemistry in Bulgaria During Saharan Dust Outbreaks. In: Dobrinkova N., Gadzhev G. (eds) Environmental Protection and Disaster Risks. EnviroRISK 2020. *Studies in Systems, Decision and Control*, 361, 263-277, Springer, Cham. https://doi.org/10.1007/978-3-030-70190-1_18 The objective of this work is to investigate the influence of Saharan dust events on the chemical composition of rain samples collected at three sites in Bulgaria during 2017–2018. Saharan dust intrusions were identified through a combination of satellite retrieved aerosol data and results from dust forecasting models and from backward trajectory model. The chemical composition of the samples (acidity pH, conductivity EC, main ions and elements) is analysed in view of the direction of the approaching air

	masses—"direct" influence (south-west), and "indirect" influence from other directions and regions, already impacted by Saharan dust. The samples were characterised by pH from 4.1 to 7.4, elevated values for EC (max 202 μScm^{-1}) and for Si, Ca, Fe, Mg concentrations. For cases with direct influence Si and Ca values were up to 1.5 and 25 mgL^{-1}. In most of the indirect cases increased concentrations of sulphate, nitrate and ammonium were observed (up to 39.5, 23.1 and 8.3 mgL^{-1}).
6.	Hristova E., Veleva B., Velchev K., Georgieva E. (2021) Chemical Characteristics of Precipitation and Cloud Water at High Elevation Site in Bulgaria. In: Dobrinkova N., Gadzhev G. (eds) Environmental Protection and Disaster Risks. EnviroRISK 2020. *Studies in Systems, Decision and Control*, vol 361. pp. 91-106, Springer, Cham. https://doi.org/10.1007/978-3-030-70190-1_7 The aim of this work is to present and discuss newly obtained data for the chemical composition of precipitation (RW) and cloud water (CW) at a high-elevation site in Bulgaria. Sampling of RW and CW was organized in 2017 and 2018 during field experiments at Cherni Vrah, the highest peak in Vitosha Mountain. Passive collectors designed and constructed at NIMH were used. All collected samples (118) were analysed for acidity (pH), conductivity (EC), main anion - SO_4^{2-}, NO_3^-, Cl^-, ammonium ions (NH_4^+), macro and micro elements (Na, K, Mg, Ca, Fe, Si, Zn, Cu). The average pH values for both types of samples were in the acidity range (<5.0). The values of EC varied from 5 to 89.2 μScm^{-1} for RW and from 0.7 to 202 μScm^{-1} for CW. The ion composition was dominated by $nssSO_4^{2-}$, NO_3^-, Ca and NH_4^+ which made up more than 63% of the total ionic content for RW and 75% for CW. The relative contribution of the major compounds to the CW and RW composition is presented and discussed. The volume weighted mean (VWM), fractional acidity and neutralization factor are also calculated. The effect of long-range transport processes is studied for some selected periods of 2018 using HYSPLIT air mass backward trajectory analysis.
7.	Hristova E., Veleva B., Georgieva E., Branzov H. (2020) Application of positive matrix factorization receptor model for source identification of PM10 in the City of Sofia, Bulgaria, *Atmosphere*, 11 (9), art. no. 890, doi: 10.3390/ATMOS11090890 The Positive Matrix Factorization (PMF) receptor model is used for identification of source contributions to PM10 sampled during the period January 2019–January 2020 in Sofia. More than 200 filters were analysed by X-Ray Fluorescence (XRF), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), and Ion chromatography for chemical elements and soluble ions. Seasonal patterns of PM10 mass and elements' concentration are observed with minimum in the summer months and maximum in the cold period. The results from source apportionment (SAP) study showed that the resuspension factor is the main contributor to the total PM10 mass (25%), followed by Biomass burning (BB) (23%), Mixed SO_4^{2-} (19%), Sec (16%), Traffic (TR) (9%), Industry (IND) (4%), Nitrate rich (4%), and Fuel oil burning (FUEL) (0.4%) in Sofia. There are some similarities in relative contribution of the main factors compared to the years 2012–2013. The differences are in identification of the new factor described as mixed sulphate as well as the decrease of the FUEL factor. The results of comparing SAP with EPA PMF 5.0 and chemical transport models (CTM), given by Copernicus Atmosphere Monitoring Service, are presented and discussed for the first time for Bulgaria.
8.	Syrakov D., Georgieva E., Prodanova E., Hristova E., Gospodinov I., Slavov K., Veleva B. (2019) Application of WRF-CMAQ Model System for Analysis of Sulphur and Nitrogen Deposition over Bulgaria. In: Nikolov G., Kolkovska N., Georgiev K. (eds) Numerical Methods and Applications. NMA 2018. *Lecture Notes in Computer Science*, 11189, 474-482, Springer, Cham, DOI 10.1007/978-3-030-10692-8_54 The advanced air quality modelling system WRF-CMAQ is applied to estimate the spatial distribution of sulphur and nitrogen wet deposition on seasonal basis for 2016 and 2017. The numerical system is set-up for nested domains, from European scale (d1

	- 81 km resolution) to country level (d3 - 9 km resolution) to account for transport and chemistry processes taking place over broad range of scales and impacting the deposition at given location. A precipitation bias adjustment approach is applied to all grid nodes of domain d3 in order to reduce effects of precipitation overestimation by the model. The effect of the bias adjustment on the seasonal deposition pattern is discussed. The approach leads to 25% decrease in annual wet depositions for the country.
9.	Syrakov D., M. Prodanova, E. Georgieva, E. Hristova (2019) Applying WRF-CMAQ models for assessment of sulphur and nitrogen deposition in Bulgaria for years 2016 and 2017, *Int. J. of Environ and Pollution*, 66, 162-186, doi:10.1504/IJEP.2019.104523 Wet, dry and total depositions of sulphur (S) and nitrogen (N) in Bulgaria are simulated on an annual and seasonal basis for the years 2016 and 2017 using WRF-CMAQ (9 km grid resolution). The mean annual values for wet depositions are about 1,300 $kg.km^{-2}$, the dry depositions are slightly lower for S and significantly lower for N (180 $kg.km^{-2}$). The highest modelled wet depositions are in the western and south-western parts of the country, the highest dry depositions – in the northern and eastern parts. The comparison for the wet depositions at three sites with precipitation chemistry data indicates overestimation. A precipitation bias adjustment applied to the modelled depositions results in decrease of the normalised mean bias by a factor of 3. Comparison to modelled deposition data from literature for this region of the country is also provided.
10.	Petrov A., Georgieva E. (2019) An Urban Air Pollution Modelling Test: GRAL vs. CUTE-1 case, *AIP Conference Proceedings* 2075, 120007; https://doi.org/10.1063/1.5091265 The output of the Lagrangian model GRAL was compared to the measured concentration data from the COST ES1006 (Evaluation, improvement and guidance for the use of local-scale emergency prediction and response tools for airborne hazards in built environments) CUTE (Complex Urban Terrain Experiment) test case 1. The observational data set was intended for testing of emergency response tools and atmospheric dispersion models. Generally, the model showed overestimation of the concentrations at the majority of the receptor points, except for those situated on the direct path of the plume.
11.	Perrone M.G., Vratolis S., Georgieva E., Török S., Šega K., Veleva B., Osán J., Bešlić I., Kertész Z., Pernigotti D., Eleftheriadis K., Belis C.A. (2017) Sources and geographic origin of particulate matter in urban areas of the Danube macro-region: The cases of Zagreb (Croatia), Budapest (Hungary) and Sofia (Bulgaria), *Sci. Total Environ.*, 619–620, 1515-1529, doi:10.1016/j.scitotenv.2017.11.092 The contribution of main PM pollution sources and their geographic origin in three urban sites of the Danube macro-region (Zagreb, Budapest and Sofia) were determined by combining receptor and Lagrangian models. The source contribution estimates were obtained with the Positive Matrix Factorization (PMF) receptor model and the results were further examined using local wind data and backward trajectories obtained with FLEXPART. Potential Source Contribution Function (PSCF) analysis was applied to identify the geographical source areas for the PM sources subject to long-range transport. Gas-to-particle transformation processes and primary emissions from biomass burning are the most important contributors to PM in the studied sites followed by re-suspension of soil (crustal material) and traffic. These four sources can be considered typical of the Danube macro-region because they were identified in all the studied locations. Long-range transport was observed of: a) sulphate enriched aged aerosols, deriving fromSO2 emissions in combustion processes in the Balkans and Eastern Europe and b) dust from the Saharan and Karakum deserts. The study highlights that PM pollution in the studied urban areas of the Danube macro-region is the result of both local sources and long-range transport from both EU and no-EU areas.

12.	Syrakov D., Prodanova M., Georgieva E., Etropolska I, and Slavov K. (2015) Impact of NOx emissions on air quality simulations with the Bulgarian WRF-CMAQ modelling system, *Int. J. of Environ. and Pollution*, 285 – 296. doi:10.1504/IJEP.2015.074511 The WRF-CMAQ modelling system was applied for air quality simulation over Europe in the frame of the air quality model evaluation international initiative (AQMEII), phase 2. The models were run for the year 2010 for a domain of 5000×5000 km^2 with a horizontal grid resolution of 25 km. A preliminary evaluation of model results vs. EU surface measurements was conducted using JRC web-based ENSEMBLE platform. Model performance was characterised by overestimation for ozone and underestimation for NO_2. Trying to understand this fact, another set of NOx emissions, a more complete one, was prepared and the simulations were repeated for the entire year (BG1 and BG2 sets). The increase of NO_x emissions with 30% slightly increase the quality of the simulation – the overestimation of O_3 decreases by a few percent and NO_2 concentrations increase and reach observed levels at rural sites, while they still remain underpredicted at urban sites.
13.	Pernigotti D., Thunis P., Cuvelier C., Georgieva E., Gsella A., de Meij A., Pirovano G., Balzarini A., Riva G.M., Carnevale C., Pisoni E., Volta M., Bessagnet B., Kerschbaumer A., Viaene P., De Ridder K., Nyiri A., Wind P. (2013) POMI: a model inter-comparison exercise over the Po Valley, *J Air Quality, Atmosphere & Health*, 6, (4) 701-715. doi:10.1007/s11869-013-0211-1 The Po Valley (Italy) model inter-comparison exercise (POMI) has been carried out in order to explore the changes in air quality in response to changes in emissions. The starting point was the evaluation of the simulated particulate matter and ozone (O_3) modelled concentrations against observations for the year 2005 of the six participating chemical transport models. As models were run with the same configuration in terms of spatial resolution, boundary condition, emissions and meteorology, the differences presented in the models' results are only related to their formulation. As described in the paper, significant efforts have been made to improve the accuracy of the anthropogenic emissions and meteorological input data. Nevertheless, none of the models using the proposed meteorology succeeded to fulfil the quality performance criteria set in the 2008 Air Quality Directive and in the literature for particulate matter, while also for ozone the results are not very satisfying. Although the overall performances look better for O_3 than for particulate matter with an aerodynamic diameter smaller than 10 μm (PM_{10}), the models tend to exhibit a similar behaviour and show the largest model variability in locations where concentrations are the highest (urban areas for PM_{10} and suburbs and hilly areas for O_3). While differences are significant in terms of standard deviation and bias, the correlation remains quite similar among models indicating that models generally capture well the main temporal variations, especially the seasonal ones. Possible explanations for this common behaviour and a discussion of the differences among models' results are presented in this paper.
14.	Pernigotti D., Georgieva E., Thunis Ph., Bessagnet B. (2012). Impact of meteorological modelling on air quality: summer and winter episodes in the Po valley (Northern Italy), *Int. J. of Environ and Pollution*, 50, 111-119. doi:10.1504/IJEP.2012.051185 The Po-valley in Northern Italy has been identified as a hot spot area in Europe where pollutant levels are expected to remain problematic in the years to come. High anthropogenic emissions in combination with frequently occurring stagnant atmospheric conditions cause very high concentrations of pollutants. Sensitivity tests for one winter month have shown that the nudging of observational data into the mesoscale meteorological model MM5 does significantly improve the simulation of frequent low wind regimes, and as a consequence in certain conditions increases and improves modelled particulate matter (PM) concentrations. The focus of this work is to extend the

	study and assess the effect of MM5 nudging options during summer. We analyse here the impact of different observation nudging options on simulated PM_{10} and summer ozone using the CHIMERE model. Strengths and weaknesses of nudging approaches in one of the most polluted and complex topography areas in Europe are discussed.
15.	Canepa E., Georgieva E., Manca G., Feigenwinter C. (2010). Application of a mass consistent flow model to study the CO2 mass balance of forests. Special Issue on Advection: ADVEX and Other Direct Advection Measurements Campaigns. *Agric. For. Meteorol.*, 150, 712-723. doi:10.1016/j.agrformet.2010.01.017 The reconstruction of the wind field is one of the main issues in the mass conservation approach for calculation of CO_2 advection in forest ecosystems and still remains a challenging problem. In the current study, we present an advancement of this approach: the use of a mass consistent flow model (WINDS) which takes into account measured wind data and simulates the 3-D flow field, while imposing air mass conservation in the control volume. We apply the WINDS model to calculate half hourly mean total advective flux terms at the CarboEurope-IP site of Renon (Bozen/Bolzano Autonomous Province), in Northern Italy. The data used refer to six time periods of one day representing three different meteorological conditions observed during the ADVEX campaign from April to September 2005. Current results are compared with results obtained in two other studies for the same time periods. One of these studies is based on the mass conservation approach as well, but applies only interpolations to reconstruct the wind field; the other study makes use of tilt correction (sector wise planar fit method) for the vertical wind component. In the present study, the effect of the wind field reconstruction method on the estimation of the advective fluxes is discussed. The possibility of using reduced input wind data (i.e. number of towers) for WINDS is also investigated. The results suggest that the representativeness of wind tower measurements is of primary importance for estimating CO_2 advection terms and their uncertainty in complex terrain.
16.	Montagnani L., Manca G., Canepa E., Georgieva E. (2010). Assessing the method-specific differences in quantification of CO2 advection at three forest sites during the ADVEX campaign. Special Issue on Advection: ADVEX and Other Direct Advection Measurements Campaigns. *Agric. For. Meteorol.*, 150, 702-711. doi:10.1016/j.agrformet.2010.01.013 The new method for CO_2 advective flux computation, based on the air mass-conservation principle, MCA (Montagnani et al., 2009) is applied to datasets collected at the three forest sites of Renon, Wetzstein and Norunda during the ADVEX campaign. Values of advective flux, calculated for 1 month at each site, are compared to those obtained using the more common method which computes the advective fluxes along vertical and horizontal CO2 gradients, GA (Feigenwinter et al., 2008). According to both methods, night-time CO2 advection values were found to be positive at the sloping sites of Renon (MCA, 8.88 $\mu molm^{-2}s^{-1}$, GA, 14.30 $\mu molm^{-2}s^{-1}$) and Wetzstein (MCA, 2.82 $\mu molm^{-2}s^{-1}$, GA, 3.07 $\mu molm^{-2}s^{-1}$) and negative at the flat site of Norunda (MCA, -3.00 $\mu molm^{-2}s^{-1}$, GA, -8.12, $\mu molm^{-2}s^{-1}$), where the occurrence of extremely high negative advection values was calculated at night according to both methods. Daytime advection was found to be generally small and negative at all sites following both methods, while standard deviations were found to be generally higher according to the GA method. Half-hourly calculated values were found to be similar during some periods, while in others, characterized by specific wind conditions, substantial differences were present. The coefficient of correlation (r^2) between the two estimates was 0.15 for Renon, 0.55 for Wetzstein and 0.45 for Norunda. Three methodological aspects were considered to identify the reasons for the observed differences in CO_2 advections estimates: the correction factor used to attain mass conservation, the air incompressibility assumption and the vertical interpolation of wind velocities were found all to be scarcely correlated to observed differences. These results

	indicate that general information concerning sign and daily courses of CO_2 advection estimates can already be taken from direct measurements, but there are still unresolved theoretical and computational issues affecting their quantitative reliability.
17.	Montagnani L., Manca G., Canepa E., Georgieva E., Acosta M., Feigenwinter Ch., Janous D., Kerschbaumer G., Lindroth A., Minach L., Minerbi S. Mölder M., Pavelka M, Seufert G., Zeri M., Ziegler W., (2009) A new mass conservation approach to the study of CO2 advection in an alpine forest, *J. Geophys. Res.*, 114, D07306, doi:10.1029/2008JD010650 A new method is proposed for the computation of CO_2 Net Ecosystem Exchange (NEE) and its components in a forest ecosystem. Advective flux is estimated by taking into account the air mass conservation principle. For this purpose, wind and dry air density values on the surface of the control volume are first corrected and then the advective flux is estimated on the surface of the control volume. Turbulent flux is also computed along the surface of the control volume while storage flux is computed inside the volume. Additional characteristics of this method are that incompressibility of the mean flow is not assumed a priori, and that vertical and horizontal advective fluxes are not treated separately, but their sum is estimated directly. The methodology is applied to experimental data collected with a three-dimensional scheme at the alpine site of Renon during the Advex project (July 2005). The advection flux was found to be prevailing positive at night and negative during the day, as was found in previous studies on advection for the same site, but showed a lower scatter in half-hour calculated values. We tested the effect of its summation on turbulent and storage fluxes to produce half-hourly values of NEE. Night-time NEE values were used in functional relations with soil temperature, daytime values with PPFD. The effect of addition of the advection component was an increase in the values of parameters indicating ecosystem respiration, quantum yield, and photosynthetic capacity. The coefficient of correlation between NEE and environmental drivers increased.
18.	Cavallaro M., Canepa E. and Georgieva E. (2007) The SAFE_AIR II dispersion model: description and statistical evaluation of its dispersion component against wind tunnel data from area sources, *Ecological Modelling*, 202, 547-558. doi:10.1016/j.ecolmodel.2006.11.018 SAFE AIR II is a model which simulates transport and diffusion of airborne pollutants emitted in the low atmosphere above complex orography at both local and regional scale, under non-stationary and inhomogeneous emission and meteorological conditions. The aim of this paper is the assessment of the performance of the dispersive module (P6) of SAFE AIR II in simulating pollutant concentrations due to releases from area sources. This analysis has been carried out comparing the results of model simulations with the data collected in a U.S. Environmental Protection Agency Meteorological Wind Tunnel. Three different scenarios have been investigated in order to understand the effects of the shape and orientation of the area source. To compare measured concentrations against the corresponding predicted ones, both graphical analyses and appropriate statistical indices have been used. The capability of the code to simulate area sources has been outlined.
19.	Georgieva E., Canepa E. and Builtjes P., (2007) Editorial: Harbours and Air Quality. *Atmos. Environ.*41, pp. 6319-6321. doi:10.1016/j.atmosenv.2007.06.041 This special issue of Atmospheric Environment presents papers that are based on presentations given during the First International Conference on Harbours and Air Quality. The conference was held in Genoa, Italy on 15–17 June 2005. It was organized in response to the growing concern about air quality in harbours and the increase in studies devoted to this specific environmental problem.

20.	Burlando M., Georgieva E., Ratto C. F. (2007) Parameterisation of the planetary boundary layer for diagnostic wind models, *Boundary Layer Meteorology*, 125, 389–397. DOI 10.1007/s10546-007-9220-7 The planetary boundary-layer (PBL) parameterization is a key issue for the definition of initial wind flow fields in diagnostic models. However, PBL theories usually treat separately stable, neutral, and convective stability conditions, so that their implementation in diagnostic wind models is not straightforward. In the present paper, an attempt is made to adopt a comprehensive PBL parameterisation, covering stable/neutral and unstable atmospheric conditions, which appears suitable to diagnostic models. This parameterisation is implemented into our diagnostic mass-consistent code. A validation of the consistency between the implemented PBL parameterisations has been checked through an analysis of the sensitivity of the vertical wind profiles to atmospheric stability.
21.	Zerefos C., D. Syrakov, K. Ganev, A. Vasaras, K. Kourtidis, M. Tzortziou, M. Prodanova, R. Dimitrova, E. Georgieva, D. Yordanov, N. Miloshev (2004) Study of the pollution exchange between Bulgaria and Northern Greece. *Int. J. of Environ. and Pollution*, 22, 163-185, doi: 10.1504/IJEP.2004.005507 The present work aims at a detailed study and explanation of the pollution transport in the air basin over south-western Bulgaria and northern Greece and assessment of the air pollution exchange between Bulgaria and Greece. Some well-known specific climatic air pollution effects were studied and explained. Calculations were made of the SO_2 pollution of the Balkan Peninsula from both Greek and Bulgarian sources for 1995, and the country-to-country pollution budget diagrams were built. Days with extreme mean concentration for Bulgaria and northern Greece were picked out, and some further specification of the contribution of the different sources in both the countries to these cases of extreme pollution was made. Some preliminary studies of possible mesoscale effects on the pollution exchange between Bulgaria and northern Greece were carried out. A three-layer pollution transport model with a more complex chemistry block was introduced, and some preliminary simulations of the transport of sulphur and nitrogen compounds were performed.
	Publications in group G8 (Bulgarian version "Г8")
1.	Dimitrova M., Nedkov R., Syrakov D., Georgieva E., Gochev D., Trenchev P, Veleva B., Atanassov D., Spassova T., Batchvarova E. (2020) Identification of Optimal Satellite Data for Use in the Air Quality Modelling System BGCWFS (in Bulgarian) *Journal of the Bulgarian Academy of Sciences*, No. 1, 16-23, ISSN 2683-0302 (on line) In this work we present an investigation of finding and processing of optimal satellite dataset for assimilation in the air quality modelling system BgCWFS. The modelling system BgCWFS simulates the transport and chemical transformation of air pollutants over five different nested domains with different spatial resolution and the optimal satellite datasets for each of them are different. We show that data from MetOp satellites is optimal for use in Europe and, Balkan domains while Sentinel 5P data is better for two other ones - Bulgaria and Sofia district.
2.	Hristova E., Georgieva E., Syrakov D., Prodanova M., Veleva B., Velchev K., Valcheva L. (2020) Deposition of atmospheric pollutants in the Bulgarian Black Sea coastal area, In (Eds. J. Marinski*) "Environmental Protection of the Bulgarian Black Sea ports and their surrounding areas*", www.unipress.bg, ISBN 978-954-07-4985-3, pp 156-165. This work presents results from studies conducted during the last years at the National Institute of Meteorology and Hydrology for deposition of atmospheric pollutants in the coastal regions of the Bulgarian Black Sea coast. Two field sampling campaigns are organized in Burgas and Ahtopol (June - December 2014) and in Ahtopol (June - December 2017). Results from chemical analysis of precipitation samples are presented.

	Chlorine is prevailing ion (~40%) for both station following by sulphate in Burgas samples (17.48%) and by nitrate in Ahtopol samples (16.28 %) during the 2014 sampling period. The results from the 2017 experiment in Ahtopol show again the largest contribution of chlorine ions (39.05%) followed by sulphate (16.5%) and nitrate (10.58%). The Bulgarian Chemical Weather Forecast System was applied for the first time to estimate sulphur and nitrogen depositions on a monthly and annual basis for the country. Modelling results indicate that the Southern part of the coast has higher sulphur and nitrogen depositions than those on the northern coast. Since there are no major sources of pollution in this region, it can be assumed that the higher sulphur and nitrogen depositions are influenced by regional and long-range transport of pollutants.
3.	Georgieva E., Atanassov D., Spassova T., Batchvarova E., Syrakov D., Dimitrova M, Nedkov R., Veleva B. (2019) Satellite Information Downscaled to Urban Air Quality in Bulgaria - Project description, *Bulgarian Journal of Meteorology and Hydrology*, 23, (2), 47-60 http://meteorology.meteo.bg/global-change/files/2019/BJMH_2019_V23_N2/BJMH_23_2_4.pdf The present paper gives a general description of the project "Satellite Information Downscaled to Urban Air Quality in Bulgaria – (SIDUAQ)", its goals, activities and expected results. The overall objective of this project is to widen the use of satellite data for studies and management of environmental issues at national level in Bulgaria and at local level for the city of Plovdiv. Satellite air quality (AQ) information has not been used for studying and solving AQ problems in Bulgaria so far, thus, the specific goal is to modify the current Bulgarian Chemical Weather Forecasting System (BgCWFS) for assimilation of satellite information and to link its output to urban scale AQ system. The current local air quality management system (LAQMS) for the city of Plovdiv will be further improved through emission inventories and expert modules for supporting the local authorities in taking decisions and measures for reducing the air pollution in the region and in the city.
4.	Syrakov D., Prodanova M, Georgieva E., Dimitrova M., Spassova T., Atanassov D., Veleva B., Nedkov R. (2019) Aerosol optical depth calculations using the Bulgarian Chemical Weather Forecast System, *Bulgarian Journal of Meteorology and Hydrology*, 23, (2), 31-46 http://meteorology.meteo.bg/global-change/files/2019/BJMH_2019_V23_N2/BJMH_23_2_3.pdf Five different methods are tested for estimating the aerosol optical depth using results from the Bulgarian Chemical Weather Forecast System. Four of the methods are embedded in the chemical transport model of the system; the fifth one (FlexAOD) is adapted from a post-processing tool, developed for global chemistry models. The results of the five approaches are discussed qualitatively, showing maps for AOD spatial distribution over Europe for a selected day. The performance of the code FlexAOD with results from BgCWFS is discussed for a period of four days in March 2018, characterized with Saharan Dust outbreak. The preliminary evaluation with AOD from the Copernicus based forecast system CAMS-ECMWF and with data from AERONET stations shows that BgCWFS underestimates AOD and suggest further developments of the system with assimilation of satellite derived data.
5.	Dimitrova M., Trenchev P., Georgieva E., Neykova N., Neykova R., Nedkov R., Gochev D., Syrakov D., Veleva B., Atanassov D., Spassova T. (2019) Seasonal changes of aerosol pollutants over Bulgaria, *Proceedings of the Fifteenth International Scientific Conference Space, Ecology, Safety*, SES 2019, (Print ISSN 2603-3313; Online ISSN 2603-3321), 241-252 In this work we present an investigation of seasonal behaviour of atmospheric pollutant amounts over Bulgarian region. We use monthly averaged satellite and ground station data for the period of 2005 till 2018 and 2013 till 2018 respectively.

6.	Dimitrova M., Nedkov R., Syrakov D., Georgieva E., Gochev D., Trenchev P., Veleva B., Atanassov D., Spassova T., Batchvarova E. (2019) Identification of optimal satellite data for use in the air quality modelling system BgCWFS, *Proceedings of the Fifteenth International Scientific Conference Space, Ecology, Safety*, SES 2019, (Print ISSN 2603-3313; Online ISSN 2603-3321), 253-260. In this work we present an investigation of finding and processing of optimal satellite dataset for assimilation in the air quality modelling system BgCWFS. The modelling system BgCWFS simulates the transport and chemical transformation of air pollutants over five different nested domains with different spatial resolution and the optimal satellite datasets for each of them are different. We show that data from MetOp satellites is optimal for use in Europe and, Balkan domains while Sentinel 5P data is better for two other ones - Bulgaria and Sofia district.
7.	Hristova E., Georgieva E., Velchev K., Kirova H., Nikolov V., Syrakov D., Prodanova M., Batchvarova E., Veleva B., Petrov A., Neykova R., Branzov H., Kolarova M., Etropolski E., Oruc I. (2016) Composition of precipitations in the coastal area of Southeast Bulgaria. *Proceedings of the 3rd Bulgarian National Congress on Physical Sciences*, Sofia, Bulgaria, Sep. 29 - Oct. 02, 2016, pp S0617-01-08, CD, Heron Press, ISBN:978-954-580-364-2 The first joint study on air pollution related problems in the cross border area Bulgaria–Turkey, was carried out. Samples of wet only depositions were collect at two sites (Burgas and Kirklareli) during the period from June to November 2014. The samples were analysed for main cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}), main anions (NO_3^{-}, SO_4^{2-}, Cl^{-}), heavy metals (Co, Cr, Fe, Mn, Mo, Zn, Cd, Cu and Pb), acidity (pH) and conductivity (EC). The measured acidity of precipitation samples was found to be different at the sampling sites, ranging from alkaline at Kirklareli (6.76) to neutral in Burgas (5.68). The chemical composition of precipitations in Bulgarian site was dominated by Cl^{-} followed by $SO_4^{2-} > NO_3^{-} > Ca^{2+} > Mg^{2+} > Na^{+} > K^{+} > NH_4^{+}$. The dominated ion in precipitation samples from Turkish site is SO_4^{2-} followed by $Cl^{-} > Ca^{2+} > NH_4^{+} > K^{+} > Na^{+} > NO_3^{-} > Mg^{2+}$. The chemical analysis shows that there are no deviations in the content of heavy metals from commonly reported values in Europe.
8.	Belis C., Georgieva E., Janos O., Sega K., Török S., Veleva B., Perrone M., Vratolis S., Pernigotti D., Eleftheriadis K. (2015) A comparative analysis of the causes of air pollution in three cities of the Danube region: implications for the implementation of the air quality directives. *JRC Report EUR 27712* EN. doi:10.2788/73231, ISBN 978-92-79-54640-2, ISSN 1831-9424, 57pp. The causes of air pollution in three cities of the Danube region (Budapest, Sofia and Zagreb) were studied using datasets of measurements and modelling tools. It was observed that most of the pollutants are emitted locally. However, the medium to long range transport may be also considerable. On the basis of the output of the source identification, a series of measures were proposed to deal with the pollution problem at local, national and international levels.
9.	Georgieva E., Oruc I., Hristova E., Velchev K., Kirova H., Syrakov D., Prodanova M., Neikova R., Veleva B., Barantiev D., Petrov A., Kolarova M., Nikolov V., Batchvarova E., Branzov H., (2015) Assessment of trans-boundary problems. Case study for the atmospheric pollution in the cross-border region Burgas –Kirklareli, in *"Integrated Land-Use Modelling of Black Sea Estuaries",* Eds: H. Yemendzhiev and V. Nenov. Diagnosis Press, Sofia, 2015, pp. 179-190. (ISBN 978-954-8436-28-1) This paper presents preliminary results from the first joint Bulgarian-Turkish study on air pollution in the cross-border region. The main air quality problems and available standard air pollution measurements are presented. Results from the numerical modelling with the comprehensive WRF-CMAQ air quality system are discussed with regard to the most problematic pollutants - particulate matter, ozone, nitrogen dioxide

	and deposition of acidic compounds. The set-up of field campaigns for collecting atmospheric deposition samples (wet, dry and bulk) at four sites in the region is outlined. The chemical analysis of some selected precipitation samples is discussed relevant to acidity (pH), main anions, cations, and heavy metals.
10.	Syrakov D., Prodanova M., Georgieva E., Slavov K. (2014) WRF-CMAQ Regional Air Quality Modelling System Results Estimated vs. Measurement Data, *J. Intern. Sci. Publ. Ecology & Safety*, 8, pp. 370-383 (http://www.scientific-publications.net/en/article/1000109/) The air quality modelling system WRF-CMAQ was applied by the Bulgarian NIMH (National Institute for Meteorology and Hydrology) team to the European domain in the frame of the Air Quality Model Evaluation International Initiative, Phase 2 (AQMEII-2). The model system was set up for the European domain of 5000×5000 km size with horizontal resolution of 25 km. The emissions were available through AQMEII and further processed in a way to feed the chemistry transport model CMAQ. The meso-meteorological model WRF was driven by NCEP GFS data with 1°×1° resolution. The chemical boundary conditions were extracted from MACC global simulation data. Model performance was investigated by means of AQMEII-2 web-based evaluation platform ENSEMBLE. A preliminary model evaluation for ozone and particulate matter was conducted based on comparison between simulated and observed concentrations at different type of surface stations in the EU wide domain. Model performance was characterized by overestimation for ozone and underestimation for the other pollutants. The relative statistical indicators were also discussed in view of recently published performance criteria.
11.	Georgieva E. and S. Trini Castelli (2010) Active Groups in Air Pollution Modelling, Ch21 in "Air Quality Modelling - Theories, Methodologies, Computational Techniques, and Available Databases and Software, Vol. IV – Advances and Updates", ed. P. Zannetti, EnviroComp and Air&Waste Management Association (www.envirocomp.org) ISBN: 978-1-9334740-9-0 (CD ROM version), ISBN: 978-1-9334740-8-3 (hard copy) The air pollution modelling community is continuously growing and the activities and different approaches related to air quality studies and applications are diversifying more and more, facing all relevant issues and covering all spatial and temporal ranges of interest. Therefore, to identify all groups working on air pollution modelling, and to summarize all the theoretical and computational approaches to simulate the dispersion and transformation of pollutants in the atmosphere, is surely a challenge. The database provided here was built up following a two-step procedure. First, active groups in air pollution modelling have been identified examining recent specialized scientific literature and looking at participants to the main international conferences on air pollution modelling. The groups have been contacted and invited to provide specific information using a web-based template. The template was designed with the aim to provide insight in the group's main objectives, tools, skills and competences. A short version of the template is used in the printed book, while a longer one is prepared for the electronic version of the book, where submitted animations could be also found. The database contains the templates from 80 modelling groups coming from 28 countries. Of course, the list does not have any pretensions of being complete, however it provides a picture of the currently active air pollution modelling groups and of the modelling tools developed or used by them.