Month / Day / Year
12 / 14 / 2012

COOPERATIVE GRANTS PROGRAM (CGP)

FINAL PROJECT REPORT

JOINT TECHINCAL REPORT

Award Number: UKG2-2969-KV-09

Non-U.S. Principal Investigator
PI's name: Gennadi Milinevsky
Name of non-U.S. institution: Kyiv National Taras Shevchenko University

U.S. Principle Investigator
PI's name: Michael Mishchenko
Name of U.S. institution: NASA Goddard Institute for Space Studies

SECTION I:
CGP PROJECT RESULTS & ACCOMPLISHMENTS

MAJOR RESEARCH ACCOMPLISHMENTS:

New data on aerosol distribution and properties in the atmosphere over different locations in Ukraine have been collected and uploaded to the AERONET and project databases. These data were obtained at new AERONET sites (Lugansk, Kyiv-AO) established in Ukraine in the framework of the project. The analysis of aerosol properties has been provided and published/submitted in peer-review journals. Some of the project components have been incorporated into a new concept of the Ukrainian satellite aerosol polarimeter mission.

PUBLICSUMMARY (English):

The goals of the project were to obtain new valuable scientific data on atmospheric aerosol distributions and dynamics over Ukraine as well as to develop the infrastructure for aerosol monitoring and investigation.

Atmospheric aerosols influence on the atmospheric transparency causing significant climate effects. The gap in the aerosol properties data and distribution over Ukraine had created a problem for the simulation of aerosol impact on climate. The aerosol study project is important since it can provide the scientific community with new data on atmosphere aerosol properties and loading in the atmosphere over these vast territories.

As a result of our study an "aerosol" team was formed in our University, which has been equipped with up-to-date sunphotometers for aerosol investigations. Thanks to the project we have established the long-term aerosol monitoring in Ukraine regions, designed new instruments for aerosol measurements, established the database of aerosol and ozone parameters.

Our project helps to start new space mission concept with polarimeter sensor to study physical properties of atmospheric aerosols. This new mission will be extremely valuable for the scientific climate modelling community due to large uncertainties in the aerosol climate forcing.

We have significantly improved the knowledge on aerosol distributions and dynamics over Ukraine. The database of aerosol optical properties and distribution facilitates the study of the influence of aerosol transport over Ukraine on other parts of Europe.

The project provided a basis for the collaborative Ukraine/US proposal of a space mission for monitoring global aerosol properties and improving climate models. The information on aerosols, stratospheric ozone, air quality on PM2.5 maps of Ukraine will be available from our website to inform the worldwide community.

The project provided an impetus for the development of the aerosol monitoring network in Ukraine intending to fill in the gap in observation sites of the AERONET network.

PUBLIC SUMMARY (Non-US Team Native Language):

Метою проекту було отримання нових важливих даних про властивості та динаміку атмосферних аерозолів над Україною, а також розвиток інфраструктури для контролю і досліджень аерозолю.

Атмосферні аерозолі впливають на прозорість атмосфери, що викликає істотний ефект змін клімату. Недостатність даних про властивості аерозолю та його розподіл над регіонами України створив проблему для моделювання впливу аерозолю на клімат. Проект з досліджень аерозолів є важливим оскільки він може забезпечити наукове співтовариство новими даними про атмосферні компоненти та забруднення аерозолями над цими великими територіями.

В результаті наших досліджень був сформований колектив дослідників атмосфери в нашому Університеті, який був забезпечений сучасним сонячним фотометром для аерозольних досліджень. Дякуючи проекту ми встановили постійний моніторинг аерозолю в українських регіонах, спроектували та виготовили нові інструменти для їх спостережень, заснували базу даних параметрів аерозолю та озону.

Наш проект допоміг розпочати розробку нової космічної місії за концепцією аерозольного поляриметра для визначення фізичних параметрів атмосферних аерозолів. Ця нова місія буде надзвичайно цінною для наукової спільноти, яка розробляє кліматичні моделі, оскільки досі існує велика невизначеність впливу аерозолю на клімат.

Ми значно поліпшили знання про розподіл аерозолів та його динаміку в атмосфері над Україною. База даних з розподілу та оптичних характеристик аерозолів полегшує вивчення впливу переносу аерозолів над Україною та іншими частинами Європи.

Проект забезпечив базу для партнерської пропозиції космічної місії України та США для глобального контролю властивостей аерозолю і поліпшення моделей клімату. Інформація щодо аерозолів, стратосферного озону, якості повітря за параметром PM2.5 на картах України буде доступною на нашому вебсайті для інформування суспільства у світі.

Проект забезпечив важливий імпульс для розвитку мережі моніторингу аерозолів в Україні, яка має заповнити пропуск у розташуванні пунктів спостережень мережі AERONET.

SECTION II: TECHNICAL REPORT

TECHNICAL REPORT:

Outline of the goals of the original research project

The original research project had two main goals to be accomplished. The first goal was the monitoring of atmospheric aerosol distributions over Ukrainian regions by ground-based and satellite (Glory and PARASOL space missions) remote sensing. The second goal was to establish a long-term open-access database, which can facilitate continuous control of aerosol dynamics and assist monitoring of the climate change . The database should contain data of aerosol measurements collected in different regions of Ukraine, including industrial polluted South-East areas. Three additional objectives were stated to accomplish these goals: (1) acquire aerosol optical characterization over Ukraine from ground-based and satellite observations, (2) comparisons of simultaneously obtained data of the ground-based and satellite measurements, and (3) creation of a database of aerosol spatial and temporal distributions over Ukraine.

Technical description of the project goals accomplishments

To accomplish these goals we provided during 2010–12the aerosol optical parameter measurements by sunphotometers in different Ukrainian regions. **During the first half-year** of the project we started to collect aerosol property data using the sunphotometer CIMEL CE318-2 at the permanent AERONET site 'Kyiv' operated by our team. The project team was working on the preparation of the observational site equipment and learned data processing procedures and methodologies. To organize the mobile observational site we had to purchase the sunphotometer CIMEL CE318N – the novel generation of CIMEL sunphotometers with better technical characteristics. At that time the non-US PI has traveled using share costs to Laboratoire d'Optique Atmosphérique (LOA) of the University Lille1 and to CIMEL Electronique Enterprise to organize the purchase of the CIMEL CE318N sunphotometer and to discuss aerosol observation methods and sunphotometer calibration.

To achieve the main goal of the project we started to collect data on spatial and temporal aerosol distributions over Ukraine using satellite (PARASOL, MODIS) observations. We studied the methods of aerosol backward trajectory calculations and requested this information for the Kyiv site through the AERONET communication system. Also aerosol optical thickness (AOT) measurements by portable Microtops II sunphotometers were ongoing. Students participated in the project and learned basic methods and procedures of observations and data development as well as the technical characteristics of sunphotometers (CIMEL CE318N, Microtops II).

Methods and algorithms of aerosol particle properties retrieval from data of ground-based sunphotometers and POLDER and MODIS satellite instruments measurements were studied. The calibration technique used by AERONET for CIMEL sunphotometer has been studied as well because the sunphotometer calibration procedure and accuracy is one of essential constituents of ground-based measurements.

Work for the preparation of the methodology of the POLDER instrument intercomparison by the ground-based sunphotometers CE318 and Microtops II measurements was performed. That intercomparison is possible because the CE318 sunphotometers can measure both the Sun direct spectral irradiance at some wavelengths followed by spectral AOT and Angstrom exponent determination, and the Sky spectral radiance and polarization degree at 865 nm. The instrument can measure the water vapor optical thickness using the 940 nm spectral band as well. The POLDER instrument can measure the intensity of the back-scattered light at 675 and 865 nm and polarization degree at 865 nm followed by AOT at 865 nm and Angstrom exponent determination.Therefore we obtained comparable data from both instruments and developed the procedure. The example result of intercomparison is shown in fig. 1.It should be mentioned that due to the Glory mission failure the work on groundbased-satellite data intercomparison was focused on the POLDER/PARASOL satellite data.

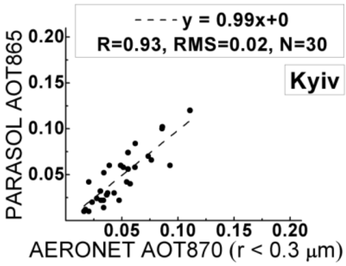

Fig. 1

The field measurements with Microtops II in other Ukrainian regions have been started and simultaneous with the POLDER radiometer measurements have been collected. For that we learned the procedure of calculation of the PARASOL sub-satellite paths over the Ukrainian territory to make observations simultaneously. To validate the Microtops II sunphotometer data we provided the calibration by simultaneous spectral AOT observations with CE318-2 sunphotometer at the AERONET Kyiv site.

In the fall of 2011 we have finalized the process of purchasing the CIMEL CE318N sunphotometer and its calibration at the LOA. We delivered the instrument from Lille to Kyiv following the custom formalities according to the CRDF tax free policy. Than we provided the CE318N instrument intercalibration with AERONET CE318-2 sunphotometer and confirmed that good quality of the new instrument didn't change after the 2000 km transportation. After that the new CE318N sunphotometer was operated during two months as the main instrument of the AERONET Kyiv site yielding measurements of aerosol optical thickness in nine spectral channels (compared to five from CE 318-2). Then the CE318N has been moved to the newly established AERONET site 'Lugansk' to collect data from the East Ukrainian region. The results of Lugansk site measurements can be downloaded from http://aeronet.gsfc.nasa.gov/new_web/photo_db/Lugansk.html.

Students participating in the project have provided independent field aerosol observations with the Microtops II sunphotometer learning procedure of observations and data processing. One of the students has developed the algorithm and software for Microtops II data analysis to acquire spectral AOT and Angstrom parameter from measurements. The data of Microtops II summer field 2011 campaign have been processed by students using their own software (see the example in fig.2).The algorithm of sunphotometer data processing has been developed for fine mode aerosol optical thickness determined from ground-based measurements of direct sun irradiance. The data obtained by the algorithm were used for the POLDER aerosol fine mode AOT data validation. The algorithm enables one to calculate the requisite fine mode AOT by evaluating the relative fractionof the aerosol fine mode AOT in the total aerosol AOT retrieved from sky radiance measurements. The algorithm includes theaerosol particle properties for specific site of measurements (type, origin etc.). Also using the algorithm we have processed much more data of ground-based aerosol measurements for comparison with satellite observations and improving the reliability of satellite data validation.

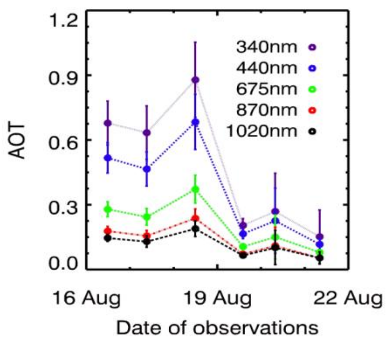

Fig. 2

The project has stimulated the work on developing new instruments for mobile aerosol and ozone photometry.

We initiated the prototyping of the Microtops II aerosol sunphotometer and UV ozone monitor. Three experimental instruments (two Microtops II prototypes SPV1-2 and ozone monitor) were designed and built. These devices are used for measurements and continued calibration/adjustment to obtain data with reliable quality. We should mention that the main components of these instruments - the filters - were supplied by the LOA. The mobile set of equipment for aerosol and ozone field observations has been created using CE318N and Microtops II sunphotometers, experimental SPV sunphotometer, the ozone monitor and the UV-index sensor (see fig. 3). The mobile site was actively used in transect observations and field measurements in different Ukrainian regions. During the winter of the **third half-year** of the project period we collected and analyzed data of spectral observations of AOT from the AERONET Kyiv site, the Lugansk site, and from field measurements in several regions of Ukraine with the Microtops II sunphotometer.

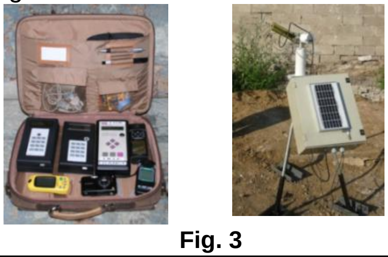

Fig. 3

We provided the Microtops II sunphotometer and two experimental sunphotometers (SPV1 and SPV2) calibration campaign by simultaneous with the CE318-2 spectral AOT observations at AERONET Kyiv site.

In February 2012 two Workshops of the CRDF team on the "Aerosol from space" topic were organized to review current satellite aerosol missions and instruments. The aim of the Workshops was the discussion of the concept proposal for the future Ukrainian aerosol satellite mission. The same topic was discussed in April 2012 during a two-day Workshop lead by the US PI, with the CRDF team joined by leading Ukraine scientists in polarimetry, where the technical understanding and description of the planned mission to study atmospheric aerosols with a polarimetric instrument was clarified. The results of the project fulfillment and the corresponding papers were discussed at the Workshop as well.

In May 2012 after five months of operation at the Lugansk site the CE318N mobile sunphotometer was relocated for two month to the new AERONET site "Kyiv-AO" located in the central part of Kyiv. The idea of the relocation was to obtain aerosol data in the central part of a large city for their comparison with data of the AERONET Kyiv site located in the Kyiv-Goloseyev station, a suburb an area. The results of the measurements with the CE318N sunphotometer from the Lugansk and Kyiv-AO sites can be downloaded from AERONET website (see site data at http://aeronet.gsfc.nasa.gov/cgi-bin/site_info).

During the final; **half-year period** of the project we continued to accumulate data from ground-based sunphotometers and POLDER satellite measurements. Data from the Kyiv site, the Lugansk and Kyiv-AO sites have been stored and processed in the AERONET data base. Additional data from the MODIS/Terra, MODIS/Aqua and MISR/Terra satellite instruments were used to retrieve the aerosol parameter distribution over Ukraine. We were finalizing the project website and the database for regional aerosol data storage available for downloading.

Finally we performed extensive summer field measurements in Ukrainian regions with the mobile station. We continued aerosol data measurements over the Kyiv AERONET site and re-established in September the additional AERONET site in the center of Kyiv - Kyiv-AO site to provide simultaneous aerosol observations in the center and in a suburb to study the big city contamination using differential method. The set of three-month observations was obtained. Also we processed the Microtops II sunphotometer measurements and data analysis for the period till the end of the project.

Fig. 4

We carried outfield aerosol observations in different regions of Ukraine including the Chornobyl region using the Microtops II sunphotometer and two experimental sunphotometers (SPV1 and SPV2). We further continued the development of new devices for mobile aerosol and ozone photometry stimulated by the project. The design of the two-channel aerosol scanning photometer was started at that time. In the summer we organized and fulfilled two field campaigns for aerosol measurements in the South-Eastern part of Ukraine. The first one was conducted in July, when measurements along the highway from Kyiv to Donetsk and in the city of Donetsk were carried out with the mobile sunphotometer CE318N.

The second field campaign included transects from Kyiv through Kharkov, Lugansk, Donetsk, Mariupol, Simferopol to Yevpatoria (the Western shore of Crimea). Beforehand the PARASOL and Aqua satellite ground tracks were calculated using the on-line orbitography software from the IXION (France) website for simultaneous measurements with the sunphotometer CIMEL and Microtops II during these field campaigns. During the South-East Ukrainian field campaigns we tested the new sunphotometer ASPV1 (fig. 4) designed and built as an analog to the scanning sunphotometer CIMEL. Data analyses from ASPV1 observations will be carried out after the end of the project.

In Yevpatoria, the third meeting with the US PI was organized, during which we discussed the project results and expected publications. We continued to take part in the “Aerosol-UA” space project (the Glory mission analogue) discussion and preparation. The ground-based validation and support of space measurements concept was proposed. Project results were presented at the 12th Ukrainian Conference on Space Research. The US PI took part in a short field measurement campaign with the Microtops II and SPV1 sunphotometer observations along the South part of Crimea.

More data for 2012 from the POLDER/PARASOL, MODIS/Terra/Aqua and MIRS/Terra satellite observations were processed and maps of AOT, Angstrom exponent and frequency of observation has been prepared for the Ukrainian territory. These maps are available from the project website http://antarctica.org.ua/crdf.html.

Data from the Microtops II instrument and satellite maps of aerosol distribution extracted for the Ukrainian region have been posted on the project website as well. The results of the measurements are used for the preparation of papers, presentations at meetings and for the project website information pages.

Upon having accomplished one of the secondary tasks of the project we have provided continuous Dobson spectrophotometer ozone measurements at Kyiv-Goloseyev site available on the project website (see at http://antarctica.org.ua/year_data.html). The precipitable water vapor values from our AERONET sites data have been retrieved to calibrate the GPS data of tropospheric humidity. The idea of this research if to create as long as possible a homogeneous calibrated set of troposphere water values for climate variation estimations. This research is ongoing.

Main research results and specific achievements

Aerosol is a critical climatology agent that changes the atmospheric transparency for solar radiation thus causing a direct radiative forcing. Aerosol particles also alter cloud formation processes influencing precipitation efficiency and causing an indirect radiative forcing. Ground-based and spaceborne optical remote sensing techniques are the most efficient ways of studying aerosol particle parameters, properties and dynamics in the Earth's atmosphere for the purposes of local and global climate change modelling. These factors make the project results of measurements in the Ukrainian region important and useful.

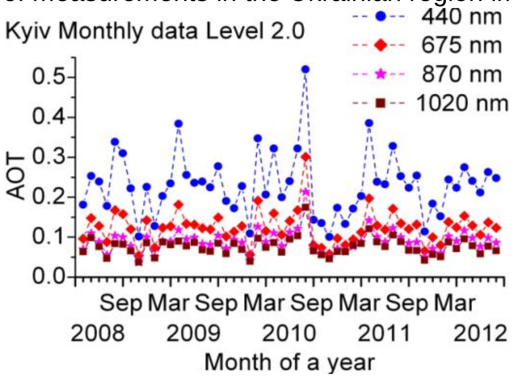

Fig. 5

During the project aerosol optical and microphysical properties were determined from ground-based observations in Ukraine at the Kyiv AERONET site and the sites Lugansk, Kyiv-AO, Donetsk and Yevpatoria that were established within the project timespan. The changes of AOT (the basic physical quantity of sunphotometers measurements) in the atmosphere over Kyiv during four years including the project period are shown in fig. 5. Note that the spectral AOT is measured by the sunphotometer with accuracy within 0.01. AOT depends on both aerosol particle number in the atmospheric column and aerosol particle optical and physical properties such as the particles size distribution and their shapes, complex refractive index, single-scattering albedo and phase function.

The spectral AOT determines the aerosol direct climate effect. Therefore, AOT is the quantity that is determined from both ground-based measurements and space-borne instruments data and is used to validate aerosol space study results. Figures 5 – 6 demonstrate the spectral AOT dynamics over the project sites in Ukraine.

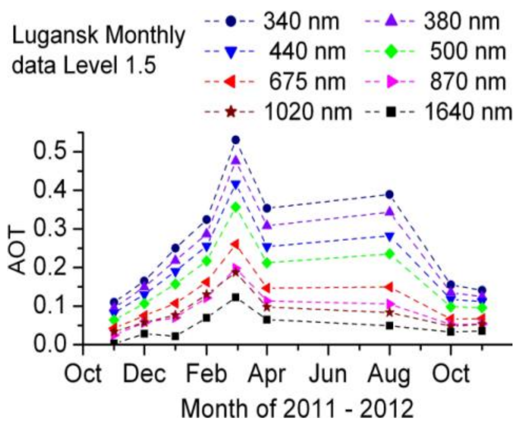

Fig. 6

The monthly averaged data are also shown in order to make them more clear. The longest time set has been obtained at the Kyiv site (fig. 5) during 2008 – 2012 with the CE-318-2 sunphotometer (polarized model) and includes four spectral intervals only. The data have been corrected for sunphotometer characteristic changes after recalibration of the sunphotometer (Level 2.0 data).

The data demonstrate seasonal variations: AOT in the atmospheric column over Kyiv during the spring and summer is higher than in the fall and winter. The peak AOT in August 2010 was caused by smoke from forest fires in Russia at that time. Also smoke from burning vegetation often caused increases in AOT during spring months. In fact AOT during certain days can deviate significantly from the monthly data, up to a factor of several. The variations are determined by different causes, such as the fire smoke mentioned above.

A relatively short set of data has been obtained at the new AERONET site Kyiv-AO located in the city center with the new sunphotometer CE-318N. We did that in order to compare atmospheric conditions in the city center and suburbs. A preliminary analysis showed that AOT for the same spectral intervals of both sunphotometers are essentially equal, however particle size distributions are different. These results need further verification and analysis, and will be continued. A longer set of AOT data was obtained with this sunphotometer in Lugansk during autumn 2011 – spring 2012 and August – November 2012 (fig. 6).

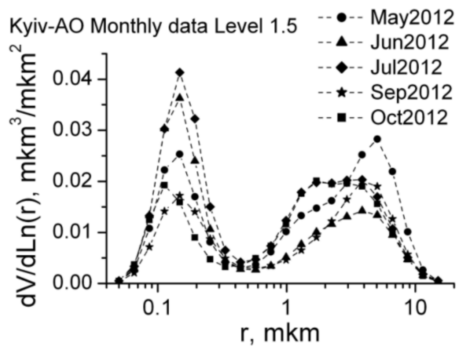

Fig. 7

On average the AOT at the Lugansk and Kyiv sites at the same wavelengths are approximately equal but the Kyiv data show more variability from month to month during that period.

The AERONET data processing procedure allows us to determine aerosol particle properties from data of the sky radiation measurements. Monthly averaged aerosol particles size distributions determined from measurements at Kyiv-AO site is shown in fig. 7, where *r* is the radius of the aerosol particles. The unit dimension used here (mkm^3/mkm^2) indicate the aerosol particles integral volume (mkm^3) in the integral atmospheric column with the cross-section area of 1 mkm^2. It can be seen from fig.7 that in the atmospheric column over Kyiv particles of the fine mode prevailed during the warm part of 2012. This is a result of increased pollution in the city by transport and summer conditions and is typical for this period of year in Kyiv. Similar properties have particles size distributions in Lugansk for the same time of the year. However properties of size distribution at Lugansk are quite variable for the period from October to February. This behavior can be explained by strong weather variations and a low number of clear days during the winter season.

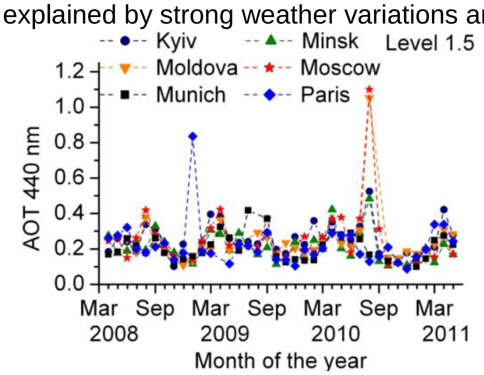

Fig. 8

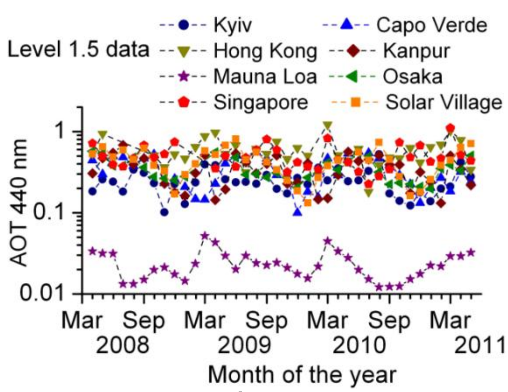

Fig. 9

Fig. 8 demonstrates that aerosol pollution and optical properties of aerosols in the atmosphere over Kyiv are very similar to the ones over large European cities. Exclusive aerosol pollution can be seen over East-European cities during strong fires in Russia in August 2010 when the aerosol optical thickness increased by more than a factor of ten. The analysis shows that the atmospheric aerosol pollution over the Kyiv site is typical of urban sites in Europe with the dominance of fine mode aerosol particles. AOT values in fig. 7 show a large variety of aerosol pollution and optical properties of aerosols in the atmosphere over the globe. Traces in fig. 7 demonstrate urban aerosol properties over big cities located in various environmental conditions (Hong Kong, Singapore, Kanpur, Osaka), and over AERONET sites at sparsely populated regions of the globe with various environmental conditions (Capo Verde – marine aerosol, Solar Village – desert aerosols, and the Mauna Loa site with a clear atmosphere is located on an island at an altitude exceeding 3 km). The important conclusion following from the comparison is that the atmosphere over Kyiv is less loaded with aerosols than somebig cities of the world.

Conclusions.

The main goal of the project was focused on establishing aerosol monitoring over Ukraine including rural and industrial areas and the development of the mobile sub-satellite polarized aerosol intercalibration/validation facility for satellite aerosol missions, existing and planned. This goal has been accomplished.

The scientific results of the project included an improved understanding of the influence of the aerosol distribution and dynamics, including transport over Ukraine, on other parts of Europe, and the effects of spontaneous aerosol releases from industrial regions, forest fires, and transportation of dust and sea salt aerosols. Special events of substantial bursts of AOT were studied as well as AOT values correlations with the transport of atmosphere masses using backward and forward trajectories (HYSPLIT model, Hybrid Single Particle Lagrangian Integrated Trajectory Model).

In spite of the failure of the NASA Glory aerosol space mission, our project has helped start a new space proposal in Ukraine: the aerosol mission concept with an instrument similar to the Glory Aerosol Polarimeter Sensor to solve the very important international-level problem of studying physical properties of atmospheric aerosols, which is the most uncertain factor of climate change impact. Should this new mission be successful, it will be extremely interesting for scientific climate modelling community due to the large uncertainty in the aerosol climate forcing.

To accomplish the sub-task of controlling air quality, we consider the results of Kacenhelenbogenf or the West Europe area. In spite of many types of aerosol particles exist in the atmosphere, but one of the most damaging to human health is known as PM2.5 (Particular Matter 2.5: particle less than 2.5 microns in diameter). These small pollutants, which come mostly from burning fossil fuels and biomass, can lodge deep in the lungs, where they could cause respiratory and cardiovascular diseases. In many countries, a ground-based monitoring system is in operation and provides PM2.5 and PM10 data. In other countries, like Ukraine, such data had not been available. The PARASOL satellite offers data useful for estimating PM2.5 when ground instruments offer limited information about the current situation over Ukraine. Based on the methods of PM2.5 retrieval by Kacenhelenbogen (2006) from the POLDER data, we derived maps that cover the Ukrainian region based on POLDER fine mode aerosol optical depth (analog of AOT) available at http://www-loa.univ-lille1.fr/ukraine/fr/quality_air.html.

Students and PhD students participating in the project have obtained valuable knowledge and practical skills making them competitive in applying for technical positions in different branches of experimental physics. They have become skilled at data processing, computing and analysis of different data using self-developed software and methods.

For future work we will continue and develop our aerosol and ozone research and observations after the end of the project. We will continue to support and update the website and the aerosol/ozone database. One permanent and two temporary AERONET sites, the ozone monitoring Regional station will be supported and observations will continue with data to be stored in the AERONET data base, and ozone data will be stored in the WMO data base. We will provide analyses of the scanning photometer ASPV and SPV data. We are going to study the chemical composition of aerosols and regional climate forcing using ground-based and satellite data collected during the project. Using a set of atmospheric monitoring and observation data the team, based on obtained experience, will work to assess in the future the aerosol impact on atmosphere regional characteristics and establish the database helping to estimate the global aerosol forcing.

In summary, the project has helped create in our University a team of atmospheric researchers, which is unique in this field in Ukraine. We will try to find financial support and opportunities for simultaneous lidar, sunphotometer and satellite instrument measurements for the collection of promising and unique data, because significant results can be obtained with lidar measurements that provide the vertical distribution of particles at the observation site.

SECTION III:
BIBLIOGRAPHY OF PROJECT-RELATED PUBLICATIONS

Peer Reviewed Journals List:

1. Milinevsky, G.P., V.O. Danylevsky, A.V. Grytsai, O.M. Evtushevsky, V. O. Kravchenko, A.P. Bovchaliuk, V.P. Bovchaliuk, M.G. Sosonkin, Ph. Goloub, L.Y. Savitska, E.V. Udodov, V.P. Voytenko. "Recent development of atmosphere research in Ukraine". Advances in Astronomy and Space Physics 2 (2012): 114-120.(Ukraine)
2. Yatskiv, Ya.S.,M.I.Mishchenko, V.K.Rosenbush, D.N.Shakhovskoy, I.I.Sinyavsky, G.P. Milinevsky, N.N.Kiselev, Yu.S. Ivanov, V.N. Petukhov, V.O. Danylevsky, A.P. Bovchalyuk. "Satellite project "AEROSOL-UA": Remote sensing of aerosols in the Earth's atmosphere."Space Science and Technology18(2012): 3-15.(Ukraine)
3. Danylevsky, V., Ivchenko, V., Milinevsky, G., Grytsai, A., Sosonkin, M., Goloub, P., Li, Z. and Dubovik, O. "Aerosol layer properties over Kyiv from AERONET/PHOTONS sunphotometer measurements during 2008-2009". International Journal of Remote Sensing32 (2011): 657-669. (UK) Cited 4 times, 2011 IF: 1.117
4. Smirnov, A., Holben, B. N., Giles, D. M., Slutsker, I., O'Neill, N. T., Eck, T. F., Macke, A., Croot, P., Courcoux, Y., Sakerin, S. M., Smyth, T. J., Zielinski, T., Zibordi, G., Goes, J. I., Harvey, M. J., Quinn, P. K., Nelson, N. B., Radionov, V. F., Duarte, C. M., Losno, R., Sciare, J., Voss, K. J., Kinne, S., Nalli, N. R., Joseph, E., Krishna Moorthy, K., Covert, D. S., Gulev, S. K., Milinevsky, G., Larouche, P., Belanger, S., Horne, E., Chin, M., Remer, L. A., Kahn, R. A., Reid, J. S., Schulz, M., Heald, C. L., Zhang, J., Lapina, K., Kleidman, R. G., Griesfeller, J., Gaitley, B. J., Tan, Q., and Diehl, T. L. "Maritime aerosol network as a component of AERONET – first results and comparison with global aerosol models and satellite retrievals". Atmospheric Measurement Techniques 4 (2011): 583-597. (Germany) Cited 13 times, IF: 3.335
5. Kravchenko,V.O., Yevtushevskyi, O.M.,Milinevsky, G.P."Distant troposphere-stratosphere teleconnections from 30-year satellite measurements of the Antarctic ozone". Space Science and Technology 18 (2012): 48–58. (Ukraine)
6. Grytsai, A., Milinevsky, G. "SCIAMACHY/Envisat, OMI/Aura and ground-based total ozone measurements over Kyiv-Goloseyev station". International Journal of Remote Sensing (2013): (UK) Submitted
7. Bovchaliuk, V., Bovchaliuk, A., Milinevsky, G., Danylevsky, V., Sosonkin, M., Goloub, Ph. "Aerosol data analysis using Microtops II sunphotometer observations over Ukraine". Advances in Astronomy and Space physics 3 (2012). (Ukraine). Submitted
8. Bovchaliuk, A., G. Milinevsky, V. Danylevsky, P. Goloub, O. Dubovik, A. Holdak, F. Ducos, M. Sosonkin. "Variability of aerosol properties over Eastern Europe observed from ground and satellites in a period from 2003 to 2011". Atmospheric Chemistry and Physics. (2013). (Germany)". Atmospheric Chemistry and Physics. (2013).(Will be submitted in December2012)

Other Non-Peer Reviewed Journals List:

1. Kabashnikov, V.P., Aculinin, A.A., Danylevsky, V.O., Kalinskaya, D.V., Korchemkina, E.M., Miatselskaya, N.S., Milinevsky, G.P., Bovchaliuk, A.P., Pietruczuk, A., Sobolewsky, P., Chaikovsky A.P. "Atmosphere aerosol transfer in the East European region by AERONET network data using the cluster analysis method". Naukovi Praci UkrNDGMI 262 (2012): (Ukraine) Accepted
2. Бовчалюк, А.П., Г.П. Милиневский, В.А. Данилевский, М.Г. Сосонкин, Ф. Голуб, В.П. Бовчалюк.“Динамика атмосферного аэрозоля над территорией Украины по данным спутникового поляриметра POLDER/PARASOL“. Состав атмосферы. Атмосферное электричество. Климатические эффекты: труды XVI Международной школы-конференции молодых ученых(2012): 70-73. (Russia)
3. Данилевский, В.А., Г.П. Милиневский, М.Г. Сосонкин, А.В. Грицай, В.Н. Ивченко, А.П. Бовчалюк, В.П. Войтенко, Ф. Голуб “Динамика атмосферного аэрозоля по измерениям с солнечным фотометром и со спутника над Украиной для исследований изменений климата”. Глобальные и региональные изменения климата (2011): 95-109.(Ukraine)

SECTION IV:
PROJECT-RELATED CONFERENCE PRESENTATIONS

Project-Related Conference Presentation List:

1. Danylevsky, V. et al. Optical and microphysical properties of aerosol in atmosphere over Kyiv in 2008 – 2011 from AERONET sunphotometer measurements, (Oral Presentation), Astronomy and Space Physics in Kyiv University. International conference in memory of P.R.Romanchuk, May 24 – 27, 2011, Kyiv, Ukraine.
2. Milinevsky, G. et al. Dobson spectrophotometer ozone measurements in Kyiv , (Oral Presentation), Astronomy and Space Physics in Kyiv University. International conference in memory of P.R.Romanchuk, May 24 – 27, 2011, Kyiv, Ukraine.
3. Bovchaliuk,V.P. et al. "Оптична товщина аерозолю над окремими регіонами України за вимірюваннями з сонячним фотометром Microtops II", (Oral Presentation), Astronomy and Space Physics in Kyiv University. International conference in memory of P.R.Romanchuk, May 24 – 27, 2011, Kyiv, Ukraine.
4. Danylevsky, V.O. et al." Ground-based support for the satellite atmosphere aerosol measurements over Ukraine", (Oral Presentation), 11th Ukrainian Conference on Space Research, August 29 – September 2, 2011,Yevpatoria, Ukraine.
5. Bovchaliuk, A.P. et al.*"*Aerosols distribution and variability over Ukraine by satellite measurements", (Oral Presentation), 11th Ukrainian Conference on Space Research, August 29 – September 2, 2011,Yevpatoria, Ukraine.
6. Milinevsky, G.P. et al."Satellite total ozone content data over Kyiv and ground-based measurements"(Oral Presentation), 11th Ukrainian Conference on Space Research, August 29 – September 2, 2011,Yevpatoria, Ukraine.
7. Milinevsky, G.P. et al. "Aerosol dynamics in Ukraine atmosphere by groundbased sunphotometer and satellite measurements", (Oral Presentation), Astronomy and Space Physics in Kyiv university. International conference in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.
8. Danylevsky, V.O. "Estimation of anthropogenic aerosols properties in atmosphere over Kyiv by AERONET sunphotometer measurements", (Oral Presentation), Astronomy and Space Physics in Kyiv university. International conference in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.
9. Danylevsky, V.O. et al. "APS and POLDER satellite aerosol polarimeter design and capability comparison", (Oral Presentation), Astronomy and Space Physics in Kyiv University. International conference in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.
10. Bovchaliuk, A.P. et al. "Aerosol dynamics over East Europe by satellite POLDER instruments data", (Oral Presentation), Astronomy and Space Physics in Kyiv university. International conference in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.
11. Milinevsky, G.P. et al. "Total ozone climatology over Kyiv/Ukraine by historical filter ozonometers and recent Dobson spectrophotometer measurements", (Oral Presentation), Astronomy and Space Physics in Kyiv university. International conference in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.
12. Milinevsky, G.P. et al. "Umkehr vertical ozone distribution in the atmosphere over Kyiv-Goloseev station", (Oral Presentation), Astronomy and Space Physics in Kyiv university. International conference

in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.

13. Bovchaliuk, V.P. "Microtops II aerosol data processing", (Oral Presentation), Astronomy and Space Physics in Kyiv university. International conference in memory of A.V. Mandzhos, May 22 – 25, Kyiv, 2012.
14. Milinevsky, G.P. et al. "Current, planned, and proposed orbital instruments to study terrestrial aerosols and their climate effect", (Oral Presentation), 12th Ukrainian Conference on Space Research, September 3 – 7, 2012, Yevpatoria, Ukraine.
15. Bovchaliuk, A.P. et al. "Dynamics of atmospheric aerosol over Ukraine during extreme wildfires", (Oral Presentation), 12th Ukrainian Conference on Space Research, September 3 – 7, 2012, Yevpatoria, Ukraine.
16. Bovchaliuk, A.P. et al."Динамика атмосферного аэрозоля над территорией Украины по данным спутникового поляриметра POLDER/PARASOL", (Oral Presentation), XVI Международная школа-конференция молодых ученых. Состав атмосферы. Атмосферное электричество. Климатические эффекты (САТЭП-2012), 28 мая – 1 июня 2012, Звенигород, Россия.
17. Milinevsky, G.P. et al."Развитие и результаты исследований нейтральной атмосферы в Украине", (Oral Presentation),The 1-st Ukrainian Conference "Electromagnetic Methods of Environmental Studies (EMES)-2012", September 25 – 27, 2012, Kharkov, Ukraine.
18. Bovchaliuk, A.P. et al."Дистанционные исследования динамики аэрозоля в атмосфере над Восточной Европой",(Oral Presentation),The 1-st Ukrainian Conference "Electromagnetic Methods of Environmental Studies (EMES)-2012", September 25 – 27, 2012, Kharkov, Ukraine.
19. Bovchaliuk, A.P. et al."Wildfires and aerosol transport: impact on Ukraine and Belarus territory", (Oral Presentation), Восьмая международная конференция "Естественные и антропогенные аэрозоли", October 1-5, 2012, St.-Petersburg, Russia.
20. Milinevsky,G.P. et al. "Atmospheric aerosol properties over Ukraine from sunphotometer and satellite measurements during 2008 – 2011", (Poster presentation),EGU General Assembly, April 22 – 27, 2012, Vienna, Austria.
21. Milinevsky, G. "Development of recent atmosphere research in Ukraine", (Oral presentation, invited), 19th Young Scientist's Conference on Astronomy and Space Physics, April 23 – 28, 2012, Kyiv, Ukraine.
22. Bovchaliuk, V. "Analysis of aerosol characteristics over Ukraine by Microtops II sunphotometer measurements", (Poster presentation), 19th Young Scientist's Conference on Astronomy and Space Physics, April 23 – 28, 2012, Kyiv, Ukraine.

1. Are you planning on making any conference presentations in the near future?

   ✓Yes

   ☐No

2. If yes, please describe planned presentations and list the titles, dates and locations of the respective conferences.

1. Bovchaliuk, A. et al. "Aerosol source and type in the Eastern Europe using back-trajectories, wavelet and cluster analyses", (Oral Presentation), 20th Young Scientist's Conference on Astronomy and Space Physics, April 2013, Kyiv, Ukraine.

SECTION V:
SUPPLEMENTAL INFORMATION (optional)

1. Do you have supplemental information you would like to provide to CRDF Global at this time?

   ✓ Yes
   ☐ No

2. If yes, please list supplemental information.

1. Presentations at the Meetings/Workshops in PDF format, titles see in Section IV Presentations No: 17, 13, 15, 8, 14. More presentations are available from the project website.
2. Photographs 1 - 8, see captures list in separate file. More photos are available to download from the project website http://antarctica.org.ua/crdf.html
3. Website link with the project information, data and photographs: http://antarctica.org.ua/crdf.html
4. Equipment CIMEL CE318N registration at University confirmation-UKG2-2969-KV-09
5. Institutional Support 18kUAH equal to 2250USD confirmation - UKG2-2969-KV-09