March 03, 2017

# IAA Study Group Status Report

**Responsible Commission:**
COMMISSION 1: Space Physical Science

**Study Number and Title:**
1.9 Satellite remote sensing of aerosols in the Earth atmosphere

**Short Study Description** (repeat from Study Group Proposal):

Overall Goal:

The polarymetry satellite remote sensing purpose and place in the investigation of temporal and spatial distribution of physical parameters of troposphere and stratosphere aerosol and cloud particles in the Earth atmosphere including evaluation their influence on climate, ecology and weather.

Intermediate Goals:

1. Long-term satellite global monitoring and database creation of optical, micro- and macrophysical and chemical characteristics of aerosol and cloud in the Earth atmosphere, their spatial and temporal distribution.

2. Precise quantitative determination of aerosol input to the Earth climate system energy balance.

3. Determination of antropogeneous aerosol impact on Earth climate change and ecology.

Methodology:

Forming an international study group, draft a detailed schedule of the study.

Agreement on a study report outline.

Assigning individual responsibility for parts of the study report.

Assigning editor to coordinate individual parts and compile a coherent study report.

Work to be conducted through on-line collaboration and study group meetings held in the course of annual International Astronautical Congresses and the IAA Spring meetings.

Time Line: 5 Years

Final Product: Report, publications

Target Community: Scientists, engineers, Governments at large, local authorities, Space Agencies, UN, European Commission

Support Needed: TBD

Potential Sponsors:

National Academy of Sciences of Ukraine; State Space Agency of Ukraine (SSAU); NASA; CNES; European Commission

**Progress in past six months:**

The works during past six months were concentrated on the progress in development of Ukrainian space project Aerosol-UA aimed in providing information on the terrestrial atmospheric aerosol spatial distribution and microphysics to quantify the aerosol contribution to the climate change and planet energy budget modeling. The aerosol remote sensing concept of the project is based on precise orbital measurements of the intensity and polarization of sunlight

scattered by the atmosphere and the surface by the scanning polarimeter ScanPol accompanied by the wide-angle multispectral imager-polarimeter MSIP.

The multi-channel scanning polarimeter ScanPol designed for remote sensing of aerosol and cloud properties will allow to measure Stokes parameters *I, Q, U* within the spectral range from the UV to the SWIR spectral bands in a wide range of phase angles (Milinevsky et al. 2016). Expected ScanPol polarimetric accuracy is ~0.15%. photometric accuracy is ~4%. The spectral channels of the ScanPol are used to estimate the tropospheric aerosol absorption capacity, the aerosol over the ocean and the land surface, the color of the ocean, the signals from cirrus clouds, stratospheric aerosols caused by major volcanic eruptions, and the contribution of the Earth's surface. The prototype instrument ScanPol has already been manufactured, assembled and is under preparing to laboratory test.

The multispectral wide-angle imager–polarimeter MSIP will collect images on the state of the atmosphere and surface in the area, where the ScanPol polarimeter will measure, to retrieve aerosol optical depth and polarization properties of aerosol by registration of three Stokes parameters simultaneously in three spectral channels. Two intensity channels of the MSIP will serve to obtain images in eight spectral wavebands to retrieve the aerosol optical depth. The main feature of the MSIP channels is the splitting of the image by a special prism-splitter for four images on the same image detector in each channel. In that way we can simultaneously measure four polarization components 0°, 45°, 90°and 135° as images in each of three polarization channels and eight images in eight spectral bands in the intensity channels. One of the special features of ScanPol/MSIP concept is calibration of the MSIP using ScanPol data in the same field-of-view. We expect that the polarization accuracy of MSIP should be better than ~1%. The computed optical and construction design of the MSIP has been developed and optical components are ready to produce.

Advantages of the project will be provided by several features: (1) polarization is a relative measurement that can be made accurately; (2) polarimetric ScanPol measurements can stably calibrated on the orbit; (3) polarization change with scattering angle and wavelength gives information on size, refractive index and shape of aerosol; (4) synergy of scanner and imager will produce new quality of data on aerosol properties.

This year stage of instruments development will be also concentrated at design single unit that joins both ScanPol and MSIP polarimeters to install at the newly created satellite platform YuzhSat. This innovative platform designed at Yuzhnoe SDO will be as expected a new tool for launch to the orbit the remote sensing research instruments.

We continue also to study aerosol parameters and behavior in the atmosphere over Ukraine. The paper on acoustic experiment which could impact on aerosol in the atmosphere has been published.

**Website Study Information update:** (please give any update regarding Study Group Membership, documents, Study Plan and Schedule):

Aerosol-UA Project website **http://aerosol-ua.mao.kiev.ua/index.php/en/main**

Documents:
New papers on the Study topic

1. Grytsai, A., Klekociuk, A., Milinevsky, G., Evtushevsky, O., and Stone, K.: Evolution of the eastward shift in the quasi-stationary minimum of the Antarctic total ozone column, Atmos. Chem. Phys., 17, 1741-1758, doi:10.5194/acp-17-1741-2017, 2017.

2. Rapoport, Y. G., Cheremnykh, O. K., Koshovy, V. V., Melnik, M. O., Ivantyshyn, O. L., Nogach, R. T., Selivanov, Y. A., Grimalsky, V. V., Mezentsev, V. P., Karataeva, L. M., Ivchenko, Vasyl. M., Milinevsky, G. P., Fedun, V. N., and Tkachenko, E. N.: Ground-based acoustic parametric generator impact on the atmosphere and ionosphere in an active experiment, Ann. Geophys., 35, 53-70, doi:10.5194/angeo-35-53-2017, 2017.

**Issues requiring resolution?** (recommend approach):

**Product Deliveries on Schedule?** (If modified explain rationale):

Report, publications

**Study Team Member Changes?** (List any Study Team Members that you wish to discontinue, and provide names plus contact coordinates of any Members you wish to add on the second page of this Study Update form.) Note: Complete contact information including email, tel. and fax must be provided for all additions. Only Members with complete contact information will be listed and receive formal appointment letters from the IAA Secretariat.)

To add:
Yury Ivanov
yutiva@gmail.com
+380679386114

Dr Mikhail Sosonkin
msosonkin@gmail.com
+380677904197

Dr Andrii Bovchaliuk
bovchaliuk@gmail.com
+380632994641

Dr Vassyl Danylevsky
vdanylevsky@gmail.com
+380509113925

**Name of person providing Study Group Status** (Study Group Chair or Co-Chair):
Study Group Chair
**Dr Yaroslav Yatskiv**
E-mail: yatskiv@mao.kiev.ua

**Status Report Date: March 3, 2017**