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 industrial 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; Yuzhnoye State Design Office, State Space Agency of Ukraine (SSAU); NASA; CNES; European Commission, ESA

Progress in past six months:

The project Aerosol-UA has the main objective to study the effects of aerosols on climate change. The Ukrainian space mission Aerosol-UA ('UA' means Ukraine), which is planned for launch in 2022, is aimed to monitor the microphysics and the spatial distribution of atmospheric aerosols. The mission payload includes the multispectral Scanning Polarimeter (ScanPol) and the MultiSpectral Imaging Polarimeter (MSIP) on board the YuzhSat satellite platform. The name

"YuzhSat" comes from the Yuzhnoye State Design Office, where the satellite platform has been developed. The ScanPol polarimeter design is based on the principle of the Aerosol Polarimetry Sensor (APS) on board of the Glory satellite. The MSIP is a multispectral wide-angle imaging polarimeter providing the aerosol parameters measurements and aerosol/clouds separation, which important for the ScanPol data corrections. The two Aerosol-UA instruments, combined together, can provide multi-angular (along-track) measurements of the polarized radiance with the considerable swath (60º provided by MSIP). Besides the aboard calibration function, the ScanPol provides the possibility for the instruments cross-calibration since their fields of view are partly overlapped.

The works during past six months were concentrated on design of the experimental model of the Aerosol-UA instruments and further development of the calibration procedure models for the 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 imaging polarimeter MSIP.

The polarimetric models have been developed for calibration of the multispectral Scanning Polarimeter (ScanPol) and the MultiSpectral Imaging Polarimeter (MSIP) of the Aerosol-UA space mission. ScanPol and MSIP polarimeters will provide the high precision measurements of the atmospheric/earth surface radiation polarization with the substantial cross-track spatial coverage. The polarimetric models simulate the main sources of the instrumental errors, such as the finite extinction ratios of polarizers and the phase retards of telescopes. The mirrors mismatching, dark reference signal, the difference in the polarimeter channels gain, and the instrumental depolarization factor are modeled as additive values and scalar multipliers. The polarimetric models are presented in a form of the Mueller matrices, which describe the transformation from the incoming polarized radiation to the measured signal.

The parameters of the polarimetric models are estimated experimentally. The numerical experiments have been carried out to validate the effectiveness of the proposed calibration procedures. The results have shown the possibility to minimize the ScanPol polarization errors below 0.15% (DoLP) and 0.2º (AoLP), and the MSIP polarization errors below 1%. The set of two polarimeters, one is the along-track scanner and the second is the wide-angle imager, allow providing the in-orbit cross-calibration of the MSIP using the ScanPol measurements when their fields of view are overlapped. The concept of the MSIP and ScanPol polarimeters cross-calibration is developing as well.

The updated timeline of the mission agreed:

Aerosol-UA mission has been included into State Space Program of Ukraine	– 2018
State Space Program of Ukraine to be adopted	– 2019
Aerosol-UA payload experimental model	– 2019
Aerosol-UA flight payload ready	– 2020
Aerosol-UA flight payload testing	– 2021
Aerosol-UA launch (planned)	– 2022

We continue also the study aerosol parameters and behavior in the atmosphere over Ukraine in preparation for calibration and validation the mission data.

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

Aerosol-UA Project website is redesigned and under updating process.

Documents:

New papers on the Study topic

Pubished:

Dubovik, O., Li, Z., Mishchenko, M.I., Tanre, D., Karol, Y., Bojkov, B., Cairns, B., Diner, D.J., Espinosa, W.R., Goloub, P., Gu, X., Hasekamp, O., Hong, J., Hou, W., Knobelspiesse, K.D., Landgraf, J., Li, L., Litvinov, P., Liu, Y., Lopatin, A., Marbach, T., Maring, H., Martins, V., Meijer, Y., Milinevsky, G., Mukai, S., Parol, F., Qiao, Y., Remer, L., Rietjens, J., Sano, I., Stammes, P., Stamnes, S., Sun, X., Tabary, P., Travis, L.D., Waquet, F., Xu, F., Yan, C., and Yin, D. Polarimetric remote sensing of atmospheric aerosols: instruments, methodologies, results, and perspectives. (2019). Journal of Quantitative Spectroscopy and Radiative Transfer 224, 474-511. https://doi.org/10.1016/j.jqsrt.2018.11.024.

In review:

Milinevsky G., Ye. Oberemok, I. Syniavskyi, A. Bovchaliuk, I. Kolomiets I. and I. Fesyanov. Polarimetric modeling and calibration of the Aerosol-UA space mission instruments. J. Quant. Spectrosc. Radiat. Transfer, (submitted, in review) 2019.

Evtushevsky O.M., Kravchenko V.O., Grytsai A.V., Milinevsky G.P. Winter climate change on the northern and southern Antarctic Peninsula. Antarctic Science. (submitted, in review) 2019.

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:

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: February 28, 2019