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; 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. Aerosols are not widely studied or understood, and scientists understand that aerosols may have as much influence on climate change as greenhouse gases. We are designing and preparing the scientific payload with appropriate sensors, processing and communications systems which will be included in the Aerosol-UA mission satellite.

The works during past six months were concentrated on the progress in design the Aerosol-UA instruments and 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.

This year stage of instruments development was also concentrated at design and testing the MSIP channel and creation of the mass-dynamical model of the single unit payload for YuzhSat satellite platform designed at Yuzhnoe SDO.

The polarimetric modeling for the multispectral Scanning Polarimeter (ScanPol) and the MultiSpectral Imaging Polarimeter (MSIP), the instruments of the Aerosol-UA space mission, has been developed. The polarimeters will measure with high precision the degree of linear polarization (DoLP) and angle of linear polarization (AoLP) of sunlight scattered by clouds and aerosols. The polarimetric models include main sources of systematic polarimetric errors such as finite extinction ratios and offsets of polarizers and birefringence of telescopes, which are all described by Mueller matrices. The signal zero level bias, the difference in the polarimeter channels gain, and instrumental depolarization factor are modeled as an additive values and scalar multipliers. The polarimetric models are the products of specified Mueller matrices and scalar values that tend to describe precisely a transformation of the incoming light polarization and intensity during light propagation through the ScanPol and the MSIP optical units. The model allows calibration procedures that provide precisely assess and effective compensation of the polarimeters instrumental polarization imperfection. It is assumed the ground-based stage calibration the both ScanPol and MSIP instruments, in-orbit permanent calibration of the ScanPol instrument with onboard reference units, and in-orbit intercalibration of the ScanPol and the MSIP, since their fields of view are overlapped. To assess the effectiveness of proposed calibration procedures the number of numerical experiments was carried out. They demonstrated an excellent compensation of the ScanPol and the MSIP polarization errors by ground-based calibration procedures. The imperfection compensation, which could be reached potentially, is restricted only by the quality of reference sources and signal-to-noise ratio. In-orbit calibration procedure demonstrates an acceptable result providing to measure the DoLP with required error < 0.15% and AoLP with error < 0.2 degrees (in case when DoLP>0.2) for the ScanPol instrument.

This first Aerosol-UA satellite when it is completed and launched will be only the first of several such satellites which are being considered to study aerosols in the atmosphere and how they contribute to climate change. The Aerosol-UA team is already beginning to look at the advanced Aerosol-UA-2.0 mission.

We continue also the study aerosol parameters and behavior in the atmosphere over Ukraine. The review paper on atmospheric aerosol over Ukraine region: current status of knowledge and research has been published.

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

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

Documents:

New papers on the Study topic

1. Syniavskyi, I.I., Ivanov, Yu.S., Sosonkin, M.G., Milinevsky, G.P., Koshman, G. Multispectral imager-polarimeter of the "AEROSOL-UA" space project. Space Sci.&Technol. 2018, 24(3):23-32. https://doi.org/10.15407/knit2018.03.023
2. Bovchaliuk, V., Milinevsky, G., Danylevsky, V., Goloub, Ph., Sosonkin, M., Yukhimchuk, Yu., Podvin, T. Aerosol properties in atmosphere over Kyiv using lidar and sun-photometer observations. Space Sci.&Technol. 2017, 23(6): 34-45. https://doi.org/10.15407/knit2017.06.034
3. Milinevsky G., Danylevsky V. Atmospheric aerosol over Ukraine region: current status of knowledge and research. 2018. Frontiers in Environmental Science. Environmental Informatics, doi:10.3389/fenvs.2018.00059

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.)

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