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Climate Change 2019: Earth's Stratospheric Aerosol Parameters Repairement From Polarimetric Measurements Of The Sky- O Zbrutskyi- Igor Sikorsky Kyiv Polytechnic Institute, Ukraine

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Earth's climate changes are the result of natural changes in the energy balance of Sun irradiation and influence of anthropogenic factors on the variations of ozone layer thickness and stratospheric aerosol abundance. A miniature ultraviolet polarimeter for satellite polarimetric experiments in the ultraviolet region of the sunlight spectrum was developed. The main task of this device is to obtain information on the aerosol physical properties as a result of sky photo- polarimetric measurements. This device was tested on a bench specially designed and manufactured by us. A set of special computer programs was developed to analyze the spectral polarimetric measurements data of cloudless sky performed at the AZT-2 telescope (Main Astronomy Observatory, Kyiv, Ukraine). Thus it is possible to calculate the spectral phase dependences of the degree of linear polarization of solar radiation scattered by the Earth’s atmosphere. A homogeneous gas-aerosol medium model is using when aerosol particles characteristics and their size distribution function parameters are changing. That is, the ground-based polarization observations of a cloudless sky make it possible to study a lot of aerosol physical characteristics in the Earth’s troposphere and bottom stratosphere.

It was proposed the method of the stratospheric aerosol studies based on using of ultraviolet polarimeter (UVP) operations. A possibility of aerosol particles microphysical characteristics determining in the Earth’s atmospheric troposphere and stratosphere by an approximate analysis of the polarizing ground based measurements data of a cloudless sky made during the day and immediately after sunset is confirmed.

It were combined the efforts of three institutions to prepare a possible experiment to study from a spacecraft the physical characteristics of stratospheric aerosol. As a result, the mock-up UAV was been created. This device allows polarization measurements of the Earth's stratosphere from a spacecraft.

The photomultiplier R1893 operates at the photon counting mode. Temperature sensors check a temperature of both the medium and the receiver. A special designed hollow-rotor piezoelectric motor rotates the polarization element. Necessary data from temperature sensors (on the receiver, on the engine, etc.) are transferred to computer interface for the purpose of processing and further analysis. The special software has been developed for control the plane of polarization of the corresponding elements position control, respectively to the put target.

A special bench to set up and study the current prototype of the UVP, its individual blocks and their combination, was been developed. It can be divided into the separate interchangeable parts, units and blocks.Such a design makes it possible to change research tasks easily and quickly as well as constantly improve the bench itself. The UVP studies performed at the test bench made it possible to determine its technical parameters and performance characteristics.

With this equipment, that was thoroughly investigated the operation of the light emission receiver (R1893 photomultiplier) to determine its noise threshold at supply voltages in the 1050-1500V range (dark pulses are 2-4 pulses/sec) and the device operating voltage was selected. Reading stability of device output signals has been investigated extensively. It was determined during long hours of dark and useful signals measurements. To verify the methodology for conducting polarization observations of the cloudless sky, there was used a modification of current prototype the onboard ultraviolet polarimeter UVP. It was mounted on the AZT-2 telescope (70 cm mirror and 15 m focal length) . We have realized the polarimetric observations with improved prototype of ultraviolet polarimeter on 26-th and 27-th of September 2017. Remark, that from the 24-th till 29-th of September all days and nights were cloudless above Kyiv, Ukraine. We oriented the telescope at a part of the sky with the Sun declination equal to zero degree for an angle equal to 1h from the central meridian. Operation began by turning off the clockwork mechanism of the telescope at 14:00 UTC+2 and observations were completed at 20:00. We used for observations the λ = 362 nm filter located between the visible and ultraviolet light spectral regions and also have cut a portion of the sky using a diaphragm with a diameter of 0.5 mm. The piezoelectric motor rotates the modulator unit with the polarization element (Glan prism) at a 45° the same angle. Thus, one rotation through 360° the modulator carried out in 8 steps. Exposure was selected in 2 seconds. At the beginning of operation, the useful signal stream was about 300 k pulses per second with a dark stream of no more than 20 pulses per second. The results of obtained observations, as well as the additional results were used for analysis and subsequent processing.

The DLP phase dependence of light scattered by small isotropic particles with low true absorption is close to Rayleigh scattering. However, if the imaginary part of complex refractive

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index of those particles increasing significantly, the maxima of the DLP from the phase angles of shifted toward values equal to 60°/300°, respectively. In case the aerosol physical parameters unchanging, the DLP of the light scattered by particles decreases with wavelength decreasing. There were modeled the characteristics of light scattering by a static ensemble of homogeneous randomly oriented particles, having the simplest non-spherical shape (for example, elongated and oblate spheroids, cylinders). Results of such works showed a significant effect of particles shape on the radiation characteristics scattered by them. However, attempts to simulate the scattering characteristics of aerosol particles with complex shapes that actually exist in nature (crystals, snowflakes, soot, dust, etc.) encounter the impossibility of an analytical description and the complexity of the algorithmizing of such a problem. The results of observational data processing have shown the effectiveness of our methodology and program codes for data analysis of spectral polarimetric measurements the linear polarization degree values phase dependences of daylight and twilight zenith sky. The shapes and absolute values coincidence of calculated model dependences with the measurement data in a wide range of wavelengths indicates a possible correspondence between the values of the reconstructed model aerosol parameters and their real data.

It should be emphasized that the proposed technique allows one to determine the probable parameters of gas-aerosol medium averaged over the whole atmospheric column, the height of which is determined by the zenith distance of the Sun. The task of determining the altitude and characteristics of individual aerosol modes requires additional research.