SOLAR RADIANCE MEASUREMENTS DURING 22° CIRCULAR HALO OBSERVATIONS IN KISHINEV ON MAY 21, 2007

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On May 21, 2007 over the Kishinev city it was observed 22° circular halo (see Fig. 1). The halo is very beautiful natural phenomenon but it cannot be considered as an infrequent one among the other optical phenomena in the atmosphere. Specific meteorological conditions are only responsible for the halos appearance. Millions of ice crystals in the high cirrostratus cloud at the height of more than 6 kilometers above the Earth surface form the halo and this cloud is on the advancing edge of warm fronts in atmosphere. Halos appear in skies often enough and they can be seen on average twice a week in Europe and in some parts of the United States. Halo represents a colored ring of 9°, 18°, 22°, 46°, and 90° around the Sun. But the most frequent halo has 22° circle. The variety of halos and accompanying complex optical phenomena such as parhelic circles, arcs, Sun pillars, etc. are due to form of crystals (hexagonal ice pillars and plates), size and their orientation. The inner edge of the circle for each of halos is colored in red. Hexagonal prism crystals (pillars and plates) with an effective size (diameter) of 15-50μm are suspended in air and they have poor orientations. The rays passing (with refraction and dispersion) through two prism side faces inclined 60° to each other produce the 22° halo.

Fig 1. Photo of the coloured 22^0 circular halo has been made at the Kishinev station #7 of the State Hydrometeorological Service on May 21, 2007. At the right side of the image it can be clearly seen the faint arc which is a part of the parhelic circle observed during the halo episode.

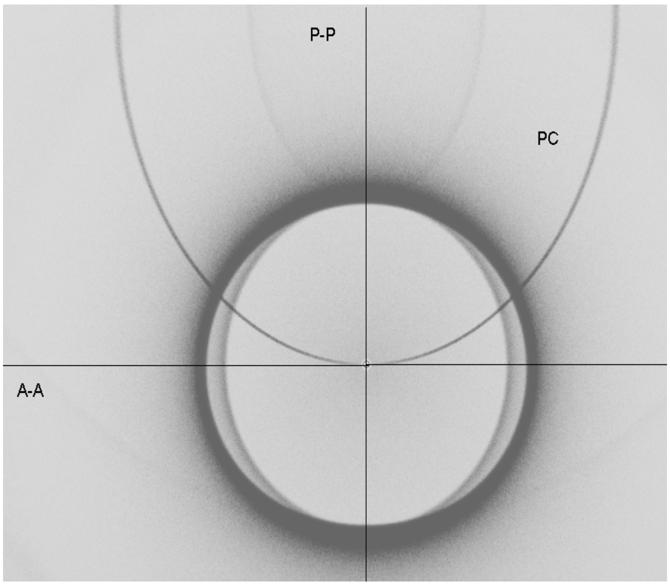

Fig. 2. Result of computer modeling the of 22^0 circular halo phenomenon. The image of the halo is presented in grey scale and as negative one. Numerical ray tracing consists of 10^8 rays. Sun was centered for camera view. Principal and almucantar planes are designated with symbols (P-P) and (A-A). Parhelic circle is marked with symbols PC.

Numerical ray tracing in computer modeling of 22° circular halo was fulfilled with using of the HaloSim software (http://www.sundog.clara.co.uk/halo/downld.htm). It was used of 10^8 rays in modeling and results of modeling are shown in Fig. 2. The image of modeled halo has a colored circle, but here it is presented in a grey scale and it is negative one. It can be clearly seen the resemblance between the observed halo (Fig.1) and results of halo computer modeling (Fig.2), in particular the solar radiance distribution pattern and the presence of the faint arc which is a part of the parhelic circle (PC).

Sun and sky radiance measurements with sunphotometer Cimel CE-318 are fulfilled at the ground solar radiation monitoring station within the framework of the international Aerosol Robotic Network (AERONET) programme, managed by NASA/GSFC. In the course of time of the 22^o halo observation direct sun radiance and sky radiance in the almucantar and principal planes were carried out with sunphotometer. Variability of sky radiance measured with sunphotometer in principal (P-P) and almucantar (A-A) planes are shown in Fig.3 and 4. Position of the halo's circle is clearly seen at both figures and it is marked with the arrow.

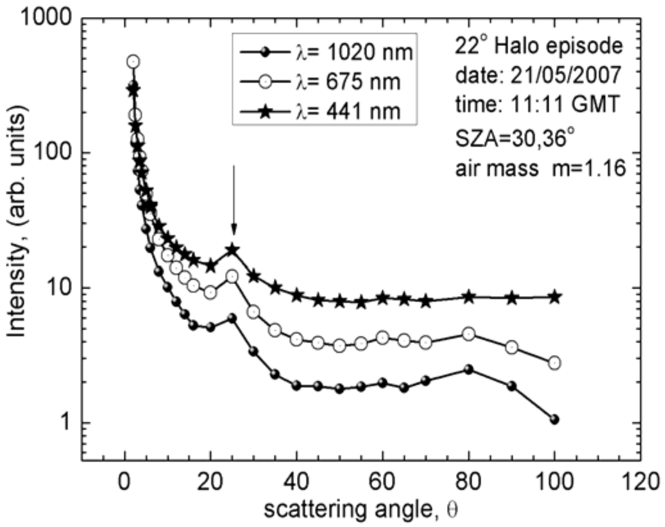

Fig. 3. Variability of sky radiance measured with sunphotometer Cimel-318 in principal plane indicated in Fig. 2 as (P-P).

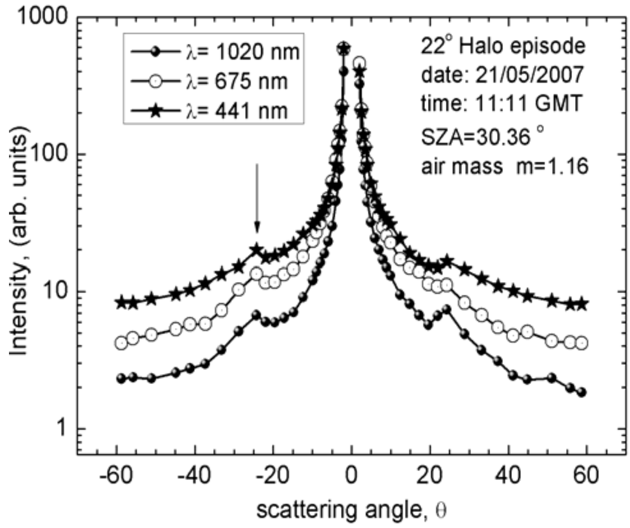

Fig. 4. Variability of sky radiance measured with sunphotometer Cimel-318 in almucantar plane indicated in Fig. 2 as (A-A).

Angstrom exponent α_{440_870} and aerosol optical depth $\tau_a(500)$ at λ=500 nm were derived from sun/sky radiance measurements during the period of halo observations from 11:00GMT to 12:00GMT. These characteristics amounted to α_{440_870} ~0.2 -0.3 and $\tau_a(500)$~ 0.28 (from AERONET database v.2 Level 1.0), taking into account that their daily mean values were $<\alpha_{440\_870}>$~ 0.8 and $<\tau_a(500)>$~ 0.15. Low value of α_{440_870} is evidence of the presence of large particles in atmosphere, namely in the cirrostratus clouds, which were clearly observed. Values of particle effective radius of the volume size distribution function have been retrieved from direct solar radiance measurements carried out in 09:03GMT and 12:03GMT. Estimations of the effective radius of cloud particles (spheroidal model was used in retrieving procedure) amounted to ~ 3.9 μm and ~ 5.1 μm, respectively . Relatively large value of aerosol optical depth $\tau_a(500)$ confirms the fact of solar radiation extinction by thin semitransparent cirrus clouds consisting of large particles.