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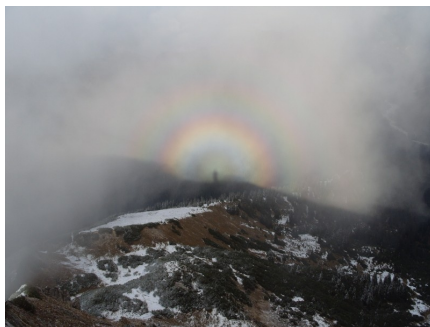


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# **Computation of angular distributions for solar radiation scattered by clouds. Visualization of coronas, glories and fogbows**

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On this Web page we present results of our research aiming at computation of angular distributions for solar radiation scattered by clouds and fogs. You can find here a few papers, references, links and corresponding software to compute the angular distributions and visualize such optical phenomena like coronas, glories and rainbows.



- ▲ The software is free. Please, refer to the software when you use it in your work.
- ▲ Please, inform us about successful application of the software.
- ▲ The software is still **under development**. Any feedback is highly appreciated. Please, send your remarks to Sergei M. Prigarin [\[send e-mail\]](#) or to the authors of the corresponding software
- ☼ The research was partially supported by RFBR (15-01-00783, 16-01-00145, 16-31-00038).

## Software

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Programs to compute phase functions and Mueller matrices of water-drop clouds and fogs, [FORTRAN sources and MS Win binaries](#)

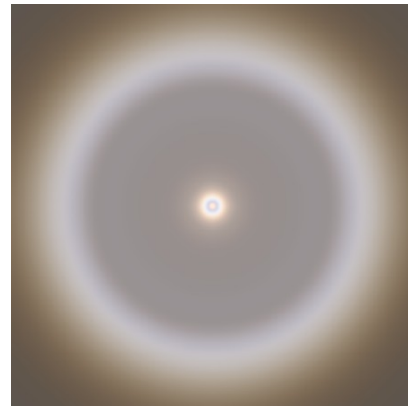
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Simulation of the radiation transfer in a plane-parallel layer with an optically isotropic and homogeneous scattering medium: [MS Win binary files](#)

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Visualization of rainbows, glories and coronas: [DisplayCIE](#), [ShowRainbow](#), a [brief description](#) for both programs (only in Russian at the moment).

These two similar programs are aimed to visualize such optical phenomena as halos, coronas, rainbows and glories.



An image of glory from the Internet (on the left) and results of simulation (on the right)

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## References

**S.M. Prigarin, K.B. Bazarov, U.G. Opperl, Looking for a glory in A-water clouds, Atmospheric and Oceanic Optics, Vol.25 (2012), No.4, P.307-313**

**Abstract:** In this paper we discuss a hypothesis proposed by Anatoly N. Nevzorov that considerable amount of water in cold clouds can exist in a specific phase state with the refractive index  $\approx 1.8$  and density higher than  $2 \text{ g/cm}^3$  (so called A-water). One of the arguments mentioned in favor of this hypothesis is that the glory phenomenon can be better explained by existence of A-water. In our paper we consider this argument in detail studying the phase functions of A-water clouds for different distributions of droplet size.

**Key words:** clouds, A-water, glory, rainbow, corona, phase function, polarization

**DOI:** 10.1134/S1024856012040124

**S.M. Prigarin, K.B. Bazarov, M. Kerscher, U.G. Opperl, Numerical study of rainbows and glories in water-drop clouds, Russian J. Numer. Anal. Math. Modelling, V.28 (2013), No.3, P.245-266**

**Abstract:** In this paper we study scattering phase functions in water-drop clouds for various distributions of droplet size and various conditions of glory, rainbow and corona formation, and discuss the hypothesis proposed by A. N. Nevzorov that a considerable amount of water in cold clouds can exist in a specific phase state with the refractive index  $\approx 1.8$  (so called A-water). Polarization and angular distributions are studied by the Monte Carlo method for radiation reflected by cloud layers with drops of water or hypothetical A-water taking into account multiple scattering. Computational results make it possible to develop procedures for analysis of microphysical structure of clouds and confirmation or disproof of the existence of A-water.

**Key words:** optics of water-drop clouds, A-water, glory, rainbow, corona, scattering phase function, polarization of light, multiple scattering.

**DOI:** 10.1515/ mam-2013-0015

**Sergei M. Prigarin, Kim B. Bazarov, Ulrich G. Opperl, The effect of multiple scattering on polarization and angular distributions for radiation reflected by clouds: results of Monte Carlo simulation, Proc. SPIE 9292, 20th International Symposium on Atmospheric and Ocean Optics: Atmospheric Physics, 929201 (December 3, 2014)**

**Abstract:** In this paper we study the light scattering in water-drop clouds for various distributions of droplet size. Polarization and angular distributions are simulated by Monte Carlo method for radiation reflected by cloud layers. Computational results make it possible to develop procedures for analyzing the microphysical structure of clouds.

**Keywords:** optics of water-drop clouds, polarization of light, multiple scattering, Monte Carlo simulation

**DOI:** 10.1117/12.2177947

**E.G. Kablukova, S.M. Prigarin, S.A. Rozhenko, Phase functions, glories, fogbows and coronas for clouds with mirror-transformed gamma- and bimodal-distributions. Proc. SPIE 9680, 21st International Symposium Atmospheric and Ocean Optics: Atmospheric Physics, 968026 (November 19, 2015), 5p.**

**Abstract:** In this paper we study the phase functions for water-droplet clouds and fogs computed by the Mie theory for specific bimodal and "mirror"-transformed droplet size gamma-distributions. In addition, we construct images of coronas, fogbows and glory that can occur for such cloud and fog models.

**Keywords:** optics of water-droplet clouds and fogs, scattering phase function, fogbows, glory, coronas.

**DOI:** 10.1117/12.2205949

**E.G. Kablukova, S.M. Prigarin, Monte Carlo simulation of specific features of radiation regime in clouds caused by underlying surface, Proc. SPIE 10035, 22nd International Symposium on Atmospheric and Ocean Optics: Atmospheric Physics, 100351N (November 29, 2016)**

**Abstract** — This paper presents the results of Monte Carlo simulation of the radiation regime in clouds and describes the effects caused by solar radiation reflected by the underlying surface. Simulation results show that under certain conditions the actinic flux and irradiance can achieve maximal values at specific heights inside.

**Keywords:** radiation transfer, clouds, underlying surface, Monte Carlo simulation

**DOI:**10.1117/12.2248976

## A few additional Links

[Atmospheric Optics](#)

[Weather Facts](#)

[АТМОСФЕРА И МИР АТМОСФЕРНЫХ ЯВЛЕНИЙ](#)

[Атмосферные явления](#)