Interplanetary Magnetic Field Disturbances Affect on the Ozone Profiles

Nugzar Nachkebia, Marine Despotashvili, and Jumber Kharchilava
M. Nodia Institute of Geophysics of Georgian Academy of Sciences, 1, M. Alexidze str, 380093, Tbilisi, Georgia

Abstract

We study interplanetary magnetic field (IMF) disturbances possible affect on the ozone vertical profiles. We use the data of ozone and temperature profiles measured from 231 ozonesondes flown at Boulder (CO) Station in 1997–2002. 45 cases of galactic cosmic ray (GCR) intensity Forbush decreases are observed at Tbilisi Neutron Monitor Station and 51 events of the IMF clouds were used as sign of the IMF disturbances. The solar proton fluxes data were used as well. The data set used for the investigation enables to reveal only 23 events of the IMF disturbances accompanied with ozonesonde flights. We have noted that the IMF clouds are main reasons of the ozone depletions. The maximum depletion is observed at the altitude about 13 km, which is about 20 % of main ozone peak value. Due to the IMF cloud affect on GCR is small, our finding is surprise.

1. Introduction

The ozone molecules concentrated mainly between altitudes of 15 to 35 km have determined the temperature structure of the stratosphere and by absorbing the harmful ultraviolet radiation have safeguarded life on our planet. The life-protecting role of the atmospheric ozone stems from its ability to absorb dangerous ultraviolet radiation [1].

Over the past half century, humans have placed the ozone layer in jeopardy. Unwittingly we have released into the atmosphere chemicals, which are the main reasons of the ozone depletion. Beside the chemicals, the interplanetary media disturbances may affect to the processes determined the ozone losses. There are still some uncertainties regarding the connection between the ozone layer and solar activity. In the present work we study the interplanetary magnetic field (IMF) disturbances possible affect on the ozone vertical profiles.

2. Experimental Data and Method

We use the data of ozone and temperature profiles measured from 231 ozonesondes flown at Boulder (CO) Station in 1997–2002 [2]. During the discussed

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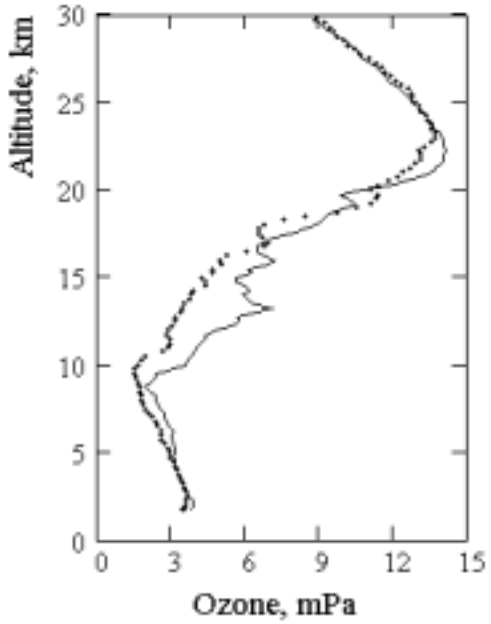

Fig. 1. Averaged ozone vertical profiles before (lines) and after IMF magnetic clouds (points).

period there were observed 45 cases of Fds with magnitude $\geq 4\%$ according to the high latitude neutron monitors [3]. We used the data of 51 events of IMF clouds [4]. The magnetic clouds are ideal objects for solar-terrestrial studies because of their simplicity and their extended intervals of southward and northward magnetic fields [5,6]. The solar proton fluxes data were used as well [7]. Existence of the Fds, IMF cloud either enhanced solar proton fluxes were assumed as a sign of interplanetary media disturbances. We compare the pair of ozonesonde flights (prior and during IMF disturbances) with time intervals less than 8 days. We consider only the ozonesonde flights which happen after start moment of the IMF disturbance within < 3 days. Due to the gap in the ozone observations, the data set used for the investigation enables to reveal only 23 events of the IMF disturbances accompanied with the ozonesonde flights.

3. Results and Acknowledgement

We have noted that about 75% cases of Fds and 50% of enhanced solar proton fluxes are accompanied with the ozone depletions. So, it's not clear affect of Fds or solar proton fluxes in ozone depletions. However, we have noted that IMF clouds are accompanied with the ozone depletions in all cases (Fig.1, the lines and points- the ozone vertical profiles before and after the IMF magnetic clouds respectively). During all cases (9 events) of the IMF clouds, the ozone depletions were observed at the altitude 9–19 km and 20–24 km. The maximum

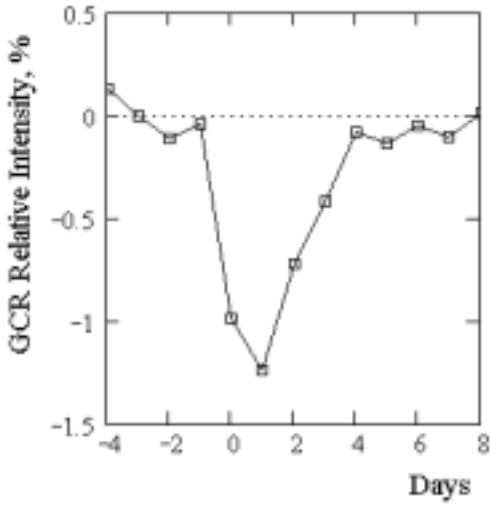

Fig. 2. Magnetic cloud affect in Oulu Neutron Monitor daily relative intensity. 51 zero days are selected as the start days of the IMF clouds during 1997–2002.

of averaged depletion is observed at the altitude about 13 km, which is about 20 % of main ozone peak value.

There were observed a narrow layer of ozone increase. Averaged total ozone decreases from 326 to 303 DU. We calculated the temperature effect in the ozone depletion. It is neglected due to small differences between the temperatures before and after magnetic clouds. We also tried to estimate the magnetic cloud effect in cosmic rays. Fig. 2 represents the superposed epoch analyses for Oulu Neutron Monitor daily data during discussed period. 51 zero days are selected as the start days (days of arrival at Earths orbit) of the IMF clouds. Analyses of the Fig.2 show that the IMF cloud affect on GCR intensity is small (about 1 %). The same analyses for Tbilisi Neutron Monitor data reveal even smaller effect, as it was expected. So, the IMF cloud effect in GCR intensity is smaller than the affect of Fds. That means that the IMF cloud affect to ozone depletion goes not via the GCR intensity variation. In this respect our finding is surprise. Probably, this is a new link of solar terrestrial connections.

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