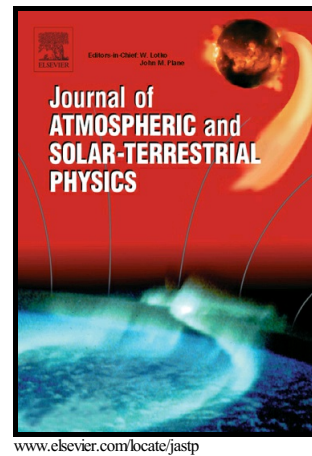


# Author's Accepted Manuscript

Response of the middle atmosphere to the geomagnetic storm of November 2004

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PII: S1364-6826(16)30361-3  
DOI: <http://dx.doi.org/10.1016/j.jastp.2016.12.013>  
Reference: ATP4530

To appear in: *Journal of Atmospheric and Solar-Terrestrial Physics*

Received date: 2 November 2016  
Revised date: 7 December 2016  
Accepted date: 9 December 2016

Cite this article as: Klemens Hocke, Response of the middle atmosphere to the geomagnetic storm of November 2004, *Journal of Atmospheric and Solar Terrestrial Physics*, <http://dx.doi.org/10.1016/j.jastp.2016.12.013>

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1 Response of the middle atmosphere to the geomagnetic  
2 storm of November 2004

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6 **Abstract**

7 Ozone and temperature profiles of the satellite microwave limb sounder  
8 Aura/MLS are used for the derivation of the middle atmospheric response to  
9 the geomagnetic superstorm of 9 November 2004. We find a destruction of the  
10 tertiary ozone layer at 0.022 hPa (77 km) in the northern winter hemisphere  
11 lasting for about one week. This effect is surely due to the solar proton event  
12 (SPE) of November 2004. At the same time, the zonal mean temperature is  
13 enhanced by 5-10 K in the northern polar mesosphere. On the other hand,  
14 the zonal mean temperature is decreased by 5-10 K in the northern polar  
15 stratosphere. We do not think that the strong temperature perturbations are  
16 directly related to the SPE. It seems that the polar vortex was moved by the  
17 geomagnetic storm, and this vortex movement caused the strong temperature  
18 variations in the zonal mean. However, internal variability of temperature  
19 in the polar middle atmosphere in winter without any significant link to the  
20 geomagnetic storm cannot be excluded.

21 *Keywords:* Ozone, middle atmosphere, geomagnetic storm, solar proton  
22 event, Aura/MLS

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23 **1. Introduction**

24 The present study is focused on the mesospheric effects of the solar proton  
25 event (SPE) of 7-10 November 2004. This SPE was accompanied by a geo-  
26 magnetic superstorm which was subject of numerous articles (Rastogi et al.,  
27 2012; Rama Rao et al., 2009; Yermolaev et al., 2008; Simi et al., 2013; Tsu-  
28 rutani et al., 2008; Panasenko and Chernogor, 2007). However, these studies  
29 are about the ionospheric and magnetospheric effects of the November 2004

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