Atmospheric impact of SEP events during the last years of solar cycle n. 23 highlighted by MLS OH radicals

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The descending phase of solar cycle n. 23 has been characterized by several Solar Energetic Particle (SEP) events. These events were not so strong as the previous ones that occurred close to solar maximum, even though they were able to impress their traits on the terrestrial atmosphere. Moreover, since August 2004 the availability of the data from Microwave Limb Sounder aboard the quasi polar orbit EOS AURA spacecraft allowed to monitor the polar middle atmosphere. In particular, the last release (MLS Version 2.2) of OH radical abundance (which extended toward the mesopause the upper boundary for the data use) confirmed that it is a very good proxy to follow transient solar activity as predicted from past modelled findings. Due to some isolated SEP events with flux around few hundreds of pfu (Particle Flux Units; 1 pfu = 1 cm\(^{-2}\) sr\(^{-1}\) s\(^{-1}\)), it was possible to test the lowest particle flux which is able to influence the middle atmosphere. In this way, the presence/absence of SEP-induced effects in the atmospheric environment seems easily to be checked very quickly.

It has been known since early 70 that the impact of SEP events induces an increase of H\(_3\)O\(_2\) (H\(_2\)O + HO\(_2\)) on the polar atmosphere (e.g., Swider and Konesha, 1973); nevertheless we had the possibility to compare models with experimental data only since August 2004 when the Microwave Limb Sounder (MLS) started recording OH and HO\(_2\) radicals (Verronen et al., 2006). Since the instrument is able to make measurements also in the nighttime, when the hydroxyl abundance is low, we have the possibility to study also SEP events of medium/low intensity. Indeed, these events induce low ionization compared with other daytime sources, so the SEP-induced OH increases are often not evident under sunshine. We can utilize the MLS OH recorded at nighttime as proxy of almost all SEP events which reach the Earth’s environment. Therefore we have a tool that can discriminate quickly whether medium SEP events are able to induce mesospheric perturbations. In this work we used OH values of daily zonal means averaged over 75–82° latitude N&S under nighttime conditions unless otherwise noted.

\[ \text{Fig. 1} \text{ – Goes daily proton flux from November 2004 to December 2006.} \]

Tab. 1 – SEP events list from November 2004 to December 2006.

<table>
<thead>
<tr>
<th>Start</th>
<th>Maximum</th>
<th>Maximum</th>
<th>Energy</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/0425</td>
<td>1880</td>
<td>1880</td>
<td>1.65E+08</td>
<td>171</td>
</tr>
<tr>
<td>15/0240</td>
<td>3140</td>
<td>1900</td>
<td>2.87E+07</td>
<td>160</td>
</tr>
<tr>
<td>07/1910</td>
<td>29/1715</td>
<td>41 38</td>
<td>9.40E+06</td>
<td>15/0345</td>
</tr>
<tr>
<td>11/0425</td>
<td>1880</td>
<td>1880</td>
<td>1.65E+08</td>
<td>171</td>
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</tr>
</tbody>
</table>

**Conclusions**

This work points out the possibility to utilize daily zonal means of OH recorded under nighttime conditions as proxy of almost all SEP events which hit the Earth’s environment. Changes of OH abundance are evident at least up to about 300 pfu. The OH increases connected to SEPs events could be hidden during times of increased air descent inside the polar vortex.

**Acknowledgments**

This work was supported by ASI contract I/015/07/0 (ESS2 Project) and the National Antarctic Research Program of Italy.

References