Pollution events over the East Mediterranean: Synergistic use of GOME, ground based and satellite observations and models

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Introduction

Retrievals of trace gas columns of O3, NO, and HCHO from the measurements of backscattered radiation by GOME (Global Ozone Monitoring Experiment) [Burrows et al. 1999 and 2000], interannual comparisons and comparisons with Systeme d’Analyse by Observation Zenithale (SAOZ) [Goutil et al. 1999], balloon [Thompson et al. 2003; Simeonov et al. 1998, Calpini et al. 1997] and LIDAR measurements show that the East Mediterranean is in spring, and particularly in May 1999 during the International PAU II campaign in Crete carried out at Finokila (35°24' N; 25°60') by the University of Crete [Kouvarakis et al., 2001], is influenced naturally by back ground conditions but also by biogenic emissions and urban pollution related to different changes in wind direction between north and south. When following air masses along the trajectory we derived that air masses transported from N-NW (North-North-West) Europe towards the Mediterranean region are associated with an increase of tropospheric amounts of NO, by a factor of 1.4 to 1.5 and of HCHO by a factor of 1.6 to 1.8 as can be seen from GOME. Box model calculations show that such an increase of tropospheric amounts of NO, and HCHO column enhanced the tropospheric O3 column in the tropical regions) on the Hudson and Thompson [1998] for the background calculations show that such an increase of tropospheric amounts of NO, and HCHO show that such an increase of tropospheric amounts of NO, and HCHO column enhanced the tropospheric O3 column in the tropical regions) on the Hudson and Thompson [1998] for the background calculations show that such an increase of tropospheric amounts of NO, and HCHO column enhanced the tropospheric O3 column in the tropical regions) on the Hudson and Thompson [1998] for the background calculations show that such an increase of tropospheric amounts of NO, and HCHO show.

Results

The comparison of the vertical columns of O3 from GOME [Burrows et al. 1999 and 1999] with SAOZ (Systeme d’Analyse by Observation Zenithale) and TOMS (Total Ozone Mapping Spectrometer) (a.m. and p.m. data [Goutil et al. 1999] data show a variation of 120 DU (Dobson Units) during May 1999 over Crete (see Fig 1a) situated in the sub-tropical region. From the calculation of 5-day back trajectories it can be seen that in the case that Crete is affected by south winds (influence by the transport of air masses from the tropics) the total columns of O3 are in the range of 270 DU (1° to the 4° of May 1999, see Fig. 1b) whereas high O3 columns up to 402 DU (2° to the 10° and 26° to 31° of May 1999, see Fig. 1c) are reached for the same trace gas when air masses are coming from the north.

Figs. 1a-c: Total columns of O3 measured by SAOZ and TOMS system and compared with GOME data for May 1999. 5-day back trajectories of air masses on May 1, 1999 (left) and on May 31, 1999 (right) showing strong influence from NW Europe and Balkans over Crete. The calculations were performed using the HYSPLIT 4-model (http://www.arl.noaa.gov/readdy/hysplit4.html).

The comparison of the tropospheric column amounts of O3 based on ozonesonde [Thompson et al. 2003; LIDAR [Simeonov et al. 1998, Calpini et al. 1997] and GOME data show (see Fig 2) an increase of 23 DU (27DU to 50DU) e.g. between the 5° and the 10° of May 1999 (north-west) followed by a reduction down to background conditions of 20 DU (a value that is close to the 24-25 DU estimates by Hudson and Thompson [1998] for the back ground tropospheric O3 column in the tropical regions) on the 26th of May 1999 (south winds). During the pollution events when air masses were transported from N-NW (North-North-West) Europe and the Balkans (more pollution) to Crete the back ground conditions over the Mediterranean, see tab. 1, towards the Mediterranean region the precursors of tropospheric NO, O3 and HCHO show an increase of a factor of 1.4-1.5 and of 1.6-1.8 respectively as can be seen from GOME when following air masses along the trajectory. Box model calculations show that such an increase of tropospheric amounts of NO, and HCHO column enhanced the tropospheric O3 column by only 1-2 DU per day. As no trend were observed for NO2 and HCHO tropospheric columns for the time period of 1996 to 2002 (see figs. 3a-b) no significant increase of locally produced tropospheric O3 is estimated.

Figs. 2: Variation of tropospheric vertical columns of O3 from satellite based observations by GOME, ozonesoneds and ground based LIDAR observations as carried out at Nafplio, Crete for May 1999.

<table>
<thead>
<tr>
<th>Trace</th>
<th>Crete</th>
<th>Atlantic</th>
<th>Subtropical</th>
<th>Pe</th>
<th>Subarctic</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>1.23±0.6</td>
<td>1.1±0.6</td>
<td>0.9±0.6</td>
<td>0.9±0.6</td>
<td>0.9±0.6</td>
</tr>
<tr>
<td>HCHO</td>
<td>4.5±1.0</td>
<td>3.0±1.0</td>
<td>1.5±1.0</td>
<td>1.5±1.0</td>
<td>1.5±1.0</td>
</tr>
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</table>

Tab. 1. Mean values of tropospheric NO, and HCHO (given in molecules cm^-2) for the month May based on GOME data for different regions.

Conclusions

The Mediterranean region is mainly influenced by clean air conditions but from time to time an increase of the total columns as well as of the tropospheric column amounts of O3, associated with the transport of air masses from the north direction towards the Mediterranean region, can be seen from GOME data compared with SAOZ, TOMS and ozonesonde measurements. Model calculations (TMS and ROSE) showed that only 1-3 DU are photochemically produced whereas -1.2 are caused by transport processes mainly from the stratosphere irreversible to the troposphere (STE, -1.2 DU).

References


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