Estimation of UV flux at the Earth's surface using GOME data

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Preliminary results of global UV fields estimation at the Earth's surface computed using data from the GOME instrument are presented. A first simple model is used to test the best strategy for implementing the cloud effect on surface UV flux. It relies heavily on the cloud coverage estimation from GOME (ICFA and PMD measurements). A second, more accurate model is derived from the algorithm developed for the TOMS instrument by NASA/GSFC.

Introduction

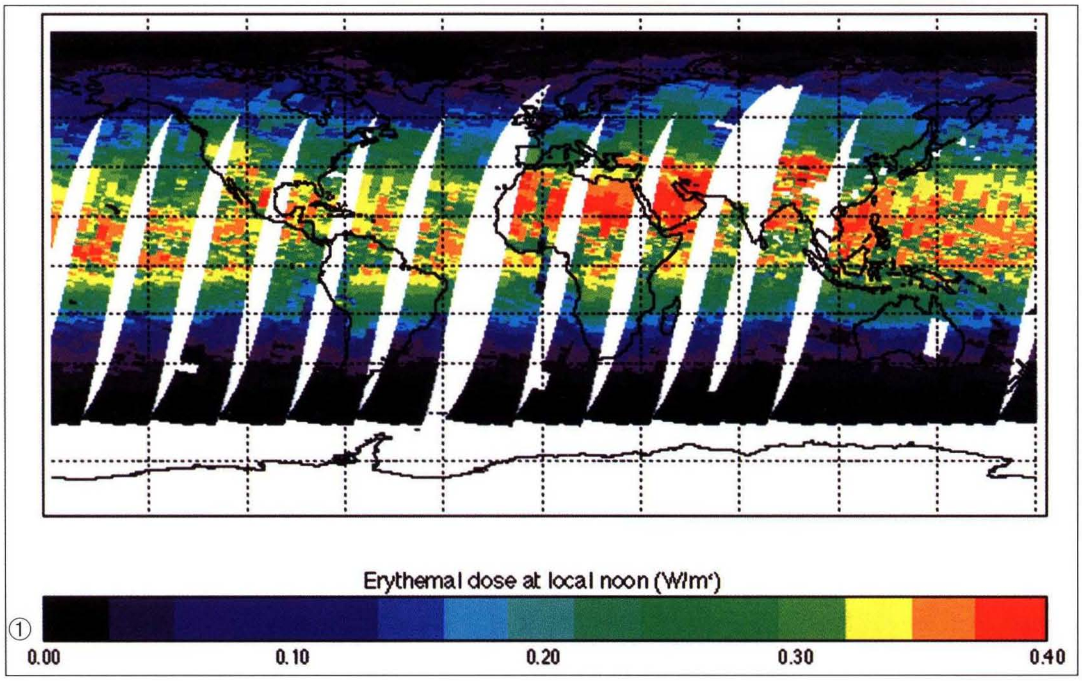
It is now established that an increase of surface UV radiation is linked to the stratospheric ozone depletion. Since UV exposure increase may have several harmful effects on human health or ecosystems and given that the ozone depletion has not yet reached its maximum, the necessity for monitoring the surface UV radiation is of great importance.

The monitoring of UV radiation at the Earth's surface essentially relies on ground-based observations. Remote sensing is, however, the only way to achieve a global view of the radiative fields. The European GOME instrument on board of the ERS-2 satellite measures the radiation backscattered by the atmosphere and reflected by the ground. Its performances make it a potentially good instrument for providing valuable information for UV monitoring from space.

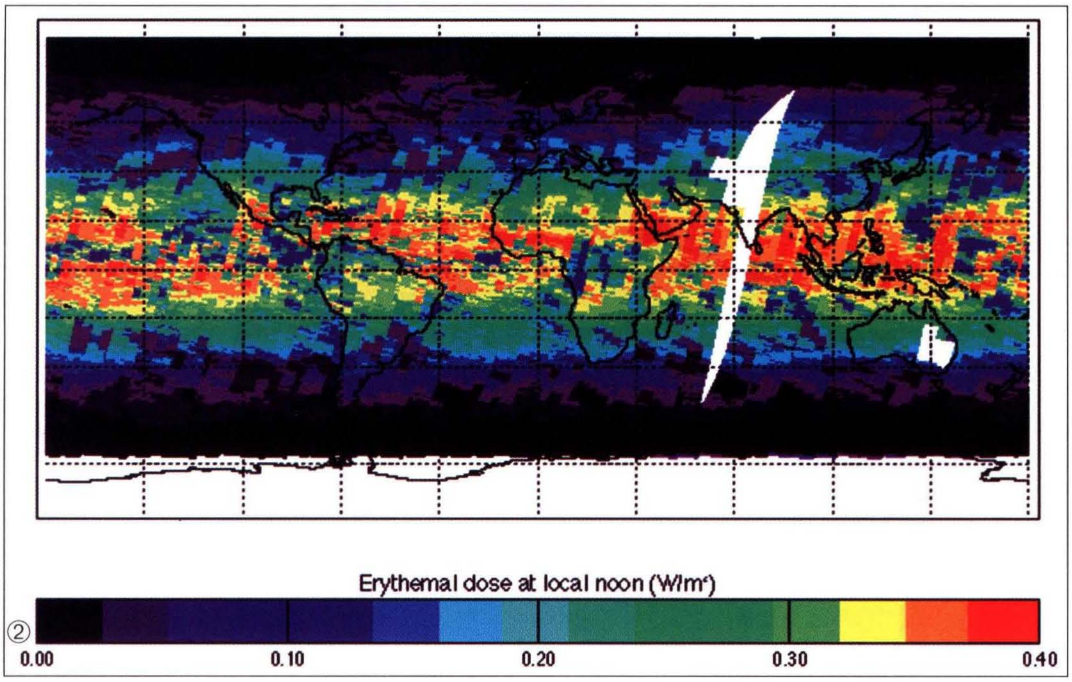
Since 1996, NASA/GSFC has provided UV erythemal exposure maps derived from the 15 years (1978-1993) data set of the TOMS/Nimbus-7 instrument (*Eck et al. 1995*). The estimation of surface UV-B from GOME data can certainly benefit from the TOMS experience. Moreover, the GOME instrument provides additional information about the state of the atmosphere observed by the spectrometer. In particular, it gives useful information about the cloud coverage of the observed scene.

UV-B estimation using GSFC algorithm

Since the release of the first UV erythemal doses from TOMS measurements in 1996, the original TOMS algorithm has been considerably revised and several improvements have been implemented. The main improvements deal with the estimation of the putative cloudiness of the scene. The Lambertian equivalent (effective) reflectivity at



① *GOME UV/GSFC, 10-13 July 1996 (GDP V1.0)*



② GOME UV/IASB VO.9
20 April 1997

380 nm is now replaced by a Cloud Correction Factor (CCF) derived from the measured radiance at 360 nm (*Krotkov et al. 1996*).

We have tested a preliminary release of the updated GSFC algorithm using GOME data. Figure 1 displays the UV erythemal dose at local noon from GOME data processed through a preliminary version of GSFC algorithm. The GOME inputs are the N values at 6 different channels (radiance/irradiance) for CCF computation, total ozone, satellite solar zenith angle and location. A test set of 30 orbits from 10-13 July 1996 has been used.

UV-B estimation and cloud modeling

In addition to the usual atmospheric absorbers in the UV like oxygen and ozone, clouds have a dramatic screening effect on the incoming extraterrestrial fluxes from the Sun. Incoming flux is scattered by cloud droplets and the intensity reaching the ground is considerably reduced.

GOME provides an estimation of the cloud coverage of the observed pixel using the Initial Cloud Fitting Algorithm (ICFA). Cloud top pressure and pixel cloud coverage are estimated by comparing computed and measured radiances around the oxygen A-band (761 nm) and is a standard level 2 product.

To test the possible use of ICFA cloud coverage for UV-B estimation, we have build a very simple model based on a 2-stream pseudo-spherical radiative transfer model making use of the ozone measurements from GOME as well as the cloud coverage and cloud top pressure from ICFA. When a cloudy scene is detected, the final surface flux is a linear combination of the clear sky estimated flux and fully cloudy scene flux. The cloudy scene is defined such that a water cloud layer of optical thickness 50 (at 550 nm) and physical depth of 1 km is inserted at the prescribed altitude.

Figure 2 shows the UV erythemal dose at local noon from the same set of data as before computed using the described algorithm. For clear sky pixel both algorithm gives the same results but the cloudy pixels UV dose exhibit in general a value lower than the GSFC algorithm. A partial explanation for this discrepancy lies in the fact that the ICFA product used in this test are unfortunately wrong and overestimated especially when the surface albedo is high like the Sahara region. ICFA has been corrected since then and is implemented in the operational data processing version 2.3.

Information about the cloud field can also be obtained from the 16 PMD measurements for each pixel. Such a product has already been developed at the DLR. It has the advantage to give a higher resolution of the cloud coverage, each PMD subpixels being 1/16 the size of a regular pixel. This approach will be tested very shortly. Another approach could be to use very high-resolution cloud information from other spaceborne instruments like AVHRR. Given the huge amount of data needed, this technique is best suited for regional maps (*Meerkoetter et al. 1997*)

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