Air pollution linked to Remote Sensing tools - Science training using a Master's Level e-Learning Tool

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Introduction

As we know it today air pollution is a release into the atmosphere of any substances, chemicals or particles, which are harmful both to the human and animal health as well as the health of the wider environment. The use of satellite based instruments is a young and developing research field and excellent for studying air pollution events over large areas at high spatial-temporal resolutions, especially when ground measurements, which are limited in spatial-temporal coverage, are not available.

Students on postgraduate level should be trained in using and analysing remote sensing data from both ground and satellite based instruments and/or in interpreting the high variety in remote sensing, e.g., satellite images or maps. Therefore an online e-learning module has been devised and constructed to facilitate the teaching of *Remote Sensing of the Troposphere from Space* to research students at Master's level.

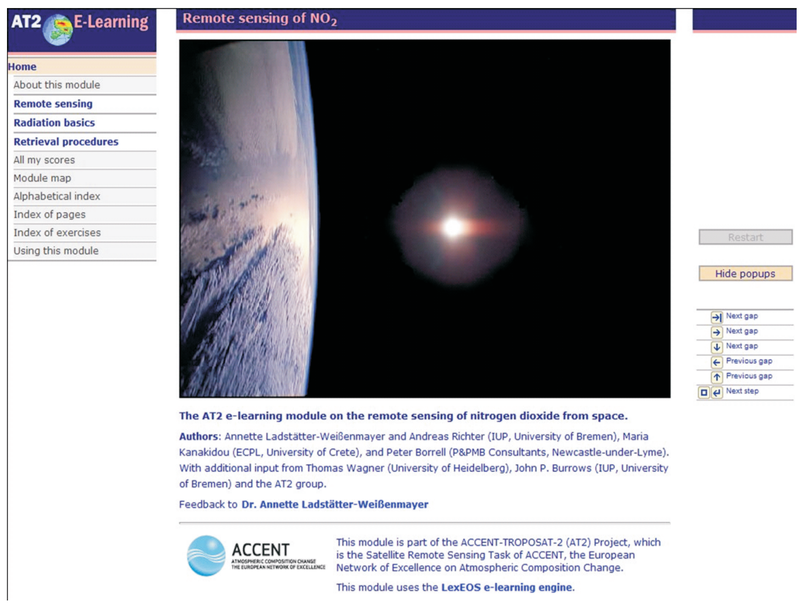

Fig. 1. Starting the AT2 e-learning module on "Remote Sensing of the Troposphere from Space"

Presenting the material in the module

Starting the AT2 e-learning module on "Remote Sensing of the Troposphere from Space", you will find three segments in the browser window:

Left column: index and your current position in the module
Middle: main text and tutorial questions
Right column: navigation (only within the same level), some options and exercise scores

Since tropospheric NO_2 is highly variable in space and time, the advantages of remote sensing from space are evident.
The first section on Remote Sensing deals with the importance of the nitrogen oxides, NO_x (= NO and NO_2) and the use of satellite instruments (GOME [Burrows et al., 1999] and SCIAMACHY [Bovensmann et al., 1999, Gottwald et al., 2006]) and remote sensing measurements. The satellite scanning concepts and techniques such as polar, near-polar and sun-synchronous orbits, swath, scan sequences, different observing modes such as nadir, limb and occultation mode and their measurement sequence and wavelength ranges are explained as well [Gottwald et al., 2006].

Fig. 2. The student is taken, step-by-step, through a case study of biomass burning, presented in terms of the emission and distribution of the trace gases NO_2, HCHO, and O_3, as observed by GOME [Ladstätter-Weißenmayer et al., 2005, Meyer-Arnek et al., 2005].

Different types of nitrogen compounds in the atmosphere, sources and sinks and their altitude and spatial distribution are explained in more detail [Wayne, 2000].

Different processes such as absorption, scattering and reflection have to be taken into account to understand the radiative transfer in the atmosphere. The second section deals with an introduction to the concepts of electromagnetic radiation, radiative transfer and the radiation transfer equation. Blackbody radiation, blackbody absorption and Planck's Law are explained in more detail.

The concentration of the trace gas like NO_2 is determined by the DOAS (Differential Optical Absorption Spectroscopy) method [Platt, 1994] which is explained both graphically in a step-by-step guide and, mathematically [Richter and Burrows, 2002], in a step-by-step presentation of the DOAS equation in the third section on Retrieval Procedures.

Testing comprehension in the module

In order to verify the level of comprehension attained, the learning process is supported by about 70 interactive exercises that allow the student to evaluate his or her understanding and comprehension of the material at each step.

Five exercise types (Gap option exercises, Category marker exercises, Multiple choice exercises, Gapfill exercises, Type-in exercises) are used in the interactive sections of the AT2 e-learning module. Each of these principal types has several variants. In addition the module offers a complete scoring system, so the students have an overview of their knowledge directly.

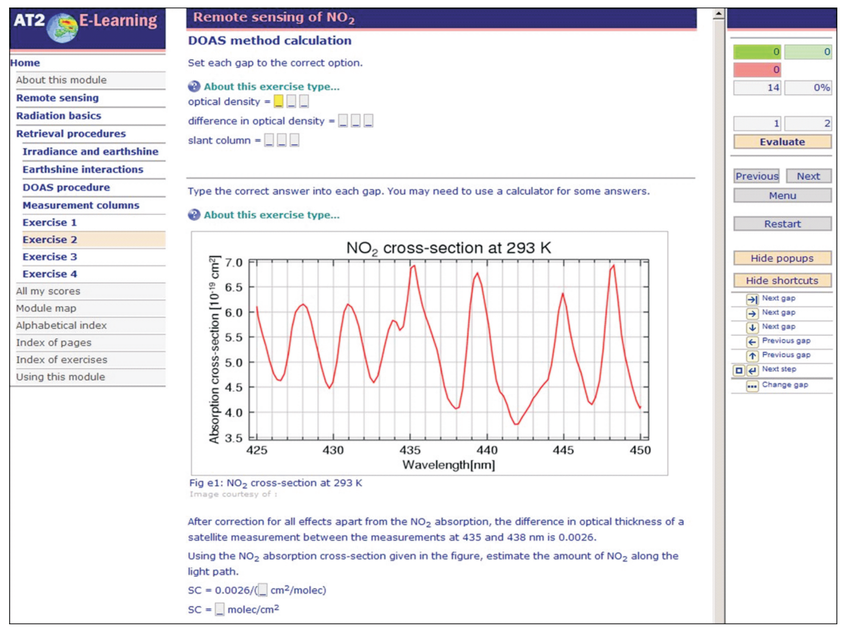

Fig. 3. An example of a gap option and type-in exercise.

Conclusions

The AT2 e-learning module on "Remote Sensing of the Troposphere from Space" has been constructed to facilitate the teaching of the Remote Sensing of Troposphere from Space to research students at a Master's level. The module is essentially an 'interactive on line text book' with high-level material and which allows students to test and to improve their comprehension. The module is a stand alone module and accessible on the internet:
http://www.iup.uni-bremen.de/E-Learning/at2-els_NO2/index.htm

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