driven by the outcome of data validation. The comparison to collocated observations from other instruments makes systematic errors visible that may be recognised as deficiencies in instrument calibration or retrieval algorithms.

The division leads the international effort to validate the data products of SCIAMACHY on board of ENVISAT (launched March 1st, 2002). SCIAMACHY measures trace gasses such as ozone, methane and carbon monoxide that are important for climate and atmospheric chemistry studies.

Four distinct phases of validation of SCIAMACHY data products are distinguished: the preparatory phase until launch, the commissioning phase, the main validation phase and the long-term validation phase. The main validation phase started in the second half of 2002 and will last until the end of 2003.

Preparation of future satellite missions
An early involvement in the preparation of future satellite missions gives opportunities to influence instrument design such that it optimally fulfils scientific needs.

The Satellite Application Facility on Ozone Monitoring (O3MSAF) project is a joint project of EUMETSAT and several European meteorological institutes and prepares for the operational delivery of ozone products from the GOME-2 instrument on the three METOP missions in the timeframe 2005-2020. KNMI has the responsibility to develop retrieval algorithms for the ozone profile and aerosol and leads the validation.

Coordinated by the group, scientific requirements have been established for a possible future atmospheric chemistry mission, ACE-CHEM. This study formed the basis of a proposal for an Earth Explorer Core mission delivered to ESA in 2001. Although the mission was not selected in this round of further studies and possible launch, the concept remains ‘alive’ and new possibilities for development and future launch are being studied. Also, the results of the requirements study are frequently used in preparations for other missions.

Paramaribo Station
In 1999 KNMI and the Meteorological Service of Surinam (MDS) have started an atmospheric observation programme in Paramaribo, Surinam (South America, 5.8° N, 55.2° W). Initially the observations consisted of surface ozone concentrations, weekly ozone soundings and continuous observations of UV spectra, ozone...
columns and (stratospheric) Umkehr profiles with a Brewer spectrophotometer. These observations are submitted on a routine basis to international networks such as NDSC, SHADOZ, WOUDC and the Envisat calibration/validation database. In 2002 a sun photometer, a solar radiation station, a total-sky imager and a MAX-DOAS spectrometer have been installed. These observations are very valuable for satellite validation and for studies of atmospheric composition and radiation in the tropics. Some results are presented in the Highlight on tropical processes in this Report.

The Ozone Monitoring Instrument

The Ozone Monitoring Instrument (OMI) will fly on NASA’s EOS-AURA satellite, now scheduled for launch in January 2004. OMI is a UV/VIS, nadir viewing spectrometer that will provide near global coverage of solar backscatter radiances in one day. OMI has heritage from the TOMS, SBUV, GOME, GOMOS and SCIAMACHY, but has several technological advances. Using the wavelength range 270 to 500 nm with a 0.5 nm resolution, OMI will measure several key parameters for stratospheric and tropospheric chemistry and for climate research, including O₃, NO₂, SO₂, OClO, BrO, HCHO, UVB, aerosol and cloud properties (see Figure 2). Combining OMI data with the other Aura instruments will allow derivation of further tropospheric gases important for air quality studies and climate. OMI’s high spatial resolution (13 x 24 km) will allow more frequent observations between clouds, thus giving better penetration into the troposphere than any other UV/VIS backscatter instrument flown to date.

The overall project management resides with the Dutch Space Agency NIVR in co-operation with FMI (Finnish Meteorological Institute) and NASA. A consortium of Dutch Space and TNO-TPD built the OMI instrument and developed the level 0 software with contributions by the Finnish industry (VTT and Finavitec).

KNMI is the Principal Investigator (PI) institute. The PI has to safeguard the overall scientific value of the mission. This is done in close co-operation with NASA GSFC and FMI scientists, represented in the international OMI science team, which is chaired by the OMI PI. Responsibilities of KNMI are to define the science, instrument and calibration requirements, to develop data products and to validate those. Moreover, KNMI will manage the Instrument Operation Team (IOT), which will perform the commanding of the OMI-instrument during the lifetime of the mission. A data processing site is also being developed, which will process part of the OMI-data and will be used to monitor instrument parameters for in-flight calibration. All data will be available via the EOSDIS NASA Goddard Space DAAC System. Preparations have been made for a KNMI Near Real Time system that produces ozone columns within 3 hours after measurement. These provide wind fields at high altitudes, which will be used for operational meteorology. Furthermore, OMI will provide Very Fast Delivery (VFD) ozone and UV products (within 30 minutes of detection) for north and middle Europe using the direct broadcast feature from Aura.

During 2001 and 2002 the KNMI OMI science team has worked on many aspects of the OMI project. Two of them, the development and review of retrieval

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Figure 2. Mini Ozone hole above Europe on 30 November 1999, as derived from GOME measurements
algorithms and tests of the performance of the instrument are discussed in more detail in the next paragraphs. Another highlight occurred in November 2002 when OMI was the first instrument of the EOS-Aura payload which was delivered for spacecraft integration. Currently, KNMI is heavily involved in tests concerning the operation of the instrument.

OMI ATBD Review
For each data product developed within the NASA EOS system, the scientific foundation is described in the so-called Algorithm Theoretical Basis Documents (ATBDs). The ATBDs present a detailed picture of the instrument and the retrieval algorithms used to derive atmospheric information from the instrument’s measurements. NASA reviews all ATBDs by installing an external panel of independent experts. The OMI ATBDs were written by the International OMI Science Team. The Dutch contribution is predominantly from KNMI researchers and describes the algorithms for total ozone DOAS, Ozone Profile, UV-VIS aerosol optical thickness, NO$_2$ total columns and cloud fraction and cloud pressure. The OMI ATBD review took place in Washington DC, USA at the 8th of February 2002. The review was chaired by Prof. Burrows from Bremen University and was very favourable, which is seen as a strong indication for the scientific validity and accuracy of the data products to be produced by OMI. Based on the review report, the OMI ATBDs were updated and posted on the NASA web site: http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/

Initial tests of the performance of OMI
In August 2002 two types of test measurements were performed with the OMI flight model. The purpose of these measurements was to test OMI under in-flight thermal-vacuum conditions, by measuring atmospheric constituents using scattered solar radiation observed at different solar elevations (zenith sky measurement) and thus to perform OMI’s first real atmospheric experiment. First the overall performance of the OMI instrument was successfully checked, by measuring the absorption of radiation from a lamp with known properties by ozone and nitrogen dioxide present in a gas cell that was put in front of the instrument.

To perform the zenith sky measurement the instrument, placed on the ground, views the sky in zenith, looking at solar radiation that has travelled through the ozone layer, is partly absorbed there, and is subsequently scattered towards OMI by aerosols or molecules in the atmosphere (Figure 3). The ratio of the two spectra measured at two different solar elevations matches the absorption cross section of ozone. Figure 4 shows that the measured absorption spectrum of atmospheric ozone compares well with literature values of this spectrum. The zenith sky and absorption gas cell measurements have demonstrated that the OMI flight model is capable of measuring ozone and nitrogen dioxide from space.

**Figure 3.** Principle of zenith sky measurements. At two solar elevations, $E_1$ and $E_2$, the path through the absorbing ozone layer differs and the ratio of these spectra will correspond to the absorption spectrum of ozone.

**Figure 4.** Example of a DOAS fit for the wavelength window used for the retrieval of ozone from a zenith sky measurement. The circles are the measurements, the line the fit, based on absorption cross-sections taken from the literature.
Scientific publications in reviewed journals

2001


2002


Other scientific publications and reports 2001


2002


Pollutants, Torino, Italy, 7–20 September, J. Hjorth, F. Raes and G. Angeleletti (Eds.), CD-ROM, AP128.


Number of national presentations
2001: 24
2002: 27

Number of international presentations
2001: 30
2002: 56
Education and organisation of workshops

2001
Kelder, H.M., professor of Atmospheric Physics, Technical University of Eindhoven.

2002
Kelder, H.M., professor of Atmospheric Physics, Technical University of Eindhoven.

Committees
Brinksma, E.J., OMI Validation Working Group, chairman.
Claas, J., OMI Operations Working Group, chairman.
Dobber, M.R., OMI Calibration Working Group, chairman.
Goede, A.P.H., BESC Begeleidingscommissie Sciamachy (NIVR), member.
Goede, A.P.H., GeoTROPE, (ESA), co-investigator.
Goede, A.P.H., ROAT Remote sensing Onderzoek Atmosfeer (BCRS), member.
Goede, A.P.H., SCIAMACHY, co-principal investigator (NIVR).
Goede, A.P.H., TROPOSAT Steering Group (EuroTRAC), member.
Haan, J.F. de, Dutch OMI Algorithm Working Group, chairman.
Kelder, H.M., EGS session Chemical data assimilation, co-convenor.
Kelder, H.M., EU Project Vintersol, Coregroup, member.
Kelder, H.M., ICACO, member.
Kelder, H.M., International Ozone Committee, member.
Kelder, H.M., PhD Committee E. Brinksma, member.
Kelder, H.M., PhD Committee C. Ethé, rapporteur.
Kelder, H.M., PhD Committee G. Koch, co-examiner.
Kelder, H.M., PhD Committee R. Koelemeier, member.
Kelder, H.M., PhD Committee M. Marchand, rapporteur.
Kelder, H.M., PhD Committee E. Meijer, member.
Kelder, H.M., PhD Committee J. Meloen, 1st promotor.
Kelder, H.M., PhD Committee W. Peters, member.
Kelder, H.M., PhD Committee A. Segers, member.
Kelder, H.M., PhD Committee R.J. Spurr, promotor.
Kelder, H.M., PhD Committee A. Staay, member.
Kelder, H.M., PhD Committee O. Tuinder, member.
Kelder, H.M., PhD Committee M. Zachariasse, 1st promotor.
Kelder, H.M., Review Committee University of Graz, Austria, member.
Kelder, H.M., SCIAMACHY Validation and Interpretation Group, chairman.
Kelder, H.M., SSAG, member.
Kelder, H.M., TROPOSAT Steering group, member.
Levett, P.F., Dutch OMI Science Team, chairman.
Levett, P.F., EOS Investigators Working Group (IWG), member.
Levett, P.F., OMI Science Advisory Board (OSAB), chairman.
Levett, P.F., OMI Science Coordination Team (OSCT), chairman.
Levett, P.F., OMI, principal investigator.
Piters, A.J.M., SCIAMACHY Validation and Interpretation Group, project manager.
Siegmund, P.C., PhD Committee J. Meloen, co-promotor.
Timmermans, R., SCIAMACHY Validation and Interpretation Group, scientific secretary.
Veenkind, J.P., Dutch OMI Algorithm Working Group, chairman.
Veenkind, J.P., OMI Algorithm Working Group, chairman.
Veenkind, J.P., OMI Datasystems Working Group, co-chairman.
Velthoven, P.F.J., van, EGS session Aircraft Emissions, co-convenor.
Velthoven, P.F.J., van, Eumetnet Theme-group Ozone forecasting feasibility study.
Velthoven, P.F.J., van, PhD Committee M. Zachariasse, co-promotor.