User Requirements Document (URD)

AMIL2DA

(Advanced MIPAS Level 2 Data Analysis)

Deliverable D3
Project EVG1-CT-1999-00015
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Shared Cost Action within the RTD generic activities of the
5^{th}-FP EESD Programme of the European Commission.

1 THE MAIN USER GROUPS:

1. **The scientific community of remote sensing theory and application.** This group of users includes all scientists who work on theory and application of radiative transfer in the atmosphere, remote sensing retrieval theory and application, as well as remote sensing technology.

2. **The community of space borne Fourier spectroscopy of the atmosphere.** This community communicates via the periodic workshop on Atmospheric Sciences from Space using Fourier Transform Spectrometry (ASSFTS).

3. **The scientific community of atmospheric research.** This user group includes all scientists who work on atmospheric physics or chemistry and who plan to use MIPAS-Envisat data for their research. While our results in general will be useful for a wide community, they will be of particular interest for groups working on MIPAS data. Particular use of improved and/or extended data products as provided by AMIL2DA will be made by scientific groups doing data assimilation in the framework of operational weather prediction (like ECMWF), ozone/UV prediction (like KNMI), predictions of climate trends (like DLR Oberpfaffenhofen), or predictions of climate-chemistry coupling (like DLR Oberpfaffenhofen). All these applications have direct implications on economics, environmental politics, and public health.

   Groups indicating their interest in using MIPAS data by having submitted a related proposal to ESA are: Atmospheric and Environmental Research Inc.; Belgian Institute for Space Aeronomy; Bologna University; British Antarctic Survey; Byrd Polar Research Center; Deutsches Zentrum für Luft und Raumfahrt e.V.; Dipartimento de Ingegneria Elettronica; Forschungszentrum Jülich; Forschungszentrum Karlsruhe; I. N. P. E. Institute of Applied Physics, Switzerland; Instituto di Astrofisica de Andalucia; I. R. O. E.; Istituto Spettroscopica Molecolare C. N. R.; Laboratoire de Meteorologie Dynamique; LPCE-CNRS; LPMA-CNRS; Marmara Research Center; Meteorologiska Institutionen, Sweden; NASA; National Institute of Water and Atmospheric Research, New Zealand; Royal Meteorological Institute of Belgium; Service d'Aeronomie, CNRS; St Petersburg University; Swedish Institute of Space Physics; Universität Bremen; University of Liege; University of l'Aquila; Universität München; University of Oxford; University of Reading.

4. **The European Space Agency.** In particular the Agency's Envisat calibration and validation activities will benefit from AMIL2DA. This does not only include MIPAS validation activities but also GOMOS and SCIAMACHY, since these experiments will benefit from AMIL2DA activities in a sense that AMIL2DA will provide data suitable for cross-validation purposes. Furthermore lessons learned during AMIL2DA will help ESA to properly select and define experiments for future missions.

2 THE SORT OF RESULT AND OPERATIONAL CONSTRAINTS OF THE USER

1. **Demonstration of retrievability of data beyond MIPAS standard data products**. This includes retrieval of abundances of species not covered by the MIPAS standard product as well as retrieval of MIPAS key-species at better quality. AMIL2DA will provide knowledge on the retrievability of the following non-standard products: trace gas abundances of NOy species (N_2O_5, NO, $ClONO_2$, etc.), non-methane hydrocarbons (NMHC's), inorganic and organic chlorine species, and others. Moreover, AMIL2DA will provide data product characterization with respect to: extended altitude coverage, improved global coverage of non-standard products by optimizing data processing, more complete error characterization (in particular useful for application in data assimilation schemes), and additional quantities like PSCs properties, photolysis rate of NO_2, and others.

   ESA product specifications are: accuracy of trace gas abundances of H_2O, CH_4, N_2O, O_3, HNO_3, NO_2 of 5 %, temperature accuracy of 1 K. These requirements, however, over-optimistic, since in most cases the error in spectroscopic data alone exceeds this threshold. The spatial coverage is 500 km sampling width along-track and 2800 to 500 km sampling-width across-track.

   As an example of user "operational constraints", the accuracy requirements as posed by the ESA funded study "Atmospheric Chemistry Experiment" by Kerridge et al, 2000, are listed. While these accuracies will not be reachable by MIPAS, in particular at the desired spatial resolution, these numbers may serve as a rough guideline into which direction to work.

   (a) MIPAS key species
   - O_3 (2-30 % at 25 × 25 × 2 km grid);
   - NO_2 (5-20 % at 25-50 × 25-50 × 1-2 km grid);
   - H_2O (1-10 % at 25-50 × 25-50 × 2 km grid);
   - HNO_3 (1-20 % at 25-50 × 25-50 × 1-2 km grid);
   - CH_4 (5 % at 50-100 × 50-100 × 2 km grid);
   - N_2O (5 % at 50 × 50 × 2 km grid);

   (b) Further species
   - CO (5-20 % at 25-50 × 25-50 × 2 km grid);
   - N_2O_5 (20 % at 25 × 25 × 2 km grid);
   - SO_2 (20 % at 25 × 25 × 2 km grid);
   - C_2H_6 (20 % at 25 × 25 × 5 km grid);
   - C_2H_2 (20 % at 25 × 25 × 5 km grid);
   - C_3H_8 (20 % at 25 × 25 × 5 km grid);
   - CH_2O (20 % at 25 × 25 × 5 km grid);
   - ClO (5 % at 50 × 50 × 2 km grid);
   - CFC-11 (2-5 % at 50-100 × 50-100 × 2 km grid);
   - CFC-12 (2-5 % at 50 × 50 × 2 km grid);
   - HCFC-22 (5 % at 100 × 100 × 2 km grid);
   - CFC-113 (5 % at 50-100 × 50-100 × 2 km grid);
   - CH_3CCl_3 (5 % at 100 × 100 × 2 km grid);
   - CCl_4 (5 % at 100 × 100 × 2 km grid);
   - CH_3Cl (20 % at 25 × 25 × 2 km grid);
   - $ClONO_2$ (5 % at 25 × 25 × 2 km grid);
   - HOCl (5 % at 25 × 25 × 2 km grid);
   - SF_6 (2 % at 100 × 100 × 2 km grid);
   - HO_2NO_2 (20 % at 25 × 25 × 100 km grid);

- NO (5-20 % at 25-50 $\times$ 25-50 $\times$ 2 km grid);
- NH_3 (20 % at 25 $\times$ 25 $\times$ 100 km grid);
- OH (10-20 % at 25-100 $\times$ 25-100 $\times$ 2 km grid);
- HO_2 (10-25 % at 25-100 $\times$ 25-100 $\times$ 2 km grid);
- H_2O_4 (5-20 % at 25 $\times$ 25 $\times$ 2 km grid);
- CH_3COCH_3 (5-20 % at 25 $\times$ 25 $\times$ 2 km grid);
- CH_3OH (20 % at 25 $\times$ 25 $\times$ 2 km grid);

2. **Data sets:** These are spectroscopic data and vibrational temperature data, which are useful for the atmospheric remote sensing and radiative transfer modelling community. The new spectroscopic data are supposed to be more accurate and complete than any existing data in a sense that they include spectral transitions not included in commonly used data sets available to the public, such as HITRAN (Rothman et al., 1998), and that line strengths, widths, and positions are given to better accuracy, and thus will be useful for the scientific community in general and not only the contractors. The final target accuracies are given by the desired trace gas abundance accuracies, which imply even more stringent spectroscopic data accuracies.

   Vibrational temperatures will be improved concerning three main aspects: a) By the improvement of the non-LTE models (in particular the radiative transfer) which will result from a non-LTE model intercomparison (CO_2) and from new developed more accurate non-LTE models (N_2O); b) By the inclusion in the models of the most recent information gained from the analysis of satellite measurements (ISAMS, CRISTA, CIRRIS); and c) by the inclusion of new kinetics rates measured in the laboratory.

3. **Characterization of results:** Well-characterized and interconsistent MIPAS results of different groups will enhance the confidence of the scientific community in, and thus improve the usage of the data produced by the contractors. This will be in particular important for operational applications such as numerical weather prediction or ozone/UV predictions.

4. **MIPAS instrument diagnostics:** Reports on MIPAS instrument diagnostics will help the European Space Agency to understand and improve the MIPAS instrument and its low-level data processing.

3 DEGREE OF INTERACTION

1. The most effective interaction between AMIL2DA activities is guaranteed due to the fact that AMIL2DA scientists are also part of the radiative transfer science community, remote sensing community, and atmospheric sciences community. By this, improvements of knowledge and data gained within AMIL2DA will be spread within the scientific community.

2. This applies in particular for the effective interaction with the Fourier spectroscopy community, which shares their knowledge among each other at the periodic workshop on Atmospheric Sciences from Space using Fourier Transform Spectrometry (ASSFTS). Many AMIL2DA groups are regular attendants of this workshop, and IMK, which co-ordinates AMIL2DA, is part of the ASSFTS organization team. This guarantees that AMIL2DA results are effectively spread among the ASSFTS.

3. The study team will publish preliminary and final results at workshops, conferences, and via the AMIL2DA web-site. Final results will be published in reports and journal papers. Feedback from data users to the study team will take place during conference discussions, and through direct informal contact between the members of the study team and other groups in the scientific community.

4. Interaction between the study team and the European Space Agency will take place since (a) representatives of the European Space Agency will be invited to AMIL2DA key meetings, and (b) since some AMIL2DA activities are also part of the official European Space Agency's Envisat calibration and validation activities.

   Moreover, some of the contractors belong to the Scientific Advisory Group of MIPAS. Personal contact to the head of ESA's Earth Science Division, Chris Readings, is guaranteed.

   Part of the AMIL2DA activities contribute to the ESA's MIPAS Envisat calibration/validation programme, for example:

   - The AMIL2DA activities under WP 5000 contribute directly to the ESA AO Proposal INFLIC. The INFLIC proposal has been accepted by ESA as Cal/Val proposal; the statement of work is negotiated at the moment.
   - WP 5510 contributes directly to the ESA AO Proposal NLTE (ID 304).
   - The ESA AO Proposal 'MIPAS Spectra: Analysis and Retrievals; (ID 323) is also linked AMIL2DA.
   - Further ESA AO Cal/Val proposals linked to AMIL2DA are 'Valiground' and 'Minres'
   - The AMIL2DA activities will in general contribute directly to the work carried-out under ESA contract 11717/95/NL/CN - CCN5 aiming at the pre-flight and in-flight characterization and validation of ESA's near real-time level 2 processor. Since some of the AMIL2DA scientists are also involved in this ESA contract, flow of information is guaranteed.
   - Furthermore the scientific ESA AO proposal 'Retrieval of CO in the middle atmosphere from MIPAS' (M.A. Lopez-Valverde, PI) (ID 520) will be provided
   - ESA Cal/Val activities includes support of several AO proposals which provide validation measurements of trace constituents. AMIL2DA team members have access to the NILU database which is used to distribute these validation results among the ENVISAT calibration validation community.
   - As far as related directly to the ENVISAT Cal/Val activities, AMIL2DA results will be transferred to the NILU database and thus will be available to the entire ENVISAT calibration validation community.

Several AMIL2DA scientists are members of the ESA Atmospheric Chemistry Validation Team and thus participate in related coordination meetings, share information with ESA via frequent reports on their activities and receive requirements from the responsible ESA coordinators.

5. Since authors of the operational MIPAS level 2 analysis code are in the AMIL2DA consortium, and since AMIL2DA scientists are, due to their ESA AO proposals and related commitments permanently in touch with responsible persons at ESA, it is guaranteed that all information about problems with MIPAS data and most recent updates of ESA data analysis strategies will be available to the AMIL2DA team immediately.

6. Some AMIL2DA team members are part of a consortium which, in the framework of an ESA funded study, is involved in defining requirements to a future atmospheric chemistry mission (ACE study). This guarantees that results of AMIL2DA directly enter future ESA activities.

7. The installation of a User Advisory Group (UAG) for AMIL2DA including representatives of main user groups (data assimilation, numerical weather prediction, UV prediction, calibration/validation, climate modelling and climate-chemistry interaction modelling) is under discussion.