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THE PRELIMINARY VALIDATION OF GOMOS, MIPAS AND SCIAMACHY BY GROUNDBASED INSTRUMENTS AND SOUNDINGS

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ABSTRACT

1. INTRODUCTION

Commissioning-Phase validation of the atmospheric chemistry sensors on Envisat consists of global intercomparison with 16 trace gases and physical quantities in a short time frame. A large validation team involving hundreds of scientists has been formed to achieve this validation. In view of the similarity in planning requirements, collocation methods, correlative data handling and validation activities, the scientists working on validation involving ground-based instruments and soundings have worked together via the formation of a dedicated team. For organisational reasons, the Envisat Cal/Val Data Centre activities were also handled and reported via this organisational channel. The team is therefore called ACVT-GBMCD subgroup: Atmospheric Chemistry Validation Team – Ground-based Measurements and Campaign Database.

This paper introduces the preparations, data collection and initial validation activities performed by the team. The Campaign Database objectives, development and initial performance are addressed in a separate papers [1,2,3,4]. The subsequent papers consist of a set of overview papers concentrating on validation analysis results for specific products, and a set of individual papers outlining in detail the

work performed by each group, and the detailed results that these activities have generated. The overview papers address the quality of GOMOS density and temperature retrievals [5], Ozone retrievals [6], and altitude registration [7], followed by papers on MIPAS pressure and temperature retrievals [8], ozone retrievals [9], and by papers on SCIAMACHY ozone and NO₂ total column quality assessment [10], CH₄, CO, and H₂O column assessment [11], and a review of quality of scientific retrievals from SCIAMACHY data [12]. For the other species the dataset available at the time of writing does not allow derivation of an overall result, and validation of these species is therefore only presented in the detailed papers of individual groups.

It is of particular importance to notice that the contribution to the validation campaign by a number of team members is inevitably underrepresented in these proceedings, due to the unfortunate circumstance that at the time of writing insufficient data products are available for correlation to the many collocated measurements that they have performed. Their contributions will be adequately represented in future ACVT validation workshops.

2. OBJECTIVES OF THE GROUNDBASED VALIDATION CAMPAIGN

The groundbased validation campaign is aimed at acquisition of a global set of accurate measurements from instruments operated in controlled conditions. These instruments are operated where possible in close collocation with relevant GOMOS, MIPAS, and SCIAMACHY observations. Other instruments are operated routinely, but precisely for these instrument types a larger number of individual instruments is deployed so that still a significant number of collocations is available.

The objective is to obtain a large set of collocated data, in order to have multiple collocations for various combinations of geophysical conditions. This will allow to statistically quantify the accuracy and precision under given conditions, and the range of available conditions enables the team to characterise discrepancies, thereby supporting algorithm improvement.

3. THE ACVT-GBMCD TEAM ORGANISATION

The top of the team iceberg consists of the Principal Investigators of calibration and validation science teams. The activities outlined in Table 1 are performed within the context of the ACVT-GBMCD team:

Table 1: ACVT-GBMCD Principal Investigators and activity

Principal Investigator	Summary of activity
De Maziere	Global O ₃ and NO _y validation using NDSC FTIR instruments
Pal	O ₃ , temperature and aerosol validation using LIDAR at the Toronto primary NDSC station
Lambert	Global validation of many trace gases using NDSC spectrometers, lidars and soundings
Kelder	The Sciamachy core validation programme
Matthews	Validation of many trace gasses using NDSC instruments in the southern hemisphere
Blumenstock	Validation using UV, VIS and IR spectrometers at several locations in Northern and Mid-Latitudes
Visconti	Validation and data assimilation using a spectrometers, soundings, lidars in Central Italy
Fricke	Temperature, Aerosol and Cloud validation in the arctic, using backscatter lidar system
De Muer	Ozone, temperature and water vapour validation using soundings and spectrometers
Burrows	Global validation of Sciamachy, using various ground-based instruments and soundings
Keckhut	Validation of Ozone, Temperature and Aerosol of using groundbased profilers and assimilation
Timofeyev	Validation of SCIAMACHY data with the Russian ground-based spectroscopic measurements
Kyro	High-latitude validation measurements with spectrometers and soundings
Ciotti	Validation using radar, radiometers, GPS receivers, laser ceilometers and satellite data in Central Italy
Petricoli	ENVISAT Nitrogen Dioxide Total Column and Ozone Profile Validation in the Mediterranean Area

Swart	RIVM contribution to NIWA/RIVM ground-based validation of MIPAS, GOMOS and SCIAMACHY on board ENVISAT: Lauder and Bilthoven
Hansen	Validation and Application of ENVISAT Atmospheric Trace Gas Data
Cuomo	Ground based observations of water vapour and aerosol for the validation of ENVISAT products
Congedutti	Validation of ENVISAT measurements by ground based, night-time lidar soundings in Central Italy

In particular in the ACVT-GBMCD team, each Principal Investigator leads a large group of Co Investigators, who are partially referenced in the individual papers [13] to [28].

Preparation for the Envisat Commissioning Phase has been intense, and included deployment, preparation and calibration of instruments, definition of observation schedules, contribution to the definition and homogenisation of the metadata standard for the correlative data files, participation to the two validation rehearsals, formulation of data requirements, review of the User Service Facility, EnviView and other tools provided by ESA and study of GOMOS, MIPAS and SCIAMACHY algorithms.

The combined geographical coverage of the instruments deployed by the members of the team is presented in Fig. 1, for each category of instruments. The wide geographical coverage, and the large number of locations with multiple instrument types are evident from this figure.

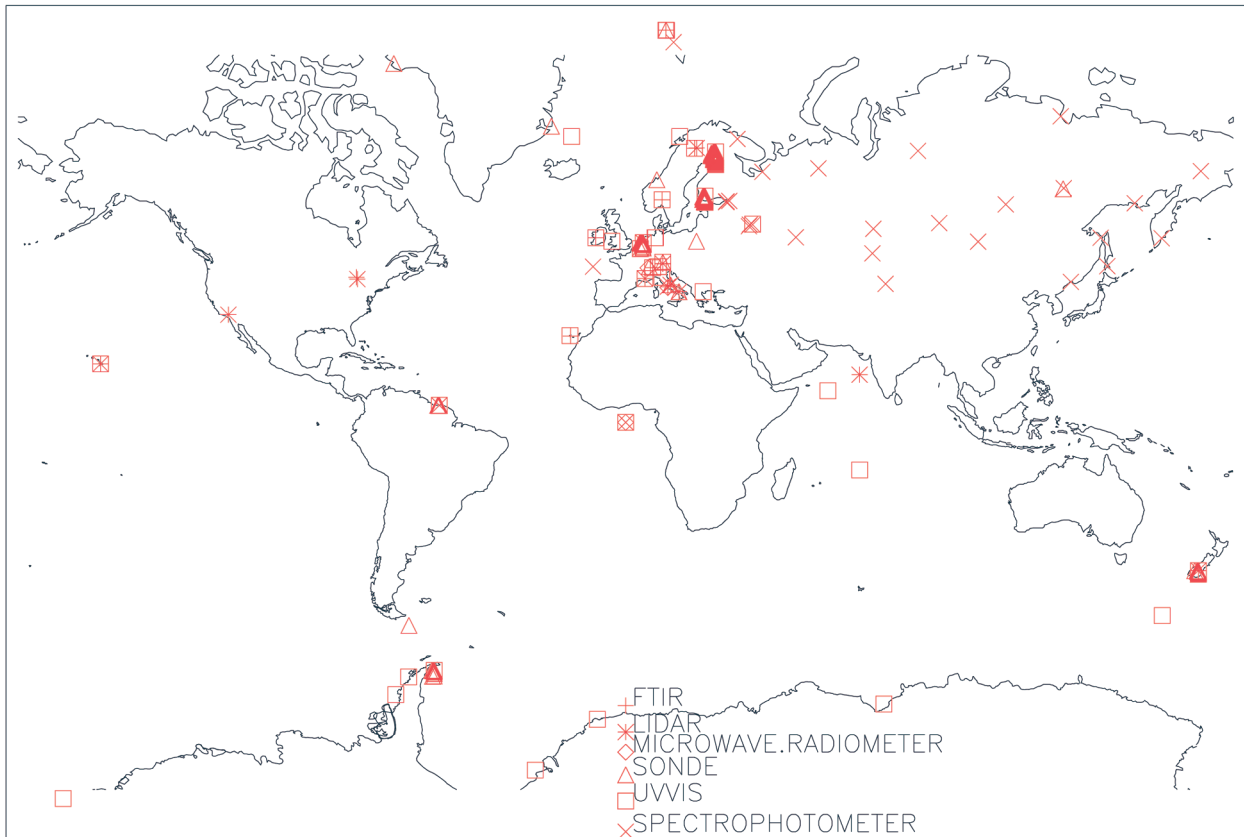


Fig. 1. Geographical distribution of ACVT-GBMCD measurement locations.

3. CORRELATIVE DATA ACQUISITION DURING THE COMMISSIONING PHASE

During the Commissioning Phase, the group has performed a large number of measurements, consisting of both routine observations and dedicated campaigns carefully collocated with measurements of the Envisat instruments. The majority of these measurements are already stored on the central data archive (more than 5000 ACVT-GBMCD observations were available at the end of commissioning, making up 93% of the archive). Fig. 2 and Fig. 3 show the coverage of measurements of ozone and temperature acquired during the commissioning phase, and similar coverage is obtained for most of the other Envisat-relevant parameters

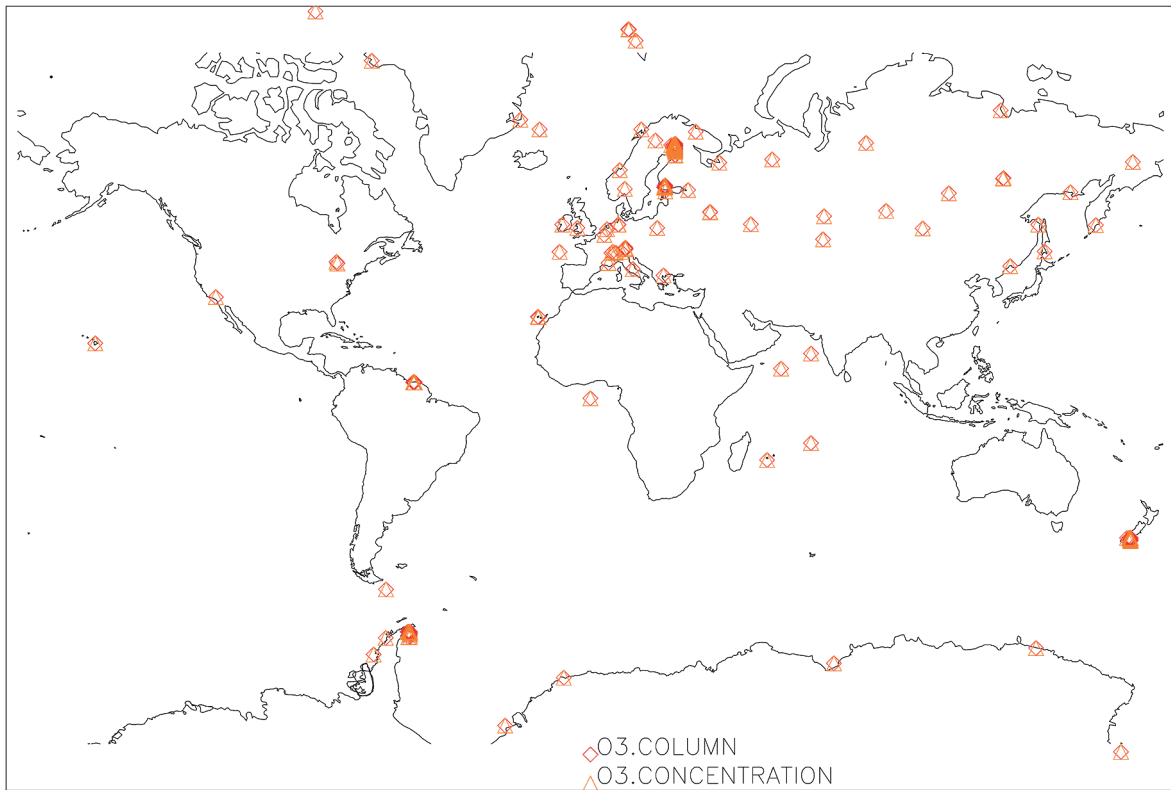


Fig. 2 Geographical coverage of ozone observations acquired during the Commissioning Phase

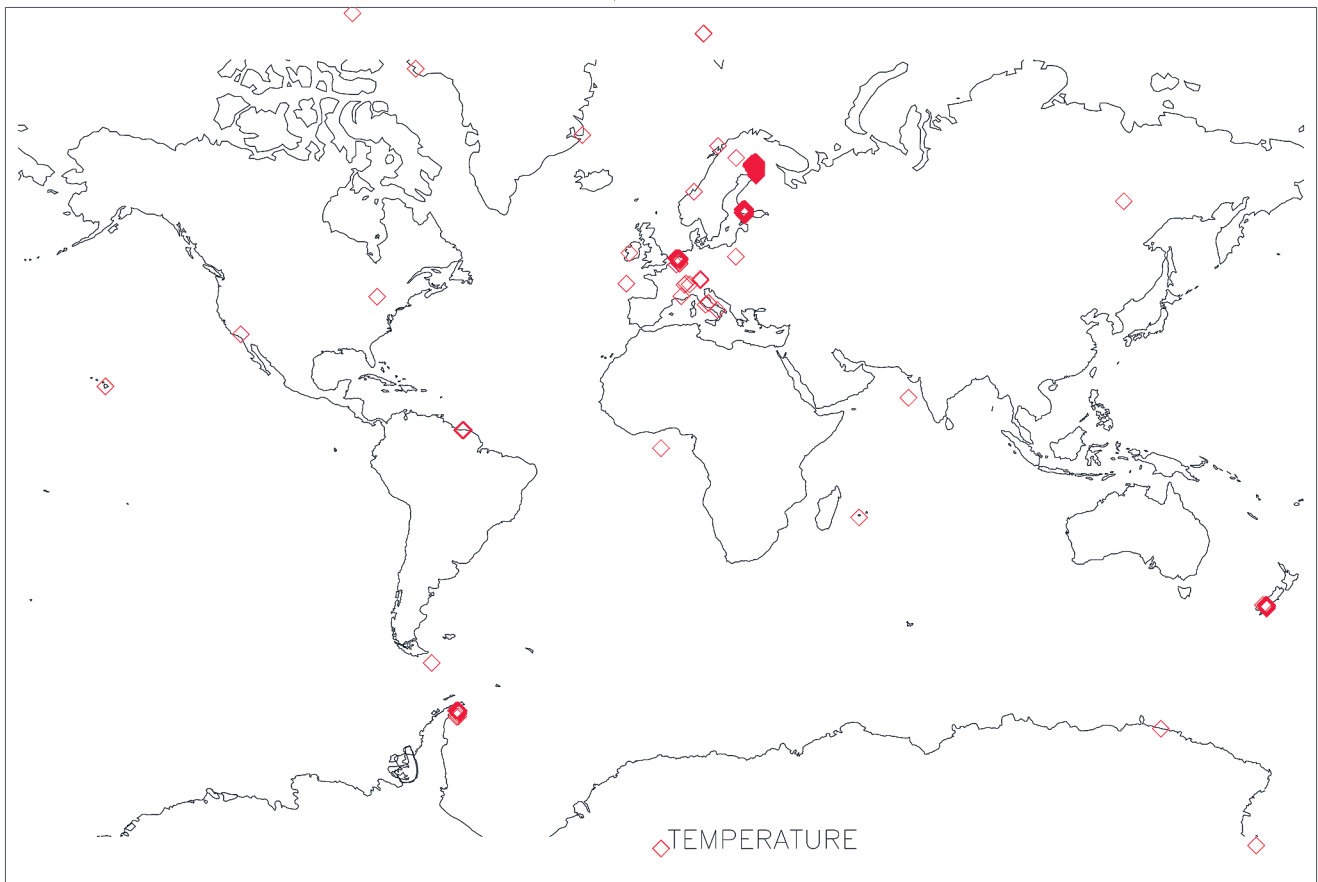


Fig. 3 Geographical coverage of temperature observations acquired during the Commissioning Phase
 As all three atmospheric instruments onboard Envisat have profile retrieval capability, the subgroup validation programme includes instruments with a large range in altitude coverage. The altitude coverage is presented in Fig. 4.

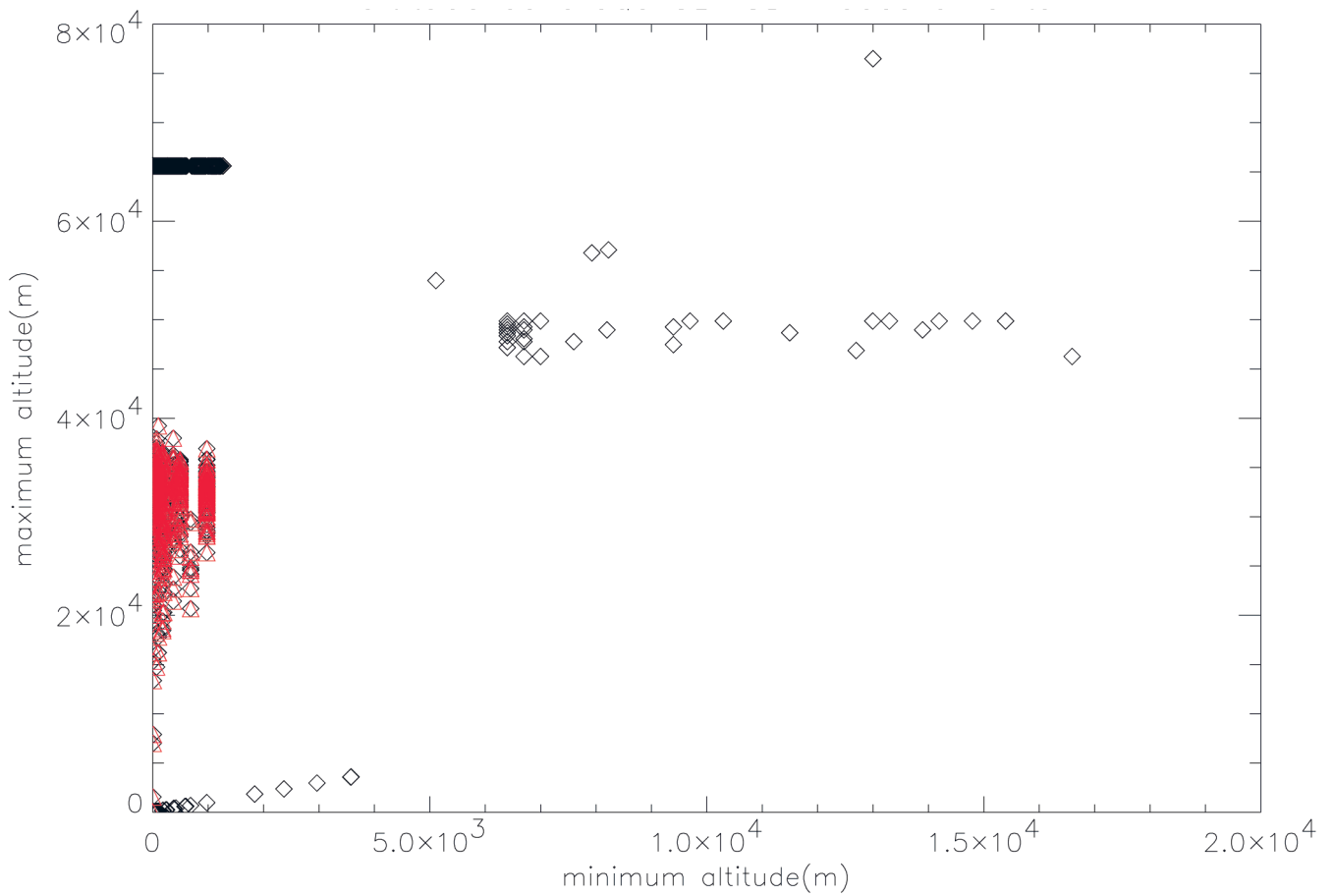


Fig. 4 Altitude coverage of the ACVT-GBMCD measurements during the commissioning phase. The figure represents for each observation the minimum and maximum altitude as a single data point in min vs. max altitude space. Soundings are depicted in red, and show a variation in maximum altitude, among others due to the variable burst altitude of the balloons that carry the meteorological payload.

The high observation frequency and the increase of the acquisition activity with time is evident from Fig. 5 where the start time of measurements is presented against latitude of the measurement.

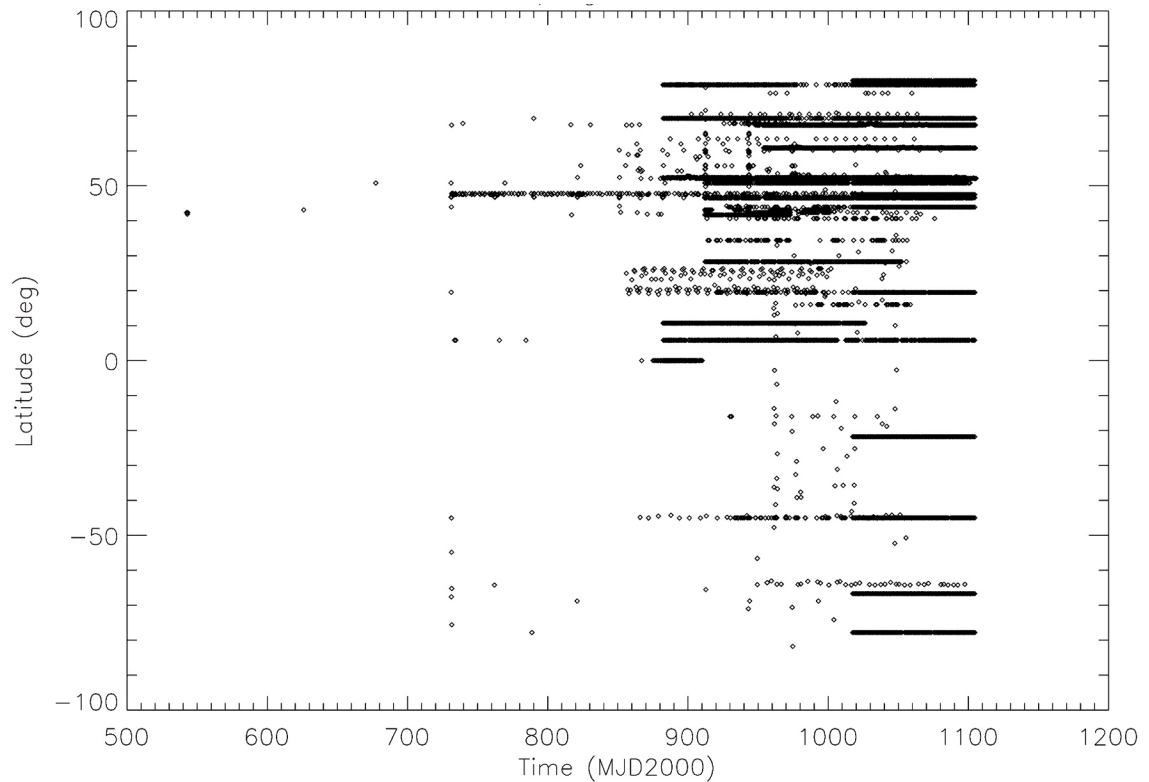


Fig 5. Start times of individual observations, against latitude of the station.

4. PRELIMINARY VALIDATION ANALYSIS ACTIVITIES

Whereas the correlative data acquisition activity of the team proceeded according to plan, with a few exceptions due to instrument repairs, the validation analysis activity has been hindered by the inadequate distribution of Envisat data during most of the Commissioning Phase. The analysis results presented in the following papers are derived from a small subset of the actually available number of collocations, and the corresponding Envisat data arrived only shortly before the Validation Workshop. This lack of data and time has reduced the information that can be extracted from the dataset, and does not allow a full geophysical validation of the products at the time of writing. The validation analysis scientists have performed an exceptional effort however, and have detected several error signatures in the data products by individual intercomparisons, and have obtained preliminary indicators from analysis of global datasets as presented in several of the overview papers.

5. CONCLUSIONS

The reader is referred to the papers [5] to [28] for conclusions on the preliminary assessment of the quality of individual atmospheric data products from Envisat. The most important general conclusion that can be drawn from the ground-based validation campaign at its current stage is that insufficient GOMOS, MIPAS, and SCIAMACHY data files are available to allow a statistically relevant error quantification and characterisation. The small subset of collocations for which the Envisat data are available merely provide initial indications of data quality. In summary:

- For GOMOS, the initial results indicate that the Ozone profiles retrieved from dark limb occultations are reasonable (in particular there are indications that bias with respect to ground-based measurements is generally at the few percent level).
- Under bright-limb conditions the data quality is poor. The errors reported in these cases are not realistic, and the subgroup therefore recommends not to distribute the current combination of bright-limb concentrations and associated error data.
- Initial indications are that GOMOS density retrievals are reasonable.
- The mixing of model and retrieved data does not allow to judge the quality of the temperature retrieval.
- The MIPAS data set available is particularly sparse, but in these few collocations available, no major problems are detected in the intercomparisons with pressure, temperature, ozone and water vapour. Altitude registration has improved with the update of the pointing characterisation information in the processing chain on 13 November 2002, and remaining differences are a fraction of the measurement spacing.
- Also the processed collocated SCIAMACHY products are particularly sparse. The first indications are that total ozone columns from processor version 3.53 show significant deviations from correlative measurements, but show an improvement over the earlier versions.
- SCIAMACHY Total NO₂ columns from version 3.53 show excessive deviations in most of the collocations and the subgroup recommends not to distribute this version.
- The quality of NO₂ columns generated by processor version 4 cannot yet be independently assessed.
- The total columns of CH₄, CO, and H₂O show excessive deviations, which clearly show the signature of the calibration issues that are currently subject of investigation.
- Scientific retrieval studies have provided indications of the potential of accurate retrievals from SCIAMACHY

The brief summary above is derived from the extensive analysis results and conclusions, recommendations and discussion that are described in papers [5] to [28]

In addition to these geophysical conclusions and recommendations, the subgroup also recommends to urgently process historic collocated data in order to obtain a single homogeneous dataset covering the Commissioning Phase. This activity should include both the data that have never been processed before, and the data that have been processed with processor versions that are now out of date.

The team recommends that the Envisat data products should fully specify the contribution of retrieved data versus any external information reproduced in the data product.

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