CEOS Intercalibration of Ground-Based Spectrometers and Lidars

Minispectrometer Intercalibration and Satellite Validation

Report 5 :

Minispectrometer Validation Data

	Name	Function	Date
prepared by	Martin Tiefengraber	LuftBlick	2013-11-29
	Christian Retscher	LuftBlick, CTO	2013-11-29
checked by	Alexander Cede	LuftBlick, CSO	2013-11-29
approved by			

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Document Change Record

Issue	Date	Page	Observations
1	2013-11-14	All	First version
2	2013-11-18	All	Minor changes
3	2013-11-29	6	Minor additions

1 Introduction

This report is deliverable D5 of the project [RD01, RD02]. In section 2 we introduce the ESA and NASA operated data centers relevant to this project. Section 3 gives details on a community metadata standard GEOMS and the conversion of native Pandora data into it.

1.1 Reference Documents

No	Description
RD01	Inter-calibration of ground-based spectrometers and Lidars – Minispectrometer Intercalibration and Satellite Validation [Statement of Work], Issue 1, Revision 0, GMES-CLVL-EOPG-SW-13-0001, 15 January 2013.
RD02	Inter-calibration of ground-based spectrometers and Lidars – Minispectrometer Intercalibration and Satellite Validation [Proposal], Contract: 22202/09/I-EC, RFQ/3-12340/08/I-EC, 22 January 2013.
RD03	Retscher C., et al., The Generic Earth Observation Metadata Standard (GEOMS), `http://avdc.gsfc.nasa.gov/PDF/GEOMS/geoms-1.0.pdf`, 2011.

1.2 Definitions, Acronyms and Abbreviations

No	Description
AVDC	Atmospheric Validation Data Center
DOAS	Differential Optical Absorption Spectroscopy
EC	European Commission
EOS	Earth Observing System
ESA	European Space Agency
EVDC	Earth Observation Validation Data Center
FTIR	Fourier Transform InfraRed
FP7	Framework Programme 7
GEOMS	Generic Earth Observation Metadata Standard
HDF	Hierarchical Data Format
IDLCR8	IDL create tool suite
LIDAR	Light Detection and Ranging
MWR	Microwave Radiometer
NASA	National Aeronautics and Space Administration
NDACC	Network for the Detection of Atmospheric Composition Change
NIR	Near InfraRed
NORS	Demonstration Network Of ground-based Remote Sensing Observations in support of the Copernicus Atmospheric Service
NPP	Suomi NPOESS Preparatory Project
OMPS	Ozone Mapping Profiler Suite
TAV	Table Attribute Values
UV	Ultraviolet
VIS	Visible

2 Validation data centers and standardization

ESA and NASA operate validation data centers to support satellite data validation in atmospheric chemistry and dynamics with some coverage as well for ocean science. For more than ten years the ESA funded Earth Observation Validation Data Center (EVDC) has been collecting, harmonizing, converting, and distributing data for the comparison of satellite data e.g. Envisat. Validation data sources are from ground, e.g. DOAS, FTIR, MWR, LIDAR, but as well from other platforms such as balloons, aircraft, and ships. Pandora is a new source of data which will enhance the suite of available validation data from ground.

NASA operates the Atmospheric Validation Data Center (AVDC) which was initially setup to support the validation of data from the EOS/Aura mission, but later has been starting to cover data from other A-Train satellites and NPP/OMPS.

In order to guarantee the highest quality of information on measurements per dataset, including uncertainties, a metadata standard was defined. Originally, the standard was known as Envisat and later Envisat/Aura metadata standard, before it was generally overhauled and amended to cover new satellite missions. Since 2011 the standard is known as the Generic Earth Observation Metadata Standard (GEOMS). It continues to be applied for satellite validation at EVDC and AVDC, but is now used as well at the NDACC and related projects, e.g. the European Commission Framework Programme 7 (EC-FP7) funded project NORS.

GEOMS guarantees that files include all necessary data and metadata in order to perform a validation study without other auxiliary information. The GEOMS files are meant to be self standing and contain all relevant information from each measurement. Currently GEOMS supports files in the Hierarchical Data Format (HDF) format. HDF is commonly used in version 4 and 5, where the latter is the preferred format, since many satellite data are available in the same format and HDF5 is compliant to another community data format, netCDF (v4).

As of the writing of this document, the AVDC is chairing the work on GEOMS. This includes collecting all GEOMS related requests, such as updates on templates, metadata vocabulary or related documentation. Any partner data center mirrors related information onto its GEOMS compliant server, but maintains the right to perform additional checks on data, e.g. the EVDC requests additional mandatory metadata, which is otherwise optional in basic GEOMS. The metadata vocabulary currently covers the entire GEOMS data set. Any new request on data reporting amends the GEOMS vocabulary. More information on this can be found on `http://avdc.gsfc.nasa.gov/GEOMS`.

3 Conversion of native Pandora data into GEOMS HDF

The current final product in the native Pandora data processing chain is a Level 3b dataset. This contains datetime resolved vertical column densities, uncertainties and quality information including e.g. measurement and retrieval quality, but as well cloudiness.

For data conversion into GEOMS we have used the AVDC provided idlcr8 suite. This tool, written in IDL, allows converting back and forth from GEOMS ASCII to GEOMS HDF 4 and 5 data by implicitly performing quality assurance (QA) checks. AVDC provides as well stand-alone QA and GEOMS template (TE) checker tools.

The most important data variable within the Pandora GEOMS HDF dataset is related to vertical column densities. In the current stage of the project we have decided to cover only direct-sun measurements with GEOMS, even though Pandora is capable of retrieving data from other viewing geometries such as zenith sky and MAXDOAS.

The following steps have been performed to provide a Pandora GEOMS HDF dataset.

3.1 Agreement on GEOMS template

We have agreed with EVDC and AVDC on the Pandora GEOMS metadata template including the naming of the dataset within GEOMS. None of the existing GEOMS templates cover the Pandora suite of measurements in the UV, VIS, and

upcoming NIR. Thus we have created a stand-alone template GEOMS-TE-PANDORA-GAS-VA.csv. This template currently covers Pandora trace gas data, mostly O_3 and NO_2, but will later be extended for other trace gases, e.g. BrO, SO_2 and aerosol optical depth (AOD). The Pandora GEOMS template is available at `http://avdc.gsfc.nasa.gov/index.php?site=196622016` with an overview of all GEOMS templates at `http://avdc.gsfc.nasa.gov/GEOMS`.

3.2 Enhance the metadata vocabulary (TAV)

In discussion with EVDC and AVDC we enhanced the table attribute variable (TAV) where needed. We included the Pandora data investigator, originator, and submitter information, added affiliation and data source names. All geophysical products related information e.g. vertical column densities, was already available in the TAV.

3.3 Design a wrapper to be used for data conversion

In order to be able to use the idlcr8 implicit QA routines and variable validity checks, we decided to design wrapper functionality around the AVDC tool. Idlcr8 checks on compliance with GEOMS vocabulary, template, but as well content, e.g. consistent array lengths, min/max values, fill values, datetime ordering, units. See more at: `http://avdc.gsfc.nasa.gov/PDF/idlcr8hdf-v4.0_Readme.pdf`. We expanded the operational Pandora data production stream and allow GEOMS HDF data generation as a separate output stream. Further we have setup a metadata mapping table, which translates from Pandora into GEOMS metadata. This has mostly been used in compliance with data location names.

3.4 HDF files compliance checks

With the conversion wrapper successfully setup we have submitted test HDF files to EVDC and AVDC for further compliance checks with their systems.

3.5 Full dataset conversion

We have reached an agreement with EVDC and AVDC on the new Pandora files. All files are processed and delivered to EVDC by end of November. Each HDF file covers all measurements from beginning of life per instrument. No granularity, e.g. monthly data, has been introduced in the current version.

3.6 GEOMS DATA_VARIABLES

The following is the list of agreed GEOMS DATA_VARIABLES as they are found in Pandora GEOMS HDF files including dependencies, data type, variable unit, and description.
DATETIME,DATETIME,DOUBLE,MJD2K,"Mean time of the measurement sequence used for each retrieval; defined relative to reference datetime of Jan. 1 2000 at 0:00:00 UT which is equal to 0.00"
LATITUDE.INSTRUMENT,CONSTANT,REAL,deg,"Instrument geolocation; latitude north (decimal degrees) of the location of the instrument (+ for north; - for south)"
LONGITUDE.INSTRUMENT,CONSTANT,REAL,deg,"Instrument geolocation; longitude east (decimal degrees) of the location of the instrument (+ for east; - for west)"
ALTITUDE.INSTRUMENT,CONSTANT,REAL,m,"Instrument geolocation; altitude of the instrument relative to the location site"
ANGLE.SOLAR_ZENITH,DATETIME,DOUBLE,deg,"Solar zenith angle at the center-time of the measurement"
ANGLE.SOLAR_AZIMUTH,DATETIME,DOUBLE,deg,"Solar azimuth at the center-time of the measurement in degree, 0=north, increases clockwise"
[GAS].COLUMN_ABSORPTION.SOLAR,DATETIME,DOUBLE,DU,"Total vertical column of target gas retrieved from direct-sun measurements"
[GAS].COLUMN_ABSORPTION.SOLAR_UNCERTAINTY.COMBINED.STANDARD,DATETIME,DOUBLE,DU,"Total combined uncertainty on vertical column of target gas retrieved from direct-sun measurements"
FLAG.PROCESSING.QUALITY,DATETIME,INTEGER,1,"0 = high quality (ready to use), 1 = medium quality (use with care), 2 = low quality (do not use)"