GEWEX/ESA DUE GlobVapour workshop on long term water vapour data sets and their quality assessment

The Concept & Planning Paper

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1. Background

1.1. Introduction

Water vapour is a key climate variable. In the lower troposphere, condensation of water vapour into precipitation provides latent heating which dominates the structure of tropospheric diabatic heating. Water vapour is also the most important gaseous source of infrared opacity in the atmosphere, accounting for about 60% of the natural greenhouse effect for clear skies, and provides the largest positive feedback in model projections of climate change.

The network of radiosonde measurements provides the longest record of water vapour measurements in the atmosphere, dating back to the mid-1940s. However, early radiosonde sensors suffered from significant measurement biases, particularly for the upper troposphere, and changes in instrumentation with time often lead to artificial discontinuities in the data record (e.g., see Elliott et al., 2002). Consequently, most of the analysis of radiosonde humidity has focused on trends for altitudes below 500 hPa and is restricted to those stations and periods for which stable instrumentation and reliable moisture soundings are available.

Satellite observations relevant for water vapour climatology were mostly build for weather forecasting purposes and their utilisation for building climate data records is rather complex and involves the creation of high quality radiance records, so called Fundamental Climate Data Records (FCDR) and subsequently so called ECV products[1] that are water vapour parameters. Currently, water vapour climatology is obtained from satellite observations either using retrieval schemes or through assimilation into a Numerical Weather Prediction Model forming model-based reanalysis products.

GEWEX and in particular its Radiation Panel (www.gewex.org/projects-GRP.htm) is generating climate data records concerning the Earth Energy and Water Cycle by means of dedicated reprocessing activities. Currently, a missing element is a water vapour product that can be used in a consistent way with the other products. This workshop shall help to answer questions on how such a water vapour climatology should be designed to be most useful in the context of GEWEX.

Global organisations as CEOS, CGMS and WMO help to organise the creation of FCDRs and ECV products leading to the fulfilment of GCOS requirements. As a consequence space agencies have started several programs and projects to create both types of data records.

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[1] The term ECV product was introduced by GCOS. Other documents also use the term *Thematic Climate Data Record* (Climate Data Records from Environmental Satellites, National Research Council, 2004) or *integrated climate product* (GCOS Implementation Plan).

1.2. Problem areas

There is a clear need of a global time series of temperature and humidity profiles for studies of the 3D T, q distribution, e.g., for water vapour transport, and the use within the derivation of cloud property data sets and components of the radiation budget climatology. Such a data set should cover a period of approximately 30 years starting in the late 1970ties. Taking the ISCCP data set as an example the use of T-, q-profile data from satellite data real time processing systems can easily corrupt the quality of a data set for long term climate variability analysis. Currently, no single retrieved data set or NWP model-based reanalysis is capable of completely fulfilling the needs in terms of temporal coverage, homogeneity and accuracy. There are manifold reasons for this:

- The work on high quality radiance records for relevant satellite instruments has only started in the last decade. Many problems as for instance the diurnal drift of satellites and the consequences for a derived data set have not been studied to great extent.

- The instrumentation for deriving atmospheric profiles before the advent of IASI and AIRS suffers from the inherent problem that the information content on the profile is rather low. This forces the use of a priori information where the impact of uncertainties in the a priori on the final data sets has been barely investigated.

- Most existing water vapour products focus on the use of one particular instrument or instrument type. As a result many data sets only cover parts of the needed time series. Additionally, all problems related to specific instrument capabilities or sampling properties remain in the final data set, e.g., an SSM/I total column water vapour can only be derived over oceans.

- Merging of different products is a very difficult task as to reach a very high quality the error characteristics of individual products needs to be understood. Most of the existing data sets do not have measures of uncertainty within the products. Early attempts of merging data did not reveal data sets that improved much on real time data processing.

- Early NWP based reanalysis data sets suffered from inadequate data assimilation techniques that prohibited the full use of satellite observations, e.g., most of the observations were only used over oceans and under clear sky conditions.

2. Workshop objectives

The major objective of the workshop is to bring together the producers and users of water vapour data sets to define a way to a most useful water vapour data set for GEWEX.

- Review and assessment of the existing data sets for total column water vapour as well as temperature and water vapour profiles including an analysis of their appropriateness for long term climate applications needed by GEWEX. This includes the existing FCDRs (underlying radiance records) used for the creation of water vapour climatology as well as the variety of retrieval and mapping methods used in existing data sets;

- Critical assessment of the status of validation of the existing water vapour data sets build on satellite retrieval or model-based reanalysis;

- Development of an assessment procedure for water vapour data sets;

- Identification of critical gaps in the existing and planned data sets for climate applications;

- Development of the optimal strategy for improving the data sets in view of the needs of GEWEX.

3. Workshop dates and venue

8-10 March 2011, ESA-ESRIN, Via Galileo Galilei, Frascati (Roma) I-00044, Italy.

4. Workshop format

Up to 70 people by invitation only.

5. Workshop time frame

3 full days with 30% for keynote talks, 20% for posters and discussions and 50% for breakout groups and discussion.

6. Proposed sessions and keynote presentations (tentative, to be discussed, ~2-4 key-note talks for each session)

6.1. Topics

1. GEWEX needs for 3D temperature and water vapour products

2. Usage of radiance records and temperature/water vapour data sets in climate analysis providing feedback to the current products

3. Existing temperature/water vapour data sets including radiance records and derived total column and temperature and water vapour profile data sets – current status, quality and possible improvements

4. Validation methodology and data for temperature/water vapour data sets including reanalysis – existing comparison and validation results, independent reference data etc.

6.2. Poster Presentations

There is a dedicated poster block planned. Posters are welcomed by all participants.

7. Proposed breakout groups

1. Feedback on the current water vapour data sets discussing:

    a. Impact of uncertainties in climate applications;

    b. Identification of gaps in existing and planned data sets;

    c. Needs for improvement and/or redesign.

2. Feedback group on a comparison of temperature/water vapour data sets discussing:

    a. What data sets can participate?

b. Develop a strategy for the assessment, particularly establishing a basis for estimating the range of uncertainties in such data on various time and space scales. One question is at what space and time scales should the comparison be performed to assess systematic differences due to (1) different instruments, (2) different (inter)calibration procedures, (3) different retrieval schemes including their a priori and cloud mask, (4) different aggregation and data reduction schemes, etc.?

c. What independent validation data are available and what validation methodology is appropriate at what level of data?

8. Program outline

The program will give large room for the presentations of existing data sets

Day 1

- Opening and key note on GEWEX needs

- Presentations on topic 2

- Presentations on topic 3

- Poster block on all themes with wine and food

Day2

- Presentations on topic 3

- Presentations on topic 4

- Break out groups discussion

Day 3

- Break out groups preparation for plenary discussion

- Report and discussion of break out group results

- Summary and Closure of Workshop