

## **RO-CLIM Project Plan and Progress Report**

Note: Format, main outline is based on the Letter of Intent

### **1. Project title:**

“Radio occultation based gridded climate data sets - RO-CLIM”

### **2. Main applicant<sup>1</sup>:**

Name: Hans Gleisner  
 Title: Research Scientist  
 Institute: EUMETSAT ROM SAF / DMI  
 Address: Lyngbyvej 100, DK-2100 Copenhagen, Denmark

Telephone: + 45 39 15 74 84  
 E-mail: [hgl@dmi.dk](mailto:hgl@dmi.dk)  
 Website: <http://www.romsaf.org>

### **3. Project team:**

<b>Name and title</b>	<b>Institute</b>	<b>Address</b>
K. Lauritsen, S. Syndergaard H. Gleisner	ROM SAF / DMI	Danish Meteorological Institute, Copenhagen, Denmark
S. Healy	ECMWF	European Centre for Medium Range Weather Forecasts, Reading, UK
C. Marquardt, R.A. Roebeling, A. von Engeln	EUMETSAT	EUMETSAT, Darmstadt, Germany
T. Schmidt, J. Wickert	GFZ	GeoForschungsZentrum, Helmholtz Centre, Potsdam, Germany
C. Ao, T. Mannucci	JPL	NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA
M. Ringer	Met Office	Met Office, Exeter, UK
R. Kursinski	SS&E	Space Science and Engineering, Boulder, USA
B. Schreiner, S.-P. Ho, D. Hunt	UCAR	COSMIC Program Office, University Corporation for Atmospheric Research, Boulder, Colorado, USA
A. Steiner, U. Foelsche, G. Kirchengast B. Scherllin-Pirscher	WEGC	Wegener Center for Climate and Global Change, University of Graz, Graz, Austria

### **4. Purpose of the Document**

This document collects the within the team agreed annual project plan steps and (once applicable), the progress reports of the RO-CLIM project. The overall aim of the 5 year RO-CLIM project is presented in the RO-CLIM Project Description [RO-CLIM PD]. Within this document the annual steps on the intended areas of activity for a particular year are summarized, and, after each year a short progress report is added. This progress report is then also used for reporting to the SCOPE-CM Executive Panel (SEP).

<sup>1</sup> The project lead of RO-CLIM was shifted from Axel von Engeln, EUMETSAT, to Hans Gleisner, EUMETSAT ROM SAF/DMI, on 24. March 2014.

## **5. Annual Project Plans**

### **a. 2014 (*obsolete*)**

The following development steps are foreseen for the 1<sup>st</sup> year, the lead institute/scientist is given in brackets:

- Increase maturity level of the *ROtrends* CHAMP data set by:
  - re-assess implemented processing software at center, in particular with respect to the initialization of bending angles at higher altitudes, re-process data set if required, investigate outlier statistics (all centres);
  - cross-check data set against radio occultation data from more recent missions that overlap with CHAMP, such as COSMIC, GRACE, GRAS (WEGC);
  - provide information on the structural uncertainty of the CHAMP data set in form of tables (Andrea Steiner);
  - generate an ensemble of products, i.e. RO data are provided by each centre, including uncertainty information (representative of each centre);
  - generate a re-analysis based data set that uses the same processing and gridding setup as the instrument one, using e.g. ERA-Interim data or ERA-CLIM if available (Sean Healy, Axel von Engel, Hans Gleisner);
  - improve documentation of data set (representative of each centre);
  - make information publicly available through <http://www.scope-cm.org>, pointing to a dedicated project page at <http://www.irowg.org> which includes links to the individual centres. The download data will be hosted at <http://www.romsaf.org>. (Andrea Steiner, Ben Ho, Hans Gleisner, Axel von Engel).
- Start the generation of the extended *ROtrends* data set that includes more recent missions and will be updated throughout the project:
  - develop a common Level 1A format that can be used across the different centers (Christian Marquardt, Doug Hunt, DMI, representative of each centre);
  - develop capability at the different centers to ingest this format into their processing (representative of each centre).

### **b. 2015**

The following development steps are foreseen for the 2<sup>nd</sup> year. The lead institute and/or scientist is given in brackets:

- Increase maturity level of the *ROtrends* CHAMP data set by:
  - re-assessment of the high-altitude smoothing and initialization of bending angles that are currently used at the processing centres, and reprocess data set if required (JPL, all centres);
  - cross-check CHAMP data set against RO data from more recent missions that overlap with CHAMP, such as COSMIC, GRACE, Metop (WEGC, UCAR);
  - make the *ROtrends* CHAMP climate data ensemble, including uncertainty information and with a minimum amount of documentation, publically available on the RO-CLIM web page (DMI);
  - assessment of the CHAMP climate data set according to the Maturity Matrix Model (DMI);
  - generate a reanalysis data set that uses the same sampling and gridding setup as the instrument one, based on e.g. ERA-Interim (DMI, EUMETSAT);
- Initiate the development of higher-resolution RO climate data sets by:
  - identification of missions, time periods, resolutions, etc.
  - identification of gridding methods, handling of multi-mission data, etc.
- Build capacity for climate-model usage of RO data:
  - assessment of RO data as an obs4MIPs data set: potential of, e.g., dry temperature as a CMIP-5 observational data set, potential for an RO contribution to the CMIP-6/7 protocols, and clarification of the possibilities to provide several RO data sets or ensembles of data to obs4MIPs (JPL, DMI, UCAR);

## 6. Annual Progress Reports

### a. 2014

#### **Administrative**

The RO-CLIM project (SEP-08) is slowly progressing according to plan, although a few changes of the plan have been made during the period. The project lead was shifted from Axel von Engel (EUMETSAT) to Hans Gleisner (ROM SAF/DMI) on March 24, 2014. During 2014, there were two telecon meetings held, in March and September, as well as a splinter meeting at the COSMIC Data User Workshop in Boulder in October 2014. A project web page is now in place, with common access to documents (<http://irowg.org/projects/ro-clim-under-scope-cm>). RO-CLIM progress was reported by Hans Gleisner at the SCOPE-CM telecon on November 10, 2014.

#### **Project work**

The RO-CLIM project largely builds upon the informal *ROtrends* collaboration between six RO processing centres, extended with expertise on RO technology, re-analysis, and climate modelling. Over the last few years, the *ROtrends* collaboration resulted in three published journal articles on the quantification of uncertainties of RO data. The progress of the RO-CLIM project during the first year reflects this background.

**1)** Re-assessment of the currently implemented processing software, partly based on the outcome of *ROtrends*/RO-CLIM studies, has been ongoing at several centres, e.g. DMI has implemented the use of the BAROCLIM climatology as *a priori* in the statistical optimization of bending angles.

**2)** Bending angle profiles from the CHAMP mission for Dec 2006 and July 2008 were collected by JPL (Chi Ao). The impact of quality-control procedures on the data numbers and the causes of discrepancies between retrieved refractivity profiles were investigated. Earlier results on the importance of QC procedures were confirmed, and two causes of differences amongst centres were identified: vertical smoothing and high-altitude initialization of bending angles. These issues will be further addressed in the RO-CLIM project work.

**3)** An initial set of multi-mission data (including data from the CHAMP, GRACE, COSMIC, Metop, SAC-C, and TerraSAR-X missions) for July 2008 and Jan 2011 were collected by WEGC (Andrea Steiner). Statistics for each centre, as well as difference statistics for a subset of centres, were computed and presented at a RO-CLIM telecon. The results form the basis for a larger study on multi-mission data, encompassing a large fraction of the currently available RO data.

**4)** A common RO climate data set, consisting of a six-member ensemble based on data from the CHAMP mission, has been collected, and the associated structural uncertainties has been quantified and documented. A publically available access point for the RO climate data has been allocated at the RO-CLIM web page. The documentation is currently in the form of published journal articles, but will be extended with a brief note on usage and data format. The data set will be made publically available during 2015 – see Section 5b (annual project plans).

**5)** The JPL team has made substantial progress towards formally submitting an RO dataset for Obs4MIPs. The dataset is derived from the latest post-processed version of CHAMP and COSMIC profiles retrieved at JPL. It consists of monthly averages of temperature and geopotential height on a 5 degree x 5 degree latitude-longitude grid from 400 hPa to 10 hPa, obtained with a Bayesian mapping technique with spherical harmonics basis functions up to 18<sup>th</sup> degree.

**6)** The project plan for 2014 also covered the development of a common Level 1A file format (i.e., excess phase, amplitude, and satellite orbit data) to be used across the different centres and missions. However, it was concluded that the work required, and the complexities involved, in developing a generic Level 1A file format may be substantial, and most likely not worth the effort. Hence, it was agreed not to further pursue this task.

***Presentations, international activities, etc.***

A brief summary of the RO-CLIM project was contributed to a CEOS/CGMS WGClimate report to SBSTA-21 (solicited by John Bates, WGClimate Chair). SBSTA is a permanent subsidiary body of the UNFCCC and reports at the COP meetings.

**7. References:**

**[RO-CLIM PD]** SCOPE-CM RO-CLIM Project Plan, EUM/RSP/DOC/13/701839, available at <http://www.scope-cm.org>.