The First TUNER Meeting

Thomas von Clarmann[1]

[1]Karsruhe Institute of Technology, Germany, (**thomas.clarmann@kit.edu**)

DATE:
15 June 2017

ORGANISERS:
Thomas von Clarmann, Doug Degenstein

HOST INSTITUTION:
University of Saskatchewan, Canada

NUMBER OF PARTICIPANTS: 20

SPONSORS:

BACKGROUND:
TUNER (Towards UNified Error Reporting) is an emerging SPARC activity aiming to provide a complete and consistent data characteriSation in terms of uncertainty, resolution, and content of a priori information, for the largest possible number of space-borne temperature and composition sounders.

ACTIVITY WEBSITE:
www.sparc-climate.org/activities/emerging-activities

The first meeting of the emerging SPARC activity "Toward Unified Error Reporting (TUNER)" was held at the University of Saskatchewan, Saskatoon, Canada, on 15 June 2017. The aim of this project is to harmonize the reporting of uncertainties of satellite data of atmospheric temperature and composition.

In order to get an inventory of the retrieval methods and error estimation schemes used in the satellite community, a questionnaire was distributed to the instrument/data processing teams. The responses were presented by **Thomas von Clarmann** and discussed in Saskatoon. Responses were obtained for 12 limb and one nadir mission. Limb missions include limb emission, limb scattering, and occultation. Measurements in the following frequency ranges were represented: microwave, far-infrared (IR), IR, near-IR, visible, and ultraviolet. All retrievals are based on a matrix formalism with or without regularisation, the latter being either optimal estimation or Tikhonov-type. Some groups provide their data on the native retrieval grid, while others interpolate their data to a regular grid after the retrieval. In the latter case, care has to be taken to also transform the diagnostic data onto the new grid. Good agreement was found with respect to the schemes for estimating how noise is propagated into the results, but the estimation of parameter errors needs much more discussion. Since such parameter errors depend largely on instrument specifics and the retrieval strategy chosen, harmonization of related error reporting is not expected to be a trivial task. All participating groups seem to be well aware of possible forward model errors which might affect their results but quantification of these is often difficult. Some groups prefer to provide total error estimates to the data users while others find it more appropriate to provide information on the error components and to leave their combination to the data users. Averaging kernels are provided by all groups who perform constrained retrievals. No agreement has thus far been reached about the altitude resolution of non-constrained retrievals. Validation papers are available for most of the participating instruments. Within TUNER no validation studies will be made, but it will heavily draw upon existing validation studies; these are considered particularly useful to judge which error estimation schemes are adequate. In order not to duplicate work ongoing in other projects, it was decided not to assess instrument drifts within TUNER.

The next point on the agenda was deductive error analysis, which is understood to be the propagation of ingoing uncertainties through the retrieval system. Several talks were given on

***Figure 22**: Participants of the first TUNER workshop held at the University of Saskatchewan, Saskatoon, Canada, on 15 June 2017.*

this topic. **Natalya Kramarova** and **Patrick Sheese** presented results of error estimation work done for OMPS and ACE-FTS, respectively. Both studies included detailed analyses of the leading error sources. **Thomas von Clarmann** discussed the problem that covariances between the atmospheric state and averaging kernels can cause the application of mean averaging kernels to a mean profile to be inaccurate. Instead, he suggested using a mean covariance term for correction. **Stefan Bender** reviewed machine learning methods and raised the question of whether these might be useful within TUNER, as their mathematical structure is similar to that of retrieval and error estimation.

Under the header of inductive error analysis, which is understood to be error analysis based on the observations, and which is thus closely related to validation, two presentations were given. The first, by Arne Babenhauserheide, Quentin Errera, and **Thomas von Clarmann** (presented by the latter) tackled the problem of natural variability. This, along with less than perfect co-locations of measurements seems often to be used as a "universal excuse" whenever discrepancies between two datasets are encountered in validation studies. Highly-resolved temperature and mixing ratio fields calculated with the BASCOE model were used to statistically quantify the effect of spatial and temporal mismatch between observations. In the following presentation Thomas showed, by comparing three or more datasets, that their precision estimates can be assessed such that it becomes clear which instrument group over- or under-estimates their random uncertainties. It was agreed that this method showed promise and should be further investigated within TUNER.

A problem has been identified with respect to how user-driven TUNER should be. On the one hand, the data users should be provided with the error estimates and other diagnostic data they need. However, on the other hand, data users often do not know how relevant certain diagnostics (e.g. averaging kernels or error covariances) are and would thus never request them. The following solution has been identified: Instead of asking the data users which diagnostics they would like, they will be asked for which applications they require satellite data. The data providers will then decide which diagnostics will be necessary.

Finally, TUNER has been selected as an International Team by the International Space Science Institute in Bern, Switzerland, where two project meetings will be held, and it was decided to propose a special issue on TUNER to the journal Atmospheric Measurement Techniques.