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An Approach of Error Propagation Modelling of SAR Interferometric Data

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Abstract

SAR interferometry has proved to be a promising technique for a number of geoscientific applications by providing height information. The theoretical aspects are basically understood and the current research focuses on the potentials investigating the limitations of the technique. In order to reach an operational status, it is necessary to have a good quality assessment of the results. One possible way to assess the accuracy and reliability of SAR interferometric products is the development of an error propagation model. This can provide information about the sensitivity of each single input parameter or processing step as well as a quantitative quality measure for the output, which is independent from additional information introduced as reference data. The development and implementation of this error propagation model is addressed in this paper.

Keywords: Error propagation model, quality assessment

Introduction

As user of any products based on a certain processing scheme it is essential to have information on the reliability of the data sets. Often the details of the different processing steps are not available. This makes it even more difficult to estimate the quality of the data set. A common approach for assessing the quality of interferometric products is the comparison with a reference data set. We will focus in this paper on the quality assessment of digital elevation models (DEMs).

In order to be able to compare an interferometrically derived DEM with a reference model, such a reference model needs to be accessable. This can be a problem in remote areas where no additional information is available. The use of a reference model for a comparison is done assuming that this model is reliable and without any distortions. From the statistical point of view, a reference DEM with an accuary, which is one order better than the InSAR DEM, is required. The result of the comparison of the DEMs gives a quantitative measure how well the two elevation models fit together. Any systematic errors remain undetected.

To overcome these problems, we estimate the quality of an InSAR DEM using an error propagation model based on an empirical approach. The theoretical background and the implementation of this error propagation model is described in the following chapters.

Error propagation model

The error propagation model is implemented in an empirical way because this needs only a limited knowledge about the software used for the processing. The values of all input parameters as well as their accuracies are needed in the model. A list of all output parameters is also required. Each single processing step needs to be estimated separately. On the other hand, it is possible to perform the error propagation in a flexible way to different stages of the processing.

The accuracy of the input parameters is sometimes difficult to estimate. There are studies undertaken to assess the quality of some parameters, e.g. baseline (Solaas, 1994). Using precise orbit information for the processing also quality estimates are provided (Massmann, 1995). Other values such as wavelength, bandwidth, etc. vary slightly in the data sets and are difficult to calibrate.

The use of an error propagation model has also its limitations. Errors caused by atmospheric effects (described by Tarayre and Massonnet, 1994) or backscatter related influences are not considered unless there are included in any of the processing steps.

Another aspect of discussion is the question how the final result of the quality assessment is required. There are three different levels for which the quality measure could be defined: the pixel level, the feature level, and the whole image. The user might be most interested in certain features.

Implementation

In order to keep the approach as flexible as possible, the implementation of the error propagation model is performed in an empirical way. There is no information necessary how the software is actually implemented. Figure 1 shows a general scheme of the error propagation.

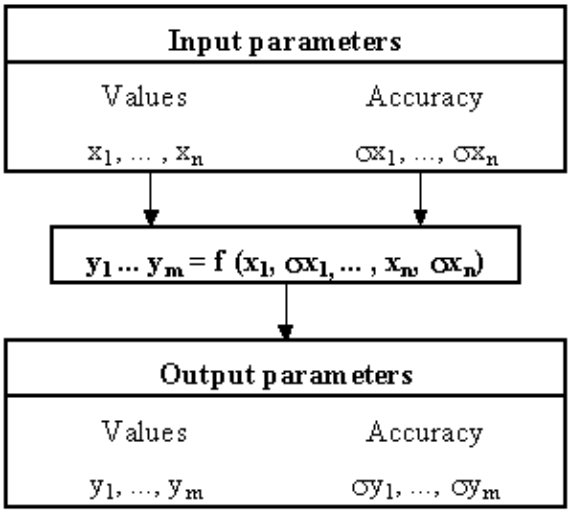

Figure 1: General scheme of the error propagation

For each single processing step the values and the accuracies of all input parameters as well as a list of output parameters have to be known. The data set is then processed once with the original values and afterwards each time with one slightly changed input parameter. The accuracy of the output parameters is then derived from the changes of the adapted and the original calculation.

This empirical approach also allows to estimate the sensitivity of the different parameters on the processing step. In this early stage of the implementation, the processing is performed with full quarter scenes in order to investigate the influence of input parameters on characteristics such as the terrain height, slope direction, etc. Another aspect is to setup rules for choosing areas for the quality assessment. The data processing can be performed using the full scenes but the quality assessment should be limited to a small representative area. As mentioned before, this also depends on the final result of the quality assessment. The user could choose an area, which is representative and where also features of interest are included.

Conclusions

The development of the error propagation provides the opportunity to assess the quality of interferometric data independently from any reference data. It can be adapted to different software realisations because it is independent from the actual calculation. This is an advantage due to the fact that there is no standard method in the processing of SAR interferometric data sets. It can also be used for optimising the interferometric processing in terms of accuracy. It is a promising tool but for a final evaluation of the usefulness of this approach it needs to be further investigated.

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References

Massmann, F.-H., 1995:
Information for ERS PRL/PRC Users, Technical Note, German Processing and Archiving Facility (D-PAF).

Solaas, G.A., 1994:
ERS-1 Interferometric Baseline Algorithm Verification, ESA report ES-TN-DPE-OM-GS02.

Tarayre, H. and Massonnet, D., 1994:
Effects of a Refractive Atmosphere on Interferometric Processing. *Proceedings of IGARSS '94*, Pasadena, California, pp. 717-719.