Assimilation of InSAR-derived Atmospheric Data in Operational Weather Models

Mulder, Gert; van Leijen, Freek; Barkmeijer, Jan; de Haan, Siebren; Hanssen, Ramon

Publication date
2017

Document Version
Final published version

Citation (APA)
Mulder, G., van Leijen, F., Barkmeijer, J., de Haan, S., & Hanssen, R. (2017). *Assimilation of InSAR-derived Atmospheric Data in Operational Weather Models*. 15-15. Abstract from Fringe 10th International Workshop on , Helsinki, Finland.

Assimilation of InSAR-derived Atmospheric Data in Operational Weather Models

Mulder, Gert (1); van Leijen, Freek (1); Barkmeijer, Jan (2); de Haan, Siebren (2); Hanssen, Ramon (1)
1: Delft University of Technology; 2: Royal Netherlands Meteorological Institute (KNMI)

The influence of signal delay due to the varying atmospheric refractivity can be significant in individual interferograms. This signal is generally considered to be noise in deformation studies, but it can also potentially be used to improve weather models [1]. This application has an enormous potential, because, contrary to deformation studies, every acquired SAR image contains valuable information on the state of the atmosphere.

Until recently, revisit times of SAR satellites were too low to operationalize this application of SAR data. With the launch of the Sentinel-1 satellites, the theoretical revisit time reduced to less than 2 days for mid-latitude regions, which potentially enables operational implementation in weather models. The availability of other current and future SAR satellites further strengthens this opportunity. Even though practical operational applications will be strongly dependent on data latency (downlink, throughput, processing, and dissemination), we aim to develop and demonstrate the business-case.

Here we analyze and demonstrate the assimilation of InSAR-derived atmospheric measurements to numerical weather models. We perform a quantitative analysis of the differential integrated refractivity (DIR) values, as observed by InSAR and a Limited Area Model (LAM). LAMs have become popular for short-range numerical weather prediction on km-scale [2], while medium-range models such as the ECMWF have global coverage and a resolution of about 0.25 degrees. Here we use the HARMONIE LAM, which is developed by the HIRLAM and ALADIN consortia [3] and currently used as the operational weather model for the Netherlands.

As the DIR-fields are highly correlated to the vertically integrated water vapor over the full air column, which is a difficult to measure but important variable for a well-performing weather model, the contribution of InSAR proves to be very significant.

We compare the DIR values and their uncertainties as observed by InSAR with the DIR values, derived from weather model predictions. The results show that there are many similarities on wide scales, but that the precision of the integrated refractivity values from InSAR is much higher. We analyze the scales of both datasets using spectral energy distributions, which show that (i) SAR data holds much more detailed information on scales below 10 kilometers, and (ii) the dynamic range of the DIR observations seems to be underestimated by the weather model. The InSAR data are then assimilated in the numerical weather prediction to find the best compromise (or 'analysis') between the model simulation ('first-guess') and the observations [4].

[1] Hanssen, R. F., Weckwerth, T. M., Zebker, H. A., & Klees, R. (1999). High-resolution water vapor mapping from interferometric radar measurements.Science, 283(5406), 1297-1299.

[2] Degrauwe, D., Caluwaerts, S., Voitus, F., Hamdi, R., & Termonia, P. (2012). Application of Boyd's periodization and relaxation method in a spectral atmospheric limited-area model. Part II: Accuracy analysis and detailed study of the operational impact. Monthly Weather Review, 140(10), 3149-3162.

[3] Navascués, B., Calvo, J., Morales, G., Santos, C., Callado, A., Cansado, A., & García-Colombo, O. (2013). Long-term verification of HIRLAM and ECMWF forecasts over southern europe: History and perspectives of numerical weather prediction at AEMET. Atmospheric Research, 125, 20-33.

[4] Marseille, G. J., Barkmeijer, J., de Haan, S., & Verkley, W. (2016). Assessment and tuning of data assimilation systems using passive observations. Quarterly Journal of the Royal Meteorological Society, 142(701), 3001-3014.