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Towards assimilation of InSAR data in operational weather models

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InSAR signal delays due to the varying atmospheric refractivity are a potential data source to improve weather models [1]. Especially with the launch of the new Sentinel-1 satellites, which increases data coverage, latency and accessibility, it may become possible to operationalize the assimilation of differential integrated refractivity (DIR) values in numerical weather models. Although studies exist on comparison between InSAR data and weather models [2], the impact of assimilation of DIR values in an operational weather model has never been assessed. In this study we present different ways to assimilate DIR values in an operational weather model and show the first forecast results.

There are different possibilities to assimilate InSAR-data in a weather model. For example, (i) absolute DIR values can be derived using additional GNSS zenith or slant delay values, (ii) DIR values can be converted to water vapor pressures, or (iii) water vapor pressures can be derived for different heights by combining GNSS and InSAR data. However, an increasing number of assumptions in these processing steps will increase the uncertainty in the final results. Therefore, we chose to insert the InSAR derived DIR values after minimal additional processing.

In this study we use the HARMONIE model [3], which is a spectral, non-hydrostatic model with a resolution of about 2.5 km. Currently, this is the operational model in 11 European countries and based on the AROME model [4].

To assimilate the DIR values in the weather model we use a simple adjustment of the weather parameters over the full slant column to match the DIR values. This is a first step towards a more sophisticated approach based on the 3D-VAR or 4D-VAR schemes [5]. Where both assimilation schemes can correct for different weather parameters simultaneously, and 4D-VAR allow us to assimilate DIR values at the exact moment of satellite overpass instead of the start of the forecast window. The approach will be demonstrated based on several case studies.

This research can be seen as a first step towards the operational use of InSAR data in state-of-the-art weather models and can be a driver for the design and development for new SAR missions, such as NISAR.

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