Use of SEVIRI radiances for handling of position errors in a limited-area data assimilation system

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HIRLAM Data Assimilation

The HIRLAM limited-area forecasting system (Undén et al., 2002) has been developed within an international cooperation, including 10 European countries. It can be applied for both deterministic for probabilistic forecasting. The deterministic upper-air data assimilation is based on a variational approach when running in probabilistic mode a hybrid ensemble/variational upper-air data assimilation is applied. The upper-air data assimilation utilizes various types of in-situ measurements, radar and satellite based remote sensing data as well as GNSS atmospheric delays. The deterministic and the probabilistic forecasting systems are set up over two European domains as illustrated in Figure 1. The deterministic system is set up with 40 vertical levels and with a horizontal resolution of 22 kilometers. The probabilistic system is set up with 60 vertical levels and with an horizontal resolution of 10 kilometers. There are 20 ensemble members and a control run.

Handling of Position Errors Utilizing SEVIRI Data

For the correction of position errors in deterministic data assimilation a twodimensional displacement field is estimated using the background state and high resolution radiances data from the SEVIRI instrument, as input to an optical flow algorithm. This is illustrated in Figure 3, in the case of SEVIRI radiance data from one particular channel. The displacement fields from the two channels, having sensitivities to different vertical levels of the atmosphere, are then combined to obtain a three-dimensional displacement field. The displacement field is estimated with a smoothness constraints and we introduce constraints to prevent displacement in areas of high orography and also close to the sea. The same displacement field is applied to all upper-air parameters. In order to obtain a position error corrected and balanced modified background state in the case of deterministic data assimilation, vertical profiles from the aligned model state are assimilated as pseudo observations within the traditional variational data assimilation framework. The methodology can thus be summarized as follows:

- Apply image processing to obtain displacement field and generate pseudo-observations from the position error corrected background state.
- Use pseudo-observations in a first step to obtain a balanced and position error corrected background state.
- Use this modified background state to minimize the amplitude error using a standard variational method and real observations in a second step.

Position Error Handling in Deterministic Data Assimilation

For the correction of position errors in probabilistic data assimilation a two-dimensional displacement field is estimated using the background state and high resolution radiances data from the SEVIRI instrument, as input to an optical flow algorithm. This is illustrated in Figure 3, in the case of SEVIRI radiance data from one particular channel. The displacement fields from the two channels, having sensitivities to different vertical levels of the atmosphere, are then combined to obtain a three-dimensional displacement field. The displacement field is estimated with a smoothness constraints and we introduce constraints to prevent displacement in areas of high orography and also close to the sea. The same displacement field is applied to all upper-air parameters. In order to obtain a position error corrected and balanced modified background state in the case of deterministic data assimilation, vertical profiles from the aligned model state are assimilated as pseudo observations within the traditional variational data assimilation framework. The methodology can thus be summarized as follows:

- Apply image processing to obtain displacement field and generate pseudo-observations from the position error corrected background state.
- Use pseudo-observations in a first step to obtain a balanced and position error corrected background state.
- Use this modified background state to minimize the amplitude error using a standard variational method and real observations in a second step.

Position Error Handling in Probabilistic Data Assimilation

In the case of hybrid ensemble variational data assimilation two-dimensional displacement fields are calculated for each of the ensemble members and for the two different SEVIRI radiances channels. These are then combined to one single two-dimensional displacement field for each ensemble member by taking the average of the displacements fields of the two SEVIRI channels. These displacement fields are then used to glue together a best member field, in which the ensemble member with the smallest displacement field is used in each horizontal position. An example of such best member field is shown in Figure 3. The best member field is used to generate pseudo-observations to be assimilated within the traditional hybrid data assimilation framework to obtain a phase error corrected and balanced modified background state. In the second step this modified background state is used together with a full set of observations in a traditional hybrid ensemble variational data assimilation to minimize the remaining amplitude errors. The methodology can thus be summarized as:

- Apply image processing and in each location use the member state with least displacement error.
- Assemble pseudo observations from best member model state.
- Use this modified background state to minimize the amplitude error using normal ensemble/variational data assimilation and real observations in a second step.

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References