Surface Assimilation in HIRLAM

Information collected by

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Surface assimilation in HIRLAM is carried out for:

- Water surface temperature
- (Sea ice fraction)
- Snow depth
- 2 meter temperature and relative humidity, only to be used as input to soil temperature and soil water content assimilation
- Soil temperature
- Soil water content

Basic assimilation techniques

- **The 2-dimensional spatial interpolation is based on successive corrections (Cressman-type) or statistical interpolation with a box data selection (Lorenc). The code originates from the SMHI MESAN system, and was adapted for HIRLAM by Navascues.**
- **The sequential soil assimilation is based on Mahfouf (1991), Bouttier (1993) and Giard and Bazile (2000). It was implemented in HIRLAM by Ayoso and Navascues.**

Water temperature and sea ice fraction analysis (1)

- The background field is the previous analysis with a weak relaxation toward climatology (to ensure a correct seasonal evolution and to avoid noise accumulation)
- Grid points and observation stations are classified: (Inland, Near coast, Coast, Lake and Open sea).
- Successive correction analysis with weights depending on distance and a scaling factor related to the classification of grid points and observation points.
- Pseudo-observations from ECMWF (NCEP) analysis fields + SHIP and BUOY observations
- Fractions of open water and sea ice are diagnosed from the analysed water temperature

Scaling factors related to land/sea/lake anisotropy

obs.class	grid point class				
	inland	near coast	coast	lake	open sea
inland	1.	0.5	0.0	1.	0.0
near coast	0.5	1.	0.5	0.5	0.3
coast	0.0	0.5	1.0	0.0	0.9
lake	1.	0.5	0.0	1.	0.0
open sea	0.0	0.3	0.9	0.0	1.0

Water temperature and sea ice fraction analysis (2)

- Various input data sets of SST and fraction of sea ice are utilized by different HIRLAM groups, for example, OSI SAF data (DMI and met.no) and special data from the Baltic Sea (SMHI and FMI)
- A new statistical interpolation assimilation for sea surface temperature and fraction of sea ice is being developed (Homleid and de Vries). Data from the EUMETSAT OSI SAF will be utilized.
- Within the EU project DAMOCLES, SMHI is developing assimilation of SST and fraction of sea ice for a coupled atmosphere/ocean/sea ice model system (HIRLAM+HIROMB).

Analysis of snow depth

- The background snow mass field is obtained by fractional averaging from the different surface tiles, relaxed toward climatology and converted to snow depth. The conversion factor takes snow aging and snow melting into account.
- Statistical interpolation analysis is applied with a structure function based on a second order autoregressive (SOAR) function.
- Only land surface observations are used. A station-by-station bias correction is applied.

Analysis of 2 meter temperature and relative humidity (1)

Careful estimation of the background field:

- **Moving the atmospheric profiles to the elevation of the stations**
- **Fractional averaging of surface fields over the surface tiles**
- **Re-calculation of the surface temperature to keep the potential temperature lapse rate in the surface layer**
- **Diagnosis of 2 meter temperature and relative humidity following Geleyn (1988)**

Background deviation check.

Analysis of 2 meter temperature and relative humidity (2)

2-dimensional statistical interpolation ("optimum interpolation" OI):

- **Box data selection**
- **OI QC in boxes following Lorenc**
- **Autocorrelation model based on vertical and horizontal distances**
- **Analysis boxes are wider than QC bozes**

Analysis of soil temperatures

- **Surface temperature T_s and mean layer soil T_d temperatures are analysed separately for each surface tile following Giard and Bazile (2000)**

$$\Delta T_d = \Delta T_{2m}/(2\pi)$$
$$\Delta T_s = \Delta T_{2m}$$

Complications with the new snow scheme:

- **Most surface stations are in low vegetation areas.**
- **How to diagnose 2 meter temperature from snow and canopy temperatures?**

Analysis of soil water content

The assimilation of soil water content follows Giard and Bazile (2000) with a adaptation to surface tiles introduced by Ayuso:

$$\Delta w_s = \alpha_s^T \Delta T_{2m} + \alpha_s^H \Delta H_{2m}$$
$$\Delta w_d = \alpha_d^T \Delta T_{2m} + \alpha_d^H \Delta H_{2m}$$