GNSS slant total delays :
phasing from cy40h1 to cy43t2

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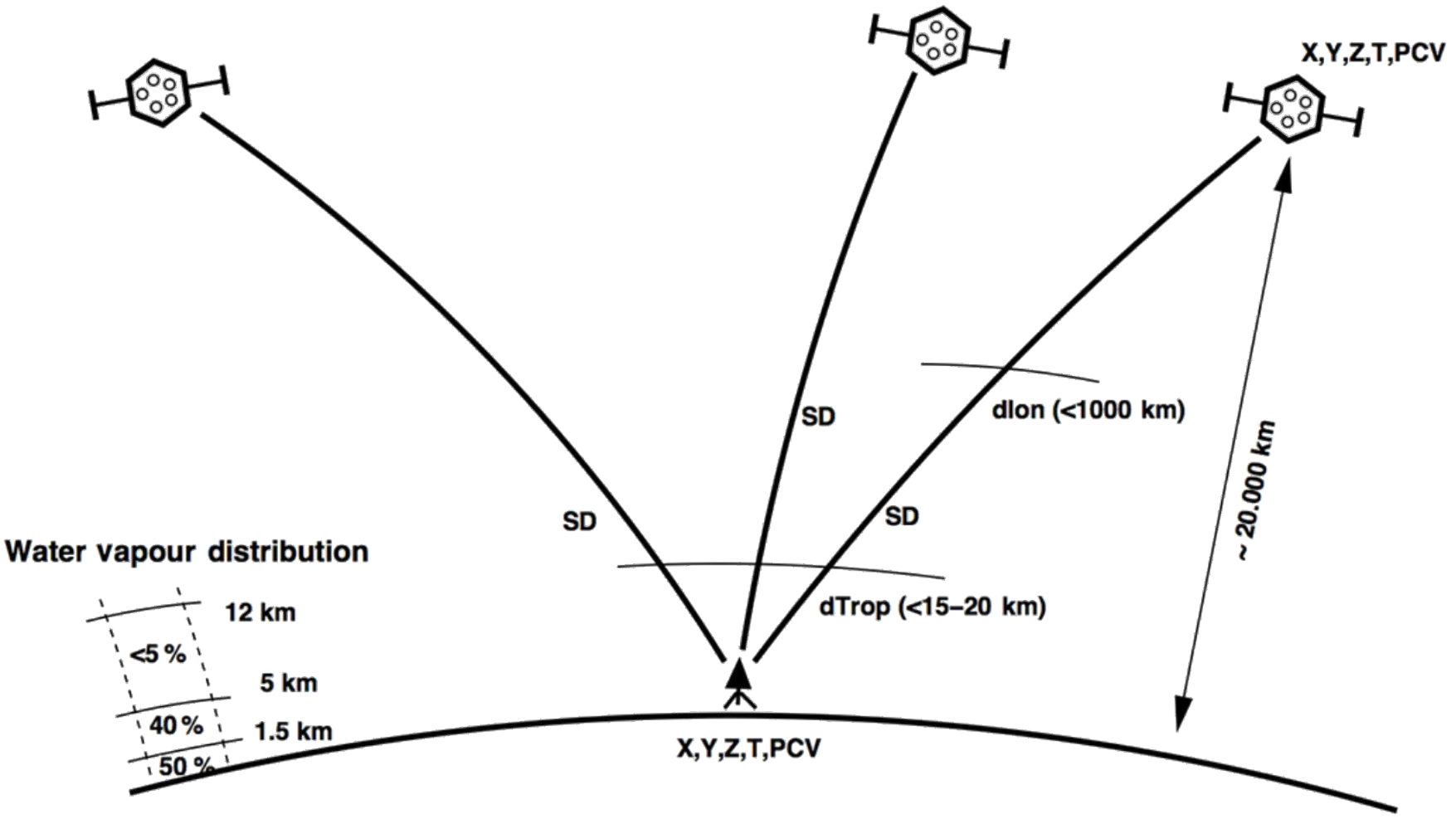
GNSS slant total delays



Schematic picture of slant total delays (SD) from Guerova et al. (2016).

GNSS slant total delays

- Slant total delays are estimated in near real time (20 minute delay)
- Bernese software 5.2
- Actual results from GNSS processing can be found here
- More information about processing can be found in article Estimation of GNSS tropospheric products and their meteorological exploitation in Slovakia

$$STD = mf_h(e)\,ZHD + mf_w(e)\,ZWD + mf_g(e)\,(G_N \cos(A) + G_E \sin(A))$$

Parameters estimated from GNSS processing

Parameters estimated from NWP model data

Parameters estimated from precise positions of GNSS satellites

Stay at KNMI

- Supervisor Siebren De Haan
- Phased from cy40h1 to cy43t2bf10.
- Observation type (19) and observation (129) were added.
- Nonlinear, TL, AD observation operators were developed.
- Preliminary assimilation tests were performed.
- Report available at :
  - RC LACE/Data Assimilation
  - EUMETNET Portal

BATOR

```
1    20190824 00
2    17 19 111 48.751804 19.151007 'BBYSSUT_' 20190824 000000 448.183 1 11111 0
3    129 165.186112 64.179396 2.681502 1.003
4
5         NSTD                          NCINLV - number of slants/ROBODY-s  NCISTD
6    NGNSS   |        LAT        LON station id      date  time altitude |  Flag |
7        |   |          |          |          |         |     |         | |     | |
8    17 19 111 48.751804 19.151007 'BBYSSUT_' 20190824 000000 448.183 1 11111 0 -- header
9                         satellite number
10   ASTD   azimuth elevation      STD | error
11     |          |         |        | |   |
12   129 165.186112 64.179396 2.681502 1.003                                  -- body
```

Listing 1: The example of OBSOUL.conv file

New fields added to BODY table:

- MDB_SATID_AT_BODY – Satellite identifier, meant to be used for satellite blacklisting,
- MDB_AZIMUTH_AT_BODY – Azimuth of satellite at GNSS station,
- MDB_ELEVATION_AT_BODY – Elevation angle of satellite at GNSS station,
- MDB_REFCONST_AT_BODY – Refractivity constant at GNSS station.
- MDB_PHI_AT_BODY – geocentric angle between GNSS station and GNSS satellite.

SCREENING

The number of vertical profiles in model space is set by namelist variable NOBSPROFS:

```
&NAMNPROF
  NOBSPROFS(19)=87,
/
```

- φ is the geocentric angle from GNSS station to satellite,
- $\Delta\varphi_k$ s the difference of geocentric angles between two intersections of GNSS signal and model levels,
- h_{top} is the level closest to satellite where the signal is bent for the last time.

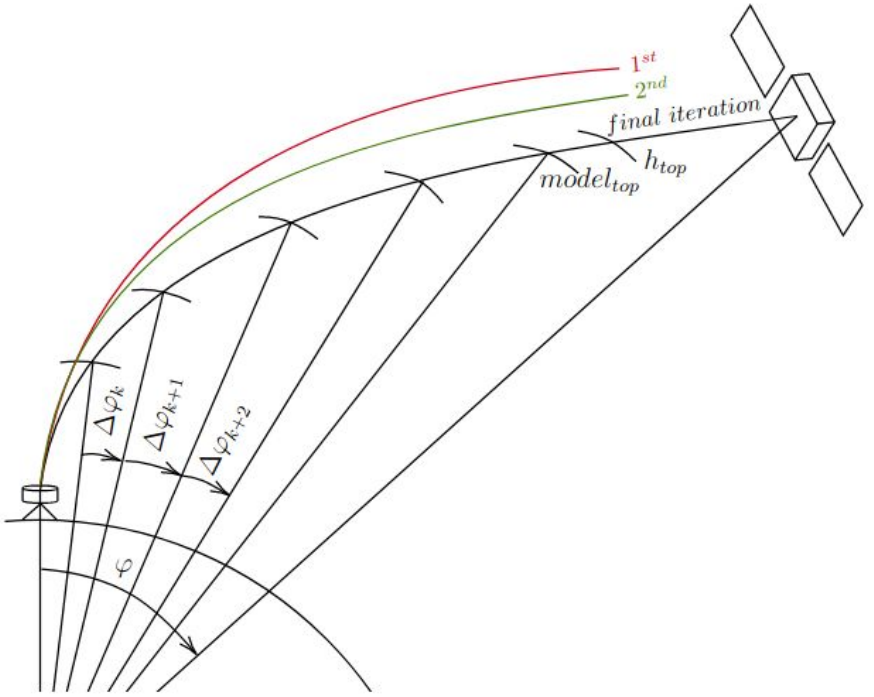


Figure 2: GNSS signal path.

MINIMISATION

Model setup:

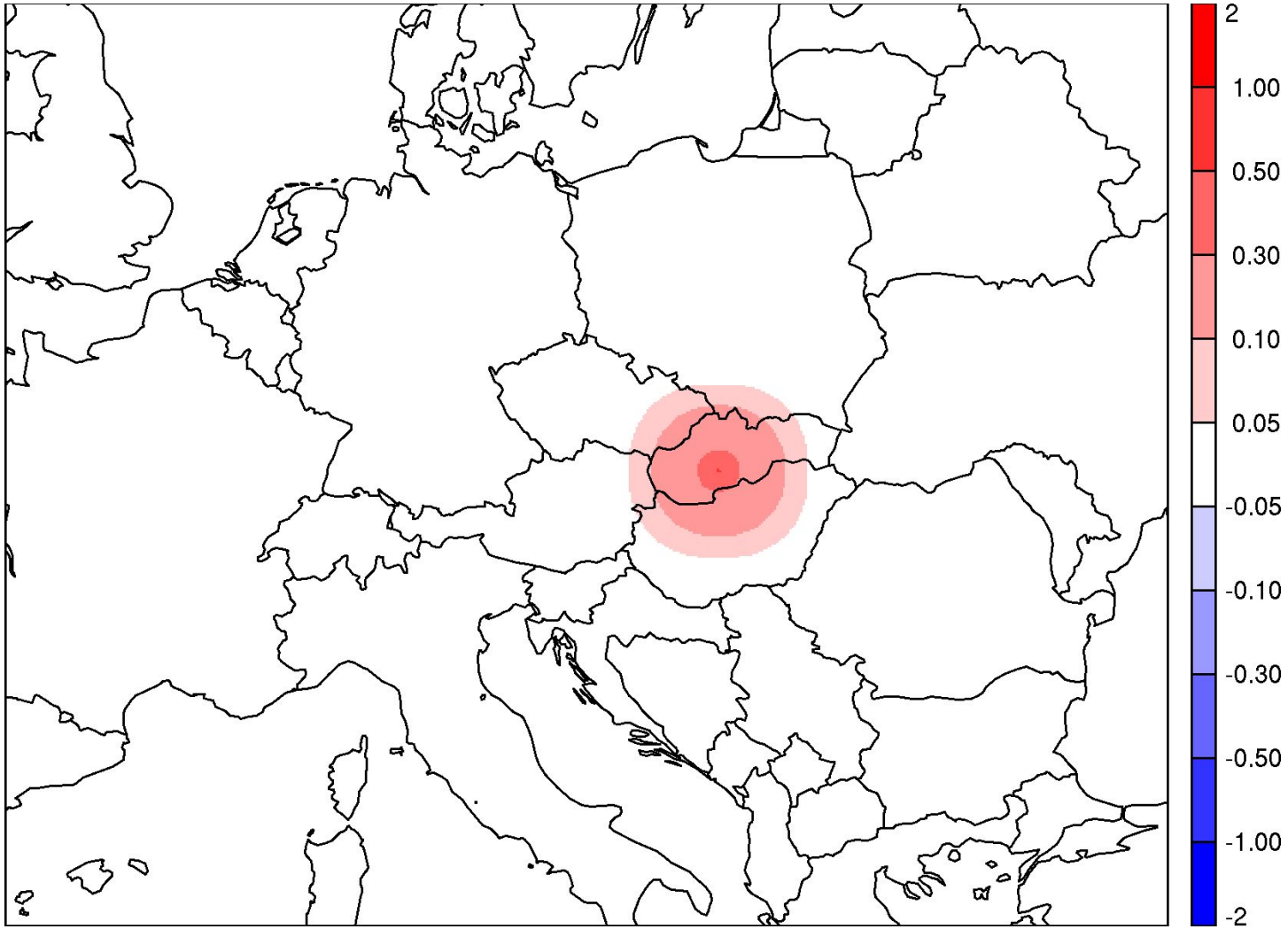
- Old operational ALADIN/CHMI NWP setup
- ALadin–AROme (ALARO)-1 physic,
- domain: Δx 4.7 km, 529x421 grid points,
- 87 vertical levels, model top 49 555 m.

It is mandatory to switch on the use of STD observations in J_o. This is done with NOTVAR variable in minimisation namelist:

```
1 &NAMCOSJO
2   NOTVAR(1,19)=-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,
3 /
```

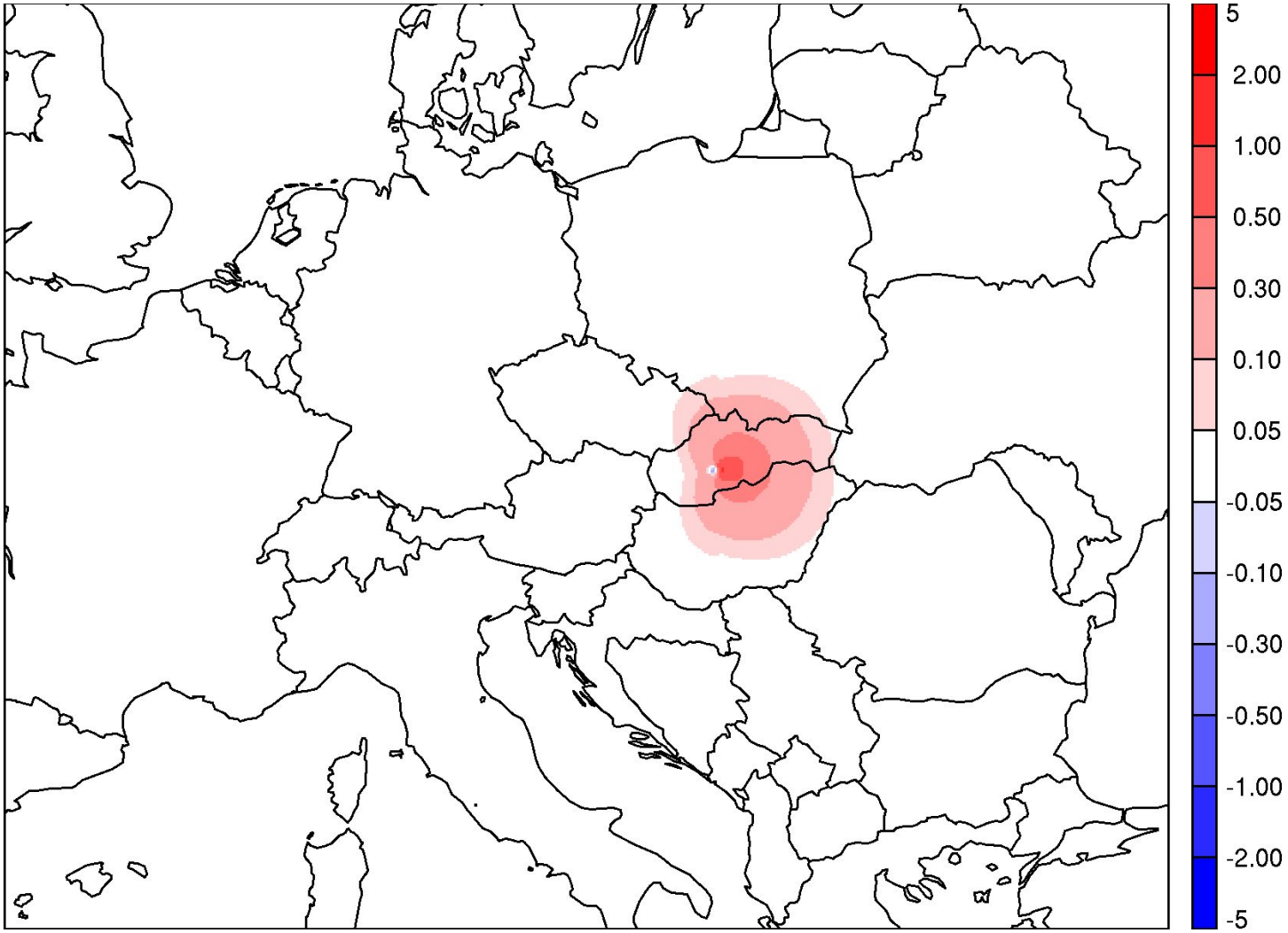
Listing 8: New NOTVAR variable in *fort.4* file for MINIMISATION

MINIMISATION



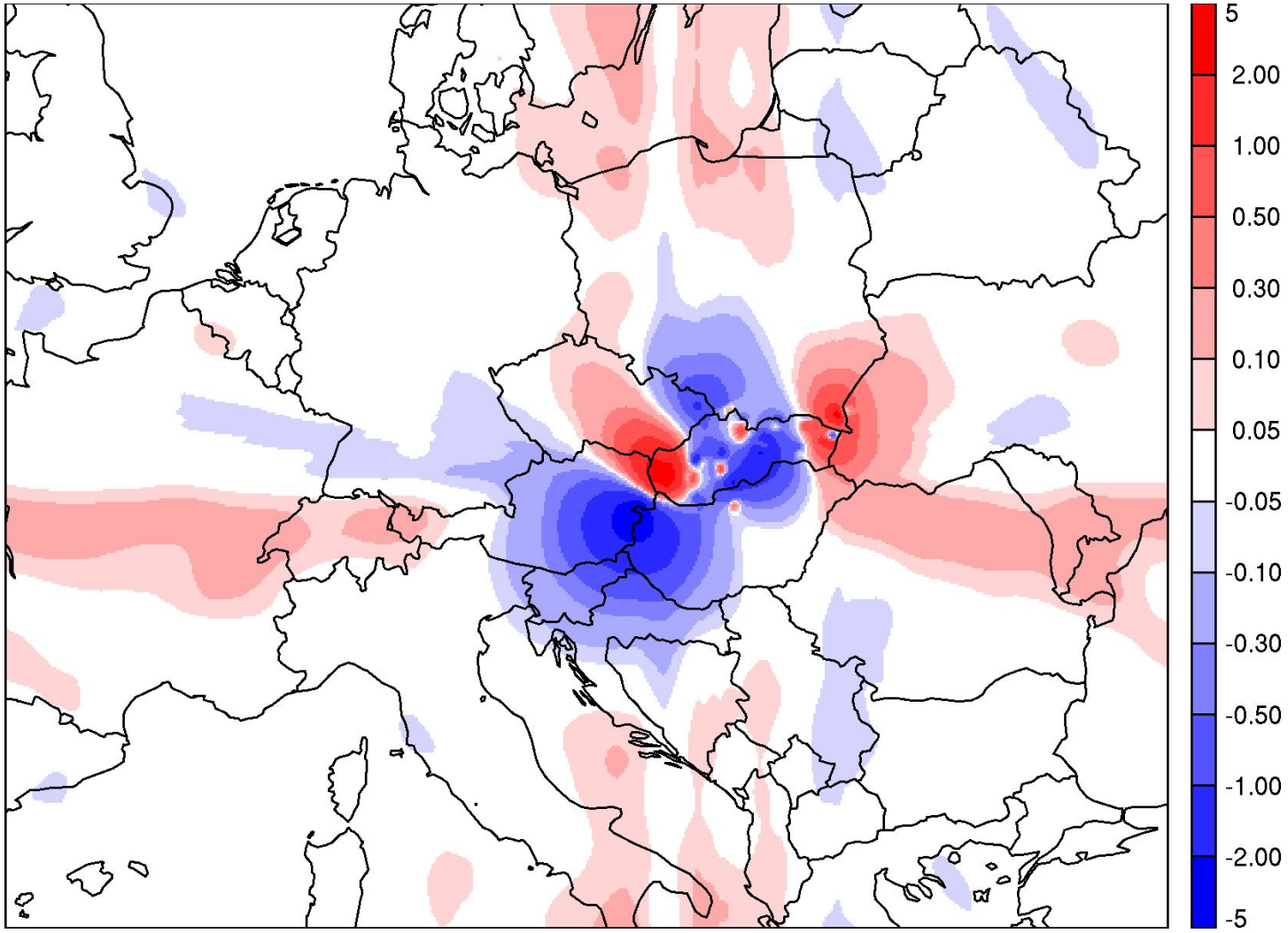
Increments of specific humidity [0.1 g/kg] at model level 60 of single STD assimilation at station BASV on 7 January 2019 00 UTC.

MINIMISATION



Increments of specific humidity [0.1 g/kg] at model level 60 of all STDs assimilation at station BASV on 7 January 2019 00 UTC.

MINIMISATION



Increments of specific humidity [0.1 g/kg] at model level 60 of all STDs assimilation at all stations on 7 January 2019 00 UTC.

Outlook

- Phase the actual version of the code to higher cycles gradually
  - Development on Beaufix - cy46t1bf05
- Perform more assimilation studies:
  - Case studies
  - Long term experiments

Acknowledgement

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