Benefit of SYNOP observations: OSE with aLMo

- This is a follow-up to a **EUCOS study** evaluating the impact of a proposed downsizing of the European **radiosonde** network and the use of additional **AMDAR** platforms [Bettems 2001]:
  - in the *analysis* and the *very short range forecast* (+6h) a clear degradation of mesoscale structures has been associated with the reduction of the number of radiosonde stations ;
  - increased observation frequency of the remaining stations does not compensate for the reduced horizontal resolution;
  - additional AMDAR platforms bring a local improvement of wind, temperature *and humidity;*

- The experiments presented here are based on the same set-up, but model sensitivity to **synop** observations is evaluated.

Jean-Marie Bettems
Swiss Federal Office for Meteorology and Climatology
COSMO – Warsaw, September 2002

Experimental set-up

- A **27 days period** was chosen, from 19th October 1999 to 15th November 1999; this period is part of the EUCOS special observing campaign and includes seven MAP heavy precipitation events (MAP SOP).

- **Three observing systems** have been considered:
  S1 is the standard observing system (synop, buoy, aircraft, temp, pilot)
  S4 has no synop observations (but buoys still present)
  S5 uses a reduced density of the synop network (mean minimal distance between stations from 40km to 80km, resulting in 50% less bulletins)

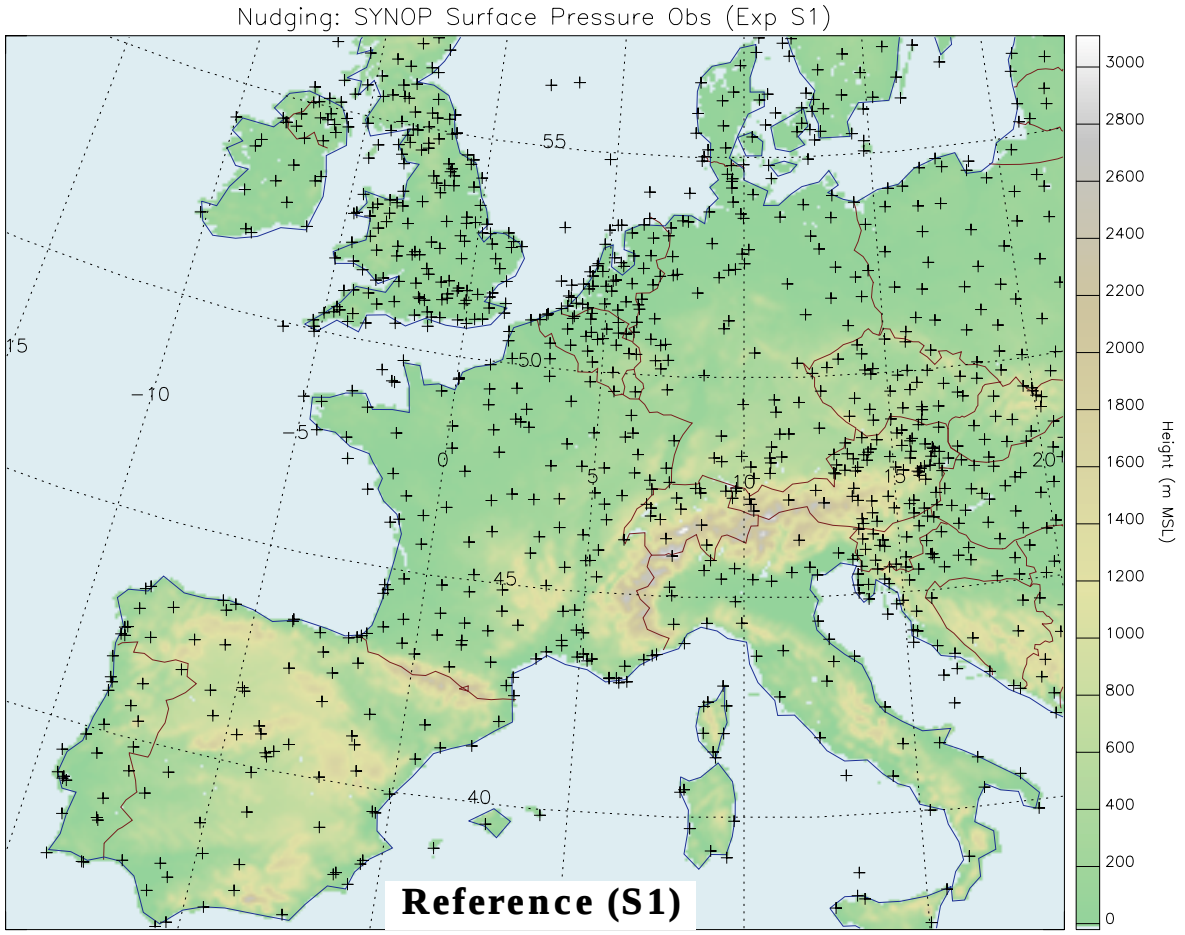
- For *each* observing system: a 27 days **continuous assimilation** and a **daily 24h forecast** (12UTC) have been calculated

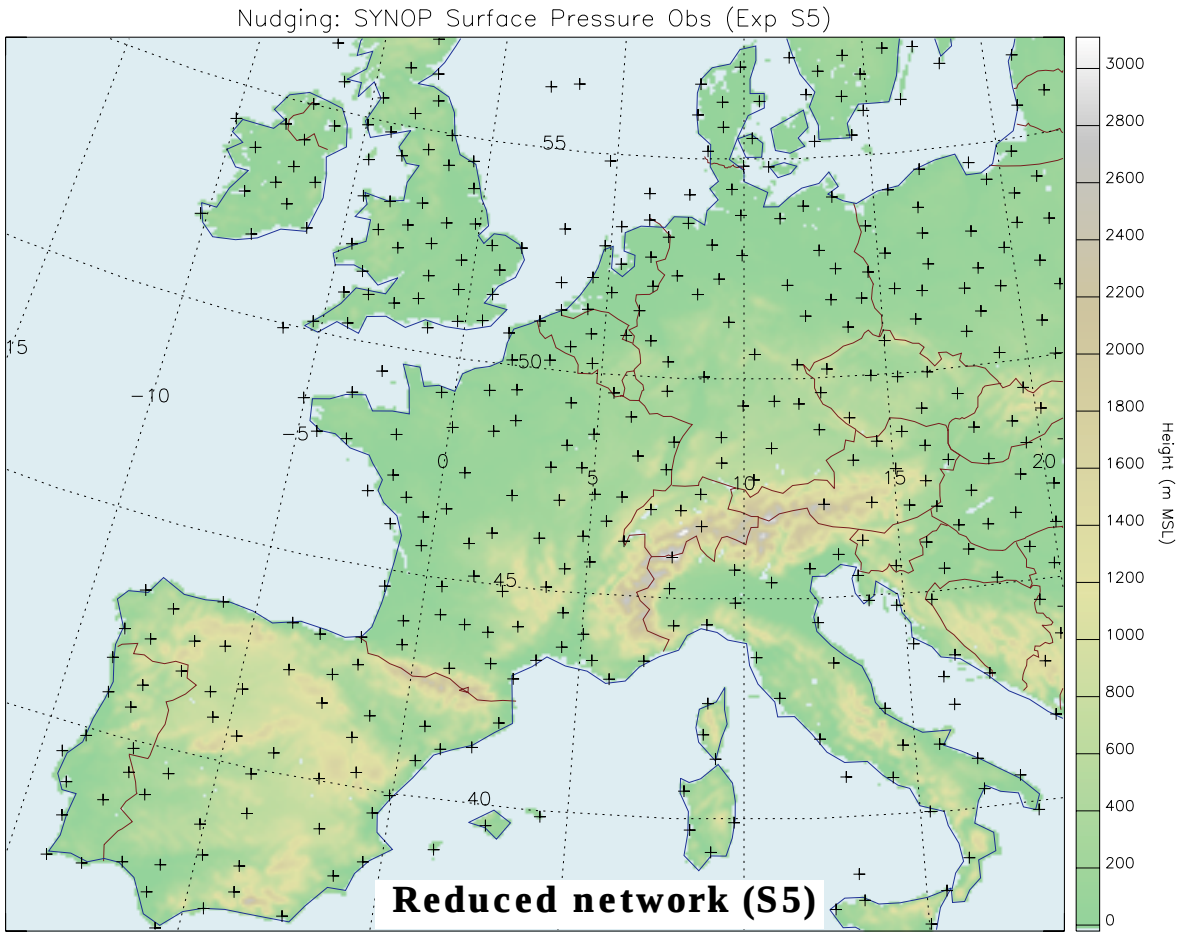
- All experiments were based on the **operational configuration of aLMo**, the version of the Local Model installed at MeteoSwiss:
  1. 385x325 mesh, about 7km horizontal resolution, 45 layers in the vertical
  2. boundary conditions from the ECMWF operational deterministic forecast (forecast) and from the operational 4d var stream (assimilation)
  3. *same boundary conditions* are used for all three experiments

- Usage of synop observations in **assimilation algorithm**
  1. **Surface P** *only if*: -100m < (station height - model orography) < 400m
     mass field corrected up to 400hPa
     associated T and (partly) geostrophic UV correction
     horizontal scale of correction is 70km
  2. **2m RH** *only if*: -160m < (station height - model orography) < 160m
     correction up to about 300m above station
  3. **10m UV** *only if*: station height < 100m
     correction up to about 800m above station

jean-marie.bettems@meteoswiss.ch

Assimilated surface pressure observations





jean-marie.bettems@meteoswiss.ch

Impact of synop network (1)

1. Improvement of **surface pressure** (bias and stdev) limited to 10% in the mean. Day to day correction can reach 30%. Impact visible in both analysis and 24h forecast.

2. Surface pressure observations improves **wind direction up to 600hPa** (bias and stdev), even at the location where wind profiles are assimilated. Impact mainly on analysis, but still visible in 6h forecast.

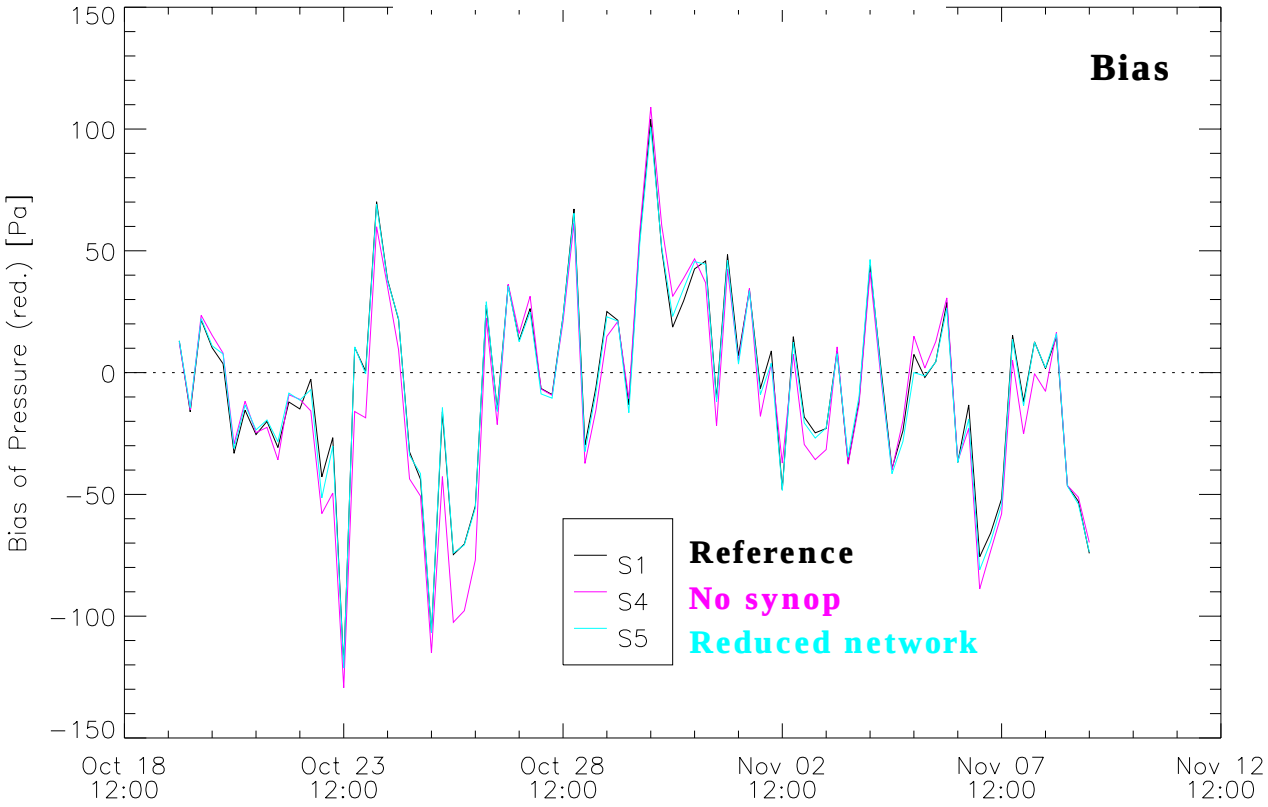
3. Small (<10%) positive impact on the **humidity profile** (stdev) in the whole troposphere. Impact visible in forecast.
   Small impact (~10%), both positive and negative, on **2m dew point** forecast.

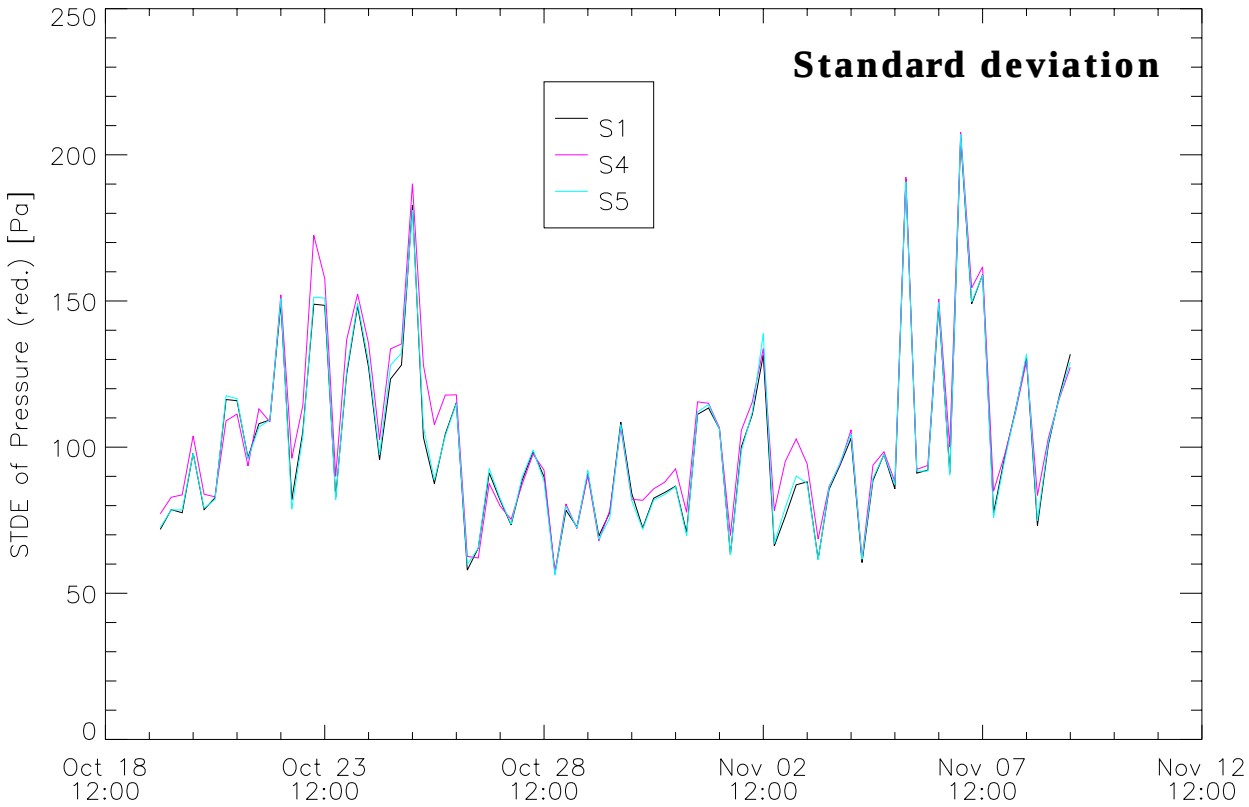
4. **Over Switzerland**, assimilation of synops is slightly detrimental to forecasted **moist processes** (dew point, cloud cover, precip).
   Possibly a weakness of current assimilation algorithm in presence of mountains (geostrophic wind correction associated to p_s increments, extent of structure function for 2m humidity measured by slope stations, …).

5. The impact on forecasted **temperature profile** is slightly negative (add 0.3 [degree] bias in the first kilometer).
   Possibly an effect of the temperature correction associated to p_s increments.

jean-marie.bettems@meteoswiss.ch

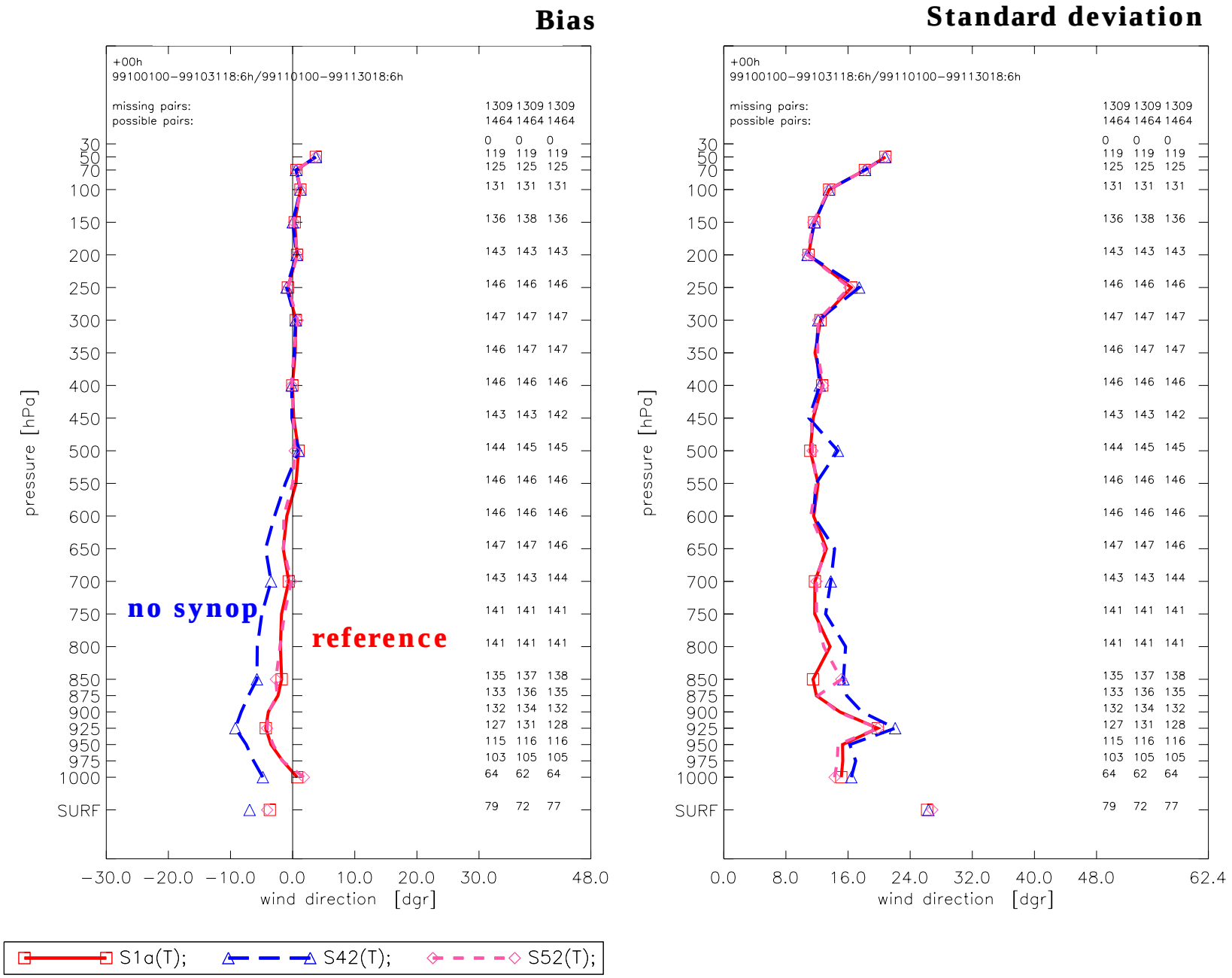
Time serie of reduced surface pressure errors





jean-marie.bettems@meteoswiss.ch

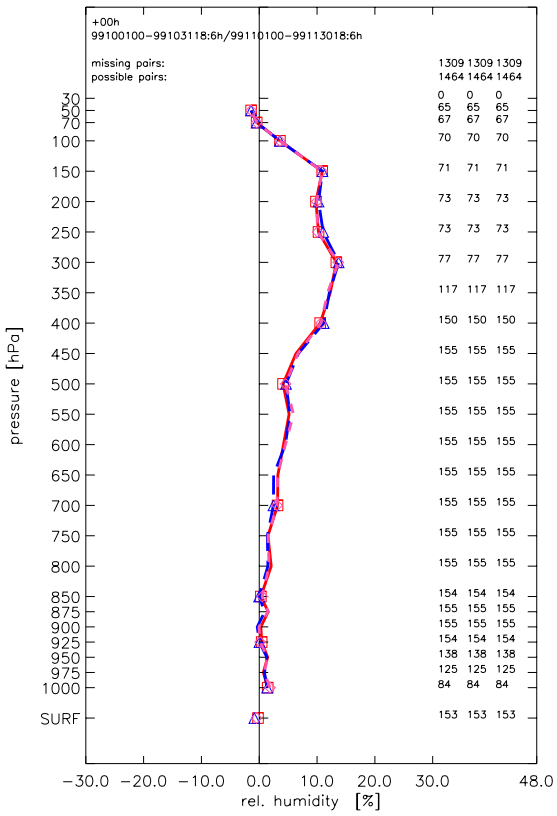
Wind direction errors – west of Alps, analysis



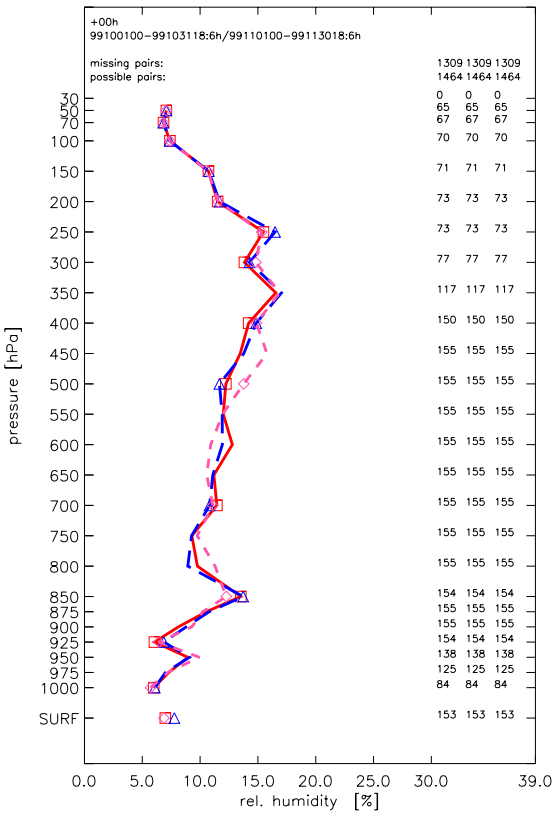
jean-marie.bettems@meteoswiss.ch

Relative humidity errors – west of Alps

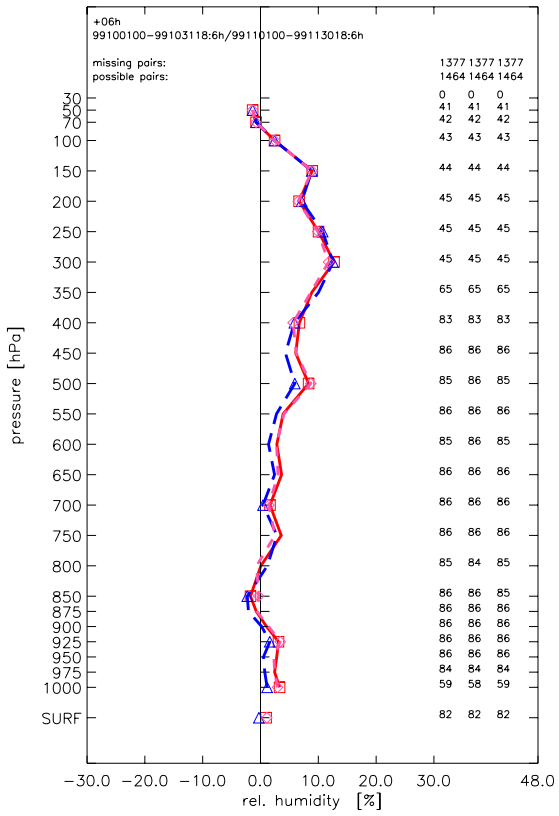
Bias, +00h



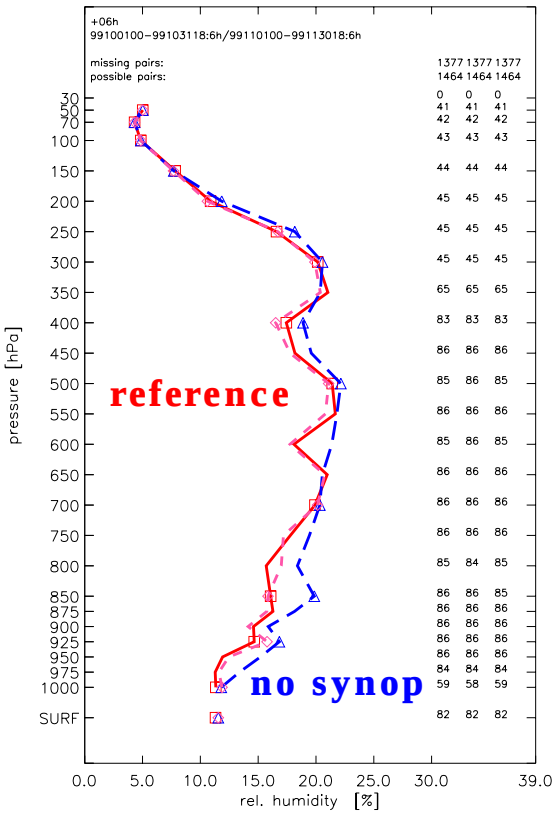
Standard deviation, +00h



Bias, +06h



Standard deviation, +06h

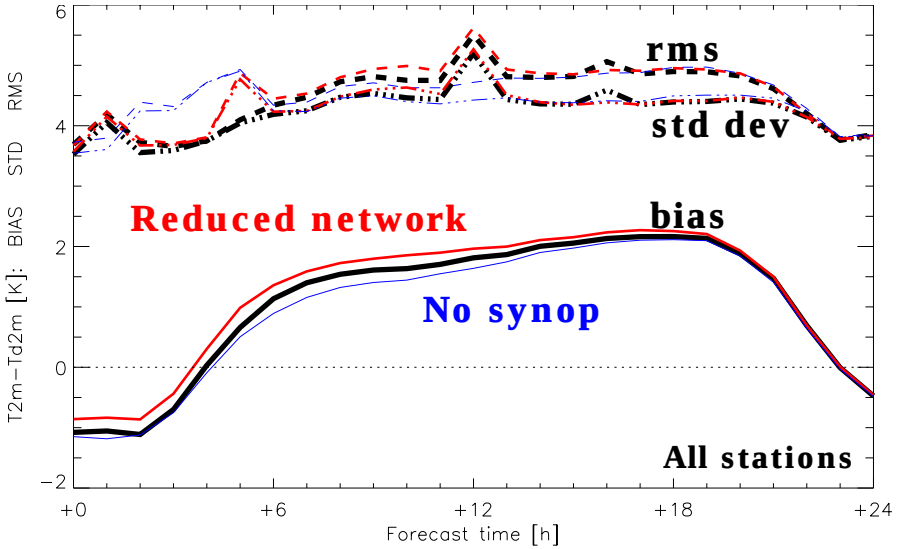


S1a(T); S42(T); S52(T);

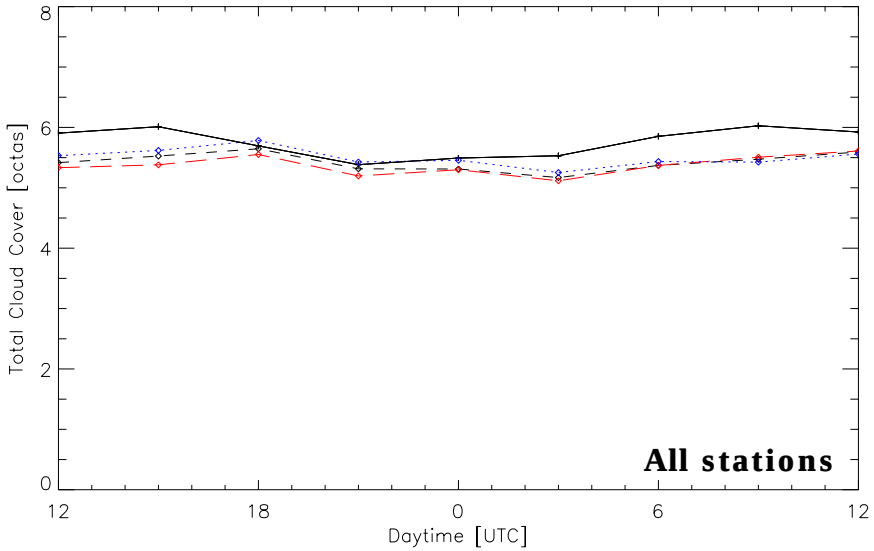
jean-marie.bettems@meteoswiss.ch

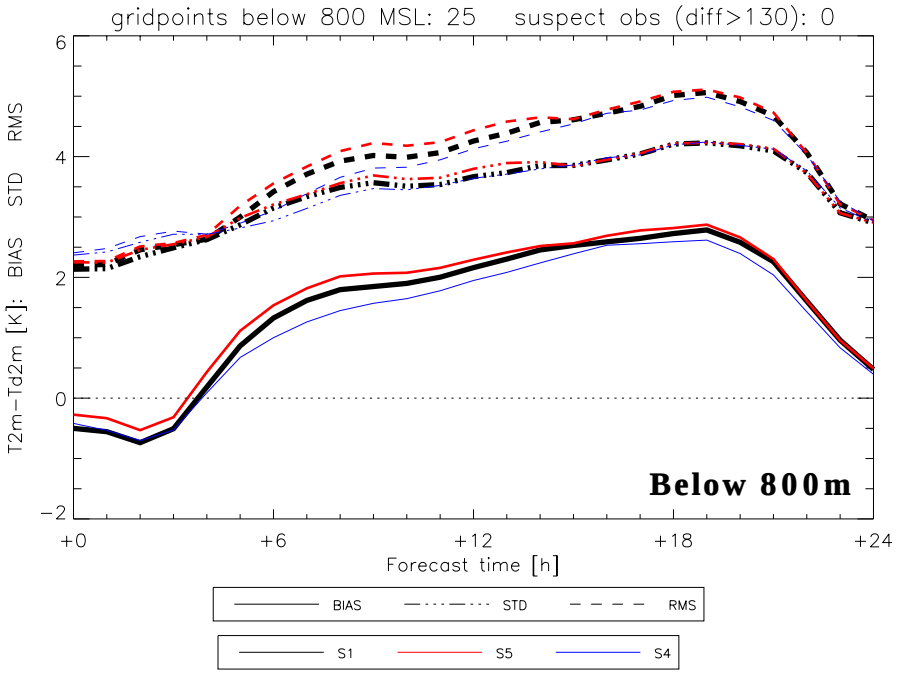
Impact of synop on humidity – Switzerland

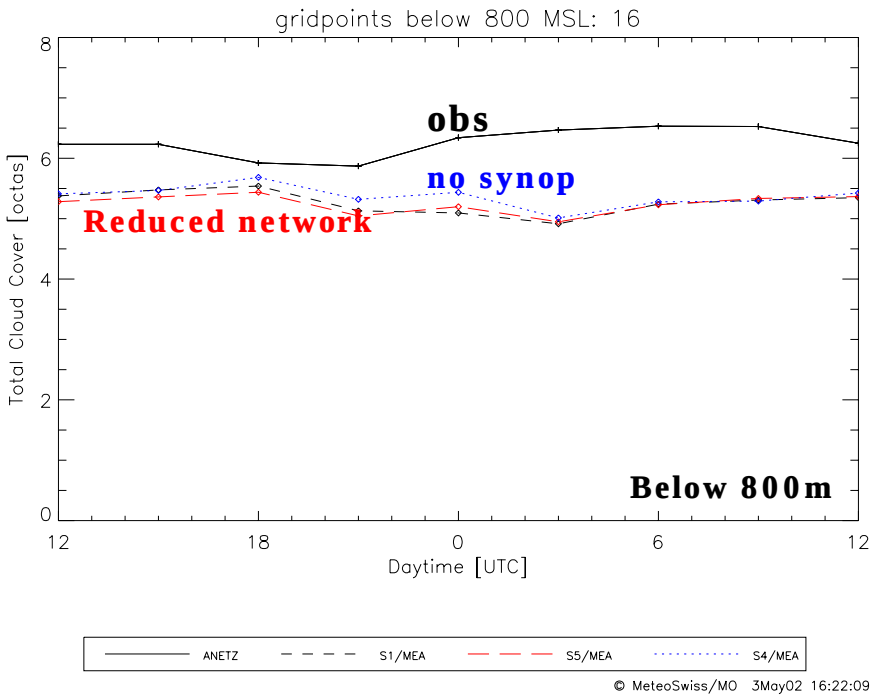
Dew point depression, daily cycle



Total cloud cover, daily cycle



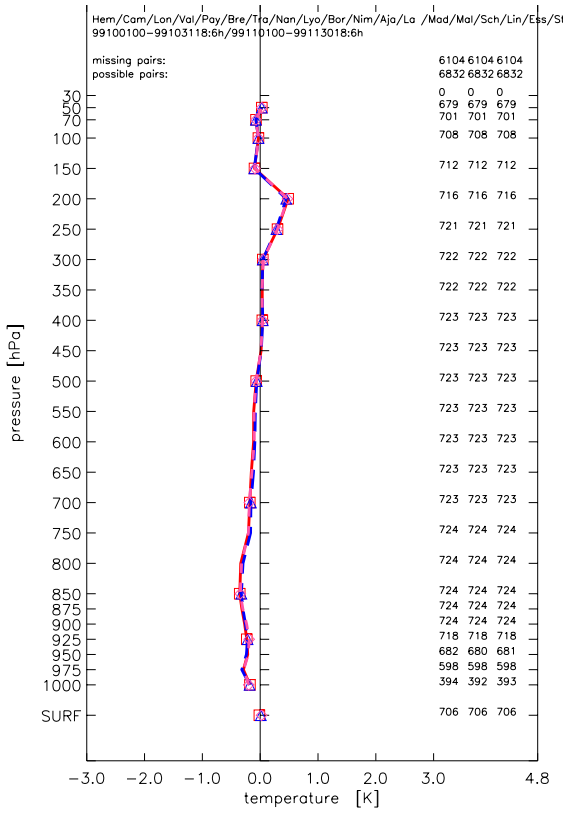




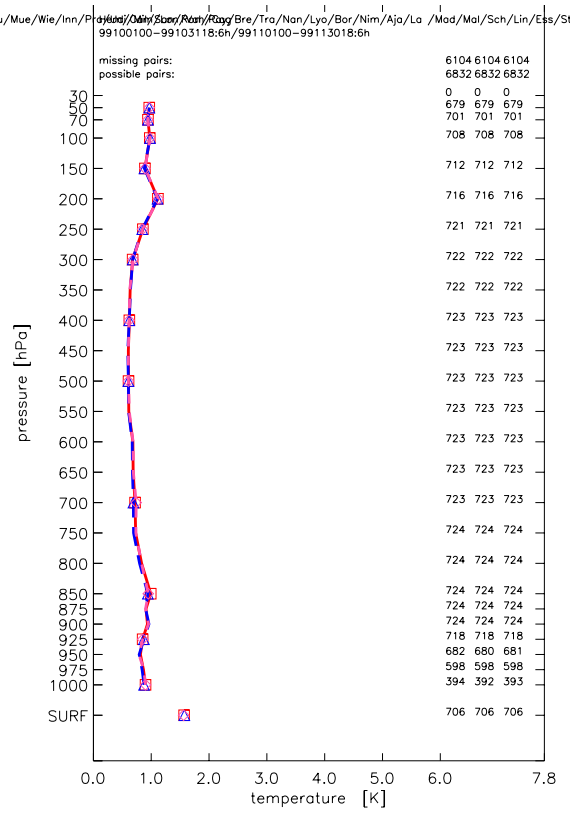
jean-marie.bettems@meteoswiss.ch

Temperature errors – whole domain

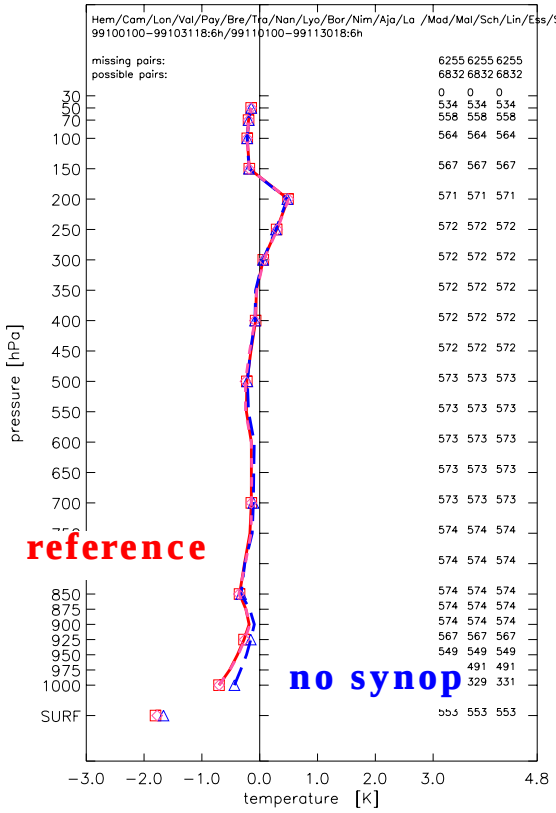
Bias, +00h



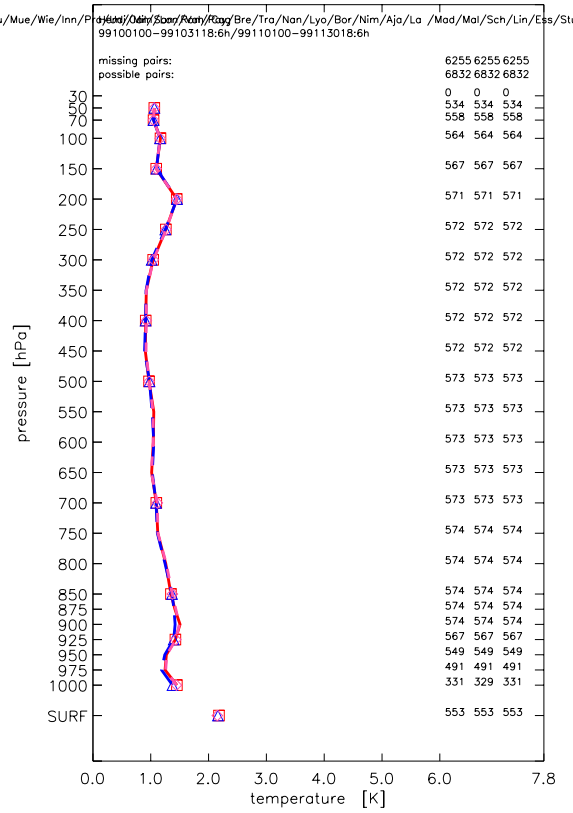
Standard deviation, +00h

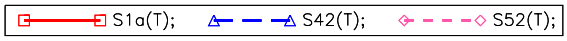


Bias, +06h



Standard deviation, +06h





Impact of synop network (2)

No dramatic effects, smaller impact than radiosonde network thinning or assimilation of gps derived integrated water vapor.

Mainly surface pressure and wind benefit from synop.

Some tuning required in mountainous regions.

Halving the number of synop stations by making the network more homogeneous has no significant impact.

Is this surprising?

surface pressure:
- dominated by synoptic scale features
- information from temp network present in both experiments

humidity:
- how representative is 2m humidity at aLMo scale?
- some studies have shown that synop are important when combining them with radar observations.

… high density synop network could become more important at higher resolution and when more elaborate assimilation schemes are used.

jean-marie.bettems@meteoswiss.ch