

Operational Verification of Vertical Profiles at MeteoSwiss

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The operational upper-air verification at MeteoSwiss uses TEMP stations all over the integration domain to verify the vertical structure of the forecasts. For the operational setup of the Alpine Model (aLMo), refer to Section 4 in this newsletter. However note that the aLMo runs with ECMWF lateral boundary conditions rather than GME lateral boundary conditions since September 16th, 2003.

In the following, we present the average vertical structure for 24 TEMP stations for the full climatic year 2003 (averaged over verification times 00 & 12 UTC; see figures 1–4).

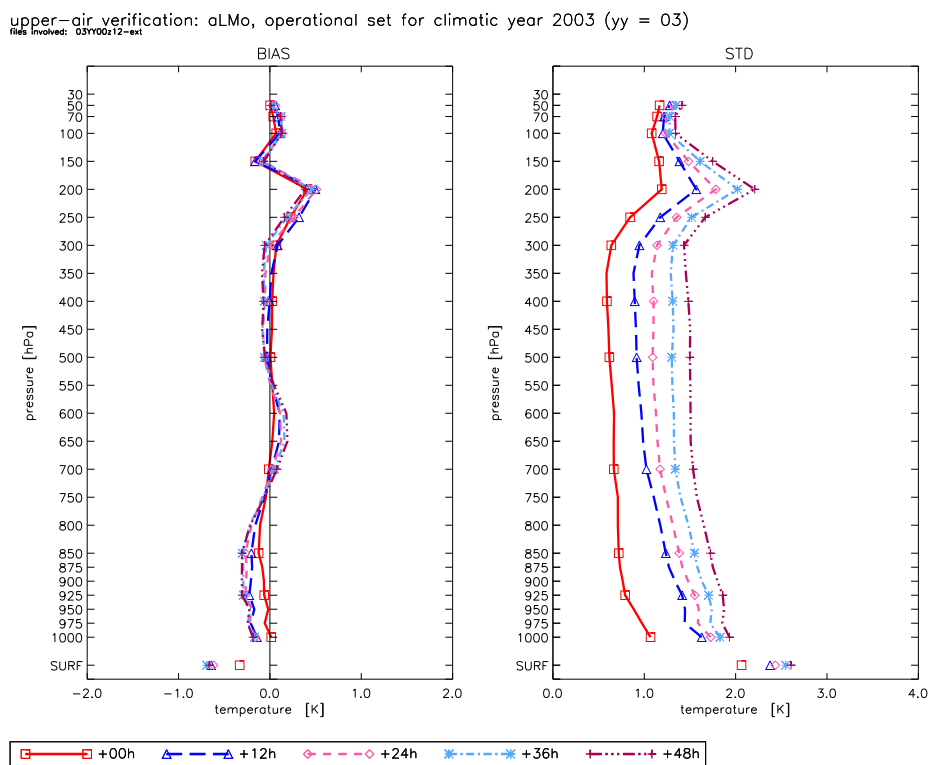


Figure 1: Mean error (BIAS) and standard deviation (STD) for temperature. Various forecast times (averaged over all stations and verification times 00 & 12 UTC) for the climatic year 2003 (1.12.2002 – 30.11.2003).

The verification plot for *temperature* (*cf.* figure 1) shows different mean errors (biases) for different regions of the atmosphere. Starting from the surface, a cold bias is observed up to 750 hPa, followed by a warm bias between 750 and 550 hPa, both of which are mainly caused by the summer season. A cold bias from the middle atmosphere up to the tropopause, mainly observed in autumn and winter, is followed by a saw-like structure in the mean error of temperature at and above the tropopause level. The fact that most temperature biases increase with increasing forecast time hints at a systematic model deficiency, which is not yet understood. Concerning the standard deviation, largest spread is seen around the tropopause level.

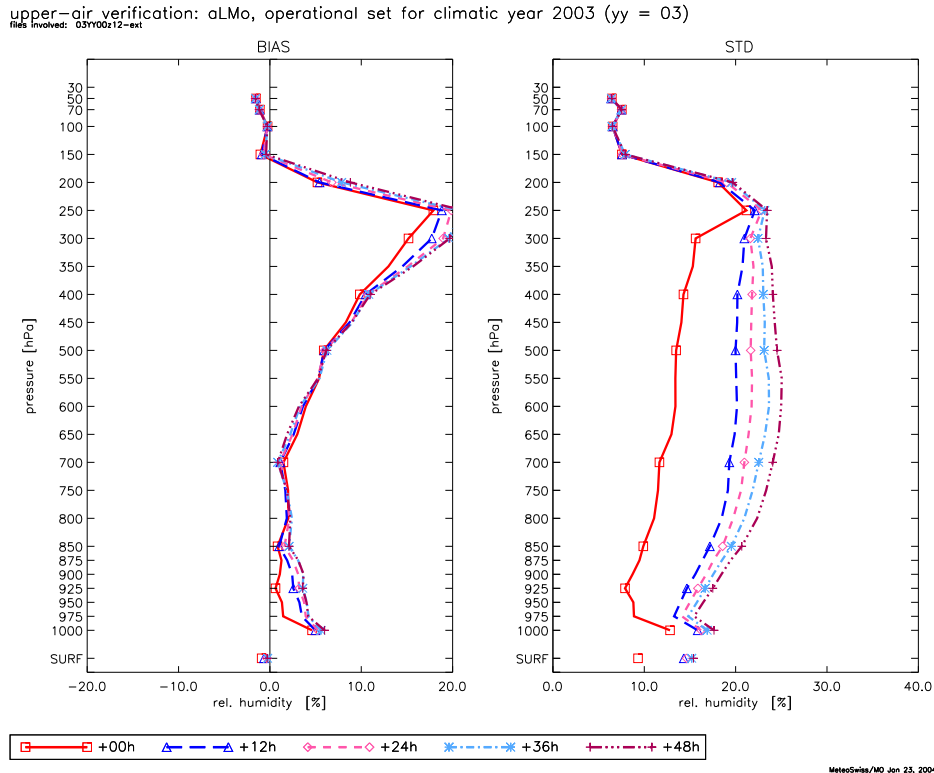


Figure 2: Mean error (BIAS) and standard deviation (STD) for relative humidity with respect to water. Various forecast times (averaged over all stations and verification times 00 & 12 UTC) for the climatic year 2003 (1.12.2002–30.11.2003).

Looking at the verification results for the *relative humidity* (cf. figure 2) the mean error is moderate up to 700 hPa, with a clear and increasing moist bias towards the surface. Above 700 hPa, relative humidity with respect to water is systematically biased towards positive values, since for the current grid-scale precipitation scheme (no cloud ice) specific humidity values need to be artificially increased at analysis time to compensate for the difference in saturation vapour pressure over water and ice at temperatures below freezing. The standard deviation is reasonably uniform throughout the troposphere, with a slight increase towards the surface.

Wind direction (cf. figure 3) exhibits a very small mean error, especially above the boundary layer. As expected, there is a marked increase for both mean error and standard deviation towards the surface. A deterioration of the standard deviation is also observed in the stratosphere.

The mean error of the *wind speed* (cf. figure 4) is small. The largest bias is observed for the boundary layer and at the tropopause height. Worth remarking is the non-negligible slow-down of the atmosphere with increasing forecast time throughout most of the troposphere, especially for the winter season (not shown), hinting at another systematic model error or a systematic bias of the driving global model. The standard deviation is largest at the tropopause, consistent with the highest winds at this level.

Finally, we note that the standard deviation increases almost linearly from forecast time +12 h to +48 h with a substantially larger difference between analysis time (*i.e.*, +00 h) and +12 h for all parameters except the (un-nudged) geopotential (not shown).

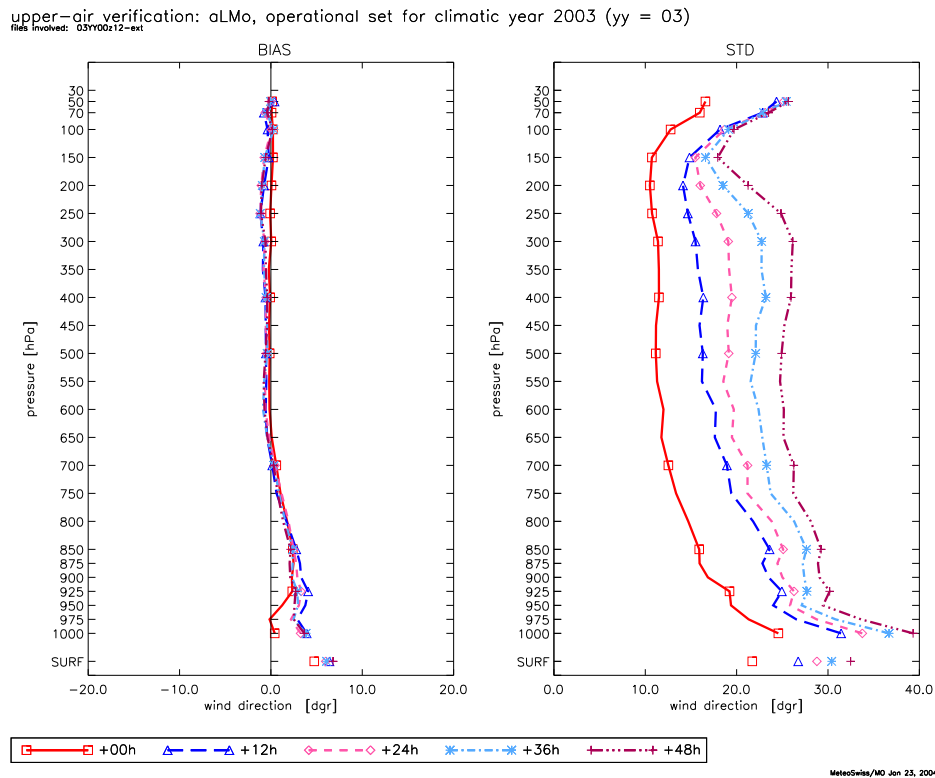


Figure 3: Mean error (BIAS) and standard deviation (STD) for wind direction. Various forecast times (averaged over all stations and verification times 00 & 12 UTC) for the climatic year 2003 (1.12.2002 – 30.11.2003).

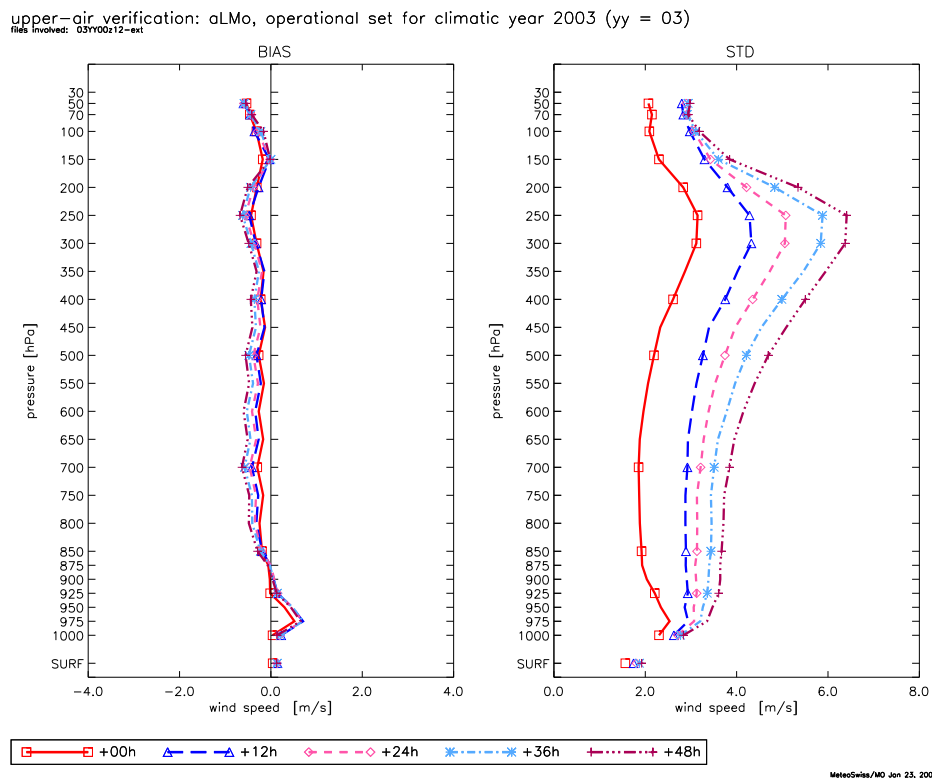


Figure 4: Mean error (BIAS) and standard deviation (STD) for wind speed. Various forecast times (averaged over all stations and verification times 00 & 12 UTC) for the climatic year 2003 (1.12.2002 – 30.11.2003).