On the Correction of Systematic Rain Gauge Measurement Errors

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Problems and Tasks

A central goal of the Mesoscale Alpine Programme (MAP) is to yield an accurate estimation of the areal precipitation distribution over the Alps from both observations and NWP models. One of the key problems in getting the true precipitation from rain gauge networks is the systematic measurement error. Without correcting this error the analyzed precipitation fields gives monthly values, which are on average 5 – 30 % too low. If one looks at daily values the systematic measurement error could be much larger. Therefore it is necessary to correct the observations to reduce the bias and to get an estimate of the true precipitation amount (Legates and Willmot 1990, Reiss *et al.* 1992, Rudolf 1995). But, one should note that a correction could never replace an accurate measure-ment, moreover the correction procedure itself may introduce new uncertainties and reduces the sytematic error only in a statistical sense.

Solutions

To correct the systematic rain gauge measurement error, a statistical model (Rubel and Hantel 1999) was applied to observations within the MAP region. Global results from this correction model (Ungersböck 2000) correspond quite well with the monthly correction factors (given by Legates 1990) and used at the GPCC (Reiss *et al.* 1992, Rudolf 1995). A mayor improvement of this model is its application to daily measurements taking into account synoptic observations with high temporal resolution. Nevertheless, it was necessary to implement some simplifications for routine use. Further, measurements from mountain stations are difficult to interpret (Auer 1992). Therefore stations above 1500 m are not considered. We present first results for the 1997 rain gauge observations within the MAP region (Fig. 1) and discuss present and future features of the used correction model (Fig. 2 – Fig. 5).

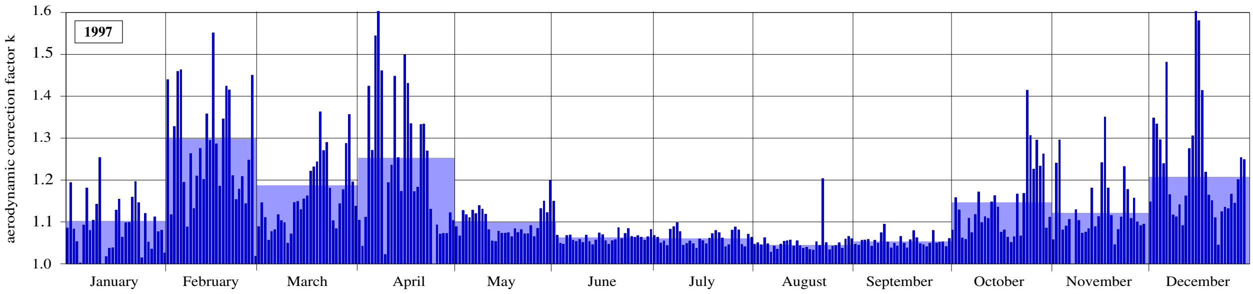

Fig 1 Daily and monthly values of the aerodynamic correction factor k averaged over the MAP model domain. Only gauges located at synoptic stations below 1500 m sea level have been used.

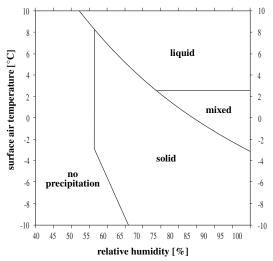

Fig 2 Distinction between liquid, mixed and solid phase

The corrected precipitation amount Z is estimated in the present evaluations as

$$Z = k(Z_m + \Delta Z_w + \Delta Z_e)$$

where Z_m is the measured precipitation, ΔZ_w the wetting loss, ΔZ_e the evaporation loss and k the aerodynamic correction factor. The latter is calculated for liquid

$$k = \exp(-0.001\log(Z_I) - 0.012v\log(Z_I) + 0.034v + 0.008 + c)$$

and solid

$$k = \exp(c_1 + c_2 + c_3 T + c_4 vT)$$

phase. The figure shows the precipitation phase depending on temperature and humidity.

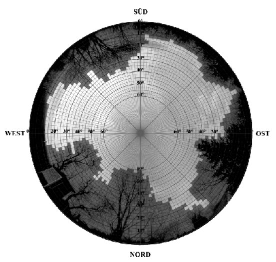

Fig 3 Classification of rain gauge site exposure

Characteristic parameters to classify the gauge site exposure are roughness length and vertical angle to obstacles in the vicinity of the gauge. The figure shows the photo taken with a fish-eye lense at the Austrian station *Bruckneudorf* (source: ZAMG). The digital calculation of the average angle to obstacles in this example is α=35°, which corresponds to an over protected location (Sevruk and Zahlavova, 1994). The gauge site exposure is used to reduce the wind speed to the level of the gauge orifice. The main problem is, that for many gauge locations no information is available. Then pre-defined values of roughness length and angle α are used.

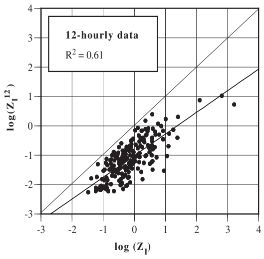

Fig 4 Estimation of the rain intensity

The rain intensity is used to describe the influence of the drop size distribution on the undercatch of the gauge. At the most non-synoptic stations the rain intensity is not measured. In that cases 24-, 12-, 6- or 3-hourly observations are used to calculate an estimate of the rain intensity using the following relation (Rubel and Hantel, 1999):

$$Z_I = \exp[(\log(Z_I^{24}) + 1.261)/0.626]$$

$$Z_I = \exp[(\log(Z_I^{12}) + 1.017)/0.738]$$

$$Z_I = \exp[(\log(Z_I^{6}) + 0.740)/0.888]$$

$$Z_I = \exp[(\log(Z_I^{3}) + 0.456)/0.971]$$

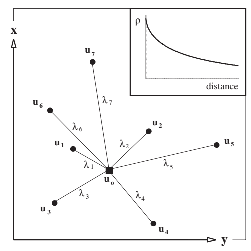

Fig 5 Interpolation of meteorological parameters to non-synoptic stations

If the meteorological input parameters needed for the correction model are not observed at the location of the rain gauge, they are taken from the nearest synoptic station. A more accurate method would be to use an optimum interpolation schema.

$$\hat{Z}_A(u_0) = \sum_{i=1}^{n} \lambda_i [Z(u_i) + \delta(u_i)]$$

The optimum interpolation (kriging) method is a statistical least-squares technique based on spatial autocorrelation functions. It could also be used to calculate gridded precipitation fields (Rubel, 1998).

Acknowledgements

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