RECONSTRUCTION OF SHORT-TERM PRECIPITATION TOTALS WITH ALLOWANCE FOR WEATHER PHENOMENA DATA

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Measured precipitation totals are needed to verify developing numerical methods for precipitation analysis and prediction. However, precipitation totals measured at weather stations are frequently not consistent with standard times and accumulation periods, which makes the standardization of measured precipitation totals an important problem [1]. A method for obtaining short-term precipitation totals from longer-term ones in conjunction with other precipitation data received from weather stations is suggested.

The method is based on data from SYNOP messages (code form FM 12-IX SYNOP). We consider precipitation totals (RRR, R_{24} R_{24} R_{24}), time periods for the totals (t_R), past weather (W_1W_2 or $W_{a1}W_{a2}$), present weather (ww or w_aw_a), types of low and medium level clouds (C_L, C_M), fraction of the celestial dome covered by C_L or C_M (N_h), and indices of $RRRt_R$ and wwW_1W_2 groups presence (i_R, i_x).

For each message we can set a problem as follows [2]:

$$\begin{cases} \left(\sum\limits_{j=d,p,h} l_j r_j t_j - R(1-q) \right)^2 \to \min \\ 1 - t_j \geq 0, \; j = d, p, h \\ t_j - 1/60 \geq 0, \; j = d, p, h \\ k - \sum\limits_{j=d,p,h} l_j t_j \geq 0 \\ r_j - a_j^{\min} \geq 0, \; a_j^{\max} - r_j \geq 0, \; j = d,p,h \\ q \geq 0, \; 1 - q > 0 \\ m(r_d + r_p + r_h) - Rq \geq 0 \end{cases}$$

where indices mean the type of precipitation (*d* – drizzle, *p* – steady precipitation, *h* – heavy precipitation); *R* is the precipitation total for some time period *T*; l_j are the hours with precipitation of type *j*; r_j is the rate of precipitation of type j; t_j is the duration of precipitation of type *j* (a fraction of an hour), which is assumed to be the same for any hour with precipitation of type j; *k* is the number of hours with precipitation in the period T; m is the number of hours in the period T for which there is no information about precipitation; *q* is the fraction of *R* for *m* hours, and $a_j^{\min}$ and $a_j^{\max}$ are the thresholds for the rates of precipitation of type *j*.

We solve the problem by the method of gradient descending with penalty functions. We use climatic values of the rate and duration of precipitation of each type as a start point for descending.

Messages from stations placed in Germany were used for verification of the method. Precipitation and weather data are sent every 3 hours from these stations. Messages may contain 3-, 6-, and 24-hour precipitation totals. Based on the method suggested, 3- and 6-hour precipitation totals were estimated from the 24-hour ones for different seasons. The results were compared to observations. The RMSE obtained for the reconstructed 3-h precipitation totals, averaged for more than 120 stations, was from 0.5 to 1.9 mm for different seasons; the correlation coefficient (CORR) was about 0.5, and the Hanssen-Kuipers discriminant with zero threshold (HKD) was approximately equal to 0.7. For the 6-h precipitation totals, RMSE was from 1.2 to 2.5 mm, CORR was about 0.6, and HKD was approximately the same as for the 3-hour totals.

We are to use satellite data as an additional condition in the problem formulation and hope that this will improve precipitation estimates.

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References:

1. Assimilation of clouds and precipitation, *ECMWF/EuroTRMM Workshop Proc., 6-9 Nov. 2000.* — ECMWF, Reading, United Kingdom, 2001, 414 p.

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