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Freezing precipitation in Russia and Ukraine: conditions of formation and an approach to probabilistic forecasting

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Conditions for freezing precipitation (FP), including freezing rain (FR) and freezing drizzle (FZ) in 8 airports in Russia and 4 in the Ukraine are studied on the basis of 10 to 20 years series of hourly surface weather observations, radiosounding and objective analysis. Statistical characteristics are obtained of FP episode duration and its occurrence frequency dependences on surface air temperature, wind, and cloud base height. The FP occurrence frequency is maximum in December or January and strongly depends on local conditions and on regional atmospheric circulation features. In general, the FP occurrence frequency decreases from the west to east, being maximum (4.8% in December) in Mineralnye Vody, North Caucasus. Strong and disastrous FR are associated with the Mediterranean cyclones, their effects is well expressed in the Ukraine, Central Russia, and North Caucasus. To the east of Moscow, the FR occurrence frequency sharply decreases from the month-mean maxima of 1-1.4 % to 0.5% (Nizhni Novgorod, January), while in East Syberia and Far East, FP is an extremely rare event. So, in Irkutsk, no one case of FP is observed during 15 years.

From the radiosonde data, it is found that the “classical mechanism” of FP generation (stratification of “warm nose” type in the cloud layer) takes place relatively rarely: in 25% of FP cases in Odessa, in 3.9 % in Mineralnye Vody. In these cases, mainly FR is observed, while the “non-classical” conditions produce mainly FZ. In many sites, FP from the “all-cold” clouds dominates, in particular, in all airports of Moscow. The cloud layers under the inversions produce mainly FZ, air temperature in the inversion

layer being positive in many cases.

From the objective analysis data, relationships are studied between FP occurrence frequency and the grid-scale flow characteristics, including the surface pressure field curvature, baroclinicity, cold and warm advection. On this basis, a statistical approach for the FP probability forecasting is developed. Examples are presented of the developed approach application to episodes of FP, including both “classical” and “all cold” conditions.

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