SYNOPTIC CONDITIONS IN THE COURSE OF THE SATOR EXPERIMENT

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The spatial distribution of large–scale processes at summer and fall stages of the SATOR experiment is presented with the purpose of interpreting the measurements.

INTRODUCTION

In 1991 the integrated SATOR experiment was carried out by the scientists of the Institute of Atmospheric Optics, Siberian Branch of the Russian Academy of Sciences.

Because the large–scale processes strongly affect gas and aerosol composition and optical properties of the air at the given point,[1] the present paper deals with the synoptic conditions in the course of the experiment.

In order to have the complete description of meteorological conditions, it is necessary to take into account the large–scale processes at different altitudes since a wide altitude range was investigated.

In this paper the absolute constant–pressure charts up to the altitude corresponding to a pressure of 100 mb, key and circular near–ground maps, and data of radiosonde observations performed over the sites, in which the principal means for performing the SATOR experiment were set, are used.

SALIENT FEATURES OF ATMOSPHERIC CIRCULATION OVER WESTERN SIBERIA

Tomsk region is in the south–east part of Western Siberia and local synoptic processes have some salient features caused by its topography.[2, 3]

Cold–air injections into the rear of cyclones change their directions and intensify them under the impact of the Urals, while the cyclone trajectory usually drifts toward the north–east under the impact of Central Siberian plateau and of anticyclogenesis over Eastern Siberia, and the speed of their movement decreases. In the middle current of the Enisei the cyclones are often stationary. In such cases Tomsk has been under the impact of the rear part of cyclone for a long time.[2]

Circulation processes depend on a season as well. In Tomsk region spring lasts, on the average, two months (April and May), summer lasts three months (June, July, and August), fall lasts two months (September and October), and winter lasts five months (from November to March).[3]

Usually in summer the circulation over Western Siberia becomes weaker, while the thermal depression or the low–pressure field with small baric gradients is formed over its south regions.[4] In winter one can clearly trace the impact of Asian anticyclone centered over Tuva and Mongolia.[2] In the transient seasons the circulation intensifies and the recurrence of cyclones and anticyclones increases.

The SATOR experiment had two stages, the first was performed in summer and the second was performed in fall. The fall stage of the experiment includes not only the fall but also the first winter month. The analysis of synoptic conditions in the course of the SATOR experiment is given below.

SUMMER STAGE OF THE EXPERIMENT

The summer stage of the experiment, in contrast to the climatic data, was characterized by meridional processes. Most of the time, from June 16, a blocking crest (or anticyclone) was traced over the Urals, and a trough (or cyclone) was traced over Western Siberia, with the baric formation descending by its rear part in the region under study.

Let us now analyze the concrete synoptic conditions.

June 14, 1991. The axis of the crest was seen over Tomsk in all constant–pressure charts, which gave rise to a weak unstable wind up to an altitude of 9 km. The south–west periphery of the ground–based anticyclone was observed at that time. Hereafter our own classification is used.[6]

June 15, 1991. The vertical baric field remained the same as on July 14. The ground–based anticyclone drifted toward the region of Kirensk and the weather in Tomsk was affected by its crest. The weather in the region was affected by the south part of the cyclone after 6 p. m. (Moscow time).

June 16, 1991. The rear part of a slightly pronounced crest affected the vertical baric field. The south part of the ground–based cyclone remained unchanged.

June 17, 1991. The front part of the trough was seen over Tomsk in the absolute topography maps. Near–ground baric field was affected by the central part of the cyclone formed at the arctic front.

June 18, 1991. The vertical baric field was the same as on June 17 and was affected by the front part of the deepening trough. The ground–based cyclone drifted toward the north–east and the weather in the region was affected by its rear part. The ground–based fronts became more sharply pronounced at that time and turned into the principal fronts.

June 19, 1991. The cyclone was formed in the high–altitude trough whose center was followed up to an altitude of 3 km, but the front part of the trough was seen above it as in the preceeding days. The ground in Tomsk was within the region occupied by a cold arctic front formed in the rear part of the cyclone.

June 20, 1991. The cyclone center delineated by a closed isohypse in the constant–pressure charts was followed even at an altitude of 5 km. The axis of a jet stream was seen over Tomsk in the AT_{300} chart. At that time the front part of the ground–based cyclone with arctic and polar fronts was traced.

June 21 and 22, 1991. The cyclone was traced at all altitudes over the region of Tomsk. The weather in the examined region was affected by the rear part of the cyclone with ground–based cold fronts.

June 23, 1991. The cyclone center was clearly seen in the vertical baric field over Tomsk as in the preceeding days. On the contrary, the crest of the ground–based anticyclone appeared.

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June 24 and 25, 1991. The rear part of the trough was seen over Tomsk in all the altitude charts. The crest of the anticyclone was still existing as on June 23.

June 26, 1991. Baric field was formed by the rear of the trough at the high altitudes. At about 3 p. m. a ground–based cold arctic front passed against the background of the pressure crest.

June 27, 1991. The cyclone was formed in the high–altitude trough whose rear part was followed over the region of Tomsk. The ground–based anticyclone crest remained unchanged.

June 28 and 29, 1991. The baric field was characterized by the existence of the cyclone rear at high altitudes. The front part of the cyclone formed by the warm arctic front affected the weather in Tomsk.

June 30, 1991. The vertical baric field remained unchanged. The south part of the ground–based cyclone determines the weather conditions. The occlusion front associated with this formation passed over the region of Tomsk at 6 p. m.

July 1–3, 1991. The central part of the cyclone was seen over Tomsk in all the constant–pressure charts. There was the rear of the ground–based cyclone with several ground–based cold fronts in the observation region.

July 4, 1991. The west part of the cyclone affected the vertical baric field. The cyclone trough with cold arctic front affected the weather in Tomsk.

July 5–7, 1991. The axis of trough was traced at all altitudes in the region of Tomsk. The cyclone affecting the weather conditions drifted toward the north and its rear part with cold ground–based fronts was observed in the city.

FALL STAGE OF THE EXPERIMENT

At this stage the measurements were cyclic: one measurement day a week. The period of observations lasted twelve hours. The daytime and nighttime cycles alternated. If the first cycle was performed during the day, the subsequent cycle was performed at night. Because of this periodicity, we cannot unequivocally characterize the circulation intensity.

We describe now the synoptic conditions of each measurement cycle.

September 25, 1991. The crest was seen over Tomsk in all the constant–pressure charts. Its axis was traced over the city up to an altitude of 3 km and the front part of the crest was traced even higher. The ground–based anticyclone crest centered westward of Irkutsk affected the weather.

October 2, 1991. The vertical baric field was formed by the front part of the crest. The axis of a jet stream was followed at an altitude of 9 km over the region of Novosibirsk. The north–east anticyclone periphery affected the weather in Tomsk.

October 9, 1991. A small–gradient baric field was formed below an altitude of 3 km over the region of Tomsk. The rear part of the trough was traced above. The south–east ground–based anticyclone periphery characterized the weather in Tomsk.

October 17, 1991. At the begining of this measurement cycle the front part of a slightly pronounced crest was seen in the absolute topography maps. The jet stream axis was traced to the east of Tomsk at an altitude of 9 km. To the end of the cycle the jet stream axis drifted toward the north–east and the wind speed at the altitudes of 5 and 9 km sharply decreased. At that time the south part of the ground–based cyclone affected the weather in Tomsk.

October 23, 1991. The central part of the cyclon was seen over Tomsk in the AT_{850} and AT_{700} charts. The jet stream, whose axis was traced to the south of Novosibirsk, was above.

At the beginning of the measurement cycle Tomsk was under the impact of the cyclone with arctic and polar fronts. In the afternoon the fronts drifted and the observation region was under the impact of the rear part of the cold arctic front.

October 31, 1991. The rear of the trough was seen over the examined region in the constant–pressure charts. The ground–based arctic wavefront affected the weather in Tomsk.

November 6, 1991. The front part of the crest formed the vertical baric field over Tomsk. The observation region was in the warm sector of the cyclone.

November 13, 1991. The front part of a crest was seen at all the altitudes. The small–gradient baric field was traced near the ground.

Finally, we can note that the summer and fall stages of the SATOR experiment were characterized by the intensified cyclonic and frontal activity over the region of Tomsk. On the one hand, it engenders a variety of weather conditions in the course of the measurements. On the other hand, the variety of weather conditions resulted in insufficient statistics of particular weather situations. In addition, the frontal activity was accompanied by heavy precipitations, which prevented accumulation of gas and aerosol polluttants in the surface layer thereby making the long–term studies of transformations of the fields of ozone and ozone–active components impossible.

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