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The Editor
V.P.Parkhomenko

The numerical experiment modelling the long range climatic changes due to black out the atmosphere by the dust and the soot is described. The results show the strong temperature drop over the surface of continents of the Northern hemisphere, the warm up of large mountains, the crucial change of the hydrological cicle and of the mechanism of the global circulation of the atmosphere.

1. The computational experiment is performed using the climate model of the Computing Centre of the USSR Academy of Sciences. The experiment imitates the long-range climatic consequences induced by the lift up of fine dust and soot to the atmosphere. The global, zonal and geographical distributions of the change of the surface air temperature and zonal means of the lapse rate are presented. The results demonstrate the strong temperature drop over the continents of the Northern hemisphere for a long time, the crucial change of the hydrological cicle and the regime of the general circulation of atmosphere.

2. The climate model of the Computing Centre of the USSR Academy of Sciences (Aleksandrov et al, 1983) consists of the two-level Mintz-Arakawa model of the global circulation of the atmosphere and the thermodynamic model of the upper ocean. The atmospheric model based on the well-known version of Gates et al, 1971, has the geographical resolution equal to 12^{o} along the latitude and 15^{o} along the longitude. The ocean model describes the quasihomogenios upper layer, depth and temperature of which are the prognostic variables and the thermocline. The temperature profile of the thermocline is self-similar, the depth of thermocline and the temperature on its lower boundary are the prescribed functions of the latitude only.

The climate model describes the motion of air between the surface and the tropopause, where the pressure is equal to 200 millibar. The surface corresponds to the geographical map with the land outlines, oceans with the sea ice distribution, real orography with the continental ice sheets and the snow.

The climate model describes the large-scale atmospheric motions generated by the non-uniform energy release in the troposphere. The sources and the sinks of energy are due to short wave solar radiation, long wave thermal radiation and the latent heat of water in atmosphere and on the underlying surface. The transfer of solar and thermal radiation depends on the thermodynamic state of the atmosphere and the cloudiness which is obtained in the process of the solution.

The calculations were performed on the BESM-6 computer of the Computing Centre of the USSR Academy of Sciences. The simulation of one year needs 40 hours of BESM-6 time. All calculations were done in the mean annual regime when the solar heat flux doesn't depend on time and is equal to its mean value at any latitude.

3. This report deals with the calculation of the evolution of the quasiequilibrium state of the joint ocean - atmosphere - land system under the instant change of the optical properties of the atmosphere in Northern hemisphere. This change is induced by the nuclear dust ejected by the surface and near-surface nuclear explosions and by the soot emitted by the urban fires, the fires of fuels and the wildfires. The parameters of the atmospheric pollution are chosen

in accordance with the estimations of their values after the global nuclear conflict (Ambio, 1982).

It is supposed that at the beginning the atmosphere stays at statistically equilibrium state. At the moment $t=0$ the atmosphere northward of $12^{\circ} N$ is instantly polluted uniformely over the mass and surface. It is supposed that the troposphere is polluted by the soot only and the stratosphere is polluted by the dust only. The absorption of the short-wave radiation by these components as the function of time is presented on Fig. 1 where the solid line corresponds to the total vertical optical depth of atmosphere and the dotted lines correspond to the approximations used here for the description of the optical depth of the whole atmosphere and the stratosphere only. It is also supposed that this pollution doesn't change the transfer of the long-wave radiation in the atmosphere.

The climatic model doesn't describe the dynamical processes in stratosphere (Gates et al, 1971; Aleksandrov et al, 1983). We describe the stratospheric pollution the following way. It is supposed that the solar radiation is decreased by the stratosphere in accordance with the Bouger law, the corresponding optical thickness of stratosphere is described by the approximation presented on Fig. 1. The stratosphere reemits the absorbed solar radiation in the form of the long-wave radiation. The optical thickness of stratosphere for the long-wave radiation is small. Hence the half of the energy absorbed by the stratosphere falls on the upper boundary of the troposphere in the long-wave radiation form, the other half the stratosphere reemits back into the space. This mechanism decreases strongly the solar flux on the upper boundary of the troposphere and induces the warming of the troposphere from above by the long-wave radiation of stratosphere which doesn't exist practically at regular conditions.

4. The absorption of the solar radiation by the polluted atmosphere decreases strongly this radiation at the surface level (at time $t = 0$ the attenuation is over 400). The land surface and the adjacent air over the continents of Northern hemisphere cool rapidly. But the entire system with the "dirty" atmosphere absorbs more energy compared with the system with normal "clean" atmosphere. The whole atmosphere is warming up during about one half of a year. During first three months the heat balance of the climatic system is positive. Then it changes the sign and drops to the value - 10 W/m^2 which characterises the mean cooling rate of the thermally inertial ocean.

Fig. 2 shows the changes ΔT_G and ΔT_L of global mass averaged temperature T_G of the atmosphere and global mean temperature T_L of the land air temperature as the functions of time elapsed from the beginning $t = 0$ of the "conflict". The first curve demonstrates the temperature T_G strong increasing during the first half of a year, then it decreases slowly. The second curve, on the contrary, shows the sharp drop of the temperature T_L. In the first decade T_L drops over 15°C then it goes up slowly. The sea surface temperature T_O goes down, its drop is about 1.2°C in 10 months.

The deviations of zonal mean (averaged along the latitudinal circle) surface air temperature at the moments t = = 40, 243 and 378 days are shown on Fig. 3. The maximal decrease of zonal mean temperature takes place in the middle latitudes of the Northern hemisphere, at the t = 40 and 243 days it is equal to 23°C and 10°C respectively. The Southern hemisphere is cooling down up to 3-4°C.

The Fig. 1 shows that the optical thickness of the atmospheric pollutant becomes equal to zero at day 360. After this moment the surface obtains the solar radiation in the usual manner. But the upper atmosphere is reheated strongly because of the previous absorption of the short wave radiation by the soot. So the lower layer of atmosphere gets the significant additional heat flux from the above in the form of the long-wave radiation. As a result, instantly after the switch off of the black out the temperature of the surface air of the Northern hemisphere goes up. At the moment t = = 378 days this temperature is 25°C above the normal value in middle latitudes (Fig. 3). In time the radiative cooling eliminates this overheating.

The dash-dotted line on Fig. 4 marks the zonal mean of the temperature lapse rate (the vertical gradient $-\partial T/\partial z$ of the air temperature) for the control (undisturbed basic state of atmosphere), the solid lines correspond to the times t = 259 and t = 378 days. The curve for 259 days points out that the disturbance penetrates into the Southern hemisphere up to 30°C. Northward from 30°C the atmosphere becomes superstable, the lapse rate changes its sign in the Northern hemisphere. Hence the convection is suppressed, which decreases the precipitation and increases the residence time of the soot in the troposphere.

The interhemispherical temperature contrast deforms the existing regime of the global circulation of the atmosphere. In the equatorial zone the interhemispherical circulation cell arises. Fig. 5a,b displays the streamfunction for the zonally averaged mass flux in $10^{12}\ g \cdot sec^{-1}$ for the unperturbed state and for the time $t = 297$ respectively. The shift of the circulation cell icreases strongly, up to 4 mm/day, the precipitation rate in the tropics of the Southern hemisphere and in the band $20^{\circ} N - 30^{\circ} N$ of the Northern hemisphere. This cell intensifies highly the mass, momentum, energy, water vapor and pollution exchange between the hemispheres.

The Fig. 2-5 describe the global and zonal situations. The real geographical temperature contrasts are significantly larger. Fig. 6 portrays the drop of the surface air temperature at the moment $t = 40$ days. The hemispherical means of this temperature drop is equal to $12.9^{\circ}C$ and $3.2^{\circ}C$ for the Northern and Southern hemispheres respectively. But the temperature over Alaska drops up to $36^{\circ}C$, in center and on the east of the Northern America up to $34^{\circ}C$ and $40^{\circ}C$, over Central Europe up to $51^{\circ}C$, over Kola Peninsula up to $56^{\circ}C$, over Kamchatka up to $41^{\circ}C$. The mostly intensive decrease in low latitudes lays over the Arabian Peninsula where the temperature drop reaches $51^{\circ}C$.

In time the air is warming up over the Northern hemisphere and cooling down over the Southern hemisphere. The temperature drop at t = 243 days is on Fig. 7. One can easely see, that the temperature drop over the continents of the Northern hemisphere decreases, but it is about 32°C on the north-east of the Northern America, 30°C in the Central Europe, 10° in the Central Africa, 24°C over the Arabian Peninsula and so on. At this stage the new very important effect is developped: the strong warm up of the air over the large mountain systems. Over the Cordilleras the air becomes 7°C warmer the normal temperature, over the Andes Mountains 5-6°C, over the Tibet this warming up reaches 20°C. It can change the heat balance of the mountain snow and glaciers and provoke the continental size floods.

The last maps show that the temperature drop over the oceans in the Northern hemisphere is sufficiently less than over the continents. The strong sea-land temperature contrast should form severe storms along the seashore. During these storms the heavy snowfalls will take place, so these regions will suffer from nuclear winter for some months. The spacial resolution of the used model is not sufficent to describe these effects.

Fig. 8 portrays the temperature change map on the day 378. The Northern hemisphere is warmed up extreemly, because of the above described reheat after the switch off of the black out. The temperature of the air over the continents is greater the normal state up to the values 25-35°C. The maximal warming is located in the Northern middle latitudes and over mountains. The Southern hemisphere is 2° cooler the normal state.

5. The estimations of the processes of the pollution of the atmosphere by the dust and the soot show the strong change of the optical properties of atmosphere for a long time (Ambio, 1982). The main amount of the dust is lifted up to the atmosphere mechanically during the surface and near-surface bursts (Glasstone and Dolan, 1977). The fireballs of the nuclear bursts create the mass fires. During these the troposphere is polluted by the soot which formed by the uncomplete burning of plastics, fuel, housing, industrial plants, forest etc. (Crutzen and Birks, 1982; Broido, 1960). The general circulation of the atmosphere mixes this dust and soot over the Northern hemisphere in the time about one month. It is clear now that the effects of optical pollution of the atmosphere play the most important role in the middle and long range climatic change.

The above discussed experiment shows that during the prolonged black out of the Northern hemisphere the surface air temperature over the continents drops up to the value about some dozens degree centigree, the lapse rate changes the sign, the temperature in the planetary boundary layer over the large mountains goes up, the regime of the precipitation in the tropics and in the Northern hemisphere changes drastically, the mechanism of the general circulation of the atmosphere is changing. The strong ocean-land temperature contrast induces the heavy storms along the sea-coast.

The Southern hemisphere will suffer less. In this experiment the disturbance penetrates up to 30 S . But the effects of climate change in the Southern hemisphere are here underestimated because the expansion of the optically active components to the Southern hemisphere is not taken into account.

The above described climate change will probably disappear in two years.

Professor N.N.Moiseev had created the climatic programm at the Computing Center of the USSR Academy of Sciences. We would like to express our deep grattitude for his most creative help and suggestions in the work done.

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FIGURE CAPTIONS

Fig. 1. The vertical optical thickness of the atmospheric pollutant as the function of time. The solid line corresponds to the "basic" scenario. The dashed lines correspond to the approximations of that optical thickness of the whole atmosphere (a) and the stratosphere (s) only. After the day 360 the modelled optical thickness is equal to zero.

Fig. 2. The changes of the global mass averaged temperature ΔT_G and the global mean land air temperature ΔT_L as the functions of time.

Fig. 3. The change of the zonal mean surface air temperature at the day 40, 243 and 378 after the beginning of the "conflict".

Fig. 4. The zonal mean value of the lapse rate at the day 0 (dash-dotted line), 259 and 378 (solid lines).

Fig. 5. The streamfunction for the zonally averaged mass flux in $10^{12}\ g \cdot sec^{-1}$ for the time 0 (above) and 297 days (below).

Fig. 6. The change of the surface air temperature at the day 40.

Fig. 7. Same as Fig. 6 but for the day 243.

Fig. 8. Same as Fig. 6 but for the day 378.

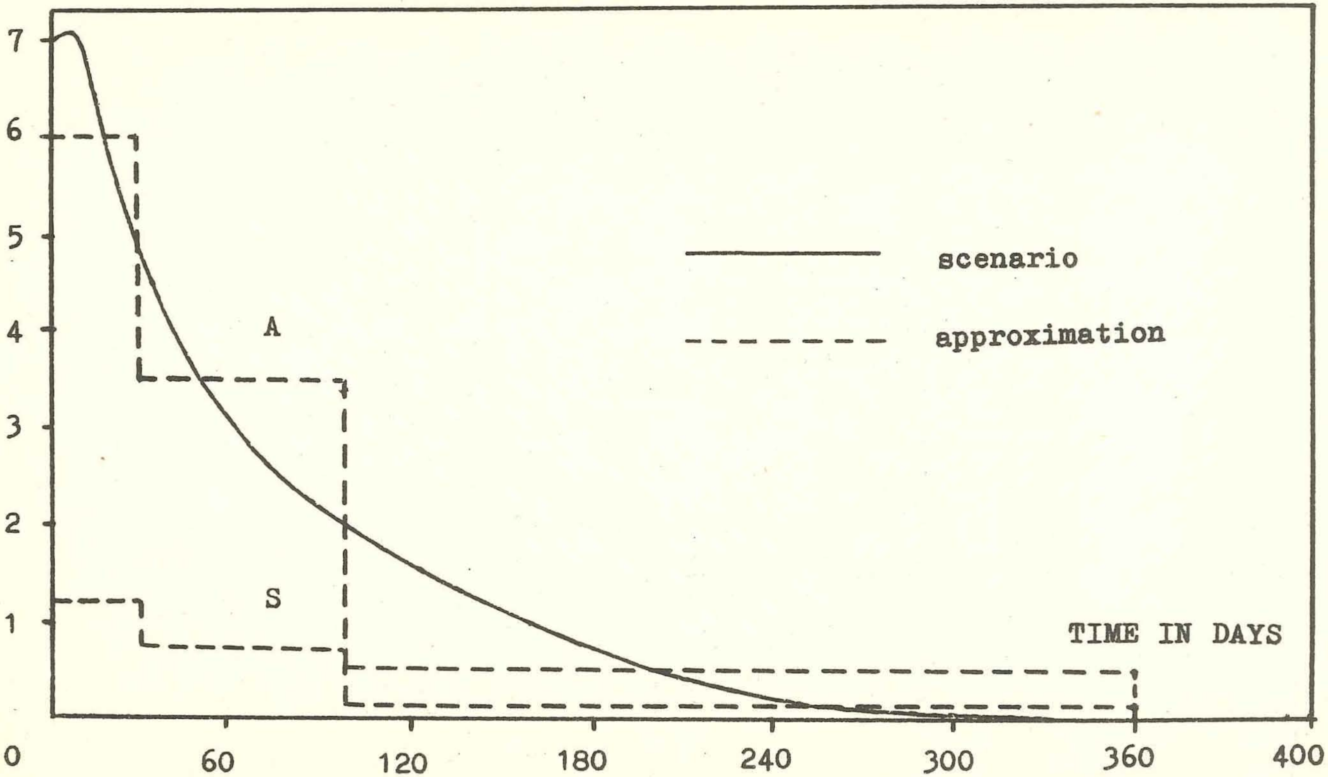
7
6
5
4
3
2
1
0
60
120
180
240
300
360
400
scenario
approximation
A
S
TIME IN DAYS

FIG.1

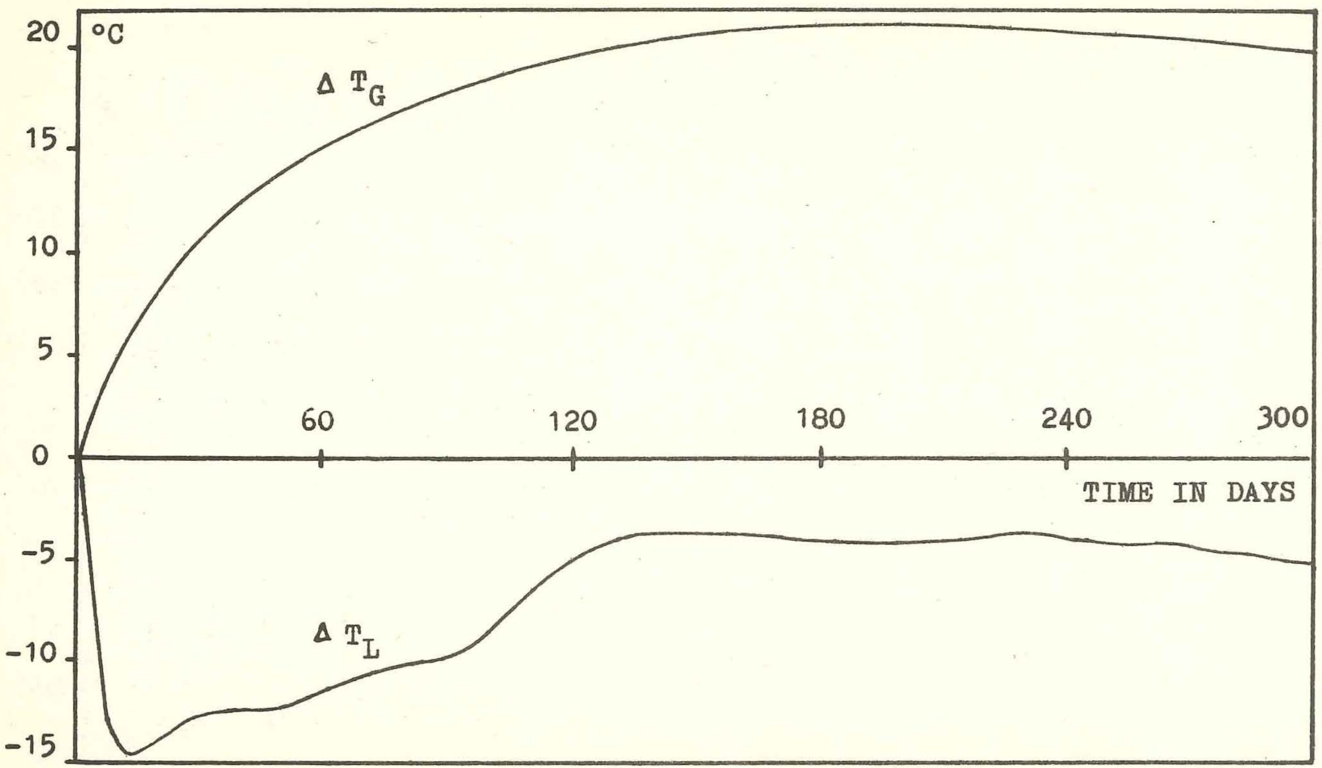

FIG. 2

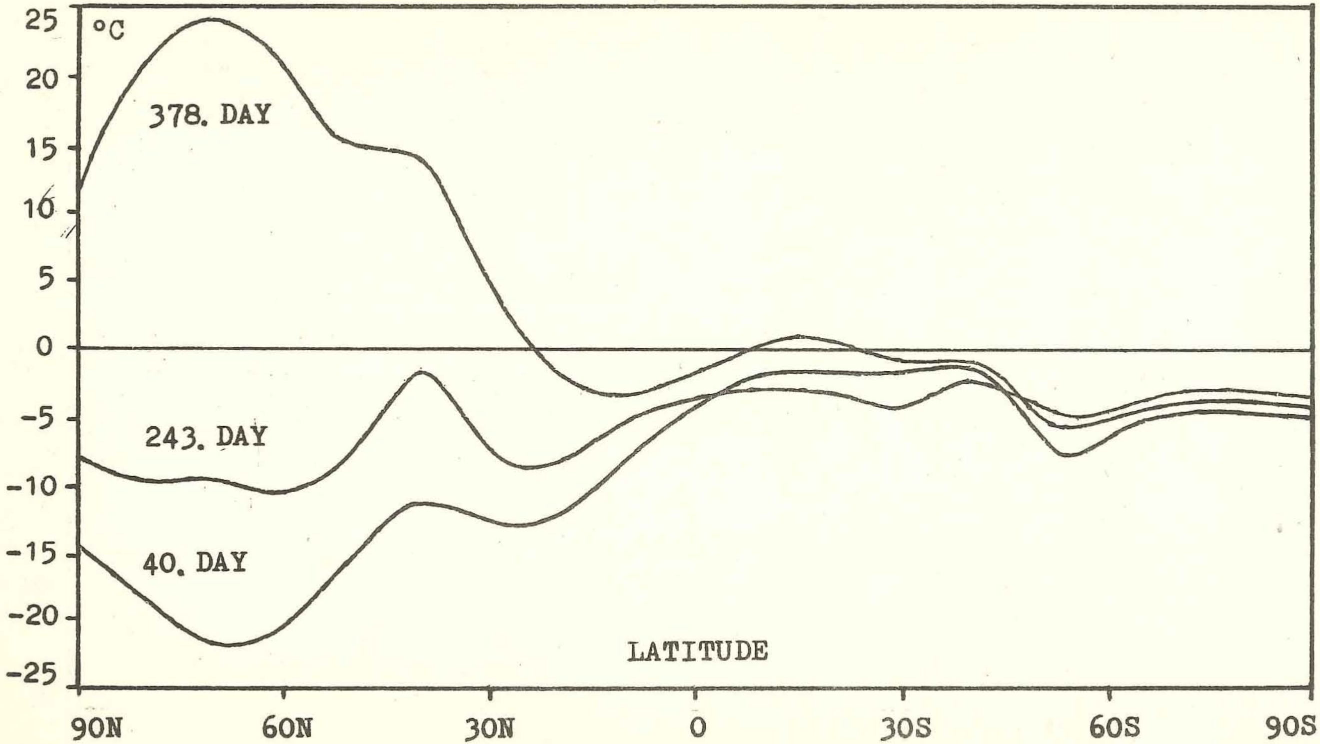
°C
25
20
15
10
5
0
-5
-10
-15
-20
-25
378. DAY
243. DAY
40. DAY
LATITUDE
90N
60N
30N
0
30S
60S
90S

FIG. 3

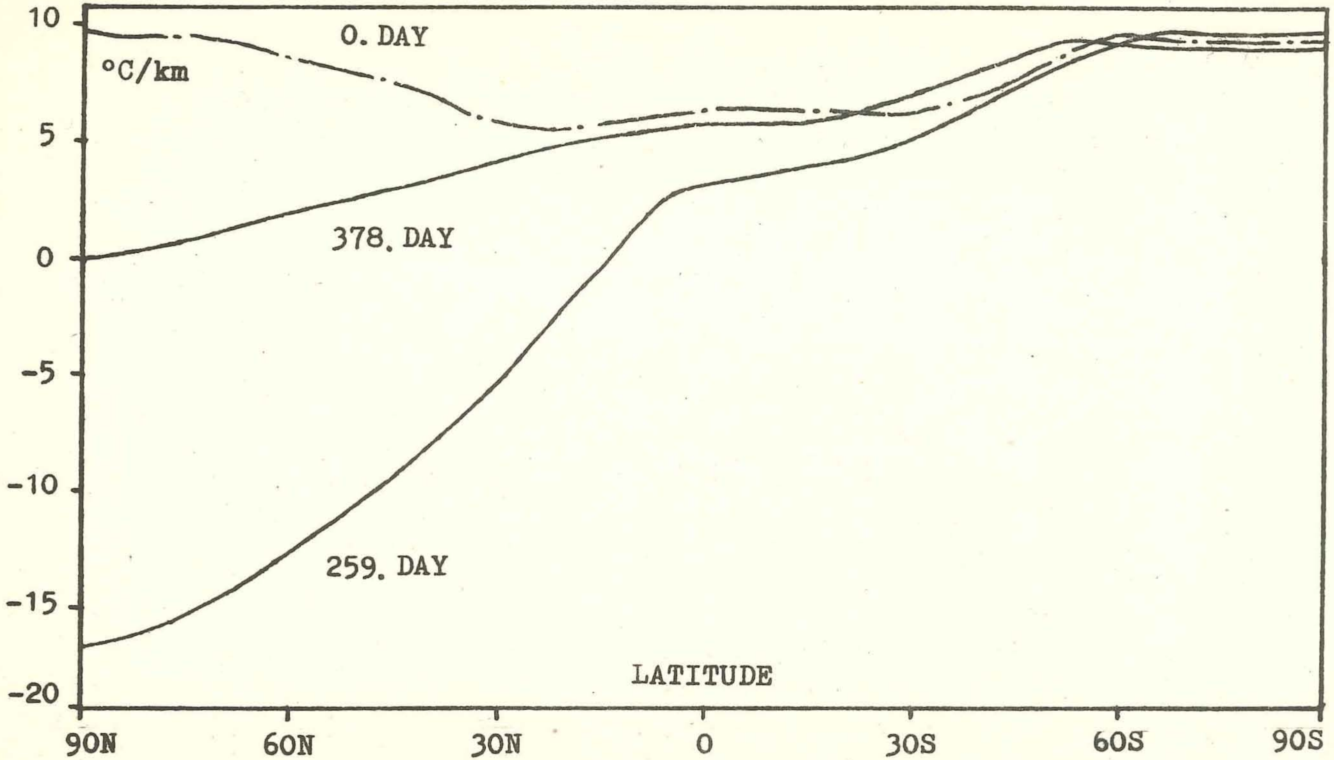
°C/km
0. DAY
378. DAY
259. DAY
LATITUDE
10
5
0
-5
-10
-15
-20
90N
60N
30N
0
30S
60S
90S

FIG. 4

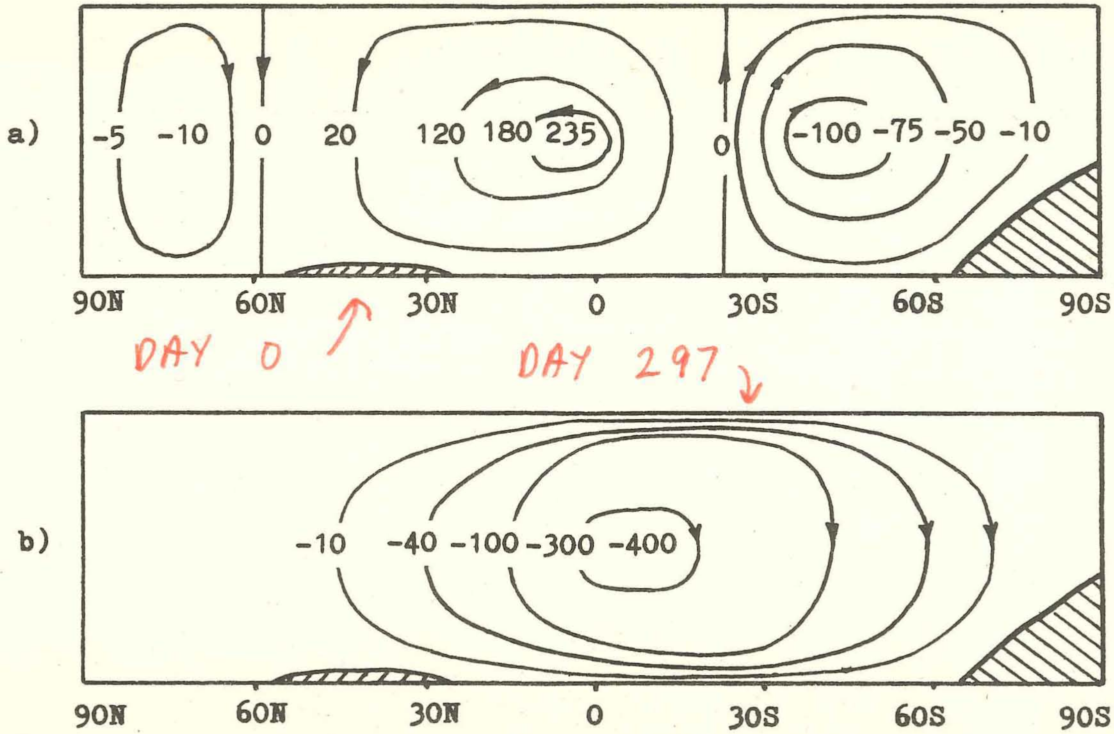
a)
-5 -10 0 20 120 180 235 0 -100 -75 -50 -10
90N 60N 30N 0 30S 60S 90S
DAY 0
DAY 297
b)
-10 -40 -100 -300 -400
90N 60N 30N 0 30S 60S 90S

FIG. 5

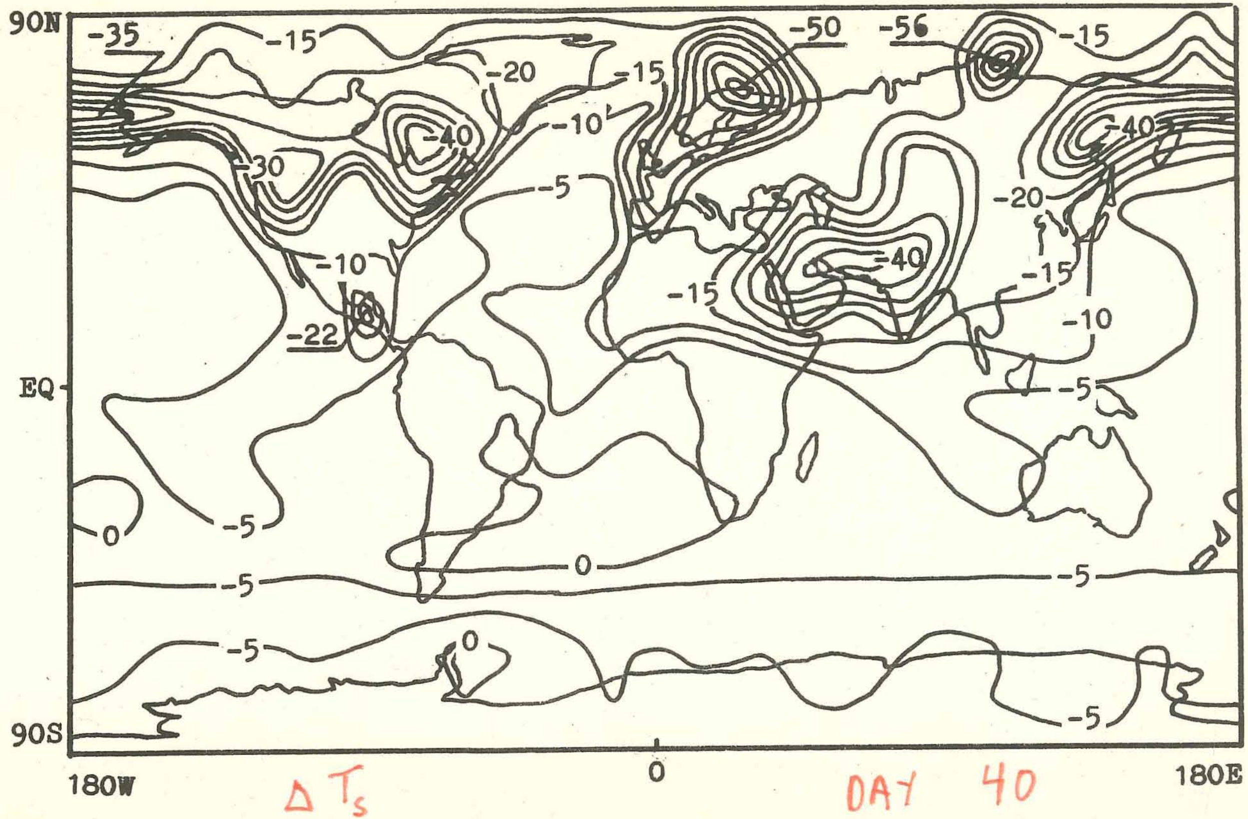
90N
EQ
90S
180W
0
180E
-35
-15
-20
-15
-50
-56
-15
-40
-10
-30
-40
-5
-20
-10
-40
-15
-15
-22
-10
-5
0
-5
0
-5
-5
-5
0
-5
-5
ΔT$_s$
DAY 40

FIG. 6

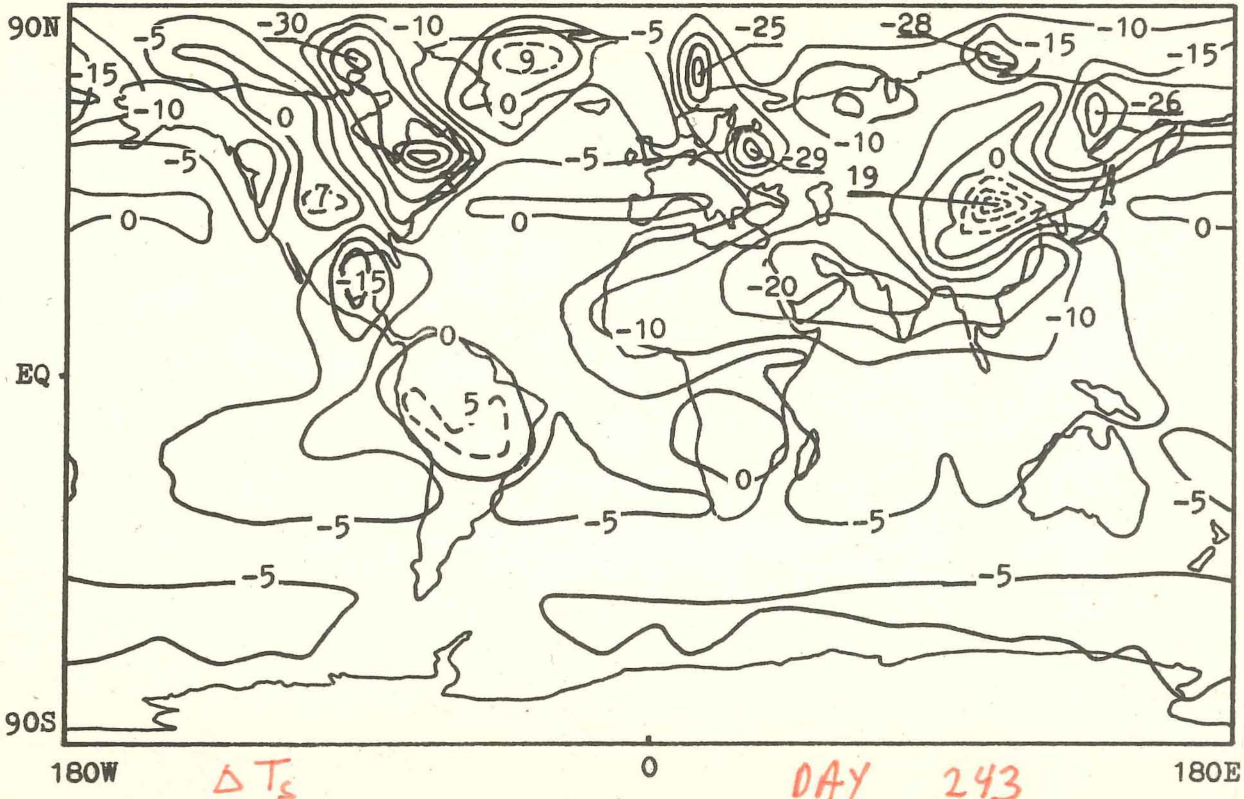
90N
EQ
90S
180W
0
180E
-30
-10
-5
-25
-28
-10
-15
-15
-10
-26
-29
19
-20
-10
-15
-5
-7
-9
0
5
-10
-5
-5
-5
-5
-5
-5
-5
ΔTs
DAY 243

FIG. 7

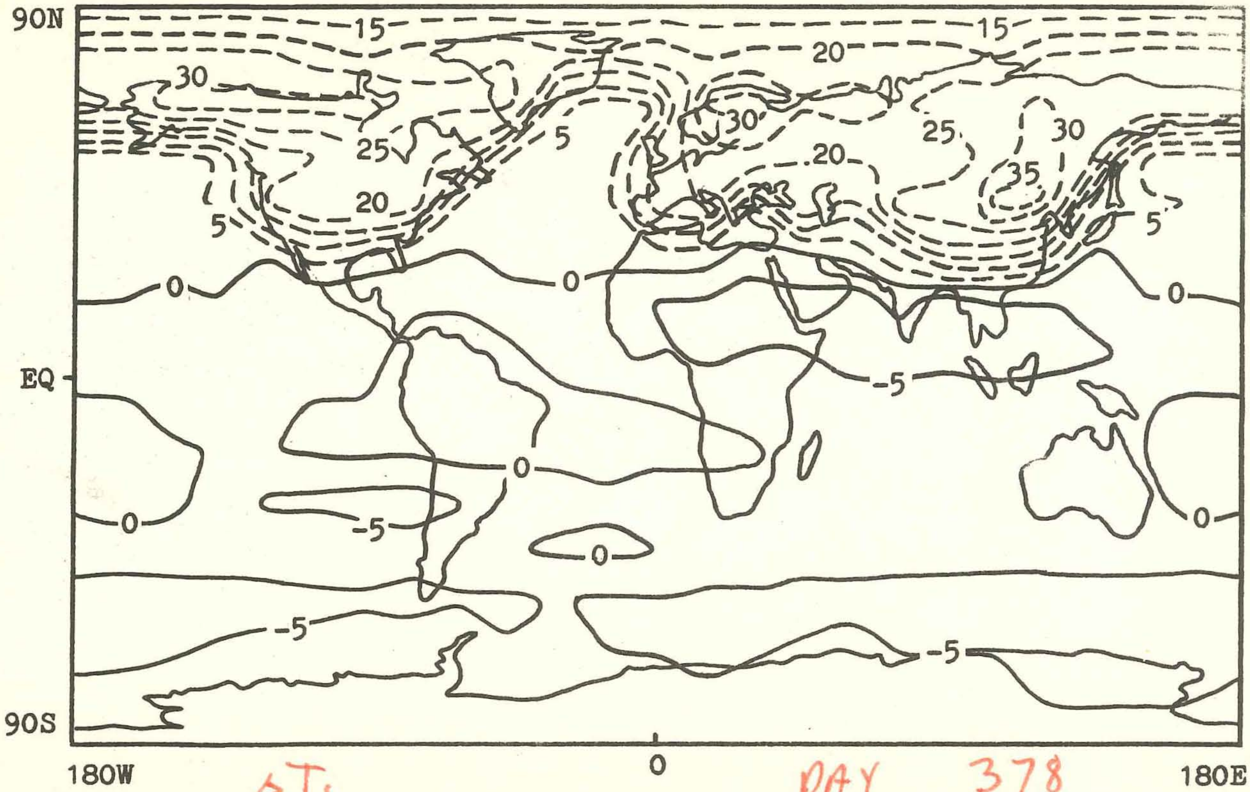

FIG. 8

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ядерной войны

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