CONVECTION IN THE 5-KM NEAR SURFACE LAYER OF THE MARS ATMOSPHERE. V.G.Vasin {1}, R.O.Kuzmin {2}
{1}-M.V.Keldysh Institute of Applied Matematics of the USSR Academy of Sciences, Miusskaya Sg.4 Moscow 125047;
{2}- V.I.Vernadsky Institute USSR of Academy of Sciences, Kosygin st.19, Moscow 117975.

An Aerostat is a new vehicle for remote sensing of the martian surface and is one from the major component of the mission "Mars-94".Because an aerostat will fly during a major part of the day the comprehension of the atmospheric dynamics influence on its flignt is represented as principle. The goal of our investigation is to concider the influence one of the atmospheric dynamics factors on the regime of an aerostat drift-the convection in the bound layer of atmosphere.We have considered the influence of the vertical wind shear effect, the temperature different between the lower and upper boundaries of tne considered layer and irregular heating of the lower boundary on the convection stracture, generation and intensity. In the framework of 2D roll model the convection to vertical wind shear interaction was studied . If the horizontal wind (U) was strong enough (U>C, where C is the sound velocity) only longitudinal roll structures,i.e. the rolls whose axes were parallel to the wind direction, remained stable. Under the weak wind, the transverse roll structures (the rolls with axes oriented along a perpendicular to the wind direction) were stable as well . A horizontal length of the transverse rolls (in considered plane it is the vortex size) varied along the layer.The vortices whose rotation coincided in direction with the horizontal wind were appreciably wider then those with opposite rotation(Fig.1). The motion velocites in these oppositely rotating vortices were also different: the both vertical and horisontal components in the vortices with windwise rotation were about two-fold less than those components in the vortices with opposite rotation, i.e. it proved that the motion in the vortices with counterwind rotation was more intensive, however, the vortices were more compressed.

Under the strong horisontal wind, the only available longitudional roll structure was no different (due to independence of motions in two mutually orthogonal planes) from a similar roll structure which would exist with no wind at all. From this it follows that in the strong wind case we may consider a convective roll model unperturbed by wind. However, we should keep in mind that there is still wind strong enough and that the roll structure under consideration is oriented in parallel with this omitted wind.

For different Grashof number ($3x10<G<5x10^5$) the numerical values of temperature ratio T_2/T_1 betwen the lower and upper boundaries were determined. These value correspond to a threshold of convection origination when a maximal vertical velocity of convection exceed 4 m/s,i.e. a critical value for an aerostat floating throw atmosphere can be reached. When $G=3x10^5$ the convection arises at $T_2/T_1>1.2$ while at $T_2/T_1>1.28$ the maximal vertical velocity approaches 4 m/s. For $G=10^4$ the convection threshold at $T_2/T_1=1.14$ and at $T_2/T_1>1.15$ the maximal velocity is close to 4 m/s. For $G=2x10^4$ the convection threshold at $T_2/T_1=1.12$ and at $T_2/T_1>1.135$ the maximal velocity also reaches the value 4 m/s. It should be noted that in the case of inviscous gas it follows from the theoretical stability criterion [1] that convection must arise when $T_2/T_1>1.12$. Its velocity will be very high even for $T_2/T_1=1.3$ (about 150 m/s according to the formula given in [2]). Thus, for a given real dayly temperature lapse on the lower boundary [3] and a given constant value of temperature on the upper boundary (220K) the convection occurs usually in the interval from 10 a.m. to 4 p.m., and during all this time the maximal velocity is of the order of 10 m/s. In the considered atmosphere layer of 50 km long and 5 km thick the temperature of lower boundary was given proceeding from the condition of convection absence in central part of this layer. A size of this region was 5 km along the horizontal. In the formed convective flow the cells proved to be nonidentical (Fig.2). Two central convective vortices in the above 5-km region were about twice as long as the rest and extended beyond this region. Correspondingly,the flow velocities in these vortices may be approximately two times as low as those in other vortices located in the rest part of the atmosphere layer. For comparison Fig.2 shows convection in the same layer for the case when the lower boundary temperature is the same atall point.

From the simple computer simulation saw that the convection dynamicsin the martian atmosphere is very sensibility to the boundary conditions.In order to approximate our understanding of the convection influence on an Aerostat we have plan to add in the convection model the daily dynamics of the boundary conditions and the thermal contrast from megaslopes.

References:1-L.D.Landau,E.M.Lifshitz.Hydrodynamics.Moscow,Nauka,1986;2-V.S.Avduevsky,F.S.Zavelevich,M.Ya.Marov et al.Computer simulation of radiative convective heat exchange in Venusian atmosphere. Izd. AN USSR, Space Research,v.IX,issue 2,1971. 3- V.V. Vdovin. Izd.AN USSR, Spase Research, XV,issue 2, 1977
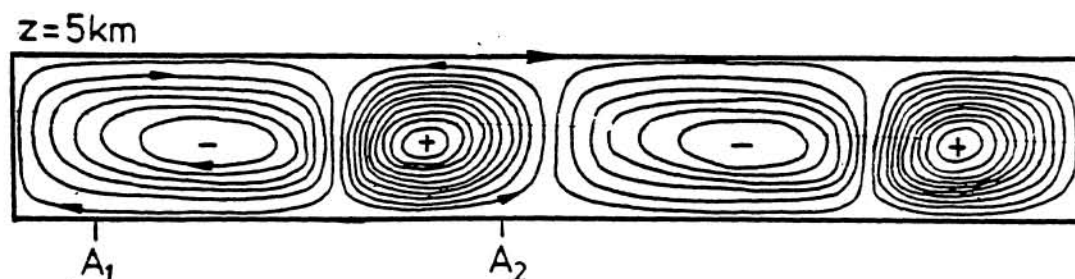
CONVECTION IN MARS ATMOSPHERE: Vasin V.G.,Kuzmin R.O.

z=5km

Fig.1. Vertical wind shear effects upon the convection structure. Initial conditions: $R_a=10^4$, $U_0=0.2$, L/H=10(ratio of the horizontal to the vertical sizes of the atmosphere layer),$T_2/T_1 = 1.5$; A_1,A_2 -vertical cross-sections.

z=5km

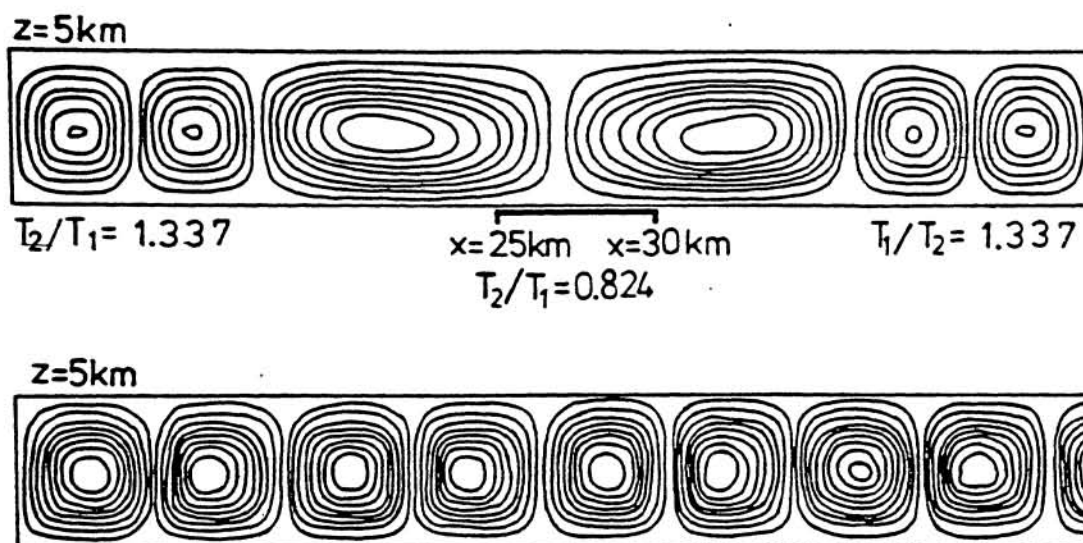$T_2/T_1= 1.337$ x=25km   x=30km $T_1/T_2= 1.337$
$T_2/T_1=0.824$

z=5km

Fig.2. An influence of irregular (A) and regular (B) heating of the lower boundary upon the convection structure. Initial conditions: $R_a= 10^4$,L/H =10, $T_1 =220K$, $T_2=294K$ and 181K.