SPLOTCHES ON VENUS: MODELS REVISITE. B. Ivanov[1], [1]Institute of Geosphere Dynamics, Russian Academy of Sciences, 119334 Moscow, Russia (baivanov@idg.chph.ras.ru).

Introduction: Splotches on Venus are believed to be surfaces disturbed by atmospheric "explosions" of bolides, catastrophically disrupted at some altitude [1]. Bondarenko and Kreslavsky [2] present an accurate analysis of the Magellan radar reflection physics and describe splotches in following words: "Passage of atmospheric shock wave lifts surface regolith particles and produces fluidized mixture of particles and dense atmospheric gas; later, this fluidized mixture settles producing flat horizontal facets. This also explains, why the splotches occur only in some regions on Venus [3]":

The mechanism favored in [2] seems to make surface smoother, while large splotch's periphery are typically radar-bright, what may corresponds to enhanced local roughness. Tentatively one could assume that shock wave winds drag large boulders as it was proposed by Takata et al. [4].

Population of Splotches: One of the most detailed discussions of splotch's areal and size distribution as well as numerical modeling of aerodynamic failure and above-surface "explosion" with estimates of shock pressure and shock-derived winds has been done in PhD thesis by Wood [5]. Here the database is collected for 262 "reliable" and 91 "possible" splatches, comparable with 367 "diffuse splotches", counted by Schaber and Strom [6]. We revisited Wood's splotch list using JMars software (https://jmars.asu.edu/) to copy FMIDR mosaics. Coordinates, measured with JMars/Venus software, are slightly differ from older Wood's coordinate. Linear dimensions, listed by Wood are not exactly the same as one could measure in JMars mosaics, but the general similarity seems to be good.

Fig.1 presents a splotch example.

Numerical Modeling: To prepare a tool for the further study of the airburst action we start a small set of modeling with the available SALEB hydrocode. Venusian stratified atmosphere is modeled as an ideal gas with γ=1.3. The atmosphere stratification is modeled as an isentropic gas below80 km and as isothermal gas above [9, 10, 11].

The explosion is modeled with the gas sphere (10 and 20 km in diameter) filled with the gas at normal near-surface density at a temperature of 500,000K or 1,000,000K. These conditions result from a compromise between the source resolution (CPPR =20 at the cell size 100 or 200m) and the reasonably large distance of interest for the shock wave propagation.

General scheme of events. Fig. 2 illustrate the first minute after an explosion centered at 20 km altitude. Initially spherical air shock reflects from the rocky surface at the bottom and expand to the rarified atmosphere at the top. Hot gas buoyancy moves it up (in a uniform atmosphere we would see a classic mushroom formation), and the expanding source gas accelerates the upper part of the leading shock wave ahead of the shock front at the surface (Fig. 3). This upper part of the leading shock wave starts to incline and at the later stages strike the surface again (as a low intensity shock).

In the stratified atmosphere the leading shock wave is looking as a cylindrical wave at some moments of time, however the near-surface shock pressure decay close to the point source solution. However, we observe the formation of the tail shock front which abruptly barely stop the wave motion – this is more typical for cylindric shock waves (similar to N-wave).

Discussion: We use model results to find any critical details to calibrate models to real splotch's size. In addition to [1, 2, 5] we plan to estimate big boulders rolling and tracing with the behind-shock air motion. The amplitude of the forward/backward air motion (winds) could be as large as +/-5 km and lasted for a few minutes (Figs. 4, 5].

Conclusions: While the numerical modeling of the meteoroid airburst could be significantly improved in comparison with early publications, The general picture does not change in a sense of shock wave parameters. However new modeling is necessary to improve our understanding of the surface roughness change due to shocks and winds.

Acknowledgments: The project is supported by Russian Academy of Science.

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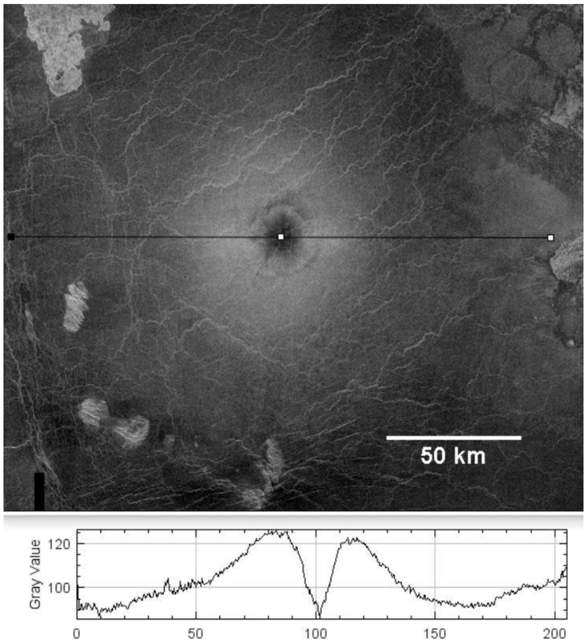

Fig. 1. Typical splotch with a central dark feature and a bright outer zone (4.844E, 26.984N, JMars/Venus soft). North is to the right; the outer zone has a diameter of 100 to 120 km (150 km in Wood's catalog [5]).

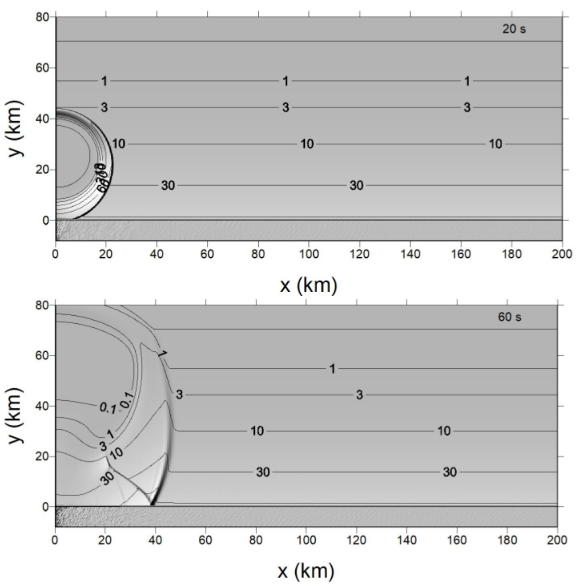

Fig. 2. Initial moments of the explosion at 20 km altitude. Contour lines for gas density outline shock front position.

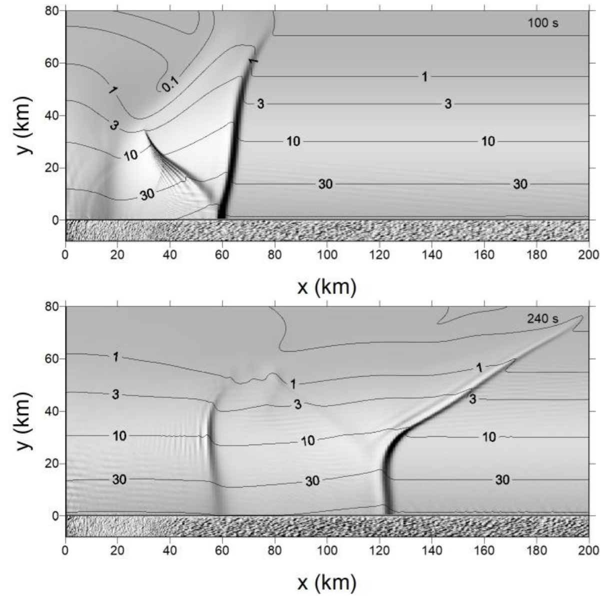

Fig. 3. Late stages of the explosion. Two shockwaves running along the surface are accompanied with multiple weak shock fronts from the collapsing plume.

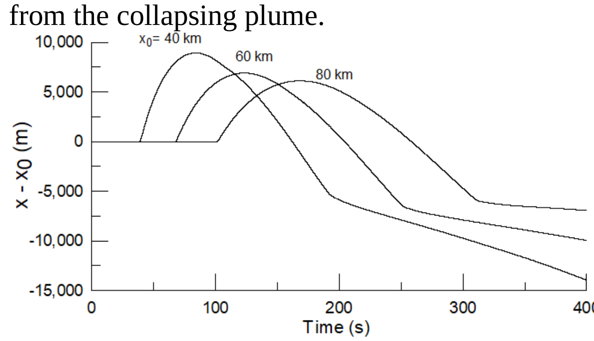

Fig. 4. Horizontal displacement of three "air particles" one cell above surface after the airburst at 15 km HOB and energy of 10^{22} J.

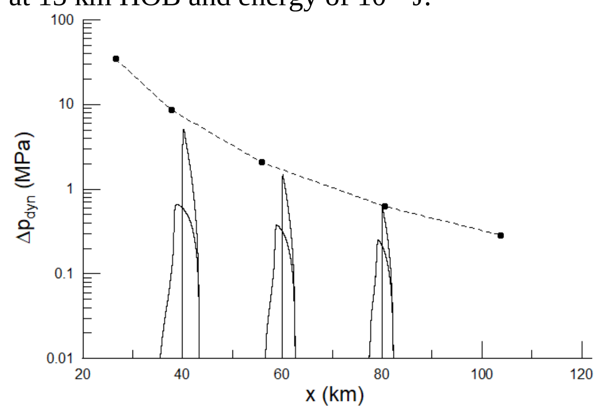

Fig. 5. Dynamic pressure ρU^2 vs. horizontal position for the explosion of 1.4×10^{21} J at HOB=5 km. Black dots – point source solution. Smaller domes – backward (U<0) motion phase.