Comet and Meteor Threat: Historical Aspect

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An intensive study of one campaign unless based on an extensive knowledge of the whole history of war is as likely to lead us into pitfalls as onto the peaks of military achievement. But if a certain effect is seen to follow a certain cause in a score or more cases, in different epochs and diverse conditions, there is ground for regarding this cause as an integral part of any theory of war.
B. H. Liddell Hart

Abstract

Based on the statistical data nearly for 290 years is shown that there are two thirteen-year cycles of appearance of very bright bolides exploding in Earth's atmosphere. The frequency of such bolides' explosions during two four-month and one nine-month windows of these phenomena is approximately 2.5 times greater than for such phenomena in the «background» of time. If in these «windows of explosions» highlight more narrower periods of maximum activity in 3 – 4 weeks, the frequency of such events regarding the background grows up to order. Thus, the existence of two families of meteoroids which are fragments of comet and periodically once in 13 years colliding with the Earth [1 – 4], is confirmed. These groups of comet's debris were named earlier as Eagle and Tungus families.

Moreover, exactly 81 thirteen-year cycles back from 2013, in 960, such event took place over the Irish city Dublin. From estimations, this fragment of a comet exploded at a height of 9 to 12.5 km with the energy of 10 to 25 Mt in TNT, which led to the deaths of 1,100 people. Thus, the object of Tungus family, which was very similar to Tunguska meteoroid itself, has led to the largest cosmic catastrophe of our era, the remembrance of which, nevertheless, almost faded from the memory of mankind.

Olmec (Mayan) calendar, built on two cosmic catastrophes in Mesoamerica, which were separated by time interval with duration of 52 years, fits exactly into the thirteen-year cycle considered here, and two these disasters, apparently, also occurred in February, as Chelyabinsk incident, but 244 and 248 thirteen-year cycles before it, that is, in 1211 and 1159 BC.

In accordance with this study Mesopotamian (Biblical) Flood of 3201 BC occurred back from present time of exactly 401 thirteen-year cycles of Tungus family. Calculations show that falling of large cometary fragment in the Arabian Sea leads to the phenomena, which are quantitatively consistent with what was happening during this flood according to historical sources. Moreover, new, previously unknown material evidences of the disaster of the first civilization of ancient world were found during of this study on the Indian and Iranian shores of the Arabian Sea.

Keywords: Chelyabinsk meteoroid, Tunguska meteoroid, bolide, cometary fragments, trajectory, explosion, energy, disaster, victims, Mayan calendar, Flood

I. Introduction

It was concluded by averaging the data of Chelyabinsk meteoroid's orbit before its collision with the Earth, presented by several research groups, that the meteoroid revolved around the Sun so that its period of revolution was in 13:6 resonance with the orbital period of the Earth [1 – 4]. This means that Chelyabinsk meteoroid performed 6 turns for 13 Earth's years around the Sun, periodically, once in 13 years of coming close to the Earth until it collided. Furthermore, it was demonstrated that between explosions of Chelyabinsk and Tunguska meteoroids has been exactly 8 such cycles, if we take into account the existence of two windows, during which there is an approachment of the beam of more or less similar meteoroids orbits with the Earth's orbit. Based on assumption about the proximity of orbits of Chelyabinsk and Tunguska meteoroids were calculated characteristics of Tunguska object and parameters of its explosion, which turned in excellent agreement with those previously obtained [3, 4]. The correctness of regular physical and mathematical procedures and calculated on this basis characteristics of Tunguska explosion was confirmed by acoustic estimations of its explosion energy [5]. In the case of Tunguska explosion there are seismic evaluations of the released energy and evaluations with barograms, which are also in good agreement with these results [3 – 5].

Existence of a family of celestial bodies, the members of which move in orbits close to those which had Tunguska and Chelyabinsk meteoroids, was postulated in paper [6]. A second family of celestial bodies with similar characteristics whose orbits are in 13:6 resonance with the Earth was found also (but these orbits are somewhat different from the orbits of the first family by other parameters). It was shown that all these celestial bodies cannot be anything else as fragments of a comet probably destroyed tens of thousands years ago. The first found family was named Tungus family, and the second – Eagle family in accordance with the most famous of their representatives [1, 2, 6].

The foundation of all these mental constructions is the resonance in relation 13:6 of orbits of these two detected meteoroids families and the Earth. If this is true, then a statistically significant manifestation of bolides activity with a period of 13 years must exist. This article shows that this thirteen-year period, consistent with the windows of approach of the objects of Tungus and Eagle families is really detected. We also give the evidences that in the history of civilization have been several major cosmic catastrophes that fit into this thirteen-year Tungus cycle.

II. Frequency of bolides explosions and appearance of meteor showers

Tungus and Eagle families in accordance with assumptions are swarms of cometary fragments that have yet not lost the basic substance of its core probably ruined blow of iron meteorite – a composite of ice and partially re-melted snow mixture contaminated chondrites with density of approximately 500 – 600 kg/m^3 [1 – 4, 6]. Due to periodic phase transitions and loss of the ice and snow under the influence of solar radiation, these fragments were covered by chondrite crust quite dark in color, which density is about 3000 kg/m^3. The smaller fragments of the swarm, the faster they evolve to the components of a conventional meteorite stream, tens or hundreds of which cross the orbit of the Earth [7]. Obviously, the main feature of these swarms are large (the size of tens and hundreds of meters, as Chelyabinsk object) snow-ice meteoroids that when to enter in the Earth's atmosphere manifest themselves in the form of very bright fireballs. Furthermore, due to their relatively low density, which is 5 – 7 times lower than for typical stone meteorites, they are destroyed comparatively easily, that is, at sufficiently high altitude in the Earth's atmosphere. This is manifested in the form of bolide explosions, accompanied by strong roar, rumble, «thunder» and shedding of pieces of chondrites and in rare cases, iron-nickel fragments that seem to be the splinters from iron meteorite, which destroyed the comet nucleus [6].

At the same time, there is a paradox – the largest meteoroids and the most powerful explosions are generally giving a small amount of falling debris or they may be absent almost completely. The most intense meteor showers, such as for example, Pultusk, were formed in explosions of small meteoroids. According to calculations, mass of Pultusk meteoroid from Eagle family was about of 1.9 kilotons that is 10^3 times smaller than the mass of Chelyabinsk meteoroid. Because of lower entry speed and much higher energy loss in the atmosphere, Pultusk explosion was about $3.5 \cdot 10^3$ times weaker than Chelyabinsk explosion [6]. But this explosion with TNT equivalent of about 17 kilotons has scattered the sizeable part of chondrite crust of small meteoroid in form of quite large pieces, but has not destroyed it almost fully, as Chelyabinsk explosion with TNT equivalent of 57 Mt. And Pultusk rain with its 69 thousand fragments became, therefore, the strongest meteor shower in history [8]. At the same time fragments of Tunguska meteoroid with blast energy of about 14.5 Mt searched for a whole century with no visible results.

From the foregoing it follows that to identify the above two cycles of thirteen-year duration we should pay attention to the frequency of very bright fireballs, which are accompanied with explosions with a possible, but not mandatory falls of meteorites. Cometary debris of smaller sizes entering the Earth's atmosphere at high angles during observations under adverse conditions – in the afternoon with bright sun, or, conversely, at night, but with heavy clouds, could not be identified visually as not only bolides, but also just as meteors. However, meteorites falling after the explosion in the sky should be interpreted as signs of entry into the atmosphere of such comet fragments.

Periods when are possible the entries into the Earth's atmosphere of objects of two considered families were defined in the first paper of author on the subject – memorandum [9]. For objects of Tungus family the first window of their inputs in the last cycle was in May – August 2012 approximately, and the second – in November 2012 – February 2013 inclusive. Entry windows for objects of Eagle family in this study were somewhat clarified: they both practically merge into a single window with a nominal boundaries February – October 2011. This is because the perihelion of the orbits of Eagle family objects is very close to the average radius of the Earth's orbit [6]. Therefore, there is almost continuous transition of intersection points with Earth's orbit from the first to the second window at relatively weak variations of parameters of these orbits. Dates of possible collisions between objects of these families with the Earth during other cycles are obtained by adding or subtracting time periods, which are multiple to 13 years.

Sufficiently regular information about bright fireballs and explosions in the sky became known from the beginning – middle of the XVIII century. The Table 1 was built from this moment with using various sources listed

below – from February 1740 up to February 2013 there were 21 series of meetings between the Earth and cometary debris of Tungus family, each of which consisted of two windows encounters. Total in the table for these 42 four-month periods was 44 cases, concerning the observations of bright fireballs, their explosions and meteor showers. Of course, this information is incomplete – for example, there is known that in spring, summer and autumn of 1908 there was a sharp increase in the frequency of occurrence of fireballs. «Reports in newspapers about fireballs in that year were several times larger than in previous years. Bright fireballs were seen in England and European part of Russia, in Baltic and Central Asia, in Siberia and China» [10]. All of these events have not been reflected in Table 1, since the information about them is too fragmented for the time being.

The number of recorded events is shown in the first column in Table 1, followed by year, month and date of the incident, generalized geographical region where it occurred is shown in fifth column, and in the sixth – its more accurate localization, if possible. Comments in the seventh column are based on the original description of the incident, but they are standardized in order to process these events statistically.

Table 1

N	Year	Month	Day	Land or region	Town or territory	Comments
1	1740	February	23	France	Toulon	**Bolide explosion**
2	1765	May	3	Italy	Rome	Meteor
3	1765	November	11	Germany	–	Meteor
4	1817	December	8	England	Ipswich	**Bolide explosion**
5	1830	February	13	England	Oxfordshire	**Bolide explosion**
6	1843	June	2	The Netherlands	–	*Meteorite after explosion*
7	1843	December	11	France	–	Bolide
8	1843	December	21	Switzerland	Zurich	**Bolide explosion**
9	1844	January	–	Brazil	Entre Rios	**Bolide explosion**
10	1844	January	–	Mexico	Cosina	Meteor
11	1857	February	28	India	Madras	*Meteorites after explosion*
12	1869	May	22	France	Kernouve	*Meteorite after explosion*
13	1869	November	6	England	Cornwall	**Bolide explosion**
14	1883	February	5	Sweden	Avvika	Bolide with strange trajectory
15	1883	February	27	USA	Connecticut	**Bolide explosion**
16	1896	February	10	Spain	Madrid	**Bolide explosion at height 32 km**
17	1908	June	30	Russia	Stony Tunguska	**Bolide explosion at height 8.25 km**
18	1908	June	30	Russia	Kezhma	**Bolide explosion**
19	1908	June	30	Russia	Kansk	**Bolide explosion**
20	1908	June	30	Ukraine	Kagarlyk	**Bolide explosion**
21	1921	June	30	Vietnam	Tuan Tac	*Meteorites after explosion*
22	1922	February	7	England	Oxford	**Bolide explosion**
23	1922	February	11	Atlantic Ocean	–	Bolide
24	1934	May	14	Russia	Borovsk	Bolide
25	1947	November	5	Australia	Brisbane	Meteor
26	2000	January	11	Canada	Yukon	**Bolide explosion**
27	2000	January	18	Canada	Yukon	**Bolide explosion at height 25 km**
28	2000	February	14	Canada	Yukon	Bolide
29	2012	December	7	USA	Houston	**Bolide explosion**
30	2013	February	13	South Africa	Western Cape	Bolide
31	2013	February	13	NW Europe	–	Bolide
32	2013	February	14	Japan	Tokyo	*Meteor shower*
33	2013	February	14	Cuba	Rodas	**Bolide explosion at height 18 – 21 km**
34	2013	February	15	Russia	Kerzhenets	Bolide
35	2013	February	15	Russia	Chelyabinsk	**Bolide explosion at height 28 km**
36	2013	February	15	Russia	Talitsa	**Bolide explosion**
37	2013	February	16	USA	San Francisco	Bolide
38	2013	February	17	Saudi Arabia	–	**Bolide explosion**
39	2013	February	17	USA	Florida	Bolide
40	2013	February	19	Italy	Ionian Sea	Bolide
41	2013	February	19	Brazil	Rio de Janeiro	Bolide
42	2013	February	21	Canada	Sherwood Park	Bolide

43	2013	February	21	USA	California	Bolide
44	2013	February	25	Canada	Nova Scotia	Bolide

Events numbered 1 – 12, 14 – 16 and 21 – 23 are described in reference [11], incident 13 – in source [12], incidents 17 and 24 – in papers [1 – 4, 6], where are references to the original sources, events 18 – 20 – in sources [13, 14]. Event 25 – in source [15], Canadian series of bolides – events 26 – 28 took place in January – February 2000 and strongly reminiscent episodes in February 2013 – from source [16]. Incident 29, the first in the last cycle of Tungus family, is described in reference [17]. In February 2013, rather less than 2 weeks, from 13 to 25 February, were recorded 15 bright fireballs, at least four of which were exploded. The first of them – South African bolide (incident 30), was seen on February 13 [18], the second (incident 31) in the same evening was seen over Western Europe [19]. Further – Japan [20] (incident 32), Cuba (incident 33) [6], Russia (incident 34) [21] and, finally, Chelyabinsk meteoroid (incident 35) [1 – 4, 6]. Event 36 [22] – Talitsa bolide as Kerzhenets fireball (event 34), turned to be under the «cover» of Chelyabinsk incident, are little known. But bolide over San Francisco (incident 37) – probably one of the weakest in this series, as well as Florida's fireball (39), became quite widely known [6]. Six recent events – from Saudi Arabia up to Canada (incidents 38 and 40 – 44) are described in the sources [23 – 28].

The sources of information have been described clearly enough all these events, except incident 14. What was seen in the sky over Sweden in February 1883 – strange abrupt changes the trajectory of bolide, most simply explained by its decay into pieces at such high altitude what the sound wave from the explosion could not to reach the ground, and the observers have not heard anything.

Twenty events (from the 44 recorded in the Table 1) are explosions of bolides and five are fallouts of meteorites or even meteor showers after the explosion. That is, 25 incidents have virtually indisputable signs of that what can be considered as inputs of comet fragments to the atmosphere. The remaining 19 episodes, which, although likely to have the same nature, but, in principle, may allow other interpretations. All these three types of events are highlighted in Table 1 with different fonts.

Table 2 provides similar information for 22 cycles of cometary debris of Eagle's family. Total in the table during 22 nine-month episodes is presented information on 40 cases of observations of bright fireballs, their explosions, meteor showers, meteorites, and also about strange powerful night explosions in the skies.

Table 2

N	Year	Month	Day	Land or region	Town or territory	Comments
1	1725	October	22	South America	Petapako	**Bolide explosion**
2	1738	July	13	France	Paris	Meteor
3	1738	August	29	England	West	**Bolide explosion**
4	1738	October	18	France	Carpentras	*Meteor shower*
5	1751	May	26	Croatia	Hraschina	**Bolide explosion**
6	1764	July	20	USA	Philadelphia	**Bolide explosion**
7	1777	September	10	USA	Pennsylvania	Meteor
8	1790	July	24	France	Barbotan	**Bolide explosion**
9	1803	April	26	France	L'Aigle	*Meteor shower*
10	1803	May	9	England	–	Meteor
11	1829	May	8	USA	Forsyth	*Meteorite after explosion*
12	1829	September	9	Россия	Krasnoi-Ugol	*Meteorites after explosion*
13	1842	April	26	Yugoslavia	Milena	**Bolide explosion**
14	1842	August	5	England	Harrogate	*Meteorite after explosion*
15	1855	May	11	Estonia	Oesel	*Meteorites after explosion*
16	1855	May	17	Latvia	Igast	*Meteorite after explosion*
17	1855	August	5	USA	Petersburg	*Meteorite after explosion*
18	1868	*January*	30	Poland	Pultusk	*Explosion and meteor shower from height of 42 km*
19	1868	July	11	France	Ornans	*Meteorite after explosion*
20	1868	October	7	West Europe	–	**Bolide explosion**
21	1881	March	14	England	Middlesborough	*Meteorite after explosion*
22	1894	February	2	USA	Nevada	**Bolide explosion at height 13 km**
23	1920	August	30	India	Merua	*Meteorites after explosion*
24	1933	Март	24	USA	Pasamonte	Bolide

25	1933	August	8	USA	Sioux	**Bolide explosion**
26	1933	August	21	USA	Knoxville	**Bolide explosion at height 45 km**
27	1946	May	16	Mexico	Santa Ana	*Meteor shower with destruction of buildings and 16 wounded*
28	1946	July	27	Norway	Oslo	*Powerful explosion in the night sky*
29	1946	July	28	Norway	Oslo	*Powerful explosion in the night sky*
30	1946	August	11	Sweden	Stockholm	Meteor
31	1946	August	12	Sweden	Stockholm	Meteor
32	1946	August	21	Denmark	–	Meteor
33	1959	April	7	Czech Republic	Přibram	**Bolide explosion at height 13 km**
34	1972	April	14	Indian Ocean	–	**Bolide explosion**
35	1972	August	10	USA	Utah	**Pass of bolide through Earth atmosphere**
36	1998	June	20	Turkmenistan	Kunya-Urgench	**Bolide explosion at height 12 km**
37	2011	June	29	Mexico	–	Bolide
38	2011	August	22	Western Hemisphere	–	Bolide
39	2011	August	25	Peru	Cuzco	Bolide
40	2011	September	26	Argentina	Echeverria	*Powerful explosion in the night sky*

Incidents, which are numbered 1 – 8, 11 – 17, 19 – 21 and 23 – 32, are described in reference [11]. Widely known meteor shower in 1803 over L'Aigle – the town in Normandy (event 9), after which French Academy of Sciences recognized finally that stones may fall from the sky, is characterized in source [29]. Incident 10 is described in reference [12]. Pultusk meteor shower (event 18) and explosion of meteoroid over Candelaria town, according to modern data including in list of biggest in our era – Great Nevada Meteor of 1894 (event 22), were considered in paper [6]. Explosion of Příbram bolide in the Czech Republic (event 33) is described in the source [30], and explosion of large bolide in Indian Ocean (event 34) – in the source [31]). Unique return flight into space of Great Daylight Fireball (number 35 of the list) is described in the sources [6, 32, 33], and data on a large Turkmen meteorite (number 35 of the list) are considered in [6]. About the events of 36 – 39 one can learn something in the sources [34 – 37].

There are 13 episodes from 40 that of recorded in Table 2, which are the blasts of fireballs and 16 are explosions and fallings of meteorites or meteor showers after explosions. Passage through the atmosphere at a very flat trajectory of Great Daylight Fireball (event 34), though not led to its explosion and destruction, but the data by this orbit were the basis of the beam of Eagle family trajectories [6]. Therefore, this object has also to include in the main list of bolides with using of bold font in Tables 1 and 2. Pultusk meteor shower (event 18) took place in January 30 – formally outside the nominal window. However, if the duration of shortest month of the year to extend to another months, increasing it at least at 2 days, the event gets to the nominal window of objects of Eagle family. Yes, and the orbit of the object that causes this rain, is close to the orbit of Great Daylight Fireball, so it was definitely a member of Eagle family.

There were recorded also three powerful explosions at night, two of them were in 1946 in the skies over Oslo (events 28 and 29), as well as one in the skies over the Argentinean city Echeverria in 2011 (event 40). Individually, they could be considered as events of obscure genesis, however, together in the context of this study, the cause of these explosions almost obvious – these are enters at steep angles of cometary debris in the atmosphere (like the Turkmen bolide Kunya-Urgench, event 36), in conditions of poor visibility. Thus, there are 14 events clearly associated with entry into the atmosphere of meteoroids of Eagle family versus 20 events found for Tungus family. But fallouts of meteorites or meteor showers after explosions in the windows of collisions for Eagle family are found 16 against 5 for Tungus family. The remaining 10 episodes would likely have the same nature, but, in principle, may allow other interpretations. Interpretation of meteoroids as «rocket bombs» and «rocket vehicles» in August 1946 in the skies over Sweden and Denmark (event 30 – 32, see [11]) is clearly a manifestation of post-war hysteria among the nations, which the greatest war is almost not touched. In addition, the term UFO, which is subsequently used in such situations, will be widespread after Roswell incident only a year later [38].

So, for 21 cycles of Tungus family objects and for February 1740 – the last month of the previous cycle (169 months at all) even after a rather superficial look there are at least 25 events, which are almost impossible to interpret otherwise as the entering into the atmosphere and, how usually quite, high-altitude explosion of cometary fragments. Only the combination of a large size and steep trajectory, like for Tunguska meteoroid, could cause an explosion of the cometary fragment in the troposphere, but directly the surface of the Earth can reach such object with very steep trajectory input (input angle $\delta = 90$ °), with the diameter of at least 145 m and with the mass not less

than 0.8 Mt. For 22 cycles of objects of Eagle family and for October 1725 – the last month of the previous cycle (199 months at all) 30 of such same events were found. The frequency of inputs into the atmosphere for large objects of Tungus family, leading to explosive «fireballs» phenomena, is 0.148 per month, and for objects of Eagle family – 0.151, that is, these frequencies are very close. One can hardly doubt that this shows approximately equal density of spatial and temporal distribution of cometary debris for large enough objects of these two families.

To estimate the frequency of such events in other times, we have defined a «background level of explosive fireball events». With using the same list of events [11] for 210 years, since the beginning of 1741 to the end of 1950 were identified all incidents of fireball's explosions, high-altitude explosions and fallouts of meteorites or meteor showers during this time, except for the entrance windows of Eagle and Tungus families. During this period, 83 explosions of bolides and 50 explosive fallouts of meteorites were happened, that amounts 133 of clearly interpretable incidents during 2248 months. And more 5 explosions of bolides can be found before 1950 in the sources [31, 39].Thus, there were 138 events and the frequency of them is 0.061 per month.

In periods of entering into the Earth atmosphere of two families of 34 bolides' explosions total (and one case of flight and release of bolide back into space) and 21 explosive fallout meteorites have occurred, that is 55 incidents, which are clearly interpretable during 368 months. The frequency of events is 0.15 that is 2.5 times higher than the background. It should be noted that some of the background meteoroids clearly «gravitate» to these two families, and only strict time limits for entry windows led to the fact that these objects are not yet members of these two families. In addition, considerable number of bright fireballs in summer 1908, which are also not yet included in the list of Tungus family, should to increase real frequency of events for this group.

Thus, two thirteen-year cycles, described in the first paper on the subject [9], are clearly defined basing from historical data, since the frequency of «explosive fireball events» here is much higher than in the «background periods», and so, this discrepancy cannot be explained by any randomness and/or errors in estimations. It should be noted that the frequency of meteorites fallouts according to list containing 1109 such events from March 2, 1491 to February 15, 2013 (provided that the meteor showers in this list are counted as one meteorite) [40] in these special periods, as should have been, don't different from the background absolutely.

In addition, a strong increase of activity of large bolides in summer 1908, and still, at minimum, in January – February 2000 and February 2013, indicate that these time periods are unusual from this point of view. Generally 24 of 44 events in Table 1 occurred in February, 10 of which are significant for statistics presented in the table 1 (incidents with explosions). If we consider that all these 10 events occurred in just 3 weeks – from 7 to 28 February, their frequency was 0.63 events per month, which is on order greater than for the background level of incidents with explosions of fireballs.

As is known, meteor streams can have from one to multiple windows of emergence, durations of which are generally 2 – 4 weeks [41]. For example, Aquariids [42] may appear 7 times in one year [41]. We can expect that, over time, meteoroids of Eagle and Tungus families, losing all their snow and ice, will turn into 2 ordinary meteor streams with several windows of emergence.

III. Cosmic catastrophe of dark ages

If we go now through the revealed thirteen-year cycle back centuries, then exactly 81 cycle back from the present moment, in the year 960, according to the history of the kingdom of Ireland [43] there was an incident, which can be interpreted only as an air burst of a large meteoroid, see Fig. 1.

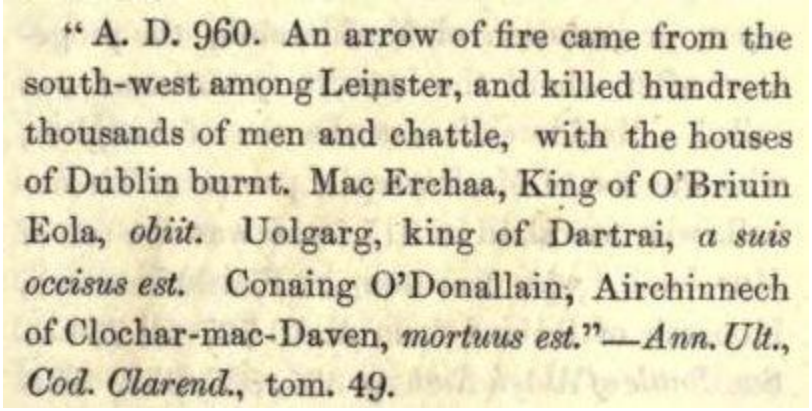
"A. D. 960. An arrow of fire came from the south-west among Leinster, and killed hundreth thousands of men and chattle, with the houses of Dublin burnt. Mac Erchaa, King of O'Briuin Eola, *obiit.* Uolgarg, king of Dartrai, *a suis occisus est.* Conaing O'Donallain, Airchinnech of Clochar-mac-Daven, *mortuus est.*"—*Ann. Ult., Cod. Clarend.*, tom. 49.

Fig. 1

In the above photocopy of fragment from this book is written that in 960 AD from the southwest through the Kingdom of Leinster onto Dublin came flying «arrow of fire» that killed 1,100 «people and slaves» and three «kings», that is, chieftains of three Irish clans and homes in Dublin have been «burned». In this case, two of the chieftains died themselves, apparently due to direct exposure of «arrow of fire», and one – Uolgarg, head of the clan Dartrai, «was killed by his own people» that was able to take advantage of chaos that started after fall of this «arrow». Since the church terminology is used, apparently, was used Julian calendar, in which year begins, as we have now, on January 1. If used more ancient Celtic account, 960 year was to begin 2 months earlier – on November 1 [44].

It is probably all information about the disaster, which happened then. The reasons for it may be interpreted by almost uniquely, but we would like to get some idea of the quantitative characteristics of celestial body that caused this phenomenon, as well as to assess the possible levels of its explosion energy. If, as is naturally to assume that it was a cometary fragment from Tungus family, then there would not have arisen of problems if there was the knowledge of the exact time of the incident. However, there is no such information, and it would seem, there is no possibility to define any quantitative parameters of the phenomenon. But, nevertheless, let us try.

So, the most probable explanation for the Dublin disaster in 960 year is that in January – February of this year (not excluded also November – December of 959 year), that is, 81 cycle ago, one of cometary fragments of Tungus family during encounter with the Earth in its second window came into the Earth atmosphere and exploded above the ground in the vicinity of Dublin. It is worth noting that 13 of the 20 explosions of bolides from this family by the Table 1 have occurred in January – February. Since the object flew from the south-west, it happened in the afternoon, and trajectory of entry was steep enough [1 – 4, 6, 9]. Therefore not even too big meteoroid could penetrate deep into the atmosphere.

Dublin was founded about 841 year by Vikings who transformed ancient Celtic settlement into their stronghold [45]. It is believed that in the XI century in London lived 20 thousand of people [46]. According to others data, in 1100 year there were in London about 15 thousand of inhabitants [47]. Thus, it is hardly after the lapse of 120 years after the founding of Dublin and about a century before the time referred to in the sources [46, 47], in this city, which was repeatedly passed from hand to hand during wars between Vikings and locals, could be more than 1 – 5 thousand of people. In the immediate vicinity of the city also could live before 1 – 2 thousand of people. Thus, the estimate of the number of inhabitants of Dublin and the surrounding area in 960 year – not more than 2 – 7 thousand of people. It known also that the number of Irish people who have taken in the V century baptized by St. Patrick, was more than 120 thousand [48], and they had to be significant fraction of the total population of Ireland. In those days, the population grew very slowly, so the estimation of the population of Ireland in 200 – 300 thousand of people in the V – X centuries seems quite plausible. Then, since the number of Irish clans is of about 100 [49], in each of them could be on average about 2 – 3 thousand of people, and in 3 clans, which were affected by the event, was within 5 – 10 thousand. Therefore, considering the intersection of these two conditions, the total population of the impact zone can be estimated at 5 – 7 thousand of people. Then share of losses in the disaster (1100 of people) will be approximately 15 – 20 %.

During nuclear explosion in the range of variation of overpressure peak at shock wave from 35 kPa (kilopascals) to 15 kPa may be killed about 5 % of people, and in the range of overpressures from 80 kPa to 35 kPa – about 50 % [50]. So that the losses of 15 – 20 % can be expected at overpressures of about 50 – 25 kPa, and a percentage of dead is negligible at the overpressure lower than 25 kPa. When estimating the parameters of the minimum meteoroid that could cause such destruction of the population in explosion zone, it should be assumed that the maximum value of the overpressure peak at the shock wave reached at the epicenter of the explosion was of 50 kPa.

Possible radius of the affected area, defined by the lower boundary of the overpressure (25 kPa) is evaluated as follows: area of the island of Ireland is about 84.5 thousand km^2 [51]. From the above for the assessment of population turns out that per square kilometer on average accounted for about 3 people. Then for the territory, at which 5 – 7 thousand of people lived, we would have to take about 2 thousand square kilometers, which corresponds to the radius of the affected area of about 25 kilometers. The population density in the vicinity of a regional center with accounting this center itself grows very sharply compared to the average values. Therefore, the upper limit for the radius of the affected area is equal of about 20 km (population density increases by 1.5 times compared to the average value for the island generally).

Lower bound of this range is obtained if we assume that all the 5 – 7 thousand people lived in Dublin itself. In the medieval city per capita accounted for about $5 \cdot 10^{-3}$ hectare [46], that is, all the people in Dublin could have been housed an area of about 0.3 km^2. Even with the account of elongation of the residential area of Dublin along the river Liffey [52] and the possible fragmentation of settlements, length of Dublin was no more than 3 – 5 km at that time. Even now the length of Dublin in this direction is no more than 12 km [53]. This gives a lower bound of magnitude of the affected area. However, the calculations showed that the characteristics of atmospheric meteoroids

explosions themselves impose by the lower boundary of the zone size much more stringent conditions, since the explosion of celestial snow/ice fragment near the ground is impossible in a «point».

Now, after determining the radius of upper boundary of the affected area we will move with a fixed step down in the direction of its reduction. Entry speed of Dublin meteoroid because of its approach from the southwest, in accordance with previous results, is assumed to be approximately 18.4 km/s (see [3, 4, 6], its density as a member of Tungus family is 570 kg/m^3 [3, 4]. At the overpressure in the shock wave in the epicenter 50 kPa and at the outer edge of the affected area at a given radius of 25 kPa, the entry angle and size of the object have been varied. The results are presented in tables 3 and 4 under the names of DM-1 – DM-3. For comparison, the basic parameters and options of Tunguska and Chelyabinsk objects (TM-1 and ChM-7) are also given (see [3, 4].

In Table 3 are shown: var – variant of calculation, L_1 is radius of outer boundary of the affected area in kilometers, δ is entry angle in degrees, H is height of explosion in kilometers, D is diameter of the object in meters, m is mass in megatons, E_0 is kinetic energy of the object entering the atmosphere in megatons of TNT, E_e is explosion energy of the object in the same units.

Table 3

var	v (km/s)	L_1 (km)	δ (°)	H (km)	D (m)	m (Mt)	E_0 (Mt)	E_e (Mt)
DM-1	18.4	20.0	28.4	12.4	132	0.69	27.8	27.0
DM-2	18.4	17.5	36.7	10.8	115.5	0.46	18.6	18.2
DM-3	18.4	15.0	50.7	9.26	98.5	0.29	11.6	11.4
TM-1	18.72	–	50.5	8.25	105	0.35	14.6	14.4
ChM-7	18.85	–	7.22	28.2	182.5	1.82	77.4	56.8

At known entry speed and density of the object, and also at predetermined overpressures at the epicenter and at a certain distance from it, the diameter, the angle of entry of the object and any other parameters and characteristics of the explosion are computed uniquely. When moving the outer boundary of the affected area by 20 km, which is estimated as upper bound of this parameter (version DM-1), the diameter of the object is 132 m, its mass – 0.69 megatons, and the explosion energy would be approximately equal to 27 megatons TNT. The angle of entry is average amounts to 28.4°. For this angle of entry the meteoroid would explode at an altitude of 12.4 km. Reducing the size of the affected area results in increase of entry angle into the atmosphere and diminishing in size, mass of meteoroid and its explosion height and energy.

Discrete reduction of the magnitude of L_1 with intervals 2.5 km already in the third step (variant DM-3) is the last one – for L_0 = 12.5 km is impossible to formally satisfy the boundary conditions. The minimum limit of the distance, at which they are performed, is 12.7 km. The entrance angle of the meteoroid is then direct (δ = 90º), the mass is 0.17 megatons, and the energy of explosion – 6.9 megatons. This version of the calculation, of course, didn't accord no longer to the description of a catastrophic incident – the annals of the kingdom of Ireland informed explicitly that «arrow of fire» has flown to Dublin through Leinster, but for vertical direction of the entry the flight may be only from above, from zenith. Minimal fragment of a comet, providing specified conditions for this catastrophe, can only be an object approximate to DM-3 – for entrance angle close to 50° it is possible yet to determine the direction of its flight.

In table 4 are shown: var – variant of calculation, p is overpressure peak on the shock wave in kilopascals at a distance L from the explosion, measured in kilometers along the ground and demonstrated in the column to the left of the pressure.

Table 4

var	L_0 (km)	p_0 (kPa)	L_1 (km)	p_1 (kPa)	L_2 (km)	p_2 (kPa)	L_3 (km)	p_3 (kPa)
DM-1	0	50.0	20.0	25.0	35	17.4	80	5.5
DM-2	0	50.0	17.5	25.0	35	15.5	80	4.6
DM-3	0	50.0	15.0	25.0	35	12.9	80	3.7
TM-1	0	82.9	20.0	30.0	35	11.8	80	3.7
ChM-7	0	11.1	20.0	9.1	35	7.9	80	5.0

Thus, without any information about the object except short message of medieval chronicle about «arrow of fire» it can be estimated its characteristics: diameter is of 100 – 130 m, mass is 0.3 – 0.7 Mt, and the energy of its explosion – about 10 – 25 Mt TNT, and the most likely parameters are close to the lower limit. In general, Dublin meteoroid was quite close to Tunguska probably with somewhat smaller entrance angle and with greater height of explosion, what have followed to reduction of the level of impact on the underlying surface in the vicinity of epicenter (see data in Table 4). However, if this celestial body exploded over modern Dublin, the number of dead, apparently, it would be about 100 – 200 thousand of people. Explosion of Chelyabinsk meteoroid, as significantly

more powerful and as much more height, result in a completely different pattern on the Earth's surface – in several times weaker in a central area, but greater far afield. When the entrance angle of such meteoroid is greater it will be more dangerous in many times (the results of action of Chelyabinsk-type object with trajectory of San Francisco bolide on San Francisco Bay Area see in reference [6]).

IV. Mesoamerican disasters

Leading astronomers, geologists and climatologists from different countries met in July, 1997, in Cambridge for three-day symposium. They came then to the conclusion that, at least since the beginning of the fifth millennium to the end of XI century BC, there are many traces of material and cultural evidences of destruction on the Earth's surface caused by falling of celestial bodies from space [54]. Basing on that enlightened opinion, let us consider some cultural evidences relating to the most dangerous component of comet and meteor threat, which is investigated in this paper.

When February 10, 1519 (behind 494 years and 5 days before the fall of Chelyabinsk meteoroid, what is precisely equal to 38 describable thirteen-year cycles) expedition of the Spanish conquistadors was started from the shores of Cuba to disembark on the coast of Yucatan (at first landing was carried out on a small coastal island Cozumel) a few days later, their leader Hernan Cortes could not even imagine how well was chosen the time of the invasion into Aztec Mexico. Not only military and technical superiority, courage and ruthlessness of the conquerors, not only the hate of neighboring Indian tribes to their cruel oppressors – the Aztecs, but this seemingly random date was one of the reasons for the victory of a handful of conquistadors over numerous Aztecs armies that took considerable combat experience [55].

This is the reason lay in the culture, which alien barbarians-Aztecs have received from previous Mesoamerican civilizations – Olmecs, Mayas and Toltecs. All religious and cultural activities of these peoples were based on the idea that «time embodies the divine presence, and determines a happy, unhappy or neutral destiny» [56].

And counting of this time was due to two calendars – civil (Aztecs called it xiuhpohualli), in which the year consisted of 365 days, and sacral (tonalpohualli), with 260 days duration, which approximately corresponds to the average time interval between occurrences of Venus as the morning or evening star [57]. Each 52 years of civil (solar) calendar their dates coincided, and around of these cycles was built the entire religious life of tribes, who took this doctrine, which first put forward by the Olmecs, lived in the end of second and first millenniums BC, about in 1150 – 500 years BC. The Aztecs, as well as their cultural and religious teachers-predecessors believed that at the end of this 52-year cycle the world is in danger of being destroyed [56]. So that's when they expected of this catastrophe and come together to meet the disaster. White-faced, bearded and winged serpent Kukulcan-Quetzalcoatl, the god of Venus, the Morning Star, over time received more human traits and personified this time cycle, and one day he had to come down to Earth at a critical moment [58].

The problem of leap years in xiuhpohualli solved by introducing an extra day every 4 years, and the year is believed to have started with the first appearance of the Pleiades above the eastern horizon immediately before sunrise. It is believed that exact correlation with the Gregorian calendar (or the Julian calendar, which was still in force at the time of the Spanish conquest of Mexico) to install still failed [56]. Comparing dates of the most important events in the period 1519 – 1521 years the beginning of xiuhpohualli was defined as February 13 [59], but there are other dating from 2 to 24 February [60].

Here's how to describe the behavior of the natives of pre-Columbian Mexico during the change of cycles: «When the night of this ceremony arrived, all the people were seized with fear and waited in anxiety for what might take place». They were afraid that «it will be the end of the human race and that the darkness of the night may become permanent: the Sun may not rise anymore». «They watched for the appearance of the planet Venus, and when, on the feared day, no catastrophe occurred, the people of Maya rejoiced. They brought human sacrifices and offered the hearts of prisoners whose chests they opened with knives of flint. On that night, when the fifty-two-year period ended, a great bonfire announced to the fearful crowds that a new period of grace had been granted and a new Venus cycle started» [61].

Aztecs have led this, to put it mildly, original eschatological culture up to the highest degree of perfection. Historians say that supreme ruler of the Aztec Ahuitzotl has come to power the in 1487, during the opening of the great temple in the imperial capital Tenochtitlan was sacrificed from 20,000 up to 80,000 people [62, 63]. Perhaps only the XX century gave again the examples of comparable and even more large scale killings such as Nanjing Massacre in 1937 [642], Nazi executions on «Eastern lands» [65] or genocide of Khmer Rouge in 1975 – 1979 [66] and Hutu against Tutsi in 1994 [67]. But nowhere except Mesoamerica similar killings not lasted for hundreds of years. And massive public ritual killings of the tribes who lived on lands surrounding Tenochtitlan were certainly one of the reasons that these tribes almost immediately have allied with aliens – conquistadors.

However, the Aztecs were very unlucky: exactly in the middle of the ordinary and the last 52-year cycle, which was interrupted by the Spanish conquest, almost the first day of a new, 27-th year called 1 Acatl (Reed), that approximately corresponds to February 13, 1519 in the Gregorian calendar, the bearded paleface for Mongoloids-Indians Hernan Cortes Quetzalcoatl – god of the morning star and ancient ruler who returned to his subjects, whether from the sea, or from the sky has stepped ashore of Yucatan, which is located near the central Mexican lands and belonged to the people of Maya that has experiencing 5 – 6 centuries ago heavy environmental catastrophe [68]. And after the «cultural shock» despite several paroxysms of Aztecs regime, when veterans of many wars and piratical raids were turned gray for overnight, 90-year reign of the Aztec in Mesoamerica has collapsed. Analogue of these events in medieval Europe seems to be the second coming of Christ, which the faithful Christians devoutly waited at least millennium.

Fundamentally important for the subsequent events proved to be the fact that at the end of the first millennium of our era figure of the god Quetzalcoatl, responsible for the 52-year cycle, merged in the popular mind with the figure of an outstanding ruler of the Toltec tribe (which was dominated then in Mesoamerica), part of the name of which coincided with the name of the winged god, as it was his priest. This ruler named Ce Acatl Topiltzin Quetzalcoatl [69]. He was born, in accordance with his name, in the year of the 1 Acatl, was the son of Mixcoatl – the great conqueror and founder of the state of the Toltecs, and was himself the greatest reformer in the history of Mesoamerica. According to legend, he has taught his people sciences and crafts, and has stopped human sacrifice. However, in the end, he was defeated in the struggle with the priests, supporters renewed bloody sacrifices, and it so happened that exactly 52 years after his birth again in the 1 Acatl year, he left his land, according to legend, floating away into the ocean to the east – whence Cortes came after about half a millennium. Ce Acatl Topiltzin Quetzalcoatl predicted that he would return in the same year the 1 Acatl [69]. Thus, in minds of Mesoamerican people have merged two images – mythical and semi-mythical, and a hope has appeared that in the middle of the dark, bloody and disastrous 52-year cycle, finally, the liberation shall come.

Thus, even the supreme ruler of the Aztecs, Montezuma II at the first meeting with Cortes, welcomed the conquistadors in Tenochtitlan: «Welcome, we've been expecting you. This is your home» [70, 71]. Montezuma has also waited for the god Quetzalcoatl. That what Hernan Cortes became not such, as well as a new incarnation of Quetzalcoatl Ce Acatl did not happen – that's another story, and there is no need to describe it here. However, mass ritual murders have been terminated by Cortes, so that the main precept of Toltec's reformer has been performed.

In the framework of our theme this complicated and far ambiguous cultural and historical context is interesting as a source of two simple and absolutely reliable facts: the existence of a 52-year cycle of disaster at the concept of the calendar, regular and interrupted the Spanish conquest of Mexico last cycle of which began in the month 1 Altkualo (Termination of water) of the year 1 Callie (Home), or about 13 February 1493, and reverence by Indians of Mesoamerica and some tribes of North American prairie of the planet Venus – the Morning Star (see, for example, [72]). One of the first Mexican scientists, Fernando de Alva Ixtlilxochitl (born, probably, in 1568 and died in 1650), because of their origin could read not yet completely burned old Mexican texts. In his writings he described these ancient traditions, according to which fifty-two-year cycle played an important role in the repetition of world catastrophes. According to it, a mere 52 years have separated the two great disasters, and each of it has become the end of a world age. Thus, there were two great catastrophes that have passed under the sign of Venus [61].

We now turn our attention to that what 52 divisible by 13 without remainder, and the time period between February 13, 1493 – the first day of the last and unfinished catastrophic cycle and 15 February 2013 contains exactly forty 13-year or ten 52-year cycles. Even if the start date of the Aztec year is not quite accurate, as some historians believe (that is, it lies in the range from 2 to 24 February), this is not important – sufficiently so that it was within the second input window of objects belonging to the Tungus family. Thus, Olmec and Mayan fifty-two-year sacred catastrophic cycle completely and exactly fit into the framework of thirteen-year cycle calculated a week after the fall of the Chelyabinsk meteoroid through its orbit characteristics [1 – 4] absolutely without any thoughts about some ancient calendars. And this cycle is confirmed by historical research, described in the previous two sections this article based mainly on the Eurasian historical material. Moreover, constant references by Indians on Morning Star – the planet Venus, apparently, cannot be interpreted otherwise than that the source of the disaster came down both times from heaven at sunrise. Namely such approaches from the Sun are typical for cometary debris of Tungus family [1 – 4, 9]. Tunguska and Chelyabinsk meteoroids together with two celestial bodies, which were causes of the Mesoamerican disasters, and with object of X century incident at Dublin, give 5 sizeable invasions of members of Tungus family in the Earth's atmosphere (sixth case will be described in the last section of this paper). And 4 from them seem to have happened in January-February. And yet it should be added that the outstanding member of Eagle family – Great Nevada Meteor [6], was also entered to the Earth atmosphere in February.

It should be noted that still barbarians-Olmecs understood that two catastrophes with a time lag of 52 years are related together and built on this basis the whole religious doctrine. But modern analogous events, occurred through double the amount of time, not were not only understood but not assimilated after their apparent explanations. Of course, there was now a slight complication, which related to the fact that impact of Tunguska meteoroid on the Earth occurred on the descending part of its orbit, but of Chelyabinsk meteoroid – on the ascending, that slightly increased the interval between these impacts. However, science, it seems, is the means to untangle these small knots, and our contemporaries could try not to inferior in the sharpness of mind at least in relation to Indians-Chichimecs who were also supporters of this doctrine.

Let us now try to determine the time of these disasters. It is known that Olmecs came on the historic arena at the end of the second millennium BC. Images of snakes with bird-like characteristics first appeared at the beginning of preclassic period, which lasted from 1150 to 500 BC [58, 73]. Where the inhabitants of Ireland saw «arrow of fire», Olmecs beheld «bird-like snake». That was so apparently because of the lighting conditions at the times of the events, which have influenced the perception of these phenomena, the absence of snakes in Ireland, their abundance in the jungles of Central America, as well as widespread use the Vikings (that were the Irish opponents) in combats arrows with fire. Therefore, in principle, the 12th century BC and its immediate surroundings are quite suitable as a time of possible events that initiated the Olmec-Mayan calendar.

As we know, one of the most important methods of dating of major disasters that affect the climate of the whole Earth or at least, the climate of vast territories is dendrochronological. Variability of the width of tree rings of Irish and Lancashire oaks, which for oaks from Irish bogs was traced for nearly 7300 years [74, 75]). This method is one of the few that directly, without any presetting, can determine the dates of some events – only enough to count the annual rings of trees.

For the final determination of the year of this event we should be guided by the research of Siberian scientists. After analyzing the response variability of thickness of tree rings at powerful volcanic eruptions in the last 2000 years, they determined that the minimum wood growth turns at the fourth year after onset of causes [76], see Fig. 2, where the normalized index of growth is shown on the ordinate, and the number of years relative to the event – on the abscissa.

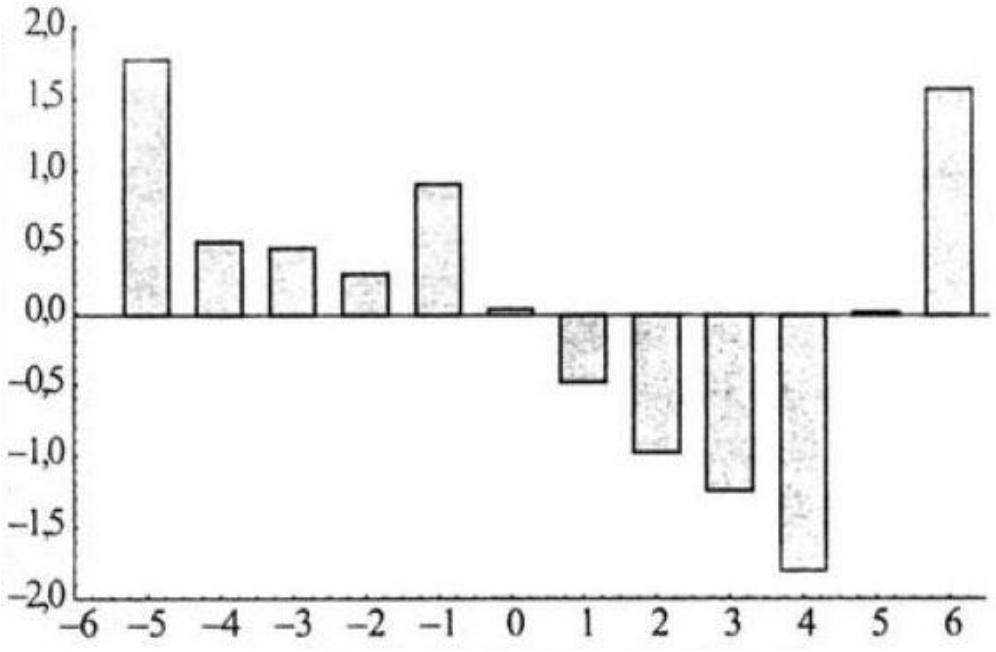

Fig. 2

The dendrochronological studies of Irish and English oaks give at least four appreciable cold periods until the beginning of our era [75]. Events that caused them can be dated back to 3201, 2357, 1630 and 1161 years BC. Third of these incidents seems to usually be associated with a grand Mediterranean volcanic eruption of Santorin that according to various estimates happened in 1500 – 1645 BC [77] and first, second and fourth are lie in the matrix of thirteen-year cycle. From the first date to the last window of contact with the Earth in 2012 year have gone 401 of thirteen-year orbital cycles of Tungus, and, respectively, 336 and 244 thirteen-year cycles have gone from the third and fourth date up to present time (up to 2011) at the cycle of Eagle family [6]. At the same time, in 1161 BC according to the annual growth of wood was only the beginning of a series of catastrophes, which lasted for 15 years up to 1146 BC, from which to 2013 was exactly 243 thirteen-year periods at the cycle of Tungus family. Usually,

this period of cold weather is associated with the so-called event Hekla 3 – catastrophic eruption of the Icelandic volcano Hekla, but with this opinion is competing version of what this event was occurred much later – in the 929 ± 34 BC [78].

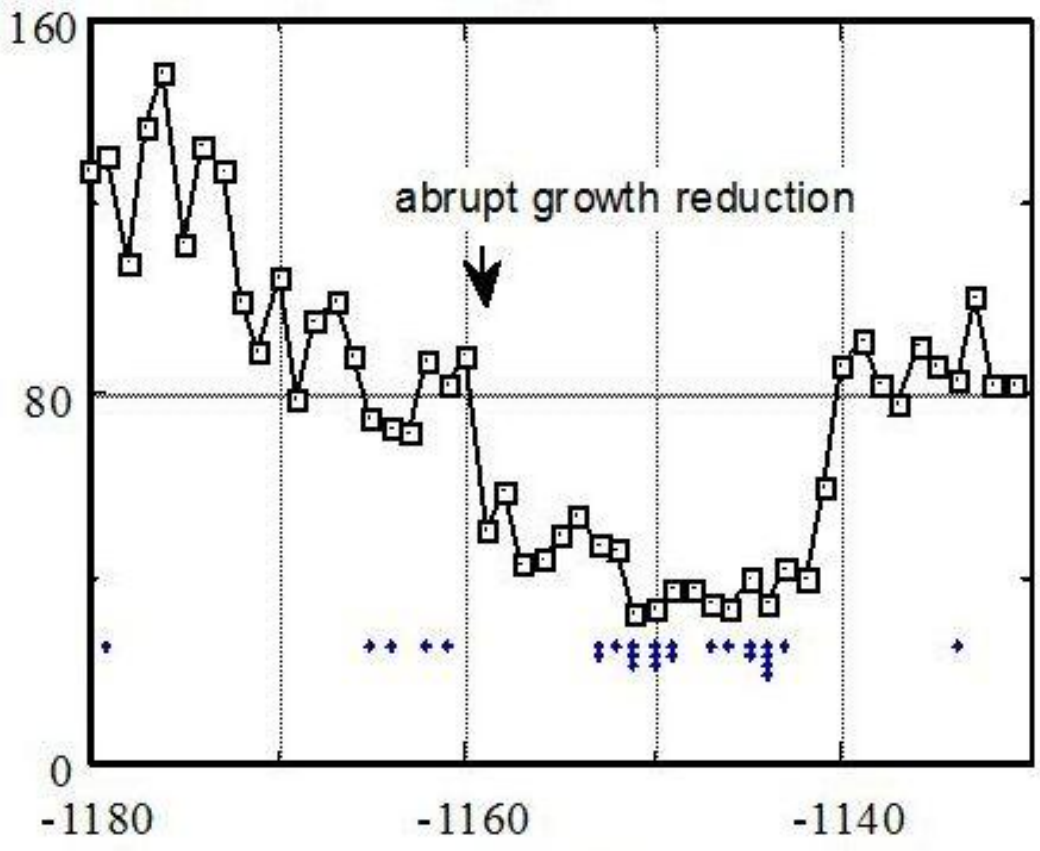

Fig. 3

We can see that between 1159 BC and 1493 – the last year of the beginning of the 52-year cycle of the Olmec-Mayan calendar was exactly 51 such cycles that is 2652 years. Therefore, from the combination of all these and previously described in section IV data we may suggest that the most probable date of Mesoamerican disaster was February 13 (± 11), 1159 BC. If it was the second event, the first occurred 52 years earlier in 1211 BC, and, as follows from the concept of this calendar creating, also in February. The same dendrochronological data also indicate 1211 BC, as a year in which there was something that led over the next four years to some inhibition of growth of Irish, British and European oaks and American pines. In contrast, in the four years since 1107 BC similar phenomena have not been observed [75].

However, it should take into account another factor affecting the dates of these events in the limits of about 1.5 months. This is the precession of the Earth's axis of rotation with a period of about 25,765 years [79]. It leads to a shift of more shorter solar calendar every year by 20 minutes compared with stellar calendar that are playing the role of «absolute time». Consequently, stellar dates are moved every 70.5 years on one day «forward» on the solar calendar, and the sun's dates – on one day «back» on the stellar calendar. These meteoroids' collisions with Earth for constant orbits occur at the stellar time, but we live according to solar time. Therefore, for 3172 years from1159 BC to last contact window of Tungus cycle, the event dating on the solar calendar from 2 to 24 February, should move to 45 days forward, that is, at the period from 19 December 1158 until 10 January 1159 years BC. That is, the orbits of these meteoroids were closer to the orbits of meteoroids that exploded over Yukon in January, 2000, see Table 1.

In the case of Dublin incident in 960 year, such shift is 15 days, and because of ignorance of the exact date of this event, does not have any significant value.

V. Late Bronze Age collapse and the Day of Atonement

It should be noted that in the Old World (in the Eastern Mediterranean and the Middle East) at this time was just happening so-called the Late Bronze Age collapse [80]. Its cause is usually considered a general system crisis in the most developed region on the Earth at that time, violated possibly the former balance of power due to mass advent of iron weapons, as well as the ecological crisis because of a possible eruption of Iceland's the most active Hekla

volcano – Hekla 3 event. However, the coincidence of the period 1161 – 1146 B. C. events of which, as shown in Section IV, led to the creation of Mesoamerican eschatological doctrine, with thirteen-year cycles of Eagle and Tungus families hints at least to a possible involvement of falls and explosions of cometary debris to the Late Bronze Age collapse.

In this regard, it should pay attention to fifty-year cycle of well-known Jewish Day of Atonement when «Israelis used to sent a scapegoat to Azazel in the desert» (this «Stellar Angel», among other things, «was a fallen star or Lucifer» – whether has been he the alter ego of the Quetzalcoatl in the Middle East?) This fifty-year cycle was explained by I. Velikovsky [61] very artificially: «The Jews fasted and prepared themselves for the Day of Atonement on the earliest possible date of its return». However, this fifty-year interval easily and naturally is derived from two described here thirteen-year cycles – it may be a period from February 1211 B. C. (the end of Tungus cycle and the starting point of the Olmec/Mayan calendar) up to February 1161 B. C. (the beginning of the ordinary Eagle cycle at the moment of appearance of fifteen year oppression of Irish Oaks) that are well suited for formation of the Atonement cycle and dates back to the early biblical history of the Jews. Thus, the above arguments indicate to 4 regional disasters or, possibly, to 2 regional and 1 accident, which also had an impact on both Mesoamerica and the Middle East. However, the latter option seems unlikely, since in 1211 B. C. the oppression of the Irish Oaks was less than a half a century later. And all of these disasters could be associated with falls or air blasts of cometary debris of two considered families. Apparently, these indirect evidence would be worth either confirm or refute by special cycle of studies.

VI. On the trail of Biblical Flood – from Greenland to Antarctica and further throughout the world

Now back from the jungle of the Yucatan and the Middle East deserts to the green plains and swamps of Ireland and let us try to understand what binds the objects of Tungus family with the Biblical Flood.

VI. 1 Two recent global cooling

But first take a quick look at explanations of the reasons of transition to the last geological period in the development of the Earth – to the Holocene, in which we now find ourselves. This climatic optimum began about 11,700 years ago after the last stage of the Great Glaciation, which lasted nearly a thousand years, and were called the Younger Dryas. Significant and fairly rapid warming with melting glaciers on the Earth began more 13,400 years ago, however, after passed about 700 years, then it suddenly changed to the cold snap, and the advent of the Holocene was delayed for 1700 years [81, 82]. This cooling was accompanied by mass extinction of fauna – mammoths, mastodons, saber-toothed cats, dire wolves and giant sloths have not survived [85, 86]. The Neolithic Revolution began at the same time [82]. And recent studies are referred to as the cause of this cooling a fall a large meteoroid in central Mexico or in Quebec [83 – 87], although it may well be that it fall could occur elsewhere, for example in the Indian Ocean [88]. Thus, there is every reason to believe that the fall of the celestial body was so trigger that turned back the climate change and led to cooling of the Earth.

But in the Holocene occurred also climatic fluctuations, although their scale was less than during the change of epochs. Nevertheless, about 5,200 years ago, protracted warming was ended and the middle of Holocene is characterized by a very sharp and substantial cooling. In reference [89] is described a wide variety of evidences of these climate changes. They are scattered around the globe – from Greenland to Antarctica. Alpine glaciers began to grow then, and only now, after five thousand years, they returned to the state in which they were before the start of this cold snap. And that is why quarter century ago in the Alps was found Ötzi – Tyrolean Iceman mummy, which was been buried in the ice all this time and so well preserved [90]. The age of mummy Ötzi is estimated in 5200 ± 150 years of radiocarbon method [89]. Largest Andean glacier Quelccaya, which grown quickly at the same time, has buried then unpretentious mountain plants – Distichia muscoides. Radiocarbon data from its tissues showed that it is happened 5138 ± 45 years ago with respect to 1950 [89] or 5201 ± 45 years ago with respect to 2013.

Again, one of the most important evidence of a sharp cold snap in mid-Holocene are the dendrochronological data on the variability of the width of the growth rings of Irish and Lancashire oaks and American pines [74, 75]. Their study suggests that the onset of cold weather is dated at the boundary between the XXXIII and XXXII, see Fig. 4 from reference [75]. In this figure, on the vertical axis is shown the index of wood growth, on the horizontal axis – the date of the annual ring with the given index.

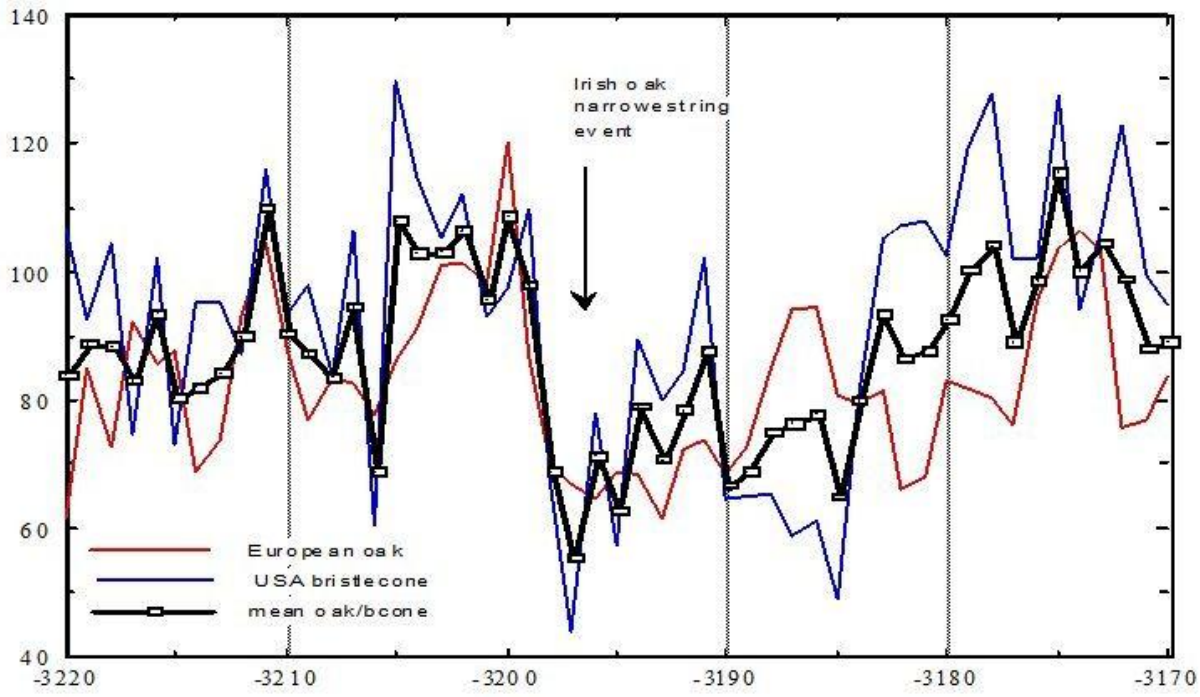

Fig. 4

From the totality of the data is followed that the incident that led to the beginning of the cooling in the middle of Holocene occurred in 3201 BC. And in this year in ice core from Greenland was sharp increase of deposits of marine biogenic sulphate, indicating a strong change of conditions in the ocean off the coast of Greenland [74].

VI. 2 Year of the «World Deluge»

Notorious «World Deluge», which is known to the majority from the Bible or general cultural references to biblical stories, as shows the most elementary acquaintance with this event, in reality, was the regional flood, which occurred between the Tigris and Euphrates rivers [91]. In accordance with Septuagint – the canon of Scripture in the Greek language and one of the oldest biblical texts [92], Biblical «global» flood occurred in 3248 BC by Alexandria's Code Septuagint or 3268 BC by Vatican's Code [91]. Sumerian legend of the flood was established in the III millennium BC, a clay tablet, on which its fragments were preserved, is dated to the XVIII century BC [91].

It is known that the popular hero of Sumerian legends Gilgamesh was a real historical figure – he was lugal (ruler) of the city Uruk about 2700 BC, and about 2675 BC he seized power in Lower Mesopotamia [93]. Sumerian list of «kings» informs about 23 lugals of neighboring city Kish that were dominated there since the flood to Gilgamesh [94]. This list designates an absolutely fantastic time of their reign – in the tens of thousands of years, so to assess this duration we should use more reliable data – the duration of the reign of their neighbors and contemporaries – Egyptian pharaohs of Early Kingdom (first and second dynasties), which were also prevailed over the human community, the basis of whose existence was irrigated agriculture. Altogether there were 17 pharaohs of Early Kingdom, duration of the first dynasty according to various sources was 170 – 179 years, and the second 140 – 146 years [95], that is sum total of 310 – 325 years. Then the duration of 23 lugals reign would be close to 420 – 440 years. In addition, Kish, and the entire area of agrarian civilization lower reaches of Euphrates, was hit disaster, and is quite natural to expect that some time there lasted a period of chaos and anarchy. Thus, this assessment leads us to the flood date of about 3150 BC, only100 years before the time of Septuagint.

It is interesting to note that 17 Russian tsars of Romanov dynasty [96] (not counting the imbecile Ivan V, which was for 14 years a member of the «tandem» as a co-ruler of Peter I) were on the throne in comparable time period with the first two dynasties of pharaohs – 304 years, from 1613 to 1917. In this case, as well as Sumerian lugals of Kish, they came to power after a natural disaster – the explosion of the volcano Huaynaputina (Young Volcano in Quechua language) February 19, 1600 [97]. Because of tremendous volcanic emissions there was a strong cold snap in the whole world, and famine has killed during period of 1601 – 1603 in Russia a third of the population [98]. Later on, as is known, has begun the Time of Troubles, after which the Romanov dynasty appeared on the Russian throne. Thus, recalculation of reign duration of 17 Russian tsars onto 23 lugals of Kish with adding of 13 years of chaos gives about 425 years, that is, a value close to the recalculation of Early Egyptian kingdom's period, which is

not surprising, since for the mode of inheritance of power its term correlates with a life expectancy of monarch. And the average life expectancy from the first Pharaohs to the Russian tsars seems to have changed very little.

Archaeological excavations in Mesopotamia showed that at a depth of 4 – 5 meters from the current level of the soil in the ancient Sumerian cities (Ur, Uruk, Kish and Shuruppak) was discovered layer of deposits of clay and silt, dating from 3000 – 3200 years BC [99]. Thus, there is no doubt that of about 3200 years BC in Lower Mesopotamia was the strongest regional flood, known in history as «World Deluge». It seems, this flood has killed almost all original – Ubaid population of this area and after the recession of water, the oldest civilization on the Earth was recreated through efforts by the others who came to this land and which were named as Sumerians. Naturally to associate this catastrophe with the incident of the year 3201 BC, that caused the global cooling in the middle of Holocene, especially that in the vicinity of this date, over several hundred years such notable climatic events have not been registered. The Sumerians, according to researches in the framework of DNA-genealogy, probably were branch of the Middle East Arbins (bearers of R1b haplogroup) where there appeared 3300 ± 700 years BC (other branches of Arbins passed through North Africa, put on the throne of Egypt's Pharaohs from themselves, and then they got to Europe through Gibraltar and made there unprecedented genocide between 3000 – 2500 years BC) [100].

These conclusions, in general, are not new for some time, as well as that the fact what all these events could be caused by the fall of a celestial body (see, for example, [101, 102]). However, the author of this paper can report on them, that no one can say: it is easy to make sure that between 2012 – the year of opening of contact windows of cometary debris with the Earth and 3201 BC were exactly 401 thirteen-year resonant cycles for objects of Tungus family [1 – 4, 6]. Hence it is easy to take another step – to assume that the source of flood in Mesopotamia is the fall of one of the most prominent members of Tungus family. Together with the numerous testimonies of similar phenomena less remote from our times, as well as with a clear increase in the number of entering the Earth's atmosphere of large celestial bodies in the time of opening of contact windows, we should recognize that this assumption is just suggests itself. After that, it becomes possible to assess the scale of this incident.

VI.3 Month, when there was the «World Deluge»

That what the Bible has given the date of the deluge, which differs by only fifty years (not more than 2 %) from the time that has elapsed from the events up to the period when they were described in the Old Testament, increases confidence to the Bible so and to Sumerian primary sources, of which, obviously, was received factual material. Therefore, it seems that it is possible to determine the time of the event even more precisely, because 2 % of the length of the year – it's just one week.

However, at first glance, it's impossible to do, because there are two different dates of the flood differing on 5 months. According to the chronology of the Septuagint, the Flood occurred on 27 Cheshvan, which corresponds (in accordance with experts estimates) 1 December of Julian calendar [91] or December 11 to the modern Gregorian calendar (the dates were moved to 10 days in 1582 A. D. by changing the calendars). If be based on modern Greek text of the Bible, the date of the Flood is 12/22 November Julian/Gregorian calendar. Thus, the biblical sources in the average yield as the date of the flood 1 – 2 December to the modern style of about ± 10 days. But according to the Babylonian legend, presented by Chaldean historian Berosus, who wrote in Greek, the flood has happened in the 15 day of the month Dais on the Syrian-Macedonian calendar [91], that corresponds to the beginning of June of Julian calendar [103].

These both periods fall within the windows of contacts with the Earth for Tungus family, and at first glance it seems that we cannot find the reasons for preferring one of them. However, minimal knowledge of the Greek language is enough to resolve this dilemma. Berosus wrote in the III century B. C. in a language that was not his mother tongue. His history was based on sources that were older, at least, on 1.5 thousand years than his work. A quarter of the millennium later Greek Alexander Polyhistor, which was at first a Roman slave, and then a Roman citizen, retold this lost history, obviously, in Latin language. And then this story was cited another eight and a half centuries after by religious writer George Syncellus – personal secretary of Constantinople Patriarch [91], and only the last work has reached of our time.

Thus, there were no less than four consecutive translations of the original and, obviously, the Sumerian text (or of oral Sumerian legends) from one language to another, and the names of the months were from the fifth – though Macedonian was the Hellenized language, but it was not Greek. Moreover, at least twice translations did not natural, native speakers of the target document: Chaldean translated from the local, probably Aramaic language to Greek, Greek – into Latin. In addition, it is unknown how many times lists of «Selected chorography» by Syncellus were copied by medieval monks before it reached us. It is also known that in addition to the month with name Dais (Δαίς) in the Syrian-Macedonian calendar existed the month Dios (Δῖος), corresponding to the Julian November [103, 104]. As pronunciation and spelling of these months, shifted with respect to each other just on those same five months, are almost identical on Greek language. Thus, there is very little doubt that there was the substitution of Dios to Dais on

one of the many stages of information translation. And in fact the two independent sources indicate essentially on the same date of the Flood – to November or beginning of December of the modern Gregorian calendar.

If we take into account the precession of the Earth's axis during 5213 years, it turns out shift of the stellar calendar compared with the solar at 74 days. Then the solar period from November 22 to December 11 corresponds to stellar period of 10/29 September of contact window of Tungus family objects. These dates are already beyond the borders of the current approximate determination on contemporary events of the first contact window, and, apparently, they give an estimate of the influence of disturbances during 5 millennia of these fairly steady orbits. But, for the earliest dates of the event the deviation from modern borders is not exceed 10 days.

VI.4 Topography of Mesopotamia and the mechanism of flooding

Based on the foregoing, it seems quite reasonable to try to deepen our understanding about the course of the Mesopotamian flood and about the characteristics of the object named the Meteoroid of Flood, using the orbit of Chelyabinsk and Tunguska objects, which in this simplified model differed only by inclination of orbits to the ecliptic plane. At monotonic variation of this angle into the dates of contact its value will be equal $i \approx -1.5^{\circ}$ for the Meteoroid of Flood. It is known that the flood (in the form of heavy rainfall) began in the first half of the day, so that the meteoroid, the reason for its occurrence, fell in the morning like those two objects. Calculations showed that when $i = -1.5^{\circ}$ and the angle of entry into the atmosphere is maximal (is equal to 90º), the entry speed of Meteoroid of Flood was equal to 18.55 km/s. For preliminary estimates characteristics of a celestial body, which has destroyed the first agricultural civilizations in the world, we will use such input parameters as they meet to the minimum size and energy of the meteoroid.

Scene, on which has been played this performance, is Mesopotamian plain between the rivers Tigris and Euphrates. It is a vast flat plain were formed by sediments of rivers, so it rises slightly with increasing the distance from the coastline of the Persian Gulf [105]. Baghdad lies at an altitude of 34 m above the sea level at the distance of about 550 km from coast [106]. It should be remembered that more than 5000 years ago Mesopotamian plain was by 15 m lower with respect to sea level of those times, and the coastline was approximately 220 – 240 km further inland of plain [107]. And Ur, one of the most famous cities of Mesopotamia affected by flood, was almost on the sea coast. Excavations have revealed that in several major cities of Ur, Uruk, Kish and Shuruppak were flooding. All these cities were located along the river-bed of Euphrates, and the distance from Ur to Kish, which was the most remote city from the sea, was about 225 km. This combined with 5 – 10 km from the coast to Ur is a minimum distance of flooding. Note that Kish, which was affected during the flood the least, has become the dominant force in Lower Mesopotamia for several centuries, until Uruk has captured the hegemony.

The thickness of sediments layer in Ur was reached in some places up to 3 m, and water, according to the British archaeologist sir Leonard Woolley, who led the excavations at Ur, should to rise by at least 7.5 m [108]. Elsewhere in his book Sir Leonard writes: «The Bible says that the water rose to eight meters. Apparently, the way it was». Then «a huge space – five hundred kilometers in length and in width one hundred fifty» should to be covered with water at the flat Mesopotamian plain [108]. However, there is also known that the excavations in Mesopotamia everywhere except in the areas mentioned above have not led to the finding of traces of flooding [109]. Sediment thickness in Kish was less than 0.5 m [110]. There is an obvious discrepancy between the height of water and the limitation of space in which it appeared. This dilemma is familiar to the author of this article – after the catastrophic flooding in Krymsk July 7, 2012 a lot of copies were broken in trying to figure out where it came from so much water and which way the most of it has disappeared, and why this phenomenon of relatively modest scale has led to so many victims. All these questions have been removed after it was shown that the main role in this catastrophe played shock wave in shallow water [111]. The same explanation arises in the analysis of the Mesopotamian flood, only here cause of the wave coming from the sea (that is, tsunami) and flooding coastal areas, in the results of the analysis carried out in this section of the article, became falling of the celestial body in ocean. Especially because in the North Indian Ocean there are no large active volcanoes and very strong earthquakes were not fixed therein earlier [112].

Let us to model the Biblical flooding of Mesopotamia corresponding in accordance with the descriptions of flood, using tsunami caused by the fall of the cometary fragment of Tungus family. There are two fundamentally different possible causes of the incident of this kind: a meteoroid falls in the near zone of the Persian Gulf, which is optimal for creating a tsunami, or a fall occurs in the Arabian Sea, the nearest to Mesopotamia part of which is called the Gulf of Oman. For the formation of high waves, ceteris paribus is required maximum depth of dropping zone and minimum distance from it to the coast, which should be flooded. Persian Gulf is quite a large, but shallow aquatory, with a maximum depth of 102 m now (and at that time probably on 5 – 10 deeper) and average – less than 50 m [113]. Therefore, this aquatory is not too suitable for the formation of high waves after falling of space object that will be shown later. Gulf of Oman, with its depth of up to 3.7 km [114], and the Arabian Sea (maximum depth is 4.65 km [115]), despite the fact that they are located farther from Mesopotamia, in this sense, are more promising.

In this case, as shown by preliminary calculations, a fragment of comet , or even more so, stone asteroid, should made an impact crater of large size at sea bottom of the Gulf for the depth of the water layer of a few tens of meters, if there is a tsunami height of 8 m in Ur. This dredging of the Gulf can increase the height of the generated waves or reduce the size requirements for the meteoroid, but this crater it would be impossible not to notice now. Since it is not, it turns out that the flood could not have been caused by the fall of a celestial body in the Persian Gulf. Essentially, there is only one option – the drop of the object into the Arabian Sea.

VI.5 Determination of crash site of Flood Meteoroid

There was originally considered a hypothetical fall of cometary fragment in the Gulf of Oman [114] or in the northern part of the Arabian Sea into the water, which depth is at least 3.5 – 3.7 km. Then it has seemed impossibly to accurately determine the point of the falling. However, it was done at present.

There are so-called chevron dunes (chevrons) on many shores of seas and oceans, which according to opinions of many researchers have been aroused by Megatsunami that occurred, including, in the falls of large celestial bodies in the oceans. There is a list of chevrons, numbering 221 points [116]. And along with well-known chevrons of Madagascar, South Africa and Australia, which sometimes reach a height of 200 m or more, in the list at the number 167 in the north-eastern Indian coast of the Arabian Sea is modest chevron with a maximum height of about 10 m (its coordinates are near to 22.78° N and 69.44° E). In contrast to their known counterparts, some of which form interconnected groups, as expected because of their common origin, this chevron may be not included at any group, what has been seen from the axis of its azimuth that is the direction to the source of its occurrence. But this azimuth indicates at the northern part of the Arabian Sea and at that area, which had previously been considered as a possible area of Flood Meteoroid falling. In this case, as shown by preliminary estimates, wave height that has created this chevron is consistent with the wave height in Mesopotamia.

In this regard, revision of large-scale photos of northern shores of the Arabian Sea has been made in Google/Earth system and on the Iranian coast in about of 90 kilometers west of Konarak town at 25.47° N and 59.48° E (see Fig. 5) typical dunes were found [88], which are very similar to the chevron 134 in South African or chevron 154 on the southern tip of the Madagascar Island (the numbering of chevrons is given by source [116]). Everyone can easily make sure in this fact, using Google. Photo of newly found Iranian chevron, which was named Konarak, is presented in [88]. Lines in Fig. 5 are the bearings to source of tsunami wave created these chevrons. The intersection of bearing lines of Konarak chevron and Indian chevron 167 gives a point of falling of the meteoroid, which is converted from a hypothetical to real object in that moment. It should be noted that these two chevrons are positioned very well to determine the point of incidence (the angle between the bearing lines is only on 10 – 15° more than direct) and the size of the impact area is estimated at no more than 0.5°. The coordinates of the nominal point are 21.12° N and 62.79° E. It is located in the deepwater area of the Arabian Sea in the north of its Arabian Depression with a flat bottom and depths in this area of 3 to 4 km [117]. Therefore, the thickness of the water layer at this point was evaluated in 3500 m.

Fig. 5

Distances from the point of meteoroid's incidence to chevron 167 and to Konarak chevron were measured, and they were equal to 710 km and 590 km respectively.

Fig. 6

From this nominal point of incidence through Arabian Sea, Oman and Persian Gulfs was held a curved trajectory to the Great Ziggurat of ancient Ur at about the middle of these gulfs. It is known that the wave on the water surface in narrowness at sufficiently large distance from the source forms a rectilinear front of constant height and is moved there with very small losses, even when their depths are small. The wave front is practically normal to the longitudinal axis of the narrowness and its twists don't interfere to wave propagation (see, e.g., [88, 111]). Therefore, the approximate trajectory of the tsunami to Ur was carried out taking into account these considerations (the ancient coastline of the Persian Gulf was lying near of this city). The length of the path of the wave from the point of meteoroid's incidence to Ur was approximately 2200 km, despite the fact that the distance in a straight line to the city was equal to 1990 km (see Fig. 6).

And finally, absolutely unexpected fact for the author was that in the last quarter of the XX century, at the last moment before the Islamic revolution in Iran, after which all such work, apparently, ceased, a geological survey of Makran coast – Iranian and Pakistani shores of the Arabian Sea was carried out. There was no interest of geologists to Konarak chevron ostensibly, but their research showed that the radiometric age of the sediments at the bottom of the Chah Bahar bay is 5300 years [118]. This bay is highly visible in Fig. 5 as circular blue spot on the coast, which is situated left of the black point – the city of the same name, «in two divisions markup» of bearing line to east from Konarak chevron. Given the accuracy of such techniques (in the determination of the age of the mummy Ötzi, who was killed in the Alps during the same period, the accuracy is ± 150 years), there is practically complete agreement of this date with the fall of Flood Meteoroid. Thus, in addition to deposits on the Mesopotamian plain, excavated by archaeologists in 1922 – 1934 years, now identified another 3 material evidence of impact of cosmic origin at times of Mesopotamian Flood – 2 chevrons and sediments in the Chah Bahar bay.

VI.6 Estimations of Flood Meteoroid

There were carried out the calculations (with the aid of interactive program [119, 120]) of possible parameters of Flood Meteoroid obtained from the condition that if it falls by the sea depth of 3500 m at a distance of 710 km, then the maximum height of chevron dunes is 10 m. From the article [88] follows that due to energetical considerations

$$h_{max} = kH_{max}^{4/3},$$
$$h_{cr} = H_{cr} = k^{-3},$$

where h_{max} is the maximal height of the chevron (in m), H_{max} is the maximal wave height in shallow water (in m), k = 3/16 $м^{-1/3}$ – is empirical coefficient, $h_{cr} = H_{cr} \approx 150$ м is critical values of these heights when they are compared, and then the maximum height of the chevron should be derived from a purely geometric constraint:

$$h_{max} \leq H_{max}$$

In that case the maximal height of tsunami on this beach was equal to 19.9 m.

Changing the wave height H with the thickness of the water layer S, as follows from the theory of waves in shallow water (for such waves, even the Arabian Sea is the «shallow water»):

$$H \sim S^{-1/4}$$

So that a decrease in the water depth increases the height of wave until its value in shallow (on the water layer that thickness is comparable to the height of the wave) H_{max} does not become equal to 3/5 of the depth S:

$$H_{max} = \frac{3}{5} S^{*},$$

where S* is the value of the water layer thickness (depth of water) at which the maximal wave height is reached. As follows from the empirical data the growth of the wave height from this moment is terminated due to strong turbulent energy dissipation at the forefront of a wave [111]. Then, it is moving with a constant height, and next, at very shallow water, the wave decays losing its energy. Therefore, while maintaining the original thickness of the water layer, the wave height at a distance of 710 km should be equal to 6.2 m – this is output of the program [119] at the specified parameters of Flood Meteoroid presented in Table 5. In this case, the estimated maximum height of the Konarak chevron in removing 590 km from the point of impact should be little more than 12 m.

Thus, in the limits of a reasonable permissible variation we have learned the orbit of a celestial body – the causes of Flood, its density, coordinates of the point of impact, the approximate date of the event, as well as the height of the tsunami that occurred in the sea with known depth at a certain distance from the point of impact. In direction to the coast of northern India the wave was propagating freely in a straight line in the «infinite ocean» with a monotonic rise of the bottom, that is, the computational situation is the simplest with minimum error of calculation (see Fig. 5).

For unique solution of the problem is not enough two parameters only – the exact time of the object's fall and the azimuth of its trajectory at the point of incidence. However, we can do something and here. In the Babylonian version of the description of the event – Tale of Utnapishtim was written the following: «In the morning it began to rain and was the god of the storm, was the god of death and other fearsome deities in clouds, bringing death and destruction». Even there, in the south (the coordinates of Ur are 30.96° N, 46.10° E) in late November – early December the morning comes rather late, for example, December 1, 2014 the Sun was rose at 6 hours 35 minutes [121]. Calculations showed that the flash of light was not during the incident, and in any case it could not be seen from the distance of 1990 km at the explosion on the surface of the sea due to the curvature of the Earth. Therefore, the airblast came first to Ur, approximately 1.7 hours after the fall of the object. According to calculations it was quite weak (the maximum pressure on it were about 0.5 kPa), but, nevertheless, such waves may, say, to break a badly installed window glass [122], which in Ur obviously never have not been.

But, directly behind the shock wave in the atmosphere a huge mass of water vapor was spread, which was aroused in the atmosphere as a result of explosion in the water of the Arabian Sea, with formation a cavity, a diameter of which was about 16 km, at maximum depth of 3.5 km and a volume of 400 km^3. This water in the atmosphere should have led to showers of unprecedented intensity. But the main blow was struck by tsunami of the height of about 8 meters later, approximately, 10 hours after the arrival of the air shock wave, that is, in the evening after sunset, which at this time of year occurs about 17 hours. The duration of daylight in Ur in this period was less than the time it took the tsunami to reach the city. And to the more distant cities the wave passed even later. The people was stunned by what is happening and really could not see anything in the dark and poorly understood, what happened at the time of the main disaster, which was flooding from the sea. Something similar, but on a much smaller scale, we recently saw in Krymsk [111]. In June daytime lasts on 2 hours longer and tsunami could still be seen. So that light month Dais worse fit to «World Deluge», than dark month Dios.

Thus, if we take two time moments in the morning in Ur: one moment – an hour with a little after sunrise, and the other – less than 2 hours before noon, which are differing in only 2 hours, we can approximately determine the possible time of flood. And were held two series of calculations – for «eight» and for «ten o'clock» meteoroids, that

is, those in which air blast came in the city of Ur in 8 and 10 hours of local solar time. In this case, fall of meteoroids occurred about 6 hours 18 minutes (before sunrise in Ur) and about 8 hours and 18 minutes in time of Ur.

It should say now a few words about azimuths of meteoroid's trajectory. As before in all calculations of the author, the zero azimuth corresponds to exactly flying from east to west, and its positive values correspond to a deviation of the trajectory to the south, so that the azimuth of 90° – it's flying from south to north. As it follows from calculations, the minimum possible value of the azimuth of eight o'clock meteoroid was approximately equal to 18 – 19°. In this case, the entry angles δ of meteoroid became very small and its mass and energy would have to exceed these values for the meteoroids with steep entrances at least 2 orders of magnitude. Due to the existence of the lower limit values of azimuth, the main computations have been performed at azimuths of 30° to 90° in steps of 15°.

The dimensions of options under consideration are greater in 4 – 5 times than that of Chelyabinsk meteoroid. It was assumed that at such scale a contribution of chondrite surface crust with approximately constant thickness and a relatively high density (3300 kg/m^3) in the total mass of such fragment of the comet is small, and therefore its average density is lower than for relatively small fragment of the comet, known to us as Chelyabinsk meteoroid (570 kg/m^3), but higher than that for comet 67P/Churyumov-Gerasimenko (500 kg/m^3) [123]. The estimations give the average density of 515 kg/m^3 for meteoroids of such dimensions. And almost all of calculations were held at this density. However, the most recent data about the comet give larger average density – 535 kg/m^3 [123]. Then the density of Flood Meteoroid should be about 550 kg/m^3 that was taken into account in the latest calculations.

The main results of the calculations are presented in Tables 5 – 8. The notations are as follows: var – variant of calculation, A is the azimuth of trajectory in degrees, v is the speed of the object in kilometers per second, δ is entry angle in degrees, D is the diameter of the object in meters, m is mass in megatons, E_0 is kinetic energy of the object entering the atmosphere in megatons of TNT, E_e is impact and explosion energy of the object in the same units.

Table 5

var	A (º)	v (km/s)	δ (º)	D (m)	m (Mt)	E_0 (Gt)	E_e (Gt)
MF-8-1	30	18.87	32.02	928	216	9.17	6.87
MF-8-2	45	18.71	58.77	735	107	4.48	3.79
MF-8-3	60	18.62	71.13	702	93.3	3.86	3.33
MF-8-4	75	18.58	76.99	693	89.7	3.70	3.21
MF-8-5	90	18.55	79.92	690	88.6	3.64	3.16

Under these conditions and at azimuthal angles more than 45º entry angles of meteoroid δ into the Earth's atmosphere are rising, but their effect on the diameter, mass and energy of the object is not too large. And in view of the azimuths A = 75º – 90º changes in the physical characteristics of the meteoroid were not significant, and these characteristics are not very different from the absolute minimum, which is impossible under the terms of the intersection of orbits of the meteoroid and Earth, the version with extremely steep entrance δ = 90º (D = 685 m, m = 86.7 Mt, E_0 = 3.56 Gt, E_e = 3.10 Gt). Diameter of MP-8-5 version, its mass and energy are only on 1 – 2 % higher than for the absolute minimum. Thus, there is no big difference between versions of object with permissible big azimuths. And they all are only cometary fragments and not entire cometary nuclei, as their typical mass is of 2 orders of magnitude smaller than the mass of the nucleus of not very big 67P/Churyumov-Gerasimenko comet, see, [123].

Table 6 shows the height of the tsunami at three distances: H_1 – for the location of chevron 167 in the Indian coast, H_2 – for Iranian chevron Konarak and H_3 – for the city of Ur (all in meters). In this case, wave height for the initial depth of the sea in the point of incidence, that is, 3500 m, is given before slash, – this is a calculated magnitude from the program [119], and after – in shallow water, which is a real tsunami height at this point. And L_1, L_2 and L_3 are the distances up to these points (all in kilometers). Why a complicated path of wave in bottleneck of sea has a little effect by its height in Ur compared to its height at the same distance in the open ocean, is discussed in detail in article [88].

Table 6

var	L_1 (km)	H_1 (m)	L_2 (km)	H_2 (m)	L_3 (km)	H_3 (m)	L_4 (km)	p_4 (kPa)	d (km)
MF-8-1	710	6.2/19.9	590	7.5/23.1	2200	2.0/8.0	1990	0.53	0.001
MF-8-2								0.44	0.006
MF-8-3								0.42	0.008
MF-8-4								0.41	0.009
MF-8-5								0.41	0.009

Equality of H_1 – wave's height forming the chevron 167 for all options considered, is, as already mentioned above, just the boundary condition. Equality of wave's heights in the other two points is a consequence of inverse proportionality of wave's heights from distance run for water layer of constant thickness (see article [88]). In contrast to the height of waves on the water surface, p_4 – values of pressure in air shock wave in Ur (given in kilopascals) differ for different options, but these pressures are rather small. There is a difference in diameters of the craters on the sea bottom, but they do not exceed minuscule quantity of about 9 m (and depth not more than 2 m), and they are substantially within the limits of accuracy of the results [119]. In reality, apparently, a crater could not be formed there at all. So its trace could not be found now on the bottom of the Arabian Sea.

Similar data are shown in Tables 7 and 8 for ten o'clock Meteoroid of Flood. In general, shift of event in time at 2 hours reduces (at a given azimuth) the entrance angle of meteoroid and thus leads to some increase of its diameter, mass and energy of the explosion (there is an opposed dependence at small azimuths). But with azimuths more than 45º the difference in diameters is less than 8 %, and in energy of the explosion – 23 %, which is not a fundamental differences in qualitative examination of the disaster.

Table 7

var	A (º)	v (km/s)	δ (º)	D (m)	m (Mt)	E_0 (Gt)	E_e (Gt)
MF-10-1	30	18.89	27.97	989	261	11.1	7.99
MF-10-2	45	18.77	46.23	796	136	5.72	4.68
MF-10-3	60	18.67	58.16	738	108	4.51	3.82
MF-10-4	75	18.60	65.12	717	99.4	4.11	3.52
MF-10-5	90	18.55	68.96	708	95.7	3.93	3.38

Table 8

var	L_1 (km)	H_1 (m)	L_2 (km)	H_2 (m)	L_3 (km)	H_3 (m)	L_4 (km)	p_4 (kPa)	d (km)
MF-10-1	710	6.2/19.9	590	7.5/23.1	2200	2.0/8.0	1990	0.56	0.001
MF-10-2								0.47	0.003
MF-10-3								0.44	0.006
MF-10-4								0.42	0.007
MF-10-5								0.42	0.008

Really strong influence on meteoroid's characteristics and parameters of catastrophic process has only the azimuth of the trajectory, at the approach of azimuth to the minimum values. In this case, the input trajectory is becoming flatter, and for creating of tsunami with desired height required size, mass and energy of the meteoroid are soaring. But, with very flat trajectory of the object hit with the water occurs at small angles of approach. In this case, ricochet occurs usually. It is known the fact that tank's builders are trying for 75 years to tilt the armor of the tank to 30º with respect to the direction of flight of high-speed armor-piercing projectile to achieve ricochets. Furthermore, it is also known that if the velocity of impactor is greater than several kilometers per second (that occurs when cumulative jet hits the armor), then properties of liquid and armor are virtually indistinguishable.

Suffice it is also clear that at very oblique impact cannot be achieved the central symmetry of the wave on the surface of the water, but the results of calculations for such a wave and experimental data on the thickness of the layer of sediment in Ur and the height of the chevron 167 correlated perfectly. It should be noted that the oblique impact would be directed toward Ur and chevron 167 would have been in the «back» zone of wave propagation, and violation of its central symmetry would be then very noticeable.

The original conception of this work had implied that in order to determine the boundaries of possible angles of approach of high-speed body to water surface we could conduct appropriate experiments and numerical calculations to determine degree of asymmetry of the impact. But, after some time, a new, more interesting possibility is appeared. Powerful explosions spew into the atmosphere of the Earth large amounts of aerosols, obscuring the atmosphere, that lead to reduction of its global temperature. The energy of these explosions should not be less than tenths of gigatons of TNT, see. Fig. 7 (where E_0 = 1 Gt TNT [124]) that is performed for the process under study. Simultaneously, the data on the Earth's global temperature drop were detected in the vicinity of 3200 years BC, see Fig. 8 [125] that made it possible to use for estimating the parameters of Flood Meteoroid a new region of data – climatology.

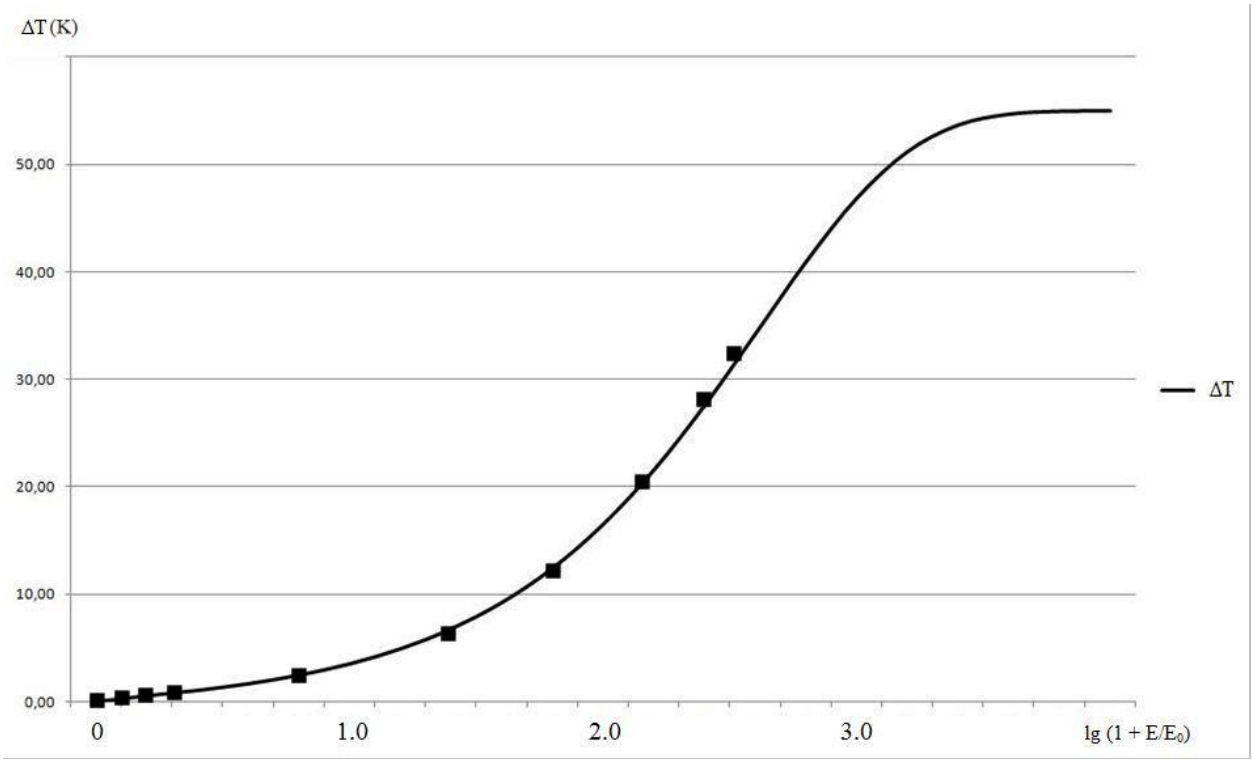

Fig. 7

Gray line on Fig. 8 with number 1 shows the historical reconstruction of temperature deviation of the Earth's northern hemisphere from the mid XX century data up to the time of instrumental measurements of temperature, and then the results of these measurements. Black line 2 is the result of calculations with the aid of climate program, see [125].

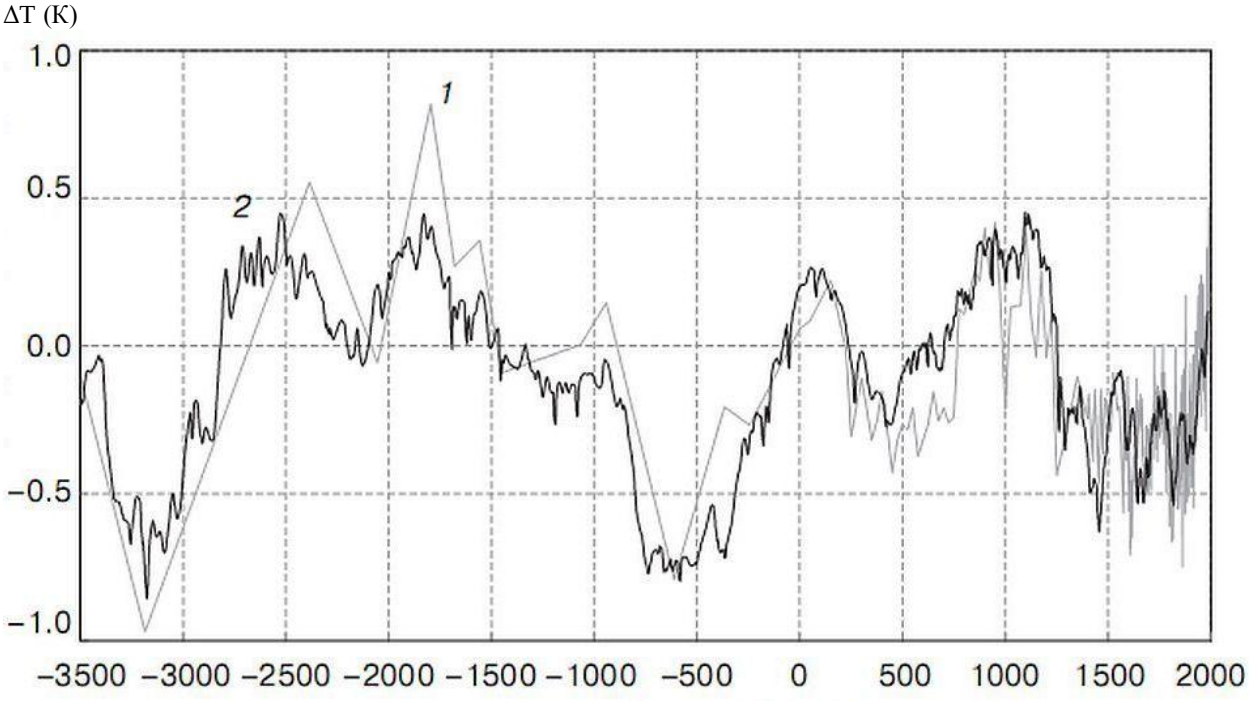

Fig. 8

It is known that the larger ranges of space and time, for which is addressed the climate effects of local events such as volcanic eruptions and meteoroid's impacts, the less visible effects on the change in temperature. For example, maximum drop in global temperature of the Earth after Tambora volcano eruption in 1815 amounted to 2.5 K, but for the maximum monthly regional temperature drop was reached value of about 15 K [124]. At the same

time the temperature drop of Northern Hemisphere after the explosion of Tambora in Fig. 8, in accordance with the above, amounted to only 0.4 K. In the same proportion is decreased the Earth's temperature after the eruption of Krakatau volcano – with 0.9 K in the annual scale up to approximately 0.15 K in the scale of 5.5 millennia. Accordingly, reducing the temperature of the Northern Hemisphere in the fall of Flood Meteoroid of about 0.35 K in Fig. 8, is converted to the amount of reduction in annual global temperature scale $\Delta T \approx 2.2$ K. According to formulas of article [124] this reduction is provided by the explosive process, the energy of which amounts 4.5 Gt that is perfectly consistent with values, which are presented in Tables 5 and 7.

After applying this condition, both options – «eight» and «ten o'clock» meteoroids have got close characteristics, and, moreover, their data became virtually the same except the azimuths of their trajectories, which, however, also don't differ too much, see the first two rows of the table 9 (in these cases, as earlier, the average density of the meteoroid material was assumed to be 515 kg/m^3). The contributions of the Earth rotation velocity components in the object's entering speed into the atmosphere differ because of the difference of azimuths, which in turn leads to very small differences in size and mass of meteoroid's variants. However, the accuracy of calculation for all variants is so that these differences may be neglected. Increase to the average density of the objects up to 550 kg/m^3, conducted after receiving the recent data on the average density of the nucleus of 67P/Churyumov-Gerasimenko comet, affects also very small (see the last two rows of the table 9).

Table 9

var	A (º)	v (km/s)	δ (º)	ρ (kg/m^3)	D (m)	m (Mt)	E_0 (Gt)	E_e (Gt)
МП-8-01	35.0	18.82	48.2	515	783	129	5.48	4.50
МП-10-01	47.0	18.76	48.2	515	784	130	5.46	4.50
МП-8-02	35.0	18.82	48.2	550	763.5	128	5.42	4.50
МП-10-02	47.0	18.76	48.2	550	765	129	5.42	4.50

Thus, Flood Meteoroid has entered the Earth's atmosphere at speed of about 18.8 km/s. Its size was about 765 m, mass was about 130 Mt, the energy of its impact and explosion $E_e \approx 4.5$ Gt when the total energy of meteoroid was $E_0 \approx 5.4$ Gt of TNT. Maximum pressure on the air shock wave in Ur was about 0.46 kPa, and evaluation of the crater diameter created by it at the bottom of the Arabian Sea was about 5 m, that is, this crater didn't exist in reality. This Flood Meteoroid could well be called a «fragment» of the nucleus of a comet, because from small 67P/Churyumov-Gerasimenko comet it would be possible to «carve out» of the order of 75 such objects (their mass would be in 70 times larger than Chelyabinsk meteoroid).

In the case of maintaining of geometric similarity the wave energy at the surface of the liquid is proportional to the fourth power of its height (see, for example, [126]). Having before eyes the consequences of passage of the wave with a height of about 3 m in shallow water on the left bank of the river Adagum in the town Krymsk [111], we can imagine what can do eight-meter wave, the energy of which is greater in 60 times than of the wave in Krymsk (or 100 times greater for quite possible heights of waves 2.7 and 8.5 m). Such wave, propagating along the river-bed of Euphrates on a flat plain, which is barely rising above sea level, could destroy almost everything that was on there. Tsunami has gone along the Euphrates river as a tidal wave – bore, as well as and along flat plains of Mesopotamia that were already flooded by strong showers (a kind of «diminished model of the phenomenon» can be seen, for example, on video [127]). Thin initial layer of water should also appear before the arrival of the main wave, since gravitational waves on the shallow water have strong dispersion – the longer the wave, the more its speed. And the long-wavelength component of the wave packet arising from falling into the ocean of the cometary fragment was ahead the main wave, to prepare conditions for its spread on a flat plain at a great distance. Same thing seemed to happen along the river-bed of Tigris, but in those days there were no significant urban settlements on this river.

In general, the energy of impact and explosion in the event of Mesopotamia tsunami with height of about 8 m due to the fall of a celestial body at any case is much greater than the energy of the explosion of Krakatoa volcano in 1883 (1.1 Gt of TNT) and, in the most likely option is close to energy of the explosion of Tambora volcano in 1815 (5.4 Gt) [5]. That is a natural disaster of comparable scale occurred on the Earth not more than two centuries ago, but it was at the other «boundary conditions».

Thus, the results of calculations revealed no contradictions in the hypothesis that the Mesopotamian («World») flood was caused by the fall of the cometary fragment of Tungus family. All known data of the flood are well explained. Moreover, unknown material traces of this event not only in Mesopotamia, but also on the shores of the Arabian Sea were discovered in the result of following to this concept. However, another question arises: why 3201 BC event turned out to be on initial assumptions as the trigger of global cooling in the mid-Holocene, but the eruption of Tambora volcano in 1815 (see Fig. 9), which was more or less equivalent according to energy, was not such trigger?

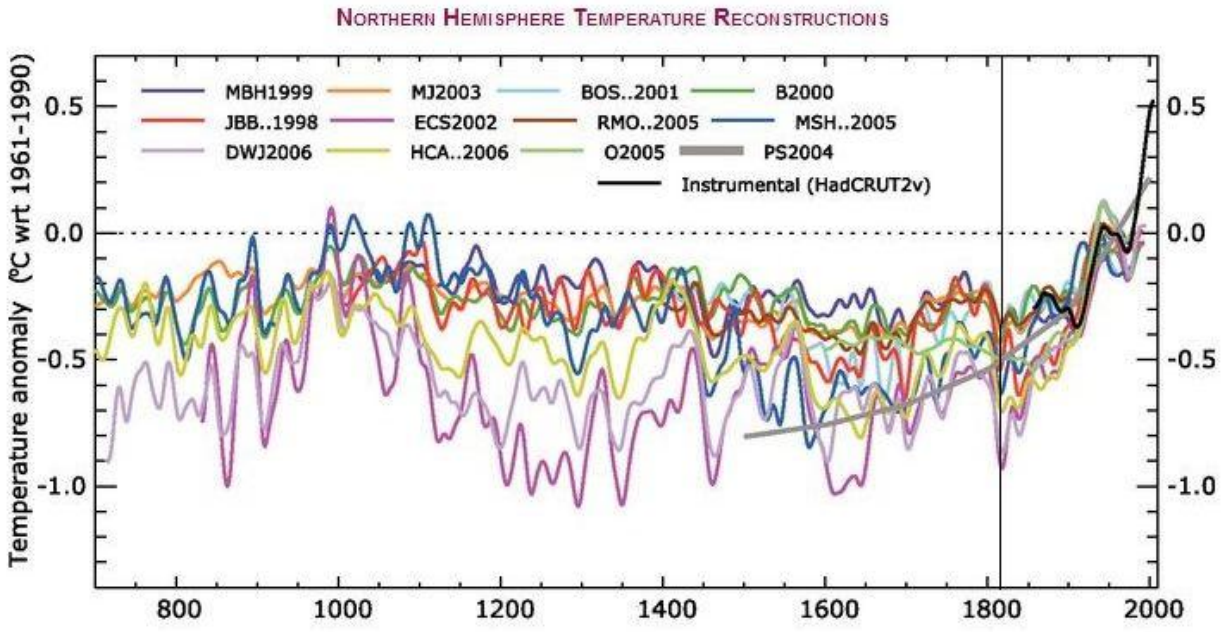

Fig. 9

But if we look an unbiased at the graph of global temperature change in the last thousand or so years on Northern hemisphere of the Earths [128] (see Fig. 9) or in the last 5.5 thousands of years (see Fig. 8), we can come to an unexpected and somewhat paradoxical conclusion – the global warming began immediately after the «year without a summer», after eruption of Tambora, which was marked on the chart by a vertical line. Or there is another variant of interpretation of these graphs – the eruption of Tambora nearly thwarted the modern global warming, which should been to begin on the turn of the XVIII and XIX centuries, detaining of it more than on a century, see Fig. 9. So, this cold period due to natural disaster was, but its duration was on order of magnitude shorter than for the Younger Dryas. A similar recovery in global temperatures after the disaster for a period of about one and half or two centuries happened after the fall of Flood Meteoroid, according to Fig. 8. And this event has led only to abrupt magnification of global cooling, which has begun apparently for two centuries before this disaster.

Conclusions

1. On basis of the statistics for nearly 290 years is shown that the historical data allow clearly distinguishing two thirteen-year cycles, characterized by the appearance of very bright fireballs, exploding in the Earth's atmosphere with a possible, but not mandatory dropping of meteorites, as well of meteor showers.

2. The dates of nominal boundaries of the latest realized contact window with the Earth of the first group of objects, called Eagle family, are February – October 2011 inclusive. The dates of nominal boundaries of the latest pair of contact windows of another group, named Tungus family, are May – August 2012 and November 2012 – February 2013 inclusive.

3. The dates of windows of possible collisions between objects of these families with the Earth during other cycles are obtained by adding or subtracting of periods multiple of 13 years at least for a period of several hundred years. The boundaries of windows of contacts may be shifted on a larger time intervals because of the disturbances of the orbits of these objects, as well as due to difference of stellar and solar years as a result of the precession of the Earth's axis.

4. Frequency of the «explosive fireball events» during these periods is about 2.5 times higher than in the «background» time.

5. If within these contact windows allocate more narrow time periods in 3 – 4 weeks with the highest fireballs activity, the exceedance of frequency of such events over the background is around of order.

6. Exactly 81 thirteen-year cycles back from 2013 year, in 960, there was the largest cosmic catastrophe of our era – the fall of object of Tungus family on Dublin. Then at a height from 9 to 12.5 km was air blast with energy from 10 to 25 Mt TNT, which led to the deaths of 1,100 people.

7. Calendar of Olmecs and Maya, built on two Mesoamerican cosmic catastrophes, which were separated by time interval duration of 52 years, exactly fits into the thirteen-year cycle considered here. Most likely that these catastrophes occurred in February 1211 and near February 13, 1159 BC.

8. Responsibility, which was attributed by Indians of Mesoamerica for the planet Venus – the Morning Star because of these disasters, correlates well with the morning and evening approaches from the Sun of the objects of Tungus family.

9. In 3201 BC, exactly 401 thirteen-year cycles of Tungus family back from the present moment, there was an event which triggered the launch of global cooling in the mid-Holocene associated with Mesopotamian (Biblical) flood. Flood scenario was built, which is based on the assumption that the flooding was caused by fall of cometary fragment of Tungus family in the Gulf of Oman or Arabian See that quantitatively agrees well with the known data.

10. New, previously unknown material evidences of the disaster, which occurred with the first civilizations of the ancient world, were found. These are the chevron dunes on the shores of the Arabian Sea and the sediments in Chah Bahar bay, age of which is consistent with the time Mesopotamian flood.

11. Mesopotamian Flood, two Mesoamerican disasters and incident of X century in Dublin together with Tunguska and Chelyabinsk explosions have led to an estimate of the number of intrusions of very large members of Tungus family to the Earth's atmosphere in number not less than 6 in the historical time. Together with the Great Nevada Meteor of Eagle family such intrusions were recorded 7. How many of such objects without leaving a trace for mankind exploded over the oceans and deserts, apparently forever remain unknown to us.

12. Inter alia, from the considered data is followed that the perturbation effects on the objects of these families are small, at least in the last five millennia, as evidenced by «the February aggravation of fireballs», which is quite clearly traceable for 270 years, the incident in Dublin of 960 year, two Mesoamerican catastrophes, as well as Mesopotamian flood. Possible deviations from «stable schedule» do not exceed a month.

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