Minimization of natural fires

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Abstract
Annually in the mid-latitudes with the onset of heat, and in the tropics - dry season, there are massive fires. The combination of focal maps of fires with geological information in a number of regions of Russia (Moscow, Urals and Siberia), as well as in the Far East, the Mediterranean, India, North and Latin America, Tasmania) indicates the geological linking of a significant part of the fires to positive anomalies of the magnetic field and mass degassing of methane, as well as the basic connection with tides, solar and geomagnetic activity. It is assumed that in the zone of rifts of the earth's crust there occur: activation of deep-seated channels of increased heat and mass transfer (emanation of fluids), abrupt changes in the amplitude-frequency characteristics of electromagnetic fields, ionization of air, formation of "static" minima of atmospheric humidity, reduction of precipitation, occurrence of atmospheric lineaments. Analysis of the above suggests a number of schemes for forecasting and preventing dangerous phenomena of different lead times. Recommendations are given to minimize damage from natural fires. An international action program (roadmap) is proposed, including scientific and applied research, the development of an ultra-short-term monitoring and warning system and an emergency service with technical means for eliminating foci of fires.

Keywords: the natural fires, dry thunder-storms, crust breaks, magnetic anomalies, methane.

Introduction

Annually in mid latitudes with occurrence of heat, and in tropics – a dry season, there are mass ignitions. Combination of maps of seats of fire with geological information in a number of regions of Russia, and also in Korea, the Mediterranean, India and America indicates of considerable part of ignitions to mass decontamination of methane — the major for emergence of natural ignitions.

In lack of surges in concentration of methane in the lower troposphere of the Yellow Sea on its coast there are only fragmentary fires (fig.1a), at increase of concentration of methane for only 10% mass ignitions cover all North Korea and "stop" at border with South Korea. The fires in general don't pass South Korea and Japan, but in them they are only fragmentary, so, apparently, the culture of land use and work of fire services (fig.1b) affects.

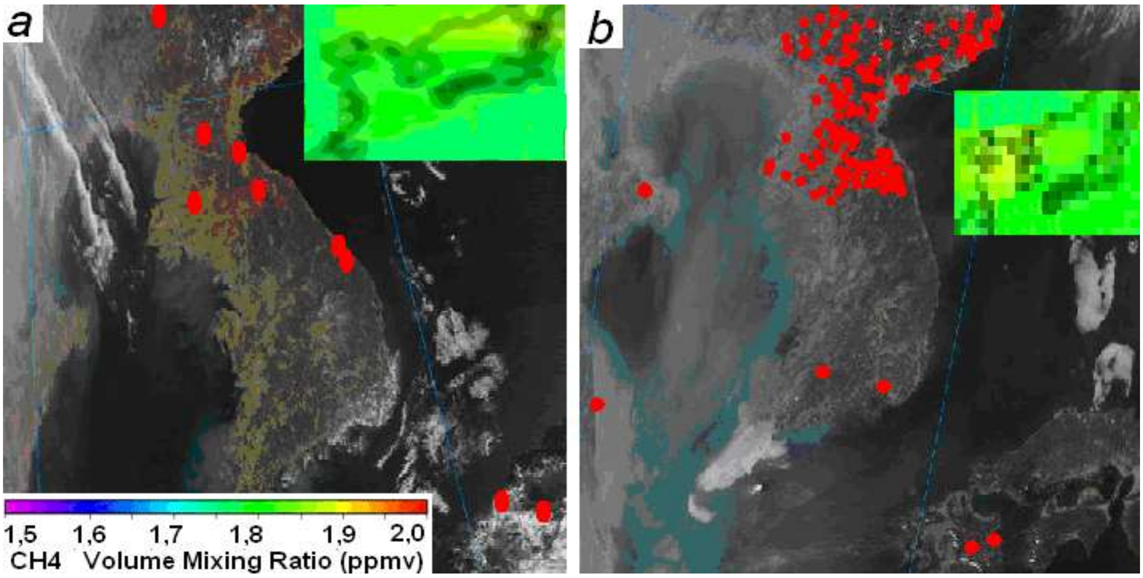

Fig. 1. Seats of fire (red points) on the coast of the Yellow Sea: (*a*) - *Terra/Modis* 17/04/2009; (*b*) - *Aqua/Modis* 09/04/2005. On green inserts concentration of methane 681hPa the scale for which is given below is shown (*a*).

Combination of maps of seats of fire with other geophysical data in Moscow, and Siberian regions indicates by Ural of considerable part of ignitions to positive anomalies of a magnetic field in areas of mass decontamination and sharp changes of amplitude-frequency characteristics of electromagnetic fields. Radiation level from background values ≈60÷100nzb/h. over breaks (which width in the Moscow region some tens meters) increases to 180÷300nzb/h. The air ionization caused by a radon emanation promotes decrease in atmospheric humidity, frequency and an amount of precipitation on a quarter in comparison with the periphery. "Match" of the natural fires — dry thunder-storms [8,9]. According to the Federal forestry Agency and the *EMERCOM*, two thirds of fires in *Yakutia* are caused by dry thunderstorms, in *Yamal* - 90% [19,23]. Lightings arise" not only during a thunder-storm or a hurricane, but also during sandy storms (so-called dry thunder-storms), and also during eruptions of volcanoes" [7]. In the Central Europe on average it happens from 15 to 25 storm days. Daily about 45 thousand thunder-storms fall upon Earth. According to international statistics, number of victims associated with lightning reaches 10 thousand people annually [1].

Region situated near Moscow

The main role among the fossil fuels in the region is played by peat deposits, their area is almost 2 thousand km^2, and peat reserves exceed 10^9tons. Concentration of the bio gas promoting ignitions changes from sizes equilibrium with the atmosphere over water areas ($\approx 10^{-6}$ppmv) to concentration of self-ignition over boggy soil and peat bogs. Some fields of peat are over crust breaks with positive anomalies of a magnetic field (fig.2).

In the summer of 2010, the fires captured all the central European part of Russia (fig.3). The analysis of existential distribution of thunder-storms in Moscow area showed multiple increase of thunder-storms in areas with the increased anomalies of a magnetic field over crust breaks, just at peat bogs [11-13,22]. The large-scale fires in the north of Moscow area weren't, there are no the increased anomalies of a magnetic field there.

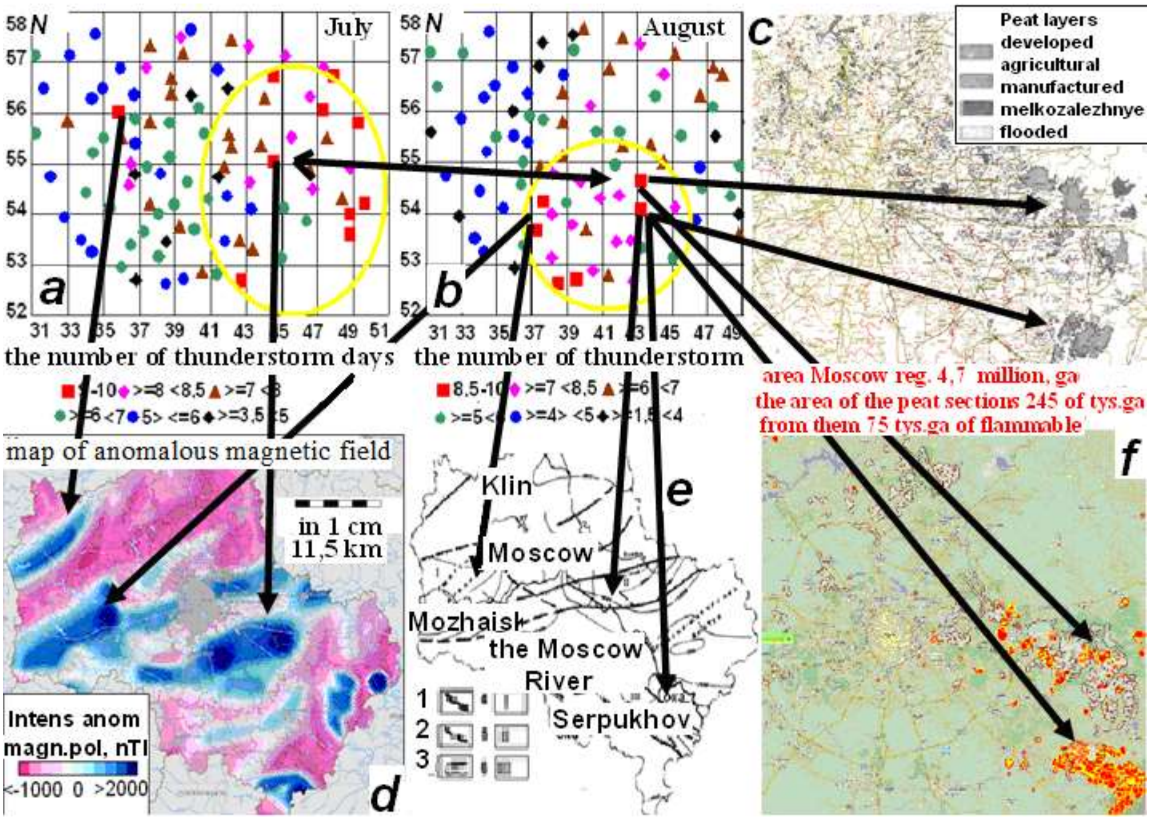

Fig. 2. The coincidence of places of natural fires with the maximum distribution of thunderstorms, location of peatlands, geological faults and positive magnetic field anomalies in the Moscow region. The average monthly number of thunderstorms (*a*) July, (*b*) - in August 2012 and 2013; (*c*) map of peatlands of Moscow region; (*d*) part of the map of magnetic field anomalies [22]; (*e*) schematic tectonic map (1 - proved faults, 2 – probable faults, 3 - contour line of the foundation surface); (*f*) map of fires, 2010 (red dots).

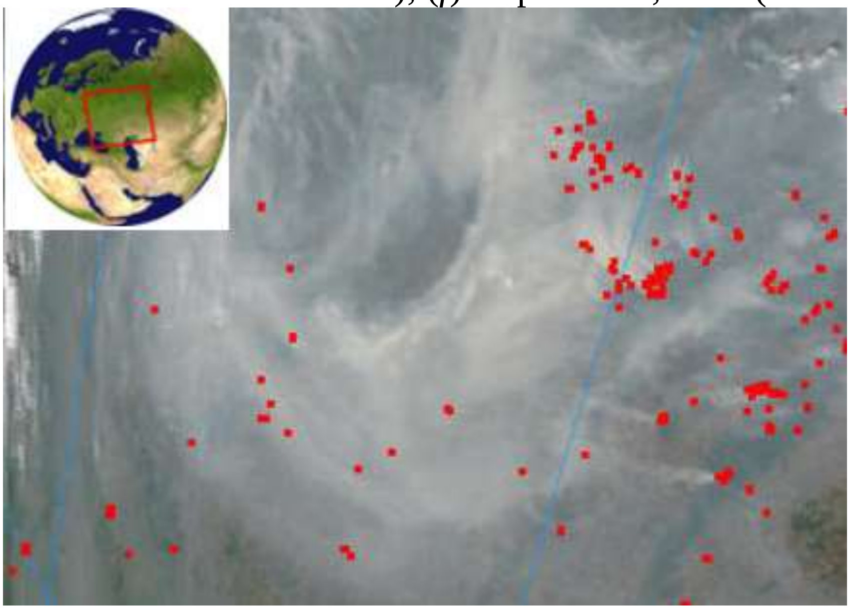

Fig. 3. 7/08/2010 *Aqua/Modis* image of the European part of *Russia*. Red dots indicate fire spots [24]. On the inserts - positions of the images.

Ural region

Fires in the region are typical for its south part. In the summer of 2010, the vast majority of fires (area of detected fires was from 0.5–2 hectares and more) in the middle *Urals* occurred along 60 degrees at length of 300-400 km, and the fires were confined to the folded structures displacement zone (fig.4), areas of positive magnetic field anomalies. Regional earthquakes are concentrated near the center of the fires in 50-100 km zone.

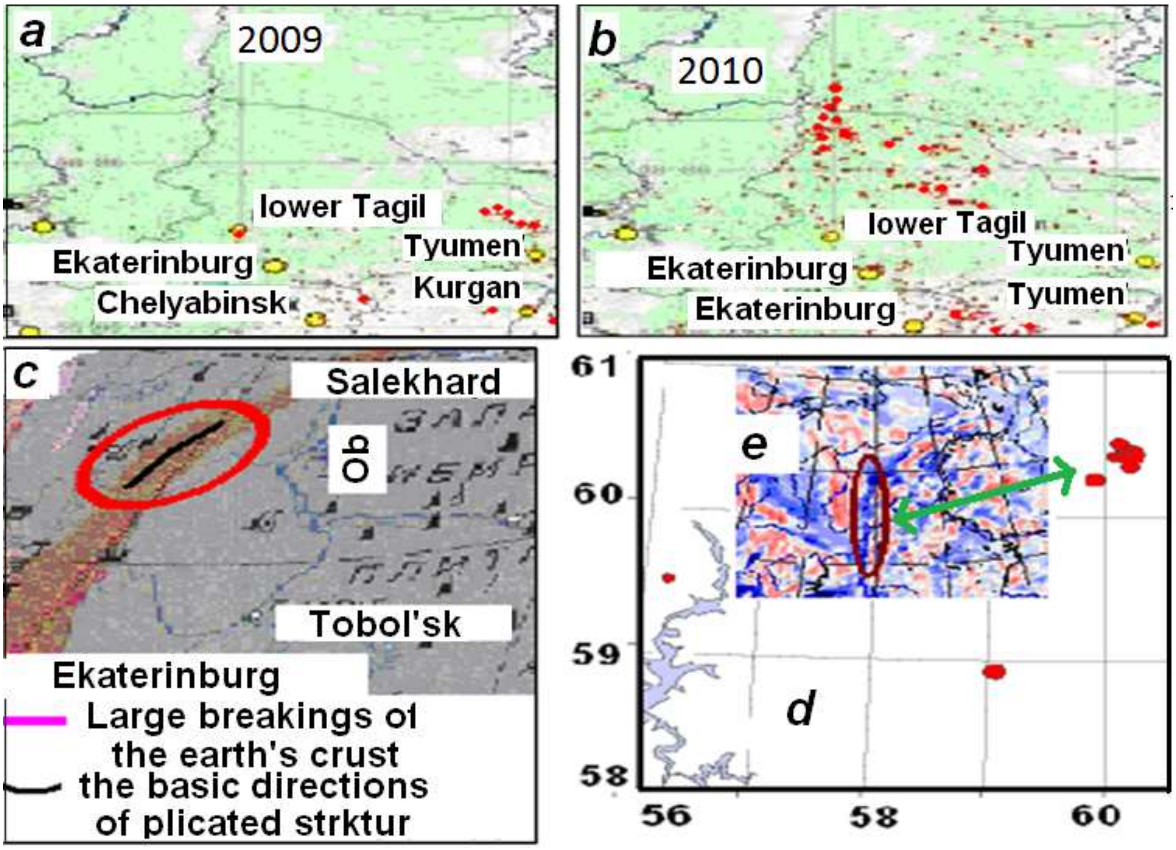

Fig. 4. Centers of fires, earthquakes, faults and magnetic anomalies in the Urals region: (*a*) 2009; (*b*) 2010; (*c*) faults and main directions of folded structures; (*d*) earthquake foci 1995-2013; (*e*) anomalies of the magnetic field (blue - positive, red - negative).

Southern Siberia

Fires to the west of the Baikal lake dominate in the *Altai* and *Krasnoyarsk* regions and, fragmentary, in Buryatia (fig.5). In 2010, situation changed dramatically. Vast fires near Baikal (fig.5b), but not the entire area - mostly 400-kilometer band of seismically quiet anomalous magnetic field gradients along the north-west fault in the crust and further westward, along the faults. In other places, most fires are also confined to the faults between Baikal and Ulan-Ude, on the north of Chita and on the south of Ulan-Ude (fig.5e). Sometimes the taiga burns massively at the fault along the northern shore of the Baikal lake (fig.5f).

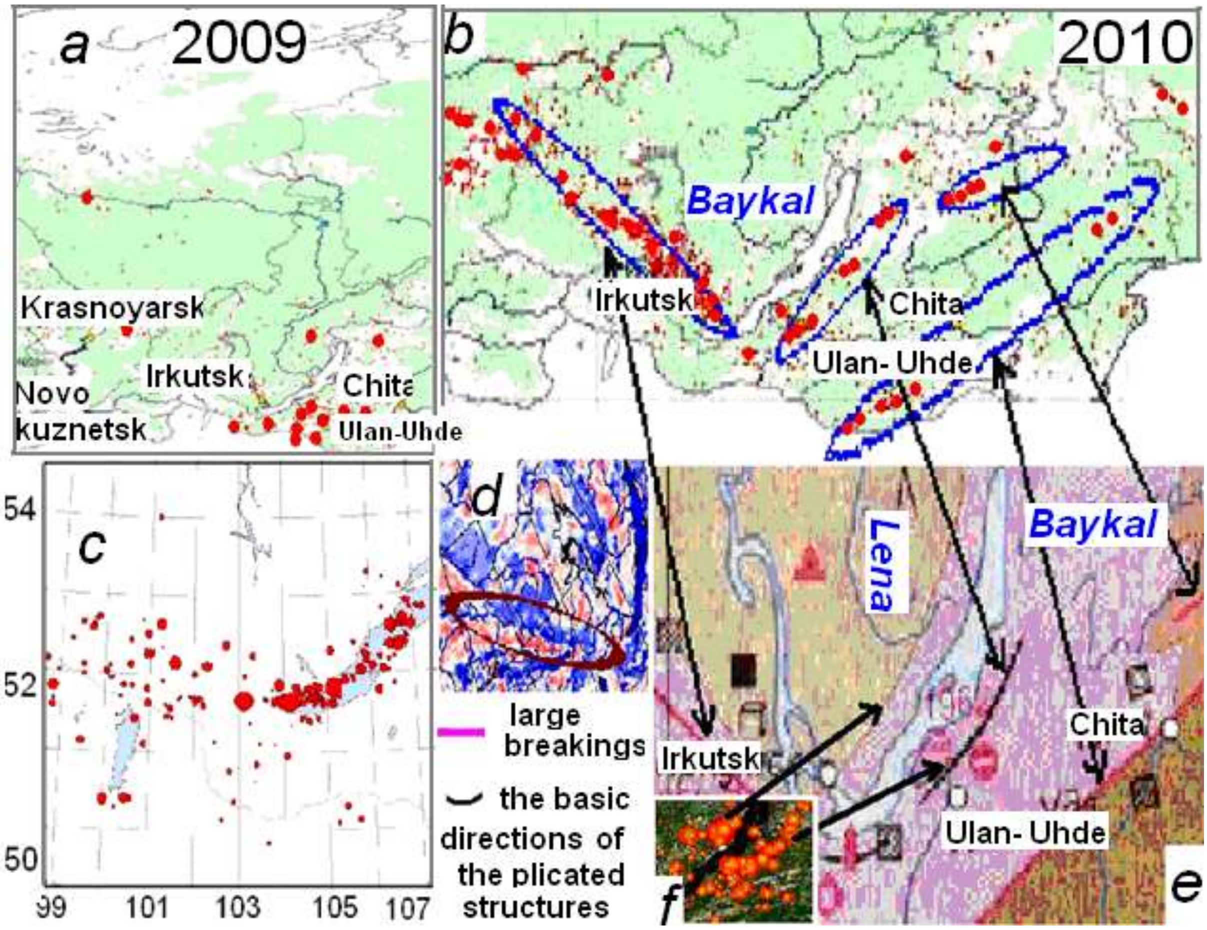

Fig. 5. Centers of fires, earthquakes, faults and magnetic anomalies in southern *Siberia*: (*a*) fires in 2009 (*b*) Fires in 2010 (*c*) - earthquake foci, 1991-2017; (*d*) - anomalies of the magnetic field (blue - positive, red - negative); (*e*) faults, direction of folded structures; (*f*) - fires near Baikal, arrow - location of fires near the faults.

Faults have activation of high heat-mass Exchange (emanation of fluids), abrupt changes in amplitude-frequency characteristics of electromagnetic fields, air ionization, appear static atmospheric humidity lows, declining rainfall, there are atmospheric lineament. In breakings of the earth's crust occurs the making more active of the increased heat-mass transfer (emanation of fluids), abrupt changes in the amplitude-frequency characteristics of electromagnetic pour on, the ionization of air, appear “static” minimums of atmospheric humidity, amount of precipitation is reduced, atmospheric lineaments appear.

Large inflow into the surface troposphere of the catalyst of lightning ignitions - methane – can be seen in satellite data. Typical parameters of CH_4 spots originated at earthquakes and extended along wind direction: the height from the ground – up to 5 km, width - about 300 km, length - ≈700 km, the concentration increase - ≈0,2÷0,3 ppmv (fig.6). The volume of methane emitted through the faults is approximately equal to

3×10^2 km $\times$ 7 $\times$ 10^2 km $\times$ (0,2÷0,3) ppmv$\times$(2÷5) km.

Above swamps also sometimes formed anomalies CH_4 5-10% (fig.7)

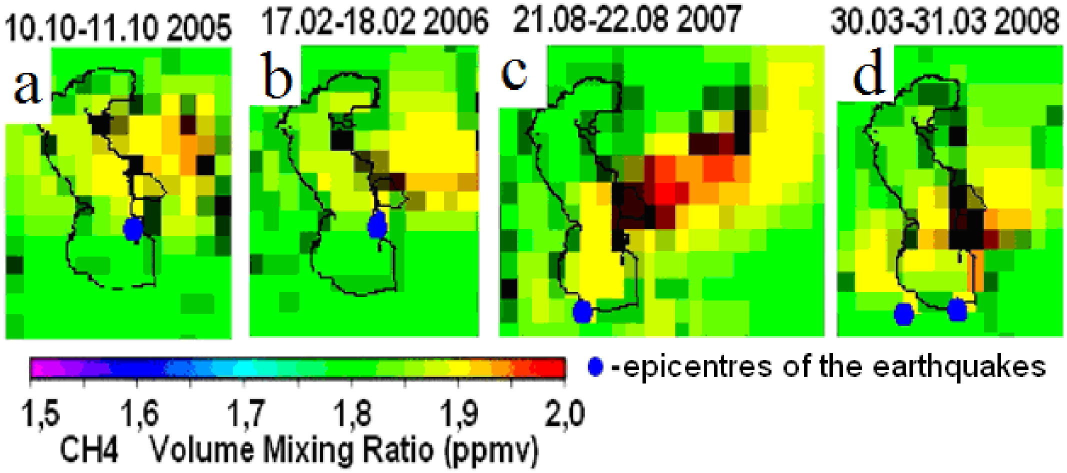

Fig. 6. CH_4 content of about 681GPa and earthquake epicenters in the same days in the Caspian region: (*a*) — 10-11/10/2005; (*b*) — 17-18/02/2006; (*c*) — 21-22/08/2007; (*d*) — 30-31/03/2008 [10,15].

Fig. 7. View from the height of the (*a*) - Baikal rift zone; (*b*) - tectonic fault of

San Andreas.

At tectonic activation of degassing, CH_4 concentration near the ground can reach spontaneous combustion value. Above the marshes, CH_4 concentration is two orders of magnitude higher than over other neighboring landscapes; in the spring, when soil is thawing, the marsh gas boils [3]. Conditions for natural fires in suburbs are created in piles of dry leaves, haystacks and straw. Due to the long-term fragmentary marsh degassing, increase by 5-15% of CH_4 concentration are also formed in the 2-5-kilometer thickness of the atmosphere.

In fig.8 shows summarized data on fires, thunderstorms, magnetic anomalies and CH_4 concentration in the troposphere.

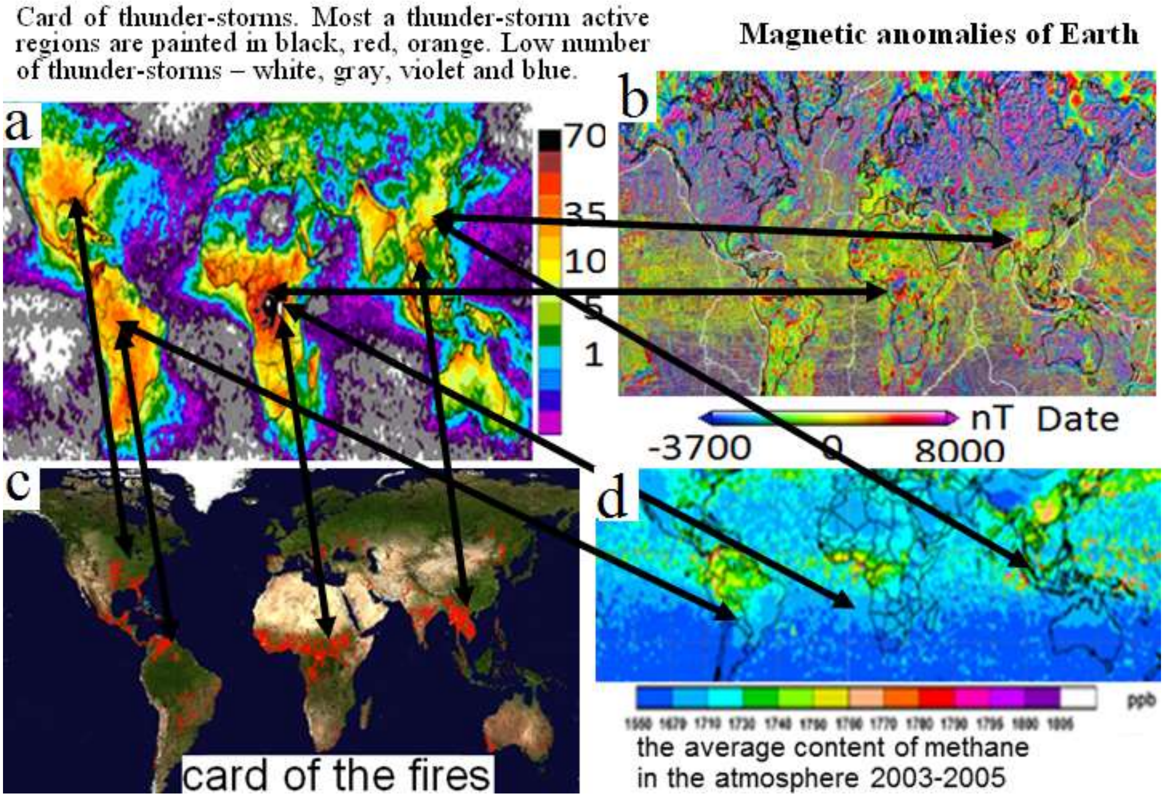

Fig. 8. Maps of fires and ignition factors: (*a*) — thunderstorm activity of the planet [4]; (*b*) — earth magnetic anomalies [5]; (*c*) — fire hazard [6]; (*d*) — average CH_4 content in the atmosphere [14].

In the lower atmosphere with number of ignitions (seats of fire) in Buryatia, the Mediterranean, India and North America follows from the regional comparisons of concentration of methane given below that is everywhere tended multiple increase in number of the fires in days of growth of intake of methane in the atmosphere (fig.9-20). In steppes and meadows (the southern Buryatia — northern Mongolia, North Africa and America) mass ignitions time proceed less than days (everywhere difficult to trace duration of the steppe fires on the used materials — stirs overcast). Deviations from a tendency of joint flashes of methane and ignitions are caused by that mass decontamination of methane is explicitly not connected with increase of dry thunder-storms and dry weather. In large quantities the decontaminating methane — the main initial fuel for dry thunder-storms, and also for maintenance and distribution of earlier flashed fire.

Flash of concentration of methane over Transbaikalia coincided on 5/04/2009 with mass ignitions in steppes of the southeast of Buryatia and the North of Mongolia in comparison with 4/04 when there was no strengthening of decontamination of methane (fig.9) yet. By 11/04 of the mass fires in steppes wasn't any more, the woods along Baikal continued to burn.

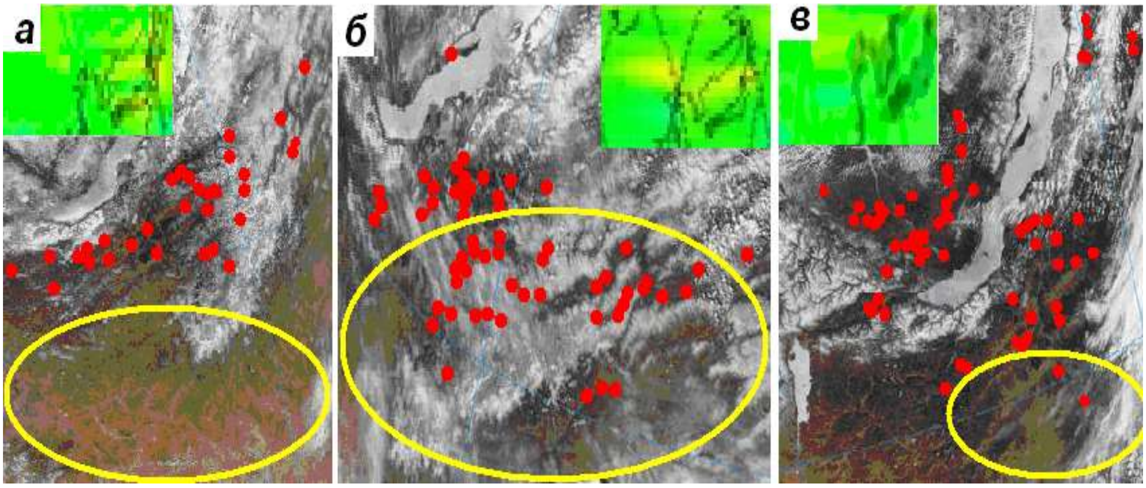

Fig. 9. Interrelation of the number of fire centers with CH_4 concentration 681hPa in Buryatia and Mongolia: (*a*) – 04/04/2009; (*b*) – 05/04/2009; (*c*) – 11/04/2009. Steppes are circled with yellow ellipses, to the north - forests.

Similar situations were observed on the Turkish coast on 30/08/2009 (fig.11), 31/08/2008 (fig.11), in Greece – 08/05/2008 (fig.12) and in the delta of Nile 28/05/2008 (fig.13).

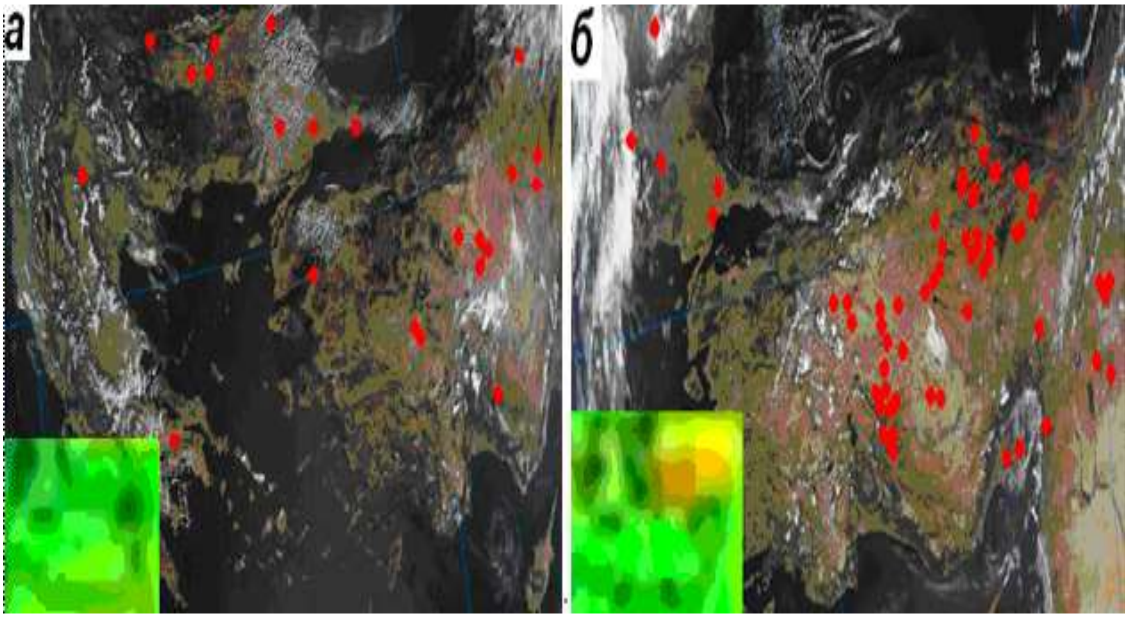

Fig. 10. Fires and CH_4 concentration 681hPa in Turkey: (*a*) – 26/08/2009; (*b*) – 30/08/2009.

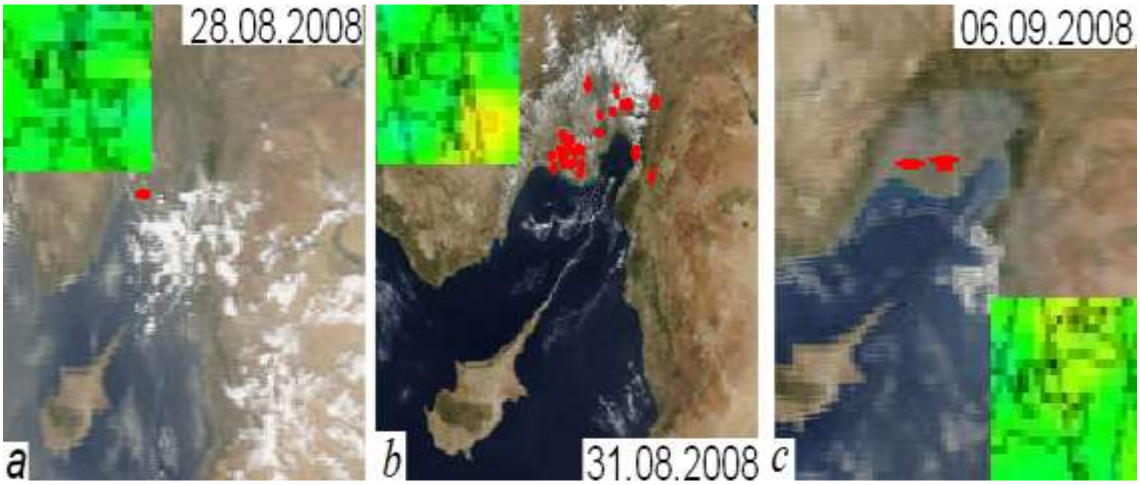

Fig. 11. Fires and CH_4 concentration 681hPa in Turkey: (*a*) – 28/08/2008; (*b*) – 31/08/2008; (*c*) – 06/09/2008.

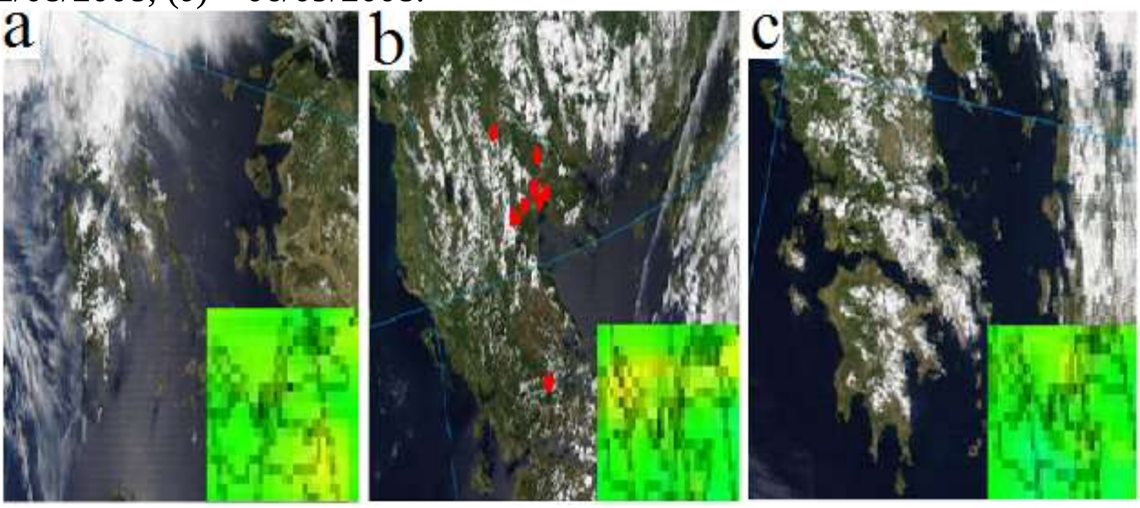

Fig. 12. CH_4 concentration in the atmosphere and fires in Greece: (*a*) – 06/05/2008; (*b*) - 08/05/2008; (*c*) – 09/05/2008.

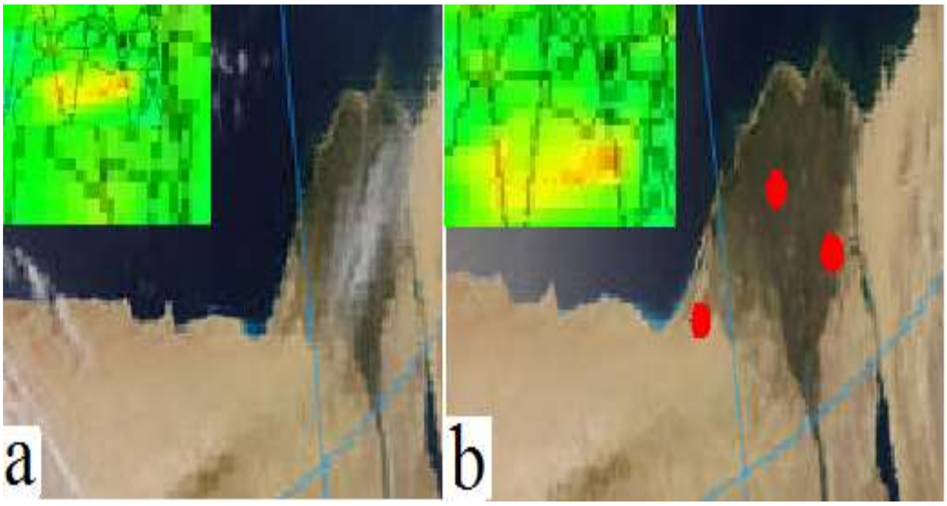

Fig. 13. *CH_4* concentration in the atmosphere and fires in the delta of Nile: (*a*) – 26/05/2008; (*b*) – 28/05/2008.

A sharp increase in *CH_4* concentration over north Africa on 27/08/2010 - massive fires in condition of single fires in the previous and subsequent weeks, when there were no *CH_4* anomalies in the troposphere (fig.14). Increase in *CH_4* content near the Persian Gulf on 8/08/2009 - massive daily fire northward of the bay in condition of single fires in the nearest days (fig.15). Increase in *CH_4* concentration in the lower troposphere on 12/10/2008 above the source of the *Indus* river - a multiple increase in the number of fires compared to the previous and subsequent weeks, when there were no significant anomalies in the concentration of *CH_4* (01 and 16/10/2008) (fig.16,17).

Increase in *CH_4* concentration in the lower troposphere on 12/10/2008 above the source and delta of the Indus River 12/10/2008 and 13/02/2009 over its delta - a multiple increase in the number of fires compared to the previous and subsequent weeks, when there were no significant anomalies in the concentration of *CH_4* (; 11 and 15/05/2009, respectively) (fig.15,16).

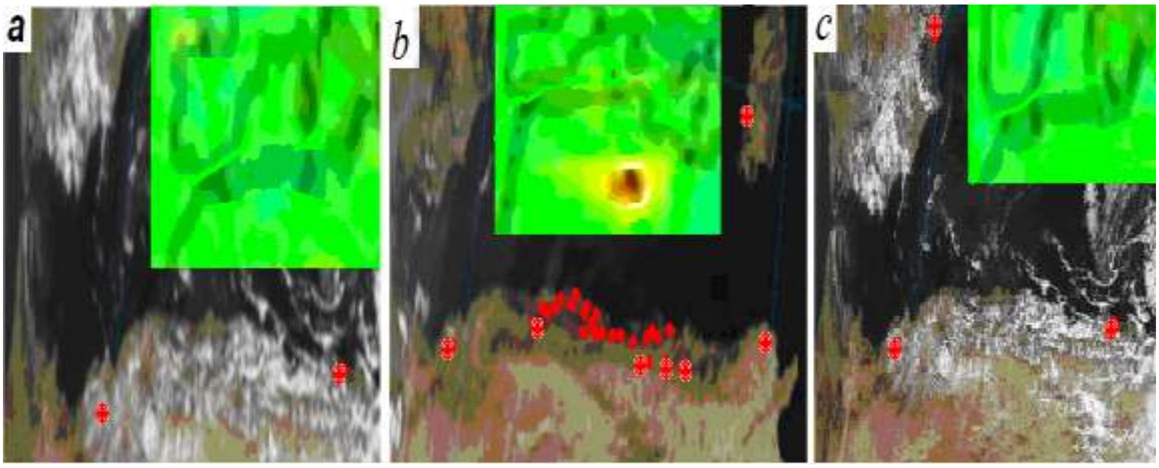

Fig. 14. Centers of fires and CH_4 content 681hPa in North *Africa*: (*a*) - 21/08/2010; (*b*) – 27/08/2010; (*c*) – 03/09/2010.

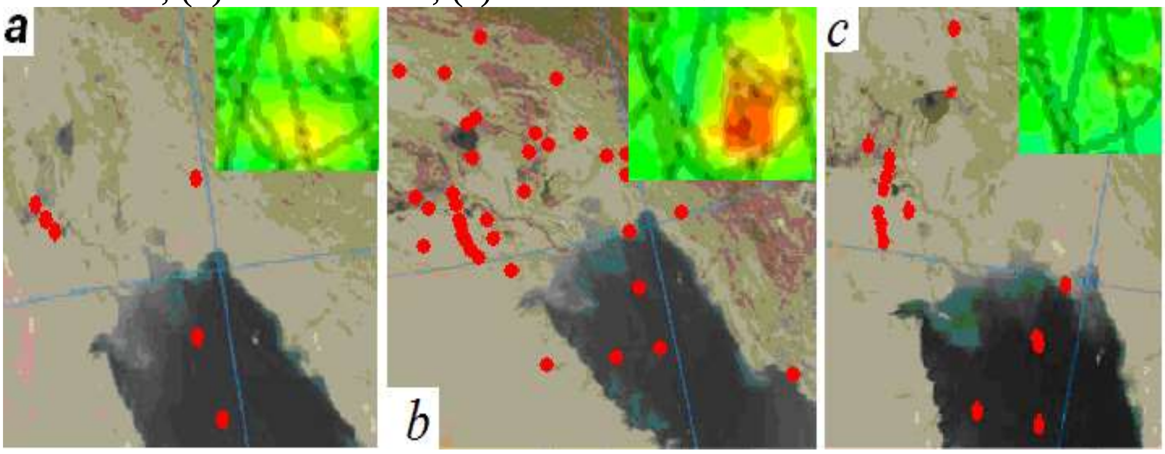

Fig. 15**.** CH_4 content in the atmosphere and fires in the Persian Gulf: (*a*) – 07/08/2009; (*b*) – 08/08/2009; (*c*) – 09/08/2009.

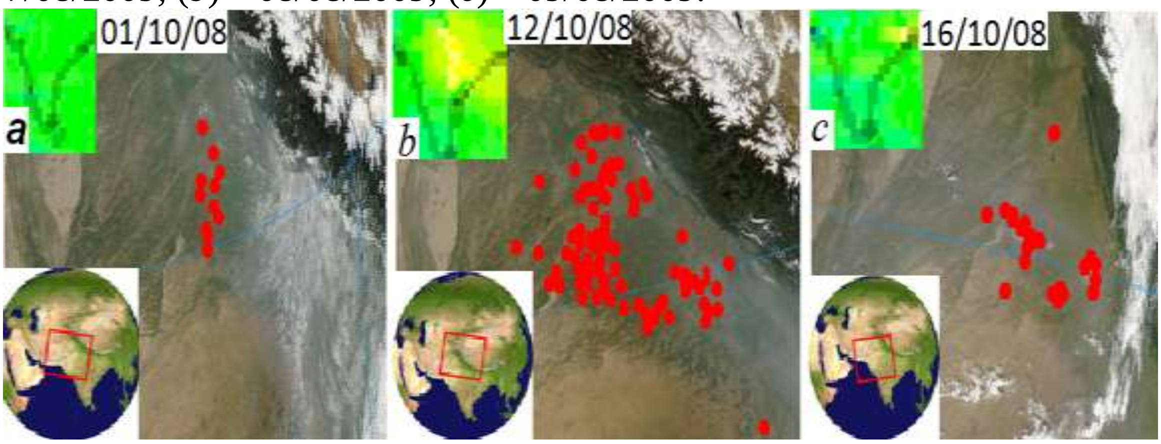

Fig. 16. Centers of fires and CH_4 content 681hPa at the origins of the *Indus* river. (*a*) – 01/10/2008; (*b*) – 12/10/2008; (*c*) – 16/10/2008. On the inserts - positions of the images.

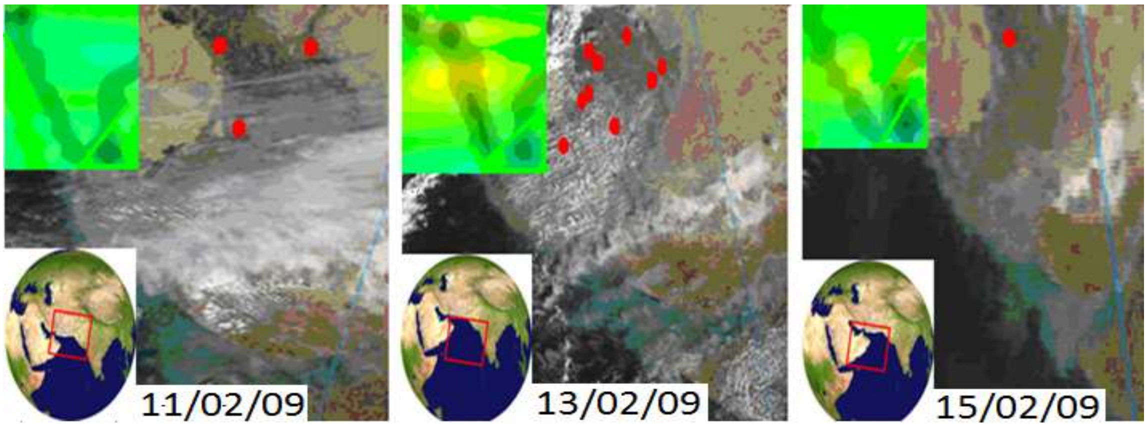

Fig. 17. Centers of fires and CH_4 content 681hPa at the origins in the delta of the Indus River (*a*) – 11/02/2009; (*b*) – 13/02/2009; (*c*) – 16/02/2009. On the inserts - positions of the images.

Increase in methane concentration over the Great Lakes and near Florida 26/03/2008 - massive fires in condition of fragmentary fires observed a day before and later, when methane concentration was normal (fig.18).

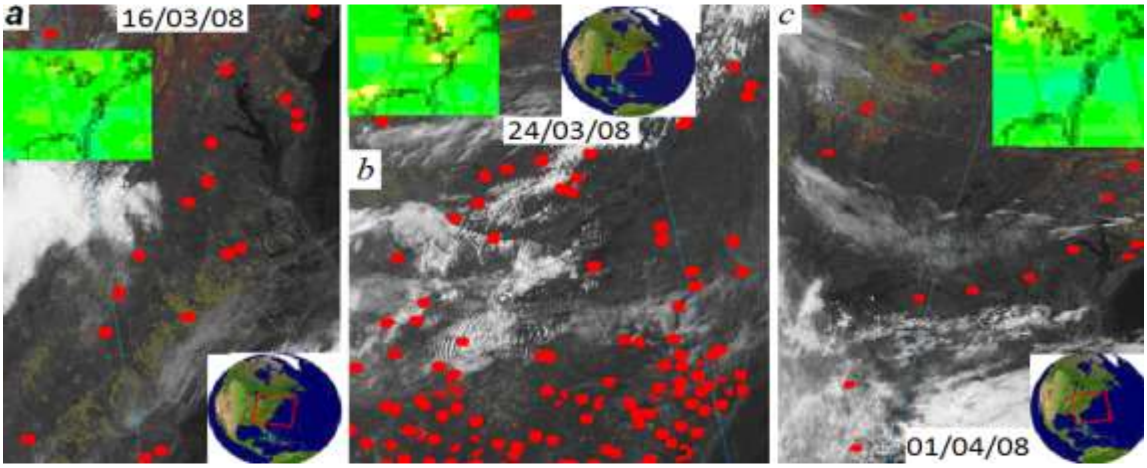

Fig. 18. Centers of fires and CH_4 content 681hPa in the east part of North America: (*a*) 23/03/2008; (*b*) – 26/03/2008; (*c*) – 02/04/2008. On the inserts - positions of the images.

Most of the fires in *California* are confined to the *San Andreas* fault. Methane emissions are "catalysts" of the fires (fig.19,20). For example, on 03/02/2007, in the absence of flares in the area of tropospheric CH_4, only single fires were recorded. In a day or two, methane emissions from the Northern coast of *California* occurred (06/02/2007) - and number of fires increased by an order of magnitude; by 12.02.2007, CH_4 concentration reduced – and fires are single.

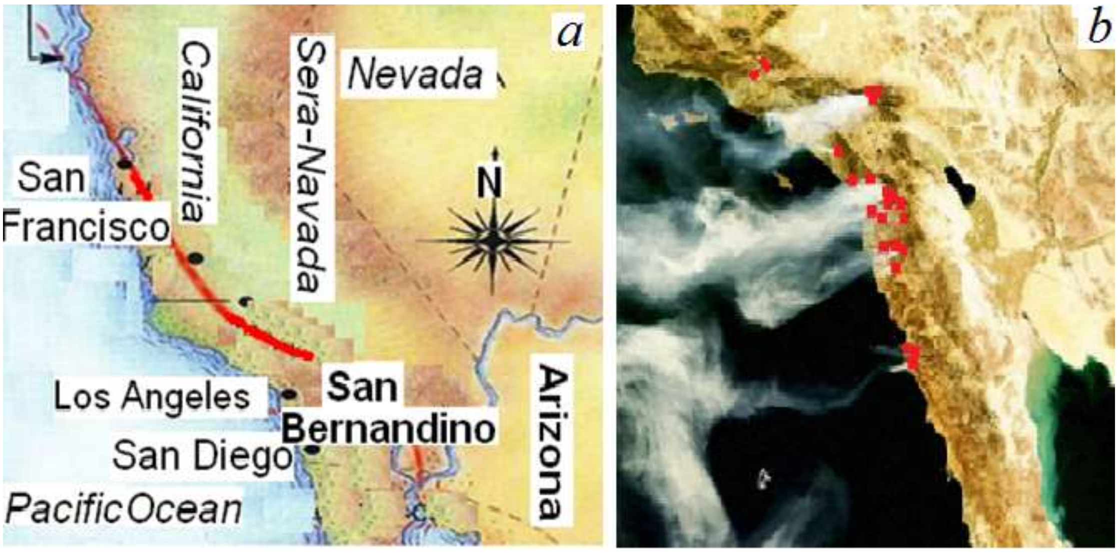

Fig. 19. Natural fires in California near the crust faults: (*a*) - San Andreas fault [17]; (*b*) - map of fires in California [21].

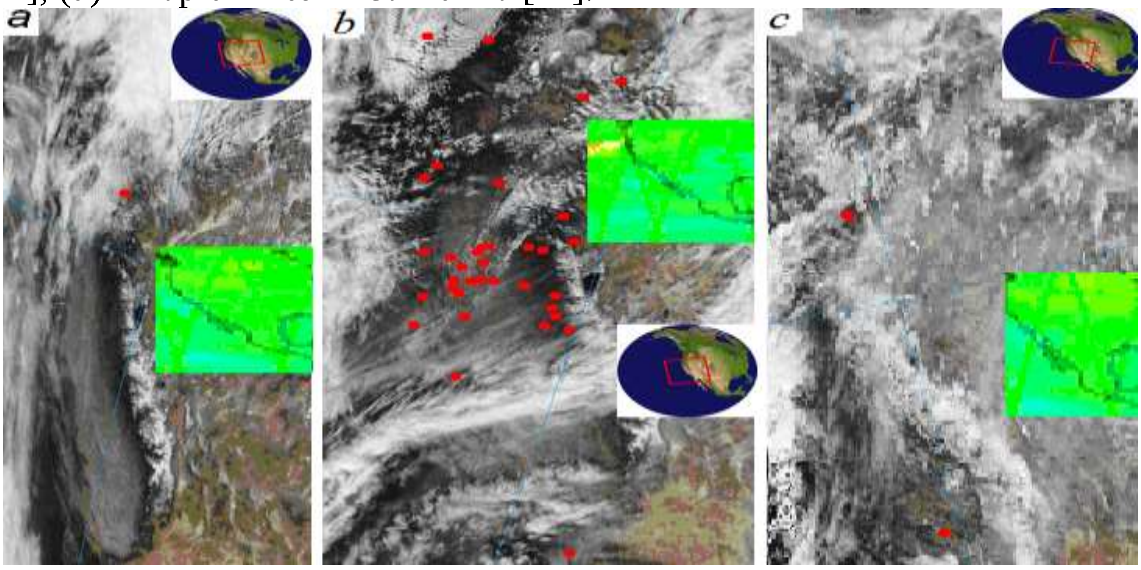

Fig. 20. Fires and CH_4 concentration 681hPa in *California*: (*a*) – 03/02/2007; (*b*) – 06/02/2007; (*c*) - 12/02/2007. On the insert - *San Andreas* fault.

It is believed that sharp rises of radon concentrations are micro seismic phenomena. In the north of Tasmania, the concentration amplitude of *222Rn* (10 000 Bq/m^3) is much higher than in the mines of northern Urals and in San Andreas, many times more than in the Tien Shan. In the Alps, Malta and the southern coast of Africa the concentration of *222Rn* is less than 10Bq/m^3 [18]. During the days of *RN* concentration rises (>1000 Bq / m^3), linear breaks in clouds occur over the region; in Tasmania and in south-east Australia, massive fires occur from dry thunderstorms, their occurrence in drought conditions is facilitated by easily flammable eucalyptus volatile oils (fig.21).

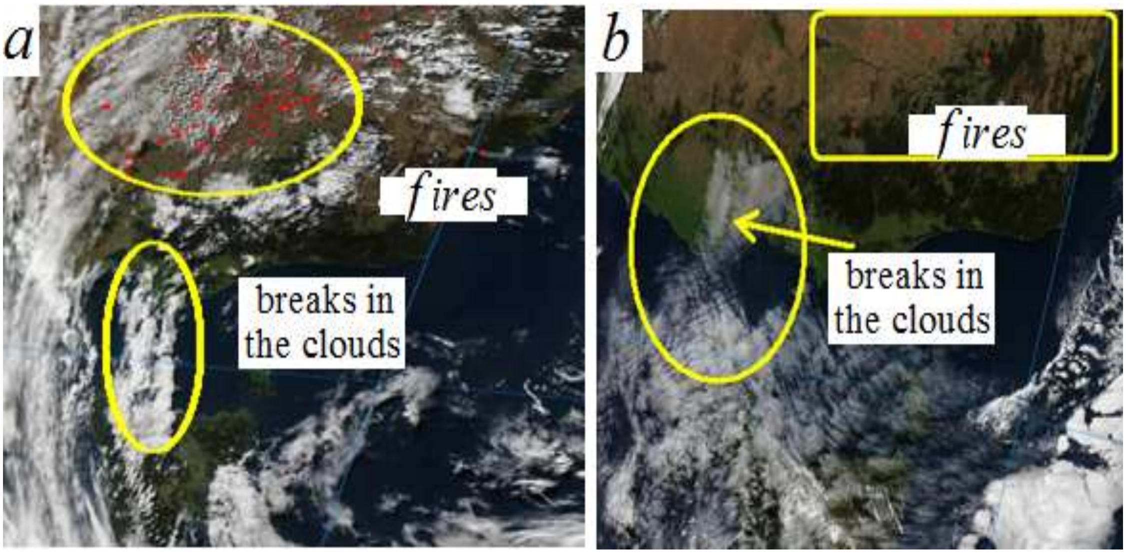

Fig. 21. Gaps in the clouds near Tasmania island and fires (red dots) in south-eastern Australia 21/05/2011 (*a*), 29/06/2005(*b*).

To minimize natural fires, especially in areas of high magnetic field anomalies and CH_4 degassing, lightning arresters (lightning receivers) should be placed. Density of their arrangement depends on the height of neighboring items (trees) and height of the lightning arresters themselves (fig.21).

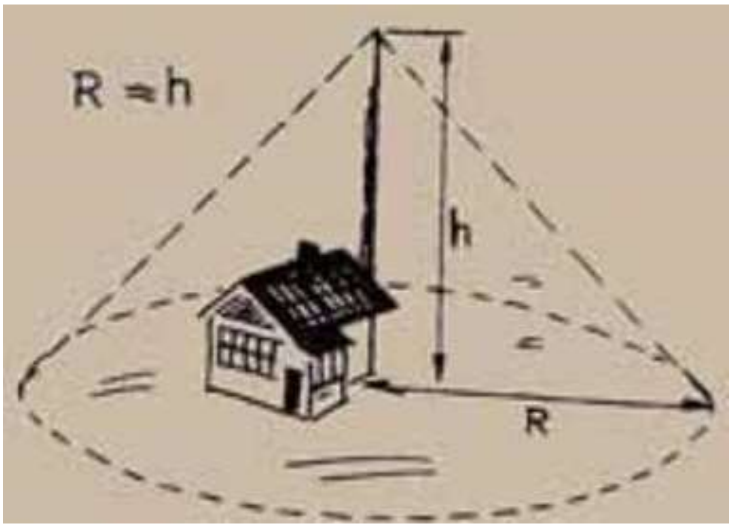

Fig. 22. The protective zone of the lightning rod has a cone form with a corner at top about 45. Radius of the basis of a cone is approximately equal to height of the lightning rod [16].

"In 1750, Franklin invented lightning arrester (lightning rod). The scientist refused to patent his invention; he just wanted to start serving people as soon as possible. The news of Franklin's lightning rod quickly spread throughout Europe, and he was chosen to all academies, including Russia. However, in some countries, the religious population met this invention with indignation. The idea itself that people can so easily tame the main weapon of the wrath of God seemed sacrilegious.

In 1780, in a small town in the North France, townspeople demanded to demolish the iron mast of the lightning rod. This came to trial. A young lawyer, who defended the lightning rod against attacks of the obscurantists, built his defense on the fact that the human mind and its ability to conquer the forces of nature are of divine origin. Everything that helps to save life is for the benefit - the young lawyer proved. He won the trial and gained great fame. Lawyer's name was ... Maximilian Robespierre.

Portrait of the inventor of the lightning rod is given on a hundred-dollar bill" [2].

Small greenhouse gases

Finally, let us analyze the annual variability of ground-based measurements of water vapor concentration (*RN*%) and small greenhouse gases CH_4, CO, CO_2 [18]. A common feature of the annual course of these greenhouse gases is the annual summer minimum due to photosynthesis (fig.23).

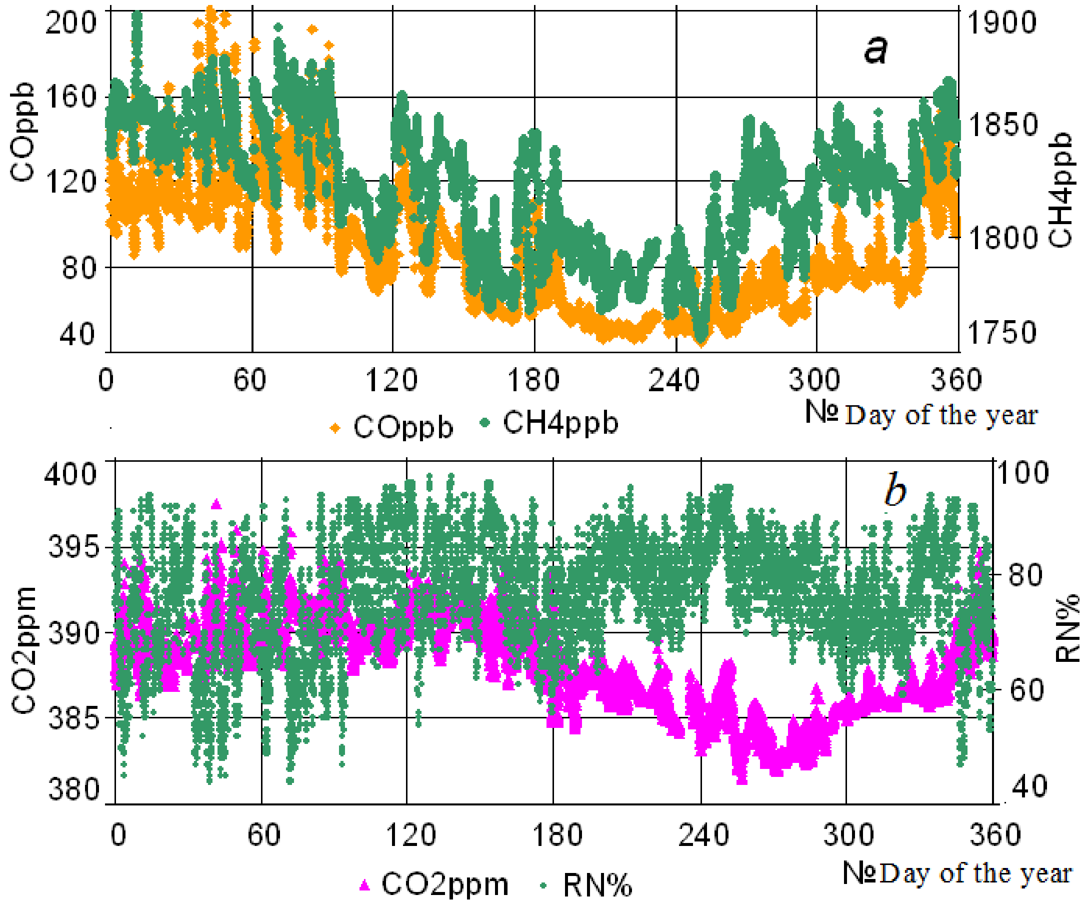

Fig. 23. Annual course of greenhouse gas concentrations at hourly measurements in 2008 at the island station (24.28 N, 153.98 S, H=8m): (*a*) — carbon monoxide and methane; (*b*) — carbon dioxide and relative humidity.

In the absence of earthquakes, there is a close, almost linear, relationship between changes in the concentrations of CH_4 and CO (R>0.9). The area of their joint changes has the shape of an elongated petal. Relationship between CH_4 and *CO* concentrations and CO_2 concentration is much weaker (fig.24).

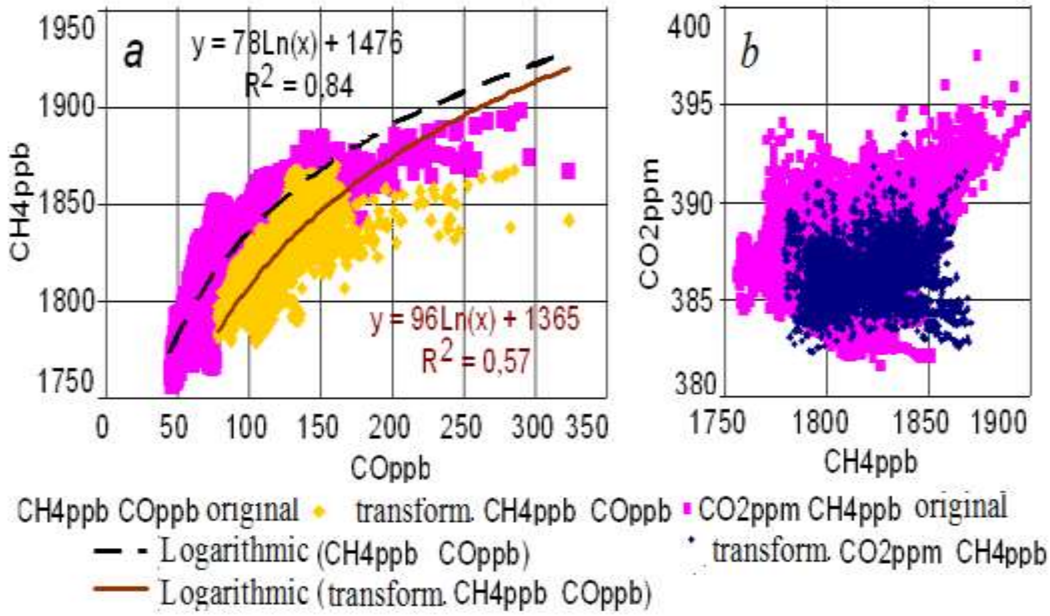

Fig. 24. Annual-adjusted ratios between the original concentrations of greenhouse gases: (*a*) - CH_4 and *CO*; (*b*) - CH_4 and CO_2.

After annual adjustment (transformation) of concentration values, magnitude of concentration fluctuation reduces by one third and also correlation between concentrations of CH_4 and *CO* is somewhat loosening, and between CH_4 and CO_2, *CO* and CO_2 disappears. And this is not due to steam (explicit relationship between relative humidity and concentrations of greenhouse gases is absent).

In local earthquakes, relationship of CH_4 and *CO* concentrations change everywhere [20]. Range of fluctuations in the values of CH_4 concentrations for the same *CO* concentrations increases from 50-100 ppb to 200 ppb or more (fig.25).

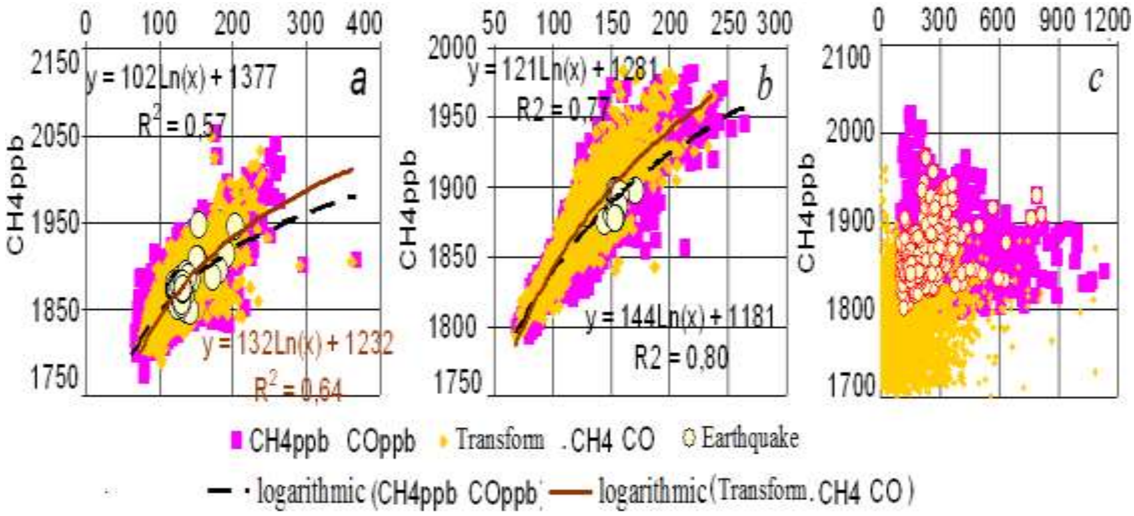

Fig. 25. Relationship between the initial values of the concentrations of CH_4 and CH_4 (circles mark seismogenic periods), as well as annual-adjusted values at the station 46.82N, 6,95E, 490 m: (*a*) 2009; (*b*) 2010; (*c*) 2008.

Deformation (expansion) of the "petal" area occurs whether near the base (at summer earthquakes), or on the opposite upper side (at winter earthquakes). There are situations when CH_4 and CO_2 concentrations increase significantly, but there are no significant changes in *CO* fields. Sometimes, in some places, only CH_4 or CO_2. content grows significantly. Apparently, the sharp rises of concentrations of some gas is a manifestation of "hot" (predominance of CO_2 degassing) or "cold" (predominance CH_4) magmatism.

Conclusions

Natural fires are confined to the positive magnetic field anomalies occurred at activation of CH_4 degassing. This is most often observed in the faults of the Earth's crust. There is a clear trend of increase in the number of fires in the days of increase in CH_4 concentration in the lower troposphere in large areas of more than 5%. Deviations from the trend - lack of a clear link between activation of CH_4 degassing, dry thunderstorms and dry weather.

To minimize wildfires, hay and straw should not be stored in the fault zones; it is advisable to plow around these places. It is advisable to install lightning arresters (lightning rods) in the areas of positive magnetic field anomalies and massive methane degassing, in peat bogs – to use the lightning rods with insulation on the length equal to the peat depth.

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