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Space monitoring and analysis of catastrophic fires in Central Siberia

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Impacts of climate change on fire and carbon in the boreal zone have global significance. Wildfires in this region burn 10 to 25 million ha per year. Russia contains two-thirds of the world's boreal forest and peat lands, yet accurate historical fire data are lacking. Official records greatly underreport past burned areas, and satellite data were not readily available before NASA established downlinks in Siberia in 1994. Changing climate is likely to greatly increase burned area, burn severity, and emissions per unit area in this region. Projecting future impacts of fire on carbon storage and atmospheric chemistry requires a baseline of at least 25 years of data to develop robust fire activity/weather relationships. We propose combining recent satellite data with fire data from archived satellite imagery (1980-1995). We will integrate these data with other data and models to estimate wildfire emissions for Siberia from 1980-2010, and provide a basis for projecting future changes.

The analysis of 2002 wildfire situation proposed that Yakutian 2002 wildfires may be consider as the prototype of the globe ecological disasters. As the result of high intensity surface fires influence we can observe high tree mortality (up to 40%) of primarily lurch stands on the huge burned areas (more than 50000 sq. km in a total).

The territory between rivers Lena and Viluy was keep without rains practically during whole fire season 2002. Mass wildfires were appeared for a short time on the 700000 sq. km of this region and they looked like as the spatially distributed high temperature gas generator which worked continuously the day and night. The energy of this generator was sufficient for prevent from the cyclones propagation through this territory.

So, we propose the development of the hypothesis of positive feedback between anticyclone growth and energy release from wildfires for the huge burned territories. The critical number of fires is defined when the fire situation becomes uncontrolled in according to the total fire intensity. We estimated the fire emissions including CO2, CO, CH4 and different kinds of the smoke aerosols more than 70 Tg (total) for Yakutian fires in 2002 using NOAA and TOMS daily data. We point attention on the increasing of emission of the methane after such mass fires from the permafrost territory and take into account that methane has more strong greenhouse effect than CO2. The post fire changes of the permafrost and vegetable cover are discussed in the connection with the solar radiance balance changes. In this context, catastrophic forest fires mean fires covering àn àrea of mîrå than 10,000 ha, resulting in the total destruction of vegetation and organogenic horizons of soils, or the simultaneous occurrence of several fires of the same total àråà and intensity îvår à total àråà of 1 ,000 km2. The classification of post fire catastrophic "traumatism" by Sapozhnikov (1984) includes the highest level of à fire's impacts following destruction of the soil ñîvår, intensive soil erosion, and development of stone fields in mountains. The forests àãå destroyed completely, and àãå not restored before new soils àãå generated. For this class, the loss of potential productive forest land is estimated at òîãå than 80% and lasts for à period of îvåã 20 years. Shvidenko and Nilsson (2003) used the term *catastrophic fire óåàr* as à óåàã for which the extent of fire is three-fold, more than the multi-year average and where the severity of fire is extremely high. Long-term pyrogenic consequences àãå the irreversible transformation of the forest environment, which is obvious beyond the restoration period of àn indigenous forest ecosystem, i.e. exceeds the length of the rotation period (i.e., ranging from 100-400 years for major forest forming species of the Russian Far East).

Generally, the long-term environmental consequences of catastrophic forest fires became apparent in the following aspects (Yefremov, Shvidenko, 2003):

1. À significant (up to several times) decrease of the biological productivity of forest lands due to the destruction of the indigenous ecotope and replacement of indigenous vegetation formations.

2. Irreversible changes in the cryogenic regime of soils and rocks.

3. Change of long-term amplitude of hydrothermal indicators beyond natural fluctu-

ation. 4. Changes of multi-year average hydrothermal and bio-chemical indicators of aquatic and sediment runoff, as well as of hydrological regimes and channel processes of water

streams.

5. Accumulative impacts îï atmospheric processes resulting in global climate change.

6. Acceleration of large scale outbreaks of insects and disease.

7. Irreversible loss of biodiversity including ãàãå and threatened flora and fauna species.

8. Transboundary water and air transfer of pyrogenic products.

9. Change of historical migration routes for migratory birds, ground and water animals.

A catastrophic fire in accordance with our determination is a fire, operating on the area more than landscape unit in the conditions of the protracted anticyclone at the class of drought more than 5, resulting in mortality of the main forest stand more than 50% and inflicting economic and/or social harm, exceed all kinds of benefits. There is not economic sense in the liquidation of such fire - it is necessary to conduct a selective suppression.
Parameters: average area of separate fire is more than 10000 ha, power more than one thousand megawatt, speed of growth of perimeter more than 40 km/day, residence time of combustion is more than one minute.
A catastrophic fire situation is the uncontrolled situation at which speed of growth of total perimeter is exceeded by speed of localization by all facilities and methods. It is characterized by the aggregate of catastrophic fires, operating on an area more than 400000 sq km in the conditions of the protracted anticyclone at the highest class of drought and impedimental of passing atmospheric fronts, percent of burnt area, exceeds 20% of total area. The smoke-screen of territory is characterized by about 200 meters of meteorological distance of visibility, which paralyses the actions of forest aviation protection guard.

- It is obvious fact of increasing of number and area of catastrophic fires in Asian Russia in accordance with global change and global warming tendency
- The concept of large fire must be revised in connection of increasing burnt area of average fire to 1200 ãà.
- Problem of prevention and suppression of large and catastrophic fires in Russia is more organizational (financial), than technical.

It is necessary to strength the conception of early detection and operative extinguishing of fires of little sizes, and also to improve the tactic of the opposite fire application.

It is necessary to develop the national Russian system of estimation of fire hazard, being based on application of facilities of the remote sensing of Earth from Space.

Conception of estimation of probable complex damage (economic, social and ecological) is needed, that will allow to create the scientifically-based system of fire situation control.