PROBLEM OF ESTIMATING WILDFIRES IMPACT ON CARBON CONTENT IN ATMOSPHERE

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ABSTRACT
During photosynthesis, atmospheric carbon sequestration goes on at the expense of formation and accumulation of organic substance, and an inverse process (carbon emission in the atmosphere) takes place during decomposition and oxidation of this organic substance. On land, in non-swamp ecosystems, these processes are balanced as a whole both under climax forms and interchange of: 1) periods of active oxidation of organic substance under influence of disturbing factors (more often, fires), and 2) periods of active formation of organic substance in the process of regeneration successions.

Duration of fire successions is not large (usually less than a month) in steppes, savannas, and meadows, whereas in forests, especially boreal forests, regeneration processes usually last for decades. Therefore, mass outbreaks of wildfires may influence carbon budget and planet's climate. Global climate warming is accompanied by climate cataclysms, including severe droughts, which cause a number of wildfires including catastrophic ones. Additional carbon discharge into atmosphere from fires may even greater intensify droughts and fire occurrence per a square unit. This very tendency has been observed for the last 25 years. Therefore, it is desirable that the Kyoto Protocol be supplemented with quotas for forest fires, and to be more exact, with quotas for greenhouse gases emissions from forest fires. Carbon dioxide emission depends upon the kind of fire, its intensity, vegetation composition, geographical region, and as a whole – from burning organic stock and level of forest ecosystems damage. We have created a simple and not expensive technique for the estimation [*Volokitina,et al.*, 2002].

Surface fires prevail among forest fires (84 % of all wildfires area in Russia). The prime conductor of burning (PCB) under a surface fire is a layer of fine vegetation remnants, mosses, and lichens. A flame spreads over it. Below this there is a layer of duff, which can smolder. A storey of grasses and undershrubs as well as fine fallen dead branches (up to 2.5 cm in diameter) burn down at the fire edge in the flame of PCB and can intensify this combustion. PCB fuels are hygroscopic. If a PCB layer has a very loose structure (dried grass stand), the whole layer rapidly dries out. PCB layers with a more compact structure (mosses or litter) dry up part by part beginning with the upper one. Combustion spreads when moisture content of the upper PCB layer part is under the critical value (25%), and the stock is over the critical value (200 gr/ m^2). Drying rate depends upon compactness of the PCB layer, soil moisture, air humidity, radiant energy flux; air humidity and rainfall determine moistening. Consequently, the load of a burning fuel even on one forest plot is a very dynamic value, which changes all the time, even during 24 hours. Therefore, the amount of CO_2 emitting during a fire changes as well.

In Russia, a forest type is indicated in every inventory unit during forest taxation. Forest types are characterized by the composition and structure of the forest floor. Russian forests are geographically diverse; therefore there are hundreds of forest types and thousands of their versions. It is well nigh impossible to study combustion in all forest types under different weather conditions. To solve this problem, we have improved the classification of vegetation fuels and elaborated the classification of prime conductors of burning (PCB). We distinguish ten PCB types. The key for determining PCB types

has been worked out. The research has been carried out of how different PCB types burn depending on drying conditions (phenological state and number of trees per a square unit, exposition and steepness of slopes, etc.) and on a level of drought [*Volokitina, and Sofronov*, 2002]. The level of drought is determined by index PV-1, which is used in Russia to estimate forest fire danger [*Vonsky and Zhdanko*, 1976]. Index PV-1 is similar to codes FFMC and DMC from the Canadian Fire Weather System [*Canadian Forestry Service*, 1987] and to codes FFM and 10Hr TLFM from the American system NFDRS [*Deeming, Burgan, and Cohen*, 1977].

Now it is possible to determine PCB types for each forest type on the basis of its description (for spring, summer, and autumn). Then, using forest inventory data, to characterize each forest plot in terms of PCB types as well as of critical drought classes, which show that plots are ready to burn. This way it is possible to make a pyrological description of plots on any territory that allows creating a vegetation fuel map (1 : 10 000 – 1 : 25 000). This technique is simple and not expensive [*Volokitina, and Sofronov*, 2002].

We have studied the stock of burning fuel in the PCB layer and in the duff in relation to a PCB type and drought class. Having a vegetation fuels map and knowing the class of drought, it is possible to estimate on a burnt area the burnt organic mass in a PCB layer and duff and the quantity of carbon emitted during combustion. It is necessary to add also herewith a mass of a burning grass-underbrush storey and fine fallen dead branches.

After the fire, died plants and their parts begin to decompose, but a normal entry of detritus reduces significantly, therefore carbon emission from soil reduces as well. Concurrently, carbon sequestration decreases to a great extent because of photosynthesis reduction, as a result of which emission into the atmosphere will prevail in a carbon cycle. To get more accurate data on trees mortality it is necessary to methodically elaborate space monitoring of burnt area for estimating the level of forest ecosystems damage.

Owing to possible noticeable contribution of forest fires into atmospheric carbon budget, the world community should be interested in accurate global estimation of fire and post-fire carbon emission, its forecasting and control with the help of wildfire management.

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