The Relationship between Fire Energy Release and Weather Conditions in Russian Siberia

Eugene G. Shvetsov

Sukachev Institute of Forest, Krasnoyarsk, Russian Federation

Active fire remote sensing performed using spaceborne systems, such as MODIS radiometer aboard the Terra and Aqua satellites, provides observations of fire locations, as well as an estimate of the amount of energy released by the fire (Fire Radiative Power).
The correlation analysis of fire radiative power and weather fire danger was performed for the territory of Siberia. The measurements were made during stable anticyclons which lead to severe drought that caused extreme fire behavior. The analysis was performed for several Siberian regions mostly liable to fires. Such regions were Yakutia where extreme wildfire situation occurred in 2002 and 2012, Angara region during fire season of 2006 and Western Siberian regions in 2012 (Fig. 1).

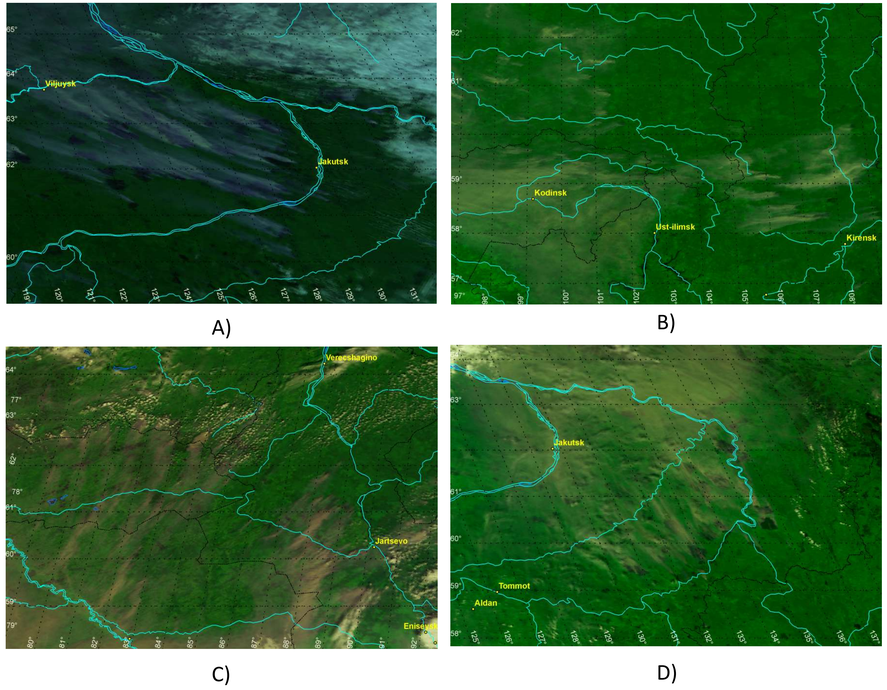

Figure 1. Burn scars and smoke plumes during extreme wildfire situations in: A) Yakutia 16.08.2002; B) Angara region 22.07.2006; C) Western Siberia (Krasnoyarsk, Tomsk, Khanty-Mansiisk regions) 04.07.2012; D) Yakutia 14.07.2012.

Weather conditions were characterized using weather fire danger indices. The measurements of FRP were performed using MODIS instrument and weather fire danger indices were calculated using weather stations data.

Fire danger was characterized using the Russian index PV-1 and indices of the Canadian fire danger rating system CFFWIS. The values of fire danger indices were calculated according to the weather station network NCDC (National Climate Data Center) data, so only fires detected in the vicinity of weather stations were considered. Time series of measured fire radiative power and fire danger index values were analyzed (Fig. 2).

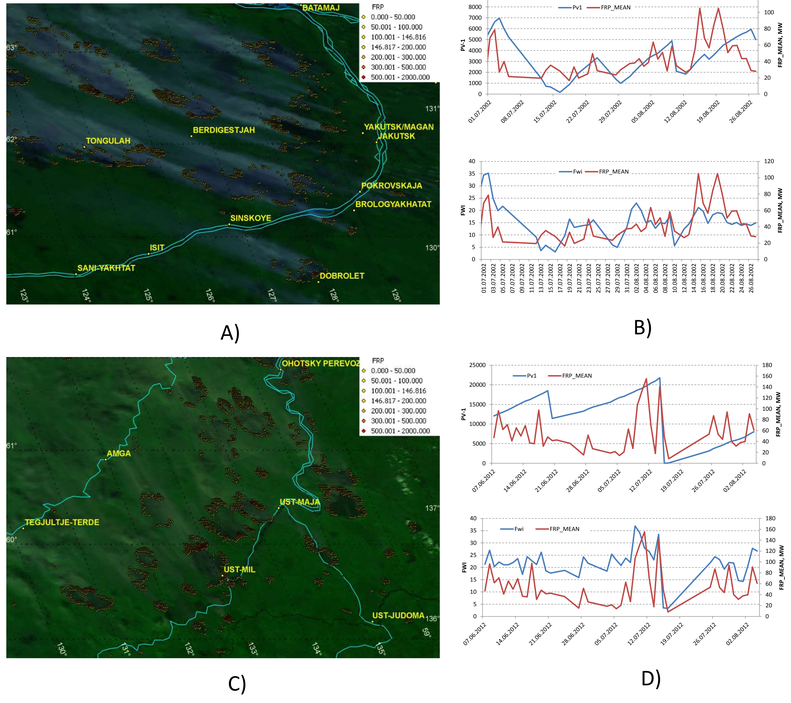

Figure 2. Map of fires in Yakutia: A) for 16.08.2002; C) for 14.07.2012. Fire pixels are shown in color according to their FRP value. The dynamics of mean FRP in comparison with Russian PV-1 index and FWI values: B) for Jakutsk weather station; D) for Ust-Maja weather station.

Fire danger index having the best correlation with the measured mean FRP values varied from station to station. Such index can be one of the following: PV-1, DMC, DC or BUI index. However, for the most cases it was found that FWI index describes the dynamics of FRP rather good.

Applying a low-pass filter to smooth the high frequency oscillations allows to slightly increase the value of the correlation coefficient between the time series of FRP and FWI values.
A regression model was formulated to characterize the relationship between wildfire radiative power and fire danger indices.

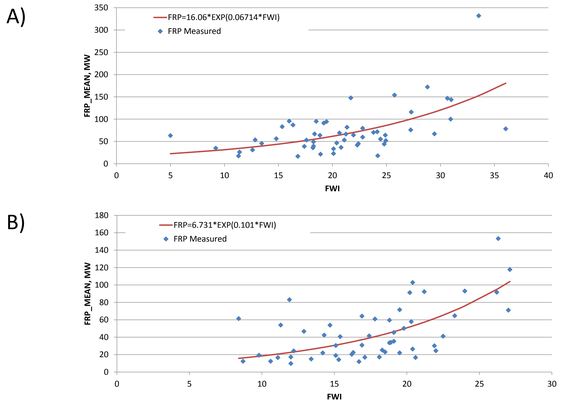

Figure 3. Scatter plots and regression curves A) for 2012 fire season in Yakutia (weather station Ust-Maja); B) for 2012 fire season in Western Siberia (weather station Sym).

Although FWI can describe the change of FRP rather good – the increase of FWI is accompanied with the increase of FRP, the magnitude of such change could hardly be predicted, since it is determined by multiple factors, such as previous FRP and FWI values, vegetation type and so on.

Conclusions

For most stations, an FWI index showed rather satisfactory correlation with dynamics of FRP, at the same time for the individual stations the better correlation can be obtained for PV-1, DMC, DC or BUI. However, these indexes could not predict the magnitude of the FRP change.