Weather Conditions During Large-Scale Widespread Forest Fires in Alaska

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Global maps of wildfires show large-scale widespread fire zones throughout the world. One major fire zone is in the boreal forests of Alaska. The boreal forest in Alaska encompasses about 0.47×10^{6} km^{2} (i.e. 32% of the total Alaskan land area) and has experienced large-scale widespread fires more frequently in recent years, most notably in 2004, 2005, 2009, and 2015. The total burnt area by wildfires in 2004 was largest on record. The burnt area by wildland fires was approximately 26,700km^{2} in 2004 (the largest burnt area on record) and 20,900km^{2} in 2015 (the second-largest burnt area). The total burnt area in just these two fire years comprised approximately 10.5% of the entire Alaskan boreal forest.
In this study, we analyzed the daily fire weather conditions during recent severe fire-periods. Synoptic-scale weather conditions were analyzed using upper (500hPa) and near surface level (1000hPa) atmospheric reanalysis data. Synoptic-scale weather maps based on the atmospheric reanalysis data were used to document the severe fire weather conditions leading to extensive wildfire activity under both high- and low-pressure conditions. For high-pressure conditions, wind direction change from south-westerly to north-easterly associate with high-pressure system movement from south to north was discussed using weather events related to Rossby waves breaking (RWB). We discussed relationship among weather events related to RWB and fire activities.
The results are summarized as follows:
1. Fire weather conditions of the high-pressure type occurred under unique weather phenomena related to RWB. RWB occurred in easterly wind flow with large Jet stream meandering (JSM) occurring near Alaska. The high-pressure system at the lower level (1000hPa) moved toward the north under a ridge and blocking high over Alaska at the upper air level (500hPa). During the movement of the high-pressure system from south to north, two severe fire weather conditions the first hotspot peak (1) and second (largest) hotspot peak (2) appeared.
2. Two distinctive hotspot peaks, the first peak (1) and second peak (2) during each fire-period, occurred under two different synoptic-scale fire weather conditions. Fire weather conditions during first hotspot peak (1) consisted of a ridge in the Gulf of Alaska at the lower- and upper-levels. The ridge in the Gulf of Alaska supplied south-westerly wind into inland Interior Alaska. The weather conditions during the second hotspot peak (2) were dominated by the Beaufort Sea High (BSH) after high-pressure system passed over Alaska related to RWB phenomena.
3. The BSH occurred in conjunction with a blocking high aloft and supplied easterly wind into Interior Alaska. The BSH located at northern coast of Alaska resulted in relatively stronger easterly wind than the south-westerly wind during the first hotspot peaks (1) due to large pressure difference between the BSH and Interior Alaska. This is likely a key reason that the second hotspot peak (2) is larger than the first during the top four fire-periods.
4. A low-pressure fire weather type also occurs with south-westerly wind in Interior Alaska that results in a single large hotspot peak. This wind condition occurs due to the large pressure difference between a low-pressure system in the Arctic Ocean and a high-pressure system in the Bering Sea.
5. The onset of the high- and low-pressure fire weather types in Alaska may both be predictable. This study suggests that : (a) onset of large Jet stream meandering in the west of Alaska may indicate the high-pressure fire weather type, (b) onset of low-pressure system development

(cyclogenesis) in the Arctic Ocean and a high-pressure system in the Bering Sea may precede the low-pressure fire weather type.

Keywords: Beaufort Sea High, Jet stream meandering, Rossby waves breaking, Widespread fires, MODIS hotspot

