Evaluating Fire Weather Indices to Support Fire Management Decisions in Alaska

Peter A. Bieniek¹, Robert Ziel¹, Uma S. Bhatt², T. Scott Rupp¹

¹International Arctic Research Center, University of Alaska Fairbanks (UAF); ²Geophysical Institute, UAF; ³Dept. of Atmospheric Sciences, UAF

10th Annual Northwest Climate Conference, 8-10 October 2019, Portland, OR

Main Results

• Daily variability of fire weather parameters compare favorability station vs downscaled reanalysis
• EDDI and SPEI show promise for identifying MODIS fire detection days
• Fire weather conditions may generally worsen in Jun-Jul by the 2040s according to two model projections

Motivation

• Summer wildfires can burn large areas and most of Alaska area burned is due to lightning-ignited fires
• Few seasons have large area burned (>1 million acres)
• Large season have occurred more often in recent decades
• Wildfires are managed in Alaska
• Operational management decisions are tied to fire weather conditions

Data and Methods

• Alaska fire managers base operational decisions on the Canadian Forest Fire Weather Index System (CFFWIS)
• Calibrated for the boreal forests
• Other fire weather indices are available: do they work in Alaska?

Components of the Canadian Forest Fire Weather Index System (CFFWIS)

• Analysis conducted over the Predictive Service Areas (PSAs) used by fire managers
• Five approaches are compared with active fire data:
  - FWI (Van Wagner 1987)
  - EDDI (Hobbsin et al. 2016)
  - SPEI (Vicente-Serrano et al. 2010)
  - VPD (Seager et al. 2015)
  - GSI (Jolly et al. 2005)

• The fire weather indexes evaluated in this study all derived from a combination of daily temperatures, humidity, winds and precipitation

Downscaling captures variability of key observed variables

• The downscaled ERA-Interim contains a wet bias in summer (Bieniek et al. 2016) that lowers the magnitudes of some indices (especially FWI/BUI)
• Downscaled ERA-Interim PSA vs. GSOD stations correlations of daily GSI, VPD, reference evapotranspiration (ETC: input for EDDI) and precipitation minus ETO (input for SPEI) show good agreement within corresponding PSA (seasonal cycle removed).

May-Aug correlation of daily fire weather index/parameter at stations vs. PSAs 1979-2017

High EDDI and SPEI values capture fire detections

• More than 250K MODIS fire detections across Alaska in 2003-2017
• MODIS hotspot detections are a good proxy of area burned and therefore a good tool for evaluating fire indices
• Good relationship with fire detections already established for FWI/BUI
• Conditional frequency analysis based on the level of each index and occurrence/non-occurrence of hotspots in a PSA
• Timescale (daily, weekly, etc.) is an important factor when comparing indices
• 15-day EDDI and SPEI both show higher frequency of high values during MODIS fire detected days along with the baseline BUI

Challenges when incorporating precipitation in SPEI

Jun-Jul fire weather conditions projected to generally worsen

• Alaska is at the forefront of climate change due to Arctic Amplification and understanding if the future will see more flammable conditions is important for long-term planning
• Analysis across the Interior PSAs indicate that ETO, VPD and BUI all show projected increases in magnitude in Jun-Jul by the 2040s.
• GSI is projected to increase at the beginning and ends of the season indicative of a lengthened growing season
• However, fire seasons are often driven by more short term conditions so these results do not necessarily indicate that more extreme fire seasons are projected

Projected changes in Alaska fire indices

Summary

• Downscaled ERI/Interim reanalysis matches the variability of station derived GSI, VPD and input parameters for EDDI and SPEI. The exact magnitudes may be impacted by a wet bias in summer precipitation
• EDDI and SPEI show favorable agreement with BUI and MODIS fire detection days at the PSA level
• Future projections indicate that fire weather conditions in Jun-Jul will likely worsen by the 2040s according to the EDDI, VPD and BUI in Interior Alaska. More uncertainty in SPEI.

Next Steps:
• Evaluate GSI and VPD against MODIS detections and FWI/FFMC
• Consider extremes in the evaluation of future projections

References


Acknowledgements

This work was supported by grant number G17AC00363 and the Alaska Climate Adaptation Science Center through Cooperative Agreement G10AC00588 from the USGS.