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Spatiotemporal Analysis of Wildfire Activity in the Tundra Biome Using MODIS Data (2000-2014)

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Spatiotemporal Analysis of Wildfire Activity in the Tundra Biome Using MODIS Data (2001-2014)

ARCSES



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Abstract

Climate change has increased the area affected by wildfire events in different parts of the Arctic. Recent studies suggest an exacerbated wildfire scenario both for the boreal forests and tundra. Although tundra wildfires have an important impact on arctic ecosystems, there is comparatively little knowledge about their geography and characteristics. Since tundra vegetation is very slow to recover, wildfires can substantially alter the biomass and animal abundance in affected areas. This study uses MODIS-derived active fire data to analyze spatial and temporal patterns of tundra wildfires between 2001 and 2014. The dataset incorporates locations of active fire events and estimates of fire radiated power.

On average there are 300–400 arctic fires registered by MODIS sensors every year. The tundra wildfires exhibit seasonality with most fires occurring in July and August. We observed inter-year fluctuations when a fire season either started earlier (in June) or lasted longer (in to September). In terms of spatial distribution, the wildfires demonstrate a strong tendency to cluster, although year-to-year locations of clusters vary. In future, we will analyze possible factors that determine spatiotemporal variation of arctic wildfires occurrence and intensity. We will study the relationship between wildfire activity and temperature, precipitation and vegetation types.

Methodology

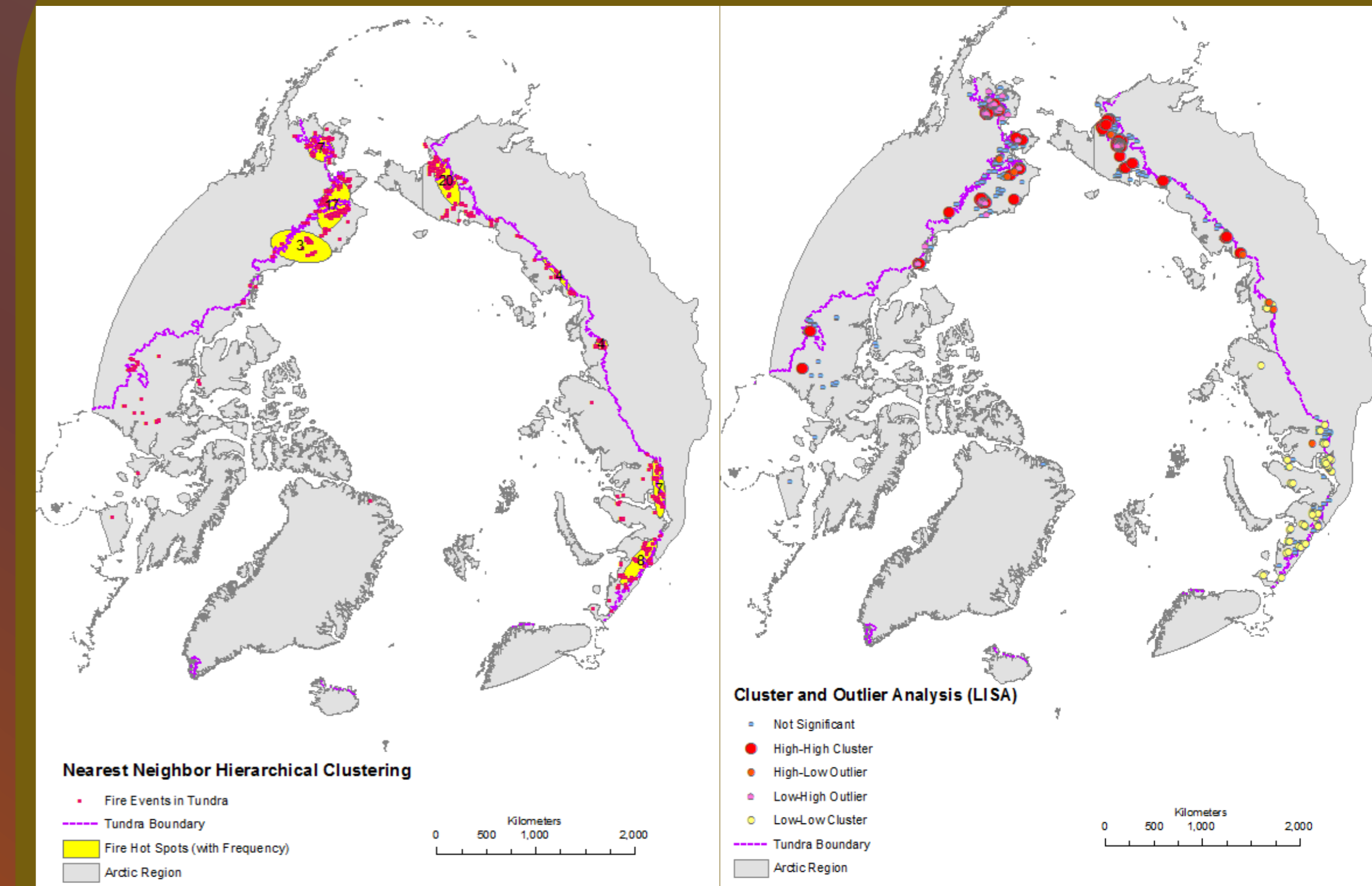
Exploratory Analysis:

- Time series analysis: character and fluctuations in seasonality and multiyear patterns.
- Analysis of spatial distribution : evidence of spatial clustering (NN, Ripley's K), spatial autocorrelation (Global Moran's I) and fire hot-spots (NNH Spatial Clustering, Local Moran's I).

Explanatory Analysis (in Future):

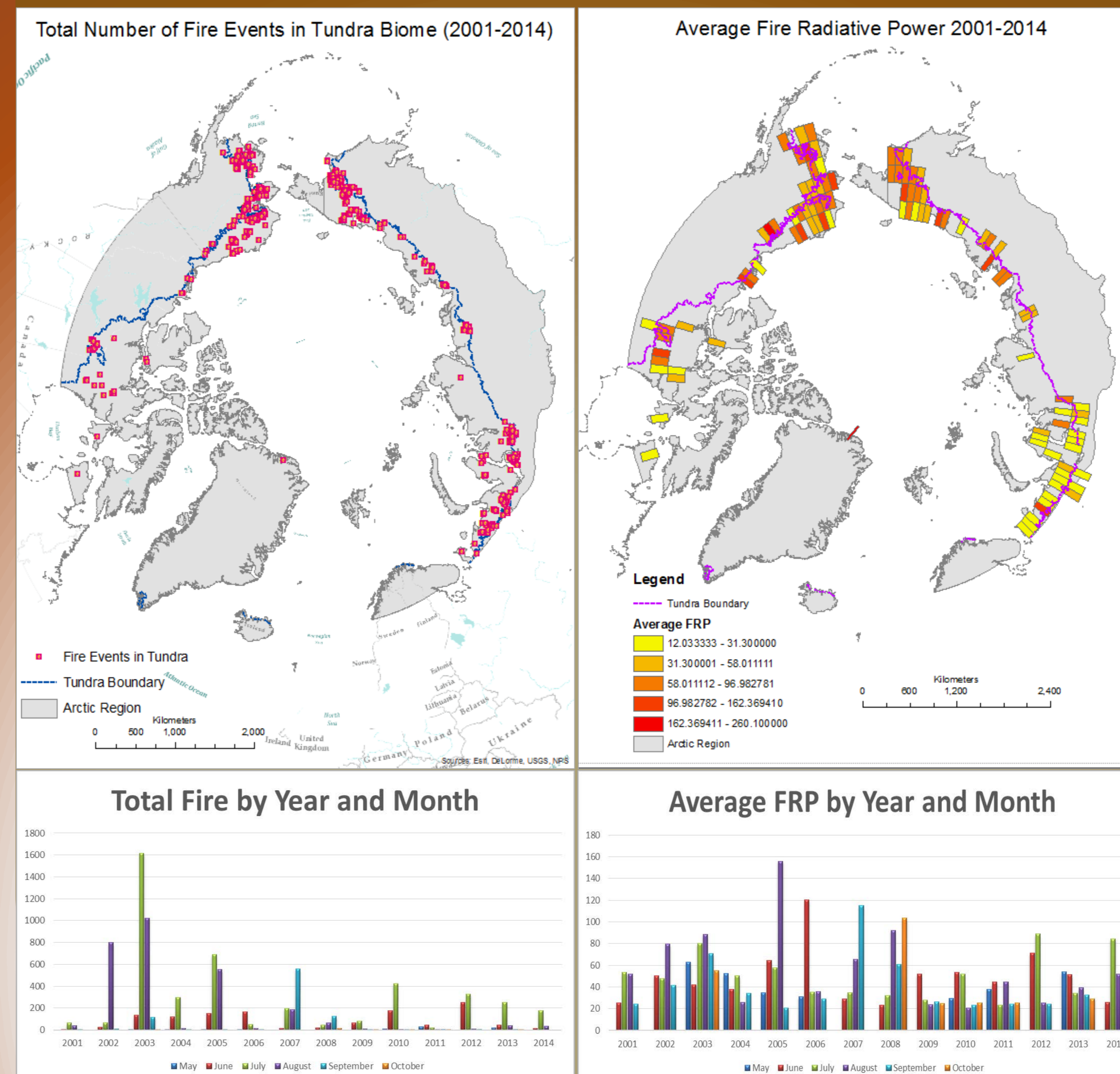
- (correlation analysis using wildfire environmental factors/drivers and grid and zonal aggregates of fire occurrences and intensity)
- Spatial correspondence with temperature and precipitation.
 - Spatial correspondence with vegetation types and biomass.
 - Spatial correspondence with human-induced disturbances.

SPATIAL CLUSTERING, HOT-SPOTS

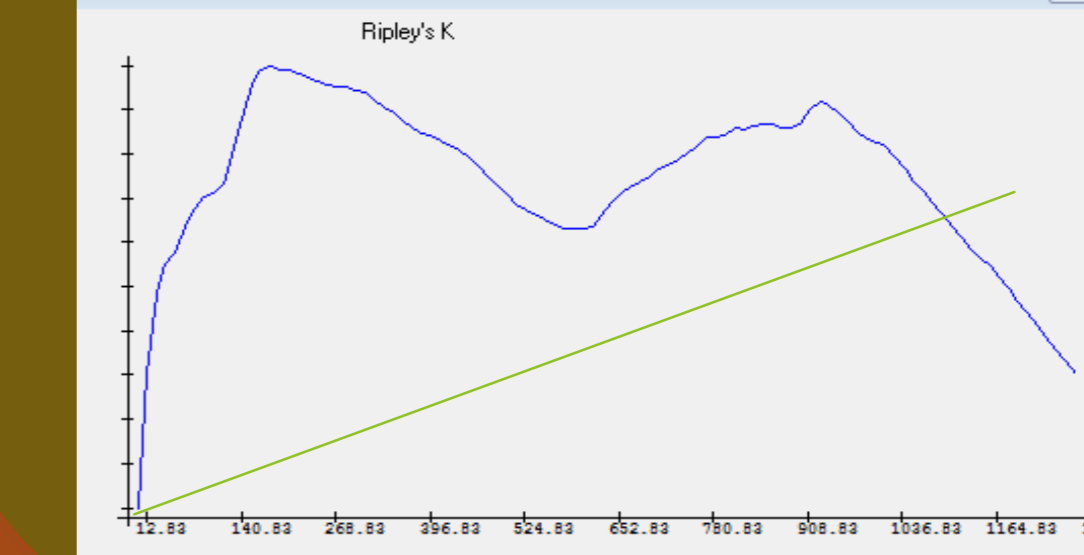


Results

ARCTIC FIRES SPATIAL AND SEASONAL DISTRIBUTION



Clustering: Ripley's K Function



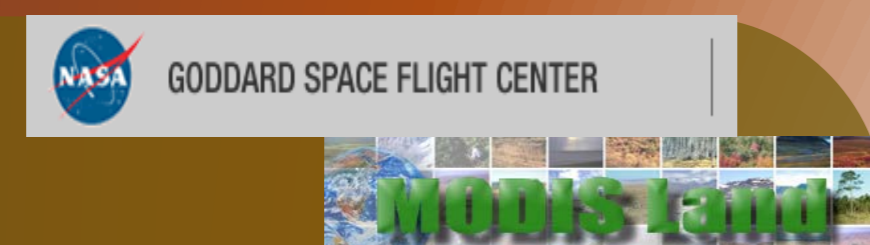
Report: Spatial Clustering Analysis

Measure	Statistics	Observations
Average Nearest Neighbor	R = 0.04; z = -176.49; P-value: 0.00	Clustered; Very Highly Stat Significant
Spatial Autocorrelation Global Moran's I (FRP)	I = 0.15; z = 7.63; P-value: 0.00	Positive; Clustered; Very Highly Stat Significant

Research Objectives

- Identify spatial (distribution and clustering) and temporal patterns (seasonal and multiyear) of arctic wildfire events and their intensity characteristics.
- Analyze relationships between wildfire occurrence and intensity and environmental conditions.

Data



Wildfire data [MODIS LAND/FIRMS]:

- **Fire events:** detected fire occurrences (confidence ≥ 50).
- **Fire Radiative Power (FRP):** a measure of radiant heat output of detected fires in MegaWatts (MW) derived from MODIS Data Processing System (MODAPS) Collection 5.1 Active Fire Products.

Other data:

- Climate variables [U Delaware]; 25-year monthly anomalies,
- Vegetation and bioclimatic variables [CAVM],
- Human-caused disturbance [GeoTREE].

Summary

Spatiotemporal characteristics of wildfires:

- Seasonality with most fires occurring in July and August. In some years a fire season either started earlier (in June) or lasted longer (in to September).
- Multiyear geographical consistency: concentrated in Alaska, NE and NW Russia. More intensive and frequent fires are concentrated in Alaska and NE Russia.
- Clustering and autocorrelation in intensity characteristics: tend to form localized isolated clusters, often of high intensity.

Future Directions

- Study the relationship between wildfire activity and environmental factors (temperature, precipitation, and temperature and precipitation anomalies).
- Study the relationship between wildfire locations, vegetation types and anthropogenic disturbance.