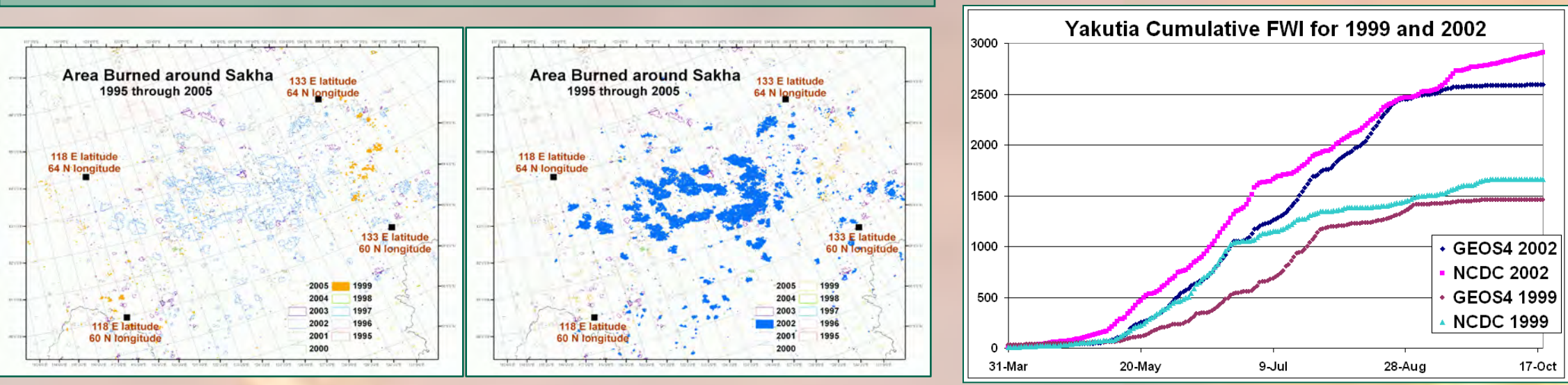


**Introduction:** Fire is the dominant disturbance that precipitates ecosystem change in boreal regions, and fire is largely under the control of weather and climate<sup>(1,2,3)</sup>. Boreal systems contain the largest pool of terrestrial carbon, and Russia holds 2/3 of the global boreal forests. Fire frequency, fire severity, area burned, and fire season length are predicted to increase in boreal regions under current climate change scenarios<sup>(4)</sup>. Therefore to predict fire weather and ecosystem change, we must understand the factors that influence fire regimes and at what scale these are viable. In previous work, we demonstrated the viability of large-scale (1°) data to assess fire weather and danger<sup>(5,6)</sup>. Meteorological parameters influence fire danger and fire is a catalyst for ecosystem change.

**Objective:** The ultimate goal of this research is to assess the viability of large-scale (1°) data to be used to assess fire weather danger and fire regimes, so these data can be confidently used to predict future fire regimes using large-scale fire weather data, like that available from current International Panel of Climate Change (IPCC) climate change scenarios. Specifically, in this poster, we relate large-scale fire weather, area burned, and the amount of fire-induced ecosystem change.

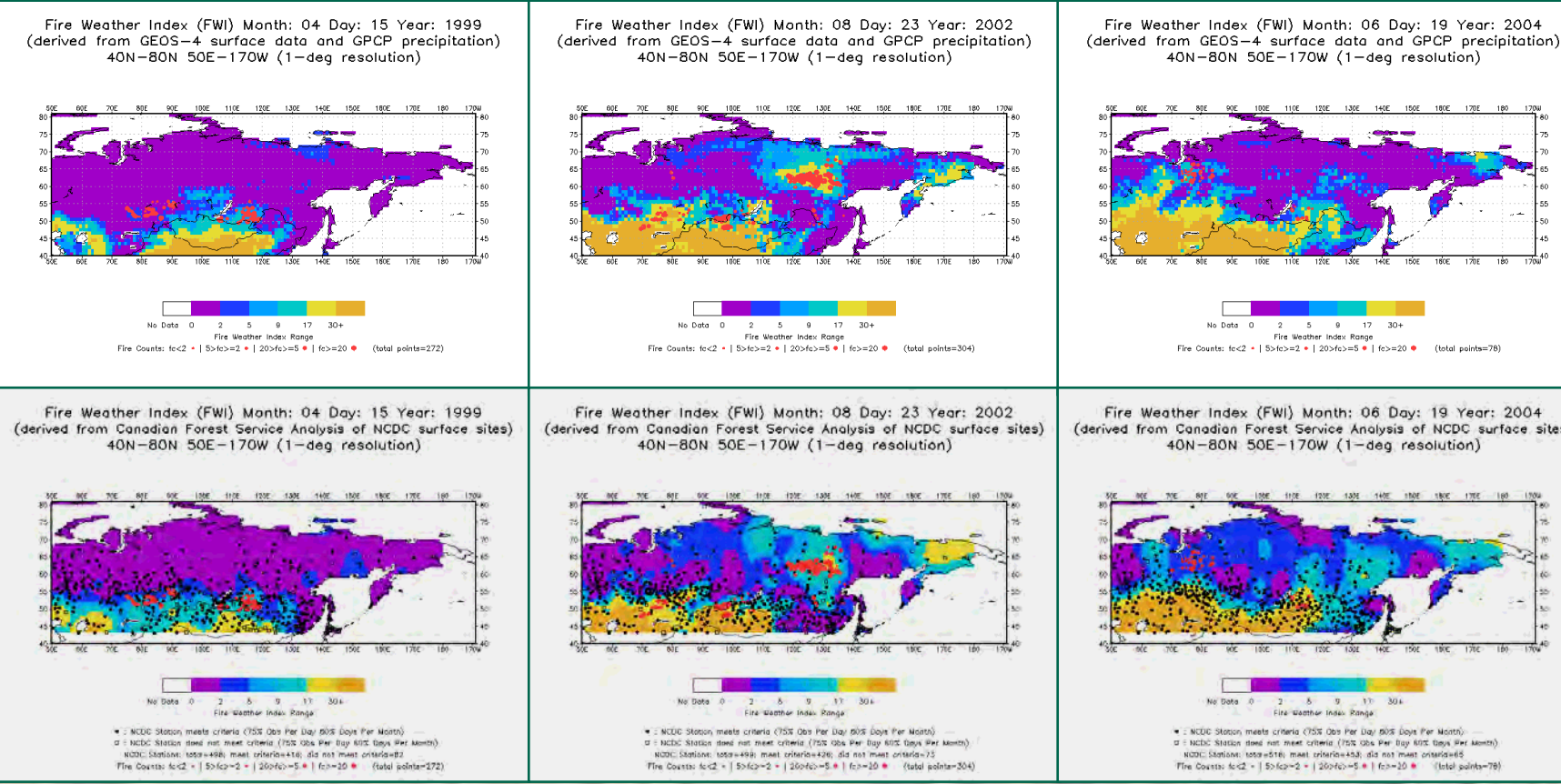
**Methodology:** First, we demonstrate the similarity in NASA Langley Research Center (LaRC)-derived fire weather indices (FWI) and National Climatic Data Center (NCDC) surface station-derived FWI. Both of these are calculated using the Canadian Forest Service (CFS) FWI, which is based on local noon surface-level air temperature, relative humidity, wind speed, and daily (noon-noon) rainfall<sup>(7,8)</sup>. The large-scale (1°) LaRC product uses NASA Goddard Earth Observing System version 4 (GEOS-4) reanalysis and NASA Global Precipitation Climatology Project (GEOS-4/GPCP) data to calculate FWI. CFS Natural Resources Canada uses Geographic Information Systems (GIS) to interpolate NCDC station data and calculate FWI. FWI's are compared spatially and temporally and with satellite-derived fire counts<sup>(9)</sup>. Then, the fraction of grid boxes that burn in each FWI class (very low to extreme) are quantified for the fire season from April through October for the years of 1999, 2002, and 2004. These are classified by International Geosphere-Biosphere Programme (IGBP) 1x1° resolution vegetation types to determine and compare fire regimes in each FWI/ecosystem class. On days with fire counts, the domain total of 1°x1° grid boxes with and without daily fire counts and area burned are tallied. The fraction of 1° grid boxes with fire counts and area burned to the total number of 1° grid boxes having common FWI category and vegetation type are accumulated, and a daily mean for the burning season is calculated. The LaRC and the CFS domain extends from 50°N-80°N latitude and 70°E-170°W longitude.

**Single Site Analysis**



Comparison of a minimal fire year (1999) and an extreme fire year (2002) for the Yakutian station in the Republic of Sakha, demonstrating the ability of the FWI to capture extreme fire weather and seasons. The LaRC NCDC and LaRC GEOS-4/GPCP cumulative FWI are in close agreement throughout the fire seasons in both 1999 and 2002.

**Examples of Daily Langley-derived GEOS-4/GPCP FWI and CFS-interpolated Surface FWI**



CFS NCDC interpolated station data offers the detailed weather data that are available from Siberia, however one advantage of the LaRC GEOS/GPCP data is that it is spatially and temporally consistent over time. Surface station locations are overlaid on the CFS NCDC maps highlighting data availability and the distance between the stations. NCDC stations meeting the criteria of 75% of the possible reporting observations per day and 60% of the possible days in each month are indicated with black circles. Those not meeting the criteria but used in FWI interpolation are indicated with open boxes. Satellite-derived fire counts are shown in red.

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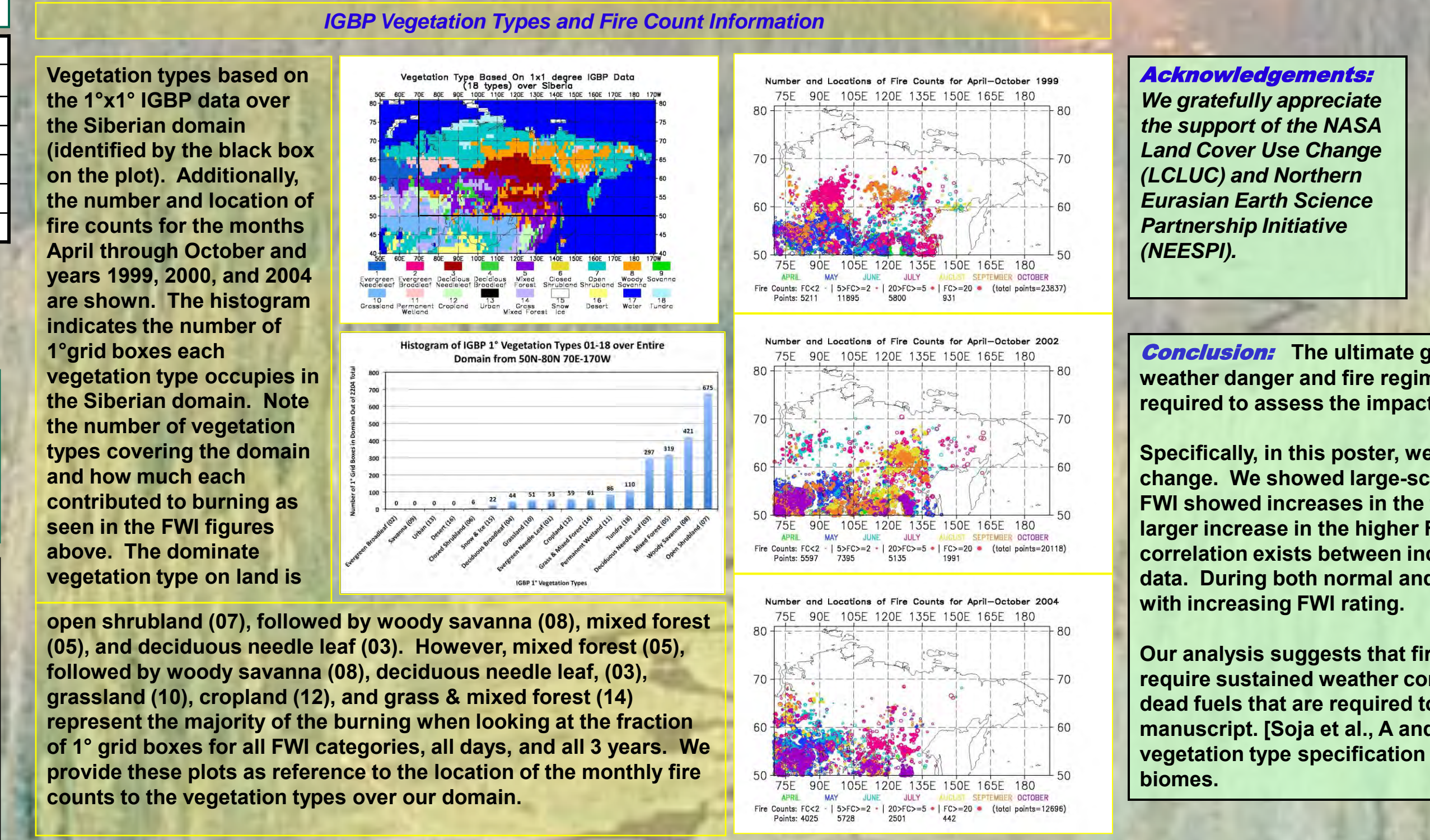
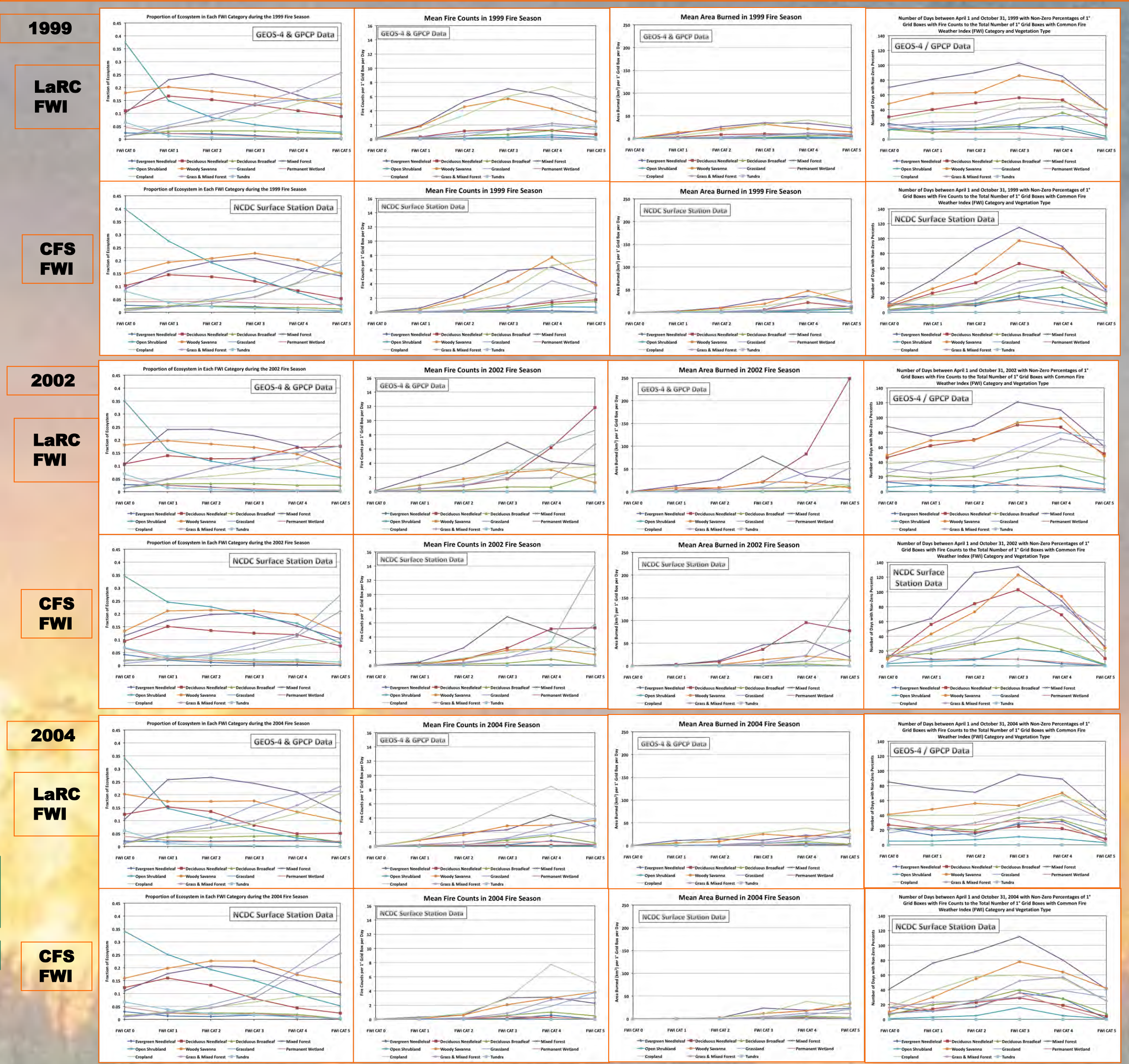
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In the adjacent plots for 1999, 2002, 2004, and the 1999-2002-2004 composite, we compare the LaRC GEOS-4/GPCP FWI and CFS NCDC FWI based on their fraction of 1° grid boxes that contain satellite-derived fire counts and area burned to the total number of 1° grid boxes with a common FWI category. We separate these by vegetation type to estimate the fraction of each of the 18 IGBP ecosystems burned, which are dependent on the FWI. For the majority of the IGBP vegetation types, the patterns on the plots are similar between the LaRC GEOS-4/GPCP FWI and the CFS NCDC FWI, although the magnitudes are not always the same, which is to be expected.

Mixed forest (05), followed by woody savanna (08), deciduous needle leaf (03), grassland (10), cropland (12), and grass & mixed forest (14) represent the majority of the burning when looking at the number of days where the fraction of 1° grid boxes for all FWI categories, all days, and all 3 years is not equal to zero.

For most ecosystems, the CFS NCDC FWI peaks at category 3, while the LaRC GEOS-4/GPCP FWI peaks at category 4. Notice how the number of days where the fraction is not equal to zero begins to decrease after category 3, while at the same time, the fraction of 1° grid boxes to total number of 1° grid boxes increases after category 3 for most vegetation types. If the CFS NCDC FWI number of days is less than the LaRC GEOS-4/GPCP FWI, but the CFS NCDC FWI category 5 is greater than the LaRC GEOS-4/GPCP FWI category 5, then this means the CFS NCDC FWI fraction of 1° grid boxes per day is larger than the LaRC GEOS-4/GPCP FWI fraction of 1° grid boxes per day. LaRC GEOS-4/GPCP FWI has more days with fraction of 1° grid boxes than CFS NCDC FWI, but CFS NCDC FWI has a larger fraction in its days.

For all 3 years, grassland (10), cropland (12), and grass & mixed forest (14) proportion of ecosystem increase with increasing FWI category, while mixed forest (05), woody savanna (08), and deciduous needle leaf (03) decrease. For all ecosystems, there is a general increase in mean fire counts and mean area burned with increasing FWI category, although some are more responsive than others. Cropland (12) with mean fire counts is a good example in year 2002 with the CFS NCDC FWI. Deciduous needle leaf (03) with area burned is a good example in year 2002 with the LaRC GEOS-4/GPCP FWI. The mean fire counts and mean area burned plots appear to be well related.

These 3 years there are few fires north of 65°N, where tundra (18), open shrubland (07), and woody savanna (08) dominate and the distribution of NCDC stations is small, which might explain the higher number of fraction of 1° grid boxes from LaRC GEOS-4/GPCP FWI categories than CFS NCDC FWI categories. Perhaps this is an indication the spatial coverage of the LaRC GEOS-4/GPCP data is an improvement over the sparsely distributed NCDC station data.

**Conclusion:** The ultimate goal of this research is to assess the viability of using large-scale (1°) data to analyze fire weather danger and fire regimes. Understanding the quantitative relationships between large scale weather and fire is required to assess the impact of potential future weather and climate changes to fire regimes and severity. Specifically, in this poster, we related large-scale fire weather, area burned, and the amount of fire-induced ecosystem change. We showed large-scale meteorological data can be used to assess fire danger potential. Both the LaRC and CFS FWI showed increases in the fraction of grid boxes with fire counts and area burned with increasing FWI category, with a larger increase in the higher FWI categories for the majority of the vegetation types. Our analysis showed that a direct correlation exists between increased fire activity and increased FWI, and these are evident using large-scale meteorological data. During both normal and extreme fire seasons, the fraction of fire counts and area burned per 1° grid box increased with increasing FWI rating.

Our analysis suggests that fires ignite and burn in many FWI categories under nominal risk conditions, but the extreme fires require sustained weather conditions that lead to FWI category 5's. This is consistent with the time required to dry living and dead fuels that are required to sustain large fires. This work will be submitted to ERL in the months in a 2-part companion manuscript. [Soja et al., A and B]. We plan to continue this work by expanding analysis to other fire seasons, improving the vegetation type specification and relating more quantitative relationships between weather, climate and fire regimes for those biomes.