Climate and Conflict in Africa

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Motivation

- Is there a link between climate and conflict?
  - Google “Africa Drought Images”
- Intuitively:
  - Drought → Food Scarcity → Conflict
  - High Temperatures → Heat Stress (crops, animals) → Scarcity → Conflict
- Debate within the conflict community
  - Changing climate = more conflict (Burke, Lobell et al. 2009)
  - Changing climate ≠ more conflict (Buhaug 2010 and Theisen et al.)

This work: Disaggregated Statistics

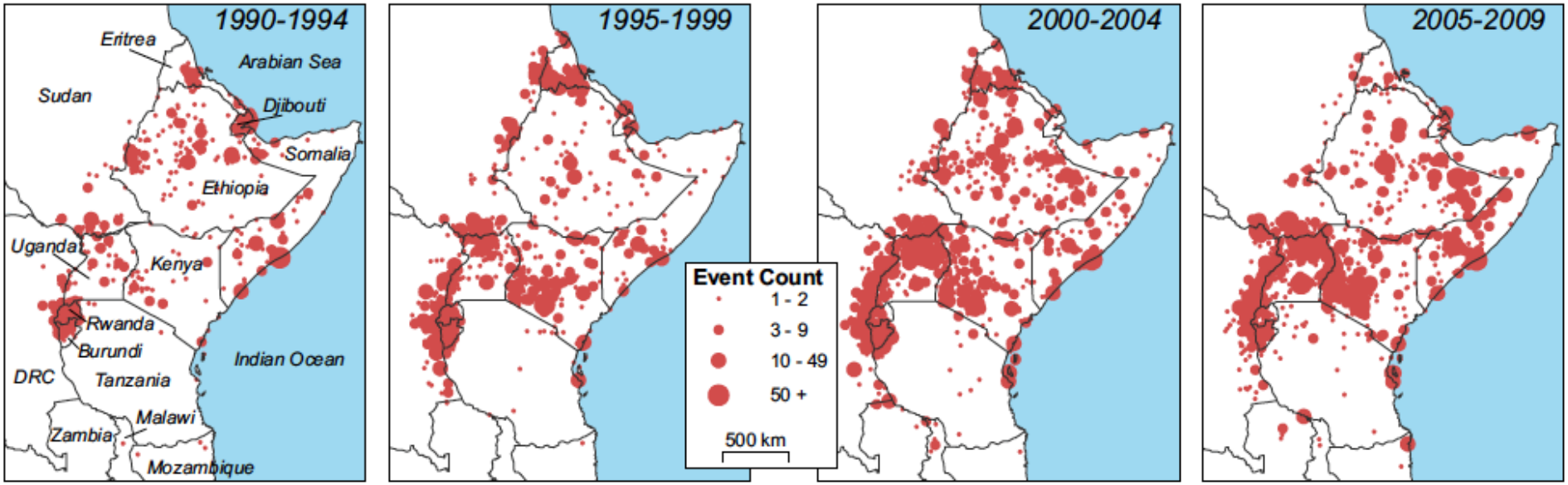
- Combine climate and conflict data
- Focus: East and Sub-Saharan Africa
  - High vulnerability to climate variability & change
- Unique: spatial and temporal disaggregation to a 1x1 degree monthly grid
- Results: Higher Temperatures have been a significant contributor to recent conflict in Africa

John O'Loughlin, Frank D. W. Witmer, Andrew M. Linke, Arlene Laing, Andrew Gettelman, and Jimy Dudhia Climate variability and conflict risk in East Africa, 1990–2009 *PNAS 2012 109 (45) 18344-18349, doi:10.1073/pnas.1205130109*

Methodology

- Focus on E. Africa (Kenya, Uganda, Tanzania)
  - 1990-2009
  - Extend to Sub-Saharan Africa
- Geo-located and gridded conflict data set
  - Thousands of hand coded entries
  - Riots to Civil wars
- Geographic data (location parameters)
- Socio-economic data (population, government)
- Climate data: SPI6 drought index and TI6 temperature index (looks at last 6 months relative to a long term mean)
  - HadCRU data for temperature and precipitation (Climatic Research Unit, University of East Anglia)
- Generalized Additive Model
  - multivariate regression model

Conflict Data (ACLED)



- Armed Conflict Location and Event (ACLED) Database

Climate Data: Temperature

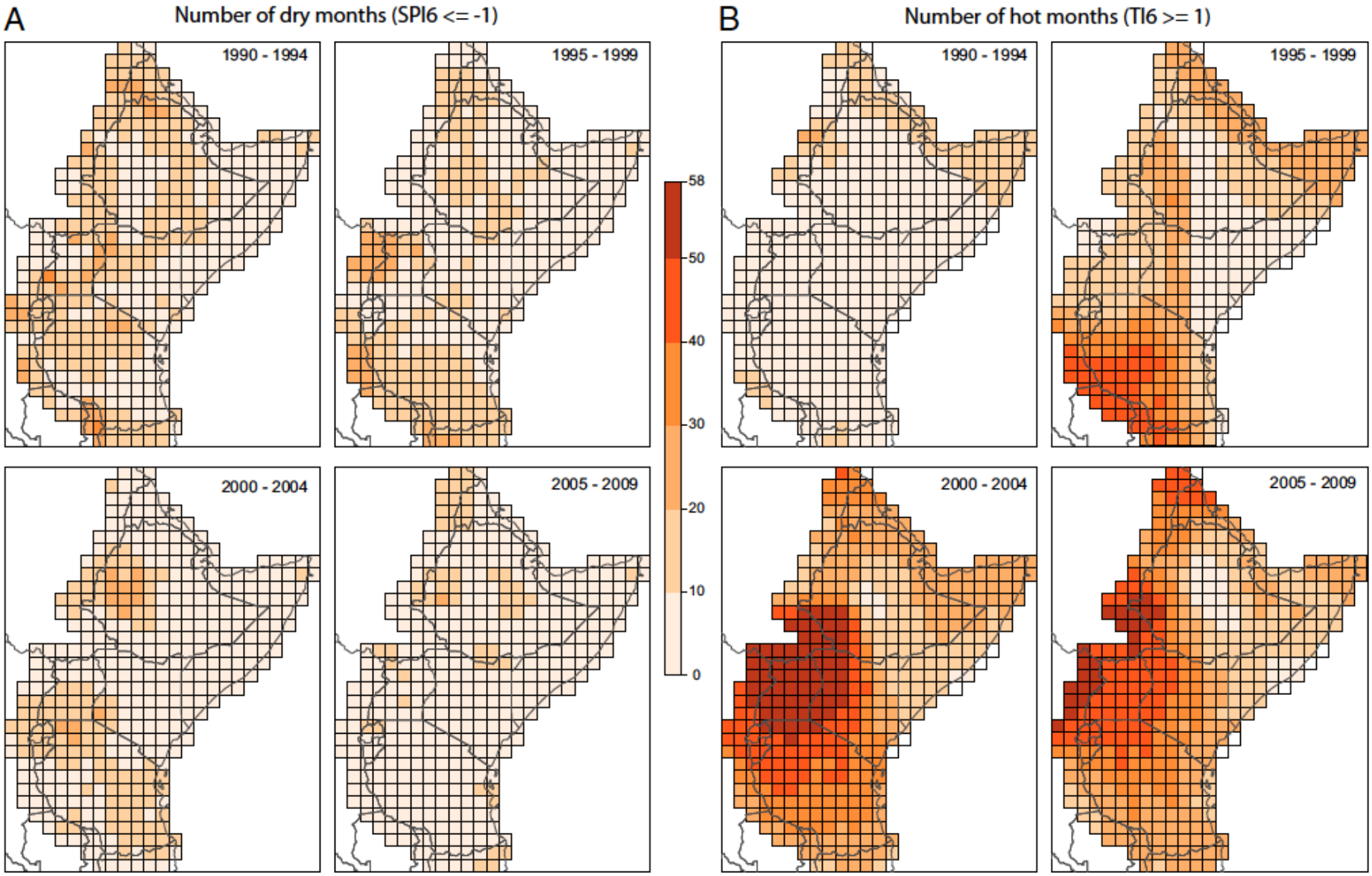
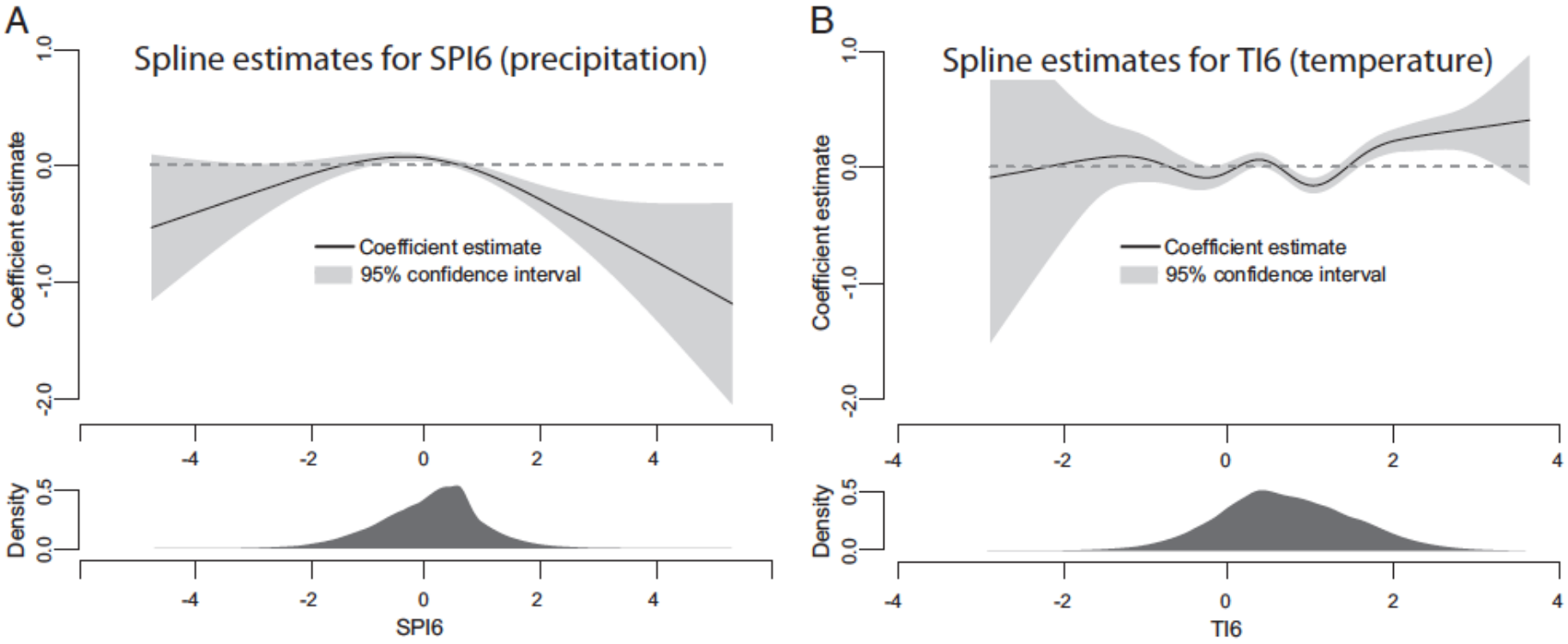


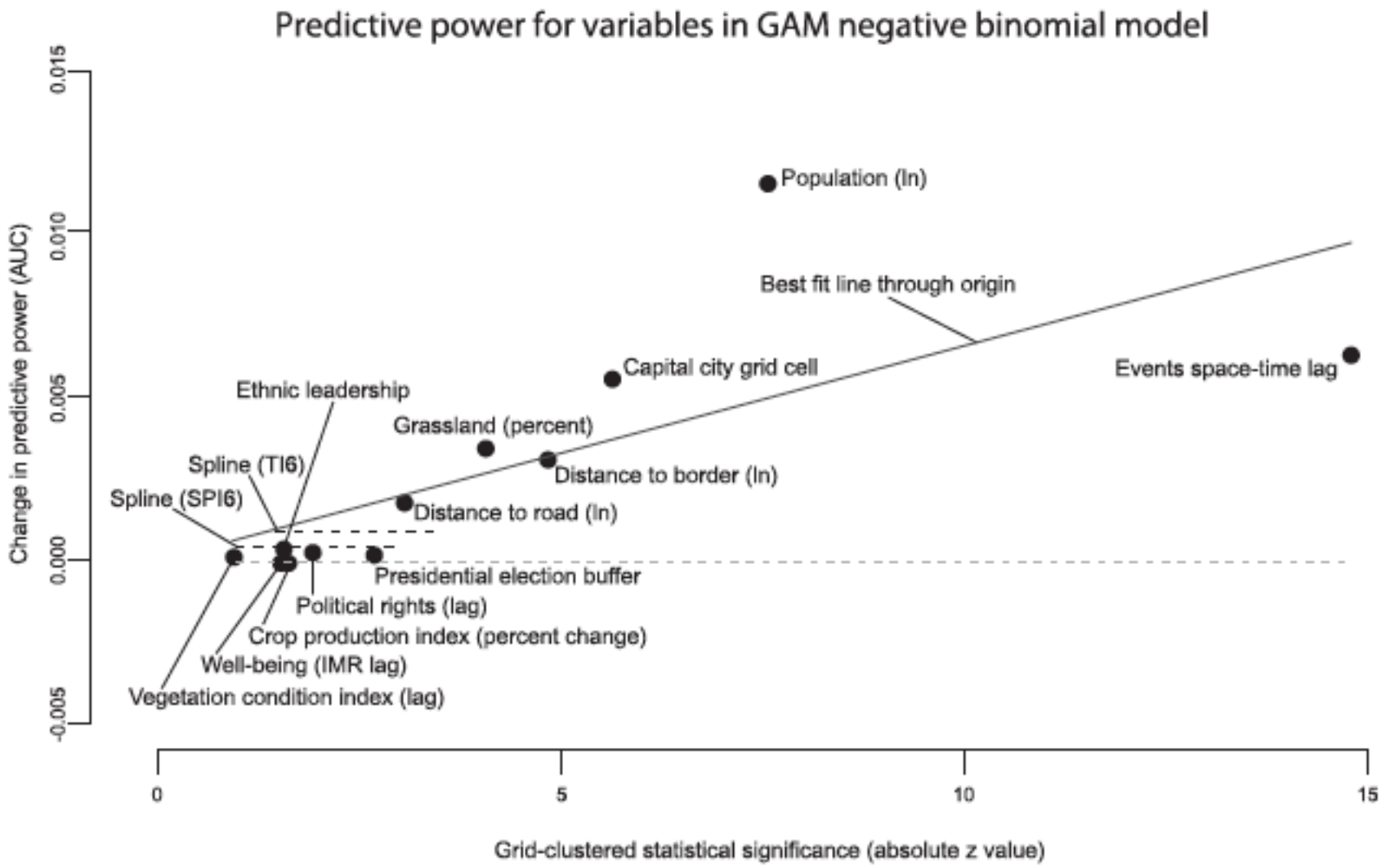
Fig. S4. Number of (*A*) dry and (*B*) hot months by 5-y period.

Generalized Additive Model Results



- A: Increased rainfall reduces conflict, though decreased rainfall (drought) does not increase it.
- B: High temperatures increase conflict tendency
- Highly statistically significant

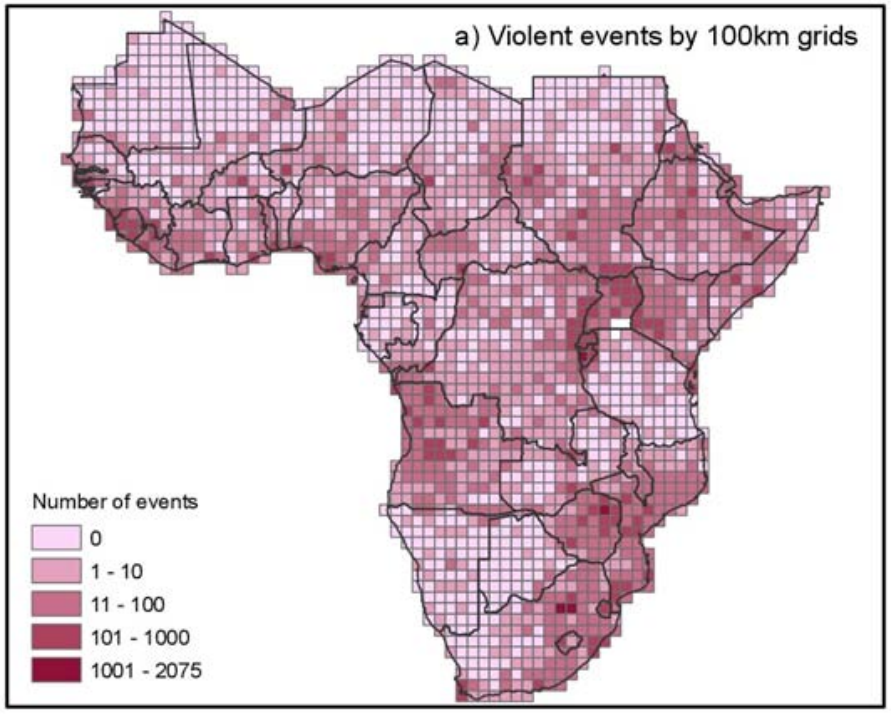
But Predictive Power is Small



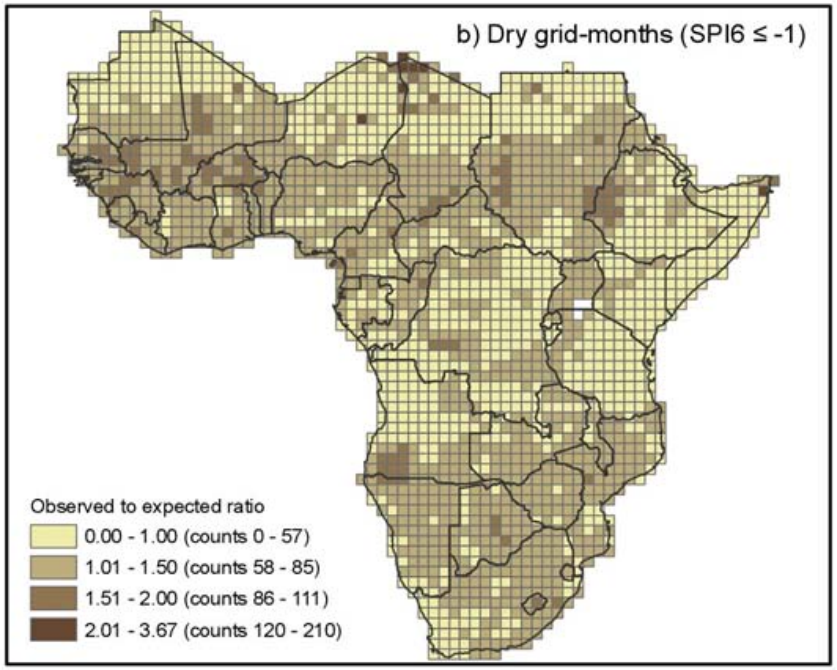
Climate effects of Temperature are significant: but smaller than socio-economic effects

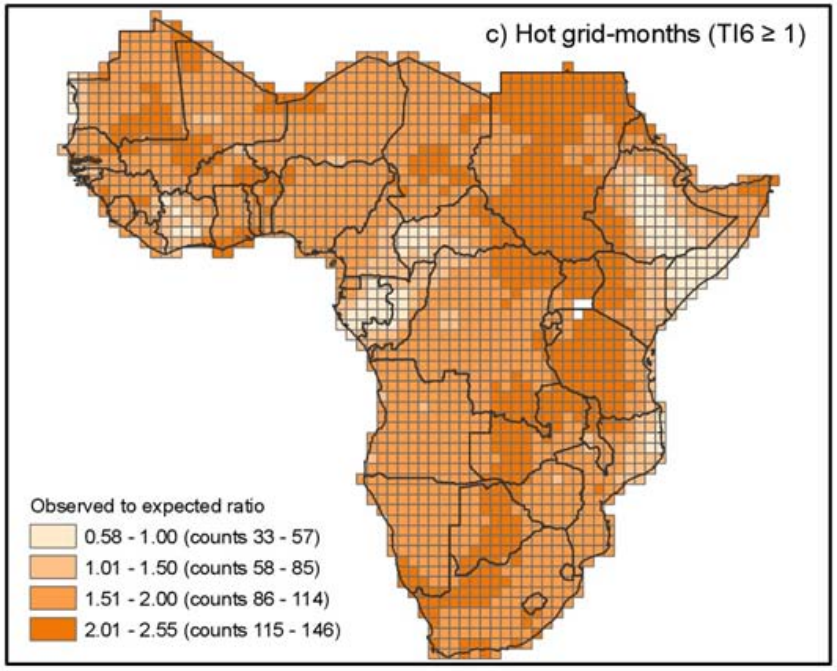
All Sub-Saharan Africa

TI6 – Grid-cell (100km) temperature deviation from the long-term monthly mean (1949-2009).
SPI6 – Grid-cell precipitation deviation from the long-term monthly mean (1949-2009).
Conflict – ACLED events (n= 55, 427), excluding non-violent types, aggregated to the grid observation units.

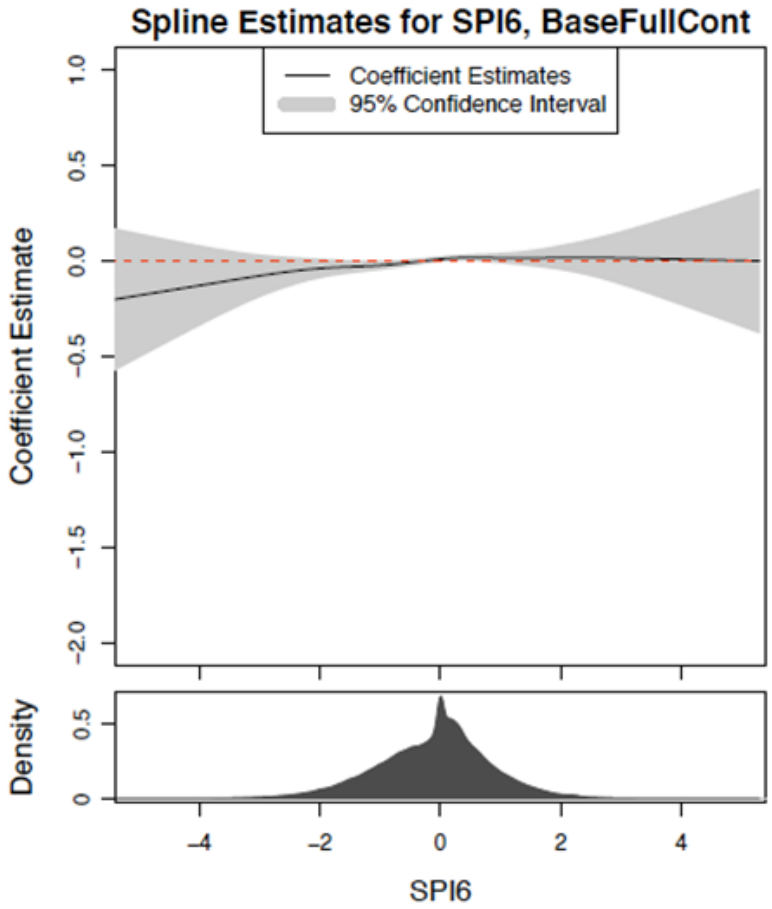


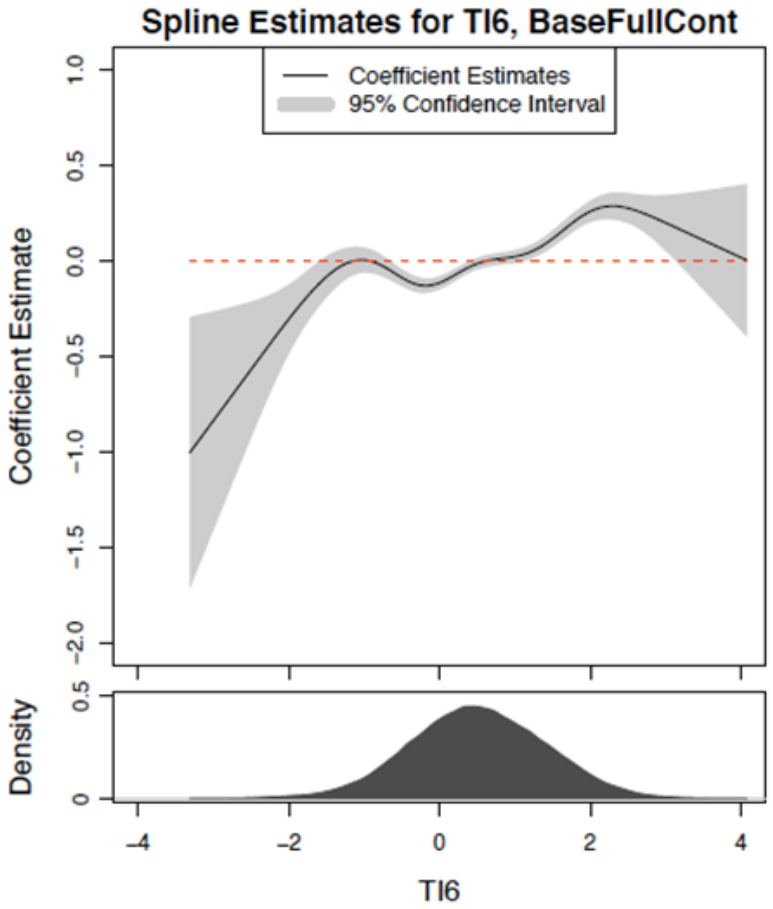
Control variable data is listed in additional slides





GAM model with expanded predictors

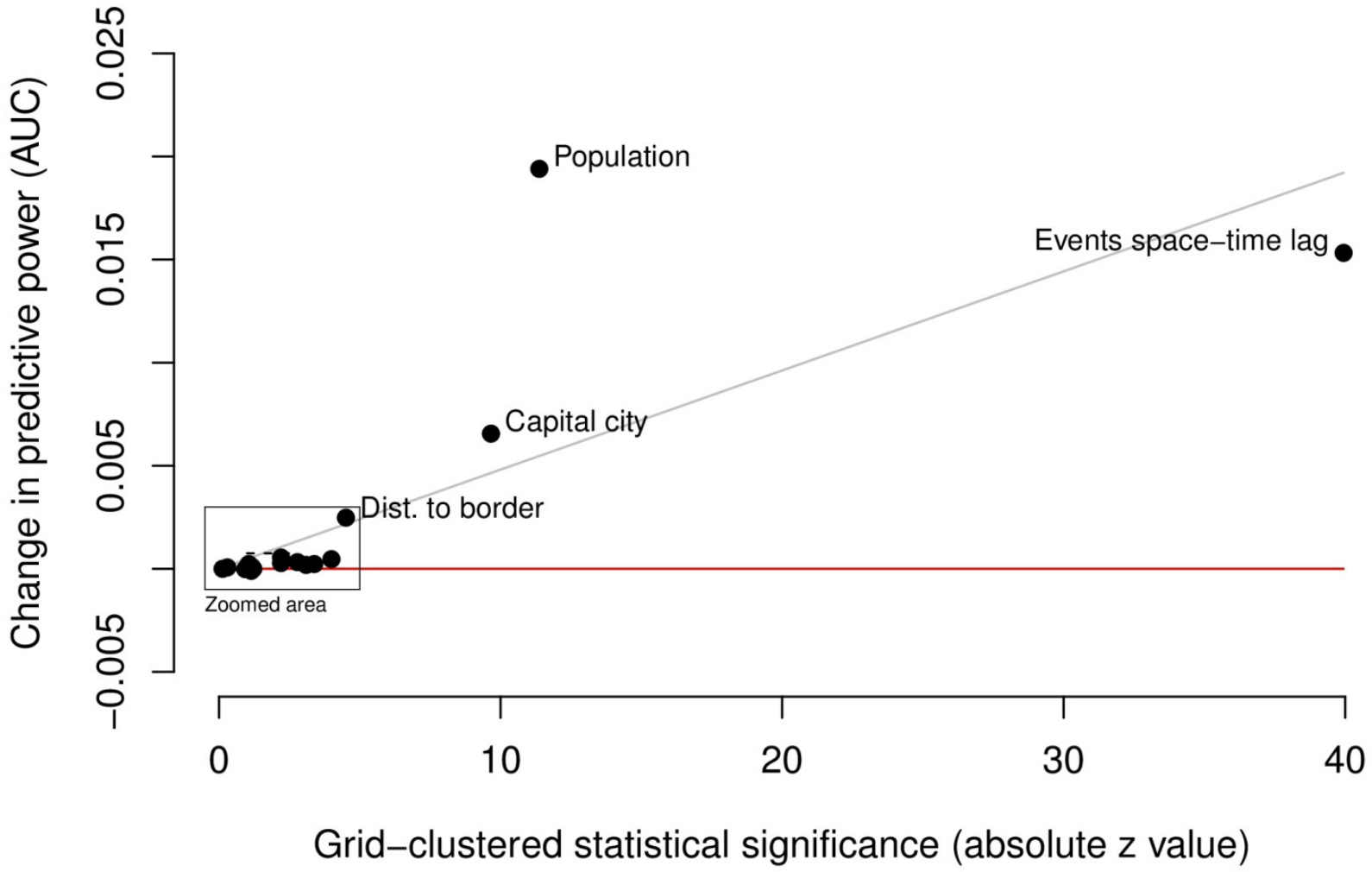




For explanation of the generalized additive modeling approach see Wood (2006)

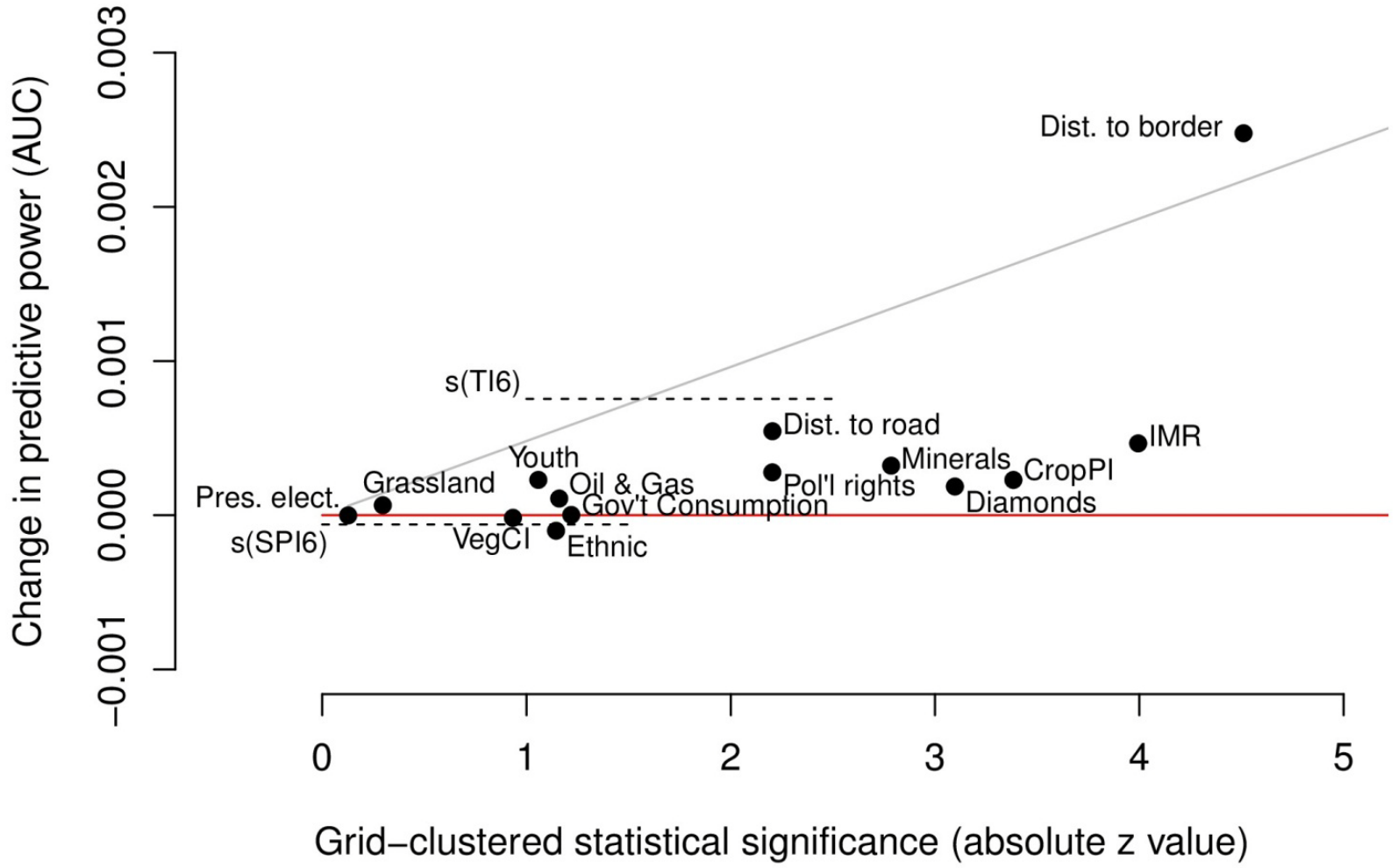
Again: temperature is significant: positive correlation with conflict

Predictive power results from GAM: All Sub-Saharan Africa



Methodological approach adopted from Ward, Greenhill, and Bakke (2010)

Predictive power results from GAM - zoomed



Methodological approach adopted from Ward, Greenhill, and Bakke (2010)

Temperature is a significant effect, more than many other factors:
But Smaller than geography or population

Summary & Future Work

- Climate Contribution to Conflict is significant using Generalized Additive Model
- Temperature is more important than Precipitation
- Robust when compositing is done (high & low temps)
- Small in comparison to socio-economic and political indicators, but significant

Next Steps:

  - Repeat the analysis with CCSM4 'synthetic' climate statistics (how robust)?
  - Attempt to project into the future using CCSM4 RCP8.5 scenarios: how much impact will climate have on conflict in the late 20th Century given this regression

Additional slides (control variables)

Table 1. Variables and their sources

Variable	Data Resolution: Temporal	Data Resolution: Spatial	Source/Notes	Grid Aggregation Method
Sociodemographic				
ACLED violent events	1980-2009[f]	Town	ACLED + Univ. of Colorado addition	Sum
Population (ln)	1990-2015[b]	2.5 minute	Gridded Population of the World, version 3 (GPWv3)	Sum
Youth population (15-20)[g]	1970-2010[b]	Country	UN 2010 World Population Prospects report	Pop-weighted mean
Infant mortality rate (1-yr lag)	1950-2010[c]	Country	UN Inter-agency Group on Child Mortality Estimation	Pop-weighted mean
Political rights (1-yr lag)	1972-2010[c]	Country	Freedom House	Majority pop
Presidential election (buffer)	1990-2010[d]	Country	Buffer is ±3 months from election month	Majority pop
Ethnic leadership	1990-2009[d]	Sub-country	Archigos (Goemans, Gleditsch and Chiozza 2009) and Ethnologue's World Language Mapping System	Minimum 20% land area
Colonial legacy[g]	Static	Country		Majority pop
Govt consumption per capita[g]	1970-2010[c]	Country	Penn World Tables v7.1, variable 'kg'	Pop-weighted mean
Physiographic				
Distance to border (ln)	Pre/post Eritrea	Country	ESRI World Country Boundaries	Mean 10km sub-grid
Capital city grid cell	Eritrea, Cote d'Ivoire, Nigeria	City	ESRI World Cities	Binary
Grassland (pct)	1700-1990[a], 2000-05[b]	5 minute	History Database of the Globel Environment (HYDE) v3.1	Sum
Distance to road (ln)	Static	Polyline	Digital Chart of the World, primary & secondary roads	Mean 10km sub-grid
Crop production index (pct Δ)	1980-2009[c]	Country	FAO agricultural production; annual percent change	Pop-weighted mean
Veg. cond. ind. (6 mnth lag)	1981-2011[e]	16 km	NOAA GVI-x Vegetation Health Product, (NDVIcurr - NDVImin)/(NDVImax - NDVImin)*100	4-week mean of 16km data
Diamond mines/grid[g]	2005	Point	PRIO Diamond Dataset	Sum
Oil & nat'l gas value/GDP[g]	1932-2009	Country	Michael Ross data normalized w/ World Bank GDP	Pop-weighted mean
Minerals (no diamonds) sites/grid[g]	2012	Point	USGS Mineral Resources Data System	Sum
Climate				
Precipitation (SPI6)	1949-2009[d]	0.5°	Climate Research Unit	Mean of 1/2 degree data
Temperature (TI6)	1949-2009[d]	0.5°	Climate Research Unit	Mean of 1/2 degree data

[a]10-year interval, [b]5-year interval, [c]yearly, [d]monthly, [e]weekly, [f]daily

[g]Denotes variable added for this paper, all other variables included in O'Loughlin et al. 2012