Civil Conflicts are Associated with the Global Climate

Hsiang, Meng & Cane (Nature, 2011)

Solomon M. Hsiang

Woodrow Wilson School of Public and International Affairs
Princeton University

December 19, 2011
Woodrow Wilson Center, Washington D.C.

Motivation: Global Climate and Civil Conflict

"Given the many causes of [civil] unrest, it is not surprising that a meaningful correlation with climate is hard to pin down....

Even if the data and methods were up to the task – which they aren't – the 'causal noise' would be too loud to discern the currently still weak climate signals in civil wars....

It is extremely difficult to identify simple, robust cause-and-effect relationships between changes in climate and societal outcomes..."

- Q. Schiermeier (Nature, September 2010)

How might climate affect conflict?

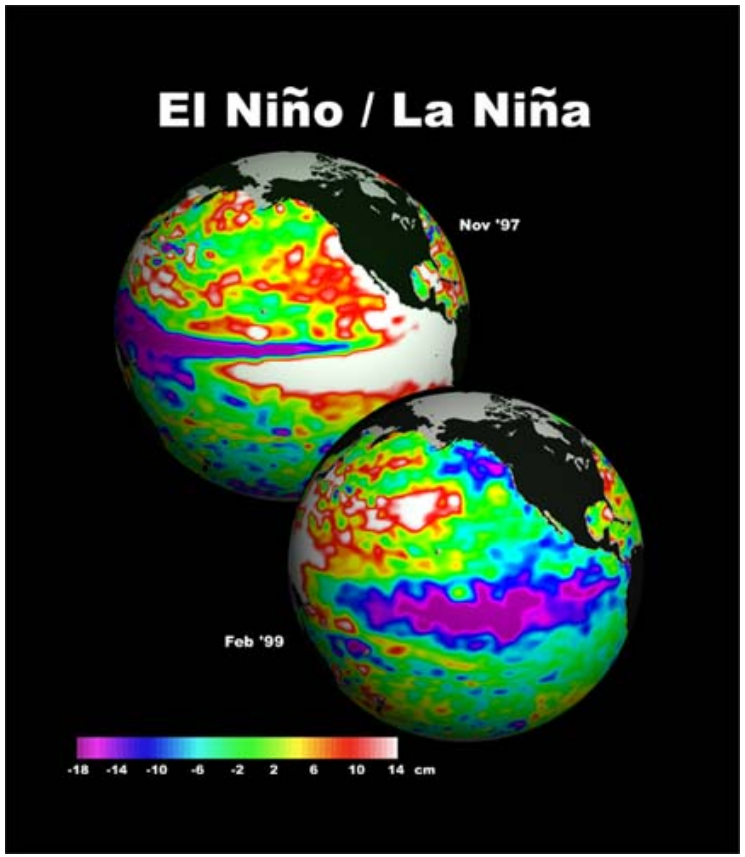
▸ Non-political political conflict

- **Malthusian hypothesis** - Conflict over resources (Homer-Dixon, 1999).
- **Predation and expropriation** - The "prize" of winning may increase in value (Dube & Vargas, 2009).
- **Labor market** - The opportunity cost to soldiering may change (Angrist & Kugler, Rev. Econ. & Stat. 2008).
- **Government capacity** - Economic losses may reduce the government's ability to enforce peace (Humphreys, J. Conflict Resolution 2005).
- **Distributional concerns** - Exacerbating inequality may lead to ideological conflict (Grove, Medieval Hist. J. 2007).
- **Psychological** - Climatic conditions affect aggression (Anderson et al., Adv. Exp. Social Psych. 2009).
- **Social structure and fragmentation** - Climate affects social structures that are more or less conflict prone (Diamond, 1999).

In this analysis, we are agnostic about mechanisms (future work). Establishing a causal link is sufficiently challenging.

Our contribution: inferring causality

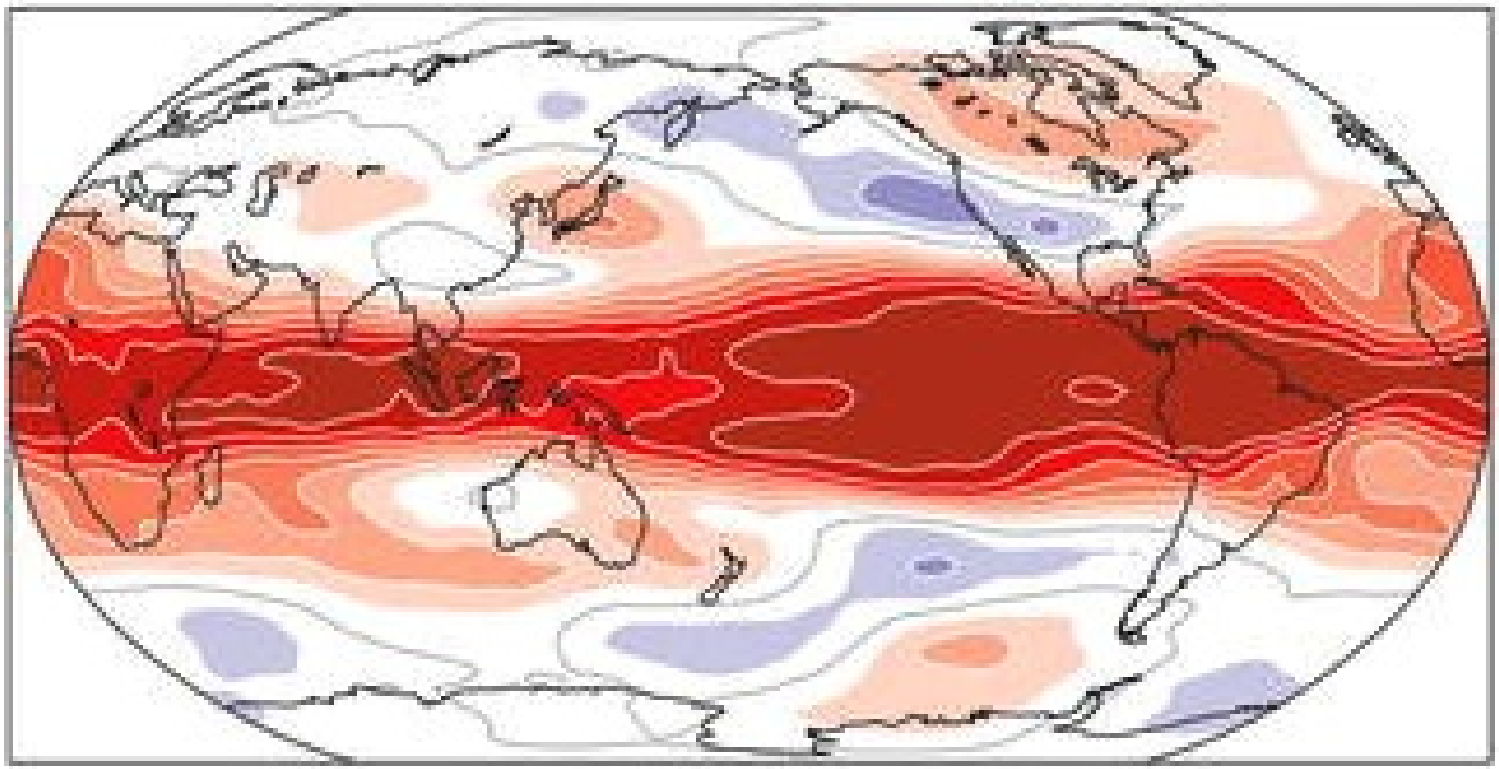
We demonstrate that the global climate can influence civil conflict by examining the El Niño-Southern Oscillation (ENSO).



Most obvious feature of ENSO: changes in Pacific ocean temperature.

Why look at ENSO?

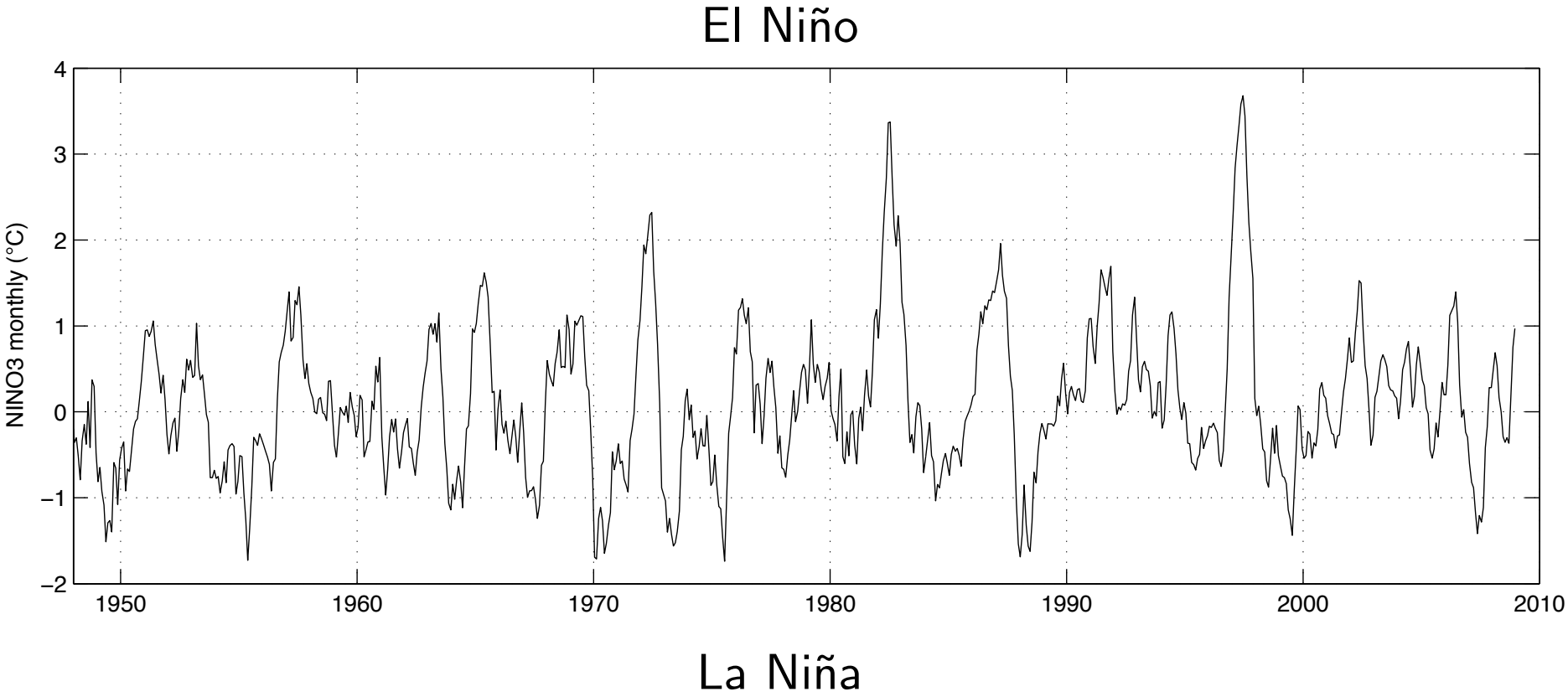
ENSO is the dominant pattern for the entire atmosphere at annual frequencies.



First mode from principle component analysis (Trenberth & Smith, Journal of Climate, 2006).

Why look at ENSO?

The state of ENSO changes from year to year. It is considered "quasi-periodic" with a characteristic period of 3-7 years.



Empirical design

Step 1: Separate countries into two groups:
Teleconnected - the countries that are highly exposed to ENSO
Weakly affected - the countries that too far from the Equator to be highly exposed

Step 2: Estimate the response of the teleconnected group to climate changes over time:
El Niño - "treatment"
La Niña - "control"
In reality, there is a spectrum of states between these two extremes.

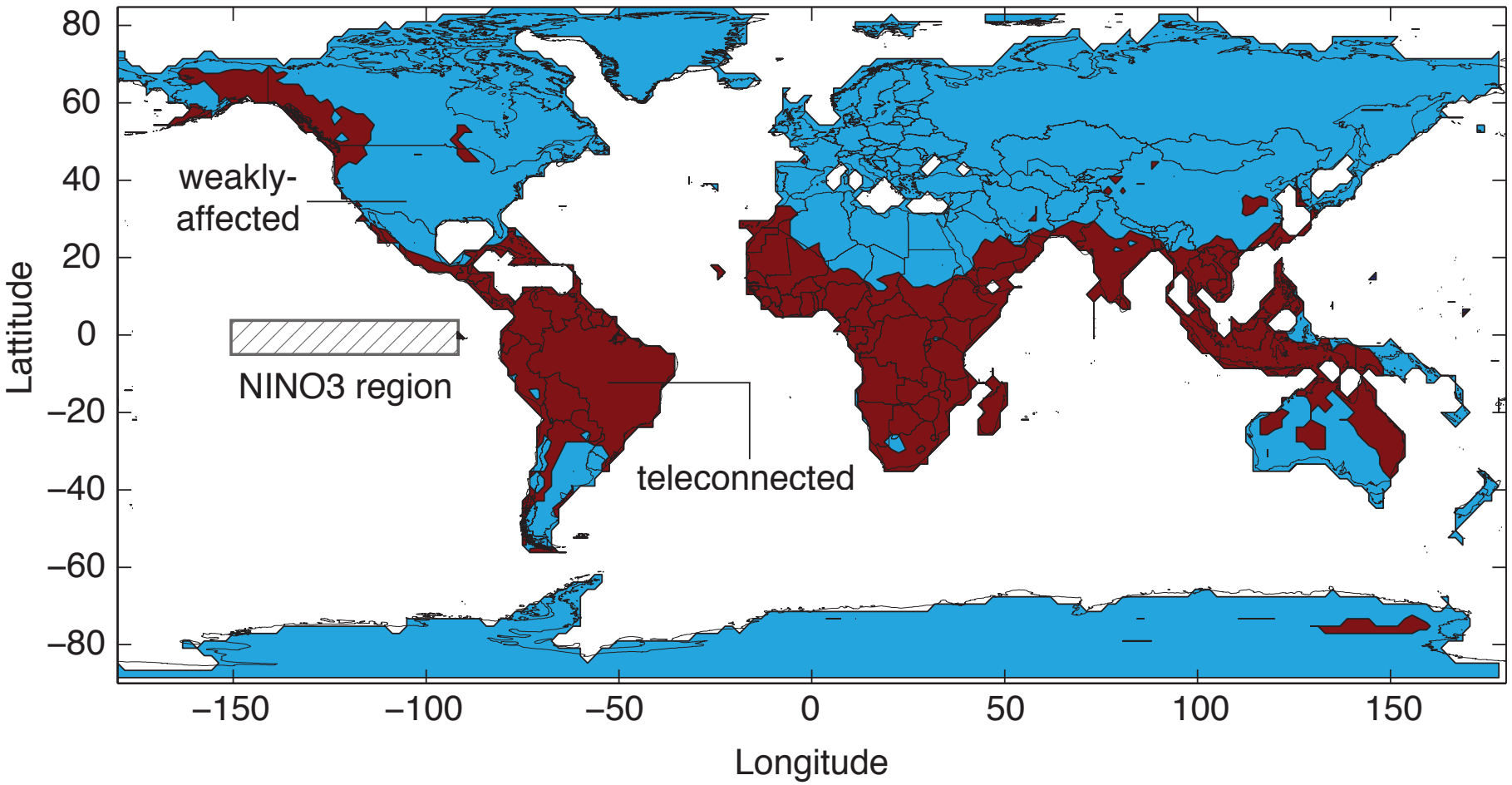
Step 3: Try to falsify our assumption that climate changes are independent of other important global changes using weakly affected group of countries.

▸ Identifying assumptions ▸ Potential outcomes notation ▸ This is not an instrumental variables approach

Watch ENSO Flipbook

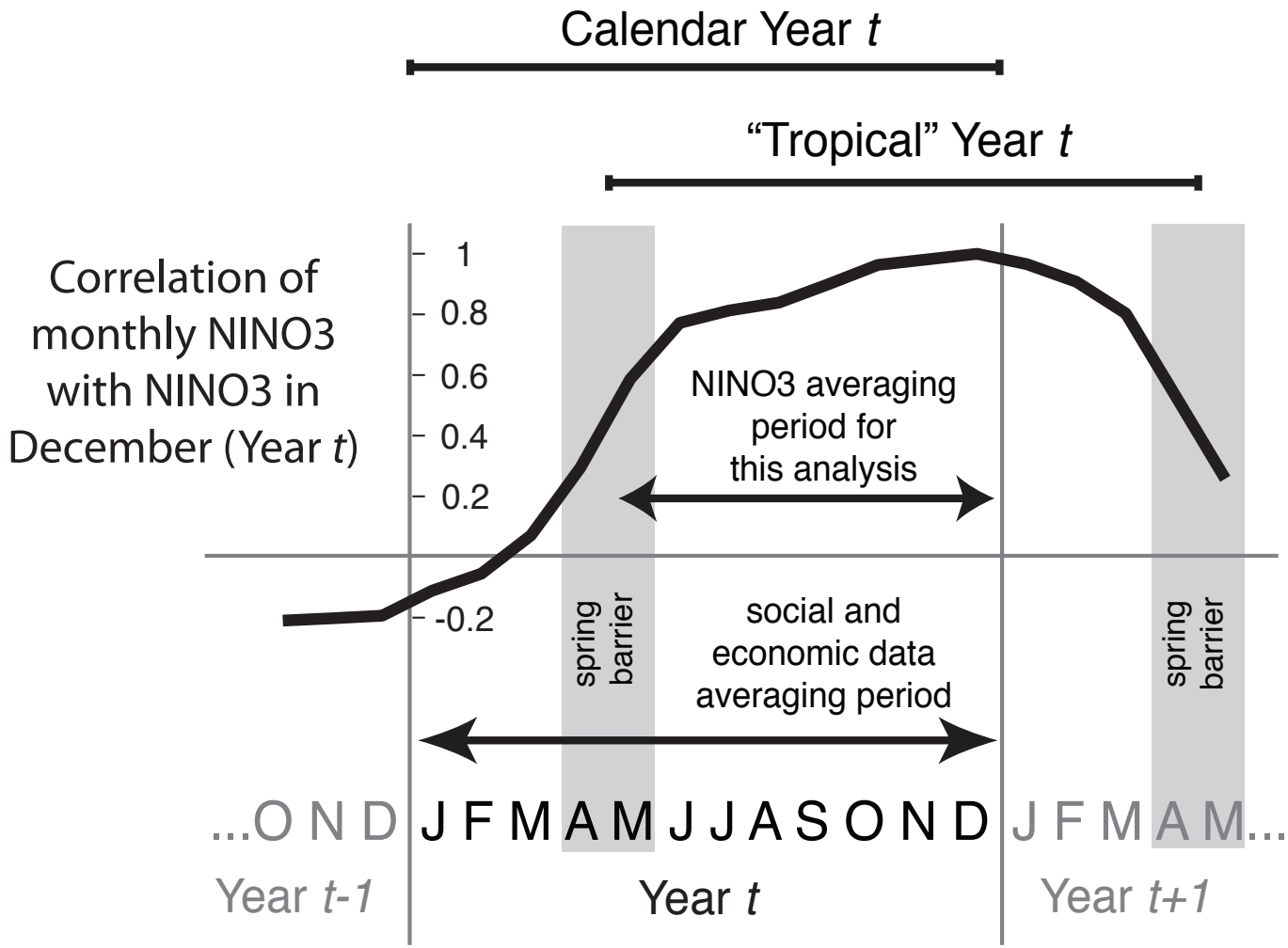
▸ ENSO flipbook

Innovation 1: Identifying teleconnected societies



▸ The Teleconnection Mechanism ▸ Robustness of construction

Innovation 2: Matching socioeconomic and ENSO data



Independent Variable: NINO3 averaged May-Dec. (°C)

	Dependant variable	Teleconnected	Weakly-Affected
(1)	**Temperature** (°C)	0.048*** [0.009] n = 4067	-0.017 [0.011] n = 3461
(2)	**Precipitation** (mm/day)	-0.12*** [0.02] n = 2323	-0.00 [0.01] n = 1835
(3)	**Cereal yields** (%)	-1.05*** [0.40] n = 3934	0.71 [0.43] n=2690
(4)	**Agricultural Income** (%)	-0.57*** [0.16] n = 3187	-0.33 [0.22] n = 2399
(5)	**Total Agr. Income** (%)	-1.06*** [0.37] n = 37	-0.22 [0.37] n = 32

Clustered SE in brackets, *** p<0.01.

Conflict Data

Onset of Intrastate Conflict Dataset maintained by the Peace Research Institute of Oslo (Gleditsch et al. 2002)(Strand 2006)

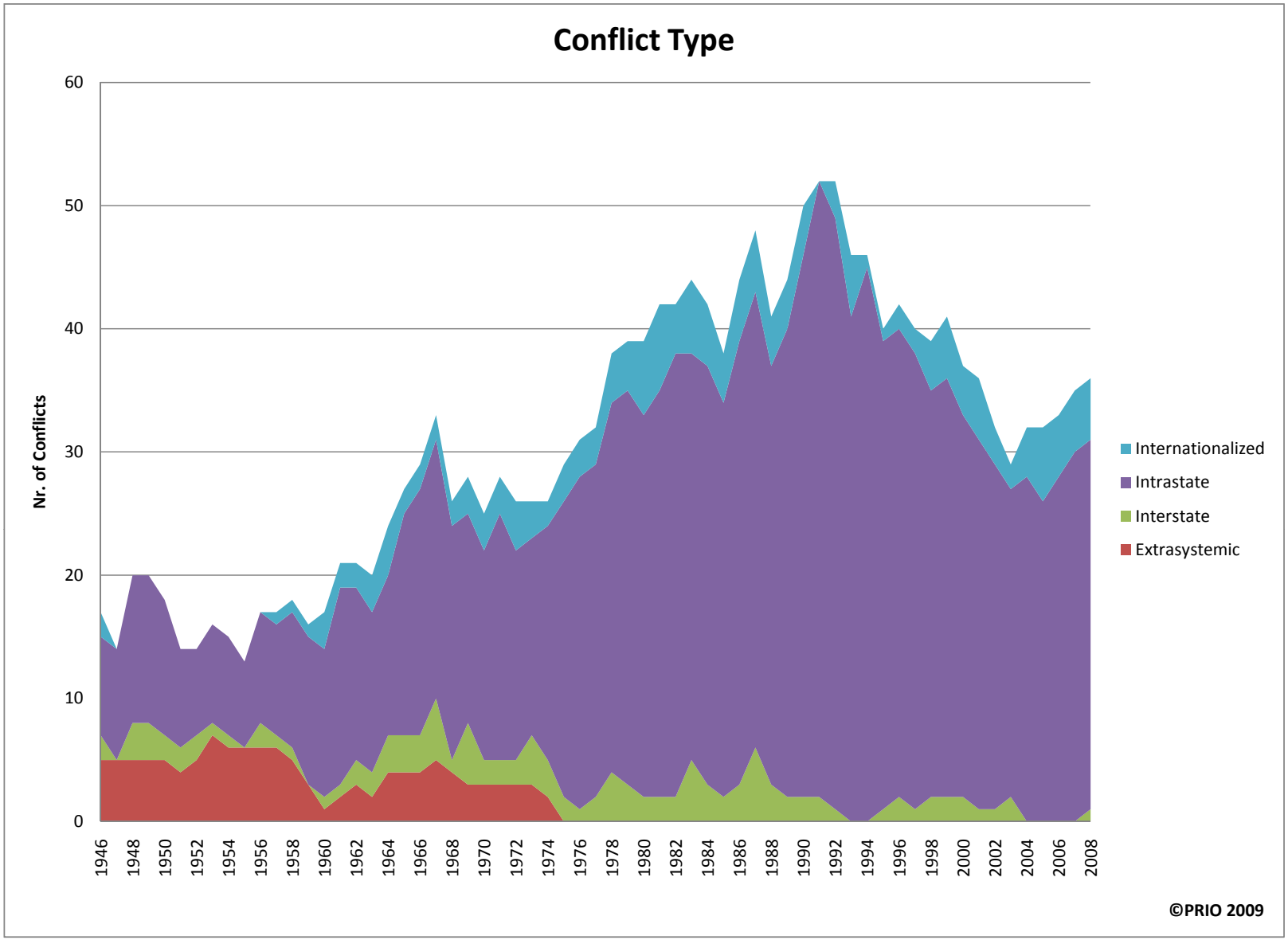
Records "conflict onset" occurring in a country-year as a binary variable.

A conflict onset occurs if more than 25 battle related deaths occur over a stated political incompatibility. ▸ FAQs

1950-2004, at most 175 countries in cross-section (after matching).
7,528 country-year observations with 234 civil conflicts onsets

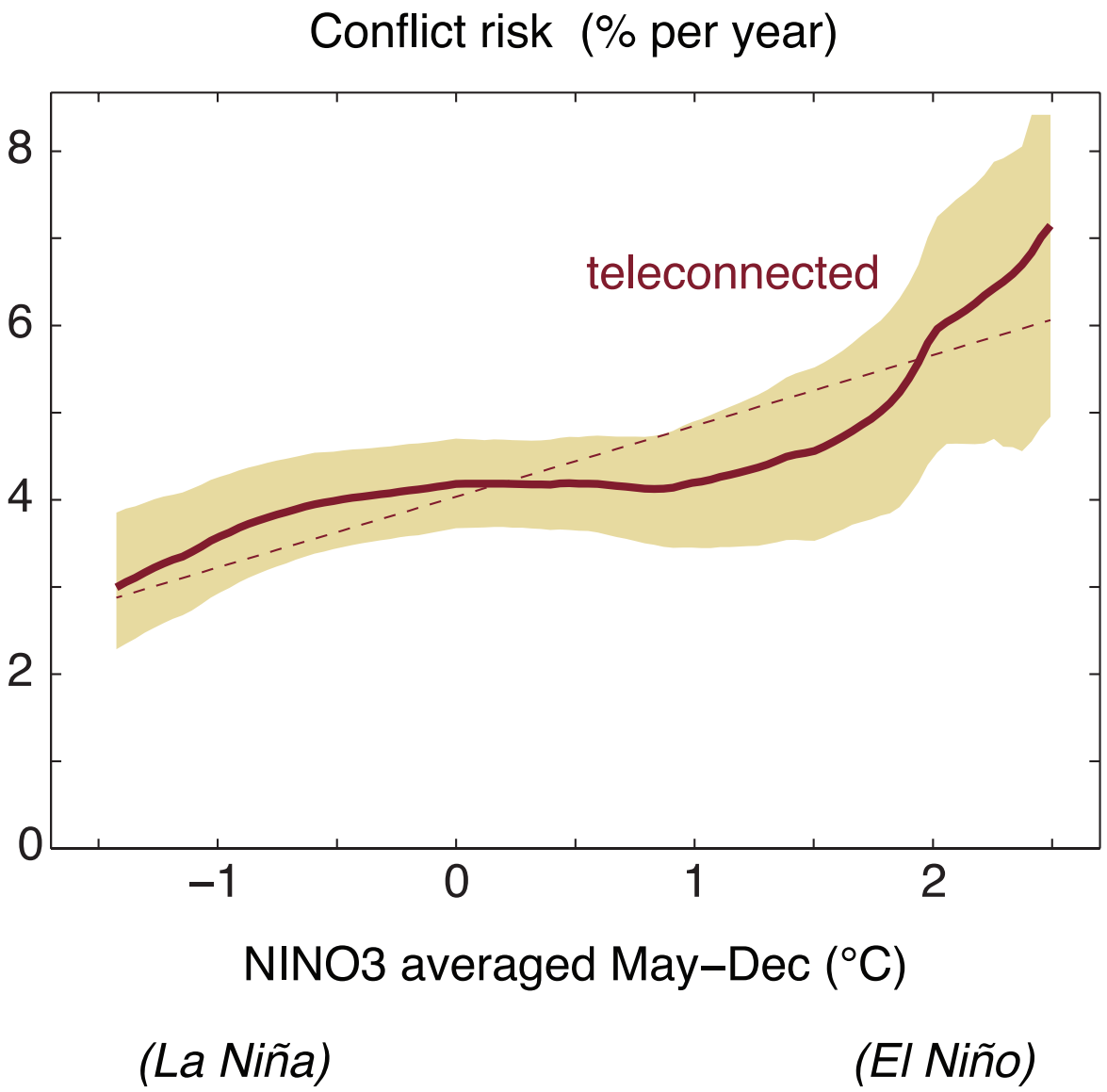
95 small conflicts ($<$ 1000 total battle deaths)
133 large conflicts ($>$ 1000 battle deaths in at least one year of conflict)

Why civil conflict?



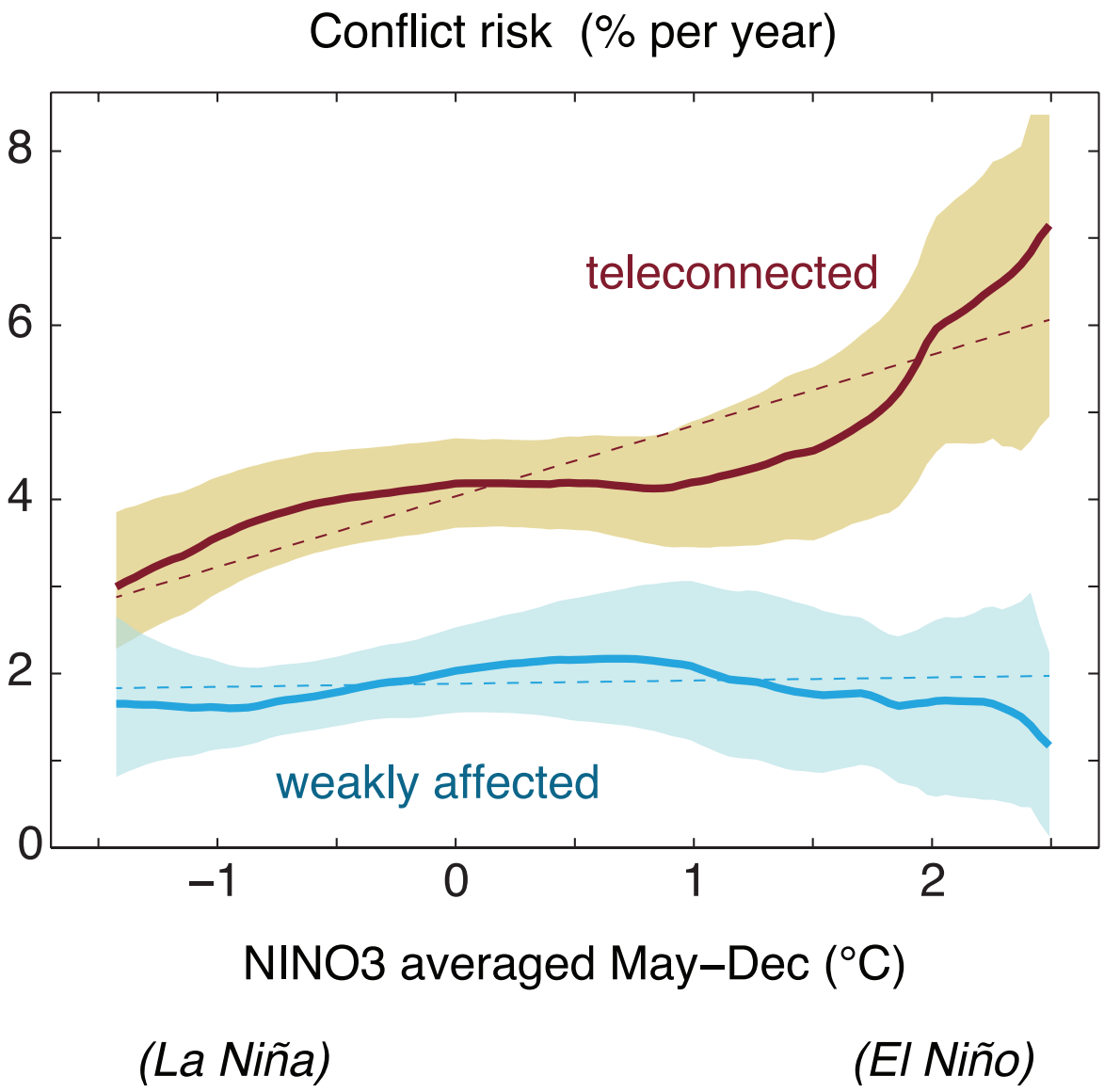
Main result: Year-to-Year Variations

▸ Time series plot



Main result: Year-to-Year Variations

▸ Time series plot

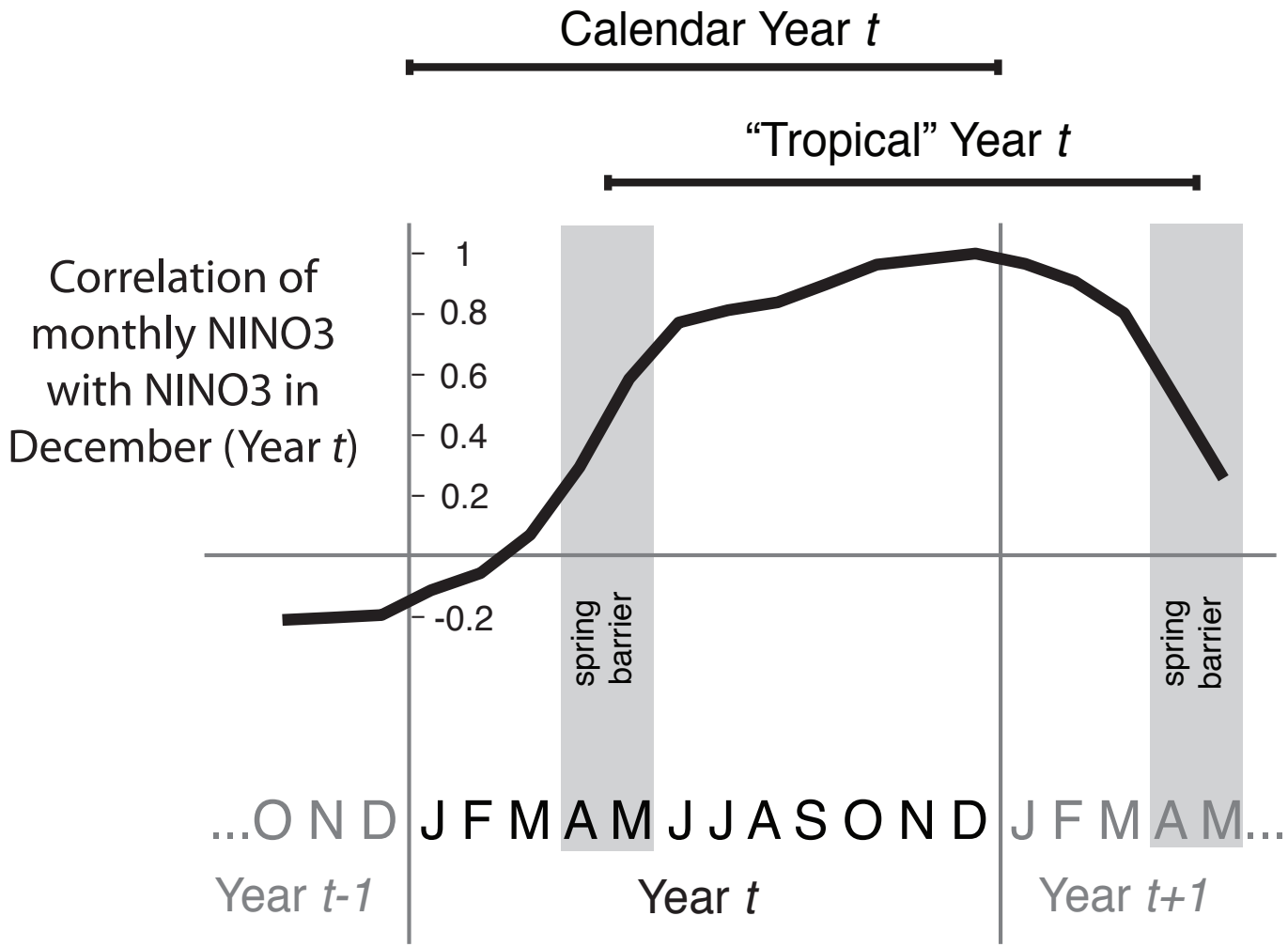


Dependent Variable: Conflict Risk (% / yr)

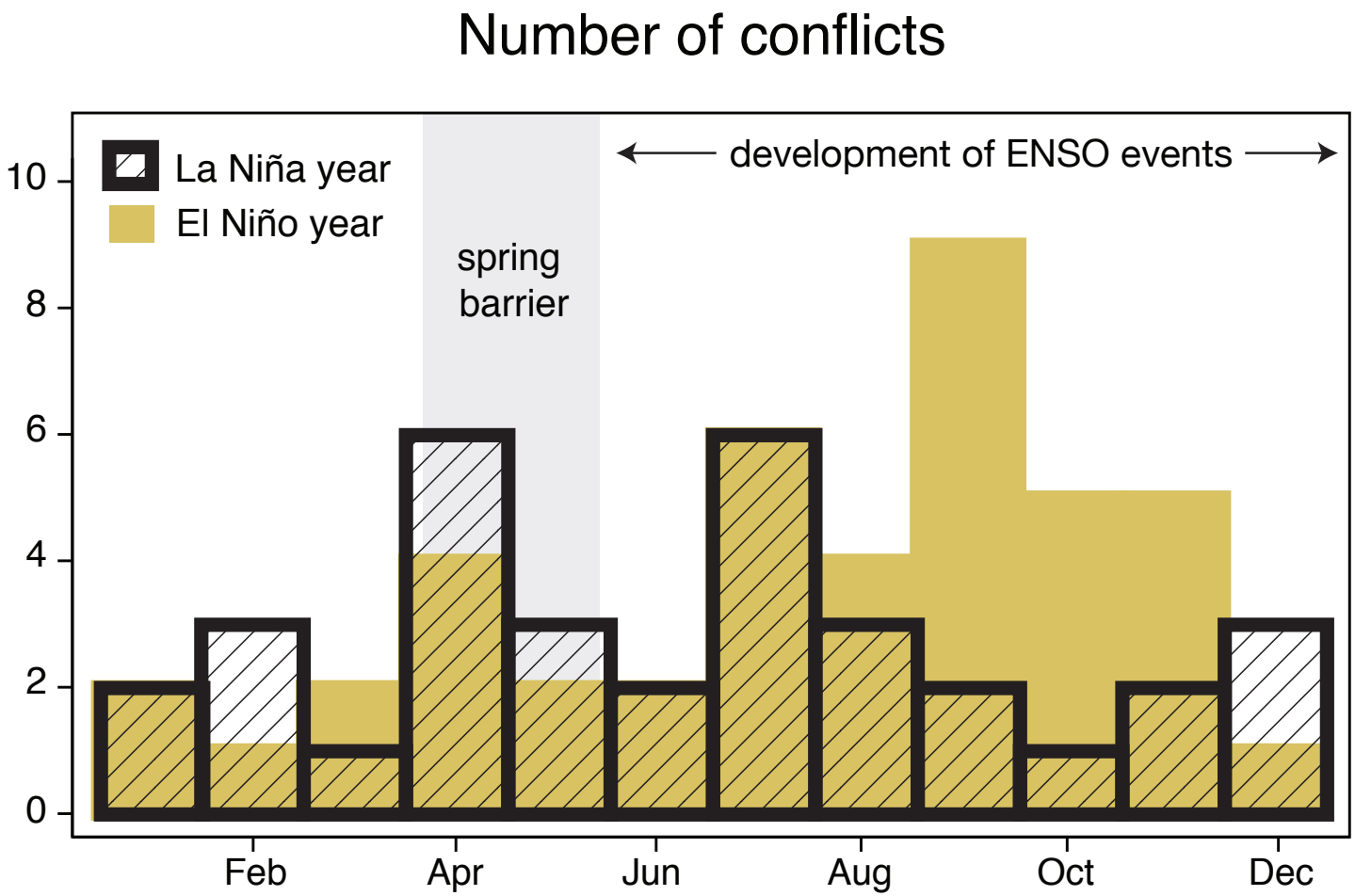
	Independant variable model	**Teleconnected** (%/yr°C)	**Weakly-Affected** (%/yr°C)
(1)	**May-Dec. NINO3** n=54	0.76* [0.39]	0.16 [0.31]
(2)	same as (1) with linear trend	0.85** [0.40]	0.06 [0.30]
(3)	same as (2) with post-89 dummy	0.81** [0.32]	0.04 [0.31]
(4)	same as (3) 1975-2004 only	0.83** [0.35]	0.33 [0.45]
(5)	**May-Dec. NINO3** FE-panel, country-trends	0.89** [0.39] n = 3978	0.04 [0.32] n = 3400
(6)	same as (5) non-African only	0.84** [0.41] n = 2084	-0.01 [0.29] n = 3203

White or Conley HAC S.E., ** p<0.05, * p<0.1.; 1989 dropped.

Within-year timing of ENSO



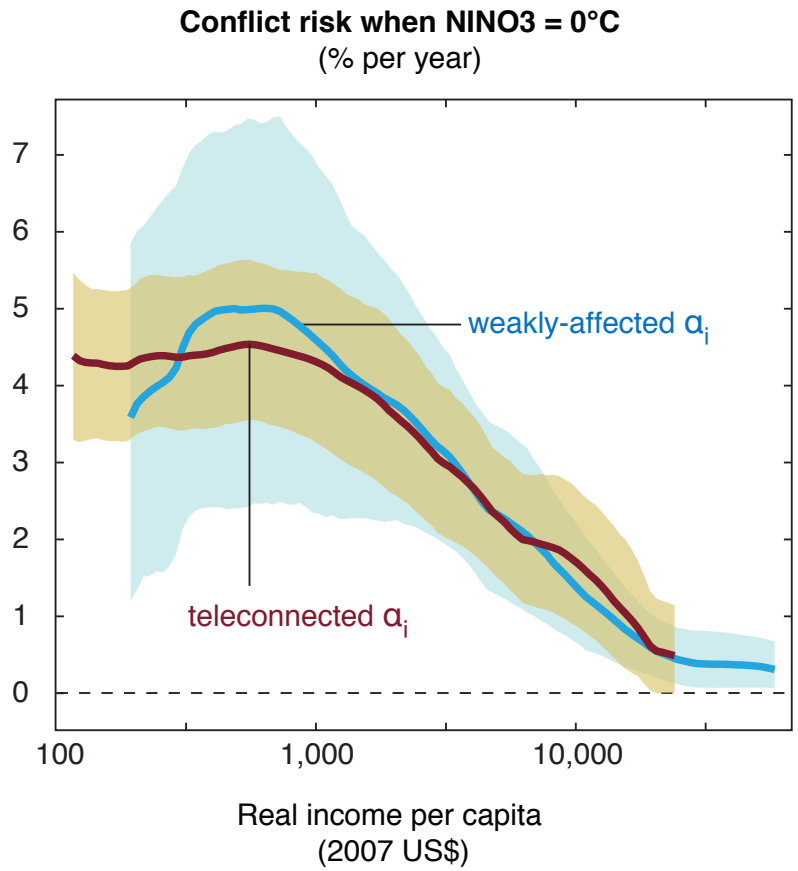
Within-year timing of conflicts



Only half of conflicts have onset month data.

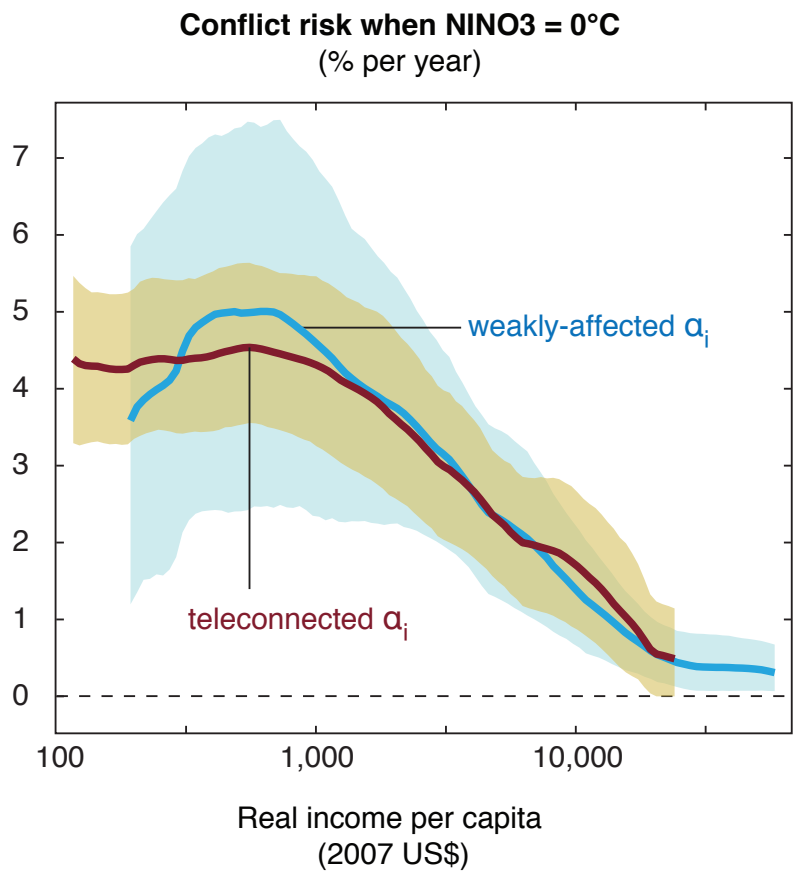
The importance of income

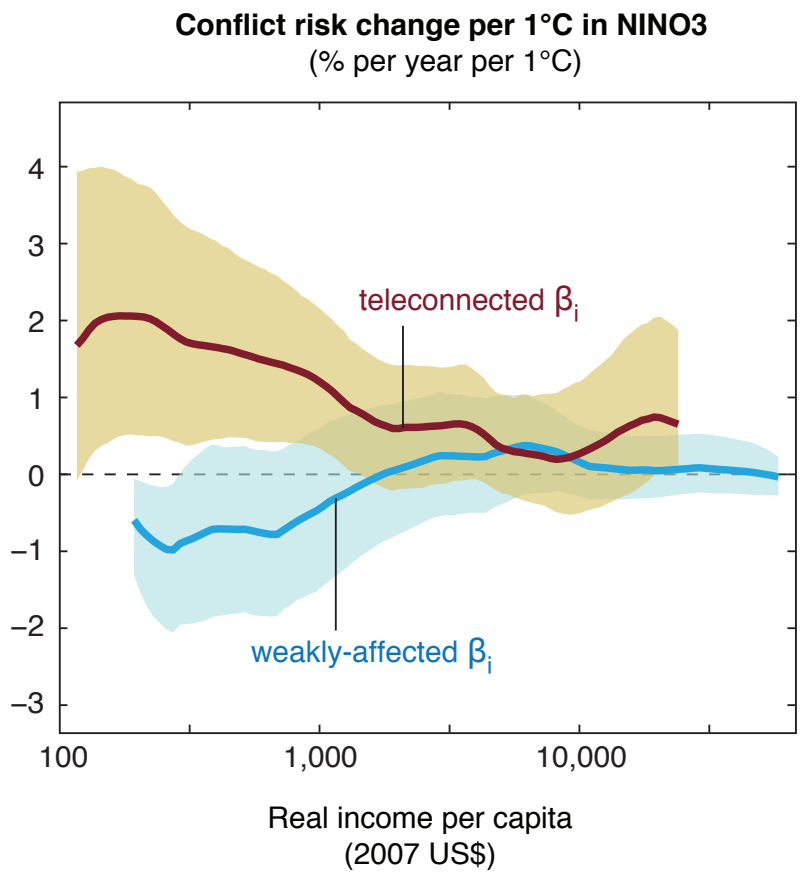
Country specific regression: $conflict\_onset_{it} = \alpha_i + \beta_i \times NINO3_t$



The importance of income

Country specific regression: $conflict\_onset_{it} = \alpha_i + \beta_i \times NINO3_t$

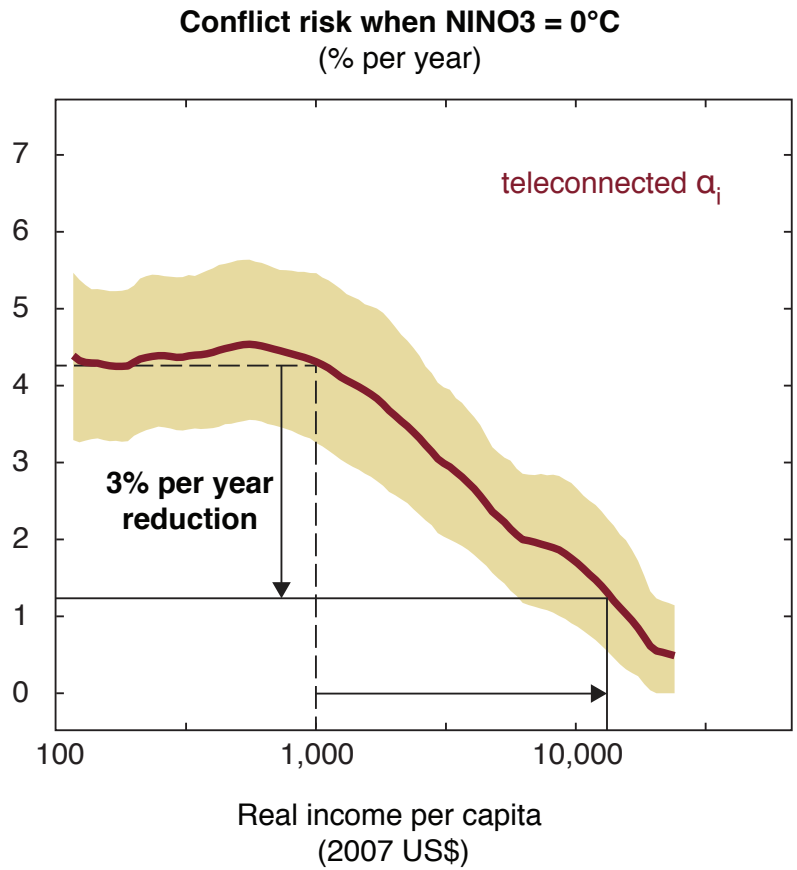


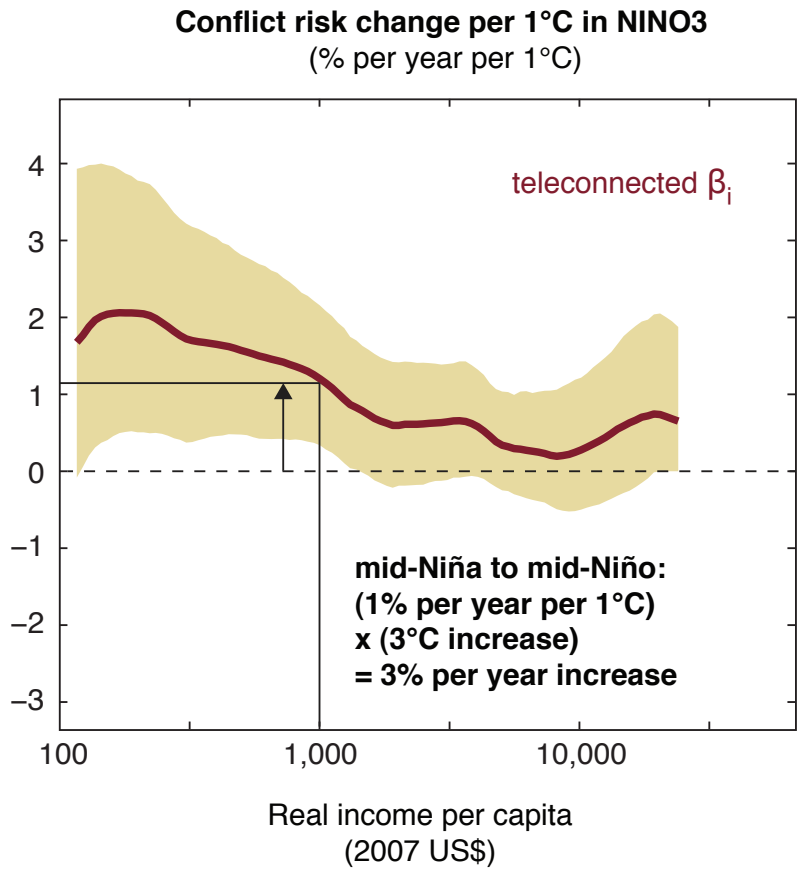


▸ By latitude

Comparing the effect of income with the effect of ENSO

Country specific regression: $conflict\_onset_{it} = \alpha_i + \beta_i \times NINO3_t$





Making sense of magnitudes

Two-thirds of observed conflicts are in the teleconnected group.

Average risk of conflict in the teleconnected group is 4.1% per year.

A change from La Niña to El Niño alters teleconnected conflict risk from 3% to 6% per year.

For a country with per capita income of $1,000, this increase in conflict risk is the same size (opposite sign) as raising income above $10,000 in the cross-section.

We estimate that between 1950-2004, ENSO affected the timing of 21% of all conflicts ($\sim$ 48 conflicts in PRIO).

Limits and applications

Limits:

1. Our results do not tell us the mechanism linking ENSO and conflict
   - Recall: smoking and lung cancer
2. Climatic changes do not cause conflict in isolation
   - Analogy: car accidents on icy roads
3. Climatic changes are not the only cause of conflict: 80% unrelated
4. Our results do not tell us what will happen under future global warming.

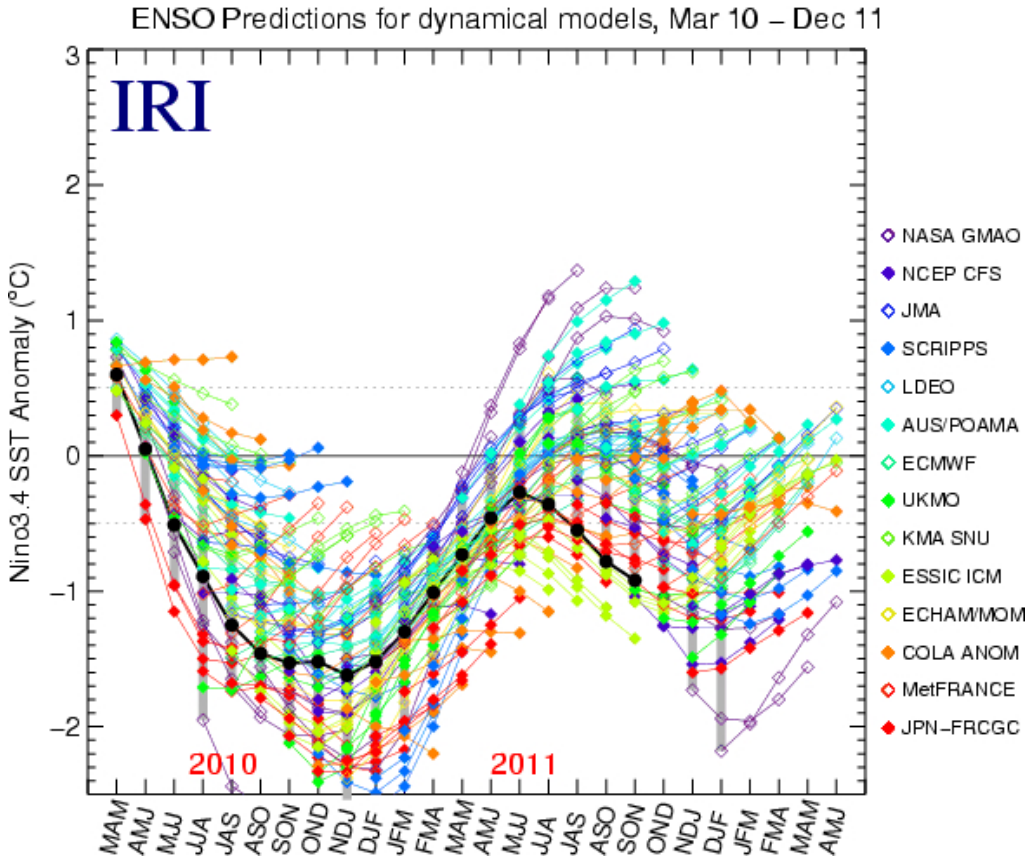
Applications:

1. Support readiness for humanitarian situations.
2. Maybe influence the timing of policy adjustments.
3. Maybe influence our valuation of greenhouse gas regulation.

Immediate policy applications: Readiness

Sep-Oct-Nov 2012 forecast:

La Niña (21%), Neutral (52%), El Niño (27%)



ENSO forecasts: iri.columbia.edu/climate/ENSO/currentinfo

The way forward for research

1. Understand which mechanisms link ENSO and conflict.
   - Labor market
   - State capacity
   - Food prices
   - Inequality
   - Psychological
2. Understand why response to the global climate and weather differ.
   - Correlation in environmental variables
   - Spatial correlation in environmental changes
   - Expectations
3. Understand how high income countries manage climate changes.
4. Conflict forecasting.
5. Possible field interventions, eg. index insurance. Although conflict-based evaluation of interventions is unlikely.

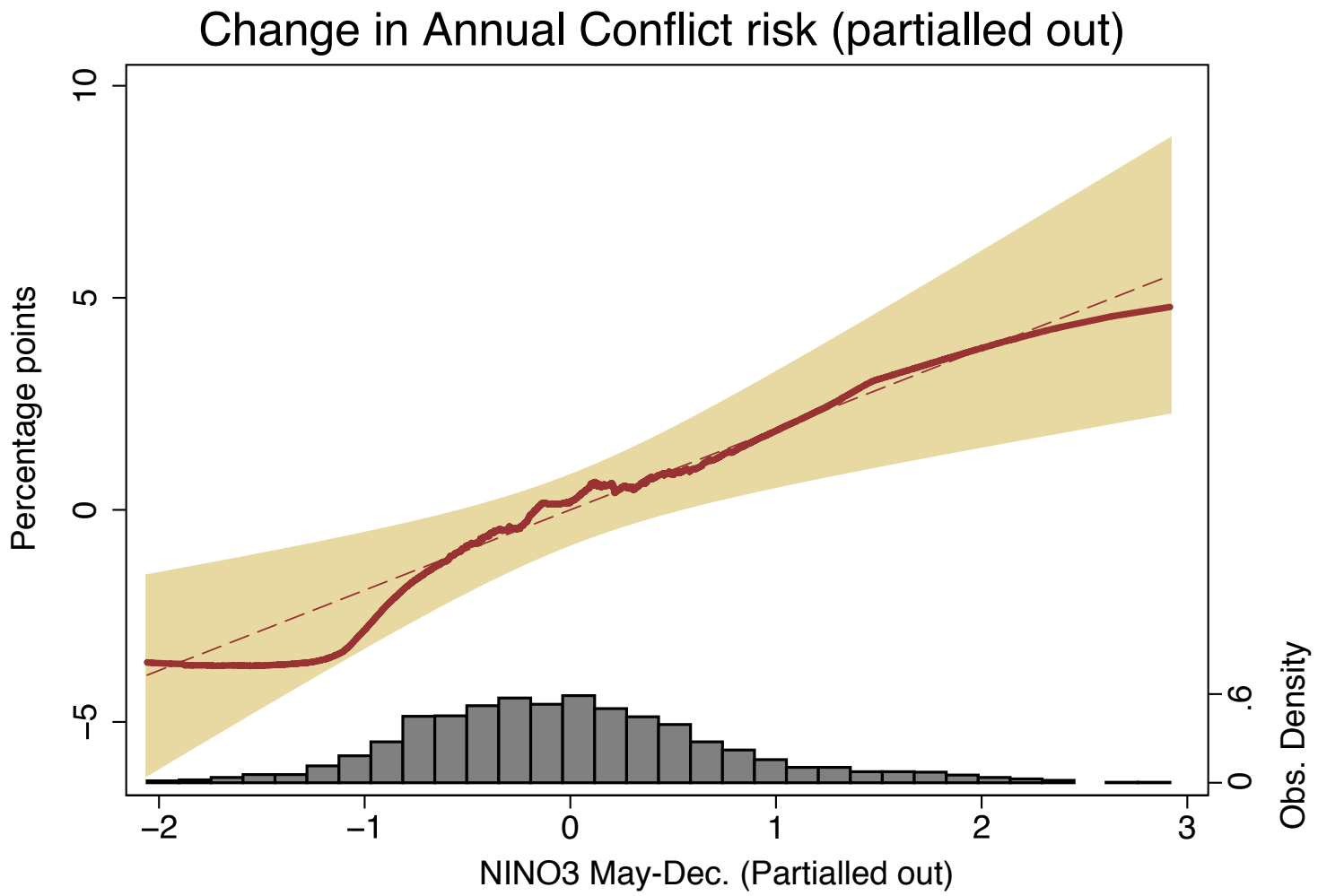
Extra Slides

Panel data model with full controls

Controls:

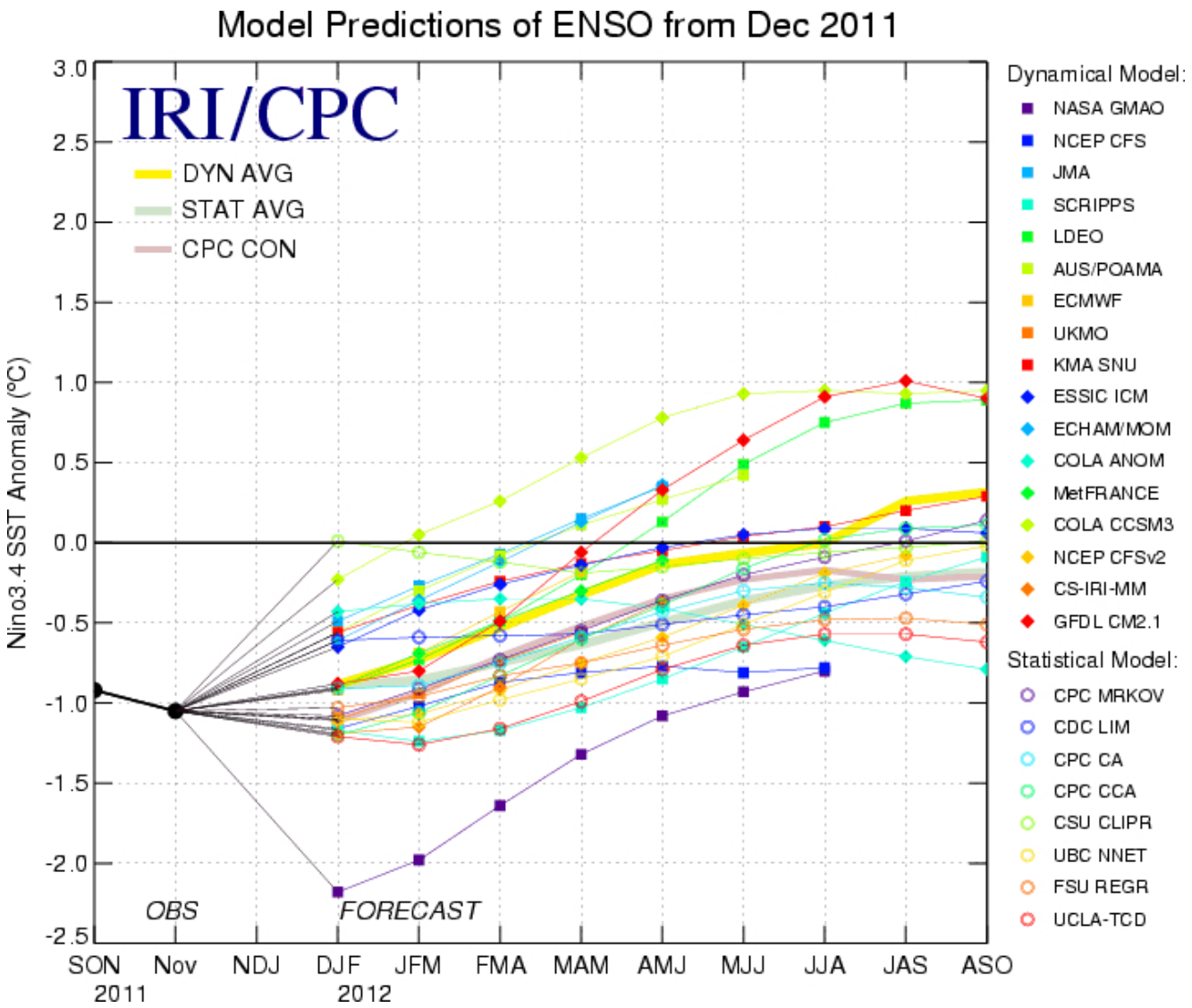
- country fixed-effects
- country-specific time trends
- log income per capita (lag)
- income growth (lag)
- agriculture industry share (lag)
- Polity IV score [quadratic] (lag)
- percent urbanized (lag)
- log population (lag)
- percent female (lag)
- percent below 15 yrs old (lag)
- percent above 65 yrs old (lag)
- monthly temperature (12 variables)
- monthly rainfall (12 variables)
- cyclone maximum windspeed (area average)

Full set of controls

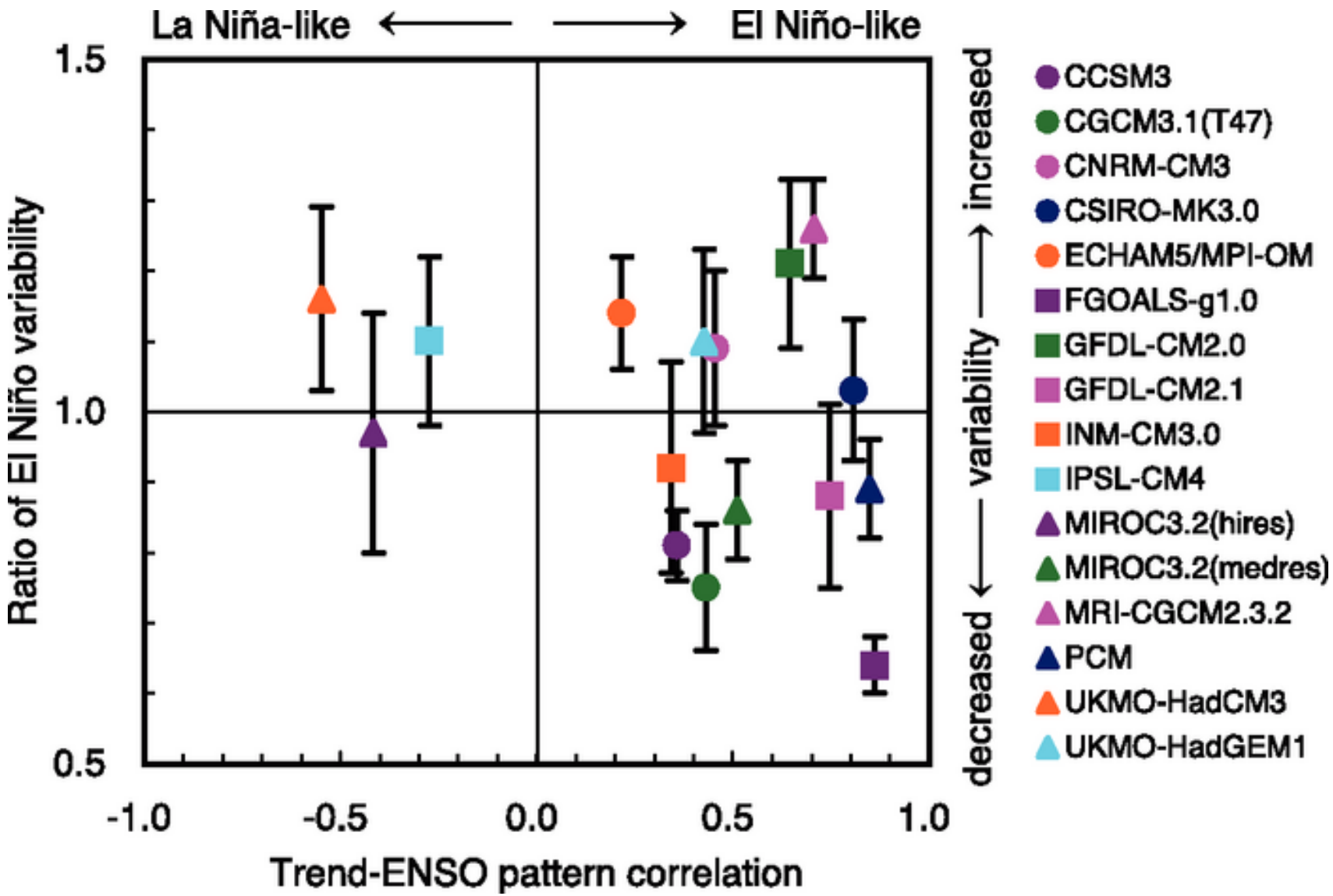


African and Non-African subsamples (with weakly affected group): ▸ Table

ENSO forecasts 2012

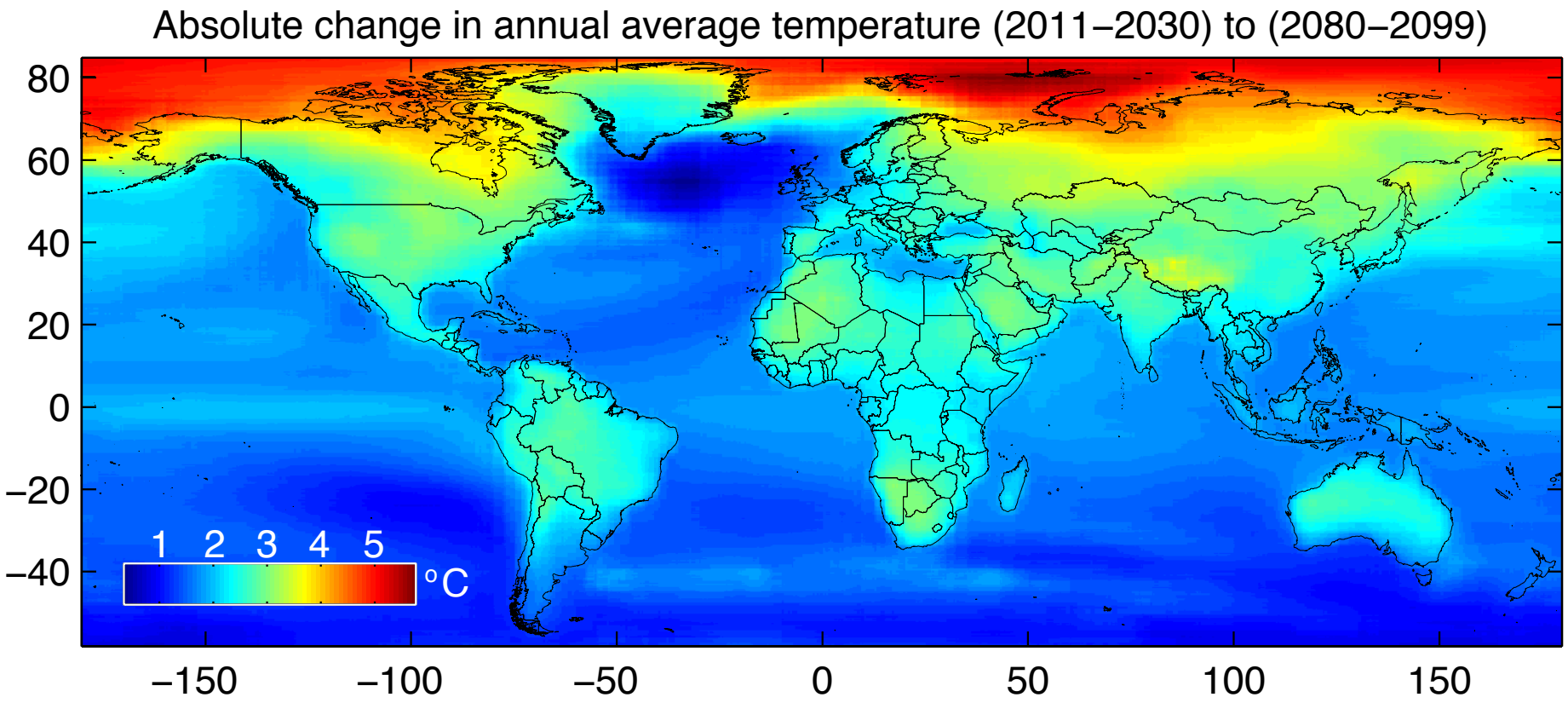


ENSO under future warming



Future climate change

NINO3 region will warm about 2°C by 2100. This corresponds with an increase in annual conflict risk from 4.1% to 5.7% (if ENSO associated conflicts are all assumed to be additional) or 5.1% (if estimated rates of harvesting are adopted) in the tropics.



From (Hsiang, 2011) Back

Some evidence that "political" conflict may not be motivated by strictly political ideologies

Collier & Hoeffler (J. Conflict Resolution, 2002) - Conflict incidence in Africa is explained in cross-section by poor economic performance, not "African-ness."

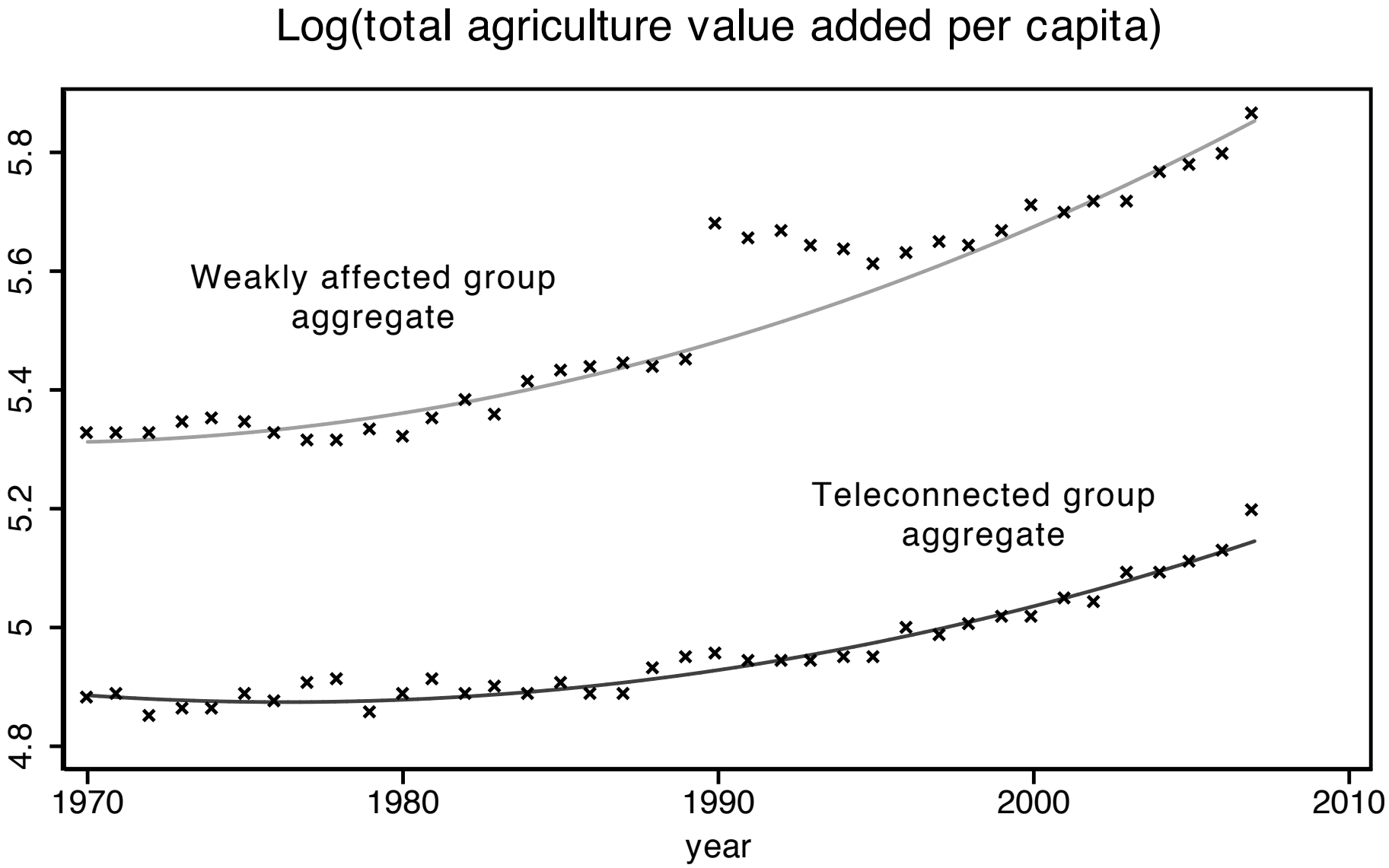
Fearon & Laitin (Am. Pol. Sci. Rev., 2003) - Ethnic and religious variables do not predict conflict, but factors that support insurgency do: poverty, political instability, rough terrain and large populations.

Miguel et al. (J. Pol. Econ., 2004) - Reductions in economic growth rates increase conflict in Africa.

Dube & Vargas (2009) - In Colombia, positive price shocks to resource extraction (oil) increases conflict intensity through "rapacity effect," but positive price shocks to agricultural labor (coffee) decrease conflict intensity through and "opportunity cost effect".

▸ Back

Partition validation: agricultural response



Back

Identification

Back

Let $Y_i(S)$ be the potential outcome $conflict\_risk_i$ for the exposable group when the climate state was i if it had been exposed to the climate state $S \in \{el\_nino, la\_nina\}$.

We want to identify the effect of $S = el\_nino$ on conflict risk Y_{el_nino}:

$$\Delta = \mathrm{E}[Y_{el\_nino}(el\_nino) - Y_{el\_nino}(la\_nina)]$$

except $Y_{el\_nino}(la\_nina)$ is never observed, we can only observe $Y_{la\_nina}(la\_nina)$ and estimate

$$\hat{\Delta} = \mathrm{E}[Y_{el\_nino}(el\_nino) - Y_{la\_nina}(la\_nina)].$$

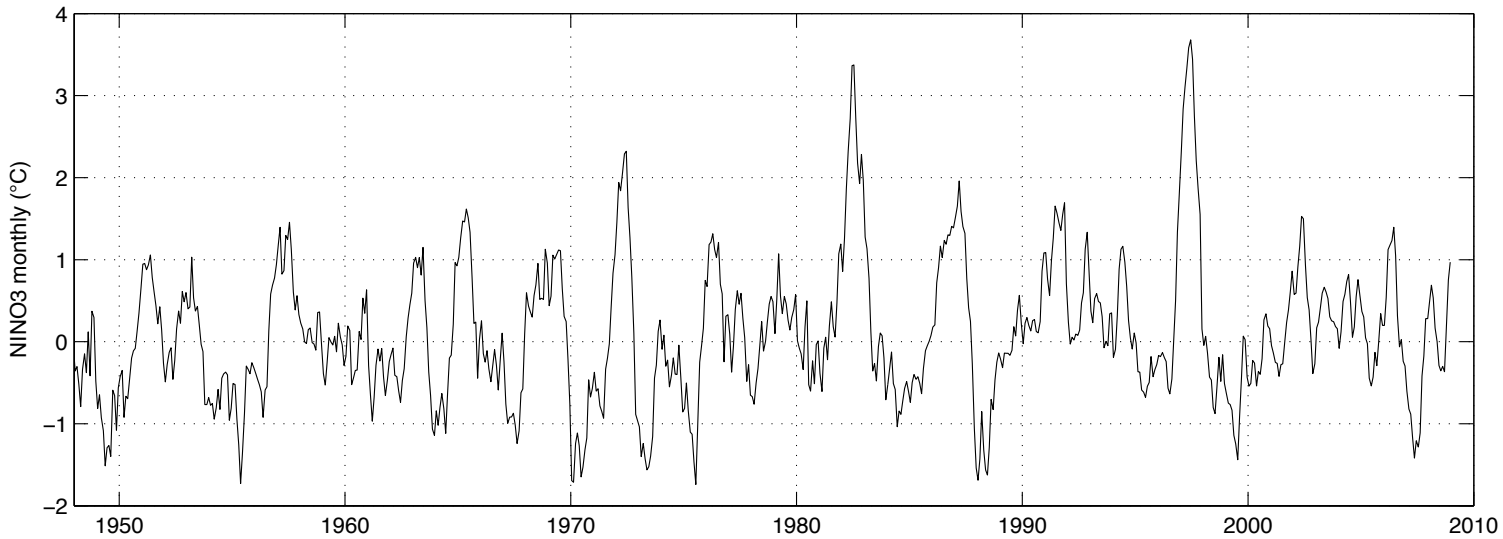
However, $\hat{\Delta}$ is an unbiased estimate of Δ if climate variations are independent of other exogenous variables, i.e. we assume

$$Y_{el\_nino}(el\_nino) = Y_{la\_nina}(el\_nino), \quad Y_{el\_nino}(la\_nina) = Y_{la\_nina}(la\_nina).$$

Which we try to falsify by testing $Y_0(el\_nino) = Y_0(la\_nina)$.

Identifying assumptions

- Sea surface temperature changes in the tropical Pacific do not affect conflict risk except through the global climate.
- Conflict risk does not affect tropical Pacific sea surface temperatures.
- Ocean temperature variations are not correlated with other exogenous variables that are global in scale and influence conflict. We try (unsuccessfully) to falsify this assumption by examining regions with limited exposure to ENSO.



Back

This is not instrumental variables

Aspects of this design may look like instrumental variables, but it is not.

Weather is not random. Different weather variables are highly correlated and respond to large-scale forcing in systematic and correlated ways.

El Niño is not an instrument for the global climate. It is a summary statistic for the high-dimensional global climate (first principle component).

El Niño is not an instrument for a weather variable. An ENSO index is a scalar, so it is not a valid instrument for any weather vector because the exclusion restriction fails.

Think of the ENSO index as a summary statistic, not as an instrument.

▸ Back

Conflict data continued

Government: The party controlling the capital of a state.
Opposition organization: Any non-governmental group of people having announced a name for their group and using armed force to influence the outcome of the stated incompatibility. The UCDP only deals with formally organized opposition. The focus is on armed conflict involving consciously conducted and planned political campaigns rather than spontaneous violence.
Extrasystemic armed conflict occurs between a state and a non-state group outside its own territory. These conflicts are by definition territorial, since the government side is fighting to retain control of a territory outside the state system (omitted from dataset).

An example: Chad

1966 Frolinat
1976 FAN
1977 FAP
1982 FAT
1989 Islamic Legion, Revolutionary Forces of 1 April, MOSANAT
1991 MDD, Military faction (forces of Maldoum Bada Abbas)
1992 CNR, CSNPD, FNT
1997 FARF
1999 MDJT

Panel data model with basic controls (Buhaug, 2010)

Dependent Variable: Conflict Risk (% / yr)
Independent Variable: May-Dec NINO3 (°C)

	Panel model	Teleconnected (%/yr°C)	Weakly-Affected (%/yr°C)
(1)	**No controls**	0.85*	0.20
		[0.44]	[0.33]
(2)	**Country fixed effects**	0.89**	0.13
		[0.40]	[0.33]
(3)	**Country-trends**	0.90**	0.09
		[0.39]	[0.32]
(4)	**Country fixed effects**	0.89**	0.04
	Country-trends	[0.39]	[0.32]
	Observations	3978	3400

Conley HAC S.E. in brackets, *** p<0.01, ** p<0.05, * p<0.1.
1989 dropped.

Robust to ENSO index selection

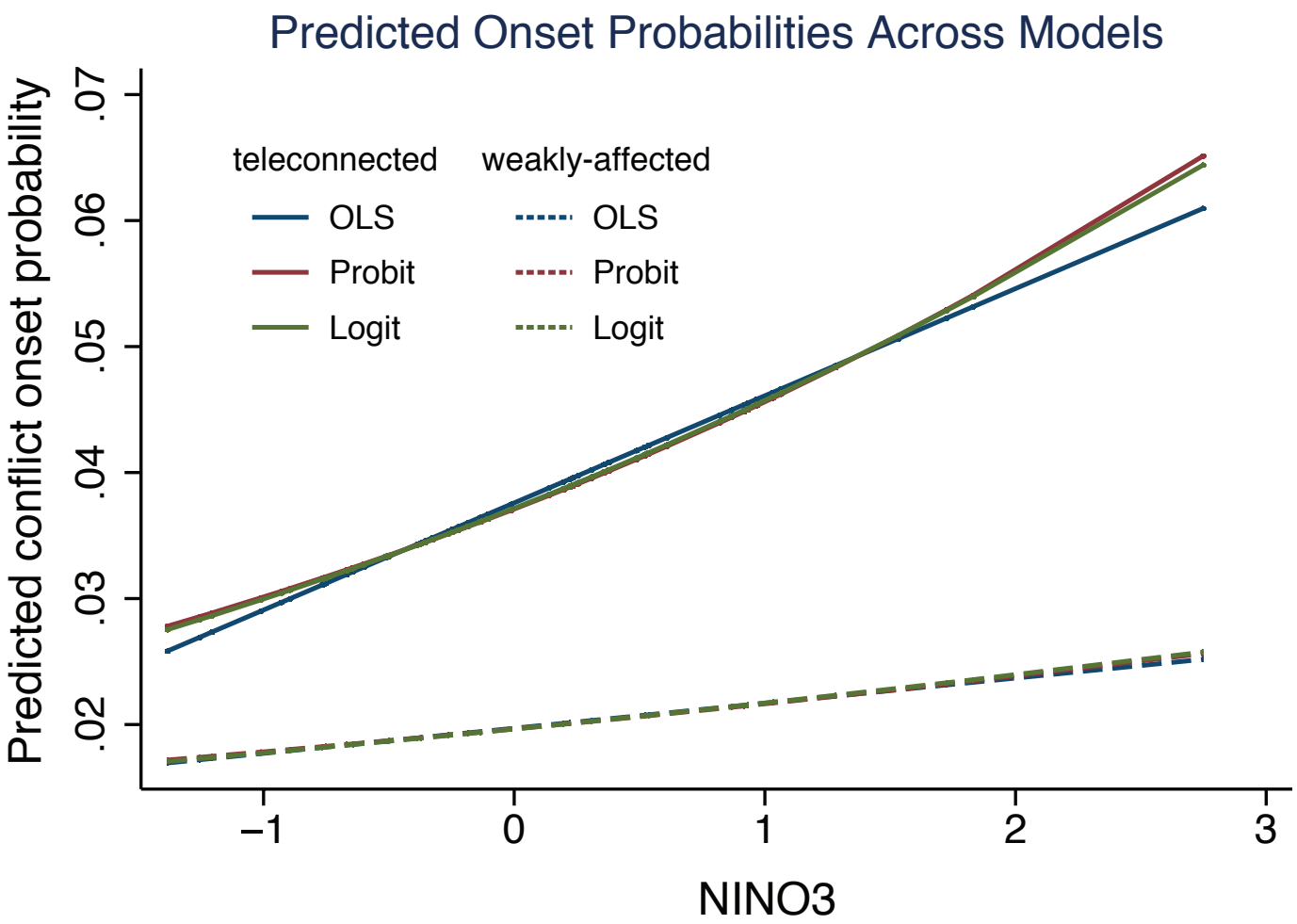
	Dependent Variable: Conflict Risk (%/yr)					
	teleconnected			**weakly affected**		
	NINO12	NINO3	NINO4	NINO12	NINO3	NINO4
Coeff.	0.63**	0.81**	0.88*	-0.07	0.04	0.32
	[0.25]	[0.32]	[0.48]	[0.21]	[0.31]	[0.45]
n	54	54	54	54	54	54

White S.E. in brackets, ** $p<0.05$, * $p<0.1$.

Models include linear trends and post-89 dummy; 1989 dropped.

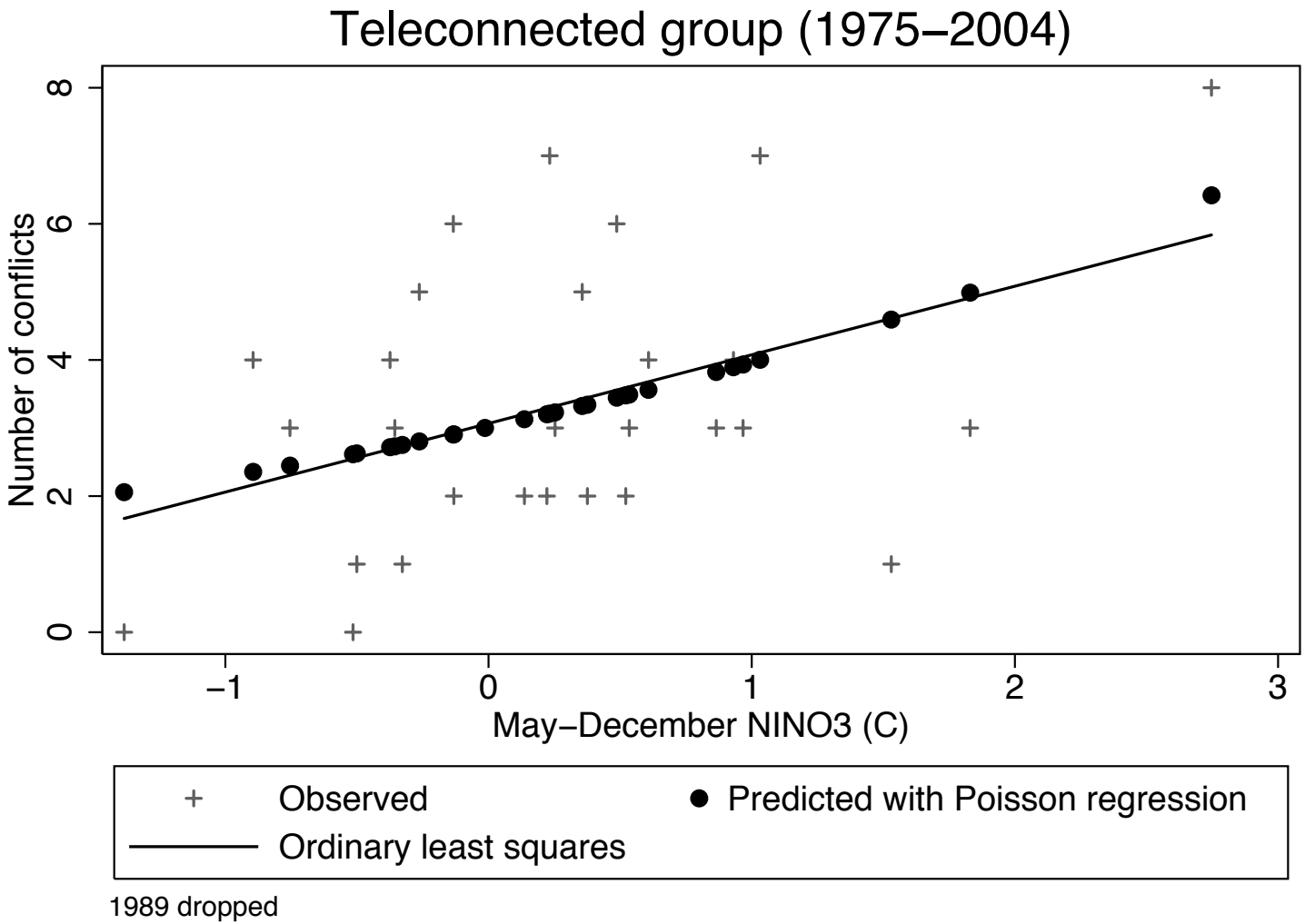
back

OLS vs. Probit vs. Logit



Back

OLS vs. Poisson regression



1989 dropped

Back

Serial correlation does not drive results

	Teleconnected Dependent Variables			**Weakly-Affected** Dependent Variables		
	ACR_t	ACR_t-ACR_{t-1}	ACR_t	ACR_t	ACR_t-ACR_{t-1}	ACR_t
$NINO3_t$	0.72**		0.74**	0.01		0.05
	[0.36]		[0.32]^a	[0.32]		[0.32]^a
			[0.30]^b			[0.34]^b
			[0.29]^c			[0.34]^c
ACR_{t-1}	0.15			0.33**		
	[0.15]			[0.14]		
$NINO3_t$-$NINO3_{t-1}$		0.61*			-0.09	
		[0.31]			[0.25]	
Observations	53	53	55	53	53	55
R-squared	0.3	0.1	-	0.2	0.0	-

Newey-West estimates with lag lengths of *a*: 3 yrs, *b*: 5 yrs and *c*: 10 yrs. Greene (2003) recommends a lag of at least $T^{0.25}$ (where T is the length of the time series) which is 2.7 in this case. All other SEs are White estimators.

▸ Back

Conflict measurement, timing and size

Dependent Variable: Conflict Onset (% / yr)

Latent period:	2 years	4 years	6 years	8 years
Small conflicts (battle deaths $<$ 1000)				
NINO3	0.45	0.34	0.41	0.45
Large conflicts (battle deaths $>$ 1000)				
NINO3	0.45	0.21	0.09	0.10

Panel model, teleconnected countries only.

▸ Back

Sample does not drive results

Sample:	(1) BASELINE $t \geq 1950$ $t \neq 1989$	(2) $t \geq 1950$ include 1989	(3) include 1946-49 $t \neq 1989$	(4) $t \geq 1975$ include 1989	(5) FULL SAMPLE include 1946-49 include 1989
NINO3	0.81** [0.32]	0.74** [0.32]	0.75** [0.32]	0.83** [0.35]	0.68** [0.32]
Obs.	54	55	58	30	59
R-squared	0.28	0.28	0.30	0.62	0.30

▸ Back

Panel data model controlling for local weather

Dependent Variable: Conflict Risk (% / yr)
Independent Variable: May-Dec NINO3 (°C)

	Panel model	Teleconnected (%/yr°C)	Weakly-Affected (%/yr°C)
(1)	**No weather**	0.89** [0.39] n=3978	0.04 [0.32] n=3400
(2)	**Include temperature** (monthly, 12 vars)	1.02*** [0.39] n=3978	0.13 [0.30] n=3400
(3)	**Include temp & rain** (monthly, 24 vars)	1.66*** [0.48] n=2234	0.36 [0.33] n=1774

Conley HAC S.E. in brackets, *** p<0.01, ** p<0.05, * p<0.1.
1989 dropped. All models include country FE and country-trends.

Back

Panel data model with full controls

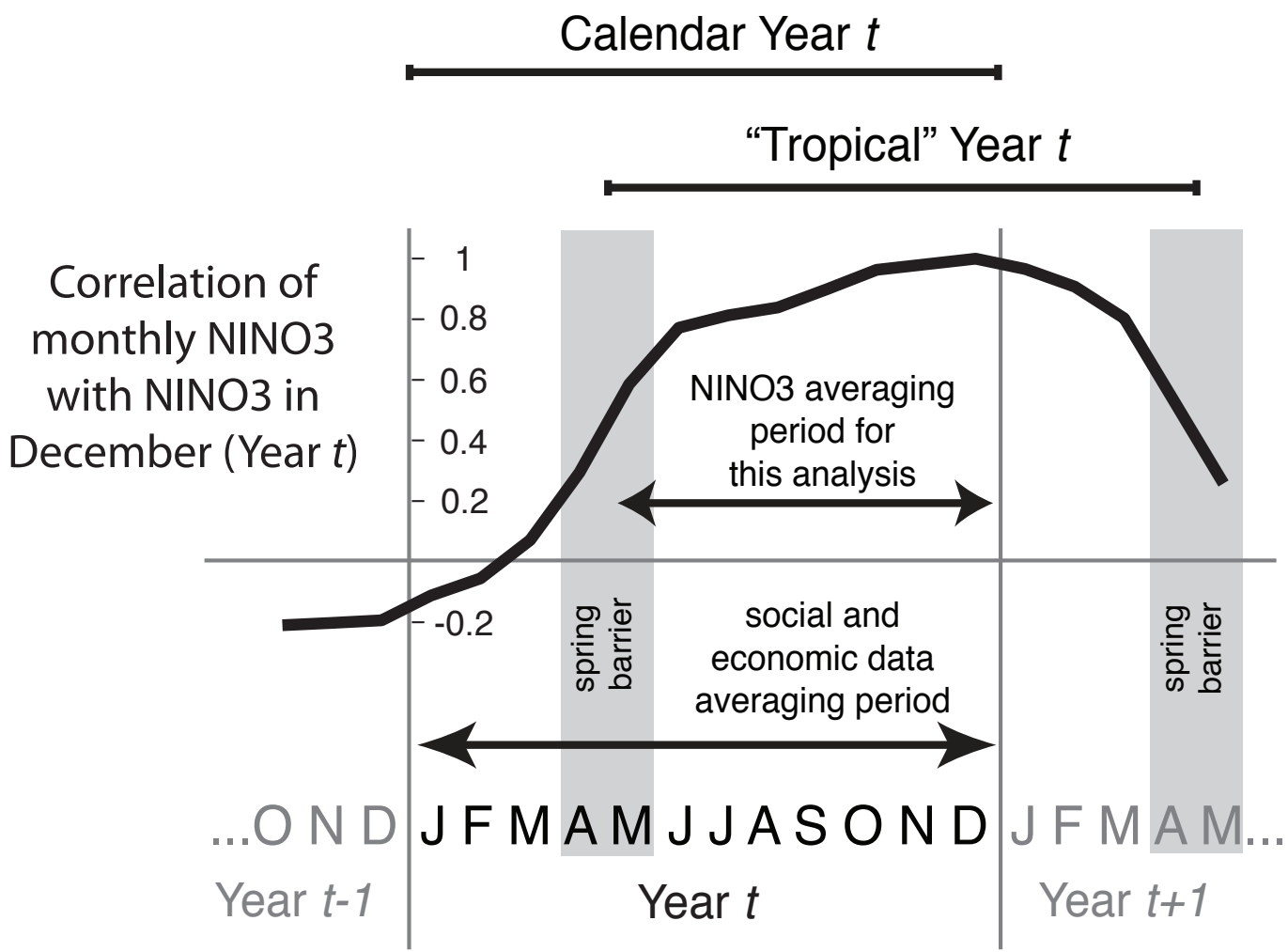
Dependent Variable: Conflict Risk (% / yr)
Independent Variable: May-Dec NINO3 (°C)

	Sample	Teleconnected (%/yr°C)	Weakly-Affected (%/yr°C)
(1)	**All Countries**	1.83***	0.46
		[0.53]	[0.33]
		n=1973	n=1467
(2)	**Africa Only**	1.95*	0.54
		[1.01]	[1.79]
		n=1083	n=75
(3)	**Not Africa**	1.49**	0.50
		[0.66]	[0.34]
		n=890	n=1392

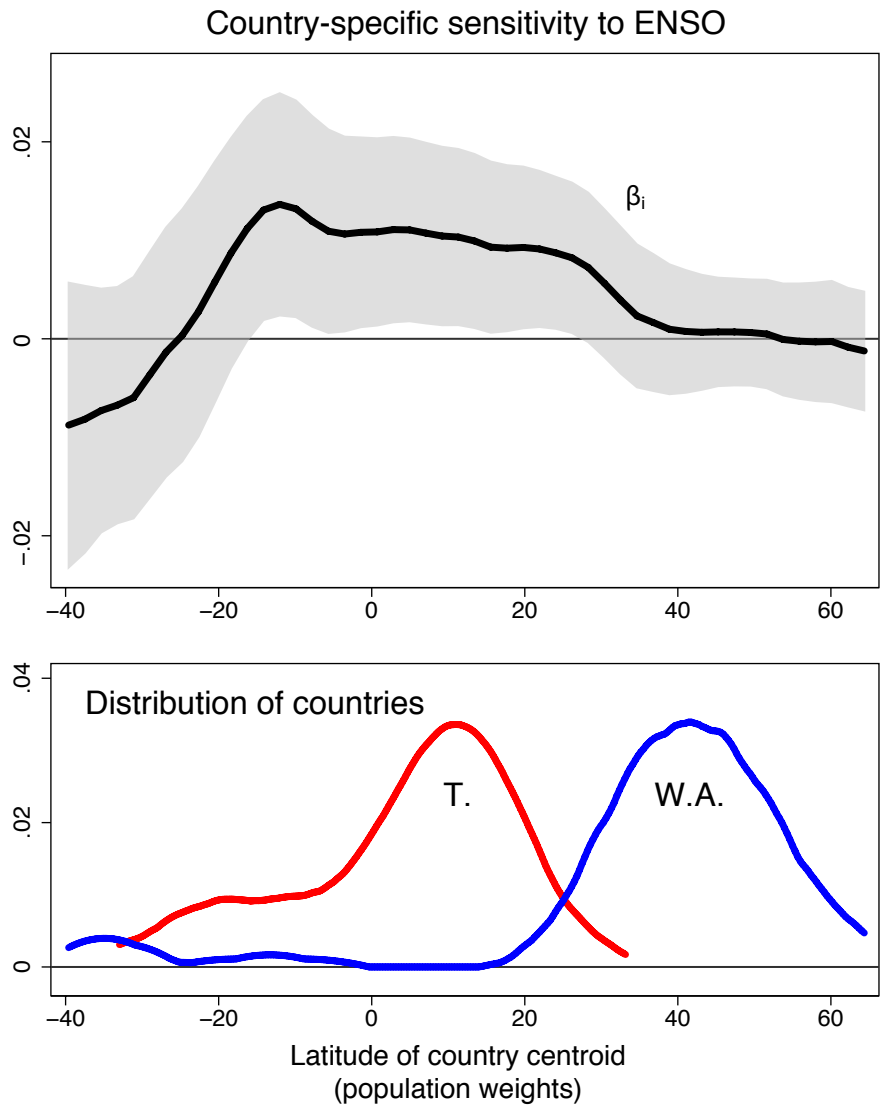
Conley HAC S.E. in brackets, *** p<0.01, ** p<0.05, * p<0.1.
1989 dropped.

Back

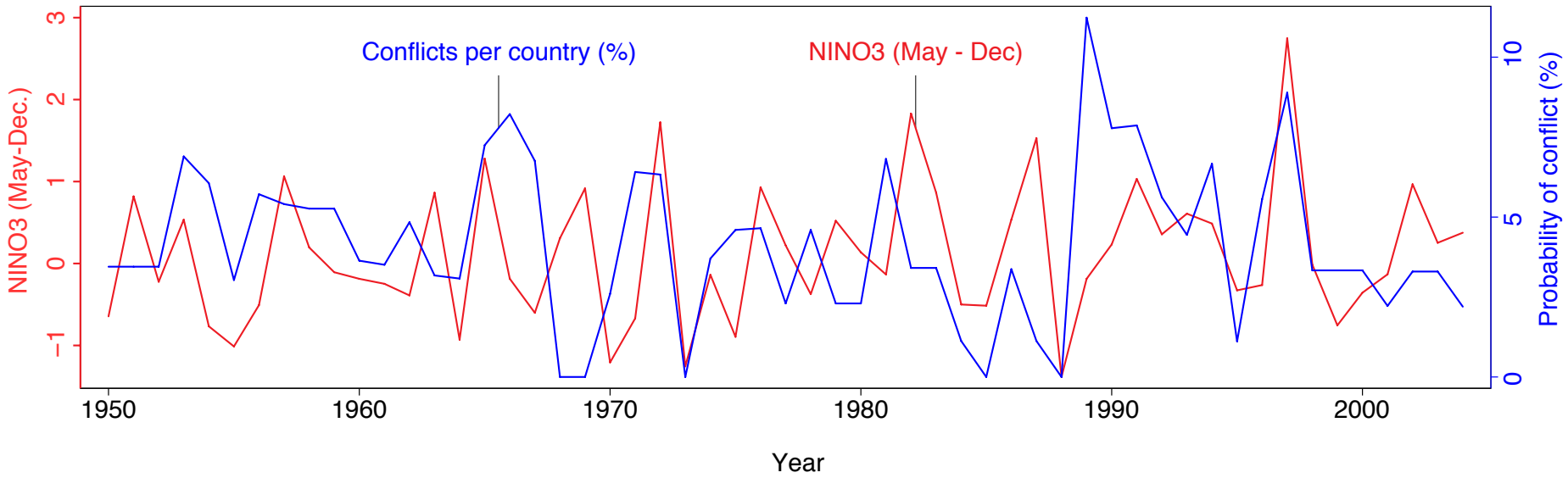
Matching socioeconomic and ENSO data



Country sensitivity by latitude

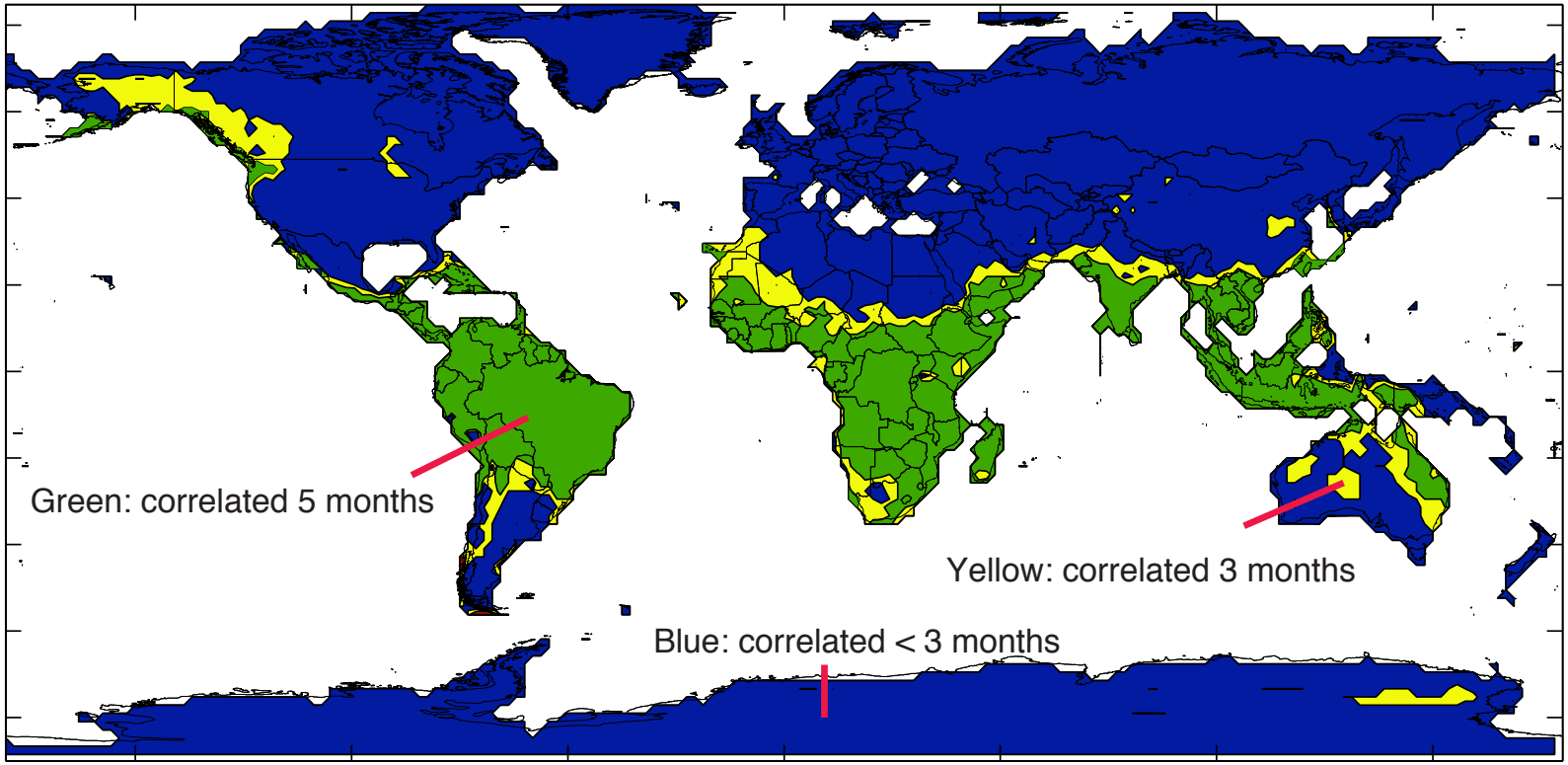


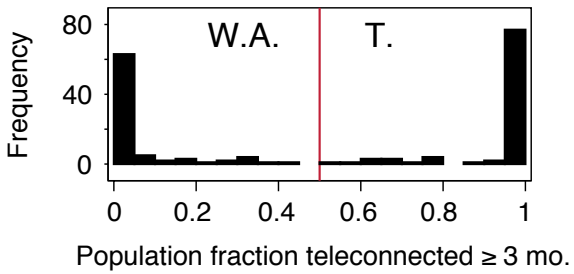
Time-series of the main result

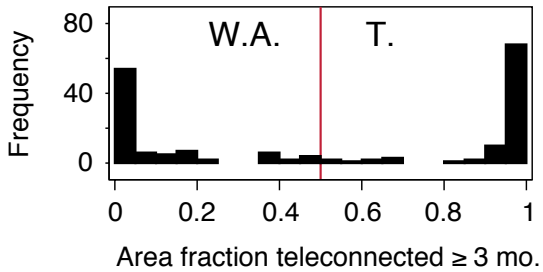


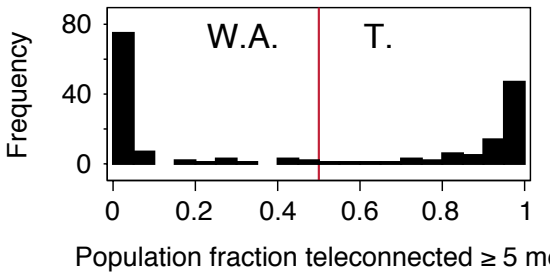
▸ Back

Identifying teleconnected regions









ENSO "Teleconnections"

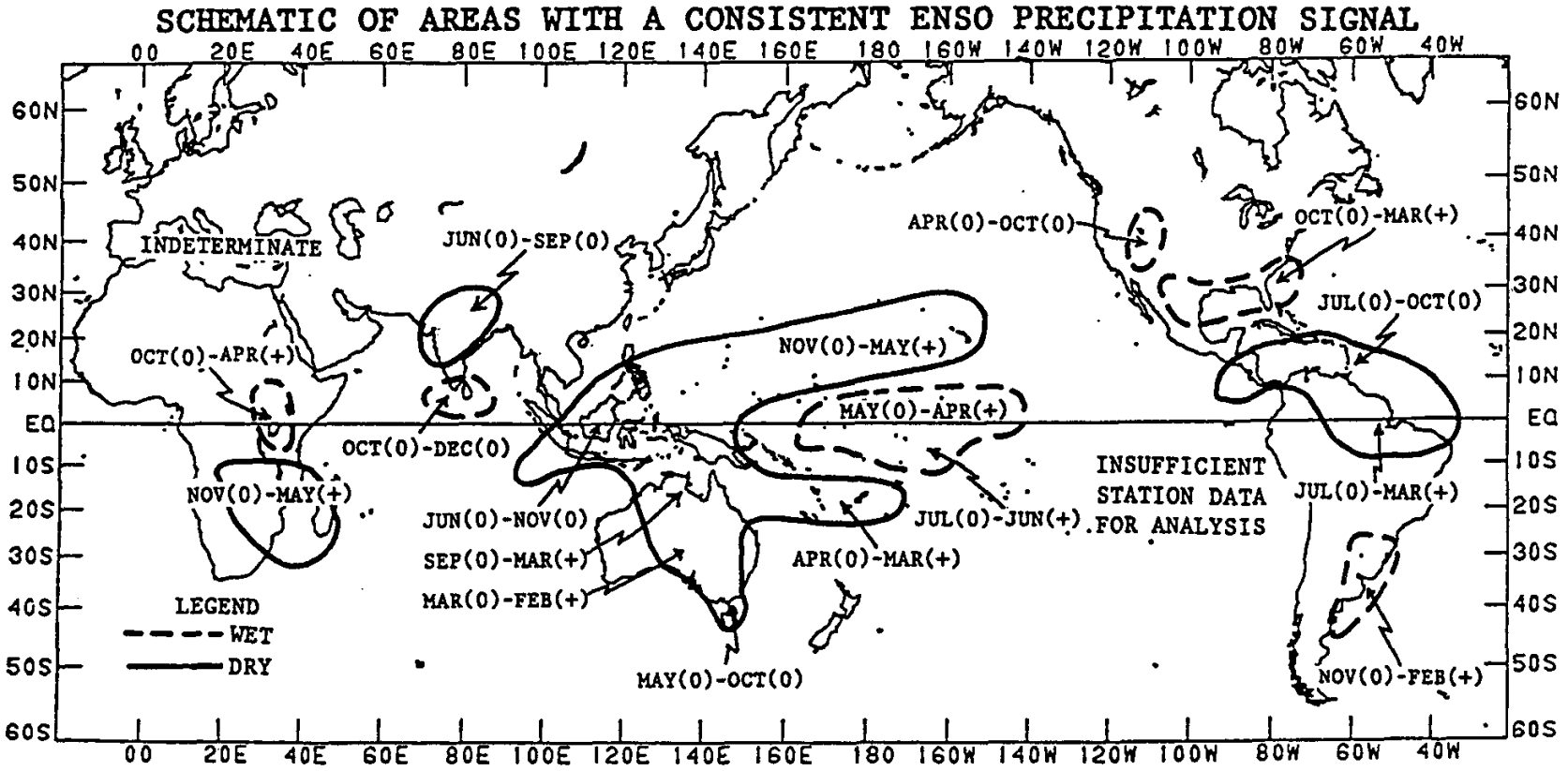
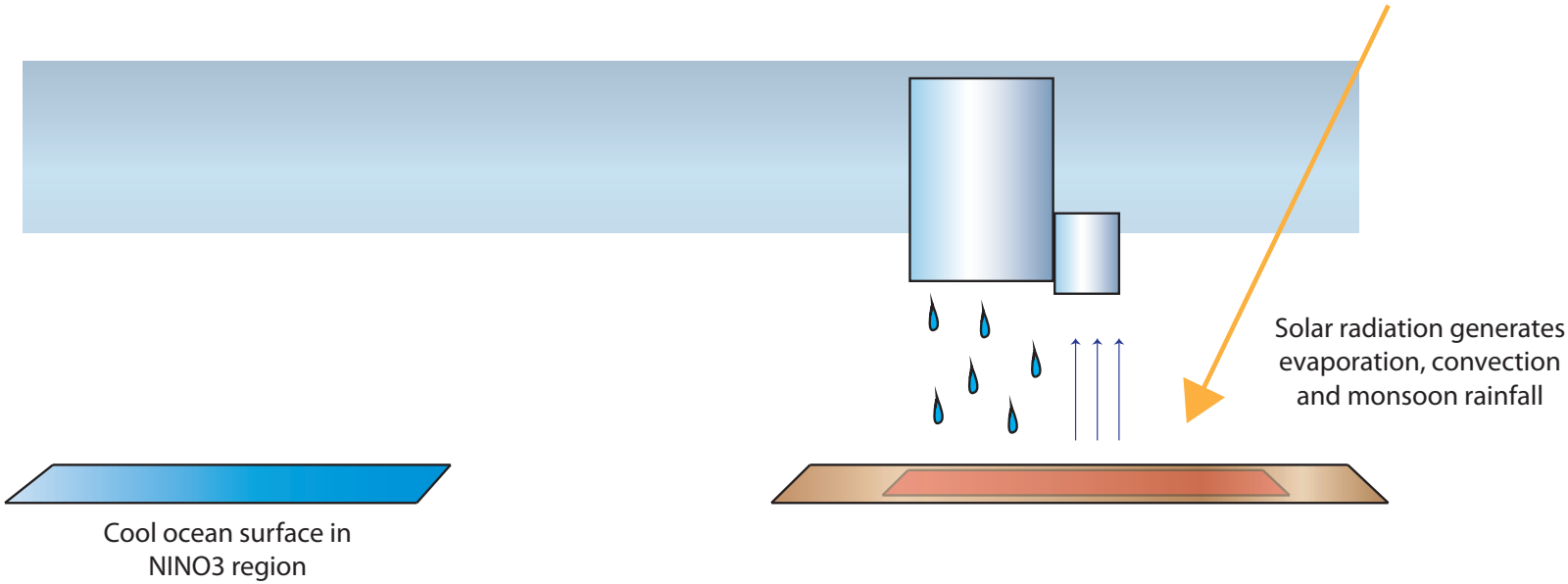


FIG. 21. Schematic representation of the principal ENSO-related precipitation based on the detailed analysis for the core regions. Regional maps should be consulted for details.

Also: (Ropelewski & Halpert 1989)(Nicholls 1989)(Nicholson & Kim 1997)(Chiang & Sobel 2002)(Giannini et al 2003)

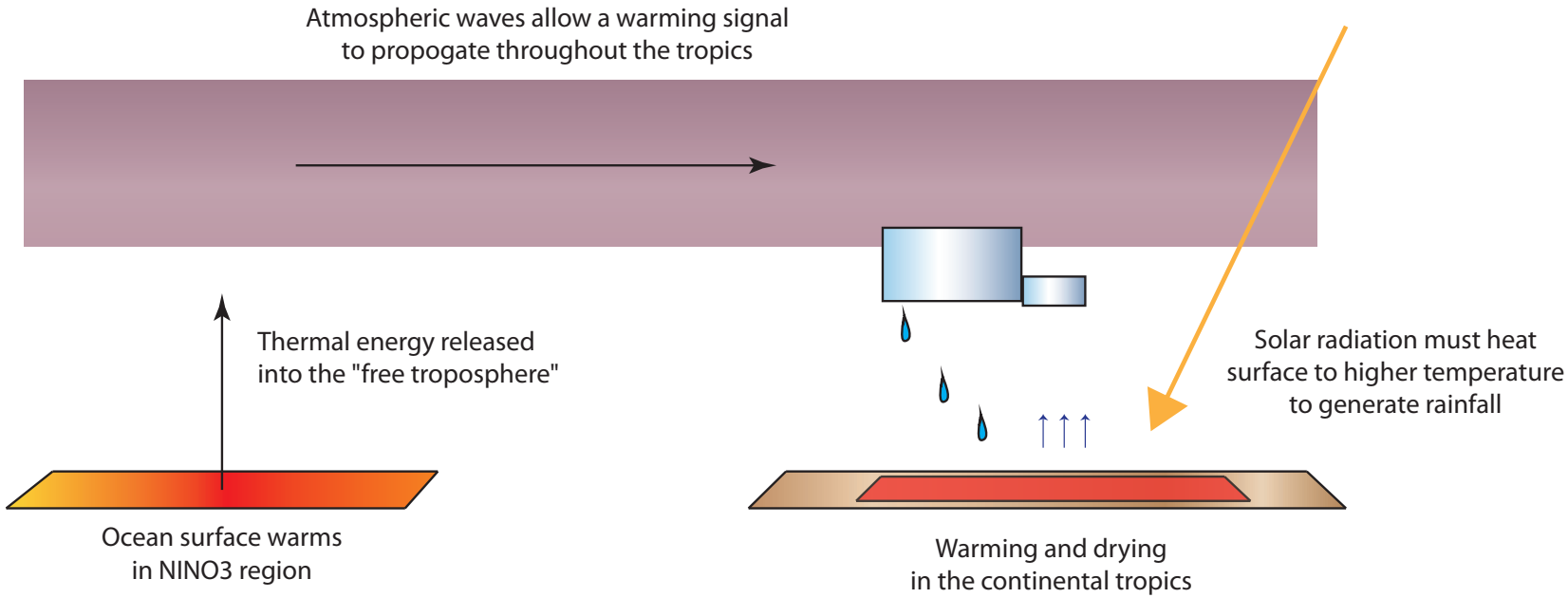
Back

Teleconnections: Normal conditions



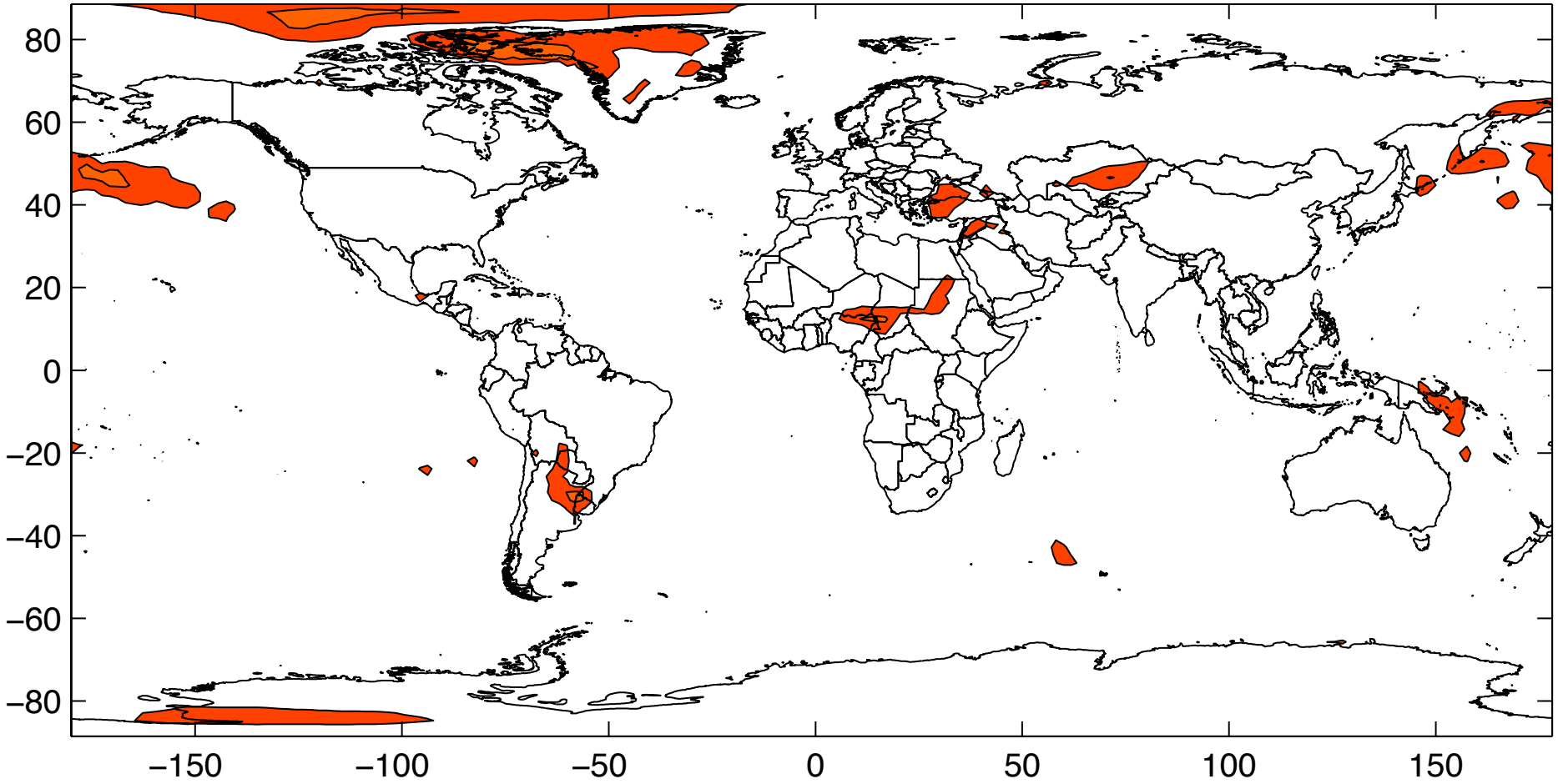
Back

Teleconnections: El Niño conditions



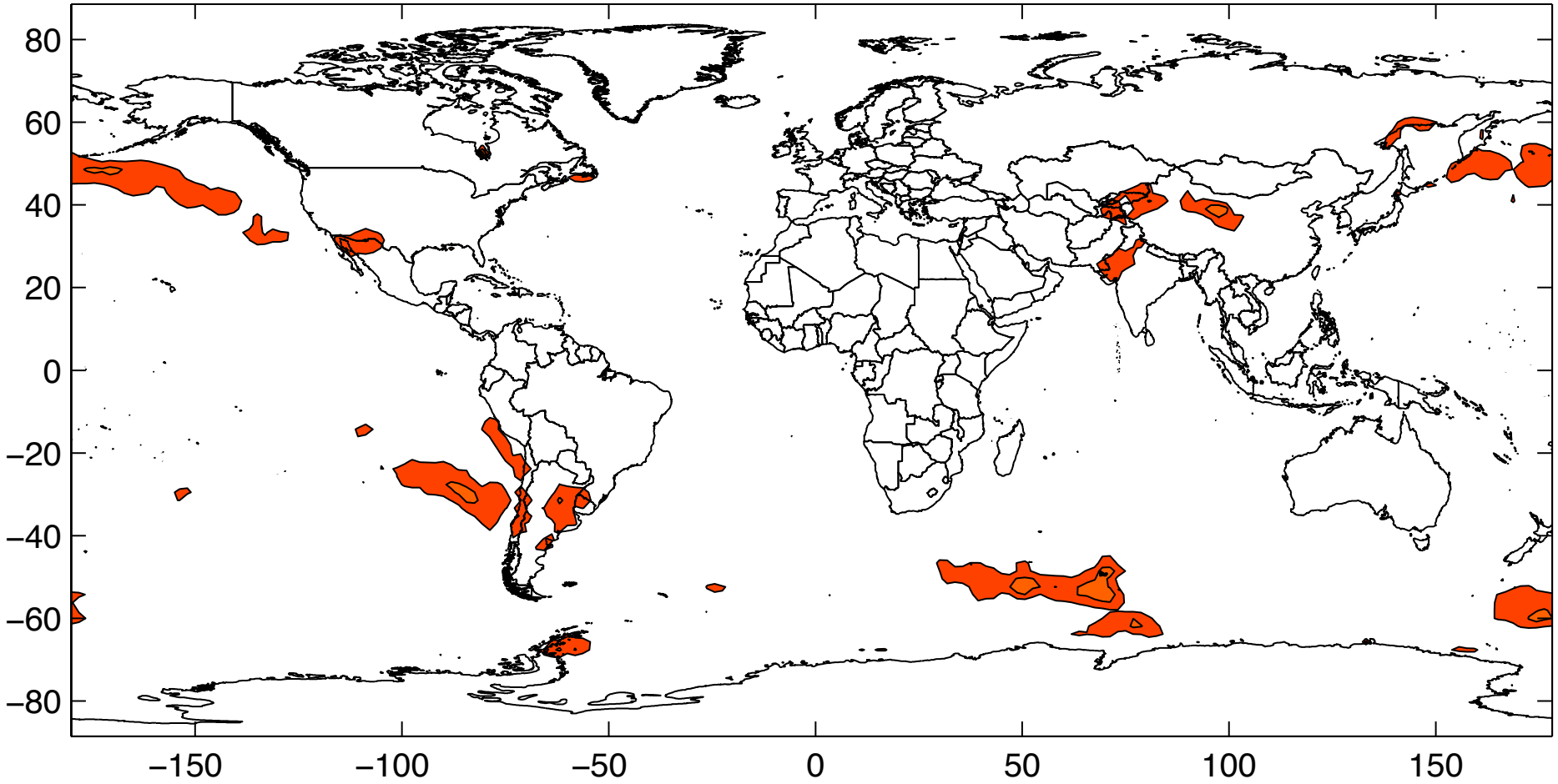
Back

Month 1 surface temperature correlated with month 12 NINO3

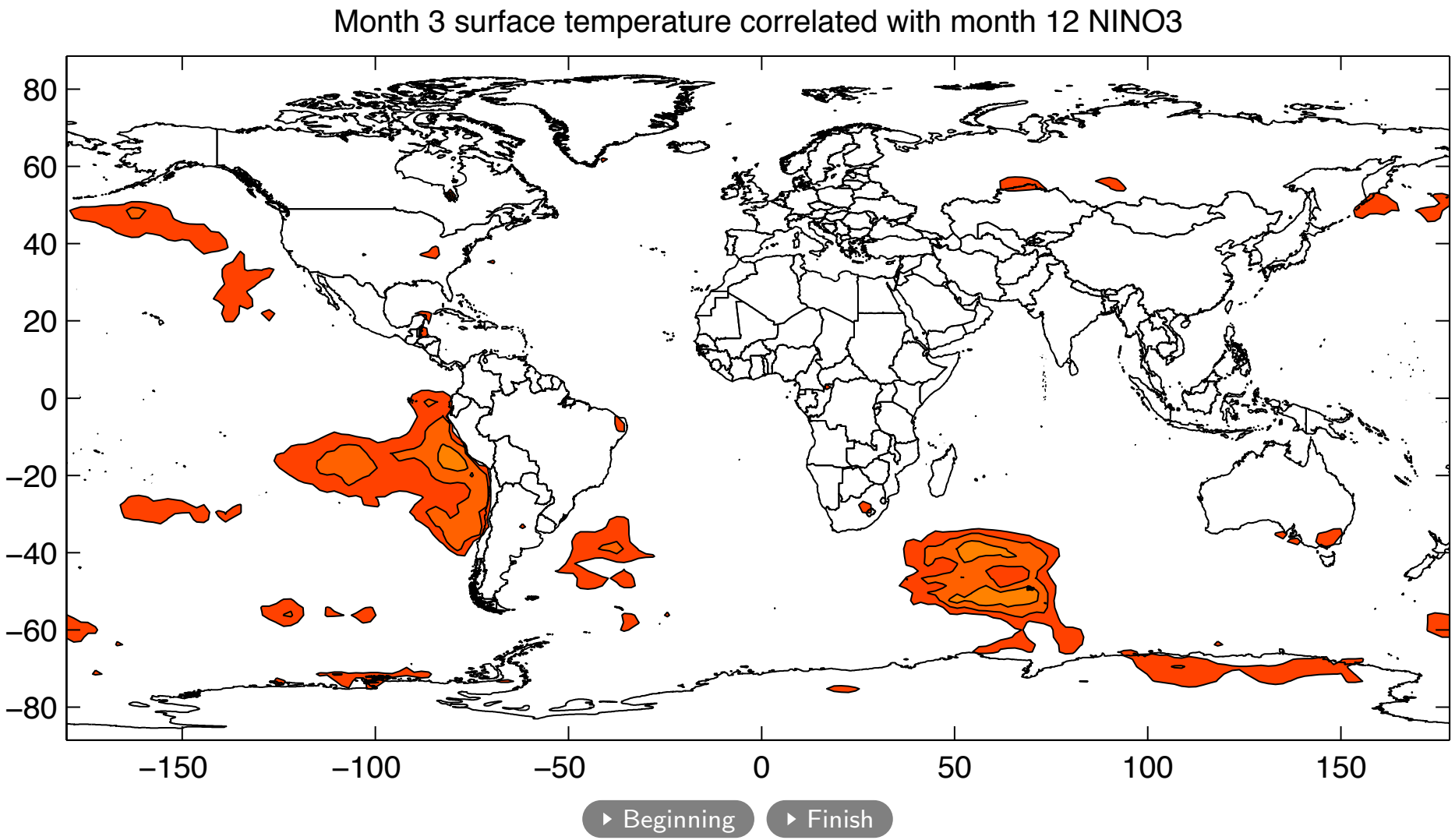


▸ Beginning ▸ Finish

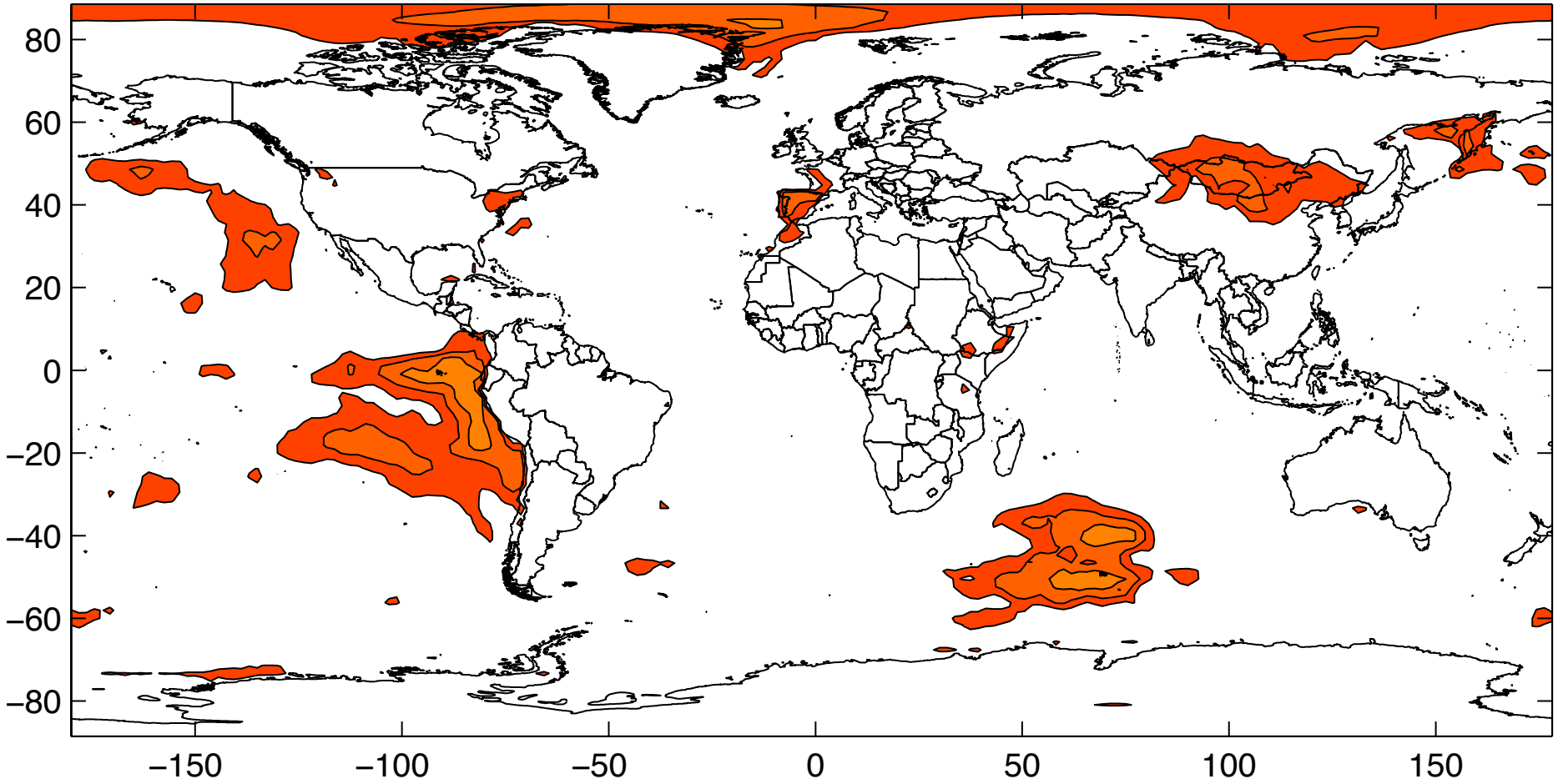
Month 2 surface temperature correlated with month 12 NINO3



▸ Beginning ▸ Finish

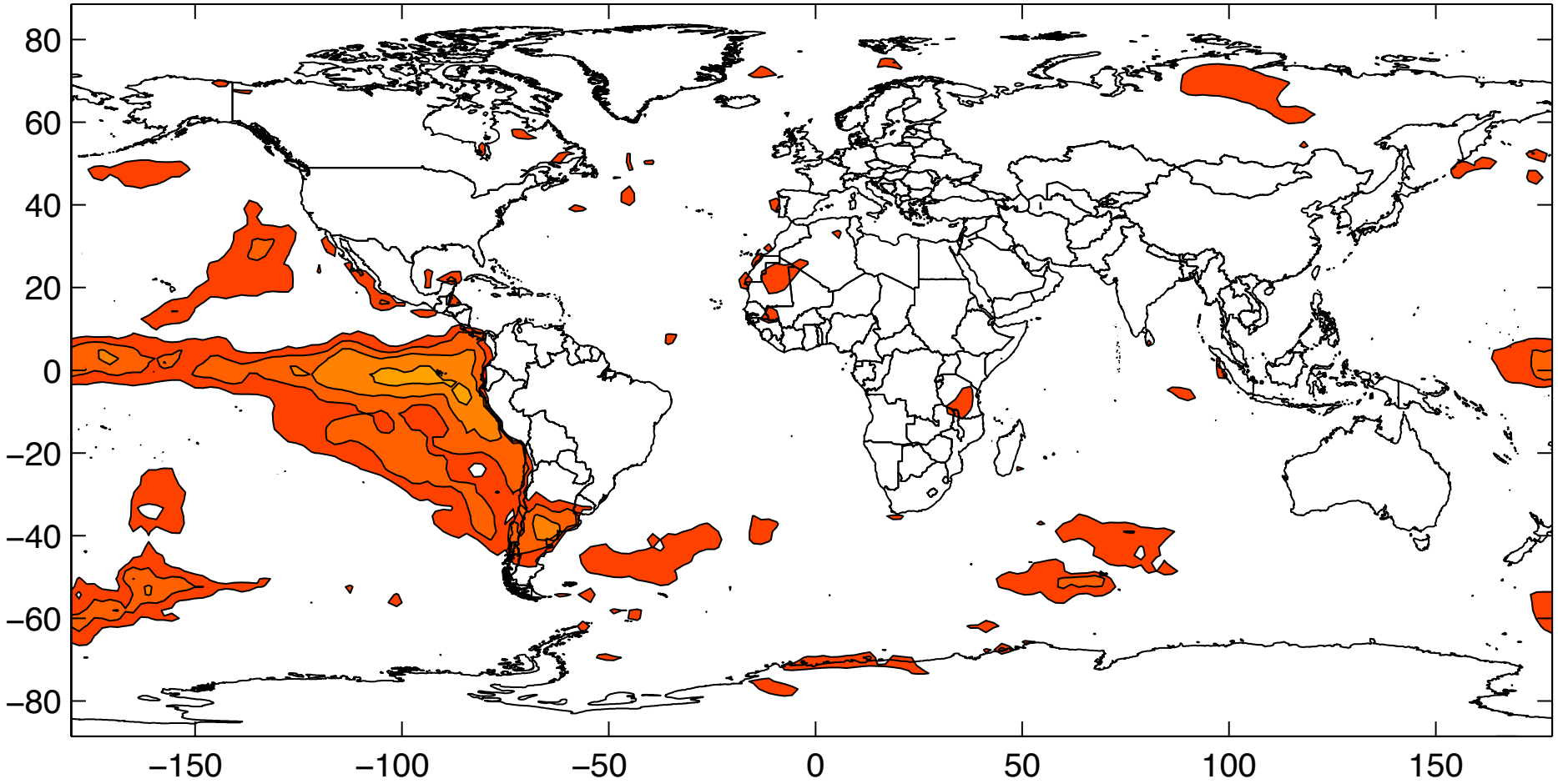

Month 3 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

Month 4 surface temperature correlated with month 12 NINO3

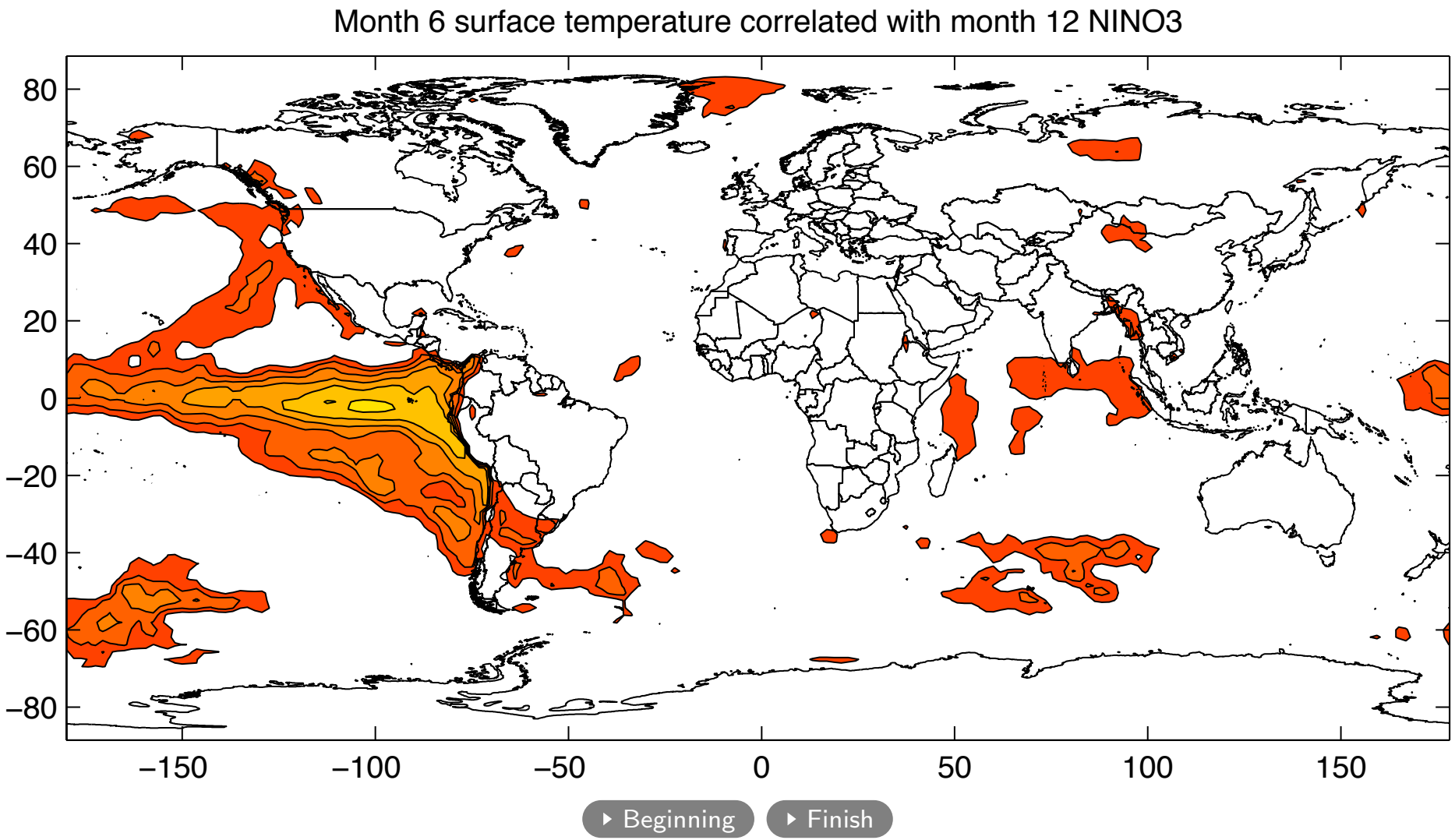


▸ Beginning ▸ Finish

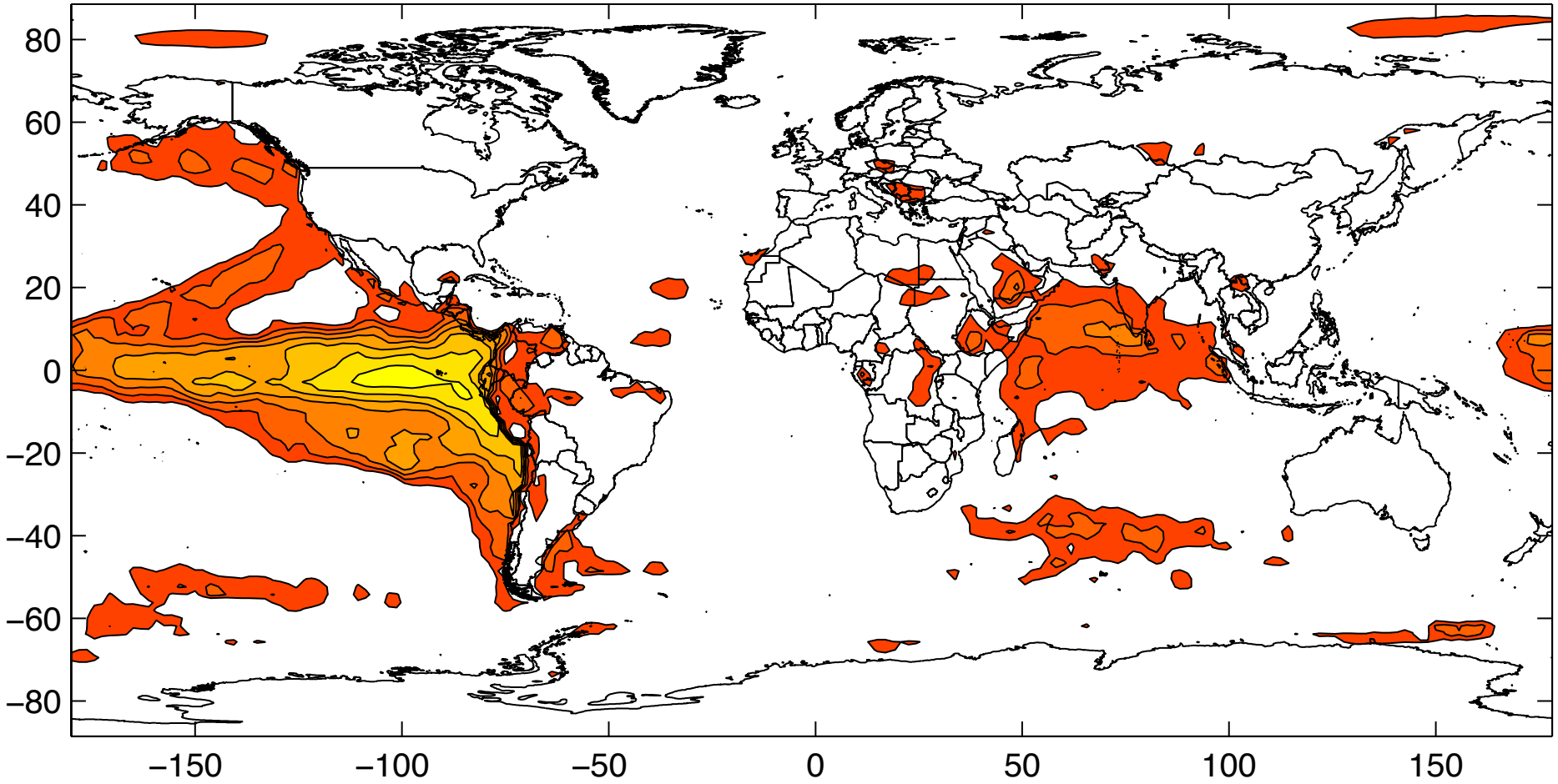
Month 5 surface temperature correlated with month 12 NINO3



▸ Beginning ▸ Finish

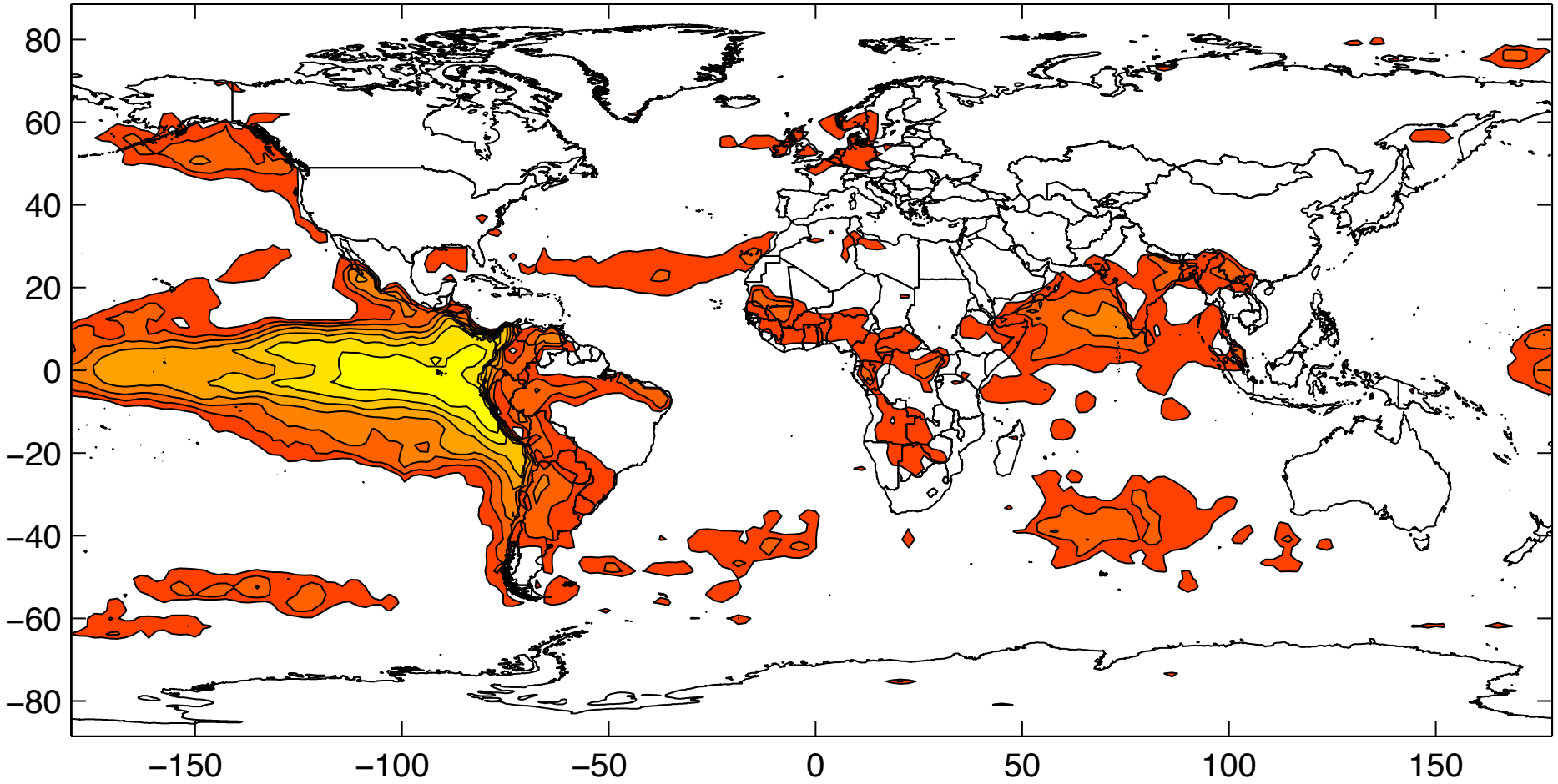

Month 6 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

Month 7 surface temperature correlated with month 12 NINO3



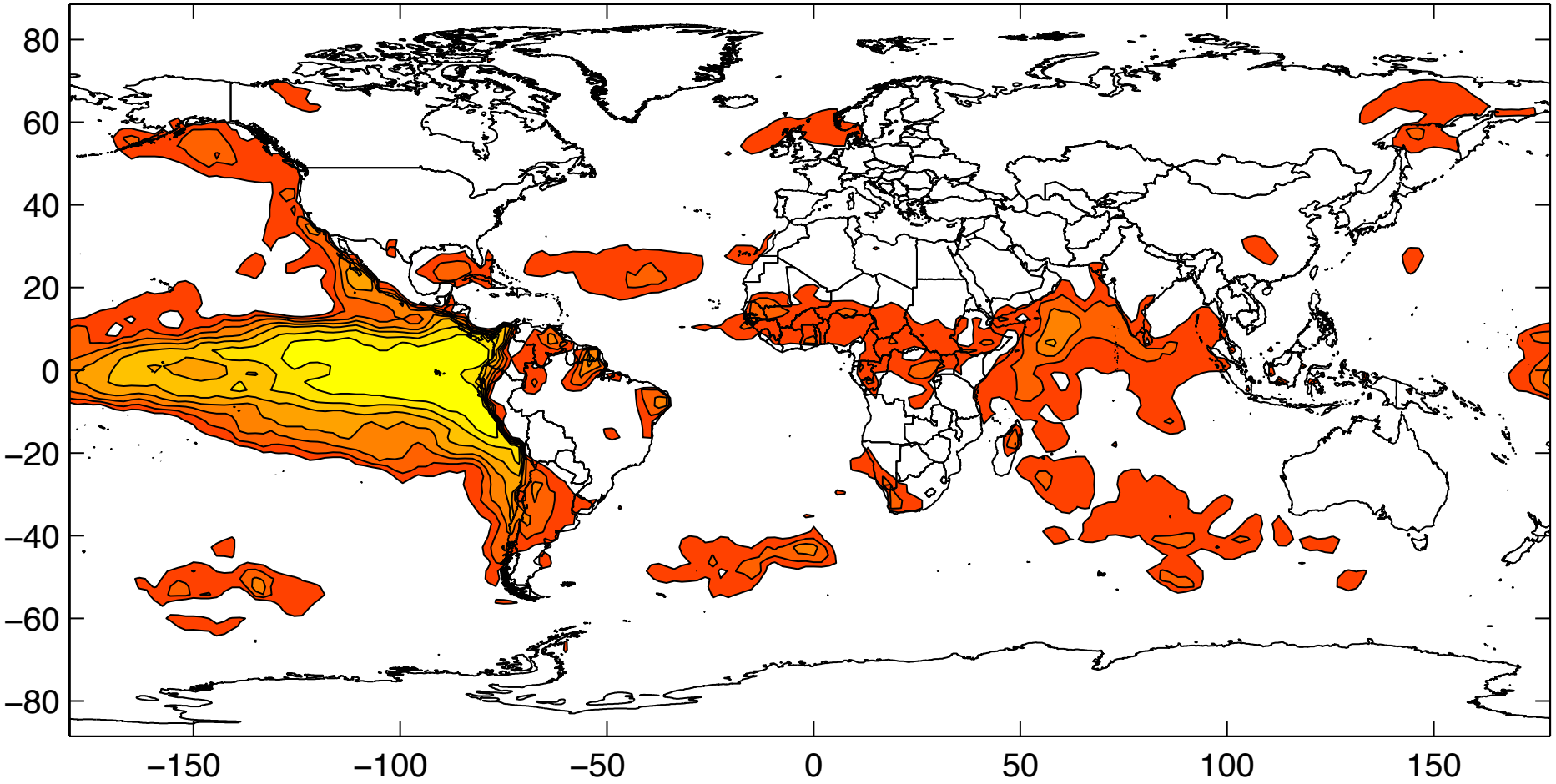
▸ Beginning ▸ Finish

Month 8 surface temperature correlated with month 12 NINO3



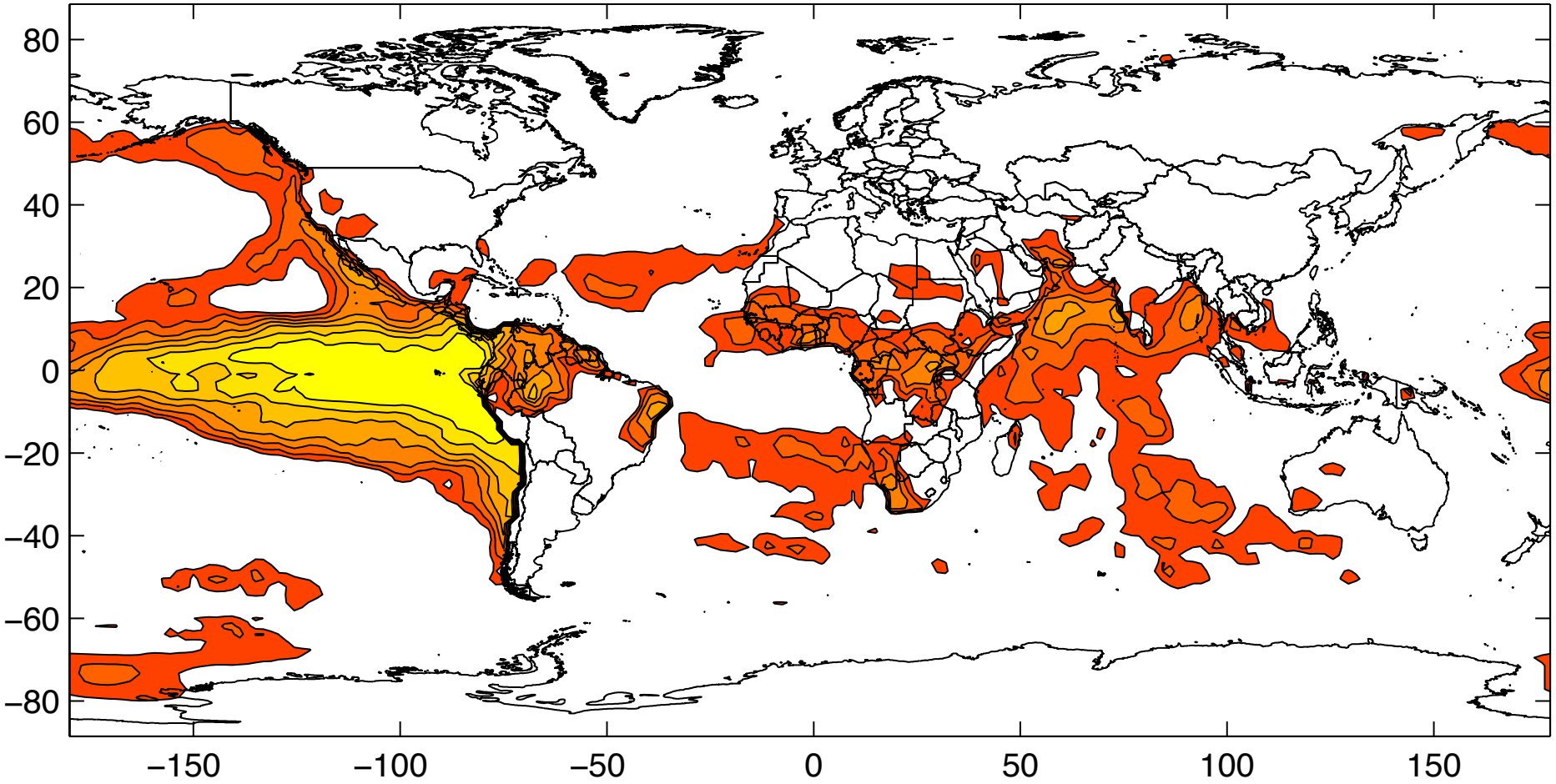
▸ Beginning ▸ Finish

Month 9 surface temperature correlated with month 12 NINO3



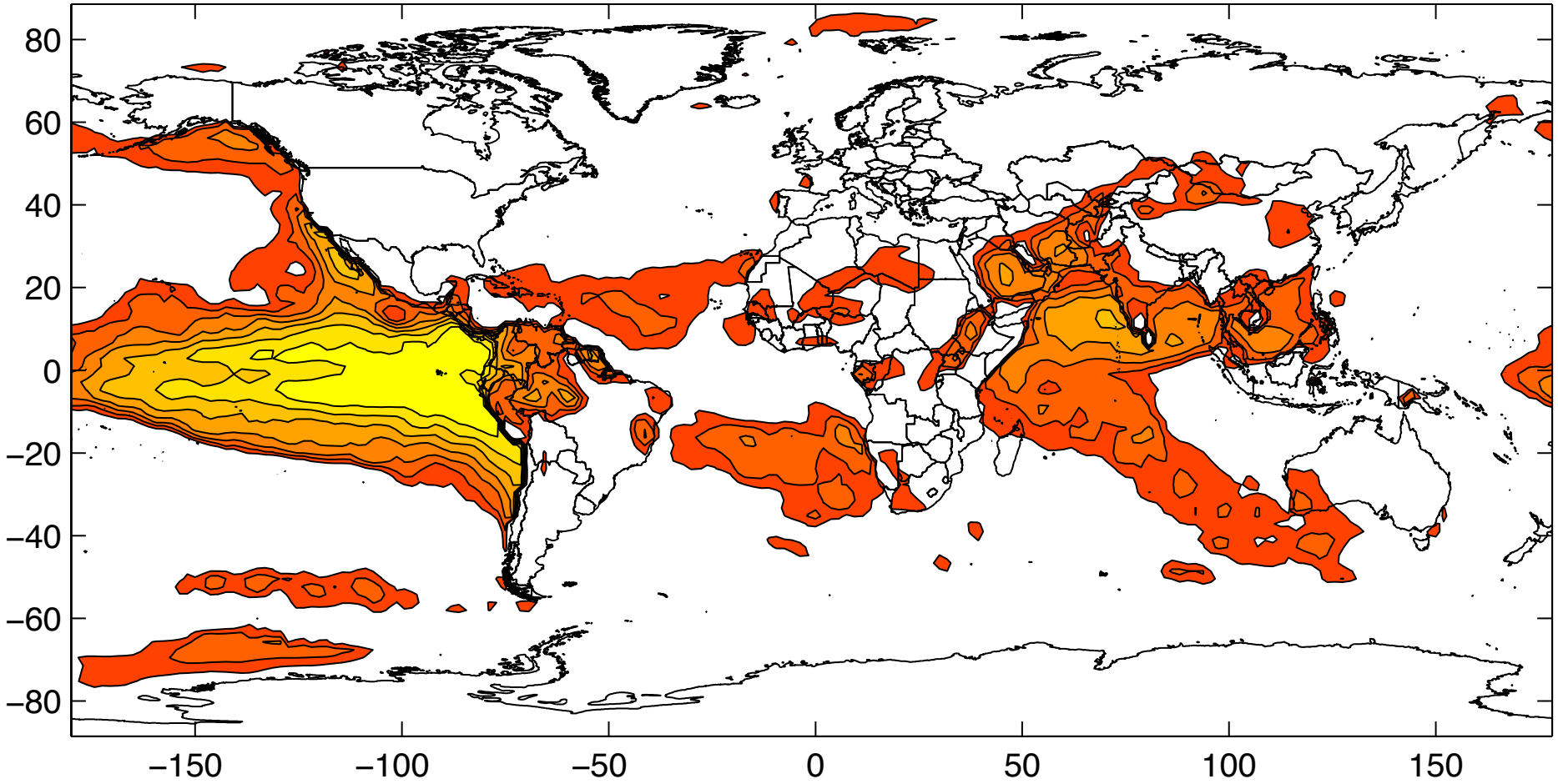
▸ Beginning ▸ Finish

Month 10 surface temperature correlated with month 12 NINO3

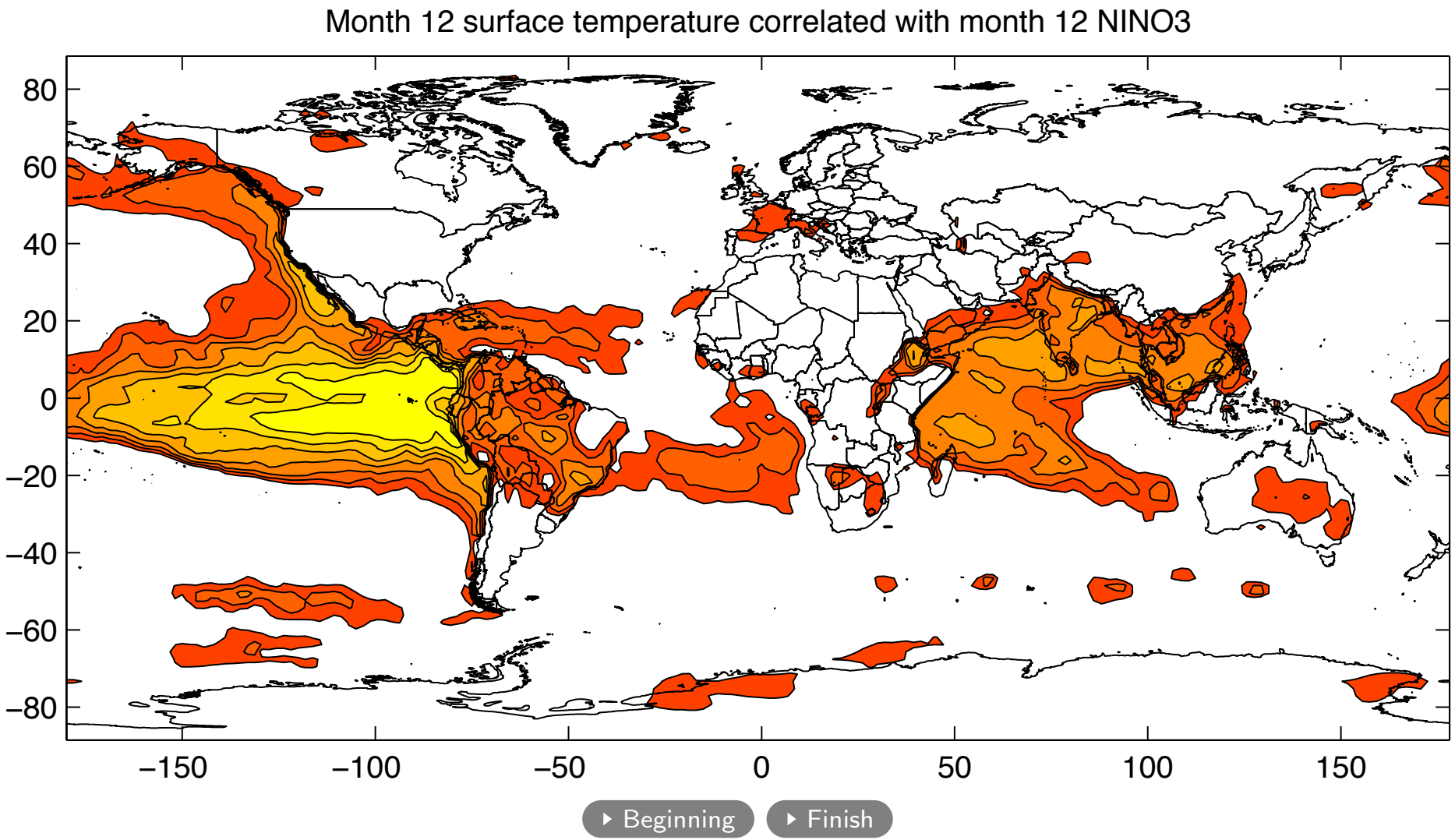


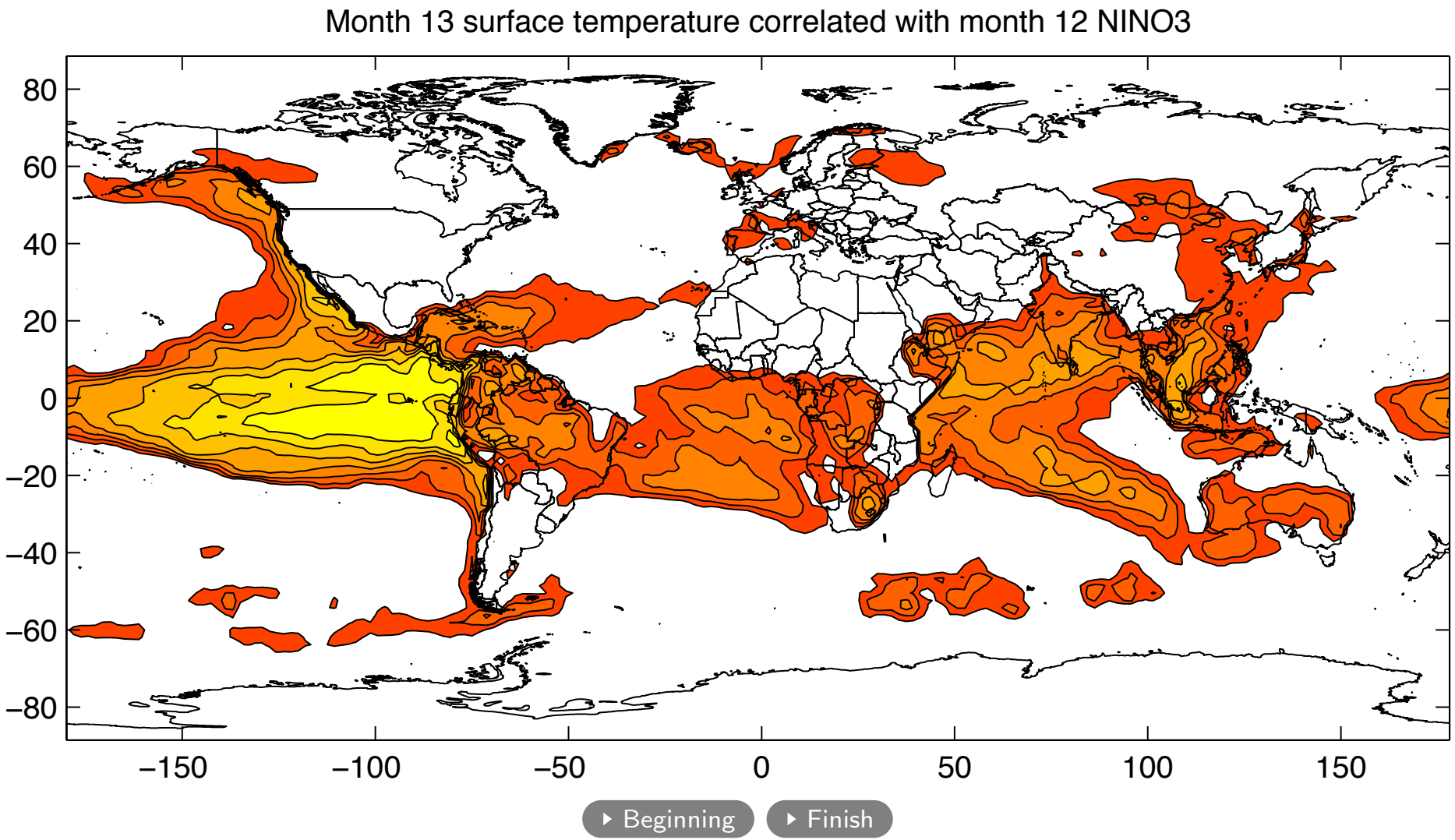
▸ Beginning ▸ Finish

Month 11 surface temperature correlated with month 12 NINO3

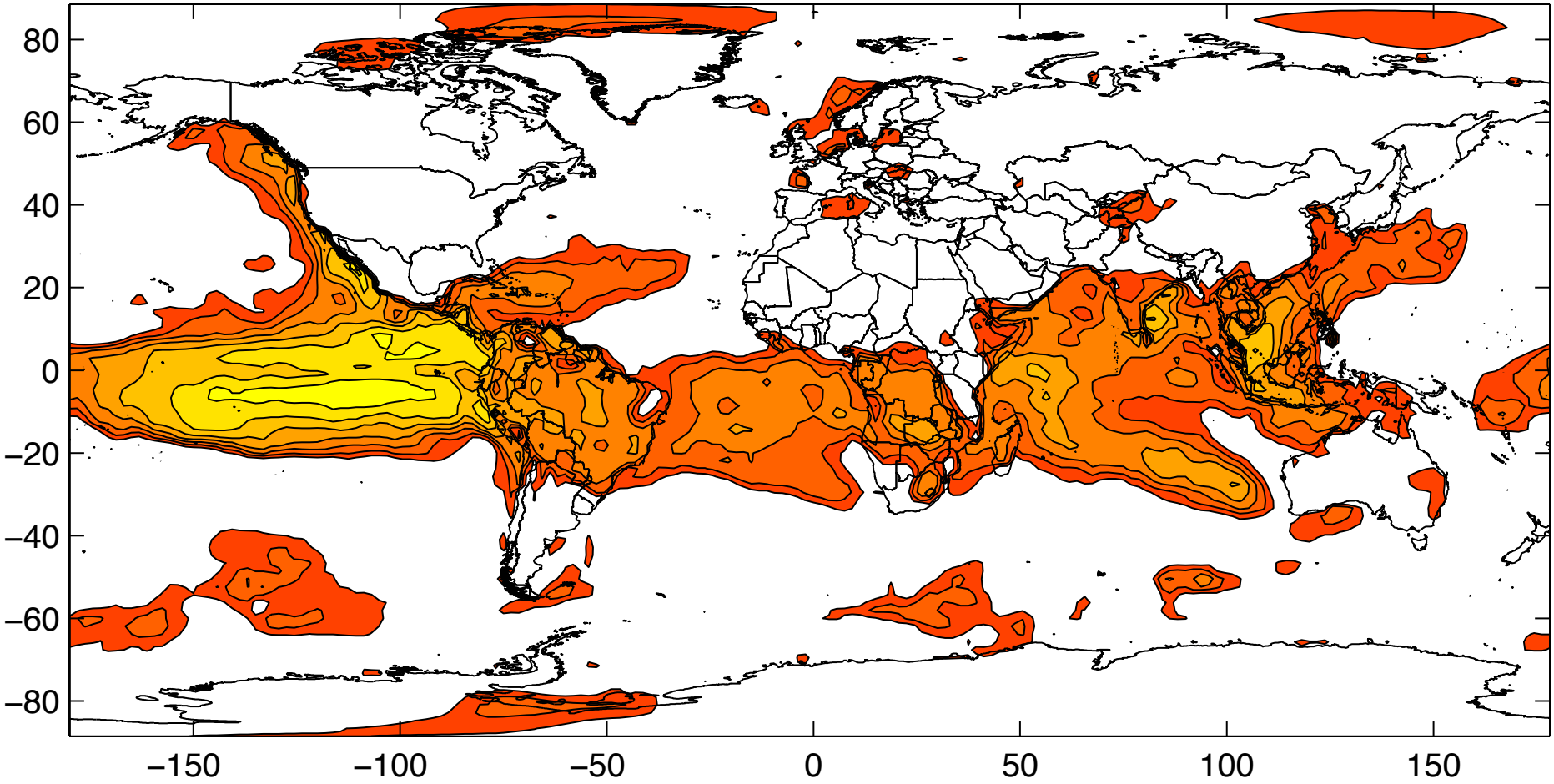


▸ Beginning ▸ Finish


Month 12 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

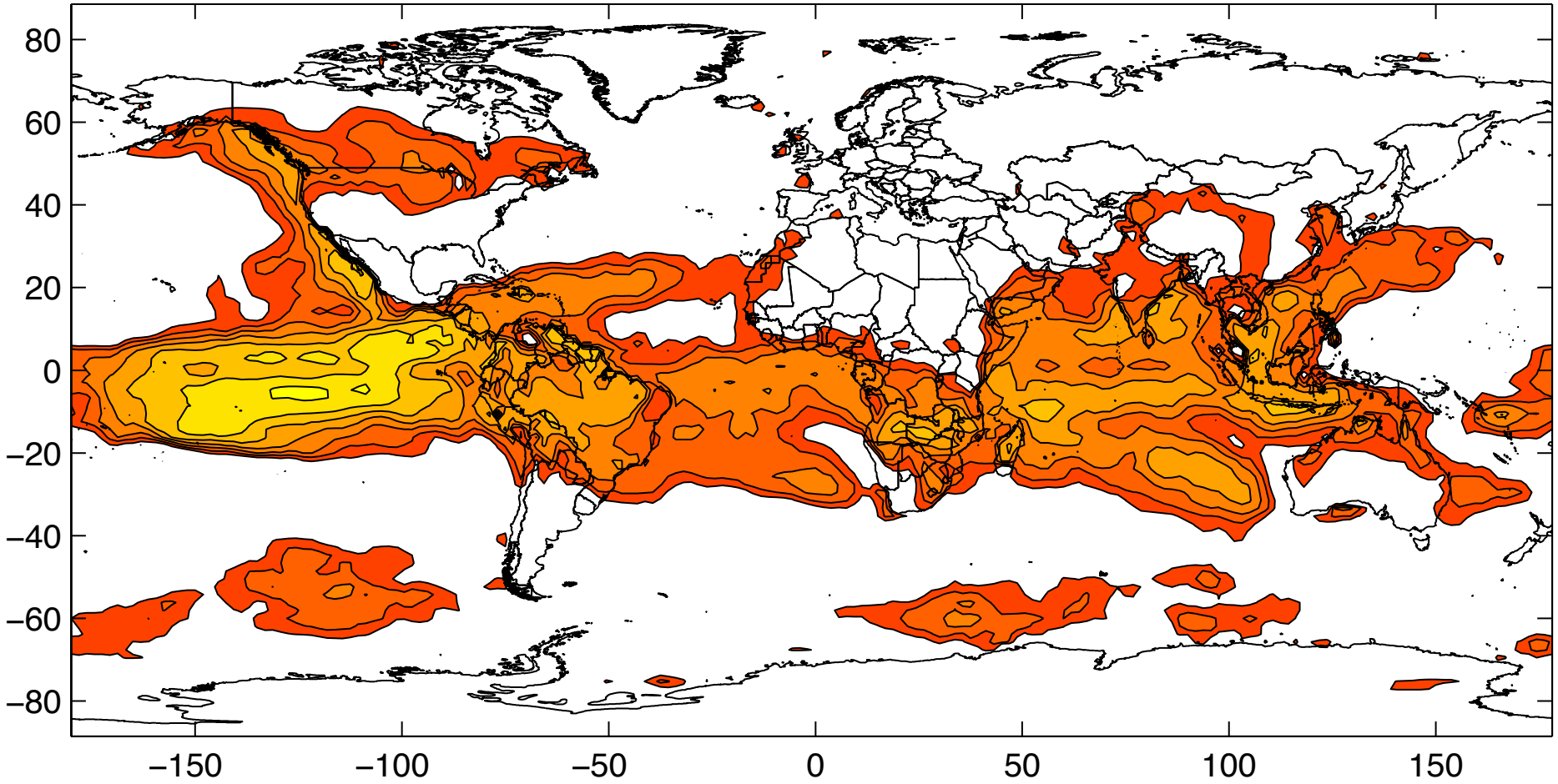

Month 13 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

Month 14 surface temperature correlated with month 12 NINO3



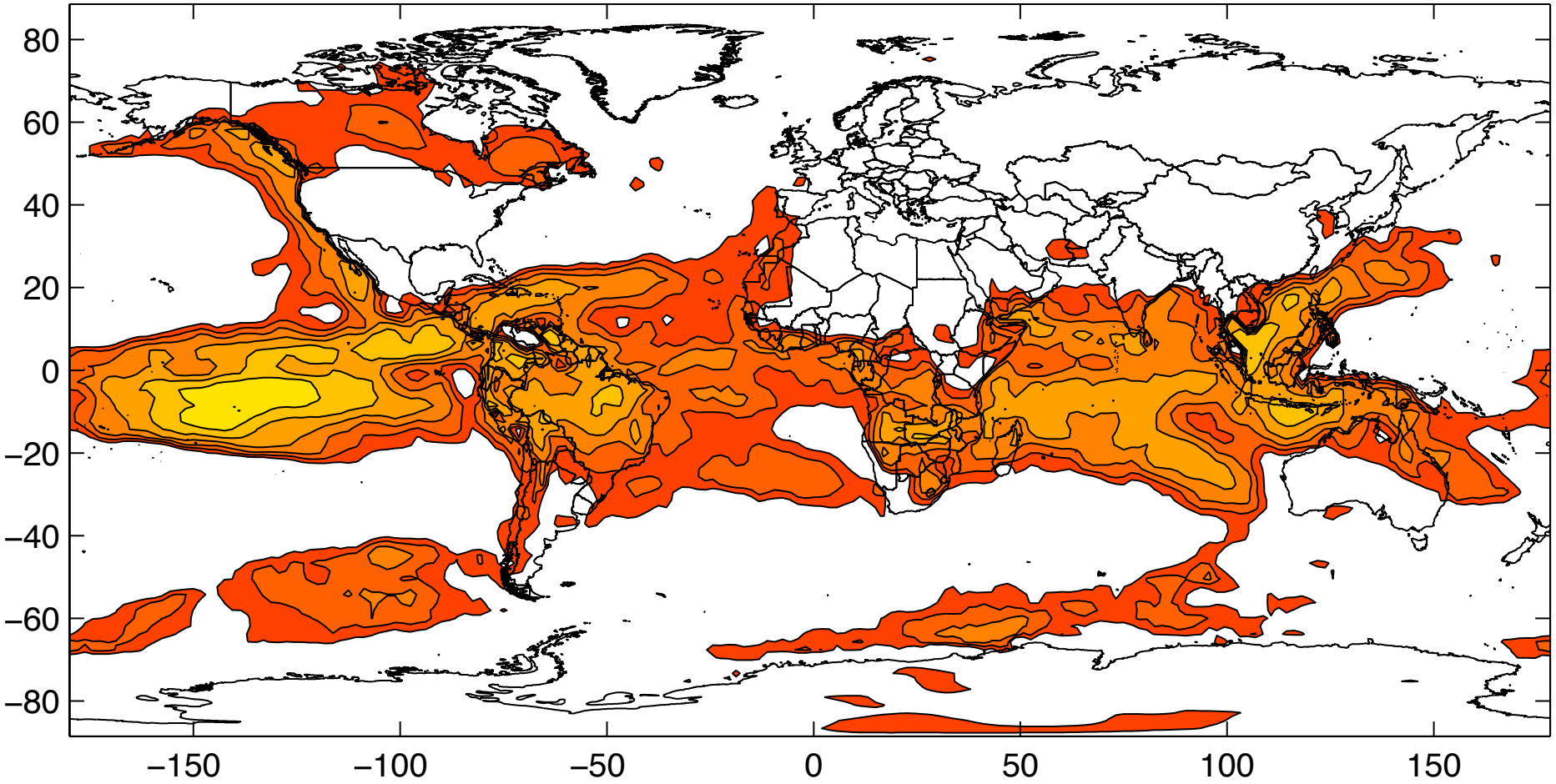
▸ Beginning ▸ Finish

Month 15 surface temperature correlated with month 12 NINO3

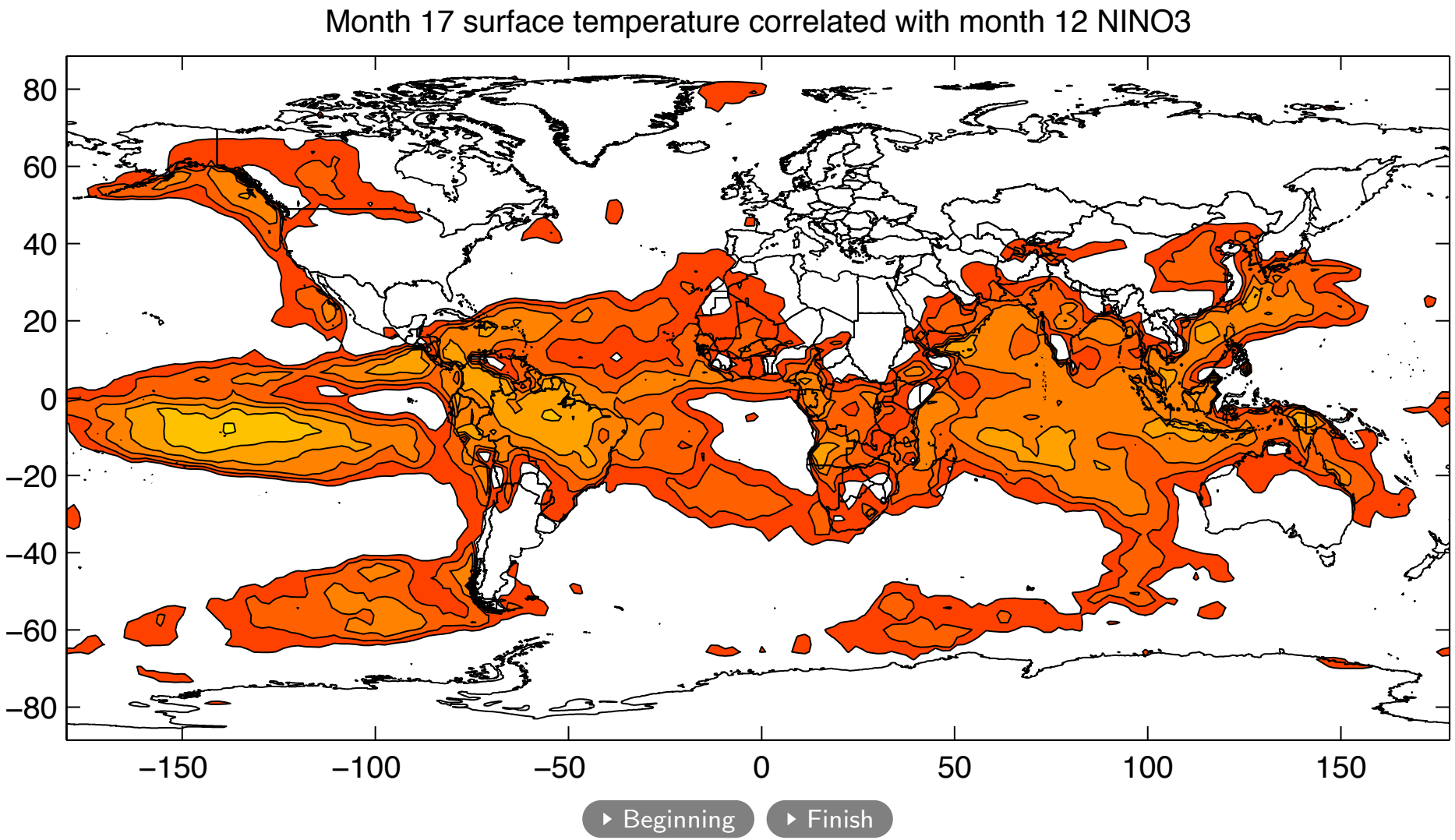


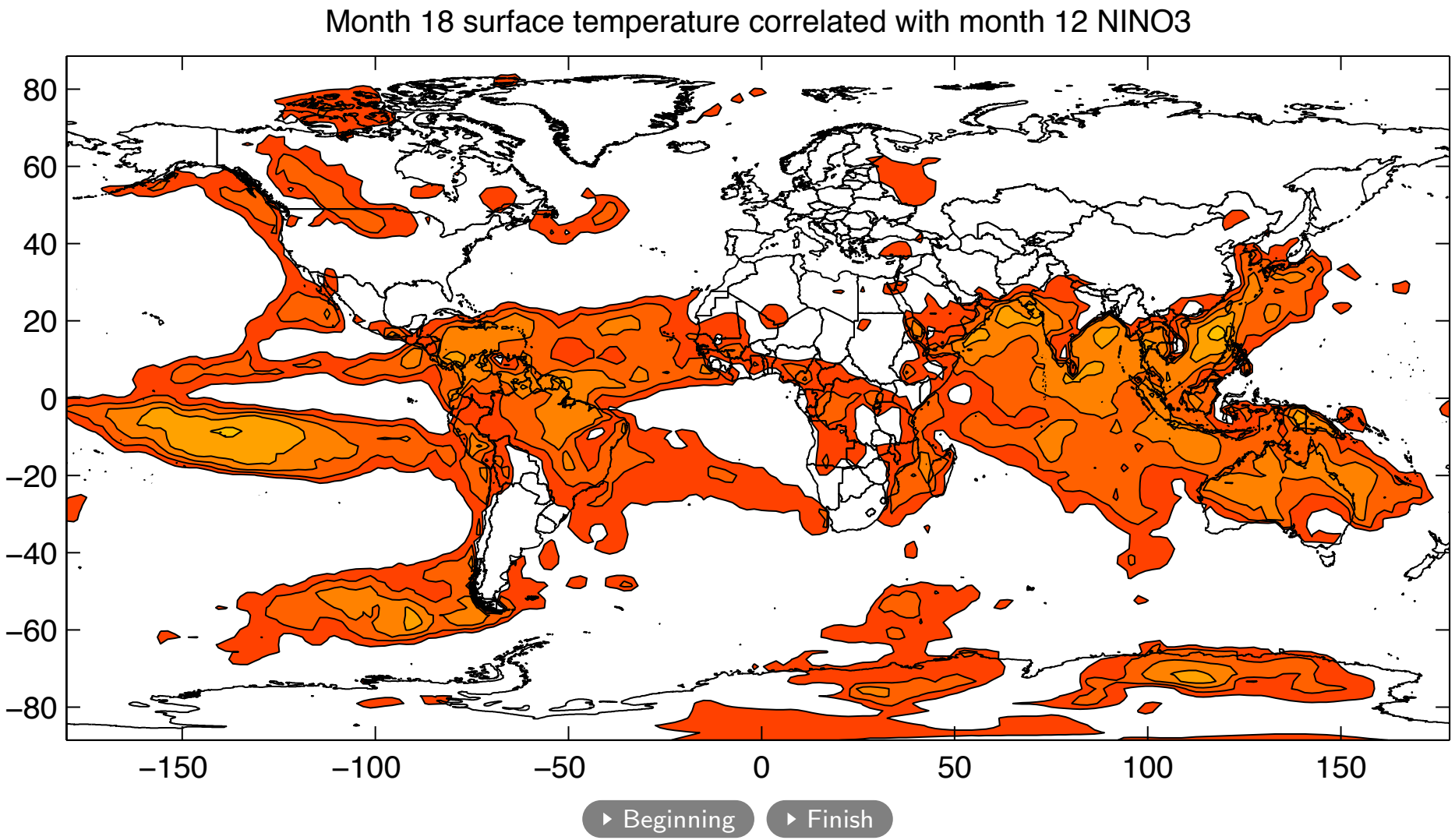
▸ Beginning ▸ Finish

Month 16 surface temperature correlated with month 12 NINO3

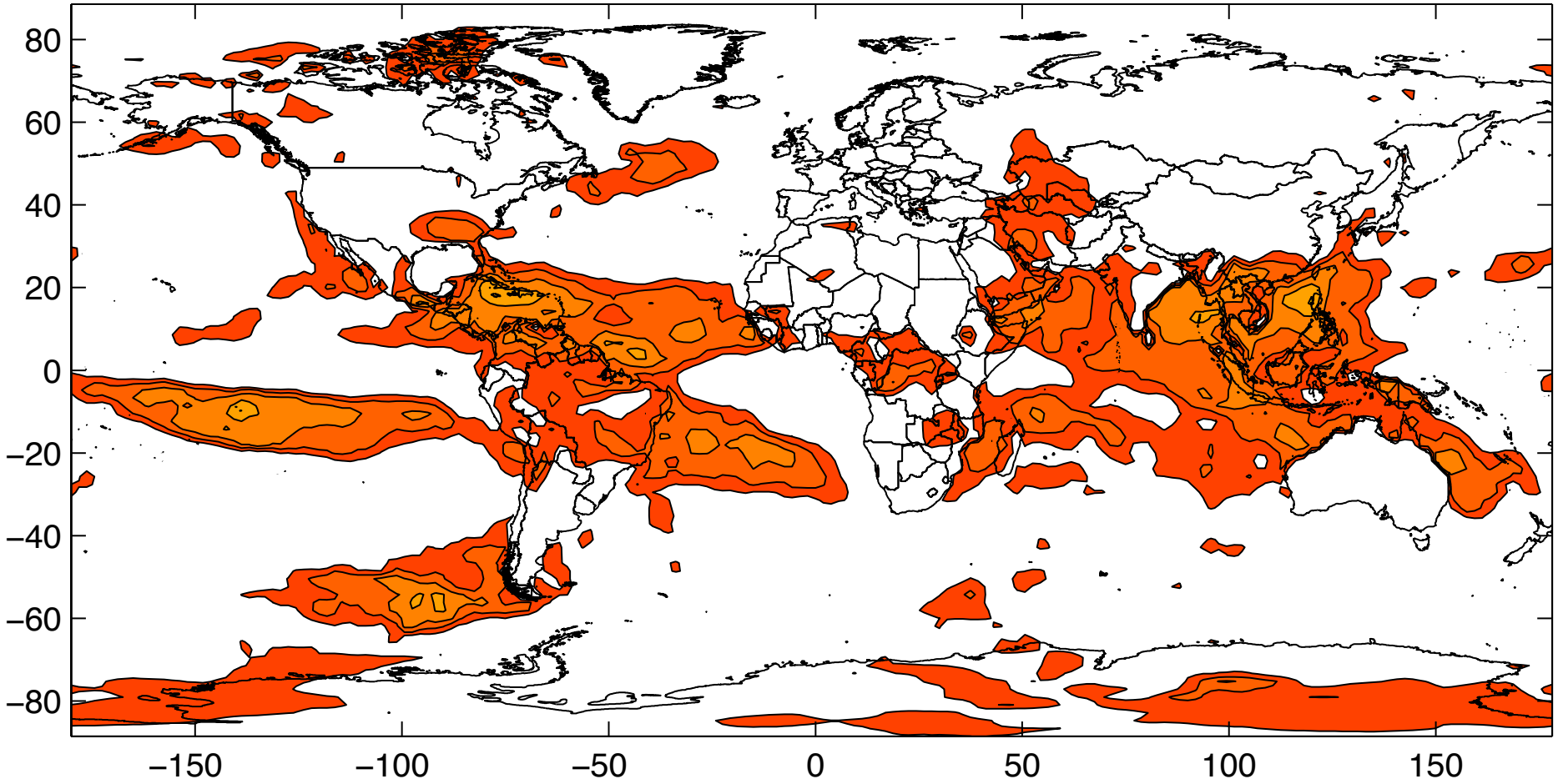


▸ Beginning ▸ Finish

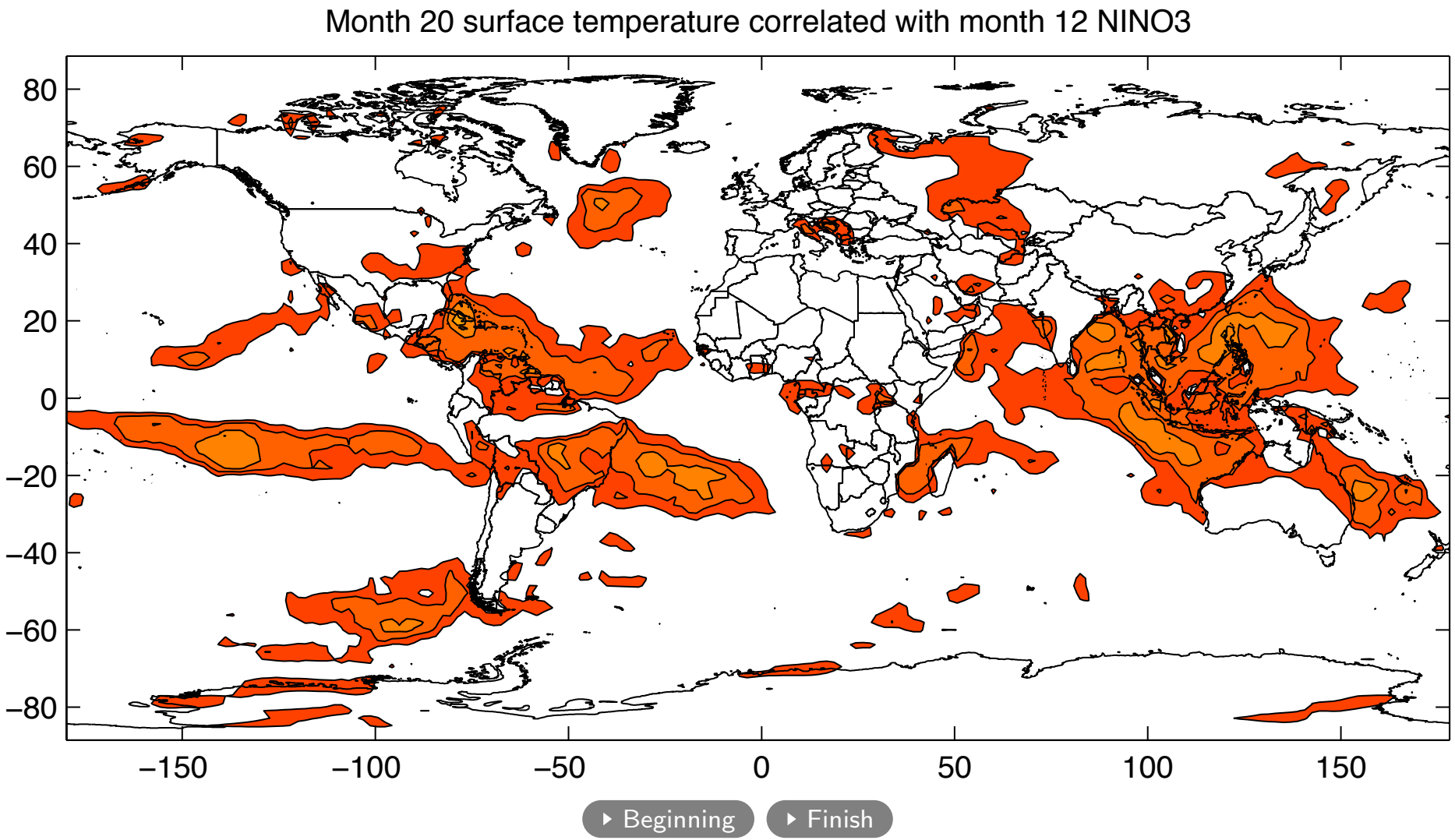

Month 17 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

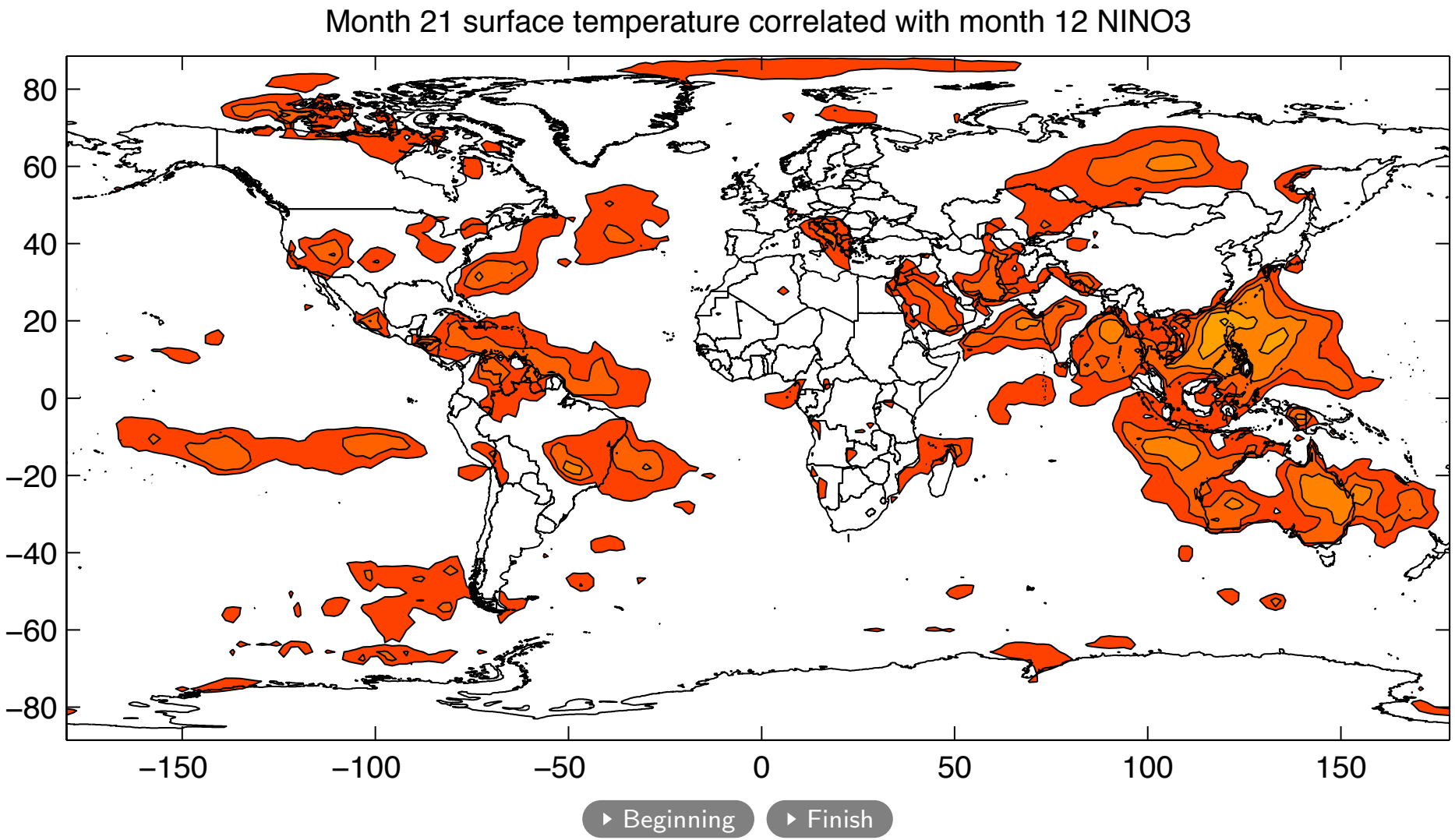

Month 18 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

Month 19 surface temperature correlated with month 12 NINO3

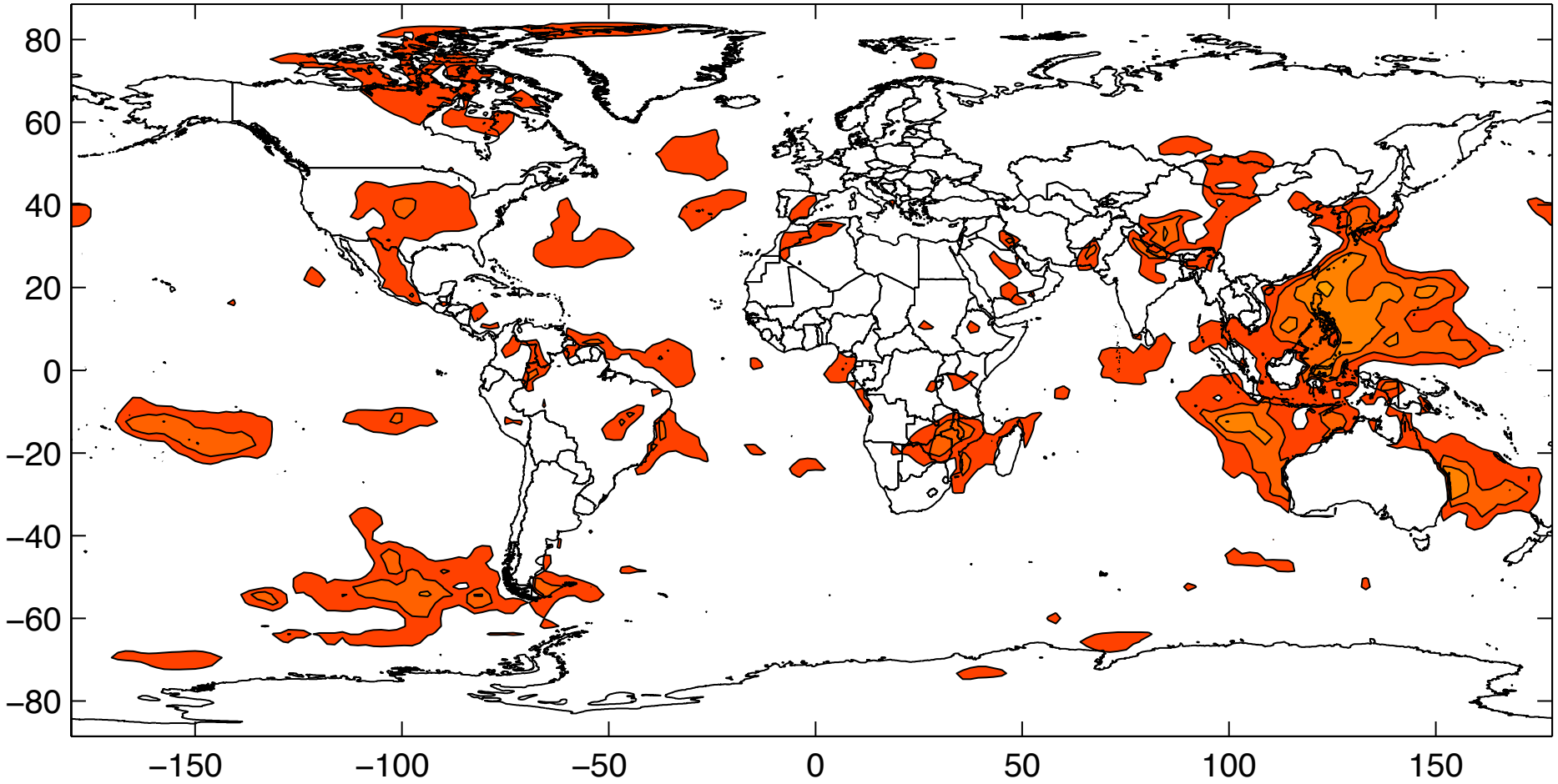


▸ Beginning ▸ Finish

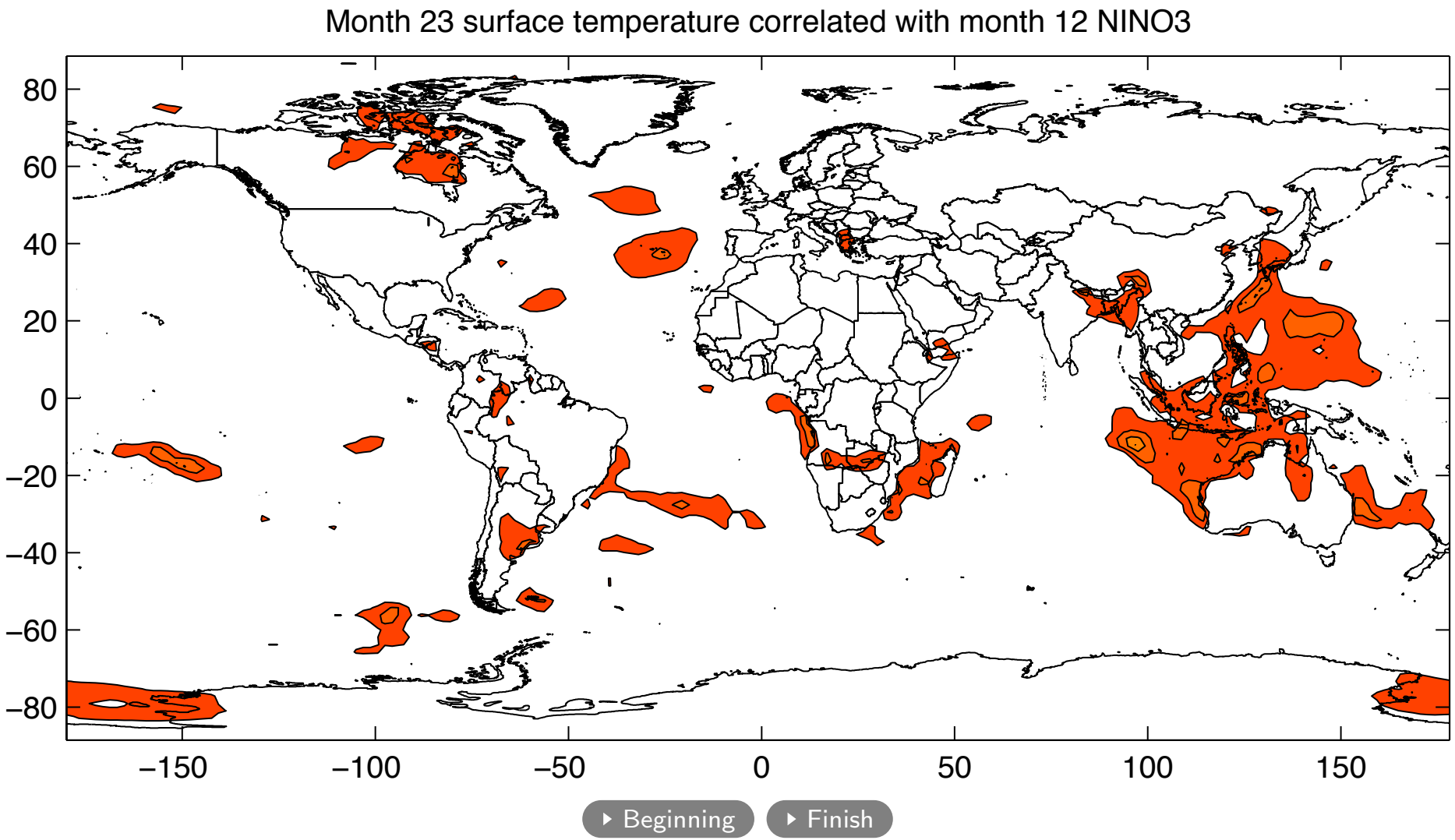

Month 20 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish


Month 21 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

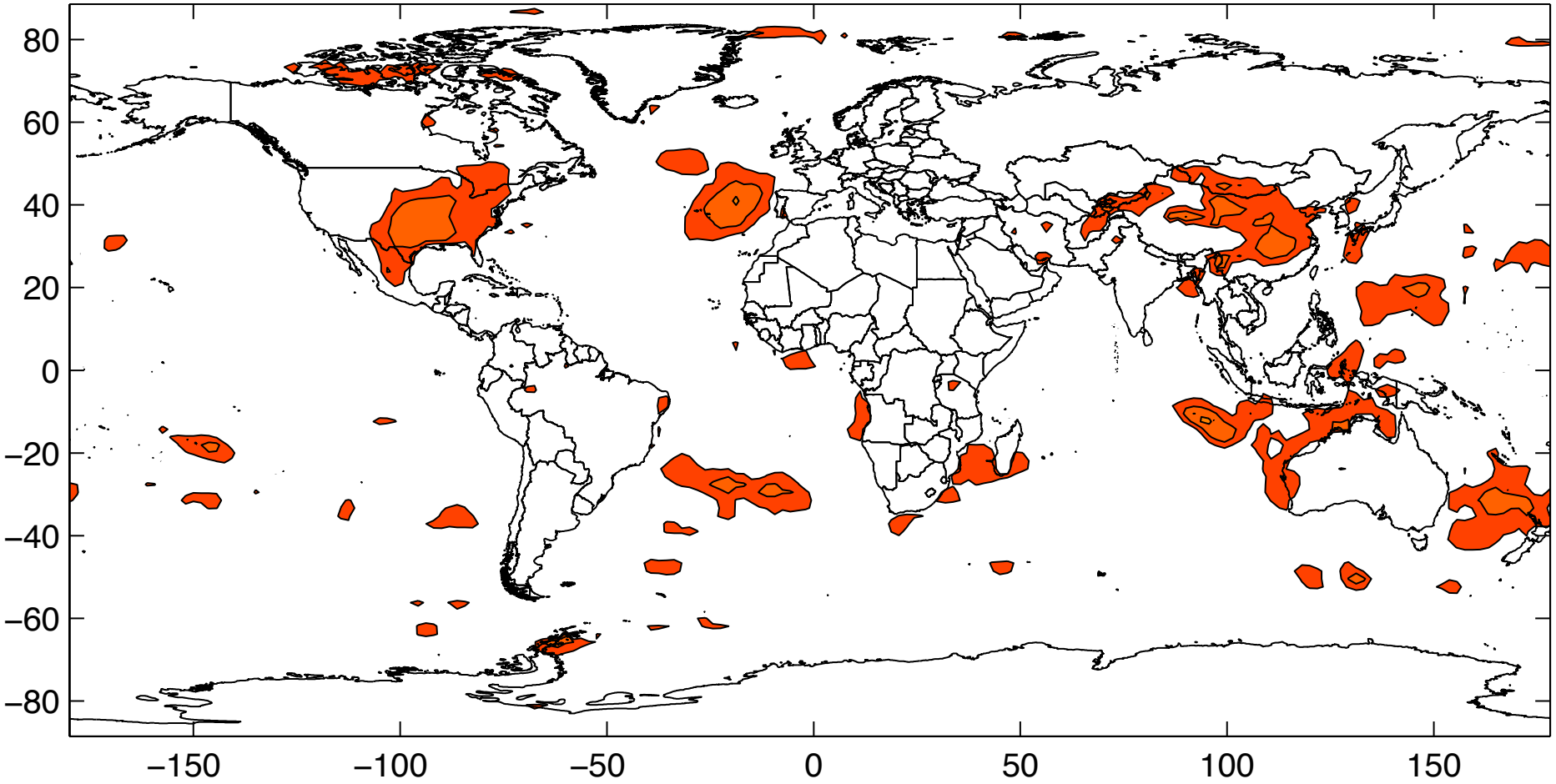
Month 22 surface temperature correlated with month 12 NINO3



▸ Beginning ▸ Finish


Month 23 surface temperature correlated with month 12 NINO3
80
60
40
20
0
−20
−40
−60
−80
−150
−100
−50
0
50
100
150
Beginning
Finish

Month 24 surface temperature correlated with month 12 NINO3



▸ Beginning ▸ Finish