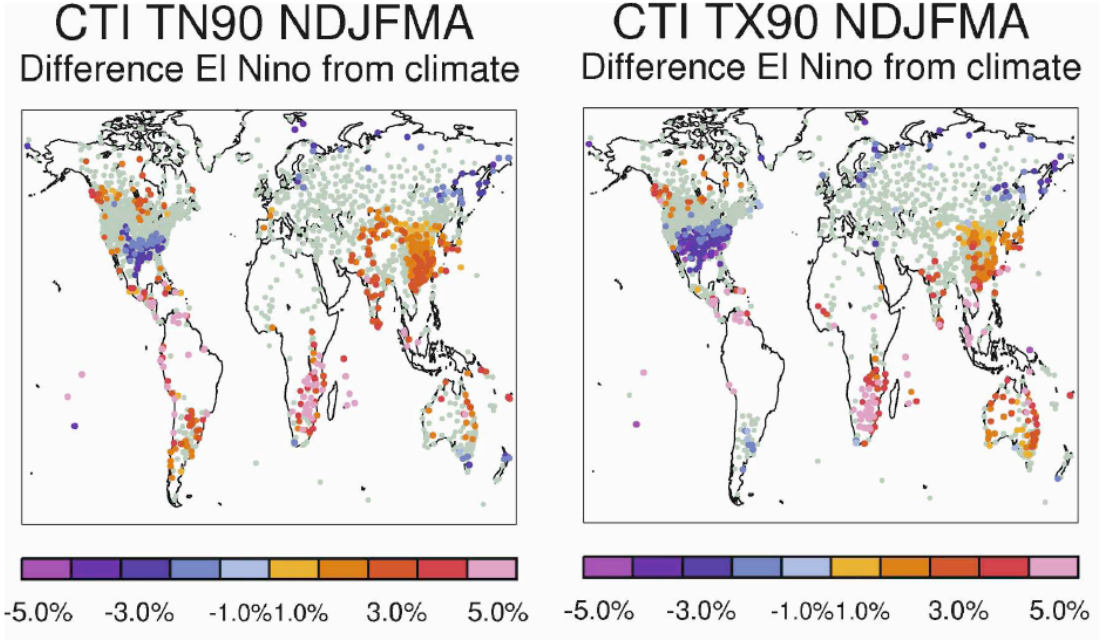
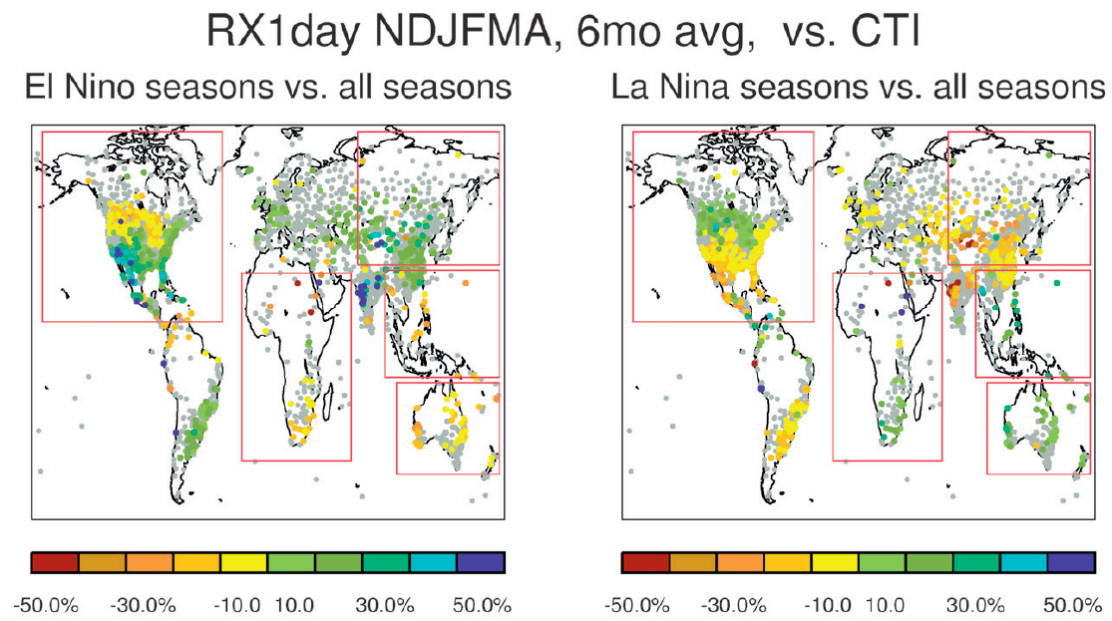


Number of warm nights number of hot days

Wettest event/month

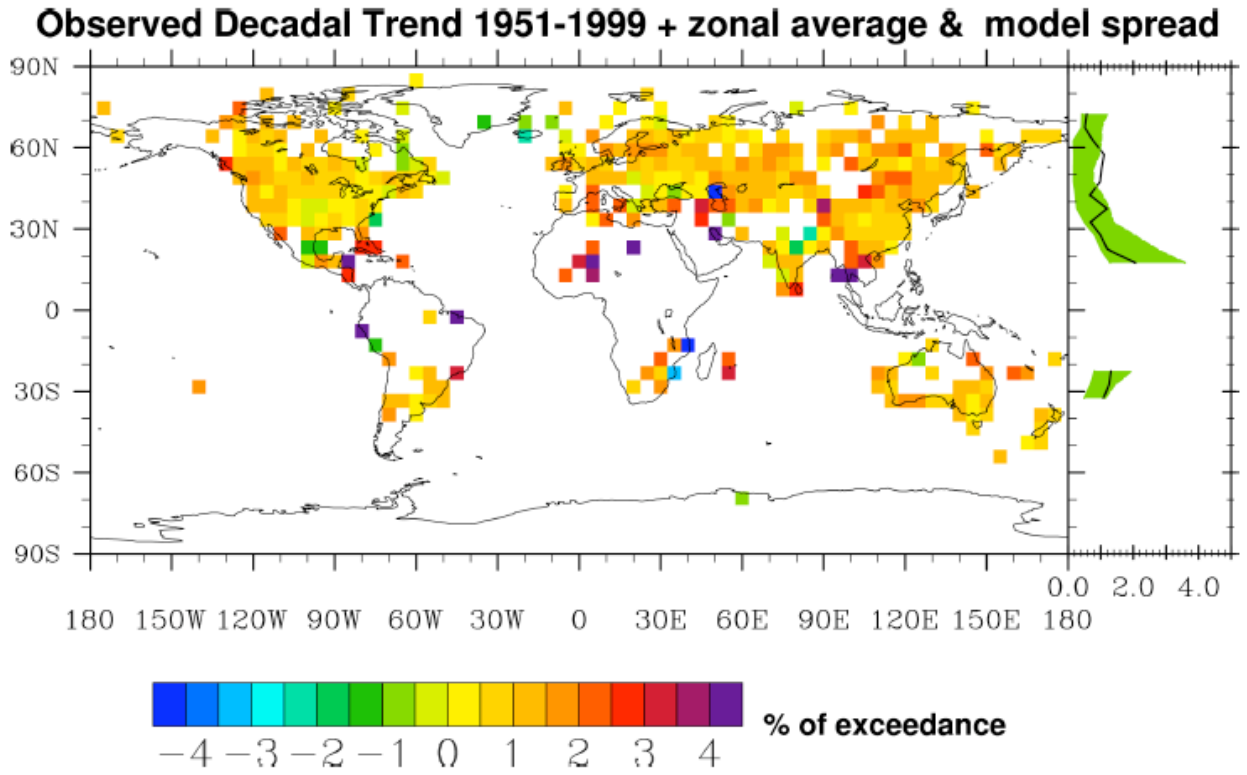


Modes of climate variability influence extremes worldwide:

El Nino; Decadal variability, NAO…

Kenyon and Hegerl, 2008 (T) and 2010 (precip)

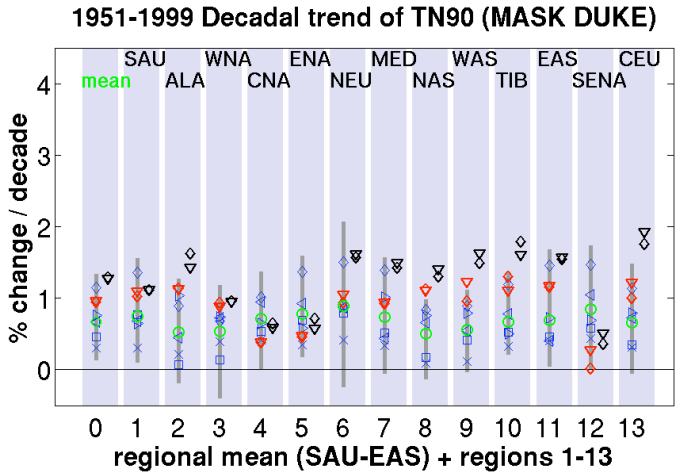
Large-scale increase in the number of warm nights

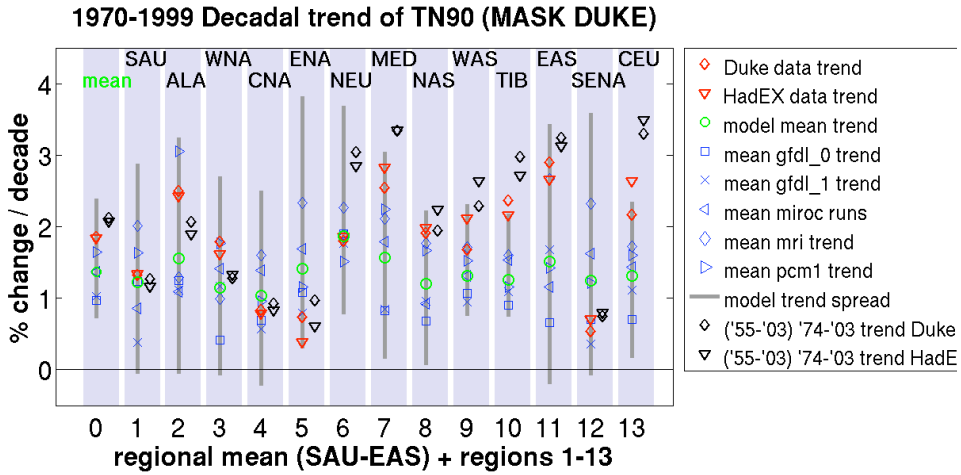


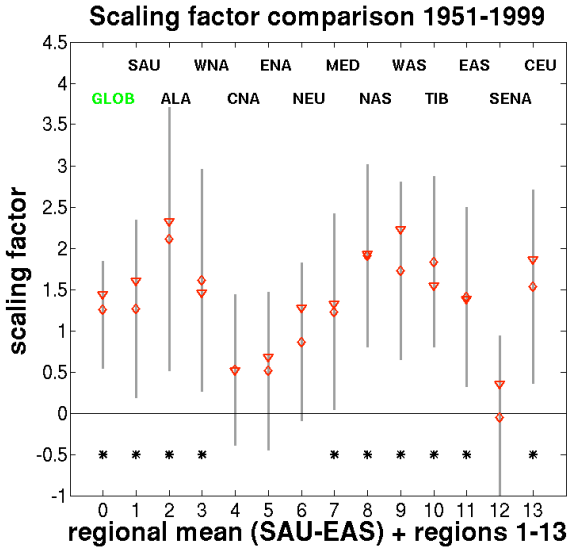
Assemble into Giorgi regions and compare model simulated with 2 observed datasets (hand-assembled into 5x5boxes, Hadex); Detection analysis: regression of observations on multi-model all forcing fingerprint

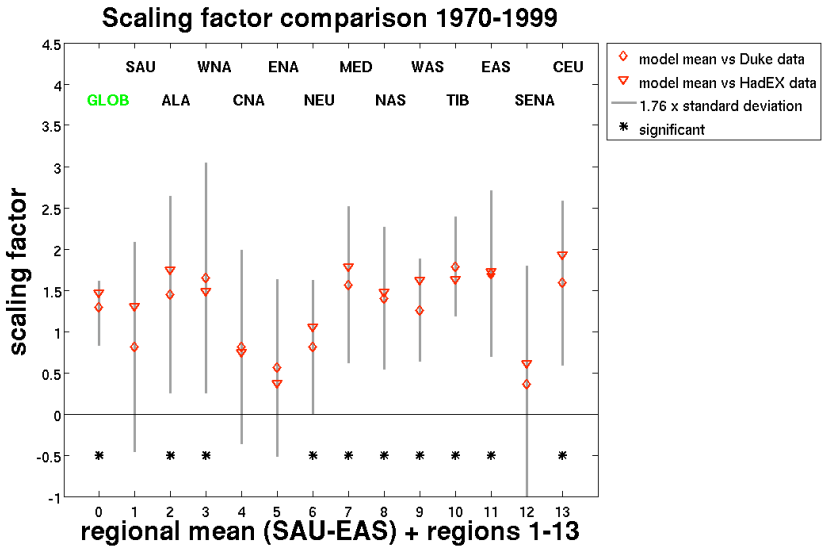
1951-99 results 1970-99 results

(black: extension to 2003)



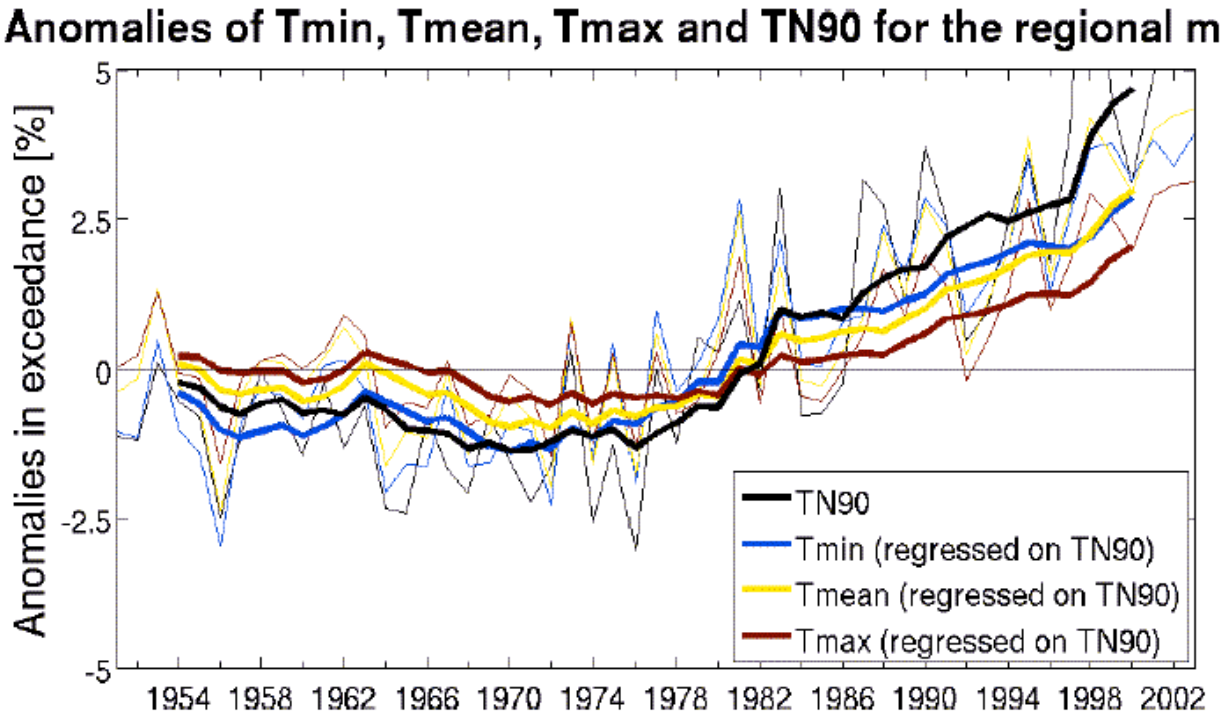






*: 5% significant change in number of warm nights in region (non-optimized)

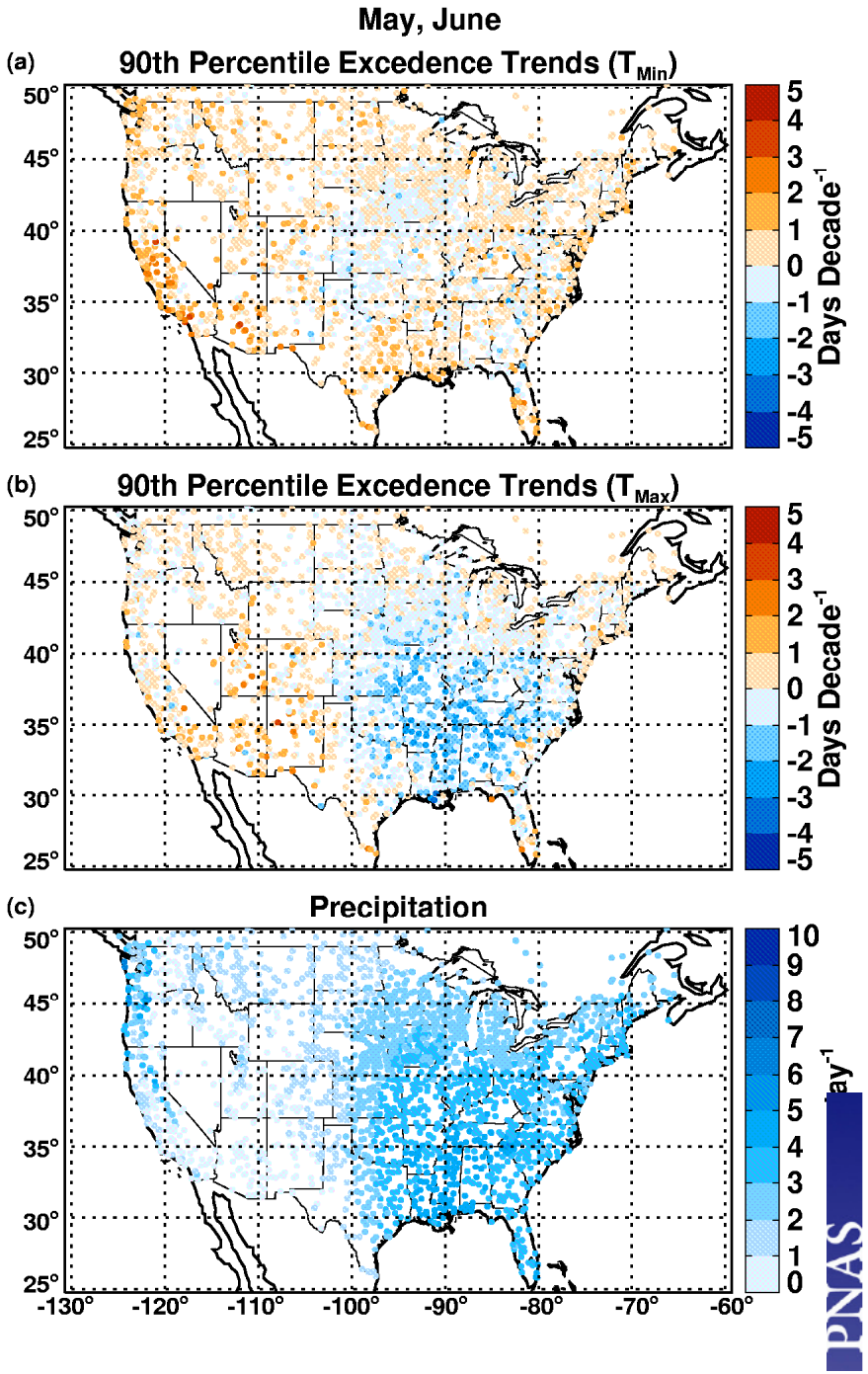
Morak and Hegerl, to be submitted



Multi-step attribution

- We have detected a significant change that projects on the fingerprint of external forcings
- TN90 correlates strongly with SAT interannually (trend subtracted)
- most of the trend in TN90 is predicted based on interannual correlation with Tmean
- Much of change in Tmean over continents and most globally has been attributed to greenhouse gas increases

=> Observed increase in Tmean probably largely due to greenhouse gas increases (note we cant easily estimate the contribution)



May and June Trend pattern in number of hot days 1950-2006

The trend in TX90 is anticorrelated with climatological precipitation => vegetation process?

PNAS

Spatial and seasonal patterns in climate change, temperatures, and precipitation across the United States

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Conclusions

- Changes in extremes don't always follow the mean, not even for temperature
- Where they follow the mean, inferences can be drawn from attributable changes in the mean in multi-step attribution; but direct assessment preferable
- Anthropogenic changes in frequency (and intensity) of warm nights are detectable
- Warm daytime extremes are more difficult and have not changed everywhere
- Plans: Simone Morak working on changes in hot/cold spells and Detection and Attribution of changes in TX90, TN90 TX10, TN10;
- Helen Hanlon on changes in heat waves (including in decadal forecasts);
- Andrew Schurer will look at changes in extremes in long station data in Europe

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