Covariance of Storm Hazards in the Atlantic Basin

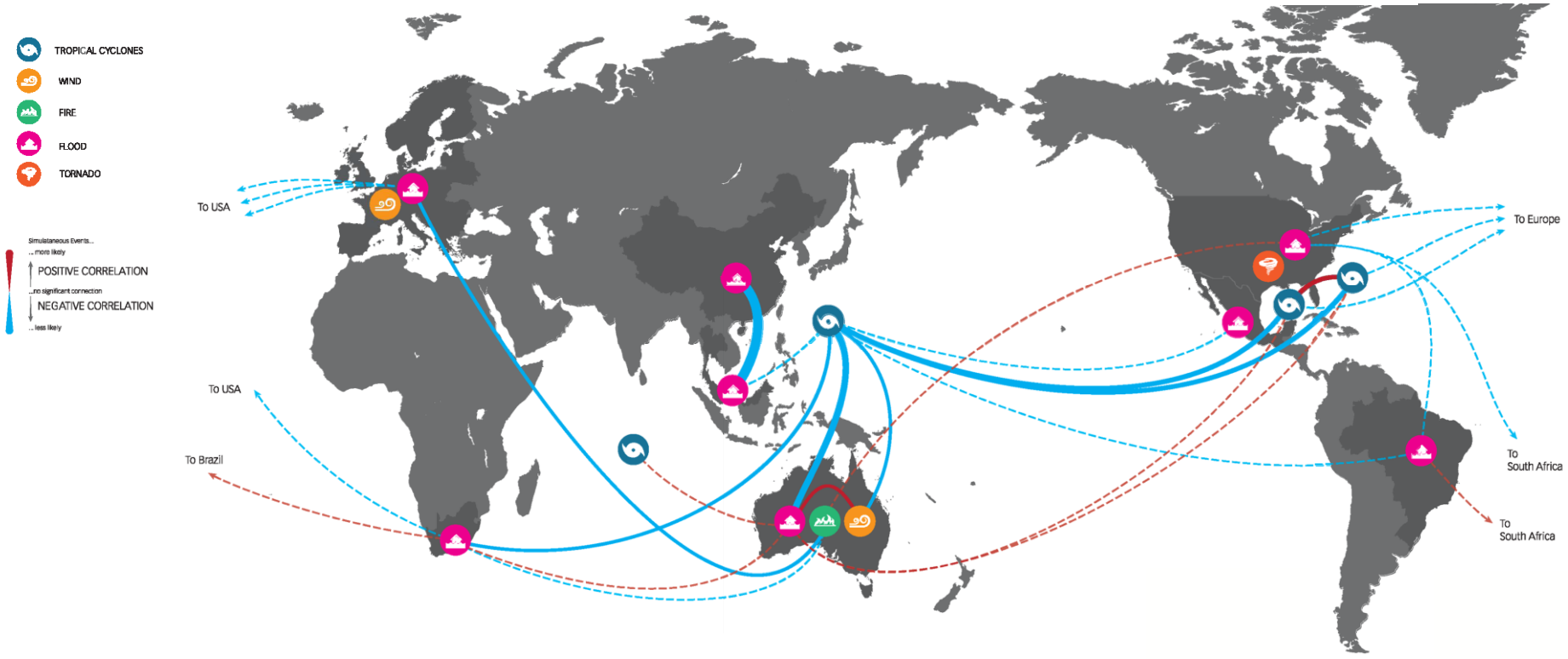
Michael Angus, Gregor C. Leckebusch & Ivan Kuhnel

UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

CoreLogic

Royal Meteorological Society
Atmospheric Science Conference 2019

Are Regional Climate Perils Related?



Risk of Global Weather Connections, Lloyd's and Met Office 2016

UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

CoreLogic

Hypothesis

The Atlantic Hurricane Season and European winter windstorm season are ***not*** independent from one another

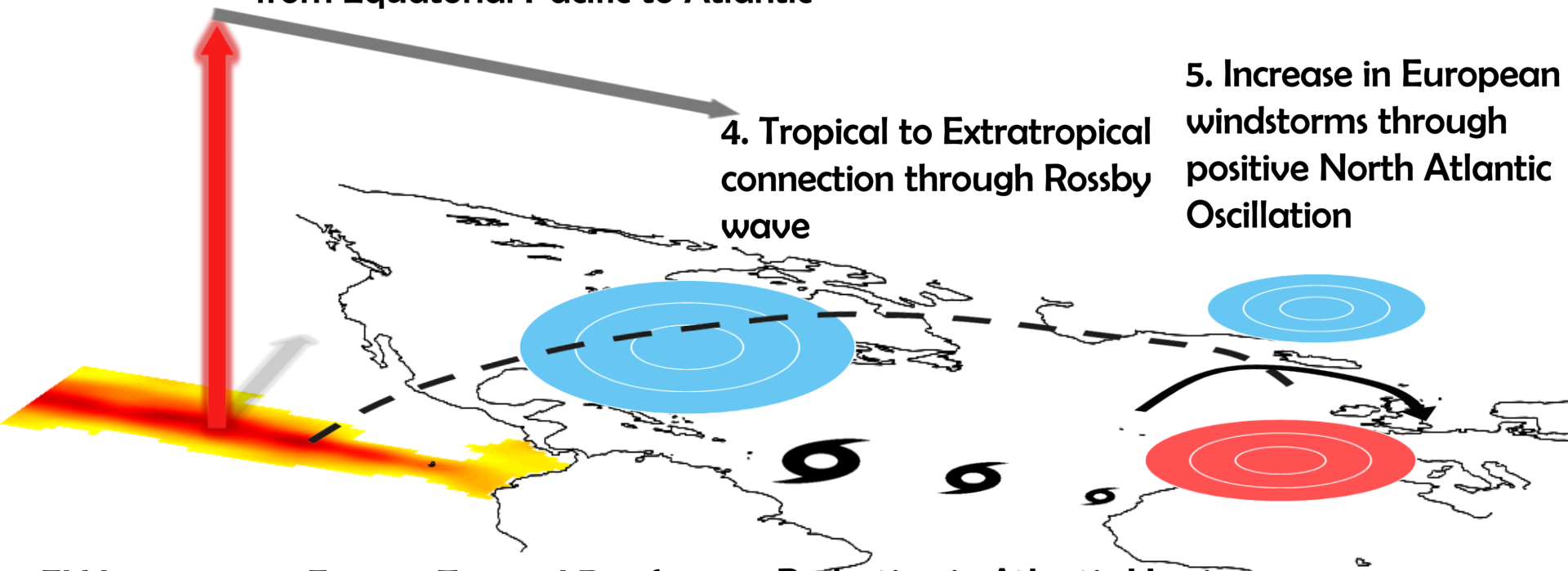
A pathway exists between the two through a climate teleconnection

Hypothesised pathways

2. Rising motion and associated upper level wind flow from Equatorial Pacific to Atlantic

4. Tropical to Extratropical connection through Rossby wave

5. Increase in European windstorms through positive North Atlantic Oscillation



1. El Niño event in Eastern Tropical Pacific

3. Reduction in Atlantic Hurricanes due to upper level wind shear increase

UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

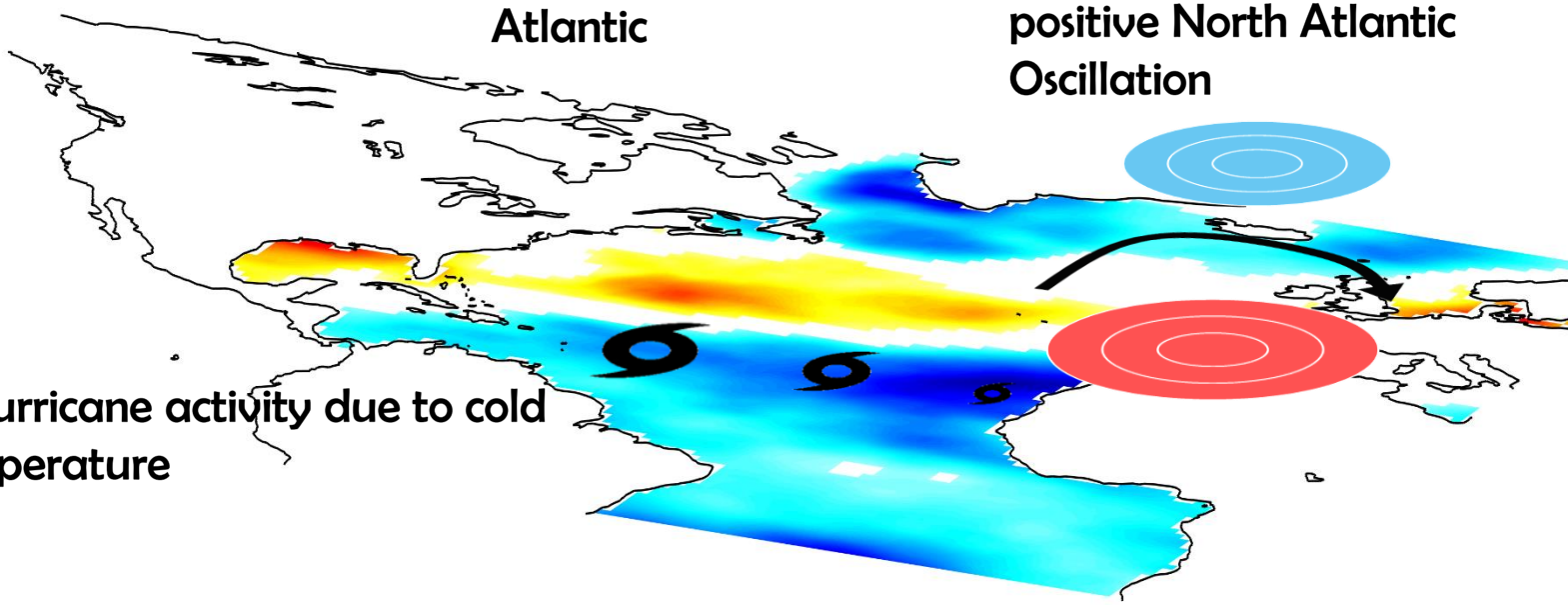
CoreLogic

Gray 1984
Scaife et al. 2017

Hypothesised pathways

1. Tripole pattern of sea surface temperature in Atlantic

3. Increase in European windstorms through positive North Atlantic Oscillation

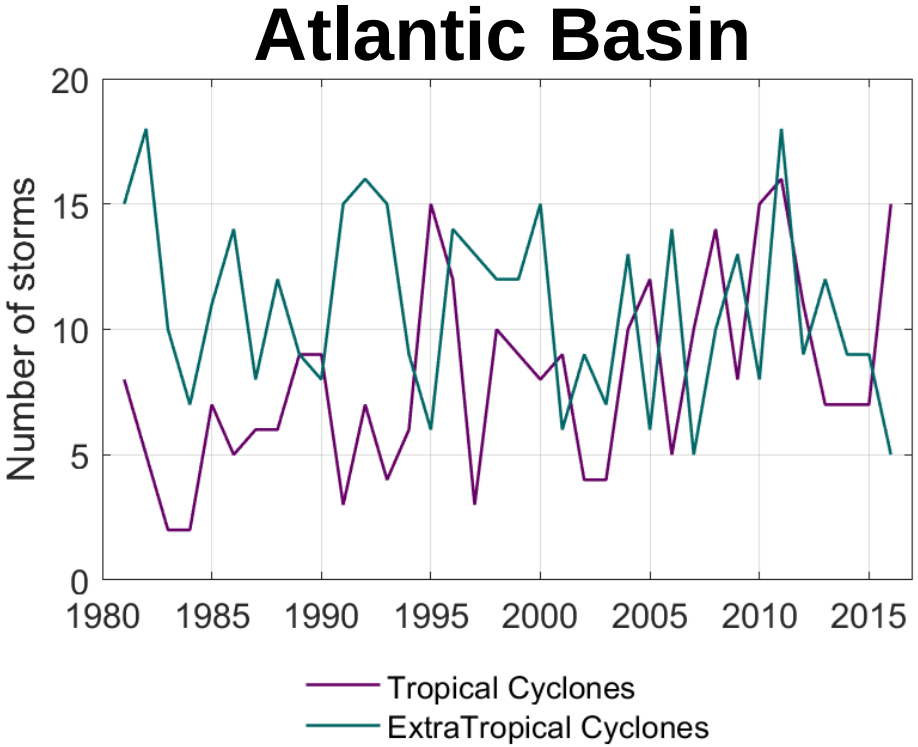


2. Decrease in Hurricane activity due to cold Sea Surface temperature

Data Limitations

Reliable count data for both Tropical and Extratropical Cyclones only in the satellite era (1979-present)

Extend by building event climatology from Ensemble Prediction System



Pearson Correlation coefficient: **-0.2**

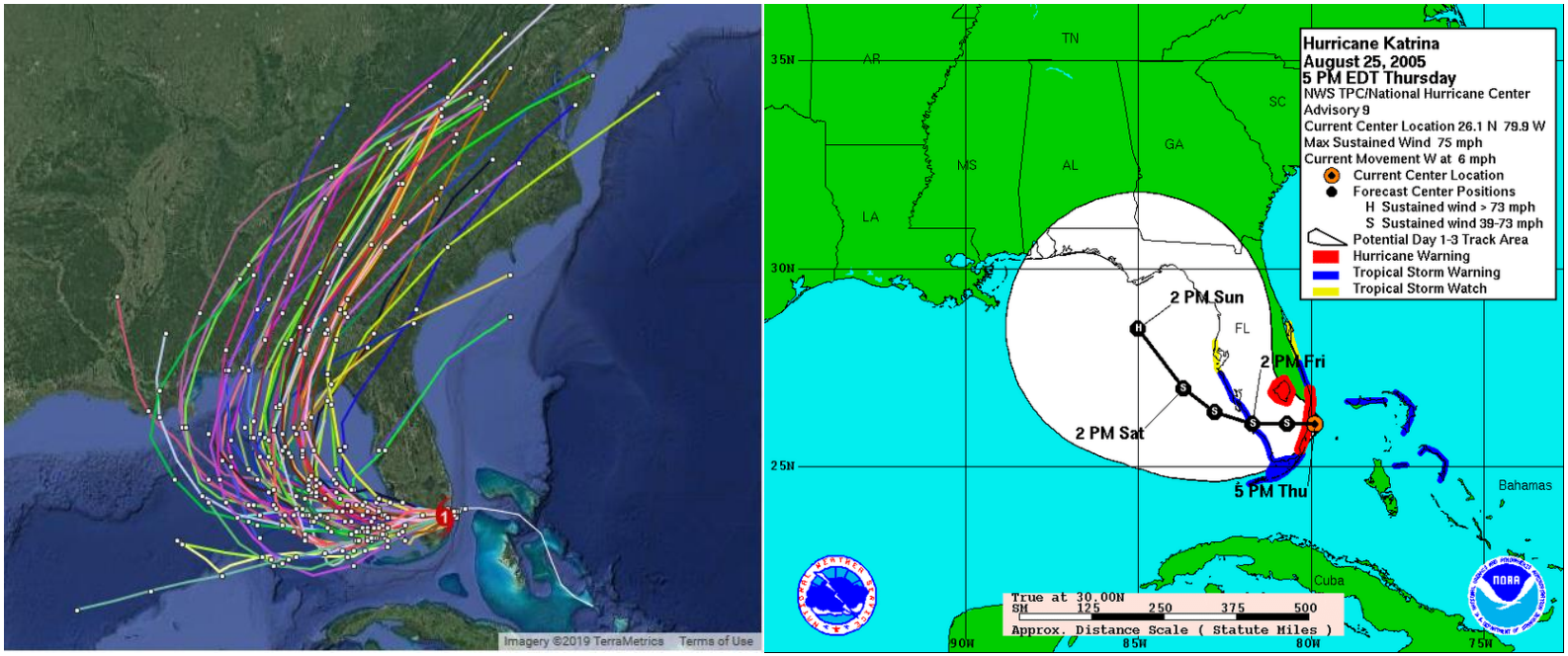
Not significant at the 95th percent confidence level

Tropical Cyclone count: IBTrACS best Track data

Extratropical Cyclone count: Cyclone Tracking in ERA-interim

Methodology

Repurpose a forecast ensemble to treat each ensemble member as a different climate realization



National Hurricane Center, Hurricane Katrina Uncertainty August 25th

UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

CoreLogic

Ensemble Prediction System

European Centre for Medium Range Weather Forecasting (ECMWF) System 5 EPS (SEAS5)

51 ensemble members over 36 years (1981-2016), total of 1836 model years

Initialised 1st of each month, run for 7 months. Selected 1st of August initialisation to cover peak Atlantic Hurricane Season (Aug-Oct) and peak European Windstorm season (Dec-Feb)

Horizontal grid spacing TCo319 (~35km, cubic grid)

Event Tracking Methodology

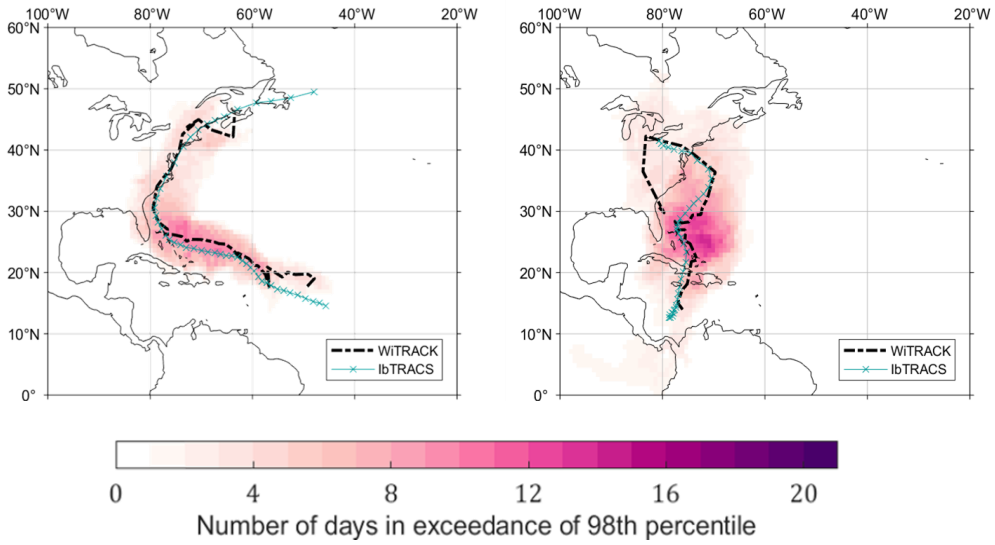
Find Clusters of 98th percentile windspeed exceedance (Leckebusch et al. 2008)

Track storms over time using nearest neighbour approach (WiTRACK; Kruschke 2015)

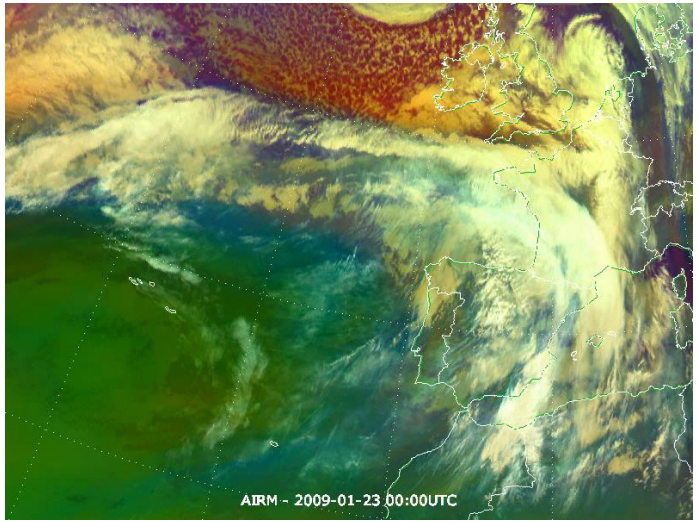
Focus on area of damaging winds, rather than central core pressure

Hurricane Floyd

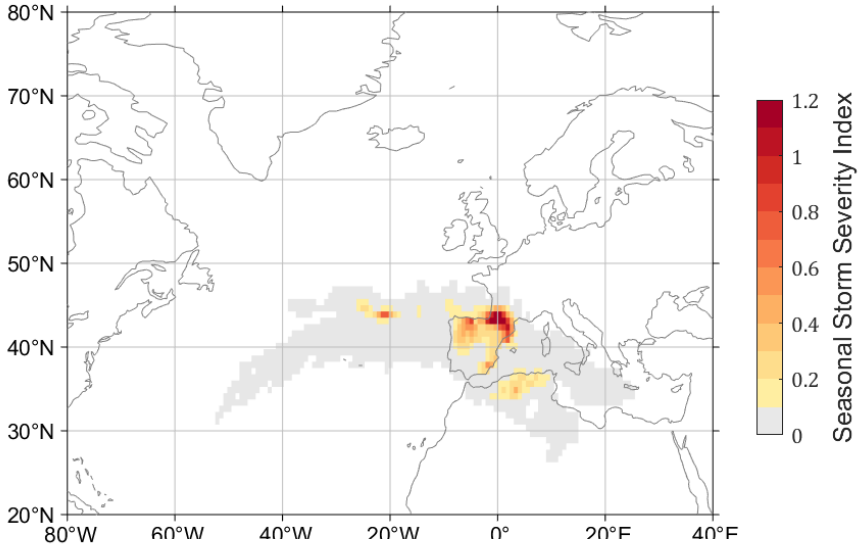
Hurricane Sandy

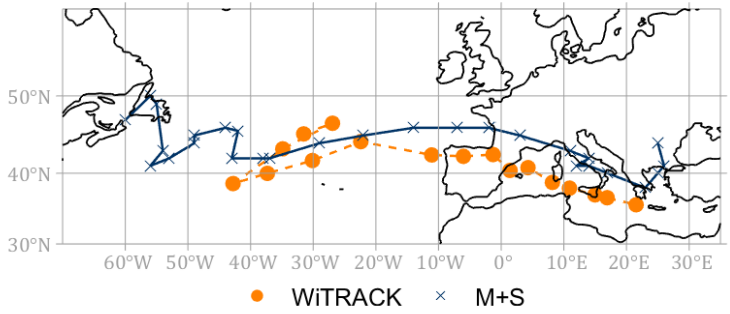


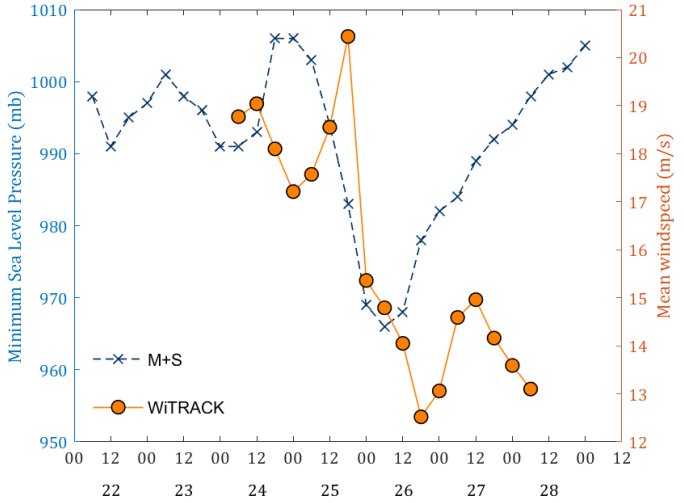
Event Tracking Methodology



EUMETSAT storm track, from Meteo Sat-9 Air Mass Product. Windstorm Klaus 2009







Blue = Murray and Simmonds (1991) min. pressure tracking methodology

UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

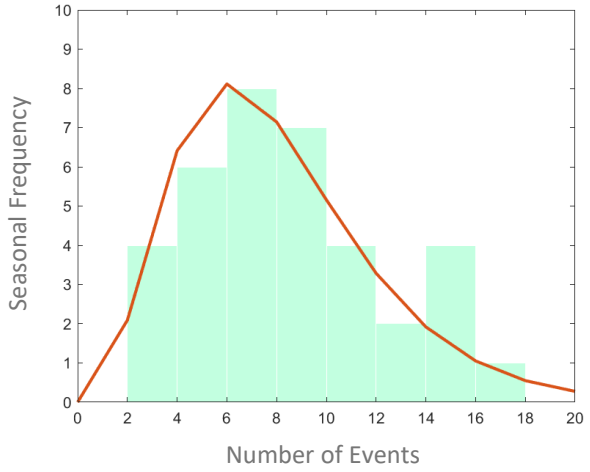
CoreLogic

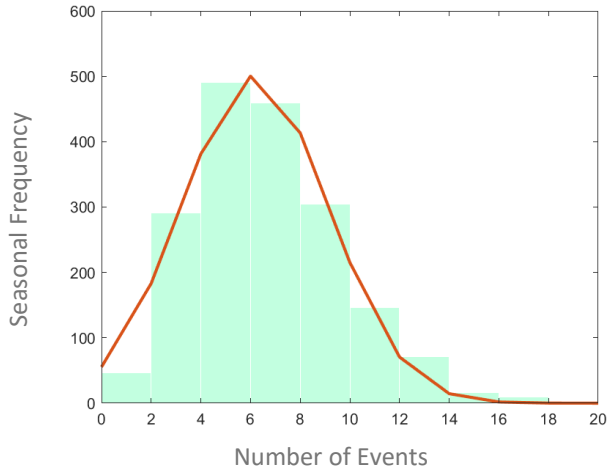
Extended Event Set

Observations from ERA interim

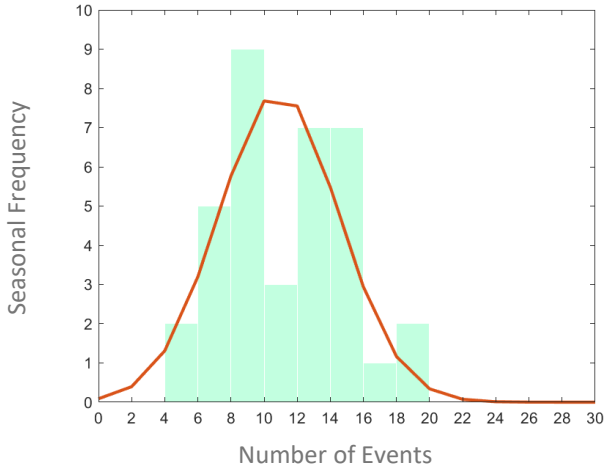
SEAS5 climatology

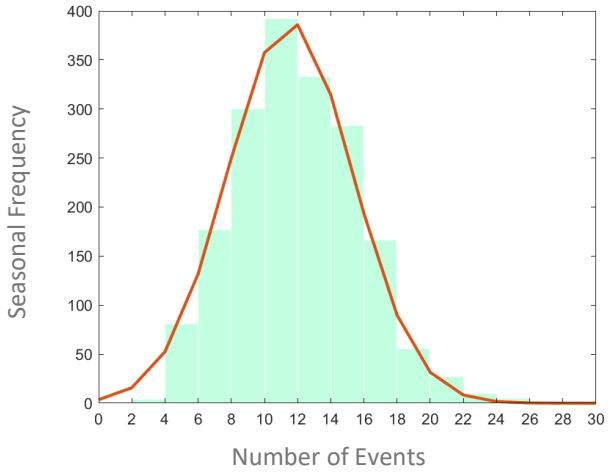
Atlantic TC Events





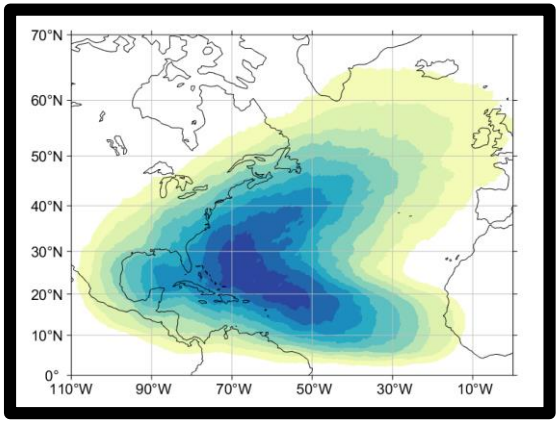
Atlantic ETC events



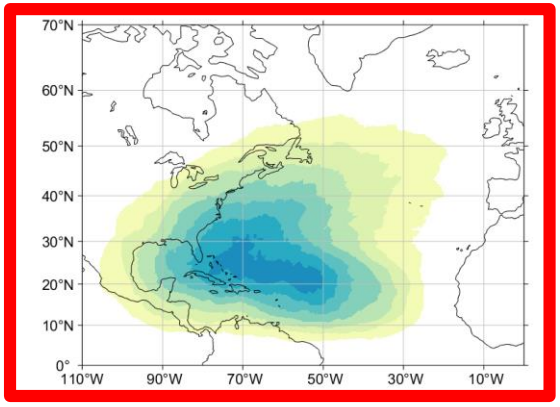


Tropical Cyclone Season in SEAS5

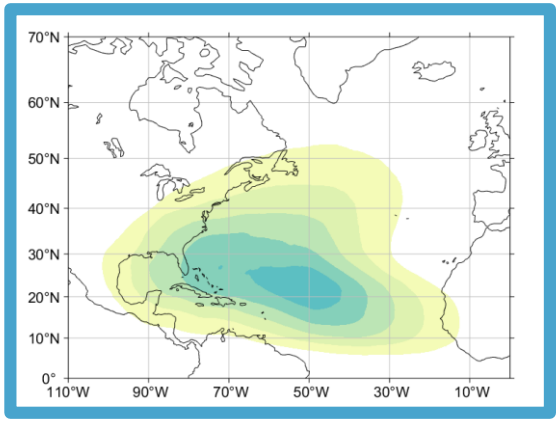
Best Tracks (IBTrACS)

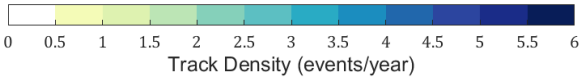


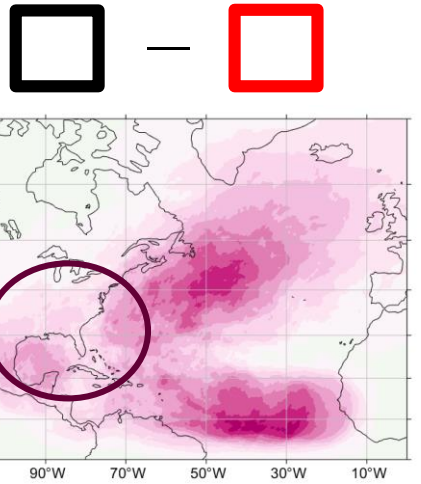
ERAinterim Tracks

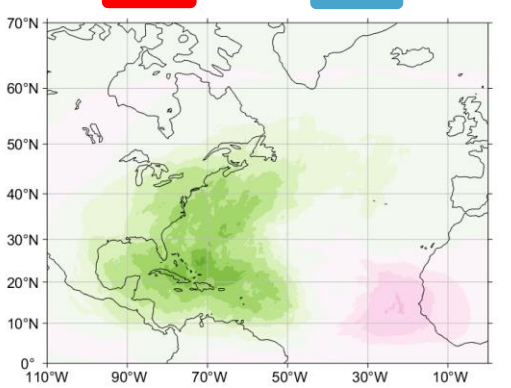


SEAS5 Tracks







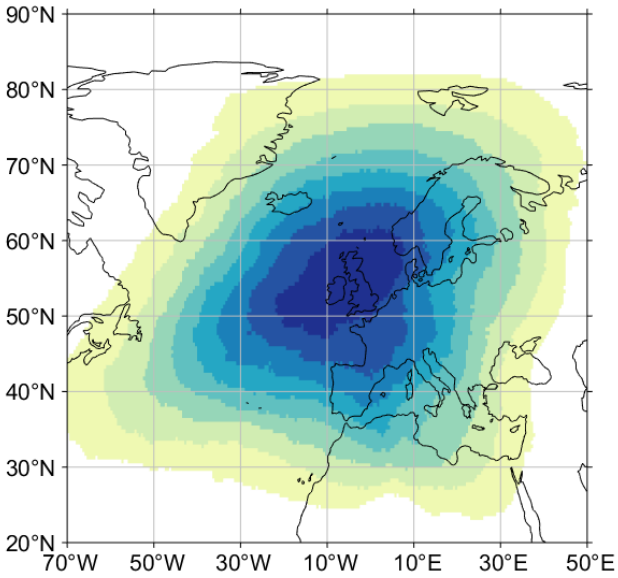


UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

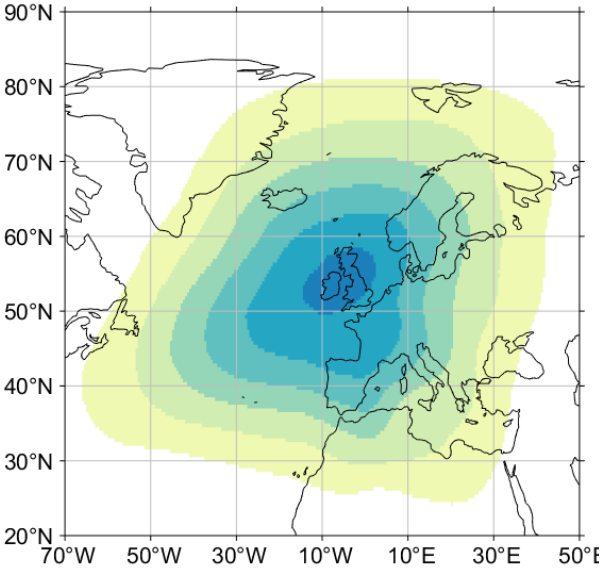
CoreLogic

European Windstorm Season

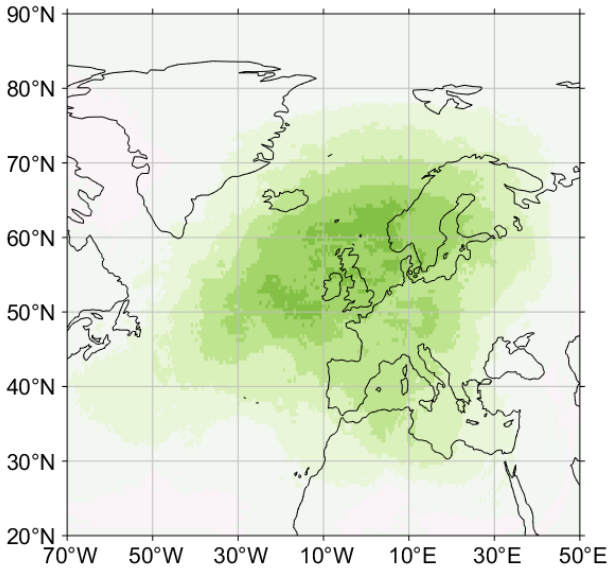
ERAinterim Tracks

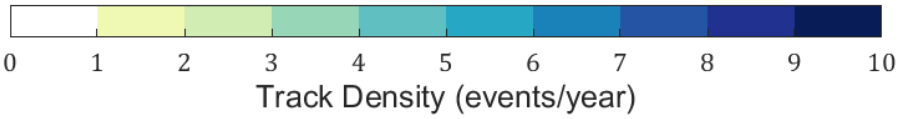


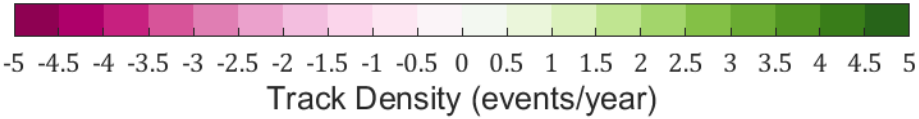
SEAS5 Tracks



Difference





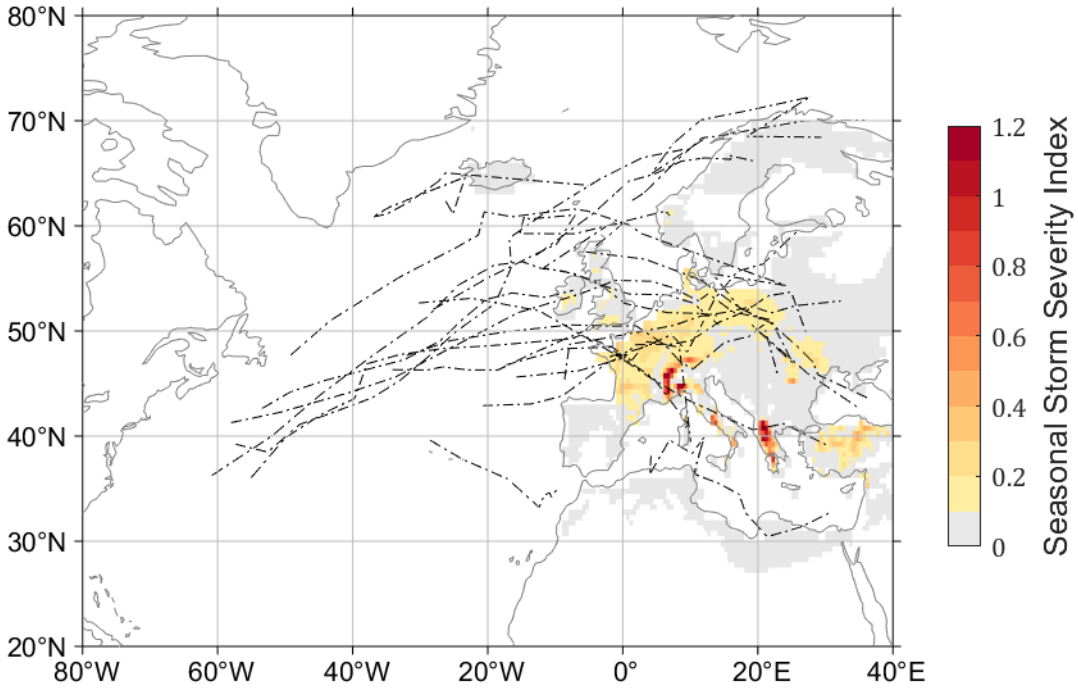


Seasonal Intensity Measures

Number of Storms

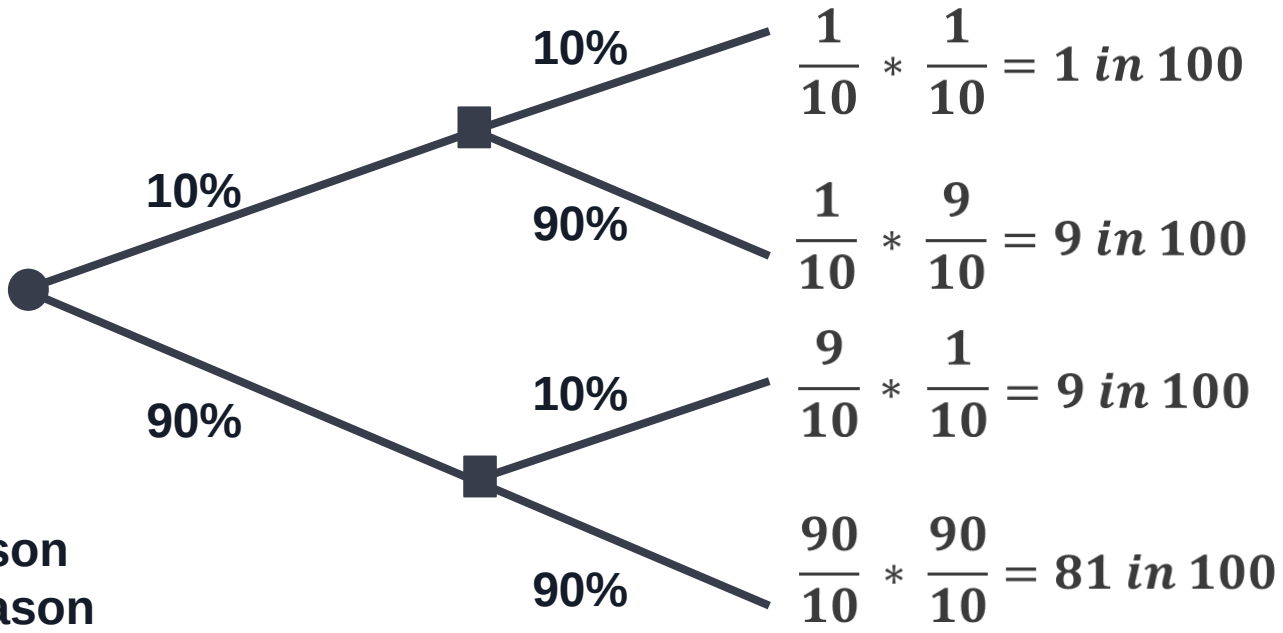
Total Seasonal Storm Severity Index (SSI)

Land Impacting SSI

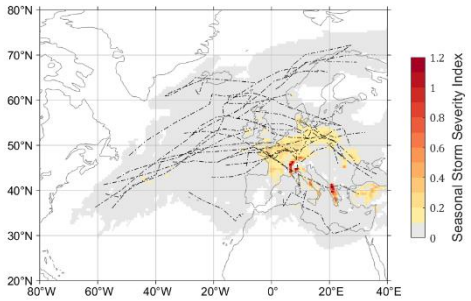


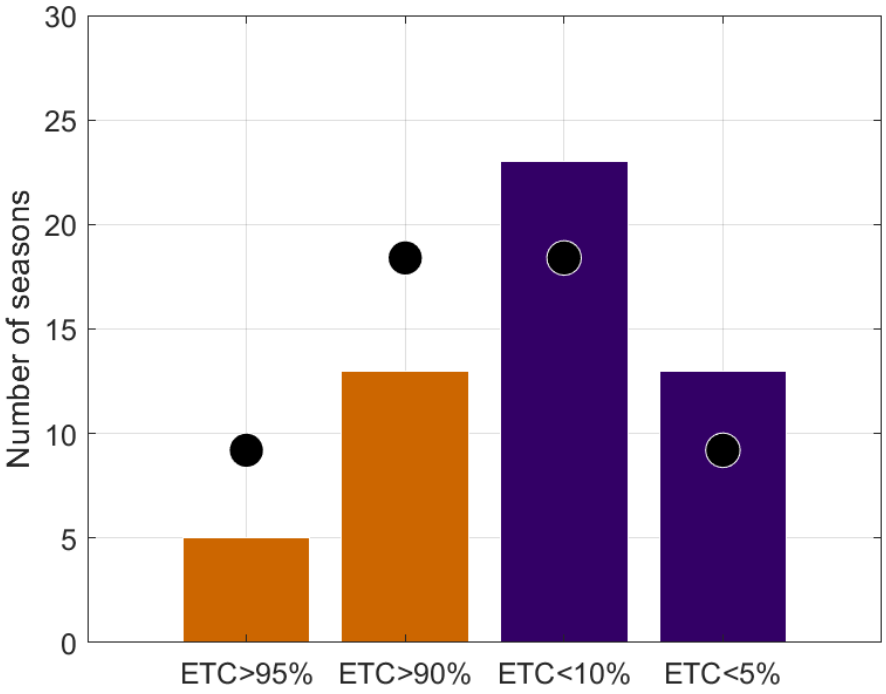
Probability of Independence

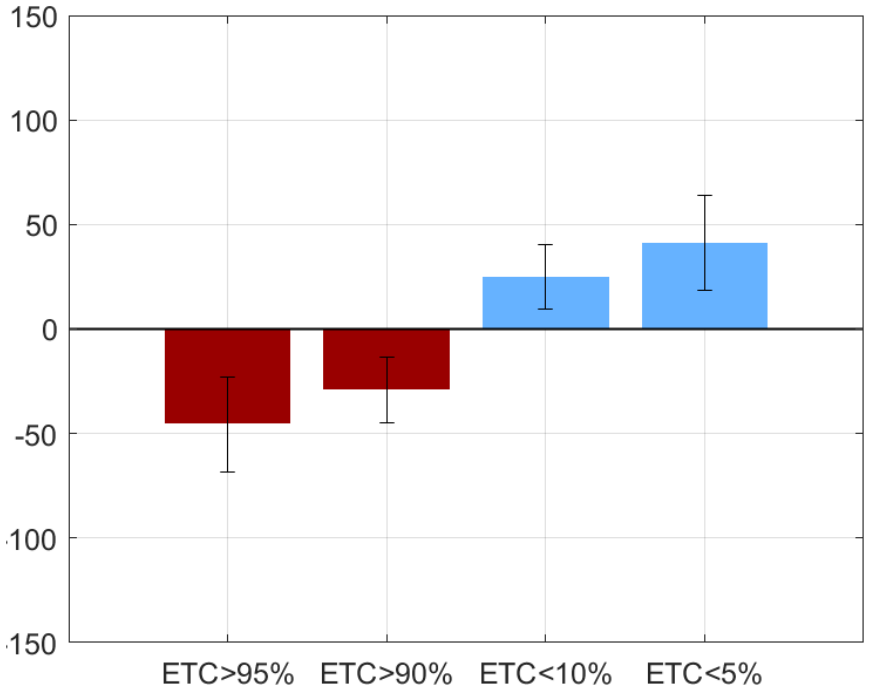
Theoretical Calculation of *Independent* Hurricane and European windstorm season



Observed European Windstorm Seasons - 90th percentile Hurricane season





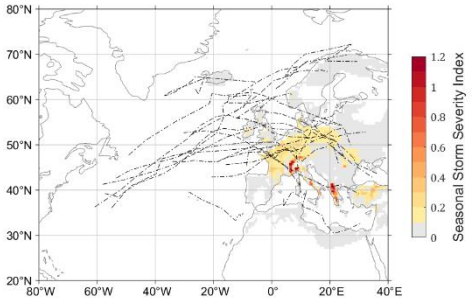


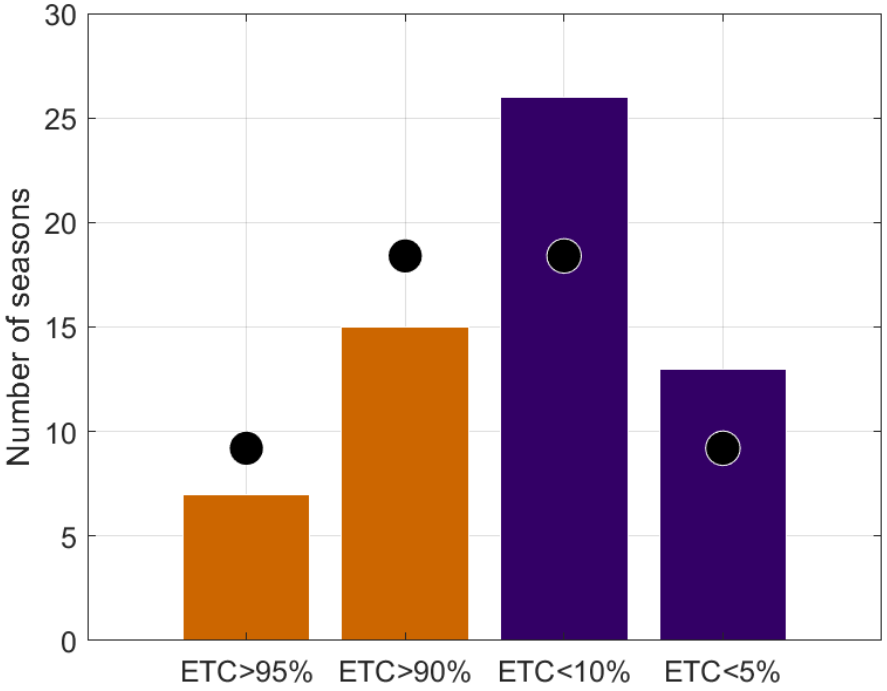
● *Predicted Number of Seasons, if independent*

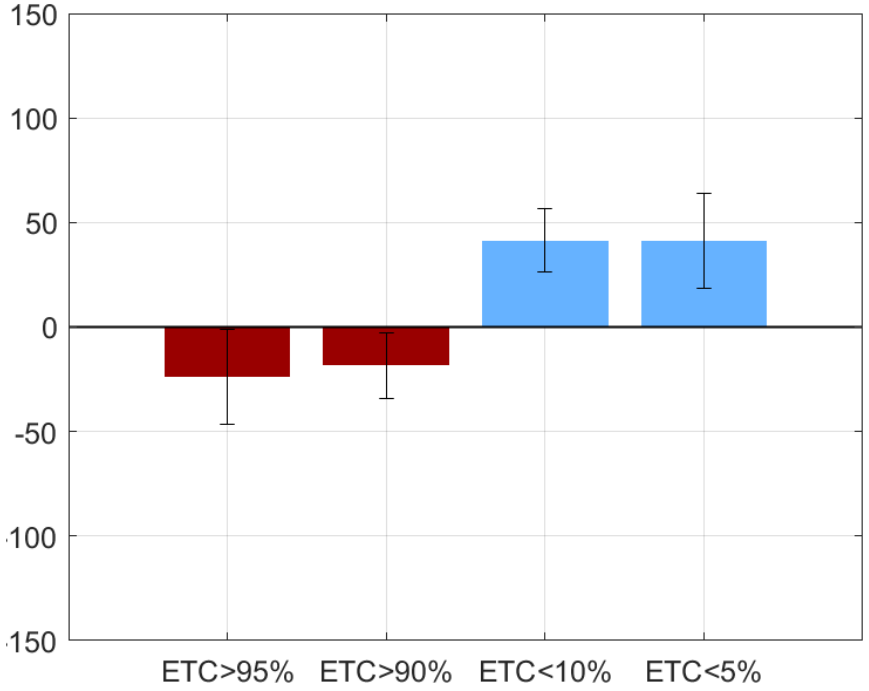
UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

CoreLogic

Observed European Windstorm Seasons - 90th percentile Hurricane season



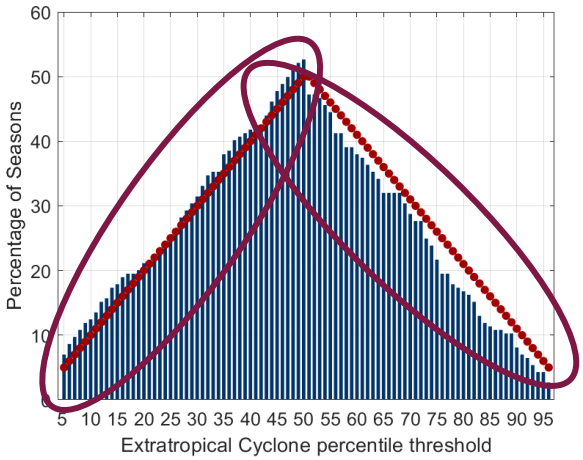




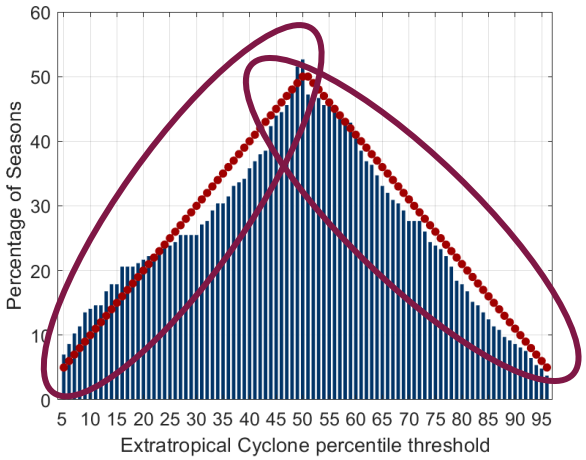
● *Predicted Number of Seasons, if independent*

Observed European Windstorm Seasons - 90th percentile Hurricane season

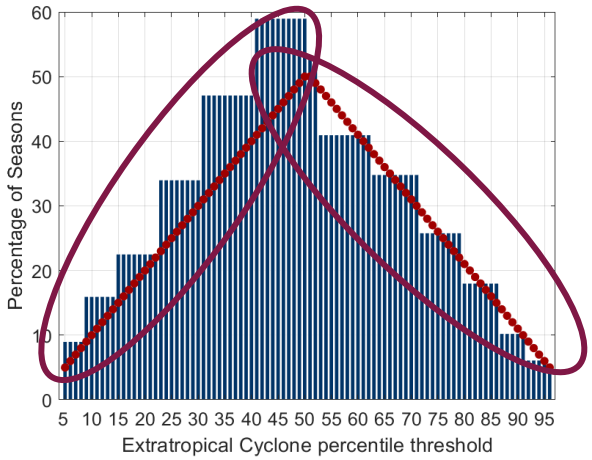
Total SSI



Land Impacting SSI



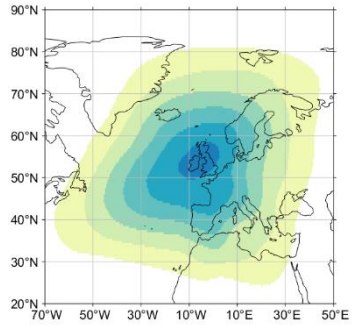
Number of Storms



UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

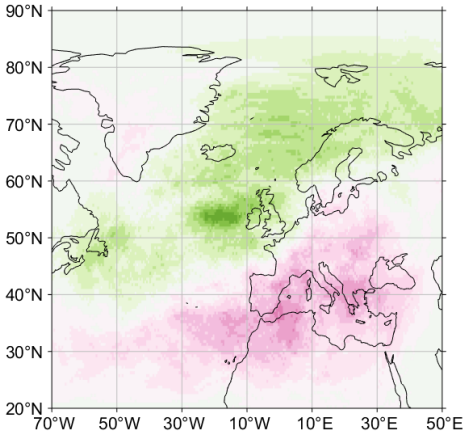
CoreLogic

Observed European Windstorm Seasons

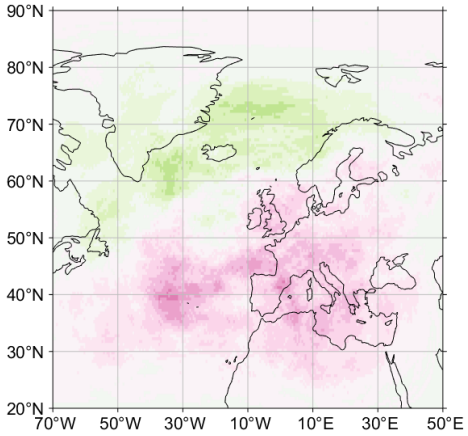


Track Density of windstorm season following top 10% hurricane season – windstorm season following bottom 10% hurricane season

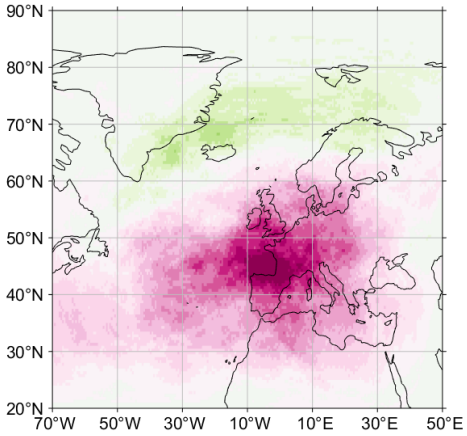
Total SSI

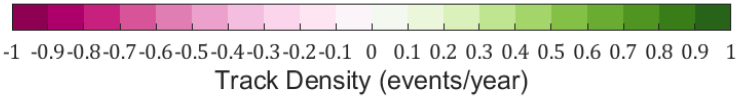


Land Impacting SSI



Number of Storms

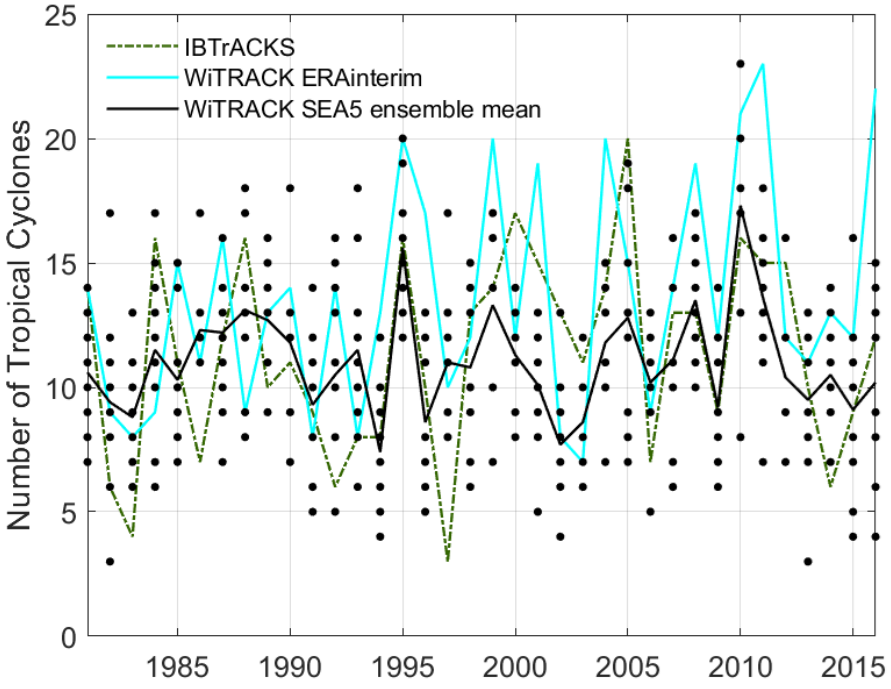




Conclusions and Future Work

- A highly active (more than 90th or 95th percentile) Atlantic Hurricane season is followed by a highly active European Windstorm season **less often** than if they were independent.
- A highly active Atlantic Hurricane season is followed by a highly inactive (less than 5th or 10th percentile) European Windstorm season **more often** than if they were independent.
- Intense Atlantic Hurricane season precedes slight storm track shift towards Central and Southern Europe
- Currently testing hypothesised pathways which explain this connection

TC WiTRACK interannual variability



	Obs	ERAint	SEAS5
Obs		.45	.50
ERAint			.55
SEAS5			

All sig. at 99% level

Interannual variability of same magnitude as observations, with significant covariation

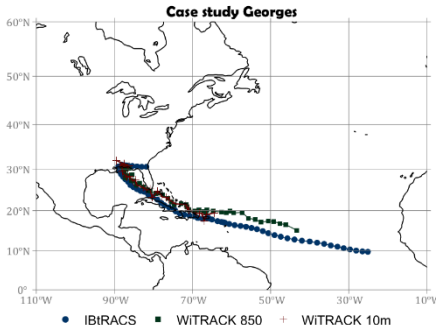
August Initialized SEAS5 ensemble mean performs as well as ERAinterim

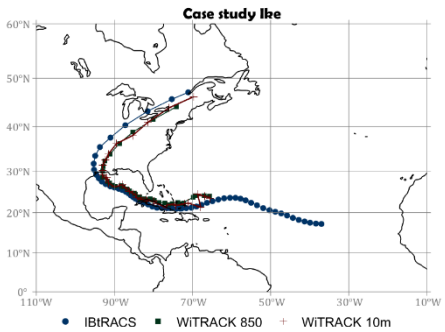
UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

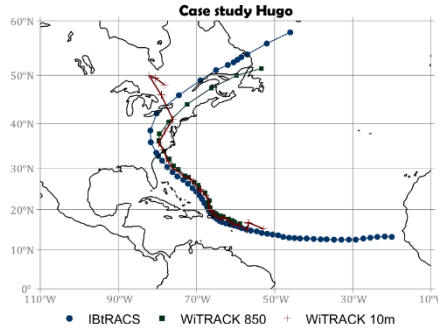
CoreLogic

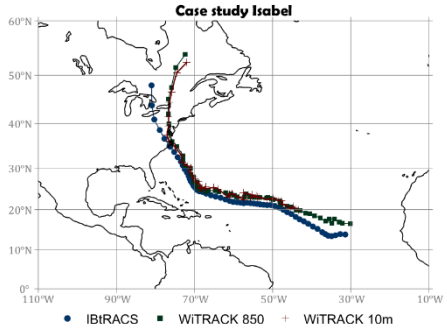
Individual Case Studies

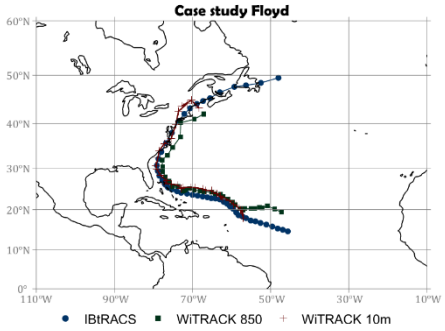
Range of most damaging Hurricanes, 1989-2009

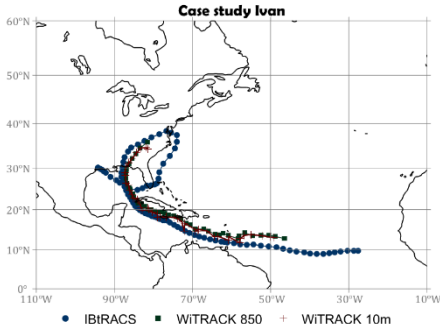


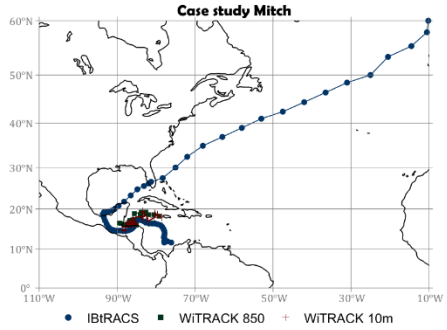


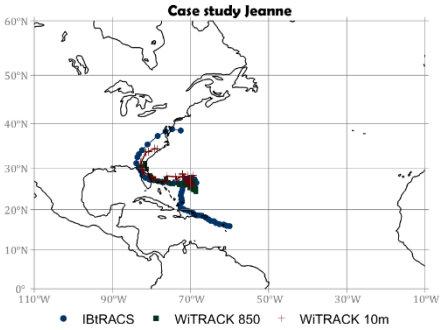


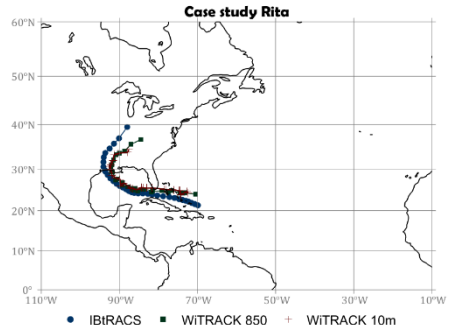


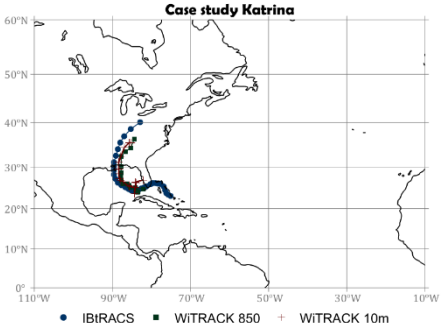


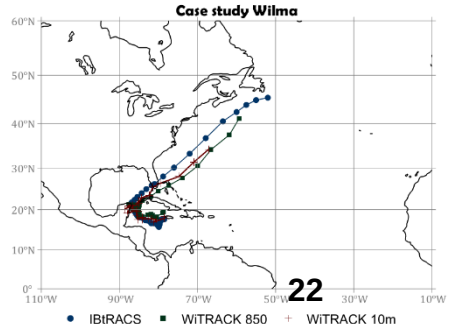












UNIVERSITY OF BIRMINGHAM | COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

CoreLogic