Social sensing of natural hazards

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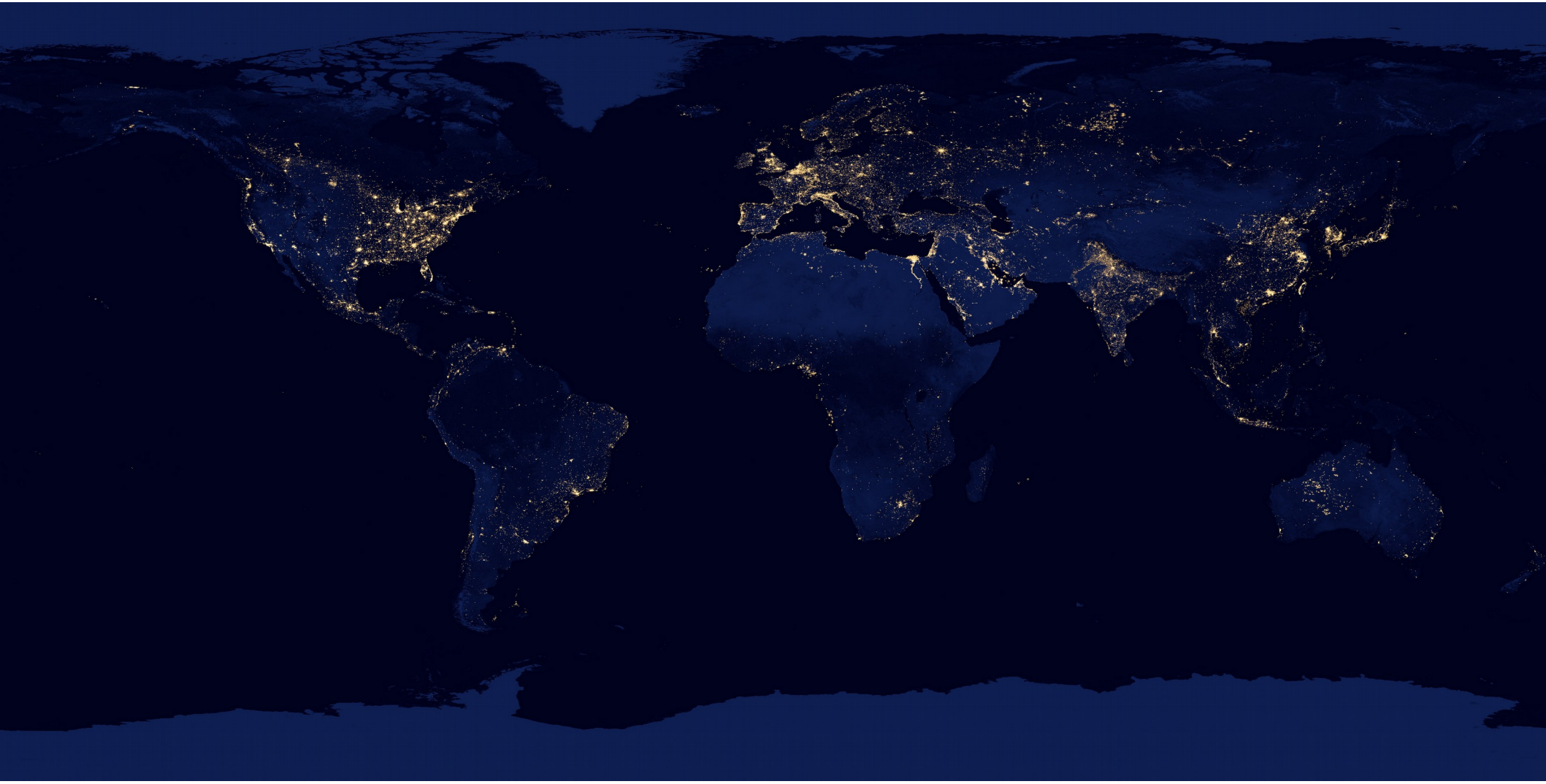
EWGLAM, Sofia

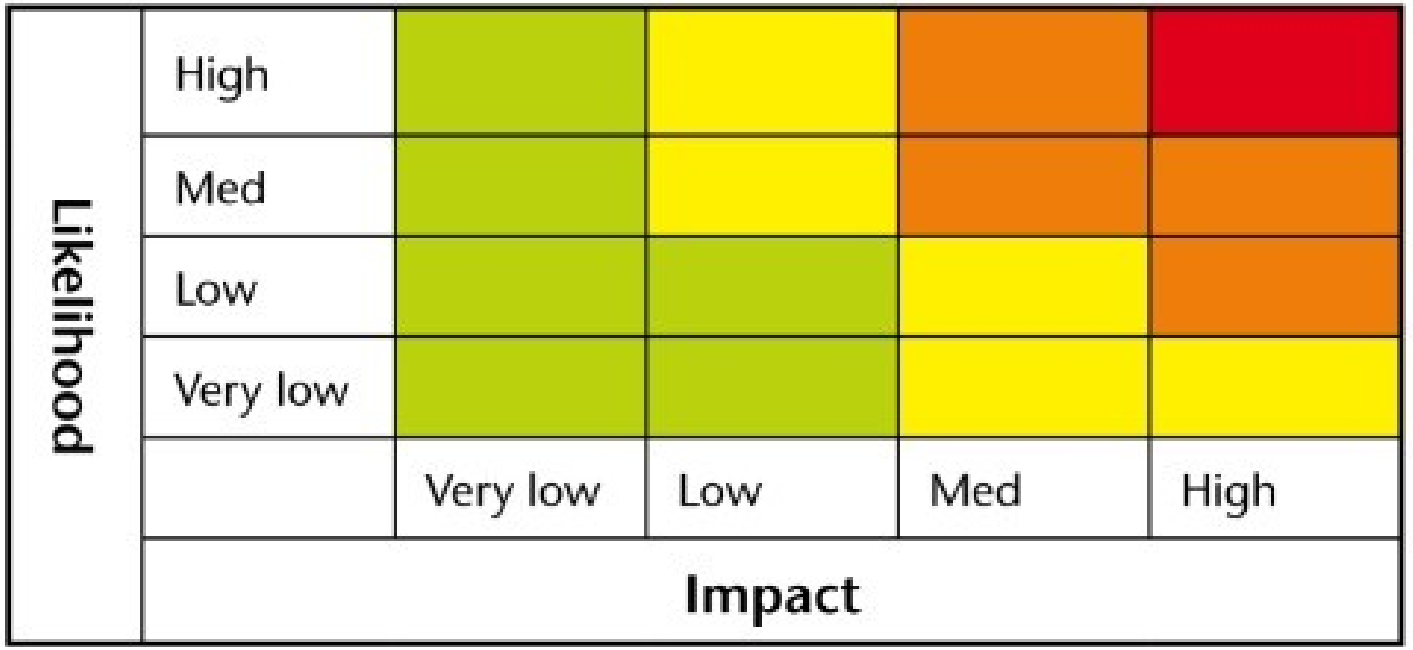
EPSRC NERC SCIENCE OF THE ENVIRONMENT E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL UNIVERSITY OF EXETER



World at night (NASA)

550m users (Q3, 2010)
1,189m users (Q3, 2013)
1,788m users (Q3, 2016)

Impact-based hazard forecasting



How can you observe “impact”?
How do you validate impact models?

Aero Allergens

Air Pollution

Avalanches

Coastal Flooding

Drought

Earthquakes

Extreme Temperatures

Fluvial Flooding

Snow

Space Weather

Surface Water Flooding

Tsunami

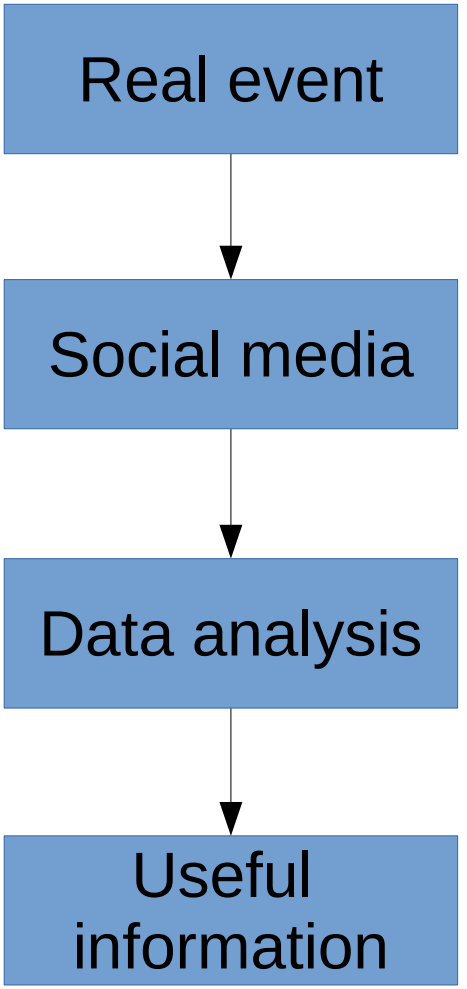
Volcanic Ash

Volcanic Gases

Wildfires

Wind

Social sensing



CASE STUDY:
Social sensing of floods in the UK

Arthur, Boulton, Shotton & Williams (2018) PLoS ONE 13(1): e0189327.

Does flood-related social media activity correlate with real floods?

Twitter dataset: 17,828,704 tweets from 2015-2016. Keywords: “flood”, “flooded”, “flooding”

Flood dataset: Known flood events in England & Wales (Flood Forecasting Centre).

Method: Correlate Tweets per day vs Floods per day

	All
Tweets Remaining	17828704
Correlation	0.206

True positives

(a)

Jonas Hey (EGNX)
@PLANEmad1999

Follow

#Calderdale #flooding

RETWEETS
2

3:25 PM - 26 Dec 2015

Yorkshire and The Humber, England

(b)

Richard Bloore
@BlooreR

Follow

Boxing Day flooding: Giant sinkhole shuts M62 motorway fb.me/7SbMrL51f

6:07 PM - 26 Dec 2015

(c)

WYP Contact Centre
@WYP_CCC

Follow

Reports coming through that Halifax Road in Todmorden is still being used despite being flooded. Vehicles are now getting stuck

RETWEETS
3

LIKE
1

10:21 PM - 25 Dec 2015

… and false positives

(a)

Clive Durdle
@Clivedurdle

Follow

Drowning in money: the untold story of the crazy public spending that makes flooding inevitable | George Monbiot

Drowning in money: the untold story of the crazy public spending that mak...
George Monbiot: Every year billions are spent in Britain and Europe on policies that wreck homes and lives through flooding
theguardian.com

3:32 PM - 9 Dec 2015

(b)

Gary Ticehurst
@GTice_86

Follow

@Shane__Allen yeah got there at 12 there was a que of 80 and they had 20 pairs left, but restock was 386 pairs, eBay is flooded with em 😐

8:53 PM - 10 Dec 2015

(c)

Megan
@megprice_

Follow

First your house is flooded, then David Cameron shows up, could your life get any worse

Sky News @SkyNews
David Cameron says he will visit areas that have been badly hit by floods later today trib.al/DpKpWLK

RETWEETS 4,044 LIKES 3,837

10:02 AM - 7 Dec 2015

Filter by timezone

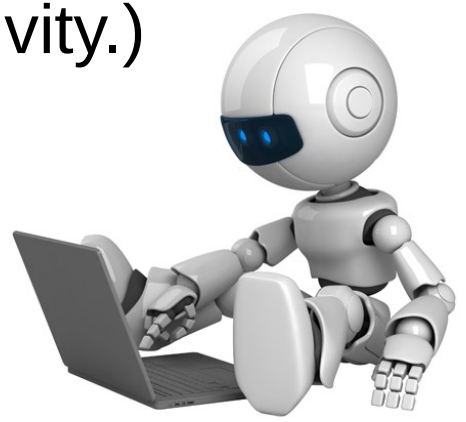
Remove all tweets from wrong (non-UK) timezone.

	All	Timezone
Tweets Remaining	17828704	1105360
Correlation	0.206	0.551

Filter out robots and retweets

Remove all tweets from obvious “bot” accounts.
(Spot them by their very large volume of activity.)

Remove all retweets (they are not useful).



	All	Bot	Retweet
Tweets Remaining	17828704	1051295	582141
Correlation	0.206	0.550	0.591

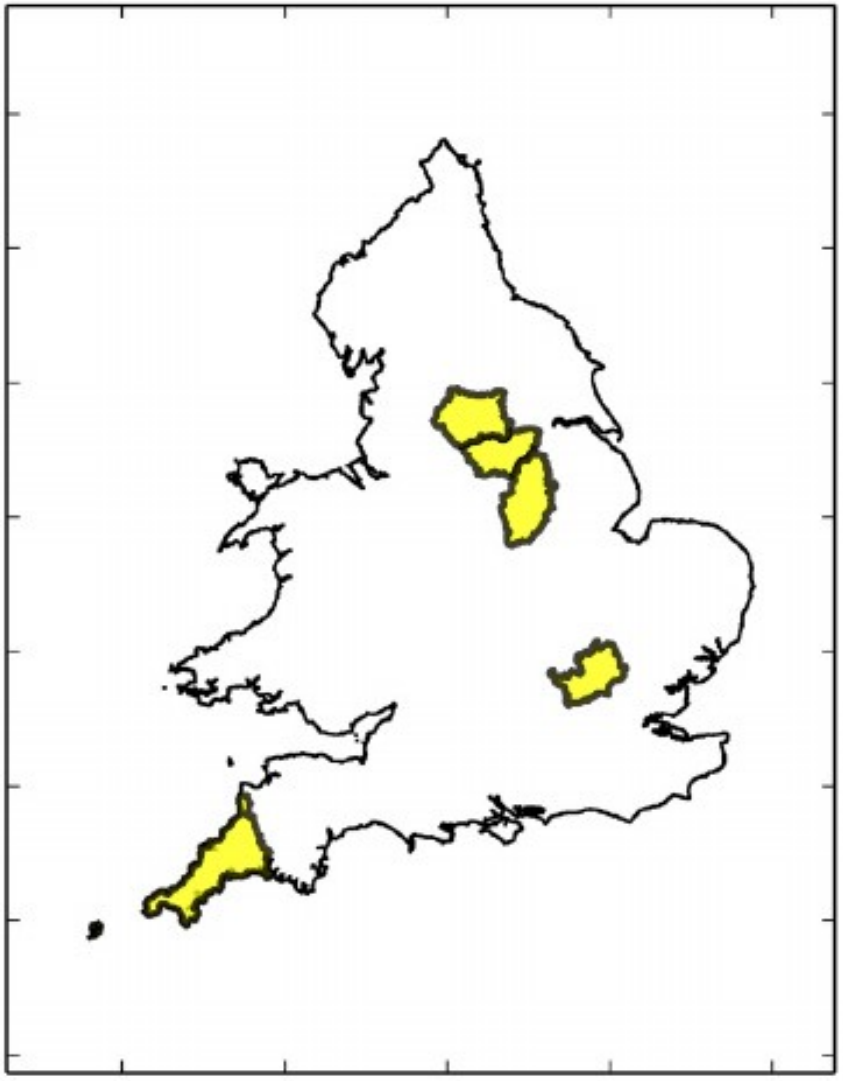
Filter for relevance

Make a relevance filter to remove all irrelevant tweets.

- Tag a few thousand tweets as “relevant” or “irrelevant”
- Make a “naive Bayes” model to automate tweet classification

	All	Relevance
Tweets Remaining	17828704	122281
Correlation	0.206	0.673

Spatial correlation



Do tweets about floods come from places where floods are happening?

Verified flood events 28th Oct 2015
(Flood Forecasting Centre)

Location inference

All Tweets	Any Location Info
122281	79163

Geotag	Loc: GPS	Loc: Toponym	Text: Toponym
1574	349	59179	41315

GPS coordinates attached to tweet

GPS coordinates in user profile

Placename in user profile

Placename in tweet text

Use GPS where available. Else infer most likely location from all available information (Arthur et al 2018)

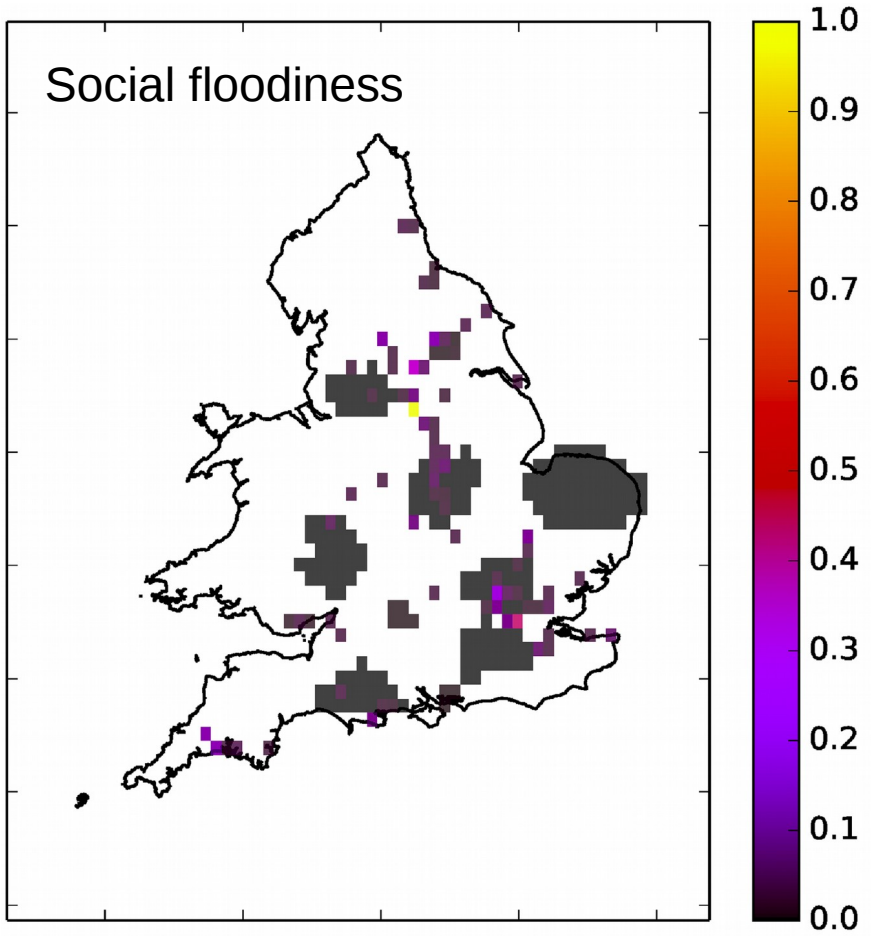
WYP Contact Centre
@WYP_CCC

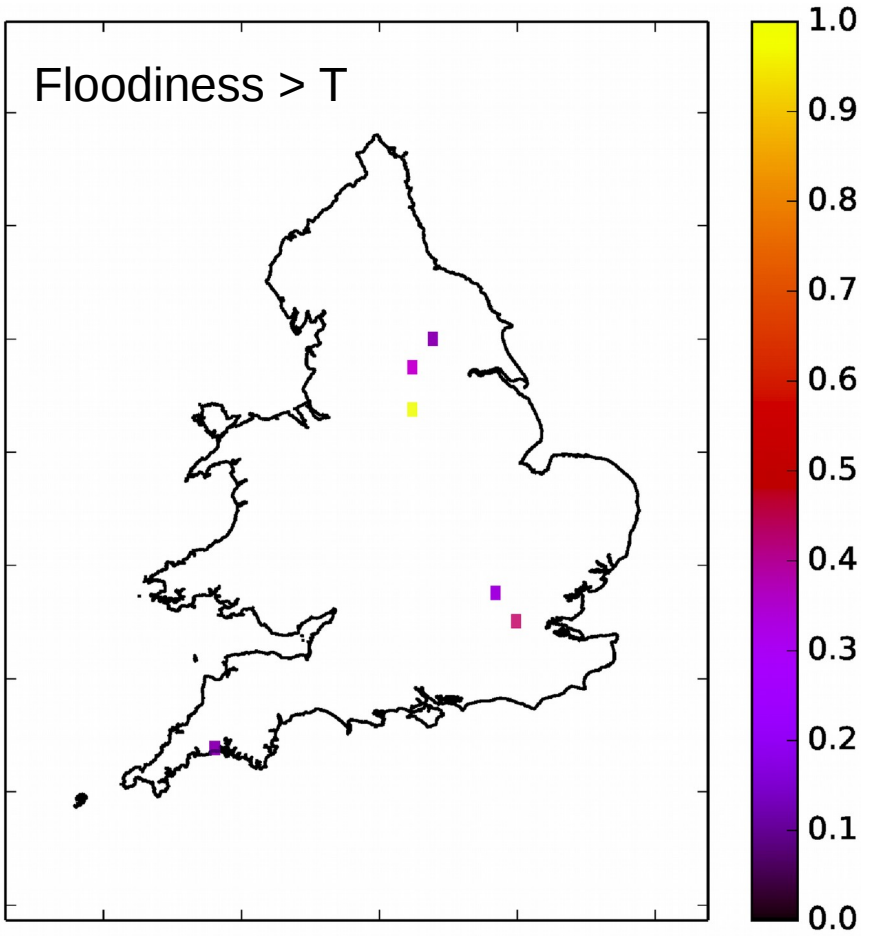
Follow

Reports coming through that Halifax Road in Todmorden is still being used despite being flooded. Vehicles are now getting stuck

RETWEETS 3 LIKE 1

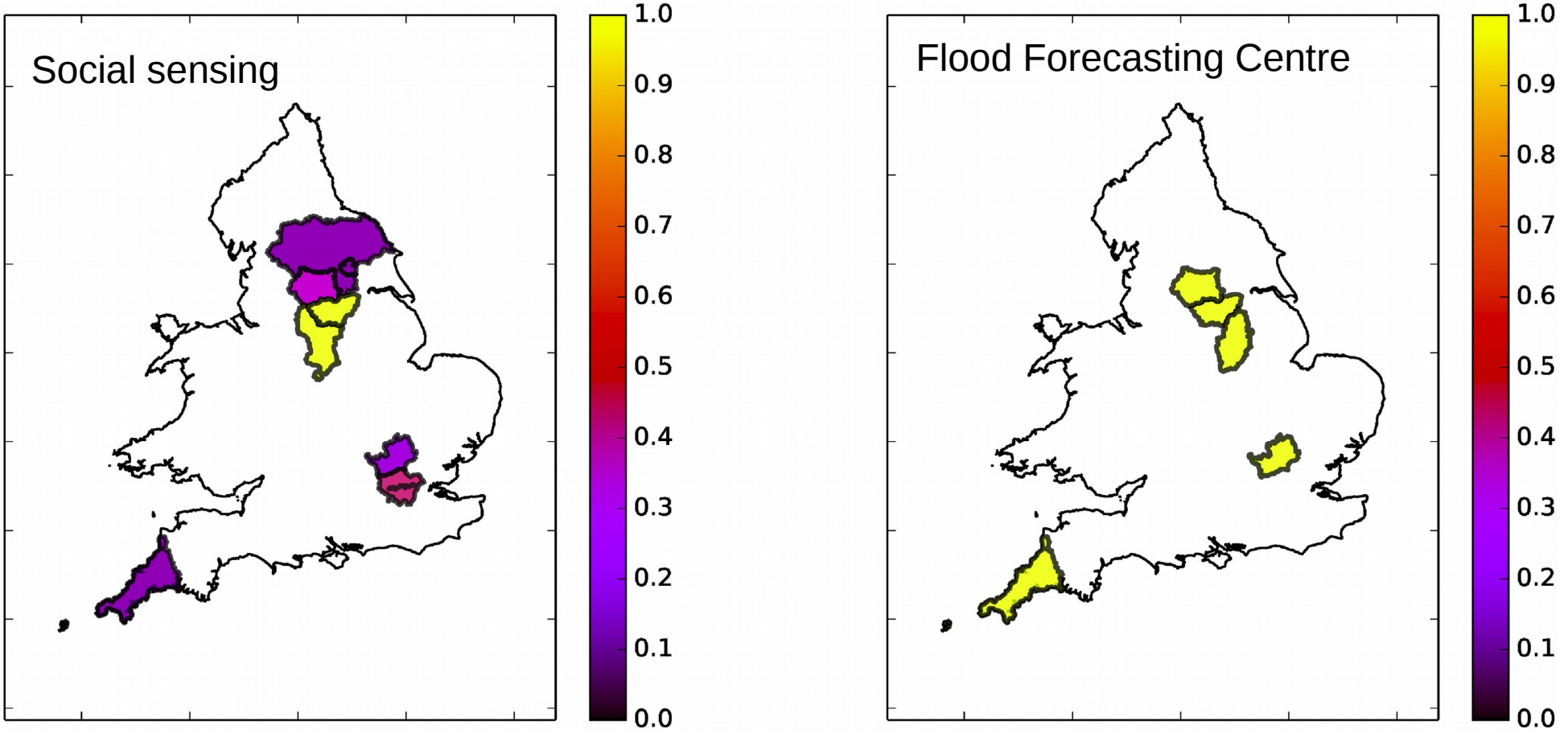
Finding floods





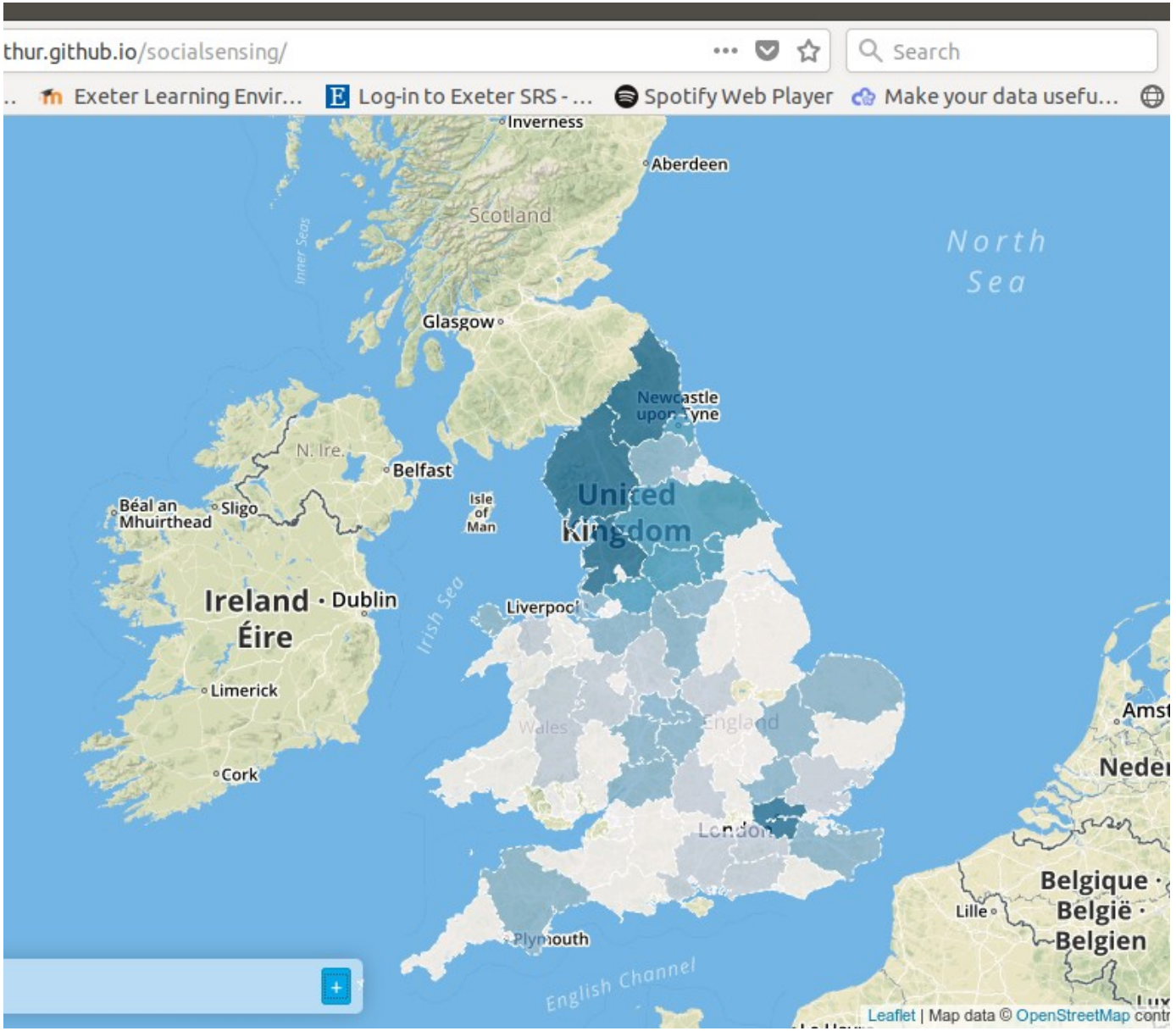
Measure activity in each cell of (arbitrary resolution) grid spanning England & Wales.
For each cell, define a threshold T to normalise for population density → “floodiness”.

Validation



FFC data is recorded at level of “administrative area” (roughly county). Colour each area by floodiness of grid cells within. For quantitative evaluation see Arthur et al 2018.

Prototype operational tool



Met Office

FLOODFORECASTINGCENTRE
a working partnership between Environment Agency | Met Office

https://rudyarthur.github.io/socialsensing/
https://rudyarthur.github.io/socialsensing/birmingham

Using Social Media to Detect and Locate Wildfires (2016)

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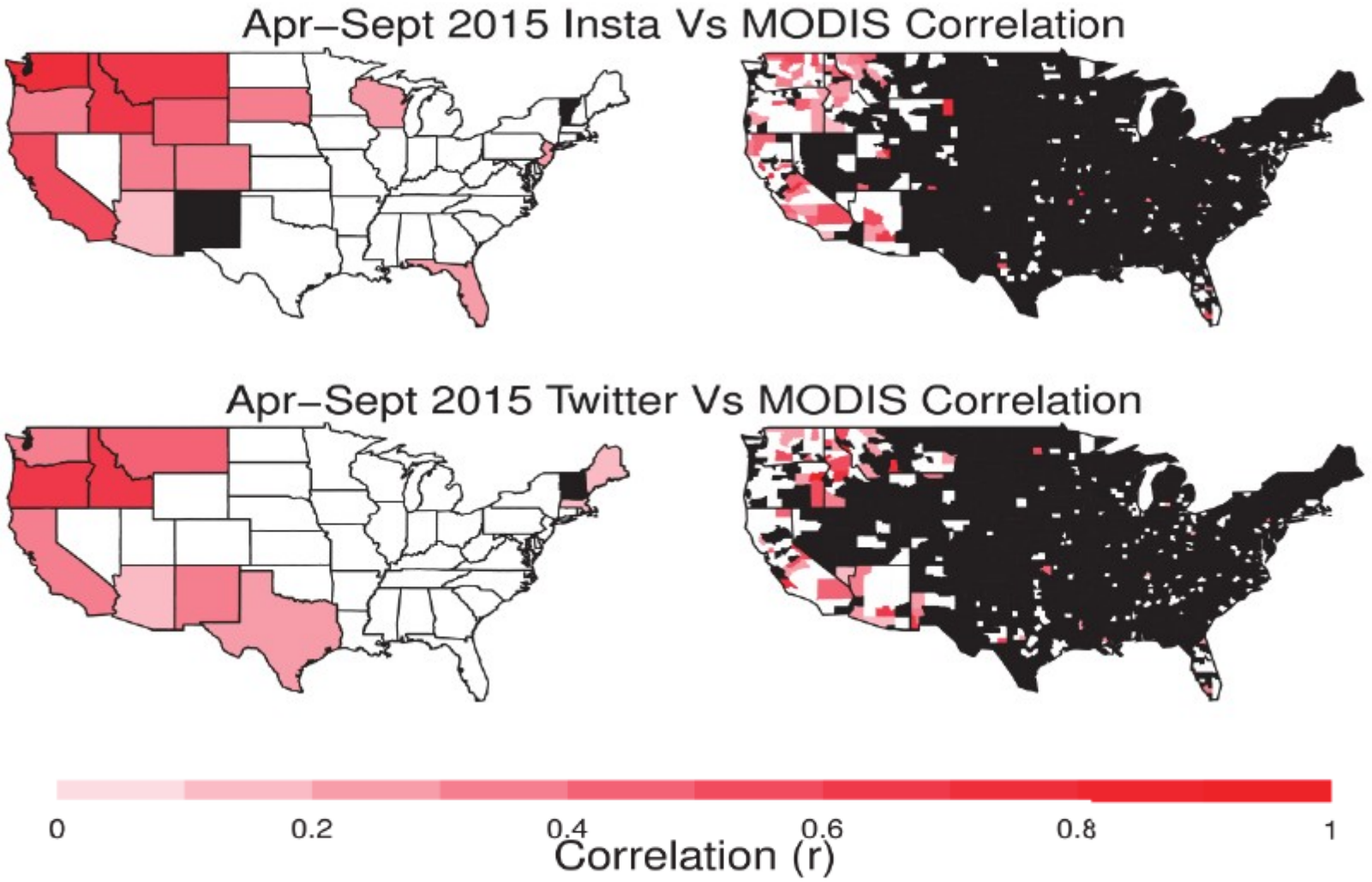
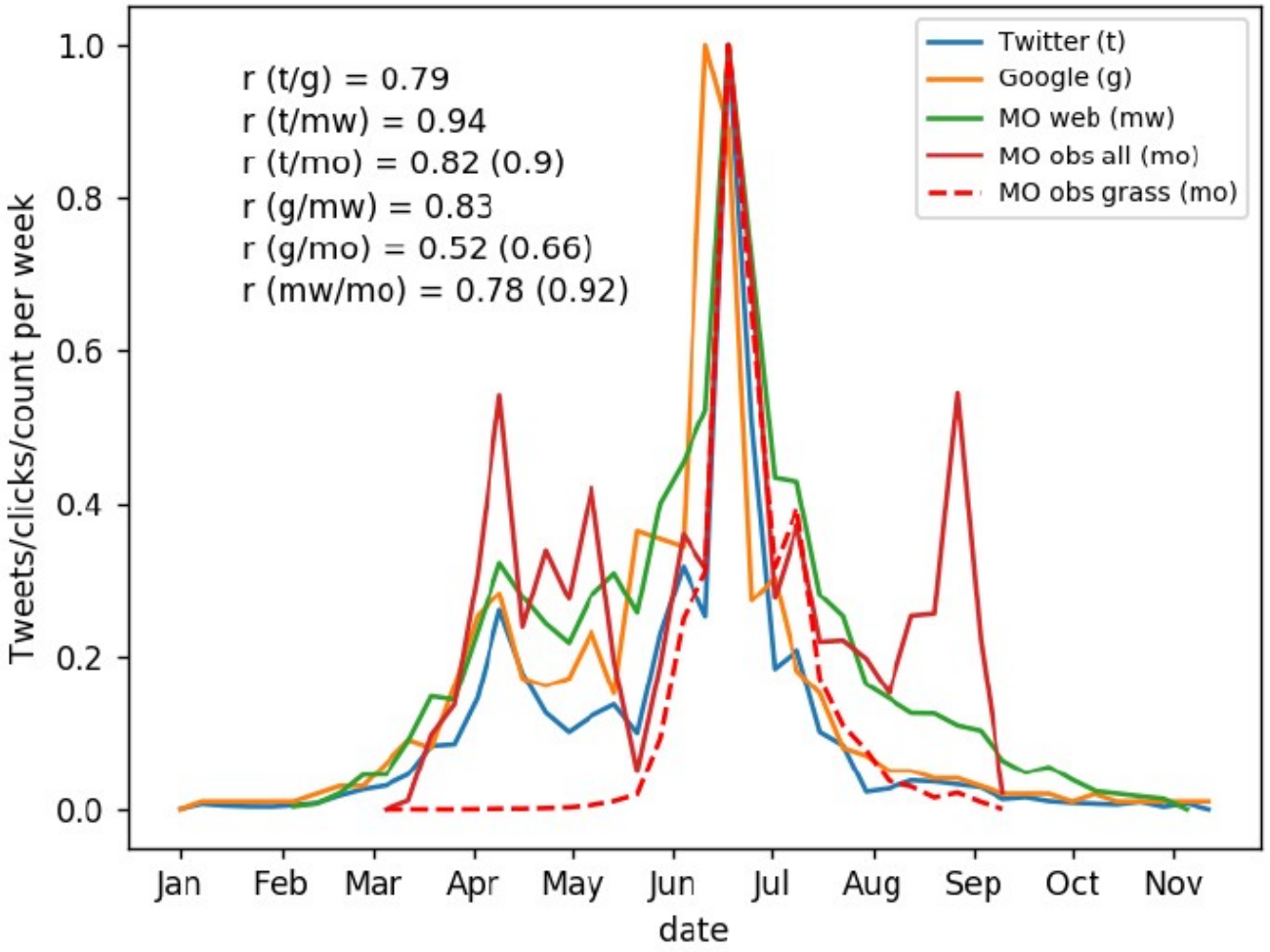


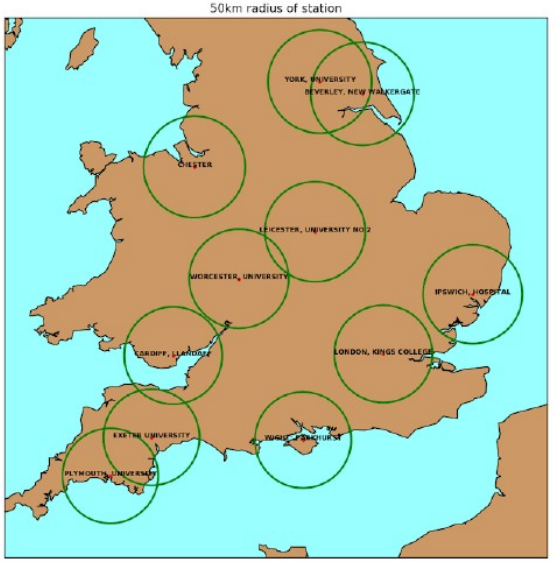
Article

@choo: Tracking Pollen and Hayfever in the UK Using Social Media

(2018)

Sophie Cowie [1], Rudy Arthur [1] and Hywel T. P. Williams [1,2,*]

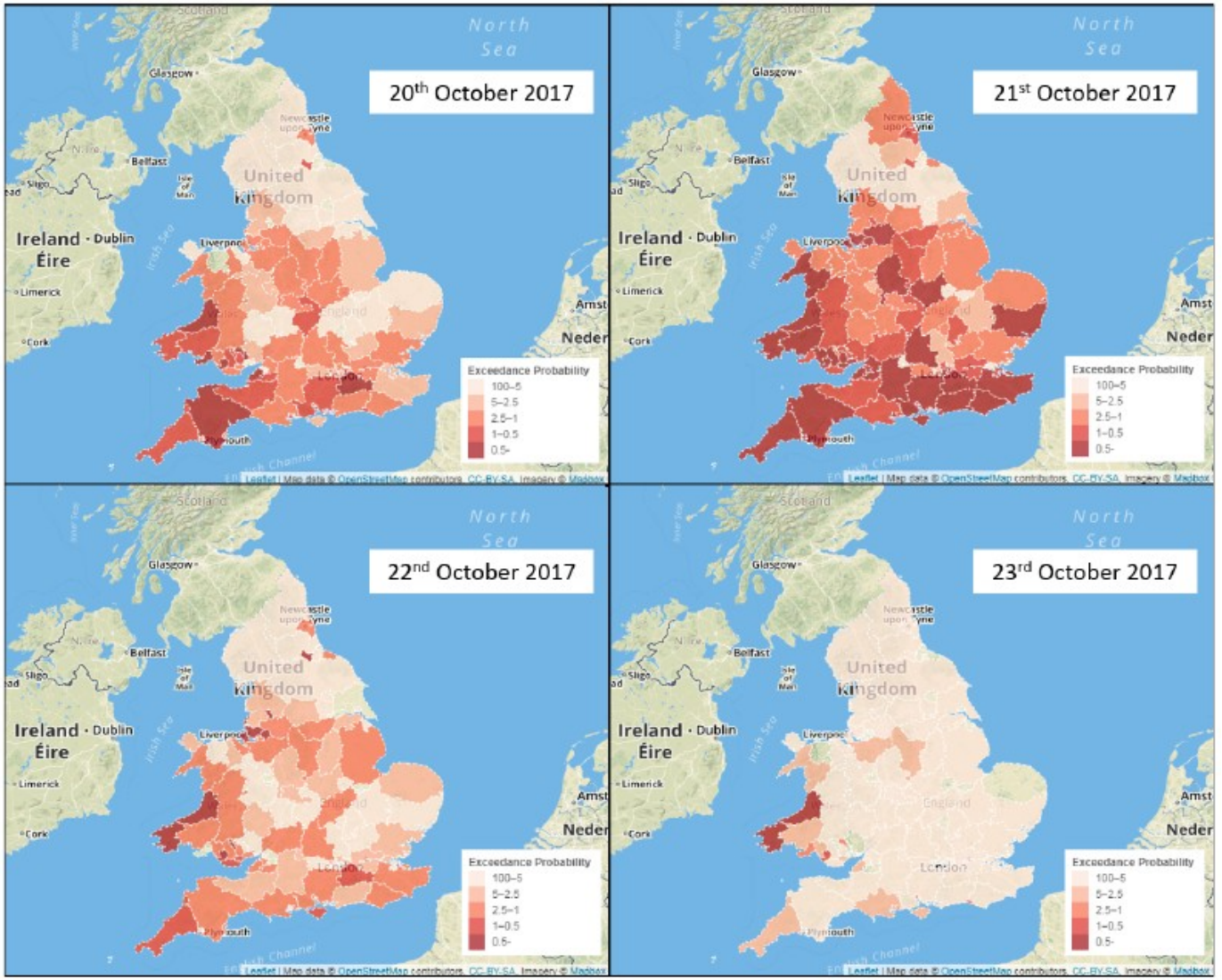




Met Office

Work-in-progress: Social Impacts of Named Storm Events in the UK and Ireland

Spruce, Arthur, Williams (in prep) Meteorological Applications.



Storm Brian (2017) observed by social sensing.

Humour

"Brian? What kind of name is that for a storm? Everyone knows Brian is a snail."
"Am I the only one to find it really hard to take a storm called #Brian seriously?"
"And Brian? Really? Storm Rambo or Terminator would be far better than #StormBrian"

Damage

"This is the scene this morning as the waves have damaged the Harbour Office during Storm Brian."
"Storm Brian damage causes floodlight damage. Revised home game vs @ChesterCityFC"
"Scaffolding in Helsby High Street BLOWN OVER by #StormBrian high winds"

Disruption

"Train delay: National Rail have warned of delays due to high winds from Storm Brian"
"Storm Brian latest - tree blocks railway lines and hovercraft suspended"
"Major motorway was CLOSED after Storm Brian floods carriageway"

Observations

"It's really windy out there!"
"Storm Brian seems to have arrived now…"
"Storm Brian just brought in the heaviest rain shower I've ever seen.....it really scared our 2 cats."

Warnings

"#StormBrian could lead to travel disruption this weekend."
"Storm Brian set to batter UK with heavy rain and 70mph winds."
"Take care on the coast folks. Waves are quite high with #StormBrian"

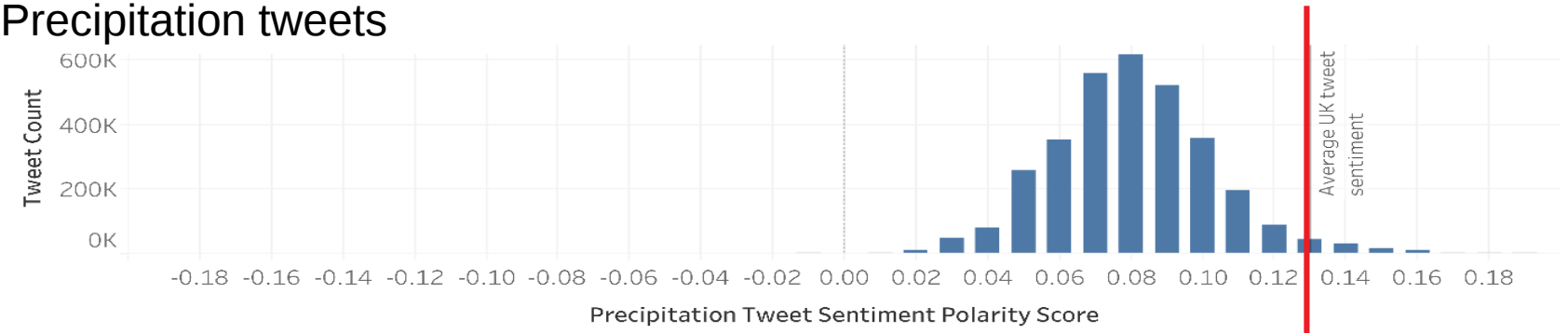
Detecting social impacts

- Collected tweets relating to wind/precipitation/storm-names over period spanning 8 named storms
- Applied filtering and location inference (retained ~2.5% of ~101m tweets)
- Two forms of impact detection: **sentiment** (emotional impact) and **content** (substantive impact)

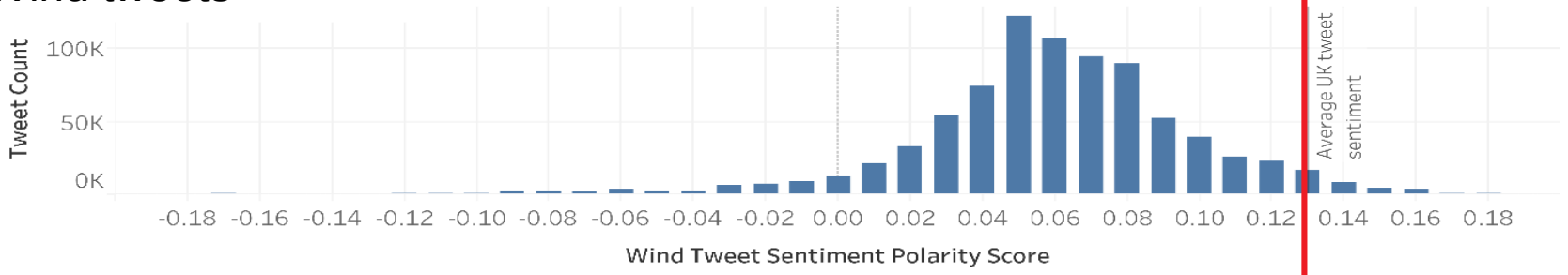
Storm Brian

Typical sentiment
(non-weather tweets)

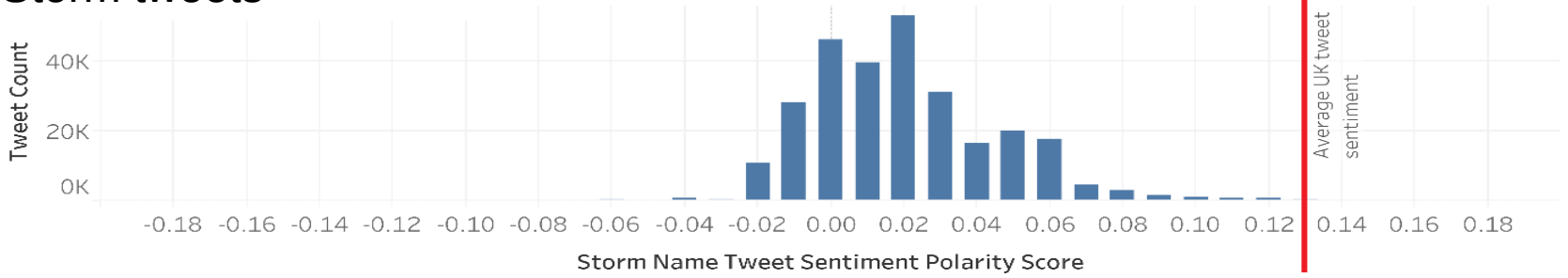
Precipitation tweets



Wind tweets

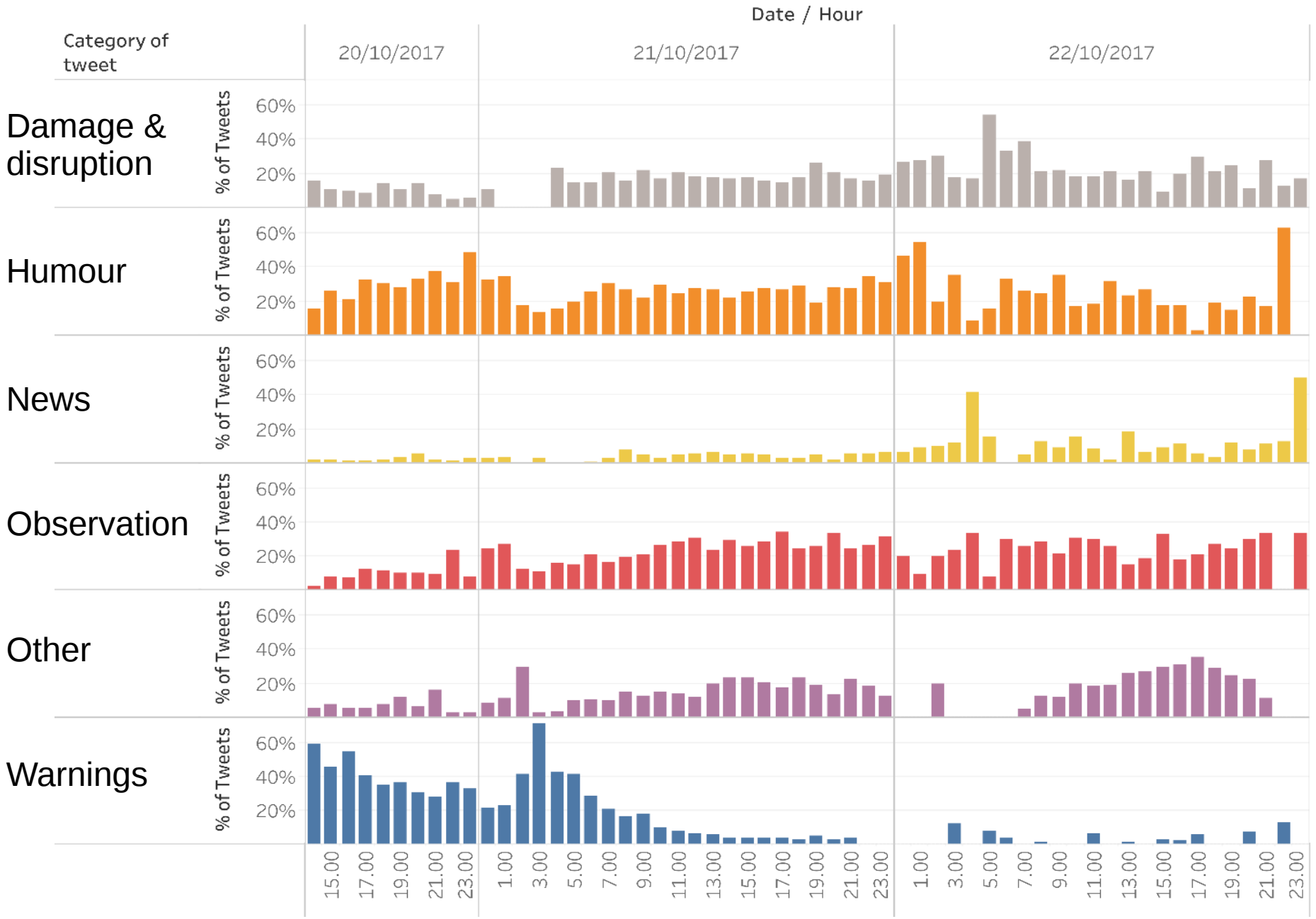


Storm tweets



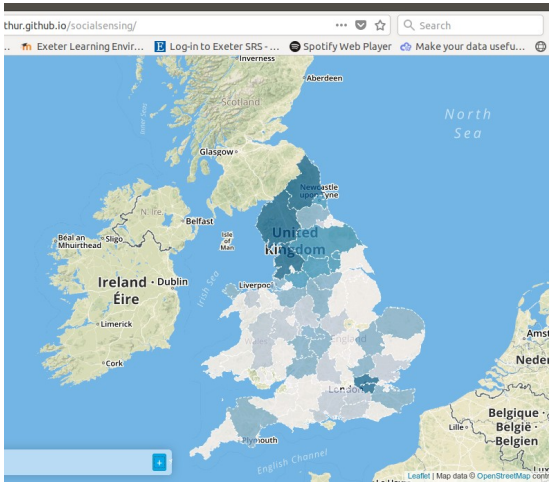
Negative ⟷ Sentiment ⟷ Positive

Storm Brian


Date / Hour
Category of tweet
20/10/2017
21/10/2017
22/10/2017
Damage & disruption
Humour
News
Observation
Other
Warnings
% of Tweets
60%
40%
20%
15.00
17.00
19.00
21.00
23.00
1.00
3.00
5.00
7.00
9.00
11.00
13.00
15.00
17.00
19.00
21.00
23.00

Discussion

- Social sensing has been demonstrated to provide robust detection/location of multiple types of weather hazard
- Developing methods to automate detection of social impacts (disruption, damage, …)
- Opportunities: Now-casting & Forecast verification
- Looking for new case studies / collaborations!



Acknowledgements: Rudy Arthur, Chris Boulton, Sophie Cowie, Humphrey Shotton, Michelle Spruce, Iain Weaver

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Tomas Saraceno “Galaxies Forming Along Filaments, Like Droplets Along the Strands of a Spider's Web”.