APSE

Delivering the appropriate data for winter and flood resilience

Richard Hogg, MetDesk

Content
  Data collected/stored by forecast providers
  How data is used
  How forecast accuracy is currently measured/reported
Winter Marginal Nights
    Trigger thresholds – are they appropriate?
Heavy Rain
    Flooding thresholds
High Winds
    Diversions and Closures
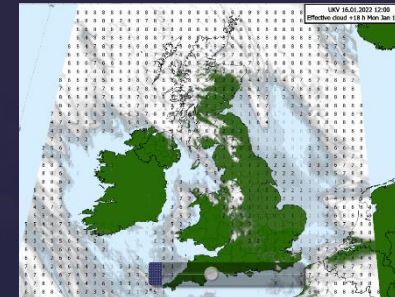
metdesk

Data collected/stored by forecast providers

Minimum Forecast Road Temperatures

Minimum Observed Road Temperatures

Other model data used as input

Other site observations

National/Global Observations

Radar

Satellite

Raw Road model output

Forecaster intervened output

metdesk

Internal uses of this data

Daily forecast performance

Post event scenario verification

Model adjustments

Sensor performance anomalies

Forecaster added value

Model comparison/verification

	A	B	C	D	E
1	Site	Min Obs R	in Obs RST DTG (Localtim	Min Lunchtime FCST RST	Min Fcst (Midday)-Obs Delta
2	A69 Brampton (Low Row)	-9.8	01/10/2022 14:00	8.1	17.9
3	A66 Old Spittal Farm (KN3)	4.1	02/10/2022 04:00	5.1	1
4	A701 Southerly Ridge	4.6	02/10/2022 06:50	5.2	0.6
5	B1257 Chop Gate	4.7	02/10/2022 07:00	5.5	0.8
6	A9 Dunkeld	4.8	02/10/2022 06:10	7.2	2.4
7	A93 South Persie	5	02/10/2022 06:00	5.8	0.8
8	A822 Amulree	5	02/10/2022 05:45	4.5	-0.5
9	B6265 Grassington	5	02/10/2022 06:50	4.7	-0.3
10	A92 Upper Victoria	5	02/10/2022 06:50	5.5	0.5
11	A68 Soutra	5.1	02/10/2022 07:10	4.9	-0.2
12	B6399 Berryfell	5.1	02/10/2022 06:40	5	-0.1
13	Oakbank	5.2	02/10/2022 06:30	6.2	1
14	A1 Stannington (AN2)	5.2	02/10/2022 07:00	5.7	0.5
15	A90 Toll of Birness	5.2	02/10/2022 06:40	5.5	0.3
16	A941 Cabrach	5.2	02/10/2022 06:30	5.9	0.7
17	Balshando	5.3	02/10/2022 06:00	5.1	-0.2
18	A9 Ord Ousdale	5.3	02/10/2022 05:50	5.5	0.2
19	A907 Bogside	5.3	02/10/2022 07:00	5.8	0.5
20	A66 North Bitts (KN3)	5.4	02/10/2022 07:10	6.3	0.9
21	A66 Stainmore (KN3)	5.4	02/10/2022 07:20	6.1	0.7

metdesk

Current external uses of the data

KPI Reporting
Post event analysis

Relationships

Domain, Route, Site
Warmest to Coldest
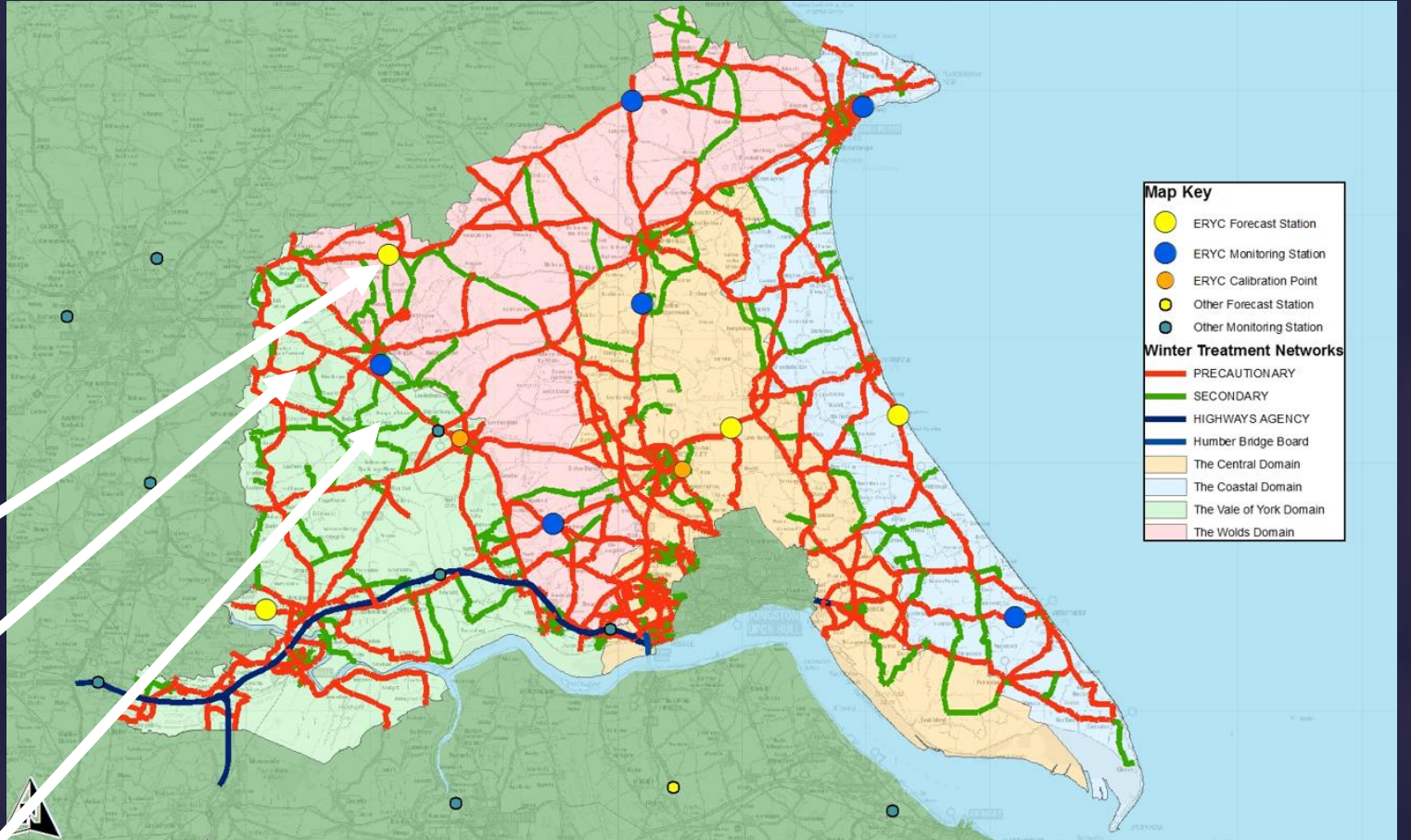
Site (Warmest)

Route (Colder)

Domain (Coldest)

metdesk

How forecast accuracy is currently measured/reported

Site Specific Forecasts

Client [1170 North Yorkshire CC (V) ▼]
Site List (overrides client) [_____]
Start dtg [2020-10-01] End dtg [2021-04-30]
Forecast 1 offset [2hours] Forecast 2 offset [12hours]
Thresholds [5]
☑ Show Detail ☑ Show nightly stats ☑ Show mo
[Select]

[Download] csv data

Seasonal Statistics

INITIAL FORECAST		FINAL	
Bias below 5C	F/F	Bias below 5C	
-0.1	679	-0.2	
RMSE below 5C	F/NF	RMSE below 5	
1.3	115	1.2	
% correct below 5C	NF/F	% correct below	
91	62	91.5	54
GG % correct below 5C	NF/NF	GG % correct below 5C	NF/NF
95.9	1107	96.4	1102
False alarms	False alarm rate	False alarms	False alarm rate
115	5.9	112	5.7
Misses	Miss rate	Misses	Miss rate
62	3.2	54	2.8

Client [1170 North Yorkshire CC (V) ▼]
Site List (overrides client) [_____]
Start dtg [2020-10-01] End dtg [2021-04-30]
Forecast 1 offset [2hours] Forecast 2 offset [12hours]
Thresholds [5]
☑ Show Detail ☑ Show nightly stats ☑ Show monthly stats ☑ Show season stats ☐ Debug
[Select]

[Download] csv data

metdesk

How forecast accuracy is currently measured/reported

Site Specific Forecasts

| October	1304480					1304477					1304476					1303472					1303457					1304474		
	init	final	obs	Err init	Err final	init	final	obs	Err init	Err final	init	final	obs	Err init	Err final	init	final	obs	Err init	Err final	init	final	obs	Err init	Err final	init	final	obs
01/10/2020	4.7	4.7	2.9	1.8	1.8	5.1	5.1	4.4	0.7	0.7	3	3	4	-1	-1	3.4	3.4				4.9	4.9	5	-0.1	-0.1	4.7	4.7	
02/10/2020	10	10	11.3	-1.3	-1.3	10.4	10.4	12	-1.6	-1.6	10.9	10.9	10.8	0.1	0.1	11	11				11.6	11.6	12.7	-1.1	-1.1	10.4	10.4	
03/10/2020	7.4	7.9	7.6	-0.2	0.3	6.8	8.1	7.4	-0.6	0.7	7	8.1	7.9	-0.9	0.2	6.9	8				8.3	8.6	9.1	-0.8	-0.5	7.3	8.8	
04/10/2020	8.3	8.3	9	-0.7	-0.7	8.2	8.8	9.4	-1.2	-0.6	9.2	9.2	9.8	-0.6	-0.6	9.5	9.7				9.7	10.1	9.9	-0.2	0.2	8.7	8.7	
05/10/2020	6.9	6.9	5.9	1	1	7.7	7.7	7.9	-0.2	-0.2	9.7	9.7	8.8	0.9	0.9	8.4	8.4				8.7	8.7	8.8	-0.1	-0.1	9.8	9.8	
06/10/2020	5.2	5.6	6	-0.8	-0.4	7.1	7.4	8.1	-1	-0.7	6.5	7	6.6	-0.1	0.4	6.6	6.9				7.4	7.4	7.5	-0.1	-0.1	8.7	8.9	
07/10/2020	6.5	6.5	7.1	-0.6	-0.6	9.5	9.1	9.5	0	-0.4	8.1	8.1	8.9	-0.8	-0.8	8.2	8.2				8.9	8.9	9.5	-0.6	-0.6	7.3	7.3	
08/10/2020	4.6	4.5	3.8	0.8	0.7	5.9	5.9	6	-0.1	-0.1	6	6	7.3	-1.3	-1.3	4.9	4.9				5.7	6	6.5	-0.8	-0.5	6.3	6.5	
09/10/2020	2.1	2.1	1.4	0.7	0.7	4.6	4.1	4.5	0.1	-0.4	5	5	4.9	0.1	0.1	3.3	3.3				4.4	4.4	3.6	0.8	0.8	5.9	5.9	
10/10/2020	5.4	5.4	5.8	-0.4	-0.4	4.4	3.7	4.9	-0.5	-1.2	5	5	6.5	-1.5	-1.5	5	5				6.6	6.6	6.1	0.5	0.5	3.2	3.2	
11/10/2020	5	5	4.3	0.7	0.7	6.8	6.8	7.7	-0.9	-0.9	6.8	6.8	8	-1.2	-1.2	6.1	6.1				6.7	6.7	6.7	0	0	7.3	7.3	
12/10/2020	5.7	4.6	5	0.7	-0.4	7.3	5.5	3.4	3.9	2.1	5.8	5.3	2.4	3.4	2.9	7.4	5.4				8.3	6.8	5.8	2.5	1	2.9	2.9	
13/10/2020	6	6	6.5	-0.5	-0.5	5.5	5.5	4.9	0.6	0.6	4.9	4.9	5	-0.1	-0.1	5.2	5.2				6.4	6.4	5.6	0.8	0.8	6.1	6.1	
14/10/2020	4.5	4.5	4.1	0.4	0.4	3.6	3.6	3.3	0.3	0.3	3.7	3.6	3.4	0.3	0.2	3.8	3.8				6.4	6.4	4.7	1.7	1.7	4	3.8	
15/10/2020	4.8	4.8	4.9	-0.1	-0.1	5.9	5.4	4.9	1	0.5	3.9	3.9	6	-2.1	-2.1	4.7	4.7				5.8	5.8	6.9	-1.1	-1.1	3.7	3.5	
16/10/2020	6.8	6.9	6	0.8	0.9	5.1	6.8	7.5	-2.4	-0.7	4.9	6	7	-2.1	-1	6.9	7.2	7.1	-0.2	0.1	9.1	9.5	7.2	1.9	2.3	4.6	5.1	
17/10/2020	6.6	6.6	6.5	0.1	0.1	7.4	7.4	5.6	1.8	1.8	7.6	7.6	4.6	3	3	7.8	7.8	5	2.8	2.8	7.9	7.9	6.9	1	1	7.3	7.1	
18/10/2020	4.9	4.9	5.2	-0.3	-0.3	6.2	6.2	7.3	-1.1	-1.1	5.7	5.7	7.3	-1.6	-1.6	5.4	5.5	6.7	-1.3	-1.2	6	6	6.7	-0.7	-0.7	6.6	6.6	
19/10/2020	7	7.5	6.9	0.1	0.6	9.8	9.8	9	0.8	0.8	8.5	8.5	8.3	0.2	0.2	8.9	9.1	8.9	0	0.2	9.5	9.5	9.1	0.4	0.4	8.4	8.4	
20/10/2020	9.4	10	9.4	0	0.6	11.3	11.3	12.3	-1	-1	10.1	11.1	10.5	-0.4	0.6	11.1	11.5	12	-0.9	-0.5	11.4	11.4	11.7	-0.3	-0.3	9.8	10.4	10
21/10/2020	6.1	6.1	6.4	-0.3	-0.3	6.8	6.8	8.1	-1.3	-1.3	8.5	8.5	8.2	0.3	0.3	7.2	7.2	7.2	0	0	6.8	6.8	8.1	-1.3	-1.3	8.1	8.1	
22/10/2020	1.6	1.6	1.1	0.5	0.5	2.5	2.5	3.3	-0.8	-0.8	2.3	2.3	4.9	-2.6	-2.6	1.8	1.8	3.7	-1.9	-1.9	2.8	2.8	4	-1.2	-1.2	2.8	2.8	
23/10/2020	2.5	2.5	1.2	1.3	1.3	4.1	4.1	3.5	0.6	0.6	3.8	3.8	3.8	0	0	3.9	3.9	3.6	0.3	0.3	4.1	4.1	4.3	-0.2	-0.2	5	5	
24/10/2020	2.1	2.1	2.7	-0.6	-0.6	3.8	3.8	4	-0.2	-0.2	4	4	3.3	0.7	0.7	3.9	3.9	4.1	-0.2	-0.2	4.8	4.8	4.4	0.4	0.4	5	5	
25/10/2020	2	2	2.9	-0.9	-0.9	3.5	3.5	3	0.5	0.5	4	4	3.4	0.6	0.6	3.6	3.6	3.5	0.1	0.1	3.9	3.9	4.2	-0.3	-0.3	5.4	5.4	
26/10/2020	2.6	2.6	2.4	0.2	0.2	3.8	3.8	3.5	0.3	0.3	3.6	3.6	3.8	-0.2	-0.2	3.8	3.8	3.6	0.2	0.2	4.1	4.1	4.4	-0.3	-0.3	5	5	
27/10/2020	3	3	1.9	1.1	1.1	4	4	2.6	1.4	1.4	4.1	4.1	3.5	0.6	0.6	4.1	4.1	3.7	0.4	0.4	4.3	4.3	4	0.3	0.3	5.5	5.5	
28/10/2020	2.3	2.3	1.6	0.7	0.7	4	4	3.5	0.5	0.5	3.8	3.5	4.1	-0.3	-0.6	4	4	3.5	0.5	0.5	4.6	4.6	4.9	-0.3	-0.3	5.3	5	

How forecast accuracy is currently measured/reported
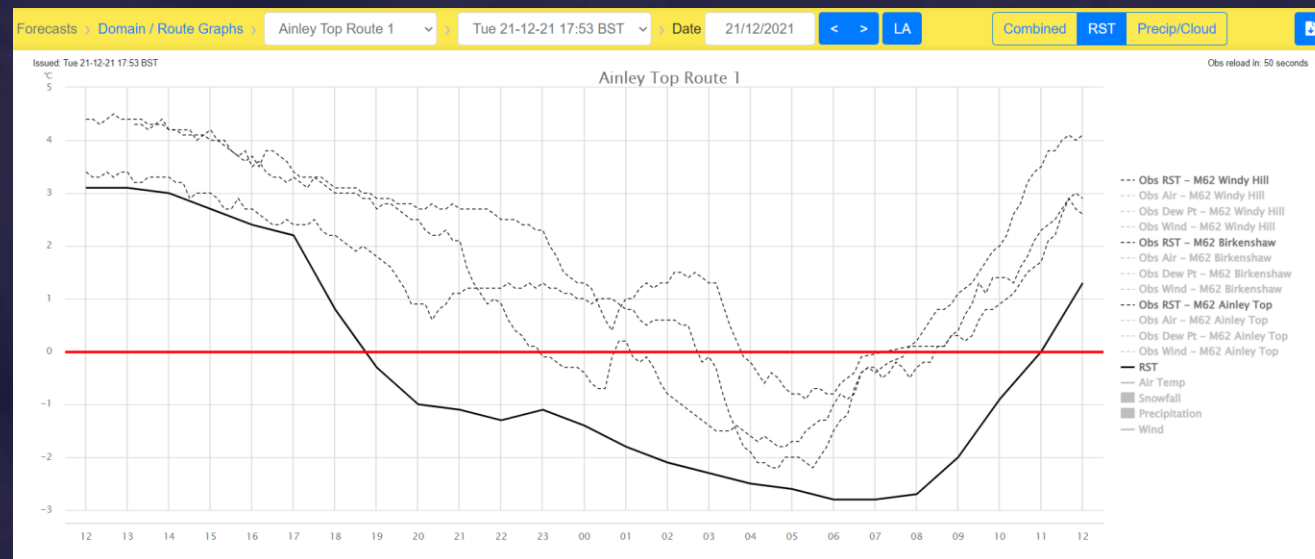
Site Specific Forecasts
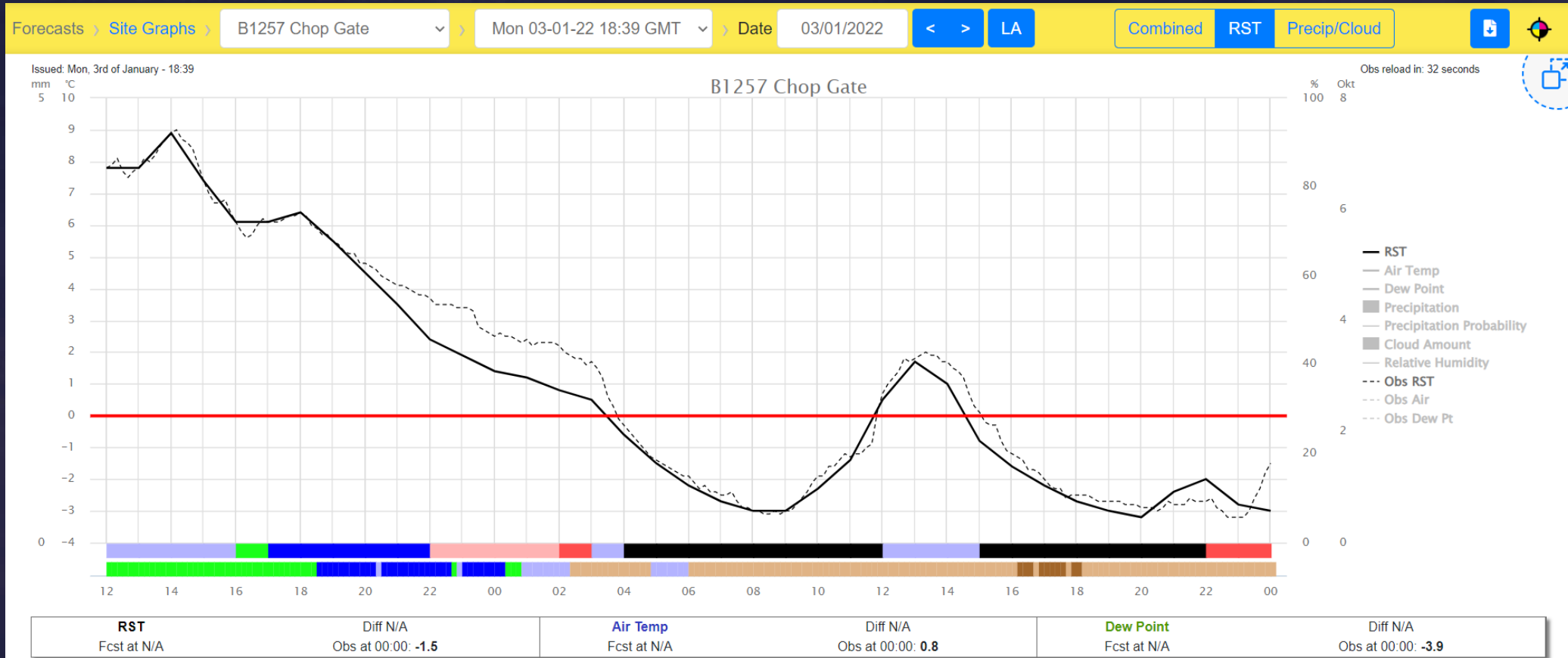
How forecast accuracy is currently measured/reported

Route Forecasts

Dynamic measurement unsuitable – hourly temporal forecast resolution : time/location of measurement

Spot measurement – possible at location of weather station

Important to have route forecast colder than any site along the route – safety issue
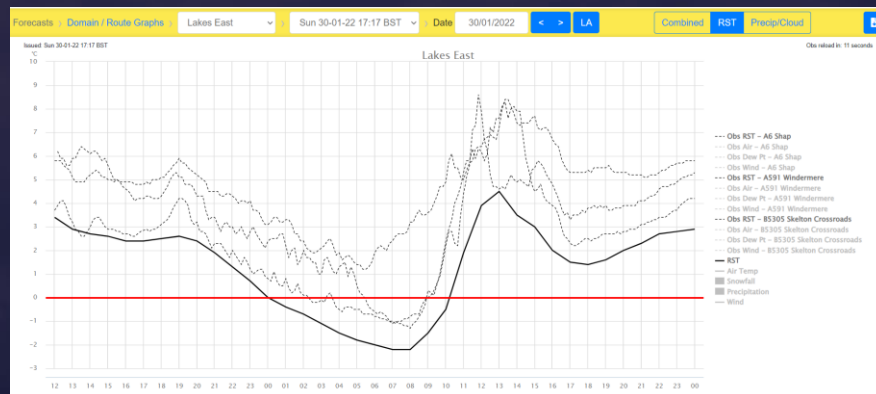
How forecast accuracy is currently measured/reported

Domain Forecast

Retrospective Thermal Map unsuitable – not based on raw data, includes bridge decks

Weather station observations unsuitable – not comparing apples with apples

Important to have domain forecast colder than any route forecast, site specific forecast/measurement

Quick Recap

Forecast accuracy is currently best measured by comparing site specific forecasts and observations from that site.

No perfect methodology exists for route and domain forecast accuracy measurement

Assumption therefore is that the accuracy of route and domain forecasts for any Forecast provider is as good as that for the site specific forecasting.
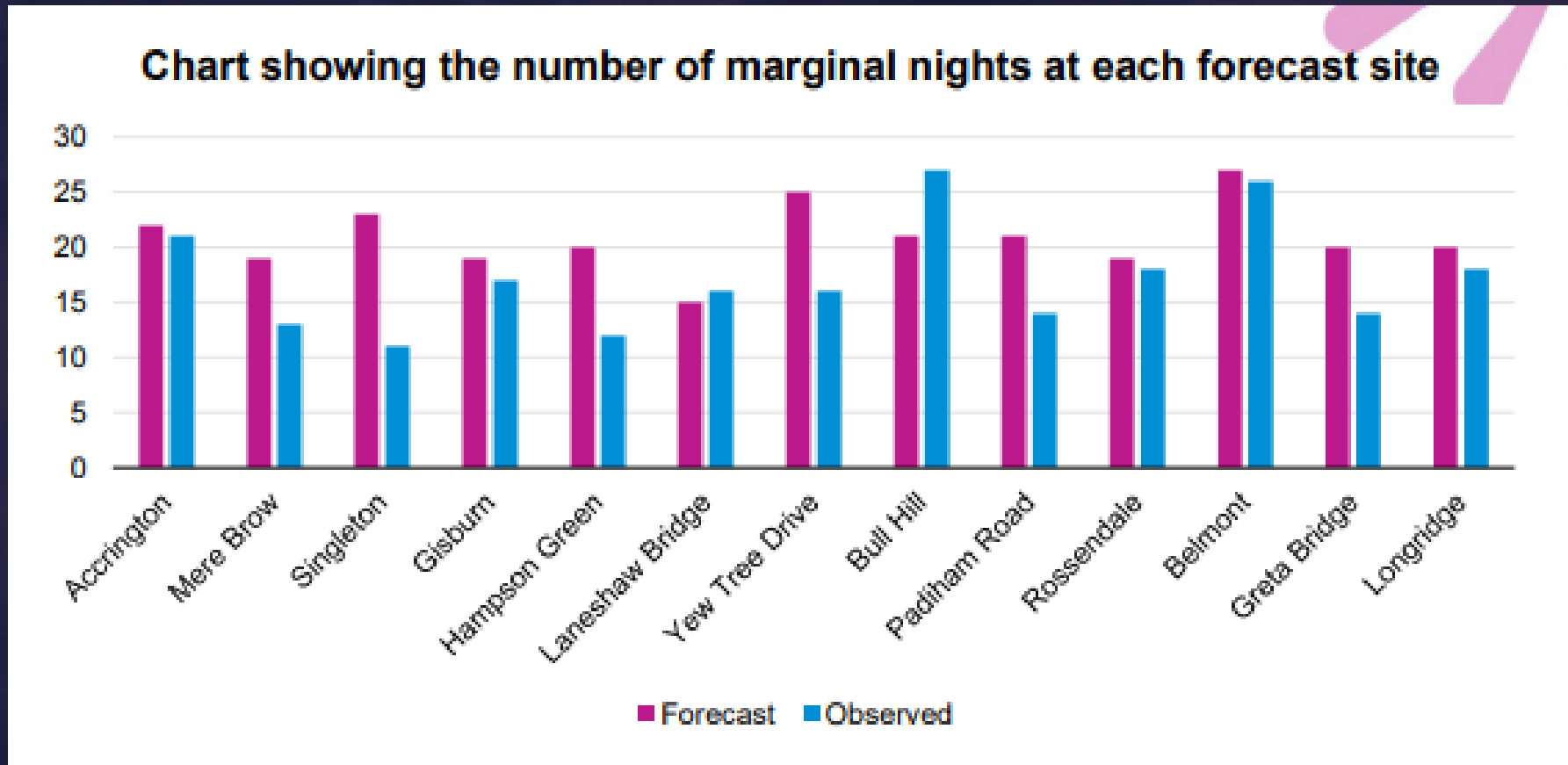
Provided the Warm - Cold - Coldest relationship exists

Marginal Nights – Background Work

Sites where there are more forecast frosts than observed have best potential

Ignore sites which you know are 'warm' - unrepresentative

Chart showing the number of marginal nights at each forecast site

■ Forecast ■ Observed

metdesk

Marginal Nights – Background Work
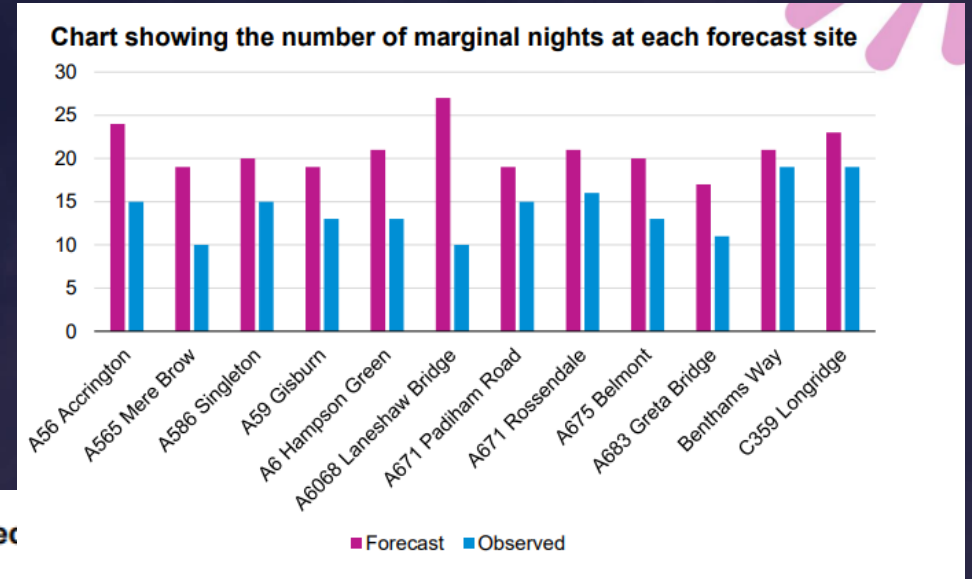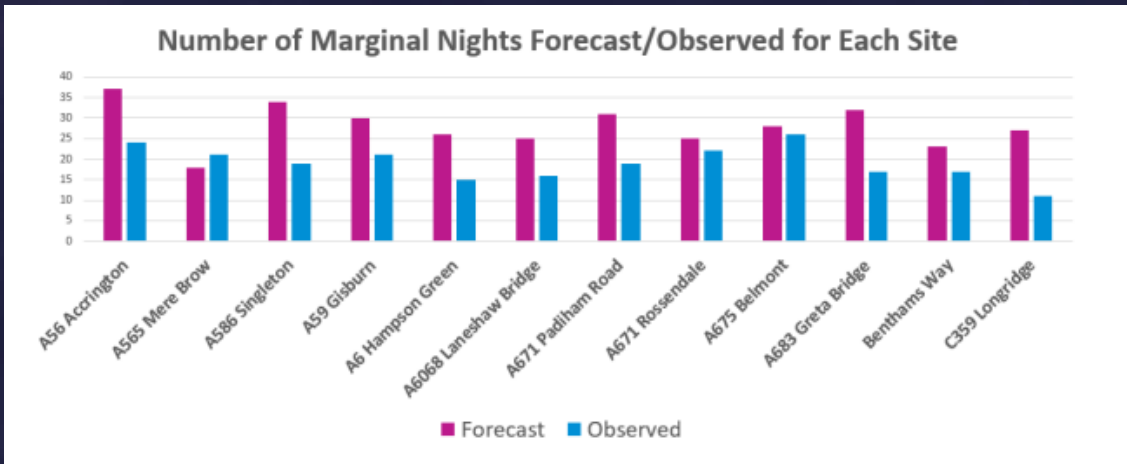
2020-21
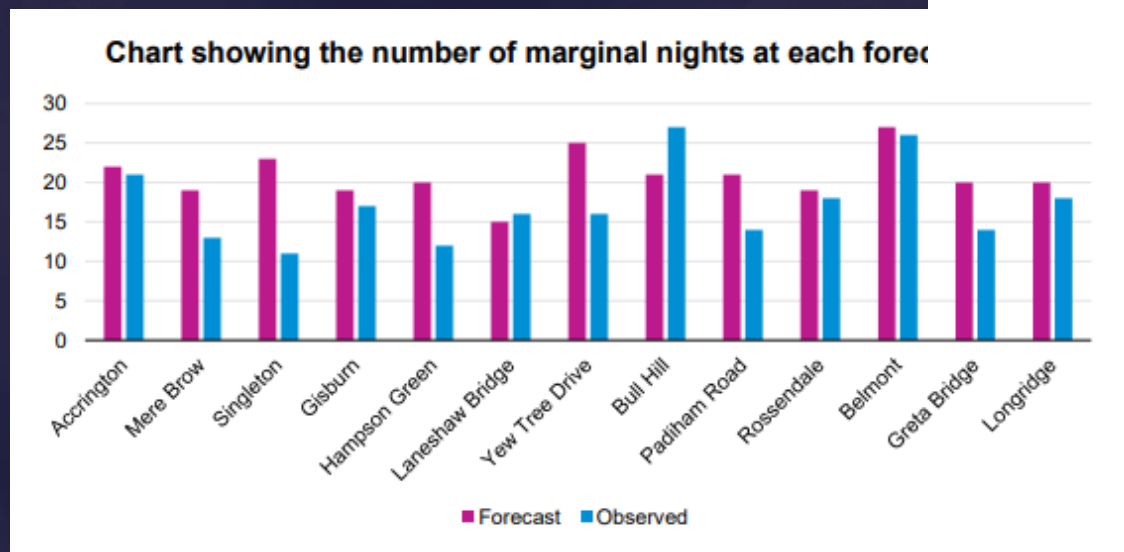
2021-22

2022-23

Trend – By forecast site (associated Route or Domain)
Use colder sites – closer to the route or domain forecast

Chart showing the trend in the observations vs forecast on marginal nights

2.99%
18.53%
42.85%
35.64%

- <0
- Between 0 and +1
- >1
- Missing obs
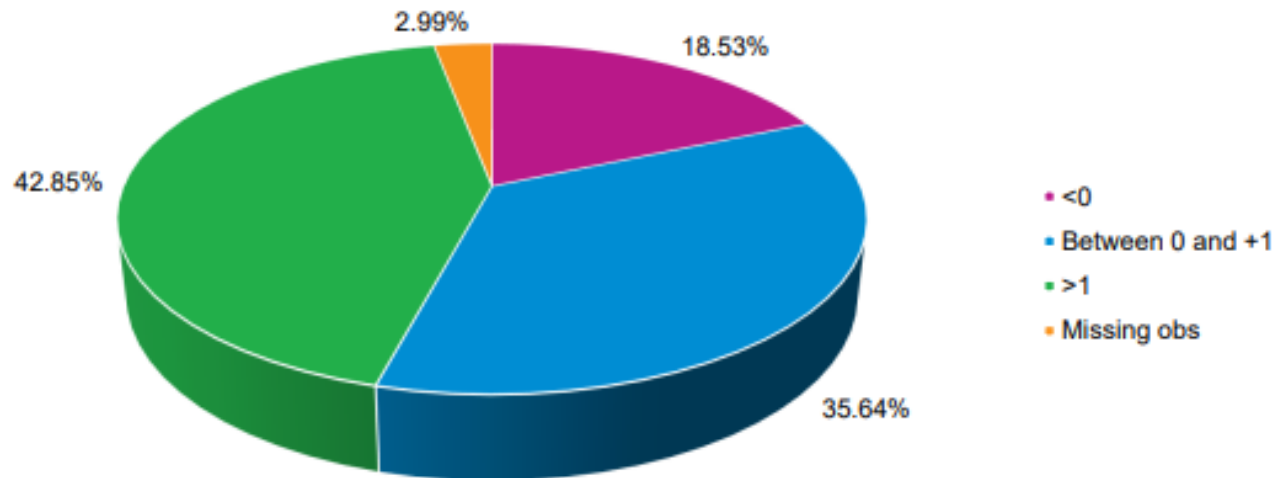
42.85% of the forecasts where the forecast minimum was between +1 and 0 didn't go below +1

metdesk

Marginal Nights – Background Work

Past Seasons
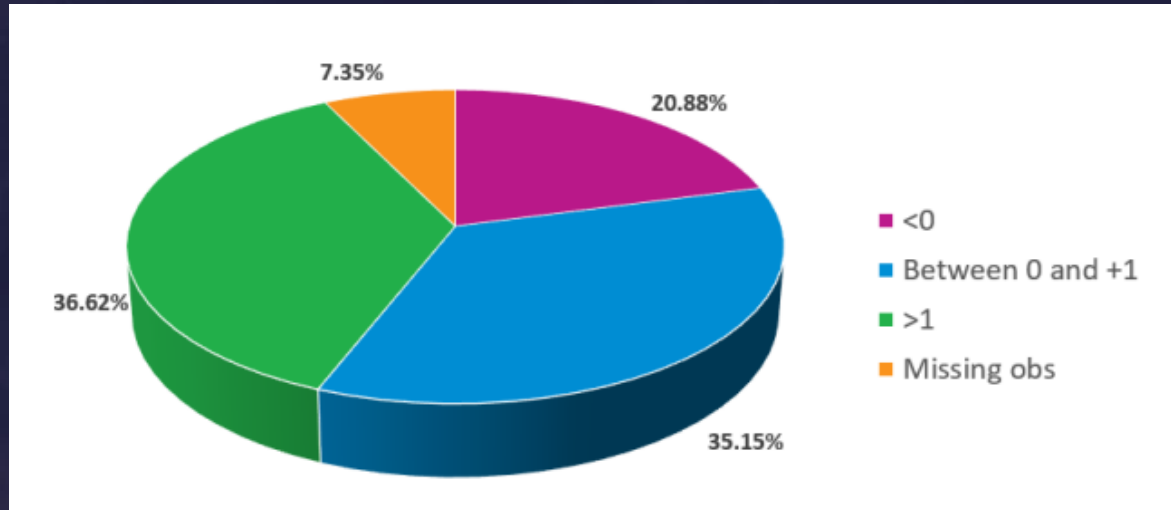
2020-21 (36.62%)
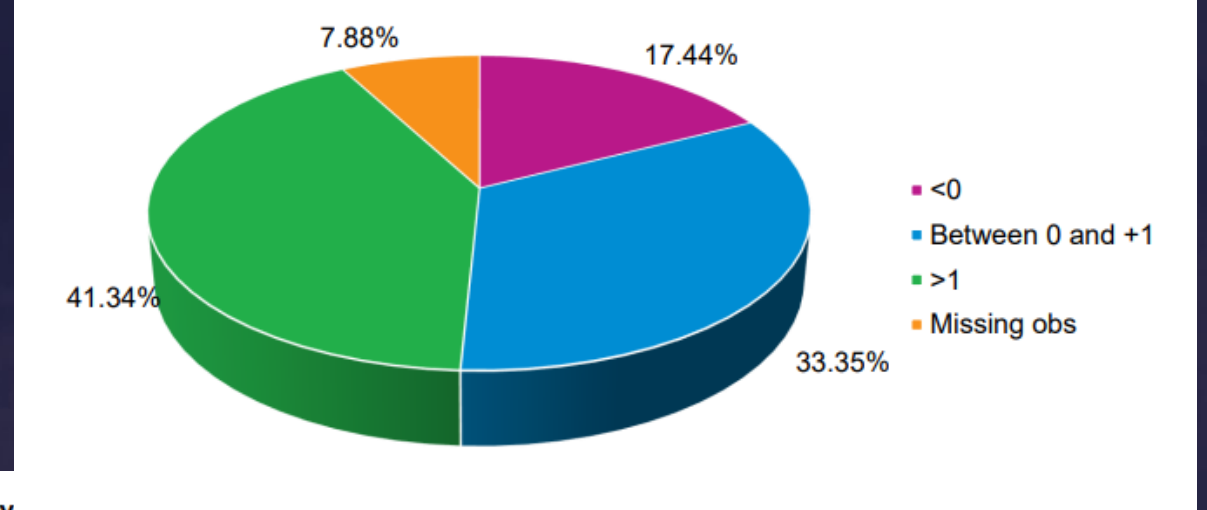
2021-22 (41.34%)
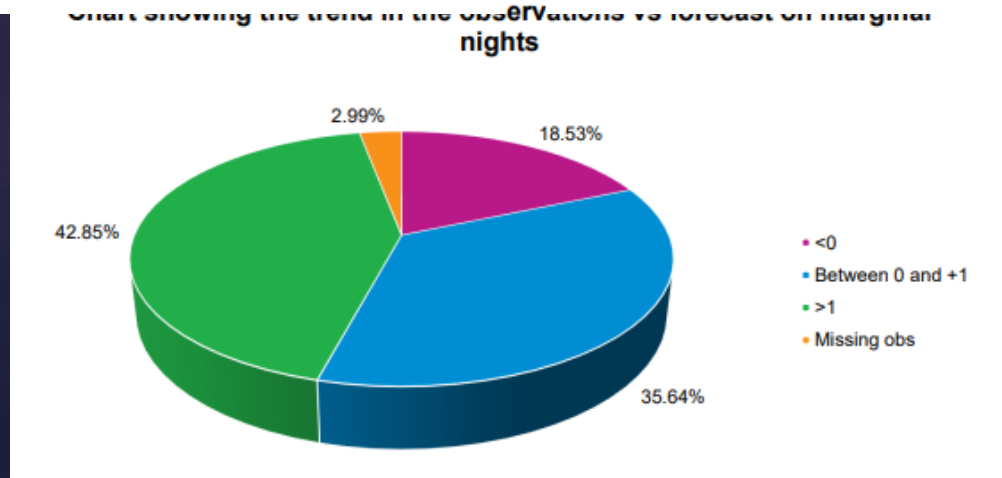
2022-23 (42.85%)

Review of Trigger Thresholds

Only applies for those with trigger thresholds above zero!

Use Marginal Night analysis

Cold sites – closest profile to route or domain

Those with lowest forecast error (RMSE)

Risk Profile – Cold Sites

    Compare nights below+1 and nights below 0

    Missed Frosts– this is where the risk is
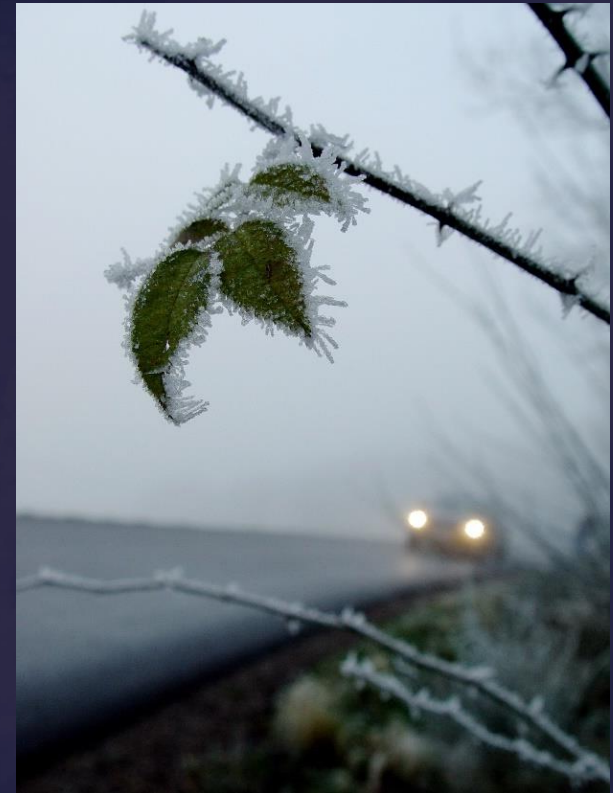
metdesk

Risk Profile – Missed Frosts

2019-20 Season
Nights where forecast and Observations PS1 or below

6 nights where RSTs went Below zero when forecast to stay above

5.6% of all forecasts issued in range

Client: 1170 North Yorkshire CC (V)
Site List (overrides client): 1304478 B1257 CHOP GA1
Start dtg: 2019-10-01   End dtg: 2020-04-30
Forecast 1 offset: 2hours   Forecast 2 offset: 12hours
Thresholds: 1
☑ Show Detail ☑ Show nightly stats ☑ Show monthly stats ☑ Show season stats
[Select]

[Download] csv data

Seasonal Statistics

INITIAL FORECAST		FINAL FORECAST	
Bias below 1C	F/F	Bias below 1C	F/F
-0.1	56	0	60
RMSE below 1C	F/NF	RMSE below 1C	F/NF
1.4	14	1.2	13
% correct below 1C	NF/F	% correct below 1C	NF/F
79.3	10	82.4	6
GG % correct below 1C	NF/NF	GG % correct below 1C	NF/NF
93.1	36	96.3	29
False alarms	False alarm rate	False alarms	False alarm rate
14	12.1	13	12
Misses	Miss rate	Misses	Miss rate
10	8.6	6	5.6

metdesk

Look at Risk Scenarios (+1, 0.8, 0.5, 0.1)

Number of forecasts of >= PS1 that went below zero/stayed above

then

Number of forecasts of <= PS0.5 that went below zero/stayed above

If the numbers are similar then the data may support a reduction in trigger threshold

Detail for February

FEBRUARY	1304478 B1257 CHOP GATE					NIGHTLY STATISTICS			
	INIT	FINAL	OBS	ERR INIT	ERR FINAL	ME INIT	ME FINAL	RMSE INIT	RMSE FINAL
2020-02-01	0.9	1.4	2.4	-1.5	-1.0	-1.5	-1.0	1.5	1.0
2020-02-02	1.0	1.0	1.6	-0.6	-0.6	-0.6	-0.6	0.6	0.6
2020-02-03	-0.7	-0.7	-0.4	-0.3	-0.3	-0.3	-0.3	0.3	0.3
2020-02-04	-4.2	-4.2	-3.4	-0.8	-0.8	-0.8	-0.8	0.8	0.8
2020-02-05	-2.6	-2.6	-4.3	1.7	1.7	1.7	1.7	1.7	1.7
2020-02-06	-0.6	-3.1	-3.3	2.7	0.2	2.7	0.2	2.7	0.2
2020-02-07	0.3	0.3	1.5	-1.2	-1.2	-1.2	-1.2	1.2	1.2
2020-02-08	4.1	4.5	4.2	-0.1	0.3	-0.1	0.3	0.1	0.3
2020-02-09	-0.5	-0.5	0.4	-0.9	-0.9	-0.9	-0.9	0.9	0.9
2020-02-10	-0.8	-0.7	0.0	-0.8	-0.7	-0.8	-0.7	0.8	0.7
2020-02-11	-2.2	-2.2	-1.8	-0.4	-0.4	-0.4	-0.4	0.4	0.4
2020-02-12	-2.3	-1.4	-2.1	-0.2	0.7	-0.2	0.7	0.2	0.7
2020-02-13	0.1	0.1	1.2	-1.1	-1.1	-1.1	-1.1	1.1	1.1
2020-02-14	1.2	1.2	0.4	0.8	0.8	0.8	0.8	0.8	0.8
2020-02-15	4.0	4.0	4.1	-0.1	-0.1	-0.1	-0.1	0.1	0.1
2020-02-16	0.4	0.6	2.2	-1.8	-1.6	-1.8	-1.6	1.8	1.6
2020-02-17	-0.3	-0.3	0.3	-0.6	-0.6	-0.6	-0.6	0.6	0.6
2020-02-18	-1.7	-1.7	-1.9	0.2	0.2	0.2	0.2	0.2	0.2

metdesk

Risk / Reward Example – Single Domain
Rutland – Uppingham

Threshold	False Alarm Rate %	Miss Rate %
+1	9.7	4.8
+0.8	10.2	5.1
+0.5	10.9	5.5
0	12.2	6.3

Change	+2.5% Potential Savings	+1.5% Increase in Miss Rates

metdesk

Risk / Reward Example – Multi Domain Nottinghamshire (4 domains)

Illustration showing change from +1 to 0 – 2022/23 Season

Domain	Reduction in False Alarms (Savings)	Increase in Miss Rates (Risk)
N+NW Notts (A631 Beckingham)	2%	2.8%
N Nottingham (A614 Burntstump)	3.2%	2.3%
SW Notts (A60 Costock)	4%	1.6%
E Notts (A614 Perlethorpe)	2.1%	2.1%

metdesk

Risk / Reward Example – Route Based Forecasting
East Riding of Yorkshire (17 Routes)

Illustration showing change from +0.8 to +0.5 – 2022/23 Season

Route	Reduction in False Alarms (Savings)	Increase in Miss Rate (Risk)
BEV1 (A1023 Routh)	1.1%	0.2%
BEV2 (A1023 Routh)	1.1%	0.2%
BEV3 (A164 Cranswick)	1.4%	0.3%
BEV4 (B1230 High Hunsley)	1.3%	0.4%
CARN1,2 (A166 Garrowby)	0.6%	0.5%
CARN 3 (Octon)	1.6%	0.6%
CARN 4 (A164 Cranswick)	1.4%	0.3%
HEDON1,3 (B1242 Mappleton)	0.6%	0.1%
HEDON 2 (B1242 Withernsea)	0.9%	0.3%
MW1,2,3,4 (Asselby Main Street)	0.5%	0.9%
MW5 (A166 Garrowby)	0.6%	0.5%
MW6 (B1247 Pocklington)	1.5%	0.2%

metdesk

Considerations/Implications

- Monitoring/Alerting +1 and 0
- Reaction times
- Blanket application or by domain/route?
  - Domain and Route specific triggers?

- Other options
  - Route Based
  - Warm routes / Cold routes
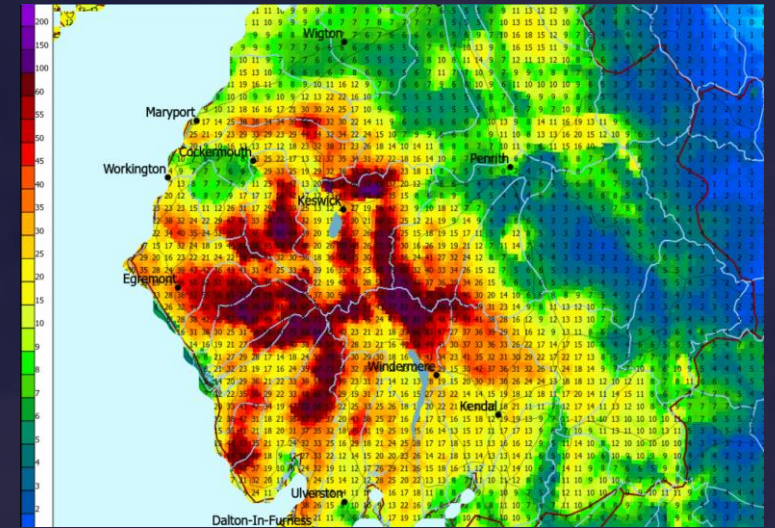 - Sub-routes

metdesk

Rainfall

- Wealth of data available – EA, UKMO, UKCEH
- Adverse weather susceptibility study (forecast provider)
- Past event analysis
  - Outcomes – surface flooding events
  - Rainfall amount – gauges and calibrated radar

Location	Radar (mm)				Forecast (mm)									
	Last 24h	08-09	09-10	10-11	11-12	12-13	13-14	13-01	01-13	Fri	Sat	Sun	Mon	Tue
01 - A29 Northside (A597)	6.5	0.3	0.4	0.4	0.5	0.4	0.3	4.5	5.5	13.5	5.2	0.0	0.3	0.3
02 - A3 Derwent (Gote) (A5086)	12.1	0.8	0.6	0.6	0.5	0.4	1.0	4.6	6.1	14.5	5.7	0.0	0.8	0.3
03 - A50 Ouse (B5291)	12.9	1.0	0.9	1.1	1.0	0.5	0.9	4.2	7.2	16.1	6.1	0.0	1.5	0.4
04 - A49 Dubwath (B5291)	11.4	0.9	0.8	0.9	0.8	0.6	1.0	4.4	7.6	16.5	5.9	0.0	1.4	0.4
05 - A15 North Row (A591)	35.5	2.7	2.0	2.2	1.8	0.5	0.9	4.2	7.8	16.8	6.1	0.0	1.6	0.4
06 - A9 Chapel (Bassenthwaite) (A591)	38.3	2.7	2.1	2.3	1.6	0.6	0.9	4.2	8.1	17.1	6.1	0.0	1.6	0.4
07 - A13 Lair Beck (A591)	15.6	1.1	0.6	0.6	0.8	1.0	1.2	5.5	10.4	19.6	5.2	0.0	1.1	0.2
08 - A34 Derwent (Keswick) (B5289)	6.0	0.5	0.2	0.2	0.2	1.1	1.1	5.5	10.7	20.1	5.1	0.0	1.0	0.2
09 - A165 Pow (C2057)	5.4	0.5	0.2	0.2	0.2	1.2	1.1	5.6	10.8	20.3	5.1	0.0	1.0	0.2
10 - A6 Greta (A5271)	16.4	1.2	0.6	0.8	0.7	1.1	1.1	5.6	10.7	20.0	5.1	0.0	1.0	0.2
11 - A90 Townfield (B5322)	26.5	2.1	0.9	1.0	0.6	1.2	1.3	5.7	9.7	17.7	5.1	0.0	1.1	0.2
12 - A19 Smaithwaite (A591)	21.8	0.9	0.2	0.6	0.3	1.3	1.1	7.3	11.9	21.1	4.7	0.0	0.7	0.2
13 - A163 Grange (C2057)	29.4	1.8	1.0	1.3	0.6	1.2	0.9	7.8	13.5	24.7	4.7	0.0	0.7	0.3
14 - A45 Strands (B5289)	12.3	0.4	0.2	0.3	0.5	1.4	1.0	9.1	15.1	27.6	4.4	0.0	0.5	0.3

metdesk

Rainfall

- Historic radar data
- Historic soil moisture index data

- Correlate with surface water flooding events
- Develop trigger/alerts levels at asset level

Soil Moisture Index (SMI)
- 0-0.2
- 0.2-0.4
- 0.4-0.6
- 0.6-0.8
- 0.8-1
- 1-1.2
- 1.2-1.4
- 1.4-1.6
- 1.6-1.8
- Over 1.8

An index of 1 is field capacity (wet soil) at the given depth, with an index over 1 showing increasingly saturated soil whilst an index under 1 depicts increasingly dry soil until permanent wilting point is reached with an index of zero.

metdesk

Rainfall Alert Thresholds Wet/Dry Soil

Rainfall Hourly Values (mm) Dry Conditions (Dry = Soil Moisture Index Top 2 soil layers <1)

Min	Max	Colour
-99	1.999	Green
2	4.999	Yellow
5	9.999	Amber
10	999	Red

Rainfall 12 Hourly Values (mm) Dry Conditions (Dry = Soil Moisture Index Top 2 soil layers <1)

Min	Max	Colour
-99	14.999	Green
15	19.999	Yellow
20	24.999	Amber
25	999	Red

Rainfall 24 Hourly Values (mm) Dry Conditions (Dry = Soil Moisture Index Top 2 soil layers <1)

Min	Max	Colour
-99	29.999	Green
30	39.999	Yellow
40	49.999	Amber
50	999	Red

Rainfall Hourly Values (mm) Wet Conditions (Wet = Soil Moisture Index Top 2 soil layers >1)

Min	Max	Colour
-99	0.999	Green
1	1.999	Yellow
2	2.999	Amber
3	999	Red

Rainfall 12 Hourly Values (mm) Wet Conditions (Wet = Soil Moisture Index Top 2 soil layers >1)

Min	Max	Colour
-99	4.999	Green
5	7.999	Yellow
8	12.999	Amber
13	999	Red

Rainfall 24 Hourly Values (mm) Wet Conditions (Wet = Soil Moisture Index Top 2 soil layers >1)

Min	Max	Colour
-99	9.999	Green
10	14.999	Yellow
15	19.999	Amber
20	999	Red

metdesk

Wind

- Past diversions/closures
- Past events
- Historic wind speed/gust and direction data
- Design parameters

- It's not just bridges!

In summary

- ## Involve your forecast provider

- Making best use of data – beyond the forecast

- Setting trigger thresholds
  - Winter
  - All Year – Rainfall
  - All Year - Wind

- Assessing the risk profile
  - Domains
  - Routes
  - Site/Asset Locations

richard.hogg@metdesk.com
M: 07903 005034

metdesk