EXTREME VALUES IN SHORT-TERM 2022 20-METER SEQUENTIAL MATCHED WSPR OBSERVATIONS

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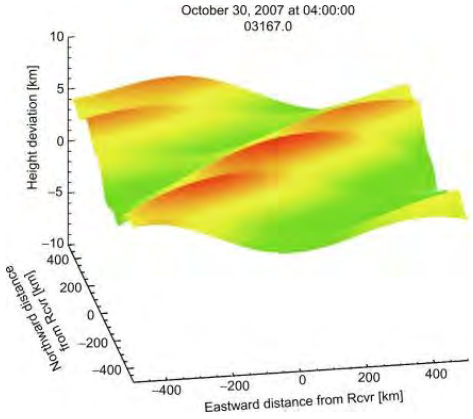
ABOUT ME

- Licensed 1971
- QTH Atlanta
- Up to date on QRZ.COM

- Environmental and public health statistics
- Retired in 2016 from the US CDC

MOTIVATION

- Ham Radio observations are being used to understand propagation-related atmospheric phenomena, in particular Traveling Ionospheric Disturbances (TIDs)
- Current models rely on QSO counts.



SNR

- Terabytes of unused SNR data
- SNR is a continuous measure
- Should be usable for predictive frameworks

ASSERTION\OBJECTIVE

- The SNR data contains useful information

APPROACH


IF YOU TORTURE THE DATA LONG ENOUGH IT WILL CONFESS TO ANYTHING
- Ronald Coase

ISSUES

- An infinite number of reasons for variations:
  - Solar
  - Meteorological
  - Station
  - Temporal
  - Geographical
  - Et. al.

APPROACH

- Control for as much as possible:
  - Single mode, WSPR
  - Matched station pairs
  - On the same band
  - Over the smallest possible time interval

DATA

- All 20 meter WSPR observations in 2022.
- Reduce by finding all observations between the same two stations that are within two minutes of one another, i.e., sequential.
- Take the difference between the two sequential values.

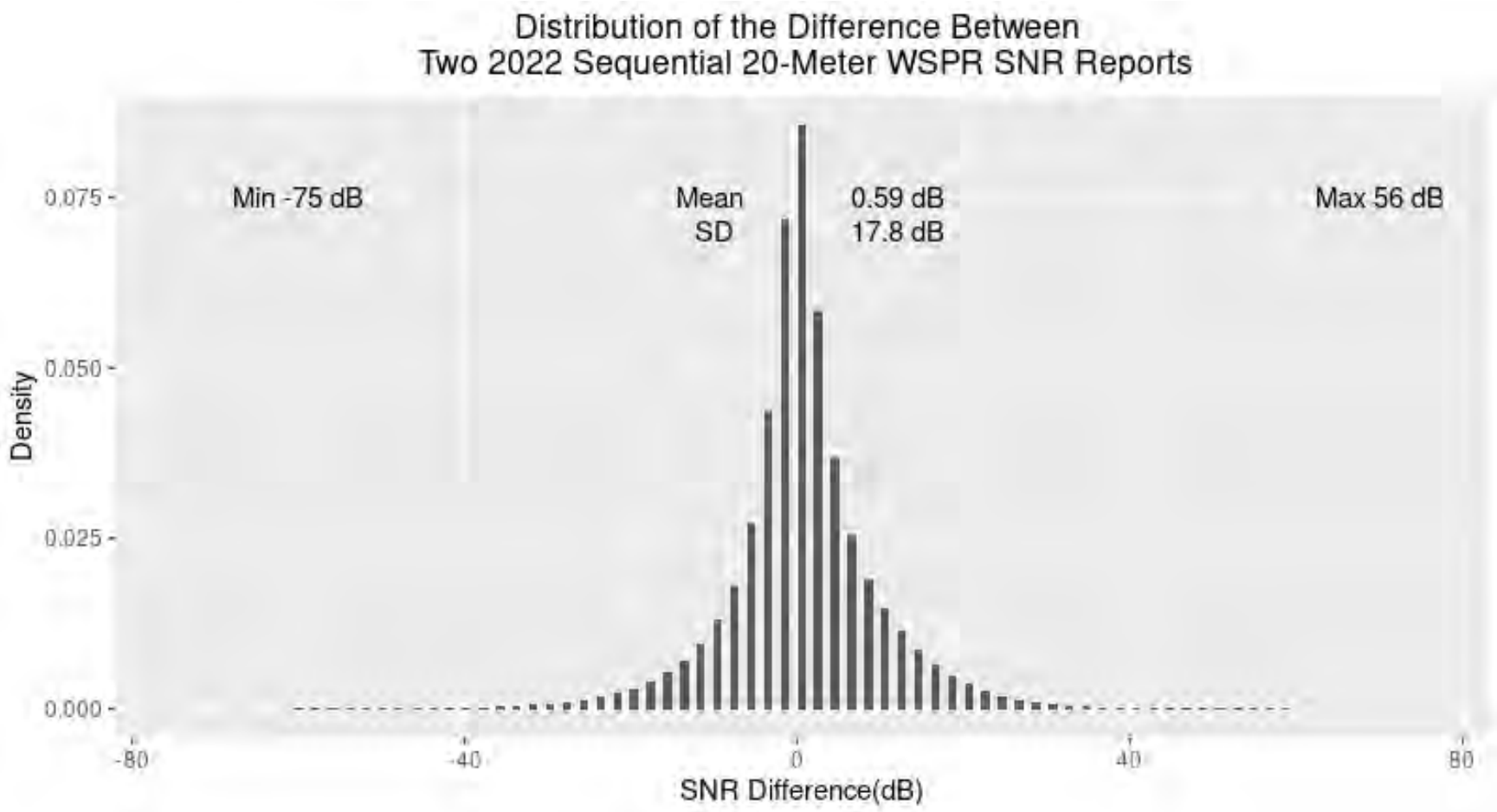
DATA

- Results in 189,704,257 paired difference observations for a single year

- (Previously, 2,286,311)

DATA

- The 189,704,257 paired observations represents 1,656,514 unique station pairs.
- DL6NL and DJ9PC exchanged 348,042 reports, nearly 20% of the reports!
- Issue with duplicates.

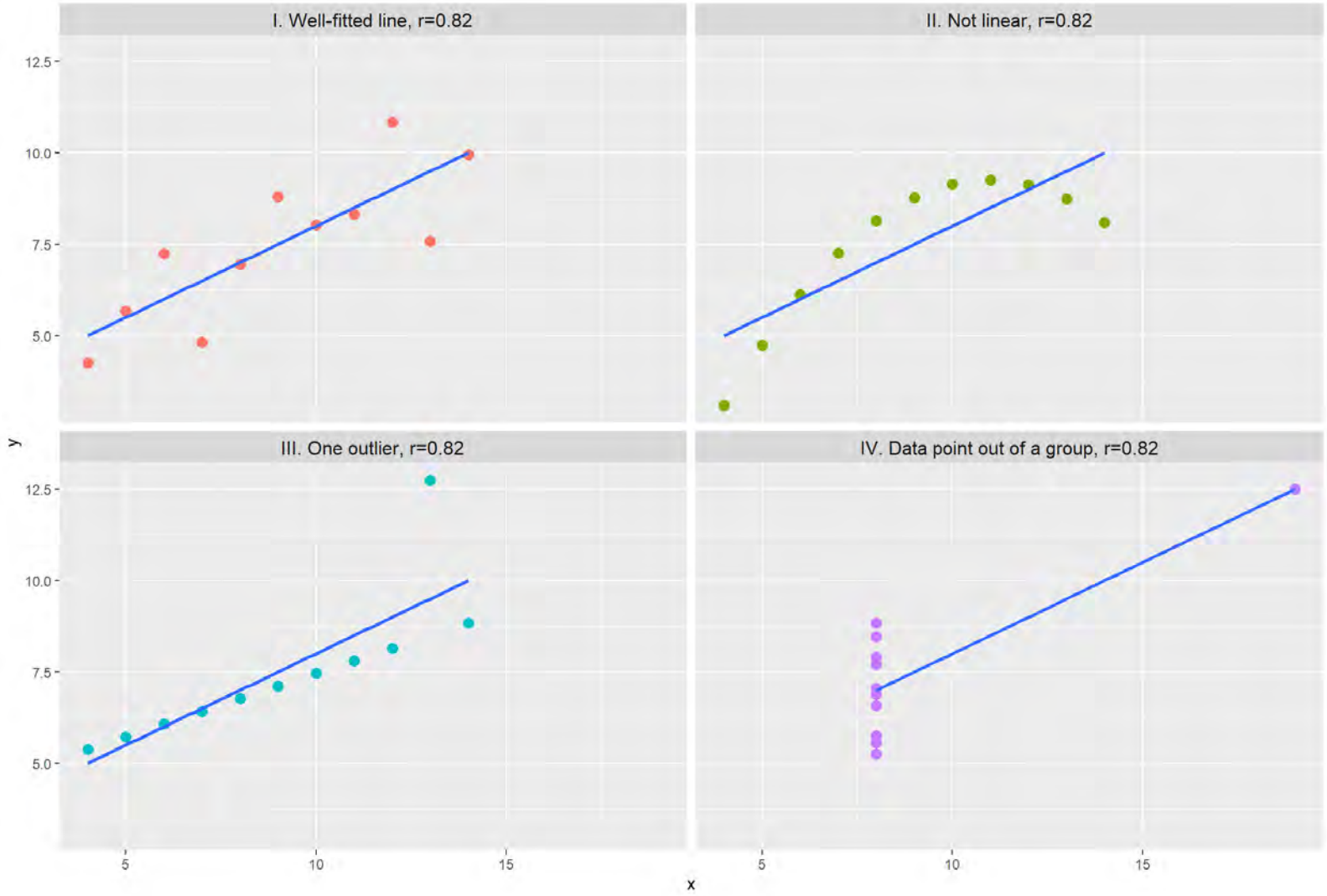

Distribution of the Difference Between
Two 2022 Sequential 20-Meter WSPR SNR Reports
Min -75 dB
Mean 0.59 dB
SD 17.8 dB
Max 56 dB
Density
0.075
0.050
0.025
0.000
-80
-40
0
40
80
SNR Difference(dB)

METHODOLOGY

- Interested in the outliers.
- Outcome: Divide the data into "extreme vs. non-extreme" observations, top 1% vs. all others.
- Model the data using logistic regression to predict the probability of extreme observations.

METHODOLOGY

- Predictors:
  - Hour (24 individual hours)
  - Month (12 months)
  - Distance (500-mile intervals)
  - All modeled as categorical
  - Adjusted for average SNR
  - Clustered by station pair and date


I. Well-fitted line, r=0.82
II. Not linear, r=0.82
III. One outlier, r=0.82
IV. Data point out of a group, r=0.82
y
x
12.5
10.0
7.5
5.0
5
10
15

METHODOLOGY

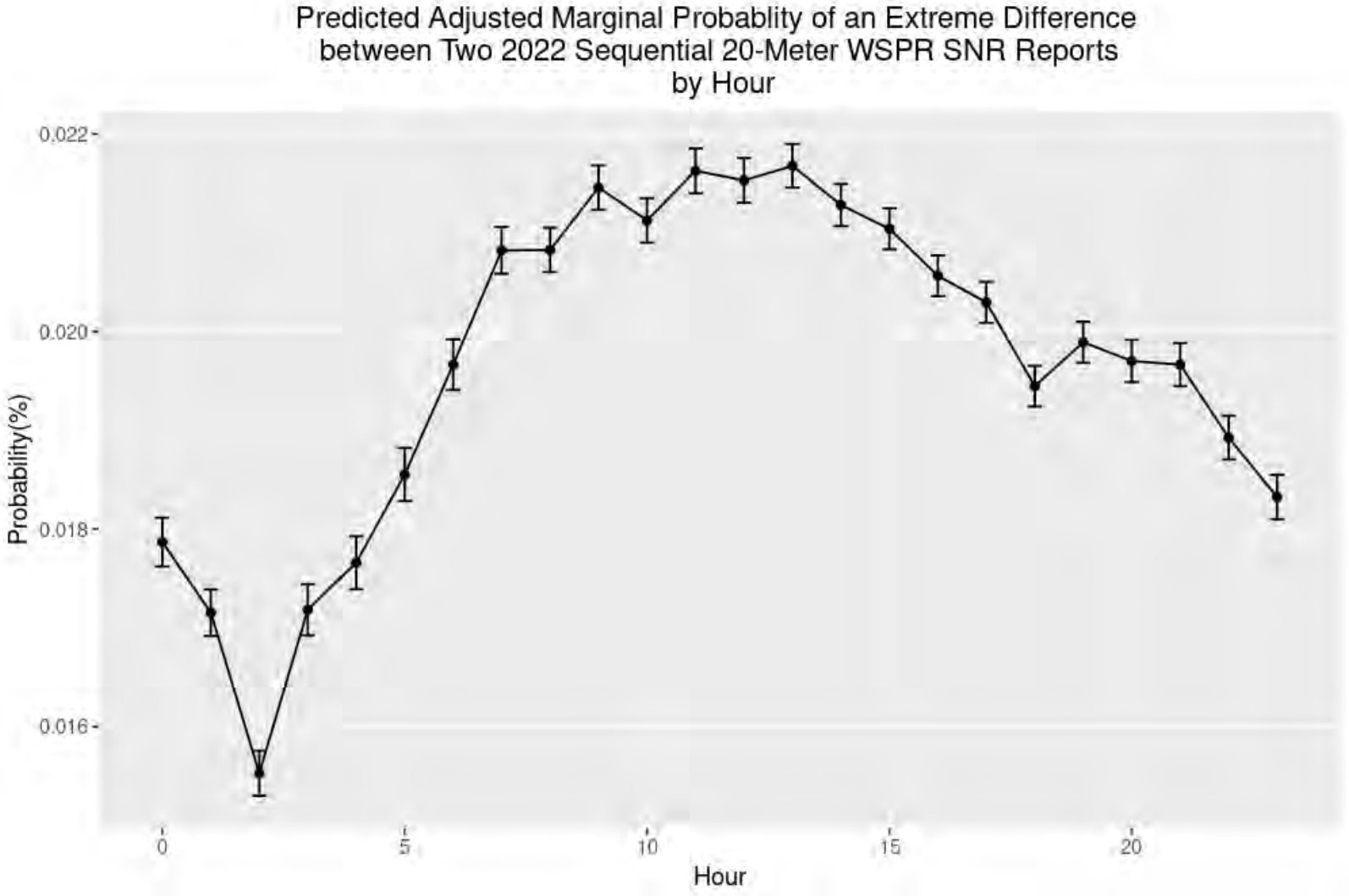
$$P(EV) = 1/(1 + \exp(-\beta_0 + \beta_{1i}*\text{Hour} + \beta_{2i}*\text{Month} + \beta_{3i}*\text{Path\_length} + \beta_{4i}\,\text{AvgSNR} + \sigma_{[\text{pair/date}]} + \varepsilon_i))$$

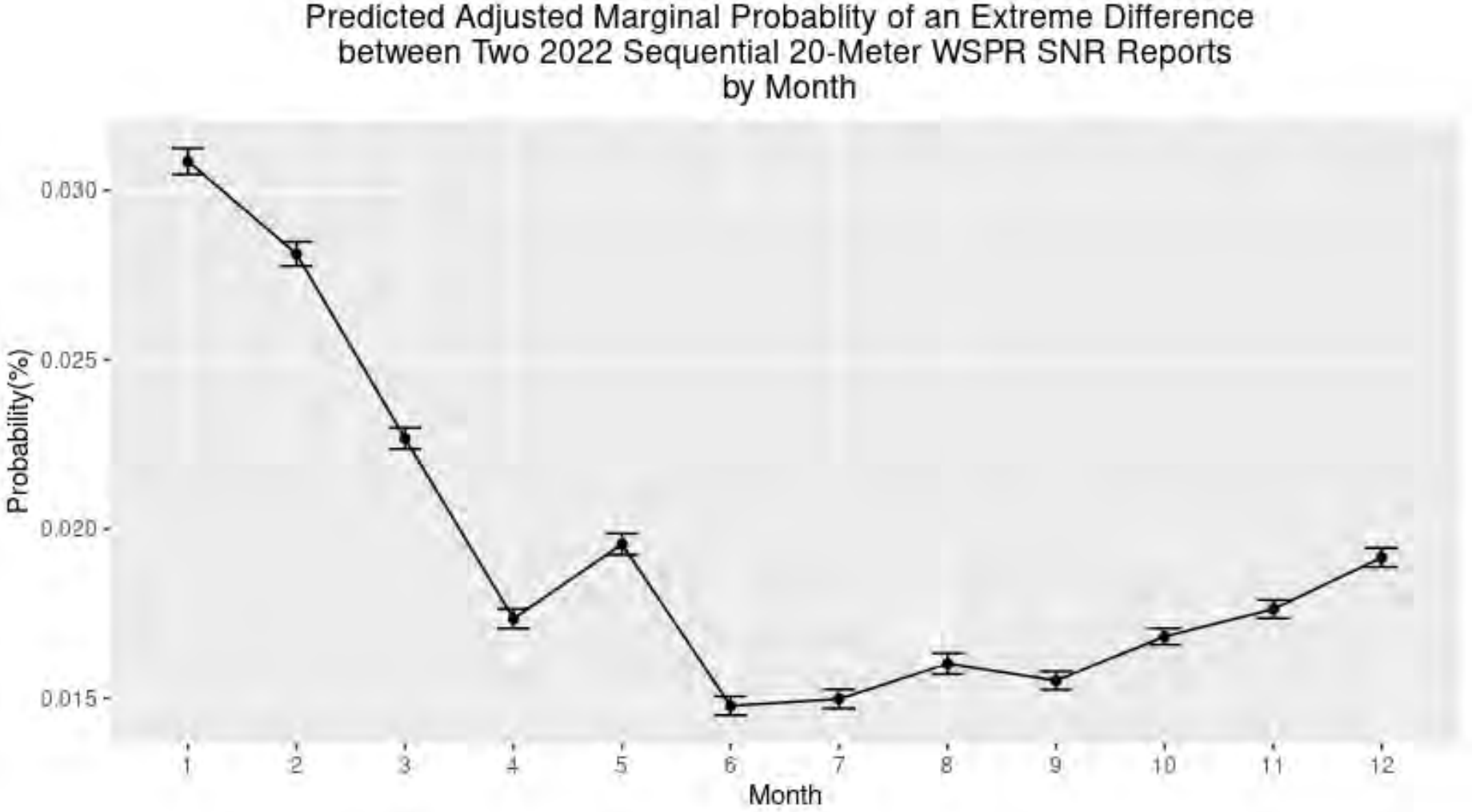
METHODOLOGY

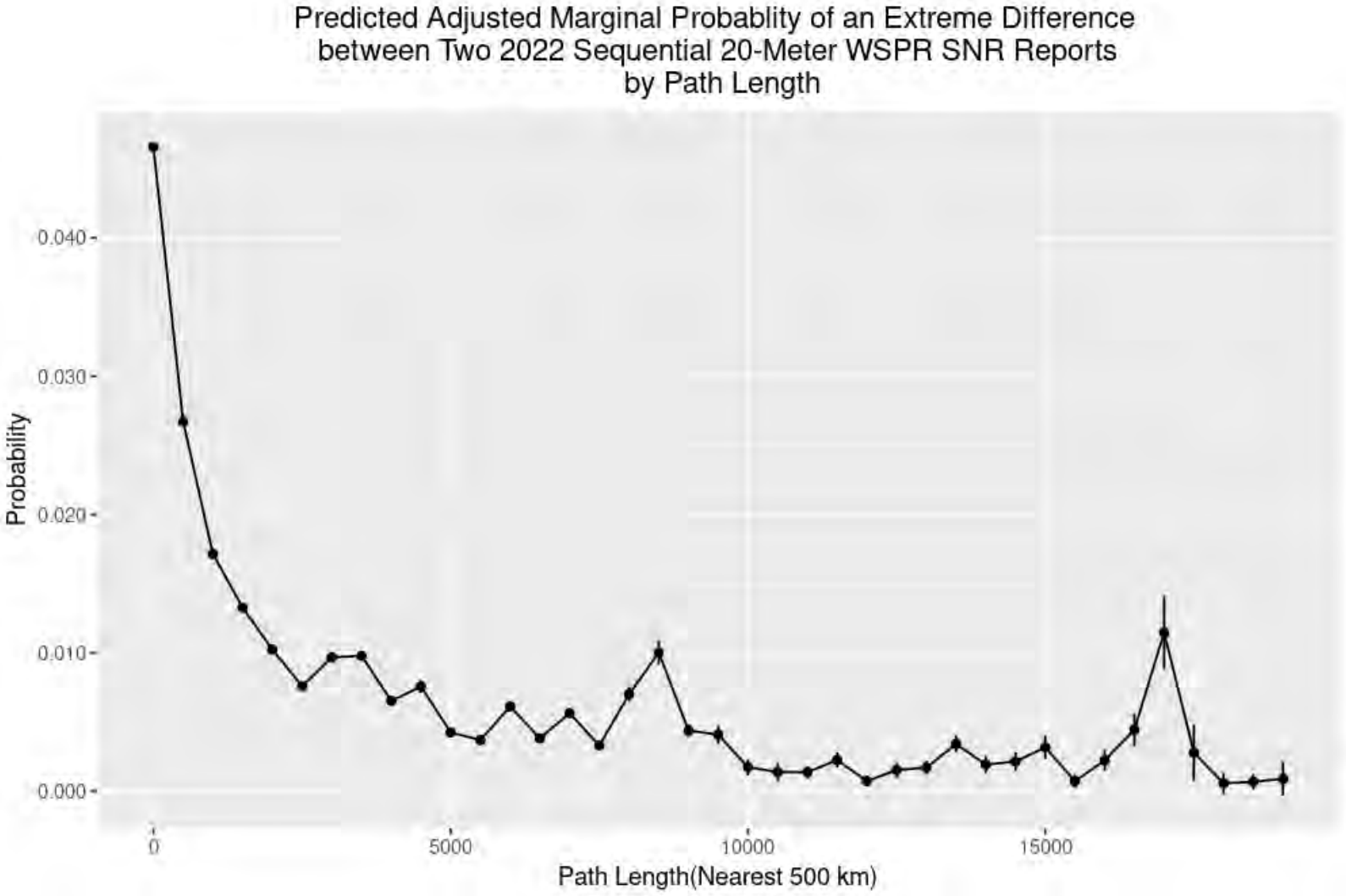
- **Measure of effect size**
  - **Not looking at P-values\significance levels**
  - **Estimated predicted margins:**

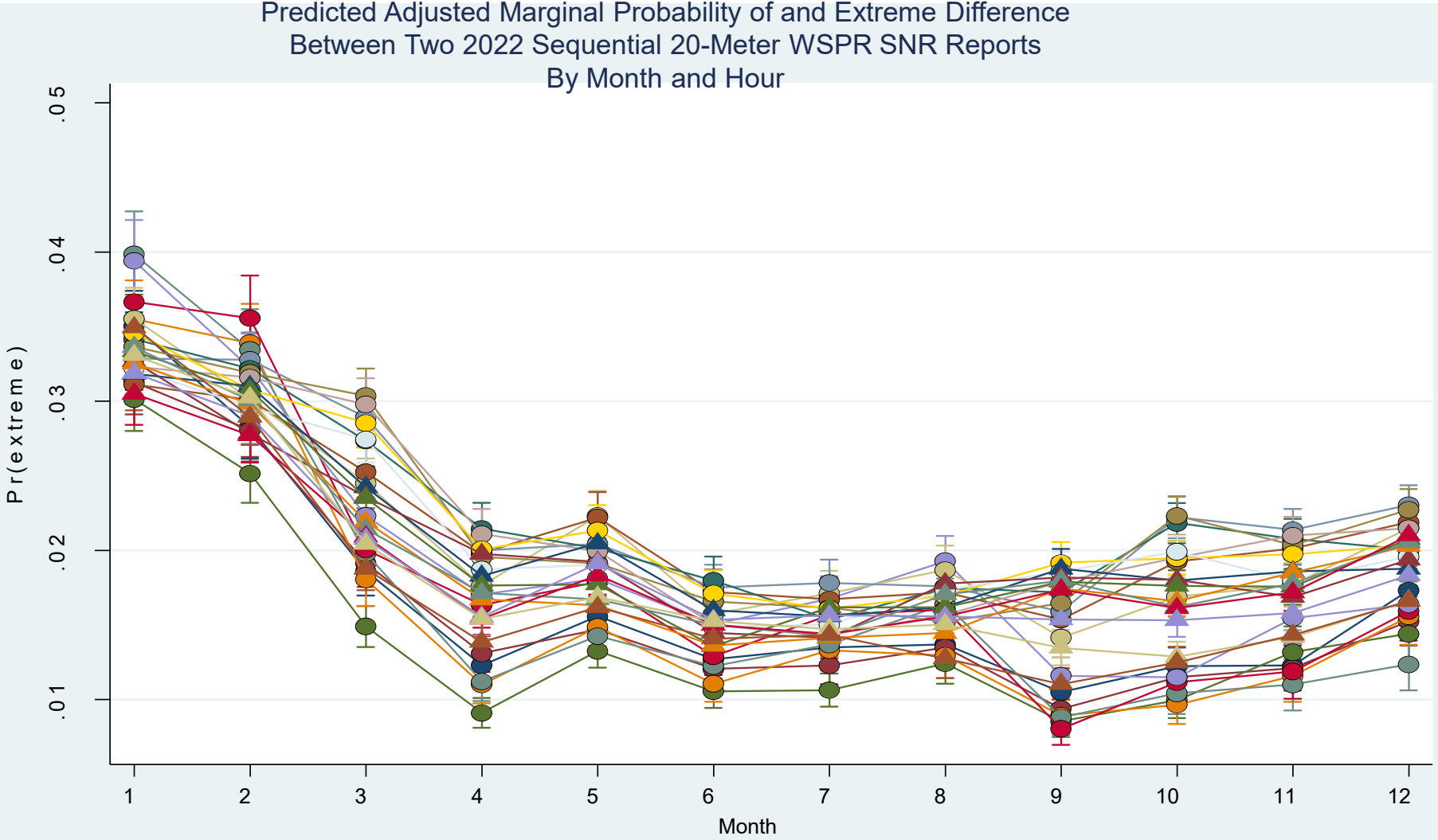
    "Margins are statistics calculated from predictions of a previously fit model at fixed values of some covariates and averaging or otherwise integrating over the remaining covariates."

RESULTS


Predicted Adjusted Marginal Probablity of an Extreme Difference
between Two 2022 Sequential 20-Meter WSPR SNR Reports
by Hour
Probability(%)
0.022
0.020
0.018
0.016
0
5
10
15
20
Hour


Predicted Adjusted Marginal Probablity of an Extreme Difference
between Two 2022 Sequential 20-Meter WSPR SNR Reports
by Month
Probability(%)
0.030
0.025
0.020
0.015
1
2
3
4
5
6
7
8
9
10
11
12
Month


Predicted Adjusted Marginal Probablity of an Extreme Difference
between Two 2022 Sequential 20-Meter WSPR SNR Reports
by Path Length
Probability
0.040
0.030
0.020
0.010
0.000
0
5000
10000
15000
Path Length(Nearest 500 km)


Predicted Adjusted Marginal Probability of and Extreme Difference
Between Two 2022 Sequential 20-Meter WSPR SNR Reports
By Month and Hour
Pr(extreme)
.01
.02
.03
.04
.05
1
2
3
4
5
6
7
8
9
10
11
12
Month

RESULTS

- SNR evidences patterns.
- Distal causes.

CALL FOR COLLABORATORS
SNR WORKING GROUP
WK2Y@ARRL.NET

THANK YOU!

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HamSCI silhouette photo by Ann Marie Rogalcheck-Frissell KC2KRQ.