Analysis of Aftershock Parameters for the Alaskan Subduction Zone Tectonic Region

Undergraduate Thesis

Gabrielle Paris

Thesis advisor: Richard Hugo

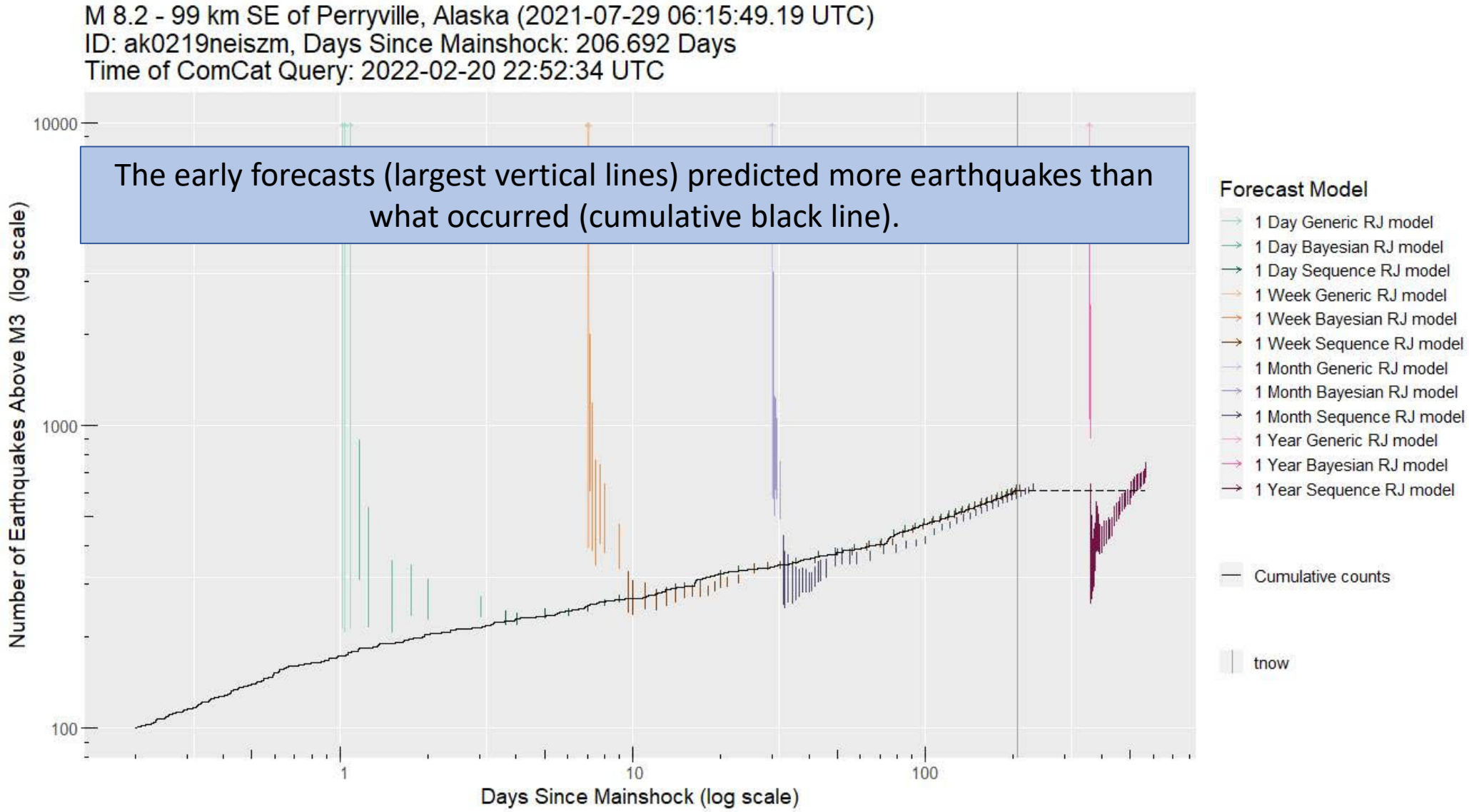
USGS Advisor: Andrew Michael

Terminology

- Earthquake Magnitude
  - The intensity of shaking from an earthquake.
- Earthquake Sequence
  - A large earthquake (mainshock) and the earthquakes that follow (aftershocks).
- Productivity
  - Describes whether the number of aftershocks above a given magnitude is higher or lower than expected.
- Reasenberg and Jones model
  - Rate of aftershocks of at least some magnitude, since some time after the mainshock.

$$\mathrm{R} = 10^{\mathrm{a}+\mathrm{b}(\mathrm{Mmain}-\mathrm{M})}(\mathrm{T}+\mathrm{c})^{(-\mathrm{p})}$$

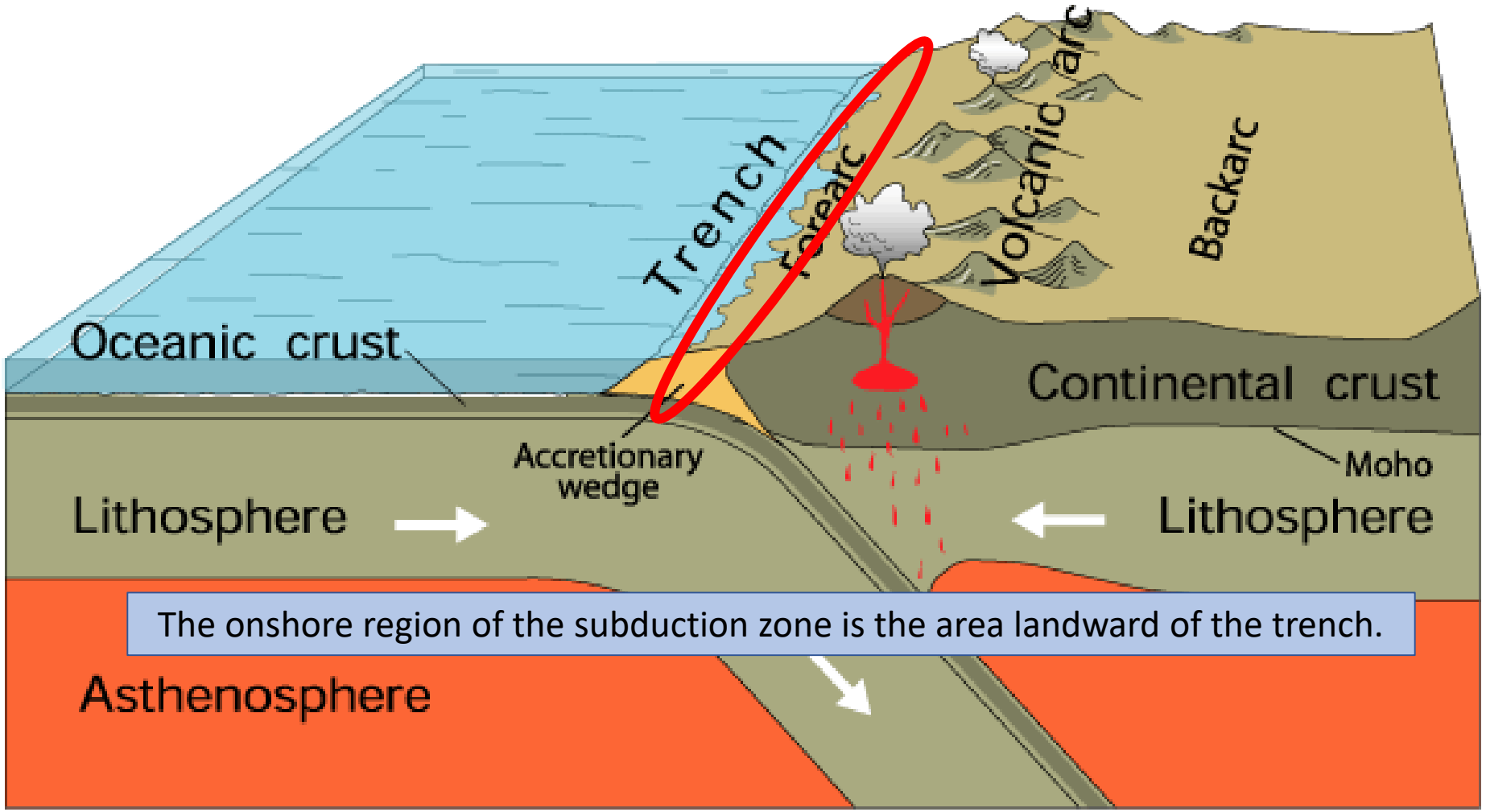
Initial Observations



Are the generic parameters used in aftershock forecasting accurately describing the observed aftershock behavior in Alaska?

- Percentage of successful forecasts using generic parameters?
- Over-prediction in early-sequence for other events?

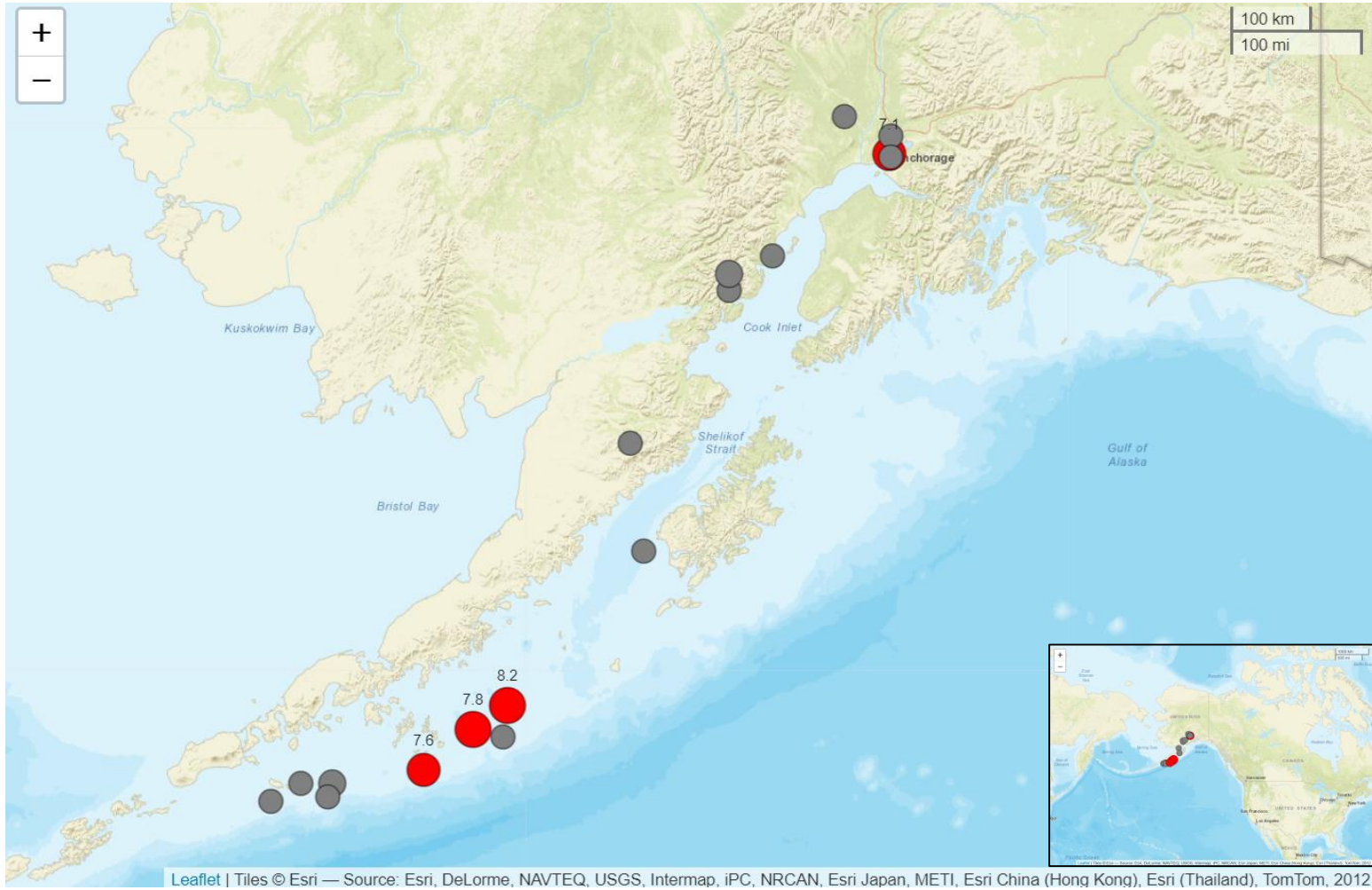
Crash Course Subduction Zone



USGS, 2016

The Where and What

- Onshore Subduction Zone
  - Alaska Peninsula
  - Kodiak Island
  - Southern Alaska
- 17 sequences
  - 2021 M8.2 Chignik
  - 2020 M7.6 Sand Point
  - 2020 M7.8 Simeonof
  - 2018 M7.1 Anchorage
  - Various M5-M6



Percentage of Successful Forecasts?

Well… pretty successful

M7.8

Mag	1 Day	1 Week	1 Month	1 Year
3	54% (7/13)	23% (3/13)	62% (8/13)	100% (13/13)
4	100% (13/13)	100% (13/13)	100% (13/13)	100% (13/13)
5	100% (13/13)	100% (13/13)	100% (13/13)	100% (13/13)
6	100% (13/13)	100% (13/13)	100% (13/13)	100% (13/13)
7	100% (13/13)	100% (13/13)	100% (13/13)	100% (13/13)

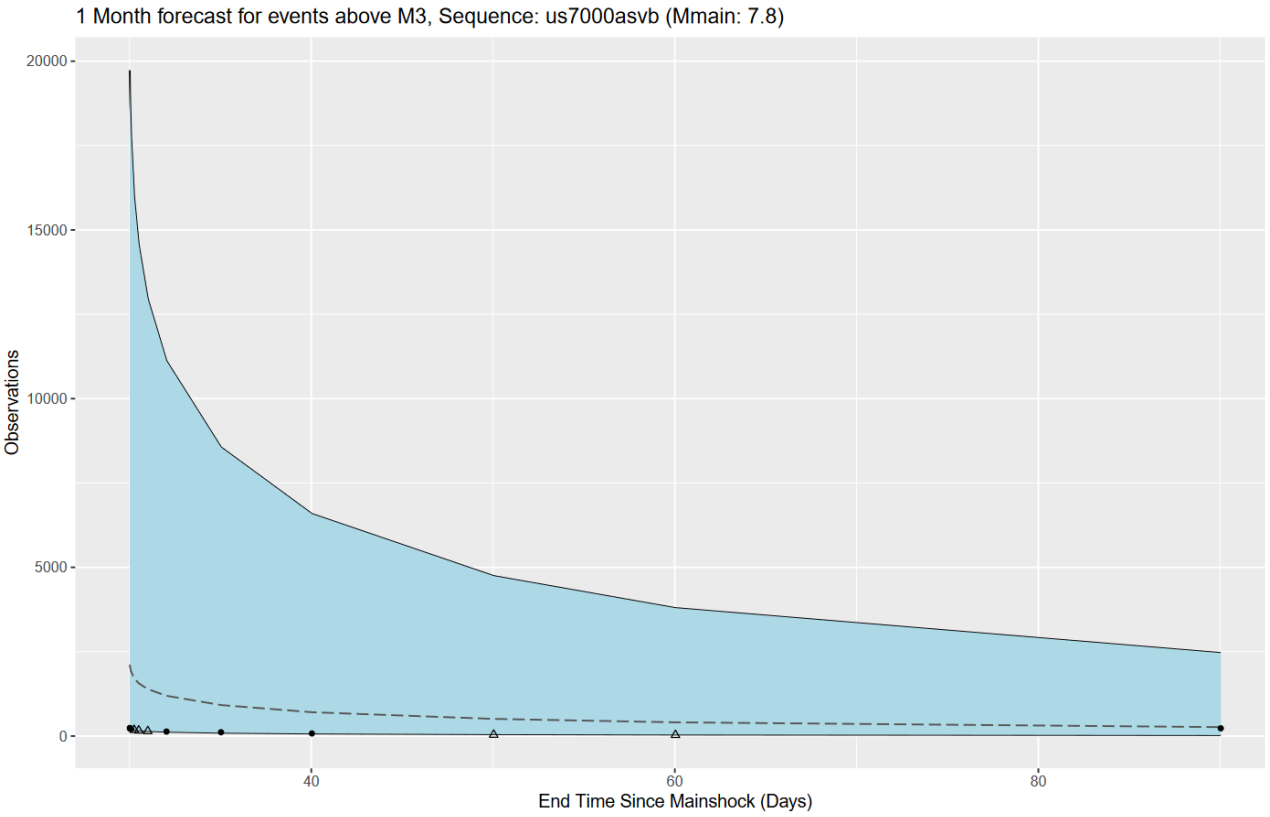
M5.3

Mag	1 Day	1 Week	1 Month	1 Year
3	100% (19/19)	100% (19/19)	100% (19/19)	100% (15/15)
4	100% (19/19)	100% (19/19)	100% (19/19)	100% (15/15)
5	100% (19/19)	100% (19/19)	100% (19/19)	100% (15/15)
6	100% (19/19)	100% (19/19)	100% (19/19)	100% (15/15)
7	100% (19/19)	100% (19/19)	100% (19/19)	100% (15/15)

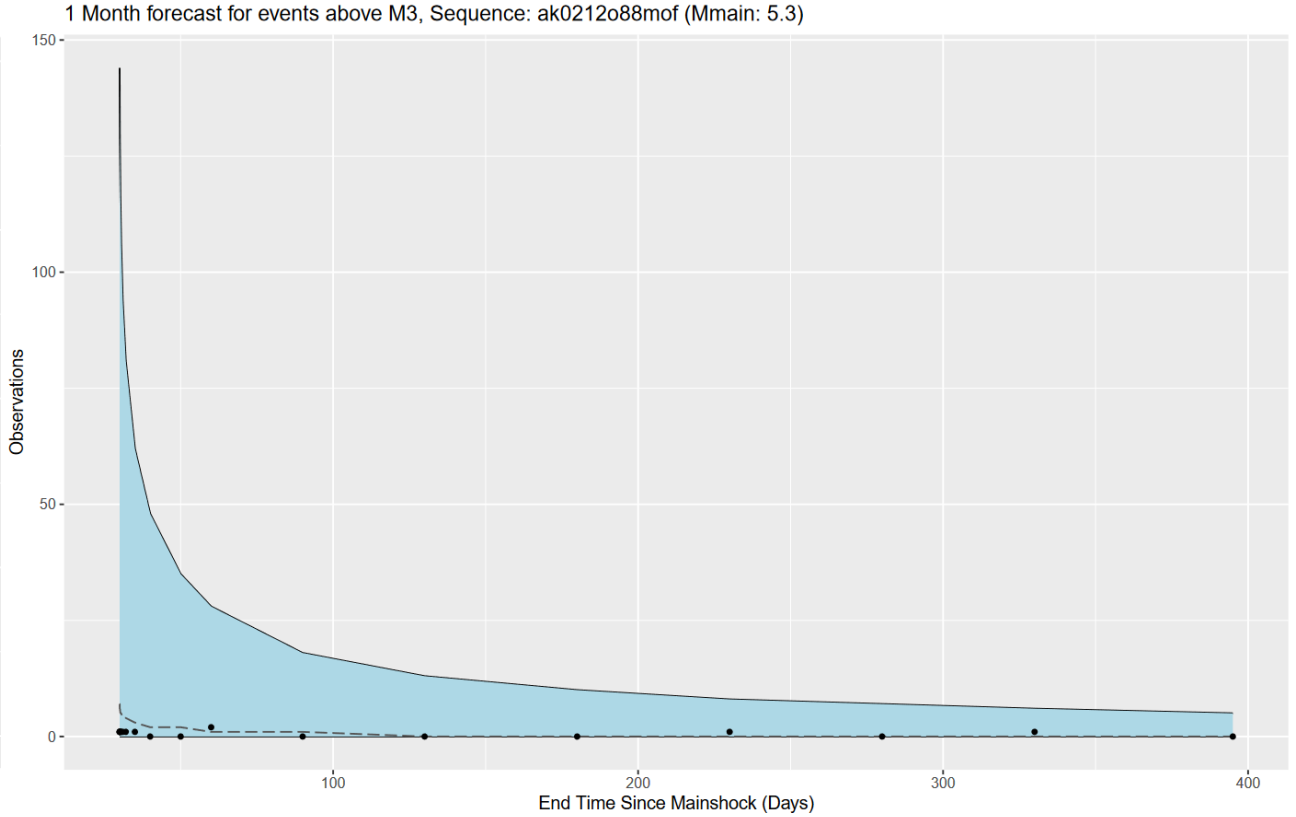
Variation in Observations

The observations, while within the 95% confidence interval (blue, capped by black lines), are consistently on the lower side of the distribution's median (dashed line).

M7.8



M5.3



Solid circles indicate the observations lie within the confidence interval and open triangles indicate the observations lie outside the confidence interval

Closing Remarks

- The forecasts, while largely successful, are overpredicting the number of earthquakes
- Future work:
  - Calculate new forecast parameters
  - Generalize code for future use by the USGS