The Role of Rainfall as a Trigger of Volcanic Activity: An Analysis of Historical Eruption Records

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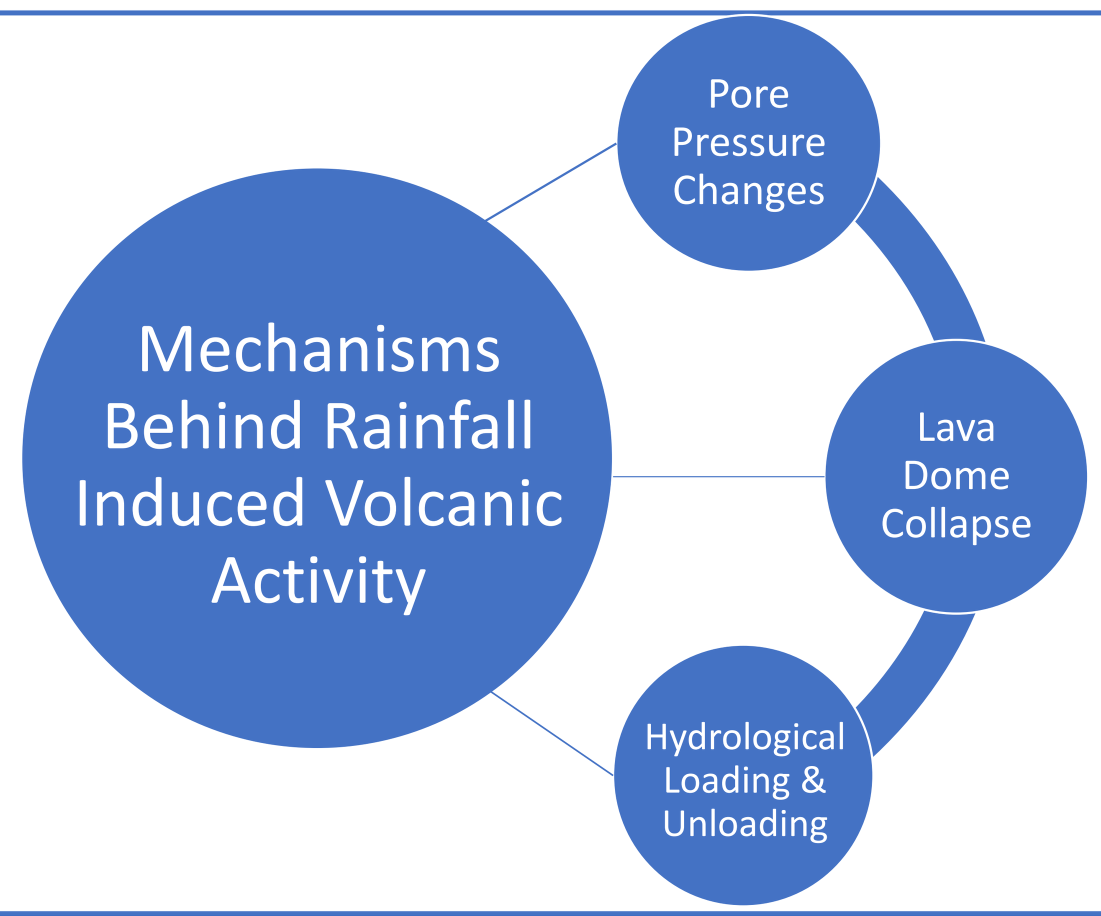
1. Background

- It's been shown extensively that rainfall can induce seismicity at a range of depths in the crust
- Intraplate earthquakes, landslides, and silent slip events at subduction zones have all been shown to be the result of rainfall induced changes in the subsurface
- A recent high profile paper attributed the 2018 Kilauea eruption to extremely heavy rainfall in the weeks and days leading up to the eruption
- There is a need to establish the spread of this phenomenon
- With the onset of anthropogenic climate change increasing the frequency of extreme weather and influencing global precipitation patterns, it is important to understand if this will then result in a corresponding increase in rainfall induced volcanic activity



2. Method

1. Identified volcanoes of interest
2. Gathered precipitation data from three databases
   - GHCN – Global Historical Climatology Network, gauge based daily station data
   - GPCC FDM – Global Precipitation Climatology Centre Full Data Monthly, gridded monthly data
   - GPCC FDD – Global Precipitation Climatology Centre Full Data Daily, gridded daily data
3. Carried out statistical and probability analysis on the precipitation data in conjunction with historical eruption data for 4 volcanoes

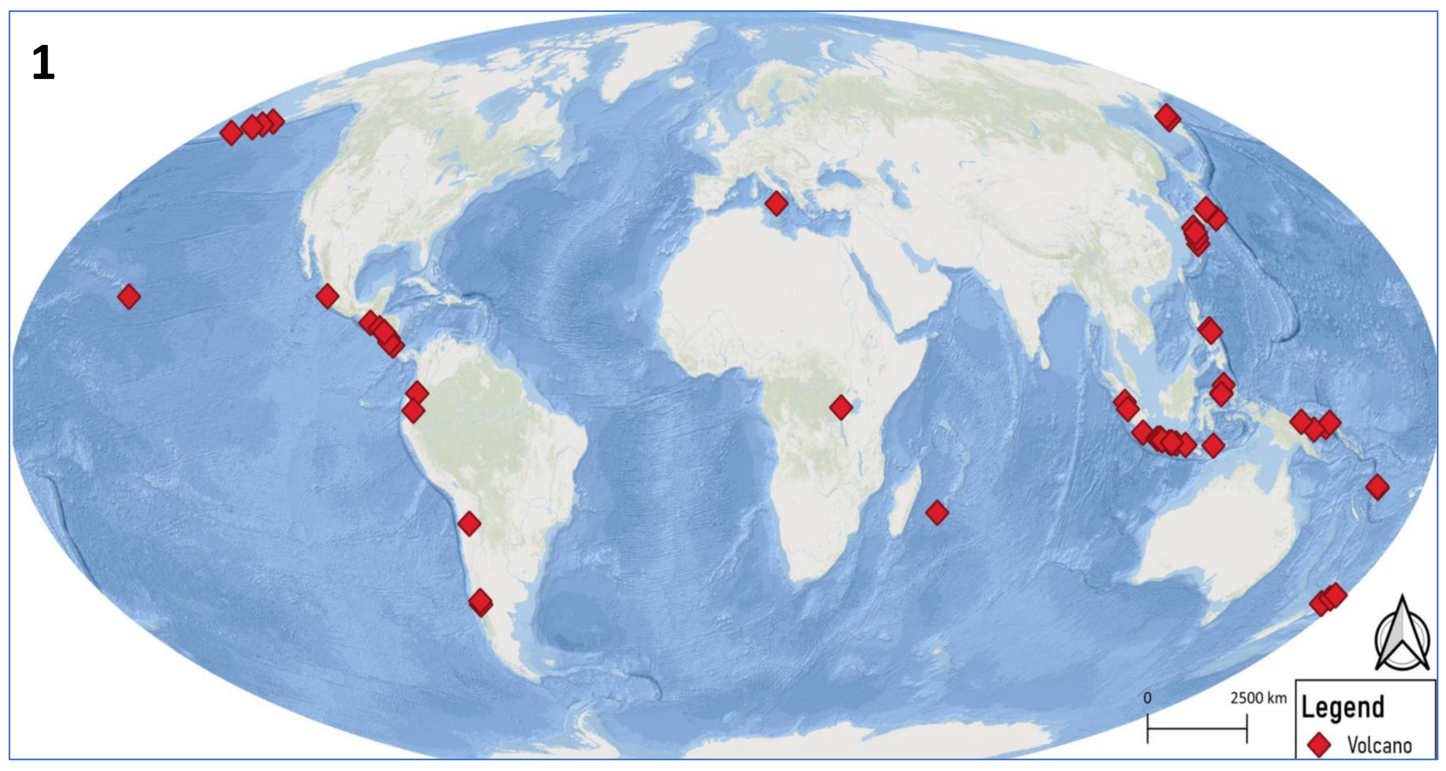


Fig. 1 Distribution of Volcanoes. 60 in total

3. Initial Results

For one location – Klyuchevskoy, stratovolcano on the Kamchatka Peninsula of Russia

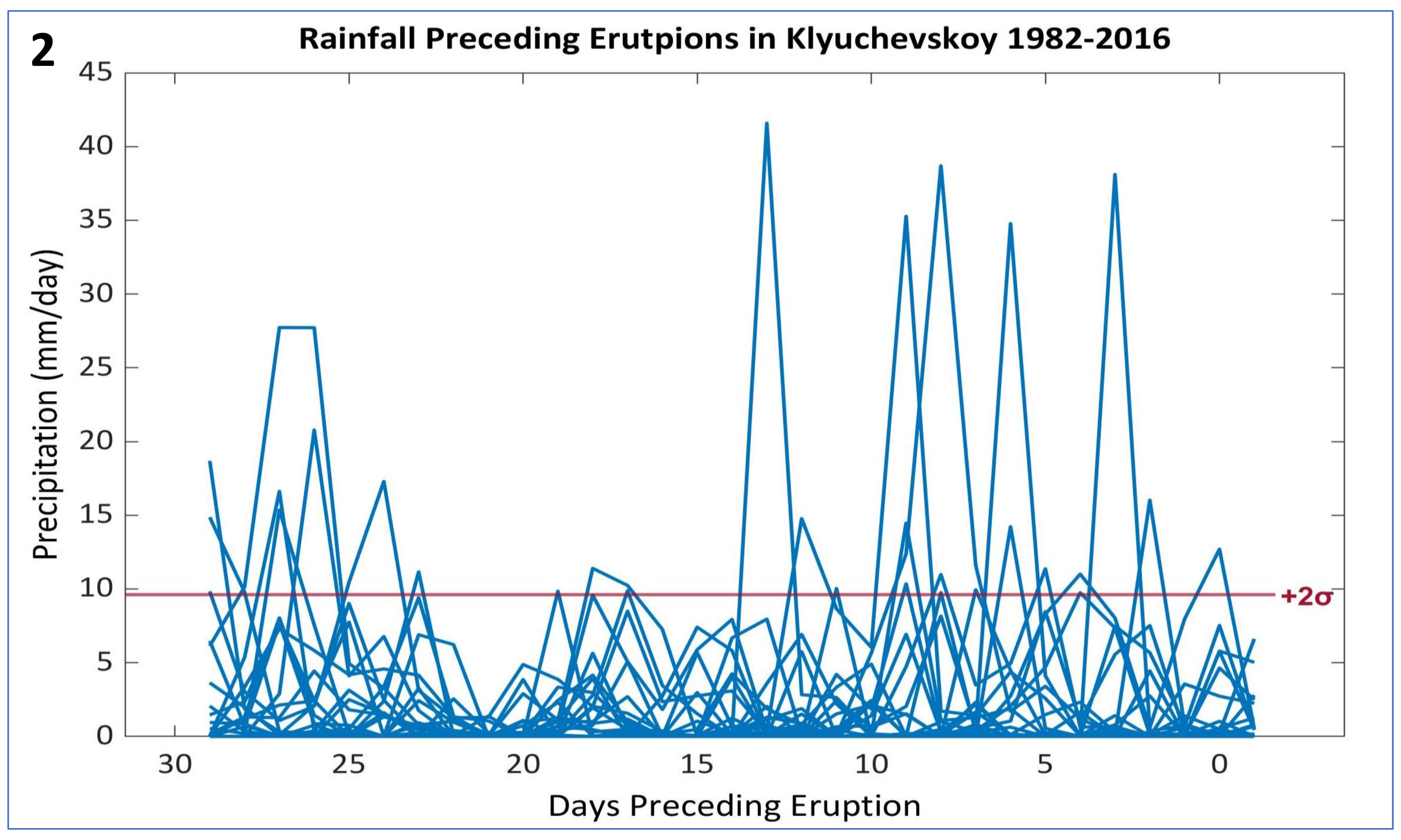


Fig. 2 Timeseries of daily rainfall in the 30 days preceding all 28 eruptions

- **Fig 2** – 71% of eruptions preceded by an extreme rainfall event in 30 days preceding eruption
- **Fig 3** – Potential regional relationship between precipitation and eruptions
- **Fig 4** – Wet season defined as August to January = 50% of the year, 60% of rainfall
- **Fig 5** – probability of 17 eruptions occurring during the wet season out of 28 eruptions = 0.079

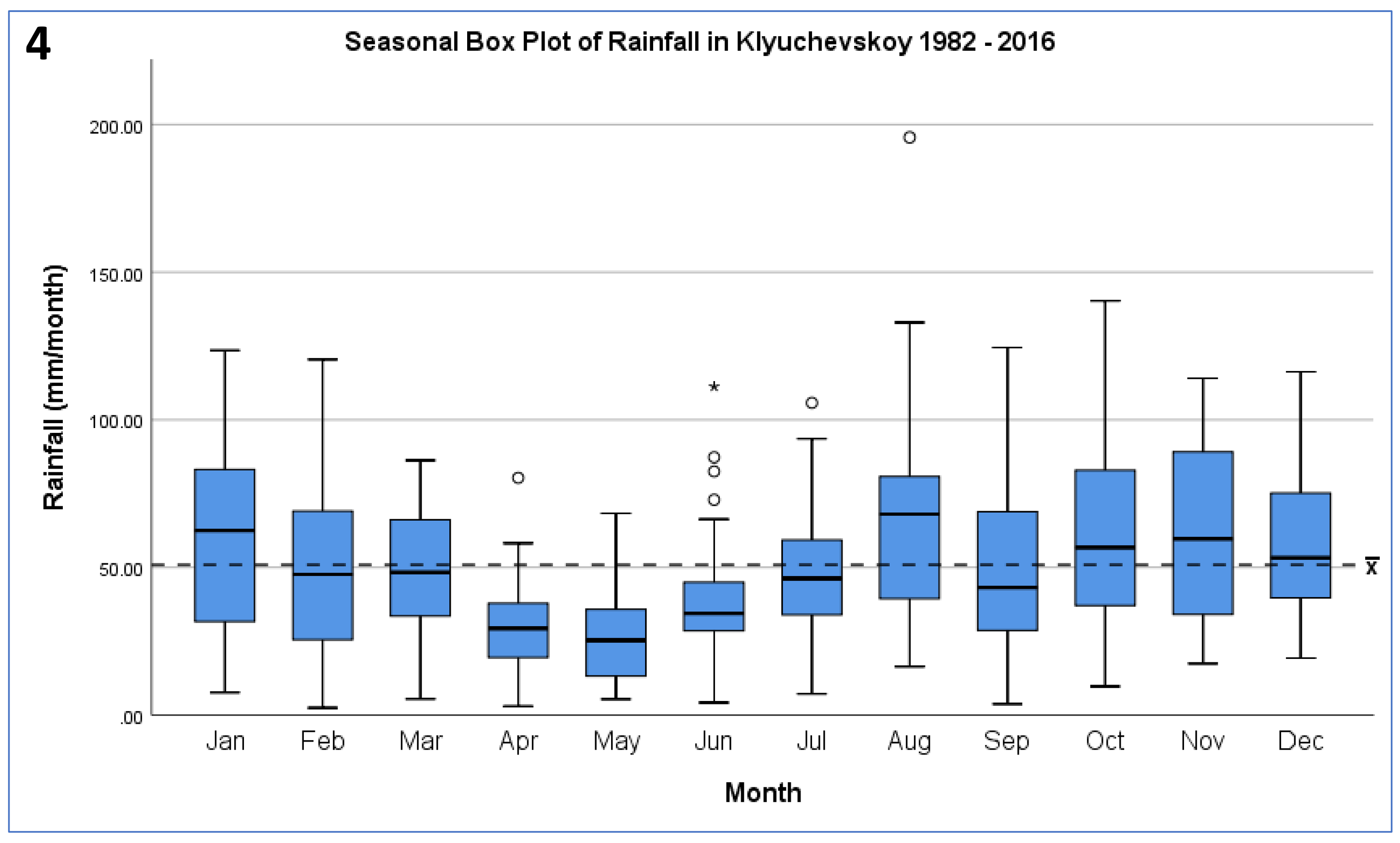


Fig. 4 Box plot of monthly rainfall used to define a wet season and dry season

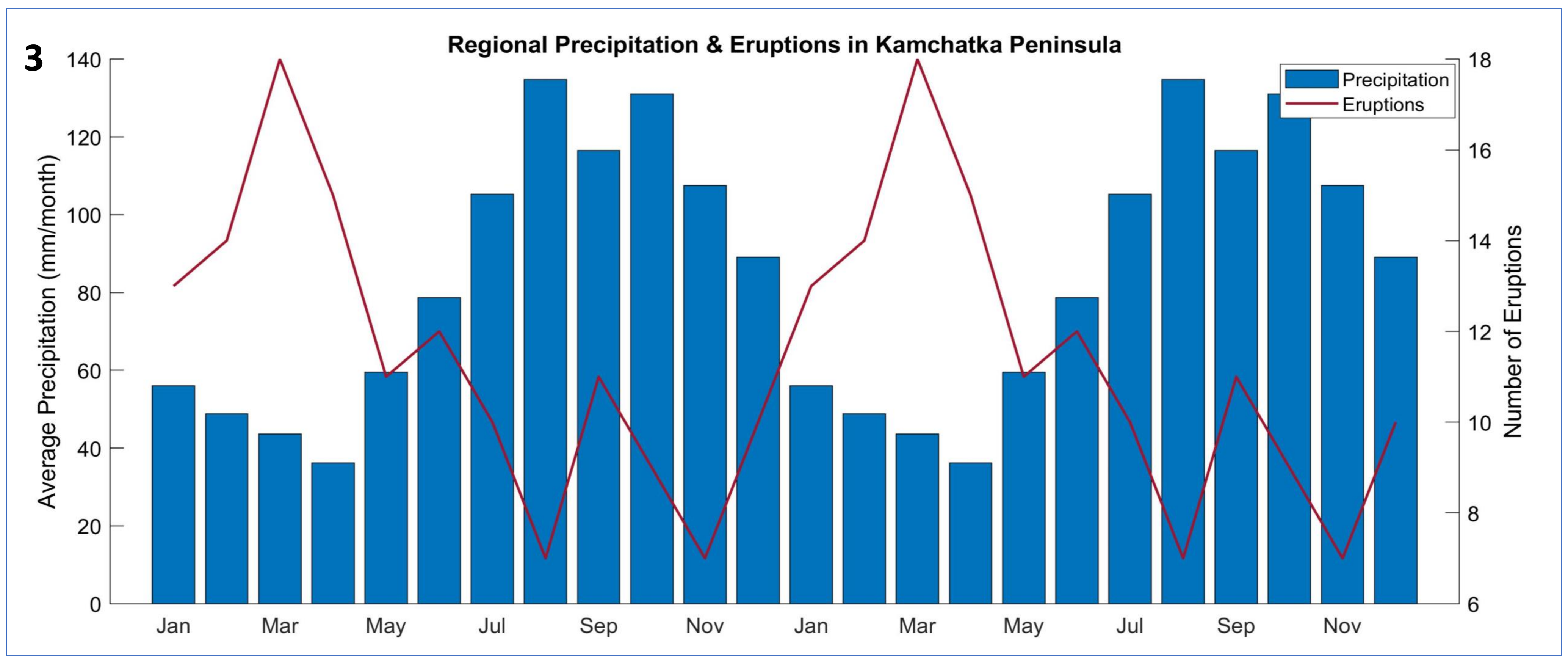


Fig. 3 Regional monthly precipitation and monthly eruptions for Kamchatka Peninsula, x-axis repeated for visual purposes

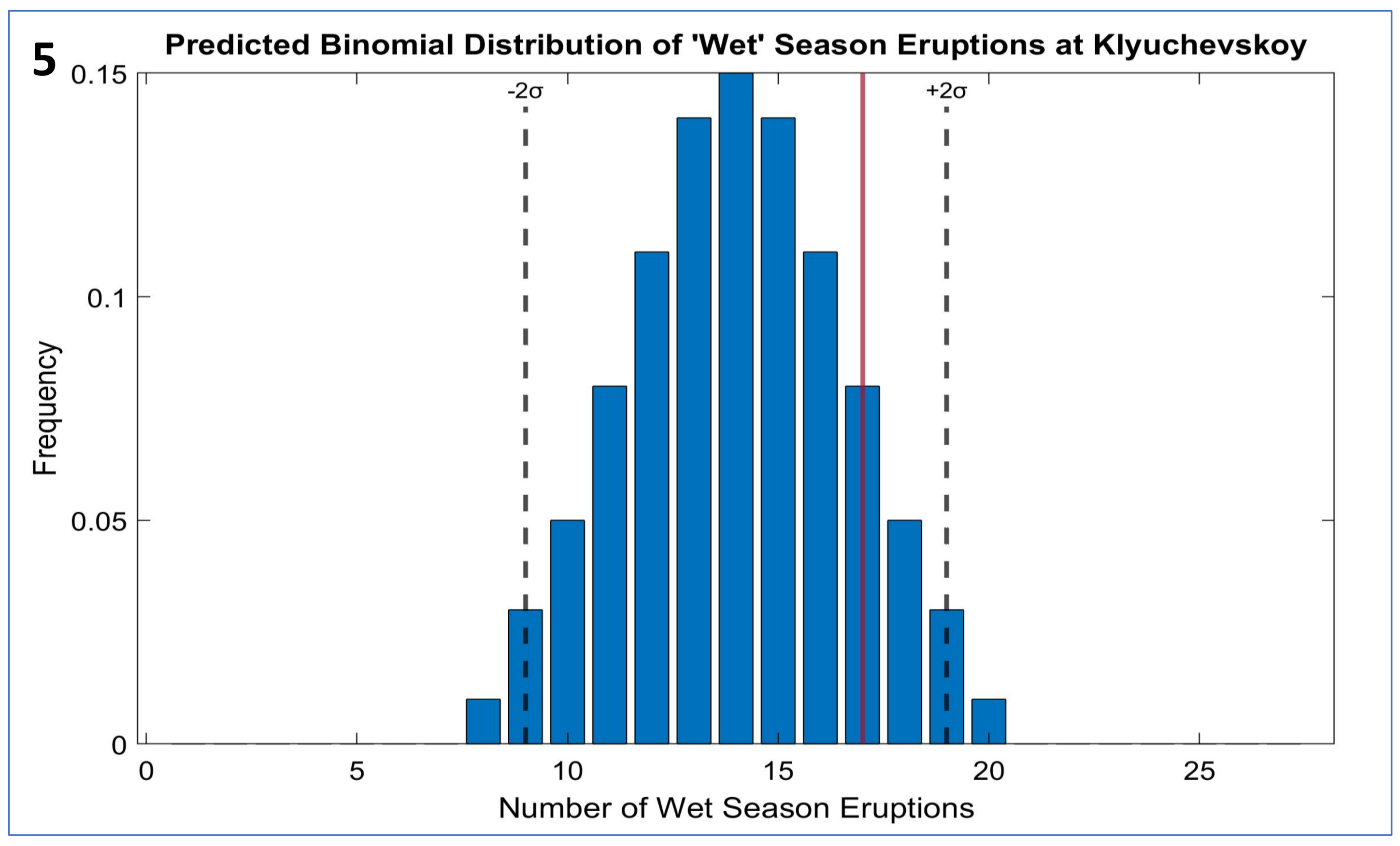


Fig. 5 Binomial probability distribution of the number of wet season eruptions

4. Discussion

- Very high proportion of eruptions to be associated with such a low frequency extreme precipitation event (fig. 2)
- Inverse relationship seems to exist regionally (Fig. 3)
- The wet season to dry season ratio exceeds the 1 sigma range but does not exceed the necessary +2σ range to allow strong statistical inferences to be made (Fig. 5)

5. Future Work

- Implement methods to more accurately and precisely constrain the wet season
- Develop a method to test the significance of the results obtained in figure 2
- Determine the significance of the relationship in figure 3
- Repeat this analyses for a broad range of volcanoes

References

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