The 1991 Mount Pinatubo eruption or why the atmosphere contributes to the excitation of the Hum.

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Overview

- The strip-chart recording which triggered our research
- Seismic signature of the 1991 Pinatubo eruption
- Characterizing the Pinatubo source
- Remaining Pinatubo mystery: phase coherence of radiated seismic energy
- Pinatubo and the evidence for atmospheric Hum excitation



LaCoste-Romberg ET-19 gravimeter - strip chart record of Mount Pinatubo eruption

Mode channel: 5.5cm / μgal



Time axis: 20min / division
Y-axis: 2mm / division

















- The signal between 06:00 and 14:00 on June 15, 1991 was not detected by any seismological agency
- Amplitude: >200ngal
- Spectrum: bi-chromatic: 3.7 & 4.4 mHz
- Not a short, transient source with its distinct Rayleigh wave packets



digital record



Identifying Pinatubo as the source of the low-frequency signal



Spectra of gravimeter records



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Source:

location:

• Philippines (cross correlation analysis)

signal:

Rayleigh waves (polarization of particle motion, group velocity)
 spectrum:

• Predominantly bi-chromatic: 3.7 and 4.4 mHz

Phasor walk: BFO @ 3.723 mHz



Phasor walk: ALE @ 4.44 mHz





Phasor walk:

we observe:

at 3.7 and 4.4 mHz the Pinatubo signal is phase coherent for 8 hrs.
 we infer:

- The source must have radiated **in phase** for the entire time of the eruption.
- This is at odds with the view that the eruption is a random sequence of explosions.

we speculate:

- a feed-back mechanism between the erupting volcano and the oscillating atmosphere must have existed to modulate the eruption process.
- We lack near-field data to test this hypothesis.

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Pinatubo and the evidence for atmospheric Hum excitation

Vertical hum spectrum: amplification at 3.7mHz



Hum spectra: amplification at 3.7 mHz



Normal modes of an Earth with an atmosphere



Vertical displacement eigenfunctions of coupled modes



(Lognonné et al, 1998)

12.09.14

Summary

- In the aftermath of the eruption of Mount Pinatubo the resonant coupling of the atmosphere and the solid Earth near 3.7mHz and 4.4 mHz was observed for the first time.
- 2. These two frequencies correspond to acoustic modes of the atmosphere: 3.7mHz is a fundamental mode while 4.4mHz is the first overtone.
- The fact that the vertical Hum is amplified at 3.7 and 4.4 mHz by ~20% is interpreted as evidence for atmospheric Hum excitation.
- 4. The gravity signal observed after the Pinatubo eruption was more than 200 times larger than the vertical Hum.

References

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Acknowledgements

Station and network operators for the high-quality data:

Networks: IRIS/IDA, IRIS/USGS, GEOSCOPE

Funding:

German Science Foundation (DFG)



