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Statistical relation of Pc1 pulsations at low latitude to Earthquake occurrence

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Goal:

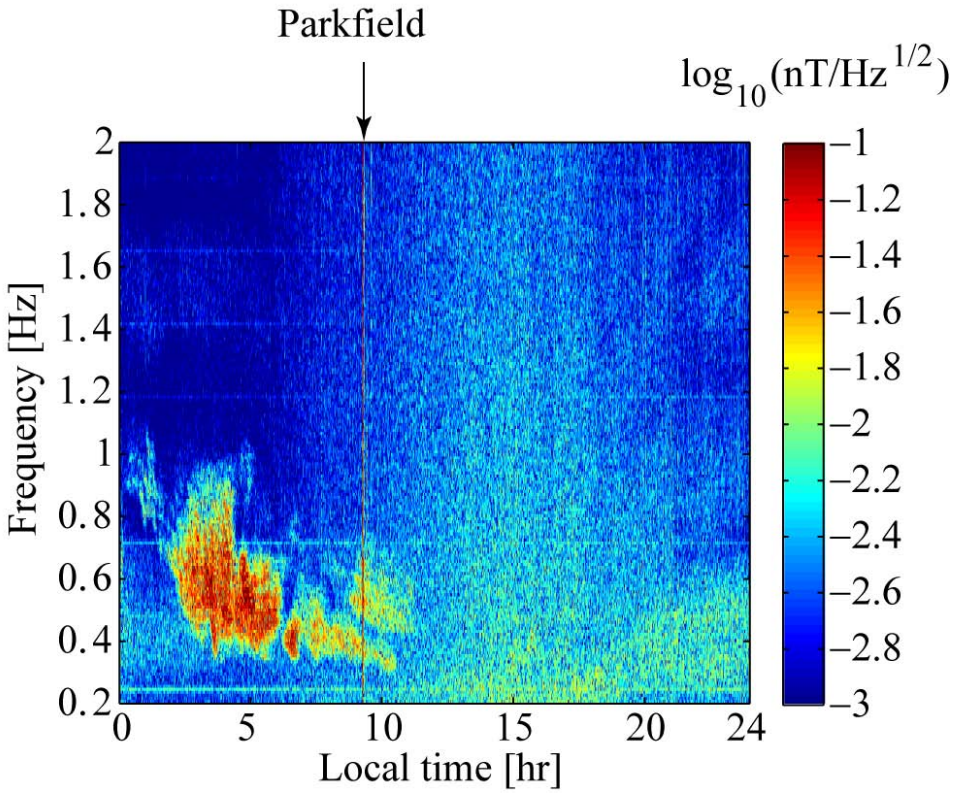
Test whether ANY Pc1 characteristics change in relation to earthquake occurrence

Outline:

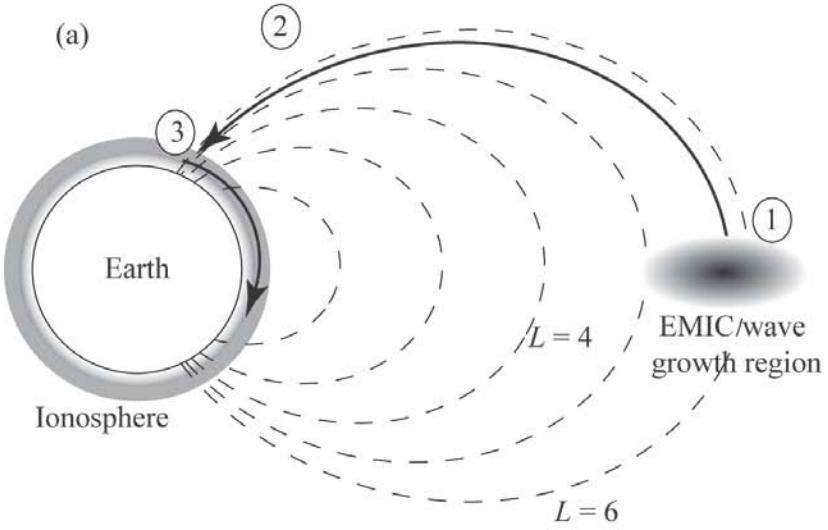
1. Examine specific event, Parkfield CA. (Sept. 28th, 2004)
2. Compare characteristics to long-term distribution
3. Superposed epoch analysis (1999-2006)

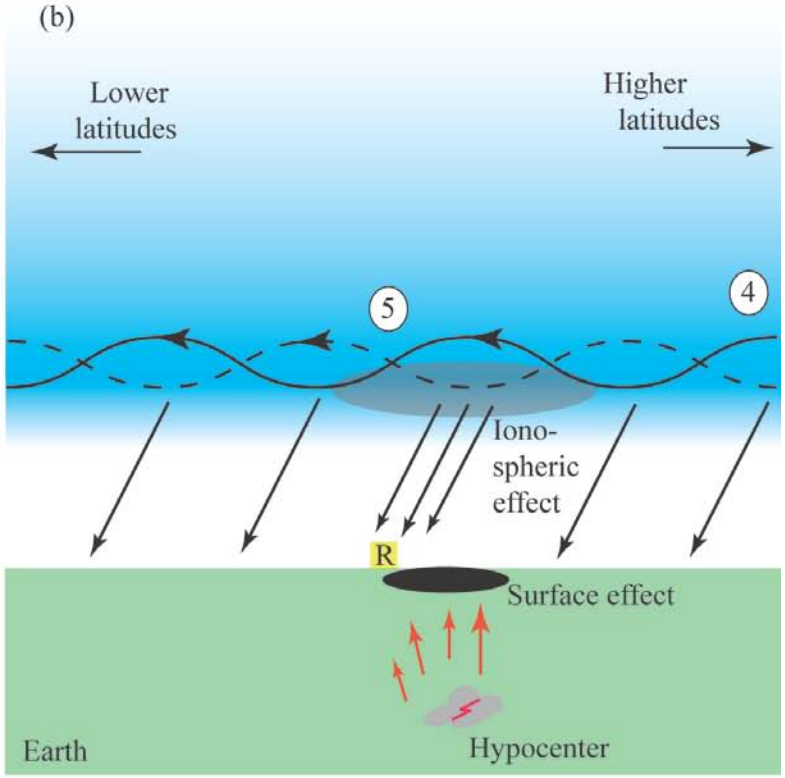
1.1 Introduction: Pc1 pulsations

- Electro-Magnetic ion cyclotron (EMIC) waves in space
- $f \sim$ 0.2-5 Hz (Pc1)
- Generated in association with geomagnetic activity
- Usually propagate from high to low latitudes



1.2 Introduction: hypothesis



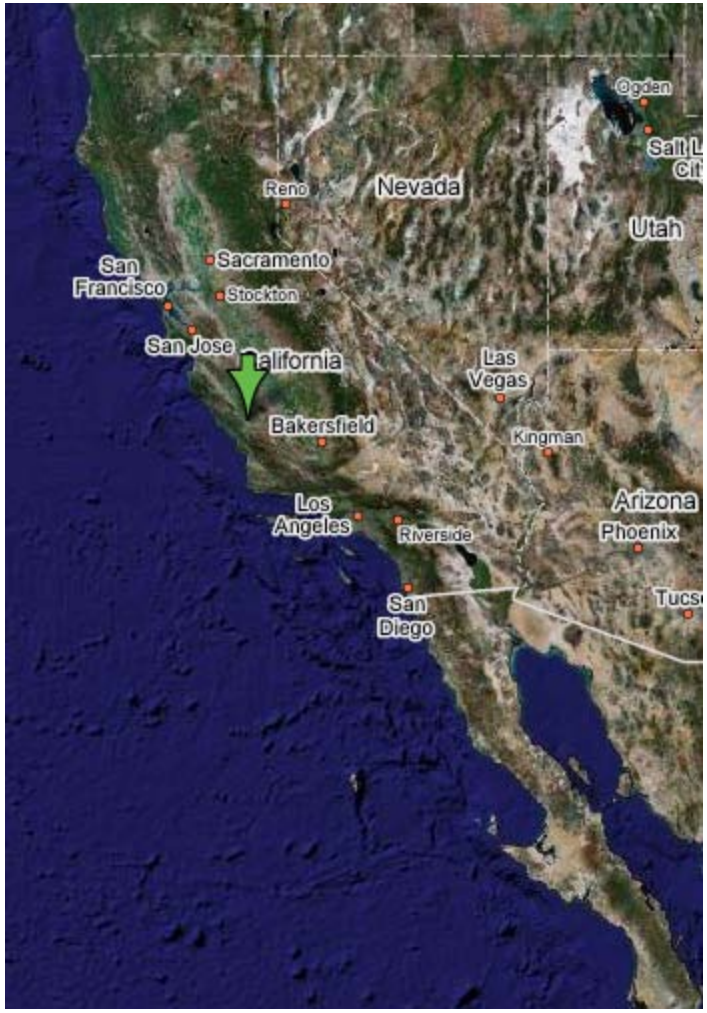


a. Generation, propagation, entry into ionosphere

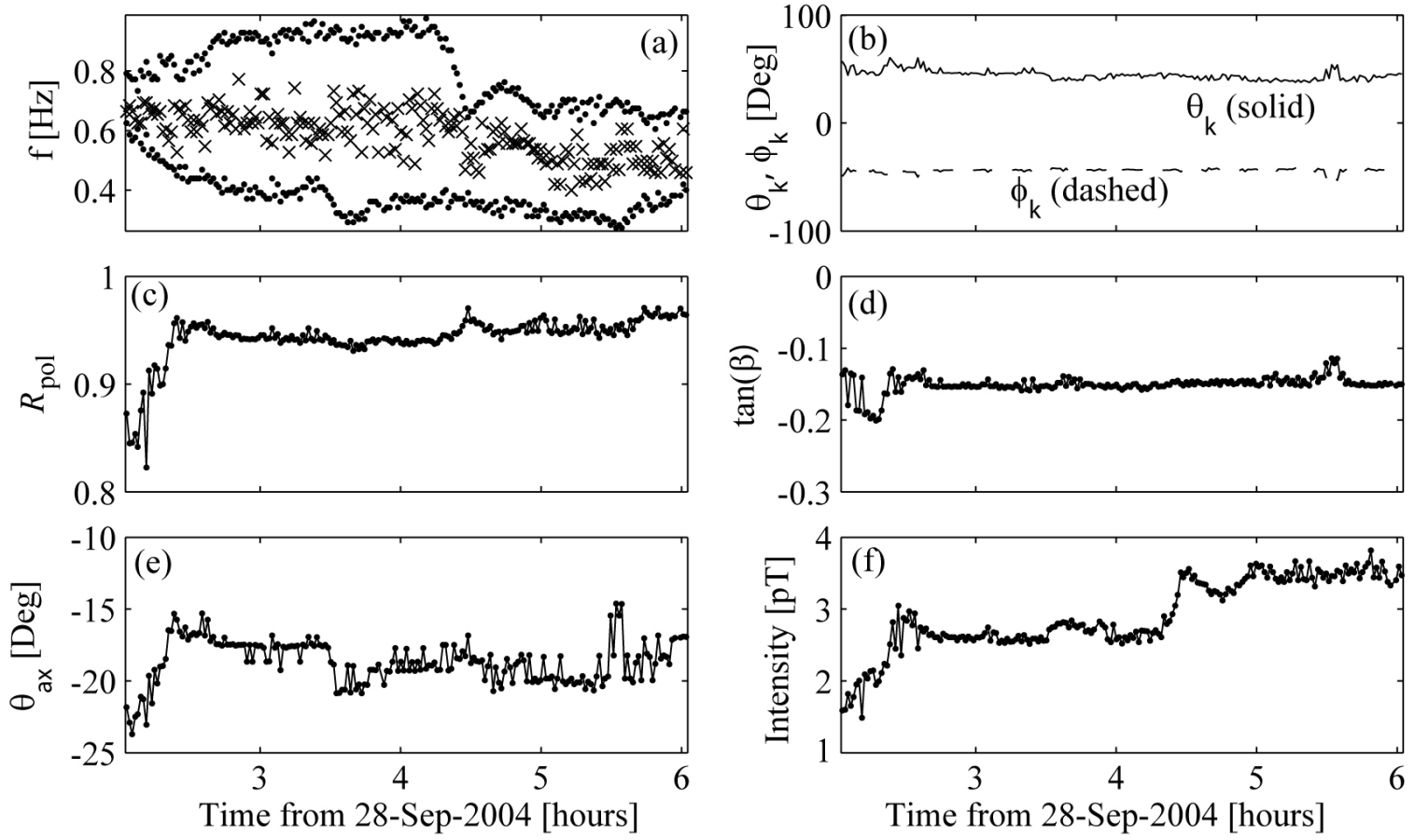
b. Ionospheric 'ducting' in F-region, altered bottomside transmission coefficient may lead to different Pc1 characteristics (EQ-associated ionospheric changes)

1.3 Introduction: magnetometer data

- Triaxial search-coil magnetometer data
  - Berkeley Digital Sesimic Network (BDSN), PKD
  - Sampling 40 Hz
- Parkfield, California
  - Geo: (35.945 , -120.542)
  - CGM: (41.61 , -56.8)
  - Dip=60.2 , Declin.=14.7
  - *L*: 1.77
- ~8 years: 1999-2006

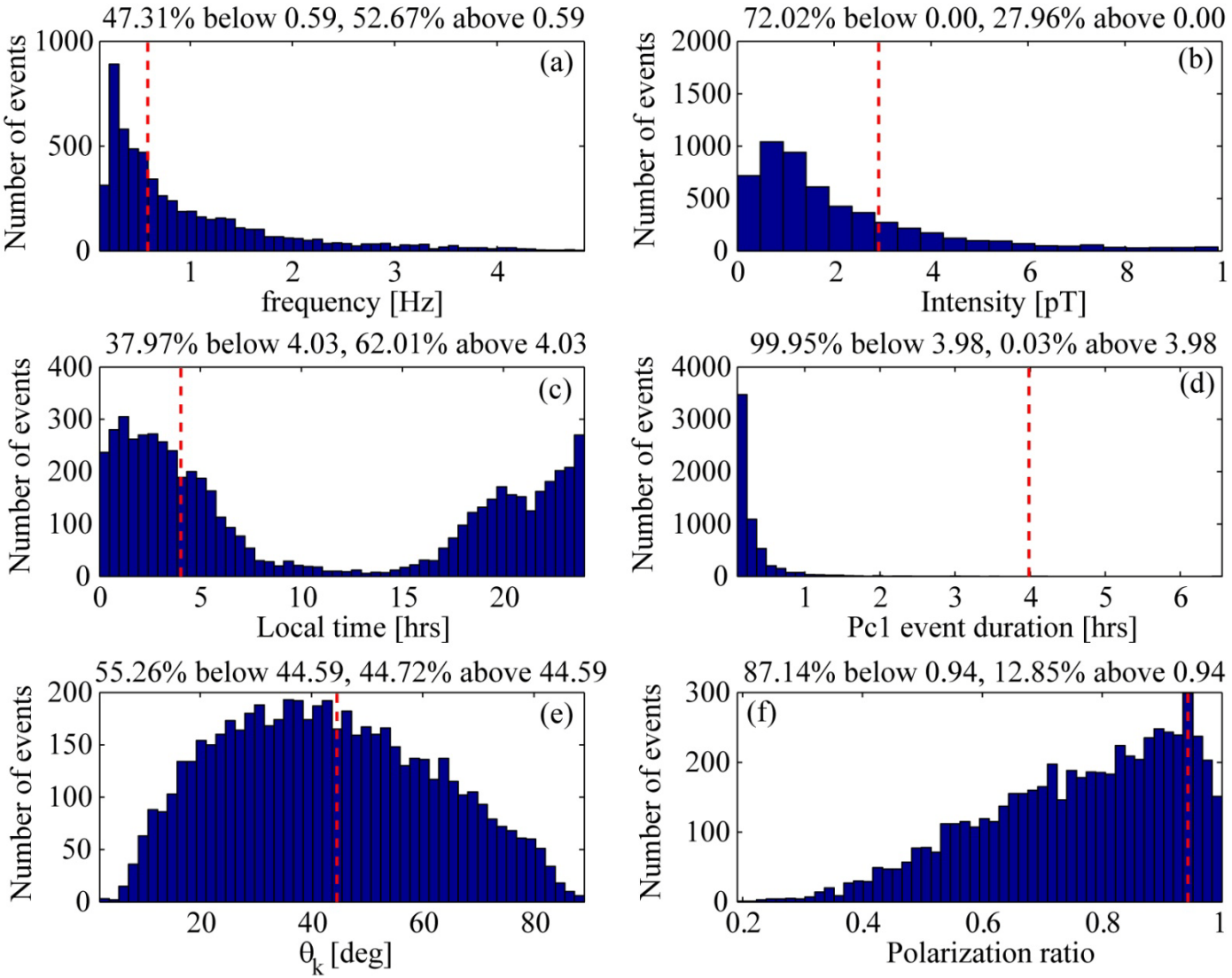


2.1 Parkfield event study (9/28/2004 M6.0)



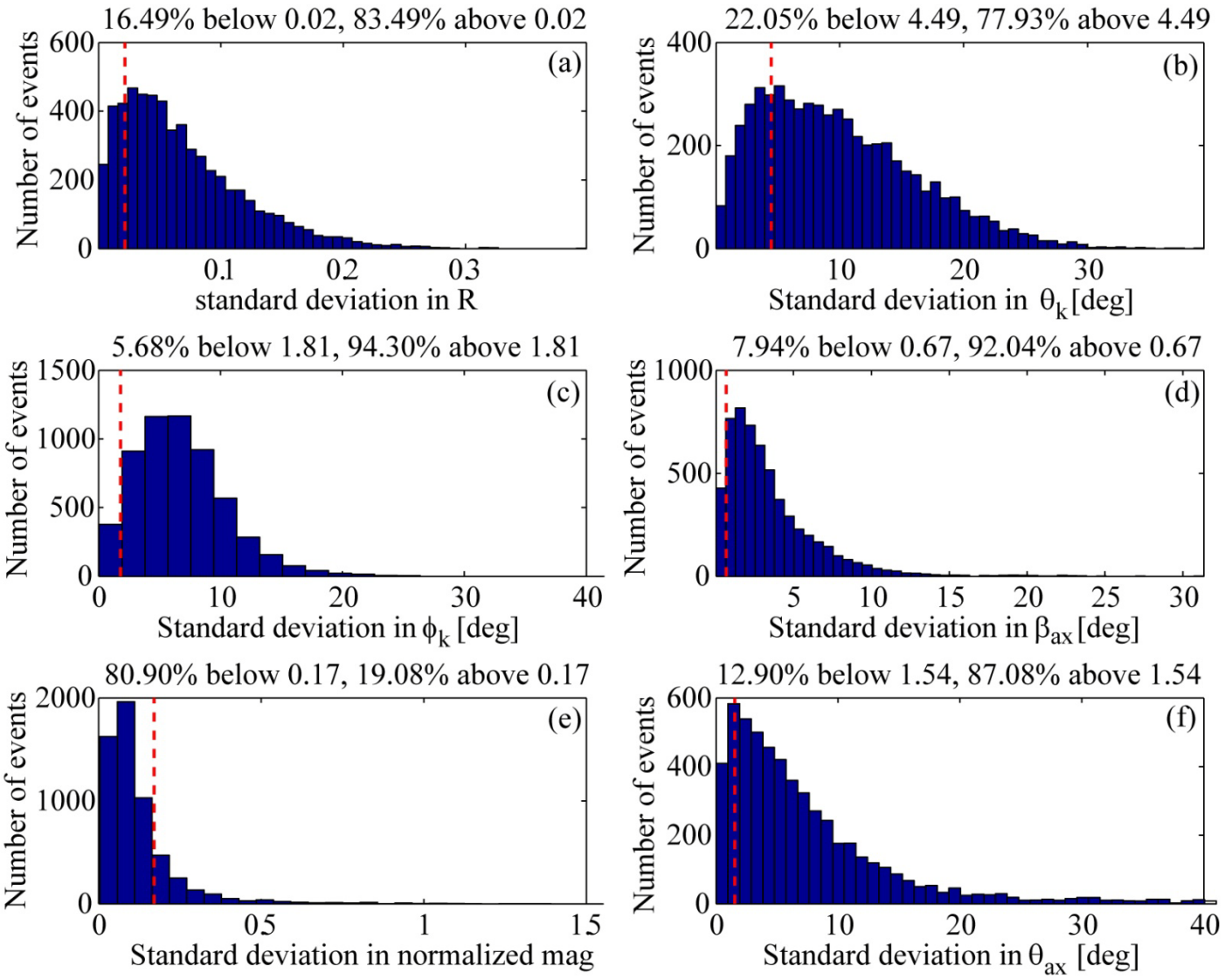
Analyze Pc1 event: (a) f-t, (b) wave normal, (c) polarization, (d) ellipticity, (e) axis orientation, (f) intensity

2.2 Comparison to statistical distribution



- Typical (mostly), very high duration.

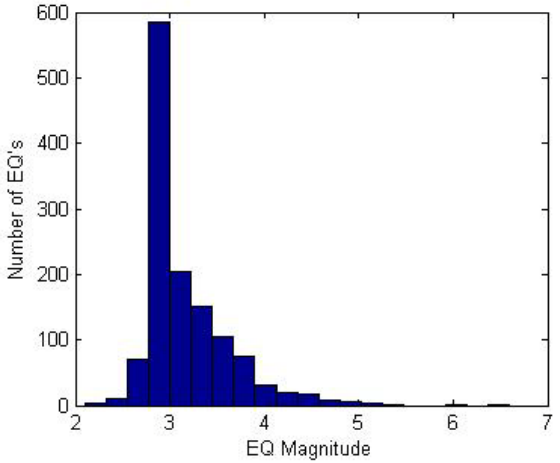
2.3 “Steadyness”Comparison

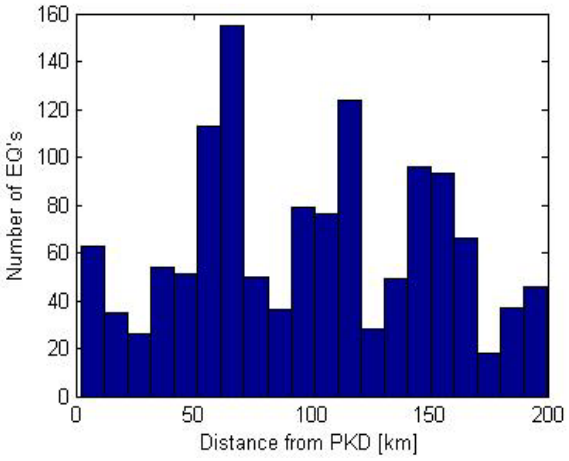


- Very steady in most parameters (not magnitude)

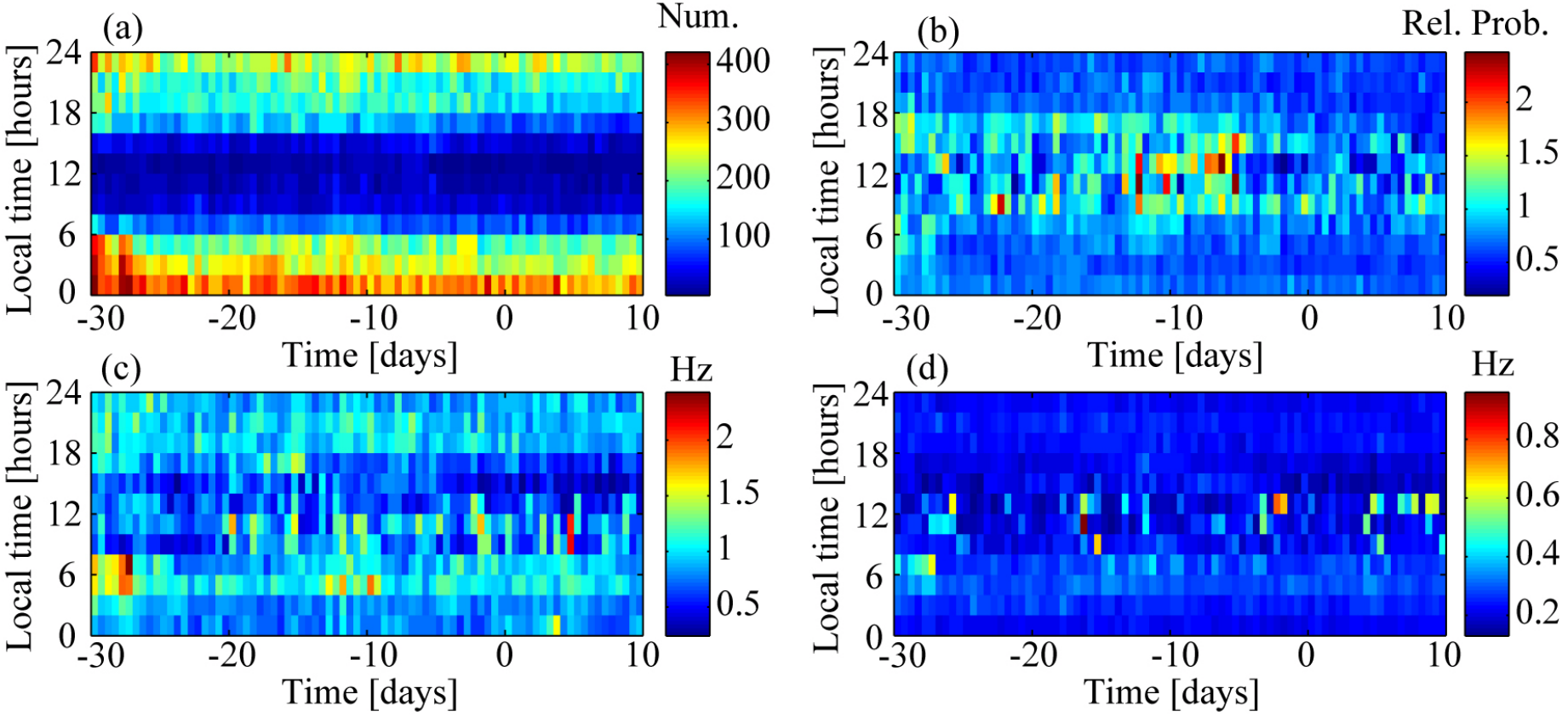
3.1 Superposed Epoch Analysis

- -30 to +10 days around nearby EQ's
- Function of time-to-EQ and local time
- Examine all Pc 1 characteristics, (vertical channel excluded)
- NEIC Earthquake catalog:
  - 1295 EQ's, Mag: 2-9
  - < 200 km from PKD
  - Depth < 50 km
- Pc 1 identification
  - 8913 individual Pc1 events
  - Nighthside, f~ 1 Hz





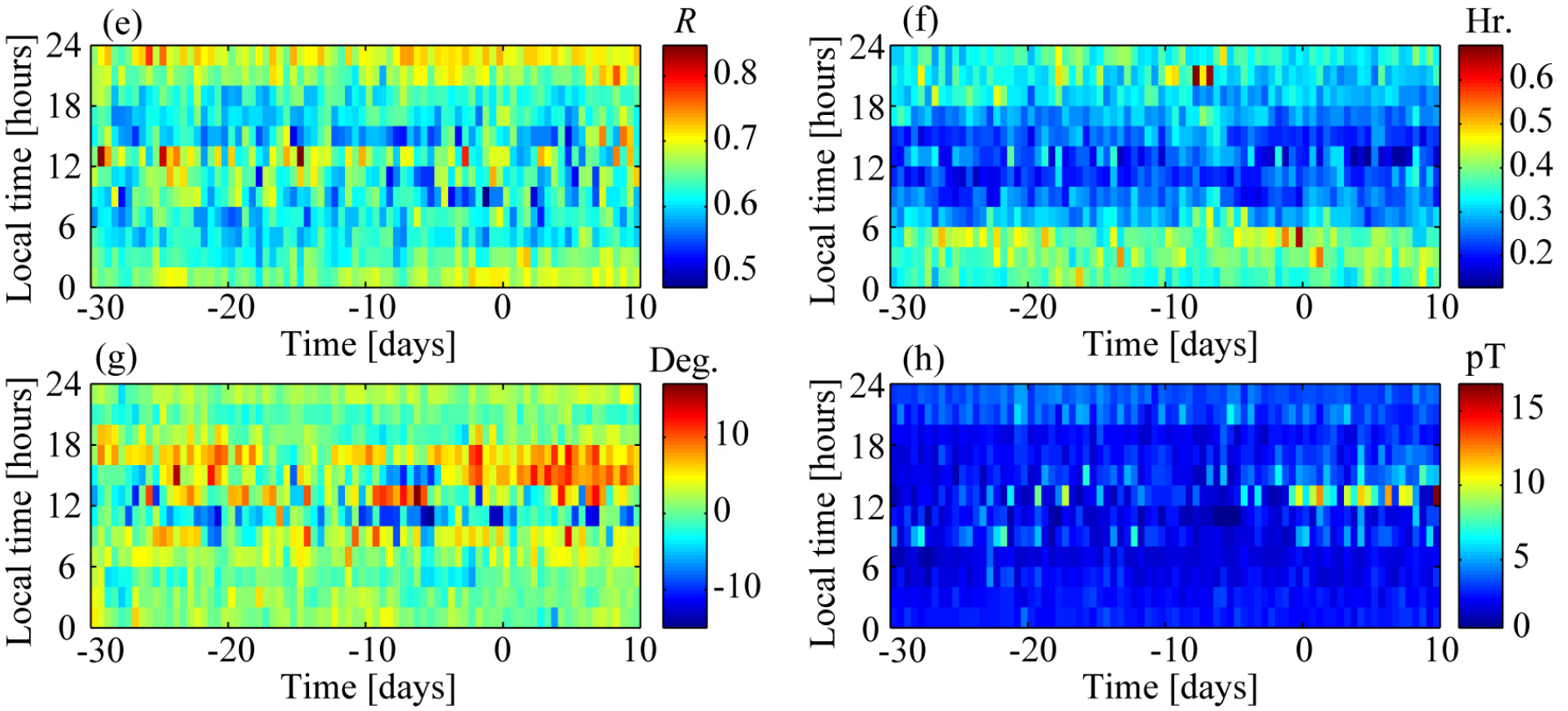
3.2 Superposed epoch results (1)



(a) number, (b) relative prob., (c) frequency, (d) bandwidth

Possible increased likelihood of detection 5-10 days prior to Earthquake

3.3 Superposed epoch results (2)



(e) Polarization ratio, (f) duration, (g) axis orientation, (d) wave intensity

No obvious change in wave other parameters

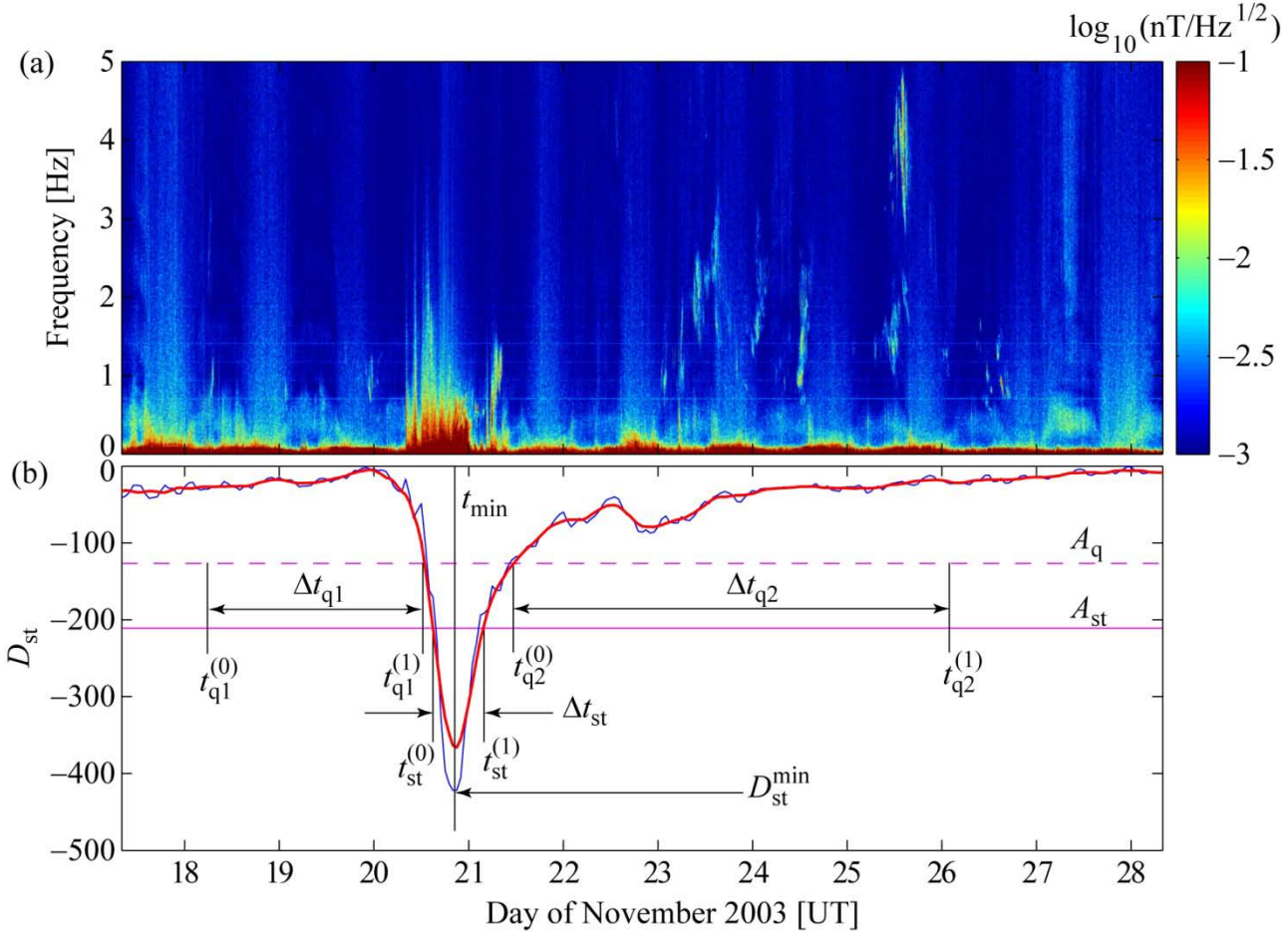
4.1 Summary (1)

- Hypothesis:
  - EQ induced ionospheric changes, modify transmission characteristics of Pc1 pulsations
- Use ~8 years of magnetometer data from Parkfield CA. for statistical analysis
- Event analysis: Parkfield EQ. (9/28/2004 M6)
  - Pulsation mostly typical, unusually long duration
  - Pulsation is very “steady” in most parameters

4.2 Summary (2)

- Superposed epoch analysis:
  - 1295 EQ's of small-moderate size, 8193 Pc1 pulsations
  - Normal behavior in all wave characteristics
  - Possible increased likelihood of Pc1 detection, 5-10 days prior to the main shock.
  - Need to test significance, other locations, and time periods.

Backup (1)



Relation of Pc1 pulsations to storms

Backup (2)

Superposed epoch analysis of Pc1 occurrence and storms.