Statistical analysis of EMIC wave properties in the inner magnetosphere

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Global distributions of Pc1-2 waves derived from AMPTE/CCE data

- **The AMPTE/CCE spacecraft:**
  - in a *low* inclination orbit,
  - with the *apogee of 8.8 RE* and the perigee of 1000 km,
  - 15.6 hr orbital period,
  - samples B field every 0.124s (sampling rate *~8Hz*),
  - from day 239, 1984 through day 009, 1989

- **Previous studies:**
  - Anderson et al. [1992]
    - from day 239, 1984 through day 326, 1985
  - Others...

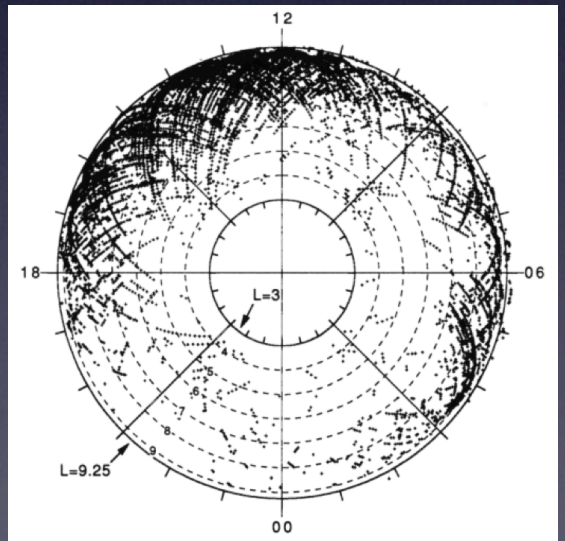
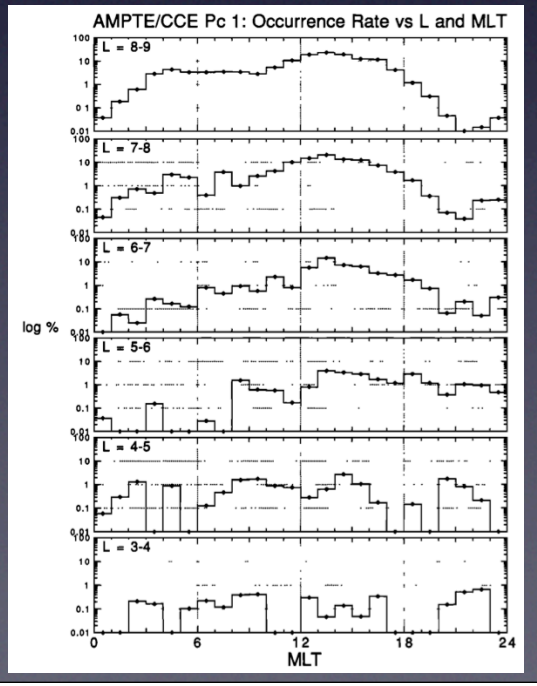
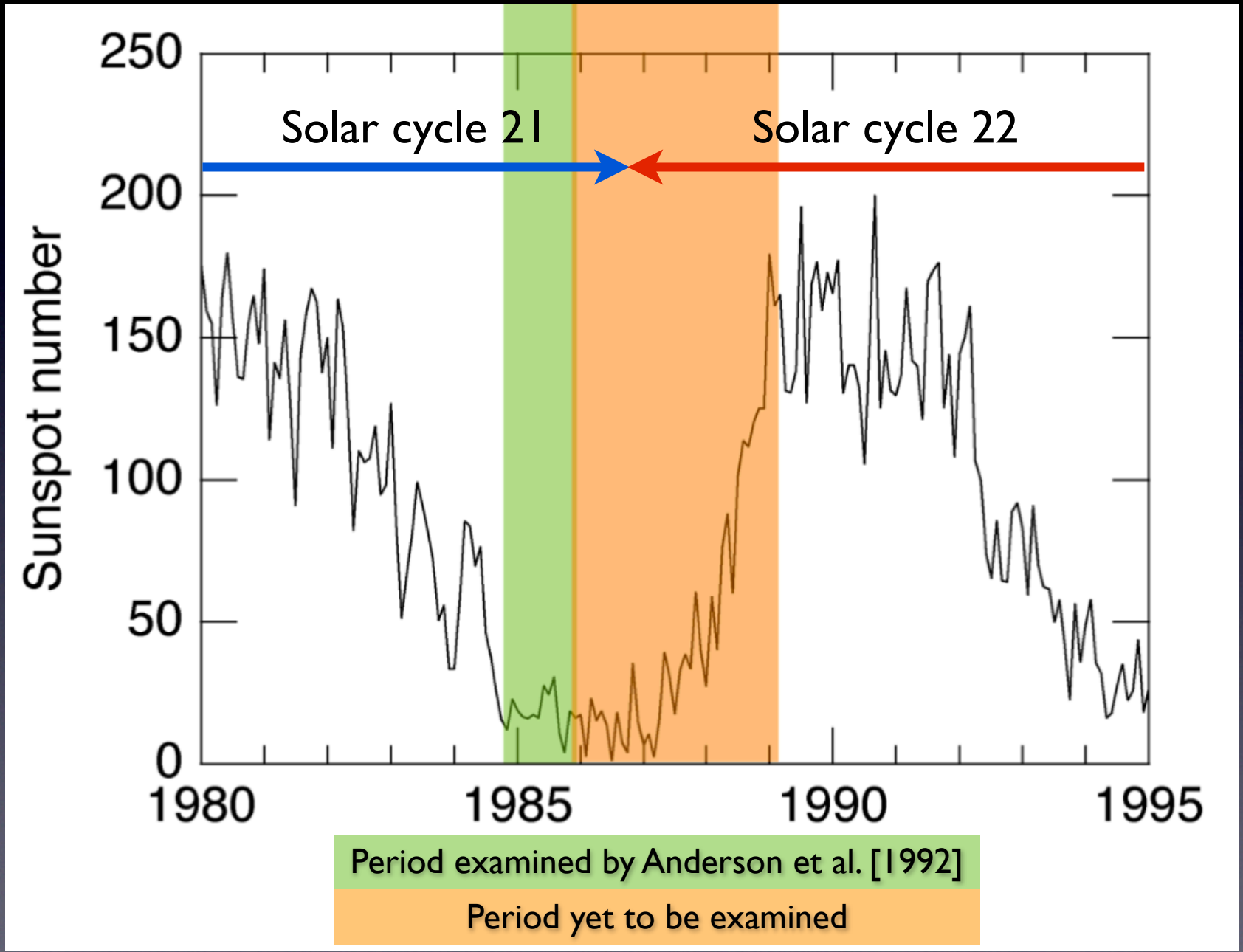


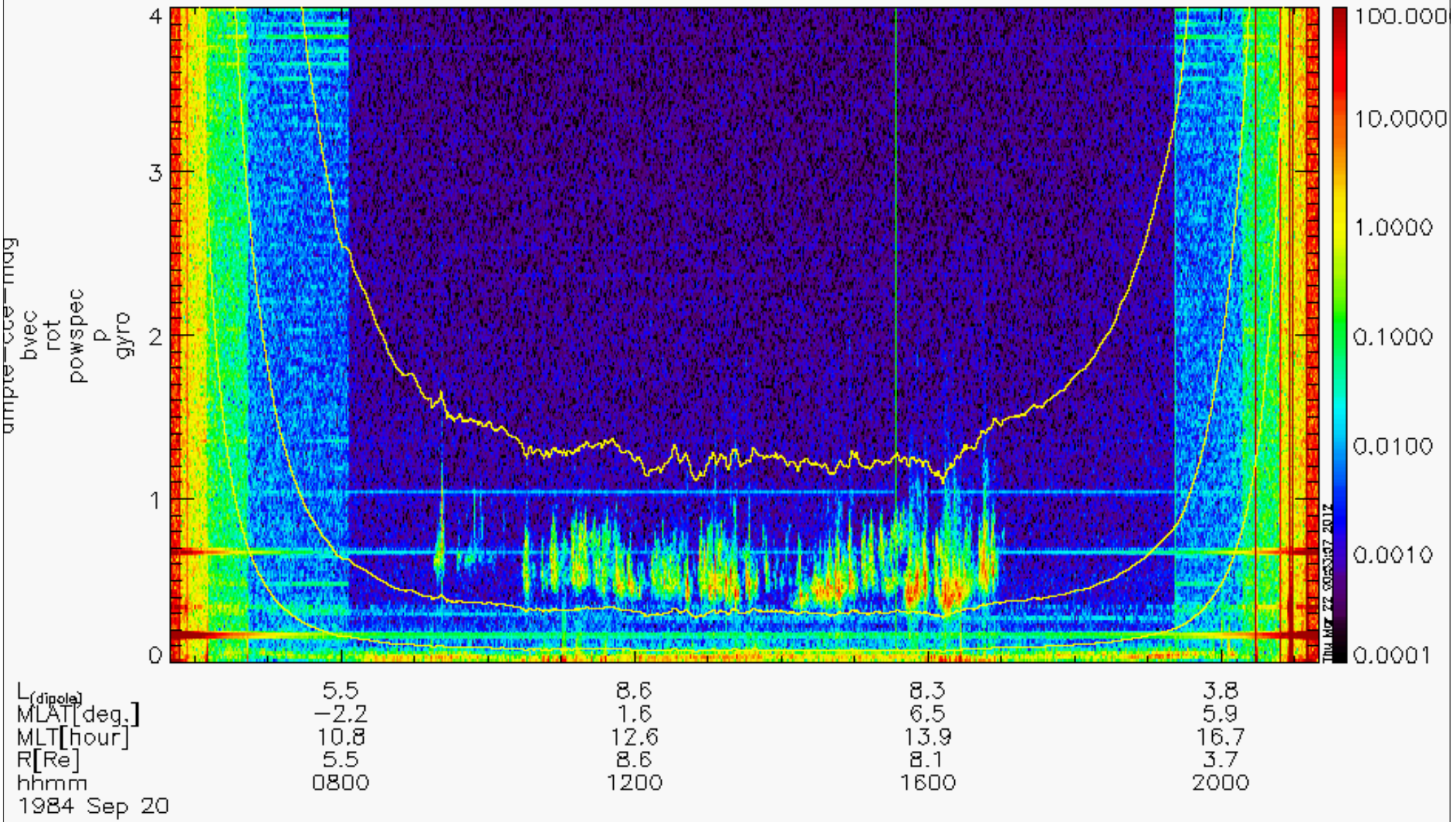
Fig. 8. Scatterplot in polar MLT/*L* coordinates of Pc 1–2 occurrences in 5-min time segments during the period 1984 day 239 through 1985 day 326.



AMPTE/CCE coverage:
Around the solar minimum & the rising phase



Example: Sep. 20, 1984

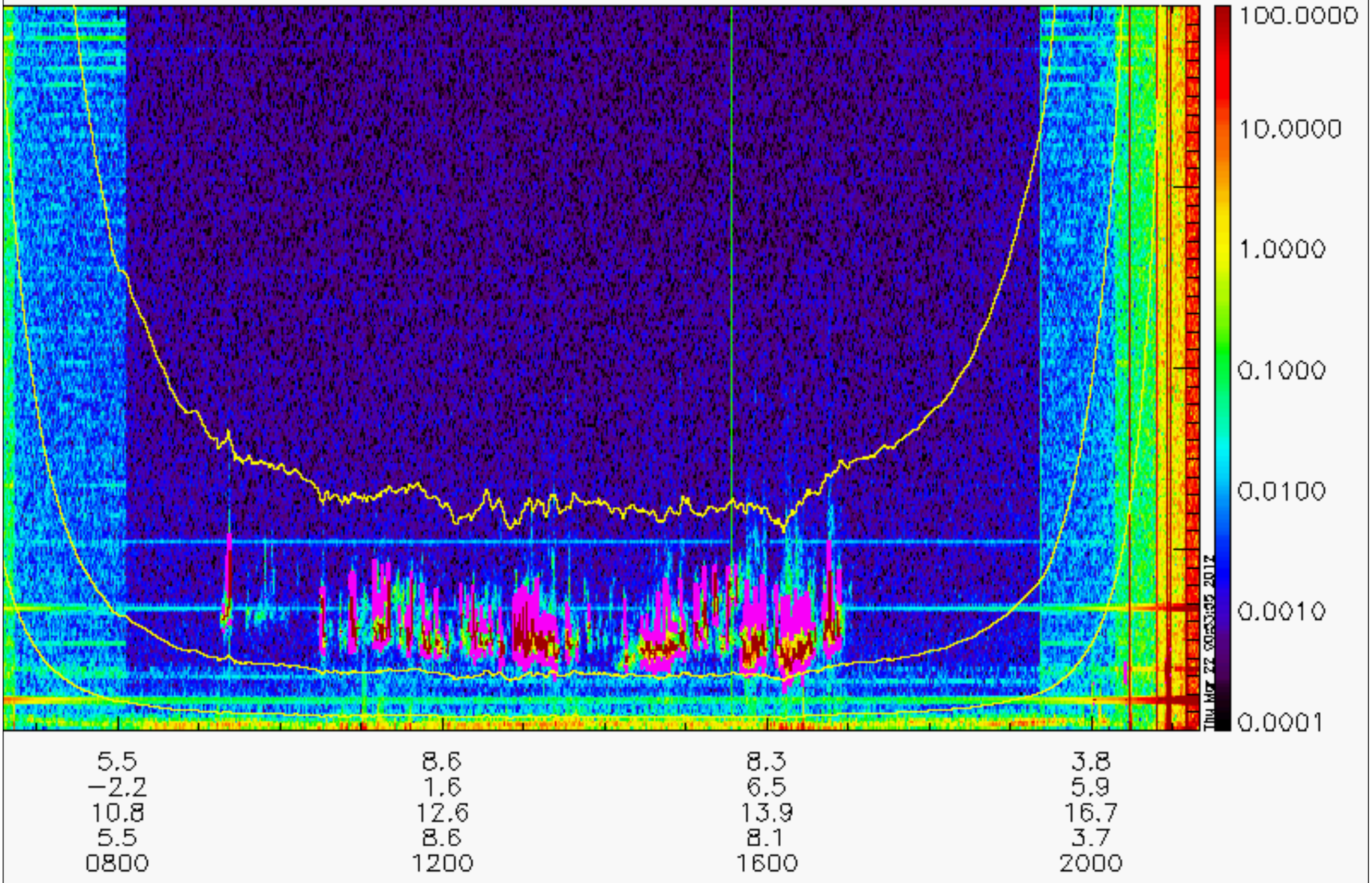


Automatic detection of Pc1-2 waves

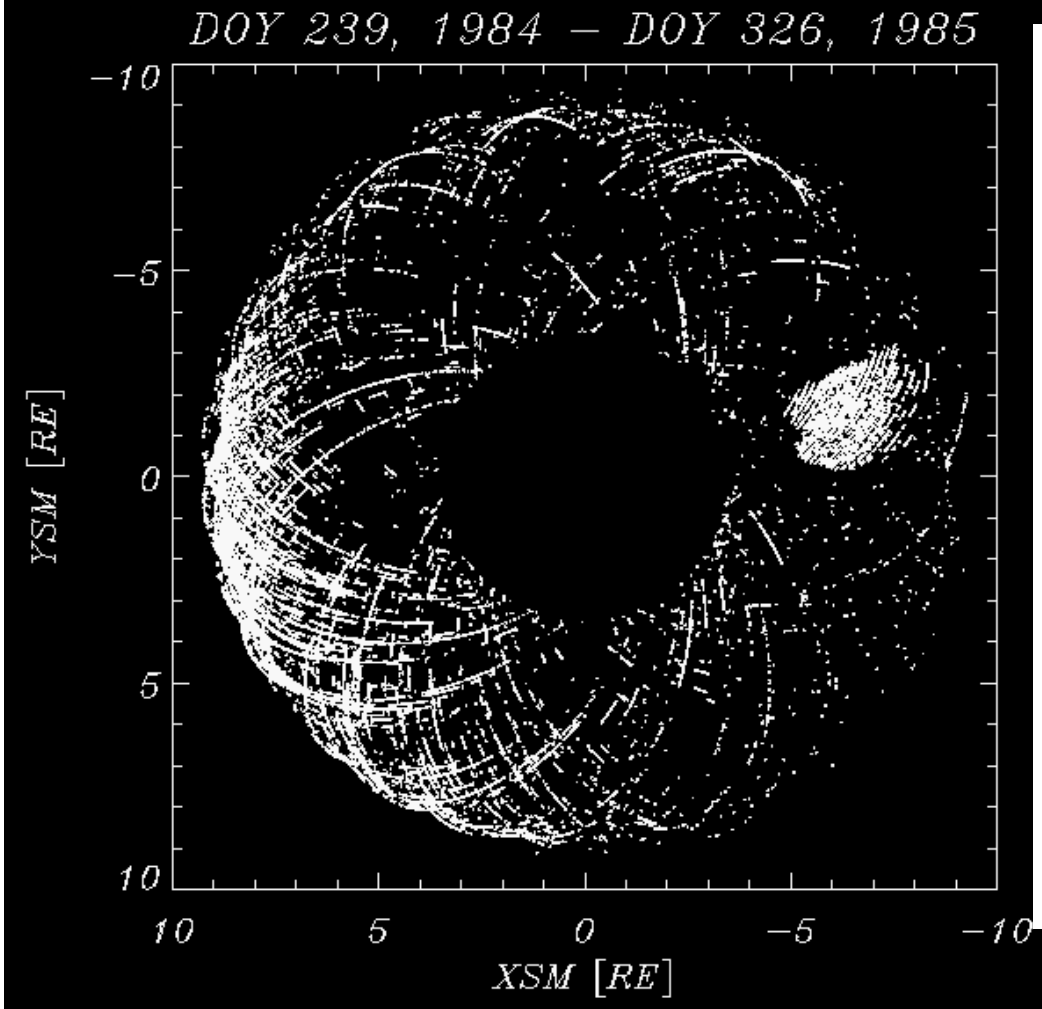
- We used the magnetic field coordinates determined from a 37.4 s sliding average.
- We calculated the Fourier transform with a time window of 64 s shifted by 50% at each step of the spectral calculation.

1. The maximum power, P_{max}, is greater than 0.1 nT^2/Hz,
2. P_{max} exceeds the minimum at lower frequencies by more than a factor of 5,
3. P_{max} exceeds the minimum at higher frequencies by more than a factor of 20, and
4. The spectral width exceeds 0.1 Hz. The width is bounded by the upper and lower frequencies where the wave power falls off <0.05 nT^2/Hz.

Example: Sep. 20, 1984



Spatial distributions



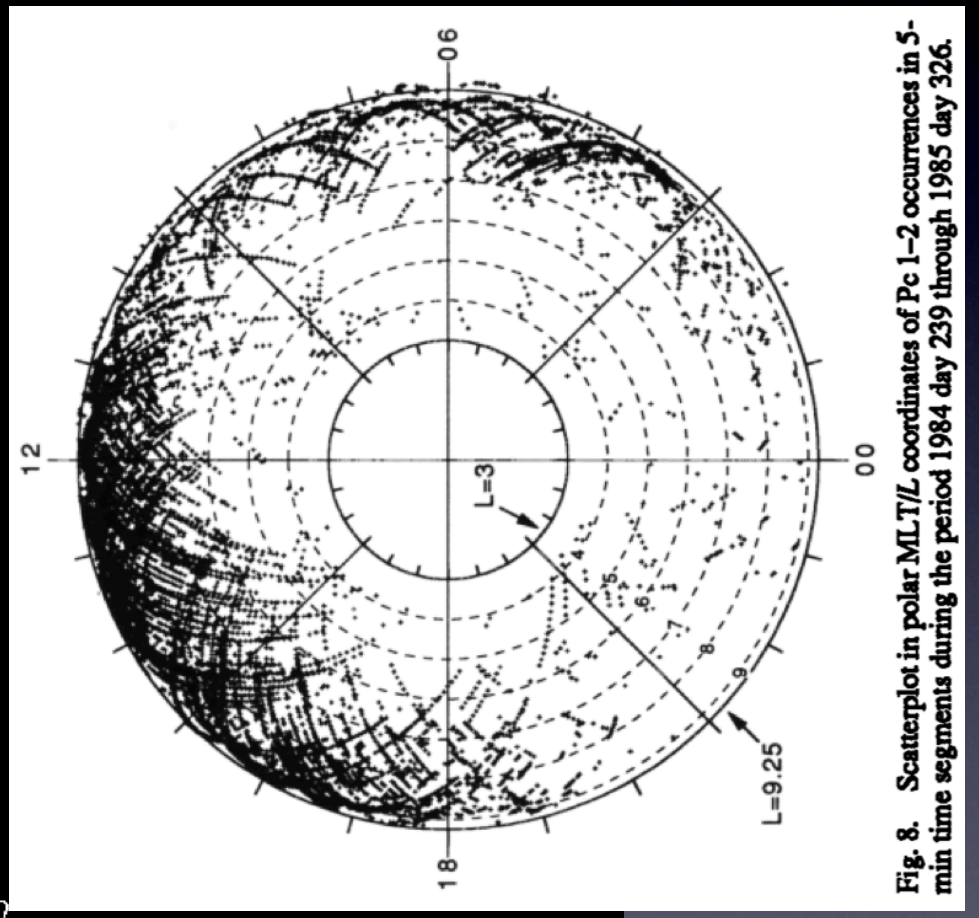
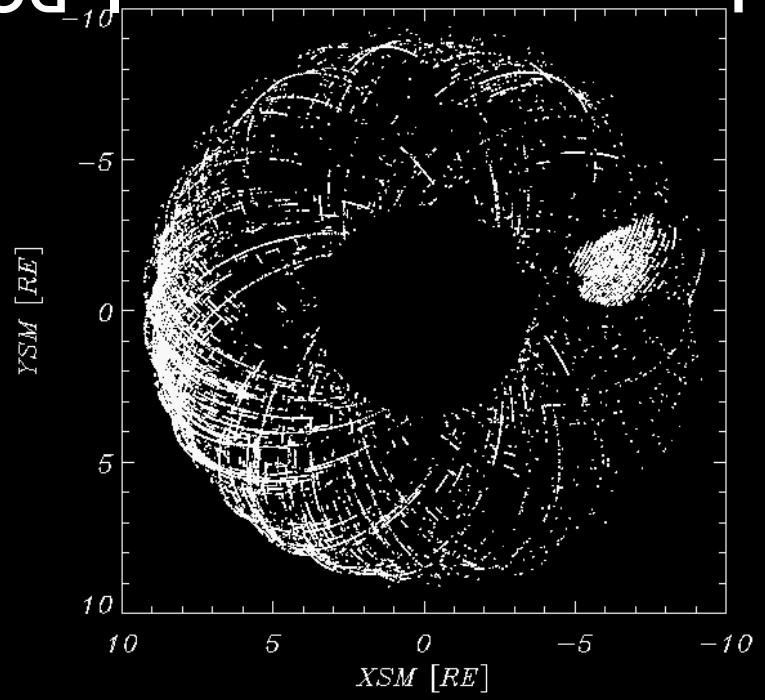
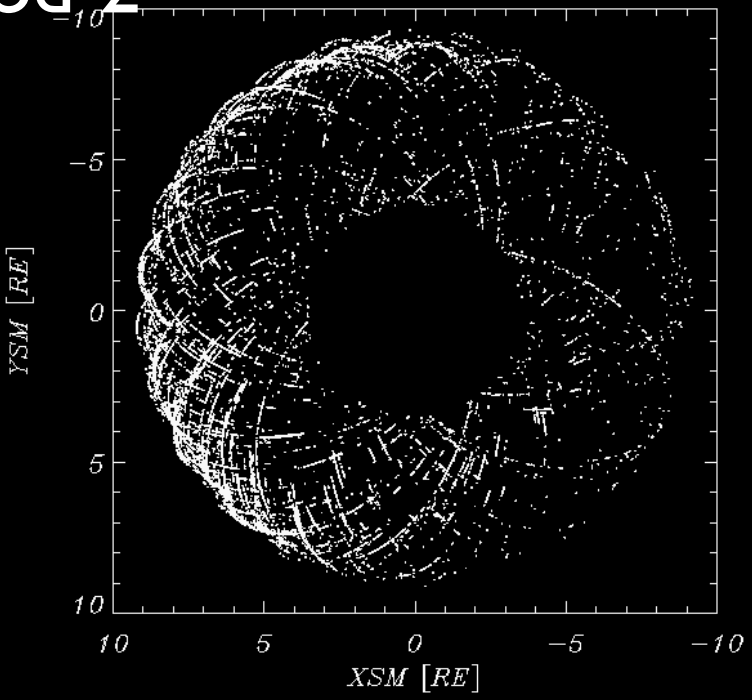


Fig. 8. Scatterplot in polar MLT/*L* coordinates of Pc 1–2 occurrences in 5-min time segments during the period 1984 day 239 through 1985 day 326.

Period 1

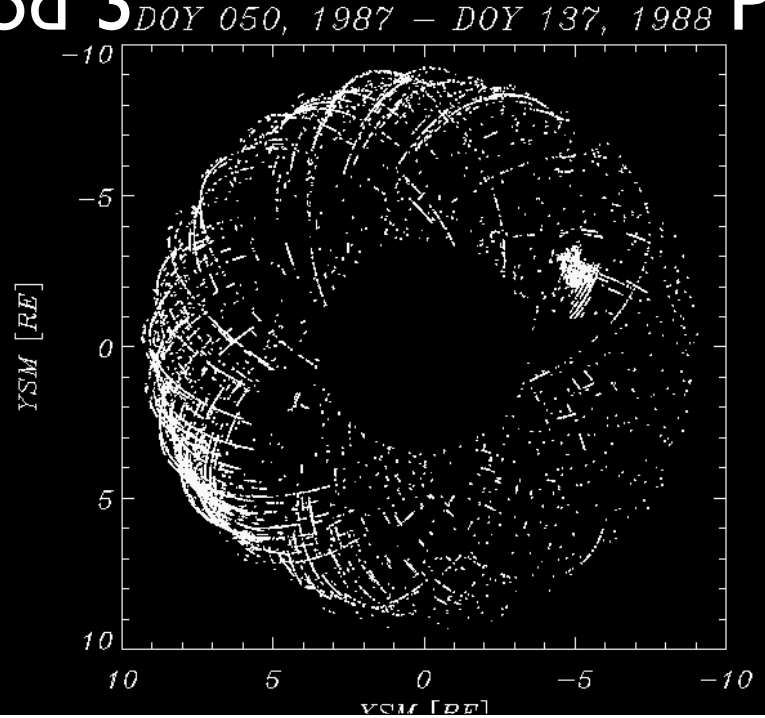


Period 2

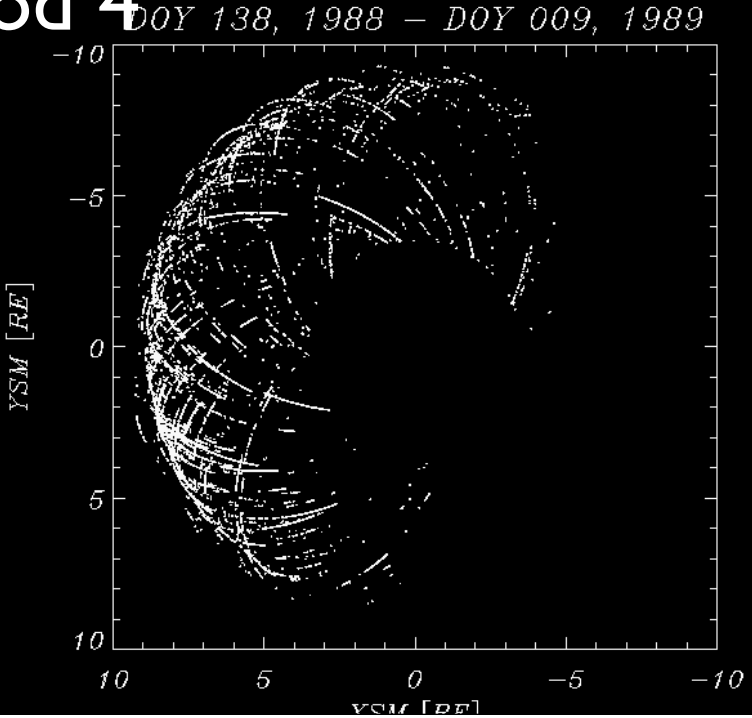


452 days

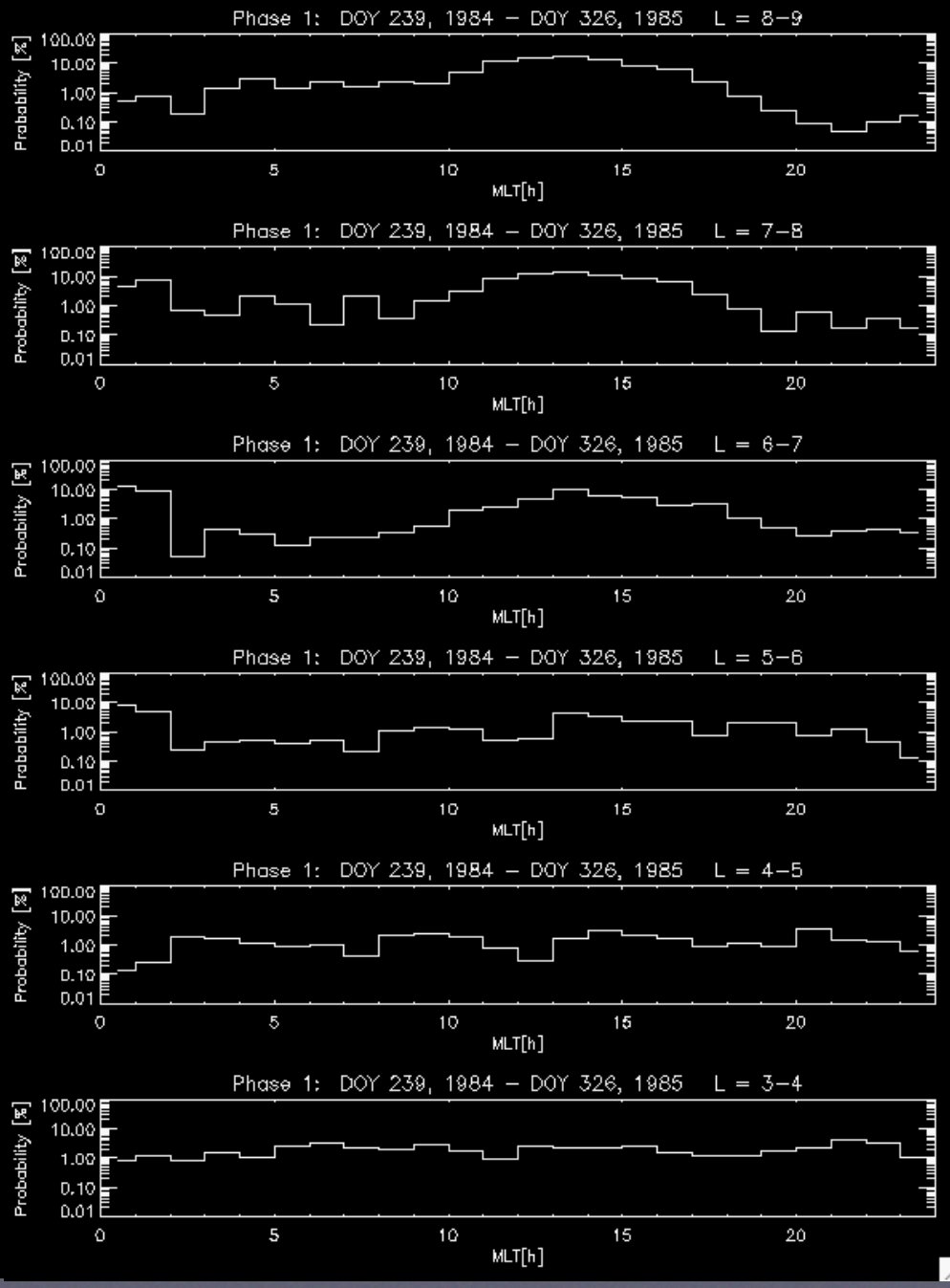
Period 3

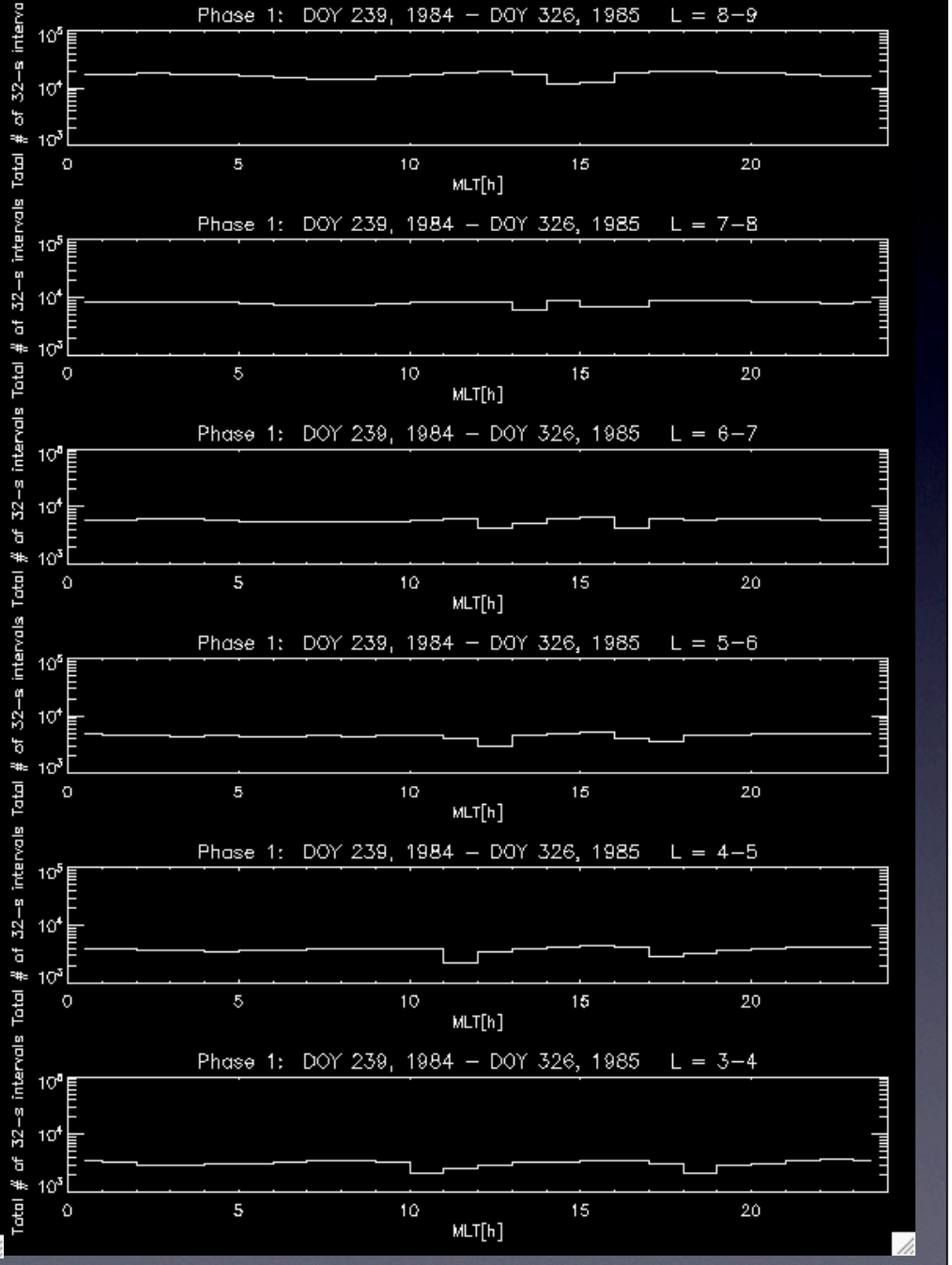


Period 4

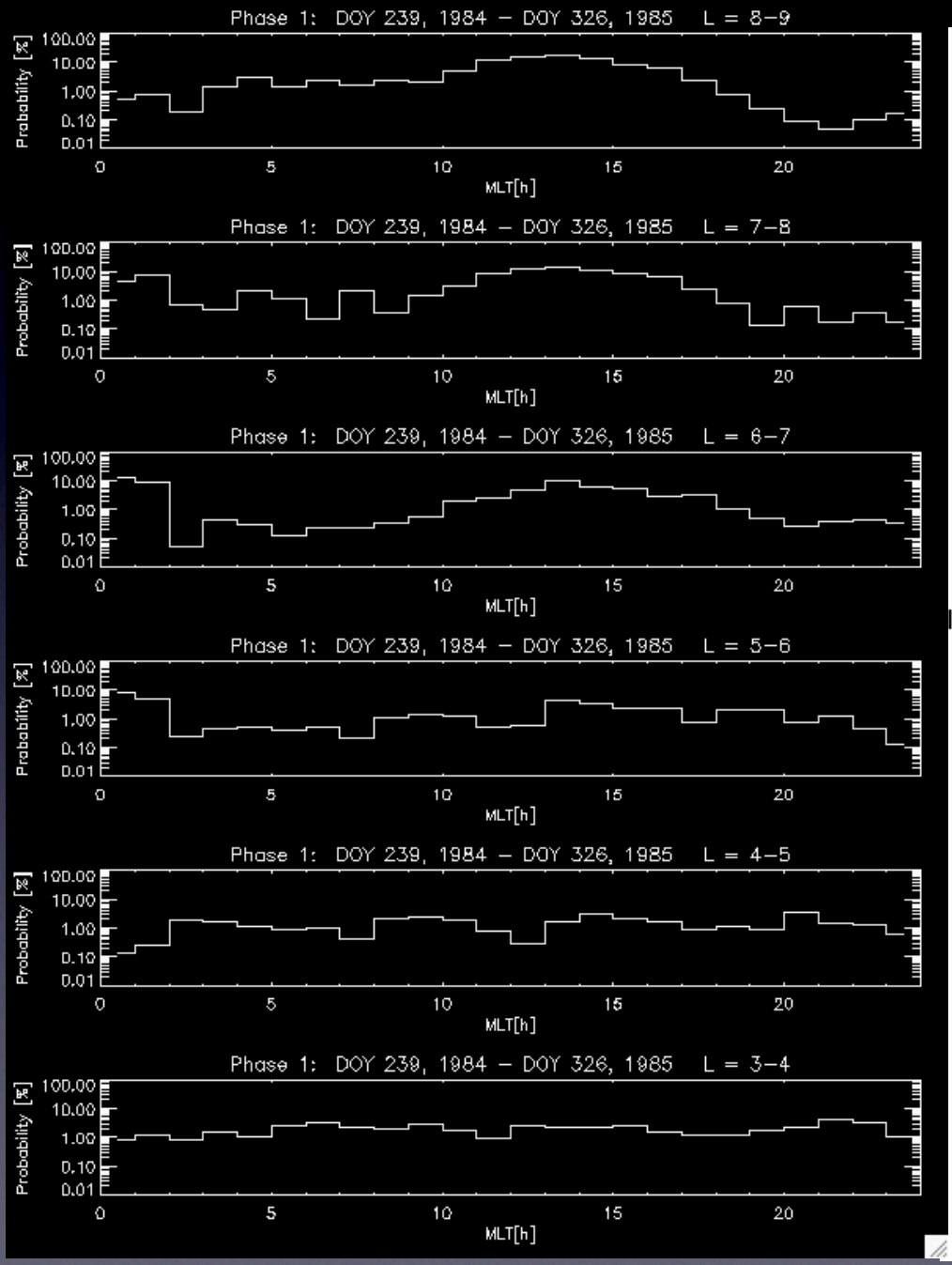


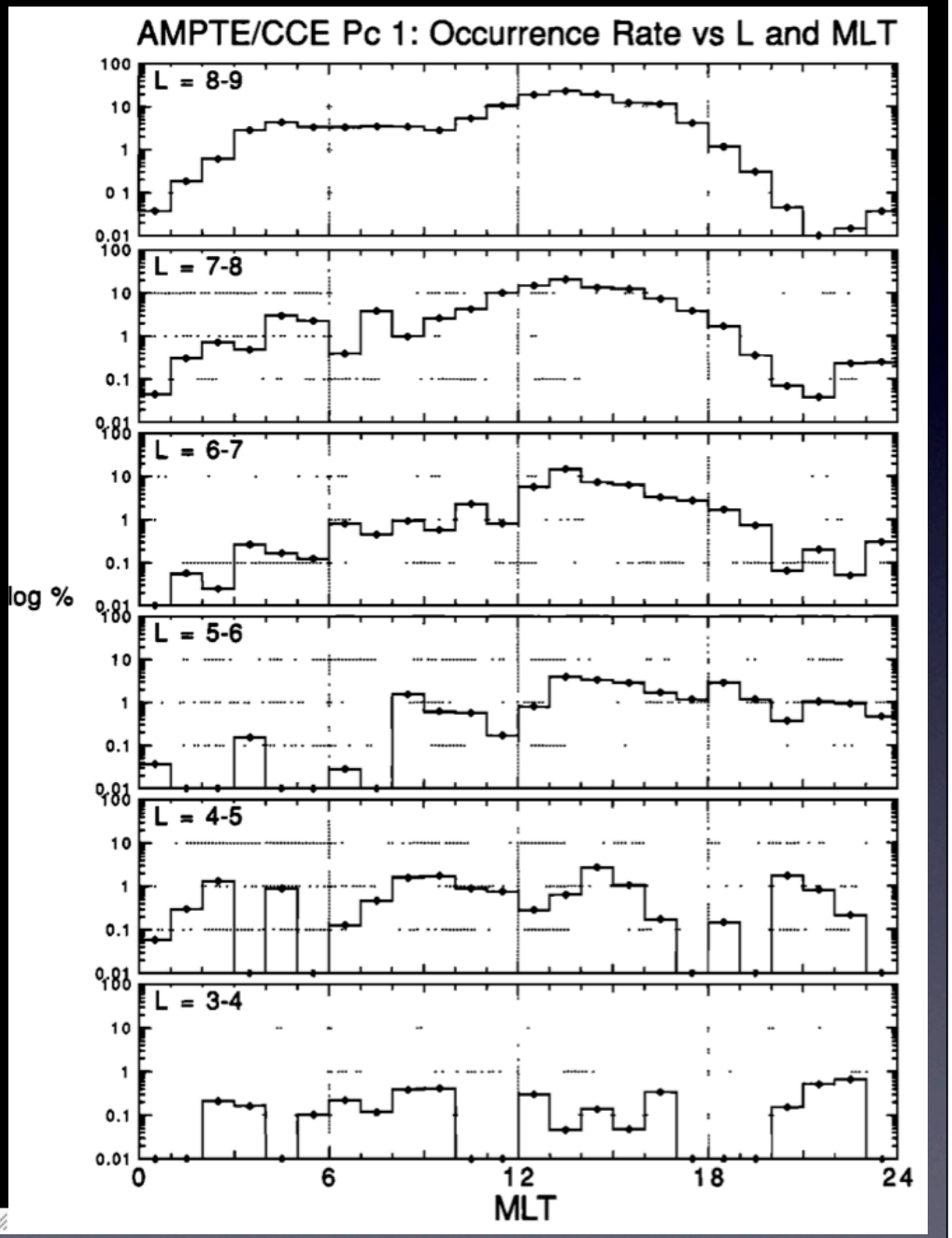
Occurrence probability & Total # of 32-s intervals for each L & MLT bin (dL=1, dMLT=1h)





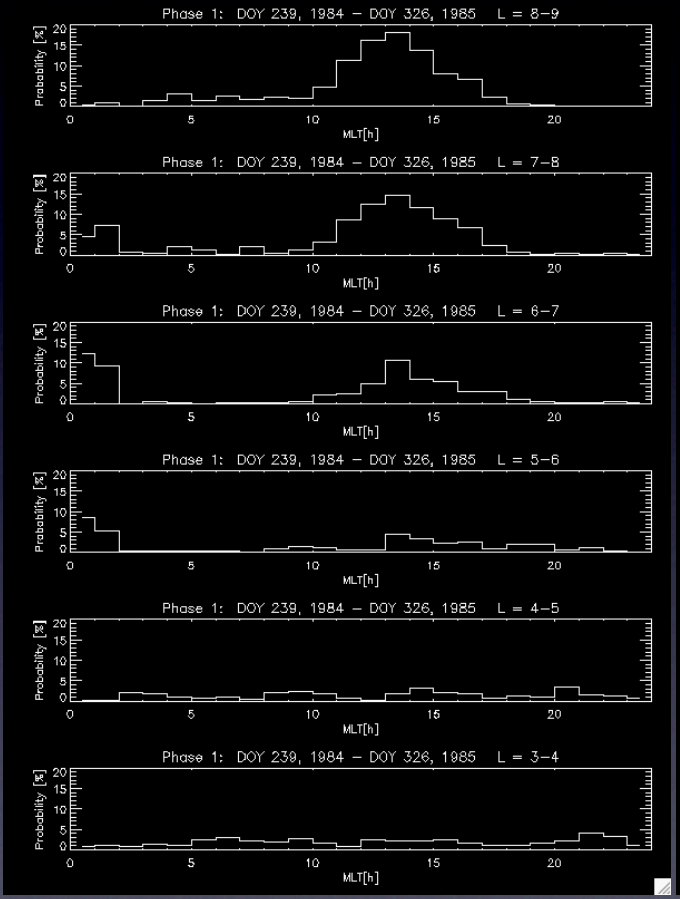
Occurrence normalized by observation times: Period 1



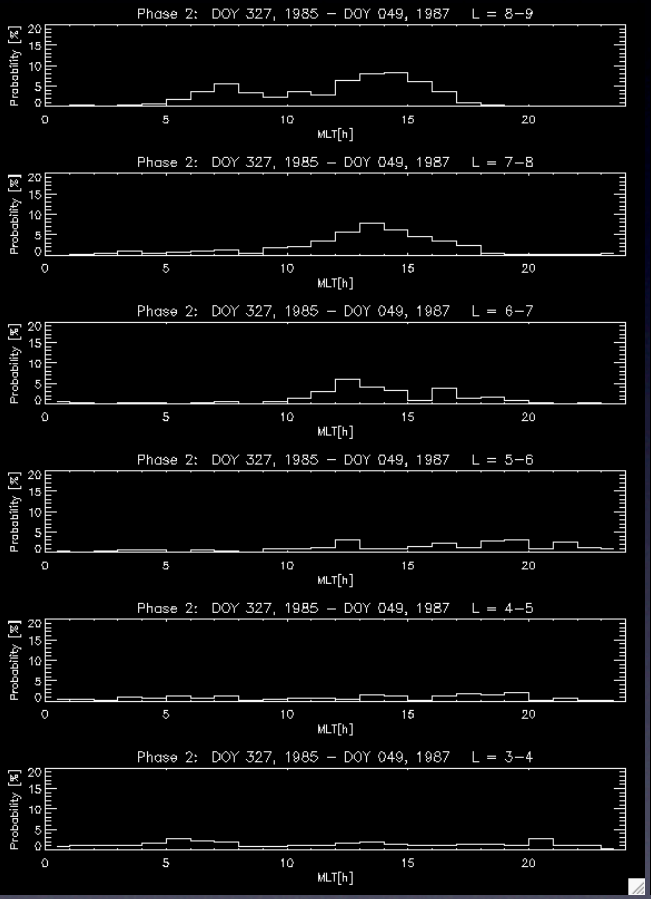


Occurrence probability
Any solar cycle dependence?

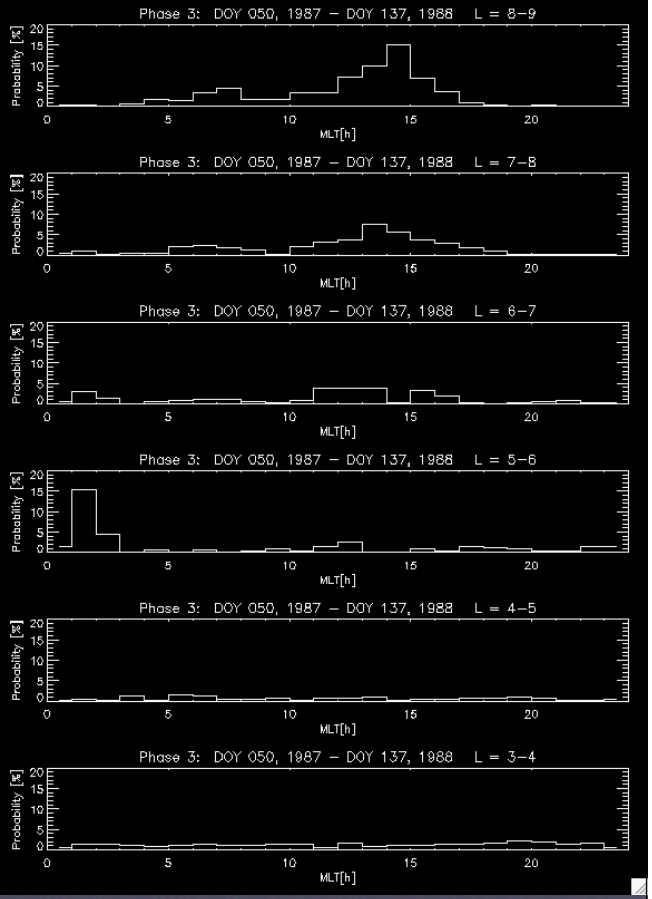
Period 1



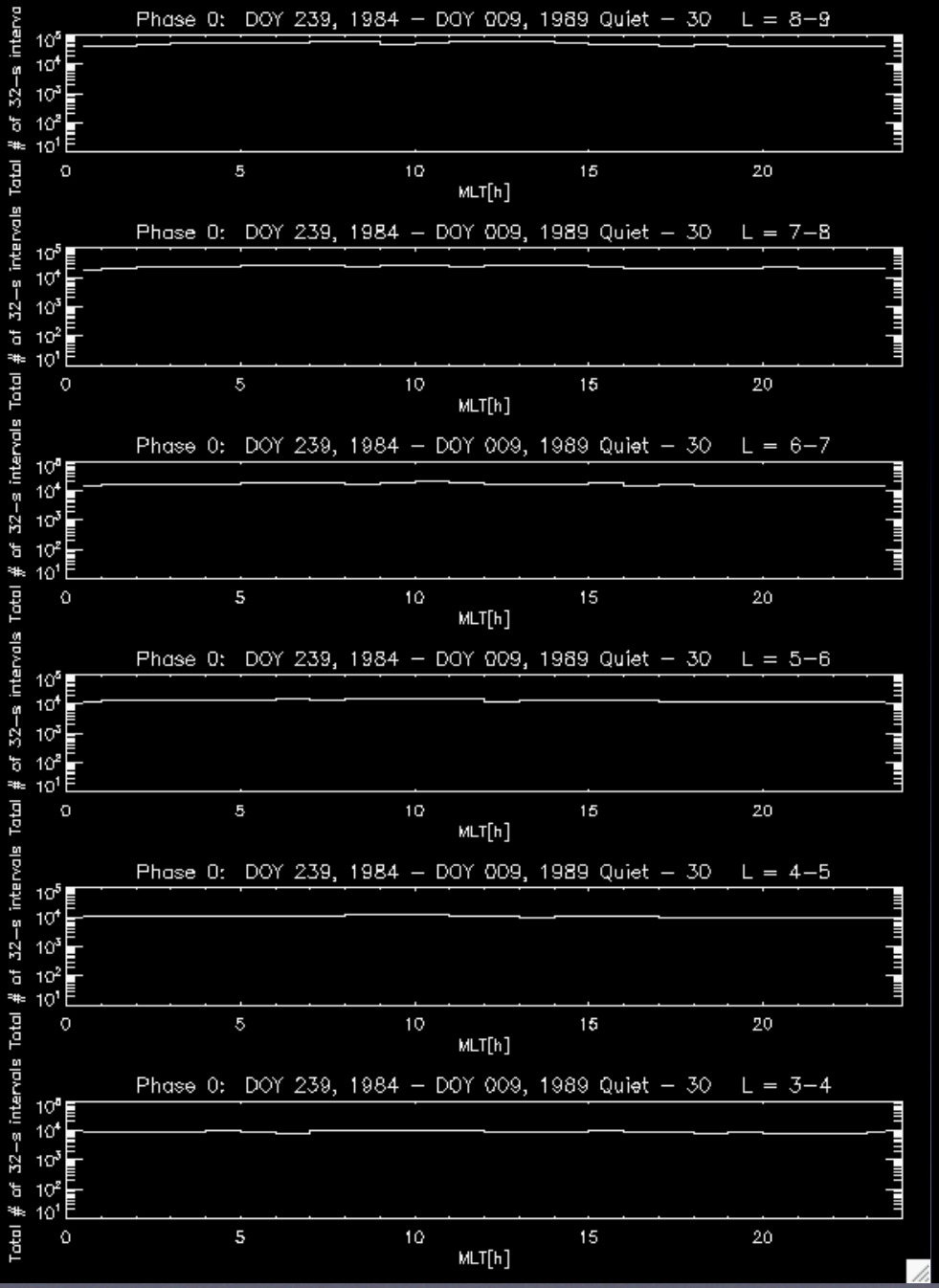
Period 2

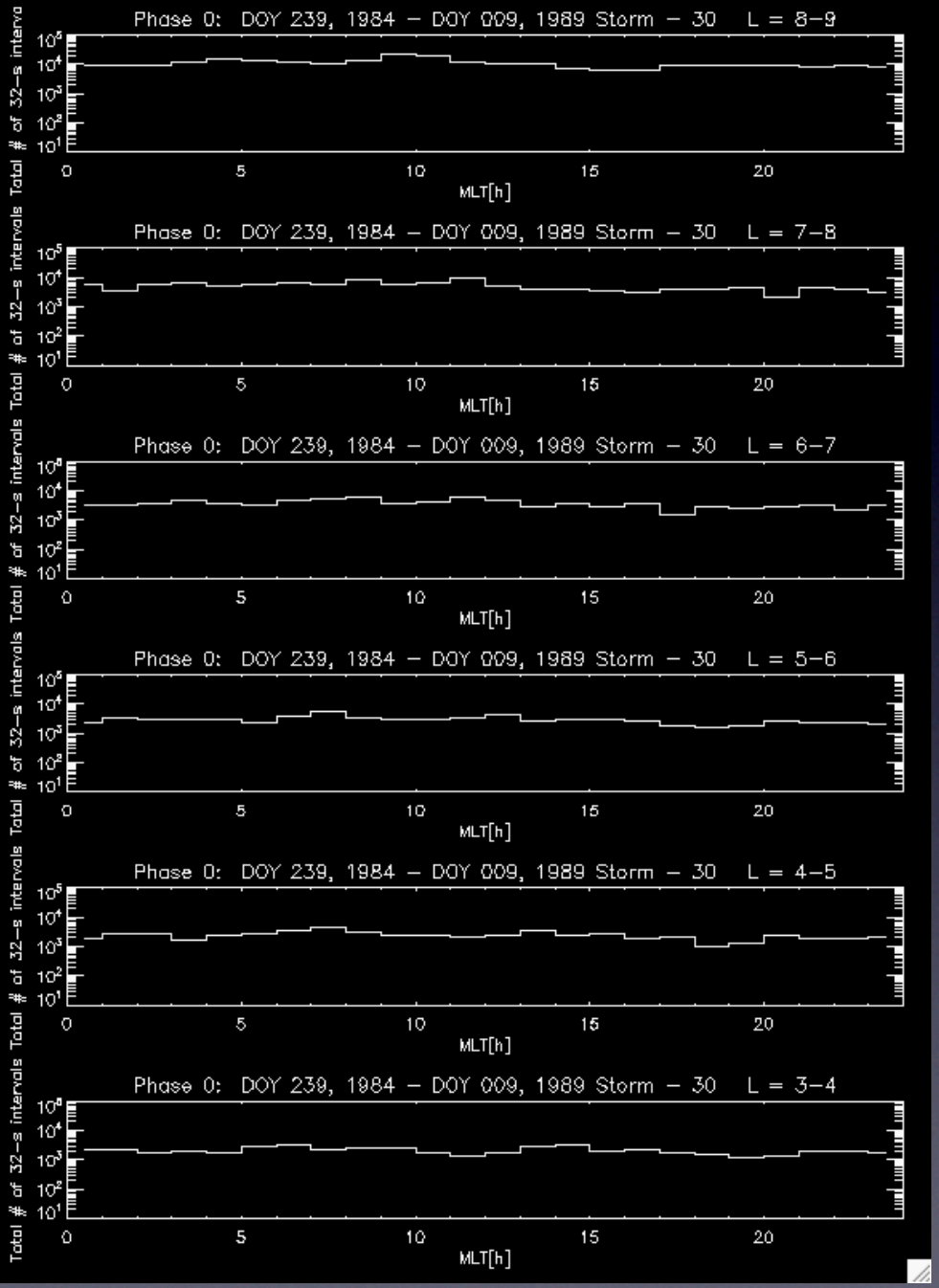


Period 3

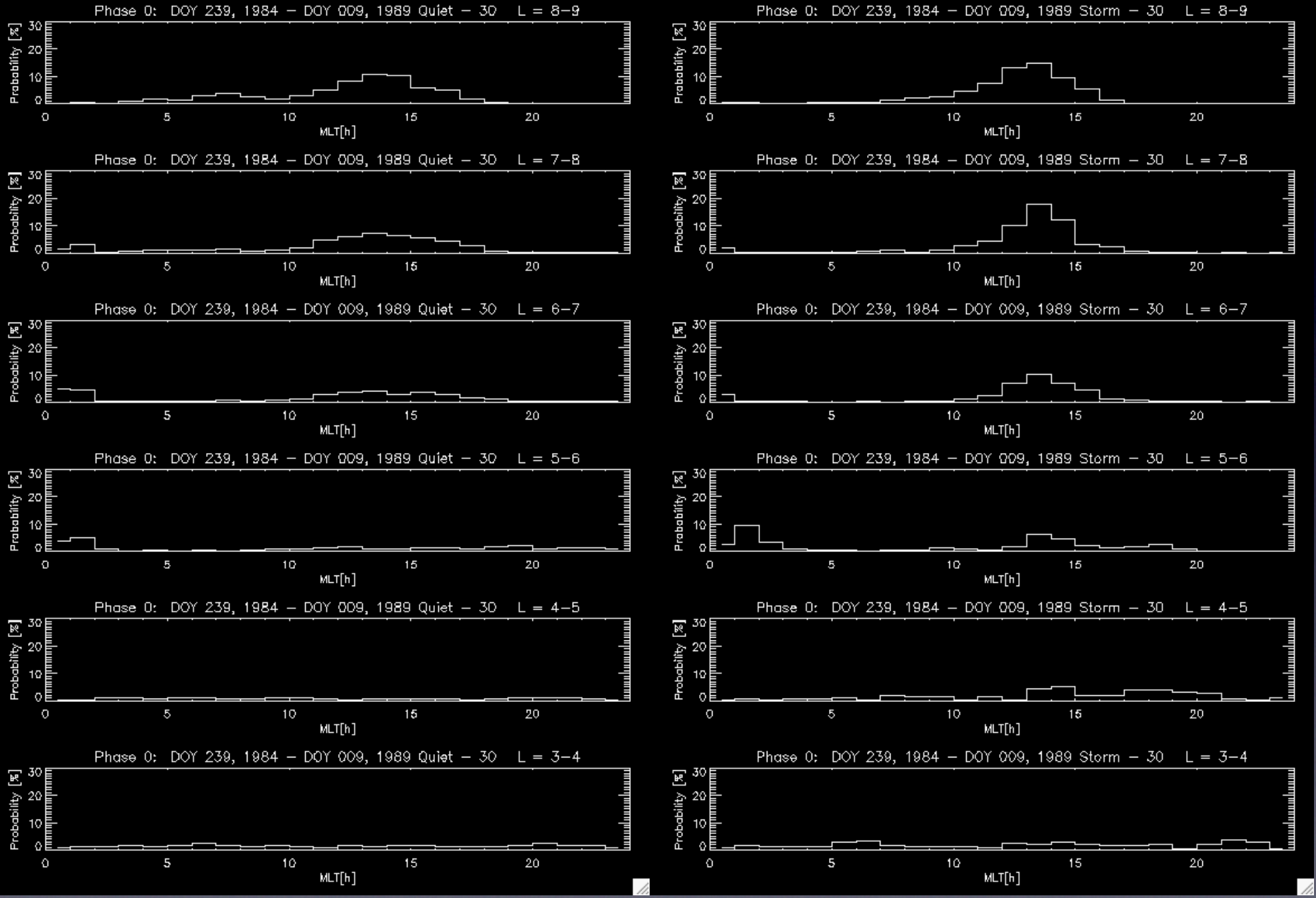


Total # of 32s intervals: Dst > -30 nT vs. Dst < -30 nT





Occurrence probability:
Dst > -30 nT vs. Dst < -30 nT



Total # of 32s intervals:
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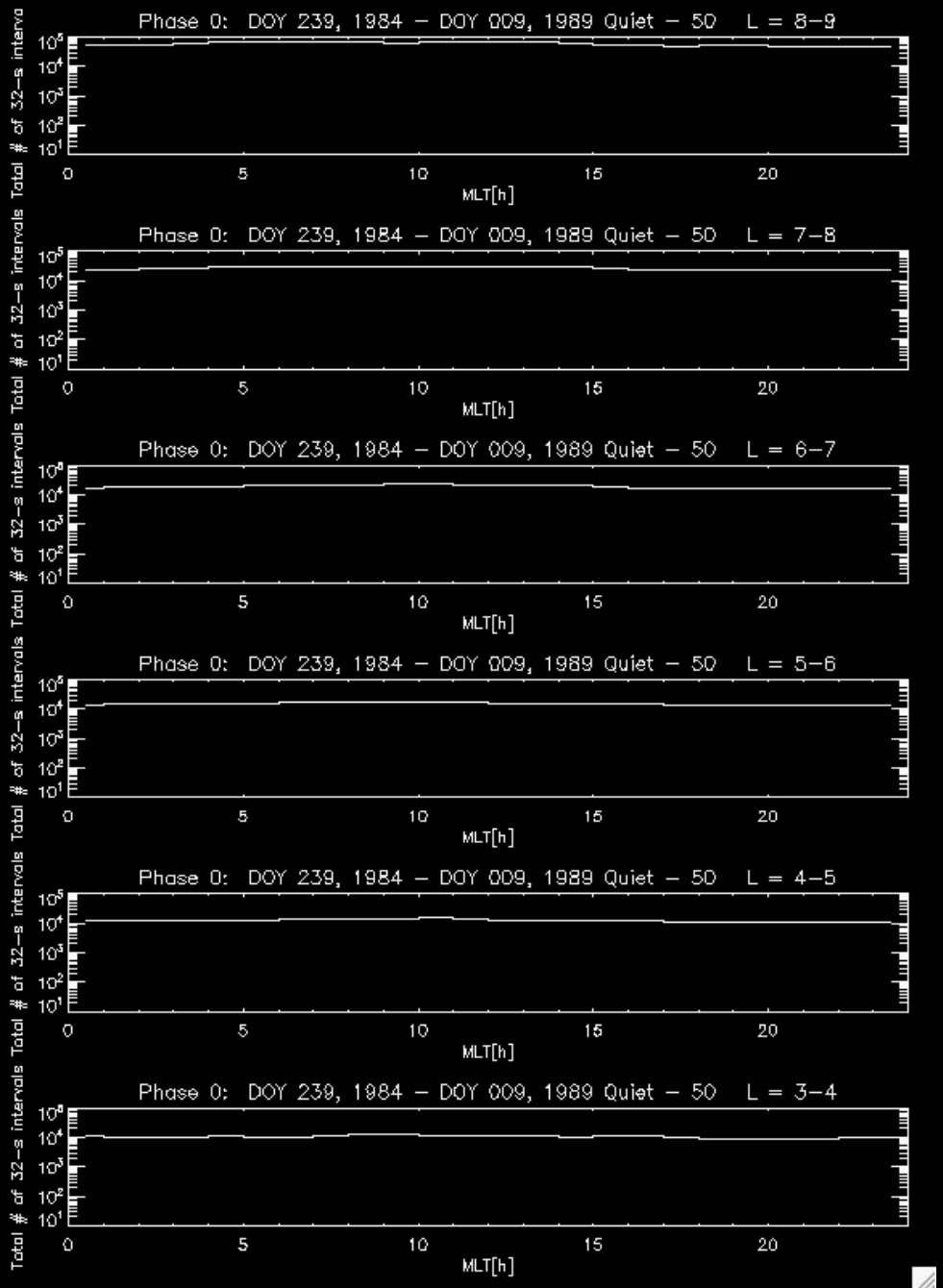
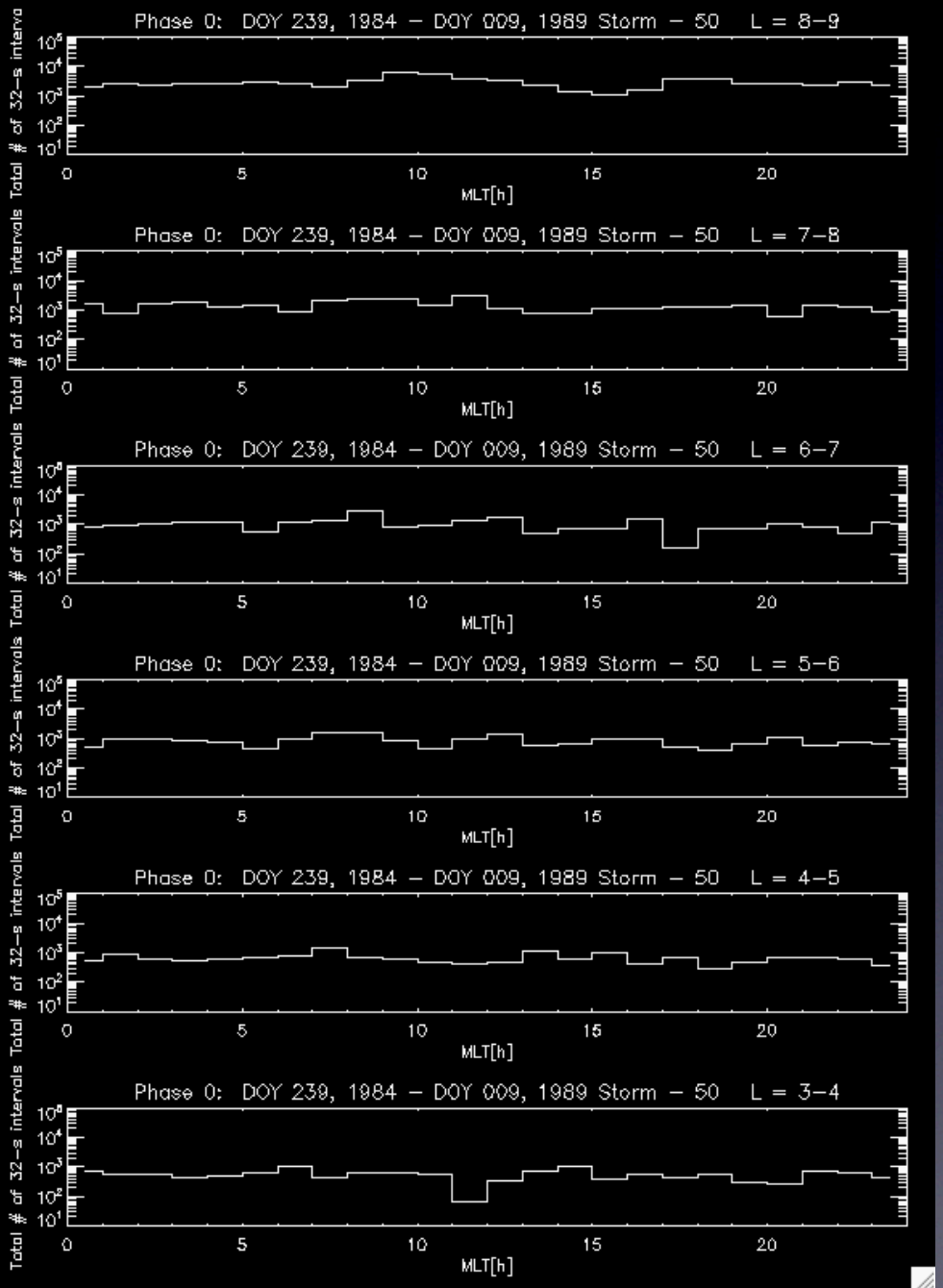
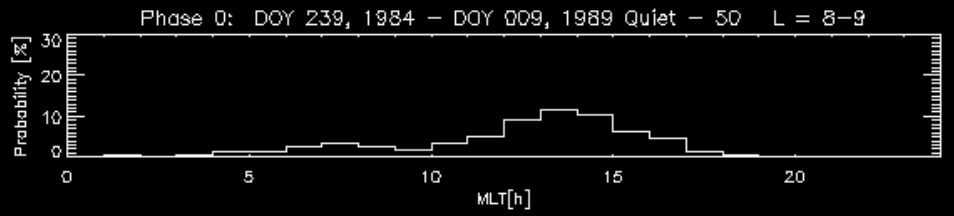
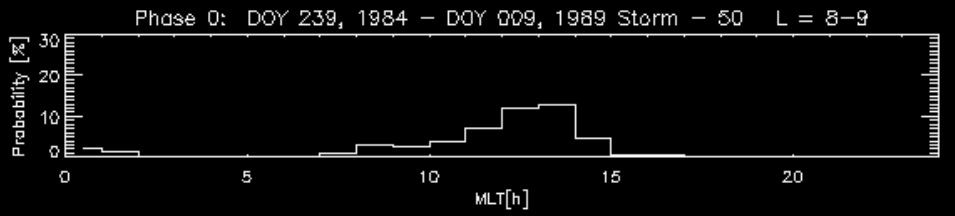
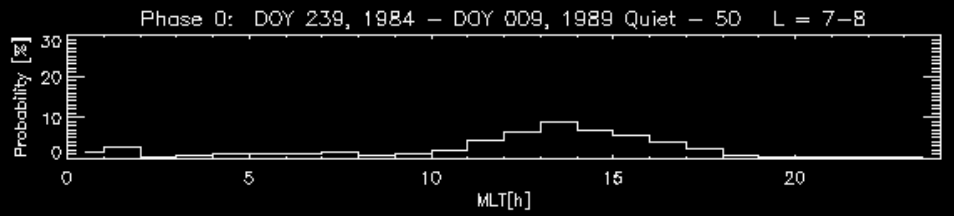


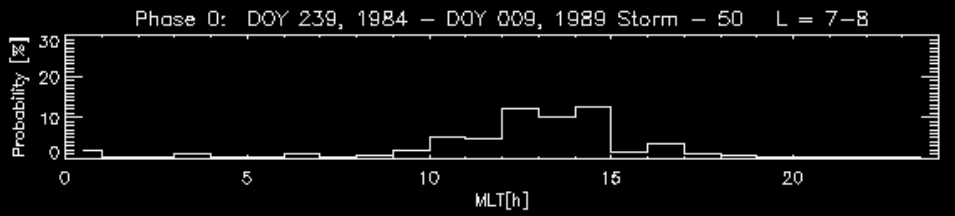


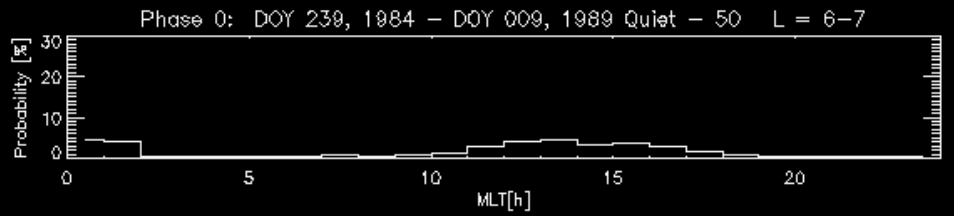
Occurrence probability: Dst > -50 nT vs. Dst < -50 nT

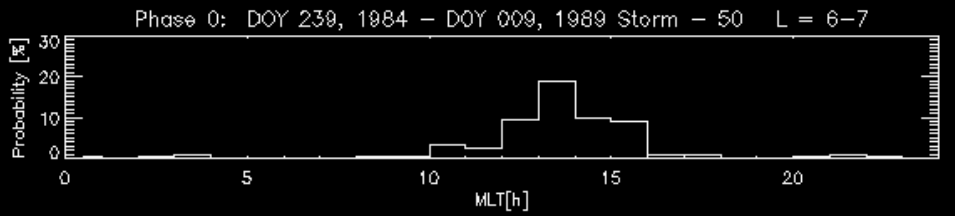


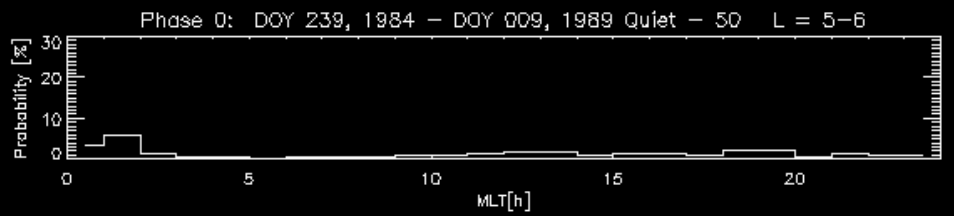


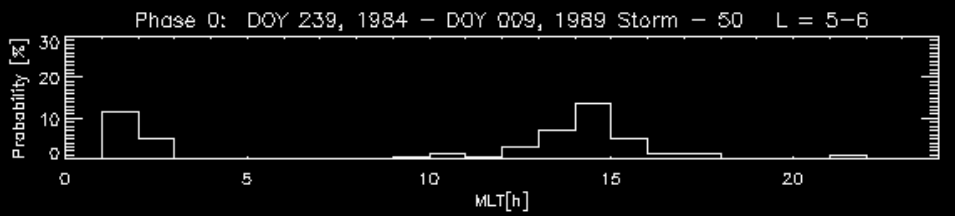


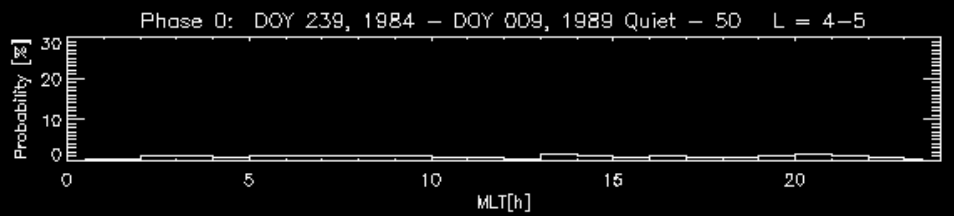


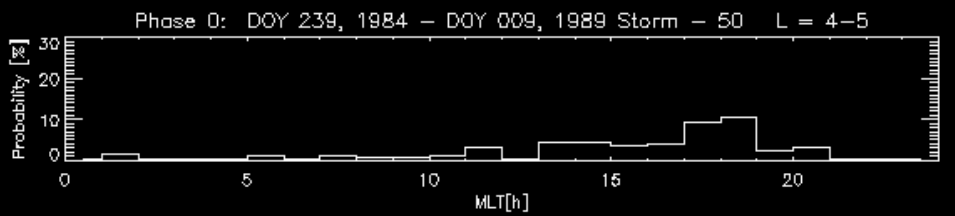


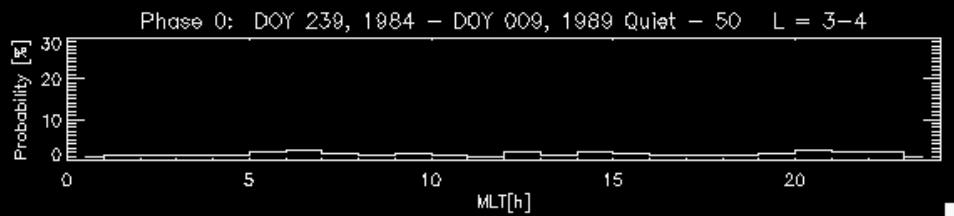


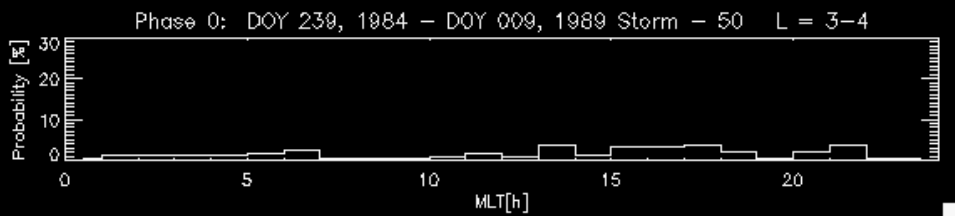




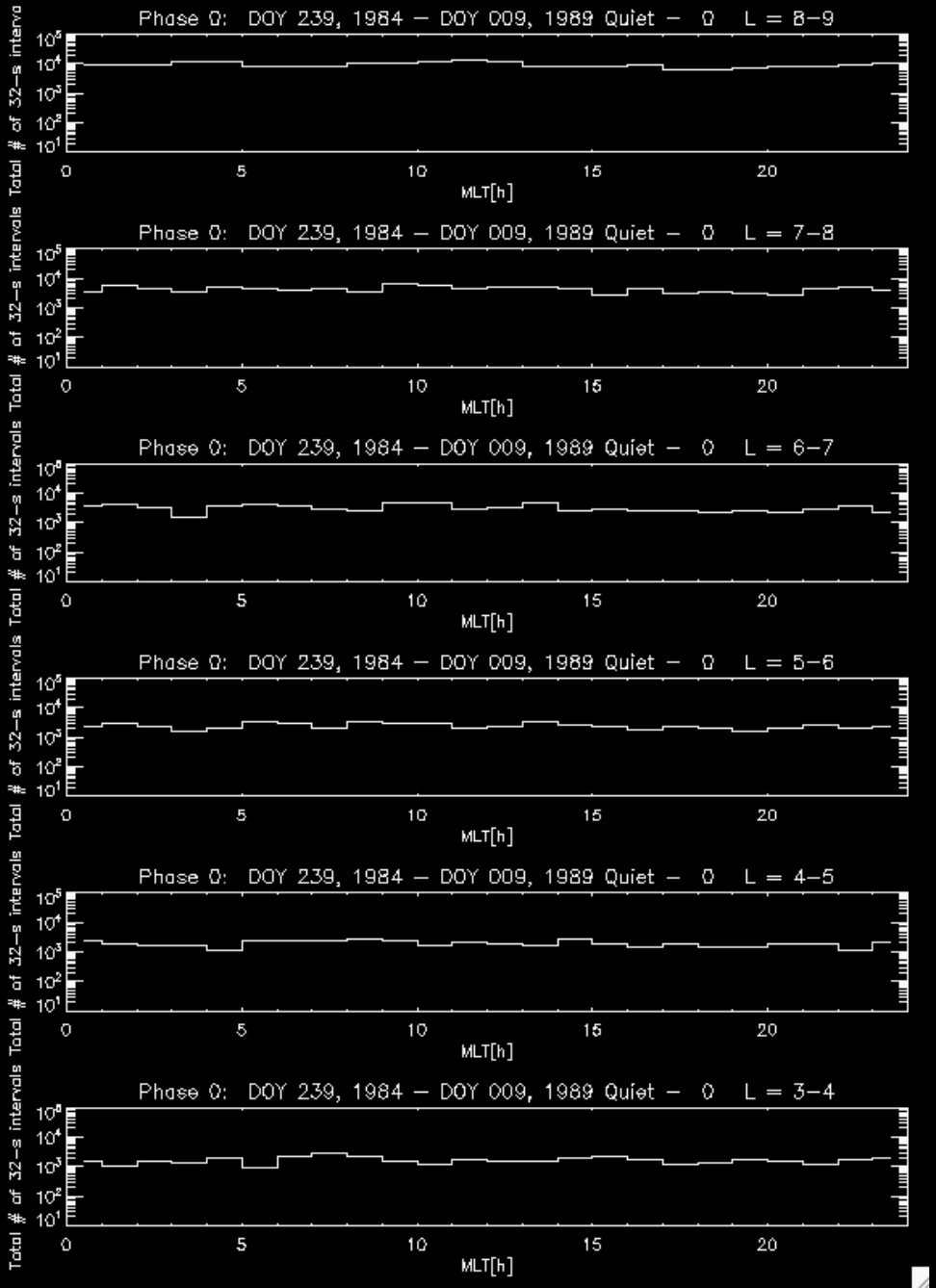


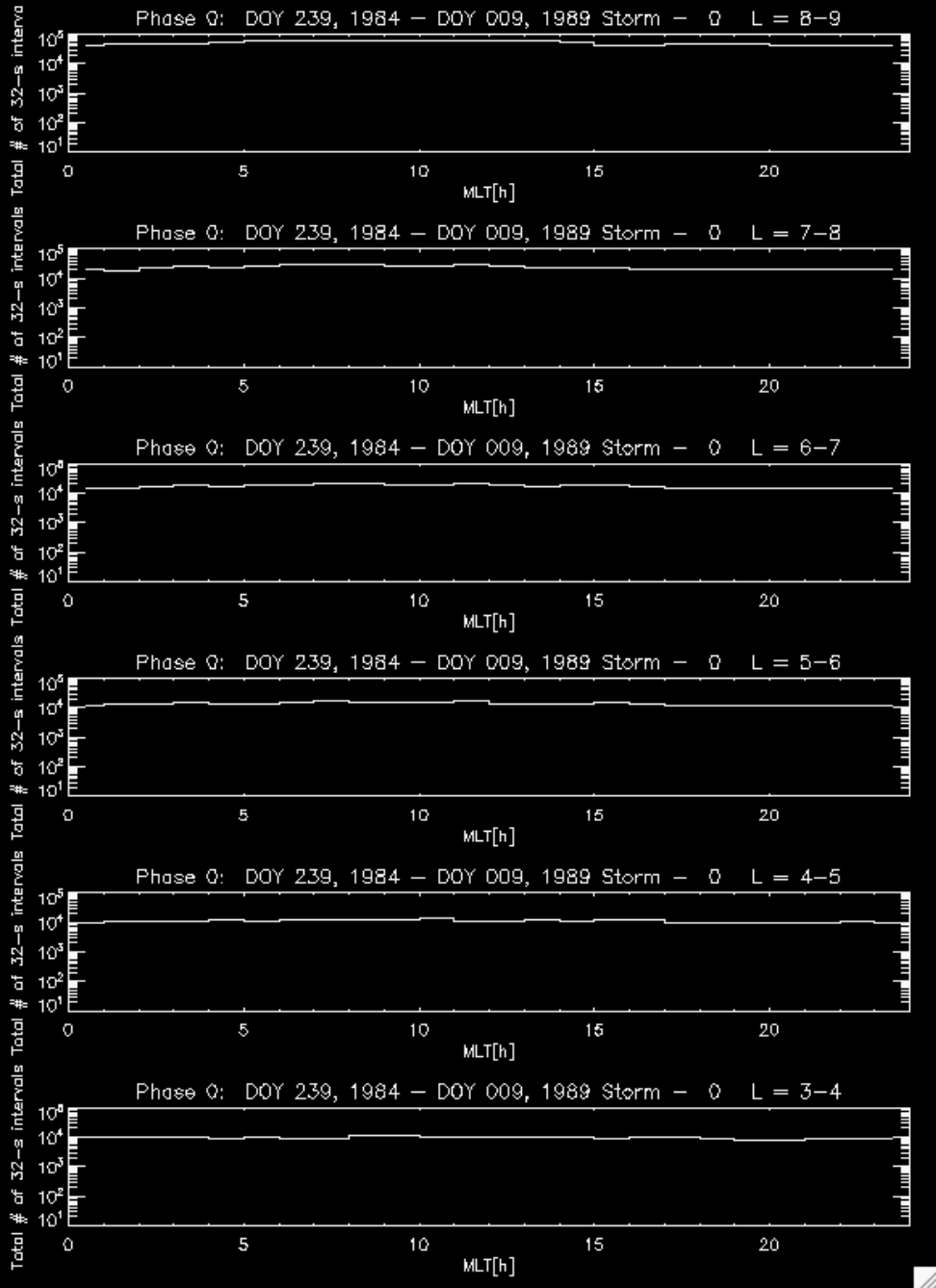




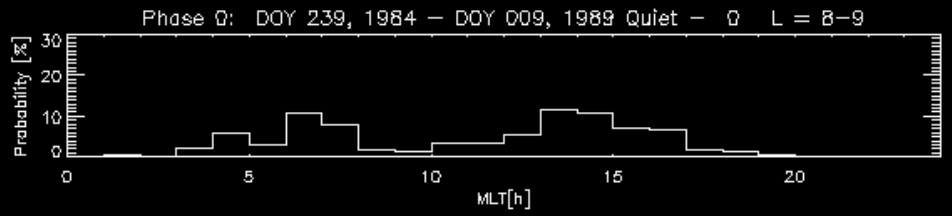


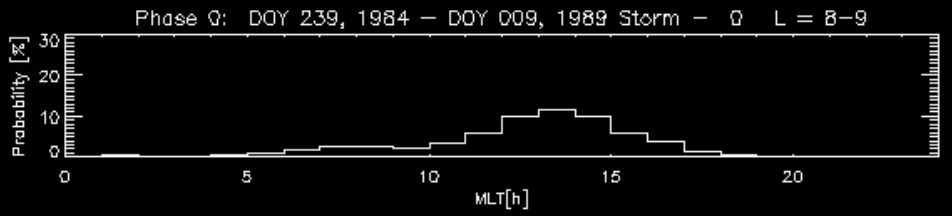
Total # of 32s intervals: Dst > 0 nT vs. Dst < 0 nT

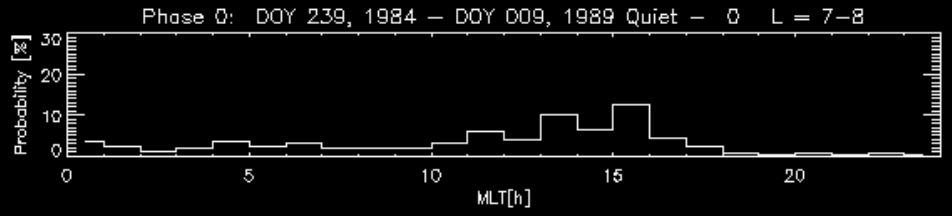


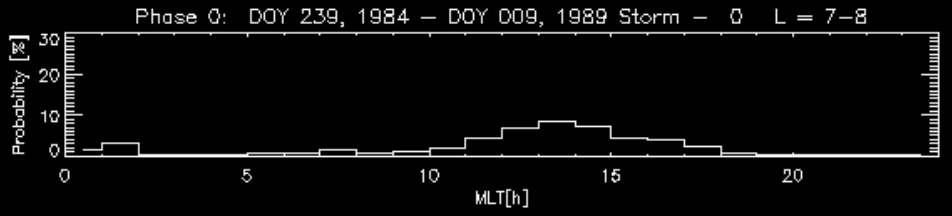


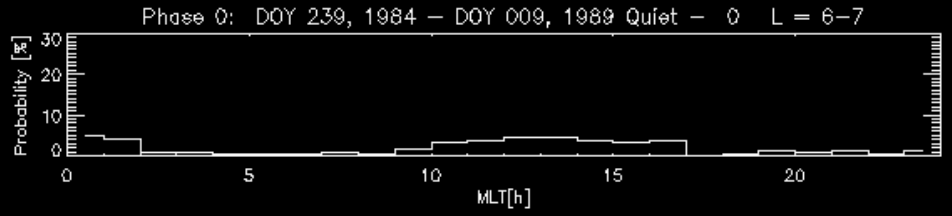
Occurrence probability: Dst > 0 nT vs. Dst < 0 nT

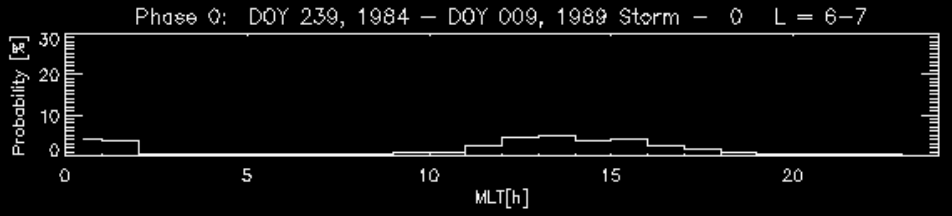


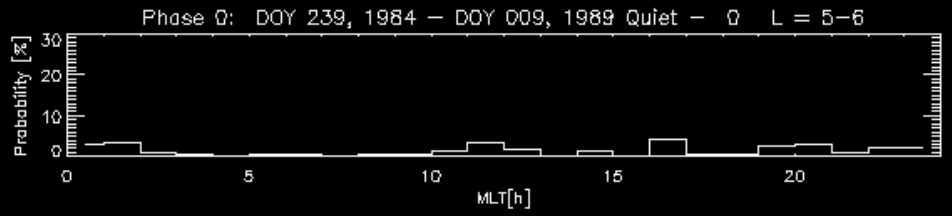


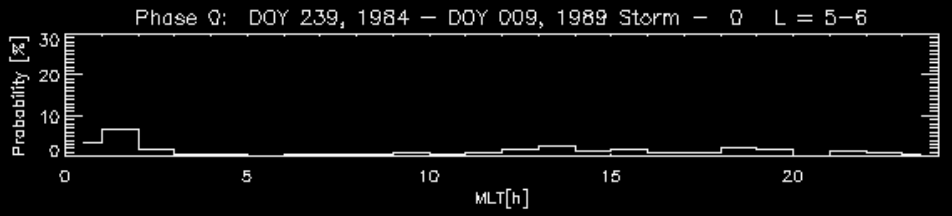


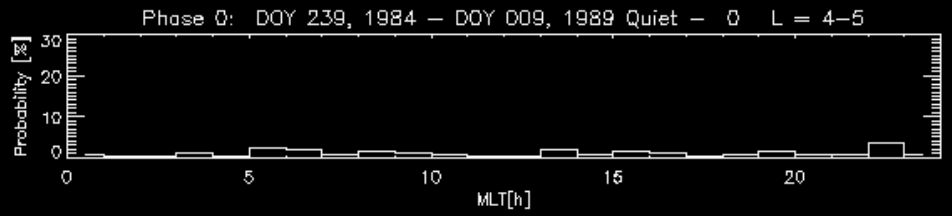


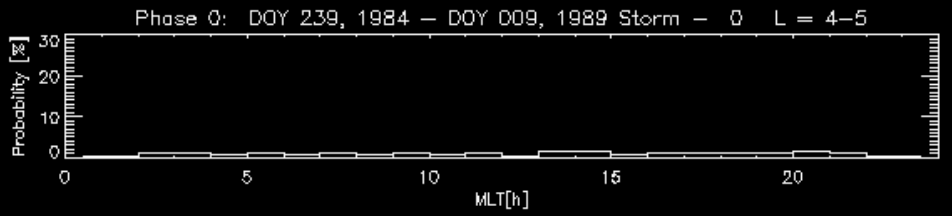


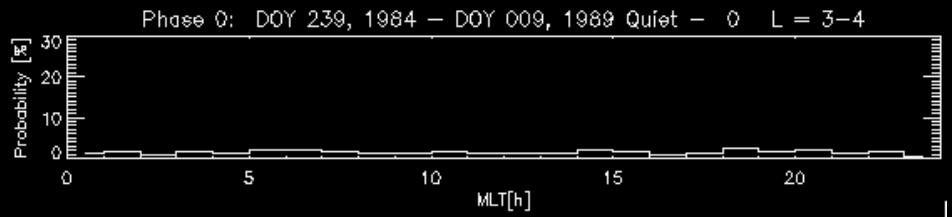


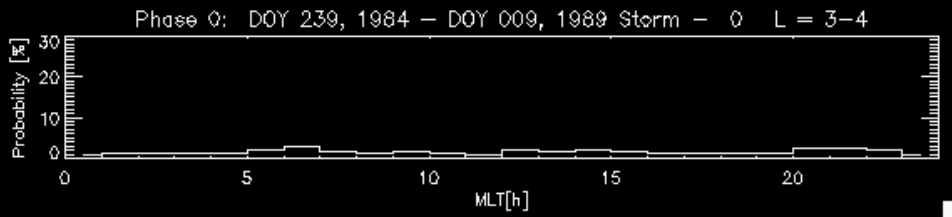




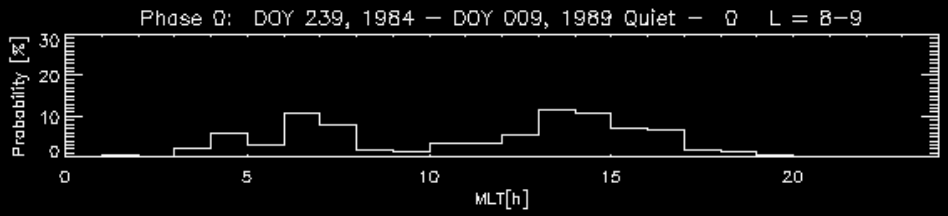


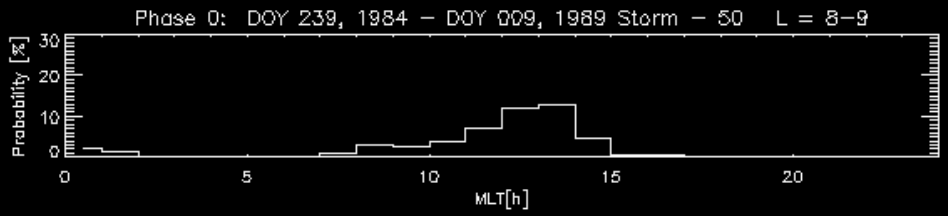


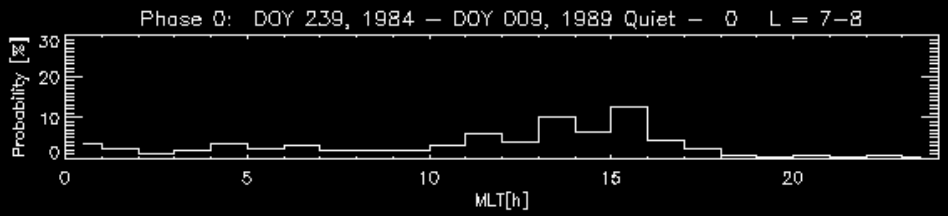


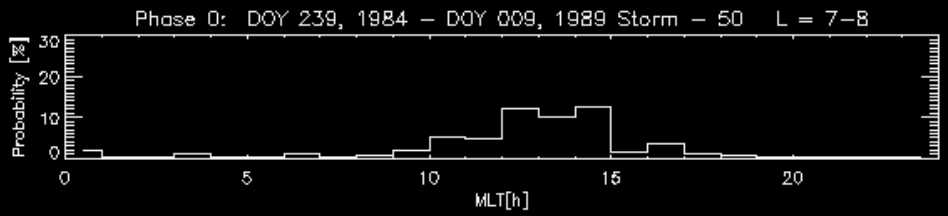


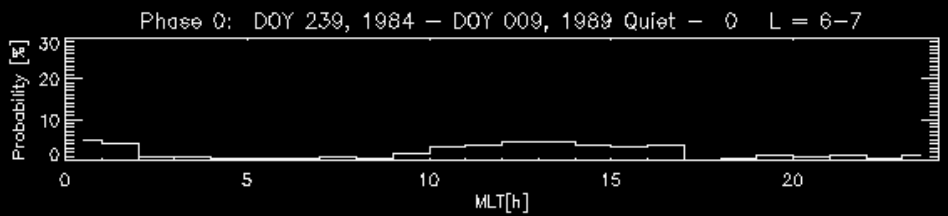
Occurrence probability:
Dst > 0 nT vs. Dst < -50 nT

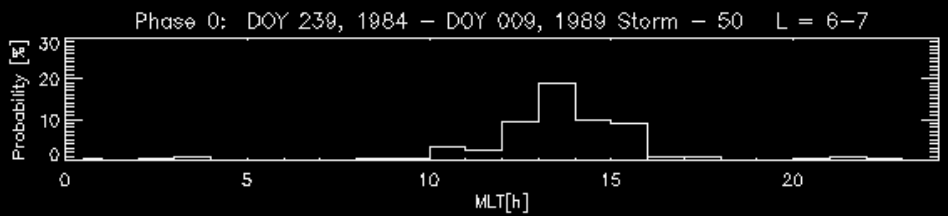


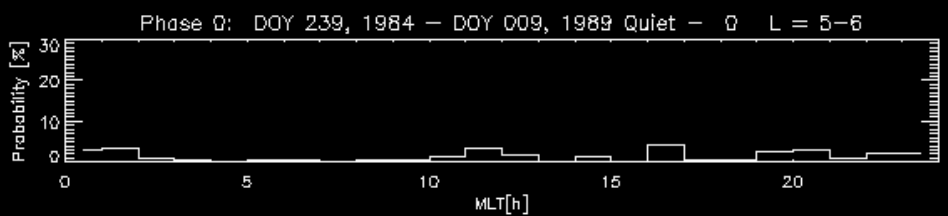


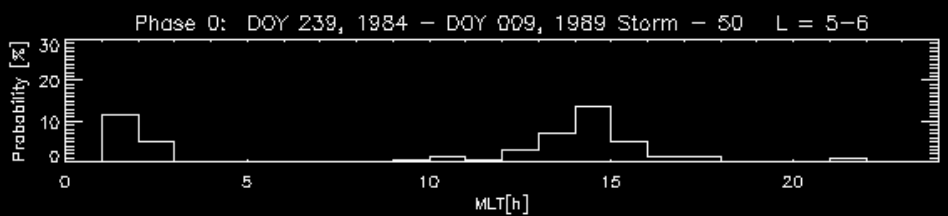


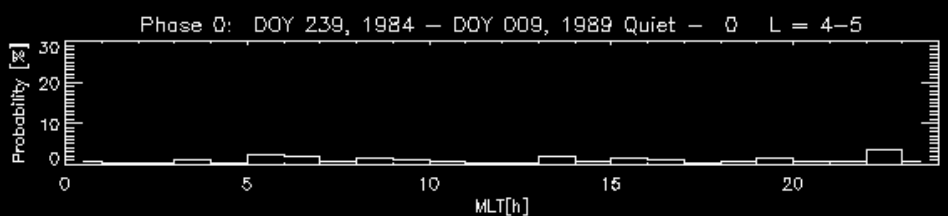


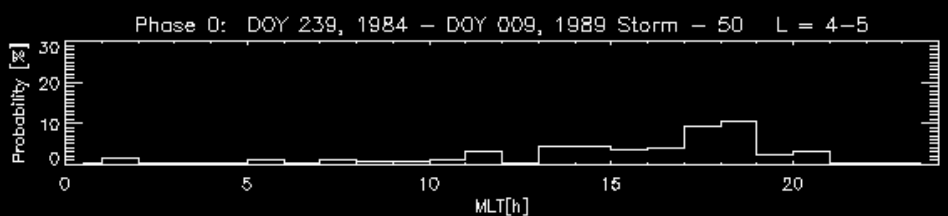


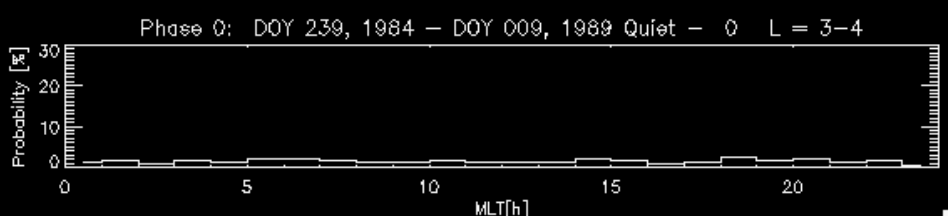


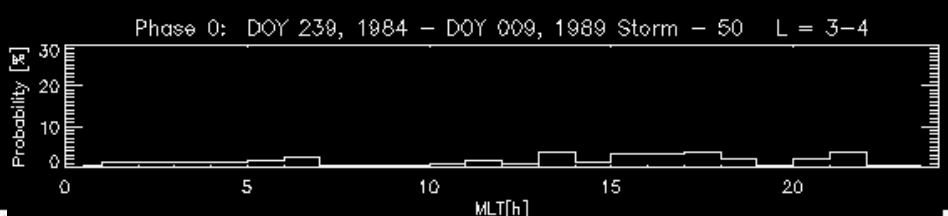




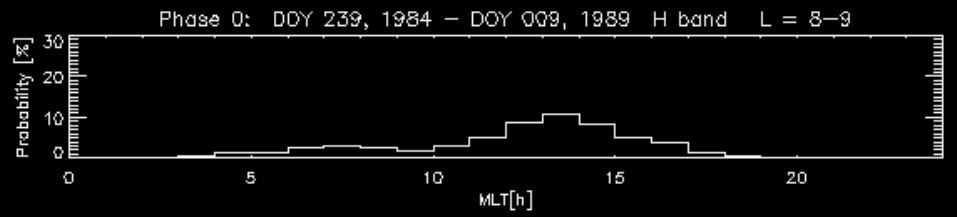


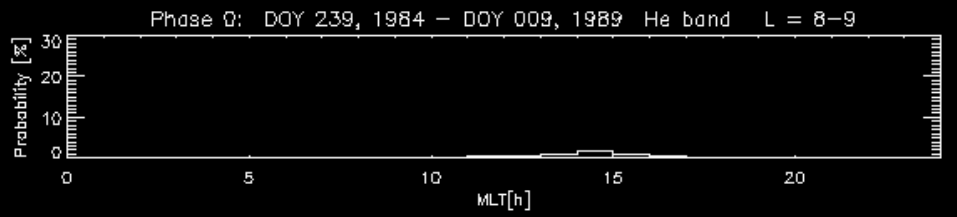


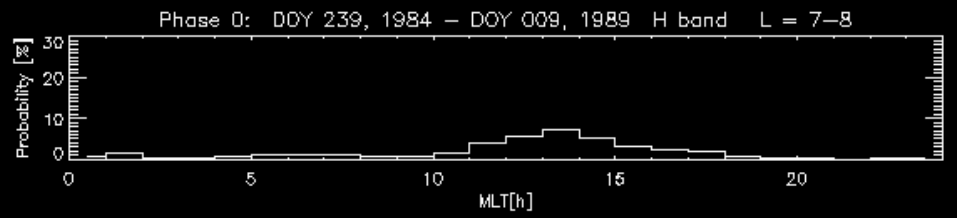


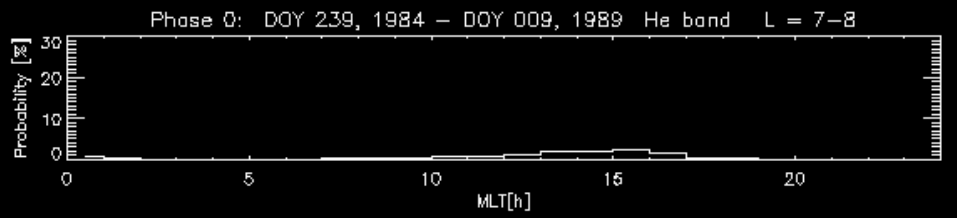


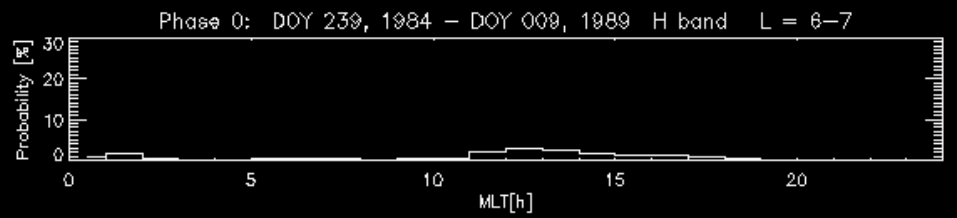
Occurrence probability: H band & He bband

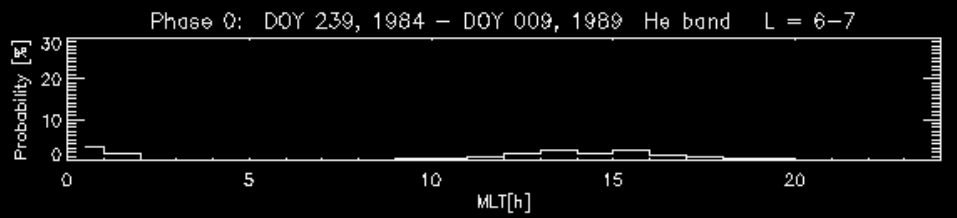


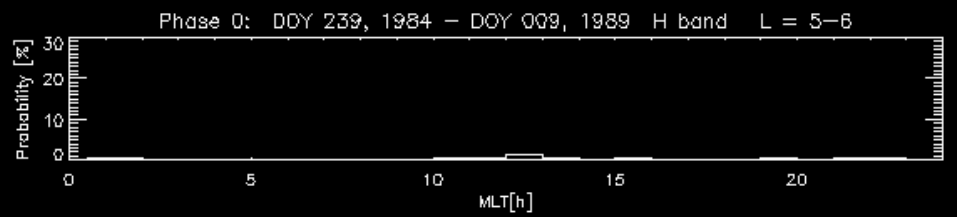


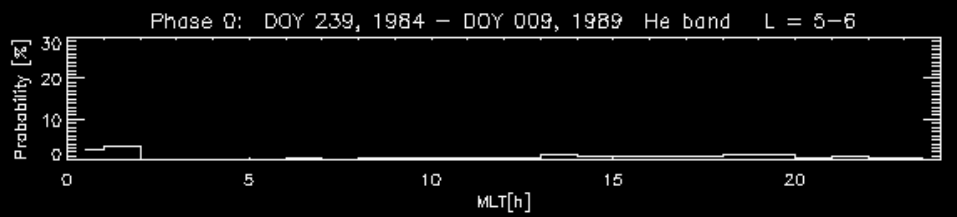


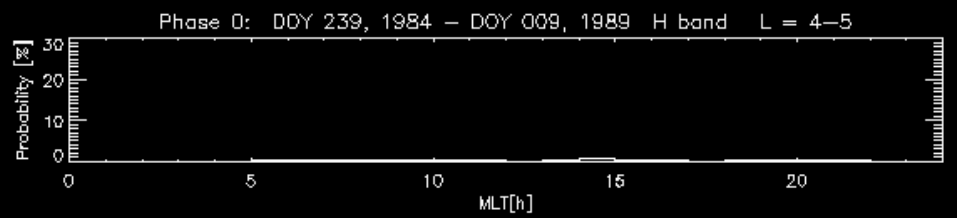


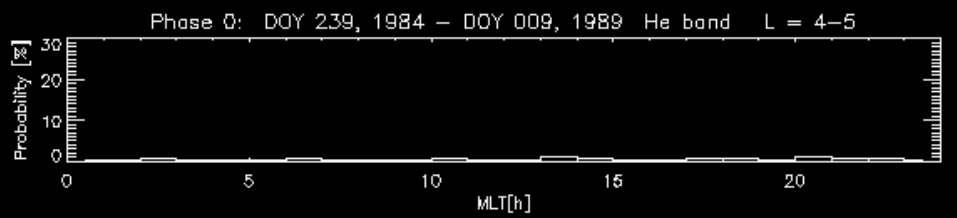


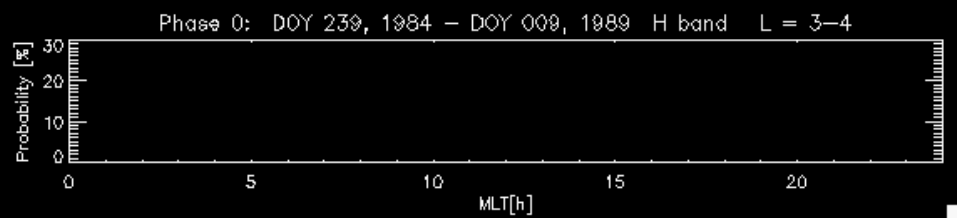


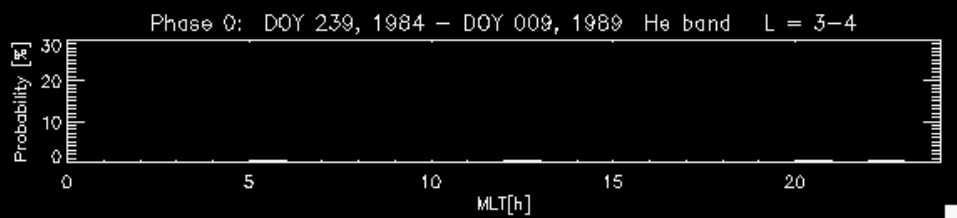












Summary: EMIC waves observed by AMPTE/CCE (~4.5 years)

- In general, higher occurrence (~15%) on the afternoon side at higher L shell (L>6). Low occurrence (<5%) inside L=6. Low occurrence (<5%) in the other regions.
- No clear solar cycle dependence found so far.
- Clear storm (Dst) dependence of occurrence
  - ✓ <u>For higher L shell (L>7)</u>
    - No clear dependence on the afternoon & dusk side (12-24 h MLT)
    - Higher occurrence (up to 10 %) on the morning & dawn side (5-12 h MLT) during quiet times (Dst>0)
  - ✓ <u>For lower L shell (L<7)</u>
    - Higher occurrence (up to 15%) on the afternoon & dusk side (12-21 h MLT) during stom times (Dst<-30 or -50)
    - Peak occurrence shifts toward dusk (~18 h MLT) as Dst decreases.
- Higher occurrence of H-band (up to 15%) than He-band (<3%).