

# *Details of the strong 2006 Orionid return*

*Jürgen Rendtel*



## Orionids 2006 – what was special?

favourable conditions: New Moon

almost major shower

pre-peaks observed (e.g. 1993 Oct 18, 204.5°) - nothing in 2006

higher rates than usual on Oct 21/22 reported

again enhanced rates on Oct 22/23 AND 23/24

plus high portion of bright meteors (report of Robert Lunsford – video)

***total amount of visual data in the IMO's VMDB:***

***12012 Orionids***

***389 observing hours***

***58 observers worldwide***

***-> detailed analysis possible***

## Orionids and 1P/Halley

Rather few papers about modelling the Orionids,

most quoted Hajduk (1970)

recent papers around perihel of 1P, Giotto, Vega & Co.

Conclusions of Hajduk, mainly based on radar data:

1. Density varies „*semi-regular*“ with a 5-12 year period
2. Density and mass distribution differs from one return to the next,  
1:4 or more in density possible
3. *Stream filaments of  $10^6$  km size along the orbit*  
activity may be roughly predicted from previous return (!)
4. ***no permanent density concentration at fixed position***

## ***Step 1: population index $r$***

*calculated from magnitude data*

*Distinguish with moon/no moonlight -> great effort (ORI 5 weeks active)      very few observations in moonlit periods  
here we concentrate to the period  $206^\circ$  -  $212^\circ$  (near maximum)*

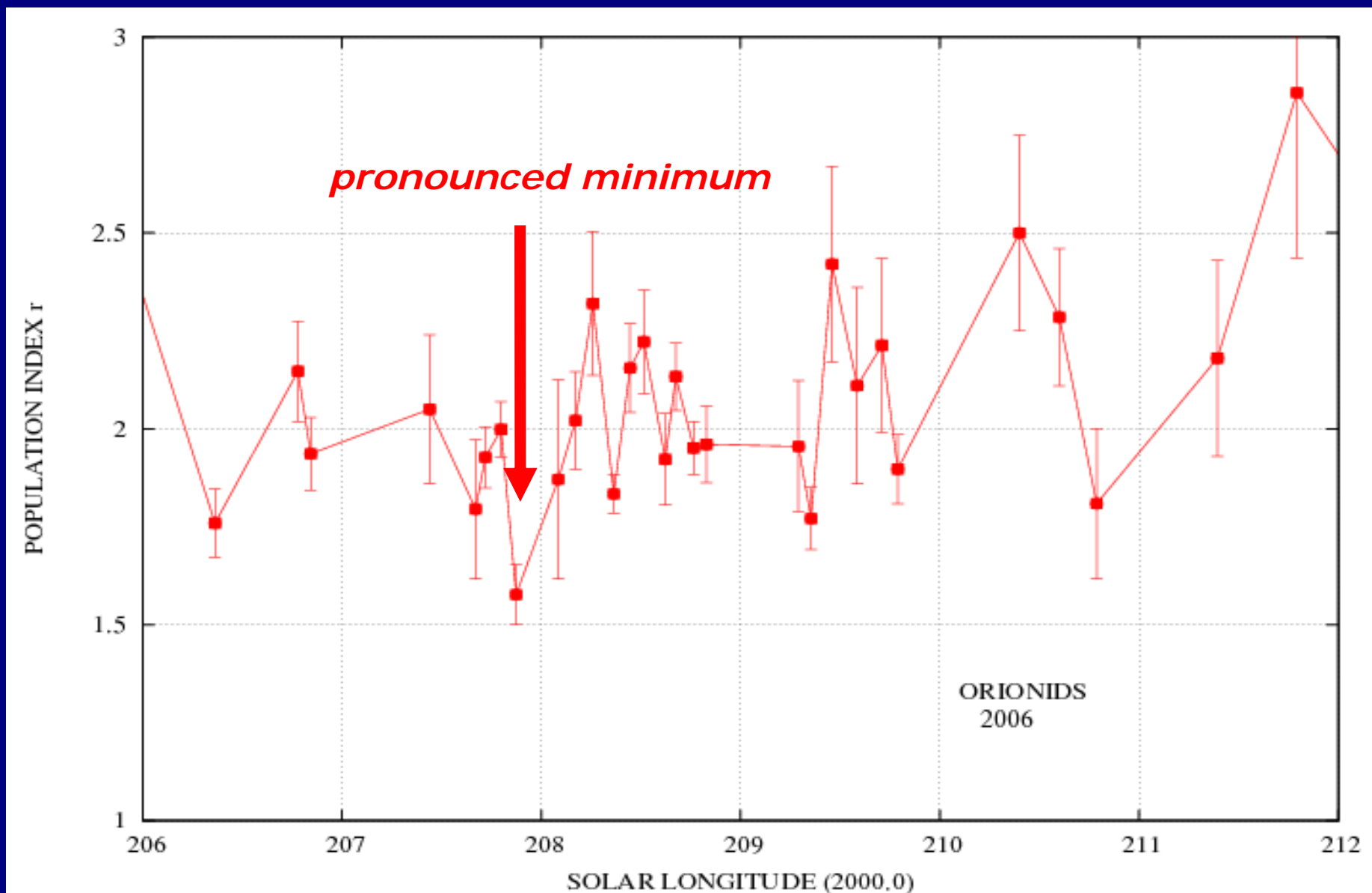
*Calculation for single returns if sample sufficient – 2006 large sample*

*Effects from other showers? ...  $\epsilon$ -Geminids (radar observers list this as a disturbing source – radar different mass range!)*

# Orionids 2006

*peculiar r-profile 2006:*

*minimum r at 207.9° – values below r=2.0 like Leonids 1998 (almost)*



## Step 2: ZHR calculation

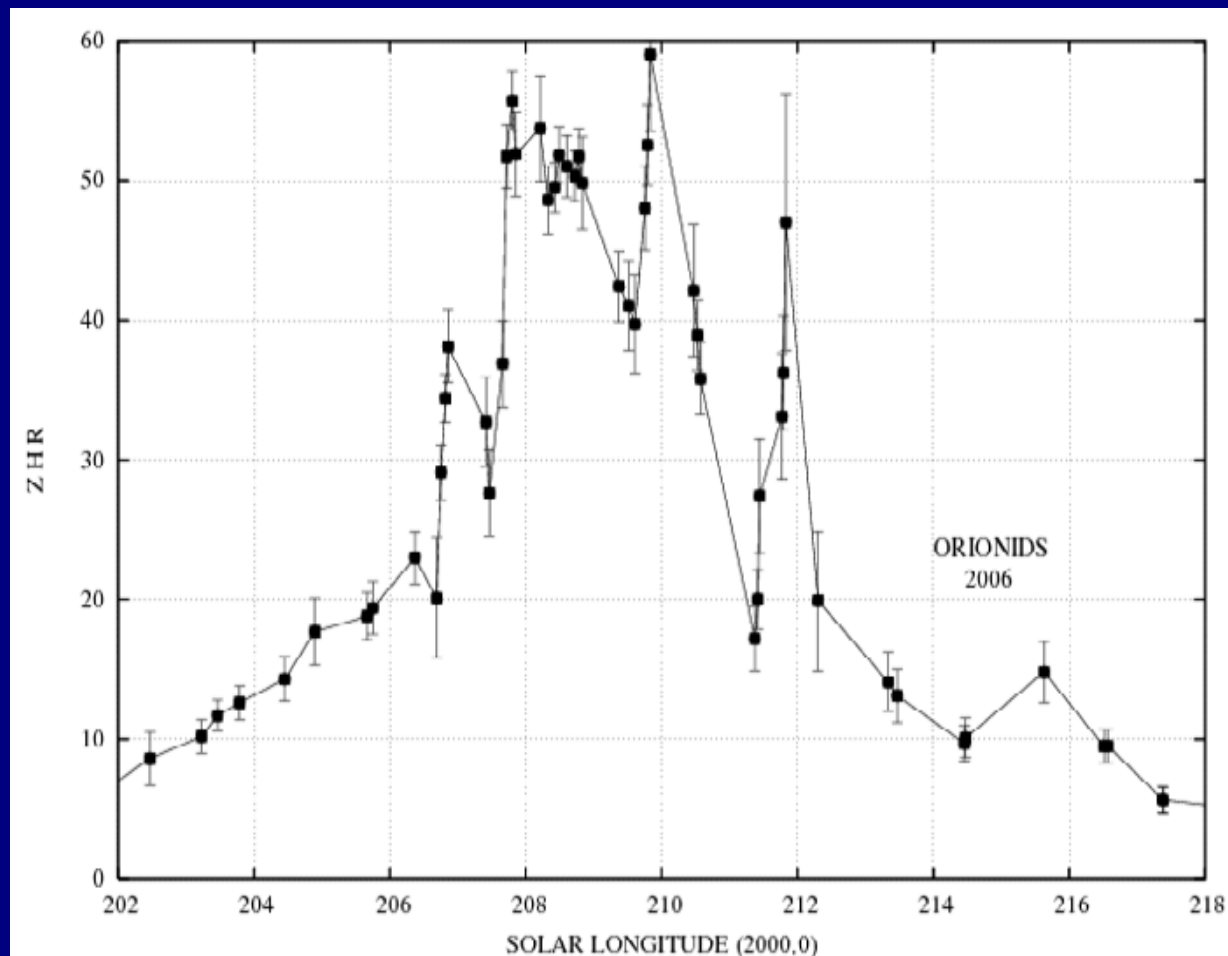
*period 206° - 212° around maximum*

*using r-profile calculated before*

*only intervals with LM > 5.8*

*total correction factor <*

*radiant elevation > 20°*



# Orionids 2006

## Details of the ZHR-profile

ZHR-peaks at  $\approx 0.8^\circ$

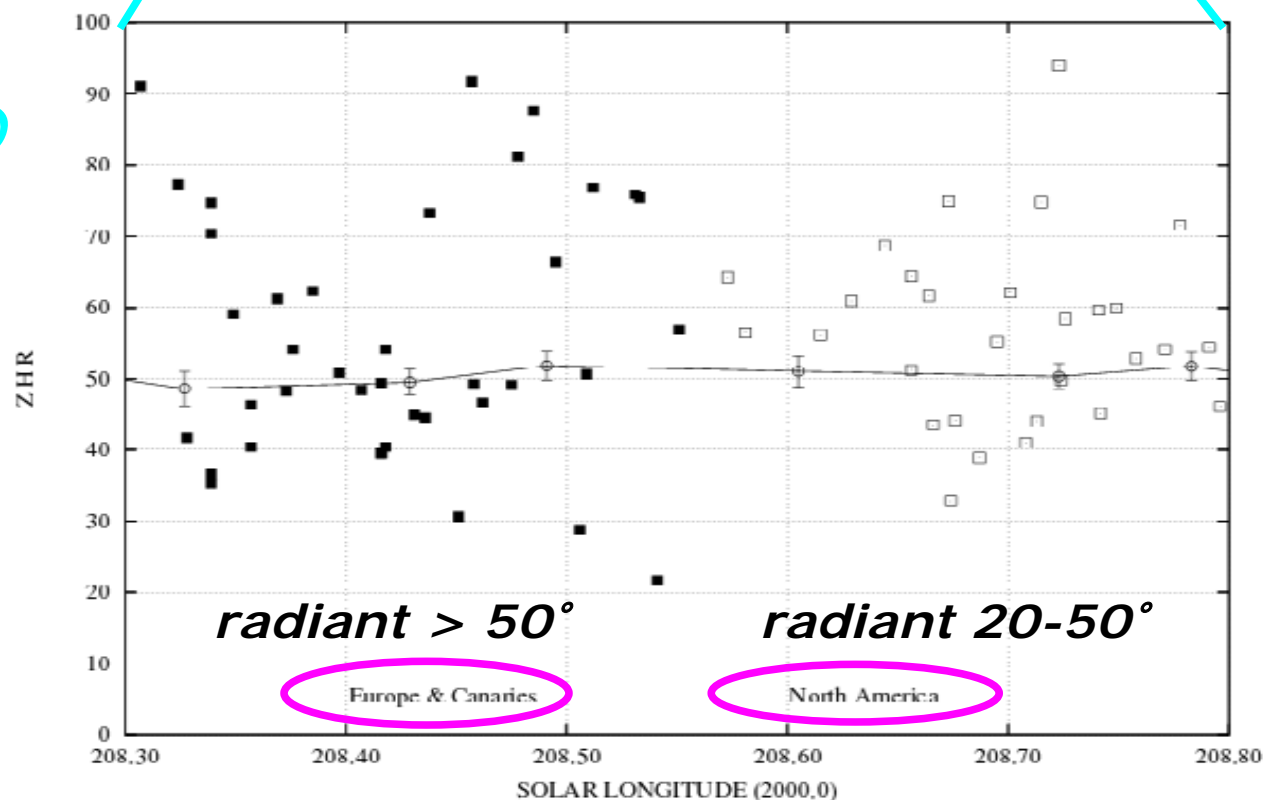
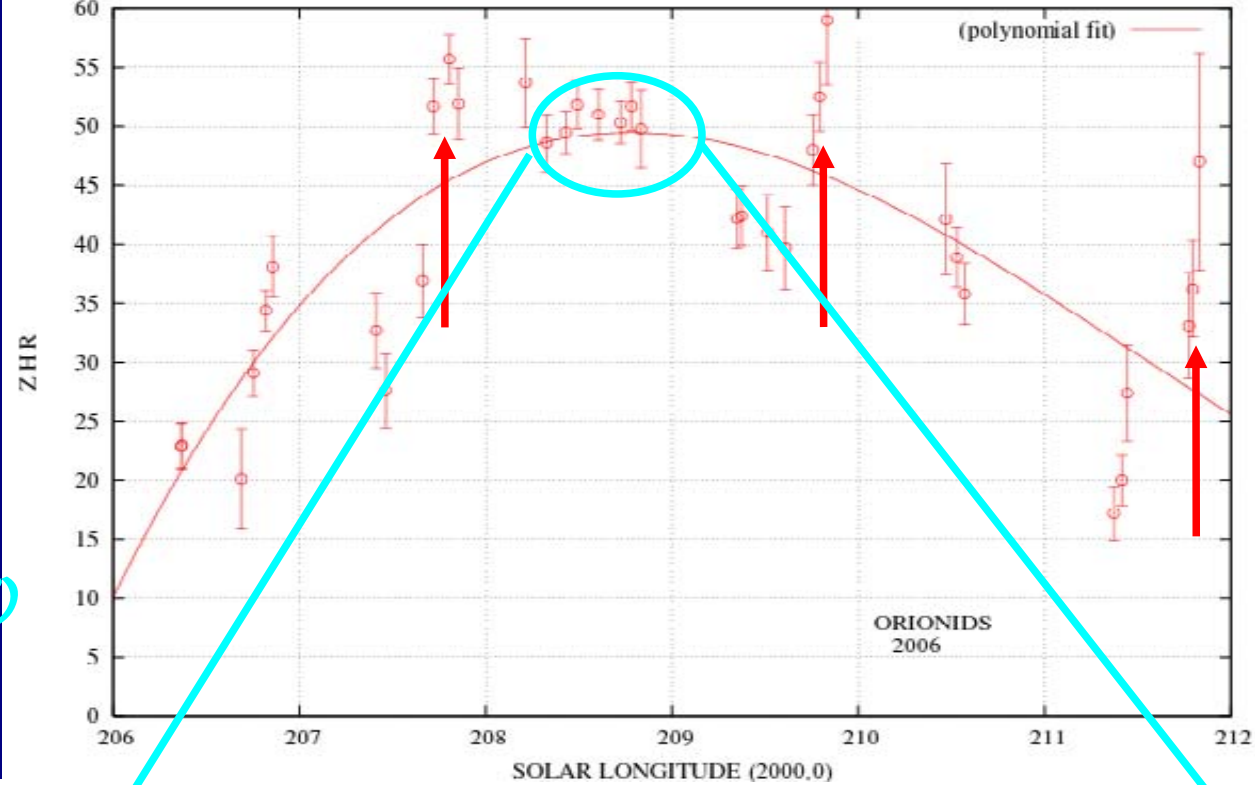
$\approx 11h$  UT (USA)

no complete overlap

(intervals of  $0.25h \sim 0.01^\circ$ )

zenith coefficient  $\gamma=1.0$

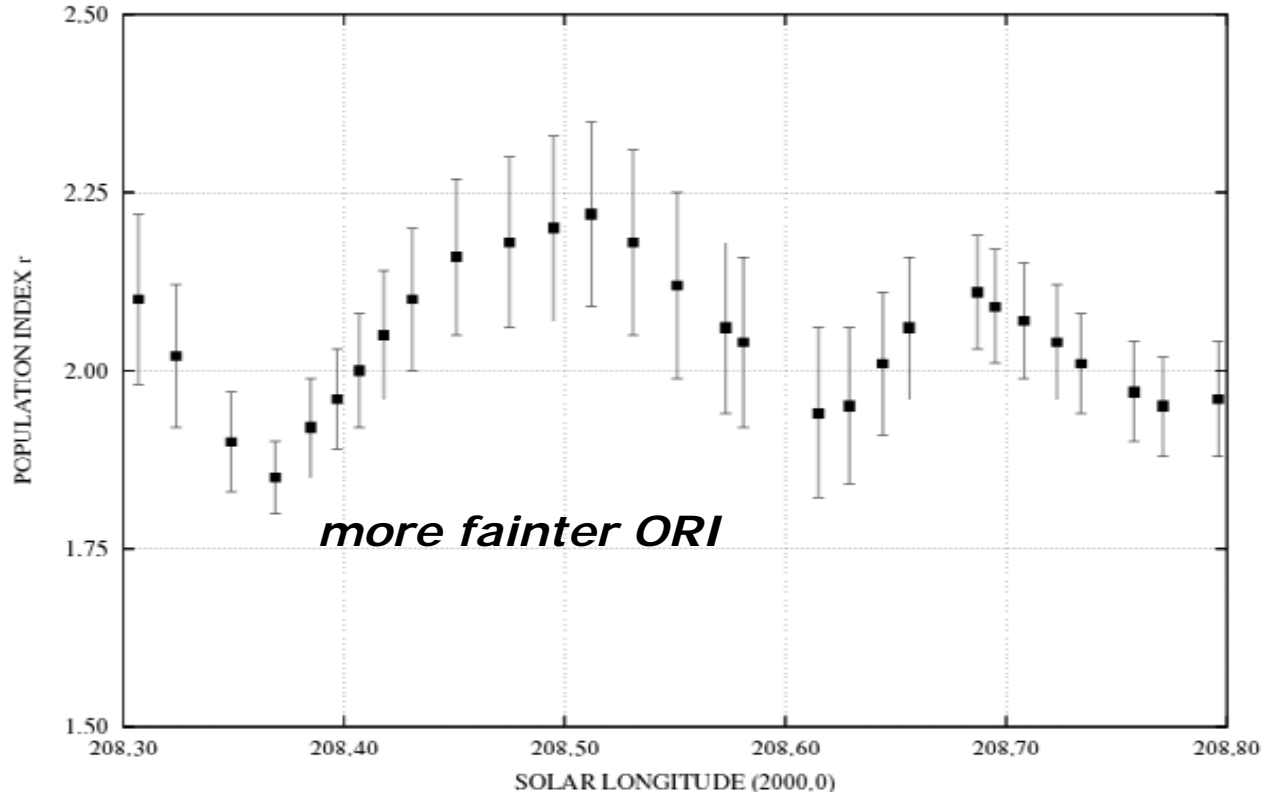
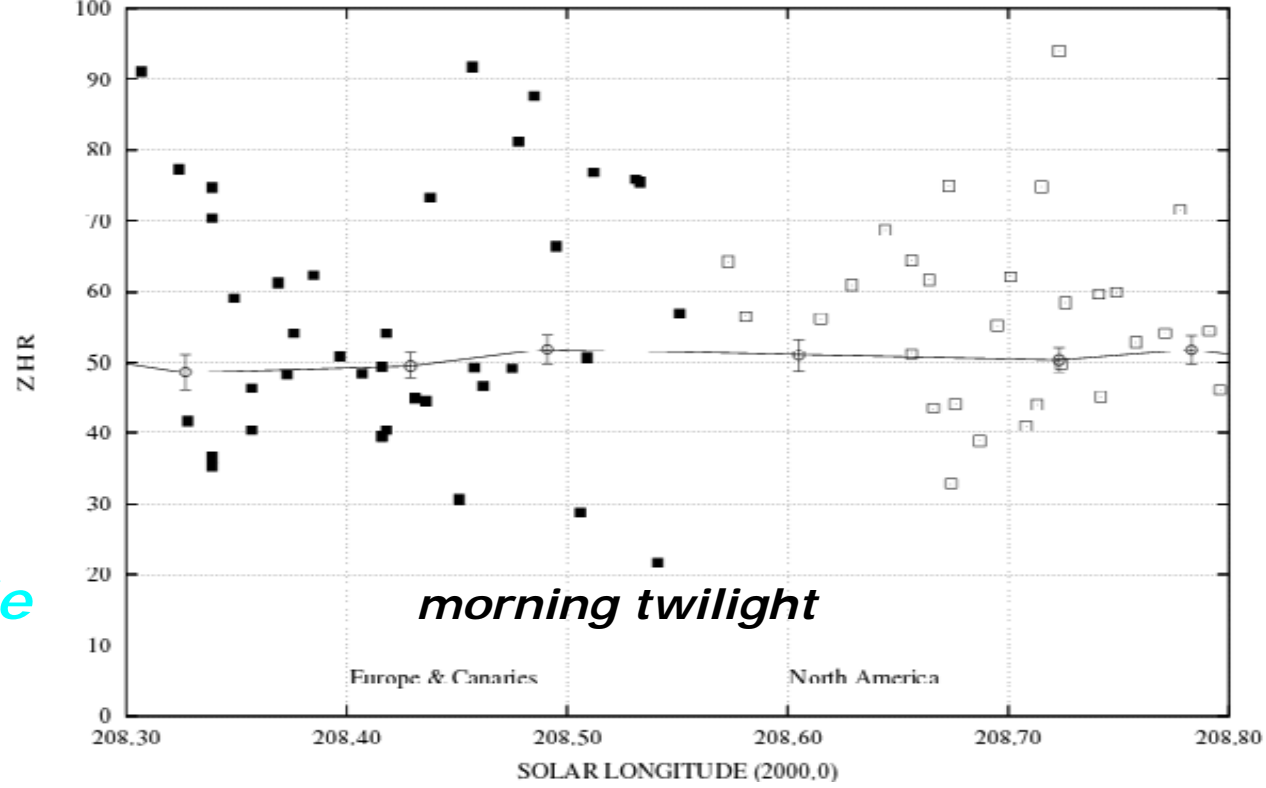
(else no smooth average)



# Orionids 2006

## ZHR-profile

features of ZHR variation  
not coinciding with *r* profile



## *r*-profile



# Orionids 2006

## ZHR-profile

### ZHR-peaks

207.9°: ZHR=55  $r=1.55$

209.8°: ZHR=60  $r=1.70$

211.8°: ZHR=45  $R=2.8$

1+2 at  $r$ -minimum

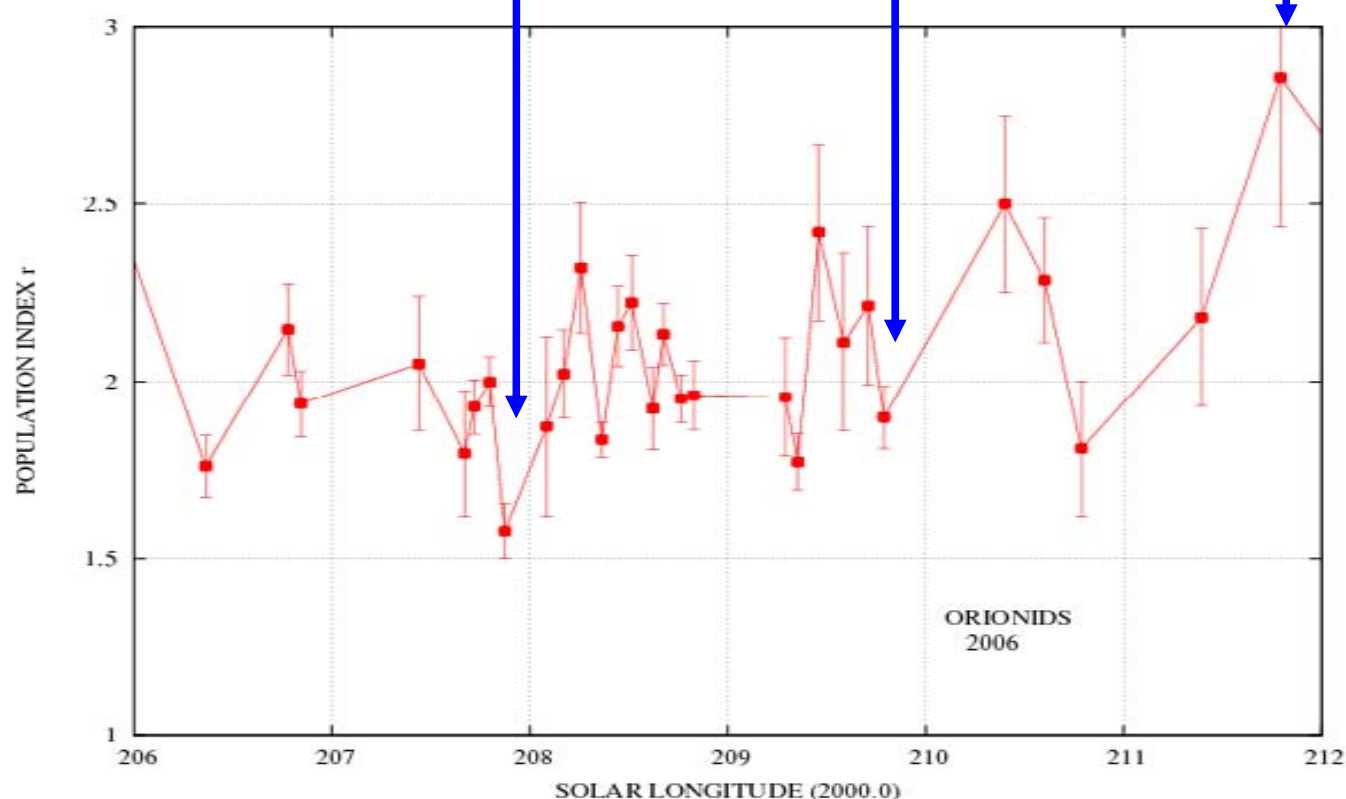
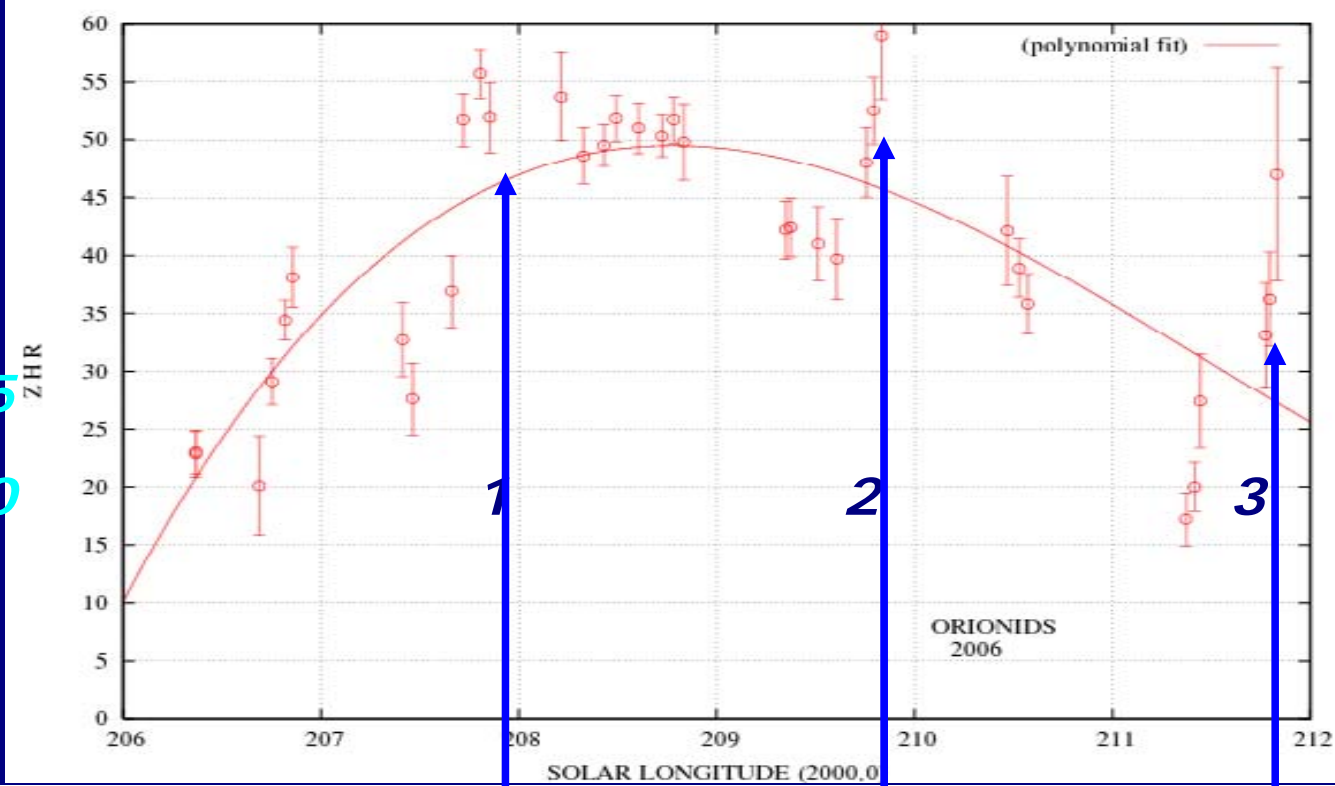
3 at  $r$ -maximum

\*.8°  $\approx$  11h UT (USA)

check overlap

systematic effects

## $r$ -profile

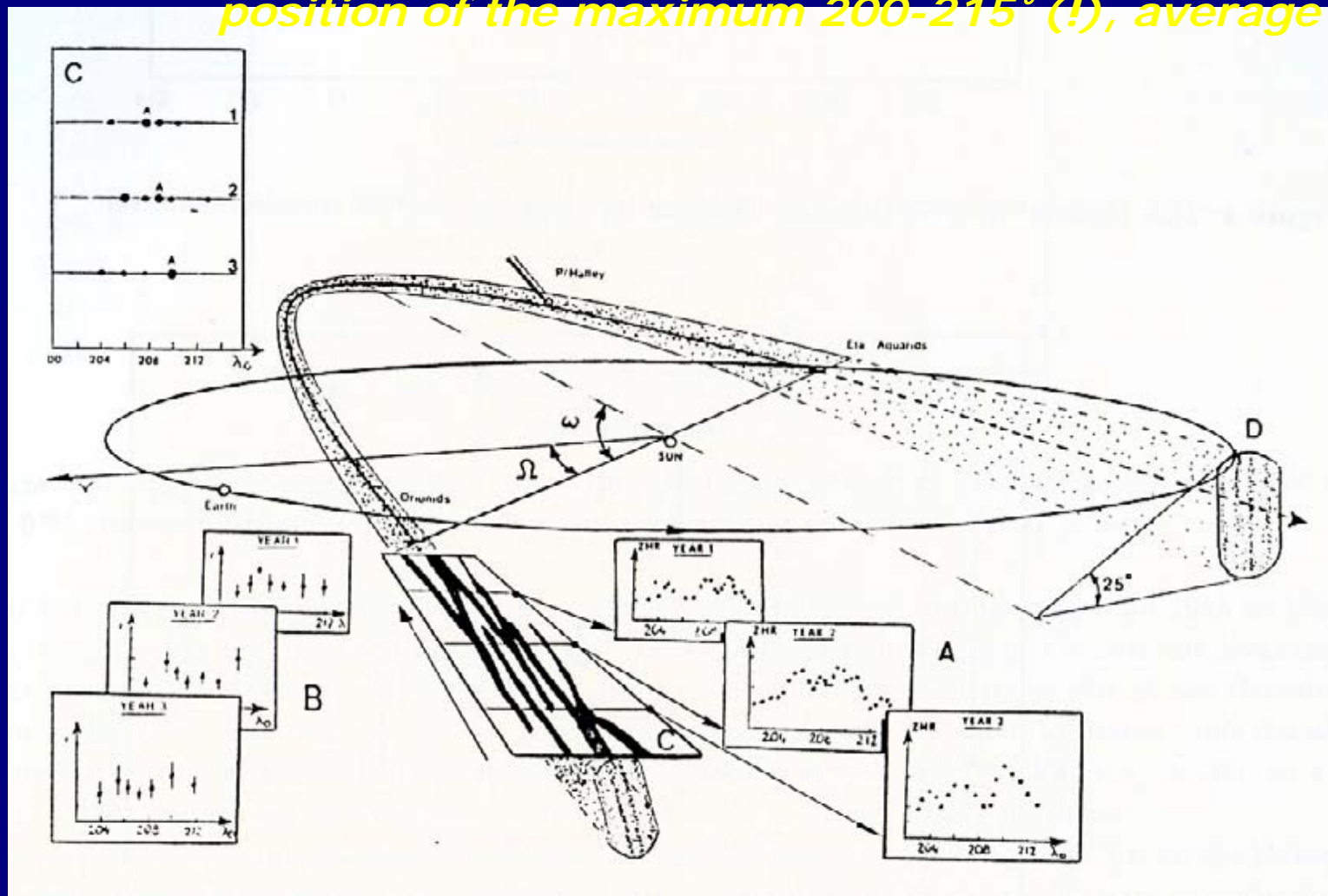


# Orionids – structure of the stream

periodic production of dust trails, orbital period  $\approx 70\text{...}80$  years

Hajduk (1970): filaments with density variations 1:4 from one return to next

position of the maximum  $200\text{--}215^\circ$  (!), average  $208^\circ$



## ***Orionids – structure of the stream***

***Meteoroids close to resonances remain (almost) undisturbed***

***Density in resonant meteoroid regions may be higher than in the vicinity of the parent comet***

***(Emel'yanenko, 2001: Resonance structure of meteoroid streams, ESA SP-495, 43-45)***

## ***Orionids – possible resonances***

***1:6     $a = 17.19$  AU     $\Delta a = 1.0$  AU (width of the resonanc zone)***

***1:5            15.22            0.9***

***1:4            13.12            0.8***

***(Emel'yanenko, 2001)***

***how do resonant meteoroids approach the Earth's orbit?***

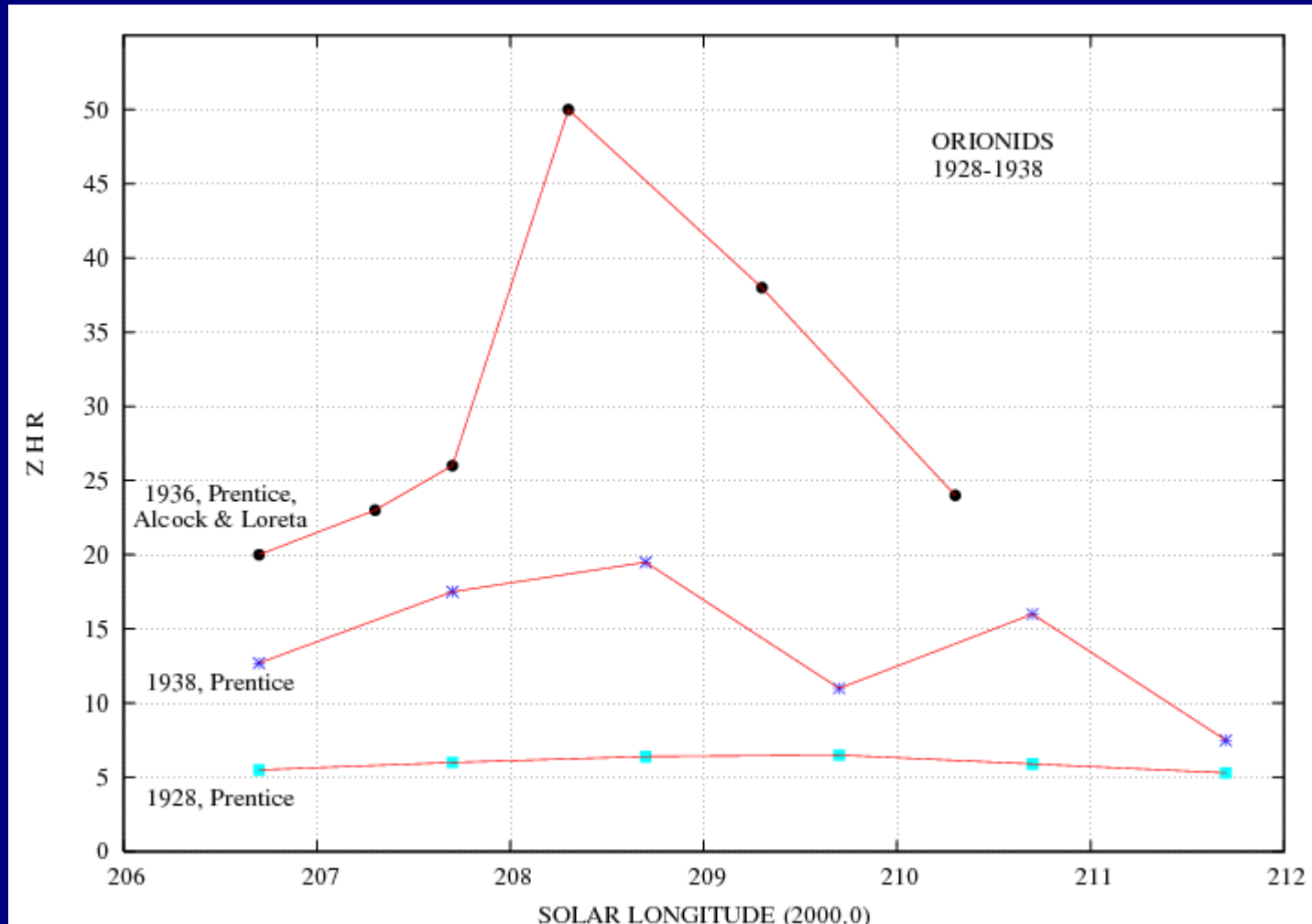
***widest resonance zone – best chance to be crossed by the Earth***

***if 1:6 -> 6 Jupiter orbital periods ( $\approx 72$  years) -> peaks 1932-36??***

***data analysis difficult – almost no raw data available***

***if 1:5 -> 56 years (max.  $\sim 1950$ ); 1:4 -> 45 years (max.  $\sim 1961$ )***

# Activity profiles 1928, 1936, 1938



*enhanced rates especially in 1936*

*despite all calibration problems: factor >2 of „average“*

## Conclusions

### 1. population index $r$

minimum of  $r$  at  $207.9^\circ$ :  $r=1.6$  – almost like Leonids 1998

further minima  $209.3^\circ$ ,  $210.8^\circ$   $r \sim 1.8$  – still very low!

local maxima  $208.2^\circ$ ,  $209.4^\circ$ ,  $210.4^\circ$ ,  $211.8^\circ$

### 2. ZHR

peak ZHR=58, extended period with ZHR~50 (>2x average)

3 ZHR-peaks:

$207.9^\circ$ : ZHR=55  $r=1.55$  ( $r$ -min. – bright meteors)

$209.8^\circ$ : ZHR=60  $r=1.70$  ( $r$ -min. – bright meteors)

$211.8^\circ$ : ZHR=45  $r=2.8$  ( $r$ -max. - faint meteors)

parameters similar to LEO 1998, JBO 1998 - resonant meteoroids?

### 3. Resonant Orionids in the past?

high rates in 1936 -> 1:6 resonance – high ZHRs in 2007 possible