

# Geminid Activity Over a Century

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# Outline

- Motivation
  - increasing rate predicted by Galina's model
  - find evidence from observations
- Last decades
  - additional data: video, radio forward scatter
  - independent samples
  - comparison and calibration (future)
- Long term data?
  - visual data – sources?
  - calibration?
- Conclusions
  - Geminids most active shower, promising

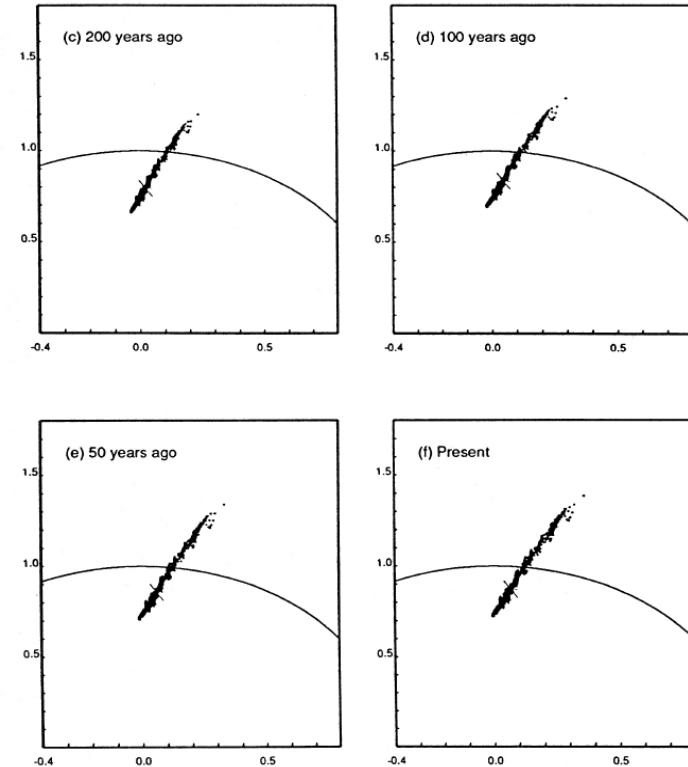
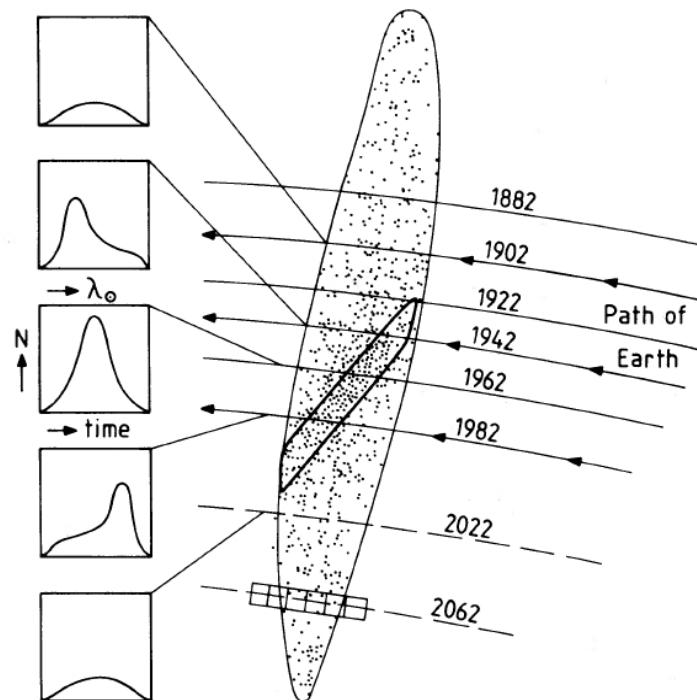


# Geminid Alert ...

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- shower known since 19th century
- ZHR approximately constant ( $\sim 120$ ) since 1980-ies
- future rather decreasing:  
models of Fox et al., 1983; Williams & Wu, 1993

*K. Fox, I. P. Williams and D. W. Hughes*



Cross-sections of the model Geminids generated 1000 yr ago (larger size). The position of Phaethon is represented by an asterisk.



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# Geminid Alert ...

- shape of profile and ZHR level roughly constant confirmed by observations over ~60 years – Rendtel, 2005
- ZHR not continuously checked (VMDB changes)
- no peculiarities during last decades?

„The Geminid peak activity level expressed in terms of the shower’s ZHR has not changed between 1944 and 2003. A slight increase from about  $120 \pm 10$  to  $130 \pm 10$  is still within the error margins.“ (Rendtel, 2005)

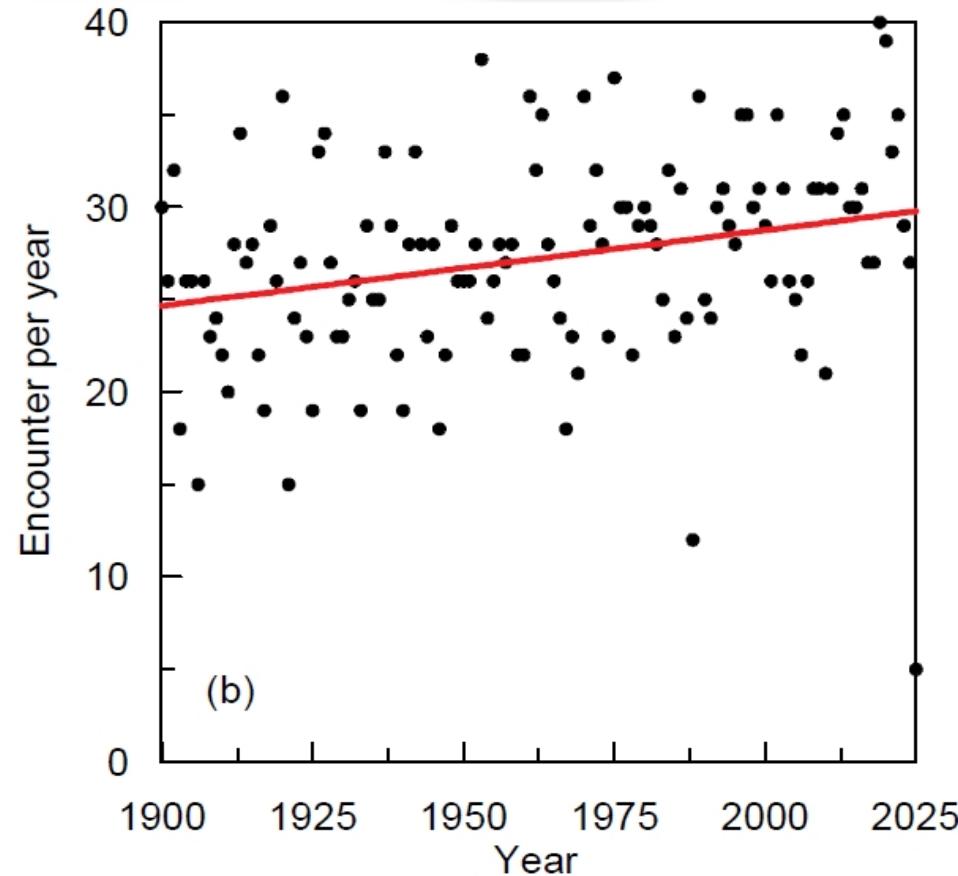
Question: is this really the case?



# Geminid Alert ...

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- October 2017 – Galina: current Geminid activity level?
- model (as described before) – different from previous slides

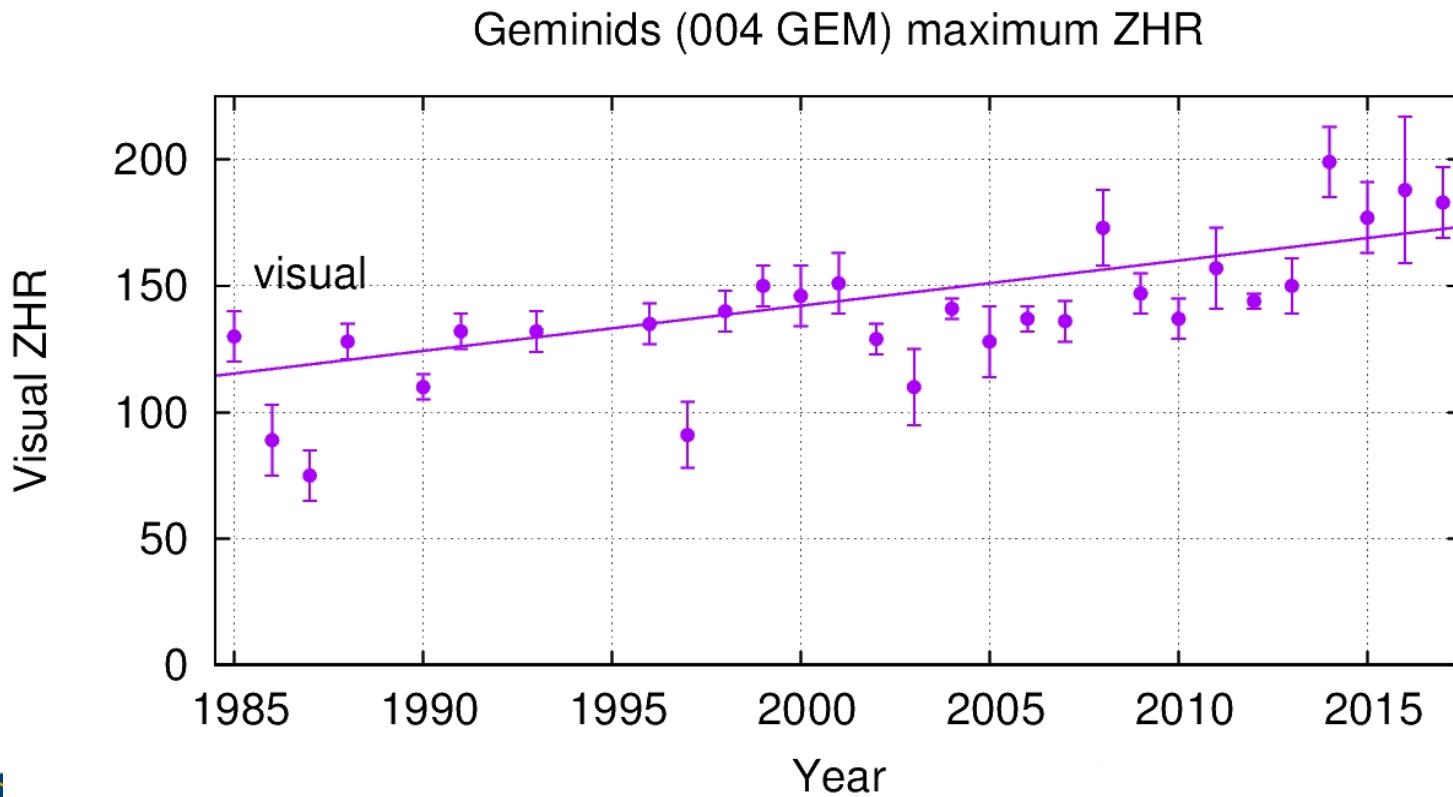




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# Observations - recent

- question: current ZHR level?
- visual

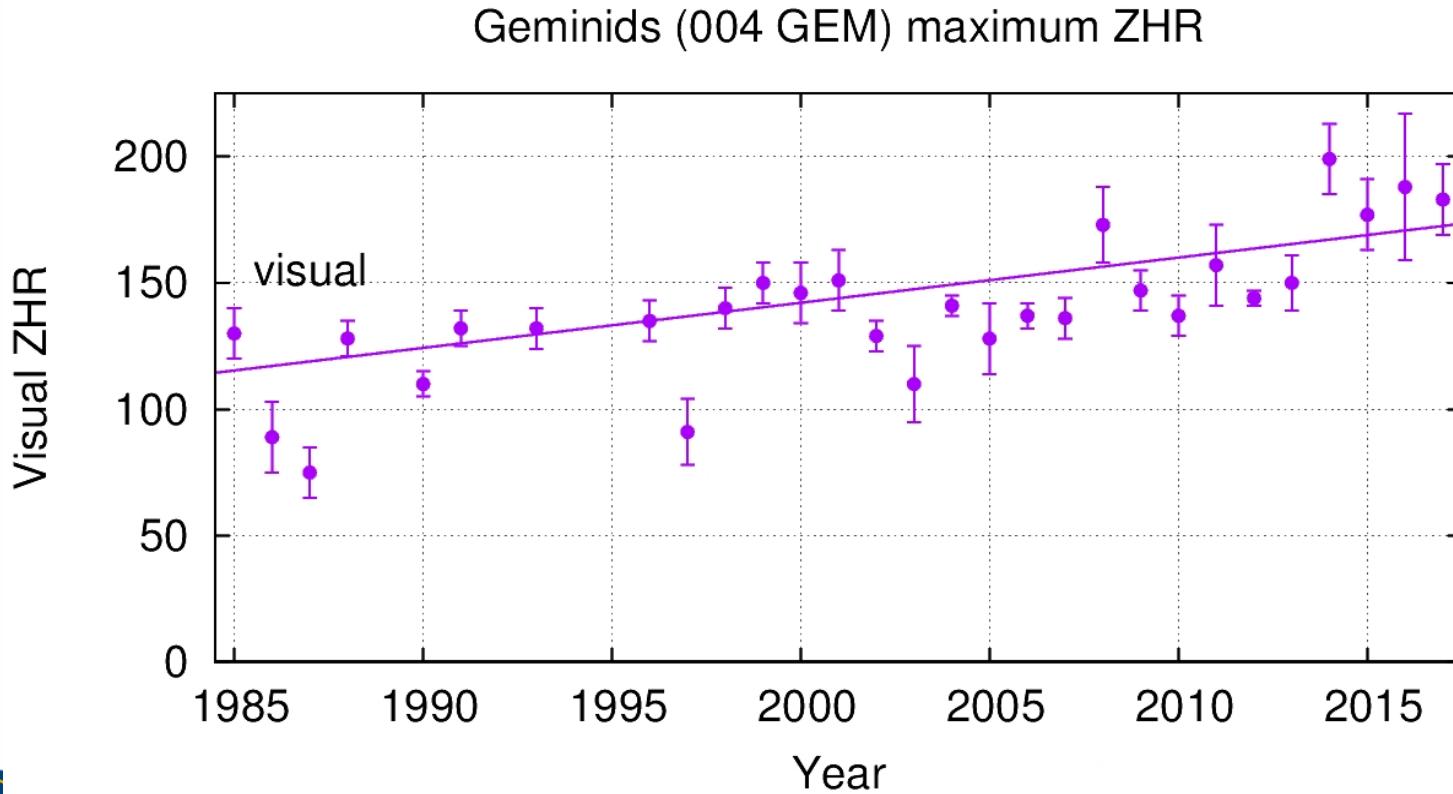




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# Observations - recent

- question: current ZHR level?
- visual → **there is an obvious increase**

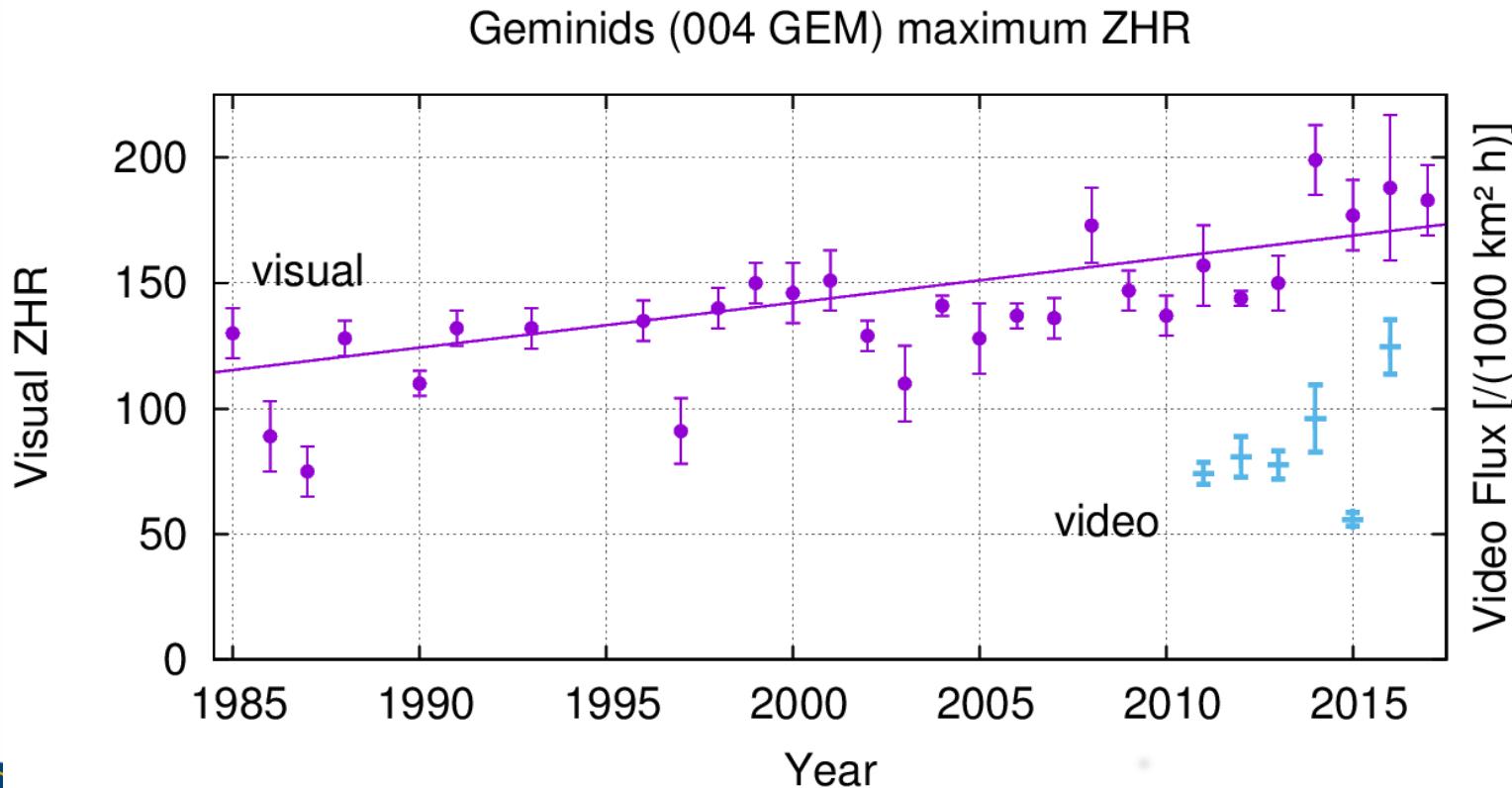




# Observations - recent

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- video meteor flux – since 2011 annually
- independent sample, same magnitude range



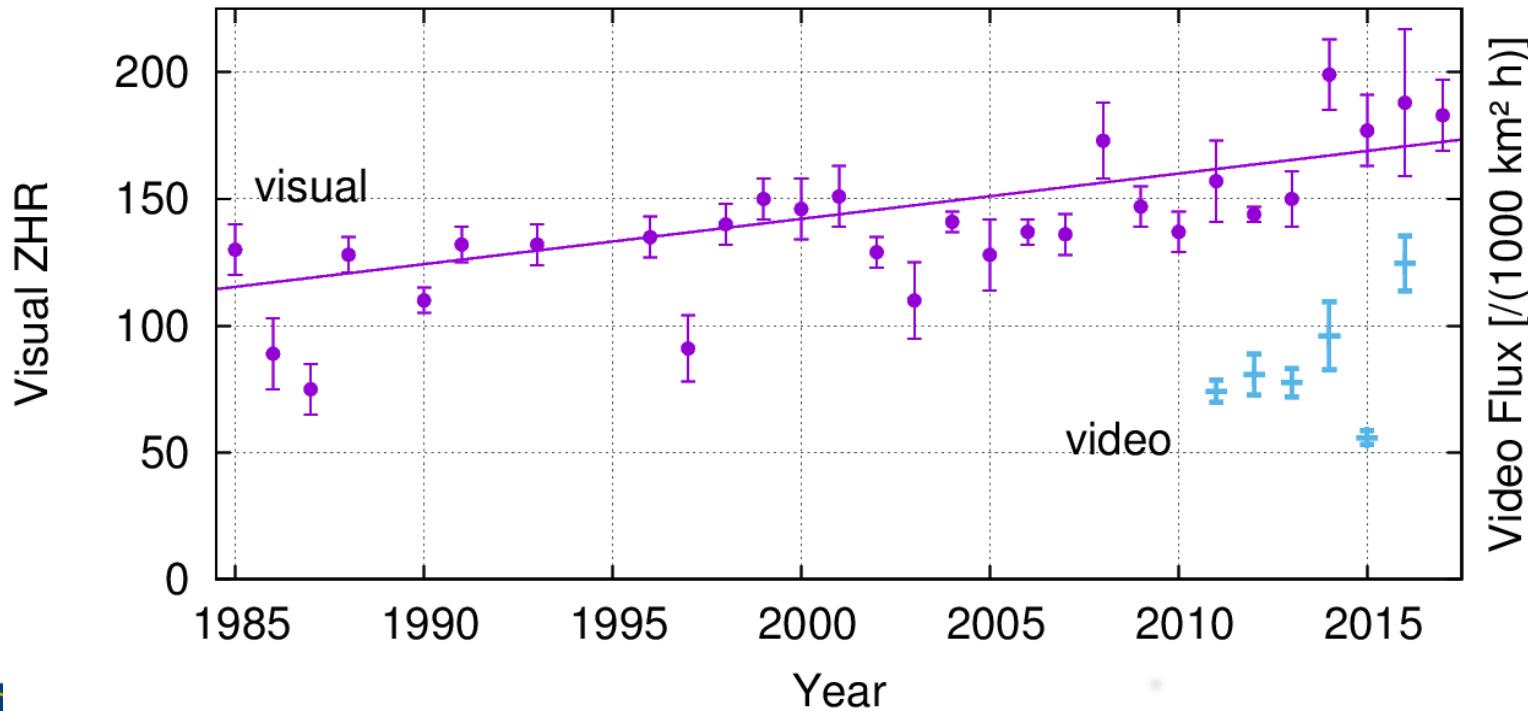


# Observations - recent

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- video meteor flux – since 2011 annually
- independent sample, same magnitude range  
→ **there is an obvious increase, too**

Geminids (004 GEM) maximum ZHR



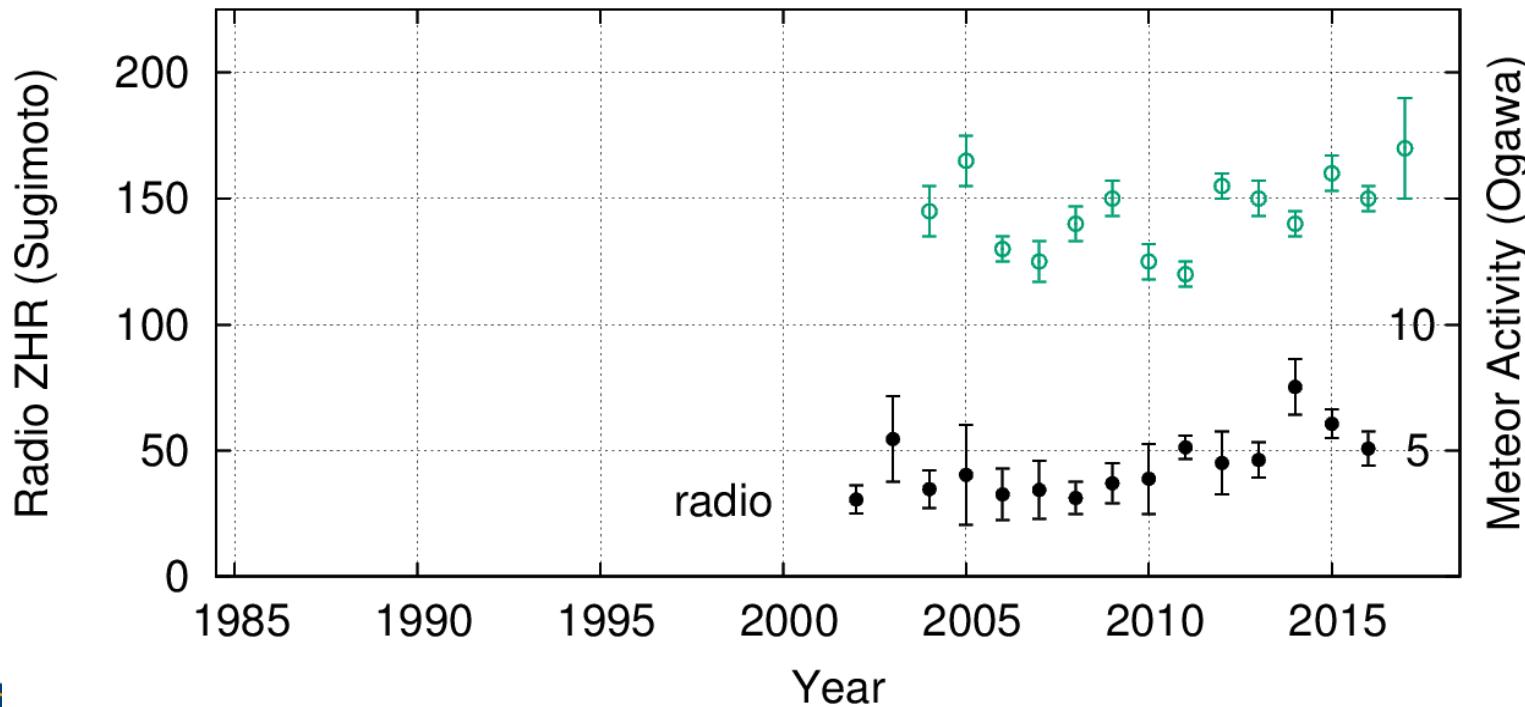


# Observations - recent

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- radio forward scatter: 2002-2016 „activity index“ (Ogawa)  
2004-2017 „Radio-ZHR“ (Sugimoto)
- independent sample, smaller meteoroids

Geminids (004 GEM) maximum ZHR





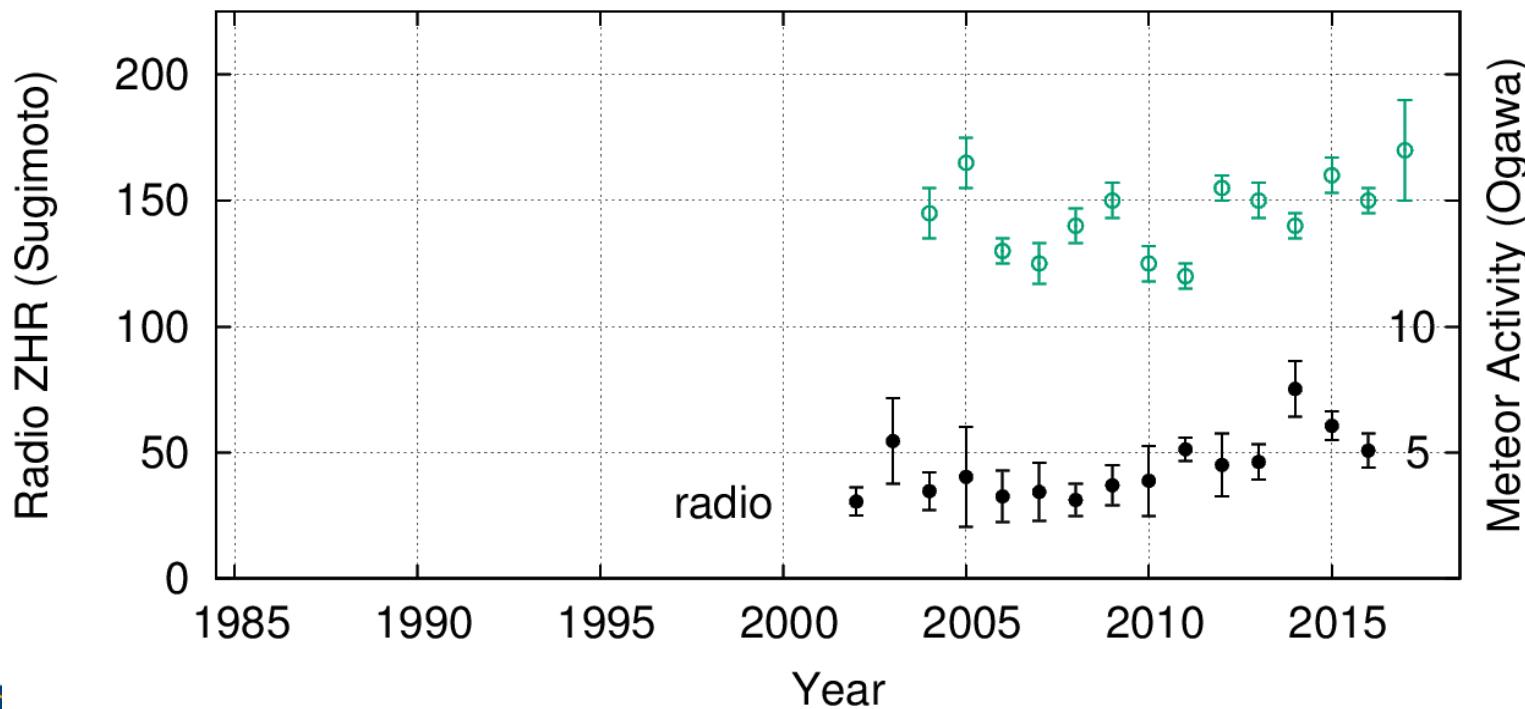
# Observations - recent

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- radio forward scatter: 2002-2016 „activity index“ (Ogawa)  
2004-2017 „Radio-ZHR“ (Sugimoto)
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**similar trend**

Geminids (004 GEM) maximum ZHR

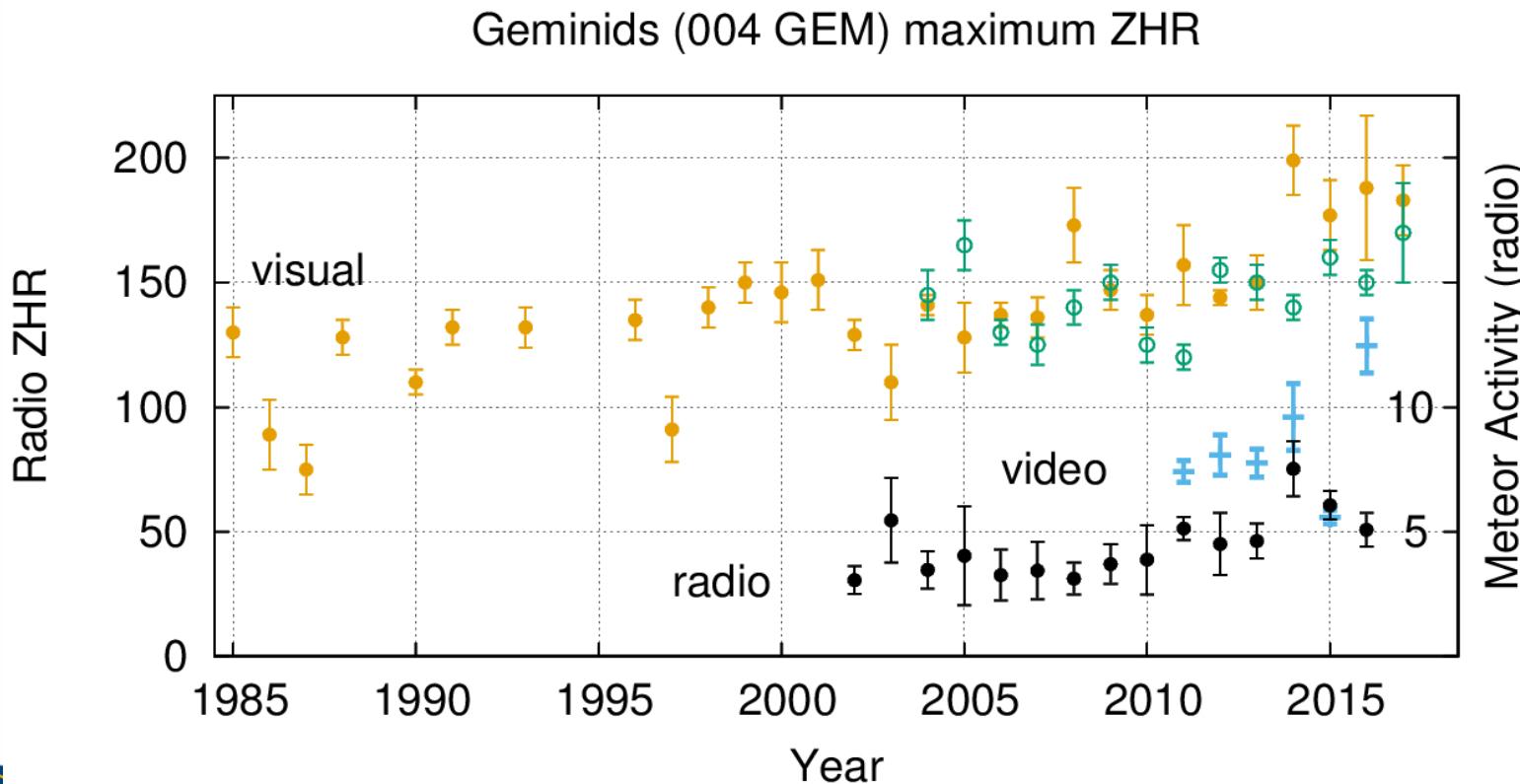




# Observations - recent

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- 1985-2017 – slight increase as shown in Galina's model  
→ **trend confirmed by various data sets**





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# Observations - past

- next step: old data – activity level in the past
- large gap roughly 1950 - 1970
- 1940-ies some comparable data, e.g. Czechoslovak reports
- first decades of 20th century: scarce information
- most dominated by radiant searches (Denning...)
- reconstruction from some reports 1868-1934

1838: only description  
no rate can be estimated  
(Besley, 1900)

some counts given like here 1986  
(Besley, 1900)

1838.— After observing the return of the Andromedids on December 6, 7, and 8 of this year, Herrick and his assistants, at Newhaven (Conn.), U.S.A., recorded 18 meteors on December 11 from 8<sup>h</sup> 45<sup>m</sup> to 10<sup>h</sup>, 28 on December 12 from 6<sup>h</sup> to 13<sup>h</sup> 30<sup>m</sup>, and 9 on December 15 from 6<sup>h</sup> to 9<sup>h</sup> 15<sup>m</sup>. These figures seemingly indicate a moderate display of Geminids.

1896, Dec. 9, 8<sup>h</sup> 30<sup>m</sup>-13<sup>h</sup> (at intervals): 39 meteors (22 Geminids). Dec. 11, 10<sup>h</sup>-15<sup>h</sup>: 111 (89). Dec. 12, 14<sup>h</sup>, 15<sup>h</sup>-16<sup>h</sup> 15<sup>m</sup>: 30 (21); 9 were of the 1st magnitude, and only three left streaks. At midnight on December 11 the horary rates for all meteors and Geminids were 30 and 20 respectively.—H. CORDER.

„data sets“ for 1914 (Bruseth, 1915) and 1934 (Millman, 1935)



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# Observations - past

- how to calibrate such data?
- period noted, but is this *effective obs. time*?
- no LM given: assuming 6.0 for good conditions, 5.0 if moon present  
this is only a guess!
- observations not primarily meant for rates!  
magnitude data hint at low perception  
uncertainty about faint meteors?  
often radiant determination in background



# Observations - past

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- another example (1934 Dec 13/14)

(1934) The actual numbers of meteors observed are recorded in Table 1.  
 13/14 Dec The hourly rates, reduced to six observers, are plotted in Figure 1.

$\frac{(\Delta T_{\text{eff}})}{\Delta T}$

TABLE 1  
head

$r = 2.4$

UT	E.S.T.	$h$	Geminids	Non-Geminids	LM	5.0	5.5	6.0	
0340-0407	10.40-11.07	0.30	11 50°	3	175	114	73		
0411-0445	11.14-11.45	0.45	8 56	1	80	51	33		
0937-0640	12.37- 1.10	0.50	19 70	2	150	96	62		
					haze				
0709-0741	2.09- 2.41	0.50	415 12 77	3	light clouds				
					sky half clouded				
3 Beads.			0804-0830	3.04- 3.30 0.40	8 74°	2	77	50	32
			0830-0850	3.30- 3.50 0.30	8 70	2	105	68	44
			0850-0910	3.50- 4.10 0.30	11 67	4	147	95	61
			0910-0930	4.10- 4.30 0.30	2 63	1	28	18	11
			Totals.....		79	18			

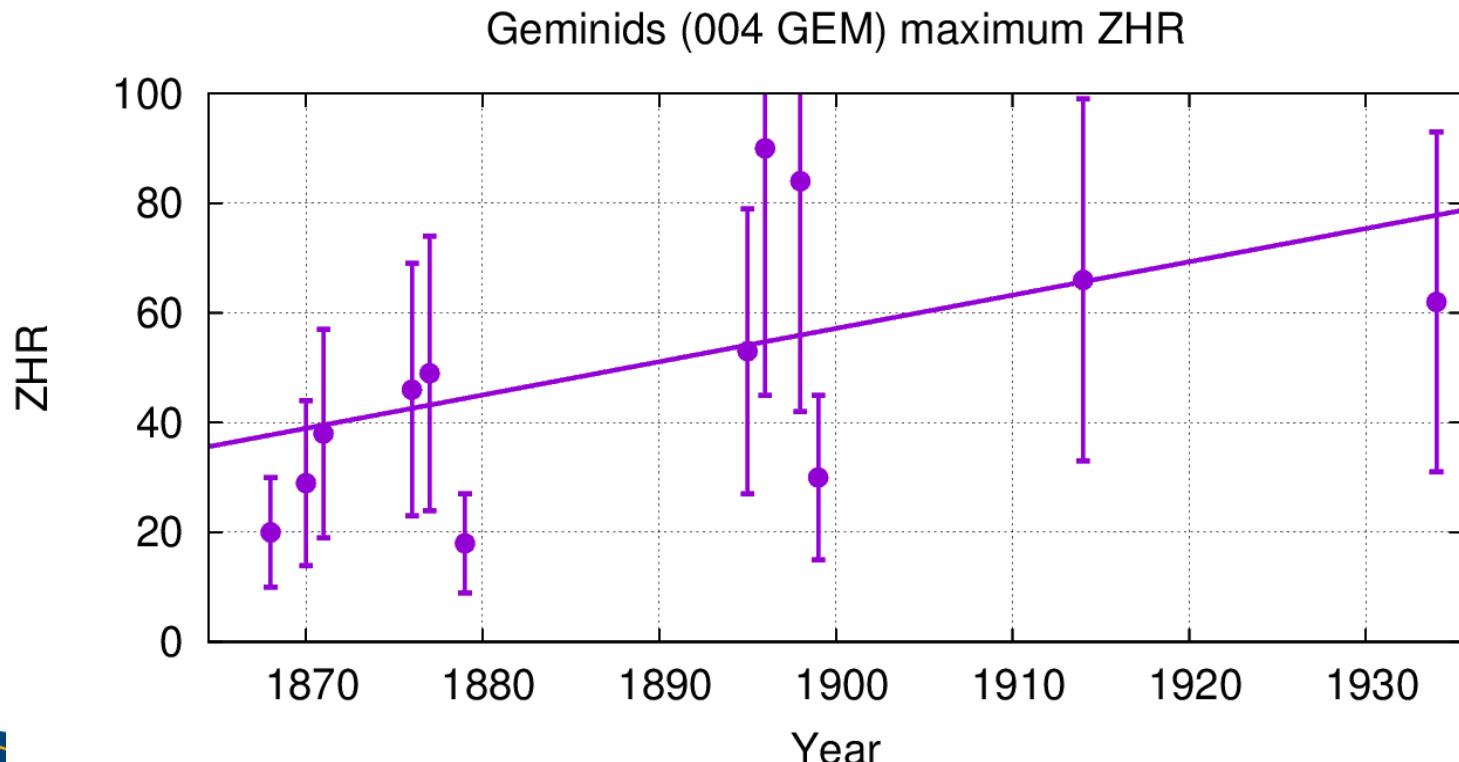


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# Observations - past

- preliminary result

1879 and 1899 pre-maximum (Dec 9, 10)  
general ZHR level <50 before 1900, >60 after 1910  
linear fit just an „educated guess“



# Summary & Conclusions

## Geminid activity increases:

from 1985 onwards well documented  
since ~2002 several independent data samples  
visual data further of importance

## Old sources?

we can: estimate a general ZHR level based on assumptions  
but: enormous error margins!

## Interaction between model predictions and observations

here: model predicts peculiar trend, confirmed by observations  
many more events to test models versus data!

**Geminids: „best shower of the year“ + interesting years to come**



**Thank you**

**& clear skies  
for observations**