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FINNISH METEOROLOGICAL INSTITUTE

Rain and flash cells in July 2003

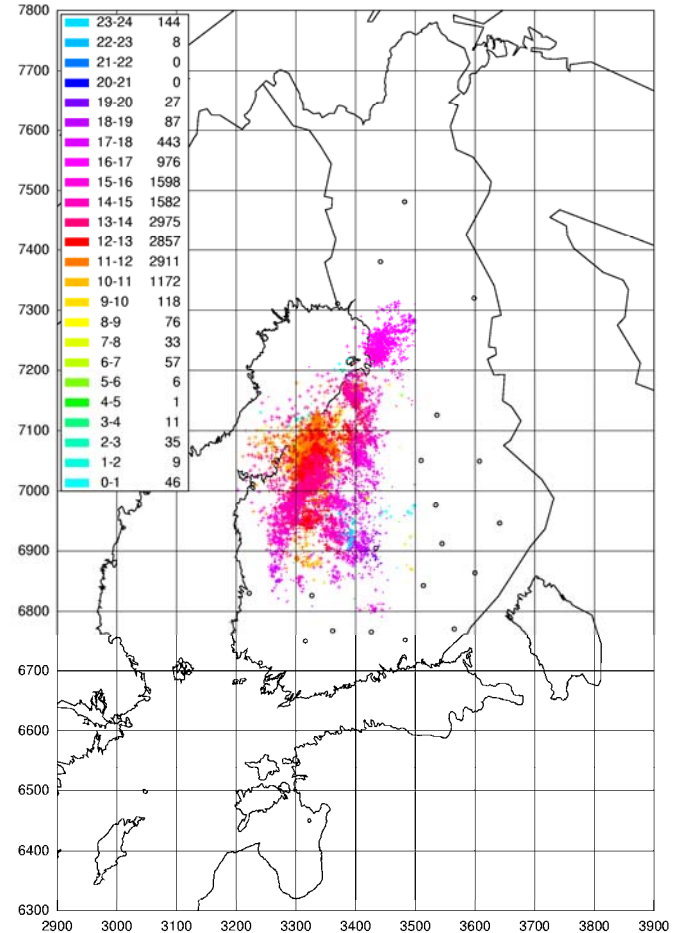
Tapio J. Tuomi
Finnish Meteorological Institute



July 15-19 2003:
unusual occurrence
of very active but
nearly stagnant air-
mass thunderstorms
in same region.
Most active day
19th (ca. 15 000 fl.)
- many positive

FMI LIGHTNING LOCATION SYSTEM
TIME 030719 00:00 - 030719 23:59 UTC
ON THE MAP 15172 FLASHES 15172 FLASHES)
(9094 negat., 6078 posit. flashes)

Hourly flashes in the table

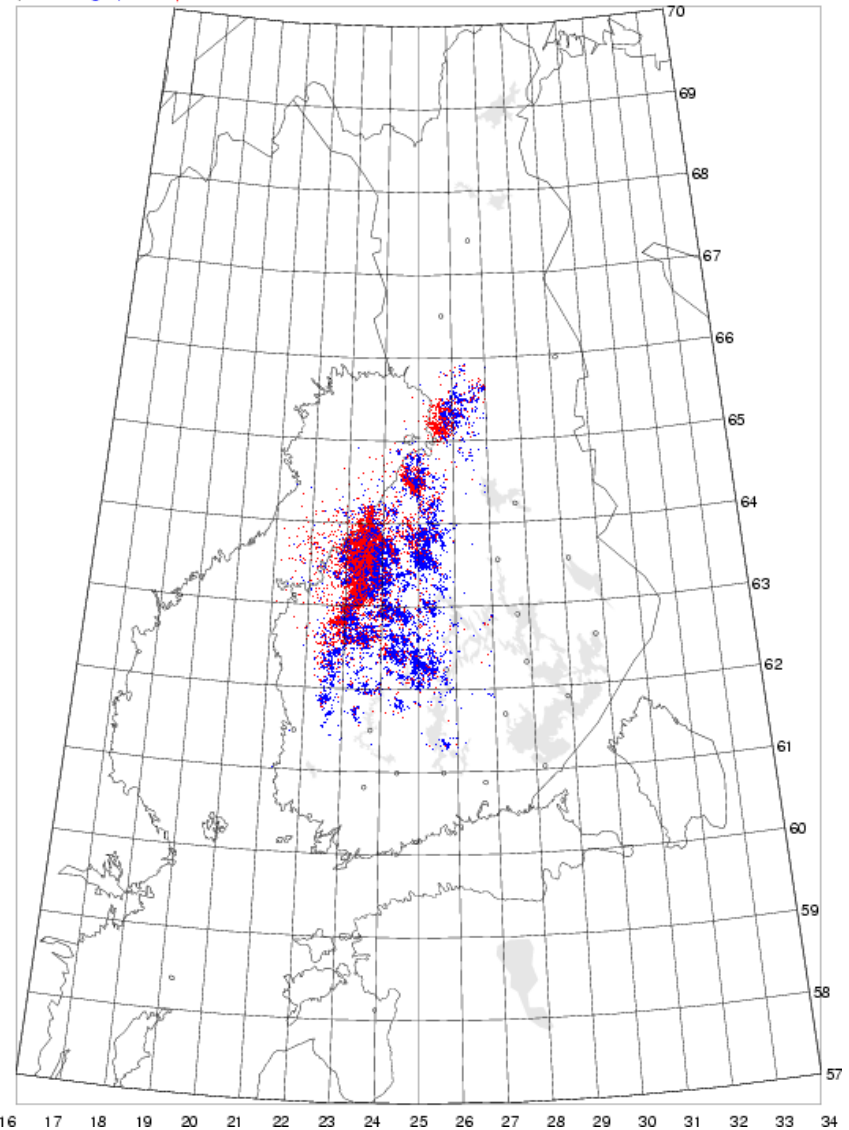




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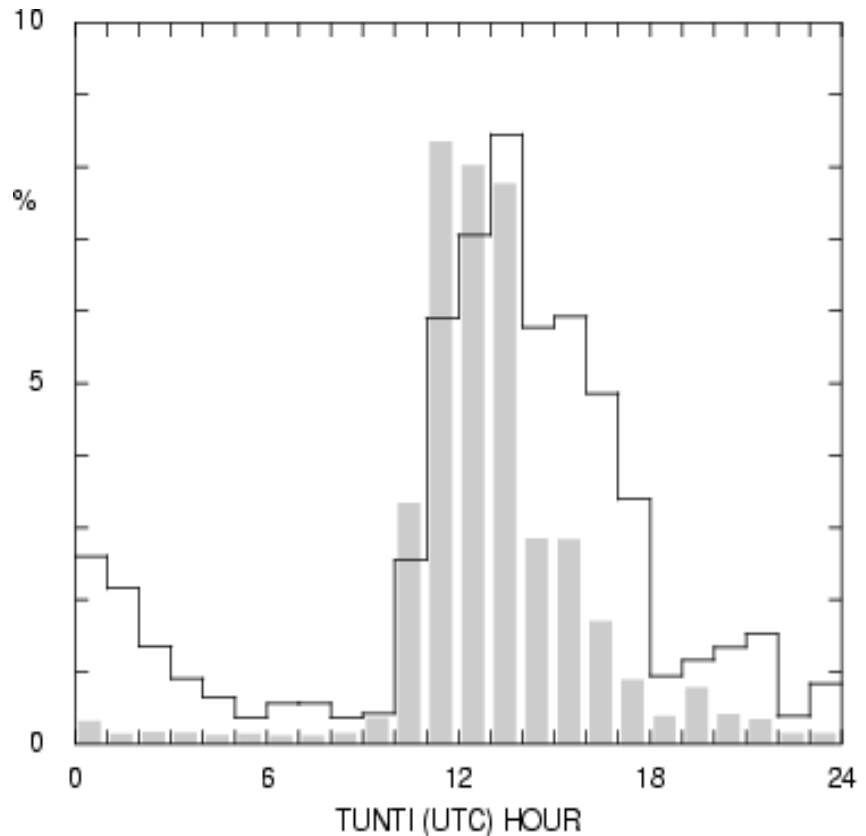
Same as previous
– neg. flashes blue
and pos. flashes
red

ILMATIETEEN LAITOKSEN SALAMANPAIKANNIN
AIKA 030719 00:00 - 030719 23:59 UTC
KARTALLA 15172 SALAMAN ISKUA (15158 SALAMAA)
(9082 negat., 6076 posit. salamaa)





As seen in the previous slide, pos. flashes are abundant in the beginning. Typical strengths (kA): + 5, - 12. Pos. flashes \Leftrightarrow cloud discharges?



Paikannettujen salamoiden tuntijakautuma 2003 (% yhteislukumäärästä).

Viiva: negatiiviset (14121), hamaa: positiiviset (9373).

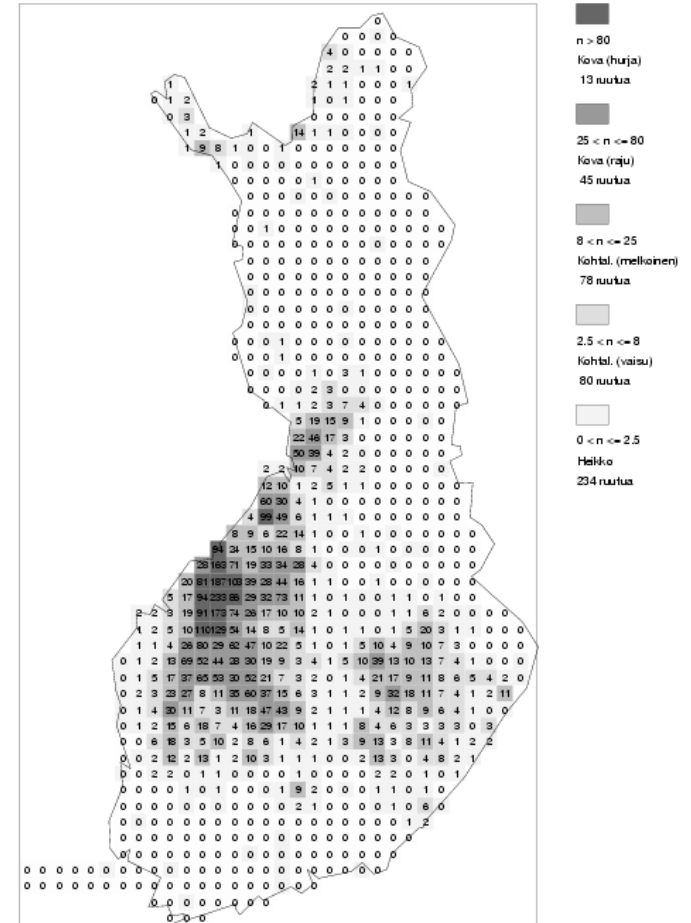
Hourly distribution of located flashes in 2003 (% of total number).

Line: negative (14121), gray: positive (9373).



Record daily flash density: max 233 fl/100 km² (20x20 km squares)
- values > 80 considered exceptionally high (13 squares on July 19)
(flashes in SE not included above)

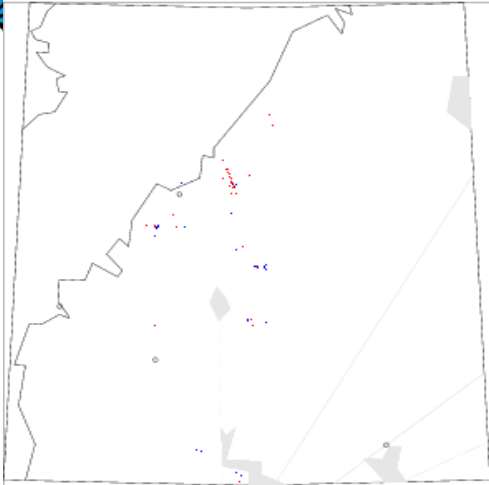
Paikannettu salamatiheys n (sal/100 km²), päivä 030719 (kokonaismäärä 20880). Ruudut 20 km x 20 km.



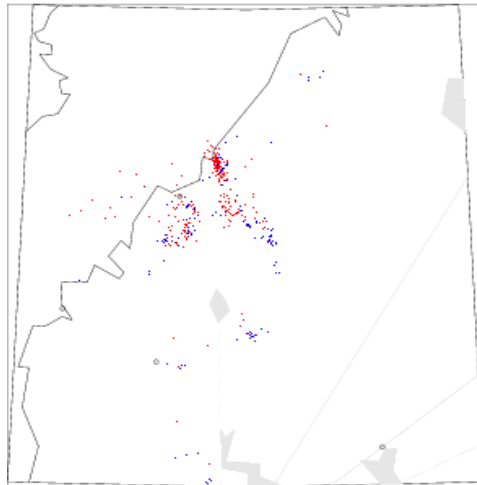


Next slide:
Flashes/10 min at 50 min
intervals starting at 10:00 UTC
blue: neg, red: pos
- slow spreading of flash “front”

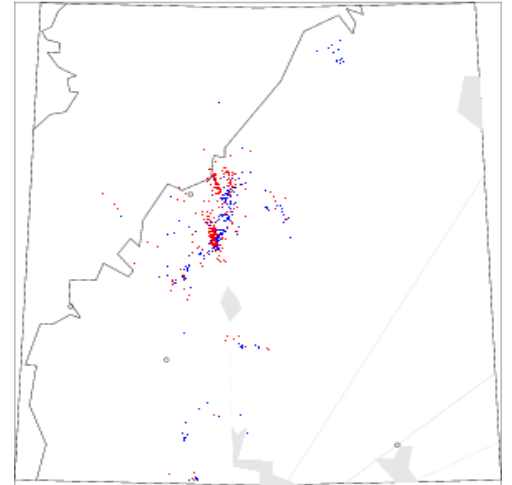
FMI LLS
TIME 030719 10:00 - 030719 10:10 GMT
LAT 62.00 - 65.00, LON 21.00 - 27.00
ON THE MAP 62 STRIKES



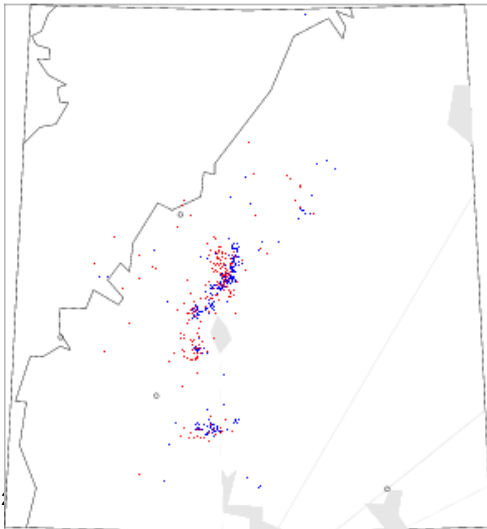
FMI LLS
TIME 030719 10:50 - 030719 11:00 GMT
LAT 62.00 - 65.00, LON 21.00 - 27.00
ON THE MAP 379 STRIKES



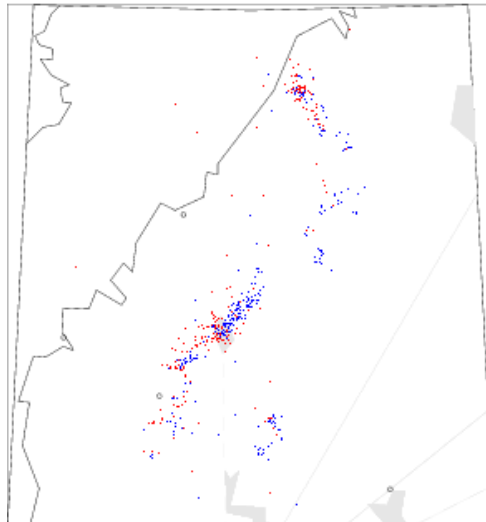
FMI LLS
TIME 030719 11:40 - 030719 11:50 GMT
LAT 62.00 - 65.00, LON 21.00 - 27.00
ON THE MAP 525 STRIKES



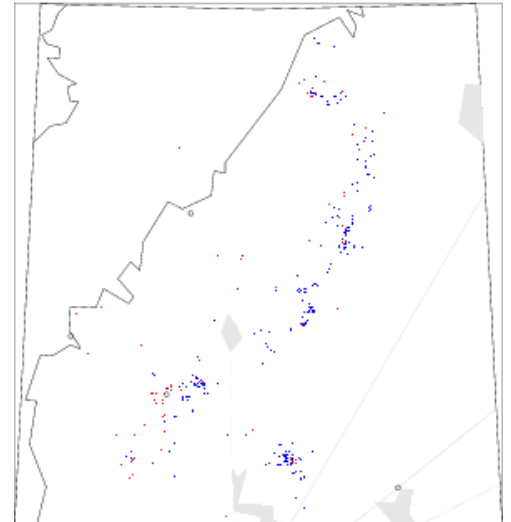
FMI LLS
TIME 030719 12:30 - 030719 12:40 GMT
LAT 62.00 - 65.00, LON 21.00 - 27.00
ON THE MAP 469 STRIKES



FMI LLS
TIME 030719 13:20 - 030719 13:30 GMT
LAT 62.00 - 65.00, LON 21.00 - 27.00
ON THE MAP 533 STRIKES

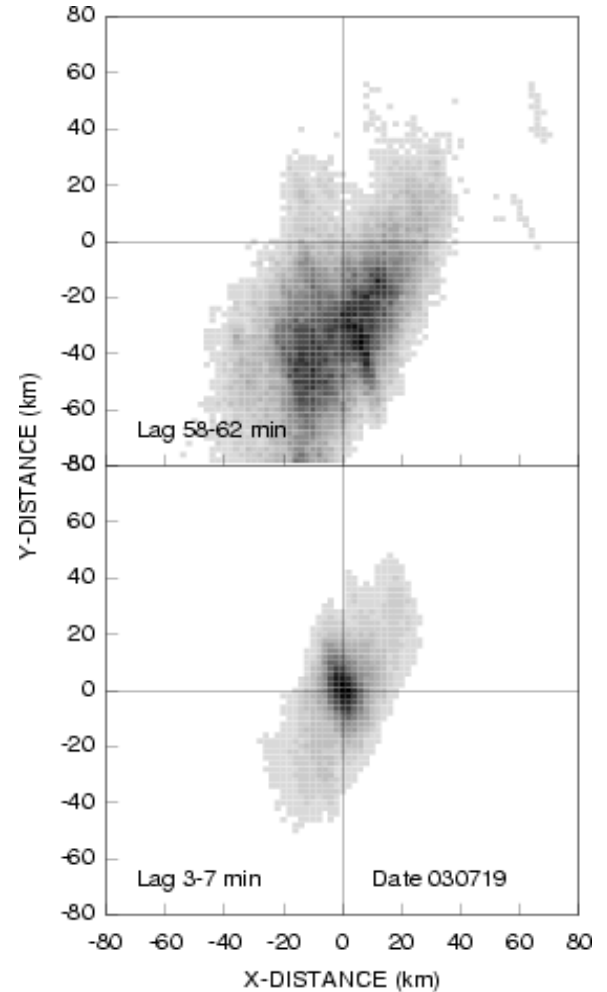
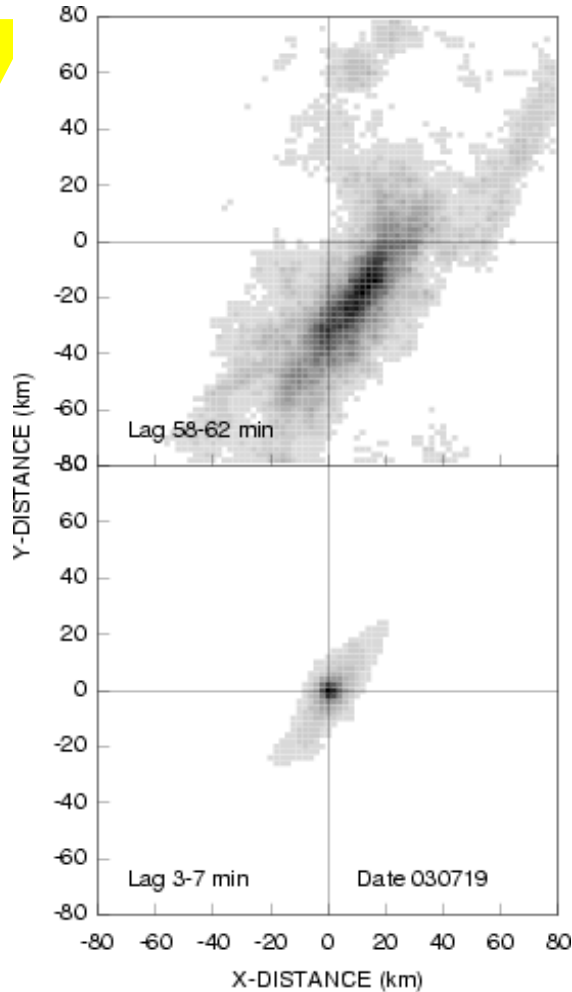


FMI LLS
TIME 030719 14:10 - 030719 14:20 GMT
LAT 62.00 - 65.00, LON 21.00 - 27.00
ON THE MAP 321 STRIKES





Spatial
correl. for
1-h & 5-min
lags for neg.
(left) and
pos. (right)
flashes





Flashes have been grouped into cells with a certain algorithm: a new flash is associated with the nearest cell whose temporal and spatial distances are below given limits

For clarity, only cell centres are drawn (floating averages of at most 20 flashes)



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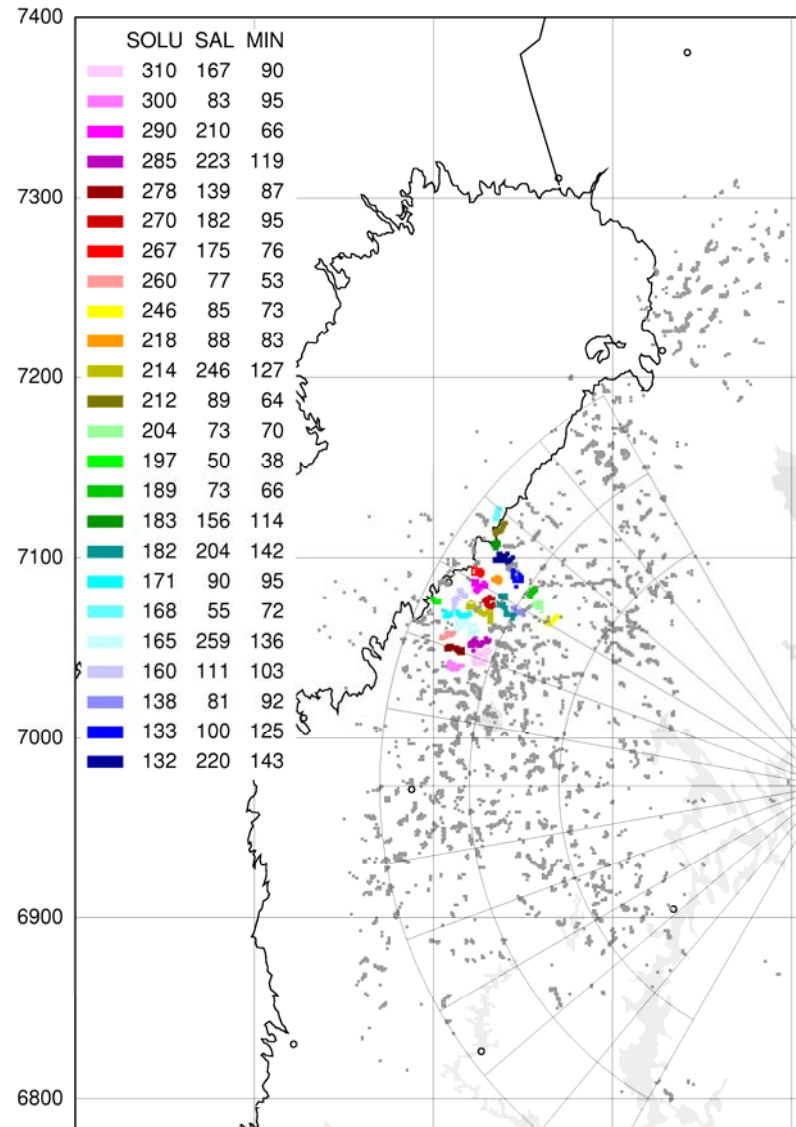
Flash cells (central points)

- a choice of 24 cells in colours, table giving # flashes and lifetime
- others in gray
- polar coord: radar view

27/10/04

AIKA 030719

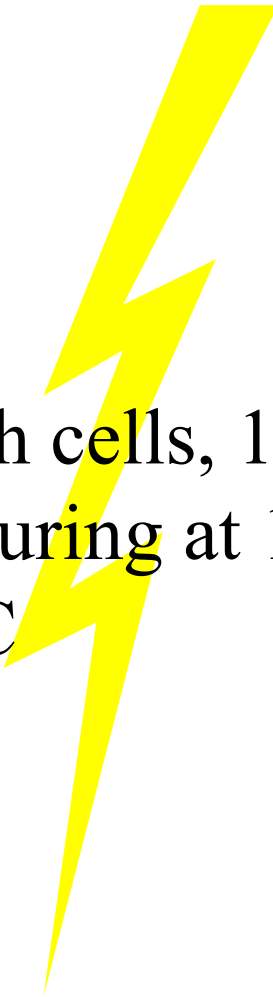
R = 10 T = 15 I = 20 straylim 50





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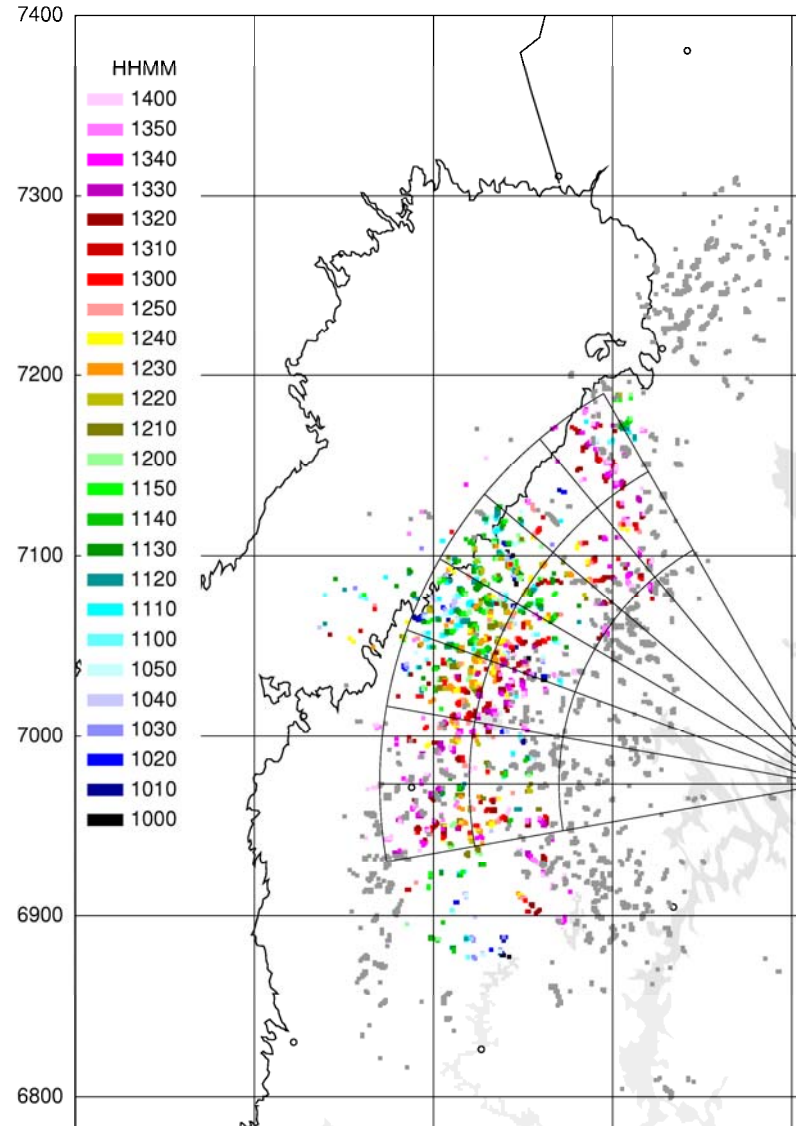
Flash cells, 10-min colouring at 10-14 UTC



27/10/04

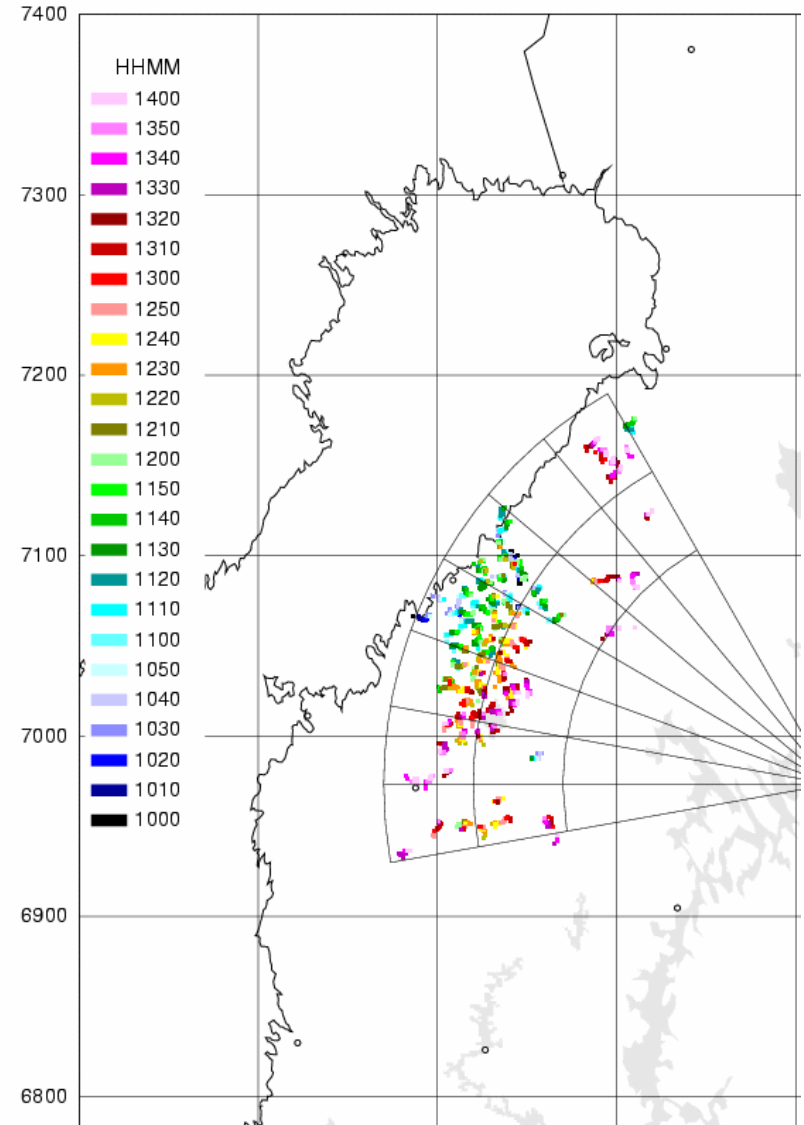
AIKA 030719

R = 10 T = 15 I = 20 straylim 50





Flash cells as in
previous slide, at
least 40 fl/cell,
limited area



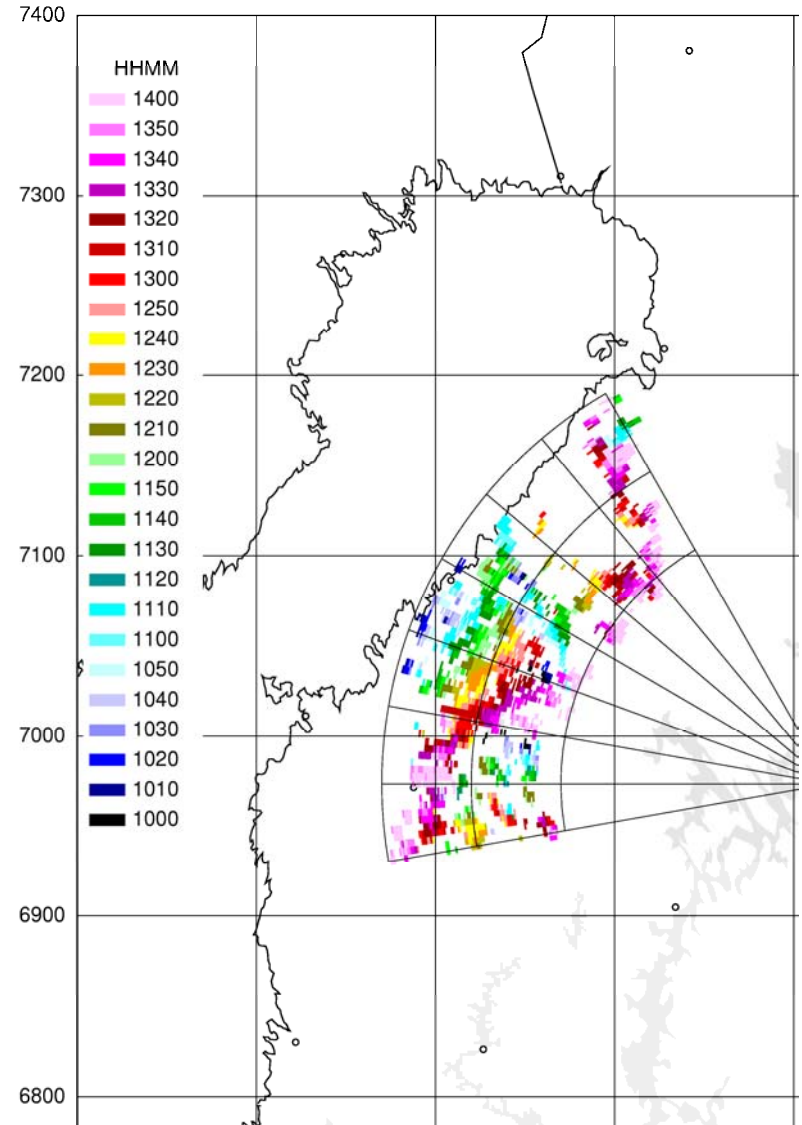


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Rain cells of at least
40 dBZ radar echo at
10-14 UTC (limited
area) with 10-min
colouring

27/10/04

PRECIP. CORES EXCEEDING 40 dBZ, DATE 030719



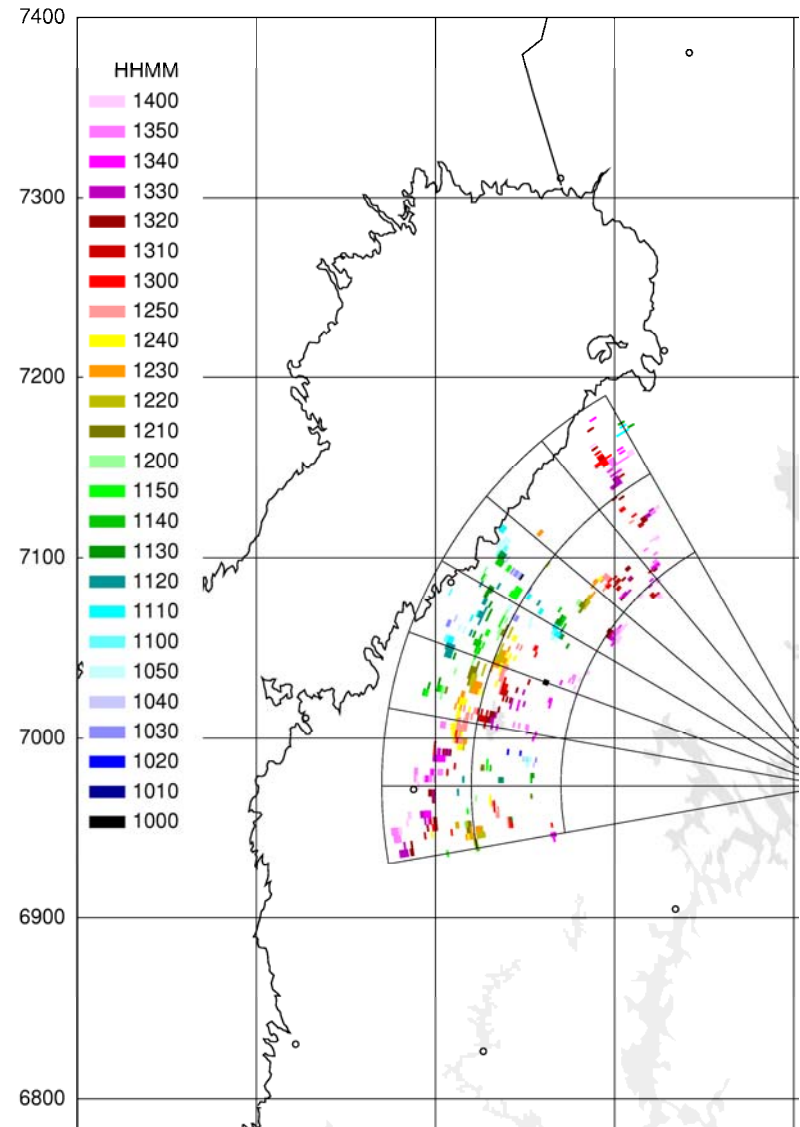


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Rain cells of at least
48 dBZ radar echo at
10-14 UTC
- these cell cores are
nearly stagnant during
their lifetimes

27/10/04

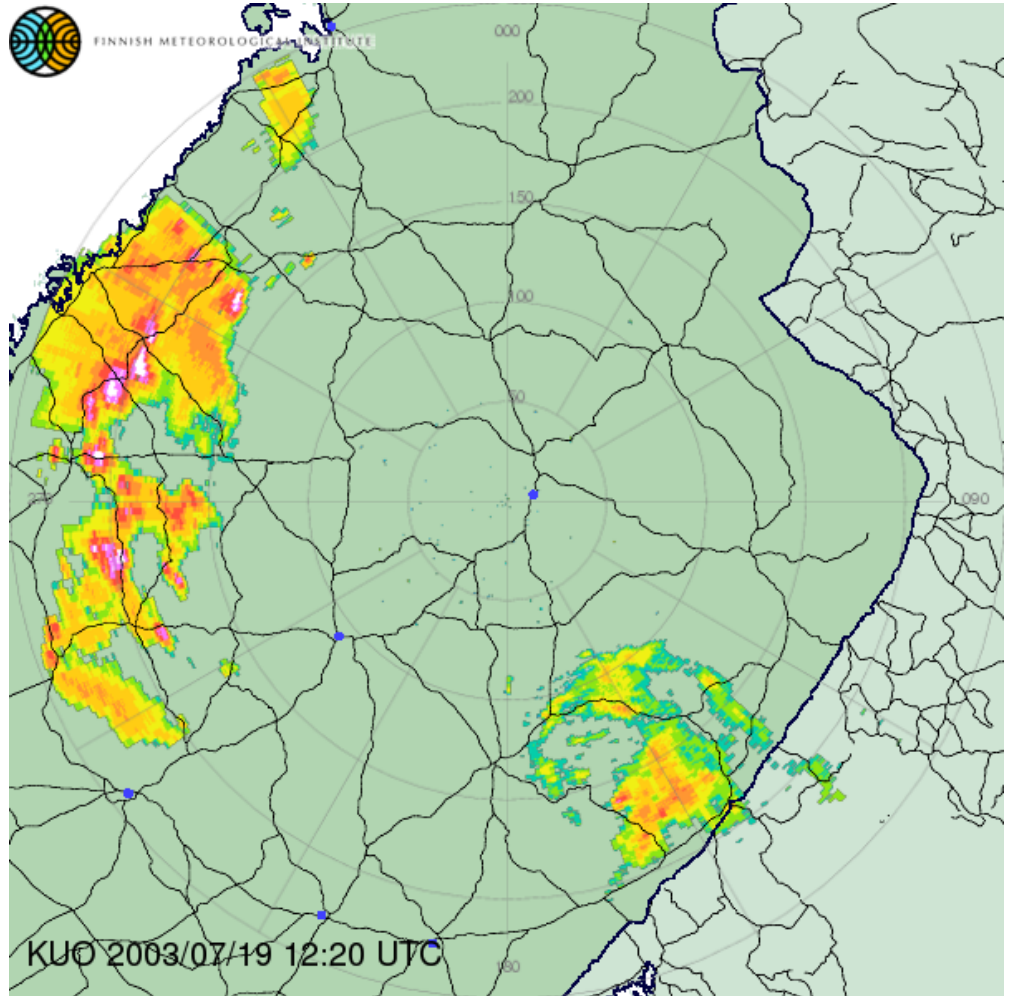
PRECIP. CORES EXCEEDING 48 dBZ, DATE 030719





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Radar CAPPI echo at 12:20 UTC



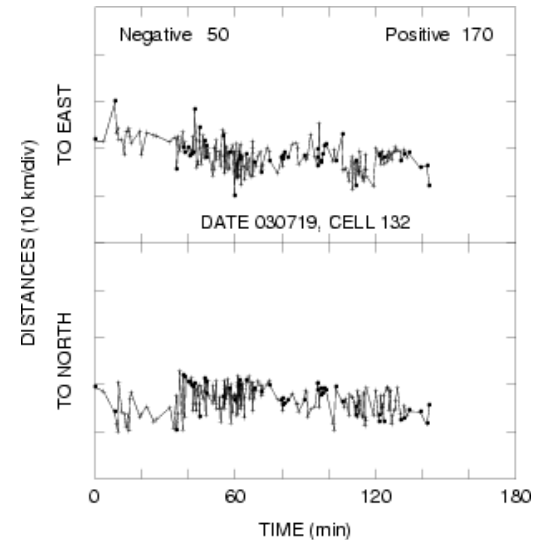
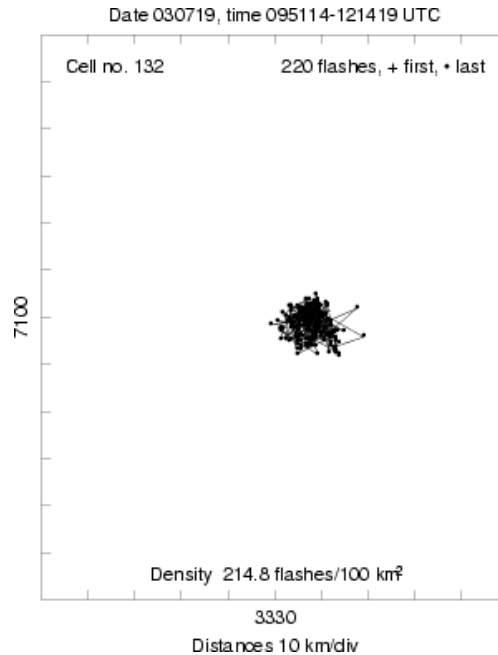


Example: cell # 132

Relatively
stagnant.

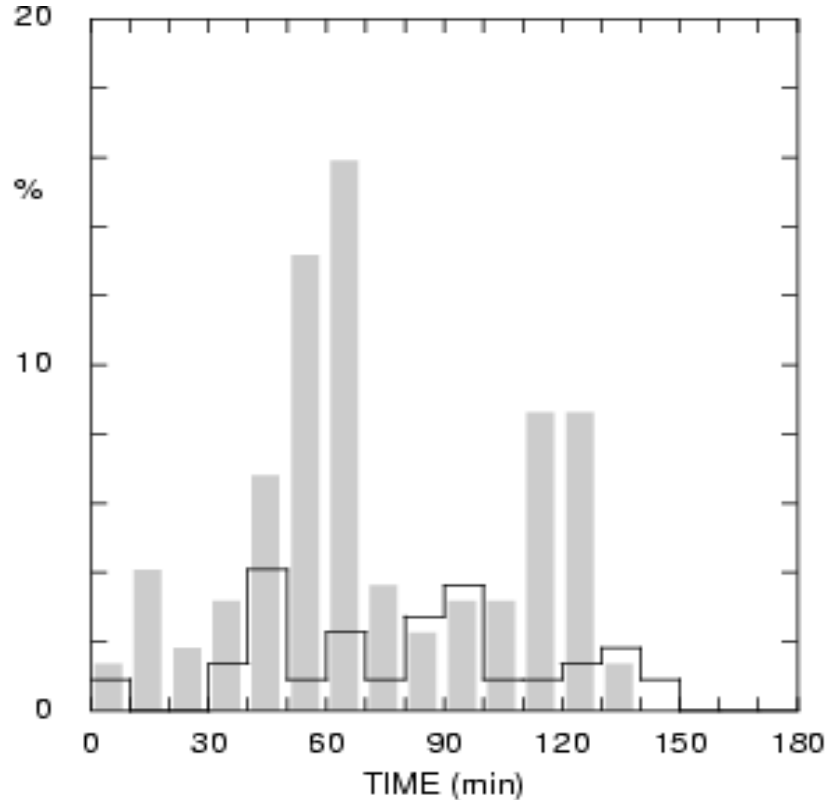
Active-phase
lifetime almost
2 hours.

Neg. fl. 50,
pos. fl. 170





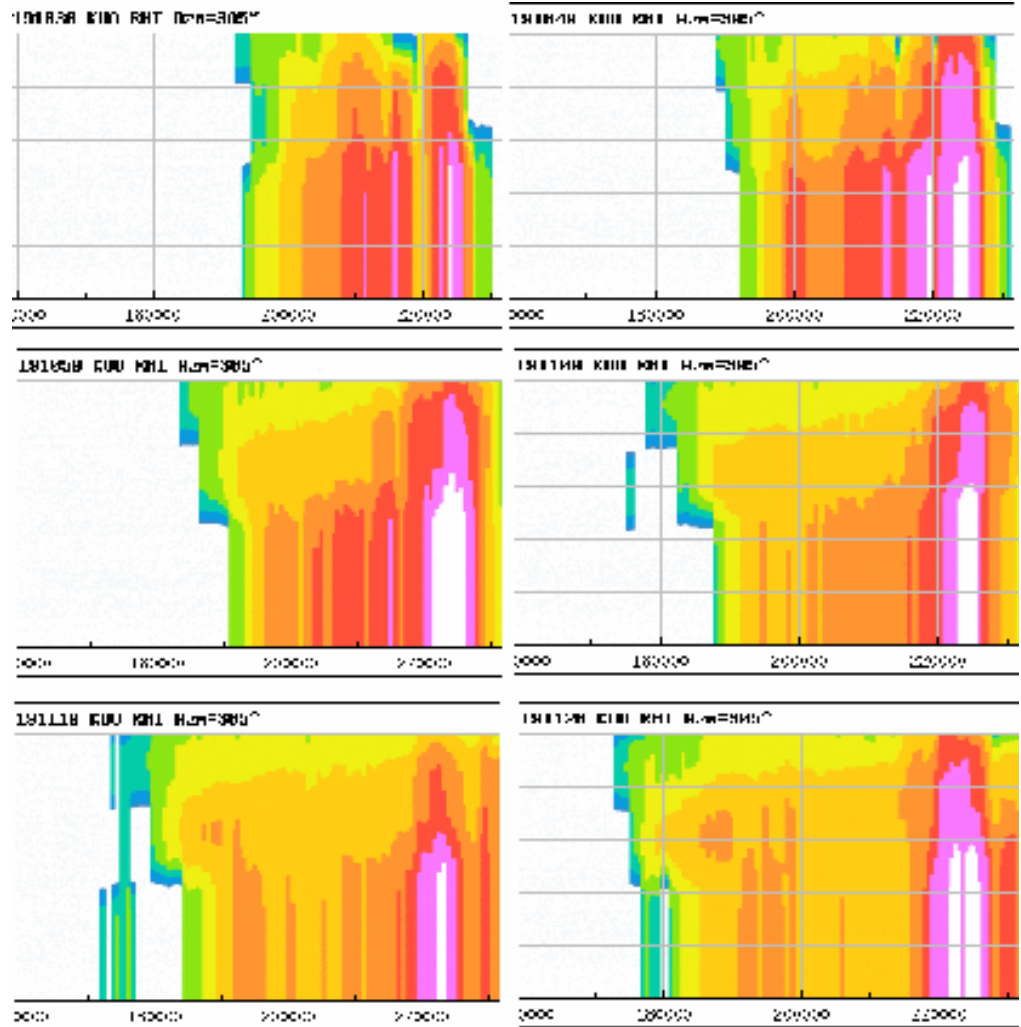
Rates (10-min)
of neg. (line)
and pos. (gray)
flashes, cell
132



Development of cell 132 (flashes/10 min, % of total number).
Line: negative (50), gray: positive (170).
Start 09:51 UTC.



Radar RHI
echo of cell
132 (10 min)
- white 48
dBZ, violet
40 dBZ.
Grid:
hor 20 km,
ver 2 km.





Relations btw. flash and rain cells

- Thundery area slowly spreads outwards (SE)
- Flash cells and precip. cores nearly stagnant
- > 40 dBZ covers lightning occurrence
- > 48 dBZ well corresp. to cells of > 40 flashes (about 70 cells in the chosen area)
- No correlation btw. # flashes or +/- flash ratio and precip. core width or height



Relations, cont.

Cells > 48 dBZ, > 40 flashes, average values:

- Width of 40 dBZ 6.5 km
- Width of 48 dBZ 3.2 km
- Height of 40 dBZ top 8.2 km
- Height of 48 dBZ top 5.7 km
- +/- flash ratio 1.0 (normal 0.2 – 0.5)
- Pos. flashes spread more longitudinally



Conclusions

- July 2003 case was exceptional: slow spread, a lot of lightning, a lot of rain, high +/- flash ratio
- Similar cases (at least for flahes) occur about one day in one or two years (many days in 2003 was also exceptional)
- No clear explanation found so far – need comparisons with other similar as well as “normal” cases, meteorological analysis