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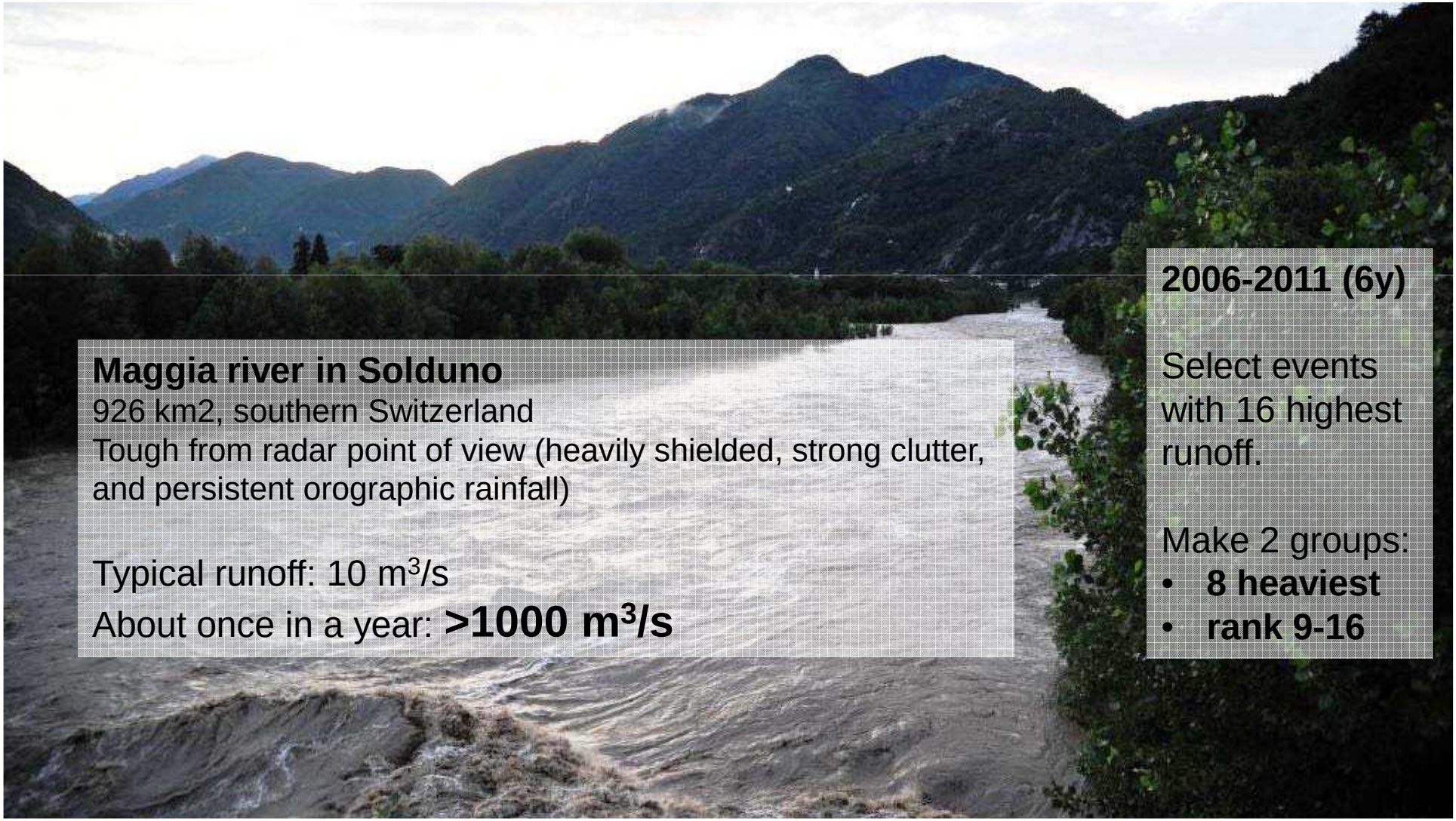
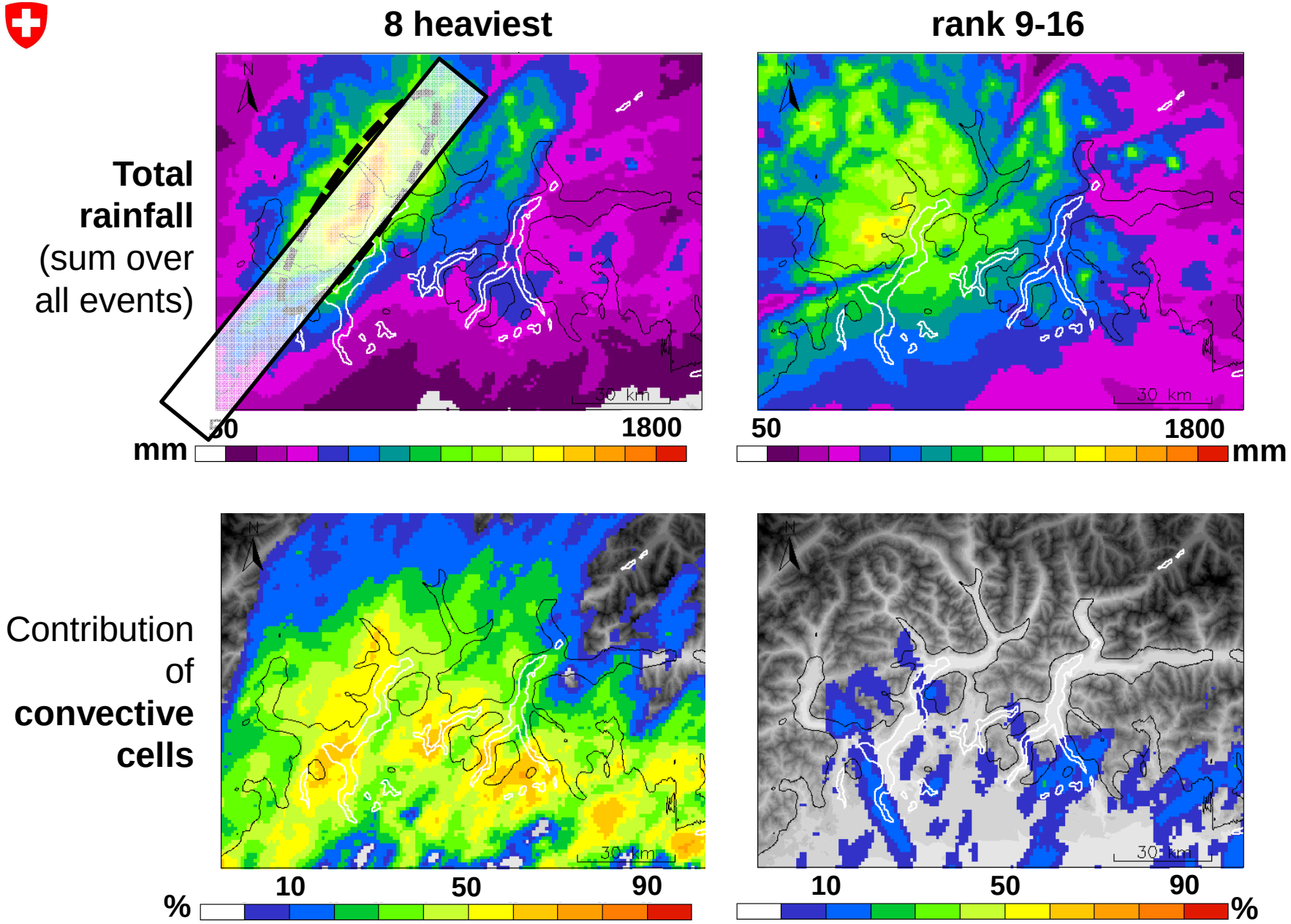
Next generation radar precipitation measurement in the Swiss Alps: strategy and first results

Urs Germann, MeteoSwiss, Locarno-Monti
M Gabella, L Panziera, M Sartori, I Sideris, M Boscacci, A Hering, L Clementi, M Sassi

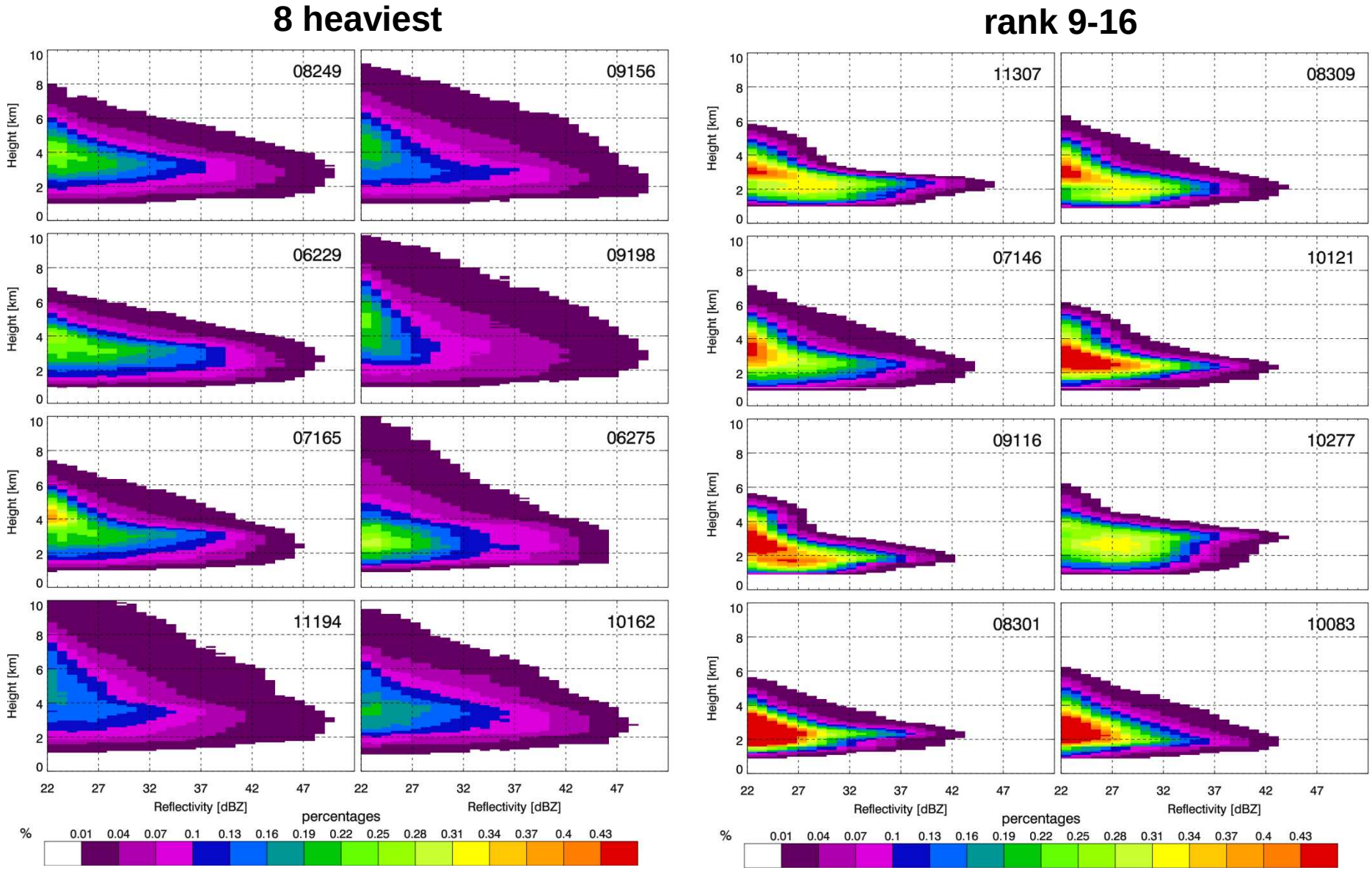
Design of new Swiss radar network

is driven by experience, new technology **and applications**.

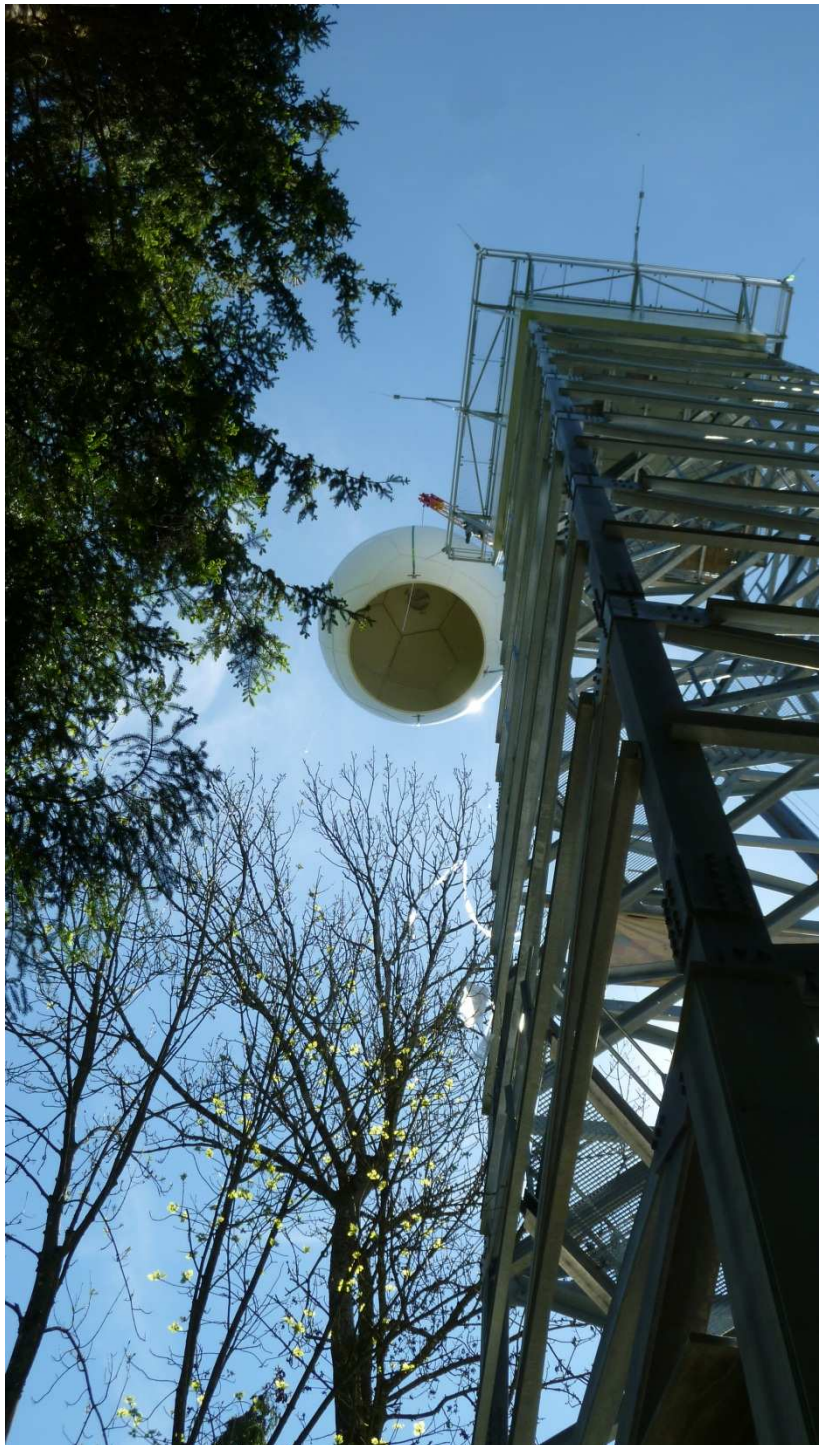



8 heaviest
rank 9-16
Total rainfall (sum over all events)
N
30 km
50
1800
mm
Contribution of convective cells
10
50
90
%

CFAD: Contour frequency altitude diagram



Panziera et al, in preparation



Scan strategy

High resolution in vertical dimension

➔ to understand orographic precipitation (combining Doppler and polarimetry)

➔ to determine the VPR

➔ to estimate precipitation at ground in shielded regions

➔ to reduce stochastic part of QPE processing (VPR, partial shielding, Z-R, …)

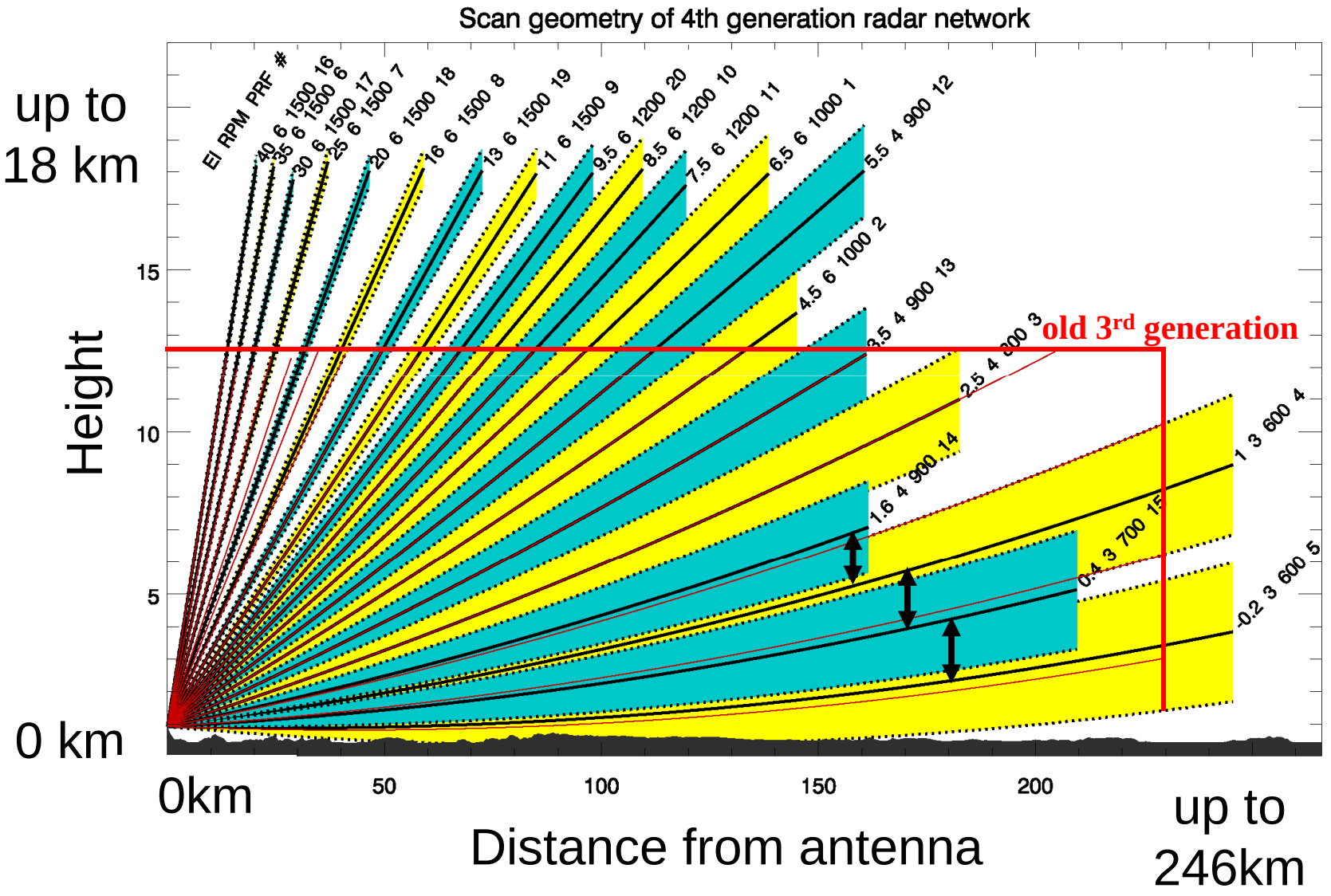
Full scan in short time

➔ 20 sweeps in 5 min to properly sample the vertical dimension + thunderstorm evolution

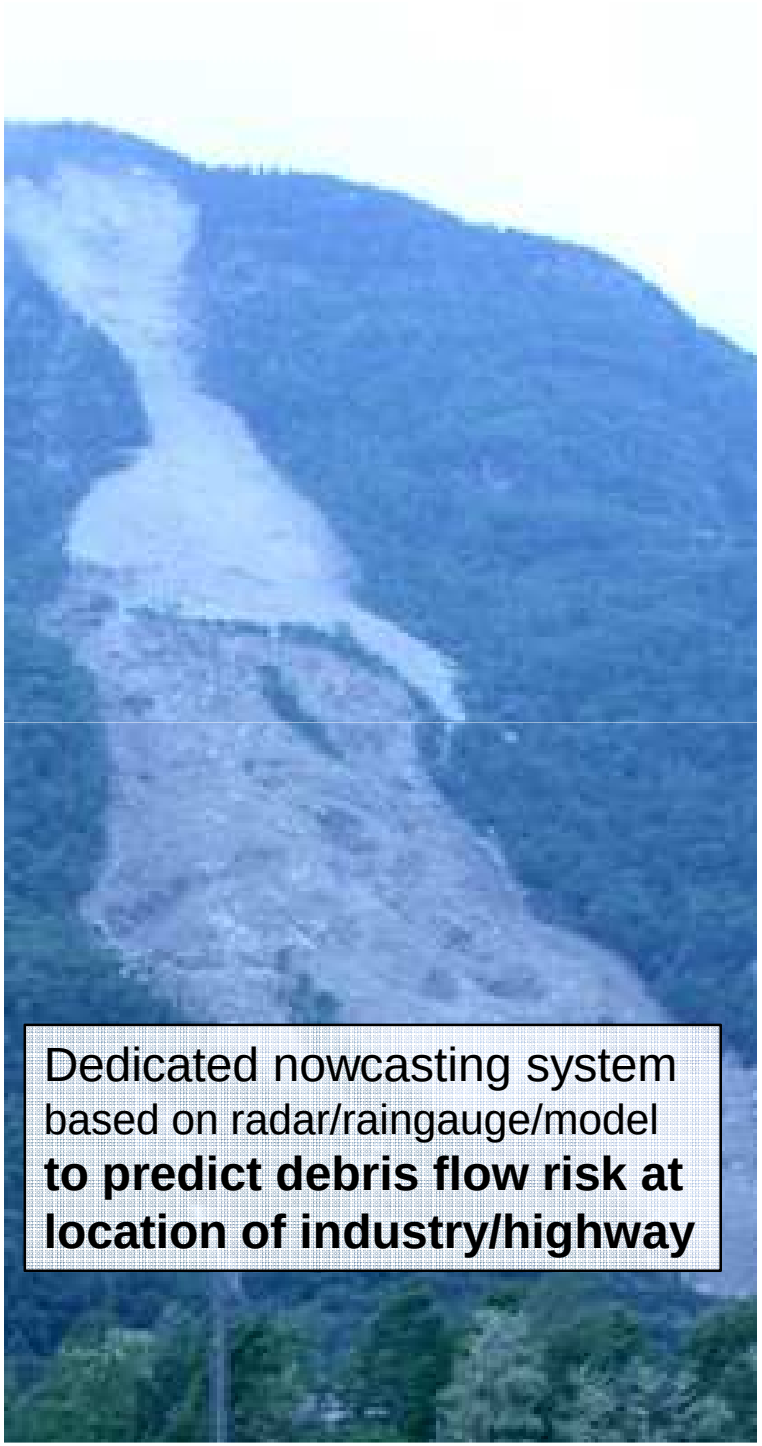
➔ 10 + 10 interleaved sweeps to obtain pseudo 2.5min resolution

➔ “oversampling” at low angles to improve QPE

20 sweeps every 5 minutes




Dedicated nowcasting system
based on radar/raingauge/model
to predict debris flow risk at location of gas pipeline
Poster by L Clementi (93 NOW)


Dedicated nowcasting system
based on radar/raingauge/model
to predict debris flow risk at location of industry/highway

System design

Real-time availability

➔ Products ready on server <1 min after scan

➔ Products updated every 2.5 min combining latest 2 half-scans (to be refined)

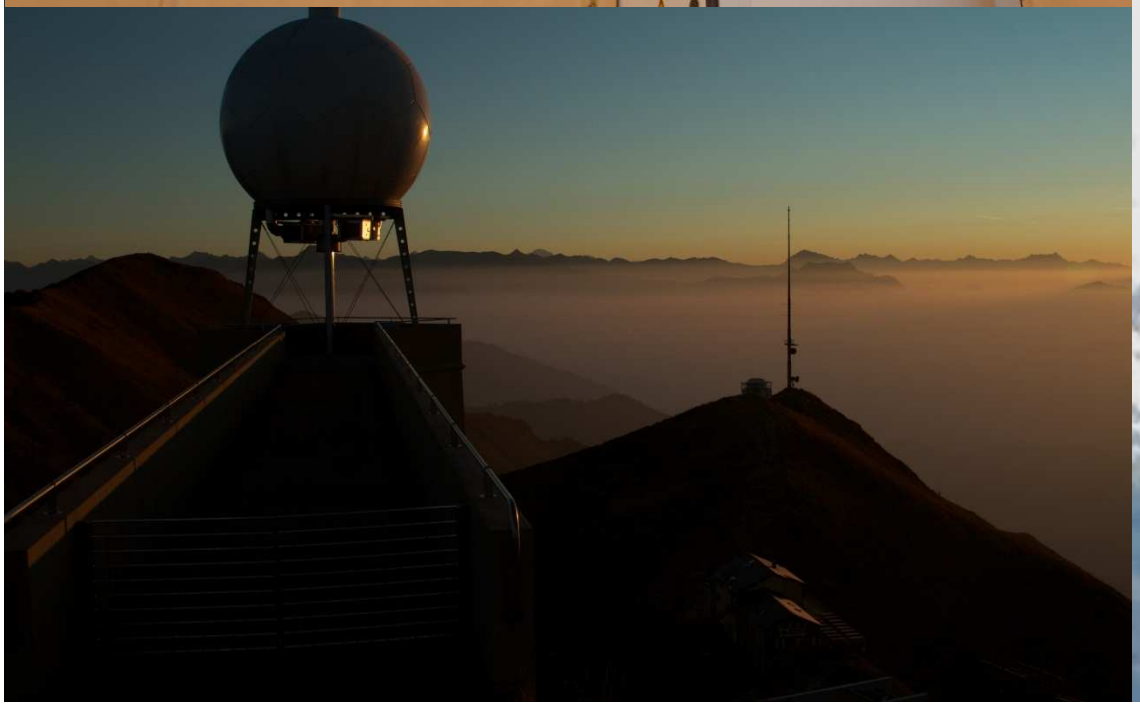
Clutter

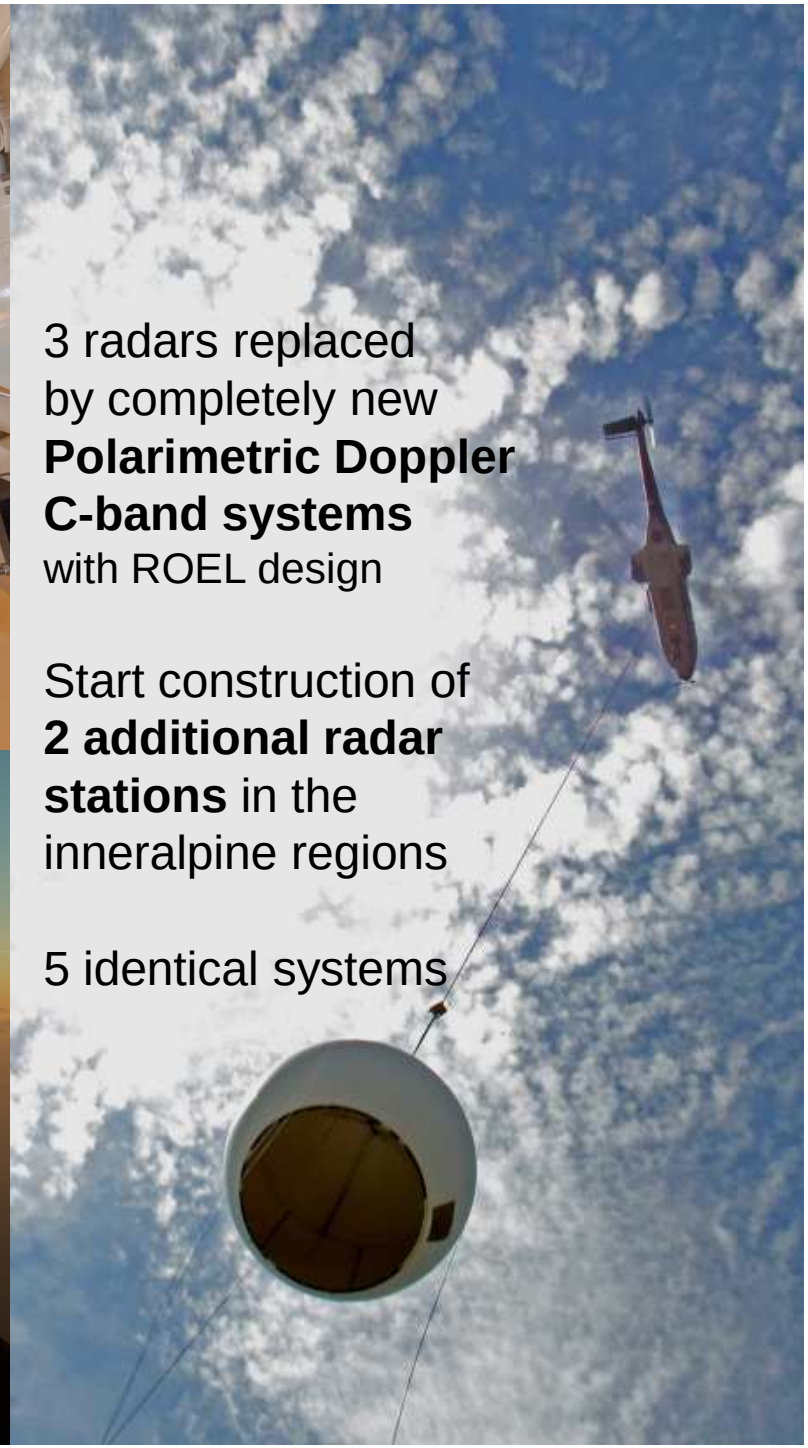
➔ all moments at 83 m radial resolution transferred to central server

➔ add polarimetry for clutter removal (to be done)

➔ short pulse-length of 0.5 mus (83m resolution)

(…)





3 radars replaced
by completely new
Polarimetric Doppler
C-band systems
with ROEL design

Start construction of
2 additional radar
stations in the
inneralpine regions

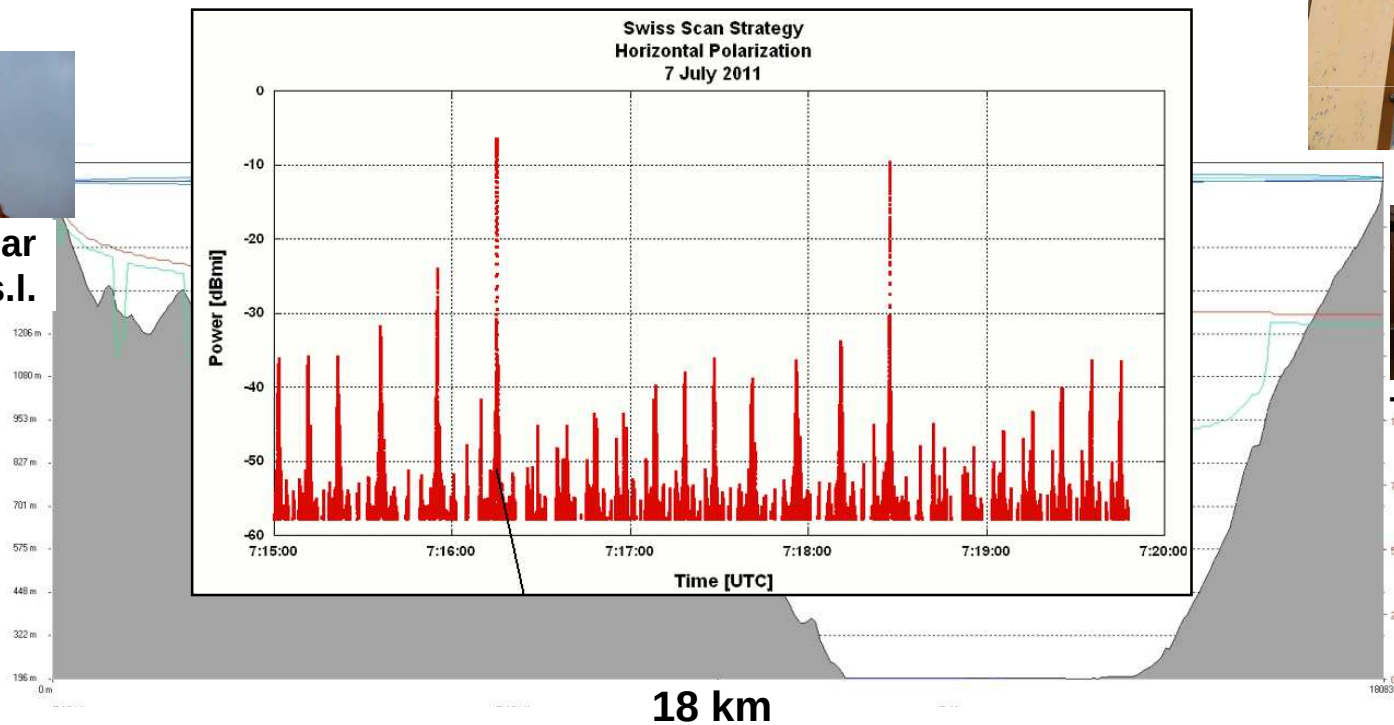
5 identical systems

Test equipment

- ZDR: 0.67 dB bias (Rx H, Tx 135°)
  In agreement with: drizzle 0.8; sun 0.8
- rho_{HV} (Rx H, Tx 135°)
- pulse shape
- scan strategy
- cross-pol isolation
- beamwidth and side lobes in H, V behind radome

Cimetta
1645 m.a.s.l.

Lema radar
1625 m.a.s.l.



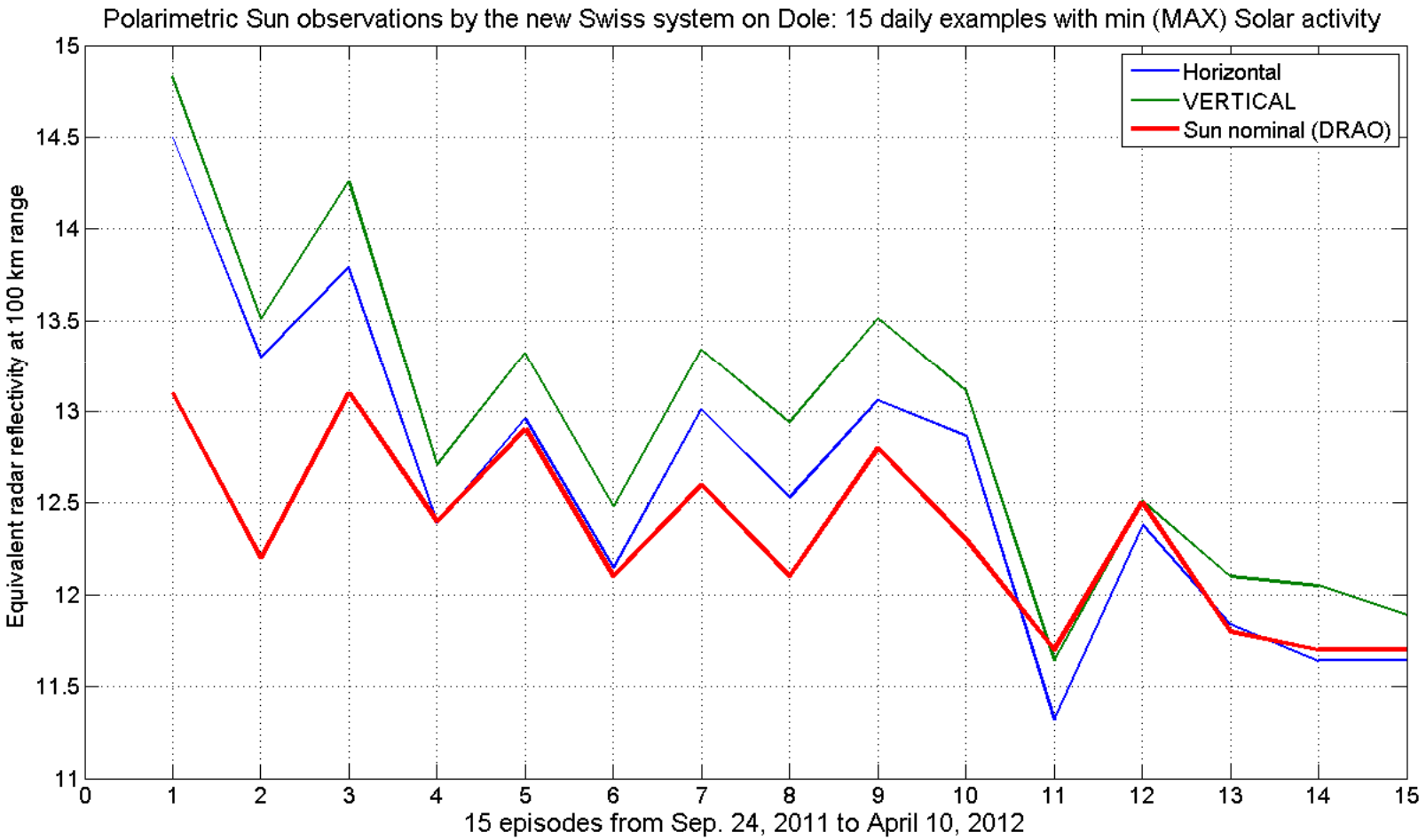
18 km

Receiver

Transponder

M Gabella, M Sartori, in collaboration with armasuisse

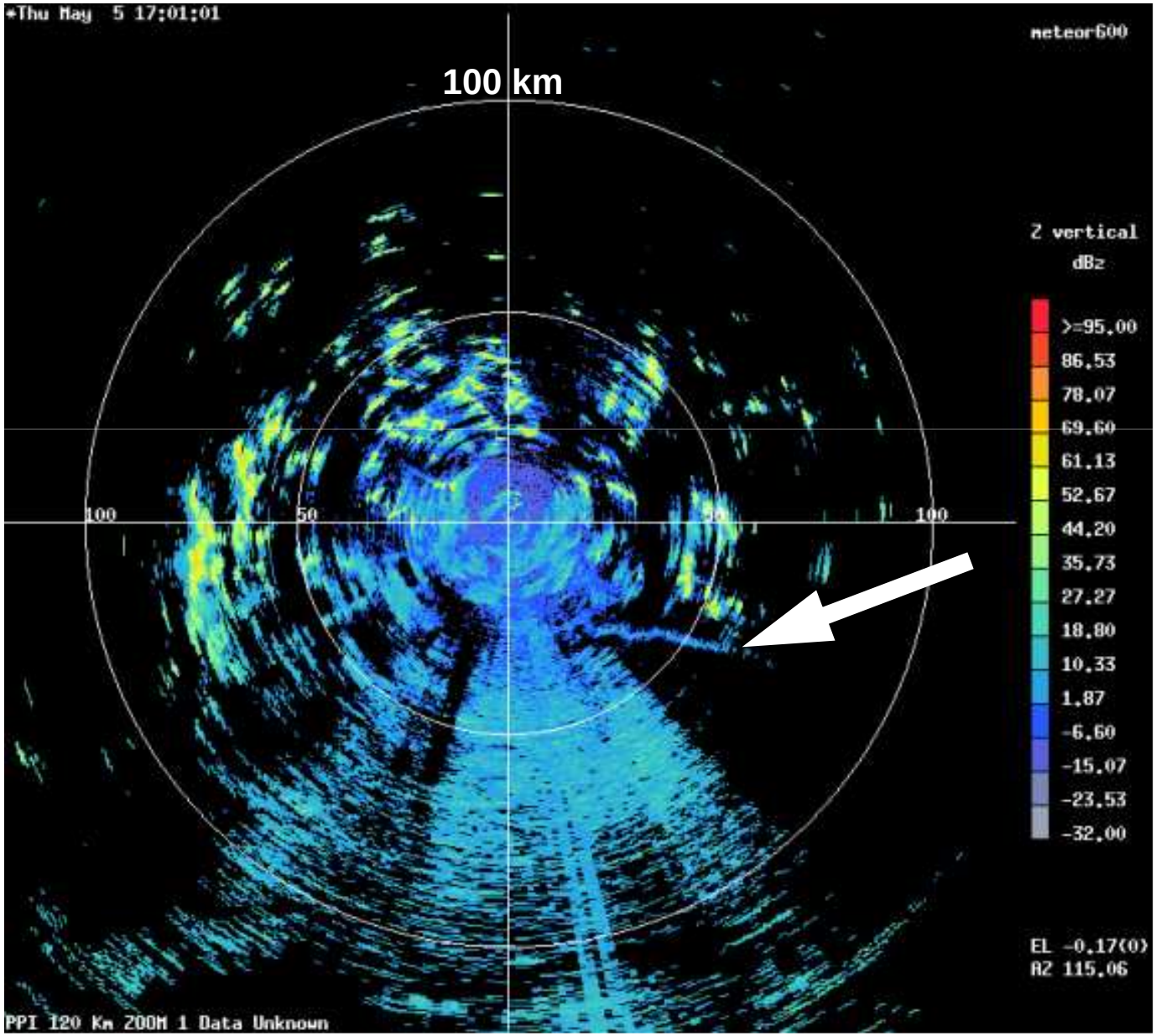
Sun: monitoring Rx and antenna pointing
Noise source: continuous automatic calibration

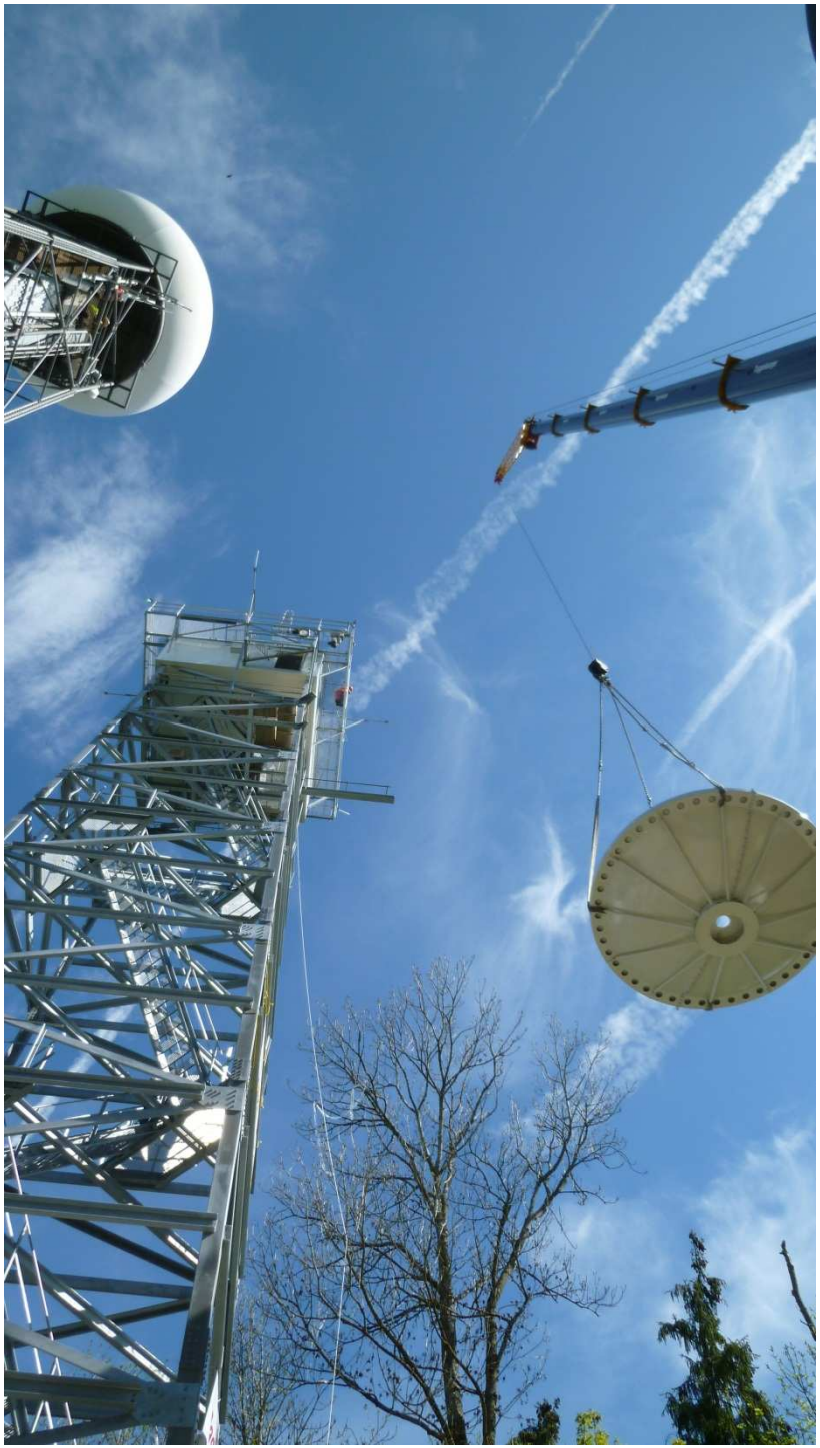


Following I Hollemann et al

M Gabella, M Boscacci

Very 1st image of new Lema radar





Higher sensitivity

Albis

Losses (Tx, Rx, Radome, NF):

old: 14.5 dB

new: 4.9 dB

Transmitted power:

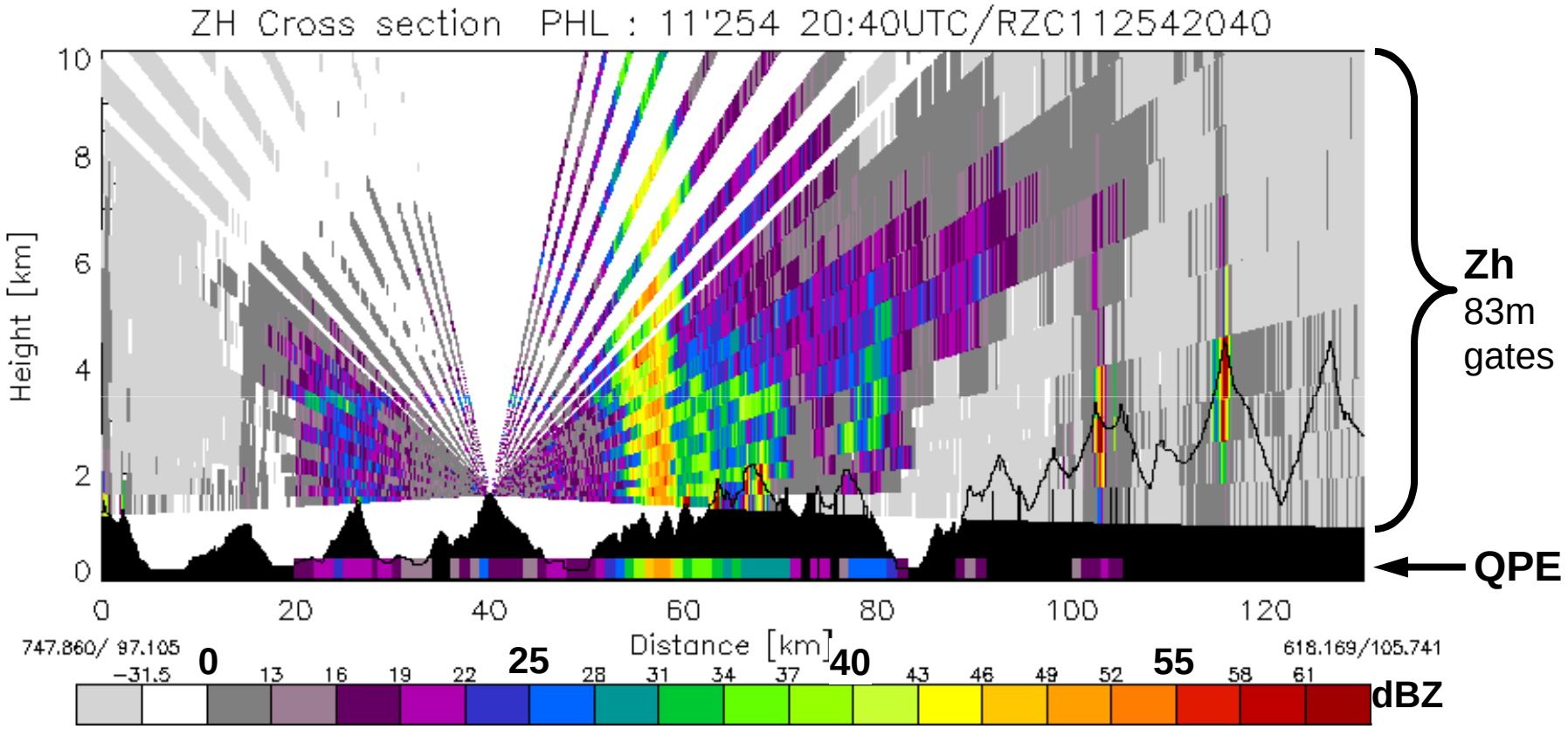
old: 270 kW

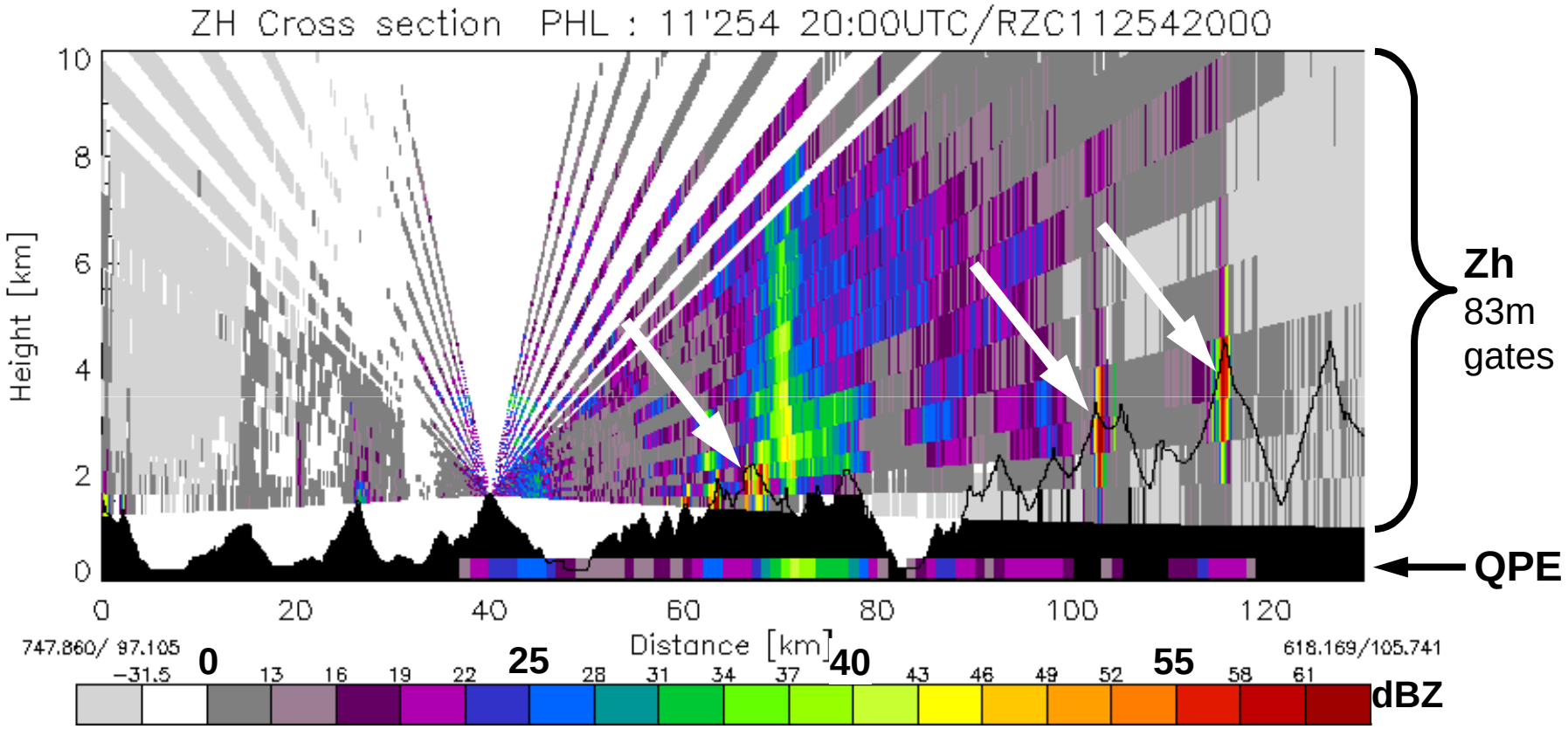
new: 235 kW per channel (loosing 0.6 dB)

9 dB more sensitivity

thanks to

- moving transmitter on tower,
- using digital receiver technology, and
- moving receiver on the antenna (ROEL)


ZH Cross section PHL : 11'254 20:40UTC/RZC112542040
Height [km]
10
8
6
4
2
0
0
20
40
60
80
100
120
Distance [km]
747.860/ 97.105
618.169/105.741
−31.5
0
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
dBZ
Zh
83m
gates
QPE


ZH Cross section PHL : 11'254 20:00UTC/RZC112542000
Height [km]
10
8
6
4
2
0
0
20
40
60
80
100
120
Distance [km]
747.860/ 97.105
618.169/105.741
−31.5
0
13
16
19
22
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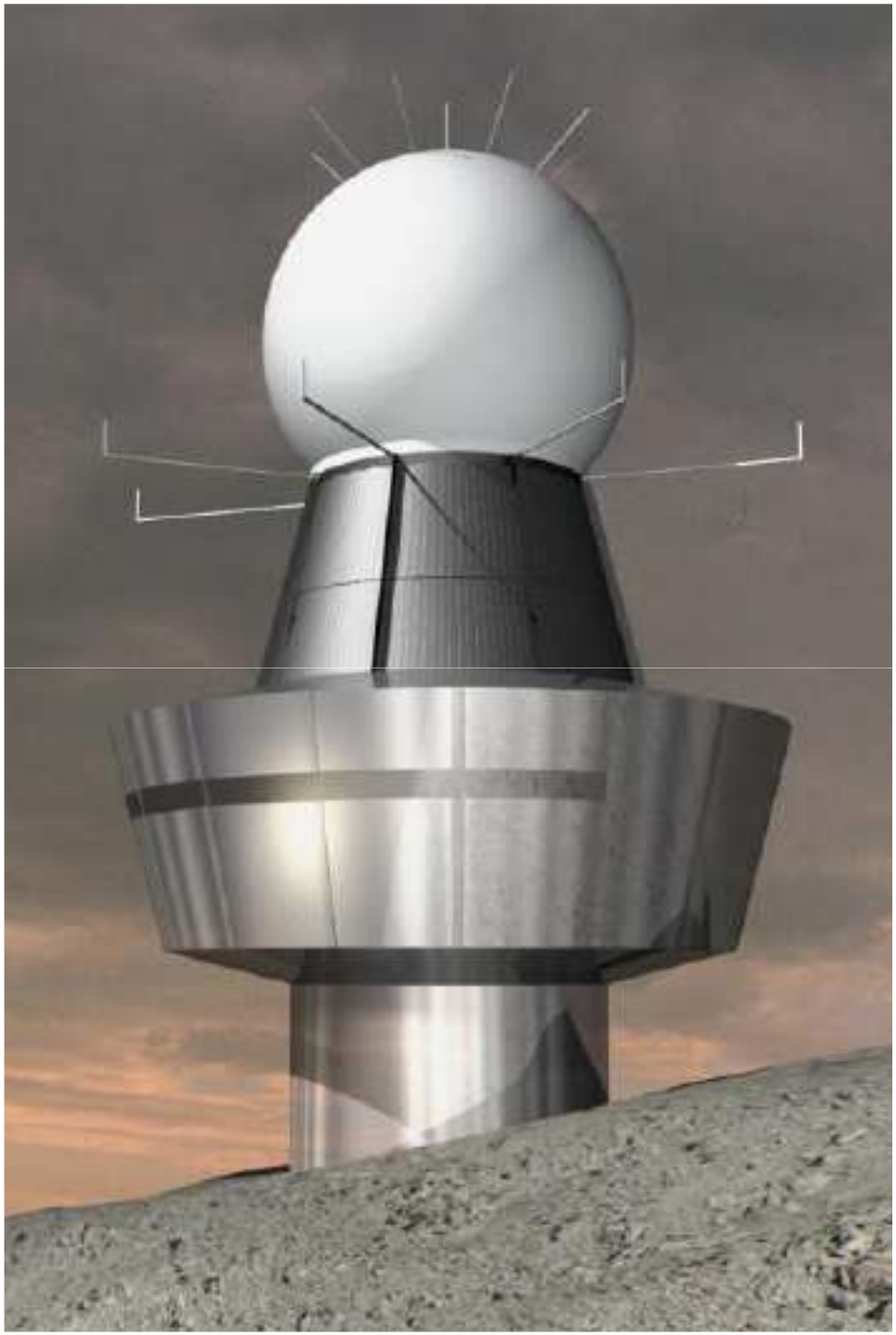
52
55
58
61
dBZ
Zh
83m
gates
QPE



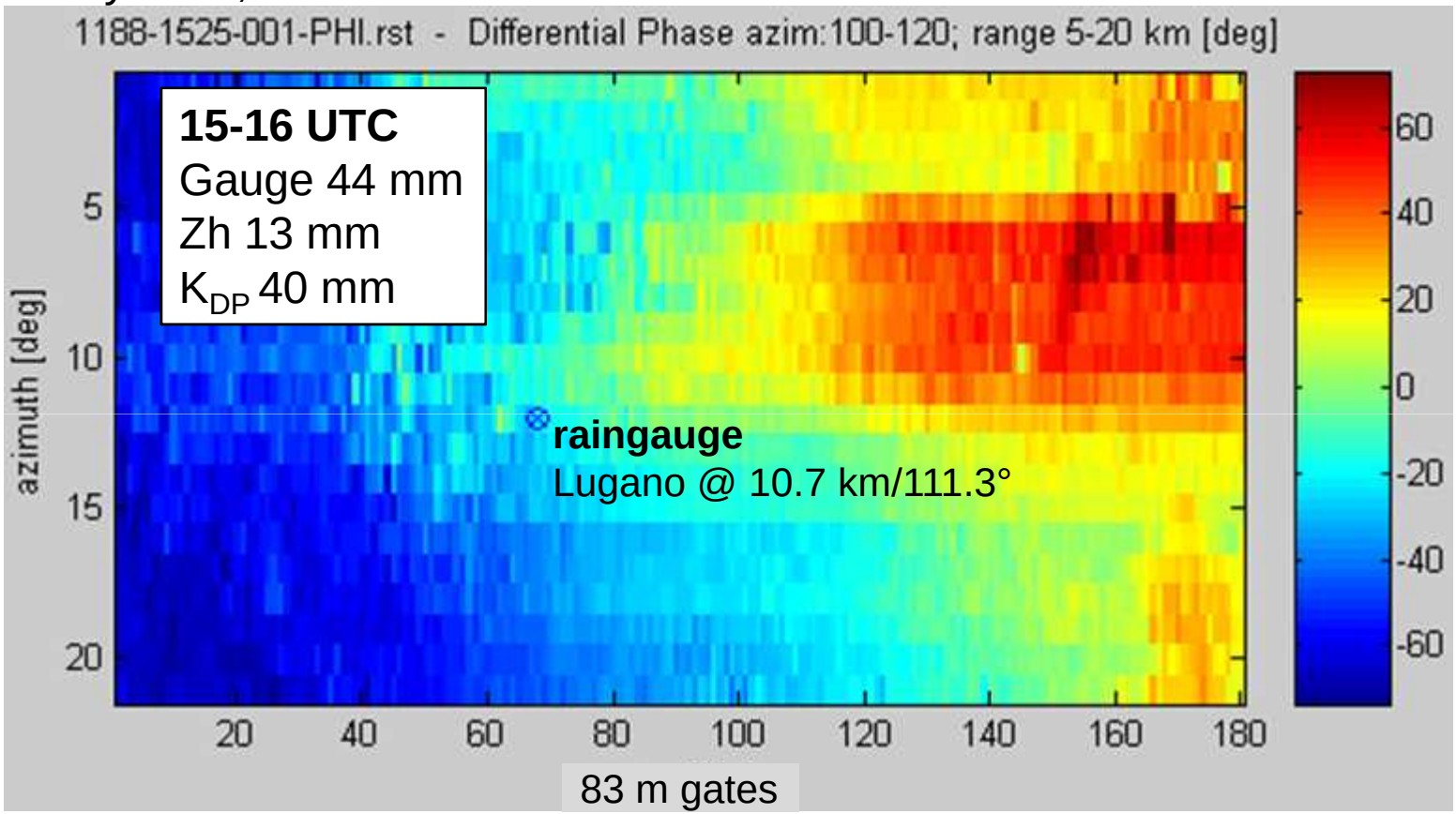
QPE design

➔ Use all sweeps and radars above a ground pixel in a weighted manner
➔ Go directly from multi-radar high resolution polar data to surface QPE (i.e. no CAPPI, no single-radar QPE)
➔ Start with single polarisation

Polarimetry
➔ Design algorithm such that QPE converges to single-pol QPE in case of failure of polarimetry
➔ Watch out for contamination of polarimetry by side lobe clutter
➔ Remind that in the Alps the lowest radar measurements are often in the melting layer or above

Tentative steps with polarimetry: $R(K_{DP})$

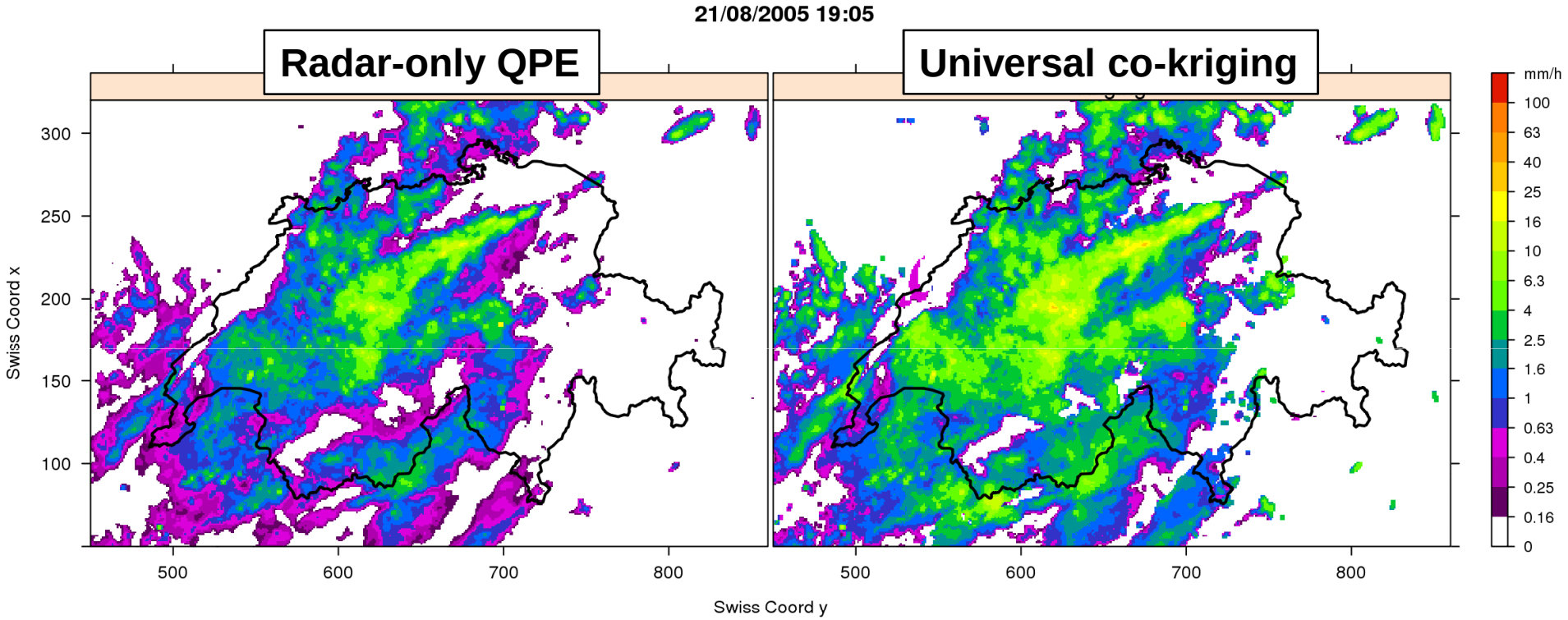
7 July 2011, 1525 UTC



Dual-Polarisation Weather Radar Handbook, Bringi et al., 2007

R Notarpietro, M Gabella

Real-time radar-raingauge merging



-0.8	Bias/dB (best is 0.0)	-0.08
2.7	SCATTER/dB (best is 0.0)	2.2

(evaluated at hourly scale, pooling 12 representative events)

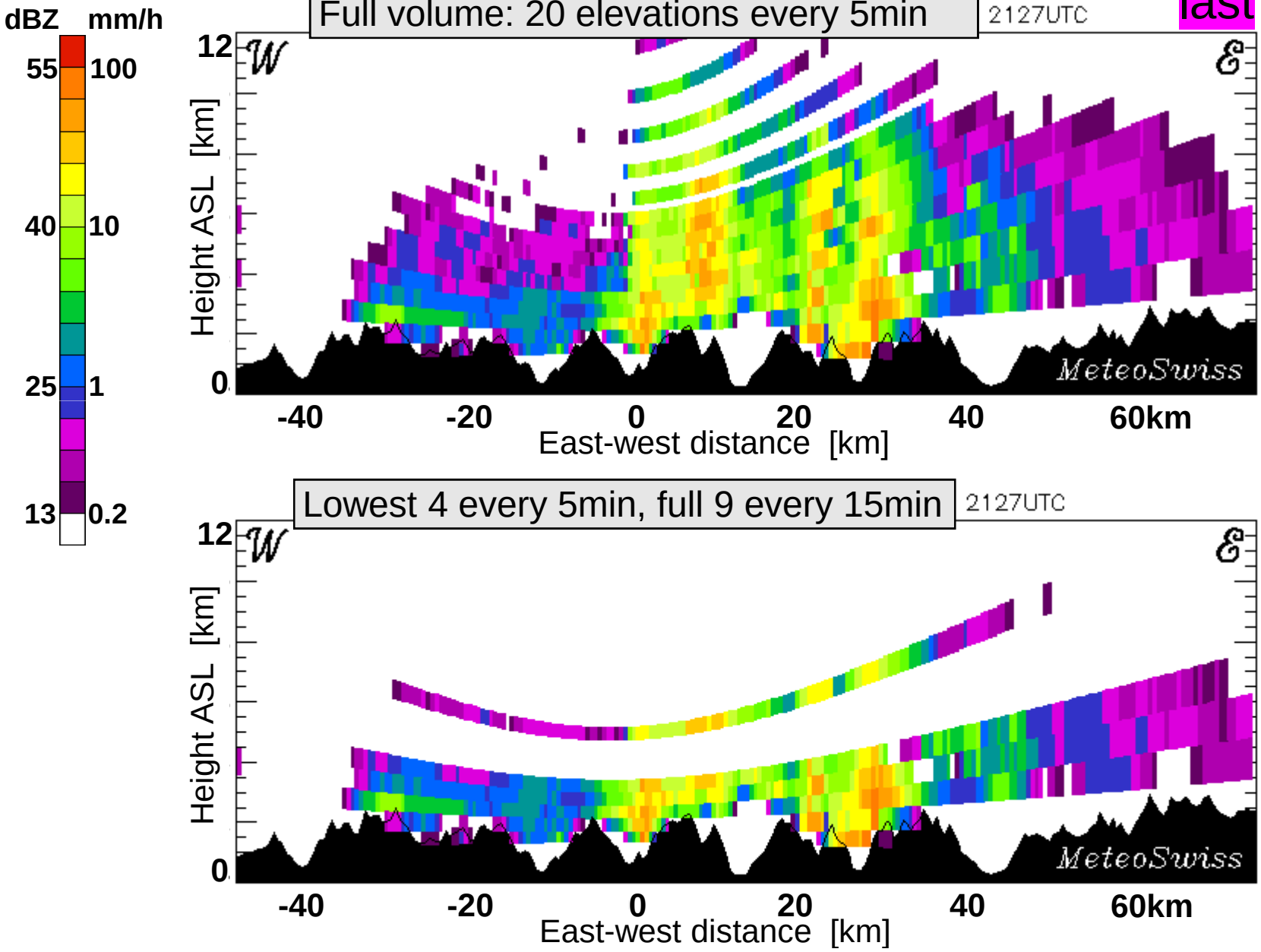
See also:
Talk 3A.6: I Sideris et al
Talk 3A.4: R Erdin et al
Poster 20: D Keller et al

Thank you

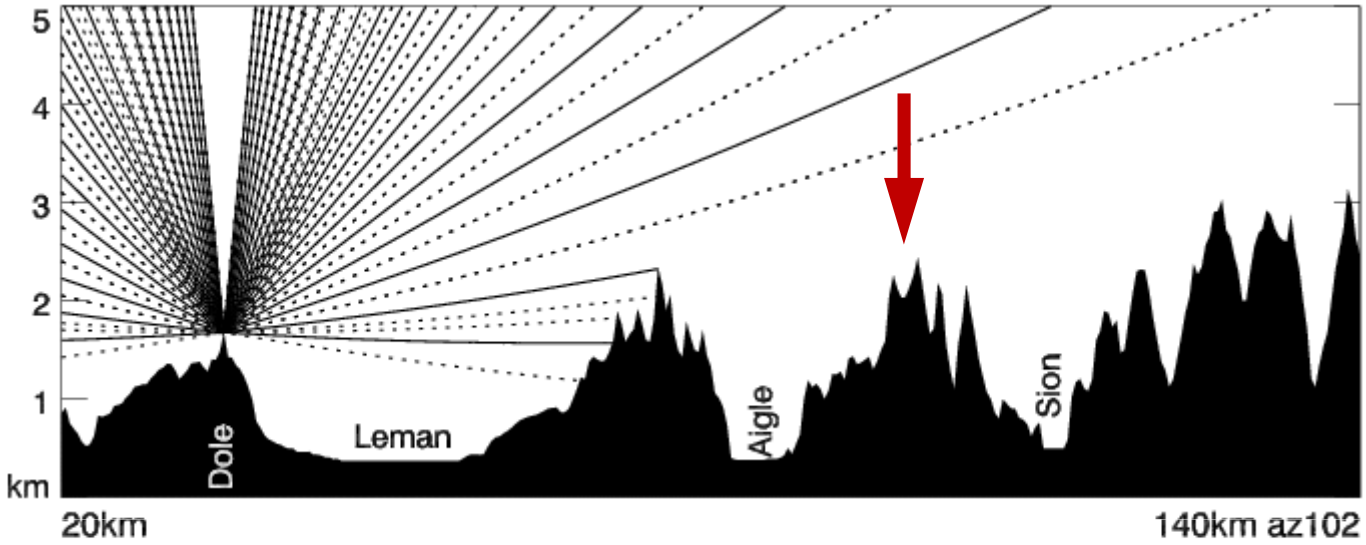
1st generation 1961

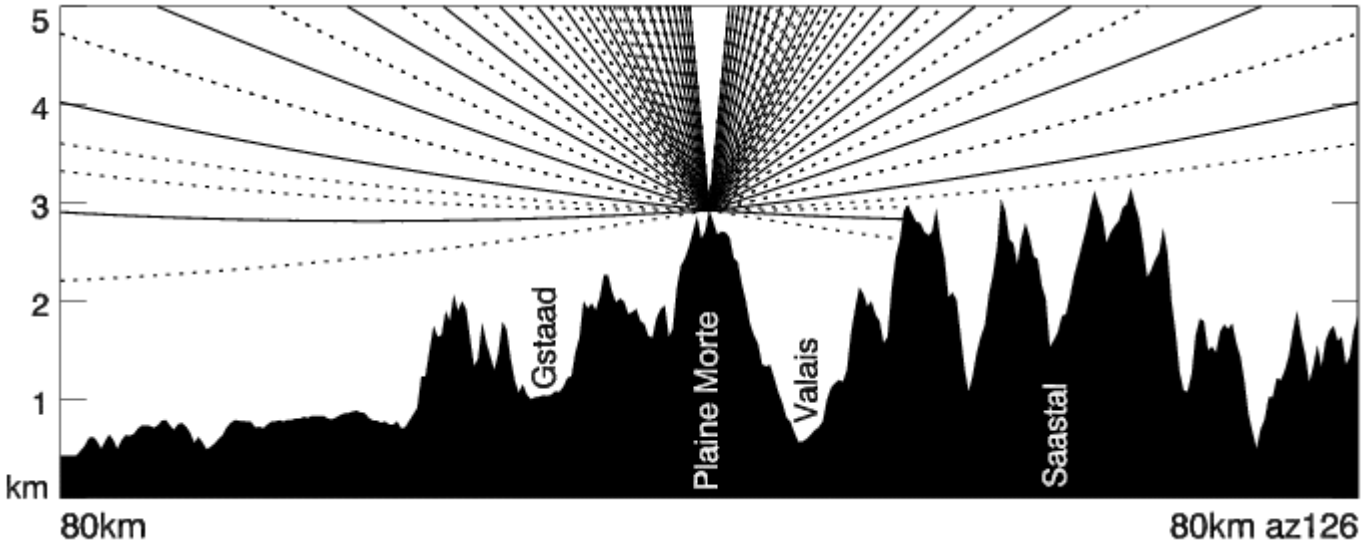
4th generation 2012

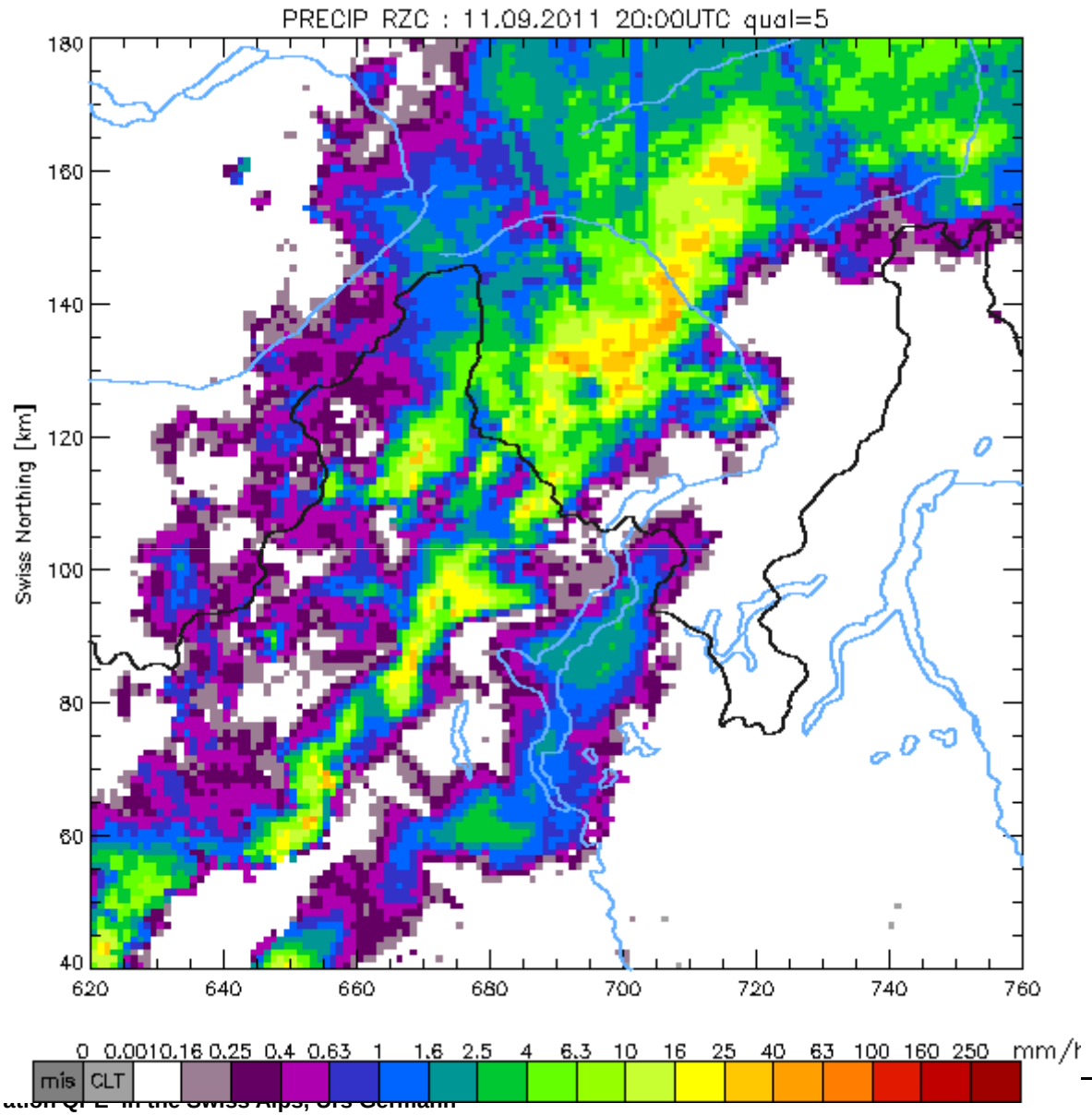
Don’t sacrifice the vertical resolution



Improve inneralpine coverage






PRECIP RZC : 11.09.2011 20:00UTC qual=5
Swiss Northing [km]
180
160
140
120
100
80
60
40
620
640
660
680
700
720
740
760
0 0.001 0.16 0.25 0.4 0.63 1 1.6 2.5 4 6.3 10 16 25 40 63 100 160 250 mm/h
mis
CLT

Inneralpine coverage and backup