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Department of Meteorology

Institute of Atmospheric Physics ASCR

Comparison of convective precipitation forecasts using one and two moment microphysical parameterization

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Outline

- Configuration of the COSMO model
- Radar data
- Assimilation method
- 1-moment and 2-moment microphysics

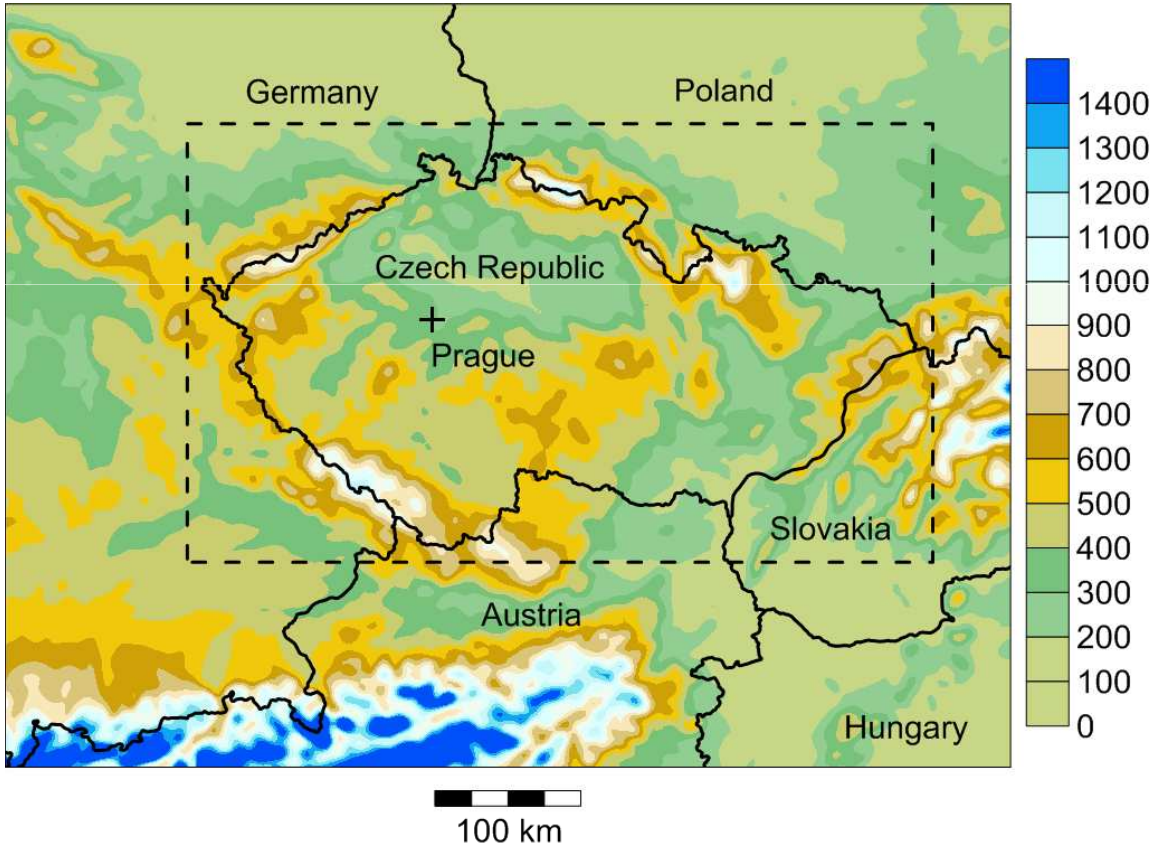
- Verification and comparison of forecasts
- Conclusions

NWP model COSMO-CZ

- COSMO 4.11
- IC + LBC COSMO-EU (7km)

- Δx = 2.8 km, Δt = 30 s
- 50 vertical layers
- 281 x 211 g.b.

- -- verification domain

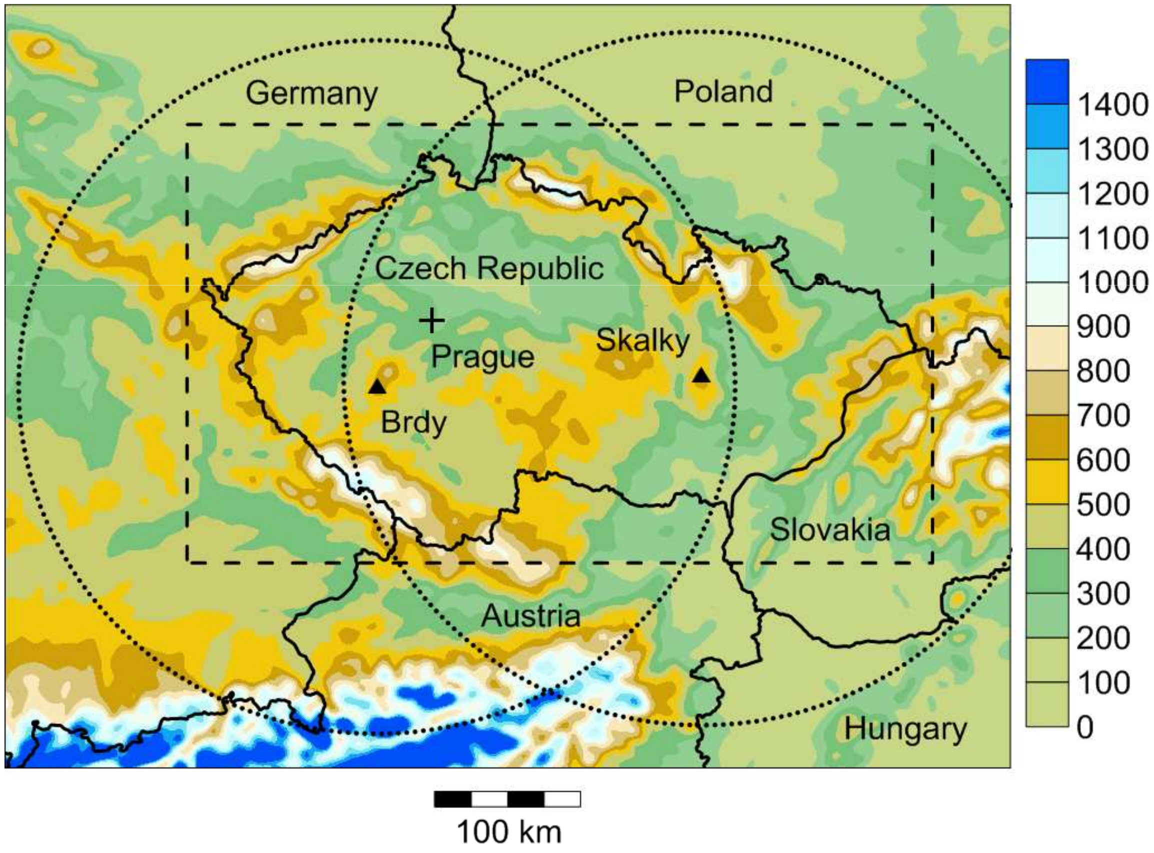


- parametrization of convection is switched off

Radar data

- CZRAD
- Radar Brdy and Skalky

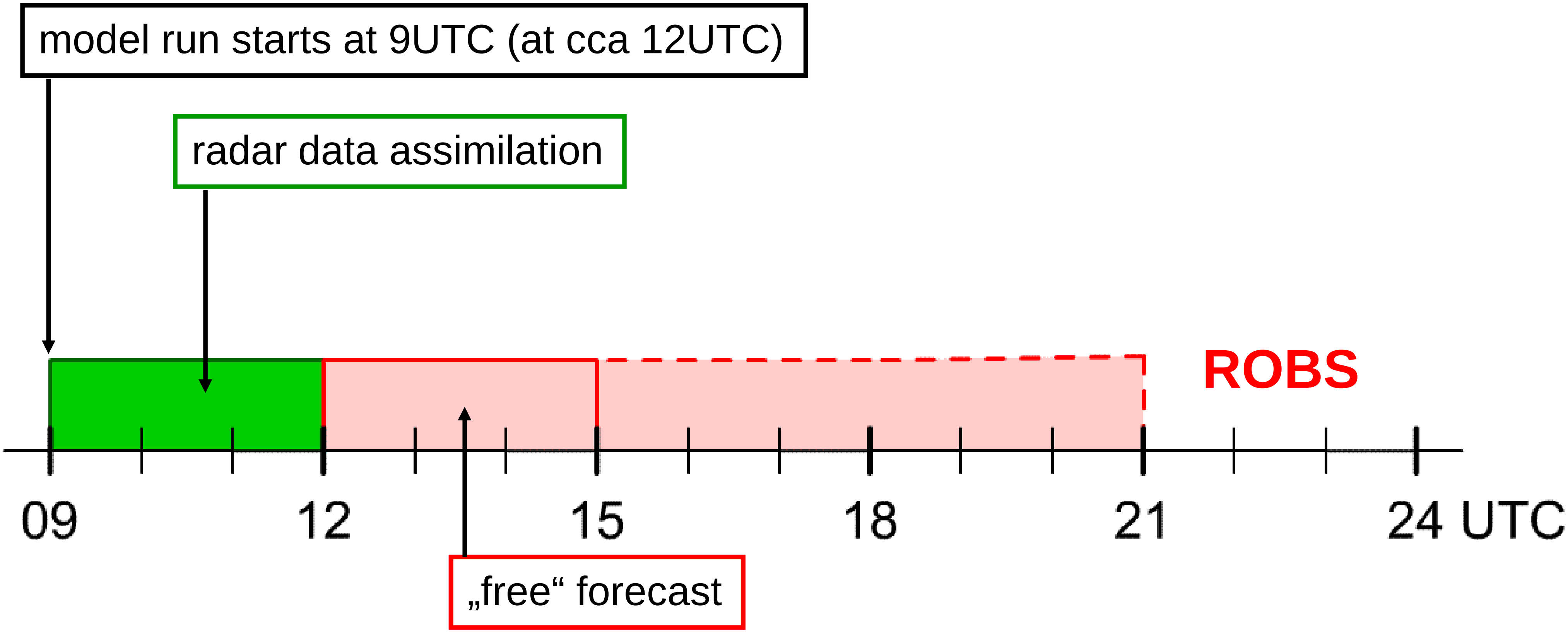
- resolution 1km x 1km
- Δt = 10 min.
- CAPPI 2km



- MERGE adjustation method (radar+gauges) developed by CHMI

Radar data assimilation

- Correction of water vapor mixing ratio
- The assimilation of radar data
- $r_{RADAR} > r_{NWP} \Rightarrow \Delta q_V > 0$
  $r_{RADAR} < r_{NWP} \Rightarrow \Delta q_V < 0$

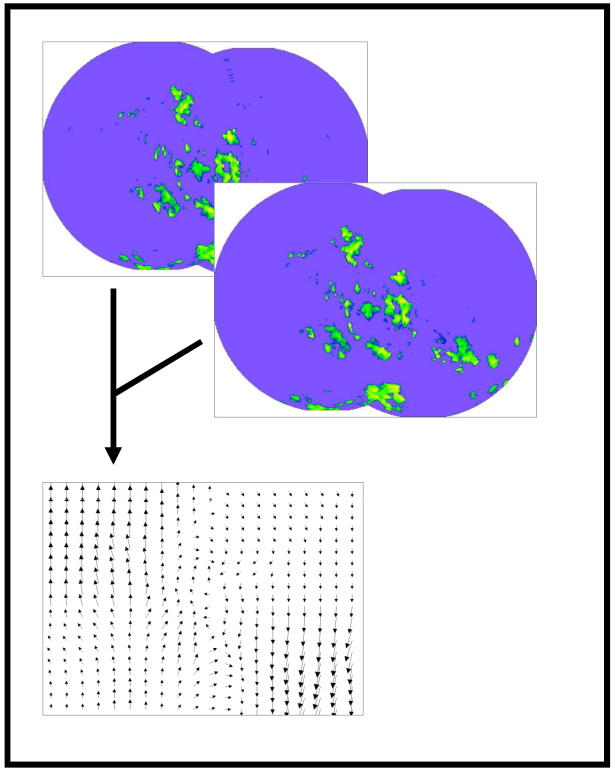


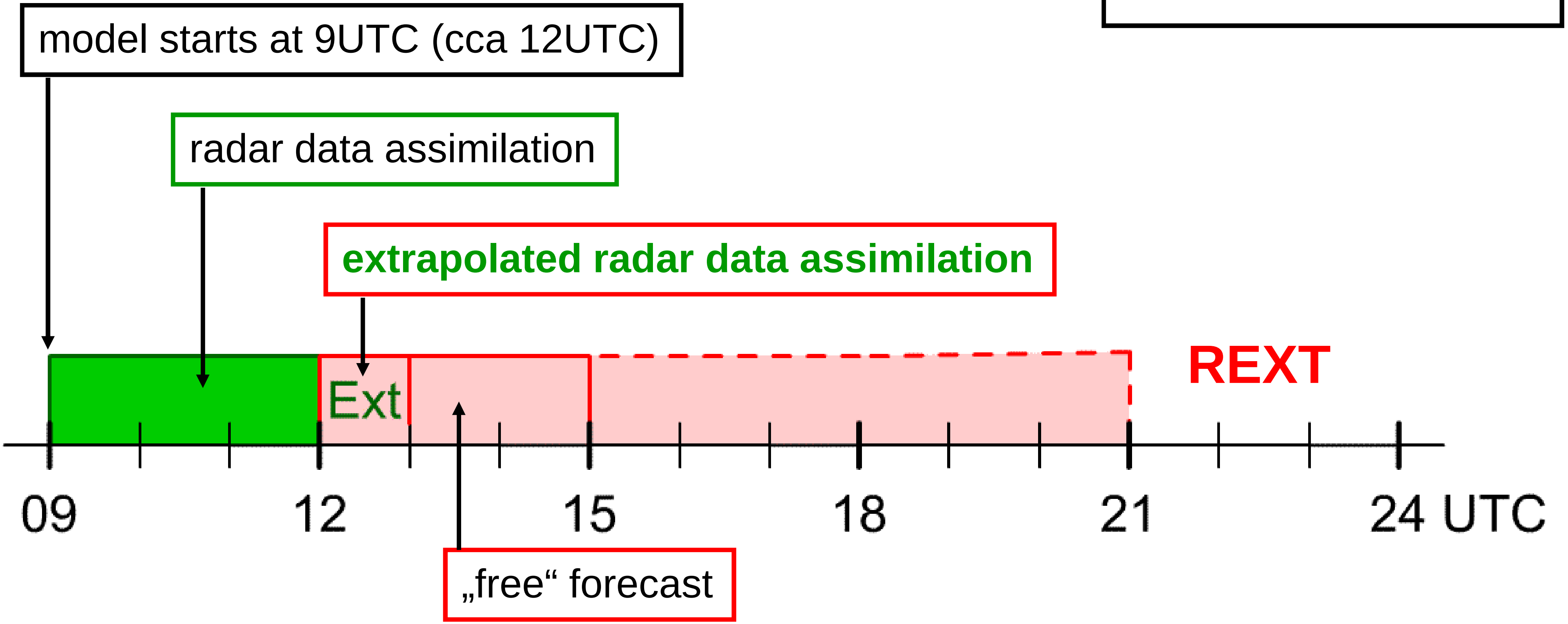
Radar data assimilation

- The assimilation of extrapolated data
- Extrapolation by COTREC for 1 hour

$r_{RADAR} > r_{NWP} \Rightarrow \Delta q_V > 0$

$r_{RADAR} < r_{NWP} \Rightarrow \Delta q_V = 0$





Set-up

Comparison:

- 1-moment microphysics parametrization – two assimilation settings
  A) without extrapolated data assimilation – **ROBS**
  B) with extrapolated data assimilation – **REXT**

- 2-moment microphysics parametrization
  – only extrapolated data assimilation
  – two CCN settings (Noppel H. et al)
  A) itype_gscp = 2463 – high CCN ‚maritime' – **REXT63**
  B) itype_gscp = 2483 – low CCN ‚continental' – **REXT83**

CCN:

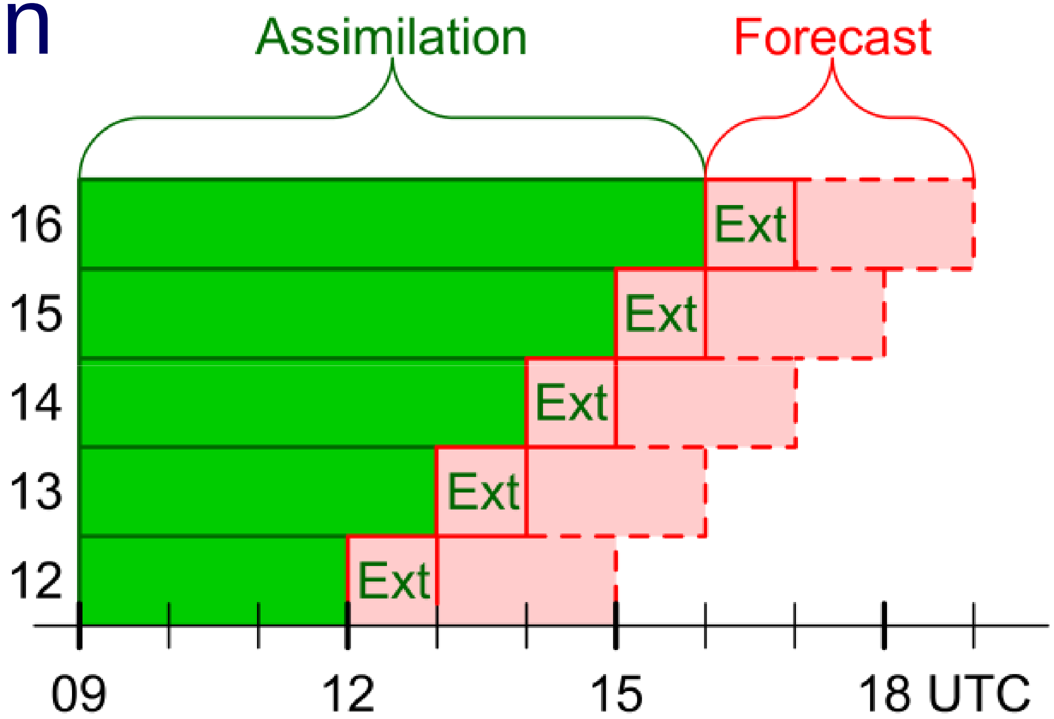
- Cloud condensation nuclei number
- Explicit description of droplets nucleation

Noppel H. et al, 2010: Simulations of a hailstorm and the impact of CCN using an advanced two-moment cloud microphysical scheme. *Atmos. Res.*, **96**, 286-301.

Model run, verification

Forecast:

- 5 forecast for every day
- 8 days 25.6. - 4.7.2009



Verification:

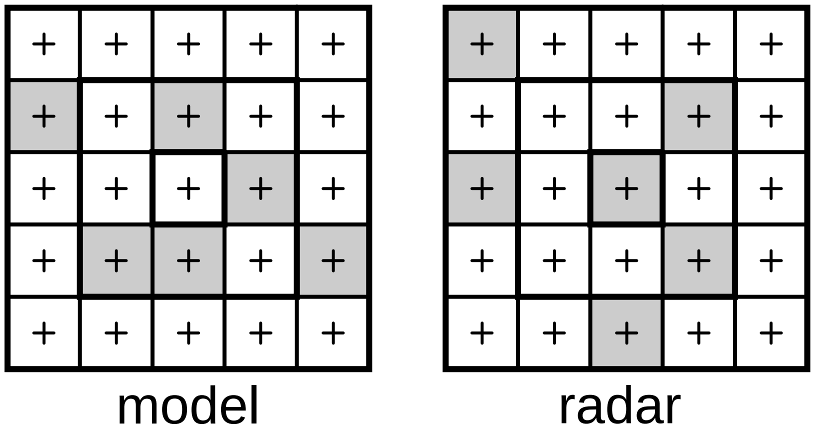
- 1h precipitation totals („free“ forecast)
- Verification methods:
    - Fraction skill score (Roberts and Lean, 2008)
    - SAL (Wernli et al, 2008)

Fraction skill score

FSS – „fuzzy“ or „neighbourhood“ verification method

- comparison of fractional coverage of an elementary area by precipitation over given threshold
- (Roberts and Lean, 2008)
- **Perfect QPF is characterized by FSS = 1 (for smallest EA)**

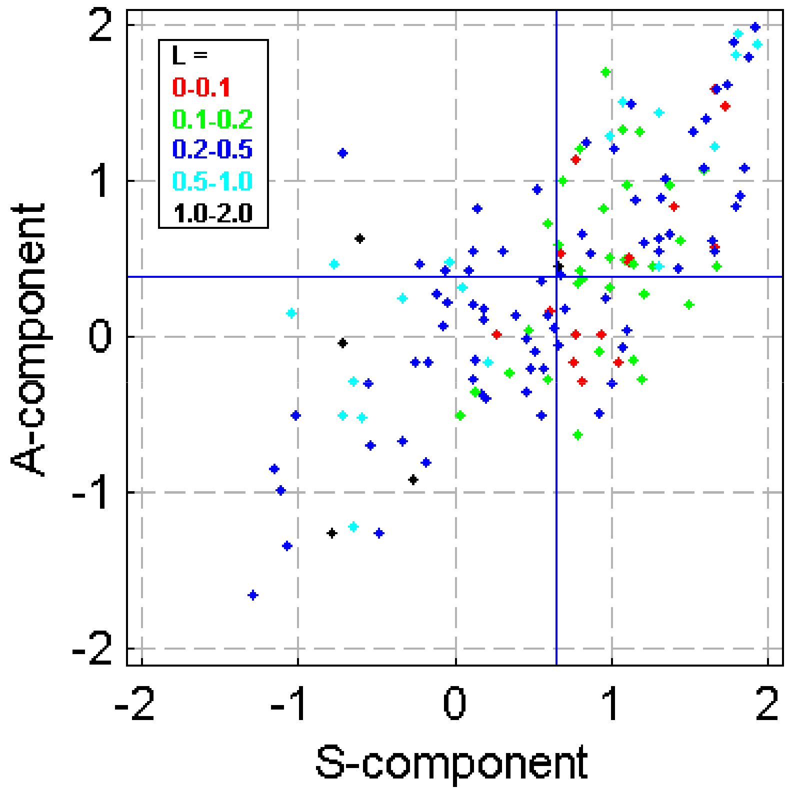
$$FSS = 1 - \frac{\frac{1}{N}\sum_{i=1}^{N}(P_{fcst} - P_{obs})^2}{\frac{1}{N}\sum_{i=1}^{N}P_{fcst}{}^2 + \frac{1}{N}\sum_{i=1}^{N}P_{obs}{}^2}$$



POD = 0.00 , FAR = 1.00, FSS(5*5) = 1.00

Roberts NM, Lean HW, 2008: Scale-selective verification of rainfall accumulations from high-resolution forecasts of convective events. *Mon. Wea. Rev.*, **136**, 78–97.

SAL



SAL – object based verification measure

S (Structure) : [-2, 2] – x-axis

2 large and/or flat model precip. area

-2 small and/or peaked model precip. area

A (Amplitude) :

[-2, 2] – y-axis

2 overestimation

-2 underestimation

L (Localization) : localization of centers of mass

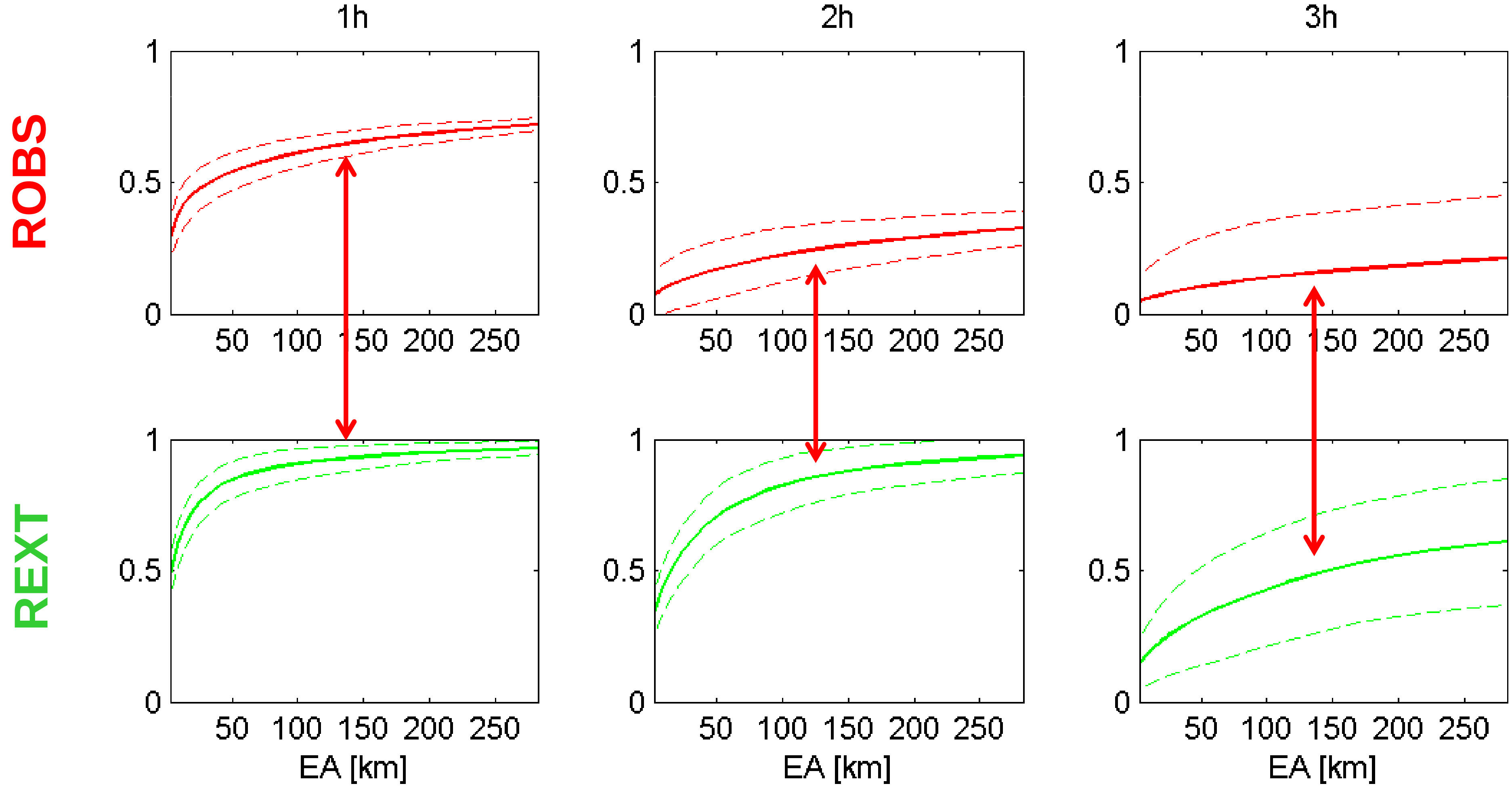
[0, 2] – color : 0 center of mass well matched, 2 wrong localization

Cross: mean(S), mean(A) and color= mean(L)

- **Perfect QPF is characterized by zeros in all components.**

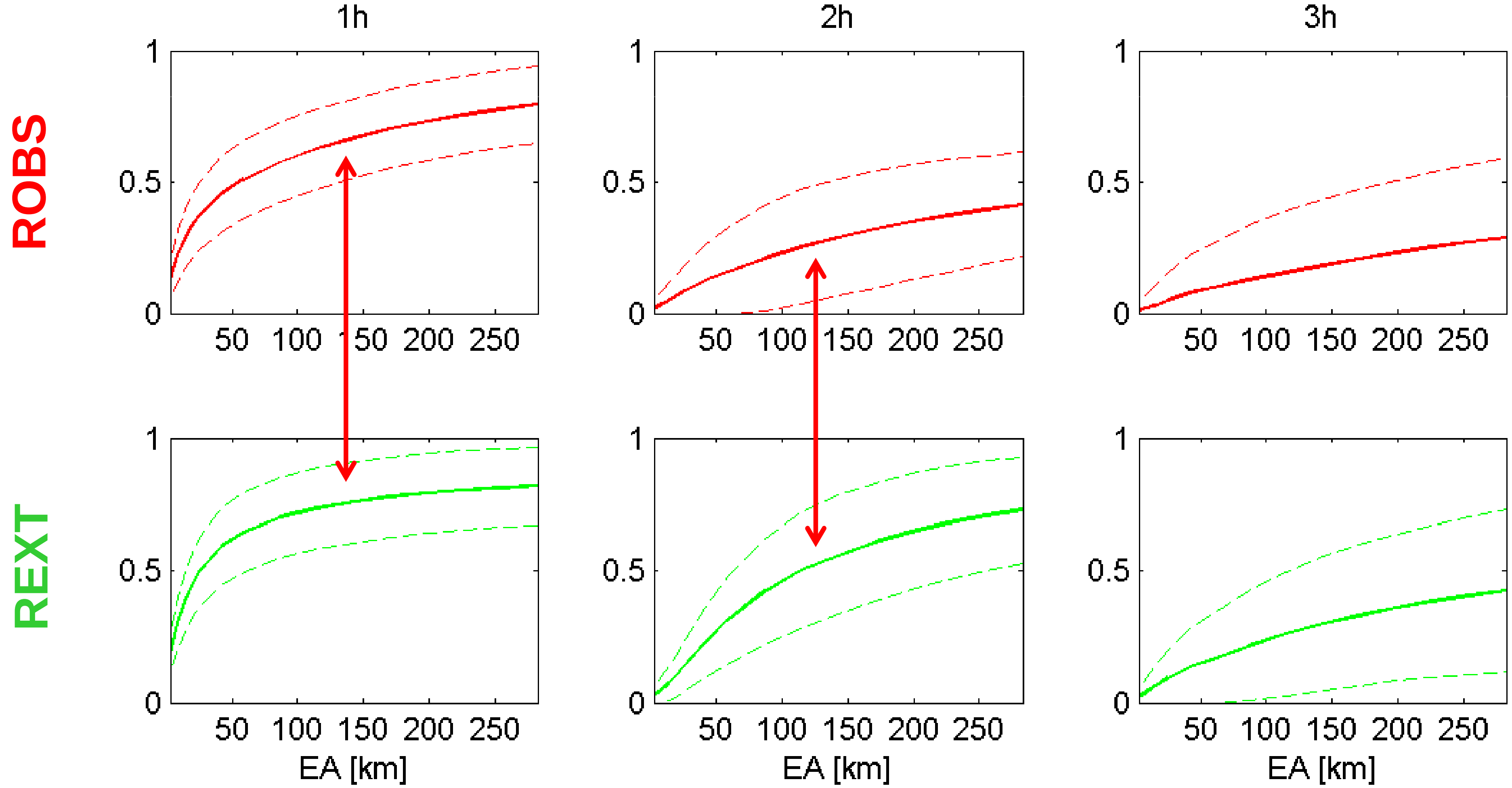
Wenli H, Paulat M, Hagen M,Frei C, 2009: SAL—A Novel Quality Measure for the Verification of Quantitative Precipitation Forecasts. *Mon. Wea. Rev.*, **136**, 4470–4487.

FSS Th= 0.5 mm/h; mean, std



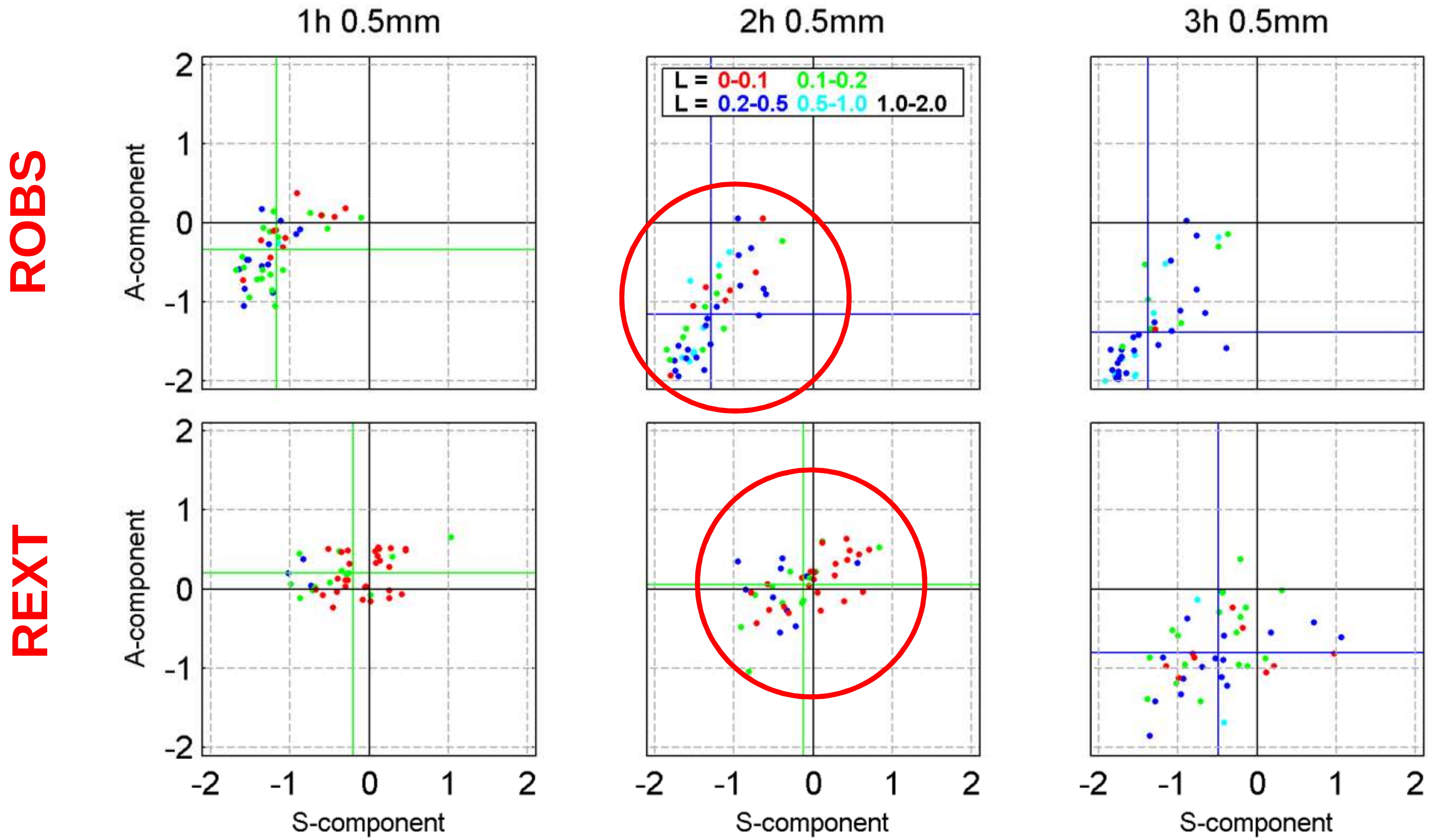
8 events x 5 runs = 40 forecasts for each hour of lead time

FSS Th= 10 mm/h; mean, std



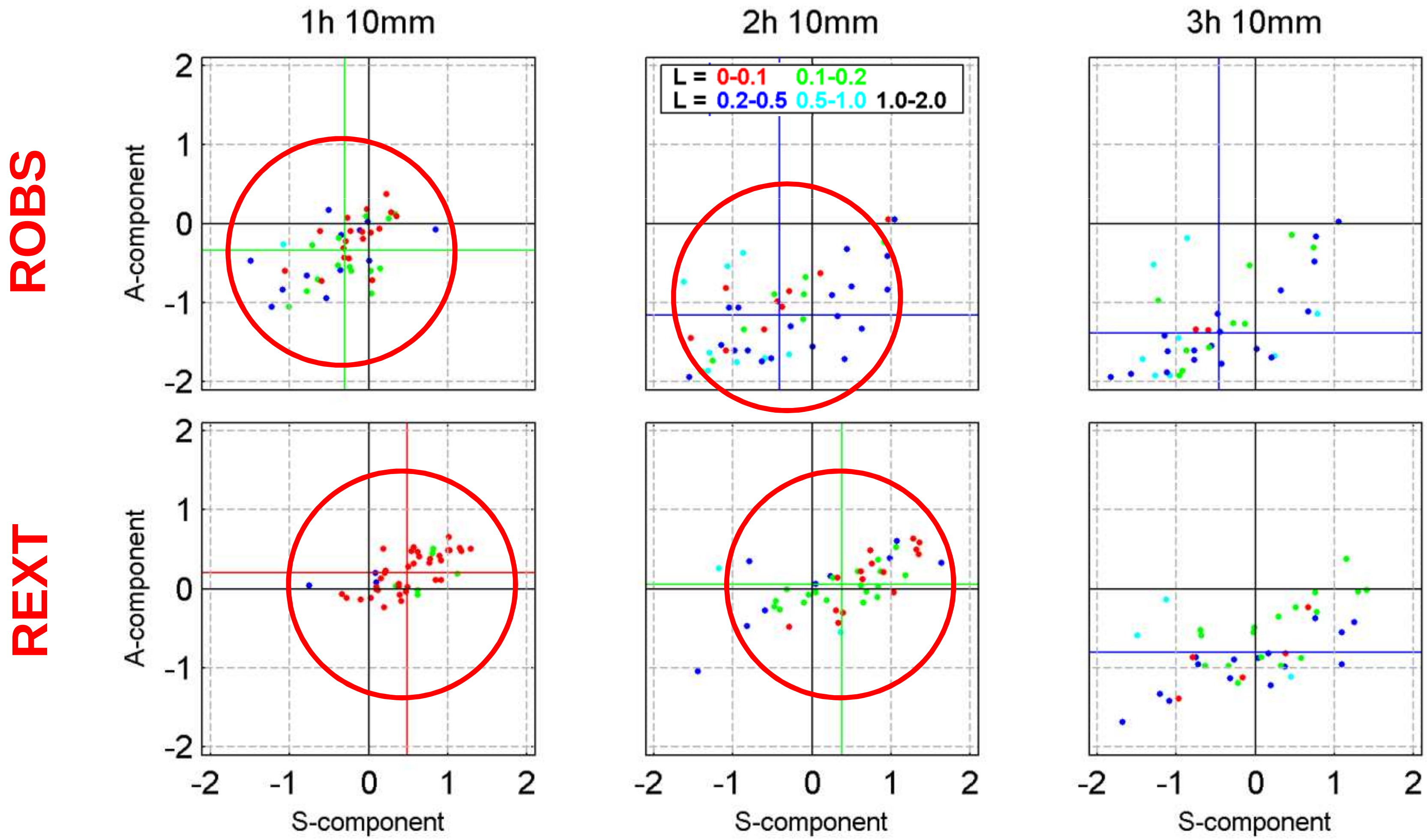
8 events x 5 runs = 40 forecasts for each hour of lead time

SAL Th= 0.5 mm/h

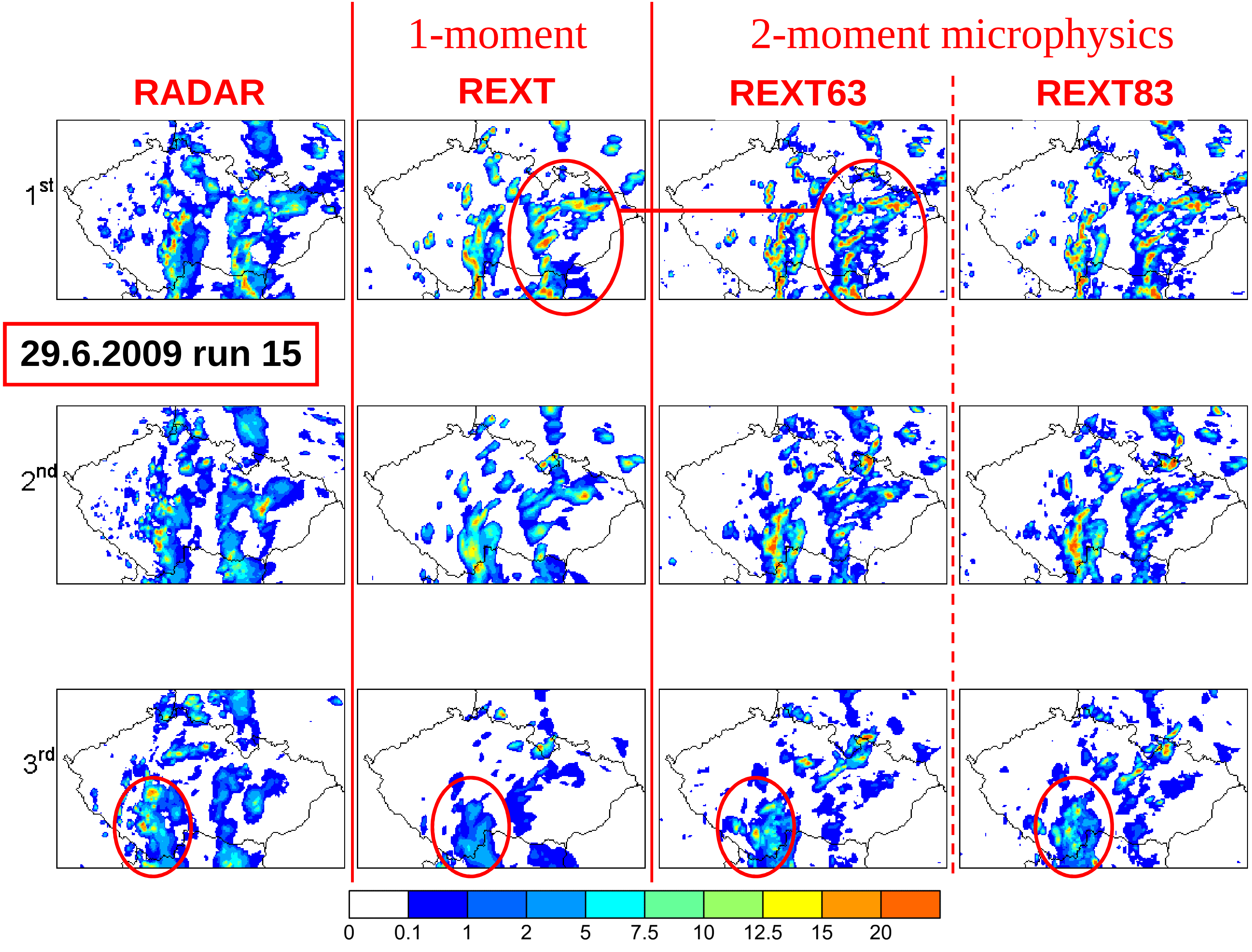


8 events x 5 runs = 40 forecasts for each hour of lead time

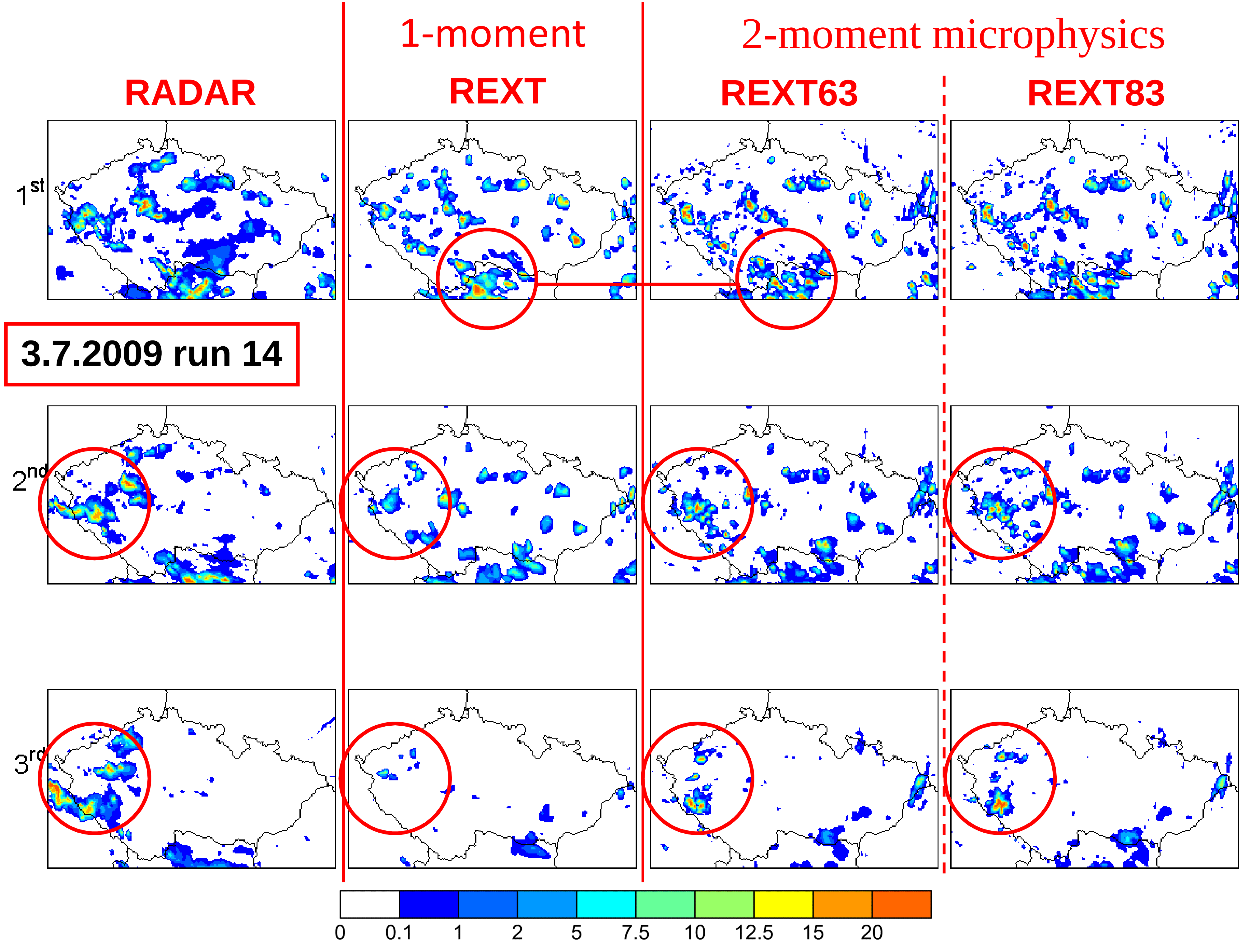
SAL Th= 10 mm/h

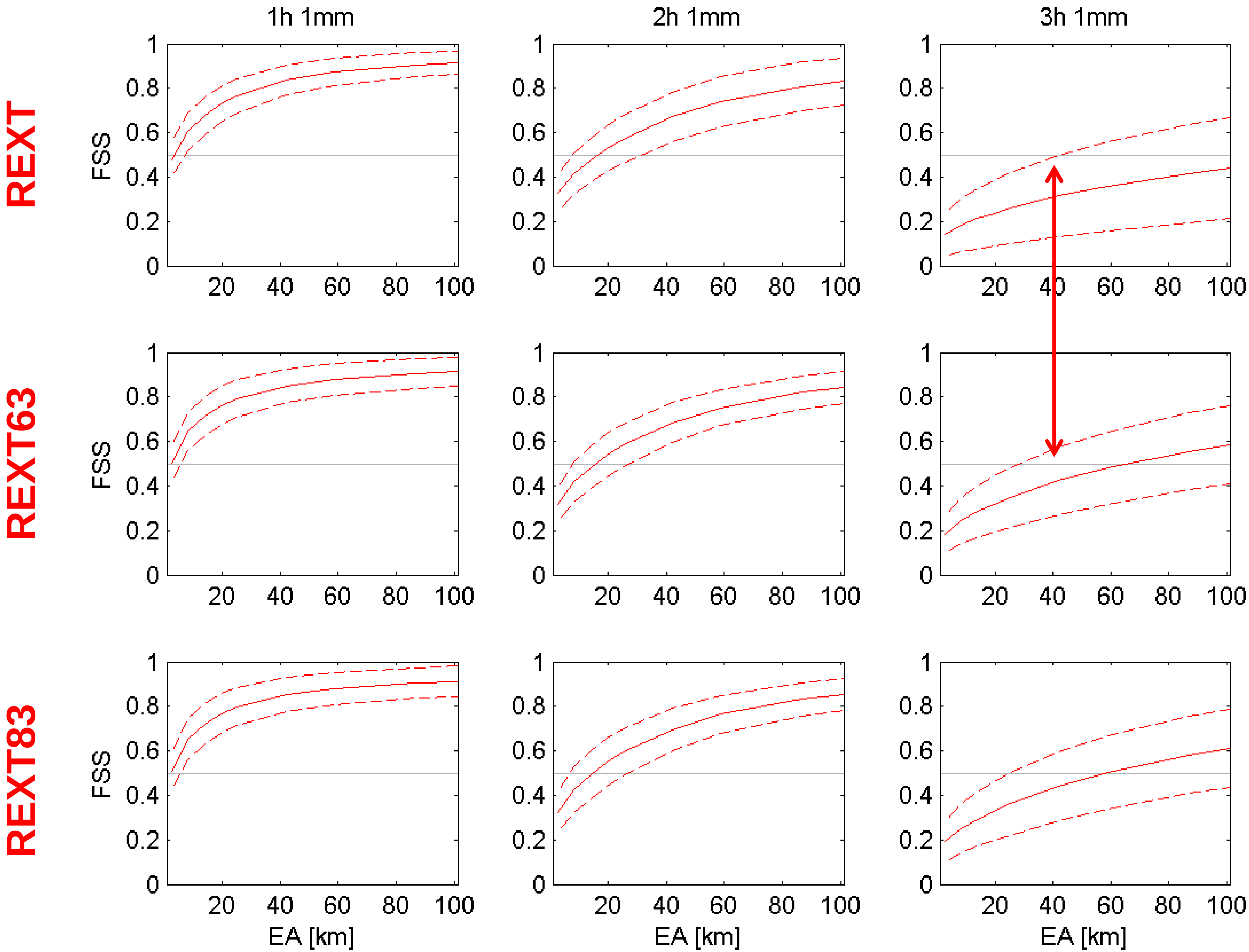


8 events x 5 runs = 40 forecasts for each hour of lead time

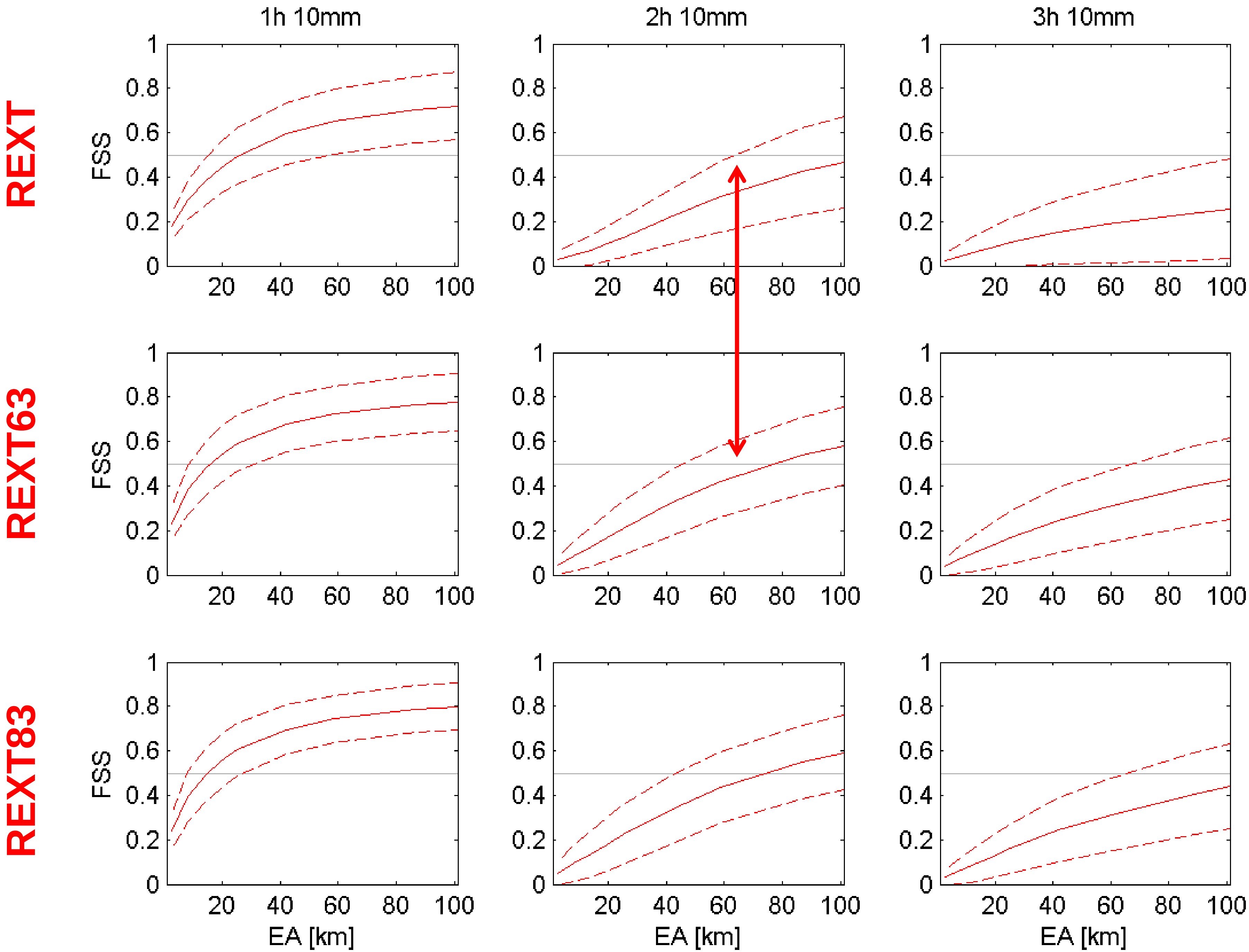


1-moment
2-moment microphysics
RADAR
REXT
REXT63
REXT83
1st
2nd
3rd
29.6.2009 run 15
0
0.1
1
2
5
7.5
10
12.5
15
20

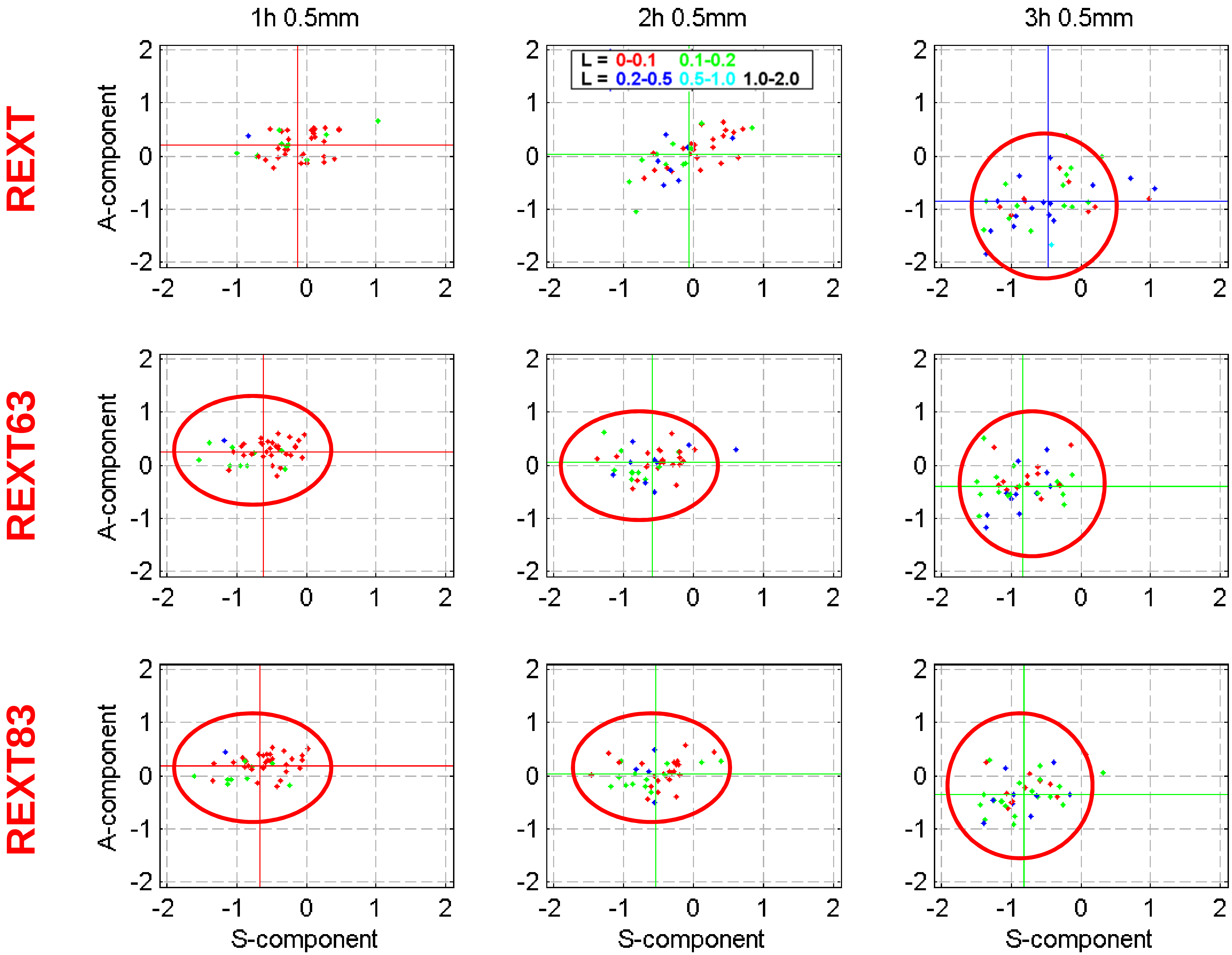

1-moment
2-moment microphysics
RADAR
REXT
REXT63
REXT83
1st
2nd
3rd
3.7.2009 run 14
0
0.1
1
2
5
7.5
10
12.5
15
20

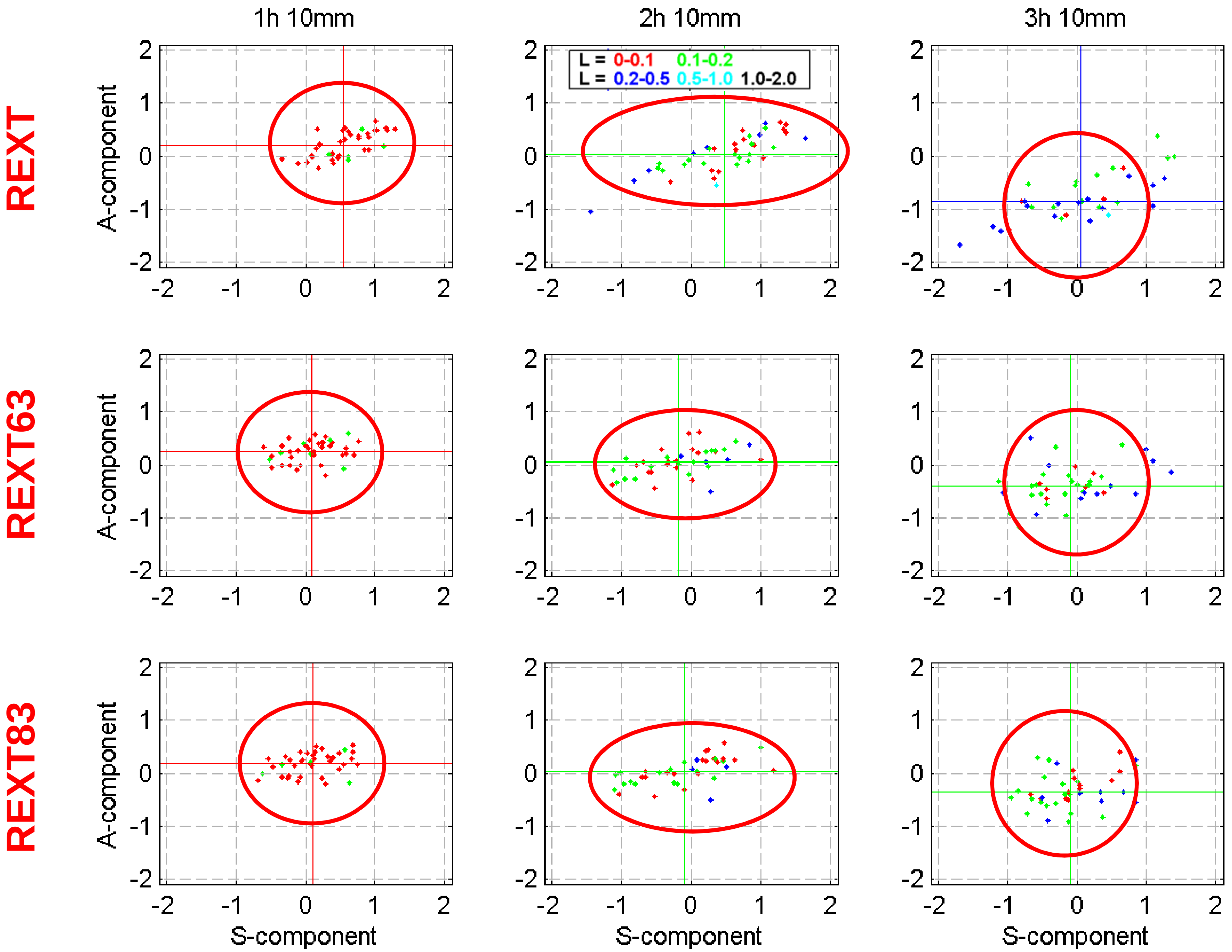


1h 1mm
2h 1mm
3h 1mm
REXT
REXT63
REXT83
FSS
EA [km]



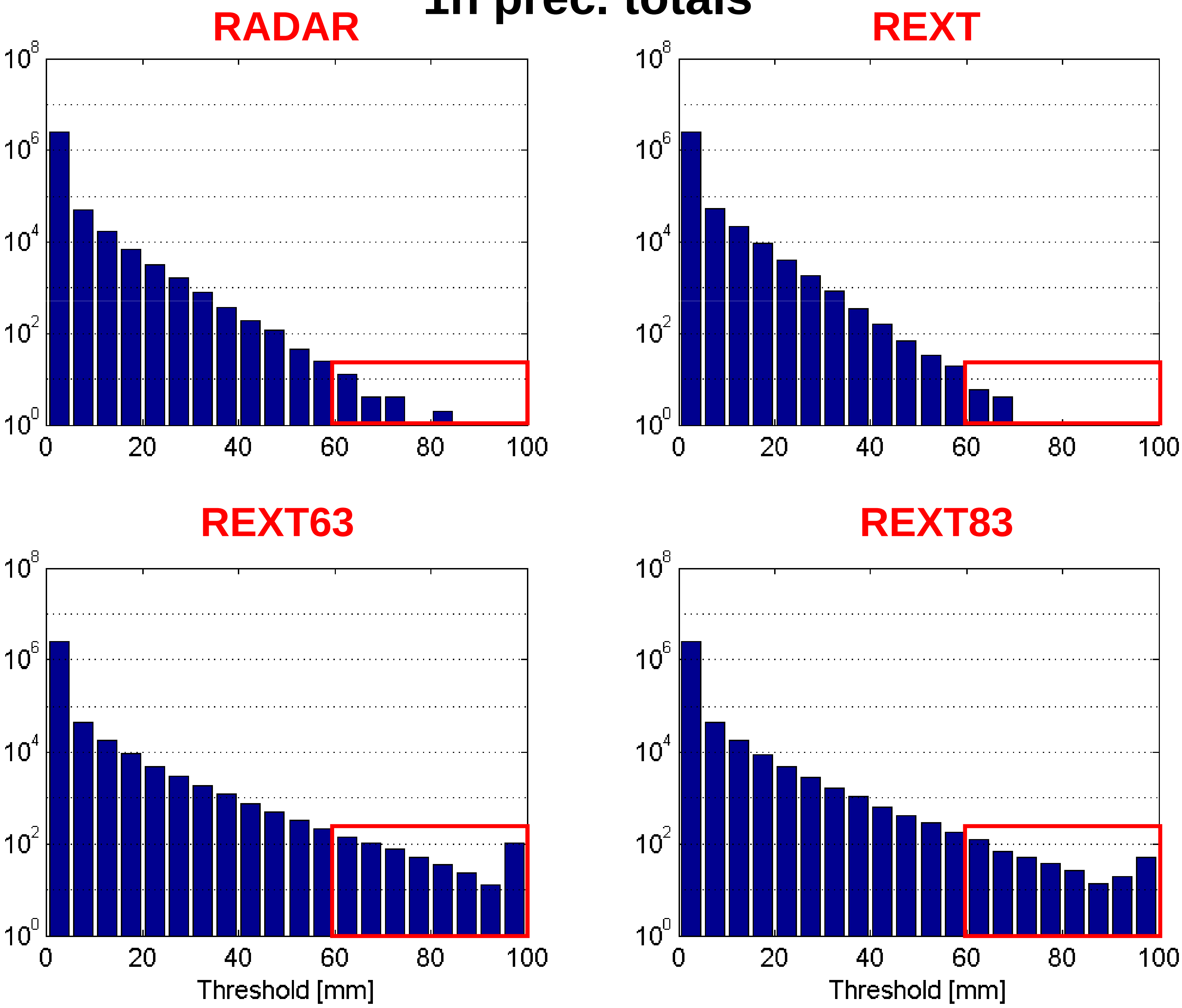
1h 10mm
2h 10mm
3h 10mm
REXT
REXT63
REXT83
FSS
EA [km]

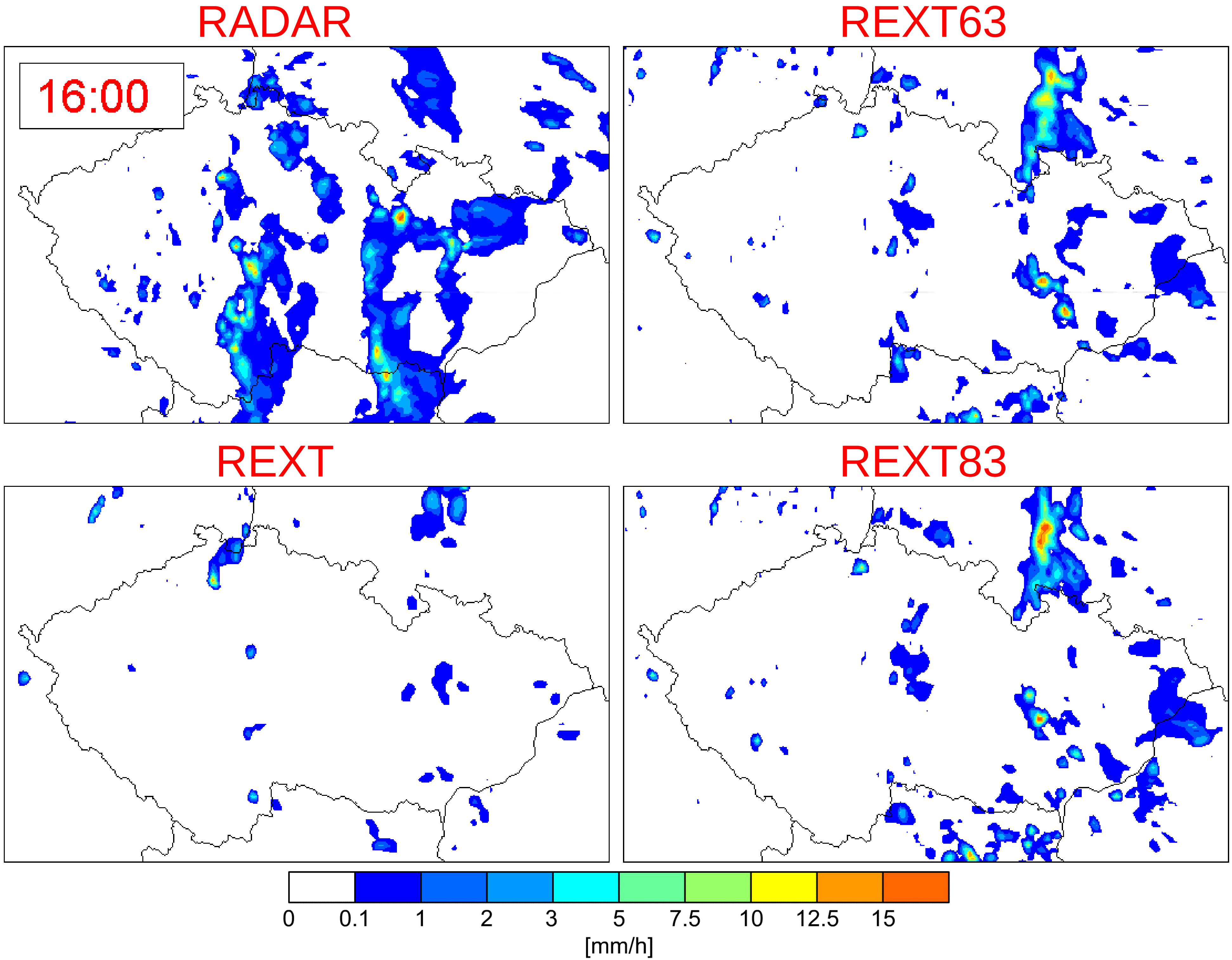

REXT
REXT63
REXT83
1h 0.5mm
2h 0.5mm
3h 0.5mm
L = 0-0.1 0.1-0.2
L = 0.2-0.5 0.5-1.0 1.0-2.0
A-component
S-component



1h 10mm
2h 10mm
3h 10mm
L = 0-0.1 0.1-0.2
L = 0.2-0.5 0.5-1.0 1.0-2.0
REXT
REXT63
REXT83
A-component
S-component

1h prec. totals




RADAR
16:00
REXT63
REXT
REXT83
0
0.1
1
2
3
5
7.5
10
12.5
15
[mm/h]

Summary

- The assimilation of extrapolated radar data improves precipitation forecasts in most cases.
- 2-m microphysics improves the forecast as well especially for higher rain rates.

- *More tests with 2-m microphysics and more detailed analysis.*

Thank you for your attention!