Use of weather radar observations for precipitation estimation and nowcasting

Laurent Delobbe and Maarten Reyniers
Royal Meteorological Institute of Belgium
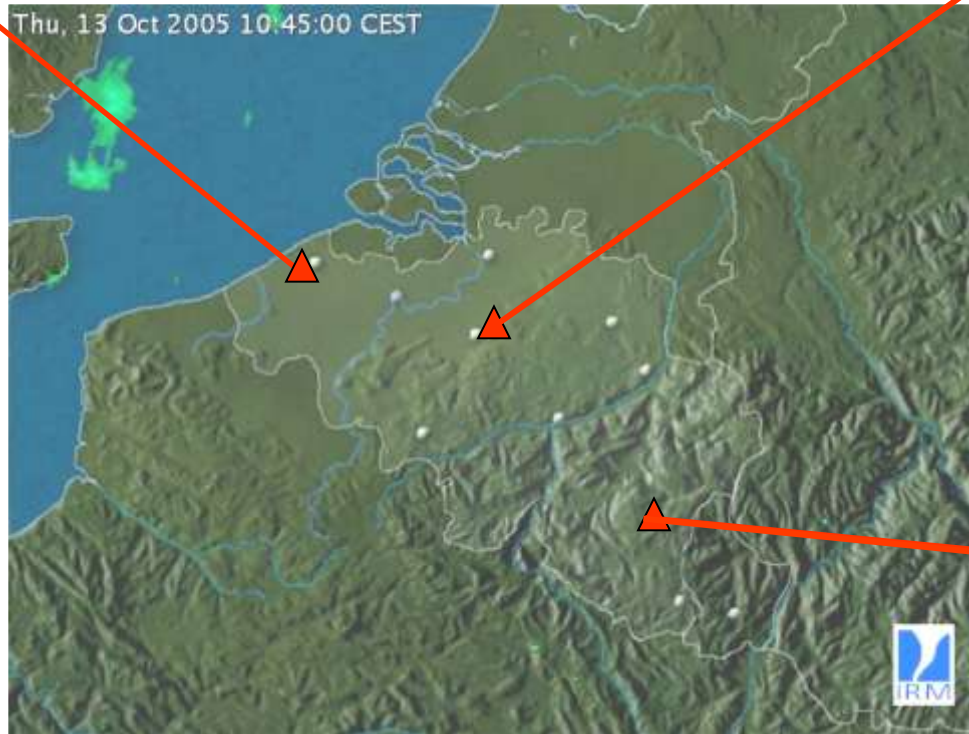
Radars in Belgium

Jabbeke
RMI
C-band, **2-pol**
Selex-Gematronik
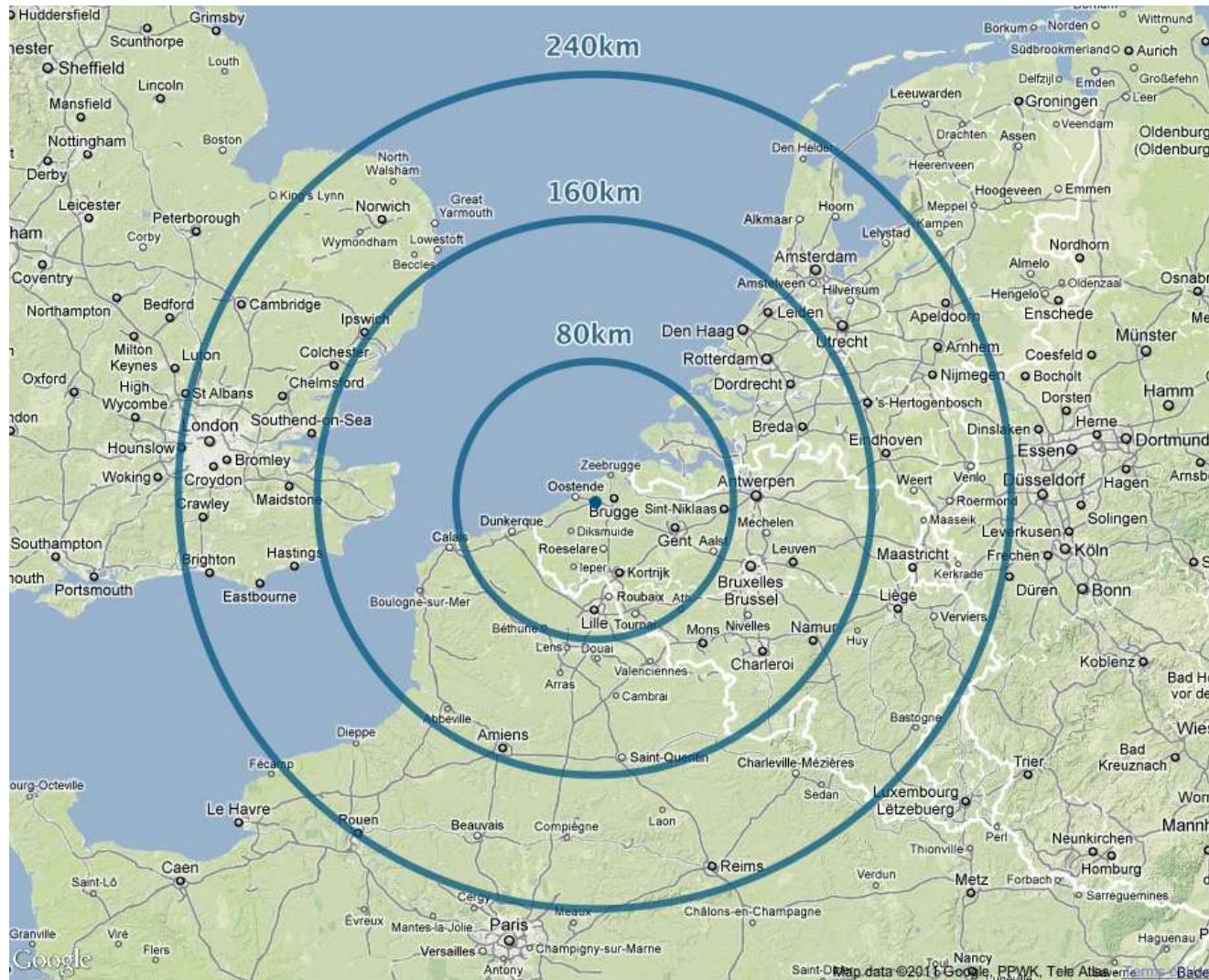Rainbow 5

Installation in
May 2012
Operational in
Aug 2012

Zaventem
Belgocontrol
C-band, 1-pol
Radtec – Sigmet
IRIS

Wideumont
RMI
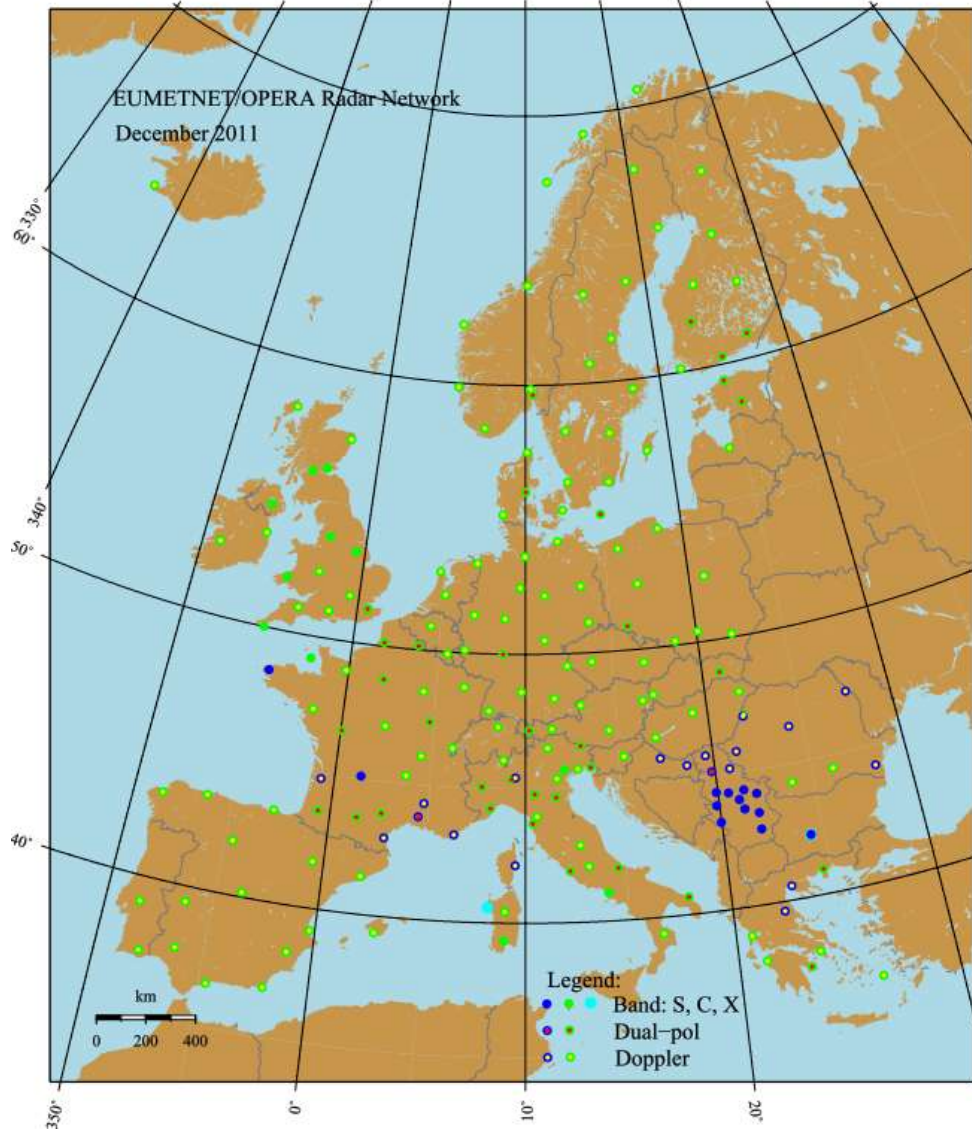C-band, 1 pol
Gematronik
Rainbow 3

Thu, 13 Oct 2005 10:45:00 CEST

Radar Jabbeke : coverage

Radars in Europe – Eumetnet/OPERA

http://www.knmi.nl/opera/

Radars in Europe – Eumetnet/OPERA

Database, software, reports available on: http://www.knmi.nl/opera/

Very soon : final report of Work package on new technology

Operational monitoring and use of polarimetric C- and S-band radars

  Data quality monitoring

  On-site antenna performance verification

  Evaluation of QPE algorithms

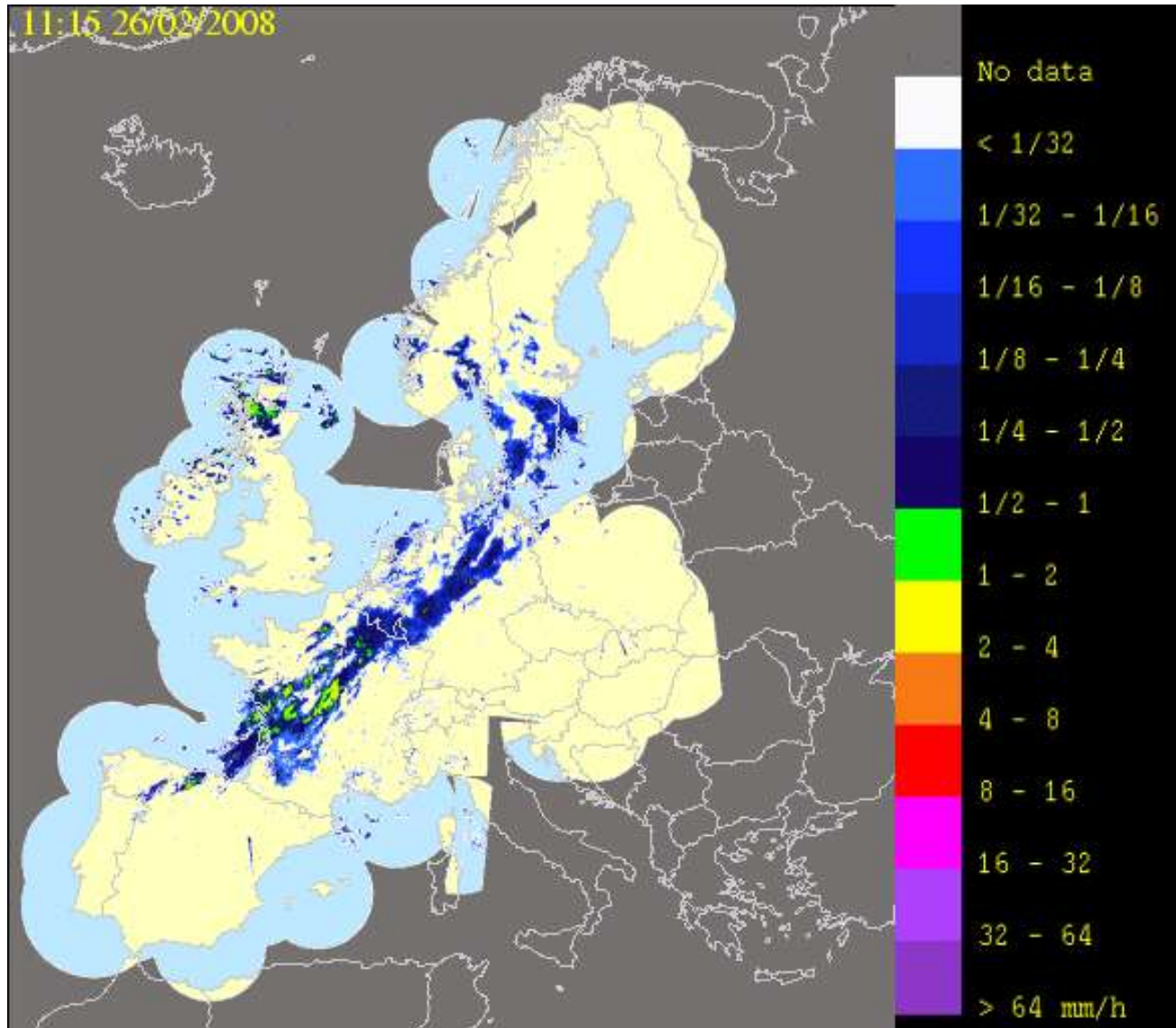Evaluation of X-band and requirements for QPE based on X-band data

  Survey

  Radome impact

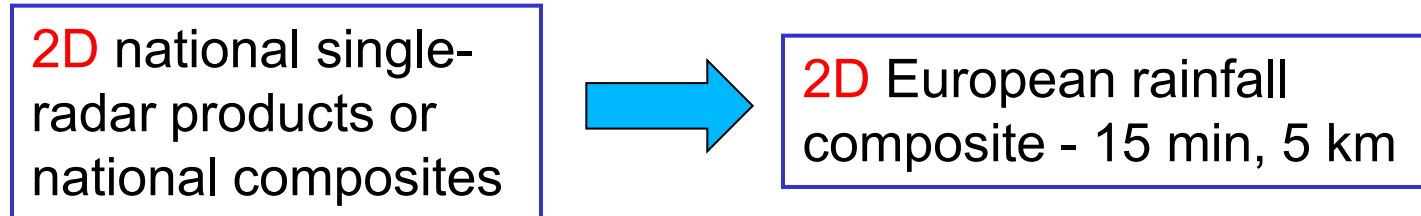 QPE based on polarimetric measurements (RYTMME project at MF)

  Recommendations

Radars in Europe – Eumetnet/OPERA
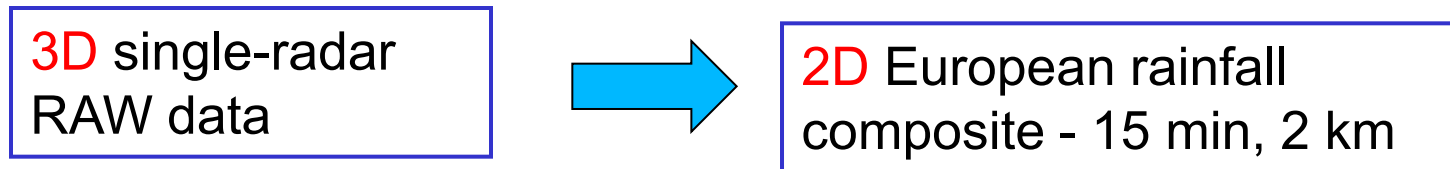
New OPERA Data Center ODYSSEY

OPERA data center till 2011 (hosted by UKMO):

| 2D national single-radar products or national composites | → | 2D European rainfall composite - 15 min, 5 km |

New OPERA data center ODYSSEY (hosted by UKMO and Météo-France):

| 3D single-radar RAW data | → | 2D European rainfall composite - 15 min, 2 km |

RMI

New OPERA Data Center ODYSSEY

- **Use of 3D input data will allow :**

  - more homogeneous composite

  - implementation of corrections (ground echo suppression, VPR, …)

- **Incorporation of quality information**

  - In the input data : for use in the compositing algorithm

  - In the output products : for optimal use in various applications

- Future : from 3D to 3D

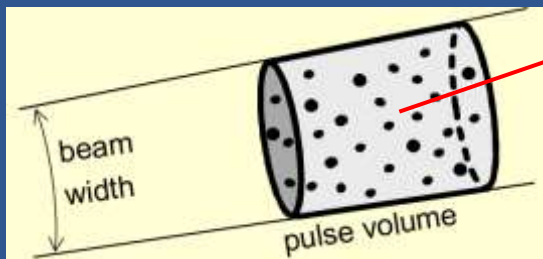# New European Radar Composite ODYSSEY
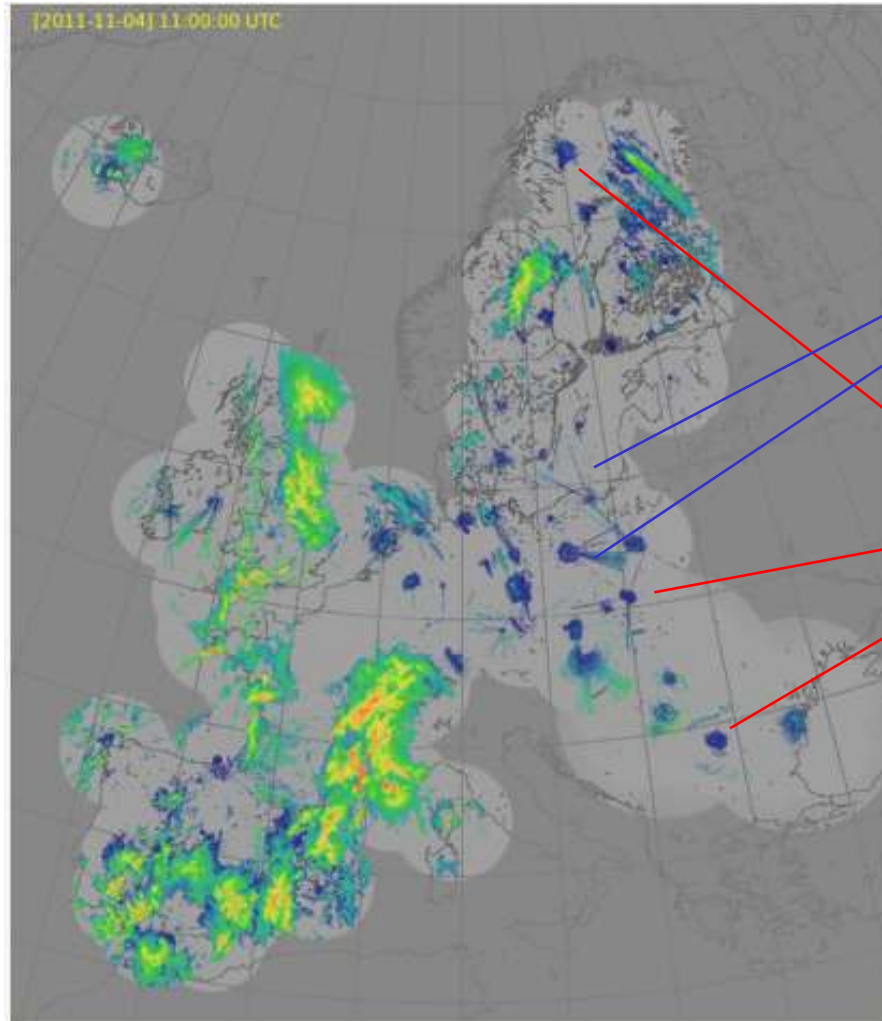
Radar does not measure surface rainrate

The radar measures the reflectivity Z (mm^6/m^3) at a given height in a given sample volume

beam width

pulse volume

$$Z = \int n(D) \, D^6 \, dD$$

r = range

D = drop diameter

$n(D)$ = drop size distribution

Received power : $P_r = k \, \dfrac{Z}{r^2}$

k = calibration constant

Hydrologists are interested in surface rain rate R (mm/h)
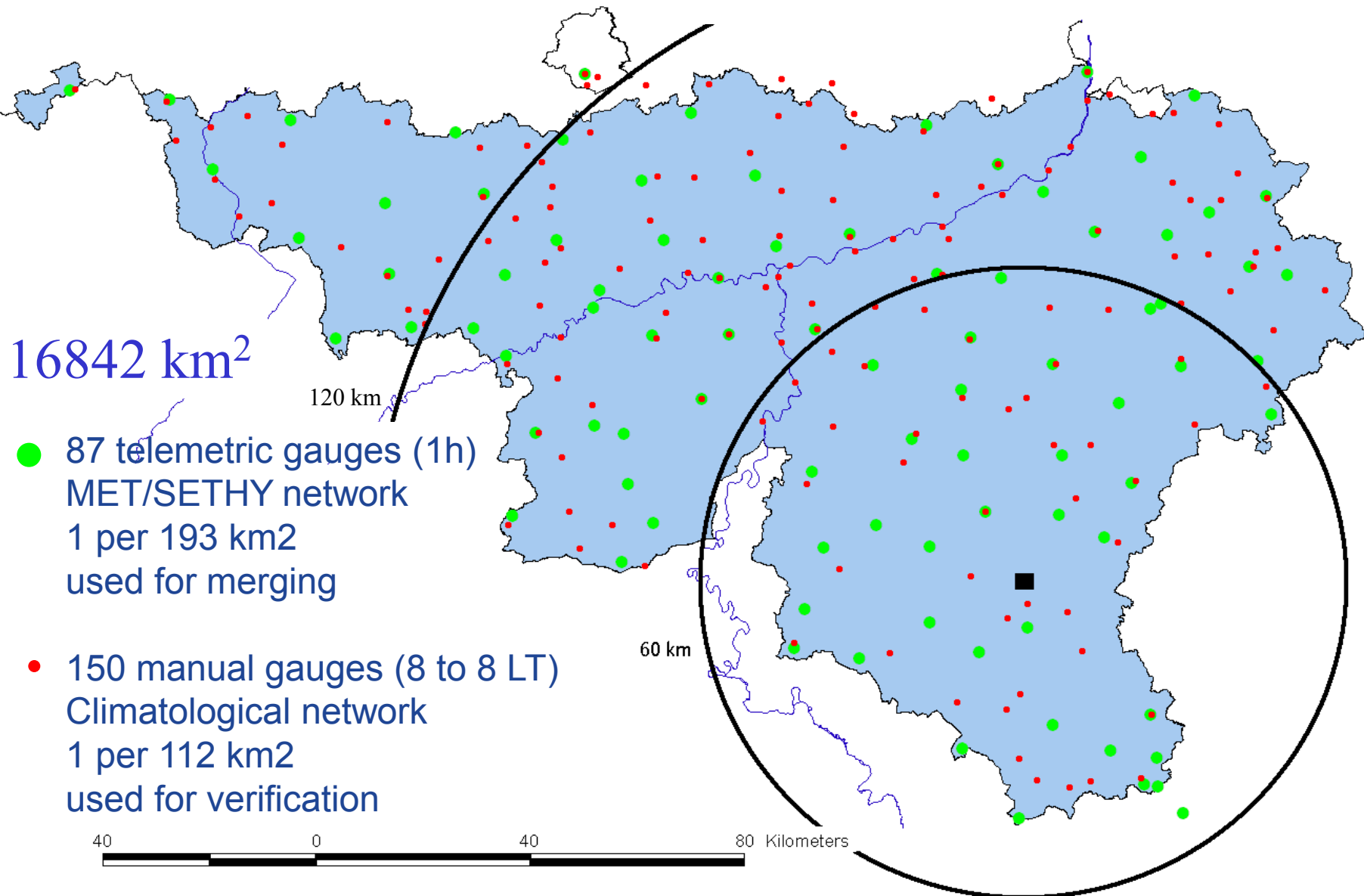
$$R \sim \int v(D) \, n(D) \, D^3 \, dD$$

$v(D)$ = hydrometeor fall speed

From radar observations to rainfall amounts

Ideal processing chain :

- Removal of non-meteorological echoes

- Beam blockage correction

- Attenuation correction

- Vertical profile of Reflectivity correction

- Z-R conversion

- Accumulation using advection correction

- Radar-gauge merging
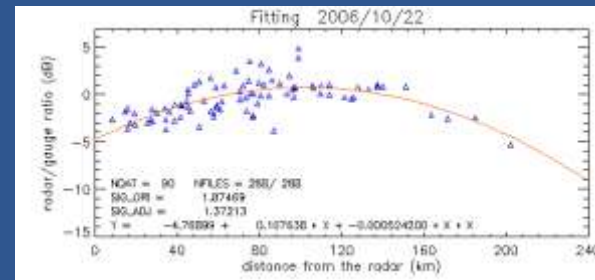
Radar-gauge merging : gauge networks

16842 km^2

● 87 telemetric gauges (1h)
MET/SETHY network
1 per 193 km2
used for merging

● 150 manual gauges (8 to 8 LT)
Climatological network
1 per 112 km2
used for verification

Radar-gauge merging methods

MFB : Mean-field bias correction

$$F_{MFB} = \frac{\sum_{i=1}^{N} G_i}{\sum_{i=1}^{N} R_i}$$

RDA : Range-dependent adjustment

R/G(dB) versus range fitted
by a 2nd order polynom

BRA : Brandes (1975) spatial adjustment

Spatial interpolation of G/R

$$F_1 = \frac{\sum w_i\, G_i / R_i}{\sum w_i}$$

$$w_i = \exp(-r_i^2 / k)$$
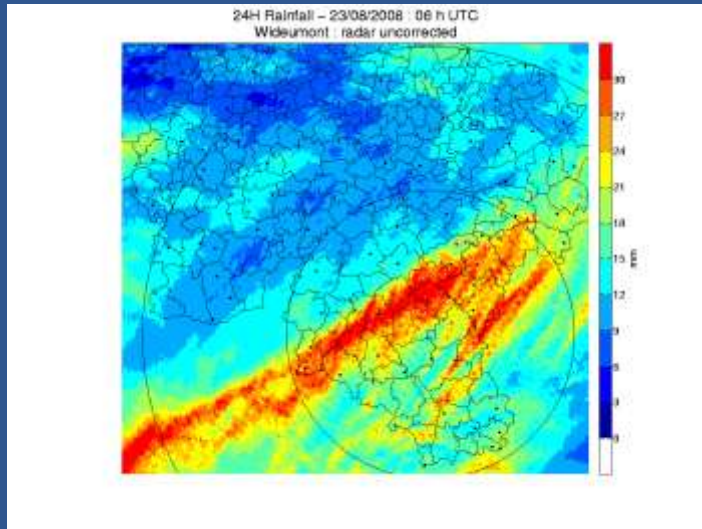
Radar-gauge merging methods

Geostatistical methods:

KRI : ordinary kriging based on gauges only

      linear estimator, mean is spatially uniform

      variogram : linear function of the distance

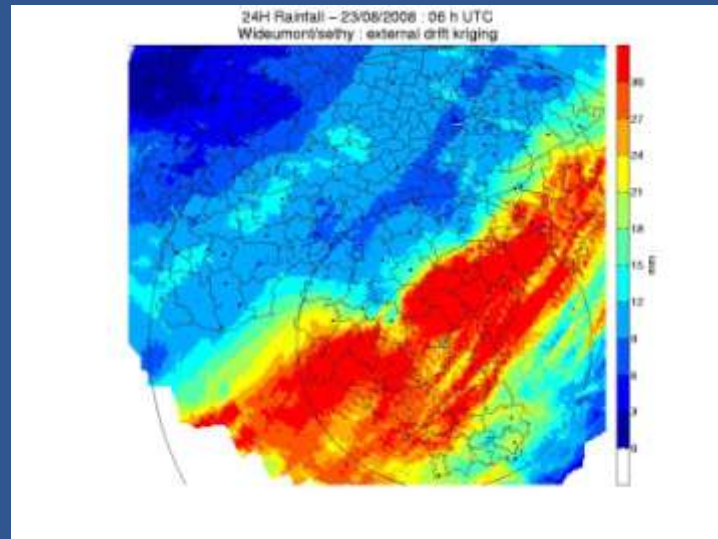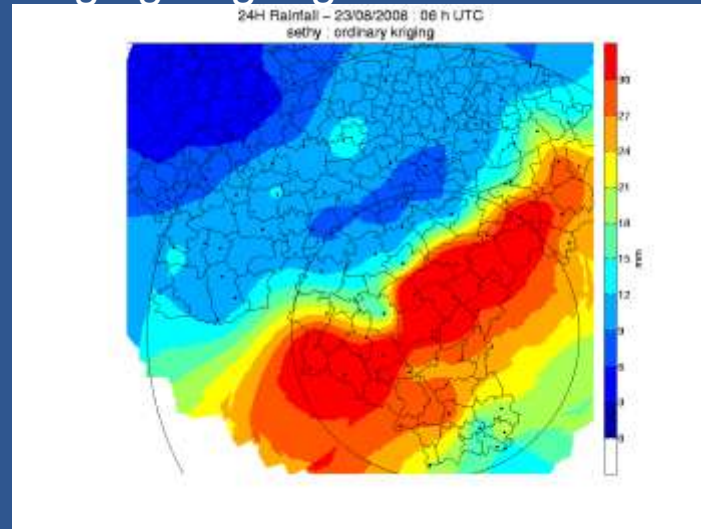KRE : kriging with radar-based error correction

      Sinclair and Pegram (2005)

KED : kriging with external drift

      mean is a linear function of the radar field
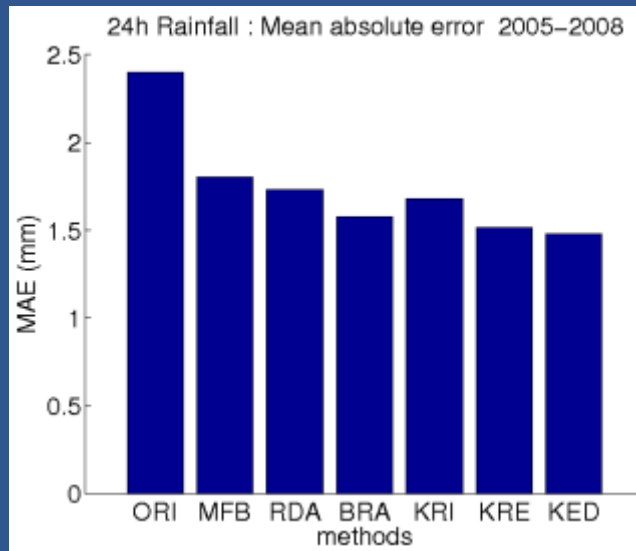
RMI

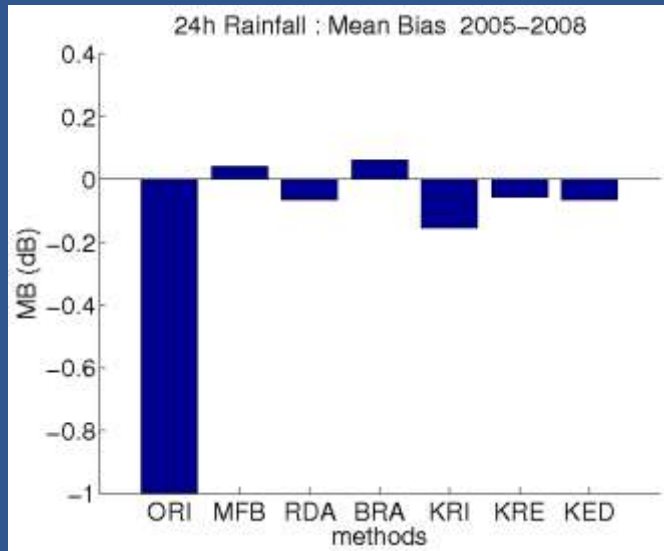# Radar-gauge merging : example

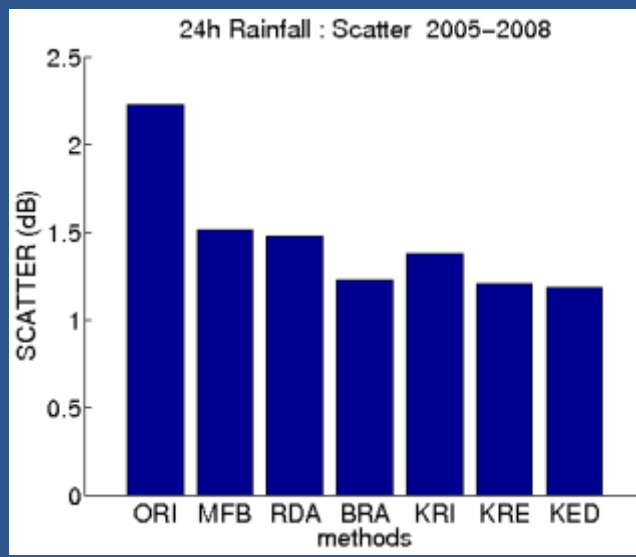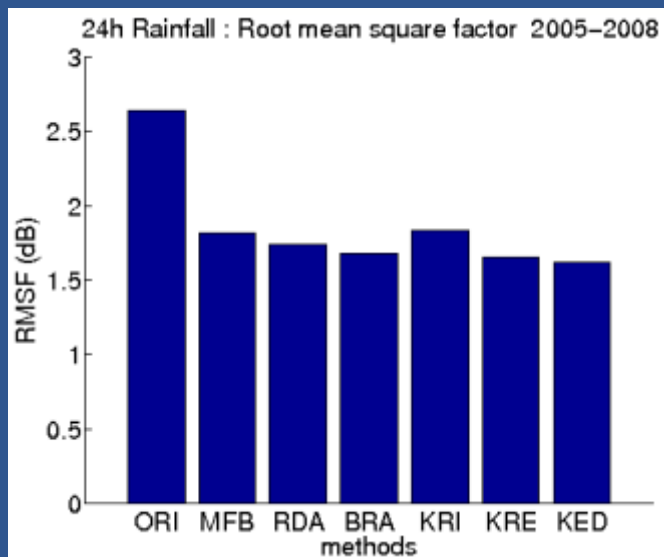Radar

Kriging of gauges

Kriging with external drift :

radar patterns are added to the

kriging of gauge values

Radar-gauge merging : verification

ORI : radar
MFB: mean bias
RDA: range-dep.
BRA: Brandes
KRI : kriging
KRE : Pegram
KED : Kri. Ext. Drift

Radar-gauge merging : verification
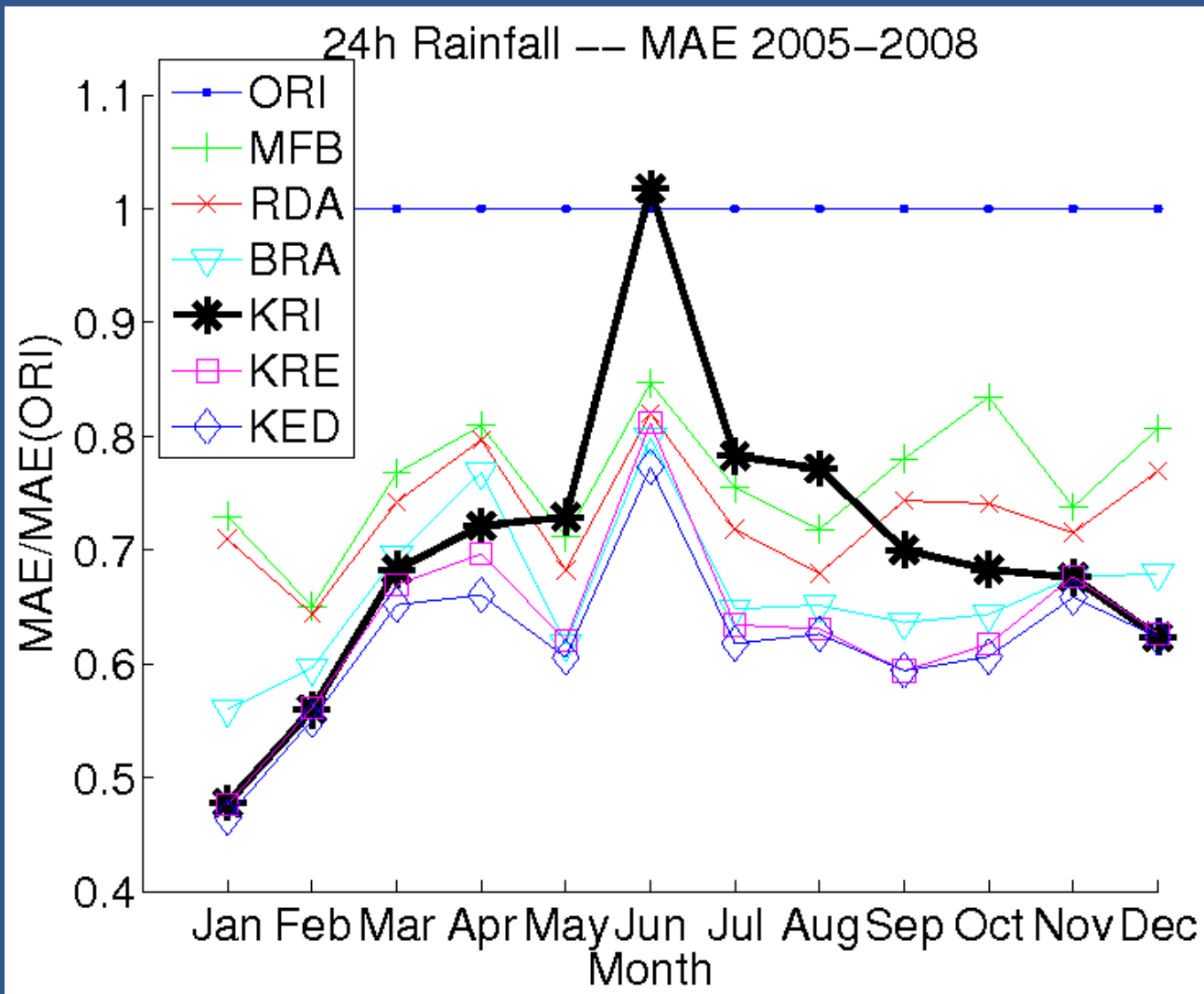

24h Rainfall –– MAE 2005–2008

ORI : radar
MFB: mean bias
RDA: range-dep.
BRA: Brandes
KRI : kriging
KRE : Pegram
KED : Kri. Ext. Drift

Radar-gauge merging : verification

ORI : radar
MFB: mean bias
RDA: range-dep.
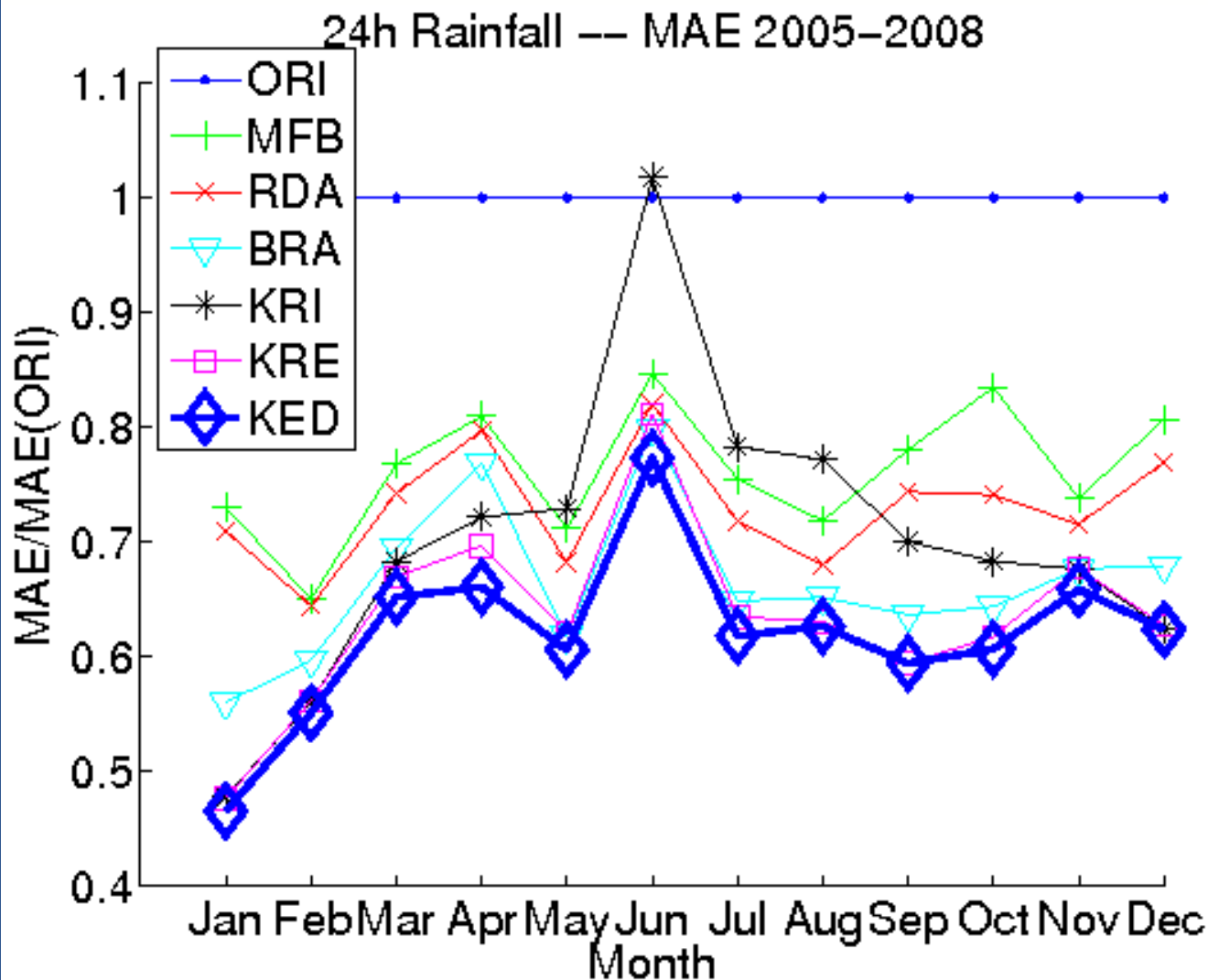BRA: Brandes
KRI : kriging
KRE : Pegram
KED : Kri. Ext. Drift

Goudenhoofdt, E. and Delobbe, L.: Evaluation of radar-gauge merging methods for quantitative precipitation estimates, Hydrol. Earth Syst. Sci., 13, 195-203, 2009