International workshop on fine-scale rainfall estimation
K.U.Leuven – Monday 16 April 2012

Use of weather radar observations for precipitation estimation and nowcasting

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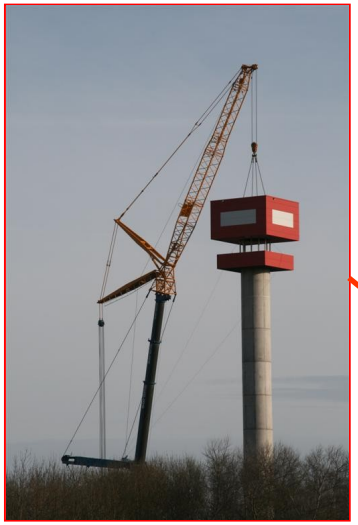
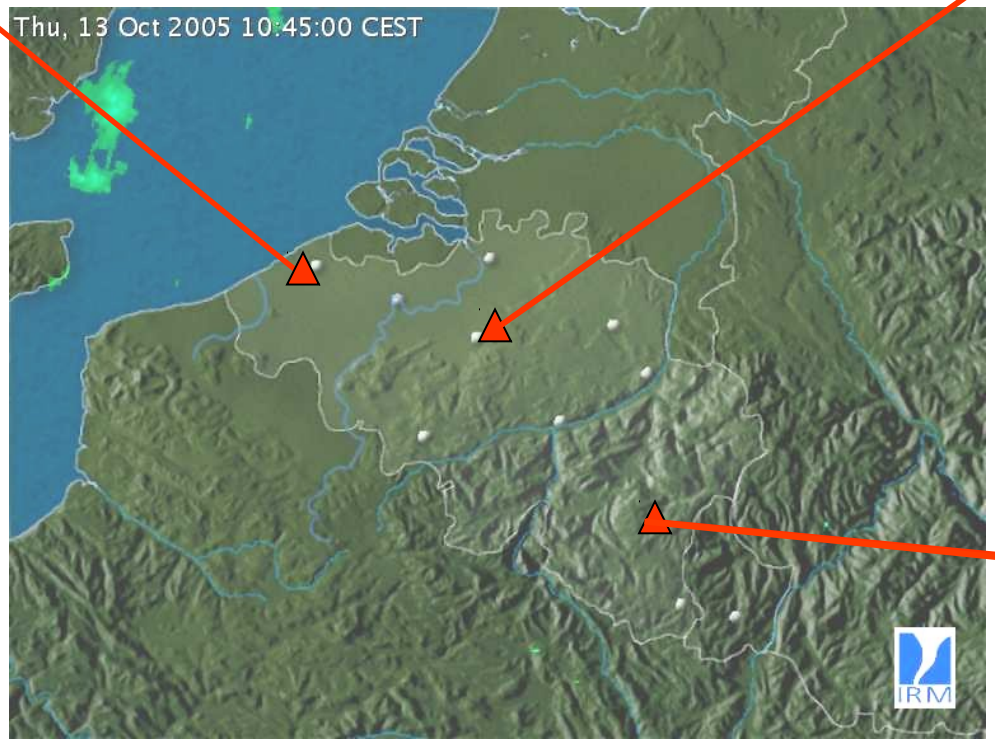
Edouard Goudenhoofdt
Royal Meteorological Institute of Belgium

Radars in Belgium



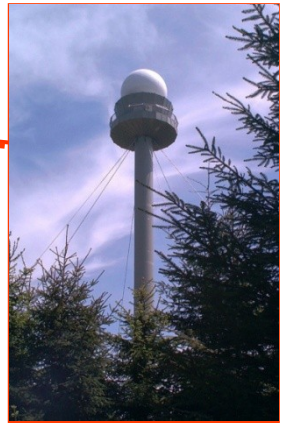
Jabbeke
RMI
C-band, **2-pol**
Selex-Gematronik
Rainbow 5

Installation in
May 2012
Operational in
Aug 2012



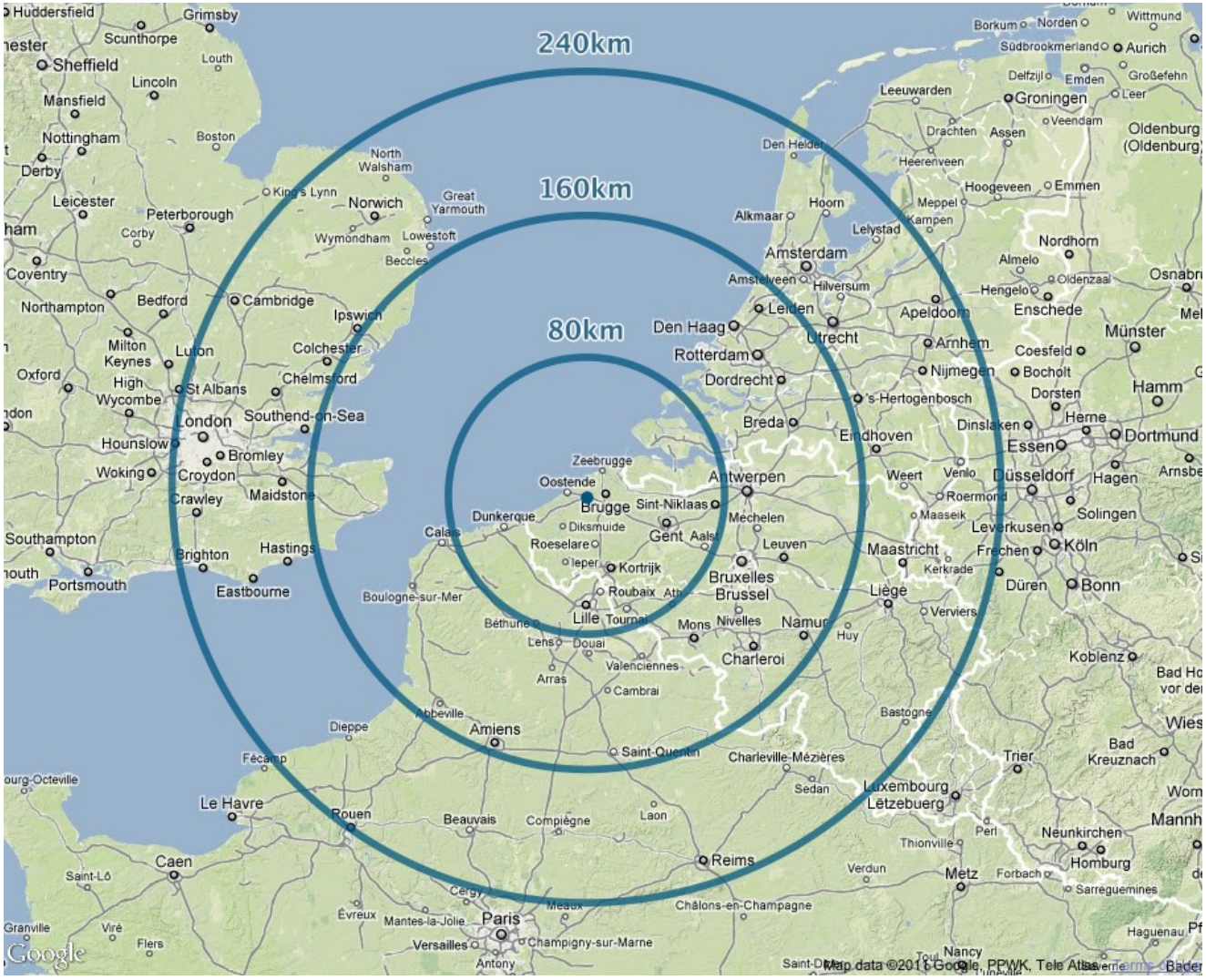
Zaventem
Belgocontrol
C-band, 1-pol
Radtec – Sigmet
IRIS

Wideumont
RMI
C-band, 1 pol
Gematronik
Rainbow 3

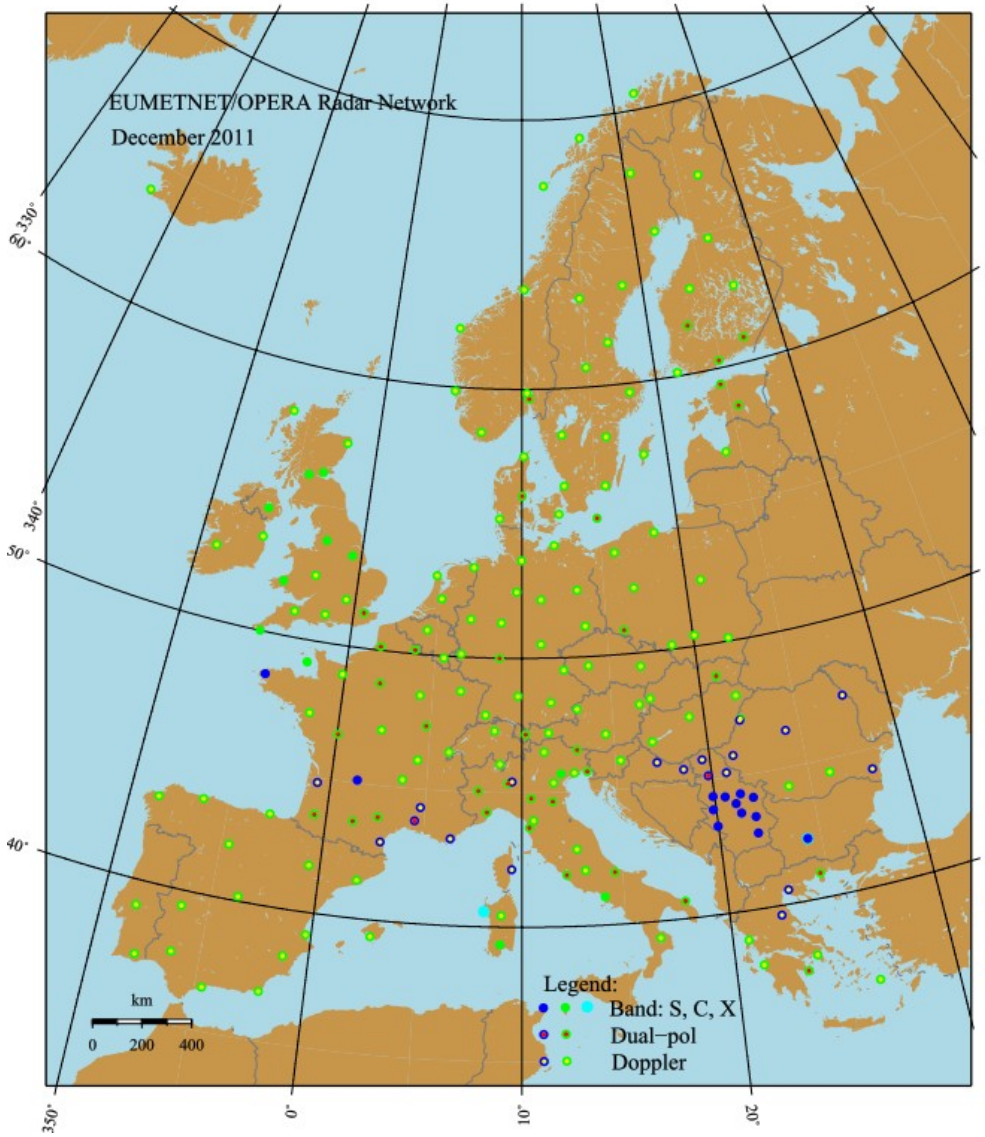


RMI

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

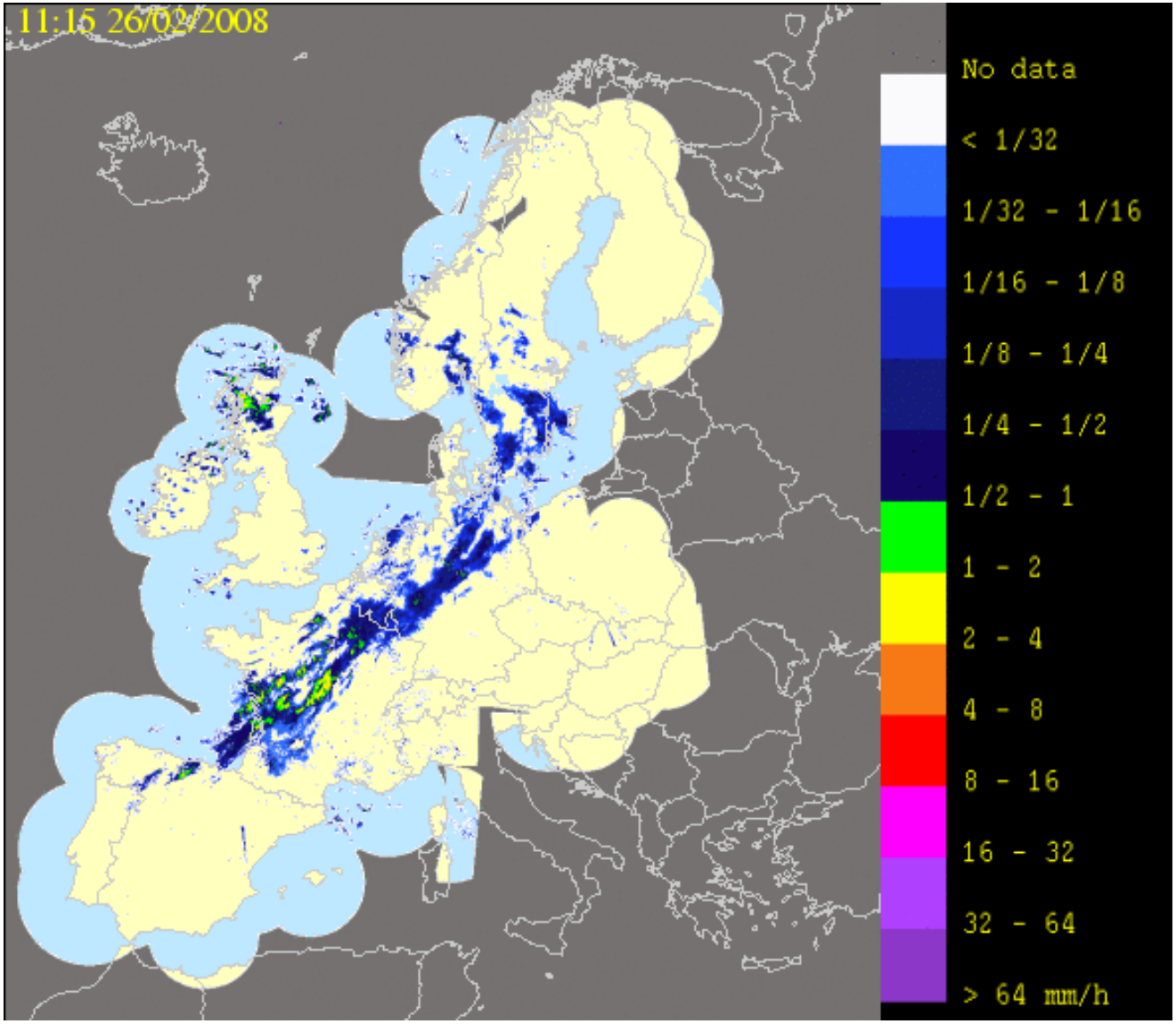
Operational monitoring and use of polarimetric C- and S-band radars

- 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):

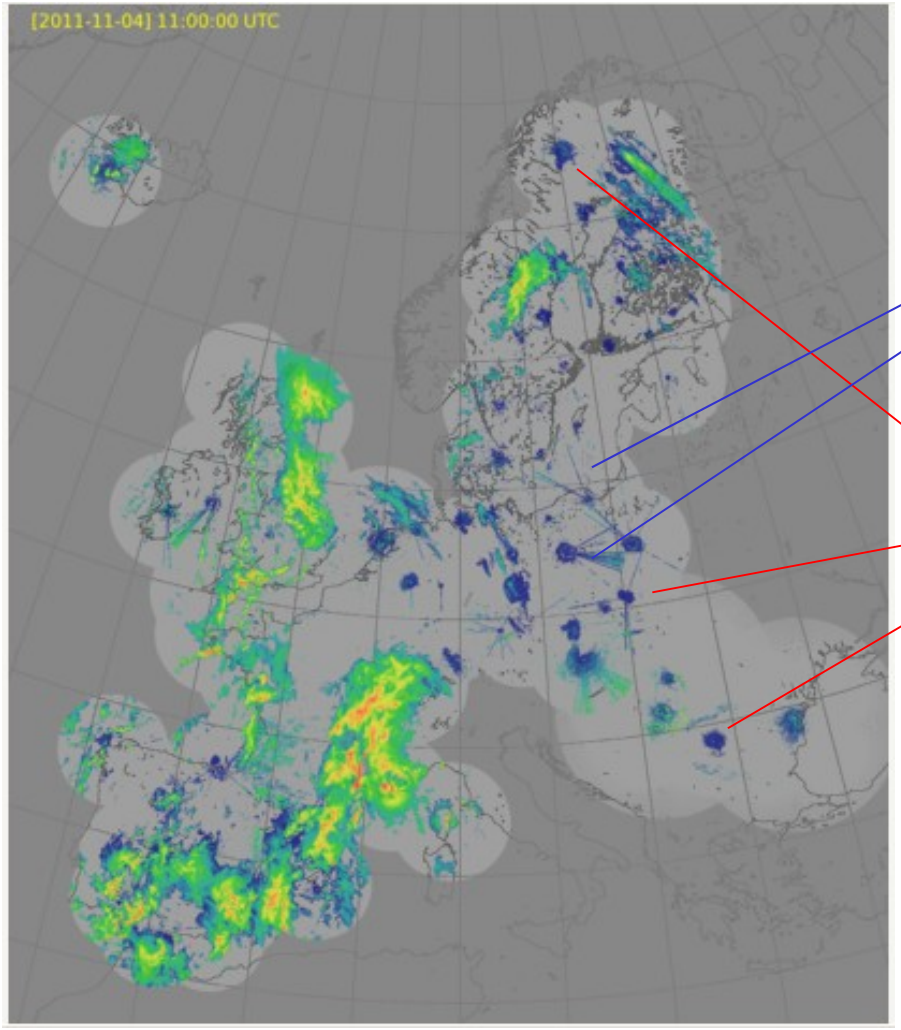
3D single-radar RAW data → 2D European rainfall composite - 15 min, 2 km

RMI

New OPERA Data Center ODYSSEY

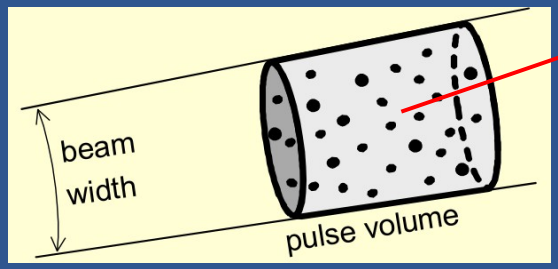
- Use of 3D input data will allow :
  - more homogeneous composite
  - implementation of corrections (ground echo suppression, VPR, …)
- Incorporation of quality information
  - In the input data : for use in the compositing algorithm
  - In the output products : for optimal use in various applications

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



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

r = range

D = drop diameter

n(D) = drop size distribution

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

k = calibration constant

Hydrologists are interested in surface rain rate R (mm/h)

$$R \sim \int v(D)\, n(D)\, D^3\, dD$$

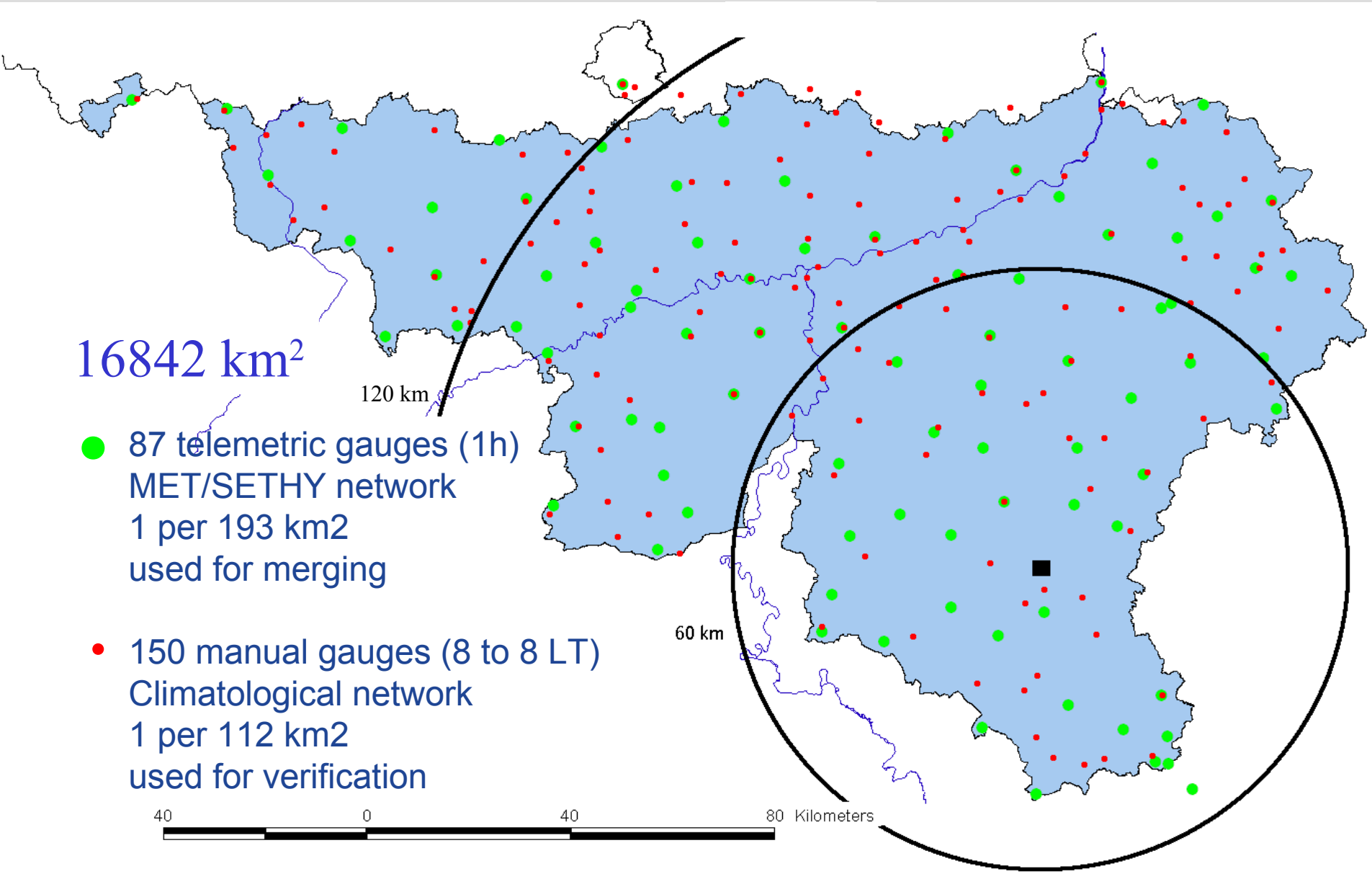
v(D) = hydrometeor fall speed

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



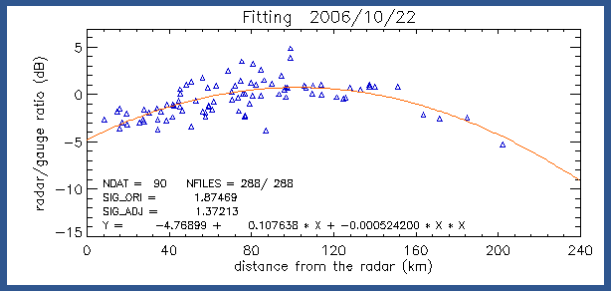
Radar-gauge merging methods

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

$$F_1 = \frac{\sum w_i G_i / R_i}{\sum w_i} \qquad w_i = \exp(-r_i^2 / k)$$

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

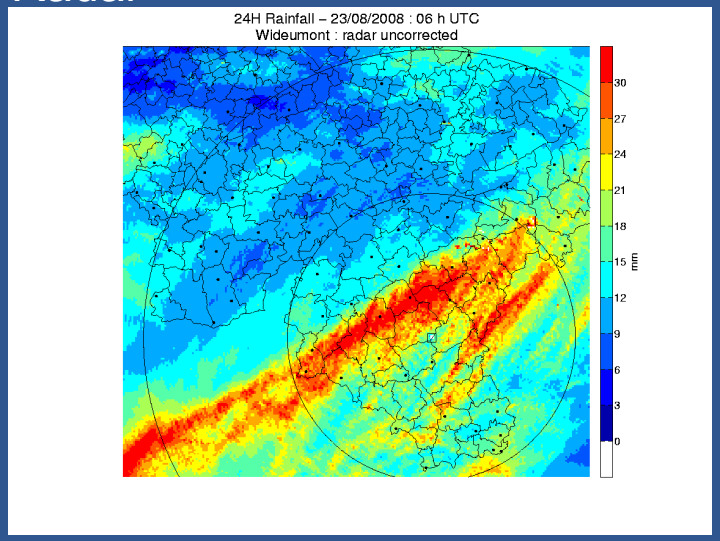
Sinclair and Pegram (2005)

KED : kriging with external drift

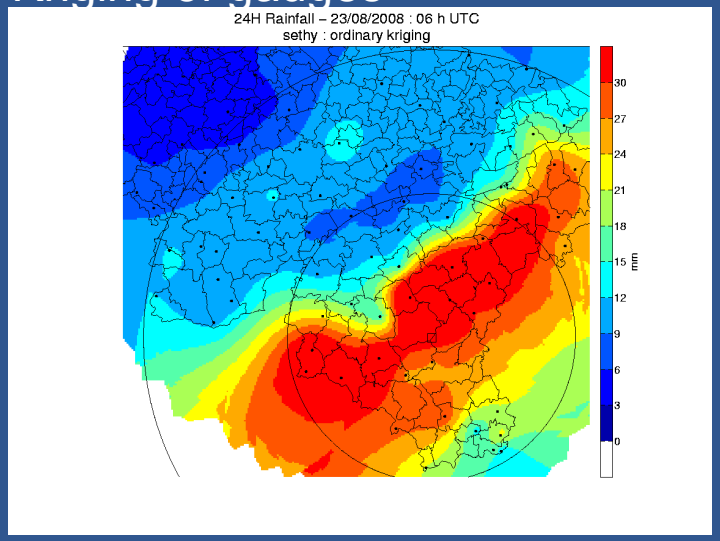
mean is a linear function of the radar field

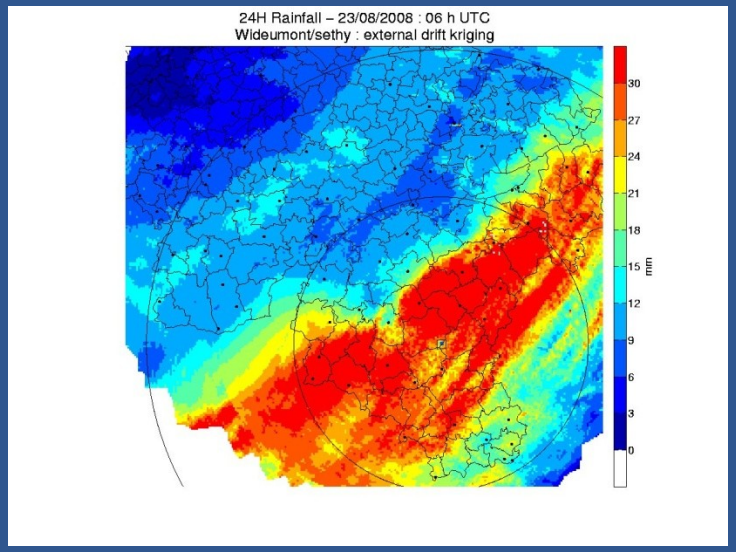
Radar-gauge merging : example

Radar



Kriging of gauges



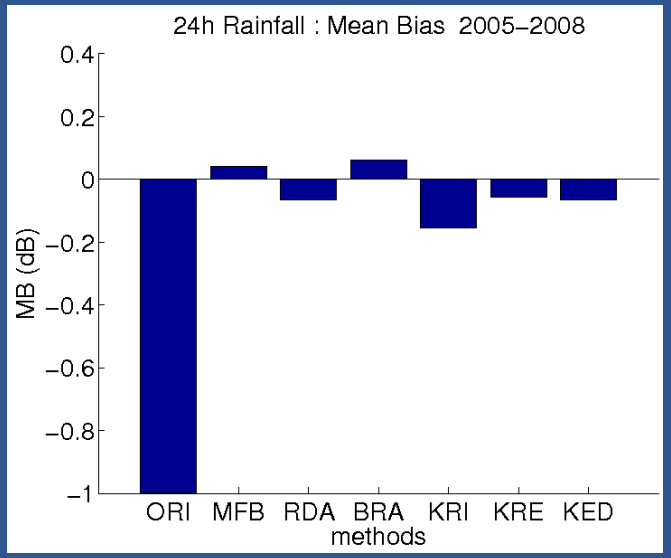


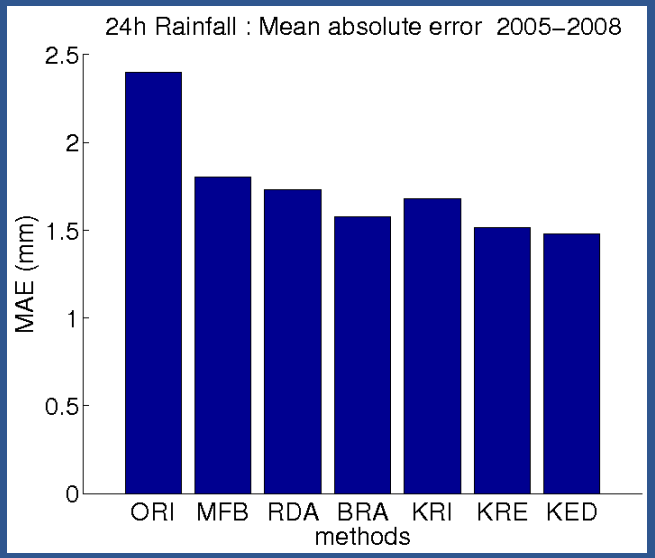
Kriging with external drift :

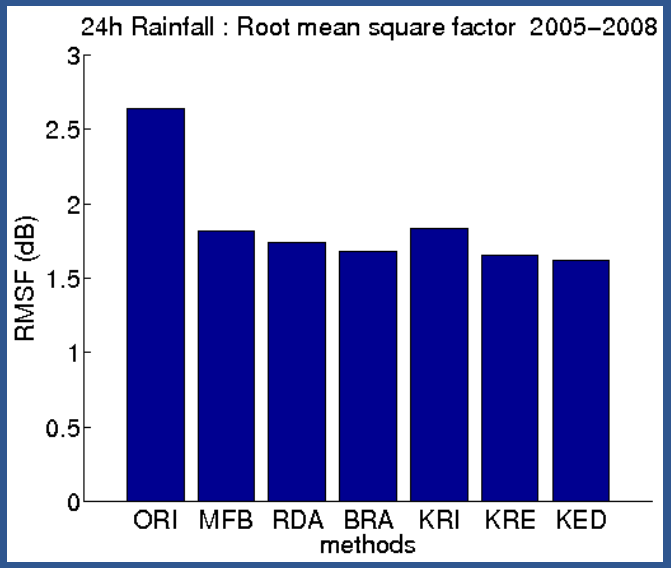
radar patterns are added to the

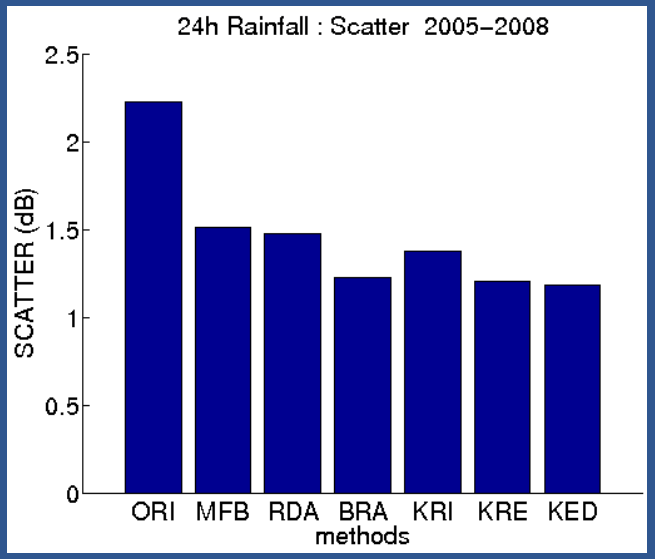
kriging of gauge values

Radar-gauge merging : verification



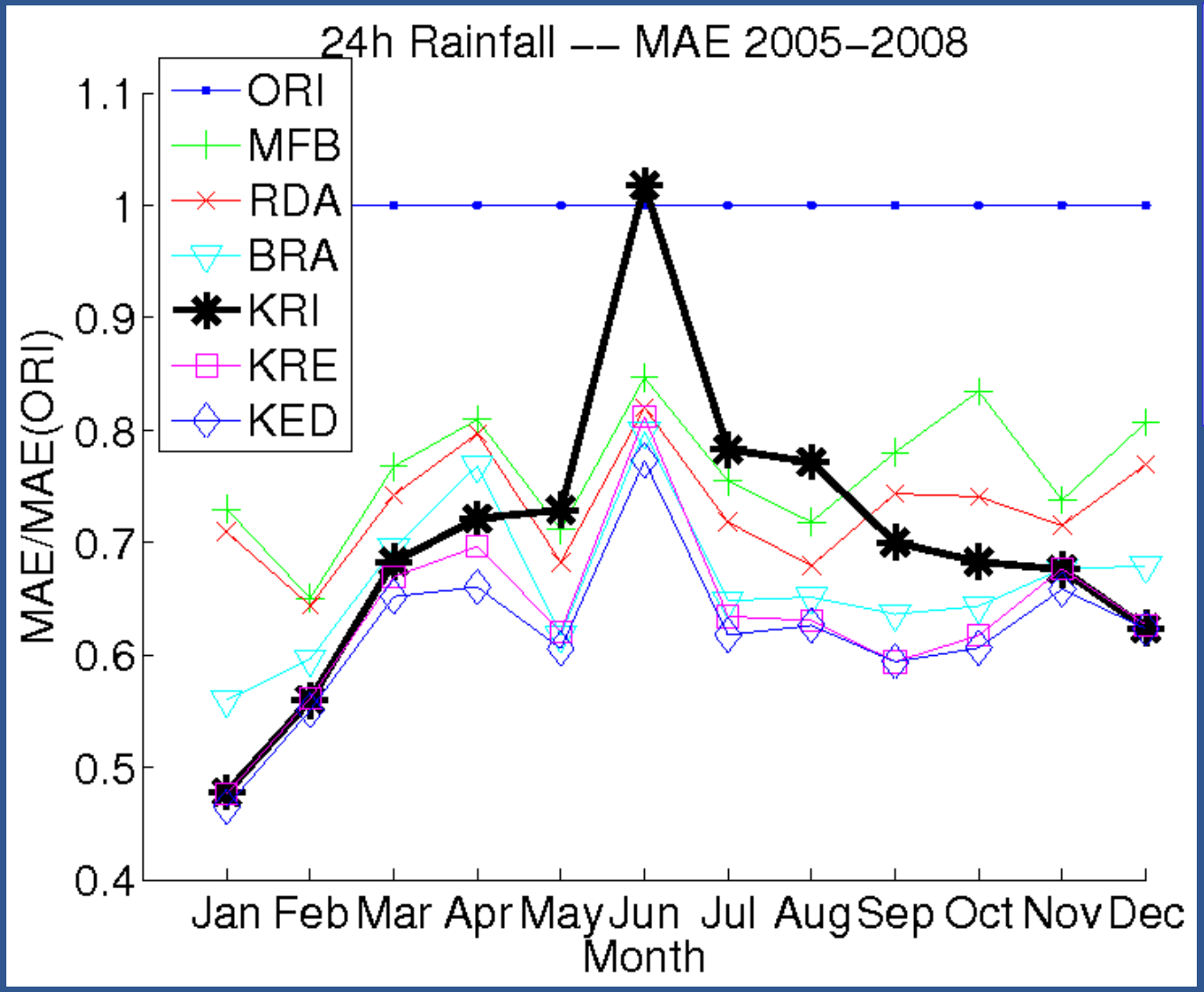






ORI : radar
MFB: mean bias
RDA: range-dep.
BRA: Brandes
KRI : kriging
KRE : Pegram
KED : Kri. Ext. Drift

Radar-gauge merging : verification



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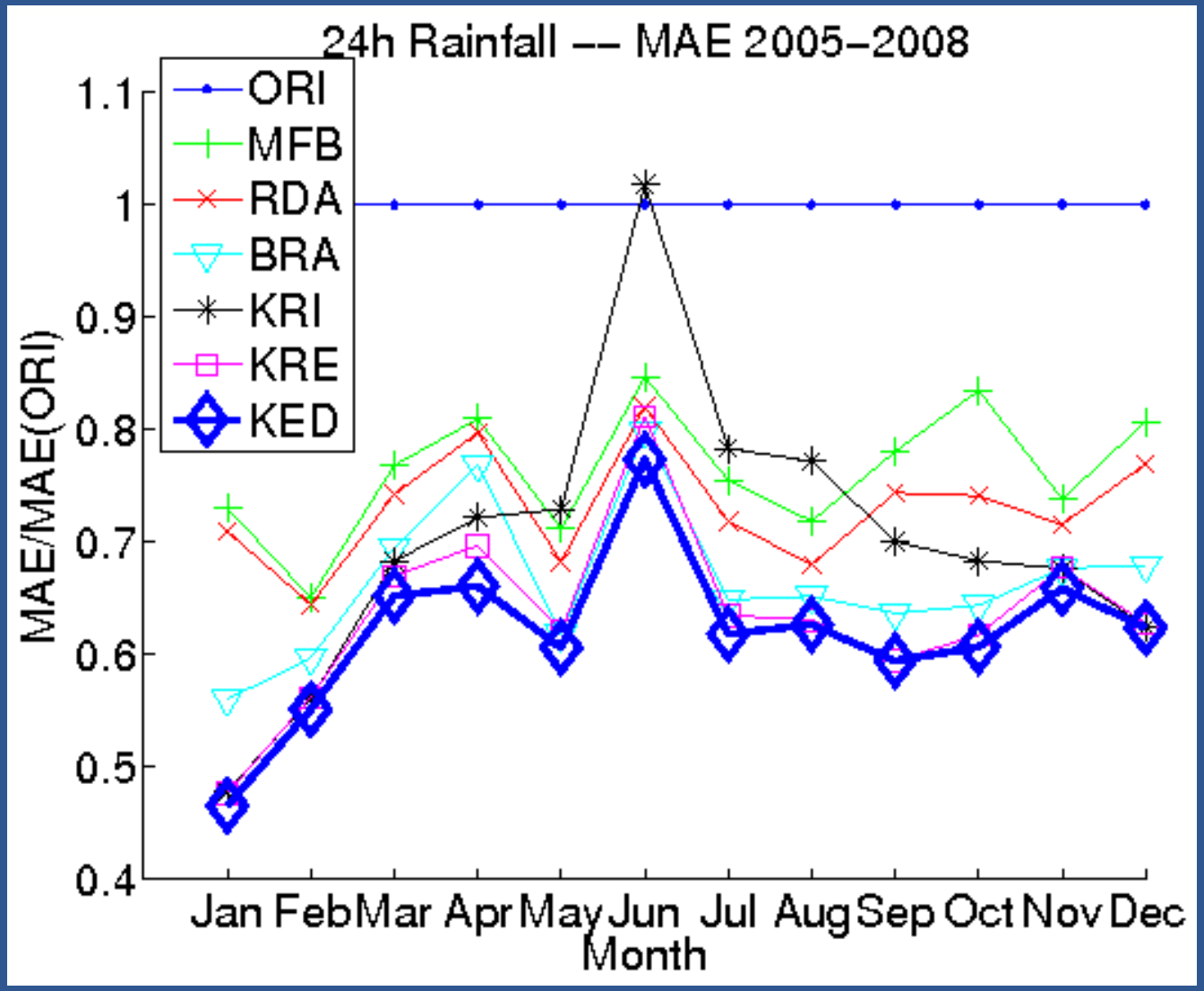

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Goudenhoofdt, E. and Delobbe, L.: Evaluation of radar-gauge merging methods for quantitative precipitation estimates, Hydrol. Earth Syst. Sci., 13, 195-203, 2009