SAL - a novel error measure for the verification of high-resolution precipitation forecasts

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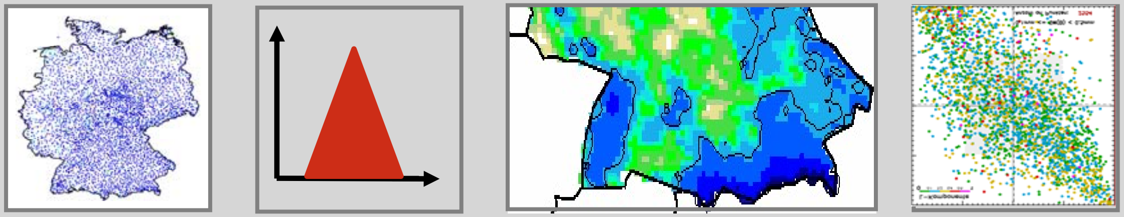
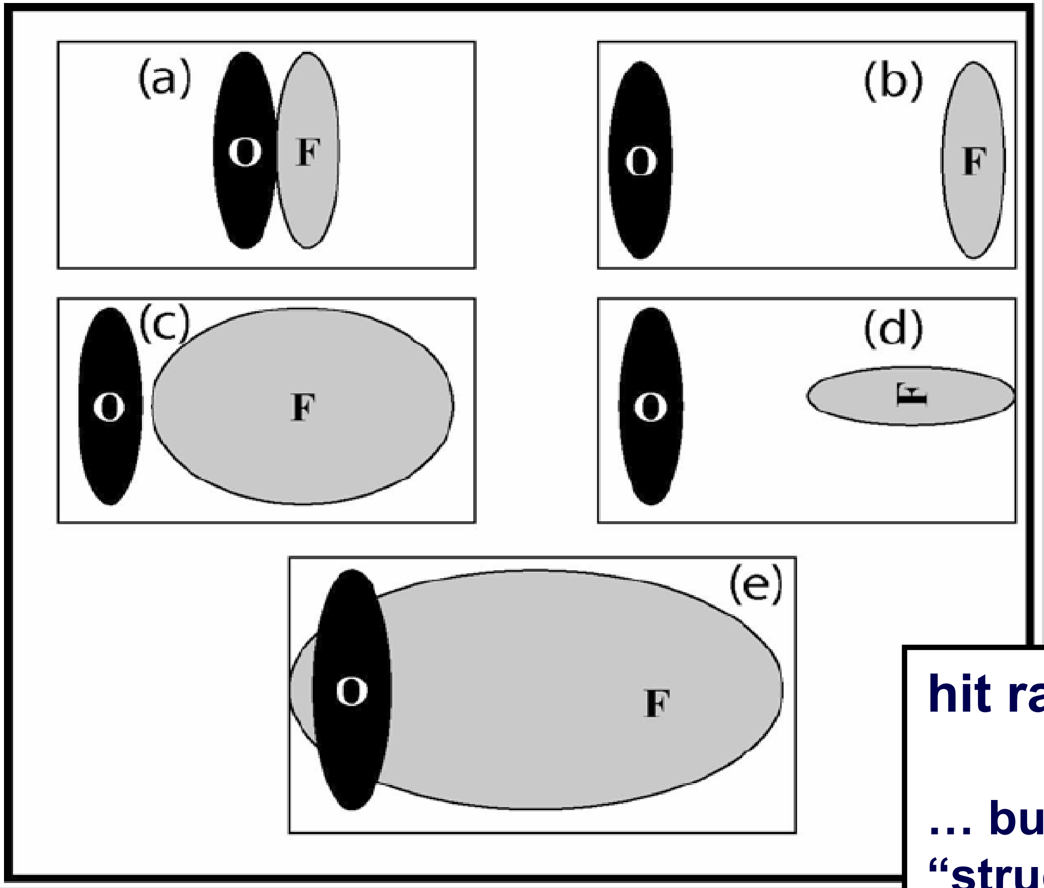


1. February 2007

Problematic aspects of grid point based error scores



Davis et al. 2006 (MWR)

hit rate = 0

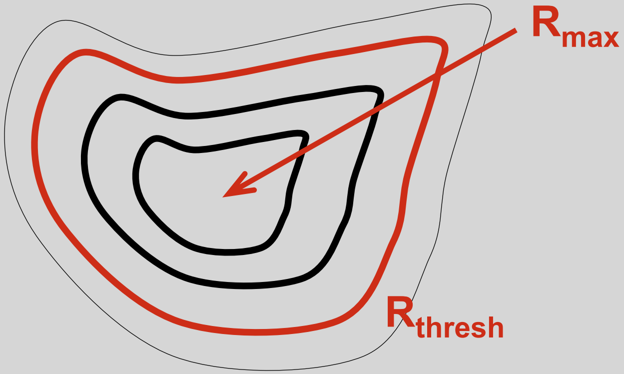
… but (a) is "better" than (b)-(d)

hit rate > 0

… but forecast has not the right "structure"

S A L – a novel error measure for precipitation forecasts

- consider precipitation in pre-specified area (e.g. river catchment)
- SAL consists of three independent components
- components address quality of structure (S), amplitude (A) and location (L) of QPF in that area
- according to SAL a forecast is perfect if $S = A = L = 0$
- S requires the definition of precipitation objects



- *but*: no attribution between precipitation objects in forecast and observations!

S A L - Definition of the components

$A = (D(R_{mod}) - D(R_{obs})) / 0.5*(D(R_{mod}) + D(R_{obs}))$

D(…) denotes the area-mean value (e.g. catchment)
normalized amplitude error in considered area
$A \in [-2, \ldots, 0, \ldots, +2]$

$L = |r(R_{mod}) - r(R_{obs})| / dist_{max}$

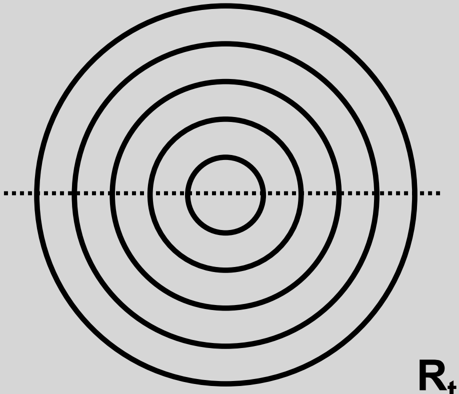
r(…) denotes the centre of gravity of the precipitation field in the area
normalized location error in considered area
$L \in [0, \ldots, 1]$

$S = (V(R_{mod}^*) - V(R_{obs}^*)) / 0.5*(V(R_{mod}^*) + V(R_{obs}^*))$

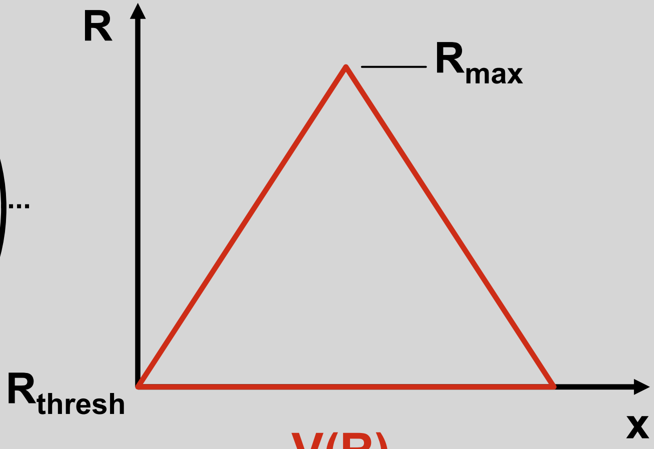
V(…) denotes the weighted volume average of all scaled precipitation objects in considered area
normalized structure error in considered area
$S \in [-2, \ldots, 0, \ldots, +2]$

SAL - the S-component

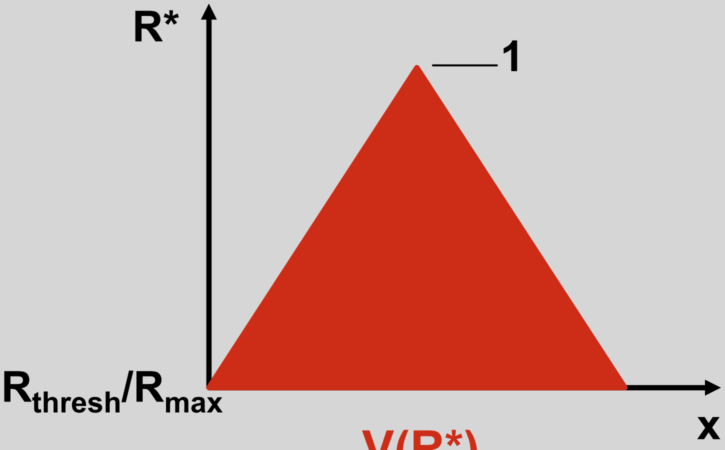
scaling for every object: $R^* = R / R_{max}$; $R^* \in [R_{thresh}/R_{max}, \ldots, 1]$



circular precipitation object

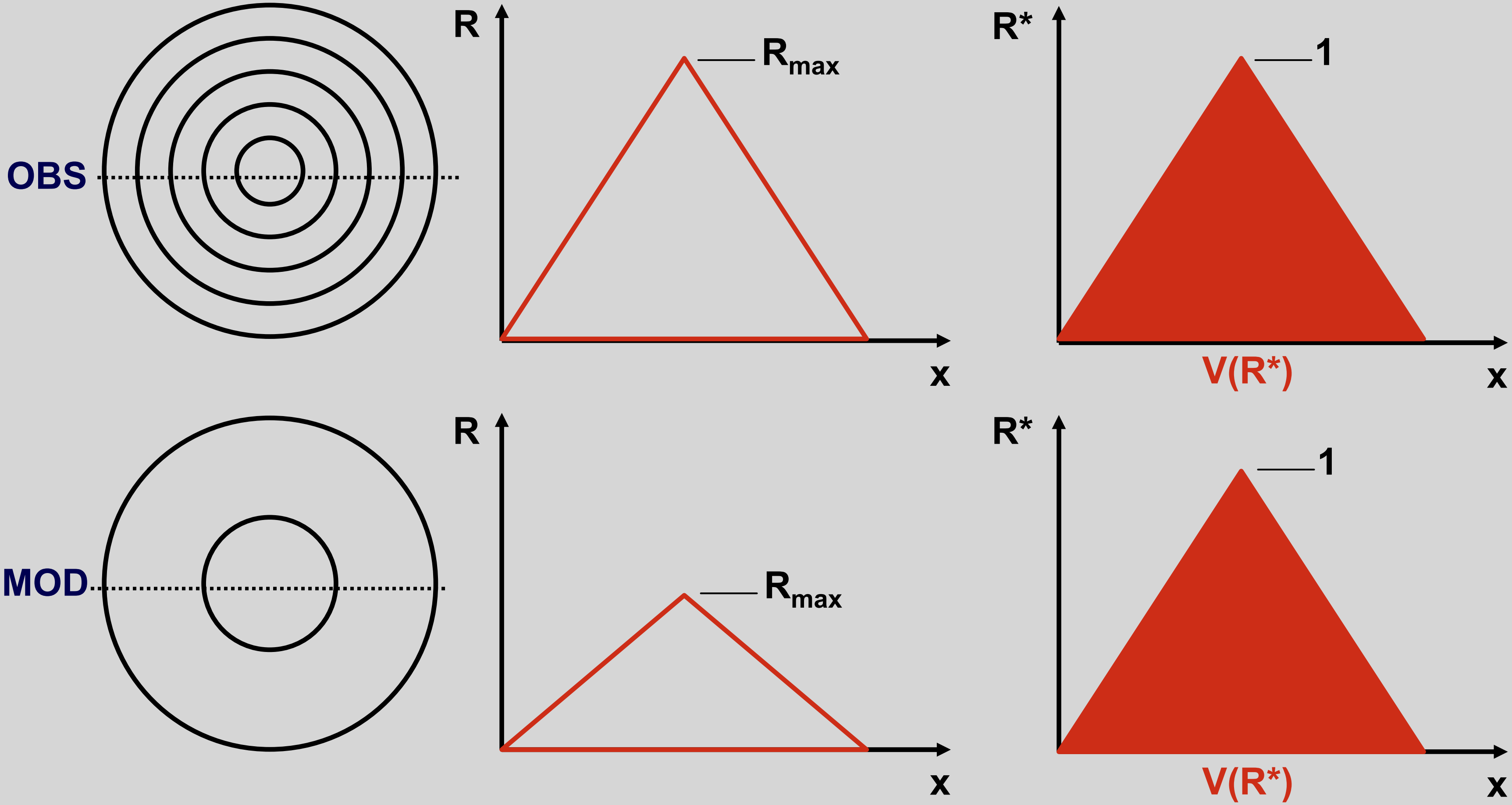


V(R)



V(R*)

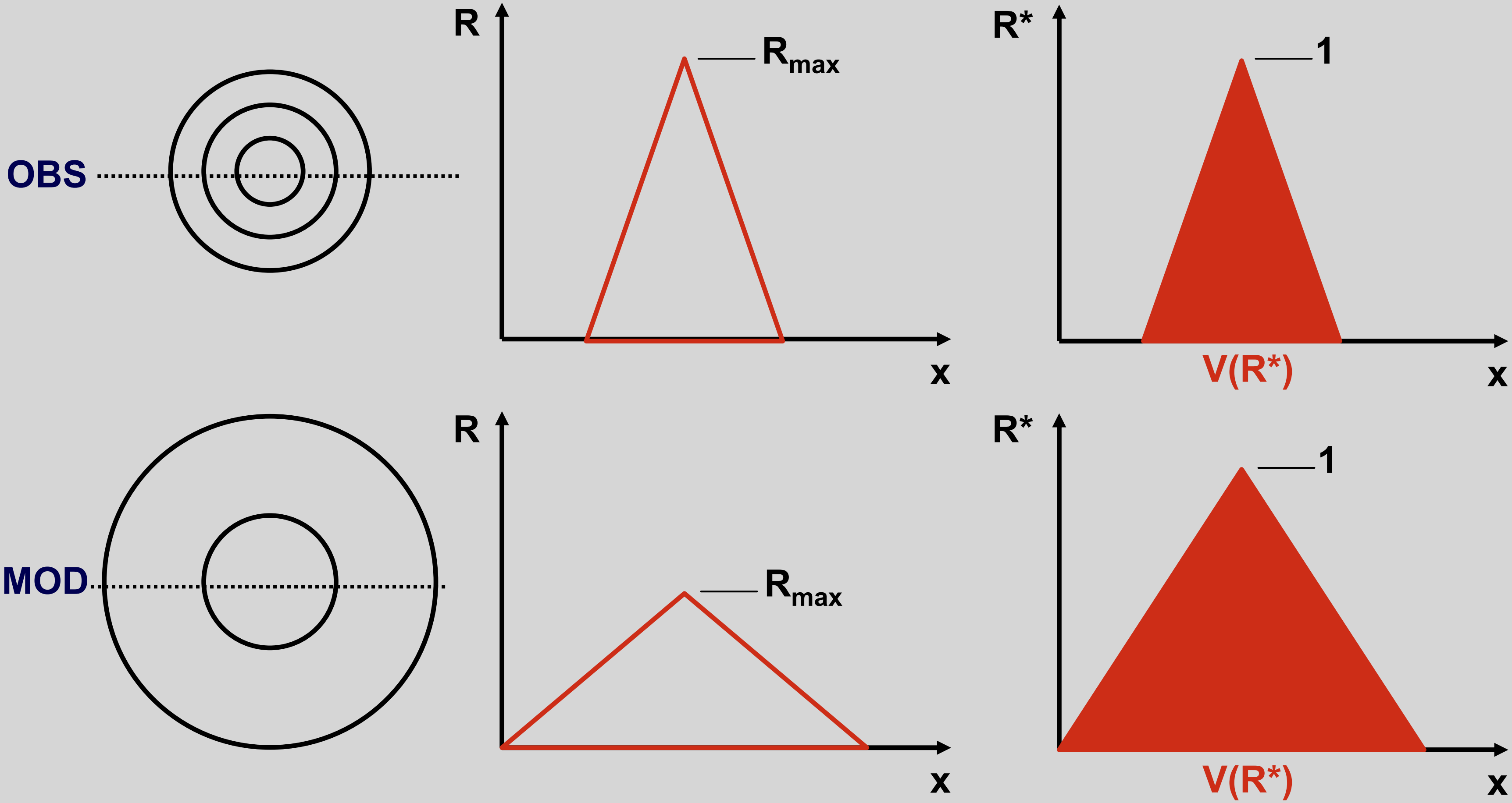
intense vs. weak objects with same size



A < 0

S = 0

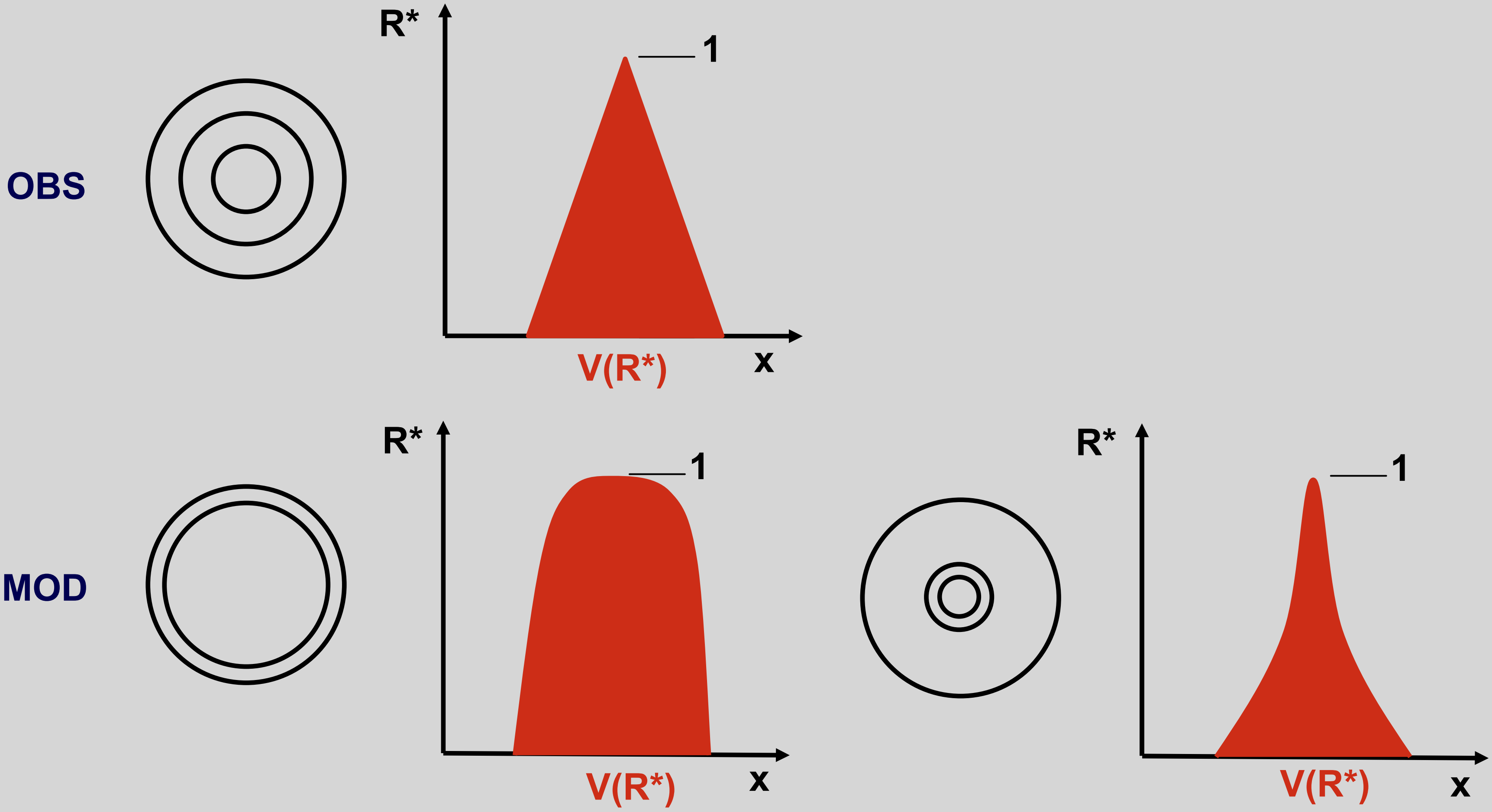
small intense vs. large weak objects



A = 0

S > 0

peaked vs. flat objects

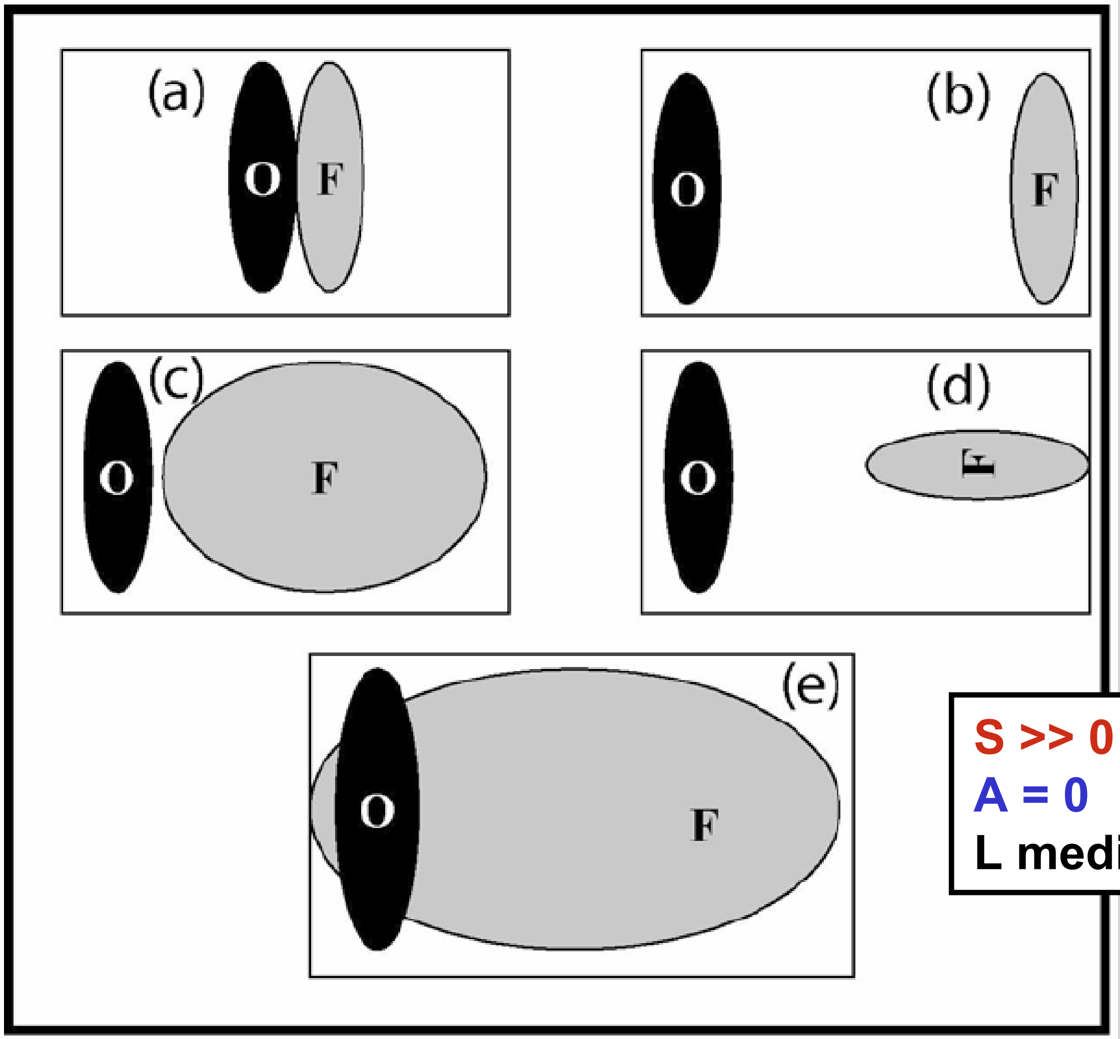


S > 0

S < 0

S = 0
A = 0
L small

S > 0
A = 0
L medium



S = 0
A = 0
L large

S = 0
A = 0
L large

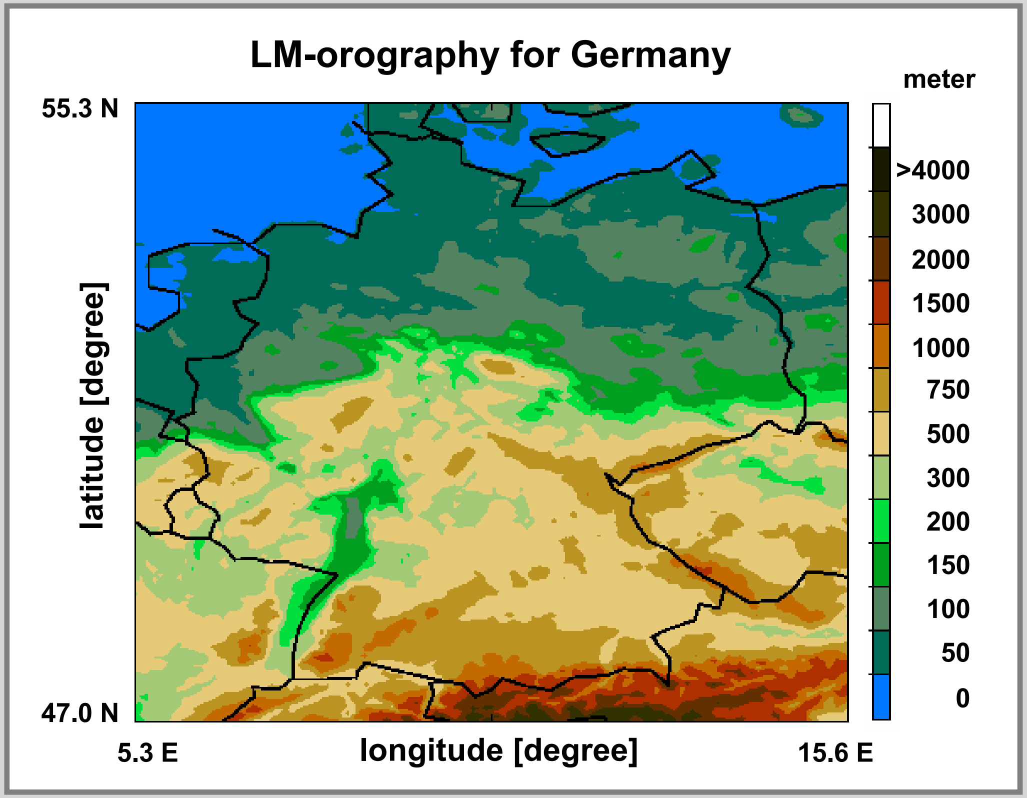
S >> 0
A = 0
L medium

Davis et al. 2006

precipitation in Germany: MOD and OBS

MOD: aLMo: operational NWP-model from MeteoSwiss: January 2001 – December 2004

OBS: hourly precip from disaggregation of 24h-rain gauges (4000 stations) with radar



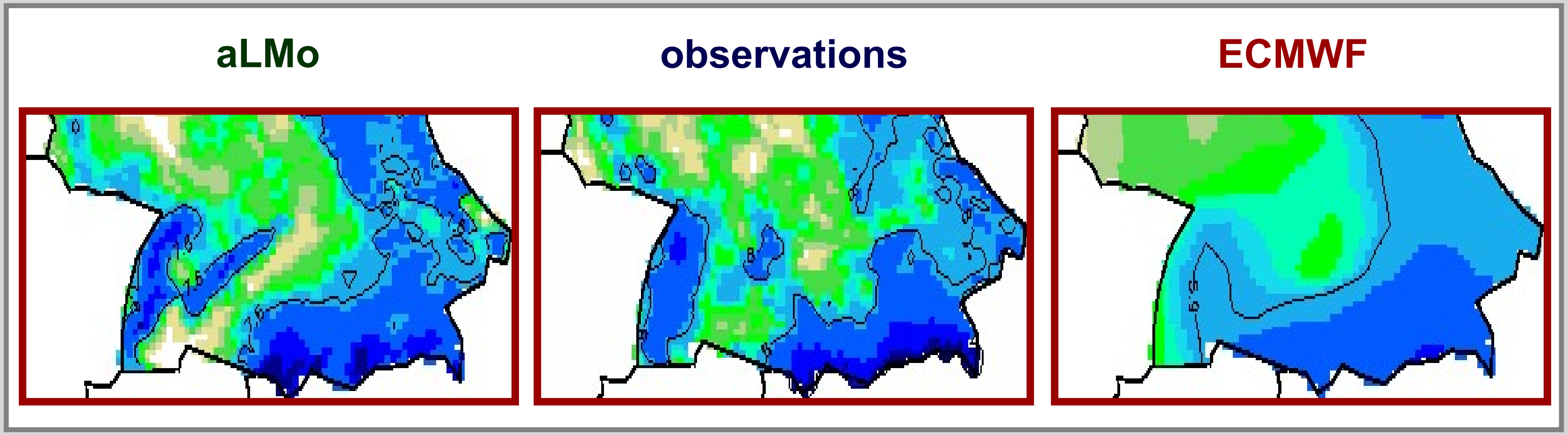
MOD

- aLMo is non-hydrostatic grid point model
- horizontal resolution: 7 km
- 45 vertical layers
- domain covers W and central Europe
- nested in ECMWF global model
- operational at MeteoSwiss since 1999
- 72h-forecasts started at 00 and 12 UTC
- model output every hour

a real case example

$R_{thresh} = R_{max}(area)/15$

$S, A \in [-2,\ldots,0,\ldots,+2]\ ;\ L \in [0,\ldots,1]$



a real case example

$R_{thresh} = R_{max}(area)/15$

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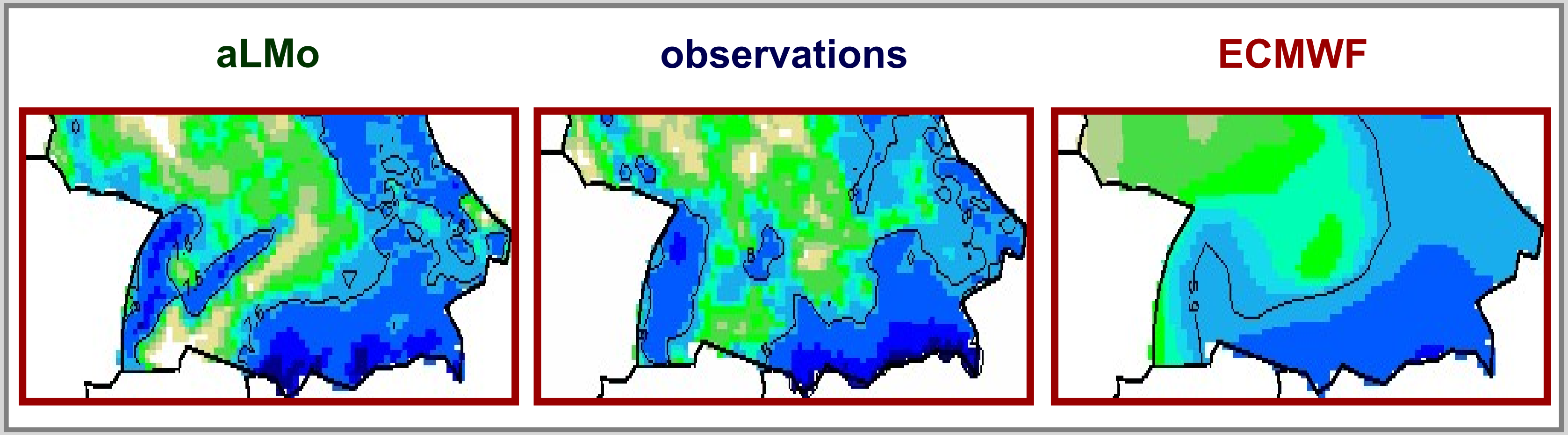


aLMo

observations

ECMWF

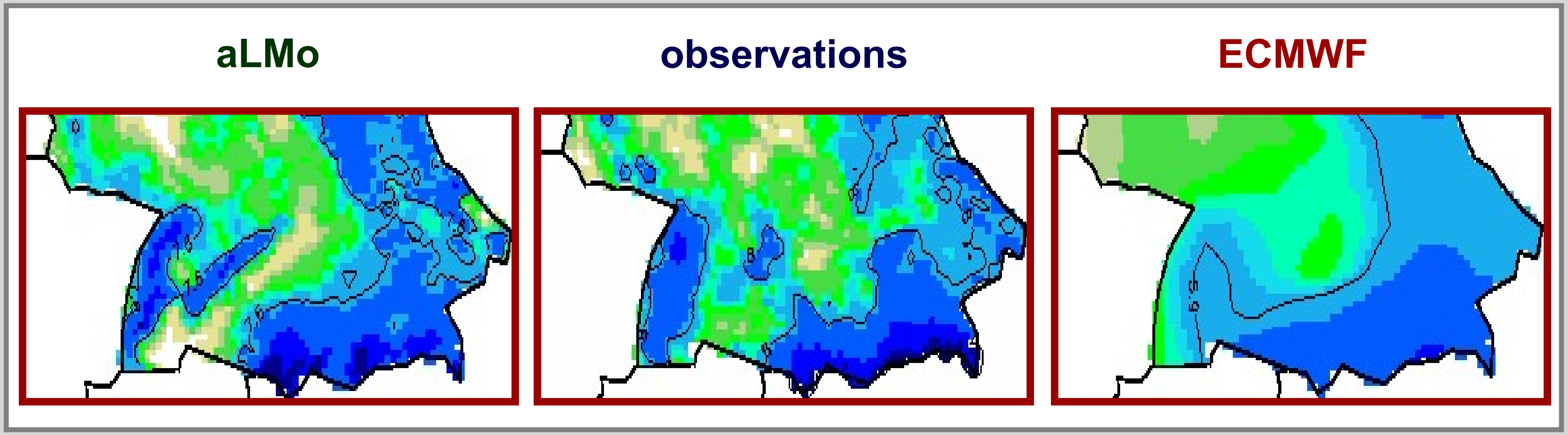
$L \approx 0$

$L \approx 0$

a real case example

$R_{thresh} = R_{max}(area)/15$

$S, A \in [-2,\ldots,0,\ldots,+2]$; $L \in [0,\ldots,1]$



aLMo

observations

ECMWF

$L \approx 0$

$A \approx 0$

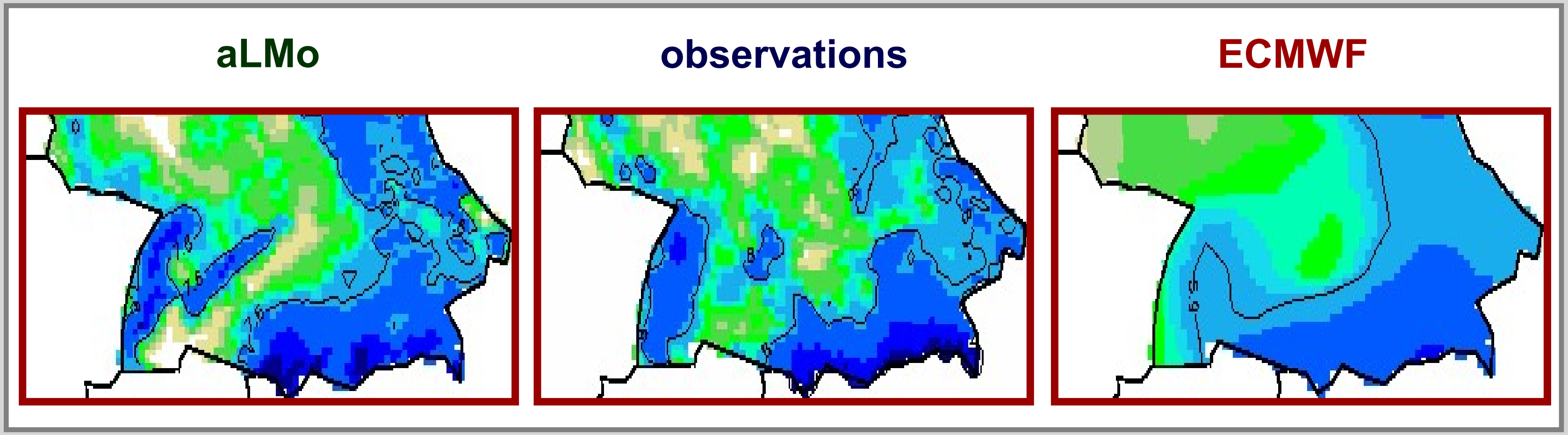
$L \approx 0$

$A = -0.14$

a real case example

$R_{thresh} = R_{max}(area)/15$

$S, A \in [-2,\ldots,0,\ldots,+2]$; $L \in [0,\ldots,1]$



aLMo vs. observations

$L \approx 0$

$A \approx 0$

$S = 0.17$

ECMWF vs. observations

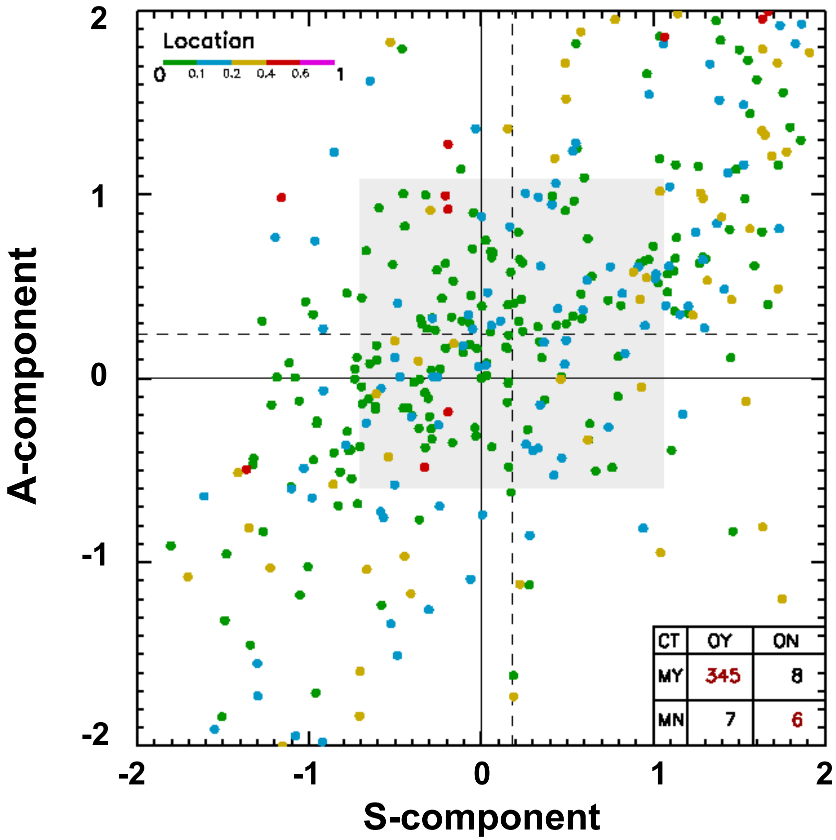
$L \approx 0$

$A = -0.14$

$S = 0.63$

S A L - statistics: 24h accumulated

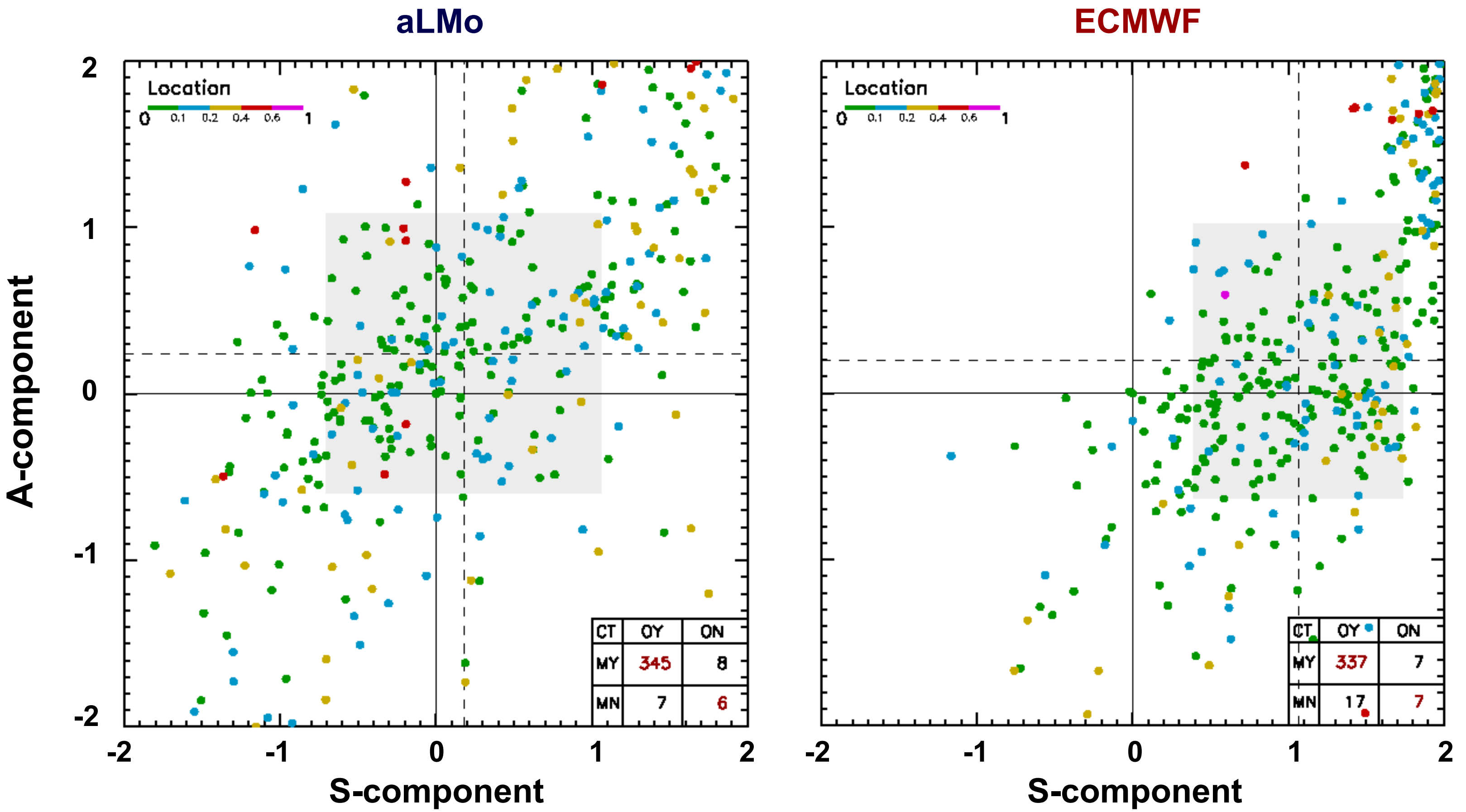
summer seasons 2001-2004 for catchment Rhine



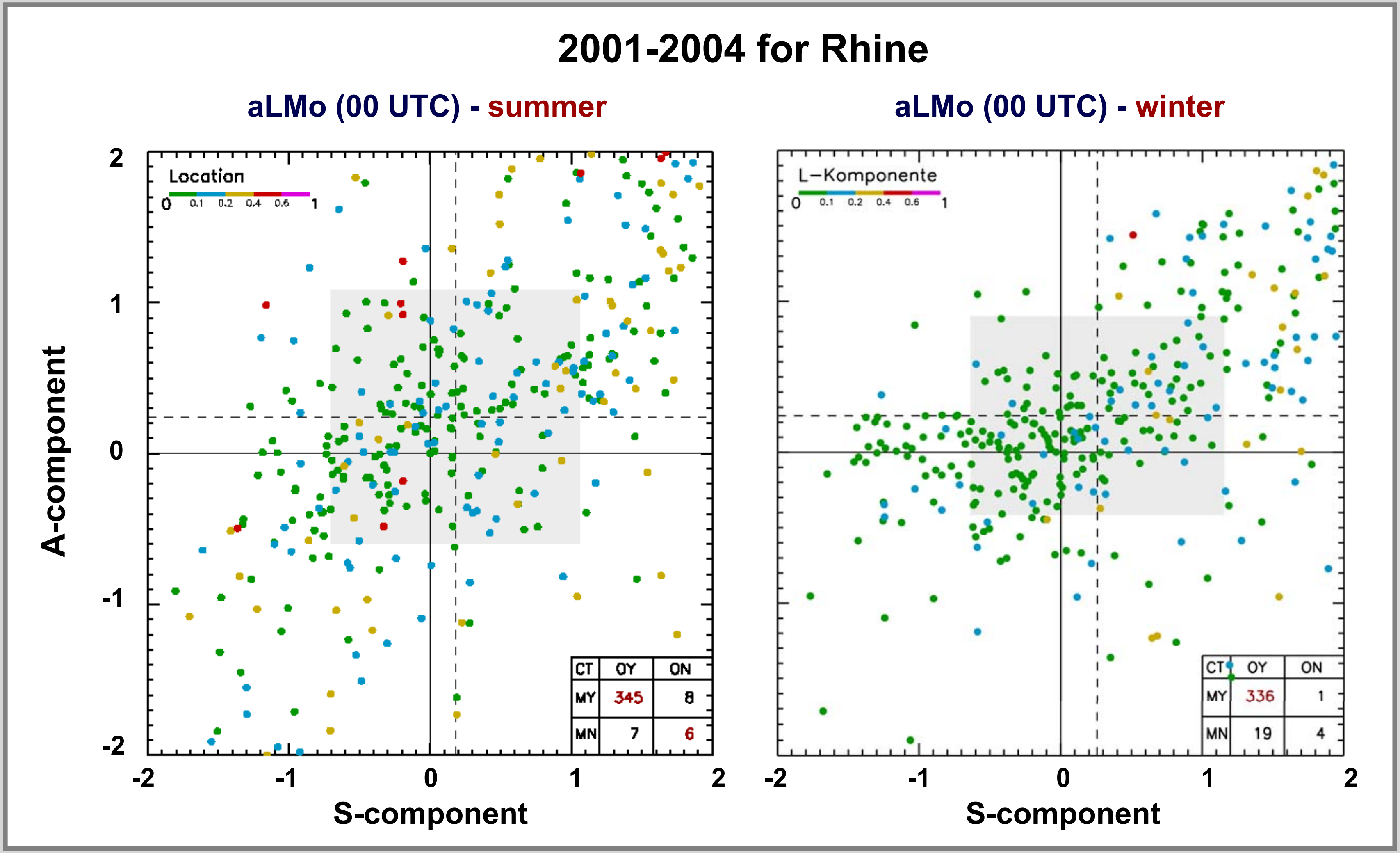
aLMo

CT	OY	ON
MY	345	8
MN	7	6

S A L - statistics: 24h accumulated


summer seasons 2001-2004 for catchment Rhine

S A L – statistics: 24h accumulated

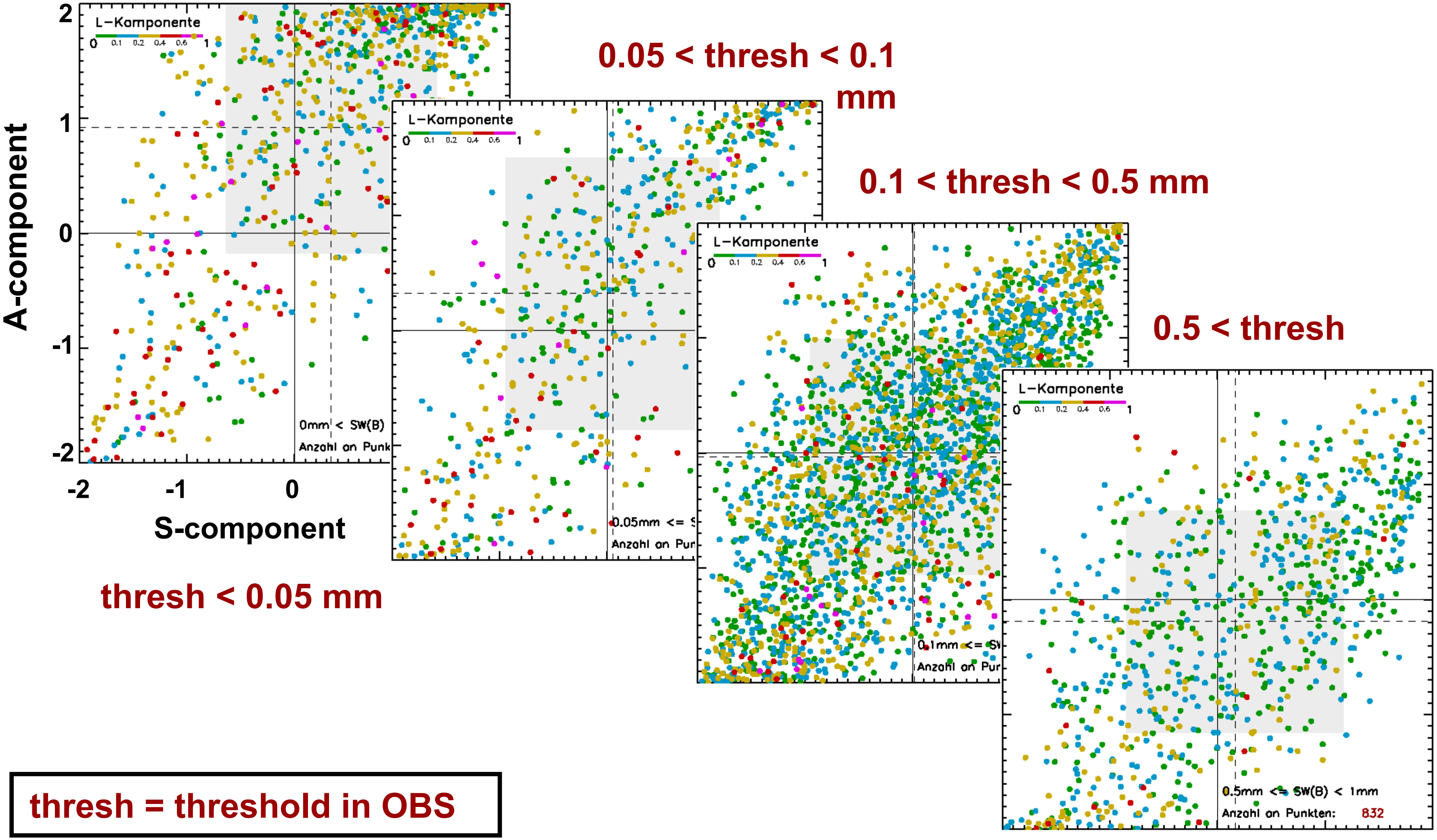


2001-2004 for Rhine

aLMo (00 UTC) - summer

aLMo (00 UTC) - winter

S A L – statistics for aLMo: 1h accumulated (summer, Rhine)



thresh < 0.05 mm

0.05 < thresh < 0.1 mm

0.1 < thresh < 0.5 mm

0.5 < thresh

thresh = threshold in OBS

Conclusions

- *SAL:* has 3 independent components to quantify quality of structure, amplitude and location of QPF

- *claim*: with SAL verification of key characteristics of precipitation field in pre-specified area, close to “subjective human judgement”

- *advantage*: no attribution between objects (difficult for small objects)

- *first results*: 24h QPF: S is smaller for mesocale model compared to global model
  1h QPF from mesoscale model: differences between seasons, intensity categories

- *caveats*: non-perfect QPFs can yield S = A = L = 0
  no consideration of orientation of objects
  currently very simple definition of objects

THANKS

DFG - German Research Foundation

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DWD

LM data

Rain gauge precipitation data

Precipitation climate data

Radar data

MeteoSchweiz

aLMo data