Automatic calibration of a flood forecasting system for the Odra river

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MOTIVATION

Extreme flooding event in 1997:

CONTENT:

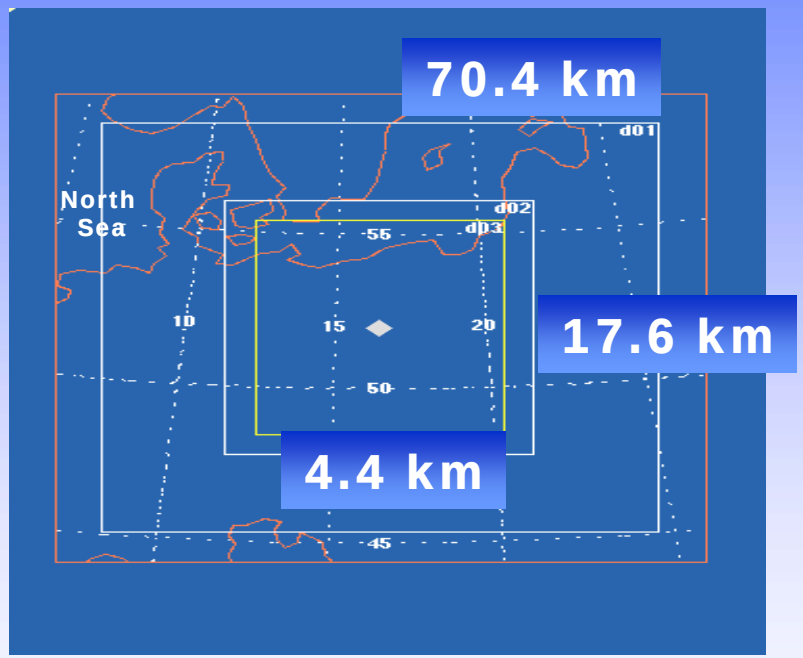
WRF/SEROS flood forecasting system for the Odra

How well can we describe the precipitation over the Odra watershed ?

How well can we determine the discharges of the Odra river ?

Weather Forecast & Research Model (WRF)

3 nesting levels:



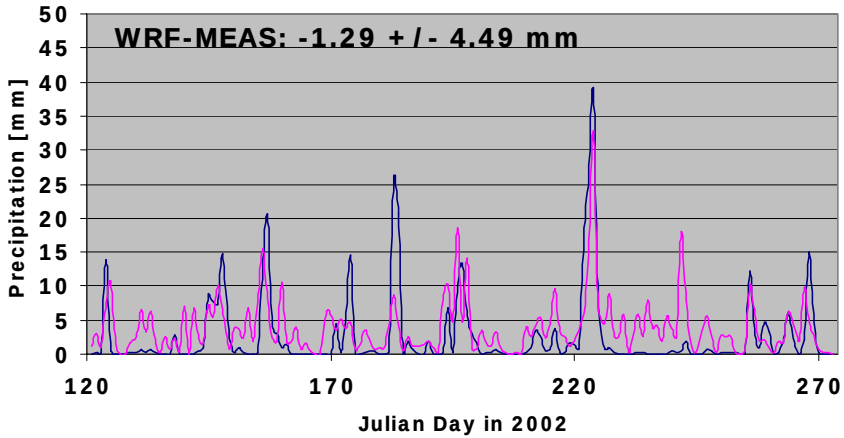
- Non-hydrostatic NWP model WRF V2
- Initialization with AVN data
- 3 nesting levels
- time: ***May to September 2002***
- time step: 30 s

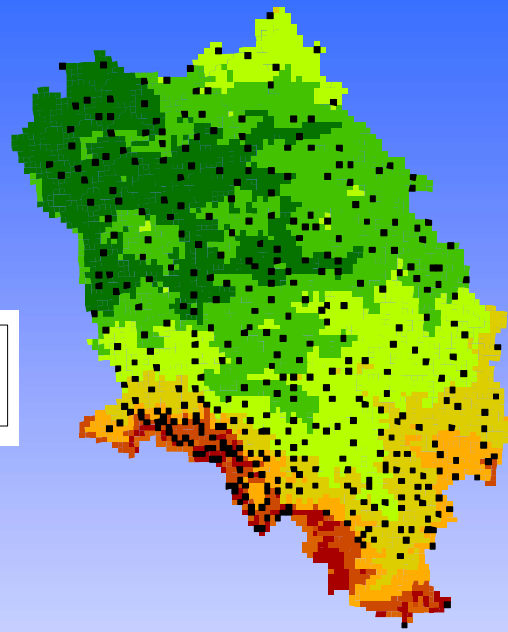
- Microphysics: Kessler scheme
- PBL scheme: Yonsei Univ. scheme
- Cumulus parameterization: Grell-Devenyi scheme
- Longwave radiation: Rapid RTM
- Shortwave radiation: Dudhia scheme
- two-way nesting

- one-way coupling to the Land surface model & routing scheme ***SEROS***

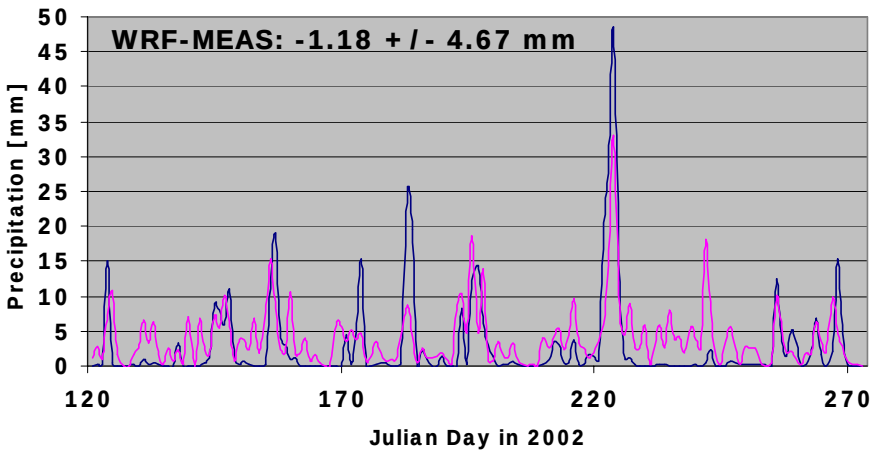
WRF and 387 PrecipStations above the Odra watershed

Nesting Level 1 – 70.4 km

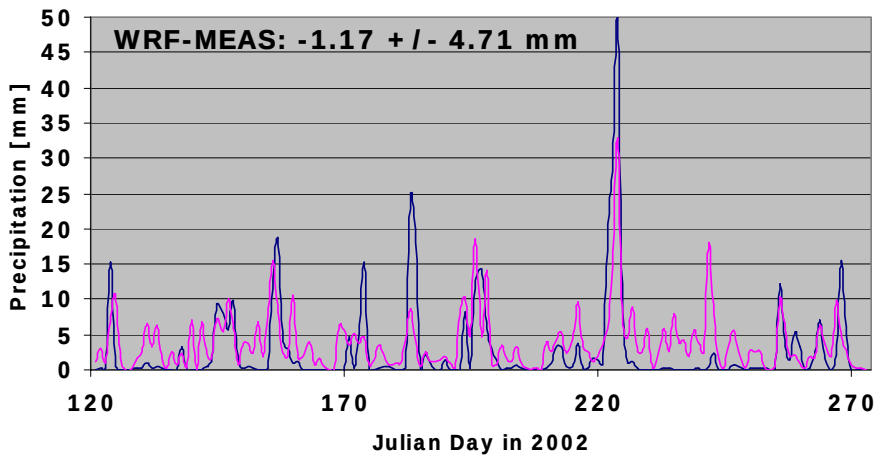




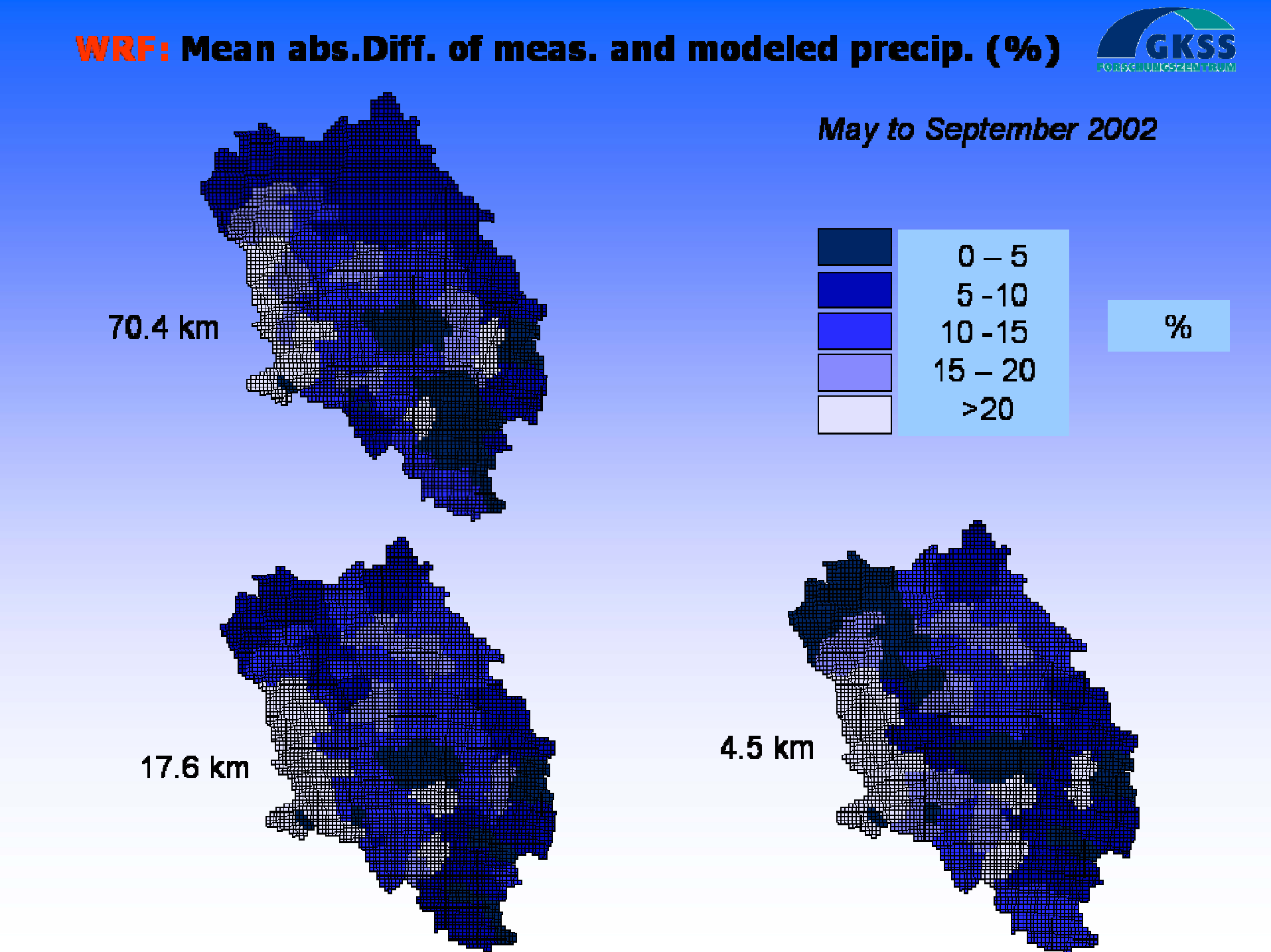
Nesting Level 2 – 17.6 km



Nesting Level 3 – 4.5 km



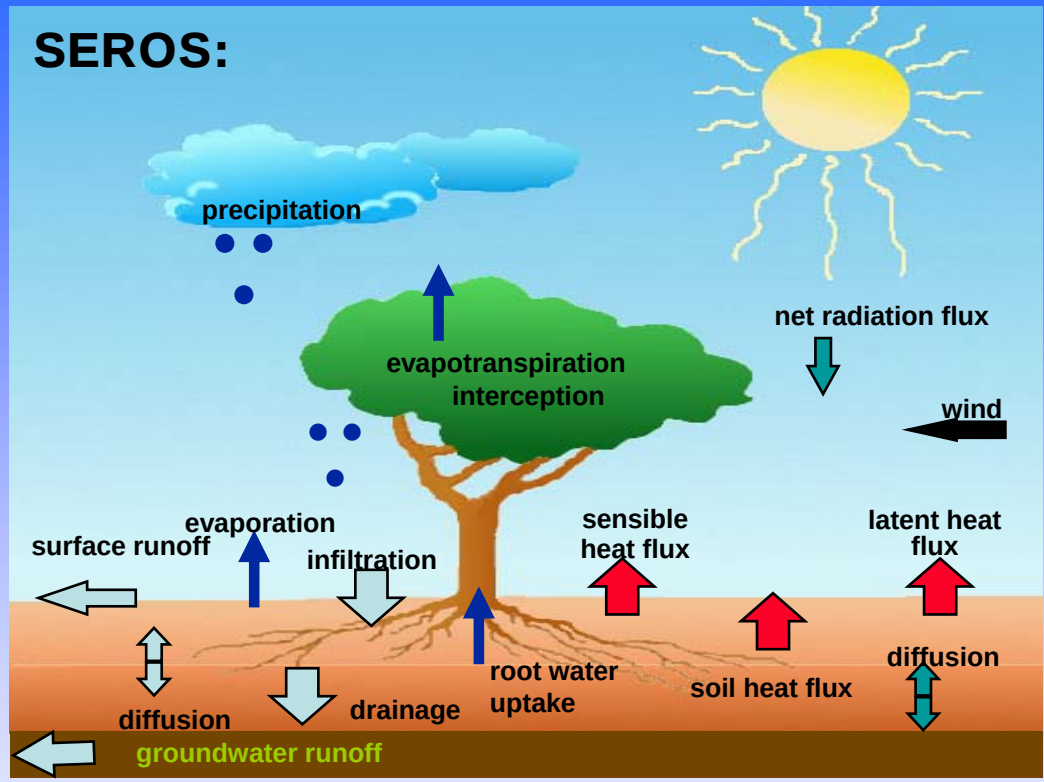
WRF: Mean abs.Diff. of meas. and modeled precip. (%)

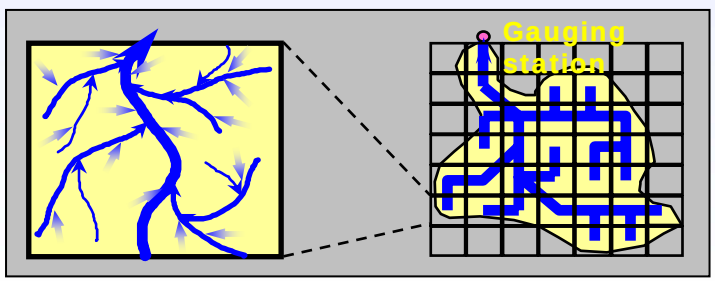


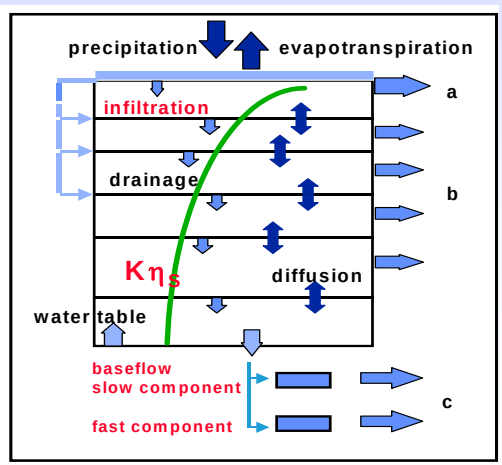
One-way coupling between WRF and SEROS

Forcing data of SEROS:

-Precipitation
-Temperature at 2 m
-Wind speed at 10 m
-Air pressure
-Relative humidity at 2 m
-Short-wave radiation
-Long-wave radiation





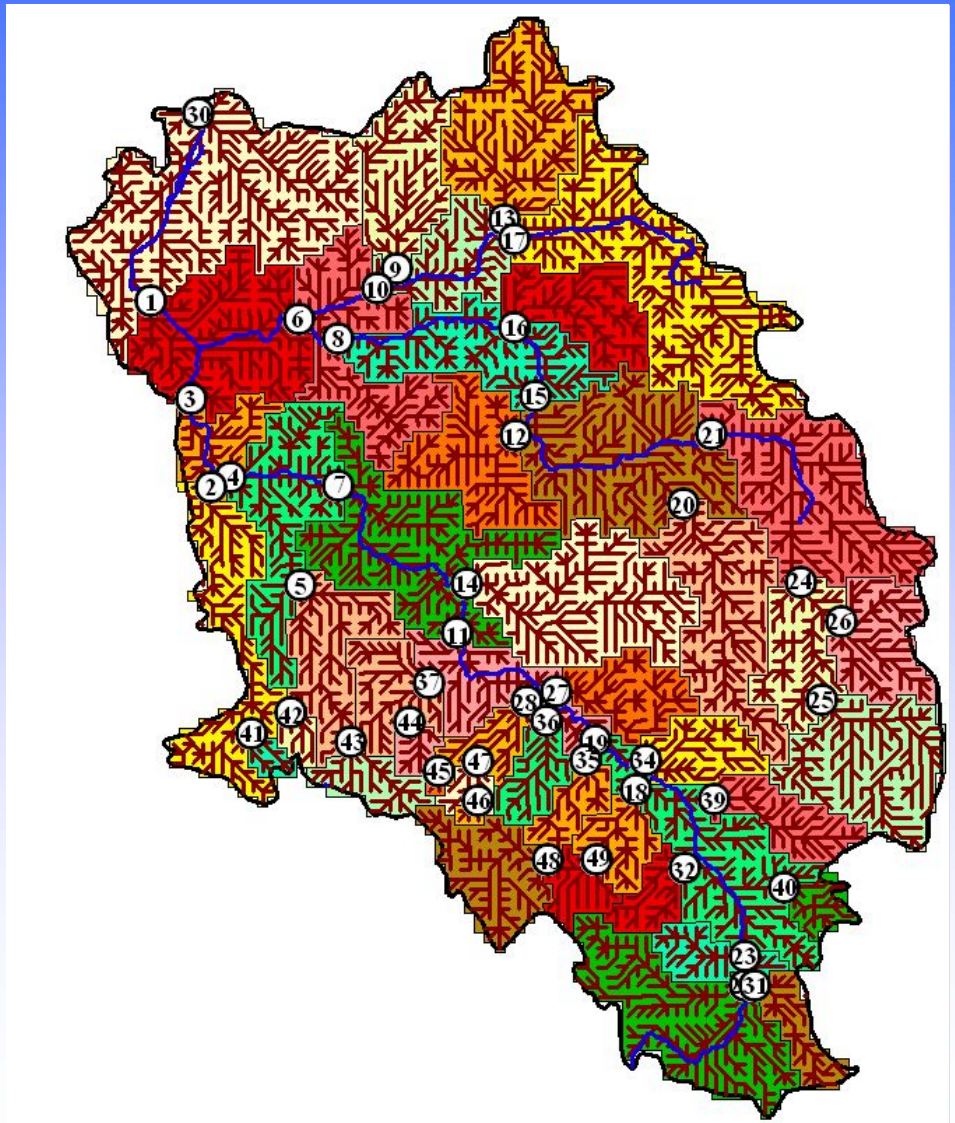


the Odra watershed and subcatchments

SEROS

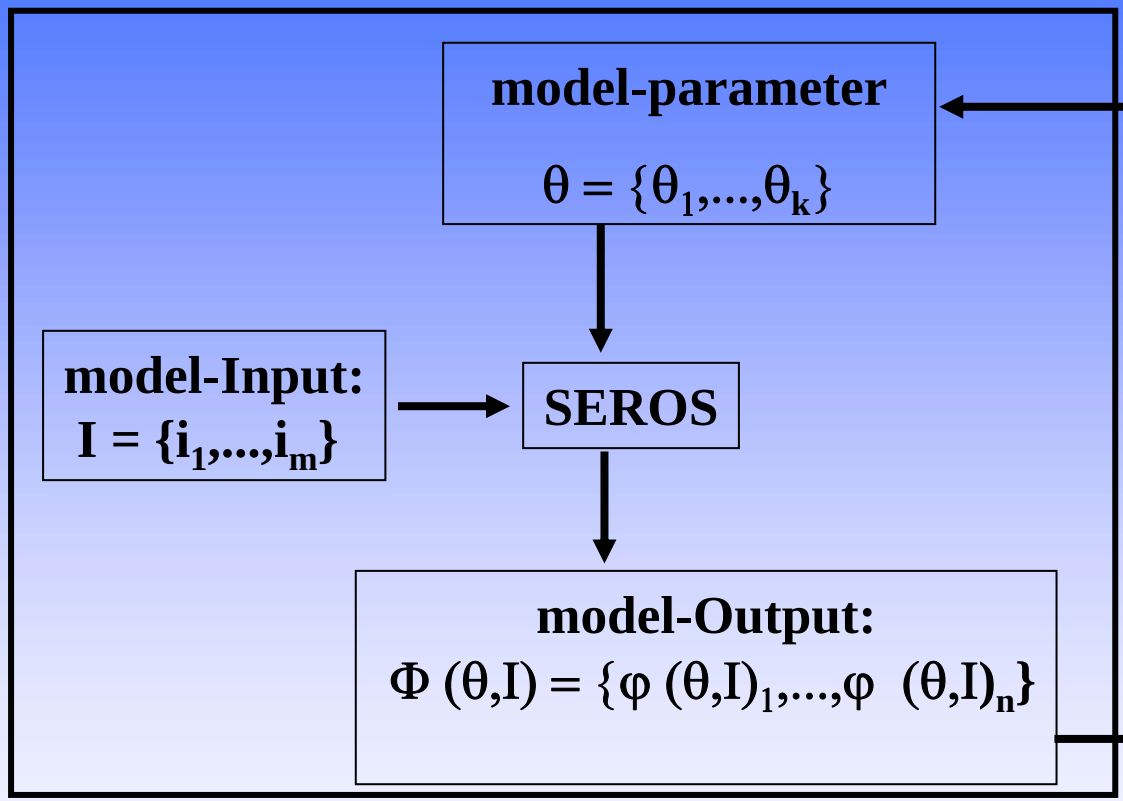
calibration for each subcatchment

Dx = Dy = 4.4 km



SEROS calibration

SCE-UA: Shuffled Complex Evolution (University of Arizona)



optimization-algorithm SCE-UA:

OF = min

$$OF = \frac{\sum_{i=1}^{N}(Q_{obs} - Q_{sim})^2}{\sum_{i=1}^{N}(\overline{Q_{obs}} - Q_{obs})^2}$$

observation:

$Q = \{q_1,...,q_n\}$

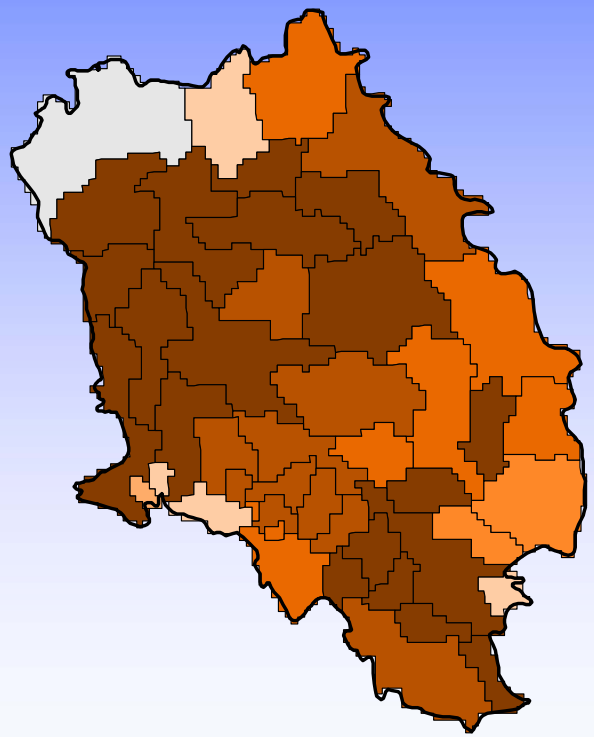
single criteria optimization:
Modified Nash-Sutcliffe Efficiency

SEROS calibration parameter

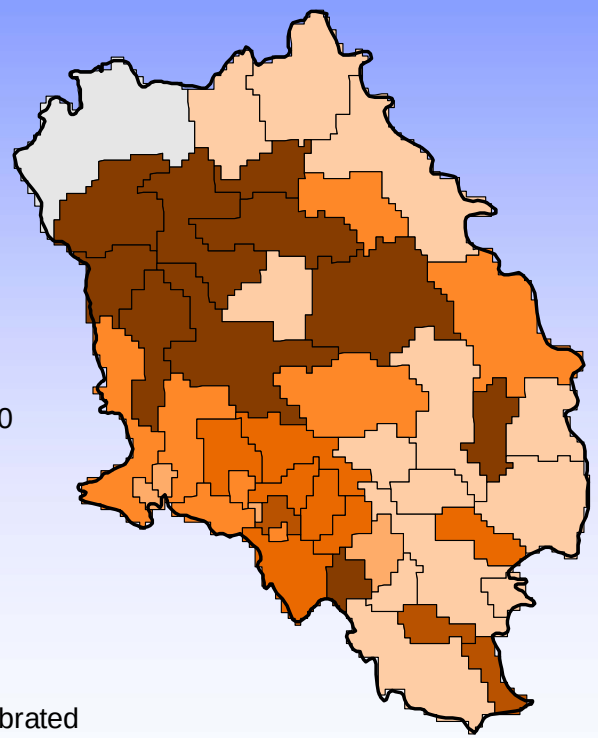
Parameter	units	description	lower limit	upper limit
BI	[-]	VIC-Parameter surface runoff	0.001	1.00
CBAS-L3	[-]	Exponent Baseflow, 3rd soil layer	1.00	3.00
T1/2-L3	[d]	Arno time constant, 3rd soil layer	50	1000
WS-L3	[-]	part.baseflow, 3rd soil layer	0.40	0.99
DM-L3	[mm/s]	Max. runoff, 3rd soil layer	0.001	0.500
CBAS-L6	[-]	Exponent baseflow, 6th soil layer	1.00	3.00
T1/2-L6	[d]	Arno time constant, 6th soil layer	50	1000
WS-L6	[-]	part.baseflow, 6th soil layer	0.40	0.99
DM-L6	[mm/s]	Max. runoff, 6th soil layer	0.001	0.500
iniGW	[m]	Initial ground water	1.50	4.0
rsFactor	[-]	Corr. min. stomata res.	0.50	2.50
N	[-]	Unit Hydrograph no. of reservoirs	1.0	4.0
K	[h]	Time delay in reservoir	1.0	24.0
Diff	[m^2/s]	Diffusion rate (in 1000)	0.8	8.0
Velo	[m/s]	kinematic wave velocity	0.2	3.0

SEROS calibration: efficiency

calibration period 1992 - 1994

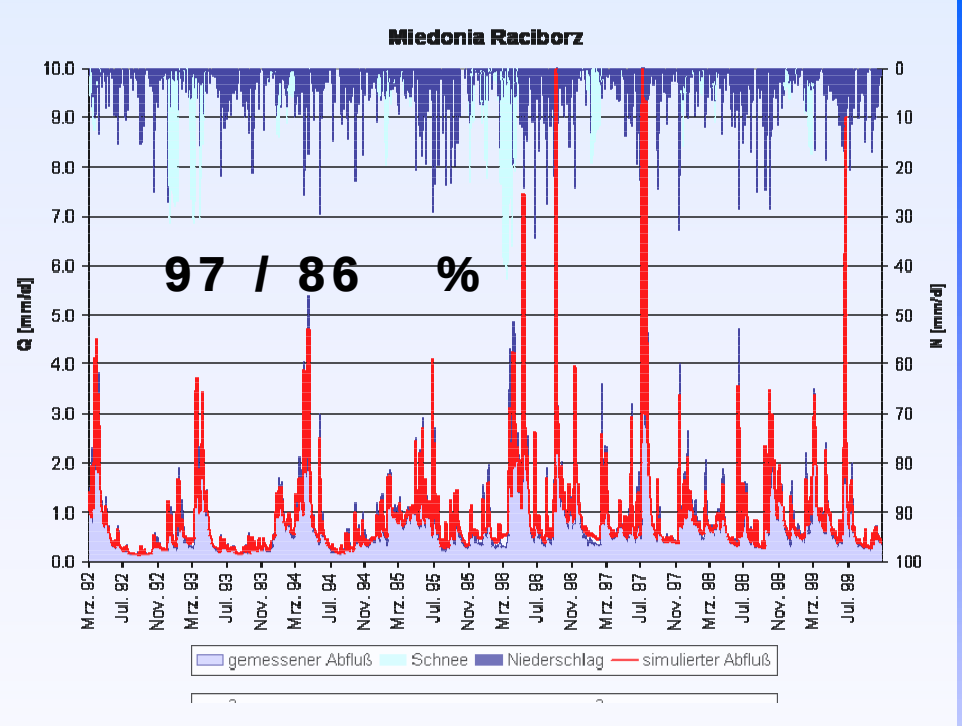


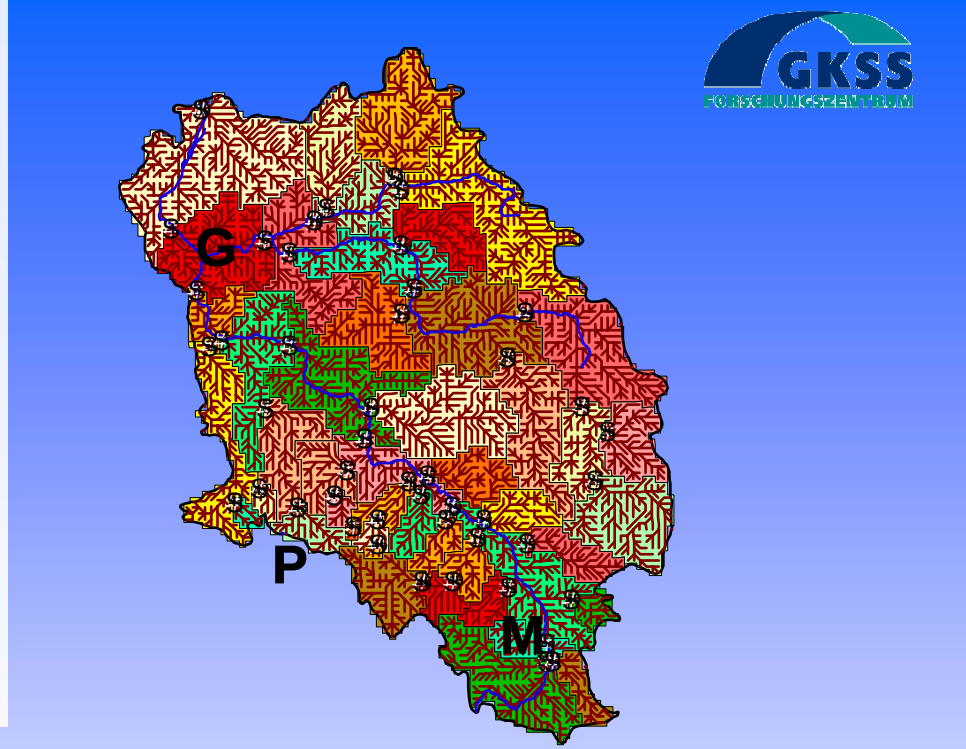
validation period 1995 - 1999

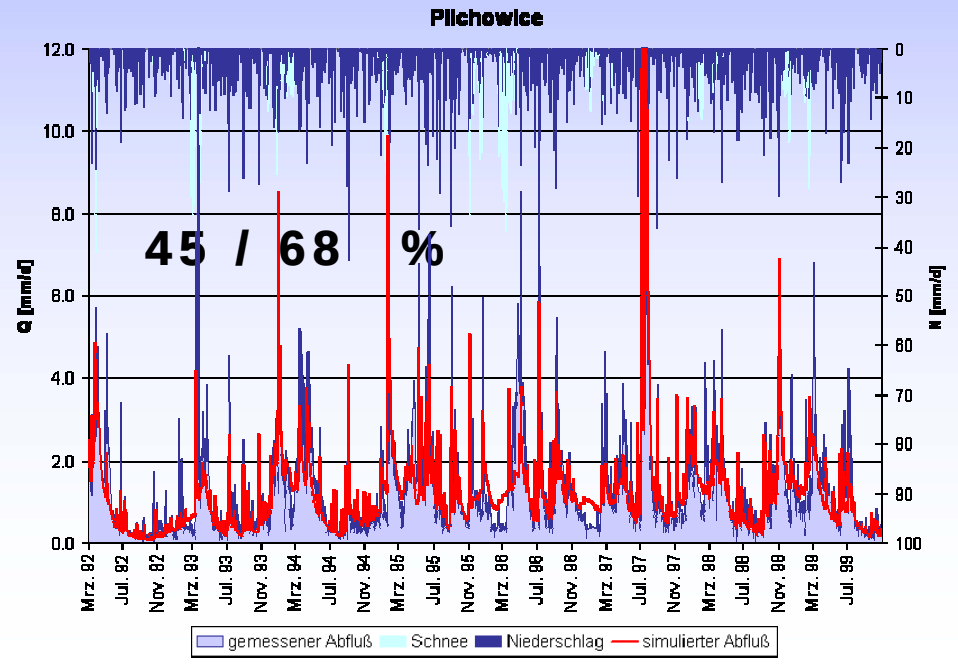


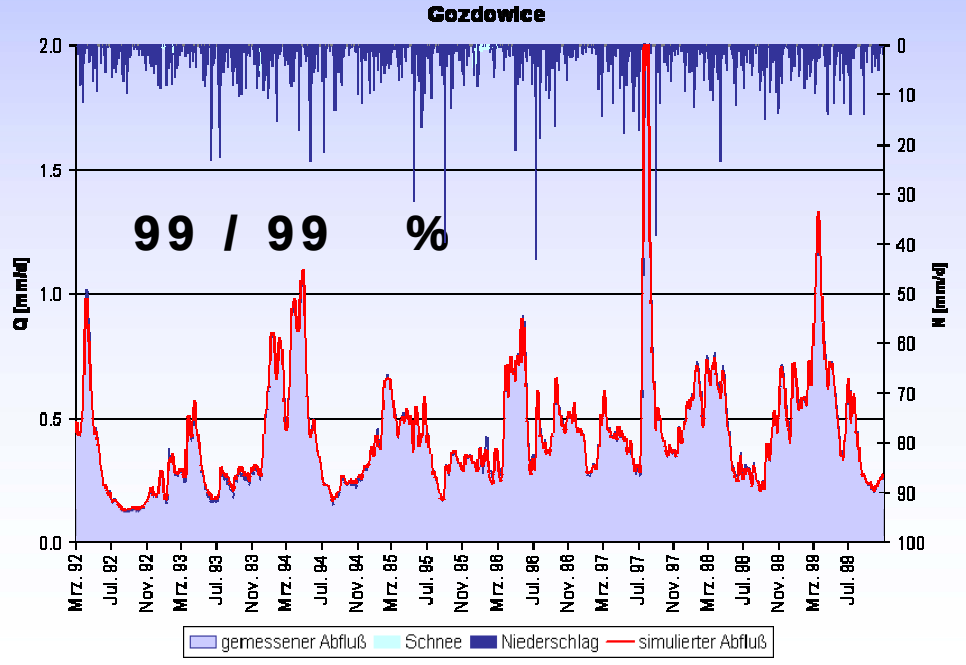
efficiency (%)

- 100 - 90
- 90 - 80
- 80 - 70
- 70 - 60
- 60 - 50
- < 50
- not calibrated

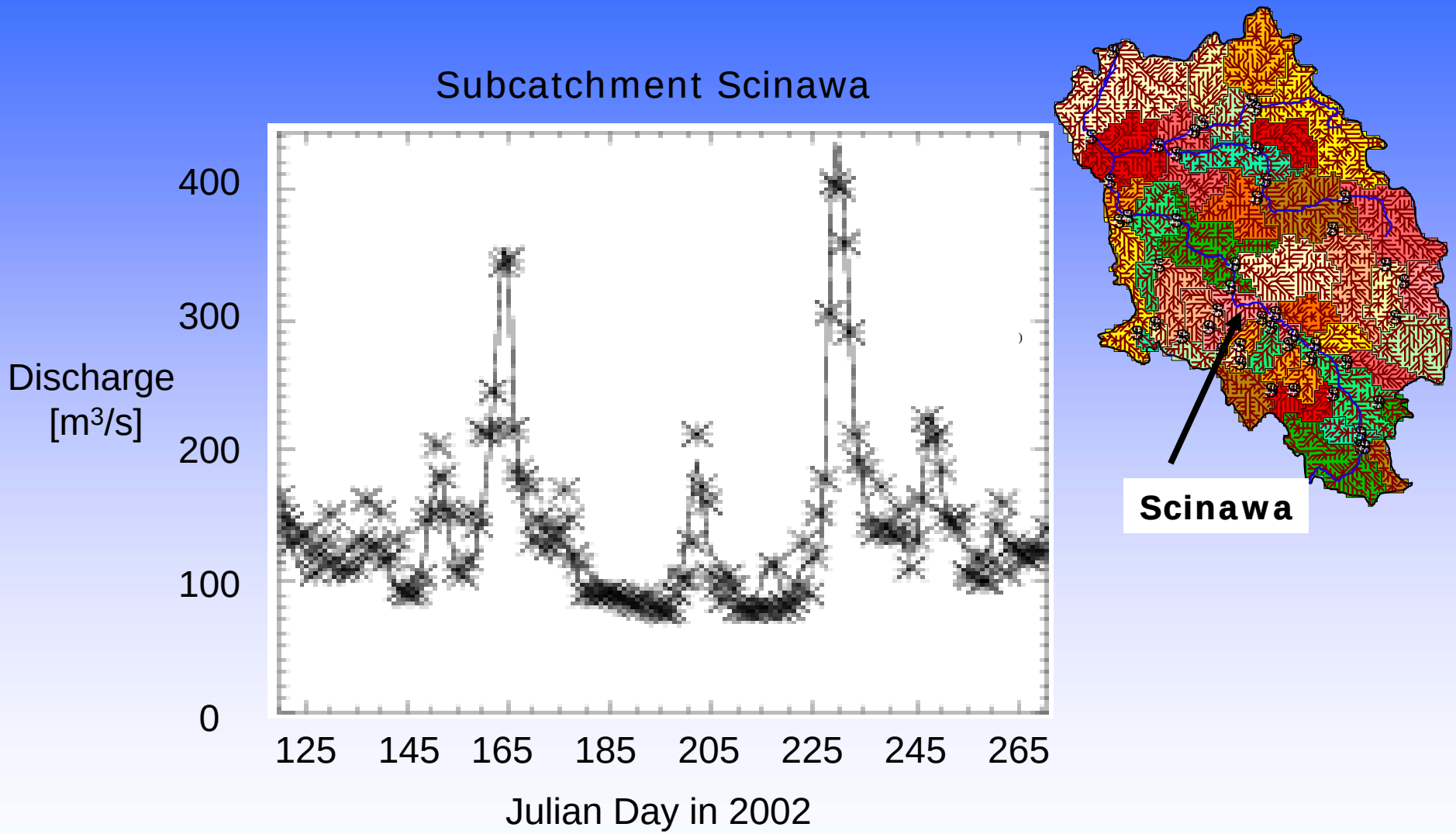

Miedonia Raciborz
97 / 86 %
Q [mm/d]
N [mm/d]
gemessener Abfluß
Schnee
Niederschlag
simulierter Abfluß


GKSS
FORSCHUNGSZENTRUM
G
P
M

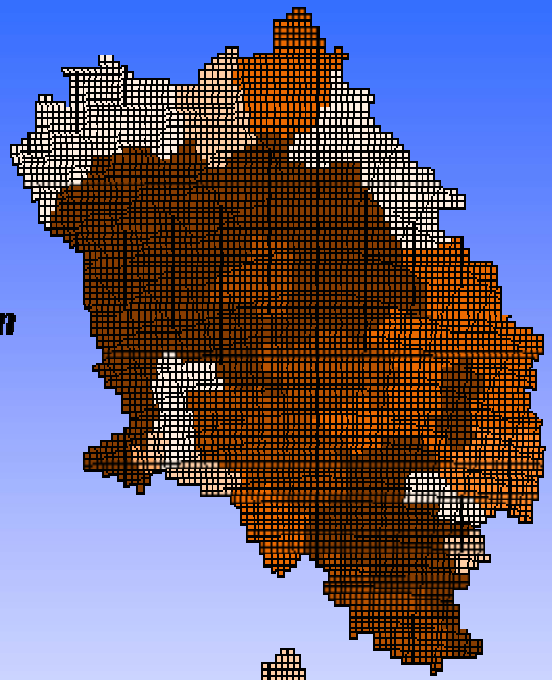

Pilchowice
45 / 68 %
Q [mm/d]
N [mm/d]
gemessener Abfluß
Schnee
Niederschlag
simulierter Abfluß


Gozdowice
99 / 99 %
Q [mm/d]
N [mm/d]
gemessener Abfluß
Schnee
Niederschlag
simulierter Abfluß

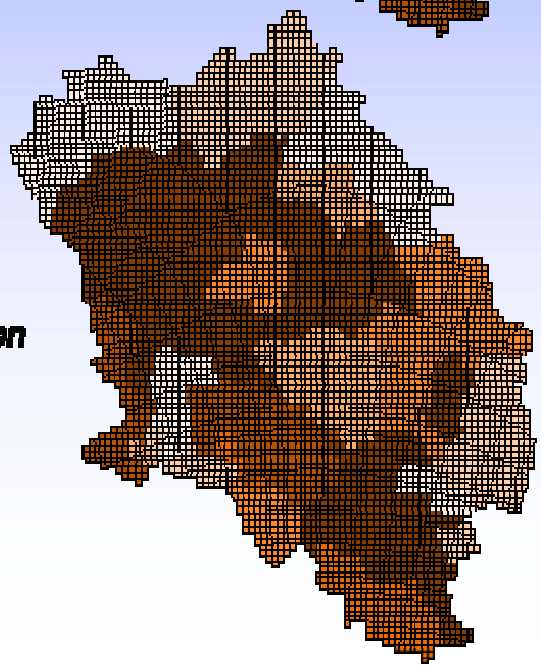
WRF / SEROS and discharge measurements (*)



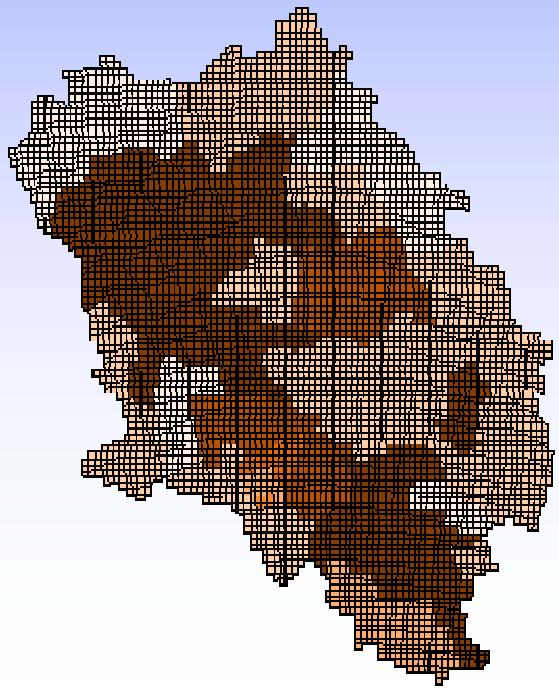
SEROS: Sensitivity of discharge on precipitation differences



Calibration



Precipitation + 10 %



Precipitation + 20 %

not calibrated
< 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100

Nash-Sutcliffe Efficiency (%)

CONCLUSIONS

Automatic calibrated WRF/SEROS flood forecasting system for the Odra watershed was developed

System can be adopted to other catchments

Currently one-way coupling between WRF and SEROS two-way coupling is planned