Development and Research on Climate Change

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SEEVCCC team

37th EWGLAM and 22nd SRNWP Meeting

Belgrade, Republic of Serbia, October 05-08, 2015

Good practices in the development and application of climate services

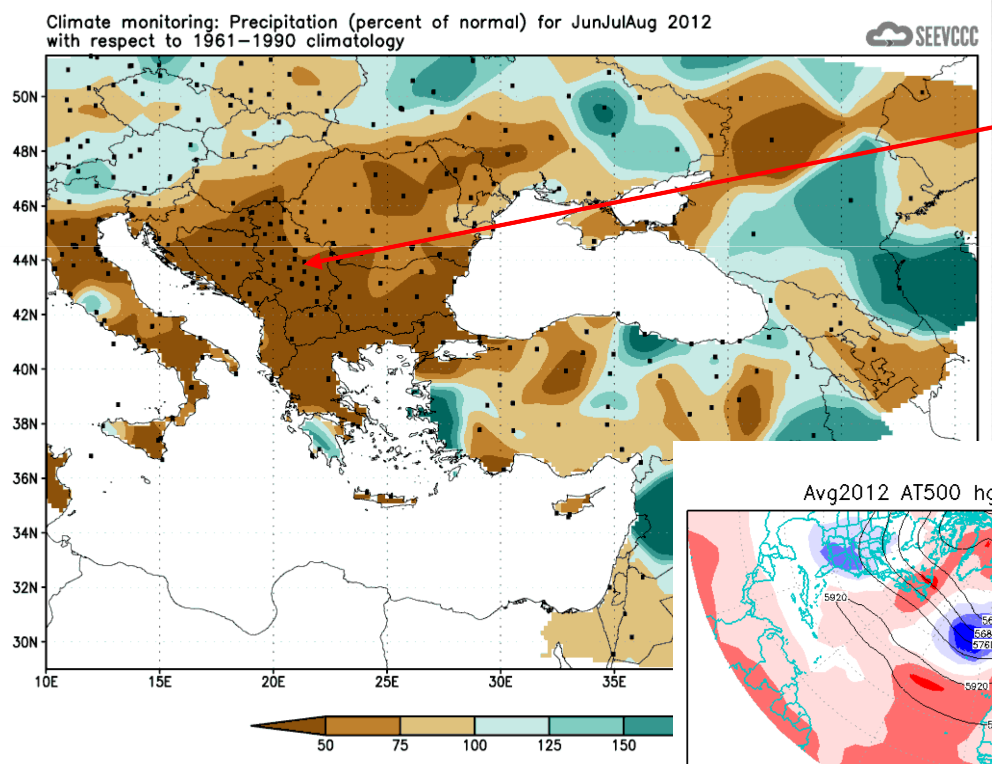
- **SEEVCCCs participation in WMO RA VI-EUROPE RCC Network**
- **Mandatory operational functions:**
- Climate Data Node
- Lead: KNMI/Netherlands (consortium member SEEVCCC/RHMS-Serbia)
- South East European gridded model datasets for
  1961-1990, 2001-2030, 2071-2100 first version RCM-SEEVCCC (ready)
  1971-2000, 2071-2100 new RCM-SEEVCCC (in progress, NMMB)

- Climate Monitoring Node
- Lead: DWD/Germany (participate SEEVCCC/RHMS-Serbia)
- Collecting data from stations (monthly, 400-500 stations)
- Main source for data KNMI-ECA&D, other climate bulletins NCDC)
- Mean temperature and accumulated precipitation
- Temperature anomaly and precipitation percent of normal
- All available monthly/three-monthly

- Long Range Forecast Node
- Lead: Météo-France & ROSHYDROMET (participate SEEVCCC/RHMS-Serbia)
- Once a month ensemble run of a regional long range forecast - 7 months ahead:
  dynamical downscaling ECMWF 51 ensemble with RCM-SEEVCCC

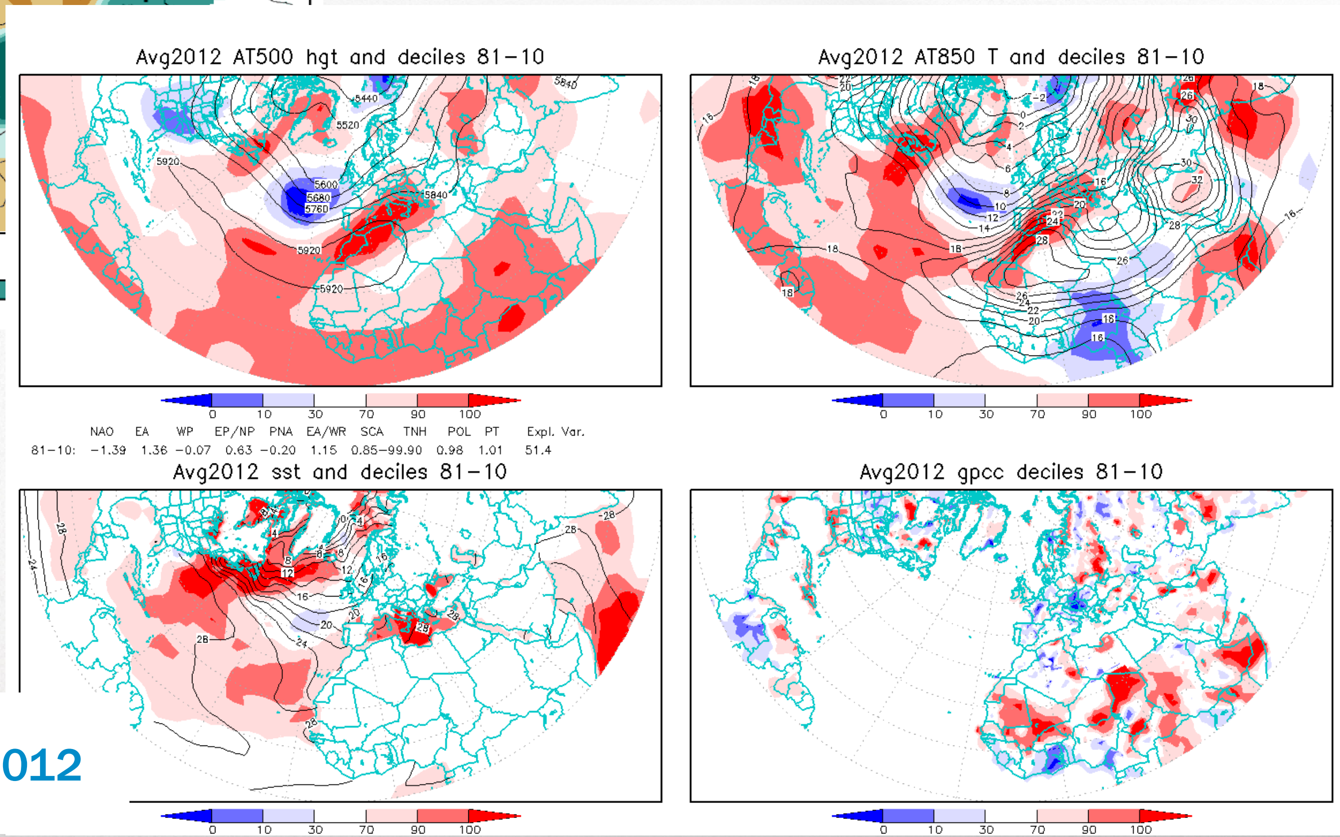
Climate monitoring node – monthly/daily data

Monthly data available through ECA&D data base by the middle of the month - late



Rainfall deficiency in JJA 2012

Reanalysis NCAR/NCEP



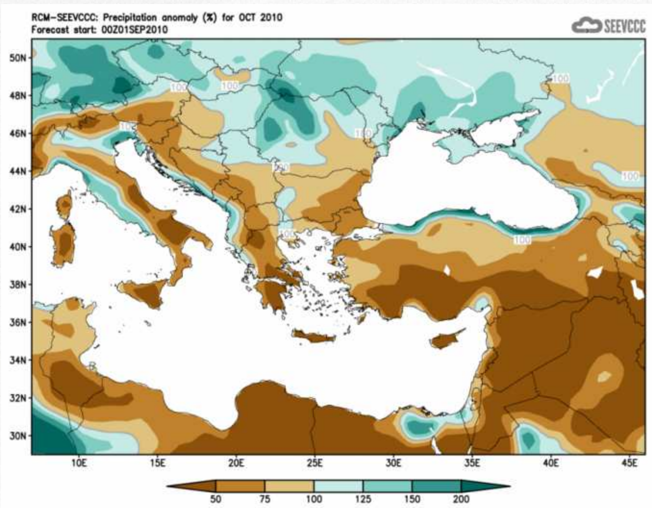
- Daily and monthly available
- Available at the beginning of the month

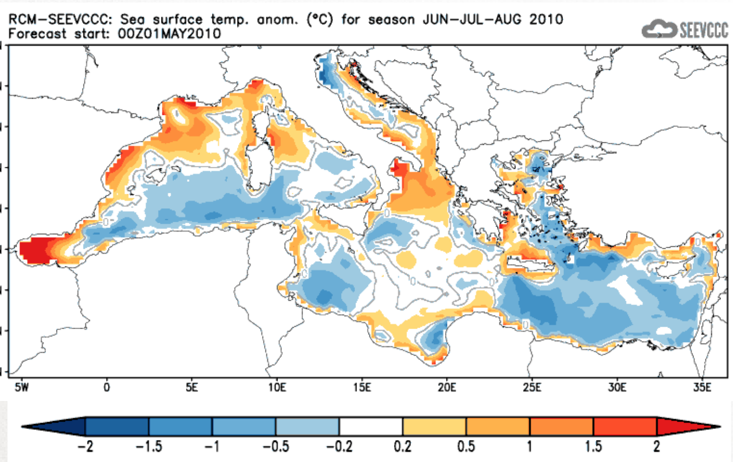
August 2012

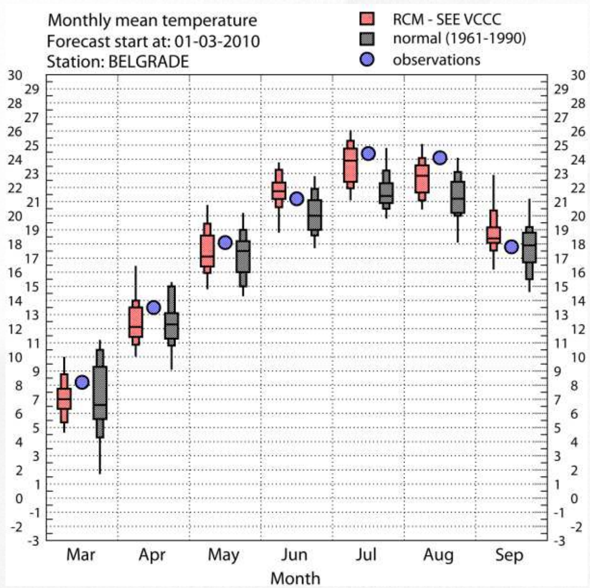
Long Range Forecast / Seasonal forecast

- **Probabilistic forecast** provides statistical summary of the atmosphere and ocean state in forthcoming season.
- **RCM-SEEVCCC LRF** regional dynamical downscaling using fully coupled atmosphere-ocean Regional Climate Model

• model start: 08th of each month; operational since June 2009.
• forecast duration: 7 months
• model resolution: ~35km atmosphere ; ~20km ocean
• model domain: Euro - Mediterranean region extended towards Caspian Sea
• 51 ensemble members
• initial & boundary conditions: ECMWF, ~75km
• winter hindcast (1981-2010) – December run, 7 months
• operational forecast available in GRIB via WIS-DCPC-Belgrade
• Member of Med-CORDEX Initiative







Climate Watch Advisory for SEE

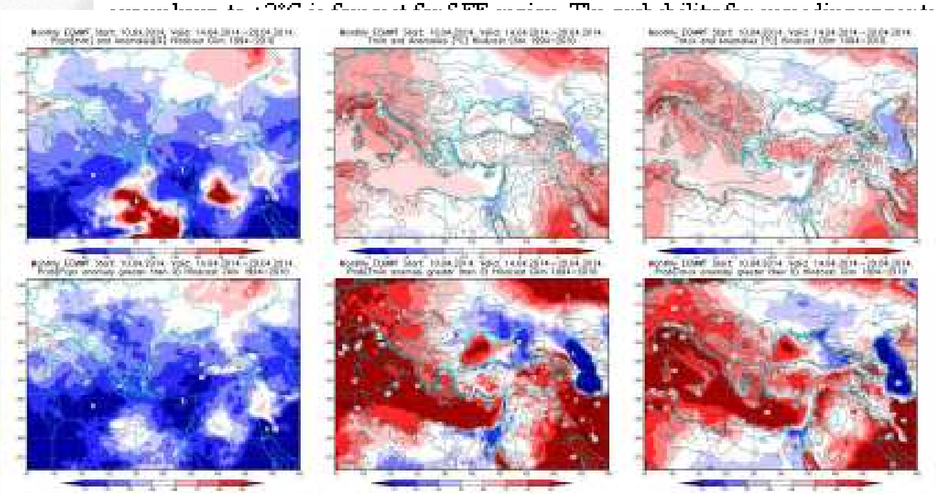
CWS issued by SEEVCCC

Outlook

Within the first week (April 14th to 20th, 2014), ECMWF monthly forecast predicts above normal mean weekly air temperature, with anomaly up to +2°C over Balkans, south Caucasus and some parts of Turkey. Probability for exceeding upper tercile is around 70%, while in central Turkey and south Caucasus it is less confident. Precipitation deficit is expected in most part of the SEE region, with the highest probability, of around 80% for exceeding l[...] tercile over eastern Mediterranean.

During the second week (April 21st to 28th, 2014), above normal mean weekly temper[...] with anomaly up to +3°C is forecast for eastern part of SEE region. Probability for exce[...] upper tercile is around 80%. Precipitation deficit is expected in central parts of Turkey, v[...] probability for exceeding lower tercile is around 60%.

In the period from April 14th to May 11th 2014, above normal mean monthly temperature [...]



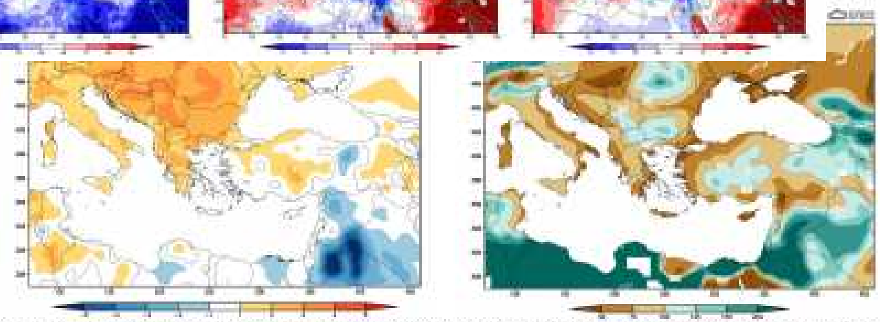


Figure5. Mean seasonal temperature and precipitation anomaly for the season MJJ (seasonal outlook for RCM – SEEVCCC)

Climate Watch (Serial No.: 20141117 – 00)

Initial/Updated/Final

Topic: precipitation

Organization issuing the statement: SEEVCCC

Issued/ Amended / Cancelled: 17-11-2014 12:00 P.M.

Contact: E-mail: cws-seevccc@hidmet.gov.rs
Phone: +381112066925
Fax: +381112066929

Valid from – to: 17-11 – 30-11-2014 Next amendment: 24-11-2014

Region of concern: South-Eastern Europe

„During the next week, precipitation surplus is expected along the Adriatic Sea coast, [...]mania, Moldova and south Caucasus. Probability for exceeding upper tercile is [...]und 80%."

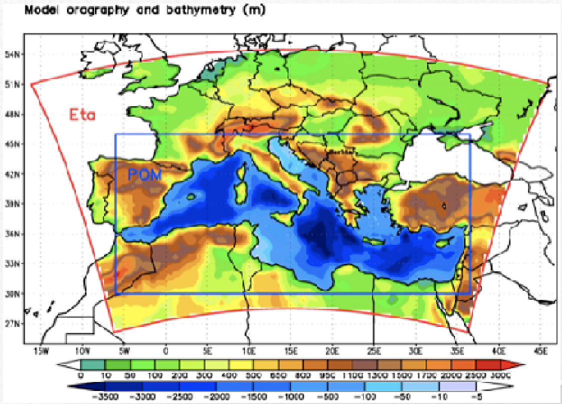
[...]nitoring

[...]he period from November 9th to 15th, 2014 above normal air temperature[1], with anomaly [...] to +7°C, was registered in most of the SEE region. Weekly precipitation sums ranging [...]n 25 mm to 200 mm were observed along Adriatic coast, western Greece and western [...]key.

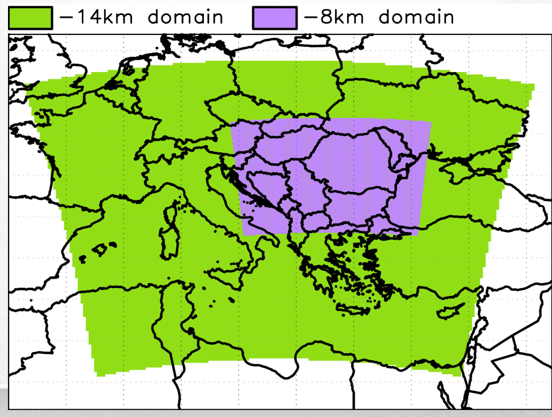
www.seevccc.rs/CWS

Climate change scenarios

- **RCM-SEEVCCC** regional climate model
  - SINTEX-G (INGV) initial and boundary conditions on 120 km resolution
  - RCM-SEEVCCC - fully coupled atmosphere-ocean model (EBU-POM)
  - resolution: ~ 35 km atmosphere, ~ 20 km ocean
    - 1961-1990 - present climate simulation
    - 2001-2030 - SRES A1B scenario
    - 2071-2100 - SRES A1B and A2 scenarios
- **NMMB** regional climate model
  - 1971-2000 with ERA40 initial and boundary conditions
    - 14 km resolution, lager part of the Europe
    - 8 km resolution, part of the Balkan peninsula
  - 1971-2100 RCP8.5 with CMCC-CM initial and boundary conditions
    - 8 km resolution, part of the Balkan peninsula



RCM-SEEVCCC



NMMB

NMMB climate simulations

NMMB (Nonhydrostatic Multiscale Model on B grid):

- developed at NCEP (Janjic et al. 2013),
- unified global and regional model,
- ability to run with on-line stationary or moving nested domains

Present climate run:

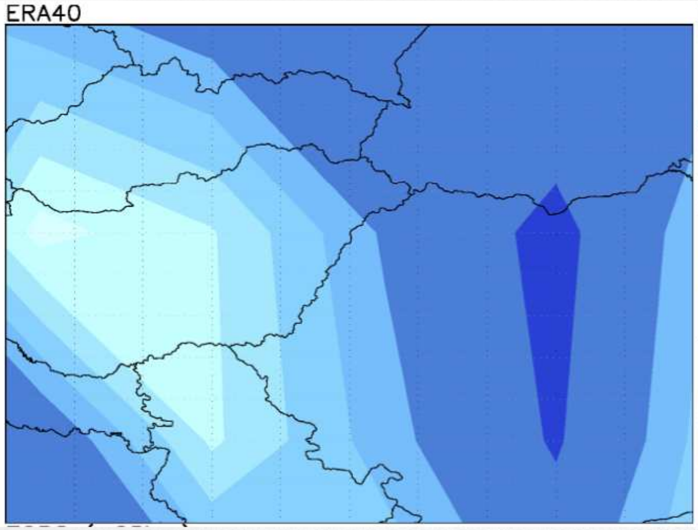
- initial and boundary conditions: ERA40 reanalysis (250 km)
- resolution: 14 km and 8 km
- period: 1971-2000
- data used for verification: RHMSS network, EOBS, ERA40, CARPATCLIM

Future climate run:

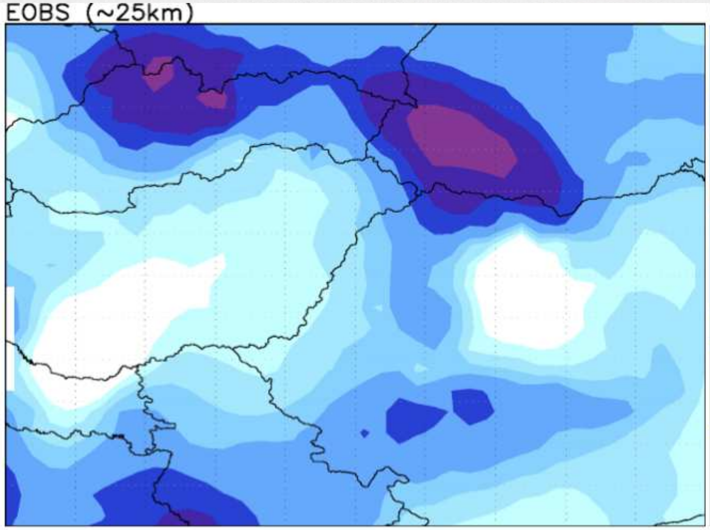
- initial and boundary conditions: CMCC-CM (75 km)
- resolution: 8 km
- periods: 1971-2005, 2010-2100
- IPCC scenario: RCP8.5

NMMB present climate simulation: mean annual precipitation 1971-2000

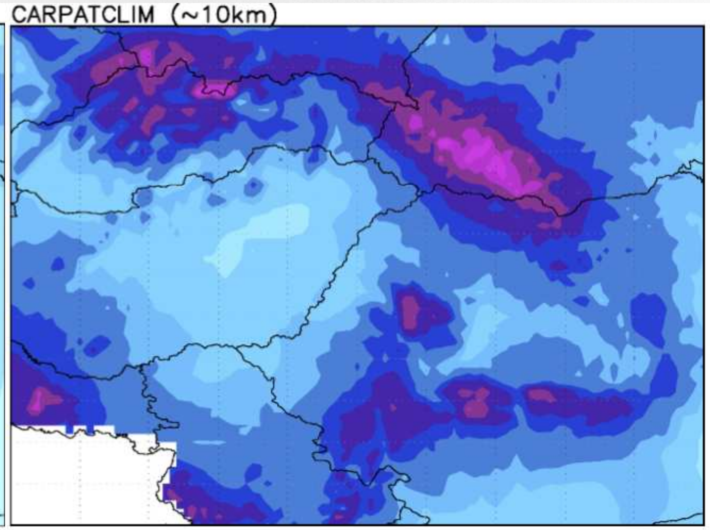
ERA40 (250 km)

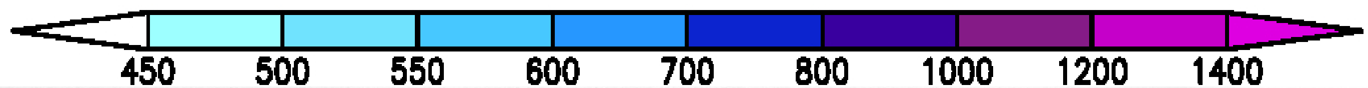


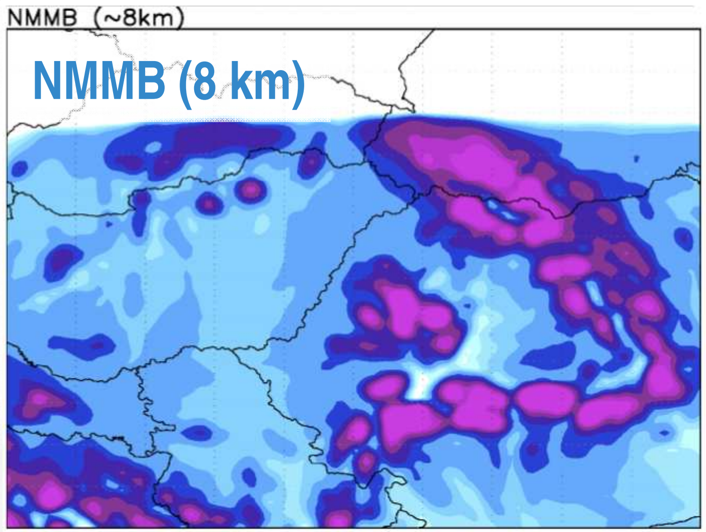
EOBS (25 km)



CARPATCLIM (10 km)







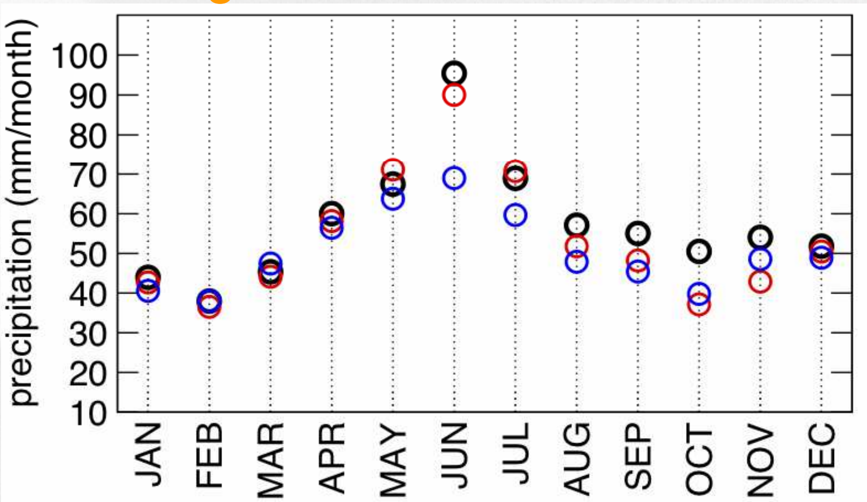
More NMMB present climate results can be found in Djurdjevic and Krzic (2013).

Precipitation annual cycle (monthly precipitation)

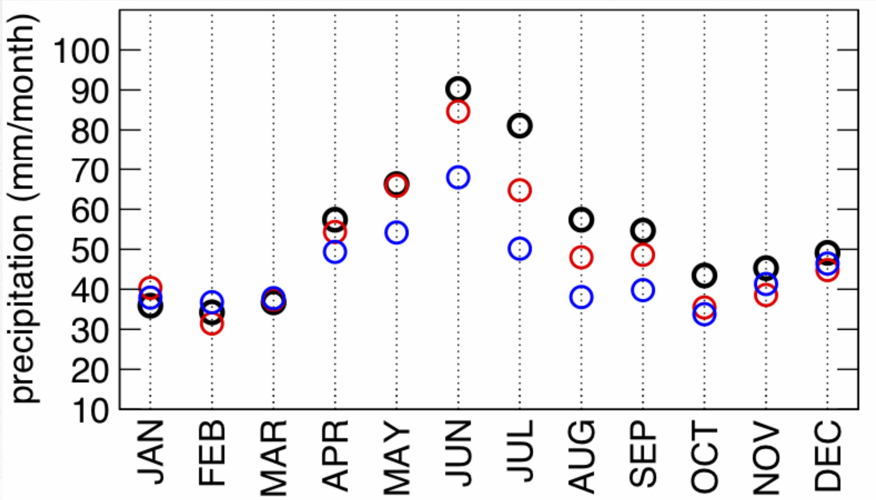
Selected stations:

o - Observations
o - NMMB-8
o - NMMB-14

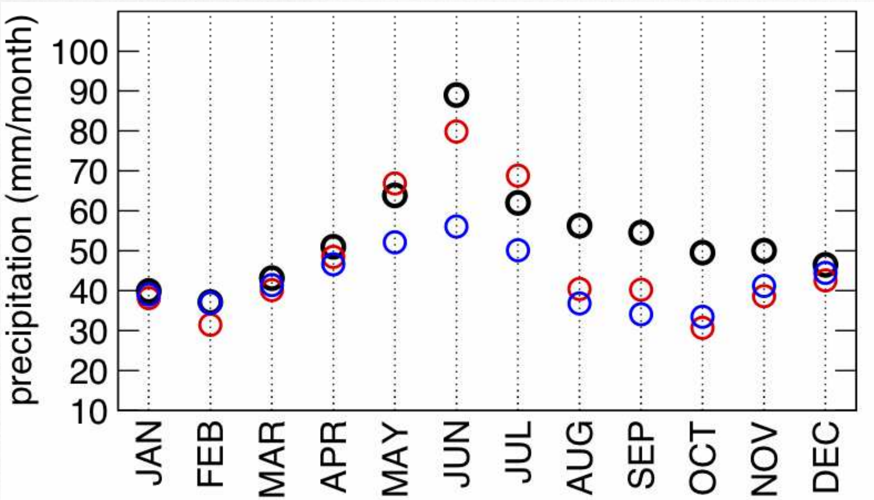
Beograd



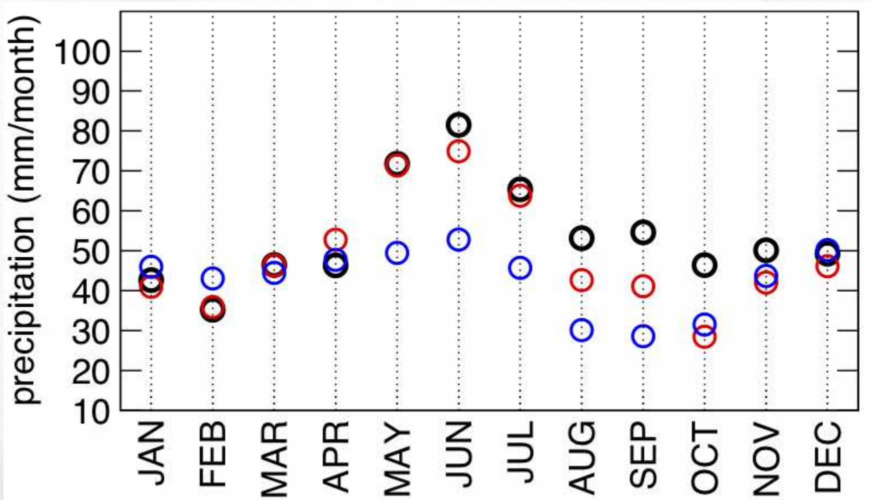
Vrsac



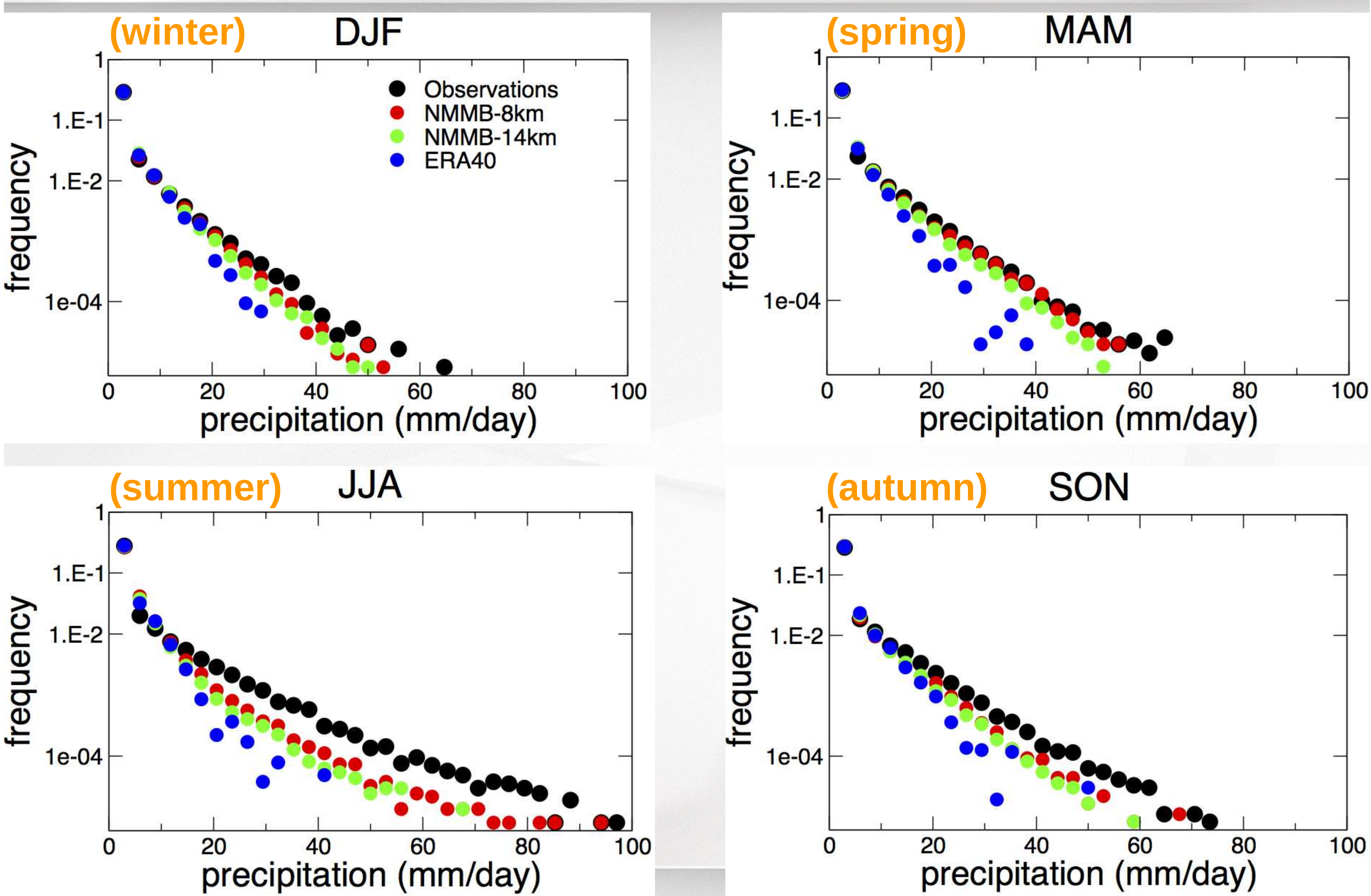
S. Palanka



Rekovac

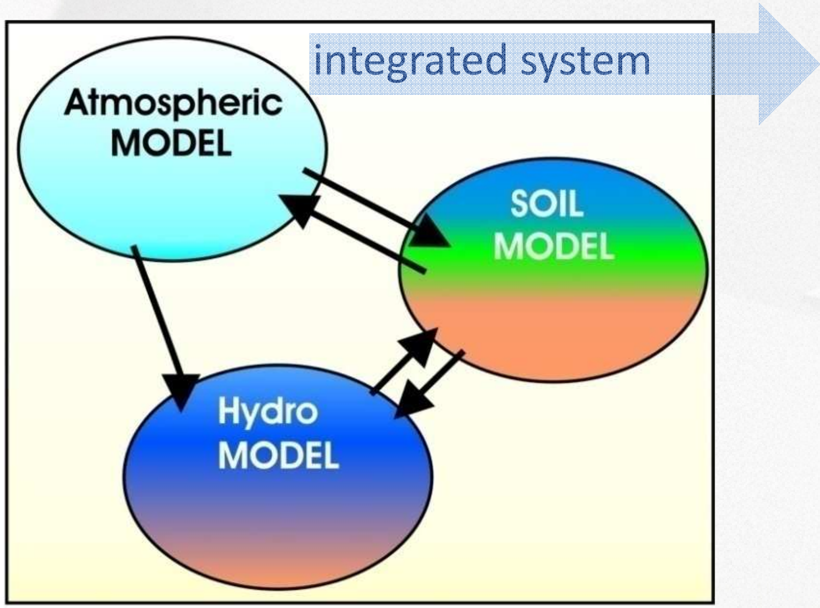


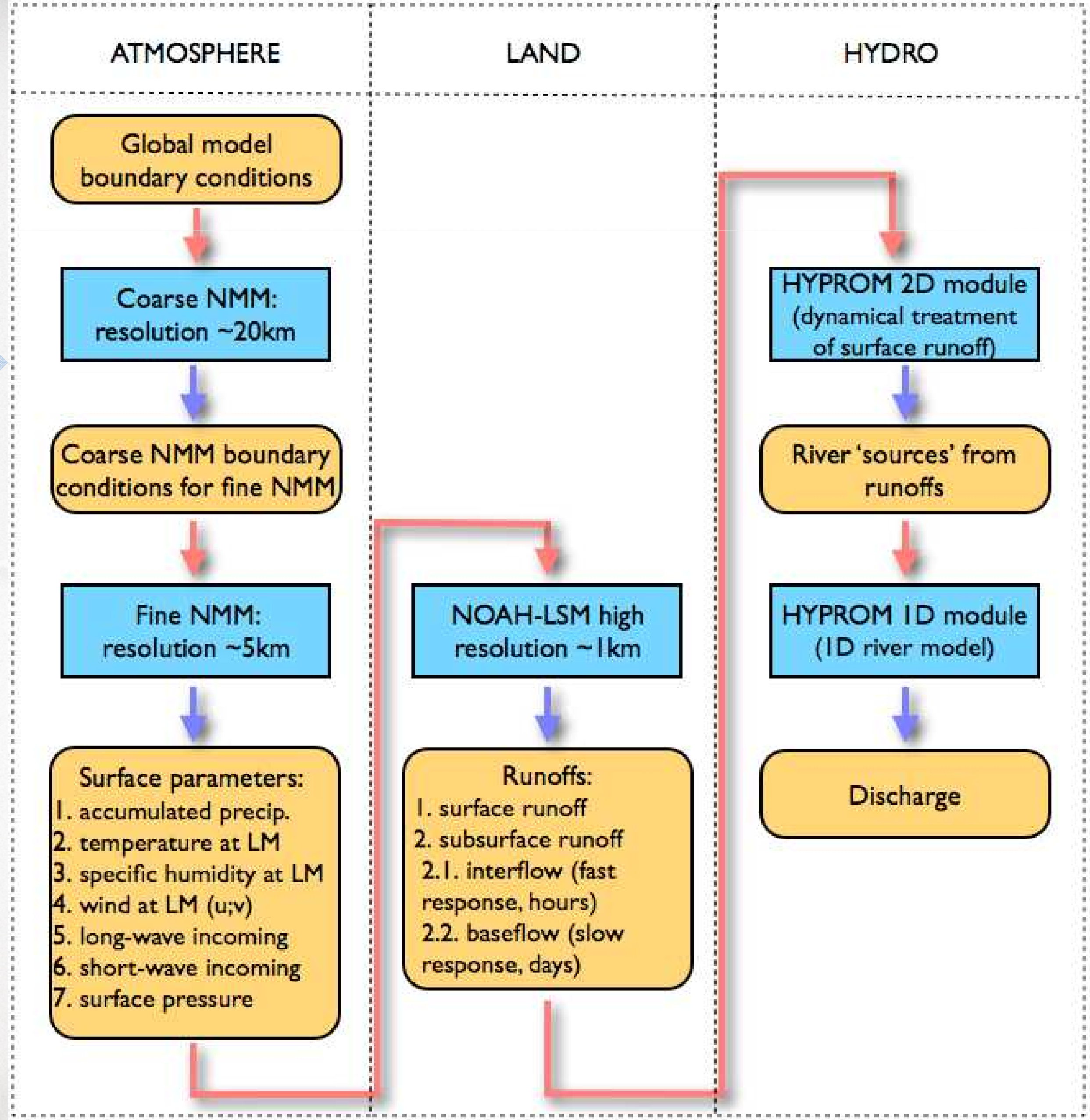
Daily precipitation - seasonal distributions



Hydrology component - HYPROM model

- Precipitation and river discharge forecast at flash floods events and for regional climate simulations





LM - lowest atmospheric model level

S. Ničković, G. Pejanović,
V. Djurdjević, M.Vujadinović

h,u,v equations:

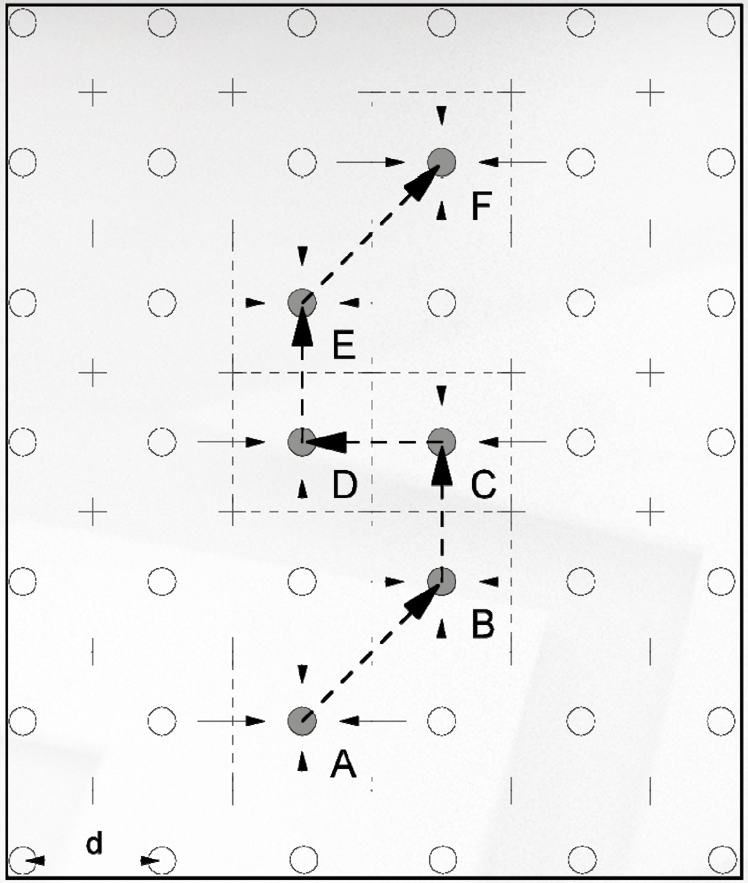
$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+g\left[\frac{\partial h}{\partial x}+S_{fx}-S_{0x}\right]=0$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+g\left[\frac{\partial h}{\partial y}+S_{fy}-S_{0y}\right]=0$$

$$\frac{\partial h}{\partial t}+\frac{\partial(hu)}{\partial x}+\frac{\partial(hv)}{\partial y}+\dot{H}=0$$

○ h - points
✦ u,v -points

A-B-C-D-E-F river points



- dynamically treatment of an overland flow (NO kinematic approximation!)
- numerically stabile implicit time scheme for the friction term
- new numerical technique for preventing grid decoupling noise
- suitable for long term and flash flood simulations
- computationally efficient

Nickovic S. et al, HYPROM Surface-Runoff Prognostic Model, *Water Resource Research*

NOAH land surface model

Water content: Darcys' law

$$\frac{\partial W_l}{\partial t} = \frac{\partial}{\partial z}\left(\boxed{K_w \frac{\partial W_l}{\partial z}} + \boxed{\gamma_w}\right) + R_{ex}$$

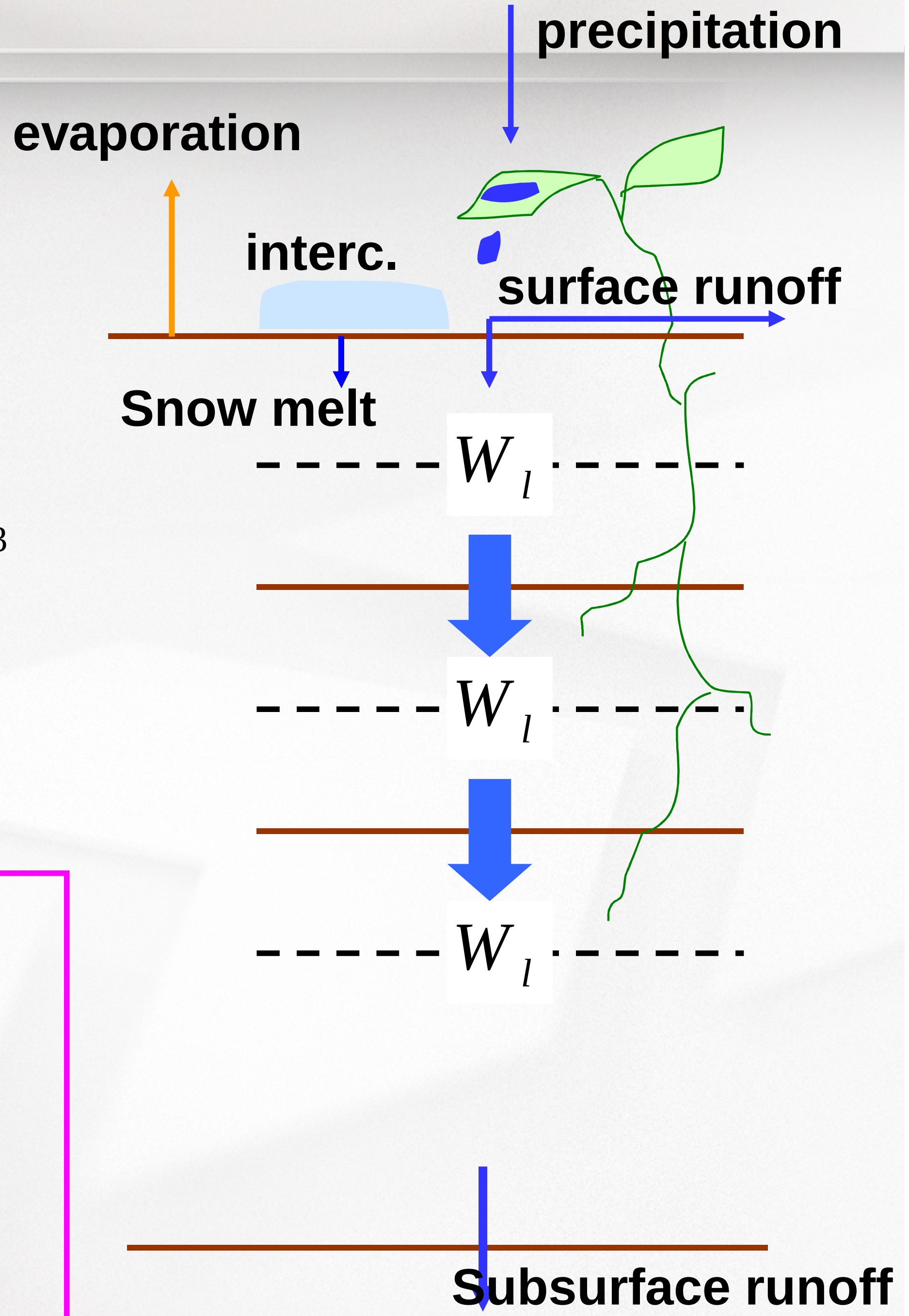
diffusivity

$$K_w = \boxed{K_{ws}} \left(\frac{W_l}{\boxed{W_s}}\right)^{\boxed{b}+2}$$

conductivity

$$\gamma_w = \boxed{\gamma_{ws}} \left(\frac{W_l}{\boxed{W_s}}\right)^{2\boxed{b}+3}$$

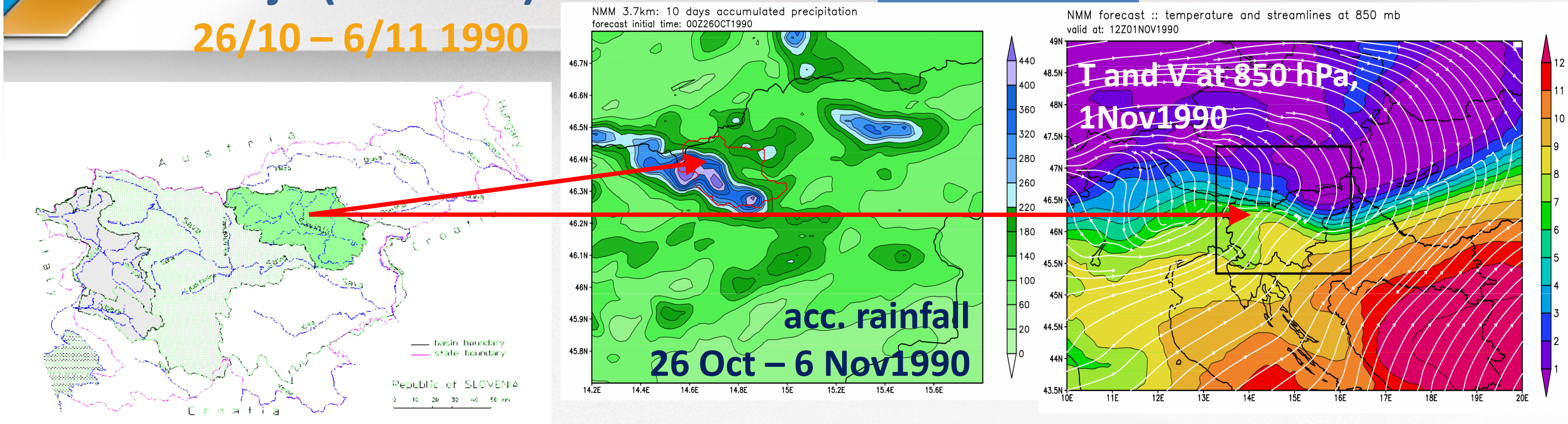
K_{ws}	diffusivity at saturation
γ_{ws}	conductivity at saturation
W_s	porosity
b	Clapp-Horneberger const



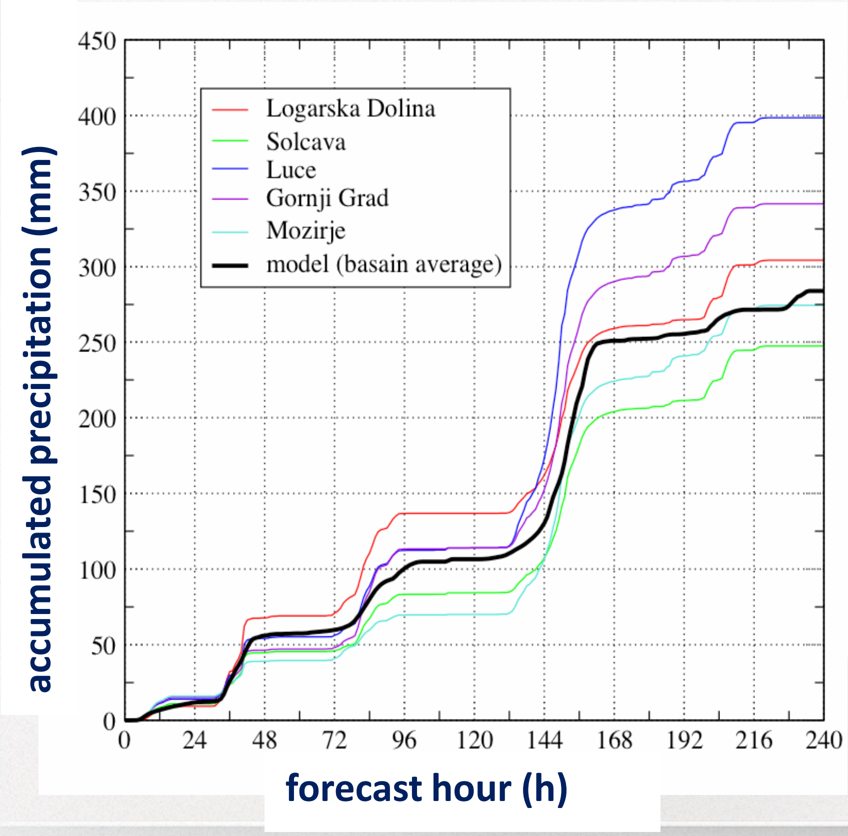
Savinja (Slovenia)

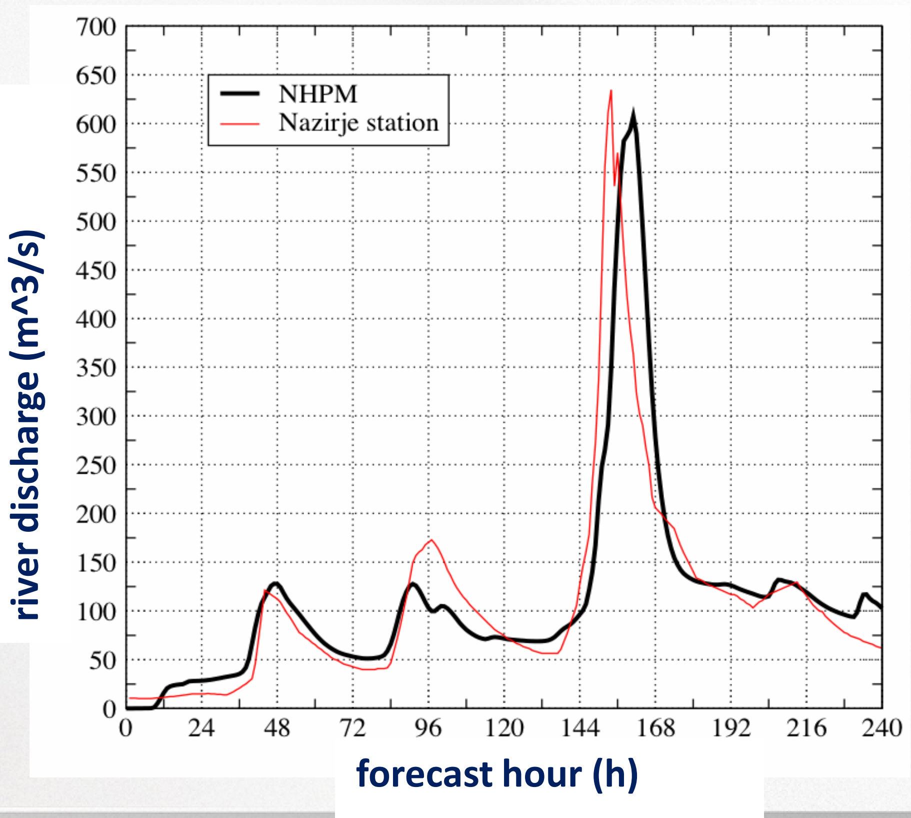
26/10 – 6/11 1990

NMM model



model vs. observations

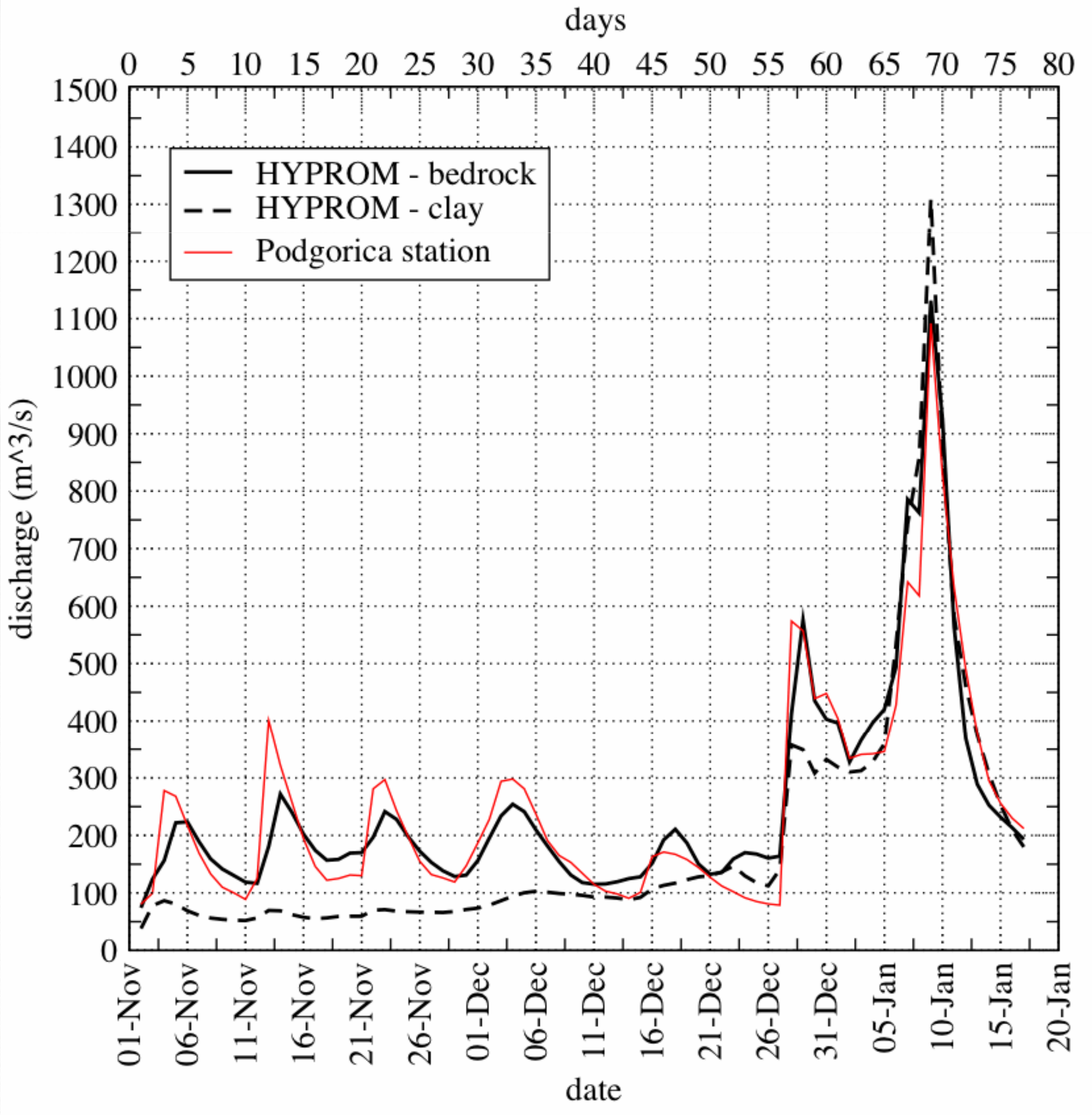


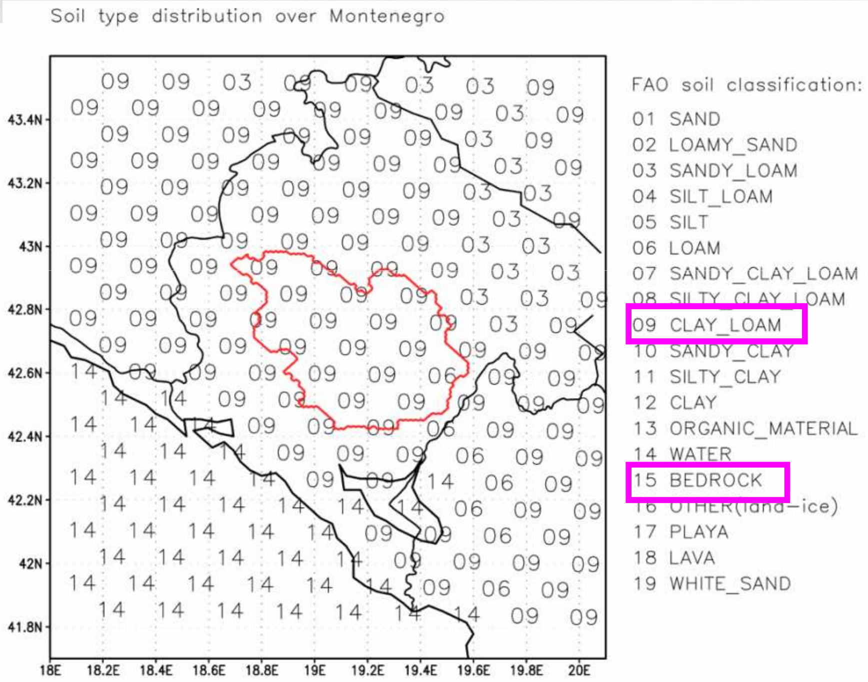


Moraca –Montenegro ADRICOSM Project

Land Surface Modelling

Sensitivity to soil type

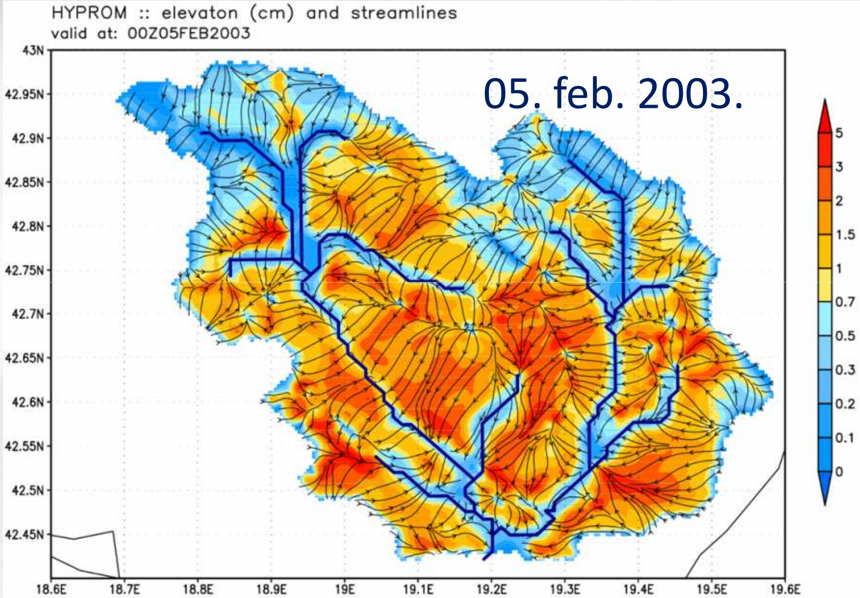


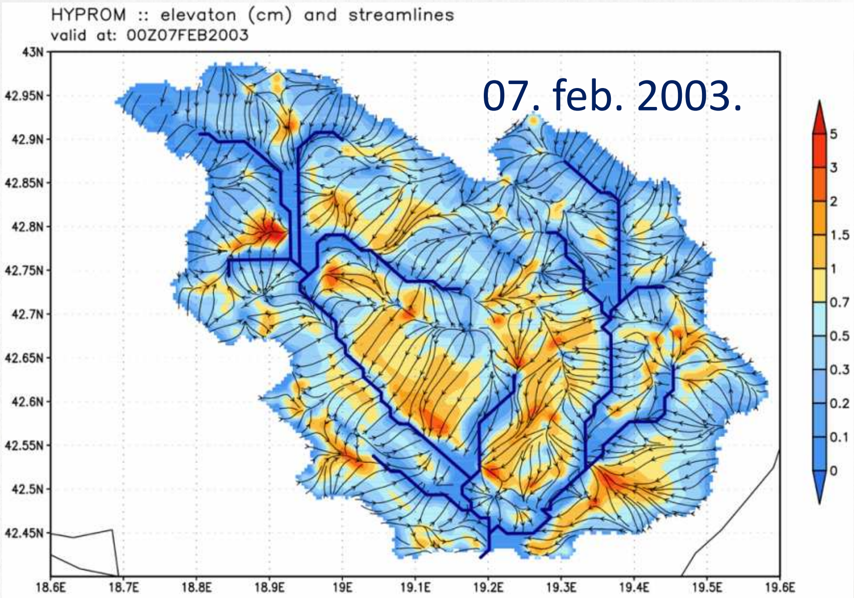


parameter	Clay Loam (09)	Bedrock (15)
sat. diffusivity	0.113×10^{-4}	0.136×10^{-3}
sat. conductivity	2.45×10^{-6}	1.41×10^{-4}
porosity	0.465	0.20
CH constant	8.17	2.79

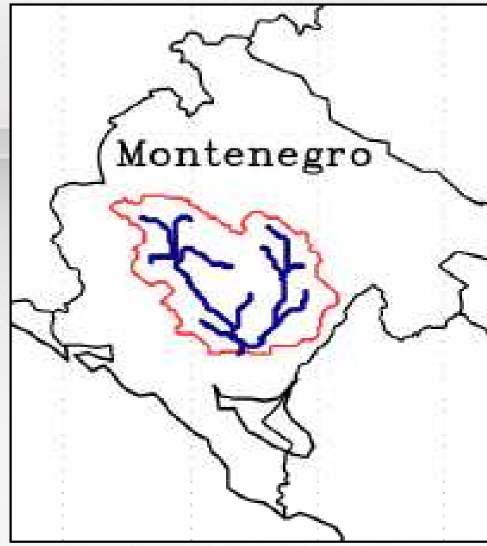
Morača (Montenegro)

elevation (cm) and stream lines

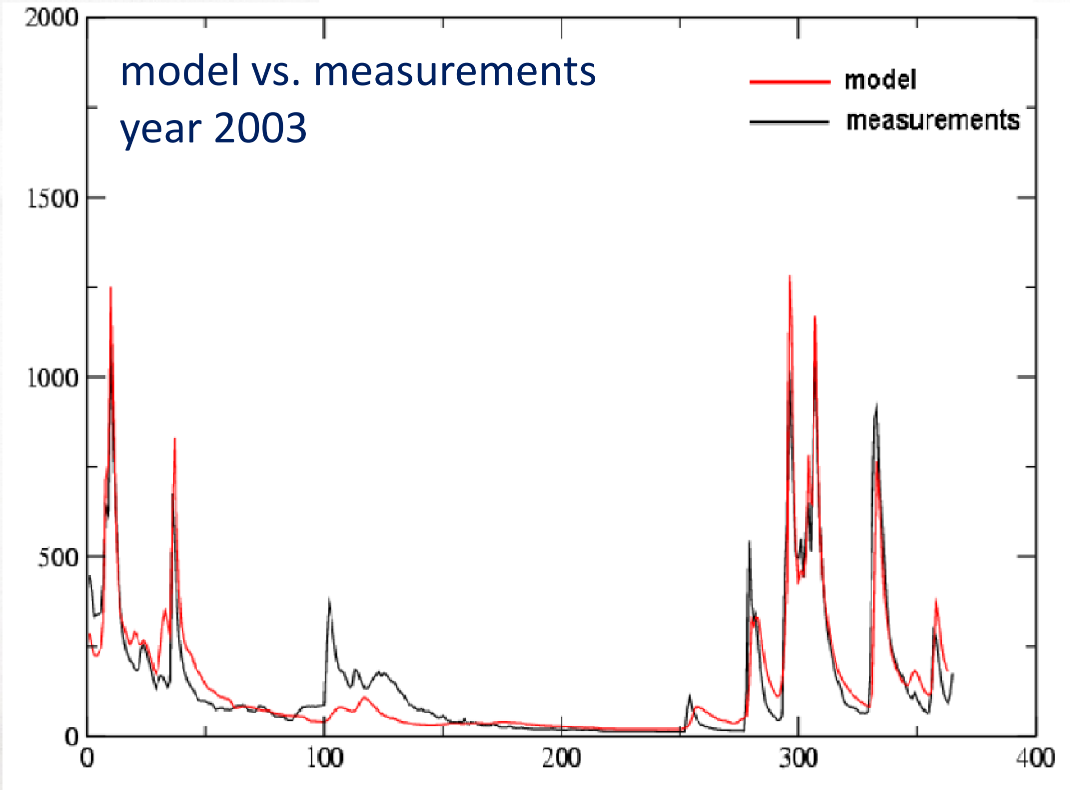




HYPROM - example of dynamical treatment of surface runoff after heavy rains



discharge (m^3/s) at
Podgorica measuring point

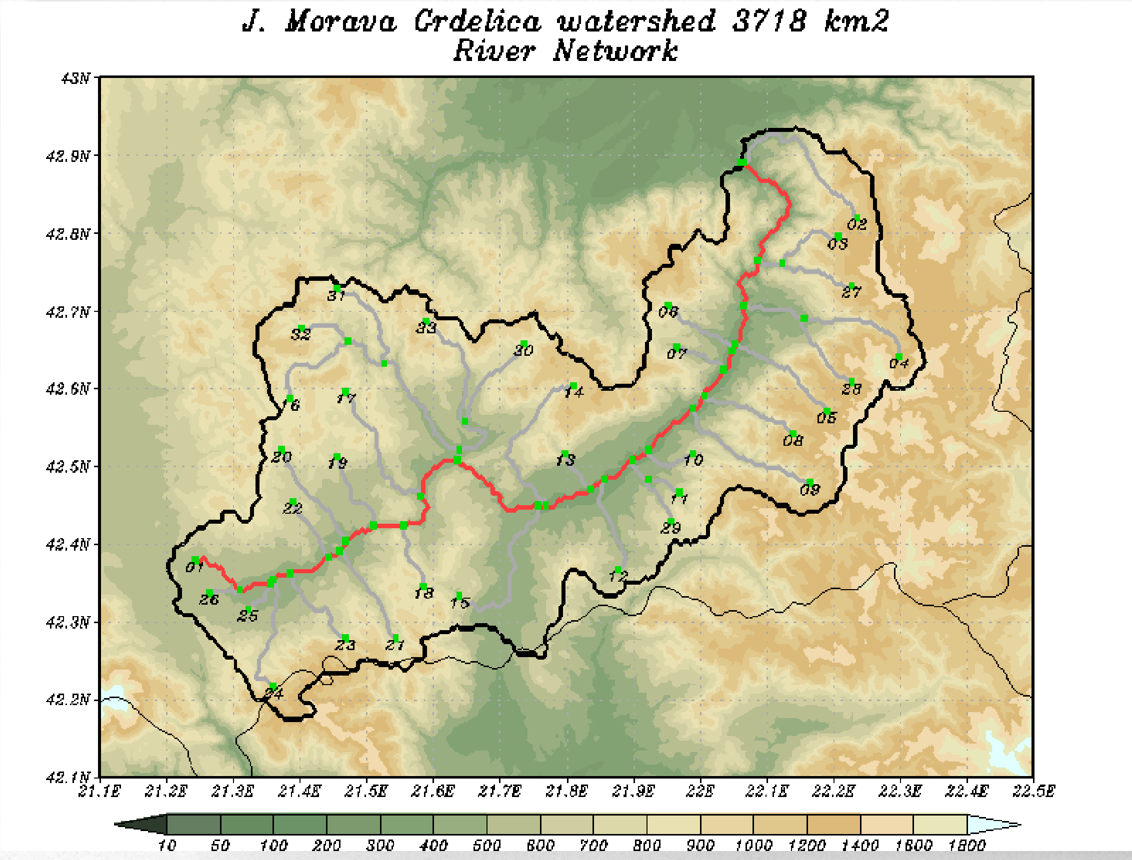


Južna Morava – profile Grdelica

1915-2013 more than **850 torrential flood events in Serbia**

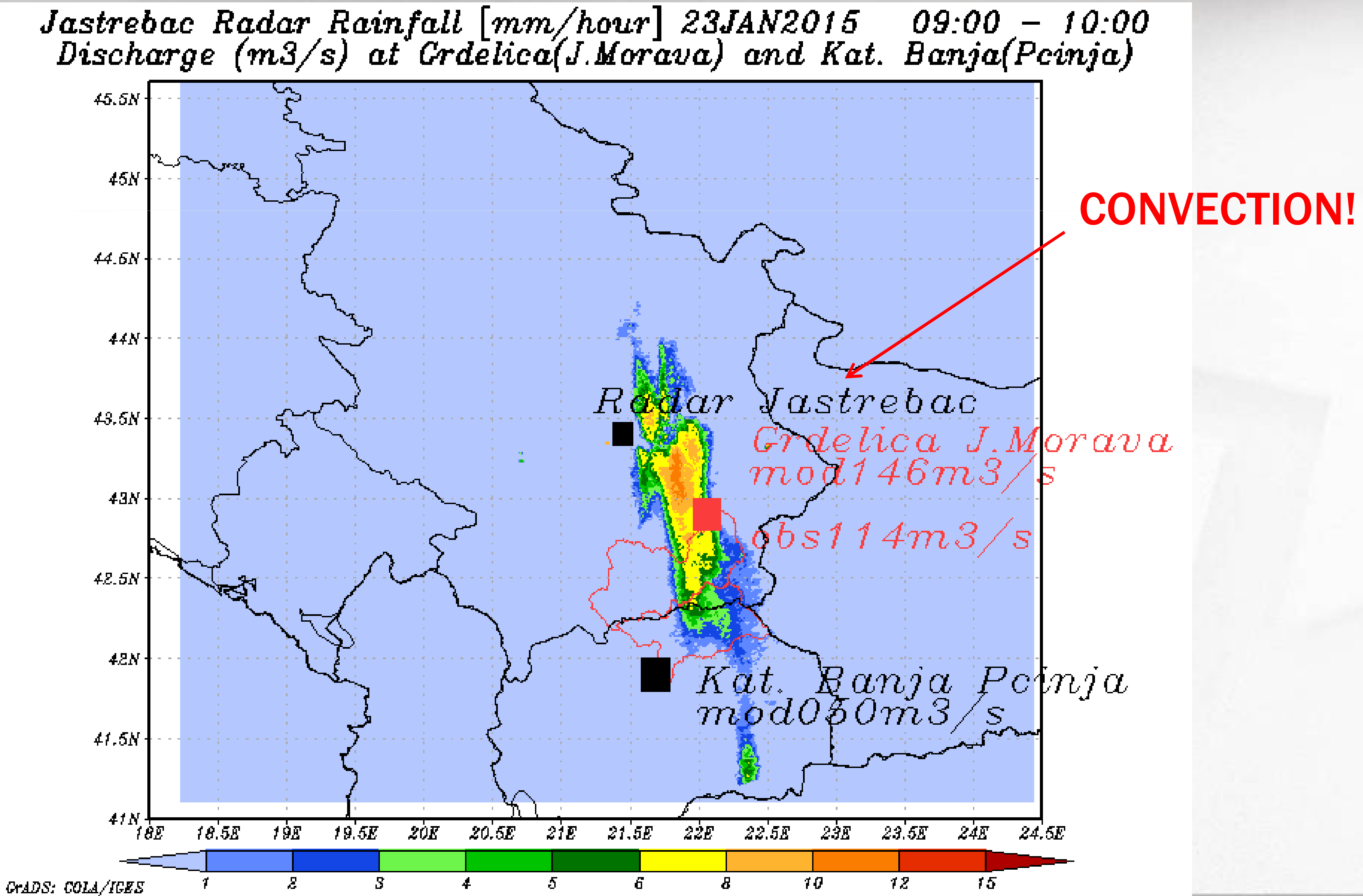
More than 200 on Južna Morava

- heavy precipitation
- sudden snowmelt

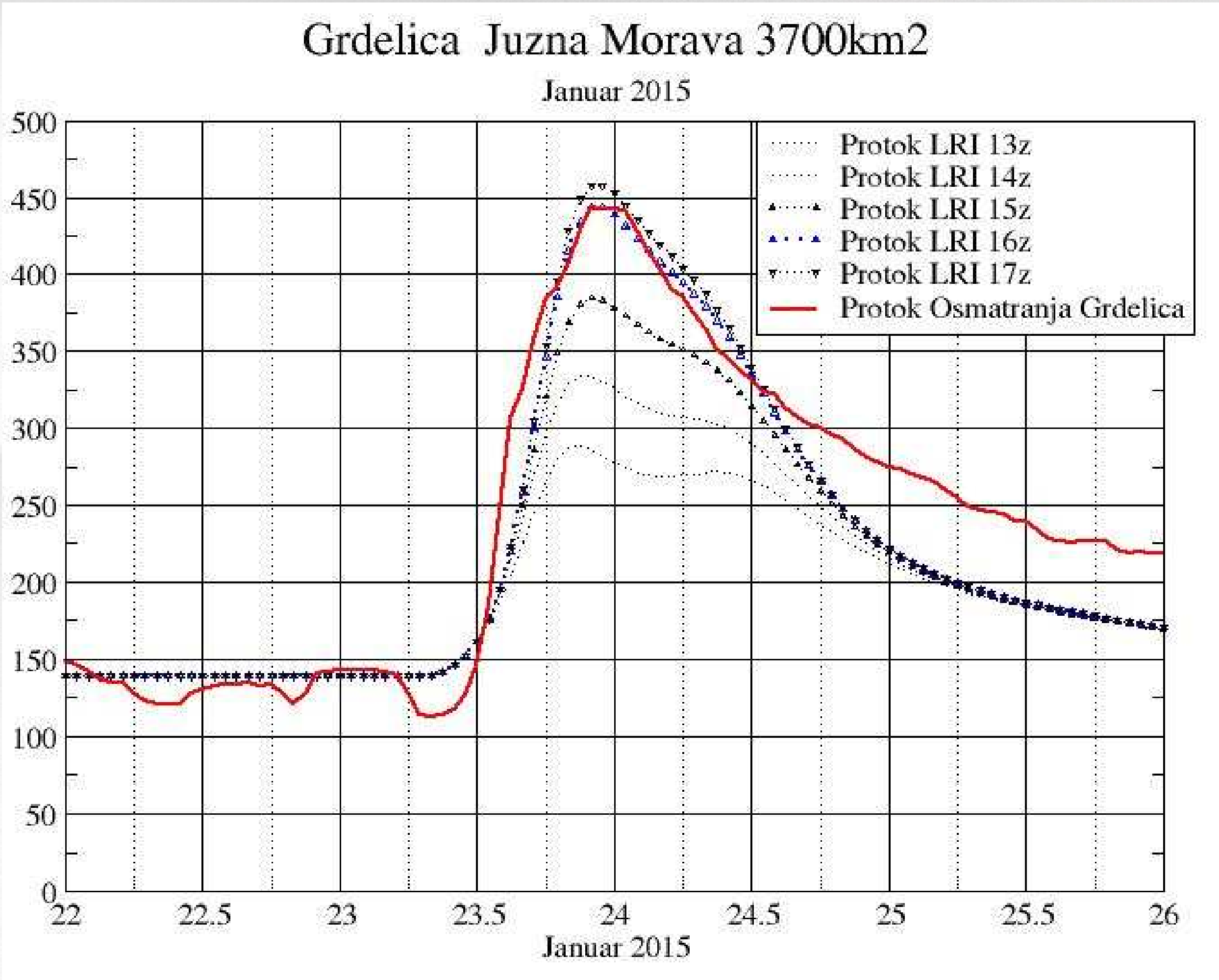


Grdelica, 23.01.2015

Jastrebac radar – observed precipitation and HYPROM model results



HYPROM forced with radar QPE vs observed river discharge



Radar precipitation input in HYPROM

Time step – 1 hour

At 15UTC model forecasted more than Q350m3/s for 21UTC

```
UTC              protok   sr.gr  sr.ap.gr sr.kv.gr   cor      cef              OSMATRANJA                                      PROGNOZA
10 n=  21 erm:  330.33 -159.40  167.20  191.11     0.92    -1.59 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 196.  at:36 q350m3/s at:-1 |||:fct
11 n=  21 erm:  330.33 -140.84  149.47  170.12     0.96    -1.05 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 220.  at:36 q350m3/s at:-1 |||:fct
12 n=  21 erm:  330.33 -118.69  127.92  144.76     0.98    -0.49 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 249.  at:21 q350m3/s at:-1 |||:fct
13 n=  21 erm:  330.33  -94.32  103.77  116.14     0.98     0.04 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 288.  at:22 q350m3/s at:-1 |||:fct
14 n=  21 erm:  330.33  -66.95   76.40   83.84     0.98     0.50 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 334.  at:22 q350m3/s at:-1 |||:fct
15 n=  21 erm:  330.33  -39.41   48.86   52.71     0.98     0.80 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 385.  at:23 q350m3/s at:21 |||:fct
16 n=  21 erm:  330.33   -9.31   21.81   32.02     0.97     0.93 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 444.  at:24 q350m3/s at:20 |||:fct
17 n=  21 erm:  330.33   -2.03   25.61   32.64     0.96     0.92 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 458.  at:23 q350m3/s at:19 |||:fct
18 n=  21 erm:  330.33   -2.03   25.62   32.64     0.96     0.92 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 458.  at:23 q350m3/s at:19 |||:fct
19 n=  21 erm:  330.33   -2.03   25.62   32.64     0.96     0.92 mx: 444.  at:23 q350m3/s at:18 |||:fct mx: 458.  at:23 q350m3/s at:19 |||:fct
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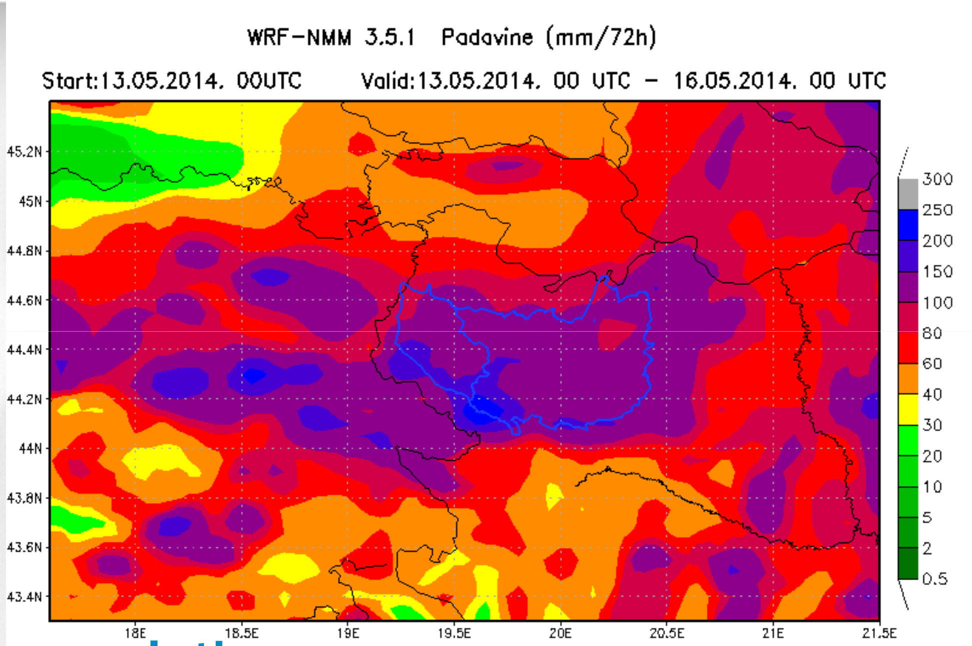
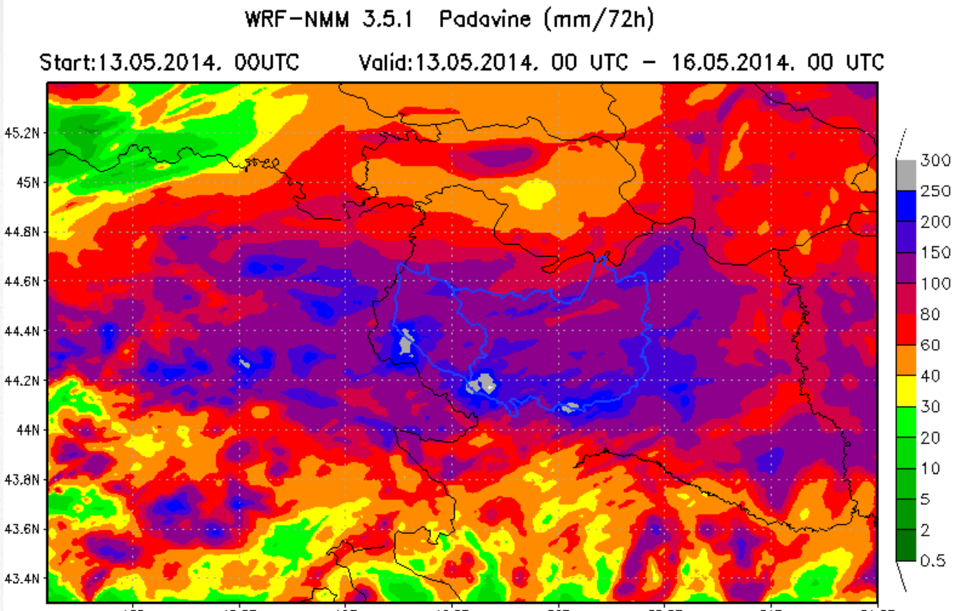
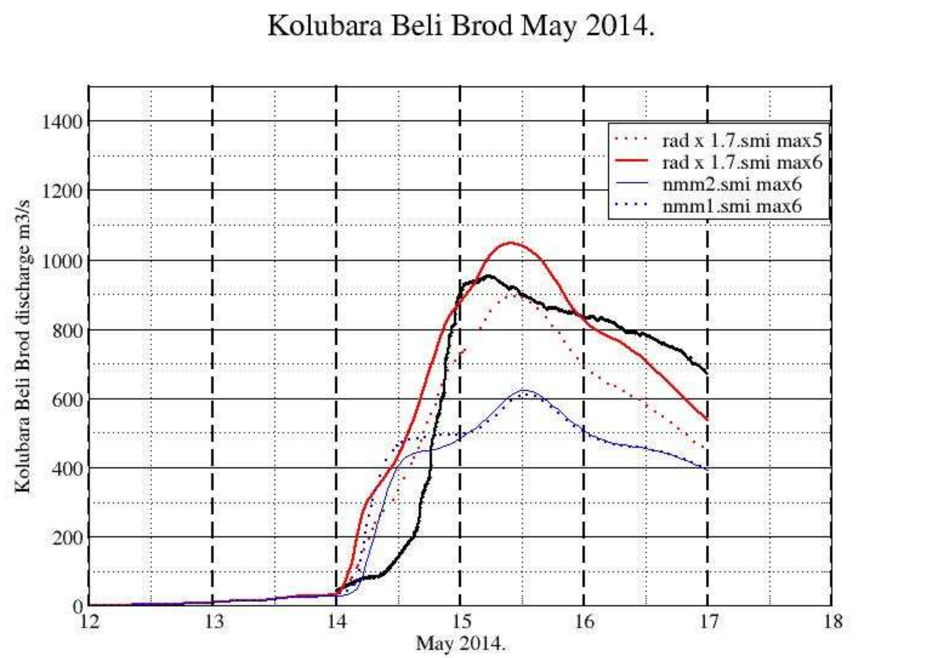
NMM precipitation - Floods May 2014

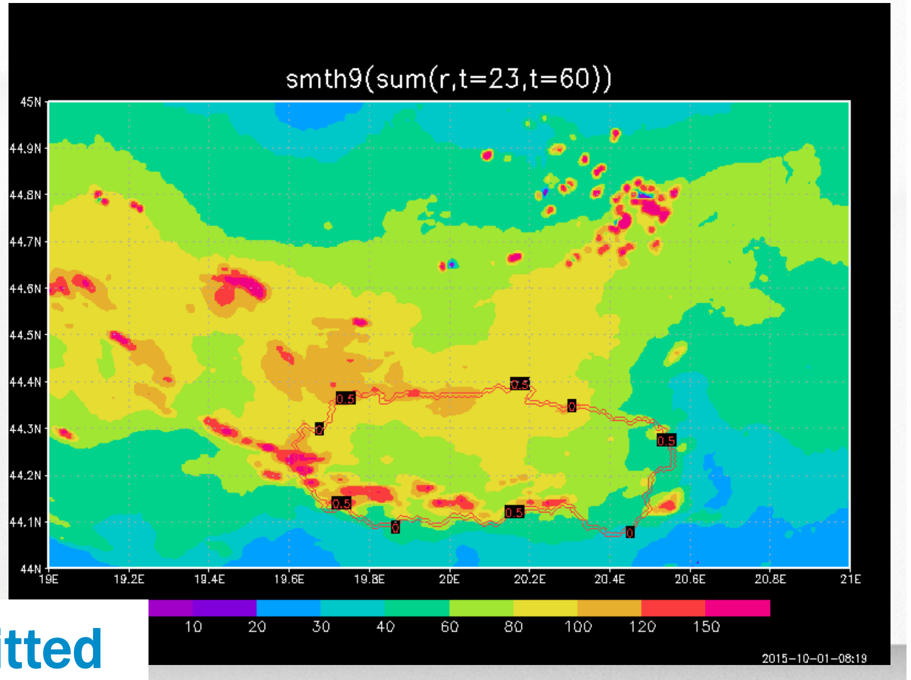


4 km resolution



1.33 km resolution NESTED - convection permitted





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