

Decrease in hydroclimatic conditions generating floods in the southeast of Belgium over the last 50 years

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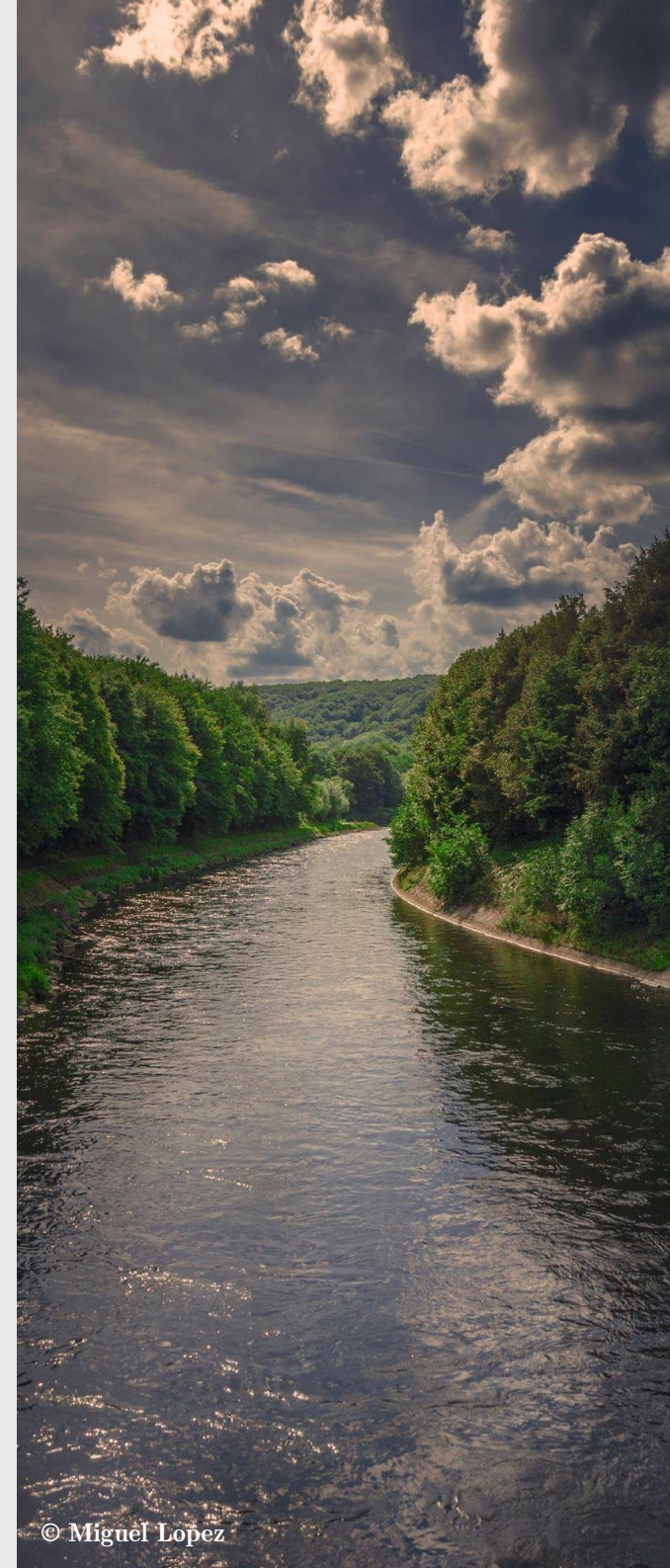
Contact : Coraline.Wyrd@ulg.ac.be

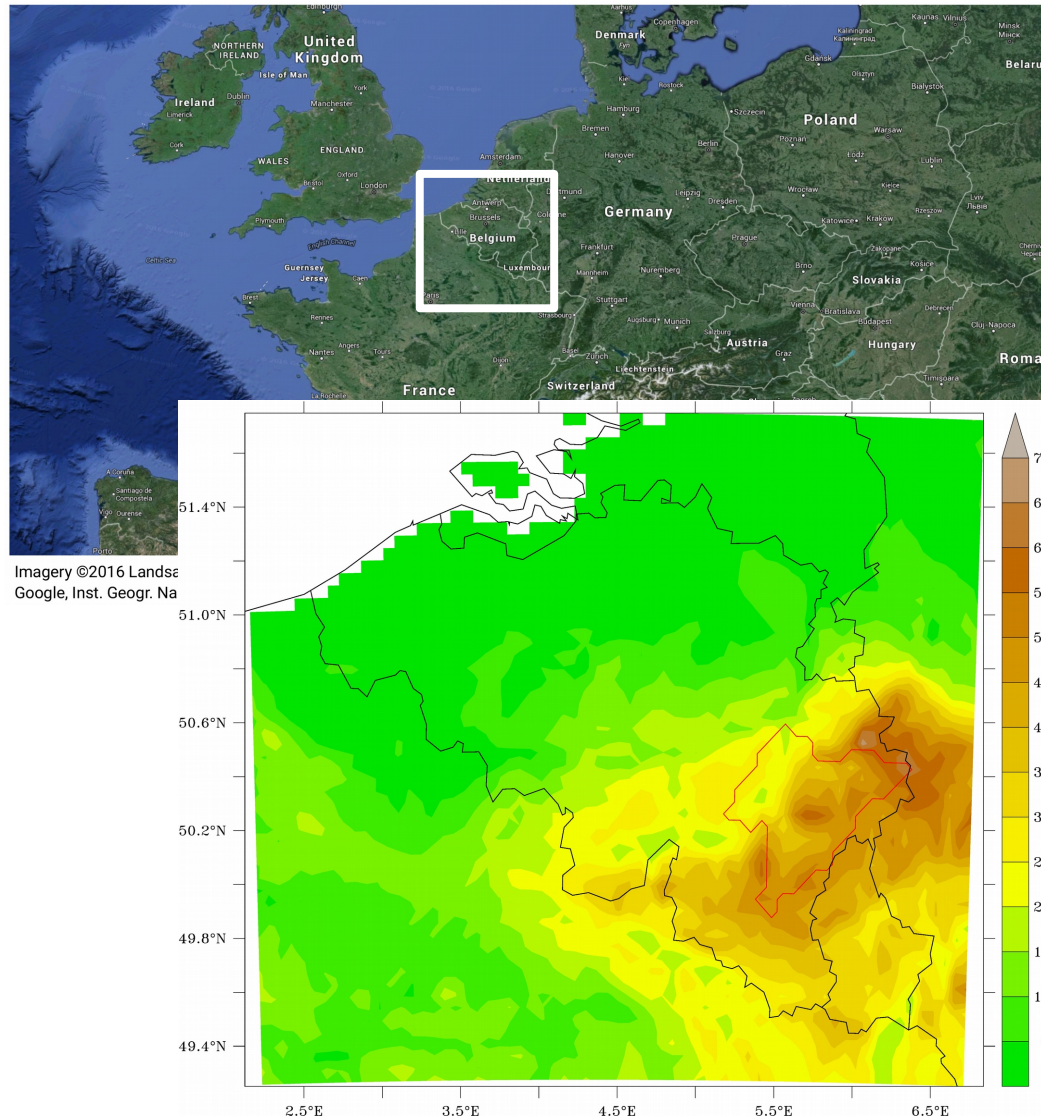


Oral communication in Session HS2.4.1

Presented at EGU General Assembly 2016, Vienna, Austria

Abstract EGU2016-14597





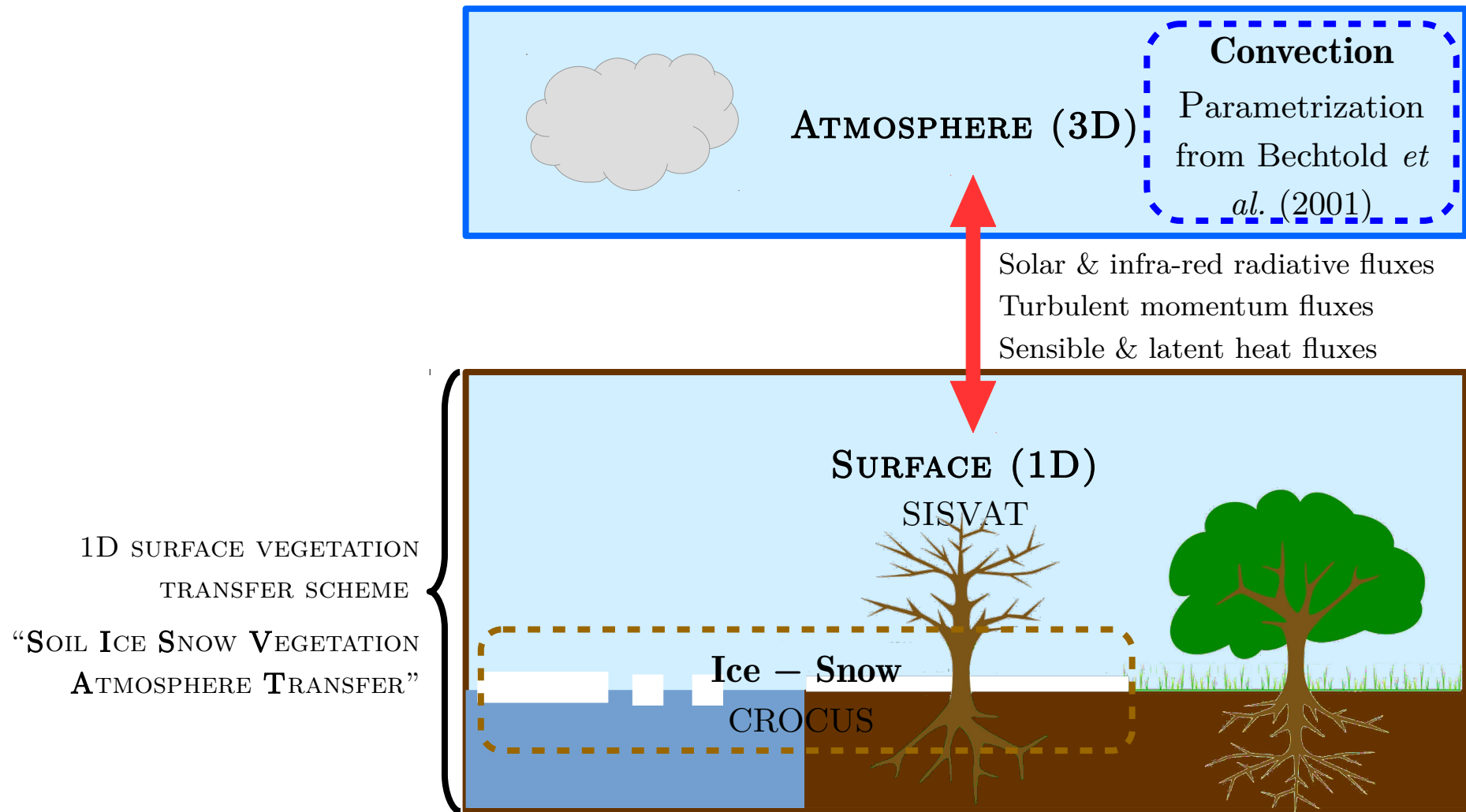
The Ourthe River

- One of the main tributaries of the Meuse River
- Catchment area of $\sim 3500 \text{ km}^2$
- ~ 30 floods over 1974-2010
 - 70% in winter
 - 50% caused by snowpack melting + rainfall

Floods occurrence and river discharge are predicted to increase in winter due to a wetter climate (Gellens, 1998 ; Driessen *et al.*, 2010)

Can we already observe changes in hydroclimatic conditions (including precipitation events and snow melting) over 1959-2010?

THE REGIONAL CLIMATE MODEL MAR “MODÈLE ATMOSPHÉRIQUE RÉGIONAL”



FORCINGS (INPUTS)

OUTPUTS

OUTPUTS EXPLOITATION

- ERA-Interim**
~80 km
60 vertical levels
- ERA-20C**
~125 km
91 vertical levels
- NCEP/NCAR v1**
~210 km
28 vertical levels

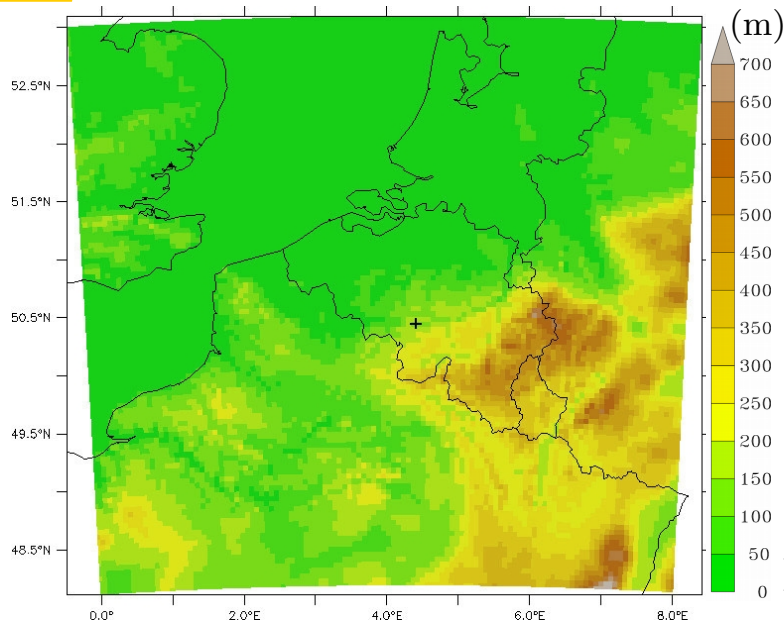
REGIONAL CLIMATE MODEL



- MAR-ERA**
T, PPN, Snow depth, Run-off, ...
- MAR-ERA20C**
T, PPN, Snow depth, Run-off, ...
- MAR-NCEP1**
T, PPN, Snow depth, Run-off, ...

1° The MAR model evaluation (2008-2014)

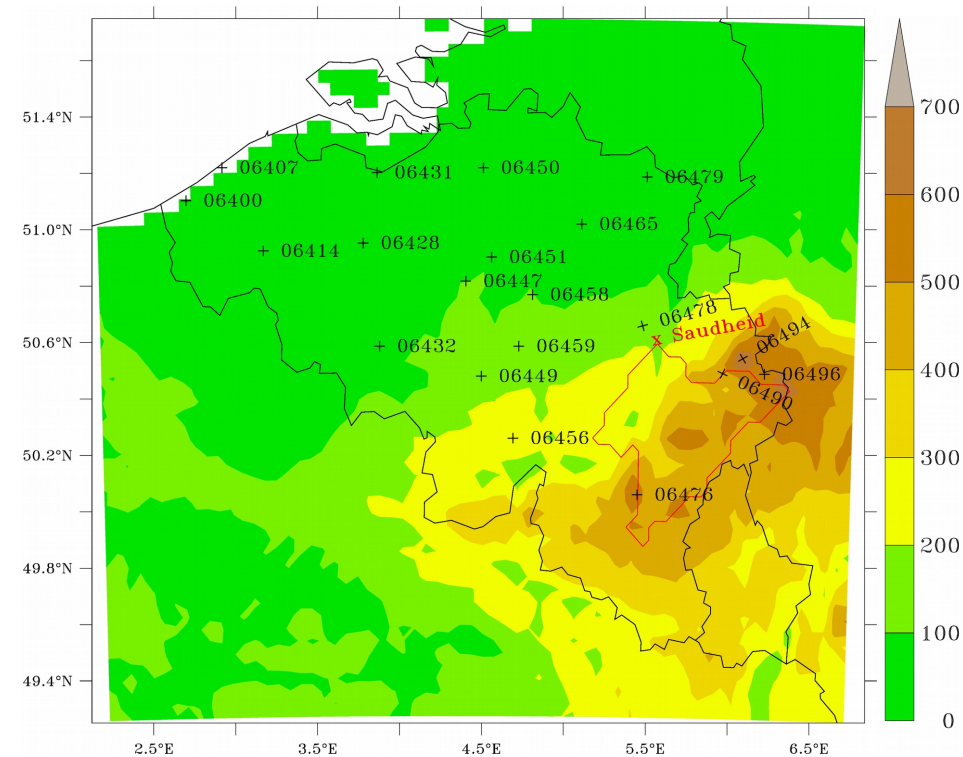
2° Trends study (1959-2010)



MAR domain and orography

1° The MAR
model evaluation
(2008-2014)

- Observations from 20 weather stations of the SYNOP network (OGIMET, 2015)
- Flow rate measurements from the gauging station of Saudheid (DGO2, 2015)

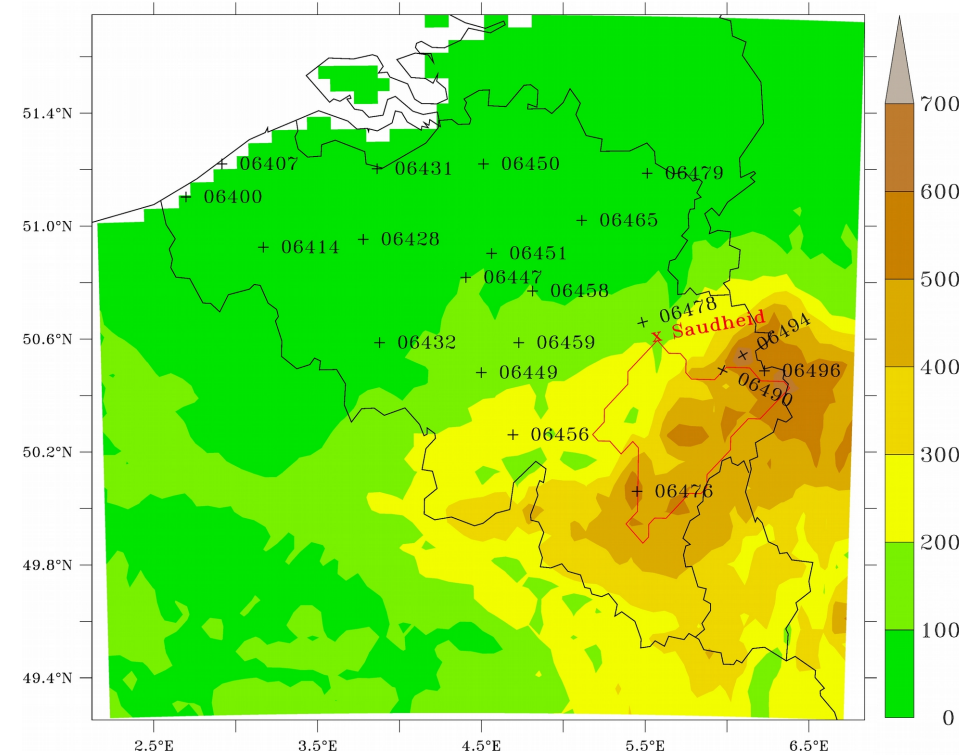


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• Daily mean temperature

	Winter	Summer
R	> 0.95	> 0.95
Bias	~ -0.4°C (-14%)	~ +1.9°C (+11%)
RMSE	~ 1.2°C (30%)	~ 2.1°C (70%)



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• Daily precipitation amount

Winter

Summer

R

0.55 → 0.70

0.40 → 0.50

Bias

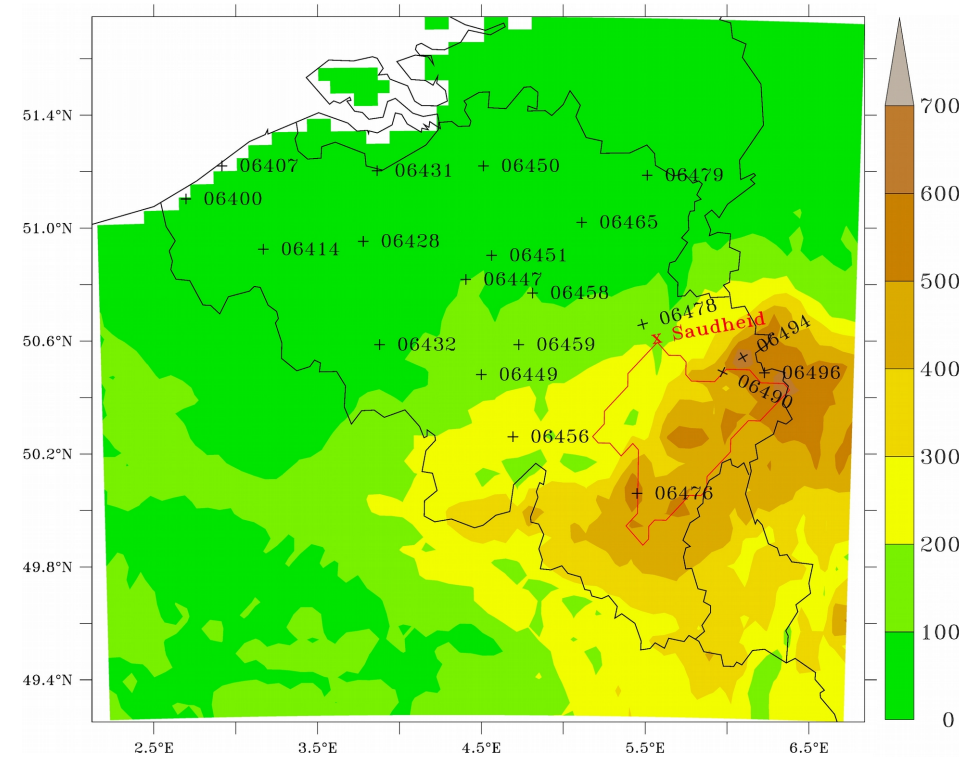
~ +5%

~ -10%

RMSE

~3 mm (80%)

~5 mm (90%)



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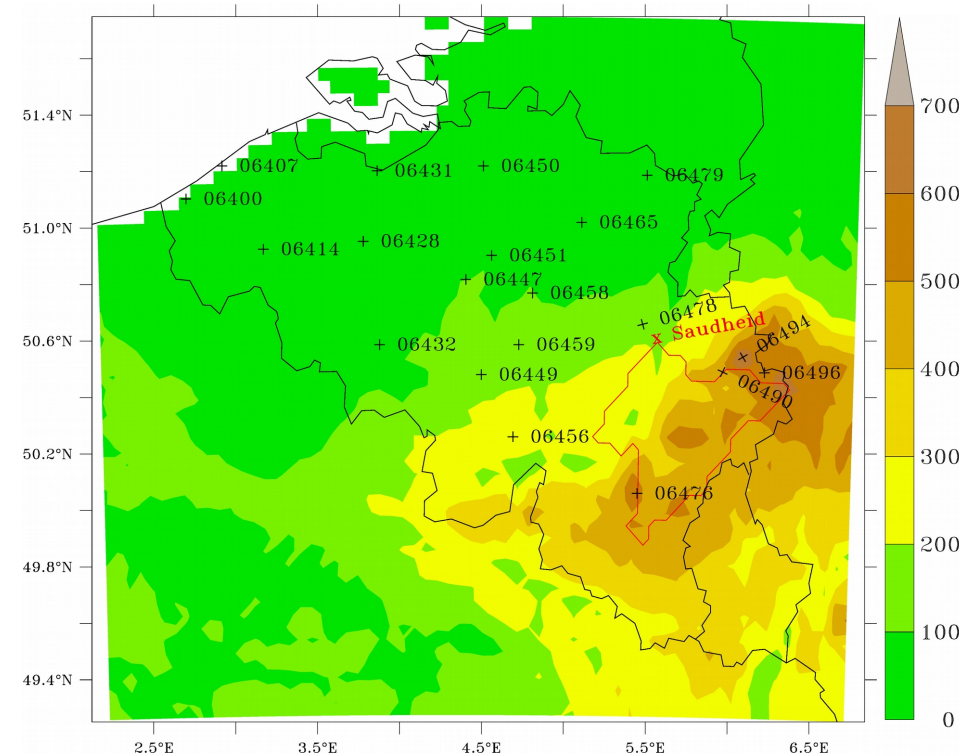
• **Daily snow depth (only at Mont Rigi (alt.=671m))**

Winter

R > 0.90

Bias < -6 cm (-40%)

RMSE ~ 9cm (60%)



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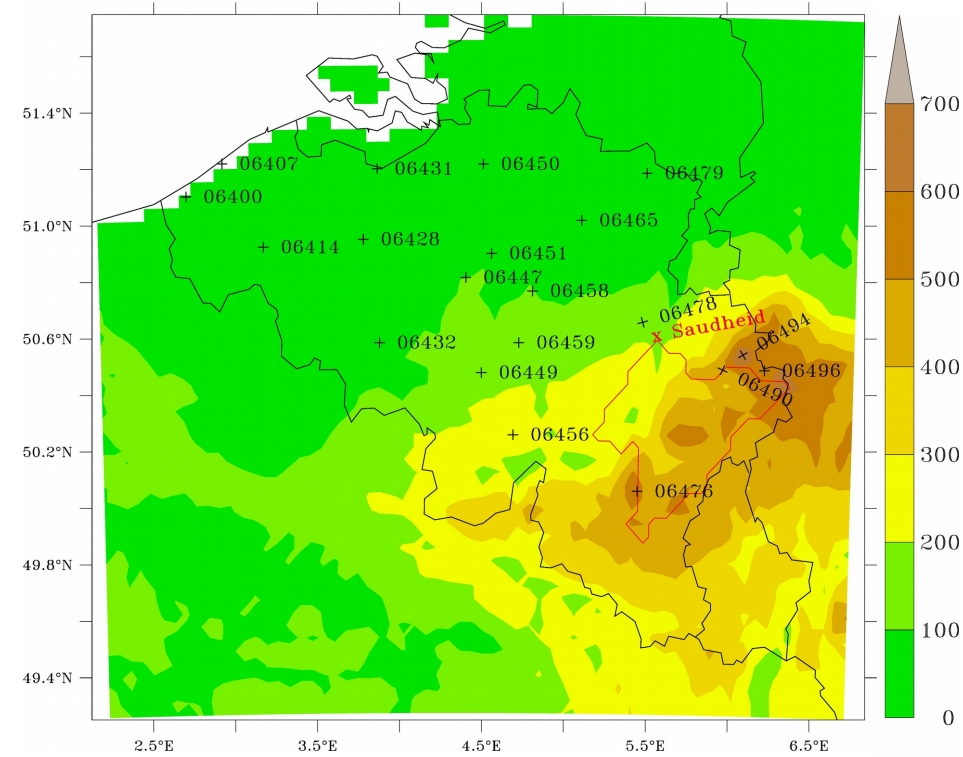
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	Winter
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Bias	< -6 cm (-40%)
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• **Flood events** (only at Saudheid)

	1974-2010	MAR-ERA	MAR-ERA20C	MAR-NCEP1
Identified flood days		60/67	59/67	41/67
Modeled flood days excess		434	702	327



1° The MAR
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- MAR allows to reconstruct the hydroclimatic conditions that could have generated floods especially in winter

• **Daily precipitation amount**

	Winter	Summer
R	0.55 → 0.70	0.40 → 0.50
Bias	~ +5%	~ -10%
RMSE	~3 mm (80%)	~5 mm (90%)

- Improvements in MAR: surface properties and convective scheme
- Use of a hydrological model

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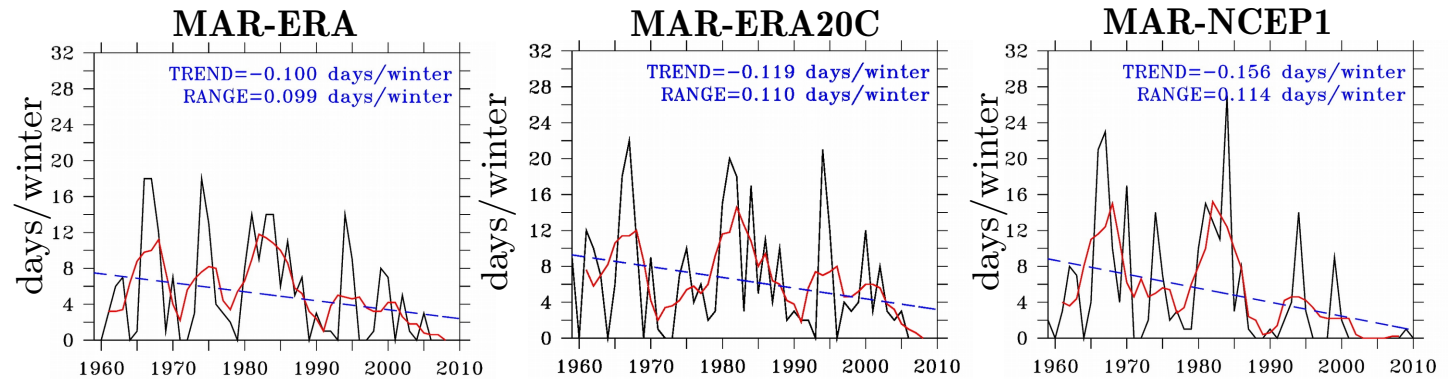
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2° Trends study
(1959-2010)

Days favourable to
floods due to snow
melting associated with
rainfall

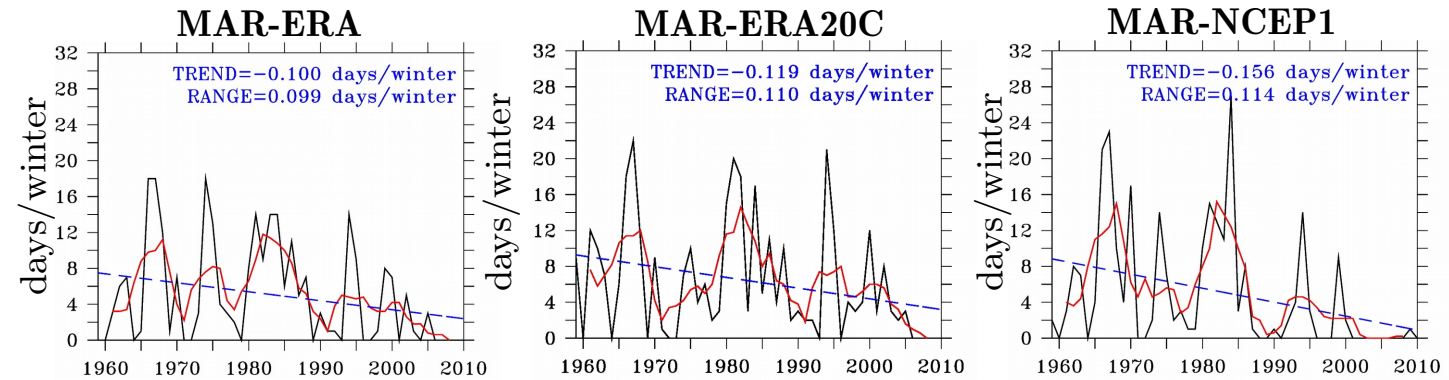
- Linear trend computation
- Trend significance assessment by computing the uncertainty range for the 95% confidence interval of Snedecor (Snedecor & Cochran, 1971)



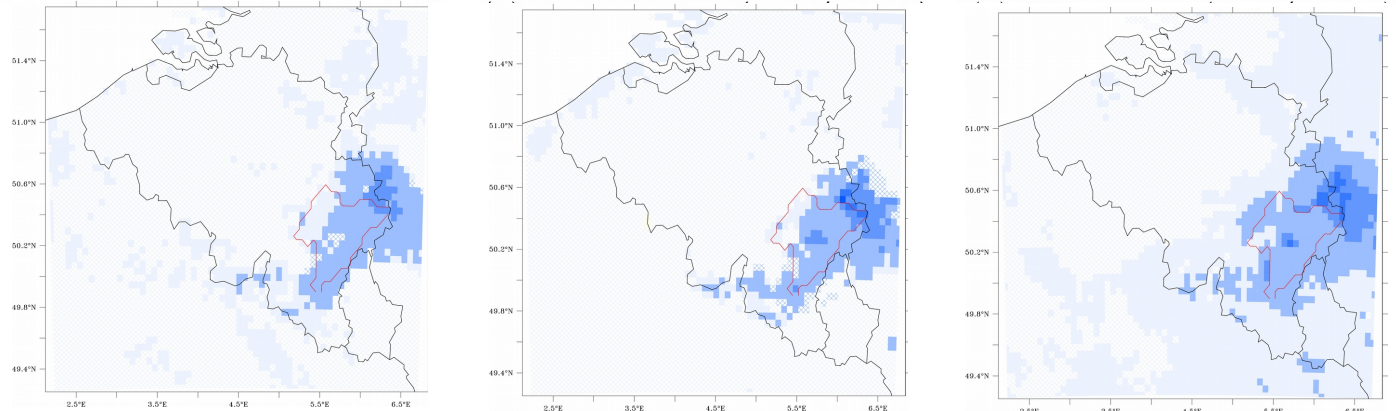
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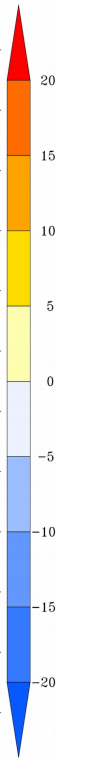
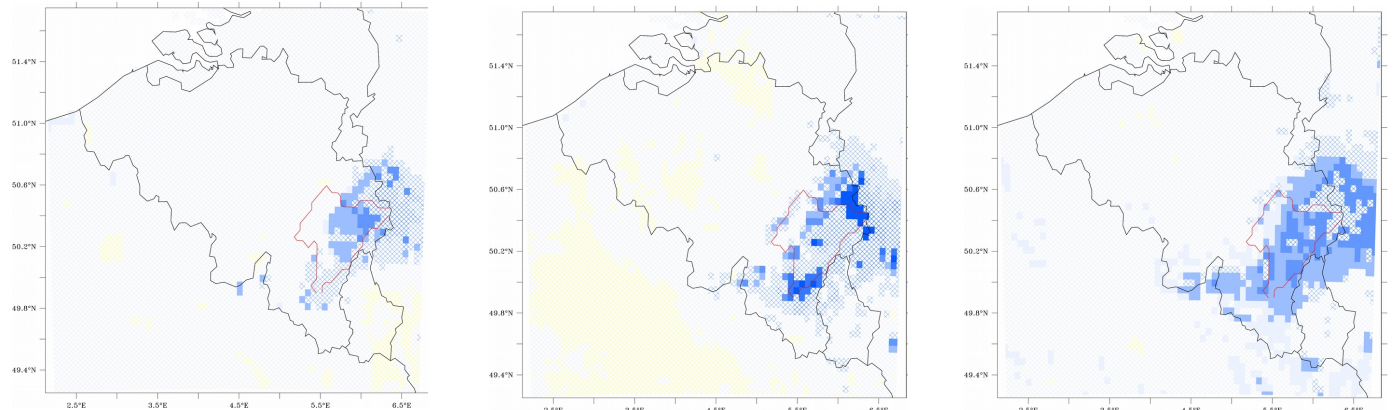
Days favourable to
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Maximum snow depth
trend
(cm/52 winters)



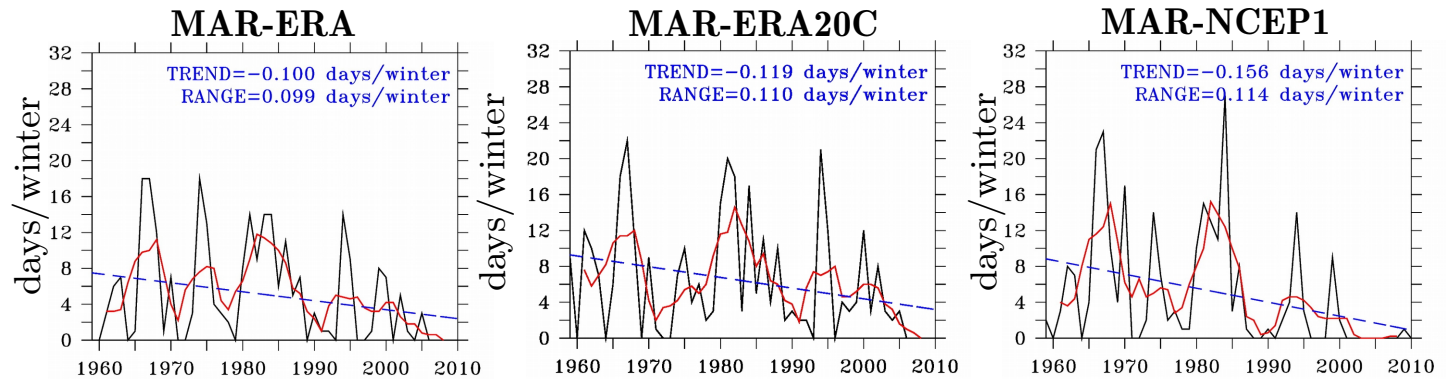
Number of days with a
snow cover of at least 5
cm of thickness trend
(days/52 winters)



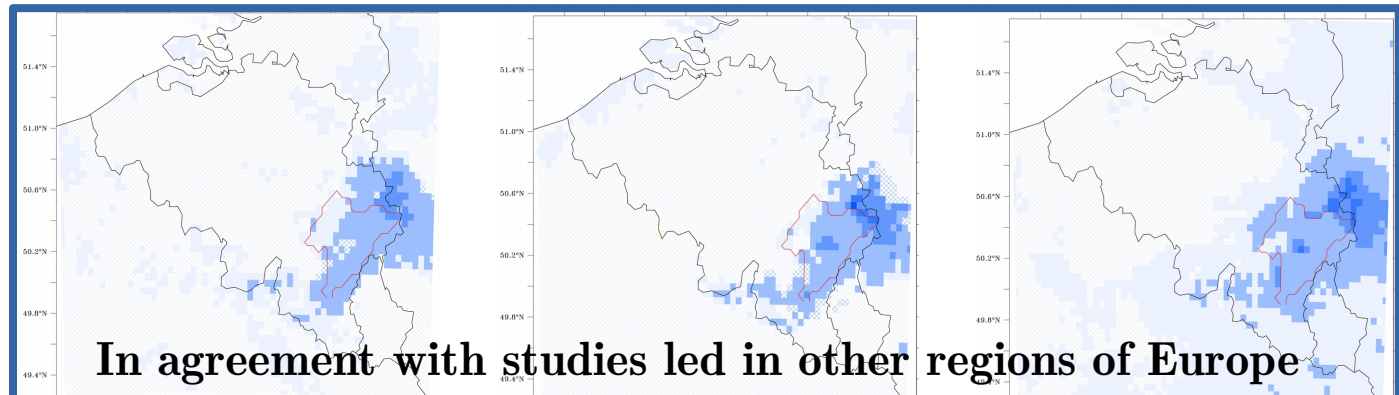
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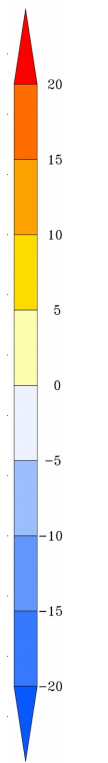
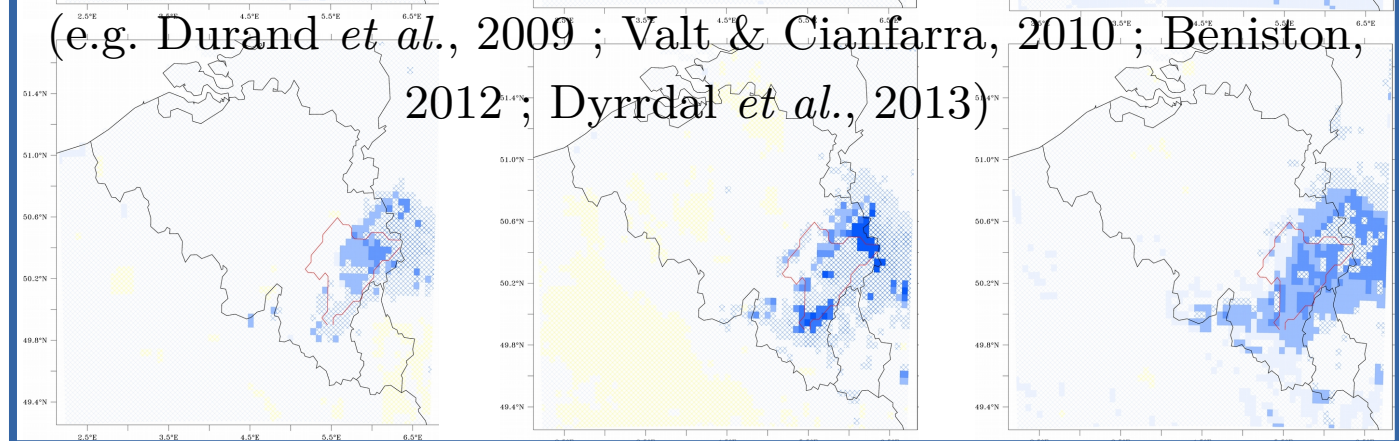


Maximum snow depth
trend
(cm/52 winters)



In agreement with studies led in other regions of Europe
(e.g. Durand *et al.*, 2009 ; Valt & Cianfarra, 2010 ; Beniston, 2012 ; Dyrddal *et al.*, 2013)

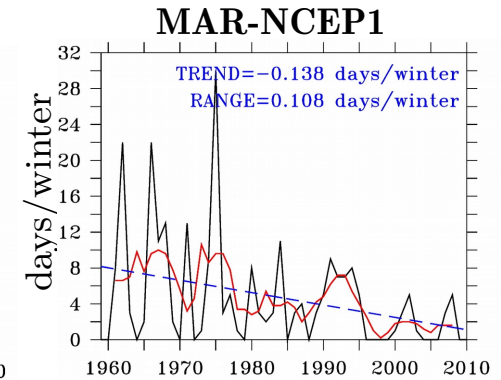
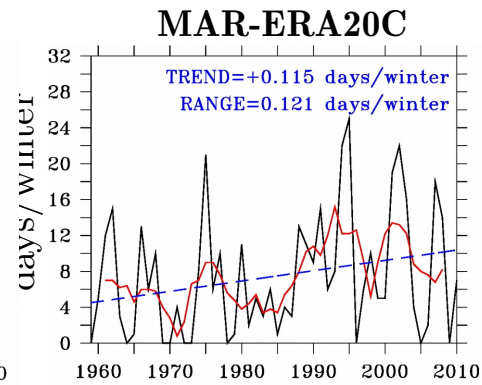
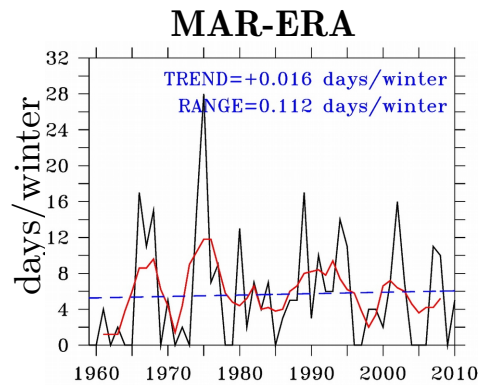
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2° Trends study
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Days favourable to
floods due to rainfall
alone

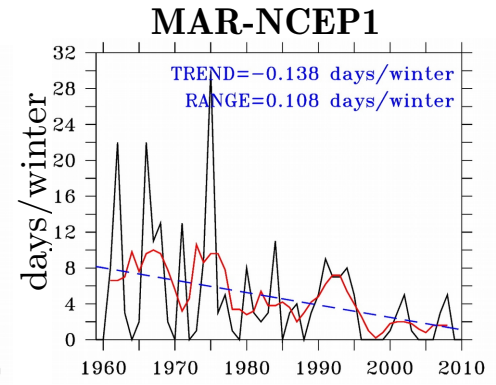
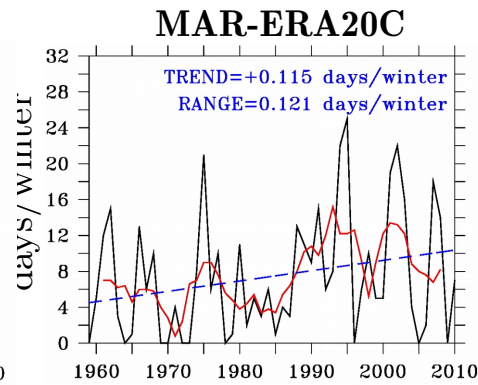
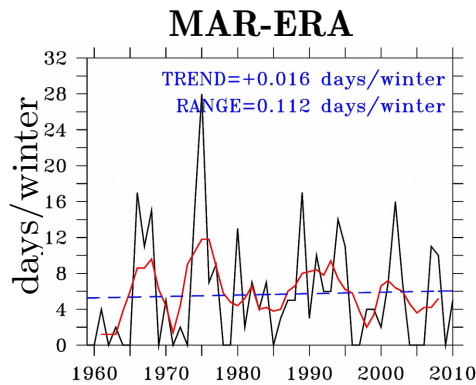
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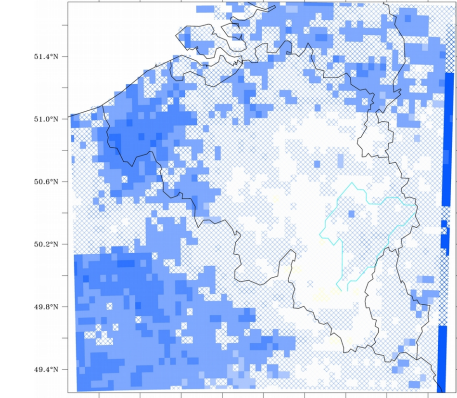
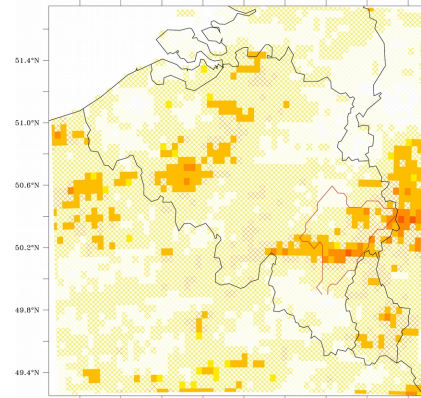
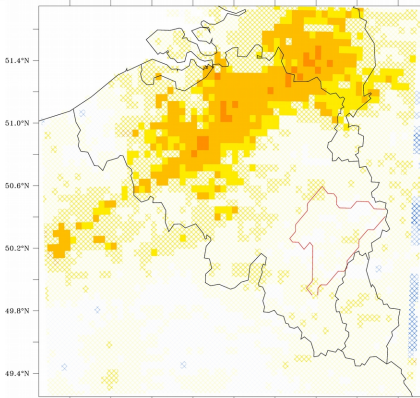
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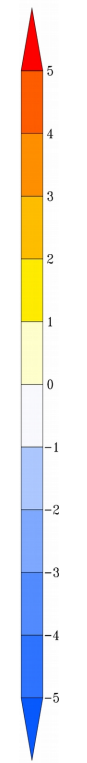
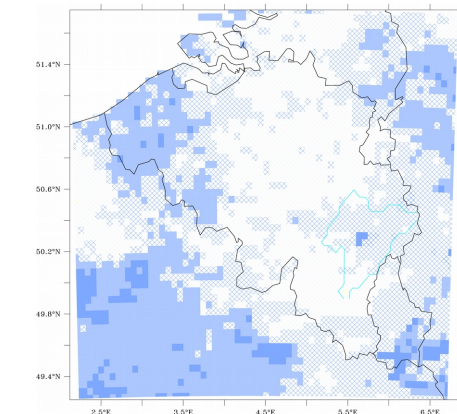
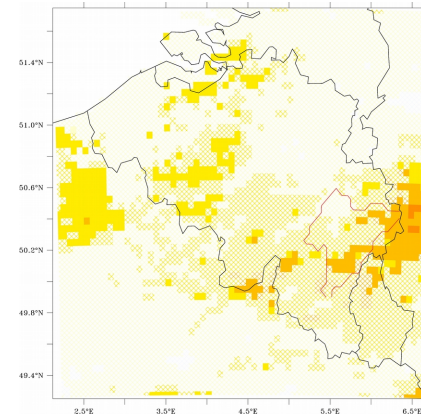
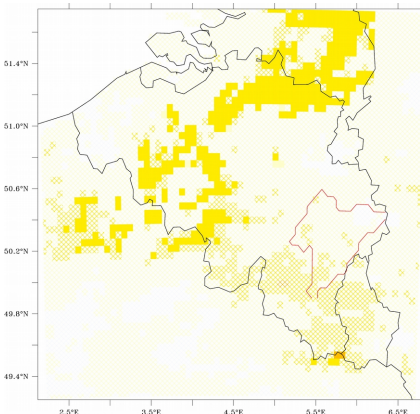
Days favourable to floods due to rainfall alone



Extreme precipitation events frequency trend (events/52 winters)



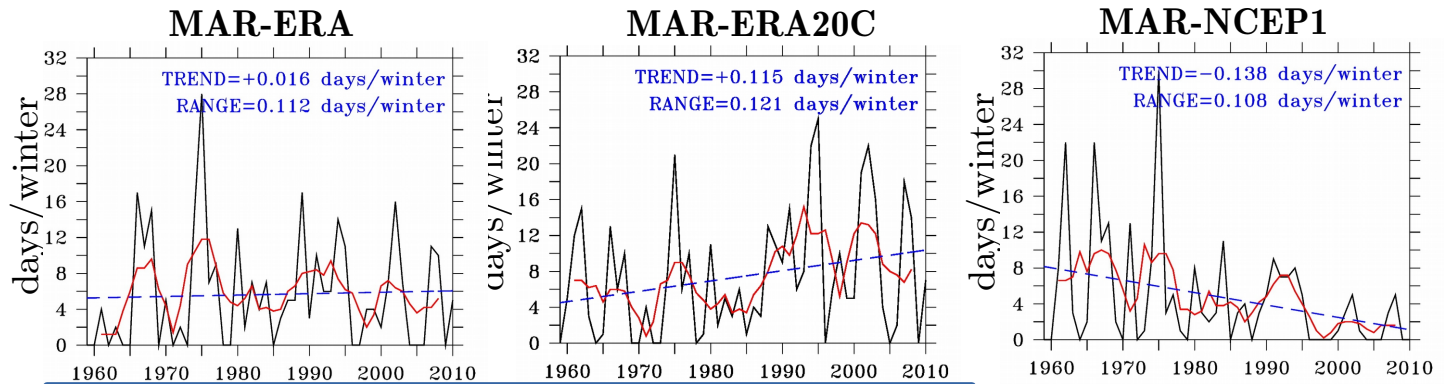
Extreme precipitation events intensity trend (mmWE/52 winters)



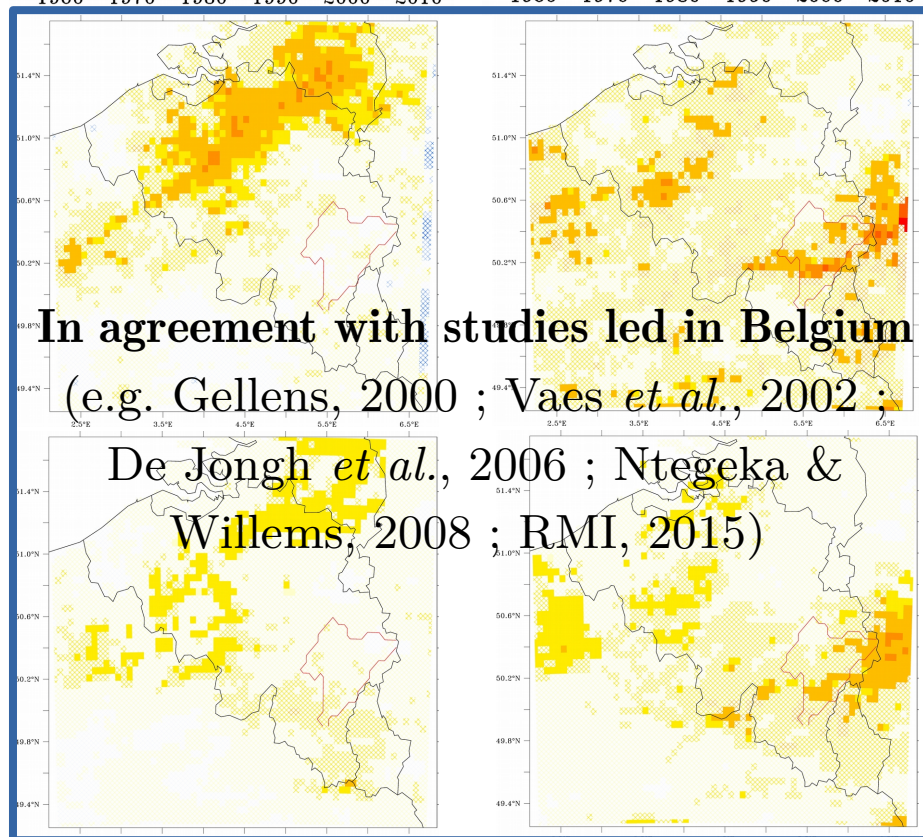
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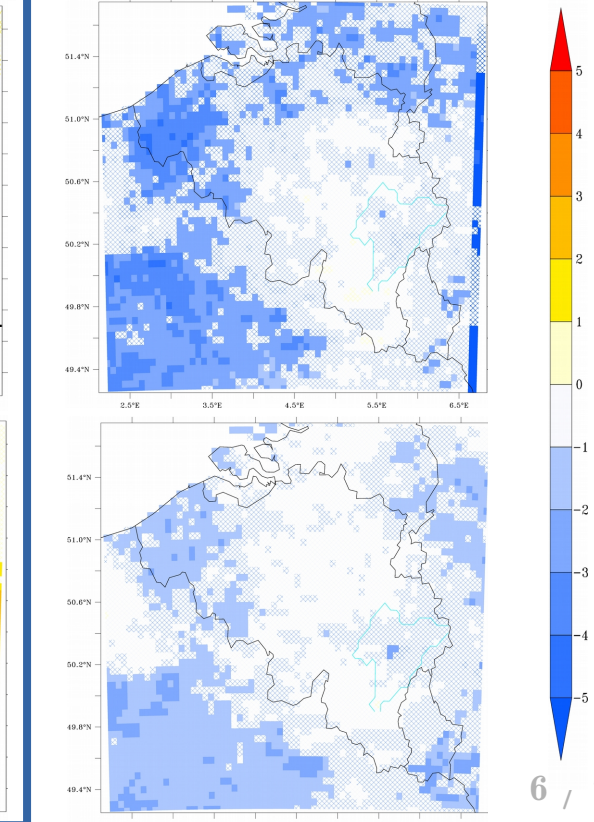


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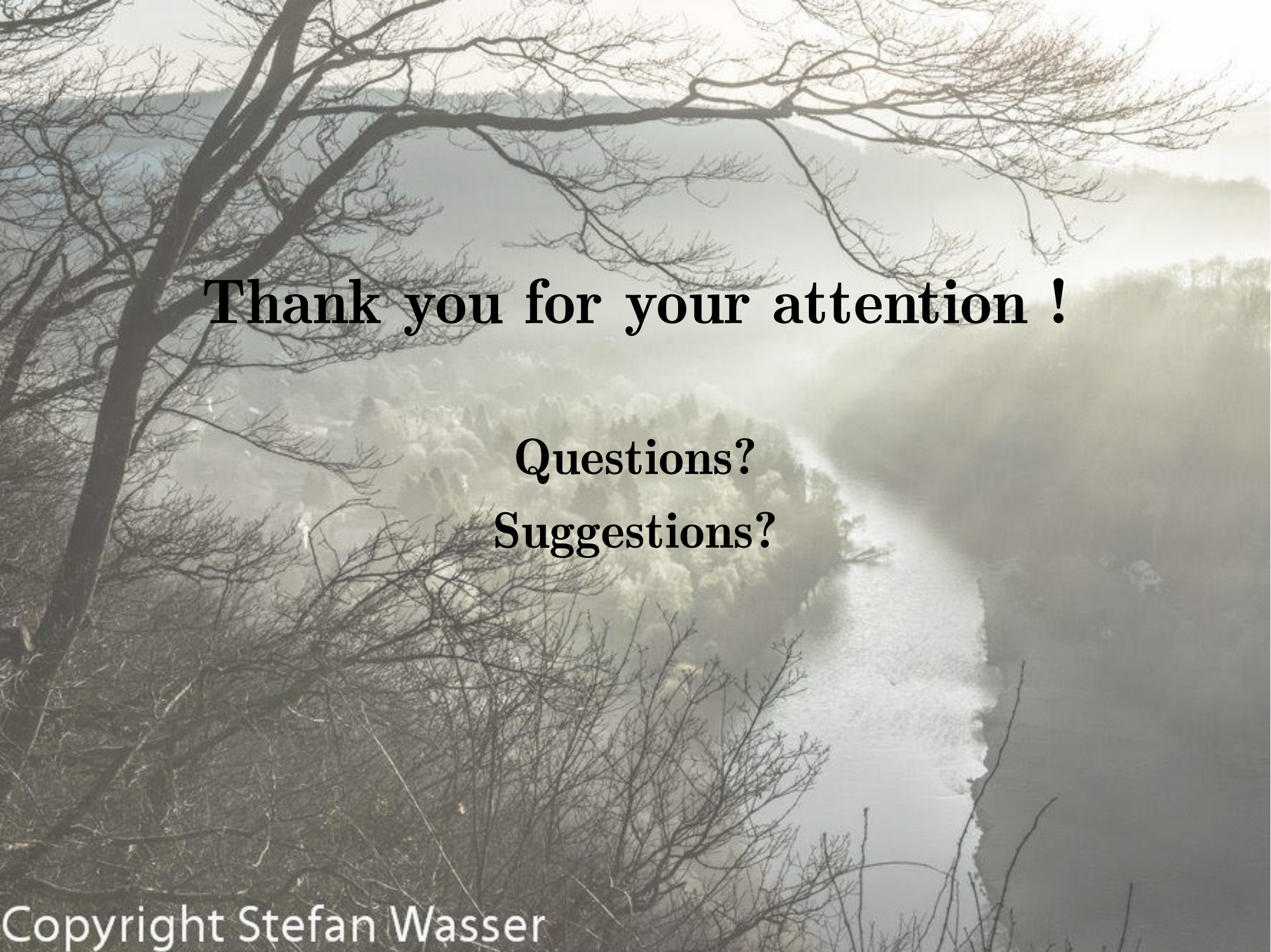


In agreement with studies led in Belgium (e.g. Gellens, 2000 ; Vaes *et al.*, 2002 ; De Jongh *et al.*, 2006 ; Ntegeka & Willems, 2008 ; RMI, 2015)

Extreme precipitation events intensity trend (mmWE/52 winters)



- **MAR is able to simulate the variability of the Belgian climate and the hydroclimatic conditions favouring floods**
 - Improvements in the MAR model: convective scheme and surface properties (**in progress ...**)
 - Use of a hydrological model: taking into account groundwater, initial state of rivers prior to extreme run-off events, ...)
- **Significant decrease in days favourable to floods due to snow melting associated with rainfall**
- **Trend in days favourable to floods due to rainfall alone depends on the MAR forcings (reanalysis)**
 - Use of an intermediate resolution between the reanalysis and the 5km-resolution of MAR

A scenic view of a river valley. In the foreground, a large, leafless tree with a thick trunk and many thin branches frames the left and top of the image. The river flows through the center of the valley, surrounded by dense green trees. On the right bank, a small house is visible. The sky is bright and hazy, suggesting a misty or overcast day.

Thank you for your attention !

**Questions?
Suggestions?**

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