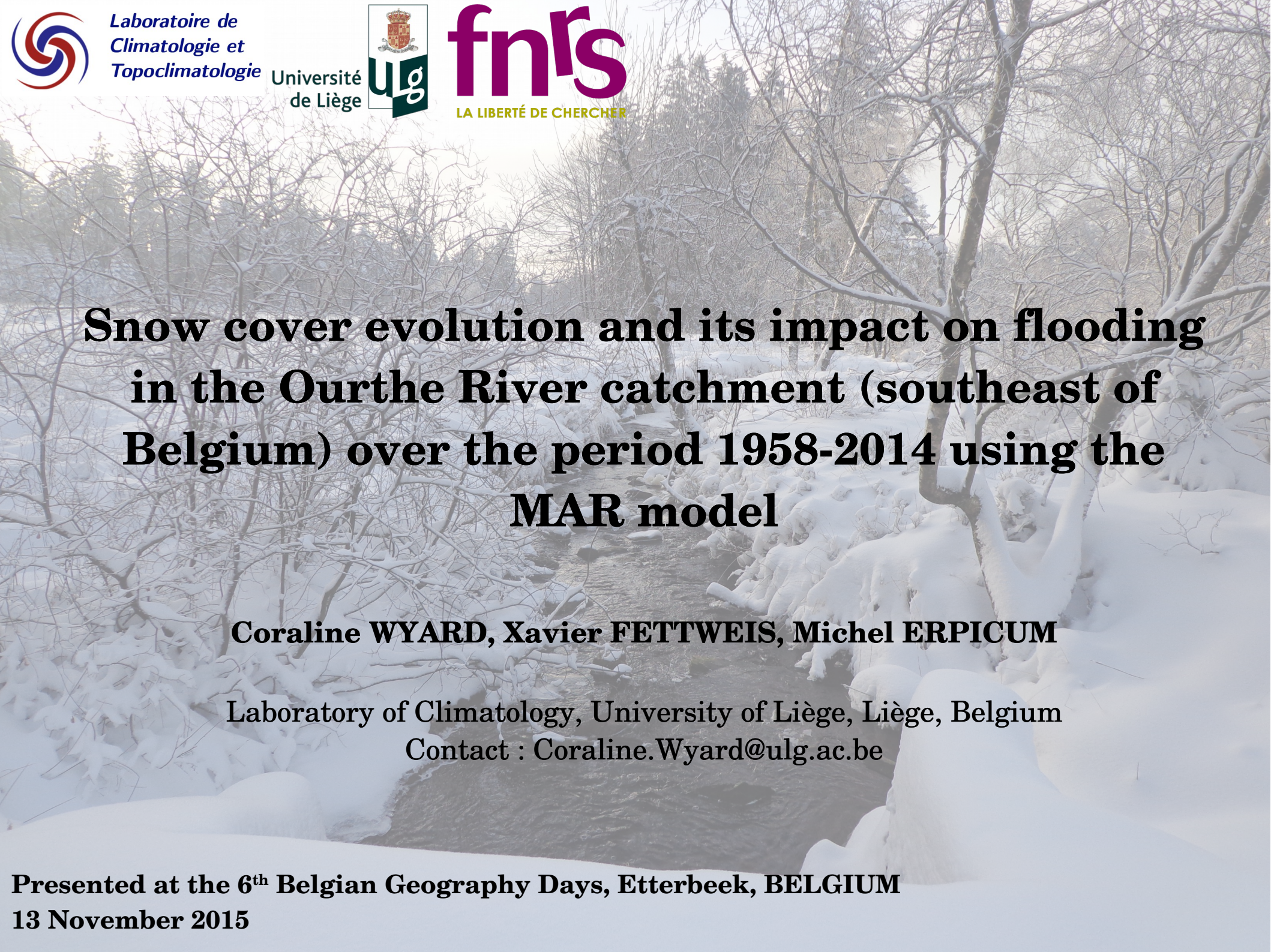

Laboratoire de Climatologie et Topoclimatologie

Université de Liège

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Snow cover evolution and its impact on flooding in the Ourthe River catchment (southeast of Belgium) over the period 1958-2014 using the MAR model

Coraline WYARD, Xavier FETTWEIS, Michel ERPICUM

Laboratory of Climatology, University of Liège, Liège, Belgium
Contact : Coraline.Wyard@ulg.ac.be

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Why study snow in Belgium ?

Ardennes : snow up to 80cm,
1 to 2 months/yr.
→ 70cm Mont Rigi, 21/12/2010

Tourism activities

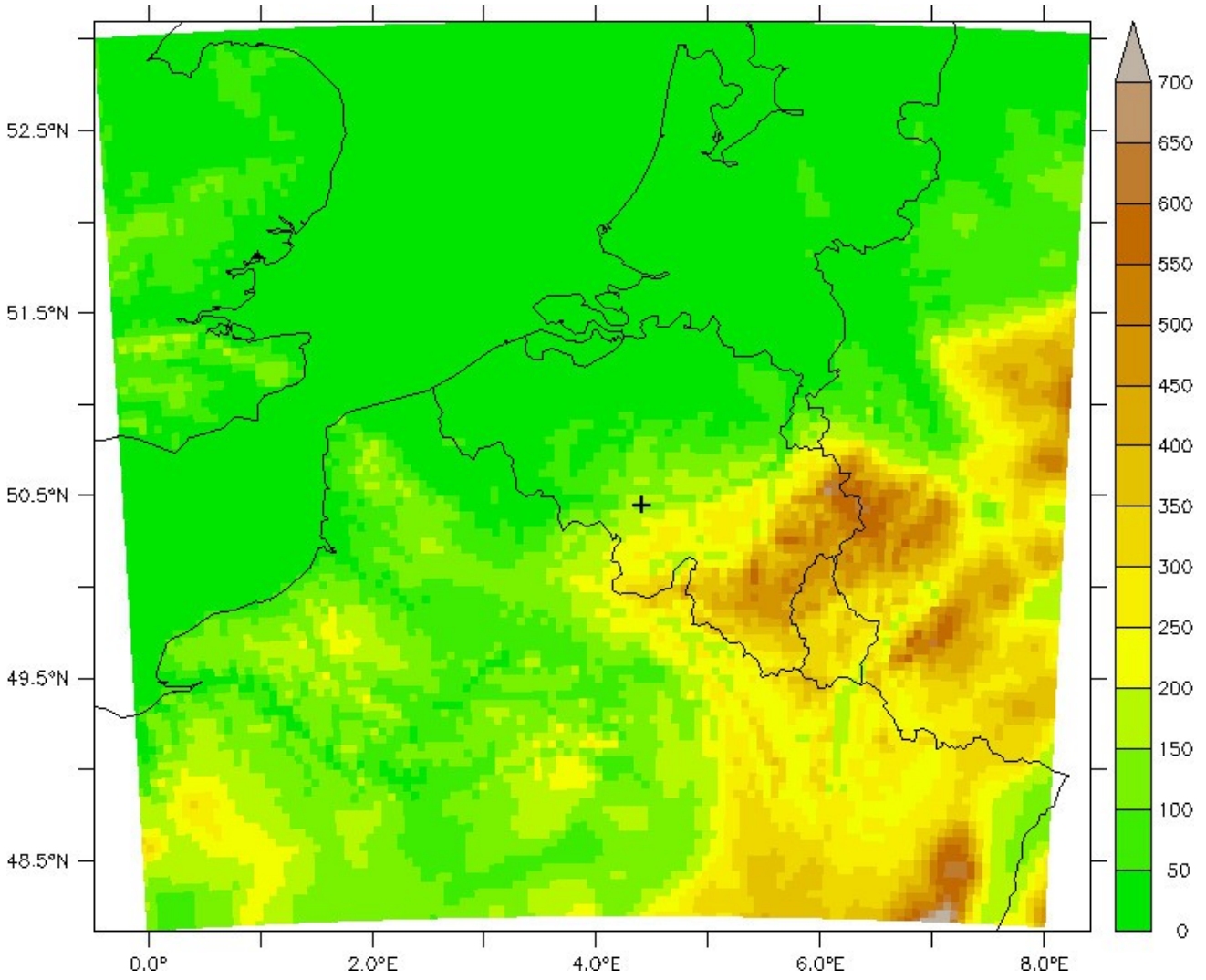
Unique ecosystem

Flooding when snow melting is associated with rainfall
→ Ourthe river in Méry, 01/2011

Reconstruction of snow cover evolution from 1958 to 2014 using the RCM MAR
→ Trends in snow cover + trends in hydroclimatic conditions favourable to flooding in the Ourthe catchment

MAR « Modèle Atmosphérique Régional » simulations set-up :

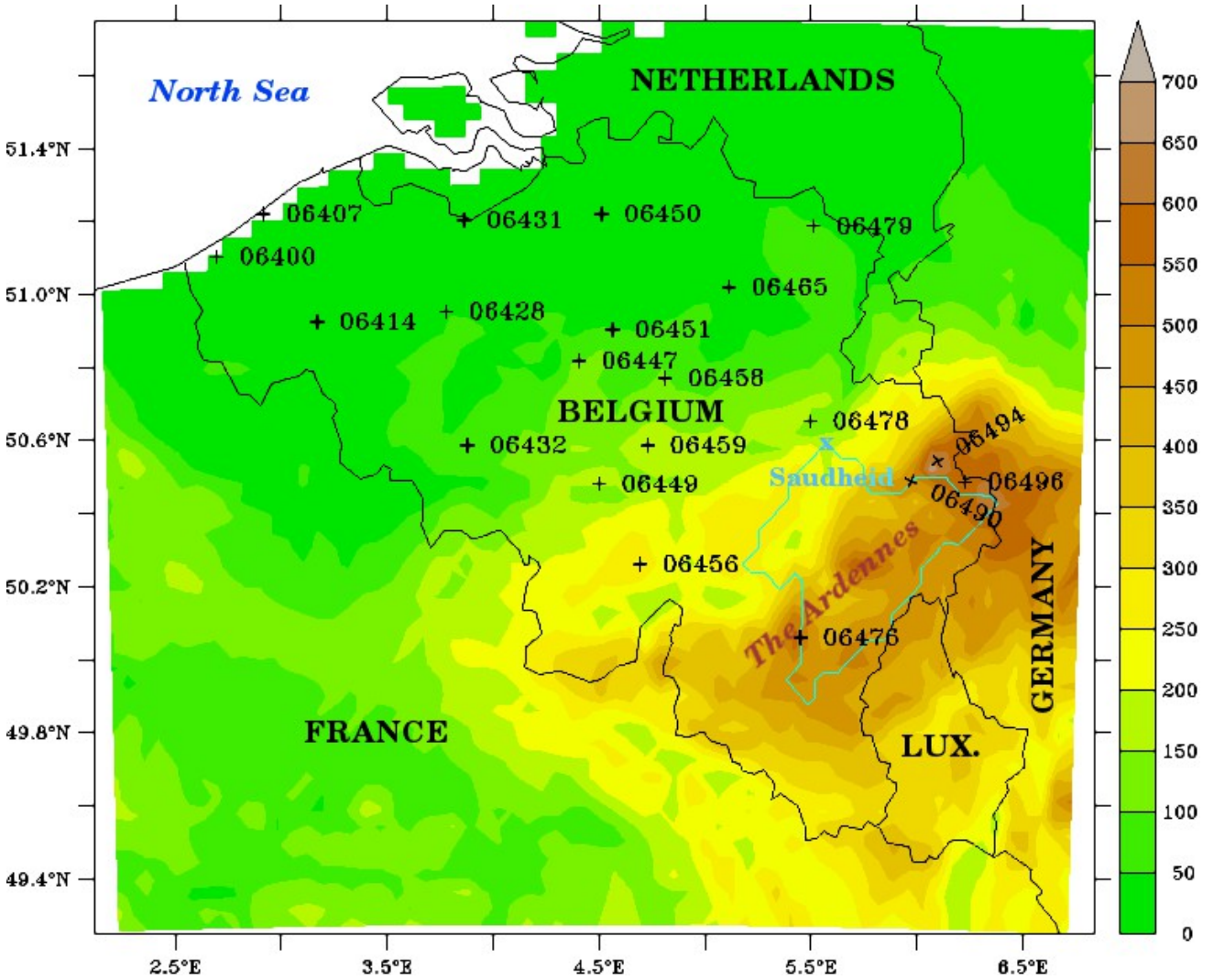
- Resolution : 5km
- Domaine : 110x120 pixels
- Period : 1958-2014
- Forcing :
  - ERA40 (1958-1978) + ERA-Interim (1979-2014)
  - NCEP-NCAR v1 (1958-2014)



1° Comparison between weather station based observations (extracted from SYNOP codes) and the MAR outputs over the period 2008-2014

Daily mean temperature
Daily precipitation amount
→ Comparison with data from 20 weather stations

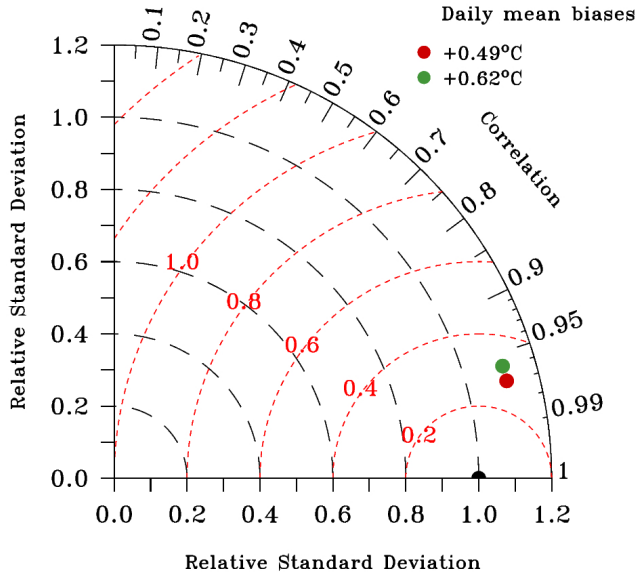
Daily snow height
→ Comparison with data from the Mont Rigi weather station (synop id. : 06494)



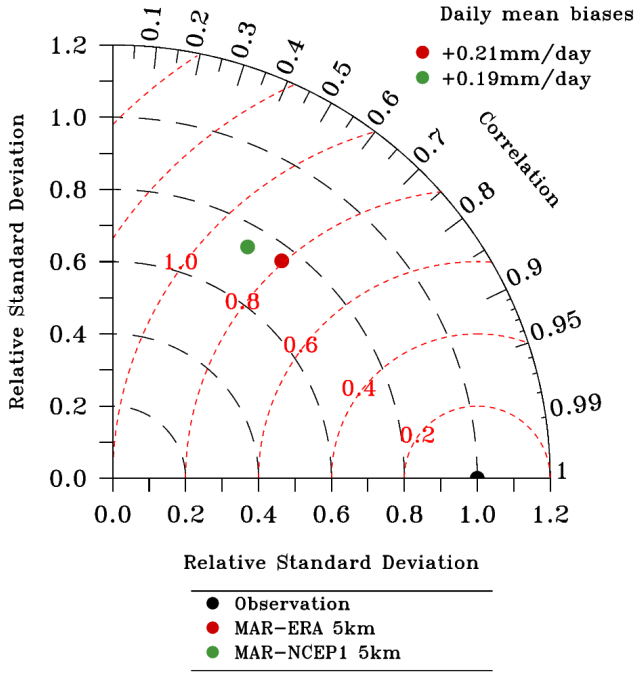
20 stations averaged statistics

Mont-Rigi station statistics

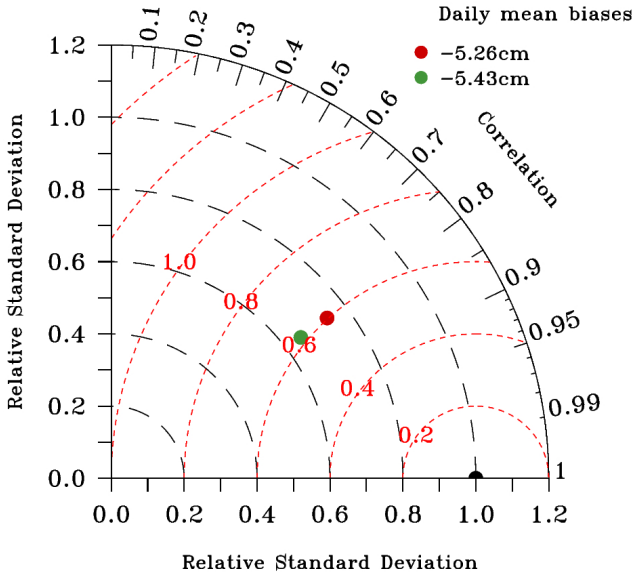
(a) ANNUAL DAILY MEAN TEMPERATURE



(b) ANNUAL DAILY PRECIPITATION AMOUNT



(c) WINTER DAILY SNOW HEIGHT



MAR successfully represents the climate variability over the Belgian territory

2° Correspondance between observed floods and days favourable to floods over the period 1974-2014

a) Definition of hydroclimatic conditions favourable to flooding

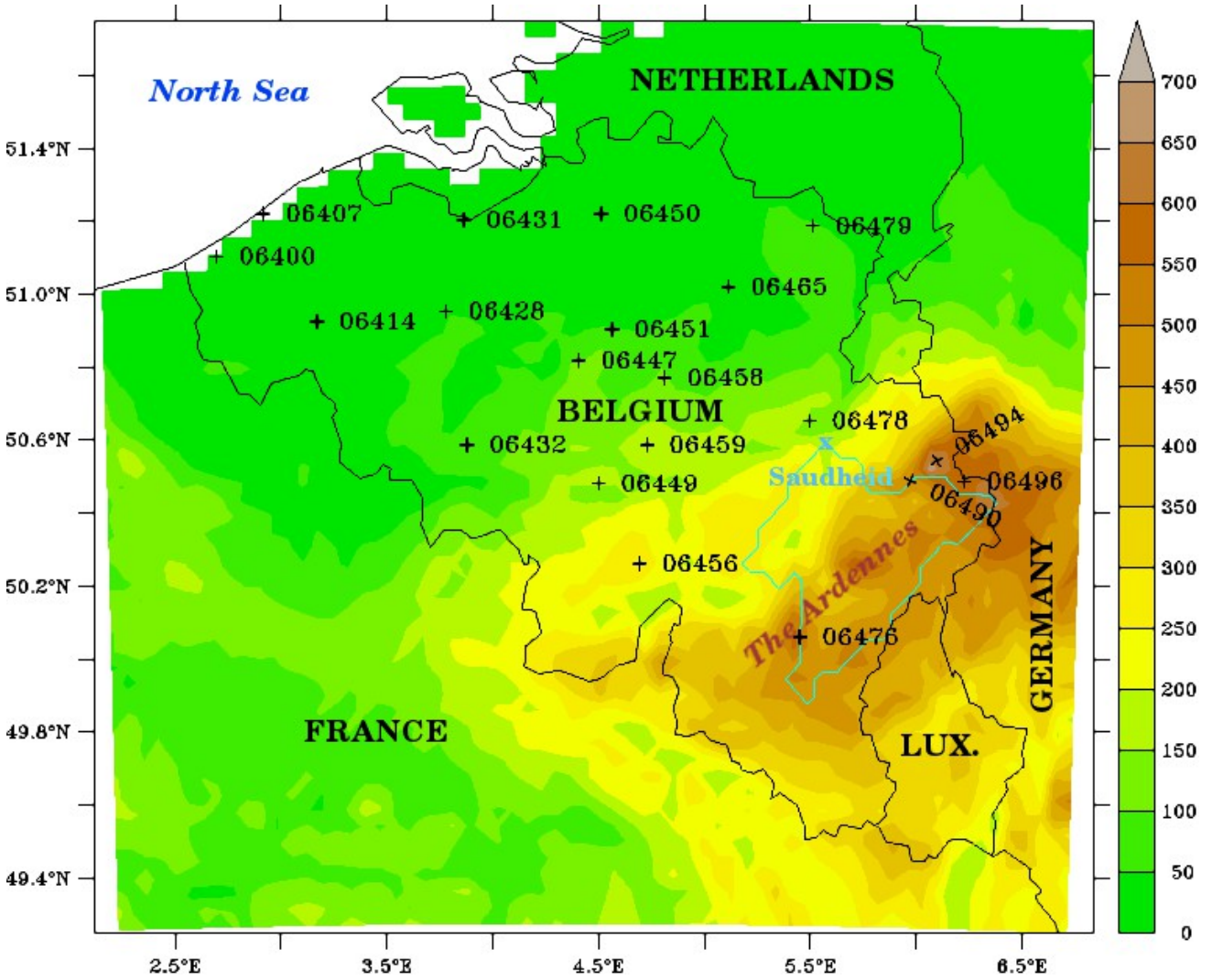
Run-off (RU)=
PPN + Snow melting

Effective run-off (RU_e) =
RU – Evaporation

RU_e is then averaged over 2 days
→ Response time of the Ourthe river flow rate to PPN = 1-2 days

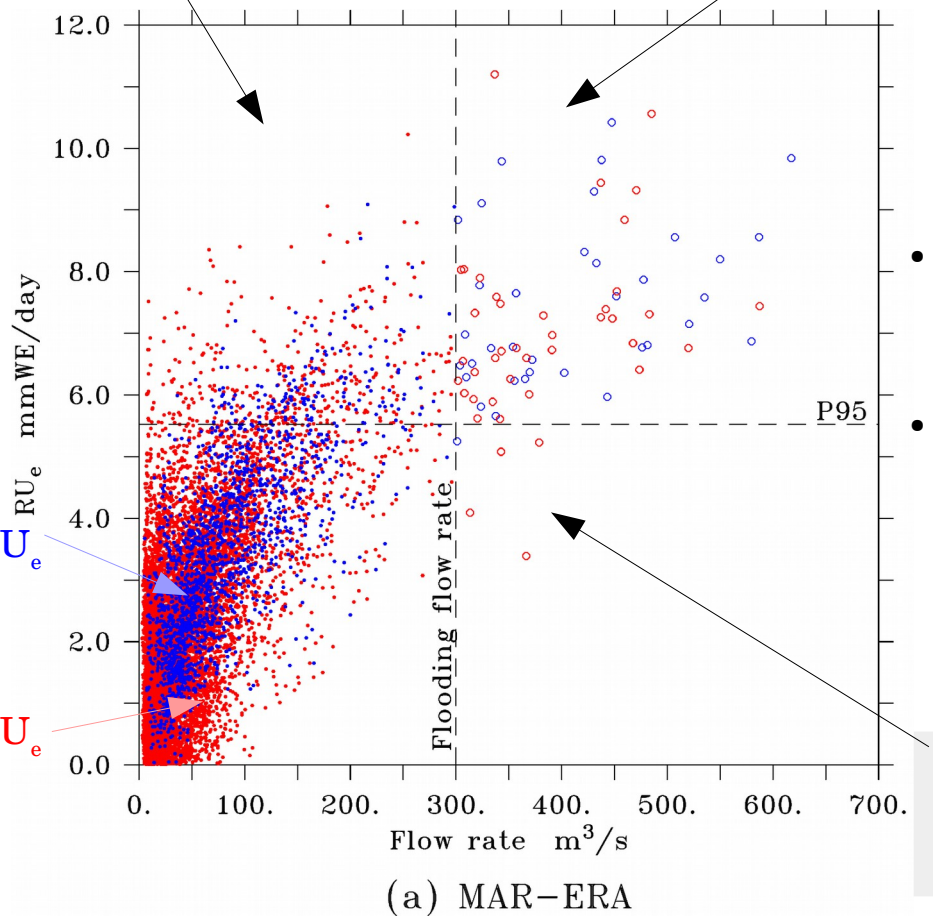
Extreme RU_e events =
RU_e integrated and averaged over the Ourthe river catchment upstream of Sauheid (~2900 km²) ≥ P95(1961-1990)

b) Comparison with flow rate measured in Saudheid (floods if flow rate ≥ 300 m³/s



Extreme run-off events which don't correspond to floods

Extreme run-off events which correspond to floods



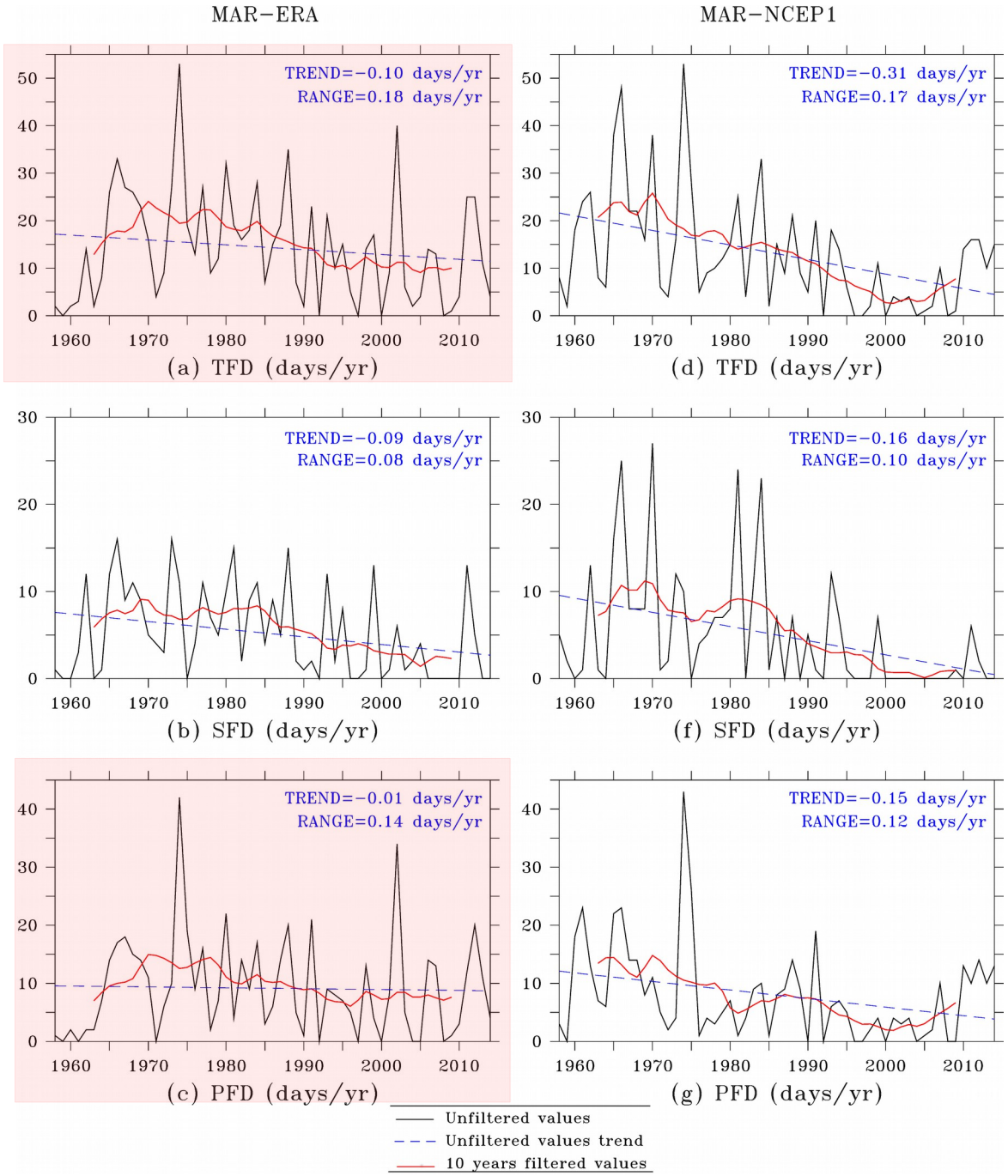
Snow melting contributes to RU_e

Only PPN contributes to RU_e

- **95 % (72/76)** of the observed flooding days correspond to days favourable to flooding
- **88 % (518/590)** of the days favourable to floods don't lead to flooding

Floods which doesn't correspond to extreme run-off events

MAR allows to detect hydroclimatic conditions favourable to flooding
An hydrological model is needed to take into account infiltration, soils permeability evolution, flow rate of rivers, saturation of catchments, ... prior to extreme run-off events



Total days favourable to flooding (TFD)

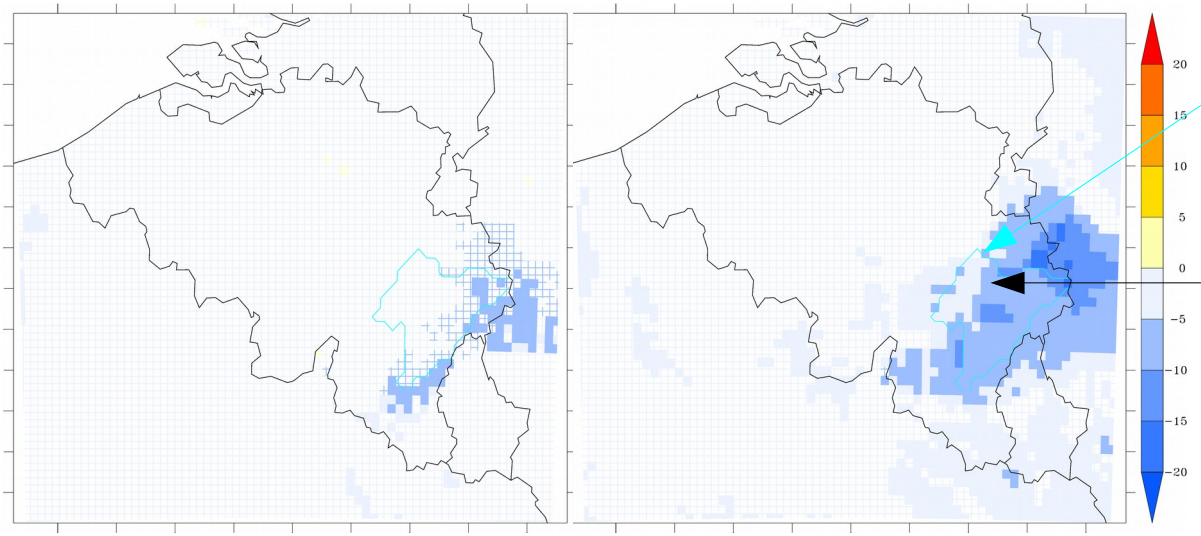
Days favourable to flooding due to snow melting associated to rainfall (SFD)

Days favourable to flooding due to rainfall alone (PFD)

MAR-NCEP1 → Significant decrease in days favourable to flooding

NB : Trends significance is assessed using the uncertainty range for 95 % confidence interval of Snedecor.

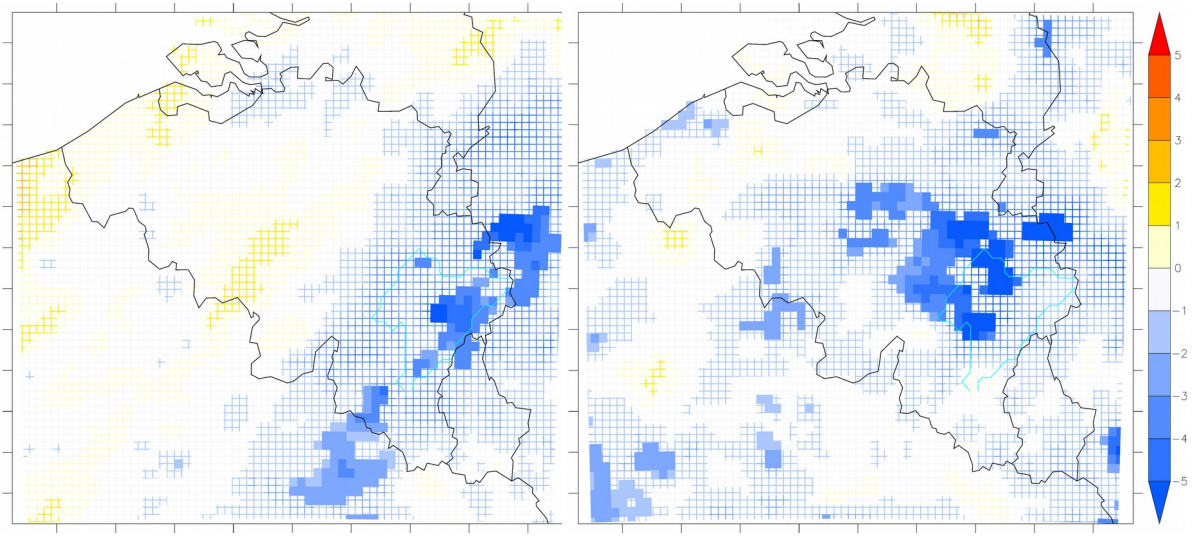
MAR-ERA MAR-NCEP1



The Ourthe river catchment limits upstream of Saudheid

Filled pixels = Significant trends

SHMAX in winter (DJF) (cm)



Extreme PPN in winter (events/yr)

Criterion // extreme RUe

The decrease in days favourable to flooding is due to

- significant decrease in **snow accumulation**
- significant decrease in **extreme rainfall events frequency**

over the Ourthe catchment

✔ **MAR model validation** over the Belgian territory

✔ **Detection of hydroclimatic conditions favourable to flooding** on the basis of the MAR outputs

MAR NCEP1 : **significant decrease in hydroclimatic conditions favourable to flooding** in the Ourthe river catchment over the period 1958-2014 as a result of decrease in snow accumulation and extreme PPN events

→ Prospects :

- New simulations over a larger domain to explain the decreasing trends
- Using an **hydrological model**
- **Future projections** over the 21st century

THANK YOU
FOR YOUR ATTENTION

Questions ?
Suggestions ?

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