EVOLUTION OF WIND BEHAVIOUR AND OF ITS POTENTIAL FOR WIND POWER PRODUCTION IN BELGIUM DURING THE LAST 22 YEARS :
A comparison between WRF-NCEP2 and WRF-ERA-Interim

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Contexts

Disadvantage
of wind energy

Models used

Evaluations,
Comparison &
Results

Conclusions

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Contexts :

Climate

Greenhouse gas emissions from fossil fuels :

Temperature of the Earth

Energy

Our society is extremely dependent on the fossil fuels
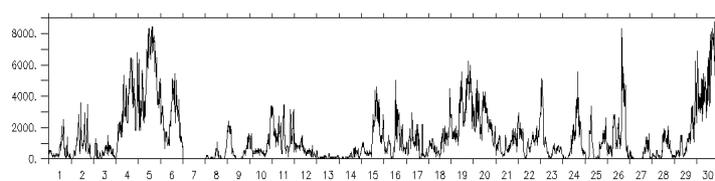
Oil reserves

Prices of energy

One of many solutions : *Use of Wind Energy*

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The wind energy is

dependent on the weather conditions

This implies that :

Day-to-day the electrical production is very different

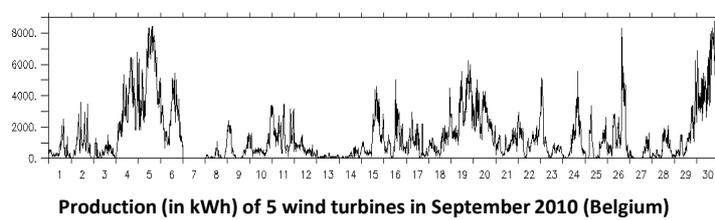**Production (in kWh) of 5 wind turbines in September 2010 (Belgium)**

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The wind energy is

dependent on the weather conditions

This implies that :

Day-to-day the electrical production is very different

But, do the wind conditions have changed in the past ?

Production (in kWh) of 5 wind turbines in September 2010 (Belgium)

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Contexts —— Climatic and energetic challenges

Disadvantage of wind energy

Wind energy dependent on weather conditions :

Do the wind conditions have changed in the past ?

Models used

Evaluations, Comparison & Results

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We compare 2 versions of WRF model :

Mesoscale model
Developed by some American institutes
OpenSource code

Configuration :
1 minute time step
10 km horizontal resolution
28 vertical levels (11 below 1km)

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We compare 2 versions of WRF model :

WRF forced by NCEP2 reanalysis model
WRF forced by ERA-Interim reanalysis model

From 1989 to 2010

We use only the level at 100m

Over Belgium territory and neighbouring regions

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Contexts —— Climatic and energetic challenges

Disadvantage of wind energy
Wind energy dependent of weather conditions :
are the wind conditions have changed in the past ?

Models used ——
WRF forced with NCEP2 Reanalysis   Over Belgium
WRF forced with ERA-Interim Reanalysis   1989 - 2010

Evaluations, Comparison & Results

Conclusions

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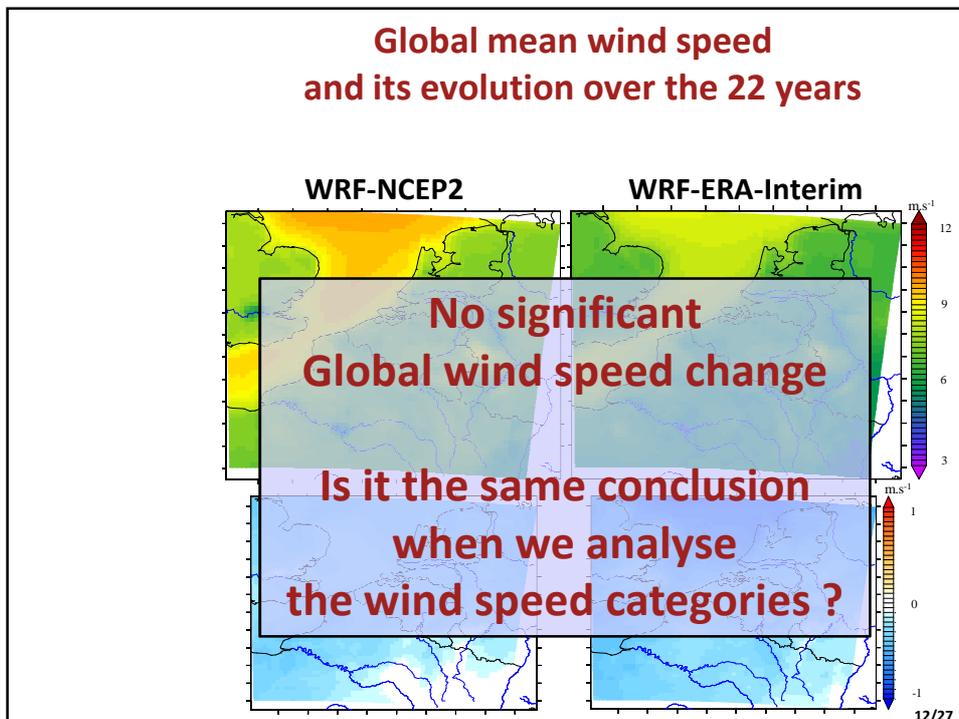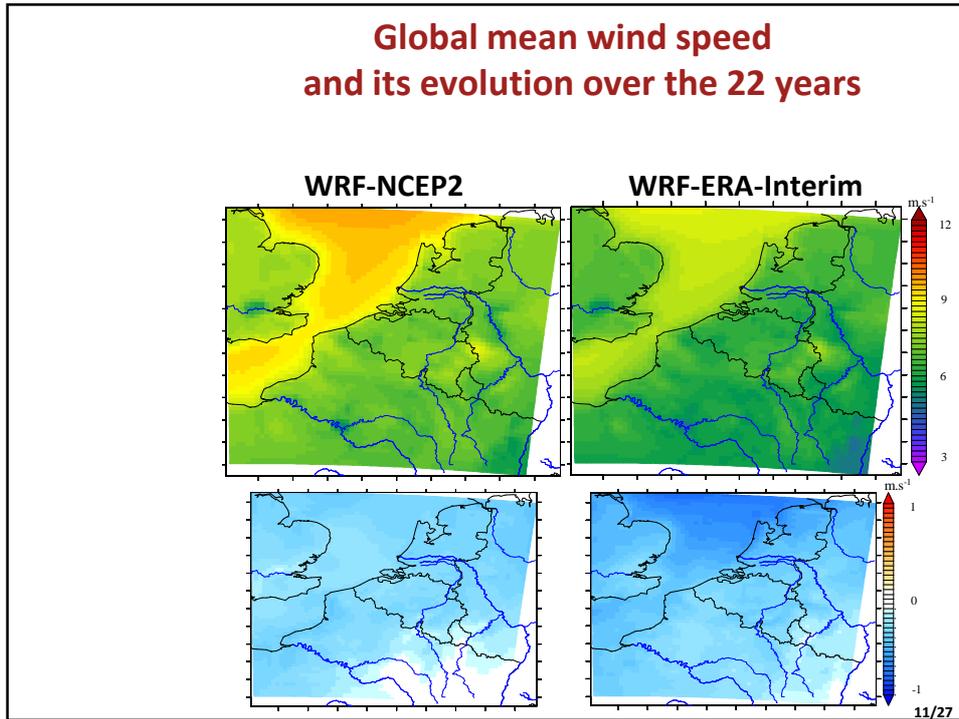## We compare 2 versions of WRF model :

For each one, we calculate :

- The **mean** wind speed
- The percentage of **low** (0-5ms^{-1}) wind speed
- The percentage of **medium** (6-10ms^{-1}) wind speed
- The percentage of **high** (11-15ms^{-1}) wind speed
- The percentage of **strong** (>15 ms^{-1}) wind speed

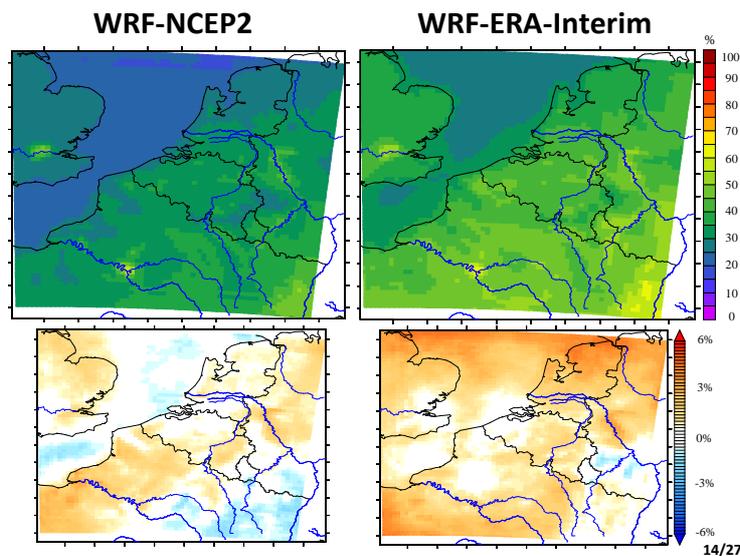- And the **evolution** of these 4 parameters during 22 years

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**Global mean wind speed
and its evolution over the 22 years**

WRF-NCEP2 **WRF-ERA-Interim**

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**Global mean wind speed
and its evolution over the 22 years**

WRF-NCEP2 **WRF-ERA-Interim**

**No significant
Global wind speed change**

**Is it the same conclusion
when we analyse
the wind speed categories ?**

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We compare 2 versions of WRF model :

We conclude :
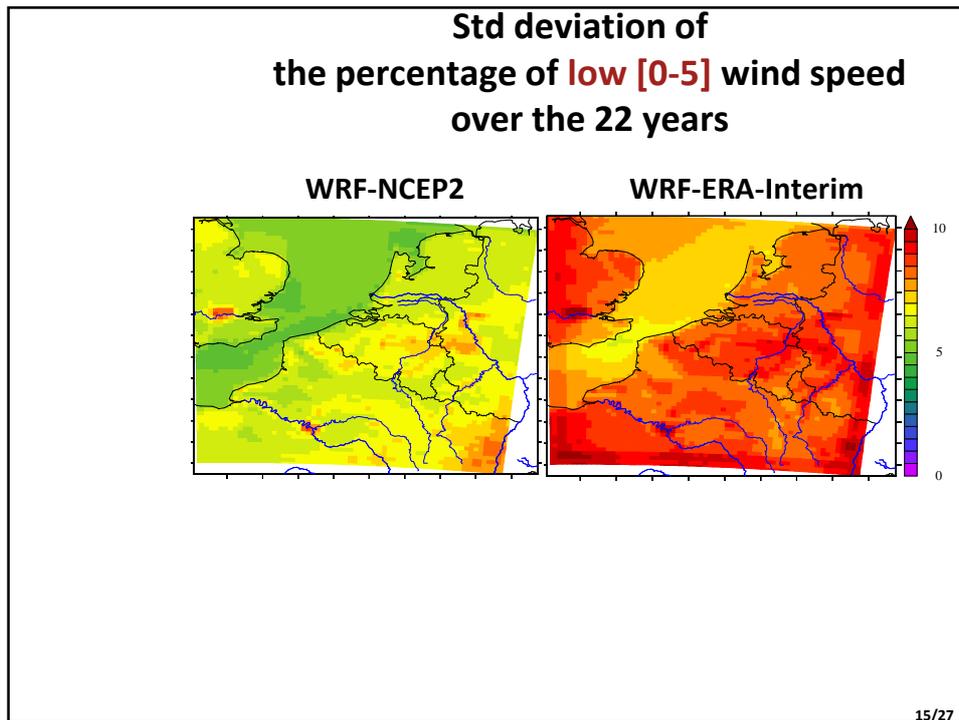
❌ The **mean** wind speed
- The percentage of **low** (0-5ms^{-1}) wind speed
- The percentage of **medium** (6-10ms^{-1}) wind speed
- The percentage of **high** (11-15ms^{-1}) wind speed
- The percentage of **strong** (>15 ms^{-1}) wind speed

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**Percentage of low [0-5] wind speed
and its evolution over the 22 years**

WRF-NCEP2   WRF-ERA-Interim

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**Std deviation of
the percentage of low [0-5] wind speed
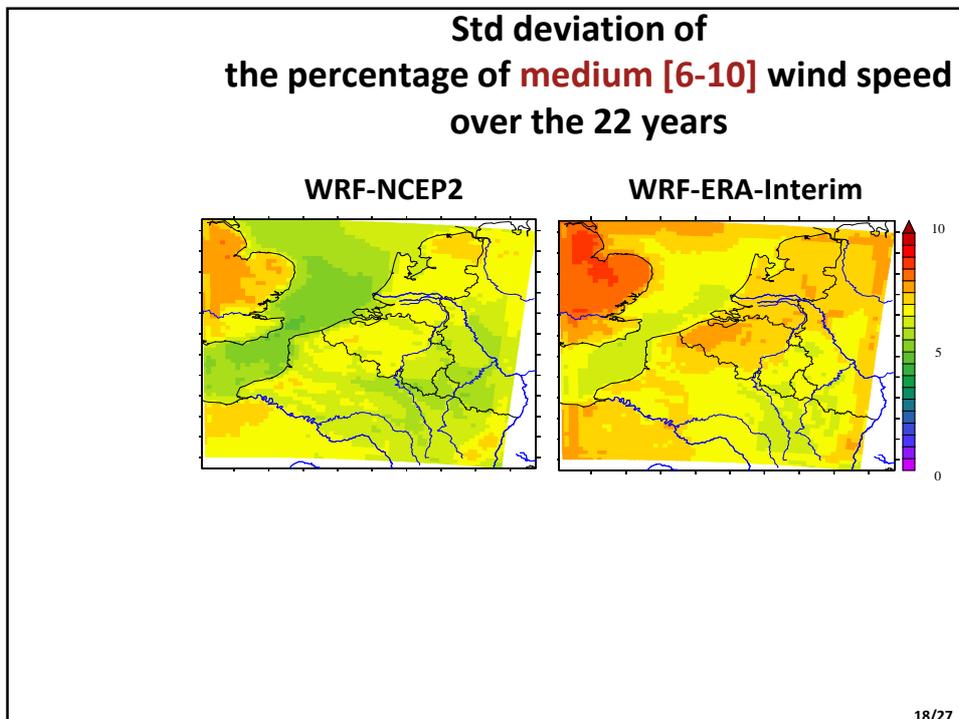over the 22 years**

WRF-NCEP2   **WRF-ERA-Interim**

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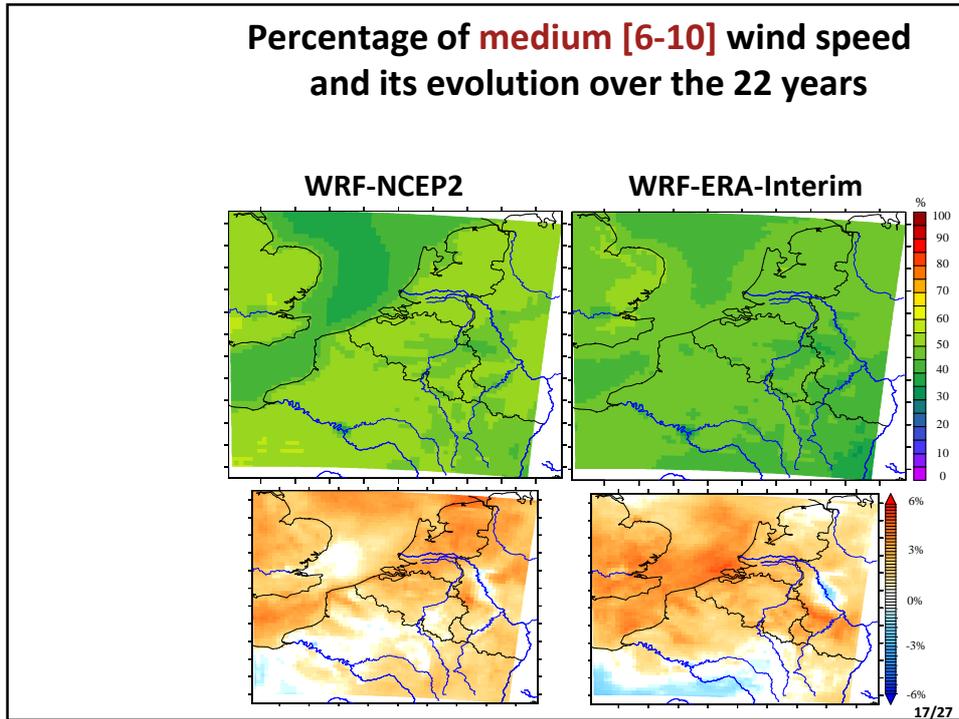**We compare 2 versions of WRF model :**

We conclude :

❌ The **mean** wind speed
❌ The percentage of **low** (0-5ms^{-1}) wind speed
- The percentage of **medium** (6-10ms^{-1}) wind speed
- The percentage of **high** (11-15ms^{-1}) wind speed
- The percentage of **strong** (>15 ms^{-1}) wind speed

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**Percentage of medium [6-10] wind speed
and its evolution over the 22 years**

WRF-NCEP2   **WRF-ERA-Interim**

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**Std deviation of
the percentage of medium [6-10] wind speed
over the 22 years**

WRF-NCEP2   **WRF-ERA-Interim**

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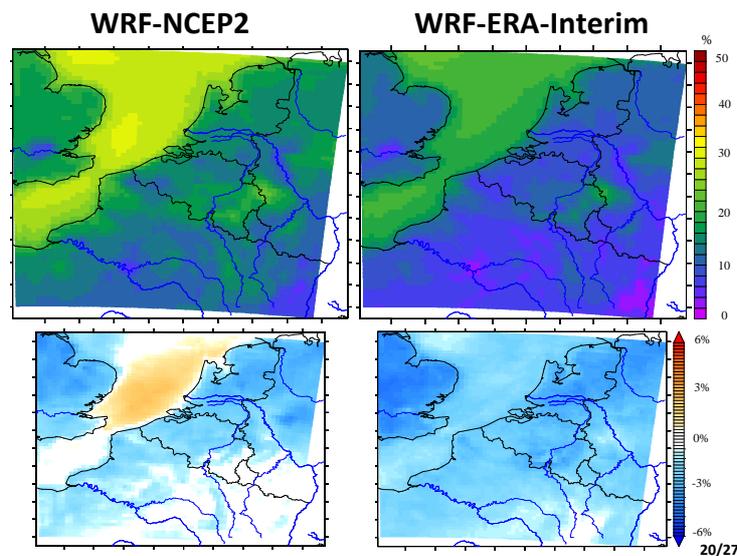University of Liège (Belgium)

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We compare 2 versions of **WRF model** :

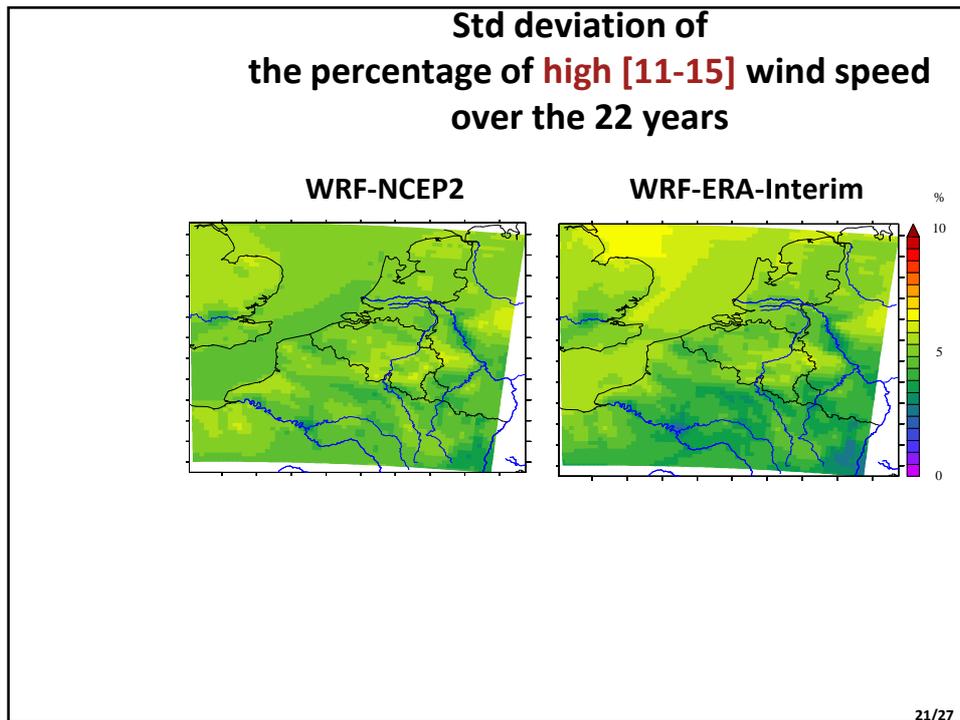### We conclude :

- ✖ The **mean** wind speed
- ✖ The percentage of **low** (0-5ms^{-1}) wind speed
- ✖ The percentage of **medium** (6-10ms^{-1}) wind speed
- The percentage of **high** (11-15ms^{-1}) wind speed
- The percentage of **strong** (>15 ms^{-1}) wind speed

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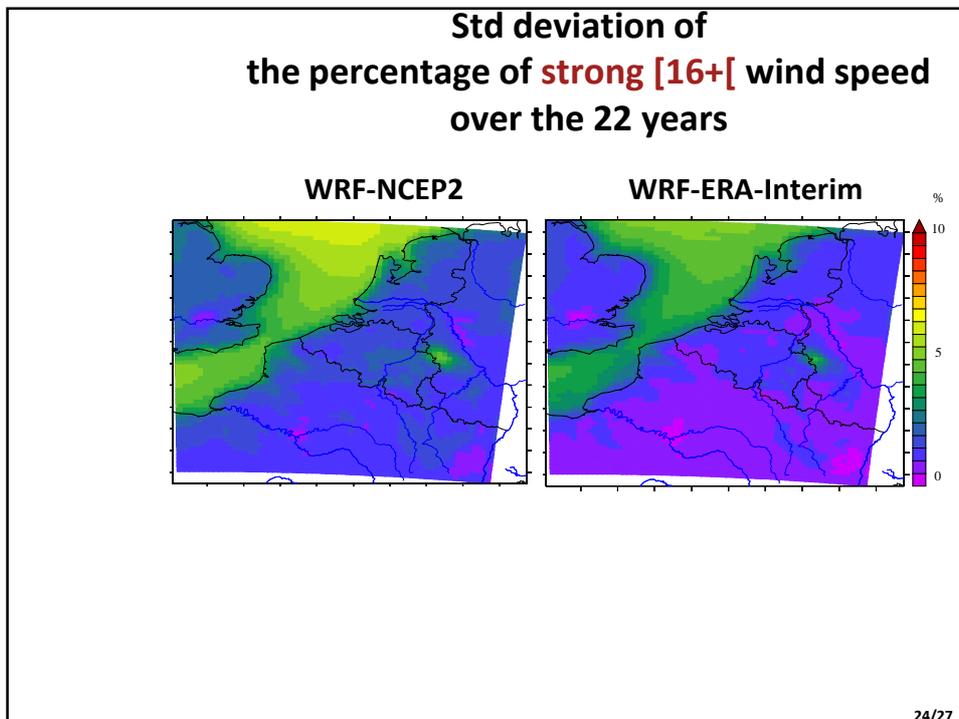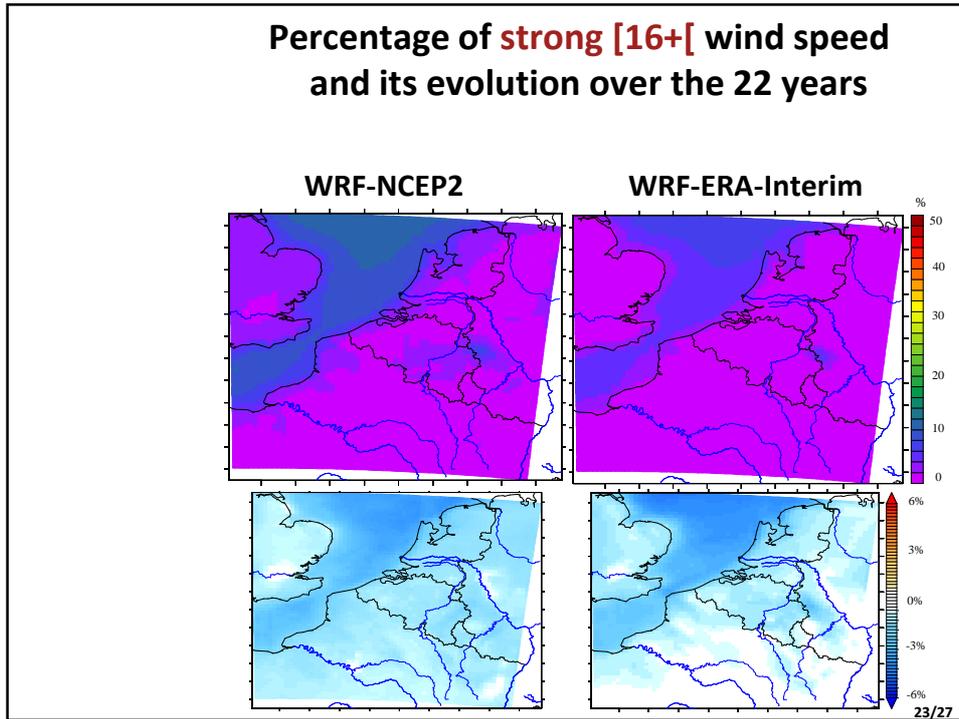## Percentage of **high [11-15]** wind speed and its evolution over the 22 years

WRF-NCEP2   **WRF-ERA-Interim**

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Std deviation of
the percentage of high [11-15] wind speed
over the 22 years

WRF-NCEP2   **WRF-ERA-Interim**

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We compare 2 versions of WRF model :

We conclude :

❌ The **mean** wind speed
❌ The percentage of **low** (0-5ms^{-1}) wind speed
❌ The percentage of **medium** (6-10ms^{-1}) wind speed
❌ The percentage of **high** (11-15ms^{-1}) wind speed
- The percentage of **strong** (>15 ms^{-1}) wind speed

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**Percentage of strong [16+[wind speed
and its evolution over the 22 years**

WRF-NCEP2   **WRF-ERA-Interim**

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**Std deviation of
the percentage of strong [16+[wind speed
over the 22 years**

WRF-NCEP2   **WRF-ERA-Interim**

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We compare 2 versions of WRF model :

We conclude :

❌ The **mean** wind speed
❌ The percentage of **low** (0-5ms^{-1}) wind speed
❌ The percentage of **medium** (6-10ms^{-1}) wind speed
❌ The percentage of **high** (11-15ms^{-1}) wind speed
? The percentage of **strong** (>15 ms^{-1}) wind speed

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Contexts —— Climatic and energetic challenges

Disadvantage of wind energy —— Wind energy dependent of weather conditions :
are the wind conditions have changed in the past ?

Models used —— WRF forced with NCEP2 Reanalysis   Over Belgium
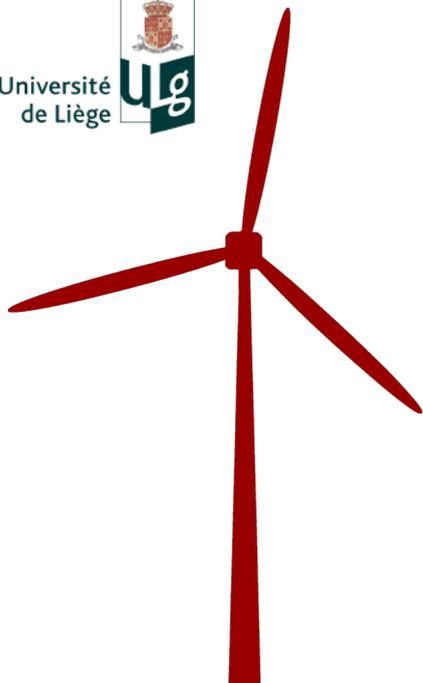WRF forced with ERA-Interim Reanalysis   1989 - 2010

Evaluations, Comparison & Results —— No significant change of the general mean wind speed
No significant change of the wind speed categories (except strong winds ?)
Differences between WRF-NCEP2 and WRF-ERA-Interim are slight

Conclusions

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Contexts

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of wind energy

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This study shows that :

The 2 models shows similar trends

There is no significant trend of low, medium, high wind speed

Correspond to the low, medium and high production of wind turbines

There may be a negative trend of strong wind speed

Correspond to the strong (or stopping) production of wind turbines

Future

- **Compare more precisely these 2 reanalyses :**

  Why is NCEP2 more windy than ERA-Interim ?

- **Validation of WRF with the METAR network / Wind Farm**

- **Calculate the WRF forced by :**

  Some CMIP5 models (scenario Historical) → Compare with this study

  Some CMIP5 models (future scenarios)   → Evolution of wind speed

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