Windstorms

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Outline

1) Introduction to windstorms

2) Results from stakeholder interviews

→ Impacts of windstorms on critical infrastructure

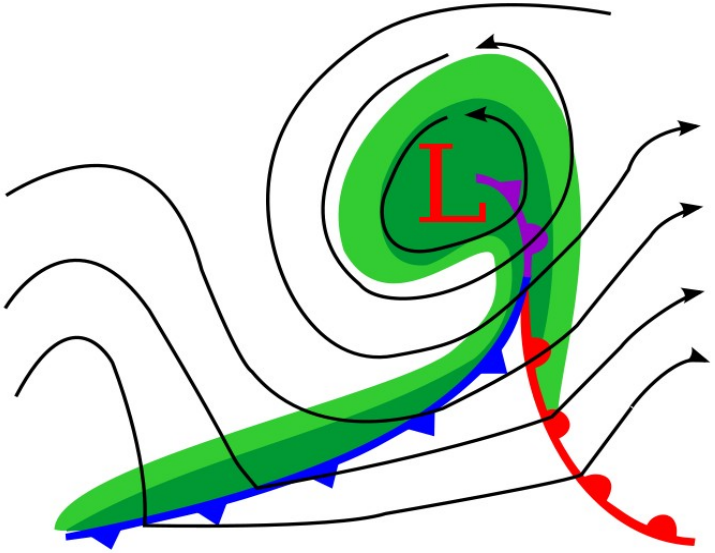
3) Windstorm example cases

→ “Lothar” and “Martin”, 1999
→ “Kyrill”, 2007

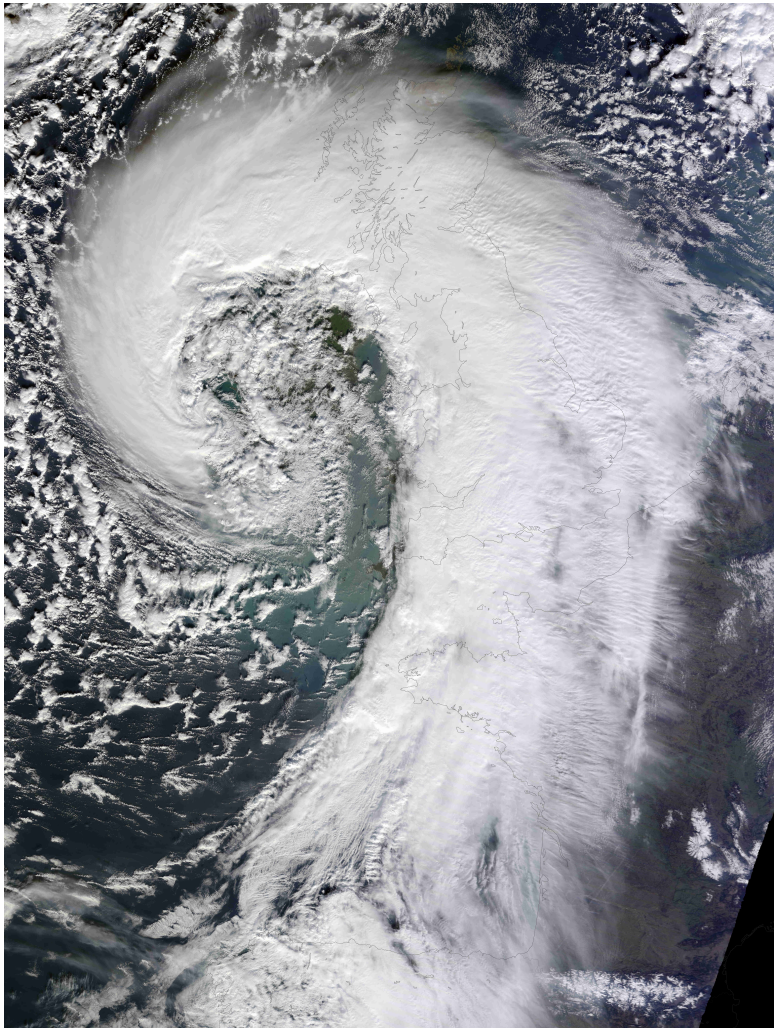
Introduction

Extra-tropical cyclones

- Low-pressure systems in the mid-latitudes
- Transport of heat and moisture
- Cause increased wind speeds and precipitation, especially along the fronts



en.wikipedia.org



http://earthobservatory.nasa.gov

Introduction

Windstorms → extreme extra-tropical cyclones

The following processes lead to an intensification of cyclones

- High baroclinicity
  → strong temperature gradient between polar and sub-polar regions
- Release of latent heat
  → Condensation of water vapour
- Advection of upper-level vorticity
- Upper-level divergence

Windstorm effects:

- Extreme wind speeds
- Trees are broken off or uprooted
- Structural damage likely

Impacts of windstorms

Results from interviews with managers of critical infrastructure

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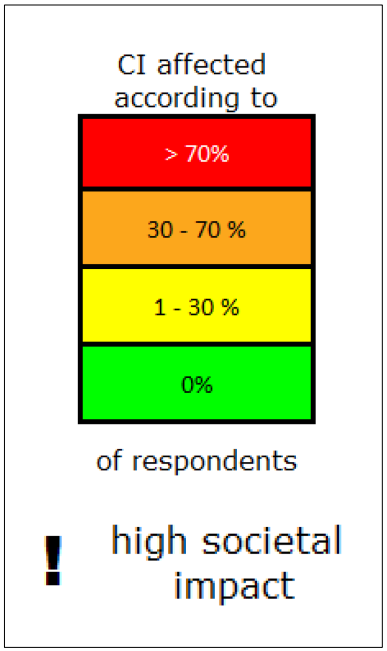
Windstorms have a wide range of impacts on all typed of critical infrastructure!



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Wind storms	!	!		!	!
Thunderstorm gusts	!				
Coastal floods			!		!
Tornadoes					
Heavy rainfall		!			
River floods			!		!
Landslides		!			
Hail					
Snow / snowstorms		!			!
Frz. rain and icing	!				!
Wildfires	!				!
Lightning	!				!
Heat or cold waves					
Dense fog					

Interview Results

Windstorms and electricity

Impacts and consequences

- Trees falling on power lines (affects mostly minor lines)
- Direct damages to lines and pylons
- Blackouts can affect large areas
- Costs for repairs and compensation payments

Preventive and response measures

- Disconnect endangered power lines
- Startup of additional power plants
- Shut down of wind turbines
- Close contact to weather services
- Load dispatch centres constantly monitor weather development


S. Marcos / Sada / Pedrido


commons.wikimedia.org

Interview Results

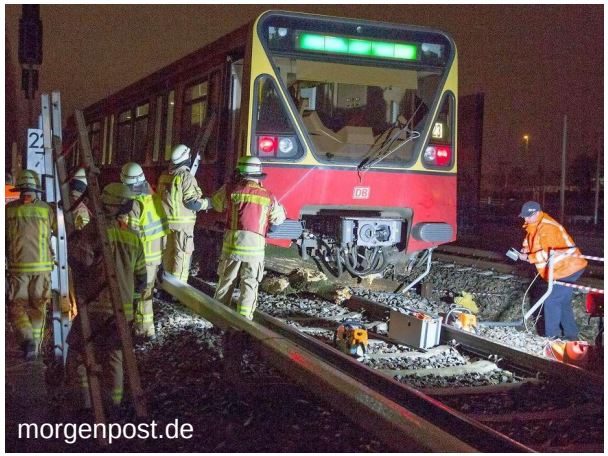
Windstorms and railways

Impacts and consequences

- Trees fall on rails
- Derailing of trains
- Damages to catenary wires
- Blackouts affect train service

Preventive and response measures

- Reduction of speed limits
- Closing of tracks
- Evacuation of stations
- Internal warning system
- DB takes part in a project to prepare for impacts of climate change


morgenpost.de


www.focus.de

Interview Results

Windstorms and road transportation

Impacts and consequences

- Blocking of roads by falling trees
- Toppling of trucks
- Leads to traffic jams

Preventive and response measures

- Speed reduction or closing of motorway bridges
- Extra personnel for monitoring and traffic control
- Close contact to weather service
- In Finland warnings are provided to road users

Interview Results

Windstorms and telecommunication

Impacts and consequences

- Disruption of power supply can lead to breakdown of telecommunication system
- Wind can cause damage to antennas or overground telecommunication lines

Preventive and response measures

- Batteries or generators provide power supply for a limited time period
- A dense network of transmitter masts assure relatively stable conditions in cases of single failures


statikbuero-witte.de

Example cases

Windstorms “Lothar” and “Martin”

- Series of windstorms in December 1999
- 140 fatalities and >15 billion dollars of economic losses (MunichRe, 2002)
- Major impact on the French energy system
- Blackouts affected 3.4 million people
- Lothar was poorly predicted by operational weather forecast models
- The storms increased the sensitivity to the Europe-wide effects of windstorms

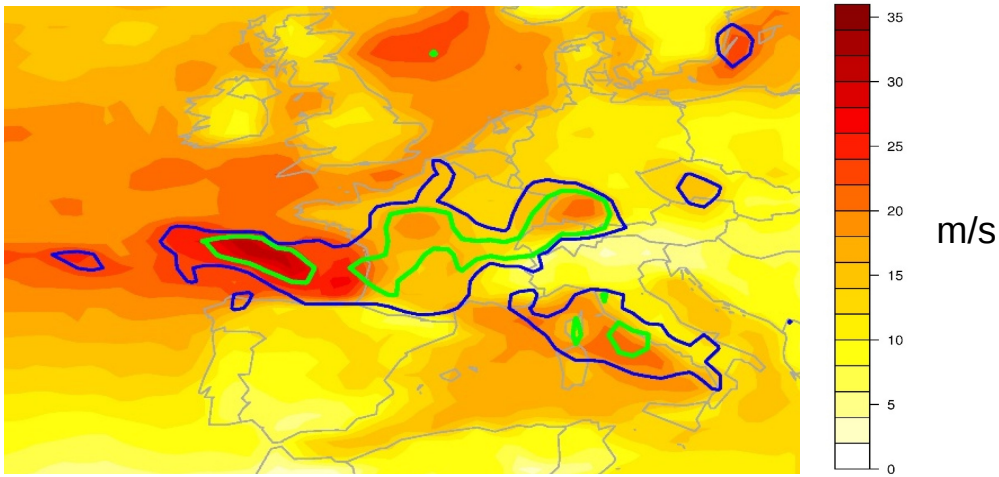


Figure: Exceedances of the 5-year (blue) and 20-year (green) return level of wind speeds by “Lothar” and “Martin”.

Example cases

Windstorm “Kyrill”

- Windstorms in January 2007
- 47 fatalities and damages of 7 billion Euros
- Major impact on the European transportation system
- The German long-distance trains traffic was shut down completely for 9 hours
- “Kyrill” was well predicted already several days in advance

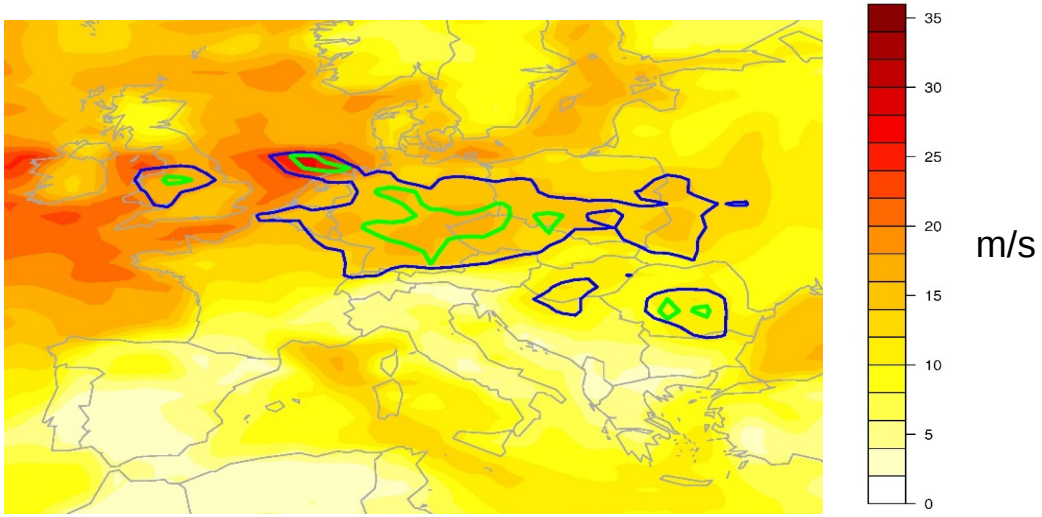


Figure: Exceedances of the 5-year (blue) and 20-year (green) return level of wind speeds by “Kyrill”.

Heavy Precipitation

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Outline

1) Introduction to heavy rainfall

2) Results from stakeholder interviews

→ Impacts of heavy precipitation on critical infrastructure

3) Heavy precipitation example cases

→ Central European flood, August 2002
→ Berlin thunderstorm, August 2013

Heavy Rainfall

3 types of heavy rainfall events:

1) Convective
- Triggered by lifting due to unstable vertical temperature gradient
- Small scale, high spatial variability, short duration

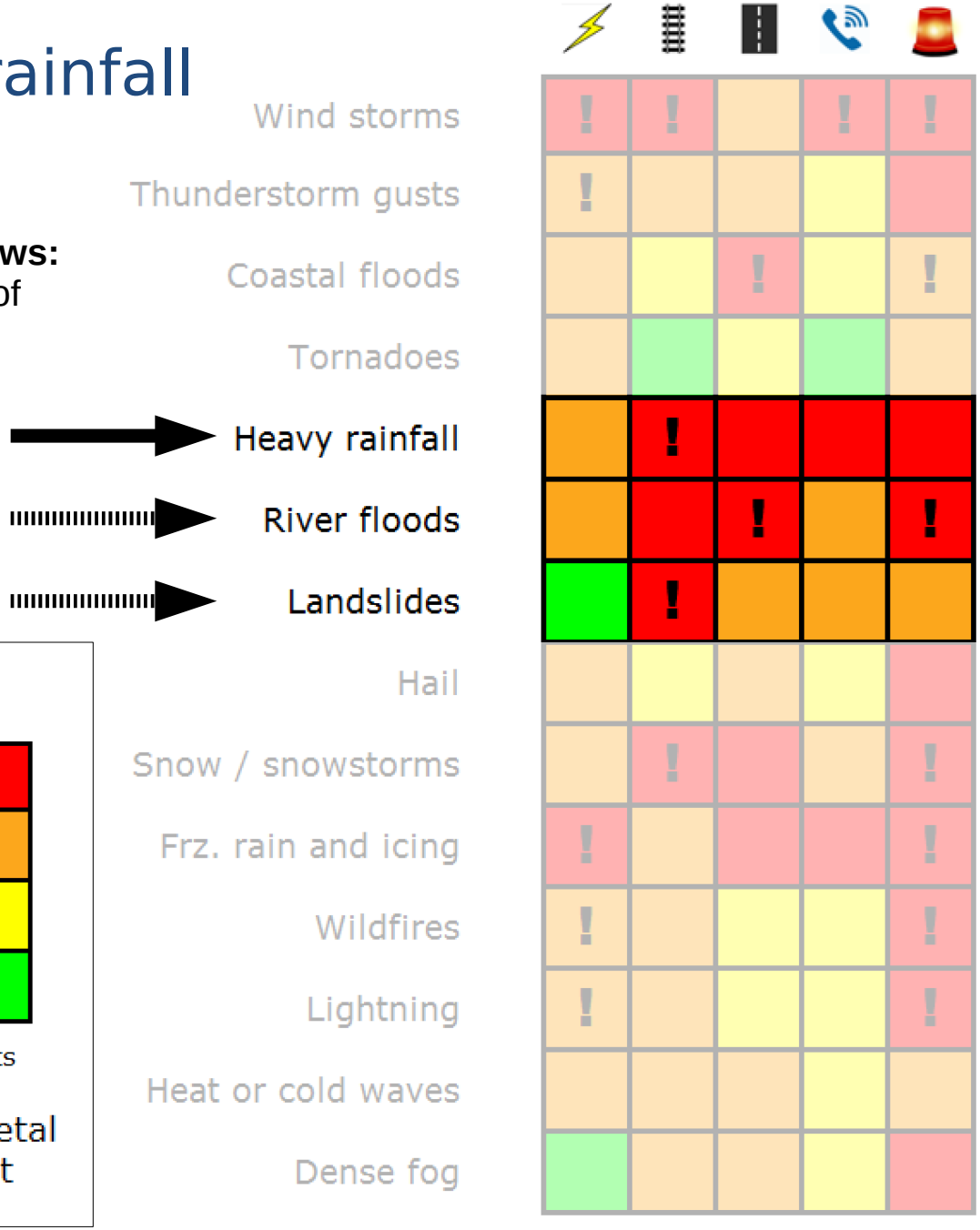
2) Orographic
- Triggered by flow of air over mountain
- Stationary

3) Cyclonic
- Associated with the fronts of a cyclone
- Large scale, long duration

Extreme events ← high atmospheric water vapour content

Impacts of heavy rainfall

Results from stakeholder interviews:
Wide range of impacts on all types of critical infrastructure by **direct** and **indirect effects**



Interview Results

Direct impacts of heavy rainfall

- Erosion of streets
- Flooding of tunnels
- Flooding of roads
- Risk of aquaplaning

- Erosion of rail embankments
- Flooding of railroads

- Dysfunctions of transmission substations due to extreme local precipitation

Critical threshold: 20mm/hour

Preventive and response measures:

- Drainage systems
- Research projects to prepare for impacts of climate change (rail, road)

Interview Results

Indirect impacts of heavy rainfall

River flooding

- Erosion on bridges crossing rivers
- Damage of bridge pillars in rivers due to floating debris
- Flooding of streets
- Flooding of railroads

Land- and Mudslides

- Streets can be blocked and damaged
- Railroads can be blocked and damaged

Preventive and response measures:

- Dykes
- Emergency plans

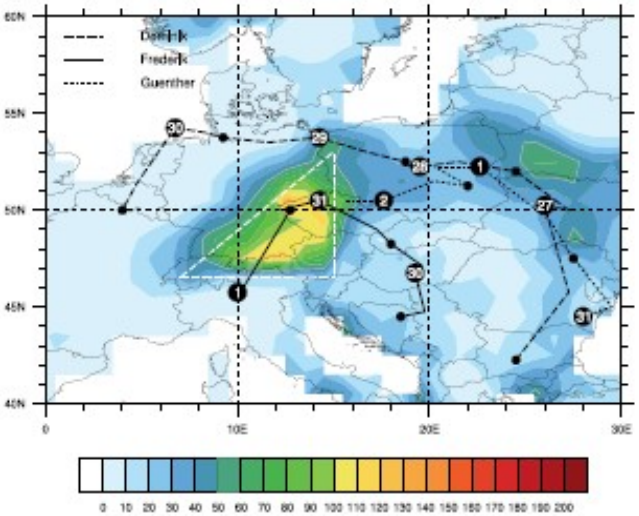

www.faz.net


www.bahnonline.ch


www.bbc.com

Example cases

3-day relative precipitation



Grams et al. 2014

Central European Flood May/June 2013

- Cyclonic and orographic precipitation
- 25 fatalities
- Bursting of dykes
- Streets and highways flooded
- Mudslides
- Railways flooded (major line closed for several month)
- Estimated costs of 12 billion Euros
- Event was well predicted by the weather service

www.wetter.at

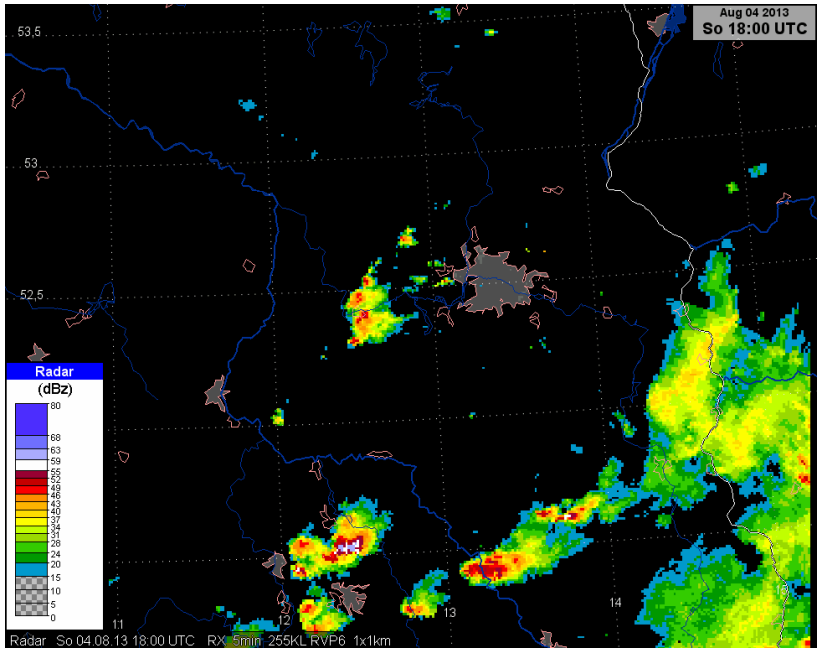
www.faz.net

www.focus.de

Example cases

Berlin thunder storm, August 2013

- Convective event
- 13 mm in 15 minutes
- Flooding of streets and subway station



Courtesy: DWD

Courtesy: Thomas Schubert

Example cases

Berlin thunder storm, August 2013

Link to video: https://www.youtube.com/watch?v=W2KiXtSH3bs