Rainfall Wind Turbine or Turbulence

Kick off meeting

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https://hmco.enpc.fr/portfolio-archive/rw-turb/

Kick off schedule

| Time	Presenter(s) / title
15:30 – 15:35	**Welcome and round table**
15:35 – 15:45	**Auguste Gires (HM&Co, ENPC)** : Project overview
15:45 – 16:00	**Ernani Schnorenberger (Boralex) :** Presentation of Boralex and its Research and Innovation
16:00 – 16:10	**Auguste Gires (HM&Co, ENPC)** : High resolution measurement campaign
16:10 – 16:15	**Q&A**
16:15 – 16:30	**Sandrine Aubrun (LHEEA, Ecole Centrale Nantes)** : Post-processing of operational data to study Power losses due to Wake interactions
16:30 – 16:45	**Paul Veers (NREL)** : The Fast-TurbSim modelling chain, and ExaWind advanced computational model
16:45 – 17:00	**Joachim Peinke (Univ. Oldenburg)** : Turbulence Effecting Windturbines
17:00 – 17:10	**Q&A**
17:10 – 17:25	**Daniel Schertzer (HM&Co, ENPC) :** Multifractal analysis and simulations : from WAUDIT to RW-Turb
17:25 – 17:35	**Jerry Jose and Angel Garcia Gago (HM&Co, ENPC)** : preliminary analysis
17:35 – 17:45	**Q&A / Wrap-up**

Why this project ?

Rainfall affects wind power production :

- Reported production decrease for similar wind of up to 20-30% (data analysis / dedicated experiment; Corrigan and Demiglio, 1985; Al et al., 2011)
  → cited as a reason why wind turbine do not produce as much as expected) :

- Confirmation through multiphase (volatile for air and liquid for rain) computational fluid dynamics (greater impact during light rain, Cai et al. 2013, and Cohan and Arastoopour 2016)

- Also some positive impacts noted (ex : cleaning the blades, Corten et al., 2002)

Intrinsic intermittent nature of wind turbulence :

- Complex to analyse and event to observe
- Standard tool (ex: 10 min average) not appropriate for such extreme variability
- Transferred to loads on turbine (torque), and power production

Fitton et al. 2014
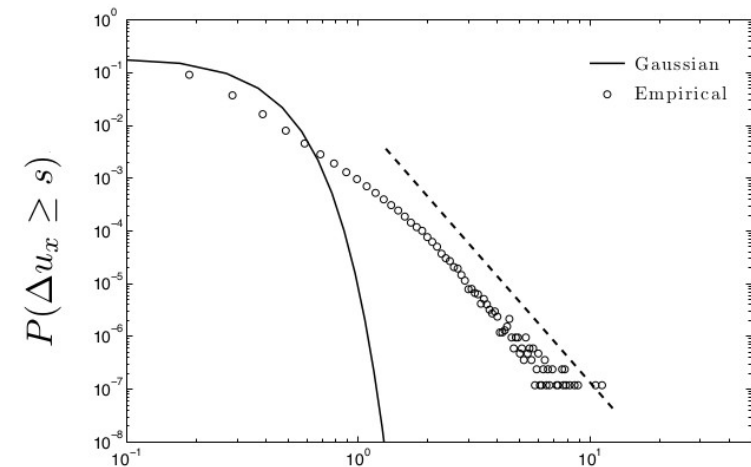
Outline of the project

Why this project ?

A need for a formalism to overcome these limitations : multifractals

- Widely used to characterize and simulate numerous geophysical fields extremely variable across wide ranges of spatio-temporal scales
- Relies on the physically based notion of scale invariance
- Universal Multifractals are parsimonious

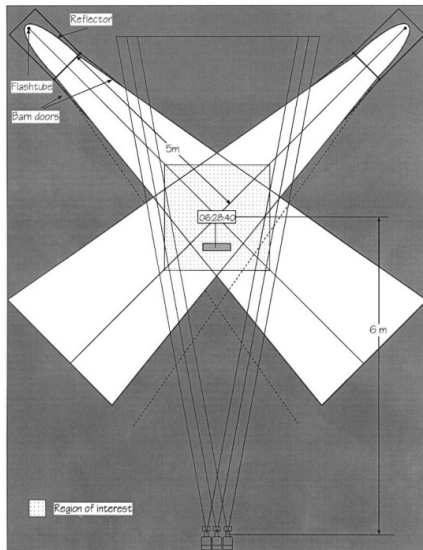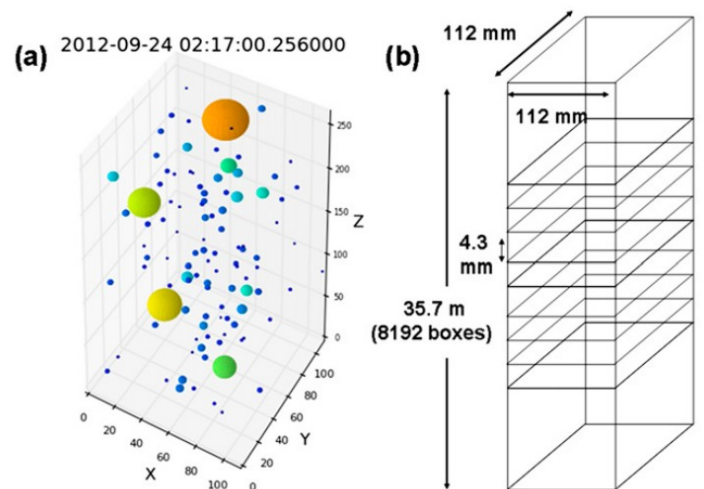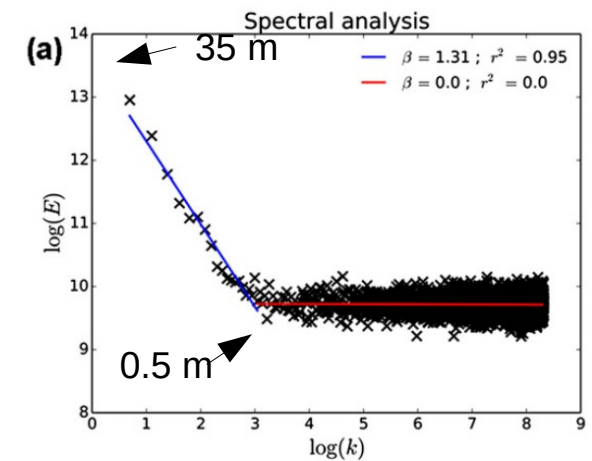**Rainfall (rain rate and DSD) also exhibits scale invariant multifractal features from drop scale to large scale**

Fig. 1. Geometry of the different optical elements.

(Desaulnier-Soucy et al. 2001;
Lilley et al 2006)

(Gires et al, 2015)

Outline of the project

What RW-Turb is about ?

RW-Turb will combine the existing knowledge on wind turbulence and rainfall fields to create a coupled framework enabling to tackle the seldom investigated but apparently significant effect of rainfall on wind turbine efficiency.

A twofold approach :

   - Data collection and analysis :
      High resolution measurement campaign (wind, rainfall, T, P, humidity, power production)
      Joint multifractal of collected fields

   - Numerical simulations :
      - Space-time wind
      - Two modelling chains
         - Theoretical torque computations
         - Multi-disciplinary model for numerical simulation of wind turbine behaviour
                  (relies on the NREL FAST-TurbSim model)

      → Quantification to the sensitivity of models to turbulent wind power inputs.
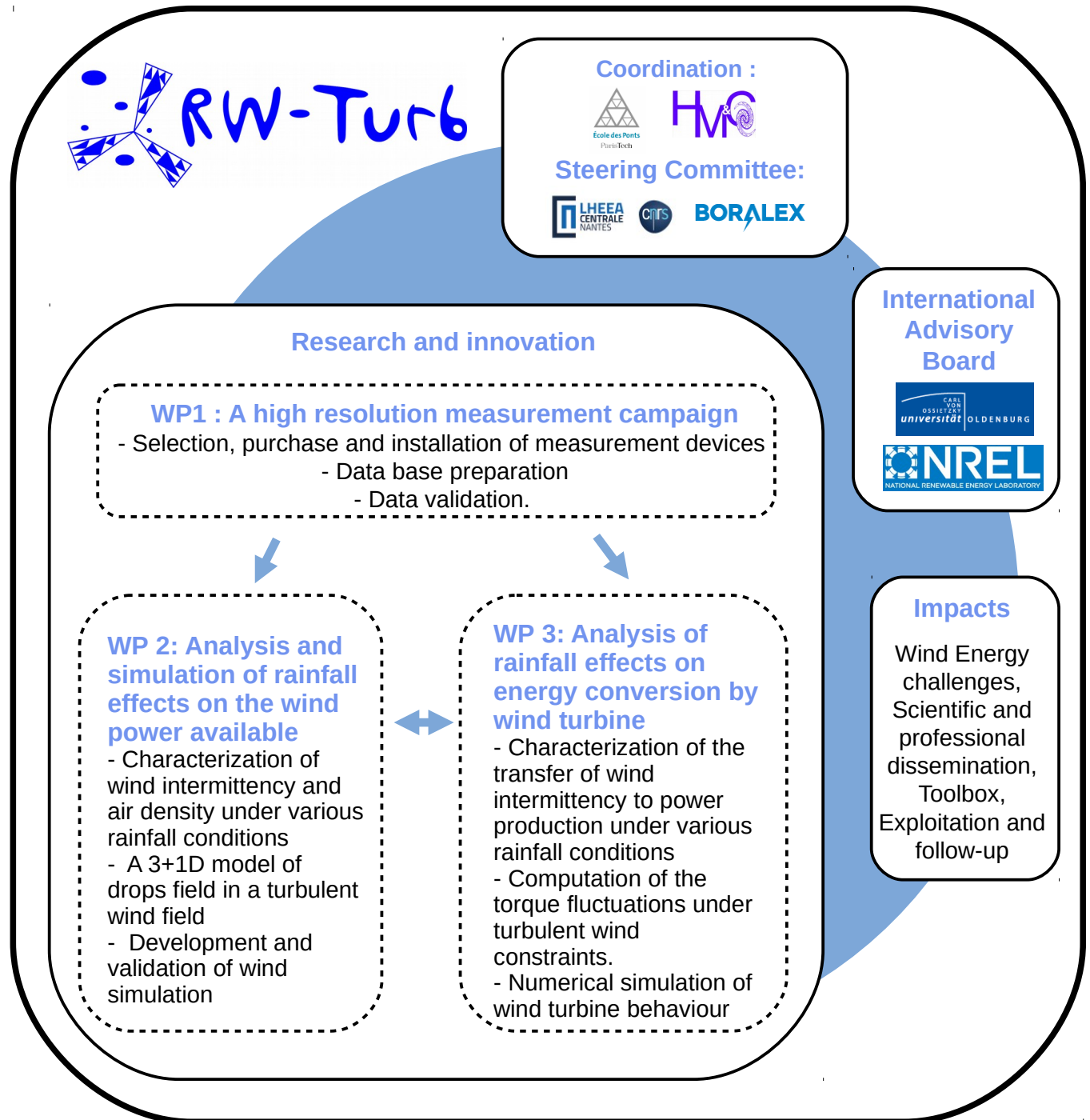
Outline of the project

What RW-Turb is about ?

RW-Turb relies on the expertise of HM&Co in measurement and modelling across **wide range of spatio-temporal scales** of atmospheric **turbulence and rainfall** to quantify the impact of the latter on **wind power production**.

This project benefits from an industrial partnership with Boralex, a wind power producer.

RW-Turb will open new paths to improve **nowcasts of power production**, a major challenge in a framework of increasing use of **renewable energies** in France and Europe.

RW-Turb

Coordination :

École des Ponts ParisTech — HMC

Steering Committee:

LHEEA CENTRALE NANTES — CNRS — BORALEX

International Advisory Board

CARL VON OSSIETZKY universität OLDENBURG

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Research and innovation

WP1 : A high resolution measurement campaign
- Selection, purchase and installation of measurement devices
- Data base preparation
- Data validation.

WP 2: Analysis and simulation of rainfall effects on the wind power available
- Characterization of wind intermittency and air density under various rainfall conditions
- A 3+1D model of drops field in a turbulent wind field
- Development and validation of wind simulation

WP 3: Analysis of rainfall effects on energy conversion by wind turbine
- Characterization of the transfer of wind intermittency to power production under various rainfall conditions
- Computation of the torque fluctuations under turbulent wind constraints.
- Numerical simulation of wind turbine behaviour

Impacts

Wind Energy challenges, Scientific and professional dissemination, Toolbox, Exploitation and follow-up

Outline of the project

HM&Co Team :

Researchers :
- **Auguste Gires** (coordination)
- **Daniel Schertzer**
- **Ioulia Tchiguirinskaia**

PhD students :
- **Jerry Jose*** : focus on data analysis (both meteorological and power production)
- **Angel Garcia Gago** : focus on simulations (both wind and power production chain)
- **Xin Li*** : focus on theoretical aspects

Partners :

Involvement of a wider academic and industrial consortium :

 Ernani Schnorenberger

 Sandrine Aubrun

 Joachim Peinke

 Paul Veers

*Co-supervised with Yelva Roustan (CEREA-ENPC)

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