N°14

Turbulent structures in the atmospheric surface layer : observation by remote sensing and impact on the small-scale variability of pollutants

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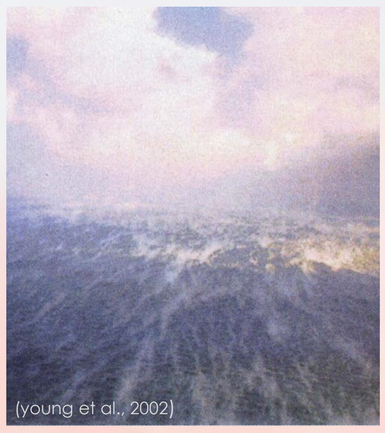
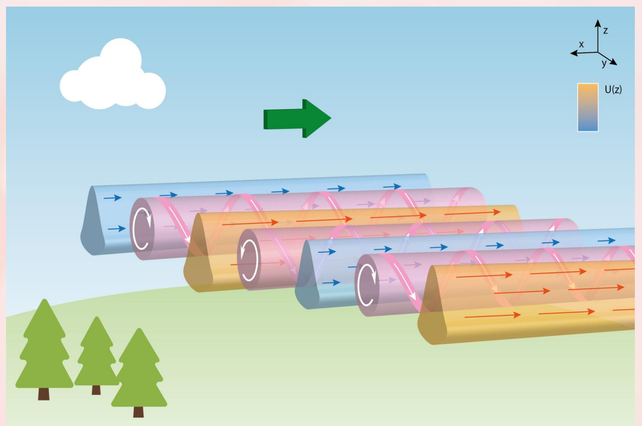


Introduction to coherent structures

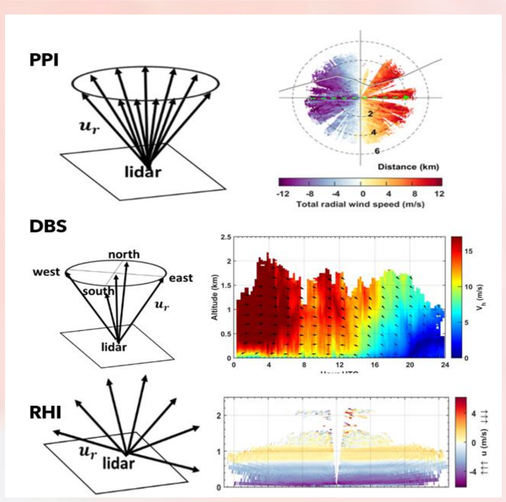
- Organized and recurrent patterns found within turbulence
- Due to instabilities and interactions within the turbulent flow as shear instabilities
- Crucial role in the **momentum**, **heat**, and **mass transport**
- **Streaks** pattern is studied

(Cheliotis, 2021)



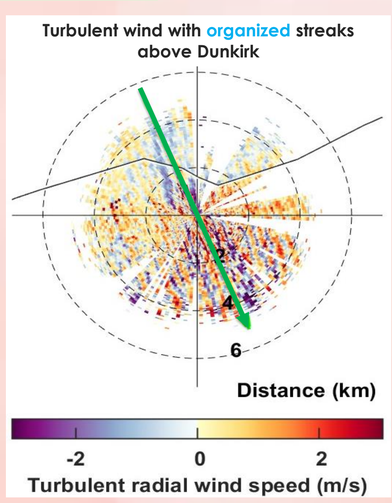
Objectives

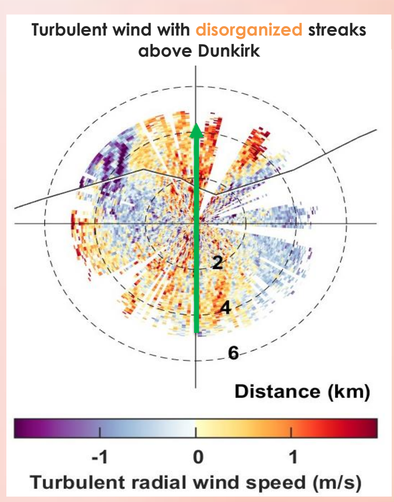
- Explore **streaks' characteristics**
- Use machine learning to determine **streaks' occurrence**
- Perform detailed **characterization** of streaks (behavior and properties)



Instrument: LiDAR Doppler

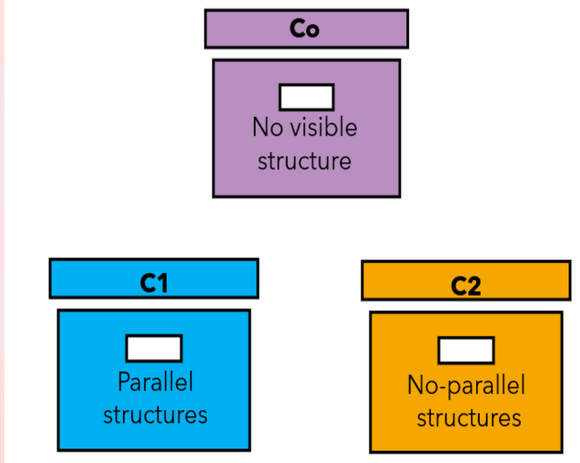
- 3 types of **measurement scan** : PPI (horizontal) DBS(vertical) RHI(vertical)
- Measurement at **15 m** above ground on the "Halles aux sucres" in Dunkirk
- PPI used to visualize turbulent structures → **40 000 scans in 1 years**
- Extraction of turbulence by subtracting mean wind from radial wind
- 2 types of structures, **organized streaks** and **disorganized streaks**

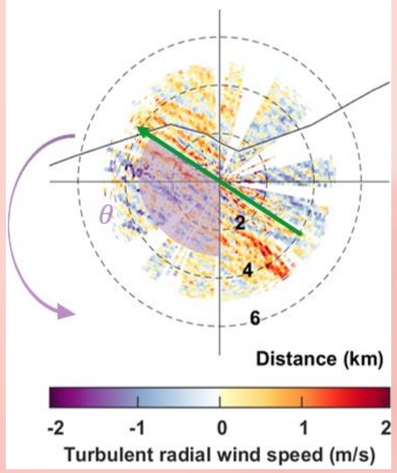


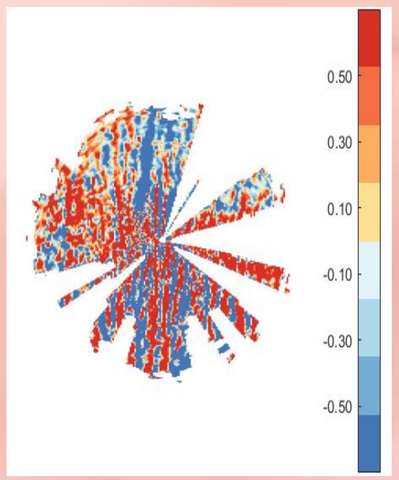


Training set for supervised machine learning

- creation of a data for supervised machine learning
- **3 categories** to classify
- Structure must be unequivocal and **quasi-steady** wind on 3 consecutive scans
- a **rotation** from the North to get wind-direction independent images
- The image contrast is enhanced, the color scale to **+/-0.5 m/s**

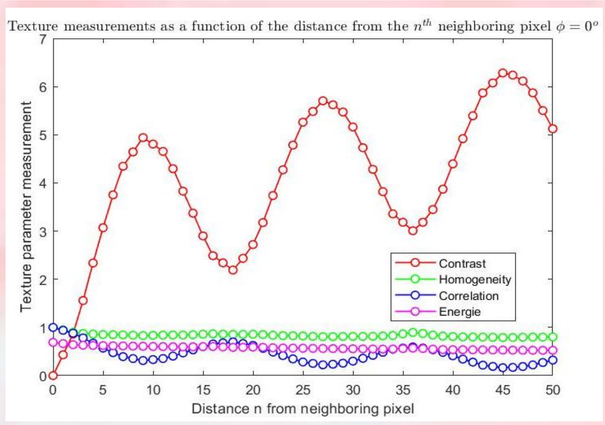


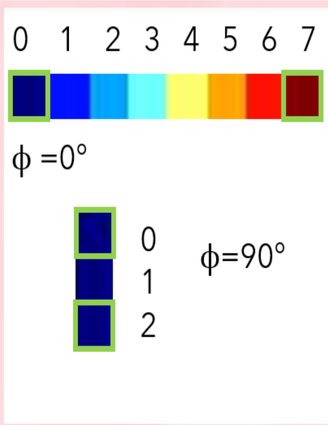


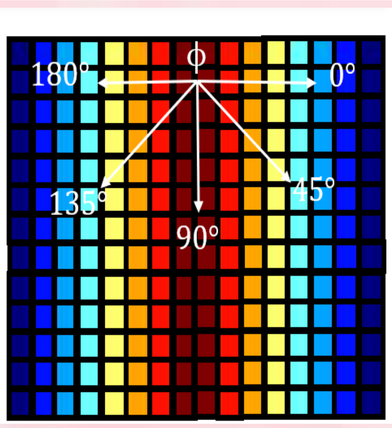


Co-occurrence Matrix (CM) and texture parameters (TP)

- A CM is computed for a specific **pixel pair** configuration (distance *n* and orientation ϕ)
- 4 TPs are computed from each CM : (Srivastava et al., 2020)
  - **Contrast** is high for images with strong color fluctuations
  - **Homogeneity** is high for uniform images
  - **Correlation** is high for images with marked deviations from the average color
  - **Energy** is high for images containing large areas of the same color
- TP variations along pixels pair distance and orientation highlight the images periodicities



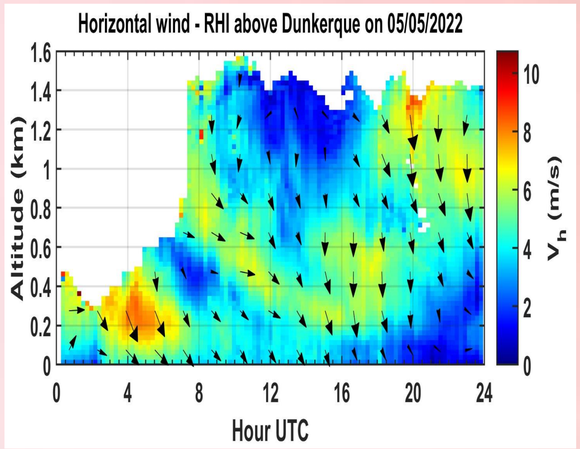


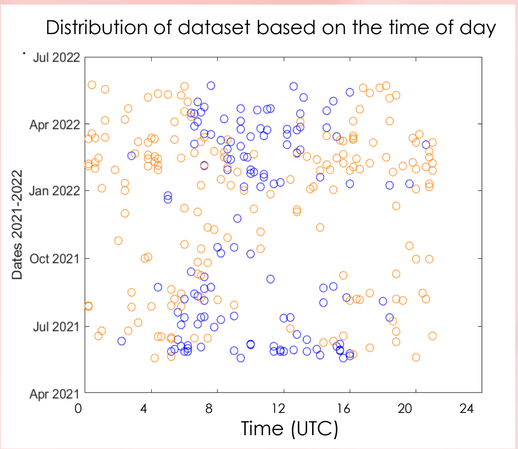


First Result

Some features appear :

- **Organized** streaks are mostly **diurnal** while **disorganized** streaks are dominantely **nocturnal**
- Streaks are **less frequent** in **Fall** and the beginning of **winter** compared to other seasons
- **Organized** streaks often appear after a **low-level jet**





Perspectives

Statistical study :

- Apply machine learning algorithms to classify the whole scan dataset
- Confirm the first results on streaks' daily/seasonal variability with dataset
- Extract information of the streaks' occurrence and size

Case study :

- Study streaks life cycle and the impact of sea/land interface
- Measurements of particle concentrations to study transport in streaks

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Aknowledgements

This project is co-funded by the CaPPA Labex and by the Région Hauts-de-France. CaPPA is funded by the French National Research Agency (ANR) through the PIA and under the contract ANR-11-LABX-0005-01, and by the Région Hauts-de-France and the European Regional Development Fund (ERDF). The lidar instrument was funded through in the CPER IRenE, funded and by the Région Hauts-de-France and the ERD. The authors also thank the Halle aux Sucres for hosting the lidar instrument.