PO.ID 311

Lidar Simulator : a coupled wind and lidar simulator

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LEOSPHERE

Abstract/Objectives

Simulation is of first interest to improve existing lidar and to develop new concept of measurement based on lidar technology. Nowadays challenges are numerous for lidar : accuracy of measurement compare to frequency of acquisition, range of measurement, meteorological condition for good measurement, autonomy and transportability of lidar casing. Besides, there is also many challenges for tomorrow : measuring turbulence, measurement in highly complex field, during storm, providing new proper characteristic of wind field adapted to different topics… In order to face those challenges, several new lidar architecture from hardware to software can be drawn and must be tested in different atmospheric condition. Lidar simulator permits to simulate wind flow with a large bench of different characteristic and to simulate measurement of wind by a coherent lidar system with a large bench of hardware and software settings. Lidar simulator architecture is presented, then wind profile generation, carrier to noise ratio (CNR) modelisation and reconstruction are presented then some results are given.

Lidar simulator architecture

User chooses lidar settings

Software	Hardware	Wind flow

All parameters

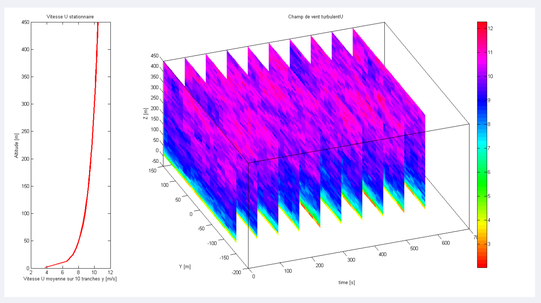
- Simulid : lidar hardware and software simulator for CNR calculation
- TurbSim : temporal 2D atmospheric flow and aerosol model
- Lidar geometry designer
- CNR
- wind profile
- Simulid : Lidar spectras generation and speed calculation
- Lidar estimated wind profile
- Lidar wind field retrival algorithm
- Retrieved wind field
- Comparison between retrieved data and real data

Estimation of lidar performance

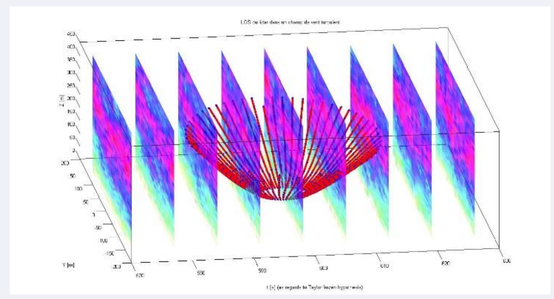
Lidar Simulator

Interface display

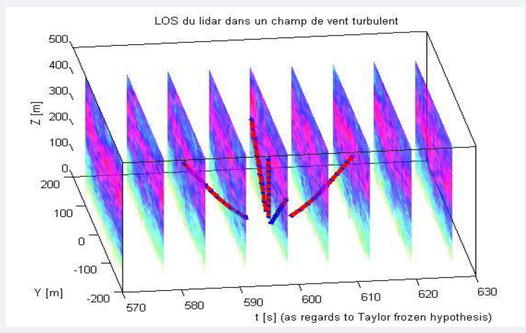
Lidar simulator plots the mean wind field and the turbulent field. It also plot the LOS of the Lidar in the wind field. User can visualize the field in which the Lidar is measuring and therefore have a better understanding of atmospheric condition.



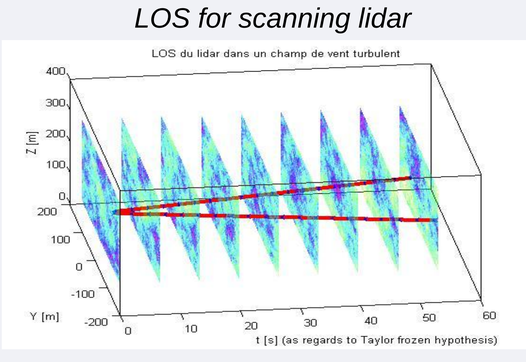
Plot of wind field



LOS for scanning lidar



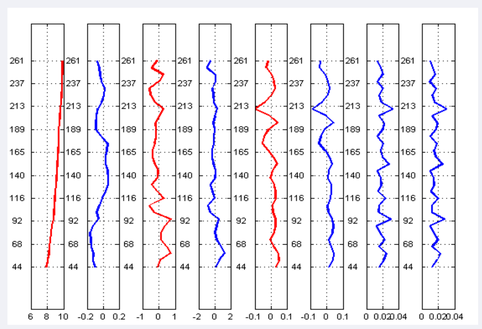
LOS for DBS lidar



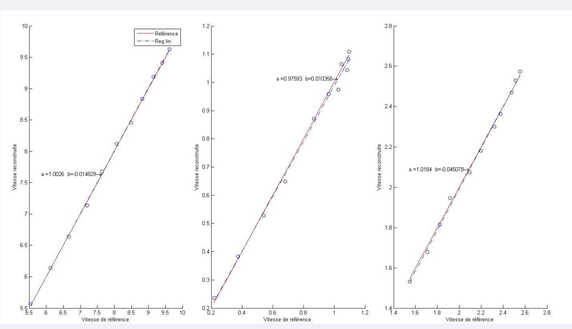
LOS for nacelle mounted Lidar

Results display

User can plot a lot of characteristic of the Lidar such as horizontal speed, vertical speed, wind direction, turbulence,… It can be plotted profile view or correlation view.



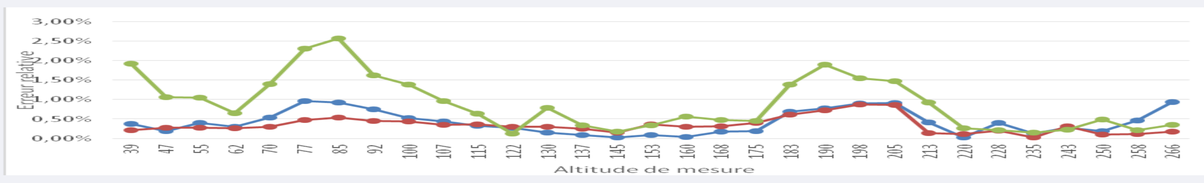
Profile view



Correlation view

Case study

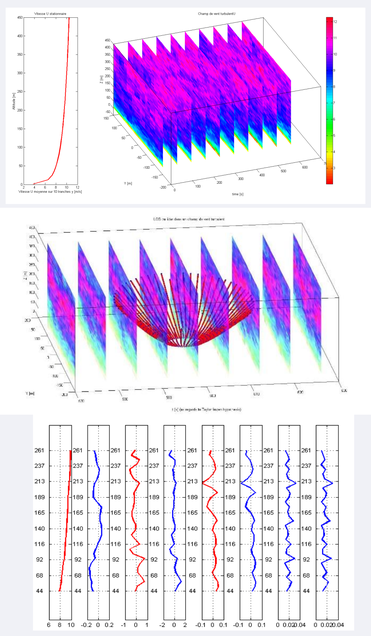
For example we have studied the impact of turbulence on wind speed retrieval accuracy. We have plot a stable wind field with a turbulence indice of 5%, 10% and 20% for a standard lidar hardware and software configuration. This study has permitted to confirm that the more turbulent the less accurate and that we observe a good accuracy at focus lidar point.



Wind speed accuracy

Lidar simulator model

Simulation of atmosphere is done by publicly available wind field simulator TurbSim. TurbSim model is a linear classic computer friendly model and permits to set a large bench of flow characteristic such as mean wind speed, turbulence IEC, shear, surface roughness and many others. Under some assumption including short time and space simulation, we can turn this field into 3D temporal field. Using Lidar geometry, Lidar simulator can acquire radial wind speed on line of sights (LOS) with the frequency and geometry user has defined in the wind field simulated. Then Simulid permits to modelize the carrer to noise ratio which combined to wind profile permits to get the estimated lidar wind speed measurement. Simulid includes an optical model of signal propagation and a model of acquisition cards to simulate signal spectra acquisition. Then Leosphere radial wind speed and wind field algorithms are applied to get the retrieved wind field. Finally we compare the real data to estimated data to get Lidar performance.



Extract of Lidar Simulator

Conclusions

By simulating wind field corresponding to wind energy typical size, Lidar simulator permits the user to set any configuration of Lidar. New concept of remote sensing can then be tested by the simulator and proof of concept from existing Lidar can be done. First study have permited to have a better understanding of the link between turbulence intensity and error of measurement. Validation of the Lidar Simulator is ongoing by comparison between real Lidar data and a simulation of this Lidar in a wind field generating with mast data. Future version of Lidar Simulator will include large wind field with coherent event such as wake and mutli Lidar wind field measurement.

References

1. MACHTA M; CARIOU J.P., Valla M.; Simulid pulsed focused lidar simulation software, LEOSPHERE J Lundquist 2011