High resolution river surface roughness characterization for near-nadir Ka band interferometry CAL/VAL

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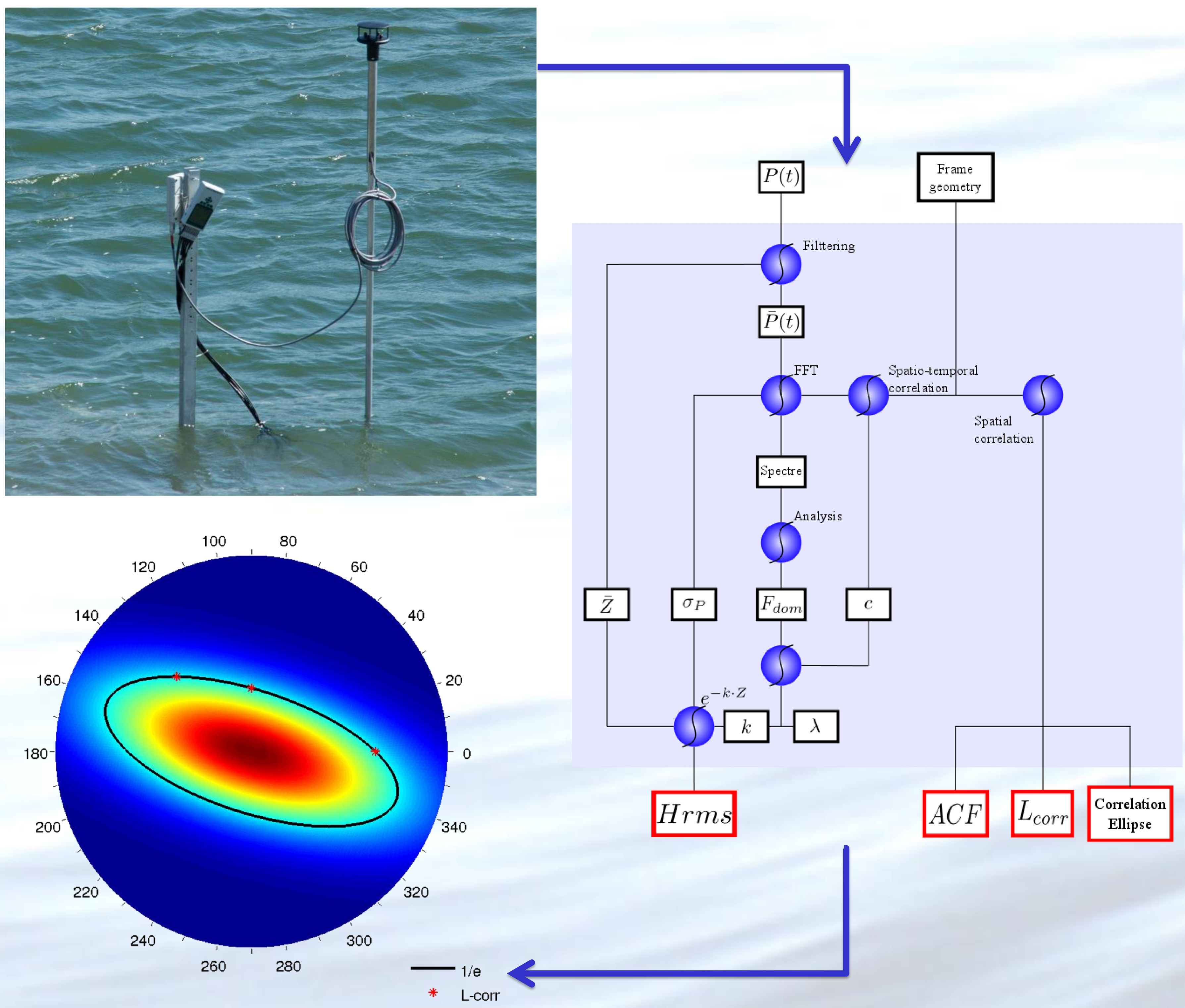
Context and Objectives

Water surface roughness strongly impacts microwave backscattering process over rivers. Therefore, developing and applying radar interferometry techniques over continental water to determine river longitudinal slope (cross-track interferometry) or surface velocity (along-track interferometry) requires a detailed characterization and understanding of water surface roughness, its relation with river flow conditions and wind conditions, and its impact on directional backscattering coefficient.

In situ measurement of river surface roughness is a complex task as surface topography is both rapidly changing and sensitive to obstacles or contact measurements. Furthermore laboratory measurements, although highly informative and valuable, fall short to represent the diversity of river flow and wind conditions.

Pressure sensors approch

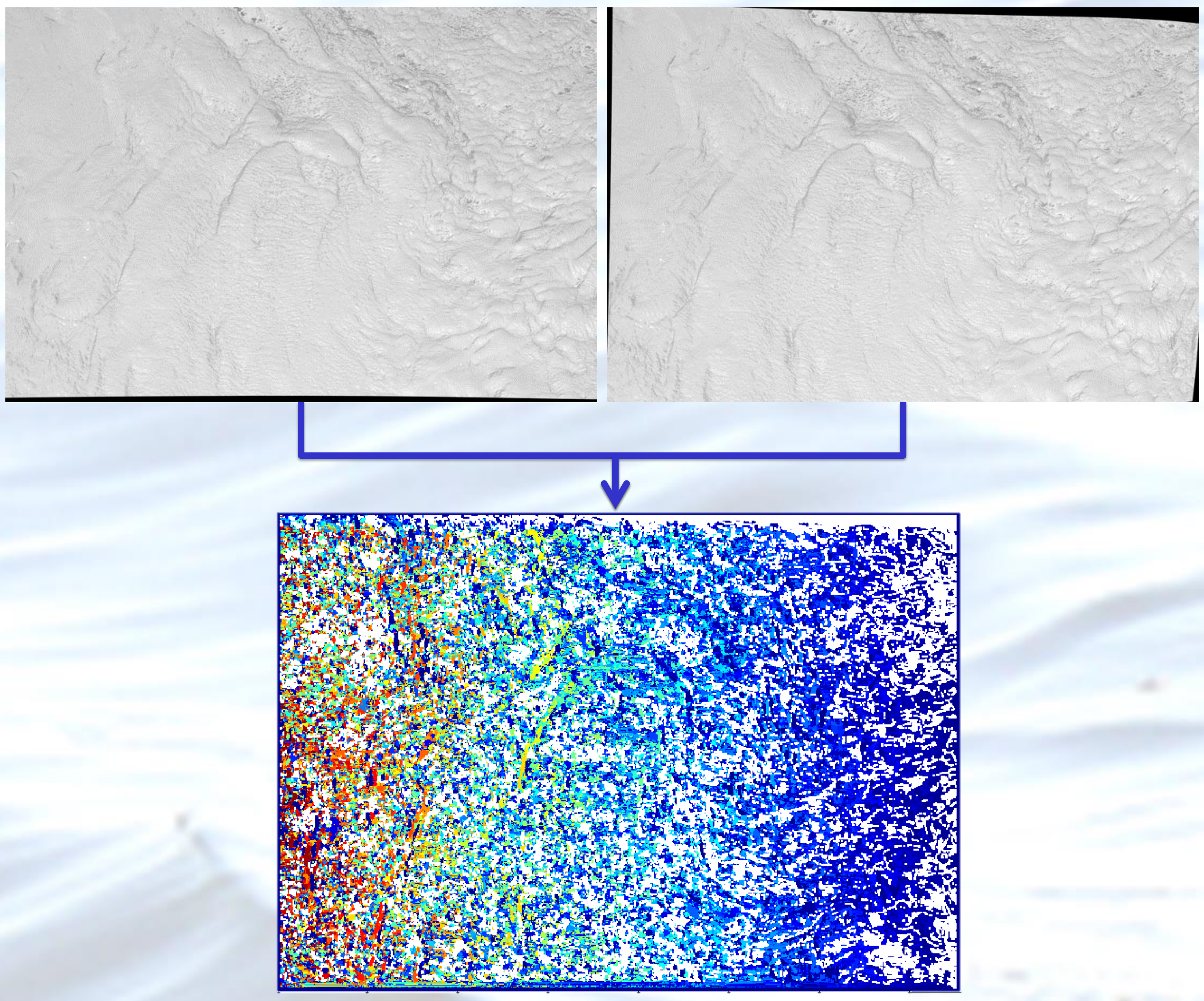
The system is based on a set of pressure sensors. The sensors are mounted on a rigid L-shaped frame and synchronized for spatial and temporal study of the surface. The sampling frequency is set to 10Hz and each sensor allow a millimeter precision of level recording.
The system has to be immerged close enough to the surface in order to record correctly the signal, which decrease exponentially in intensity with the depth (Lacombe 1965). But It also has to be deep enough not to modify the surface. The minimum recording depth appears to be 10cm with this system.
The roughness parameters Hrms and Correlation length are then computed from the pressure time series, using the spatial location of the sensors and temporal synchronization of the recording set.



Example of spatial correlation length computed from Rhône river experiment (Negrel 2001)

Stereo-photogrammetry approach

Although the pressure sensors are accurate for waves greater the 10cm they are unable to record the capillary waves.
Inspired from (Wanek et Wu, 2006), we adapted the method using a couple of 24Mpix DSLR. This resolution offer a good compromise between cost and picture density. The key point of this approach is the matching algorithm to get the perfect corresponding pixel on the right picture for each left picture pixel.
It becomes then possible to make a digital water surface model and process it to extract the roughness parameters.
A first campaign have been lead on the Garonne River (France) and several matching algorithm have been tested. The most promising one is based on a sliding cross –correlation window (Yurovskaya 2013)



Example of matching results on pictures couple from the Garonne river

Conclusion & Prospectives

The both approaches are complementary and can be easily deployed for ground measurement.
The stereo-photogrammetry method still need to be improved for a more dense surface recognition and validated on controlled conditions.
The characterization of the river water surface must now be realized on several wind and flow velocity conditions to get a better understanding of the river wave generation.

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