

# Analysis of the SAR-derived Wind Signature over Extra-tropical Storm Conditions

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# Summary

- Motivations
- Tropical cyclones monitoring
- Azimuth cutoff
- Experiments
- Conclusions





# Motivations

HURRICANE KATRINA (2005)



**Category 5 Saffir Simspon scale (SSHS)**

**1830 victims**

**Category 5 SSHS**

**1300 estimated deaths**

HURRICANE MATTHEW (2016)





# Cyclones monitoring

**HURRICANE HUNTERS**



**REMOTE SENSING**





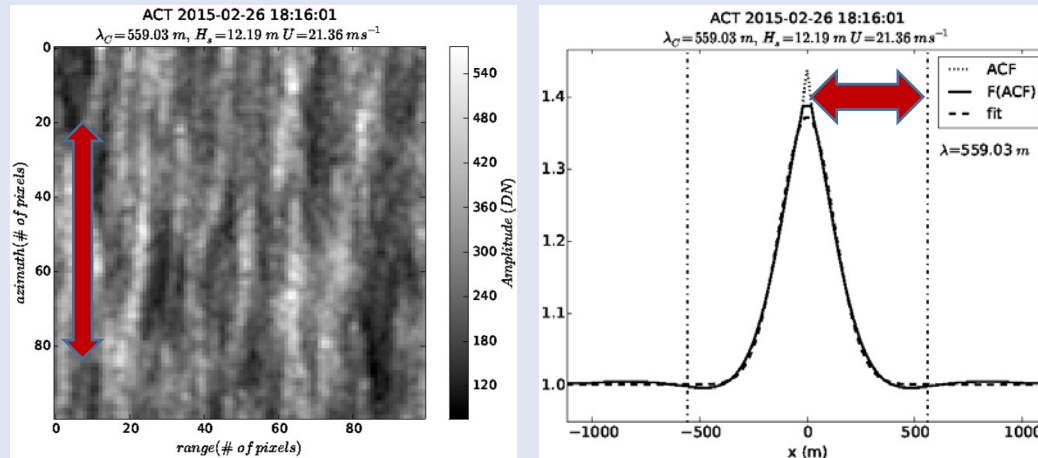
# Remote sensing

- **Microwave sensors**
- **Synthetic Aperture Radar**
- **Ocean phenomena**
- **Sea surface wind retrieval**



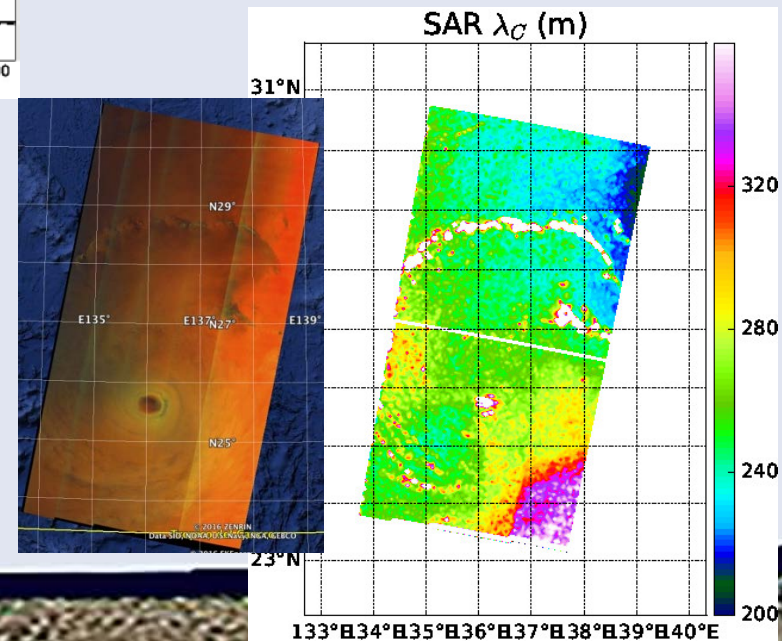
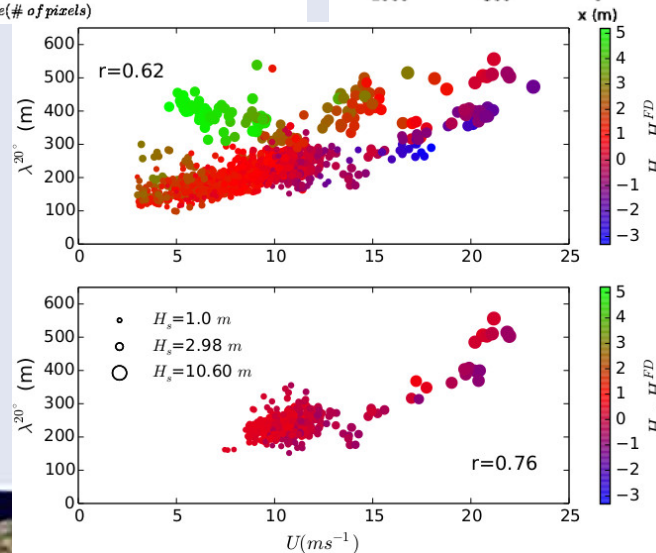
# Azimuth cutoff

The azimuth cut-off can be successfully used to retrieve  $H_s$  (and  $U^{10}$ ?)



Good agreement in FD state

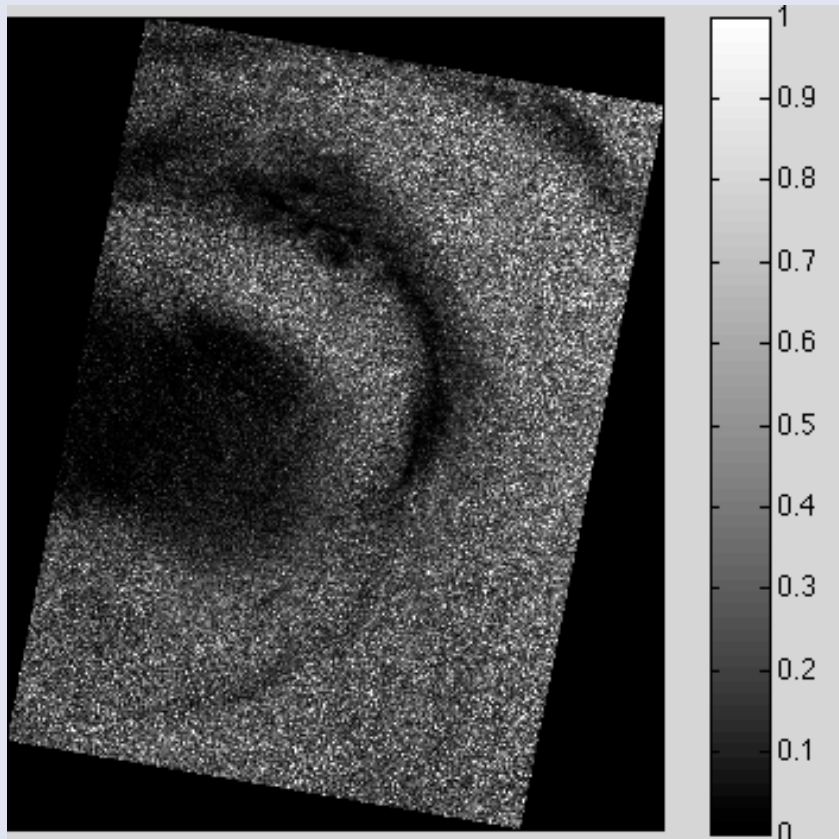
Not good in extreme cases.  
 Why? *Work in progress*





# Dataset

## Typhoon Megi



### **DATASET:**

TerraSAR-X ScanSAR  
mode

**Date:** October 21, 2010

**Time UTC:** 22:05:16

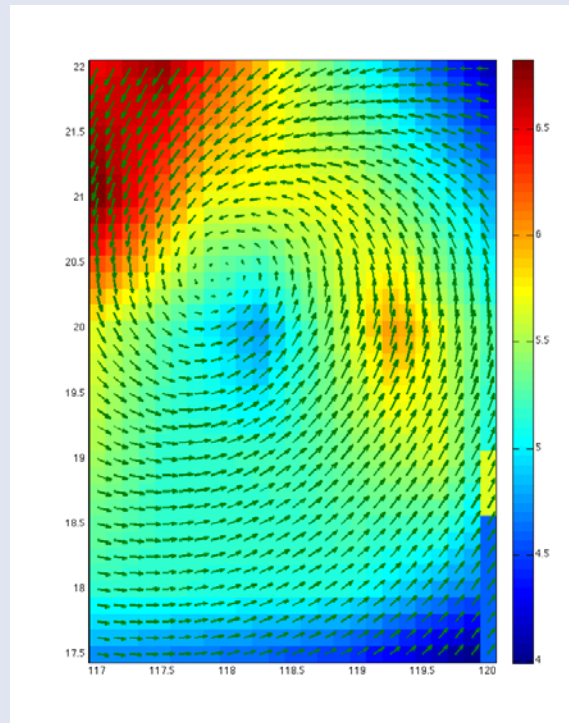
**Resolution:** 8.25 m



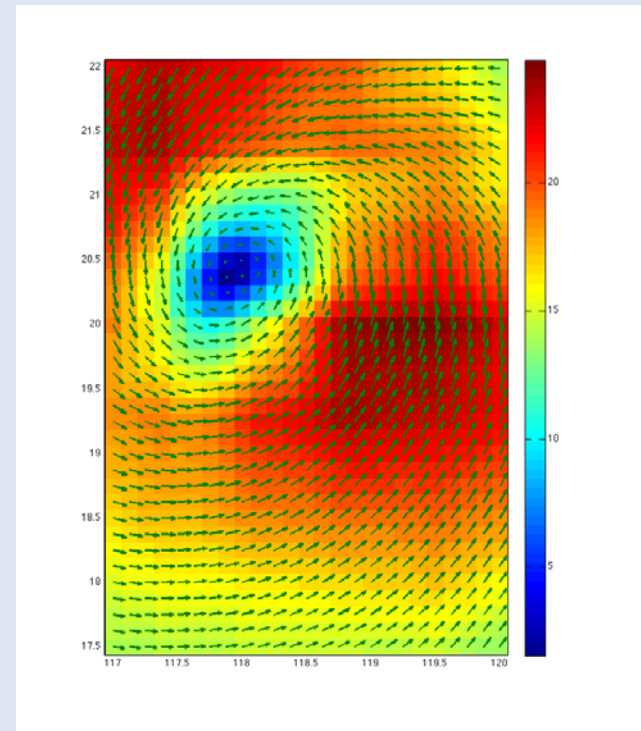
# Dataset

## ECMWF

SWH (m)



Wind speed (m/s)

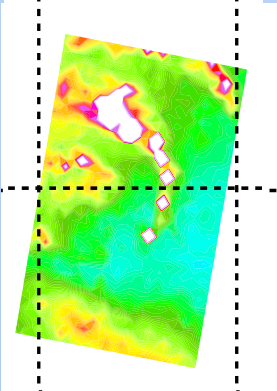
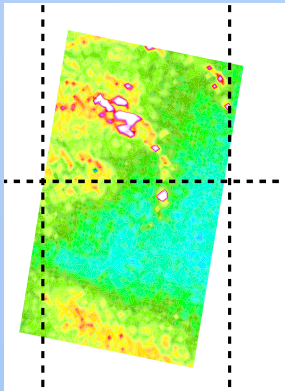


# Experiments

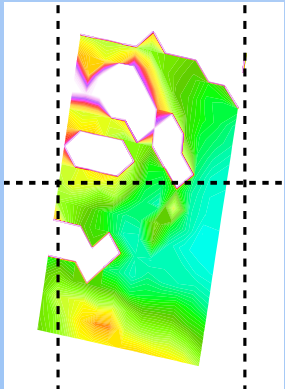
## Resolution 8 m

256x256

512x512



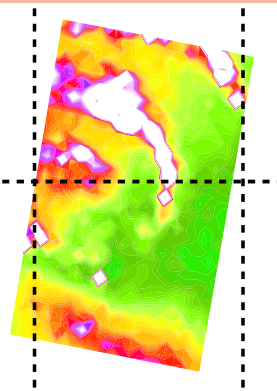
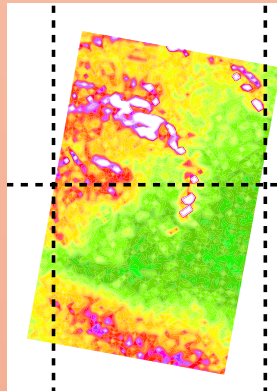
1024x1024



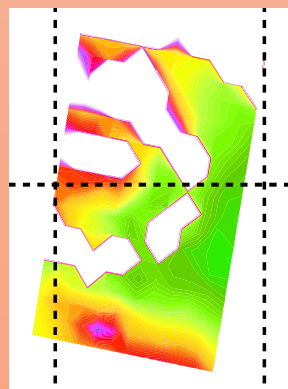
## Resolution 17 m

128x128

256x256



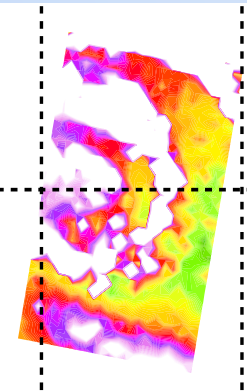
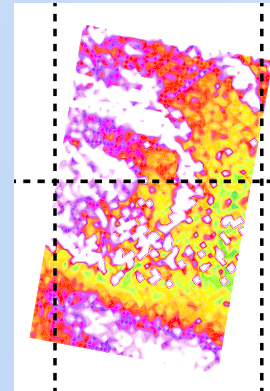
512x512



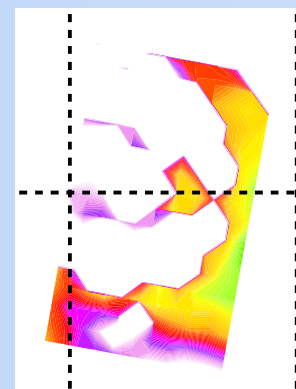
## Resolution 33 m

64x64

128x128



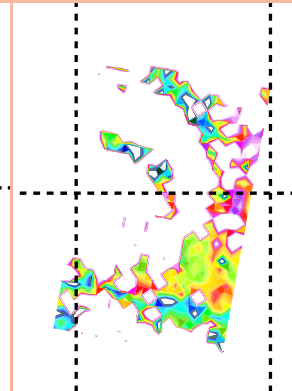
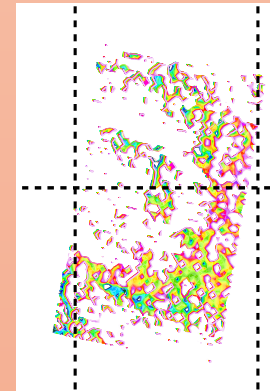
256x256



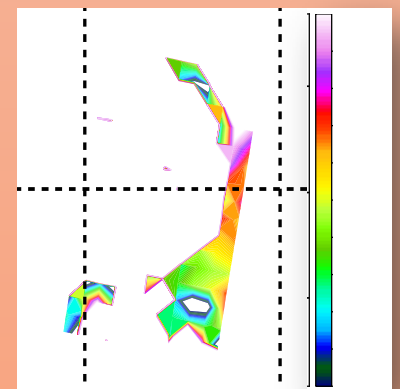
## Resolution 66 m

32x32

64x64



128x128



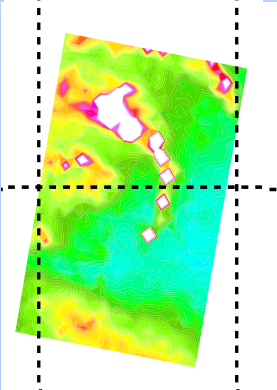
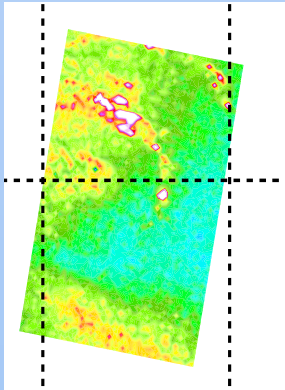


# Experiments

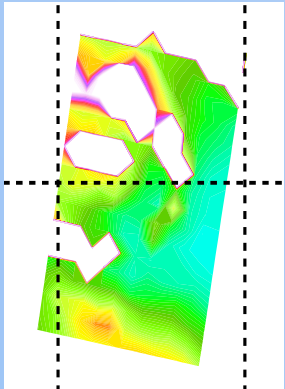
## Resolution 8 m

256x256

512x512



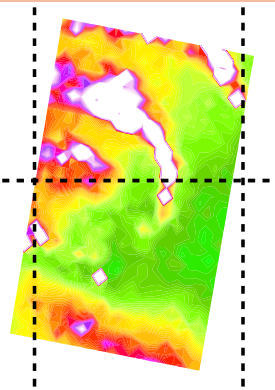
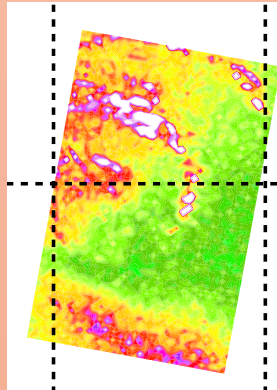
1024x1024



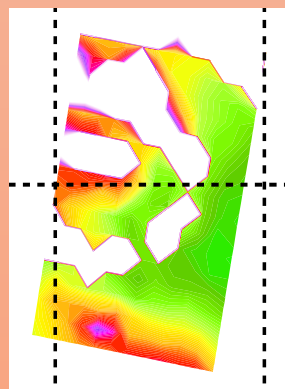
## Resolution 17 m

128x128

256x256



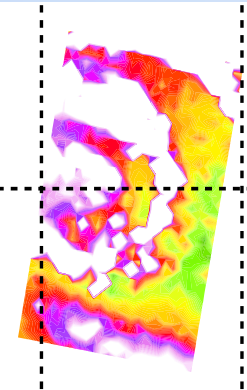
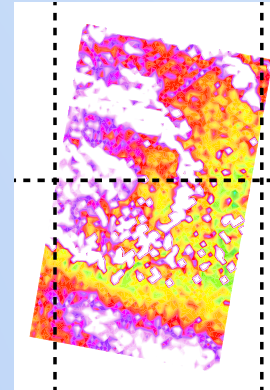
512x512



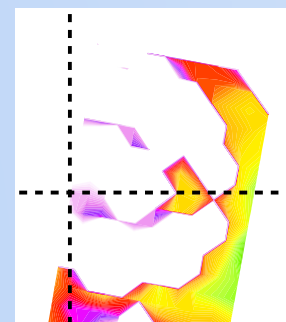
## Resolution 33 m

64x64

128x128



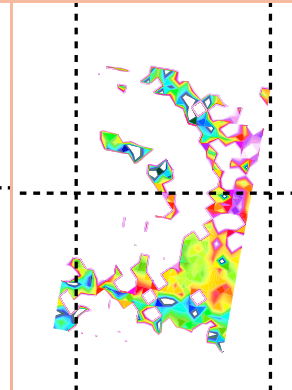
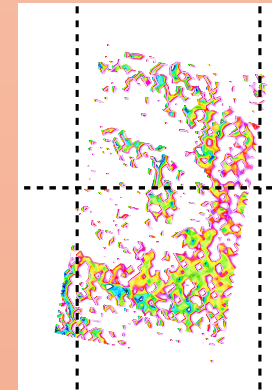
256x256



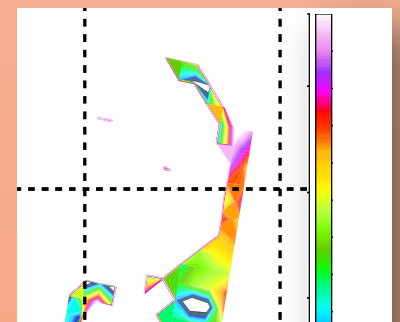
## Resolution 66 m

32x32

64x64



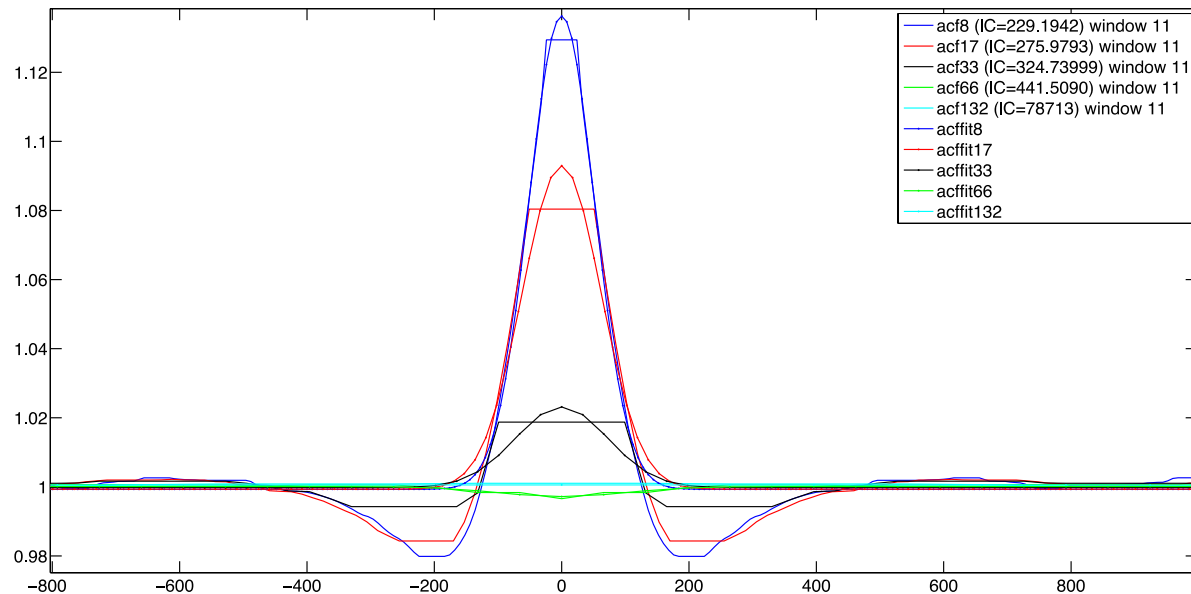
128x128



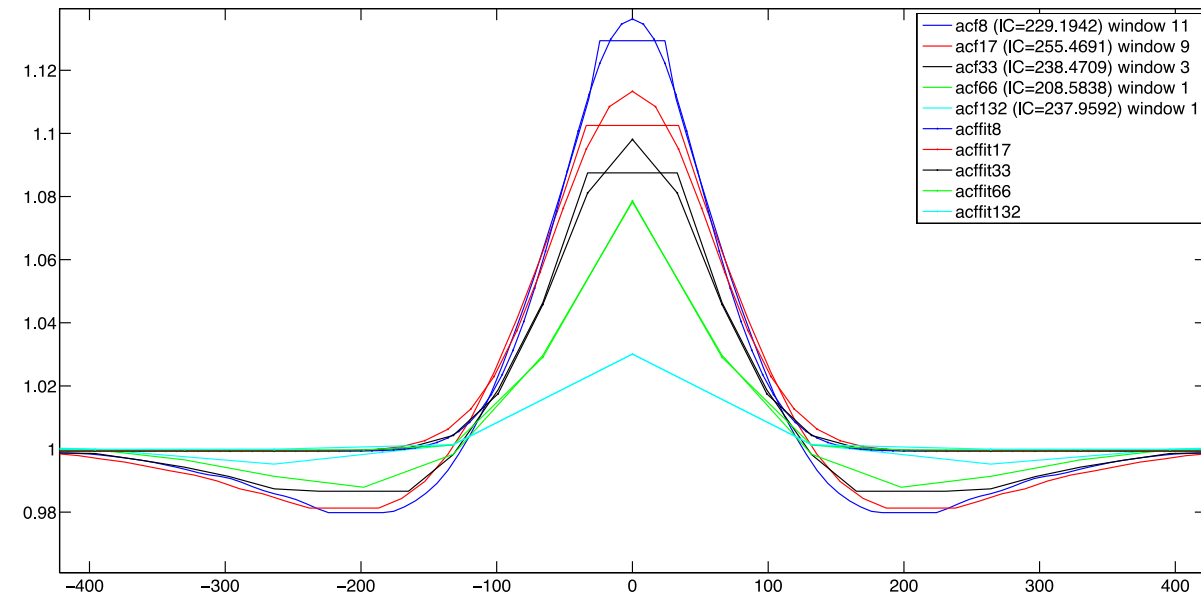
$$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$$

# Results

Acf fits at different resolutions and fixed median filter window: 11



Acf fits at different resolutions and variable median filter window

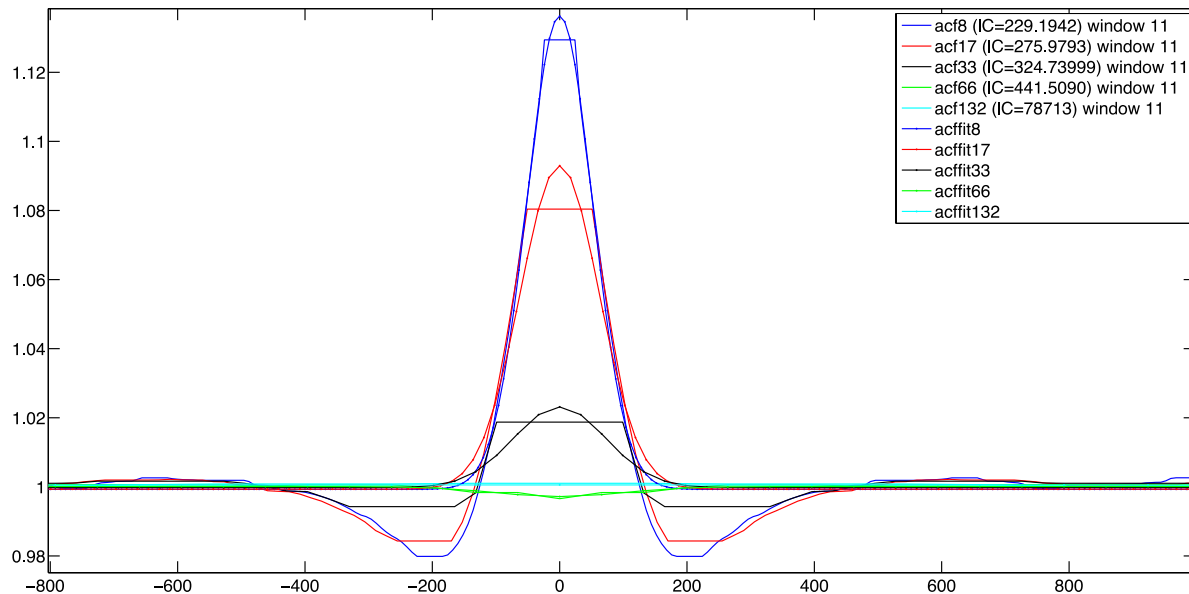


$$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$$

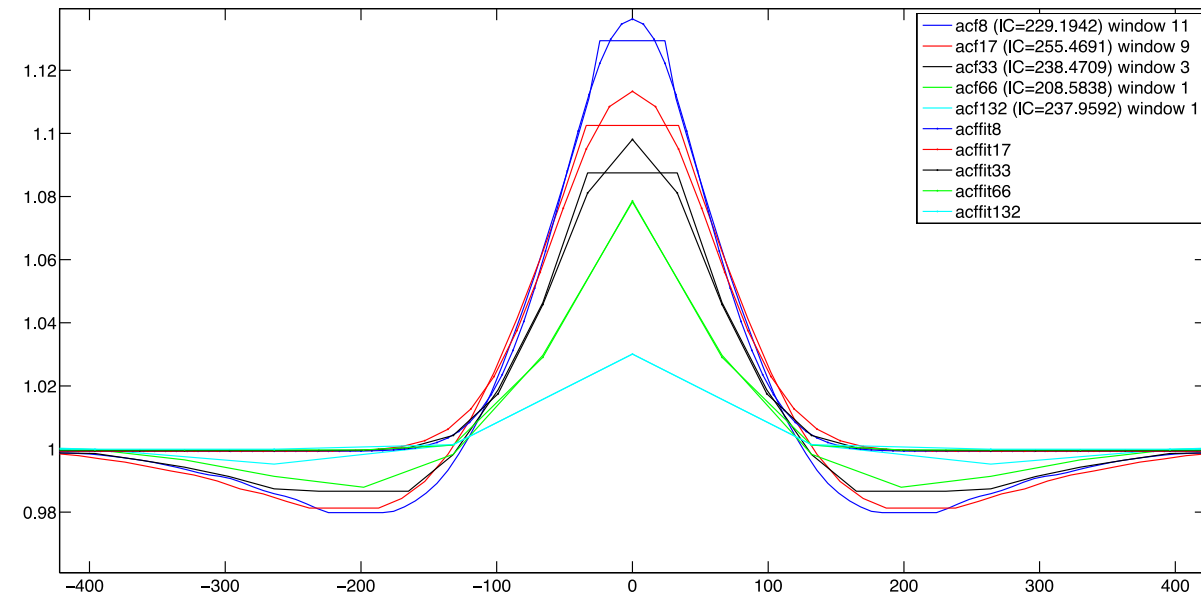


# Results

Acf fits at different resolutions and fixed median filter window: 11



Acf fits at different resolutions and variable median filter window

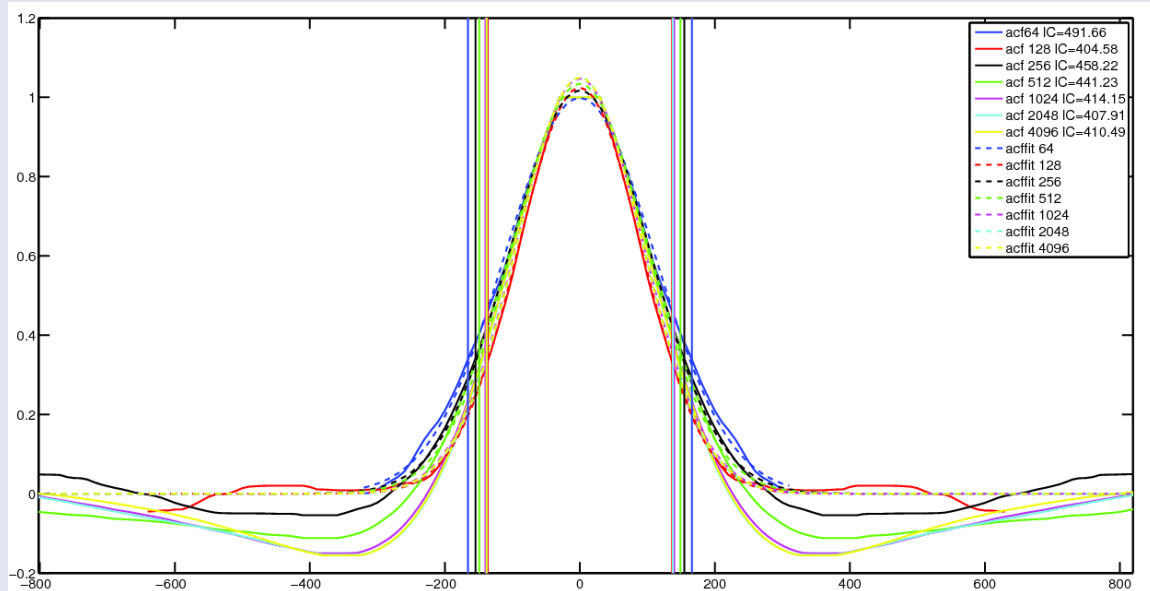


$$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$$

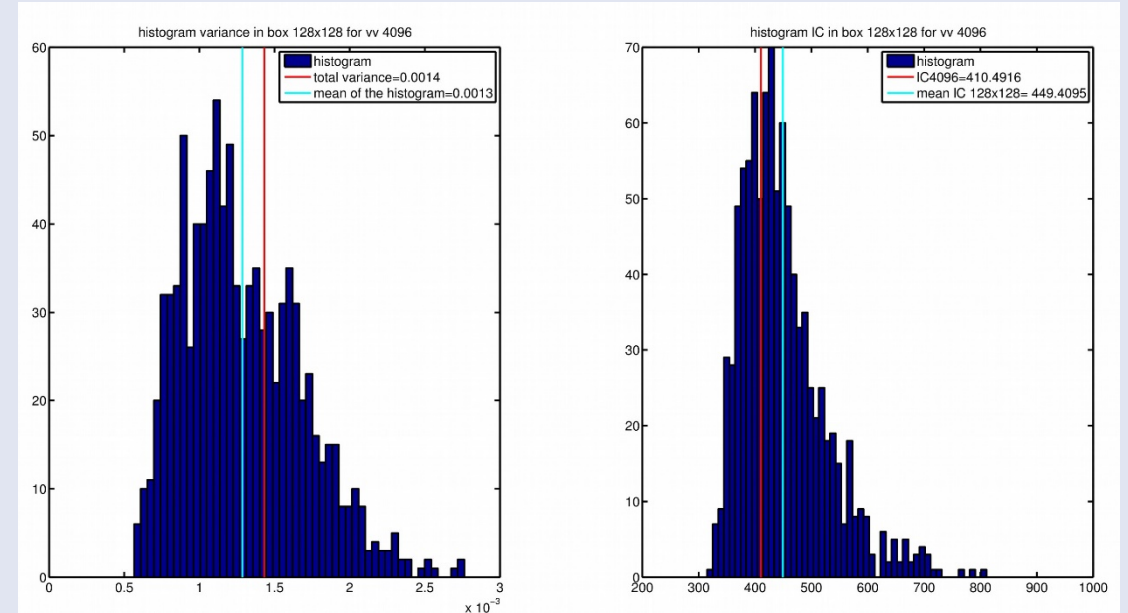
Median filter window should be fixed at about 100-120 m

# Results

$\text{mean}(\lambda_c) \pm \text{std}(\lambda_c)$



$\text{Std}(\lambda_c) \sim 5\%$



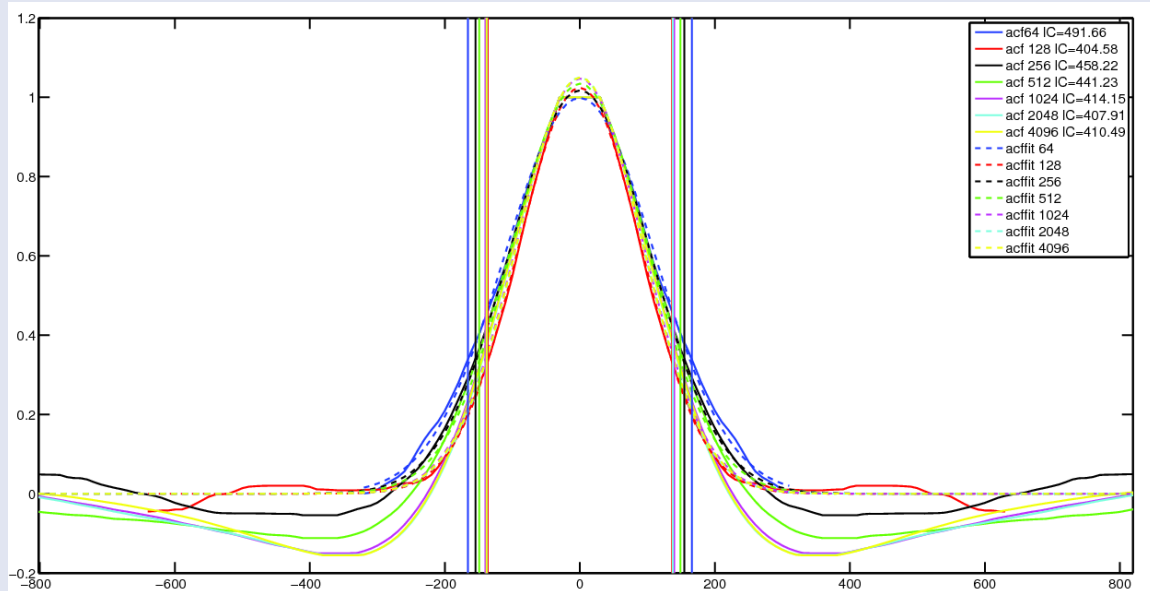
$\text{Std}(\lambda_c) \sim 13\%$

$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$

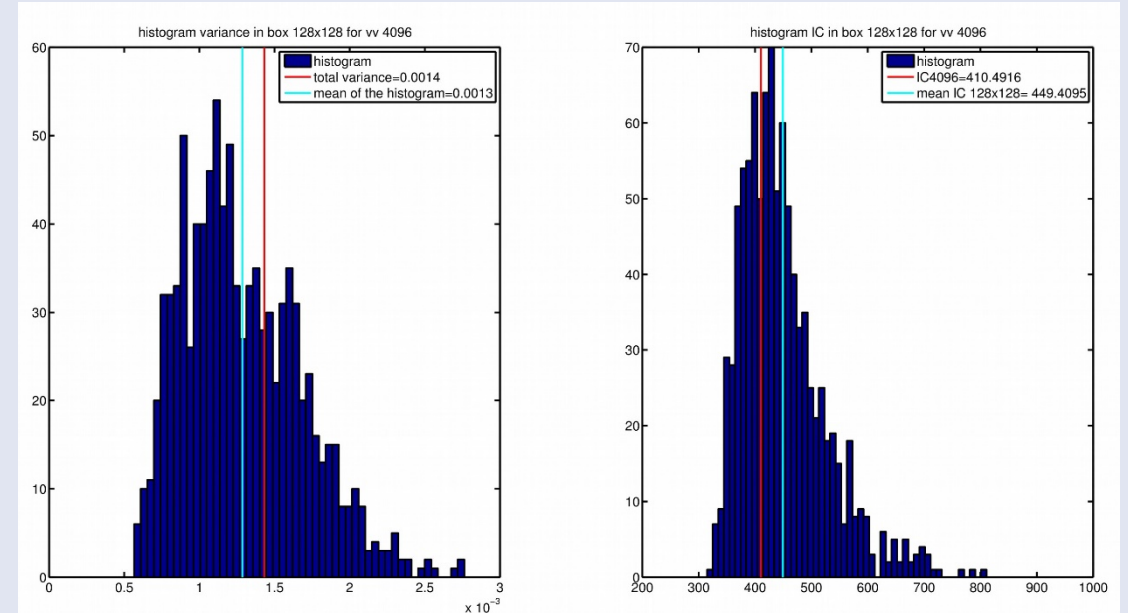


# Results

$\text{mean}(\lambda_c) \pm \text{std}(\lambda_c)$



$\text{Std}(\lambda_c) \sim 5\%$



$\text{Std}(\lambda_c) \sim 13\%$

$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$

Tolerance is of about 13%

# Results

- 3 Sentinel-1 dataset GRD Stripmap mode
- VV polarization
- 10m pixel spacing
- November 2014 – May 2015

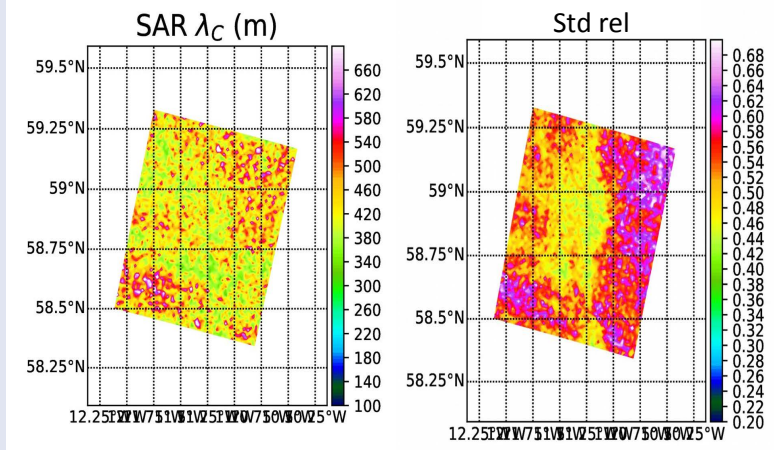
1. Less homogeneity and high wind speed
2. More homogeneity and high wind speed
3. Less homogeneity and low wind speed

$$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$$

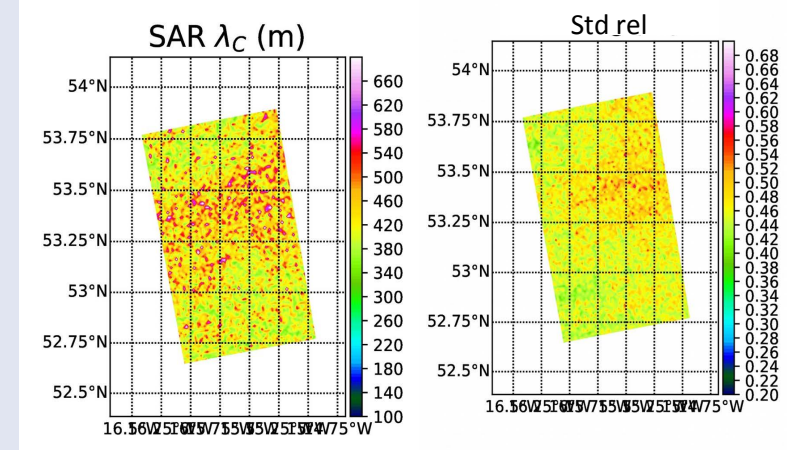


# Results

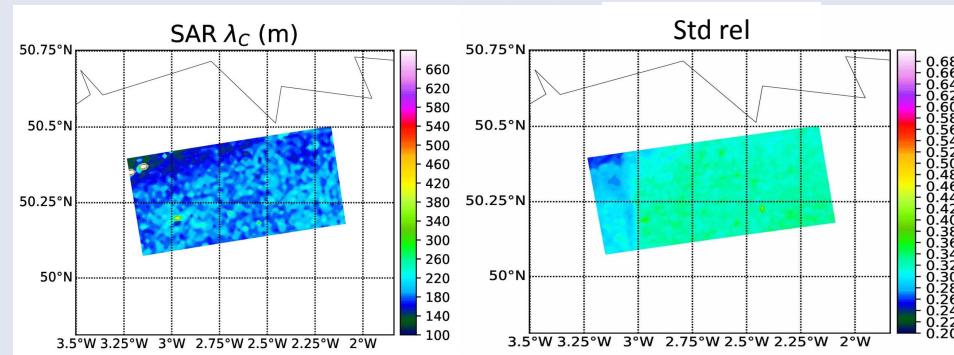
## Dataset 1



## Dataset 2

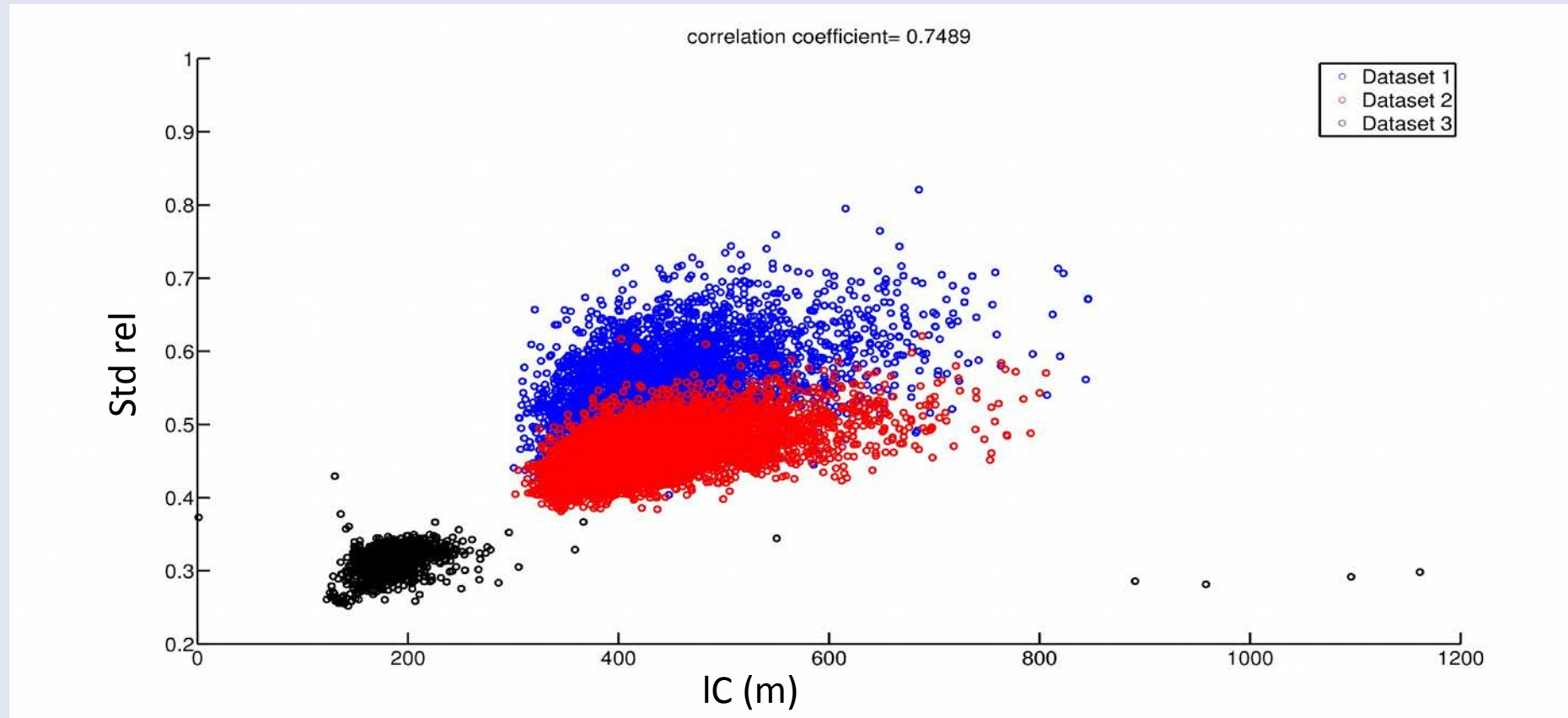


## Dataset 3



$$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$$

# Results



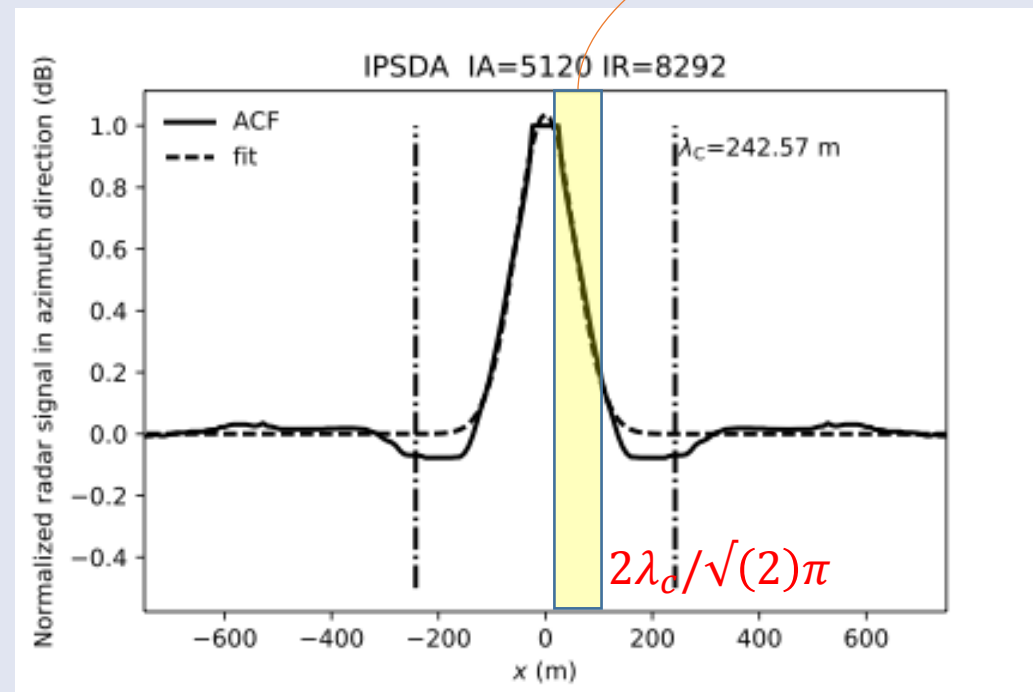
$$\lambda_c \sim F(\text{Pixel spacing}, \text{Box size}, \text{Homogeneity})$$

A preliminary analysis of std rel can be useful to apply IC approach

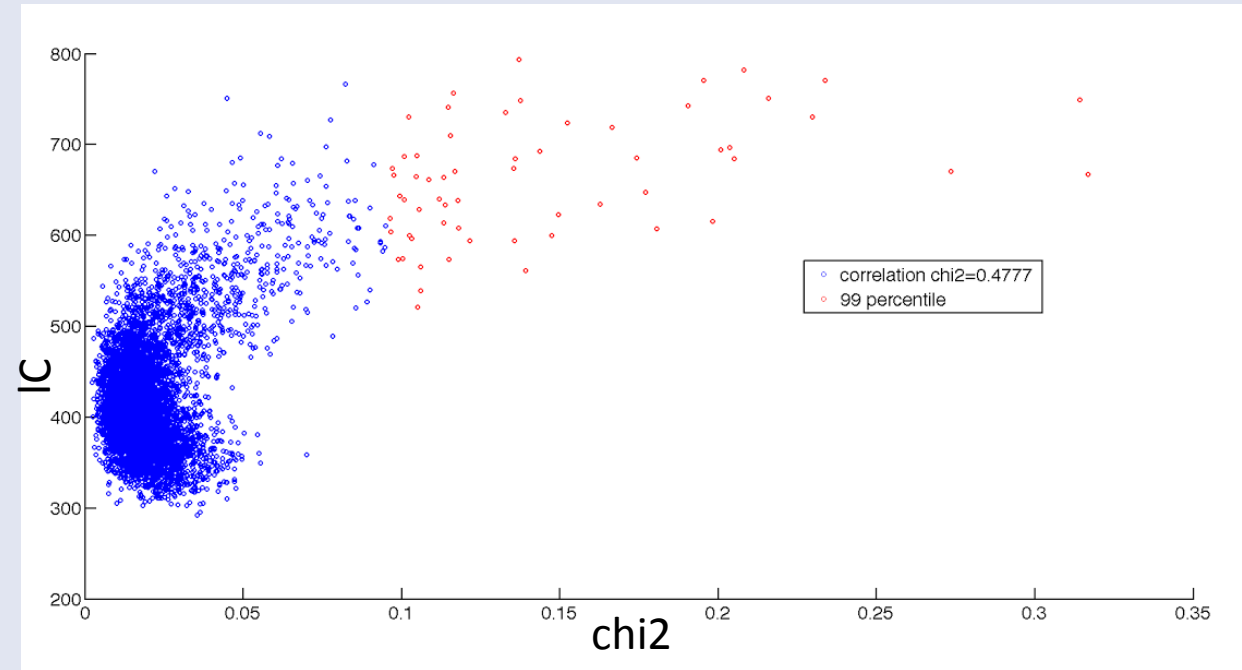
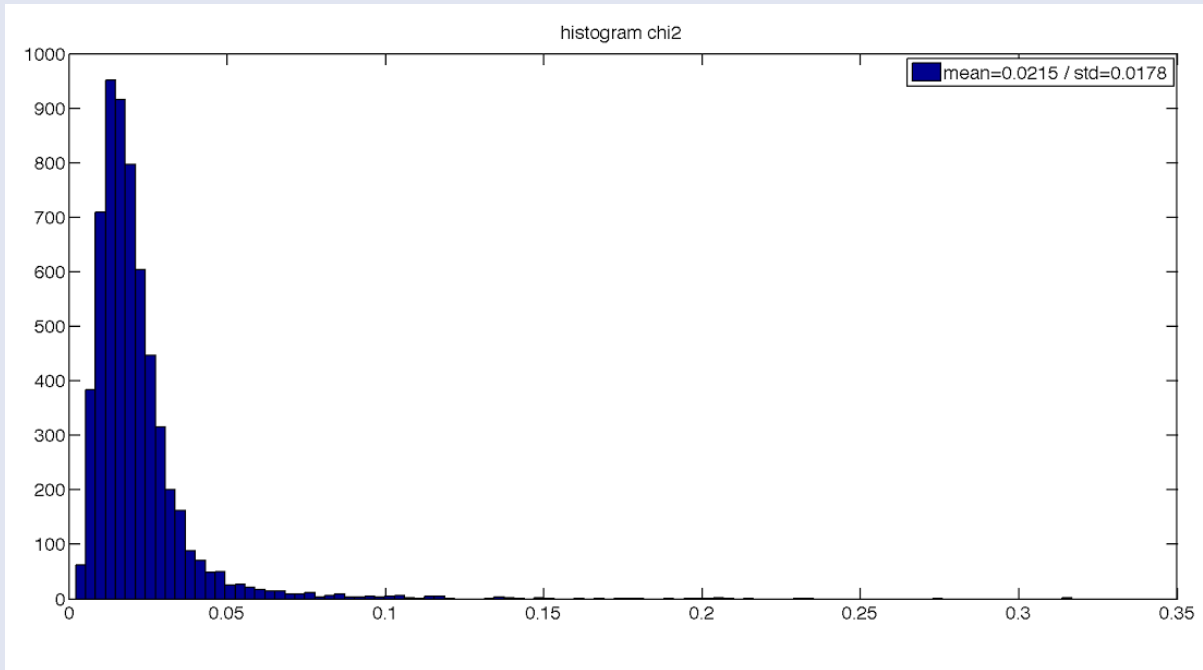


# Results

**Chi2=chisquare(acf-acffit)**

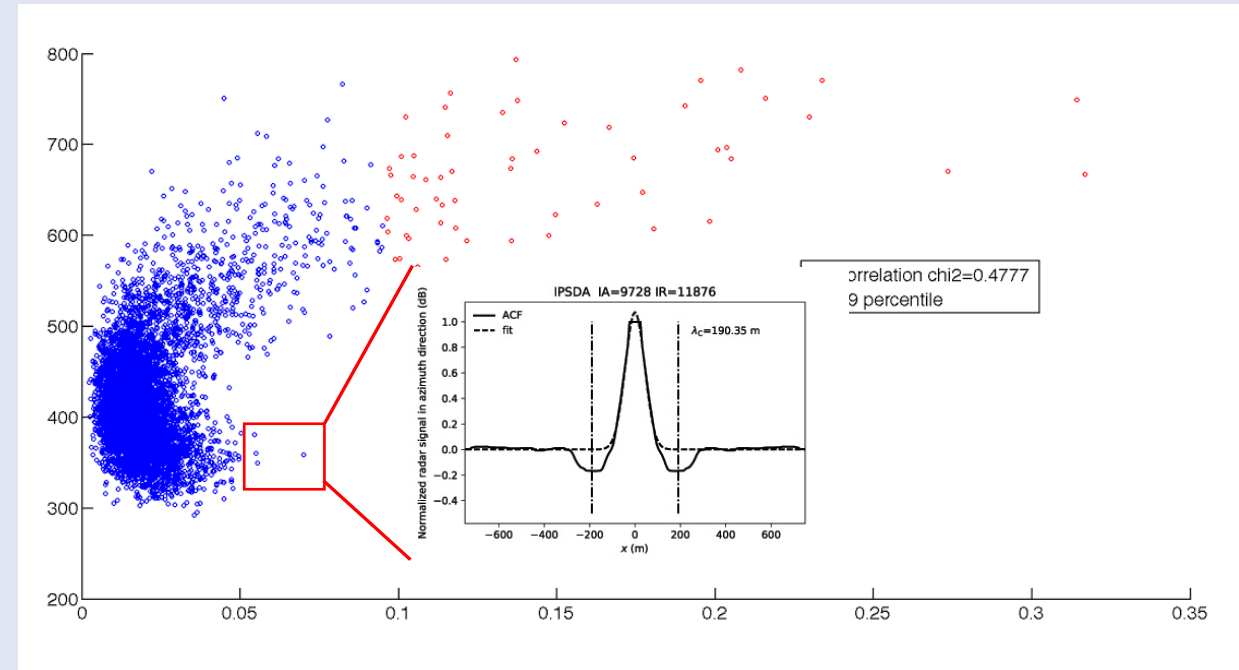
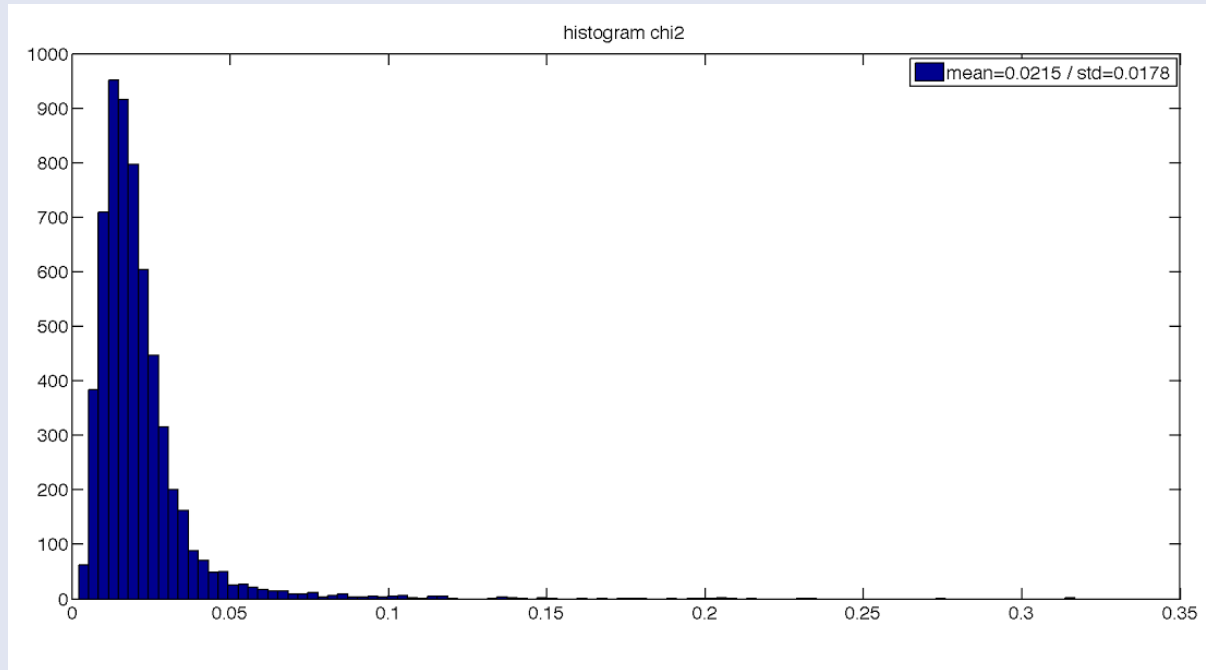


# misfit

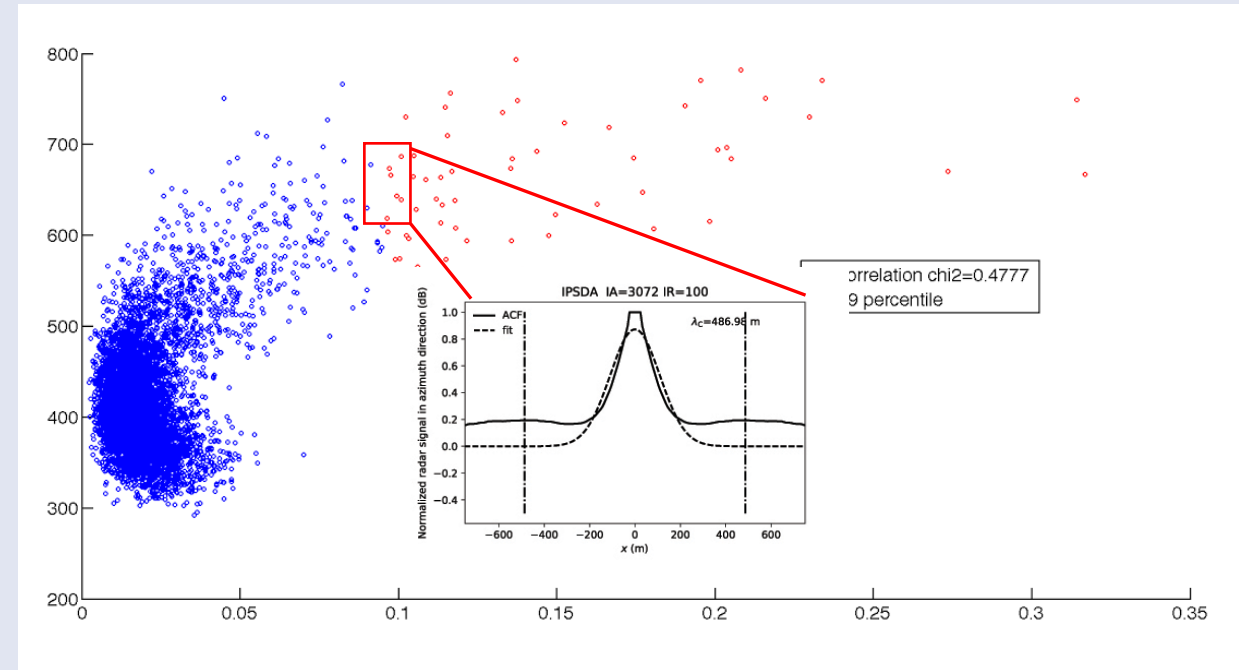
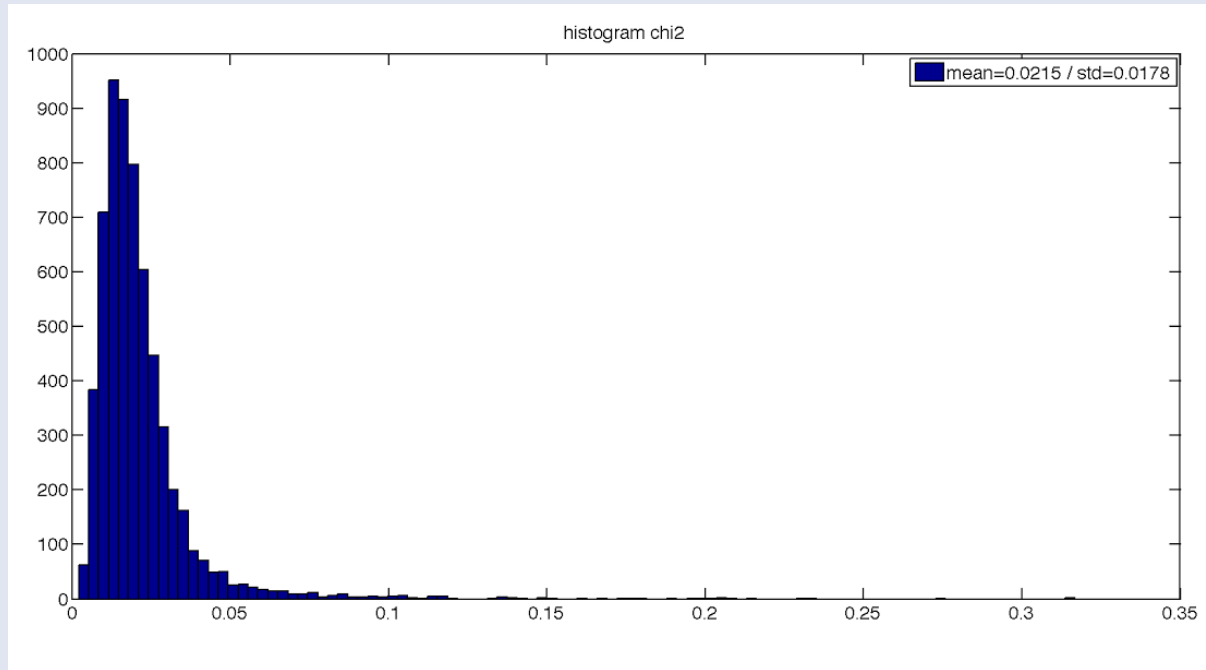




# misfit

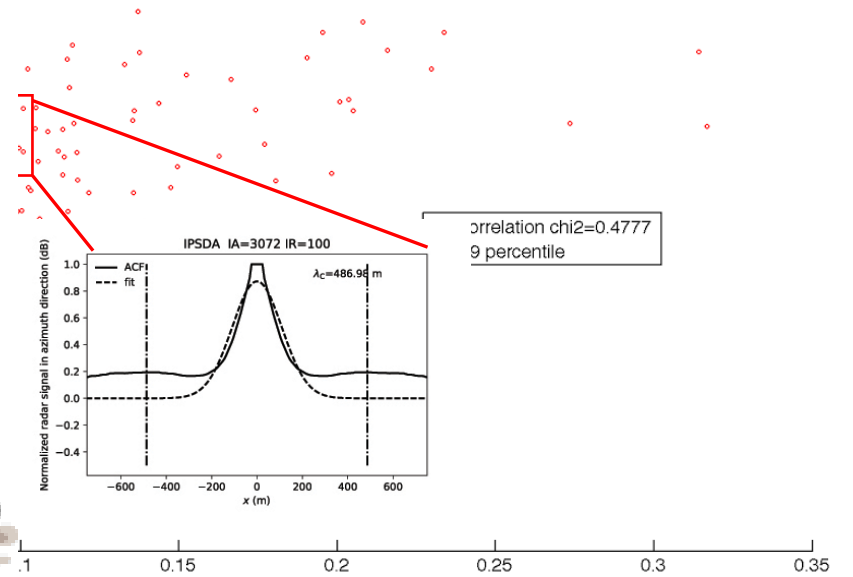
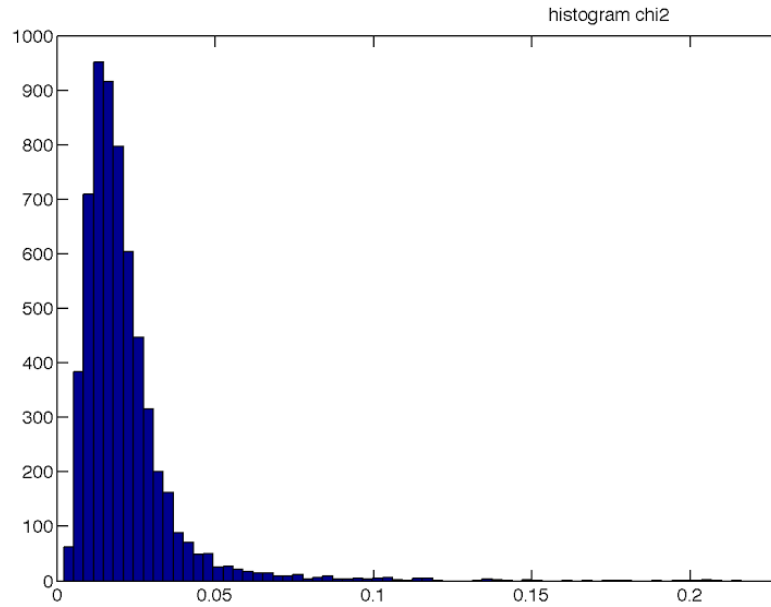


# misfit





# misfit



# Conclusions

In this work, azimuth cutoff approach has been applied under extreme wind conditions, such as typhoons.

- By downgrading the backscatter resolution and increasing the size of the boxes, we experimented an increasing in azimuth cutoff values.
- We conclude that the azimuth cutoff depends on backscatter resolution (or pixel spacing), box size and homogeneity.
- We tried to find a stand-alone criterion of the goodness of the azimuth cutoff for each parameter of dependence.
- Also a misfit analysis have been carried out, in order to find a criterion that allows to exclude non reliable azimuth cutoff values.
- Chisquare analysis should be accompanied by second analysis, because of the border line cases.





Thank you for attention