What can we learn from Ku and C band surface backscatter

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Altimeter

Most radar altimeters operate a two frequencies

- Ku band (13.5 GHz)
- And
  - C band (5.3 GHz) Jason, Topex
  - Or S band (3.2 GHz) Envisat

The two frequencies are sensitive to surface capillary-gravity wave of different wavelengths

Ku : 2.2 cm C : 6 cm S :9 cm

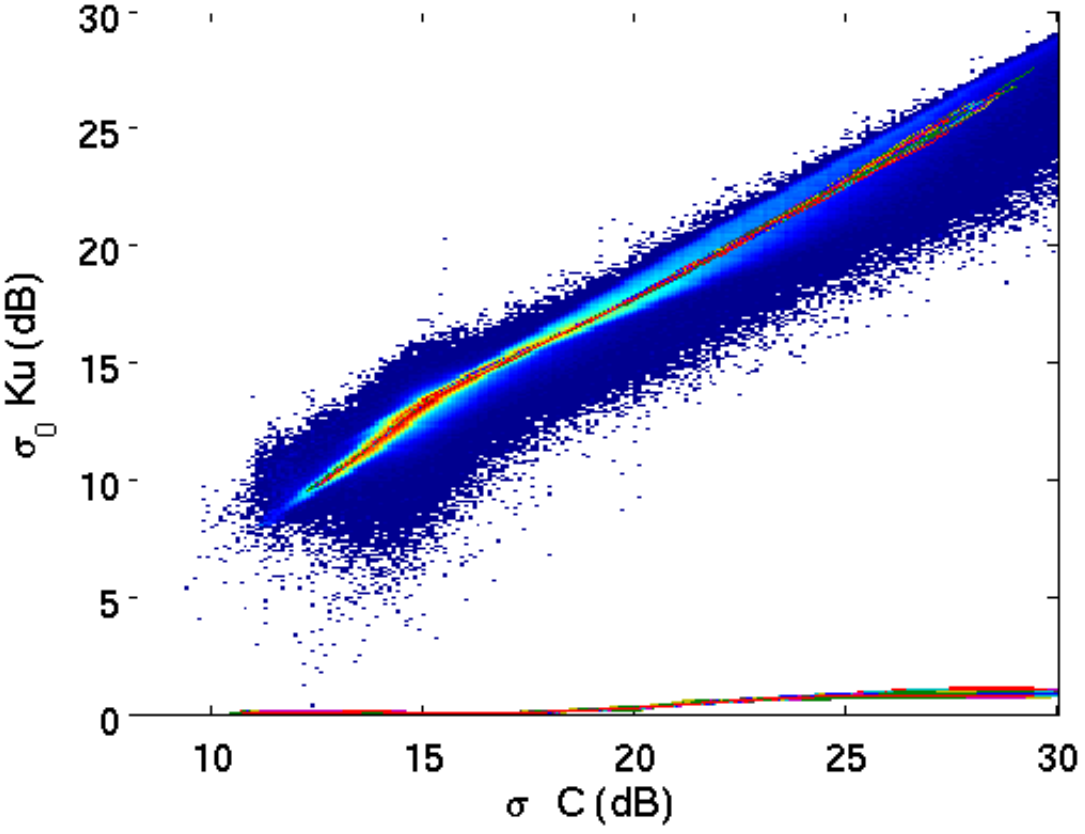
Very long archives (1992-present)

Ku/C or Ku/S relationship

- The dual frequency measurements are perfectly collocated in time and space
- Estimation of a mean relationship and its rms
- Use to detect rain affected samples Ku : Rain attenuation is frequency dependant, Detection of samples where Ku is attenuated versus C or S band and presence of liquid water
- Question : what can we learn from the samples that do not follow the mean relationship (outside 2 rms) ?
-

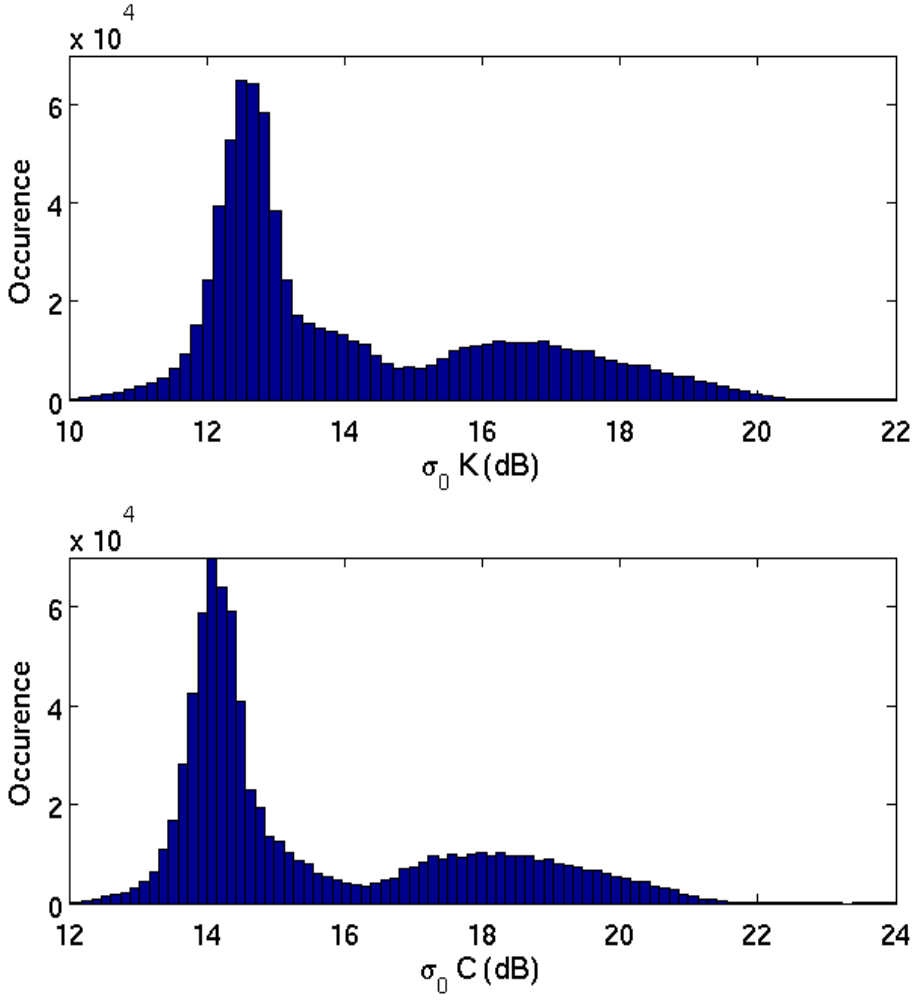
Mean relationship

2D histogram of s0 Ku and C (~2.10^8 samples)



Ku Attenuation : rain if presence of liquid water
Ku enhancement ?
Ku attenuation if no liquid water

Enhancement



$\sigma_0$ku-f(σ_0C) >2 rms(σ_0c)

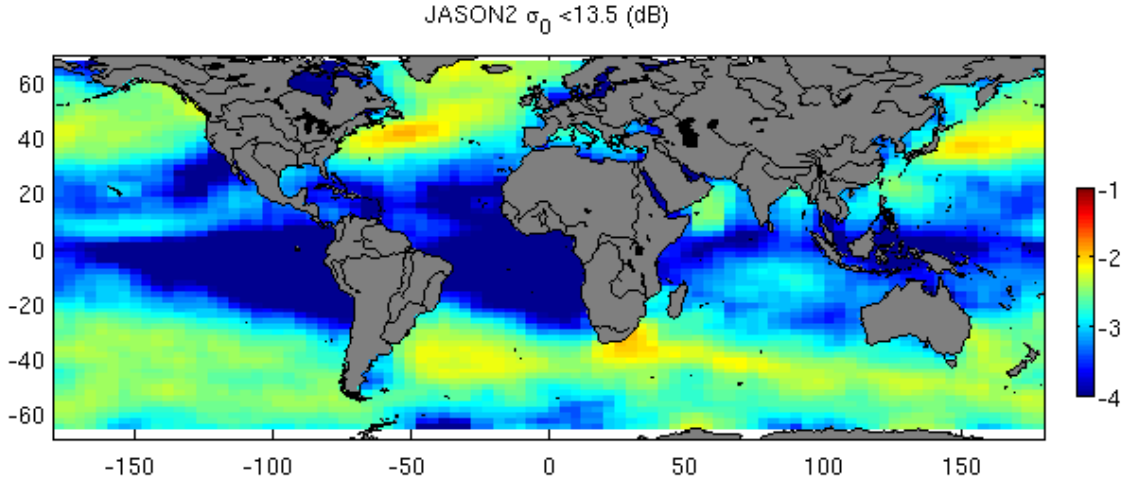
More backscatter from Ku band (2 cm waves) than C band (6 cm waves), i.e. more roughness in 6 cm range than that at 2 cm range.

T avoid any problems related to atmospheric attenuation by liquid water only case with low liquid water (<0.1 kg·m²) are considered

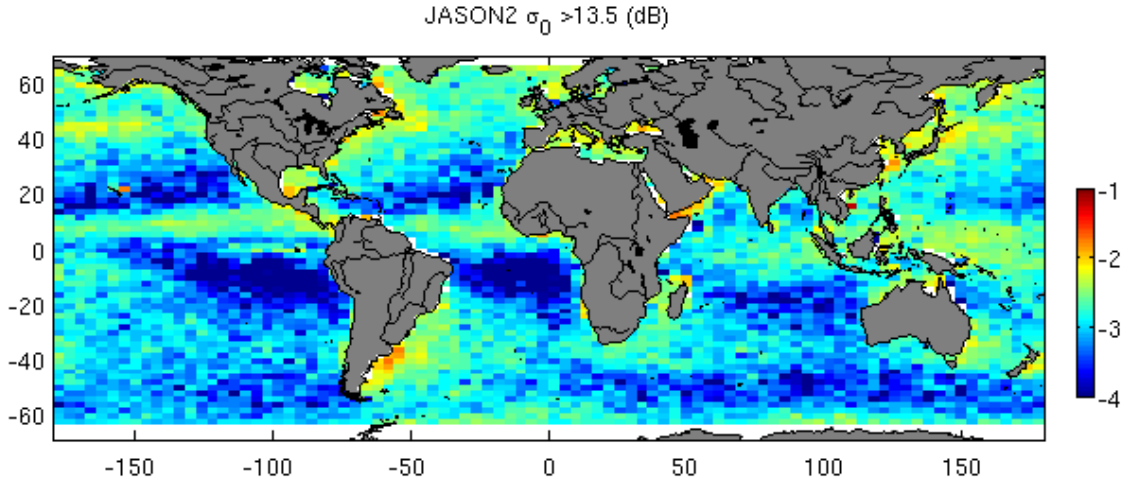
Distributions of σ_0Ku and $\sigma_0$0 C for this kind of measurements are strongly bimodal with a cutoff at 14 dB (Ku).

Two regimes one corresponding to low wind speed and the other to medium to high winds

Geographical distribution of %age of samples

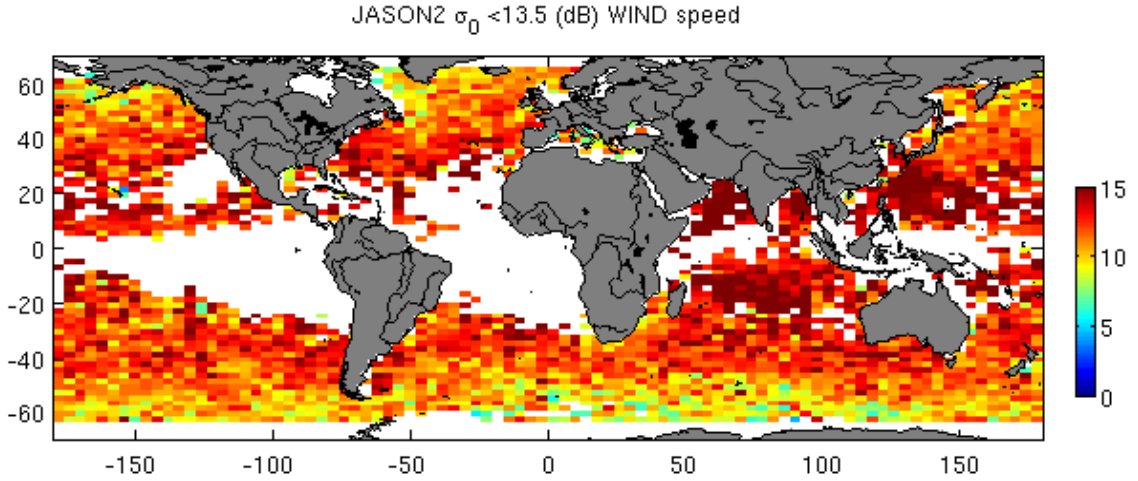


High winds
Clear association with strong currents, almost reproduces the distribution of Ocean Eddy Kinetic Energy distribution

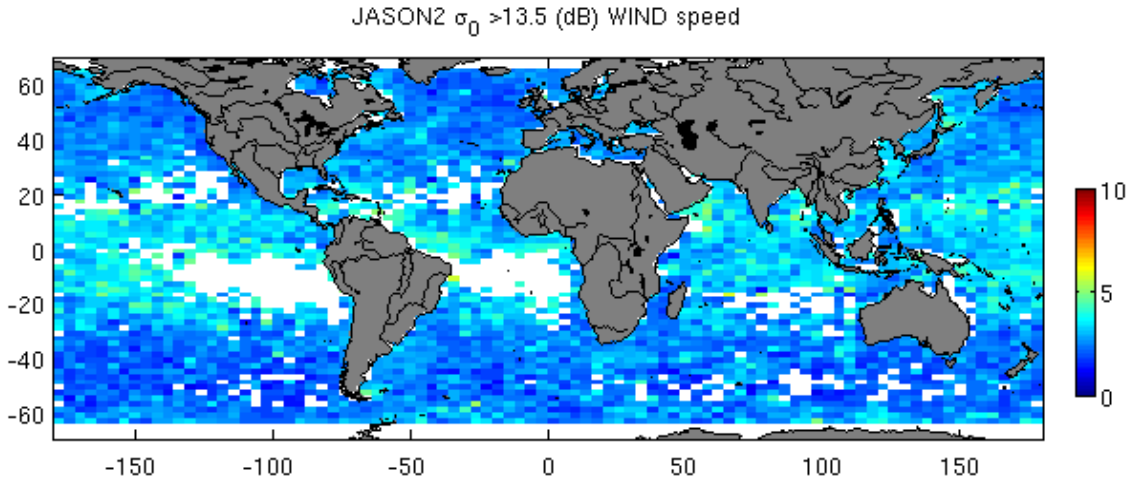


Low winds
Tropical and equatorial regions (surface films?)
Low winds and strong current

Geographical distribution ECMWF wind speed



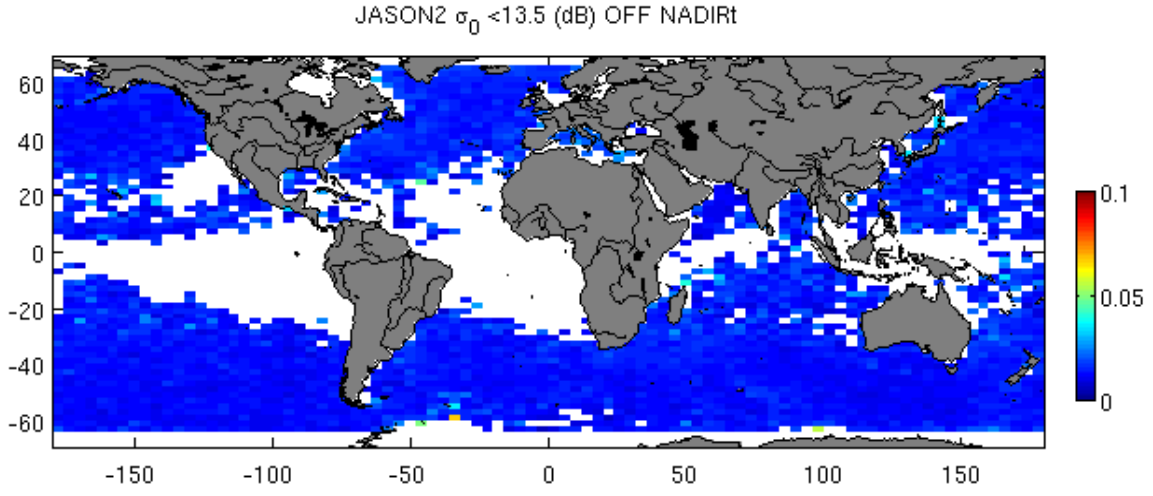
High winds
Quite homogeneous repartition of wind
Stronger winds in the tropics



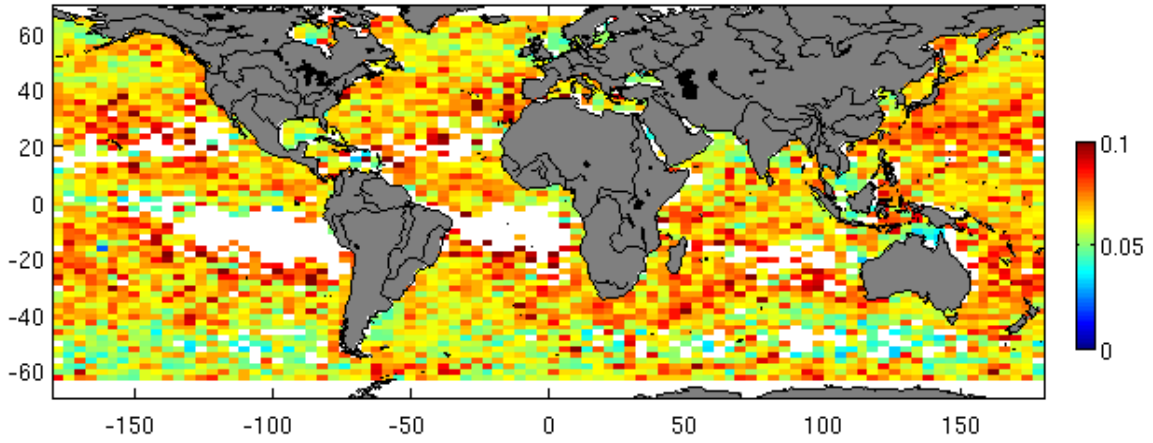
Low winds
Tropical and equatorial regions higher winds (~3-4 m/s than that at higher lat

Geographical distribution off nadir angle

Off nadir angle estimated from waveforms analysis is a good indicator of the waveforms distortion. Waveform distortion is related to the inhomogenity of the surface backscatter within the altimeter footprint



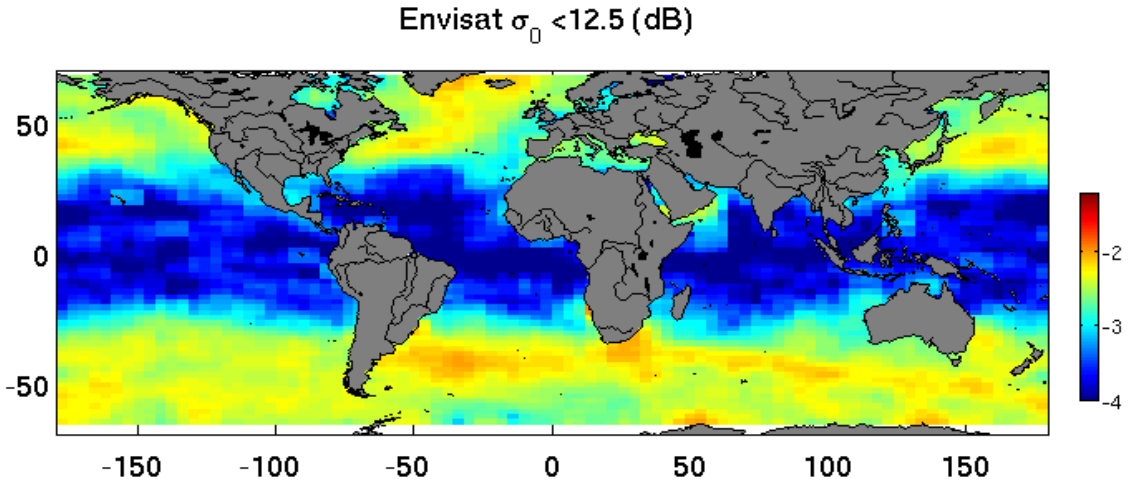
High winds
Very low off-nadir angle
No waveform distortion
Homogeneous backscatter

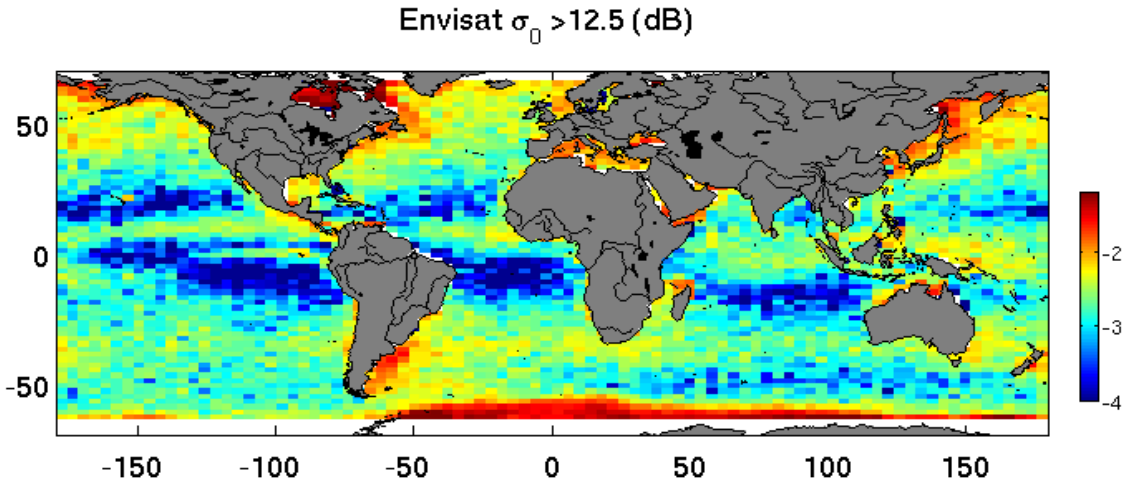


Low winds
High distortion. Under light winds the surface backscatter is strongly inhomogeneous.

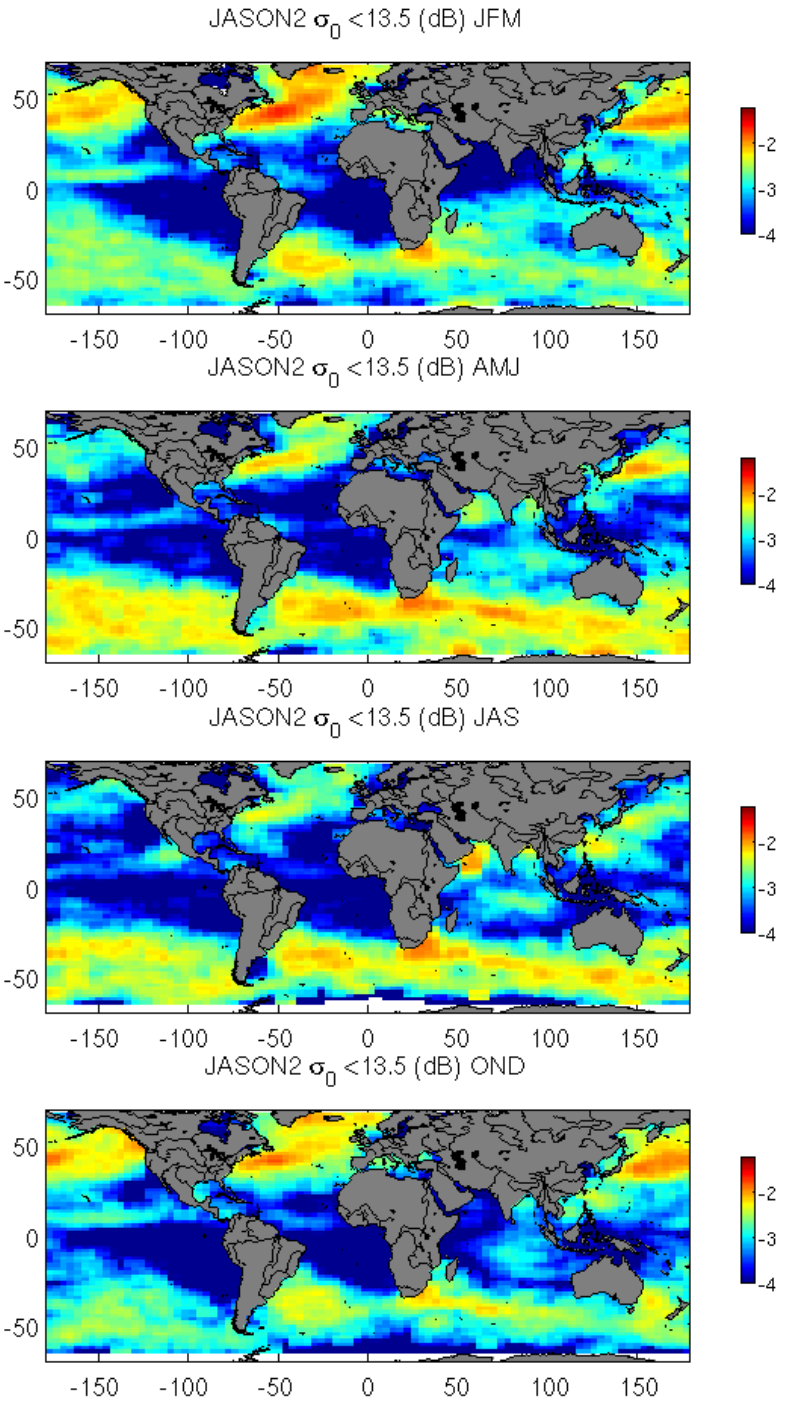
KU/S band from Envisat altimeter

Same analysis f Envisat Ku/S band backscatter . Similar to Ku/C prove the robustness of the results two independent measurements from two different instruments





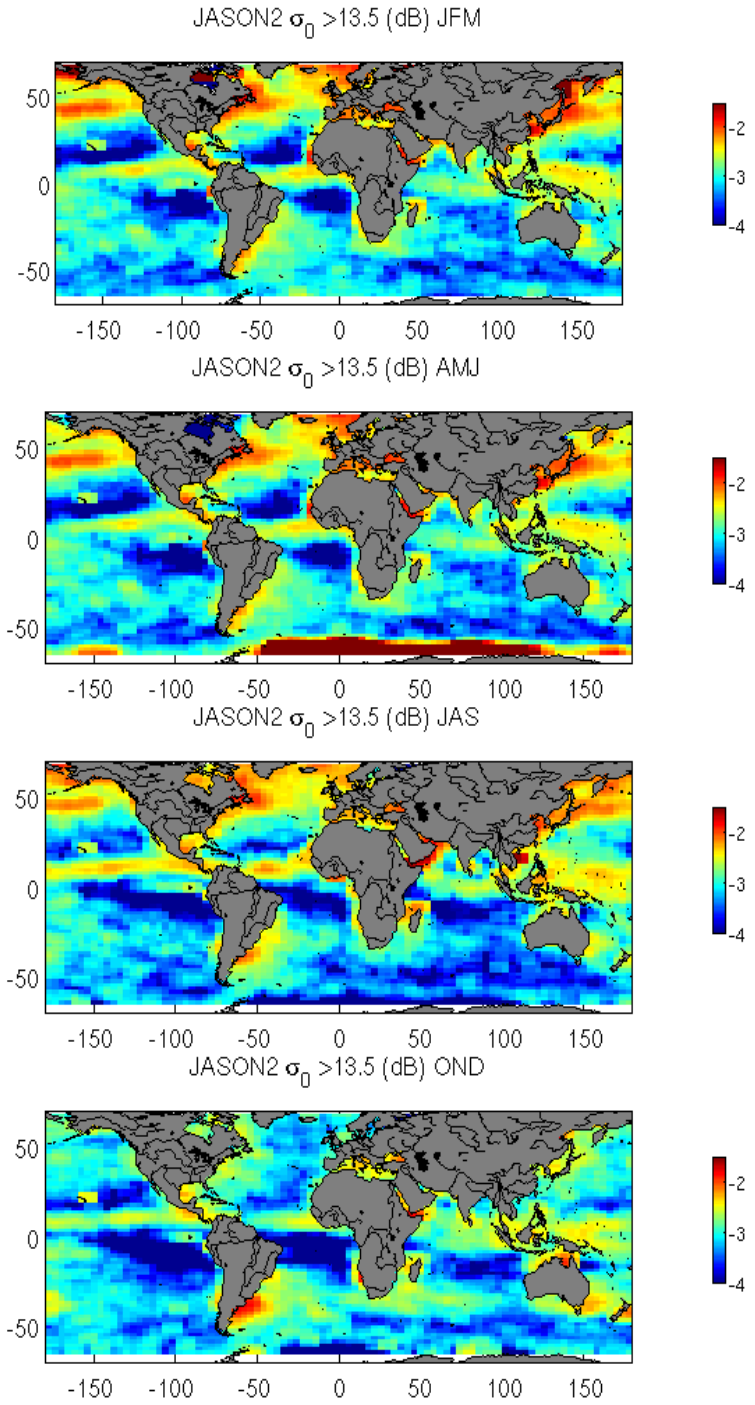
Seasonal variability



Reflects the shift of seasonal wind patterns

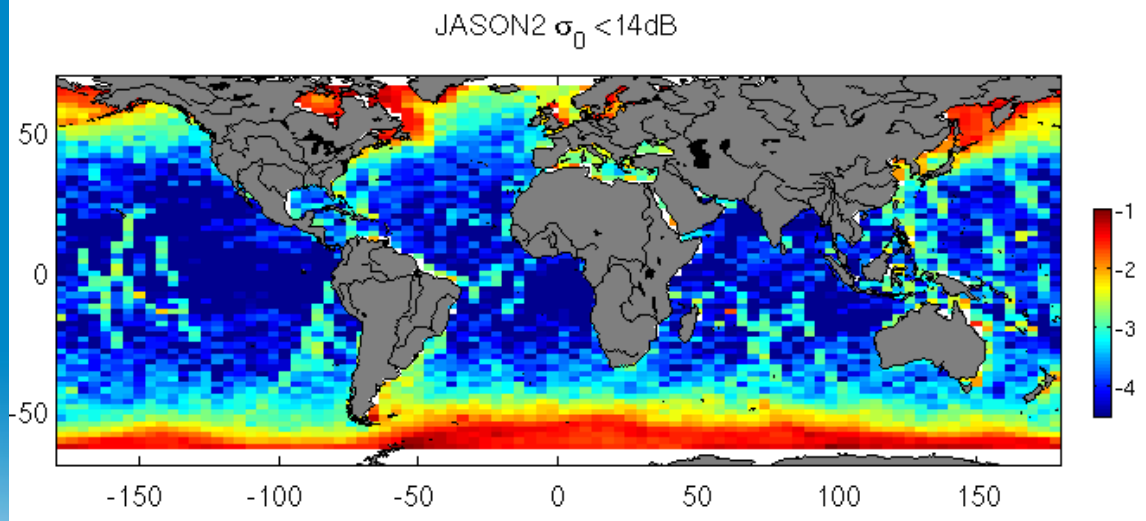
Always related to the distribution of surface current

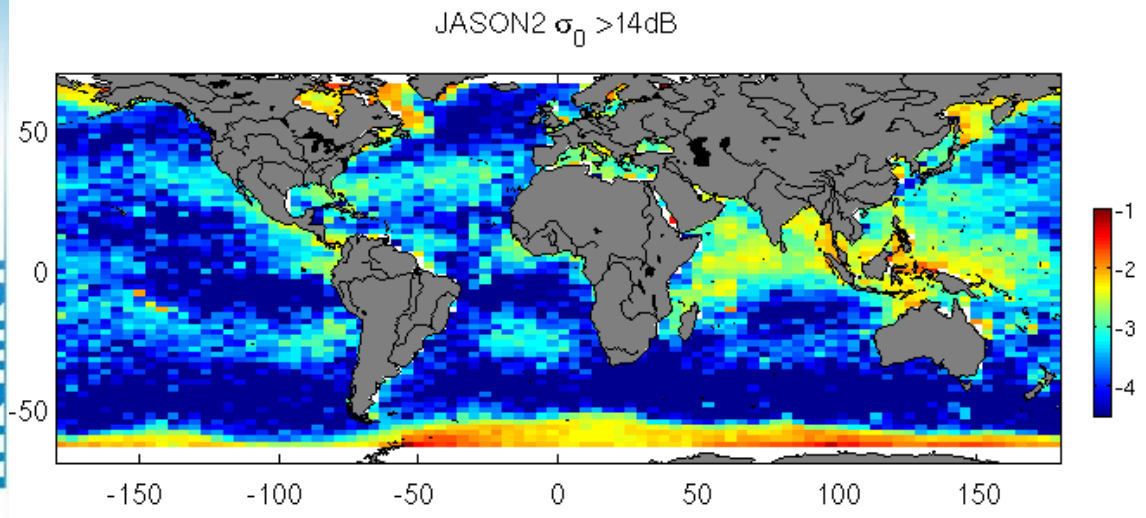
Seasonal variability low winds



Appears to be at least partly related to the distribution of ocean Chlorophyll
See in particular the patterns in Malvinas bassin.

Attenuation





$\sigma_0$ku-f(σ_0C) <-2 rms(σ_0c)

More backscatter from C band (6 cm waves) than Ku band (2 cm waves), i.e. more roughness in 2 cm range than that at 6 cm range.

More difficult because rain attenuation has the same effect on the signal.

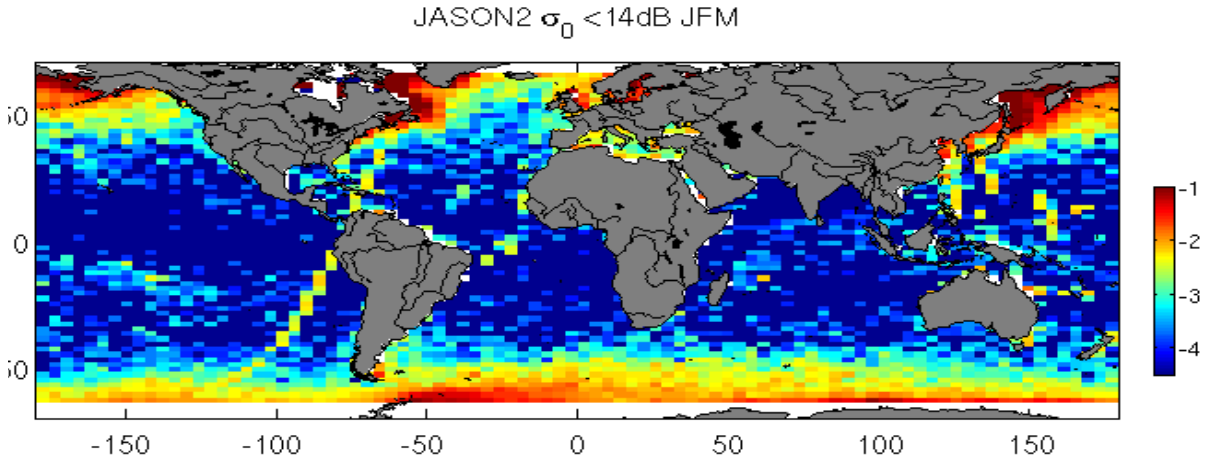
We consider only the samples for which the liquid water content is below 0.5 kg/m²

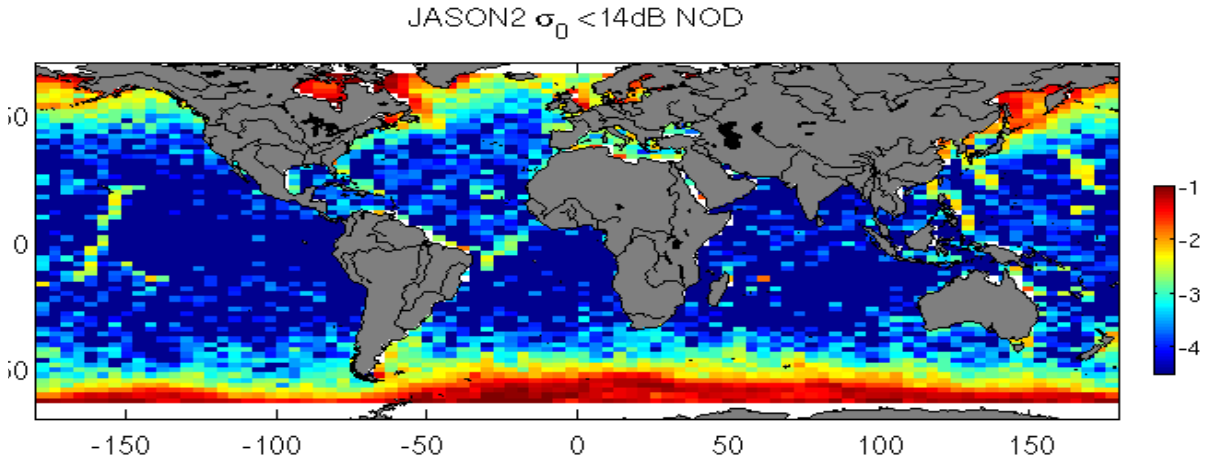
Distributions of σ_0Ku and $\sigma_0$0 C for this kind of measurements are strongly bimodal with a cutoff at 14 dB (Ku).

Two regimes one corresponding to low wind speed and the other to medium to high winds

Attenuation

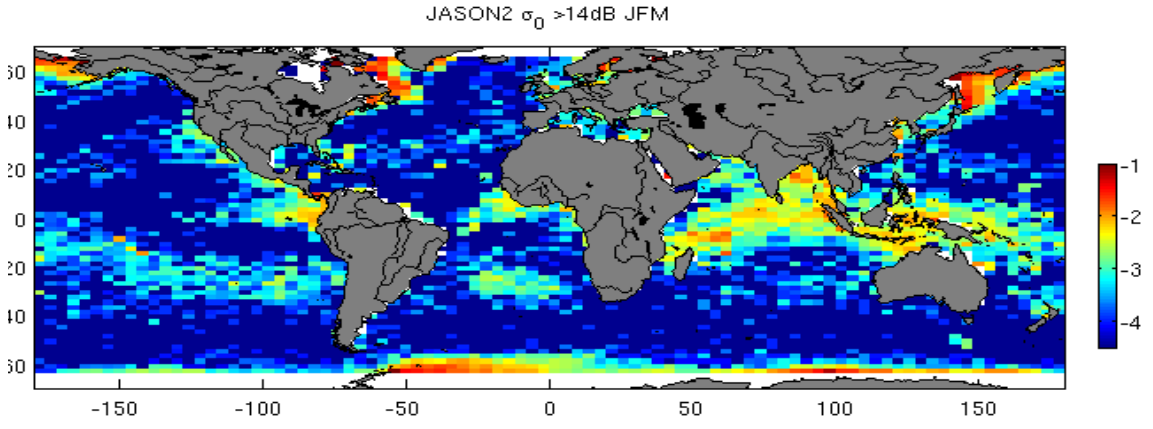
High winds seasonal variations

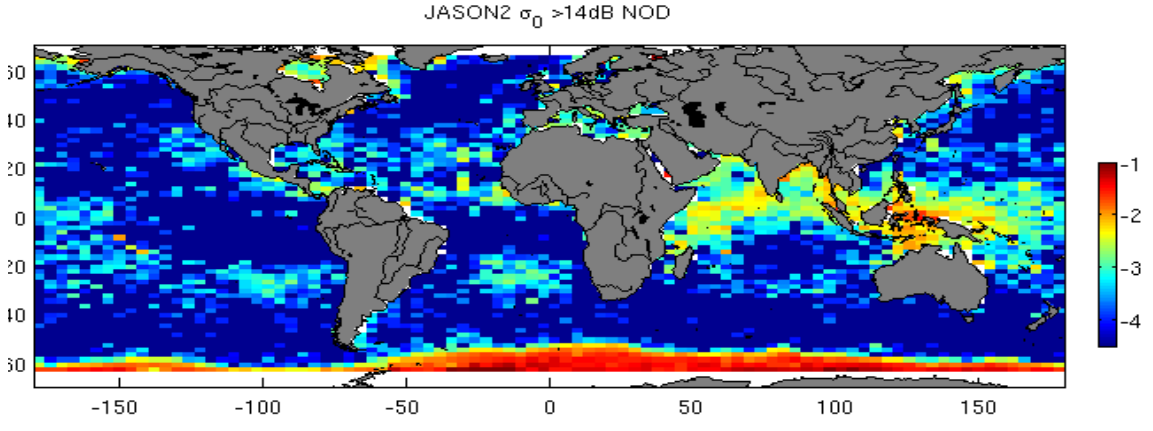




Attenuation

low winds seasonal variations





Summary

Ku/C band σ_0	Surface wave	Wind speed	Geographical dsistribution	Physics
σ_0 ku >σ_0C	2cm attenuated vs 6 cm	High (>7m/s)	Regions of strong currents	Current-wave interactions
		Low (<5m/s)	Tropical Equatorial regions	Surface films ?
σ_0 ku <σ_0C	2cm enhanced vs 6 cm	High (>7m/s)	Southern ocean south of 50°S	Fetch ?
		Low (<5m/s)	Indo-Pacific equatorial region	Rain freshening ?