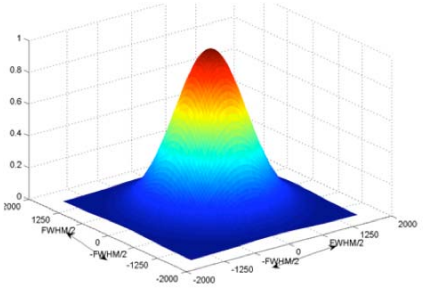
Actual Spatial Resolution (PSF) of current medium resolution products

Marie Weiss

Frédéric Baret

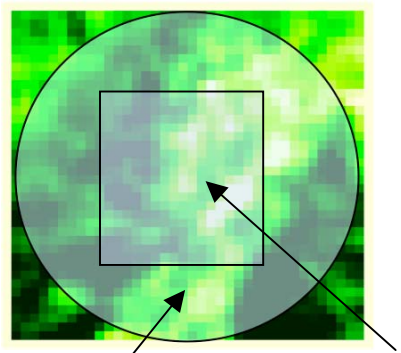


INRA

EmmaH
UMR 1114 INRA/UAPV
Environnement Méditerranéen et Modélisation des Agro-Hydrosystèmes

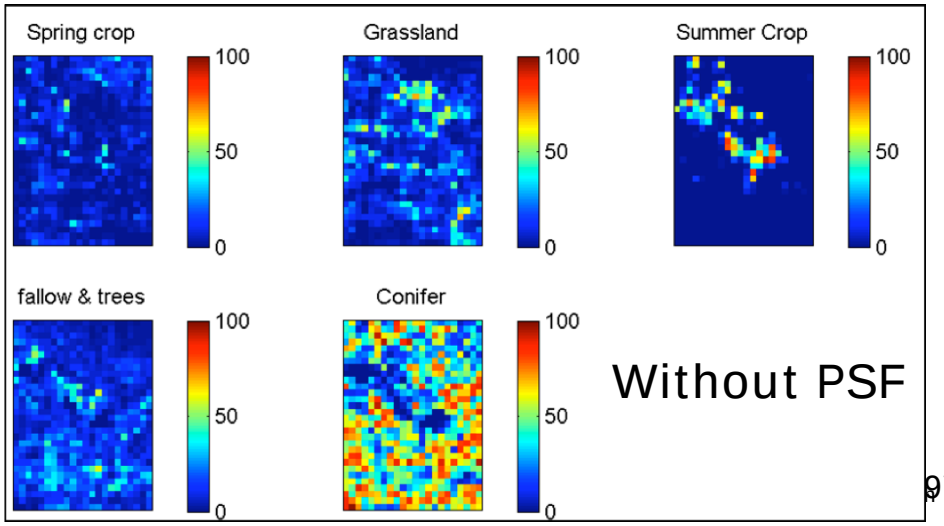
Why is the actual resolution of a product not equivalent to the sensor resolution?

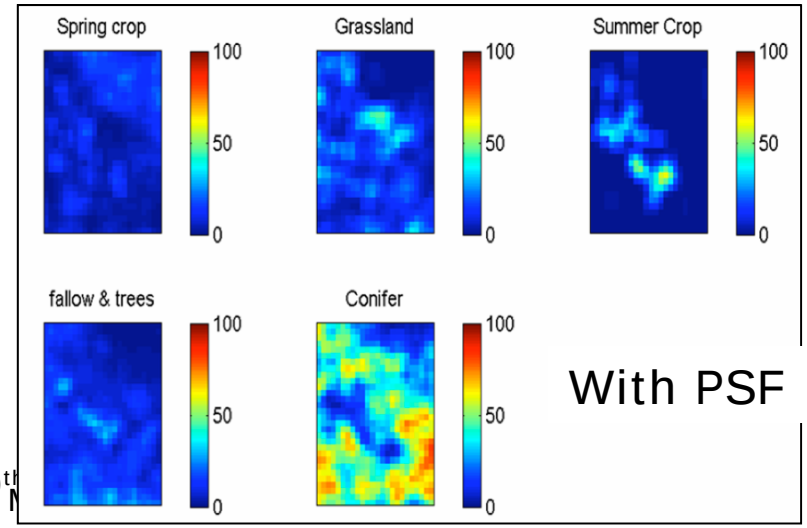
- The sensor itself is characterized by its Point Spread Function (PSF)
  - A substantial portion of the signal measured at a given pixel comes from its surrounding area
- But:
  - Products are issued from many processes which add complementary terms to the proper sensor PSF
    - geo-location uncertainties
    - spatial resampling
    - Atmospheric scattering
    - Synthesis
    - Inversion algorithm



Impact on applications?

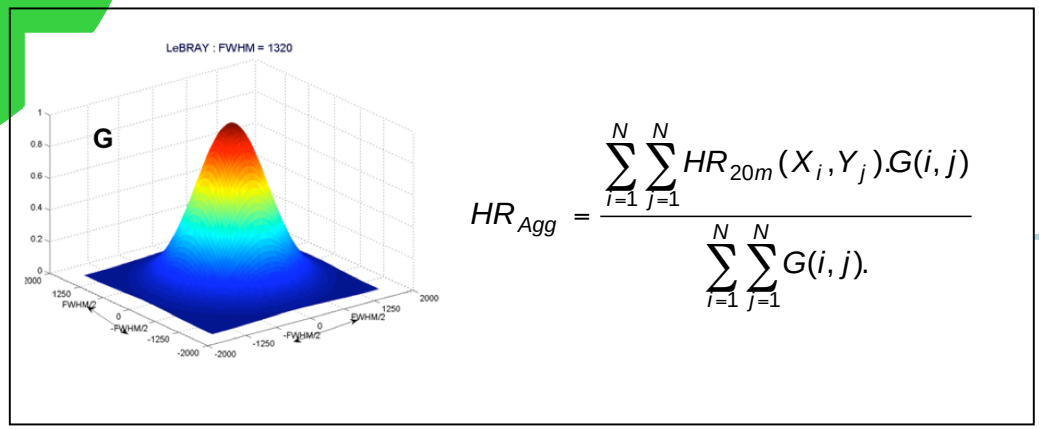
- When evaluating the products:
  - Either by comparing with other products or with actual measurements
- When using the products in models (canopy functioning, global change, climate, forestry,…):
  - Model parameters depend on the land surface type: medium resolution pixels are often mixed but when accounting for actual PSF, it is much worse!
  - This will impact model simulations !!!



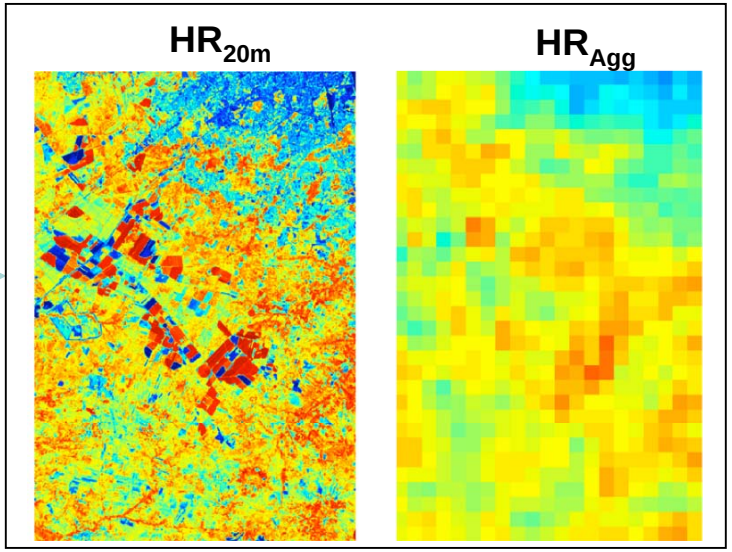


Method to evaluate the PSF (1)

- MR products are co-registered with High Resolution (HR) images assuming that
  - The PSF is the product (G) of two gaussian PSF functions in the X and Y directions characterized by their Full Width at Half Maximum (FWHM)

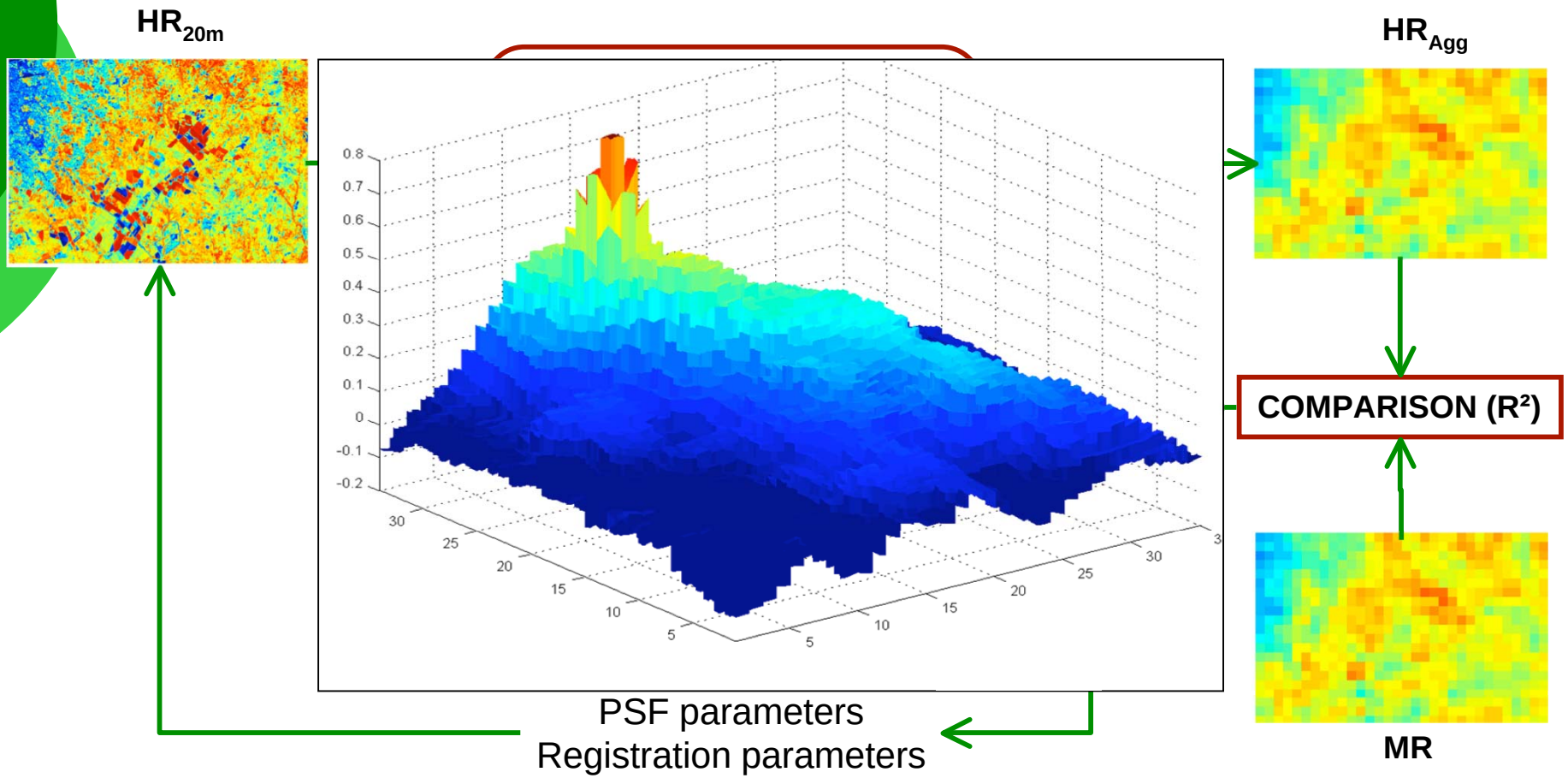


$$HR_{Agg} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} HR_{20m}(X_i, Y_j).G(i,j)}{\sum_{i=1}^{N}\sum_{j=1}^{N} G(i,j).}$$



- HR (60kmx60km) images projected in each MR image (100km x100km) original projection (Sinusoidal: MODIS, PlateCarrée: CYCLOPES, UTM/WGS84: MERIS)

Method to evaluate the PSF (2)



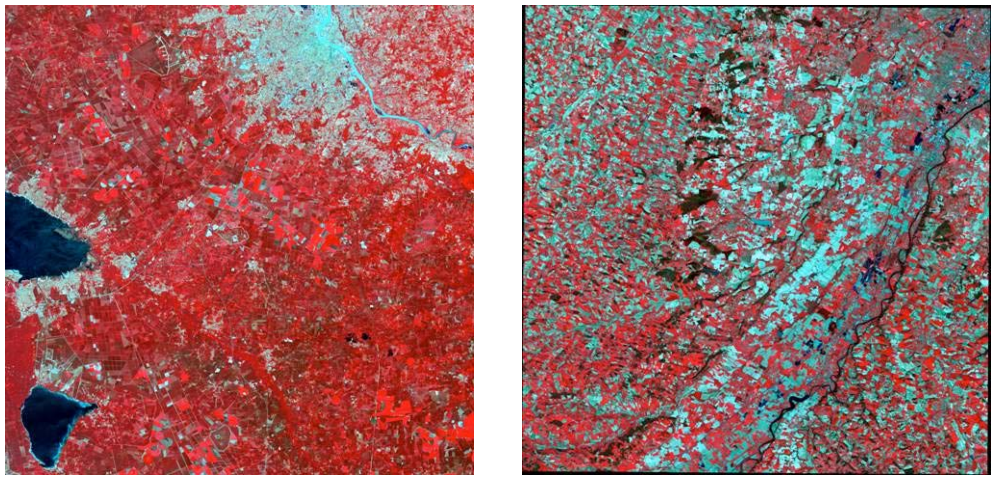
Method to evaluate the PSF (3)

- Algorithm in 4 steps:
  - Basically the same except that at each step, the process becomes more accurate
    - Step 1: Rough evaluation of the position of the HR image in the MR image (no PSF, at 3km) -> provide roughly the position in MR image
    - Step 2 : assuming a gaussian PSF (1800m) to refine HR & MR position
    - Step 3 : refine the PSF shape ($FWHM_x$ and $FWHM_y$) with fixed HR and MR position
    - Step 4 : refine all (FWHM, MR and HR positions)

Preliminary Results (1)

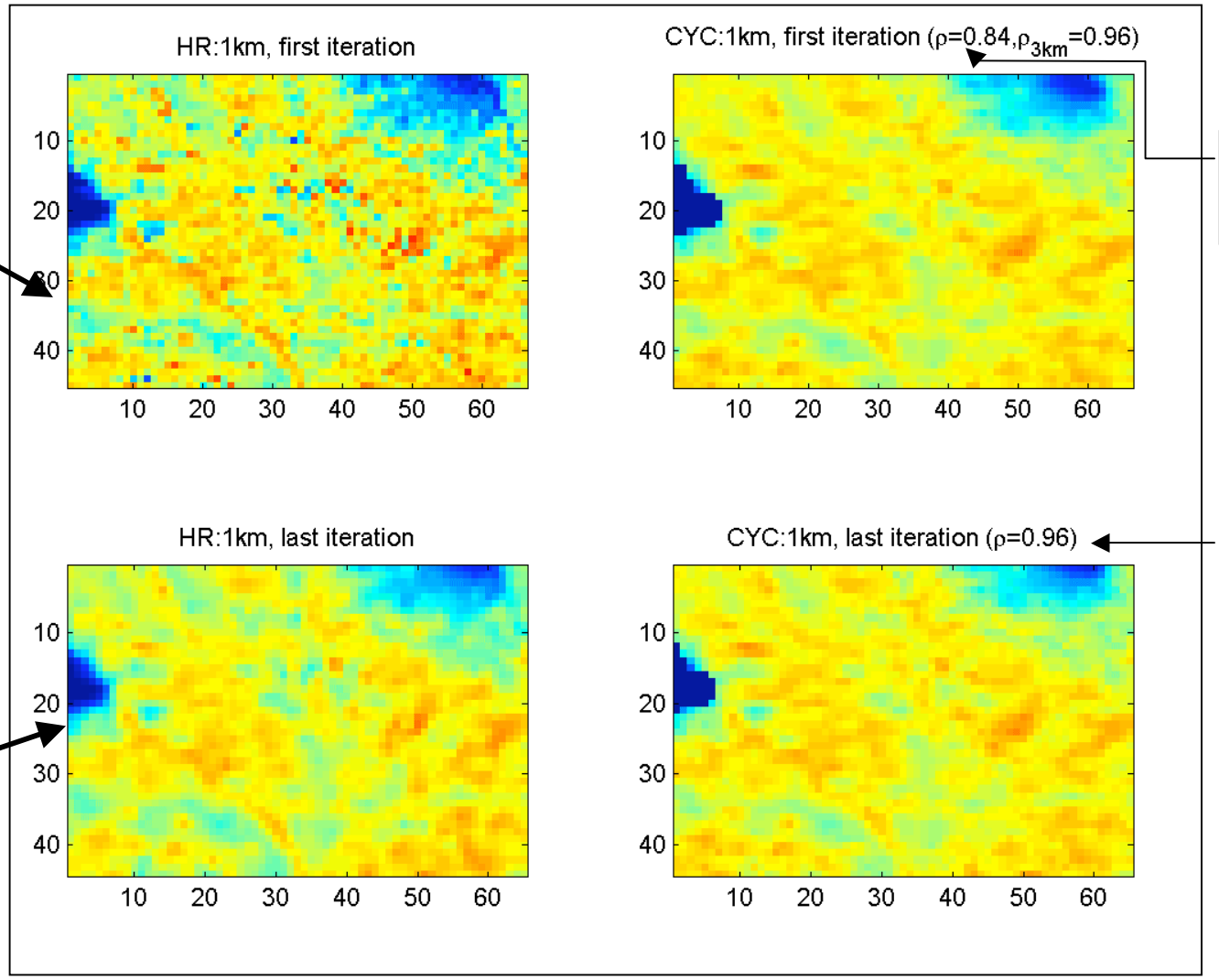
- PSF evaluated over 2 sites, on FAPAR product
  - 2 SPOT images (20m) : Corrected from atmosphere (SunPhotometer). FAPAR estimated using neural networks (NNT) trained with SAIL model at TOC level
  - MODIS: LAI/FPAR product collection 5, 16 days
  - MERIS: TOAVEG algorithm (NNT at TOA level), daily
  - VEGETATION: CYCLOPES product, V3.1 (NNT at TOC level), decade

Le Bray, France
Pine Forest



Sud Ouest,
France
Crops

Preliminary Results (2)



HR Agregation without PSF

HR Agregation with PSF

1st step results

4th step results

Preliminary Results (3)

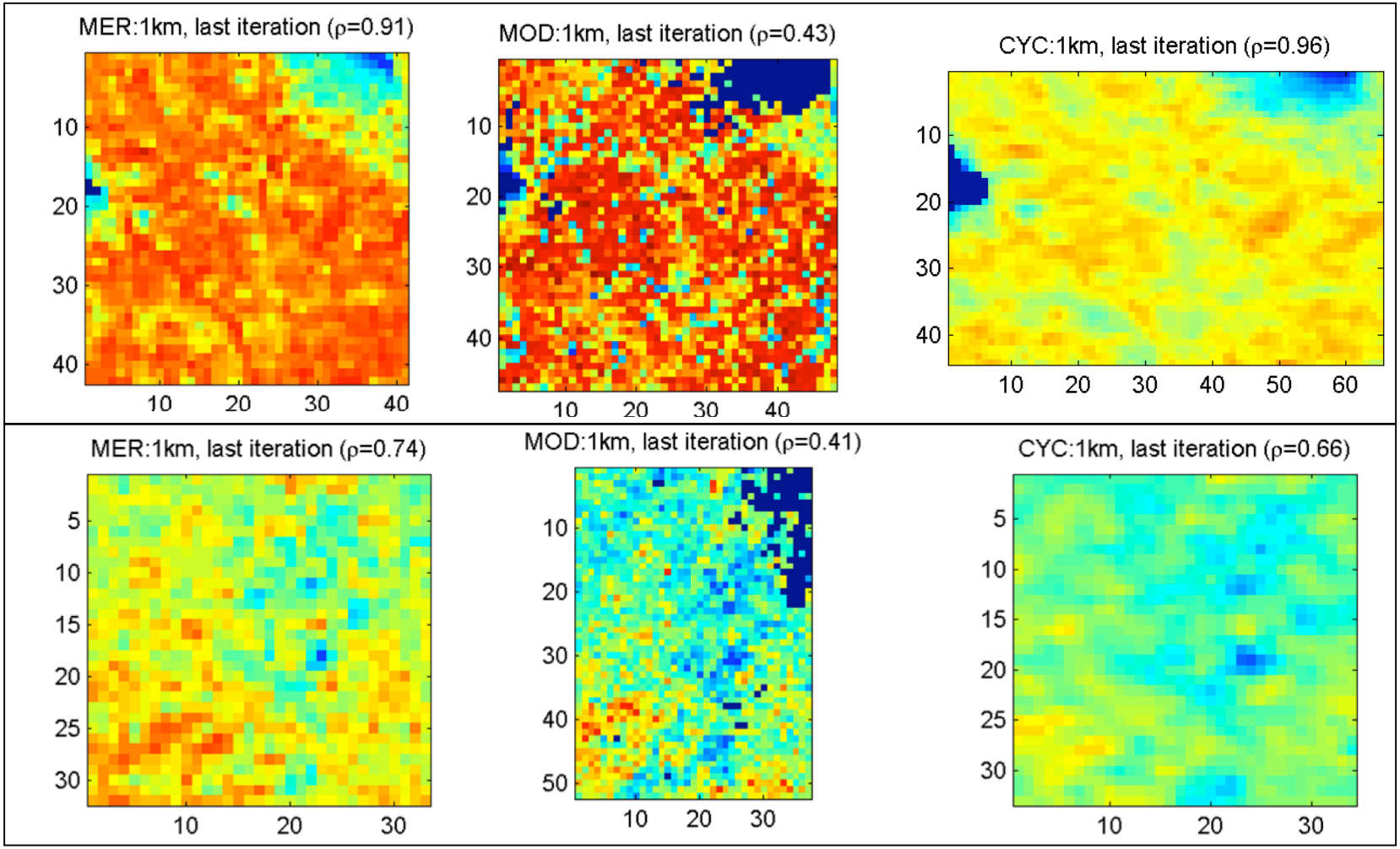
LE BRAY

	Projection	FWHMx	FWHMy	ρ(3km)	ρ(1km)
MERIS	UTM, WGS84	1490	1750	0.91	0.91
MODIS	Sinusoïdal	1600	1550	0.76	0.43
VGT (CYC)	Plate Carrée	1360	1380	0.96	0.96

SUD OUEST

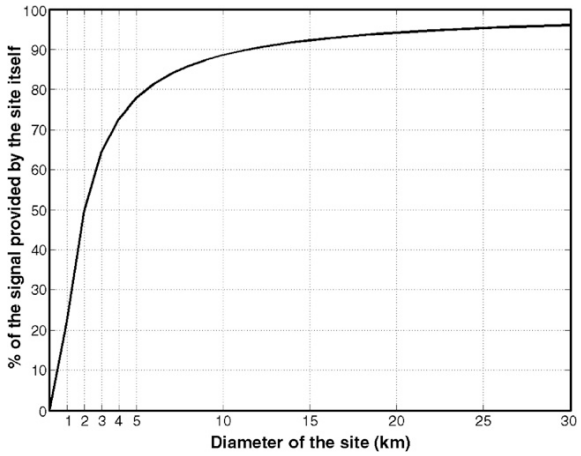
	Projection	FWHMx	FWHMy	ρ(3km)	ρ(1km)
MERIS	UTM, WGS84	2030	1530	0.87	0.74
MODIS	Sinusoïdal	2130	2030	0.64	0.41
VGT (CYC)	Plate Carrée	1600	1615	0.76	0.66

Preliminary Results (4)



Conclusions

- Actual PSF is much wider than 1km and users should be aware of that
  - either by degrading the products at 3 to 10km
  - or by taking into account the PSF



- MERIS and CYCLOPES products are more spatially smooth than MODIS FAPAR
- The PSF is not easy to evaluate:
  - sites must be contrasted
  - No topography

And what next….

- The study will be continued over about 8 sites
  - Contrasted sites will be selected (over the BELMANIP2 data base)
  - Latitudes will be well distributed (effect on the projection)
  - Effect of the projection on PSF estimation will be also studied:
    - Selection of one product,
    - Resampling in the 2 other projections
    - Estimate the PSF
    - Compare the 3 results