New reconstruction algorithms for the improvement of SMOS L1c images: preliminary results

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Settings

To avoid introducing additional artifacts, all the Fourier series were calculated on the hexagonal grids, using isommetries with Z_n

$$e^{2\pi i \vec{x}\cdot\vec{k}/N} = e^{2\pi i \Phi(\vec{x})\Psi(\vec{k})/N}$$

where $\vec{x} \in \mathbf{H}(n) \;\; ; \;\; \vec{k} \in \mathbf{H}^*(n)$

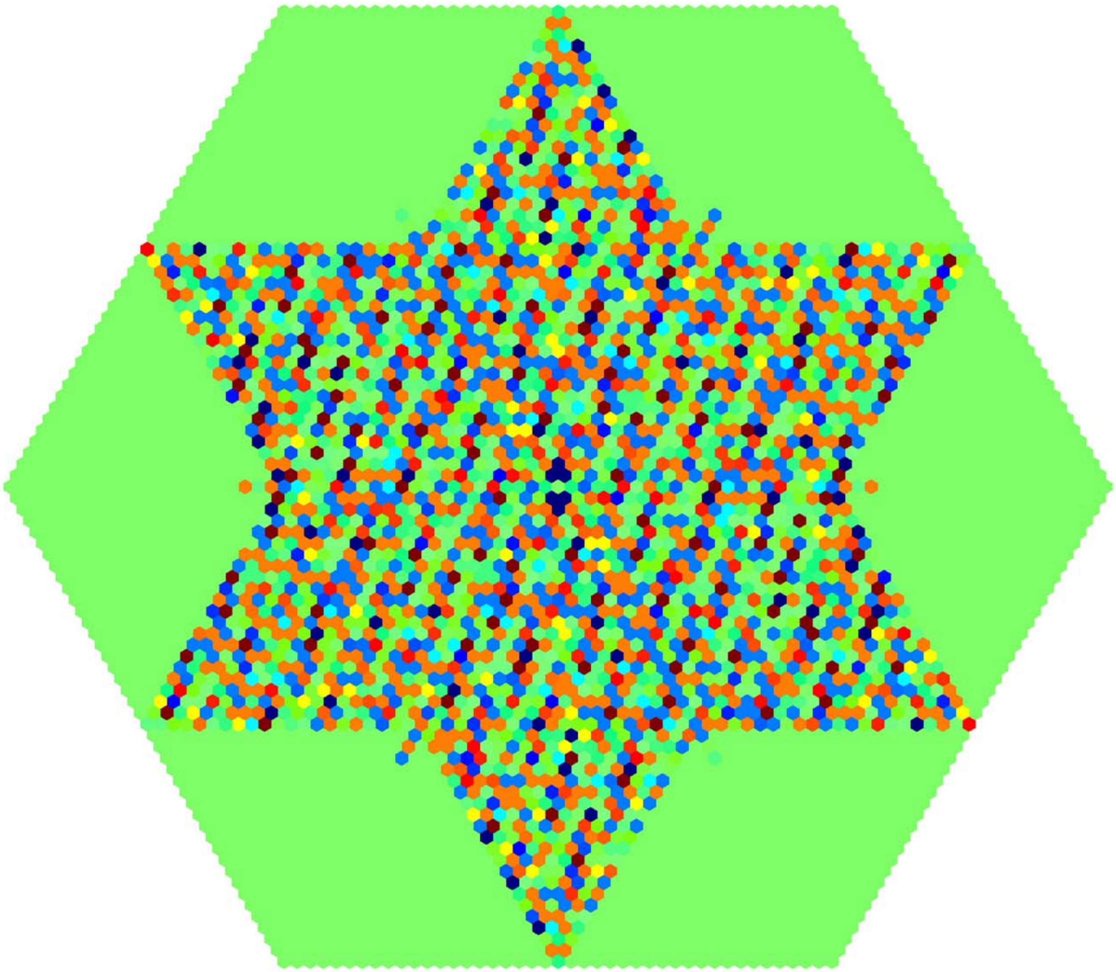
and

$$\Phi : \mathbf{H}(n) \rightarrow \mathcal{Z}_N$$
$$\Phi(x,y) \;=\; x \,+\, y(3n^2 - 1) \; (\mathrm{mod\ N})$$
$$\Psi : \mathbf{H}^*(n) \rightarrow \mathcal{Z}_N$$
$$\Psi(k,l) \;=\; nk \,-\, l(n+1) \; (\mathrm{mod\ N})$$

And the total number of points is $N \;=\; 3n^2 + 3n + 1$

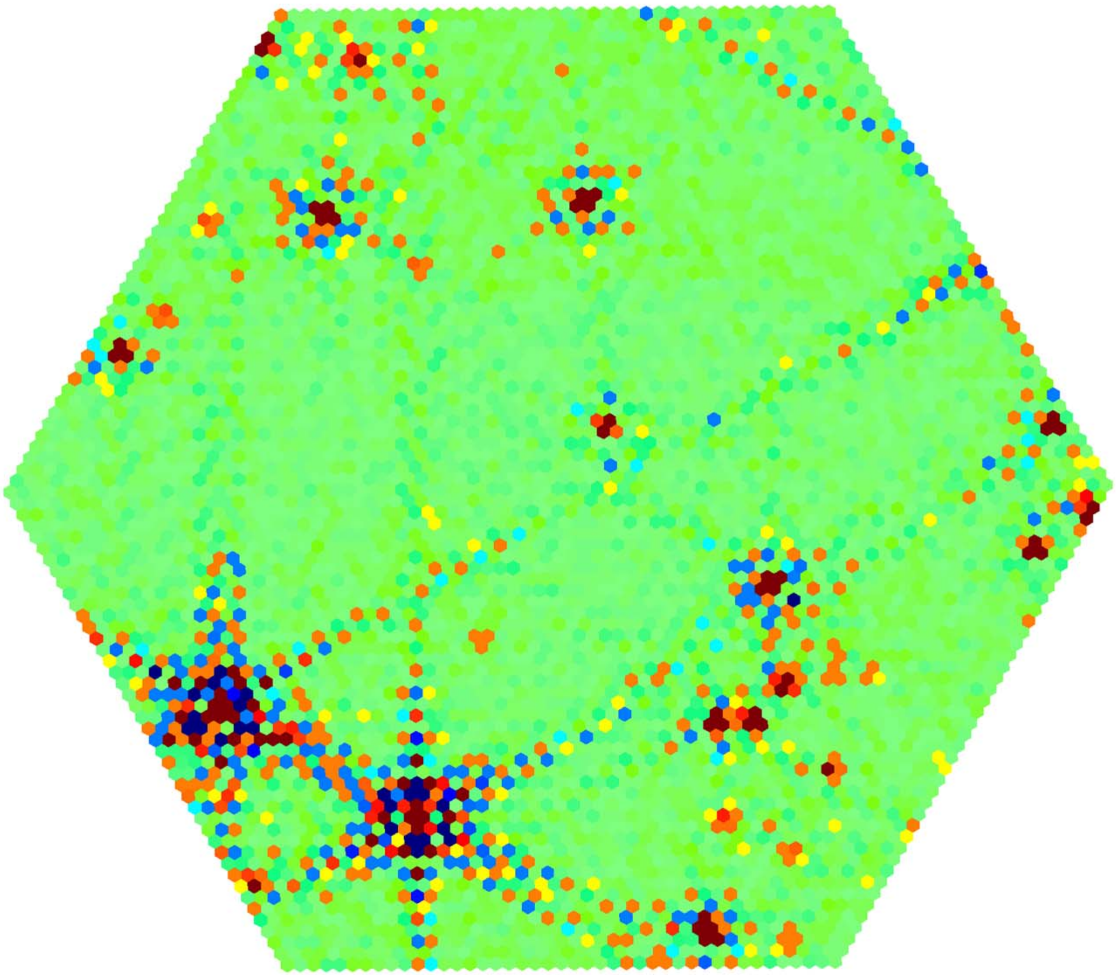
Introduction

Vis R



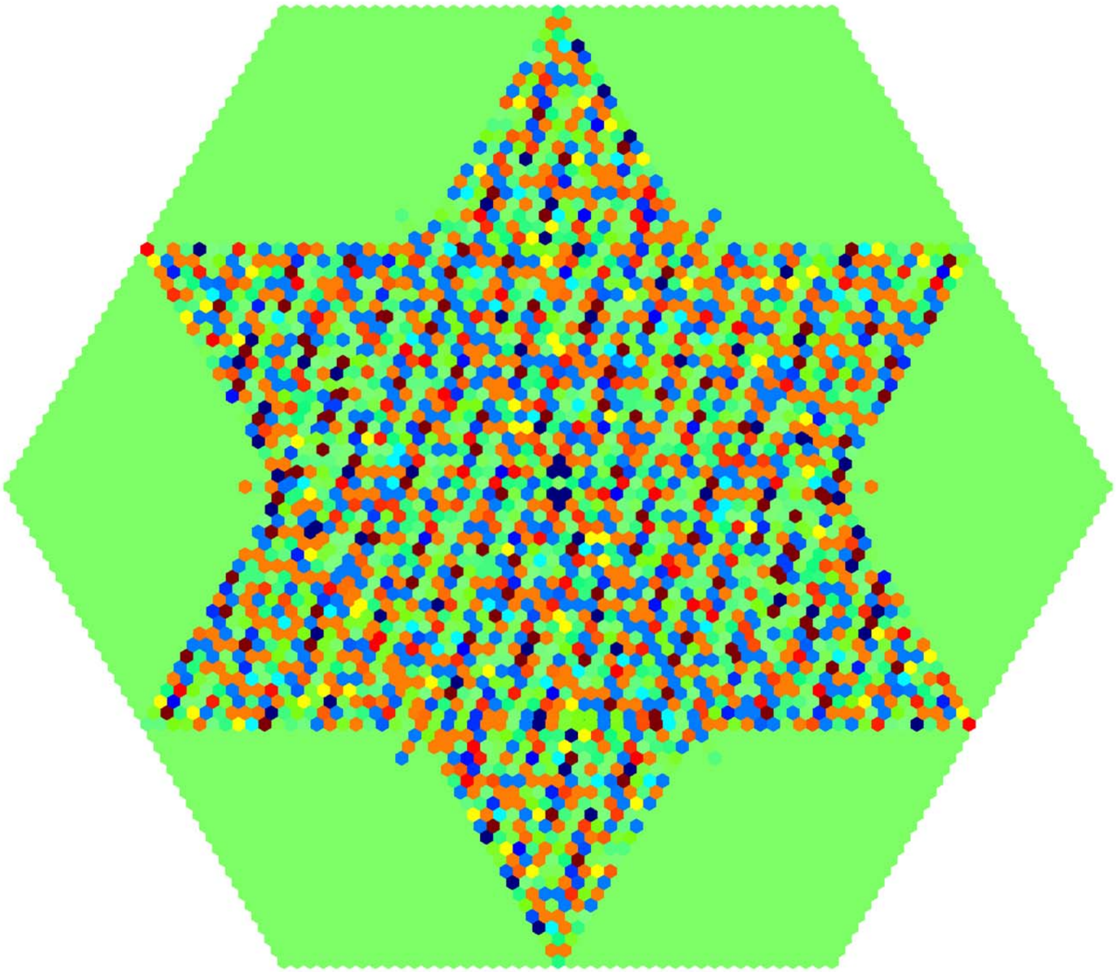
In the case of SMOS, visibilities are computed on a star-shaped subsampling in Fourier space (radius: 42)

TB



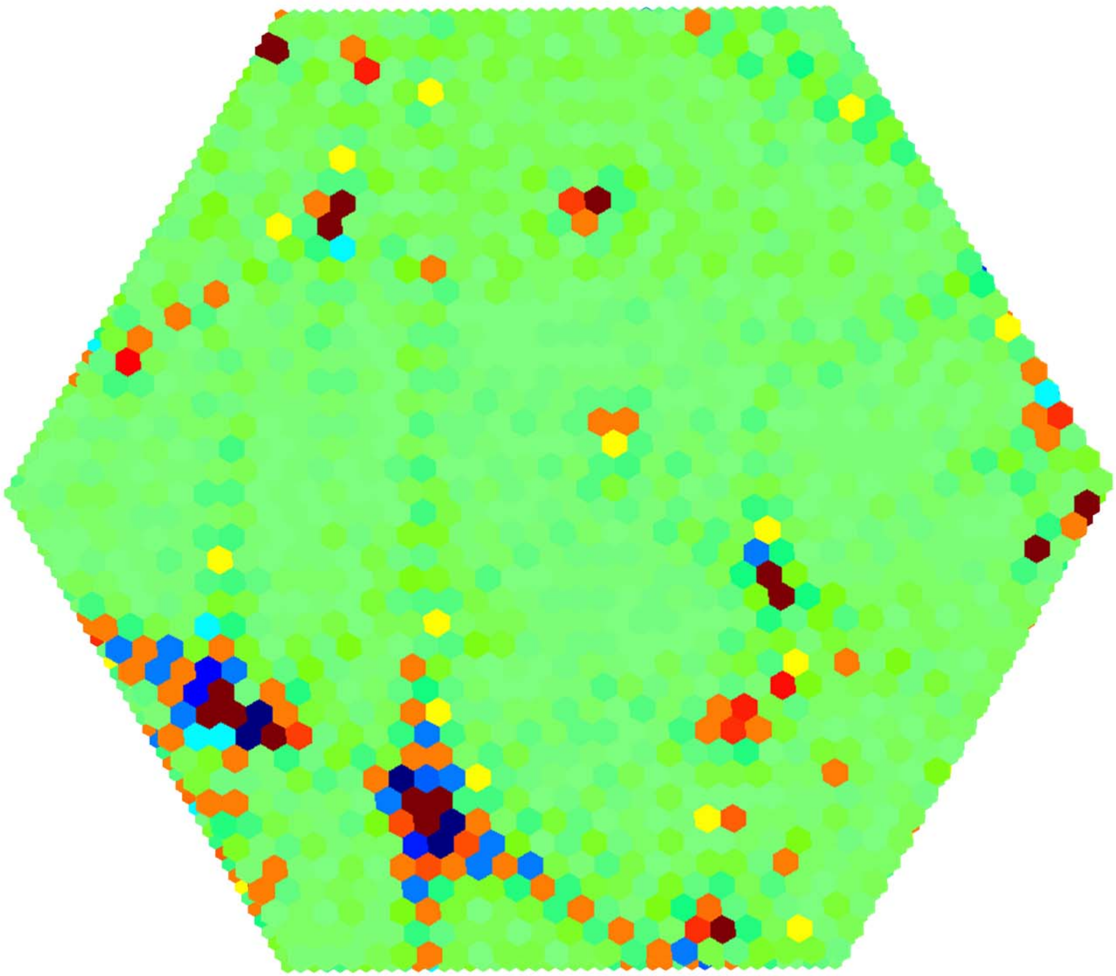
This leads to characteristic "star-like" tails that affect all the image

Vis R



And what happens if we remove the tails by taking the central hexagon? (radius=21)

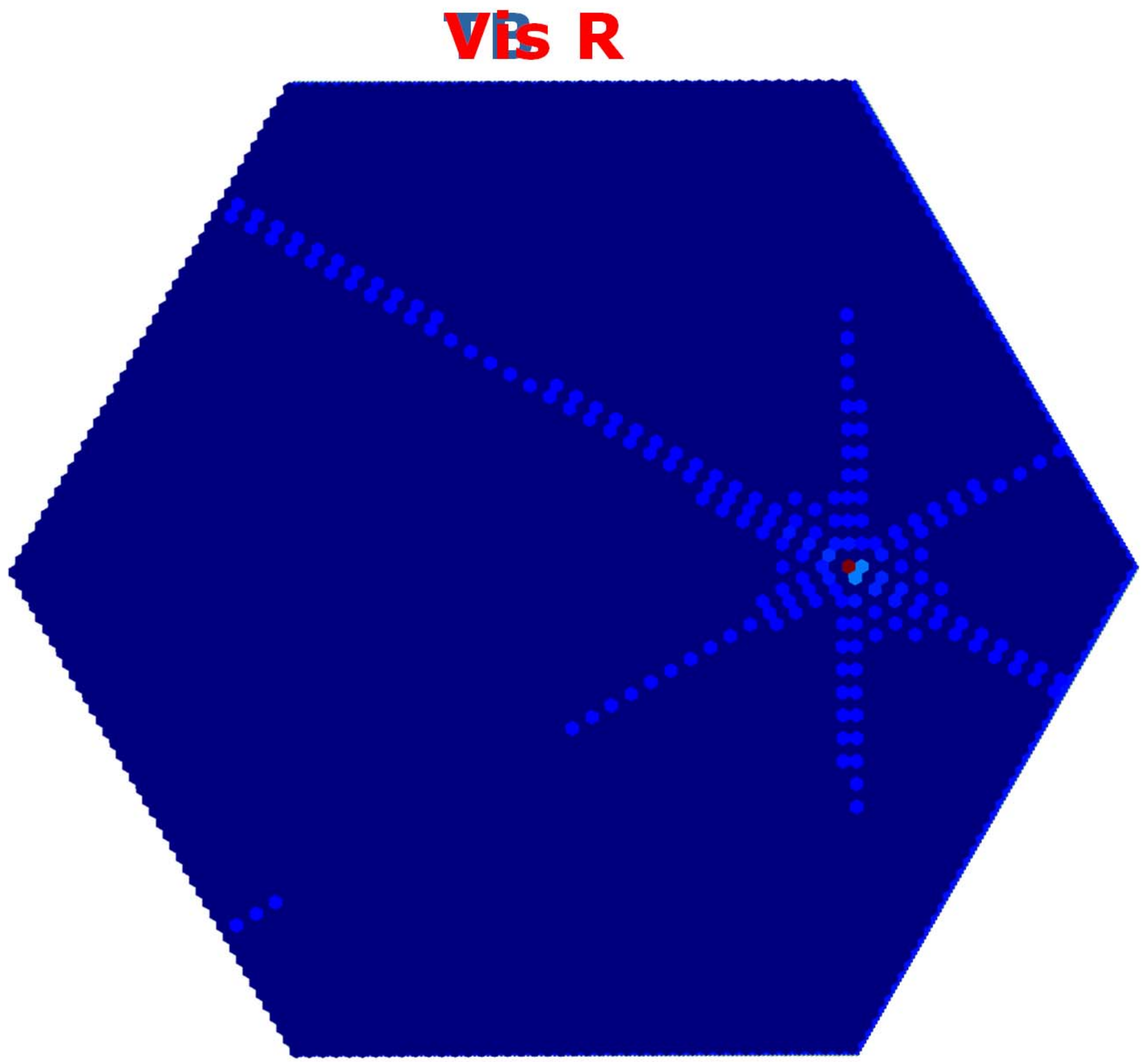
TB



Tails are somehow attenuated, but not removed.

Tails do not only come from lost high-frequency Fourier coefficients

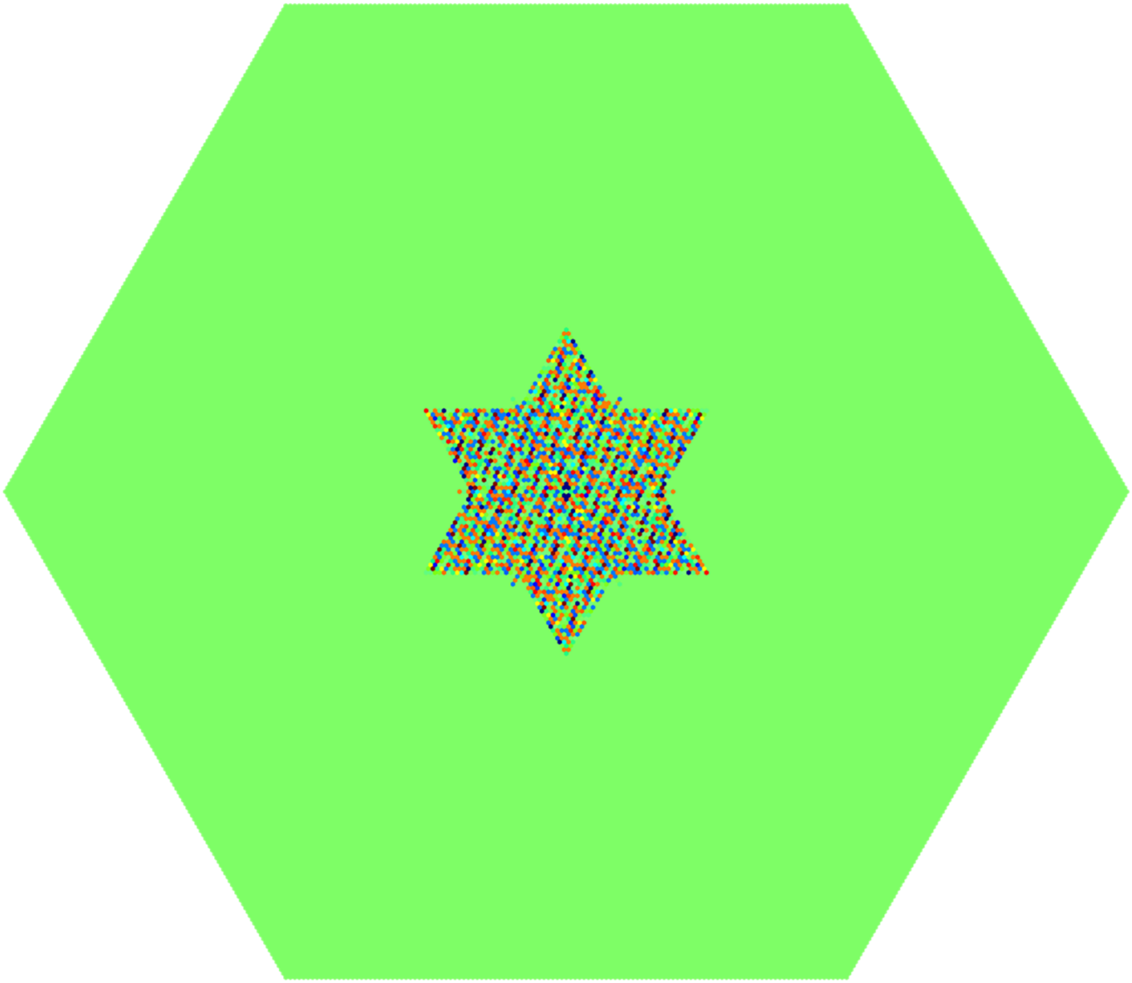
The origin of tails



Tails come from having a delta function at a resolution higher than the one resolved by our representation (radius=126, truncation=42)

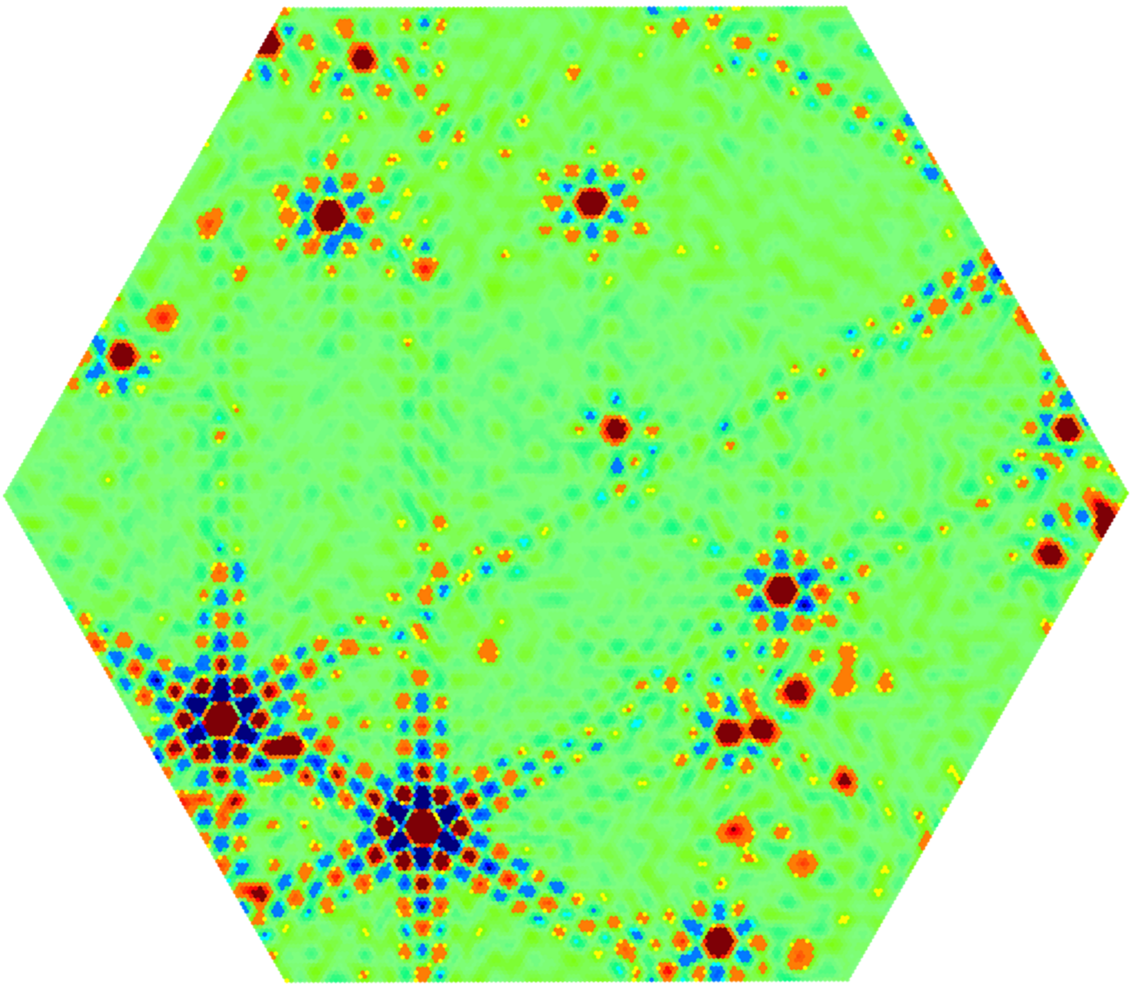
Nodal points

Vis R



What happens if we increase the size of the embedding hexagon (42, 84, 126…)?

TB



We thus increase the nominal resolution in direct space, and the oscillating structure of tails becomes more and more evident.

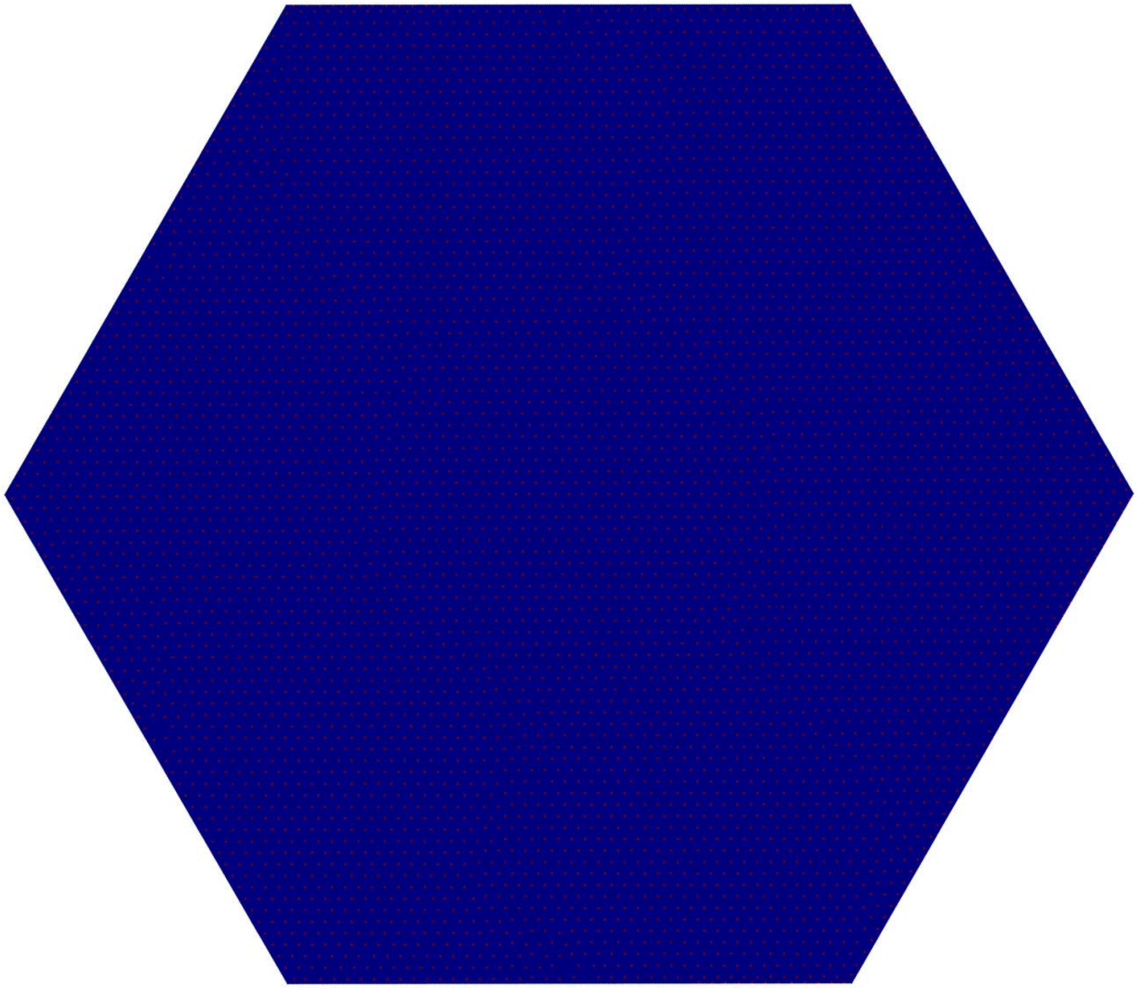
Nodal points are evident (not fused)

Nodal sampling: why?

- **Nominal sampling:** What we do by default.
  - ➢ Each pixel has nominal size
  - ➢ Adequate if high frequencies are negligible
  - ➢ Appropriate for smooth functions

- **Nodal sampling:** Subsampling of given points at higher resolution
  - ➢ Each pixel has smaller size (that of higher res.)
  - ➢ Adequate if the signal is a mixture of sharp transitions + a continuous signal (low contribution at high frequencies)
  - ➢ Appropriate for extracting the smooth component if it varies slowly in space

Nodal sampling: ideal case

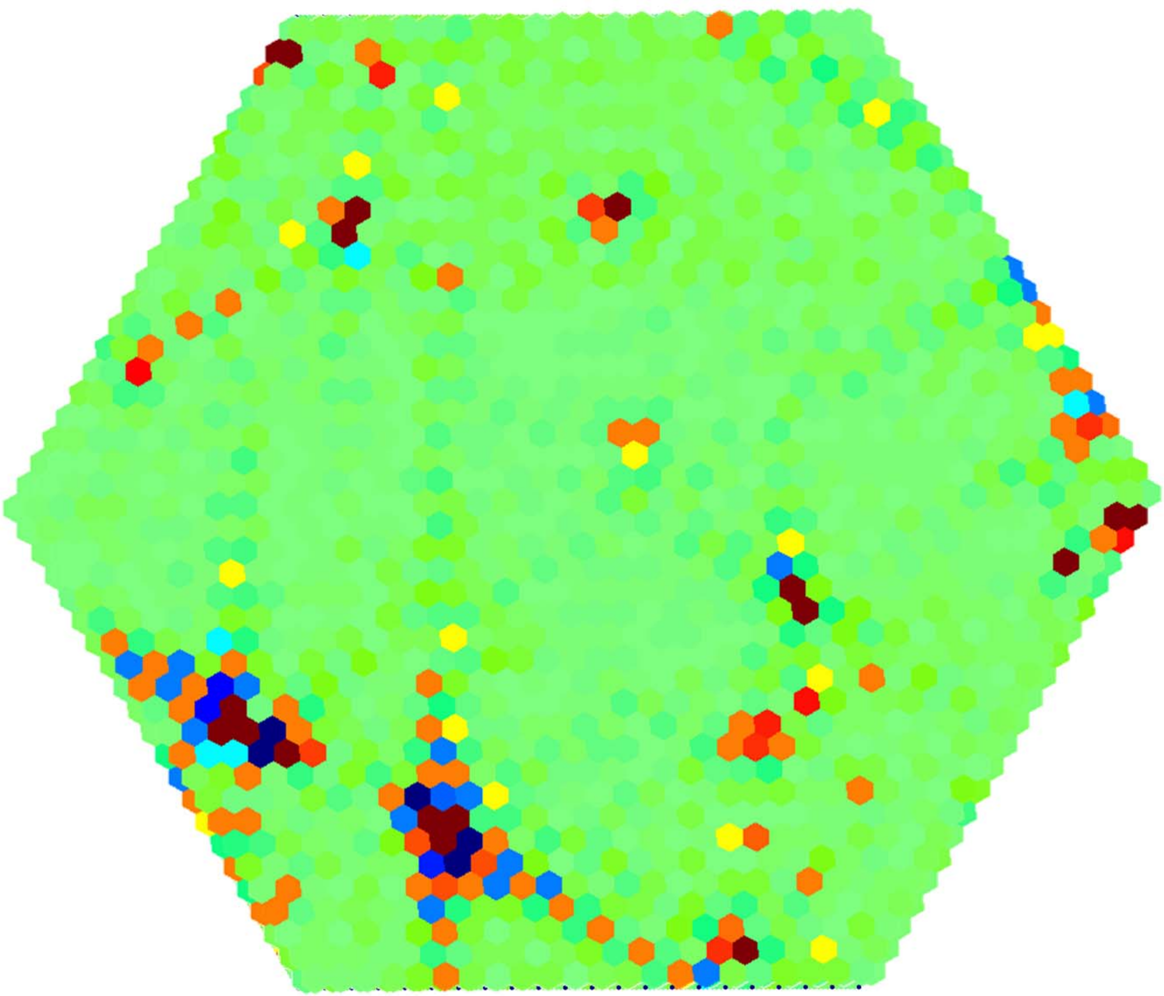


Window: star (size=42)
Deltas: size=42
Embedding: size=255

Result: minima form an almost regular grid of spacing~6≈255/42

Ideal sampling: results

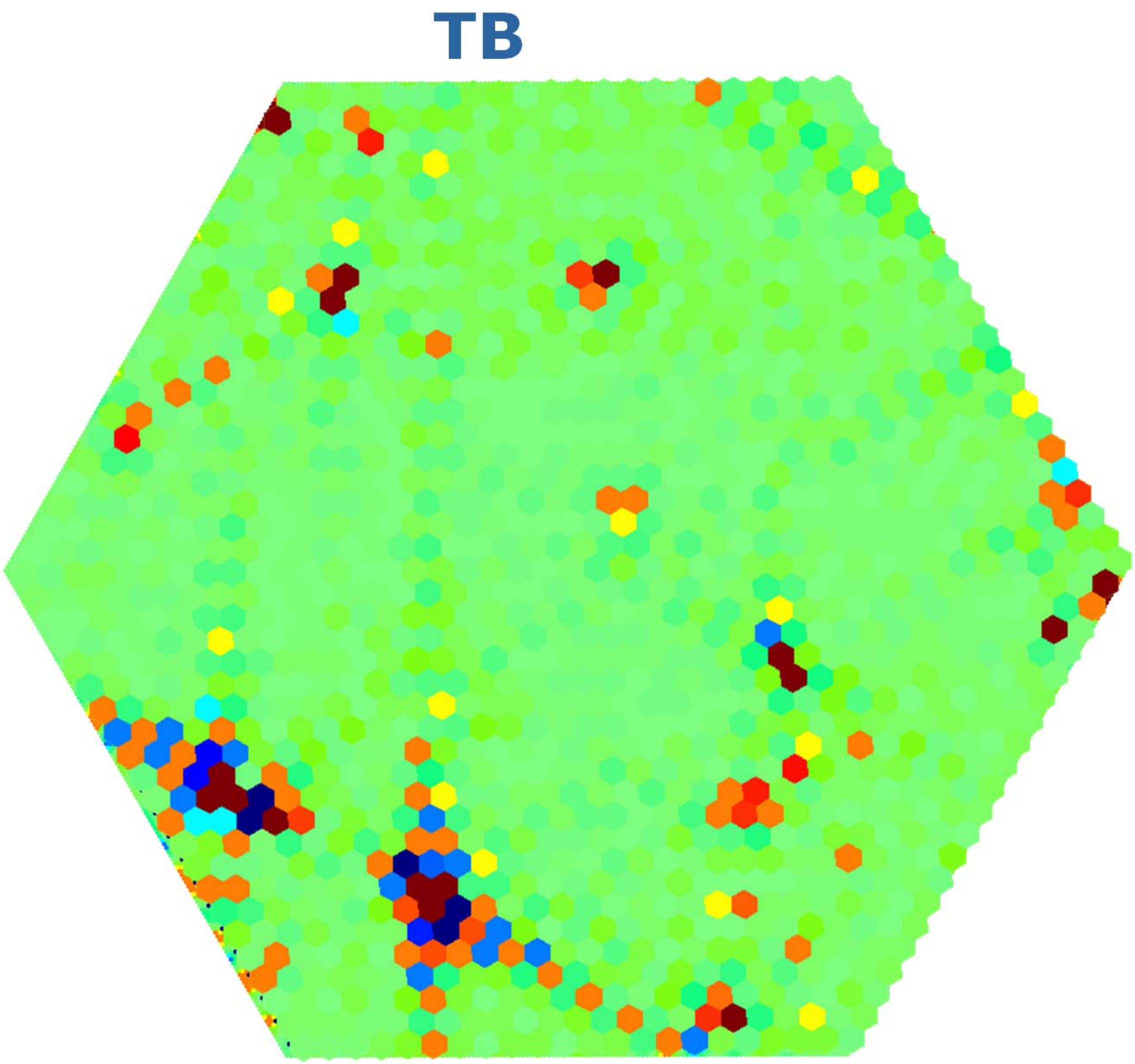
TB



Hexagonal cut=21
Size=126
Centered grid with spacing = 6

No real improvement

Constant shift on the grid

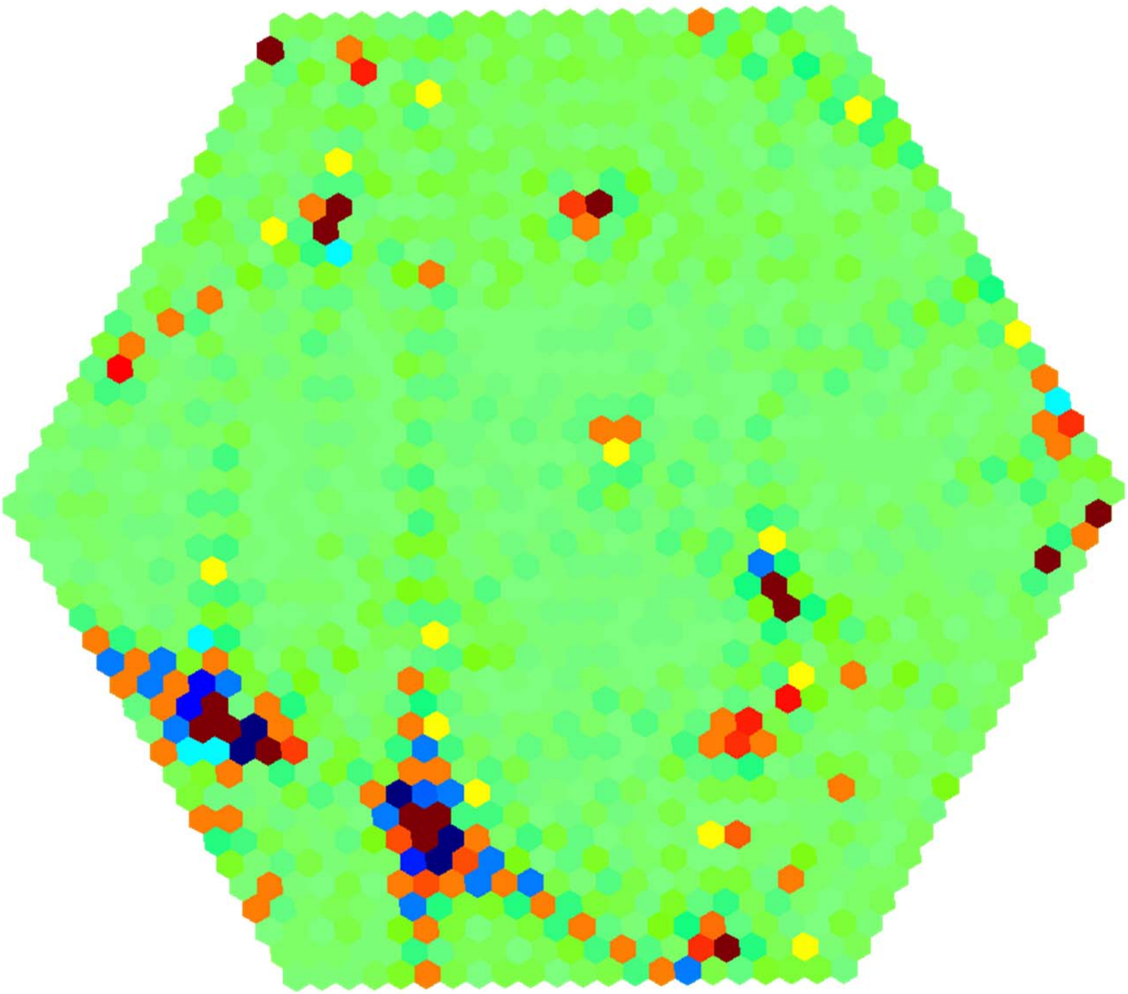


Hexagonal cut=21
Size=126
Grid of spacing=6
displaced by (2,1)
Min signal

Significant improvement

Adaptive grid

TB

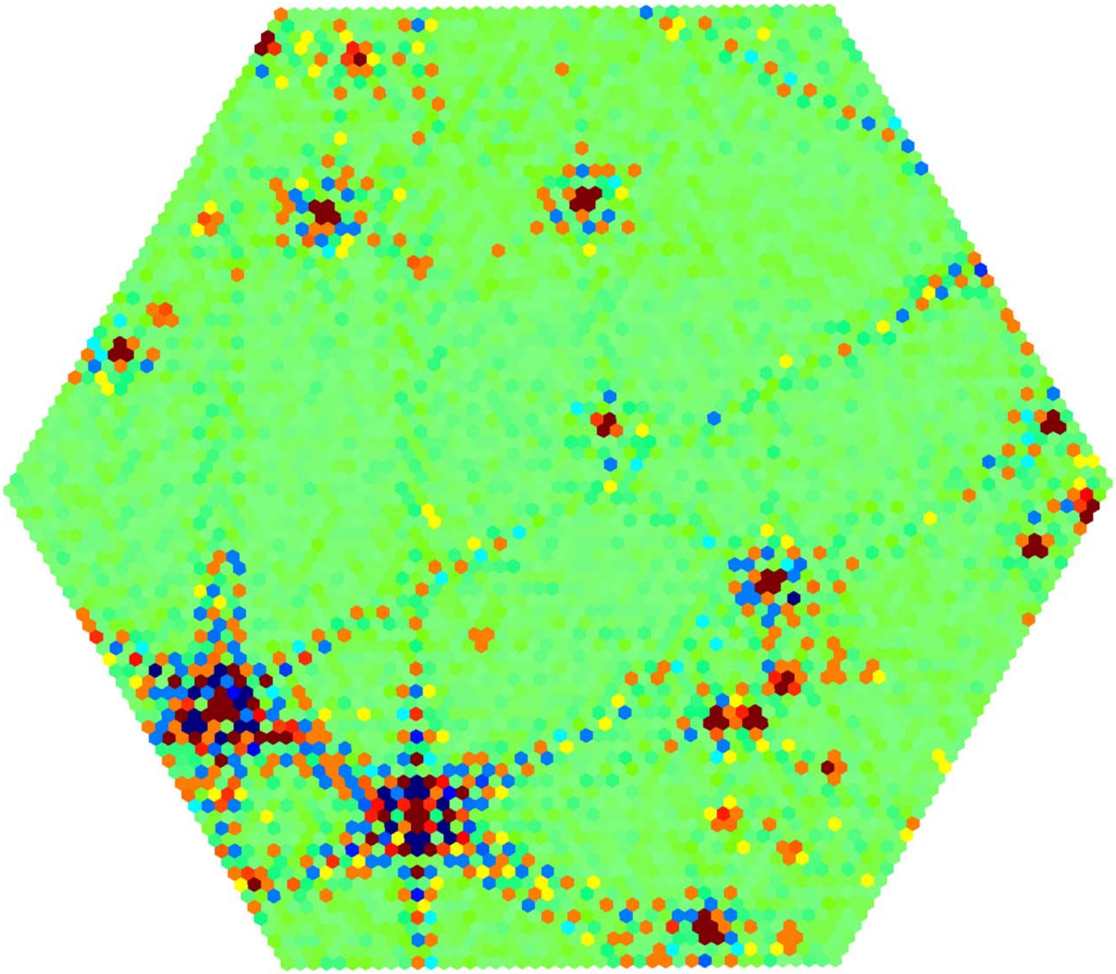


Hexagonal cut=21
Size=126
Grid of spacing=6
Local shift <=1
Max grad
Min acc. TB

Sampling: 62%
Huge quality improvement

Adaptive grid (2)

TB

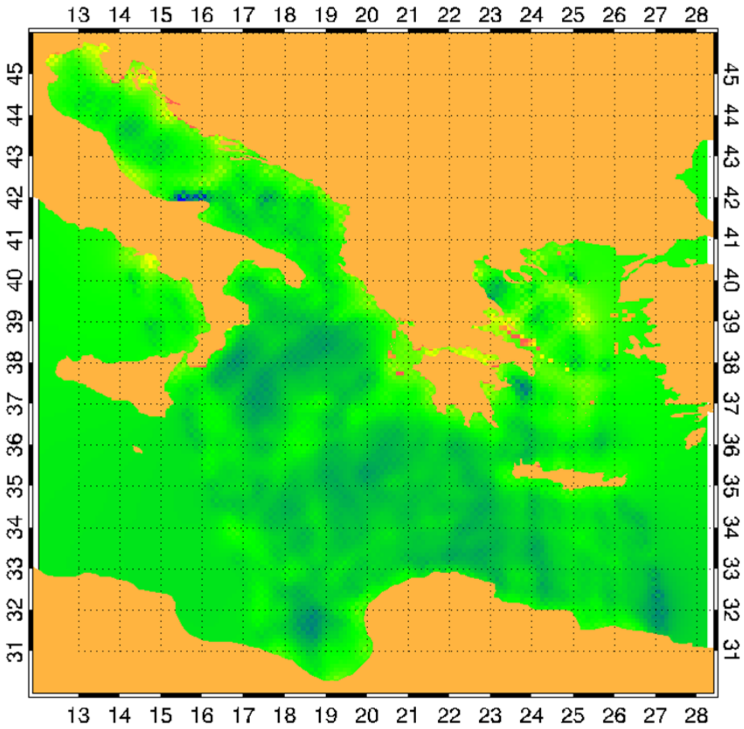


Star cut=42
Size=126
Grid of spacing=6
Local shift <=2
Max grad
Min acc. TB

Sampling: 62%
Huge quality improvement

Work in progress

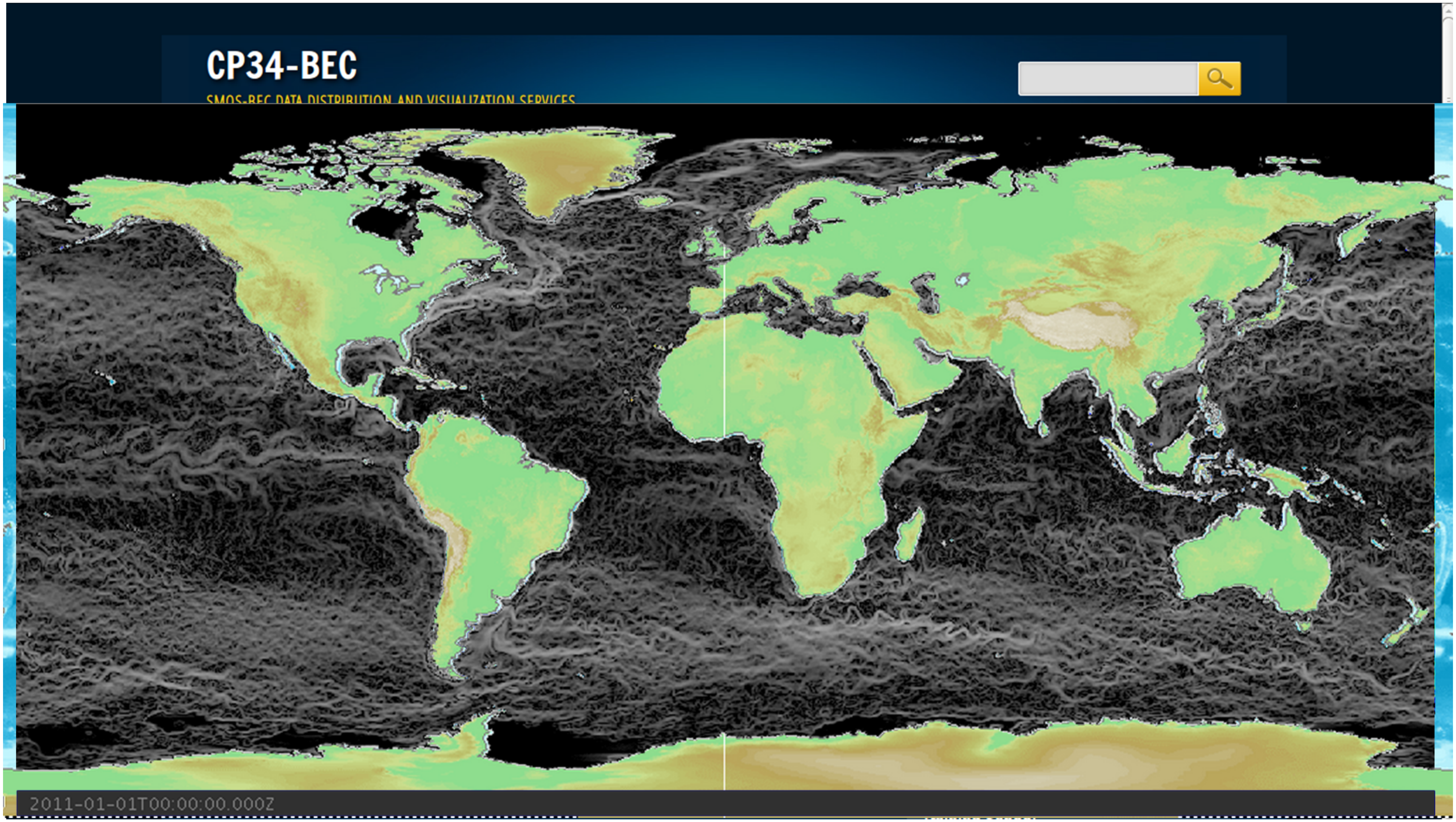
- Extensive testing with synthetic images, algorithm improvements, etc
- Fusing non-uniformly sampled TB's with SST to produce uniformly, densely sampled TB's



TH at 34º incidence angle

Data presently in CP34-BEC

http://cp34-bec.cmima.csic.es



SMOS-**M**ission **O**ceanographic **D**ata **E**xploitation

SMOS-MODE

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SMOS-MODE supports the **network** of SMOS ocean-related R&D

Next plenary meeting foreseen in **October 2013**

Additional institutions and countries are welcome!

http://smos-mode.eu/trainingschool

cost

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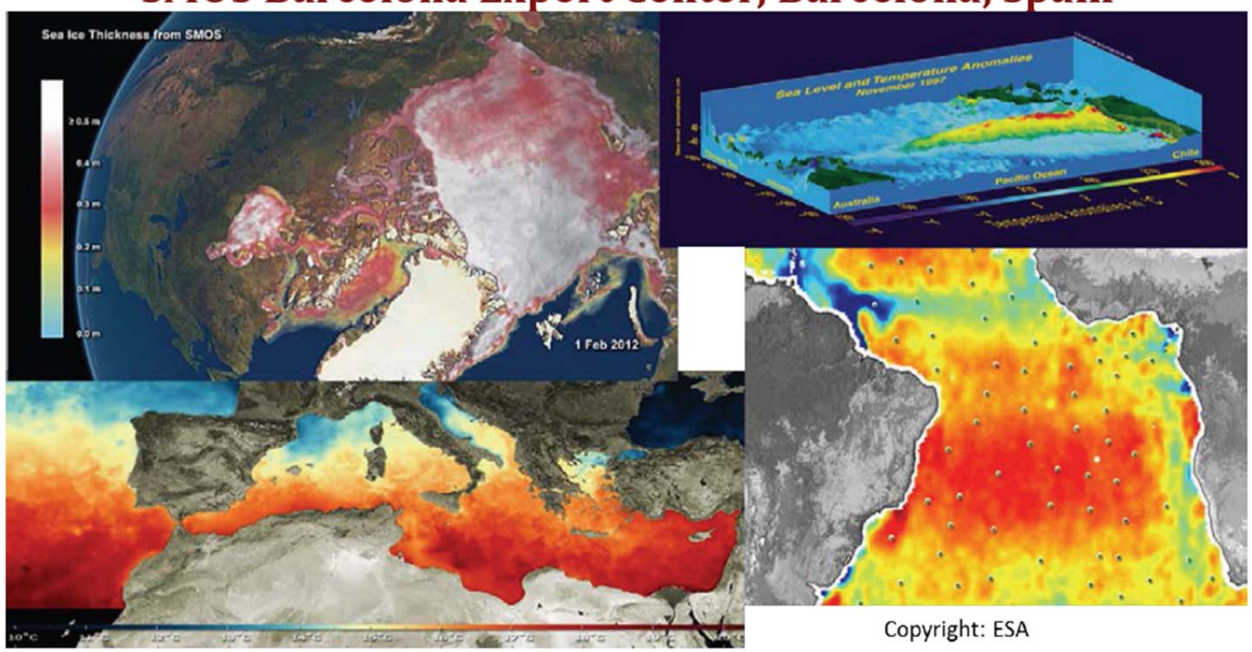
2013 Microwave Ocean Remote Sensing Training School

30 September - 4 October 2013

SMOS Barcelona Expert Center, Barcelona, Spain



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