Tracer Selection for Tracking in Water Vapour Images

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10 Inter. Winds Workshop

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... Before we start...

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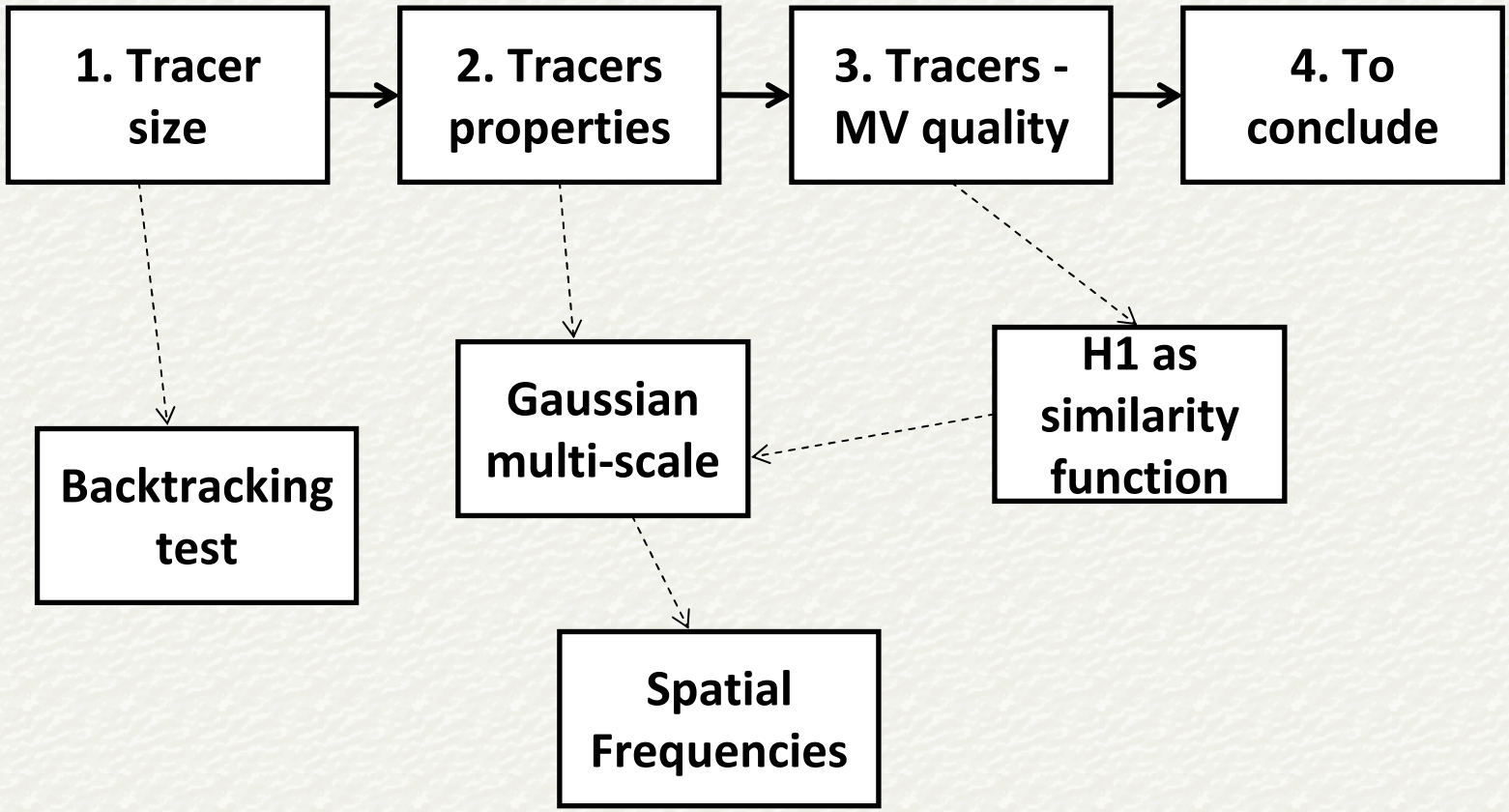
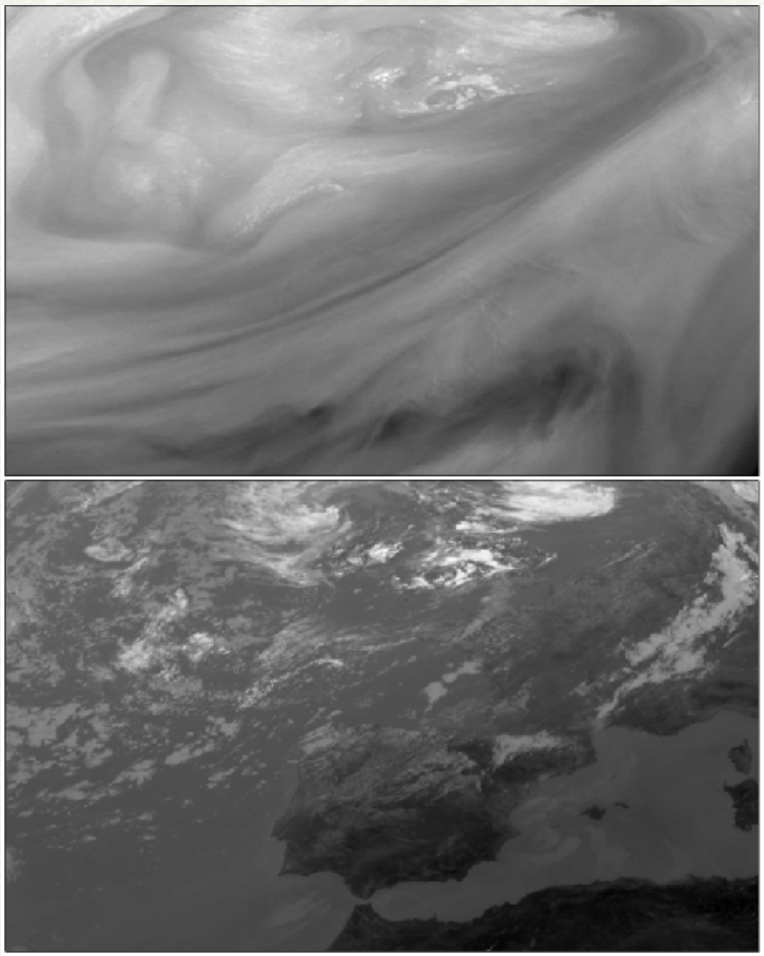
- Perspective - as in the previous IWW, focus on
  - Computer science
  - Image analysis

- Unlike the previous IWW,
  - Less concern about
    - Computational efficiency
    - How many winds
  - More concern about MV quality

Outline

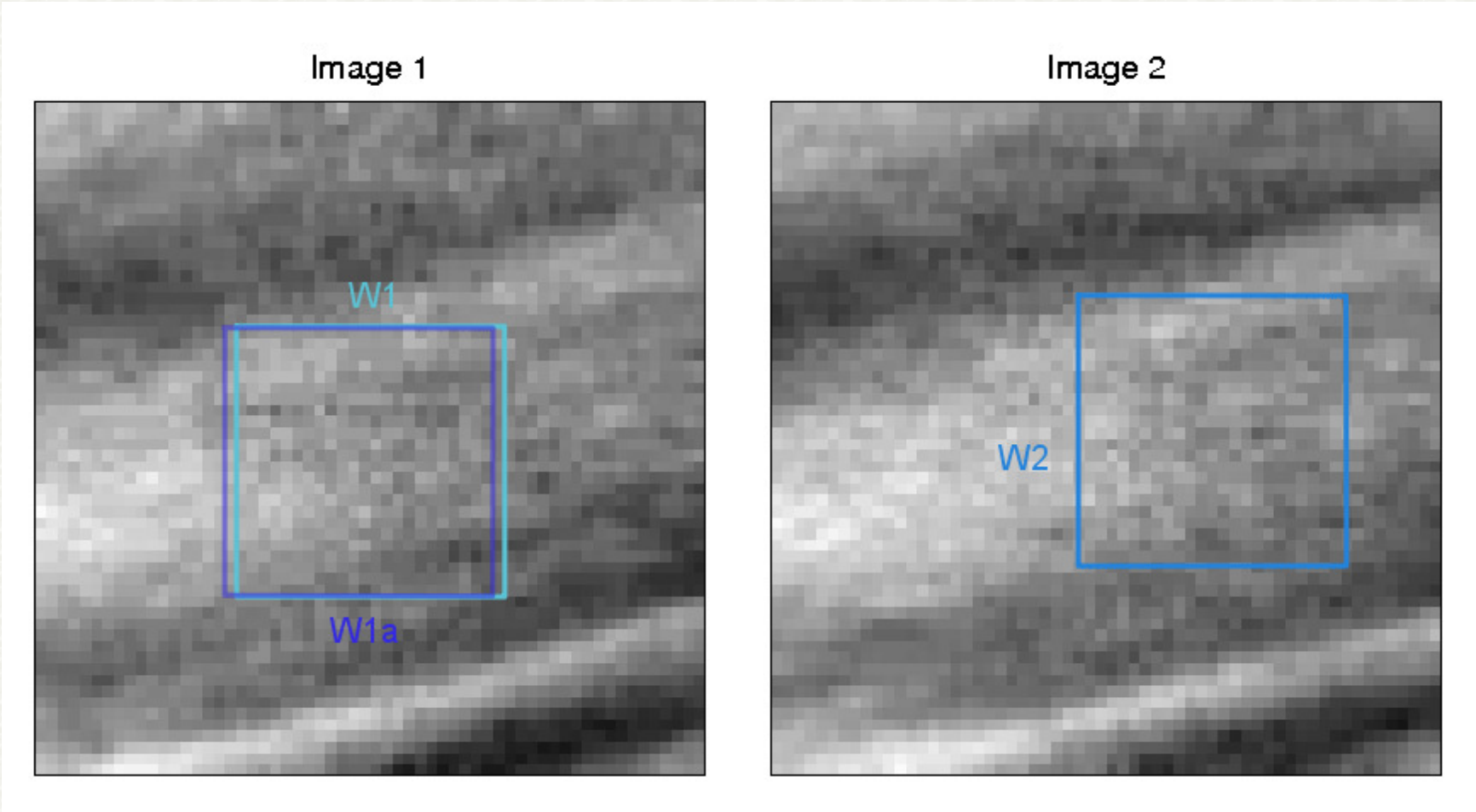

1. Tracer size
2. Tracers properties
3. Tracers - MV quality
4. To conclude
Backtracking test
Gaussian multi-scale
H1 as similarity function
Spatial Frequencies

1. Tracer size

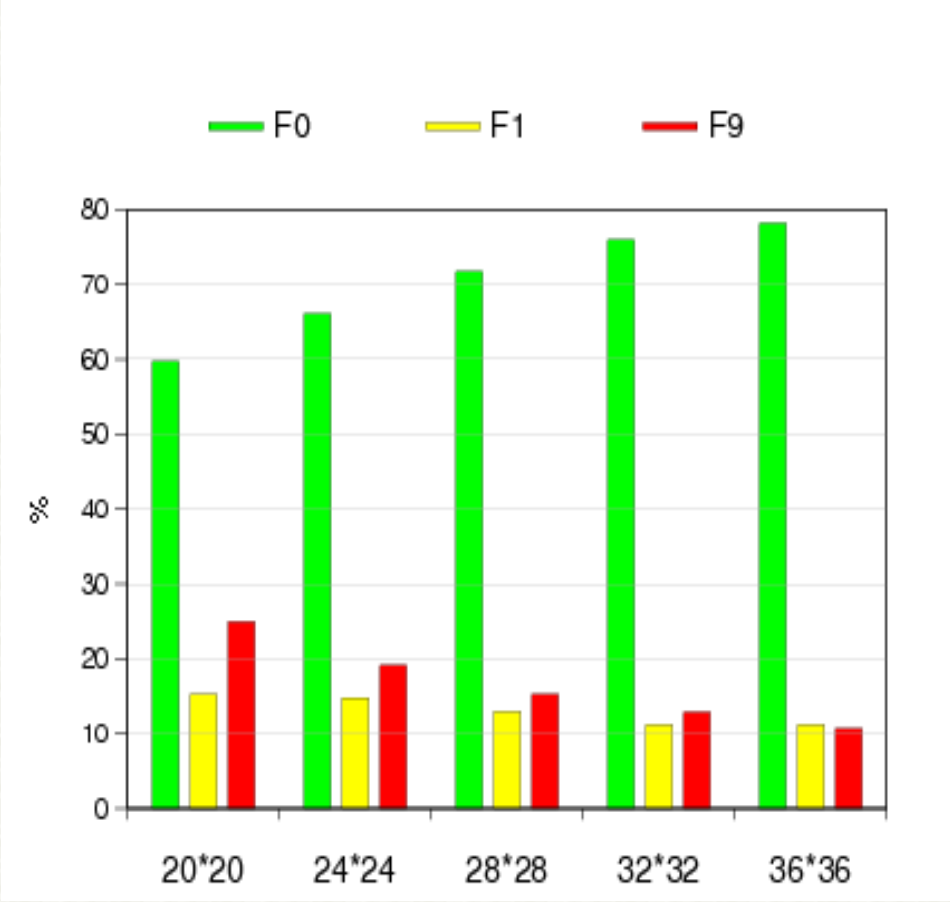


- Meteosat-9
- WV 6.2
- 17 Jul 2007
- Sampling grid: 8*8
- Euclidean distance
- Evaluation: backtracking

Backtracking test

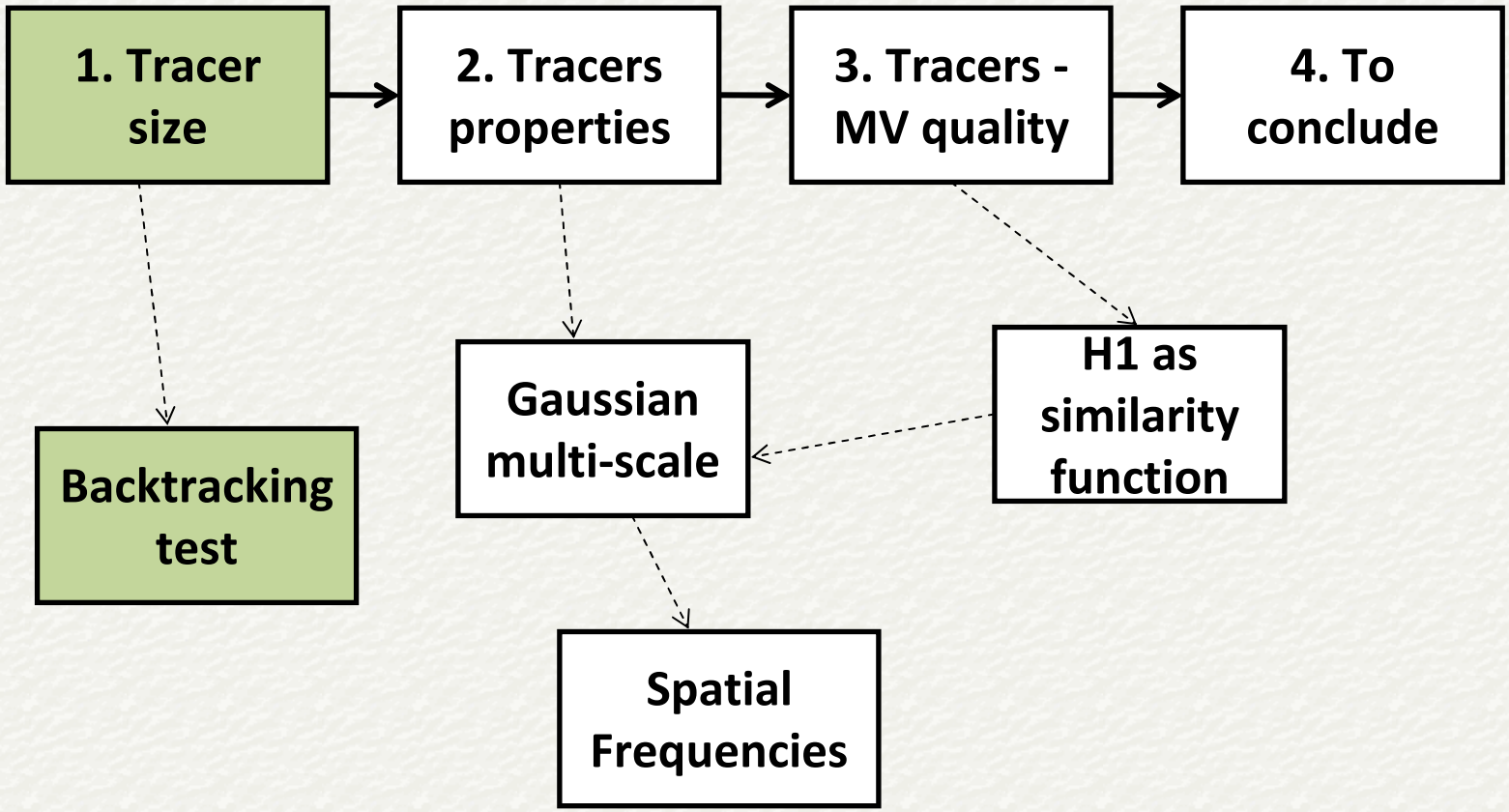


1. Tracer size



- Larger tracers more accurate.
- But an MV represents an area: how large?
- Other aspects: height assignment.
- [WV, MSG-2, backtracking].

Outline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2. Tracers properties

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- Interested in local properties of the image:
  - Gradient modulus: local max
  - Local standard deviation
  - Contrast: max BT – min BT
  - Anything useful...

- But...
  - Is there a way to avoid noise?
  - Derivatives at what scale?

Gaussian multi-scale representation

- Embed the image I in a family of convolutions:

$$L(\,.\,;\sigma) = G(\,.\,;\sigma) * I(.) \qquad (\sigma > 0),$$

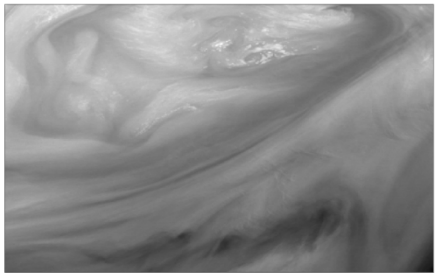
where G is

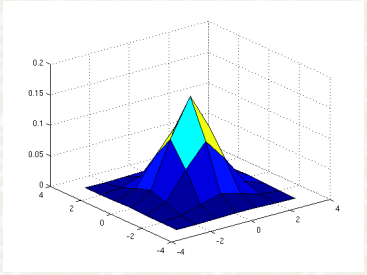
$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

- A Gaussian blur is a low-pass filter.
- The difference between two Gaussian blurs is a band-pass filter.

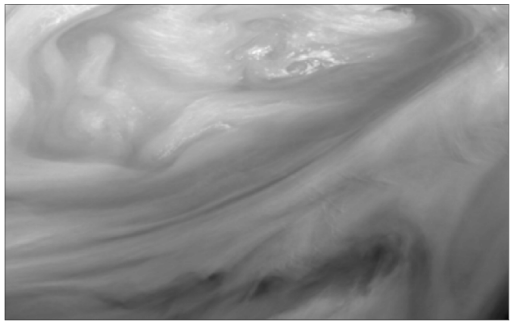
Gaussian multi-scale representation

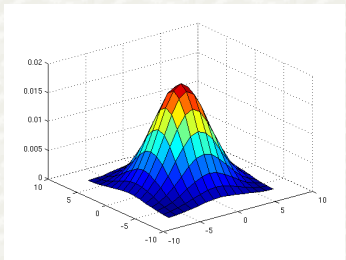
ORIGINAL



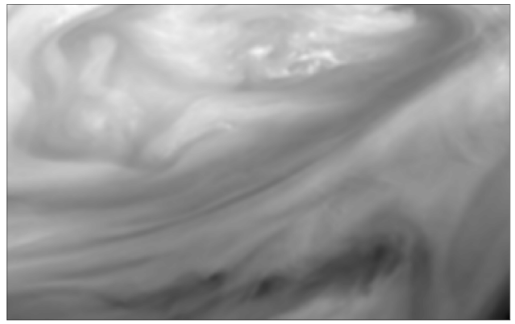


Smoothed - σ =1

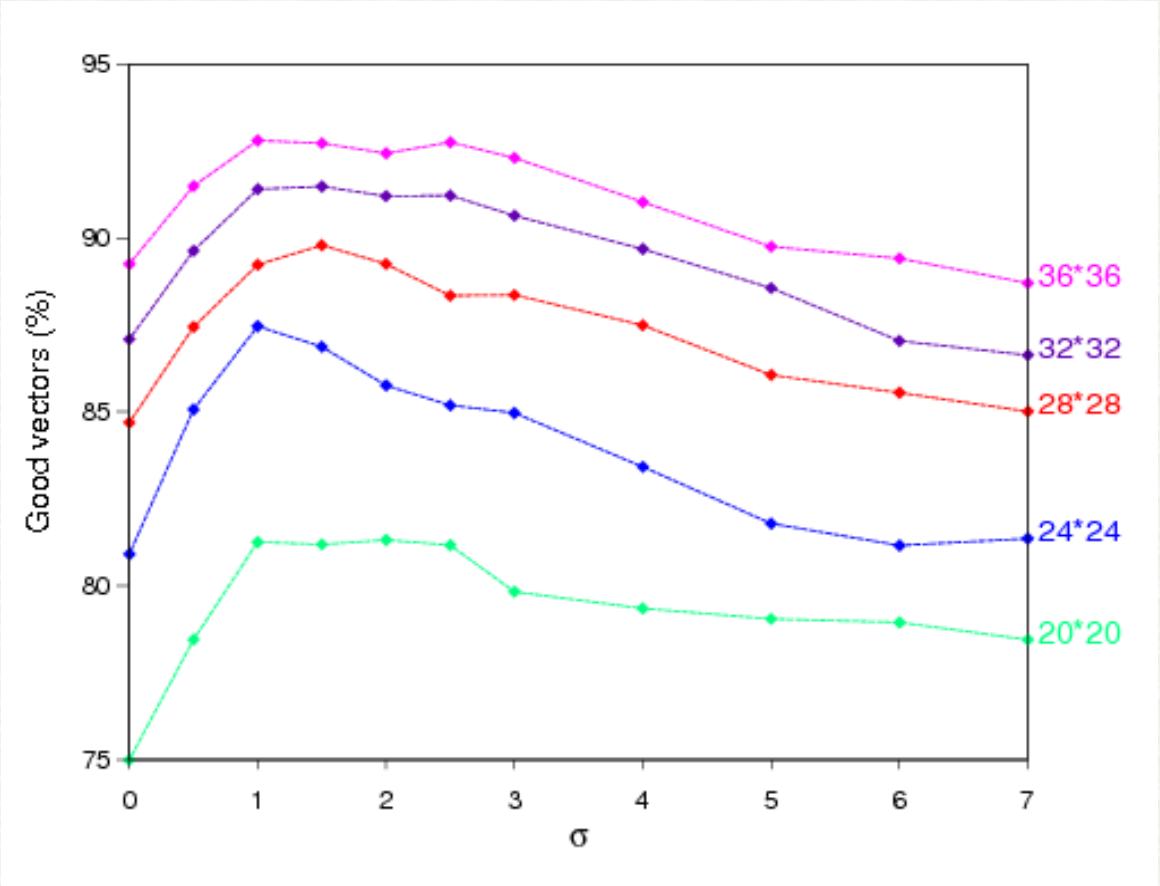




Smoothed - σ =3



Spatial frequencies: impact on the tracking



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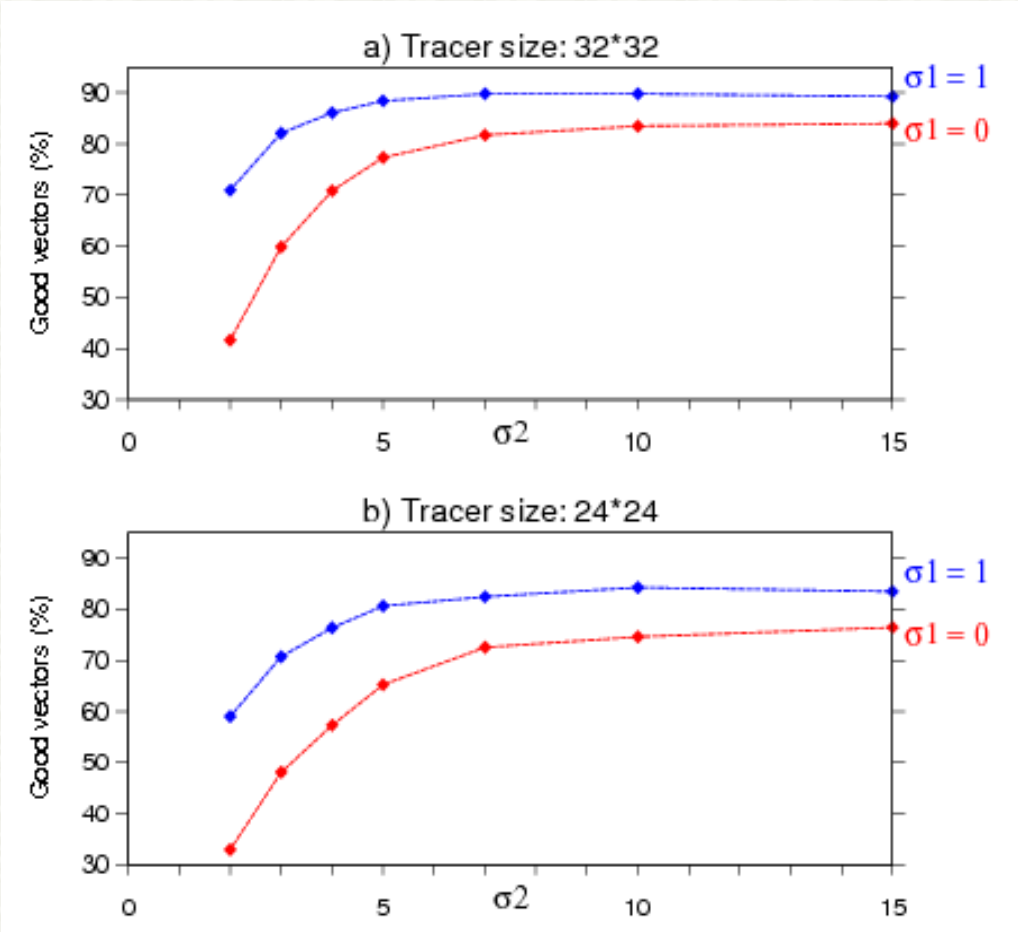
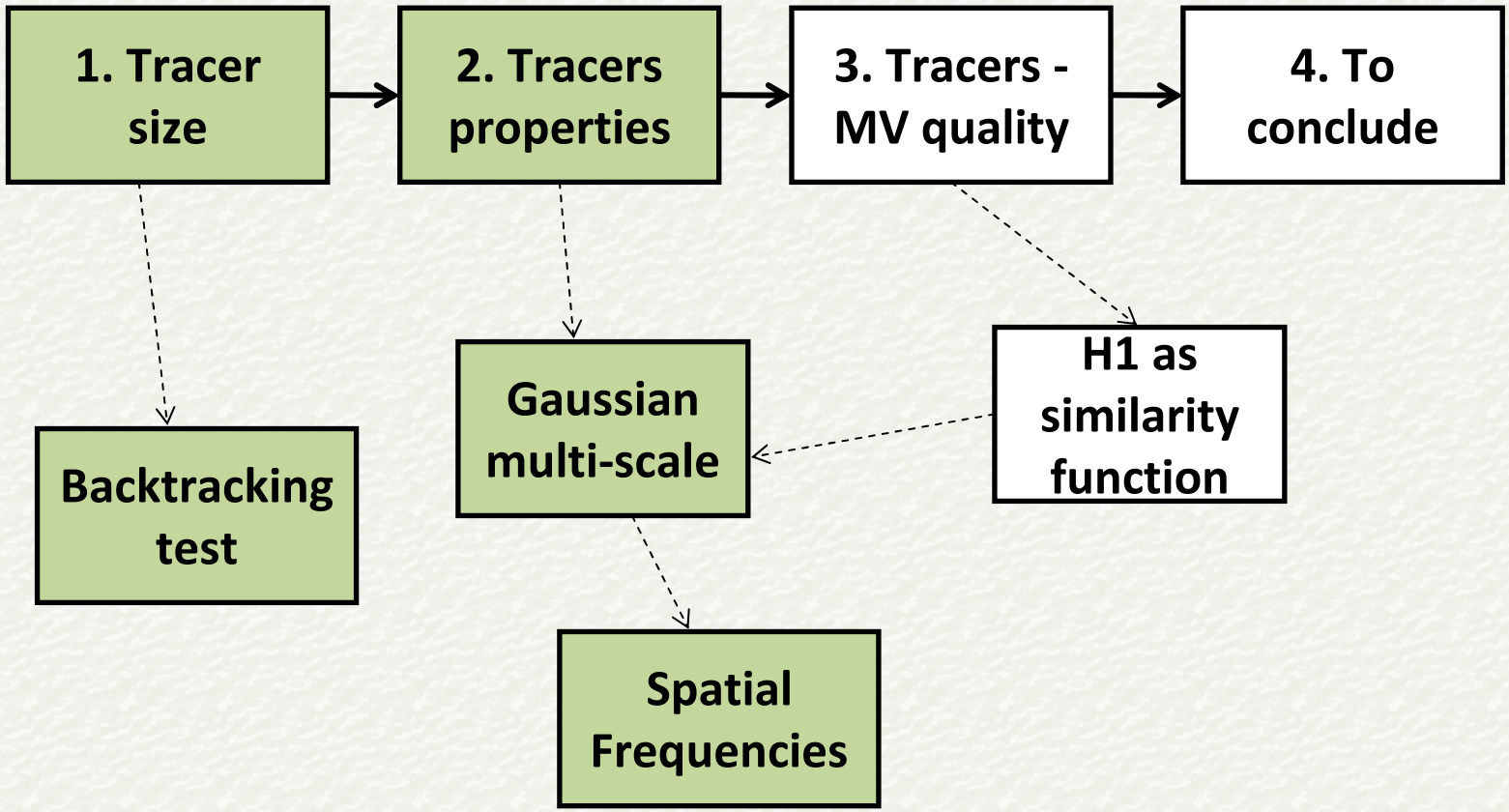


Outline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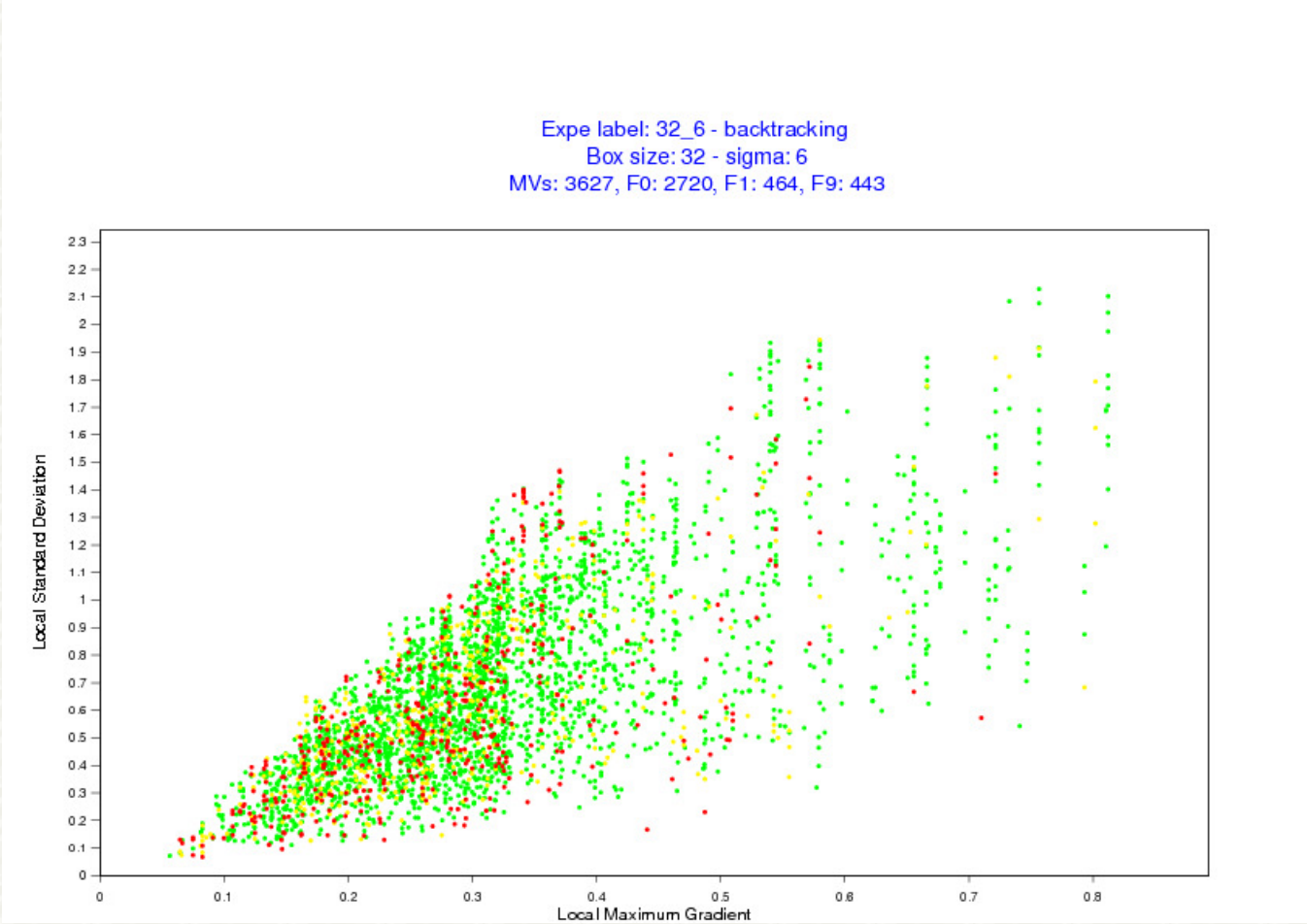
3. Tracers – MV quality



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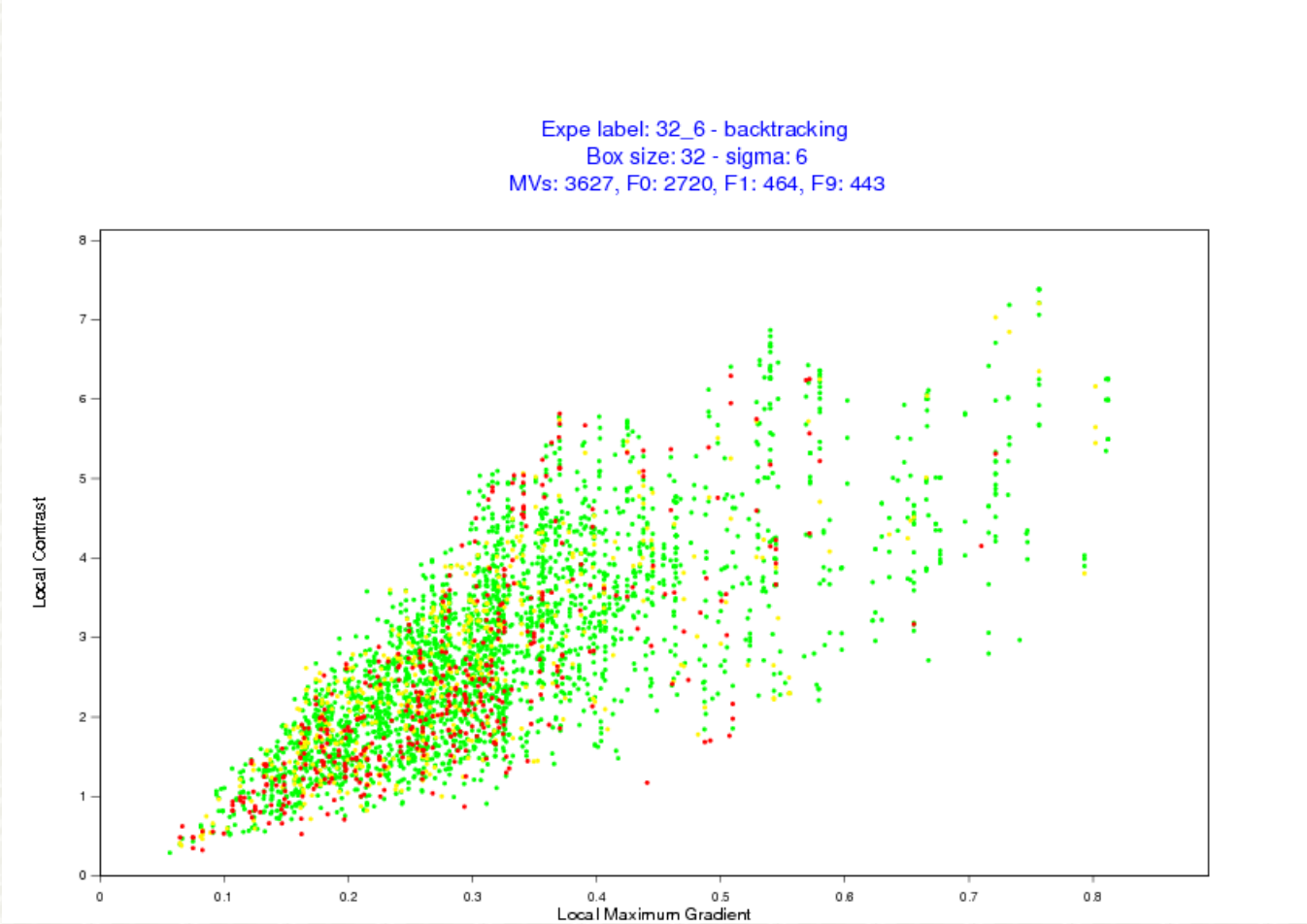

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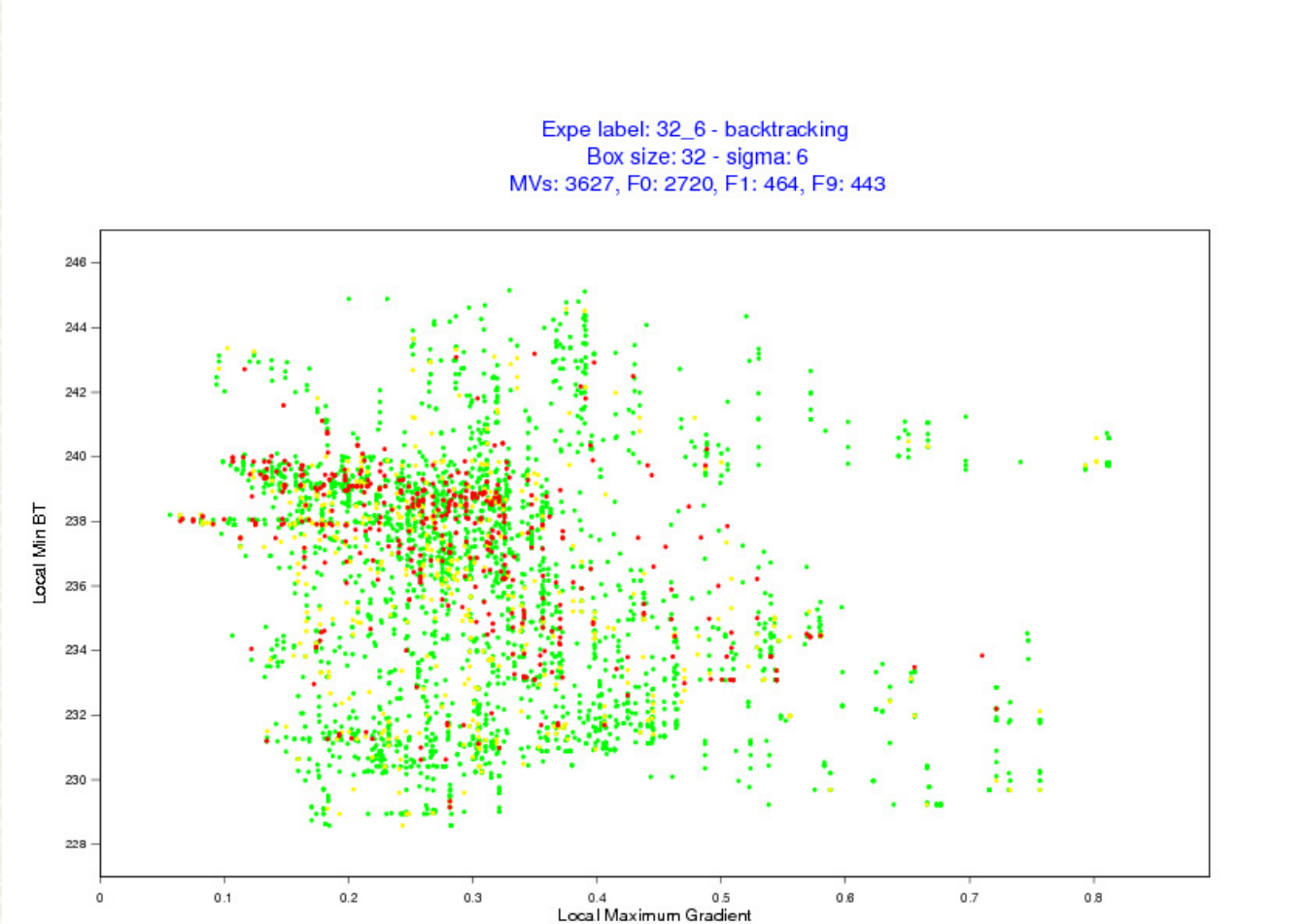
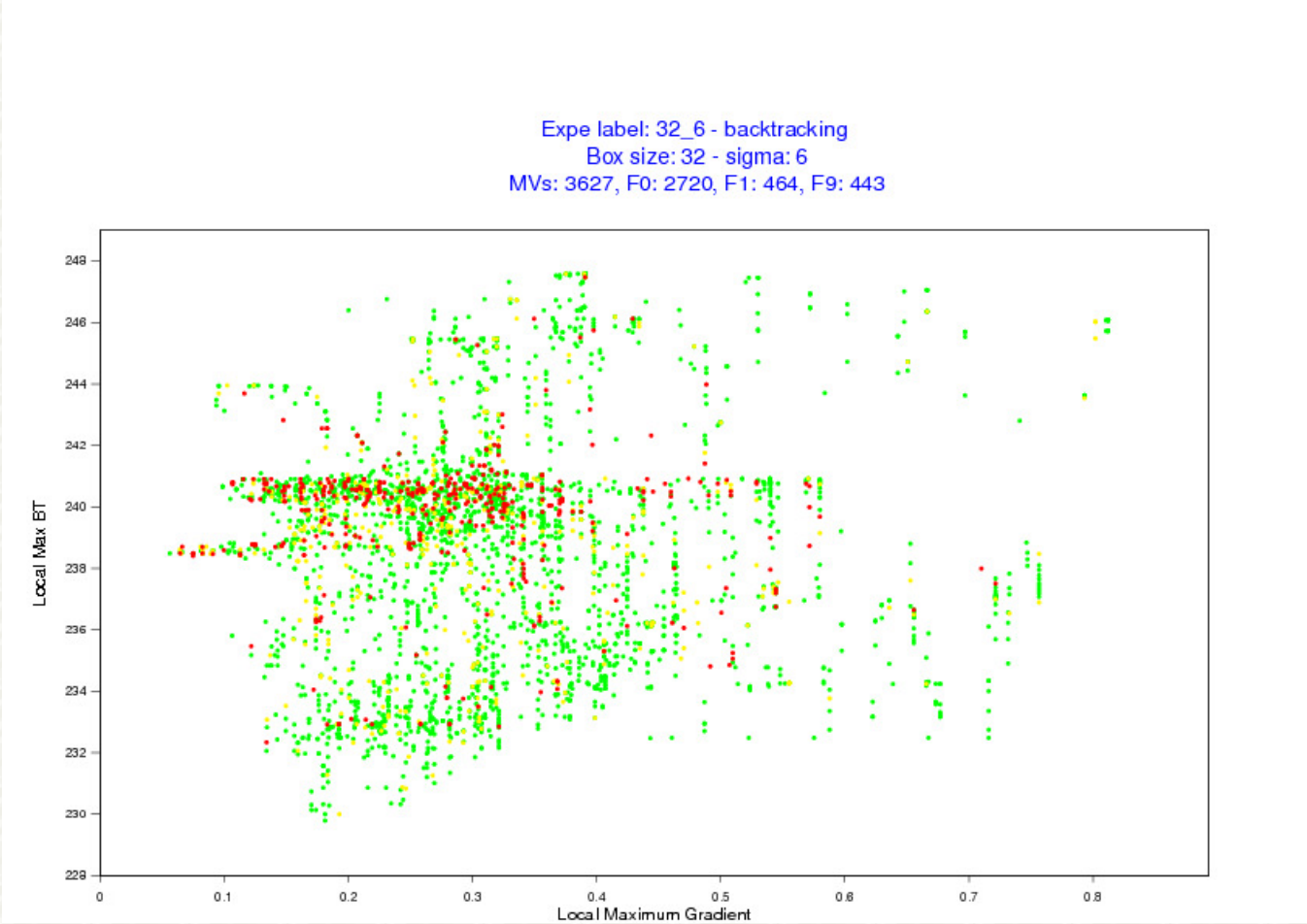


4. Tracers – MV quality



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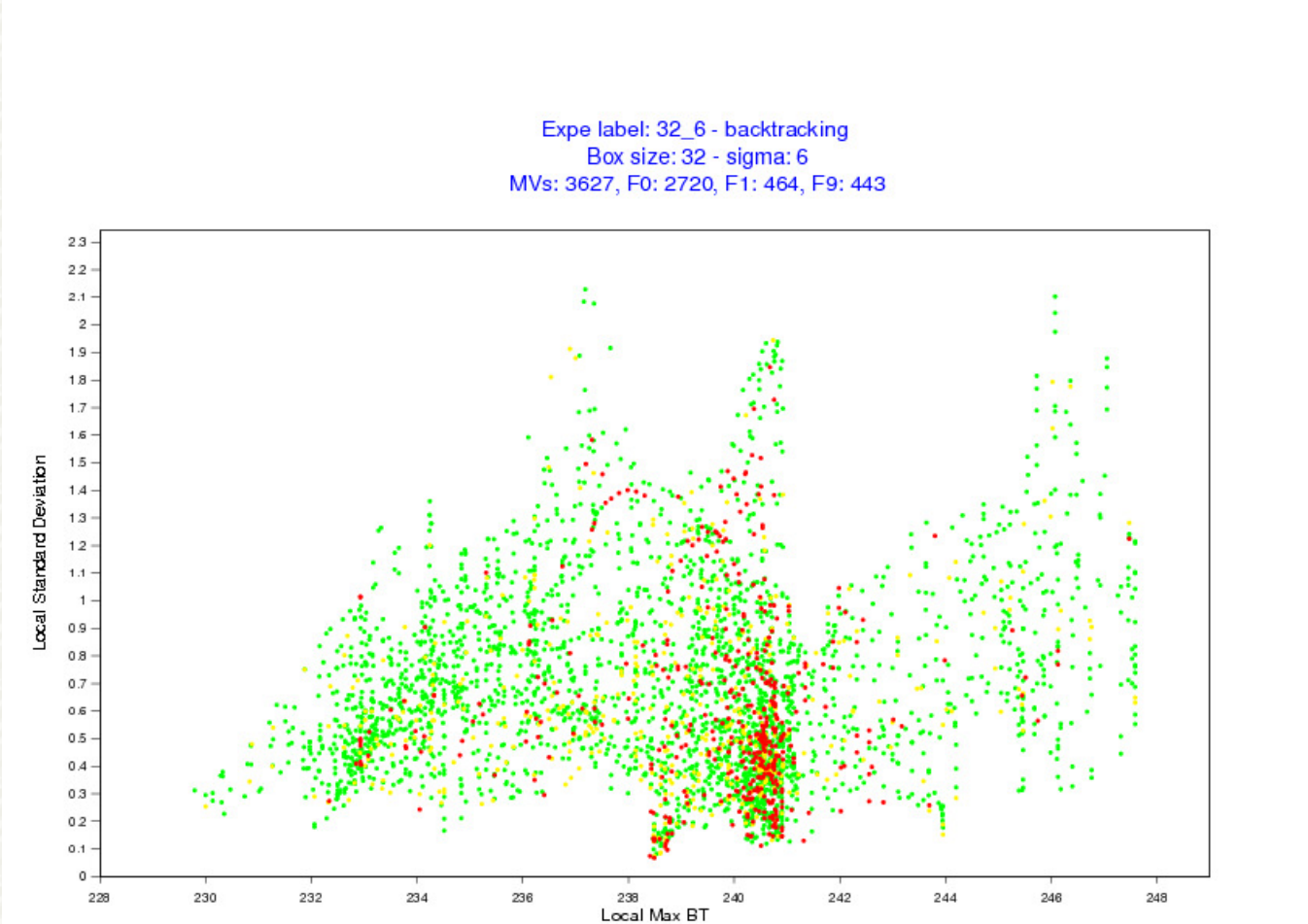

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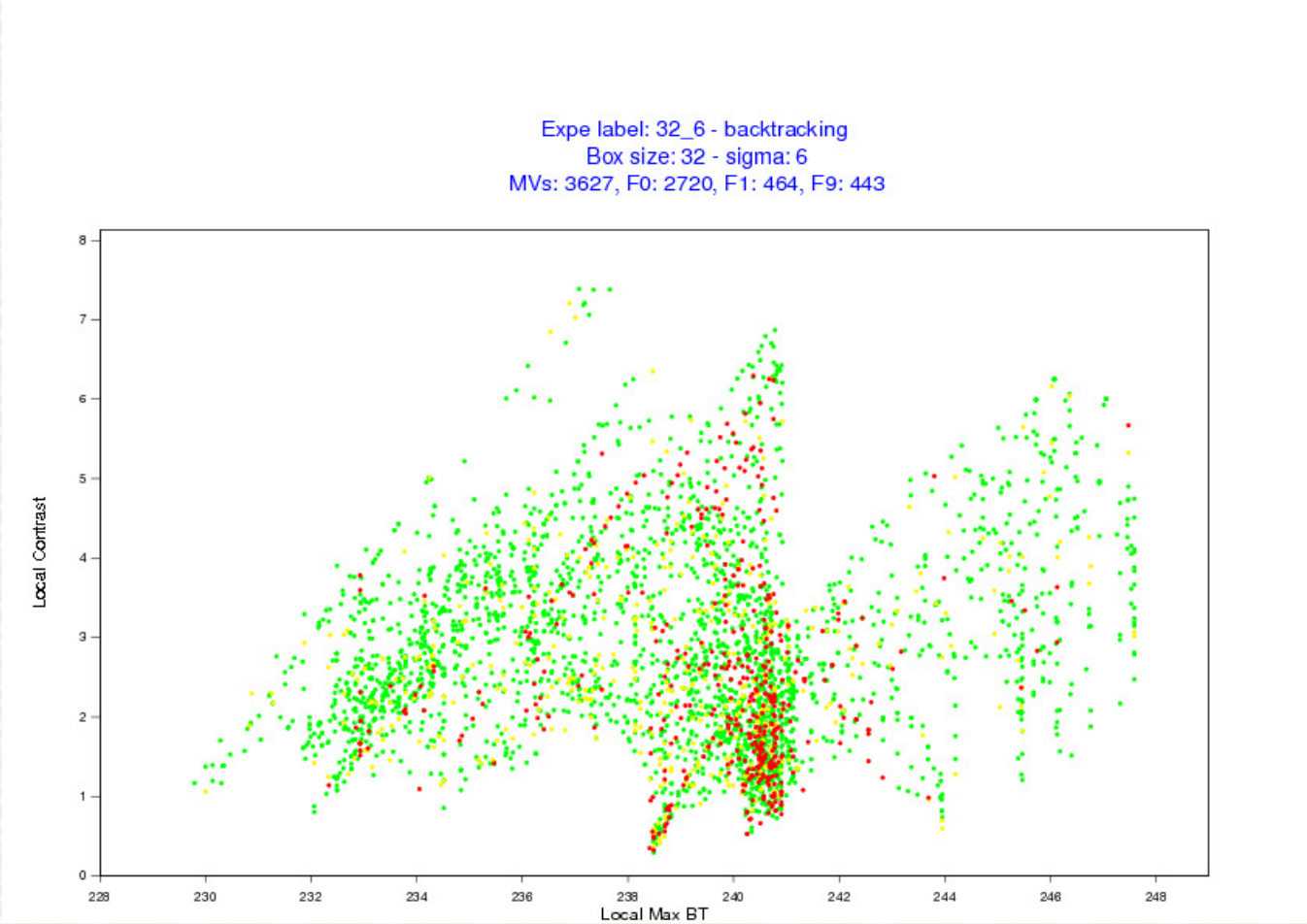

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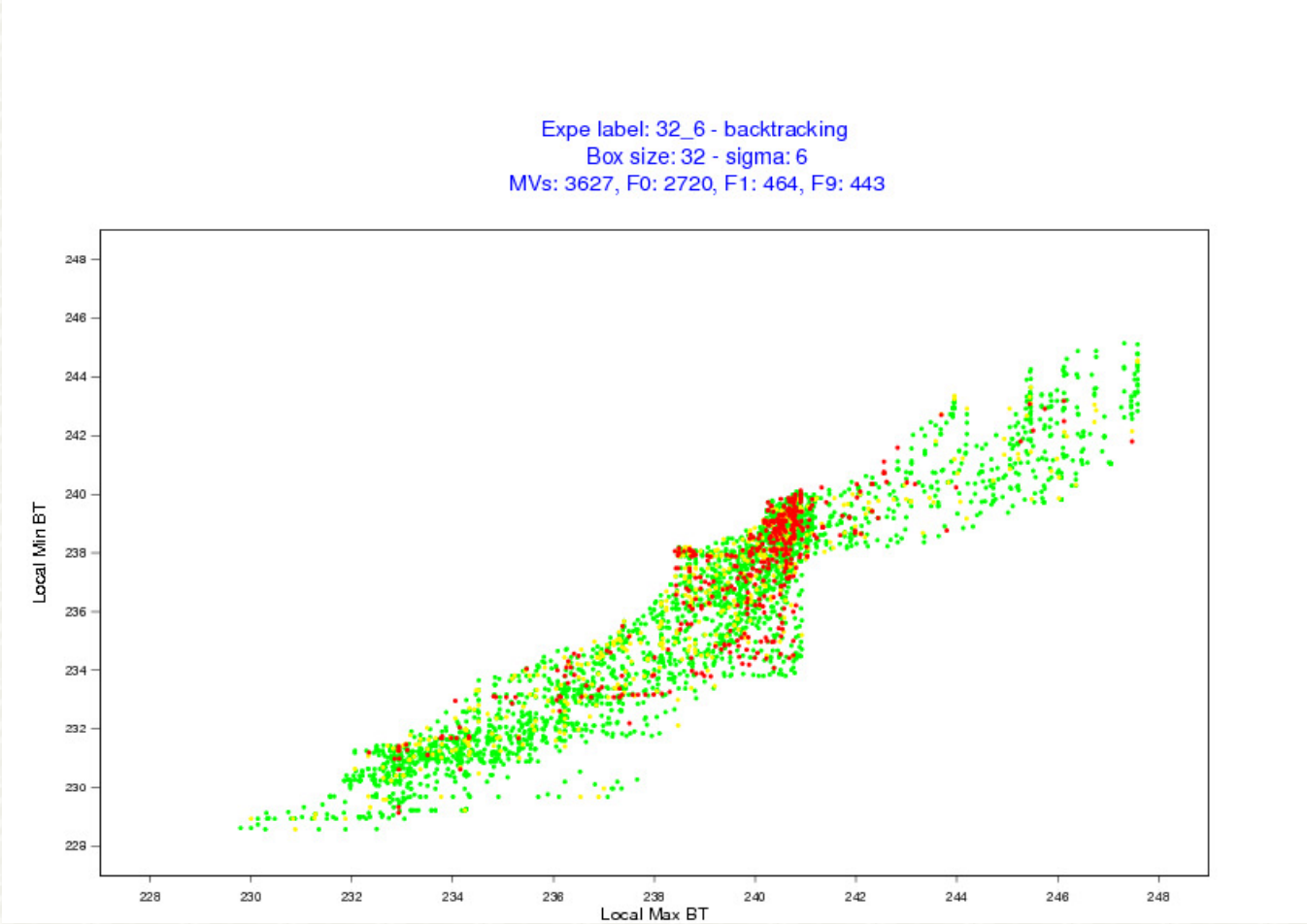

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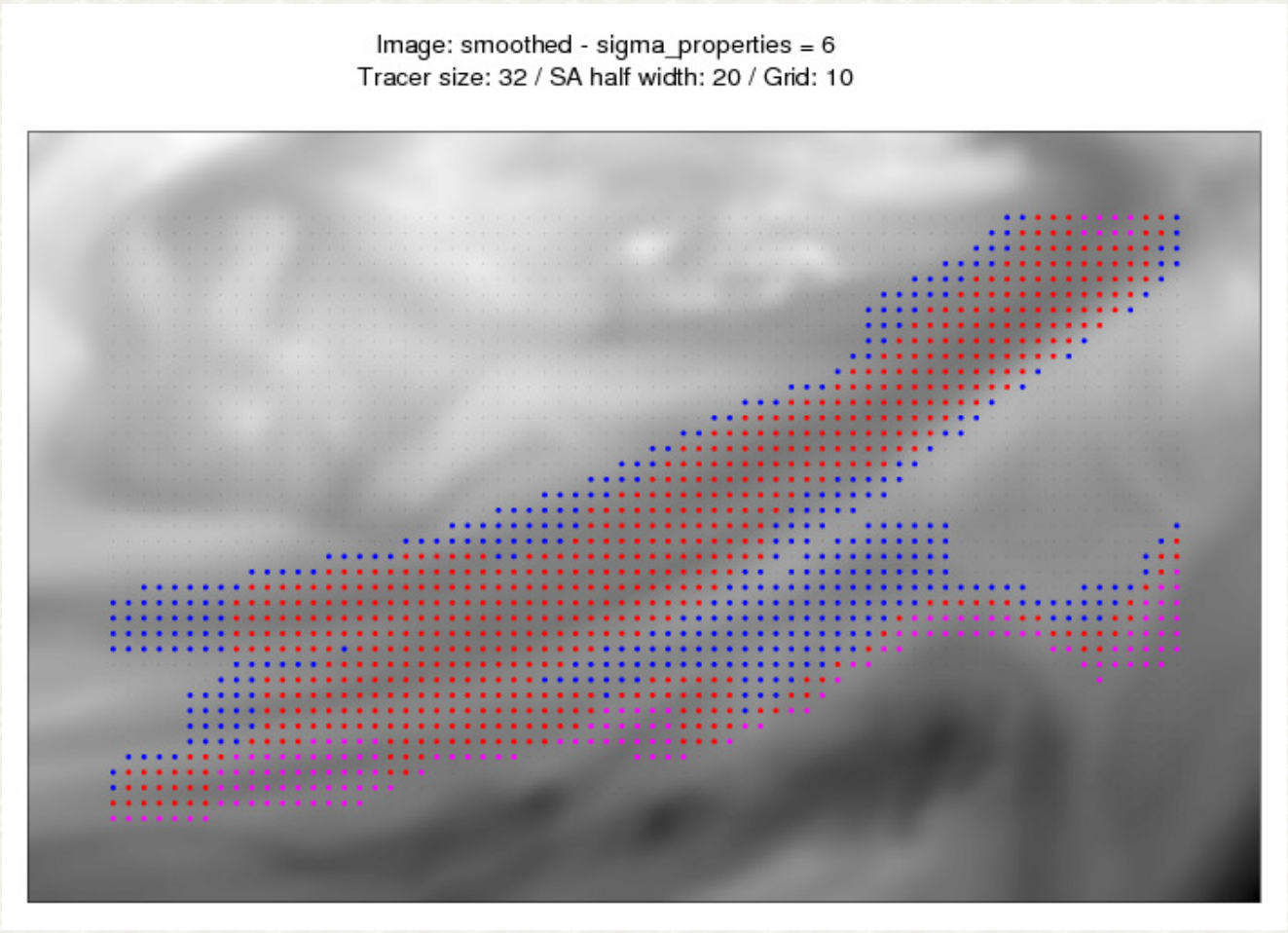

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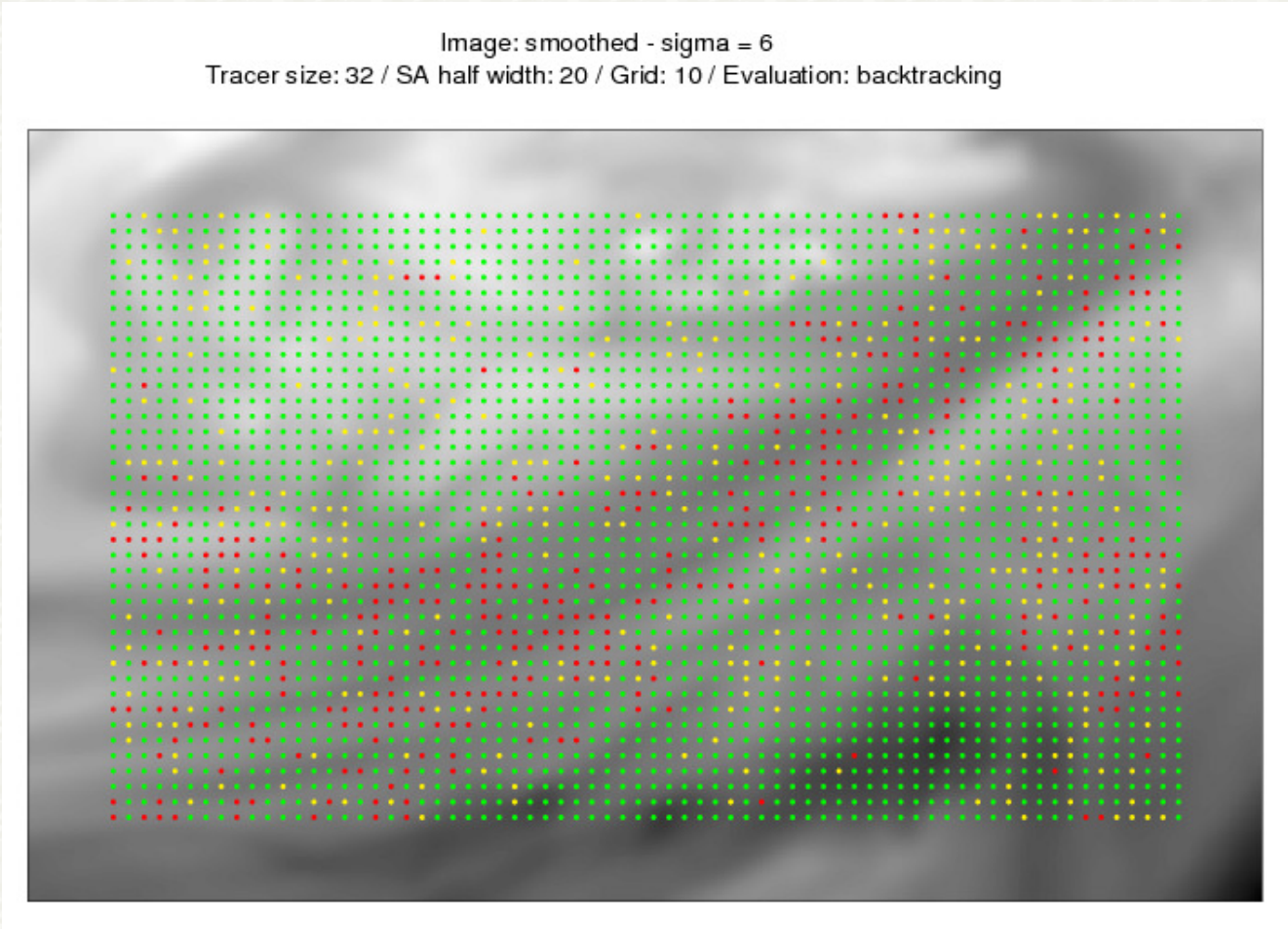


H1 as similarity function

- Euclidean distance is often used as similarity function in the tracking step.
- Behind it is the L_2 norm:

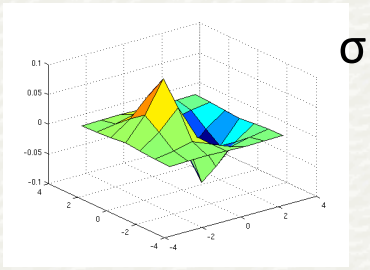
$$\|f\|_p = \left(\int |f(x)|^p \, dx \right)^{1/p} \quad \text{(p=2)}$$

- We can consider the H_1 norm:

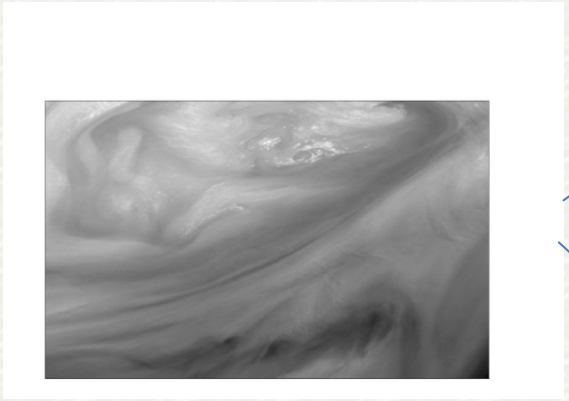
$$\|f\|_{H^1} = \left(\int_\Omega \left(|f|^2 + |\nabla f|^2 \right) \right)^{1/2}.$$

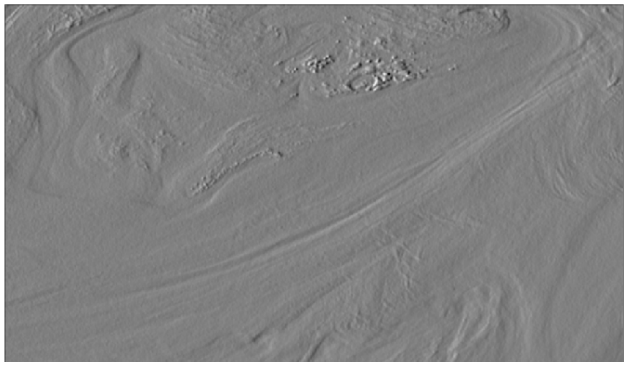
H1 as a similarity function

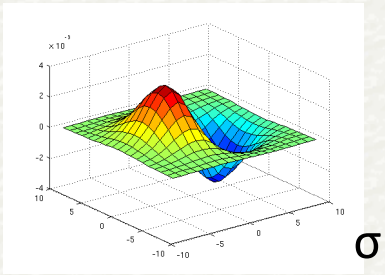
$$\frac{\partial f}{\partial x}$$



σ =1







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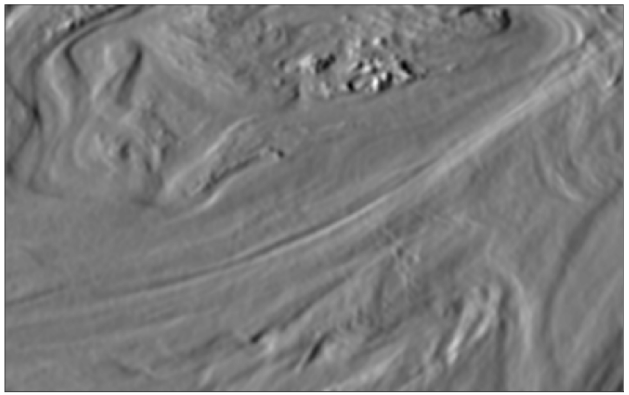

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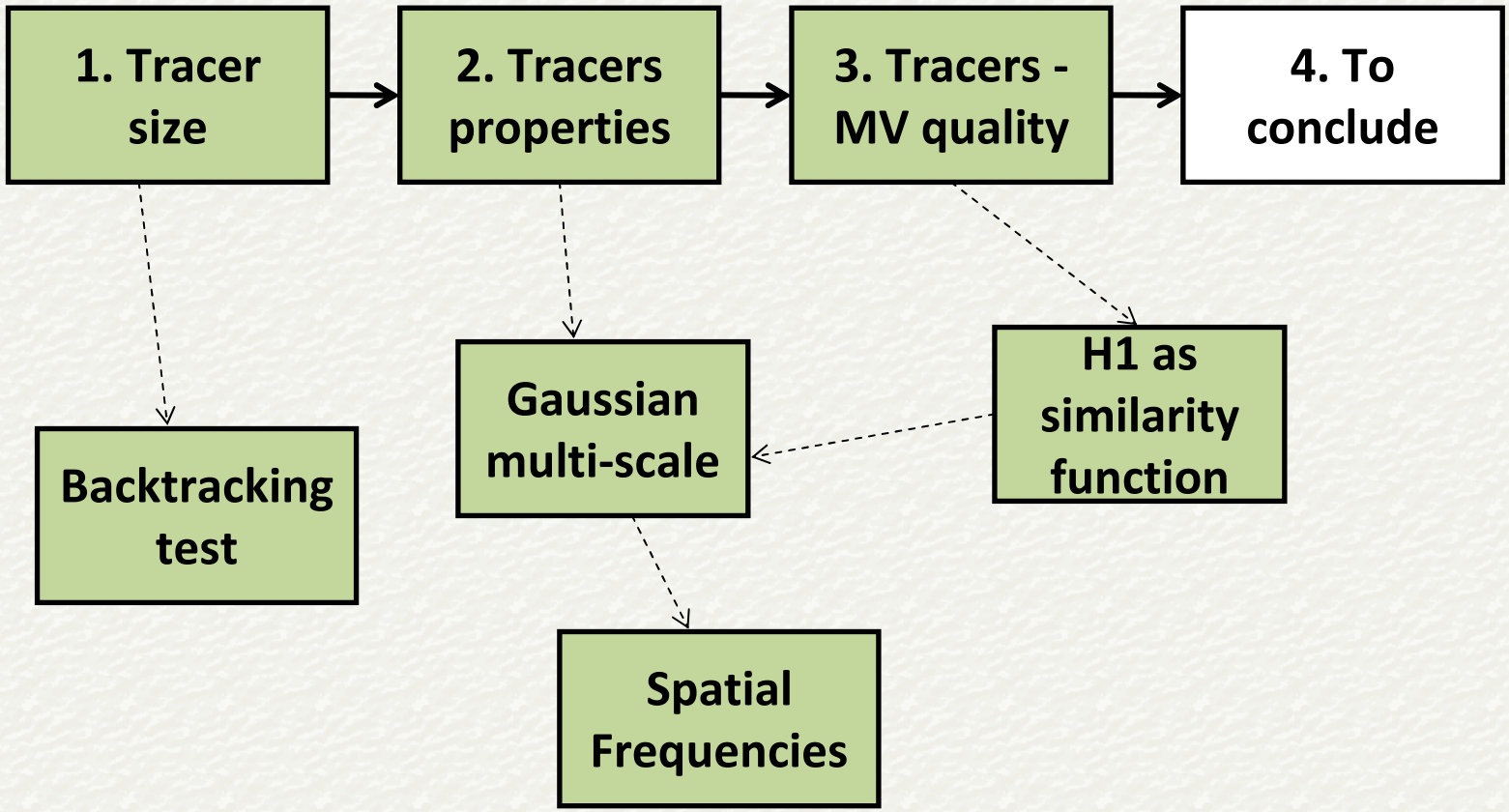
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4. To conclude

- Note: evaluation limited to backtracking test.
- MV quality improves as tracer size increases
  - Range tested: 20*20 to 36*36.
- Gaussian multi-scale representation
  - Higher frequencies: negative impact on the tracking.
  - Lower frequencies: positive impact (or neutral).
- Can we characterize good / bad tracers?
  - Perhaps we should look at the atmospheric flow...

4. To conclude

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What's next:

- Other evaluation methods (NWP, level of best fit).
- Explore H1 norm.
- Many choices, of different nature:
  - Tracer size, σ, similarity function, ...
  - We can't assume they are independent.
  - Tests computationally expensive.
  - Maybe a Genetic Algorithm would be useful...

どうもありがとうございました。

アンジー

Thank You for Your Attention!