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Methodologies for man made oil spill detection

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Satellite Monitoring and Assessment of Sea-based Oil Pollution

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Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?

Three procedures…

- Manual Inspection - classification
- Semi-automated methods
- Fully-automated methods

Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?

Manual Inspection - classification

Two steps…

2. Inspection of the image. Detection of the possible candidates being oil slicks.
2. Discrimination process (between probable oil slicks and probable look-alikes).

Exclude ‘easy’ look-alikes through characteristic shapes and configurations completely different from those of the oil slicks, such as the dark patches caused by internal wave areas and rain cells.

More detailed analysis for the ‘difficult’ cases.

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Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?

Manual Inspection - classification

Discrimination process

Some useful hints for the discrimination analysis are:

- Take into account the period of the year,
- Wind conditions,
- Analysis of the shape,
- Slick size,
- Geographic region under consideration.

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Manual Inspection - classification

Discrimination process

- Take into account the period of the year

It is improbable to find natural slicks in winter (and grease ice in summer and spring).

- Wind conditions

When no wind is present, an oil slick will be invisible. If the wind speed is above 7-8 m/s, the natural films are likely to be washed down and the slick is probably man made. If the wind speed is less than 2-3 m/s,the dark patch is a consequence of the fact that no Bragg waves have been generated.

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Manual Inspection - classification

- Analysis of the shape

This kind of analysis is quite useful since it is possible to find some surface features caused by natural phenomena that are very similar to those caused by oil slicks.

It is important to know the most typical shapes characteristics of man-made slicks, these are:

- The border
- The tails
- The wide ("rounded") slicks

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Manual Inspection - classification

- Analysis of the shape

The border: The borders of oil man-made slicks spots are well defined. Very sharp step in the backscatter intensity between the region within the spot and its surrounding area. Natural oil slicks present more structured borders. However, aged man-made oil slicks can also show a more complex border structure than a new one.

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- Analysis of the shape

The tails: Can be thin, straight or slightly curved dark features, with no sharp bends and no branches, covering few pixels; usually a bright spot can be seen in the vicinity, representing a ship or platform. If their length is of some kilometers, they are more probably due to the wind sheltering action caused by the object being the bright spot. If there is not a bright spot, then the tails can be due a wind sheltering action caused by natural profiles, such as island bays.

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- Analysis of the shape

The wide "rounded" slicks:
A slick with approximately the same width as length is considered wide. The wide slick features cover a larger region and usually have diffuse boundaries. If they are man-made, the amount of oil is typically so large that the oil spreads in a fan-shaped form in the wind direction or even close to a full circle around the pollution source.

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Manual Inspection - classification

- Analysis of the shape

The wide "rounded" slicks: (continue…)
If the slick does not have one of these two characteristic shapes, a deeper analysis is needed. For example, it is quite probable that homogeneous slicks are man-made because they contain high viscosity materials. However, since it is no possible to define an exact limit between homogeneous and inhomogeneous slicks the distinction must be based on the experience.

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Manual Inspection - classification

- Slick size

The slick size can be used in the discrimination. Extremely large slicks are usually either natural slicks or low wind areas.

- Geographic location

The value of the radar may suddenly change at the passage from a region in which no wind is present to another in which the wind is blowing. Sheltering action exercised by topography: high submarine mountains, areas close to the coast, or by oil platforms. Different size and shape.

Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?
Semi-automated methods

Four steps

3)Isolation of all the dark signatures presented on the image, through appropriate threshold and segmentation processing.

5)Extraction of key parameters for each candidate signature, which usually are related to its shape, internal structure and radar backscattering contrast.

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Semi-automated methods

Four steps

3) Test of the extracted parameters against predefined values, which characterize man-made oil spills, usually determined through phenomenological considerations and statistical assessments.

4) Computation of probabilities for each candidate signature on whether it is a man-made oil spill.

In more sophisticated approaches also, environmental parameters with impact on the spill shape e.g. the wind speed and currents, are incorporated in the testing step.

Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?

Semi-automated methods

Key parameters

- Perimeter
- Area
- Average NRCS inside the dark area
- Average NRCS in a limited area outside the dark area
- NRCS Dark Area Standard Deviation
- NRCS Outside dark area Standard Deviation
- Gradient of the NRCS across the dark area perimeter
- Form Factor: The dispersion of dark area pixels from its longitudinal axis

From the left parameters, the following quantities can be derived:

- Perimeter to Area ratio
- Intensity Ratio between average NRCS inside and outside the dark area
- NRCS Standard Deviations Ratio inside and outside the dark area
- Ratio between NRCS Intensity and its Standard Deviation Inside the dark area
- Ratio between NRCS Intensity and its Standard Deviation Outside the dark area

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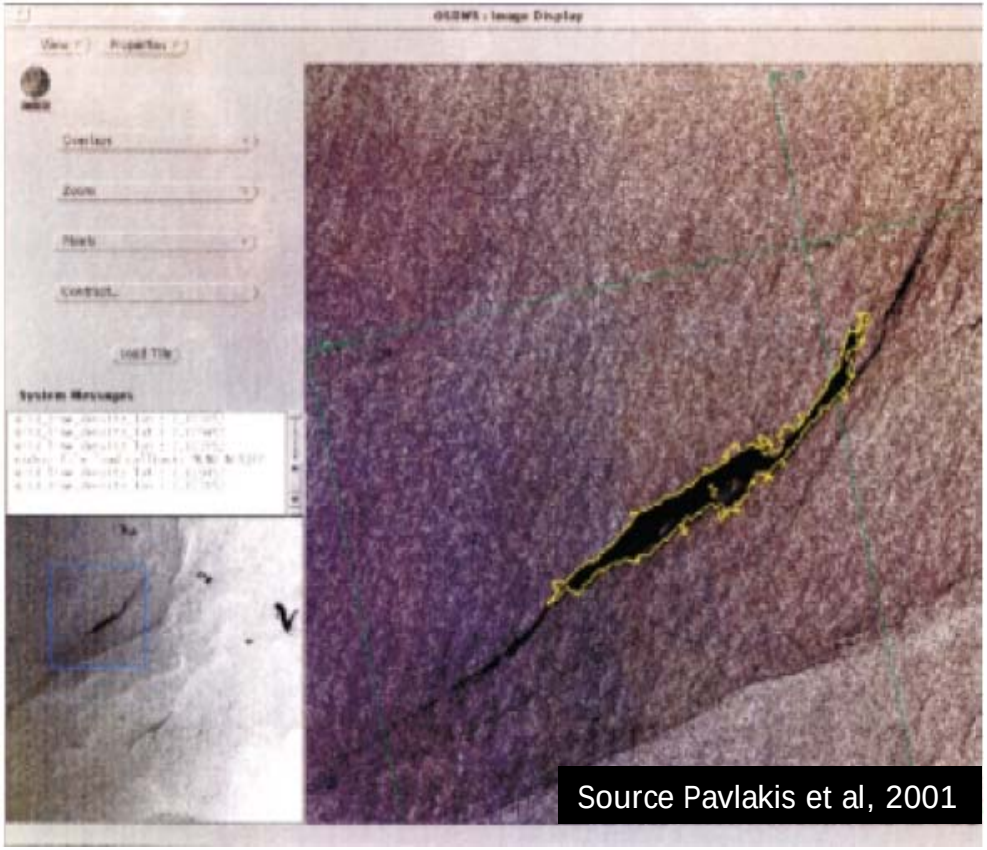
Semi-automated methods

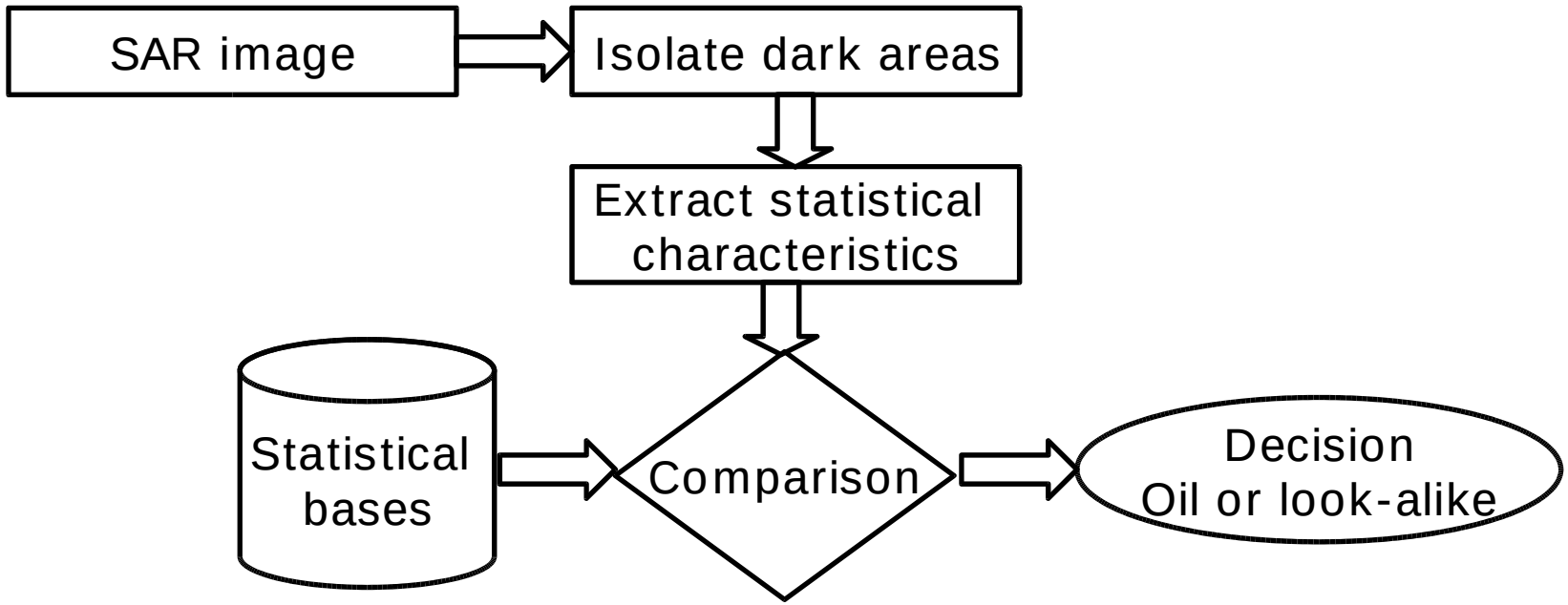


Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?

Fully-automated methods

Run the four steps through batch procedures



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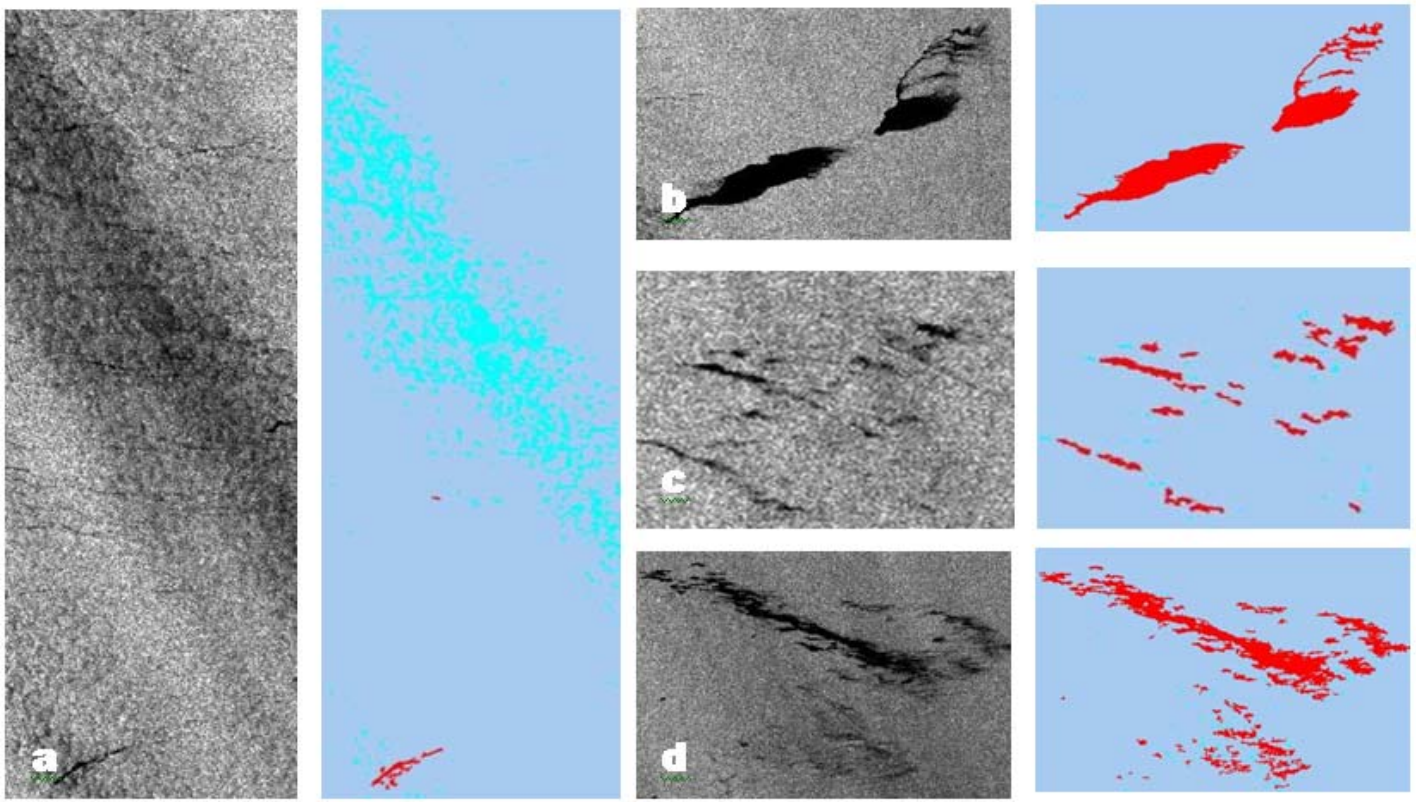
Fully-automated methods



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Methodologies for man made oil spill detection

How the several methodologies are trying to detect oil spills?

Accuracy

To a certain degree such systems succeed to discriminate man-made spills, but usually on images with less complex structure.

Failure because of poor automatic parametric description, of key shape features and internal structures of the spill-candidates.

Example: Weak radar backscattering contrast of a spill, combined with intense short scale image fabric, such as modulations due to the presence of swell, atmospheric boundary layer rolls, or turbulent wind fluctuations, associated with unstable conditions (i.e. warmer sea surface than the air above).

Accuracy is dependant from the input SAR data (type, resolution) and auxiliary data (wind info, sea surface temperature, currents, bathymetry…)

Methodologies for man made oil spill detection

Do you feel ready to identify oil spills?
Some examples…

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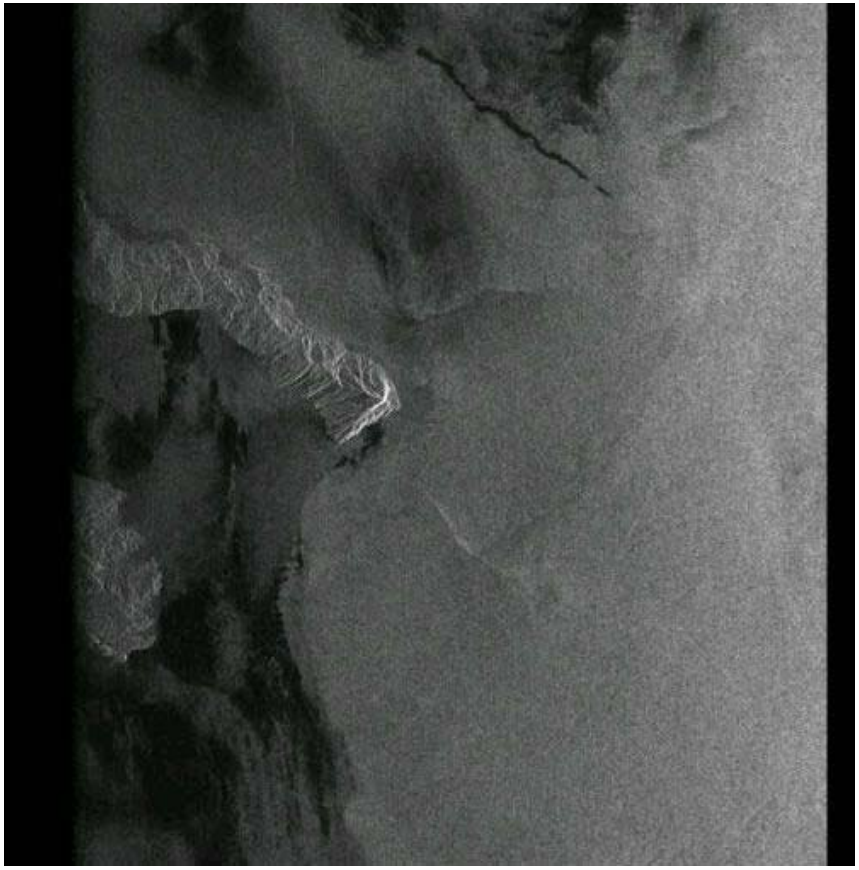

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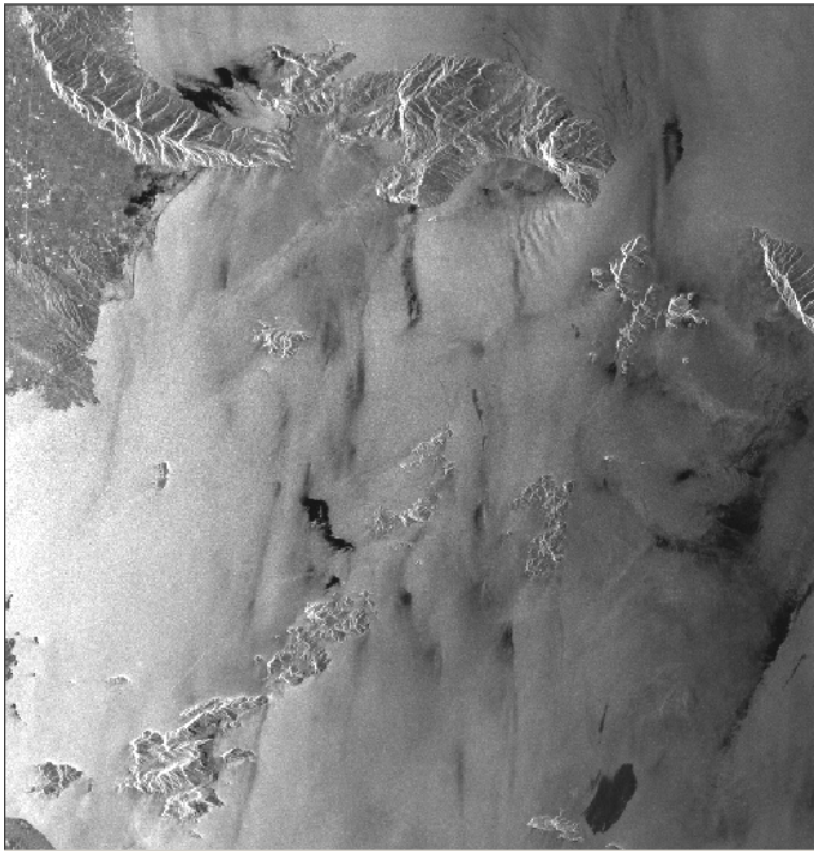
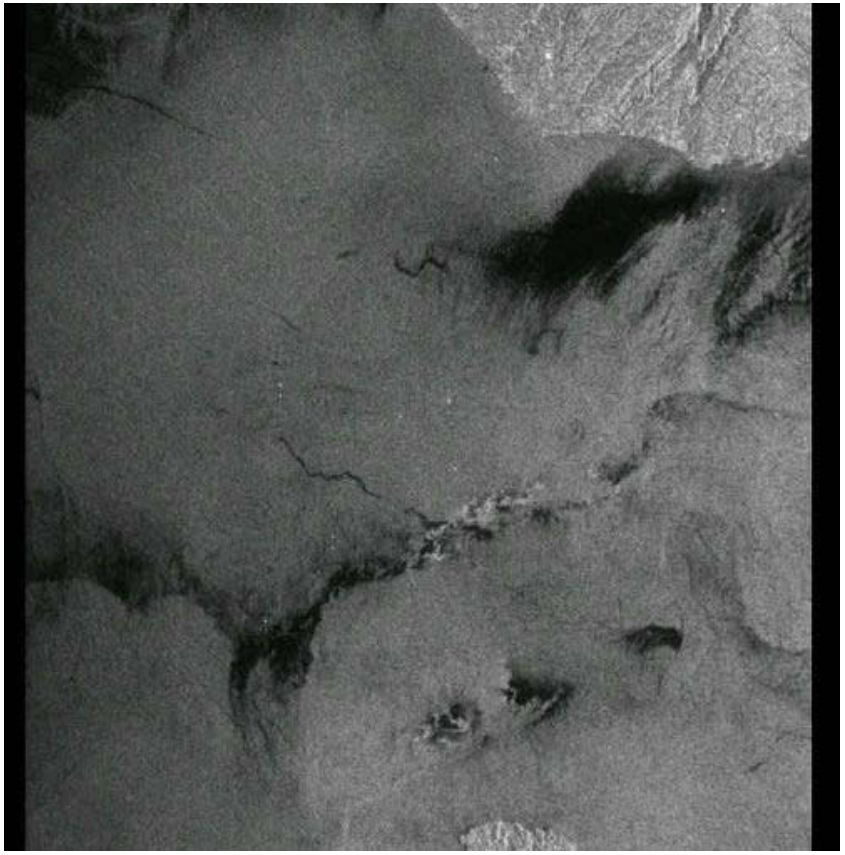
Some examples…





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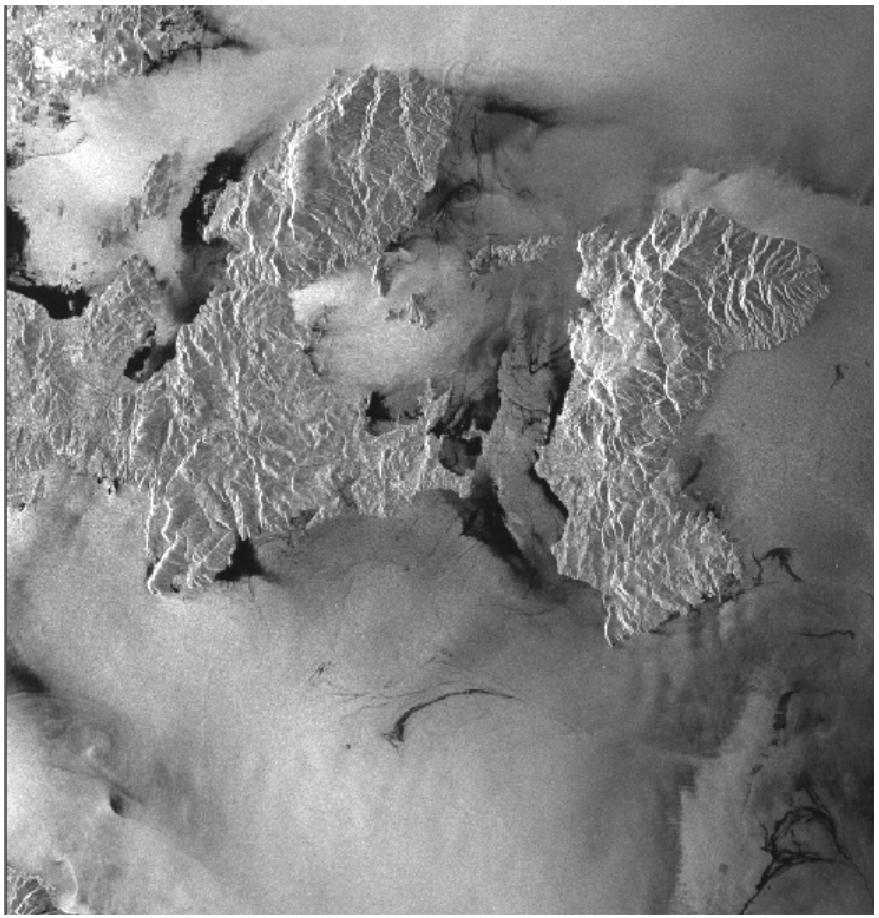

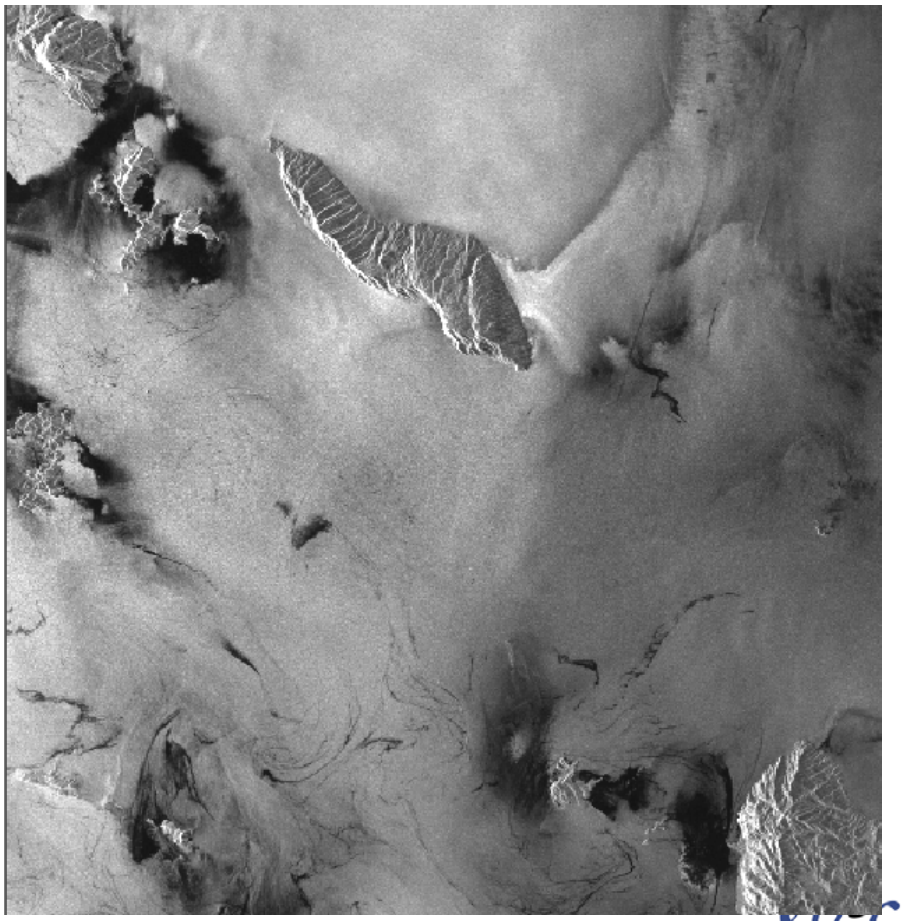

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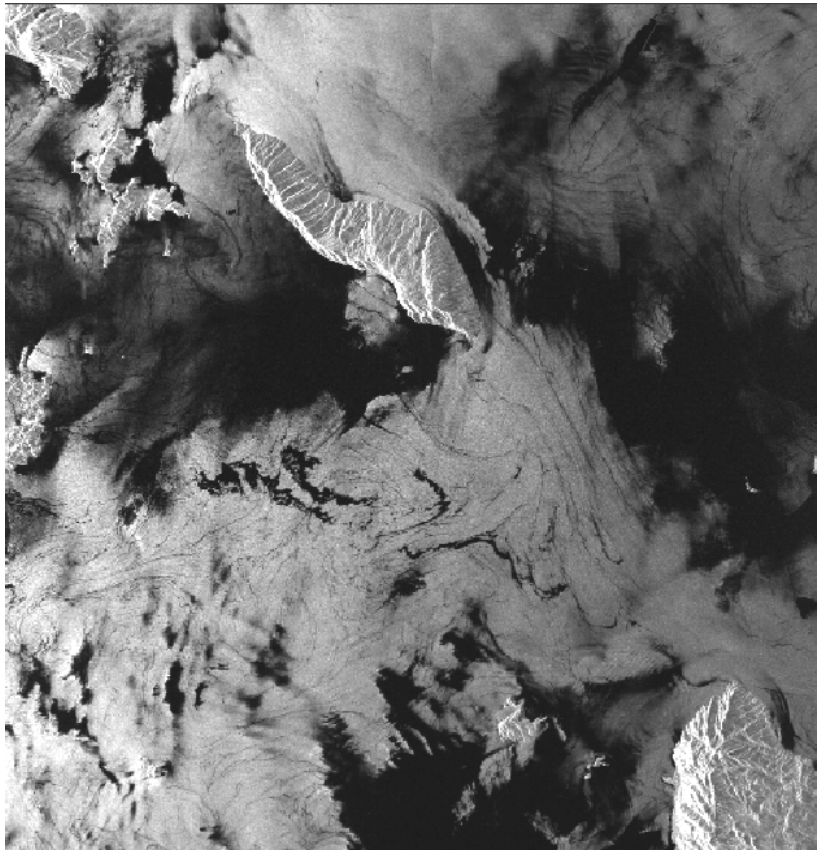

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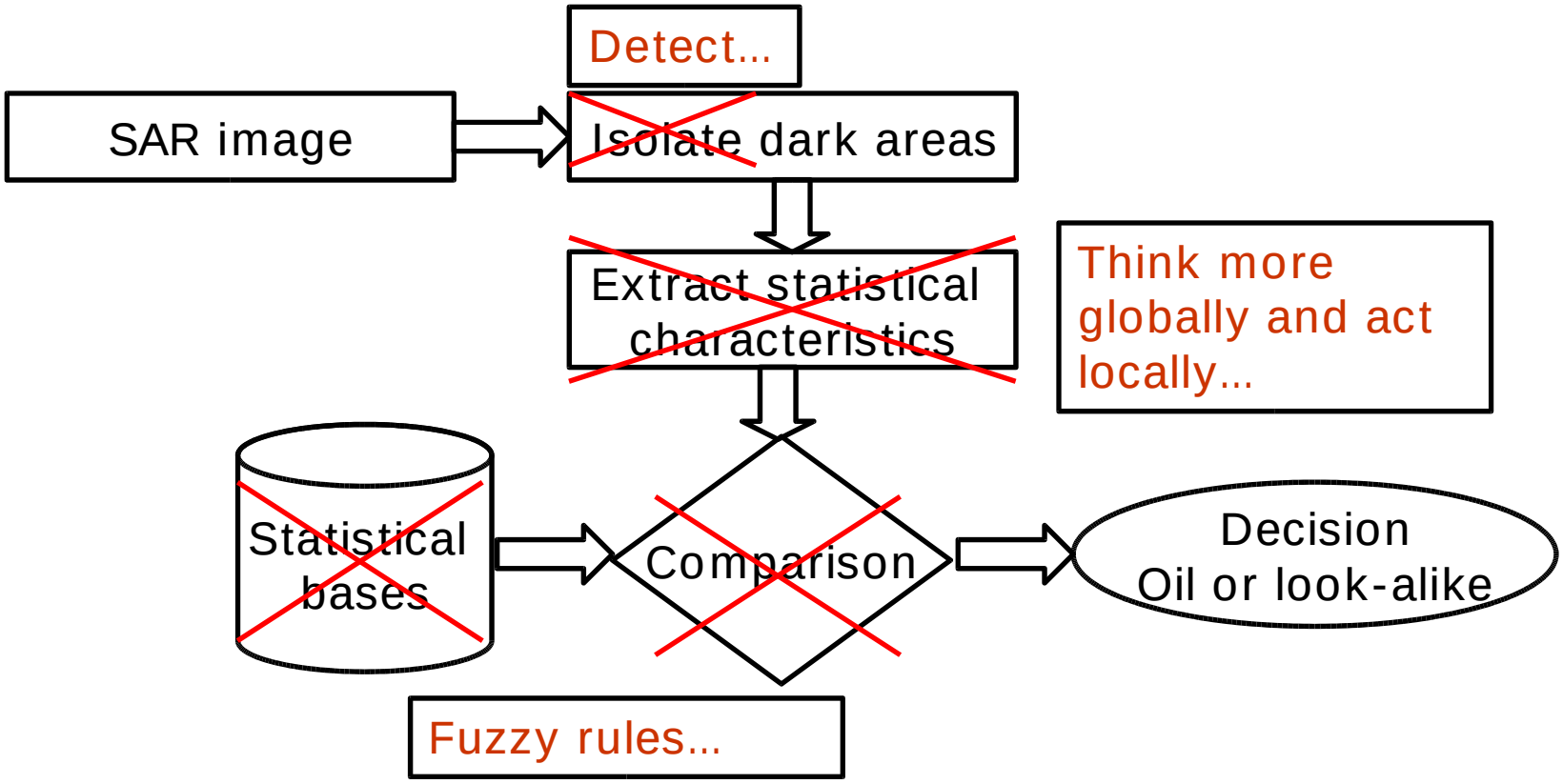
Too much?

Lets try a new automated method…



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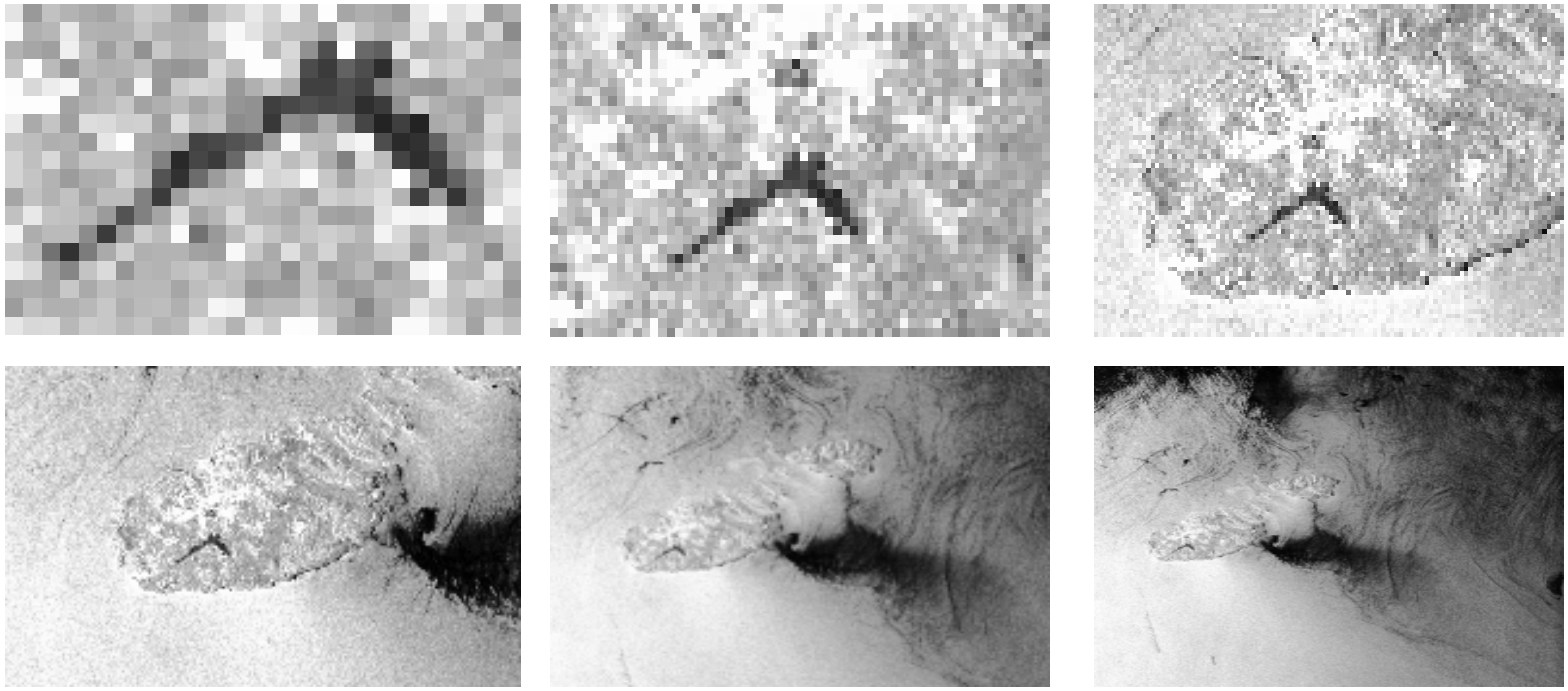
Too much?

Lets try a new automated method…

Think more globally and act locally… what???



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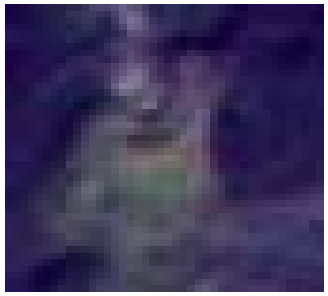
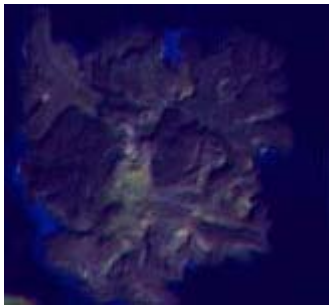

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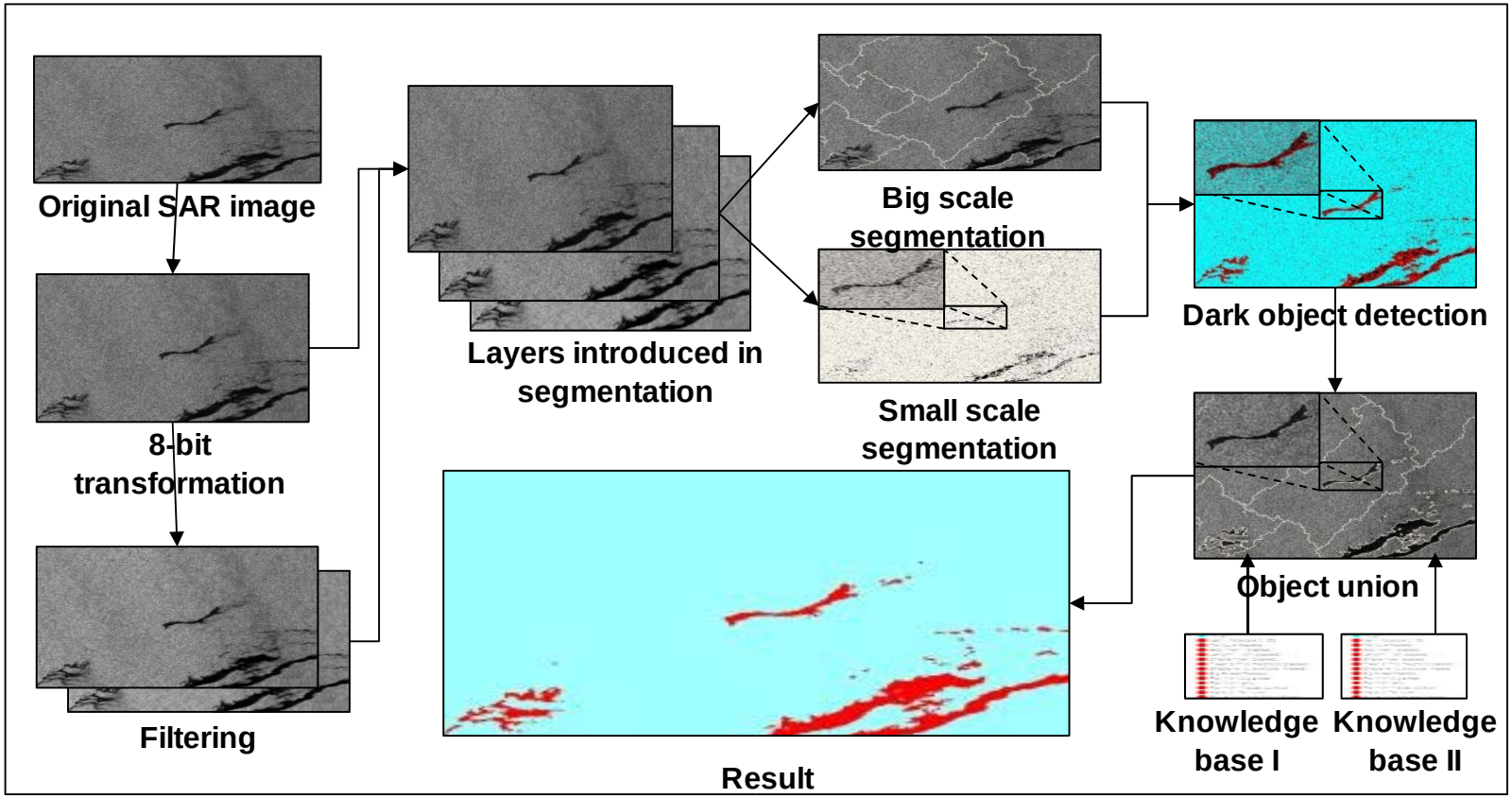

And? Is it working…?

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Thank-you

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