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An Improved Surface Classification Algorithm for SLSTR Level-1 Products

Connor McGurk[1], Caroline Cox[1], Claire Henocq[2], Dave Smith[1], Ed Polehampton[1]

[1] RAL Space, STFC

[2] ACRI-ST

Introduction

The type of surface present within a pixel's field of view is important information for many different processes. The Sea and Land Surface Temperature Radiometer (SLSTR) Level-1 products contain a number of flags to indicate the surface type, whether this is land, ocean, inland water, tidal or coastline. In Figure 1, it can be observed that the coastline mask within the existing Level-1 product has gaps around the boundary. This happens because the current algorithm only considers the interaction of the centre of each pixel with a coastline map. Many pixels that are mixtures of different surfaces are not being identified.

A new algorithm presented here considers the **true shape and size of a pixel**, to more accurately determine mixed surface types, resulting in the coastline mask shown in the right-hand image of figure 1.

Before **After**

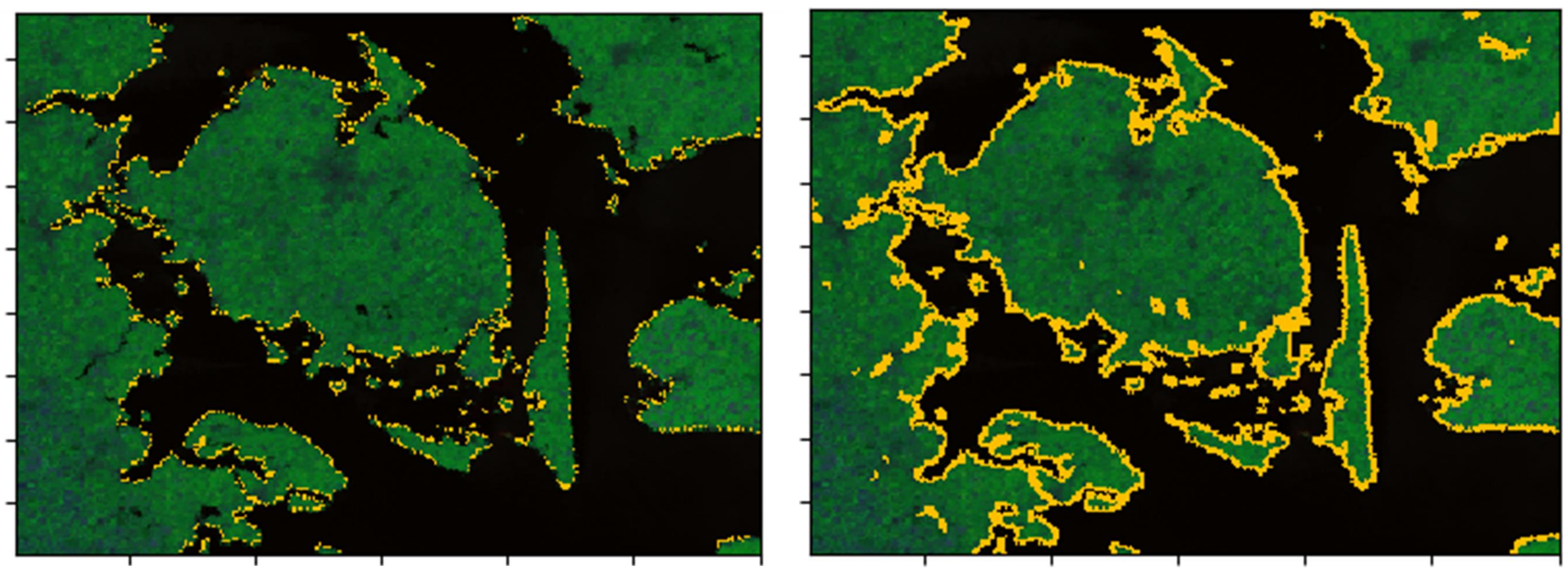

Fig 1. The left-hand image shows the coastline flag from operational Level-1 products overlaid on an RGB in yellow. There are clearly gaps around the coast. The right-hand image shows the same region with the new proposed coastline flag. The mask is now continuous, and many more pixels are marked as being mixed land-water, including inland lakes.

What is the true shape and size of a pixel?

In SLSTR, the motion of the satellite along its orbit, the integration time of the detectors, and the conical scan of the instrument results in a 6-sided pixel footprint, that actually varies in the across-track direction, in both size and shape. This can be seen in figure 2. The **new surface classification algorithm** takes these footprint shapes into account when determining the surface type.

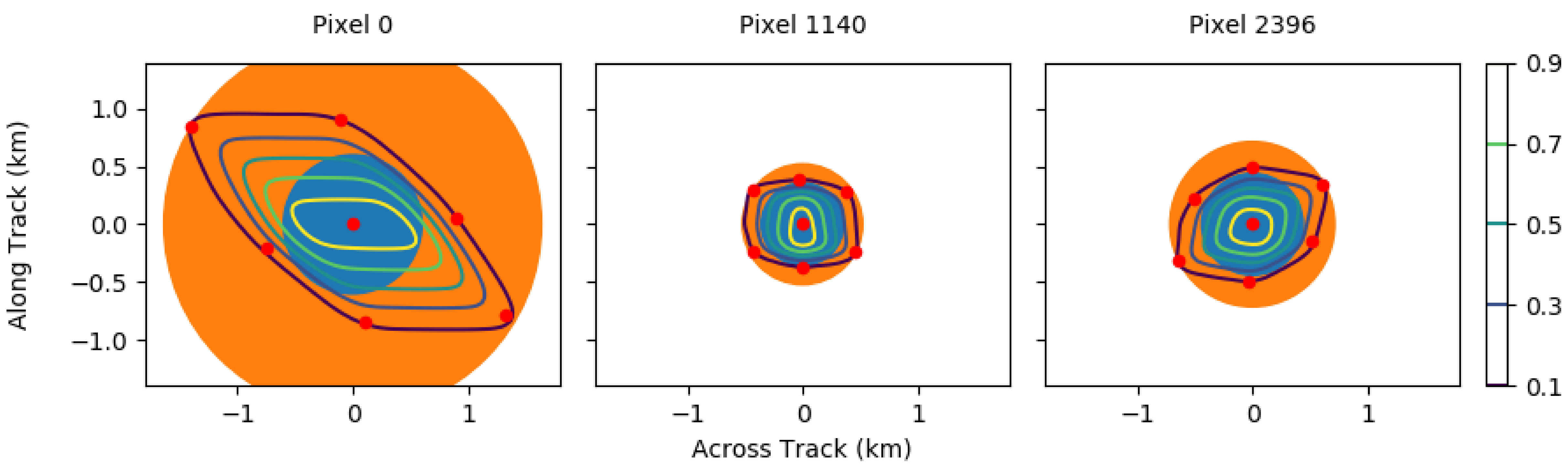

Fig 2. A contour plot of the pixel footprint, measured in the lab, of a pixel at the far edge of the nadir swath, at the sub satellite point and at the other side of the nadir swath. Also shown are circles extending from the centre of the field of view that are used in the new surface classification algorithm.

A new surface classification algorithm

Rather than consider just the pixel central field of view position, we assess the surface type at each of the true pixel footprint vertices, and centre, using a land-sea map. This results in many more pixels being classified as 'coastline', or mixed surface. The new scheme considers not only ocean-land boundaries, but land-inland-water too. Many more pixels will be classified as coastline, as can be seen in figure 3. Some of these flagged coastline pixels will only have a small proportion of mixed surface, and we propose to include an indicator of **how much of the pixel is mixed**. This new scheme considers a lot of additional information, and care has been taken to consider **processing speed** so as not to increase the production time of products beyond the allowed limits.

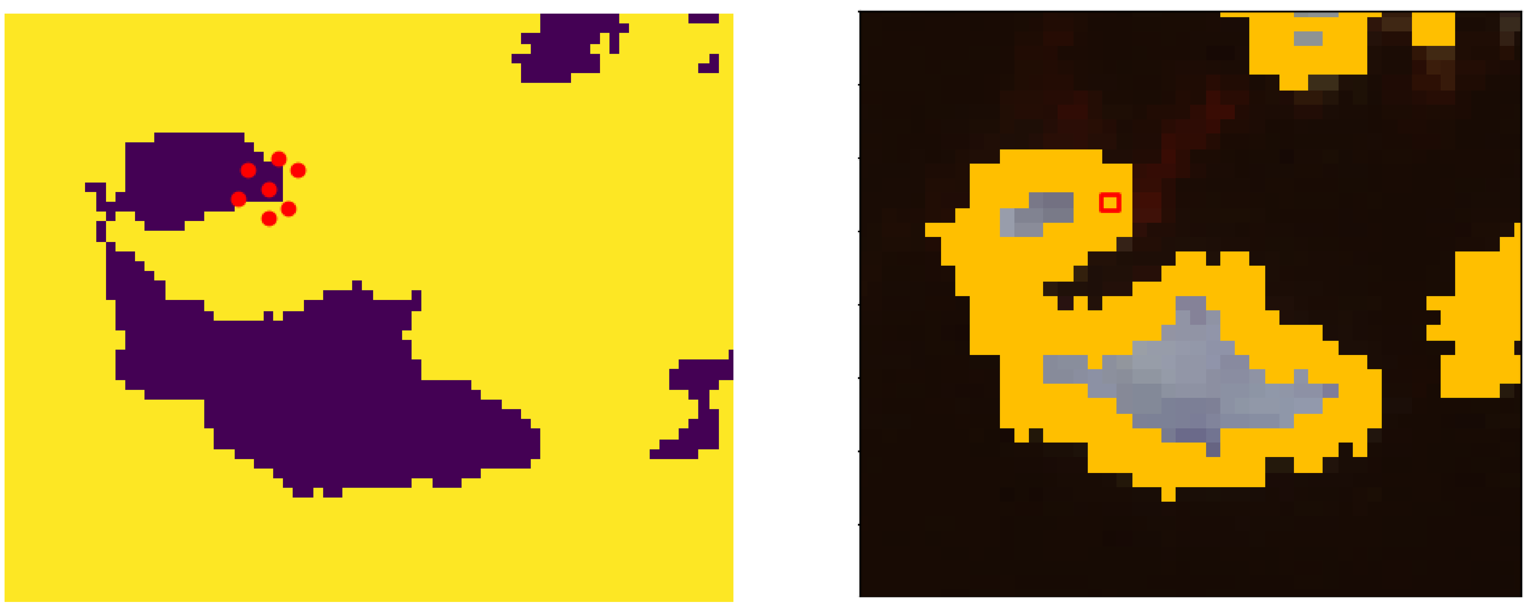

Fig 3. The vertices of a single pixel are shown by the red dots in the image above, where ocean is yellow, and land is purple. We see that three vertices and the central pixel are land, and the other four are ocean. Therefore this pixel is classified as coast.

How much of the pixel is mixed surface?

In the example image in figure 4, we show for each pixel, the number of points that are on land. In yellow pixels, all 7 points (6 vertices and centre position) are on land. In purple, the open ocean, there are 0 points in land. Near the boundary, there are different numbers of points that fall in land for every pixel. Users can user this to filter according to need. **Small features** like rivers are a special case.

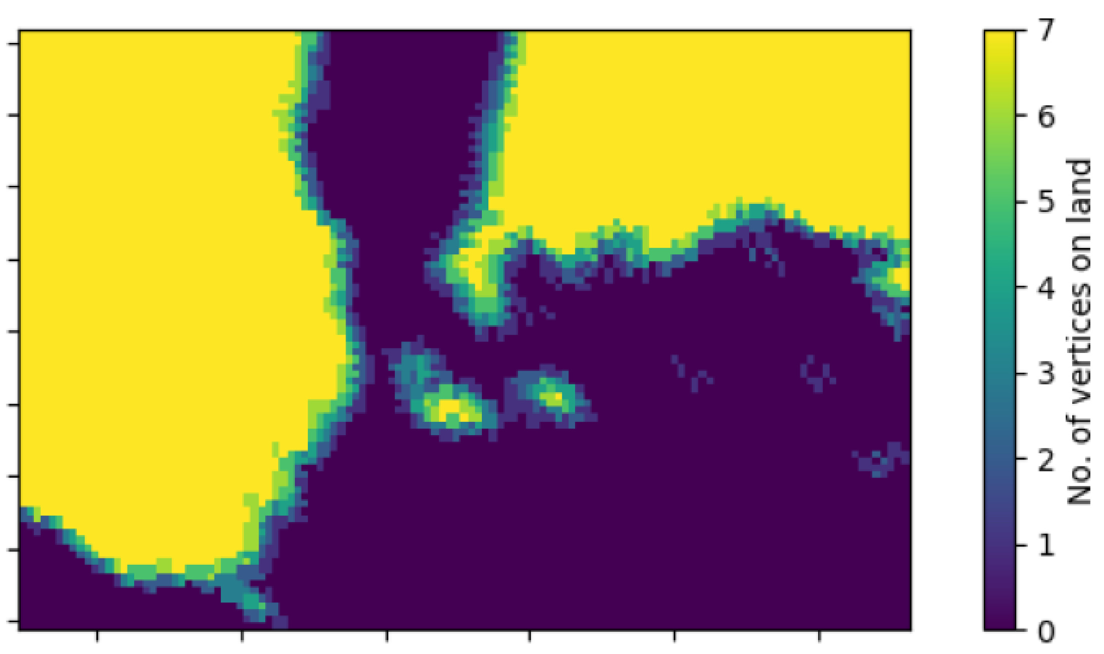

Fig 4. The number of vertices contained in land are shown for an island.

Small features

In some cases, a pixel might be classed as coastline, yet have 0 points in land. This may happen with very small island, or rivers, where the vertices and centre do not fall in land, as shown in figure 5, yet land is within the field if view. The new classification method is still able to recognises that land is viewed within the pixel as it uses information on the pixel radius.

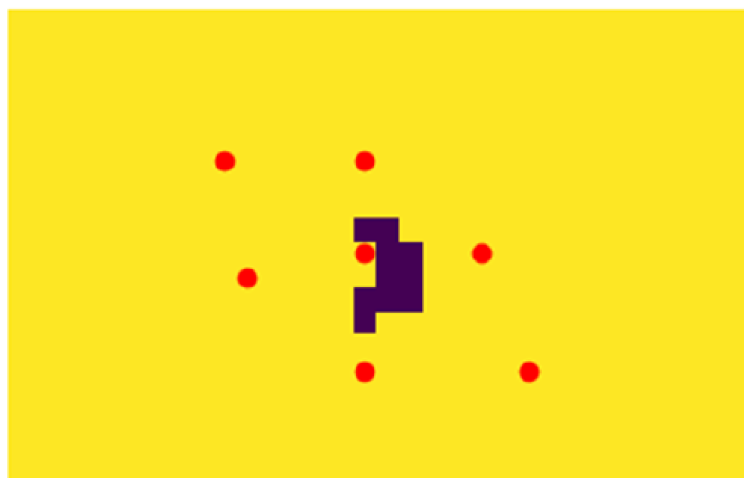

Fig 5. An example of a pixel with vertices and centre point shown by the red dots that is viewing land and water, with this being detected by the vertices.

How much will this affect the processing speed?

The processing speed will be increased, but we have taken steps to minimize this as much as possible. A distance to land/water map is used (Carrea et al, 2015), in conjunction with an inner and outer radius for each pixel, to skip testing all vertices for pixels which are not close to a boundary between land and water. Further evaluation is needed to quantify the impact on processing speed.

Disclaimer

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