SENTINEL 3 – LAND-WATER MASK

Technical Note

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Abbreviations

CCI	Climate Change Initiative
CCI WB	CCI Water Body Data Set
SRTM	Shuttle Radar Topography Mission
SRTM mask	BEAM SRTM water fraction mask
S3	Sentinel-3
WB	Water Body

1 Introduction

This document describes the generation of the new MERIS/ATSR land/water, inland water, coastline and intertidal mask at 300m resolution in S3 format. The work is conducted in the framework of IDEAS+ CCN WP3540. In a first step a comparison of current ENVISAT Land Water mask with 3 different alternatives (S3 masks, SRTM, CCI WB) is performed. After a short analysis of the ENVISAT Land Water mask, the mask was rejected due to the coarse resolution and misplacements. Thus the analysis focused on the comparison between the current S3 masks and the CCI WB as well as the BEAM SRTM mask. The current S3 water masks comprise four products, the “mask for land/water classification” (herein after referred to as S3 land/water mask), the “mask for land/ocean classification” (herein after referred to as S3 land/ocean mask), the “mask for tidal regions” (herein after referred to as S3 tidal region mask) and the “high resolution coastline” (herein after referred to as S3 coastline mask). To achieve the described aim, first of all the current S3 water masks were analysed for spatial and data consistencies, followed by an analysis of additional input data for mask generation. In this second step the current S3 land/water mask was compared to the CCI water body mask (herein after referred to as CCI WB mask) and the BEAM SRTM water fraction mask (herein after referred to as SRTM mask). The best suitable product was chosen to serve as a base product for the new land/water mask generation. The base product was refined in areas were the respective mask has shown some weaknesses, to produce the best possible land/water mask. This optimized mask then served as a baseline for derivation of all other products, to ensure consistency between the products. The complete procedure is described in the following chapters.

2 Analysis of ENVISAT Land Water mask

The ENVISAT Land Water mask was compared to the BEAM SRTM mask. As the examples in Figure 1 and Figure 2 show the ENVISAT mask has a quite coarse resolution compared to the BEAM SRTM mask and shows large displacements. The mask is known from ENVISAT data processing and analysis not to be sufficient for most applications. Thus it is not suitable as input source for the generation of precise 300m mask products for Sentinel-3.

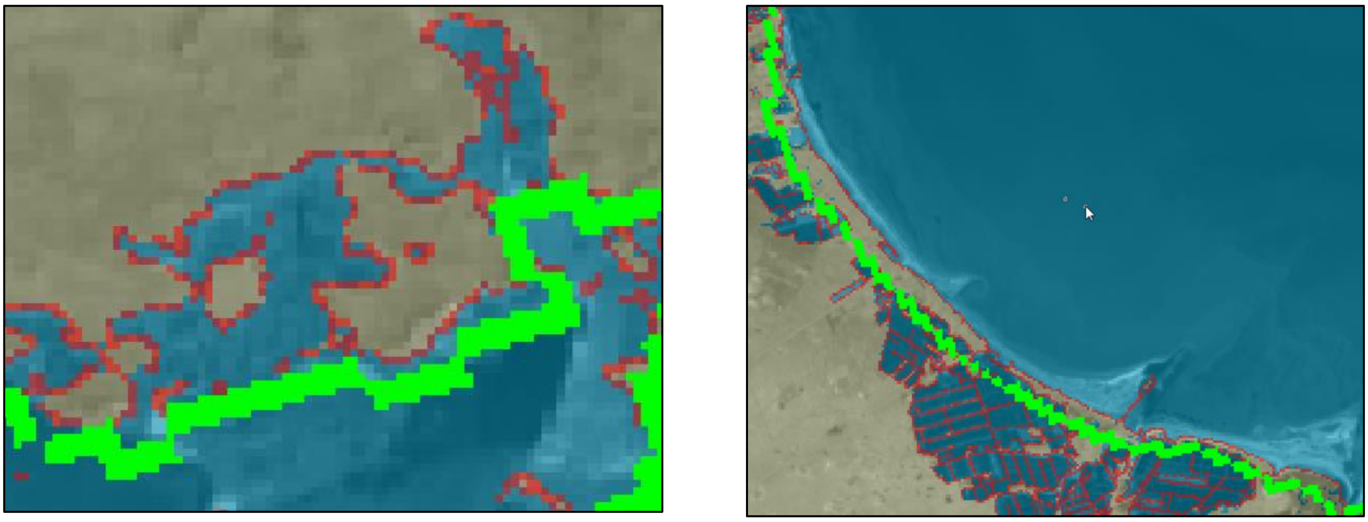


Figure 1: Comparison between ENVISAT Land Water mask (green) and BEAM SRTM mask (red).

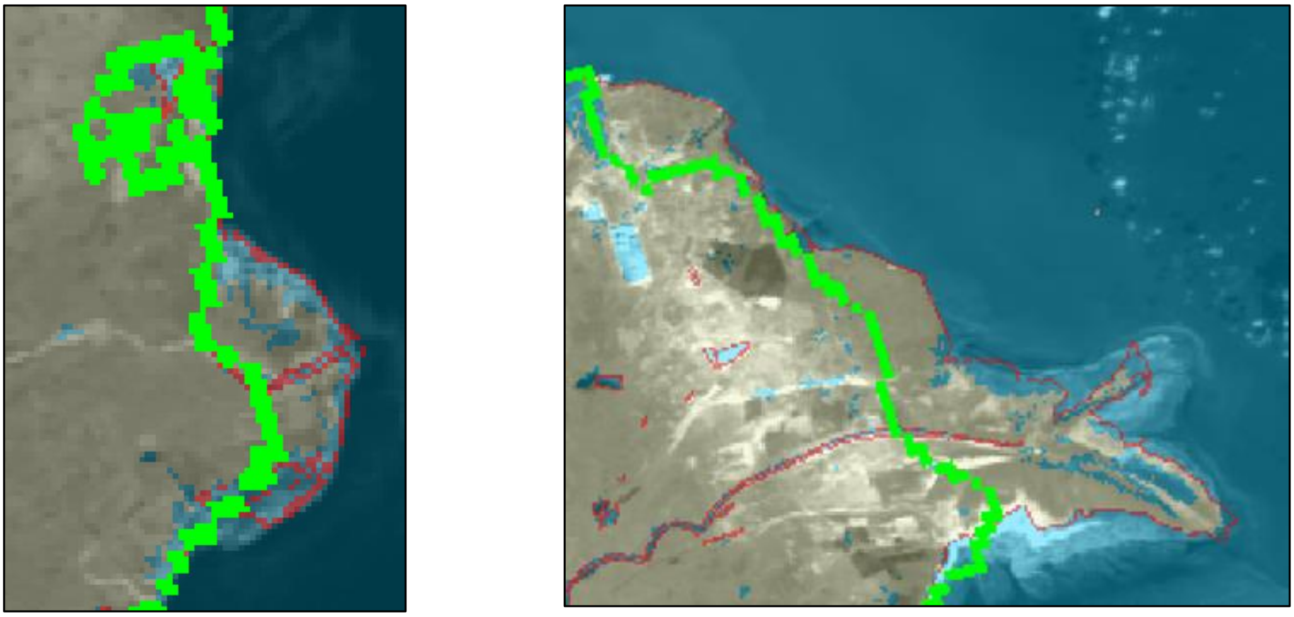


Figure 2: Comparison between ENVISAT Land Water mask (green) and BEAM SRTM mask (red).

3 Analysis of current S3 masks

The following four current S3 masks were analysed for consistency:

1. Mask for Land/Water classification (land_water_bitmask_geo.tif),
2. Mask for Land/Ocean classification (open_ocean_bitmask_geo.tif),
3. Mask for tidal regions (tidal_regions_bitmask.tif) and
4. High resolution coastline (coastline_bitmask_geo.tif).

The first part of the analysis covered the data itself. It was analysed if the described file formats are consistent with the data. The second part was an inter-comparison between the four masks.

The analysis has led to two main inconsistencies. One inconsistency was found within the S3 coastline mask product itself which is related to pixel resolution versus data resolution. Another inconsistency was found between the products.

3.1 Inconsistencies in current S3 masks resolution

The first inconsistency was found within the S3 coastline mask product. It is related to the pixel resolution and the actual data resolution.

The current S3 mask format definition is as follows:

- Data format: GeoTIFF bitmap file
- File extension: .tif
- Rows and columns: 129600 x 64800 pixel
- Projection: Equidistant lat/lon projection (WGS84)
- Pixel resolution: 0.00277 degree per pixel
- Pixel depth: Byte
- Flag values: 1 bit per flag (value 1 = flag set, value 0 = flag not set)

All four S3 masks fulfil the defined data definitions. But taking a closer look at the data itself shows inconsistencies between pixel resolution and real data resolution for the S3 coastline mask. While the file resolution corresponds to the defined 0.00277 degree per pixel, the actual information seems to be double the size corresponding to 0.00554 degree.

Figure 3 shows an example of the S3 coastline mask (coastline “pixel” shown in red) compared to the S3 land/water mask (land pixel shown in black). While the coastline product has the correct pixel resolution, the information has obviously been generated from a dataset with double the size in resolution, as you can see by comparing one land pixel to one coastline “pixel”.

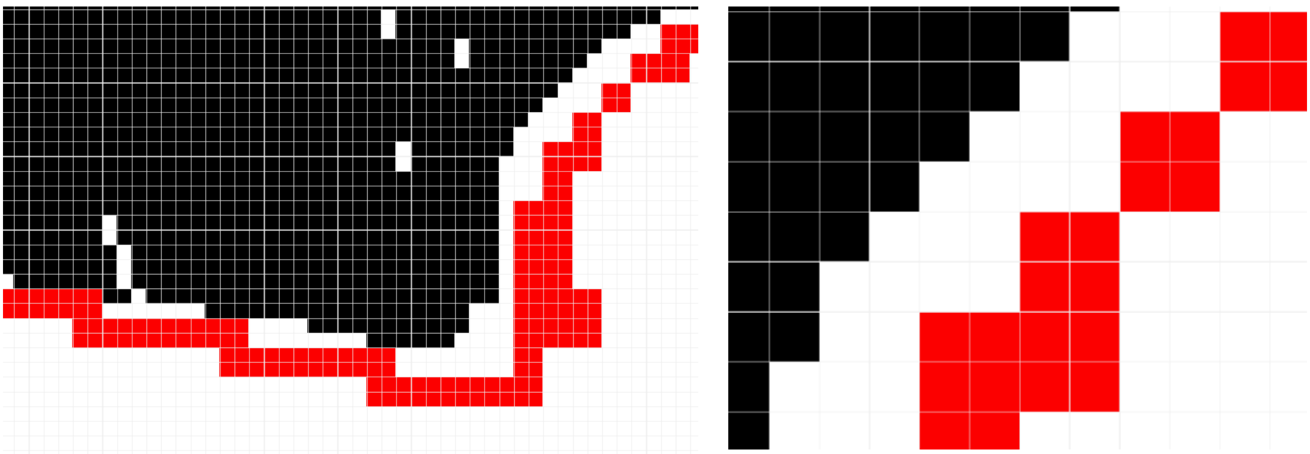


Figure 3: Inconsistencies between pixel and data resolution of high resolution coastline. The S3 coastline mask shown in red and the land pixel of the S3 land/water are shown in black. Pixel size is indicated by grey grid.

3.2 Inconsistencies between current S3 masks

A second inconsistency was found by comparing all four S3 mask products to each other. The resulting inconsistencies are due to the different input datasets used for the derivation of each product.

3.2.1 Inconsistency between S3 coastline mask and S3 land/ocean mask

As the coastline should be defined as the edge between land and ocean the S3 coastline mask was expected to be superimposable with the edge pixels of the S3 land/ocean mask. Overlaying the S3 land/ocean mask with the S3 coastline mask showed location differences between the edge pixels of the land/ocean mask and the coastline (see Figure 4). One part of the inconsistency is due to the different data sources used to derive the two products. The second part is due to the different data resolution, meaning that even if the two products would align to each other, differences would be caused by the different data resolutions. One coastline data "pixel" is always represented by four land/ocean pixels.

Besides the shift between the two masks, there is also a difference in covered land area. The upper right example of Figure 4 shows that the coastline mask assumes that there is a bigger land mass as covered by the S3 land/ocean mask itself. This divergence is also prevalent for small islands, as some examples show in Figure 5.

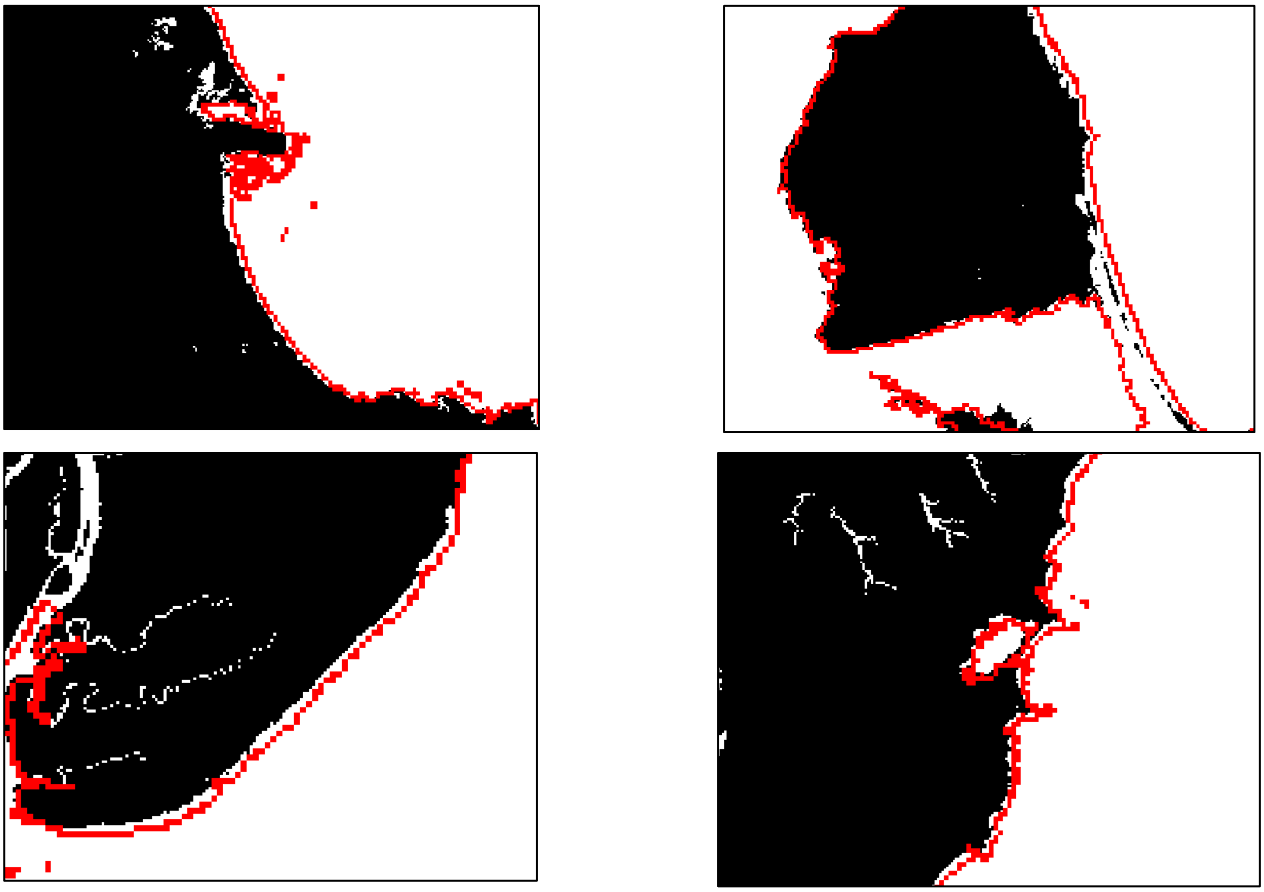


Figure 4: Location differences between high resolution coastline (red) and mask for land/ocean classification (land shown in black).

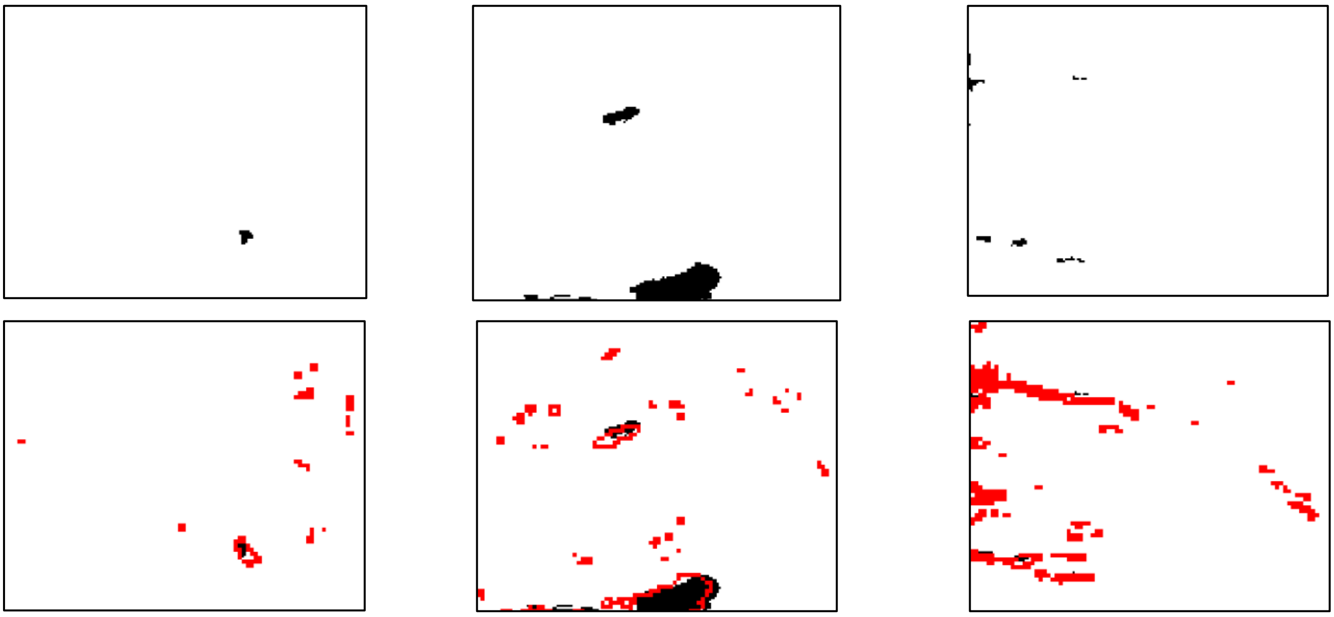


Figure 5: Land area covered by mask for Land/Ocean classification (upper images; water = white & land = black) and land covered by high resolution coastline (lower images; coastline in red).

The same inconsistencies are present between the S3 coastline mask and the S3 land/water mask as the latter is the source product for the S3 land/ocean mask.

3.2.2 Inconsistency between S3 tidal regions mask and S3 land/ocean mask

A comparison between the S3 tidal region mask and the S3 land/ocean mask has shown some inconsistencies of the data. As some examples in Figure 6 show, the tidal region mask intersects and interferes with land areas of the land/ocean mask. Furthermore some coastal water areas which should still be under tidal influence are disregarded.

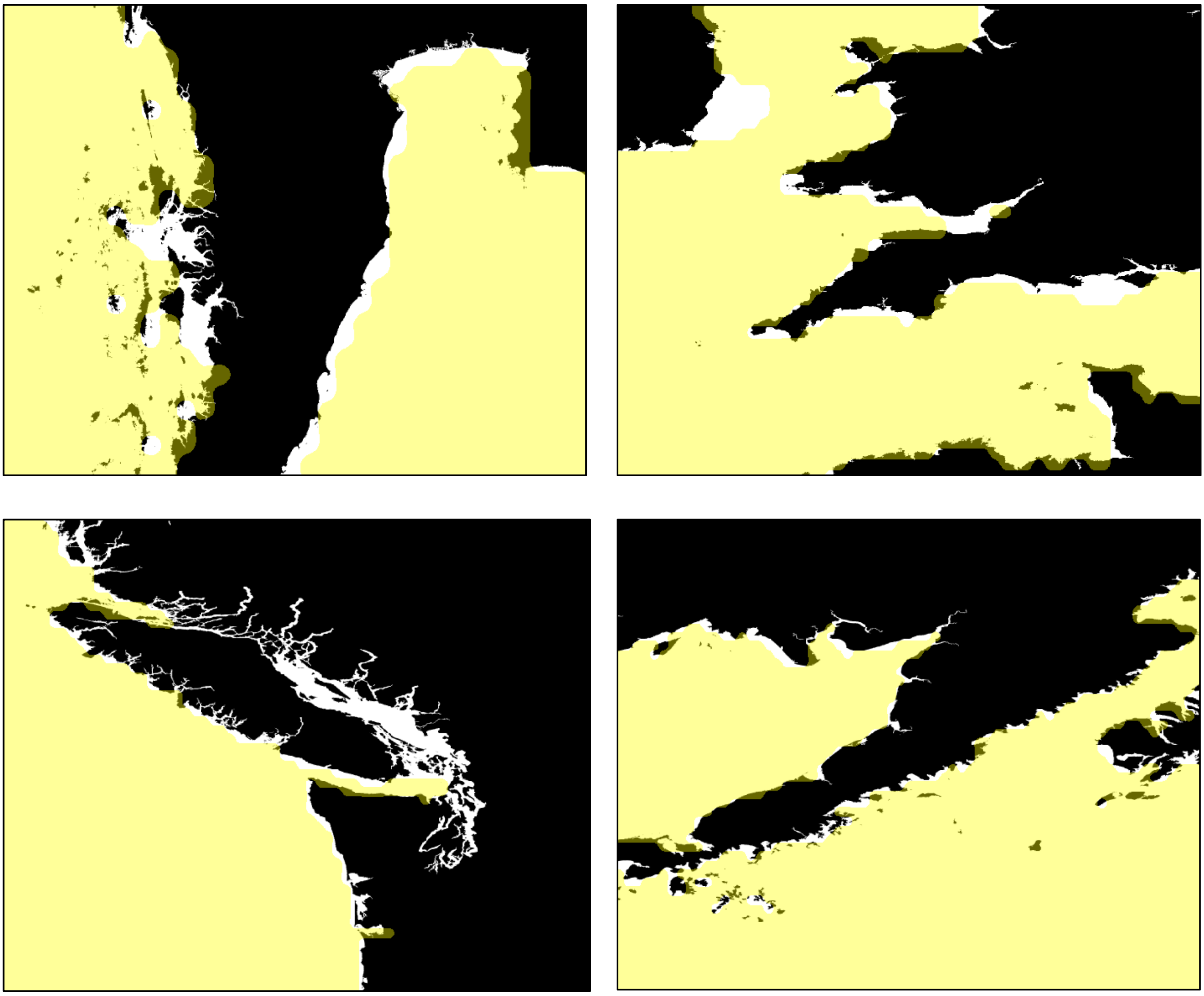


Figure 6: Mask for land/ocean classification (land = black; water = white) superimposed by mask for tidal regions (transparent yellow).

These inconsistencies are caused by different data sources used for production. Obviously there was no methodology implemented to harmonize these two products, for example by removing tidal regions over land masses or by filling coastal areas which should be under tidal influence.

4 Mask selection

To find the best suitable land/water mask product for the generation of a refined S3 land/water mask, the following masks were chosen for comparison to analyse the strength and weaknesses of each product:

- Current S3 land/water mask
- CCI WB mask
- SRTM mask

4.1 Mask comparison

The first main difference between the current S3 land/water mask, the SRTM mask and the CCI WB mask is the inclusion of Antarctica within the CCI WB mask (see Figure 7, upper right image).

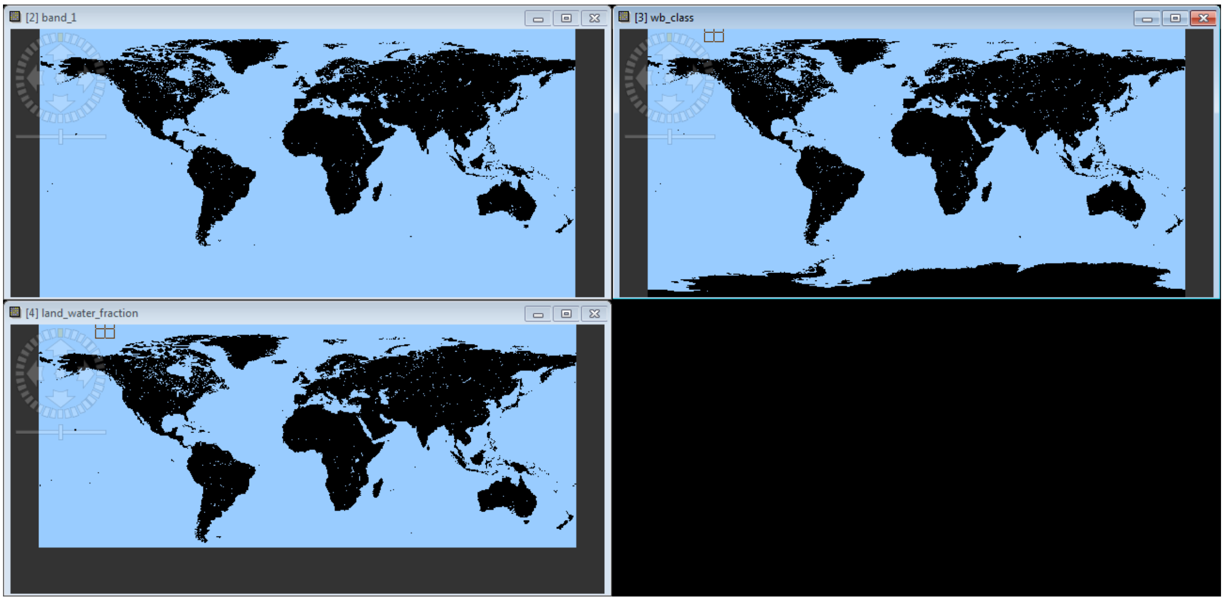


Figure 7: S3 Land-Water mask (upper left); CCI water body mask (upper right); BEAM SRTM water fraction mask (lower left).

The second difference was found for the delineation of small islands. The current S3 land/water mask underestimated the land area of small islands (see Figure 8 upper left image), compared to the SRTM mask and the CCI WB mask.

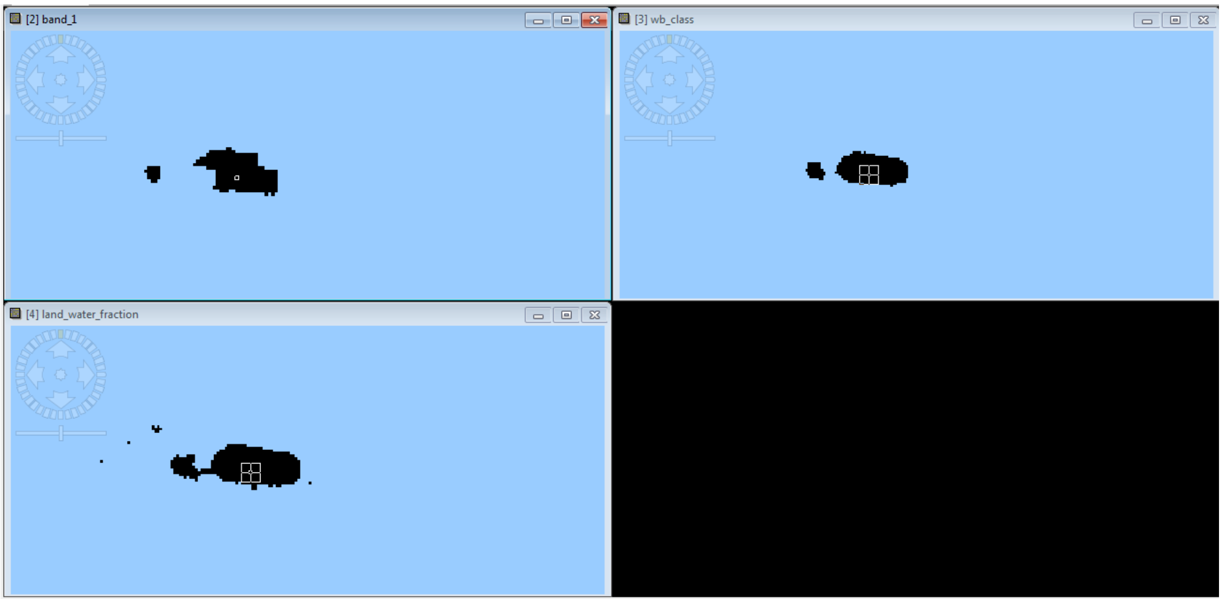


Figure 8: S3 Land-Water mask (upper left); CCI water body mask (upper right); BEAM SRTM water fraction mask (lower left).

The third difference is related to artefacts which are caused by the integration of political boundaries. Figure 9 to Figure 12 show examples of artefacts (red areas = landmass within the SRTM mask) within the SRTM mask, related to political boundaries

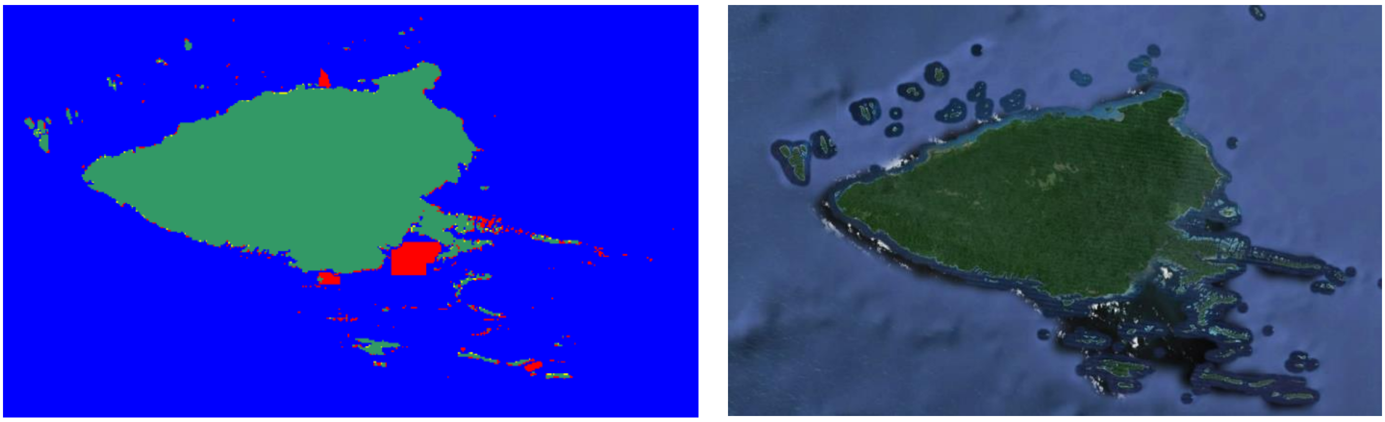


Figure 9: Differences between CCI water body mask and BEAM SRTM water fraction (left) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Satellite image (right – source: Google Earth).

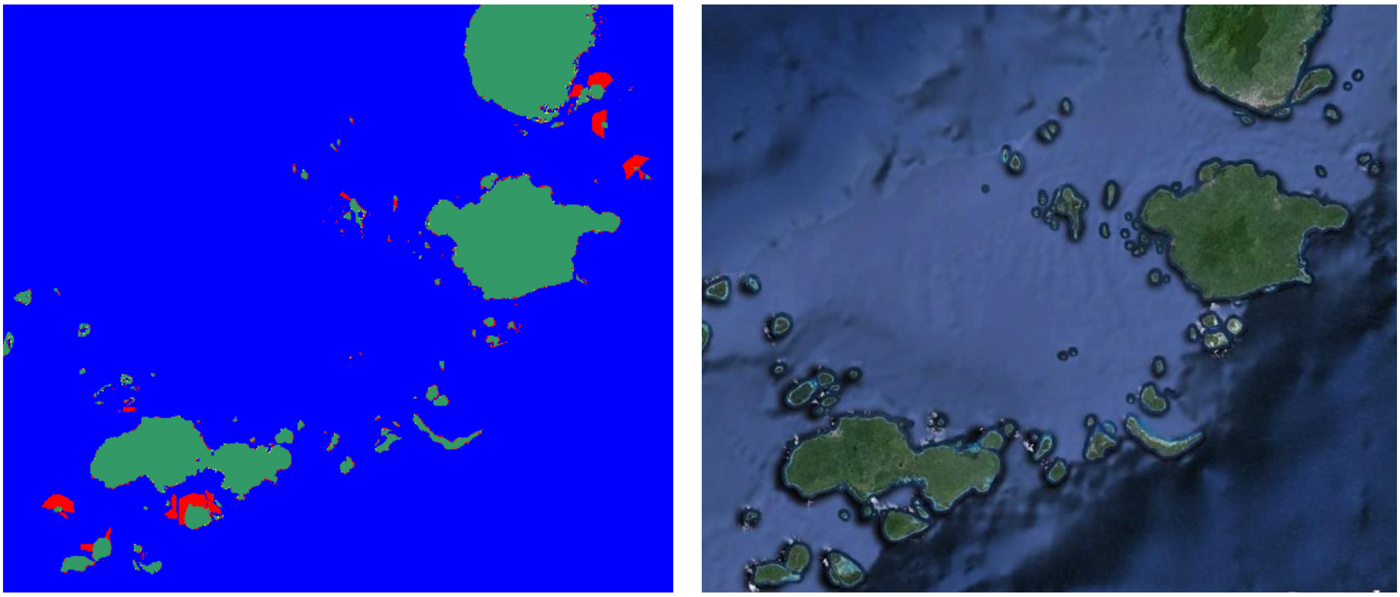


Figure 10: Differences between CCI water body mask and BEAM SRTM water fraction (left) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Satellite image (right – source: Google Earth).

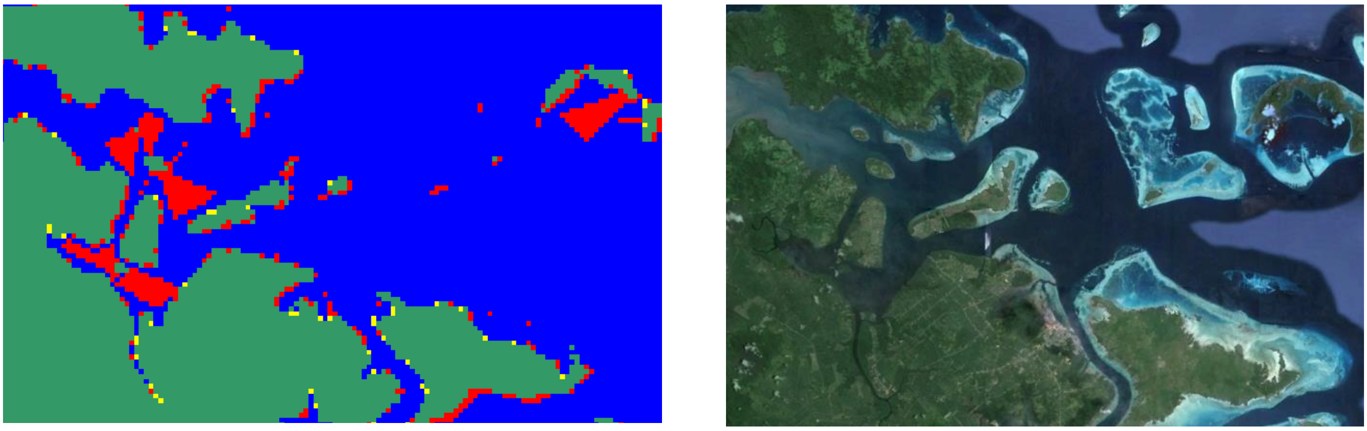


Figure 11: Differences between CCI water body mask and BEAM SRTM water fraction (left) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Satellite image (right – source: Google Earth).

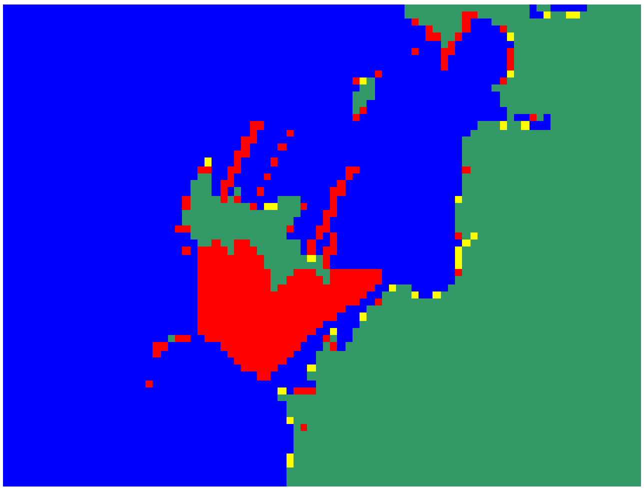



Figure 12: Differences between CCI water body mask and BEAM SRTM water fraction (left) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Satellite image (right – source: Google Earth).

These artefacts are less present in the S3 land/water mask but small islands or parts of islands are missing. Figure 13 and Figure 14 show examples of fewer artefacts within the S3 land/water mask, where yellow represents water in the S3 mask and land in the SRTM mask.

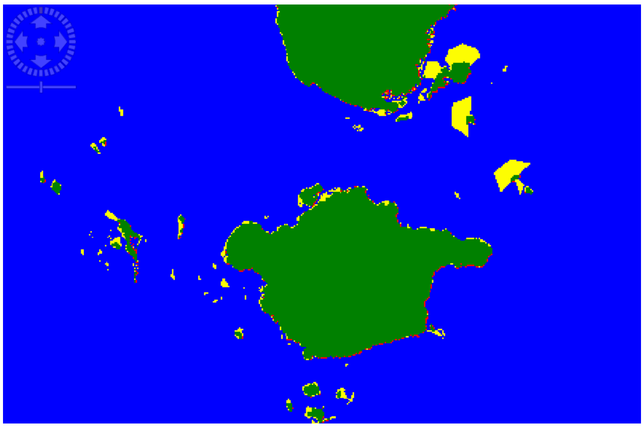
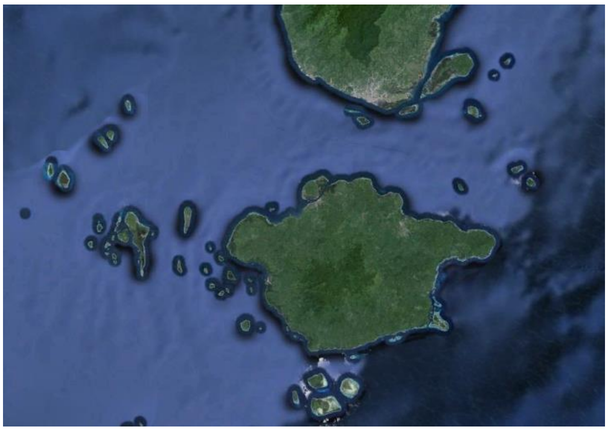



Figure 13: Differences between BEAM SRTM water fraction and S3 land/water mask (left) [green = land in both masks; blue = water in both masks; red = water in BEAM SRTM and land in S3; yellow = water in S3 and land in BEAM SRTM]; Masks superimposed over satellite image (bottom – source: Google Earth). Satellite image (right – source: Google Earth).

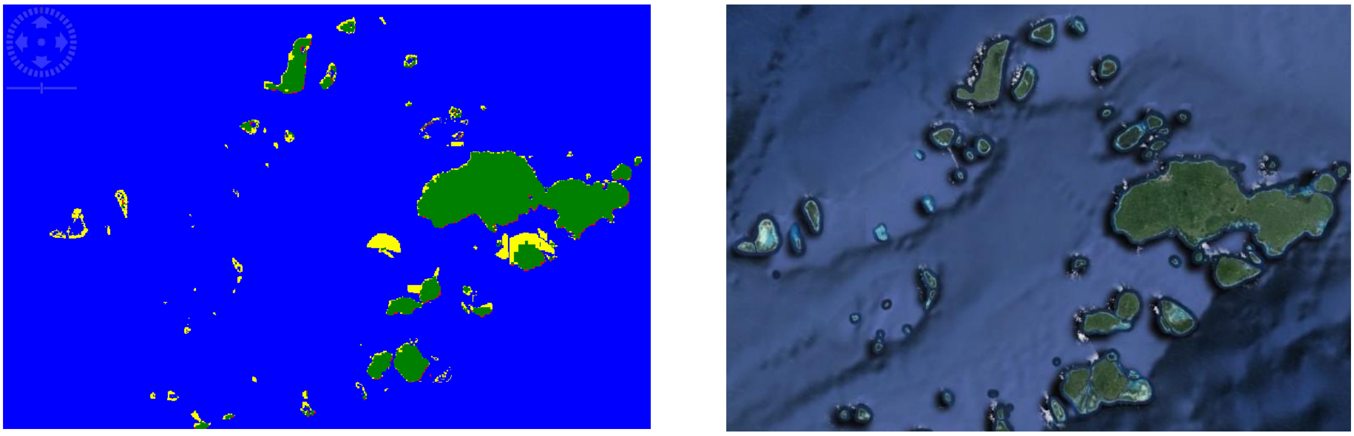


Figure 14: Differences between BEAM SRTM water fraction and S3 land/water mask (left) [green = land in both masks; blue = water in both masks; red = water in BEAM SRTM and land in S3; yellow = water in S3 and land in BEAM SRTM]; Masks superimposed over satellite image (bottom – source: Google Earth). Satellite image (right – source: Google Earth).

Figure 15 shows an example of missing islands or in this case parts of an island, within the S3 land/water mask. Here again, yellow represents water in the S3 land/water mask and land in the SRTM mask.

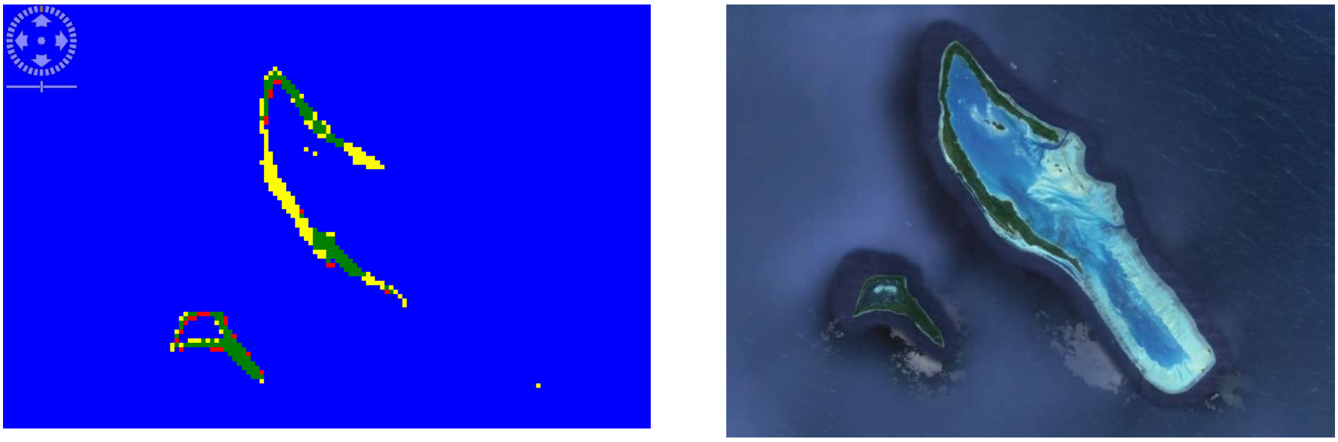


Figure 15: Differences between BEAM SRTM water fraction and S3 land/water mask (left) [green = land in both masks; blue = water in both masks; red = water in BEAM SRTM and land in S3; yellow = water in S3 and land in BEAM SRTM]; Masks superimposed over satellite image (bottom – source: Google Earth). Satellite image (right – source: Google Earth).

The fourth difference that was found was the underrepresentation of water above 60 degree latitude. This applies for the SRTM mask as well as for the S3 land/water mask. For the SRTM mask the data north of 60°N are filled with the Globcover land-water mask which explains the differences in accuracy compared to south of 60°N .

Figure 16 shows that above 60 degree the SRTM mask, as well as the S3 land/water mask, underestimate the amount of water area. Figure 17 shows additional examples including an overlay to a satellite image. These examples clearly show the underestimation of water (red areas) especially within stream courses.

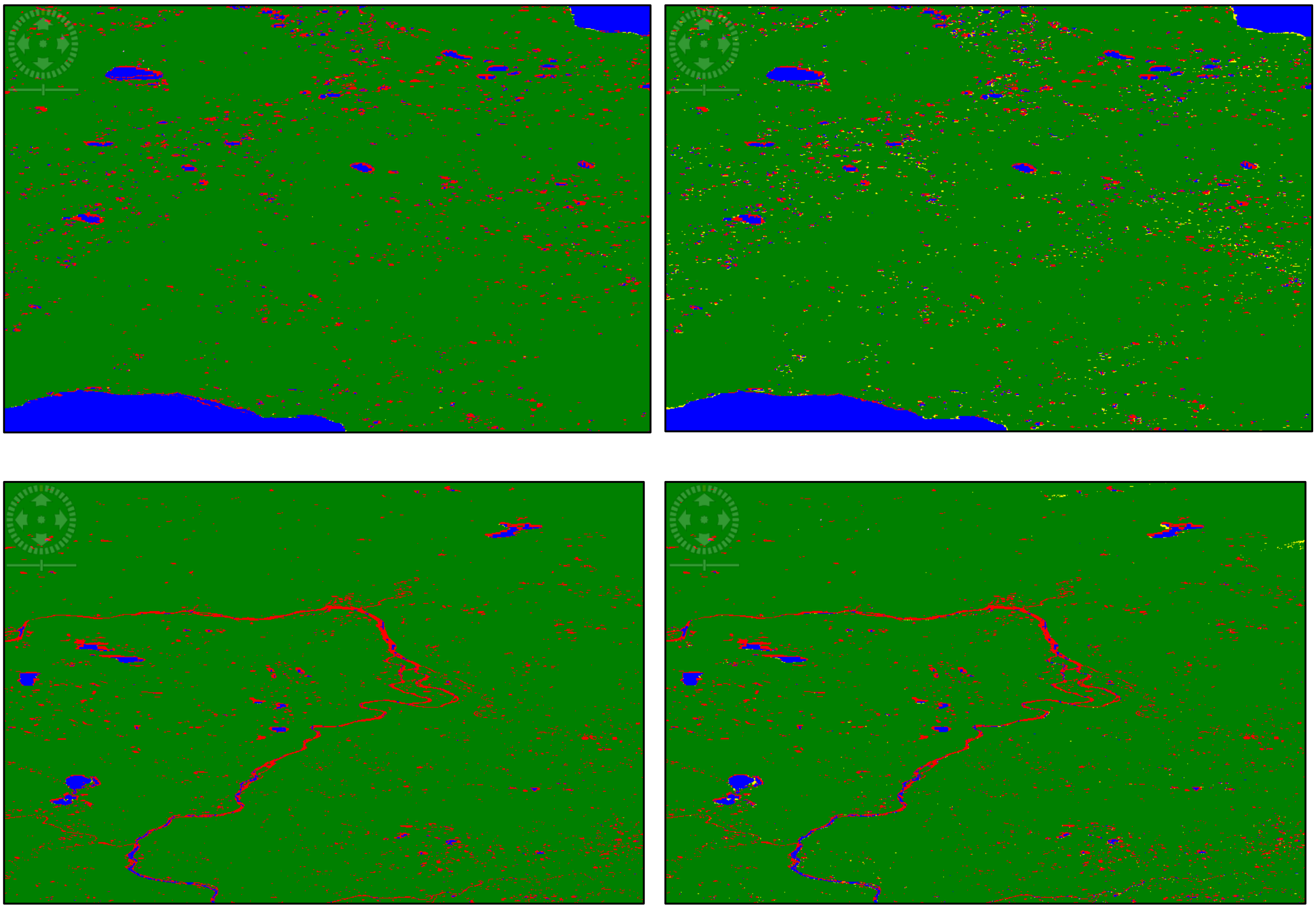


Figure 16: Differences between CCI water body mask and BEAM SRTM water fraction (left) / S3 land/water mask (right) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB].

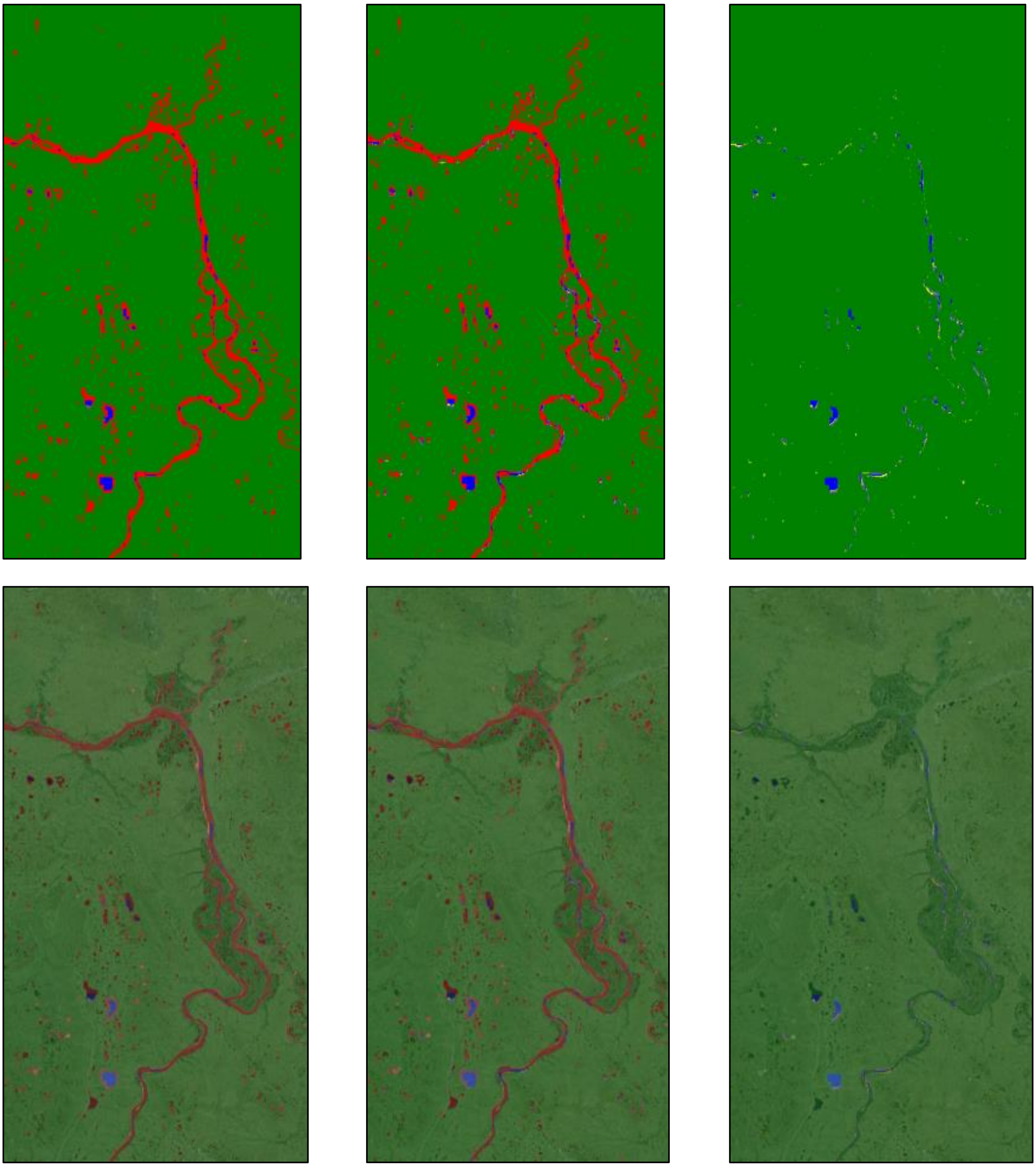


Figure 17: Differences between CCI water body mask and BEAM SRTM water fraction (top left) / S3 land/water mask (top middle) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Differences between BEAM SRTM water fraction and S3 land/water mask (top right) [green = land in both masks; blue = water in both masks; red = water in BEAM SRTM and land in S3; yellow = water in S3 and land in BEAM SRTM]; Masks superimposed over satellite image (bottom – source: Google Earth).

4.2 Mask combination

Even though the CCI water body mask has strengths in the above described areas, there are a few areas where it shows weaknesses compared to the BEAM SRTM and the S3 mask. There were three areas in which the CCI water body mask has shown weaknesses:

1. North America

A part of North America was identified were the CCI WB mask clearly underestimates the amount of water bodies. The two images of Figure 18 show the differences between the CCI WB mask and on the left side the SRTM mask as well as on the right side the S3 land/water mask. Green represents land in both masks, blue represents water in both masks, red shows water in CCI WB and land in SRTM/S3, and yellow represents water in SRTM/S3 and land in CCI WB. Thus all the small yellow fragments show water bodies which were not captured by the CCI water body mask. These small water bodies can clearly be identified in the satellite image of Figure 19.

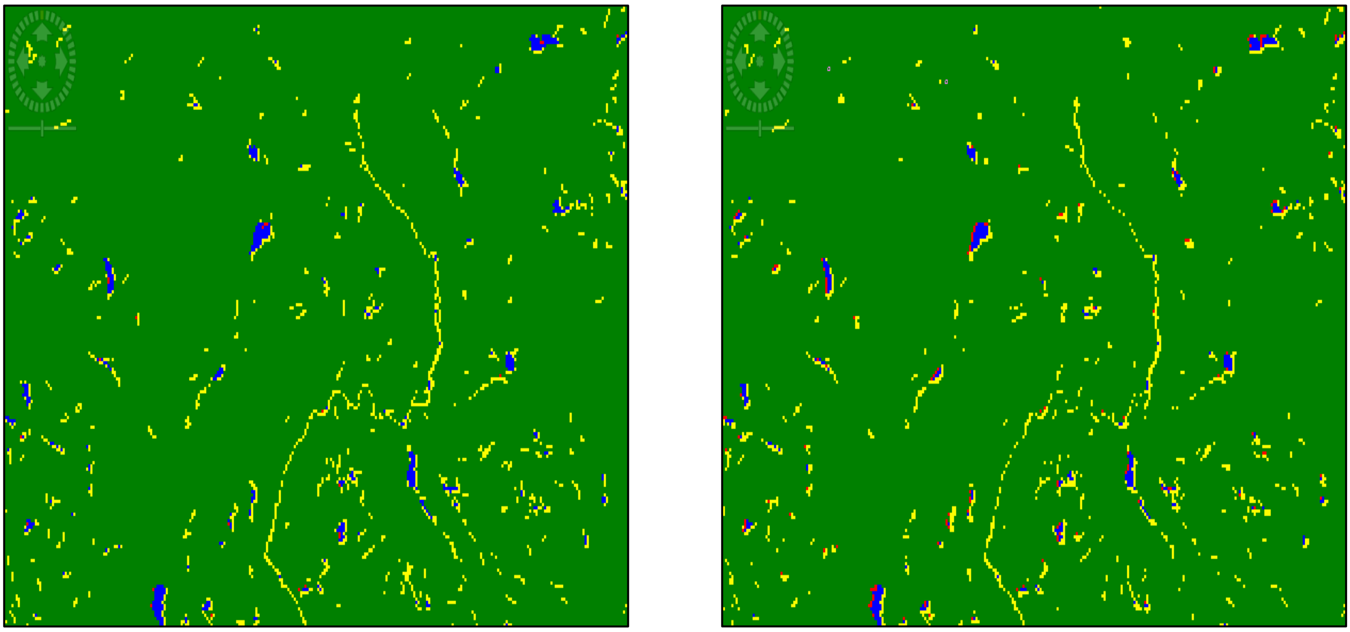


Figure 18: Differences between CCI water body mask and BEAM SRTM water fraction (left) / S3 land/water mask (right) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB].

Figure 19 shows the differences between the SRTM mask and the S3 land/water mask. The differences are shown in red and yellow. These differences slightly show a consistent difference on the western and eastern border of rivers and lakes, which lead to the conclusion that there might be a small shift between these two masks. The satellite image on the right hand side shows the same extent as the left image and the two images of Figure 18.

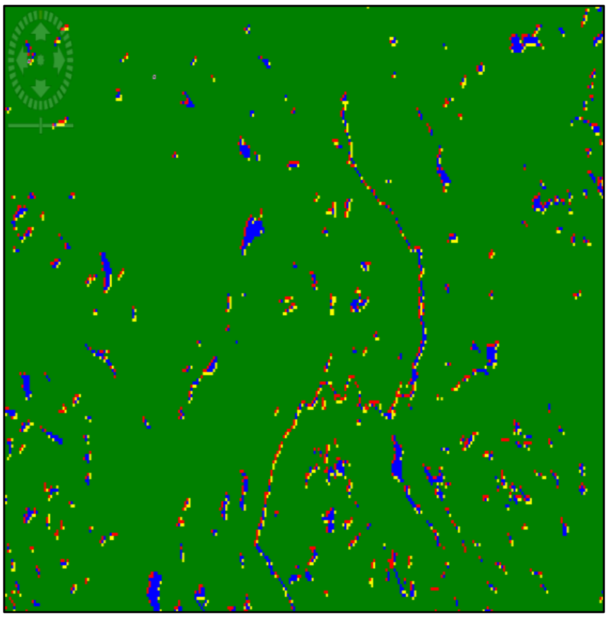


Figure 19: Differences between BEAM SRTM water fraction and S3 land/water mask (left) [green = land in both masks; blue = water in both masks; red = water in BEAM SRTM and land in S3; yellow = water in S3 and land in BEAM SRTM]; Satellite image (right – source: Google Earth).

2. Kamchatka

In the northern part of Kamchatka two big and one small angular water body exist (see Figure 20, big red areas) within the CCI WB mask. These areas are clearly artefacts and no water bodies as they do not exist in the satellite image (see Figure 20, right hand image).

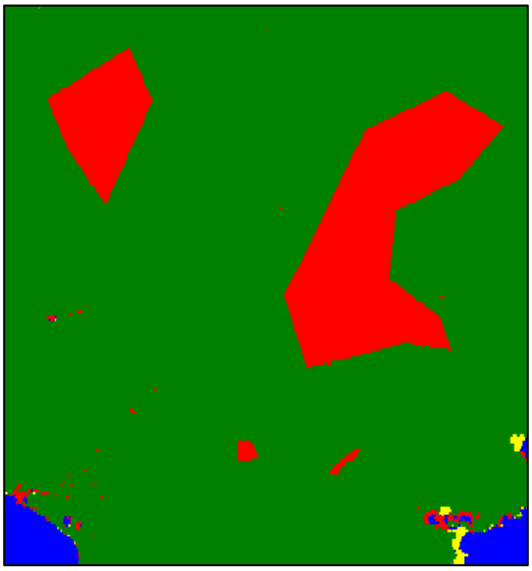


Figure 20: Differences between CCI water body mask and BEAM SRTM water fraction (left) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Satellite image (right – source: Google Earth).

3. Southern Chile and Argentina

In the southern part of Chile and Argentina parts of the land mass do not exist within the CCI WB mask (see Figure 21, red areas). These areas are present within the SRTM mask as well as the S3 land/water mask.

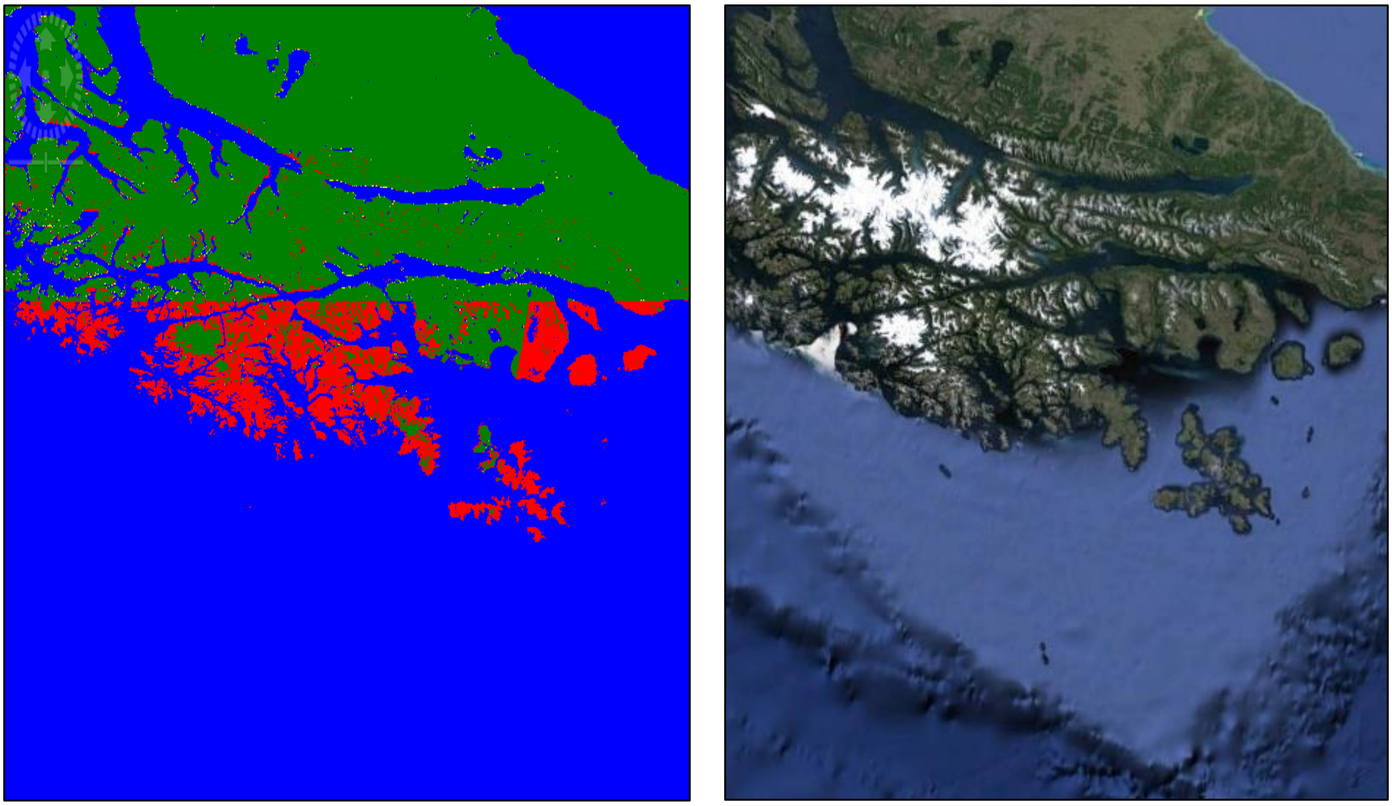


Figure 21: Differences between CCI water body mask and BEAM SRTM water fraction (left) [green = land in both masks; blue = water in both masks; red = water in CCI WB and land in BEAM SRTM/S3; yellow = water in BEAM SRTM/S3 and land in CCI WB]; Satellite image (right – source: Google Earth).

The overall conclusion of the analysis is that the CCI WB mask achieves the best delineation between land and water areas. However there are a few areas where the CCI WB mask showed weak performances. The analysis has shown that the SRTM mask delivered the second best results. Especially within the weak CCI WB mask areas the SRTM mask showed better results. This led to the conclusion of creating a merged CCI WB and SRTM mask product. The methodology is described in the next chapter.

5 Mask refinement

As described in the previous chapter the mask refinement is based on combining the CCI WB mask with the SRTM mask in areas where the CCI WB mask has weaknesses. This mask then produces the new land/water mask. Further the new land/ocean as well as the coastline mask are derived from this product, to ensure consistency between each mask product. Details about the methodology are given in the following chapters.

5.1 Mask for Land/Water classification

As demonstrated in chapter 4.2 the CCI WB mask has weaknesses in three main areas. To improve the mask, a combination approach with the SRTM mask was chosen. The areas which were improved are shown in Figure 22. For the underestimation of water of the CCI WB mask in northern America (Figure 22 upper left image) the following merging methodology was chosen:

- If “SRTM mask == water” then “water” else “CCI WB mask”

This methodology uses all water areas of the SRTM mask and integrates them into the CCI WB mask.

For the other two areas (Kamchatka: upper right image of Figure 22; Southern Chile and Argentina: lower left image of Figure 22) the opposite approach was chosen, as in these areas landmass is missing within the CCI water body mask. The merging methodology was as follows:

- If “SRTM mask == land” then “land” else “CCI WB mask”

This methodology uses all landmass of the SRTM mask within the defined areas and integrates it into the CCI WB mask.

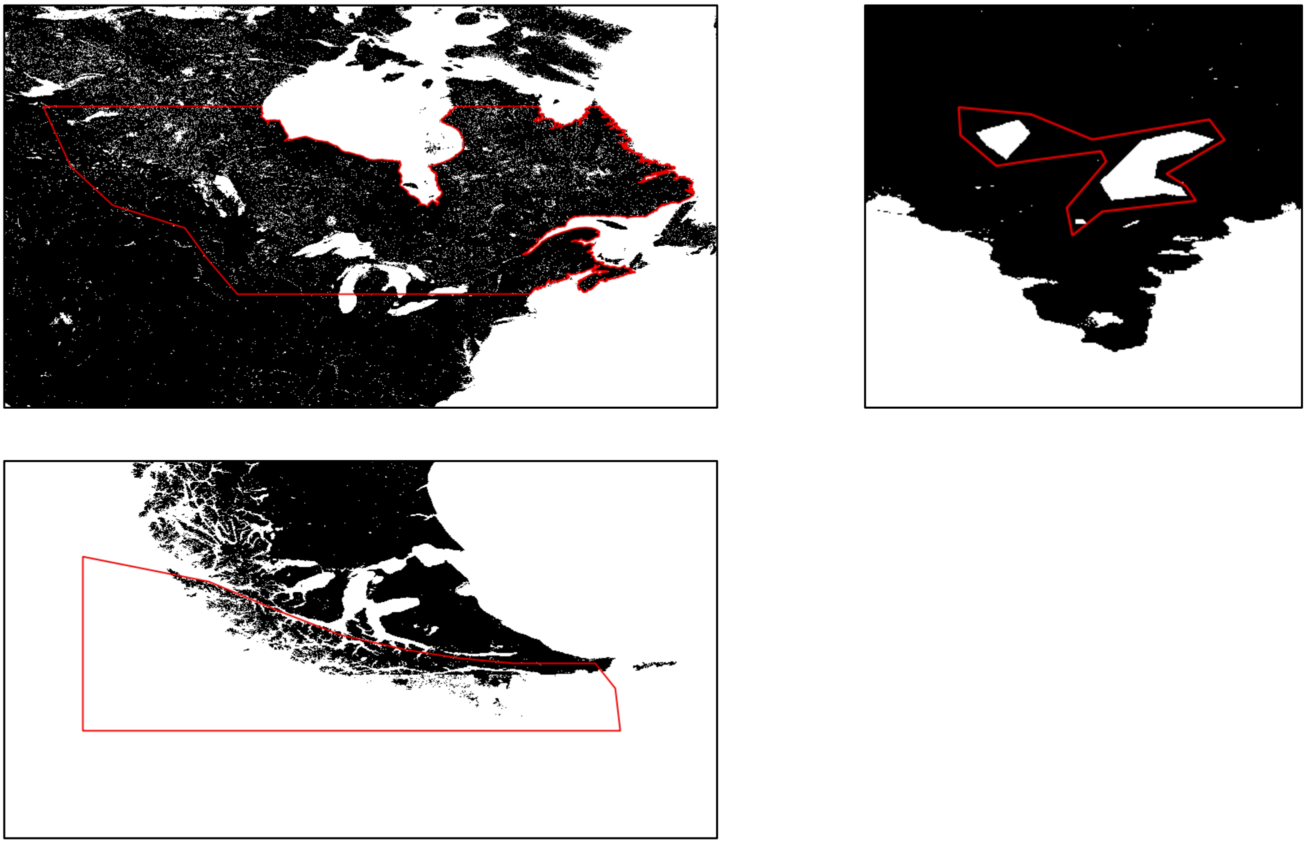


Figure 22: Areas of CCI WB mask improvement (Upper left: northern America; Upper right: Kamchatka; Lower left: southern Chile and Argentina).

5.2 Mask for Land/Ocean classification

The mask for land/ocean classification (land/ocean mask) is derived from the mask for land/water classification (land/water mask). In a first step the mask was converted from raster to polygon vector format (see Figure 23 and Figure 24). Then the ocean area, which is coherent, was selected and extracted.

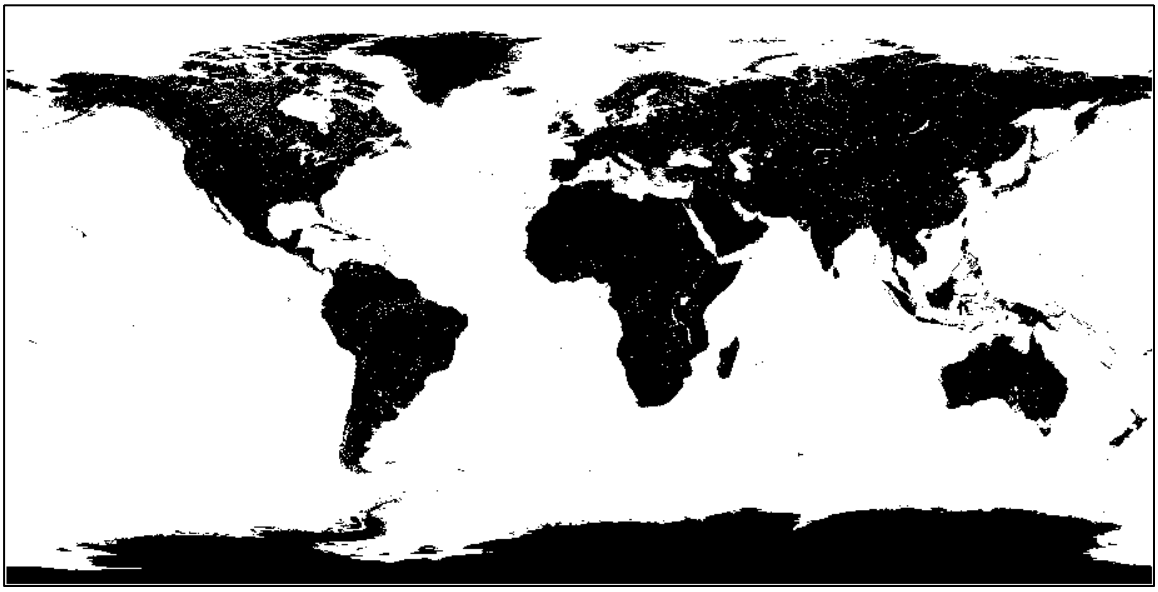


Figure 23: Mask for land/water classification as the basis for ocean extraction.

As the example of South America in Figure 24 shows, big rivers are still connected to the ocean area.

Figure 24: Example of vectorised and extracted ocean areas.

To extract these inland water areas from the ocean the GSHHS fine resolution coastline dataset was used to remove the remaining inland water from the current ocean mask. The fine resolution version of the GSHHS coastline dataset was compared to the coastline of the current ocean mask. An example of the GSHHS data (red) compared to the current ocean mask (blue) is shown in the left image of Figure 25. In some parts the GSHHS (red) extended into the ocean areas (blue) of the current ocean mask (see Figure 25). This was undesirable for the task to eliminate inland water of big rivers from the ocean mask while keeping the original coastline everywhere else.

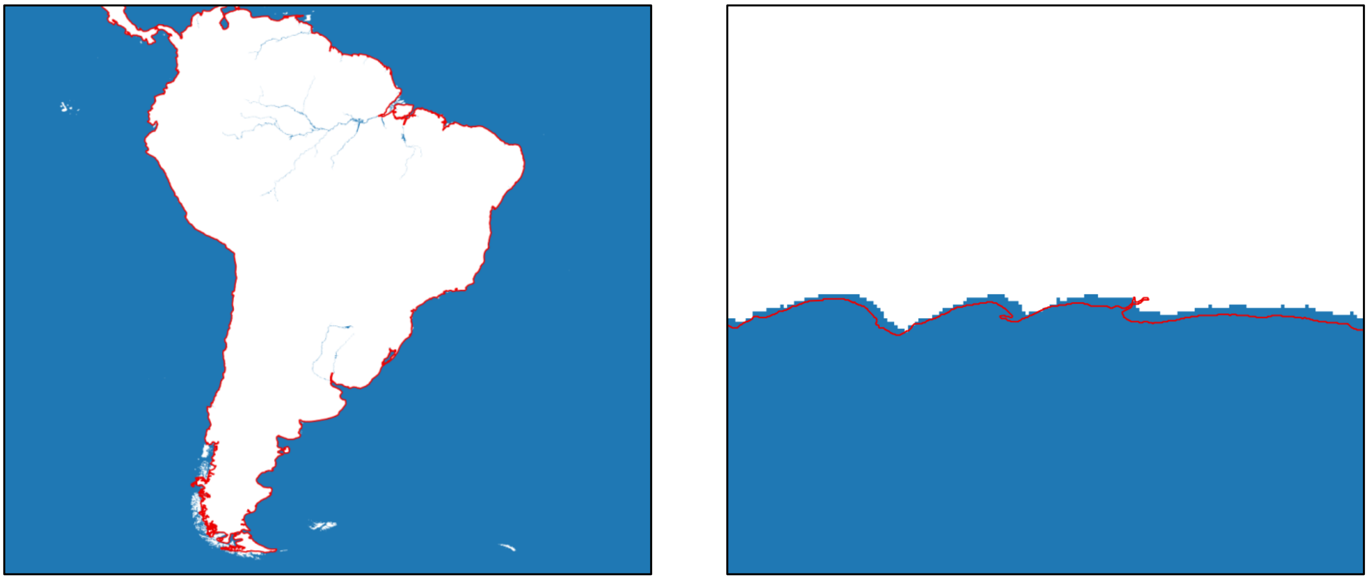


Figure 25: Example of GSHHS (red) superimposed to current ocean mask (blue) [left image]; GSHHS (red) extending into current ocean mask (blue) [right image].

To fulfil these two requirements the GSHHS was buffered 0.033 degree inward. Different buffer sizes were tested. The chosen one was the most suitable. Figure 26 shows an example of the buffered GSHHS coastline (green) in relation to the original GSHHS (red) and the current ocean mask (blue).

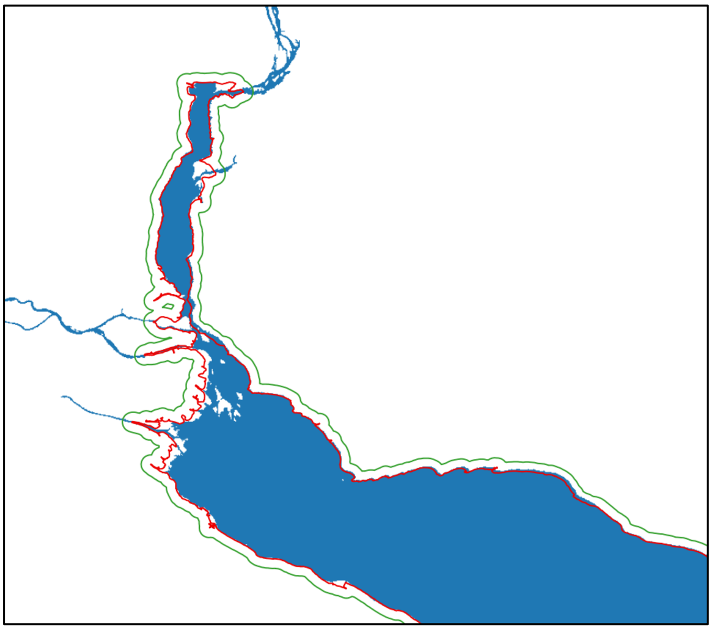


Figure 26: 0.033 degree buffered GSHHS (green) compared to original GSHHS (red) and current ocean mask (blue).

To remove the inland water from the ocean vector, a simple vector based clipping function was used. The result is an ocean mask without inland water areas. The left image of Figure 27 shows the previous ocean mask including inland water of big rivers while the right hand image shows an example of the new ocean mask without inland water.

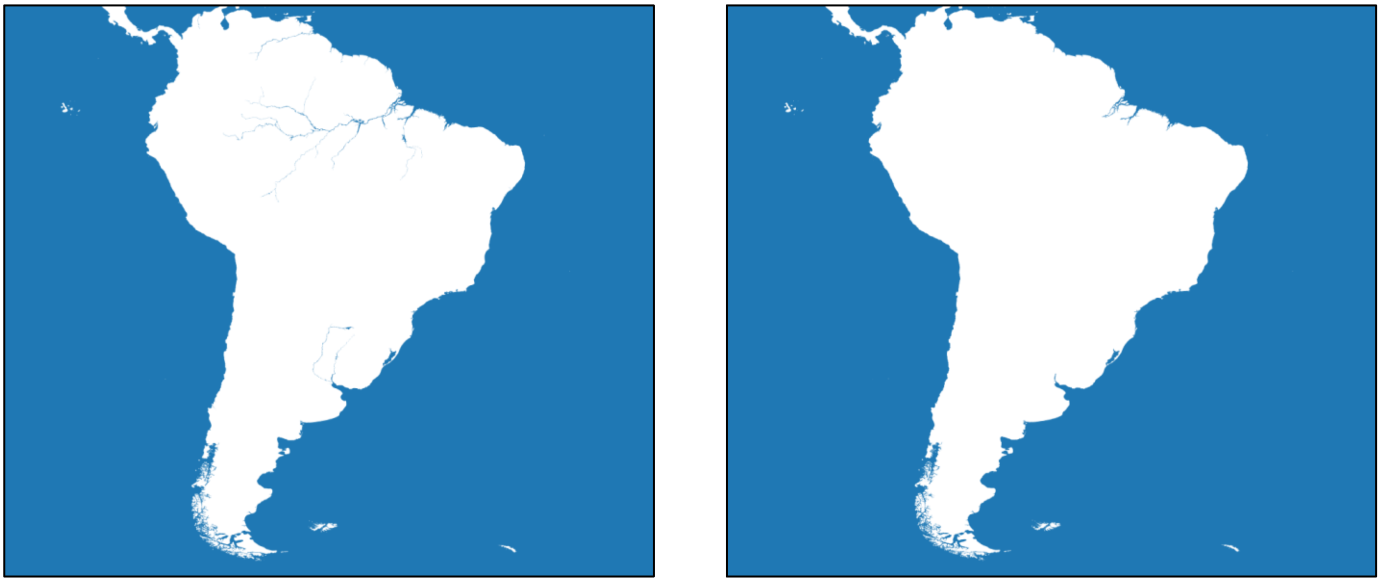


Figure 27: Ocean mask with remaining inland water (left); Refined ocean mask without inland water (right).

As a final step the vector mask was converted back to raster format with the required specifications. Figure 28 shows the new mask for land/ocean classification.

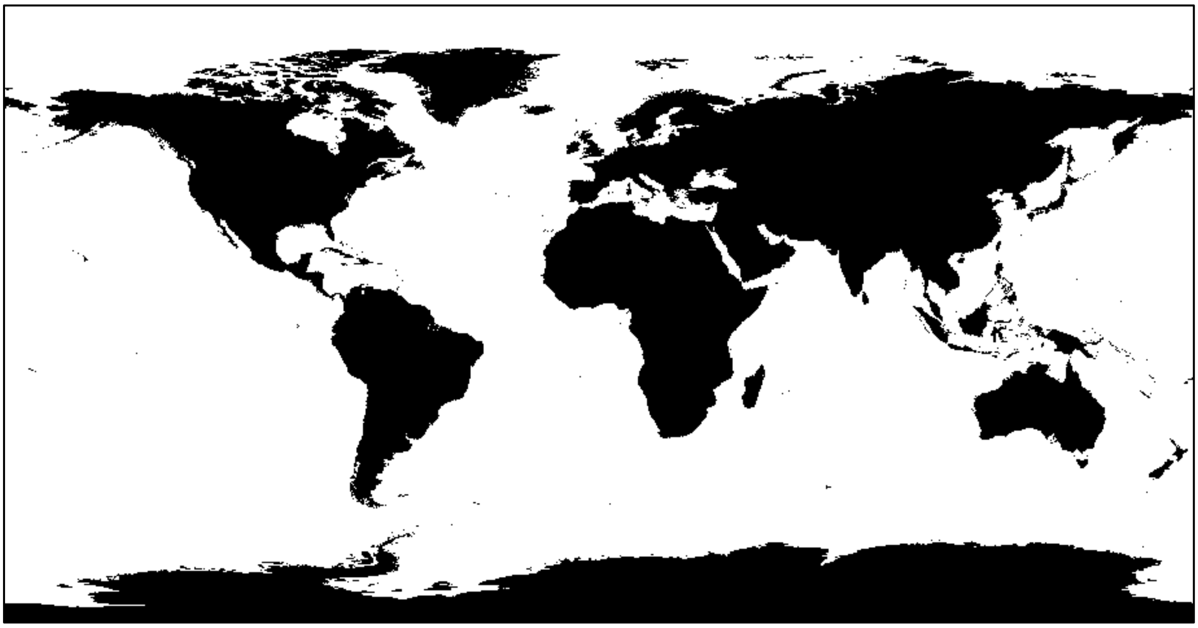


Figure 28: Mask for land/ocean classification.

5.3 Inland water mask

To be consistent with the current S3 mask products, this is not a derived product. Inland water pixels are flagged by a combination of the land/water mask and the land/ocean mask. If the land flag is not set within the land/water mask (bit = 0) and the land flag is set within the land/ocean mask (bit=1) then this pixel is an inland water pixel.

5.4 Mask for tidal regions

A first analysis of the current S3 tidal region mask was carried out in chapter 3.2.2 which led to the conclusion of inconsistencies between the different S3 masks.

In a second step it was analysed how the current S3 tidal region mask was derived. For this purpose the used FES2004 input data were downloaded and converted to the required format. As described in the technical documentation the S3 tidal region mask was derived from FES2004 K1 and M2 amplitude data. The sum of both products was computed and a threshold was applied. Reproducing the same product (sum of K1 and M2 amplitude) and defining a threshold, led to the outcome that there are deviations between the current S3 tidal mask and any chosen threshold on the reproduced product. No threshold is possible to produce the same mask with equal extents. Thus there has to be a step in the current S3 tidal region mask production which is not documented. Figure 29 to Figure 32 show the current S3 tidal region mask and three examples of thresholds used on the FES2004 K1+M2 product. The examples show that either with a low or high threshold, there are areas which cannot be masked using any threshold, as with decreasing threshold some areas tend to increase too much, while other are still not covered by the mask.

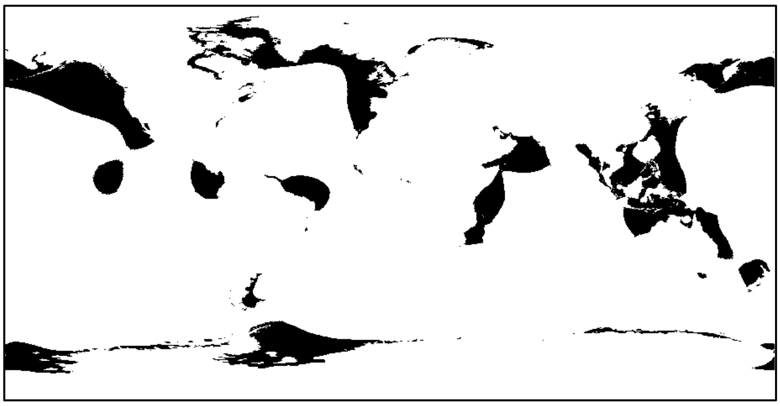


Figure 29: Original S3 tidal regions mask.

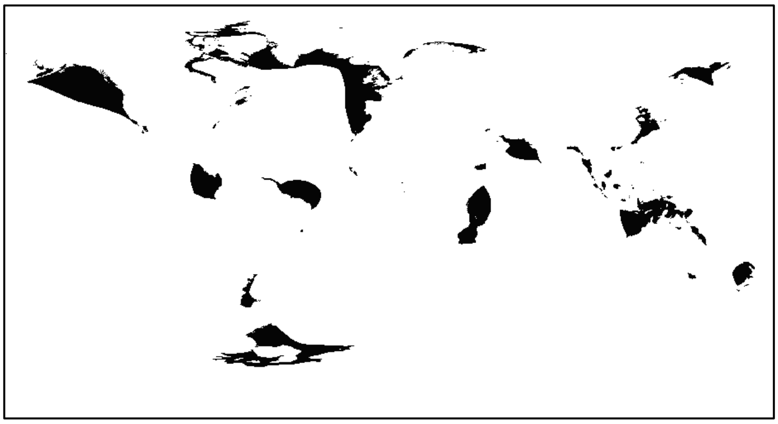


Figure 30: Reproduced FES2004 K1+M2 amplitude data with threshold 0.8.

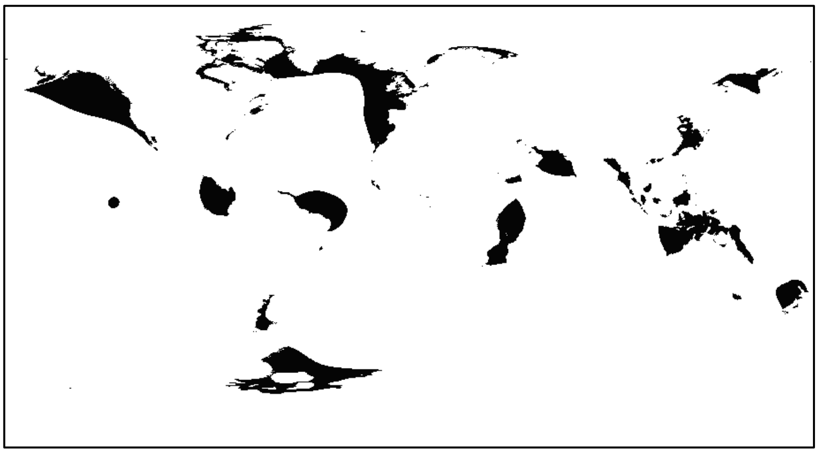


Figure 31: Reproduced FES2004 K1+M2 amplitude data with threshold 0.75.

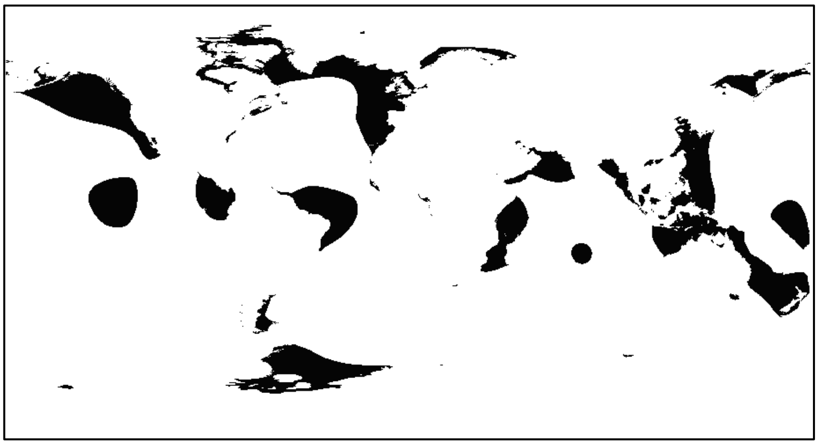


Figure 32: Reproduced FES2004 K1+M2 amplitude data with threshold 0.65.

Beside the reproduction problem of the current mask, the further analysis has shown that these tidal regions mask predominantly covers huge areas of deep sea. More valuable for masking of tidal regions are those areas under tidal influence, which have lower water depth in coastal regions and thus are under a higher influence of tidal variations.

Therefore in a third step it was analysed which additional data can be used to map tidal regions in coastal zones with low water depth, to produce a more realistic tidal regions mask. For this task bathymetry data were obtained (General Bathymetric Chart of the Oceans – GEBCO) with 30 arc seconds resolution.

The bathymetry data were resampled to 0.00277 degree, to meet the final product resolution. An example is shown in Figure 33.

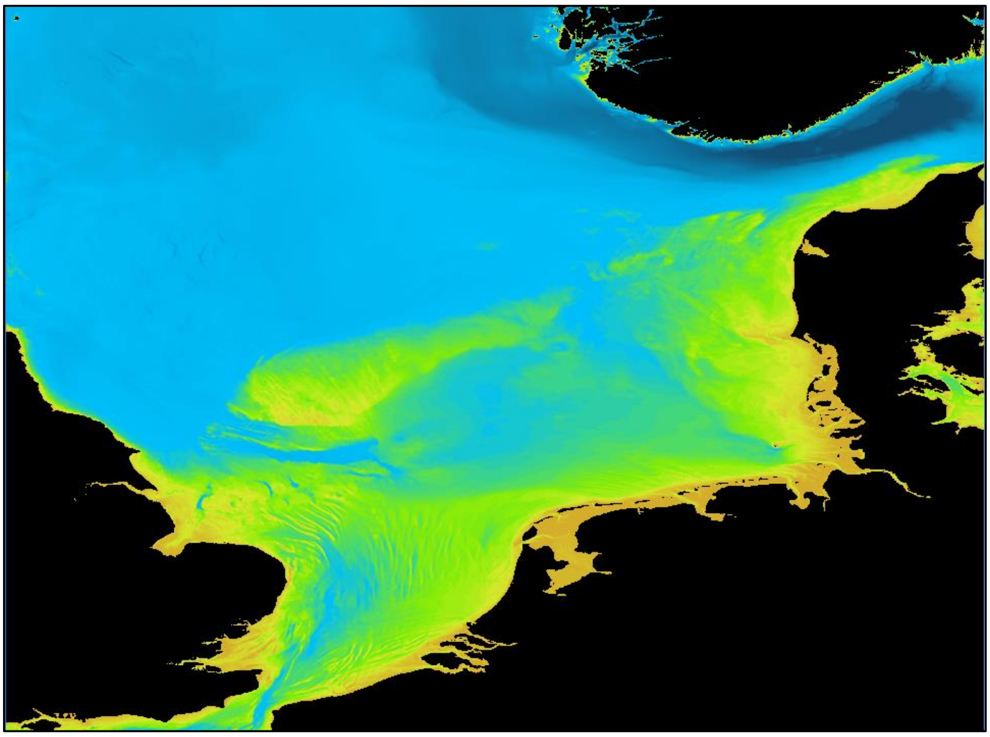


Figure 33: Resampled GEBCO bathymetry data (orange = shallow; dark blue = deep).

A mask of shallow water areas was produced by thresholding (see Figure 34).

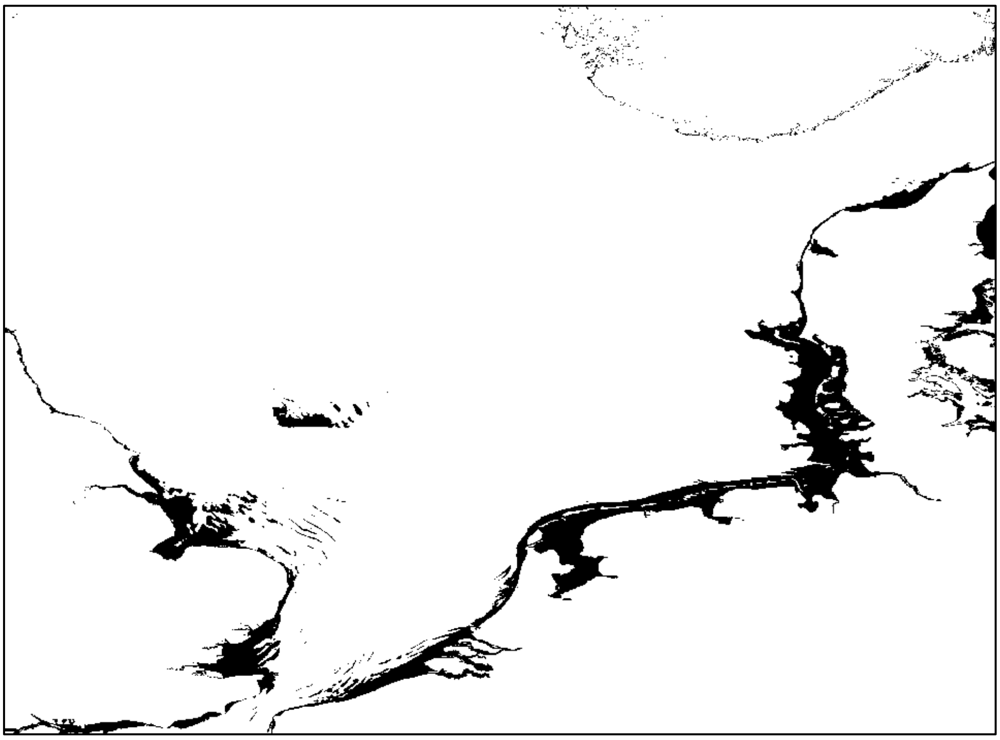


Figure 34: Bathymetry mask.

Intersecting this mask with the new land/ocean mask ensured the consistency between the land/ocean mask and the shallow water areas. In a further step these areas were intersected with the thresholded FES2004 data. Remaining are those shallow water areas under tidal influence. As shown in chapter 3.2.2, caused by the low resolution of the FES2004 data and the current land/ocean map, there are remaining shallow water areas between the ocean and the land surface. These areas where filled, as long as they are shallow water, using various GIS operations. Then all tidal regions which were not connected to land were removed as shown in Figure 35.

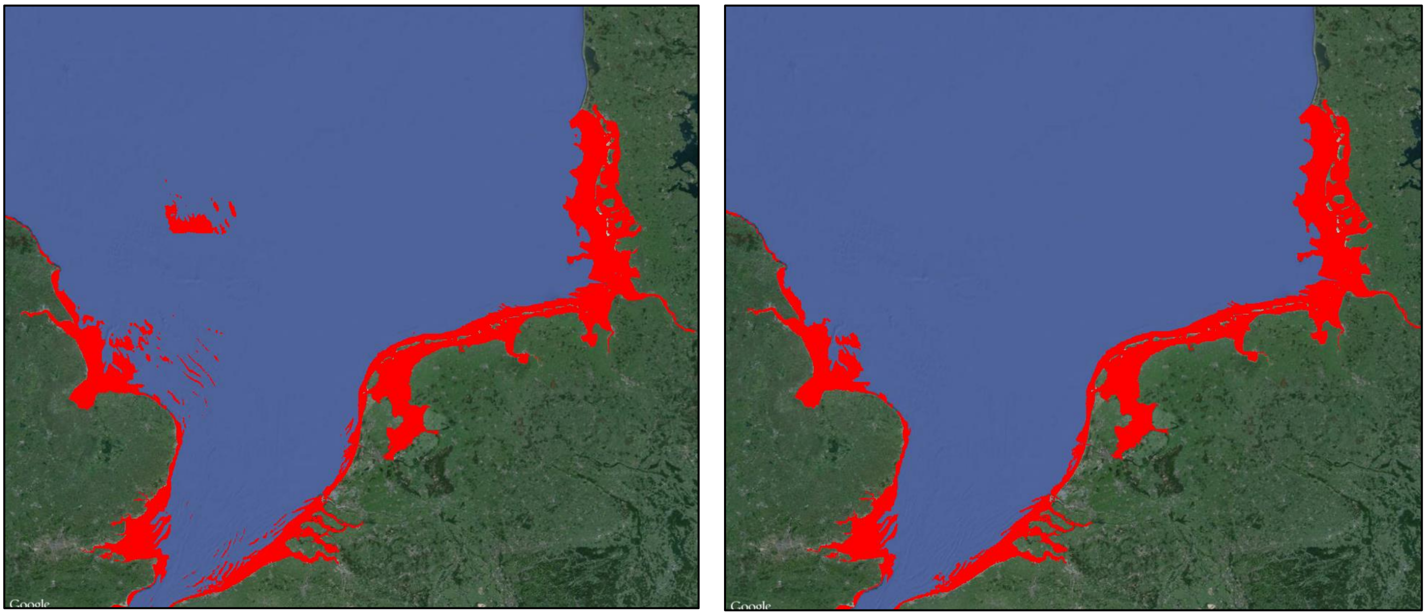


Figure 35: temporary tidal regions mask before cleaning (left) and cleaned to areas connected to onshore (right).

As decided by ESA and the consortium, the tidal region mask should also include onshore areas which reach a certain height above zero and are connected to these offshore areas shown in the right hand image of Figure 35. Therefore in a final step all areas between zero and six meter height were masked. And these areas which were connected to the temporary tidal region mask were extracted and added to the final tidal region mask. Figure 36 shows the difference before and after the extension.

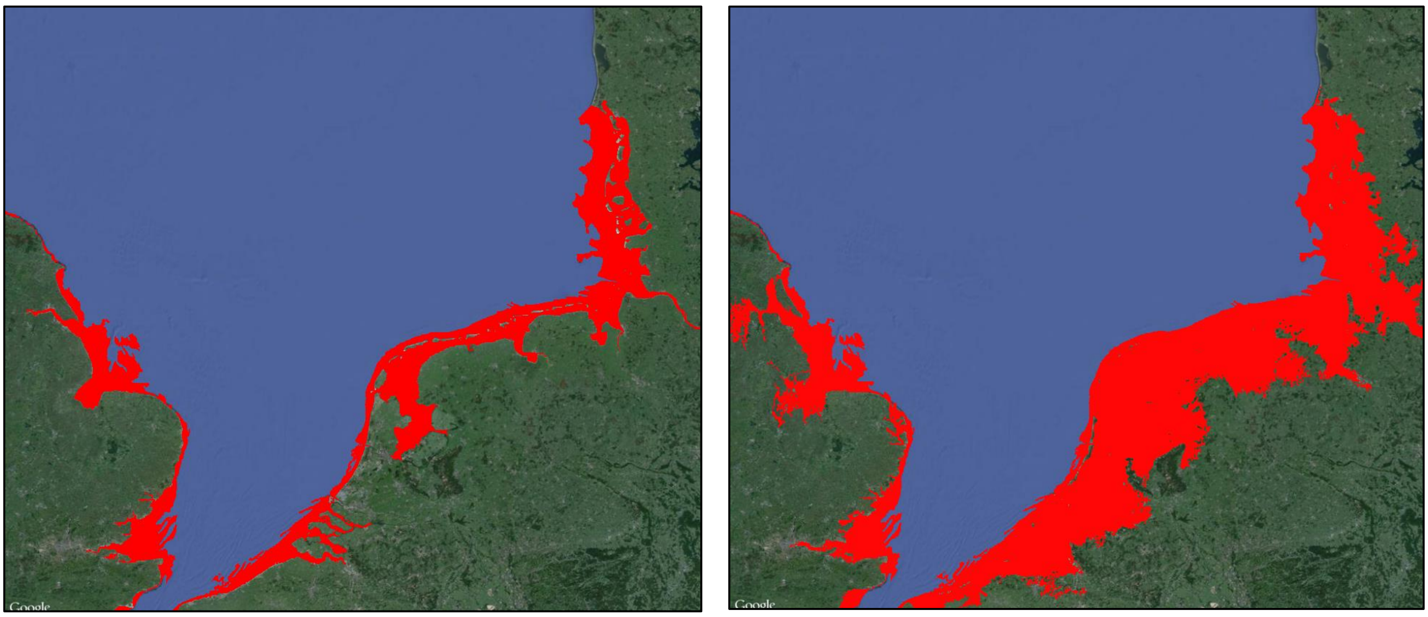


Figure 36: temporary tidal regions mask before extension (left) and final tidal regions mask after extension (right).

The resulting tidal region mask is shown in Figure 37.

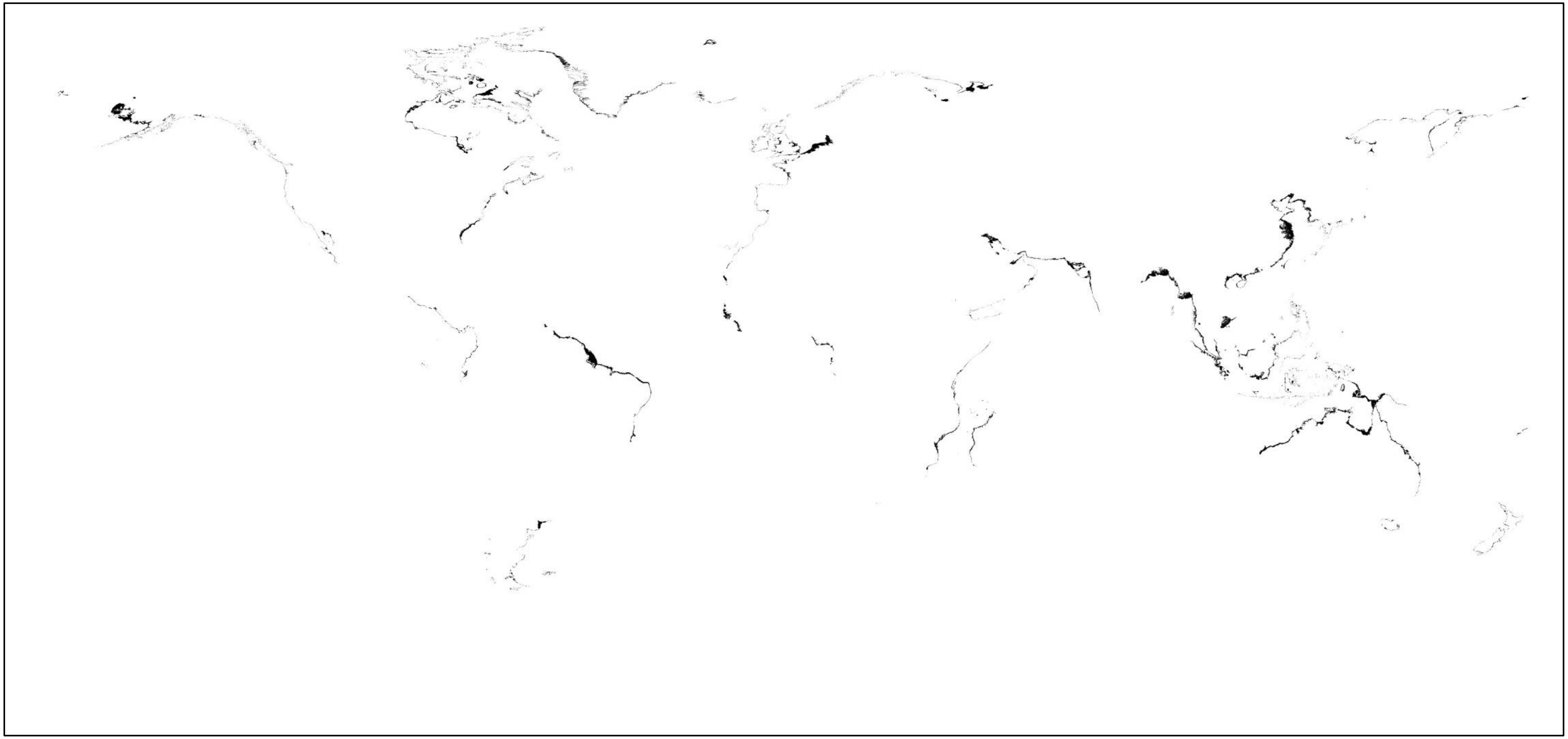


Figure 37: New tidal regions mask.

The following figure shows a comparison between the old S3 tidal regions mask and the new tidal regions mask for a region in the North Sea.

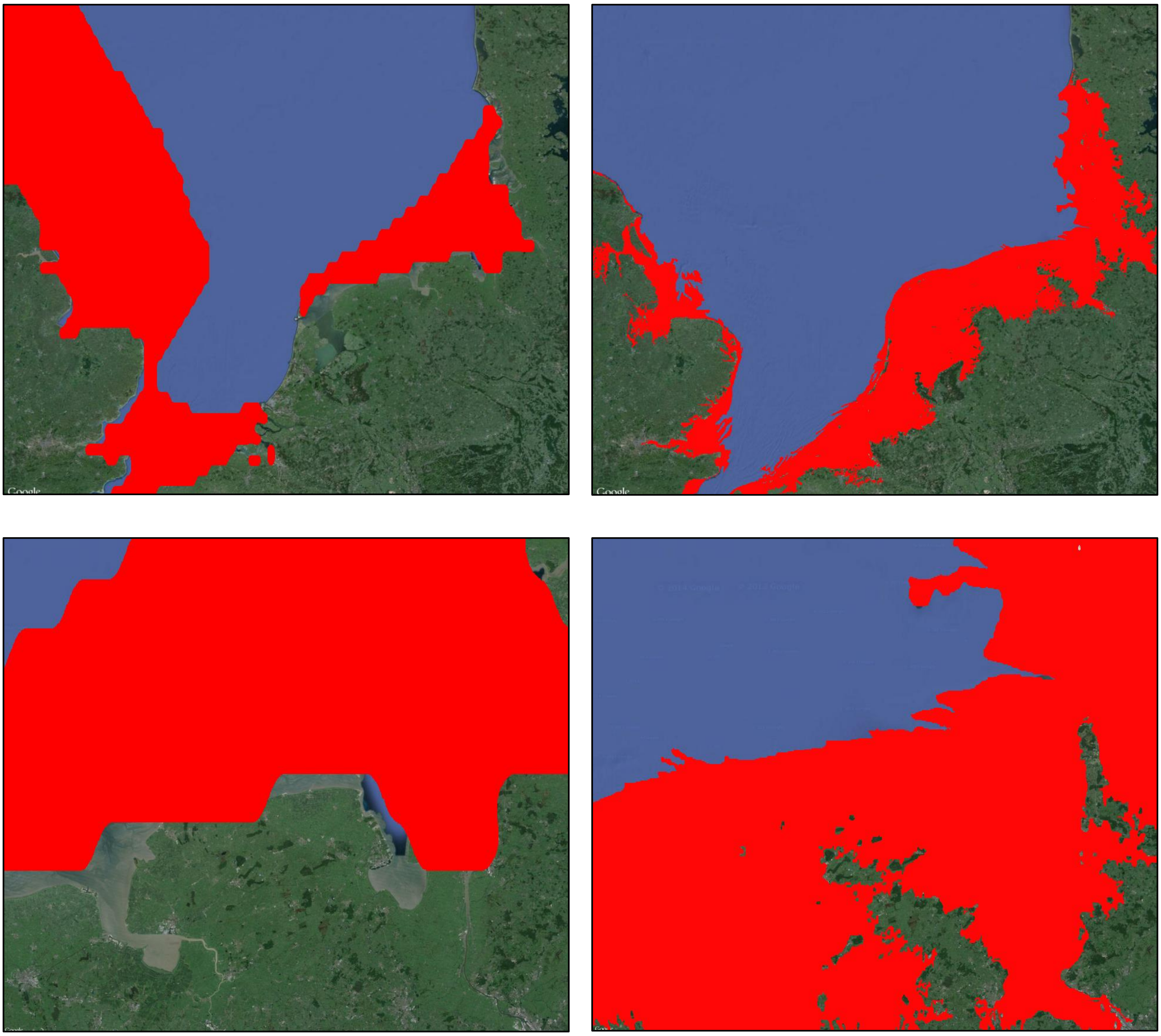


Figure 38: current S3 tidal regions mask (top and bottom left); new tidal regions mask (top and bottom right).

The examples show that the old mask covers wide areas of deep sea while missing some coastal areas. Whereas the new mask focuses on coastal shallow water and adjoining flat onshore areas.

Figure 39 shows how the land/water, land/ocean and tidal regions mask fit perfectly into each other.

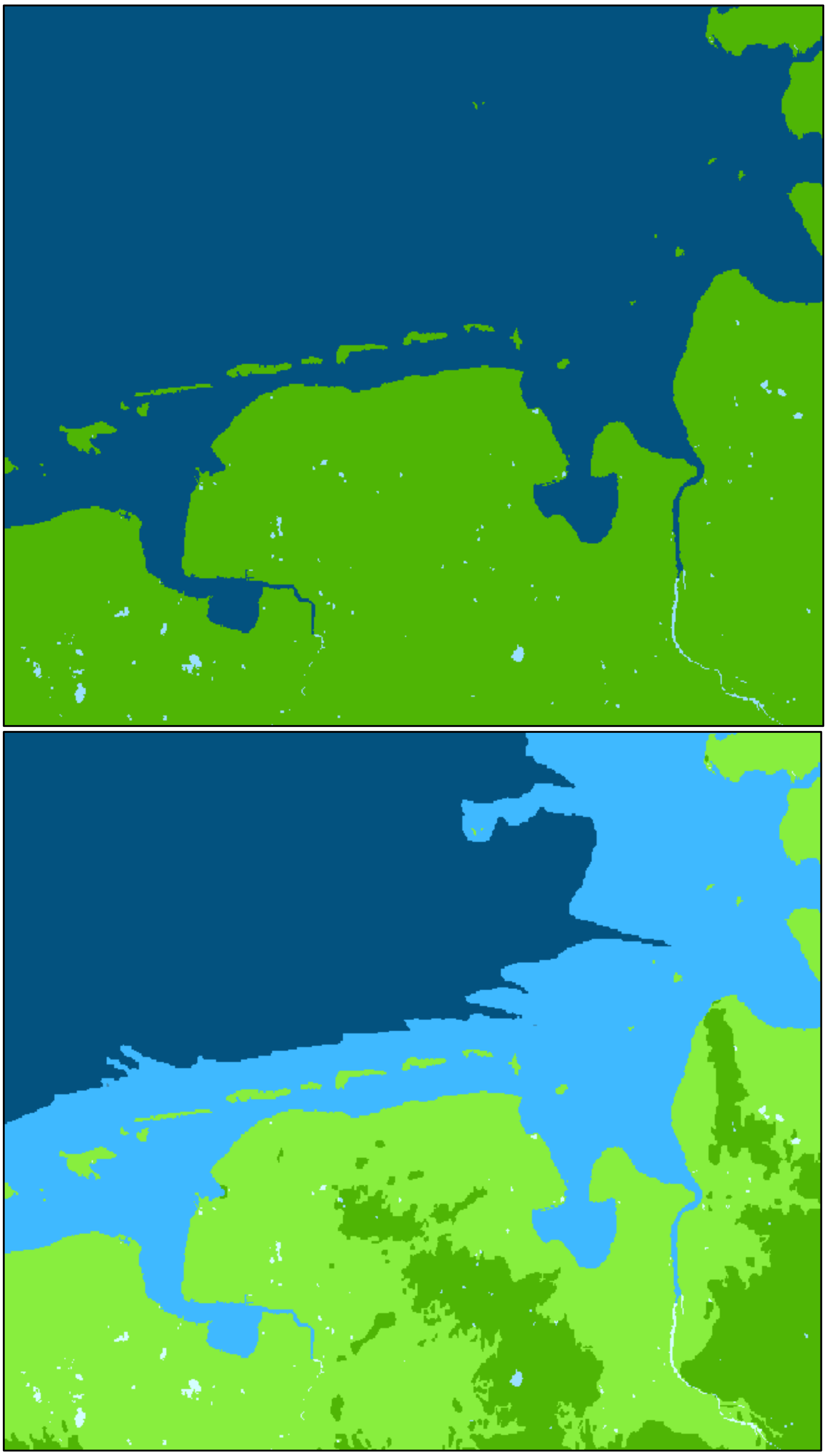


Figure 39: Top: Overlay of land/ocean and land/water mask (dark blue = water from land/ocean mask; light blue = water from land/water mask ; green = land from land/water mask).

Bottom: Overlay of land/ocean, tidal regions and land/water mask (dark blue = water from land/ocean mask; mid blue = water intersecting with tidal regions mask; light blue = water from land/water mask ; dark green = land from land/water mask; light green = land intersecting with tidal regions mask).

5.5 High resolution coastline

To create a coastline mask which is consistent to the two previous masks, the coastline was derived from the new land/ocean mask. This was achieved by converting the land/ocean mask from raster format to a line vector format (see Figure 40).

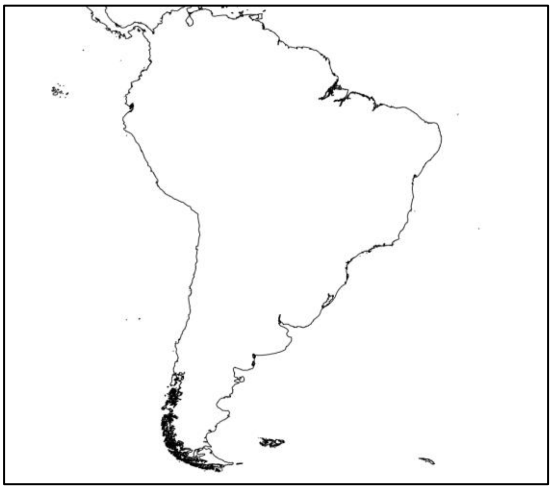


Figure 40: Vectorised coastline from mask for land/ocean classification.

The line was converted back into raster format, with the required specifications. Figure 41 shows examples of the rasterized coastline.

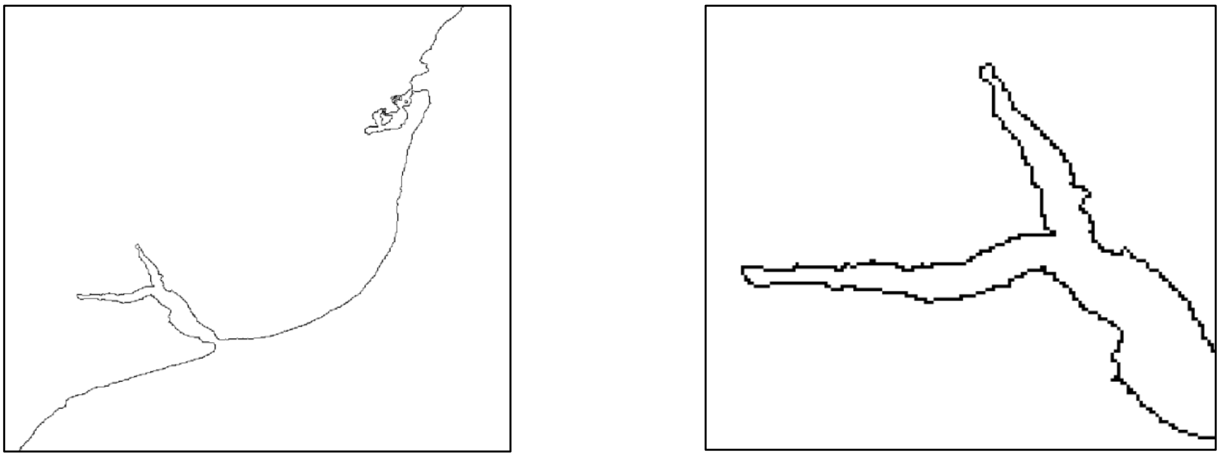


Figure 41: Rasterized high resolution coastline.

The chosen methodology ensures the alignment of the four generated masks, as examples in Figure 42 show.

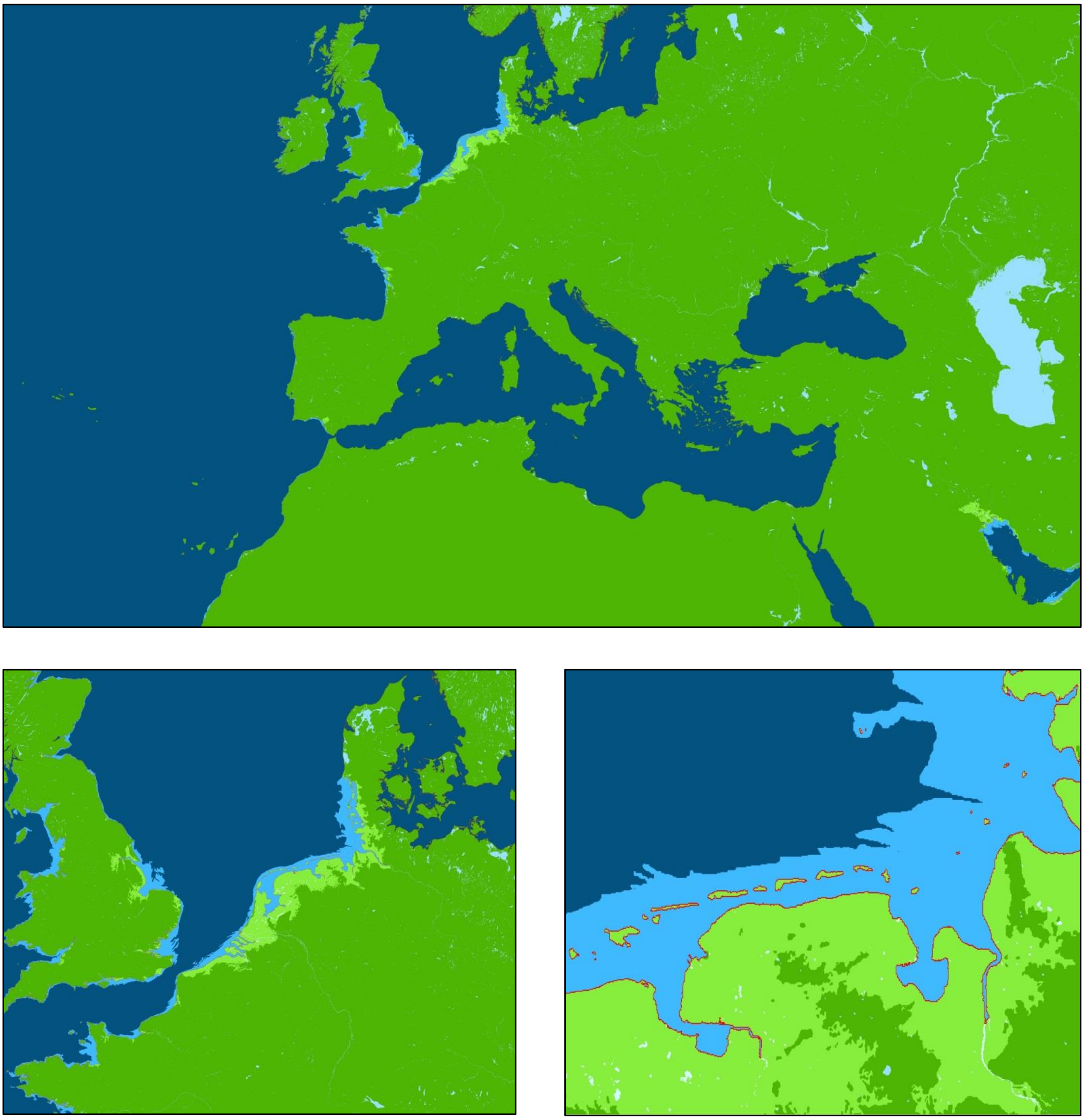


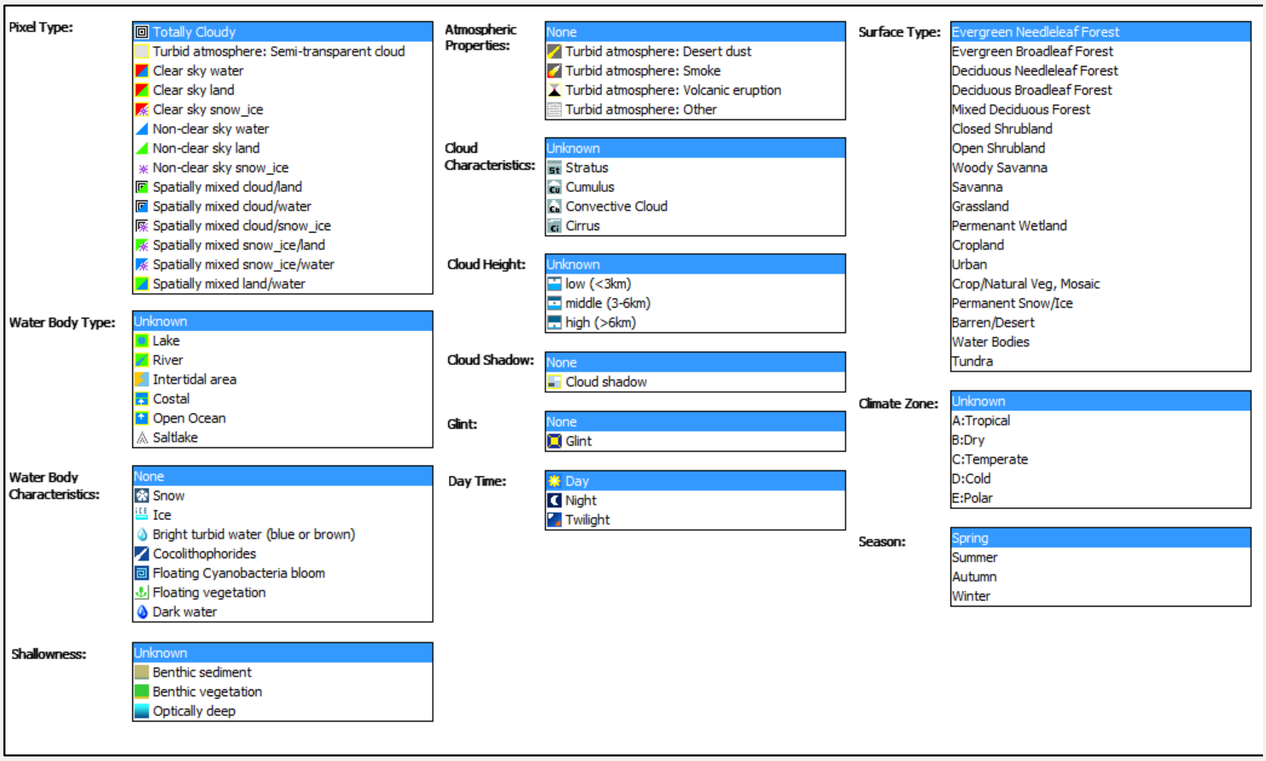
Figure 42: Example of mask alignment. Ocean areas from land/ocean mask in dark blue; Coastline mask in red; Tidal regions mask intersecting with water mid blue; Water from land/water mask light blue and land dark green; Land intersecting with tidal region mask light green.

6 Validation and inter-comparison

Validation of the land/water mask was carried out using 25815 randomly distributed sample points from the PixBox data set.

Excursion - PixBox:

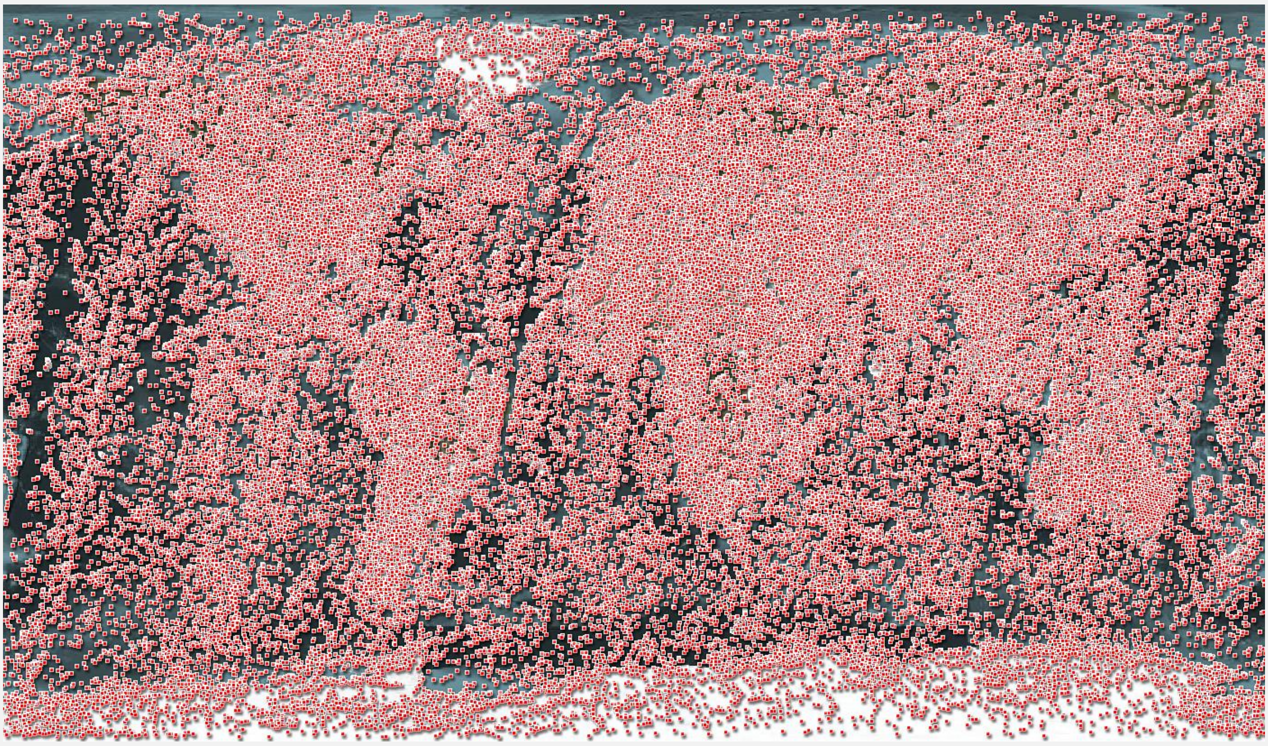
The "PixBox" database software was developed by M. Zühlke of Brockmann Consult GmbH on the basis of BEAM-VISAT specifically for the purpose of pixel collection. It allows to assign, show and store one or more characteristics for any of pixel on satellite image. Possible attributes are shown in the figure below.



Pixbox's objective is the accumulation of information from satellite images collected solely on the basis of expert opinion. The satellite data may be represented as black-white and RGB images on the computer screen using the linear combination of the available channels. The expert decides which of the pixels to be considered, and then, based solely on his own experience, he assigns some properties (e.g., " cloudless case", "semi-transparent clouds", "coastline", "seaweed", "sun glint", "sand storm", etc.) for each selected pixel to attribute it. The pixel will be ignored, if the expert has a doubt in the determination of its properties.

The information is collected in the form of the "original geo referenced satellite (L1b) data" + "assigned expert attributes" for each selected pixel and is stored as a database. It can be used, for example, for the validation of various automatic techniques.

The "PixBox" database comprises 110,000 samples as shown in the image below



The validation points are shown in Figure 43. The dataset is a subset of the complete PixBox database and comprises 16484 land and 9331 water pixels. The classification of these sample points is based on Envisat MERIS RR data. Each sample point was classified by visual interpretation. Thus 100% accuracy is given for these validation points.

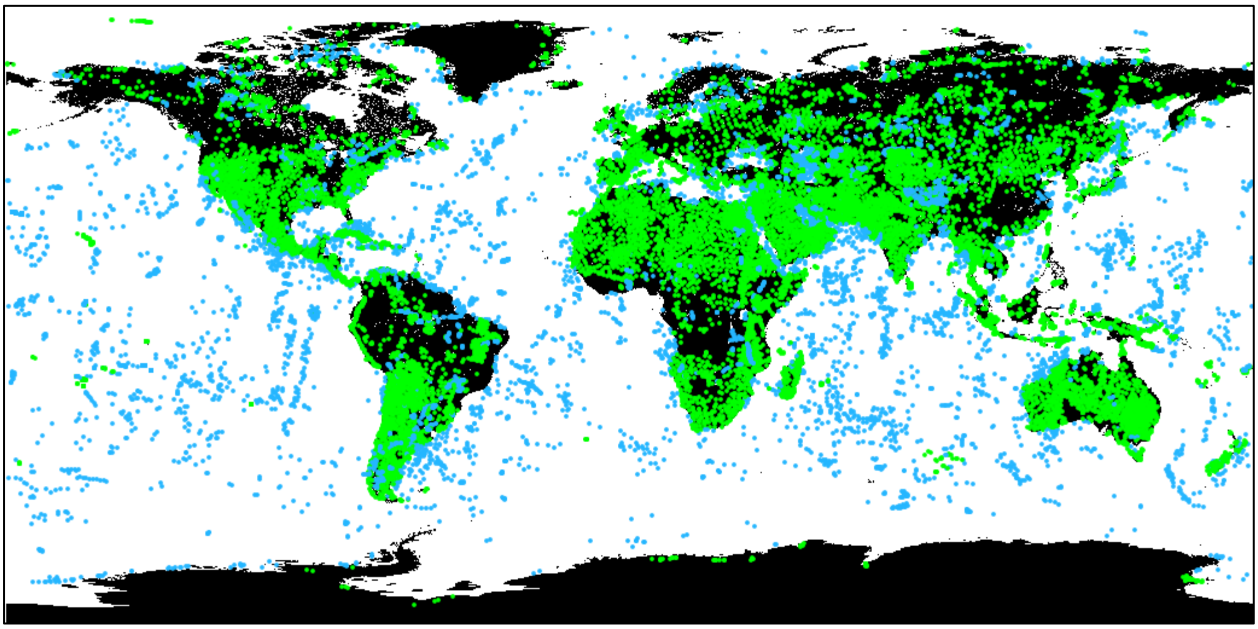


Figure 43: 250 randomly distributed sample points.

At these validation points the classification value of the land/water mask was extracted and validated against the sample point classification.

The accuracy assessment was conducted using a confusion matrix and calculating producer's, user's and overall accuracy. The results are shown in Table **1**.

Table 1: Confusion matrix showing producer's, user's and overall accuracy.

		Validation Data		
		Land	Water	Row Total
Classification Data	Land	15874	293	16167
	Water	610	9038	9648
	Column Total	16484	9331	25815

Producer's Accuracy	
Water	96.30%
Land	96.86%

User's Accuracy	
Water	98.19%
Land	93.68%

Overall Accuracy	96.50%

The overall accuracy for the land/water mask is 96.5%