Sentinel Vision
SED-259
14 June 2018

2D Layerstack

An unusual look on sargassum

Sentinel-2 MSI acquired on **07 March 2018** at 14:28:49 UTC
Sentinel-1 CSAR IW acquired on **07 March 2018** at 22:01:49 UTC
Sentinel-1 CSAR IW acquired on **29 April 2018** at 09:42:36 UTC
Sentinel-2 MSI acquired on **29 April 2018** at 14:37:49 UTC
Sentinel-1 CSAR IW acquired on **04 May 2018** at 09:50:57 UTC
Sentinel-2 MSI acquired on **04 May 2018** at 14:37:51 UTC
Sentinel-1 CSAR IW acquired on **04 May 2018** at 22:18:23 UTC
Sentinel-2 MSI acquired on **01 June 2018** at 14:47:29 UTC

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Fig. 1 - S2 (07.03.2018 14:28) & S1 (07.03.2018 22:01) - vv polarisation - Sargassum slicks off the coast of Barbados 3D animation 3D view 3D view

In the previous event sheet dedicated to Sargassum invasion in the Caribbeans, the focus was set on showing the scale and the impact of these seaweed beaching on pristine shores. This event sheet is a tentative to draw parallels between oil slicks and sargassum slicks that might be used to quantify the algae before they ground. In order to do so, an analogy will be made with the varying appearance of oil slicks according to their thickness as defined in the Bonn Agreement Oil Appearance Code (BAOAC).

The image shown in fig.1 compares one Sentinel-2 image acquired the 07.03.2018 at 14:28 and a Sentinel-1 image acquired on the same day at 22:01 off the coast of Barbados.
The Sentinel-2 uses a ndi(8,2),ndi(8,3),ndi(8,4) colour composite in which vegetation appears in bright, sargassum thus showing in bright grey over a dark grey sea. It shows what can be identified as multiple patches of sargassum following a parallel course. Only the "head" of the drop is visible on the Sentinel-1, keeping the same drop shape and appearing in bright grey on the vv polarisation. While in the EVT-255, biogenic films dampening the waves below the tail of such patches could be identified, none is visible here.

Fig. 2 - S1 (29.04.2018 09:42) & S2 (29.04.2018 14:37) - Sargassum off the coast of Martinique [3D animation](#) [3D view](#) [3D view](#)

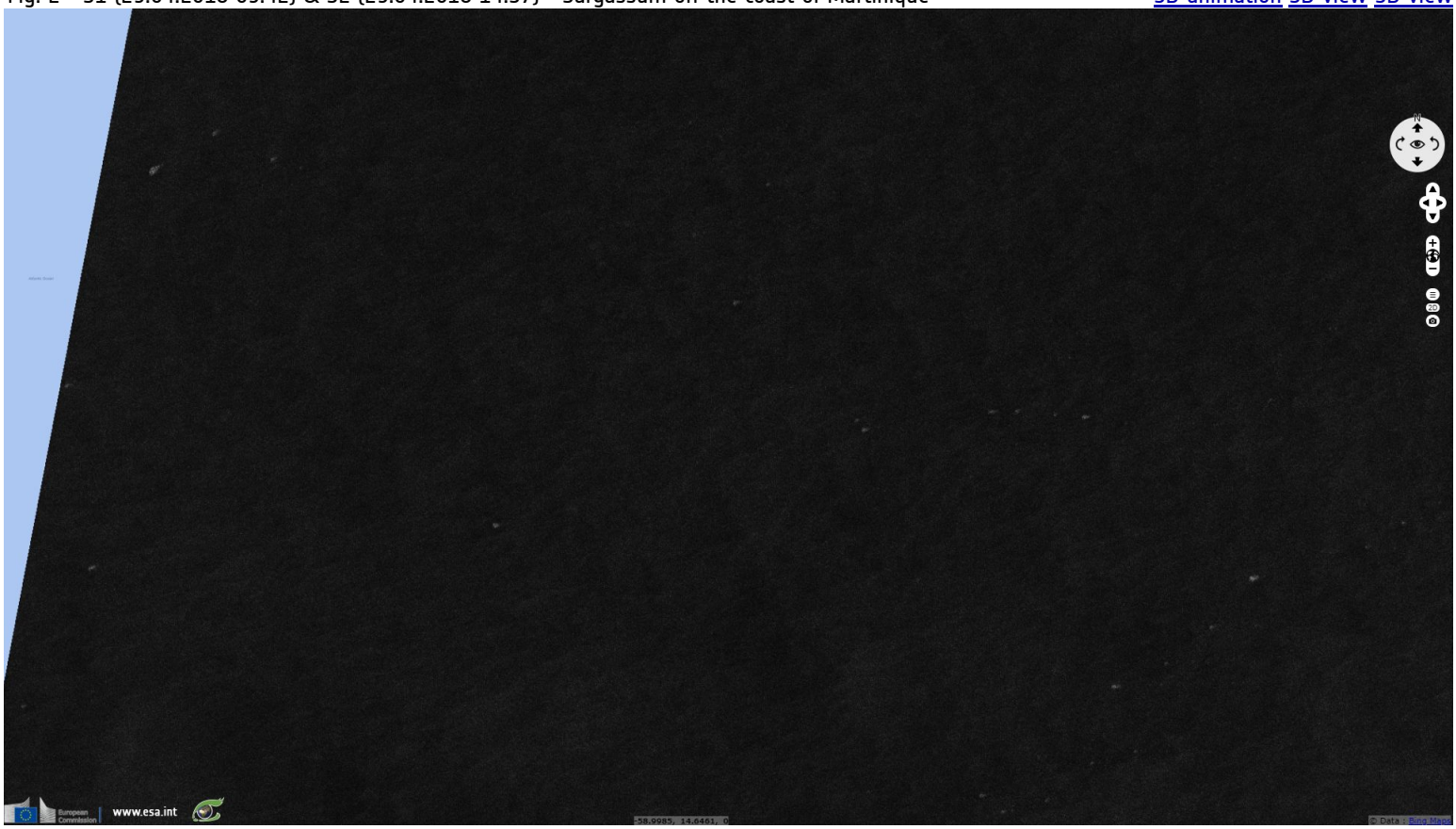
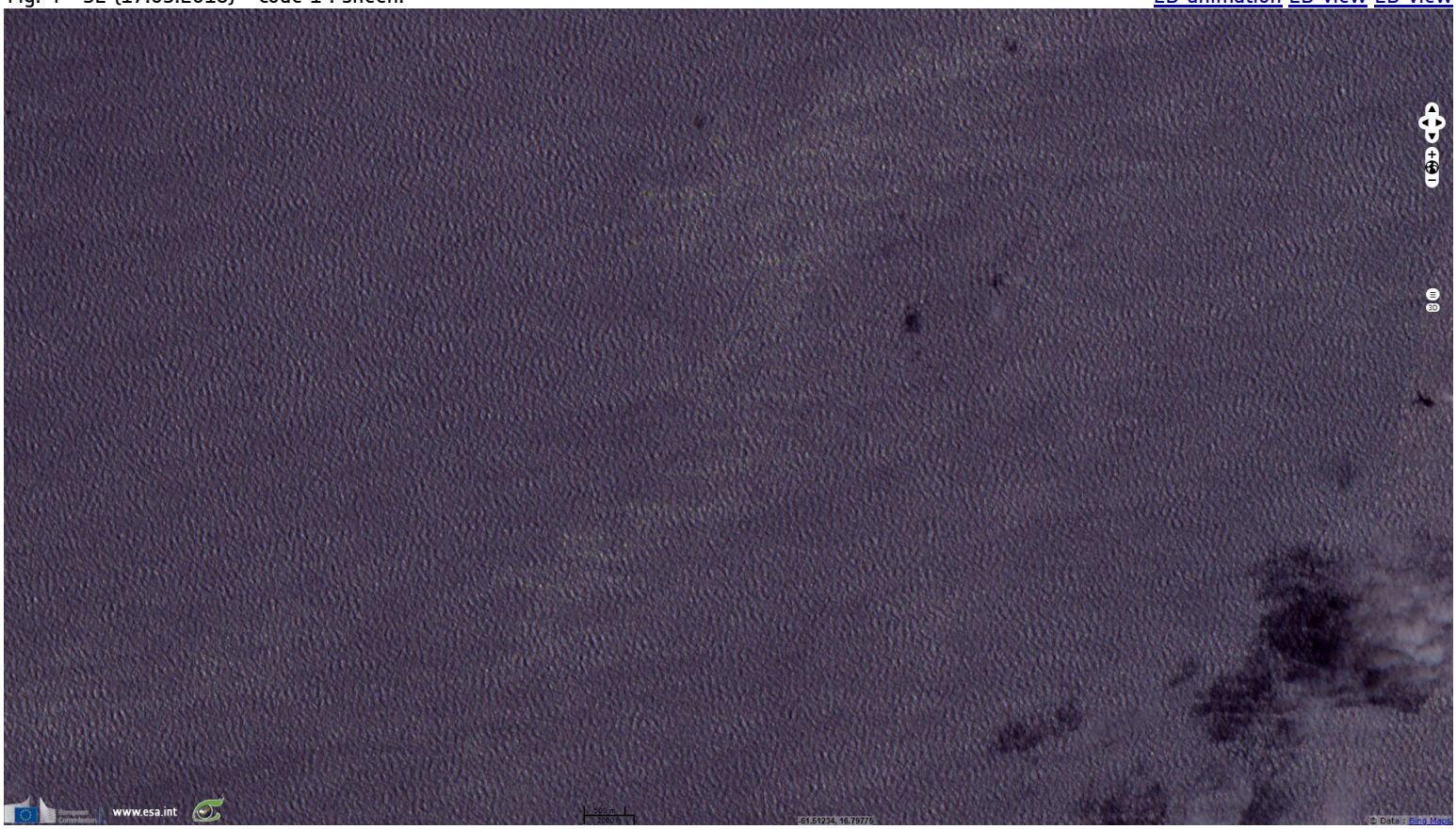


Fig. 3 - 04.05.2018, S1 (09:50 & 22:18) & S2 (14:37) - 3 views in 12h showing sargassum near St Vincent. [2D animation](#) [3D view](#) [2D view](#) [3D view](#)

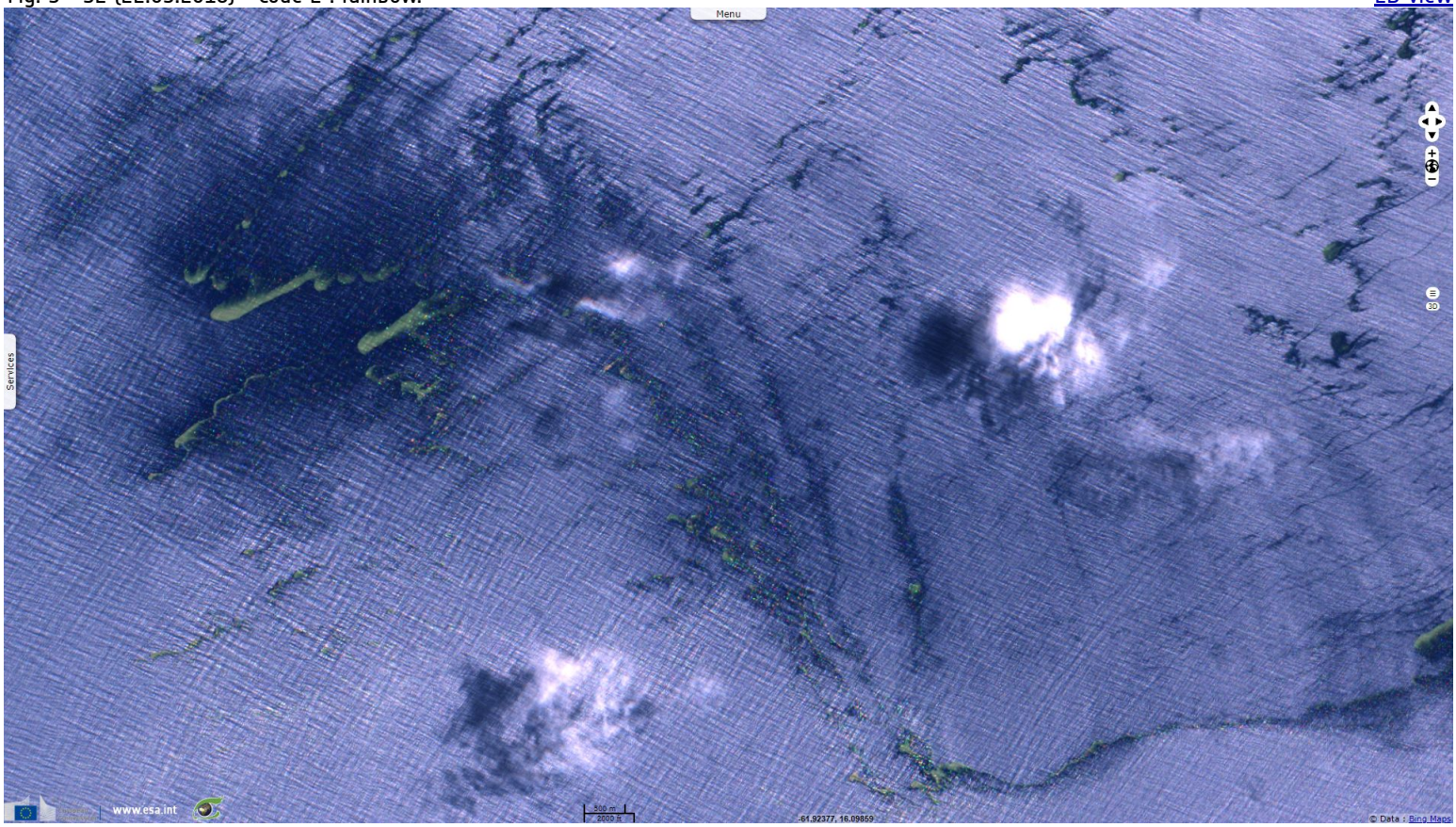
This animation is made of a Sentinel-2 acquisition between two Sentinel-1 images. All three have been acquired within 12 hours. It shows the different patches drifting in the same direction.

Fig. 4 - S2 (17.05.2018) - Code 1 : sheen. 2D animation 2D view 2D view



The BAOAC code 1 for sheen describes the aspect of the thinnest visible oil slicks: "*Under most viewing conditions, oil layers below 4 microns in thickness cannot be easily detected by the human eye and appear silvery / grey up to a thickness of 0.30 microns.*" As they do not dampen the Bragg waves on sea as much as thicker slicks, such sheen are not always visible on radar images.

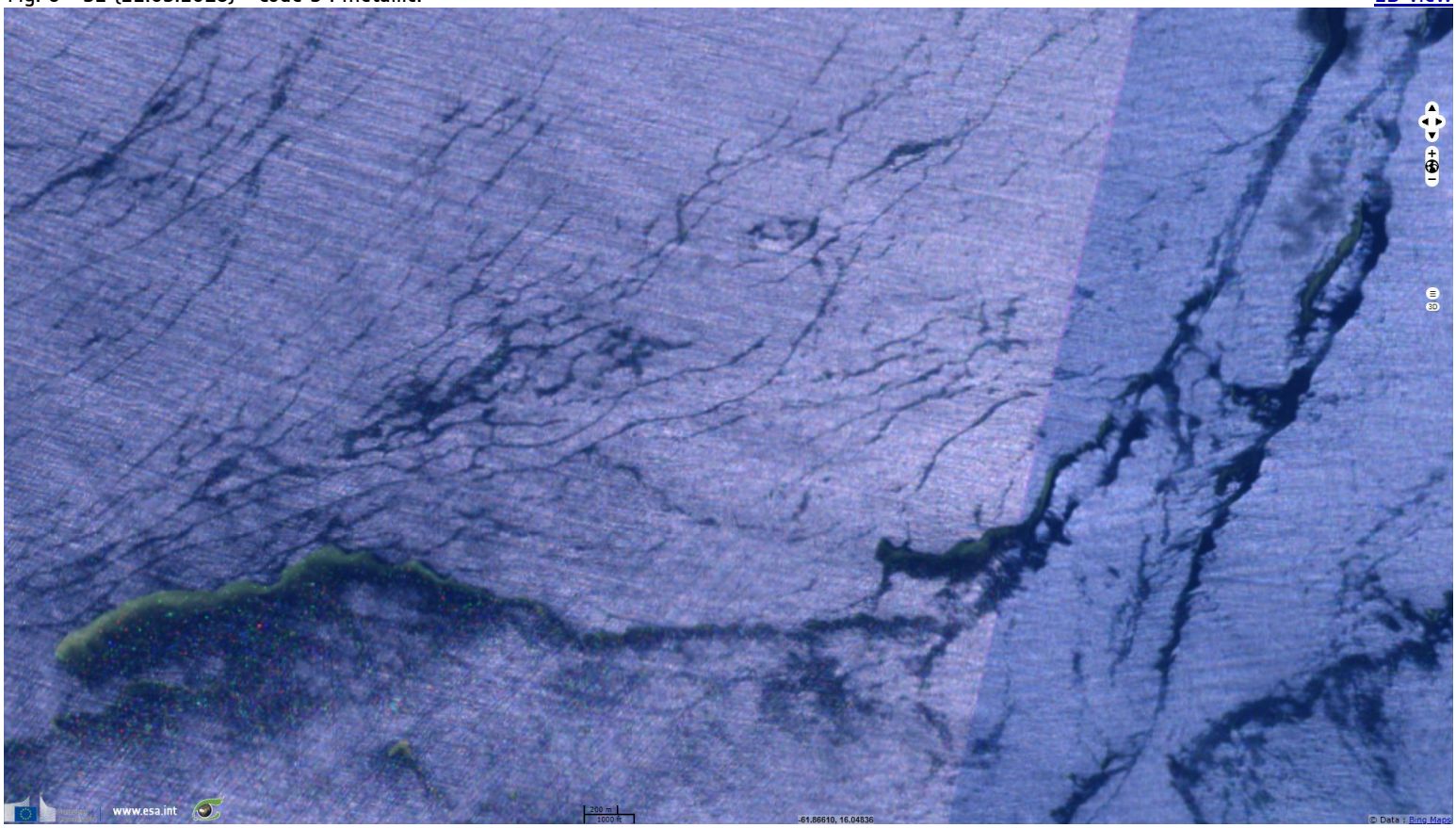
Fig. 5 - S2 (22.05.2018) - Code 2 : rainbow. 2D view



The BAOAC code 2 for rainbow describes oil slicks just thicker than sheens: "*Oil layers in the range of 0.30 to 5.0 microns in thickness appear to be rainbow coloured (bands of individual colours of the rainbow; red, orange, yellow, green, blue, indigo and violet) because of the constructive and destructive interference of the wavelengths of white light caused by the presence of the oil film. Light is reflected from both the surface of the water underlying the oil and from the surface of the oil.*
The rainbow colours are strongest when the oil layer is of the same order as the wavelengths of these different colours (0.4 microns (400 nm) for violet and 0.65 microns (650 nm) for red), but the effect persists weakly for multiples of these oil thicknesses until the oil layer is opaque and prevents light from being reflected from the underlying water surface."

Fig.5 does not show the rainbow fringes than are usually associated with code 2 of BAOAC, however it shows a significant fraction of pixels imaging the slicks appear as red, green of blue pixels. It appears specifically within parts of the patches of sargassum rather than being widespread on all their surface, it is thus unlikely to be simply noise or to be considered generalized on all sargassum aspects. One might suggest that the biogenic film formed around seaweed patches is less regular than that of mineral oil, preventing the formation of regular fringes.

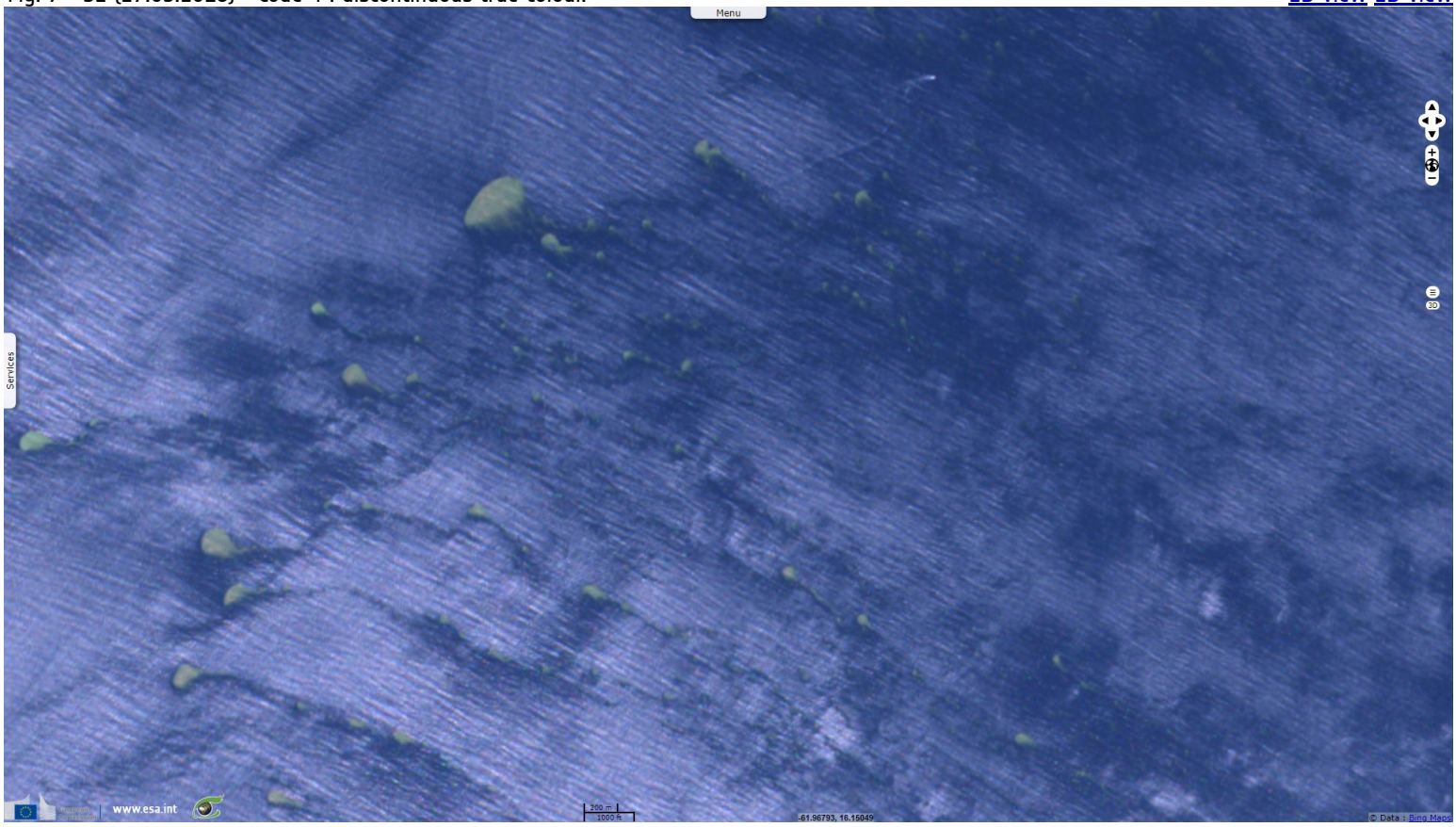
Fig. 6 - S2 (22.05.2018) - Code 3 : metallic. 2D view



The BAOAC code 3 for metallic looking oil slicks notes: "*Oil layers in the range of 5.0 to 50 microns in thickness act as an imperfect mirror. The apparent colour varies depending on viewing conditions, but is sometimes the colour of the sky (blue or shades of grey). Whatever the apparent colour, the common visual effect is of a flat, almost uniform, surface without obvious features. After some debate, this effect is described as "metallic" in the BAOAC.*"

Again an imperfect analogy, it is however tempting to compare the dark trails visible in part of fig.6 to the metallic code aspect. They appear a darker than the sea while sheen slicks appear lighter, sunglint or not.

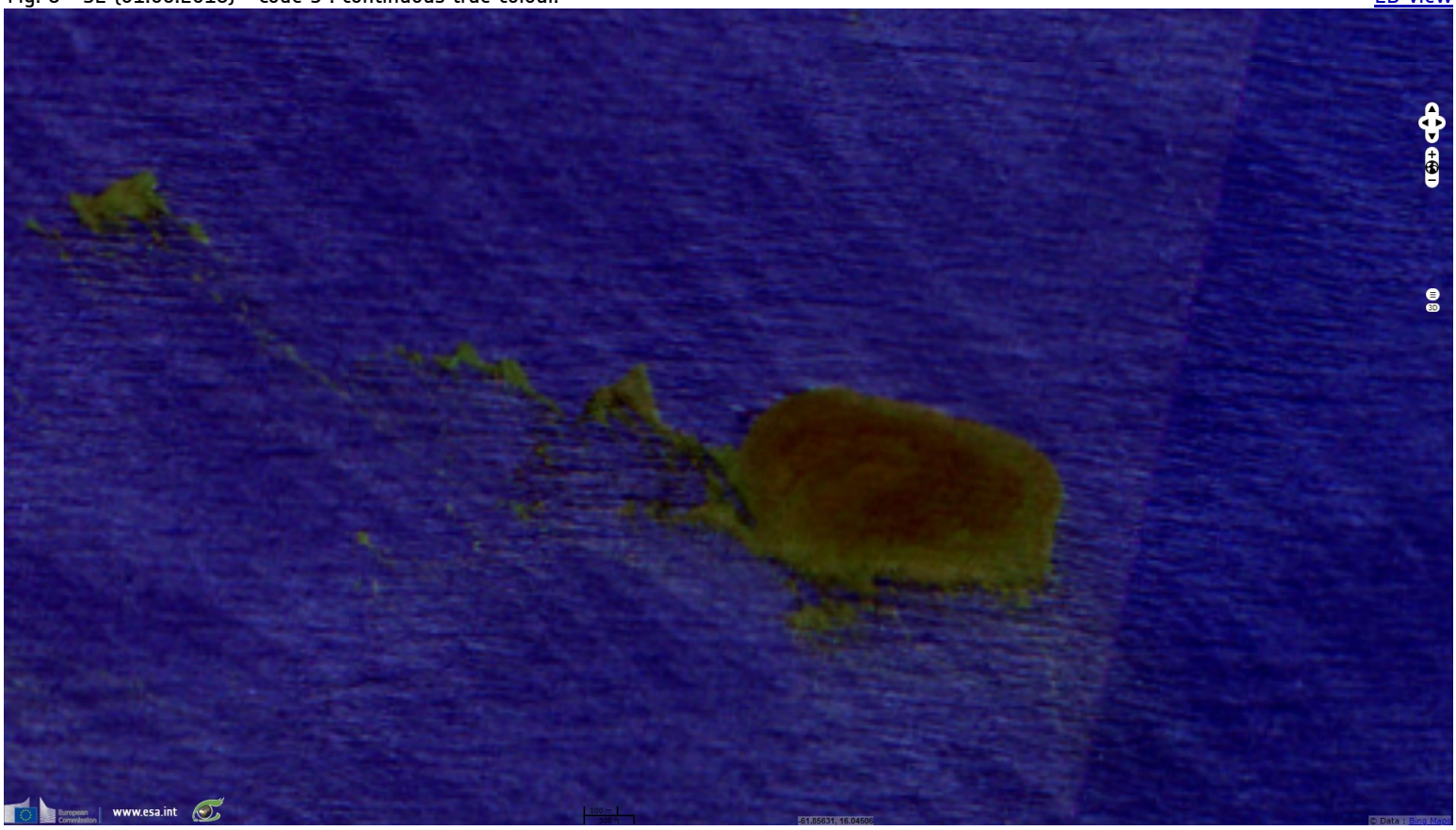
Fig. 7 - S2 (27.05.2018) - Code 4 : discontinuous true colour. 2D view 2D view



The BAOAC code 4 for Discontinuous True Oil Colour is described as: "*Oil layers in the range of 50 to 200 microns in thickness are described as Code 4 - Discontinuous True Oil Colour. Code 4 is intermediate between Code 3 and Code 5, and consists of small areas, or patches, of Code 5, Continuous True Oil Colour in a background of Code 3, Metallic. This is an accurate description of the behaviour of the oil layer – it does not spread as an even thickness layer, but consists of thicker patches in a thinner layer.*"

As the thickness of the seaweed increases, it shows greenish in natural colour images, usually at the head of the drop shape and at the beginning of the tail. These patches show in bright on the vv polarisation and even more on vh polarisation on radar images, indicating part of the algal slick is likely above the sea surface, allowing a volumic backscattering.

Fig. 8 - S2 (01.06.2018) - Code 5 : continuous true colour. 2D view



Finally, the BAOAC code 5 for Continuous True Oil Colour is related to the thicker oil slicks: : "*The last code in the BAOAC is Code 5 - Continuous True Oil Colour. Code 5 is defined by only a minimum thickness value of 200 microns. There is nomaximum thickness value for Code 5 since it is not possible by visual observation from above to estimate the thickness of oil layers above 200 microns. A spilled oil layer on water that is 0.5 mm thick will look, from the top, exactly the same as an oil layer that is several millimetres thick. The light is reflected from the top surface of the oil; this gives information about the colour and texture of the surface of the oil, but cannot give any direct information about the thickness of the oil layer.*"

Among the largest sargassum patches, which can occupy areas of several hectares, the difference between a brown centre and the green background that surrounds it is well marked. They are usually surrounded by lesser algal slicks shown above and there seems to be no difference in aspect for larger of thicker sargassum patches than this among the images studied in the framework this story.