Title	**The correction of the adjacency effects**
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Executive summary:

This report describes the correction of the adjacency effect on MERIS based on the use of the ICOL software in BEAM and the validation exercise conducted on the MERMAID data base. A specific attention was brought to the MUMM data collected in the North Sea.

Acronyms

AERONET	AErosol RObotic NETwork
ALM	Almucantar
AOT	Aerosol Optical Thickness
APF	Aerosol Phase Function
BOA	Bottom Of Atmosphere
IOP	Inherent Optical Properties
IOPA	Inherent Optical Properties of Aerosols
LUT	Look Up Table
MERIS	MEdium Resolution Imaging Spectrometer
NIR	Near-Infrared
PPL	Principal PLane
RMS	Root Mean Square error
SAM	Standard Aerosol Model
TOA	Top Of Atmosphere

Symbols

α	Angström Coefficient
Θ	Scattering angle
τ	Optical thickness
ϖ_0	Single scattering albedo
$P(\Theta)$	Phase function
λ	Wavelength
m	Real part of the refractive index

1) Introduction

The eutrophication is more important close to the coast line. When in the vicinity of the coast line, the ocean colour from space is contaminated by the presence of land. The visual effect is to reduce the contrast between land and ocean. Therefore, the determination of the chlorophyll a concentration is biased by this so-called adjacency effect.

Under an ESA contract and in the frame of the MERIS ocean colour mission; ADRINORD proposed an algorithm to correct from this adjacency effect and a German company (Brockman Consult) implemented for MERIS this algorithm in the BEAM image processor. MERIS was at that time a key sensor for the observation of the ocean colour because of it good spatial resolution (300 m). Also, PML and ADRINORD are involved in an ESA project (Coast Colour) and this project facilitates the access to the MERIS FR (full resolution) of 300 mm.

The objective here is to evaluate the performance of the ICOL processor in the frame of the improvement of the atmospheric correction in the coastal waters near the coast line. The reference satellite sensor is MERIS. ICOL is here the reference tool to improve the contrast between water and land.

A qualitative approach relies on a good understanding of the effect of ICOL both on the radiometry (Level 1) and on the geophysical products (Level 2). Section 2 will address this qualitative approach over the 2Seas region using ICOL to produce L1 images and then BEAM to generate L2 products.

A quantitative approach relies on in situ data measurements. MERMAID is the reference data base for MERIS matchups, and in section 3, we will select the data at MERIS matchups and explain how to select the "good" MERIS data.

The clear limitation of ICOL is that ICOL returns L1 products after the adjacency effectcorrection. In the BEAM environment, we can go further with the L2 algorithms implemented in BEAM. For the ocean colour, it is the case 2 regional algorithm (Doerffer,). Therefore a first evaluation of ICOL is done in the BEAM environment in section 3.

Thanks to ESA, ADRINORD and BC were also associated to evaluate ICOL to produce a new L1 and ODESA which is the official ESA processor. This opportunity is evaluated in section 4.

2) ICOL: principle and qualitative results

2.1) The ICOL formalism

As illustrated in figure 1, the adjacency effect resulting from the land vicinity is made of two extreme types of reflection which are then scattered towards the sensor. For the Lambertian term, the source is isotropic and the atmospheric scattering involves a diffuse transmittance. For the Fresnel term, when the sun is over water, we have a specular reflection of the direct sun beam, which scatters in a specific angle. This term is included in the formalism of the path radiance in the standard atmospheric correction scheme. When the sun is above land, as in figure 1b, this coupling between Fresnel reflection and atmospheric scattering is partially masked by the presence of land. In the NIR, the land is much more reflective than the water and its vicinity results in more photons. Conversely, when the sun is over land, the coupling reflection-scattering is reduced.

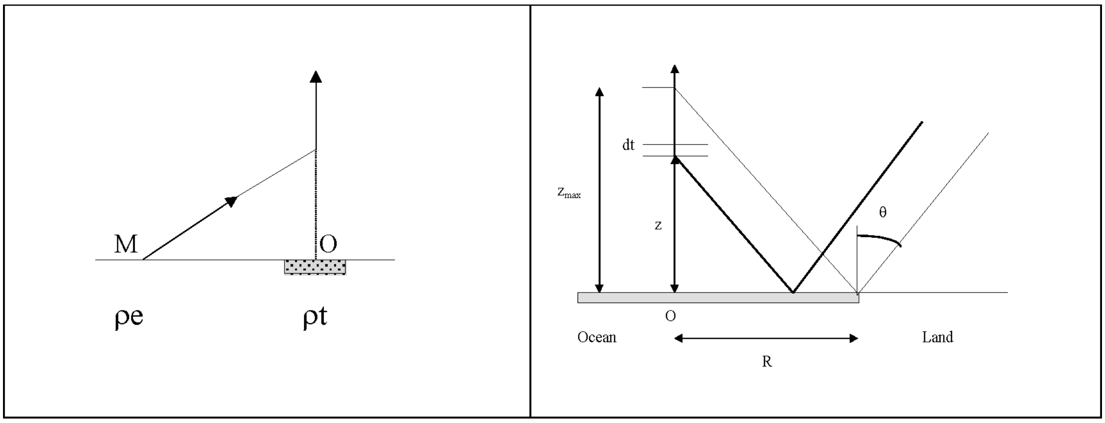


Figure 1: *The traditional adjacency effect with the Lambertian reflection couples to forward scattering (left); and the land mask for the Fresnel reflection (right).*

The two effects are modelled both for the Rayleigh scattering and the aerosol scattering. For the Fresnel, the driven parameter is the distance of the coast line from the view pixel, being computed in the principal plane. For the Lambertian AE, the role of the surface is computed from the TOA radiance image.

The introduction of the finite bright clouds follows the same scheme. The Lambertian adjacency effect is computed for the clouds assumed to be a Lambertian reflector located at the top of the cloud. The Fresnel mask is also applied to the clouds.

The key parameter is the aerosol model which is remotely sensed as described in figure 2. Three MERIS spectral bands are used (B9, B12 and B13) to derive 2 aerosol parameters (the AOT at 865 nm and the Angstroem coefficient between 778 nm and 865 nm) and the NIR water reflectance at 708 nm as side information for case 2 water.

The external loop on the NIR water reflectance starts with the case 1 dark water. The traditional double loop B12-B13 allows the retrieval of the aerosol model. If the MERIS TOA in B9 is above the predicted value, then the water reflectance is incremented.

The level 1C processor can skip the two aerosol modules to generate the level 1C_RAY.

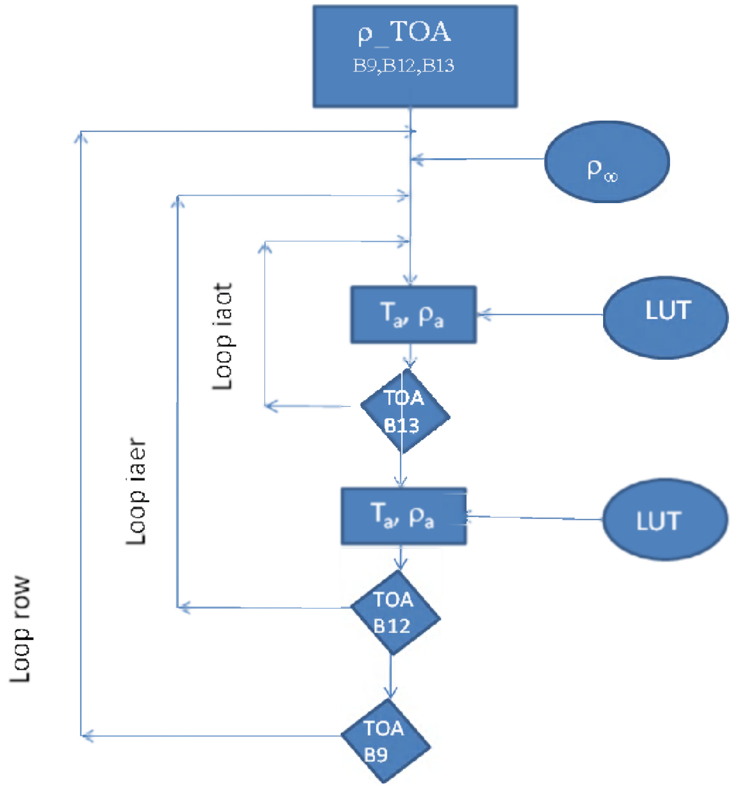


Figure 2: *Flow chart of the ICOL aerosol retrieval*

2.2 The ICOL additional indicators

It was recommended to add indicators of the effects of the land and of clouds on ICOL. Starting with a binary flag for land (LF) and cloud (CF), they are defined as the convolution of the flag matrix with the adjacency effect weighting matrix:

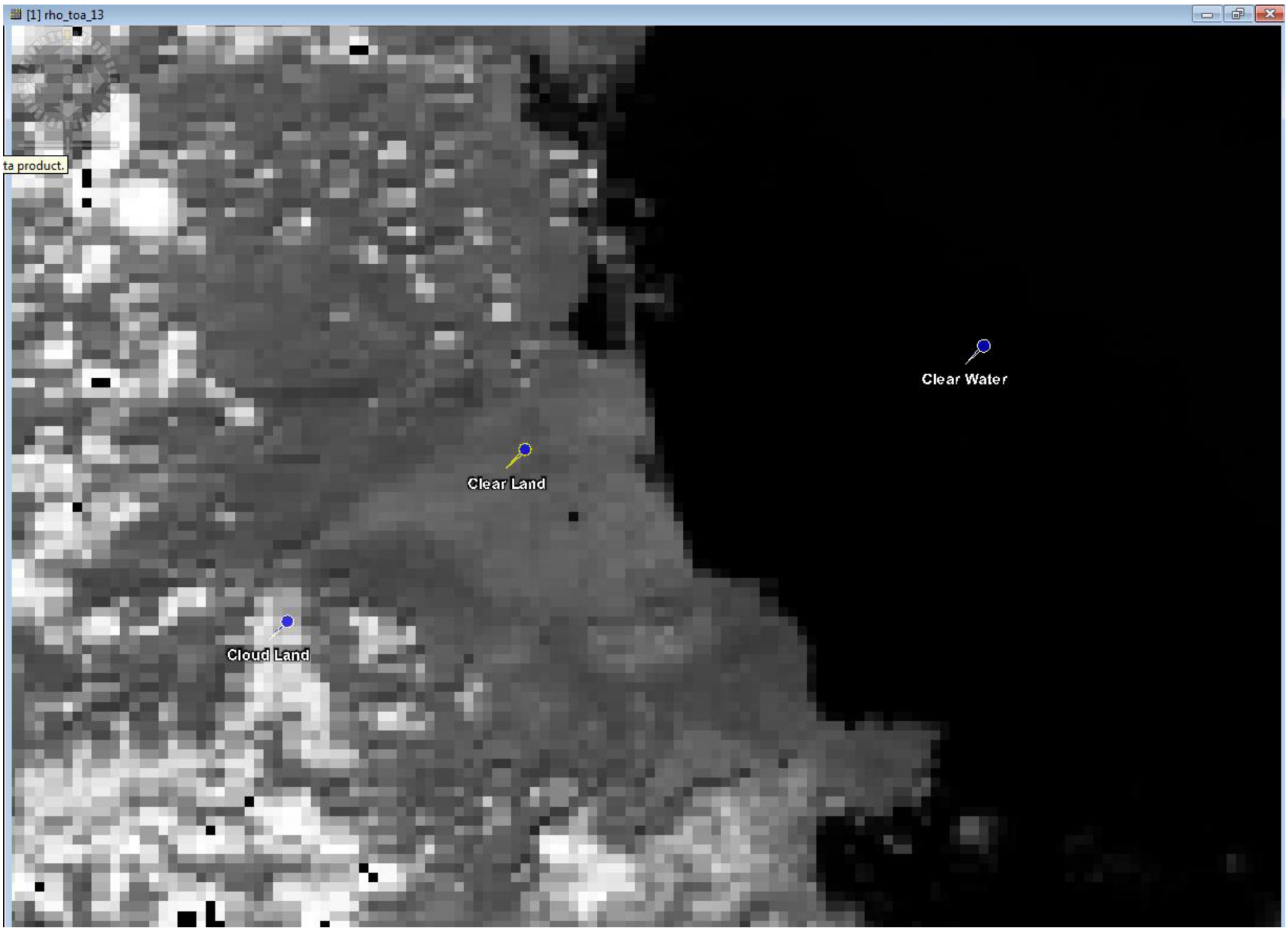
$$< LF_R > = \widetilde{LF} \otimes \widetilde{W}_R \quad (1)$$

$$< LF_a > = \widetilde{LF} \otimes \widetilde{W}_a \quad (2)$$

$$< CF_R > = \widetilde{CF} \otimes \widetilde{W}_R \quad (3)$$

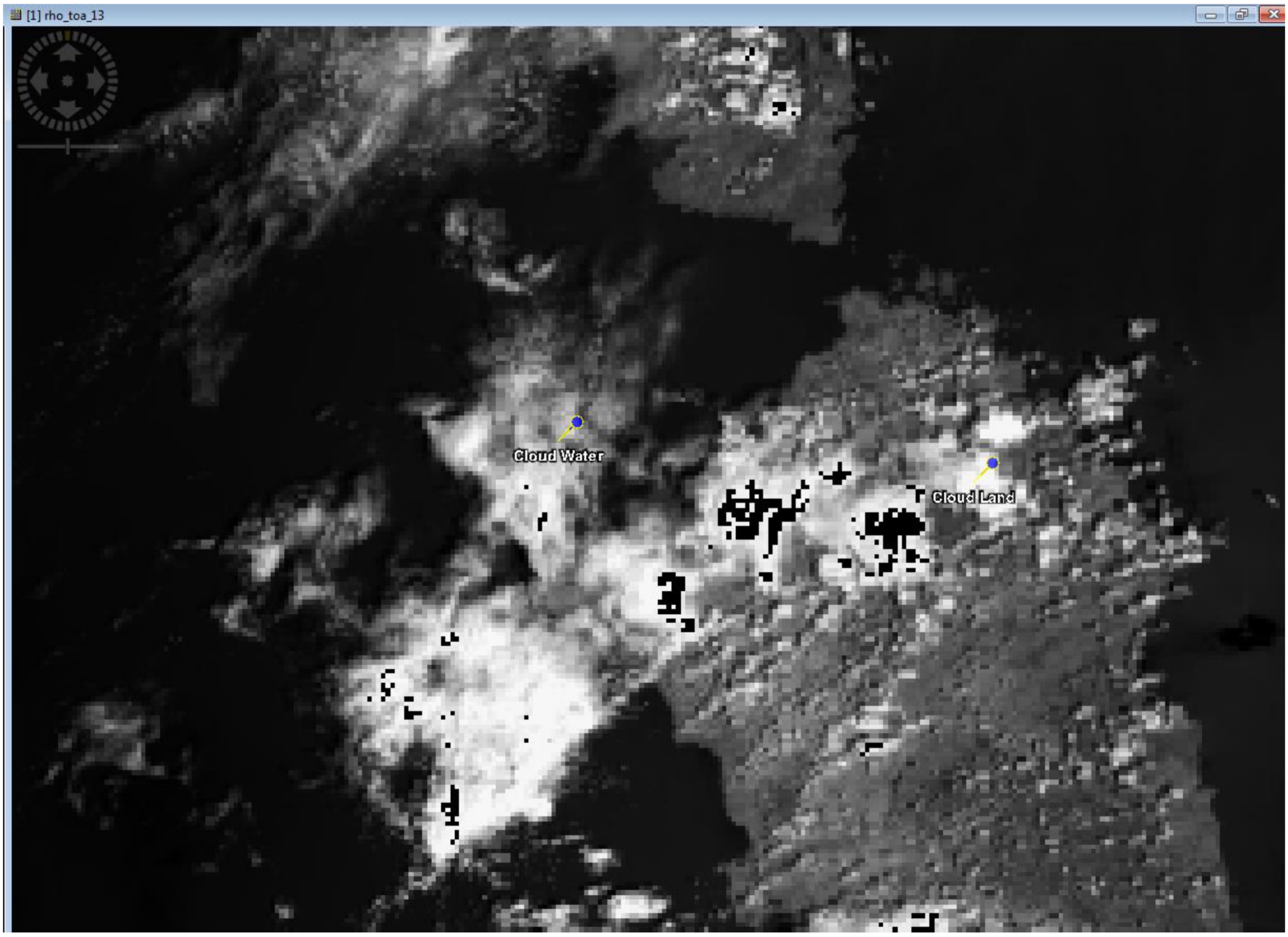
$$< CF_a > = \widetilde{CF} \otimes \widetilde{W}_a \quad (4)$$

These indicators have values between 0 and 1. The range of the Rayleigh adjacency effectis 30 kilometres: when a pixel is offshore by 30 km from the coastline, $< LF_R >$ is equal to zero. For the aerosols, the adjacency effect range is 10 km. Figures 3 to 5 illustrate the different indicators. The location of the pins corresponds to specific conditions: full land, open ocean, full cloudy region...



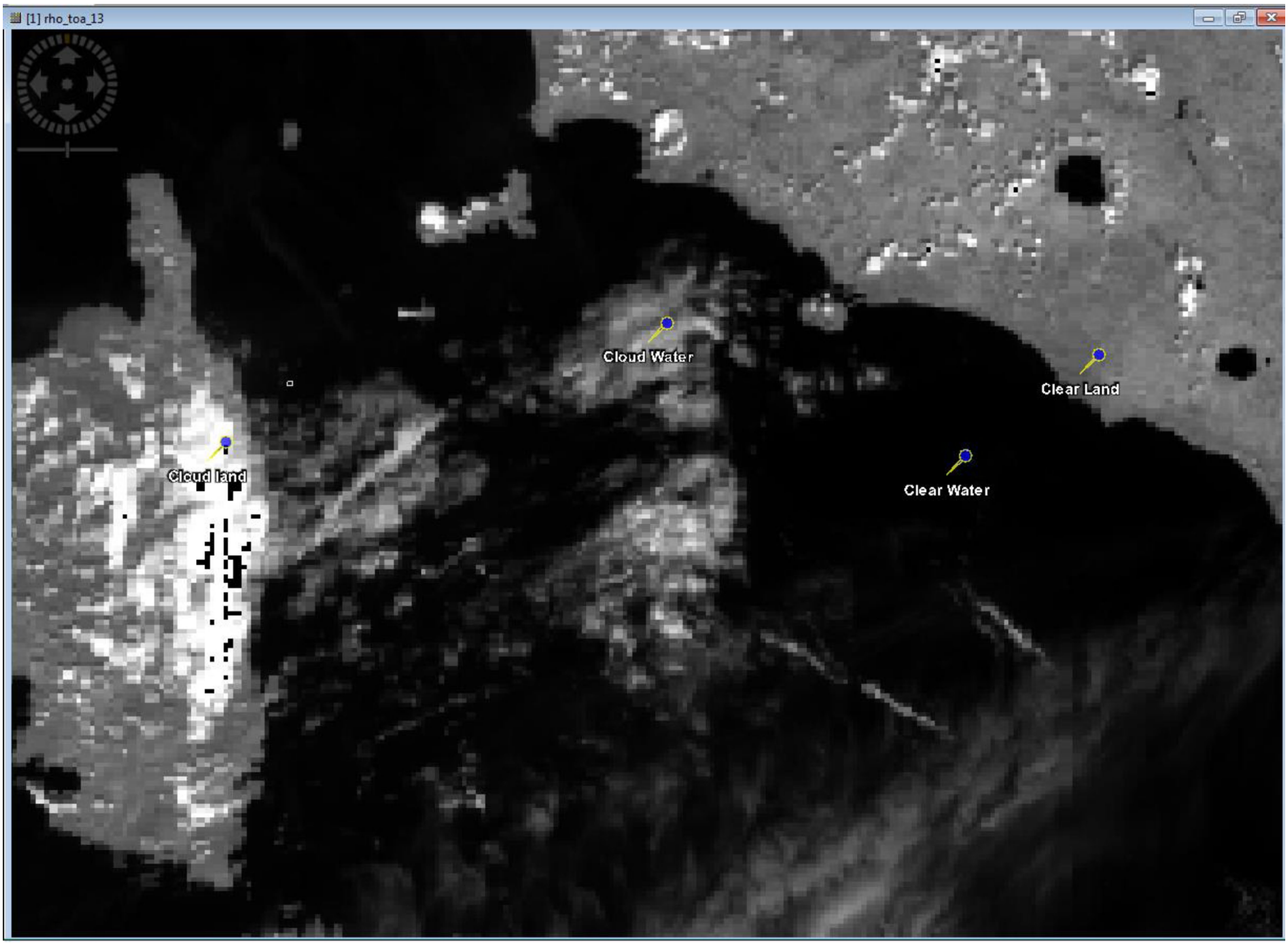
X	Y	Lon	Lat	Label	land_flag_ray_conv	cloud_flag_ray_conv	land_flag_aer_conv	cloud_flag_aer_conv
257.5	964.5	2.8333108	42.699966	Clear Land	0.9605592	0.012074418	0.9996473	3.51E-04
305.5	953.5	3.4622583	42.71962	Clear Water	0	0	0	0
232.5	982.5	2.4702988	42.561367	Cloud Land	0.9976201	0.55009574	0.9996473	0.84997135

Figure 3: *Illustration of the ICOL flags (MER_RR_20020505_100159)*



X	Y	Lon	Lat	Label	land_flag_ray_conv	cloud_flag_ray_conv	land_flag_aer_conv	cloud_flag_aer_conv
724.5	1020.5	8.328384	41.08001	Cloud Water	0.15838723	0.9386202	0.67541015	0.9999988
814.5	1029.5	9.361796	40.755817	Cloud Land	0.9933154	0.7788171	0.9999988	0.9762566

Figure 4: *Illustration of the ICOL flags (MER_RR_20020505_100159)*



X	Y	Lon	Lat	Label	land_flag_ray_conv	cloud_flag_ray_conv	land_flag_aer_conv	cloud_flag_aer_conv
351.5	847.5	11.798956	42.169216	Clear Land	0.8173818	9.48E-04	0.9602064	0
257.5	840.5	10.661758	42.428673	Cloud Water	0.002462151	0.7967633	0	0.9964839
322.5	869.5	11.375153	42.00046	Clear Water	0	7.51E-04	0	0
161.5	866.5	9.399786	42.338196	Cloud land	0.9270559	0.8231097	0.99939734	0.9980996

Figure 5: *Illustration of the ICOL flags (MER_RR_20020506_093048)*

2.3 Illustration of the ICOL aerosol product

We selected the MERIS image shown in figure 6 (23 April 2003). On this RGB image, we can first identify the presence of cirrus clouds over the Straight of Dover. Conversely to MEGS8.0, these cirrus clouds are not flagged as clouds in BEAM. We also see the plume of the Thames River with a Northern drift. The Flanders coast appears even more turbid.

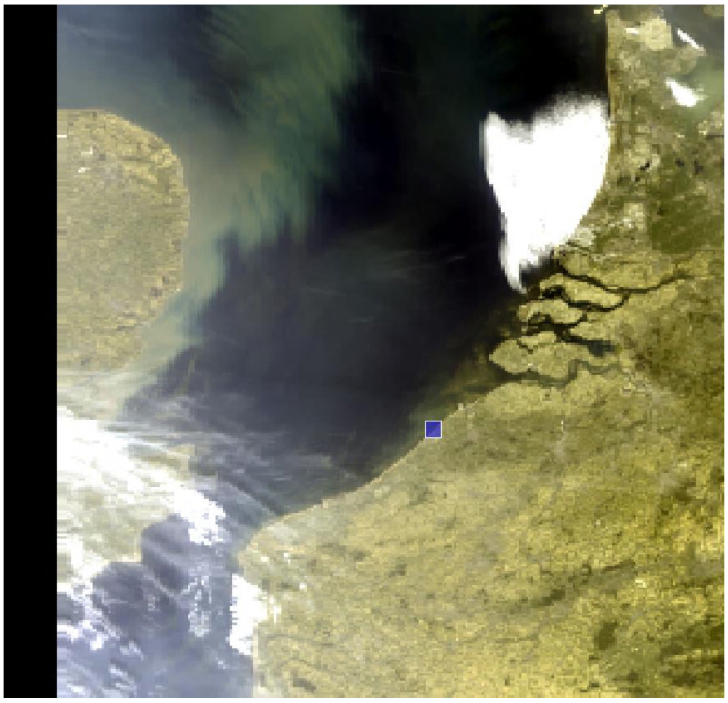
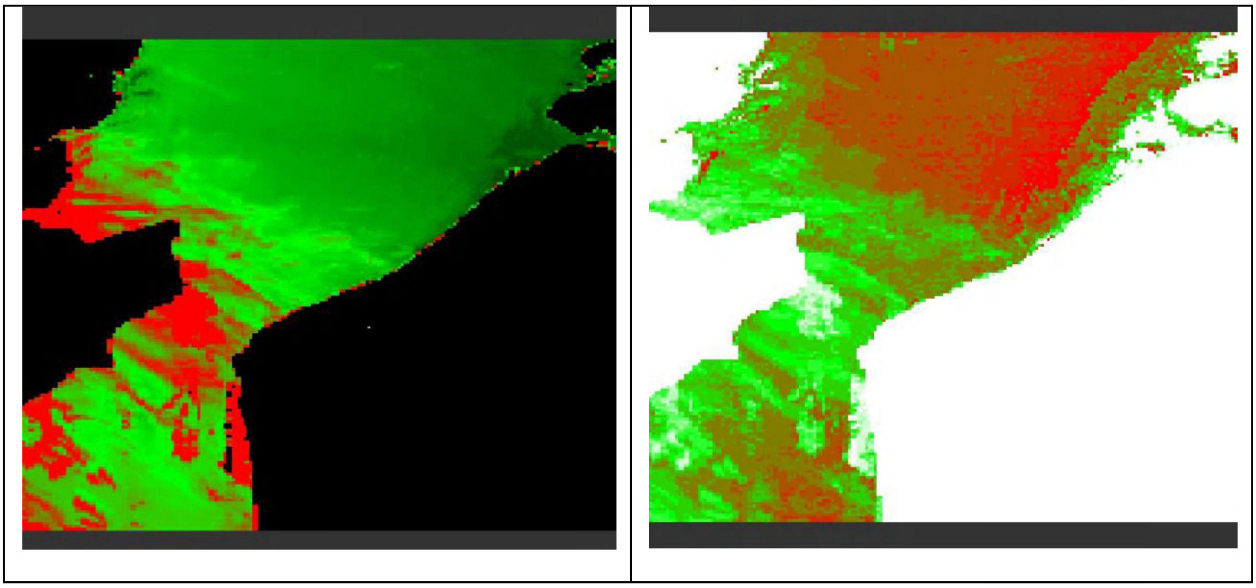


Figure 6: *MERIS RGB image over the Straights of Dover collected on* 2003/04/23

The aerosol product retrieved from ICOL is shown in figure 7. The AOT is artificially higher above the cirrus clouds, and the Angstroem coefficient reveals whiter aerosols. Along the French coast line, there is no artificial gradient on the aerosol product. Over the sediment plume of the Thames River, the aerosol layer appears homogeneous in abundance (AOT) and nature (Angstroem coefficient). Clearly, the case 2 is correctly accounted for in the ICOL aerosol retrieval. The situation is less favourable along the Netherlands' coast where ICOL is overestimating the NIR water reflectance leading to smaller AOT. AERONET in Oostende observed a value of AOT_870=0.12 with □=1.25. The plumes of the Rheine and Escaut Rivers are very turbid; certainly the NIR water reflectance values need to be refined and slightly decreased.



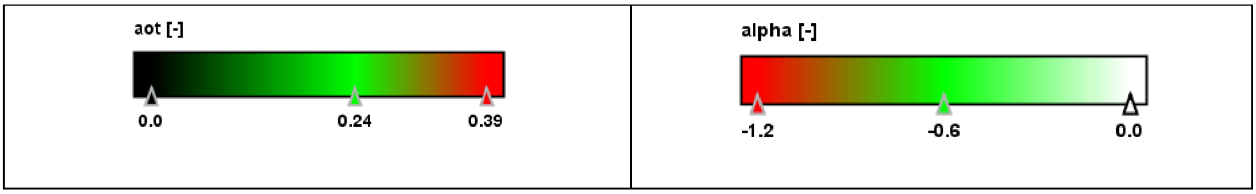


Figure 7*: AOT at 865 nm (left); and Angstroem coefficient (right).*

2.5 The Illustration of the ICOL impact on the L2 BEAM products

We now use the BEAM C2R algorithm with and without data processed with ICOL. The first outputs from the C2R algorithm are the TOA and BOA (water) values of the reflectance. Figure 8 shows the relative difference when using ICOL or not. On the TOA, ICOL reduces substantially the TOA reflectance in B12 and B13. We do not have to consider B10 and B11 which are corrected from the AE. In the visible, the contrast between water and land becomes smaller and the positive correction by ICOL mostly results from the land Fresnel mask. The ICOL correction increases the water reflectance. An expected result of a traditional atmospheric correction is to increase the water reflectance; when starting from the same TOA we introduce with ICOL less aerosols.

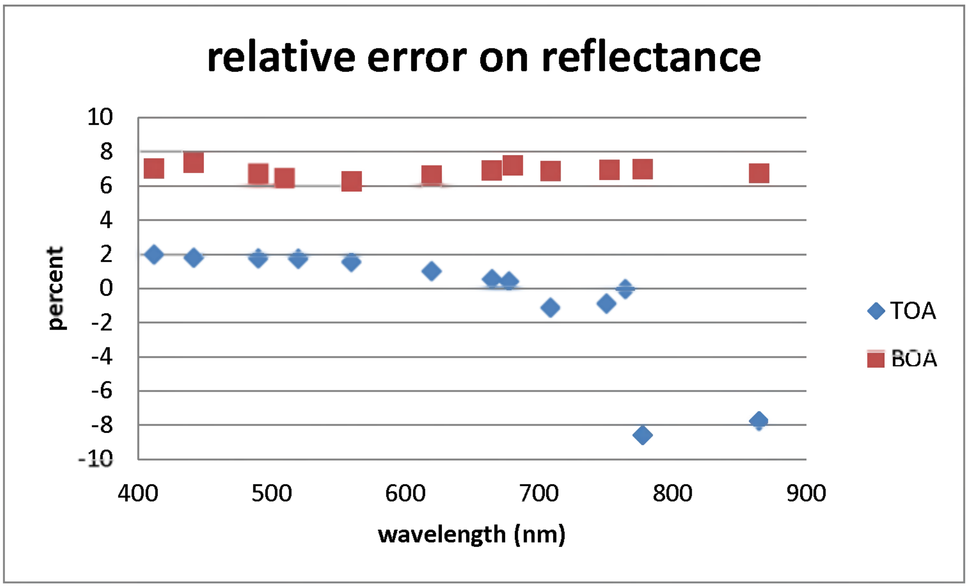


Figure 8*: Relative difference on the retrieved reflectance with and without ICOL adjacency effectcorrection.*

Figure 9 shows a comparison on the water reflectance between:

(i) The Beam C2R with and without ICOL

(ii) The MEGS8.0

(iii) The in situ measurements collected by MUMM as available in MERMAID

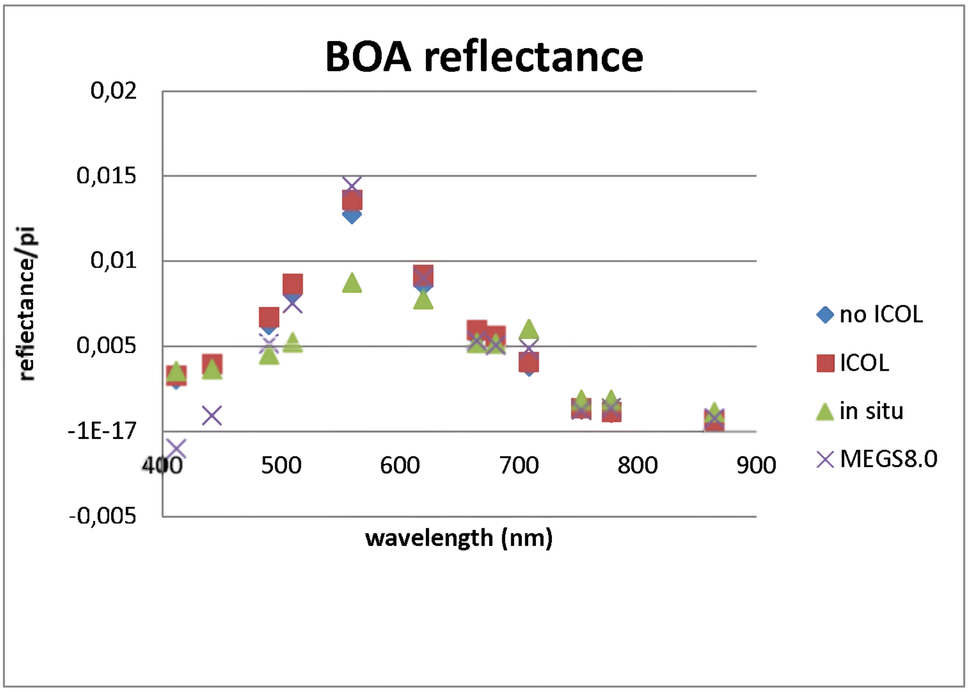


Figure 9: *Water reflectance measured on April 23, 2003 by MUMM and derived values from MERIS.*

C2R appears robust to the adjacency effect in this case, certainly because the aerosol retrieval is mostly based on the use of the visible MERIS spectral bands where the adjacency effects are small. Conversely, MEGS overestimates the atmospheric correction in the blue because of the overestimation of the AOT.

In order to get a full picture of the effect of ICOL, we first retrieved the ratio on the water leaving radiance as an output of the C2R, where again ICOL is applied or not (figure 10). Along the coastline, the use of ICOL implies a slight increase of the water reflectance as already shown in figure 9. The impact of the clouds goes the other way round, but a detailed analysis is required for a better understanding of this effect.

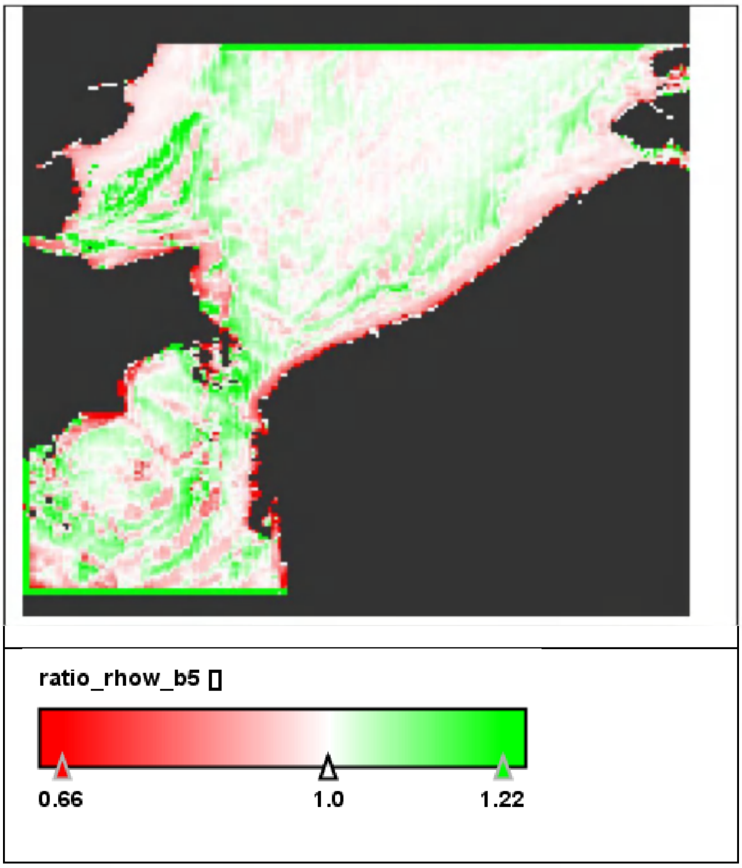


Figure 10: *Ratio Rhow_B5 with and without ICOL adjacency effectcorrection*

Because the C2R water reflectance spectra are very close to the in situ window (no matter if using ICOL or not), the influence of ICOL on these water products is small as indicated in table 1.

	a_gelbstoff	a_pig	a_total	b_tsm	tsm	chl_conc
no ICOL	0.576	0.459	1.035	4.539	7.852	9.337
ICOL	0.578	0.455	1.033	4.791	8.288	9.255
percent	0.4	-0.8	-0.2	5.3	5.3	-0.9

Table 1: *The C2R in water products at the location of the in situ measurements with and with ICOL. The relative difference, (with-without)/with, is reported in the last line*

On the full image (figure 11), the impact of ICOL is noticeable in both the chlorophyll-a content and in the TSM. It is mostly the case on the Southern coast of England, when the Fresnel masks does not make any effect and therefore does not counterbalance the traditional adjacency effect.

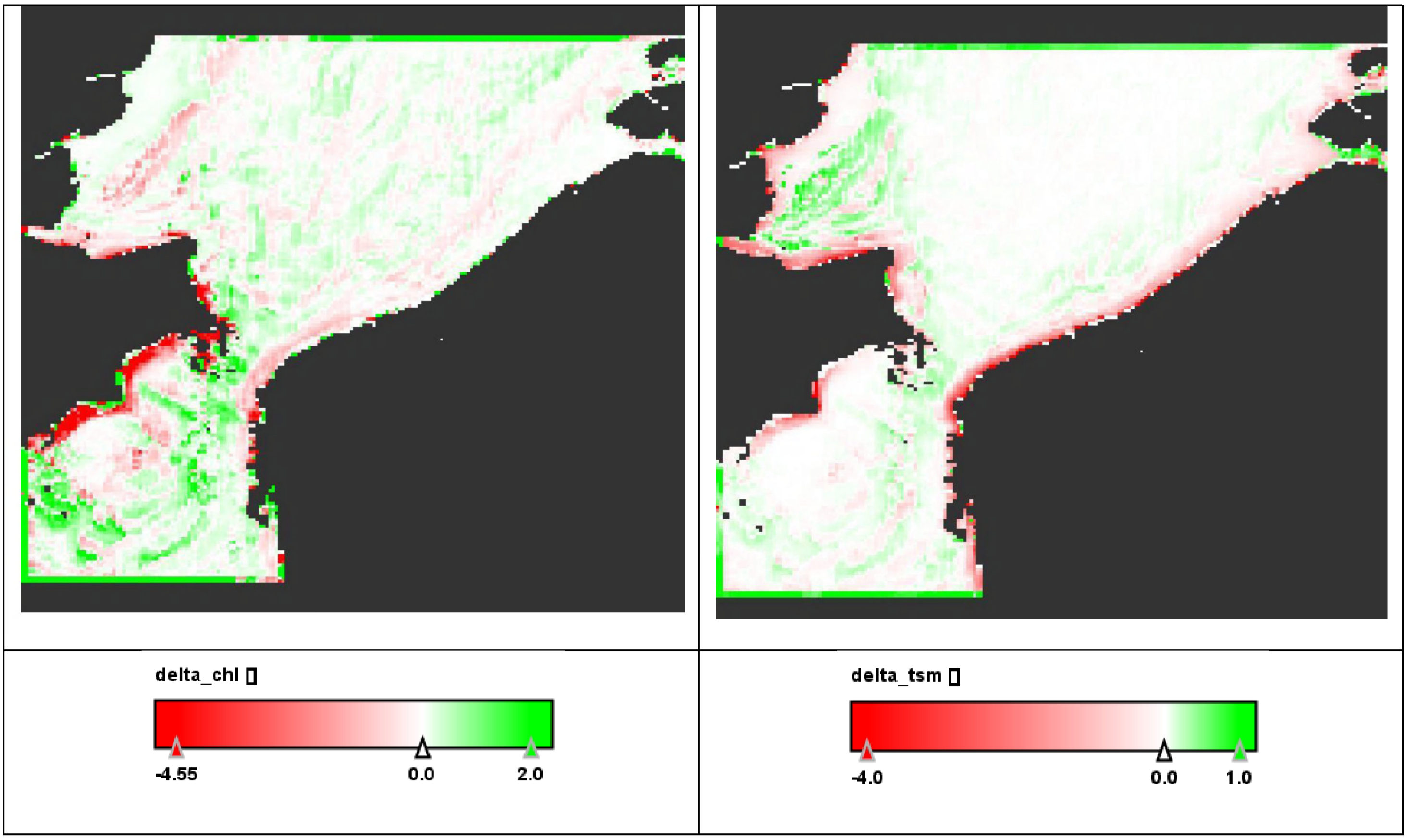


Figure 11*: Difference (without ICOL-with ICOL) in chlorophyll_a (left) and tsm (right)*

3) The 2 Seas data base

3.1) Selection of the matchups based on MERMAID and MEGS8.0

Table 2 reports the configuration parameters we used to select the MERMAID data. On a window of 5*5 RR pixel we accept a tolerance of half of the pixels flagged as clouds, ice_haze, white scatters, high glint and medium glint. We know that for those pixels, ICOL will not correctly work.

userSite	EastEngChannel	MUMMTriOS			
Period	20020409	20101231	*		
userDiffTime	3				
userSize	5				
userThetasMax	60				
userScatteringAngleMax	180				
userWindMax	9				
userFlagAcceptance	50				
LAND	CLOUD	ICE_HAZE	W_SCATTERE	HIGH_GLINT	MEDIUM_GLI

Table 2: MERMAID configuration parameters

We also have another criteria based on the use of the RGB images as enclosed in annex 1. At the end, we have 17 images from clear sky (Good) to cloudy but not fully, see table 2. The distance D between the in situ location and the centre of the MERIS window is added. Clearly the extraction window is correctly located:

MERMAID date	Comments from RGB	insitu lat	lon	D
20030423T082400Z	Good	51.27	2.90	0.13672
20030423T100200Z		51.31	2.85	0.61426
20030616T101800Z	Good	51.37	3.06	0.66568
20030616T120500Z		51.27	2.91	0.38574
20030806T094000Z	Good	51.28	2.89	0.72
20030806T101000Z		51.31	2.85	0.55
20030806T105000Z		51.34	2.84	0.77
20050427T124300Z	Good with clouds over	51.85	2.87	0.69764
20050427T101700Z		51.58	2.79	0.32997
20050427T072800Z		51.48	2.45	0.30443
20050607T101200Z	Clouds at coast	50.62	1.26	0.31477
20050719T111400Z	clouds	51.32	2.86	0.52558
20050719T101200Z		51.27	2.91	0.52049
20060713T101400Z	Good	51.27	2.90	0.54661
20060713T125400Z		51.31	2.85	0.70569
20060918T103100Z	Good	51.39	3.32	0.56905
20060921T082500Z	Good	51.79	1.87	0.59972
20060921T101100Z		51.85	1.64	0.54066
20060921T122800Z		51.92	1.36	0.30832
20070918T103700Z	Cloudy	51.30	2.58	0.43259
20070918T091300Z		51.26	2.47	0.62347
20070918T130200Z		51.17	2.67	0.6389
20070919T105300Z	Clouds	51.42	3.57	0.32864
20080425T101900Z	Clouds	51.38	3.22	0.80721
20080909T102000Z	Good	51.56	2.69	0.13047
20080909T112100Z		51.64	2.56	0.76106
20080909T081000Z		51.31	2.85	0.73632
20080909T091000Z		51.42	2.81	0.23699
20090616T124400Z	Haze	51.37	3.73	0.72603
20100421T075600Z	Cloudy over land	51.72	2.11	0.60086
20100421T100600Z		51.79	1.90	0.34554

Table 3: MERIS matchups with the date, the general aspect of the sky over the in situ point, the lat-lon of the measurements and the distance (km) between in situ and window centre

3.2) Selection of the matchups based on MERMAID and ICOL

We now use the4 ICOL indicators. The two adjacency effect indicators, AE_Ray_land and AE_aer_land quantify crudely the importance of the contamination by the vicinity of land. The larger they are and the better it is to evaluate the ICOL correction. AE_Ray_cloud and AE_aer_cloud quantify crudely the importance of the contamination by the vicinity of clouds. ICOL attempts to include the adjacency effect correction by the bright clouds. This correction relies on the MEGS cloud flag which is also raised in presence of cirrus clouds for which ICOL is not designed. Therefore, our study will rely on the absence of clouds in the pixel vicinity. It is also consistent with SIMEC which does not account for the clouds.

3.3) Evaluation

The traditional way to use the L1 data is to process the atmospheric correction on all the non cloudy, no ice-haze, no white scatters pixels. Because ICOL is not working on sunglint, we also exclude medium and high sunglint.

After MEGS8.0 L2 processing, we have the L2 product on the RR pixels. The adjacency effects produce an artificial spatial heterogeneity: increase of the AOT close to the coast line which results in an over correction of the atmosphere.

For massive processing, we need to average on the window; that is the MERMAID approach with the averaged file. We do not filter with the L2 AC flags because we want to see the evolution when applying ICOL. It will be useful as well to have the dispersion of the L2 parameters in the window. If the ocean-atmosphere system is homogeneous (may be we need to go to 3*3 pixels), then we have an indicator on the reduction of the adjacency effect through a better spatial homogeneity. If the ocean-atmosphere system is not homogeneous, it with be useful to also have the L1 and L2 for the in situ pixel.

Of course, from the MERMAID initial file, we can do by ourselves and produce the following:

(i) Table 4 with an atmospheric diagnostic on a flag (Fatm) as the sum of the land+cloud+ice_haze+white_scatters+medium_glint+high_glint flags. In this case on May 16, 2003, the sky was clean. The aerosols were quite homogeneous.

(ii) Table 5 gives the water reflectance, also reported in figure 12. The averaged value is done where the PCD_13 is not raised. The spatial dispersion gives an indication if we can use or not this average value to compare to in situ. The same indication is given by the value for the pixel corresponding to the in situ. The selection criteria can be a relative dispersion of less than 10 percent at 560nm and a difference less than one sigma between the mean and the central.

	AOT_B13	alpha	Fatm
mean	0.18	1.72	0
sigma	0.04	0.19	0
central	0.21	1.54	0

Table 4: The aerosol product and the atmospheric flag

20030616T10	412	442	490	520	560	620	665	681	709
in situ	0.016	0.022	0.036	0.040	0.054	0.032	0.023	0.021	0.014
mean	0.004	0.013	0.032	0.040	0.057	0.033	0.023	0.022	0.015
central	0.007	0.016	0.035	0.043	0.061	0.038	0.026	0.024	0.017
sigma	0.0019	0.0019	0.0022	0.0036	0.0045	0.0035	0.0034	0.0029	0.0008

Table 5: The water reflectance values on June 16, 2003.

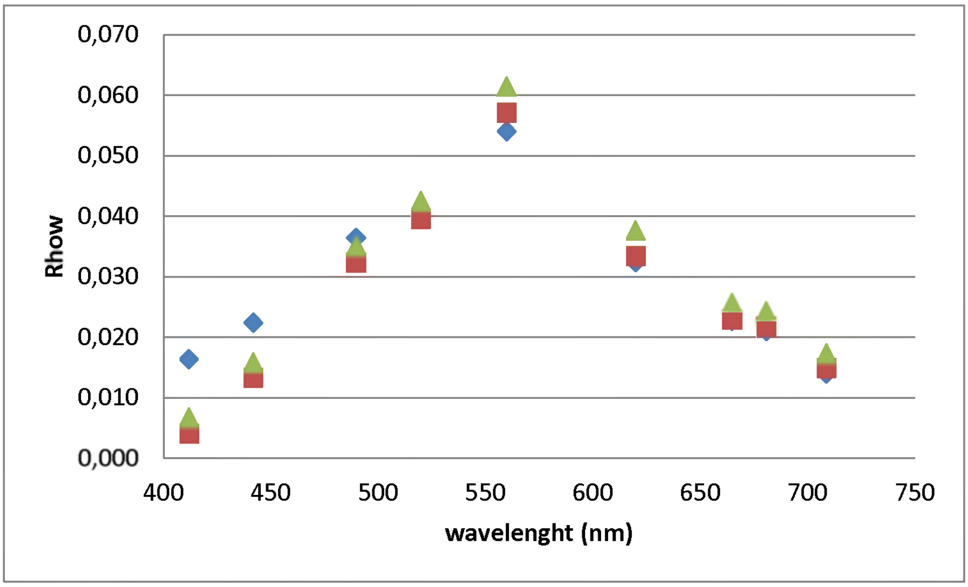


*Figure 12: spectral values of the water reflectance: in situ (blue diamond), at the closest MERIS pixel (green triangle) and averaged on the 5*5 pixel window.*

4) ICOL in MERMAID

4.1) Generation of the data base

In the frame of the MERIS validation, a study was conducted by Brockman and col. in order to investigate the impact of ICOL on the MERMAID data base. The operational scheme was:

(i) To select MERIS L1 RR over the MERMAID sites.

(ii) To process MEGS with ODESA

(iii) To process ICOL and return consolidated L1.

(iv) To do again (ii) after (iii).

(v) To generate a MERMAID like data base without and with ICOL.

A first set of data was delivered on December 21, 2011.

4.2) Analysis

In the series of MUMM measurements, some are very close to the coast line (about 4 km) as shown in figure 13.

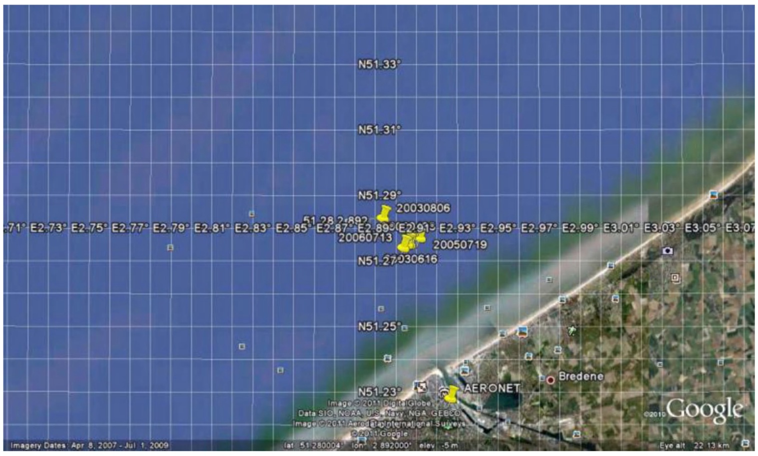


Figure 13: Google view of the Oostende AERONET site and of locations of the MUMM TRIOS measurements at sea.

Table 6 reports the ICOL indicators for the four MERMAID days. When having two in situ points on the same day, the aerosol model appears homogeneous and the turbidity decreases with the distance to the coast line. Looking closer to all ICOL outputs, there is still no explanation of what happened on July 19, 2005. First, Rayleigh adjacency effect correction was not activated despite the fact that the adjacency effect indicators for this day were very similar to the other days at the same points (see table 6). For the (51.27N, 2.91E) point, α is set to zero which is its lower limit and may correspond to an out of range point. A deeper investigation has to be conducted on this scene.

TIME_IS	Latitude	Longitude	land_ray	cloud_ray	land_aer	cloud_aer	alpha	aot	rhoW9
20030616T120500Z	51.27	2.91	0.196	0.000	0.042	0.000	0.80	0.133	0.031
	51.37	3.06	0.119	0.000	0.010	0.000	0.93	0.113	0.023
20050719T101200Z	51.28	2.91	0.209	0.017	0.046	0.001	0.00	0.077	0.044
	51.31	2.86	0.102	0.007	0.002	0.007	0.16	0.136	0.016
20060713T101400Z	51.27	2.91	0.208	0.000	0.044	0.000	0.20	0.079	0.036
20030806T101000Z	51.29	2.86	0.125	0.000	0.018	0.000	0.81	0.192	0.008

Table 6: The ICOL outputs for the MUMM data set

Figure 14 gives the relative correction of the adjacency effect on the TOA signal for May 16, 2003. In the NIR, because of the large land-water contrast, the Lambertian adjacency effect correction decreases the TOA signal both for the Rayleigh and for the aerosols. In the visible, it appears that the Fresnel adjacency effect correction brought up more photons.

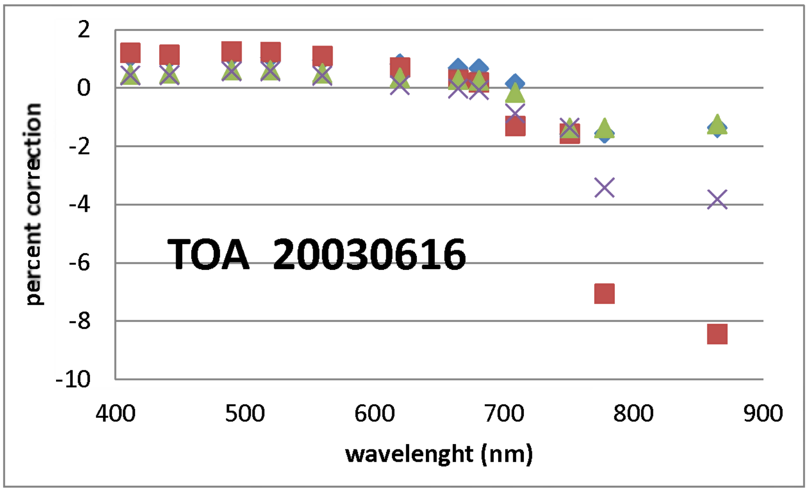
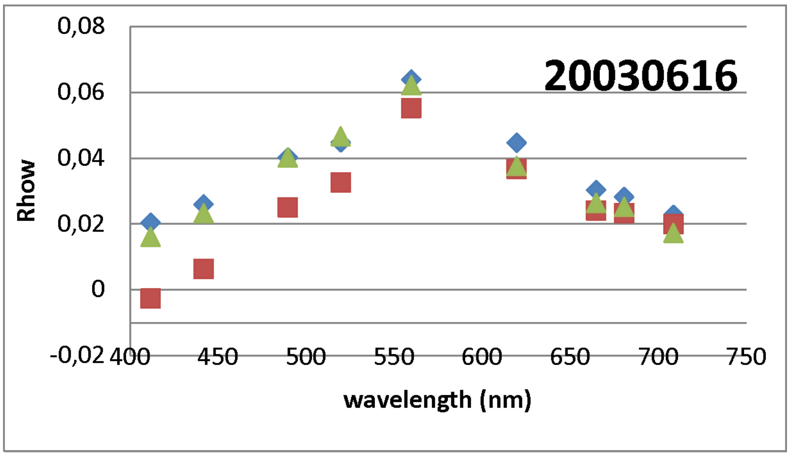


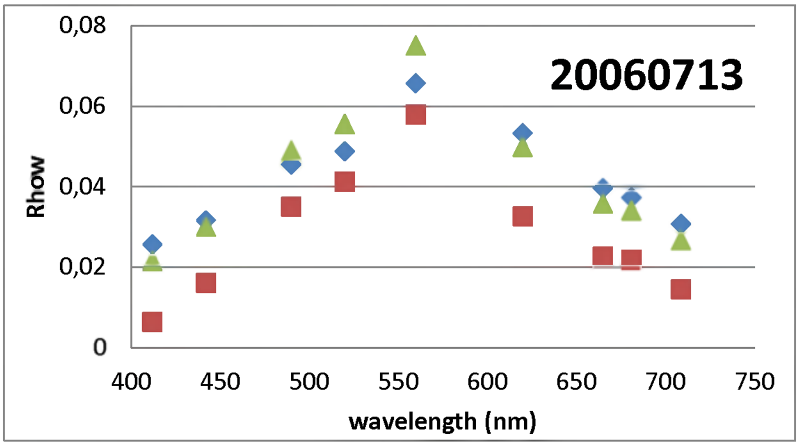
Figure 14: The adjacency effect correction by ICOL on the two in situ points collected on 06/16/2003 with:

(a) For (51.27N, 2.91E) the Rayleigh (blue diamond) and the total (Rayleigh+ aerosols) (red squares).

(b) For (51.37N, 3.06E) the Rayleigh (green triangles) and the total (Rayleigh+ aerosols) (violet crosses).

The water reflectance values are reported in figure 15. The ICOL correction is spectacular on June 16, 2003 and July 13, 2006 but not on August 6, 2003. Nevertheless, on that day, ICOL seems to work as expected (figure 16).





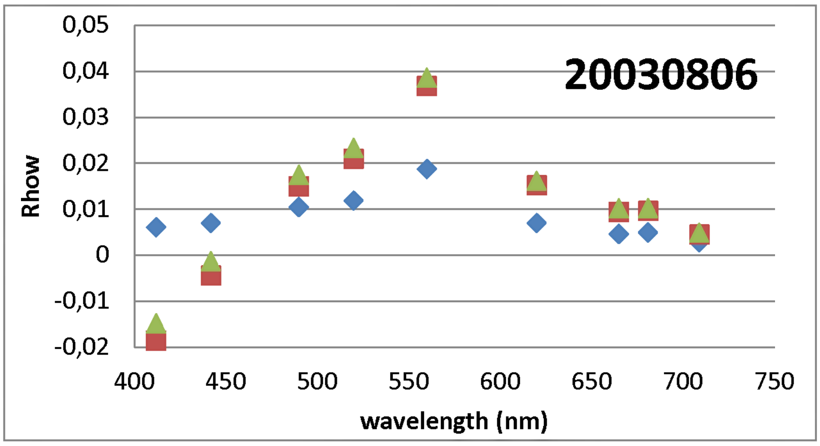


Figure 15: Spectral water reflectance values for three days at point (51.27N, 2.91E) from MEGS8.0 without red square) and with ICOL (green triangle) compared to MUMM in situ measurements (blue diamond).

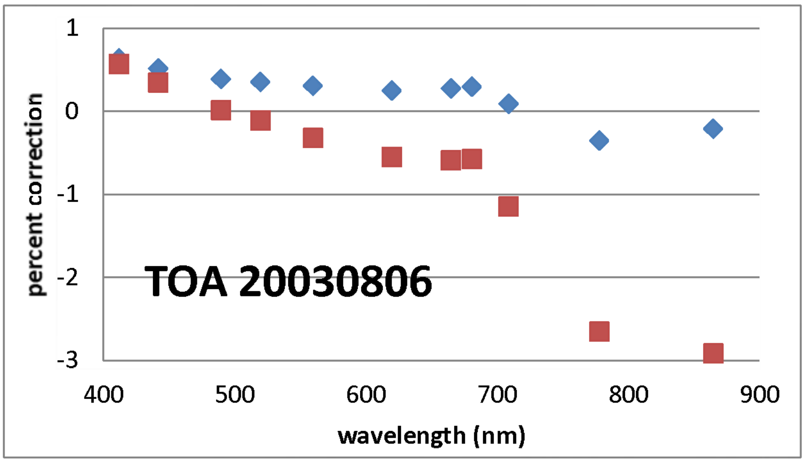


Figure 16: The adjacency effect correction by ICOL at (51.29N, 2.86E) on 08/06/2003 with the Rayleigh (blue crosses) and the total (Rayleigh+ aerosols) (red square).

For MEGS, PCD 13 and PCD 15 are raised which suggests that a problem occurred in the MEGS L2 algorithm. This is confirmed in table 7 where no Chl1 product (standard determination of Chla) was computed. What we see in table 7 is the ICOL impact on the L2 products, except, of course, for July 19th, 2005, where ICOL did not perform any correction. For the Neural Network, the impact of ICOL is not negligible on the Chla retrieval (column CHL2). We also tried to make a comparison with AERONET in Oostende. However, those results did not really provide further clarification as we can see in table 7.

						MEGS		AERONET		ICOL	
date		CHL1	CHL2	SPM	AOT_B5	AOT_B13	ALPHA	AOT_B13	ALPHA	AOT_B13	ALPHA
20030616	without	NA	11.1	13.5	0.467	0.260	1.48	0.16	1.83	0.133	0.80
	with	10.5	6.8	10.9	0.338	0.193	1.45				
20050719	without	12.0	8.7	21.0	0.190	0.133	0.92	0.06	0.09	0.136	0.16
	with	12.1	8.7	21.0	0.190	0.133	0.92				
20060713	without	13.7	5.4	9.8	0.248	0.112	2.01	0.12	1.62	0.079	0.20
	with	11.2	8.3	14.9	0.250	0.133	1.64				
20030806	without	NA	11.1	13.5	0.467	0.260	1.48	0.23	0.99	0.192	0.81
	with	NA	5.6	6.0	0.434	0.276	1.13				

Table 7: The L2 outputs for the MUMM data set with MEGS without and with ICOL, and for the AERONET and ICOL aerosol products.

5 Conclusion and perpectives

We did evaluate the performances of ICOL in the 2 Seas region on MERIS. On a qualitative basis, ICOL seems to do the job. Over clear coastal water, we see the atmosphere in the NIR. Without ICOL, we can notice an artificial increase of the signal when going close to the coast line. On the visual aspect, when applying ICOL this artificial increase disappears... what it is expected. On the L2 water products, clearly ICOL has an impact on the Chla retrieval.

It is much more difficult to evaluate the quantitative performances of ICOL simply because we have few in situ measurements. On the few cases we have, ICOL is doing the right job in the retrieval of the water reflectance when these values are not flagged by the atmospheric correction algorithm.

The next objective is an inter comparison exercice between ICOL and SIMEC we will conduct in a close collaboration with VITO.

The operational objective is to generate MERIS L2 products in FR combining the ICOL correction of the adjacency effect and the L2 processing proposed by BEAM. The outputs of the Coast Colour project should be used when available coming fall. It will consist in the BEAM environment:

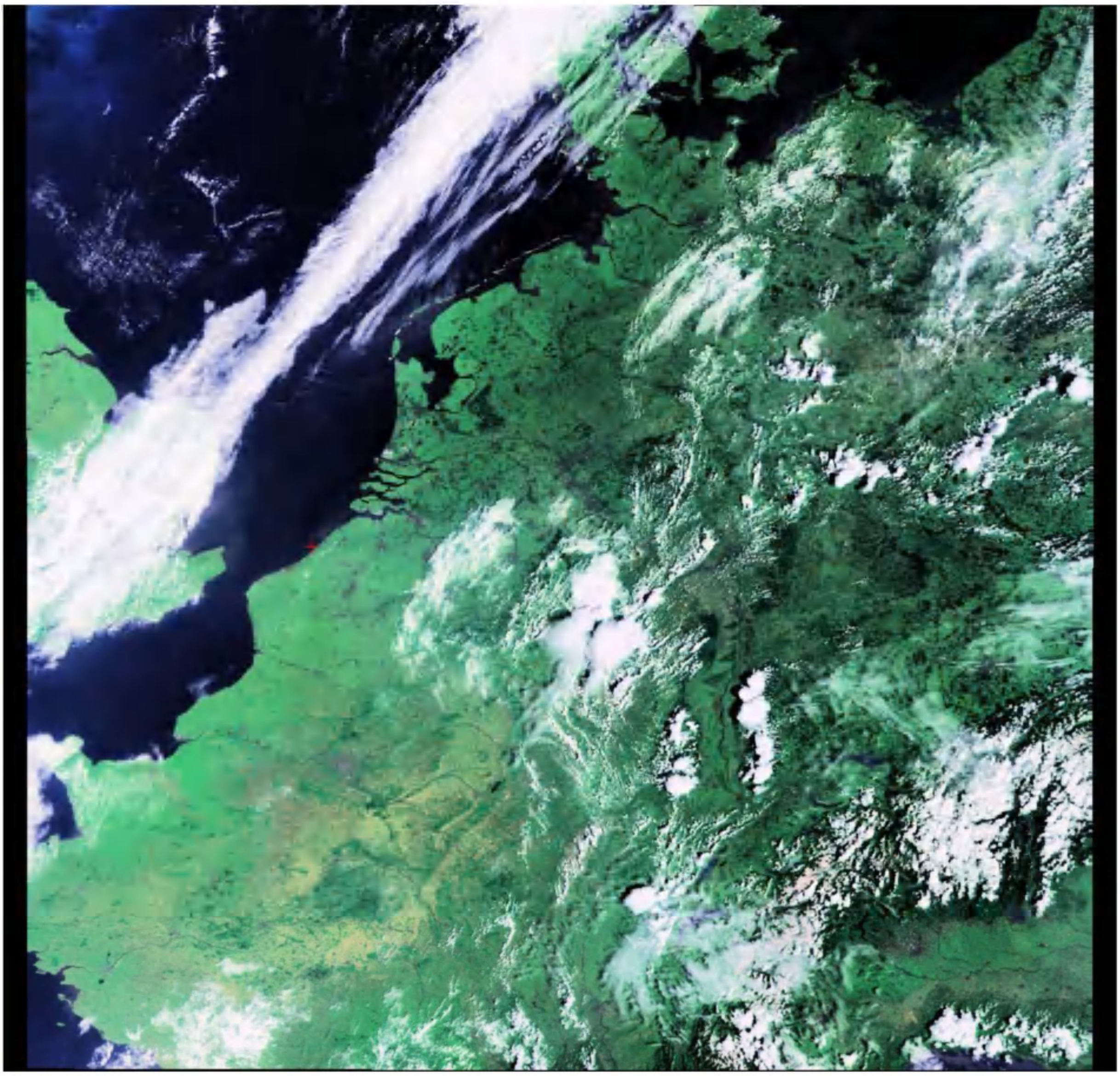
(i) To used the Coast Colour L1 product

(ii) To then apply ICOL

(iii) And finally to generate the Coast Colour L2 algorithm.

At minima, ADRINORD will describe this processing chain. At maxima, depending on the available resources, a systematic processing of the L1 FR of MERIS in the 2Seas area should be conducted by ADRINORD.

Annex 1: The 2Seas data base



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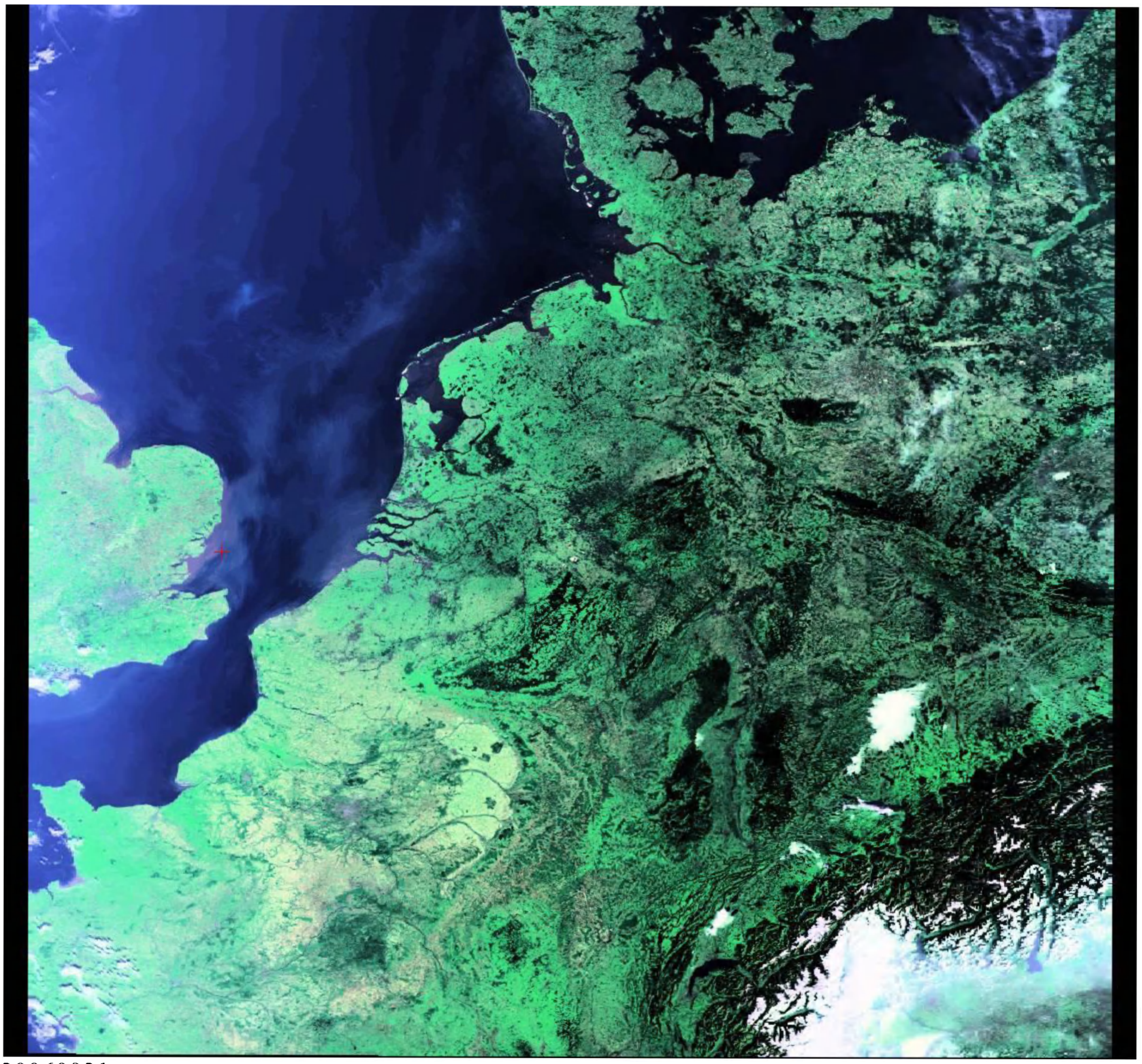

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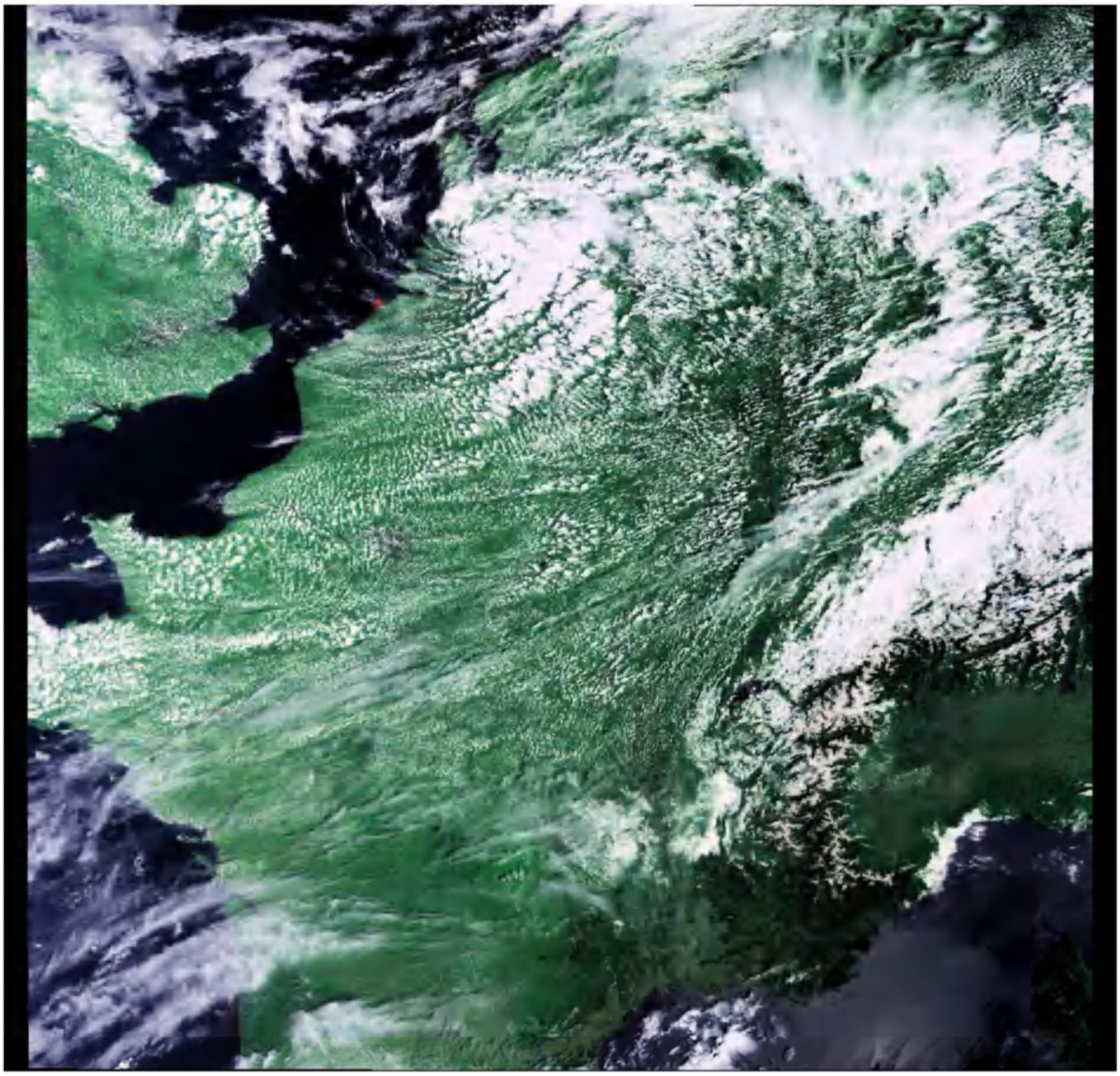
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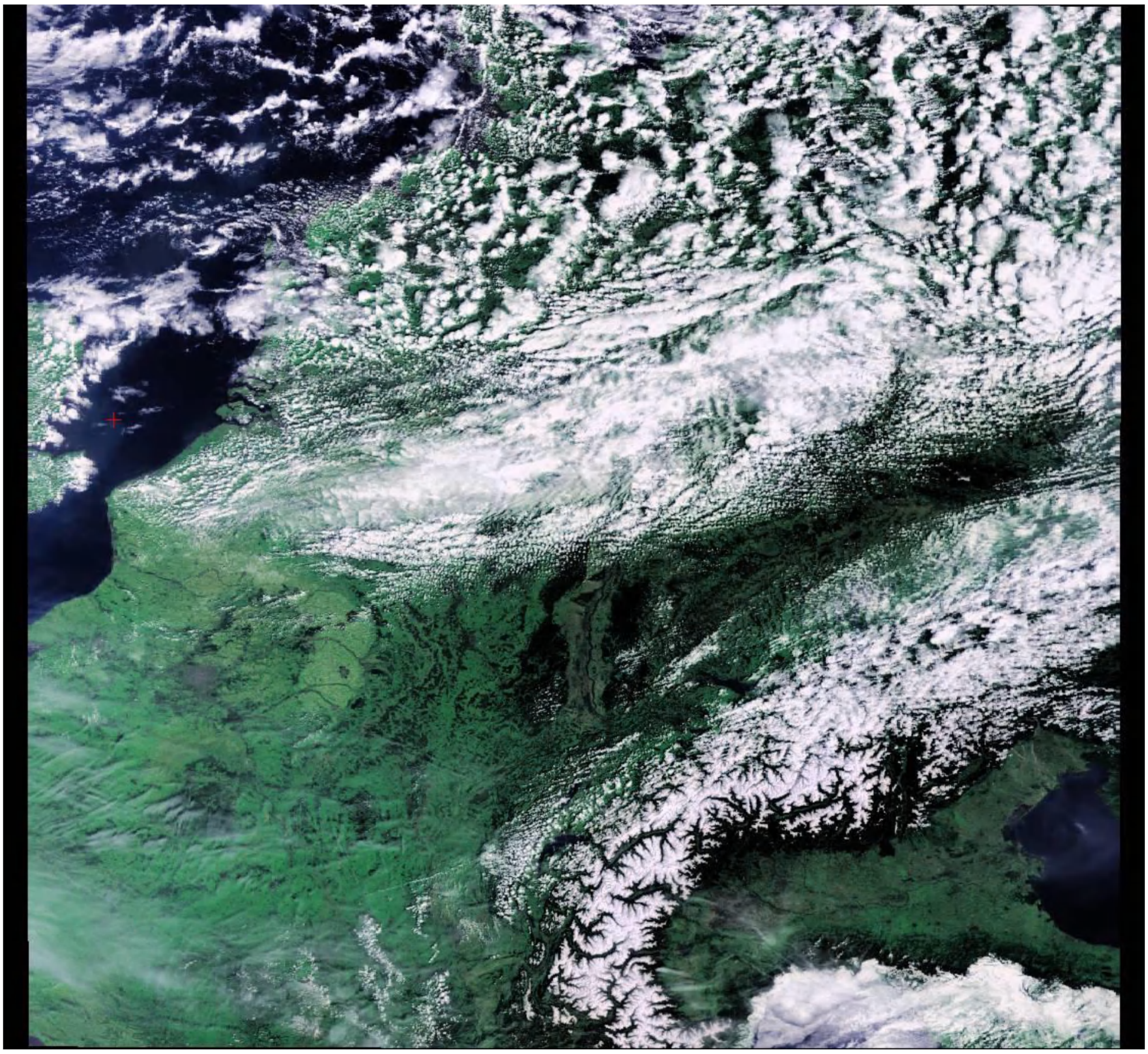
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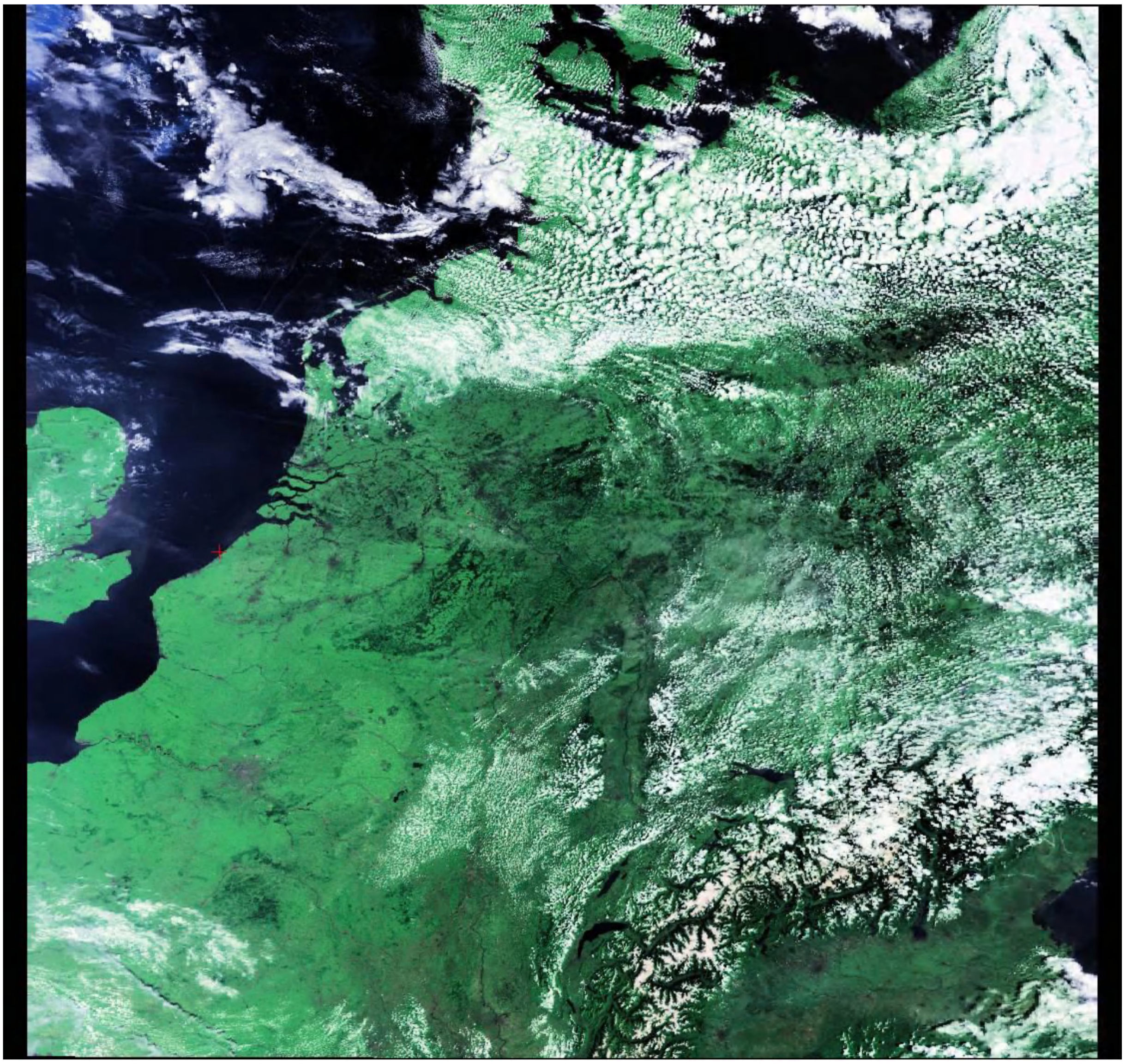
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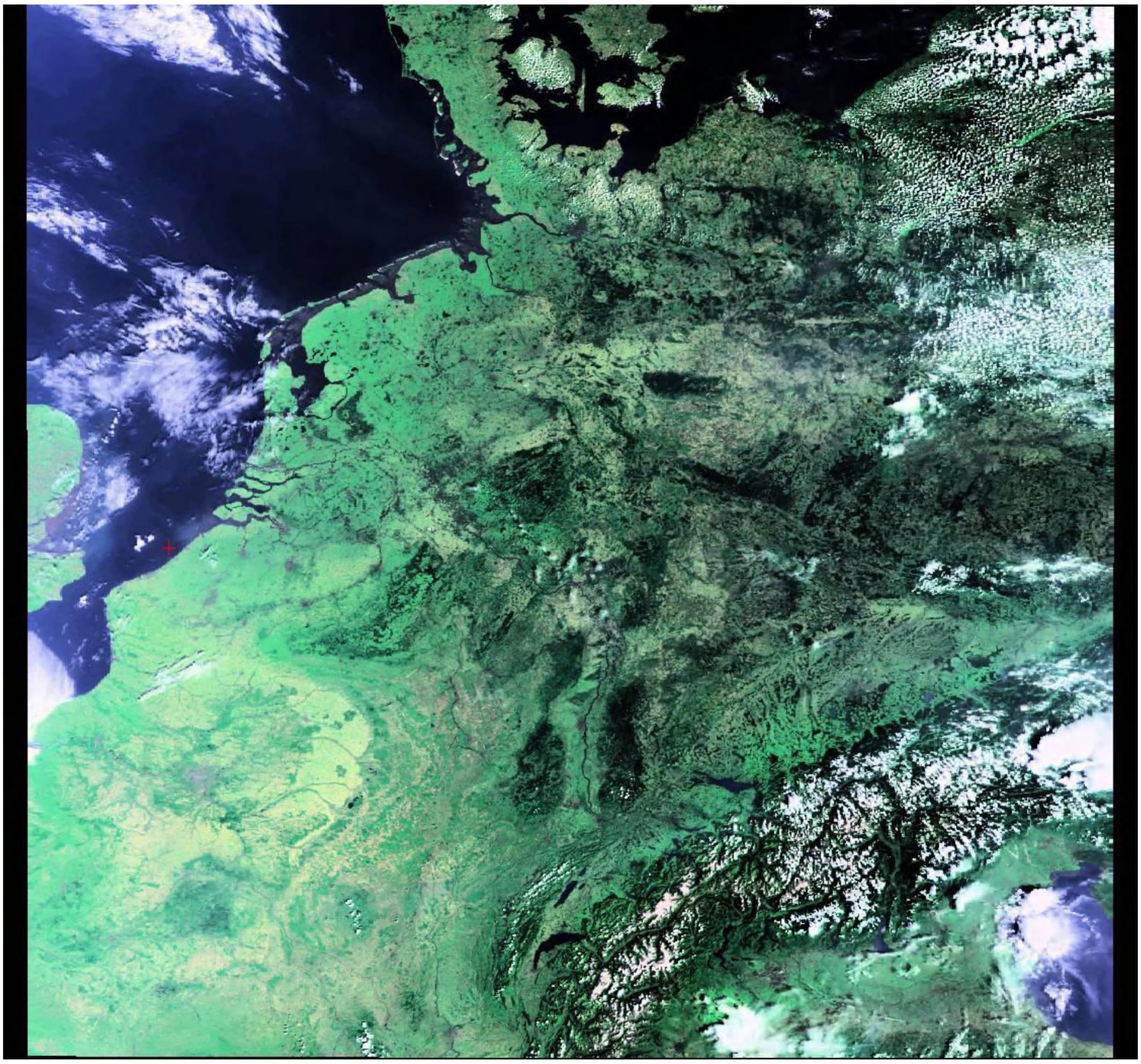

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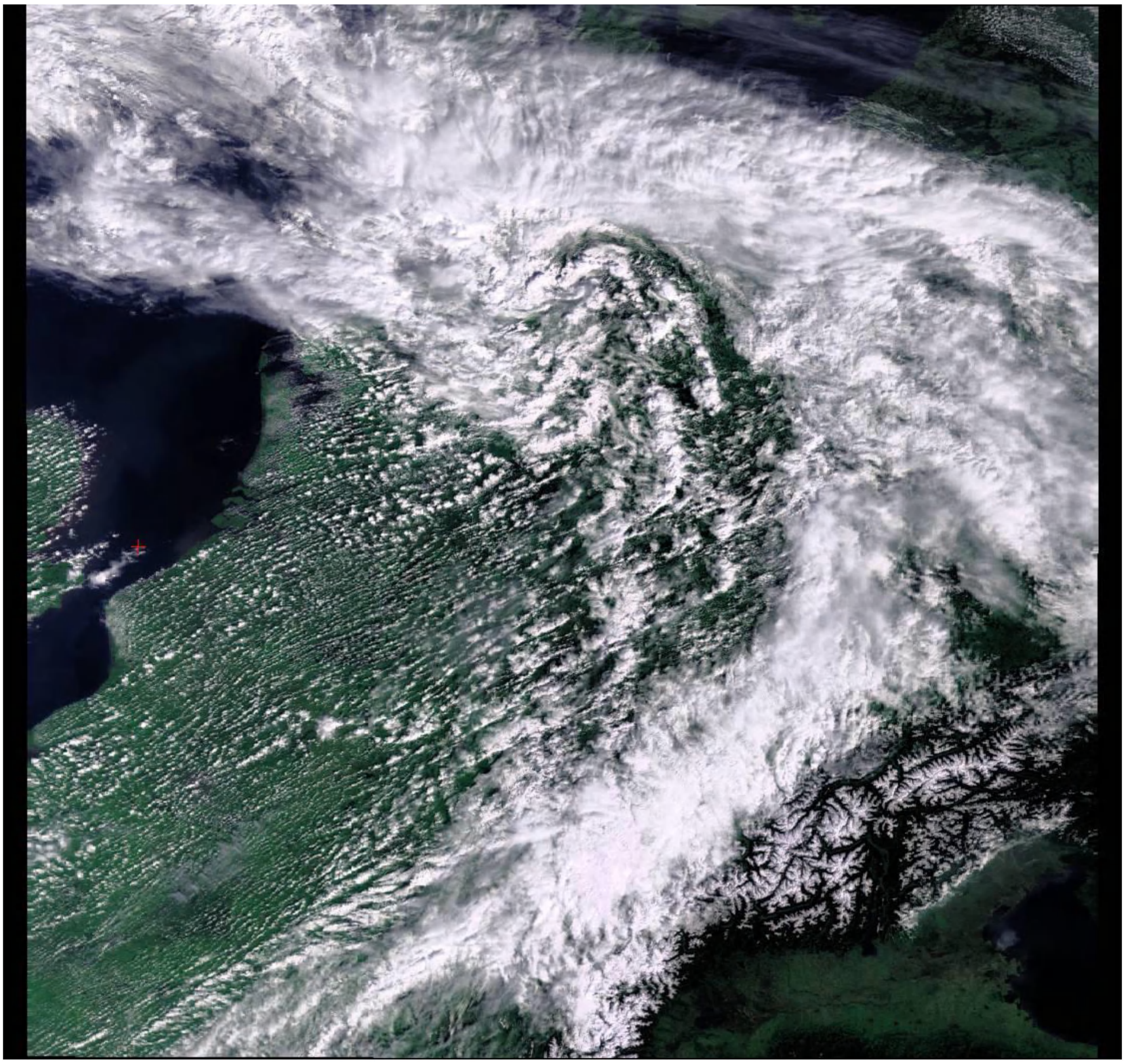

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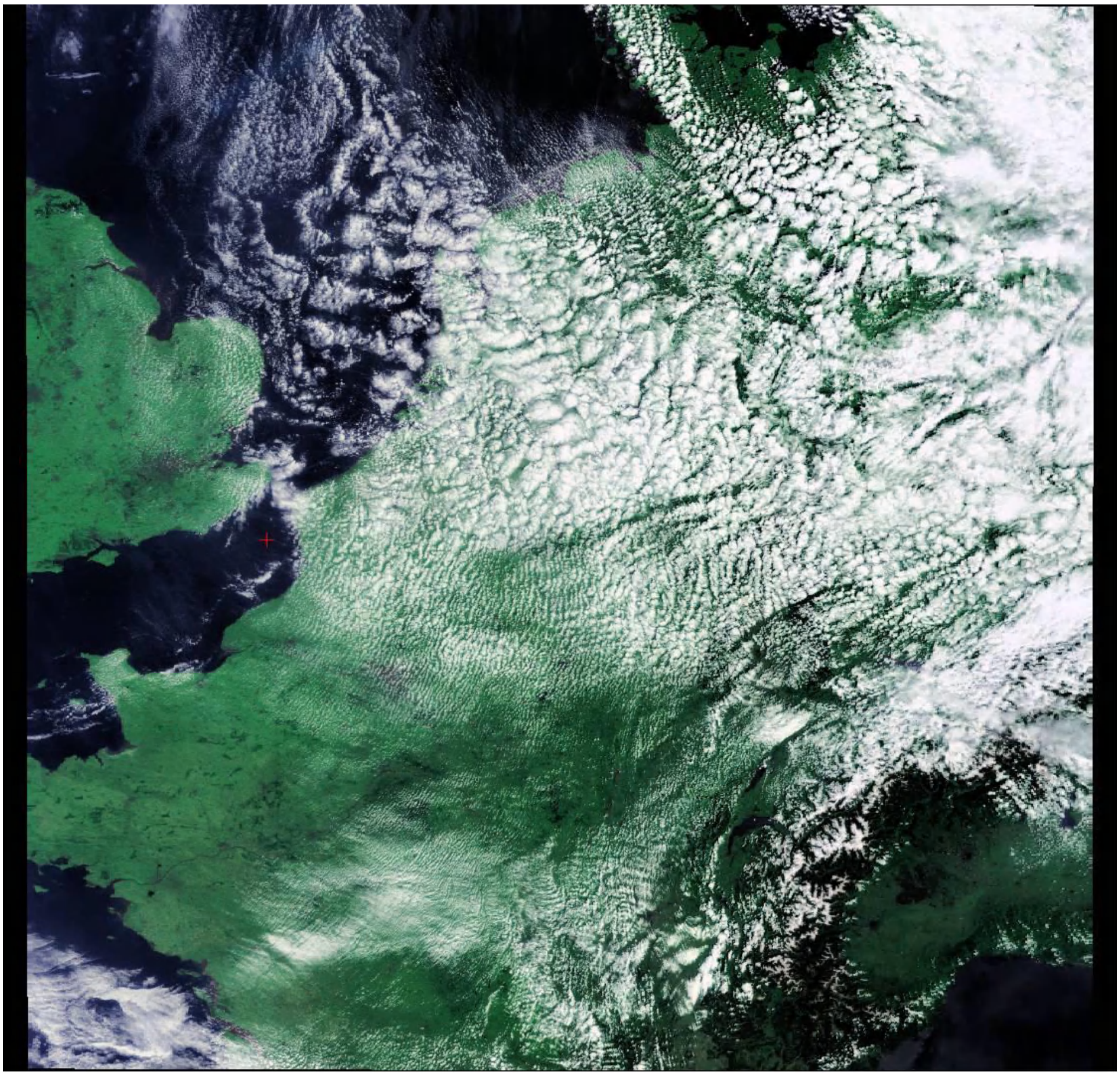

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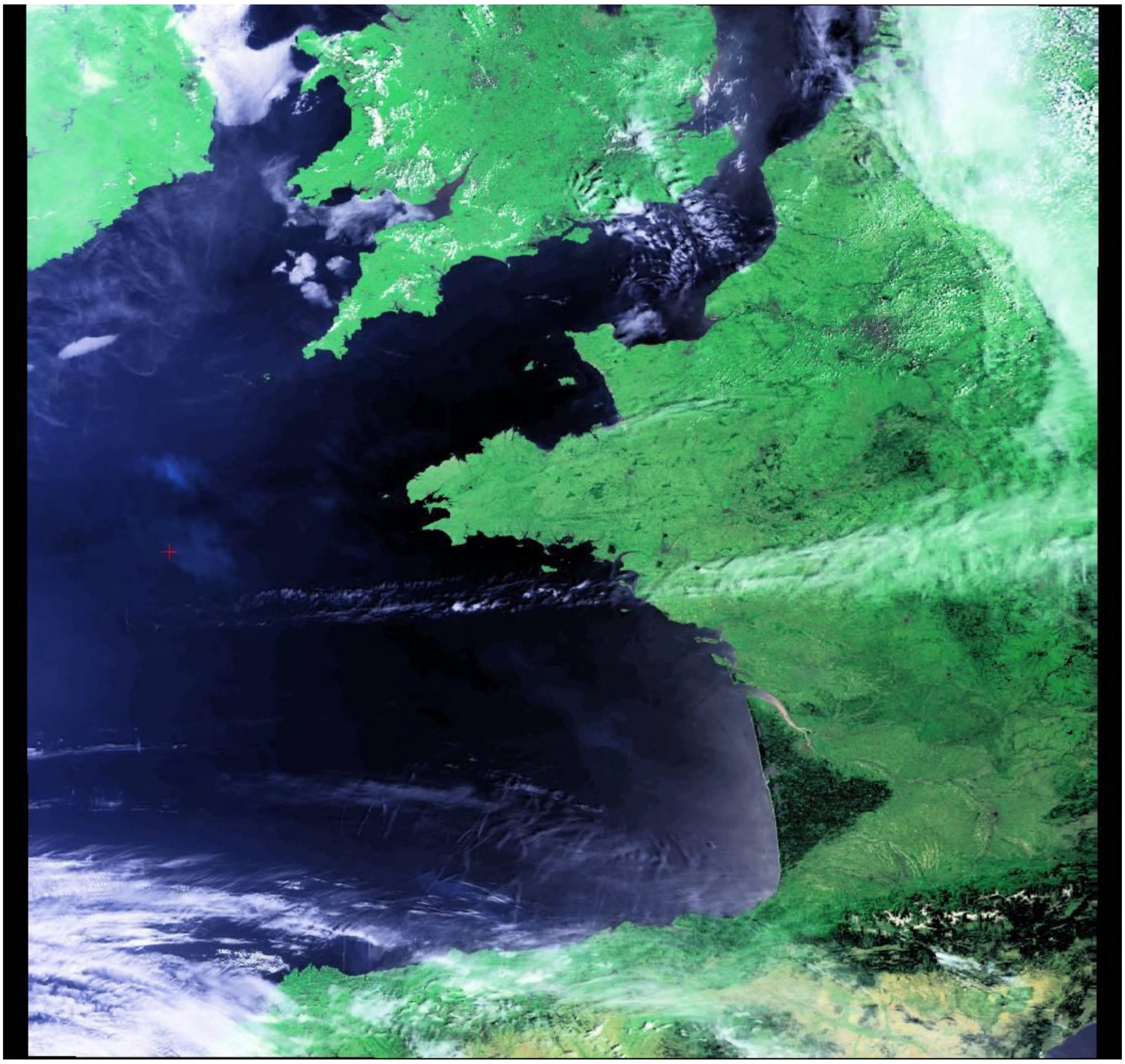
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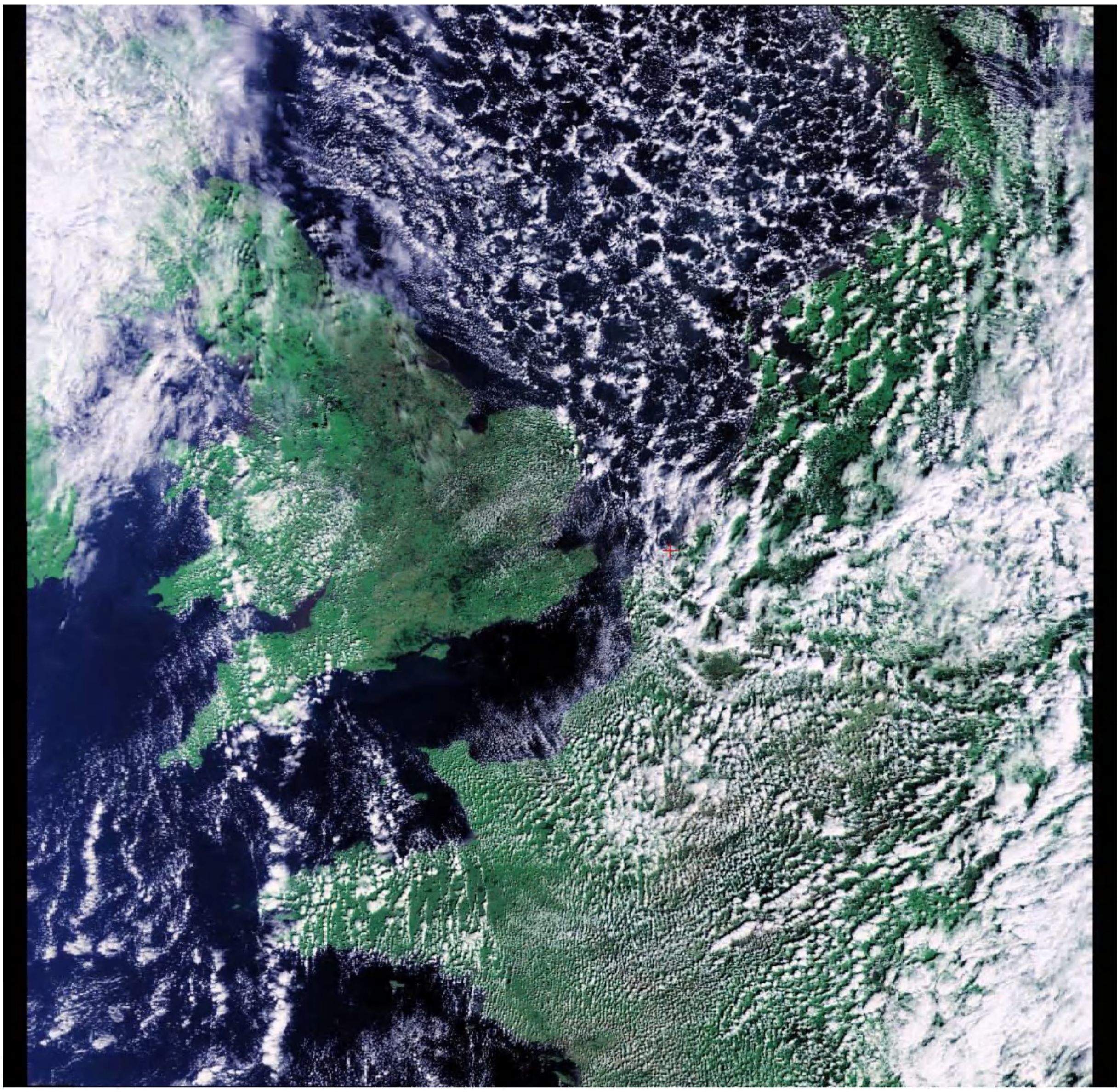
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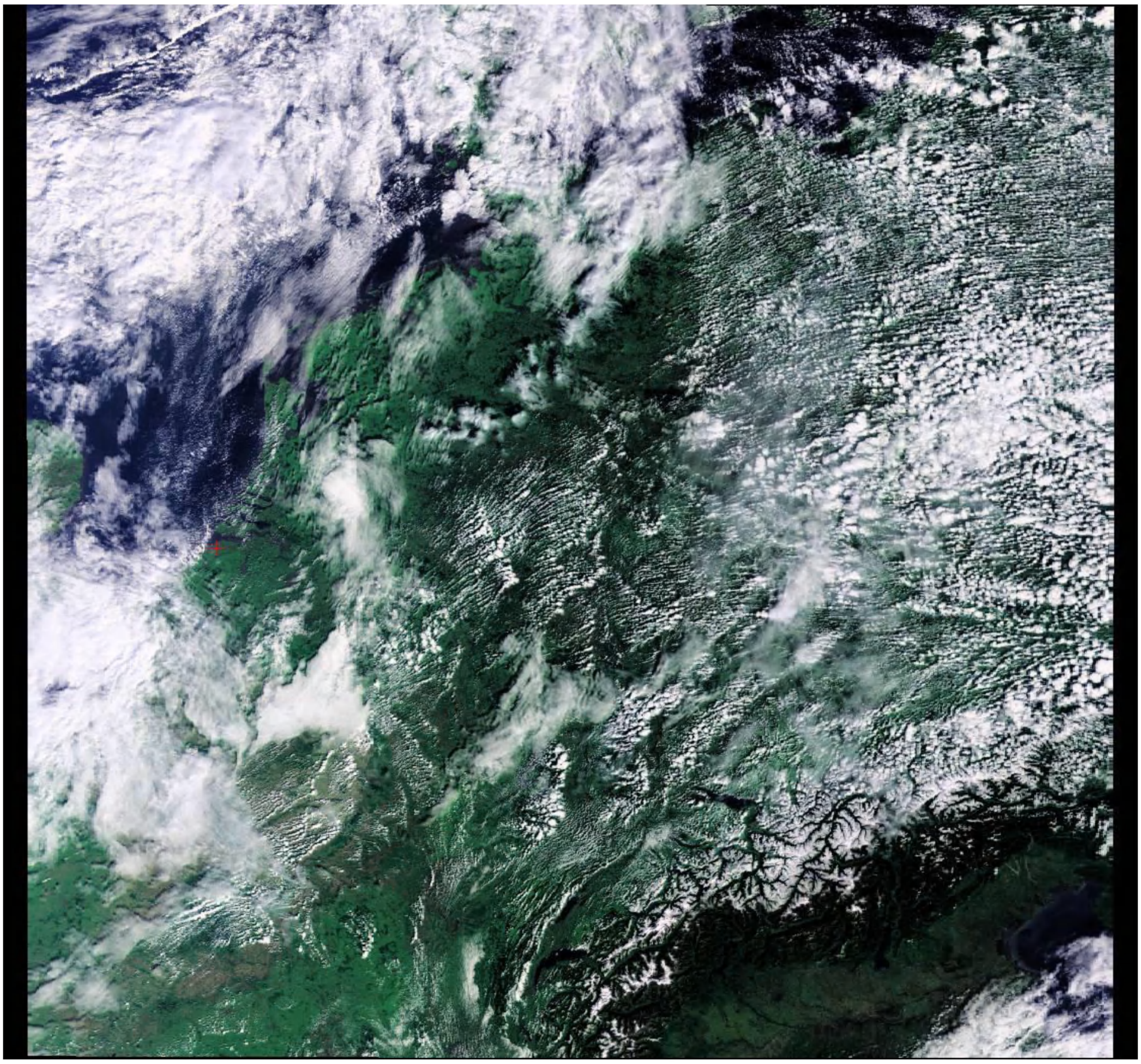
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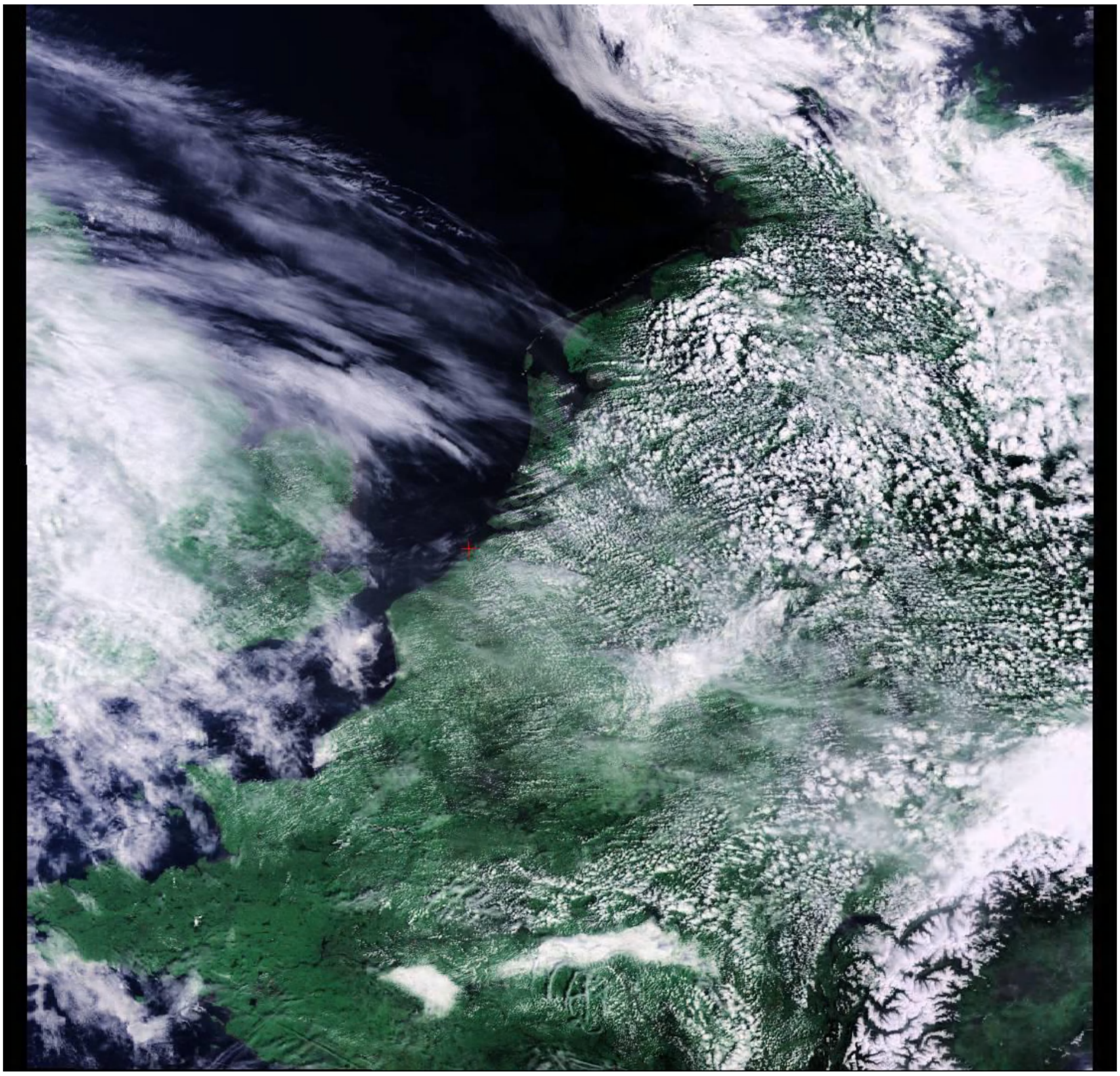

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