AATSR Technical Note

Improvements to the AATSR IPF relating to Land Surface Temperature Retrieval and Cloud Clearing over Land

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SCIENCE AND TECHNOLOGY FACILITIES COUNCIL

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1 Introduction

Recent changes have been made to the AATSR Instrument Processing Facility (IPF) in order to improve the performance of the retrieval of Land Surface Temperature (LST), and of cloud clearing over land surfaces.

The Land Surface Temperature retrieval was first implemented in Version 5.58 of the AATSR IPF. Even at the time of implementation a number of limitations of the algorithm were known, as a result of validation carried out during the AATSR Commissioning Phase using the AATSR prototype processor, and it was resolved to upgrade the IPF in due course to address these limitations. These upgrades have now been made, and are the subject of the present document, which describes the theoretical basis of the changes, and the implications for the interpretation of the product.

The specific improvements are as follows.

1. The improvement of the performance of the cloud clearing tests over land;
2. An improved treatment of pixels in areas of marginal cloud;
3. To enable the LST retrieval over inland lakes;
4. To implement the spatially averaged LST retrieval.

The improvements to the cloud clearing scheme over land are independent of the implementation of the LST retrieval algorithm proper, and consist of the introduction of new and modified cloud tests in Level 1B processing. These new and modified tests are described in Section 2 of this note. The modifications to the LST retrieval algorithm in Level 2 processing are described in Section 3. Finally in Section 4 we describe the changes to the products resulting from the new features, and their impact on the product interpretation.

The information in this document applies to Version 6.0 and later versions of the AATSR IPF.

2 Improvements to the Cloud Clearing Tests

The cloud clearing scheme hitherto used by the AATSR processor [1] is optimised for use over open ocean, and does not perform well over land. In part this is because only four of the nine tests are currently used over land (and only two of these during the day), while one of these, the infrared spatial coherence test, is not expected to perform well over land.

The nine existing tests are shown in the table below, together with an indication of whether or not they are used over land.

Table 2-1: The standard AATSR cloud tests, as used prior to IPF Version 6.0.

Test	Land/Sea	Day/Night
gross cloud test	Sea only	Day/Night
thin cirrus test	Land/Sea	Day/Night
medium/high level cloud test	Land/Sea	Night
fog/low stratus test	Land/Sea	Night
11 micron spatial coherence test	Land/Sea	Day/Night
1.6 micron histogram test	Sea only	Day
11/12 micron nadir/forward test	Sea only	Day/Night
11/3.7 micron nadir/forward test	Sea only	Night
infra-red histogram test	Sea only	Day/Night

Thus over land only the tests shown in Table 2-2 were used.

Table 2-2: Standard cloud tests over land.

Test	Day/Night
thin cirrus test	Day/Night
medium/high level cloud test	Night
fog/low stratus test	Night
11 micron spatial coherence test	Day/Night

Four potential improvements to the cloud clearing over land were proposed. These were to:

- Implement the gross cloud test over land;
- Disable the spatial coherence test over land;
- Implement a test using the visible channels and based on NDVI;
- Implement a test based on Normalised Difference Snow Index (NDSI).

These are discussed in the following subsections.

2.1 Gross Cloud Test Over Land

The gross cloud test flags as cloudy those pixels whose brightness temperature in the 12 micron channel falls below a specified threshold. The physical basis of the test is that many optically thick clouds will appear significantly colder than the surface because of their higher altitude; the 12 micron channel is chosen because clouds tend to have a greater optical depth at this wavelength than in the shorter wavelength channels [2].

In theory this test can be used over any surface, but in the original processing scheme it was only used over the ocean. This is probably because of the difficulty of specifying a suitable threshold for the test over land. The scheme uses a threshold that is a function of latitude and season (defined by the month) and is based on an SST climatology.

Saunders and Kriebel [2] remark on the difficulty of specifying a threshold for the test over land. Land surface temperature can show significant diurnal variability, and wide variations from place to place. Thus a single threshold valid for the whole globe will be very low, and will not give fine discrimination. In their own work, Saunders and Kriebel determined a threshold interactively on a scene by scene basis. Each scene was inspected, and the coldest areas of cloud-free land in the image were identified. The threshold was then set 2K lower than the brightness temperatures of these areas. This approach cannot, however, be used operationally since it depends on the user evaluating each scene. A more refined approach is to base the threshold on an appropriate LST climatology.

If a single global threshold is used, and if this is set low enough, then very cold cloud will be detected. However, regions of cloud that are warmer than this threshold would not be identified, and this would tend to limit the detection of cloud in warmer regions. A threshold that was low enough to rule out false detection of cloud in cold regions might fail to identify cloud in warmer regions.

On the other hand, if a global database of monthly mean surface temperature were available, then a look-up table giving a threshold as a function of latitude, longitude and month could be constructed. This would be quite a large file (we assume a resolution of something like 1 degree), comparable with the files used by the LST algorithm. In constructing such a table, it would be necessary to account for the diurnal range of temperature variation, because the threshold must be lower than the minimum surface temperature at each point.

Reference [3] describes a set of monthly mean climate data that may be suitable for this application, and these data have been used to construct a look-up table for the gross cloud test over land. For the present it has been assumed that the longitude dependence is not actually required to define a useful test. Thus a LUT as a function of latitude and month (as with the sea test) has been defined. This results in more efficient storage, since if the LUT were to depend on longitude, then because 70 percent of the surface of the Earth is covered by ocean, approximately 70% of the table would be unused.

2.2 Spatial Coherence Test Over Land

The small-scale spatial coherence test works by calculating the standard deviation of the 11 micron brightness temperature (BT) in a 3 x 3 group of pixels and comparing it with a threshold. If the standard deviation exceeds the threshold, the pixels in the group are flagged as cloudy. Clearly the theoretical basis of the test is that cloud may show higher spatial variability than the surface.

Prior to the present upgrade, this test was applied both to land and sea surfaces; however, in the case of land surfaces local variations of terrain type and emissivity make it quite likely that the test will falsely detect cloud.

The modification, then, has been to disable the test over land surfaces. This has been implemented by leaving the test unchanged, but clearing the resulting cloud flag if the pixel is over land. This approach was adopted because it reduces the possibility of inadvertently introducing side-effects when the test is disabled. We then have the following truth table for the modified cloud flag.

Table 2-3: Spatial coherence test truth table.

Surface type	Cloud flag	
	0 = clear	1 = cloudy
0 = sea	0	1
1 = land	0	0

2.3 Visible Channel Cloud Test

This is a new test based on the visible channel data. For this reason it can only be used in the daytime.

The test is based on unpublished work at the Rutherford Appleton Laboratory by A.D. Stevens, who derived a pixel-based classification scheme that uses two NDVI-like indices to classify individual pixels on the basis of pre-assigned classification criteria.

The NDVI used in AATSR processing is defined as

$$NDVI = (R87 - R67)/(R87 + R67),$$

where R87 and R67 are the calibrated reflectances in the 0.87 and 0.67 micron channels respectively. Since there are 3 visible channels, there are three different ways to define a normalised difference index (NDI), corresponding to the three different ways to select the channels in pairs. Thus as well as the conventional NDVI defined above, we can define two indices involving the 0.55 micron channel reflectance R55:

$$NDI2 = (R67 - R55)/(R67 + R55)$$

$$NDI3 = (R87 - R55)/(R87 + R55)$$

(If the indices were not normalised, then the three quantities would not be linearly independent, and so it is reasonable to assume that little information would be added to the first two by the use of the third.)

The method developed by Stevens uses two of these indices, NDVI and NDI2, to define a two-dimensional classification space. If the two indices are calculated for each pixel, the pixels can be plotted on a graph of NDVI versus NDI2. Such a plot defines an NDI space such that pixels of different surface types form clusters, and by identifying into which cluster a pixel falls, the surface type at the pixel can be determined.

Stevens has defined the clusters by empirically dividing the NDI space into a series of polygons, each of which represents a particular surface type (or cluster). Figure 1 shows this subdivision. The classification defines 12 surface types (numbered 0 to 11). Note that the figure shows, in the centre, a pure cloud type (Type 3) together with 4 mixed types incorporating some cloud (Types 1, 2 9 and 10).

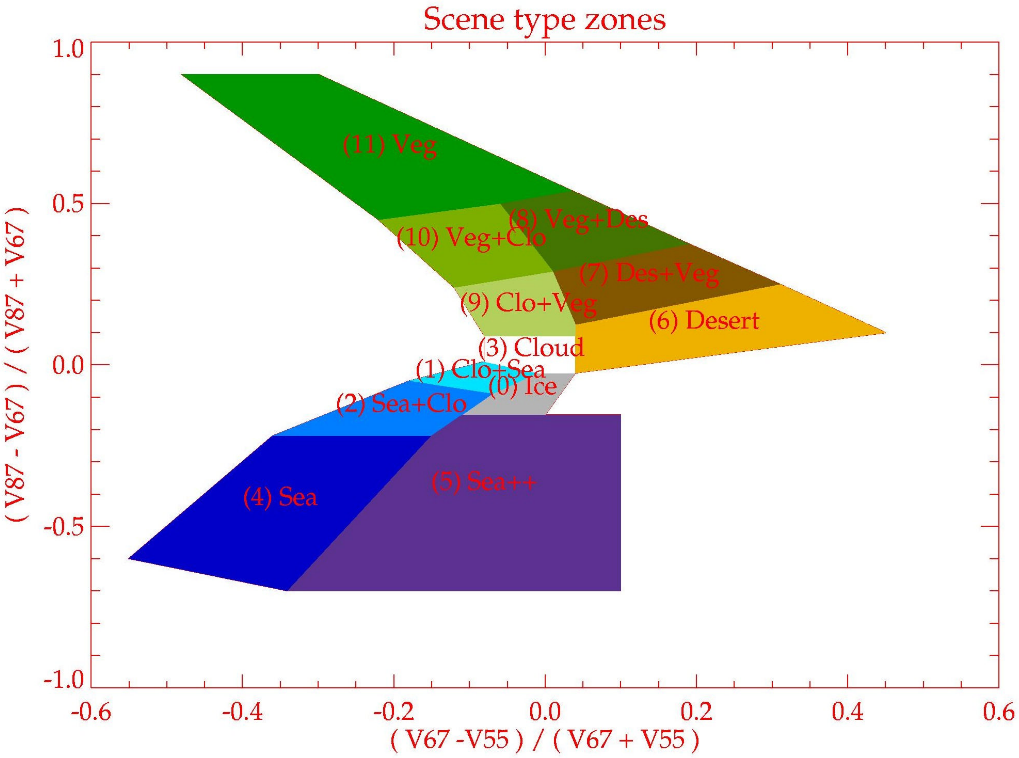

Figure 1. Surface type zones according to the classification discussed in the text.

For each valid pixel, then, both indices are calculated and the zone into which the pixel falls is determined. The cloud flag is then set if the pixel falls into one of the zones designated cloudy.

Although the test is defined for both land and sea pixels, it has not been implemented over sea so as not to compromise the existing ocean cloud flag.

2.4 Snow Test Based on NDSI

In addition to the visible channel indices described above, it is possible to define difference indices involving the reflectivity of the 1.6-micron channel. Hall et al [4] have defined a Normalized Difference Snow Index (NDSI) based on the bands 2 and 5 of the Landsat TM (Thematic Mapper) sensor. The bands in question are centred at 0.555 and 1.640 microns respectively, so the AATSR counterpart index would be

$$NDSI = (R55 - R16)/(R55 + R16),$$

where R16 is the calibrated reflectivity of the 1.6 micron channel.

The physical basis of the concept outlined in [4] is that snow has very high visible reflectance, but much lower reflectance at 1.6 micron wavelength, in contrast to water cloud, the reflectance of which is much more uniform. Thus over land a high value for the NDSI may be taken to be characteristic of snow. This is not entirely unambiguous, however, since water may also have a high value of the NDSI, and so the algorithm actually proposed in Reference [4] is that if the reflectance of a surface is greater than 11% (this eliminates water surfaces) and the NDSI exceeds 0.4, the pixel is considered to be snow-covered. The same algorithm is proposed to identify snow-covered sea ice, which has similar characteristics (although this approach may fail to detect thin sea ice with no snow cover).

It was initially thought that cloud clearing over land might be improved by the use of an NDSI based on the 0.55 and 1.6 micron channels. However, this is not totally straightforward since the original intention of the NDSI [4] was to identify and map snow covered surfaces.

The NDSI provides a way to distinguish between water cloud and snow, both of which have a high visible reflectance, because of the typically lower reflectivity of snow at 1.6 micron wavelength. Ice cloud may also show a high NDSI, and this is the basis of the idea that the NDSI can be used as a cloud test. Thus in regions where snow is not expected, a high NDSI may be an indicator of cirrus cloud.

On the other hand the NDSI cannot be used to distinguish snow cover from ice cloud. For this reason the idea of basing a cloud test on the NDSI was abandoned. Instead the NDSI has been used to define an experimental snow flag, and the question of separating snow covered surfaces from ice cloud has been left open.

In the light of this, the algorithm that has been implemented in the AATSR IPF is:

> If R87 > 11% and NDSI > 0.4, and if the 11 micron brightness temperature is less than a threshold, the pixel is considered snow-covered and the snow flag is set.

The condition based on the 11 micron brightness temperature is required to eliminate false identifications [7]. The corresponding threshold is currently 277K.

The resulting snow flag is not merged into the overall cloud flag. It has been implemented in both the nadir and forward views, although there is some doubt as to whether a flag based on the forward view measurements is reliable, since experience with MODIS [7] suggested that the flag was likely to give false indications at high angles of incidence.

3 Modifications to the LST Retrieval

3.1 Overview of the LST Retrieval Algorithm

The LST algorithm selected for AATSR is based on work by Prata [5], [6] to develop algorithms to retrieve LST from ATSR and AVHRR data. These algorithms have been subjected to a thorough validation using a network of ground-truth sites across Australia.

The basic algorithm for LST retrieval is:

$$LST = a_0 + b_0 T_{11} + c_0 T_{12}\,, \tag{3.1}$$

where a_0, b_0 and c_0 are coefficients that depend on the land surface characteristics, viewing angle, and atmospheric water vapour, and T_{11} and T_{12} represent the brightness temperatures in the 11 and 12 micron channels respectively. In order to permit an additional tuning of the algorithm, a weak non-linearity is introduced by replacing (3.1) by

$$LST = a_0 + b_0 (T_{11} - T_{12})^n + (b_0 + c_0) T_{12}\,, \tag{3.2}$$

where the index n depends on the incidence angle θ as follows:

$$n = 1/\cos(\theta / m) \tag{3.3}$$

where m is an empirical constant. Equation (3.2) reduces to (3.1) when $n = 1$. If $T_{11} - T_{12}$ is negative, then the term $(T_{11} - T_{12})^n$ in (3.2) is in general complex. This case can certainly arise in practice. The solution adopted is to set $n = 1$ if $T_{11} < T_{12}$; in other words, to revert to (3.1) in this case.

The essence of the algorithm is to apply (3.2) above to the 11 and 12 micron brightness temperatures in the nadir view. As noted above, the retrieval coefficients a_0, b_0, c_0, depend on surface characteristics and atmospheric water vapour, and since these characteristics show complex variability in space and time, the values of the coefficients must take account of these variations. This is achieved by means of look-up tables, which define the local characteristics of the surface, and the local climatology, for each cell of dimension 0.5° in latitude by 0.5° in longitude. For each cell, entries in a look-up table (LUT) define the following quantities:

- The surface classification within the cell. The cell is assigned to one of 14 surface types, represented by an integer in the range 1 to 14. The surface types adopted are listed in Table 3-1.
- The vegetation fraction f ($0 \leq f \leq 1$) representative of the cell. This quantity has a seasonal variation that is represented in the tables by defining 12 values of f, one for each calendar month.
- The monthly mean precipitable water at the centre of the cell. Again 12 values are given, one for each month, to represent the seasonal variation.

A further table defines four sets of regression coefficients a, b and c for each surface type, corresponding to vegetation and bare soil, and to day and night conditions.

Thus for a given pixel, its latitude and longitude define the 0.5° × 0.5° cell within which the pixel falls. The surface type for this cell, and the vegetation fraction for the cell and for the current month, are extracted from the look-up table. Given the surface type, the table of coefficients is entered to extract the regression coefficients a, b and c for this surface class. The day or night-time coefficients, as appropriate, are extracted for both vegetation and bare soil, and the coefficients a_0, b_0, c_0 required for use in (3.2) are derived from the mean of the vegetation and bare soil values, weighted by f, $(1 - f)$ respectively.

Before (3.2) is evaluated, a final correction is applied to the coefficient a_0 that depends on the precipitable water at the position of the pixel. This is derived from the tabulated values using a bilinear interpolation.

Table 3-1: The land type classification used by the AATSR LST algorithm.

Type	Description	Type	Description
1	Broadleaf evergreen trees	8	Broadleaf shrubs with groundcover
2	Broadleaf deciduous trees	9	Broadleaf shrubs with bare soil
3	Broadleaf and needleleaf trees	10	Dwarf trees, shrubs with groundcover
4	Needleleaf evergreen trees	11	Bare soil
5	Needleleaf deciduous trees	12	Broadleaf deciduous trees with winter wheat
6	Broadleaf trees with groundcover	13	Perennial land ice
7	Groundcover	14	Permanent inland lakes

If the surface type of the pixel is 14, representing an inland lake, the algorithm is modified slightly; Equation (3.1) is used in place of Equation (3.2), and the precipitable water correction is not applied.

3.2 Treatment of Pixels in Areas of Marginal Cloud

The current Level 2 gridded product is switchable; that is to say, the contents of the geophysical data fields corresponding to each pixel depend on the surface type and cloud flags. The product contains two fields per pixel, designated the nadir field and the combined field. Then:

- If the pixel is flagged as clear sea, the nadir field contains the nadir only SST retrieval and the combined field contains the dual view SST retrieval.
- If the pixel is flagged as clear land, the nadir field contains the LST retrieval and the combined field contains the NDVI.

If the pixel is flagged as cloudy, the nadir field contains the cloud top temperature (CCT) and the combined field contains the cloud top height (CTH). At present both these fields are represented by placeholders, represented by the 11 micron BT and zero respectively.

However, because of the poor performance of the cloud clearing over land, it is quite likely that clear pixels are wrongly flagged as cloud, in which case the nadir only field will contain the 11 micron brightness temperature instead of the LST. Thus an area that is actually cloud-free could appear in the product to be made up of irregular patches of LST and 11 micron brightness temperature, with consequent disruption of the LST field. This is a particular problem for some classes of user (e.g. validation users).

One potential solution is to calculate the LST for 'cloudy' pixels that have a high probability of being wrongly flagged. The idea is to define a new surface class of 'marginal cloud'.

Imagine a hypothetical cloud clearing scheme that assigns a probability to each pixel, representing the probability that the pixel is cloudy. The present scheme does not do this, but the concept will aid the discussion.

In the simplest case, one might set the cloud flag to 1 if the probability of cloud *P(cloud)* exceeded some threshold $P0$, and to zero otherwise. Thus if $P(cloud) < P0$ the pixel is flagged as clear, but if $P(cloud) \geq P0$ it is flagged as cloudy. This (with $P0$ small) is a binary classification scheme similar to the present scheme.

A more elaborate scheme might introduce a second threshold $P1$ to define an intermediate range of marginal cloud. Thus:

- If $P(cloud) < P0$ the pixel is flagged as clear, as before;
- If $P(cloud) \geq P1$ the pixel is flagged as cloudy; but
- If $P0 \leq P(cloud) < P1$, the pixel is defined as marginal cloud.

Thus 'clear' pixels are flagged as before, but formerly cloudy pixels are now divided into two classes, those having $P(cloud) \geq P1$ that are highly likely to be cloudy, which are treated as before, and those that have a significant probability of being in fact clear. In these cases it might be appropriate to treat the pixel as clear in the product, and calculate the LST (and NDVI) instead of the usual cloud parameters.

The approach in the first instance is to treat all cloudy pixels over land as marginal pixels, and to calculate the LST (and NDVI) in place of the CTT and CTH. In itself this is a simple modification to the existing scheme. However, it is also necessary to introduce a new marginal cloud flag to indicate those pixels that are treated in this way. This is partly to ensure backwards compatibility, so that users can distinguish between products that use the new scheme and those processed using the previous scheme, and also to allow for future development should a new cloud clearing scheme become available that permits finer distinctions among cloud pixels. This presented a difficulty, because there are no free bits in the confidence word.

The problem is not insuperable, however, because three of the confidence flags currently contain the results of selected individual cloud tests. The three cloud tests that are represented in the Level 2 confidence word are:

- The 1.6 micron test;
- The 11/12 micron nadir-forward test;
- The infra-red histogram test.

None of these tests is currently used over land, so for land pixels one of these flags can be used to indicate 'marginal cloud'. Essentially the selected flag is redefined to be switchable, like the geophysical data fields.

3.3 LST Retrieval Over Lakes

Although the surface type classification (Table 3-1) used by the LST algorithm includes a class for inland lakes, with corresponding retrieval coefficients, these were not used because most large inland lakes are flagged as sea in the land/sea database. The LST retrieval algorithms are driven by the land/sea flag that is derived from the land/sea database, so that if a pixel is flagged as sea, SST is retrieved, and the LST surface type database is not interrogated. Only if the pixel is flagged as land is a land surface temperature retrieval attempted. If therefore an inland lake pixel is flagged as sea, the LST coefficients are not used.

To correct this situation the algorithm at Level 2 has been modified to interrogate the surface type mask for each sea pixel, to detect the case where the pixel is identified as sea by the land/sea flag, but is shown as an inland lake by the surface type file.

The modified algorithm therefore introduces a new flag, termed the extended land flag. A pixel is flagged as extended land if:

1. It is flagged as a land pixel in the Level 1B product ATS_TOA_1P, or

2. It is flagged as a sea pixel in the Level 1B product ATS_TOA_1P, but it falls within a cell of the biome mask that is flagged as surface type 14 (inland lake).

The LST algorithm is then applied to all pixels that are flagged as extended land. To distinguish between lake and sea pixels, the flags in the confidence word have been modified as described in Section 4.

3.4 Averaged LST algorithm

The Level 2 processing has been upgraded to calculate the averaged LST in the averaged surface temperature (AST) product ATS_AR__2P. This does not imply any change to the product format; the new LST replaces the 11 micron averaged brightness temperature that previously occupied the LST field as a placeholder.

Note that if a cell is flagged as inland lake, then the LST algorithm is applied to the sea brightness temperature values, not the land values, since the averaging step is driven by the land-sea mask, and inland lakes are flagged as sea. (The remote possibility that a cell contains both sea and inland lake pixels is ignored in this implementation.)

4 Product Changes

4.1 New Cloud Flags

The new cloud tests have necessitated the definition of two new flags in the cloud flag words of the Level 1B product ATS_TOA_1P. One flag represents the new visible channel cloud test (Section 2.3), and the other represents the snow flag based on the NDSI defined above.

The structure of the cloud flags word is now as shown in the following table.

Table 4-1: GBTR Cloud-clearing/land flagging flags (nadir or forward view).

Bit	Meaning if set
0	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3	1.6 micron reflectance histogram test shows pixel cloudy (day-time only)
4	1.6 micron spatial coherence test shows pixel cloudy (day-time only)
5	11 micron spatial coherence test shows pixel cloudy
6	12 micron gross cloud test shows pixel cloudy
7	11/12 micron thin cirrus test shows pixel cloudy
8	3.7/12 micron medium/high level test shows pixel cloudy (night-time only)
9	11/3.7 micron fog/low stratus test shows pixel cloudy (night-time only)
10	11/12 micron view-difference test shows pixel cloudy
11	3.7/11 micron view-difference test shows pixel cloudy(night-time only)
12	11/12 micron thermal histogram test shows pixel cloudy
13	Visible channel cloud test shows pixel cloudy
14	NDSI snow flag
15	Unused

Note: Bits are numbered from ms bit 15, ls bit 0.

4.2 Flagging of Marginal Cloud

In order to distinguish those pixels flagged as cloudy for which the nominal CTT and CTH have been calculated by older versions of the processor, from those cloudy land pixels for which the LST and NDVI have been calculated by the new processor, three bits of the Level 2 confidence word have been redefined. The flags in question are bits 11 to 13 of the confidence word (see Table 4-2). For sea pixels these show whether certain cloud tests have flagged the pixel as cloudy; the tests in question are not applied to land pixels, and so for land pixels the flags are available for other uses.

One of these flags (bit 11) has been redefined as the marginal cloud flag, to indicate that the LST has been calculated even though the pixel is cloudy. A second (bit 12) is now used to indicate an inland lake pixel. Table 4-2 shows the current definition of the confidence flags.

Table 4-2: GST Confidence Flags.

Bit	Meaning if set
0	Nadir-only SST is valid
1	Nadir-only SST retrieval includes 3.7 micron channel
2	Dual-view SST is valid
3	Dual-view SST retrieval includes 3.7 micron channel
4	Pixel is over land or inland lake (extended land flag)
5	Nadir-view pixel is cloudy
6	Nadir-view pixel has blanking pulse
7	Nadir-view pixel is cosmetic fill
8	Forward-view pixel is cloudy
9	Forward-view pixel has blanking pulse
10	Forward-view pixel is cosmetic fill
11	Sea pixels: One or both views flagged cloudy by 1.6 micron test (daytime only) Land pixels: LST calculated even if pixel cloudy
12	Sea pixels: Cloud flagged by 11 micron/12 micron nadir -forward test Land pixels: Pixel is inland lake
13	Sea pixels: One or both views flagged cloudy by infra-red histogram test Land pixels: unused (set to zero)
14 - 15	Topographic variance flags for LST retrieval

Note: Bits are numbered from ms bit 15, ls bit 0.

4.3 Lake Flagging

As a result of changes to enable the calculation of lake surface temperatures, there are some changes to the interpretation and flagging of lake pixel data.

Lake pixels are now treated as land pixels, and the lake surface temperature is retrieved using the LST algorithm. This means that pixels which are flagged as sea in the Level 1B product now fall into two classes, those that are true sea pixels and are treated as such, and inland lake pixels to which a different algorithm has been applied. It is therefore necessary to introduced modified flagging to distinguish between these cases, otherwise users would be unable to tell, for a given pixel, which algorithm had been applied.

Therefore the land flag output to the Level 2 confidence word (bit 4, see Table 4-2) has been redefined. It is now set for all extended land pixels in the sense defined in section 3.2 above. Thus the output land flag for a given pixel is no longer identical to the land flag for the same pixel from the Level 1 product.

A new lake flag has also been added to the confidence word (bit 12, Table 4-2) which is set to indicate that the pixel is an inland lake pixel. The Level 1B land flag can be recovered if required since it is given by the logical expression

[Extended land] AND (NOT [inland lake]).

Finally, it was necessary to define the contents of the combined field in the Level 2 product for lake pixels. For sea pixels this field contains the dual view SST retrieval; for land pixels it contains the NDVI. The solution adopted has been to treat the lake pixels as land, not ocean, so this field contains the NDVI. This treatment is consistent in the sense that all pixels for which the extended land flag, whether land or inland lake, have been treated in the same way by the processor.

4.4 AST Confidence Word

As a result of the implementation of the spatially averaged LST in the spatially averaged product ATS_AR__2P, new flags have been added to the AST confidence word. Table 4-3 shows the current definitions of these flags.

Table 4-3: AST confidence flags

bit	meaning if set.
0	Sea MDS: Nadir-only SST retrieval used 3.7 micron channel Land MDS: Reserved
1	Sea MDS: Dual-view SST retrieval used 3.7 micron channel Land MDS: Reserved
2	Nadir view contains day-time data
3	Forward view contains day-time data
4 - 5	Topographic variance flag for LST calculation
6 - 31	Unused

The topographic variance flags, which only apply to land cells, are new. Their meaning is the same as for the full resolution product ATS_NR__2P. Note that bits 0 – 15 occupy the first two bytes of the four-byte confidence word field.

5 References

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