Structure of a QA4EO compliant QA/QC system for the automated quality processing of large volumes of Earth Observation data from the DMC satellite Constellation

Dr. Steve Mackin, Chief Scientist, Laura Brindle Satellite Campaign Manager, DMC International Imaging Ltd

Introduction

DMCii is implementing a world leading QA/QC system to provide quality indicators at the pixel level in DMC satellite data.

One of the major problems facing both end-users and data providers is the quality of the earth-observation data that is used in applications. Many issues affect the data quality of an image, some can be removed by changes in operational procedures, some by software developments or by post-processing.

The biggest problems are often associated with the absolute calibration of the imager, but additionally there may be image artefacts as shown in figures 1 to 4 (Right) DMCii removes or reduces these artefacts before the data is actually delivered to the end-user. This may sound a trivial problem. However with multiple satellites in constellation and large data volumes, changes in the sensor response are complex to process.

Additionally there are now two new initiatives which require much more stringent QA and QC of Earth Observation data.

QA4EO — http://lpvs.gsfc.nasa.gov/PDF/qa4eo_guide.pdf

This is an initiative from CEOS, which has as one of its aims that data providers must provide a quality indicator with each data product, this should be provided at the pixel level (if possible) and be fully traceable to a national / international reference standard. An example would be providing uncertainty on the TOA radiance at pixel level for a TOA radiance product. Another at higher level would be the uncertainty on an NDVI product at pixel level. All procedures used to generate these products need to be documented and all uncertainties in their generation should be calculated or estimated and provided to the end-user (if required).

ESA GMES

This is an initiative from the European Space Agency, that requires all Third Party Missions providing data to European Earth Observation Services to include a suitable quality indicator at the pixel level.

These two initiatives are driving the development of a fully automated QA/QC system within DMCii.

DMCii Approach

Processing is fully automated with feedback process control where possible

- Processing is broken up into modules which are standalone elements with a defined uncertainty related to their operation (figure 5).
- Modules are linked in a non-temporal series to generate combined uncertainties for any product (figure 6).
- Each module has an associated QC step that evaluates the output from each module, this can isolate trends that may lead to out-of-bounds conditions and in some cases allows the process to modify itself (process control) (figure 5).

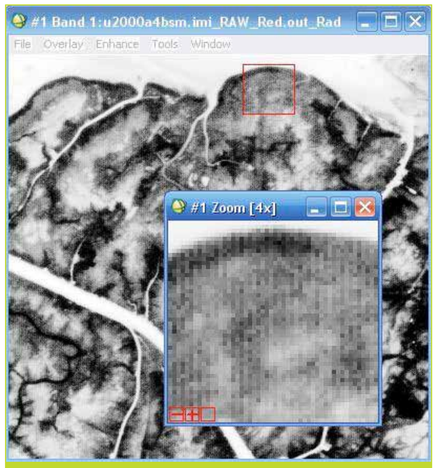

Figure 1 : Odd / Even striping effect due to reference pixel offsets

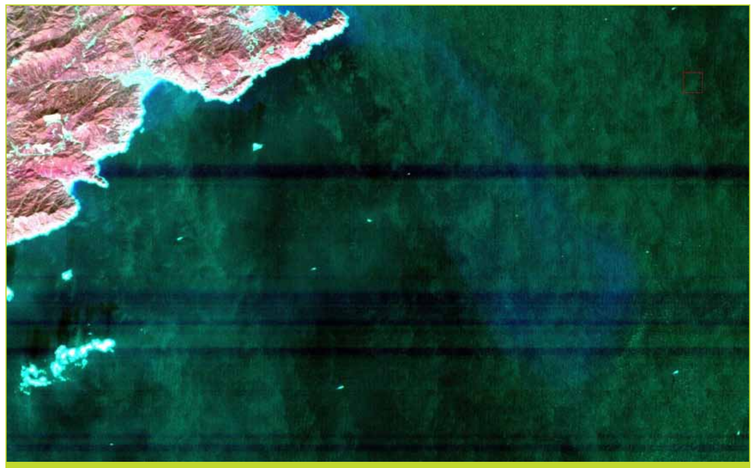

Figure 2 : Horizontal banding due to contamination of reference pixels by bright targets at the edge of the image

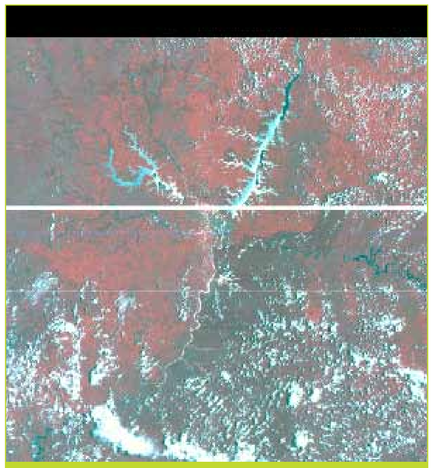

Figure 3 : Effects of sunglint, causing banding in the UK-DMC-2 Imager

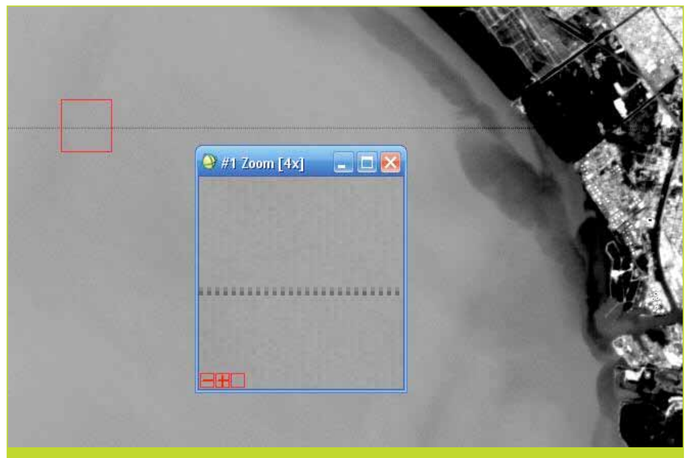

Figure 4 : Effects of a charged particle impact in the reference pixels, causing the so-called "Zipper" effect.

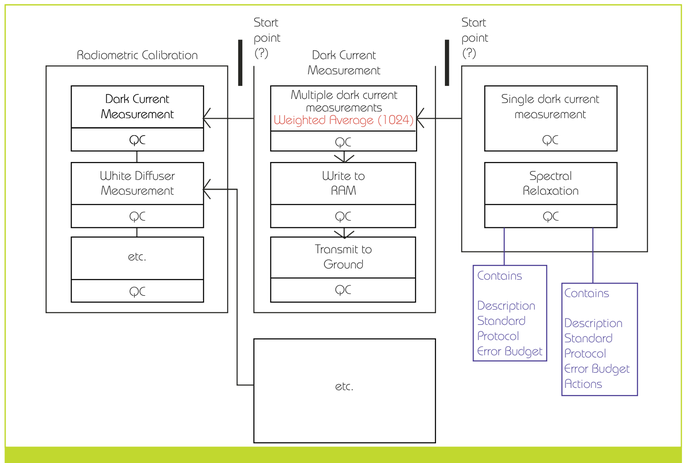

Figure 5 : Diagram showing some of the elements which could form part of the modular structure

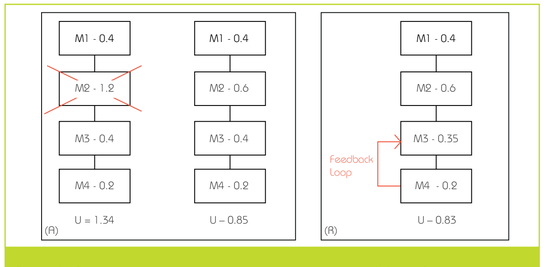

Figure 6 : Simple diagrams to explain module replacement (a) and feedback mechanism (b)

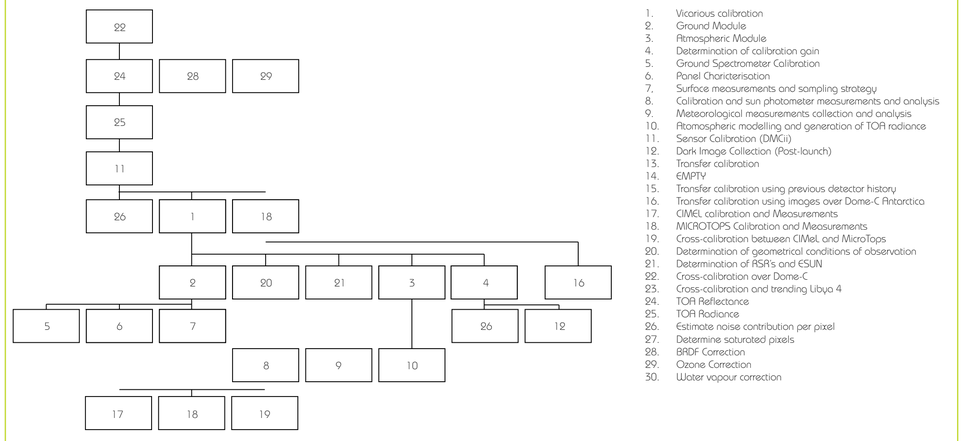

Figure 7 : Example modular structure, in the final version the number of modules will be in the hundreds in much finer detail.

Modules

Each processing step is broken down into a separate module, with description, protocol, method of estimating uncertainty and relevant quality control measures for that module.

- Modules can be replaced (with updated modules with different algorithms and lower uncertainties) (figure 6).
- Modules can be revised without necessarily reprocessing all the data.
- Metadata lists all modules used to generate a specific product.

End-User Server and Protocols Manual

There is no ideal quality indicator for all users. In the DMCii system the end-user with an image can "drill-down" using the image ID to any module in the processing chain and extract any Quality Indicator they wish, or simply look up the procedures applied in the protocols manual that covers EVERY step of the processing chain. The end user can "drill-down" to

- Signal to Noise Ratio, MTF data
- Uncertainty in radiance on any step
- Drift in calibration
- Calibration uncertainty, etc...

dmc International Imaging