Enhancement of the Huygens DISR dataset

Björn Grieger
Aurora Technology B. V. for ESA
ESAC, Madrid, Spain

Erich Karkoschka
Lunar & Planetary Laboratory
University of Arizona, Tucson, USA

Maria del Pilar Caballo Perucha
Johanneum Research Forschungsgesellschaft mbH
Graz, Austria

A few glitches . . .

- RF link problem

  → Fully mitigated by retrograde delivery flyby

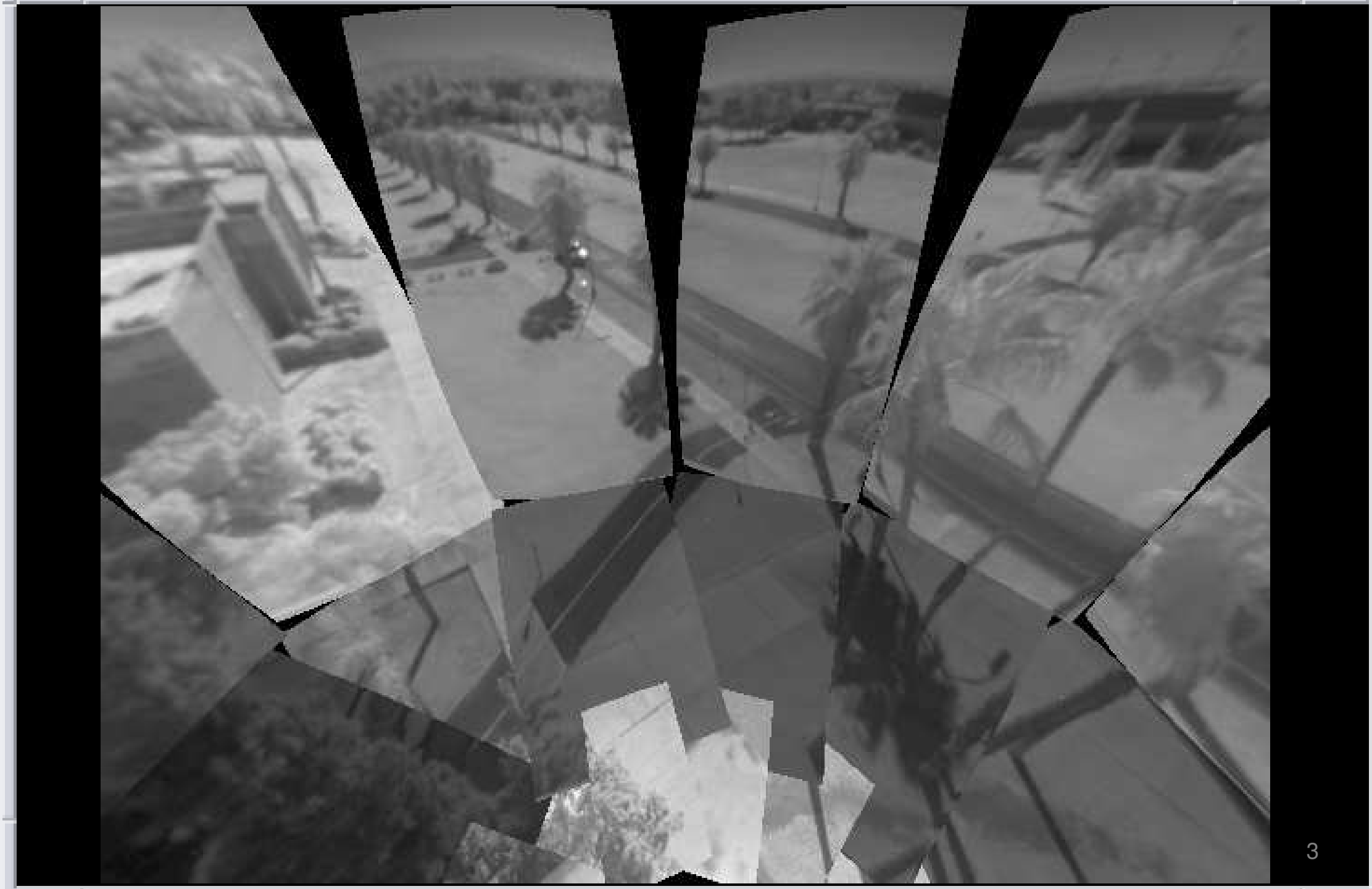
- Channel A receiver not switched on

  → Partly mitigated by ground based observation campaign (“channel C”); half of DISR images lost

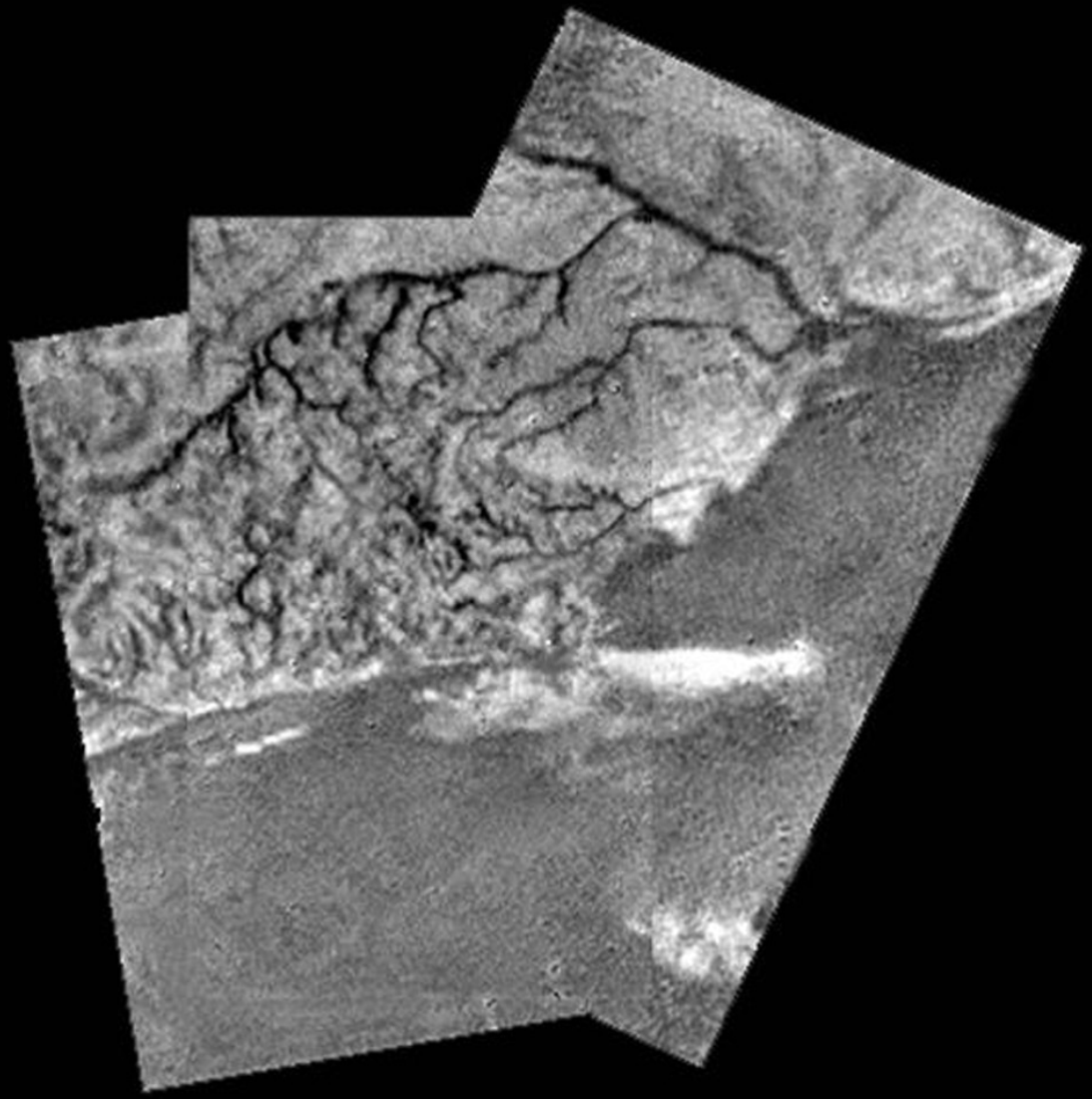
- Wrong sense of probe rotation

  → For DISR, partly mitigated by fallback preset observation sequence, but measurements in random directions instead of well aligned

Panorama as planned, 36 images 360°



In the night of the descent: 3 images . . .



. . . put together by Larry Soderblom with the software that came with his consumer camera.

Things took time

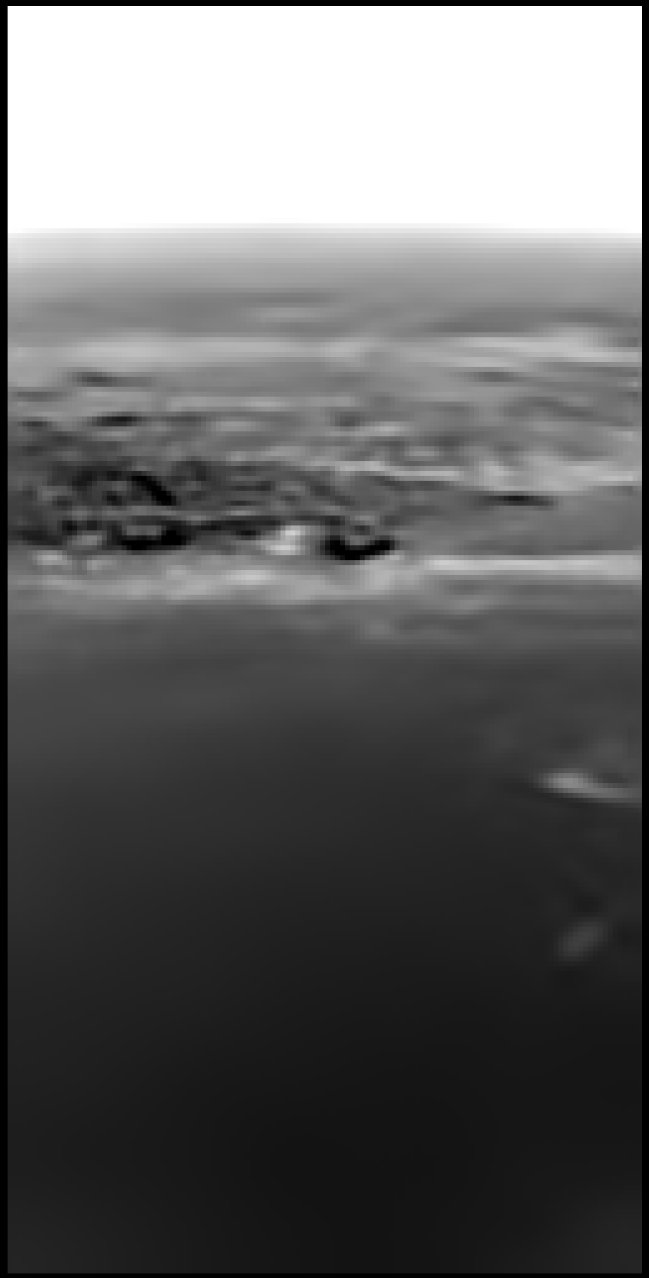
- Data analysis and modeling took much longer than expected.
- At the end, archiving was done somewhat in a hurry, with some mishaps.
- Now being responsible for “legacy mission data” at ESA’s Planetary Science Archive, these fall back onto me.

On board processing

1. Flat fielding
2. Compression
   (a) Reduction $12 \rightarrow 8$ bit by "square rooting", details selected by flight software
   (b) JPEG like Digital Cosine Transform (DCT), details selected by flight software

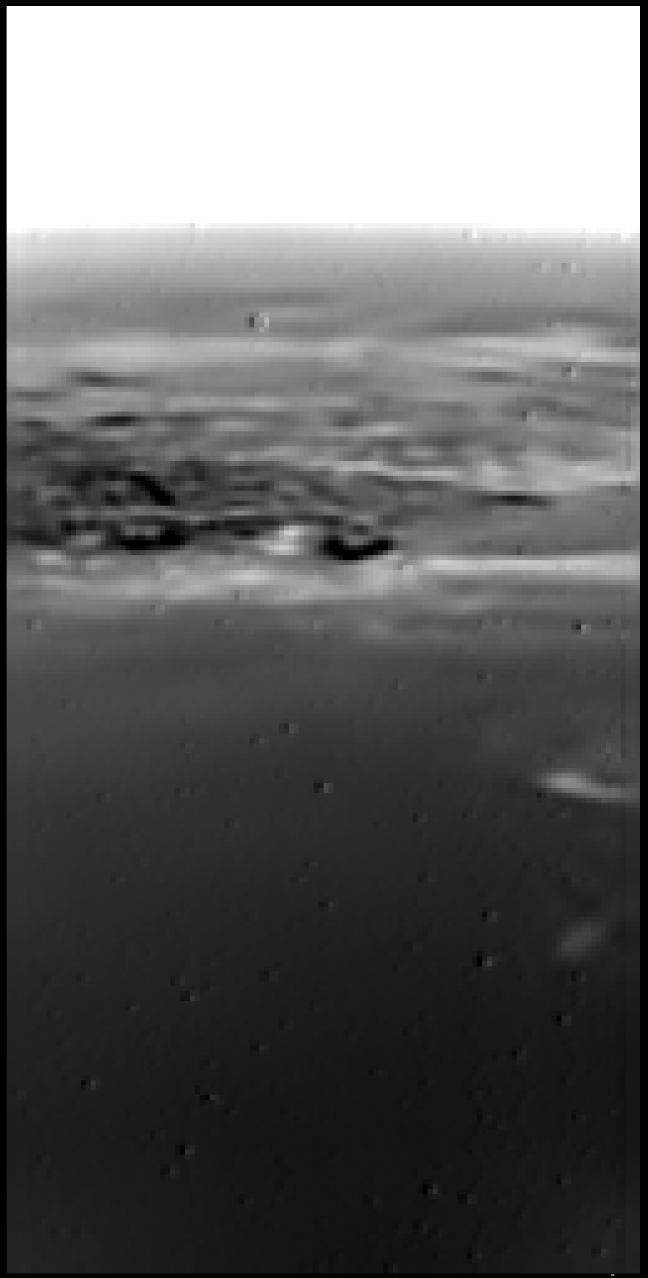
On board flat fielding

"True" image



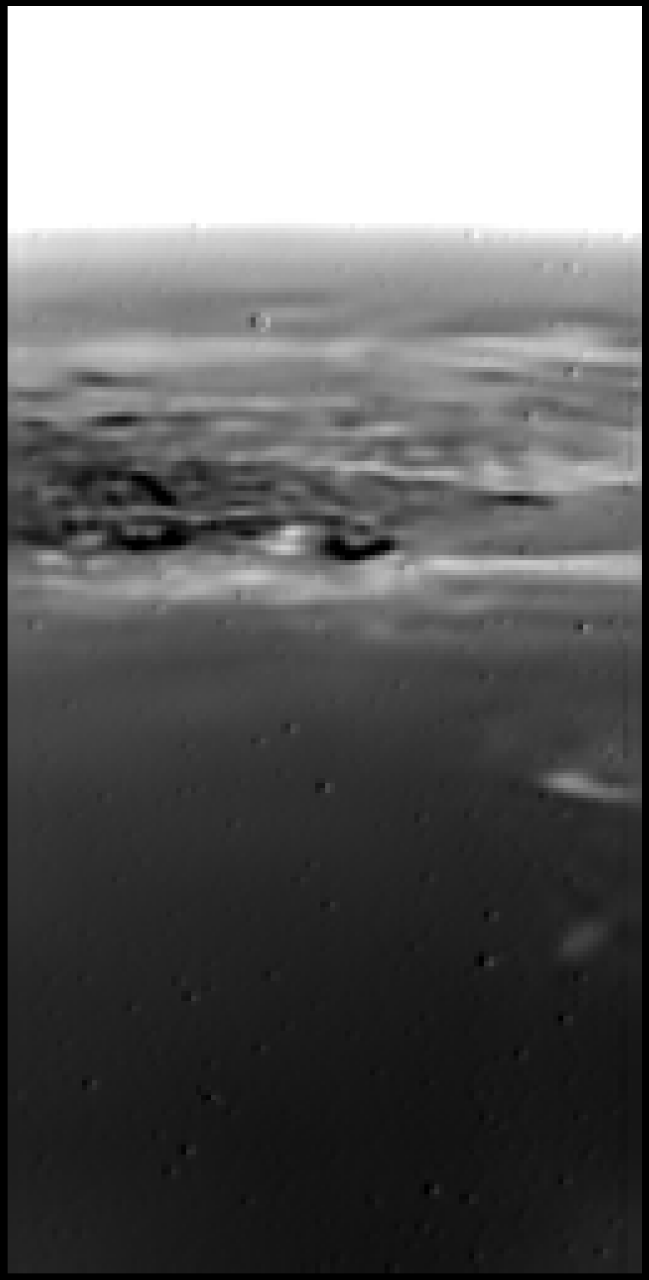
Recorded image

Flat fielded



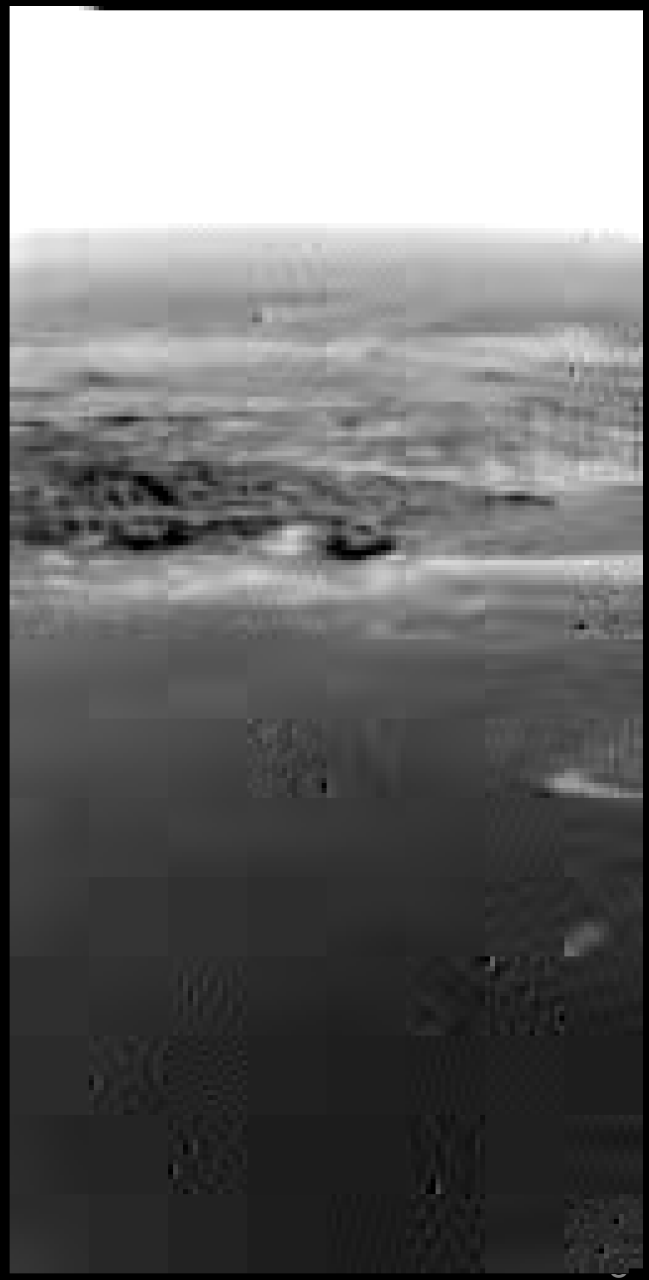
On board compression

Flat fielded



Square rooted

(De-)compressed

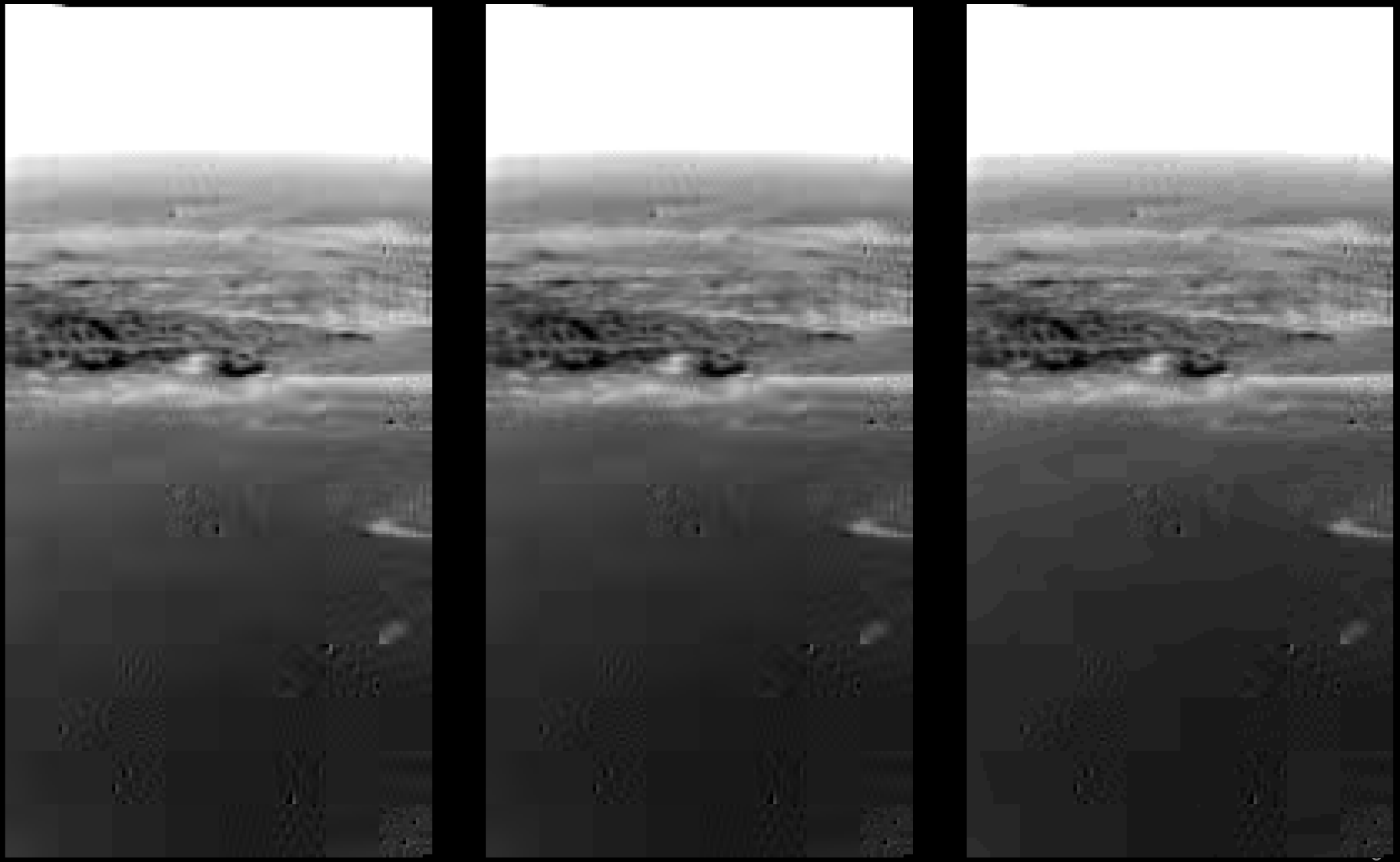


De-“square rooting”

Decompressed

“Squared” — Raw

Rounded



“Lossy decompression”

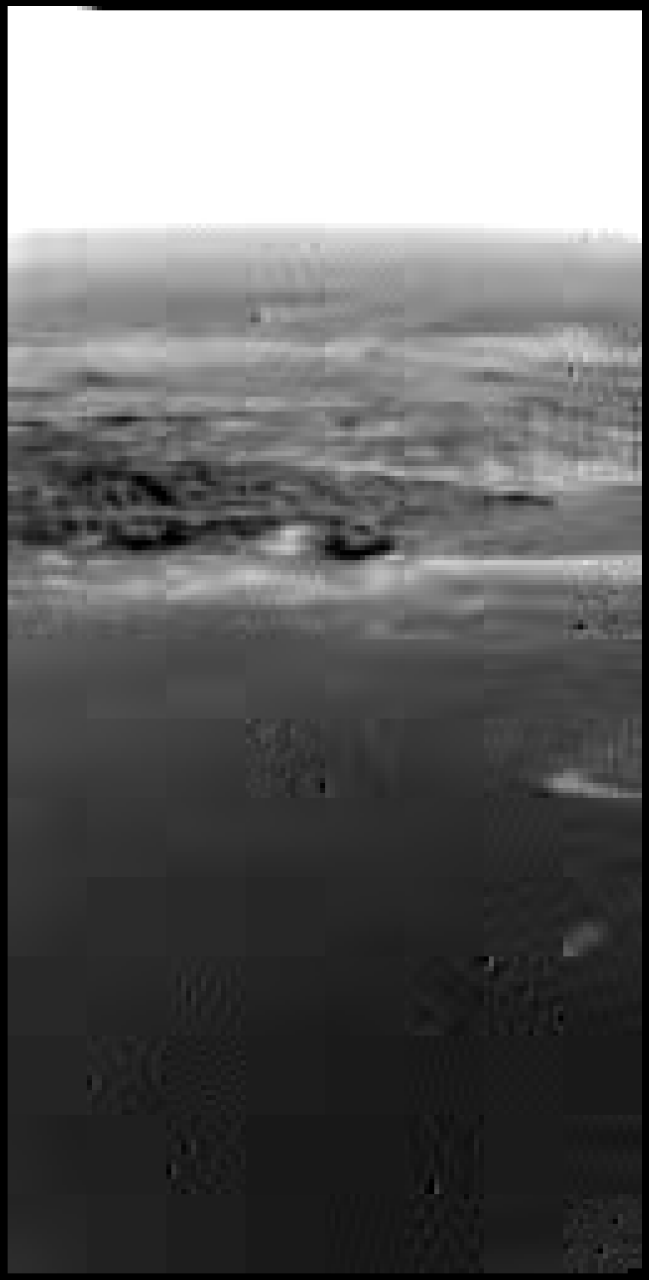
- In V1.0 of the DISR dataset, the decompressed pixel values have been rounded to integers before inverse square rooting.

V1.0 is still the one available at the PSA!

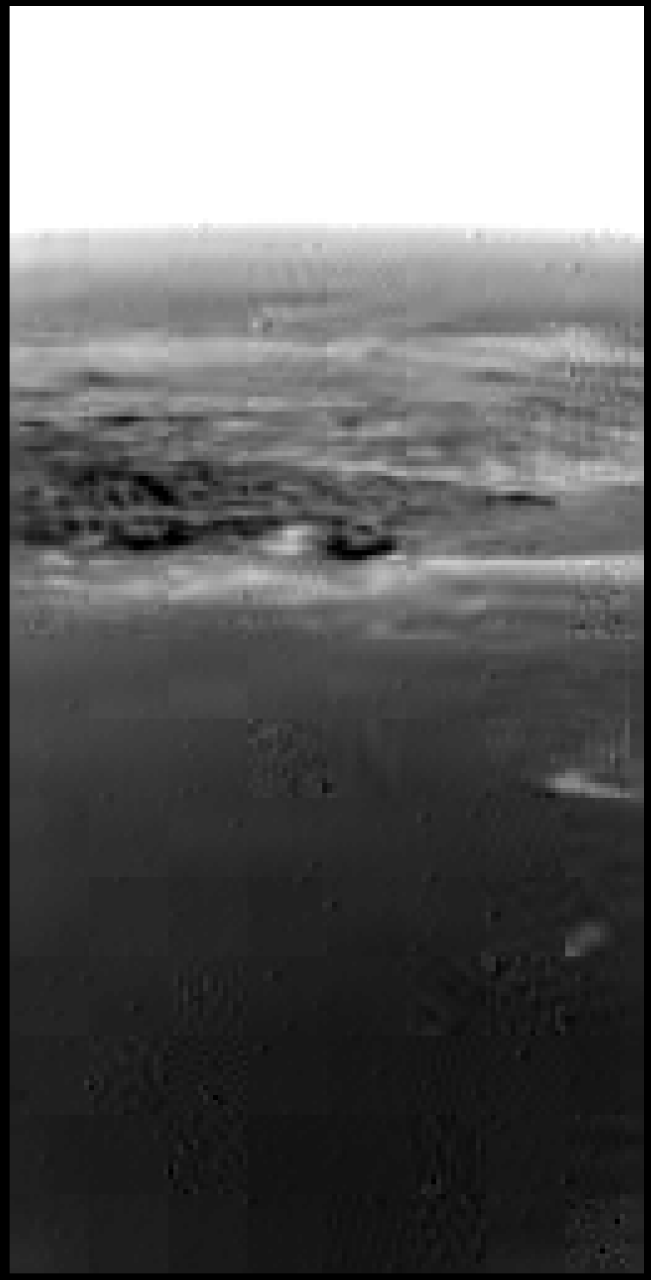
- The latest version V1.3 cannot be ingested into PSA because of PDS format violations.

Further processing

“Raw”

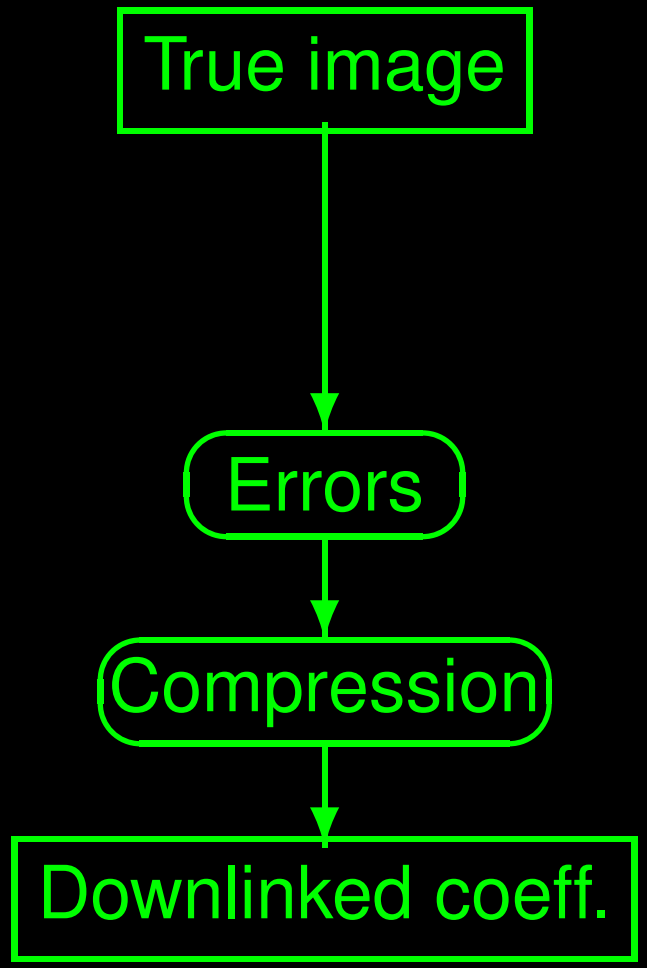


“Unsmoothed”

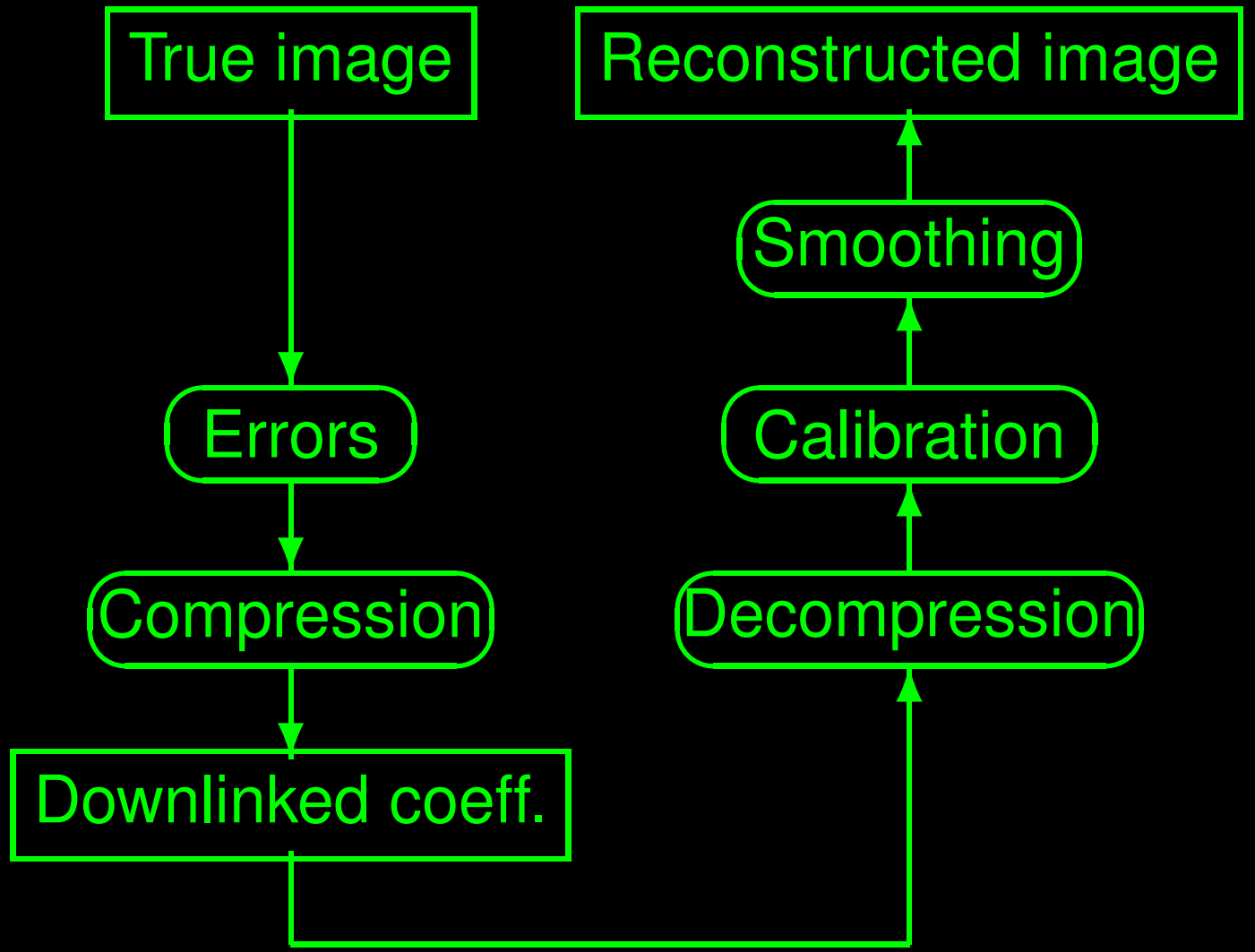


E-Images

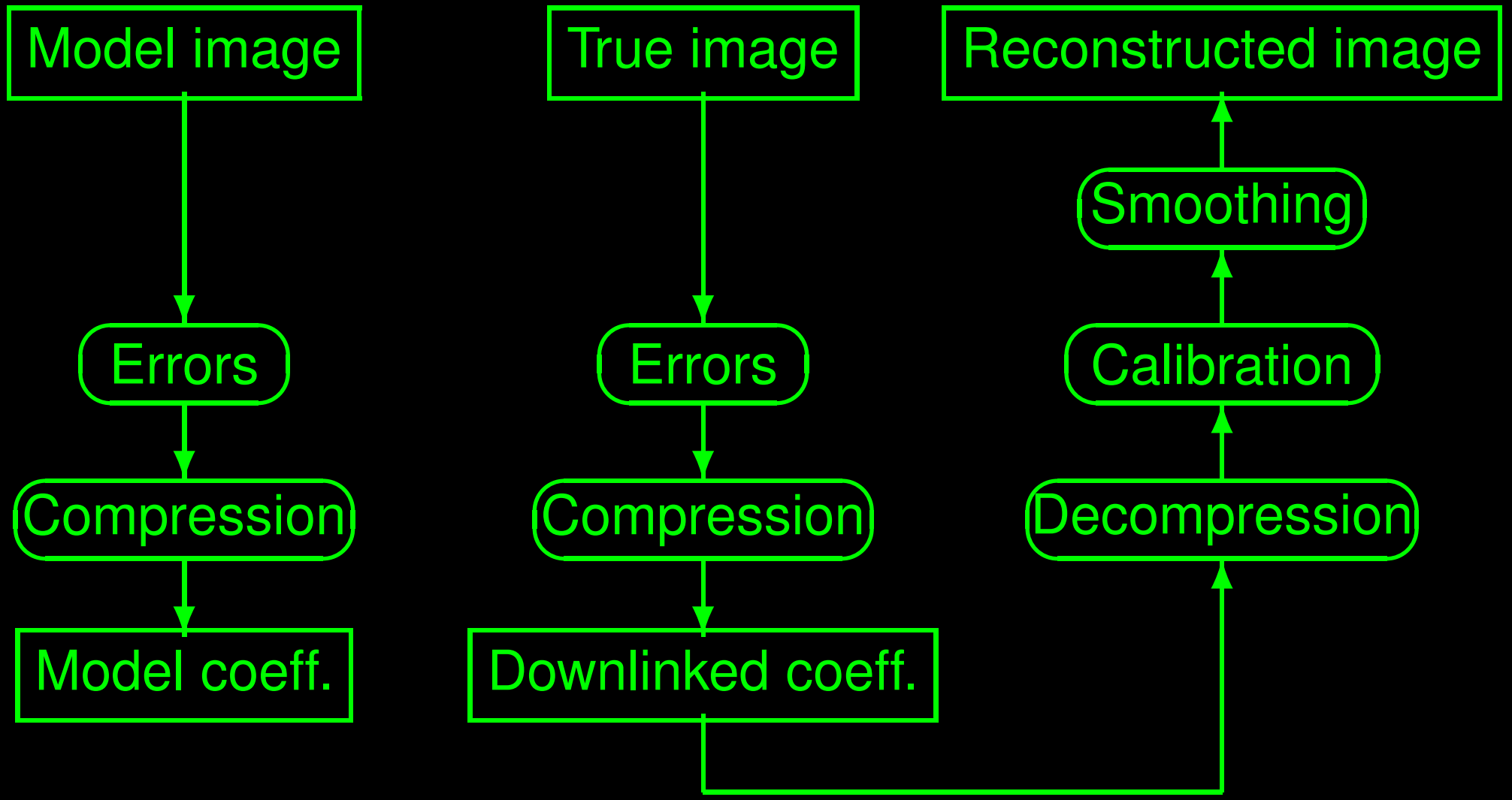
Direct and inverse approach



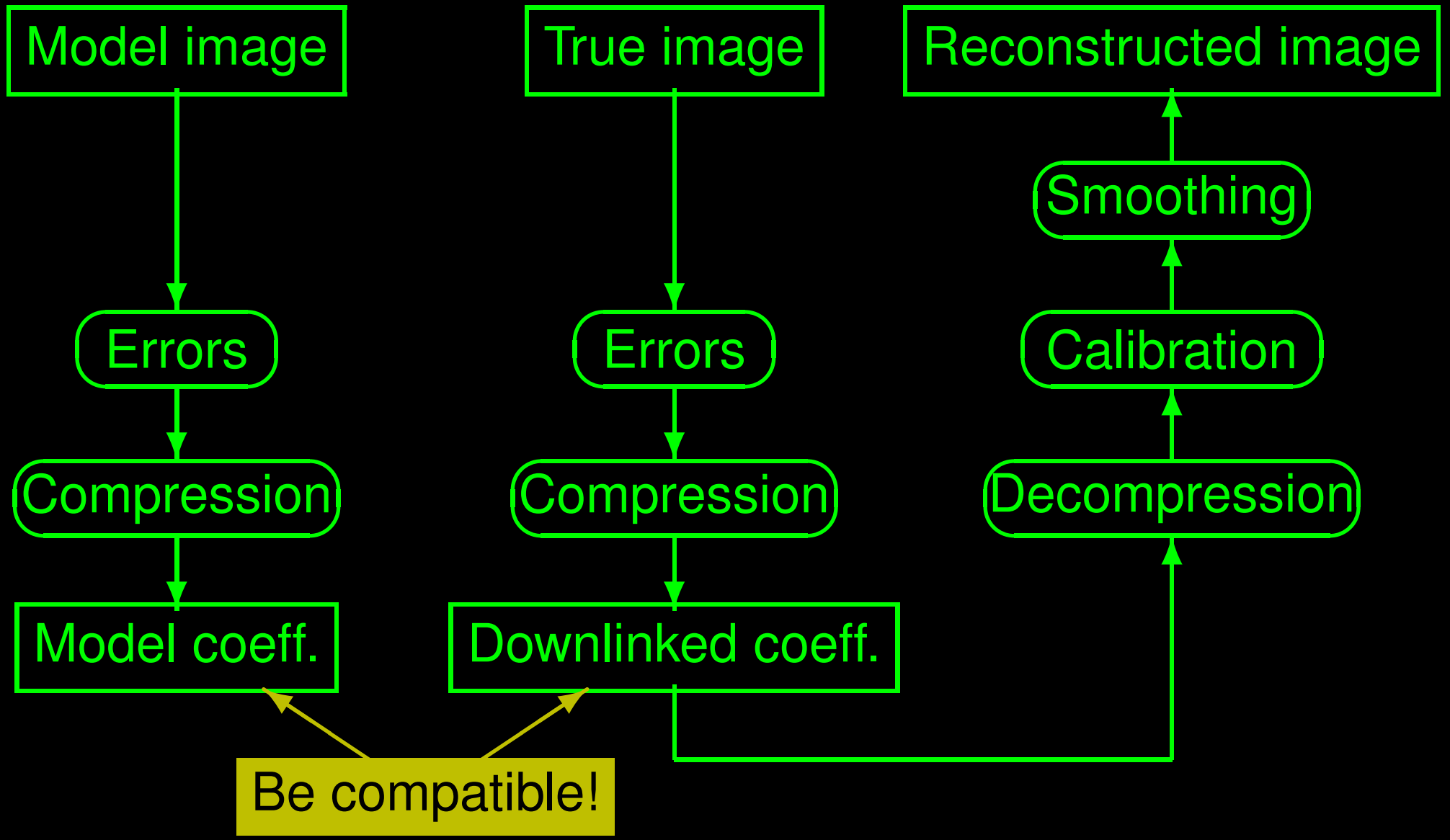
Direct and inverse approach



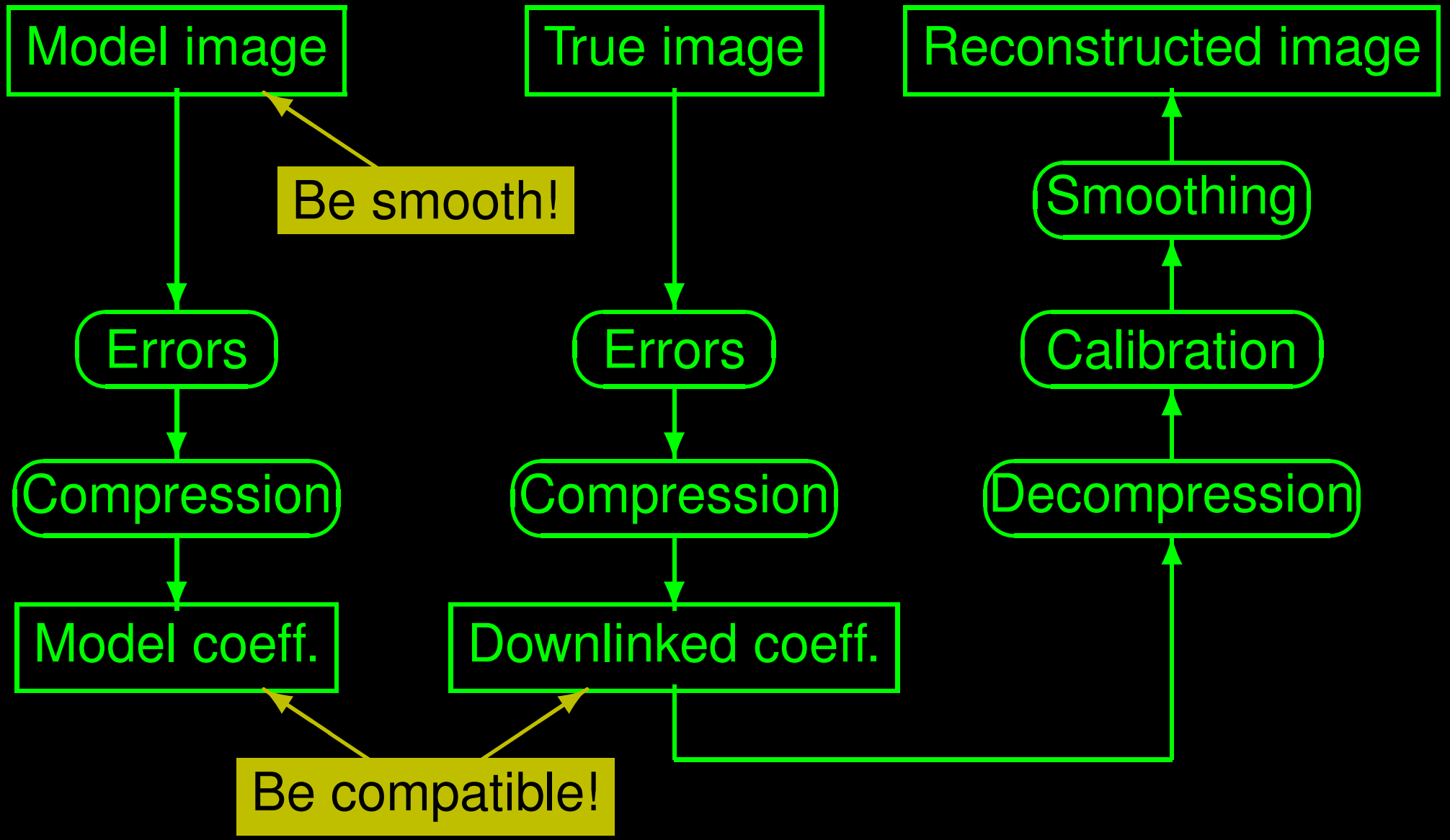
Direct and inverse approach



Direct and inverse approach



Direct and inverse approach



Simulation with JPEG

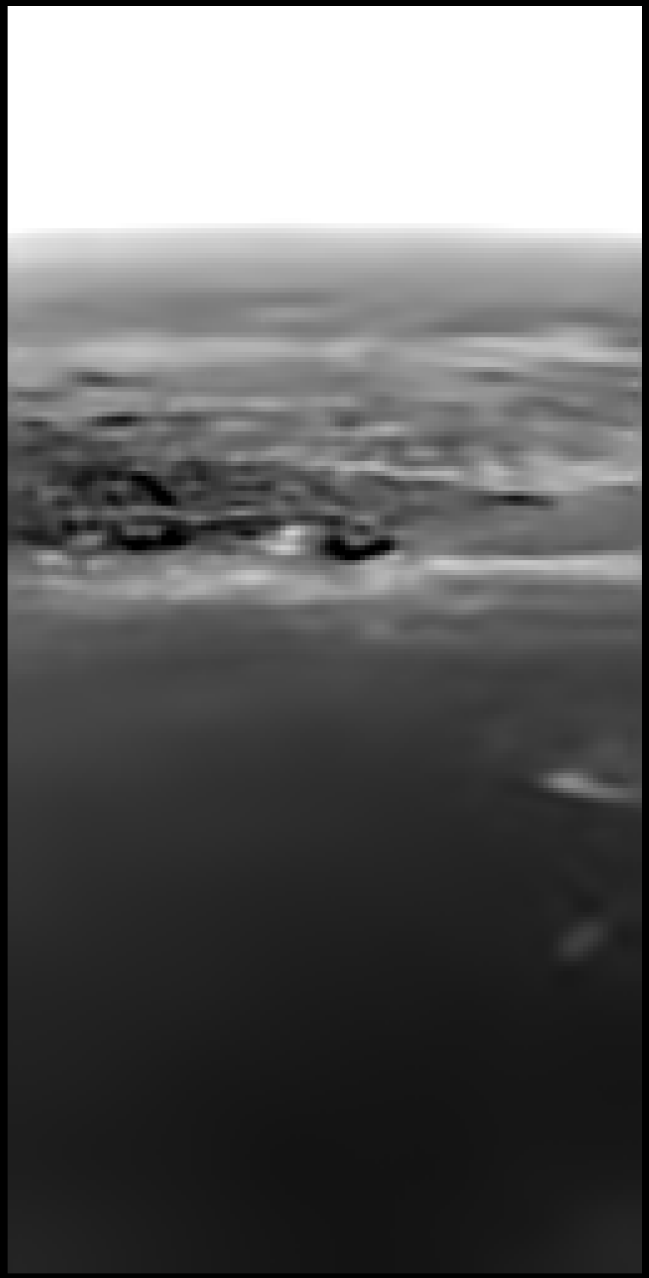
True image: E-Image

Error: Only flat fielding error, ratio of laboratory and in-flight flat field, exaggerated by power of 5.

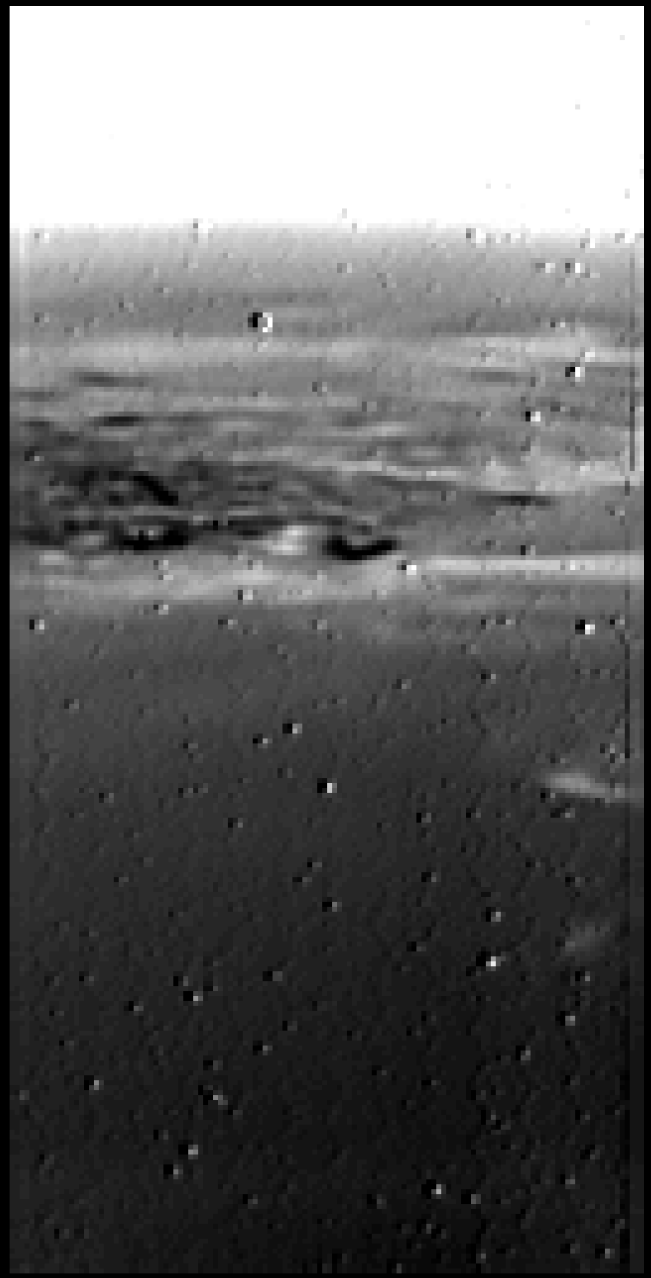
Compression: JPEG, quality 50 %.

Simulation with JPEG

“True” image



Flat fielding error



(De-)compressed

Direct approach

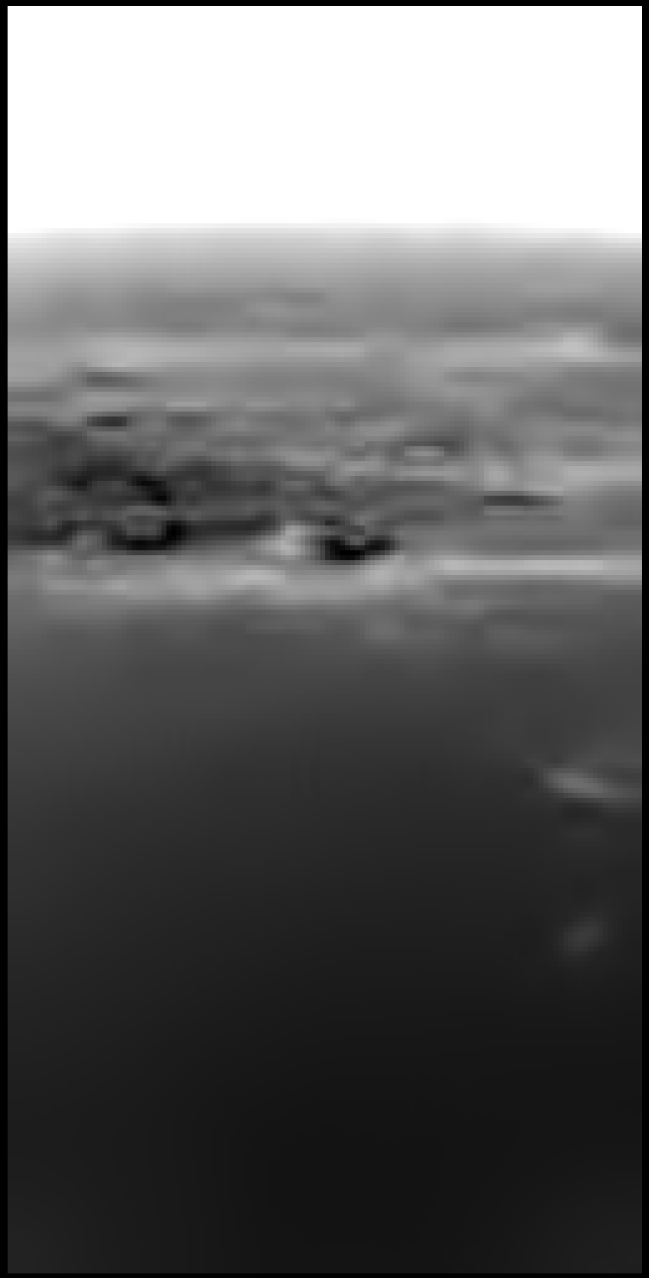
(De-)compressed

Calibrated

Smoothed

Comparison with inverse approach

Inverse approach



"True" image

Smoothed

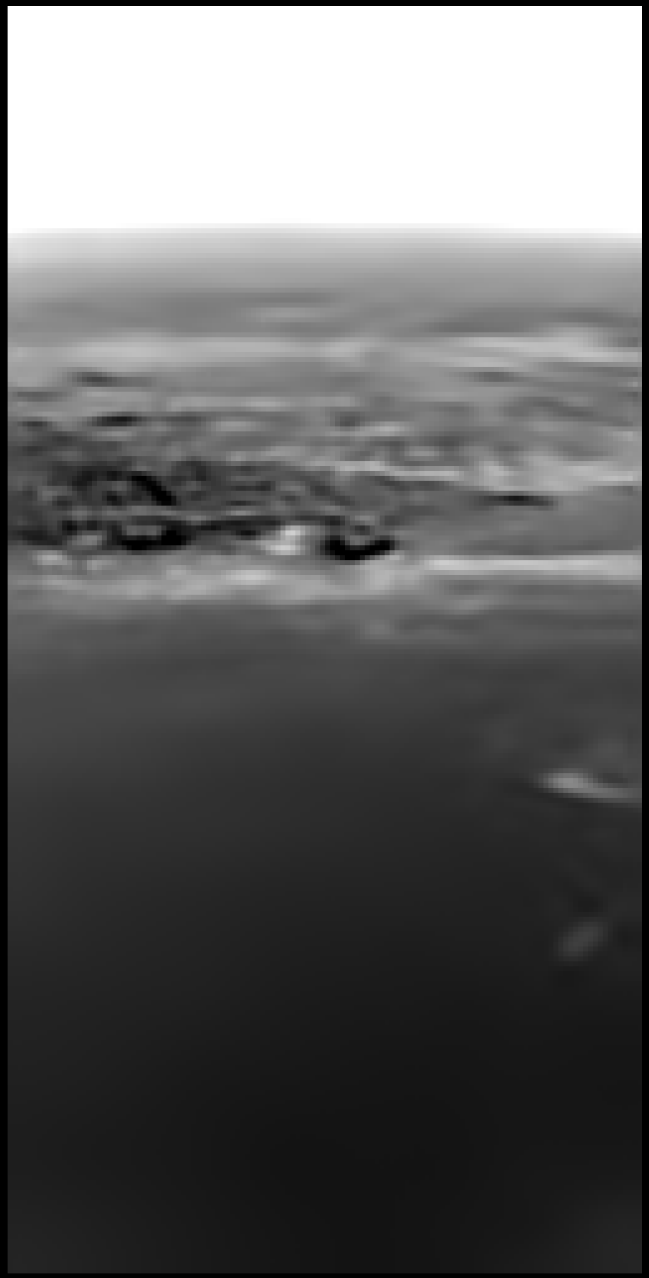
What to preserve in the archive?

Full processing information:

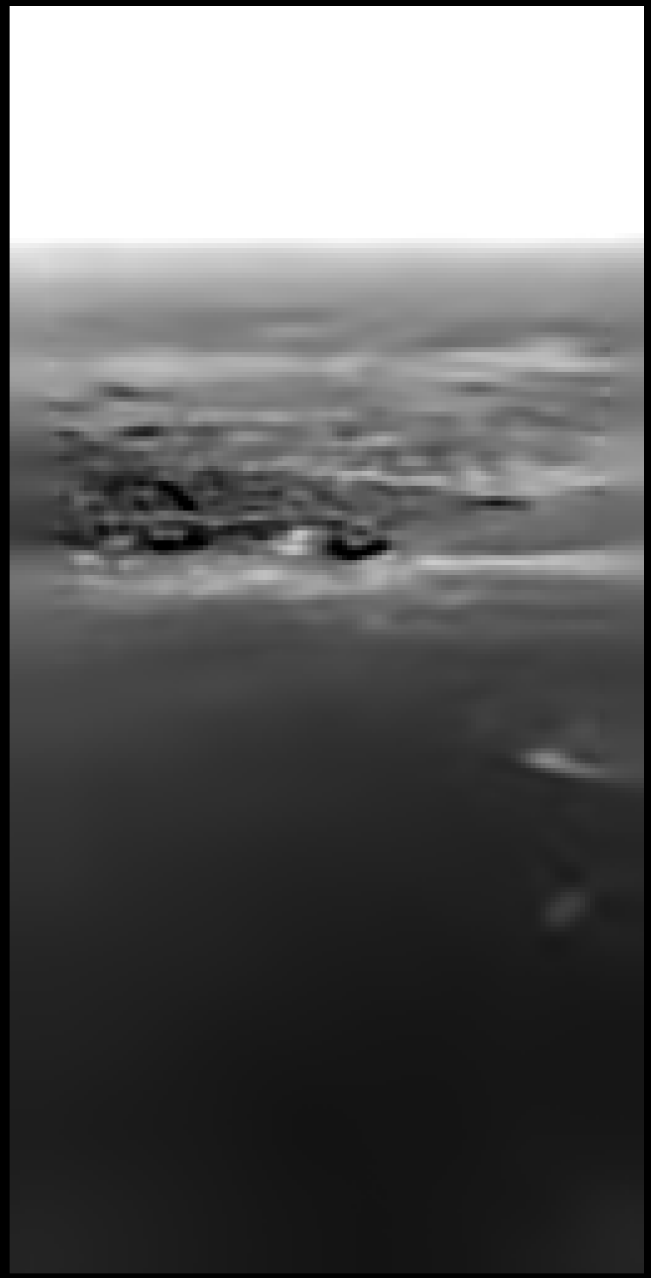
- the square rooting lookup table used on board
- the quantization values used to quantize the DCT coefficients
- the threshold value used to discard DCT coefficients (as estimated)
- the dark fields as modelled from flight data
- the flat fields as modelled from flight data
- the on board flat fields applied before compression
- the geometry fields giving the viewing direction of the center of each pixel

Geometric distorsion

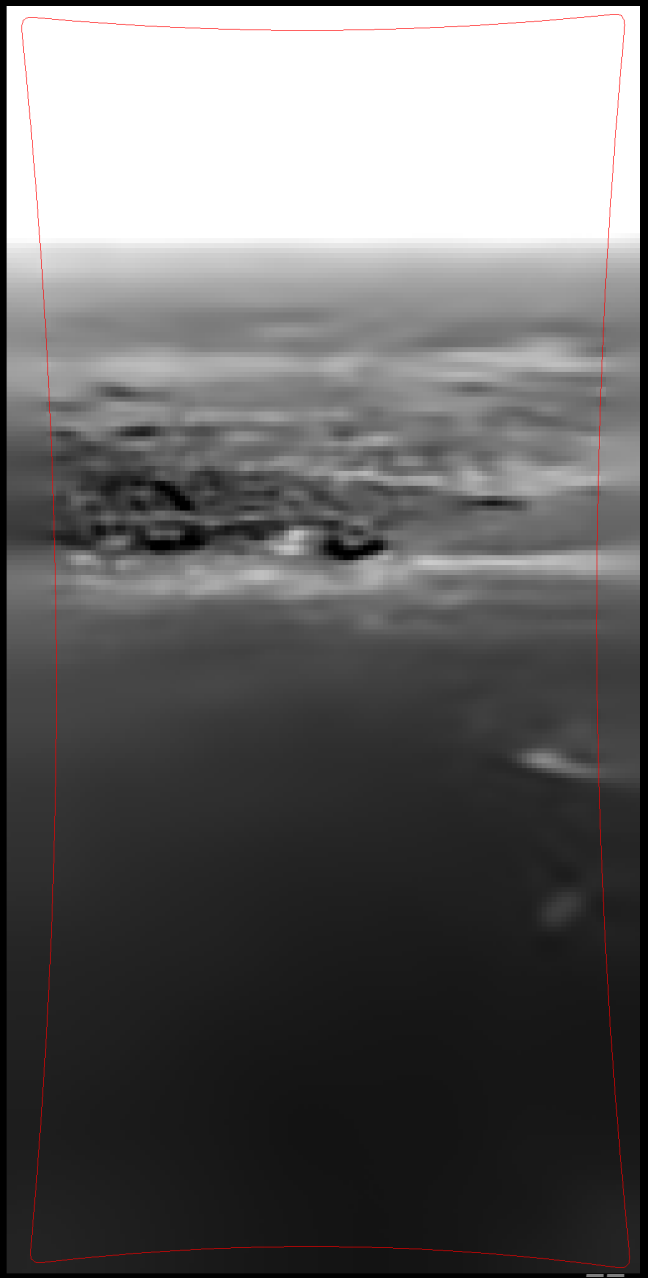
E-Image



G-Image



True edge



Atmospheric correction

G-Image

M-Image

J-Image

“Raw” images

- Reside in the ‘DATA’ directory of the archive data set.
- Make sure to get V1.3, as the images in V1.0 were “lossy decompressed”.

PSA has still V1.0 (working on ingestion of V1.3/1.4).

PDS Atmpspheres Node has 1.3, but you may also find V1.0 there.

Calibrated images

- Unsmoothed Images (calibrated)
- E-Images (compression artifacts removed)
- G-Images (distorsion corrected)

All reside in the ‘EXTRAS’ directory, either V1.0 or V1.3.

Next versions

There will be V1.4 with PDS standard violations corrected to allow ingestion into PSA.

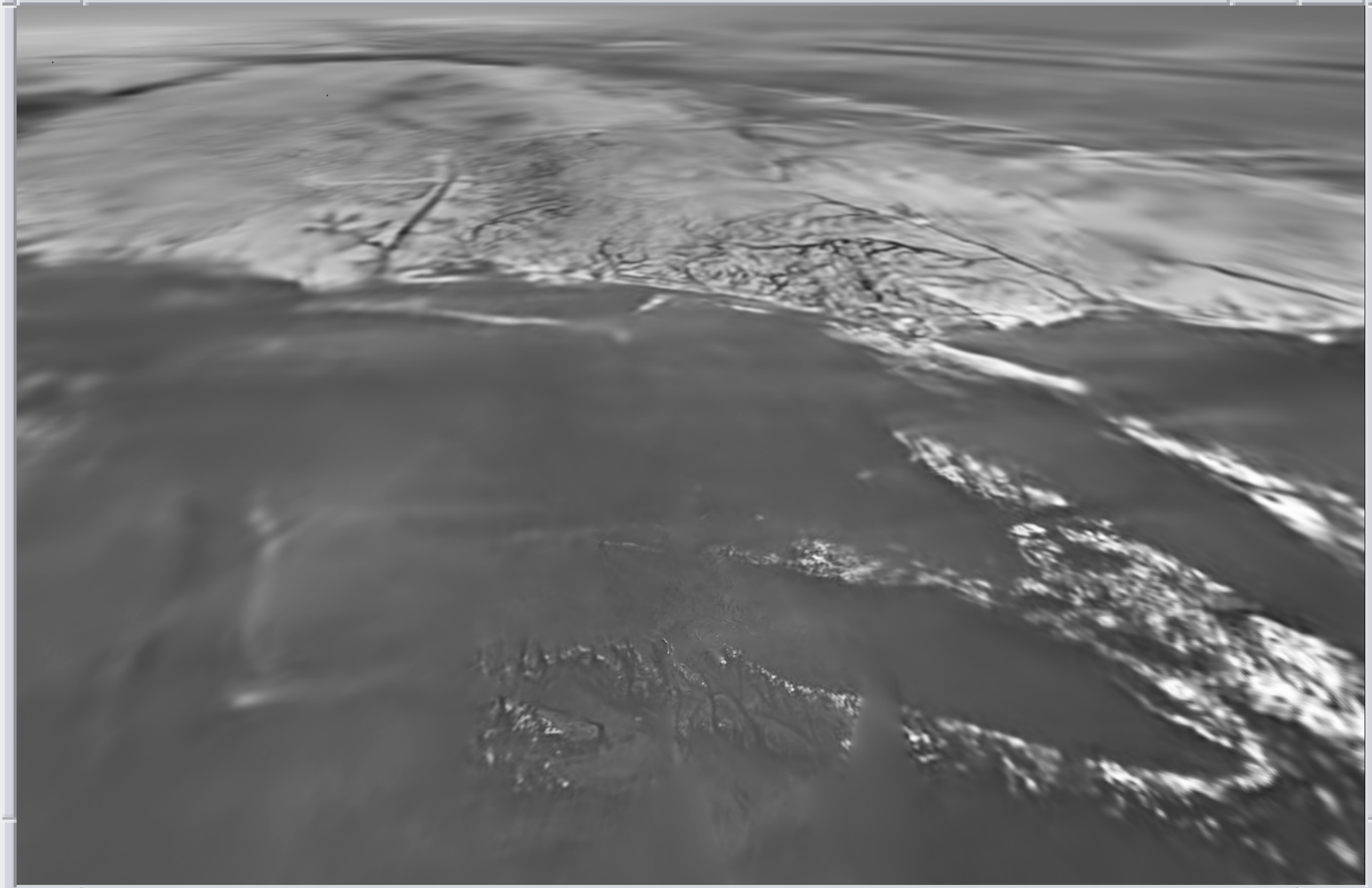
Additional data is being prepared at PSA, will either be provided in a complete new dataset V2.0 (may be in ‘DATA’ with labels or just in ‘EXTRAS’) or separately, which will comprise:

- Everything needed to redo the calibration
- Images corrected for atmospheric effects

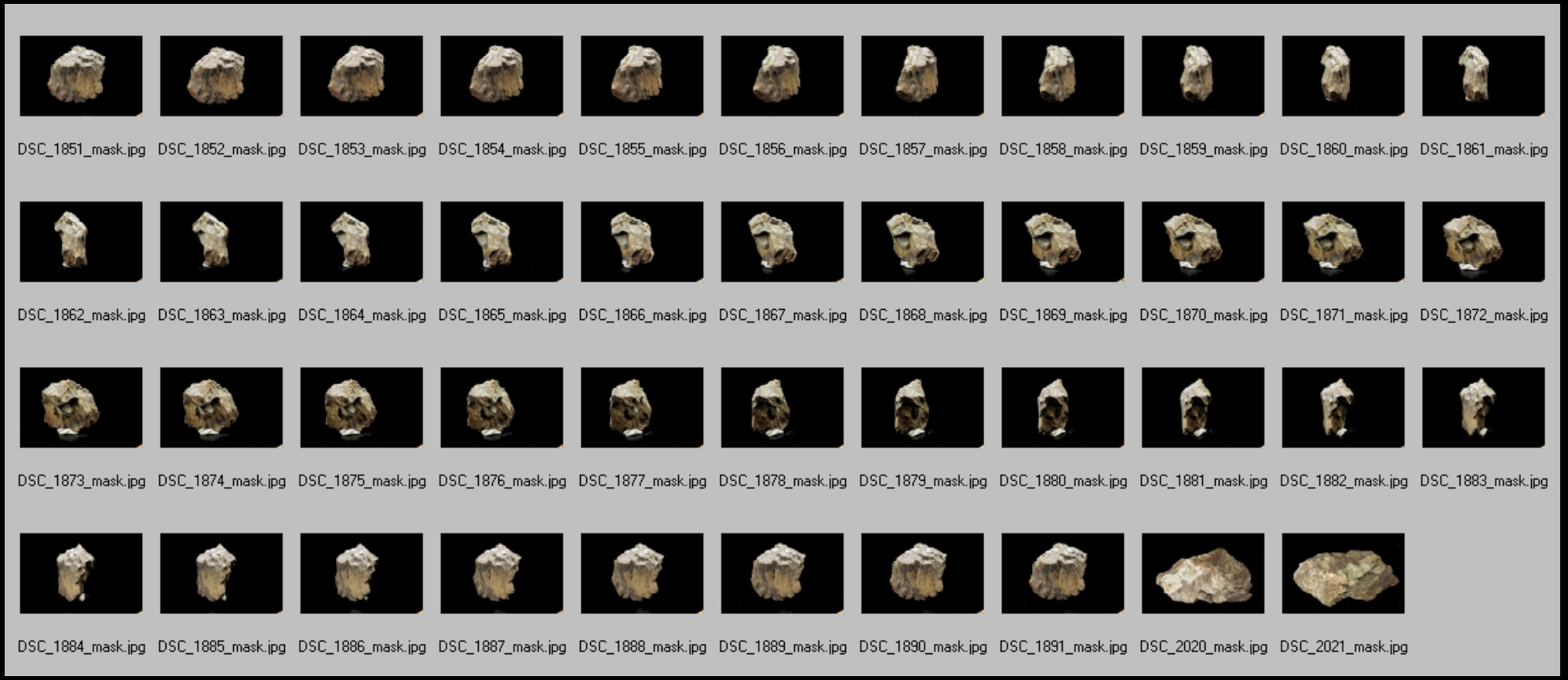
From the abstract

"We report on an attempt to create a full DEM by simultaneously employing the complete set of images."

Mosaic (rendered oblique view)

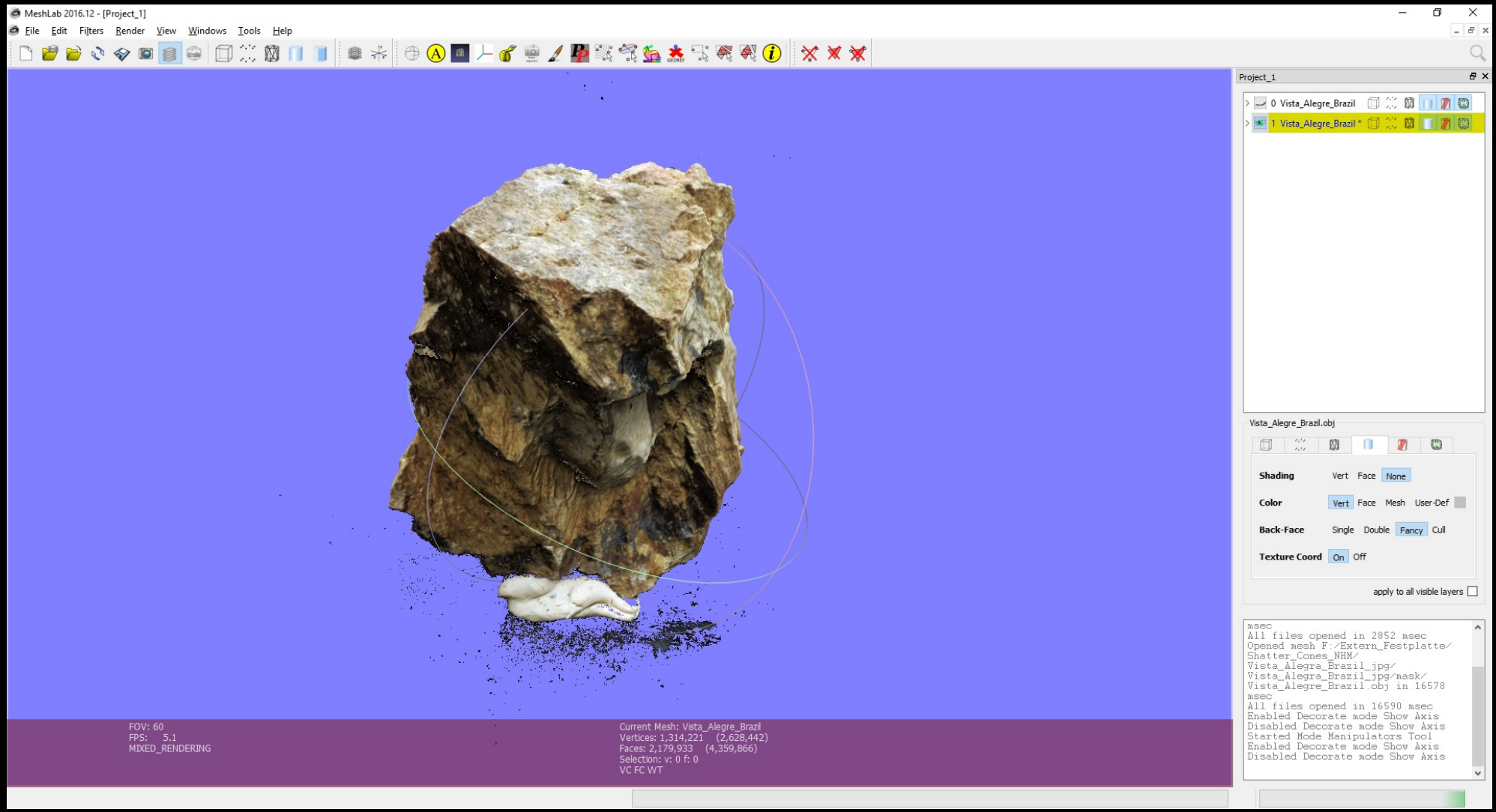


Shatter cone images



Credits: Natural History Museum Vienna, Christian Koeberl

3D reconstruction



Good results obtained with Agisoft Photoscan and Reality Capture.

No success with DISR images (only MRIs shown)