



SPOT DEM Product Description

Version 1.2 - January 1st, 2005

This edition supersedes previous versions

Acronyms

DIMAP	Digital Image MAP – encapsulation format supporting data description (raster or vector) and metadata description
DTED	Digital Terrain Elevation Data
DXF	Drawing Exchange Format –Autocad derived
HRS	High Resolution Stereoscapy - SPOT 5 instrument
JPEG, JPG	Joint Photographic Expert Group
DEM	Digital Elevation Model
SRTM	Shuttle Radar Topographic Mission
SVG	Scalable Vector Graphics
Tiff - GeoTiff	Tag Image File Format – GeoTiff is the geocoded version of the Tiff format and is the raster used by default within DIMAP
XML	EXtensible Markup Language – Format used for the data description des données within DIMAP

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1 Introduction

This document describes the specifications and format for the SPOT DEM products, exclusively extracted from SPOT 5 HRS stereoscopic data. On January 1st, 2005, more than 70 million square km of qualified HRS data are available for SPOT DEM generation.

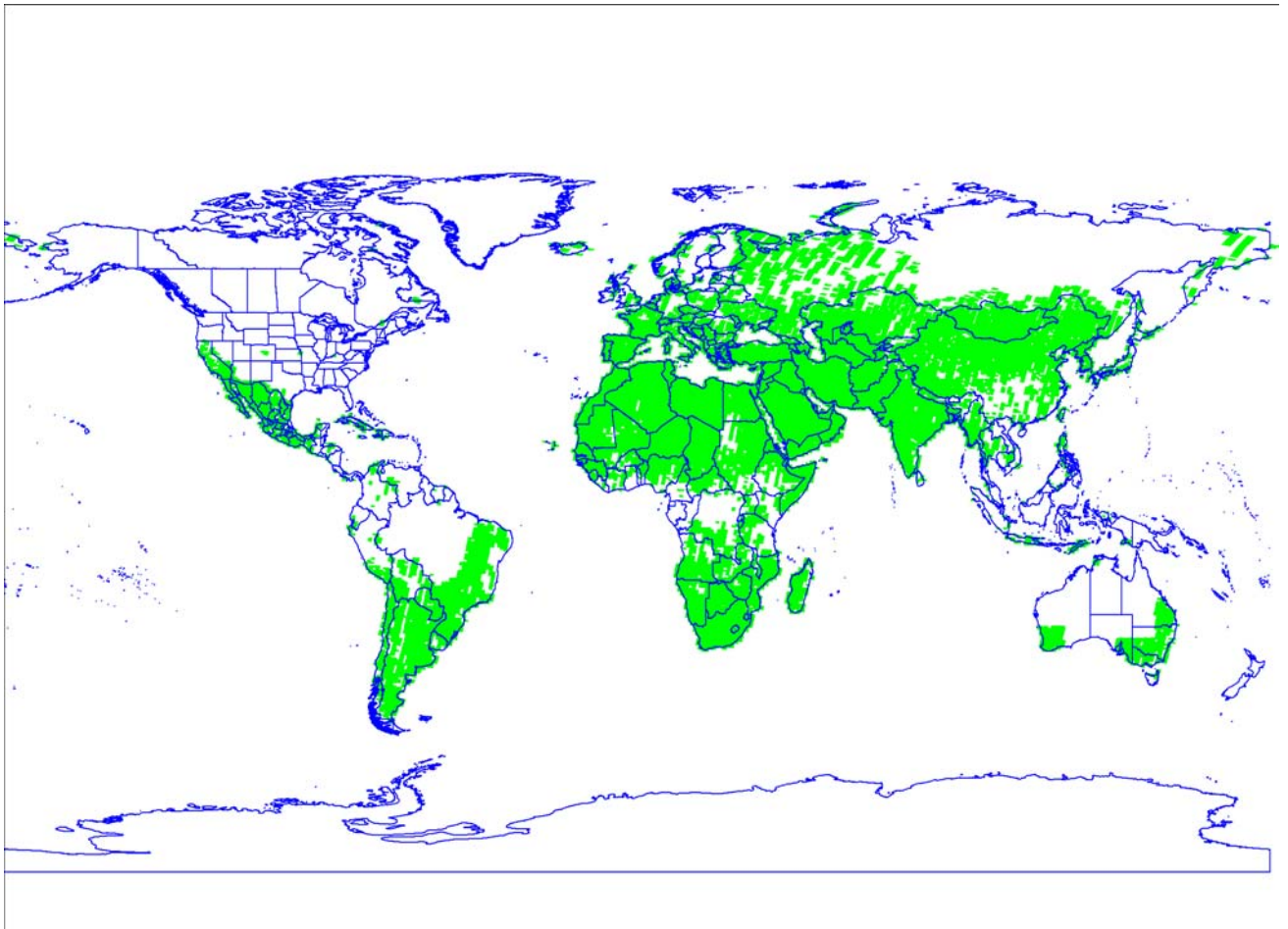
The SPOT DEM product comprises a raster layer, as well as description data in XML format::

- a DEM in 16-bit GeoTIFF format (DTED2 or 16-bit BIL as an option)
- metadata in XML format

These layers are encapsulated within a DIMAP profile for display using an Internet browser (see § 5.3).

DEMs are widely used in digital mapping, for example to apply geometric corrections to radar and optical imagery. They are also used in geographic information systems (GIS) for a broad range of applications linked to land management and terrain modelling, including impact studies; rail and road infrastructure studies; mobile telecommunications engineering; structural geology surveys; oil & gas exploration; aspect, insolation and surface runoff mapping; cartography; mission planning; weapon system navigation files; flight simulation and airport landing approaches; etc.

Worldwide HRS qualified data as of January, 1st 2005



2 SPOT DEM product features

2.1 SPOT DEM contents

SPOT DEM comprises a Digital Elevation Model layer, as well as description data in XML format.

2.1.1 SPOT DEM structure

The framing of SPOT DEM is provided by square kilometers, according to the framing provided by the customer.

2.1.2 Coverage

The HRS instrument cannot guarantee complete coverage of some zones due to weather conditions, stereopair correlation limits due to the landscape, and the inherent limits of the sensor when imaging very mountainous terrain (B/H ratio of 0.8).

SPOT DEM can be filled locally by interpolation or with other available source data such as GTOPO30 or SRTM 90m.

2.1.3 Product format

SPOT DEM products are in DIMAP format and comprise :

- a DEM in 16-bit GeoTIFF format (DTED2 or 16-bit BIL as an option)
- metadata in XML format

The advantage of DIMAP is that it allows users to read Reference3D data with off-the-shelf software. For example, they can read the raster GeoTIFF format, the WML format or both simultaneously.

2.2 Data acquisition

The HRS acquisition plan for the generation of a global coverage of SPOT DEMs relies on satellite programming requests, each of those having different priority orders. This acquisition plan is reviewed on a regular basis in order to integrate customers' new requests.

3 SPOT DEM layer specification

3.1 DEM layer

3.1.1 Data format and encoding

The DEM contains elevation values in metres, encoded as 16-bit signed integers.

The -32767 value in the DTED format that indicates a null value is used for areas where the production process did not allow automatic extraction of elevation values.

3.1.2 Datum and projection system

The SPOT DEM vertical datum is EGM 96.

On request, SPOT DEM values are provided in :

- Geographic coordinates with respect to WGS84
- Cartographic coordinates in UTM WGS84 system

Other cartographic systems can be used if all necessary conversion parameters between these systems and UTM WGS84 are provided by the customer.

3.1.3 SPOT DEM post spacing

The post-spacing of SPOT DEM products can be provided, on request, in:

- Geographic coordinates: 1 arcsecond (about 30 metres at the equator), with East/West dimension varying according to latitude

or

- Cartographic coordinates: resampled with a constant post spacing of 20 metres

3.1.4 SPOT DEM accuracies

The DEM accuracy specifications below are valid for a full square degree and solely apply to DEMs generated from HRS imagery and not to DEMs derived from external sources. The SPOT DEM absolute horizontal and vertical accuracies depend on the dimensions of the area of interest or on the availability of Reference3D on this area:

- **Absolute planimetric accuracy:**
circular error with respect to WGS84 (confidence level 90%).....**15 m to 30 m**
- **Absolute elevation accuracy:**
linear error with respect to EGM96 (confidence level 90%)
flat or rolling terrain (slope ≤ 20 %).....**10 m to 20 m**

SPOT DEM products may have variable planimetric and elevation performances :

- **Small areas** :

- ✓ One to a few HRS stereopairs

- ✓ HRS intrinsic accuracies:

 - 30 m @ 90% planimetric accuracy**

 - 20 m @ 90% elevation accuracy**

The absolute planimetric accuracy of 15 m can be achieved using excellent-quality ground control points (better than 10 m) provided by the customer.

- **Large areas** :

- ✓ 5 to 10 HRS stereoscopic strips (100 000 to 200 000 sq. km minimum)

- ✓ Block triangulation necessary :

 - 15 m @ 90% planimetric accuracy**

 - 10 m @ 90% elevation accuracy**

- **Areas covered by Reference3D** :

- ✓ DEM layer extraction from the corresponding Reference3D tile

- ✓ Intrinsic accuracies of Reference3D :

 - 15 m @ 90% planimetric accuracy**

 - 10 m @ 90% elevation accuracy**

3.1.5 DEM layer corrections

SPOT DEM production systematically includes:

- Automatic filtering to eliminate correlation artifacts
- Flattening of non-running water bodies (rivers, etc... excluded) exceeding 0.5 km²

3.2 Metadata

✓ HRS data strip

The following metadata are provided for each HRS data strip used to produce a SPOT DEM:

SPOT	S5S1S0303311040167
ID	S5S1S0303311040167
K_J	384-167
SAT	4
DATE	2003-03-31
TIME	10:40:23
INSTRUMENT	HRS1
MODE	B_W
INCIDENCE_ANGLE	23.016834 (DEG)
VIEWING_ANGLE	0.000000 (DEG)
SUN_AZIMUTH	156.916985 (DEG)
SUN_ELEVATION	48.370148 (DEG)

✓ General information

Geodetic reference system

Producer reference

✓ DEM

number of rows/columns

coordinates of 4 corners

post spacing

4 Quality checks

✓ **Block triangulation (if necessary)**

Checks are performed on:

- tie point planimetric residuals
- Z point elevation residuals

✓ **Production**

Checks are performed on:

- bias between adjacent HRS DEMs
- flattening of water bodies in the DEM
- artefact removal in the DEM
- format
- viewing of DEM and metadata layers in Internet browser

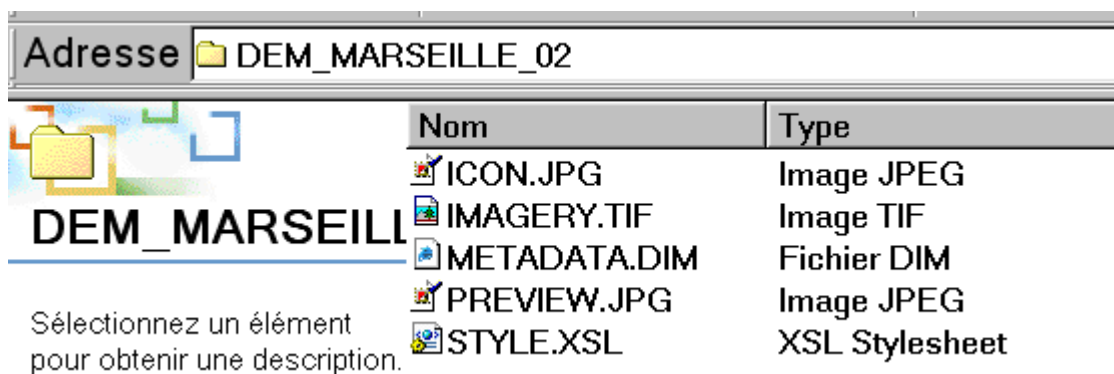
✓ **Final checks on CD-ROM before delivery**

- Format
- visual check of DEM
- viewing of DEM and metadata layers in Internet browser

5 SPOT DEM product structure

5.1 File tree

Files containing data for the demonstration SPOT DEM over Marseille area (France) are organized according to the tree below:



File names are eight characters and file extensions three characters maximum, in accordance with the ISO 9660 standard.

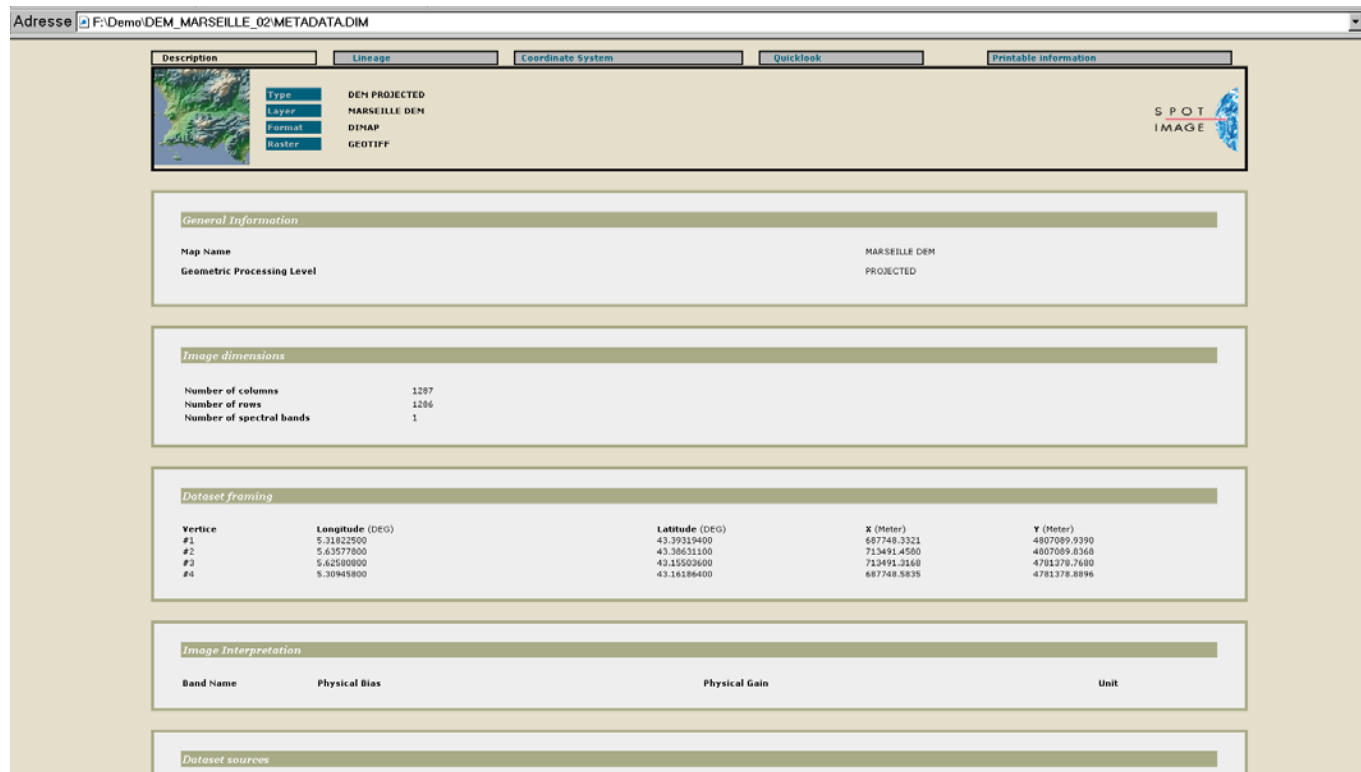
5.2 File formats

File	Format
Source metadata	XML
DEM metadata	XML
DEM	16-bit GeoTiff / DTED2 / 16-bit BIL
DEM quicklook	JPEG
DEM thumbnail	JPEG

5.3 Style sheets

Every SPOT DEM product in DIMAP format comes with several XSL style sheets that allow its main features to be displayed with an Internet browser.

An example style sheet is shown below:



Style sheets characteristics are given as an indication and are subject to change without notice.

6 SPOT DEM file size

SPOT DEM file size varies according to the considered surface.. As an example, for a SPOT DEM with a post-spacing of 1 arcsecond, located at the equator and uncompressed :

1° x 1°	30' x 30'	15' x 15'
12 000 sq. km	3 000 sq. km	750 sq. km
26 Mb	6,5 Mb	1.6 Mb