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OGC® GML Application Schema - Coverages - GeoTIFF Coverage Encoding ~~Extension~~Profile

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i. Preface

This Interface Standard is ~~an extension to a profile of~~ the OGC® GML Application Schema –Coverages version 1.0 [OC 09-146r2]. It specifies the usage of the GeoTIFF data format for the encoding of GML coverages. This encoding is used by several OGC services like the Web Coverage Service (WCS) 2.0 Interface Standard – Core [OGC 09-110r4].

Suggested additions, changes, and comments on this draft standard are welcome and encouraged. Such suggestions may be submitted by email message to OGC or by making suggested changes in an edited copy of this document and submitting this document to OGC.

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ii. Document terms and definitions

This document uses the standard terms defined in Subclause 5.3 of [OGC 06-121r9], which is based on the ISO/IEC Directives, Part 2. Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

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iv. Revision history

Date	Release	Editor	Primary clauses modified	Description
2012-08-08	0.0.1	Stephan Meissl	All	First draft based on discussions in the WCS.SWG.
2012-08-13	0.0.2	Stephan Meissl, Peter Baumann	All	Minor corrections and format adaptations.
2012-08-22	0.0.3	Stephan Meissl	Clauses 6.3.1 and B.2	Added additional notes and examples as discussed in WCS.SWG teleconference.
2012-09-12	0.0.4	Stephan Meissl	All, Clauses 2 and 3	Adjusted URIs, integrated comments received, and added ATS.
2012-10-24	0.0.5	Stephan Meissl	Clause 3 and Annex C	Moved normative references from bibliography to clause 3.
<u>2013-06-26</u>	<u>0.0.6</u>	<u>Stephan Meissl</u>	<u>Clause 6.3.1</u>	<u>Adjusted Requirement 9 and associated note.</u>
			<u>All</u>	<u>Merged again with OGC 12-101 and renamed from Extension to Profile.</u>
			<u>All</u>	<u>Integrated comments received during public RFC period.</u>

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v. Changes to the OGC Abstract Specification

The OpenGIS[®] Abstract Specification does not require any changes to accommodate the technical contents of this document.

vi. Future work

~~Based on this interface standard an extension to the Web Coverage Service (WCS) 2.0 is foreseen. This extension is going to specify how coverages using GeoTIFF encoding can be requested from a WCS including parameters defining GeoTIFF features like compression, tiling, etc.~~

It is ~~also~~ foreseen to adapt and expand the support of coverages of type `gmlcov:ReferenceableGridCoverage` based on adopted extensions of GML and GMLCOV once available.

Foreword

~~This document is an extension to the OGC® GML Application Schema—Coverages version 1.0 [OC 09-146r2] defining the usage of the GeoTIFF data format for the encoding of GML coverages.~~

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Introduction

Coverages represent digital geospatial information representing space/time-varying phenomena. OGC Abstract Topic 6 [OGC 07-011] – which is identical to ISO 19123 – defines an abstract model of coverages. Coverage instances may be encoded using the GML Application Schema – Coverages (GMLCOV) version 1.0 [OGC 09-146r2] which is based on the Geography Markup Language (GML) version 3.2 [OGC 07-036], an XML grammar written in XML Schema for the description of application schemas as well as the transport and storage of geographic information.

This ~~extension to profile of~~ GMLCOV specifies the usage of the GeoTIFF data format for the encoding of GML coverages. It is based on the authoritative format specification available as GeoTIFF Format Specification which in turn is based on the TIFF specification.

This encoding ~~will be~~ used by several OGC services like the Web Coverage Service (WCS) 2.0 Interface Standard – Core [OGC 09-110r4].

OGC® GML Application Schema - Coverages - GeoTIFF Coverage Encoding ExtensionProfile

1 Scope

This *OGC® GML Application Schema - Coverages - GeoTIFF Coverage Encoding ExtensionProfile* – henceforth abbreviated as “GMLCOV for GeoTIFF” specifies an encoding of coverages in the GeoTIFF data exchange format.

2 Conformance

This document establishes the following requirements and conformance class:

- *geotiff-coverage*, of URI http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/req/geotiff-coverage, with a single pertaining conformance class, *geotiff-coverage*, of URI http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/conf/geotiff-coverage.

Standardization target of all conformance classes are concrete coverage instance documents, as generated by some service and/or consumed by some client.

URIs given in this document for each requirement or conformance test URIs are relative paths to be appended to the root http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/.

Annex A lists the conformance tests which shall be exercised on any software artifact claiming to implement GMLCOV for GeoTIFF.

3 Normative references

This GMLCOV for GeoTIFF specification consists of the present document- and an XML Schema. The complete specification is identified by OGC URI http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0, the document has OGC URI http://www.opengis.net/doc/ISx/GMLCOV_geotiff-coverages/1.0.

The complete specification is available for download from <http://www.opengeospatial.org/standards/gmlcov>-

; additionally, the XML Schema is posted online at <http://schemas.opengis.net/gmlcov/geotiff/1.0> as part of the OGC schema repository. In the event of a discrepancy between bundled and schema repository versions of the XML Schema files, the schema repository shall be considered authoritative.

The following normative documents contain provisions that, through reference in this text, constitute provisions of this specification. For dated references, subsequent

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amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

OGC 09-146r2, *OGC® GML Application Schema – Coverages*, version 1.0

Conformance classes used:

- gml-coverage
- multipart
- special-format

OGC 07-036, OpenGIS® Geography Markup Language (GML) Encoding Standard, version 3.2

GeoTIFF, *GeoTIFF Format Specification*, version 1.8.2, supporting GeoTIFF Revision 1.0 Final, 2000-12-28, available at

<http://www.remotesensing.org/geotiff/spec/geotiffhome.html> [2011-06-17]

TIFF, *TIFF*, revision 6.0 Final, 1992-06-03, available at

<http://ftp.remotesensing.org/geotiff/spec/tiff6.pdf> [2011-06-17]

TIFF-TN2, DRAFT TIFF Technical Note #2, 1995-03-17, available at

<http://www.remotesensing.org/libtiff/TIFFTechNote2.html> [2013-06-26]

TIFF-TN, Adobe Photoshop® TIFF Technical Notes, 2002-03-22, available at

<http://partners.adobe.com/public/developer/en/tiff/TIFFphotoshop.pdf> [2013-06-26]

TIFF-TN3, Adobe Photoshop® TIFF Technical Note 3, 2005-04-08, available at

<http://chriscox.org/TIFFTN3d1.pdf> [2013-06-26]

RFC-3302, *RFC 3302, Tag Image File Format (TIFF) - image/tiff MIME Sub-type*

Registration, 2002-09, available at <http://tools.ietf.org/html/rfc3302> [2011-06-17]

4 Terms and definitions (normative)

For the purposes of this document, the terms and definitions given in the above references (in particular: GML AS – Coverages [OGC 09-146r2]) apply.

4.1 raster or image space

Space used to reference the pixel values in a grid or image (cf. GeoTIFF format specification [GeoTIFF]).

4.2 model space

Space used to reference points on the earth (cf. GeoTIFF format specification [GeoTIFF]).

5 Overview and conventions

5.1 Overview (informative)

The GeoTIFF format specification [GeoTIFF] extents the basic raster file format TIFF specification [TIFF] with georeferencing information using reserved TIFF tags. In doing so the GeoTIFF format is fully compliant with the TIFF format. Thus software incapable of reading and interpreting these extension TIFF tags is still able to open a GeoTIFF format file by simply ignoring them.

A TIFF file is composed of the Image File Header (IFH) and one or multiple Image File Directories (IFDs) holding the actual data entries in 2D rectangular arrays of pixels.

Thus, the only coverage types supported by this specification are `gmlcov:GridCoverage`, `gmlcov:RectifiedGridCoverage`, `gmlcov:ReferenceableGridCoverage`, and any coverage type derived thereof with exactly 2 dimensions. Although techniques to store 3D or even higher dimensional coverages in TIFF files are known they are not considered herein.

For coverages of type `gmlcov:GridCoverage` the GeoTIFF format specification is not needed and simple TIFF files are used instead. However, this [extension profile](#) still applies.

Following the notation of the abstract coverage definition in the GML AS – Coverages [OGC 09-146r2] the `domainSet` is limited to 2 dimensions and the `rangeType` is limited according to the TIFF specification.

5.2 Namespace prefix conventions

The following namespaces are used in this document. The prefix abbreviations used constitute conventions used here, but are **not** normative. The namespaces to which the prefixes refer are normative, however.

Table 1 – Namespace mappings

Prefix	Namespace URI	Description
xsd	http://www.w3.org/2001/XMLSchema	XML Schema namespace
gml	http://www.opengis.net/gml/3.2	GML 3.2.1
gmlcov	http://www.opengis.net/gmlcov/1.0	GML AS Application Schema – Coverages 1.0
geotiff	http://www.opengis.net/gmlcov/geotiff/1.0	GMLCOV – GeoTIFF Encoding Profile 1.0
wcs	http://www.opengis.net/wcs/2.0	WCS 2.0

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5.3 Multiple representations

When multiple representations of the same information are given in a specification document these are consistent. Should this not be the case then this is considered an error, and the XML schema shall take precedence.

6 GeoTIFF coverage representation requirements class

Requirements class *geotiff-coverage* establishes how coverages are represented in the GeoTIFF encoding format. It further specifies how coverages can be requested e.g. from a WCS by defining parameters for TIFF features like compression, tiling, etc. Its identifying URL is given by http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/req/geotiff-coverage.

6.1 General

Coverages using GeoTIFF encoding shall follow both the TIFF and the GeoTIFF specifications.

Requirement 1 /req/geotiff-coverage/tiff-specification:

A GeoTIFF encoded coverage ~~using GeoTIFF encoding instance~~ shall follow the TIFF specification [TIFF].

Note GeoTIFF encoded coverage instances may additionally follow one or more of the TIFF extensions [BigTIFF], [TIFF-TN2], [TIFF-TN], or [TIFF-TN3].

Requirement 2 /req/geotiff-coverage/type:

A GeoTIFF encoded coverage ~~using GeoTIFF encoding instance~~ shall be of type `gmlcov:GridCoverage`, `gmlcov:RectifiedGridCoverage`, or `gmlcov:ReferenceableGridCoverage`, or a subtype thereof.

Dependency: <http://www.opengis.net/spec/GMLCOV/1.0/conf/gml-coverage>

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Requirement 3 /req/geotiff-coverage/geotiff-specification:

A GeoTIFF encoded coverage ~~using GeoTIFF encoding instance~~ and being of type `gmlcov:RectifiedGridCoverage`, or `gmlcov:ReferenceableGridCoverage`, or a subtype thereof shall follow the GeoTIFF specification [GeoTIFF] and shall contain the geo-referencing information of the coverage.

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Note Coverages with type `gmlcov:GridCoverage` ~~(see Requirement 5 below)~~ only need to adhere to the TIFF specification.

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6.2 GeoTIFF identification

The GeoTIFF format shall be identified by the following URI or MIME type identifier, whenever a format identifier is required.

~~**Note** — Examples include the value of the `xlink:role` attribute of the `gml:rangeParameters` element in multipart of GML coverage instances, the Content-Type header in service responses, the `formatSupported` element in WCS *GetCapabilities*~~

~~responses, the nativeFormat element in WCS DescribeCoverage responses, or the format parameter in WCS GetCoverage requests.~~

Note Extensive examples are available online at the same place as the accompanying XML schemas.

Requirement 4 /req/geotiff-coverage/uri:

If the usage of URIs is possible GeoTIFF encoding of a coverage **shall** be indicated by the following URI:

http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/conf/geotiff-coverage

Note Examples include the value of the `xlink:role` attribute of the `gml:rangeParameters` element in multipart GML coverage instances, or the `ows:Profile` element in WCS *GetCapabilities* responses.

Requirement 5 /req/geotiff-coverage/mime-type-identifier:

GeoTIFF encoding of a coverage **shall be** indicated by the following MIME type identifier:

image/tiff

Note MIME sub-type image/tiff is defined in [RFC-3302].

Note Examples include the value of the `Content-Type` header in service responses, the `formatSupported` element in WCS *GetCapabilities* responses, the `nativeFormat` element in WCS *DescribeCoverage* responses, or the `format` parameter in WCS *GetCoverage* requests.

6.3 Mapping between GeoTIFF abstract model and GML AS abstract model

6.3.1 Domain

Requirement 6 /req/geotiff-coverage/dimensions:

The domain of a GeoTIFF encoded coverage ~~using GeoTIFF encoding instance~~ **shall** have exactly 2 dimensions.

Requirement 7 /req/geotiff-coverage/crs:

The coordinate reference system identified by the value of the `srsName` attribute of the `gml:Envelope` element of the `gml:boundedBy` element of a GeoTIFF encoded coverage ~~using GeoTIFF encoding instance~~ **shall** be the same as the coordinate reference system used in the GeoTIFF part.

Note The value of the `srsName` attribute of the `Envelope` element shall be inherited by all directly expressed geometries (see GML 3.2 [OGC 07-036] clause 9.10), i.e. for all range set values encoded in GeoTIFF.

Note “The coordinate reference system used in the GeoTIFF part” depends on the coverage’s type. For the `type gmlcov:RectifiedGridCoverage` ~~type~~ this is obvious, for the `type gmlcov:ReferenceableGridCoverage` ~~type~~ this is the coordinate reference system used for the tiepoints, and finally for the `type gmlcov:GridCoverage` ~~type~~ the coordinate reference system is limited to raster or image space ones anyway and thus “the GeoTIFF part” is in fact a pure TIFF part only.

Note GML 3.2 [OGC 07-036] does not define any concrete `ReferenceableGrid` and the ones added by Change Request OGC 07-112r3 are not suitable for usage with GeoTIFF encoding.

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Thus a new suitable one, e.g. `ReferenceableGridByGCPs`, is going to be proposed but will only be available in future.

Requirement 8 /req/geotiff-coverage/axis-ordering:

The value ordering of a `GeoTIFF encoded` coverage ~~using GeoTIFF encoding instance~~ shall adhere to the axis order of the coordinate reference system identified by the value of the `srName` attribute of the `gml:Envelope` element of the `gml:boundedBy` element.

Note This applies to all elements directly bound to a coordinate reference system i.e. the `boundedBy`, `origin`, and `offsetVector` elements but not to elements in raster or image space i.e. the grid.

Requirement 9 /req/geotiff-coverage/pixel-is-area:

The domain of a `GeoTIFF encoded` coverage ~~using GeoTIFF encoding instance~~ shall respect the coverage's raster space as defined in the GeoTIFF specification [GeoTIFF] i.e. ~~in `PixelIsArea` the first pixel value fills the square grid cell with the bounds top-left = (0,0), bottom-right = (1,1) and in `PixelIsPoint` the first pixel value is realized as a point value located at (0,0).~~

Note The definition of grids in GML 3.2 [OGC 07-036] clause 19.2.2 which GMLCOV is based on reads as: "When a grid point is used to represent a sample space (e.g. image pixel), the grid point represents the center of the sample space (see ISO 19123:2005, 8.2.2)." ~~Image pixel in this GML quote denotes the same as image space in GeoTIFF terminology. In a `gml:RectifiedGrid` used with `PixelIsArea` this applies to the `gml:origin` element which is therefore shifted by half a `gml:offsetVector` in both dimensions compared to the `gml:boundedBy` element.~~

Note GMLCOV does not store the raster type i.e. `PixelIsArea` or `PixelIsPoint` information in its current version. However, Requirement 9 above specifies that the `gml:boundedBy` element shall respect the raster type i.e. it shall include the half pixel border in case of `PixelIsArea` (see also Figure 1-) ~~but not in case of `PixelIsPoint`. In other words, in case of `PixelIsArea` the `gml:boundedBy` element is decreased by the half of both `gml:offsetVector` elements in the `gml:lowerCorner` coordinate and increased by the half of both `gml:offsetVector` elements in the `gml:upperCorner` coordinate compared to the case of `PixelIsPoint`. The `gml:origin` element stays the same independently of the raster space.~~

Examples: The following XML fragments show the `boundedBy` and the `domainSet` elements describing the domain of sample coverages respecting the axis ordering of the used CRS:

- Default axis order (easting, northing) using `PixelIsArea`:

```
<gml:boundedBy>
  <gml:Envelope srsName="http://www.opengis.net/def/crs/EPSSG/0/3857"
    axisLabels="x y" uomLabels="m m" srsDimension="2">
    <gml:lowerCorner>100 50</gml:lowerCorner>
    <gml:upperCorner>500 350</gml:upperCorner>
  </gml:Envelope>
</gml:boundedBy>
<gml:domainSet>
  <gml:RectifiedGrid dimension="2" gml:id="grid_grey">
    <gml:limits>
      <gml:GridEnvelope>
        <gml:low>0 0</gml:low>
        <gml:high>39 29</gml:high>
      </gml:GridEnvelope>
    </gml:limits>
  </gml:RectifiedGrid>
</gml:domainSet>
```

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```

        </gml:GridEnvelope>
    </gml:limits>
    <gml:axisLabels>x y</gml:axisLabels>
    <gml:origin>
        <gml:Point gml:id="grid_origin_grey"
srsName="http://www.opengis.net/def/crs/EPSPG/0/3857">
        <gml:pos>105 345</gml:pos>
    </gml:Point>
    </gml:origin>
    <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSPG/
0/3857">10 0</gml:offsetVector>
    <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSPG/
0/3857">0 -10</gml:offsetVector>
    </gml:RectifiedGrid>
</gml:domainSet>

```

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- Default axis order using `PixelIsPoint`:

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```

<gml:boundedBy>
    <gml:Envelope srsName="http://www.opengis.net/def/crs/EPSPG/0/3857"
axisLabels="x y" uomLabels="m m" srsDimension="2">
        <gml:lowerCorner>105 55</gml:lowerCorner>
        <gml:upperCorner>495 345</gml:upperCorner>
    </gml:Envelope>
</gml:boundedBy>
<gml:domainSet>
    ... (same as above)
</gml:domainSet>

```

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- Reversed axis order (latitude, longitude) using `PixelIsArea`:

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```

<gml:boundedBy>
    <gml:Envelope srsName="http://www.opengis.net/def/crs/EPSPG/0/4326"
axisLabels="lat long" uomLabels="deg deg" srsDimension="2">
        <gml:lowerCorner>
            0.000449157641044 0.00089831528412
        </gml:lowerCorner>
        <gml:upperCorner>
            0.003144103492834 0.00449157641984
        </gml:upperCorner>
    </gml:Envelope>
</gml:boundedBy>
<gml:domainSet>
    <gml:RectifiedGrid dimension="2" gml:id="grid_grey">
        <gml:limits>
            <gml:GridEnvelope>
                <gml:low>0 0</gml:low>
                <gml:high>39 29</gml:high>
            </gml:GridEnvelope>
        </gml:limits>
        <gml:axisLabels>lat long</gml:axisLabels>
        <gml:origin>
            <gml:Point gml:id="grid_origin_grey"
srsName="http://www.opengis.net/def/crs/EPSPG/0/4326">

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```

    <gml:pos>0.0030991877286375 0.0009432310483165</gml:pos>
  </gml:Point>
</gml:origin>
<gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSC/
0/4326">0 0.000089831528393</gml:offsetVector>
<gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSC/
0/4326">-0.000089831528393 0</gml:offsetVector>
</gml:RectifiedGrid>
</gml:domainSet>

```

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Note The complete examples corresponding to the XML fragments given above including GeoTIFF files are available online at the same place as the [GMLCOV accompanying XML schemas](#).

The below simple figure provides an explanation of the relation between raster or image space (blue) and model space (orange) in the case of PixelIsArea using the values from the examples above.

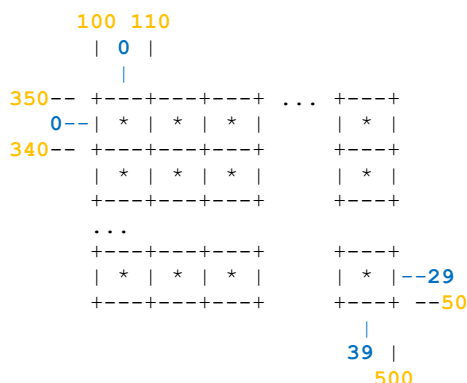


Figure 1: Relation between raster or pixel and model space in case of PixelIsArea

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6.3.2 Range

Requirement 10 /req/geotiff-coverage/range-ordering:

A [GeoTIFF encoded](#) coverage [using GeoTIFF encoding instance](#) with more than one component in the rangeType **shall** order the components of the coverage's rangeType in the same order as given in the gml:rangeType element's document order.

Note The order of components, also called *bands*, within a composite rangeSet value corresponds to document order of the rangeType elements.

6.4 GeoTIFF parameters

6.4.1 Request

[The following GeoTIFF parameters are defined for requesting GeoTIFF encoded coverages for example via WCS GetCoverage requests.](#)

Note It is always possible for a given coverage instance to determine its current parameter values, i.e., the parameter values used at creation. Thus a GeoTIFF encoded coverage is self-describing.

Requirement 11 /req/geotiff-coverage/parameters-xml:

The structure of an XML request requesting a GeoTIFF encoded coverage instance **shall** be extended as defined in Table 2 and the respective XML Schema being part of this standard.

Requirement 12 /req/geotiff-coverage/parameters-kvp:

The structure of a KVP request requesting a GeoTIFF encoded coverage instance **shall** be extended as defined in Table 2 where the parameter names shall be prefixed with "geotiff:" for example geotiff:compression.

Note This prefix is used as namespace replacement in order to minimize the risk of reusing already defined KVP parameters.

Note It is recommended for server implementations to parse the format parameter first in order to have the right context for further parameters.

Table 2 – Parameters for requesting GeoTIFF encoded coverages

<u>Name</u>	<u>Definition</u>	<u>Data Type</u>	<u>Multiplicity</u>
<u>compression</u>	<u>Compression used</u>	<u>String, one of:</u> <u>"None", "PackBits",</u> <u>"Huffman", "LZW",</u> <u>"JPEG", "Deflate"</u>	<u>zero or one</u> <u>(optional)</u>
<u>jpeg quality</u>	<u>Quality of compression;</u> <u>Allowed only in presence of</u> <u>"compression=JPEG"</u>	<u>Integer</u> <u>between 1 and 100</u>	<u>zero or one</u> <u>(optional)</u>
<u>predictor</u>	<u>Indicates if predictor is</u> <u>requested</u>	<u>String, one of:</u> <u>"None",</u> <u>"Horizontal",</u> <u>"FloatingPoint"</u>	<u>zero or one</u> <u>(optional)</u>
<u>interleave</u>	<u>Determines how the</u> <u>components of each pixel</u> <u>are stored</u> <u>(PlanarConfiguration in</u> <u>TIFF terminology with value</u> <u>1 for chunky or pixel and</u> <u>value 2 for planar or band</u> <u>format)</u>	<u>String, one of:</u> <u>"Pixel", "Band"</u>	<u>zero or one</u> <u>(optional)</u>
<u>tiling</u>	<u>Indicates if tiling is</u> <u>requested</u>	<u>Boolean</u>	<u>zero or one</u> <u>(optional)</u>

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<u>tileheight</u>	<u>Edge length of tiles in pixels (tiled storage only; TileLenght in TIFF terminology); Allowed only together with tiling being "true" and tilewidth being present</u>	<u>Integer being a multiple of 16 greater than zero</u>	<u>zero or one (optional)</u>
<u>tilewidth</u>	<u>Edge with of tiles in pixels (tiled storage only); Allowed only together with tiling being "true" and tileheight being present</u>	<u>Integer being a multiple of 16 greater than zero</u>	<u>zero or one (optional)</u>

Note It is recommended for server implementations to take some measures to cope with large values for the tileheight and tilewidht parameters to prevent high resource consumption.

6.4.2 Response

A GeoTIFF encoded coverage shall encode the TIFF features as requested using the above defined GeoTIFF parameters.

Requirement 13 /req/geotiff-coverage/compression:

The response to a successful request for a GeoTIFF encoded coverage containing a compression GeoTIFF parameter shall consist of a GeoTIFF encoded coverage using the specified compression whereas the following mapping applies:

<i>Name</i>	<i>Value of Compression TIFF tag</i>	<i>Comment</i>
None	1	No compression
PackBits	32773	As in [TIFF] section 9
CCITTRLE	2	As in [TIFF] section 10 (Modified Huffman compression)
LZW	5	As in [TIFF] section 13
JPEG	7	As in [TIFF-TN2]
Deflate	8	As in [TIFF-TN]

Requirement 14 /req/geotiff-coverage/jpeg:

The response to a successful request for a GeoTIFF encoded coverage containing a jpeg_quality and a compression parameter with value "JPEG" shall consist of a GeoTIFF encoded coverage using JPEG compression with the quality indicated.

Requirement 15 /req/geotiff-coverage/predictor:

The response to a successful request for a GeoTIFF encoded coverage containing a predictor parameter shall consist of a GeoTIFF encoded coverage using the specified predictor whereas the following mapping applies:

<i>Name</i>	<i>Value of the Predictor TIFF tag</i>	<i>Comment</i>
None	1	As in [TIFF] section 14
Horizontal	2	As in [TIFF] section 14
FloatingPoint	3	As in [TIFF-TN3]

Note The predictor parameter is in practice only used together with LZW or Deflate compression.

Requirement 16 /req/geotiff-coverage/interleave:

The response to a successful request for a GeoTIFF encoded coverage containing a interleave parameter **shall** consist of a GeoTIFF encoded coverage using the specified interleave method.

Requirement 17 /req/geotiff-coverage/tiling:

The response to a successful request for a GeoTIFF encoded coverage containing a tiling and optionally a tileheight and a tilewidth parameter **shall** consist of a GeoTIFF encoded coverage with internal tiling using the specified height and width if present.

Note A server or service not implementing the requested feature is always free to respond with an exception.

6.4.3 Exceptions

Requirement 18 /req/geotiff-coverage/exceptions:

When a server or service encounters an error described in column "meaning of exception code" in Table 3 then it **shall** return the corresponding exception report message with the contents of the locator parameter value as specified in the right column of Table 3.

Table 3 – Exception codes for GeoTIFF parameters

<u>exceptionCode value</u>	<u>HTTP code</u>	<u>Meaning of code</u>	<u>locator value</u>
<u>CompressionNotSupported</u>	<u>404</u>	<u>Server does not support the requested compression.</u>	<u>Value of compression parameter.</u>
<u>CompressionInvalid</u>	<u>404</u>	<u>Invalid compression requested.</u>	<u>Value of compression parameter.</u>
<u>JpegQualityInvalid</u>	<u>404</u>	<u>Invalid JPEG quality requested.</u>	<u>Value of jpeg_quality parameter.</u>
<u>PredictorNotSupported</u>	<u>404</u>	<u>Server does not support the requested predictor.</u>	<u>Value of predictor parameter.</u>
<u>PredictorInvalid</u>	<u>404</u>	<u>Invalid predictor requested.</u>	<u>Value of predictor parameter.</u>

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<u>InterleavingNotSupported</u>	<u>404</u>	<u>Server does not support the requested interleave method.</u>	<u>Value of interleave parameter.</u>
<u>InterleavingInvalid</u>	<u>404</u>	<u>Invalid interleaving requested.</u>	<u>Value of interleave parameter.</u>
<u>TilingNotSupported</u>	<u>404</u>	<u>Server does not support tiling.</u>	=
<u>TilingInvalid</u>	<u>404</u>	<u>Either tileheight, tilewidth, or both are missing or one or both are not a positive integer being a multiple of 16 and thus invalid.</u>	<u>Value of tileheight and tilewidth parameter.</u>

Annex A (normative)

Abstract Test Suite

This Annex specifies an Abstract Test Suite which shall be passed in completeness by any implementation claiming conformance with this GeoTIFF coverage encoding ~~extension~~profile.

Test identifiers below are relative to
http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/.

A.1 Conformance Test Class: *geotiff-coverage*

The OGC URI identifier of this conformance class is:
http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/conf/geotiff-coverage.

A.1.1 Prerequisites

Make sure that at least one GeoTIFF encoded coverage instance is available. Repeat the tests for each GeoTIFF encoded coverage instance available.

~~A.1.1~~ A.1.2 Follow TIFF specification

Test id: /conf/geotiff-coverage/tiff-specification

Test Purpose: **Requirement /req/geotiff-coverage/tiff-specification:**
A GeoTIFF encoded coverage instance shall follow the TIFF specification [TIFF].

Test method: Validate the coverage instance under test against the TIFF specification.

Test passes if coverage instance is valid according to the TIFF specification.

~~A.1.2~~ A.1.3 Correct coverage type

Test id: /conf/geotiff-coverage/type

Test Purpose: **Requirement /req/geotiff-coverage/type:**
A GeoTIFF encoded coverage instance shall be of type
gmlcov:GridCoverage, gmlcov:RectifiedGridCoverage, or
gmlcov:ReferenceableGridCoverage, or a subtype thereof.
Dependency: <http://www.opengis.net/spec/GMLCOV/1.0/conf/gml-coverage>

Test method: If the coverage instance under test is encoded in a multipart message check that its first part consists of a GML document of type
gmlcov:GridCoverage, gmlcov:RectifiedGridCoverage, or

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`gmlcov:ReferenceableGridCoverage`, or a subtype thereof.

Test passes if constraint evaluates to true.

~~A.1.3~~ A.1.4 Follow GeoTIFF specification

Test id: `/conf/geotiff-coverage/geotiff-specification`

Test Purpose: **Requirement** `/req/geotiff-coverage/geotiff-specification:`

A GeoTIFF encoded coverage instance and being of type `gmlcov:RectifiedGridCoverage`, or `gmlcov:ReferenceableGridCoverage`, or a subtype thereof **shall** follow the GeoTIFF specification [GeoTIFF] and shall contain the geo-referencing information of the coverage.

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Test method: If the coverage instance under test is encoded in a multipart message and if its first part consists of a GML document of type

`gmlcov:RectifiedGridCoverage` ~~or~~ `gmlcov:ReferenceableGridCoverage`, or a subtype thereof validate the coverage instance under test against the GeoTIFF specification.

Test passes if coverage instance is of one of the listed types and is valid according to the GeoTIFF specification.

~~A.1.4~~ A.1.5 Correct URI

Test id: `/conf/geotiff-coverage/uri`

Test Purpose: **Requirement** `/req/geotiff-coverage/uri:`

If the usage of URIs is possible GeoTIFF encoding of a coverage **shall** be indicated by the following URI:

`http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/conf/geotiff-coverage`

Test method: If the coverage instance under test is encoded in a multipart message check that the `xlink:role` attribute of the `gml:rangeParameters` element of the `gml:File` element of the `gml:rangeSet` element of its first part has the value

`"http://www.opengis.net/spec/GMLCOV_geotiff-coverages/1.0/conf/geotiff-coverage"`.

Test passes if constraint evaluates to true.

~~A.1.5~~ **A.1.6** Correct MIME type

Test id: /conf/geotiff-coverage/mime-type-identifier

Test Purpose: **Requirement /req/geotiff-coverage/mime-type-identifier:**
GeoTIFF encoding of a coverage **shall be** indicated by the following
MIME type identifier:
image/tiff

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Test method: If the coverage instance under test is encoded in a multipart message check that the gml:mimeType element of the gml:File element of the gml:rangeSet element of its first part as well as the Content-Type header of its second part have the value "image/tiff".

Test passes if constraints evaluate to true.

~~A.1.6~~ **A.1.7** Correct dimensions

Test id: /conf/geotiff-coverage/dimensions

Test Purpose: **Requirement /req/geotiff-coverage/dimensions:**
The domain of a **GeoTIFF encoded** coverage **instance shall** have exactly 2 dimensions.

Test method: If the coverage instance under test is encoded in a multipart message check that the dimension parameter of the gml:RectifiedGrid element or of a subtype thereof or of a subtype of gml:AbstractReferenceableGrid of the gml:domainSet element of its first part has the value "2".

Test passes if constraint evaluates to true.

~~A.1.7~~ **A.1.8** Correct CRS

Test id: /conf/geotiff-coverage/crs

Test Purpose: **Requirement /req/geotiff-coverage/crs:**
The coordinate reference system identified by the value of the srsName attribute of the gml:Envelope element of the gml:boundedBy element of a **GeoTIFF encoded** coverage **instance shall** be the same as the coordinate reference system used in the GeoTIFF part.

Test method: If the coverage instance under test is encoded in a multipart message check that the srsName attribute of the gml:Envelope element of the gml:boundedBy element its first part defines the same coordinate reference system as the one used in the second part which in case of gmlcov:ReferenceableGridCoverage is the coordinate reference system used for the tiepoints and in case of gmlcov:GridCoverage

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not present.

Test passes if constraint evaluates to true.

~~A.1.8~~ A.1.9 Correct axis ordering

Test id: /conf/geotiff-coverage/axis-ordering

Test Purpose: Requirement /req/geotiff-coverage/axis-ordering:
The value ordering of a GeoTIFF encoded coverage instance shall adhere to the axis order of the coordinate reference system identified by the value of the `srsName` attribute of the `gml:Envelope` element of the `gml:boundedBy` element.

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Test method: If the coverage instance under test is encoded in a multipart message check that the coordinate reference system defined by the `srsName` attribute of the `gml:Envelope` element of the `gml:boundedBy` element of its first part defines the same axis ordering as the one used in the second part.

Test passes if constraint evaluates to true.

~~A.1.9~~ A.1.10 Correct raster space

Test id: /conf/geotiff-coverage/pixel-is-area

Test Purpose: Requirement /req/geotiff-coverage/pixel-is-area:
The domain of a GeoTIFF encoded coverage instance shall respect the coverage's raster space as defined in the GeoTIFF specification [GeoTIFF] i.e. `PixelIsArea` or `PixelIsPoint`.

Test method: If the coverage instance under test is encoded in a multipart message check that the values used in the `gml:lowerCorner` and `gml:upperCorner` elements of `gml:Envelope` element of the `gml:boundedBy` element of its first part are respecting the raster space setting used in the second part.

In case of `PixelIsArea`, type `gmlcov:RectifiedGridCoverage`, and grid axis parallel to the CRS axis the difference between the values used in the `gml:lowerCorner` and `gml:Envelope` elements shall be the same as the number of pixels defined in the `gml:domainSet` element multiplied with the respective value of the respective `gml:offsetVector` element taking into account the right axis ordering.

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In case of `PixelIsPoint`, type `gmlcov:RectifiedGridCoverage`, and grid axis parallel to the

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CRS axis the difference between the values used in the `gml:lowerCorner` and `gml:Envelope` elements shall be the same as the number of pixels defined in the `gml:domainSet` element **minus 1** multiplied with the respective value of the respective `gml:offsetVector` element taking into account the right axis ordering.

Test passes if constraints evaluate to true.

~~A.1.10~~ **A.1.11 Correct range order**

Test id: `/conf/geotiff-coverage/range-ordering`

Test Purpose: **Requirement `/req/geotiff-coverage/range-ordering`:**
A GeoTIFF encoded coverage instance with more than one component in the `rangeType` **shall** order the components of the coverage's `rangeType` in the same order as given in the `gml:rangeType` element's document order.

Test method: If the coverage instance under test is encoded in a multipart message check that the ordering used in the `gmlcov:rangeType` element of its first part is the same as used in the second part.

Test passes if constraint evaluates to true.

A.1.12 Parameters XML

Test id: `/conf/geotiff-coverage/parameters-xml`

Test Purpose: **Requirement `/req/geotiff-coverage/parameters-xml`:**
The structure of an XML request requesting a GeoTIFF encoded coverage instance **shall** be extended as defined in Table 2 and the respective XML Schema being part of this standard.

Test method: Validate the GeoTIFF parameters present in the request if an XML request was used to obtain the coverage instance under test.

Test passes if an XML request was used to obtain the coverage instance under test and the GeoTIFF parameters are valid according to the XML schema and the coverage instance is encoded as requested.

A.1.13 Parameters KVP

Test id: `/conf/geotiff-coverage/parameters-kvp`

Test Purpose: **Requirement `/req/geotiff-coverage/parameters-kvp`:**
The structure of a KVP request requesting a GeoTIFF encoded coverage instance **shall** be extended as defined in Table 2 where the parameter

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names shall be prefixed with "geotiff:" for example
geotiff:compression.

Test method: Validate the GeoTIFF parameters present in the request if a KVP request was used to obtain the coverage instance under test.

Test passes if a KVP request was used to obtain the coverage instance under test and the GeoTIFF parameters are valid according to Table 2 and the coverage instance is encoded as requested.

A.1.14 Parameter for compression

Test id: /conf/geotiff-coverage/compression

Test Purpose: **Requirement /req/geotiff-coverage/compression:**
The response to a successful request for a GeoTIFF encoded coverage containing a compression GeoTIFF parameter shall consist of a GeoTIFF encoded coverage using the specified compression whereas the following mapping applies:

Test method: Check the GeoTIFF parameters present in the request used to obtain the coverage instance under test for the presence of the "compression" parameter. If found, verify that the coverage instance is encoded using the requested compression.

Test passes if the "compression" parameter is present and the coverage instance is encoded as requested.

A.1.15 Parameter for JPEG compression

Test id: /conf/geotiff-coverage/jpeg

Test Purpose: **Requirement /req/geotiff-coverage/jpeg:**
The response to a successful request for a GeoTIFF encoded coverage containing a jpeg_quality and a compression parameter with value "JPEG" shall consist of a GeoTIFF encoded coverage using JPEG compression with the quality indicated.

Test method: Check the GeoTIFF parameters present in the request used to obtain the coverage instance under test for the presence of the "compression" and "jpeg_quality" parameters. If found, verify that the "compression" parameter has value "JPEG" and the coverage instance is encoded using JPEG compression with the requested quality.

Test passes if the "compression" and "jpeg_quality" parameters are present and the coverage instance is encoded as requested.

A.1.16 Parameter for predictor

Test id: /conf/geotiff-coverage/predictor

Test Purpose: **Requirement /req/geotiff-coverage/predictor:**
The response to a successful request for a GeoTIFF encoded coverage containing a `predictor` parameter shall consist of a GeoTIFF encoded coverage using the specified predictor

Test method: Check the GeoTIFF parameters present in the request used to obtain the coverage instance under test for the presence of the "`predictor`" parameter. If found, verify that the coverage instance is encoded using the requested predictor.

Test passes if the "`predictor`" parameter is present and the coverage instance is encoded as requested.

A.1.17 Parameter for interleave

Test id: /conf/geotiff-coverage/interleave

Test Purpose: **Requirement /req/geotiff-coverage/interleave:**
The response to a successful request for a GeoTIFF encoded coverage containing a `interleave` parameter shall consist of a GeoTIFF encoded coverage using the specified interleave method.

Test method: Check the GeoTIFF parameters present in the request used to obtain the coverage instance under test for the presence of the "`interleave`" parameter. If found, verify that the coverage instance is encoded using the requested interleave method.

Test passes if the "`interleave`" parameter is present and the coverage instance is encoded as requested.

A.1.18 Parameter for tiling

Test id: /conf/geotiff-coverage/tiling

Test Purpose: **Requirement /req/geotiff-coverage/tiling:**
The response to a successful request for a GeoTIFF encoded coverage containing a `tiling` and optionally a `tileheight` and a `tilewidth` parameter shall consist of a GeoTIFF encoded coverage with internal tiling using the specified height and width if present.

Test method: Check the GeoTIFF parameters present in the request used to obtain the coverage instance under test for the presence of the "`tiling`" parameter. If found and the value is true, check for the presence of the "`tileheight`" and "`tilewidth`" parameters and verify that the

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coverage instance is encoded using the requested tiling.

Test passes if the "tiling" parameter and optionally the "tileheight" and "tilewidth" parameters are present and the coverage instance is encoded as requested.

A.1.19 Exceptions

Test id: /conf/geotiff-coverage/exceptions

Test Purpose: **Requirement /req/geotiff-coverage/exceptions:**
When a server or service encounters an error described in column "meaning of exception code" in Table 3 then it **shall** return the corresponding exception report message with the contents of the locator parameter value as specified in the right column of Table 3.

Test method: Validate possible exception responses obtained instead of coverage instances.

Test passes if exceptions are using the relevant exceptionCode.

-- end of ATS --

Annex B (informative) Resources

B.1 Links

GeoTIFF at the Open Source Geospatial Foundation: <http://geotiff.osgeo.org/>

GeoTIFF mailing list: <http://lists.maptools.org/mailman/listinfo/geotiff>

GDAL – Geospatial Data Abstraction Library: <http://www.gdal.org/>

listgeo – Dump GeoTIFF Metadata: <http://www.remotesensing.org/geotiff/listgeo.html>

LibTIFF – TIFF Library and Utilities: <http://www.remotesensing.org/libtiff/>

B.2 Examples

This clause holds a valid example of a multipart GeoTIFF encoded coverage but omitting the GeoTIFF content itself: as well as a WCS GetCoverage request including GeoTIFF parameters. Additionally the TIFF and GeoTIFF keys of the coverage are provided. These keys can easily be mapped to the GML part. The examplecomplete examples including the GeoTIFF content isare available online at the same place as the GMLCOVaccompanying XML schemas.

The following sketches a valid multipart coverage (contents of second part omitted):

```
Content-Type: Multipart/Related; boundary=wcs;
start="GML-Part"
type="application/gml+xml"
```

```
--wcs
```

```
Content-Type: text/xml
```

```
<?xml version="1.0" encoding="UTF-8"?>
<gmlcov:RectifiedGridCoverage
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:gmlcov="http://www.opengis.net/gmlcov/1.0"
  xmlns:swe="http://www.opengis.net/swe/2.0"
  xsi:schemaLocation="http://www.opengis.net/gmlcov/1.0
http://schemas.opengis.net/gmlcov/1.0/gmlcovAll.xsd"
  gml:id="grey">
  <gml:boundedBy>
    <gml:Envelope srsName="http://www.opengis.net/def/crs/EPSG/0/3857"
axisLabels="x y" uomLabels="m m" srsDimension="2">
      <gml:lowerCorner>100 50</gml:lowerCorner>
      <gml:upperCorner>500 350</gml:upperCorner>
    </gml:Envelope>
  </gml:boundedBy>
  <gml:domainSet>
    <gml:RectifiedGrid dimension="2" gml:id="grid_grey">
      <gml:limits>
```

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```

        <gml:GridEnvelope>
          <gml:low>0 0</gml:low>
          <gml:high>39 29</gml:high>
        </gml:GridEnvelope>
      </gml:limits>
      <gml:axisLabels>x y</gml:axisLabels>
      <gml:origin>
        <gml:Point gml:id="grid_origin_grey"
srsName="http://www.opengis.net/def/crs/EPSPG/0/3857">
          <gml:pos>105 345</gml:pos>
        </gml:Point>
      </gml:origin>
      <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSPG/0/
3857">10 0</gml:offsetVector>
      <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSPG/0/
3857">0 -10</gml:offsetVector>
    </gml:RectifiedGrid>
  </gml:domainSet>
  <gml:rangeSet>
    <gml:File>
      <gml:rangeParameters xlink:href="cid:grey.tif"
xlink:role="http://www.opengis.net/spec/GMLCOV_geotiff-
coverages/1.0/conf/geotiff-coverage" xlink:arcrole="fileReference"/>
      <gml:fileReference>cid:grey.tif</gml:fileReference>
      <gml:fileStructure/>
      <gml:mimeType>image/tiff</gml:mimeType>
    </gml:File>
  </gml:rangeSet>
  <gmlcov:rangeType>
    <swe:DataRecord>
      <swe:field name="grey">
        <swe:Quantity
definition="http://www.opengis.net/def/property/OGC/0/Radiance">
          <swe:description>Grey band</swe:description>
          <swe:nilValues/>
          <swe:uom code="W.m-2.sr-1.nm-1"/>
          <swe:constraint>
            <swe:AllowedValues>
              <swe:interval>0 255</swe:interval>
            </swe:AllowedValues>
          </swe:constraint>
        </swe:Quantity>
      </swe:field>
    </swe:DataRecord>
  </gmlcov:rangeType>
</gmlcov:RectifiedGridCoverage>
--wcs
Content-Type: image/tiff
Content-Description: coverage data
Content-Transfer-Encoding: binary
Content-ID: grey.tif
Content-Disposition: inline

II
...
--wcs--

```

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Below the complete GeoTIFF information obtained via the `listgeo` command is shown:

```
Geotiff_Information:
  Version: 1
  Key_Revision: 1.0
  Tagged_Information:
    ModelTiepointTag (2,3):
      0          0          0
      100        350        0
    ModelPixelScaleTag (1,3):
      10          10          0
  End_Of_Tags.
  Keyed_Information:
    GTModelTypeGeoKey (Short,1): ModelTypeProjected
    GTRasterTypeGeoKey (Short,1): RasterPixelIsArea
    GTCitationGeoKey (Ascii,25): "WGS 84 / Pseudo-Mercator"
    GeogCitationGeoKey (Ascii,7): "WGS 84"
    GeogAngularUnitsGeoKey (Short,1): Angular_Degree
    ProjectedCSTypeGeoKey (Short,1): Unknown-3857
    ProjLinearUnitsGeoKey (Short,1): Linear_Meter
  End_Of_Keys.
End_Of_Geotiff.

PCS = 3857 (WGS 84 / Pseudo-Mercator)
Projection = 3856 (Popular Visualisation Pseudo-Mercator)
Projection Method: CT_Mercator
  ProjNatOriginLatGeoKey: 0.000000 ( 0d 0' 0.00"N)
  ProjNatOriginLongGeoKey: 0.000000 ( 0d 0' 0.00"E)
  ProjScaleAtNatOriginGeoKey: 1.000000
  ProjFalseEastingGeoKey: 0.000000 m
  ProjFalseNorthingGeoKey: 0.000000 m
GCS: 4326/WGS 84
Datum: 6326/World Geodetic System 1984
Ellipsoid: 7030/WGS 84 (6378137.00,6356752.31)
Prime Meridian: 8901/Greenwich (0.000000/ 0d 0' 0.00"E)
Projection Linear Units: 9001/metre (1.000000m)

Corner Coordinates:
Upper Left  ( 100.000, 350.000) ( 0d 0' 3.23"E, 0d 0'11.40"N)
Lower Left  ( 100.000, 50.000) ( 0d 0' 3.23"E, 0d 0' 1.63"N)
Upper Right ( 500.000, 350.000) ( 0d 0'16.17"E, 0d 0'11.40"N)
Lower Right ( 500.000, 50.000) ( 0d 0'16.17"E, 0d 0' 1.63"N)
Center      ( 300.000, 200.000) ( 0d 0' 9.70"E, 0d 0' 6.51"N)
```

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The following shows the output of the `gdalinfo` command:

```
Driver: GTiff/GeoTIFF
Files: example_3857.tif
Size is 40, 30
Coordinate System is:
PROJCS["WGS 84 / Pseudo-Mercator",
  GEOGCS["WGS 84",
```

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```

    DATUM["WGS_1984",
        SPHEROID["WGS 84",6378137,298.257223563,
            AUTHORITY["EPSG","7030"]],
        AUTHORITY["EPSG","6326"]],
    PRIMEM["Greenwich",0],
    UNIT["degree",0.0174532925199433],
    AUTHORITY["EPSG","4326"]],
    PROJECTION["Mercator_1SP"],
    PARAMETER["central_meridian",0],
    PARAMETER["scale_factor",1],
    PARAMETER["false_easting",0],
    PARAMETER["false_northing",0],
    AUTHORITY["EPSG","3857"],
    EXTENSION["PROJ4","+proj=merc +a=6378137 +b=6378137 +lat_ts=0.0
+lon_0=0.0 +x_0=0.0 +y_0=0 +k=1.0 +units=m +nadgrids=@null +wktext
+no_defs"],
    UNIT["metre",1,
        AUTHORITY["EPSG","9001"]]]
Origin = (100.00000000000000,350.00000000000000)
Pixel Size = (10.000000000000000,-10.000000000000000)
Metadata:
  AREA_OR_POINT=Area
Image Structure Metadata:
  INTERLEAVE=BAND
Corner Coordinates:
Upper Left  ( 100.000,  350.000) ( 0d 0' 3.23"E, 0d 0'11.32"N)
Lower Left  ( 100.000,   50.000) ( 0d 0' 3.23"E, 0d 0' 1.62"N)
Upper Right ( 500.000,  350.000) ( 0d 0'16.17"E, 0d 0'11.32"N)
Lower Right ( 500.000,   50.000) ( 0d 0'16.17"E, 0d 0' 1.62"N)
Center      ( 300.000,  200.000) ( 0d 0' 9.70"E, 0d 0' 6.47"N)
Band 1 Block=40x30 Type=Byte, ColorInterp=Gray

```

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The `tiffinfo` command outputs the following:

```

TIFFReadDirectory: Warning, example_3857.tif: unknown field with tag
33550 (0x830e) encountered.
TIFFReadDirectory: Warning, example_3857.tif: unknown field with tag
33922 (0x8482) encountered.
TIFFReadDirectory: Warning, example_3857.tif: unknown field with tag
34735 (0x87af) encountered.
TIFFReadDirectory: Warning, example_3857.tif: unknown field with tag
34737 (0x87b1) encountered.
TIFF Directory at offset 0x8 (8)
  Image Width: 40 Image Length: 30
  Bits/Sample: 8
  Sample Format: unsigned integer
  Compression Scheme: None
  Photometric Interpretation: min-is-black
  Samples/Pixel: 1
  Rows/Strip: 30
  Planar Configuration: single image plane
  Tag 33550: 10.000000,10.000000,0.000000
  Tag 33922: 0.000000,0.000000,0.000000,100.000000,350.000000,0.000000

```

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```
Tag 34735:
1,1,0,7,1024,0,1,1,1025,0,1,1,1026,34737,25,0,2049,34737,7,25,2054,0,1,9
102,3072,0,1,3857,3076,0,1,9001
Tag 34737: WGS 84 / Pseudo-Mercator|WGS 84|
```

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Finally the `tiffdump` command gives:

```
example_3857.tif:
Magic: 0x4949 <little-endian> Version: 0x2a
Directory 0: offset 8 (0x8) next 0 (0)
ImageWidth (256) SHORT (3) 1<40>
ImageLength (257) SHORT (3) 1<30>
BitsPerSample (258) SHORT (3) 1<8>
Compression (259) SHORT (3) 1<1>
Photometric (262) SHORT (3) 1<1>
StripOffsets (273) LONG (4) 1<363>
SamplesPerPixel (277) SHORT (3) 1<1>
RowsPerStrip (278) SHORT (3) 1<30>
StripByteCounts (279) LONG (4) 1<1200>
PlanarConfig (284) SHORT (3) 1<1>
SampleFormat (339) SHORT (3) 1<1>
33550 (0x830e) DOUBLE (12) 3<10 10 0>
33922 (0x8482) DOUBLE (12) 6<0 0 0 100 350 0>
34735 (0x87af) SHORT (3) 32<1 1 0 7 1024 0 1 1 1025 0 1 1 1026 34737 25
0 2049 34737 7 25 2054 0 1 9102 ...>
34737 (0x87b1) ASCII (2) 33<WGS 84 / Pseudo-Mercator ...>
```

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The following is a valid WCS 2.0 GetCoverage request including some GeoTIFF parameters:

```
<?xml version="1.0" encoding="UTF-8"?>
<wcs:GetCoverage
  xmlns:wcs="http://www.opengis.net/wcs/2.0"
  xmlns:geotiff="http://www.opengis.net/gmlcov/geotiff/1.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wcs/2.0
http://schemas.opengis.net/wcs/2.0/wcsAll.xsd
http://www.opengis.net/gmlcov/geotiff/1.0
http://schemas.opengis.net/gmlcov/geotiff/1.0/gmlcovGeotiff.xsd"
  service="WCS"
  version="2.0.1">
  <wcs:Extension>
    <geotiff:parameters>
      <geotiff:compression>JPEG</geotiff:compression>
      <geotiff:jpeg quality>75</geotiff:jpeg quality>
      <geotiff:predictor>None</geotiff:predictor>
      <geotiff:interleave>pixel</geotiff:interleave>
      <geotiff:tiling>true</geotiff:tiling>
      <geotiff:tileheight>256</geotiff:tileheight>
      <geotiff:tilewidth>256</geotiff:tilewidth>
    </geotiff:parameters>
  </wcs:Extension>
```

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```
<wcs:CoverageId>grey</wcs:CoverageId>  
<wcs:format>image/tiff</wcs:format>  
<wcs:mediaType>multipart/related</wcs:mediaType>  
</wcs:GetCoverage>
```

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Annex C Bibliography

OGC 09-110r4, *OGC® Web Coverage Service 2.0 Interface Standard – Core*, version 2.0

BigTIFF, Extending LibTiff library with support for the new BigTIFF format, available at <http://www.remotesensing.org/libtiff/bigtiffpr.html> [2013-06-26]

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