Contents

Annex D
(informative)

Temporal Aspects

Guidelines for the use of Observations & Measurements [reference D2.9] gives a general description on how to use of phenomenonTime, resultTime and validTime for Inspire Annex II and III data specifications. However, meteorological data involve several additional types of time information. This informative annex gives some illustrative examples on how to specify nominal analysis time, issue time of forecasts, and aggregation time periods thus giving a mapping from traditional terminology in operational meteorology to O&M and the AC-MF model.

Numerical Weather Prediction (NWP) Model Forecast Runs
For numerical weather predictions, another important time point in a forecast run (in addition to the phe-nomenon time) is the nominal analysis time. This time point is used to distinguish consecutive forecast runs from each other. The nominal analysis time is nominal in the sense that the actual start of the obser-vation assimilation and forecasting may not occur exactly at the nominal analysis time point. Instead, the nominal analysis time indicate approximately when the forecast was scheduled to run from. In addition to the nominal analysis time, the process of producing a forecast involves several additional time points:

- actual start of observation assimilation which may be slightly later or earlier than the nominal analysis time
- actual start of analysis (typically after the nominal analysis time).
- cut-off time for observations used in the assimilation
- start of forecast computation
- end of forecast computation
- time when results are available

Note: in this specification we avoid using the term reference time since it can refer to the analysis time, the start of forecast or the even the verifying time of forecast (phenomenon time at which forecast is compared with reality).

In most use-cases, time information on these individual steps is not necessary and can be omitted. How-ever, if a data provider wants to represent the timing of individual steps, then Process.processParameter could be used.

See below an example of process parameters for analysis time and assimilation window for a global forecast model (See D2.9 version 1.0 section 5.4.1.2)

Process
- name: ukmo_global_model
- documentation: http://www.metoffice.gov.uk/research/modelling-systems/unifiedmodel/weatherforecasting
- processParameter: http://inspire.europe.eu/processParameterValue.html#AnalysisTime
- processParameter: http://inspire.europe.eu/processParameterValue.html#AssimilationWindowBegin
- processParameter: http:// inspire.europe.eu/processParameterValue.html#AssimilationWindowEnd

OM_Observation
- phenomenonTime: 2011-05-15T00:00:00+00:00 ; 2011-05-21T00:00:00+00:00
- resultTime: 2011-05-15T00:00:00+00:00
- parameter:

Name: http://inspire.europe.eu/processParameterValue.html#AnalysisTime,
Value: 2011-05-15T00:00:00+00:00
-parameter:
Name: http://inspire.europe.eu/processParameterValue.html#AssimilationWindowBegin,

Value: 2011-05-14T20:00:00+00:00
-parameter:
Name: http:// inspire.europe.eu/processParameterValue.html#AssimilationWindowEnd,
Value: 2011-05-15T02:00:00+00:00

Meteorological observations
A meteorological observation such as a SYNOP telegram is the result of an OM_Observation rather than an OM_Observation in itself (N.B. observation being a homonym). The actual OM_Observation corre-sponds to the act of measuring a property (i.e. the automated process of measuring temperatures in synoptic stations). It is not uncommon that the phenomenonTime of slightly early or late synoptic observations are rounded to the nearest "synoptic" hour. E.g. an observation event occuring at 06.03Z would be reported with phenomenon time of 06Z.

The resultTime could be either the time of observation (coinciding with the phenomenon time instant) or the time instant when the data was made available after quality control.

validTime may be omitted for meteorological observations (implying that observations are useful for an indefinite time period, in contrast to forecasts).

Time-series of observations
Each observation has a result that contains values of some property (e.g. temperature) for a specific phenomenon time point or time interval. For SamplingCoverages such as PointObservation and GridObservation, the entire observation refers to a single TM_Instant in the real world (past or future). However, for other SamplingCoverages (e.g. ProfileObservation, PointTimeSeriesObservation and TrajectoryObservation), the result may represent different time points or intervals in the real world. Here the phenomenon time for the OM_Observation is the temporal extent for the entire observation but individual value will have an additional timestamp in the result.

A common example would be a time series of meteorological measurement from a single observing station packaged into a single coverage (e.g. a PointTimeSeriesObservation). Here the phenomenon time interval would cover the entire time series from start to end, whereas the individual timepoints for the measurements are stored in the resulting coverage.

Below an example of a temperature time series encoded with swe:DataRecordType.

```
<swe:values>
2012-01-27T00:00:00+00:00 , 264.84
2012-01-27T01:00:00+00:00 , 262.74
2012-01-27T03:00:00+00:00 , 262.74
</swe:values>
```

Analysis runs
In terms of O&M, an analysis run in an O&M observation whose result is an analysis product with values of some property (e.g. temperature) for a specific point in time. Here, the resultTime describes the time when the result became available, i.e. when the analysis was completed and the result was available (commonly known as the issue time of the analysis). The phenomenon time (TM_Object, Mandatory) of O&M defines the time period the analysis product covers (may be a time instant rather than a time period). The O&M validTime (TM_Object, Optional) describes the time period during which the result is intended to be used (typically until the next analysis run is scheduled to be available). For analysis products the validTime may be omitted.

Aggregations
Aggregated observed properties involves additional temporal aspects that can be handled with statisti-calMeasure.

Example 1: Daily average temperature
OM_ObservableProperty
- basePhenomenon: "air_temperature" (from the CF Standard Names registry of ObservablePropertyValue).
- uom: “Kelvin”

Combined with a

StatisticalMeasure
- statisticalFunction: "average" (from registry of StatisticalFunctionTypeValue).
- aggregationTimePeriod: "24:00:00"

Example 2: Three hour maximum wind speed (mean wind)
There are several complex types of properties which involve multiple temporal aspects. E.g. the maximum wind speed (mean wind) as found in BUFR B011041 is defined as the 3 hour maximum of samples consisting of 15 minute averages. None of the O&M time information attributes captures this information. Instead, maximum of average wind would be defined as a ObservableProperty based on the base-Phenomenon “wind speed” with an additional StatisticalMeasure with statisticalFunction “maximum” and the aggregationTimePeriod “03:00:00”. This constraint would be derivedFrom a second StatisticalMeasure with statisticalFunction “average” and the aggregationTimePeriod “00:15:00”.

Example 3: 12-hour accumulated precipitation amount
Accumulation in another example of addition time aspect. Again, the ObservableProperty can be combined with a StatisticalMeasure to define the length of the accumulation period.

ObservableProperty
- basePhenomenon: “precipitation amount”
- uom:”kilogram per square metre”

StatisticalMeasure
- statisticalFunction: "sum”
- aggregationTimePeriod: "12:00:00"

Example 4: Wind speed gust
The averaging time period for gusts varies: 3 seconds is typically acknowledge as gust however there are many other time intervals in use. The period is as a StatisticalMeasure.

ObservableProperty
- basePhenomenon: “wind_speed_of_gust”
- uom: “metre per second”

StatisticalMeasure
- statisticalFunction: "average"
- aggregationTimePeriod: "00:00:03"

Complex temporal aspects
An example of such a properties is the accumulated dose of ozone Over a Threshold of 40 ppb for crops (AOT40). The definition is the sum of the differences between hourly concentrations greater than 80 µg/m3 (= 40 parts per billion) and 80 µg/m3:

AOT40measured = _ max(0, (C(i) - 80))

where C(i) is the hourly mean ozone concentration in µg/m3 and the summation is over all hourly values measured between 8.00 – 20.00 Central European Time(**) each day and for days in the 3 month growing season crops from 1 May to 31 July.

Since AOT40 is a Sum, the observable property would be associated with a statistical measure but the sum is not over a continuous TM_Duration.

When observed properties cannot be expressed with StatisticalMeasure, ScalarConstraint, RangeCon-straint or CategoryConstraint the model includes otherConstraint that allows free text descriptions.

Climatology

Climatological Mean Values are calculated from multiple years averages of quantities which are themselves means over some period of time less than a year. These are described in a similar manner with StatisticalMeasure chained through derivedFrom with another StatisticalMeasure .

Reanalysis products

For reanalysis, the resultTime defines when the reanalysis was completed. In other respects, see NWP data above.

Annex E
(informative)
Mandated and recommended parameter mappings to GRIB Descriptions & CF Standard Names

Parameter	GRIB2 Code (discipline, category, number)	Description	CF Standard Name
Wind speed	0, 2, 1	Wind speed	wind_speed
Wind direction	0, 2, 0	Wind direction (from which blowing)	wind_from_direction
temperature	0, 0, 0	Temperature	air_temperature
Relative humidity	0, 1, 1	Relative humidity	relative_humidity
evaporationAmount	0, 1, 6	Evaporation	water_evaporation_amount
precipitationAmount	0, 1, 52 (+ 4,.10, 1) (or 0, 1, 8)	Total precipitation rate + type of statistical processing = accumulation (or Total precipitation (depreciated))	precipitation_amount
windSpeedGust	0, 2, 22	Wind speed (gust)	wind_speed_of_gust
precipitation rate	0, 1, 52 (or 0, 1, 7)	Total precipitation rate (or Precipitation rate (depreciated))	precipitation_flux
precipitation type	0, 1, 19	Precipitation type, refering to GRIB Code Table 4.201 1 Rain 2 Thunderstorm 3 Freezing Rain 4 Mixed/Ice 5 Snow	NONE
total now depth	0, 1, 11	Snow depth	surface_snow_thickness
Pressure reduced to mean sea level	0, 3, 1	Pressure reduced to MSL	air_pressure_at_sea_level
total cloud cover	0, 6, 1	Total cloud cover	cloud_area_fraction
visibility	0, 19, 0	Visibility	visibility_in_air
global solar radiation	0, 4, 3	Global radiation flux	surface_downwelling_shortwave_flux_in_air
long-wave radiation	0, 5, 5	Net long wave radiation flux	surface_net_upward_longwave_flux
short-wave radiation	0, 4, 9	Net short wave radiation flux	surface_net_upward_shortwave_flux

Annex F
(informative)
Binary encoding formats typically used for the result grid coverage data of meteorological and atmospheric data sets

As stated in the guidelines for the encoding of spatial data [INSPIRE D2.7 3.0], there is no best practice solution for integration of meteorological data within a spatial data infrastructure. The data volume of meteorological and atmospheric datasets makes it impracticable to use XML-based encodings only. Two efficient code forms have been developed and juridically approved for international exchange of meteorological data and are widely used within the meteorological community at large, namely, GRIB (mainly for gridded data) and BUFR. . The third format presented here is CF-NetCDF, which has wide adoption in the scientific community, and thus may be more accessible to non-meteorologists than GRIB and BUFR, but does not have a *de jure* status.

F.1 WMO GRidded Binary (GRIB)

GRIB is a binary data format for exchange of processed meteorological data in the form of values typically located at an array of grid points. This format is used primarily to exchange numerical forecasts, hindcasts and analysis-data among national weather services and other users. The definition of grids, products and data representations in GRIB is handled through template numbers; if a new product, grid or type of data representation is needed, the new template(s) go through a formal process for WMO approval, as described in the WMO Manual on Codes [WMO 306].

In section 1, (identification section) the originating centre and sub-centre must be provided. Since this information is not present in the AC-MF model, the Common Code Table C-1 should be consulted. Several entities in the model for Atmospheric Conditions lack corresponding entry in the public GRIB-templates.

For a complete documentation on GRIB, refer to the WMO Manual on Codes [WMO 306].

F.2 Binary Universal Form for the Representation of meteorological data (BUFR)

BUFR is a binary encoding developed by WMO mainly for the exchange of non-gridded data, essentially measurements from observing stations. BUFR is a table-driven code form where the meaning of data elements is determined by referring to a set of tables that are kept and maintained separately from the message itself.

To be compatible with existing software, BUFR-messages should conform to the BUFR-templates defined by WMO. For instance, atmospheric conditions represented by SF_SamplingPoint could be coded with the template TM307080 developed for point-wise synoptic reports.
Many data elements in the WMO BUFR-templates have no corresponding attributes in the AC-MF model. For those missing data elements, the recommendation is to include the data-elements in the BUFR-telegram, but mark the value of those data elements to missing (BUFR reserves the highest value of a data element domain as a missing value indicator where all bits in the bitstream are set to 1's).

The BUFR templates require identification of originating/generating centre, sub-centre and station (or site) name. If applicable, the information published in the WMO publication No. 9, Volume A, Observing Stations [WMO 9] should be used.

F.3 Network Common Data Form (NetCDF)

NetCDF (network Common Data Form) is a data model for array-oriented scientific data, a freely distributed collection of access libraries implementing support for that data model, and a machine-independent format. Together, the interfaces, libraries and format, support the creation, access and sharing of multidimensional scientific data. NetCDF format is being developed by Unidata and different NetCDF variants have been adopted by organizations like Open Geospatial Consortium (OGC) and NASA. NetCDF has recently become an OGC standard [OGC 10-090], [OGC 10-092].

NetCDF-CF encoding format is netCDF conforming to the Climate and Forecast (CF) conventions which provide the necessary semantics to implement geospatial information interoperability. In fact, netCDF-CF entities can implement most of the ISO 19123 coverage geometries and related metadata (i.e. ISO 19115). NetCDF-CF data model and encodings are widely used and well supported by the international Earth Sciences Community (e.g. meteorology, climatology, and ocean Communities). Both netCDF version 3 and 4 can be used for the dataset encoding; while, CF version 1.5 or 1.6 are recommended.

Annex G
(informative)
Example of a WMS 1.3 GetCapabilities response with INSPIRE extended capabilities & AC-MF layer identification

```xml
<?xml version="1.0" encoding="UTF-8"?>
<WMS_Capabilities xmlns="http://www.opengis.net/wms"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:inspire_common="http://inspire.ec.europa.eu/schemas/common/1.0"
  xmlns:inspire_vs="http://inspire.ec.europa.eu/schemas/inspire_vs/1.0"
  xsi:schemaLocation="http://inspire.ec.europa.eu/schemas/inspire_vs/1.0
http://inspire.ec.europa.eu/schemas/inspire_vs/1.0/inspire_vs.xsd
http://www.opengis.net/wms
http://schemas.opengis.net/wms/1.3.0/capabilities_1_3_0.xsd">
  <Service>
    <Name>WMS</Name>
    <Title>An example of an INSPIRE AC-MF compliant View Service implemented using
the OGC WMS 1.3</Title>
    <OnlineResource xlink:type="simple" xlink:href="http://example-view-
service.some.org/?SERVICE=WMS&amp;VERSION=1.3.0"/>
  </Service>
  <Capability>
    <Request>
      <GetCapabilities>
        <Format>application/xml</Format>
        <DCPType>
          <HTTP>
            <Get>
              <OnlineResource xlink:type="simple" xlink:href="http://view-
service.some.org/?SERVICE=WMS&amp;VERSION=1.3.0&amp;REQUEST=GetCapabilities"/>
            </Get>
          </HTTP>
        </DCPType>
      </GetCapabilities>
      <GetMap>
        <Format>image/png</Format>
        <Format>image/jpeg</Format>
        <DCPType>
          <HTTP>
            <Get>
              <OnlineResource xlink:type="simple" xlink:href="http://view-
service.some.org/?SERVICE=WMS&amp;VERSION=1.3.0&amp;REQUEST=GetMap"/>
            </Get>
          </HTTP>
        </DCPType>
      </GetMap>
    </Request>
    <Exception>
      <Format>XML</Format>
    </Exception>

    <!-- INSPIRE Extended Capabilities as defined in the
      "Technical Guidance for the implementation of INSPIRE View Services"
    -->
    <inspire_vs:ExtendedCapabilities>
     <inspire_common:ResourceLocator>
       <inspire_common:URL></inspire_common:URL>
     </inspire_common:ResourceLocator>
      <inspire_common:ResourceType>service</inspire_common:ResourceType>
      <inspire_common:TemporalReference></inspire_common:TemporalReference>
      <inspire_common:Conformity>
```

```
        <inspire_common:Specification>
          <inspire_common:Title>D2.8.III.13-14 Data Specification on Atmospheric
Conditions - Guidelines</inspire_common:Title>
          <inspire_common:DateOfPublication>2012-04-
20</inspire_common:DateOfPublication>
        </inspire_common:Specification>
        <inspire_common:Degree>conformant</inspire_common:Degree>
      </inspire_common:Conformity>
      <inspire_common:MetadataPointOfContact>
        <inspire_common:OrganisationName>ACME</inspire_common:OrganisationName>
        <inspire_common:EmailAddress>info@acme.com</inspire_common:EmailAddress>
      </inspire_common:MetadataPointOfContact>
      <inspire_common:MetadataDate>2015-01-01</inspire_common:MetadataDate>

<inspire_common:SpatialDataServiceType>view</inspire_common:SpatialDataServiceType>
      <inspire_common:MandatoryKeyword>

<inspire_common:KeywordValue>infoMapAccessService</inspire_common:KeywordValue>
      </inspire_common:MandatoryKeyword>
      <inspire_common:Keyword>
        <inspire_common:OriginatingControlledVocabulary>
          <inspire_common:Title>AC-MF Data Type</inspire_common:Title>
          <inspire_common:DateOfCreation>2012-04-20</inspire_common:DateOfCreation>
          <inspire_common:URI>urn:x-inspire:specification:DS-AC-
MF:dataType</inspire_common:URI>
          <inspire_common:ResourceLocator>
            <inspire_common:URL></inspire_common:URL>
          </inspire_common:ResourceLocator>
        </inspire_common:OriginatingControlledVocabulary>
        <inspire_common:KeywordValue>prediction</inspire_common:KeywordValue>
      </inspire_common:Keyword>
      <inspire_common:SupportedLanguages>
        <inspire_common:DefaultLanguage>
          <inspire_common:Language>eng</inspire_common:Language>
        </inspire_common:DefaultLanguage>
        <inspire_common:SupportedLanguage>
          <inspire_common:Language>fin</inspire_common:Language>
        </inspire_common:SupportedLanguage>
        <inspire_common:SupportedLanguage>
          <inspire_common:Language>swe</inspire_common:Language>
        </inspire_common:SupportedLanguage>
      </inspire_common:SupportedLanguages>
      <inspire_common:ResponseLanguage>
        <inspire_common:Language>eng</inspire_common:Language>
      </inspire_common:ResponseLanguage>
    </inspire_vs:ExtendedCapabilities>

    <Layer>
      <!-- This is a grouping layer containing common inherited properties for
           all sub-layers. No "Name" element defined -->
      <Title>Latest ECMWF Deterministic Model Run</Title>

      <!-- Whether the data is predicted (forecast) or measured, provided here
           for convenience (no need to resolve the MetaDataURL or FeatureListURL
           to find this out). -->
      <KeywordList>
        <Keyword vocabulary="urn:x-inspire:specification:DS-AC-
MF:dataType">prediction</Keyword>
        <!-- <Keyword vocabulary="urn:x-inspire:specification:DS-AC-
MF:dataType">measurement</Keyword> -->
      </KeywordList>

      <!-- Supported Coordinate Reference Systems for this layer and child
           layers -->

      <!-- ETRS89: -->
      <CRS>EPSG:4258</CRS>
```

```xml
      <!-- WGS 84, latitude, longitude: -->
      <CRS>EPSG:4326</CRS>

      <!-- WGS 84, longitude, latitude: -->
      <CRS>CRS:84</CRS>

      <EX_GeographicBoundingBox>
        <westBoundLongitude>-31.2</westBoundLongitude>
        <eastBoundLongitude>69.1</eastBoundLongitude>
        <southBoundLatitude>27.2</southBoundLatitude>
        <northBoundLatitude>90</northBoundLatitude>
      </EX_GeographicBoundingBox>

      <BoundingBox CRS="EPSG:4326" minx="27.2" miny="-31.2" maxx="90" maxy="69.1"/>

      <!-- Two analysis times (one for each forecast model run available) -->
      <Dimension name="ANALYSIS_TIME" units="ISO8601" default="2012-04-
19T00:00.00Z">
        2012-04-19T00:00.00Z,
        2012-04-19T03:00.00Z
      </Dimension>

      <!-- (Forecast) times:
        1h resolution for the first day,
        3 hour resolution for the next day,
        the rest with 6h resolution
      -->
      <!-- Problem?: this time resolution has to be same for all "ANALYSIS_TIME"
           sampling dimensions -->
      <Dimension name="TIME" units="ISO8601" default="2012-04-20T12:00.00Z">
        2012-04-19T00:00.00Z/2010-04-19T23:00.00Z/PT1H,
        2012-04-20T00:00.00Z/2012-04-20T21:00.00Z/PT3H,
        2012-04-21T00:00.00Z/2012-04-27T12:00.00Z/PT6H
      </Dimension>

      <!-- Available elevations, in meters above the WGS84 ellipsoid.
           Problem: how to use a barometric vertical CRS? -->
      <Dimension name="ELEVATION" units="EPSG:5030" unitSymbol="m" default="0">
0,10,25,50,100,150,200,500,1000,2000,3000,4000,5000,6000,7000,10000,12000,15000
      </Dimension>

      <!-- An isoline style available for all sub-layers -->
      <Style>
        <Name>isoline</Name>
        <Title>Default isoline visualization</Title>
        <StyleURL>
          <Format>application/gml+xml; version=3.2</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://discovery-
service.some.org/?SERVICE=CSW&amp;VERSION=2.0.2&amp;REQUEST=GetRecordById&amp;ID=54
574656&amp;outputSchema=http://www.isotc211.org/2005/gmd&amp;elementSetName=full"/>
        </StyleURL>
      </Style>

      <!-- Filled contour style available for all sub-layers -->
      <Style>
        <Name>filled-contour</Name>
        <Title>Default filled contour visualization</Title>
        <StyleURL>
          <Format>application/gml+xml; version=3.2</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://discovery-
service.some.org/?SERVICE=CSW&amp;VERSION=2.0.2&amp;REQUEST=GetRecordById&amp;ID=89
458843&amp;outputSchema=http://www.isotc211.org/2005/gmd&amp;elementSetName=full"/>
        </StyleURL>
      </Style>

      <!-- An air pressure layer -->
      <Layer>
        <!-- Layer name, not restricted to the INSPIRE Harmonized naming
```

```xml
            convention -->
        <Name>AirPressureOrAnythingYouWantToCallIt</Name>
        <Title>Air Pressure</Title>

        <!-- The visualized property (air pressure) is identified by using
             external standard names.
             How to declare these vocabularies? The clients just need to
             recognize these names? -->
        <KeywordList>
          <Keyword vocabulary="urn:x-inspire:specification:DS-AC-MF:observable-
property-name:WMO:GRIB-code:2010">001</Keyword>
          <Keyword vocabulary="urn:x-inspire:specification:DS-AC-MF:observable-
property-name:cf-standard-name:1.6">air_temperature</Keyword>
        </KeywordList>

        <!-- Pointer to the INSPIRE Discovery Service, providing metadata for
             the underlying data of this layer, refers to a dataset level ISO
             metadata record. This element is required by the INSPIRE View
             Services Technical Guidance -->
        <MetadataURL type="ISO19115:2003">
          <Format>application/gml+xml; version=3.2</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://discovery-
service.some.org/?SERVICE=CSW&amp;VERSION=2.0.2&amp;REQUEST=GetRecordById&amp;ID=23
234538&amp;outputSchema=http://www.isotc211.org/2005/gmd&amp;elementSetName=full"/>
        </MetadataURL>

        <!-- Pointer to the INSPIRE Download Service providing the underlying
             coverage data (OM_Observation result) for this layer -->
        <DataURL>
          <Format>application/x-CF-NetCDF</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://coverage-
service.some.org/?SERVICE=WCS&amp;VERSION=2.0&amp;REQUEST=GetCoverage&amp;COVERAGEI
D=4883995&amp;format=application/x-CF-NetCDF"/>
        </DataURL>

        <!-- Pointer to the INSPIRE Download Service providing the
             CSMLObservation instance, the result (coverage) of which this layer
             represents. -->
        <FeatureListURL>
          <Format>application/gml+xml; version=3.2</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://download-
service.some.org/?SERVICE=WFS&amp;VERSION=2.0.0&amp;REQUEST=GetFeature&amp;STOREDQU
ERY_ID=urn:ogc:def:query:OGC-
WFS::GetFeatureById&amp;ID=2329873972&amp;outputFormat=application/gml+xml;version=
3.2"/>
        </FeatureListURL>
      </Layer>

      <!-- An air temperature layer -->
      <Layer>
        <Name>AirTemperatureOrAnythingYouWantToCallIt</Name>
        <Title>Air Temperature</Title>
        <KeywordList>
          <Keyword vocabulary="urn:x-inspire:specification:DS-AC-MF:property-
names:wmo-codes:GRIB:2010">011</Keyword>
          <Keyword vocabulary="urn:x-inspire:specification:DS-AC-MF:property-
names:cf-standard-names:1.6">air_temperature</Keyword>
        </KeywordList>
        <MetadataURL type="ISO-19115:2003">
          <Format>application/gml+xml; version=3.2</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://discovery-
service.some.org/?SERVICE=CSW&amp;VERSION=2.0.2&amp;REQUEST=GetRecordById&amp;ID=95
558944&amp;outputSchema=http://www.isotc211.org/2005/gmd&amp;elementSetName=full"/>
        </MetadataURL>
        <DataURL>
          <Format>application/x-CF-NetCDF</Format>
```

```
          <OnlineResource xlink:type="simple" xlink:href="http://download-
service.some.org/?SERVICE=WCS&amp;VERSION=2.0&amp;REQUEST=GetCoverage&amp;COVERAGEI
D=4883995&amp;format=application/x-CF-NetCDF"/>
        </DataURL>
        <FeatureListURL>
          <Format>application/gml+xml; version=3.2</Format>
          <OnlineResource xlink:type="simple" xlink:href="http://download-
service.some.org/?SERVICE=WFS&amp;VERSION=2.0.0&amp;REQUEST=GetFeature&amp;STOREDQU
ERY_ID=urn:ogc:def:query:OGC-
WFS::GetFeatureById&amp;ID=48873784&amp;outputFormat=application/gml+xml;version=3.
2"/>
        </FeatureListURL>
      </Layer>
    </Layer>
  </Capability>
</WMS_Capabilities>
```

Annex H
(informative)
Reasoning for Inclusion and Exclusion of Meteorological Satellite Data and Imagery Within Specific INSPIRE Themes

This annex on access to meteorological satellite data is intended to explain its:

1. Exclusion from the scope of Orthoimagery (OI);
2. Inclusion within the scope of Atmospheric Conditions/Meteorological Geographical Features (AC-MF) and Oceanographic Geographical Feature (OF) (ideally within a joint AC-MF & OF model).

There are around 30 meteorological satellites in orbit wholly or partly gathering and disseminating environmental data. The operators include EUMETSAT, ESA, US (NASA, NOAA and DoD), Russia, China, Japan, India. These satellites gather data from which information on the physical characteristics of the atmosphere and the oceans can be derived. These characteristics include: surface and upper air temperatures; upper air humidities and water vapour; cloud amounts, cloud type and cloud top temperatures; inferred rainfall rates; winds aloft; water waves and winds on the sea surface.

None of these parameters can be taken directly from the satellite images without extensive processing involving many other sources of data.

1. Temperatures, and the heights at which the temperatures apply, have to be computed from radiances used iteratively within a numerical weather prediction model.
2. Precipitation rates are inferred from overlaps with radar rainfall information and extension outside the radar coverage area.
3. Winds aloft are estimated by tracking the movement of clouds, using estimates of the cloud height from NWP models.
4. Sea surface temperatures are estimated from cloud-free radiances at the surface, processed through a numerical model analysis scheme which uses a recent past analysis for continuity, and current observed temperatures from ships and buoys.
5. Sea wave heights and sea surface winds are estimated from radar Bragg scattering from capillary waves, with numerical models used to remove gross ambiguities in wind direction.
6. Sea ice cover estimates are generated by an analysis process, which combines satellite imagery data from several sources and numerical model data.

It is clear that these products derived from meteorological satellite data are measures of atmospheric or oceanographic properties, which should be treated on a par with other such property estimates, and falling firmly within the scope of AC-MF and OF. As such they are out of scope of OI.

Satellite-derived sea surface temperature (SST) coverages are a good example; obviously important as oceanographic data, SSTs have an even more critical value as boundary information for atmospheric numerical weather prediction (NWP) models. Real-time SST analyses are produced and distributed by organisations in this community who often combine Atmospheric and Oceanographic functions. The Environmental Monitoring Facilities (EF) data specification identifies satellite-derived SSTs as required data for Marine Strategy Framework Directive, but wrongly attributed it to the OI scope.
This leaves the orthorectified images to be considered whether they are in or out-of scope for OI requirements for the atmospheric and oceanographic components of GMES, for example.

Considering the unprocessed satellite imagery, the visible, infrared (IR) and microwave data are being used to provide information about the atmosphere (e.g. presence of cloud) or the near-surface characteristics (e.g. fog or snow cover), and not specifically of the earth's surface. The scope of OI involves image information about the earth's surface, and so these unprocessed images can also be considered out of scope.

Even if the meteorological visible images are considered from the perspective of providing information about the surface, they are still a poor fit for the scope of OI. Generally at typical meteorological

satellite resolutions, the surface detail (less than 1km) which interests the ‘OI community’ is just not available

The visible images which come from EUMETSAT geostationary satellites (with one visible and 11 other images every 15 minutes) typically have 1km to 5km resolution. They may be combined (e.g. false colour images combine visible and two IR bands) or cut into tiles for distribution (the field-of-view is of the globe in fixed perspective). Polar Orbiter (sun synchronous) images are collected at a receiving station from line-of-sight satellite passes approximately once per hour. These have a typical 1km resolution, and although they are mosaiced in real time, the information about banding and seamlines is not retained or distributed with the mosaics. OI concerns of seamlines, quality commission, and high positional accuracy (typically to one pixel ~ 1km) are not of great interest to the meteorological satellite user community. With the very high frequency and regularity of production of these satellite images, all lineage information, radiance and processing information would be referenced to the web-site of the producers, rather than loaded on the metadata. Thus the visible images from Meteorological Satellites are correctly deemed out of scope of TWG OI.

Annex I
(informative)
Code list interoperability

Code list interoperability is non-trivial. A large number of international and national code lists exist for meteorological and atmospheric data. Notable examples include the BUFR B-table issued by WMO, CF standard names, and AQS parameters.
Whilst all of these code lists allow the user to identify the physical base phenomenon (1*), their entries may also specify additional aspects. However, there is no common agreement of what these additional aspects should be. For instance, some code lists specify a generic surface density whereas other code lists include precipitation per square metre. Here, one code list defines both the substance and unit of measure, whereas the other simply defines the physical base phenomenon). Beyond substance, unit, and sometimes altitude many other less obvious aspects are also used (e.g. reporting precision for temperature codes in BUFR).
The follow examples of aspects illustrate the broad variation of detail and content in existing code lists (derived from several international and national code lists including WMO BUFR B-table).

- Substance: soil temperature, air temperature, water temperature.
- Elevation: 2 metre temperature, temperature at ground level, upper air temperature)
- Unit: Celsius temperature, Kelvin temperature
- Precision of reporting : temperature with one decimal place, temperature with two decimal places
- Method-aspect: direct measurement of temperature, forecast temperature
- Quality control aspect: temperature without QC (QC0), temperature after human QC
- Source: temperature from GTS, temperature from forecast model
- Usage: Climatological temperatures, temperatures suitable for realtime production.
- Statistics: Average temperature, maximum temperature
- Accumulation time periods: 12-12 precipitation, 6-6 precipitation.
- Integration time period: 3 hour maximum of 15 minute averages.
- Instrument for measurement: Heliograph sunshine time, “Sunfollower” sunshine time.
- Method for calculating and interpolating: Kalman filtered temperature
- Corrections: Original measured temperature, corrected temperature

Since each international code lists cover different aspects, the interoperability is a challenge. The current AC-MF specification recognizes the diversity of external code lists and cannot produce a universal compatible code list. To facilitate the use of AC-MF data by non-experts (outside the meteorological institutes), we have proposed a model that separates physical base phenomena from the details of data acquisition, statistics, etc, which are instead placed in the appropriate sections of the Observable Property model or the ISO19156 O&M model; for example:

- StatisticMeasure covers: statistics, time periods (accumulations), areas, etc
- Constraint covers: constraining parameters (e.g. where temperature < 0 C) and can indicate spatial values (e.g. screen, 1.5 m, 500 mb), although this may be part of the resulting coverage range, as well as any other constraints
- Process covers: method, instrument, source
- Metadata & Quality covers: source, provenance and quality measures

By defining a simple model where the base phenomenon is clearly identified, we enable users to decide where it is appropriate to compare different datasets. For certain usage, it may be appropriate to compare data from “hourly average of digitally measured air temperature” with “forecast temperature at 2 metre”. Yet again, for other purposes these data may not be compatible. The decision lies with the user of the data.

Note (1): Within the meteorological domain the most common physical phenomena include: thermodynamic temperature, pressure, substance amount, intensity of luminosity, speed, pressure, mass, time, current, surface density, specific energy, energy surface density, mass concentration. All of those can be found in any basic text book of physics.
See also: Root definitions of quantities in *http://dx.doi.org/10.3247/SL1Phys06.004*.