How to Integrate Processing Functionality into WMS ?

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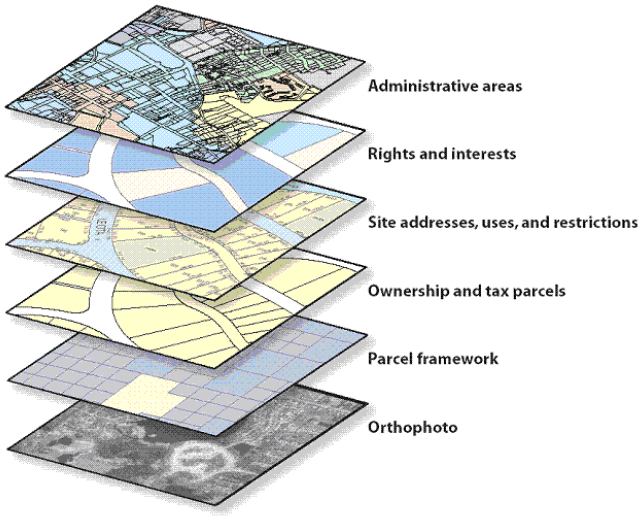
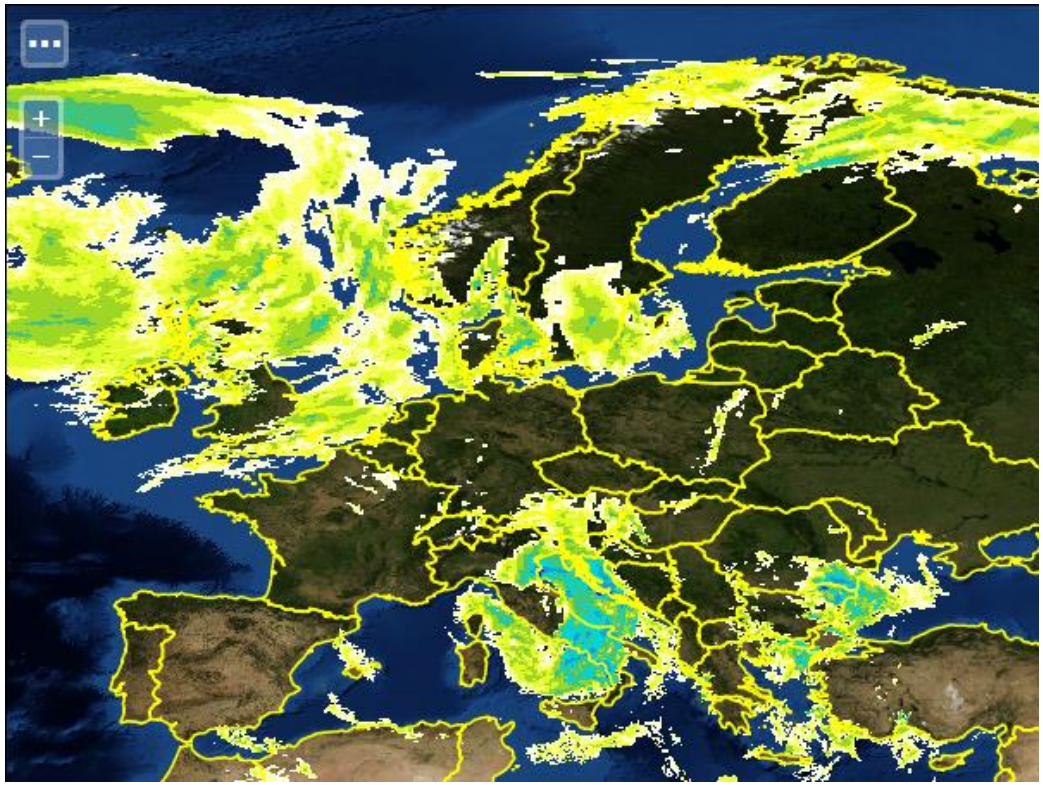
WMS Basics

- WMS is a standard of the Open Geospatial Consortium (OGC).
- WMS describes how 2-dimensional map images shall be served over the Internet.
- WMS specifies the interface of a number of request types, e.g. GetMap and GetFeatureInfo.
- WMS is based on the layer technology.



GetMap Example

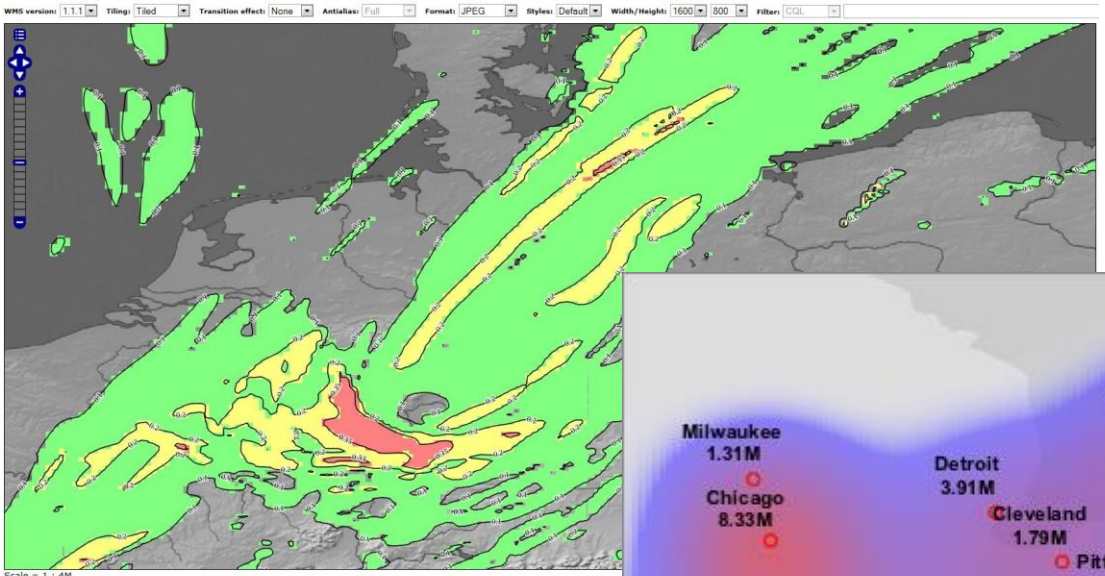


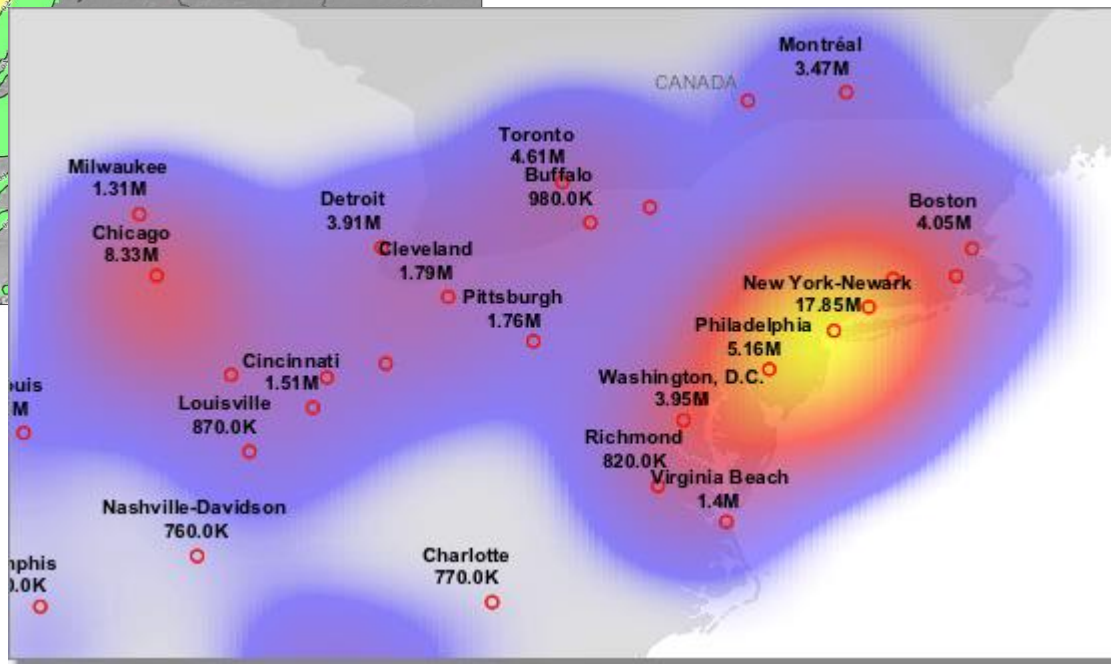
http://wms_server?service=WMS
&version=1.3.0
&request=GetMap
&layers=bluemarble,
total_precipitation,
border
&styles=,
&bbox=1,44,19,56
&width=600&height=450
&crs=EPSG:4326
&format=image/png
&time=2015-09-124T08Z

Use cases for processing functionality in WMS

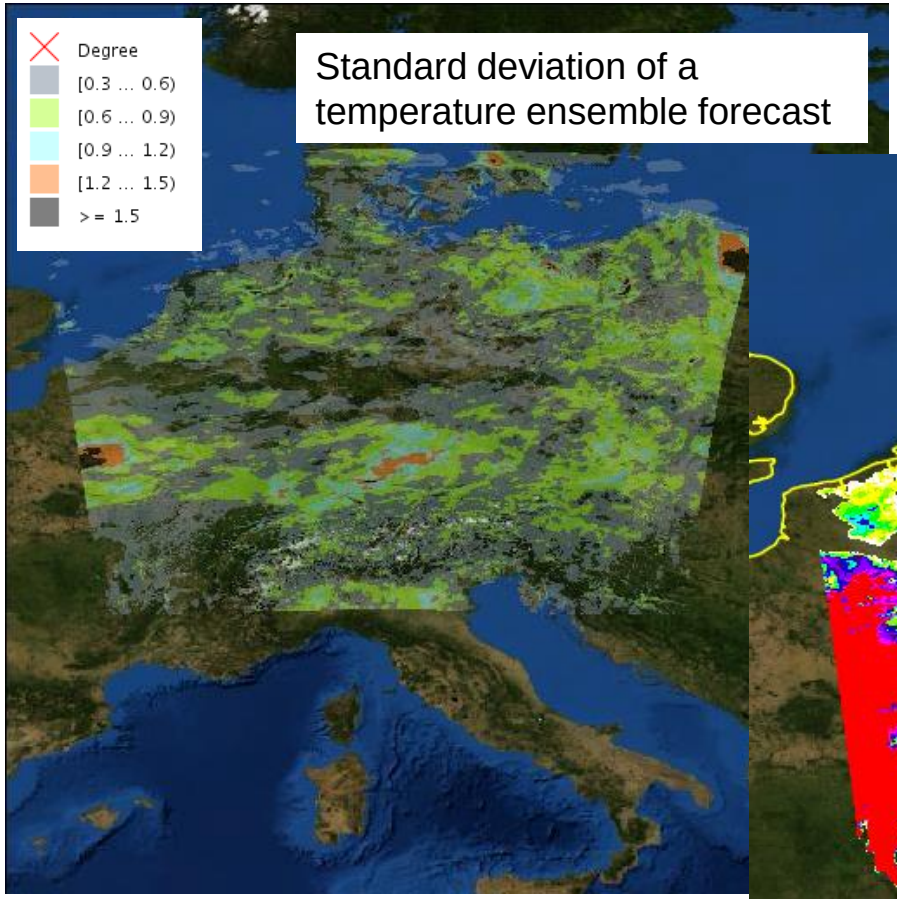
- Rendering transformations
  - heat maps
  - contouring
- Statistic maps derived from base layers
  - aggregation, e.g. ensemble mean
  - quantiles
  - probability

Rendering transformations

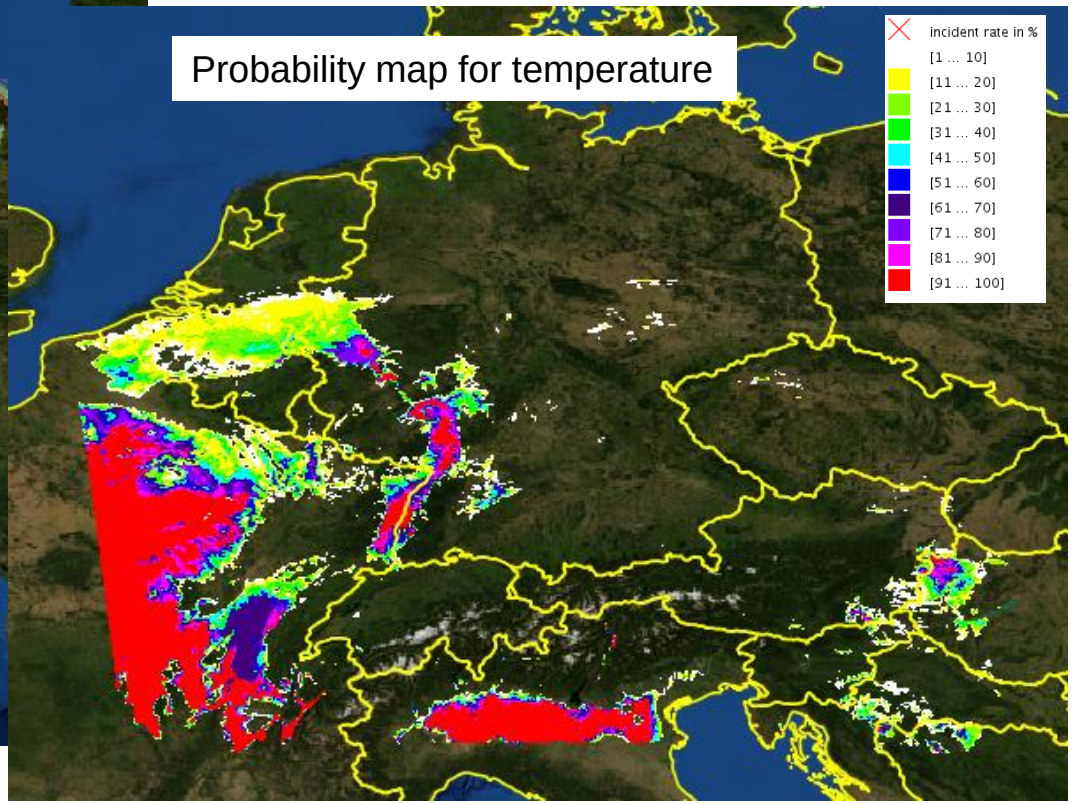




Statistic maps

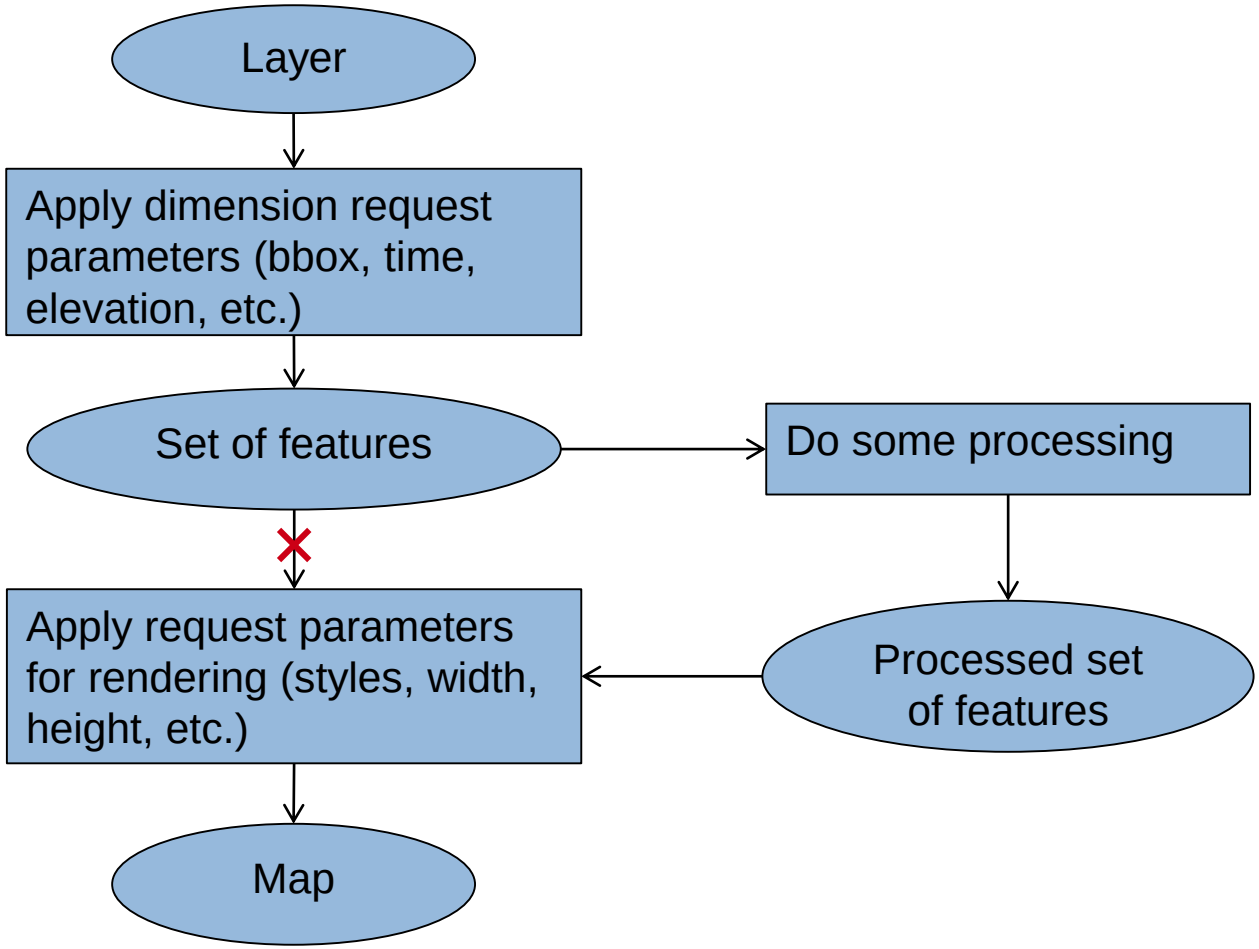


Standard deviation of a temperature ensemble forecast



Probability map for temperature

Execution plan of a GetMap request



A mathematical view

F(X(lat, lon, dims…), params…)

- F = processing function
- X = n-dimensional layer
- lat = latitude range
- lon = longitude range
- dims… = optional list of additional dimension values (e.g. time, elevation, etc.)
- params… = optional list of parameters for F

Examples

1. Ensemble mean of the current 2m temperature ensemble forecast.

➔ mean(T_2M_ENSEMBLE(lat=[1,19], lon=[44,56], time=default,
dim_reference_time=default, dim_member=[1,20]))

2. Probability that 2m temperature is above 5°C (= 278.15 K).

➔ prob_above(T_2M_ENSEMBLE(lat=[1,19], lon=[44,56], time=default,
dim_reference_time=default, dim_member=[1,20]), threshold=278.15)

Options for the integration of processing functionality into WMS

- Implement a rendering transformation process **F(params…)**. Use this process in a SLD for the base layer X. The values of the parameters of F are specified in a GetMap request with the vendor parameter `env`. This solution has been realised in GeoServer (http://geoserver.org).
- Specify a new vendor parameter `process`. This parameter could define a function call **F(params…)** for each layer in the `layers` parameter. Extend the WMS such that this parameter can be handled in a GetMap request.

- Example: Probability that 2m temperature is above 5°C (= 278.15 K).

http://server?service=WMS&version=1.3.0&request=GetMap
&layers=bluemarble,T_2M_ENSEMBLE,border&styles=,
&bbox=1,44,19,56&width=600&height=450&crs=EPSG:4326
&format=image/png&time=2015-09-124T08Z&dim_member=1/20
&processes=,prob_above(278.15),

An extended WMS capabilities document

```
<Layer queryable="1" opaque="0">
  <Name>dwd:T_2M_ENSEMBLE</Name>
  <Title>T_2M_ENSEMBLE</Title>
  <Abstract/>
  <KeywordList>
    <Keyword>WCS</Keyword>
    <Keyword>ImageMosaic</Keyword>
    <Keyword>T_2M_ENSEMBLE</Keyword>
  </KeywordList>
  <CRS>EPSG:1000003</CRS>
  <CRS>CRS:84</CRS>
  <EX_GeographicBoundingBox>
    <westBoundLongitude>1.0445387229002496</westBoundLongitude>
    <eastBoundLongitude>19.840677216452132</eastBoundLongitude>
    <southBoundLatitude>44.908117999055555</southBoundLatitude>
    <northBoundLatitude>56.67608058413707</northBoundLatitude>
  </EX_GeographicBoundingBox>
  <BoundingBox CRS="CRS:84" minx="1.0445387229002496" miny="44.908117999055555" maxx="19.840677216452132" maxy="5
  <BoundingBox CRS="EPSG:1000003" minx="-5.0" miny="-5.0" maxx="5.5" maxy="6.5"/>
  <Dimension name="time" default="2015-09-22T06:00:00Z" units="ISO8601">2015-09-22T06:00:00.000Z/2015-09-23T12:00
  <Dimension name="REFERENCE_TIME" default="2015-09-22T09:00:00.000Z" units="iso8601">2015-09-22T06:00:00.000Z,20
  <Dimension name="MEMBER" default="1" units="">1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20</Dimension>
  <Style>
    <Name>temperature_K</Name>
    <Title>temperature in Kelvin</Title>
    <Abstract>style for temperature in Kelvin</Abstract>
    <LegendURL width="20" height="20">
      <Format>image/png</Format>
      <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink" xlink:type="simple" xlink:href="https://maps.dwd
    </LegendURL>
  </Style>
  <Process>
    <Name>prob_above</Name>
    <Title>Probability above a threshold</Title>
    <Abstract>This process calculates the probability above a given threshold value</Abstract>
    <Parameter name="threshold" type="double">
  </Process>
</Layer>
```

Conclusions

- ➔ The integration of processing functionality into WMS is useful
  - ➔ It makes WMS more flexible and more powerful
  - ➔ It helps to limit the number of layers
- ➔ The current WMS standard needs extensions to support a processing of layer data
- ➔ The introduction of a new vendor parameter `processes` will be a simple solution
- ➔ Performance could be an issue