Air Quality & e-reporting
from the perspective of Belgium
Content

• Who are we (IRCEL – CELINE) and what do we do?
• E-reporting from our perspective:
  – Some background
  – What's in it for us?
  – The different approaches from a technical perspective
• E-reporting via an ETL-tool (e.g. HALE)
• E-reporting via services
  – Sensor Observation Service (SOS)
  – Other INSPIRE downloading services
• Future developments
• Concluding remarks
IRCEL – CELINE

Cellule Interrégionale de l'Environnement (CELINE)
Belgische Interregionale Umweltagentur (IRCEL - CELINE)
Belgian Interregional Environment Agency (IRCEL - CELINE)

Cooperation agreement between the three Belgian regions

Vlaamse Milieumaatschappij (VMM)
Leefmilieu Brussel - Bruxelles Environnement
Agence wallonne de l'Air et du Climat (AWAC)
IRCEL – CELINE

The three Belgian networks
IRCEL – CELINE

• Most important functions of IRCEL - CELINE (air quality):
  – Continuous forecasts (cf SMOG alert)
  – Informing the public on air quality (real-time and assessment)
  – National report under the air quality directive (2004/107/EC)
  – Enforcing a common scientific basis between monitoring networks
  – Interregional calibration laboratory
  – Interregional data processing centre (IDPC) - real-time database

• National Focal Point (Eionet)

• Compilation GHG inventory
IRCEL – CELINE

http://www.irceline.be
- Real-time data
- All major pollutants (incl. BC)
- Forecasts
- Information about pollutants
- Publications
- Etc.

Integration of OGC-services into website

... and tables with (real-time) data:
E-reporting and Air Quality

Exchange of Information Decision 97/101/EC


Air Quality Directive 2008/50/EC

Implementing Provisions for Reporting (IPR) 2011/850/EU

XML-schema (AQD-xsd)

Guidance document
E-reporting under the IPR

**Before:**
- Regional agency
- Regional agency
- Regional agency

Air Quality Questionnaire (.xls)

Transmission .xls after approval from ministries

**After:**
- Regional agency
- Regional agency
- Regional agency

Internal dataflows

Transmission XML after approval from ministries

INSPIRE-compliant transmission (cf 2011/850/EU)
The IPR – Decision (2011/850/EU)

Preamble, paragraph 7 - To streamline the amount of information made available by Member States, to maximise the usefulness of such information and to reduce the administrative burden, Member States should be required to make the information available in a standardised, machine-readable form. The Commission, assisted by the European Environment Agency, should develop such a standardised machine-readable form in line with the requirements of Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) (6). It is of particular importance that the Commission carries out appropriate consultations during its preparatory work, including at expert level.

- never make slides with too much text!!
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The IPR – Decision (2011/850/EU)

• The pilot process was successful in:
  – Developing a standardised, machine readable data format
  – There was a consultation process (12 pilot meetings so far)

• Remains to be seen:
  – Reduction of the administrative burden (but I have not yet lost my faith yet)

• Has not (entirely) delivered:
  – INSPIRE compliance:
    • INSPIRE compliance of the data model for e-reporting is OK (ca. 10% INSPIRE with ca. 120% Air Quality specifics added)
    • INSPIRE is not only about data specifications, but also about data access via convenient, querriable services
E-reporting: what's in it for us?
Early Warning System

Sometimes working at local level is not sufficient: a PM10 forecast example

Based on **forecasts**

In BE speed limits + industrial emissions are lowered during SMOG episodes

2 consecutive days PM10 > 70 µg/m³ (daily mean, average across BE)

PM10 Forecast, 24 Jan 2010 from BE was OK…

…BUT…

**Forecasted daily mean PM10 concentrations**

CHIMERE: run initialised on 24/01/2010 at 12:00 (UT)
OVL: run initialised on 25/01/2010 at 10:30 (Local Time)

<table>
<thead>
<tr>
<th>Zone / City</th>
<th>Monday 25/1</th>
<th>Tuesday 26/1</th>
<th>Wednesday 27/1</th>
<th>Thursday 28/1</th>
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</table>

More information about these forecasts: [IRCEL-CELINE website](#) or [CHIMERE interface](#)

Caution: since the current spatial resolution of the CHIMERE model is 50x50km, forecasted concentrations for cities should be carefully interpreted. A white colored cell means that no forecast could be calculated. The OVL forecasts are interpolated using the RIO-corine interpolation tool. RIO-corine was developed by the VITO in collaboration with IRCEL-CELINE. The Spatial resolution of RIO is 4x4 km.

If you have problems to read this HTML formatted e-mail, you can click [here](#) to view the same in your web browser.

© IRCEL-CELINE

PM10 > 70 µg/m³
A SMOG alert was missed!

Why did our models underestimate this episode?

Measured PM10 : >100 µg/m³
Long Range transport of Air Pollution

NOAA HYSPLIT MODEL
Backward trajectory ending at 1200 UTC 27 Jan 10
GDAS Meteorological Data

German map available only for day –1 ...
Impact of lower speed limit (EC)

EC (Elemental Carbon, diesel soot) reductions up to 30%

... probably the most toxic components of PM

Source: VITO - Lefebvre et al. (2009)
### E-reporting: the data flows involved

*(cf Implementing Provisions for Reporting (IPR) 2011/850/EU)*

<table>
<thead>
<tr>
<th>INPIRE Data Theme</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>III.11.AM</td>
<td>Dataset B – &quot;zones and agglomerations&quot;</td>
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<tr>
<td>III.11.AM</td>
<td>Dataset C – &quot;assessment regime&quot;</td>
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<tr>
<td>III.11.AM</td>
<td>Dataset D – &quot;assessment methods&quot;</td>
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<td>Dataset E1a – “primary validated assessment data – measurements”</td>
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<tr>
<td>III.13 AC</td>
<td>Dataset E1b – “primary validated assessment data – modelled”</td>
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<tr>
<td>III.7. EF</td>
<td>Dataset E2a – “primary up-to-date assessment data – measurements”</td>
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<td>III.7. EF</td>
<td>Dataset F1a – “aggregated data - primary validated measurements”</td>
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<tr>
<td>III.13 AC</td>
<td>Dataset F1b – “aggregated data - primary validated modelled”</td>
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<td>III.7. EF</td>
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<td>Dataset G – “attainment of environmental objectives”</td>
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<td>Dataset H – “air quality plans”</td>
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<td>Dataset I – “source apportionment”</td>
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<td>III.11.AM</td>
<td>Dataset J – “scenario for the attainment year”</td>
</tr>
<tr>
<td>III.11.AM</td>
<td>Dataset K – &quot;measures&quot;</td>
</tr>
</tbody>
</table>

+ a header transmitted with every separate submission
E-reporting: plenty of ways to skin the cat

Data extraction layer

- Custom Scripts (PHP, java, python, ...)
- Desktop tool (cf AQUI)
- web based tool (cf AQR-system)
- ETL – tool (HALE, FME etc.)
- OGC – services (WFS, SOS, WCS, etc.)

Database layer

- DB1
- DBx

Data acquisition

- Monitoring network A
- Monitoring network x
E-reporting via an ETL-tool

ETL = Extract, Transform and Load
HALE - the GUI
Why use HALE?

- Intuitive GUI for mapping data from your database to the schema
- You can execute HALE from the command line (meaning you can do a crontab on Linux), e.g.:
  
  [hale@hale ~]$ HALE -nosplash -application de.fhg.igd.hale.fme.app.exec -project <URI-to-project> -source <URI-to-source-data> -out <Path-to-target-file>

Optional parameters:

- reportsOut <Path-to-report-file> (Write report of transformation to a file)
- validate (Enable XML validation)
- format <format> (Its either 'GML' or 'XML', with 'GML' set as default)
- root <root-element-name> (The name of the root element to use when using 'XML' as format)
- root-ns <root-element-namespace> (The namespace of the root element to use if using 'XML' as format)

- NO closed source dependencies (like MS Access, cf AQUI)
- Can be used as an XSLT-editor
- Versatility of the tool
E-reporting – via services

(INSPRIE)-services

SOS (UTD-data - incl. data quality flags)

SOS/WFS (validated and/or aggregated)

WMS/WCS (e.g. modeled data)

e.g. SPARQL-Endpoint (Linked Data - e.g. “Plans and Programs”)

Reporting obligations

Incl. validation steps & official approval

IPR (2011/850/EU) XML-schema for reporting under the Air Quality directive (2008/50/EC)

The general public

The Commission

The Commission

The Commission

The Commission

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Using our SOS in projects: PMLab

Input data is harvested in realtime via SOS

http://pmlab.irceline.be/
Using our SOS in projects: ATMOSYS

Plan, Predict and Improve Air Quality
Why air quality needs our attention?

Discover our solutions
The ATMOSYS system offers different spatial tools to explore:
- Air pollution forecast (3 days ahead)
- Historical annual maps
- Time Evolution maps
- Human exposure to air pollution
- and Model validation tools

ATMOSYS delivers air quality information from regional level up to detailed street level.

Learn more
ATMOSYS provides valuable information for air quality experts on the following topics:
- EG emission inventories
- Data assimilation techniques
- High resolution and microscale air quality modelling
- INSPIRE compatibility

These topics were the core scientific backbone for development of the ATMOSYS system.

Background
The core goal of the ATMOSYS LIFE+ project is to demonstrate the solutions and knowledge, specifically designed to evaluate and analyse air pollution in European hotspot regions. The established system is based on advanced technology, including 3D atmospheric computer models, results from recent air pollution measurement campaigns in urban agglomerations and generic OGC-communication protocols to facilitate a fully automated web-based service.

Input data is harvested in realtime via SOS

http://www.atmosys.eu
SOS-server within the Joaquin - project

Exchange of data in realtime via SOS

http://www.joaquin.eu/
The development of a reporting service

http://www.eenvplus.eu
Sensor observation services (SOS) ... on the verge of becoming an official INSPIRE downloading service

- Efficient transmission of time series

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</swe:values>

- querriable:

http://sos.client.irceline.be
Sensor observation services (SOS)

- SOS is an OGC-standard
- components:
  - DB with O&M data model (PostgreSQL, but also MySQL, Oracle, MS SQL server)
  - Java runtime environment (JRE)
  - Servlet Container (e.g. Apache Tomcat)
  - WAR file (http://52north.org/downloads/sensor-web/sos)
  - Web server (Apache of Nginx)
- GetCapabilities, GetObservation, DescribeSensor
- RegisterSensor, InsertObservation
- GetFeatureOfInterest, GetObservationById, GetResult

https://wiki.52north.org/bin/view/SensorWeb/SensorObservationServiceIVDocumentation
http://52north.org/communities/sensorweb/sos/
SOS and the IPR (and INSPIRE)

- The IPR data model expects some extra elements
  - startTime and endTime
  - Validity and verification flag
  - The IPR header
- More convenient to have IPR specific interpretation of standard SOS elements
  - e.g. URI's as pollutant names
- INSPIRE specifications for downloading services
  - Service has to be able to handle multilingual
  - Return geometry in multiple coordinate systems
  - Some extra metadata elements

IPR compliant SOS

- Development of an open source implementation has been completed (financed by NL, SE, UK and BE)
- Multilingual response
- Flexible identifiers
  (http://dd.eionet.europa.eu/vocabularyconcept/aq/pollutant/5 versus PM10)
- Configurable reporting header (plus specific elements per data flow)
- e.g. wget
  http://sos.irceline.be/service?service=AQD&version=1.0.0&request=GetObservation
  (future)
  (development machine)
Documentation

• General documentation SOS server
  – https://wiki.52north.org/bin/view/SensorWeb/SensorObservationServiceIVDocumentation

• INSPIRE Download Service extension
  – https://wiki.52north.org/bin/view/SensorWeb/SensorObservationServiceIVDocumentation#INSPIRE_Download_Service_extension

• About the additional elements/functionalities for e-reporting
  – https://wiki.52north.org/bin/view/SensorWeb/AqdEReporting

• Flexible identifiers
  – https://wiki.52north.org/bin/view/SensorWeb/FlexibleIdentifier
Future development

• Possibly also implementing other data flows via SOS e.g. data flow D (the station meta data)

• Other data flows are better served by other services, e.g. WFS for dataflow B (polygon layer of air quality assessment zones)
  – Problem of the certain IPR-specific elements (possible solution via XSLT-extension for GeoServer)

• Setting up a harvesting system (PULL, rather than PUSH)
  – EEA harvesting UTD from SOS-endpoint maintained by the member states
In conclusion

• Regular e-reporting via open INSPIRE service is the best way to assure that quality data is regularly updated
• Think of the services which are already available from the start when developing a data model for e-reporting
• Be pragmatic and don't get lost in academic details
• Be sure to involve the people which need to input the data into an EU-database already during schema definition
• Avoid having non-INSPIRE people believe that they are INSPIRE compliant because they are reporting in compliance with an INSPIRE-compliant schema (without services)
Thank you!

Olav Peeters
peeters@irceline.be

Belgian Interregional Environment Agency (IRCEL – CELINE)