Informing you on ambient air quality
in the Belgian Regions

HALE for e-reporting, Shiny/R for advanced interactive analyses and a Cordova mobile app:

a fully open source SDI for Belgian air quality data

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Content

- Who are we (IRCEL – CELINE) and what do we do?
- Our spatial data infrastructure (SDI)
- HALE and e-reporting
  - OGC-services (SOS & WFS) for e-reporting
  - HALE as general purpose ETL
  - HALE transformation as (queryable) service
- Shiny webapps with (real-time) data via a REST-api
- A Cordova mobile app

IRCEL – CELINE

<u>Intergewestelijke</u> Cel voor het Leefmilieu (IRCEL)

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)

BRUXELLES ENVIRONNEMENT LEEFMILIEU BRUSSEL

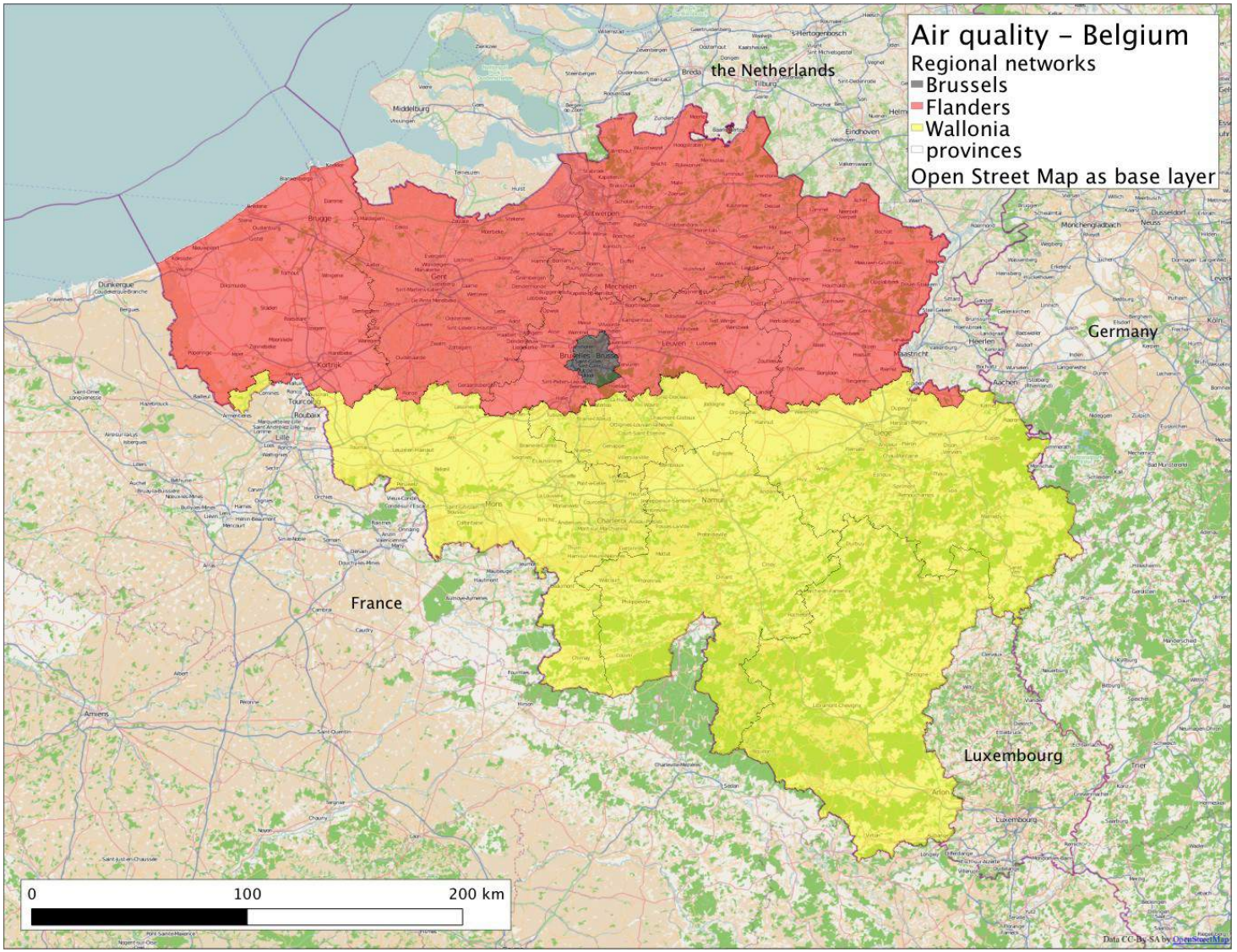
Leefmilieu Brussel - Bruxelles Environnement

Air Climat

agence wallonne de l'air & du climat

Agence wallonne de l'Air et du Climat (AWAC)

IRCEL – CELINE



The three Belgian networks

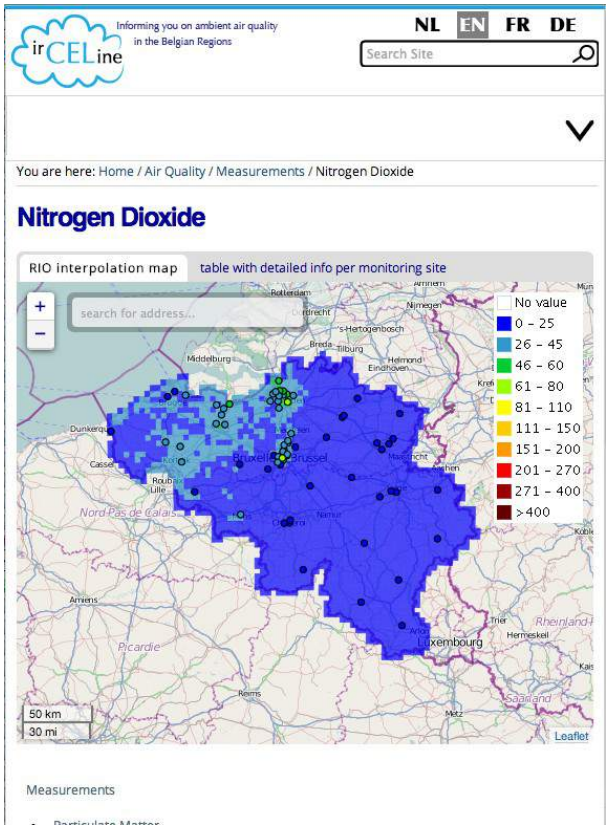
IRCEL – CELINE

- 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

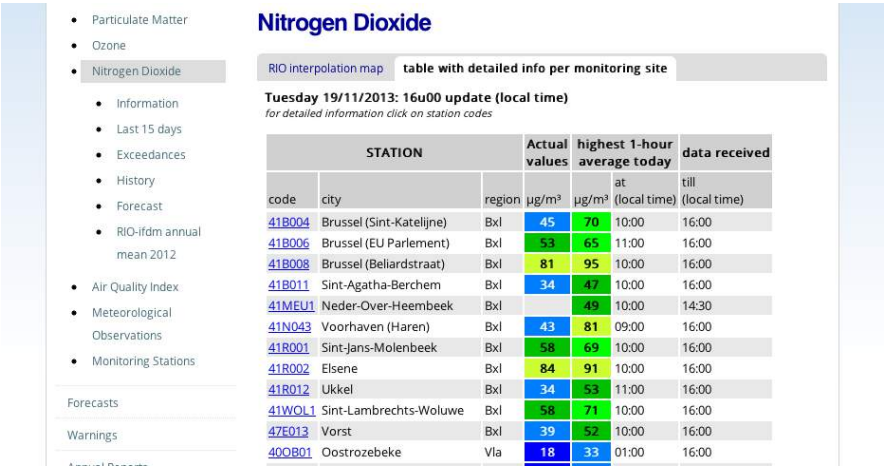
IRCEL – CELINE

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

Integration of OGC-services into website (leaflet.js)

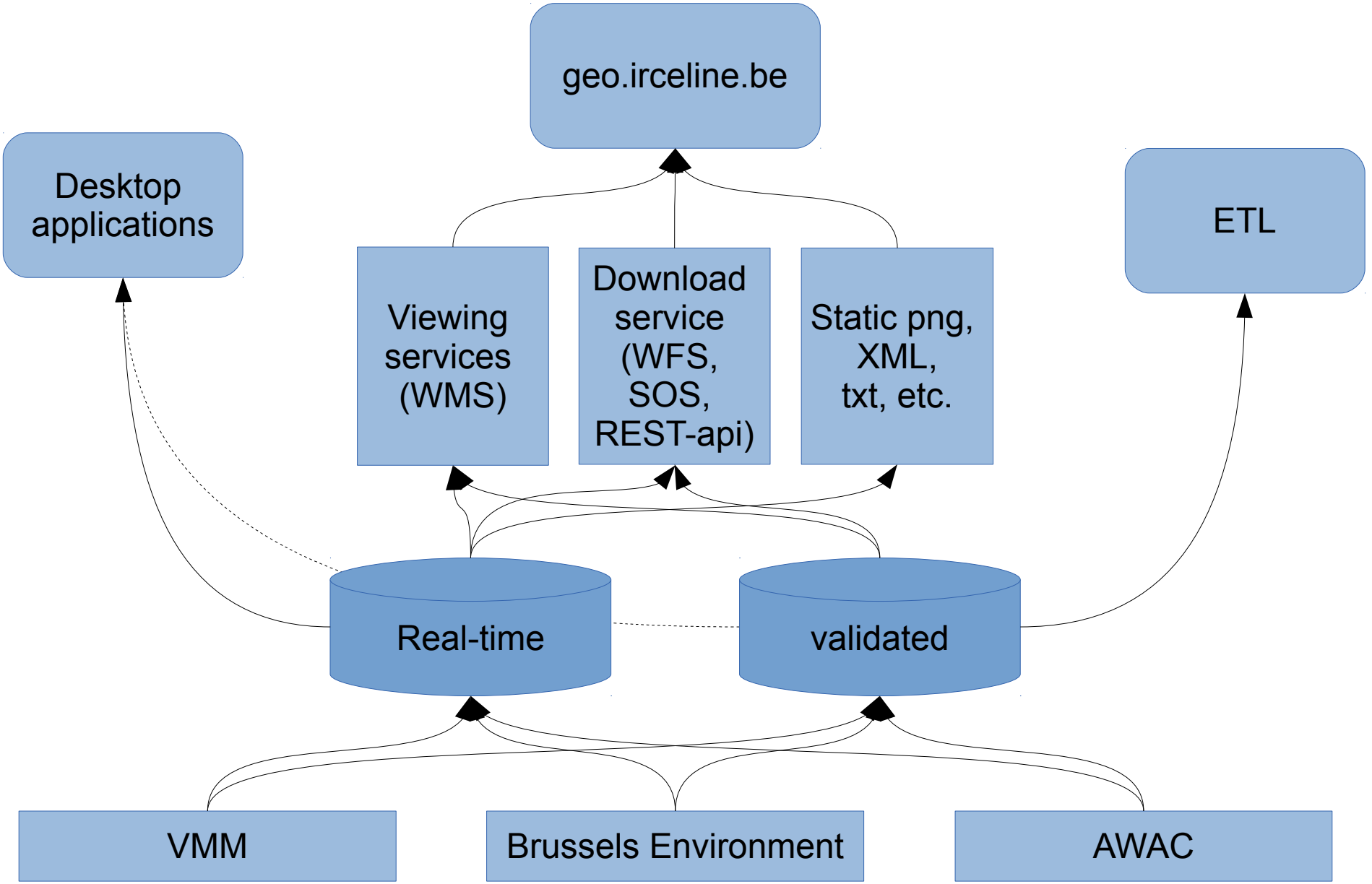


… and tables with (real-time) data:

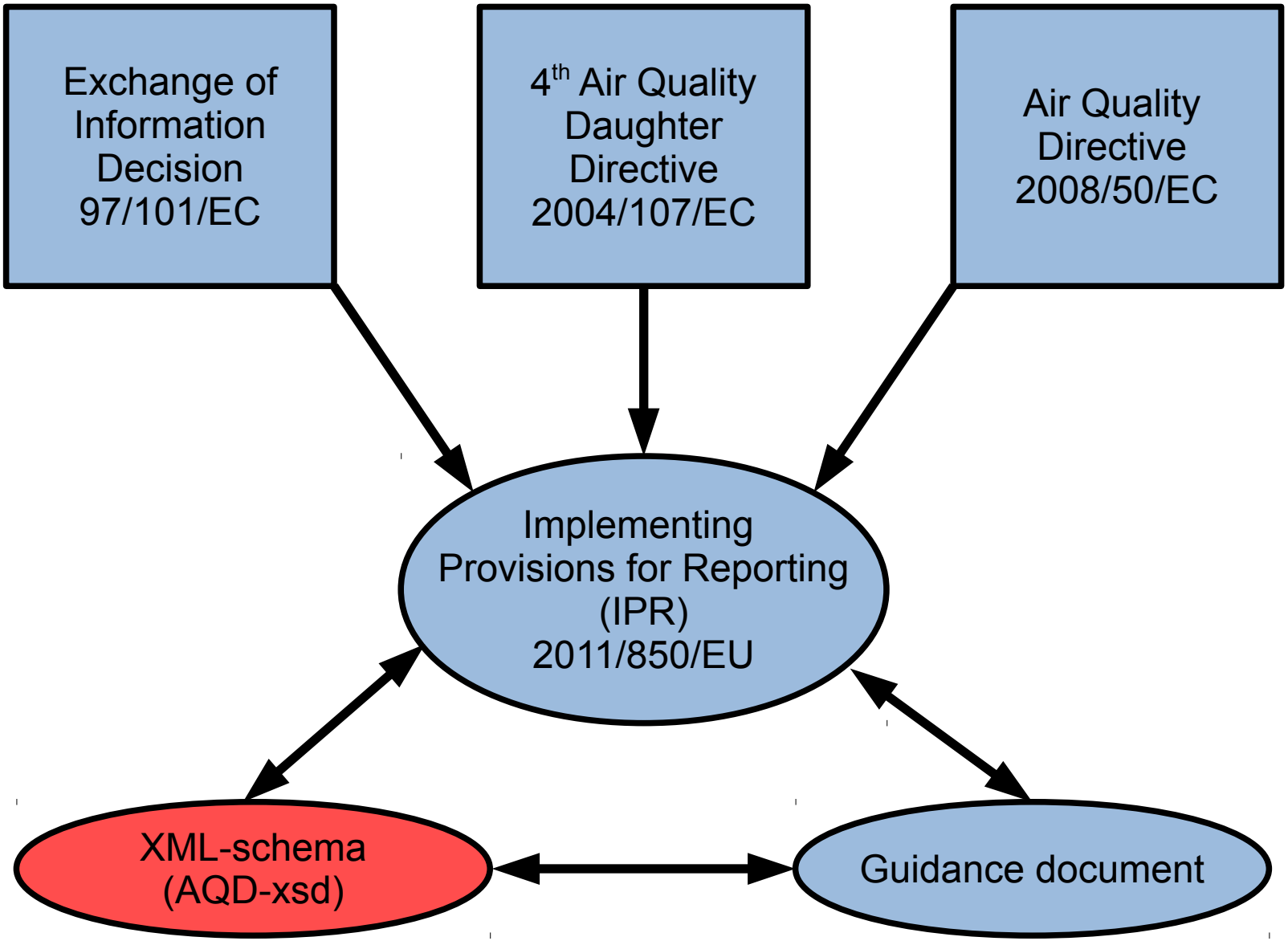


STATION			Actual values	highest 1-hour average today		data received
code	city	region	µg/m³	µg/m³	at (local time)	till (local time)
41B004	Brussel (Sint-Katelijne)	Bxl	45	70	10:00	16:00
41B006	Brussel (EU Parlement)	Bxl	53	65	11:00	16:00
41B008	Brussel (Beliardstraat)	Bxl	81	95	10:00	16:00
41B011	Sint-Agatha-Berchem	Bxl	34	47	10:00	16:00
41MEU1	Neder-Over-Heembeek	Bxl		49	10:00	14:30
41N043	Voorhaven (Haren)	Bxl	43	81	09:00	16:00
41R001	Sint-Jans-Molenbeek	Bxl	58	69	10:00	16:00
41R002	Elsene	Bxl	84	91	10:00	16:00
41R012	Ukkel	Bxl	34	53	11:00	16:00
41WOL1	Sint-Lambrechts-Woluwe	Bxl	58	71	10:00	16:00
47E013	Vorst	Bxl	39	52	10:00	16:00
40OB01	Oostrozebeke	Vla	18	33	01:00	16:00

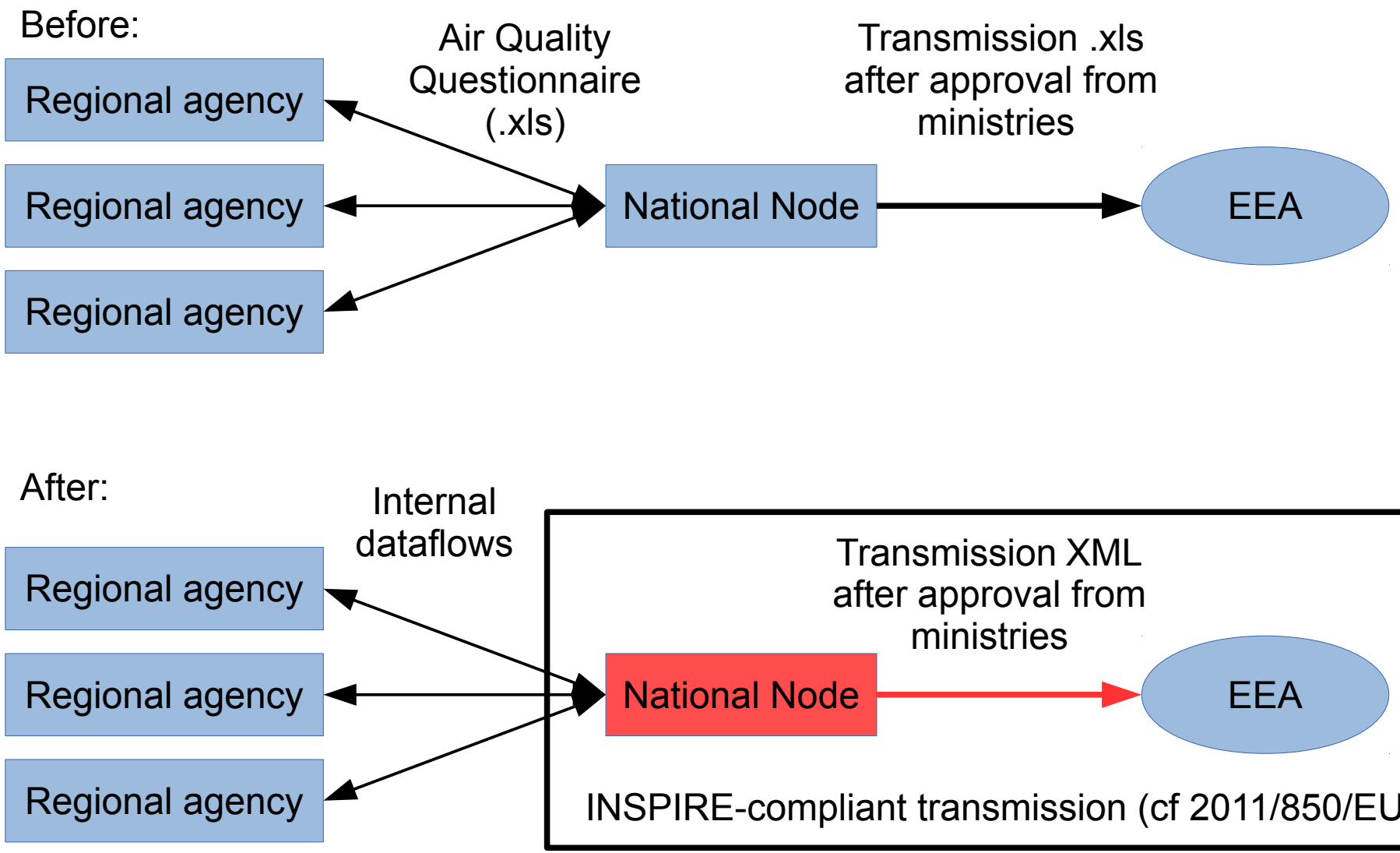
Overview SDI @ IRCEL - CELINE



E-reporting and Air Quality



E-reporting under the IPR



E-reporting: the data flows involved

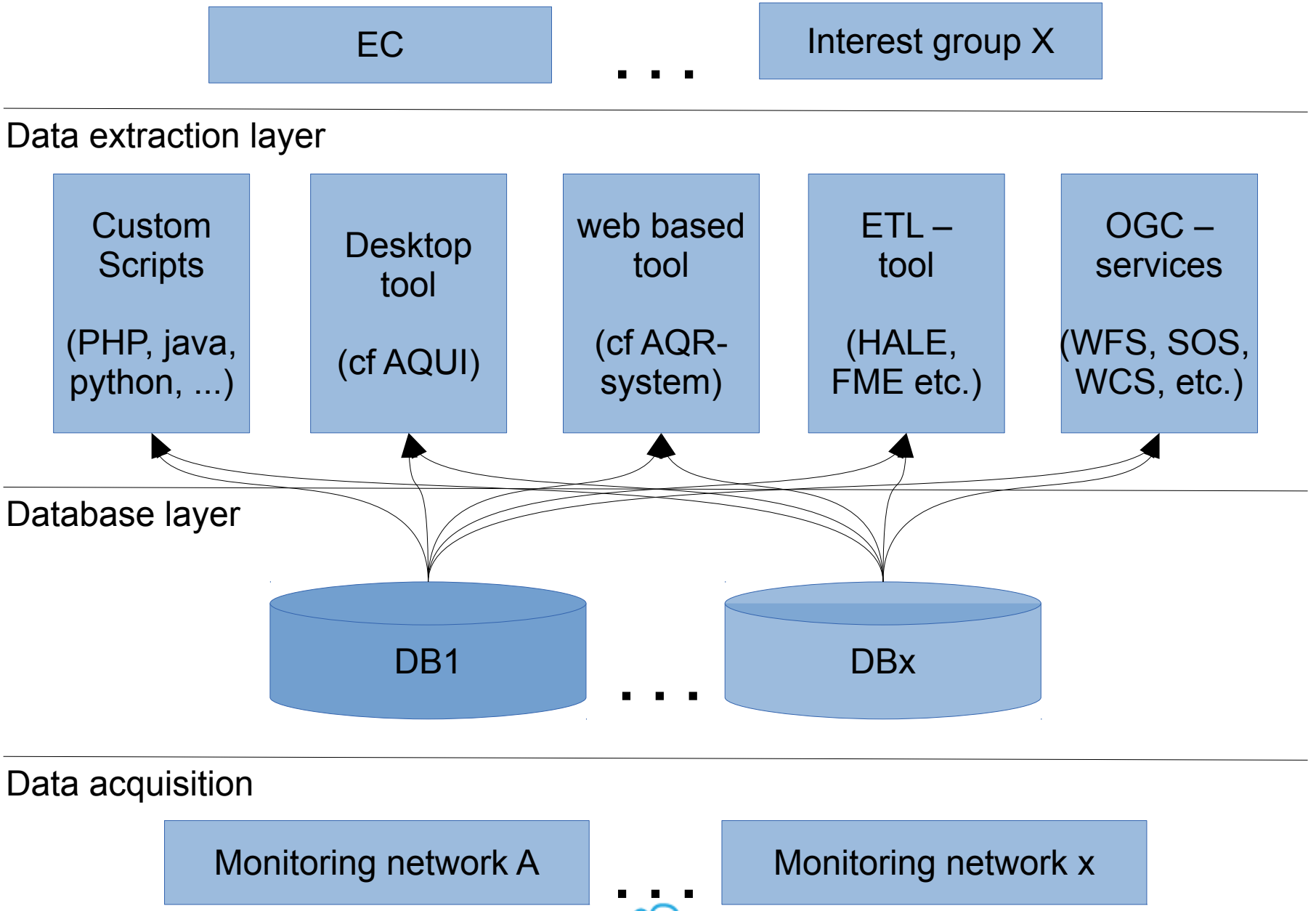
(cf Implementing Provisions for Reporting (IPR) 2011/850/EU)

INPIRE Data Theme	Content
III.11.AM	Dataset B – "zones and agglomerations"
III.11.AM	Dataset C – "assessment regime"
III.11.AM	Dataset D – "assessment methods"
III.7. EF	Dataset E1a – “primary validated assessment data – measurements”
III.13 AC	Dataset E1b – “primary validated assessment data – modelled”
III.7. EF	Dataset E2a – “primary up-to-date assessment data – measurements”
III.13 AC	Dataset E2b – “primary up-to-date assessment data – modelled”
III.7. EF	Dataset F1a – “aggregated data - primary validated measurements”
III.13 AC	Dataset F1b – “aggregated data - primary validated modelled”
III.7. EF	Dataset F2 – “aggregated data - primary up-to-date measurements”
III.11.AM	Dataset G – “attainment of environmental objectives”
III.11.AM	Dataset H – “air quality plans”
III.11.AM	Dataset I – “source apportionment”
III.11.AM	Dataset J – “scenario for the attainment year”
III.11.AM	Dataset K – "measures"

+ a header transmitted with every separate submission

colours represent similar data types

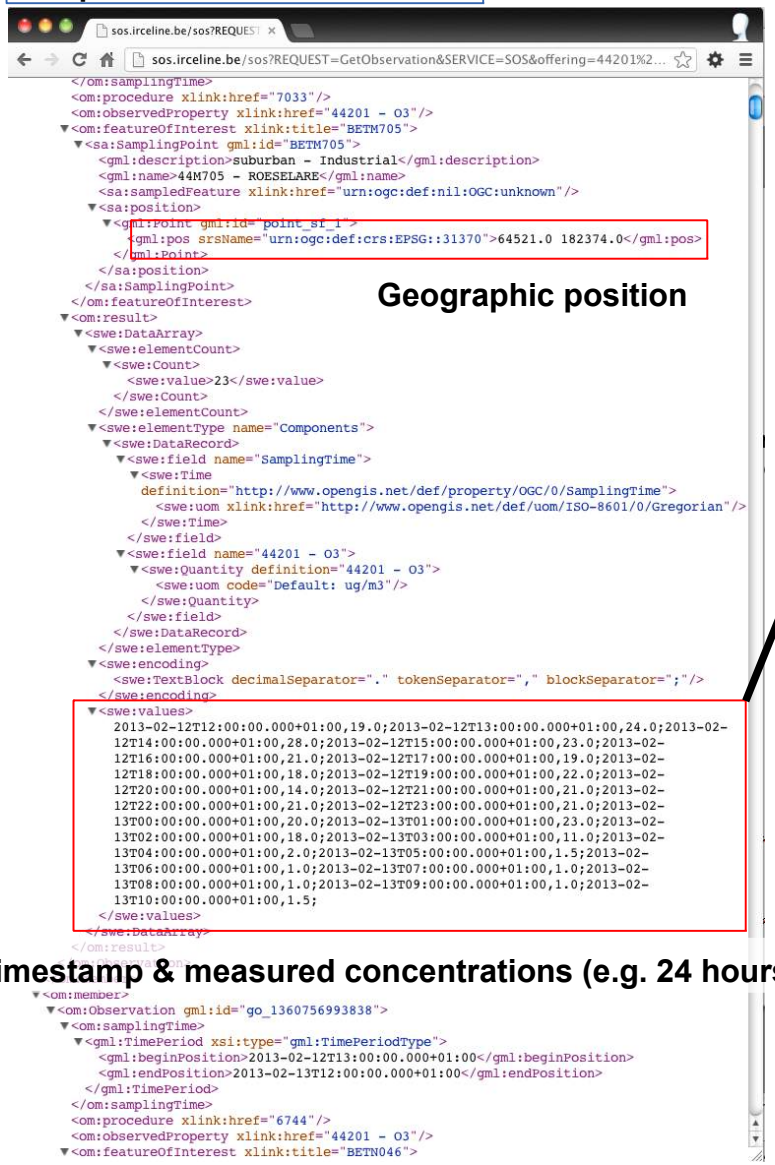
E-reporting: plenty of ways to skin the cat



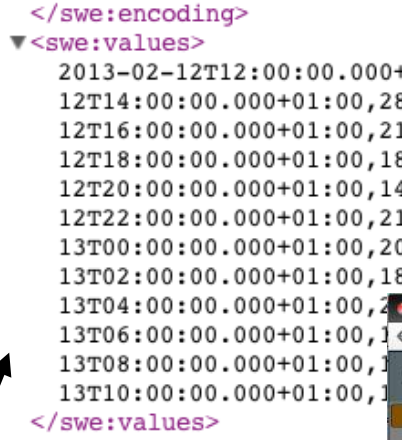
Sensor observation services (SOS)

… an INSPIRE compliant downloading service

http://sos.irceline.be

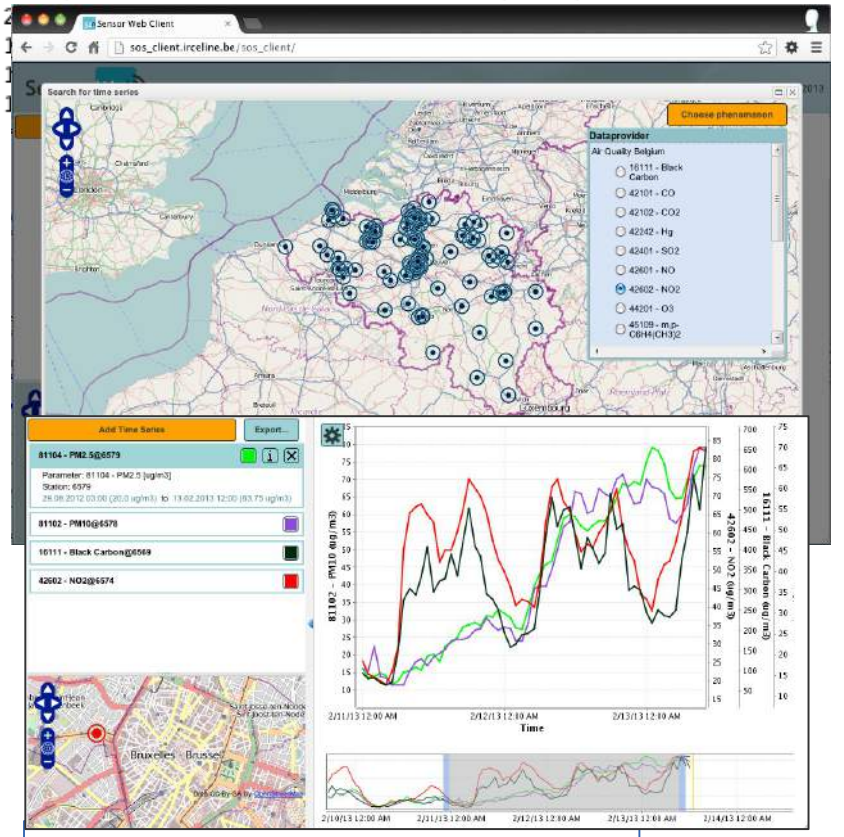


- Efficient transmission of time series



- queryable:

Extended for e-reporting since version 4.3.x



http://sos_client.irceline.be

http://viewer.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

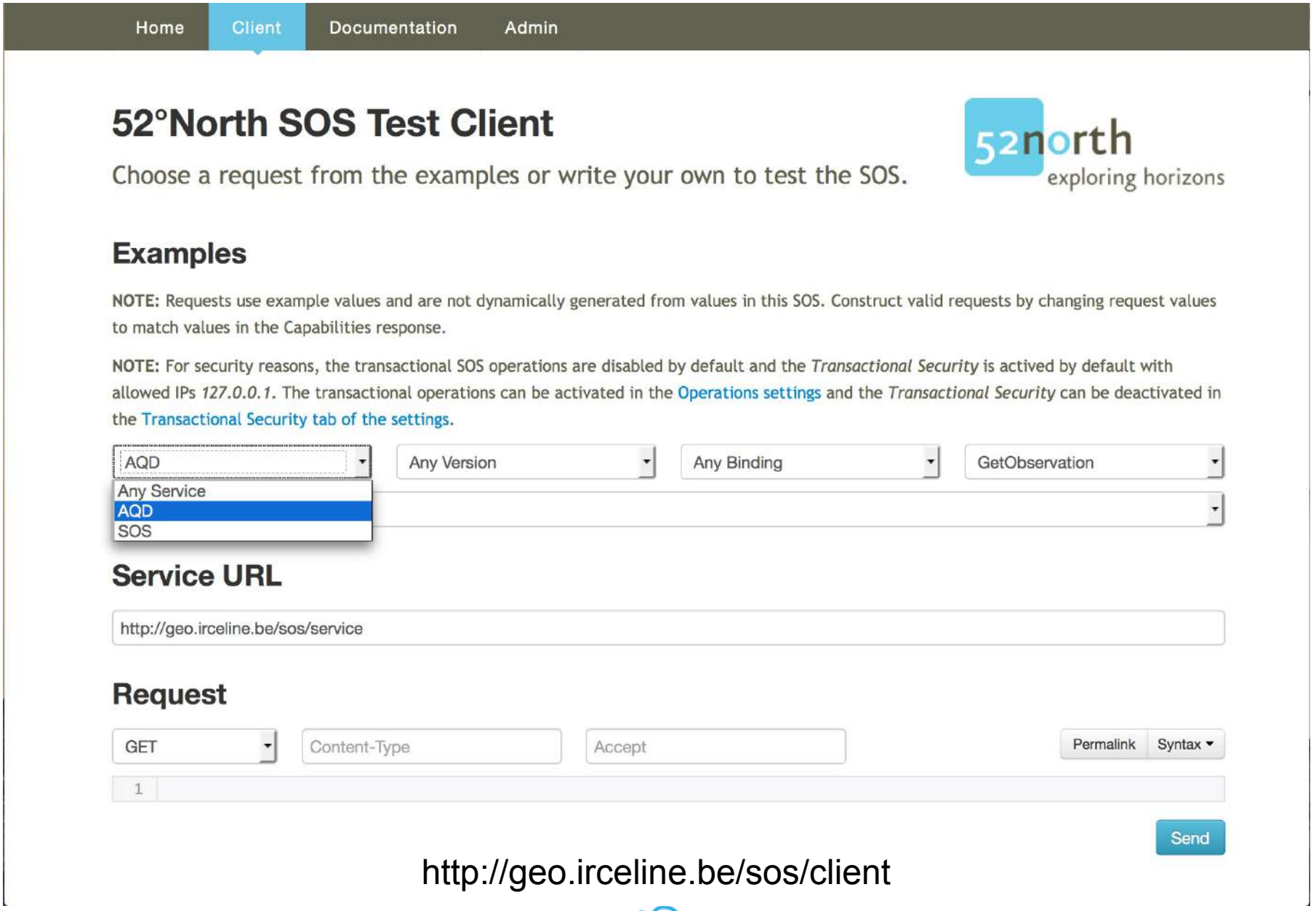
https://wiki.52north.org/bin/view/SensorWeb/SensorObservationServiceIVDocumentation
http://52north.org/communities/sensorweb/sos/

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

See: https://ies-svn.jrc.ec.europa.eu/projects/download-services-tg/wiki/ARE3NA_SOS_study

SOS and the IPR (and INSPIRE)



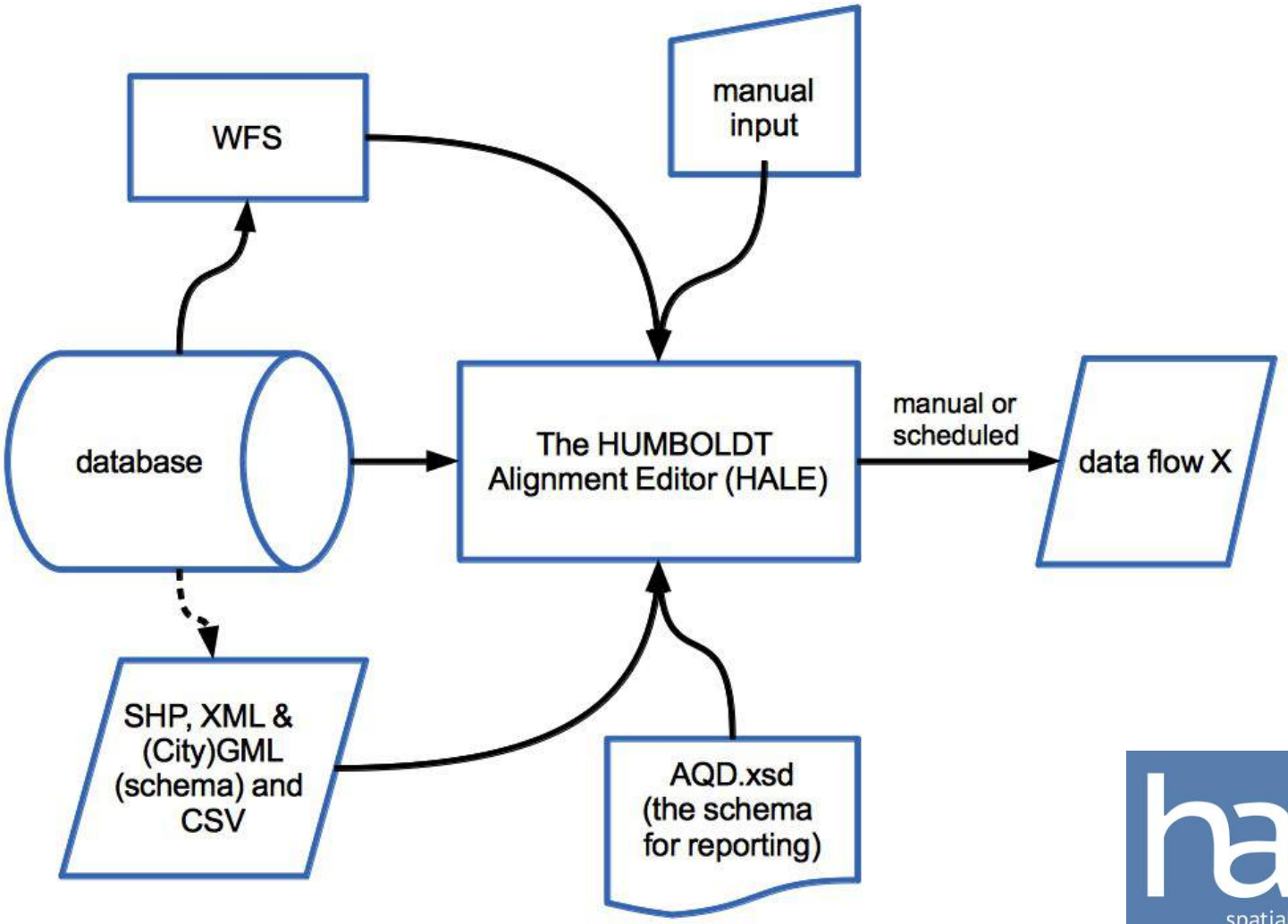
http://geo.irceline.be/sos/client

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_extensi
- 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

E-reporting via an ETL-tool

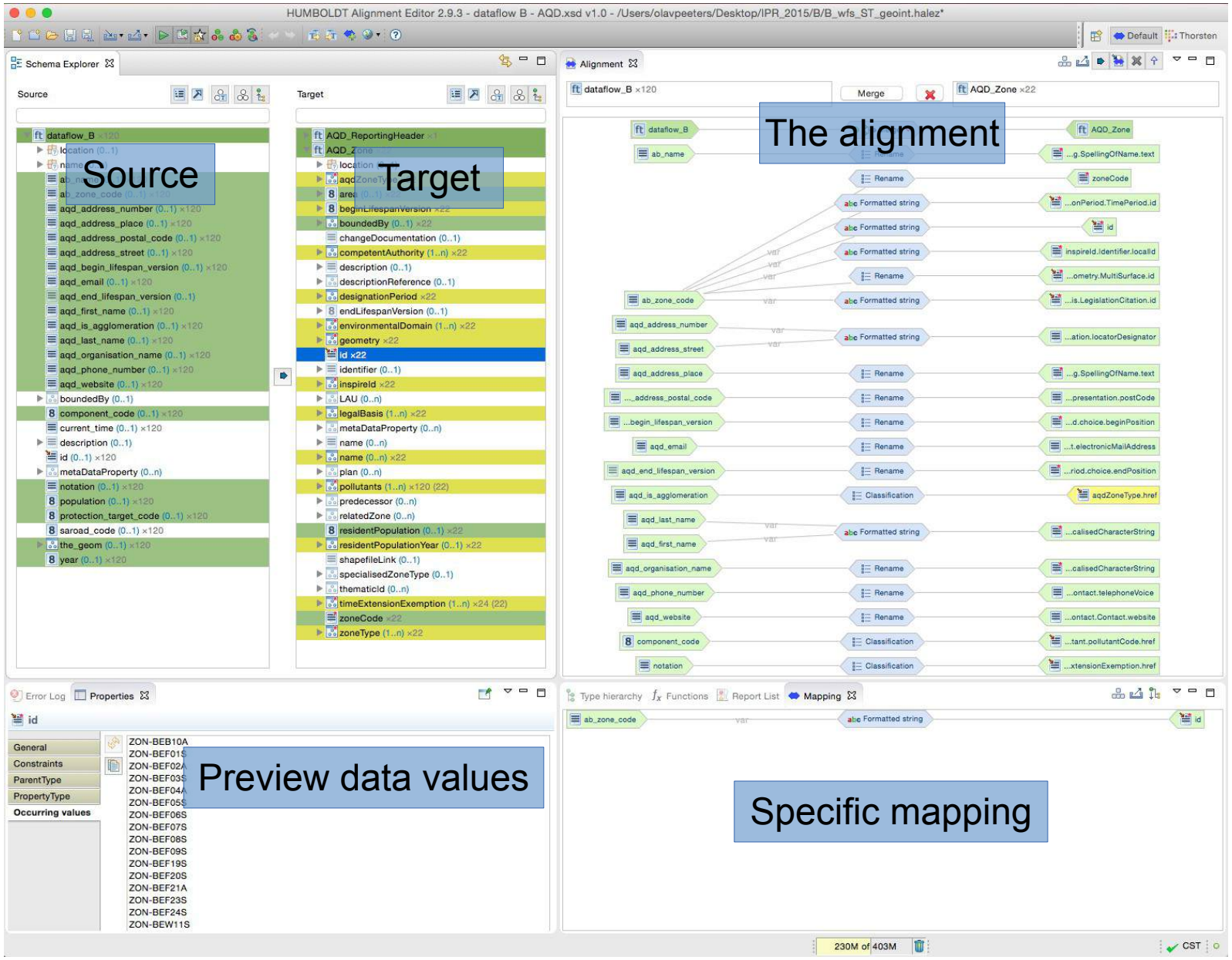
ETL = Extract, Transform and Load



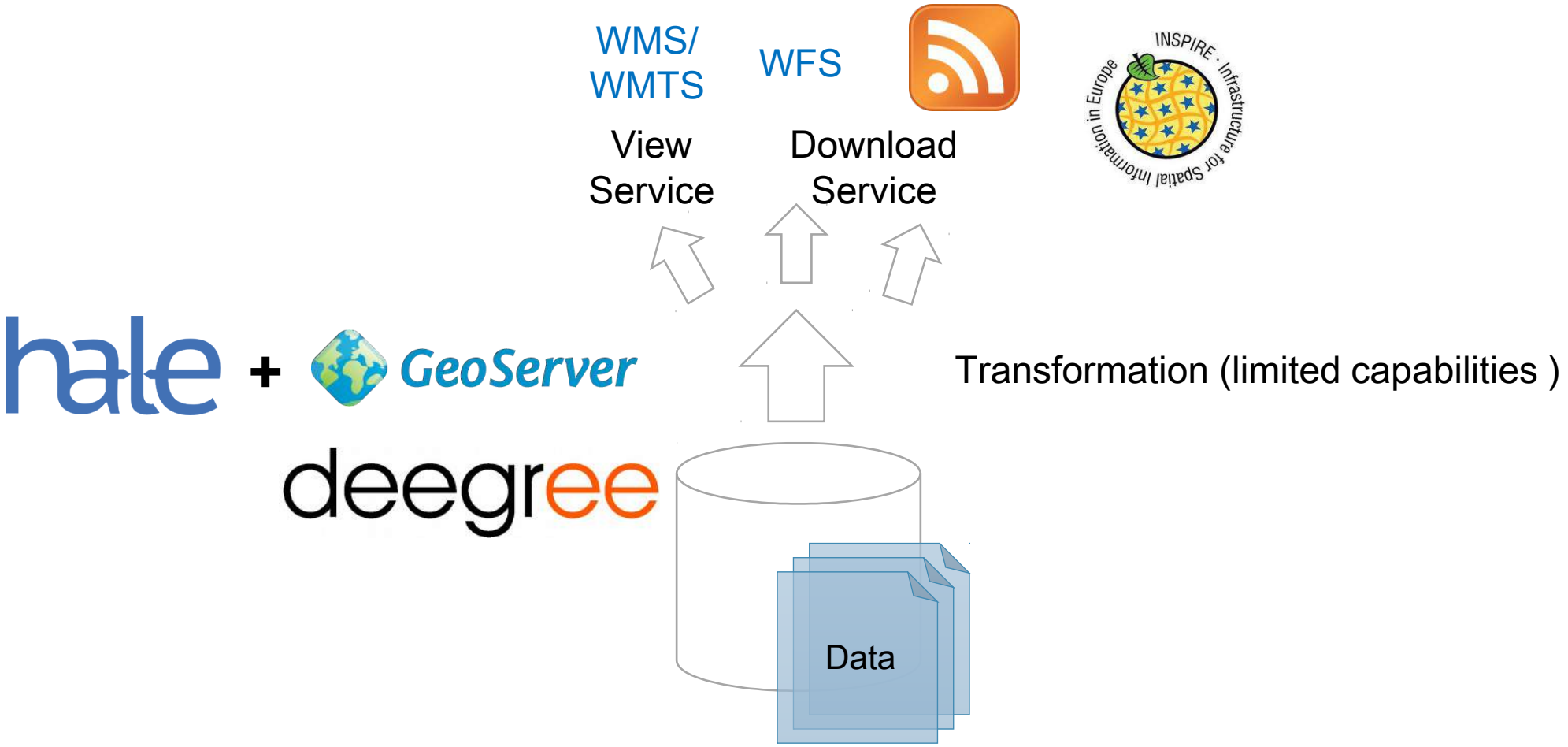
http://www.esdi-community.eu/projects/hale
https://github.com/igd-geo/hale

HUMBOLDT Alignment Editor

HALE - the GUI


HUMBOLDT Alignment Editor 2.9.3 - dataflow B - AQD.xsd v1.0 - /Users/olavpeeters/Desktop/IPR_2015/B/B_wfs_ST_geoint.halez*
Schema Explorer
Source
Target
Alignment
The alignment
Source
Target
Preview data values
Specific mapping
Error Log
Properties
Type hierarchy
Functions
Report List
Mapping

A HALE transformation as a queryable service



Transformation (limited capabilities)

For GeoServer see:
http://geoserver.geo-solutions.it/complexfeatures/intro/index.html

But you can also export transformation to JDBC database (incl. SpatiaLite, PostGreSQL etc.)

Why use HALE?

- Intuitive GUI for mapping data from you 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)
- Can be used as an XSLT-editor (cf XSLT-extention for GeoServer)
- Versatility of the tool (incl. cross-platform)

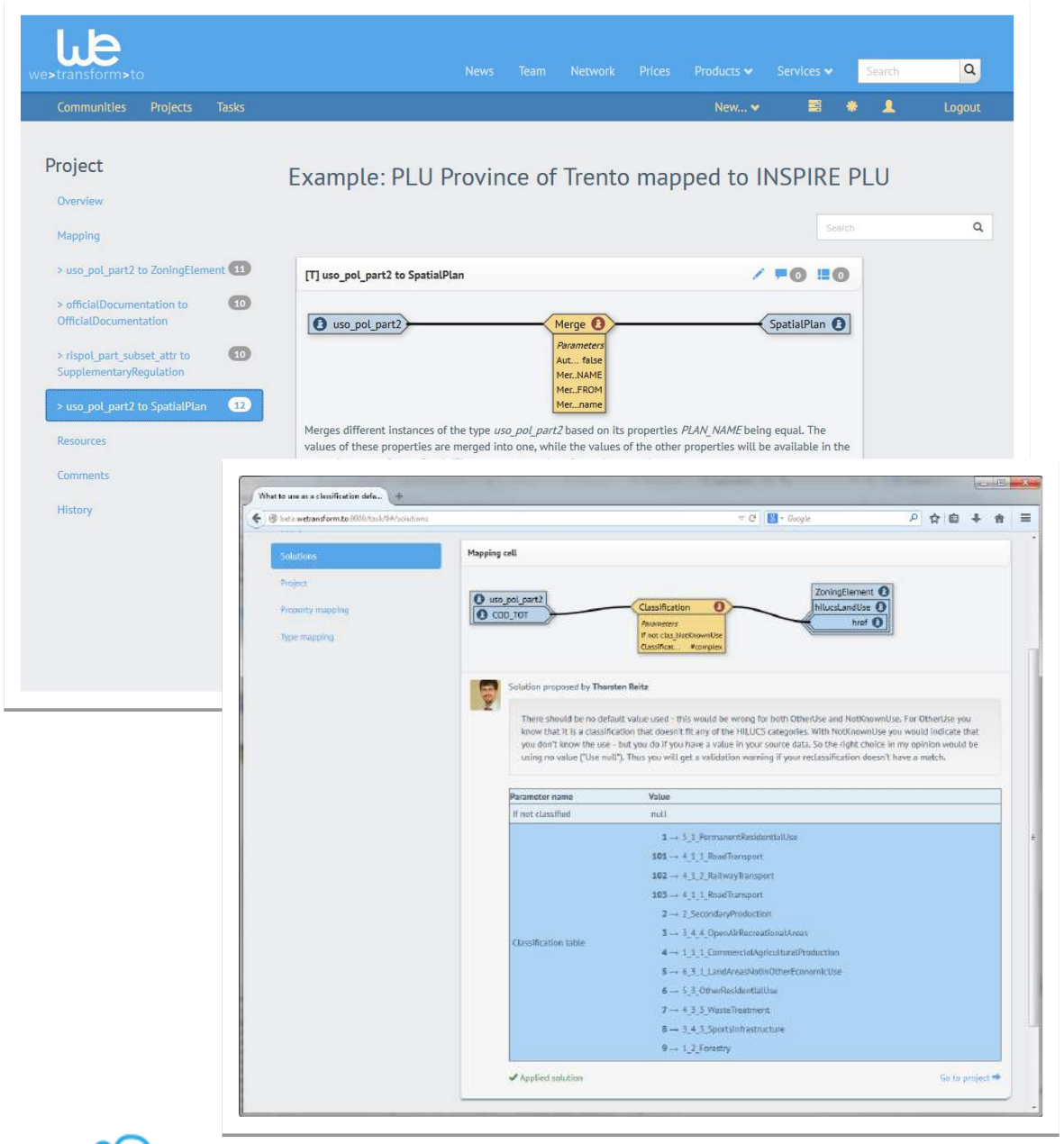
https://www.wetransform.to/

by the developers of HALE

Online Collaboration Platform **we»Exchange**

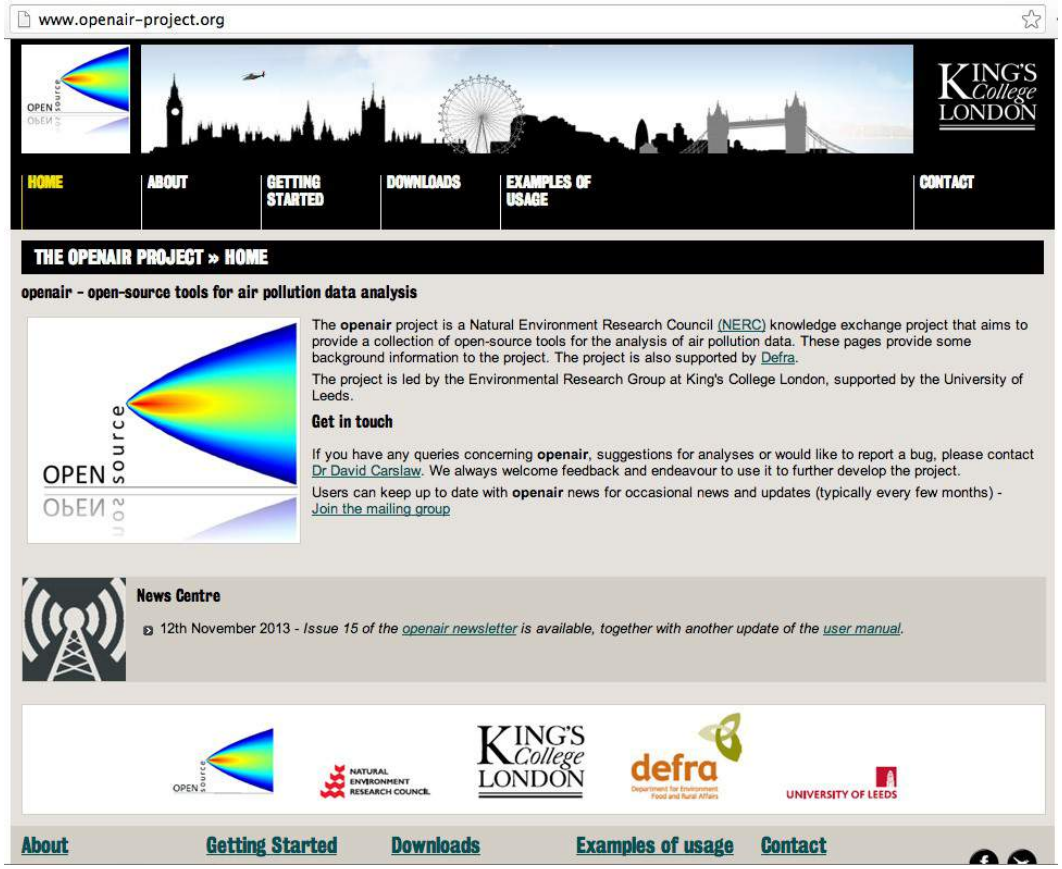
- Extend and adapt models
- Develop transformations projects
- Transform and validate data
- Publish services

- Fork, Diff, Merge
- Comment, Discuss, Annotate



Shiny webapps for advanced interactive R-analyses

http://www.openair-project.org

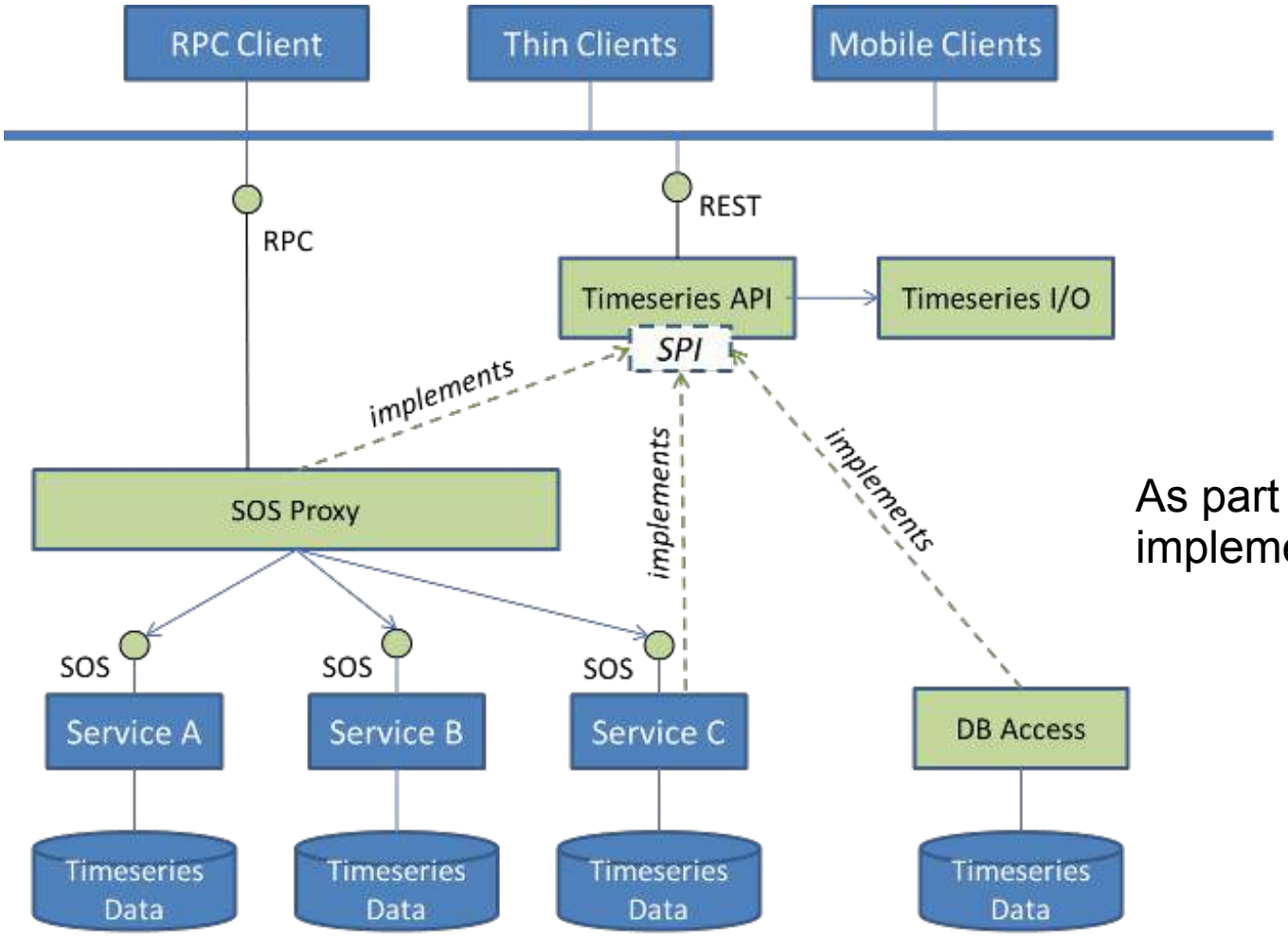


A package for R specifically for the **air quality** community

How to integrate the power of R into an SDI?
- SOS4R: existing SOAP (xml) based implementation → to slow for longer time series

http://shiny.rstudio.com/

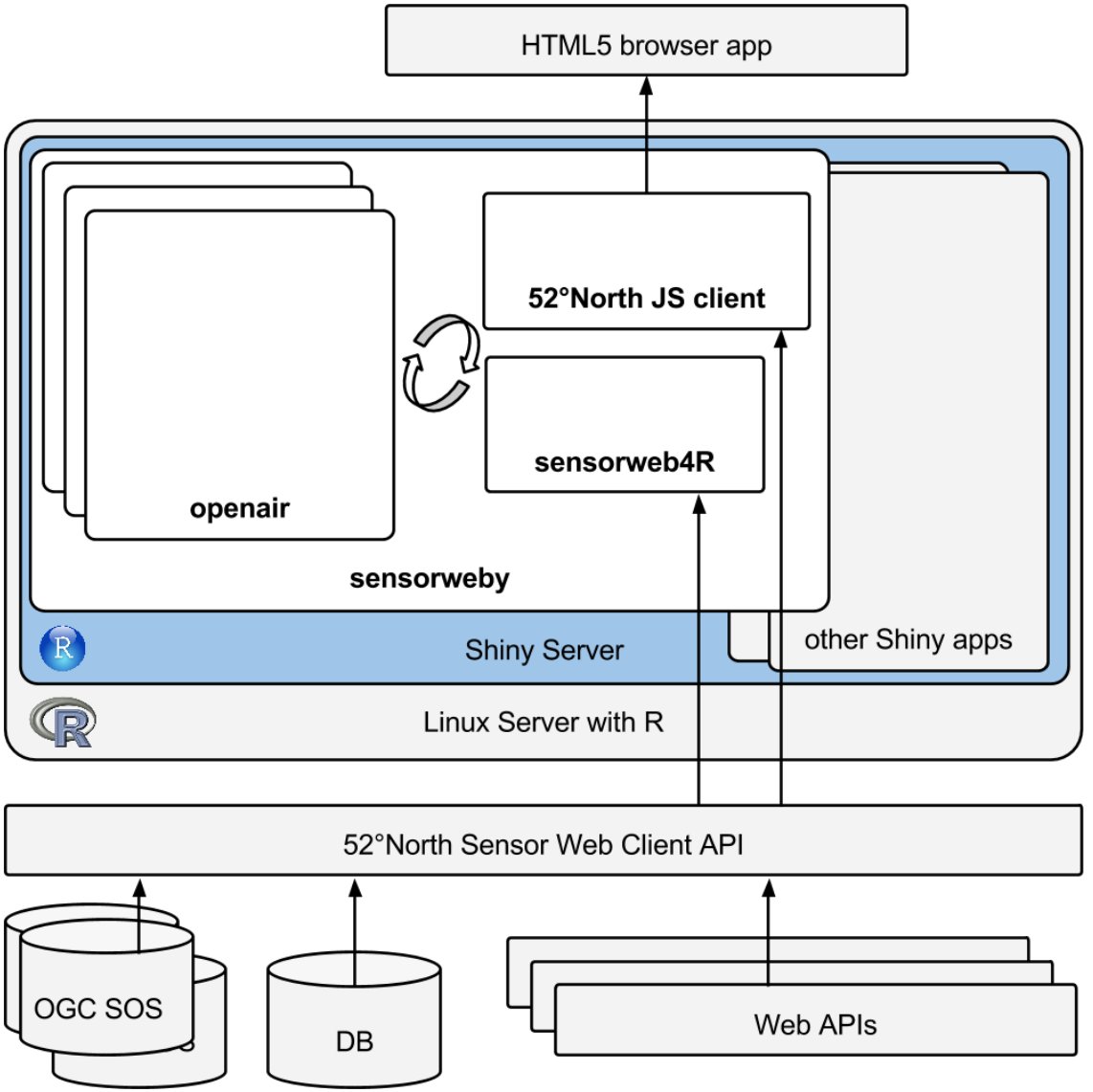
Faster data access via a REST-api



As part of the SOS implementation of 52°North

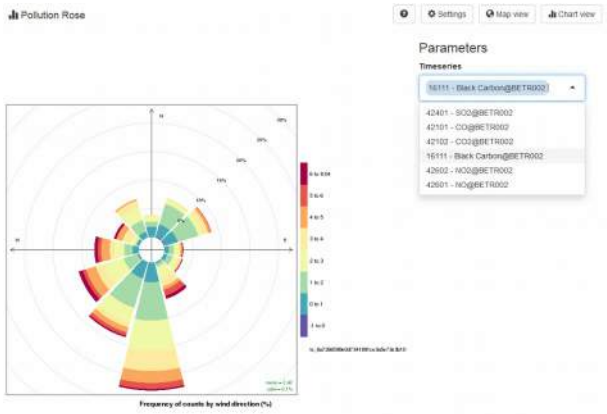
http://52north.github.io/sensorweb-rest-api/
http://52north.github.io/js-sensorweb-client/

Shiny webapps for advanced interactive R-analyses

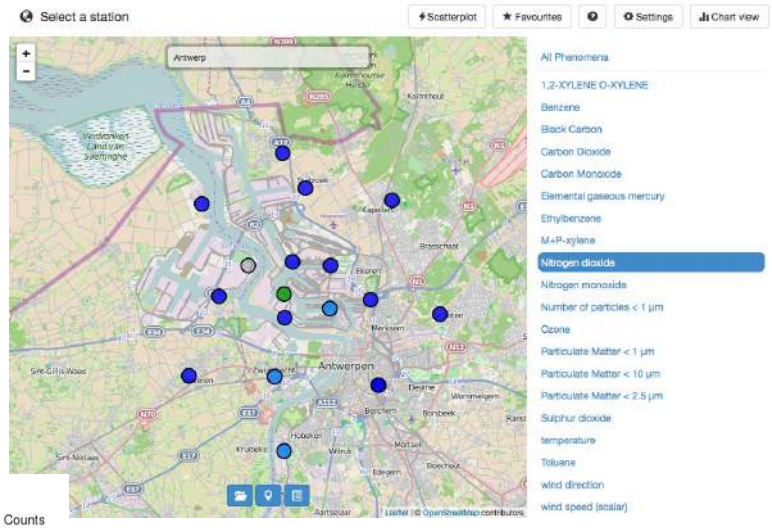


Shiny webapps for advanced interactive R-analyses

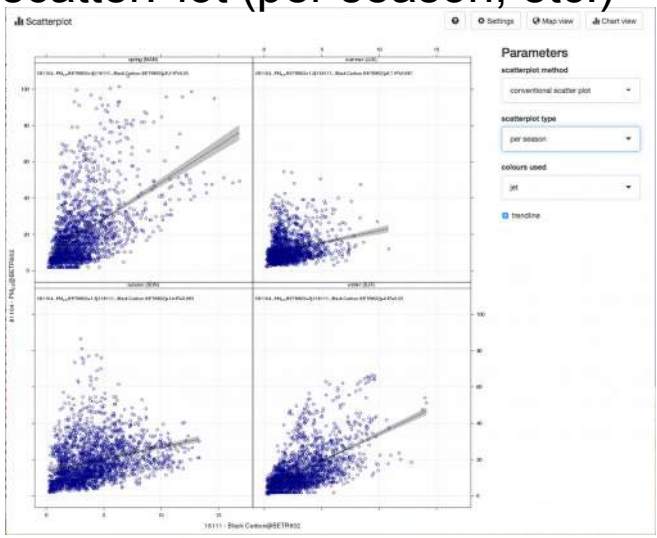
PollutionRose



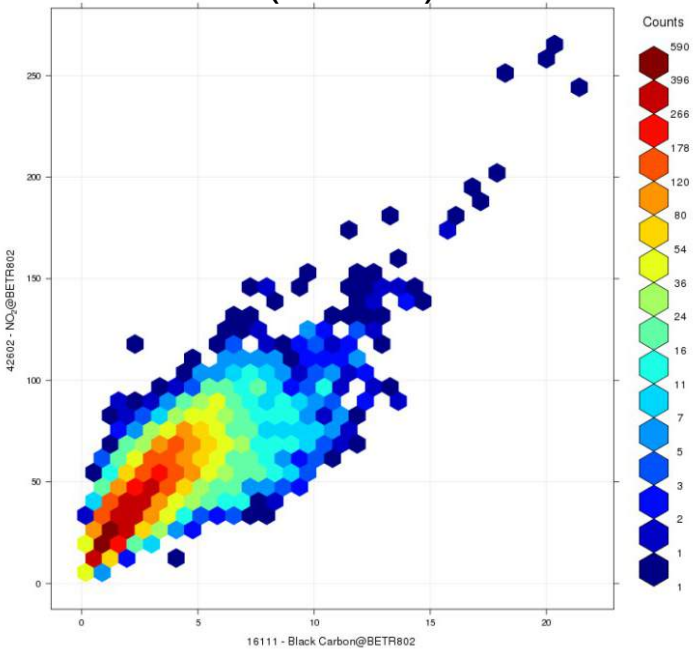
Select time series (jsClient)



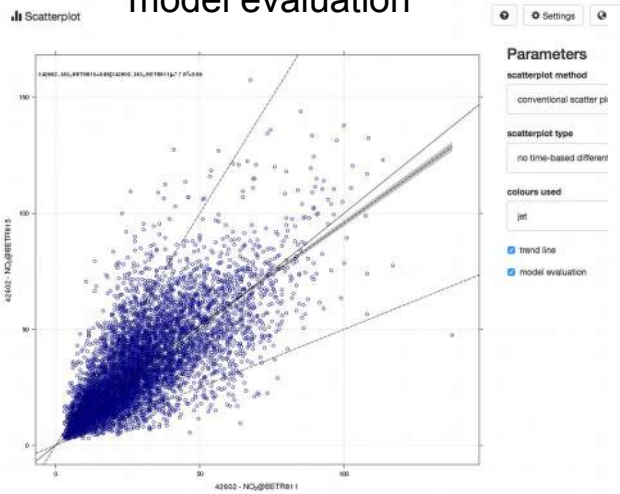
scatterPlot (per season, etc.)



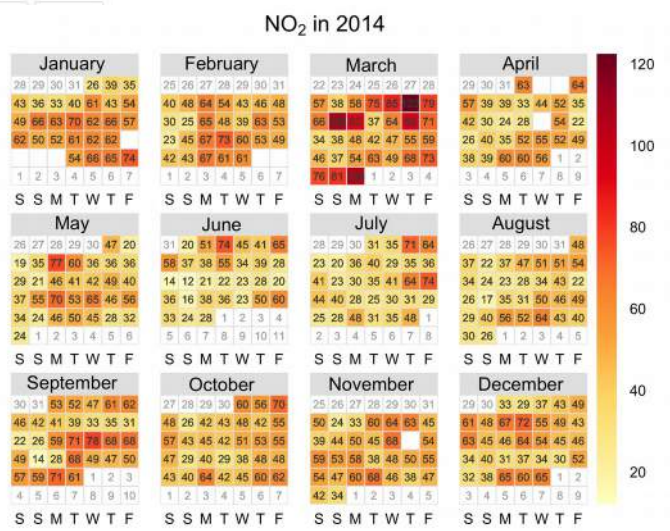
ScatterPlot (hexbin)



scatterPlot with model evaluation



calendarPlot



irCELine

Shiny webapps for advanced interactive R-analyses

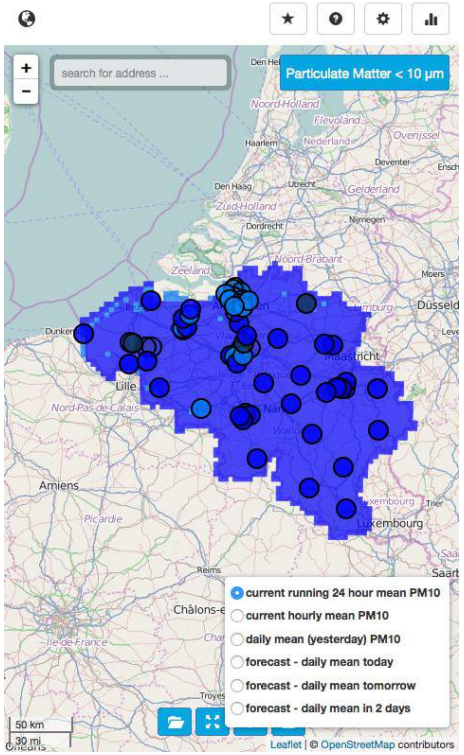
- https://github.com/52North/sensorweb4R
- https://github.com/52North/sensorweby
- http://blog.52north.org/2015/04/22/advanced-time-series-analysis-on-the-web-with-r/ (google “blog sensorweby”)
- You can run this locally in R-Studio or on a remote Shiny server
- Example apps: http://shiny.irceline.be/examples/
- Better security since there is no direct DB-connection
- REST is still very fast data access

A Cordova mobile app

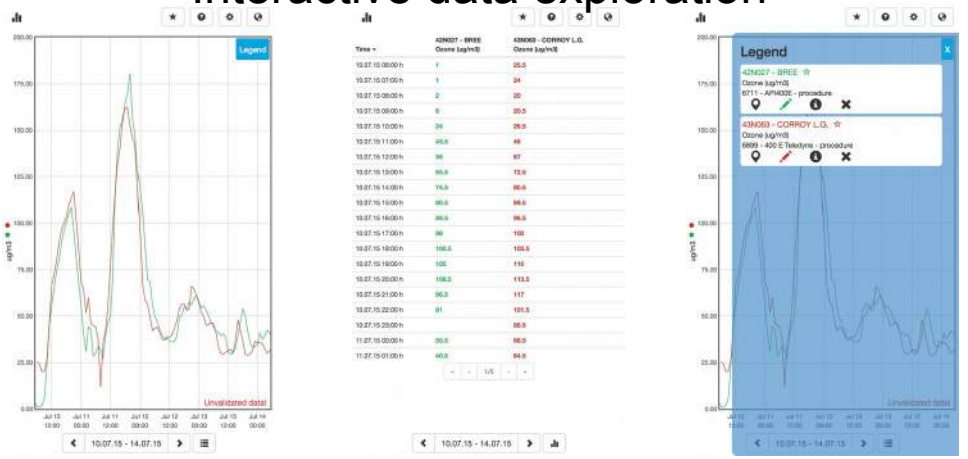
- Apache Cordova is the open source project behind Adobe PhoneGap
- Build apps with HTML, CSS and JavaScript
- Does not have the best reputation, but we don't have any complaints (google for “tips cordova”)
- Online build via https://build.phonegap.com
- Android, iOS and Windows Phone
- We hooked the JsClient for time series data into Cordova
- Added WMS layers to the Leaflet.js map view + other JavaScript customisations

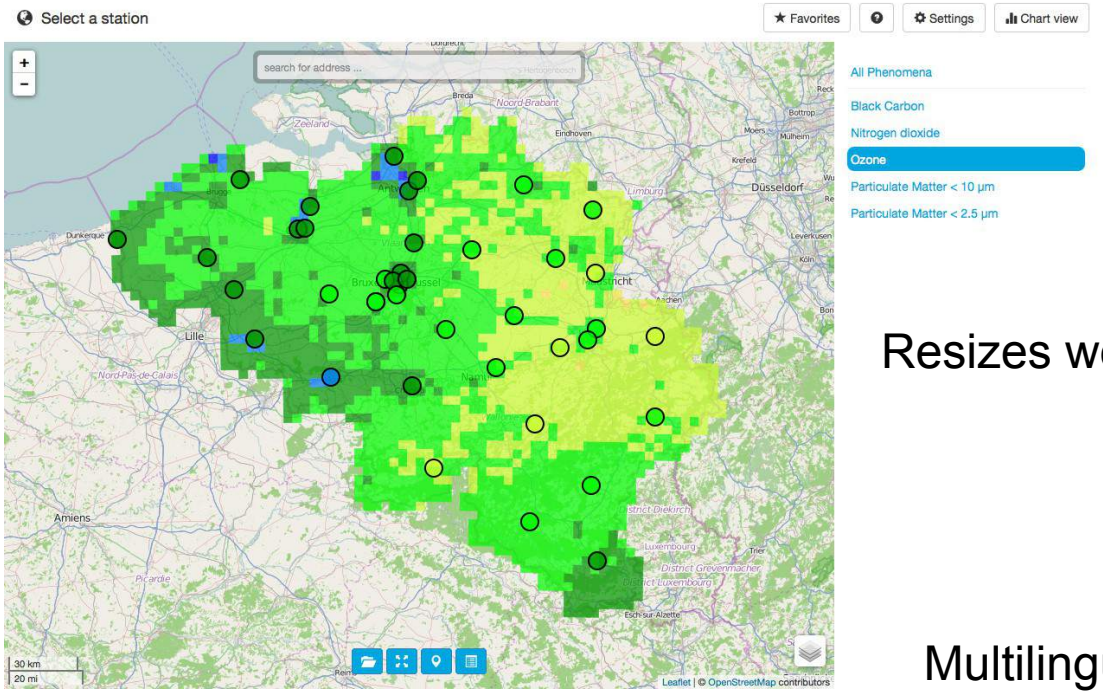
A Cordova mobile app

Real-time data

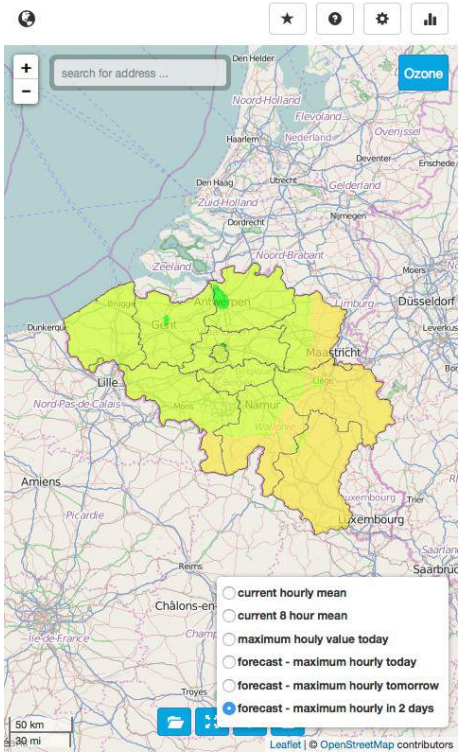


Interactive data exploration





Forecasts



Resizes well for tablets

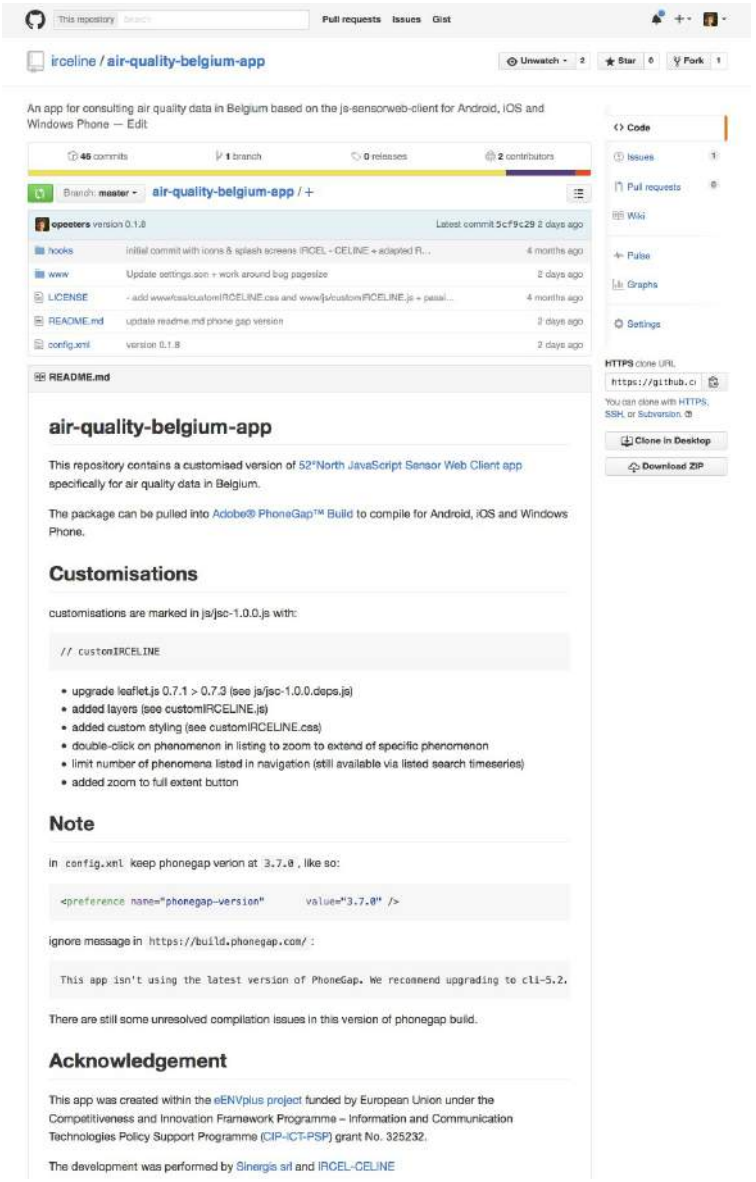
Multilingual (EN, NL, FR, DE)

eENVplus

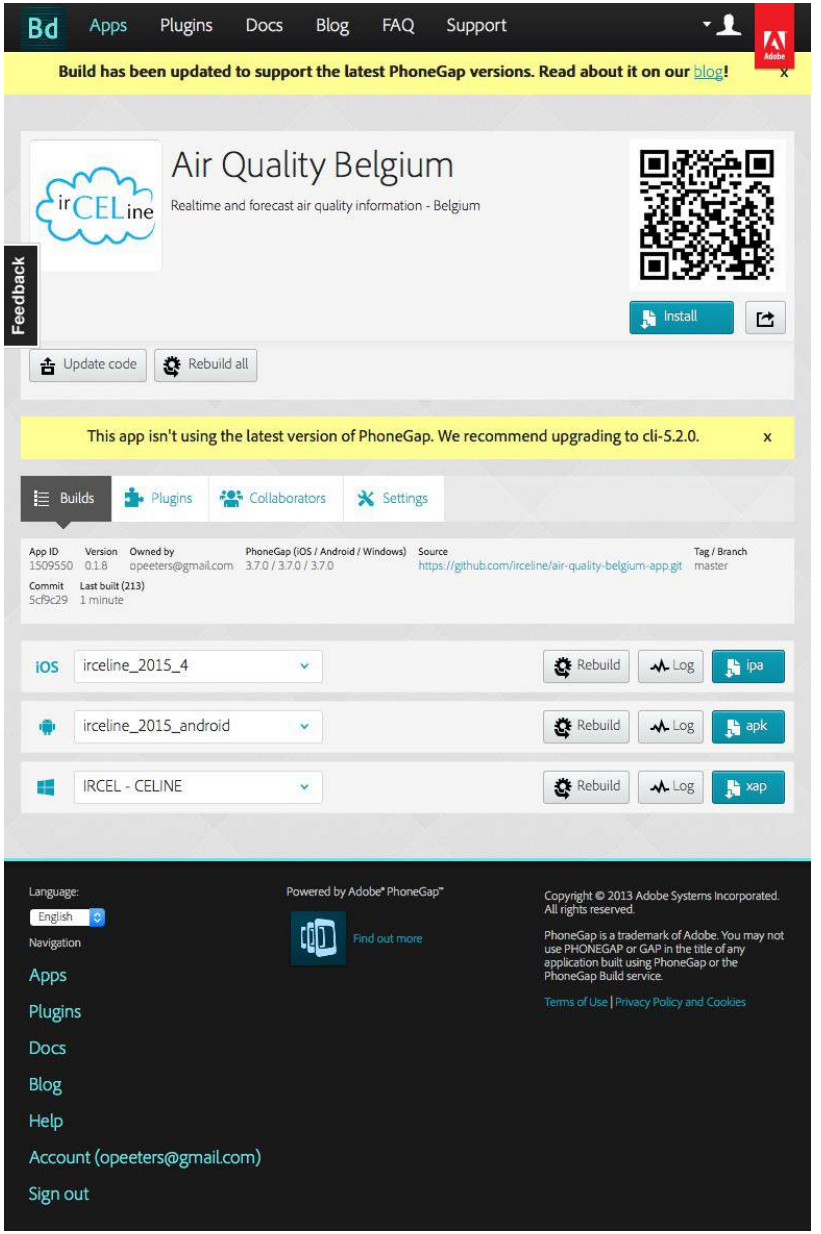
http://www.eenvplus.eu/

A Cordova mobile app

https://github.com/irceline/air-quality-belgium-app
https://github.com/irceline/js-sensorweb-client-app (generic)



https://build.phonegap.com/apps/1509550/builds



Conclusion

- All of this is 100% open source
- Interlinkage of different elements was only possible due to open source
- Fetching data via services (instead of straight from a DB) improves security
- There often is a trade-off between interoperability and usability (speed, adapted to the purpose, etc.)
- Think in terms of reusable lego blocks
- Get the right people involved to make, polish and maintain … per lego block

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in the Belgian Regions

Thank you!

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