Technical report on common in-situ data interface description document to describe how FMI measured in-situ data can be accessed and utilized

Mwaba Hiltunen and Jyri Heilimo
Arctic Space Centre, Finnish Meteorological Institute
Sodankylä, 04.10.2019

WP 3: Integrating in-situ and satellite components

Task 3.1 Streamlining satellite remote sensing data flows for new multi-sensor, multi-dimensional products, Delivarable 3.1.2

Document version 1

Introduction

This document provides a description on how FMI measured in-situ data can be accessed and utilized. It includes an overview of the available in-situ measurements, where they are stored and how they can be accessed. It also includes future plans of using Web Feature Service. This document is part of iCUPE projects work package 3.1 Streamlining satellite remote sensing data flows for new multi-sensor, multi-dimensional products.

Overview of the In-situ Data Interface

The in-situ data dissemination interface is deployed at the Arctic Space Centre, in Sodankylä. The location of Finnish Meteorological Institute's Sodankylä site at Finnish Lapland is ideal for the atmospheric and environmental research of boreal and sub-arctic zone. The principal observation infrastructure of Finnish Meteorological Institute (FMI) is deployed to two main areas: Arctic Research Centre at Sodankylä (67°22 'N, 26°39 'E) and Pallas clean air research station (67° 58'N, 24°07 'E). The Sodankylä facility hosts programs addressing upper air chemistry and physics, atmospheric column measurements, snow/soil hydrology, biosphere-atmosphere interaction and satellite calibration-validation studies. The Pallas station focuses to the monitoring the near-surface air chemistry and physics as well as greenhouse gas exchange.

Observations at Sodankylä

There are several measurement stations at Sodankylä site, these are highlighted in Figure 1 below based on color codes. Table 1 further uses the color codes to state the various types of observations done at the stations and some useful comments or attributes about the observations.

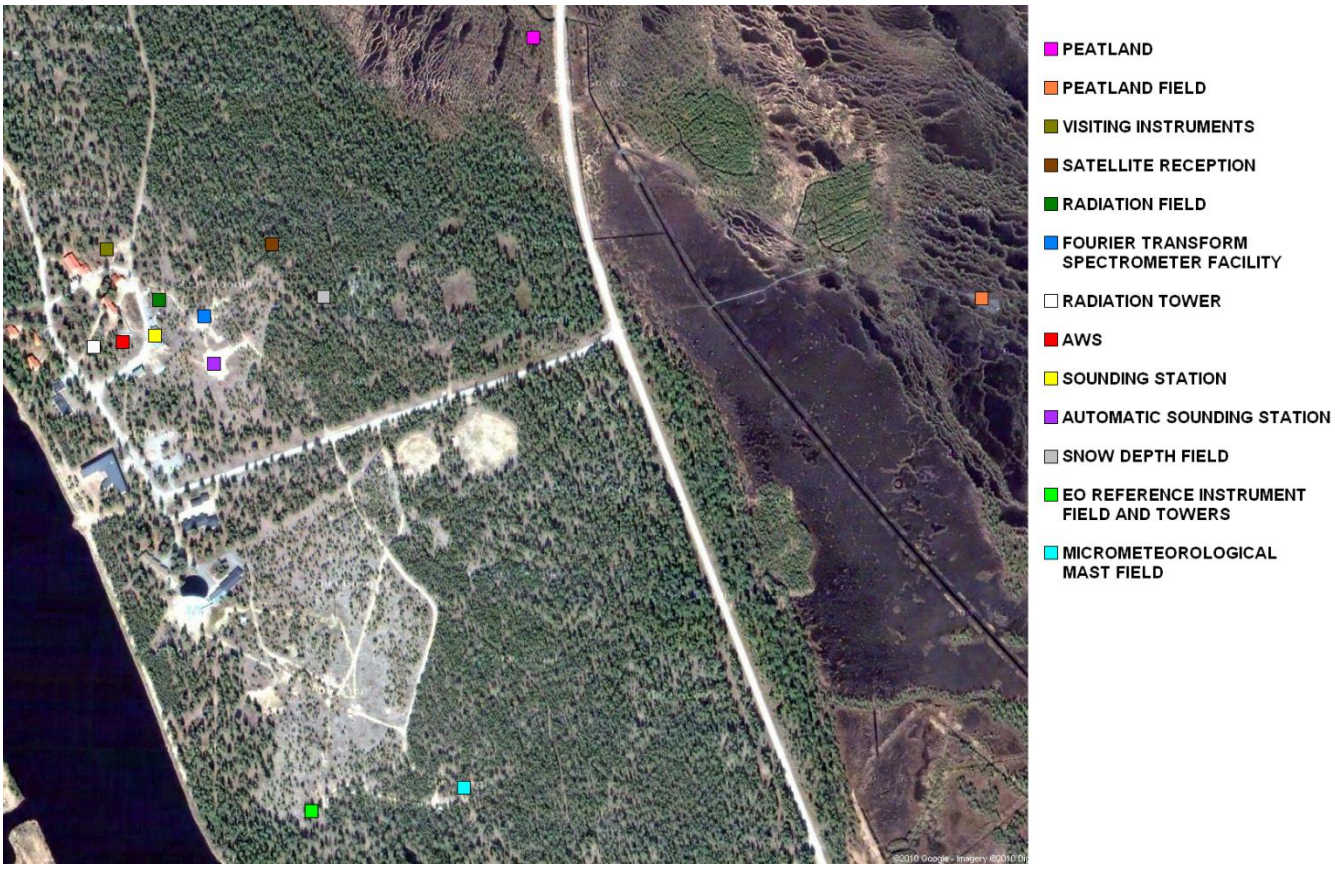
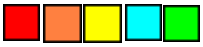


Figure 1 Arctic Space Centre Sodankylä : measurement stations

Table 1. Observations at Sodankylä.

Ground weather observations 	**Comments**
Temperature 2m, Temperature ground, Dew point temperature, Air pressure, Air relative humidity, Wind speed, Wind direction, Precipitation, Cloud height, Amount of clouds, Visibility, Snow depth, Prevailing weather code	First measurements since 1908 Automatic weather station 2006

Soundings 	
Temperature, Air pressure, Air relative humidity, Wind vertical profile	Measured since 1949
Ozone vertical profile	Measured since 1988
Stratospheric water vapour vertical profile	Campain measurements since 2002
Aerosol backscatter vertical profile	Campain measurements since 1994

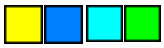
Solar radiation observations 	
Global, diffused, reflected, direct and net radiation, PAR up and down, Radiation balance, Sunshine duration, Aerosol optical depth, UVA and UVB radiation, UV index, Spectral UVB, Albedo	First measurements since 1957
Surface reflectance, Reflected radiance	Spectrometer: 350-2500 nm. Measured since 2006

Mast observations 	
Temperature profile	Heights: 3, 8, 18, 32, 45, 48m. Measured since 2000
Humidity profile	Heights: 3, 8, 18, 32, 48m. Measured since 2000
Wind speed profile	Heights: 18, 32, 38, 48m. Measured since 2000
Wind and turbulence	Heights: 25, 48m

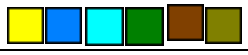
Soil and snow observations 	
Soil temperature profile, Soil moisture profile, Soil heat flux, Soil respiration	First measurements since 2000
Snow temperature profile, Snow moisture profile	First measurements since 2000
Manual snow observations	Snowpack layering and snow grain size on snow bits, SWE and snow depth on snow pits, Dirstibuted snow observations on a 4 km-long snow course

Microwave observations 

Brightness temperature (surface / atmosphere)	SodRad radiometer: 10.65, 18.7, 36.5, 90 GHz SodRad2 radiometer: 21, 150 GHz Elbara L-band radiometer: 1.4 GHz Measured since 2009. (On loan from ESA)
Backscattering (surface)	Snow Scatterometer: 9-18 GHz Measured since 2009. (On loan from ESA)

Air chemistry observations 

Ozone column, SO_2 column, NO_2 column	First measurements since 1988
Total water vapor	Radiosondes, FTS, GPS, MW radiometer
CO_2 flux	Mast and ground measurements
Greenhouse gas columns: CO_2, CH_4, N_2O, HF, CO, H_2O, O_2	FTS in the near IR region. Measured since 2009

Other observations 

Radioactivity, Aerosols, Cloud camera	
Satellite reception	2.4 m system and 7.3 m system

Overview of LitDB database

The ground based measurement data sets are stored in LitDB database. All data presented in LITDB is available for download. Datasets are checked annually and inserted into the database after checking. The data can be downloaded from the LitDB web interface. Data can be downloaded as a comma separated text file which contains two header lines. The measurement data stored in the LitDB database is free and open for use, but by using the data the user shall agree the general data disclaimer:

"GENERAL DATA DISCLAIMER

The data sets are freely available for scientific and educational use. However, it is requested that when data is used for a publication either (1) appropriate referencing to data provider is provided, or (2) co-authorship to data provider (or to principal investigator responsible for the data) is offered and, additionally, that possible specific disclaimers attached to different data sets are respected. In case of some data sets contacting the principal investigator responsible for the data is required prior to obtaining the actual data."

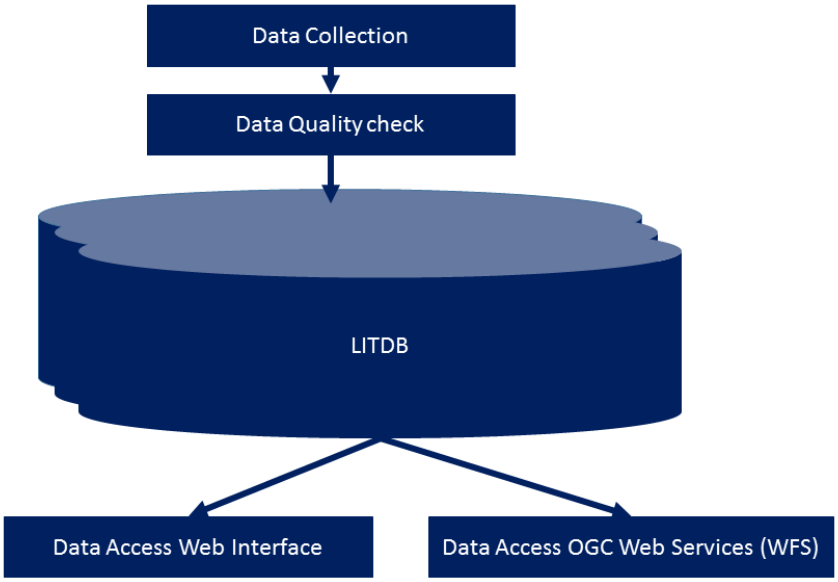


Figure 2 In-situ data interface: data flow

Data description

Each measurement data set has unique identifier and respective meta-data describing essential information of the data set. The types of data sets are different, so also the meta-data contents vary accordingly, but in general the meta-data contains at least following information.

- Data ID
- Data name
- Site description
- Location coordinates
- Measurement type
- Textual description of measurement site
- Sensor type and description
- Contact person maintaining data set

For example:

```
DATA FROM SAA0001 STATION AT SAARISELKÄ

Description: Station is located to the eastern slope of Niilanpää in UKK national
park near Saariselkä, Finland. Bald, infertile fell slope with juniper, heather,
lichen and crowberry. Station includes a Mobotix M24 camera. Measurements are snow
depth, air temperature, air relative humidity, wind speed, prevailing wind
direction, incoming and outgoing SW- and LW-radiation (Spot 1) and soil temperature
and dielectric constant profile in three different spots:
```

Spot 1: -5, -10, -20, -40, -80 cm (Installed 2011-09-09)
Spot 2: -5, -10 cm (Installed 2011-09-09)
Spot 3: -5, -10, -20, -40, -63 cm (Installed 2017-10-15)

Altitude above sea level: 440 m

Coordinates:
Spot 1: N68.33019, E27.55062
Spot 2: N68.33025, E27.55076
Spot 3: N68.33013, E27.55083

Soil type Spot 1 and 2: organic/sand for sensors at -5cm, sand for sensors at -10 to -80 cm
Soil type Spot 3: organic for -5cm, organic/sand for -10cm, sand for sensors at -20 to -63 cm

Sensor for soil measurements Spot 1 and 2: Decagon Devices 5TE Soil Moisture Sensor
Sensor for soil measurements Spot 3: Decagon Devices GS3
Sensor for snow depth: Campbell Scientific SR50A
Sensor for radiation: Kipp&Zonen CNR4
Sensor for air temperature and relative humidity: Campbell Scientific CS215
<=”” b=”” style="color: rgb(0, 0, 0); font-family: Arial, Helvetica, sans-serif; font-size: 13px; font-style: normal; font-variant-ligatures: normal; font-variant-caps: normal; font-weight: 400; letter-spacing: normal; orphans: 2; text-align: start; text-indent: 0px; text-transform: none; white-space: normal; widows: 2; word-spacing: 0px; -webkit-text-stroke-width: 0px; background-color: rgb(255, 255, 255); text-decoration-style: initial; text-decoration-color: initial;">R.M. Young 05103 Wind Monitor

For more information contact NN.

GENERAL DATA DISCLAIMER

NOTE: The station is located in the fell area. Snow is packed into sensors in wintertime and they need to be cleaned. The cleaning dates are:

2013-02-07
2014-01-10
2015-02-13 HOX! 1st European Snow Science Winter School at the area, the effect on data may be possible!

Cleaning and prevailing conditions affect the data quality. Due to this the data quality is unknown.

```
2016-09-06 CNR4, CS215, and Wind Monitor were relocated from above
the juniper bush onto bare ground.
```

List of data stored in LitDB

AIR TEMPERATURE DATA:	
LUO0015	Operative automatic weather station
LUO0016	Manual SYNOP observations daily values
LUO0017	Manual observations monthly values
LUO0018	Manual SYNOP observations
SUO0003	Automatic weather station at the peatland
IOA0003	Station at the Intensive Observation Area
SUO0003	Automatic weather station at the peatland
SUO0010	Station at the peatland methane flux station
MET0002	Station at the Micrometeorological mast
VUO0001	Station at the CO2 flux mast field
VUO0002	Station at the CO2 flux mast
KAI0002	Station at forest
RWS0001	Station at the Road Weather Station
RWS0003	Station at the Road Weather Station
DIS0001	Station at forest
DIS0002	Station at forest
SAA0001	Station at the Saariselkä
SAA0002	Station at the Saariselkä
SAA0003	Station at the Saariselkä
AIR RELATIVE HUMIDITY DATA:	
LUO0015	Operative automatic weather station
LUO0018	Manual SYNOP observations
IOA0003	Station at the Intensive Observation Area
SUO0003	Automatic weather station at the peatland
SUO0010	Station at the peatland methane flux station
MET0002	Station at the Micrometeorological mast
VUO0001	Station at the CO2 flux mast field
VUO0002	Station at the CO2 flux mast
RWS0001	Station at the Road Weather Station
RWS0003	Station at the Road Weather Station

SAA0001	Station at the Saariselkä
SAA0003	Station at the Saariselkä
AIR PRESSURE DATA:	
LUO0015	Operative automatic weather station
LUO0018	Manual SYNOP observations
SAA0003	Station at the Saariselkä
SOIL TEMPERATURE DATA:	
IOA0002	Station at the Intensive Observation Area
IOA0003	Station at the Intensive Observation Area
IOA0007	Station at the Intensive Observation Area
IOA0009	Station at the Intensive Observation Area
LUO0008	Station at the Sounding station area (open area)
LUO0009	Station at the Sounding station area (forest)
LUO0013	Manual measurement at the Sounding station area
SUO0001	Station at the peatland
SUO0004	Station at the peatland
SUO0005	Station at the peatland
SUO0007	Station at the peatland
SUO0008	Station at the peatland
SUO0009	Station at the peatland methane flux station
SUO0010	Station at the peatland methane flux station
SUO0011	Station at the peatland
JAK0001	Station at the Lichen fence
LEN0001	Station at forest near airport
KAI0001	Station at forest
KAI0002	Station at forest
MET0001	Station at the Micrometeorological mast field
MET0003	Station at the Micrometeorological mast field
VUO0001	Station at the CO2 flux mast field
RWS0001	Station at the Road Weather Station
RWS0003	Station at the Road Weather Station
RWS0005	Station at the Road Weather Station
DIS0001	Station at forest
DIS0002	Station at forest
DIS0003	Station at forest
DIS0004	Station at forest
SAA0001	Station at the Saariselkä

SAA0002	Station at the Saariselkä
SAA0003	Station at the Saariselkä
SOIL MOISTURE DATA:	
IOA0002	Station at the Intensive Observation Area
IOA0003	Station at the Intensive Observation Area
IOA0007	Station at the Intensive Observation Area
SUO0004	Station at the peatland
SUO0005	Station at the peatland
SUO0007	Station at the peatland
LEN0001	Station at forest near airport
KAI0001	Station at forest
KAI0002	Station at forest
MET0001	Station at the Micrometeorological mast field
MET0003	Station at the Micrometeorological mast field
VUO0001	Station at the CO2 flux mast field
RWS0001	Station at the Road Weather Station
DIS0001	Station at forest
DIS0002	Station at forest
DIS0003	Station at forest
DIS0004	Station at forest
SAA0001	Station at the Saariselkä
SAA0002	Station at the Saariselkä
SAA0003	Station at the Saariselkä
SNOW DEPTH DATA:	
LUO0015	Operative automatic weather station
LUO0016	Manual SYNOP observations daily values
IOA0003	Station at the Intensive Observation Area
SUO0003	Automatic weather station at the peatland
MET0002	Station at the Micrometeorological mast field
SAA0001	Station at the Saariselkä
SAA0002	Station at the Saariselkä
SAA0003	Station at the Saariselkä
SNOW TEMPERATURE DATA:	
SUO0004	Station at the peatland
IOA0007	Station at the Intensive Observation Area
MET0004	Station at the Micrometeorological mast field

SNOW WATER EQUIVALENT DATA:	
IOA0011	Station at the Intensive Observation Area
WIND DATA:	
LUO0015	Operative automatic weather station
LUO0018	Manual SYNOP observations
MET0002	Station at the Micrometeorological mast
RWS0001	Station at the Road Weather Station
RWS0003	Station at the Road Weather Station
SAA0001	Station at the Saariselkä
SAA0003	Station at the Saariselkä
VISIBILITY DATA:	
IOA0006	Station at the Intensive Observation Area
LUO0015	Operative automatic weather station
LUO0018	Manual SYNOP observations
RWS0002	Station at the Road Weather Station
RWS0003	Station at the Road Weather Station
RWS0004	Station at the Road Weather Station
PRECIPITATION DATA:	
IOA0006	Station at the Intensive Observation Area
LUO0015	Operative automatic weather station
LUO0016	Manual SYNOP observations daily values
LUO0017	Manual observations monthly values
RWS0002	Station at the Road Weather Station
RWS0003	Station at the Road Weather Station
RADIATION DATA:	
IOA0001	Spectral radiance measurement at the Intensive Observation Area
IOA0008	SW radiation at the Intensive Observation Area
MET0002	SW, LW, PPFD, and net radiation at the Micrometeorological mast
MET0005	SW and LW radiation at the Micrometeorological mast
VUO0002	SW, PPFD and net radiation at the CO2 flux mast
SUO0006	SW radiation at the peatland
SUO0009	SW and PPFD radiation at the peatland methane flux station
SUO0010	SW, PPFD, and net radiation at the peatland methane flux station
JAK0002	SW and LW radiation inside the Lichen fence

JAK0003	SW and LW radiation outside the Lichen fence
SAA0001	SW and LW radiation at the Saariselkä
SAA0002	SW radiation at the Saariselkä
SAA0003	SW and LW radiation at the Saariselkä
UV DATA:	
LUO0002	Brewer #037 Spectrophotometer
LUO0010	Brewer #214 Spectrophotometer
OZONE DATA:	
LUO0002	Brewer #037 Spectrophotometer
LUO0010	Brewer #214 Spectrophotometer
EVAPORATION DATA:	
LUO0012	Manual measurement at the Sounding station area
ROAD SURFACE DATA:	
RWS0003	Station at the Road Weather Station
RWS0004	Station at the Road Weather Station
CAMERA IMAGES FROM SODANKYLÄ:	
	Cloud camera images
	Intensive Observation area images
	Automatic weather station images

Web Feature Service for LITDB data

In the iCUPE project, the LitDB data interface will be renewed and Open Data datasets will be published using open standard web service interfaces for geospatial data defined by the Open Geospatial Consortium (OGC). The data opening is part of the growing global trend of publishing environmental information as Open Data, and is part of the implementation of the open data policy of the Finnish Government and the EU INSPIRE directive.

FMI-ARC's Open Data Services will be divided into three categories following the categorization used by the INSPIRE directive:

1. Discovery Service (a.k.a. Catalog service) provides metadata about the available datasets and services, implemented using the OGC Catalog Service for Web (CSW),

2. View Services give a visual preview of the available datasets, implemented using OGC Web Map Service (WMS), and
3. Download Services provide a continuous online access to the most up-to-date data, implemented using OGC Web Feature Service (WFS).

All these services are intended to be machine-accessible: in most cases the data users interact with these services only through applications provided by FMI-ARC, the data users themselves or third parties. In other words, FMI-ARC is providing APIs for accessing the data. Using open standard interfaces makes it easier for developers to build re-usable software being able to access many datasets from different data providers and combine them together to create new interesting and technologically advanced applications. FMI encourages both small and large developer individuals and organizations to experiment with the provided datasets and publish their creations either as free or commercial products.

The platform hosting the OGC web services, data.nsdc.fmi.fi has been implemented and the LitDB database will be linked to this interface. This will then allow LitDB data to be served using Web Feature service. The figure 3 below shows an overview of OGC Web Services platform and data flows.

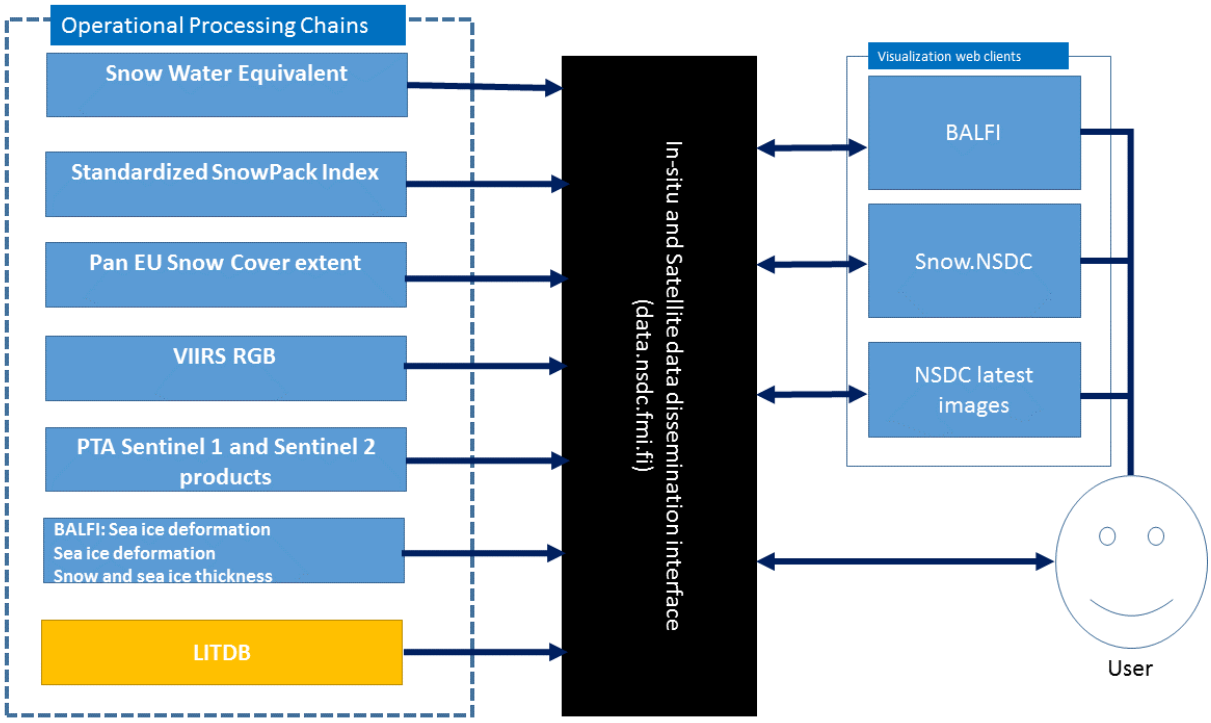


Figure 3 : Overview of OGC Web Services platform and data flows