Web Application Syntool as a Tool to Perform Sea Surface Monitoring in the Arctic Region

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Abstract. Syntool is a webapplication for environmental monitoring in the Arctic region. Its functionality makes comprehensive analysis on volumes of satellite, in situ and model data. The result of such analysis can be used to reveal different natural and artificial phenomena on a sea surface such as polar lows or oil slicks. Continuous data source renewal allows user to trace a development of a phenomenon in time up to the near real time monitoring. The application allows to select a set of products for a given date which should be displayed on a basemap. In this way each product is presented by a separate layer and can be combined with others to get a complete picture of what is happening in the region. It is possible to change visibility and opacity for each particular layer. Along with various satellite products the application’s catalog offers such data sources as meteorological model data, in situ measurements, ship and polar station tracks. Any combination of layers including their order and opacity can be shared or saved by user for later investigation. Zoom capability is activated when user wants to explore some particular region in detail. Being a simple and intuitive action on a clientside it is supported by a huge set of serverside technologies: on-demand data subsetting, tiling and caching. For vector data, such as wind speed and direction or air pressure, we developed a web feature service (WFS) by contributing to an open-source project and adopting it to serve meteorological model data. All of the above allows to cut off unnecessary detialization on low zoom levels and to provide high resolution data on high zoom levels without losing in user interface responsivity.

Key words: GIS, oceanography, remote sensing, satellite data, Arctic.

1. Introduction

Nowadays different countries and companies are highly interested in the Arctic region. Northern Sea Route importance grows. So we need more tools for monitoring and analysing situation in this region. Syntool is one of these tools. It combines different sources and displays the data on the map in a simple way.
Nowadays there are variety of devices and operating systems; for most of these platforms the easiest way to be available is to make a web app. Thus, Syntool is a web application.

However, Syntool is a web interface, it works with several other services written by SOLab team. Constant extension of available data catalog and variety of data representation options are one of the main requirements for Syntool. It is also important to maintain an acceptable level of performance and understandable user interface.

2. Syntool Architecture

Syntool consists of several components (Fig. 1). First, it is Syntool itself, web interface which communicates with Satin data catalog via JSON API. This component is working almost without server, because its responsibilities are mostly to just visualise data that come from Satin. Second, it is Satin which gathers and indexes metadata, then provides a discoverability of new data. However, Satin is not responsible for data processing. POSADA is a python service which converts raw data into its visual representation and notifies Satin about the incoming data.

Also, there is an ODYSSEY service. It is not directly involved into processing, storing or displaying images. Its responsibilities are to monitor Satin, POSADA and Syntool to provide guarantees for fresh data to be available in time.

POSADA Service is a system, which is responsible for processing of satellite data archives in automatic and manual modes. POSADA consists of two main modules: module for downloading data and module for data processing. Module for downloading data implements automatic downloading data from external data sources. There is a set of tasks and configuration files for each data source and type.
Data downloading is initialised by cron daemon. Initialization process runs a script which determines the relations between tasks, configuration and data types.

Communication between modules and external services is implemented using key value store Redis. POSADA has logging system, which logs all events: from product downloading initialization to granules processing. In addition, POSADA sends reports about all downloaded and processed data to ODYSSEY service.

**ODYSSEY** is a monitoring service which collects actual logs from POSADA and indexing service. ODYSSEY tracks processing states of individual products on a fixed timetable. This timetable sets time period during which a product should be processed and become available for API consumers. If in the end of the selected period data is not available, ODYSSEY notifies about a problem. It allows developers to be able to respond to problems quickly and effectively.

**Satin** is a data catalog which receives information from POSADA and stores processed products metadata. As the result we can access all the products and their metadata through the catalog’s API.

3. Syntool

User Interface is displayed on the Fig. 2. It consists of four logical parts: products pane, timeline, header and map.
Products are displayed as a set of granules. Each granule is represented as a separate layer. User can choose settings for each granule separately or to product as a whole. For each layer we can set opacity, zindex (zaxis coordinate) and whether to show it on map or not, or you can remove it from the map.

We can adjust settings of a product on a product pane in edit mode as displayed on Fig. 3. Also, product pane allows you to select and deselect products.

![Figure 3. Edit mode of a product pane](image)

There is also a timeline, a tool that helps you navigate in time and to inspect conditions of the region in past. You can select a date with a date picker or just by dragging timeline with the mouse.

![Figure 4. Timeline](image)

### 4. Vector products

Image distortion during scaling? is one of the main raster images disadvantages. But scaling is very important for geoportals, because it is synonymous for zooming. In this case, problem is solved by using so called “tiles”. Tile is a small, approximately 256×256 pixels, image. We can cut every images on tiles, and then build a “mosaic”, actually several mosiacs, for every zoom level.

Then while user navigates through map, we can load only those tiles, which are visible to user in a single moment. So this technique allows us to load big images seamlessly for a user. Also, browsers perform better when you are using a lot of small images instead of one big image.
Tiles are used everywhere for geoportals. However, this technique has a big disadvantage: you must prepare all tiles in advance. So, you need the preprocessing step or a lot of processing powers to compute those tiles on the fly.

Though vector images do not have this problem. Vector image consists of primitives, so it can be scaled infinitely without distortion. In fact, a lot of satellite data is represented by points in space with some parameters. Thus, we can easily convert these raw data to vector images with ability to scale it. Alas, this approach also has some problems. As long as we have the same image on different zoom levels, we can’t maintain good vector concentration for current zoom level, so for very large zoom there will be very large distance between points.

To solve all these problems we built our implementation of WFSserver (Web Feature Service). WFSserver is a service which responds with vector data serialized as GeoJSON. We catch them on the client and generate our vector image. In the moment when user decides to zoom in or out, we send another request and WFSserver responds to us with new load of data, which has appropriate vector concentration. Currently, we have one product on Syntool, which is delivered using WFSserver, it’s NCEP wind data based on model.

As we can see on Fig. 5, we can maintain the acceptable level of concentration without using a lot of CPU resources to generate new images on the fly.

Figure 5. NCEP wind
6. Results

In conclusion we’d like to mention several features of Syntool: it is a web app, so it is scalable and available almost on every device, the architecture is distributed, so every service is independent and communicates with others with HTTP or Pub/Sub. Also, we have monitoring tool (ODYSSEY) to be notified shortly if something goes wrong and fresh data are not available for too long.

We put a lot of effort into creating easy and understandable user interface, so that everybody could use it without training or instruction.

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Арктический портал Синтул: веб-приложение для мониторинга морской поверхности

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Аннотация. Работа с исходными спутниковыми данными давно сопряжена с рядом проблем для пользователей, которые часто лишены возможности более широкого использования этих данных из-за их больших объёмов, сложностей с доступом, большого разнообразия форматов и типов. В то же время, существующие вебсервисы, предоставляющие доступ к спутниковым данным, не приспособлены для широкой аудитории, требуют специфических навыков в использовании, и обладают существенными ограничениями: предоставлением доступа к исходным файлам без предварительной визуализации их содержимого, недостаточной гибкостью системы поиска, невозможностью совместного анализа разнородных данных.

Проект «Арктический портал Синтул» представляет собой информационную систему для мониторинга окружающей среды в районе Северного Ледовитого Океана. Он позволяет проводить комплексный анализ спутниковых и модельных данных, а также in situ измерений, выявлять различные природные и техногенные явления на морской поверхности, такие как полярные циклоны, природные или нефтяные плёнки, ледовый покров, температуру поверхности моря, данные спутниковой алтиметрии. Непрерывное пополнение системы новыми данными позволяет проследить развитие того или иного явления, вплоть до мониторинга в режиме реального времени.

Ключевые слова: геоинформационные сервисы, вебсервисы, мониторинг, спутниковые данные, Арктика.

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