

A global webservice to generate
SWAT+ hourly and daily input
climate files from ERA5 reanalysis
data

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WaterWebTools

Introduction

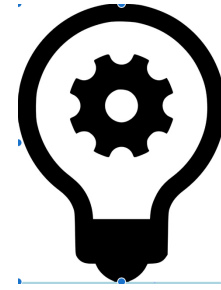
- Waterwebtools provides operational SWAT modelling
- Forecasts
- Global datasources
- Danish Innovation Fund grant in 2019
 - InnoExplorer
 - Allowed exploration of commercialization of research

Motivation



- Waterwebtools need access to global Climate data
 - High quality
 - Preferably for a long time record
- ECMWF ERA5 WEB-API 2019
 - Free
 - Slow
 - Unpredictable
 - Problems

Solution



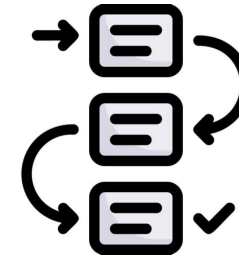
- Keep a local copy of the ECMWF historic Climate record
 - The Climate record is updated daily
 - Only storing needed variables
 - 5 TB of local storage
- Provide a graphical user interface to facilitate data retrieval
- Store data for fast retrieval
 - Only for dry land
 - Sea and large waterbodies are excluded

Performance



	1 point	10 points	1 point (era5 api)
6 month	-	-	1521 s
1 year	4.6	37.6	-
5 years	50.8	477.6	-
10 years	61.5 s	585 s	-

The Workflow



- Find the area You want data from
 - Select one or more points on the map
- Provide location name and an email address
- Provide the wanted daterange
- Press the request button
- After receiving a mail with a link, download a zip file

The User Interface

Global Weather data

First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button.

SWAT+ Model
 SWAT+ Model Hourly
 GOTM-WET Model

Name * Email *

Name of location Email for notification

Land date range: 1978-01-01 - 2023-04-07 Land and sea date range: 1959-01-02 - 2023-06-20

Start date * End date *

Start date of data set End date

Point interface

Pick points on the map and press the button. Or use the lasso tool to select many stations at once. Check if point is in the sea. Requests will be slower.

Latitude * Longitude * Elevation *

Latitude of cursor Longitude of cursor Elevation of position

ADD POINT

List of jobs to be send to the execution queue

Place Name	lat	lng	elevation
<input type="checkbox"/> boelling 0	56.445	8.400	60.000

Size of execution queue: 0

Expected time to retrieve data: 1 second Job ID: 304e4e11-c939-4703-9682-93bec2330e95

The following link is first valid when the dataset is complete. You can copy the link for later use. [Link to data](#)

REQUEST DATA

The User Interface (model selection)

The screenshot displays the 'Global Weather data' user interface. On the left is a map of Denmark with a blue location pin over the 'boelling' area. On the right is a configuration panel with the following sections:

- Global Weather data** (header)
- Instructions: "First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button."
- Model Selection:** Three radio buttons are shown: SWAT+ Model, SWAT+ Model Hourly, and GOTM-WET Model. This section is highlighted with a red box.
- Name and Email:** Name: boelling; Email: redorlik@gmail.com
- Date Ranges:** Land date range: 1978-01-01 - 2023-04-07; Land and sea date range: 1959-01-02 - 2023-06-20
- Start and End Dates:** Start date: 30.11.2020; End date: 31.12.2020
- Point interface:** Includes a section for picking points on the map and a form with fields for Latitude (56.445), Longitude (8.400), and Elevation (60). A checkbox for "Check if point is in the sea" is present.
- ADD POINT** button
- List of jobs to be send to the execution queue:** A table with columns: Place Name, lat, lng, elevation. Row: boelling 0, 56.445, 8.400, 60.000.
- Size of execution queue: 0**
- Expected time to retrieve data:** 1 second
- Job ID:** 304e4e11-c939-4703-9682-93bec2330e95
- REQUEST DATA** button
- Link to data:** [Link to data](#)

The User Interface (location name and email)

The screenshot displays the 'Global Weather data' user interface. On the left is a map of Denmark with a blue location pin on the west coast. The right panel contains the following elements:

- Global Weather data** (header)
- Instructions: "First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button."
- Model selection: SWAT+ Model, SWAT+ Model Hourly, GOTM-WET Model
- Location and email input fields: and (highlighted with a red box)
- Date ranges: Land date range (1978-01-01 - 2023-04-07) and Land and sea date range (1959-01-02 - 2023-06-20)
- Date pickers: Start date * (30.11.2020) and End date * (31.12.2020)
- Point interface section with a collapse arrow (^):
 - Instructions: "Pick points on the map and press the button. Or use the lasso tool to select many stations at once." and "Check if point is in the sea. Requests will be slower."
 - Latitude * (56.445), Longitude * (8.400), Elevation * (60)
 - Labels: Latitude of cursor, Longitude of cursor, Elevation of position
 - Check if point is in the sea
 - ADD POINT** button
- List of jobs to be send to the execution queue:

Place Name	lat	lng	elevation
boelling 0	56.445	8.400	60.000
- Size of execution queue: 0
- Expected time to retrieve data: 1 second
- Job ID: 304e4e11-c939-4703-9682-93bec2330e95
- The following link is first valid when the dataset is complete. You can copy the link for later use. [Link to data](#)
- REQUEST DATA** button

The User Interface (Date range)

The screenshot displays a web application interface for requesting weather data. On the left is a map of Denmark with a blue location pin. On the right is a 'Global Weather data' panel. The panel includes instructions, model selection (SWAT+ Model, SWAT+ Model Hourly, GOTM-WET Model), name and email input fields, and a date range selection section highlighted with a red border. Below this is a 'Point interface' with latitude, longitude, and elevation input fields, and an 'ADD POINT' button. At the bottom, there is a table for the 'List of jobs to be send to the execution queue' and a 'REQUEST DATA' button.

Global Weather data

First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button.

SWAT+ Model SWAT+ Model Hourly GOTM-WET Model

Name * E-mail *

Land date range: 1978-01-01 - 2023-04-07
Start date * Start date of data set

Land and sea date range: 1959-01-02 - 2023-06-20
End date * End date

Point interface

Pick points on the map and press the button. Or use the lasso tool to select many stations at once. Check if point is in the sea. Requests will be slower.

Latitude * Longitude * Elevation *

Latitude of cursor Longitude of cursor Elevation of position

ADD POINT

List of jobs to be send to the execution queue

Place Name	lat	lng	elevation
<input type="checkbox"/> boelling 0	56.445	8.400	60.000

Size of execution queue: 0

Expected time to retrieve data: 1 second Job ID: 304e4e11-c939-4703-9682-93bec2330e95

The following link is first valid when the dataset is complete. You can copy the link for later use. [Link to data](#)

REQUEST DATA

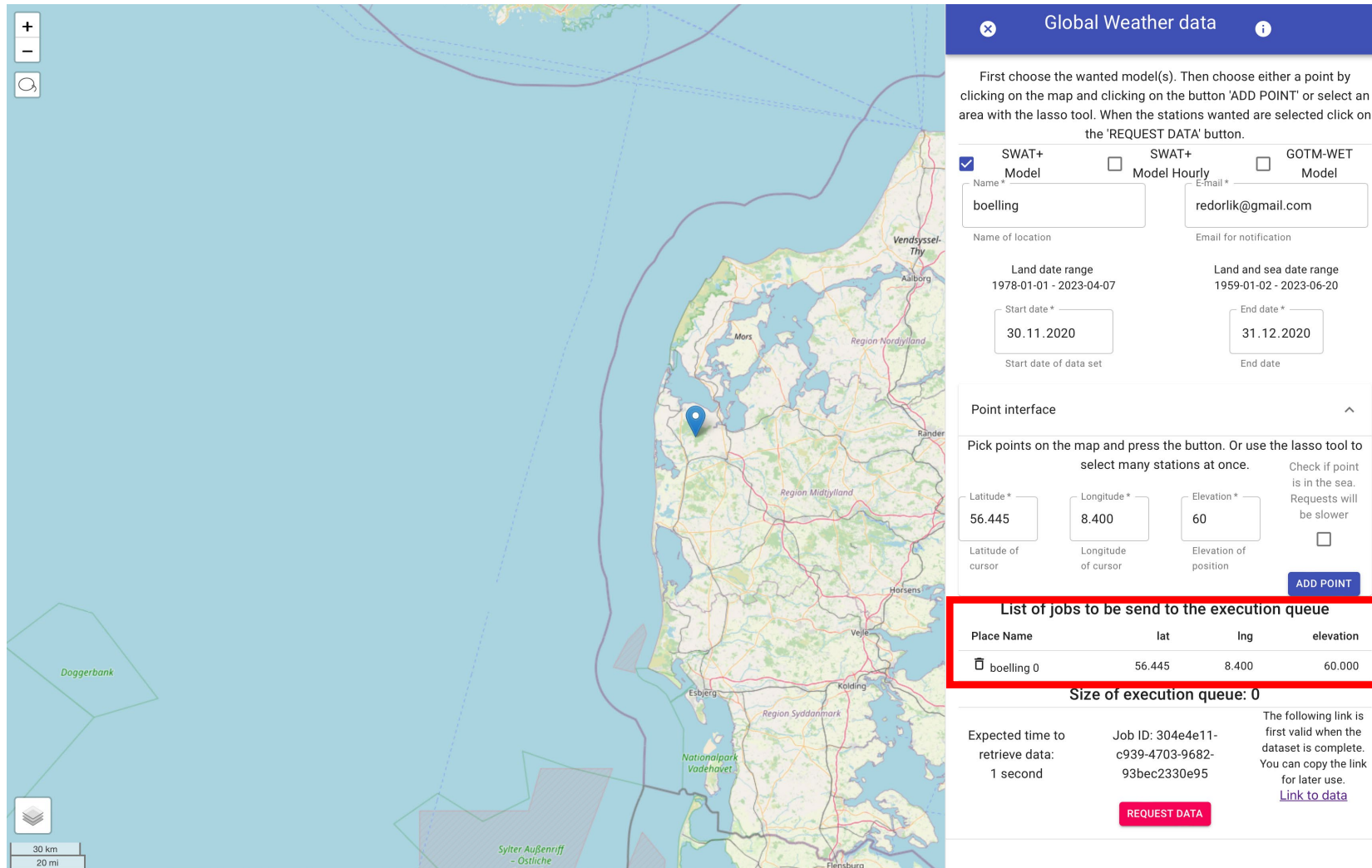
The User Interface (Manual point selection)

The screenshot displays the 'Global Weather data' user interface. On the left is a map of Denmark with a blue location pin on the west coast. The right panel contains the following elements:

- Global Weather data** header with a close button and an information icon.
- Instructions: "First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button."
- Model selection: Three radio buttons for "SWAT+ Model" (checked), "SWAT+ Model Hourly", and "GOTM-WET Model".
- Form fields: "Name*" (boelling) and "E-mail*" (redorlik@gmail.com).
- Date ranges: "Land date range" (1978-01-01 - 2023-04-07) and "Land and sea date range" (1959-01-02 - 2023-06-20).
- Date pickers: "Start date*" (30.11.2020) and "End date*" (31.12.2020).
- Point interface** (highlighted with a red box):
 - Instructions: "Pick points on the map and press the button. Or use the lasso tool to select many stations at once."
 - Form fields: "Latitude*" (56.445), "Longitude*" (8.400), and "Elevation*" (60).
 - Checkboxes: "Check if point is in the sea." (unchecked) and "Requests will be slower" (unchecked).
 - "ADD POINT" button.
- List of jobs to be send to the execution queue**:

Place Name	lat	lng	elevation
boelling 0	56.445	8.400	60.000
- Size of execution queue: 0**
- Expected time to retrieve data: 1 second
- Job ID: 304e4e11-c939-4703-9682-93bec2330e95
- Text: "The following link is first valid when the dataset is complete. You can copy the link for later use." with a [Link to data](#) link.
- "REQUEST DATA" button.

The User Interface (List of selected points)



The screenshot displays the 'Global Weather data' user interface. On the left is a map of Denmark with a blue location pin on the west coast. On the right is a form with the following sections:

- Global Weather data** (header)
- Instructions: "First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button."
- Model Selection:** Three radio buttons for "SWAT+ Model", "SWAT+ Model Hourly", and "GOTM-WET Model". The "SWAT+ Model" option is selected.
- Name and Email:** Input fields for "Name *" (containing "boelling") and "E-mail *" (containing "redorlik@gmail.com").
- Date Ranges:** Fields for "Land date range" (1978-01-01 - 2023-04-07) and "Land and sea date range" (1959-01-02 - 2023-06-20). Below these are "Start date *" (30.11.2020) and "End date *" (31.12.2020) fields.
- Point interface:** A section with a caret icon, containing instructions: "Pick points on the map and press the button. Or use the lasso tool to select many stations at once." It includes input fields for "Latitude *" (56.445), "Longitude *" (8.400), and "Elevation *" (60). A checkbox "Check if point is in the sea." is present and unchecked. A blue "ADD POINT" button is at the bottom right of this section.
- List of jobs to be send to the execution queue:** A table with a red border containing one entry:

Place Name	lat	lng	elevation
boelling 0	56.445	8.400	60.000

- Size of execution queue:** 0
- Expected time to retrieve data:** 1 second
- Job ID:** 304e4e11-c939-4703-9682-93bec2330e95
- REQUEST DATA** button
- Text: "The following link is first valid when the dataset is complete. You can copy the link for later use." followed by a [Link to data](#) link.

The User Interface (Information)

The screenshot displays the 'Global Weather data' user interface. On the left is a map of Denmark with a blue location pin on the west coast. On the right is a form for requesting weather data. The form includes instructions, model selection (SWAT+ Model, SWAT+ Model Hourly, GOTM-WET Model), input fields for location name ('boelling') and email ('redorlik@gmail.com'), date ranges for land and sea data, and a 'Point interface' section with latitude (56.445), longitude (8.400), and elevation (60) fields. A table below shows the job details for 'boelling 0'. A red box highlights the bottom section of the form, which includes the 'Size of execution queue: 0', 'Expected time to retrieve data: 1 second', 'Job ID: 304e4e11-c939-4703-9682-93bec2330e95', and a 'REQUEST DATA' button.

Global Weather data

First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button.

SWAT+ Model SWAT+ Model Hourly GOTM-WET Model

Name * E-mail *

Name of location Email for notification

Land date range: 1978-01-01 - 2023-04-07
Land and sea date range: 1959-01-02 - 2023-06-20

Start date * End date *
Start date of data set End date

Point interface

Pick points on the map and press the button. Or use the lasso tool to select many stations at once. Check if point is in the sea. Requests will be slower.

Latitude * Longitude * Elevation *

Latitude of cursor Longitude of cursor Elevation of position

Check if point is in the sea. Requests will be slower.

ADD POINT

List of jobs to be send to the execution queue

Place Name	lat	lng	elevation
boelling 0	56.445	8.400	60.000

Size of execution queue: 0

Expected time to retrieve data: 1 second
Job ID: 304e4e11-c939-4703-9682-93bec2330e95
The following link is first valid when the dataset is complete. You can copy the link for later use.
[Link to data](#)

REQUEST DATA

The User Interface (Lasso tool)

The screenshot displays a web application interface for weather data collection. On the left, a map of Denmark is shown with a red box highlighting a lasso tool icon. The right side of the interface is a form titled "Global Weather data" with the following sections:

Global Weather data

First choose the wanted model(s). Then choose either a point by clicking on the map and clicking on the button 'ADD POINT' or select an area with the lasso tool. When the stations wanted are selected click on the 'REQUEST DATA' button.

SWAT+ Model SWAT+ Model Hourly GOTM-WET Model

Name * E-mail *

Name of location Email for notification

Land date range Land and sea date range

Start date * End date *

Start date of data set End date

Point interface

Pick points on the map and press the button. Or use the lasso tool to select many stations at once. Check if point is in the sea. Requests will be slower

Latitude * Longitude * Elevation *

Latitude of cursor Longitude of cursor Elevation of position

ADD POINT

List of jobs to be send to the execution queue

Place Name	lat	lng	elevation
<input type="checkbox"/> boelling 0	56.445	8.400	60.000

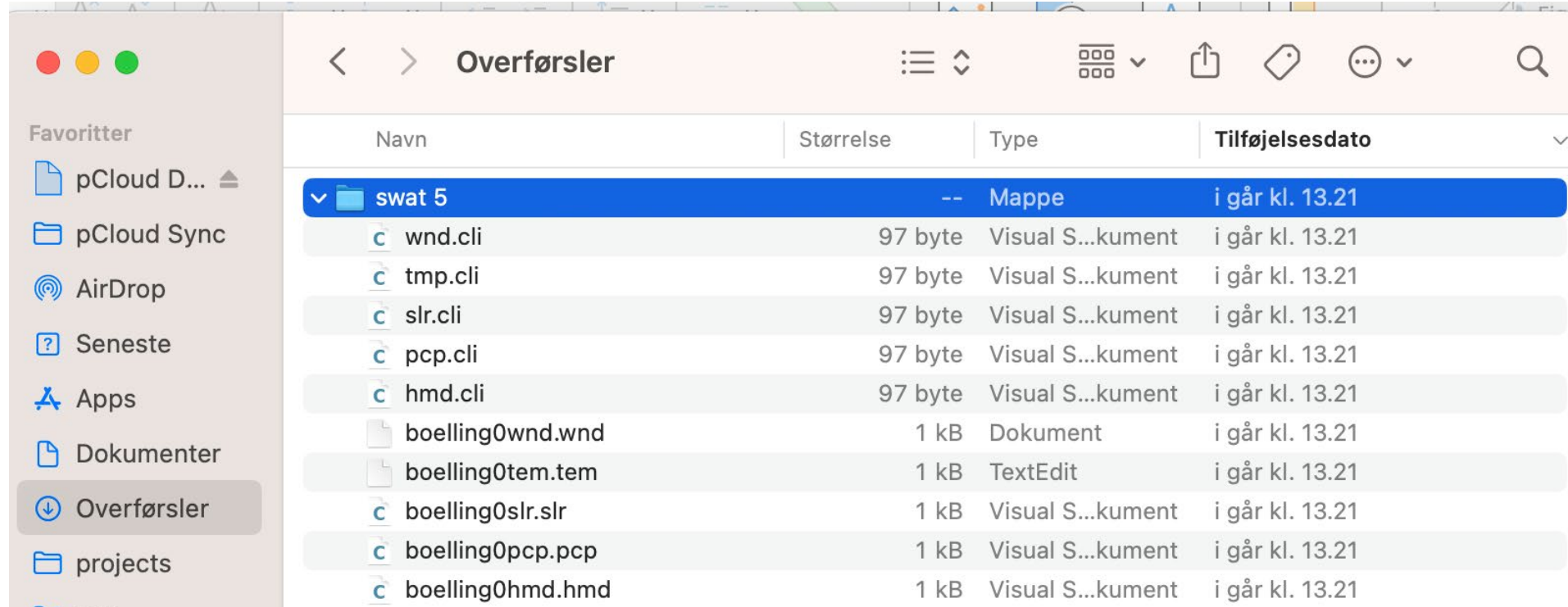
Size of execution queue: 0

Expected time to retrieve data: 1 second Job ID: 304e4e11-c939-4703-9682-93bec2330e95

The following link is first valid when the dataset is complete. You can copy the link for later use. [Link to data](#)

REQUEST DATA

The result



Demo

Thank you!

- Try it at:
 - [Http://era5.asap-forecast.com](http://era5.asap-forecast.com)
- Bugs can be reported at anders@ece.au.dk
- Thank you to ECMWF, who have recently updated their service
 - Much faster access
 - More predictable

Hardware

- ERA5 dataset
 - Standard 2019 AU Desktop running Windows
 - 16 GB RAM
 - 6 core Intel
 - 20 TB external harddrive
- Queue
 - Python REST service running on AWS virtual machine

ERA5

- Global reanalysed climate dataset
- Temporal resolution
 - 1 hour
- Spacial resolution
 - 0.25 degree
 - ~ 1 million points
- Range
 - 1958 to current day minus five days