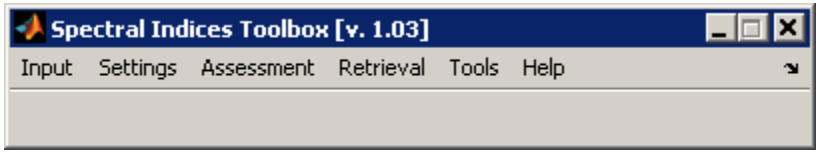
Spectral Indices (SI) toolbox - v.1.03

Tutorial: Training/Validating & Mapping with User data



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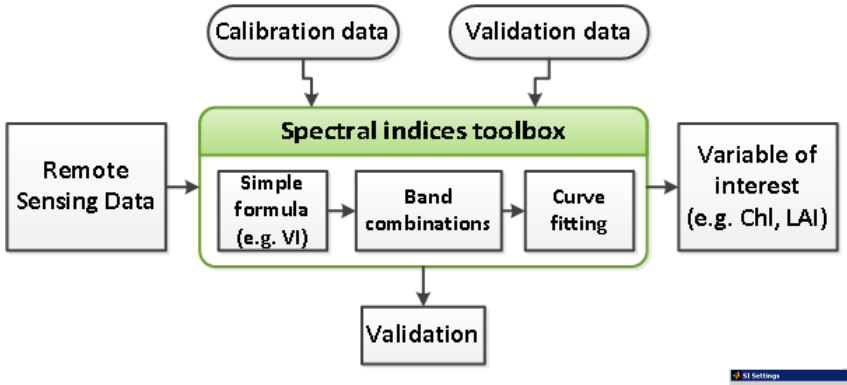
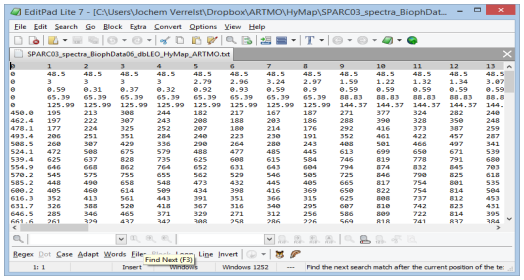
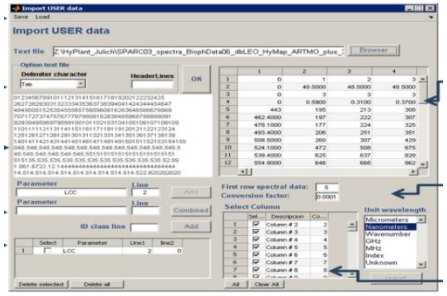
Outlook:

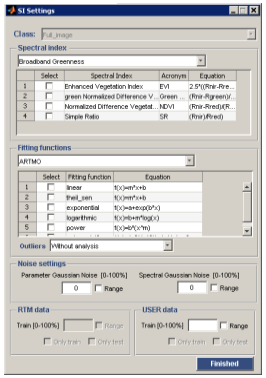
SI mapping based on User data

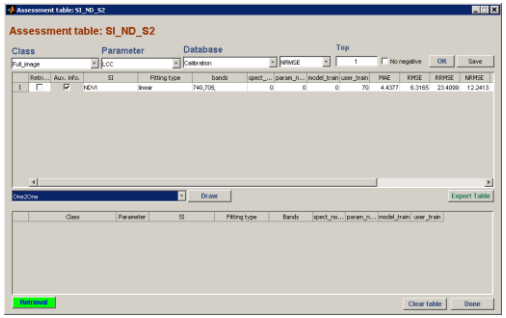
- User Input data
- SI setting
- Validation
- Mapping

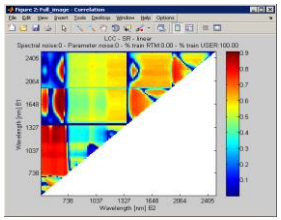


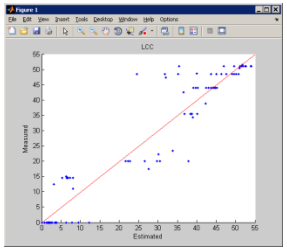


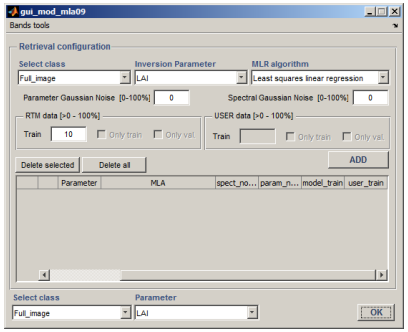


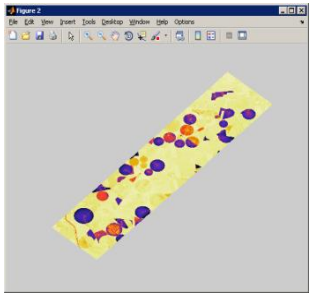




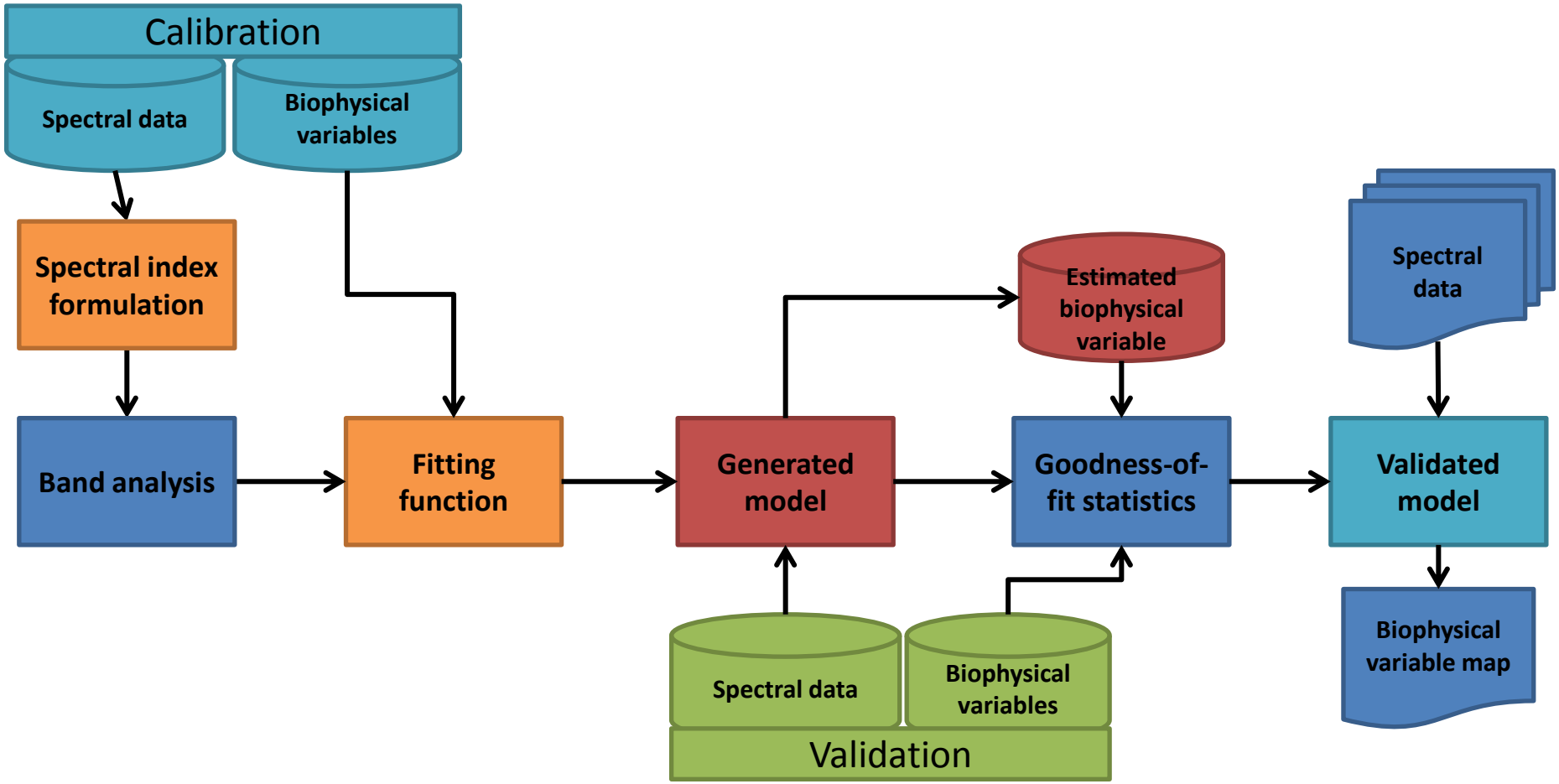








Schematic overview for systematic evaluation of spectral indices models to estimate biophysical variables

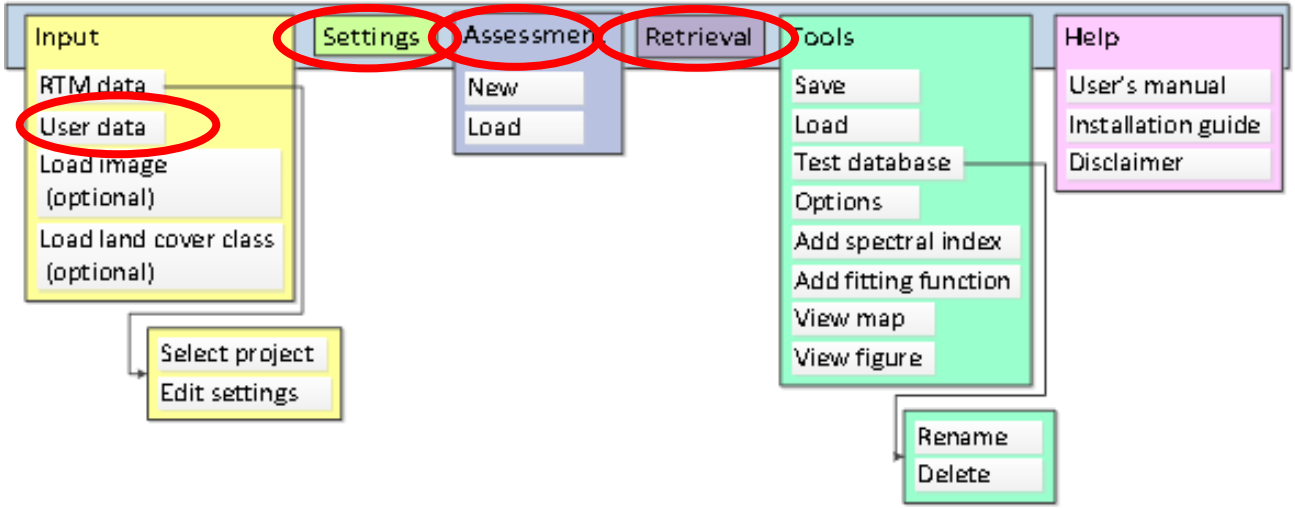


SI mapping based on User data

*The **example** will demonstrate how to assess and validate SI models and apply it to an image using a field dataset for training. Consult the **Manual** for more details.*

The procedure will be as follows:

1. ***User data:** Insert field data for training and validation*
2. ***Assessment:** Evaluate best performing band combinations, formulations and fitting functions*
3. ***Validation:** Validate the defined MLRA strategies*
4. ***Retrieval:** Apply the best one to a remote sensing image.*

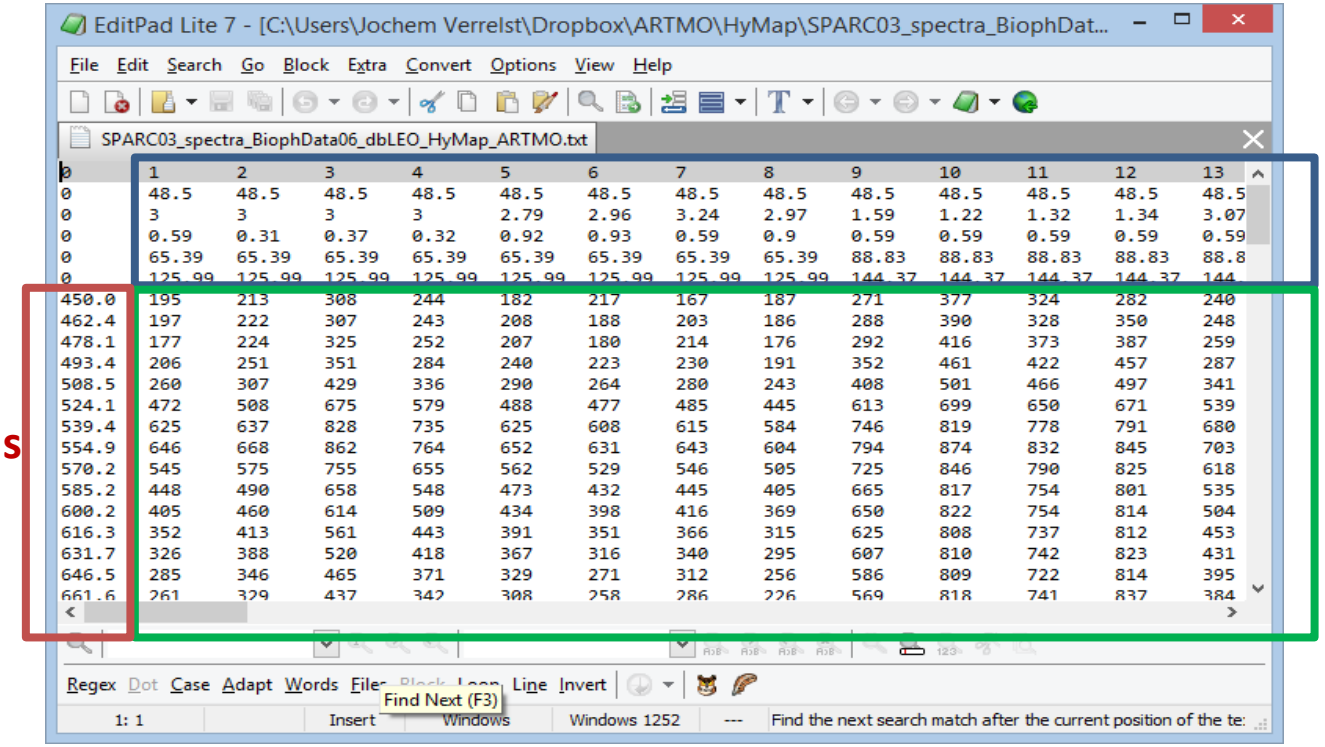


Input: User data (e.g. field data)

User data for training and validation requires one input file, including:

1. Biophysical parameters (e.g., LAI, chlorophyll content,…)
2. Associated spectra (e.g., obtained from a remote sensing image)

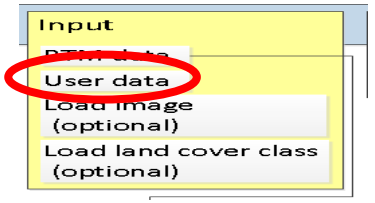
User data need to be organized in a matrix format in plain text file, according to example below:

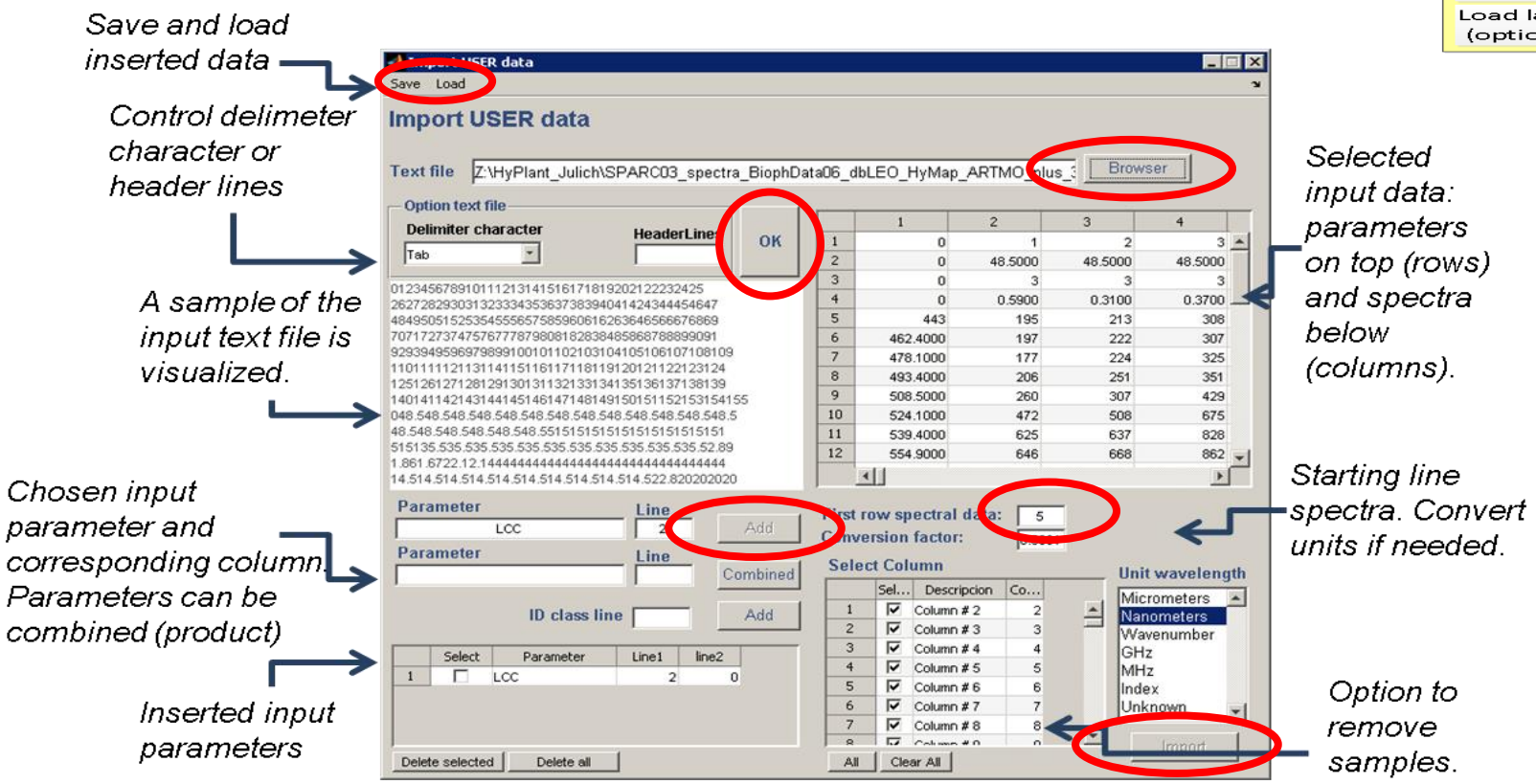


0	1	2	3	4	5	6	7	8	9	10	11	12	13
0	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5
0	3	3	3	3	2.79	2.96	3.24	2.97	1.59	1.22	1.32	1.34	3.07
0	0.59	0.31	0.37	0.32	0.92	0.93	0.59	0.9	0.59	0.59	0.59	0.59	0.59
0	65.39	65.39	65.39	65.39	65.39	65.39	65.39	65.39	88.83	88.83	88.83	88.83	88.8
0	125.99	125.99	125.99	125.99	125.99	125.99	125.99	125.99	144.37	144.37	144.37	144.37	144
450.0	195	213	308	244	182	217	167	187	271	377	324	282	240
462.4	197	222	307	243	208	188	203	186	288	390	328	350	248
478.1	177	224	325	252	207	180	214	176	292	416	373	387	259
493.4	206	251	351	284	240	223	230	191	352	461	422	457	287
508.5	260	307	429	336	290	264	280	243	408	501	466	497	341
524.1	472	508	675	579	488	477	485	445	613	699	650	671	539
539.4	625	637	828	735	625	608	615	584	746	819	778	791	680
554.9	646	668	862	764	652	631	643	604	794	874	832	845	703
570.2	545	575	755	655	562	529	546	505	725	846	790	825	618
585.2	448	490	658	548	473	432	445	405	665	817	754	801	535
600.2	405	460	614	509	434	398	416	369	650	822	754	814	504
616.3	352	413	561	443	391	351	366	315	625	808	737	812	453
631.7	326	388	520	418	367	316	340	295	607	810	742	823	431
646.5	285	346	465	371	329	271	312	256	586	809	722	814	395
661.6	261	329	437	342	308	258	286	226	569	818	741	837	384

- Make sure to fill up the whole Matrix! In case of empty cells, use **NaN** and remove those samples in the following step.
- Make sure that wavelengths are the same as the remote sensing image! They need to match.

Import User data window





1. **Browser**: Import User data file.
2. Inspect if right data in left panel. By clicking on **OK** data will appear in right panel.
3. Define a row with a parameter to its line. Click on **Add**. Multiple parameters can be define by repeating this step. Parameters can be combined.
4. **Define the row where spectra starts.**
5. If needed, **convert** spectral data.
6. Option to **remove** samples.
7. Configured input data can be **save**d and **load**ed as .m file.
8. Finally, click on **Import**.

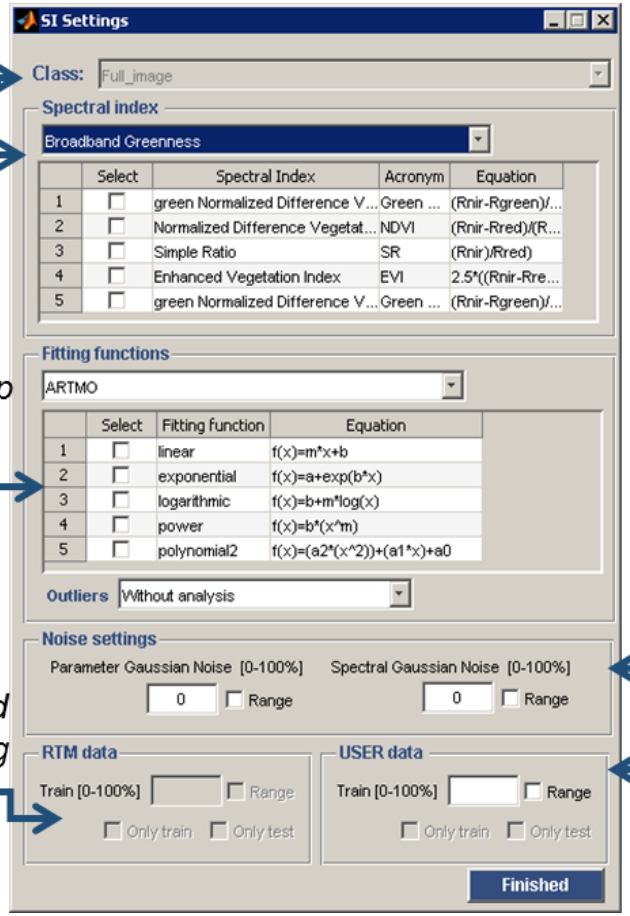
Settings

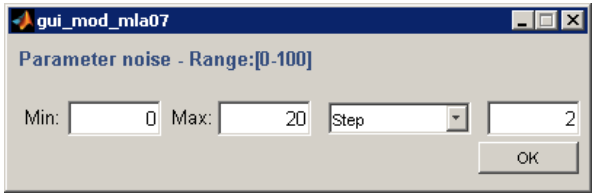
If a land cover map has been provided, per class scan be configured.

A SI group and then multiple SIs can be selected

A fitting function group and multiple fitting functions can be selected

If RTM data is inserted it can serve for training or validation





Range options:

- Step
- Distribution

Options to add noise to parameters and spectral data

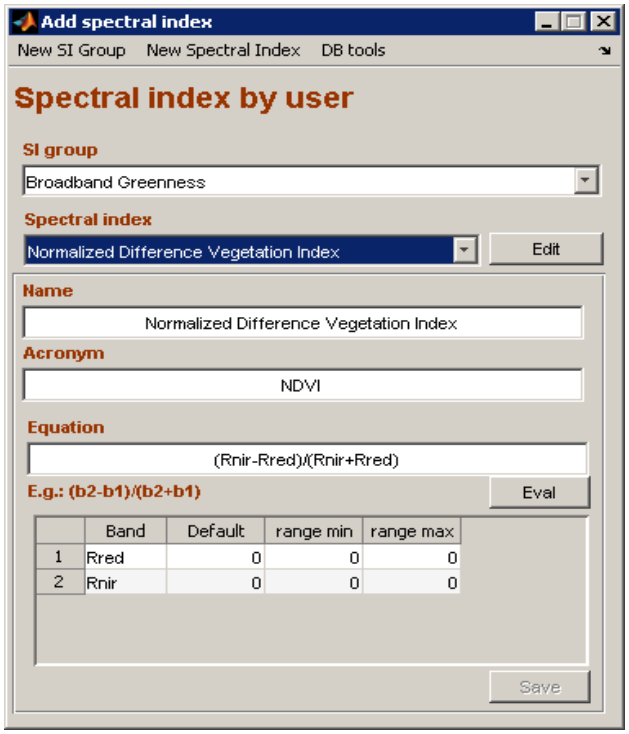
Options to control the training/validation partitioning for user data

New formulations and fitting functions can be configured in Tools:

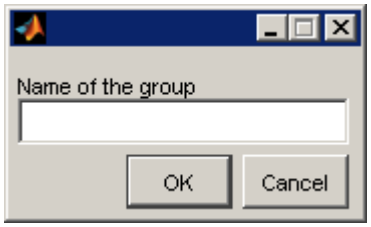
- Add Spectral Index
- Add Fitting function

Add spectral index

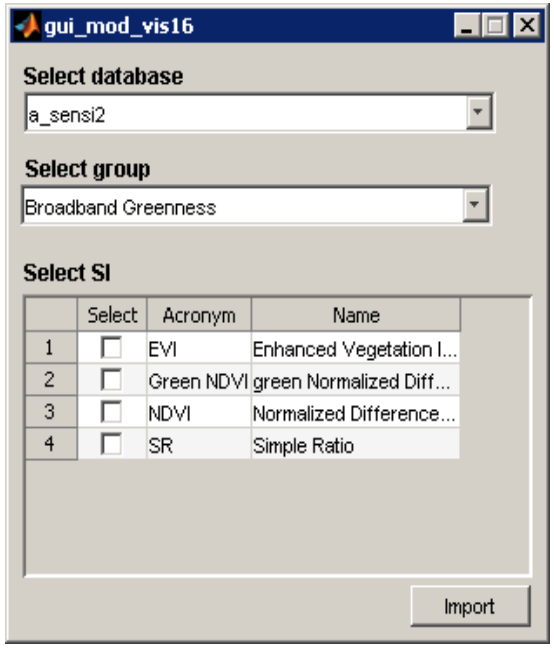
The **'Add spectral index'** window allows adding a new index to a list with pre-defined SI's. Spectral indices can be created manually using the GUI or imported.
SI's are organized in 'SI Groups', according to their similarity in definition, e.g., broadband, narrowband or according to certain pigments or water absorption properties.



New SI group:

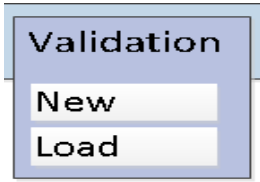


Import SI:

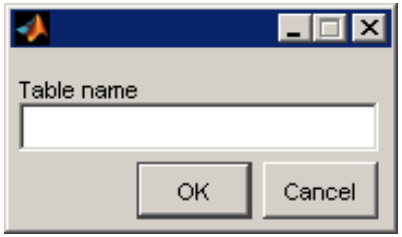


New spectral indices can be added by clicking on '**New Spectral Index**' in the top bar. When doing so, the boxes '**Name**', '**Acronym**' and '**Equation**' become editable.

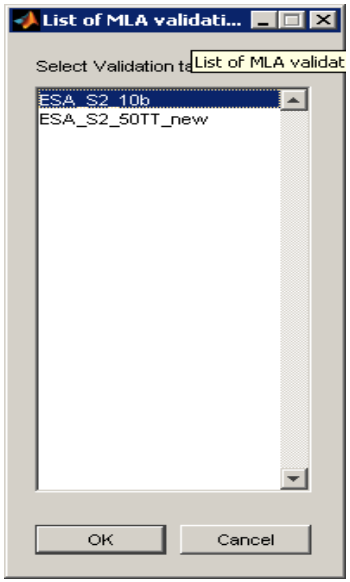
Validation



- Start a **New** validation: provide a name



- All SI models will be trained using training data and validated against validation data according to goodness-of-fit indicators:
  - R, R^2, RMSE, RELRMSE, NRMSE, ME, MAE (see manual)
- Results will be automatically stored in a MySQL table.
- When finished, an overview table will appear (*see next slide*). Such overview table can also be consulted when selecting: **Load.** A window with generated validation results will appear: (see next slide)

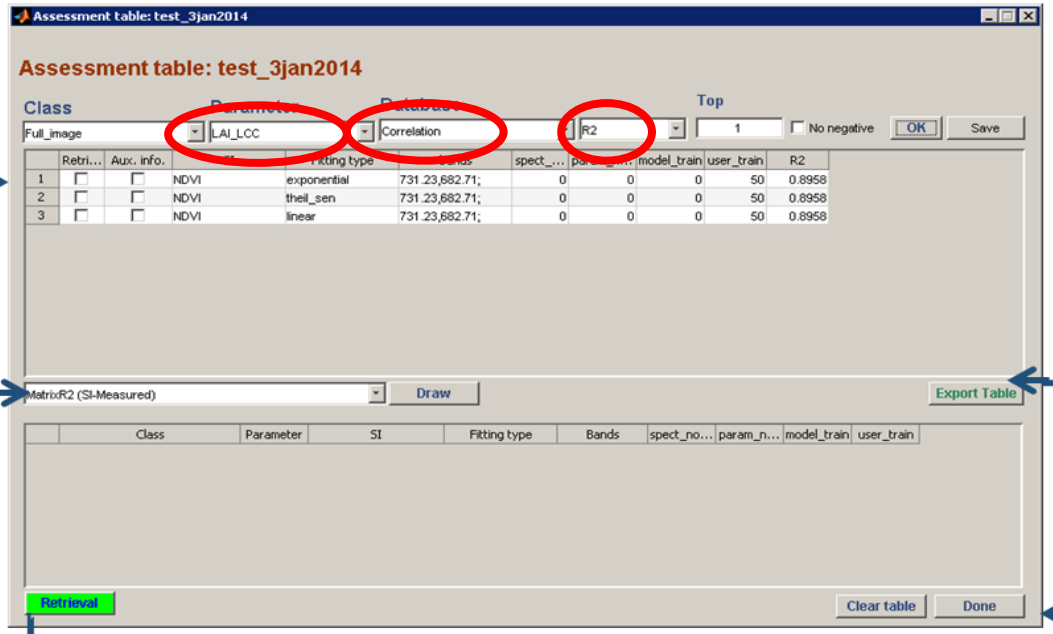


Calibration/validation

Options to organize statistics per Class, Parameter, stat. and # of best results

Overview of best performing SI correlation. The check boxes allow to select a SI for estimation, the graphics for graphics outputs.

Graphic options: 2D correlation matrix (based on correlation between SI values and calibration data)



Option to export a table to a .txt file.

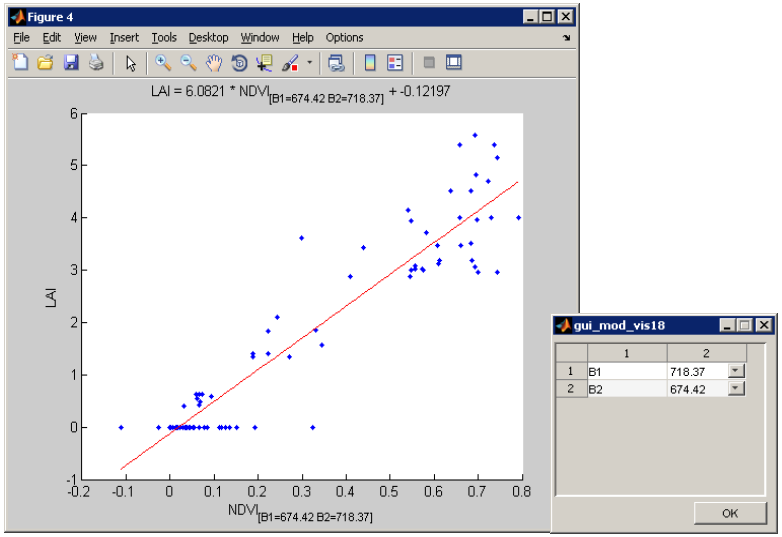
*Selected SI model. With **Done** it will be moved to **Retrieval.***

Option to proceed directly with the mapping.

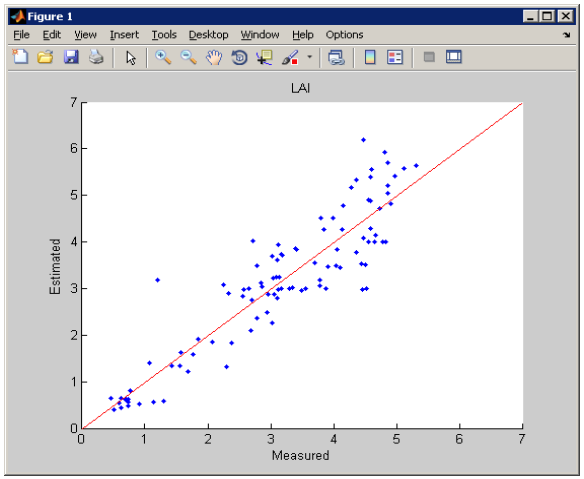
1. Choose how to **sort outputs,** according to parameter, statistic and number of top results per regressor. Click on **OK**.
2. **Select** a **SI model for retrieval** (e.g. the top performing one). It will move to lower panel. When clicking on **Done** it will move to the Retrieval window (slide 11).
3. Select a SI model for **Graphics plottings: 1:1-line measured vs. predicted. Make sure to have User data loaded, because the selected model will be regenerated.**
4. In case ranges were introduced (noise, training/validation partitioning), validation results can be plotted in a **2D-matrix**. Results are plotted according to selected parameter and statistic.

Examples of validation results

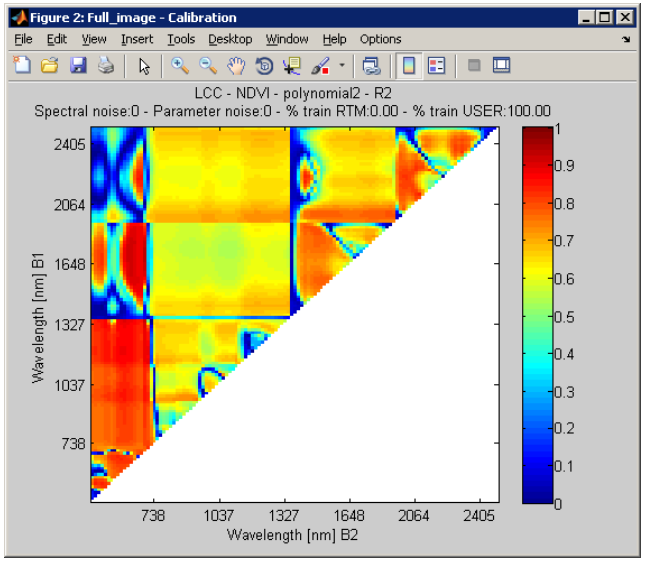
Index vs. variable & fitting function



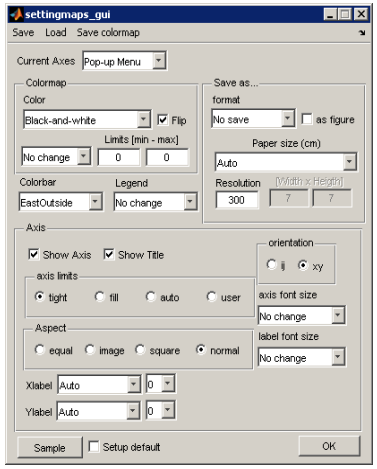
Measured data (validation) vs. estimated data along 1:1-line



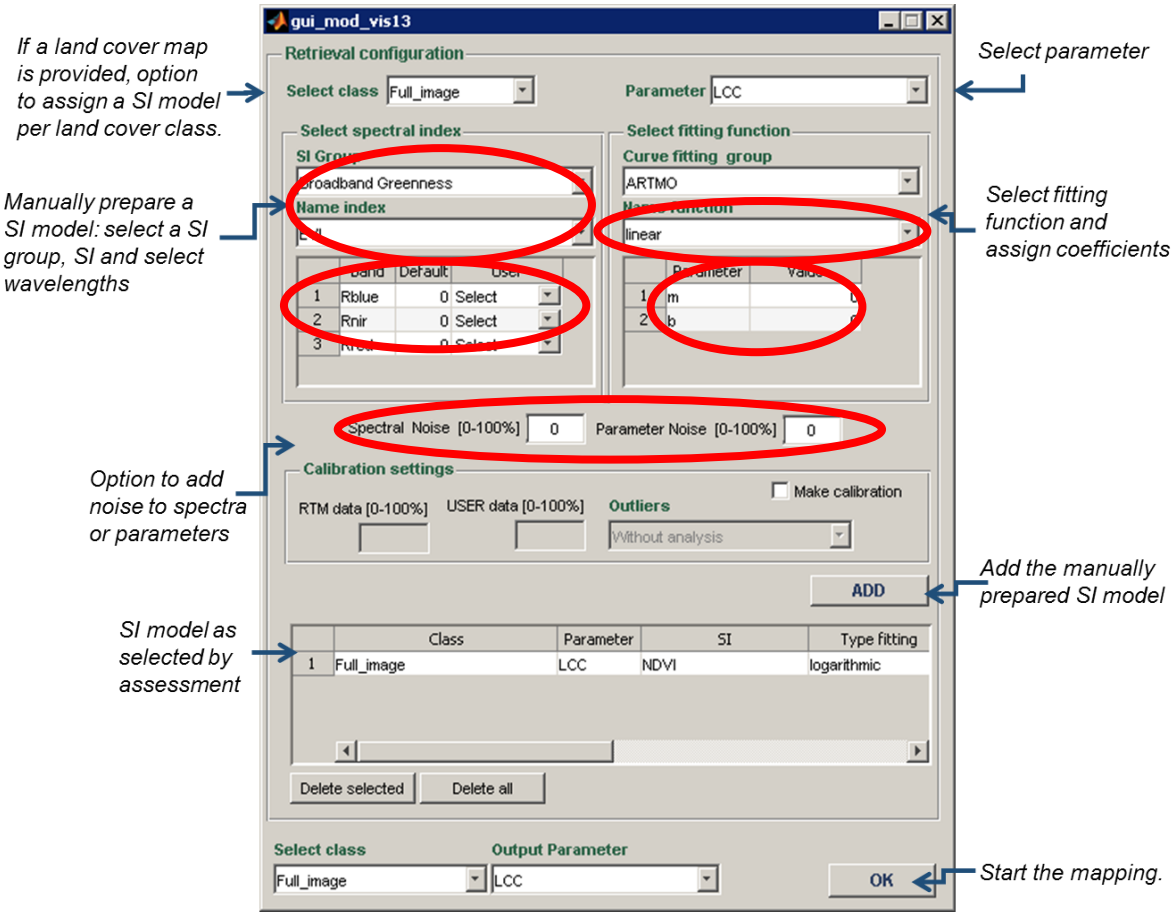
Correlation matrix



When clicking on **Options**, options are provided to control the the figure properties and export it.



Retrieval



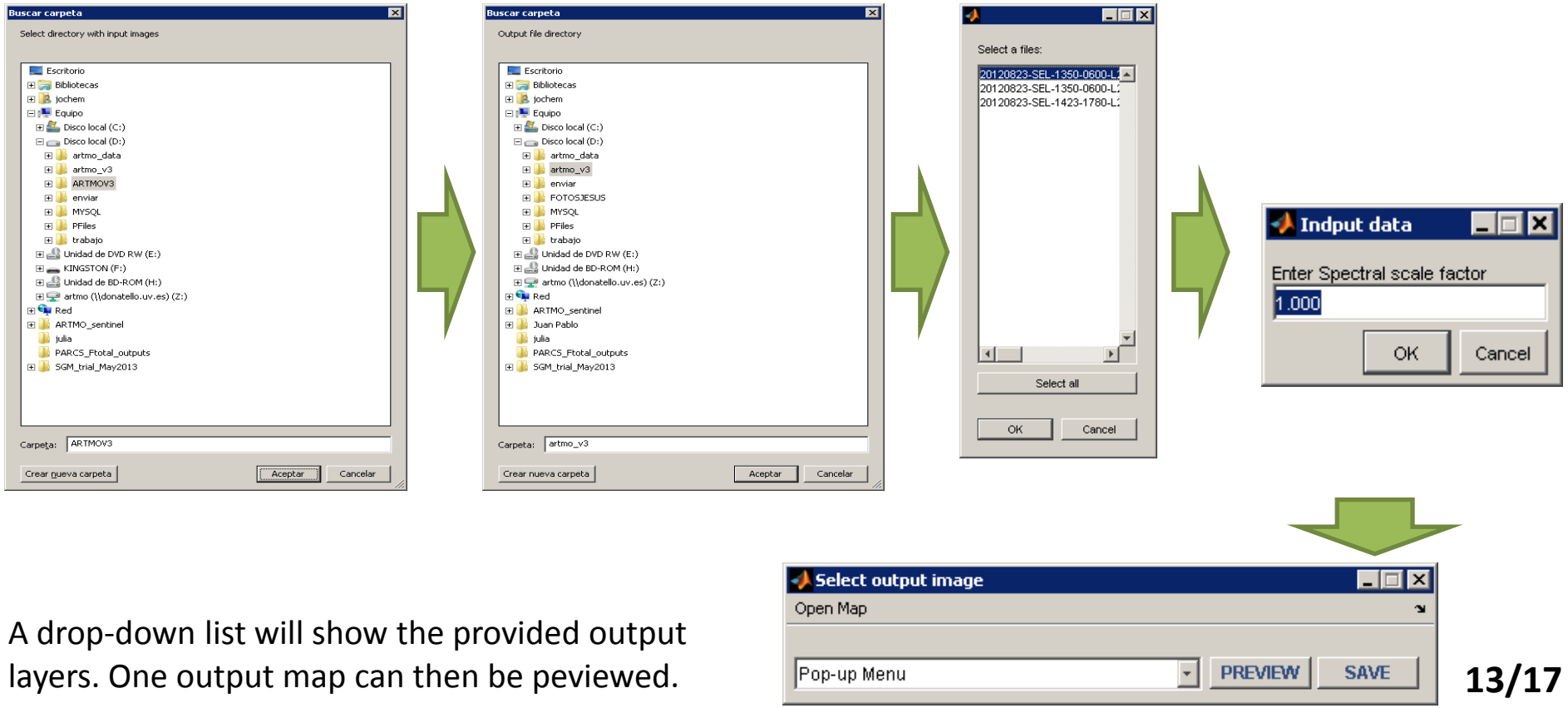
Instead of going through the validation procedure, **one can also choose to immediately apply a SI model (e.g from literature) to a remote sensing image**. User data has for training to be first inserted (see slides 4 & 5).

1. Select the **index formulation, spectral bands and fitting model**.
2. Optionally **noise** can be added.
3. Select the **training partitioning**. Here 100% training data can be applied. The configuration need to be **ADD**ed and chosen model will appear in the down panel. When clicking on **OK**, the mapping procedure will start (see next slide).

Retrieval

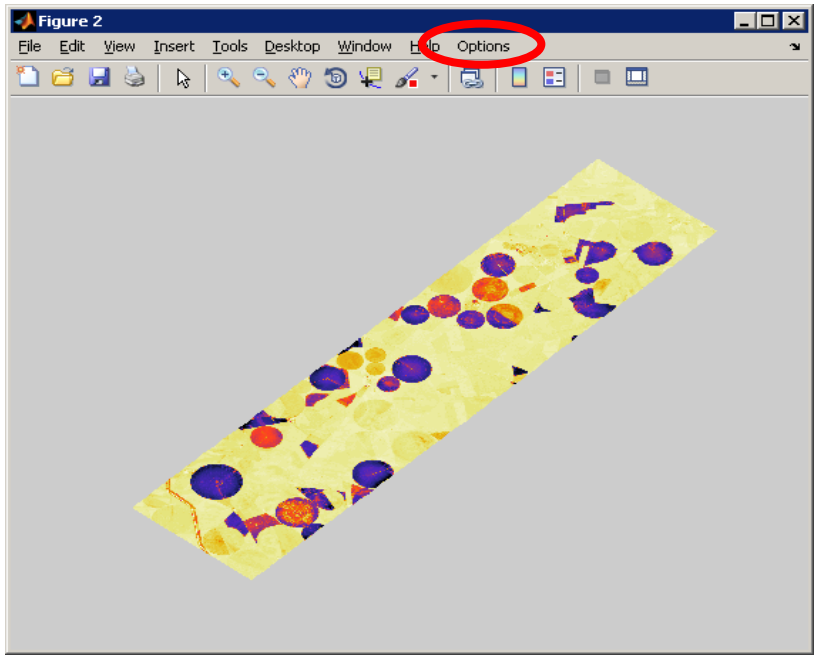
The mapping of selected biophysical parameter requires the following steps:

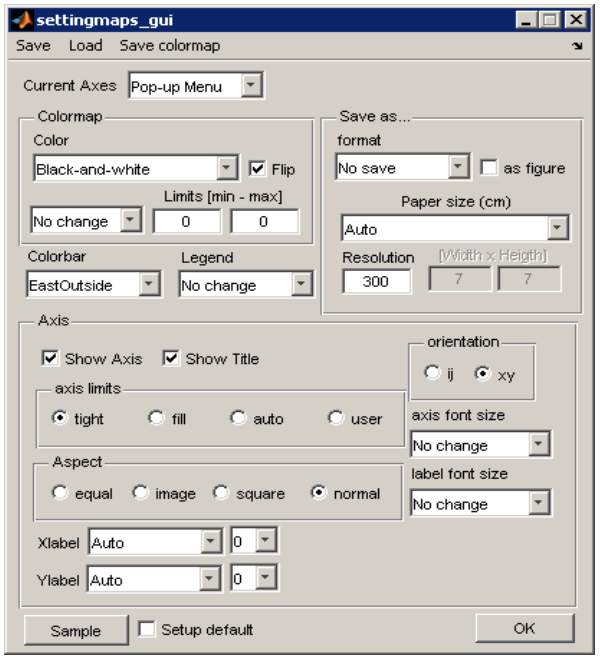
1. Select the **Output directory**
2. Select the directory with **Input images**
3. Images according to **ENVI file format** (including .hdr file) will be identified and listed. **Multiple images can be selected**. They will be processed one-after-another.
4. When the processing is done, the output maps can be viewed. Select one through **Open Map** and click on **PREVIEW**.



A drop-down list will show the provided output layers. One output map can then be peviewed.

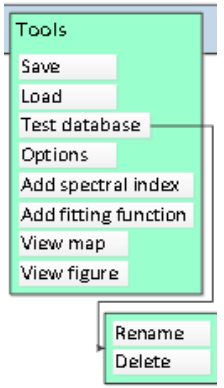
Final maps



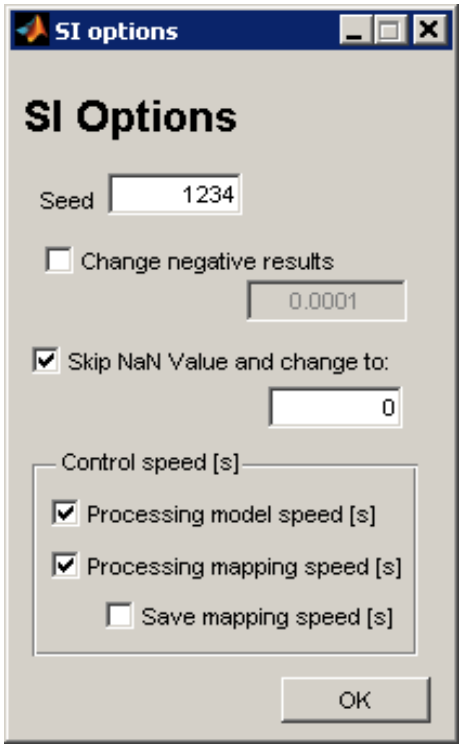


- Visualization of an output layer. In **Options**, map properties can be controlled (e.g. color scale, color table.
- Make sure to orient the map according to **ij** for **correct orientation**.
- The map can be **saved** according to various vector or bitmap formats. Redundant white space around the figure will be automatically removed.
- Settings can be set as **default** – will be automatically applied to subsequent maps.
- Click on **Sample** to visualize the map. Click on **OK** to save it away.

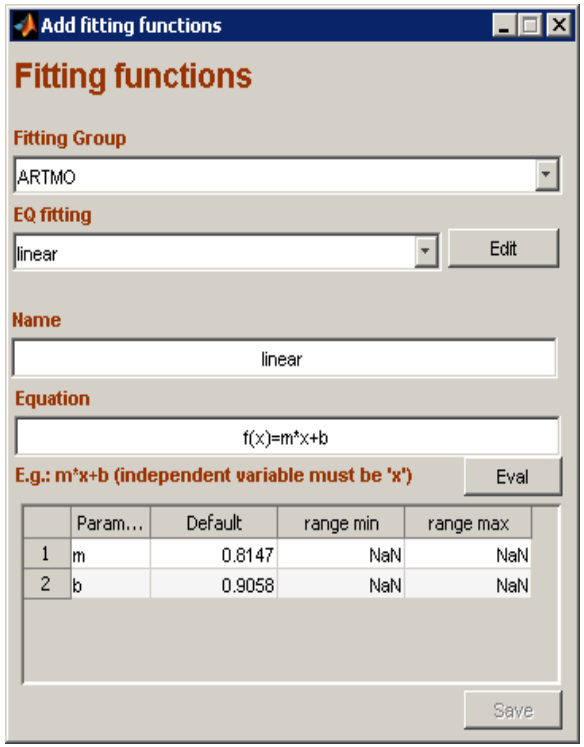
Tools



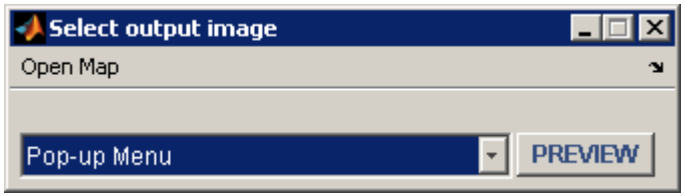
Options



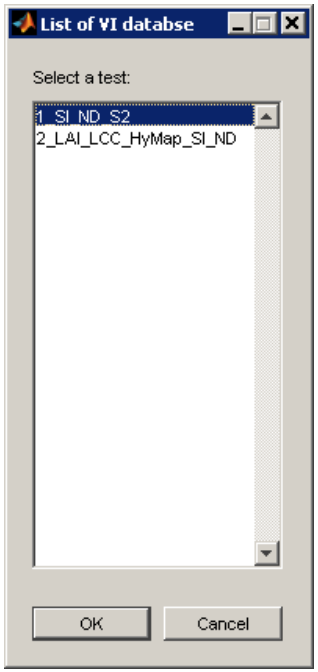
Add fitting function



View map



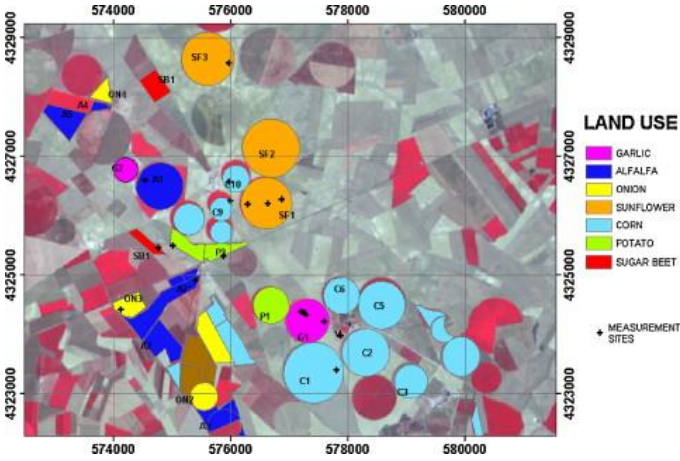
Rename/delete DB SI results



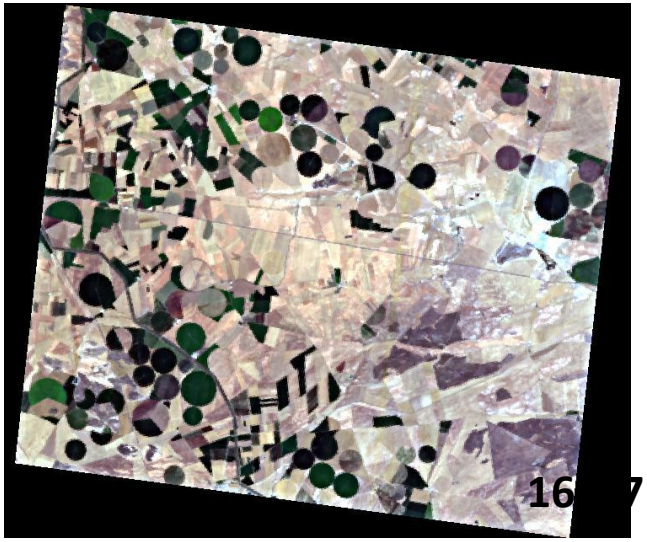
Field & RS data

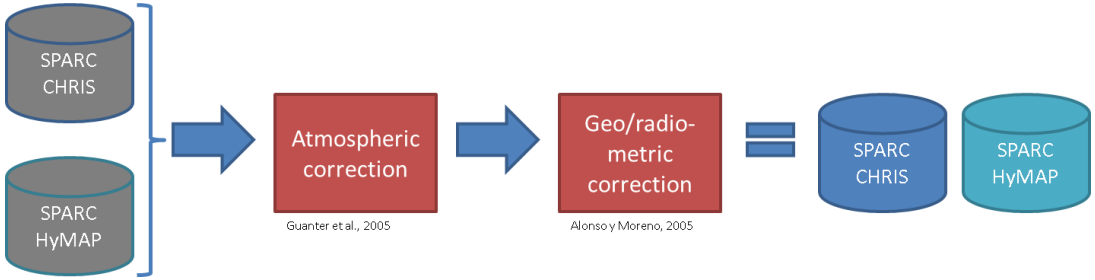
SPARC data set (July 2003; **Barrax**, Spain)

- **Field data** (135 points):
  - **Leaf Chl** measured with CCM-200
  - **LAI** measured with LiCor LAI-2000
  - **FVC** measured with hemispherical photographs
  - 30 additional **bare soil samples**



- **Spectral data**:
  - **CHRIS mode 1** (62 bands; 34m) nadir spectra (July 2003). Data has been resampled to Sentinel-2 (20 m: 8 bands)
  - **HyMAP** (125 bands; 5 m)





Excercise

- ✓ Evaluate the performance of SIs using a field dataset and remote sensing data.
- ✓ Apply the best performing SI model to a RS image.