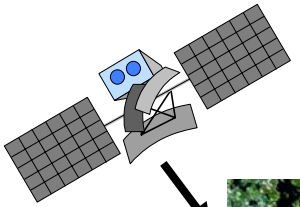
Model bank in forest parameter estimation

Heikki Astola

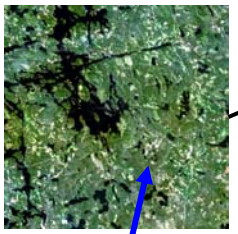
Model bank concept

- Model contents in general:
  - probability model: cluster means & covariances of K-means clustering and cluster data content
  - metadata of input image, ground data, model generation process
- The concept relies on absolute calibration of used images
  - Atmospheric correction of the images required (very demanding)
- The preliminary tests are promising, but input data further pre-processing may be needed (relative calibration of images wrt. each other)

Model bank concept



SATELLITE IMAGE FOR MODEL TRAINING



PRE-PROCESSING

SEGMENTATION

FEATURE IMAGE

K-MEANS CLUSTERING

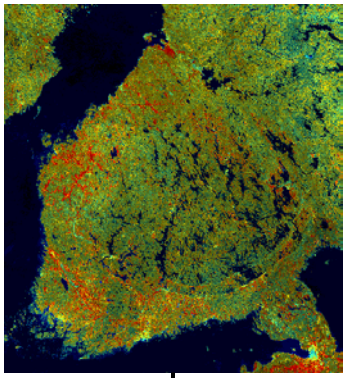
CLUSTER STATISTICS

GROUND DATA

ASSIGN CLUSTER DATA CONTENT

ESTIMATION MODEL

NEW SATELLITE IMAGERY



PRODUCE ESTIMATE

FOREST VARIABLE ESTIMATE

AUXILIARY DATA

NEW GROUND DATA

MODEL POST-PROCESSING

MODEL BANK

ESTIMATION MODELS

Model generation

- Using multiple images in model generation (multiple ground data sets?)
- Combining multiple models
- Assigning the data content of a new image clustering with an existing model
- Using ground data from a geographically separate area than model input image (‘ground data bank’)
- Using image from another instrument as reference data

Model modification

- Adding or removing ground data plots
- Removal of cluster outliers
- Removal of plots too close to border of very different landscapes (e.g. clear cut and old forest)
- Re-location of ground data plot spatially (produce minimum variance in cluster statistics)
- Requires an interactive tool

Model usage

- Select the model closest to the input image using
  - – geographical location or distance
  - – difference of absolute or seasonal dates
  - – similarity of image data distributions

    of model and input image acquisition as the selection criteria

- Using model for image data from another instrument (e.g. Landsat ETM+ $\rightarrow$ Modis)

Model bank development status

- Model bank preliminary definition completed
- Model bank utility software prototype for testing model bank concept
  - ready to be used in model bank development and testing
  - MatLab (simple GUI) routines calling C executables
  - simplifies data management and helps to obtain requirements for EOFrame in Forestry application
- GIS software (ArcView trial version) used for ground exploration

Future tasks/Phase 1

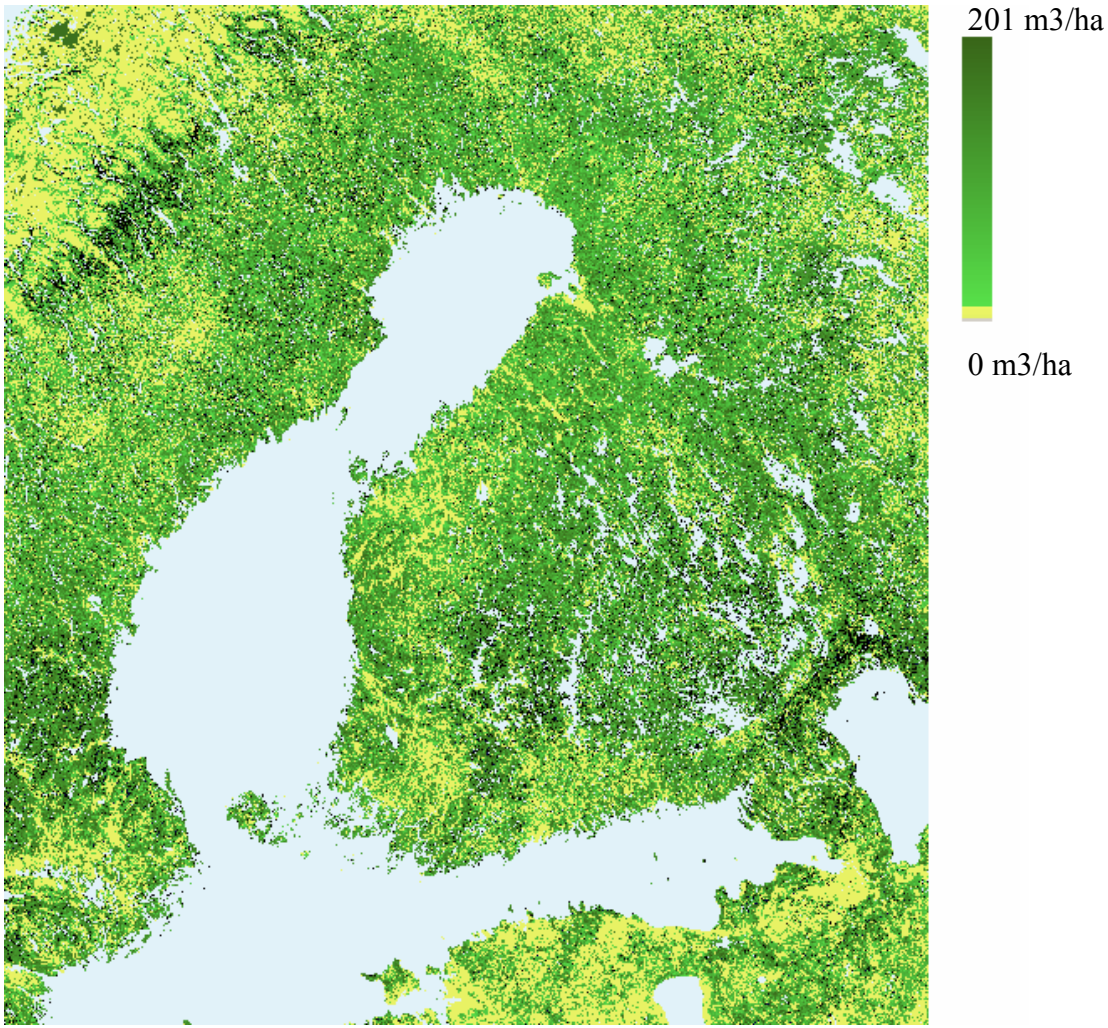
- model generation coding into model bank utility software prototype tool
- model bank test definition
  - model generation and bank usage
  - ground data handling and post-processing
- model bank testing and reporting
- documentation

- software requirements for EOFRAME
  - model bank definition
  - bank usage and post-processing definition
  - interactive model bank processing tool preliminary definition
  - ground data exploration tool (GIS SW) preliminary definition

Example of model bank usage

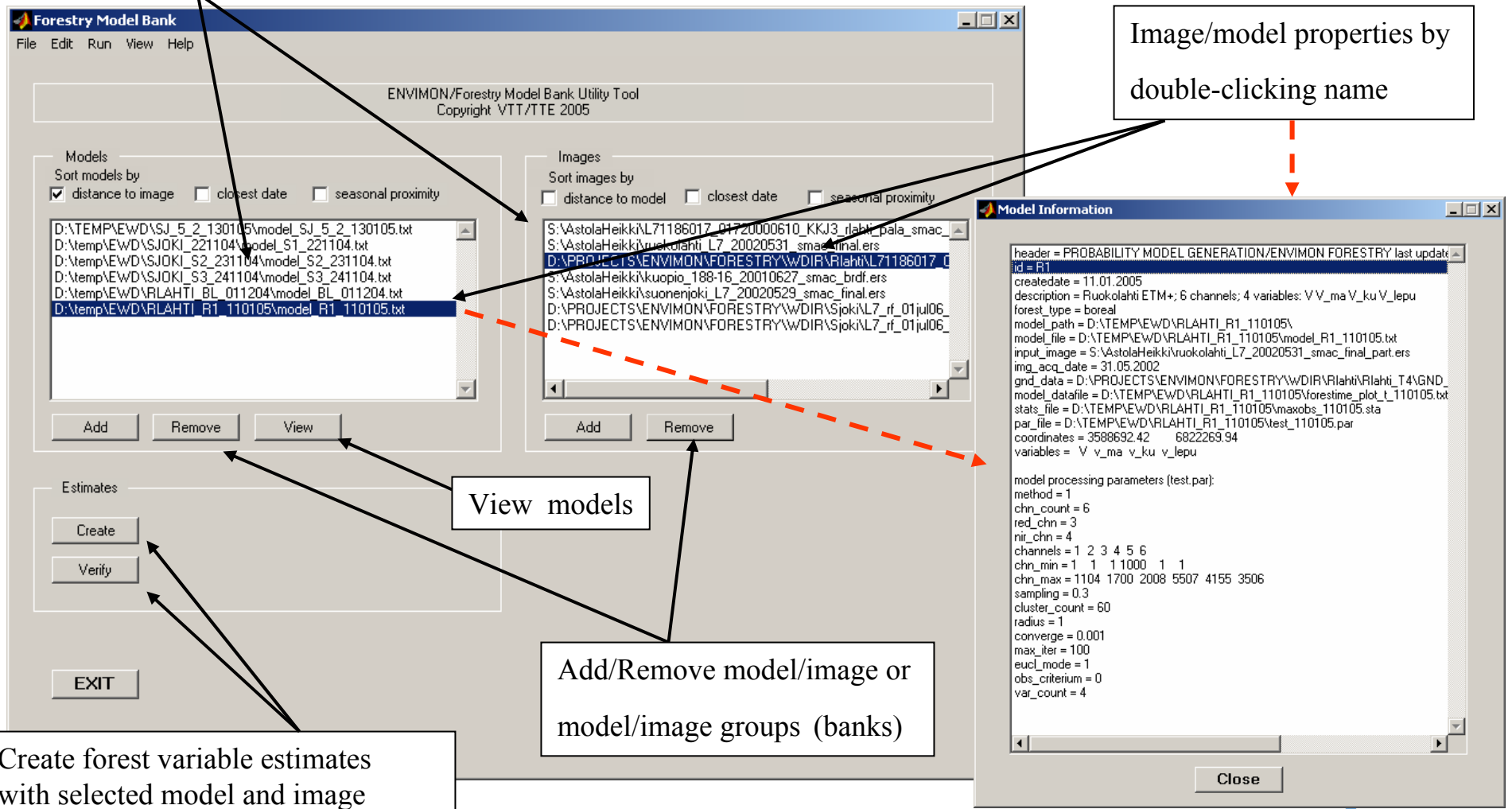
- Model generated using Landsat ETM+ image from Suonenjoki area 27.6.2001

- model applied to an extract of Modis image mosaic (2001 -2002) to produce total stem volume estimate
  - model 6 channels from which 2 used (red & nir)
  - image 2 channels (red & nir)



Software prototype / Model bank utility tool

Selection of models/ images from list



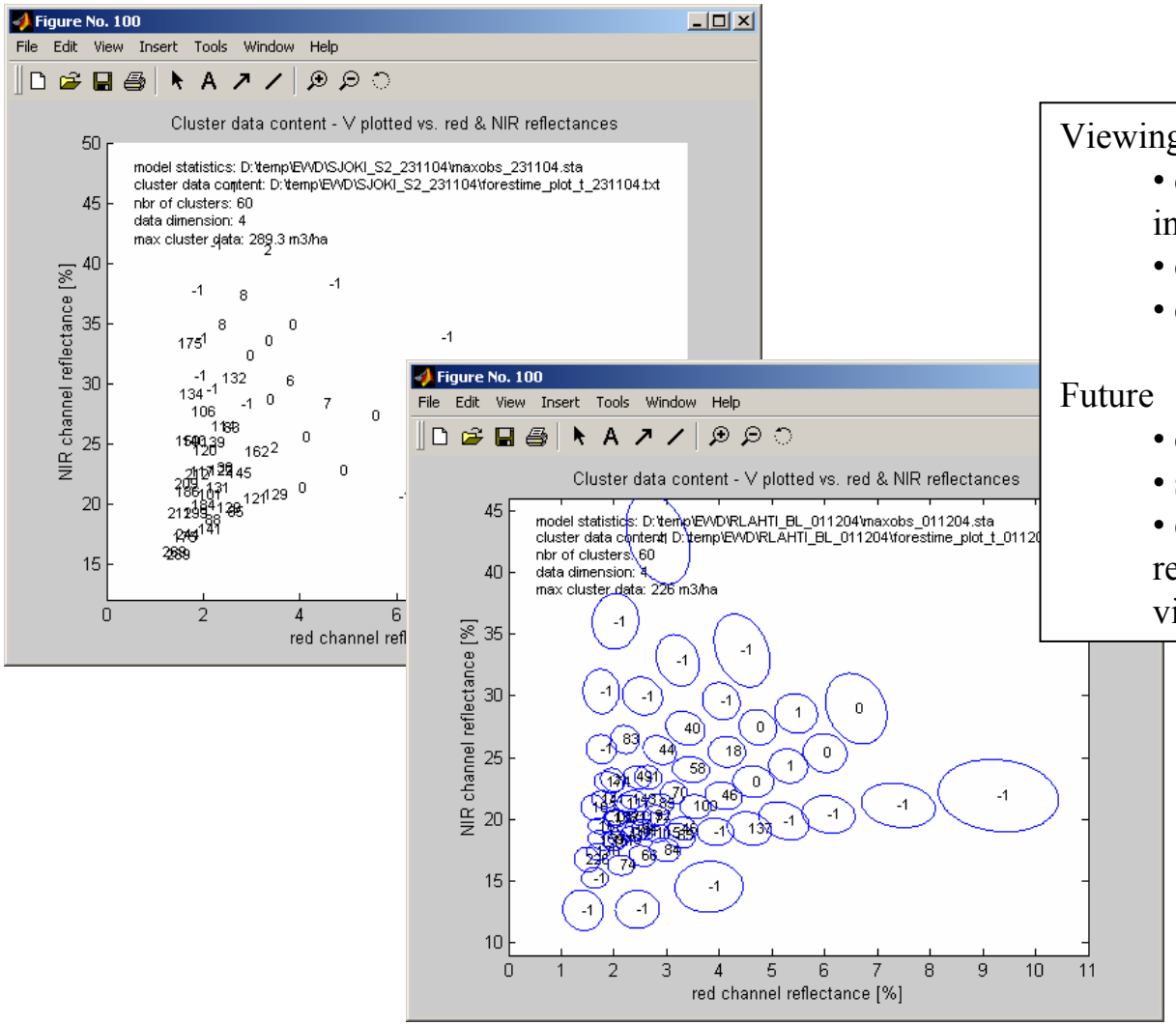
Image/model properties by double-clicking name

View models

Add/Remove model/image or model/image groups (banks)

Create forest variable estimates with selected model and image + verify estimate against ground data

Software prototype / Viewing Models



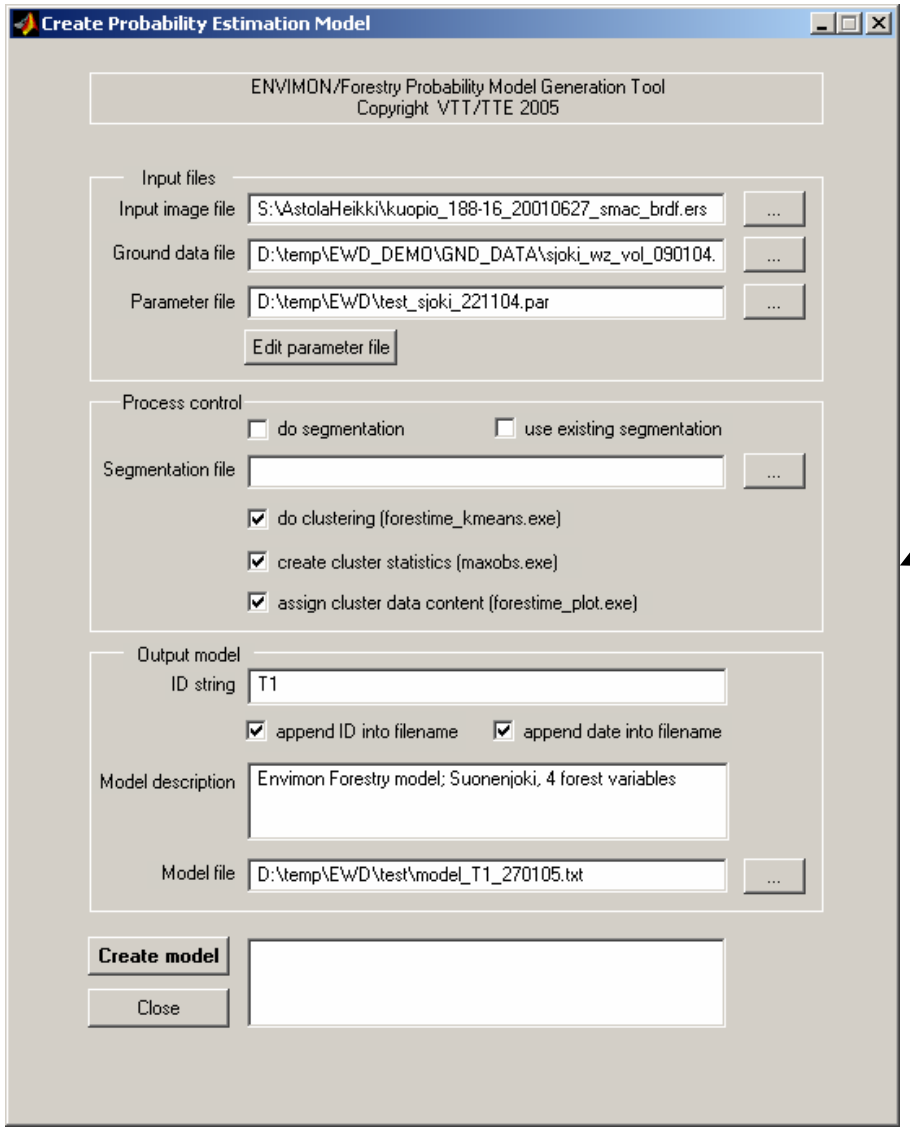
Viewing models

- data cluster positions against two selected input image bands
- clusters' data content
- cluster' sampling percentage

Future

- cluster statistics
- spectral bank
- editing models (select model clusters, remove cluster ground data vectors, viewing ground data vectors on map)

Software prototype / Model Generation Tool



Models generated using Model Generation Tool

User selects

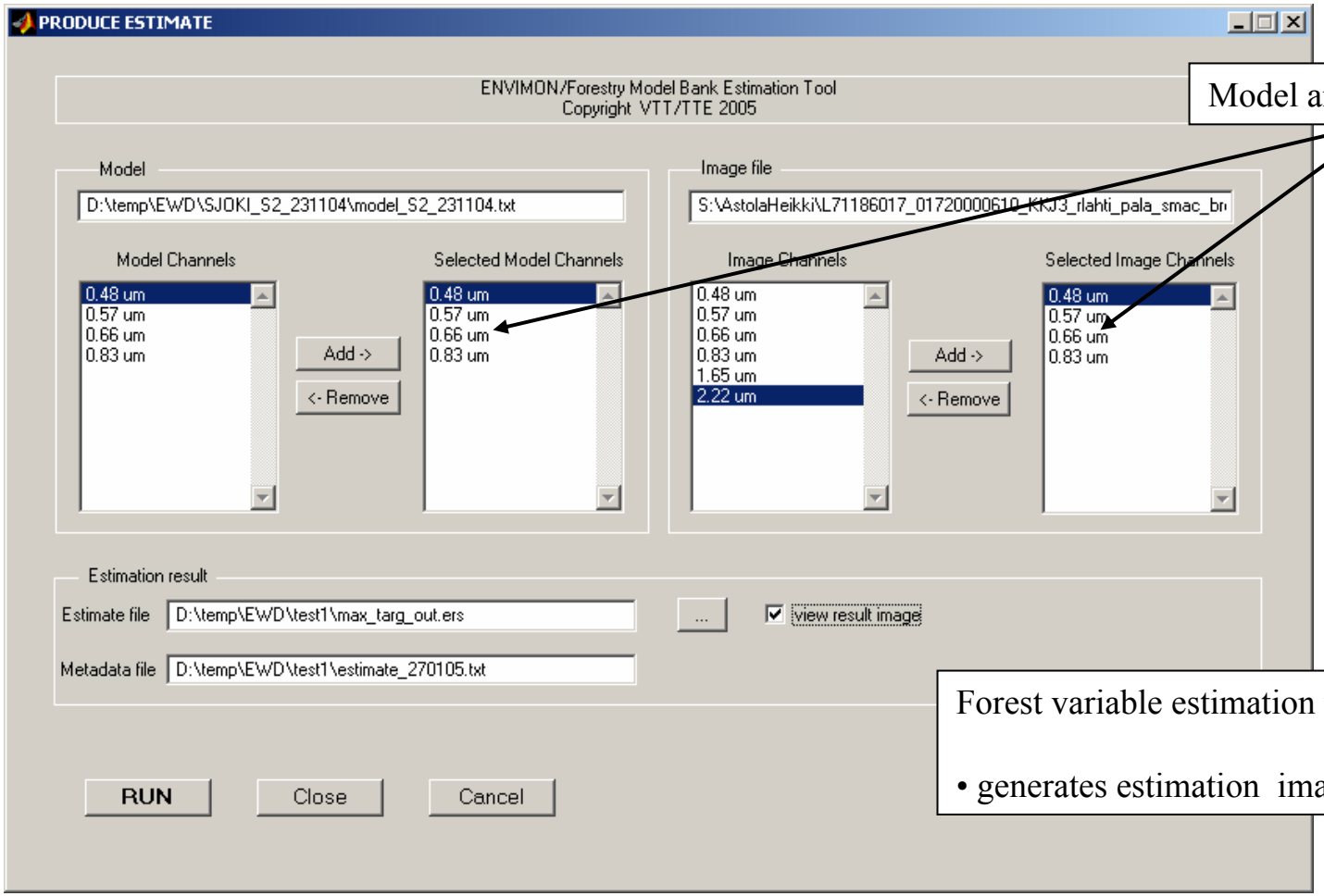
- input image file
- ground data set
- process parameter file

Process

- segmentation (optional)
- clustering
- calculating cluster statistics
- assigning cluster data content

Generates model data and metadata files for later usage

Software prototype / Estimation Tool



Model and image channels selectable

Forest variable estimation using Estimation Tool

- generates estimation image and metadata files