**Tutorial of the 3DCanopyModel**

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Step 1. Using MVS64 system to collect images. Point cloud calculations with 3D reconstruction software Agisoft Metashape. Point cloud denoising, clustering, and segmentation to separate leaves and stem. All leaves were numbered by 1, 2, 3 and etc. Those leaves lower than the center of the plant were lower layer leaves and were labeled with 1; those leaves upper than the center of the plant were up layer leaves and were labeled with 2. Then, the maize single plant point cloud was reconstructed.

Step 2. Build vector model and mesh model of single plant from the single plant point cloud data. Using leafVectorModel\_run Matlab script. Those vector model and mesh model will be used for building virtual canopies and for adjusting plant architecture parameters. The output files are in .\CM-singlePlant, eg. CM\_A619\_31\_1\_vector.txt and CM\_A619\_31\_1\_mesh.txt.

Step 3. Extract plant traits from the vector model with extractTraitFromVectorModel\_run.m Matlab script. The traits data were used to calculate the adjusting rates for each parameter between the two maize cultivars. The output files are plantTraits\_output\_all.csv, plantTraits\_output\_CultivarAvg.csv, and plantTraits\_output\_LayerAvg.csv.

Step 4. Sensitivity analysis and canopy photosynthesis dissection analysis. The analysis were carried out with the following Matlab scripts.

Sensitivity analysis of leaf chlorophyll content (SPAD):

script1\_sensitivitySPAD.m and script2\_Ac\_summarySPADsensitivity.m

Sensitivity analysis of plant structural traits:

script2\_Ac\_sensitivity.m.

Sensitivity analysis of Pmax, Phi, Theta and Rd: script2\_Ac2\_sensitivity\_PmaxPhiThetaRd.m.

Dissection of chlorophyll content (SPAD) and structural traits: script1\_substituteChlandStructuralTraits\_1.m.

script2\_Ac\_subChlStracturalTraits.m.

Dissection of chlorophyll content (SPAD) and leaf AQ curves:

script2\_Ac\_ECEP.m.

Dissection of individual AQ curve parameters:

script2\_Ac2\_PmaxPhiThetaRd.m.

Others functions:

Fitting AQ curves:

fittingAQs.m, a matlab function for fitting AQ curves based on the data in .\AQcurves, the output file is AQ\_fit\_param\_W64A\_A619.xlsx.