

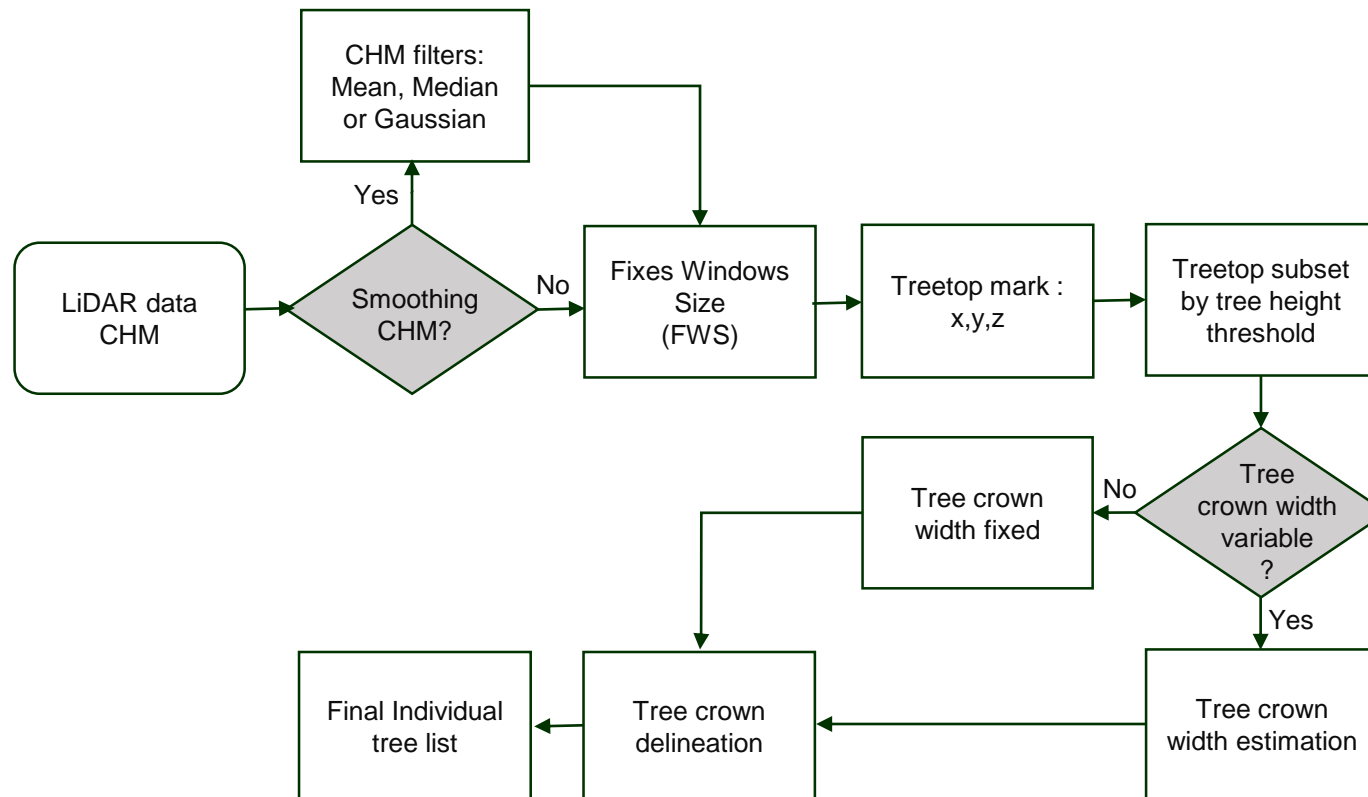


Tutorial “ Web-LiDAR forest inventory: TreeTop application”



USDA - Rocky Mountain Research Station - RMRS
SILVA, C.A.; HUDAK, A. T.; CROOKSTON, N. L. (2014)

1. How does the algorithm works?



Flow chart of the method for individual tree detection on the LiDAR CHM

2. Input LiDAR data – CHM (.asc)

Input CHM file

☐ Custom data ☐ Example data

Choose File No file chosen

File size limitation for upload is 30 MB

3. Height Threshold (m) parameter

The screenshot displays the UAS application interface. The top navigation bar includes 'Welcome', 'Application', 'About', and 'N° of Visits: 13'. The left sidebar contains a 'SETTINGS MENU' with options for 'Input CHM file' (Custom data, Example data, Choose File, Upload complete), 'Tree Height Threshold' (Slide bar, Numeric input), 'FWS', 'CHM color' (3x3, Greys), 'Tree Crown Width (TCW) Estimation' (Fixed Width, Variable Width), and 'Smoothing CHM' (Plot 3D CHM, Plot 3d trees). The main content area is divided into three panels: 'Summary of LIDAR metrics', 'Individual Trees Detected on the Canopy Height Model', and 'Canopy Height Model and 3D trees'. A red box highlights the 'Tree Height Threshold' section in the settings menu, and a red line connects it to a detailed view of the parameter. This detailed view shows a slider bar with a blue triangle marker at 1.37, ranging from 1.37 to 13.89. The 'Slide bar' radio button is selected, and the 'Numeric input' radio button is unselected. Below the slider, there are buttons for 'Download LIDAR metrics' and 'Download CHM Profile'. The text 'Default = 1.37 m' is displayed to the right of the slider.

Tree Height Threshold

☒ Slide bar ☐ Numeric input

1.37 13.89

Download LIDAR metrics Download CHM Profile

Default = 1.37 m

4. Fixed Windows Size (FWS) and CHM color

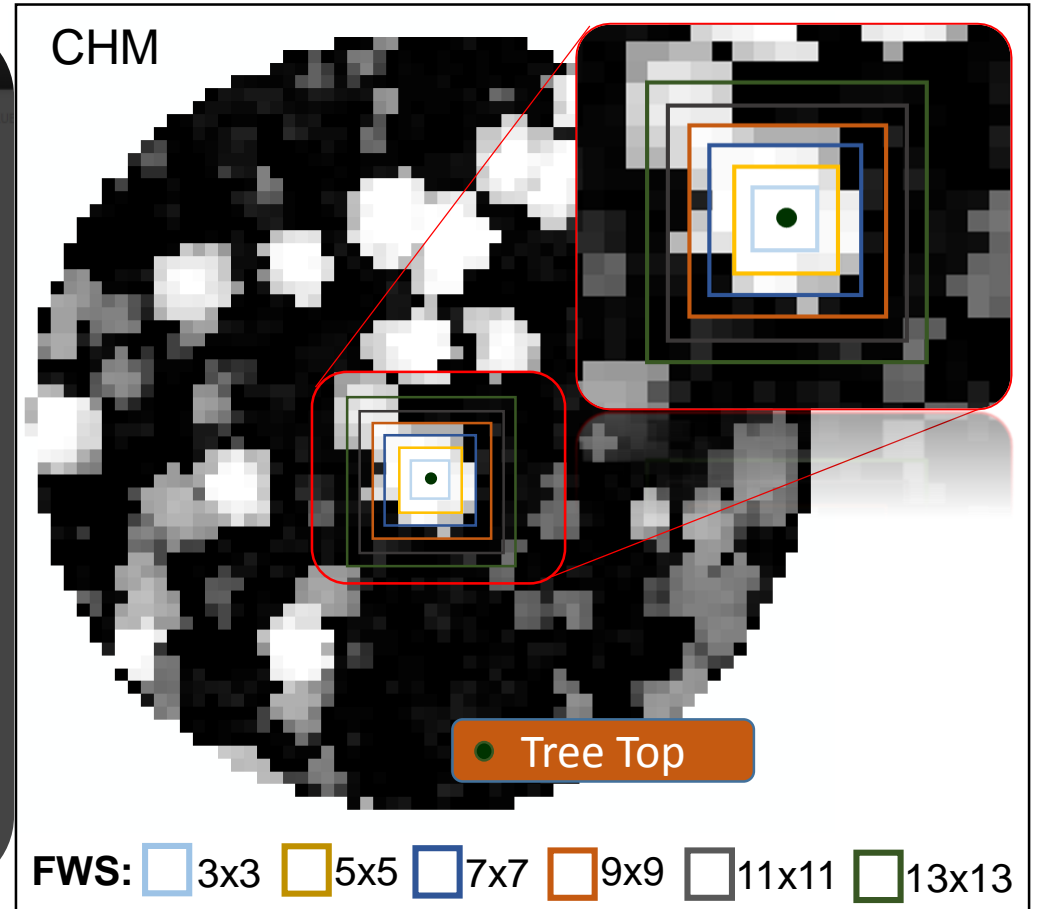
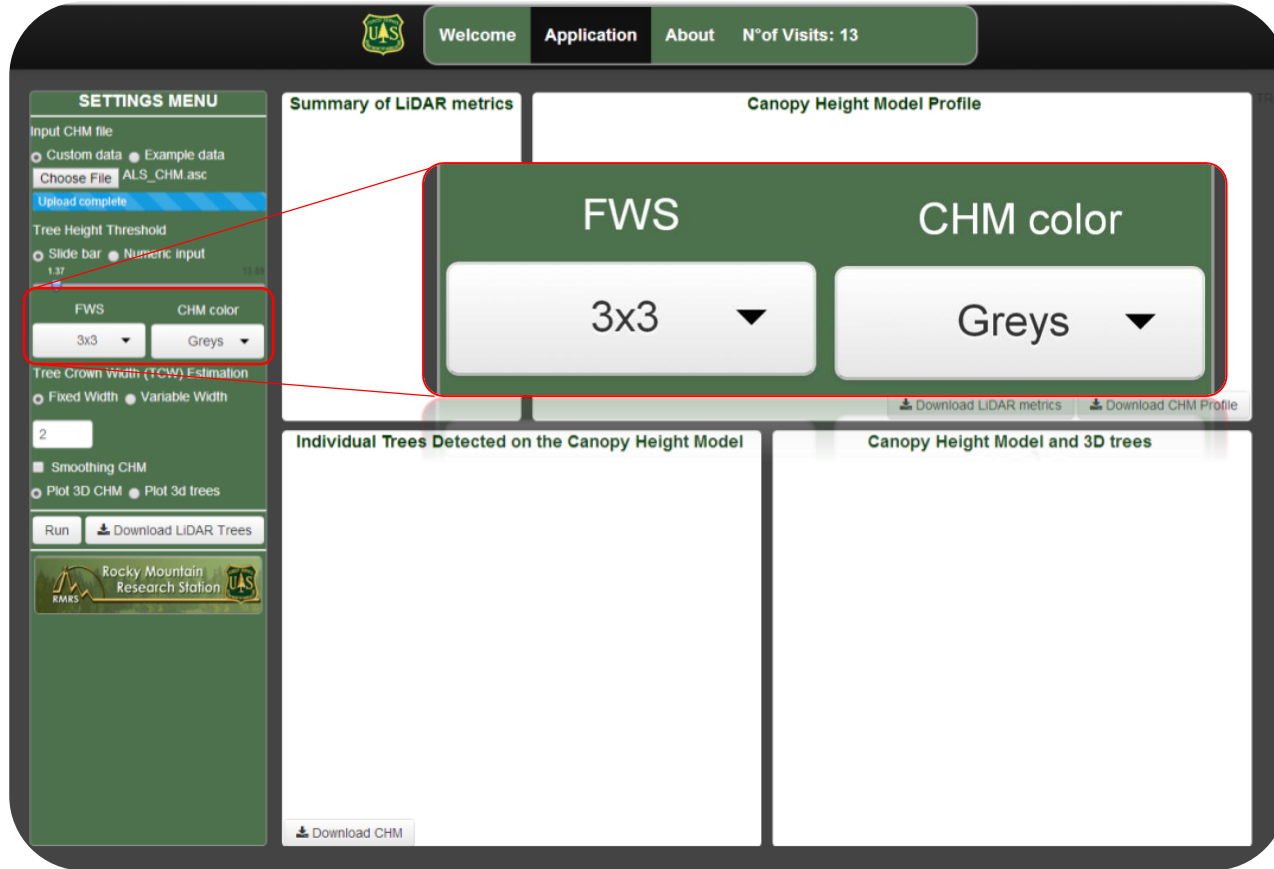


Illustration of the FWS in the CHM.

5. Tree crown width (m)

UAS

Welcome

Application

About

N° of Visits: 13

SETTINGS MENU

Input CHM file

☐ Custom data

☒ Example data

Choose File ALS_CHM.asc

Upload complete

Tree Height Threshold

☒ Slide bar

☐ Numeric input

1.37

15.03

FWS

CHM color

See

Gray

Tree Crown Width (TCW) Estimation

☒ Fixed Width

☐ Variable Width

Equation: TCW = f(ht); ht= Height (m)

☒ Deciduous

☐ Pines

☐ Combined

☐ Use custom polynomial

Inter

ht

ht^2

ht^3

☒ Smoothing CHM

☐ Plot 3D CHM

☒ Plot 3d trees

Run

Download LIDAR Trees

Rocky Mountain Research Station

UAS

Summary of LIDAR metrics

Canopy Height Model Profile

Tree Crown Width (TCW) Estimation

☐ Fixed Width

☐ Variable Width

Equation: TCW = f(ht); ht= Height (m)

☐ Deciduous

☐ Pines

☐ Combined

☒ Use custom polynomial

Inter

ht

ht^2

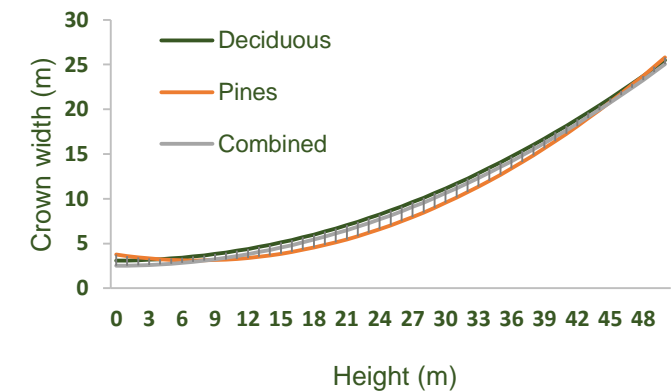
ht^3

Individual Trees Detected

Download CHM

The deciduous, pines and combined equations are from Popescu and Wynne (2004).

Popescu, S.C. and R.H. Wynne, 2004. Seeing the trees in the forest: using lidar and multispectral data fusion with local filtering and variable window size for estimating tree height. Photogrammetric Engineering & Remote Sensing 70(5): 589-604.



6. Smoothing CHM

The screenshot shows the Rocky Mountain Research Station (RMRS) web application interface. The top navigation bar includes 'Welcome', 'Application', 'About', and 'N° of Visits: 13'. The main content area is divided into three sections: 'Summary of LIDAR metrics', 'Canopy Height Model Profile', and 'Individual Trees Detected on the Canopy Height Model'. A 'SETTINGS MENU' is located on the left side, containing options for inputting a CHM file, setting a tree height threshold, and selecting smoothing options. The 'Smoothing CHM' section is highlighted with a red box and expanded to show the following options:

- ☒ Smoothing CHM
- ☐ Mean
- ☐ Median
- ☐ Gaussian
- ☐ Plot 3D CHM
- ☐ Plot 3d trees

The 'Filter Windows Size' dropdown is set to 3x3. A red line connects the 'Gaussian' option to a text box at the bottom right stating: 'Filter Windows Size for the Gaussian filter is fixed in 3x3'.

7. Plot 3D CHM or Trees

UAS Welcome Application About N° of Visits: 13

SETTINGS MENU

Input CHM file

☐ Custom data ☐ Example data

Choose File ALS_CHM.asc

Upload complete

Tree Height Threshold

☐ Slide bar ☐ Numeric input

1.37 13.03

FWS CHM color

3x3 Greys

Tree Crown Width (TCW) Estimation

☐ Fixed Width ☐ Variable Width

Equation: $TCW = f(ht)$, ht = Height (m)

☐ Deciduous ☐ Pines ☐ Combined

☐ Use custom polynomial

Inter ht*2 ht*3

Smoothing CHM

☐ Plot 3D CHM ☐ Plot 3d trees

Run Download LIDAR Trees

Rocky Mountain Research Station UAS RMRS

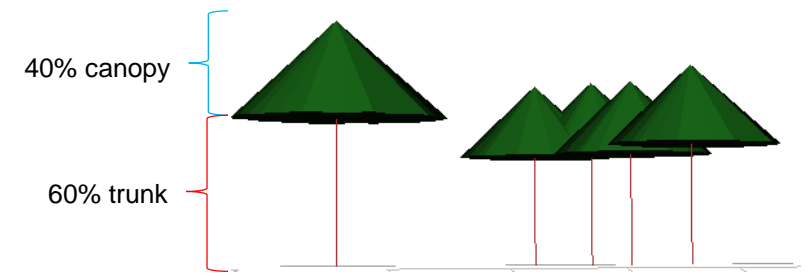
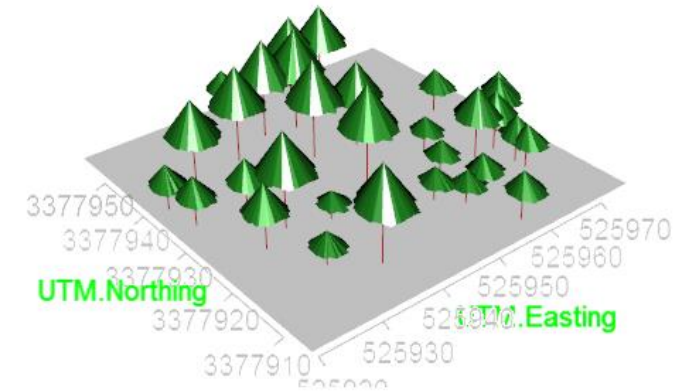
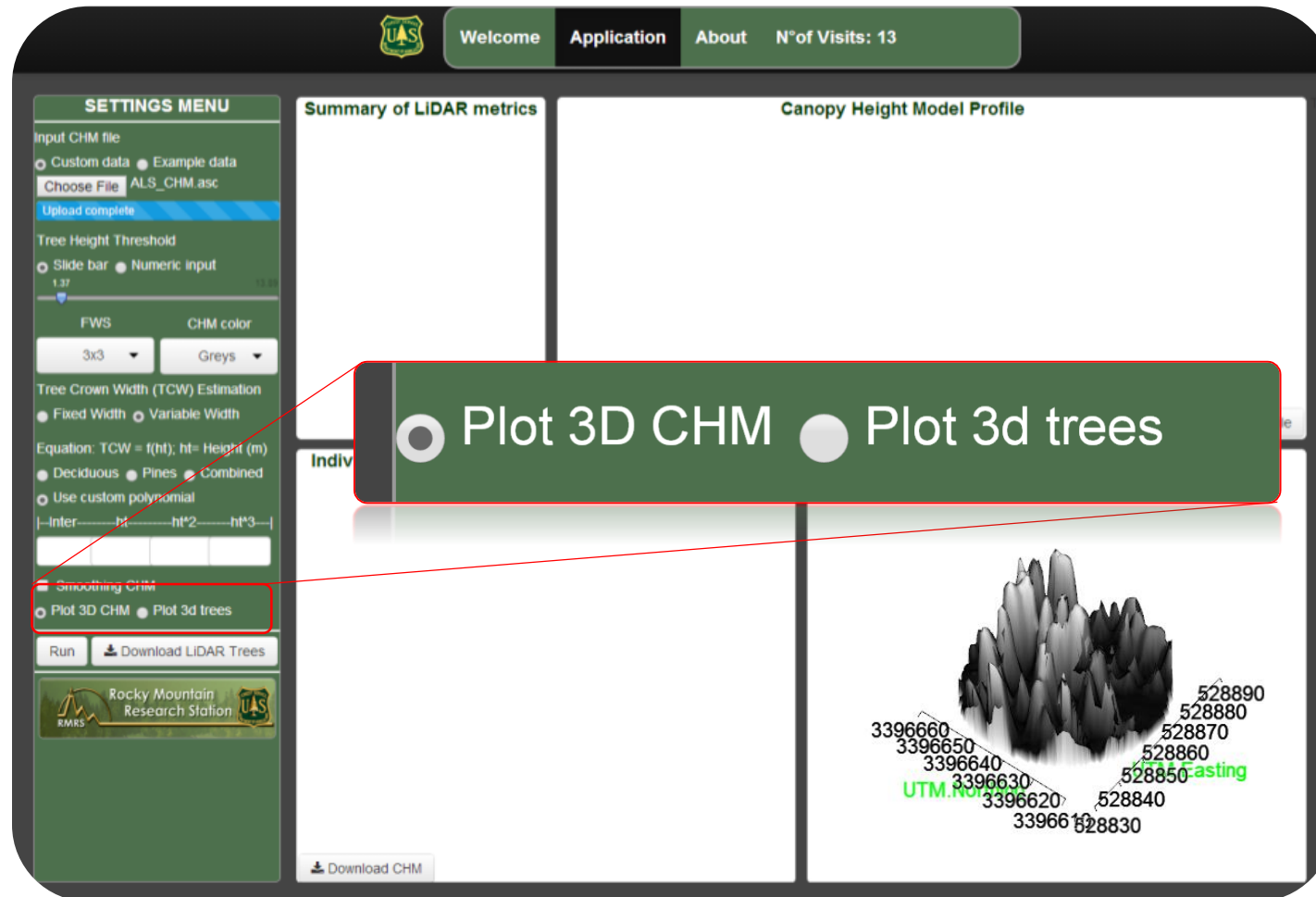
Summary of LIDAR metrics

Canopy Height Model Profile

Download CHM

Download LIDAR Trees

Plot 3D CHM Plot 3d trees

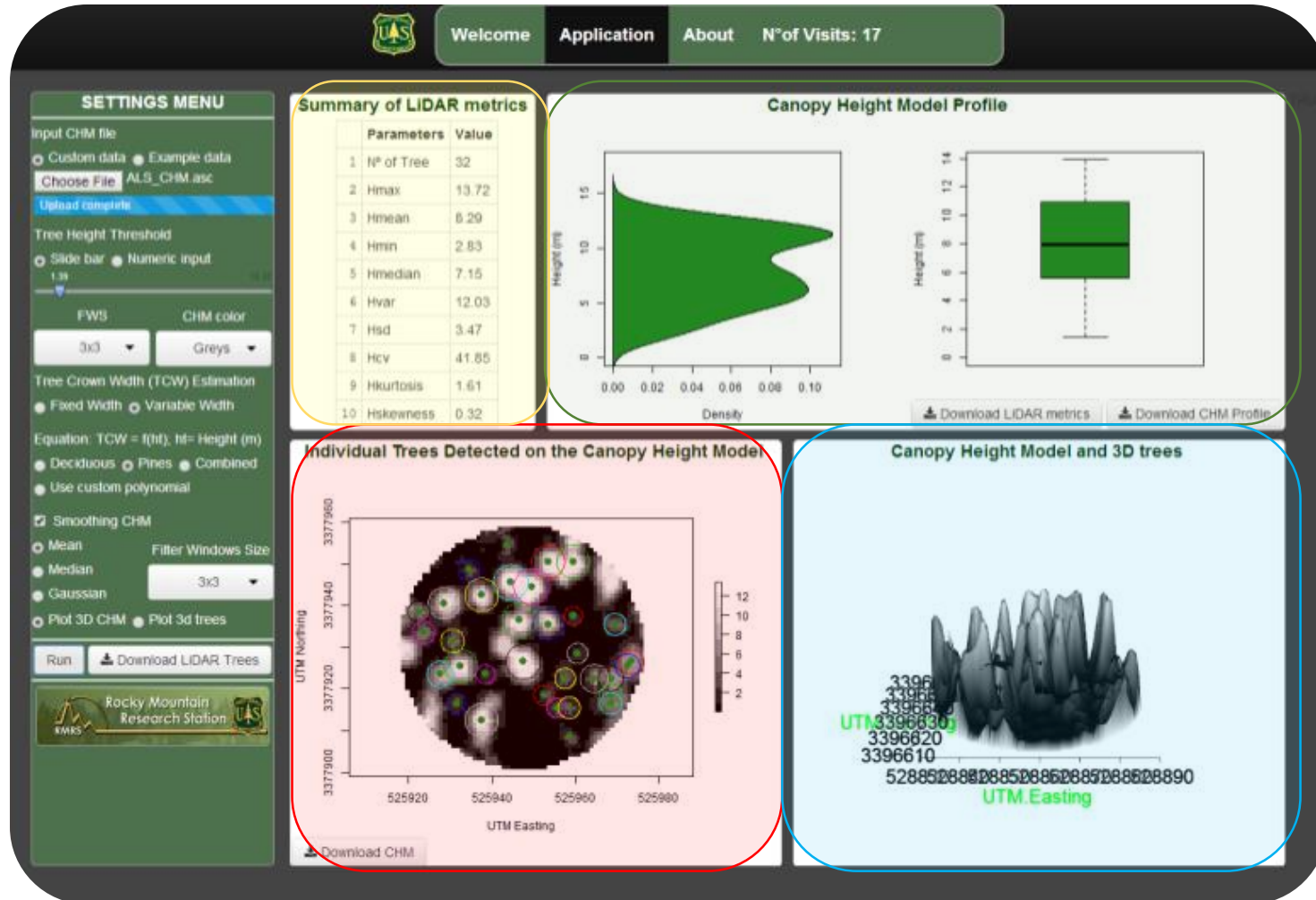


8. Start the LiDAR data processing

The screenshot shows a web application for LiDAR data processing. The interface is divided into several sections:

- Header:** Includes a logo, navigation tabs (Welcome, Application, About), and a visitor count (N° of Visits: 13).
- SETTINGS MENU:** A sidebar on the left containing various configuration options:
 - Input CHM file:** Radio buttons for 'Custom data' and 'Example data'. A 'Choose File' button is next to 'ALS_CHM.asc'. An 'Upload complete' status bar is shown.
 - Tree Height Threshold:** Radio buttons for 'Slide bar' and 'Numeric input'. A slider is set to 1.37.
 - FWS:** A dropdown menu set to '3x3'.
 - CHM color:** A dropdown menu set to 'Greys'.
 - Tree Crown Width (TCW) Estimation:** Radio buttons for 'Fixed Width' and 'Variable Width'. Below is an equation: $TCW = f(ht)$, $ht = \text{Height (m)}$. Options include 'Deciduous', 'Pines', 'Combined', and 'Use custom polynomial'. A polynomial input field shows ht^2 .
 - Smoothing CHM:** A checkbox.
 - Plot 3D CHM:** Radio buttons for 'Plot 3D CHM' and 'Plot 3d trees'.
 - Buttons:** A 'Run' button (highlighted with a red box) and a 'Download LIDAR Trees' button.
- Summary of LiDAR metrics:** A large empty box for displaying metrics.
- Canopy Height Model Profile:** A large empty box for displaying the profile.
- Individual Trees Detected on the Canopy Height Model:** A section for displaying detected trees, containing a 'Run' button (highlighted with a red box).
- Processing Status:** A grey box with the text 'LiDAR data processing' and 'This may take a while...' above a blue progress bar.
- Footer:** Includes a 'Download CHM' button and a logo for 'Rocky Mountain Research Station'.

9. LiDAR data viewer



Summary of the LiDAR Metrics



Profile viewer of the LiDAR data

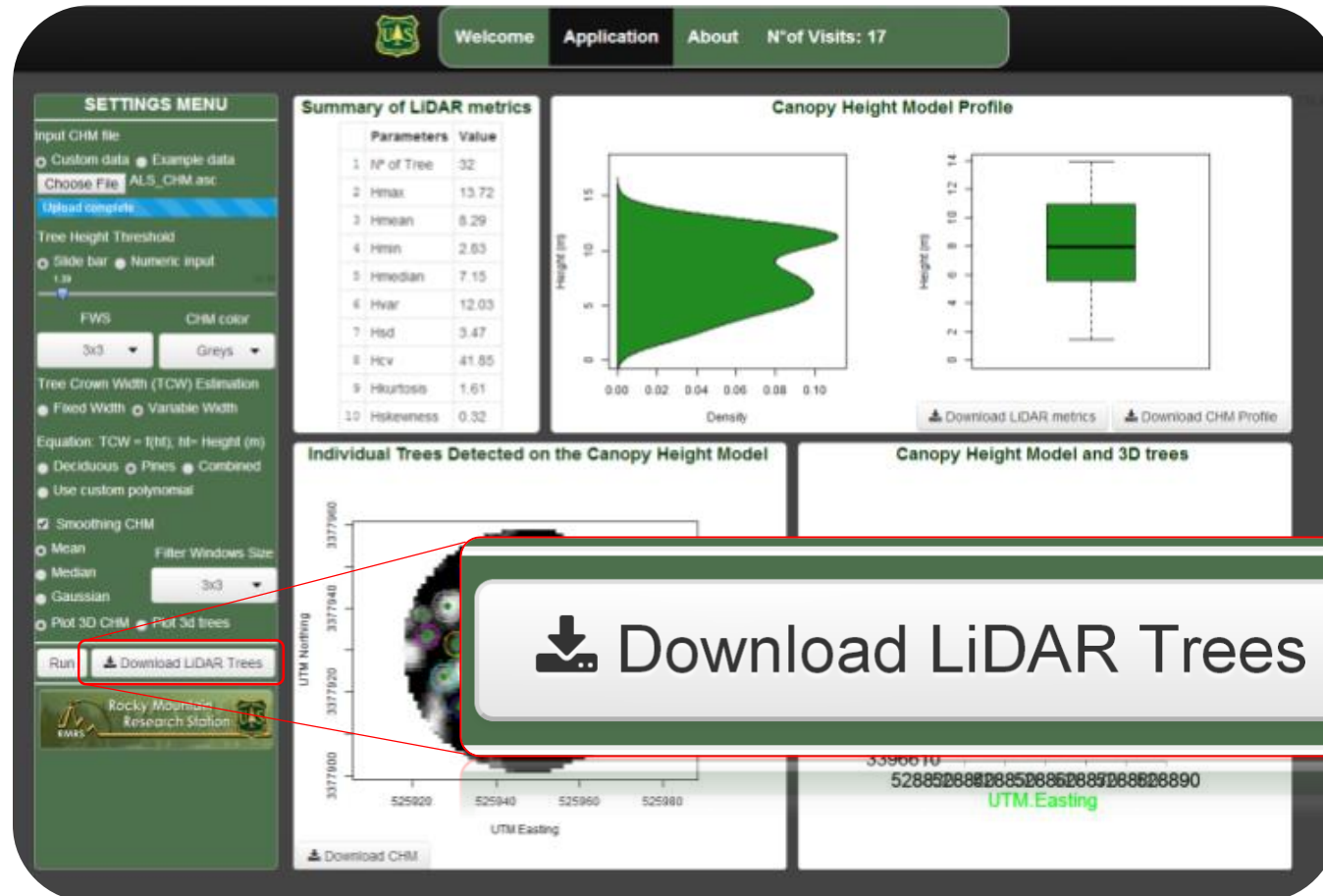


2D CHM and individual tree detected viewer



3D LiDAR viewer

10. Download of the LiDAR data processed



G6						
	A	B	C	D	E	F
1	Tree	x	y	Height	Crown Width	
2	1	525944	3377955	6.23	5.34907	
3	2	525954	3377951	12.42	7.89091	
4	3	525960	3377951	12.59	7.97414	
5	4	525935	3377949	5.9	5.24026	
6	5	525945	3377946	13.31	8.33458	
7	6	525950	3377945	13.72	8.54558	
8	7	525938	3377943	12.76	8.05808	
9	8	525929	3377941	11.69	7.54168	
10	9	525923	3377939	6.01	5.27623	
11	10	525960	3377938	2.83	4.35755	
12	11	525947	3377937	13.22	8.28882	
13	12	525954	3377936	11.52	7.46225	
14	13	525970	3377936	6.01	5.27623	
15	14	525924	3377934	6.5	5.44011	
16	15	525931	3377932	7.15	5.66669	
17	16	525961	3377929	4.76	4.88518	
18	17	525948	3377927	13.42	8.39078	
19	18	525974	3377927	7.76	5.88886	
20	19	525933	3377926	12.57	7.96431	
21	20	525973	3377926	7.73	5.87772	
22	21	525928	3377924	8.47	6.15909	



Acknowledgement:

Funding to support Carlos Silva's development of Web-LiDAR and its underlying functions was provided through a grant (RC-2243) from the Department of Defense Strategic Environmental Research and Development Program: Patterns and processes: monitoring and understanding plant diversity in frequently burned longleaf pine landscapes. J. O'Brien, PI; R. Mitchell, A. Hudak, L. Dyer, Co-PIs.

The LiDAR data provided as an example dataset is from a longleaf pine forest at Eglin AFB. It's collection was funded by a grant (11-2-1-11) from the Joint Fire Science Program: Data set for fuels, fire behavior, smoke, and fire effects model development and evaluation—the RxCADRE project. R. Ottmar, PI; multiple Co-Is.

Objective:

Web-LiDAR was developed to support lidar-based forest inventory and management at Eglin Air Force Base (AFB), Florida, USA. However, it has general applicability to other forests in other ecosystems, and we encourage users to test it broadly.

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