OzFlux 2016 - Hobart

"Using Lidar and hyper-spectral data to investigate vegetation for the flux footprints at OzFlux towers"

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- Results
  - Great Western Woodlands
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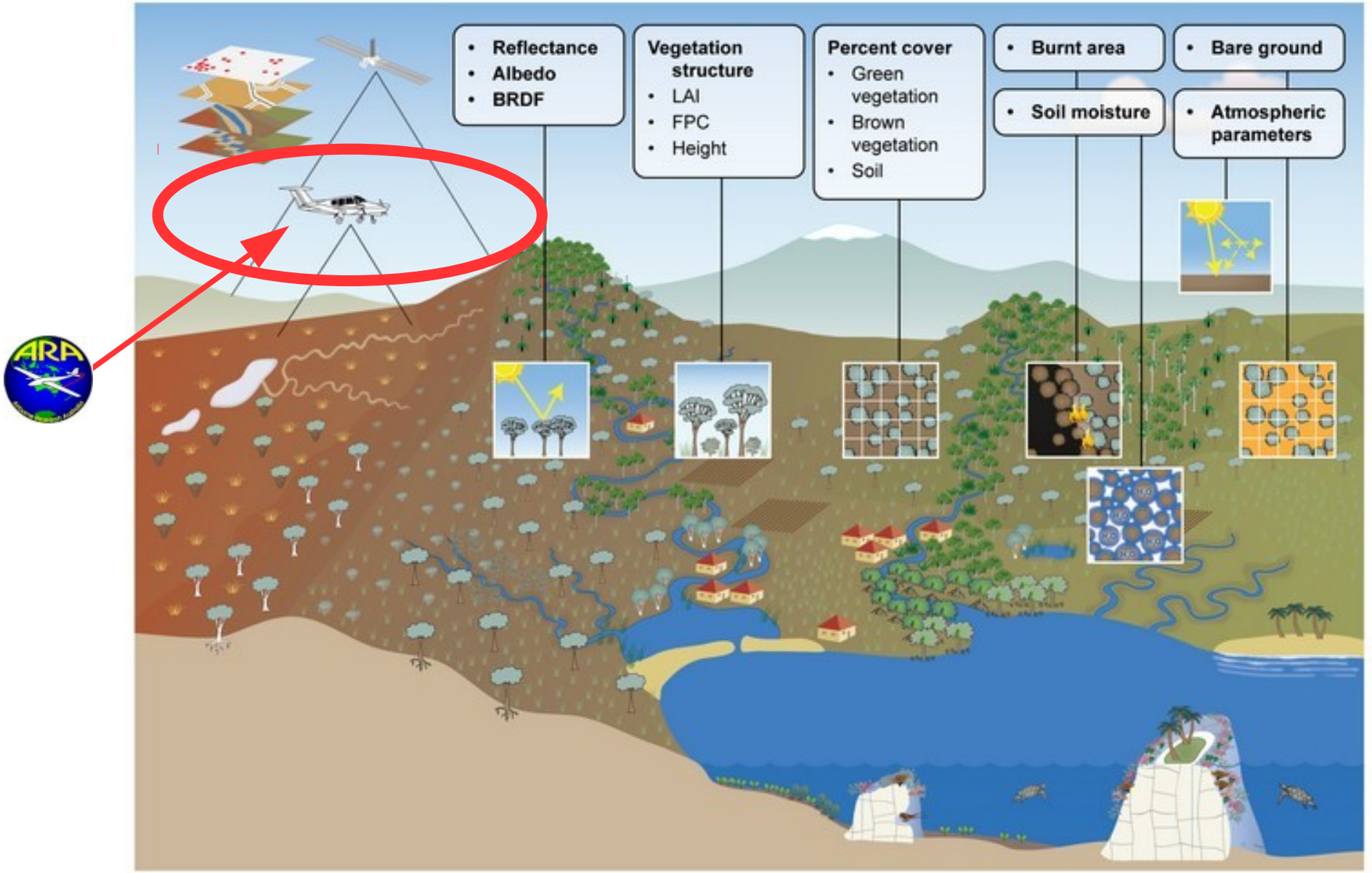
Remote Sensing



TERN-AusCover (http://www.auscover.org.au/about)

Lidar instrumentation

- **Riegl Q560** full waveform airborne lidar
  - outgoing pulse rate = 240kHz
  - scanned at 135 lines per second
  - each scan line is angular sweep through 45 degrees
  - contains 882 individual laser shots
  - at 300 metres above ground with forward speed of 40m/s

    ==> homogeneous surface point distribution of 0.30m in along-track as well as across-track directions


Airborne Research Australia
FLINDERS UNIVERSITY
Riegl Q560

Hyper-spectral instrumentation

- (A) SPECIM **AisaEAGLE** VNIR hyperspectral scanner
- (B) SPECIM **AisaHAWK** SWIR hyperspectral scanner

AISA Eagle Sensor head

SENSOR HEAD	TYPICAL SPECIFICATIONS				
Spectrograph	High efficiency transmissive imaging spectrograph. Throughput practically independent of polarization. Smile and keystone < 2 microns.				
F/#	F/2.4				
Spectral range	400-970 nm				
Spectral resolution	2.9 nm				
Slit width	30 microns				
Spectral binning options	1x	2x	4x	8x	8x + sw2x
# of spectral bands	488	244	122	60	30
Spectral sampling/band	1.25 nm	2.3nm	4.6nm	9.2nm	18.4nm
Image rate, up to (images/s)	30	50	80	100	120
Spatial pixels, up to	1024, of which 70 - 80 FODIS pixels (optional)				
FORE OPTICS					
Fore optics options		OLE23	OLE18,5		OLE9
Focal length		23 mm	18.5 mm		9 mm
FOV		29.9 degrees	37.7 degrees		62,1 degrees
IFOV		0.029 degrees	0.037 degrees		0.060 degrees
Swath width		0.53 x altitude	0.68 x altitude		1.20 x altitude
Ground resolution @ 1000 m altitude		0.52 m	0.68 m		1.2 m
ELECTRICAL CHARACTERISTICS					
Camera	Progressive scan CCD camera				
Output	12 bits digital				
Integration time	Settable independent of image rate				
Shutter	Electromechanical shutter for dark background registration, user controllable by software.				
FODIS	Diffuse light collector and fiber optic cable (5 m standard) with SMA connector				
Calibration	Sensor head comes with wavelength and radiometric calibration file.				
Operating modes	Hyperspectral and multispectral				

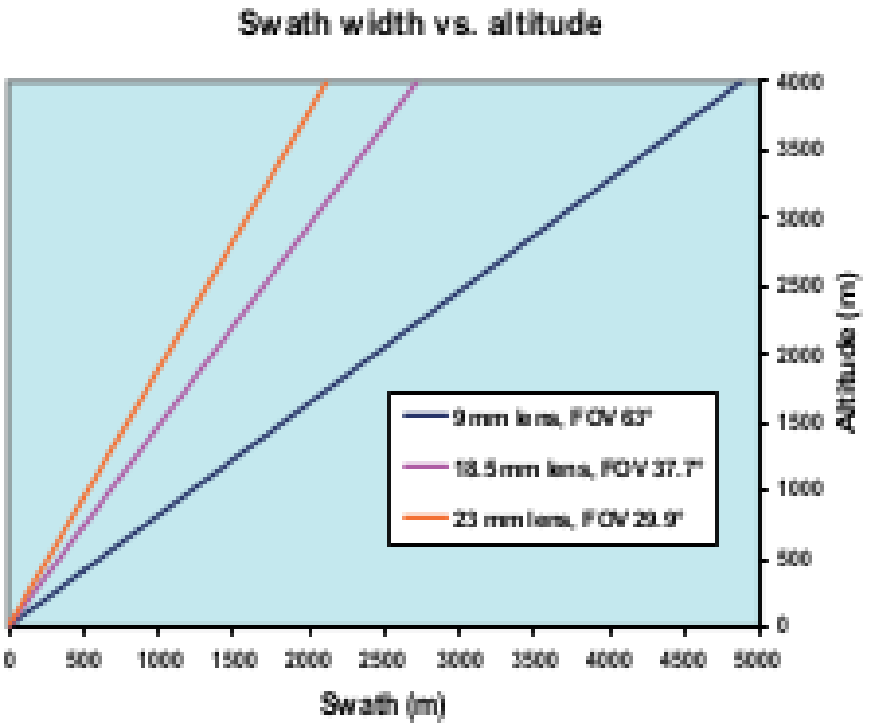
AISA Hawk Sensor head

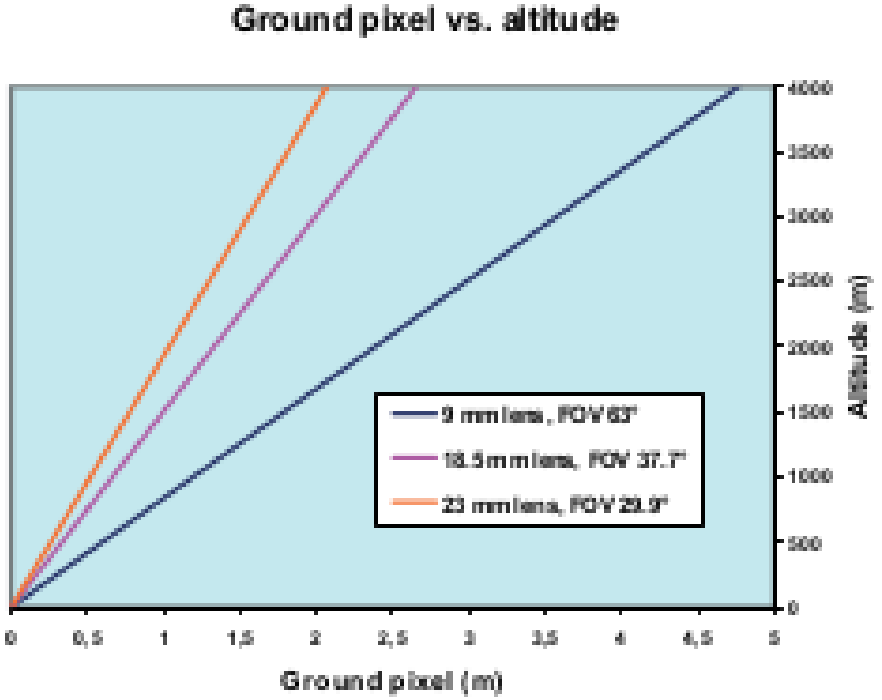
SENSOR HEAD	TYPICAL SPECIFICATIONS		
Spectrograph	High efficiency transmissive imaging spectrograph. Throughput practically independent of polarization. Smile and keystone < 5 microns. Spectrograph is temperature stabilized.		
F/#	F/2.0		
Pixel size	30 x 30 microns		
Spectral range	970 - 2450 nm		
Spectral pixels	254		
Spectral sampling/pixel	5.8 nm		
Spectral resolution	8.5 nm		
Slit width	30 microns		
Spatial pixels	320, of which 20-25 FODIS pixels (optional)		
FORE OPTICS			
Standard fore optics	30 mm	22.5 mm	15 mm
FOV	17.8 degrees	24.0 degrees	35.5 degrees
IFOV	0.054 degrees	0.075 degrees	0.111 degrees
Swath width	0.31 x altitude	0.43 x altitude	0.64 x altitude
Ground resolution @ 1000 m altitude	0.97 m	1.34 m	2,0 m
ELECTRICAL CHARACTERISTICS			
Camera	MCT camera with maintenance-free cooler		
Output	14 bits digital		
SNR	800:1 (peak)		
Integration time	Settable independent of frame rate		
Image rate	Up to 100 images/s		
Shutter	Electromechanical shutter for dark background registration, user controllable by software.		
OPERATING MODES			
Hyperspectral	254 spectral bands with max speed		
Programmable multispectral	Yes		

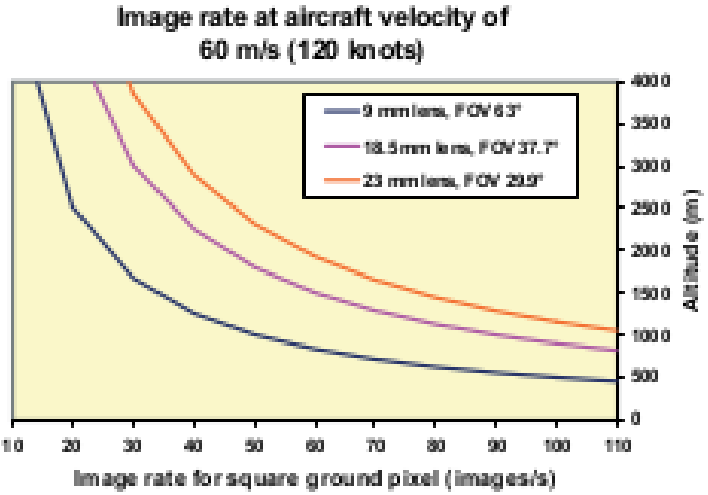

AisaEAGLE


FLINDERS UNIVERSITY
ENVIRONMENTAL RESEARCH
RESTRICTED
AisaHAWK

What does it show on the ground?

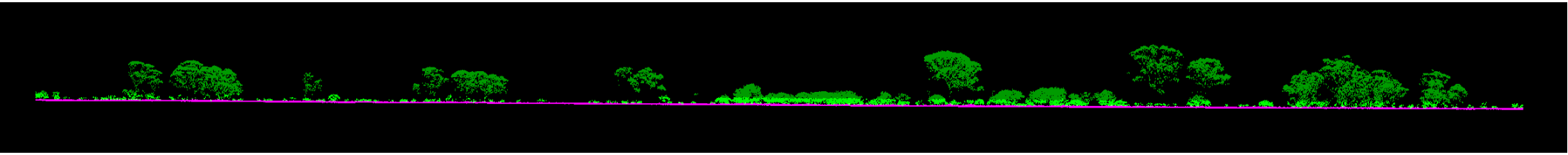






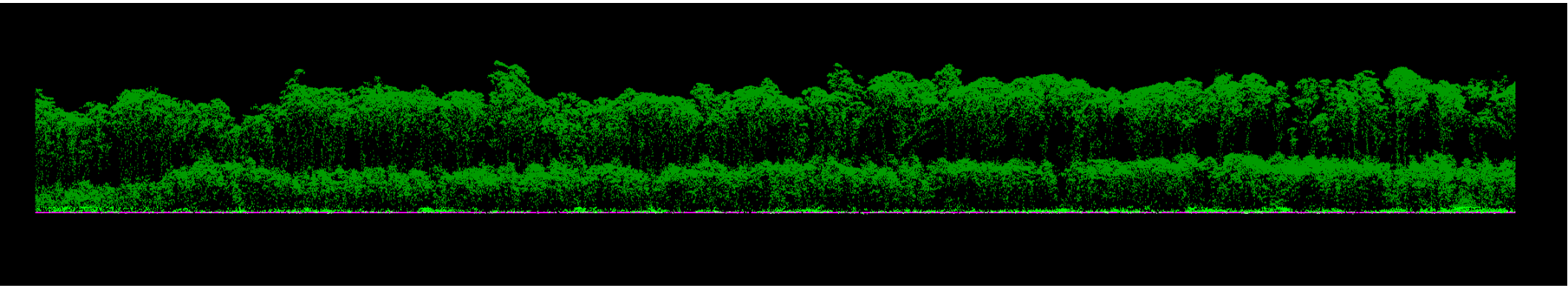
Results

- Chowilla and Great Western Woodlands



GWW

- Warra



Warra

Footprint Calculations

Footprint area depends on wind and atmospheric stability

Input data:

tower height,

MO-length,

friction velocity,

wind direction,

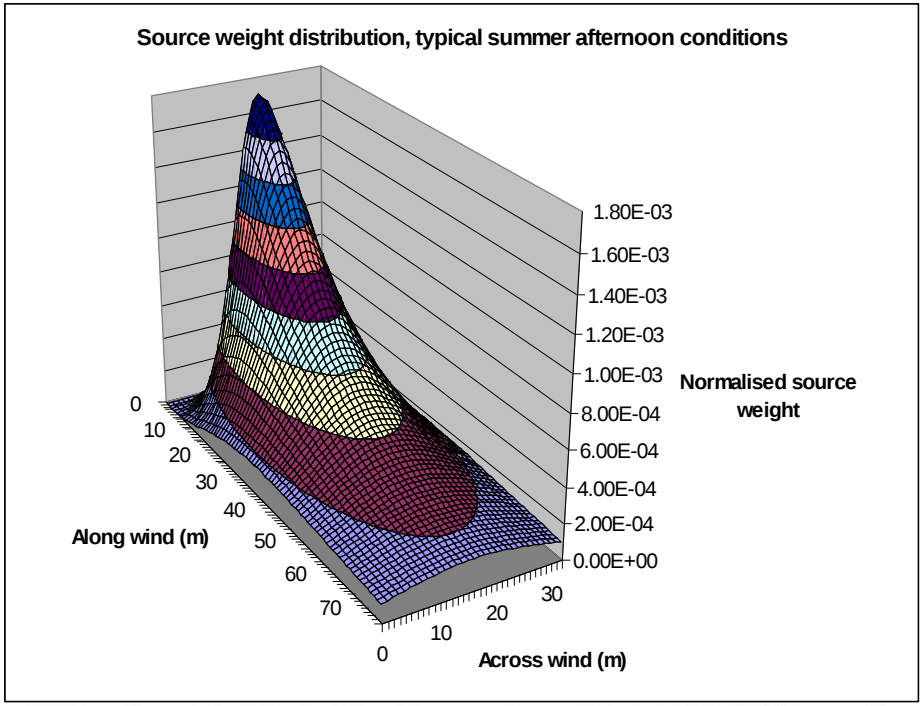
across wind variability

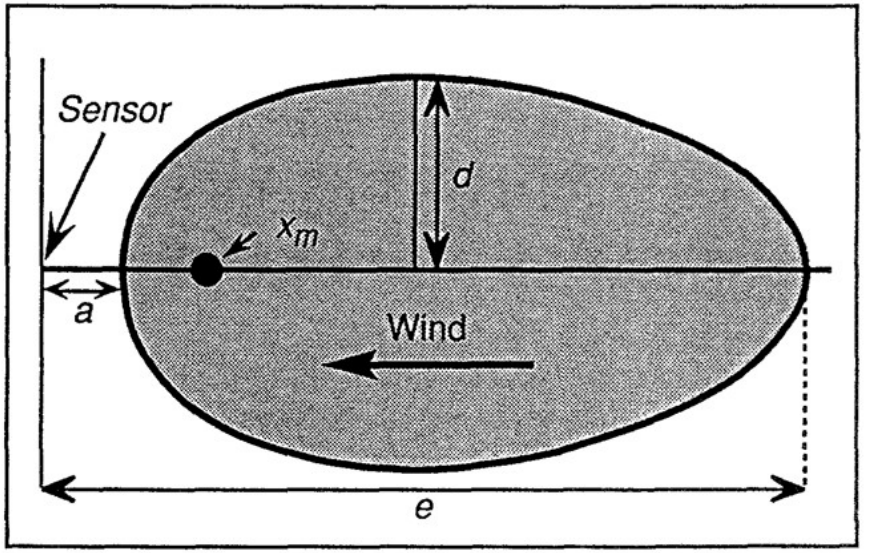
ART-Footprint model (Neftel et al., 2008)

Excel file

easy to use

BUT it is only an estimate



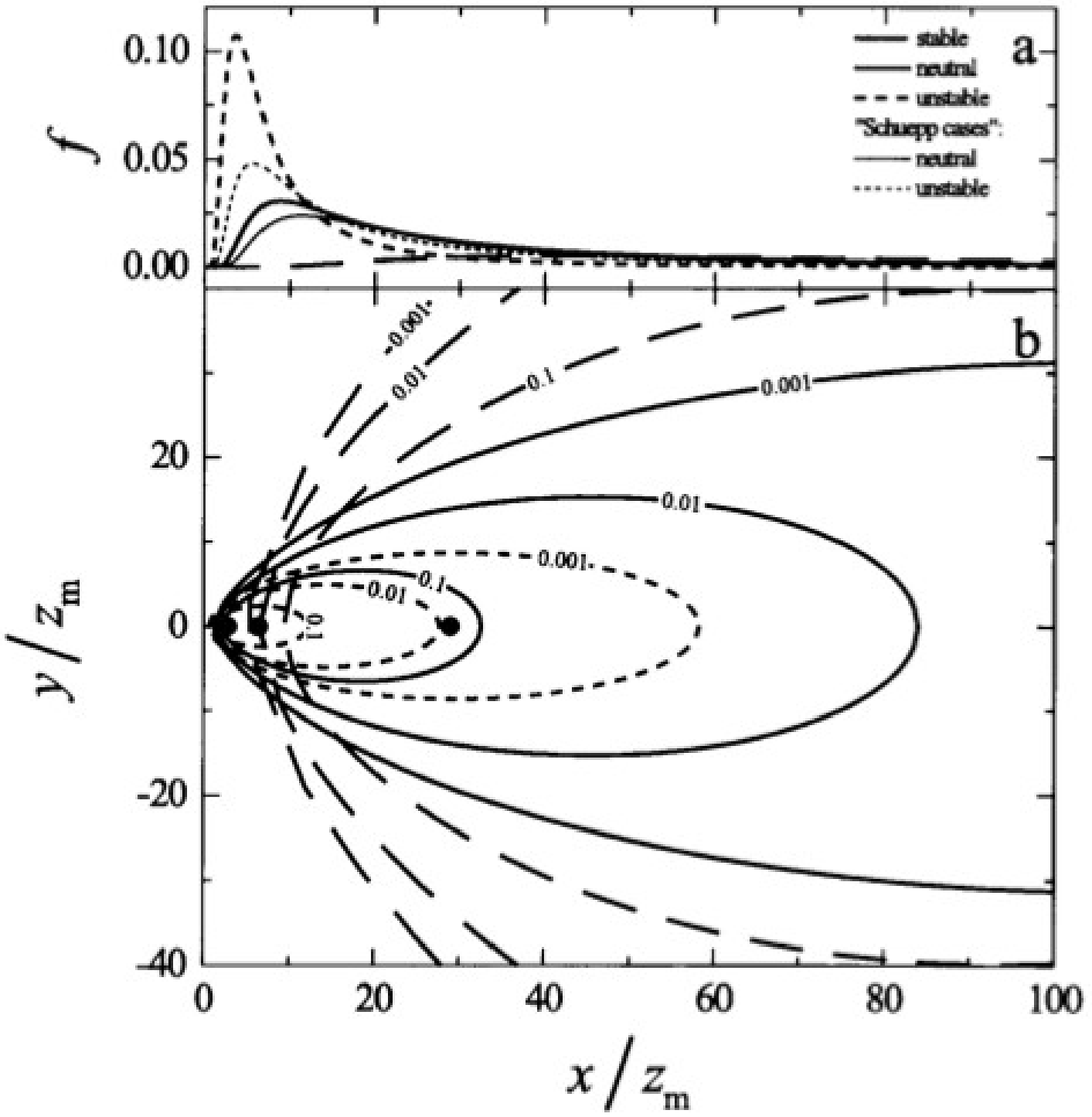


Kormann-Meixner

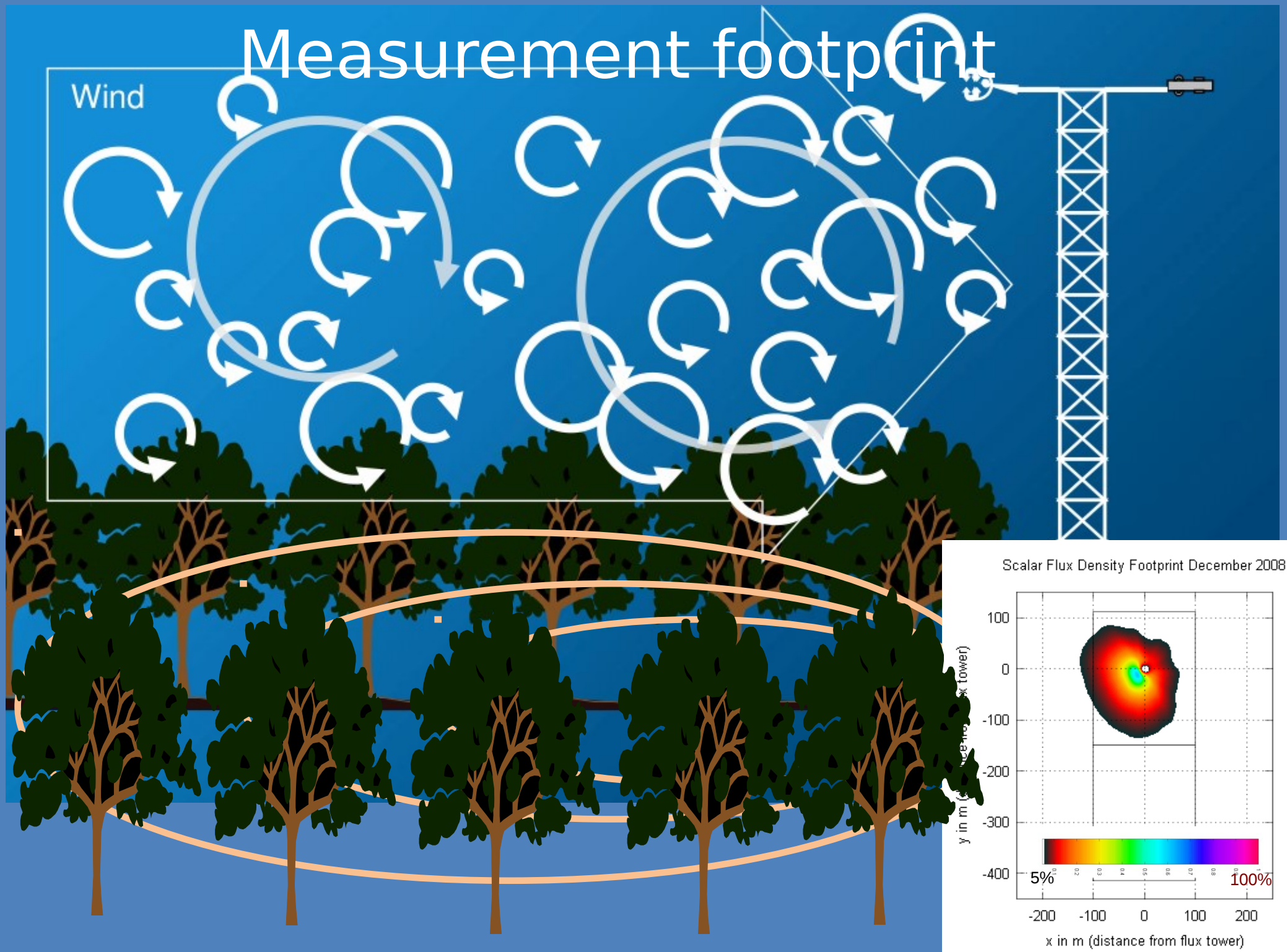
- Analytical
- Useful for neutral and near neutral conditions
- Power law wind profiles
- Monin-Obukhov Similarity
-
- ART-Footprint model (Excel file, easy to use)
- BUT it is only an estimate

Kormann and Meixner, 2001:

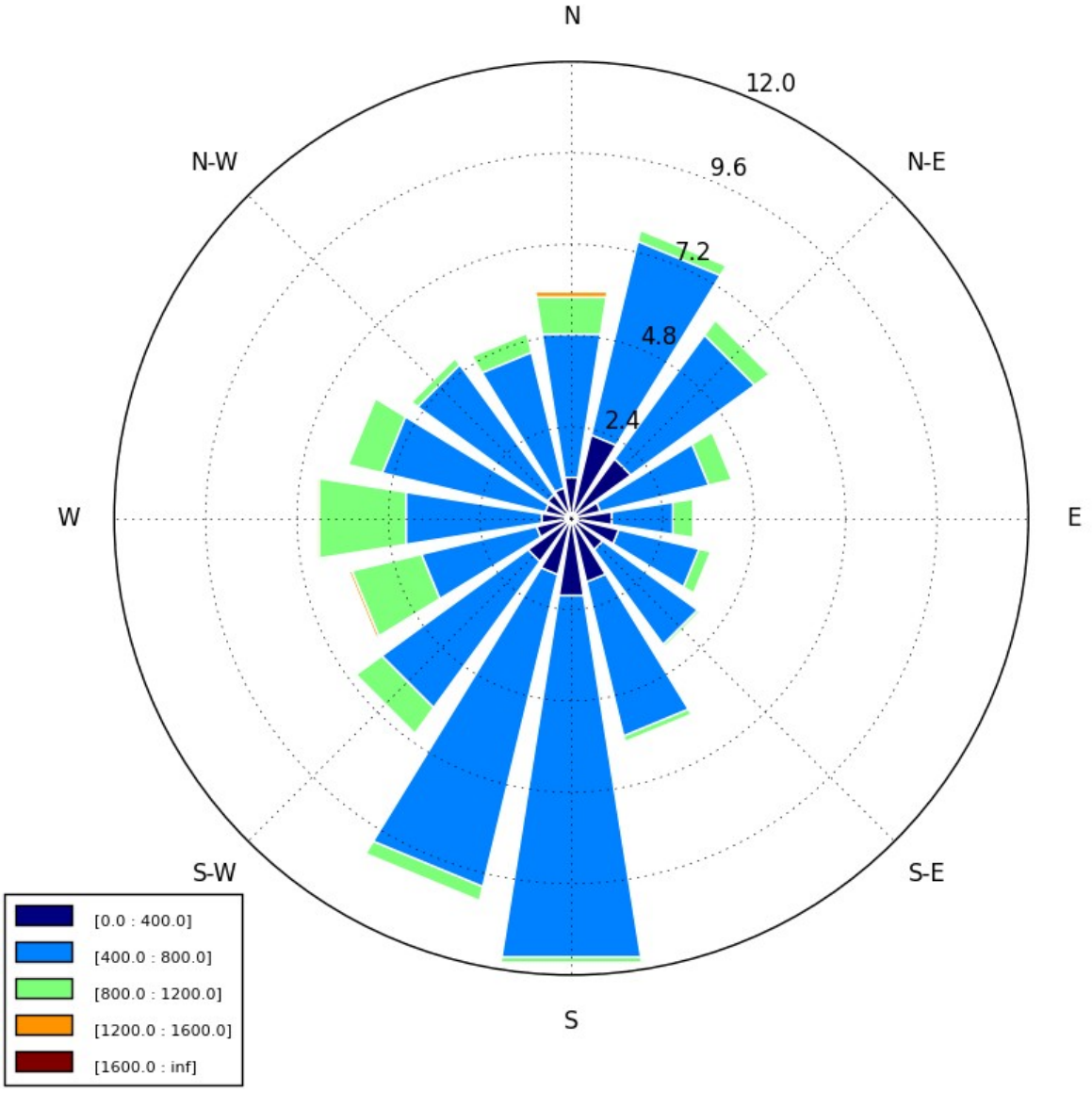
Figure 4.
(a) The crosswind integrated footprint f (x, z m) for the examples given in section 5.
(b) Isopleths of the footprint φ with D y from Eq. (9) at the levels φ 0 /φ max = 0.1, 0.01 and 0.001. The solid lines depict the neutral case, the dashed and the dotted lines the stable and the instable case, (φ) respectively. The dots indicate x max for the different stratifications.



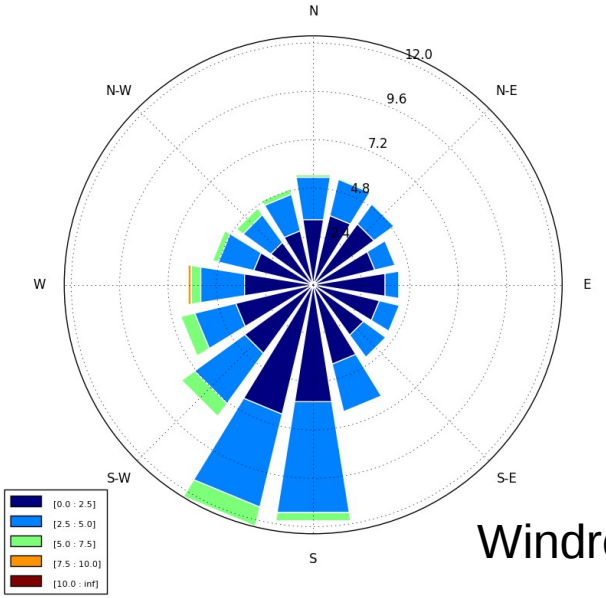
Measurement footprint



Chowilla - footprint



- Year = 2013
- Kormann-Meixner
- Ustar ≤ 0.25
- zm/L = [-3,3]

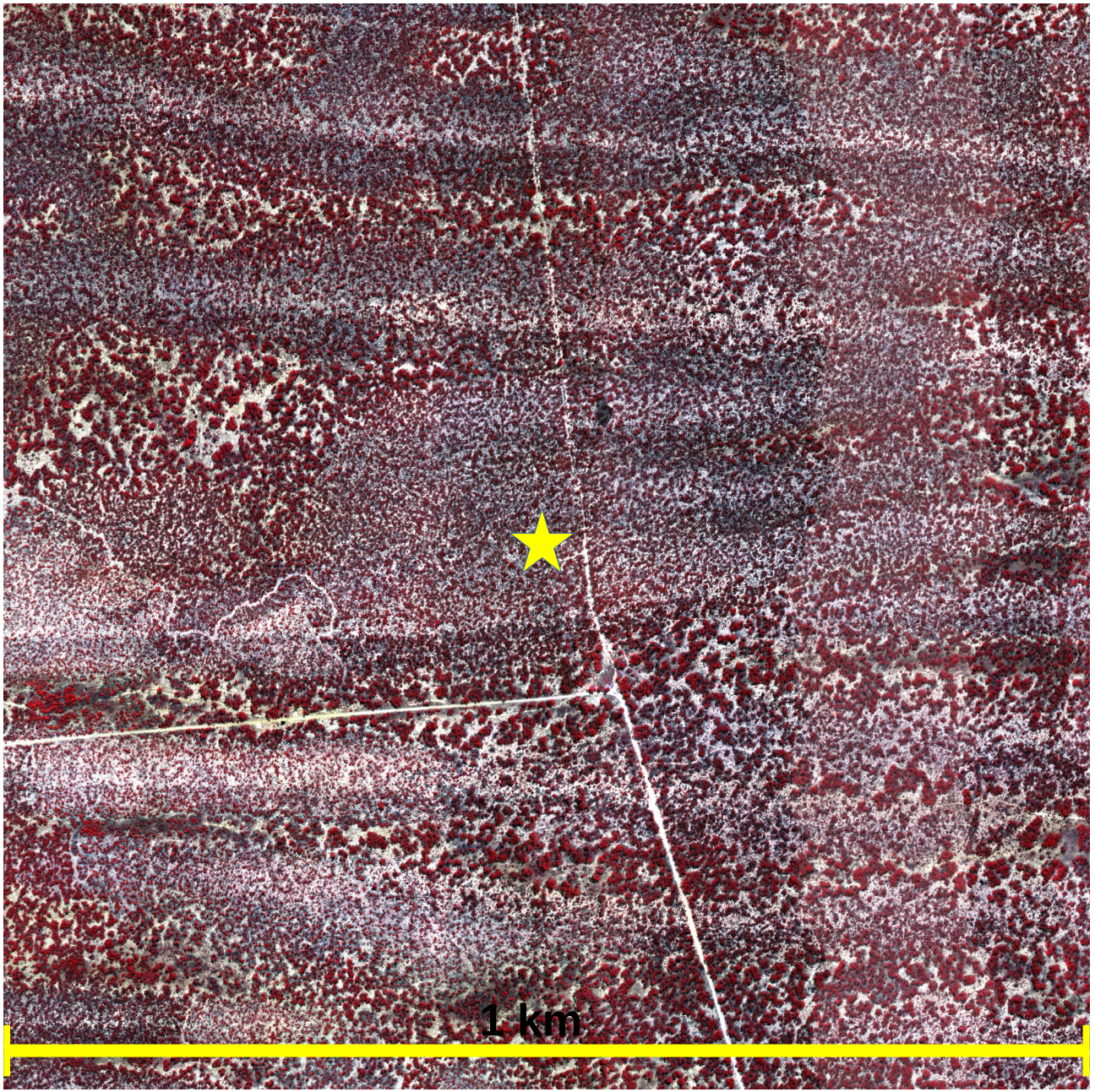


Windrose

Chowilla

Chowilla

Eagle - CIR



Chowilla

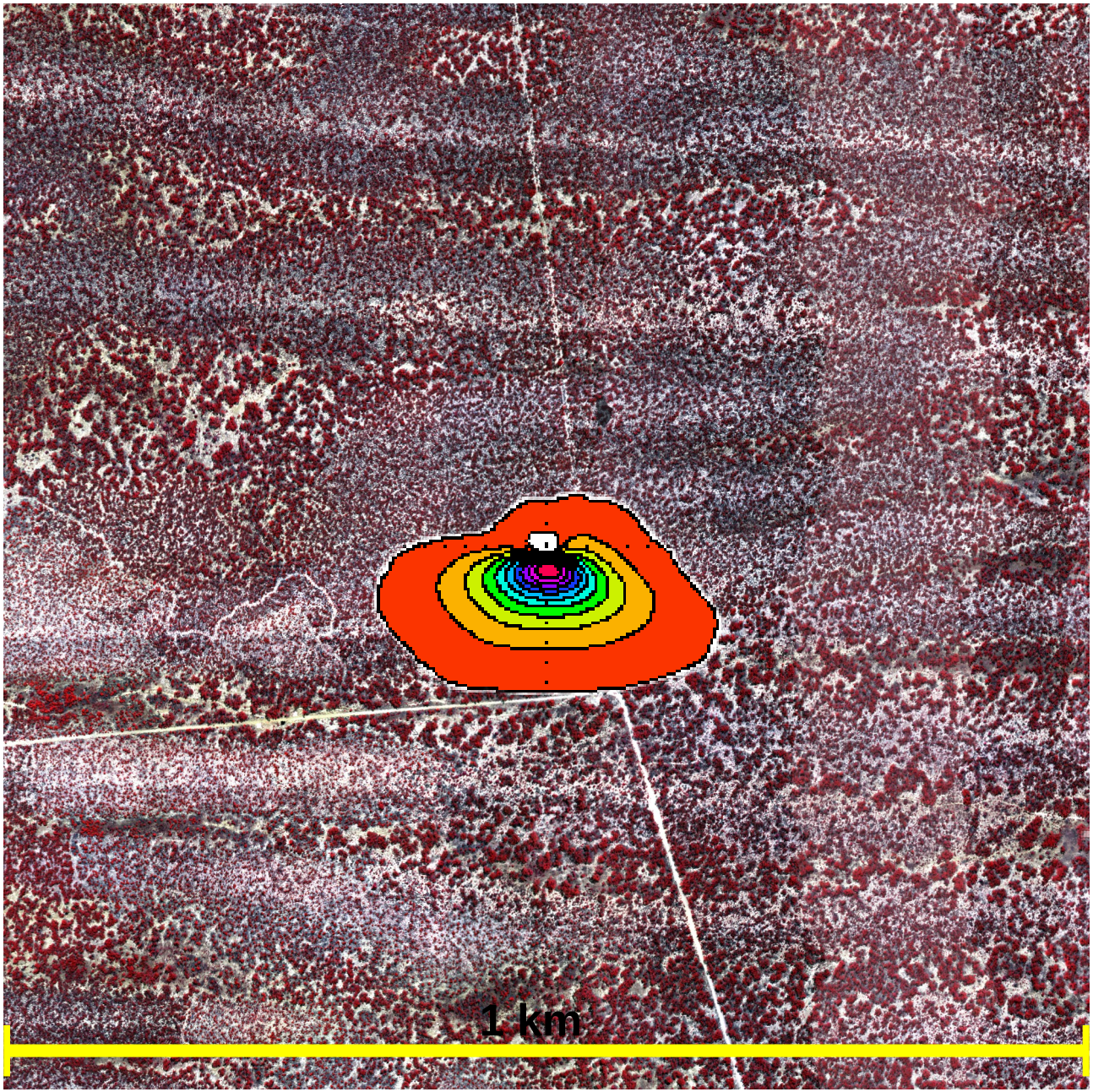
Chowilla

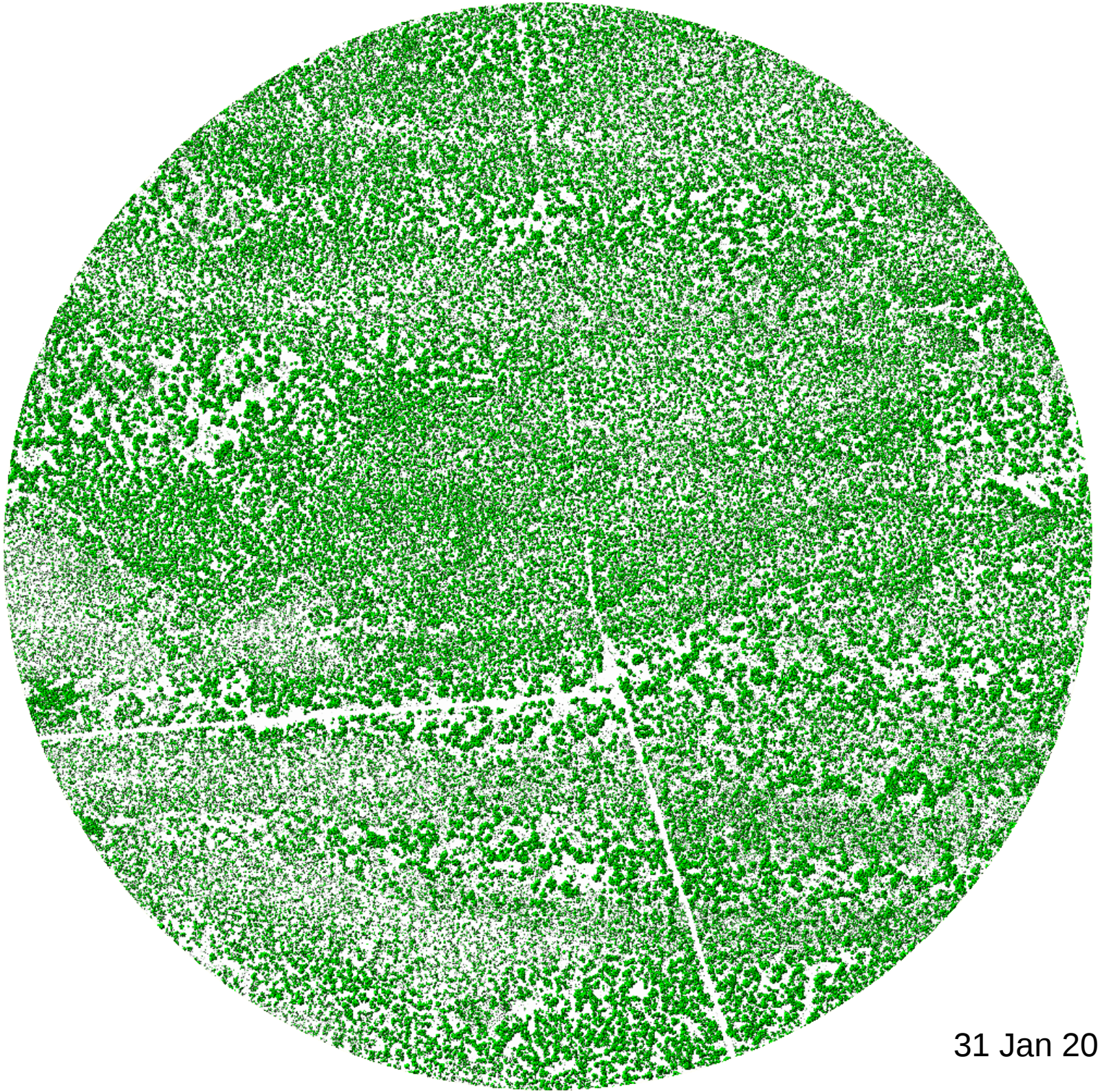
Eagle - CIR

January 2013

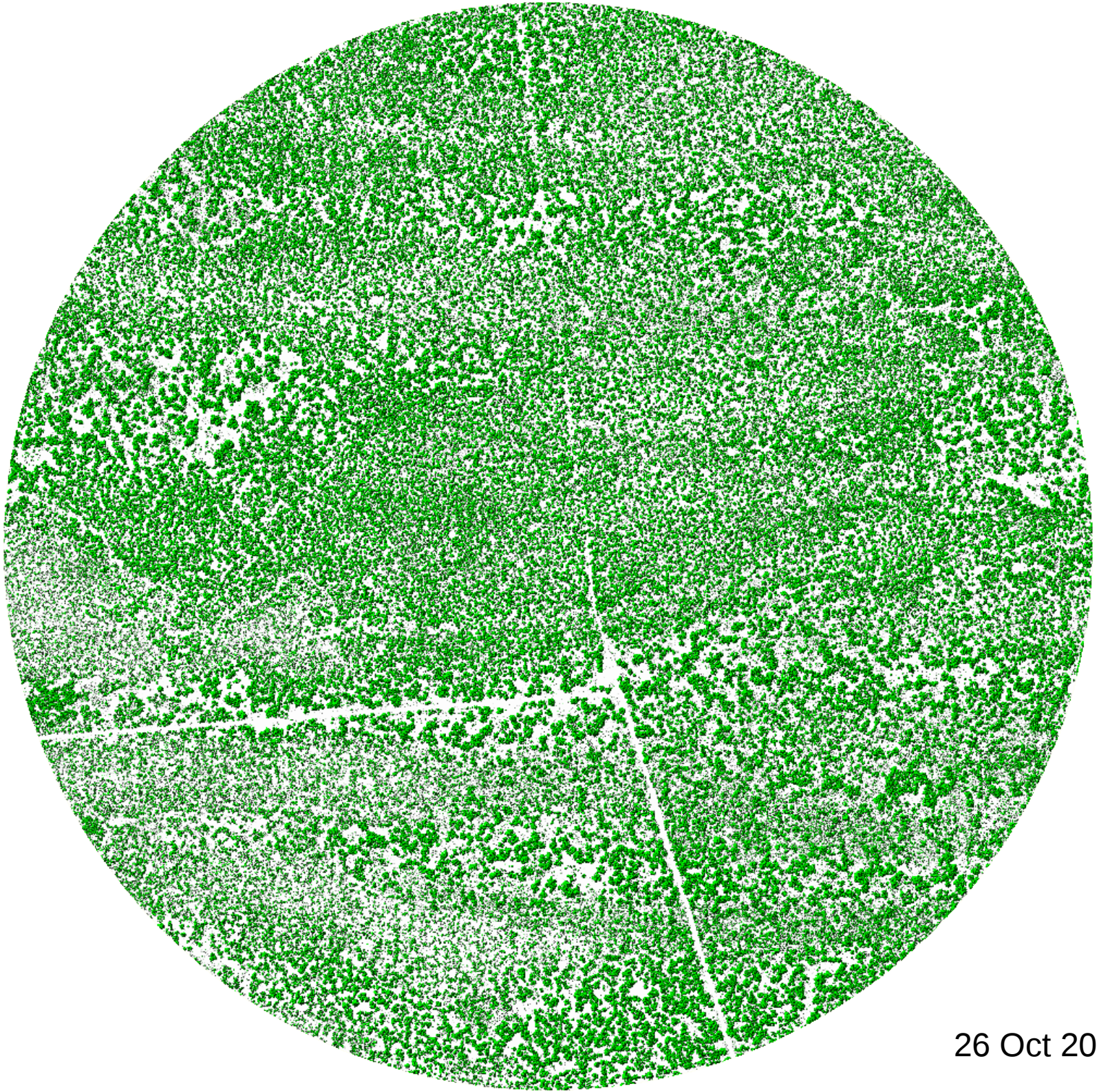
- footprint not scaled!

? use ET for scaling if
interested in water
? use Fc for scaling
if carbon,
what about neg/pos



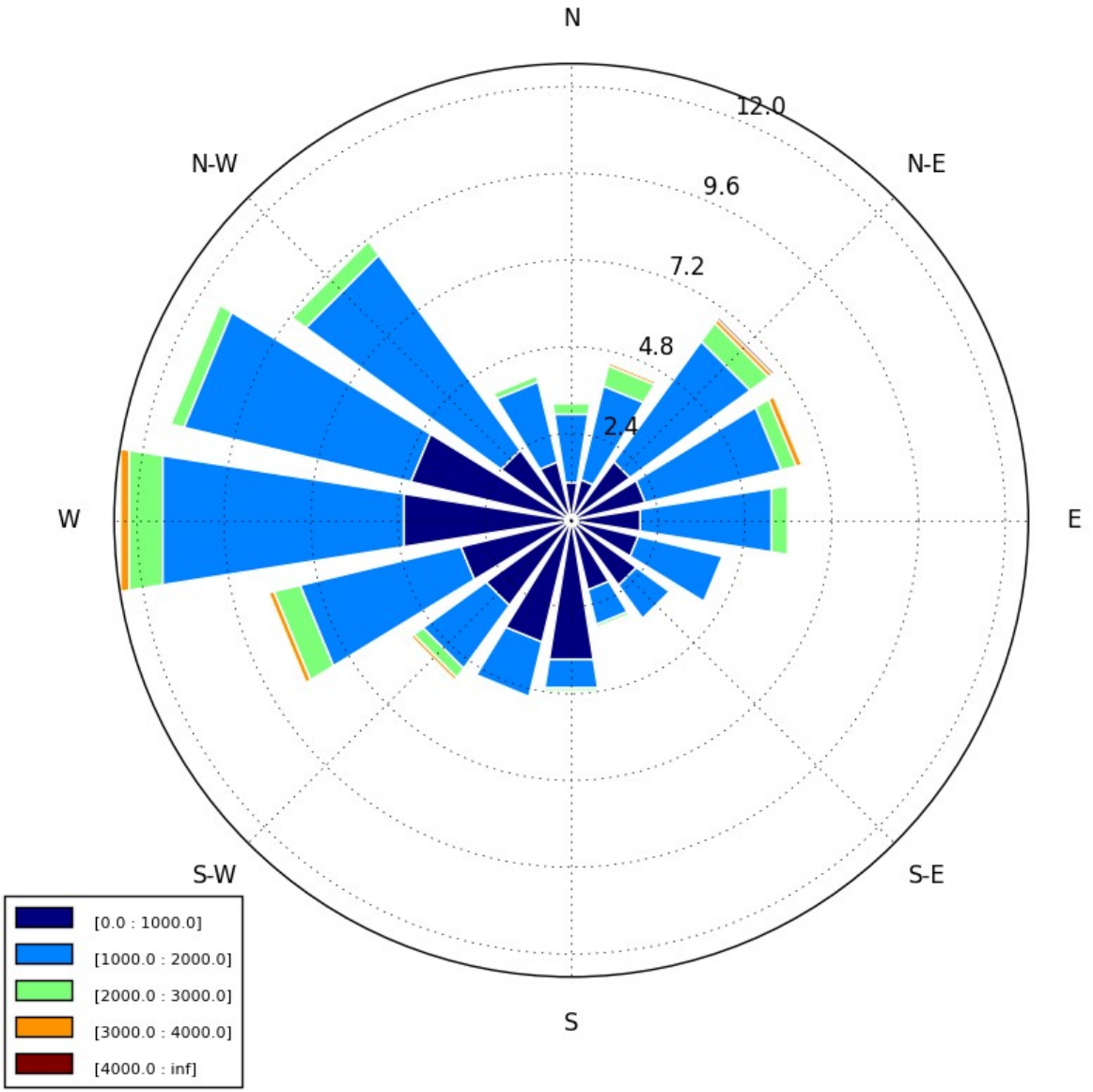


31 Jan 2012



26 Oct 2013

GWW - footprint



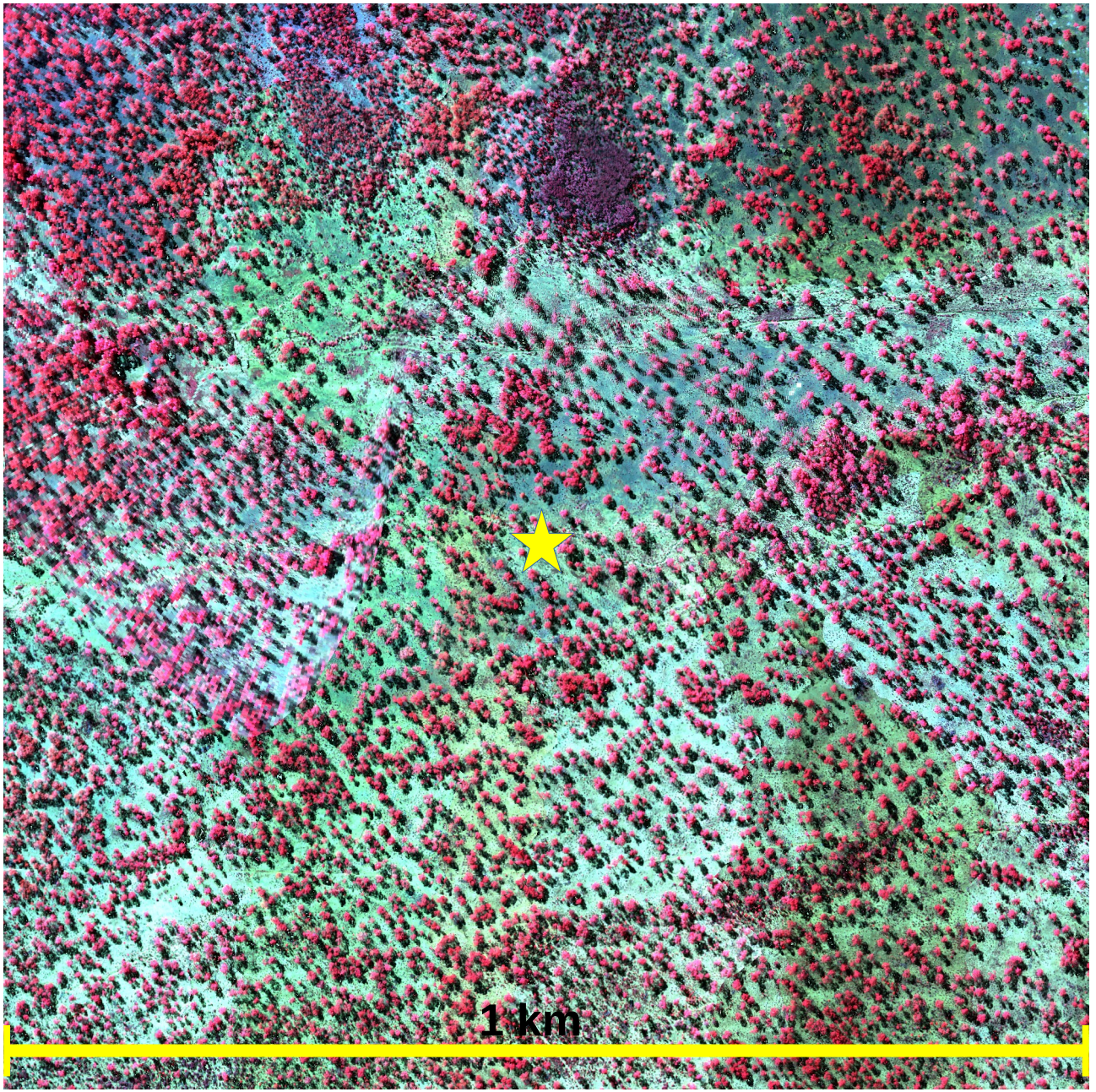
- Year = 2013
- Kormann-Meixner
- Ustar ≤ 0.25
- zm/L = [-3,3]

Great Western Woodlands

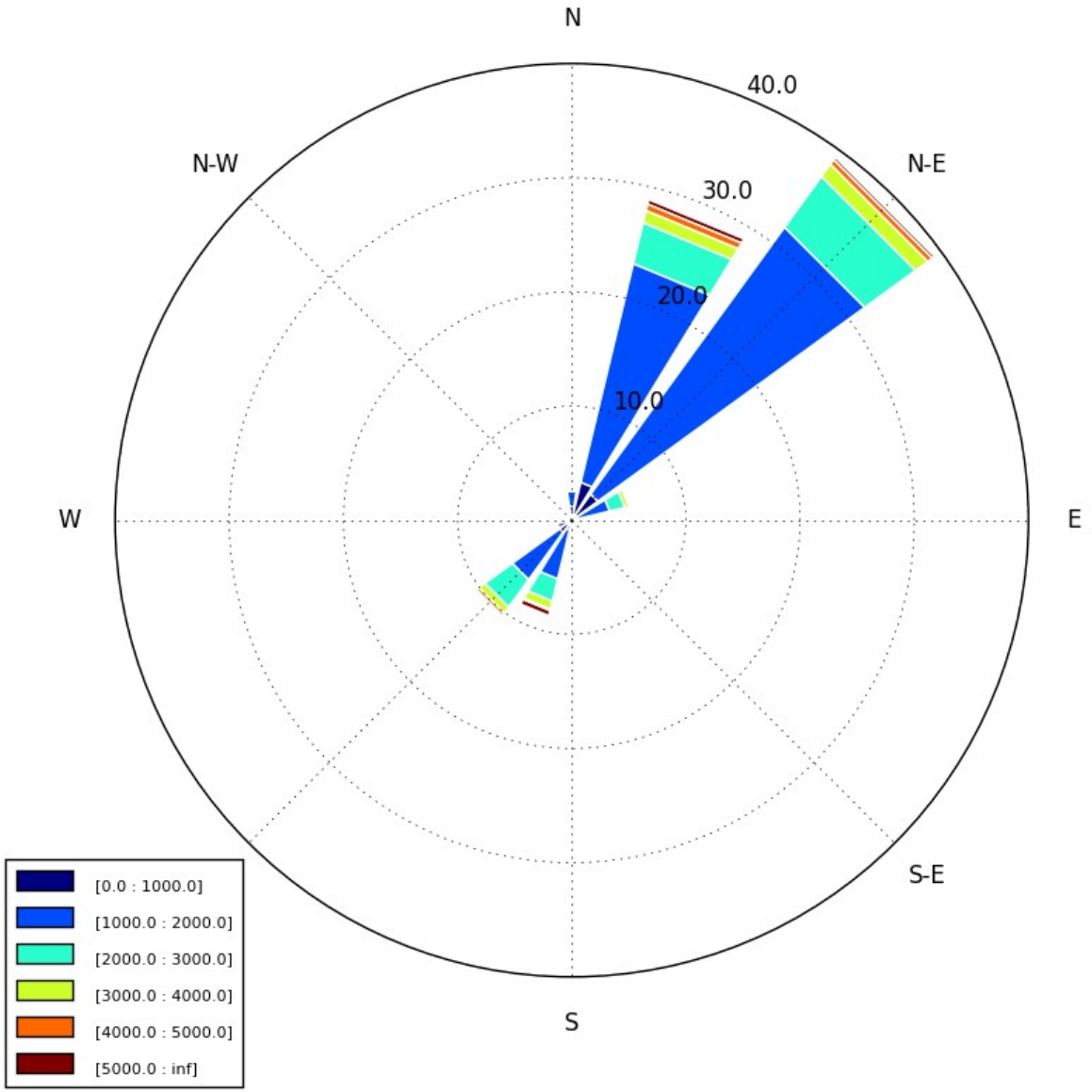
Credo tower

Eagle - CIR

(colour infra red)

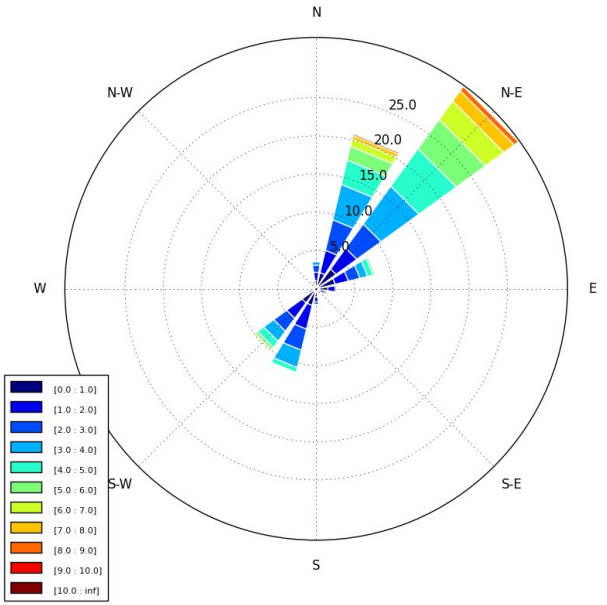


Warra - footprint



max ~ 10 km

- Year = 2013
- Kormann-Meixner
- Ustar ≤ 0.25
- zm/L = [-3,3]



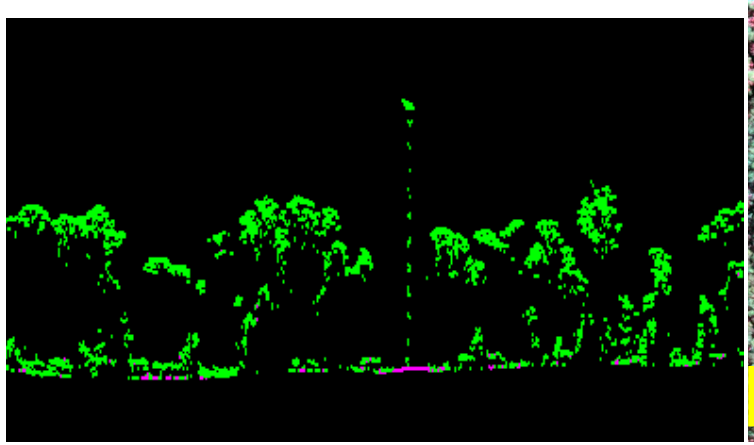
wind

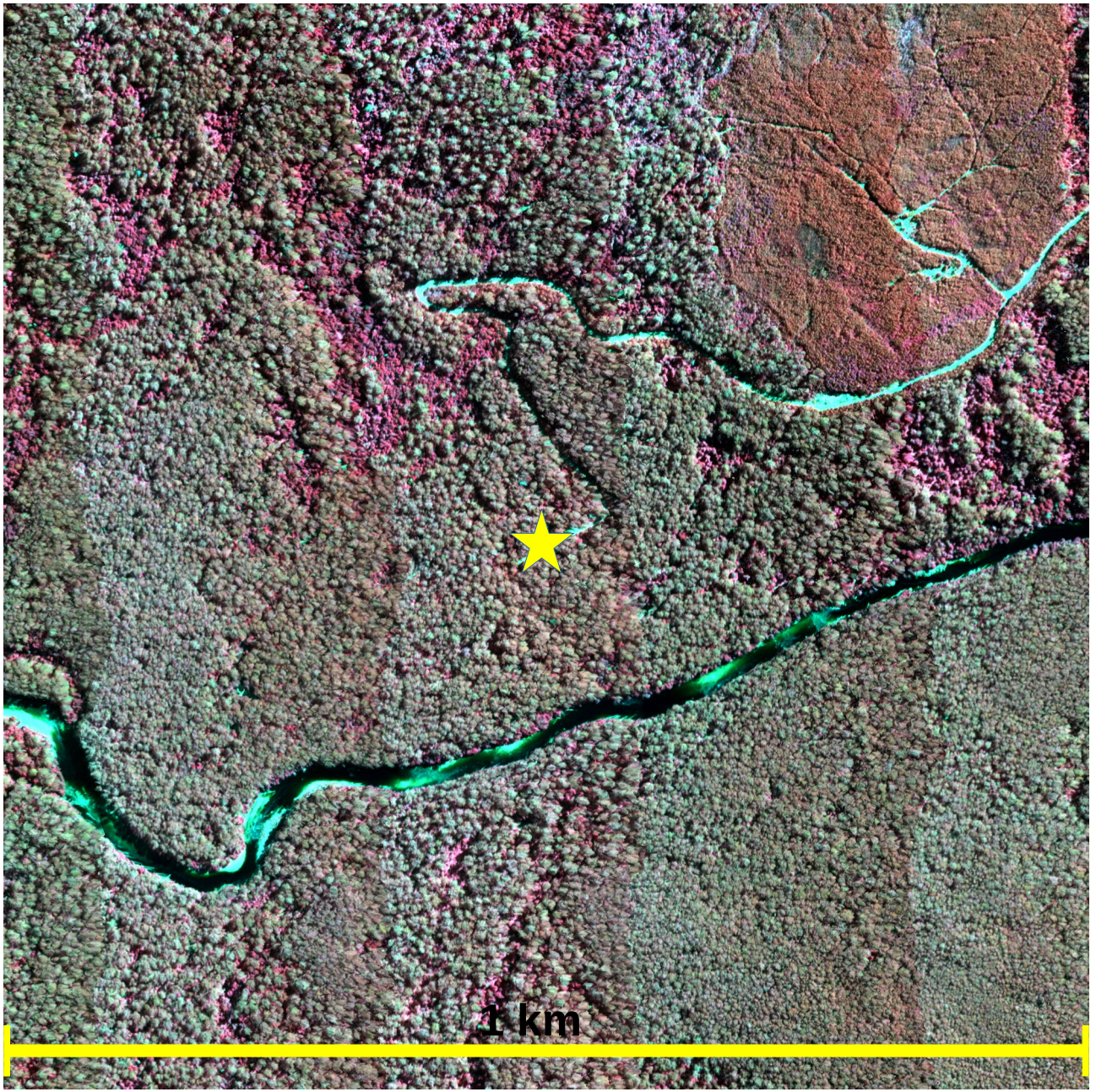
Warra

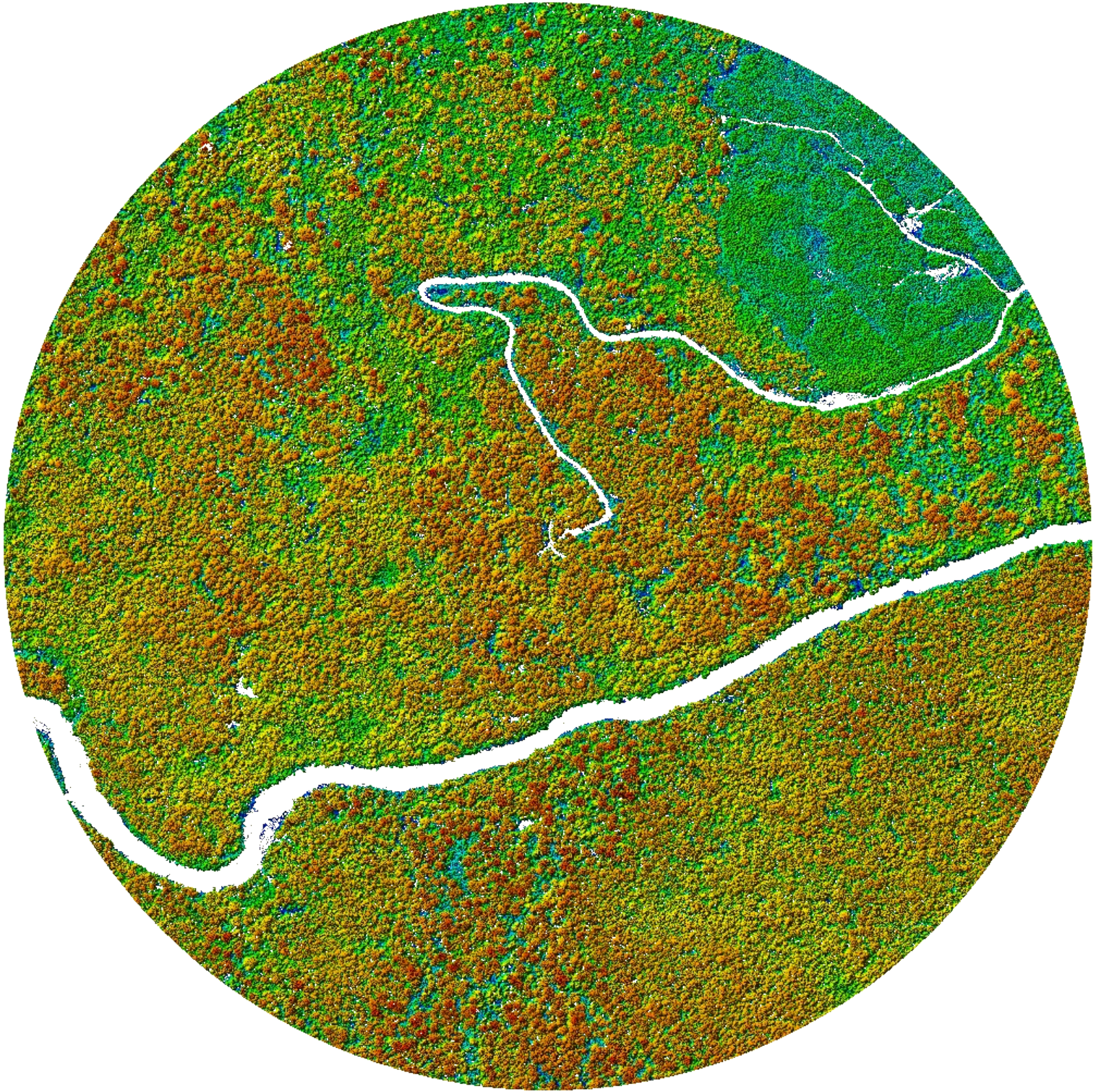
Warra tower

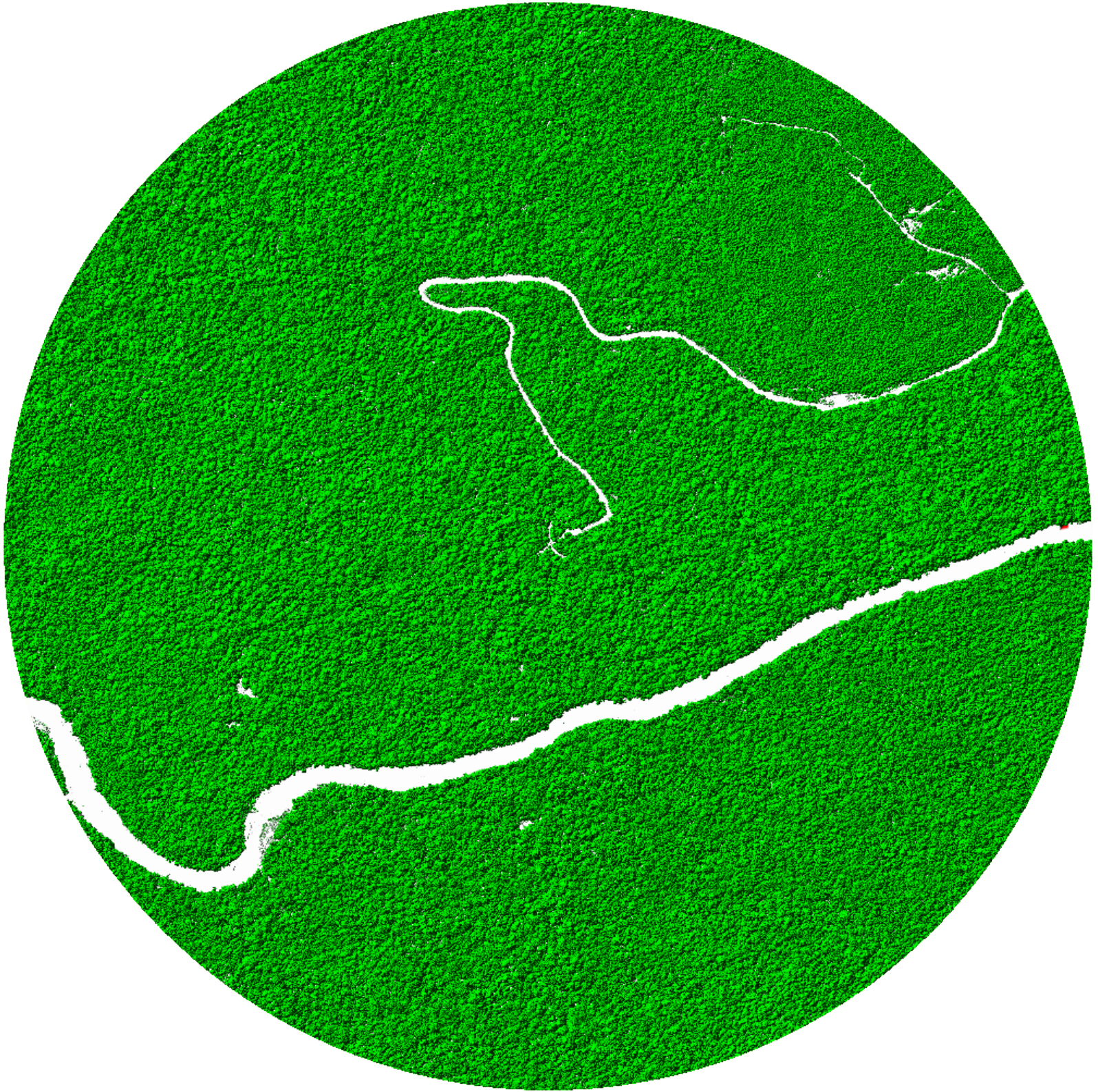
Eagle - CIR

(colour infra red)









Wishlist

- Use footprint analysis to determine the source area in more detail
- Estimate height, density, “other structural parameters” from Lidar and hyper-spectral
- Combine FP and Lidar and hyper-spectral results