Insights on wildfire with Radar

What we know and what we don't

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Introduction to Radar in Wildfire
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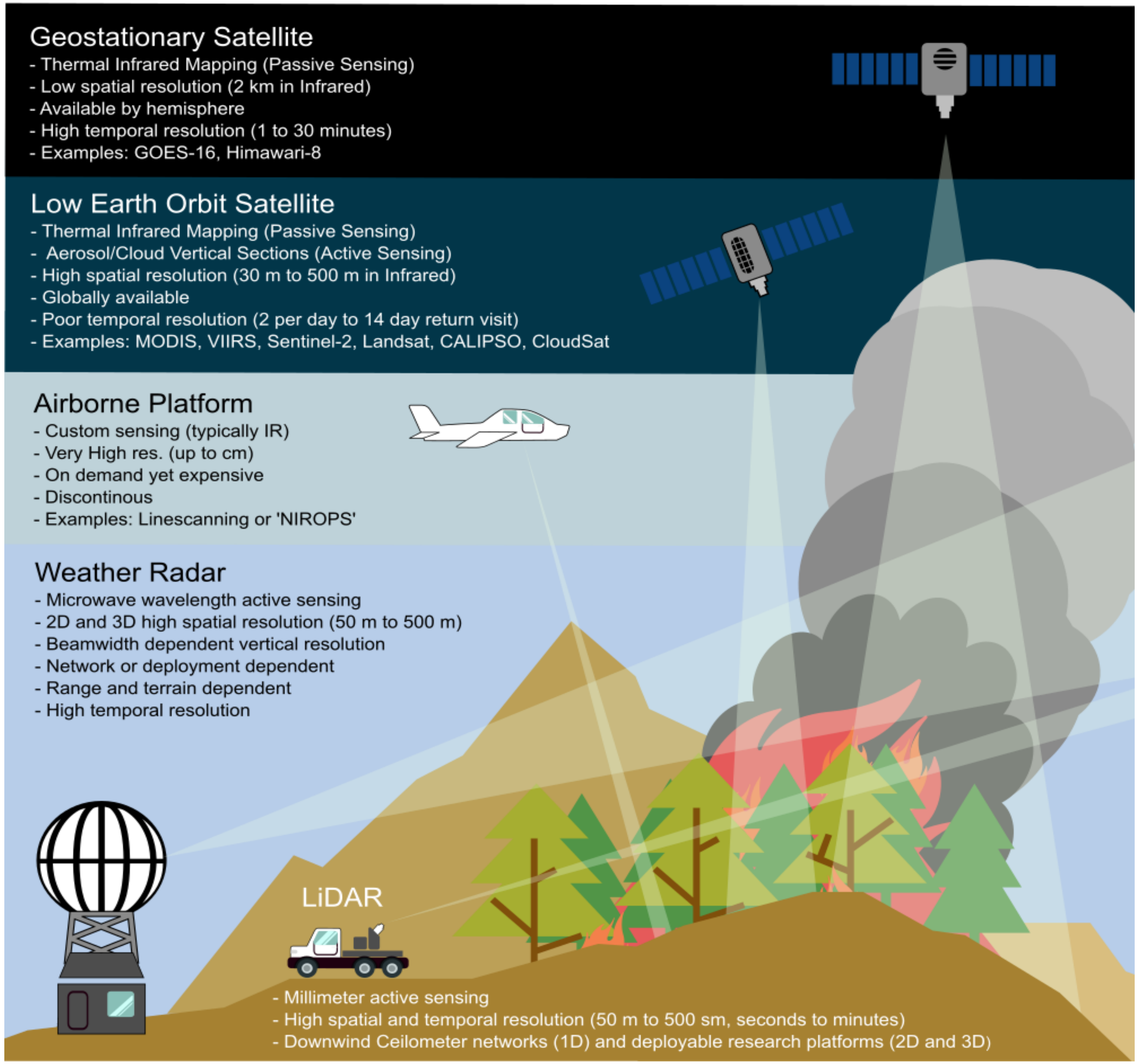
Observations and Uses
Quantification and Future Prospects
Questions



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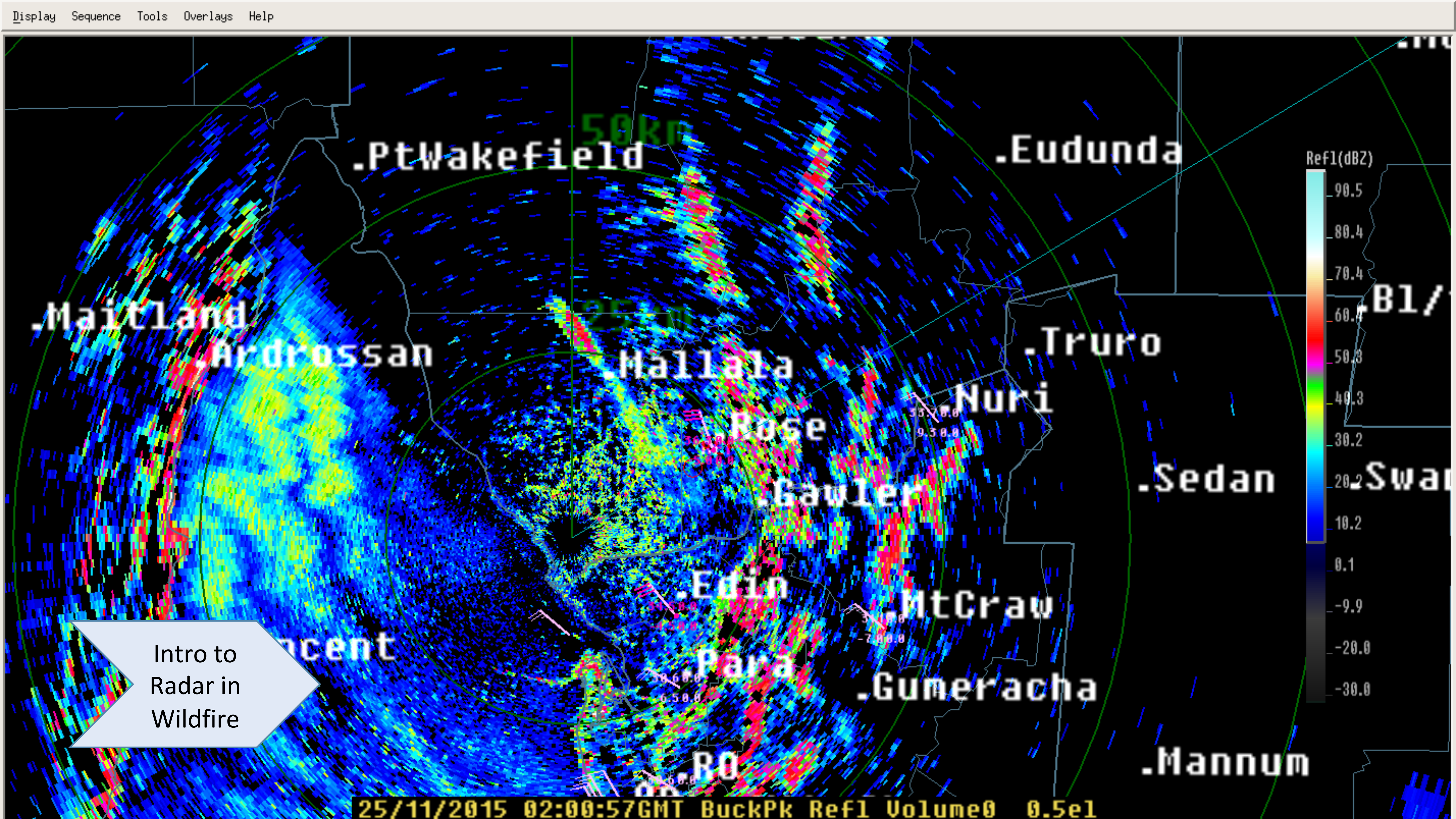

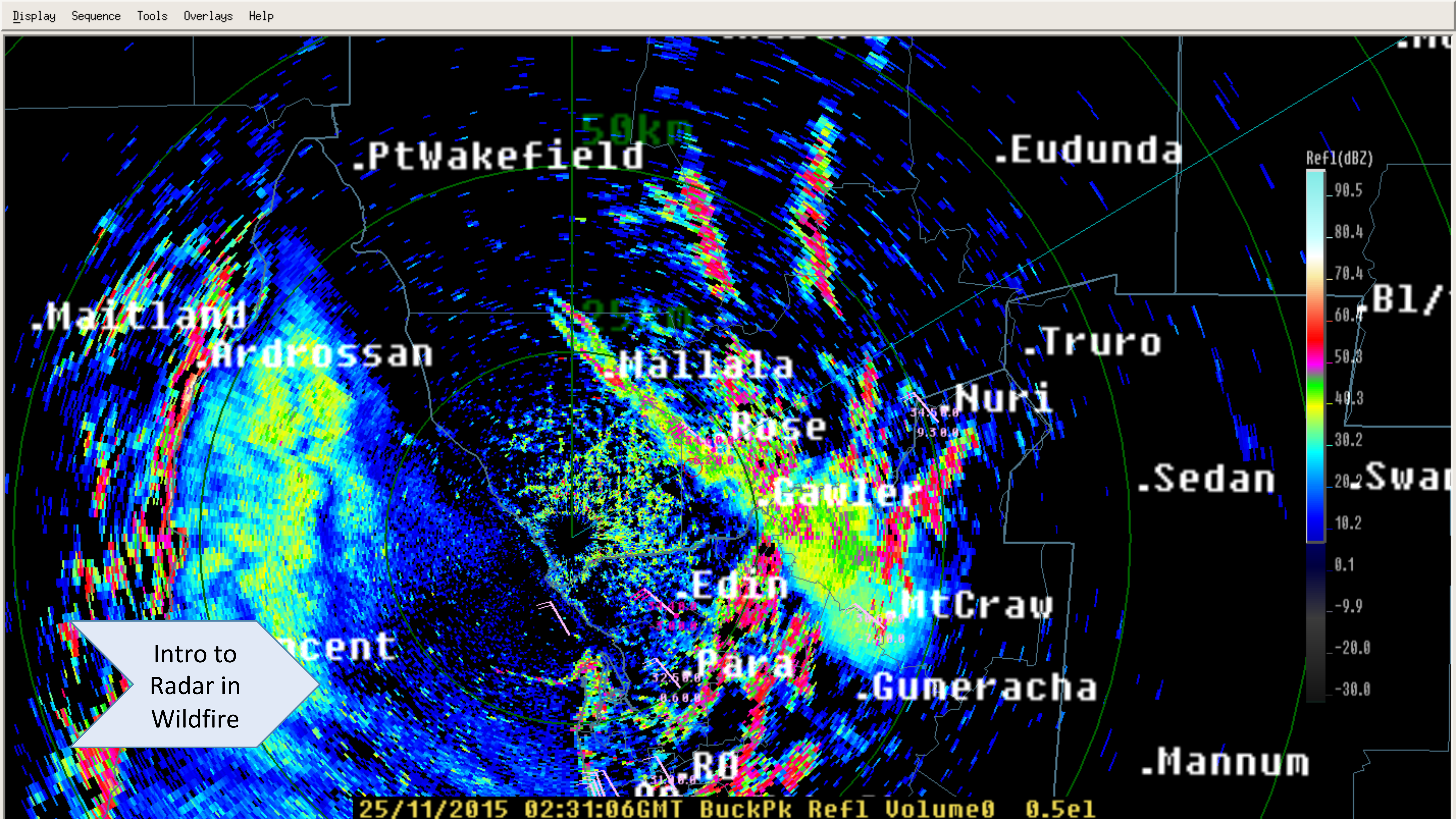

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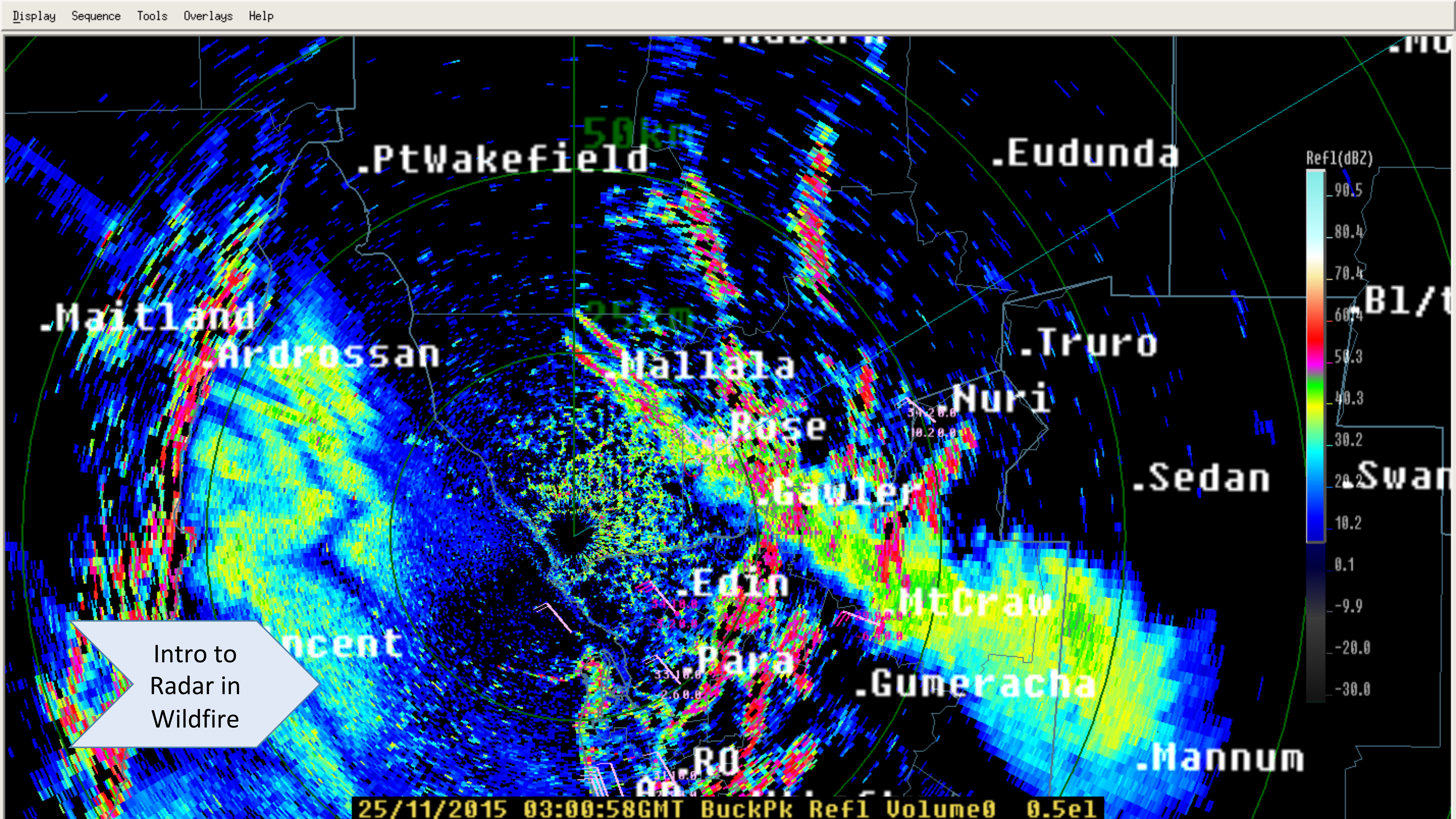

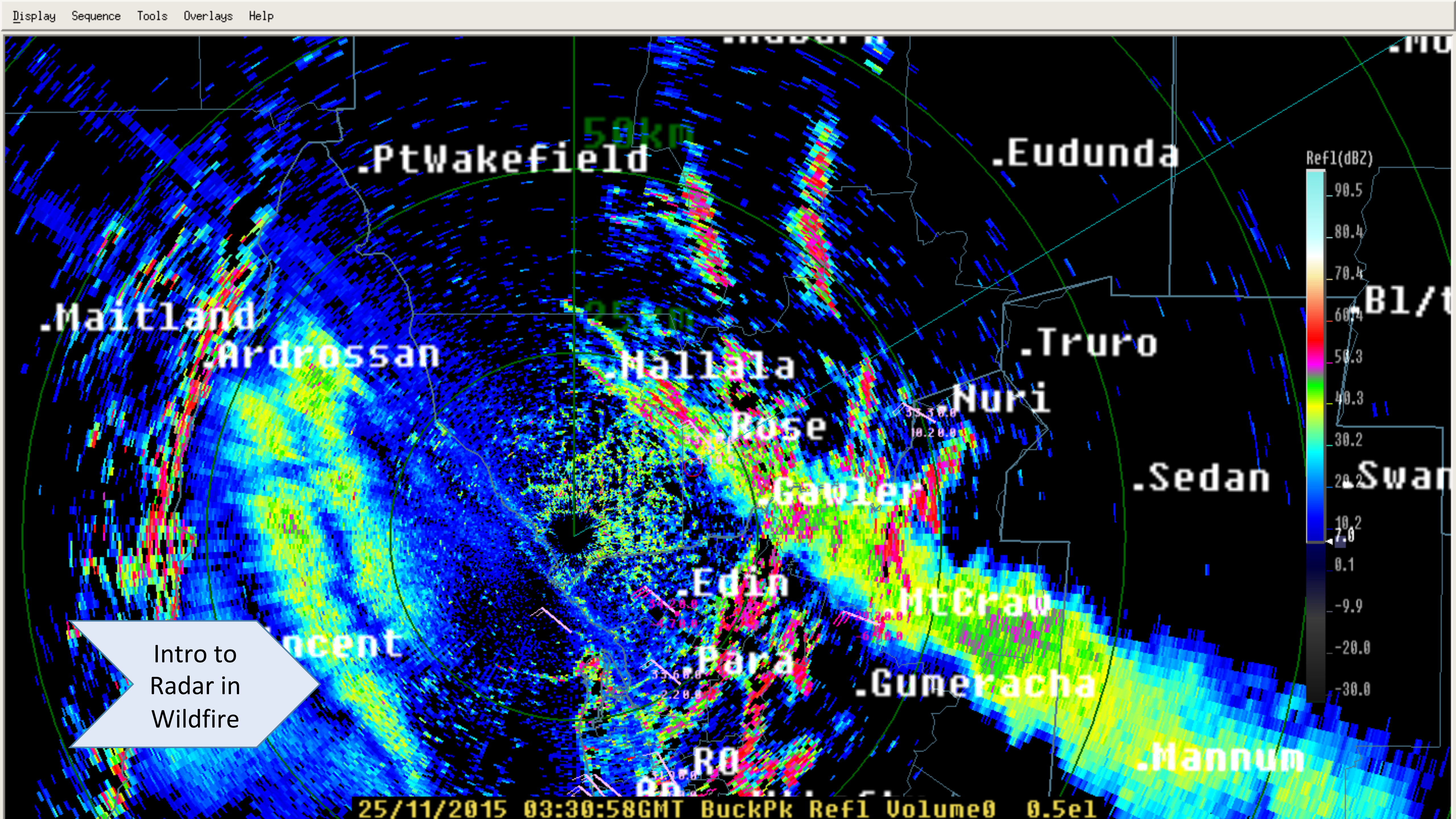
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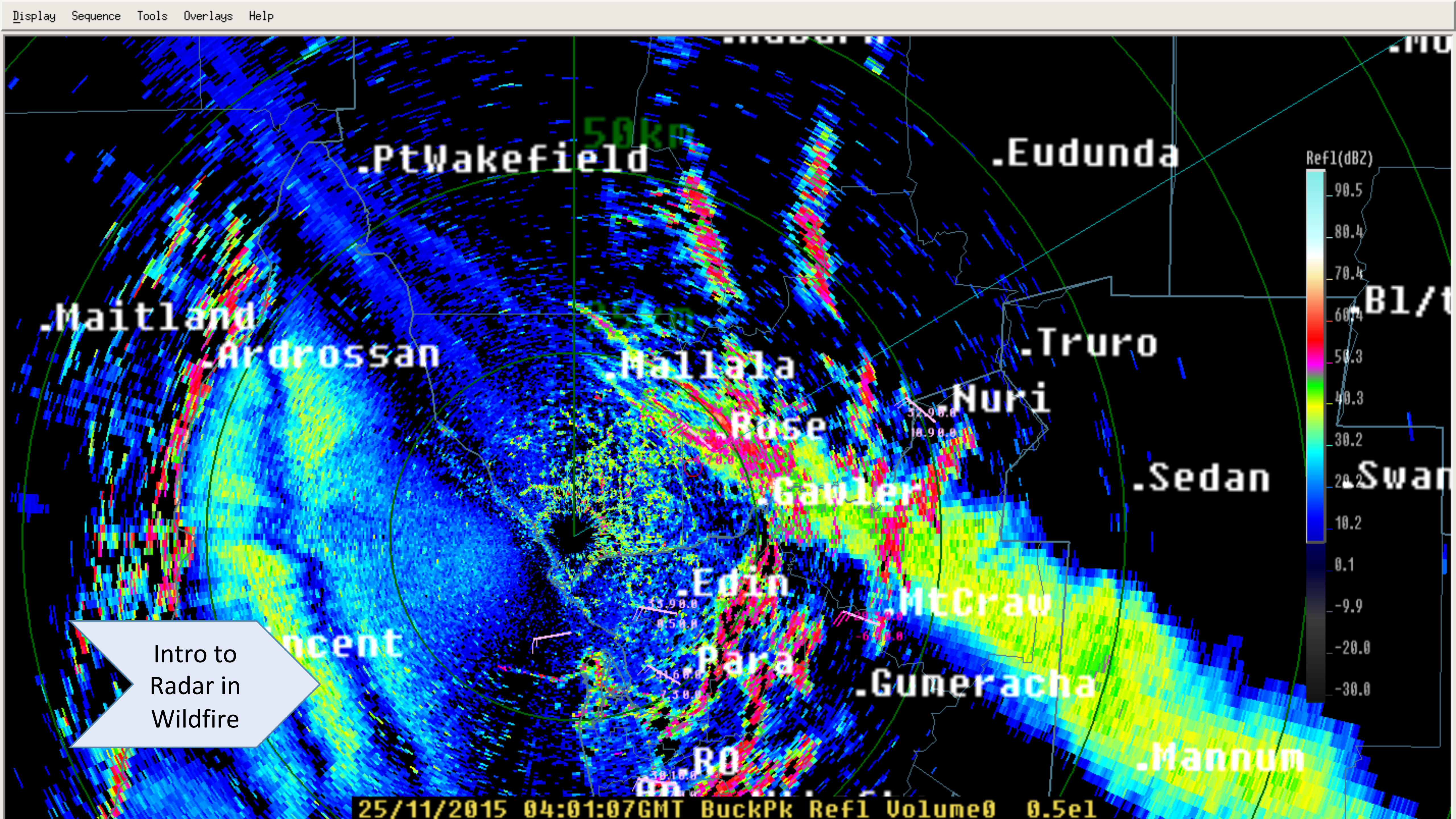
50km
.PtWakefield
.Eudunda
Refl(dBZ)
90.5
80.4
70.4
60.4
50.3
40.3
30.2
20.2
10.2
7.0
0.1
-9.9
-20.0
-30.0
.Maitland
.Ardrossan
25km
.Mallala
.Truro
.Nuri
Rose
.Sedan
Gawler
.Edin
.Gumeracha
.Mannum
Intro to Radar in Wildfire
25/11/2015 03:30:58GMT BuckPk Refl Volume0 0.5el



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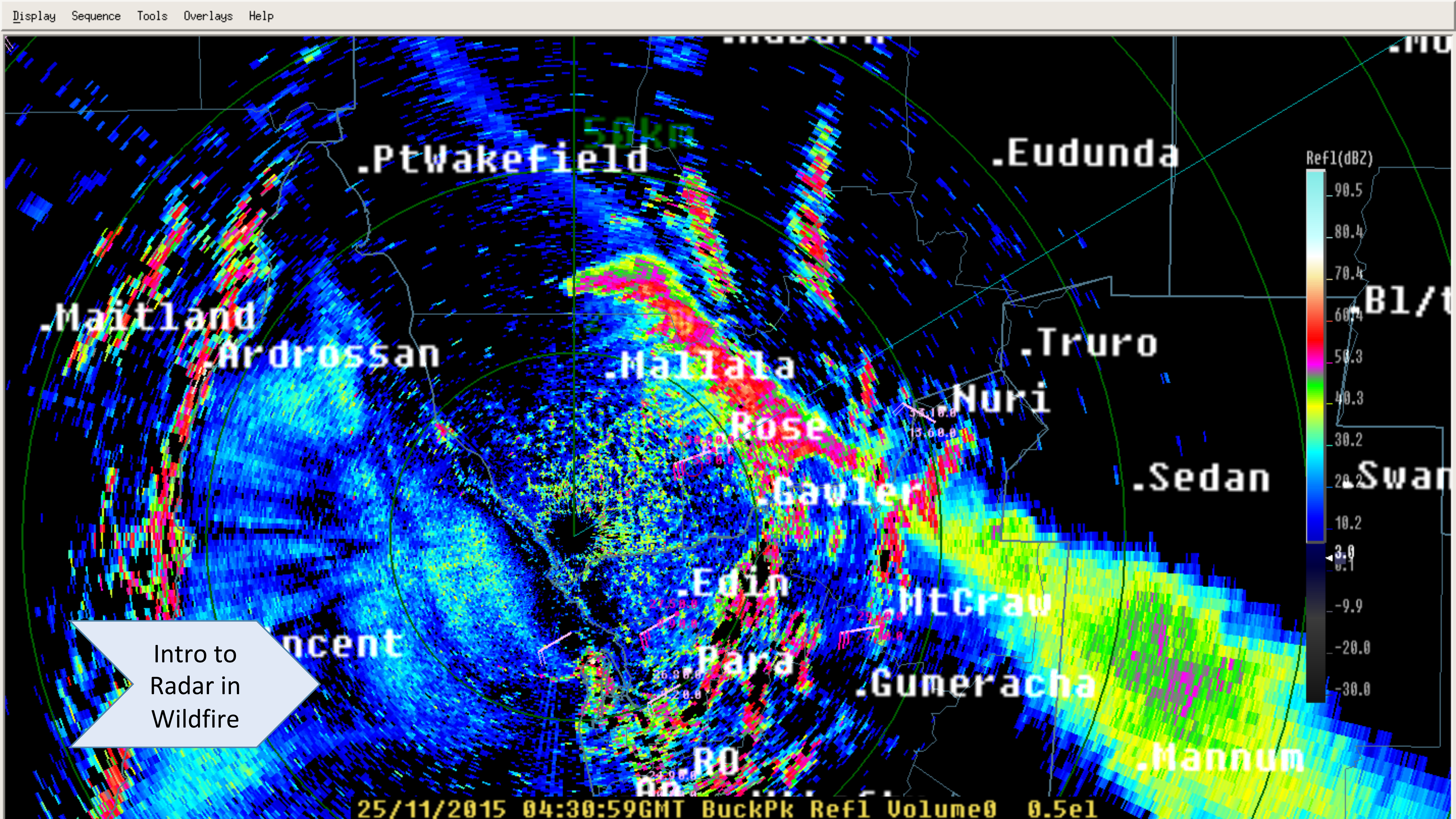
Display Sequence Tools Overlays Help
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.Ardrossan
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90.5
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20.2
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-9.9
-20.0
-30.0
25/11/2015 04:30:59GMT BuckPk Refl Volume0 0.5el
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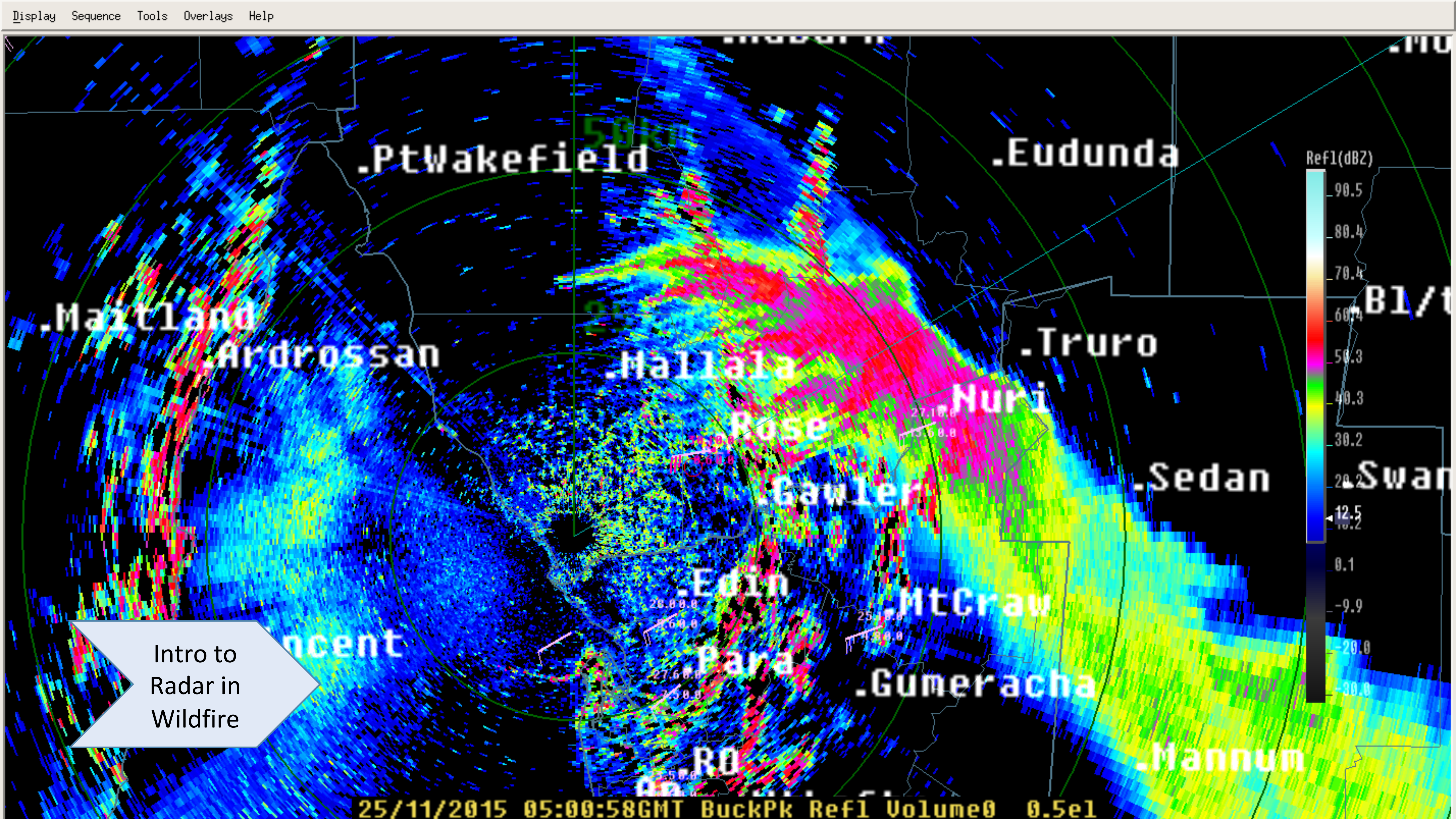

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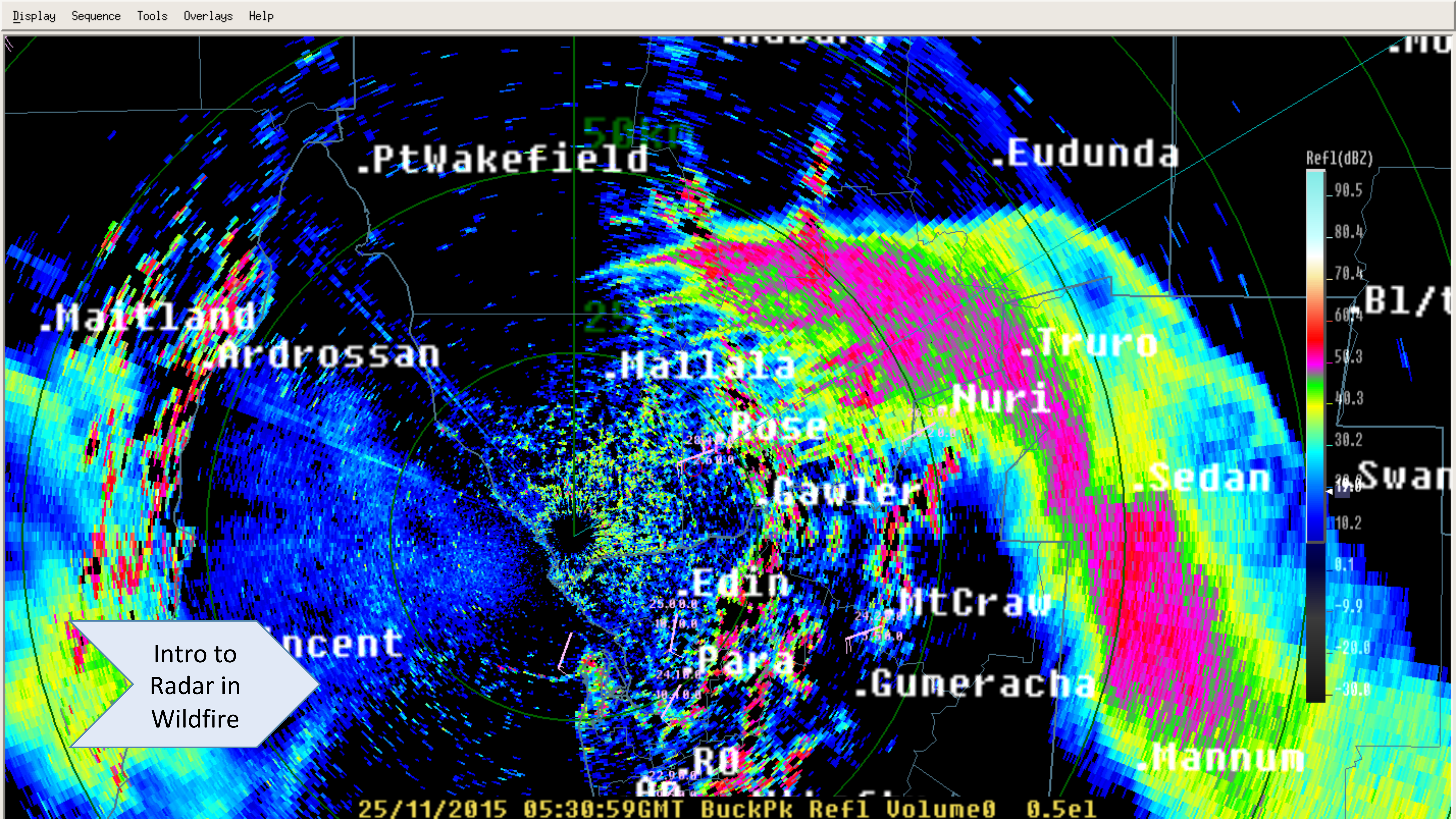


Intro to Radar in Wildfire

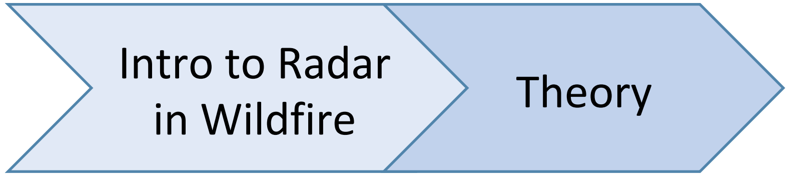

Introduction to Radar in Wildfire
Theory

$$Z = \frac{\lambda^4}{\pi^5 |K|^2} \eta$$

$$Z=\frac{\lambda^4}{\pi^5 |K|^2}\eta$$

Reflectivity Factor:

“What we see”



$Z= \lambda^4 / \pi^5 |K|^2 \eta$

Radar Wavelength:

Typically 5 or 10cm

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Theory

$$Z = \frac{\lambda^4}{\pi^5 |K|^2} \eta$$

Complex Dielectric Factor

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Theory

$$Z = \frac{\lambda^4}{\pi^5 |K|^2} \eta$$

Radar Cross Section

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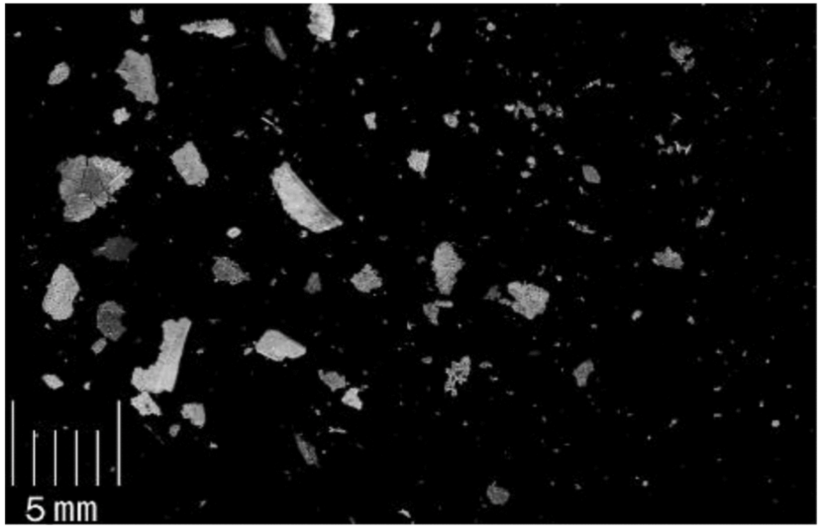
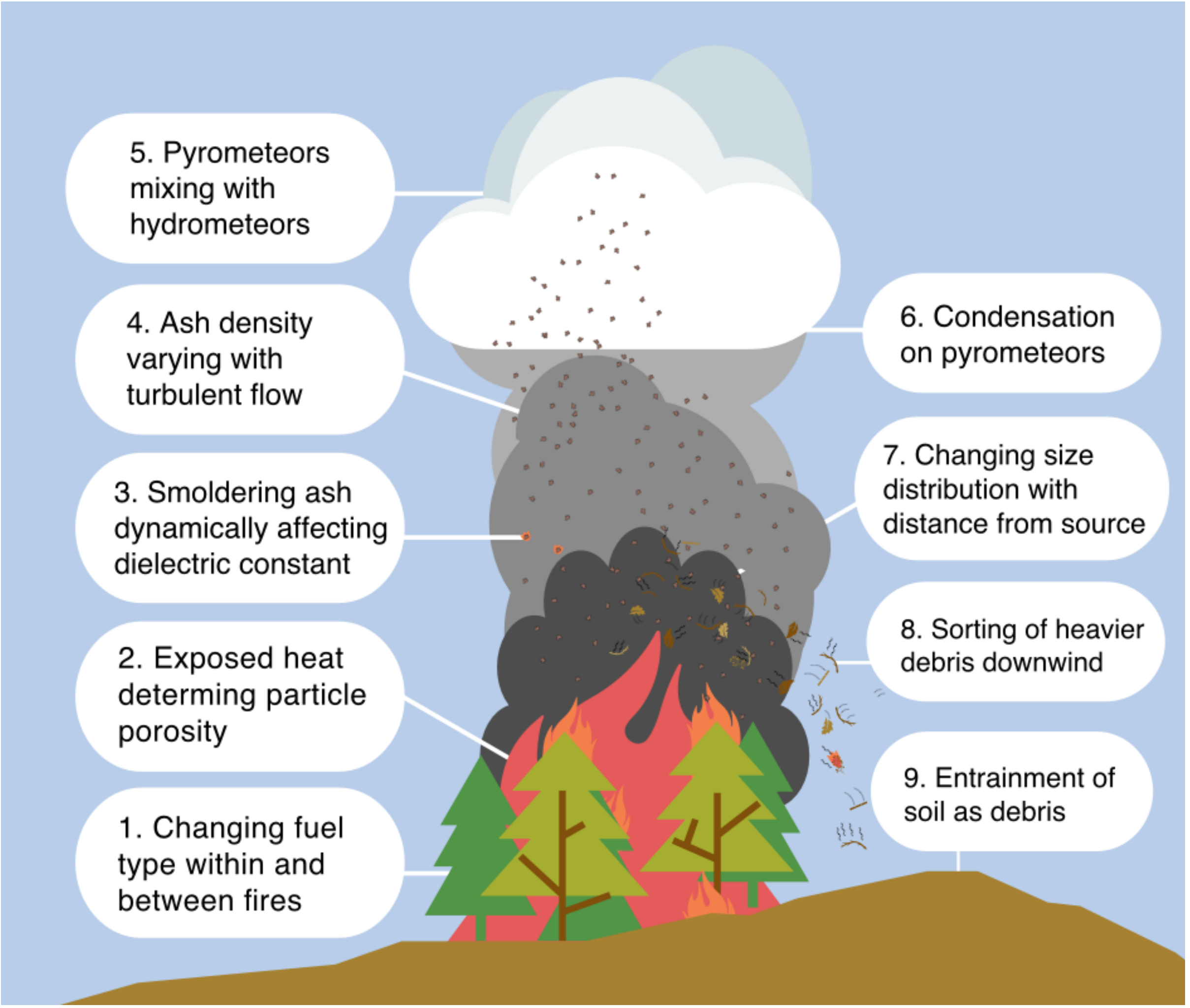
Theory

The "Pyrometeor"





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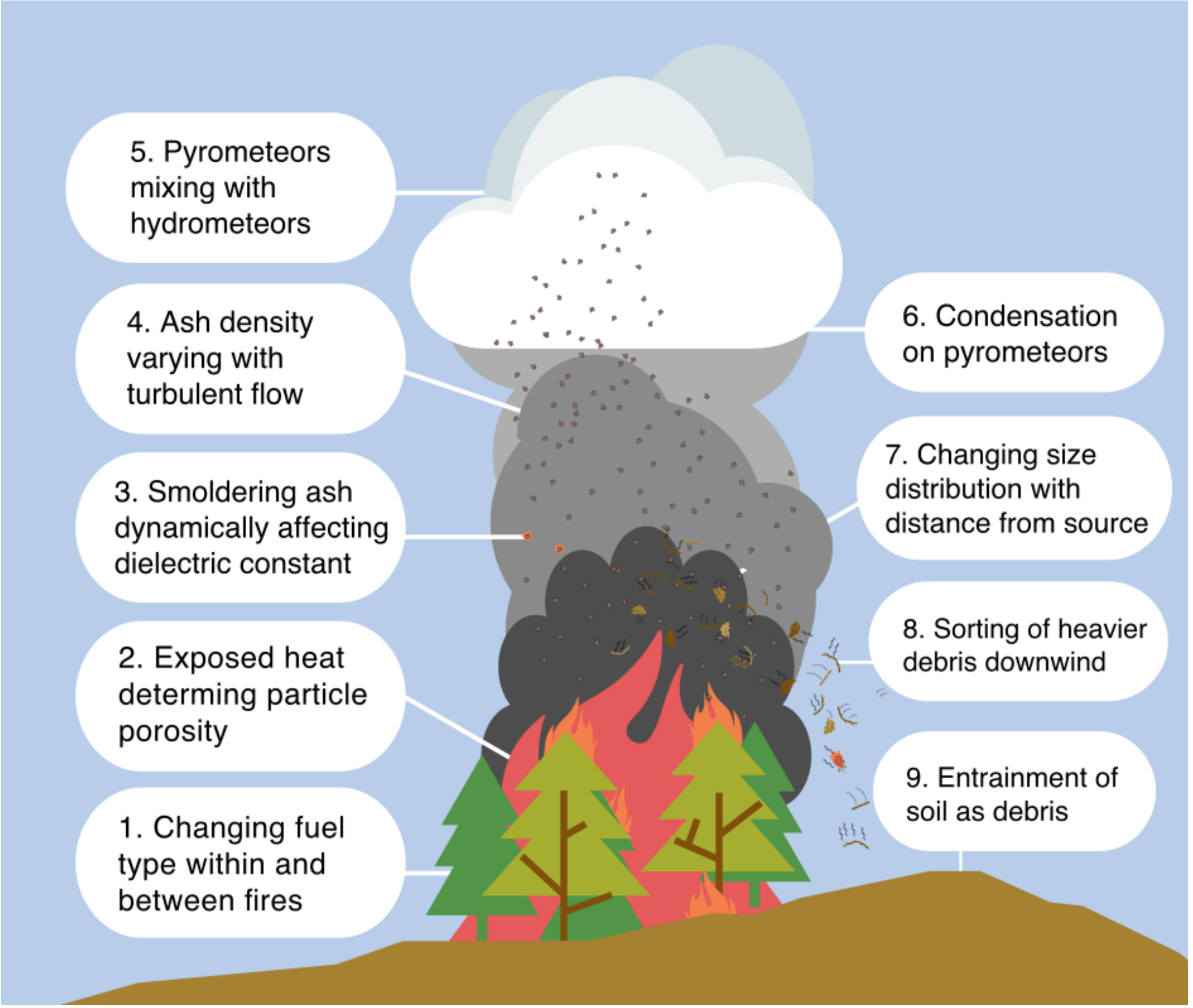
The “Pyrometeor”



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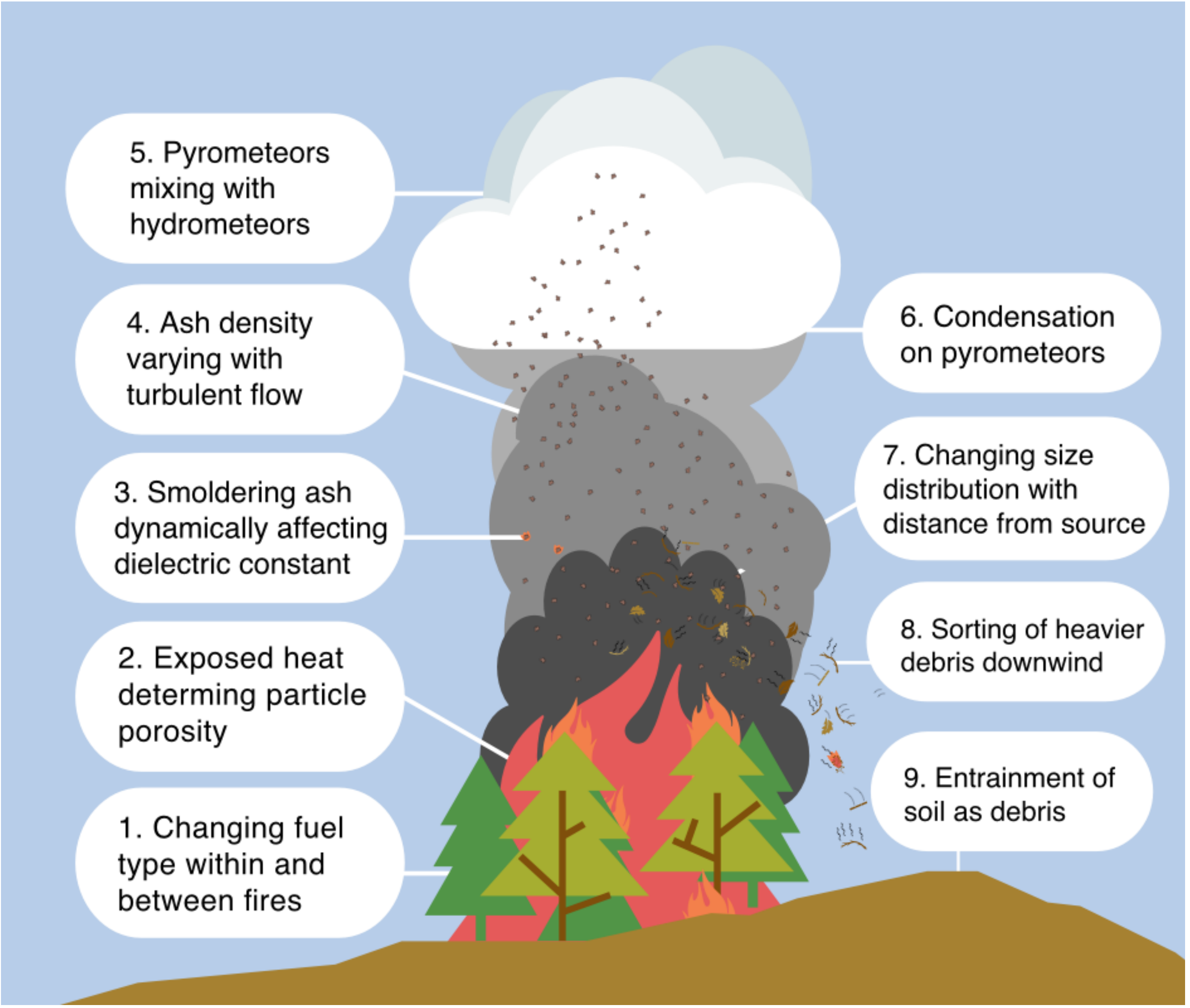
The "Pyrometeor"



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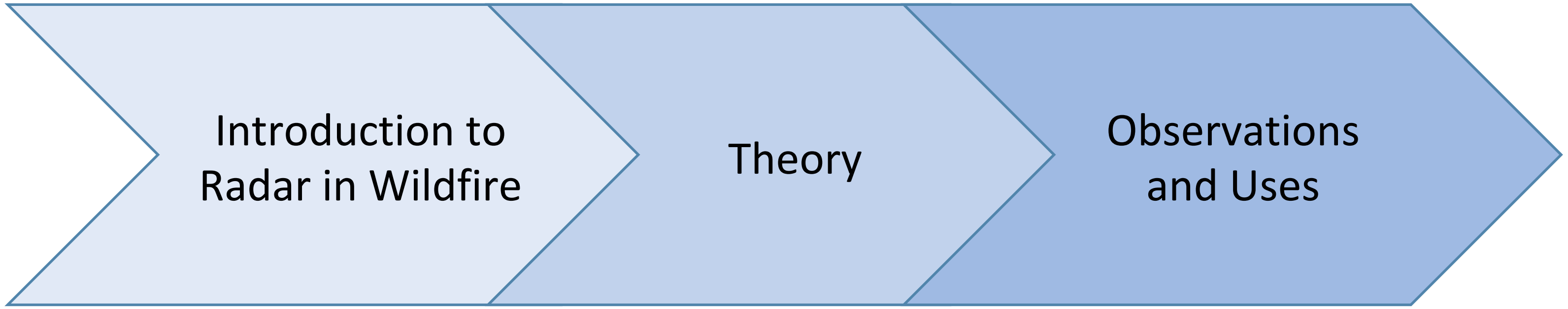
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Reflectivity

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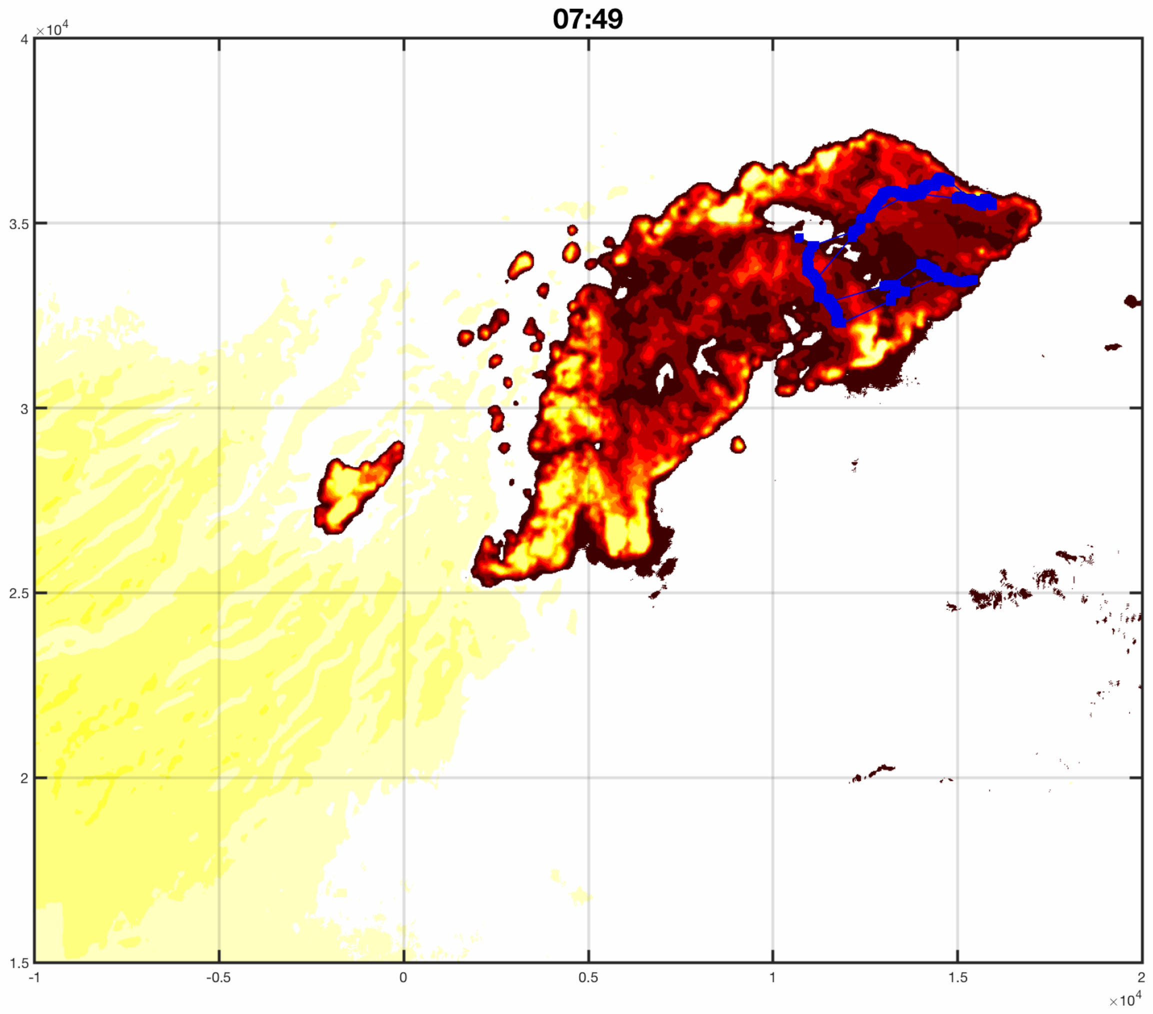
The Camp Fire: Preliminary Results

- Base map: Landsat pass
- Radar-derived isochrones
- Every 5 minutes



Work being led by Neil Lareau (UNR)

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Doppler Velocity

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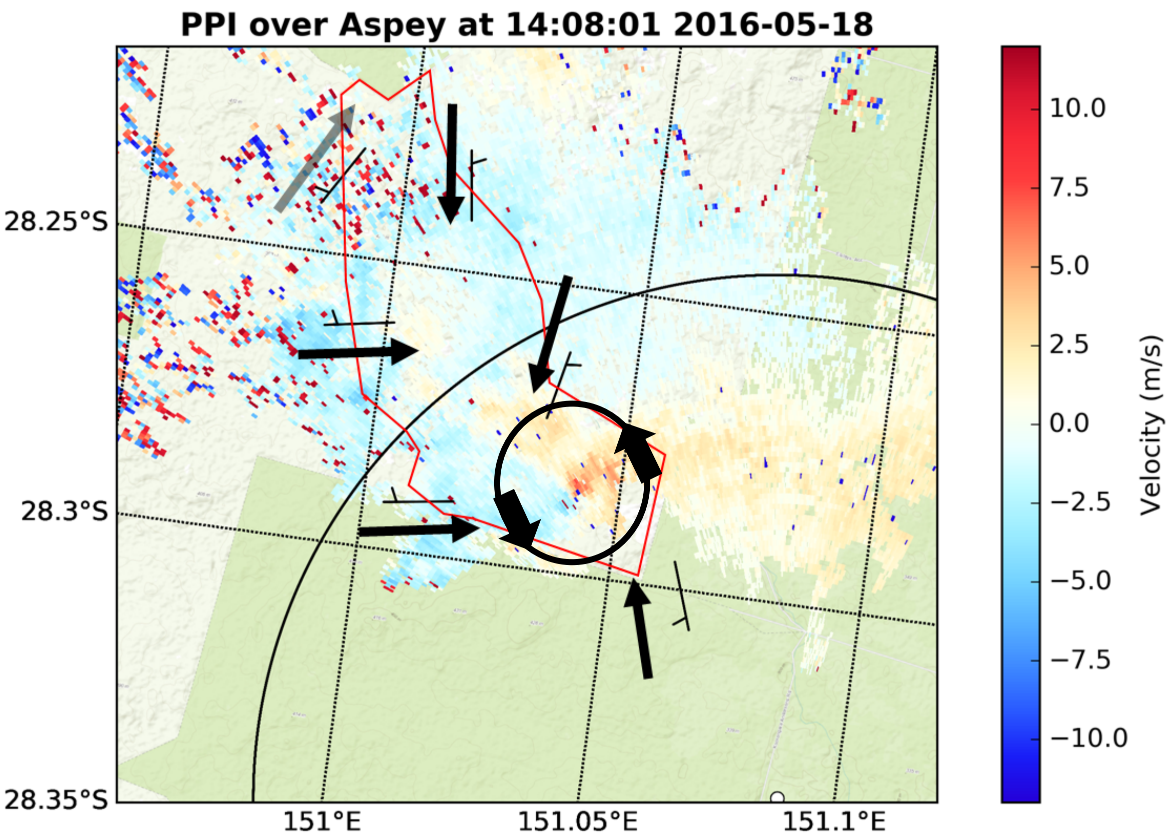
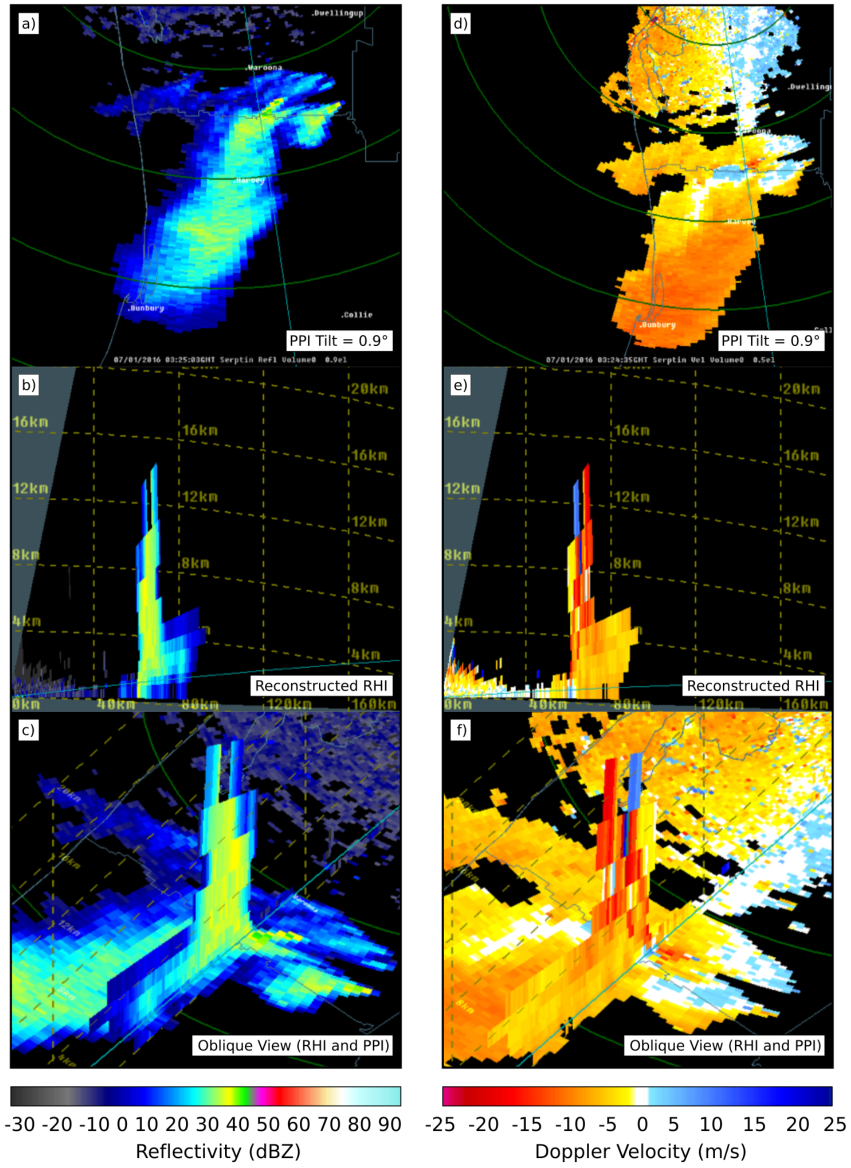
Peace et al. 2017





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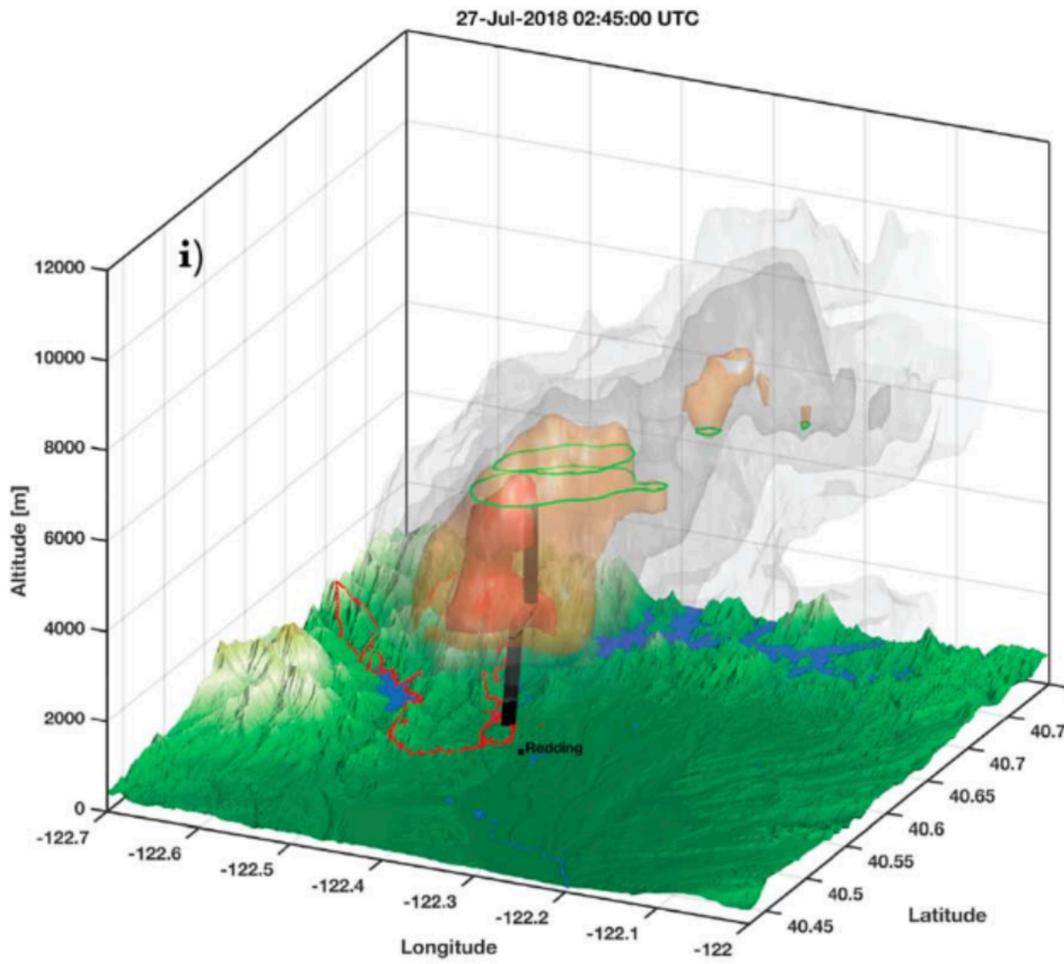
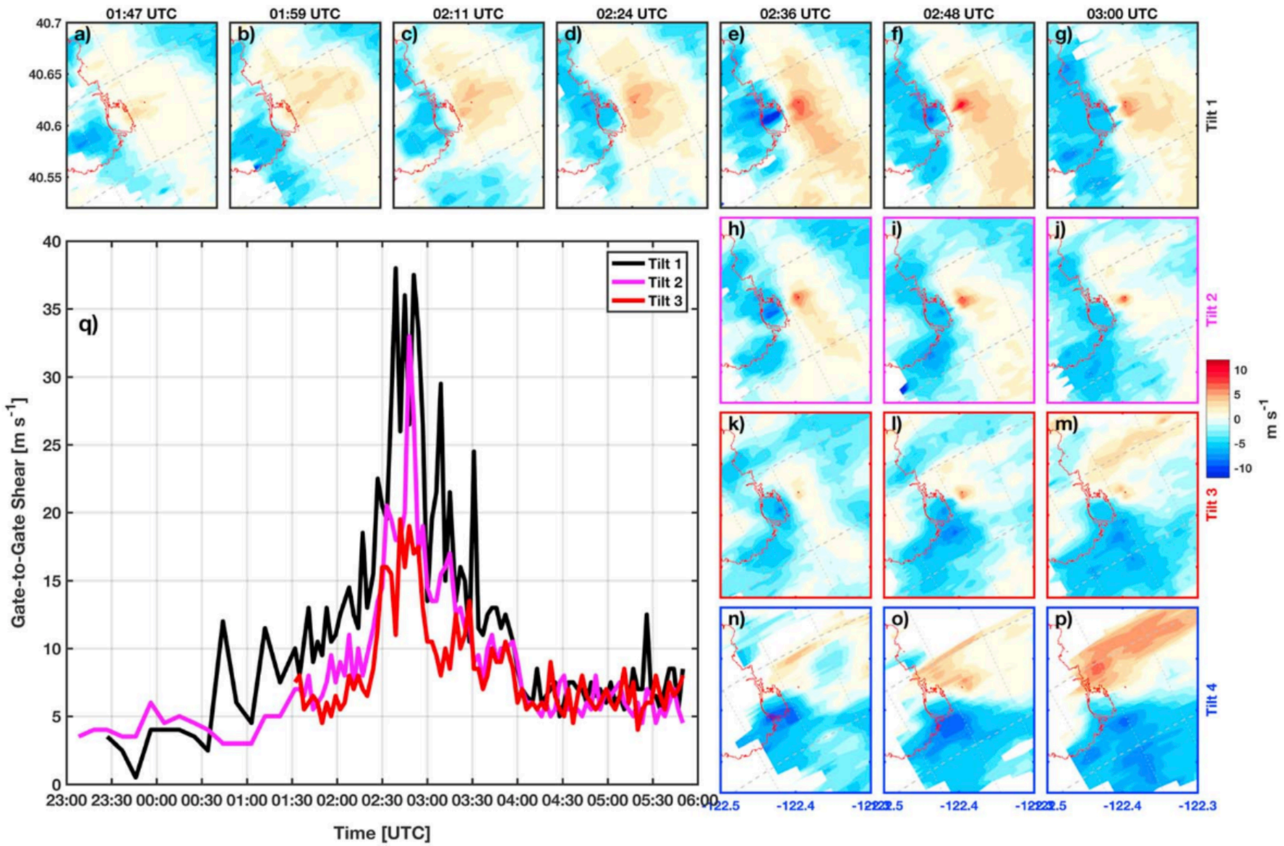
The Carr Fire:





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Lareau, N. P., Nauslar, N. J., & Abatzoglou, J. T. (2018). The Carr fire vortex: A case of pyrotornadogenesis? Geophysical Research Letters,45,13,107–13,115.

Echo-Tops

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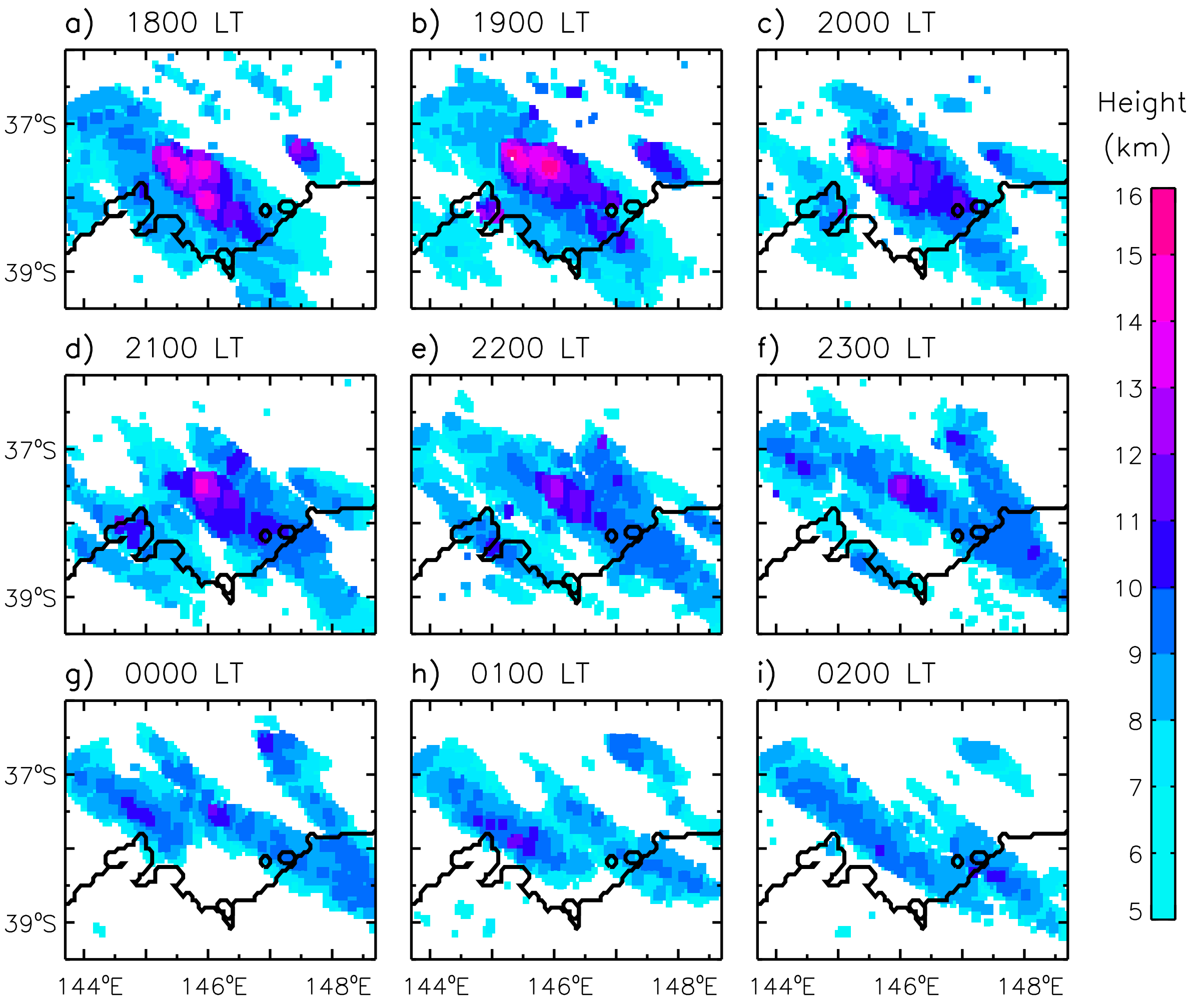
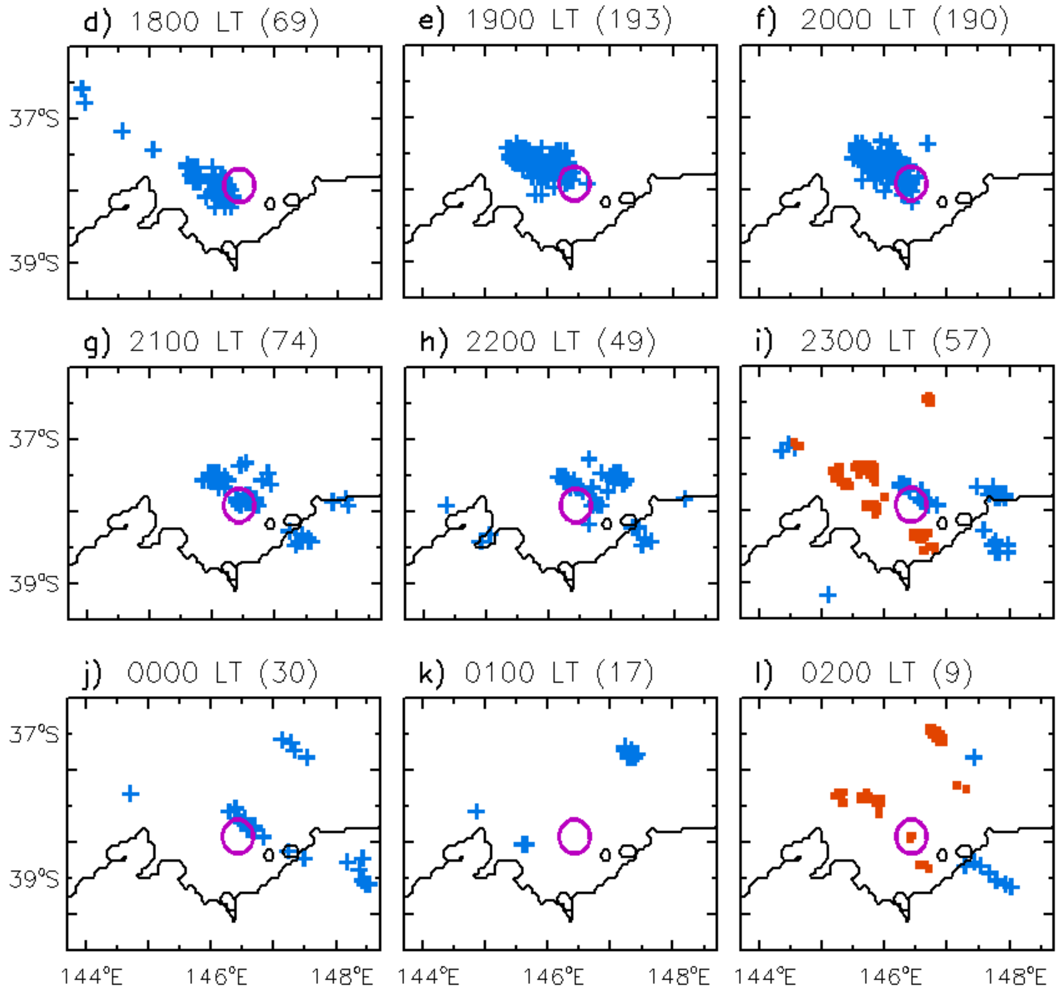
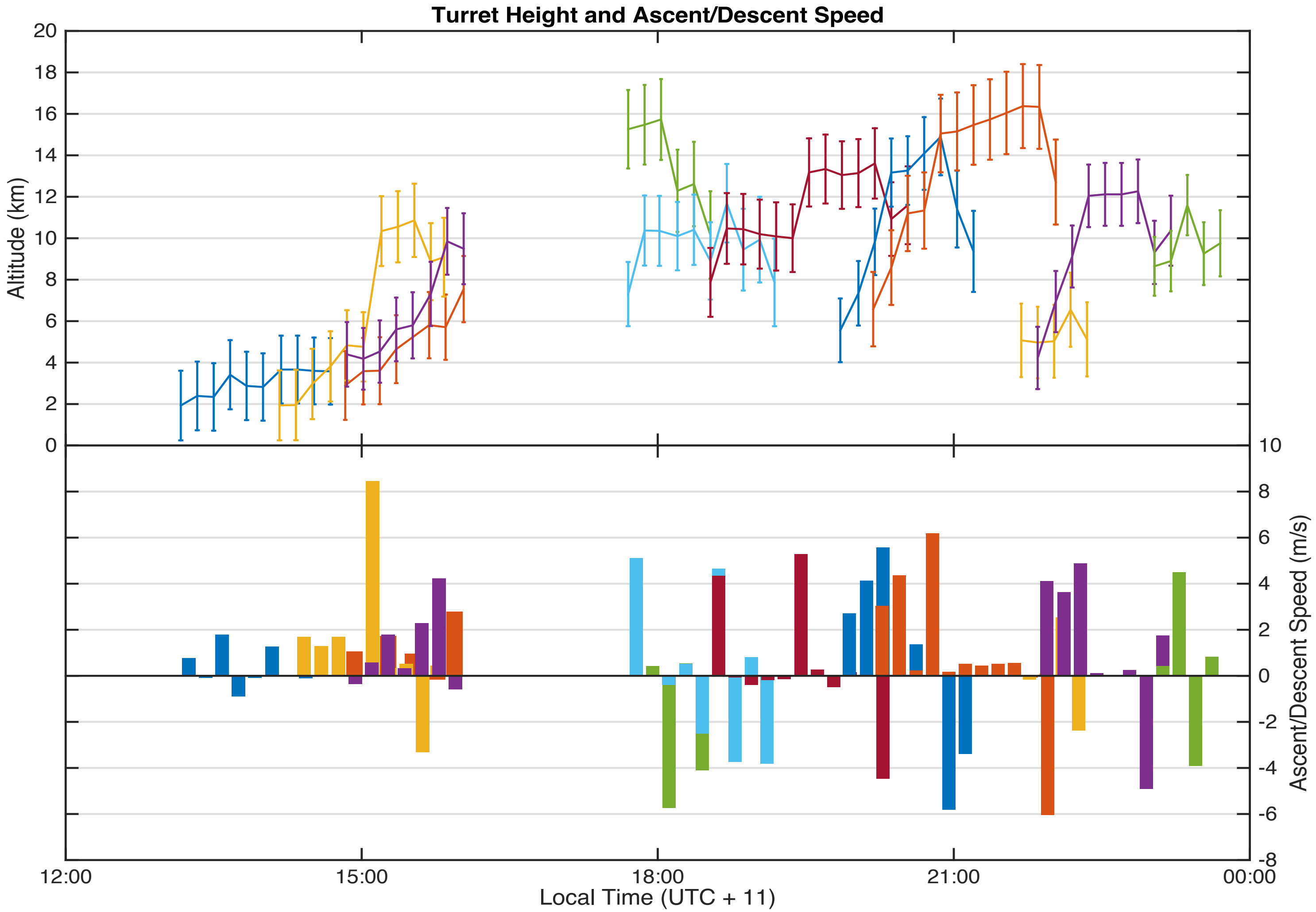

a) 1800 LT
b) 1900 LT
c) 2000 LT
d) 2100 LT
e) 2200 LT
f) 2300 LT
g) 0000 LT
h) 0100 LT
i) 0200 LT
37°S
39°S
144°E
146°E
148°E
Height (km)
16 15 14 13 12 11 10 9 8 7 6 5


d) 1800 LT (69)
e) 1900 LT (193)
f) 2000 LT (190)
g) 2100 LT (74)
h) 2200 LT (49)
i) 2300 LT (57)
j) 0000 LT (30)
k) 0100 LT (17)
l) 0200 LT (9)
37°S
39°S
144°E
146°E
148°E

Velocity ‘Turrets’



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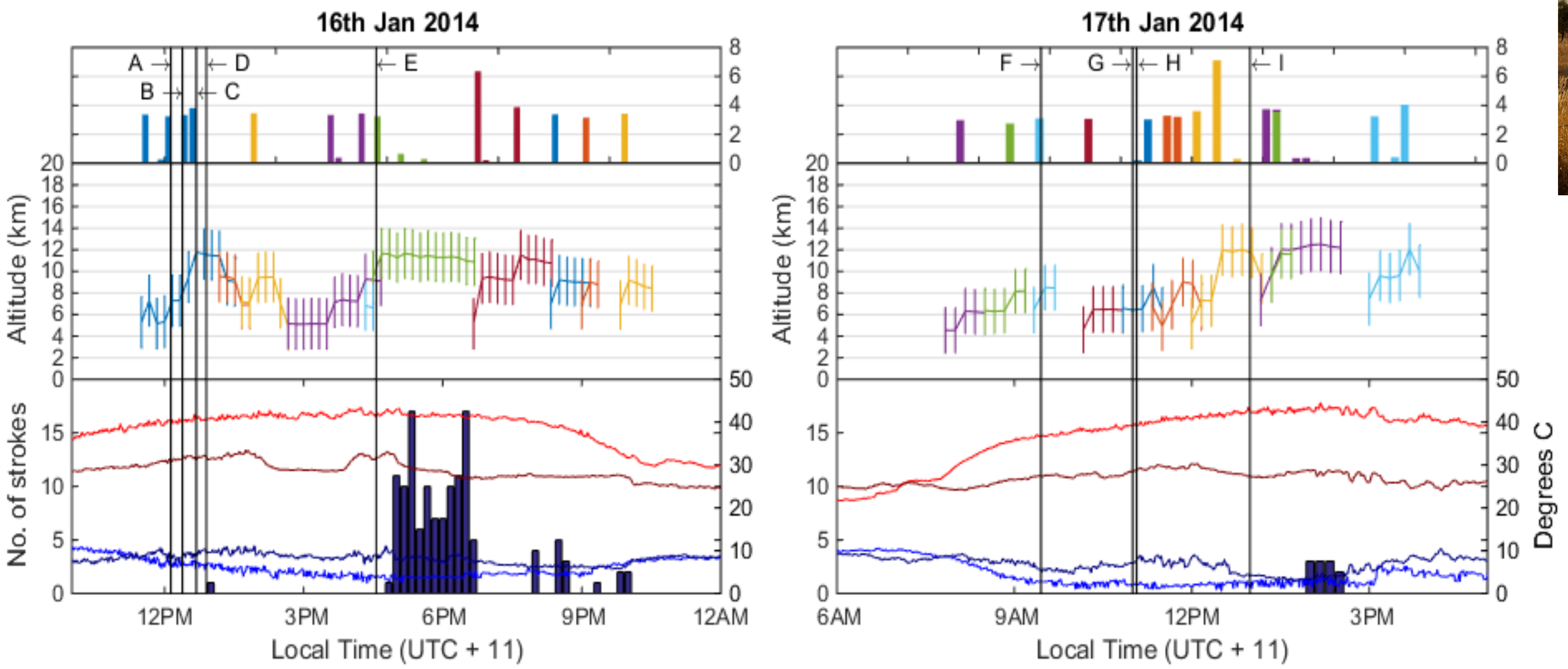

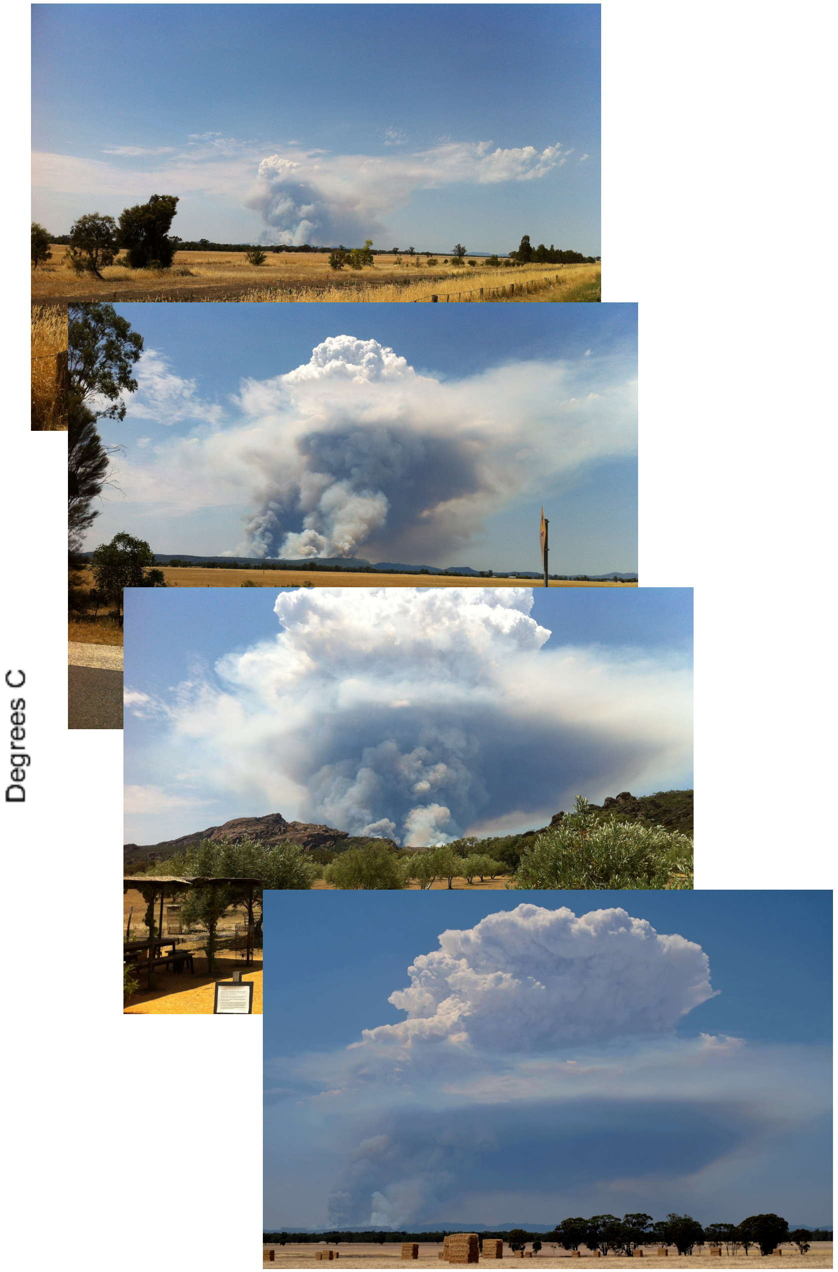

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Convective Outflows

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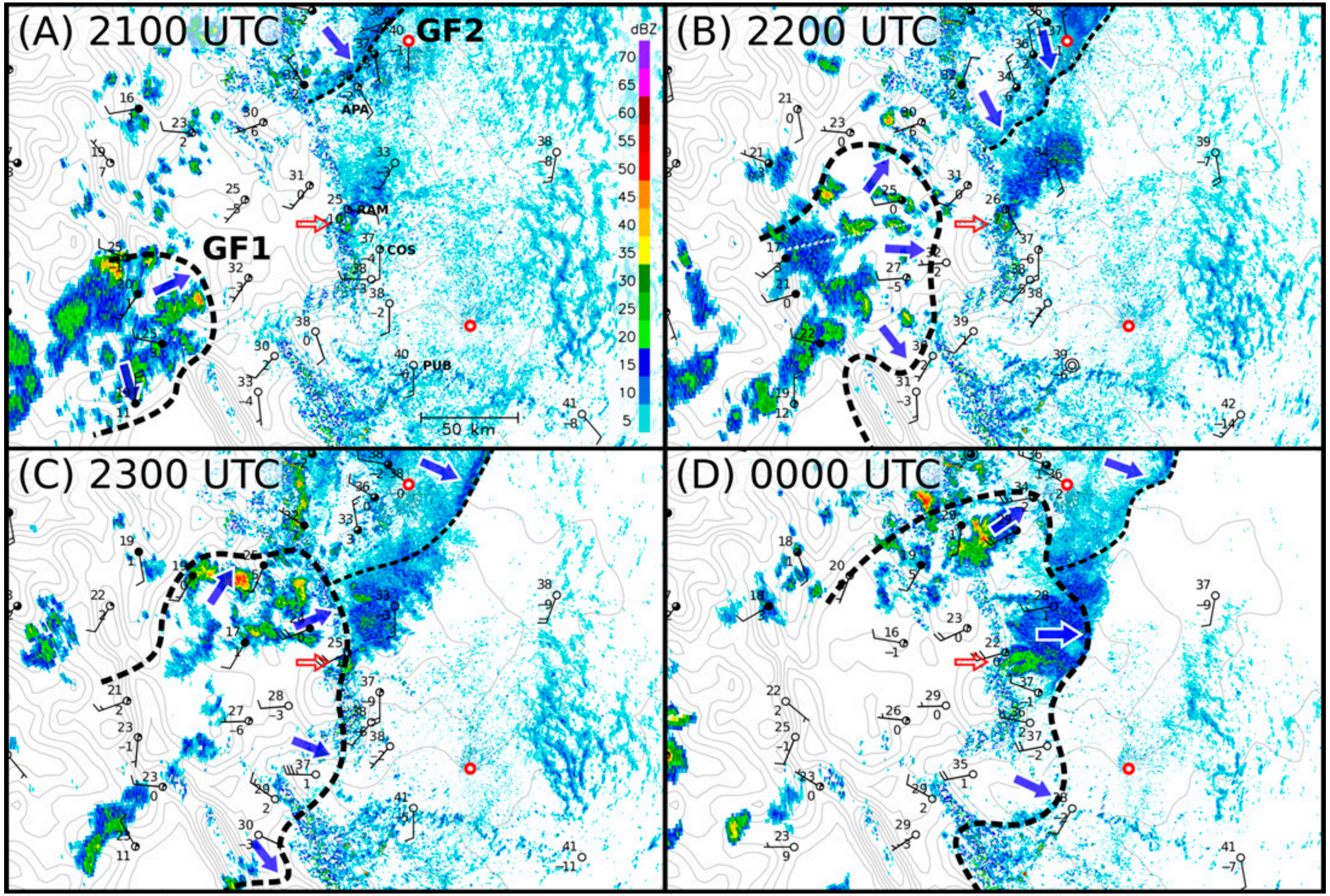

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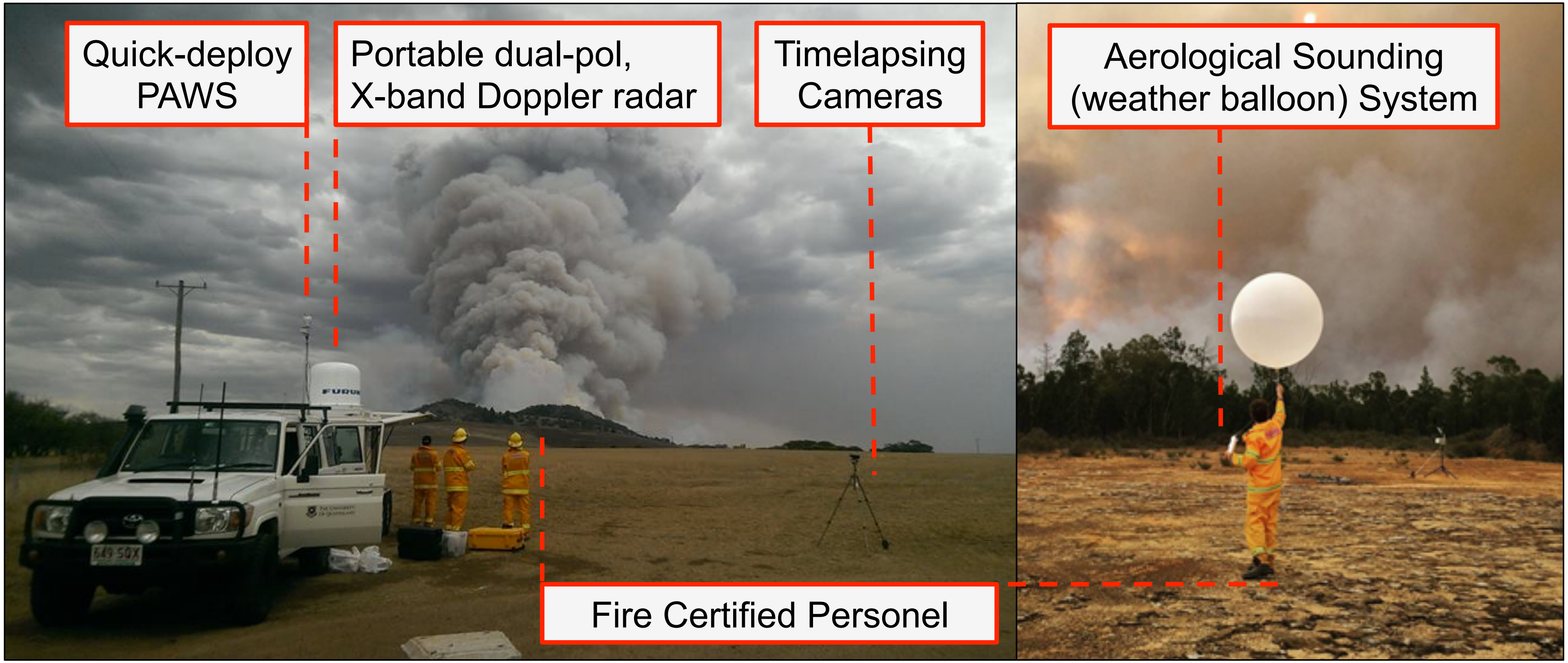
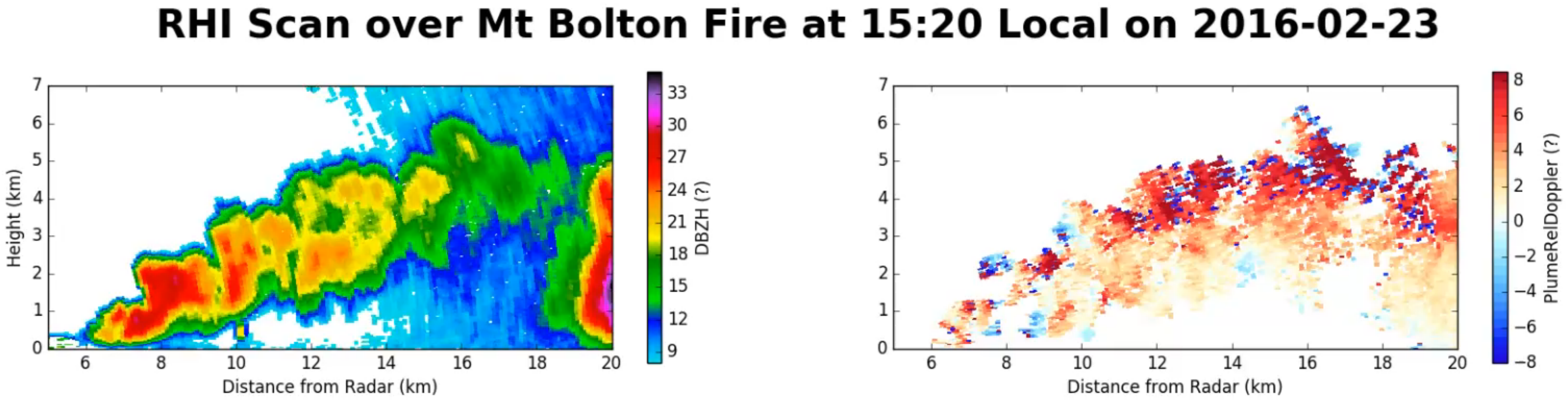
The Waldo Canyon Fire:
Johnson et al. (2014)

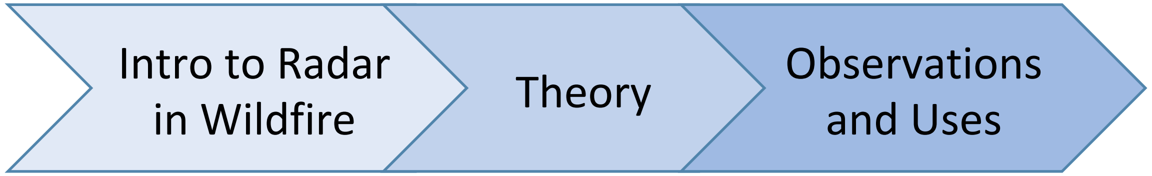
Mobile Radar Observations

Mobile Radar Observations



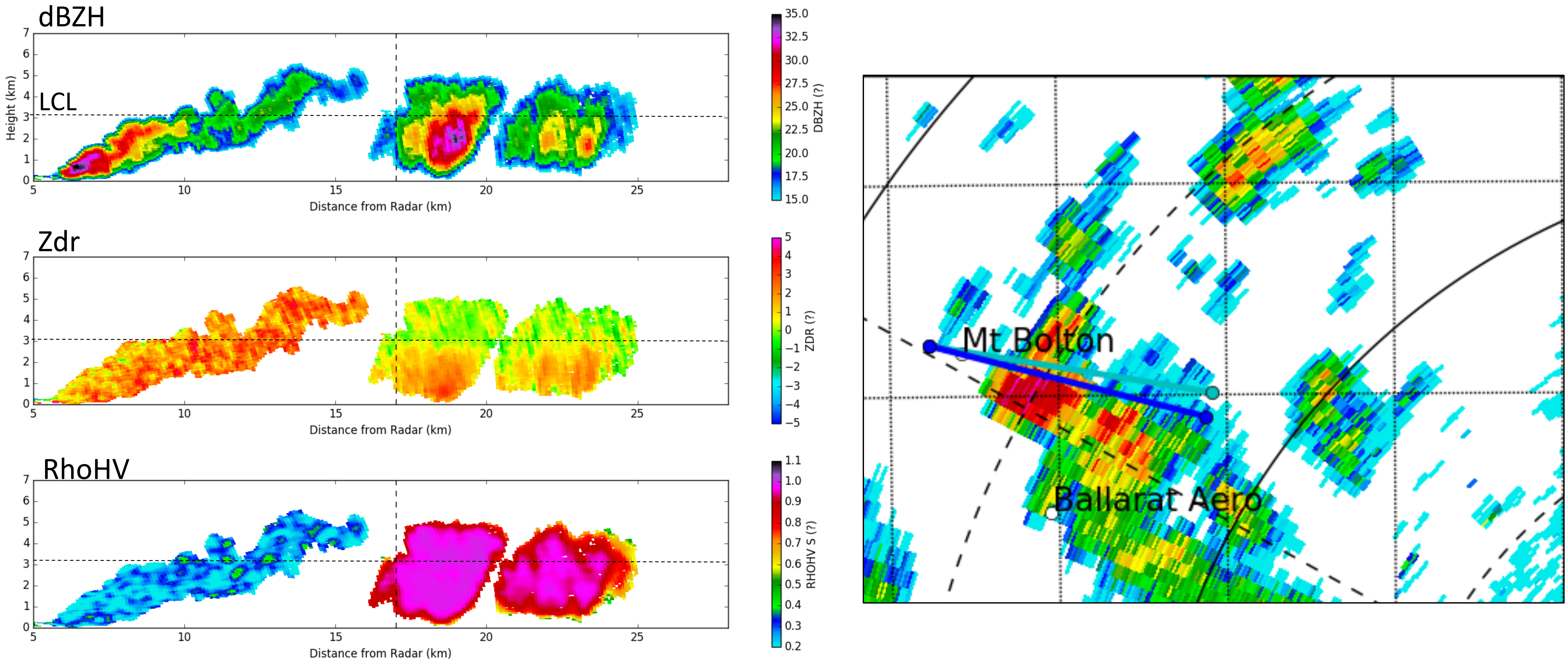
Reflectivity and Doppler Velocity





Dual Pol

RHI Scan over Mt Bolton Fire at 15:18:03 Local Time



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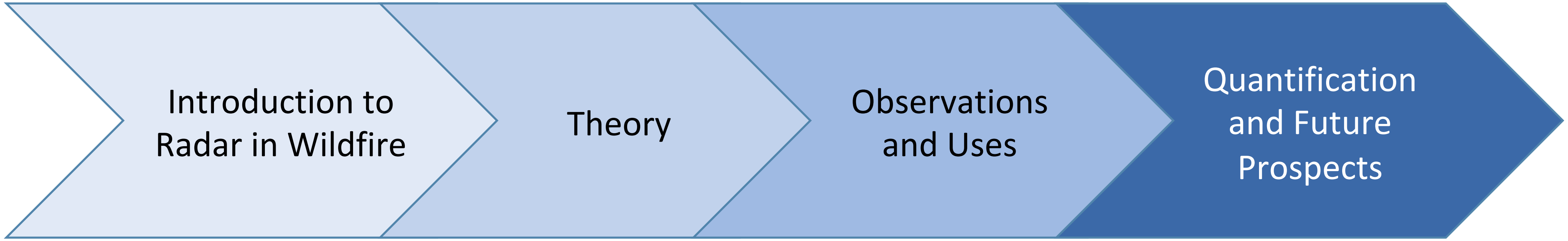
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Dual Polarization Clustering Methods

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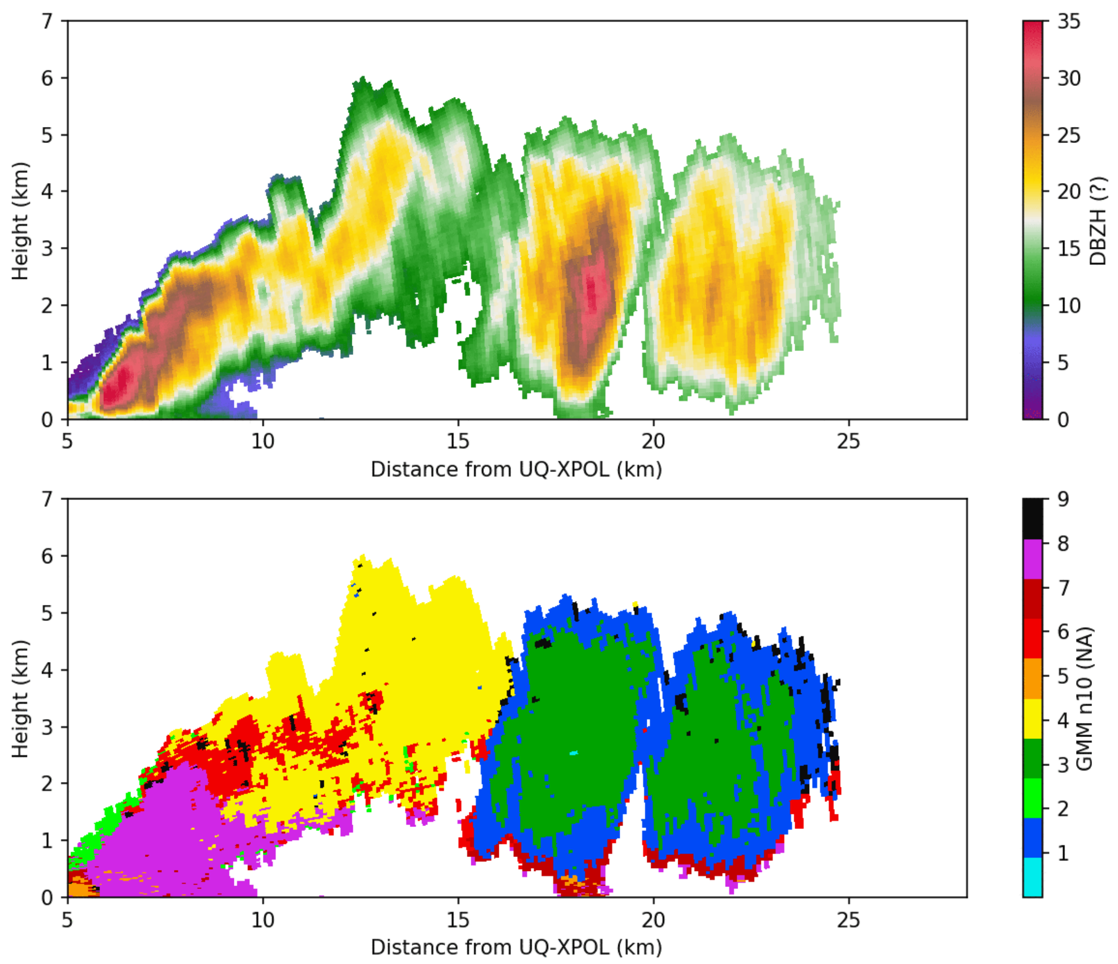

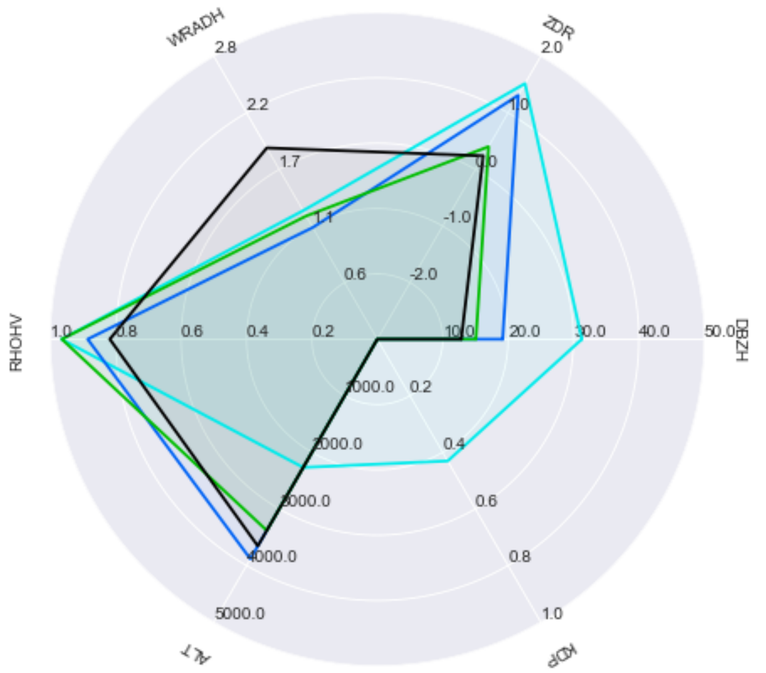

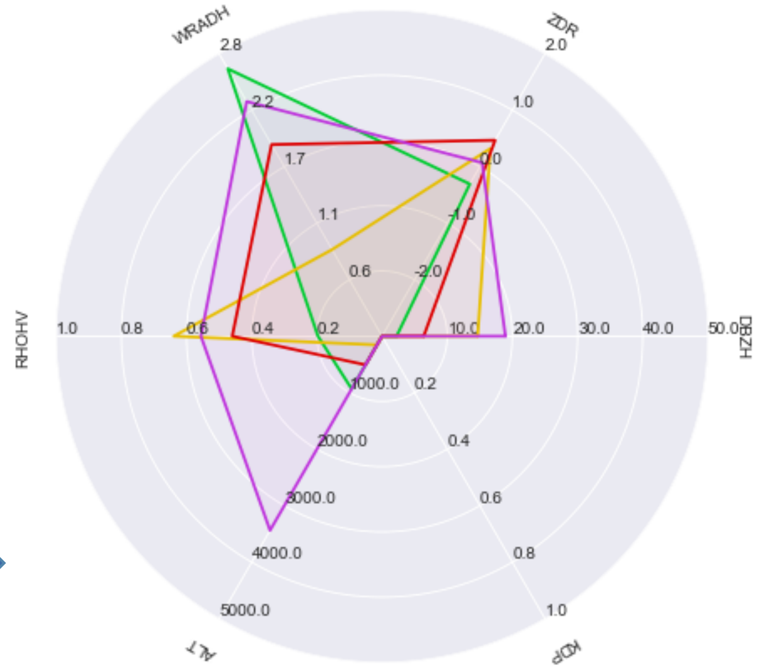

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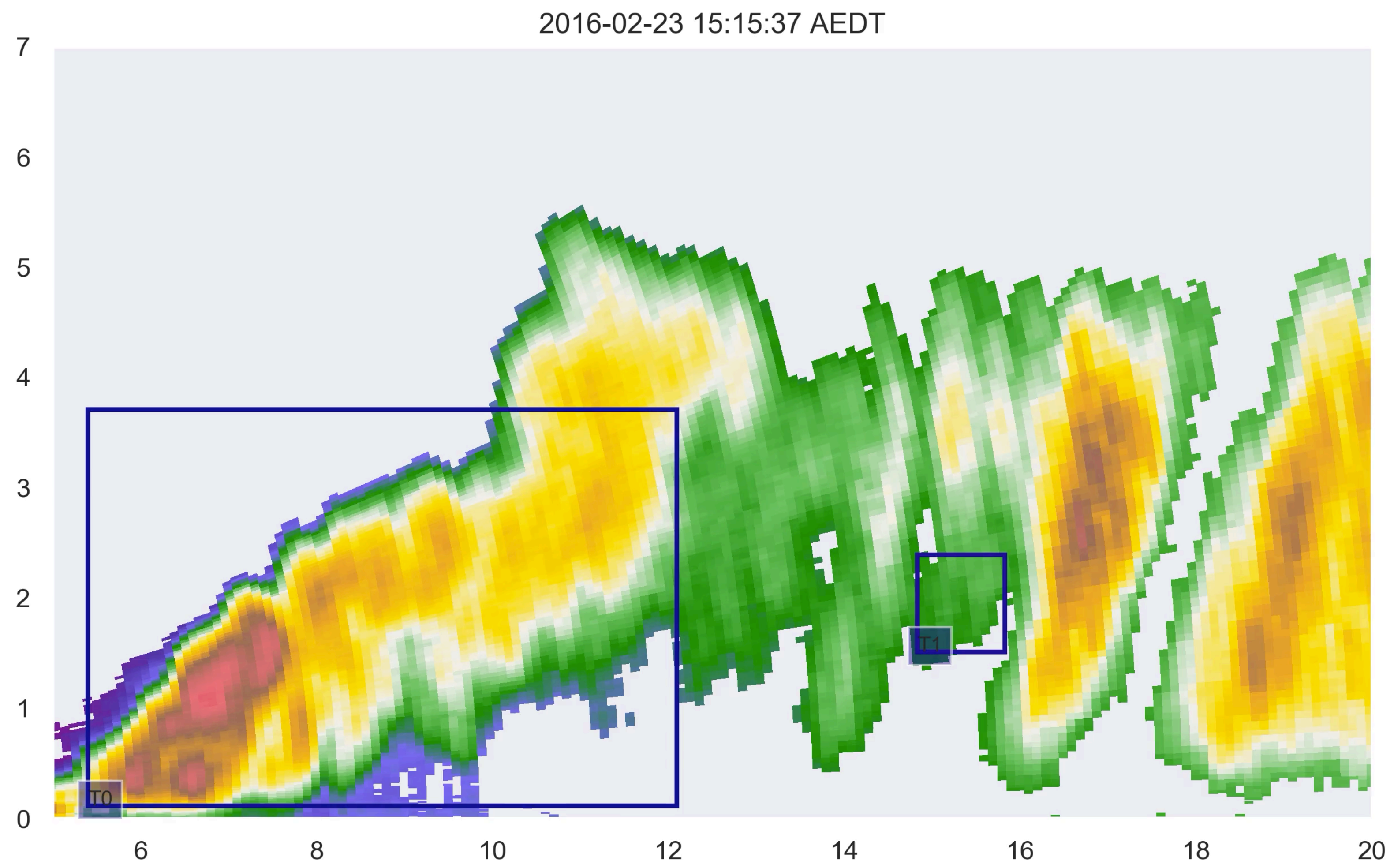
2016-02-23 15:15:37 AEDT
7
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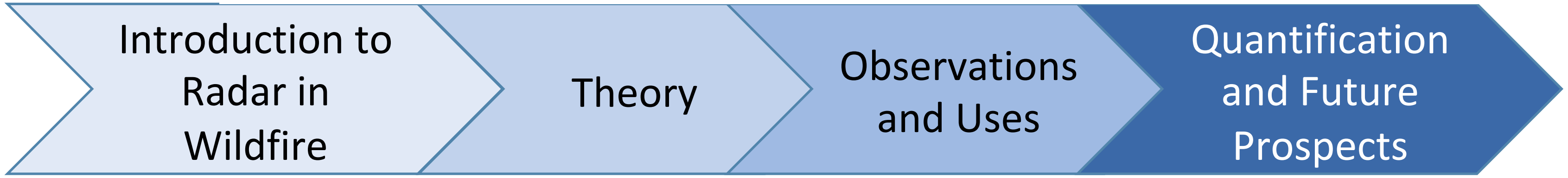
18
20
T0
T1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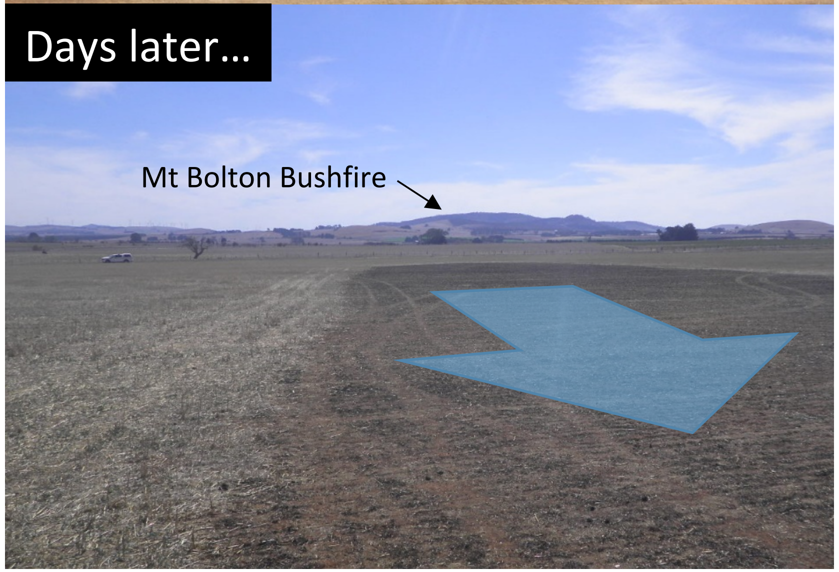
Spotting: Mt Bolton Bushfire Findings



Tracking Reflectivity Volumes

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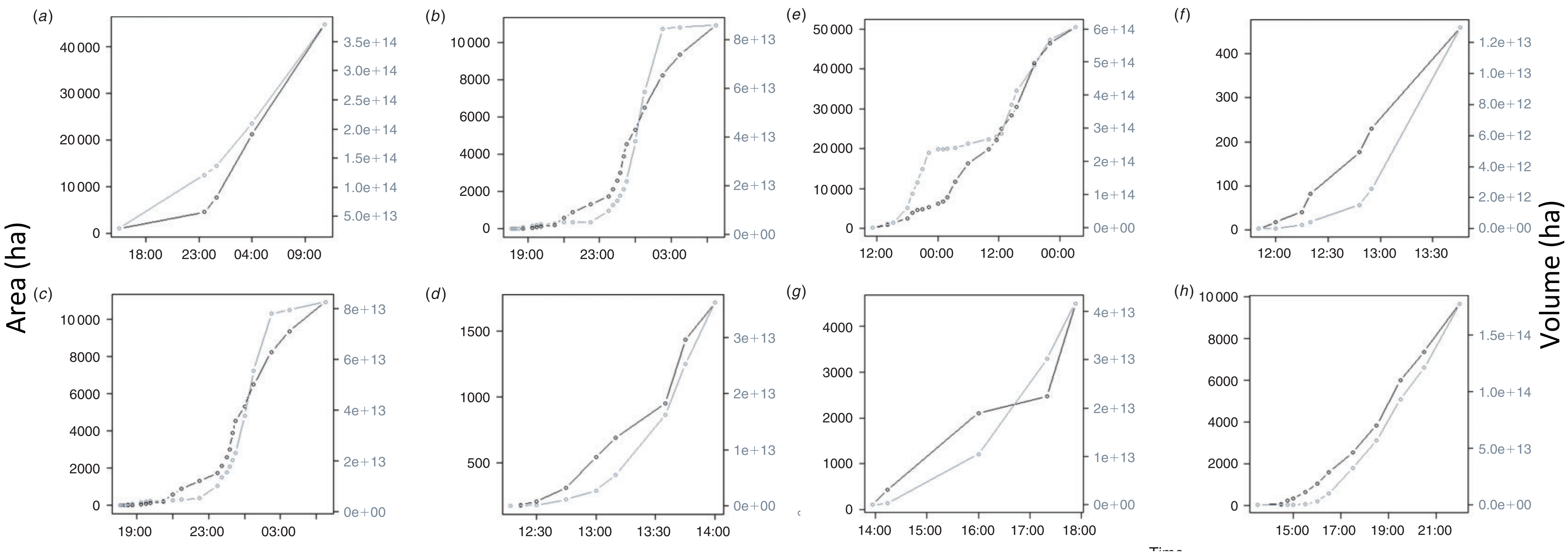

Fig. 3. Change in area and plume volume for fire–radar pairs (*a*) Aberfeldy (IDR68), (*b*) Beechworth (IDR68), (*c*) Beechworth (IDR49), (*d*) Bunyip Ridge (IDR02), (*e*) Grampians (IDR14), (*f*) Kilmore (IDR02), (*g*) Tostaree (IDR68), (*h*) White Timber Spur (IDR68). Volumes are calculated filtering out returns below 10 dBZ and calculating the sum of returns within a 60-km radius of the fire location. Points represent fire observations.

Time

Duff et al. (2018)

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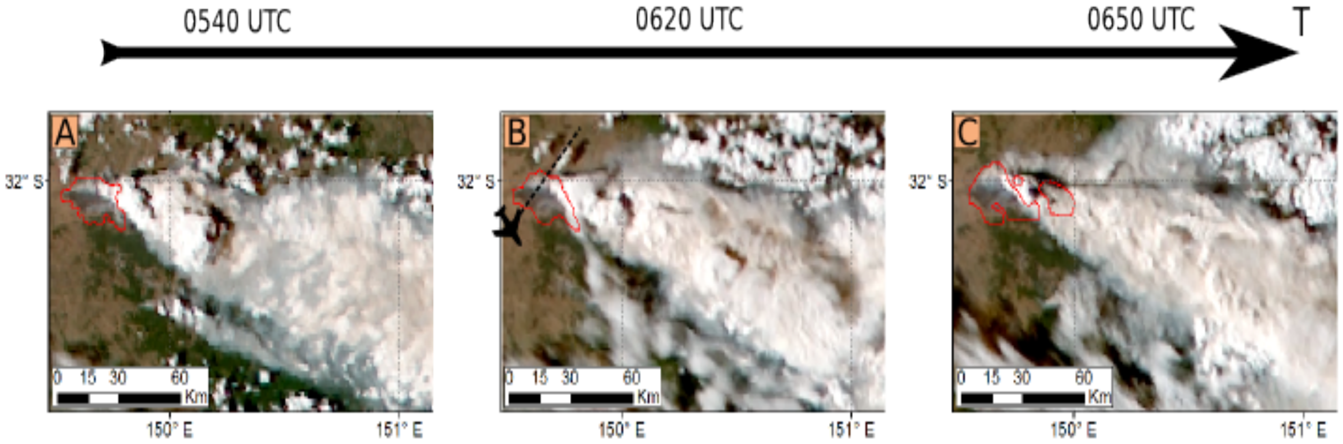
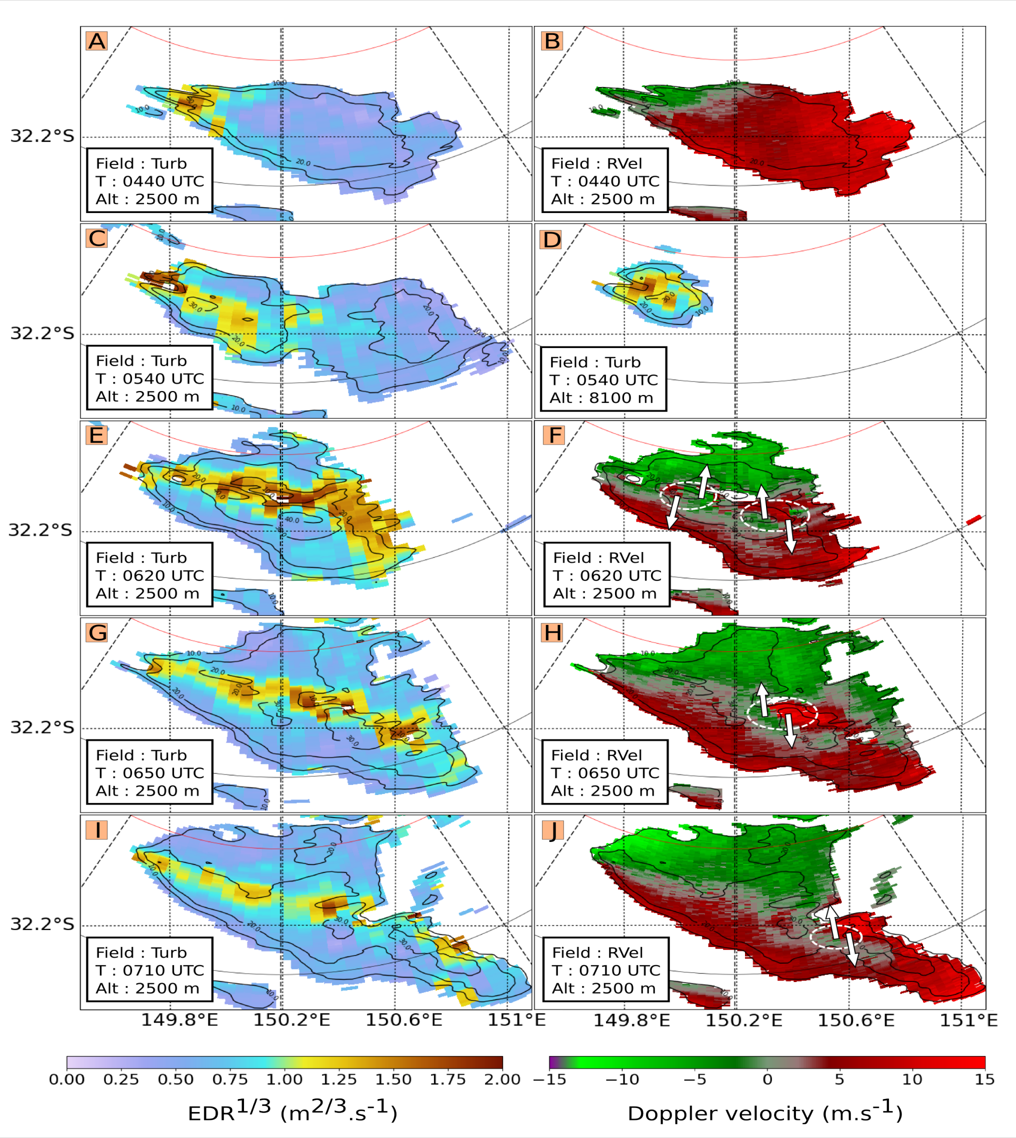
Quantifying Turbulence





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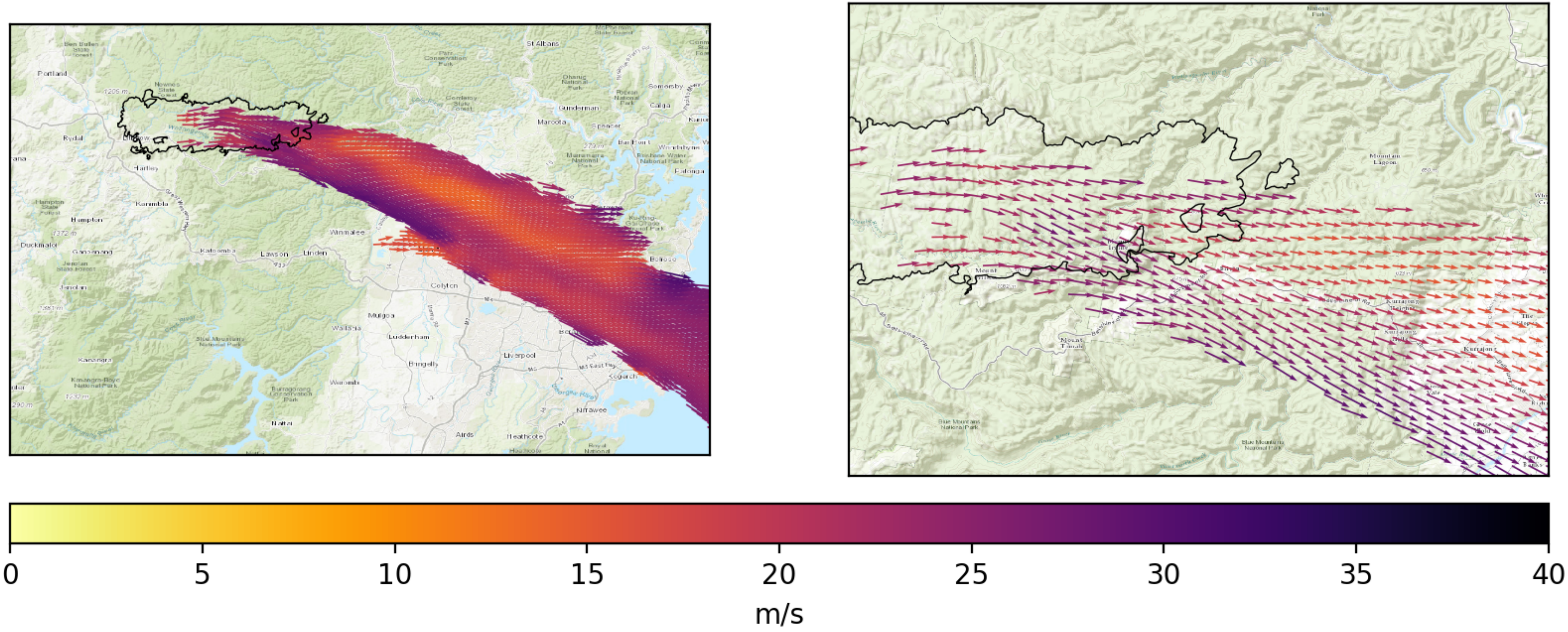
Credits: Alex Terrasson

Dual Doppler for Resolving 3D Winds

- Introduction to Radar in Wildfire
- Theory
- Observations and Uses
- Quantification and Future Prospects

State Mine Fire at 17:07 17 Oct: Horizontal Winds at 2.0 km A.S.L.



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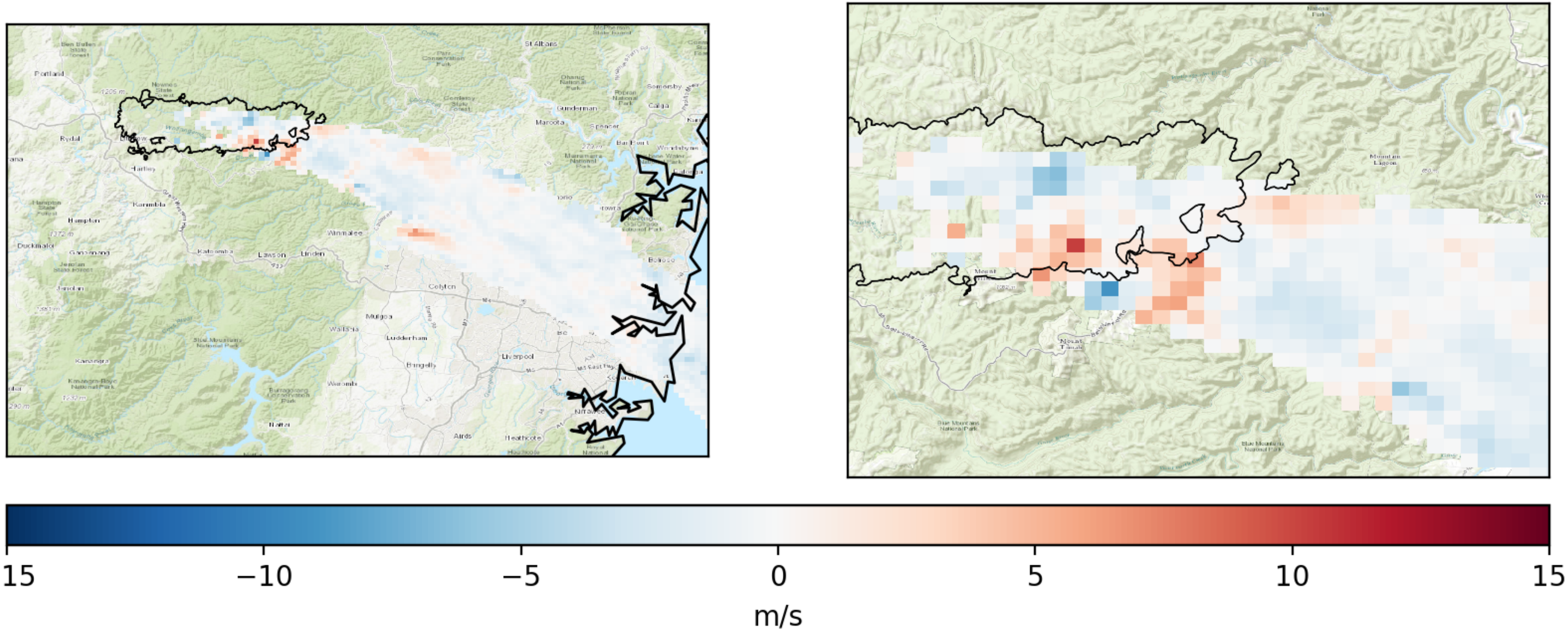
Credits: Alain Protat

State Mine Fire at 17:07 17 Oct: Vertical Wind at 2.0 km A.S.L.



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Credits: Alain Protat

Aircraft Cloud Radar

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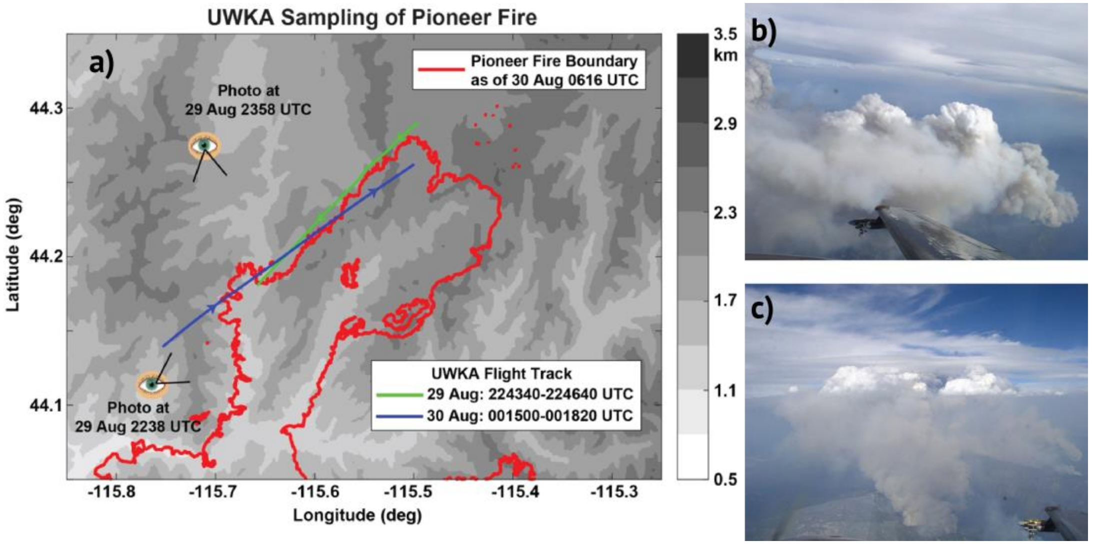
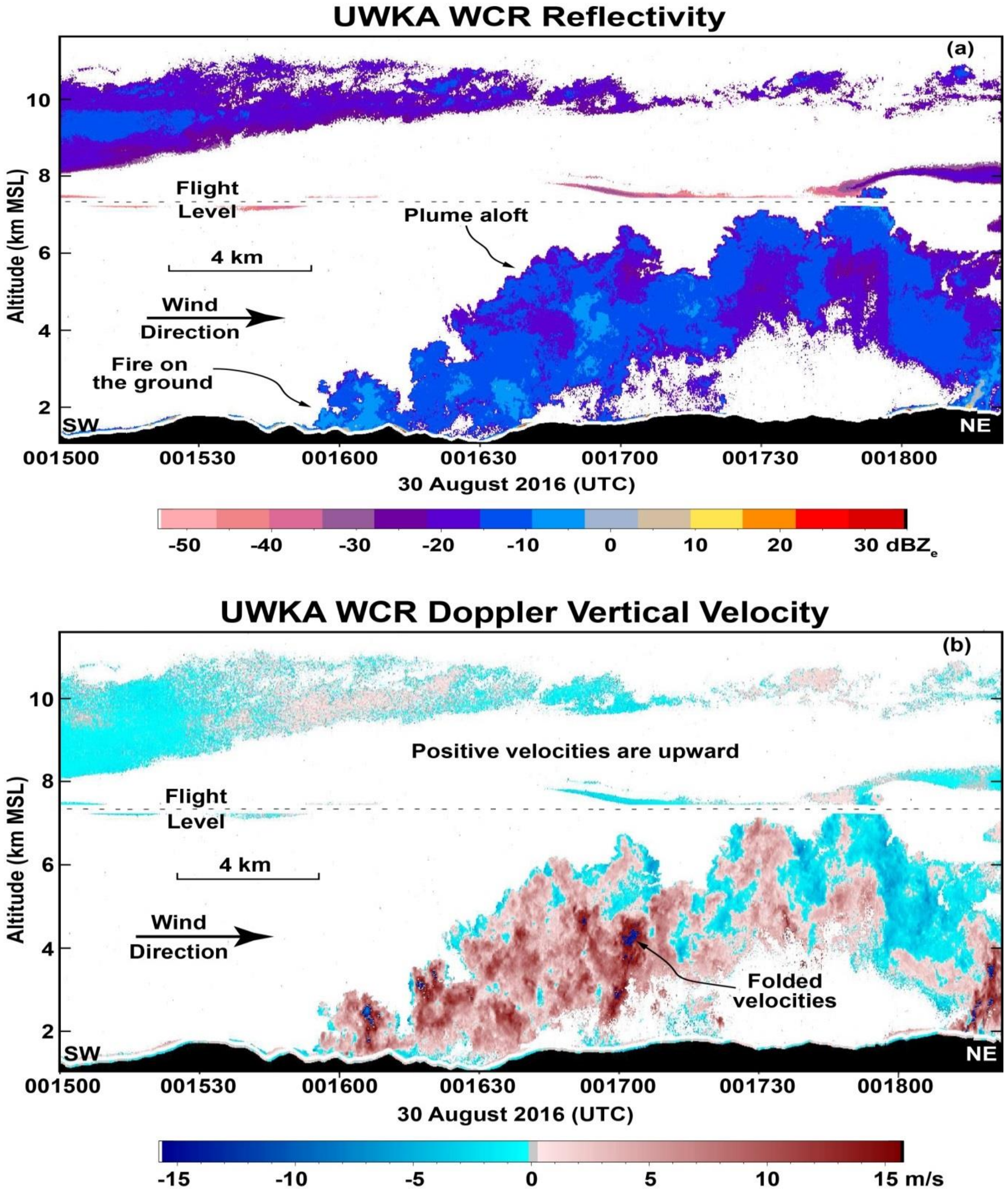
Wyoming King Air

Aircraft Mounted W-band Radar

Clements et al. (2018)



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Acknowledgments

Funded by:

- Country Fire Authority (Victoria)
- University of Queensland
  - Collaborative Industry Engagement Funding (CIEF)
  - School of Geography, Planning and Environmental Management
- Queensland Fire and Emergency Services

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Special thanks to Roland Barthelemy, Stan Badatcheff, Alex Terrasson, Michael Gray, Christopher Chambers, Joshua Soderholm, Andrew Sturgess, Tim Wells and Tim McKern, Claire Yeo, Kev Parkyn and all other FBANs, meteorologists and volunteers who made the observations possibe.


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