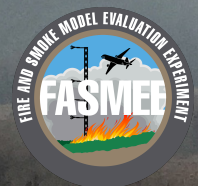


Muti-Remote Sensor Observations of a Rotating Pyrocumulus Plume

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Aydell², Matthew Brewer², Adam
Kochanski³

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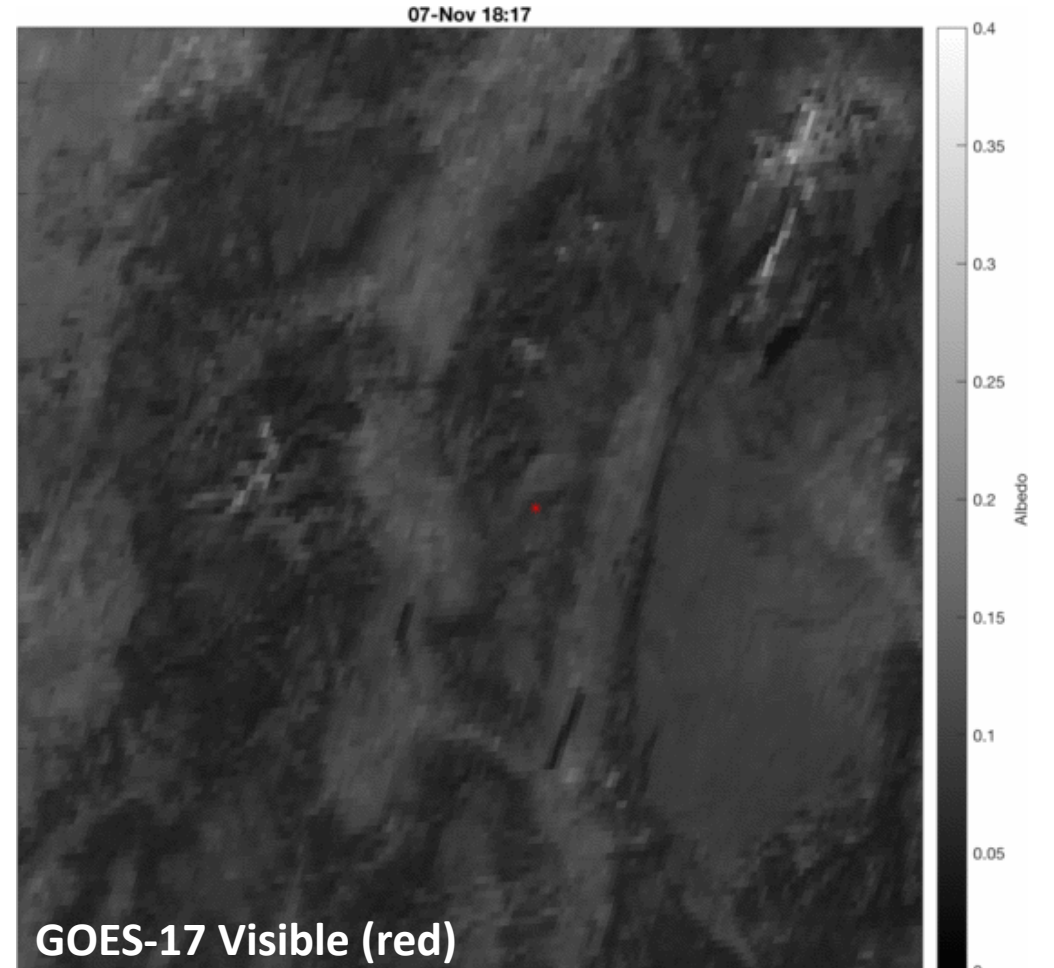
From the Ground:



The goals of this talk are to describe and understand:

- Vigorous convection/Plume Evolution
- Strong rotation

From Space:



- Pyrocumulus (pyroCu) initiation and growth

The Burn and the Instruments

The Fire:

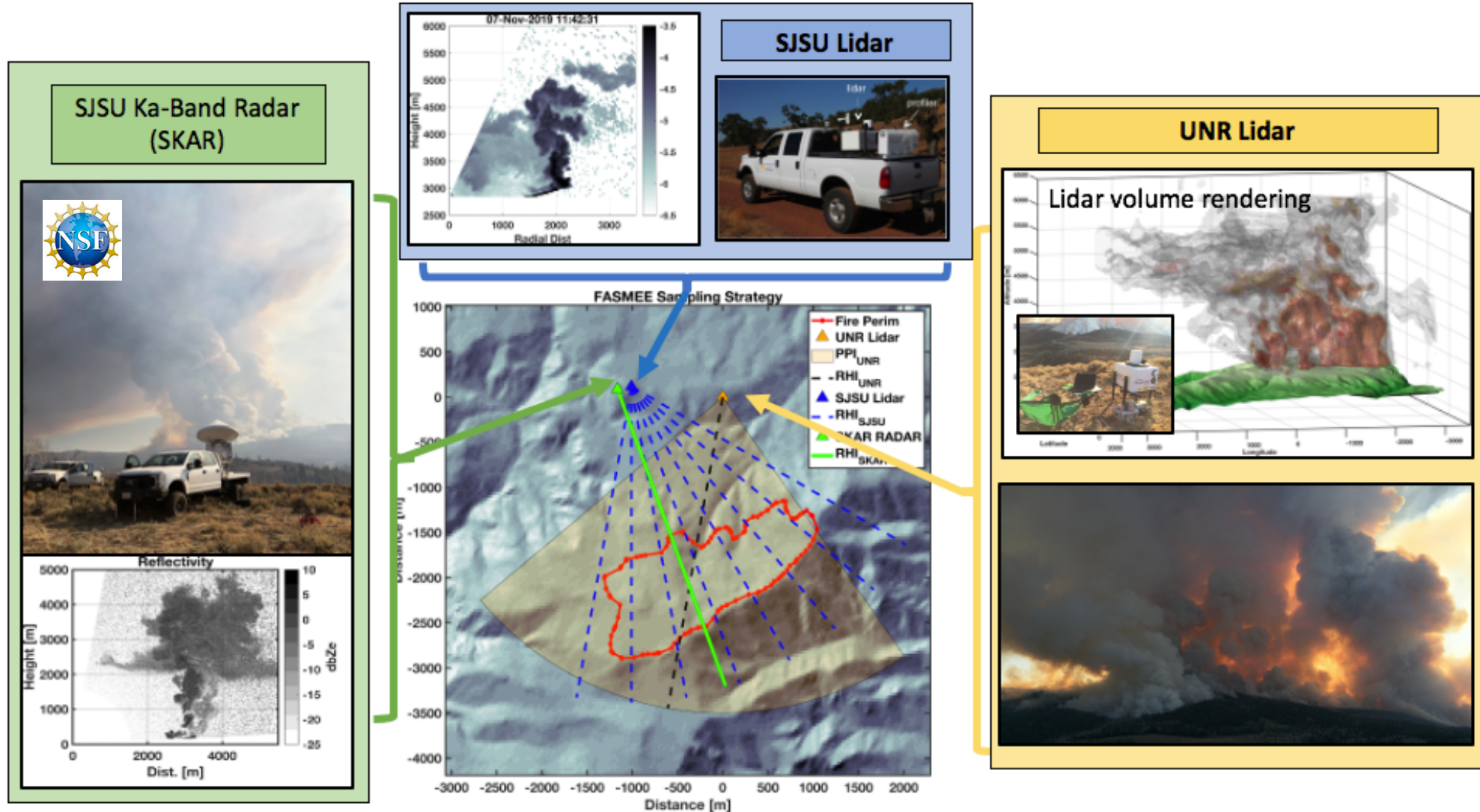
- FASMEE
- ~1000 Acres
- Aerial drip-torch ignition
- Heavy fuels

Primary Instruments:

- SJSU Scanning Ka-Band Radar (SKAR)
- SJSU Scanning Doppler Lidar
- UNR Scanning Doppler Lidar

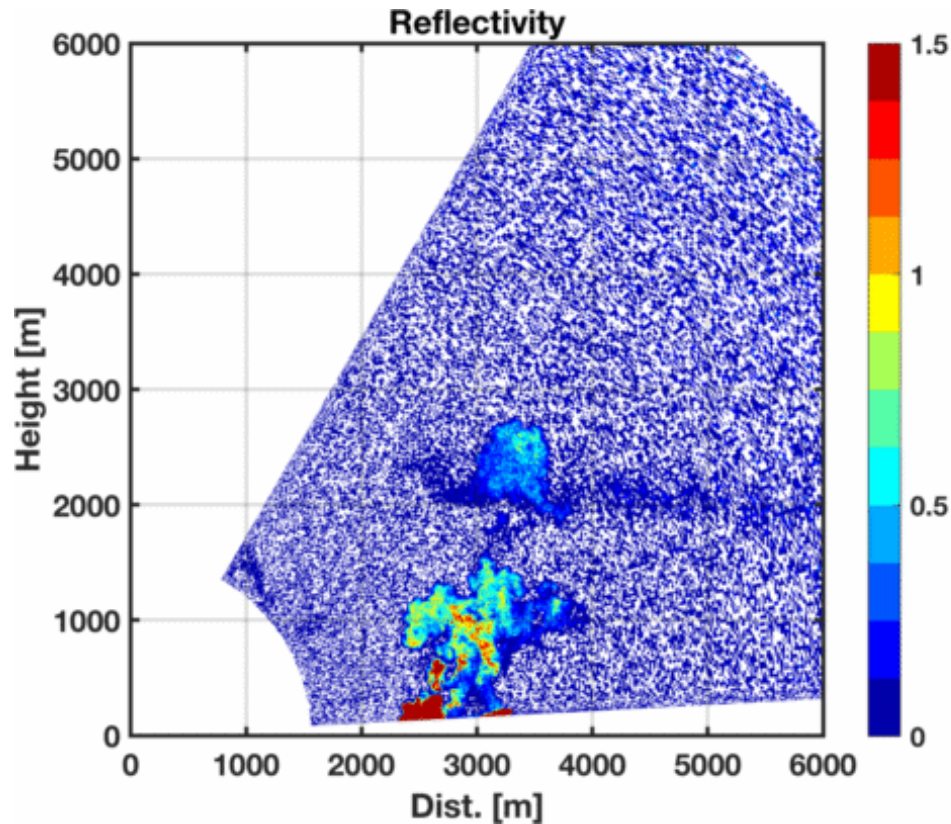
Ancillary data:

- SJSU drone
- Grand Junction, CO radiosonde



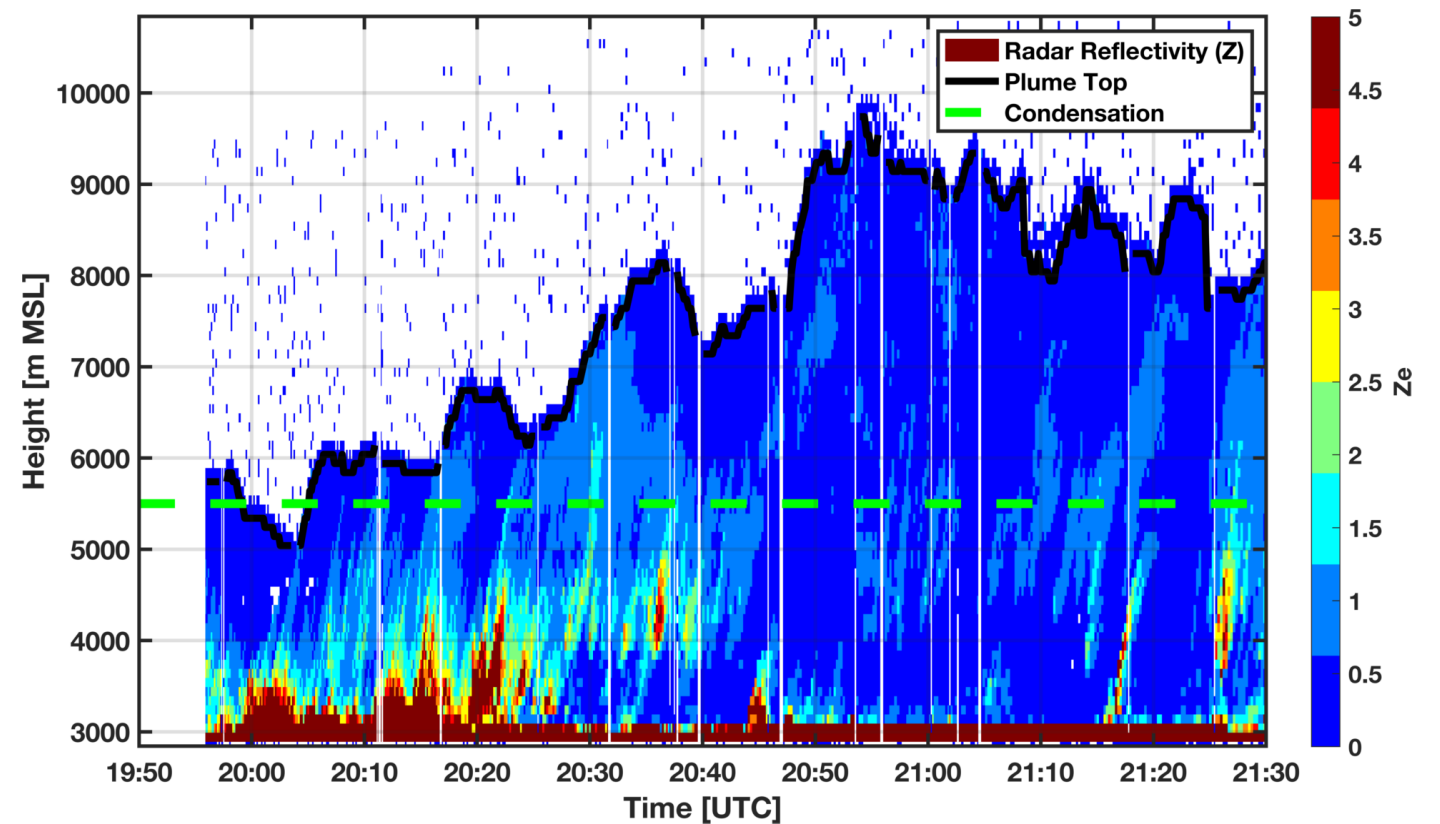
Interleaved PPI and RHI scans from the radars and lidars

Plume Evolution: Time-Height



Radar reflectivity shows pulses of high “pyrometeor” loading lofted in the convective updrafts

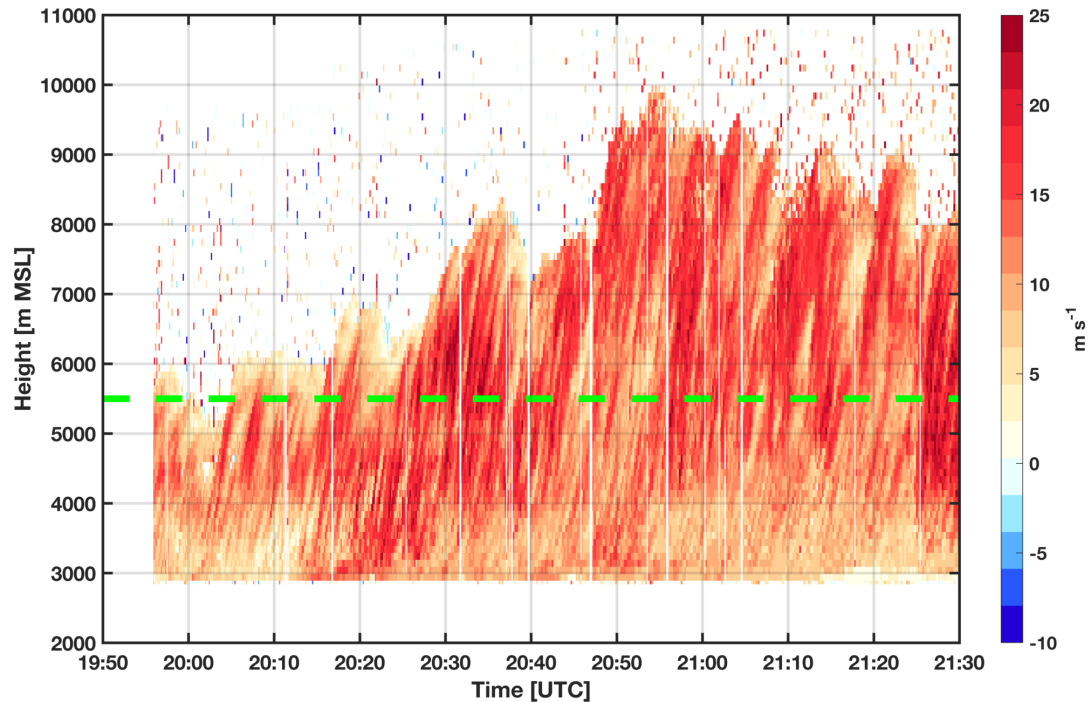
Plume height and reflectivity



Time-height diagram of radar reflectivity shows the plume growth with time, reaching a peak of ~10 km MSL

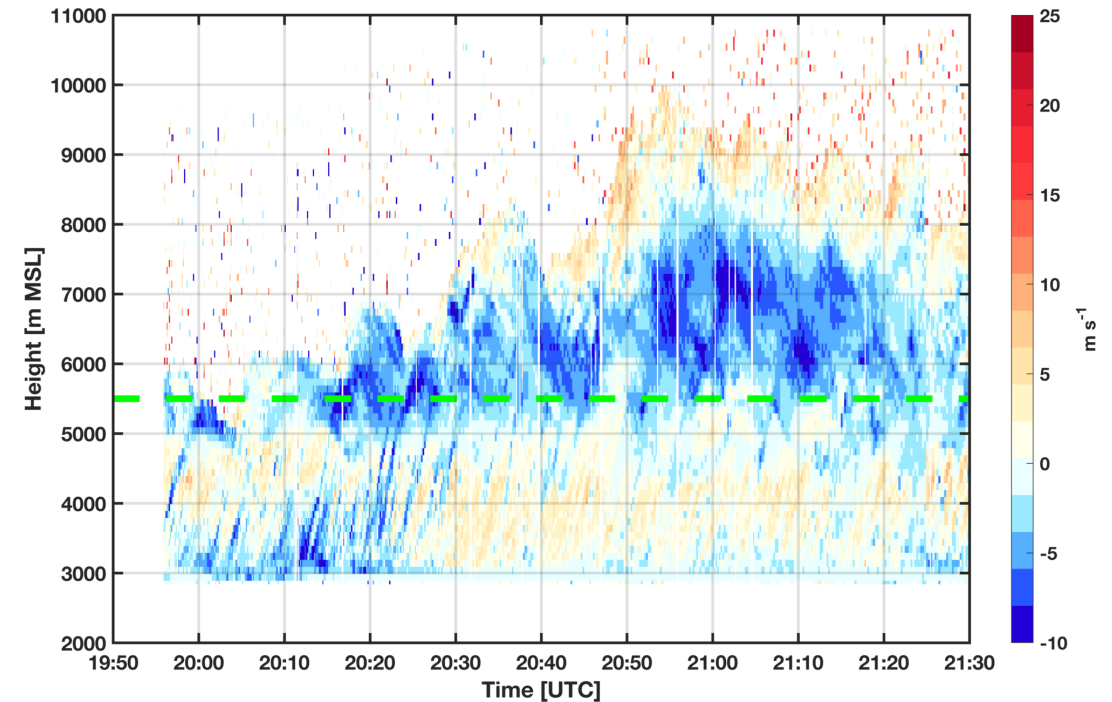
Plume Evolution: Vertical Velocity

95th percentile Vertical Velocity



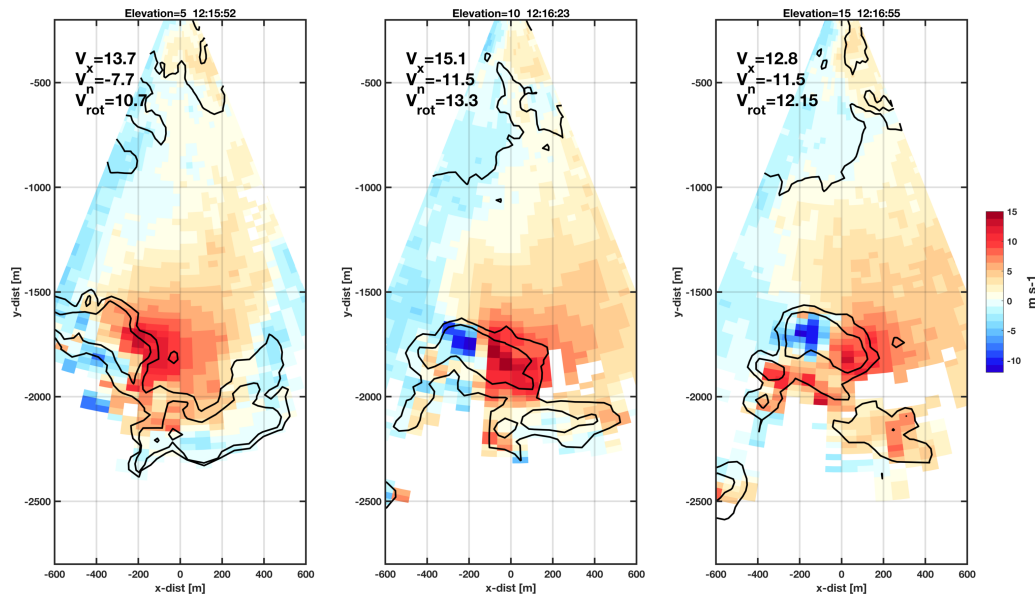
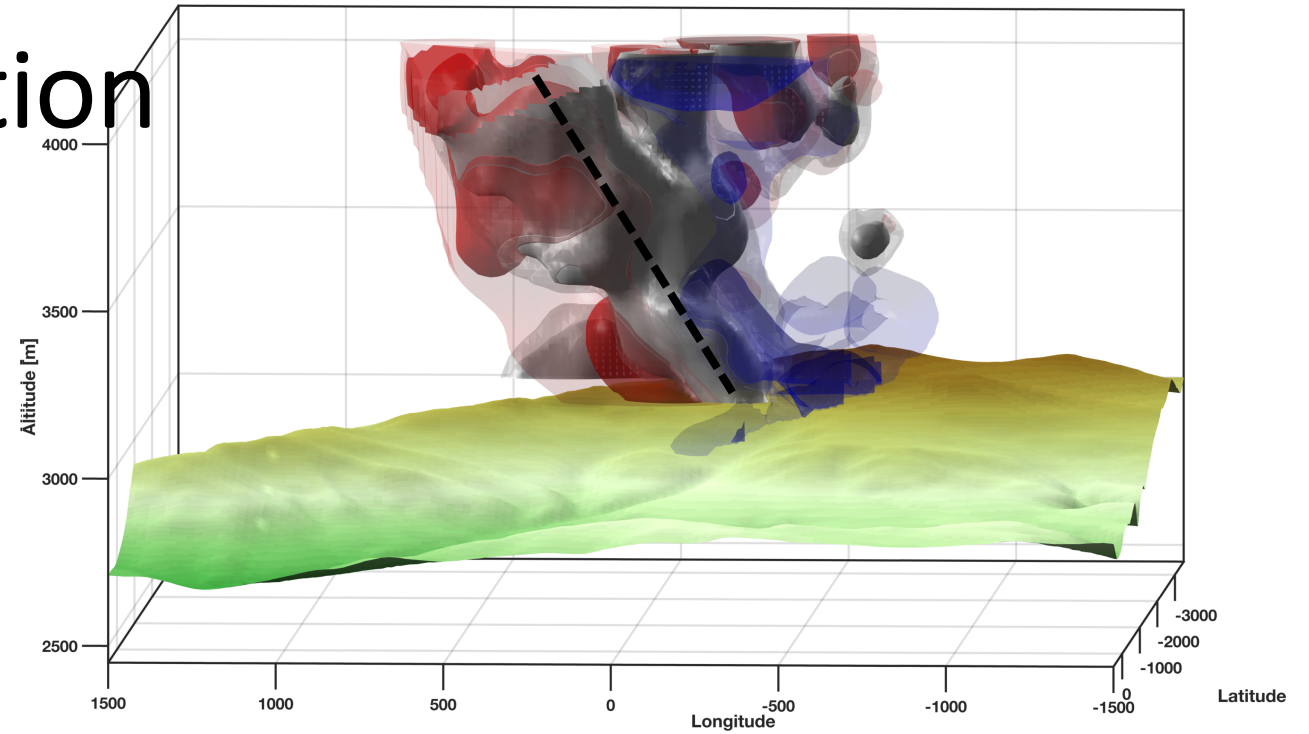
- Pulses of strong “vertical” velocity propagate upward.
- Strong updrafts present above the condensation level (green dashed line)

5th percentile Vertical Velocity



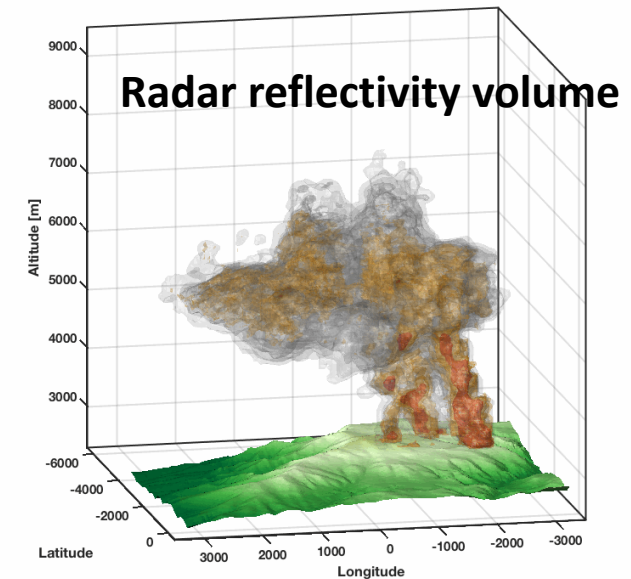
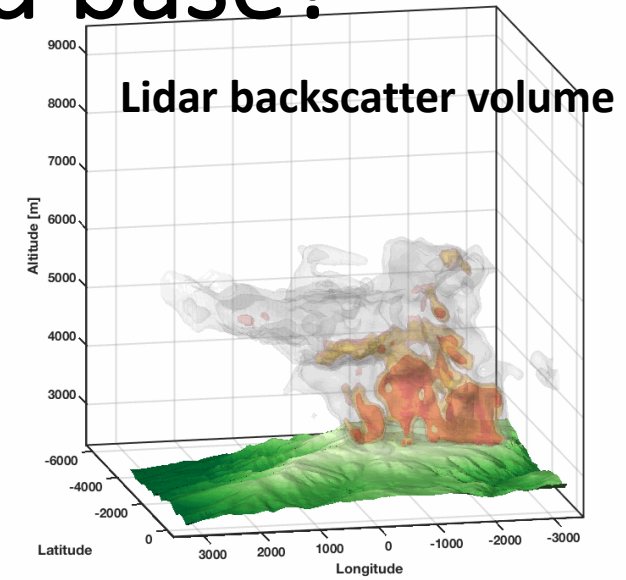
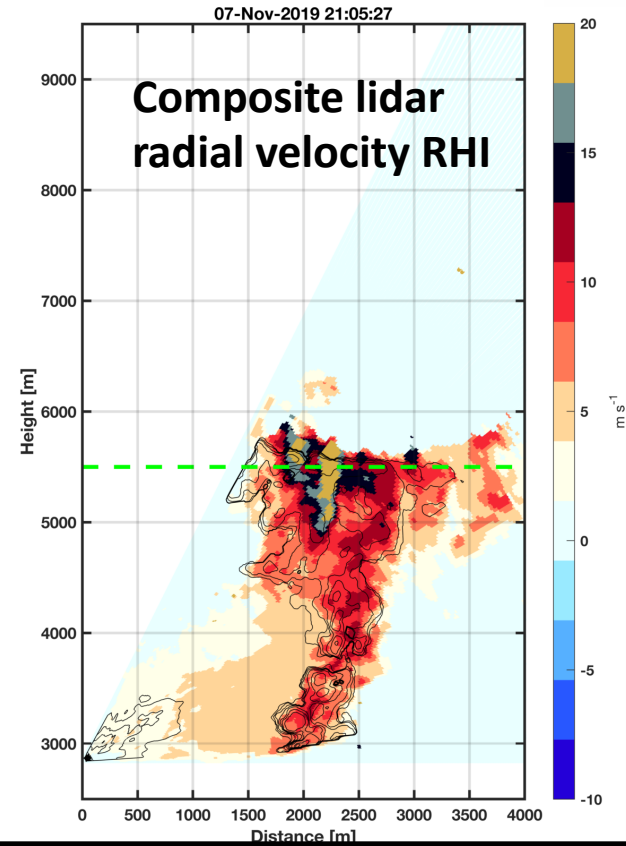
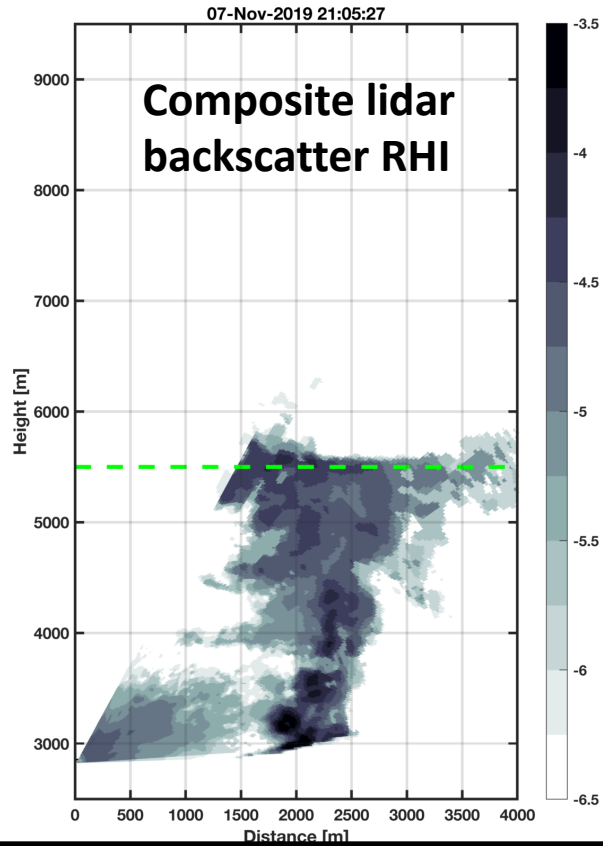
- Strong down drafts are prevalent in the 5.5-8 km layer
- This is in the pyroCu.

Plume Evolution: Rotation



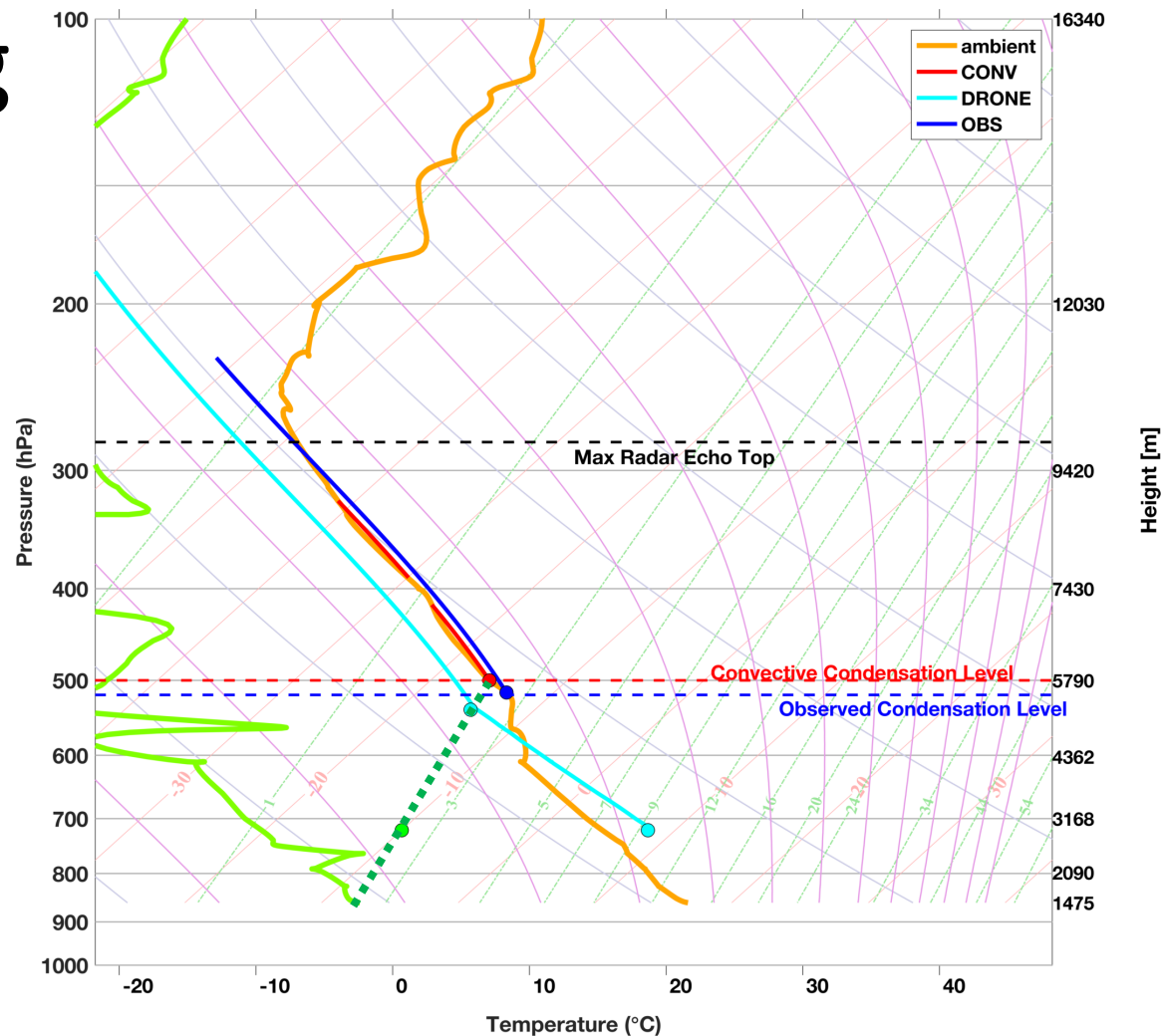
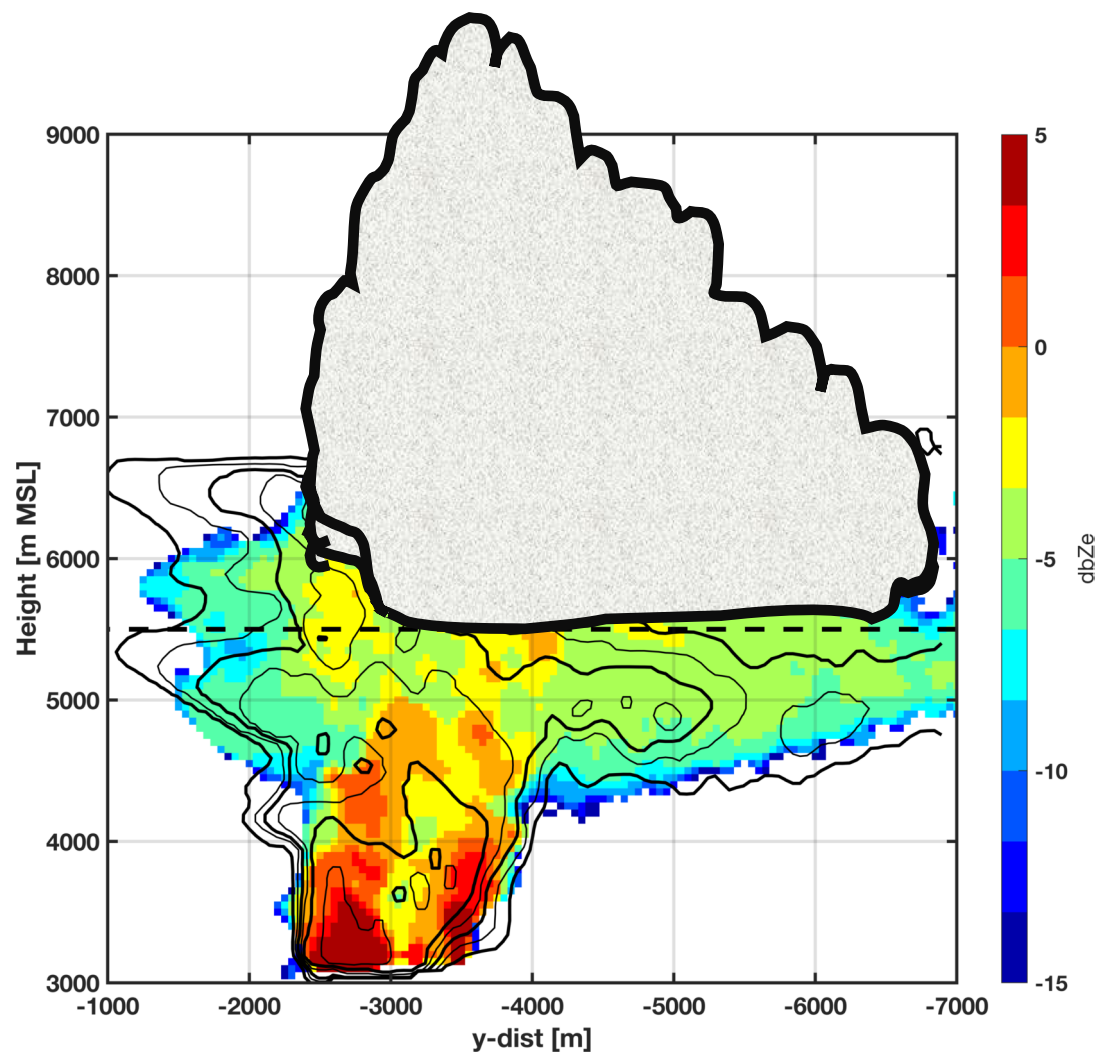
- Coherent cyclonic rotation of the plume for ~20 mins
- Strongest rotation is above the surface: ($V_{rot} = 13.3 \text{ m s}^{-1}$)
- Diameter ~150 m between velocity maxima
- $\zeta \approx \frac{2\nabla V}{D} \approx 2 \frac{15.1 \frac{m}{s} - (-11.5 \frac{m}{s})}{150 \text{ m}} = 0.18 \text{ s}^{-1}$
- “L” shaped fire line and plume-plume interactions?

Plume Evolution: Where is cloud base?



- Lidar data show cloud base at >5500 m MSL
 - Lidar attenuates in liquid water
 - Radar "sees" into the cloud (but likely ash dominates scattering)
- Cloud base updrafts $\sim 20 \text{ m s}^{-1}$
 - Much much larger than typical Cumuli

Plume Evolution: Estimating thermodynamics



ML CCL 5790 m

Drone LCL 5247 m

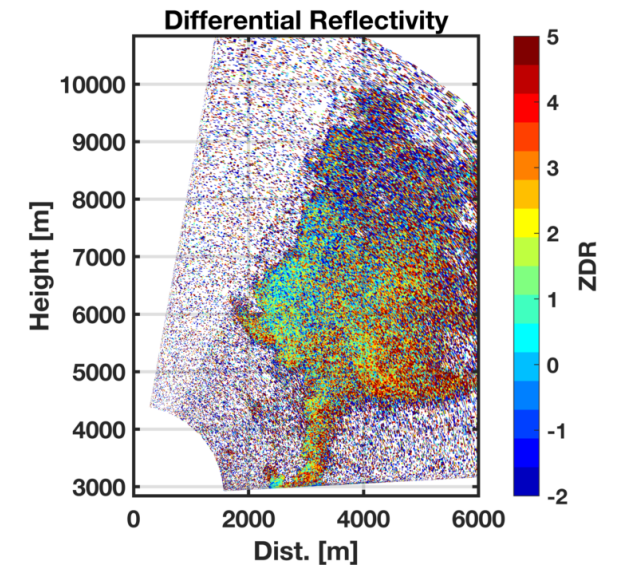
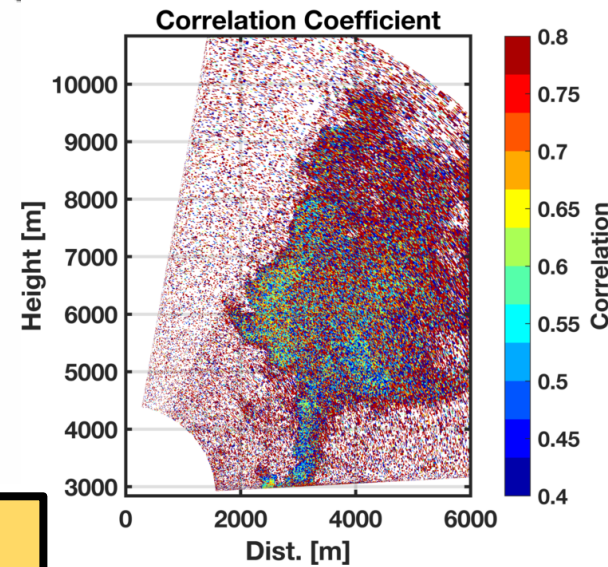
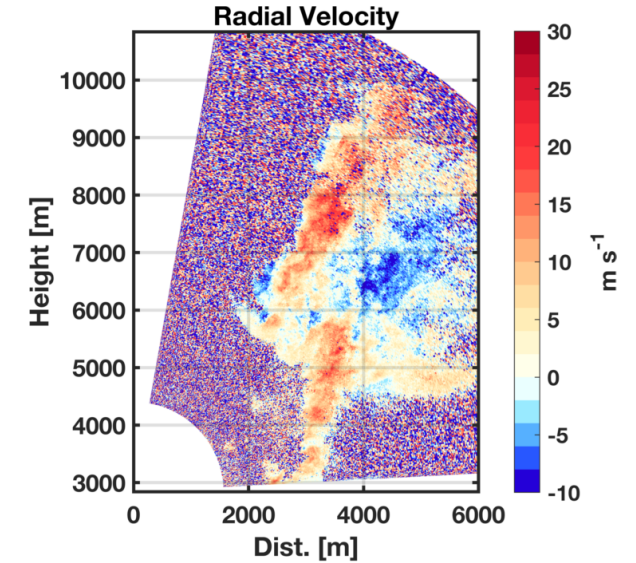
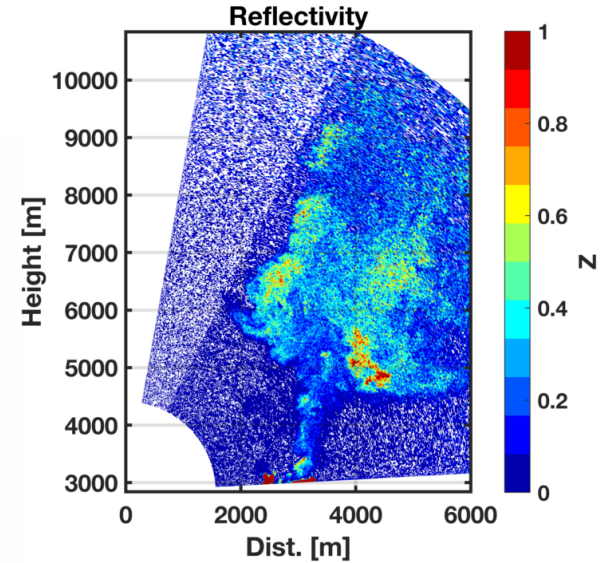
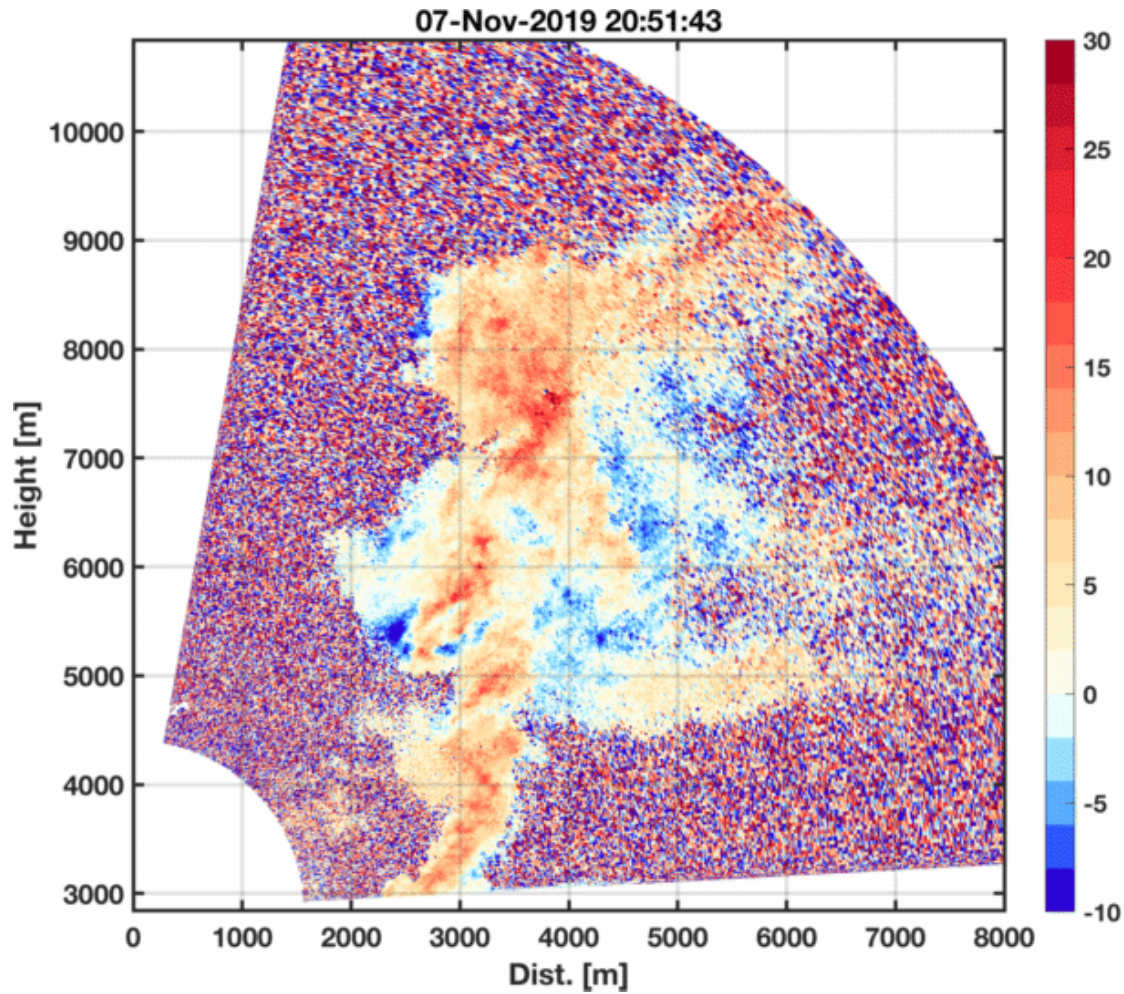
Observed CL ~5500 m

Observed plume top ~10000 m

Plume top temp -50 C (pyroCb?)

Connected along a moist adiabat

Plume Evolution: Active Convection



Parcels in the updraft continue to accelerate
Mechanically forced downdrafts and (maybe) ash fall out?

Summary

- Deep pyrocumulus (10 km) initiated from a “stand replacement” prescribed fire.
- Plume exhibited:
 - Vigorous ($>25 \text{ m s}^{-1}$) updrafts
 - Pronounced rotation (13 m s^{-1})
- Cloud base and cloud thermodynamics inferred from multi-sensor observations
 - Active convection through a deep layer
- FUTURE WORK:
 - Polarimetric properties of the plume (Taylor Aydell)
 - Parcel tracking
 - Simulations

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