Colorado ground facility operations during DC3

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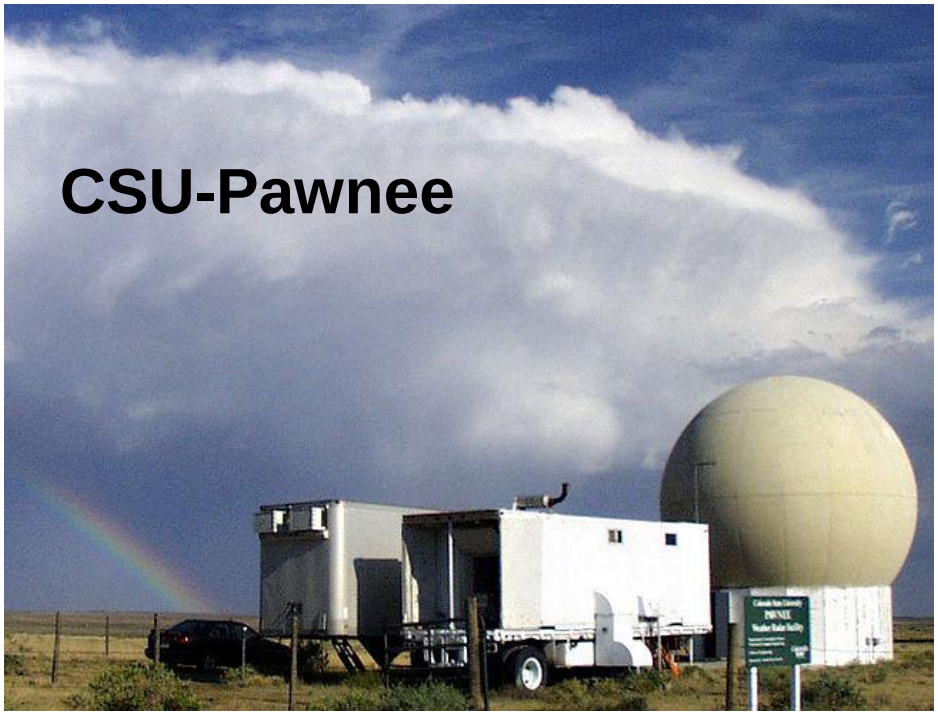
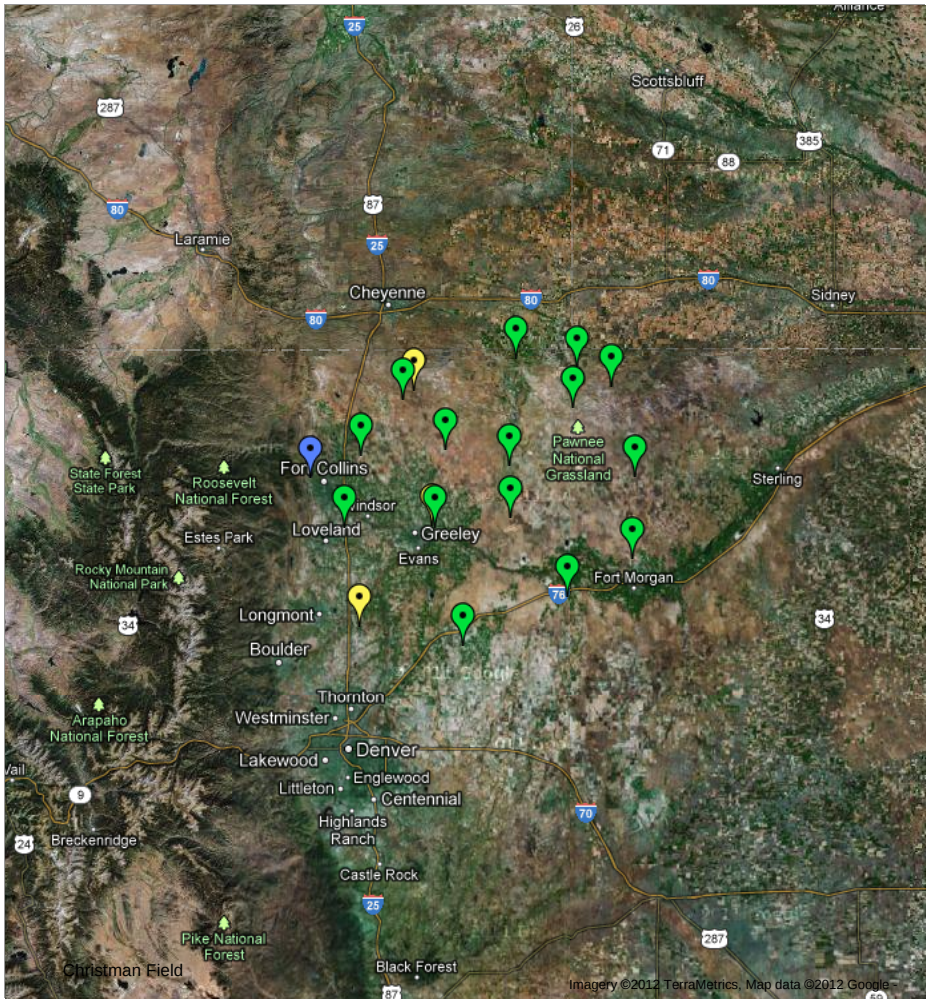
- CSU-CHILL: Advanced S-band polarimetric Doppler radar
- Innovative antenna design – minimal sidelobes and cross-pol contamination
- Dual-frequency capability (X/S-band), S-band only DC3 field phase by design
- Pawnee radar provides dedicated dual-Doppler capabilities



Colorado LMA (COLMA)

15 stations spread over NE CO
Solar-powered, advanced electronics
Extremely low noise and very sensitive



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http://lightning.nmt.edu/colma/

Soundings

- Frequency set by morning telecon and meteorological conditions, typically every 1-3 hours starting near noon local on priority days

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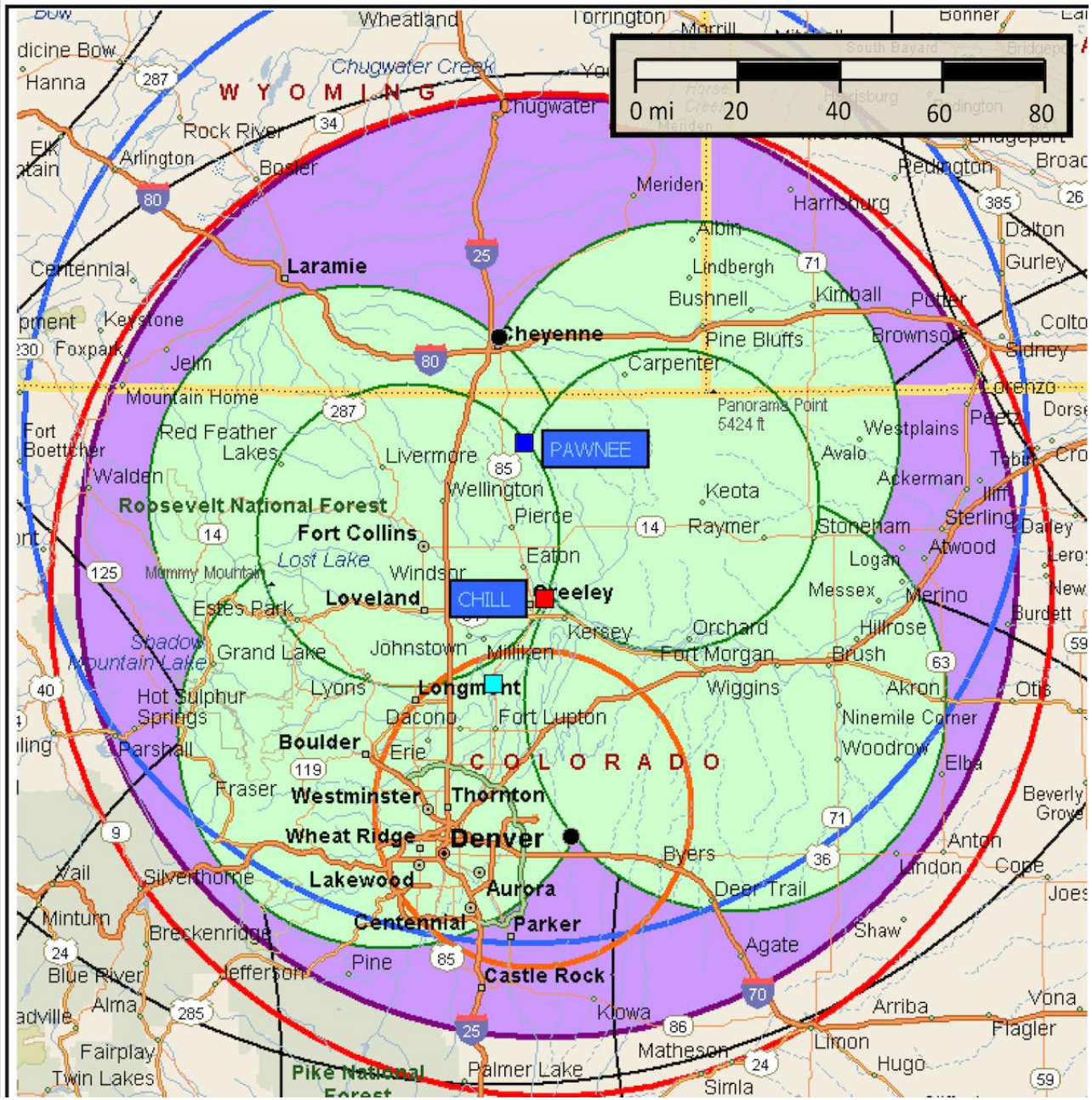
Mobile GPS Advanced Upper-air Sounding System (MGAUS)

- Inflow soundings
- Directed to storm by CHILL-based scientists
- Real-time provision of data to DC3 servers

Mobile Integrated Sounding System (MISS)

- Pre-storm soundings
- **Fixed** at Fort Morgan airport
- Wind profiler
- Surface meteorological measurements
- Real-time provision of data to DC3 servers



Radars along Front Range provide several different multiple-Doppler synthesis opportunities, depending on storm placement

Upcoming addition of S-PolKa between CHILL and Denver provides even more coverage (FRONT program)

COLMA provides high spatial and temporal resolution coverage over the entire region

COLMA likely to be supported for foreseeable future (GOES-R GLM validation)

Summary of Cases
Colorado Ground Operations
15 May-30 June 2012

Aircraft days with CHILL/Pawnee support:
6/1 (Boundary layer flights)
6/2 (DC8 anvil flight)
6/5 (Full lifecycle dual-Doppler)
6/6 (Intense storms in east lobe)….probably the flagship case

Aircraft days with CHILL support:
5/18 (WY/NE convection)
6/15 (potential dual-Doppler w/ KFTG)
6/22 (CHILL range-boosted, observed part of storm)
6/27, 6/28 (Mobile radars primary)

No significant COLMA downtime

Multiple soundings on most priority days, both pre-storm and inflow

At least 8 significant non-aircraft days, including a range of "garden variety" to severe storms, plus unusual cases like smoke plume lightning

6 June 2012

GV and DC8 flights to Colorado

Classic severe weather forecast for Colorado

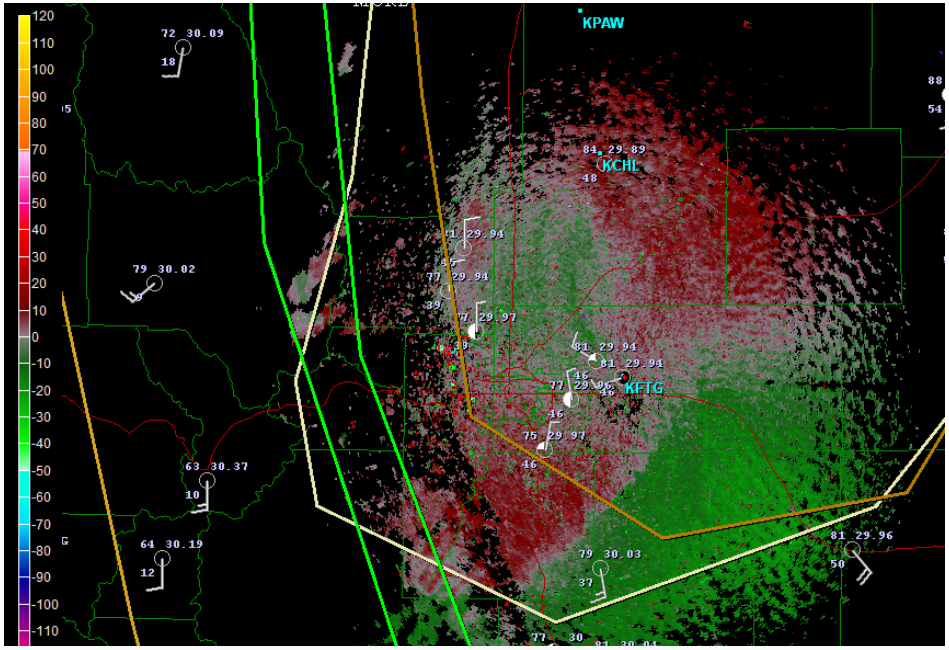
Well-developed Denver Cyclone

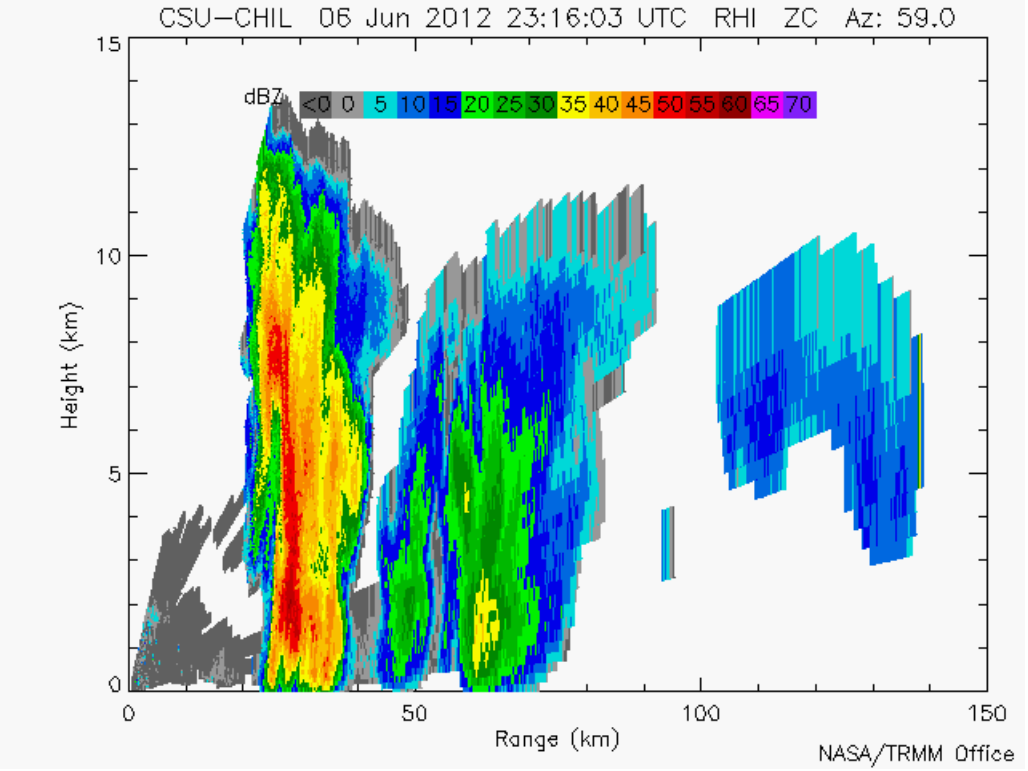
Intense convection spawned by convergence line in east dual-Doppler lobe (CHILL + Pawnee), coordinated scanning 21-00 UTC

Five soundings performed near Fort Morgan (18-00 UTC)

After aircraft departed:

- Coordinated RHIs with CHILL and X-band polarimetric radar
- Long-term CHILL scanning of tornadic storm near Denver, capturing transition to stratiform

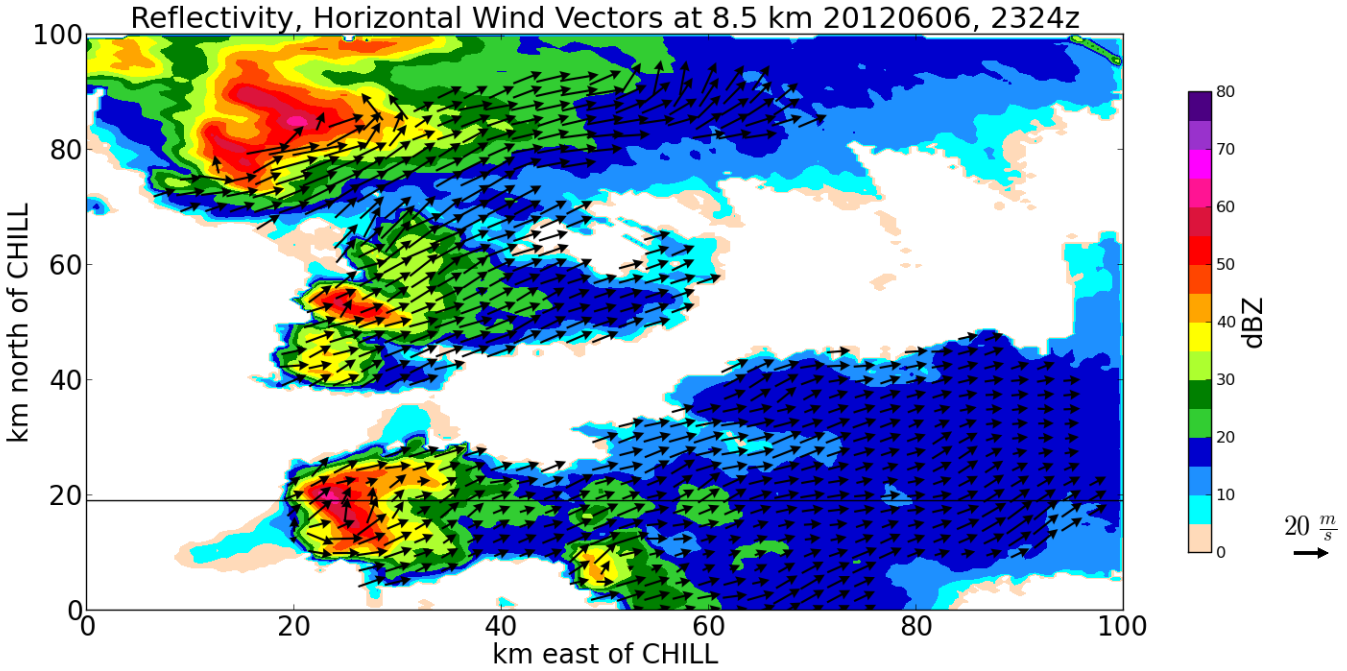


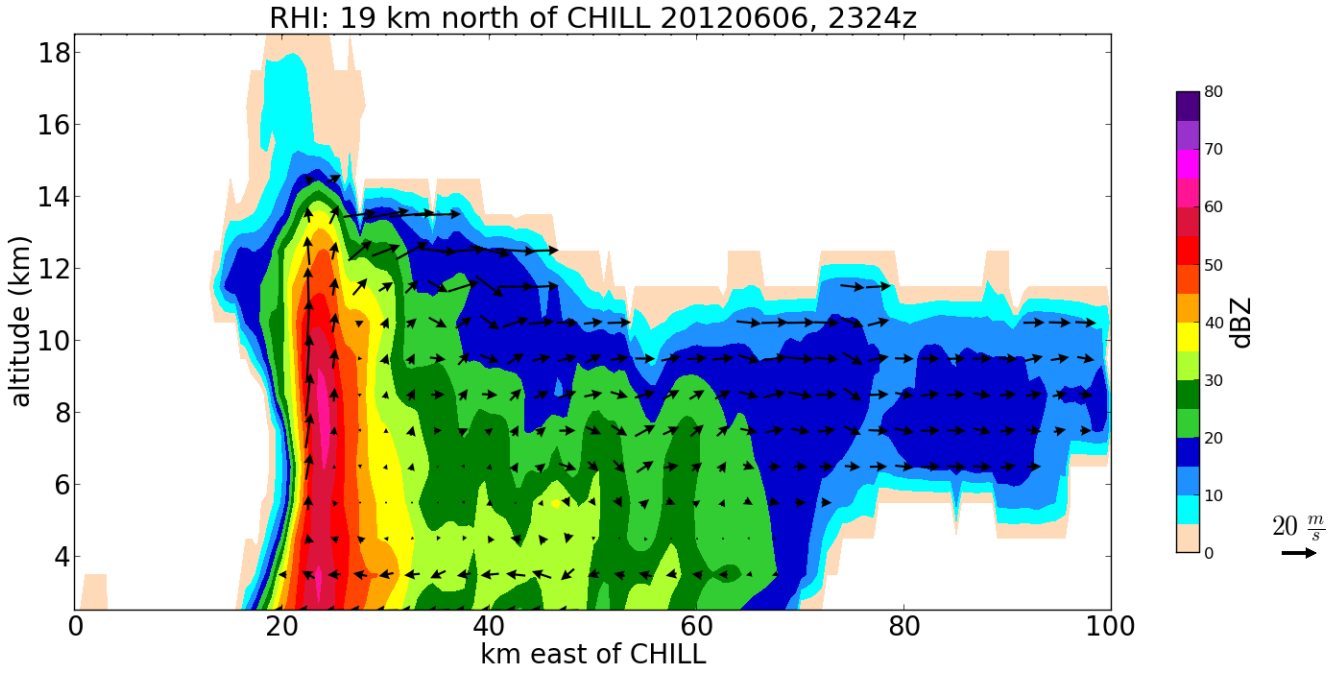


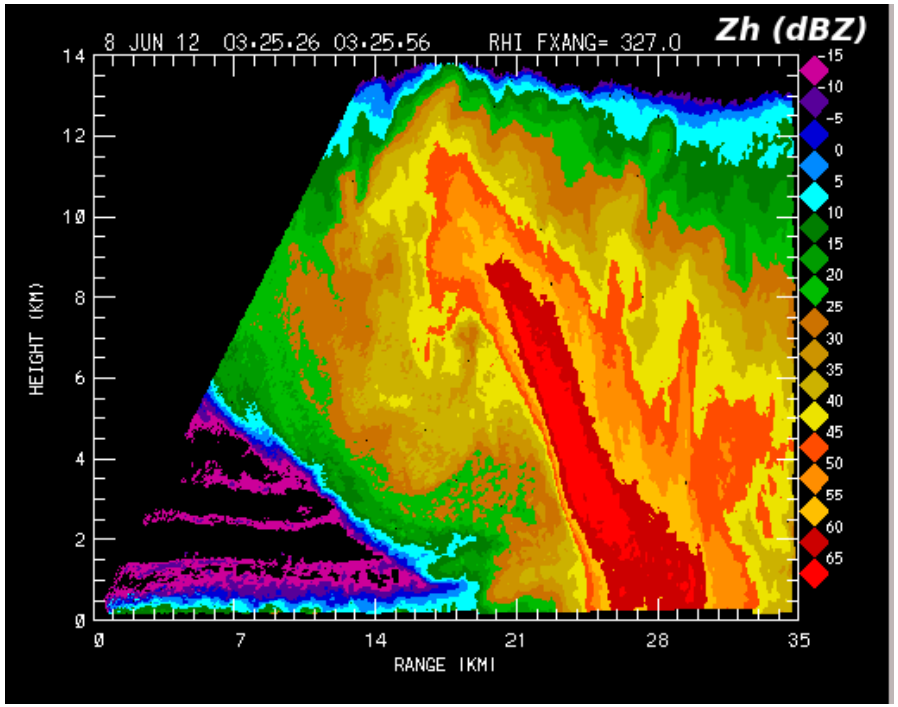
6 June

Dual-Doppler analysis

Courtesy:
Brett Basarab
and
Brody Fuchs



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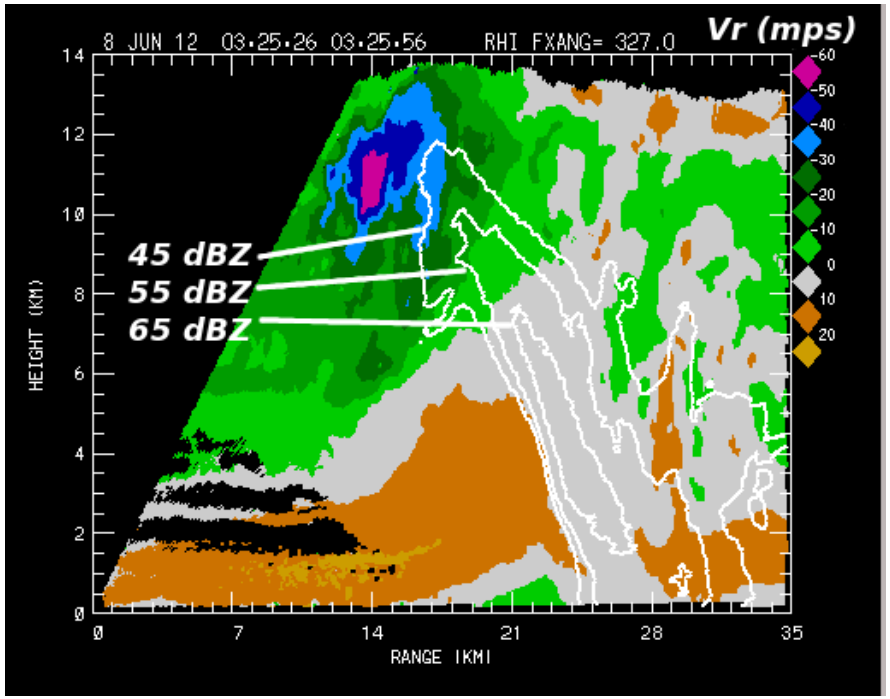
Zh (dBZ)
HEIGHT (KM)
RANGE (KM)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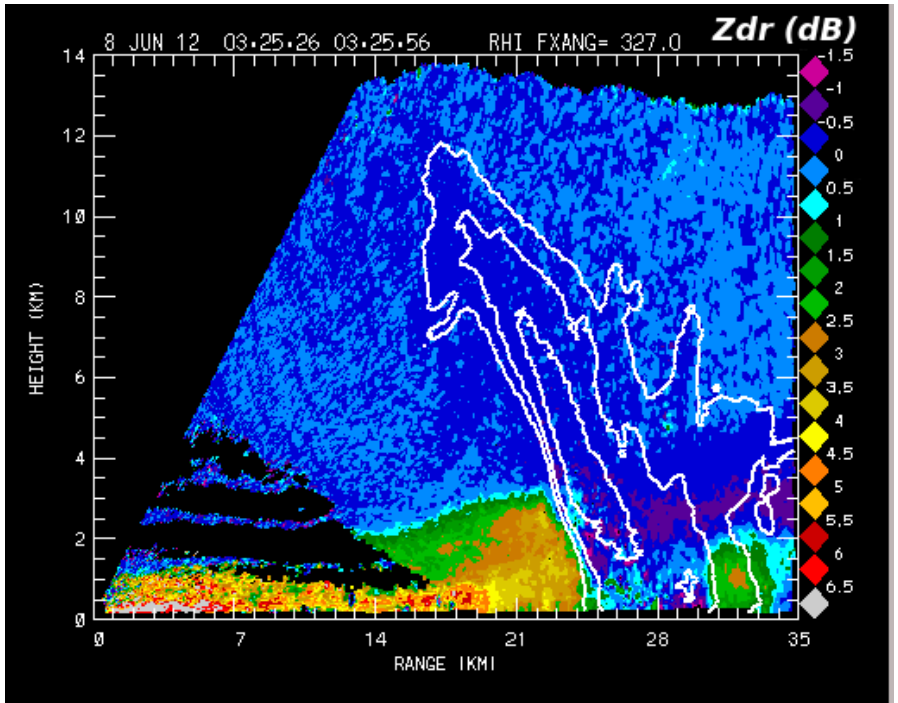
Vr (mps)
45 dBZ
55 dBZ
65 dBZ
HEIGHT (KM)
RANGE (KM)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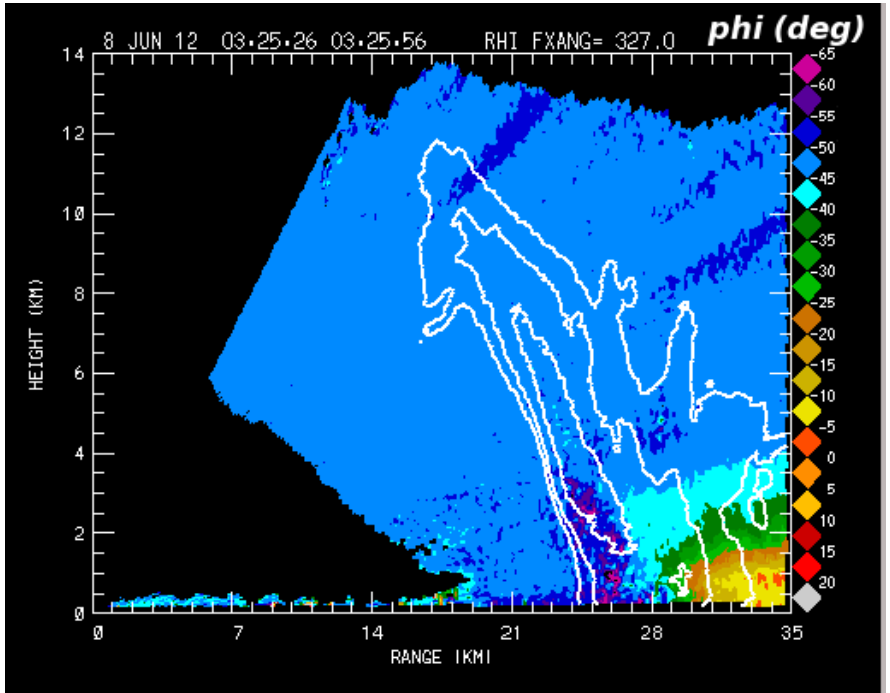
Zdr (dB)
HEIGHT (KM)
RANGE (KM)

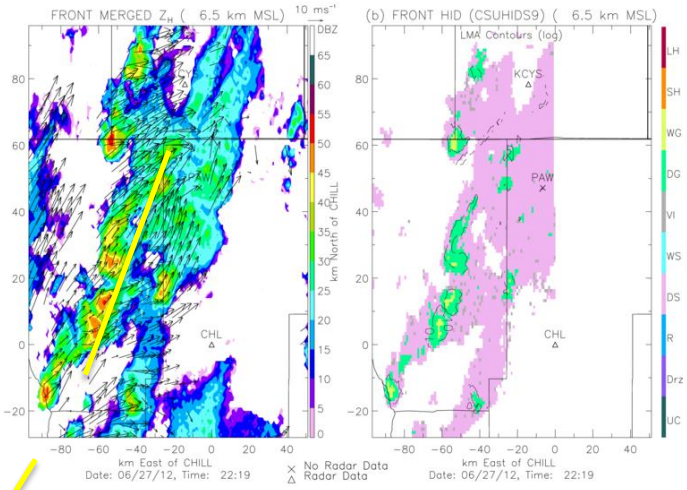

8 JUN 12 03:25:26 03:25:56 RHI FXANG= 327.0
phi (deg)
HEIGHT (KM)
RANGE (KM)

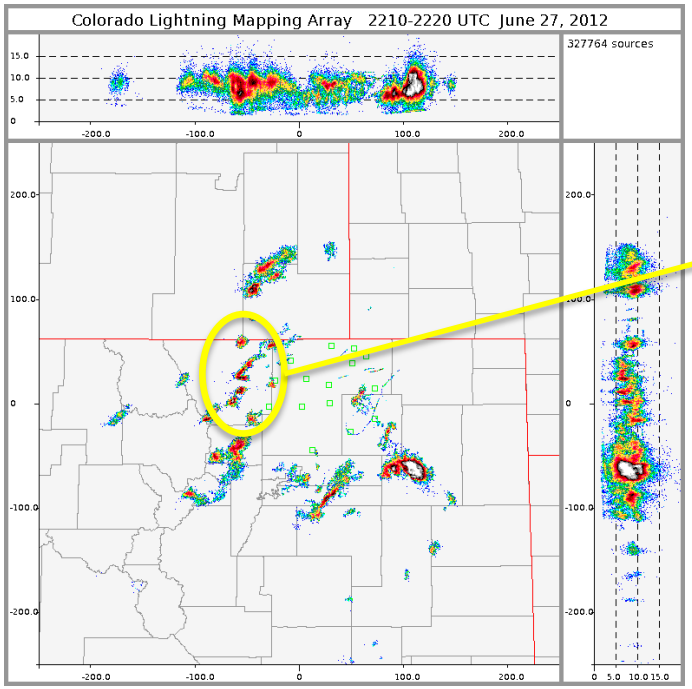
27 June 2012

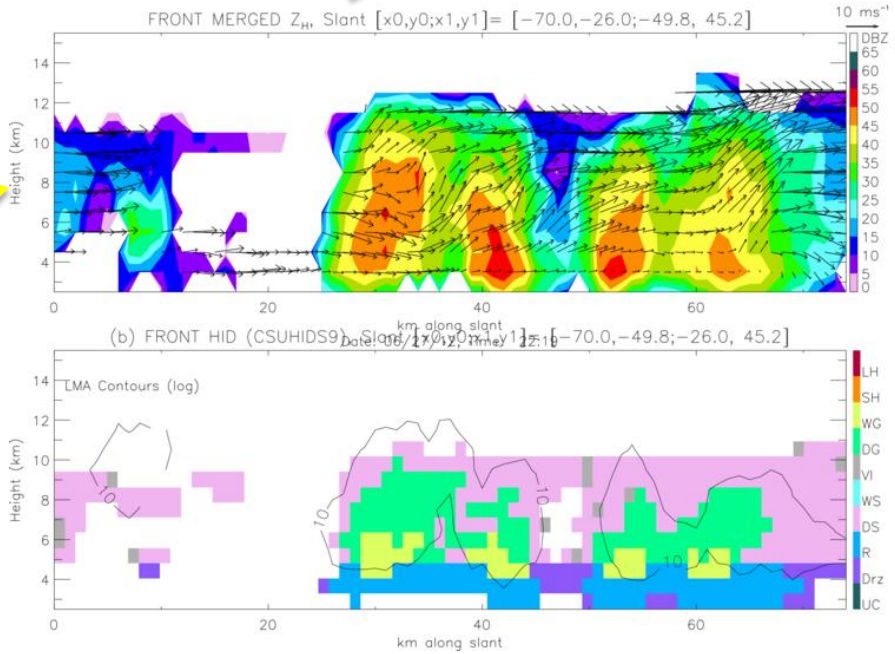
“Garden Variety” Inverted Storms

Early foothills convection on this day

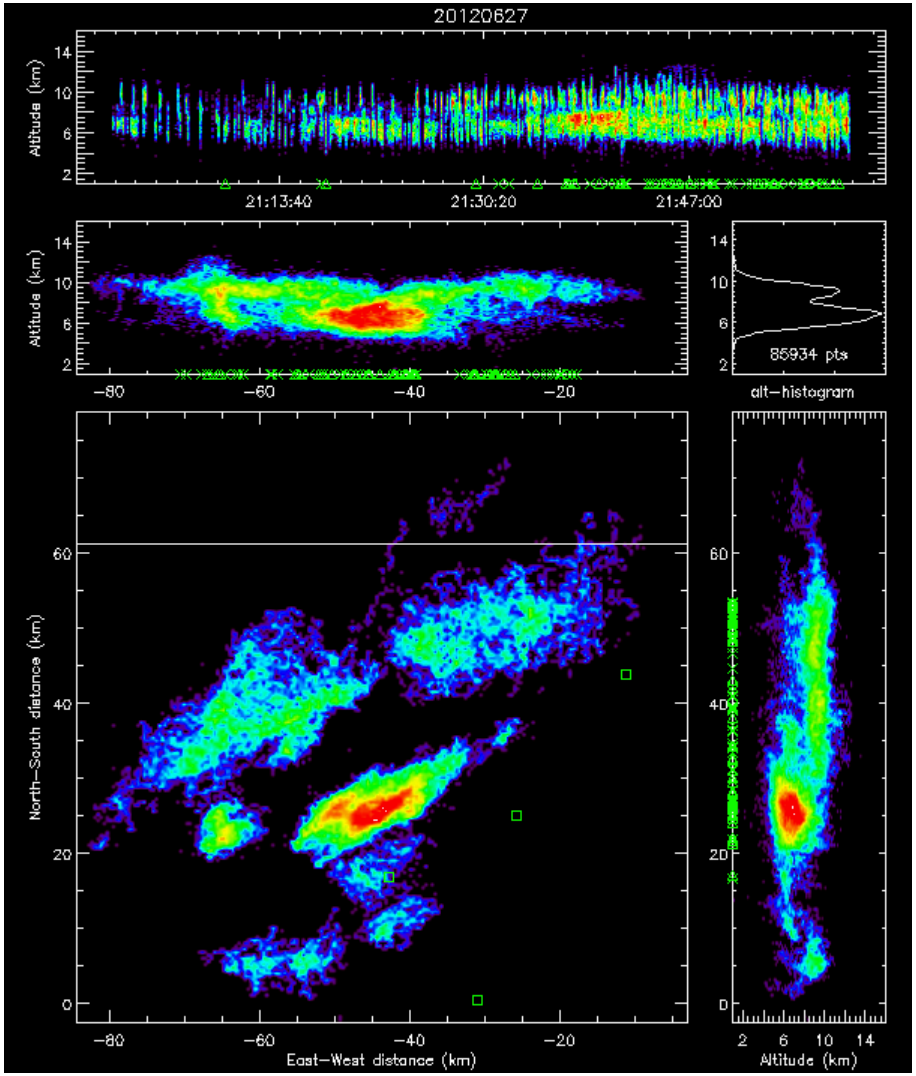
(Later period – GV flight to far eastern CO, supported by mobile radars)



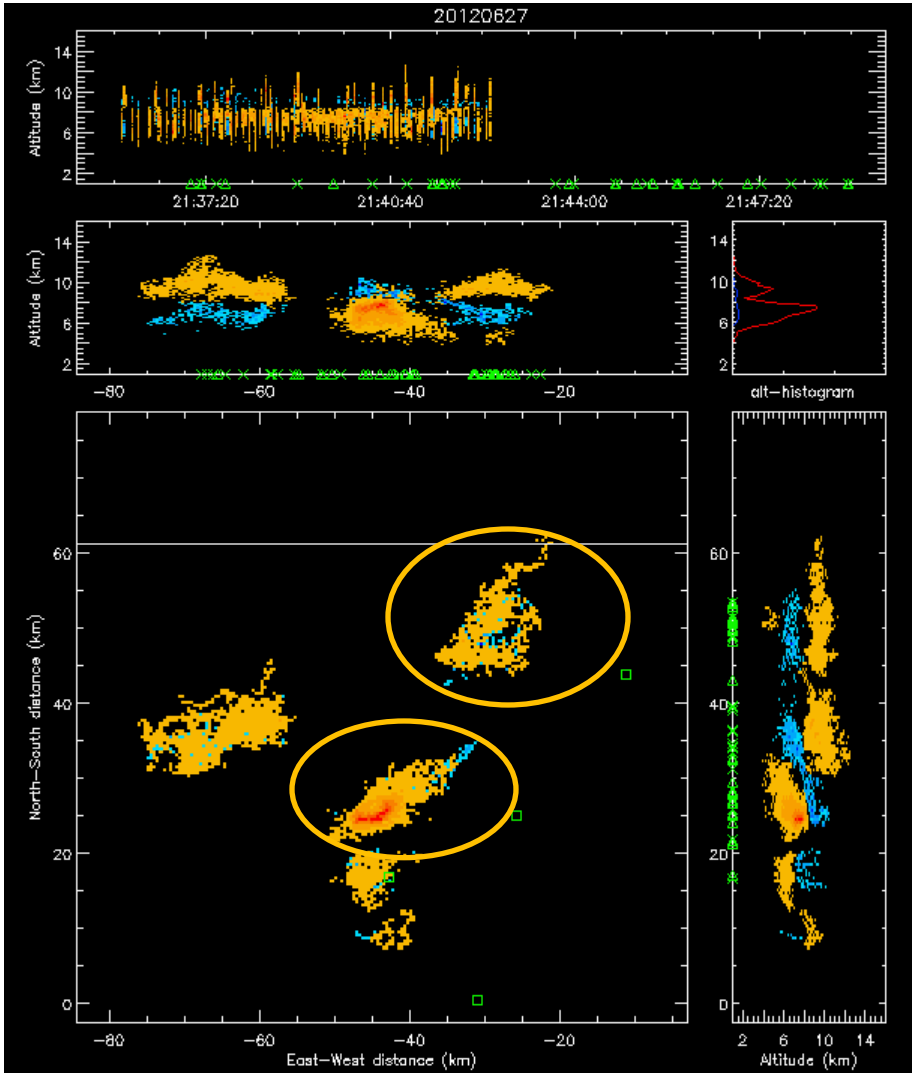




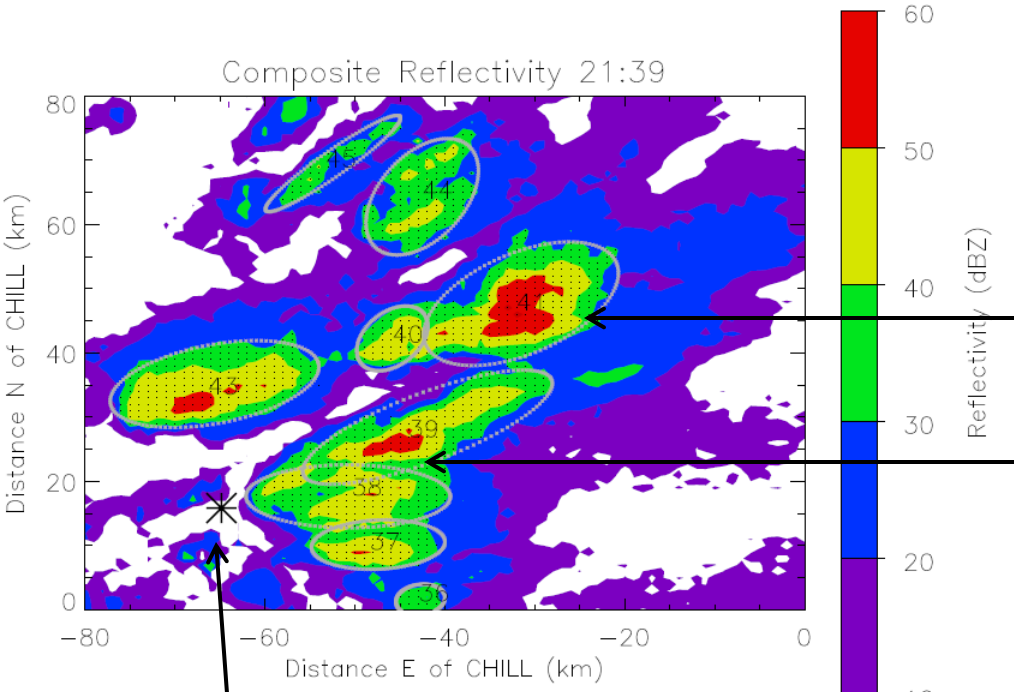
2100-2200 27 June LMA density; Inverted storm distinctive with more sources and at a lower altitude than surrounding normal convection



~2130-2142 UTC 27 June charge identification; Inverted storm with mid-level positive charge below upper-level negative



Inverted cells are closest downwind cells from High Park Fire

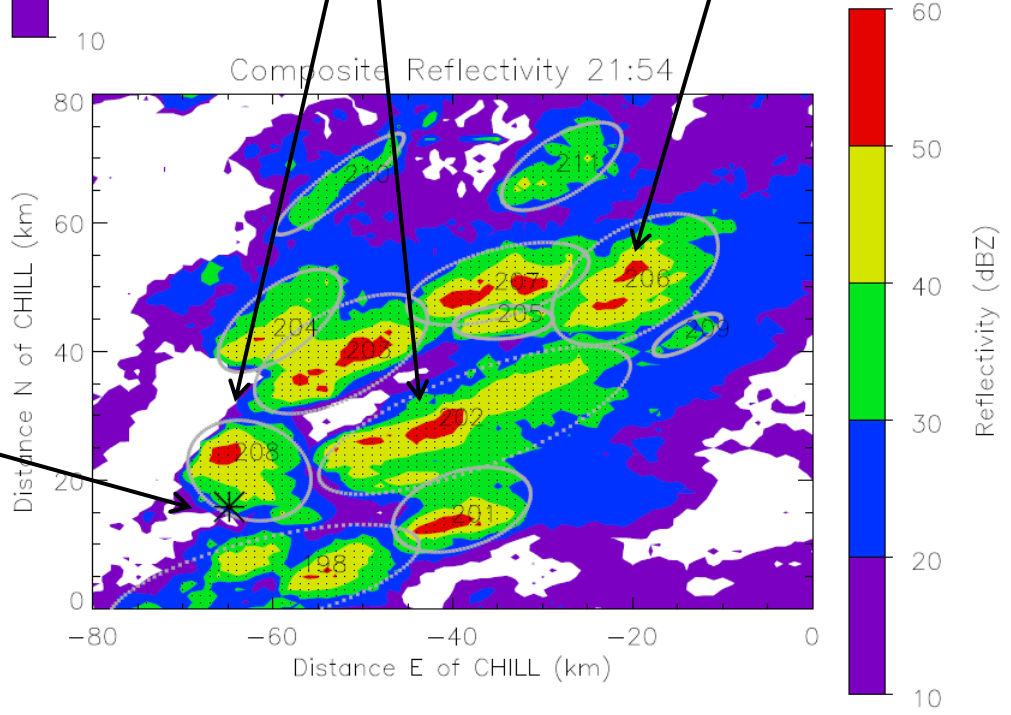


Normal

Inverted

Normal

High Park Fire

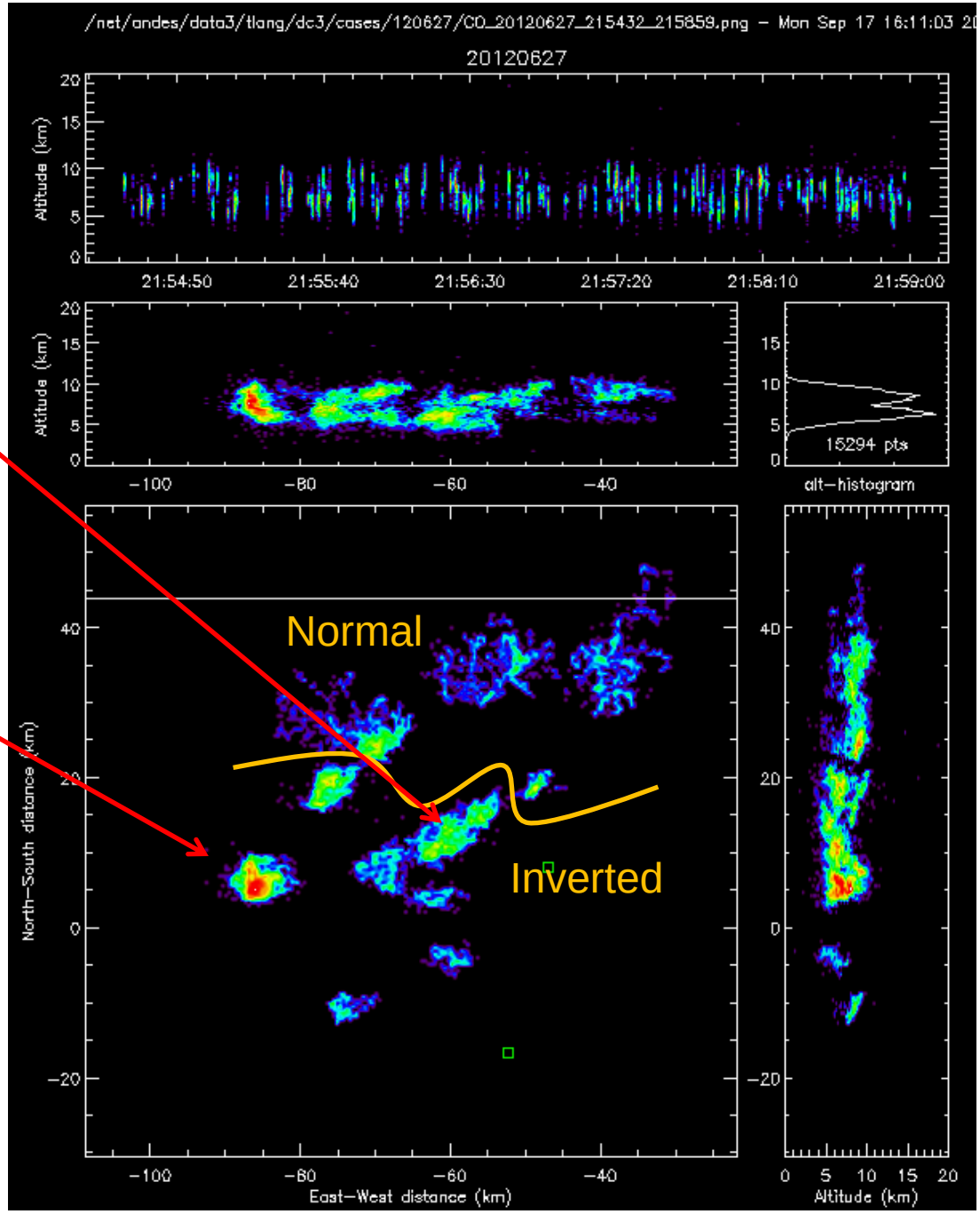


Last five minutes of analysis period (2154-2159)

Original inverted storm fading, but new one developing in its wake near fire

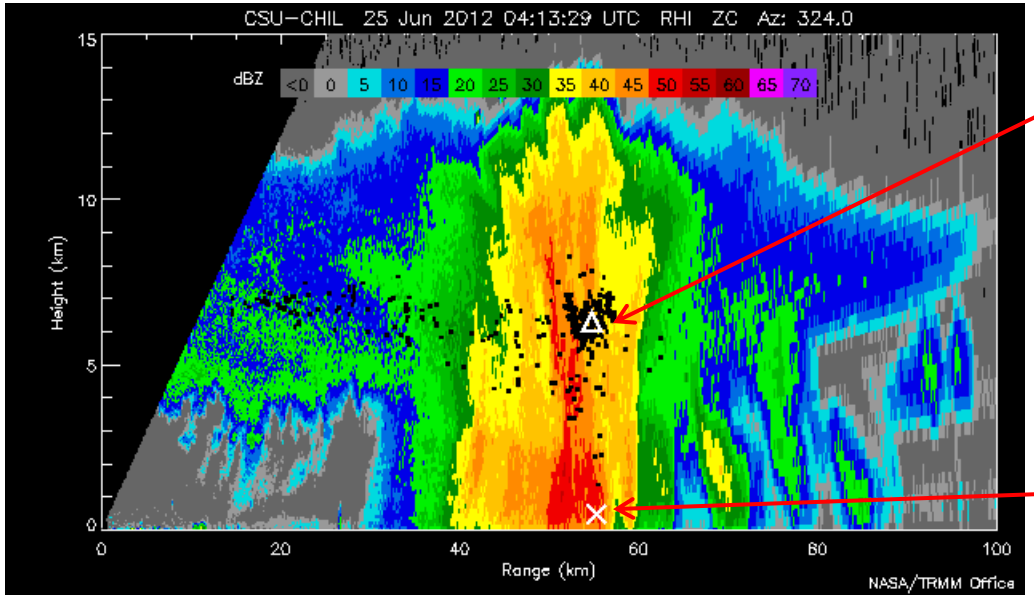
Note the weakly electrified inverted storms near the original one

What role does smoke ingestion play, if any?



25 June Sprite-Producing Storm

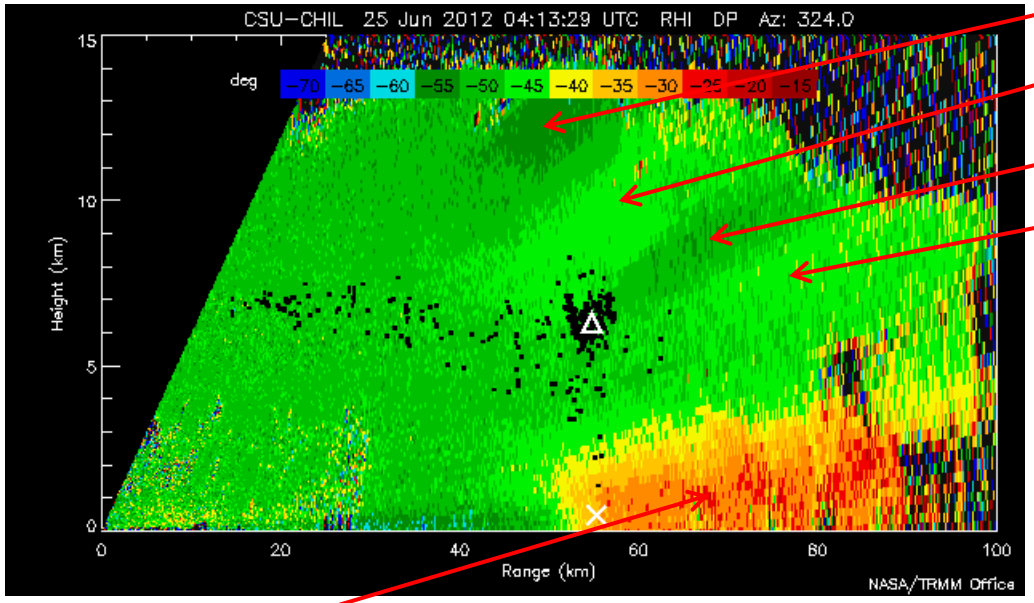
T. Lang-PI



Initiation (Triangle)

Black = LMA sources for SP+CG; RHI sweep close in time and space to flash

Sprite Parent +CG (X)



Negative Phase Shift

Positive Phase Shift

Negative Phase Shift

Positive Phase Shift

Rain

Sprite-parent +CGs in this storm initiated and terminated in convection, tapping charge in surrounding anvil – different than typical sprite parents!

Summary

About half of the CO aircraft cases are well-supported by dual-Doppler coverage by Pawnee and CHILL, most of the rest have some volumetric coverage by CHILL, or were supported by mobile radars. LMA uptime was essentially 100%, and most high-priority cases featured several soundings **(a database has been established to determine radar coverage for all DC3 flights to CO)**

Convective surges featuring high tops, high-altitude lightning, hail shafts, BWERs, and lightning holes were surprisingly common; Other unusual electrical structures (e.g., inverted storms) also were frequently seen; CG lightning seemed rarer than expected

DC3 observations also serve as a mini field campaign on smoke effects in thunderstorms, as well as provide valuable data for sprite research

We are particularly interested in working with the DC3 aircraft teams to integrate chemical measurements with our airflow, microphysical and lightning analyses to study storm transport and NOx production by lightning