Updraft Characteristics of Convection During TWP-ICE and Links to Microphysical Habits

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Scott Collis, Alain Protat, Peter May and Kao-Shen Chung

19th ARM Science Team Meeting

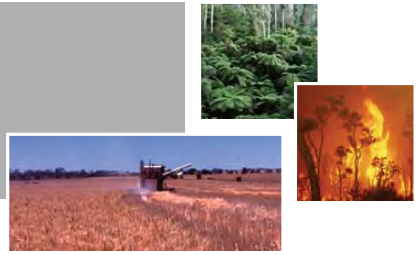
Australian Government
Bureau of Meteorology

ARM

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Introduction/Program goals



Link between updraft characteristics and anvil Cloud properties

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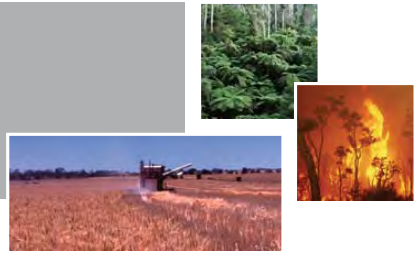

TWP-ICE Forcing data

Models

Updrafts

Microphysics

Link between updraft characteristics and anvil Cloud properties

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Doppler radar velocity retrievals

TWP-ICE Forcing data

Models

Polarimetric radar Microphysics retrievals

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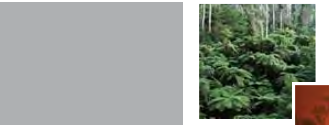
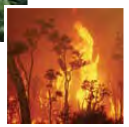
Velocity retrievals from Doppler radar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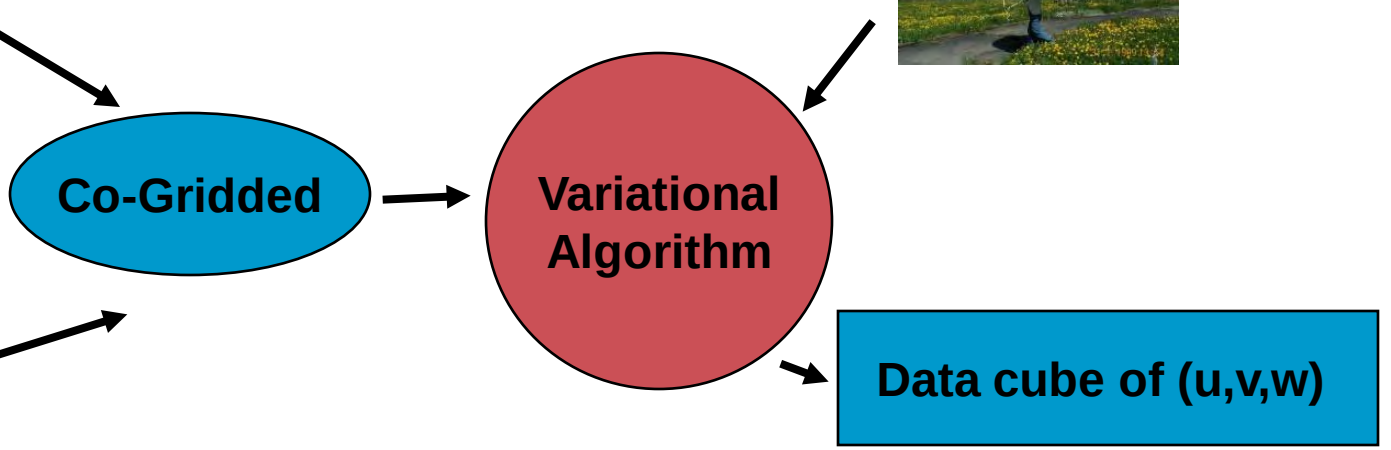
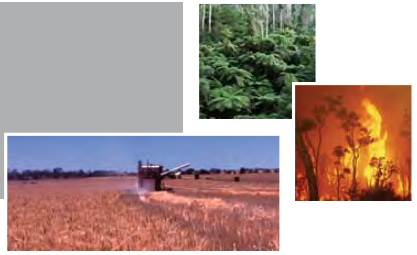
- Essentially variational assimilation of radar data using the anelastic mass continuity equitation as an constraining model





Velocity retrievals from Doppler radar



- rk by Protat and Zawadzki
- data using the anelastic
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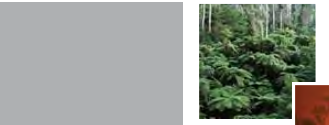
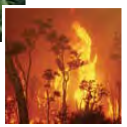
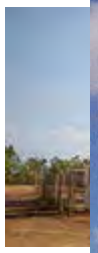
Data cube of (u,v,w)

Velocity retrievals from Doppler radar

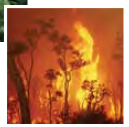

- U… …e work by Protat and Zawadzki (1…
- E… …adar data using the anelastic m… …t model



Variational Algorithm

Data cube of (u,v,w)

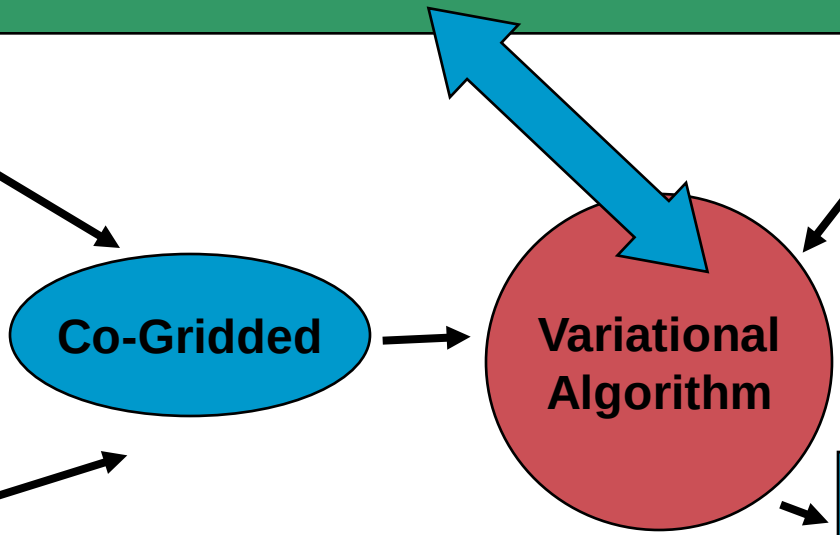
Velocity retrievals from Doppler radar


- t and Zawadzki
- the anelastic

Cost function to be minimised:
Measurement + continuity + smoothness
Boundary conditions for continuity: w=0 @ Echo top and z=0





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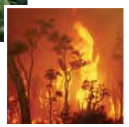


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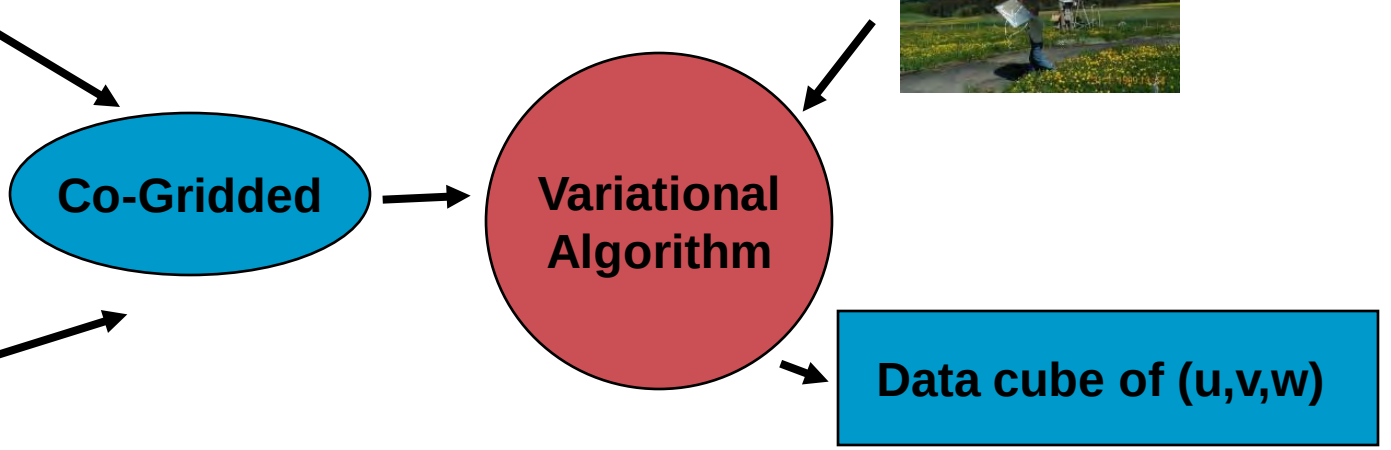
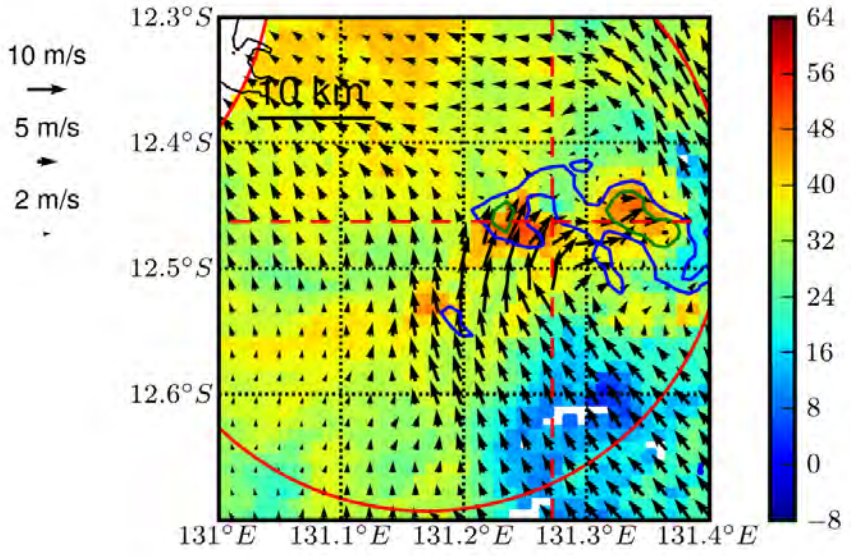
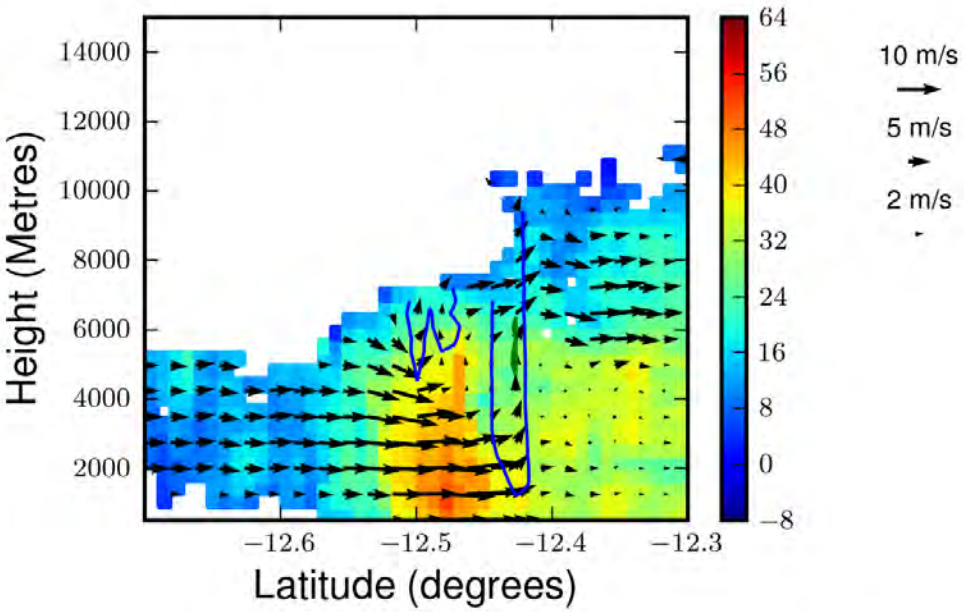
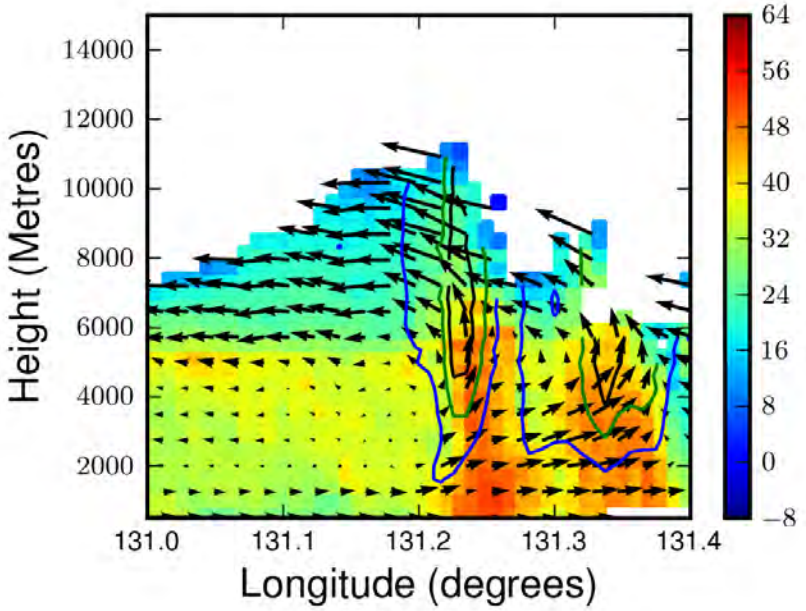








CPOL Horiz. reflectivity and retrieved winds

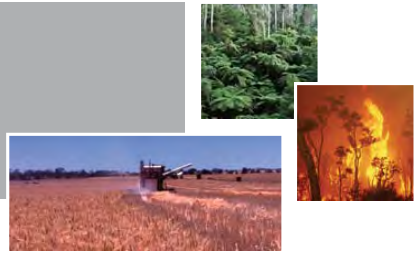
22/01/2006 at 12:20Z

Contours of updrafts:

Blue=2m/s Green=4m/s

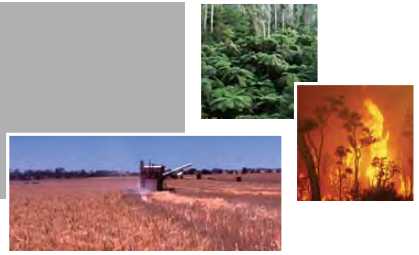
Black=6m/s Red=8m/s

Notes:



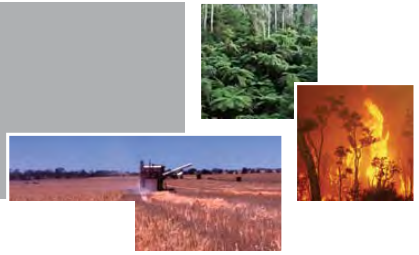
- Variational: More constraints and observations can be added, possibility of adding a NWP constraint.
- Fall speed reflectivity relationship may break down in regions of large hail in its current version. This would impact on retrievals close to the radar. Possibility of using polarimetric particle ID retrievals to improve this.
- Pre processing is VITAL!

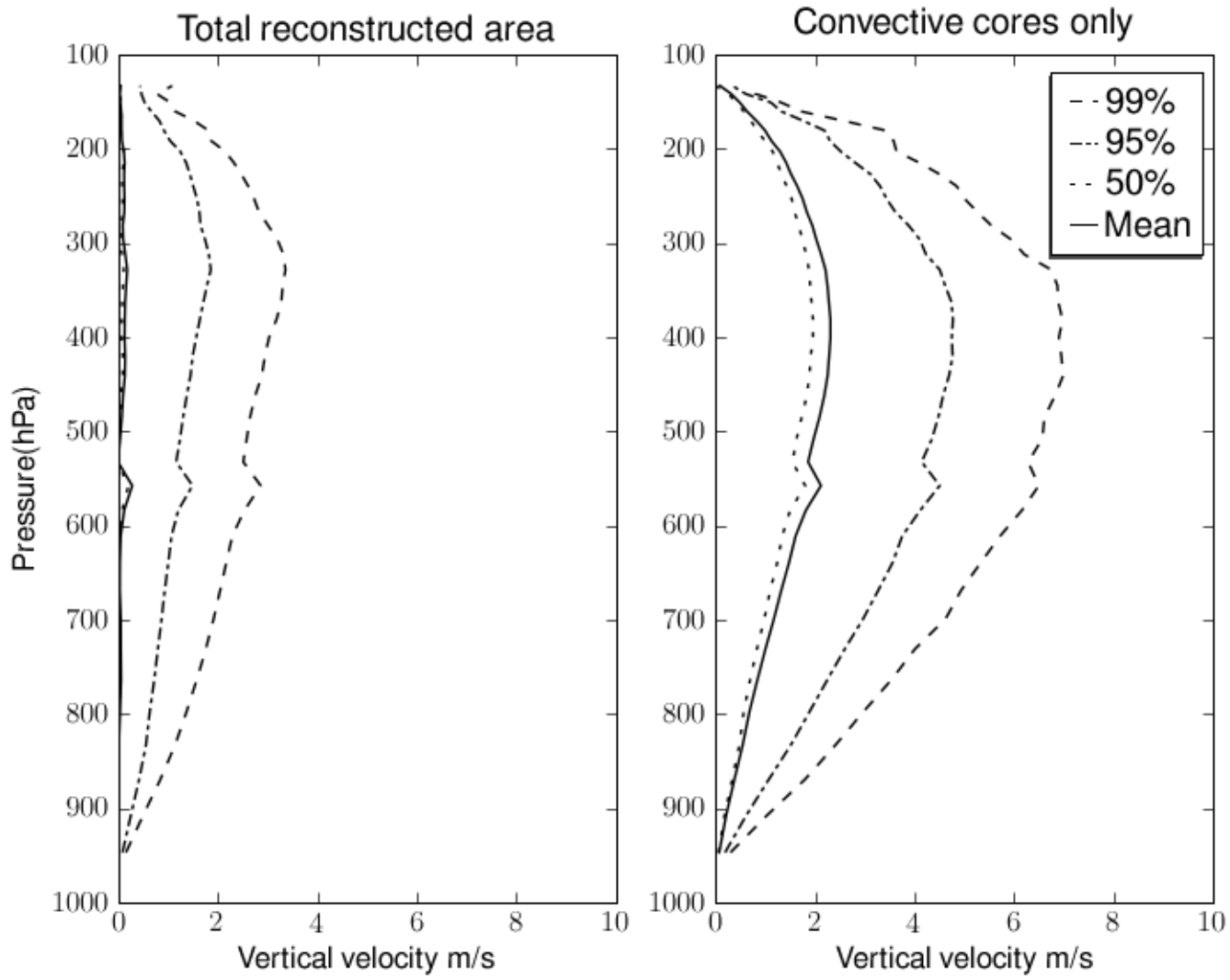
“Wet monsoon”19-22/01/2006



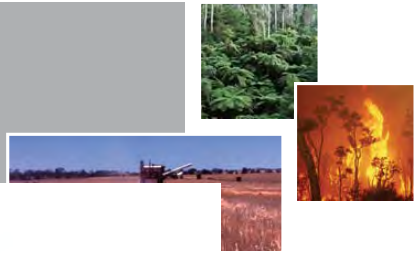
- Corresponds to the same period chosen by the ARM Cloud Modelling Working Group and the GEWEX CSS model intercomparison exercise
- Alternating cirrus layer, stratiform rain and stratiform rain with embedded squall lines.
- Retrievals performed from 0Z on the 19th to 1950Z on the 22nd every 10 minutes
- “Deep convective cores” defined as a column where w>1m/s for at least 5500m

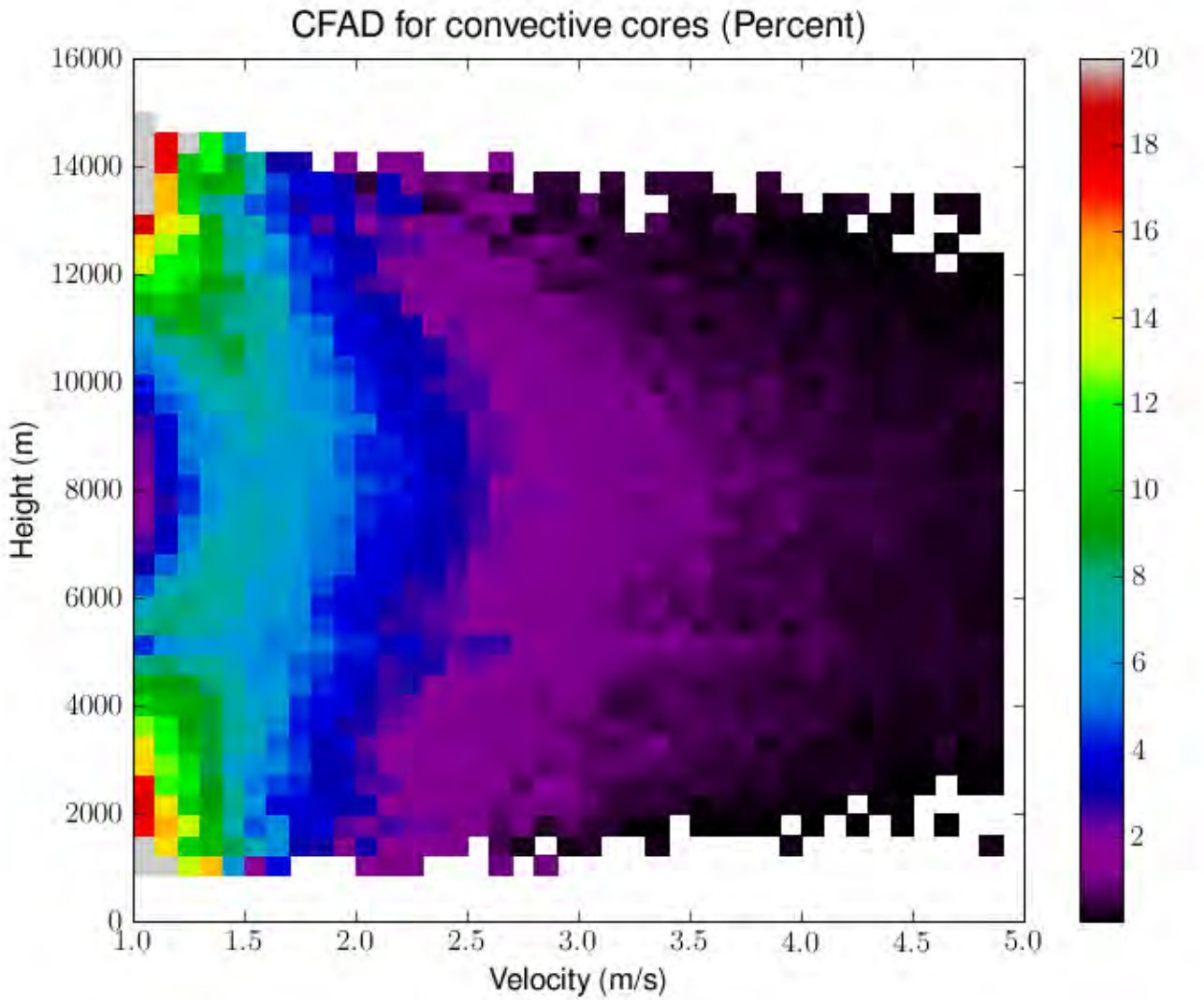
Vertical profiles of convective cores



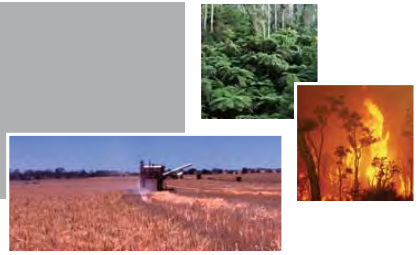


Or… if you prefer..



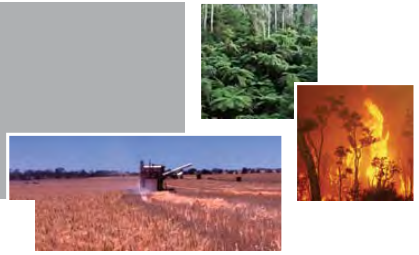


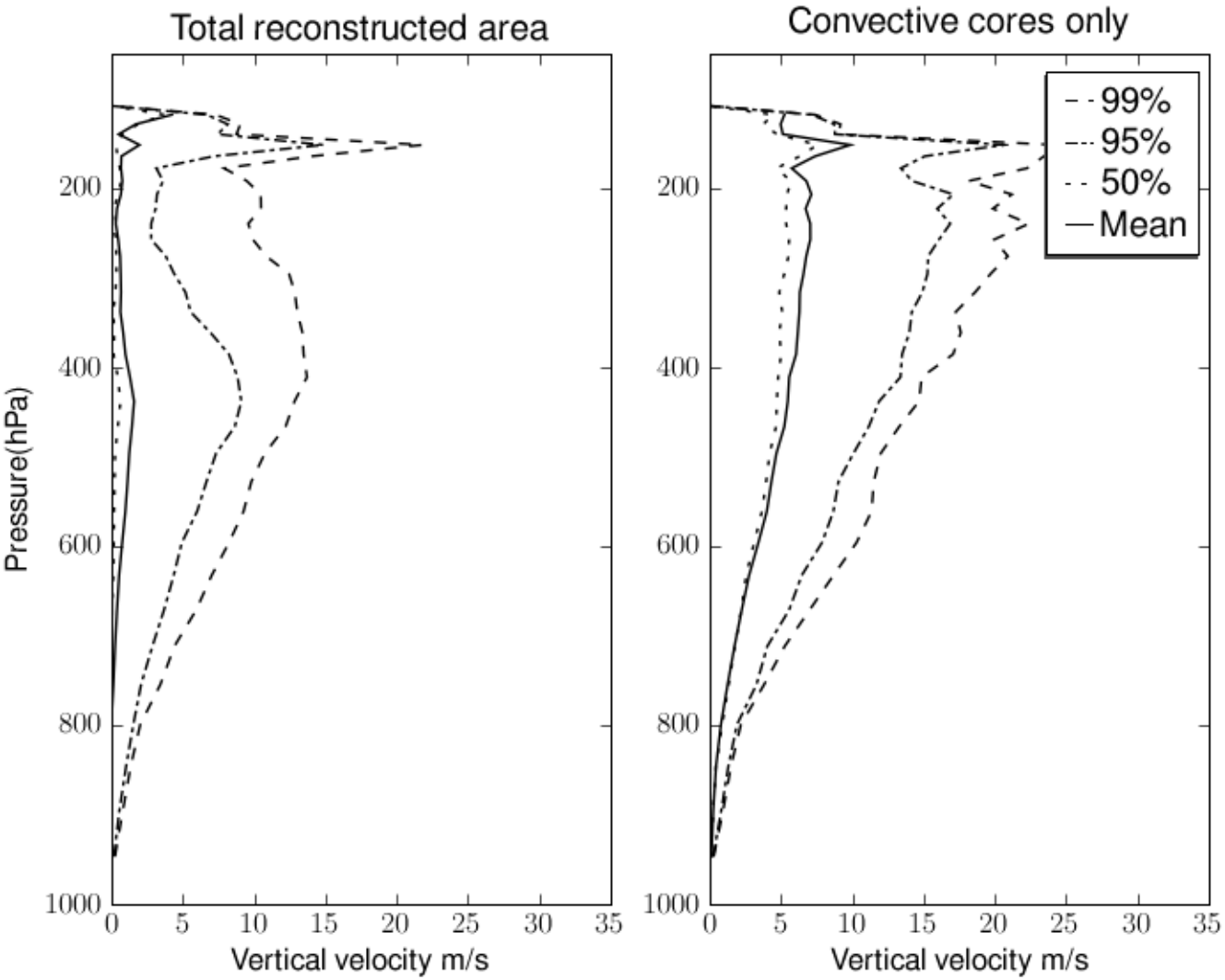
Break period 7-14/02/2006



- Isolated deep convection
- Most convection occurring on the sea breeze convergence line on the Tiwi islands or inland from Darwin (both outside of the dual Doppler lobes)
- Some systems propagated into the lobes after forming and there was at least one instance of a squall line
- Some issues with erroneous data rejection in the operational radar as well as intractable aliasing in outflow aloft.
- May need more constraints or moving frame of reference to extend range to capture boundary driven storms for a more complete picture of PDFs

Single squall line





Limited data gives some problems with stats

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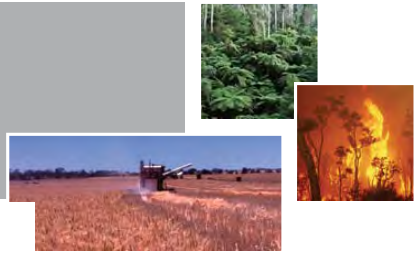
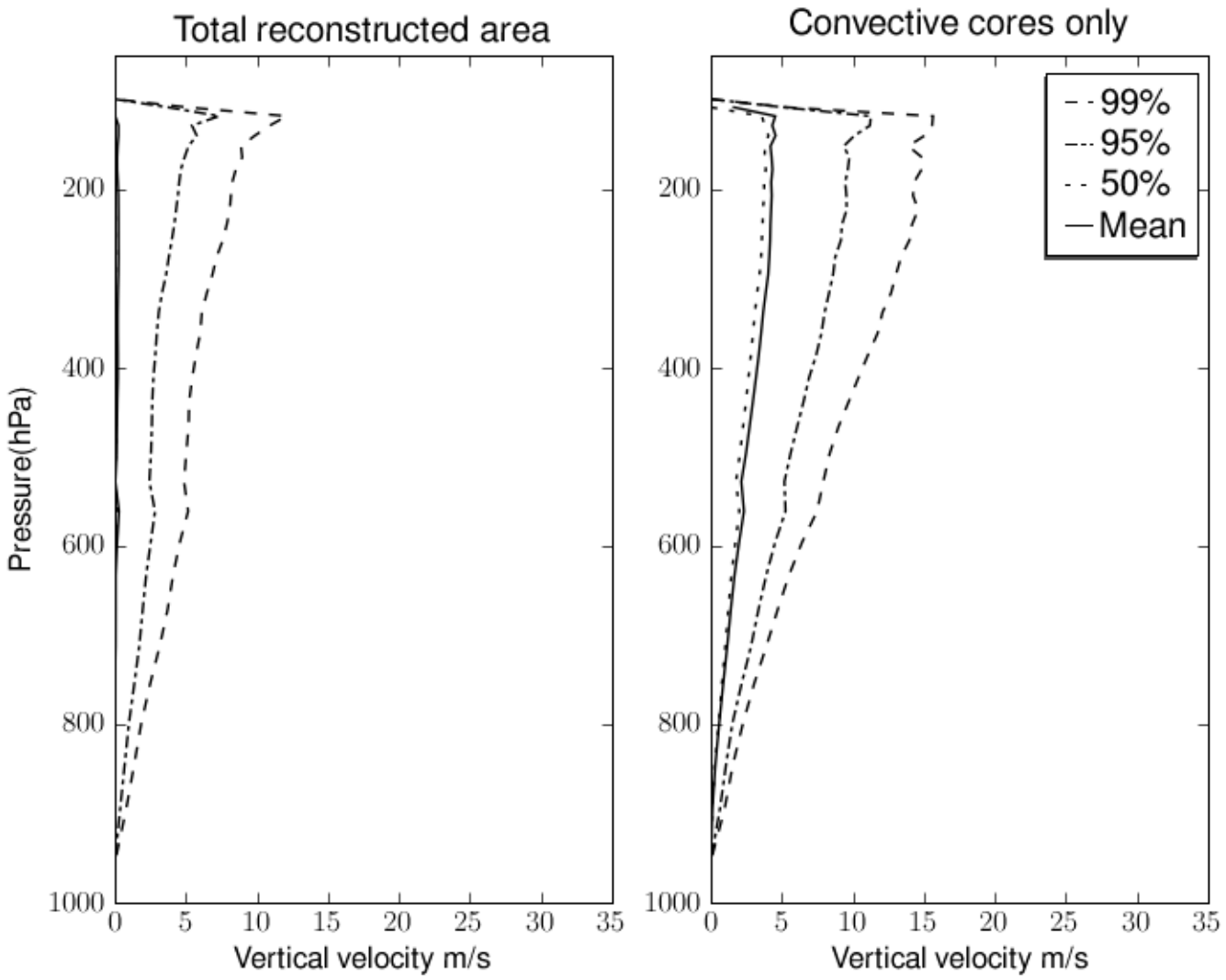
9-14th February 2006





Lack of updrafts in DD lobes gives un-representative statistics

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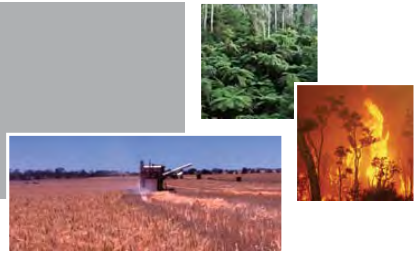
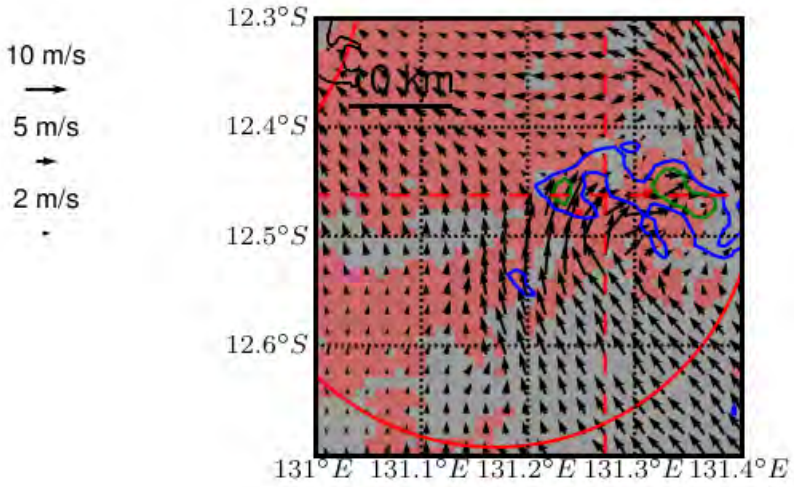
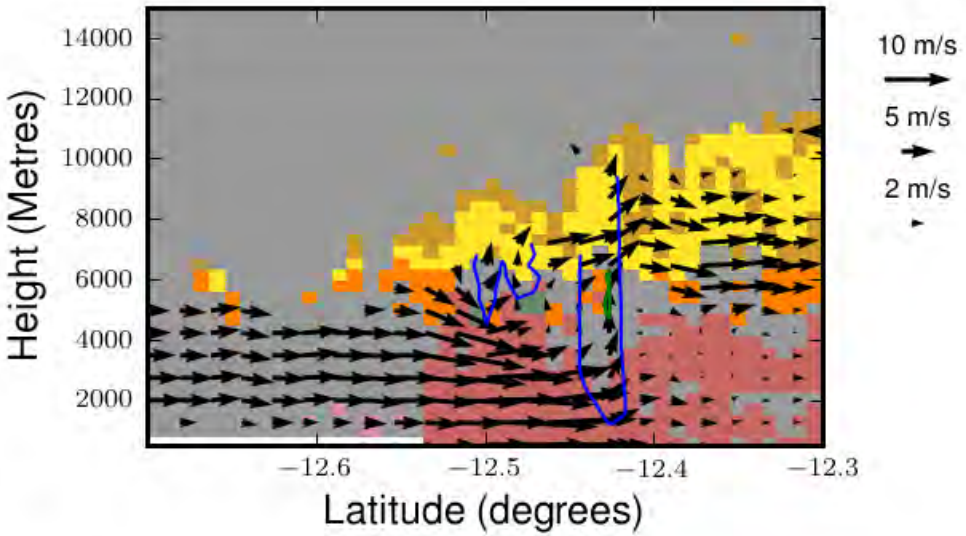
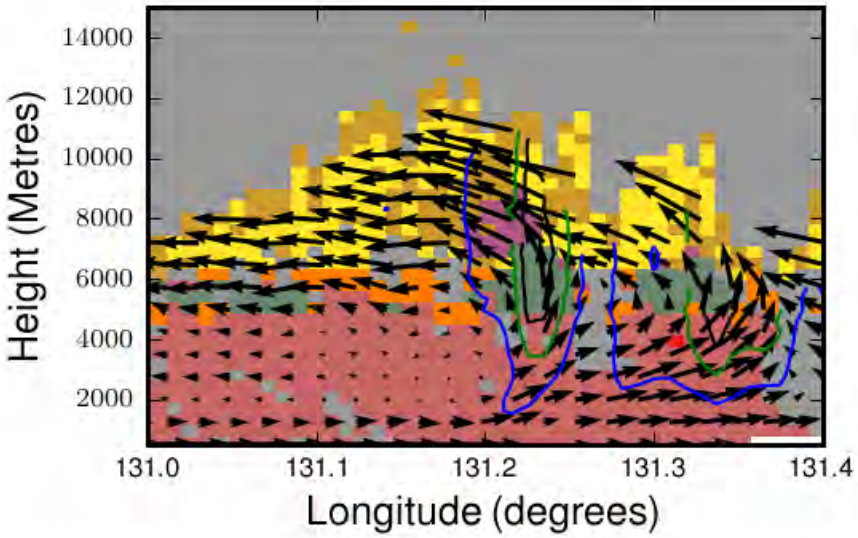
Another tool: Microphysical retrievals



- Uses moments from the C-POL polarimetric radar.
- Various different classifiers exist, we use the one described in Keenan, T, 1999: *Hydrometeor classification with a C-band. polarimetric radar*. 29th AMS Conf. On Radar. Meteorology, Amer. Meteor. Soc.
- Based on a decision tree echoes are classified as unclassified, drizzle, rain, dry graupel, wet graupel, high density snow, low density snow melting snow, small hail (<2cm) , large hail (>2cm) or rain hail mix







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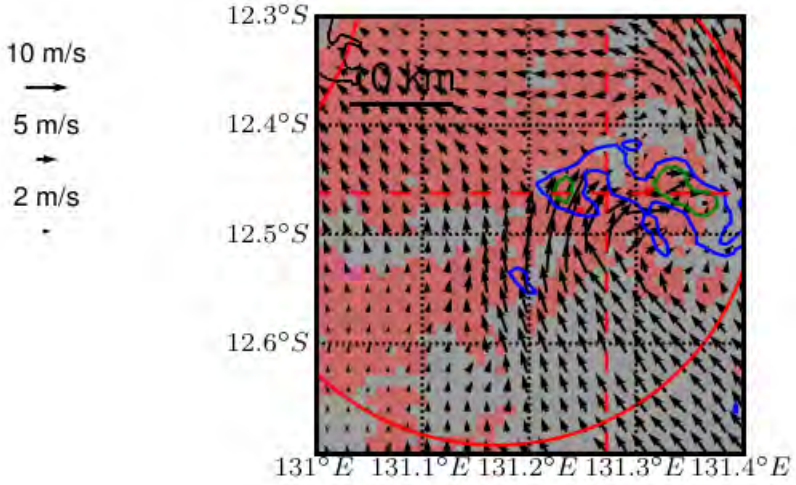

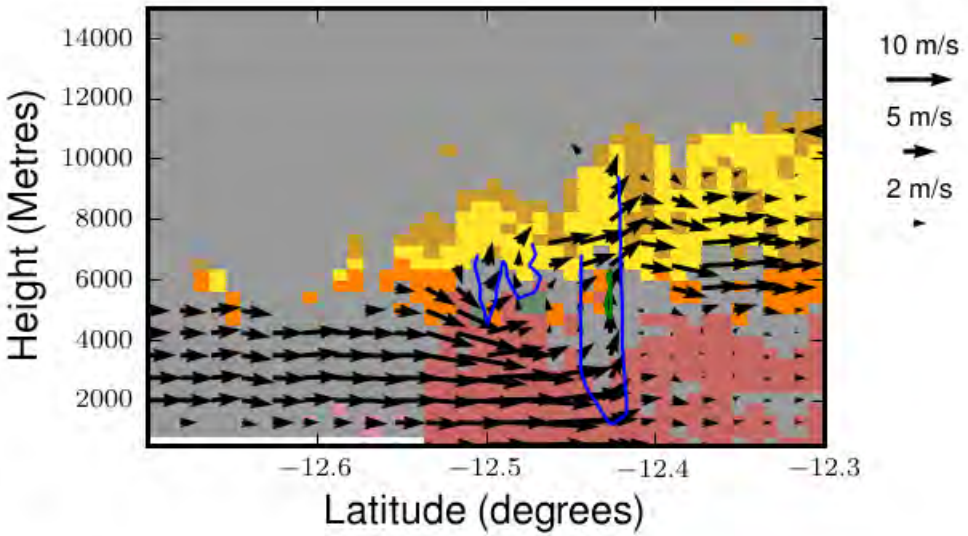

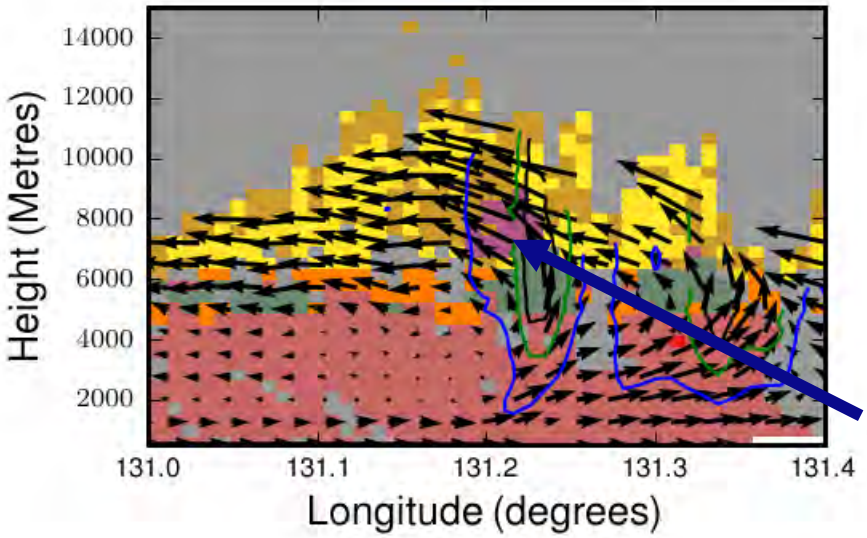

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Contours of updrafts:

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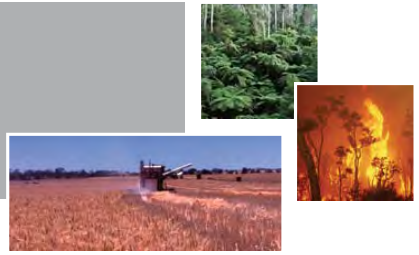
Dry Graupel being lofted into the upper Troposphere consistent with updrafts

Conclusions



- We have developed a robust tool for the retrieval of storm dynamics from radar data based on the McGill variational code
- There is a clear difference between the shape of the updraft PDF with height between the break and wet monsoon
- Locations of graupel consistent with retrieved updraft locations.
- Initial studies on the sensitivity of graupel production to updraft properties will be shown on the poster.
- Information on how this work ties in with the rest of the ACRF work will be shown on the poster by Peter May.

Special thanks to Michael Whimpey and Brad Atkinson (CAWCR)

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Thank you

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