

Deep-convective vertical velocities  
from stereo photogrammetry

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Lawrence Berkeley Laboratory  
November 5, 2013

Work done by  
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a project scientist  
first at LBNL,  
now at UC Berkeley



## Stereo photogrammetry of oceanic clouds

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Several other collaborators:

Prabhat (LBNL, computer vision)

James Lee (LBNL, DAQ)

Aaron Thomas (LBNL, DAQ)

Paquita Zuidema (RSMAS, second  
camera and CAROb instruments)

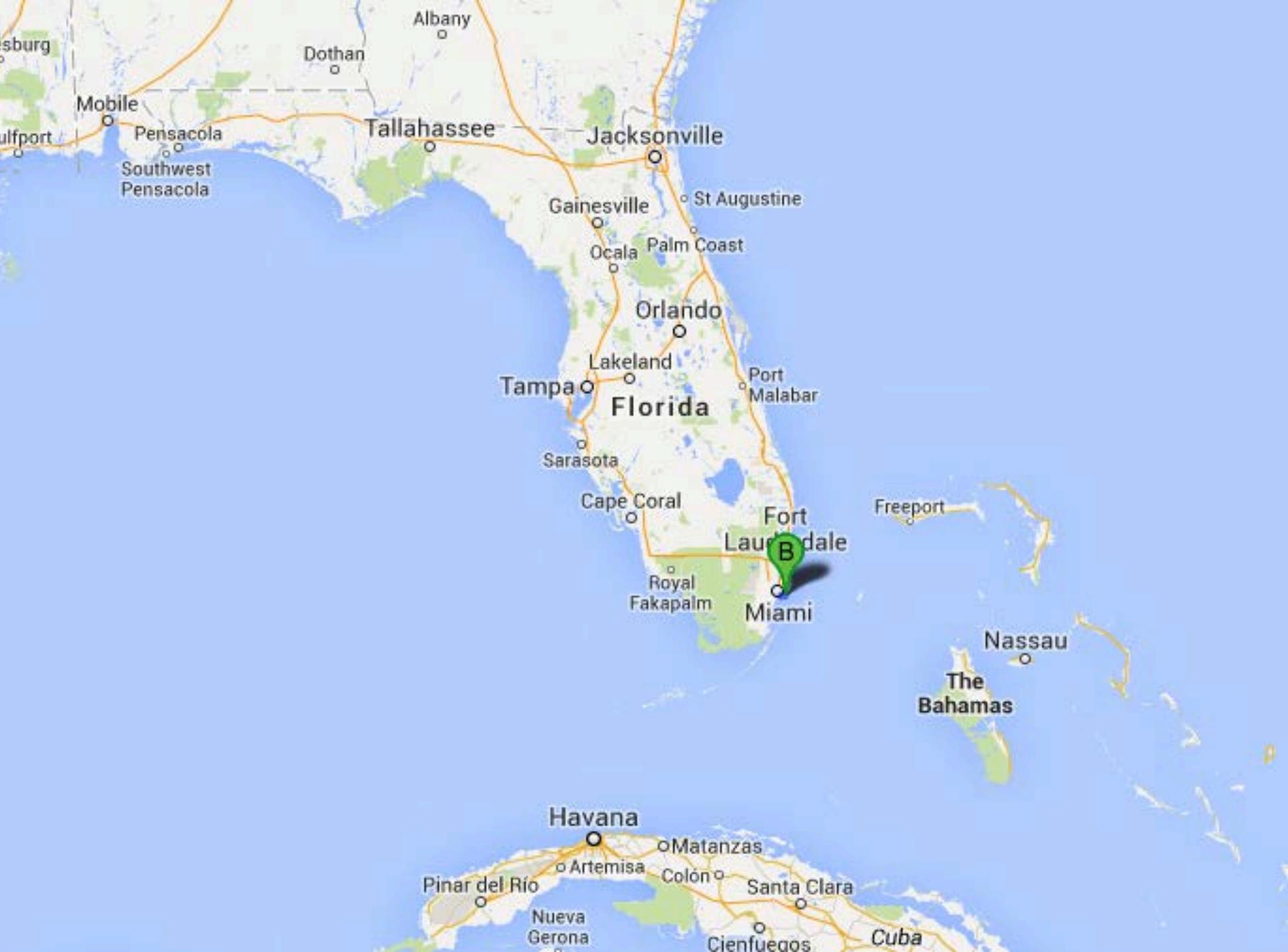
Research supported by:



Laboratory Directed Research and Development Program



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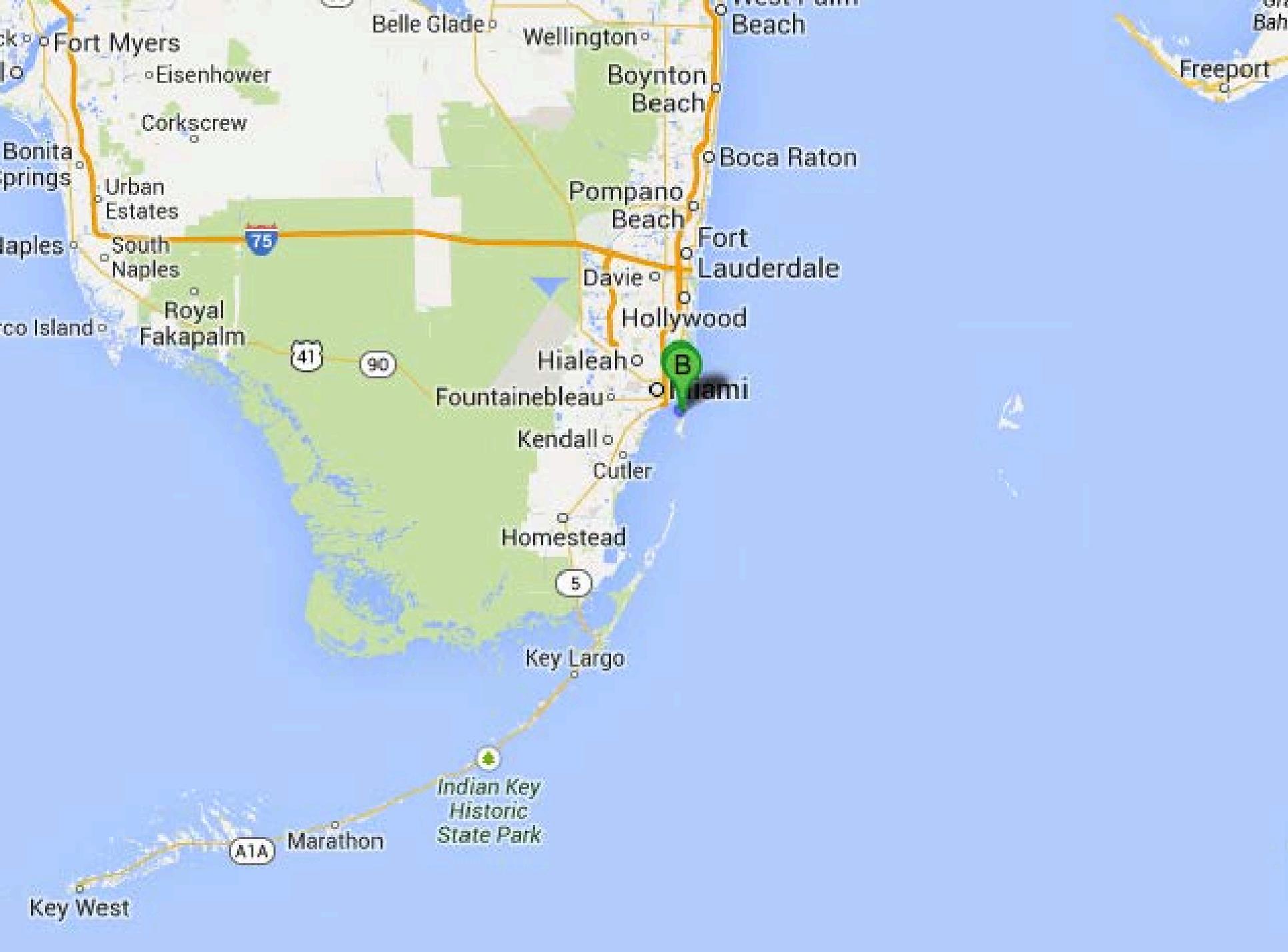
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41

90

Fountainebleau

Kendall

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5

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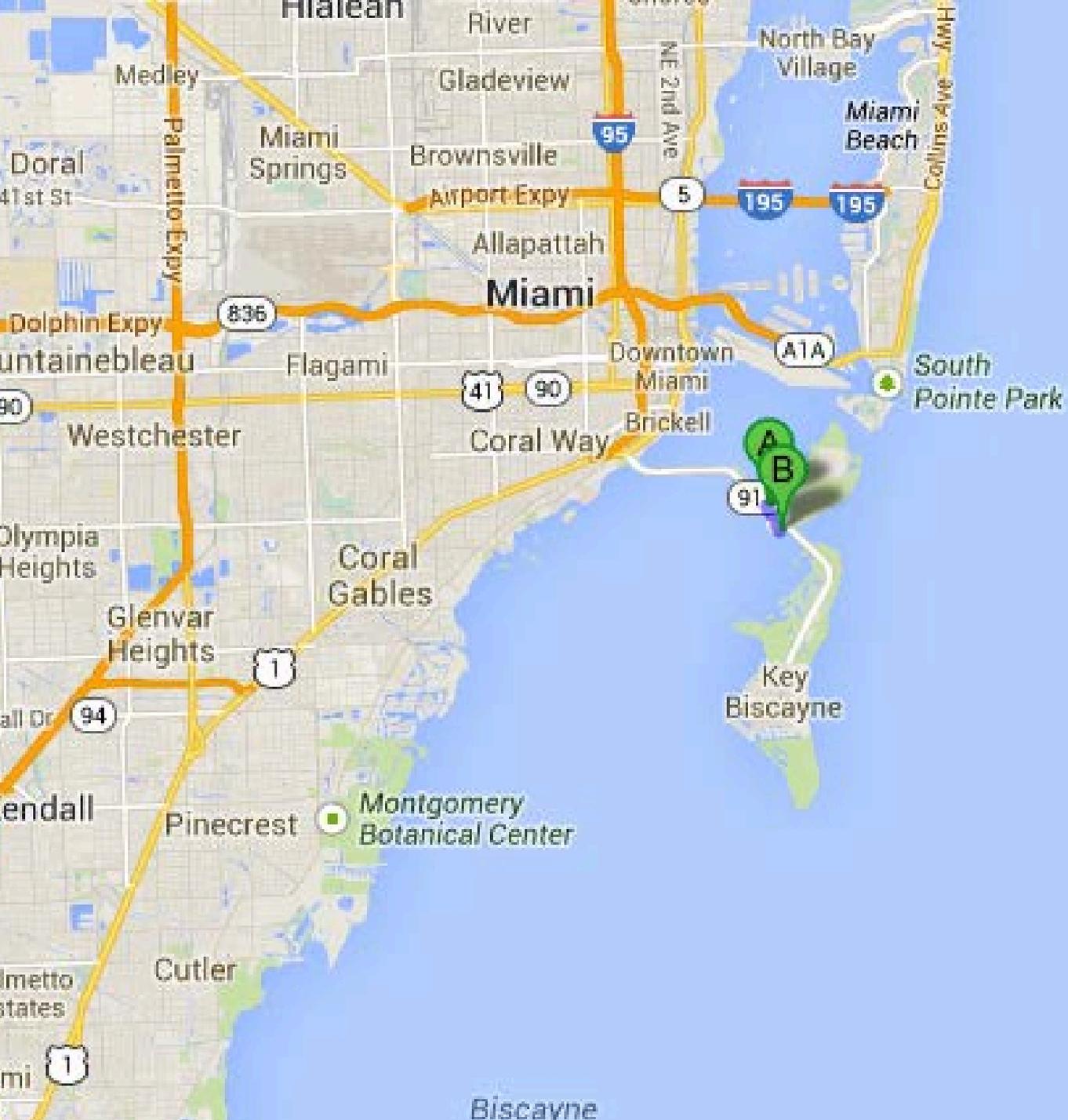
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# Stereo photogrammetry of oceanic clouds

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This paper addresses three questions:

1. How to perform stereo photogrammetry over the ocean without traditional landmarks?
2. How does the accuracy of reconstructions depend on the arrangement of cameras?
3. How close are we, in practice, to the theoretical limits on accuracy?

Too much detail  
for this talk

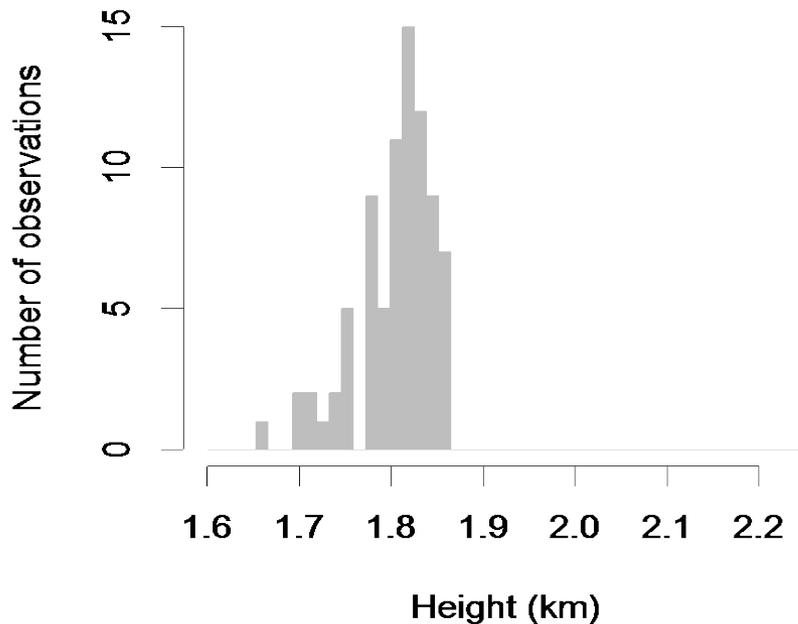
Coming up...



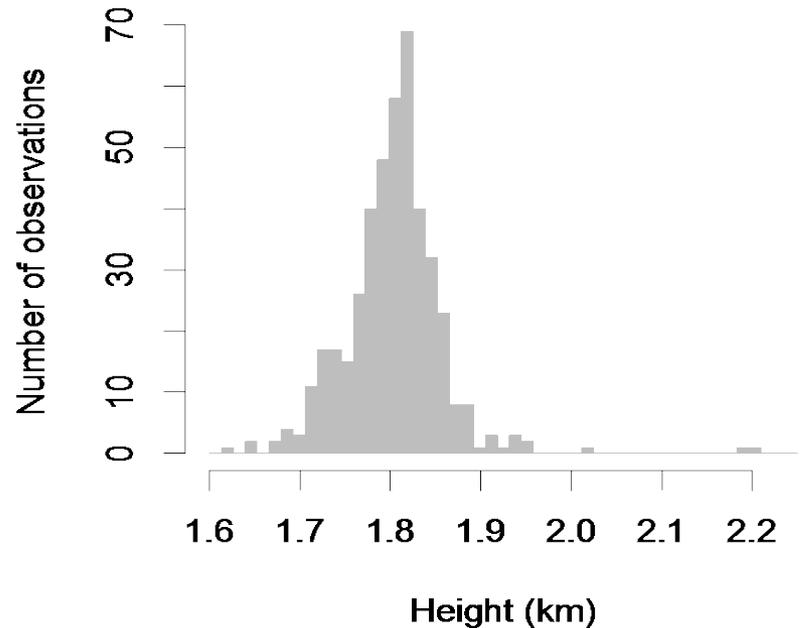


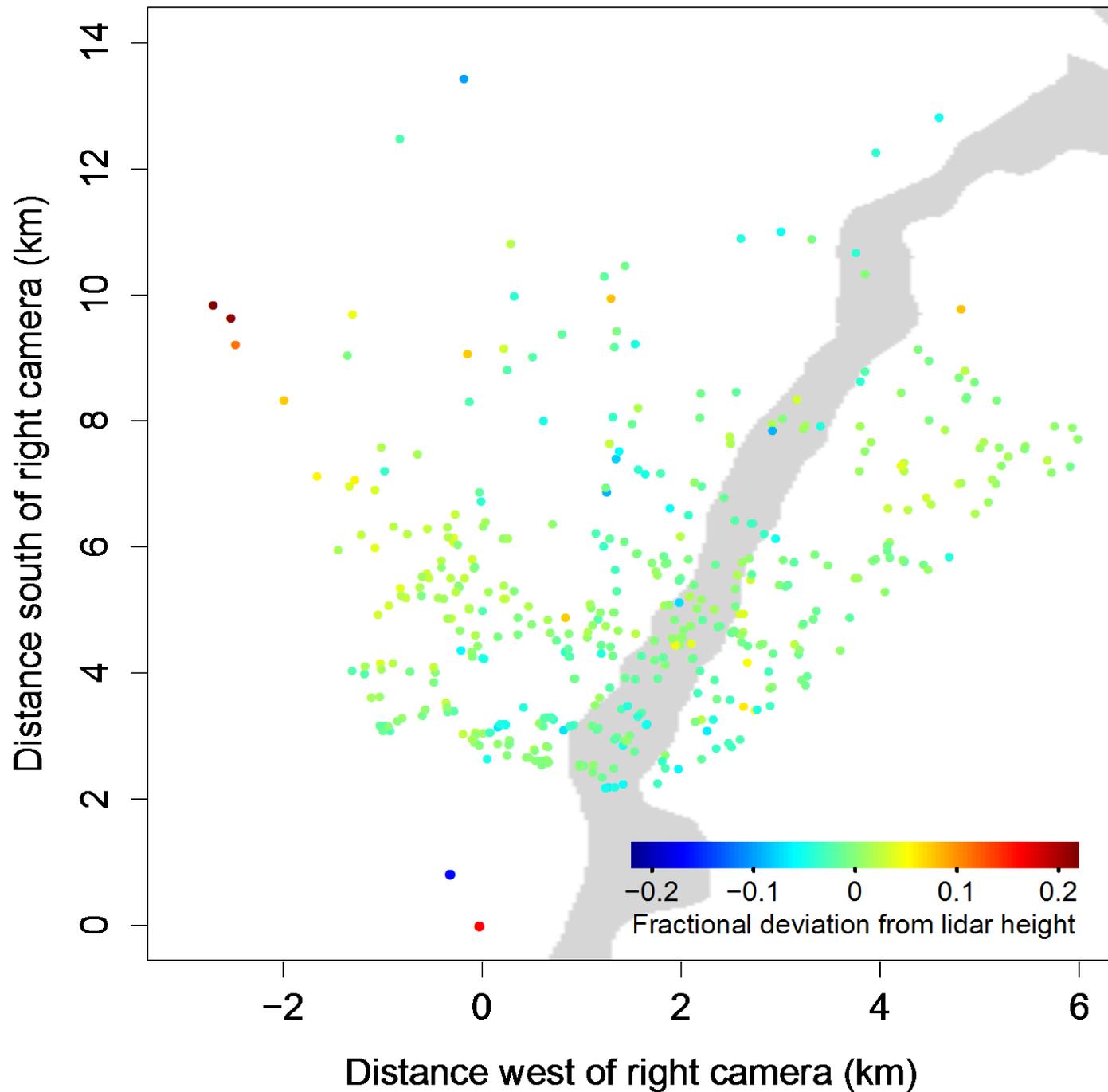
## Validation of stratocumulus heights against a lidar

**Histogram from ceilometer**

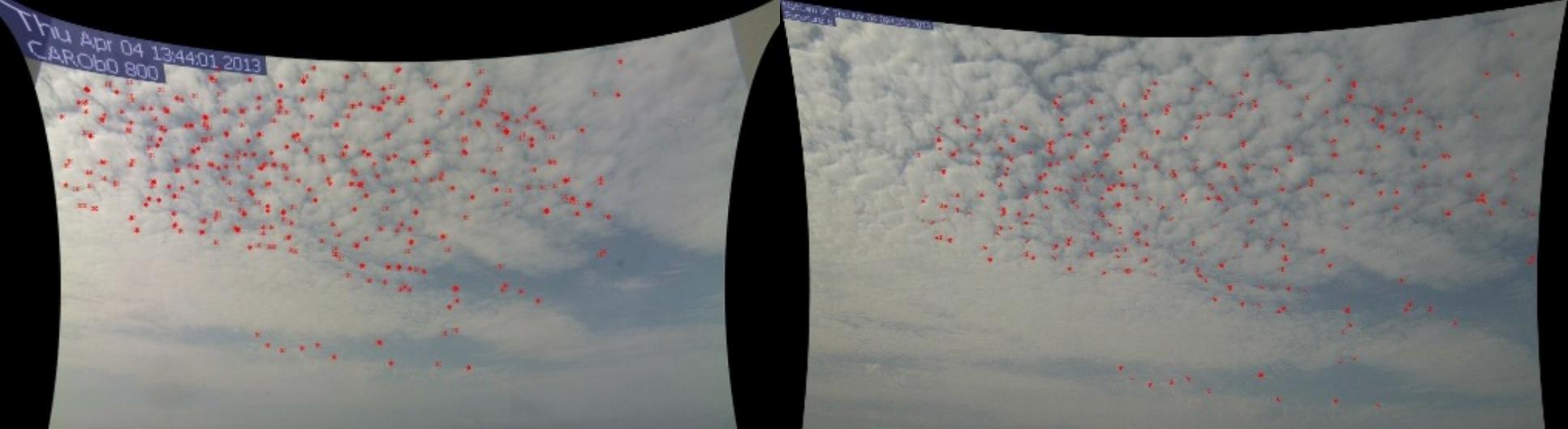


**Histogram from stereo cameras**



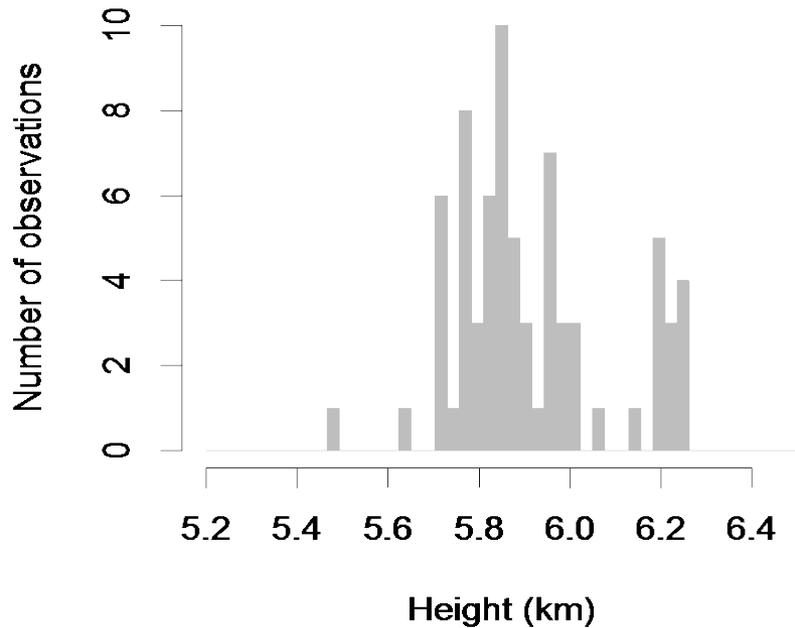


Fractional  
deviation  
from mean  
lidar height

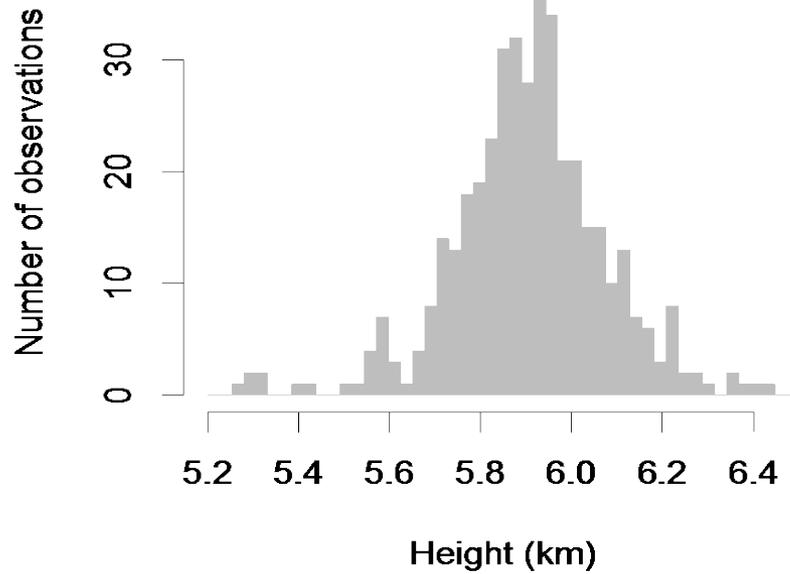


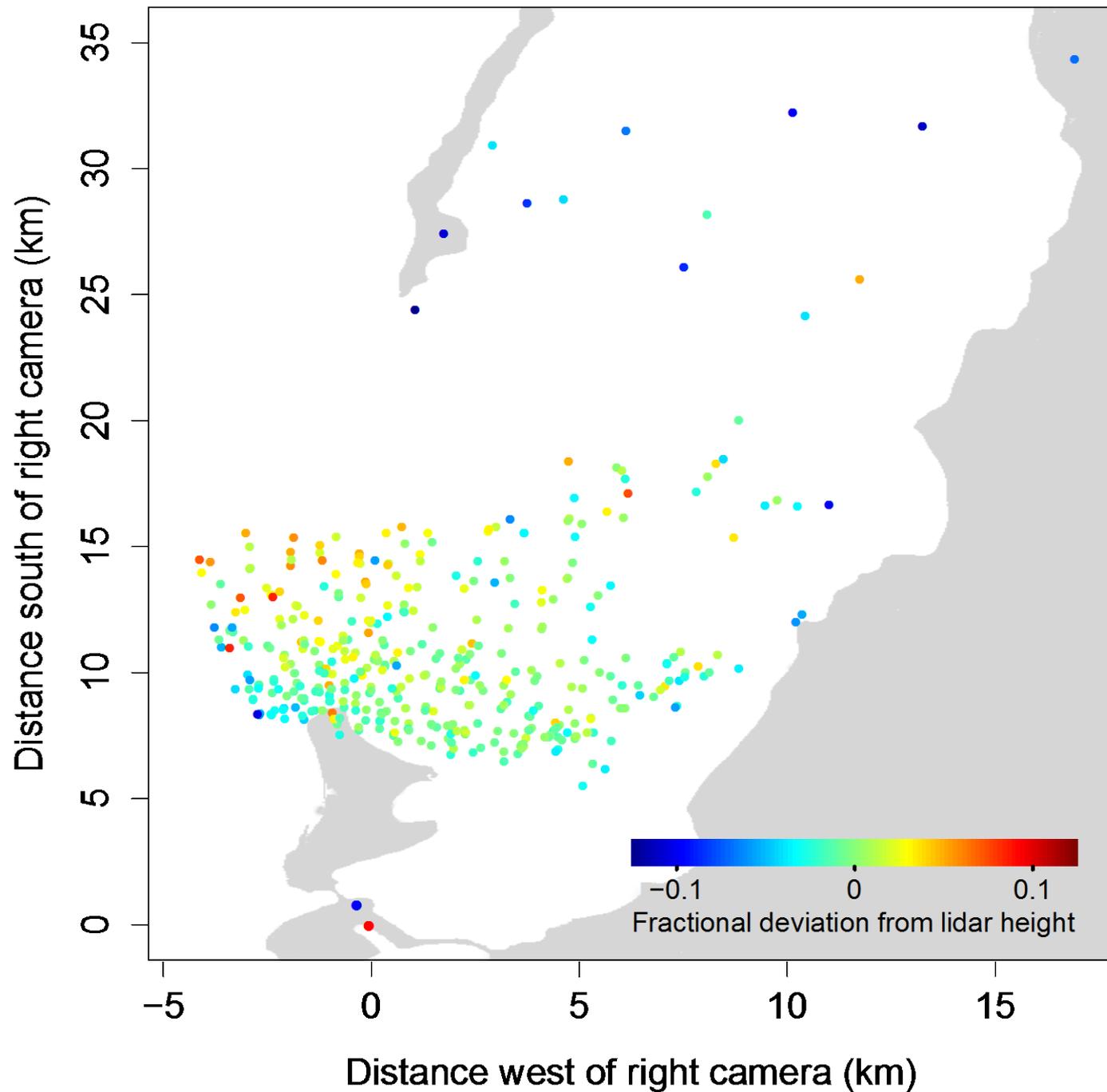
## Validation of altocumulus heights against a lidar

**Histogram from ceilometer**



**Histogram from stereo cameras**



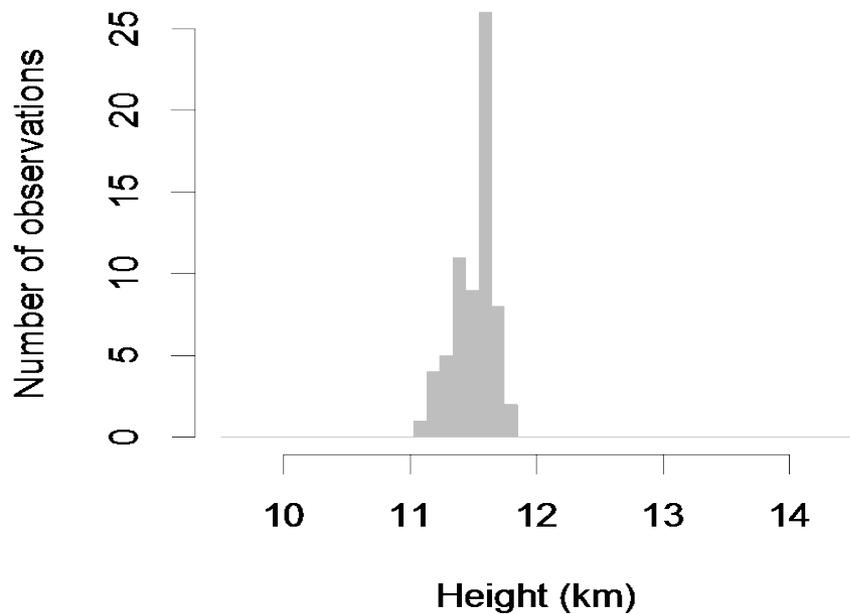


Fractional  
deviation  
from mean  
lidar height

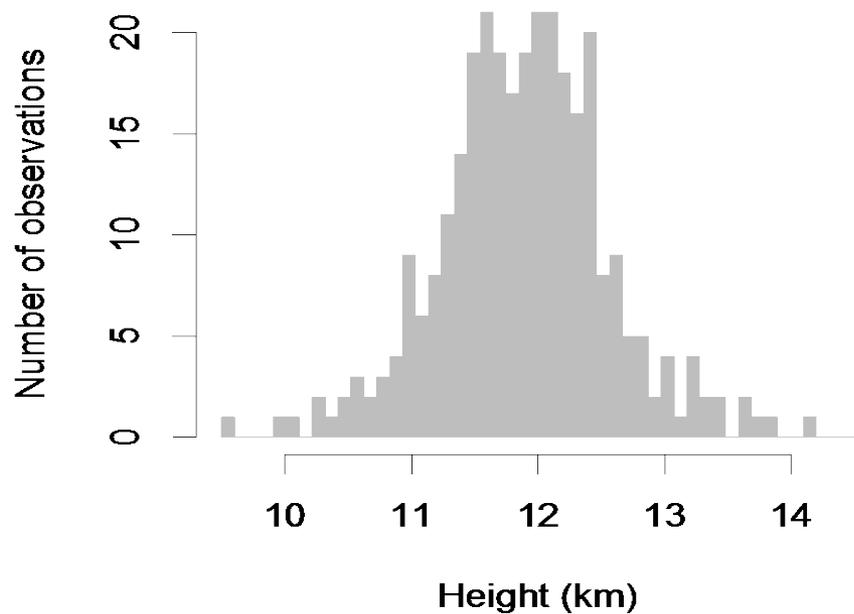


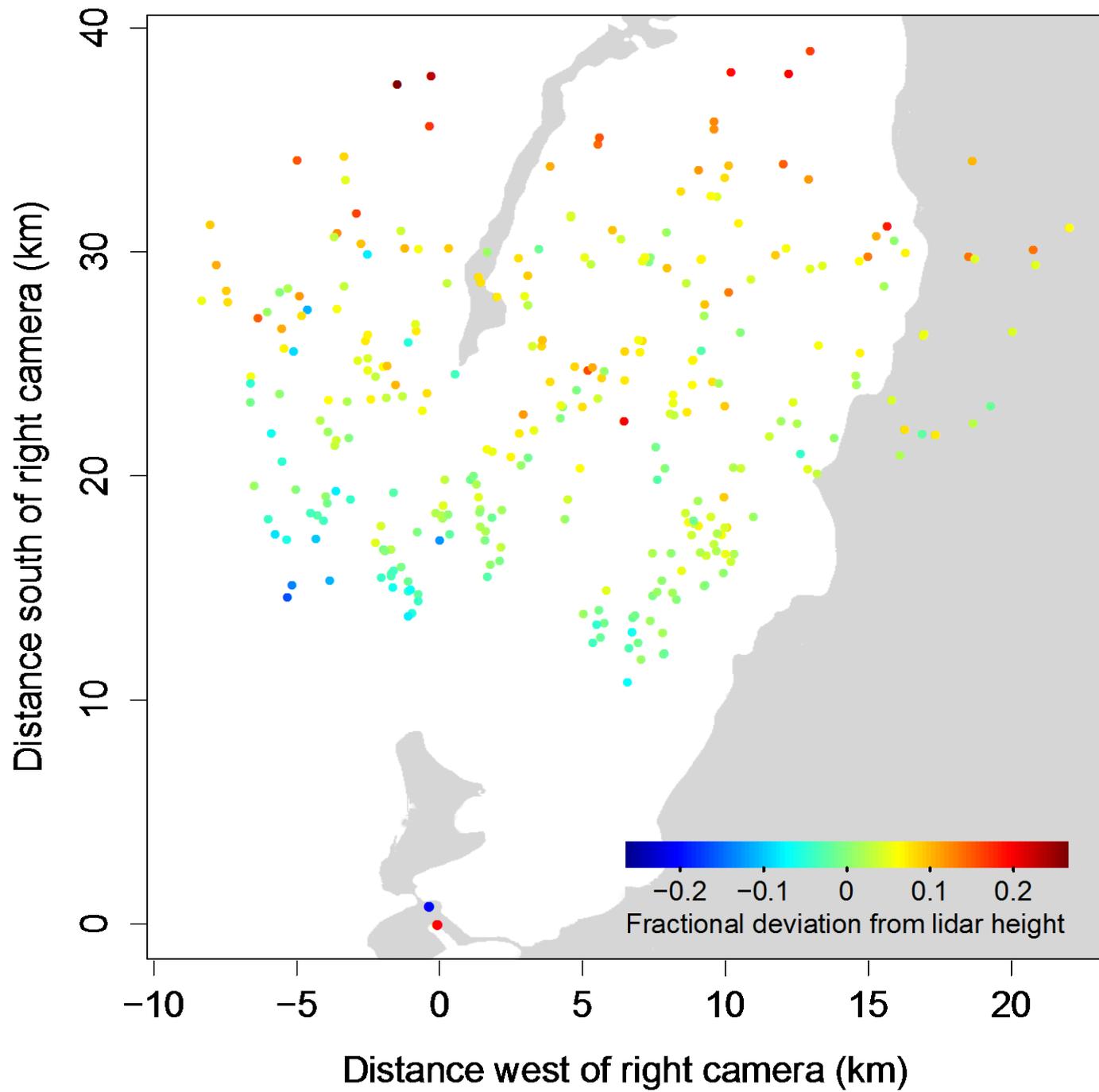
## Validation of cirrocumulus heights against a lidar

**Histogram from lidar**



**Histogram from stereo cameras**

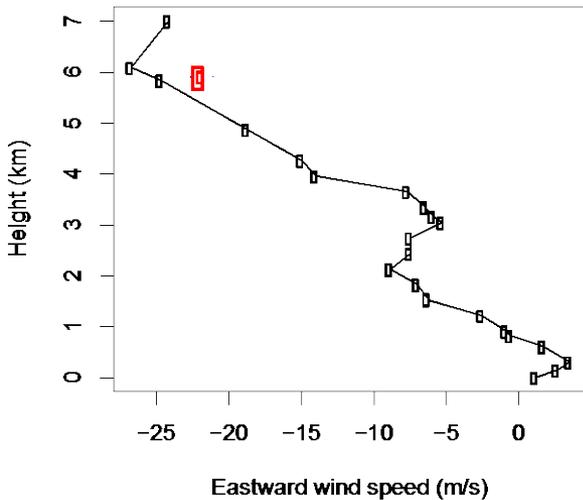




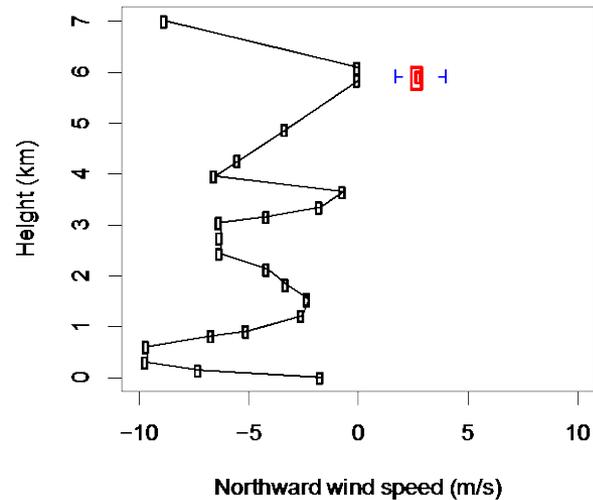
Fractional  
deviation  
from mean  
lidar height

# Validation of cloud-layer wind speeds against radiosondes

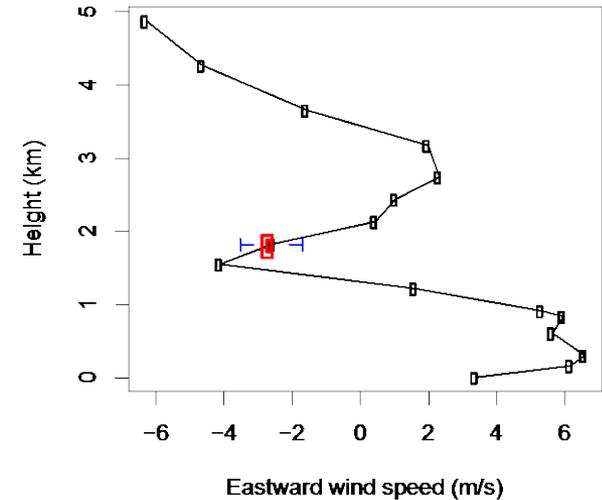
April 4, 2013



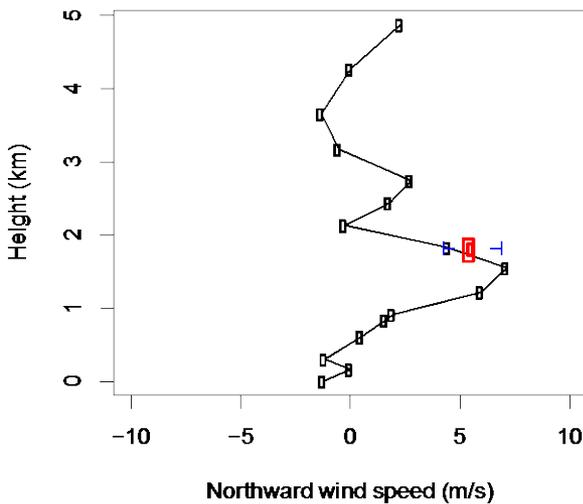
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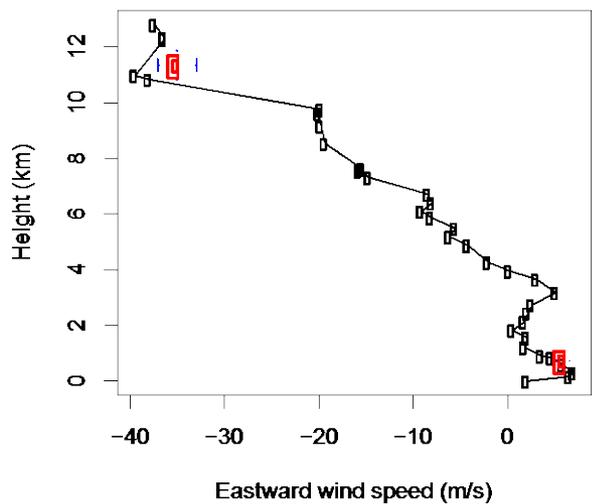
April 8, 2013



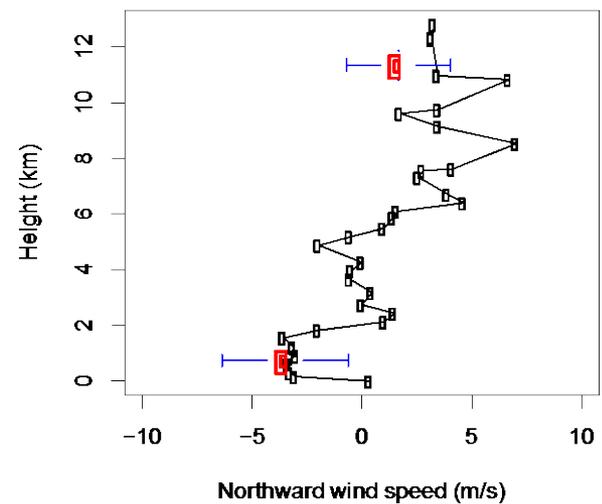
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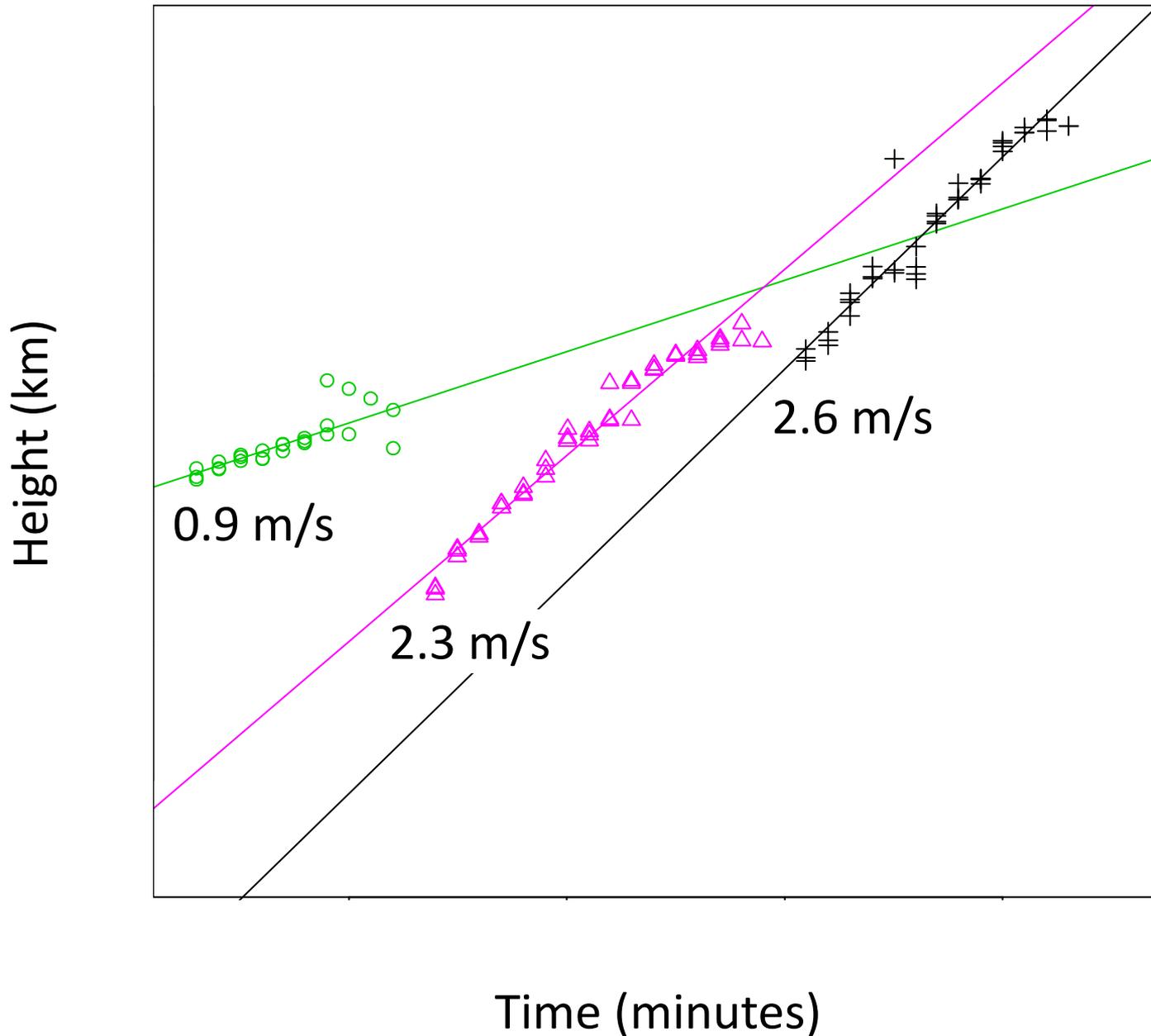
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April 9, 2013

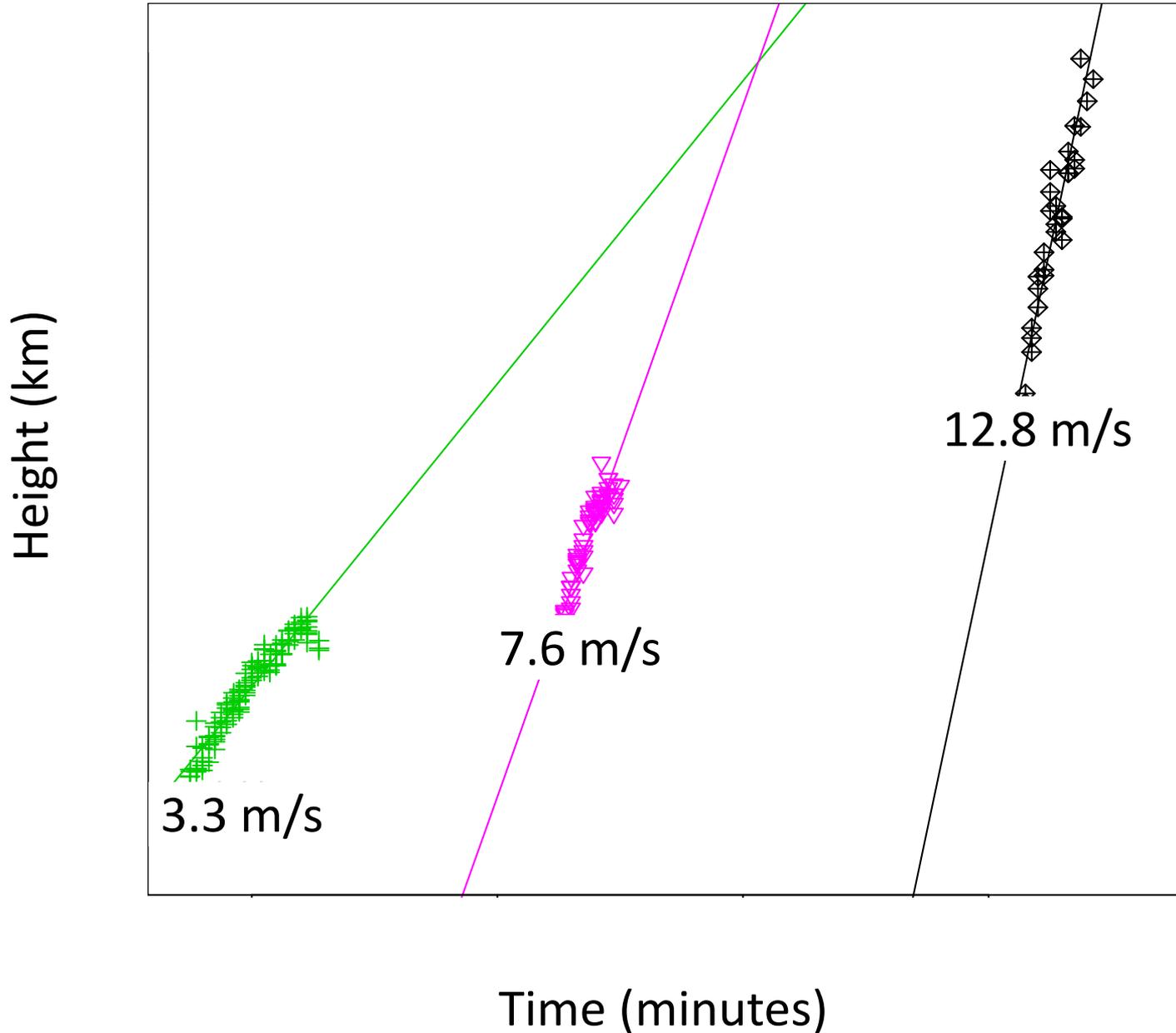


# Time series of cloud-top heights



Shallow clouds have cloud-top ascent speeds in the range of 1-3 m/s, as expected

# Time series of cloud-top heights



Deep clouds  
have cloud-top  
ascent speeds  
**well in excess  
of 10 m/s**

This implies  
core velocities  
in the ballpark  
of **20 m/s**

## Near-term plan

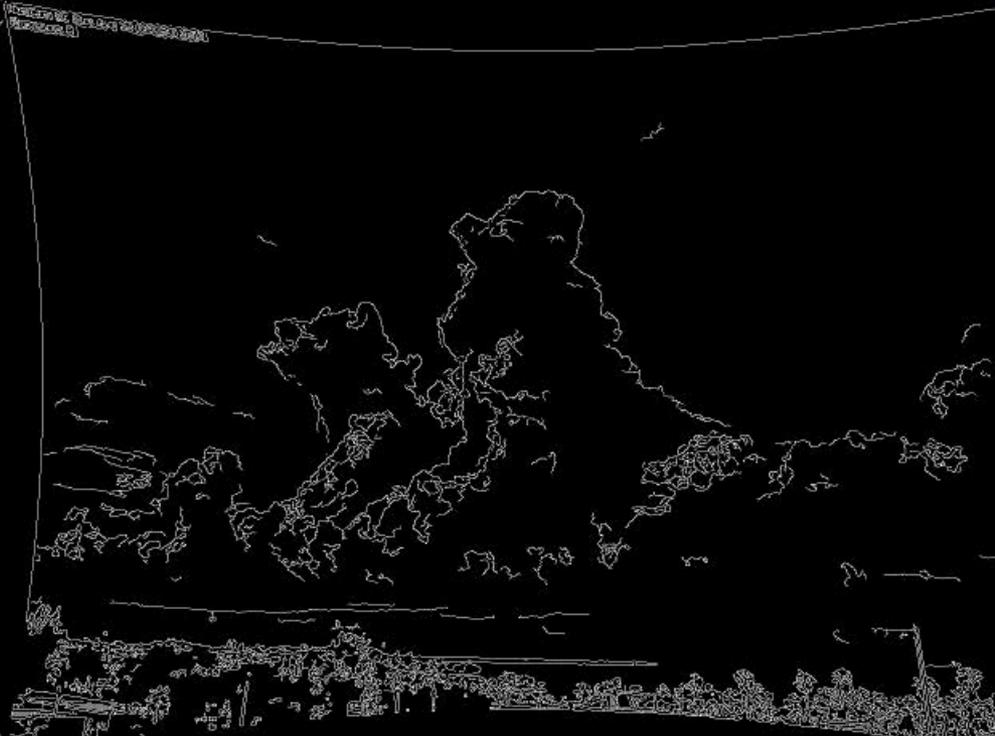
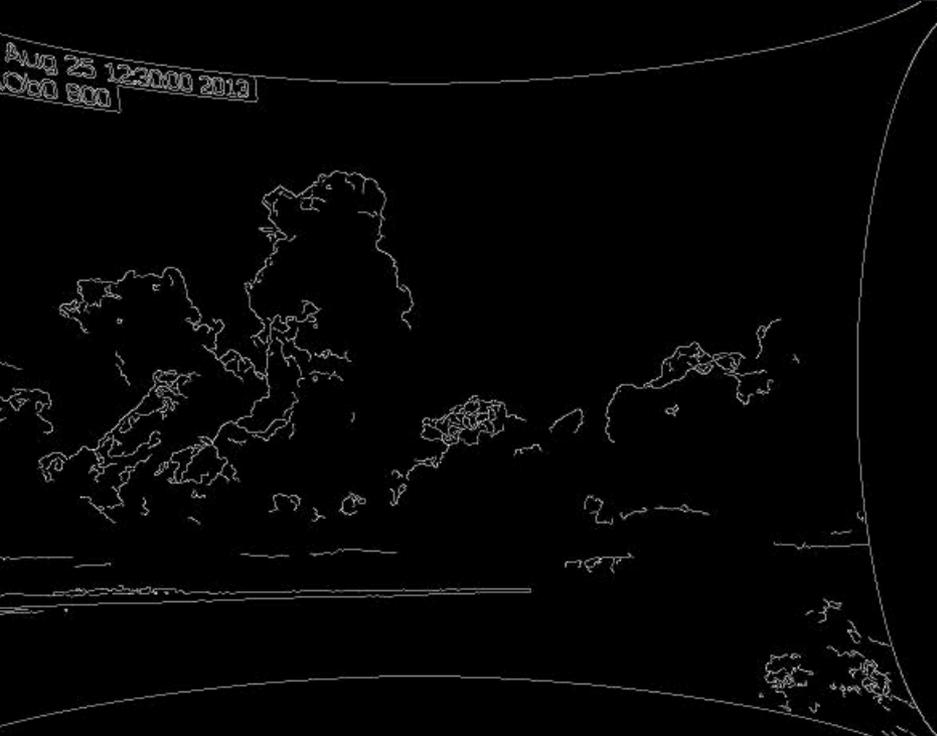
Measure cloud-top vertical velocities  
for tropical, oceanic deep convection.



AUG 25 12:30:00 2013  
060 800



AUG 25 12:30:00 2013  
060 800



AUG 25 12:30:00 2013  
060 800



## Near-term plan

Measure cloud-top vertical velocities for tropical, oceanic deep convection.

For longer-term plans,  
**seeking feedback and collaboration**

How best to augment the existing ARM instruments?

- Provide temporal interpolation for SACR?
- Provide life-cycle data for WACR?
- Provide benchmark for volumetric wind retrievals?
- Provide benchmark for 50-MHz wind profilers?