

NEW (TO METEOROLOGY)
IDEAS IN STORM
IDENTIFICATION AND
TRACKING

lakshman@ou.edu, madison.burnett@noaa.gov,
travis.smith@noaa.gov

Where in the world is Lak?



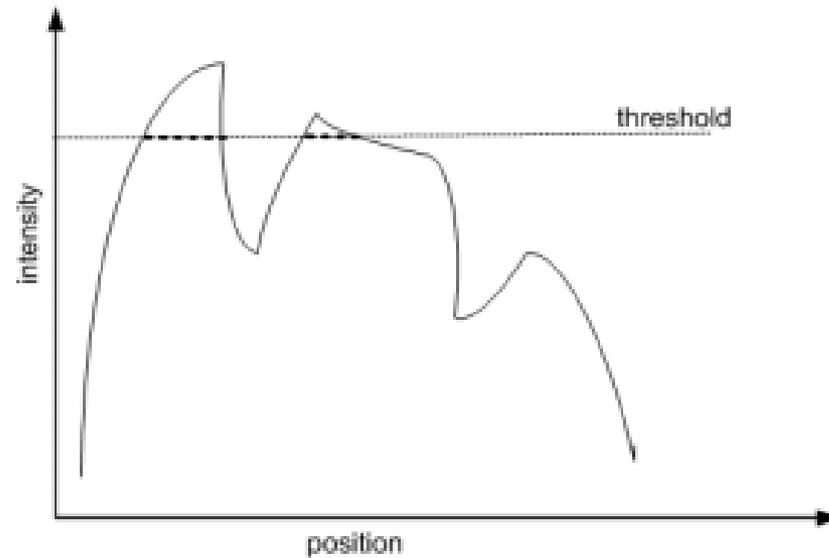
Thanks to Don MacGorman,
Will Agent & Madison Miller
for making the Webex
possible

The common approach

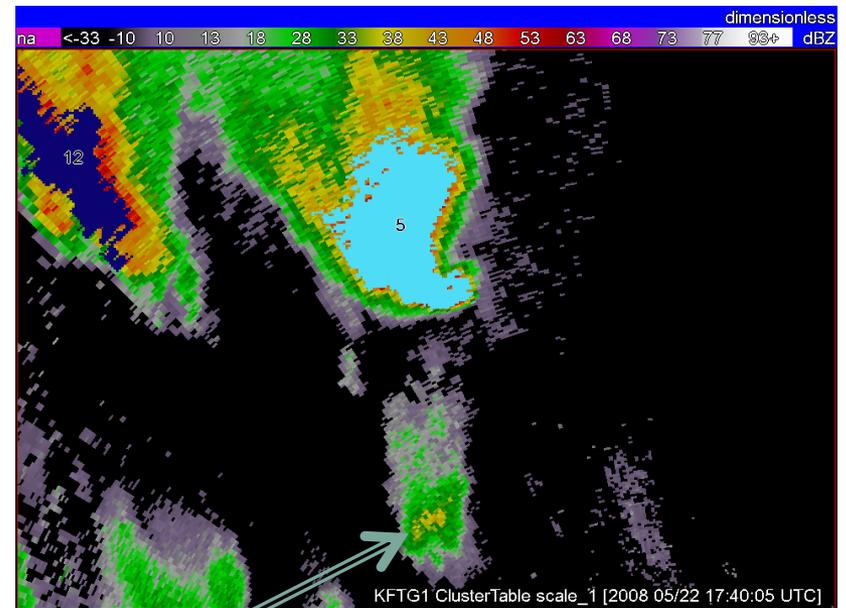
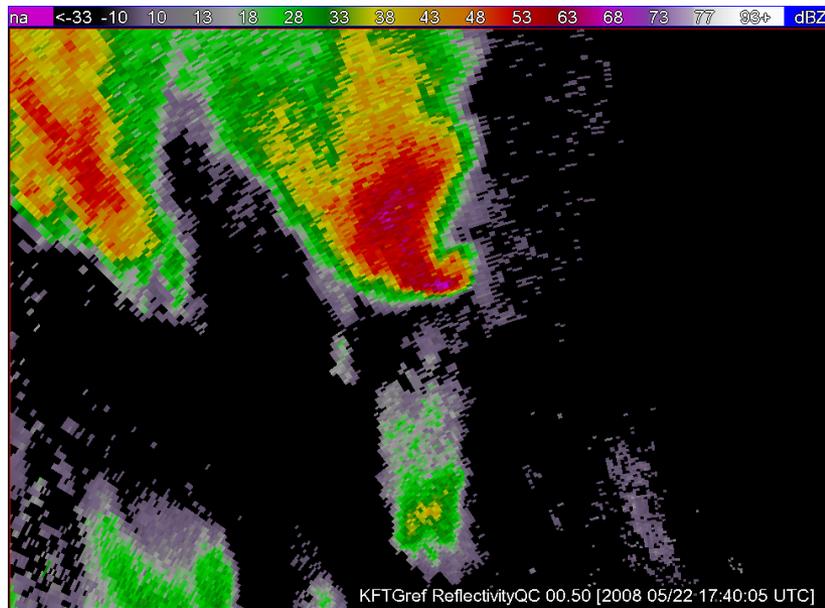
- Objects identified based on a threshold
 - ▣ All pixels above threshold are part of object
 - ▣ Contiguous pixels form an object
- Objects tracked by association between frames
 - ▣ Several strategies to associate objects
 - Closest centroid, greatest overlap, cost function optimization, etc.
- In this talk, will introduce new (to meteorology) ideas in storm tracking
 - ▣ These ideas used in tracking missiles since the 80s

Problem: threshold is global

- Same threshold does not work for initiating vs. mature storms

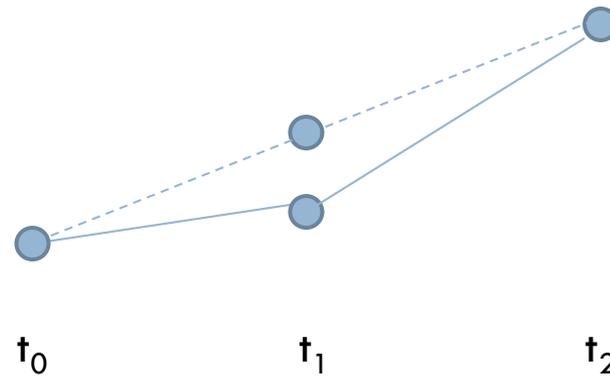


Example of threshold problem

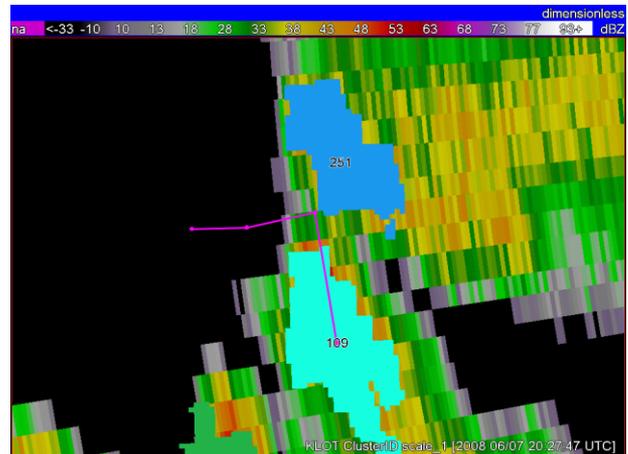
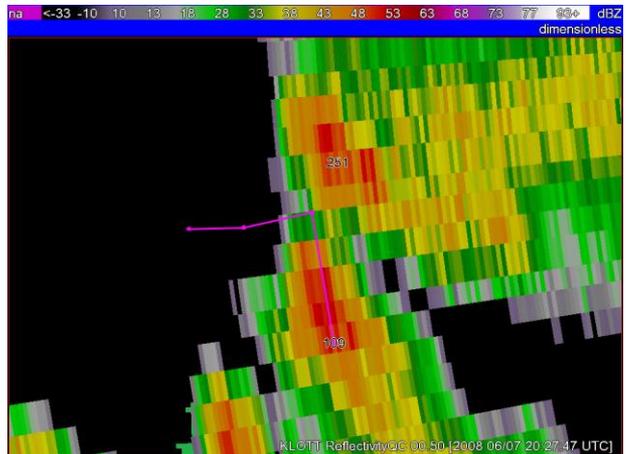
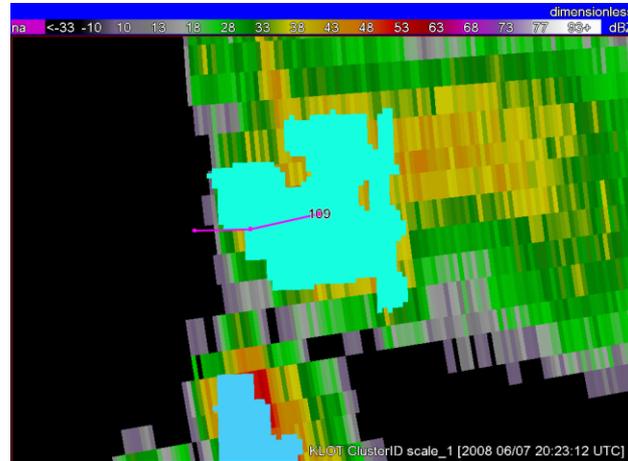
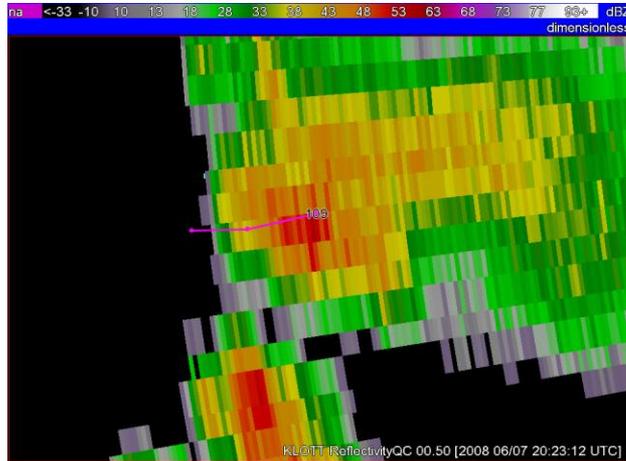


Problem: Association is final

- Association takes only two frames into account
 - ▣ Bad decisions percolate



Example of association problem

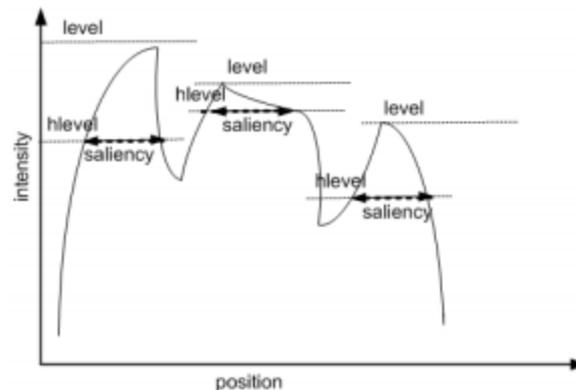


Premise ...

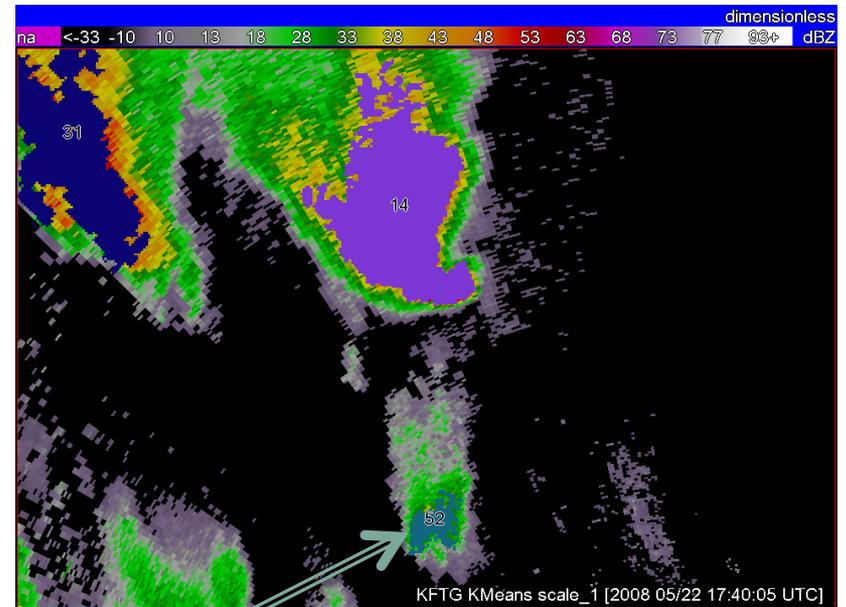
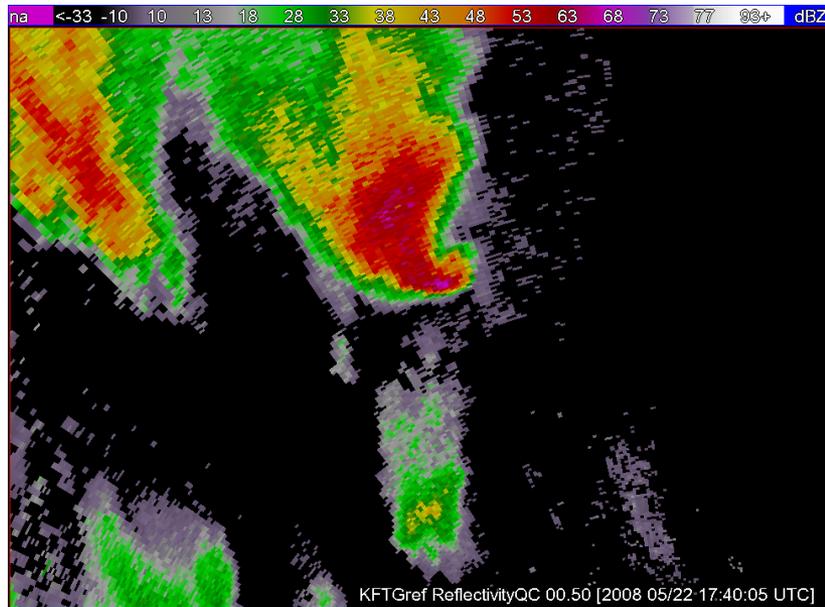
- Try to avoid hard decisions
 - ▣ Use locally adaptive thresholds to identify storms
 - Based on size of storm rather than data threshold
 - Different regions of image subject to different thresholds
 - ▣ Keep around several possible tracks
 - Finalize the associations after a few frames

Enhanced Watershed Transform

- Start from local peak
 - ▣ Grow till specified size is reached
 - ▣ In effect, we are trying every possible data threshold
 - Within limits, of course



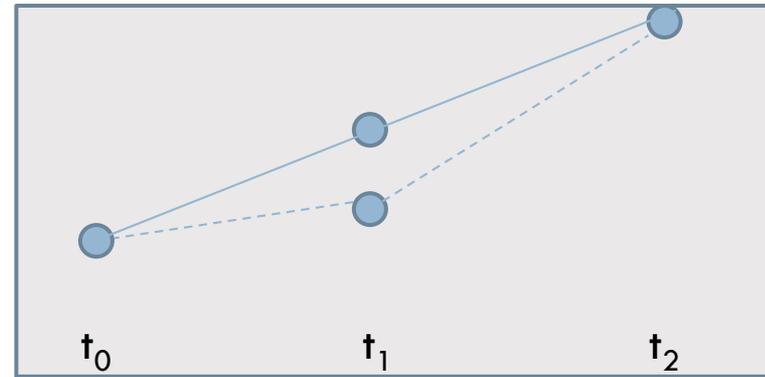
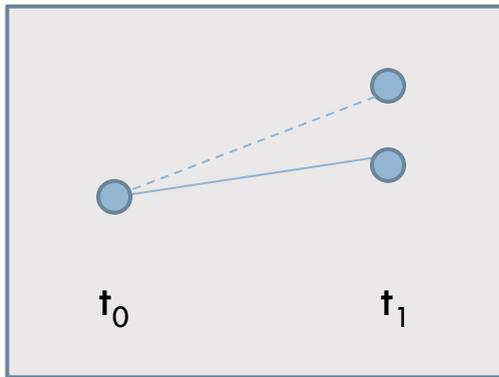
EWT Example



Multiple Hypotheses Tracking (MHT)

- MHT is based on two useful algorithms:
 - Hungarian Method or Munkres algorithm
 - Optimal way to associate cells at one frame to the cells at the next frame using linear programming
 - Based on a “cost” for each pair: could be simply distance between centroids or something more complex
 - Murty’s K-best association
 - Way to get not just the best way to associate cells, but the next best way, and the next best way, etc.
 - Ranked set of associations

MHT

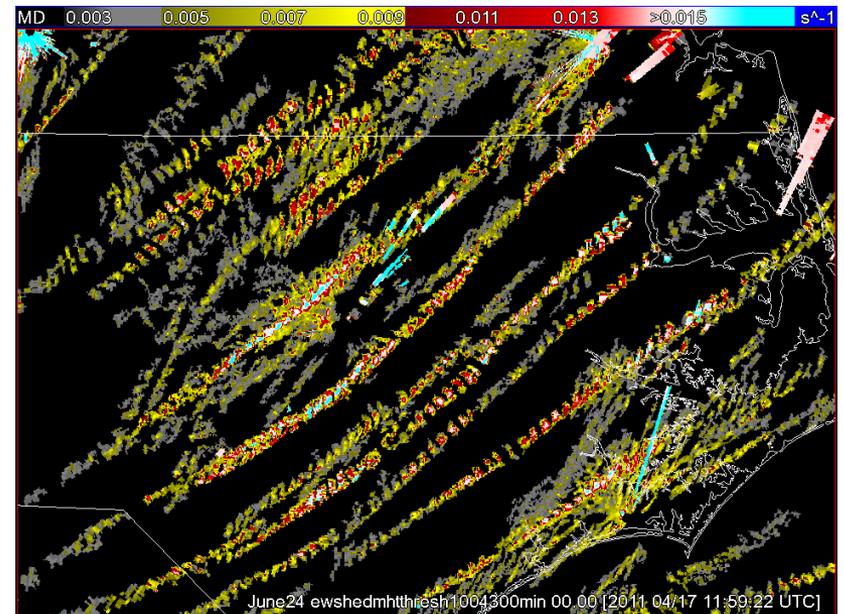
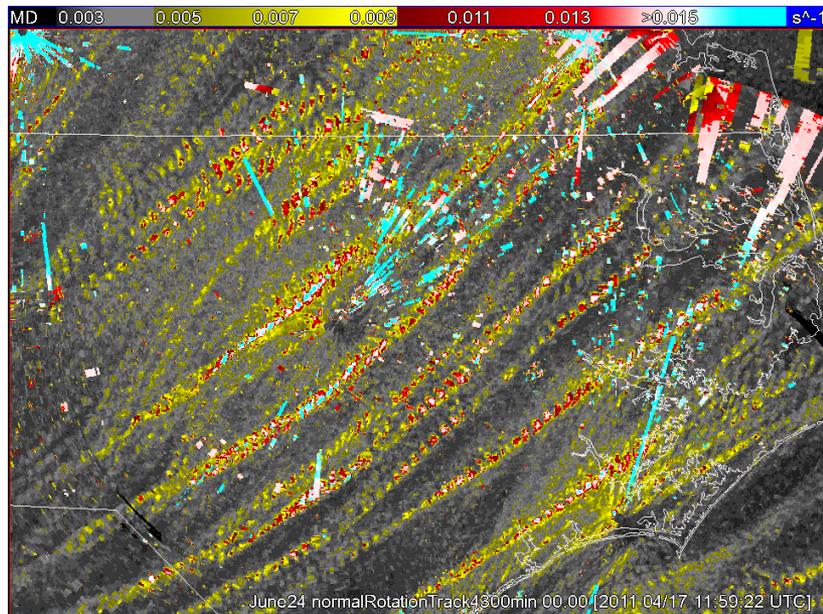


- In practice, will lead to combinatorial explosion
 - ▣ So, prune to keep around only K total possibilities
 - ▣ “Confirm” cells at frame t_{-N}
- N and K depend on the type of data you have

EWT and MHT in QC of Az-Shear

- Azimuthal Shear a very noisy field
 - ▣ Rotation tracks (accumulation of Az-Shear) even noisier
 - ▣ A problem at even one time step persists for long time
- Can use EWT and MHT to QC the Az-shear field
 - ▣ Identify “cells” of Az-Shear
 - ▣ See which cells potentially pan out
 - ▣ The real-time accumulation uses all Az-Shear from current time, but only the “cells” from previous time steps that are associated with one of the K-best associations ...

Rotation Tracks Cleanup



Summary

- Can avoid/postpone hard decisions in tracking
- Use locally adaptive thresholds to identify storms
 - ▣ Paper in J. Tech. 2009
- Keep around several possible tracks to decide later
 - ▣ In situations where strict causality can be avoided
 - ▣ Paper coming ...

Questions?

