Evaluating a Storm Tracking Algorithm

Objectively and without human truthing

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Storm tracking algorithms

Many heuristics have been proposed to associate storms identified at the current time frame, t_n, with storms identified at the previous time frame t_{n-1}:

1. *PRJ* [Johnson et al., 1998]
2. *CST* [Dixon and Wiener, 1993]
3. *AGE* [Lakshmanan et al., 2009]
4. *OV* [Morel et al., 1997]
5. *OC* [Han et al., 2009]
6. *NEW* [Lakshmanan and Smith, 2010]

Need for scoring

It is important to be able to objectively evaluate these suggested techniques in order to determine which criterion or set of criteria provide the best skill.

Different techniques will probably be better on different fields and for different scales.

Using forecast fields is indirect

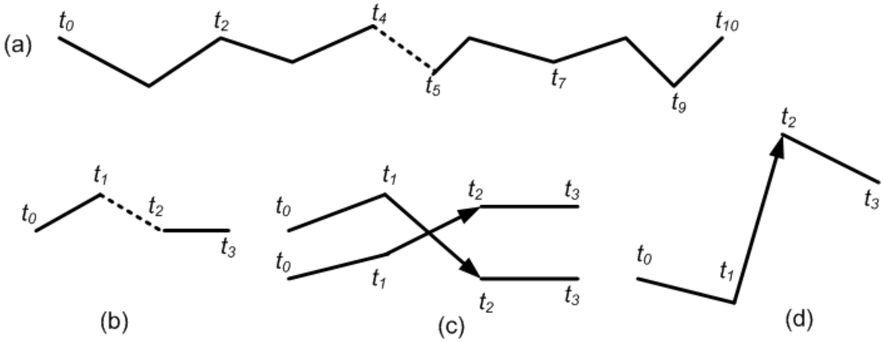
- Can create a short-term forecast using tracking information and then compare the short-term forecast with actual data.
- This is an *indirect* measure of storm tracking effectiveness.
- The key reason for poor extrapolation forecasts is not errors in forecast displacement [Wilson et al., 1998].

Direct method is triply flawed

Could look at each pair of time assocations and classify it as ”correct” or ”incorrect”.
This method suffers from three serious flaws:

1. labor-intensiveness
2. overestimation of skill
3. non-specificity

Overestimation and non-specificity



Statistics of each track

Compute the following statistics on each track:

1. *dur* is the duration of the track. The duration is longer if there are fewer dropped assocations.
2. σ_V is the standard deviation of the VIL of the cell in time (i.e. along a track). The σ_V is lower if there are fewer mismatches.
3. e_{xy} is the Root Mean Square Error (RMSE) of centroid positions from their optimal line fit. The e_{xy} is lower for more linear tracks.

Statistics over each dataset

Central tendencies of the track statistics are computed on a large dataset of tracks:

1. $\widetilde{dur}$ is the median duration of tracks in the dataset.
2. The mismatch error ($\overline{\sigma_V}$) is the mean σ_V on tracks with duration greater than $\widetilde{dur}$.
3. The linearity error ($\overline{e_{xy}}$) is the mean e_{xy} on all tracks with duration greater than $\widetilde{dur}$.

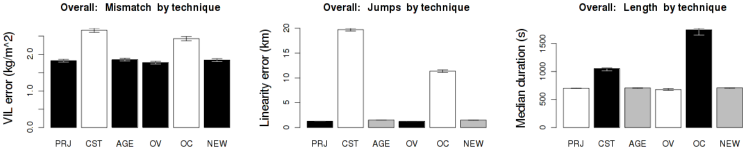
Evaluation Method

Run the association method on the exact same storm cells.
Note: not the original TITAN, SCIT, etc. but only the association part.
We coded it up based on the journal papers describing the technique.
This is *not* a comparison of TITAN vs. SCIT – just a comparison to see whether the size-based cost function or closest centroid or ... was best.

The dataset

For example ... the techniques were evaluated on a common dataset consisting of the WSR-88D radar data (geographically and meteorologically diverse).
Storms were identified on Reflectivity Composite and tracked across volume scans.

Result


Overall: Mismatch by technique
VIL error (kg/m^2)
0.0
1.0
2.0
PRJ CST AGE OV OC NEW
Overall: Jumps by technique
Linearity error (km)
0
5
10
15
20
PRJ CST AGE OV OC NEW
Overall: Length by technique
Median duration (s)
0
500
1000
1500
PRJ CST AGE OV OC NEW

Summary

If you need storm tracking for your application and you are wondering what technique to use, compute these statistics on a large dataset. Combine them appropriately to meet your duration, mismatch and jump criteria. The NEW method was a judicious combination of PRJ, CST and AGE. See [Lakshmanan and Smith, 2010] for details.

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