The pivotal nature of merger and splitting in the cyclone life cycle

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Pivot-\textit{al} adj. [© HarperCollins Publishers 2003]
1. Of, involving, or acting as a pivot – e.g. an event causes a change in direction or intensity
2. Of crucial importance – e.g. significant role in storm life cycle
Motivation

- Method-based uncertainty in cyclone tracking?
- Physical causes of merger and splitting (MS) events
  - secondary cyclogenesis
  - wave breaking
  - topographical obstacles
- Higher frequencies of MS events in intense mature storms
  [Hanley and Caballero, 2012]
  - impact lifecycle track of significant events
Approach

- IMILAST ensemble dataset and thresholds
  (ERA-Interim 1979-2008, DJF, 16 methods, >24h life)
- Merger and splitting IMILAST methods: M13, M14, M21
  - Compare event climatologies and composites
  - Use to select case study events for IMILAST ensemble (> 2 methods agree on time and location)
  - 4 merger cases, 4 splitting cases hand selected
### Algorithms M13, M14, M21

<table>
<thead>
<tr>
<th></th>
<th>M13 - SLP</th>
<th>M14 - Z850</th>
<th>M21 - VORT850</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boundary:</strong></td>
<td>Anticyclonic</td>
<td>Area criterion</td>
<td>Threshold value C</td>
</tr>
<tr>
<td><strong>Track forming:</strong></td>
<td>Past motion</td>
<td>Advection by local winds</td>
<td>Old position</td>
</tr>
<tr>
<td><strong>ID field/Intensity:</strong></td>
<td>SLP</td>
<td>Geopotential height 850 hPa</td>
<td>Relative vorticity 850 hPa</td>
</tr>
<tr>
<td><strong>MCCs:</strong></td>
<td>Explicitly allowed</td>
<td>Effectively allowed</td>
<td>Effectively allowed</td>
</tr>
<tr>
<td><strong>Dominance:</strong></td>
<td>Size evolution</td>
<td>Largest / equal</td>
<td>Closest</td>
</tr>
</tbody>
</table>

**MCCs** – Multi-centre cyclones
Climatology M13

**MERGER**

**SPLITTING**

*Units: Events per DJF season, per 7.5° circle.*
Climatology M14

MERGER

SPLITTING

Units: Events per DJF season, per 7.5° circle.
Climatology M21

MERGER

SPLITTING

Units: Events per DJF season, per 7.5° circle.
Climatology M21

**CYCLONE DENSITY**

**SPLITTING**

Units: Events per DJF season, per 7.5° circle.
Dependence of MS frequency on intensity

- Intensity decile bins defined for each method separately
Lifecycle composites of intensity

Merger

(d) M13 Splitting

Splitting

50% mean
Splitting

\[ T = S - 1 \quad T = S \quad T = S + 1 \quad T = S + 2 \quad T = S + 3 \]
Merger

T=M-3 | T=M-2 | T=M-1 | T=M | T=M+1

Diagram showing the progression from T=M-3 to T=M+1.
Merger: example 1

Ensemble division – size vs. position criterion

- Current position
- Genesis
- Lysis
- Merger location
- Continued
- Terminated
Merger: example 2

Ensemble agreement – lysis points clustered
Merger: example 3

Merger leads to intensity increase

**BEFORE**

**AFTER**

- **Continued**
- **Terminated**
- **Genesis**
- **Lysis**
Splitting example 1

*Ensemble agreement, end of Pacific storm track, cyclones have similar tracks*

**BEFORE**

**AFTER**

- **C**
  - **A**
  - **B**

Legend:
- Green: Continued
- Pink: Terminated
- Circle: Genesis
- Black dot: Lysis
Splitting: example 2

Ensemble division – A and B move apart in opposite directions
Pivotal?

- Pivotal importance
- Divergence in track ensemble: - intensity vs. location
- But, MS may locally increase ensemble agreement over lysis and genesis locations respectively