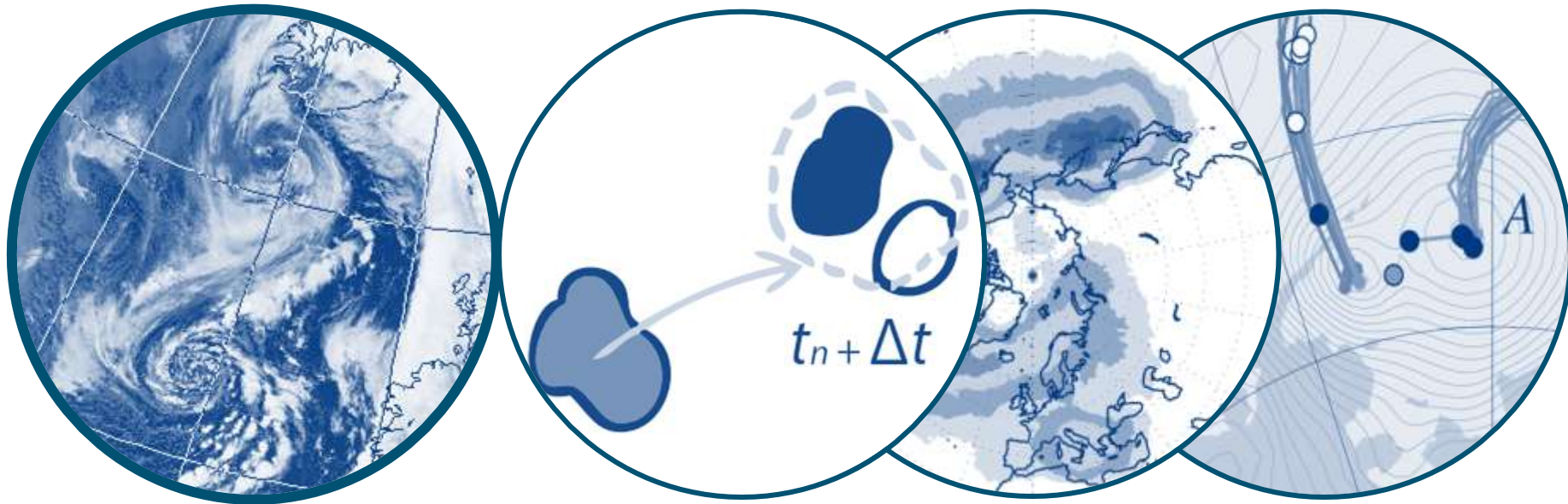# The pivotal nature of merger and splitting in the cyclone life cycle

**Sarah Kew**[1], Rodrigo Caballero[2], John Hanley[3], Masaru Inatsu[4].

Piv-ot-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

$t_n + \Delta t$

A

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1. Wageningen University, 2. Stockholm University, 3. Munich Re, 4. Hokkaido University.

Motivation

- Method-based uncertainty in cyclone tracking?

- Physical causes of merger and splitting (MS) events

  - secondary cyclogensis
  - wave breaking
  - topographical obstacles

- Higher frequencies of MS events in intense mature storms
  [Hanley and Caballero, 2012]

  - impact lifecycle track of significant events

?

How will ensemble of tracking methods react?
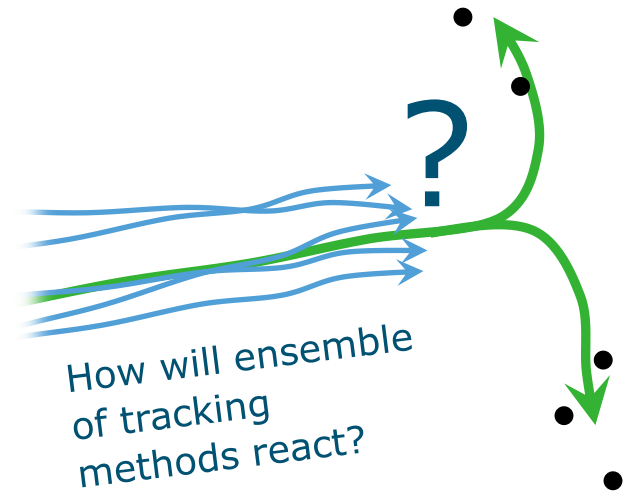
Approach

- 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

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

MCCs – Multi-centre cyclones

Climatology M13

MERGER

SPLITTING

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

5
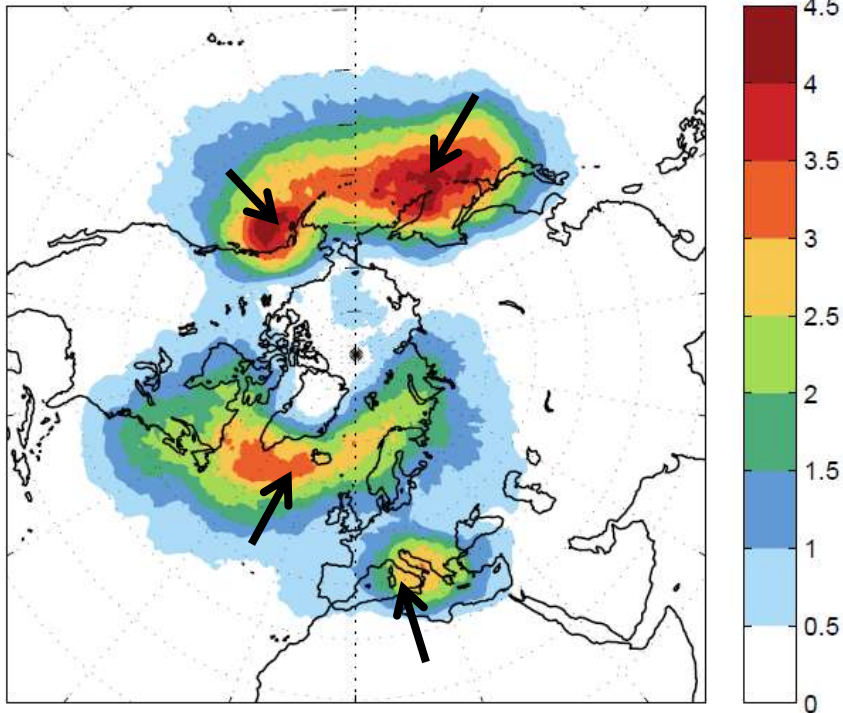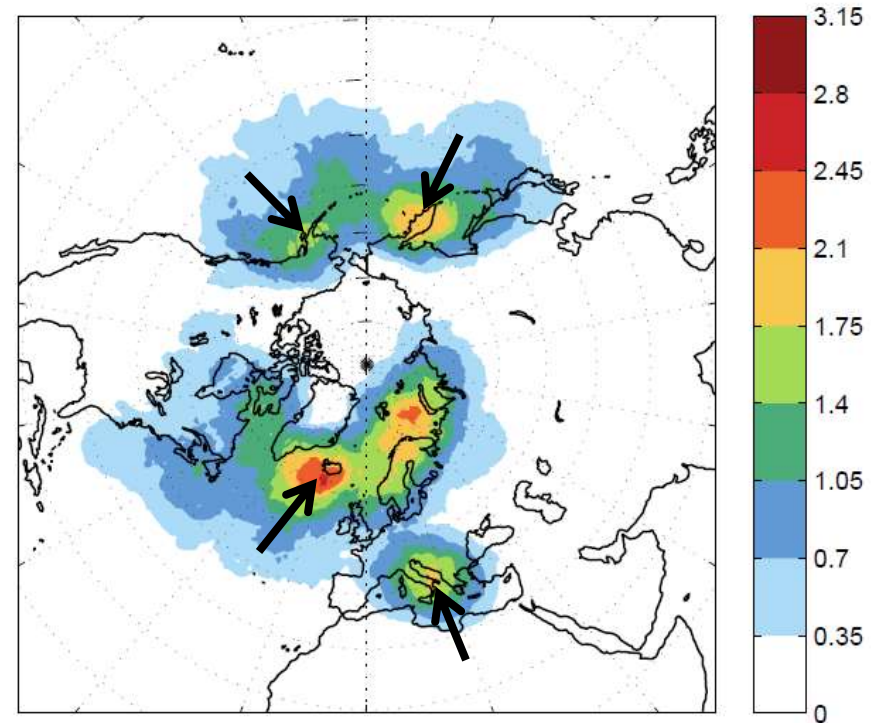
Climatology M14

MERGER

SPLITTING

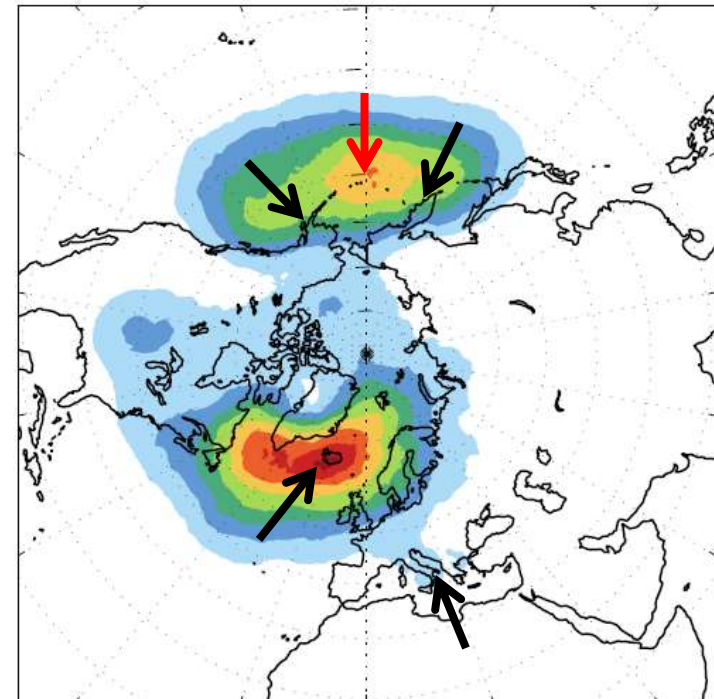*Units: Events per DJF season, per 7.5° circle.*
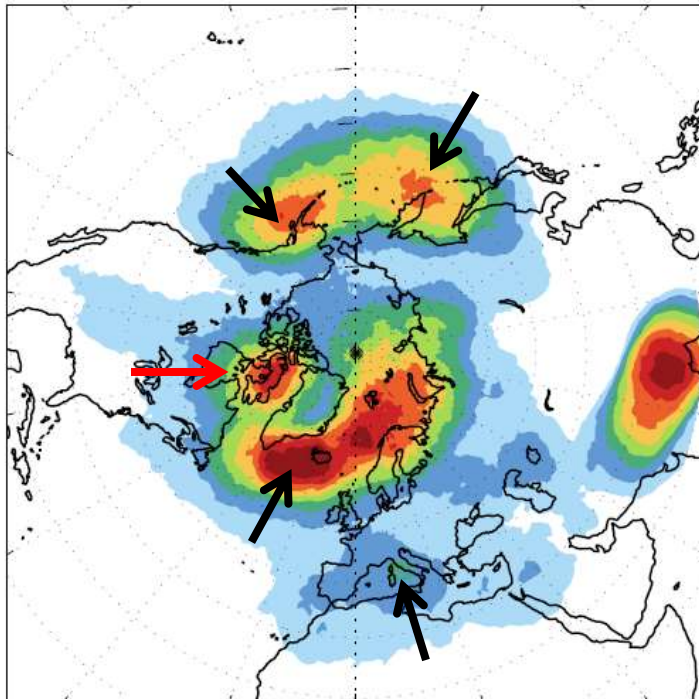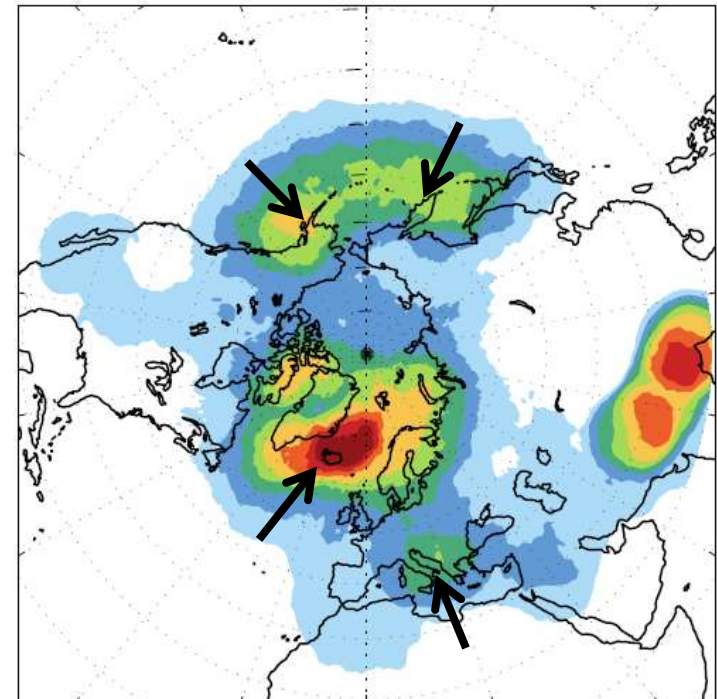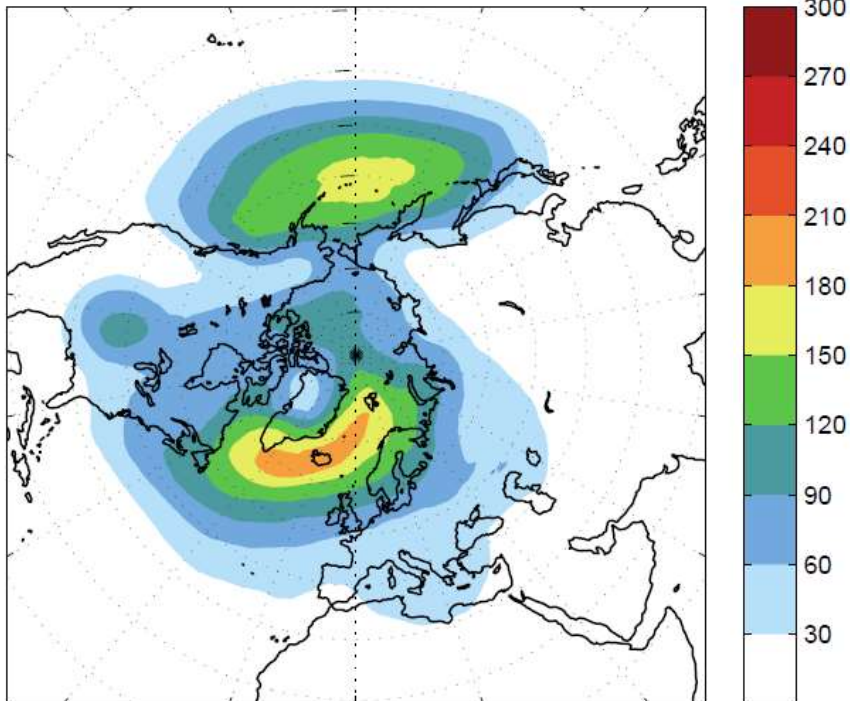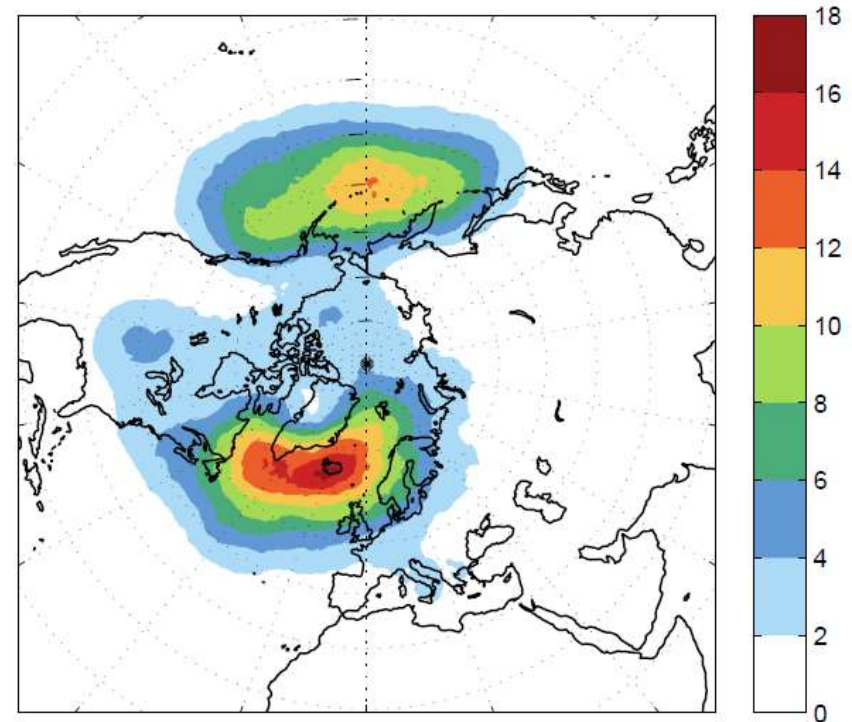
Climatology M21

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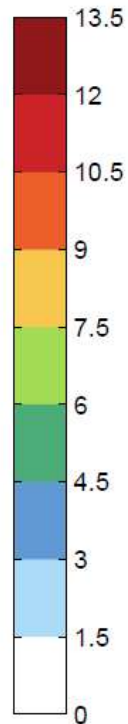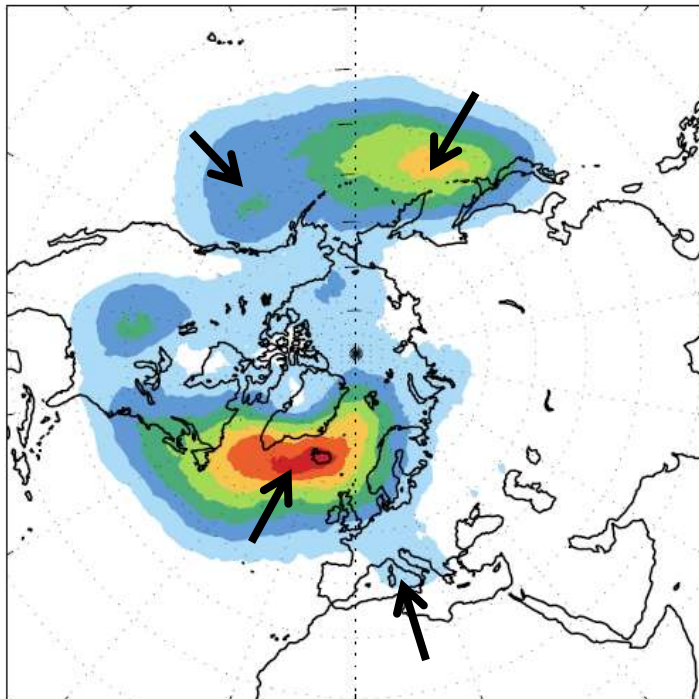
SPLITTING
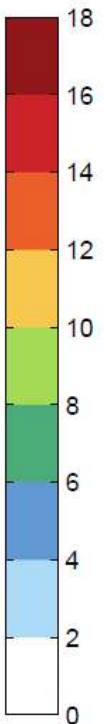
Units: Events per DJF season, per 7.5° circle.
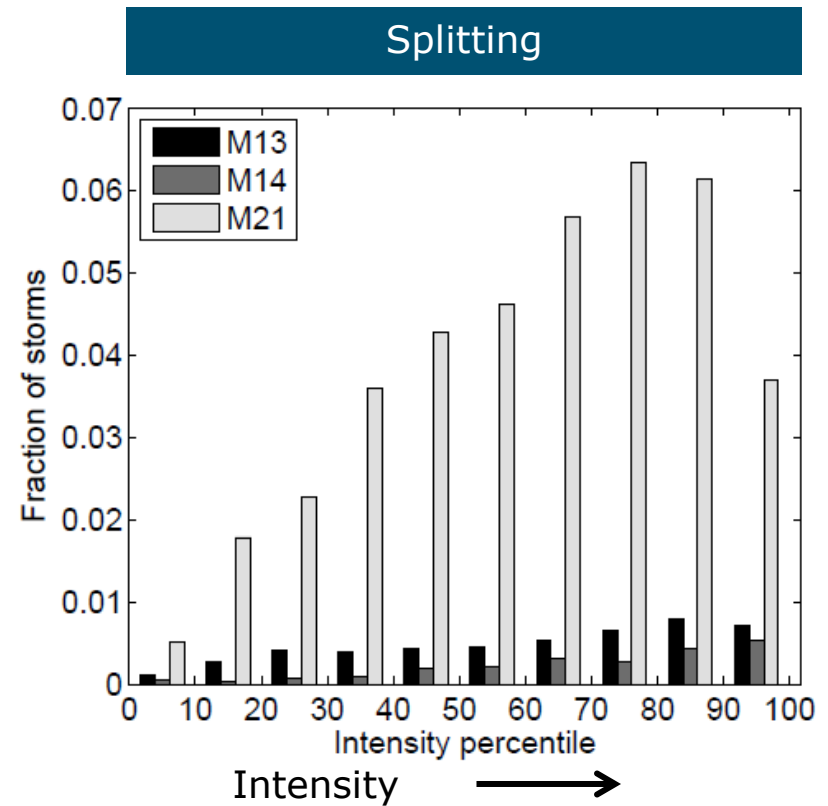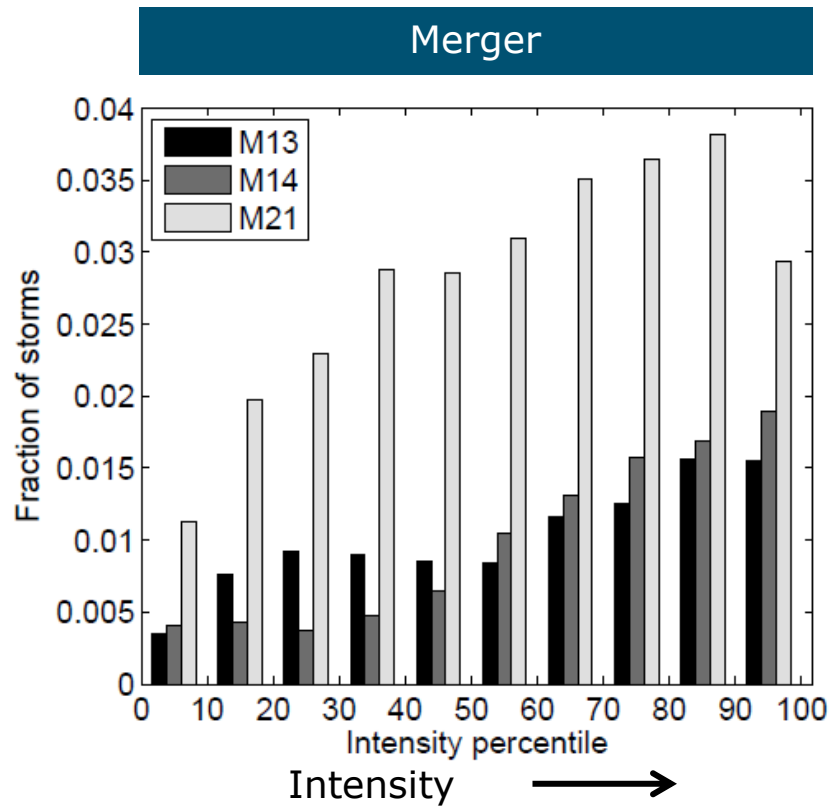
Climatology M21

CYCLONE DENSITY

SPLITTING

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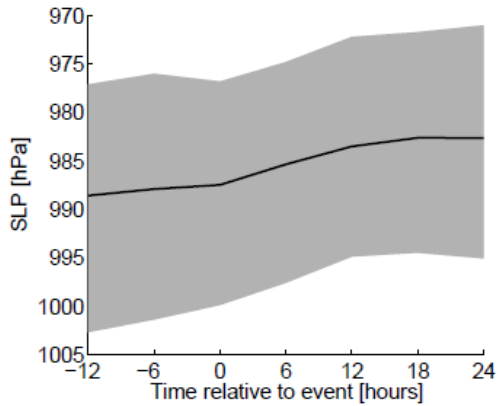
Dependence of MS frequency on intensity
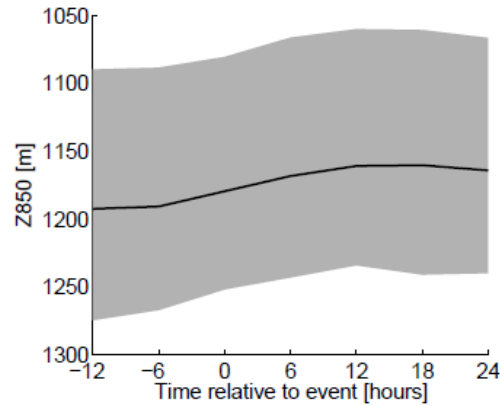

- Intensity decile bins defined for each method separately
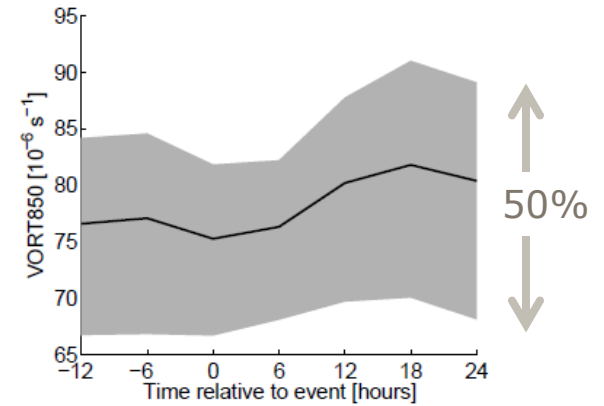
Lifecycle composites of intensity

(d) M13 Splitting   (e) M14 Splitting   (f) M21 Splitting
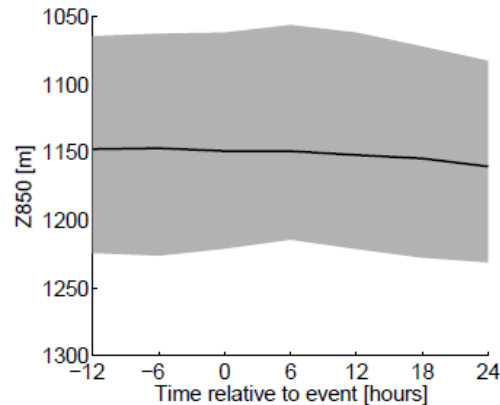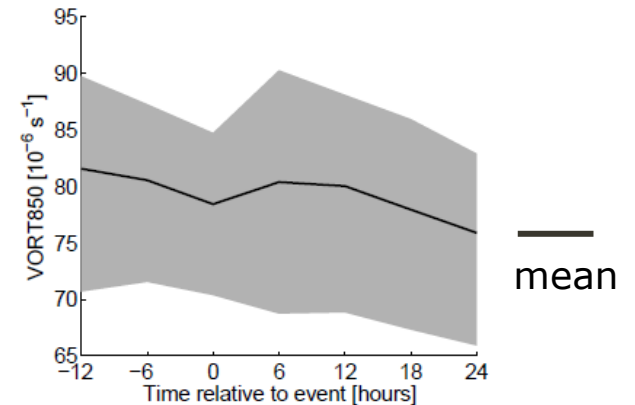
Splitting

T=S-1   T=S   T=S+1   T=S+2   T=S+3

S

Merger

T=M-3   T=M-2   T=M-1   T=M   T=M+1
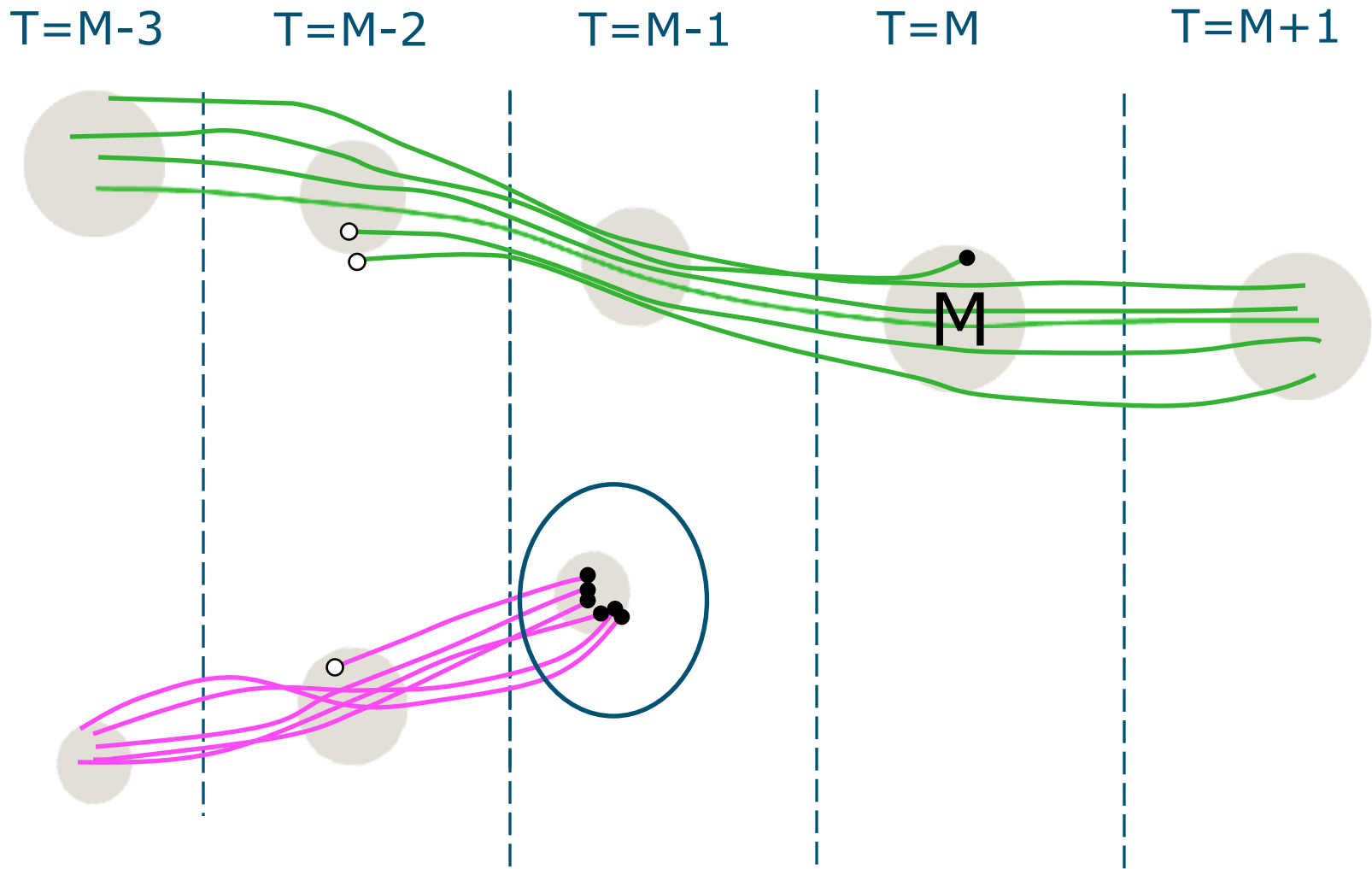
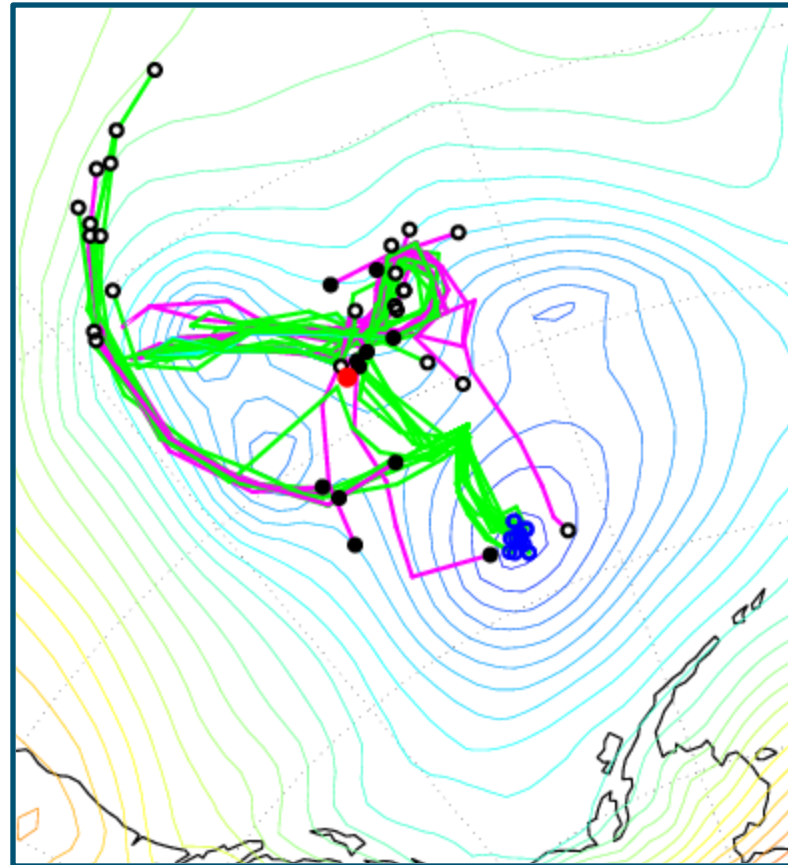M
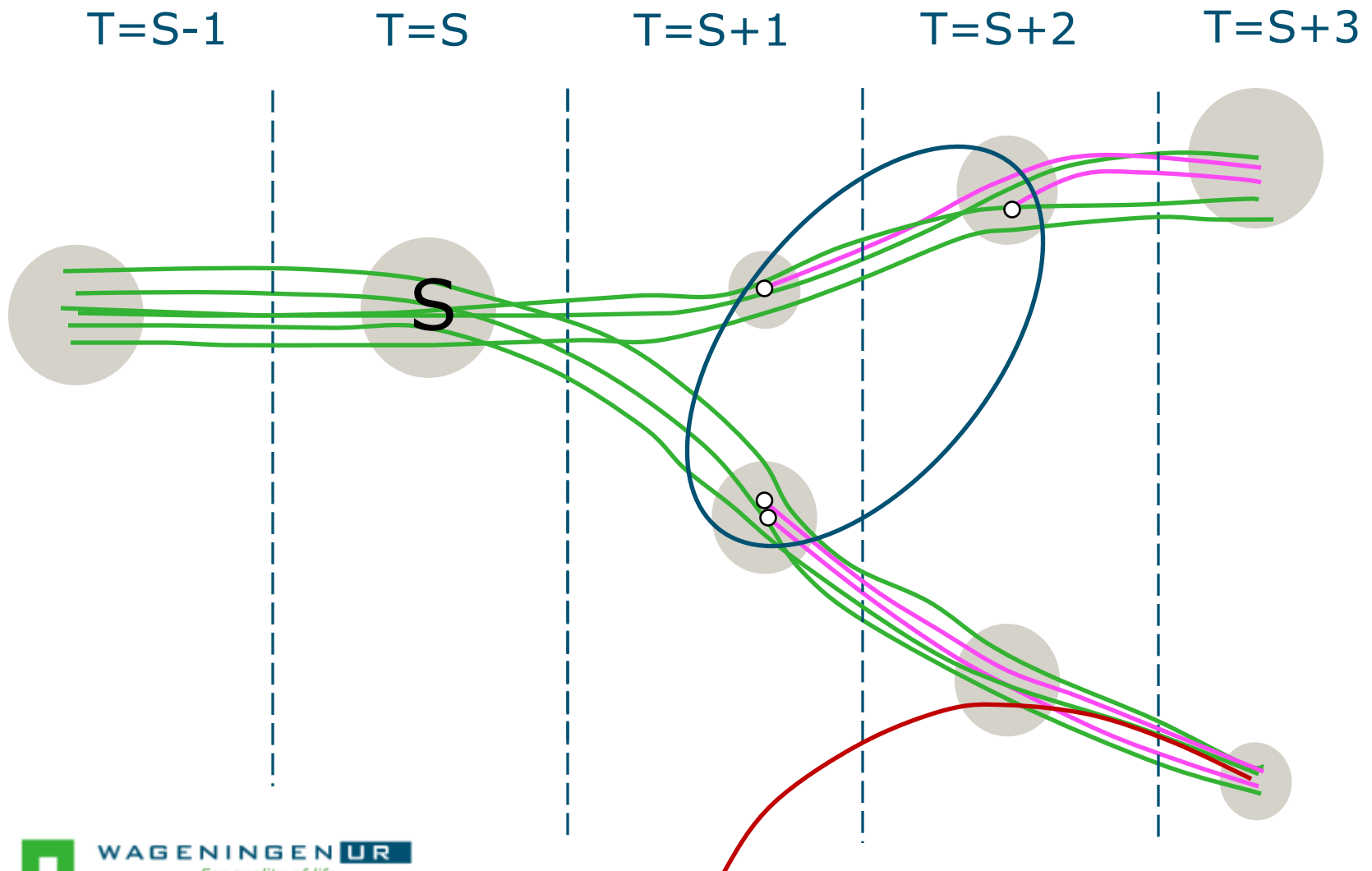
Merger: example 1

Ensemble division – size vs. position criterion
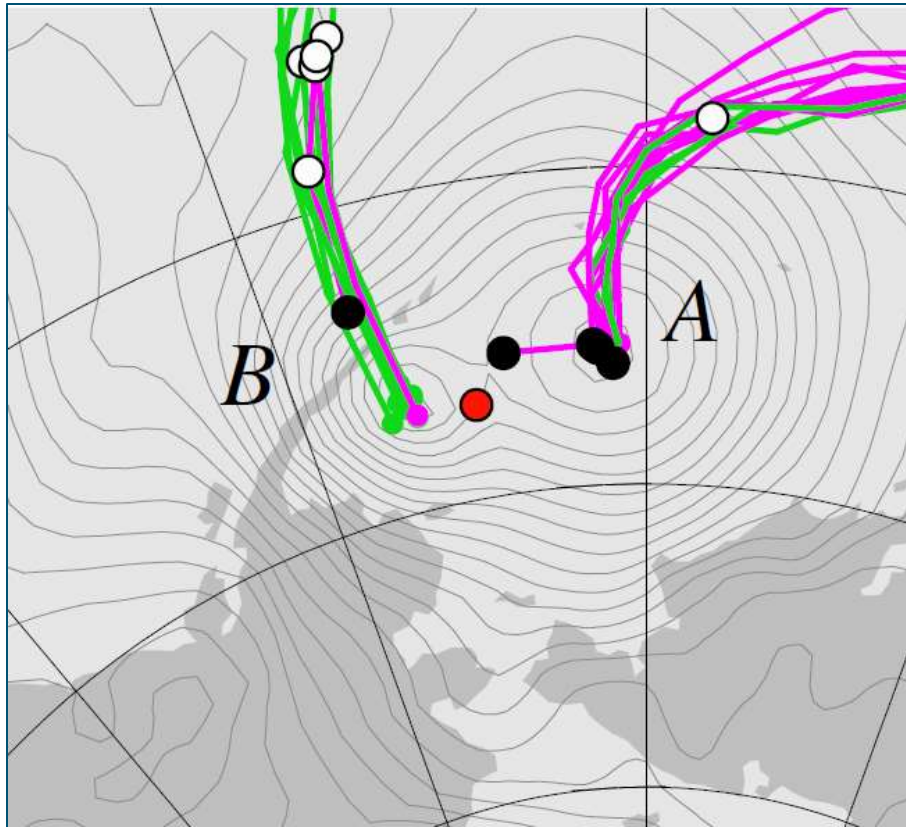
○ Current position

○ Genesis

● Lysis

● Merger location

— Continued

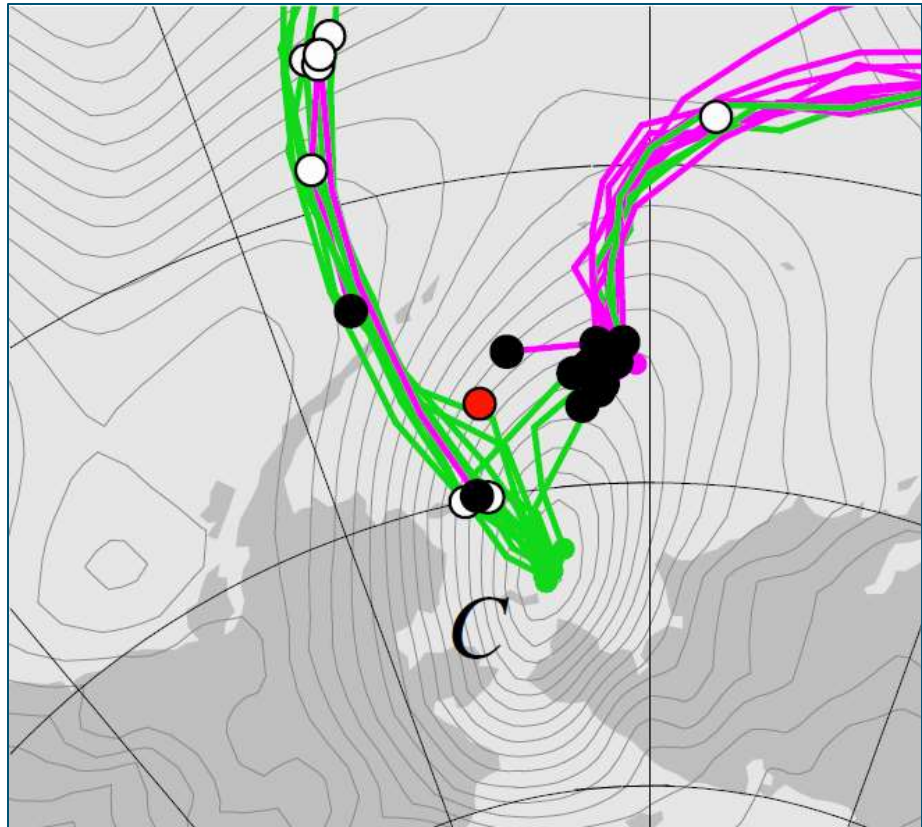— Terminated

Merger: example 2

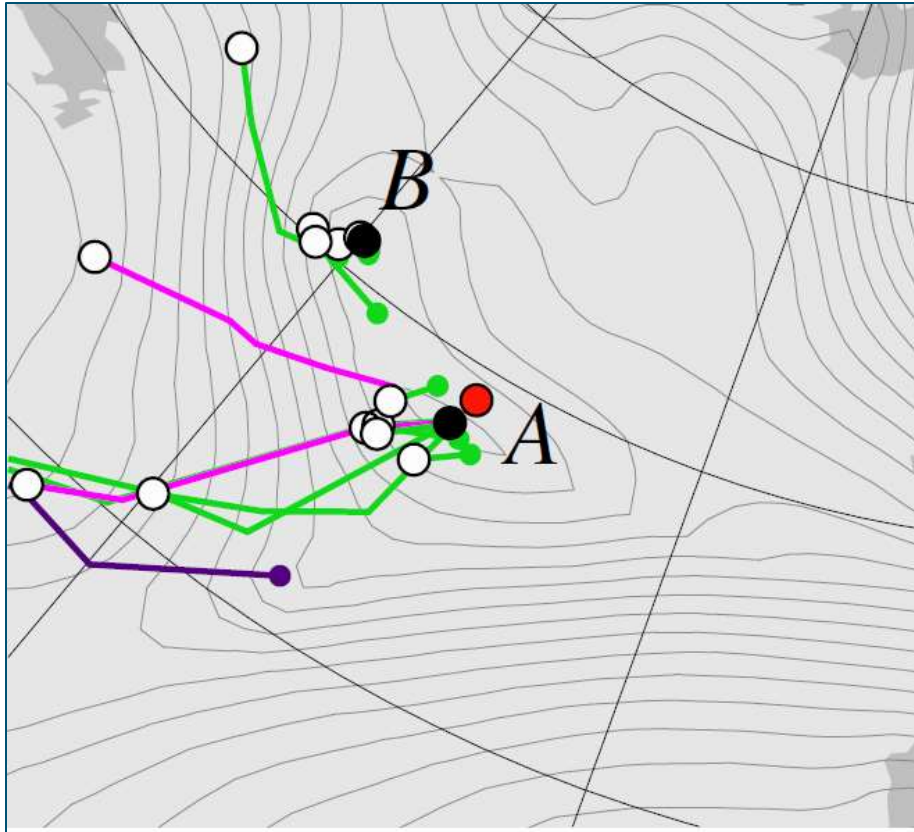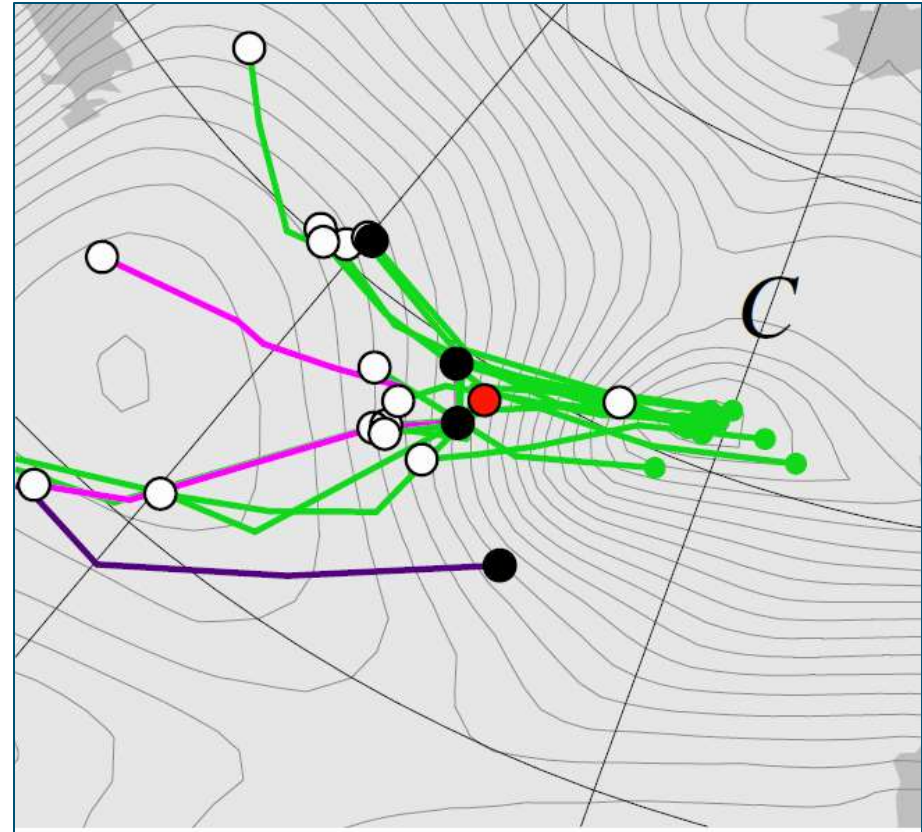*Ensemble agreement – lysis points clustered*

BEFORE

AFTER

Continued
Terminated
○ Genesis
● Lysis

Merger: example 3

Merger leads to intensity increase

BEFORE

AFTER

Continued — Genesis ○

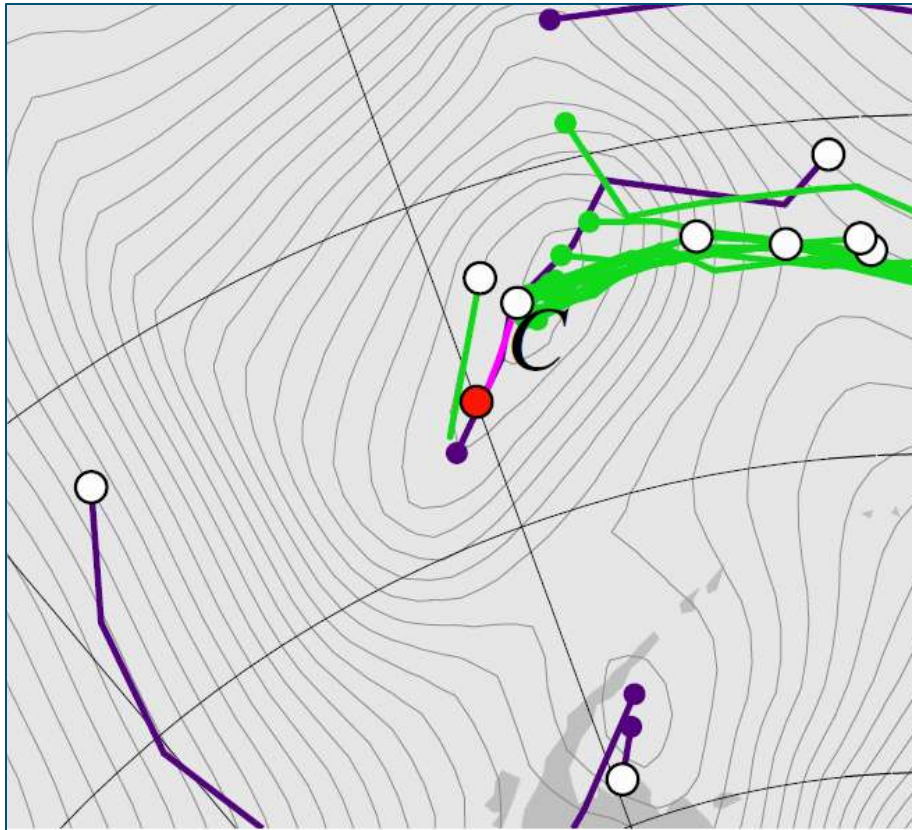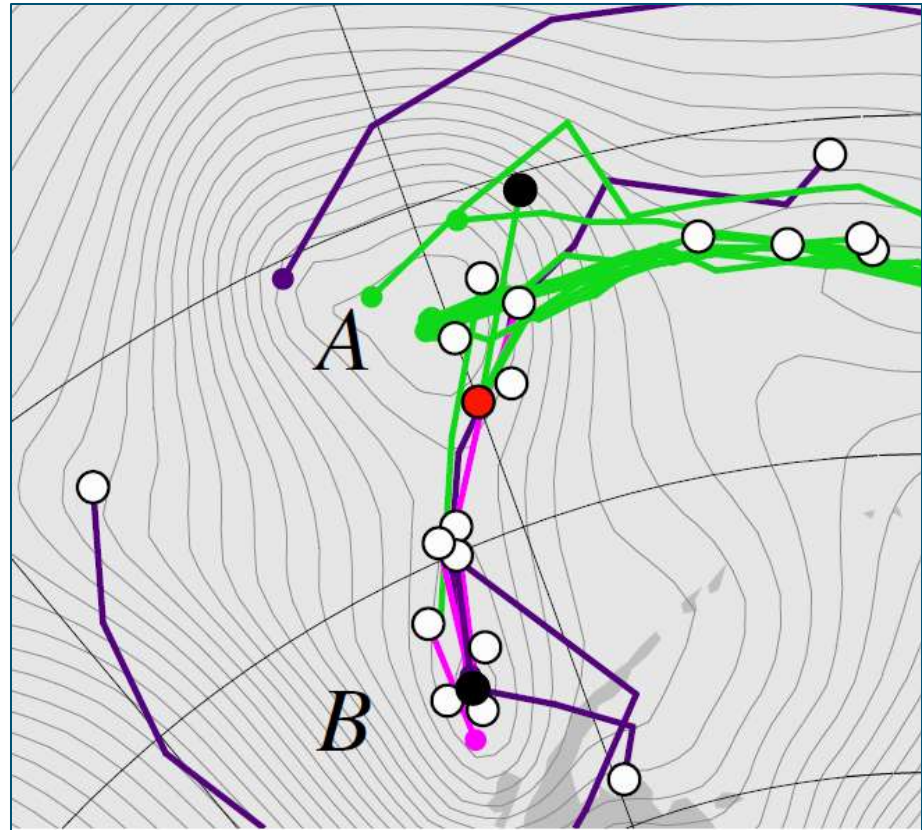Terminated — Lysis ●

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Splitting example 1

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

BEFORE

AFTER

Continued
Terminated

○ Genesis
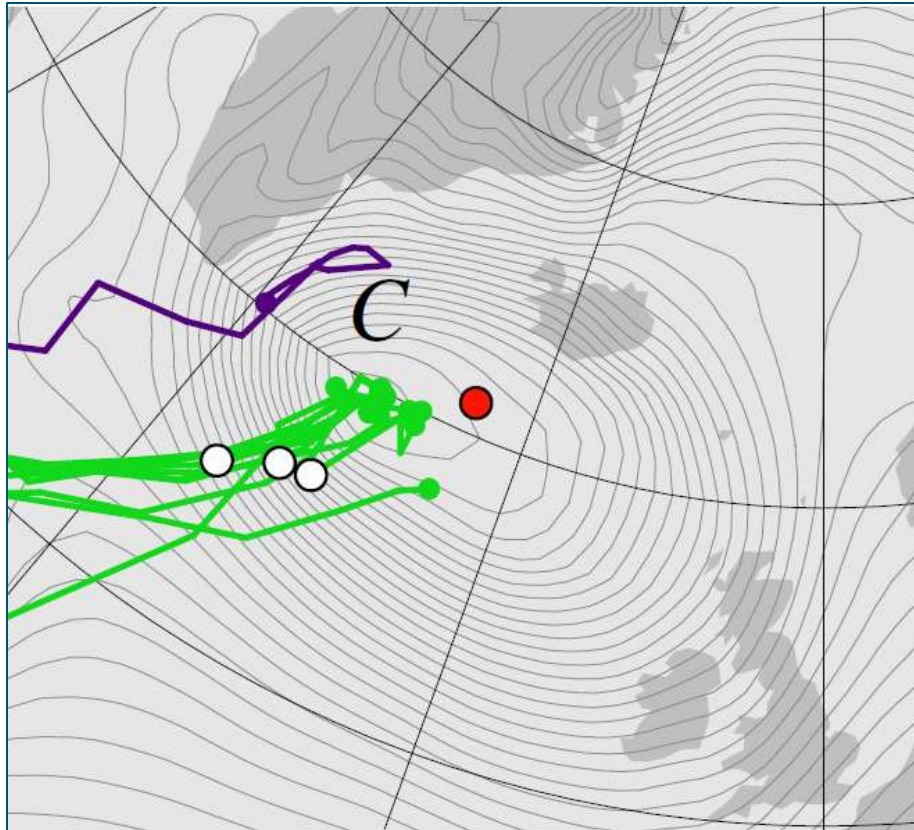● Lysis

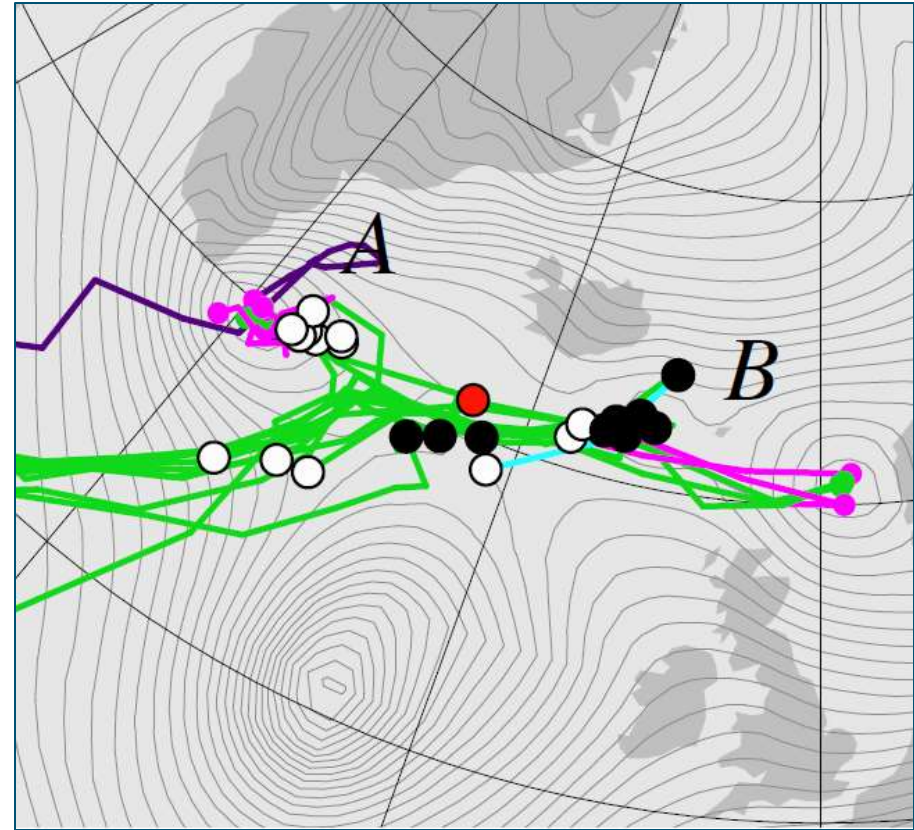WAGENINGEN **UR**
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Splitting: example 2

Ensemble division – A and B move apart in opposite directions

BEFORE

AFTER

Pivotal?

- Pivotal importance

- Divergence in track ensemble: -
  - intensity vs. location

- But, MS may locally increase ensemble agreement over lysis and genesis locations respectively