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VU VRIJE UNIVERSITEIT AMSTERDAM

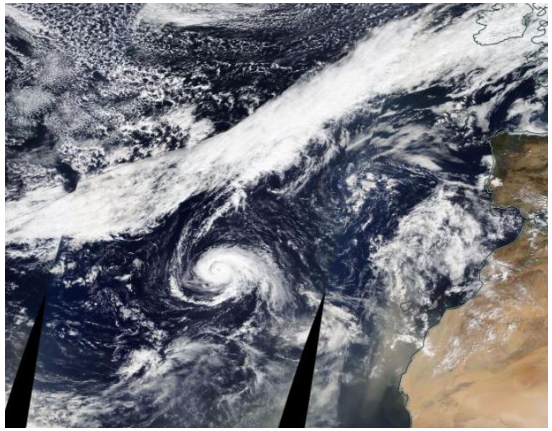
STORM-EX: A statistical synthetic generating model for extratropical transition to quantify post-tropical cyclone risk

Marjolein Ribberink

Gallagher Re

NASA Worldview

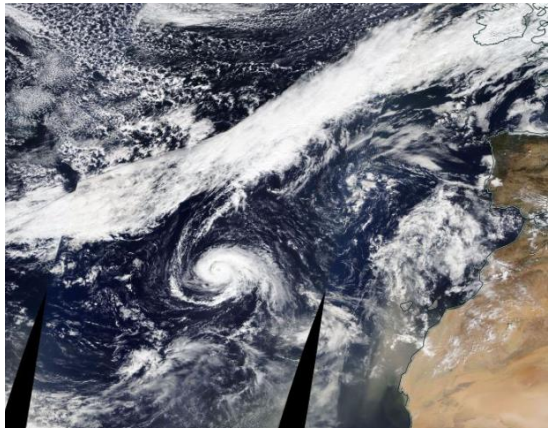
Post-tropical cyclones

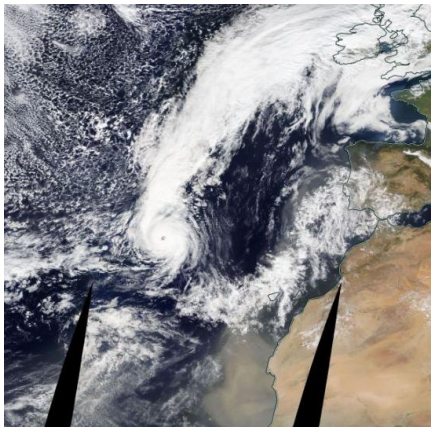


Tropical

NASA Worldview

Post-tropical cyclones

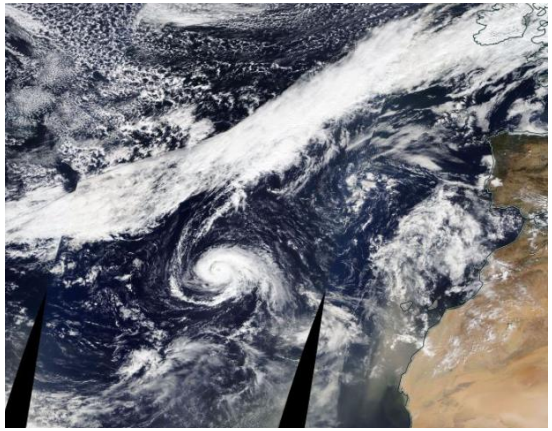


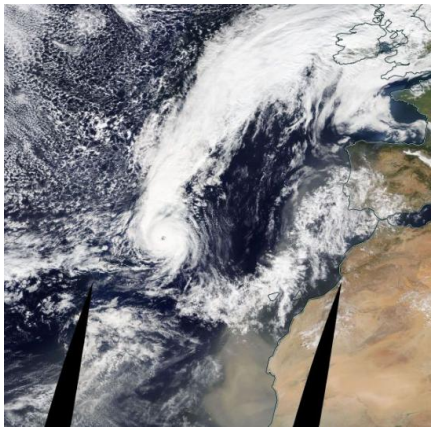


Tropical

NASA Worldview

Post-tropical cyclones

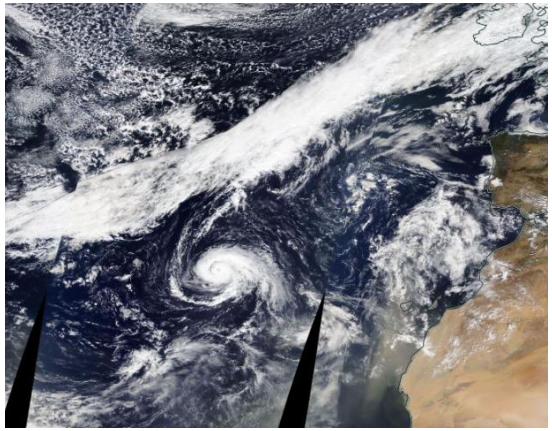
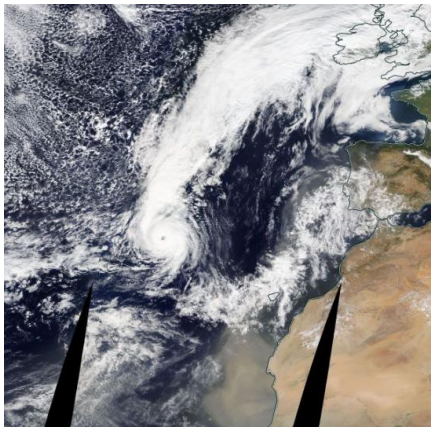




Tropical

NASA Worldview

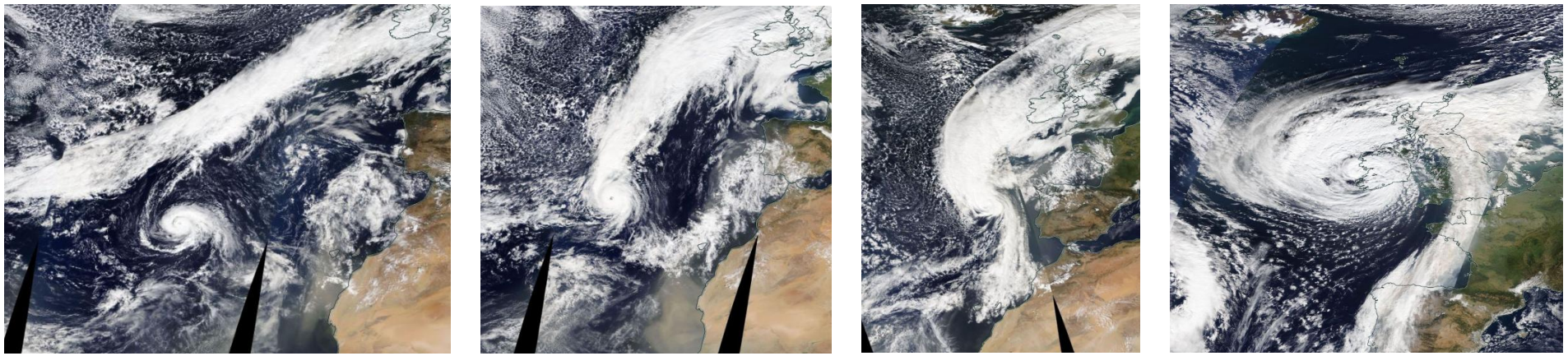
Post-tropical cyclones

Tropical

NASA Worldview

Post-tropical cyclones

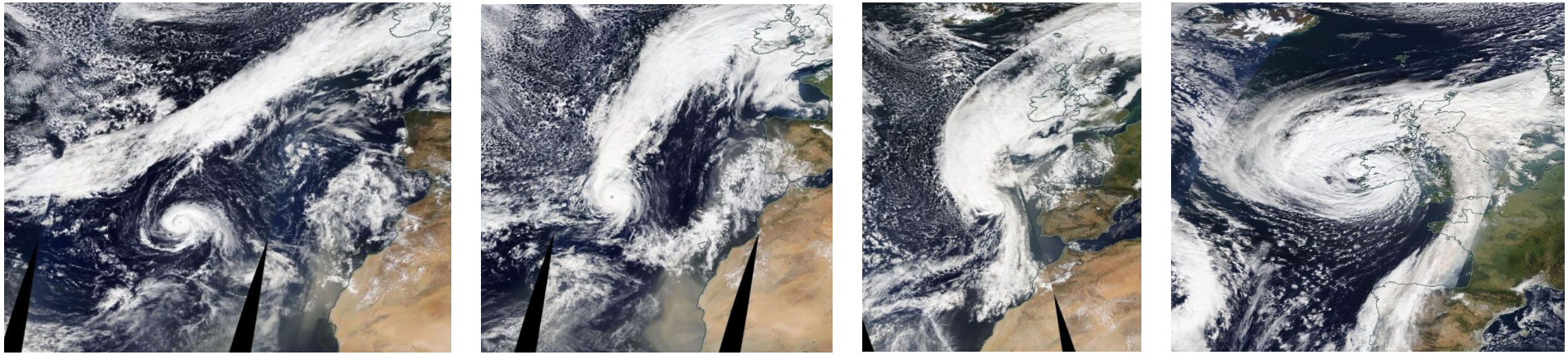


Tropical → Post-tropical

NASA Worldview

Post-tropical cyclones

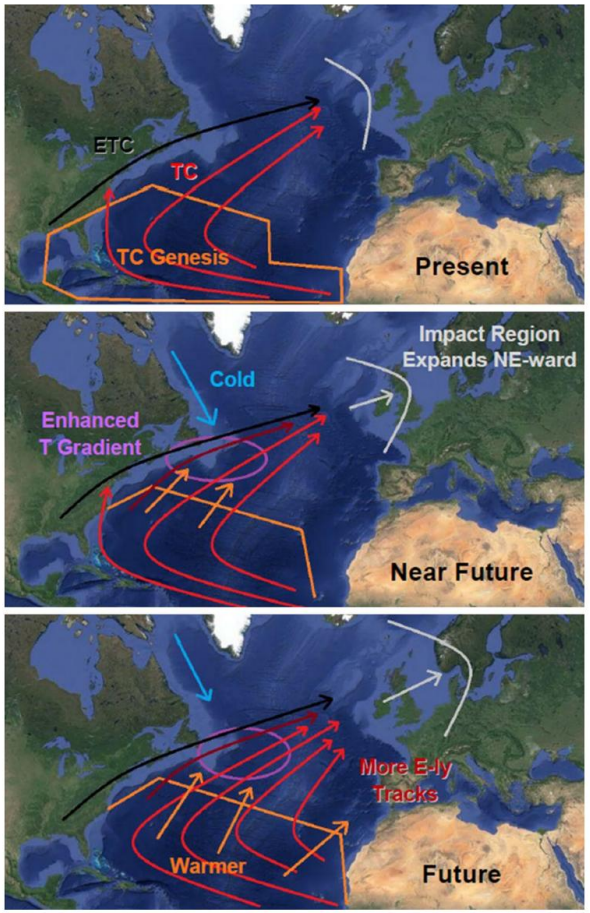
Hurricane Ophelia (2017)



Tropical → Post-tropical

NASA Worldview

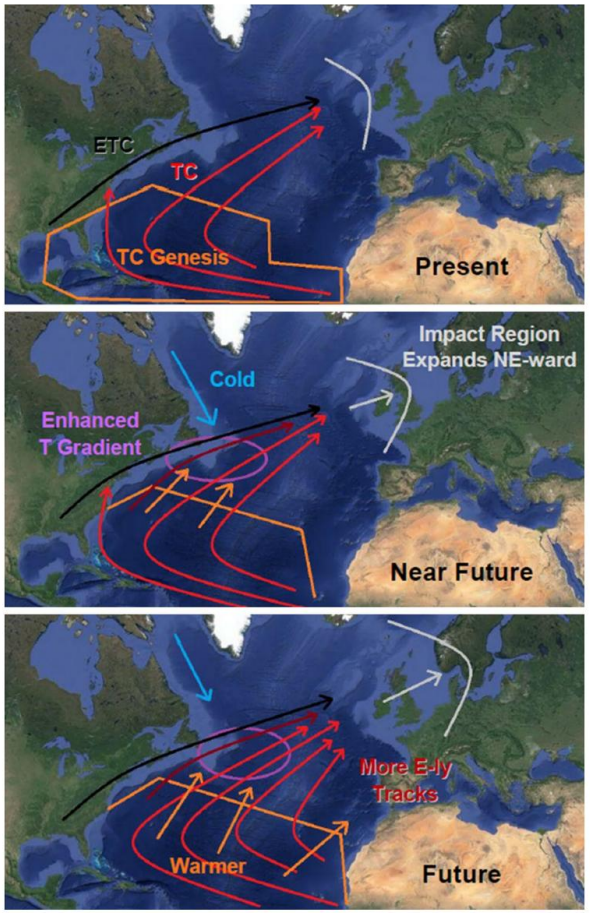
Climate change + risk assessments



Baatsen et al., (2015)

- Expanded area of high sea surface temperatures
- More tropical origin storms expected to reach Europe

Climate change + risk assessments



Baatsen et al., (2015)

- Expanded area of high sea surface temperatures
- More tropical origin storms expected to reach Europe
- Risk assessments lack data. How do we fix this?

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STORM-EX

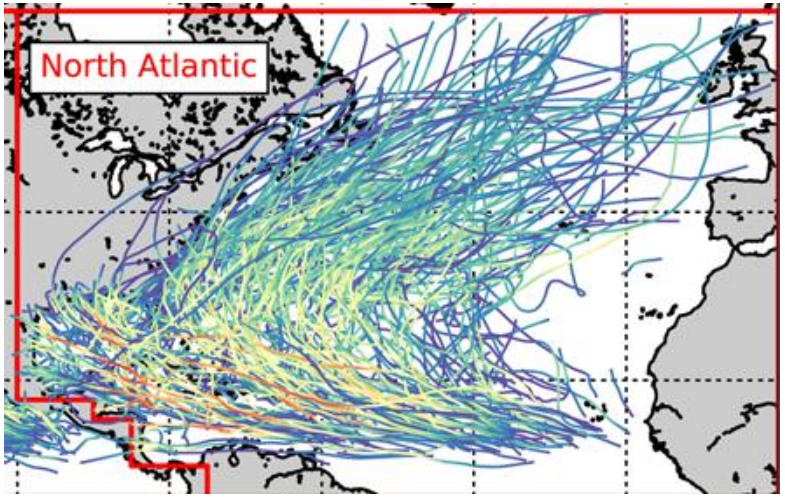
STORM-EX is the extratropical extension to the STORM model, a statistical synthetic generating model, encompassing extratropical transition and post-tropical cyclones

Synthetic **T**ropical cycl**O**ne gene**R**ation **M**odel

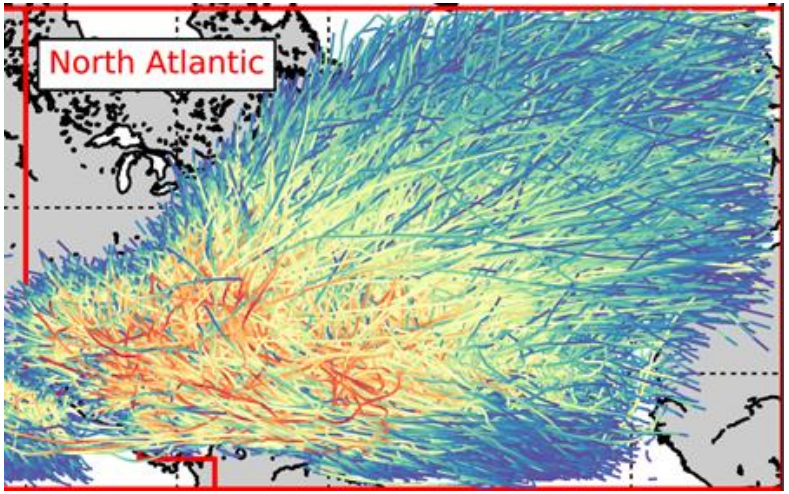
Bloemendaal et al, (2020)

Synthetic **T**ropical cycl**O**ne gene**R**ation **M**odel

IBTrACS

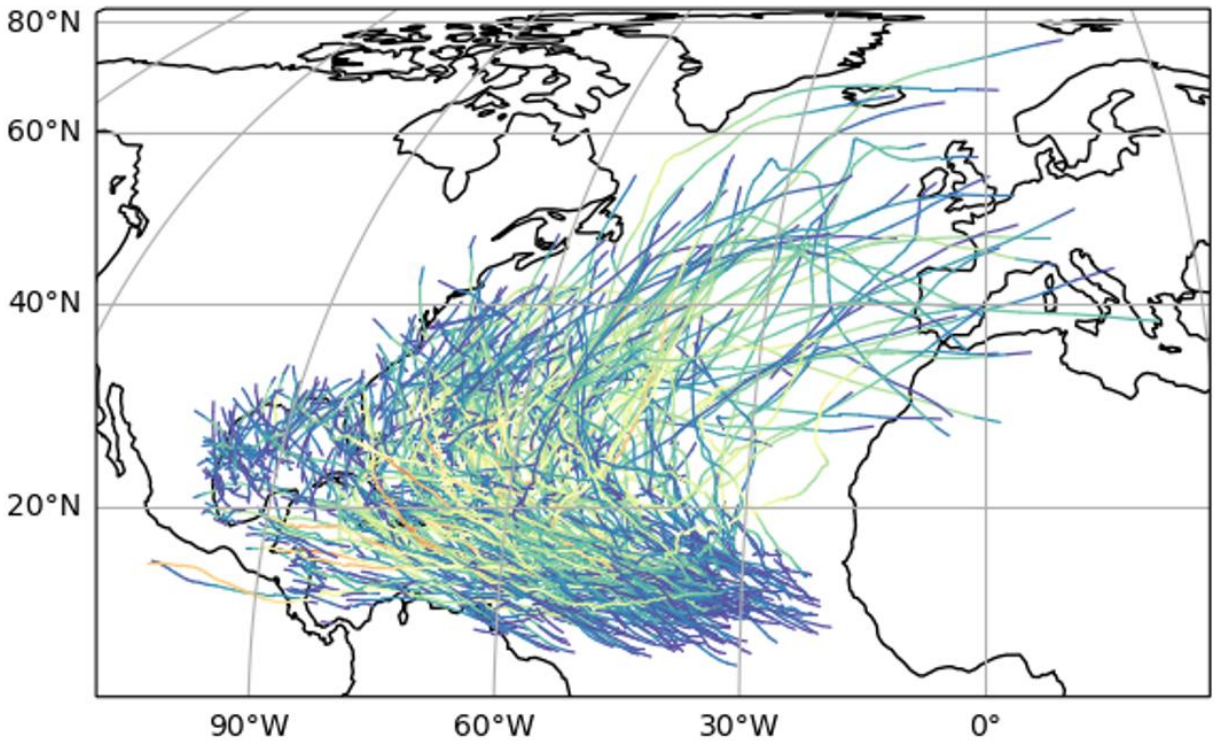


STORM (1000y)



Bloemendaal et al, (2020)

STORM 2.0



- Expanding basin boundaries
- Improved user friendliness
- Added datetime compatibility
- Updated wind threshold to match 10-minute averaging
- Fixed minor issues

https://github.com/MRibberink/STORM2.0

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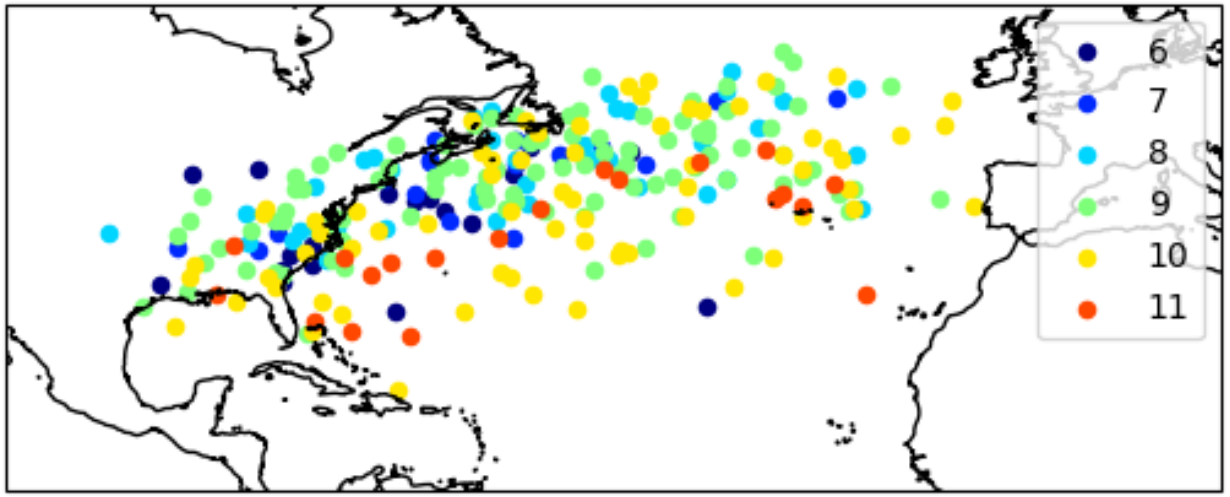
STORM-EX

STORM-EX is the extratropical extension to the STORM model, a statistical synthetic generating model, encompassing extratropical transition and post-tropical cyclones

- Extratropical transition triggering
- Jet stream modelling

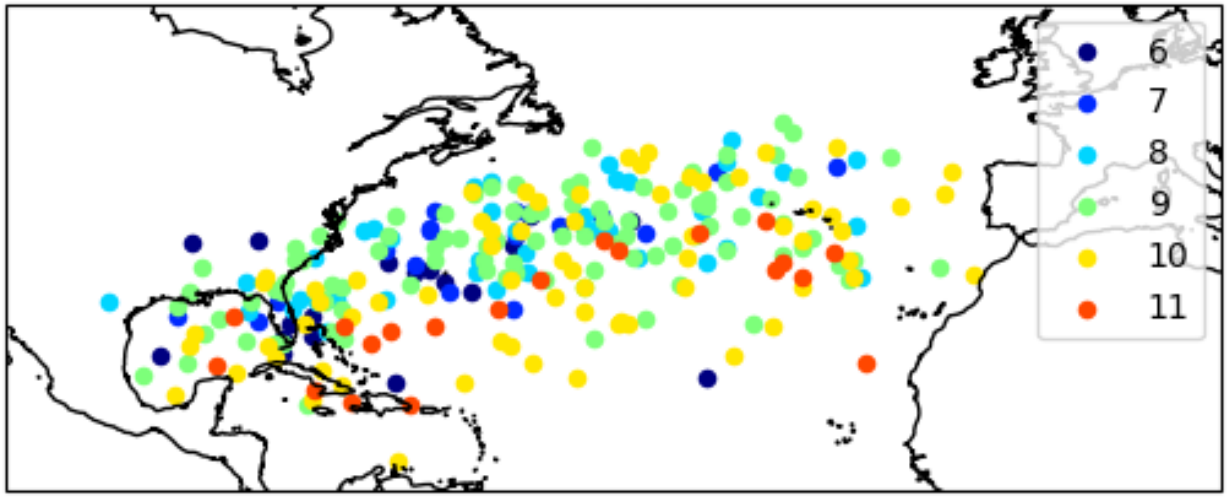
Extratropical transition triggering

ET end locations (IBTrACS)

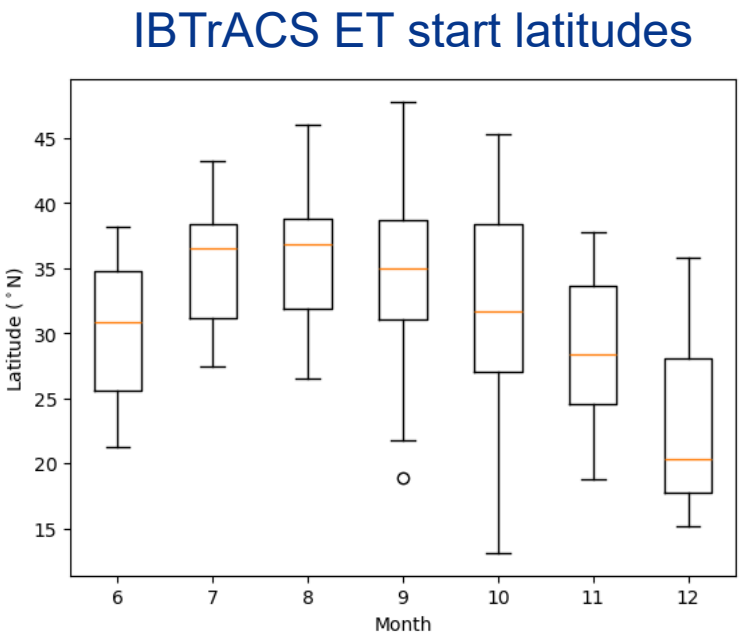


Extratropical transition triggering

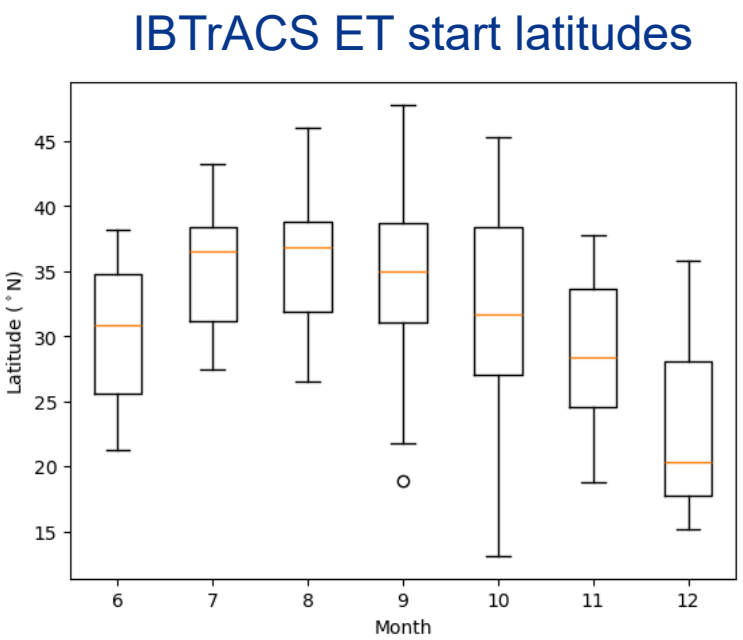
ET start locations (IBTrACS)

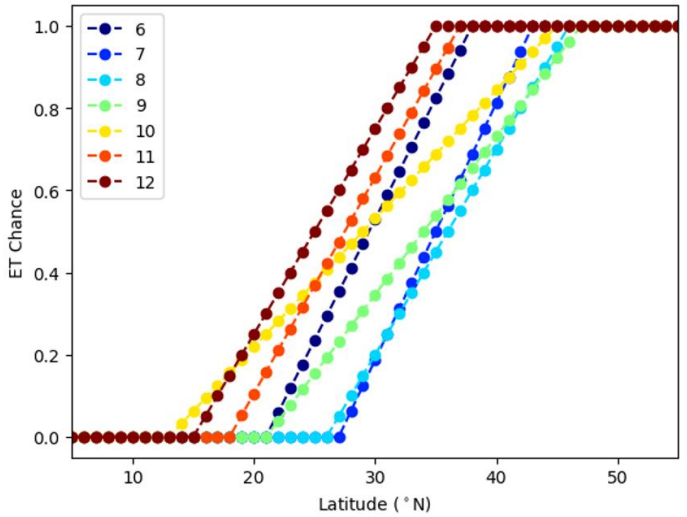


Extratropical transition triggering

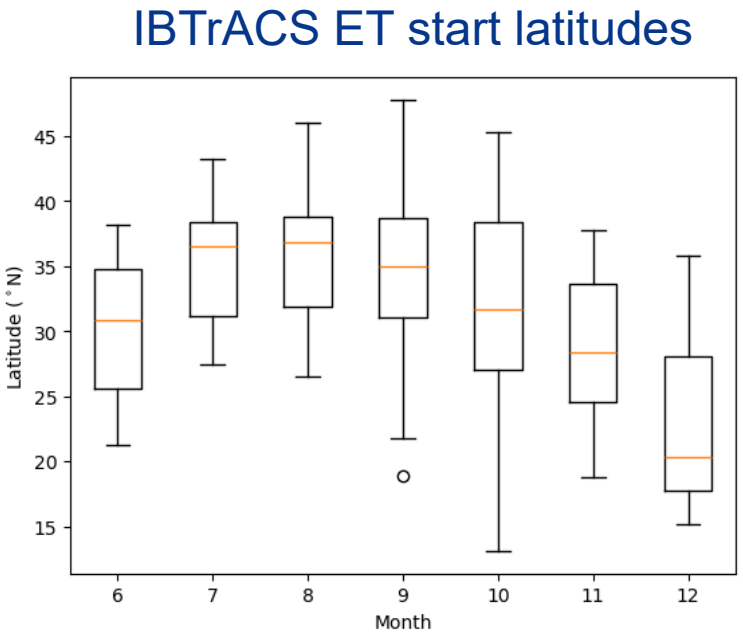


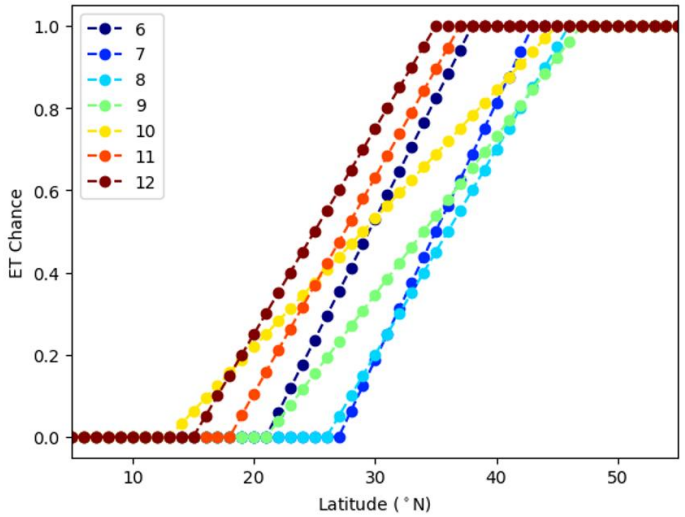
Extratropical transition triggering

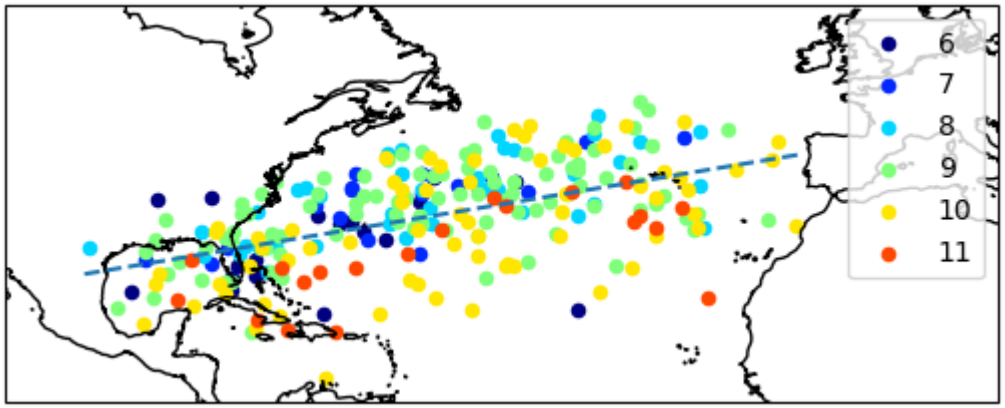




Extratropical transition triggering

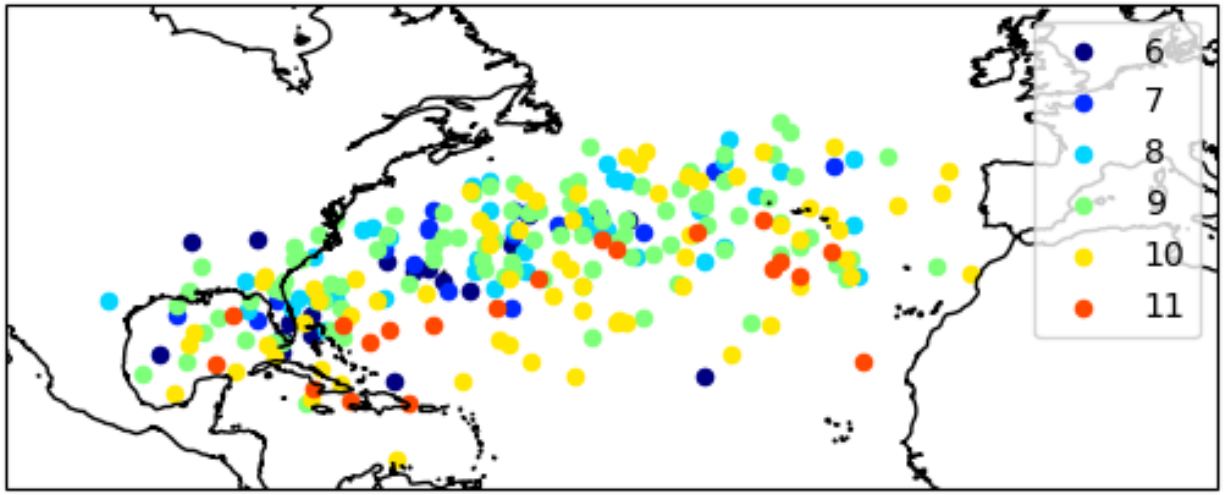






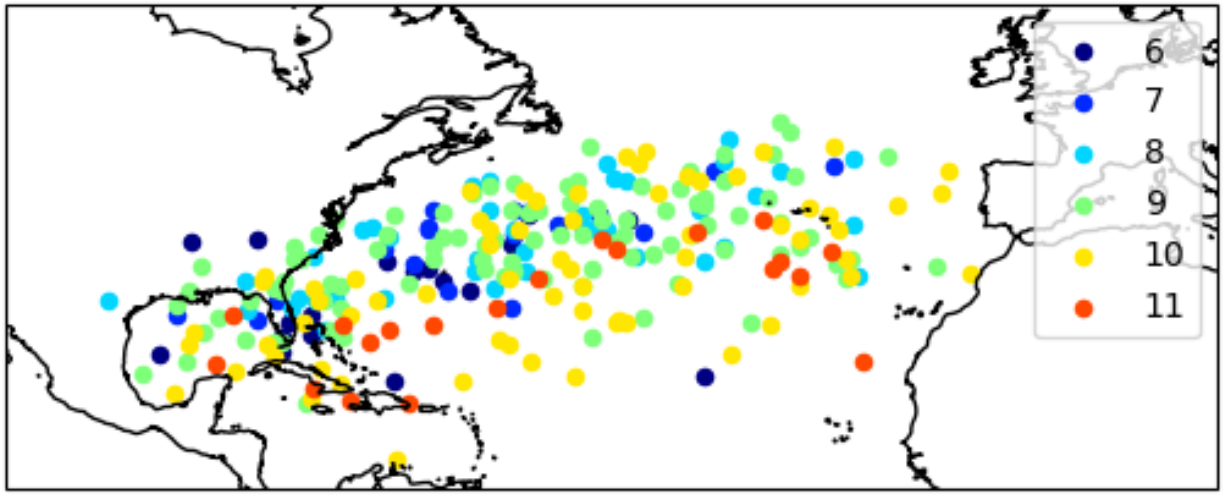
Extratropical transition triggering

IBTrACS

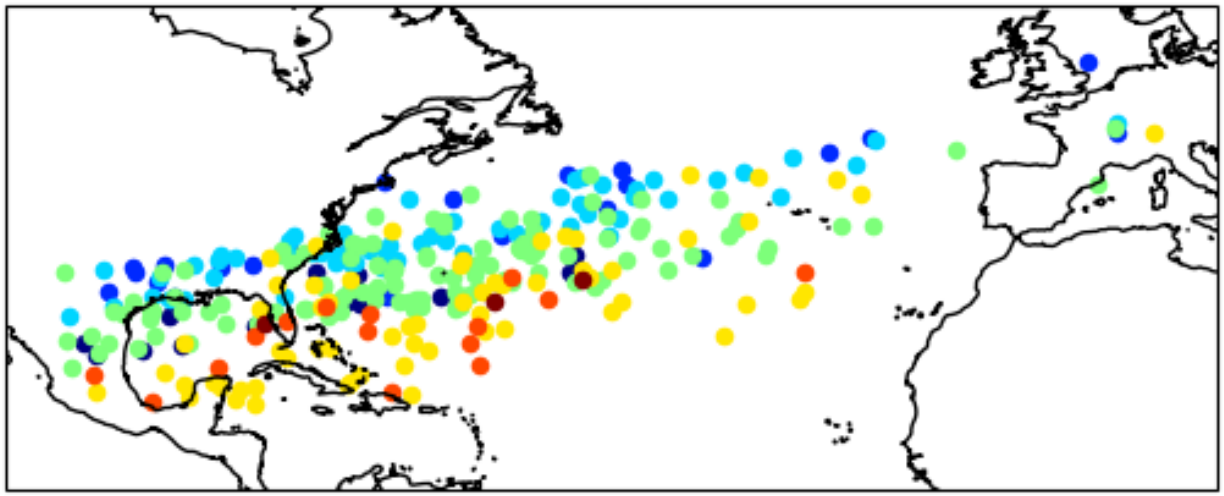


Extratropical transition triggering

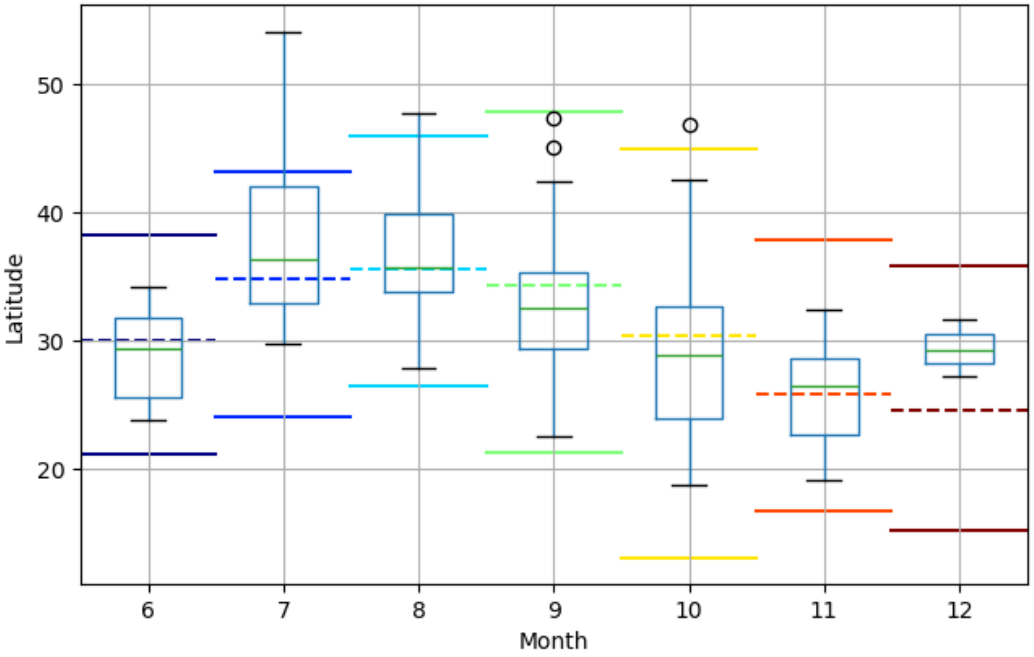
IBTrACS

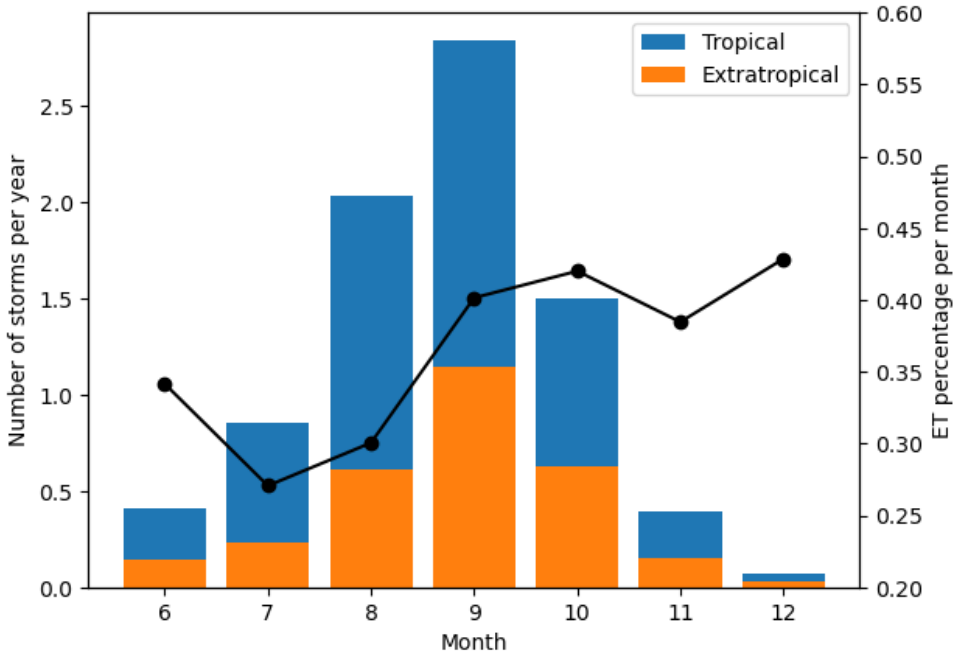


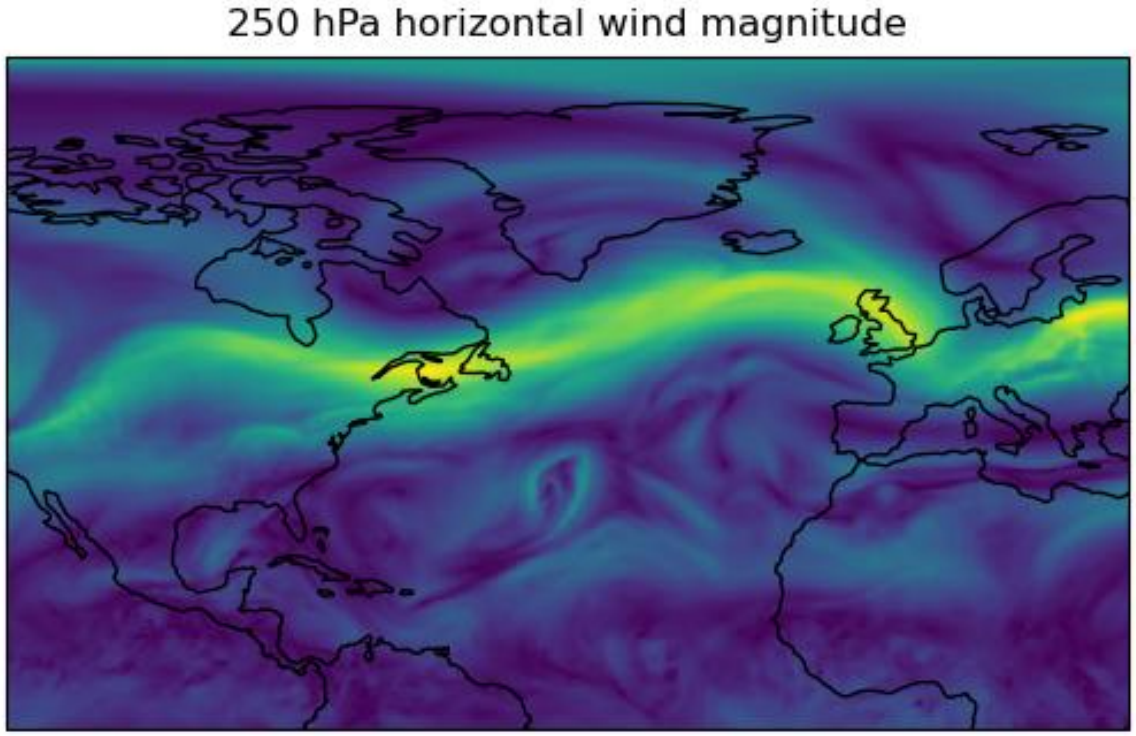
STORM-EX



Extratropical transition triggering

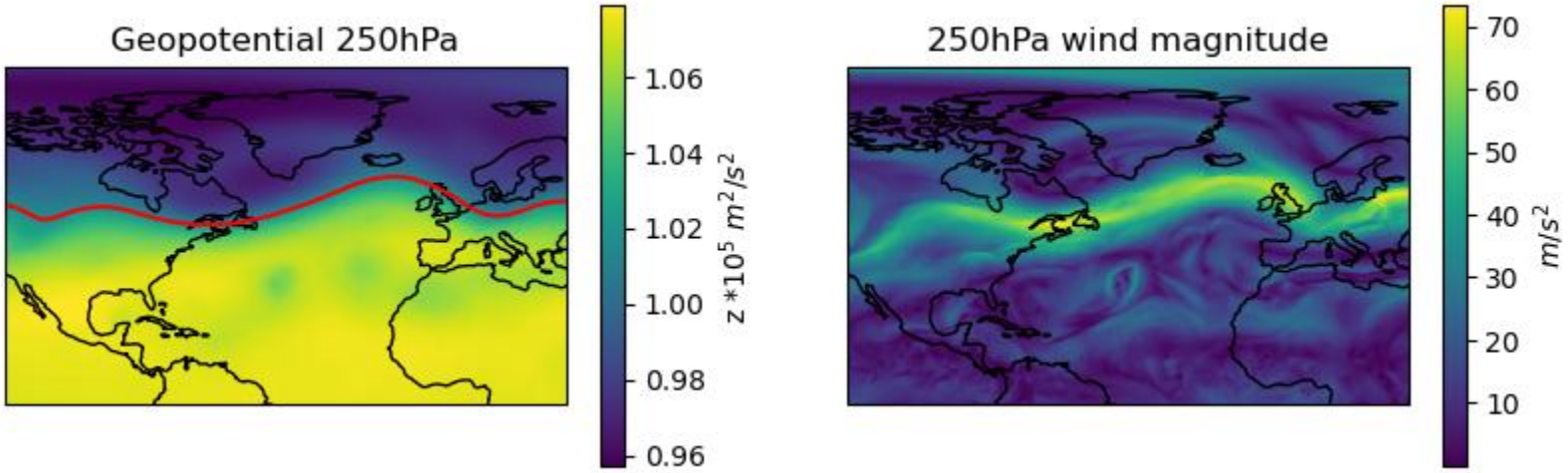






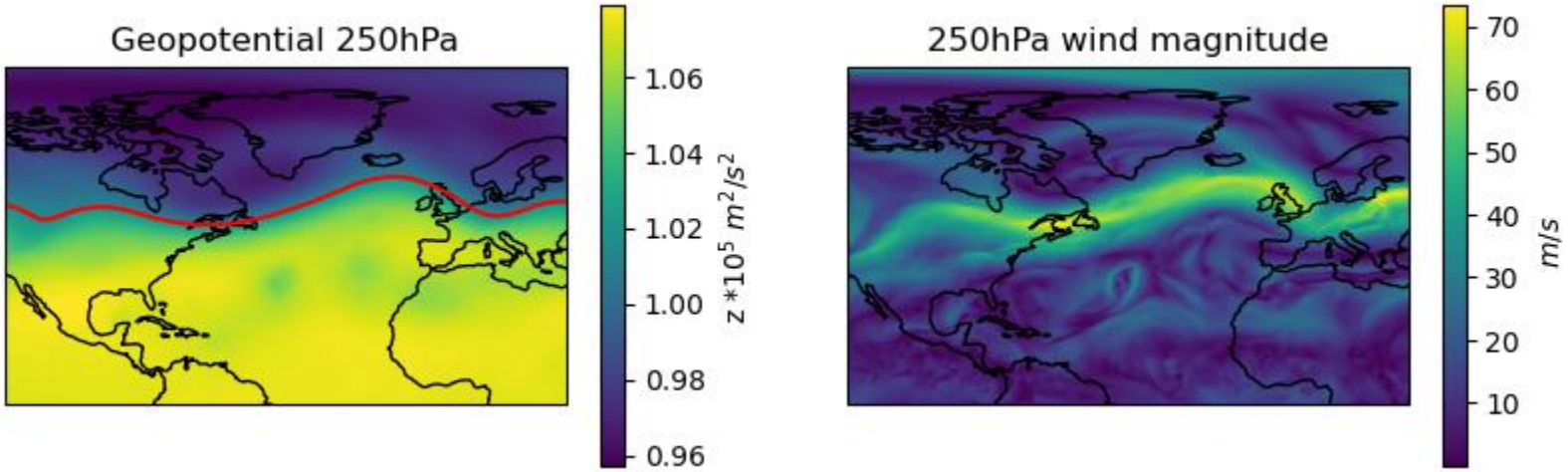
Jet stream modelling

Jet stream modelling



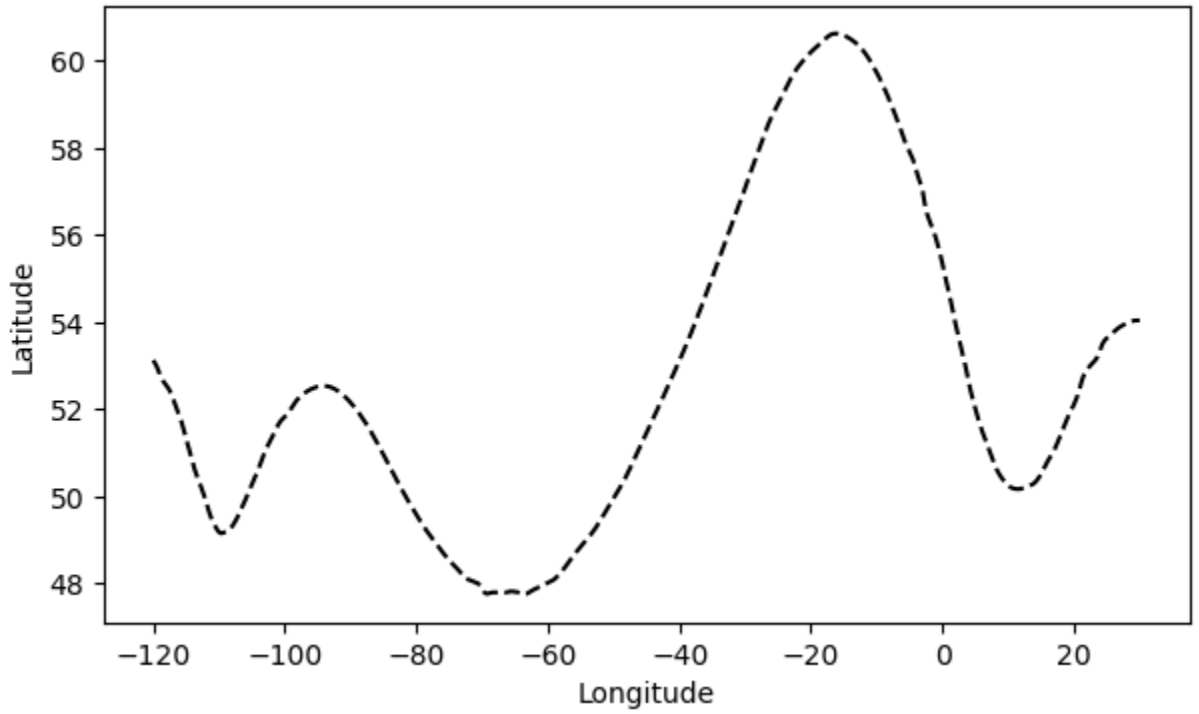
- Short answer: Fourier Transforms
- Long answer….

Jet stream modelling



ERA5 250 hPa Geopotential height contour at location of maximum wind magnitude

Jet stream modelling



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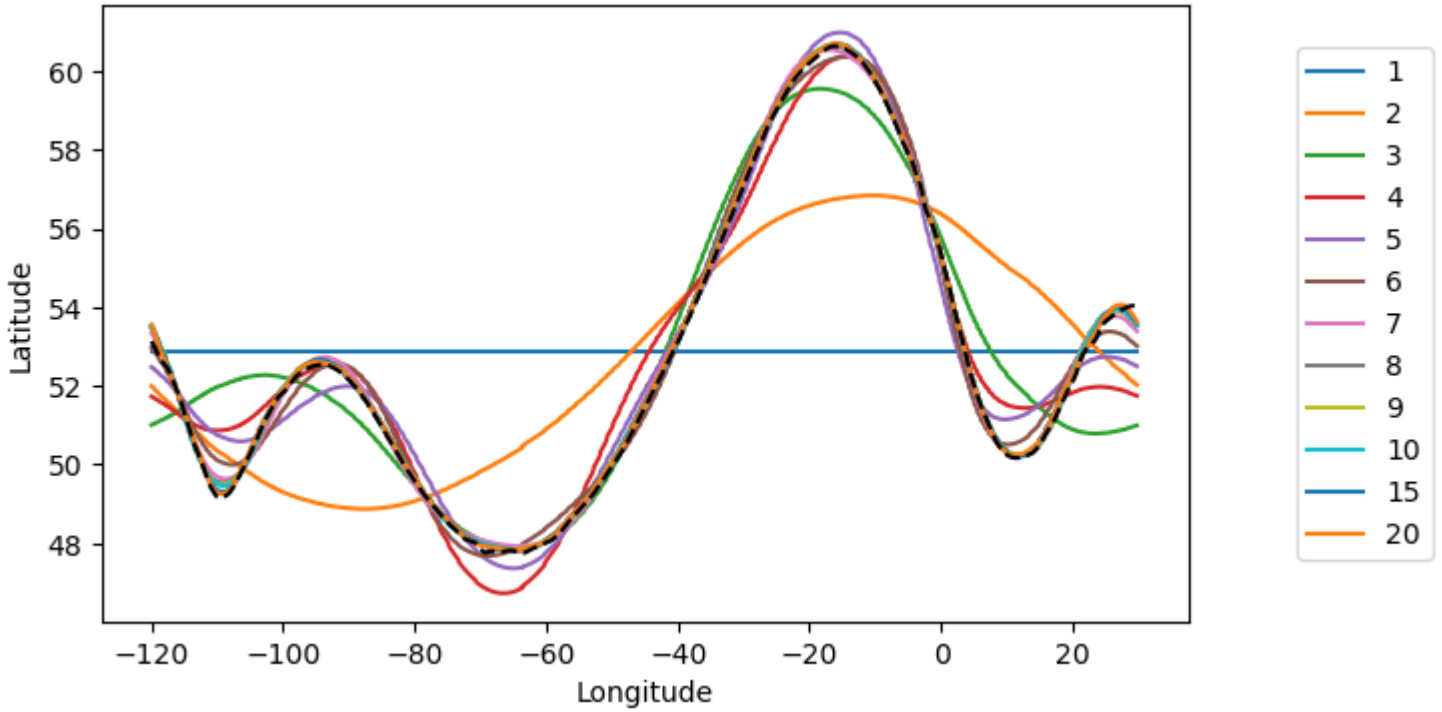

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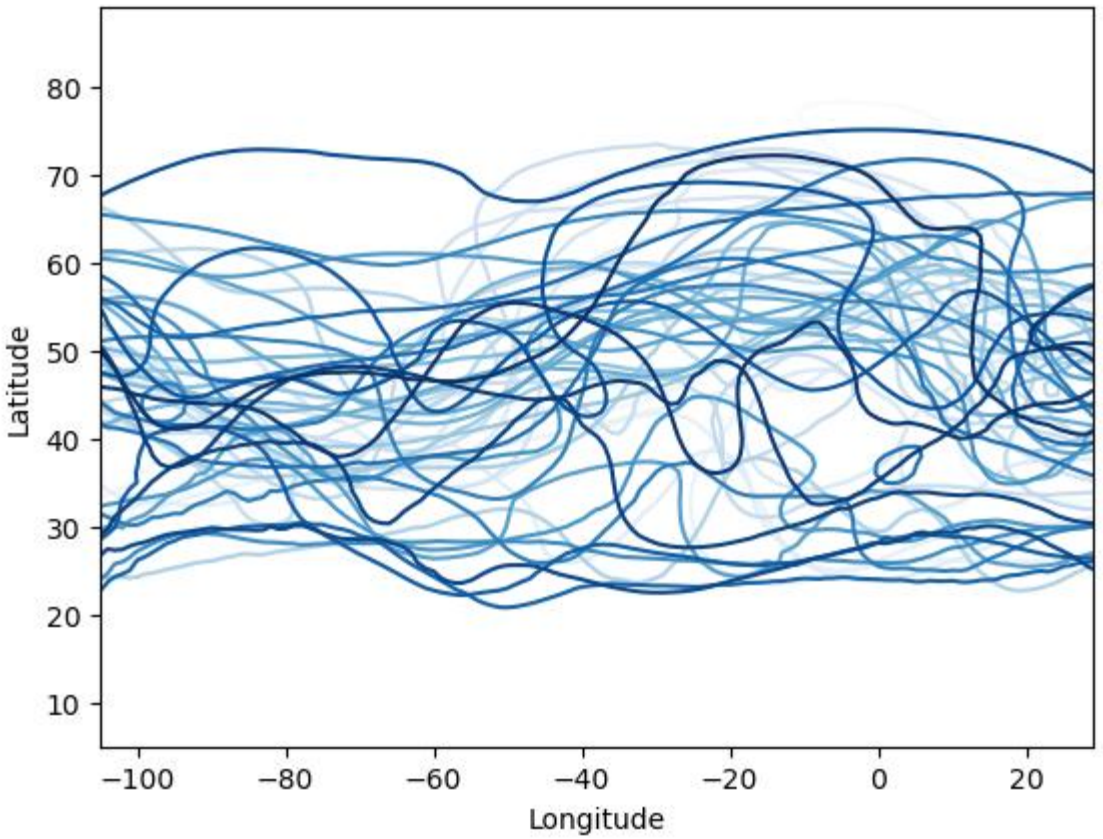

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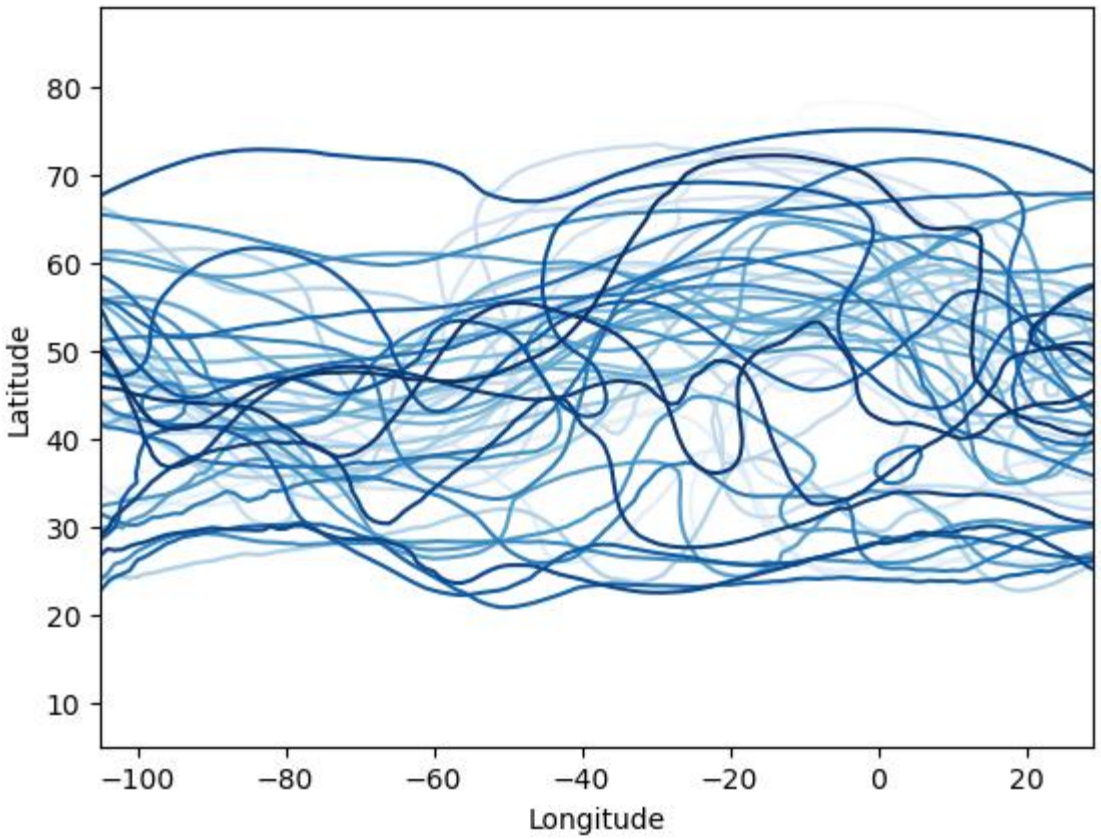
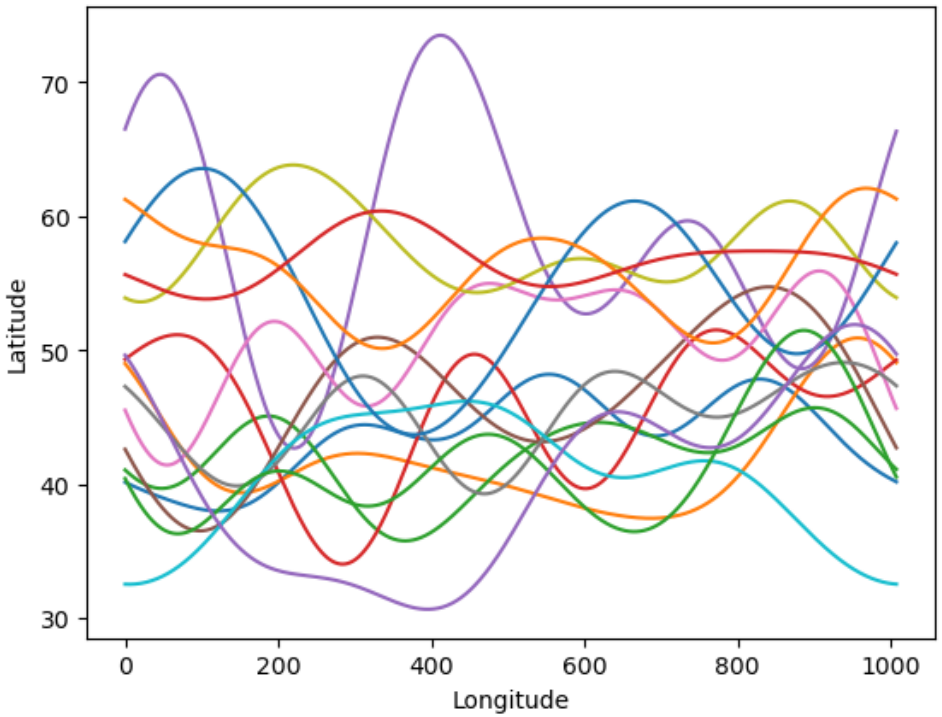


	1	2	3	4	5	6	7	8
Jet 1								
Jet 2								
Jet 3								
Jet 4								
Jet 5								
Jet 6								
Jet 7								
Jet 8								
Jet 9								
Jet 10								

Jet stream modelling



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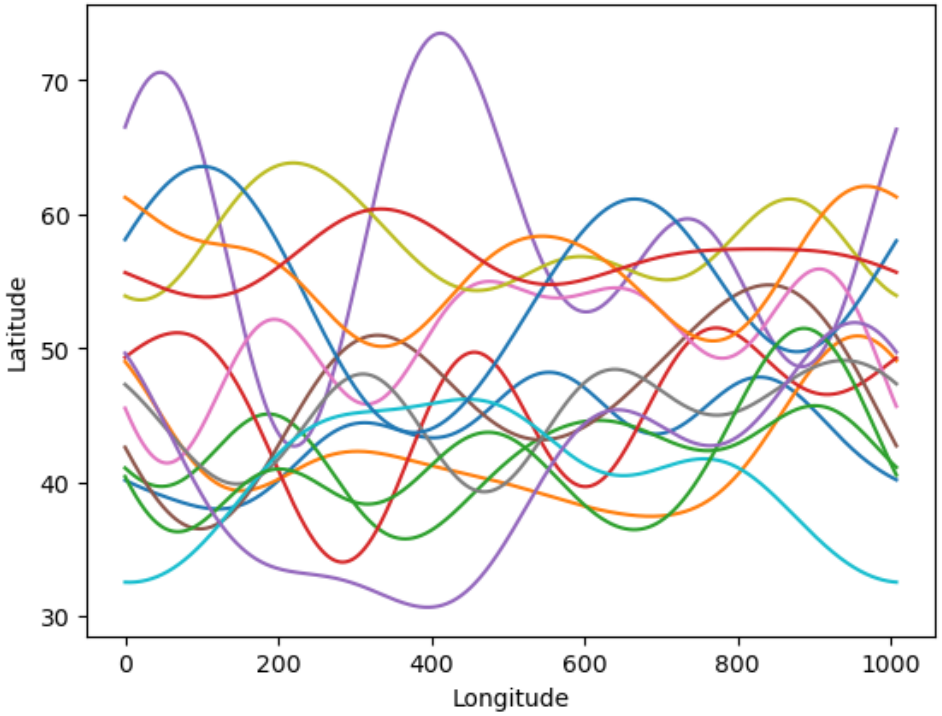

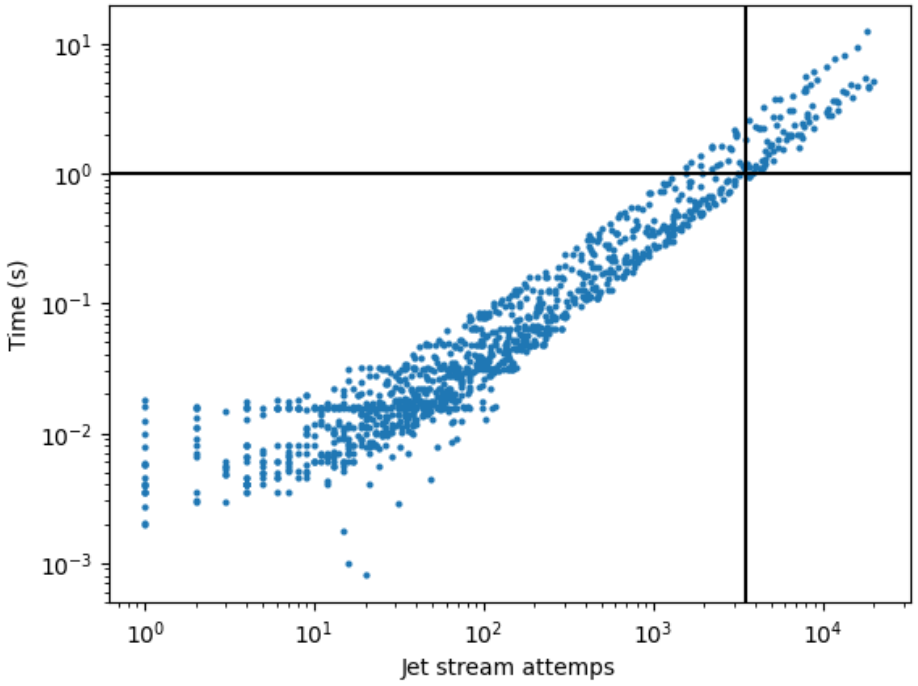

~2.5k jet streams per second

Next steps

- Intensity modelling
  - Transition from SST-based tropical convection to at least partly baroclinicity driven
- Wind field modelling and lysis
  - The normal wind-pressure relationship used for tropical cyclones breaks down
- Opensource dataset of 10,000 years of these storms
  - Return periods
  - North Atlantic for now, global coverage to come soon!

Thank you!

Marjolein Ribberink
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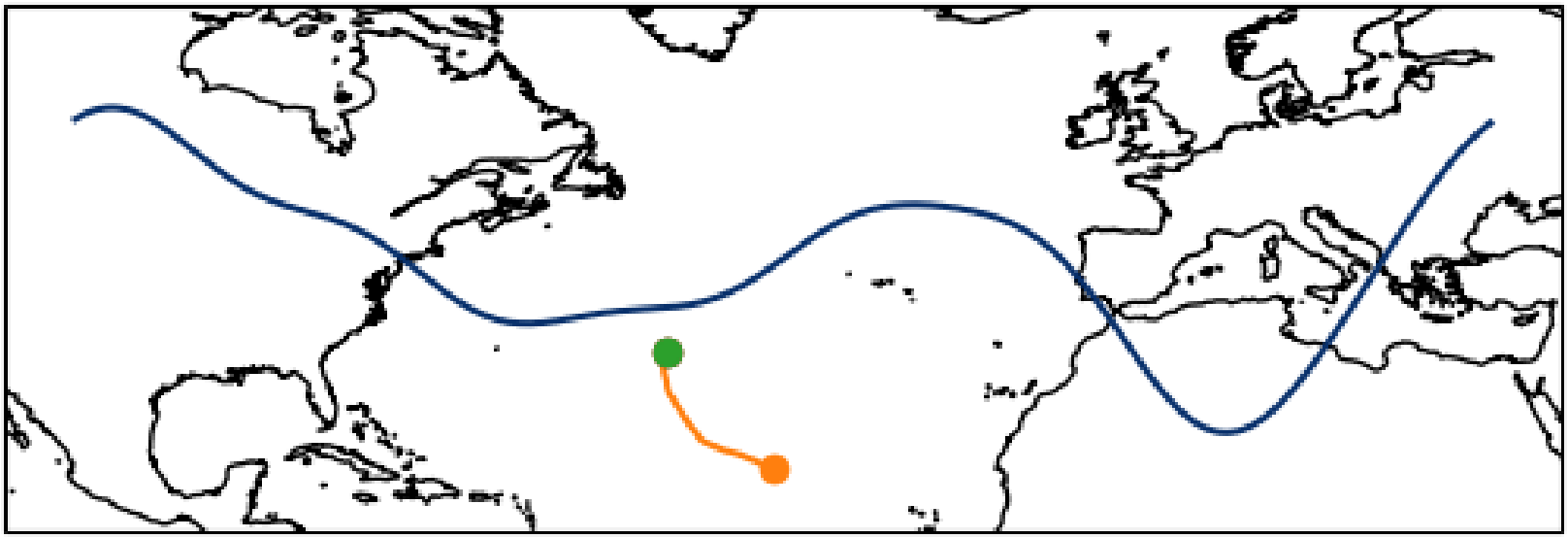
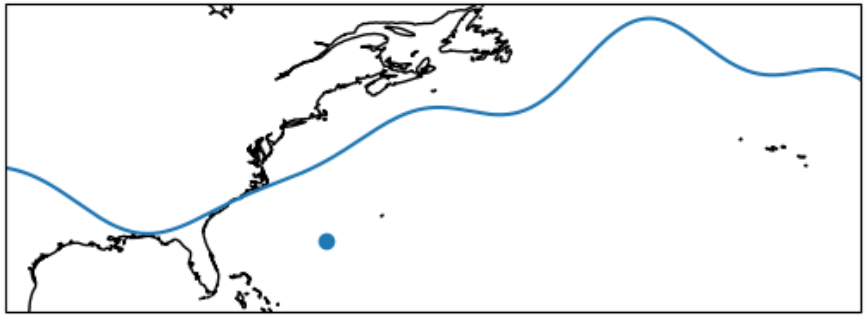
https://github.com/MRibberink/STORM2.0



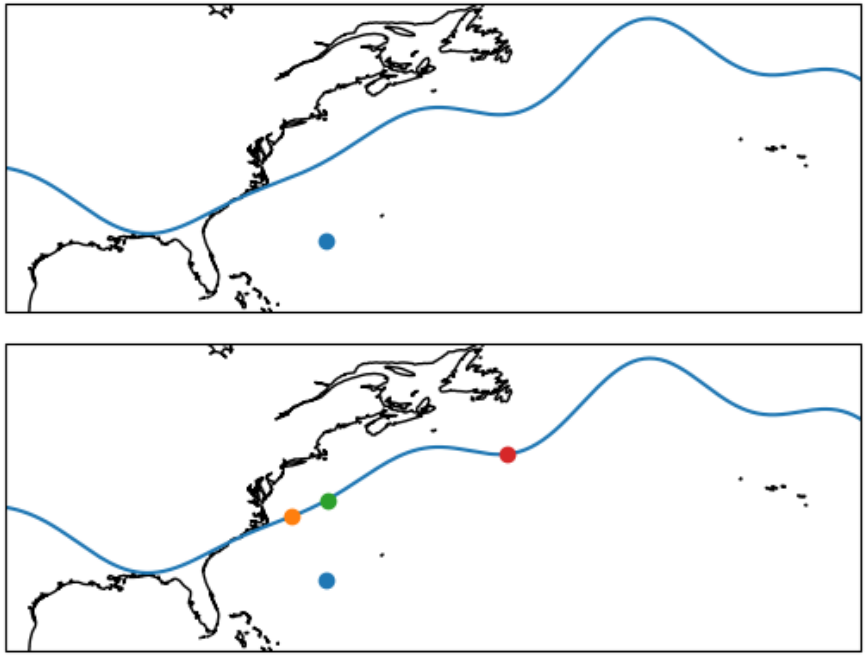
Cyclone-jet interactions

Cyclone-jet interaction



- Jet V_{jet}
- Storm (ξ_s, φ_s)

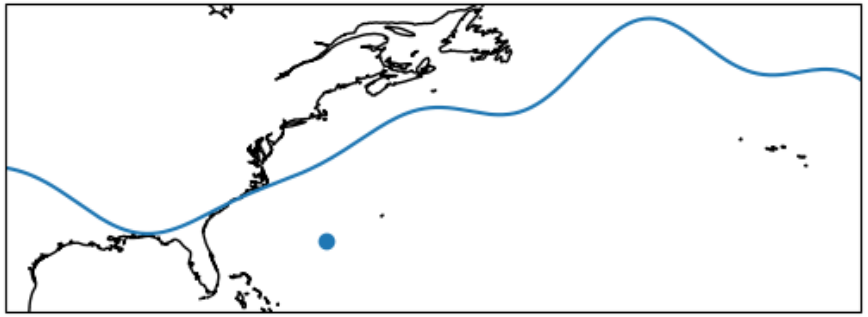
Cyclone-jet interaction

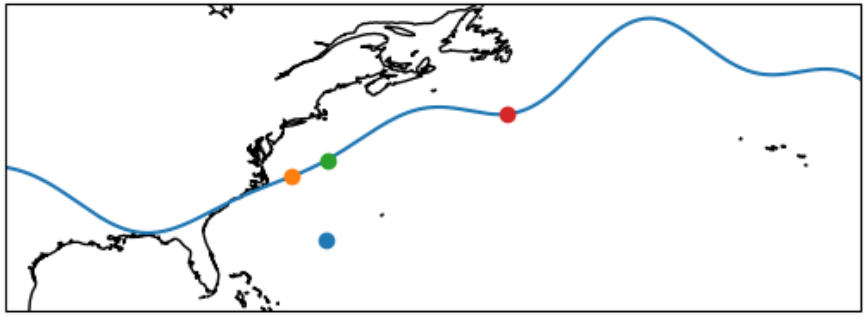


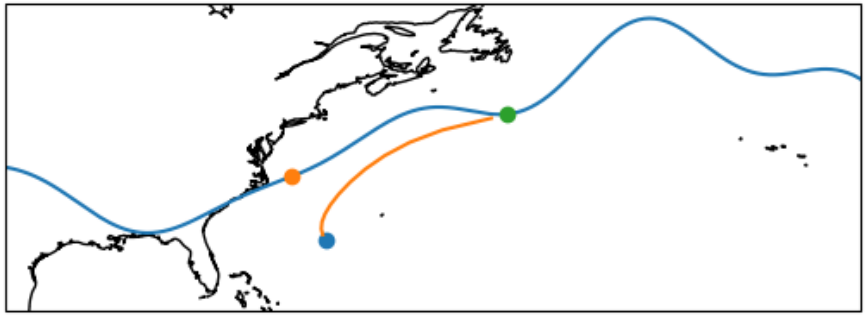
- Jet V_{jet}
- Storm (ξ_s, φ_s)

- Minimum point (ξ_m, φ_m)
- Reference point (ξ_r, φ_r)
- End point (ξ_e, φ_e)

Cyclone-jet interaction







- Jet V_{jet}
- Storm (ξ_s, φ_s)

- Minimum point (ξ_m, φ_m)
- Reference point (ξ_r, φ_r)
- End point (ξ_e, φ_e)

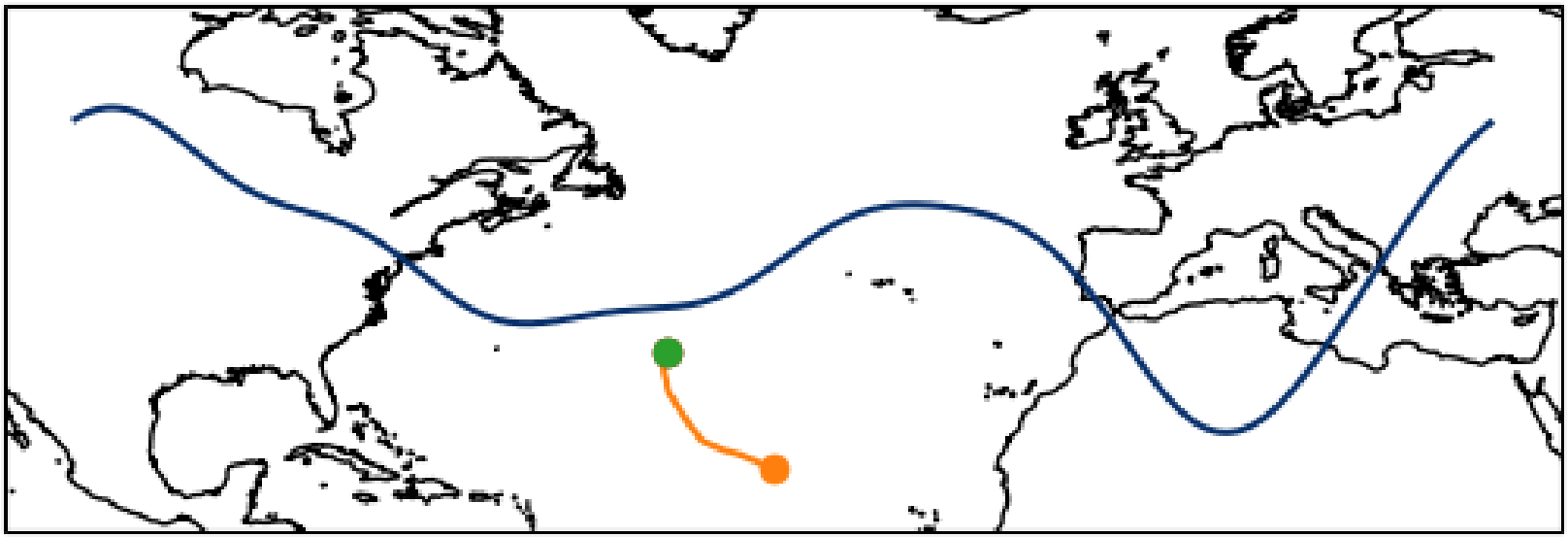
$$dist(s,r)_j$$

$$\Delta P = \frac{1}{N_{steps} - j} * dist(s,r)_j$$

in direction of reference point

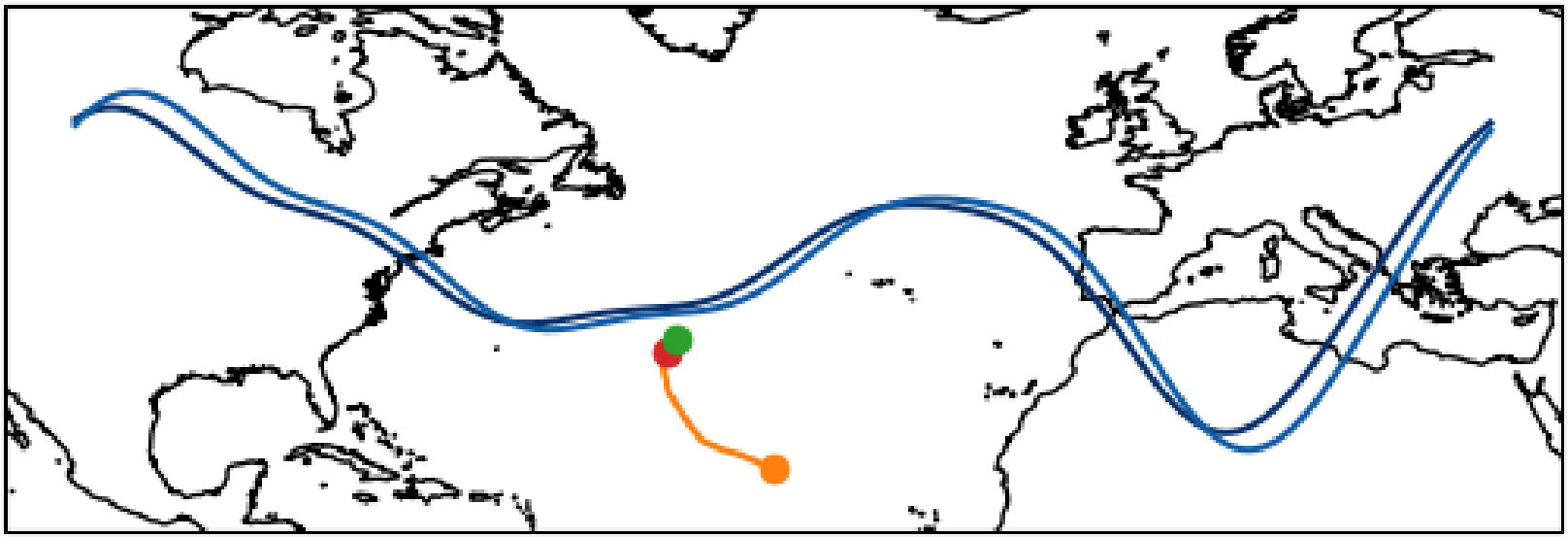
Jet-cyclone interactions

ET start



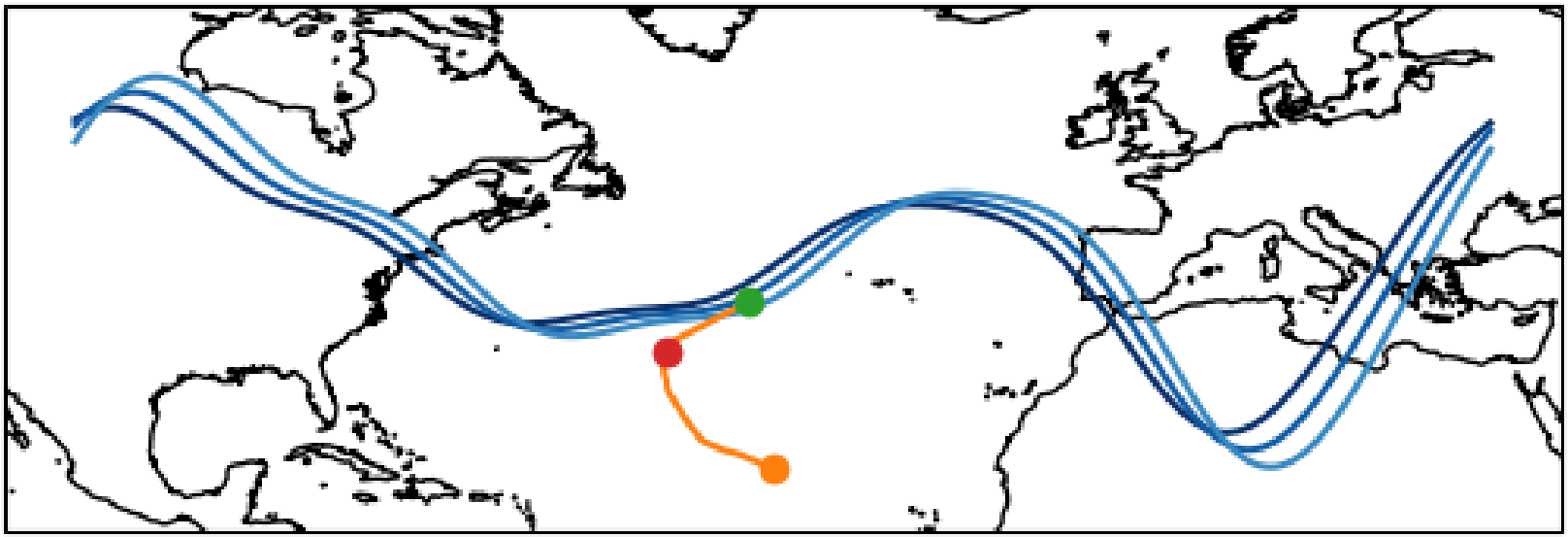
Jet-cyclone interactions

ET start +12h



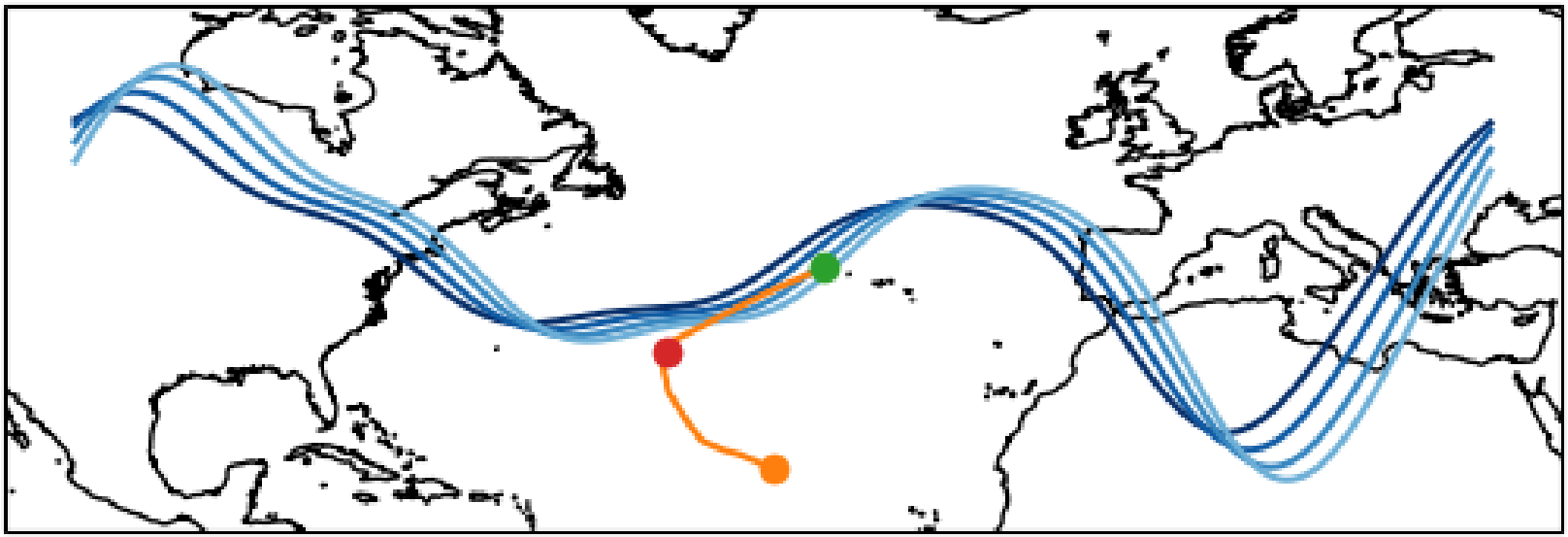
Jet-cyclone interactions

ET start +24h



Jet-cyclone interactions

ET start +36h



Jet-cyclone interactions

ET start +48h