Downstream Effects of Northern Hemisphere Extratropical Transition in a Future Climate

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Weather

- **Extratropical transition (ET)** is the process by which tropical cyclones (TCs) undergo structural changes to become extratropical cyclones
- ET occurs when TCs encounter a sufficiently baroclinic environment, associated with a large horizontal temperature gradient and vertical wind shear magnitudes
- The interaction of a TC with the midlatitude wave guide can initiate **Rossby wave packets** (RWPs) that propagate downstream along the **midlatitude jet**
- RWPs have been linked to atmospheric blocking and **extreme weather far downstream of the original cyclone**$_{b,f}$

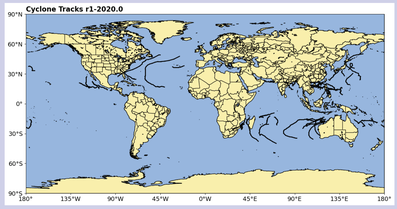
Climate

- Future climate projections include:
  - A further poleward jet stream$_d$
  - A poleward extension of TC tracks$_{g,k}$
- No consensus on how ET will change
- **The change in the downstream effects of ET has little research and is poorly understood**

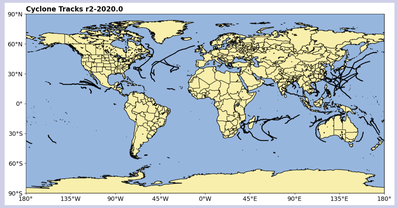
Preliminary Results

EC-Earth

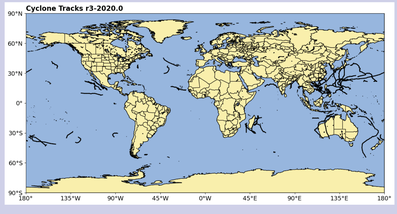
Run 1



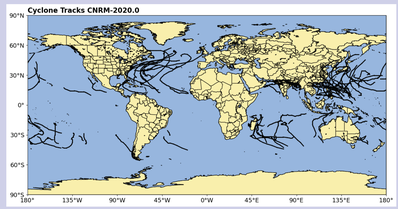
Run 2



Run 3



CNRM

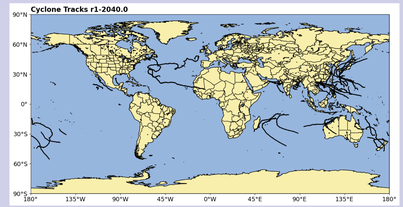


MRI

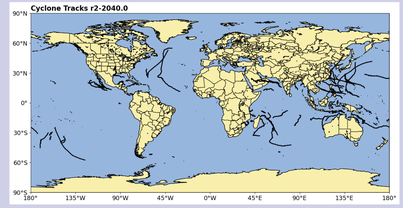
2020

EC-Earth

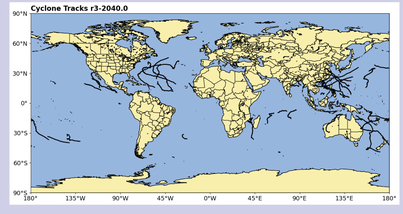
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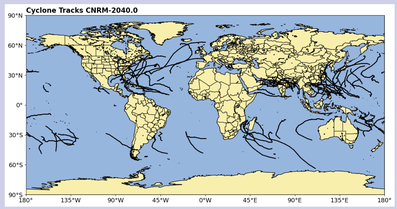
Run 2



Run 3



CNRM



MRI

2040

- Plots show less warm-core cyclones in the deep tropics than expected- a common climate model bias$_m$
- CNRM depicts a more active Atlantic tropical cyclone season than the other climate models
- CNRM and MRI West-Pacific cyclones have a more westward extent
- EC-Earth runs and the MRI run include more eastern Pacific warm-core cyclones than the CNRM run
- Atlantic cyclone paths are **further east** and have **greater poleward extent** in the future climate, consistent with current research$_g$
- A **poleward extension** of West-Pacific cyclone tracks is exhibited

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Methods

- **TempestExtremes**$_{n,p}$ used for cyclone tracking
- Parameters:
  - Pressure: 200 Pa increase from identified low pressure center within 5 degree circle
  - Thermal Character: At least 5 m decrease in 500-250mb thickness from identified cyclone center within 5 degree circle
- Tracking algorithm was run on 6 unique climate simulations from **CMIP6**$_c$ **HiResMIP/PRIMAVERA**$_h$
  - CNRM-CERFACS$_a$ (1), EC-Earth Consortium$_i$ (3), MPI-M$_e$ (1), MRI$_l$ (1)
- Tracking algorithm verified on **ERA5**$_j$ data

Future Work

- Use ExTraTrack$_o$ to diagnose and track ET
- Determine positioning and strength of jet
- Track RWPs to analyze downstream effects of ET, including blocking patterns and severe weather

References: (a) A Volodaire et al. 2019; (b) Bosart et al. 2018; (c) Eyring et al. 2016; (d) Gervais et al. 2019; (e) Gutjahr et al. 2019; (f) Haar et al. 2008; (g) Haarsma et al. 2013; (h) Haarsma et al. 2016; (i) Haarsma et al. 2020; (j) Hersback et al. 2010; (k) Liu et al. 2017; (l) Mitzuta et al. 2012; (m) Roberts et al. 2020; (n) Ullrich and Zarzycki 2017; (o) Zarzycki 2016; (p) Zarzycki and Ullrich 2017