Characteristics of tropical cyclones in high-resolution models of the present climate

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Hurricane Working Group

The U.S. CLIVAR Hurricane Working Group

- Produce a set of model experiments to improve understanding of TCs in climate models

Specifically:

- Interannual variability of TCs: 20\textsuperscript{th} century-present
- Changes of TCs in a warming climate
SST Forcing

- Climatological
- Warming
  - SST + 2K
  - Double CO₂
  - SST+2K and Double CO₂
- Historical
  - Hadley Centre SST 1980-2009
SST Forcing

- **Climatological**

- **Warming**
  - SST + 2K
  - Double CO$_2$
  - SST+2K and Double CO$_2$

- **Historical**
  - Hadley Centre SST 1980-2009
<table>
<thead>
<tr>
<th>Model</th>
<th>Resolution (km)</th>
<th>Climatology</th>
<th>Historical</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Years</td>
<td>Ensembles</td>
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<td>CAM5.1</td>
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<tr>
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<td>MRI</td>
<td>60</td>
<td>-</td>
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<tr>
<td>NCEP</td>
<td>106</td>
<td>20</td>
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</tbody>
</table>
Data

- Models
  - Climatology: 7 GCMs
  - Historical: 5 GCMs

- Observations
  - Best Track Database
    - National Hurricane Center
    - Joint Typhoon Warning Center
Tracking

- Find storm locations
  - Vorticity / Wind Speed / Pressure > Threshold
  - Warm Core > Threshold

- Connect points

- Keep tracks that last longer than n days
Tracker

- We are using TC tracks provided by each GCM
- Number of TCs depends on the tracking scheme and thresholds
- Working towards using one unified tracker on all GCMs
Climatological SST Forcing
Number of TCs

Number of Storms Per Year

CAM5.1  ECHAM5  FSU  GEOS-5  GFDL  GISS  NCEP  Obs
Tracks: 4 Years

- CAM5.1
- ECHAM5
- FSU
- GEOS-5
- GFDL
- GISS
- NCEP
- Obs
TCs per Basin

![Diagram showing the number and percentage of cyclones per basin with data from various models and observations.]
Genesis Density: Latitude

![Graph showing the number of cyclones per year across different latitudes for various models and observations.](https://example.com/graph.png)

- CAM5.1
- ECHAM5
- FSU
- GEOS-5
- GFDL
- GISS
- NCEP
- Obs
Genesis Density: Longitude

![Graph showing number of cyclones per year against longitude. The graph includes lines for CAM5.1, ECHAM5, FSU, GEOS-5, GFDL, GISS, NCEP, and Obs. Each line represents a different model or dataset, with peaks indicating high cyclone activity at various longitudes.]
Seasonal Cycle

![Seasonal Cycle Diagram](image-url)
Seasonal Cycle

North Indian Cyclones per Year

Western North Pacific Cyclones per Year

Eastern North Pacific Cyclones per Year

North Atlantic Cyclones per Year

Legend:
- CAM5.1
- ECHAM5
- FSU
- GEOS–5
- GFDL
- GISS
- NCEP
- Obs
Seasonal Cycle

South Indian Cyclones per Year

Australian Cyclones per Year

South Pacific Cyclones per Year

Legend:
- CAM5.1
- ECHAM5
- FSU
- GEOS-5
- GFDL
- GISS
- NCEP
- Obs
Maximum Intensity

The graph compares the maximum intensity of different models, including CAM5.1, ECHAM5, FSU, GEOS-5, GFDL, GISS, and NCEP. The x-axis represents the maximum wind speed in meters per second (m/s), while the y-axis shows the percent distribution.
Track Duration

![Duration Graph](image)

- CAM5.1
- ECHAM5
- FSU
- GEOS-5
- GFDL
- GISS
- NCEP

![Duration Percent Graph](image)
Historical SST Forcing
Yearly Correlation

![Yearly Correlation Diagram]

* Statistically Significant
Yearly ACE Correlation

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* Statistically Significant
Average Formation Location

Western North Pacific

Longitude

Latitude

Eastern North Pacific

Longitude

Latitude

GISS  GFDL  FSU  GSFC  MRI  Observations

La Nina

El Nino
Warming Runs

Number of Storms per Year

Percent Change from Control Run

CAM5.1  ECHAM5  FSU  GEOS-5  GFDL  GISS  NCEP

Control  SST+2K  2xCO2  SST+2K,2xCO2
Summary

- Geographic distribution of TCs similar to observations
- Maximum intensity varies between models
- North Pacific TC shifts due to ENSO consistent with observations
- Need to unify tracking schemes to investigate TC frequency differences between models