US CliVar HWG
CAM5.1 simulations

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CAM

• Public release of Community Atmospheric Model
  – Version CAM5.1
  – Developed by DOE and NSF
  – Finite Volume dynamical core
  – Latitude-longitude mesh
  – Prescribed aerosols.
0.25° and 1° CAM5.1 status

- All 4 idealized configurations completed
  - Climatological SST, 330ppm CO²
    - 1° (27 years); 0.25° (17 years)
  - Climatological SST plus 2°, 330ppm CO²
    - 1° (24 years); 0.25° (16 years)
  - Climatological SST, 660ppm CO²
    - 1° (24 years); 0.25° (14 years)
  - Climatological SST plus 2°, 660ppm CO²
    - 1° (24 years); 0.25° (16 years)

- AMIP-style
  - 1° (50 member ensemble; 1959-2008)
  - 0.25° (1 run; 1979-2005)

- 400TB, 20M Cray X1E processor hours.
1979-2005 Global average / year

- Used the GFDL tracking algorithm and default parameters from Knutson et al. 2007.
- Parallel and scalable to 150K processors…

- **total TC (>35knots)**
  - observations $87\pm8$
  - $0.25^\circ$ cam5.1 $84\pm9$
  - $1.0^\circ$ cam5.1 $8\pm3$
  - $2.0^\circ$ cam5.1 $0$
  - T341 cam4 eulerian $24\pm3$

- **total hurricanes (>64knots)**
  - Observations $49\pm7$
  - $0.25^\circ$ cam5.1 $52$
    - cat1 $21$
    - cat2 $5$
    - cat3 $12$
    - cat4 $7$
    - cat5 $1.5$
  - $1.0^\circ$ cam5.1 $1.7$
    - cat1 $1.5$
    - cat2 $0.2$
Observed (Emanuel) storm tracks
1° CAM5.1 storm tracks

23-year Climatology - climo
0.25° CAM5.1 storm tracks
Tropical Storm
Cat1
Cat2
Cat3
Cat4
Cat5
1979-2005
iBTrACS Obs.
25 km CAM 5.1
Figures by Prabhat
Cat4
Cat5

Figures by Prabhat
TC Seasonal cycle

North Atlantic

North Indian Ocean

Western Pacific

Eastern Pacific
1° CAM5.1 US CliVar HWG results

<table>
<thead>
<tr>
<th></th>
<th>climo</th>
<th>2xCO2</th>
<th>SSTplus2</th>
<th>SSTplus2_2xCO2</th>
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</thead>
<tbody>
<tr>
<td>TC/year</td>
<td>8.5</td>
<td>7.1</td>
<td>11.0</td>
<td>9.8</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>3.3</td>
<td>2.1</td>
<td>4.3</td>
<td>3.3</td>
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</table>

• Is Climo different than 2XC02?
  – Yes at the 96% level

• Is Climo different than SSTplus2?
  – Yes at the 98% level

• Is SSTplus2 different than SSTplus2_2XC02?
  – Yes at the 85% level

• Is Climo different than SSTplus2_2XC02?
  – Yes at the 91% level
Expectations from 1° CAM5.1

- A challenge to the conventional wisdom

- Total #TC/year:
  - Decrease from 2xCO2 does not offset the increase from 2C SST increase.

- Implicit in this expectation is that an SST increase causes more storms.
0.25° CAM5.1 US CliVar TCWG results

Global

# of storm / year

Climo
2xCO2_SST_plus2
SST_plus2
2xCO2

All storms TS Cat 1 Cat 2 Cat 3 Cat 4 Cat 5
0.25° CAM5.1 US CliVar TCWG results

Atlantic Basin

- Climo
- 2xCO2_SST_plus2
- SST_plus2
- 2xCO2

# of storm / year

All storms  TS  Cat 1  Cat 2  Cat 3  Cat 4  Cat 5
0.25° CAM5.1 US CliVar TCWG results

**Pacific Basin**

- **All storms**
- **TS**
- **Cat 1**
- **Cat 2**
- **Cat 3**
- **Cat 4**
- **Cat 5**

Legend:
- **Climo**
- **2xCO2_SST_plus2**
- **SST_plus2**
- **2xCO2**

Bar chart showing the number of storms per category and scenario.
Cyclogenesis region wind shear

- Not a lot of change
- And the change does not explain the change in TC frequency
Cyclogenesis region water vapor

6-18N 300-340W

US CliVar column water vapor ACR

25km cam5.1

5–15N 180–130E

US CliVar column water vapor PCR

25km cam5.1
• **2xCO2 vs climo**
  – Global and Pacific reduction in all categories
  – Atlantic reduction in total number.

• **2xCO2_SSTplus2 vs . SSTplus2**
  – Global, Pacific, Atlantic reduction in total number
  – Global and Pacific reduction in low and high categories

• **SSTplus2 vs climo**
  – Global and Pacific reduction in total number (!)
  – Global, Pacific, Atlantic reduction in low categories; increase in cat 5

• **2xCO2_SSTplus2 vs 2xCO2**
  – Little change in global number
  – Global reduction in low categories; increase in cat 5

• **2xCO2_SSTplus2 vs climo**
  – Global, Pacific, Atlantic reduction in total number
  – Global, Pacific, Atlantic increase in cat 5
### 0.25° vs 1° CAM5.1

<table>
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<tr>
<th></th>
<th>SSTplus2_2xCO2 vs climo</th>
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<th>2xCO2_SSTplus2 vs SSTplus2</th>
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<th>2xCO2_SSTplus2 vs 2xCO2</th>
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<tbody>
<tr>
<td>1°</td>
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<td>↓</td>
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<td>0.25° all</td>
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<td>↓</td>
<td>↓</td>
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<tr>
<td>0.25° Cat 5</td>
<td>↑</td>
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- **Low resolution response in total # of TC**
  - does not predict high resolution response in total.
  - does predict high resolution cat 5 response.
- **Likely a consequence of the tracking algorithm.**
(fv)CAM5.1 supports the common wisdom.
   – Fewer number of tropical cyclones
   – More intense tropical cyclones

Still searching for definitive causes.

Paper for JClim special issue planned…

All data is available now and is unrestricted.
   – ESFG (http://esg01.nersc.gov/esgf-web-fe/)
   – Or contact me
Thank You
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