

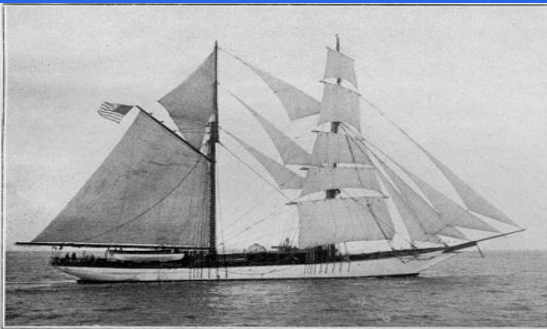
Total Storm Conduction Current Parameterization in a Global Model

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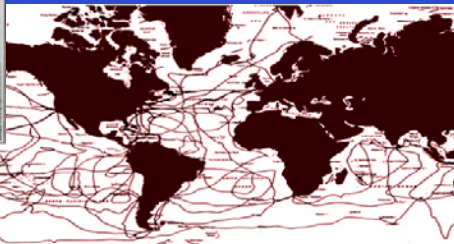
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3. Texas A&M-Corpus Christi, Corpus Christi, Texas

Global Electricity Background

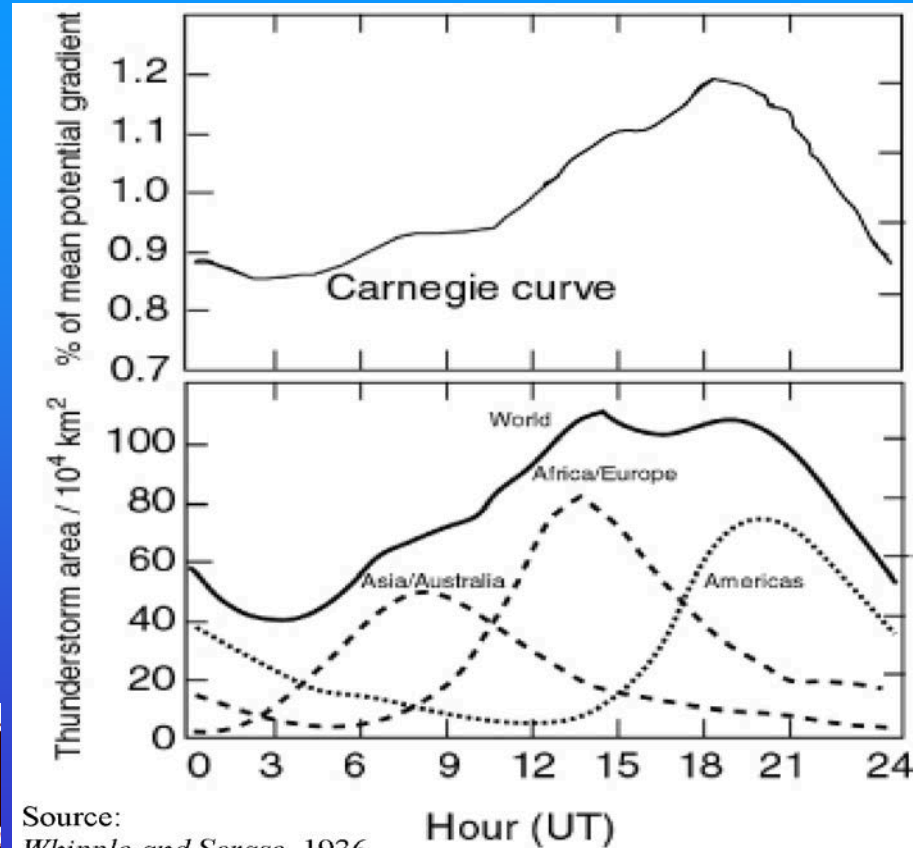
- Global electric field measurements early 1900s
- Diurnal variations of fair weather electric field
- Diurnal variations of thunderstorms, lightning activity, TRMM precipitation show similar trend



Voyages



Carnegie ship



Source:
Whipple and Scrase, 1936

Background

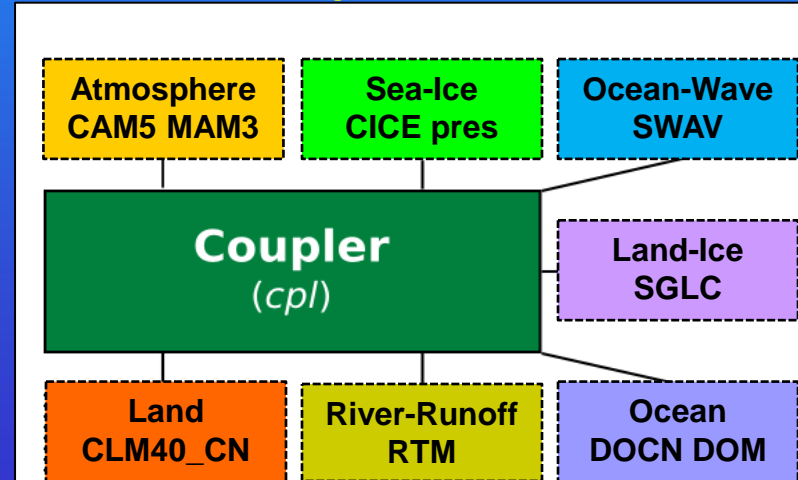
- Electrified clouds thought to play major role supplying current to GEC
 - Wilson Current
- Contribution of different cloud types/stages not well known
 - Correlation: storm dynamics, mixed phase microphysics & lightning
- Model data compared with TRMM Precipitation and derived currents
- Goals:
 - Determine model skill representing storm properties
 - Develop and evaluate current parameterization



CESM Global Model Data

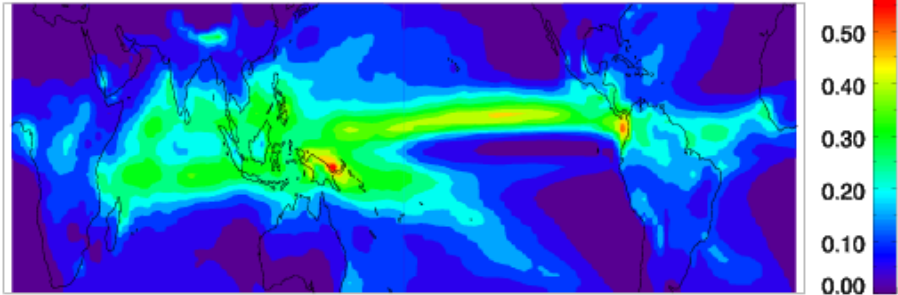
- 2 simulations, low resolution ($1.9^\circ \times 2.5^\circ$)
 - **Free running** & nudged with GEOS-5
 - Present day time period, CAM5
- Variables
 - Convective mass flux, ice water path
 - 0°C to -50°C , multiplied grid area
 - Convective precipitation

Component Set

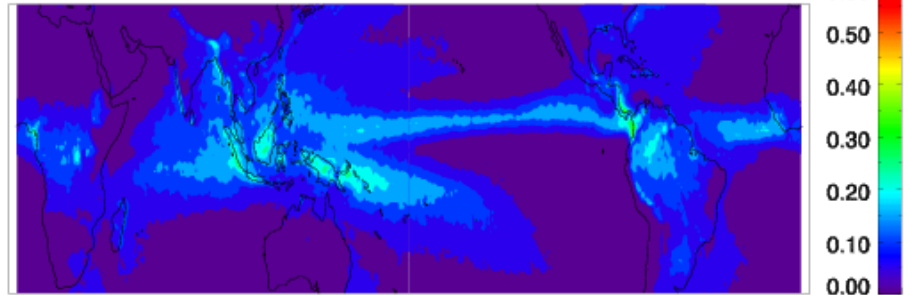


Model Precipitation Validation

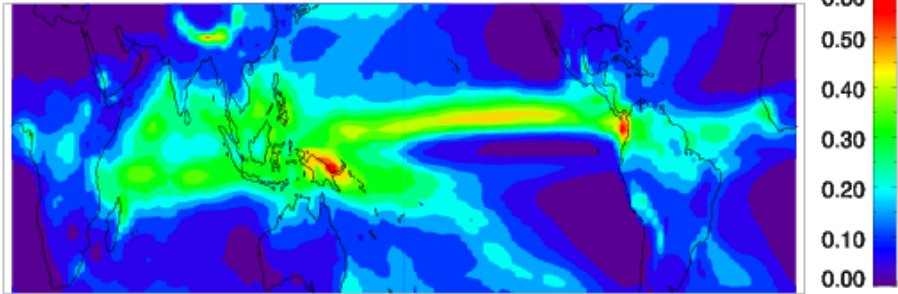
CESM Free Convective Precip Averaged for 2005



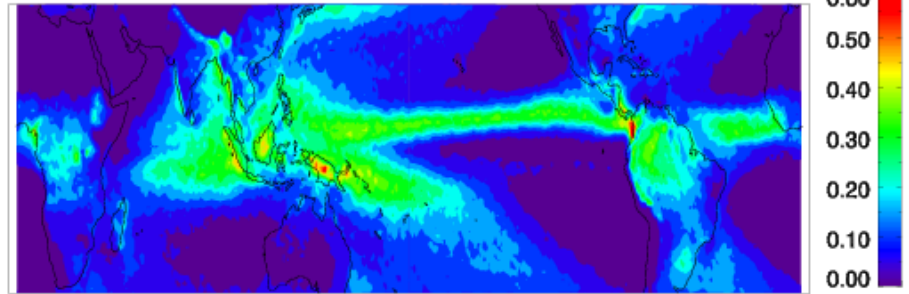
TRMM Convective Precipitation Averaged 1998-2010



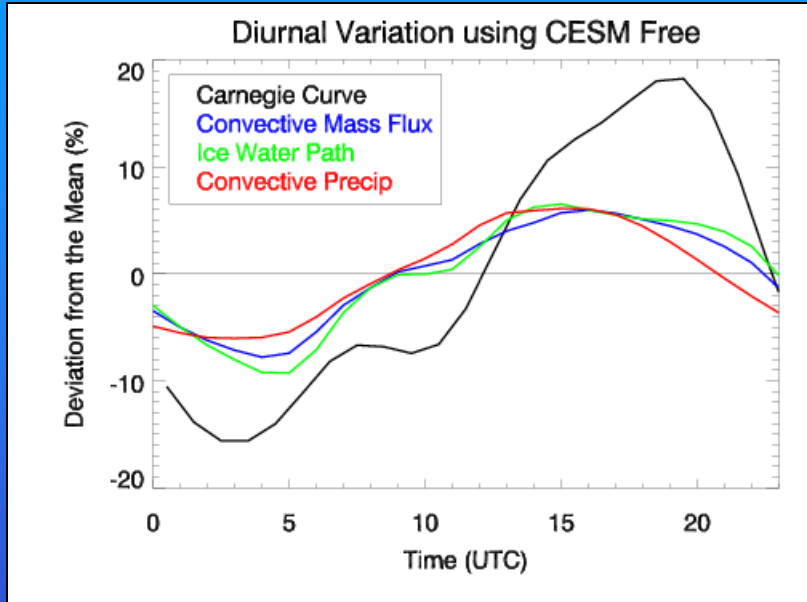
CESM Free Total Precipitation Averaged for 2005



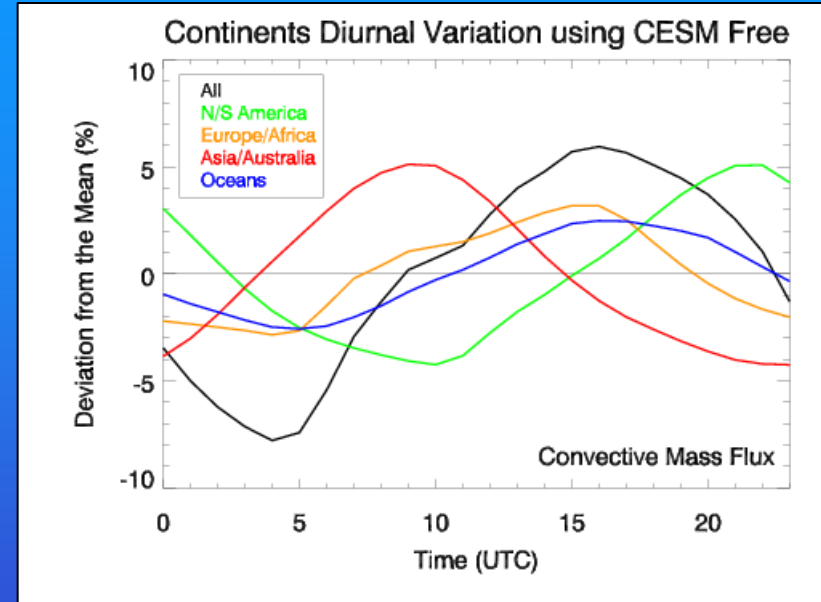
TRMM Total Precipitation Averaged 1998-2010



Diurnal Variation Validation



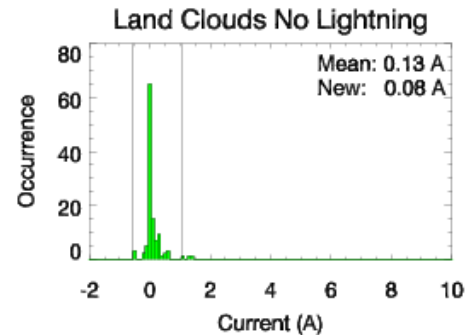
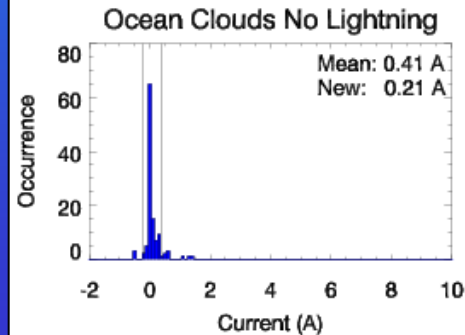
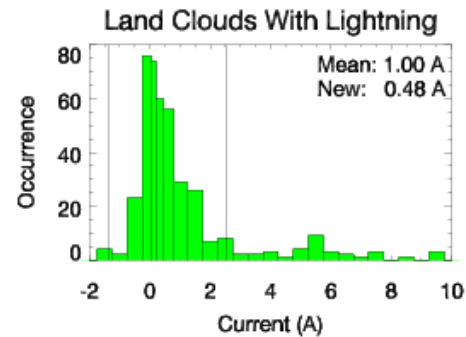
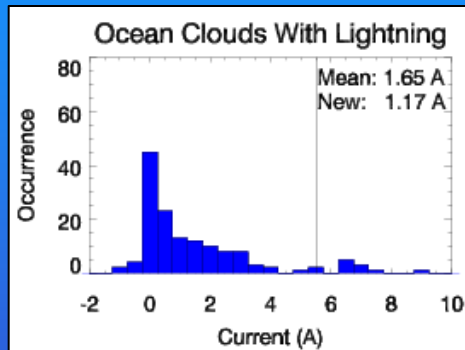
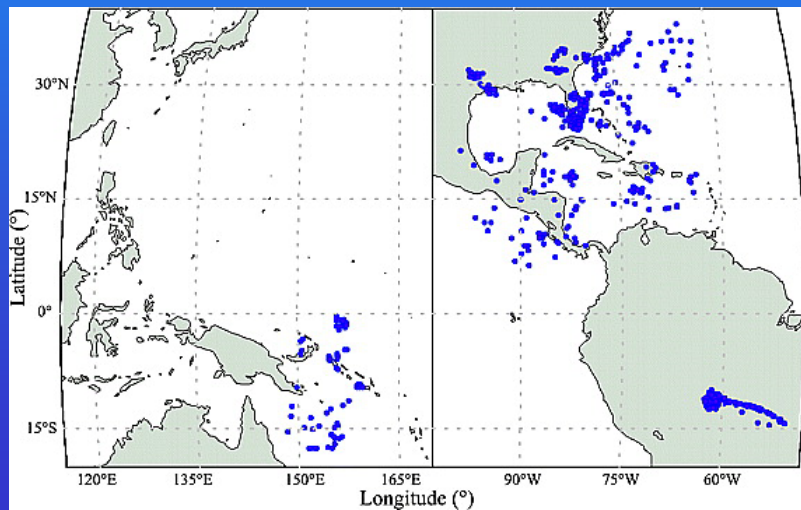
- Captures general shape
- Amplitude too small (5% – 8%)
- Early maximum (4 h – 6 h)



- Europe/Africa early, broad, flat
- Late Maximum: N/S America, Asia/Australia

Current Data

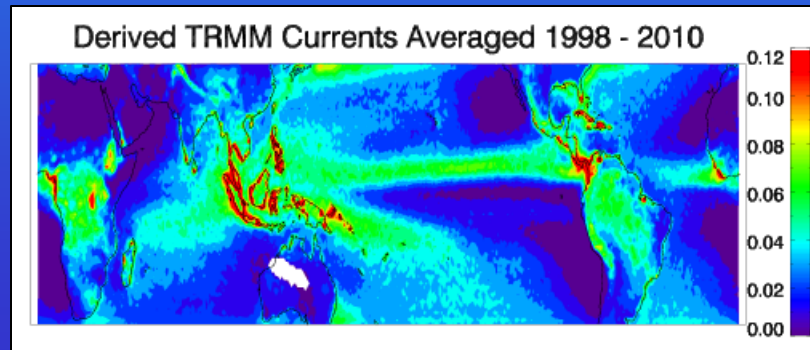
- 850 Overflights of ER-2 (Mach et al. 2010)
- Removed outliers
 - outlier = (1,3) quartile \pm 1.5*IQR



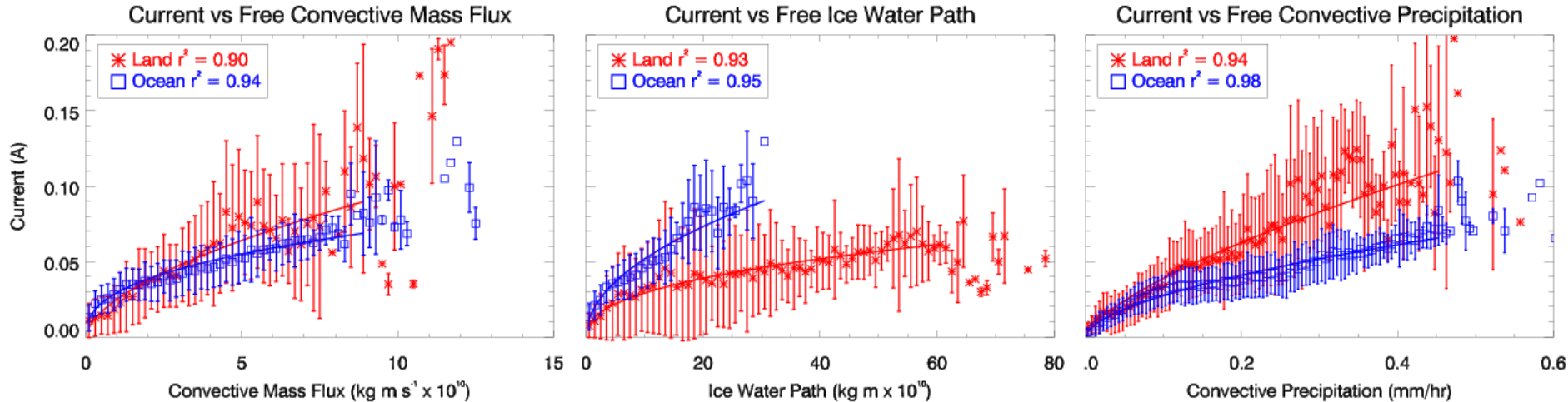
Global Current Distribution Measurements

- TRMM Precipitation and cloud feature database (Liu et al. 2010)
 - 12 years, 1998 – 2010
 - 35°S to 35°N
 - Land: $\geq 90\%$ land, ocean: $< 10\%$ land
- Storm counts multiplied by mean current estimates

New Mean Total Storm Currents (A)		
Location	Thunderstorms	Electrified Shower Clouds
Ocean	1.17	0.21
Land	0.48	0.08

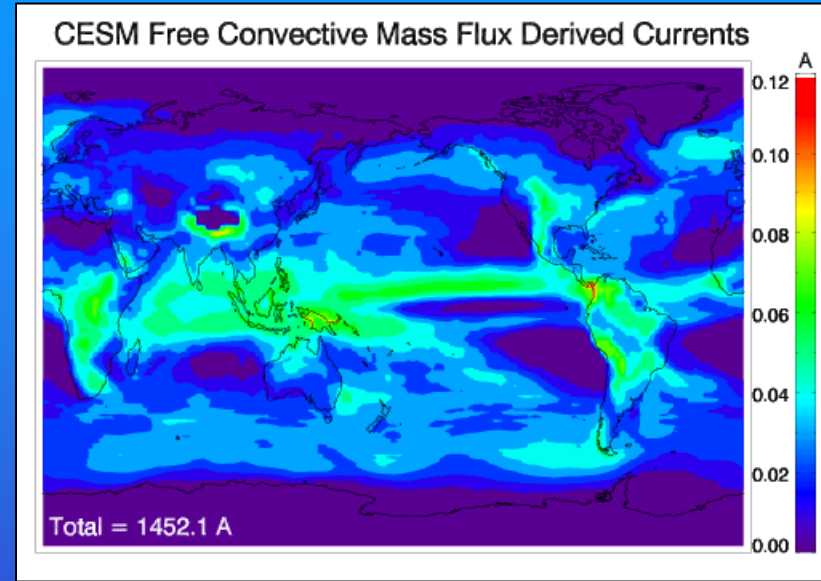
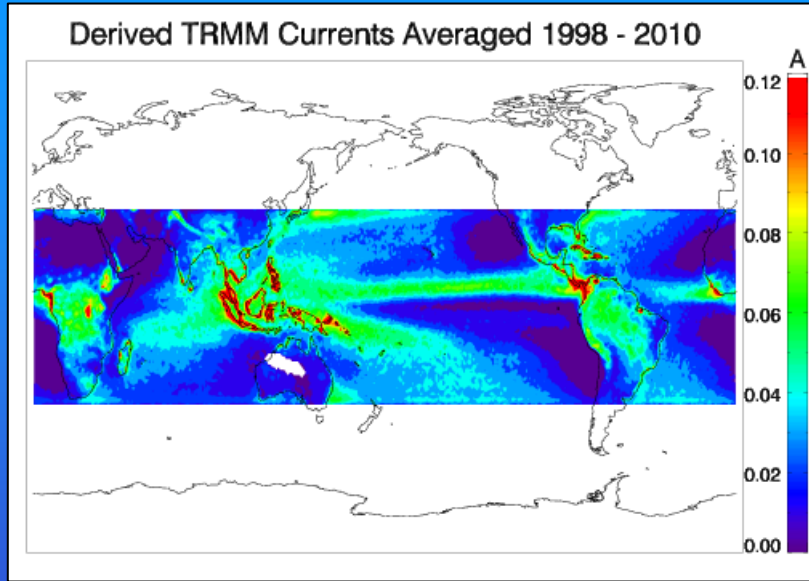


Climatological Fits



- Convective mass flux: land/ocean similar
- Ice water path & convective precipitation: land/ocean differences
- High r^2 values
- Convective precipitation may not represent mid-latitudes
 - Global observations needed

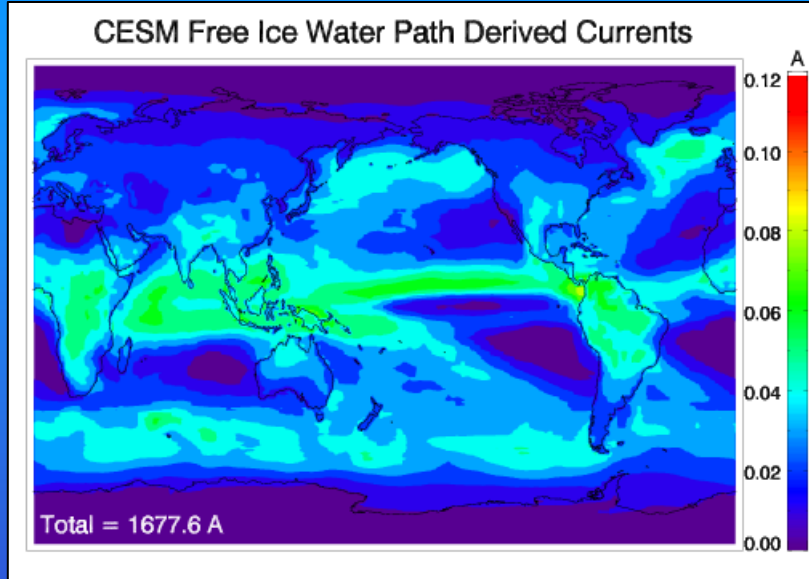
Derived Global Currents



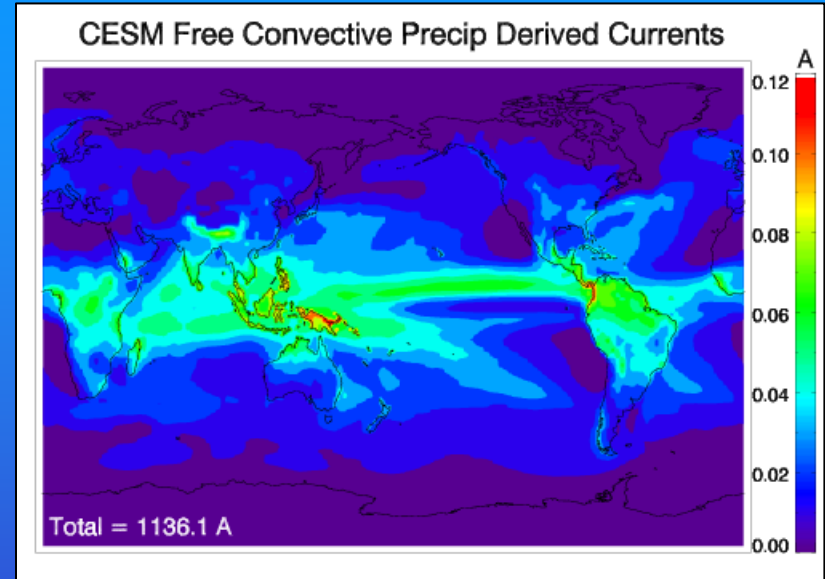
- Global Current Estimates:
 - TRMM derived tropics: 867 A
 - Kraakevik (1961): 1400 A
 - Most estimates: 1000 – 2000 A

- Model derived Currents:
 - Main features captured
 - Underestimates Indonesia, Africa
 - Global total: 1452 A

Derived Global Currents



- Ice Water path derived current:
 - Highest global total: 1678 A
 - Largest current over higher latitudes



- Convective precipitation derived current:
 - Global total: 1136 A
 - Smallest current over higher latitudes

Conclusions

- CESM precipitation captures main features seen in TRMM
 - Convective precipitation too large
 - Some biases in timing and intensity of convection evident
- Power law model current parameterization developed
 - Gives reasonable global current estimate
- Next: combine model variables, parameterization based on global map

Questions?



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