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Identifying Key Climate Change Information for Marine and Coastal Ecological Research

Finding, interpreting, and using the right data

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Outline

- Why is this important?
- Climate Data – (who, what, where and how)
- Case examples

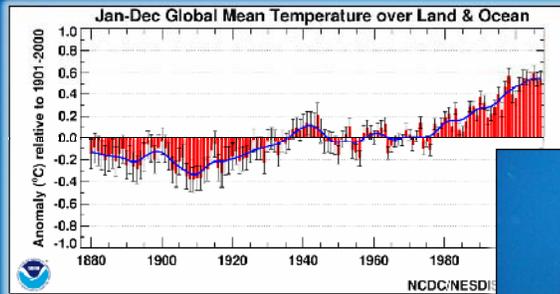


2 of 40

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How are these two things related?



3 of 40

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Climate Change as Threat

- Continued global warming will ...
 - Bleach corals
 - Force geographic shifts in species populations
 - Favor invasive species
 - Contribute to mass mortality episodes



4 of 40

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Declines in ecosystem health

- Stress
- Disease
- Migration
- Death



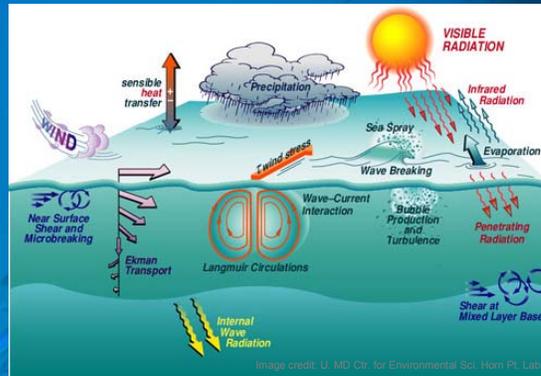
5 of 40

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What factors are involved?

- Thermal stress
- Acidification
- Salinity
- Mechanical stress
- Opacity
 - Sedimentation
 - Biomass
 - turbidity
- Pollutants
 - Pathogens
 - Nutrients
 - Contaminants
- Invasive species



All can be related to
 climate and climate
 change ...



6 of 40

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How might climate affect these factors?

- Temperature
- Precipitation
- Radiation
- Wind
- Cloudiness
- Pressure
- Trace Gases
- Other ?



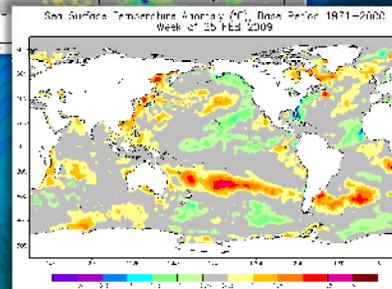
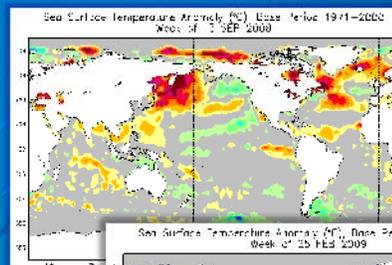
7 of 40

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This is a very geographic problem

- Direct and indirect effects
 - Socio-economic
 - Environmental
- Geographic patterns
 - Locations will not be equally impacted
 - Impacts will not be linear or constant



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It might surprise you (*or not*) to learn that until recently ...

- Climatology was not considered a primary purpose of most weather observations.
- Global climate change was considered only in the context of ice ages.
- Observational techniques varied widely ...



9 of 40

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Climate Data and Information

- Collected By:
 - Land-based stations
 - Buoys (moored, drifting)
 - Fixed marine platforms
 - Ships of opportunity
 - Aircraft and radiosondes
 - Radar
 - Satellite
 - Temporary research platforms

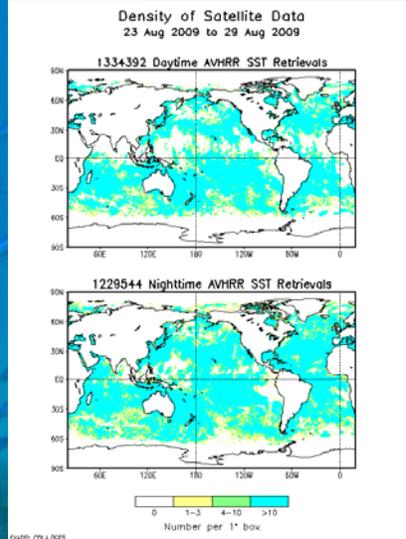
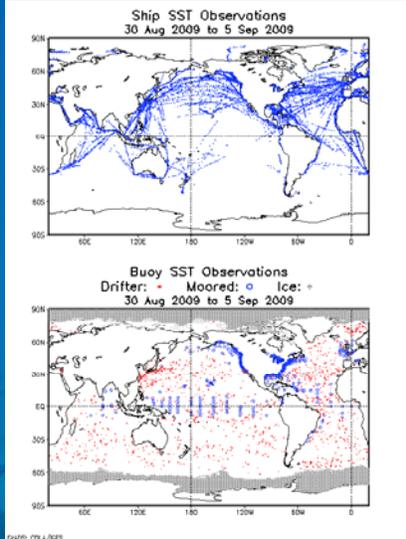


10 of 40

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How much data is out there?



Met stations around the FKNMS

- Hourly data
- Daily data
- Monthly data

- Stations with recent data
- Stations with historical data only
- Stations with no data in last 8 hours (24 hours for tsunami stations)
- Tsunami station in event mode (within previous 24 hours)

1028 stations deployed
671 have reported in the past 8 hours.

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Climate Data and Information

- Available From:
 - National Climatic Data Center
 - National Data Buoy Center
 - National Oceanographic Data Center
 - National Geophysical Data Center
 - NWS HPC
 - AOML / PMEL / Etc.
 - NASA DAACs
 - Universities and Institutes
 - UCAR/NCAR
 - NHMS
 - ... and the list goes on, and on ...
- Formats:
 - Digital
 - HDD
 - Tape
 - CD/DVD
 - Paper
 - Forms
 - Log books
 - Strip charts
 - Photo / Fiche
 - Video



13 of 40

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NOAA's National Climatic Data Center (NCDC)

- Houses much of the world's meteorological data
 - Approximately 99% of all NOAA data
 - NOAA, DoD, FAA, USCG, NHMS
 - NARA designated DoC Agency Records Center
 - One of four World Data Centers for Meteorology
 - US, USSR, China, Japan
- Roughly ...
 - 320 million paper records
 - 2.5 million microfiche records
 - 1.2 Petabytes of digital data
 - Over 1.2 million copies of climate publications annually
 - 500+ digital data sets
 - Nearly 2 million data requests per year



14 of 40

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Climate Data at NCDC

- Remotely Sensed Data
 - Satellites (sfc & u/a)
 - Radar (sfc & u/a)
 - Profilers (u/a)
- In Situ Data
 - Met. Stations (sfc)
 - Buoys (sfc)
 - Radiosondes (u/a)
 - Rocketsondes (u/a)
 - Aircraft
 - Ships
 - Narratives (sfc & u/a)
 - Climate summaries (sfc & u/a)



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Climate Database Modernization Program

- Effort to image and digitize historical analog-media records.
- To date:
 - Almost 53 million images
 - Over seven terabytes of digital information available
- "Forts" Project
 - Digitized records from US Army forts extending back to early 1800s.
- 7,200 negatives of orca, minke, and other marine mammals
 - and approximately 15,000 pages of related notes
- European ship log rescue
 - Approx. 250,000 observations 1938-1947
 - Over 31 million keyed records to be added to ICOADS
 - East India Company logbooks in progress



16 of 40

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Climate Data and Information



While in situ data accounts for only a small fraction of available climate data, it represents sizable proportion of the world's historical climate record.

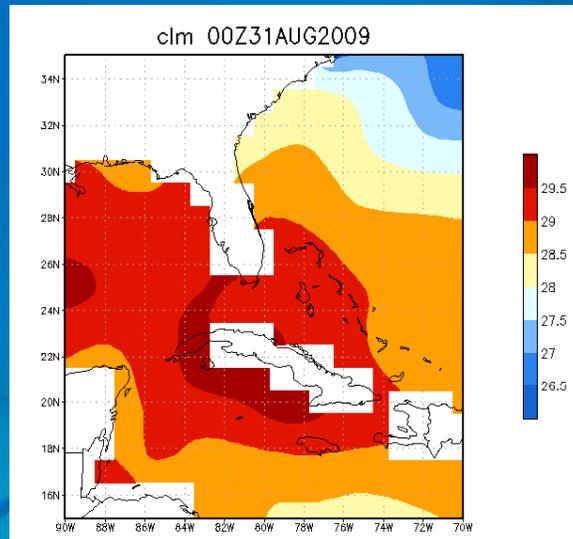


19 of 40

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Land Masks

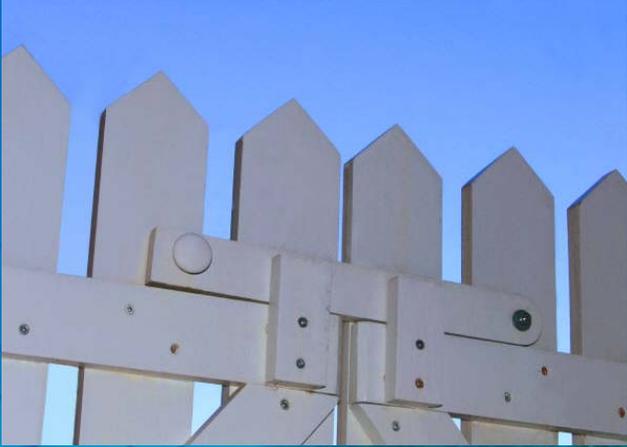


20 of 40

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Climate Products



Research

Application

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21 of 40

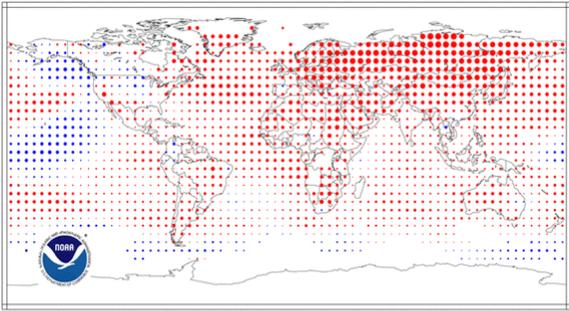


Climate summaries

(buying off the rack?)

Temperature Anomalies Jan-Dec 2008

(with respect to a 1961-1990 base period)
National Climatic Data Center/NESDIS/NOAA



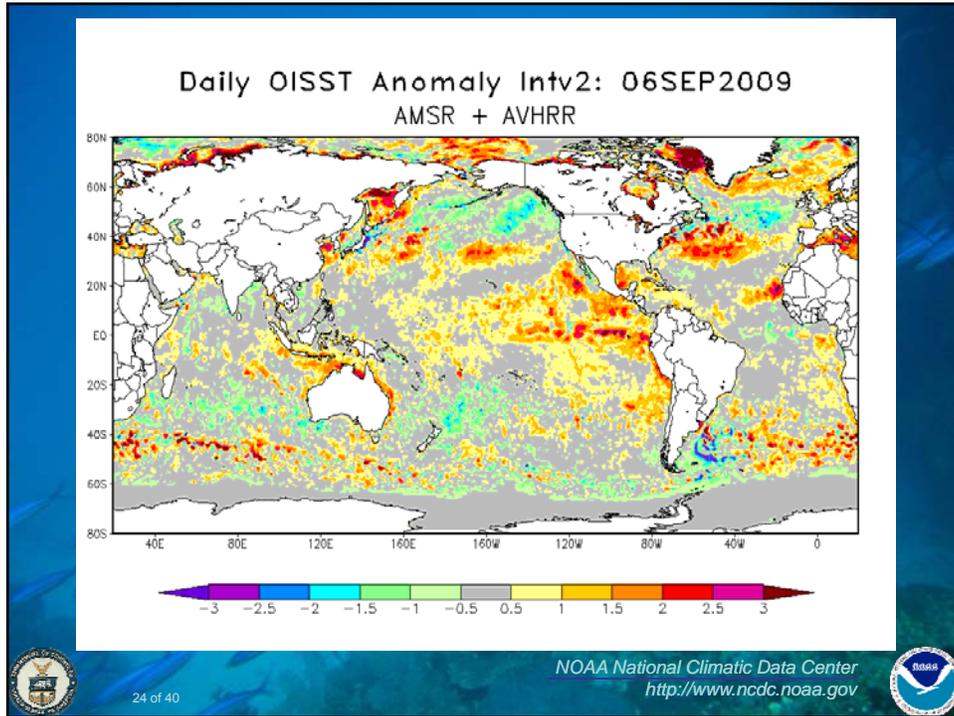
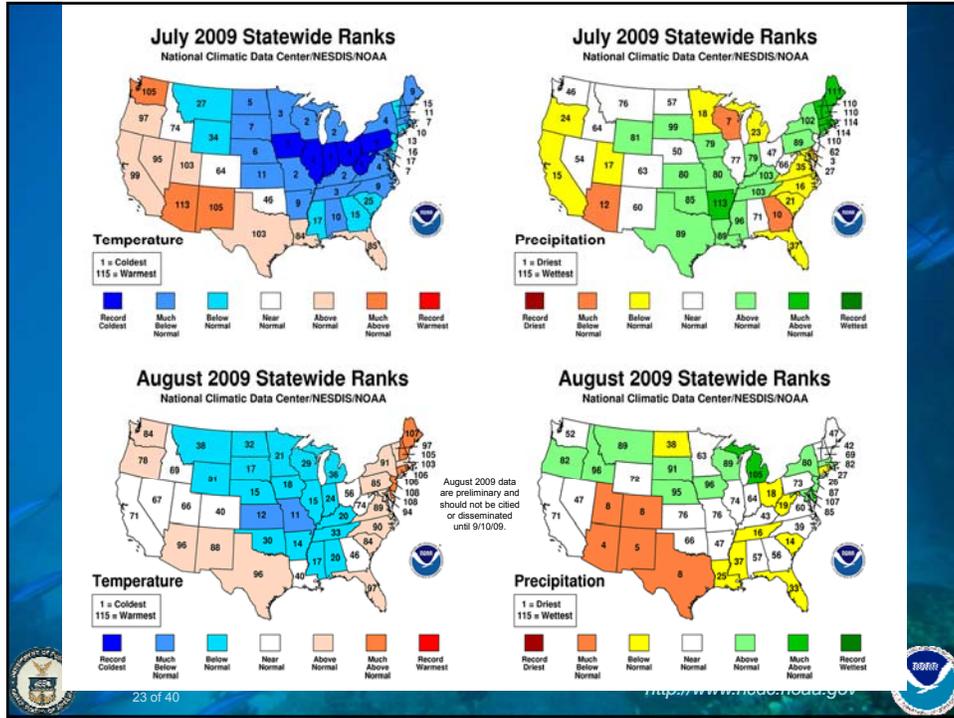
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-5C -4C -3C -2C -1C 0C 1C 2C 3C 4C 5C
Degrees Celsius

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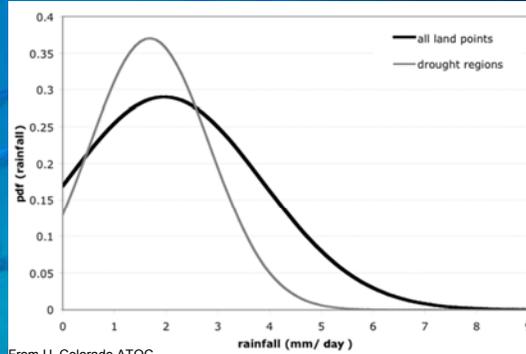
22 of 40





Making sense of climate data

- Like land masks hiding important information, spatial and temporal averages mask more subtle information.
- Important climate change information does not necessarily lie in the middle of the distribution.
- Distributions themselves do not always lend themselves to averages.
- Climate is a study in probability.



From U. Colorado ATOC



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A crude case study

Work in Progress

Coral Bay, St. John, US Virgin Islands



26 of 40

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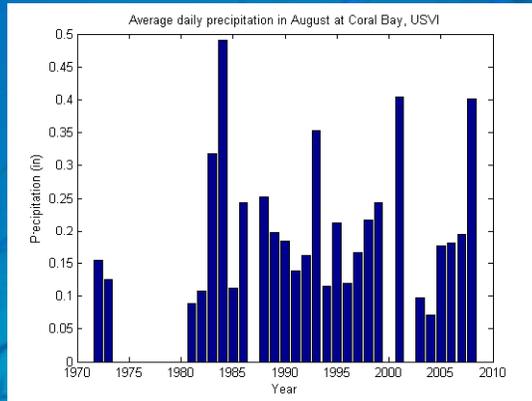
Precipitation

- Rainfall is a significant, but oft ignored issue in terms of marine ecosystem analysis.
- Too little leads to drought and water diversion
 - Increased stagnation
 - Increased salinity
 - Lower water levels
- Too much contributes to other problems
 - Runoff pollution and sediments
 - Lowered salinity



A temporal look at precipitation

- Rainstorm during coral spawning can lower ocean salinity and impact reproduction for the year.
 - November, 1981 – Magnetic Island, QLD AUS

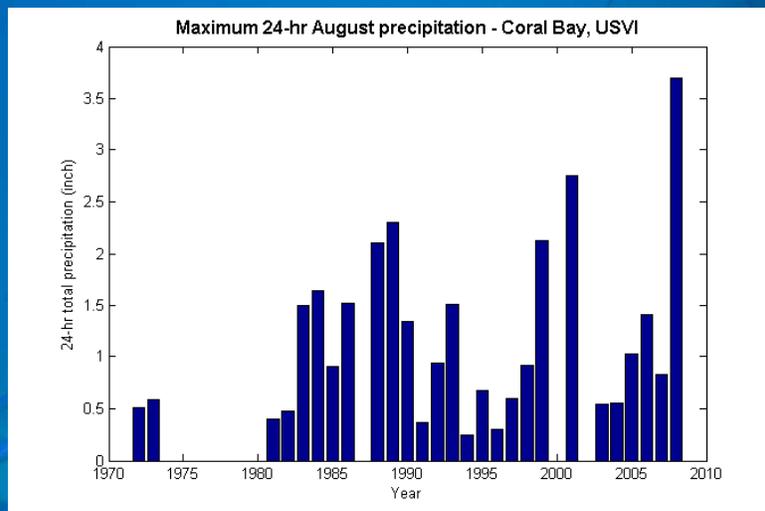


29 of 40

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Looking at maxima

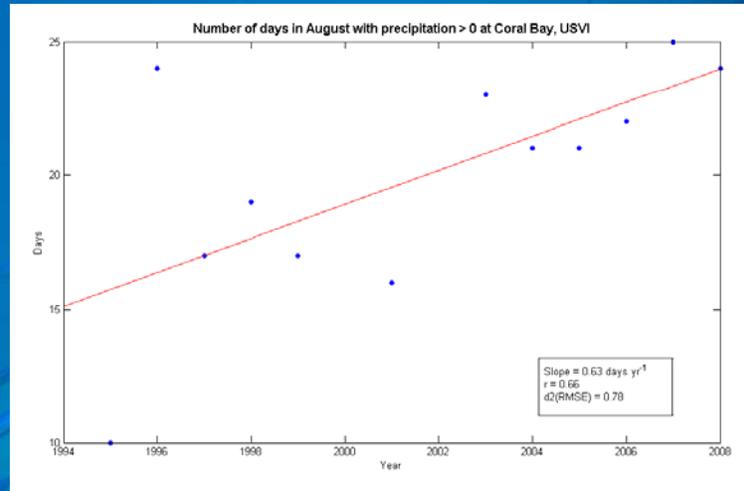


30 of 40

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Precipitation Frequency



31 of 40

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A probabilistic view

- Long-term (1988-2008) probability of Coral Bay, USVI having a 1-day rainfall total exceeding 0.5 inch on a day in August is 0.098 (9.8%). In 2008, the probability was 0.256 (25.6%)
- Although the conditional probability of a > 0.5-in rainfall occurring on the day of spawning is far lower, it is not zero and it has increased since 2001.



32 of 40

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Another Concern ...

Tropical Cyclones



- Can have significant impact on near-shore marine ecosystems.
- Systematic changes in path, intensity and timing are important to identify and understand.
- Are certain areas seeing increased or decreased vulnerability to storm strikes?
- Will earlier or later storms have greater impact on unsuspecting ecosystems?

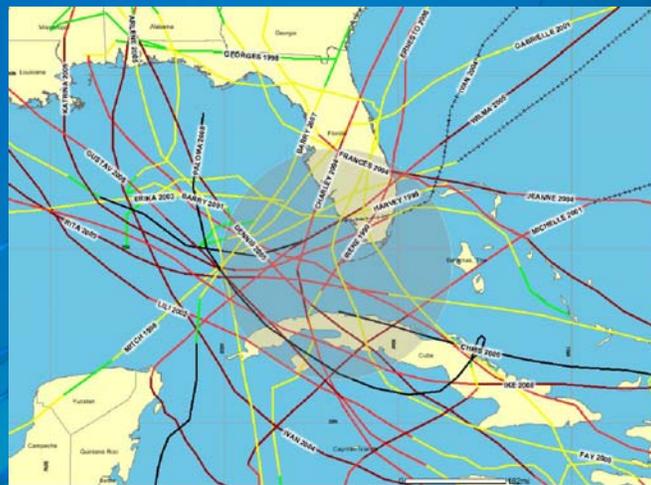


33 of 40

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Hurricane Tracks near the FKNMS (1998-2008)



Thanks to J. Schittone (ONMS) for the graphic.

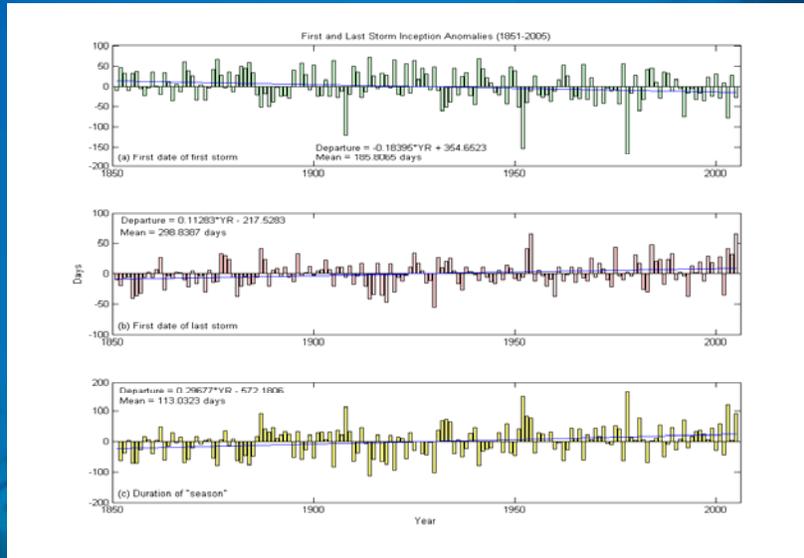


34 of 40

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Atlantic/Caribbean TC Season

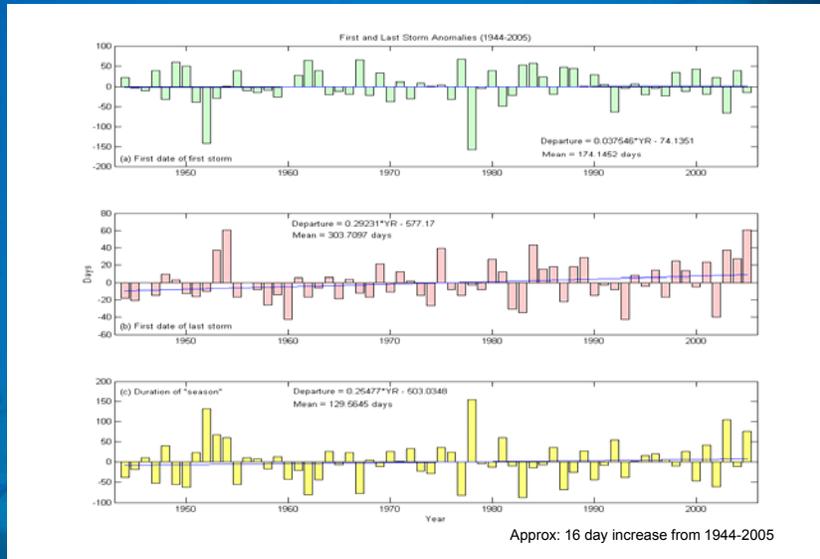


35 of 40

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Atlantic/Caribbean TC Season



Approx: 16 day increase from 1944-2005

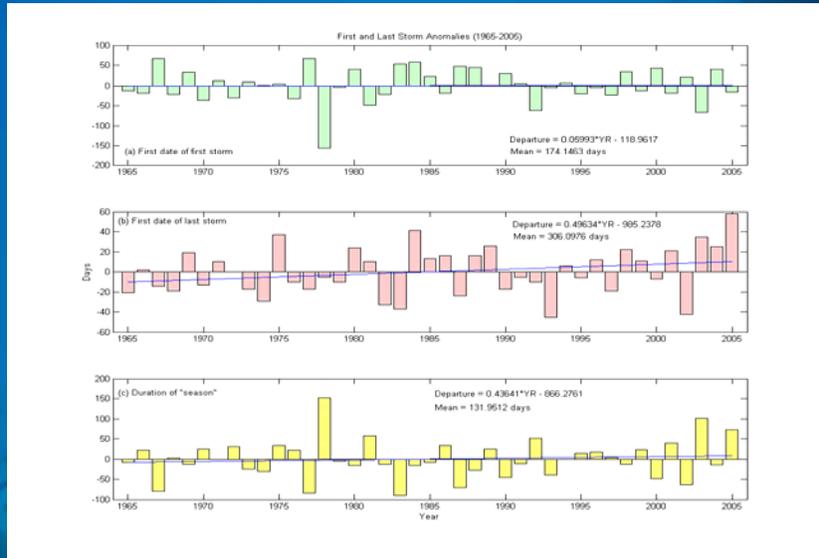


36 of 40

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Atlantic/Caribbean TC Season



37 of 40

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Collaborative Activity Integrated Marine Protected Area Climate Tool (IMPACT)

- Work between NCDC, ONMS, NODC, NCCOS, CRCP and others to develop climatologies of the sanctuaries.
 - Climate reference baseline
 - Normals, extremes, ranges, probabilities, etc.
 - Context of NMS biological resources
 - Better address climate and climate change impacts
 - Determine spatial and temporal variability of favorable and unfavorable climatic conditions.
 - Climate tool for MPA managers



38 of 40

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Last thoughts

- Nuances of data are complex in any discipline.
- Maritime climate observations need beefing up.
- Need to translate established physical linkages between ecology, biology, and climate.
- Think beyond global air and sea surface temperatures.
- Many impacts are due to second or third order interactions.
- Increase communication between atmospheric and marine scientists.



39 of 40

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Thank You!

Questions?

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