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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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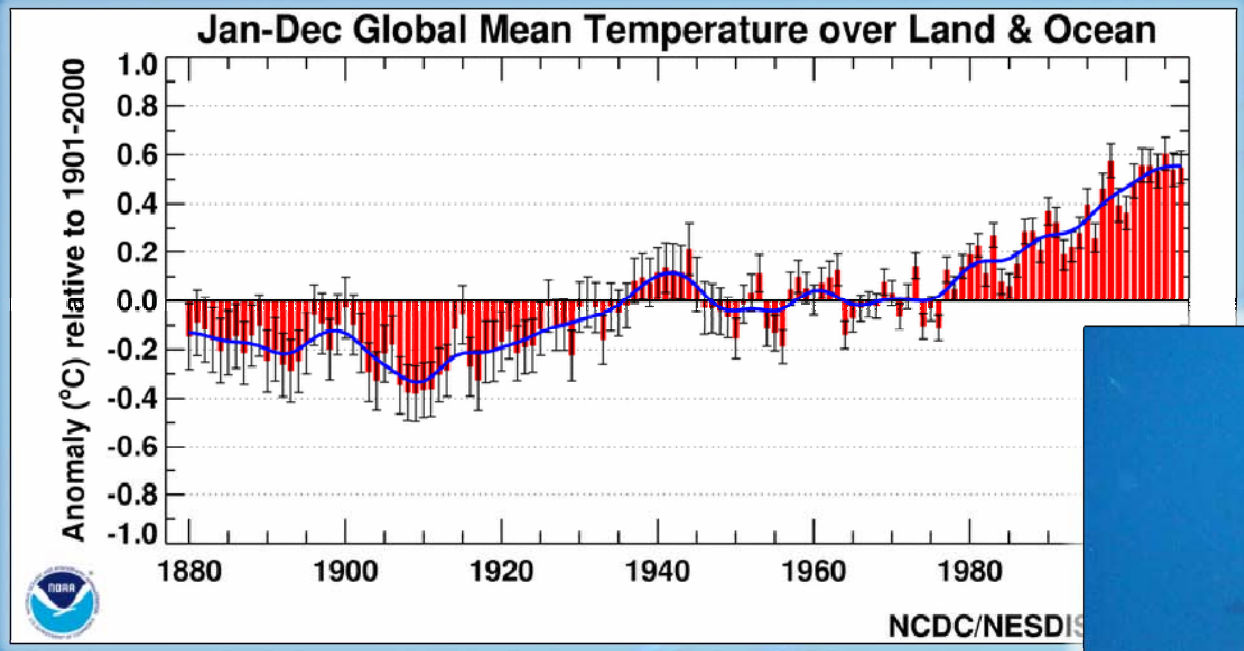
NOAA National Climatic Data Center
http://www.ncdc.noaa.gov

Outline

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

How are these two things related?



Climate Change as Threat

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

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Declines in ecosystem health

- Stress
- Disease
- Migration
- Death

What factors are involved?

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

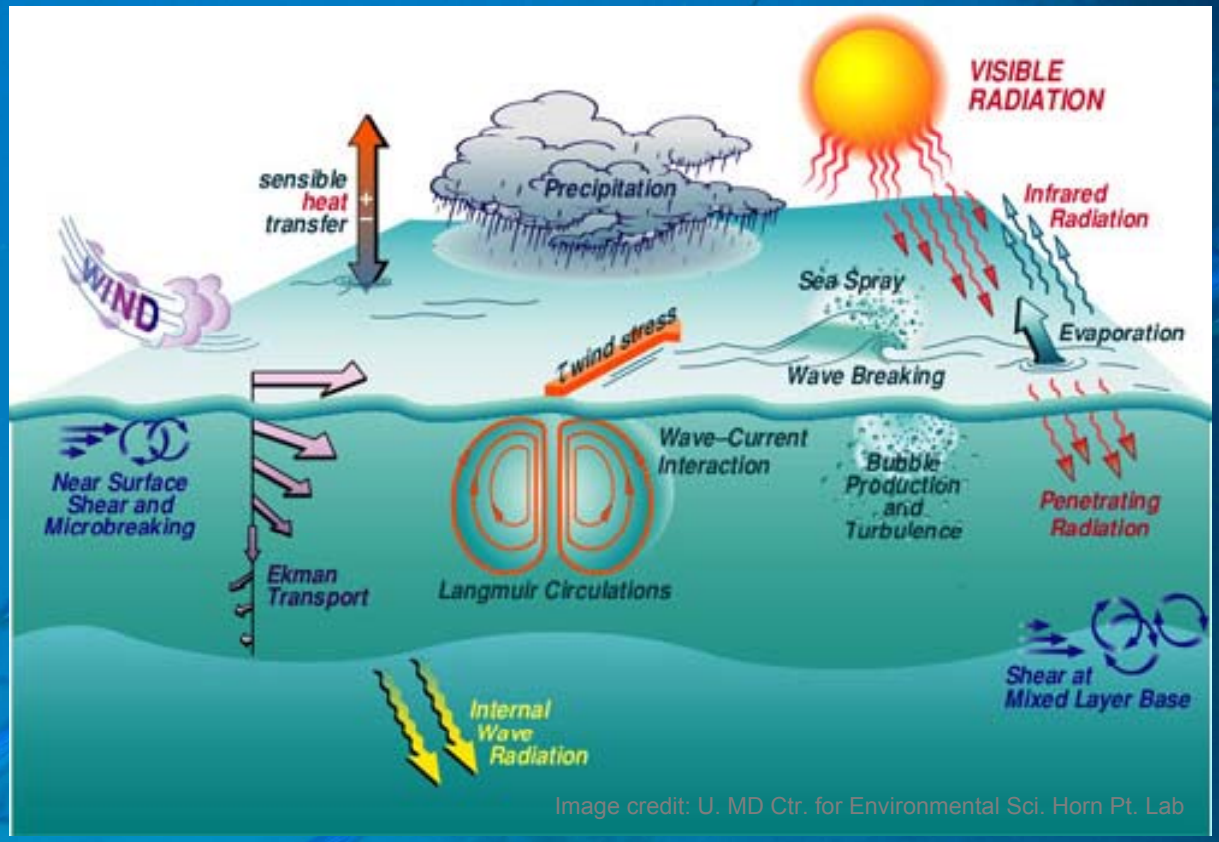

Image credit: U. MD Ctr. for Environmental Sci. Horn Pt. Lab

All can be related to climate and climate change …

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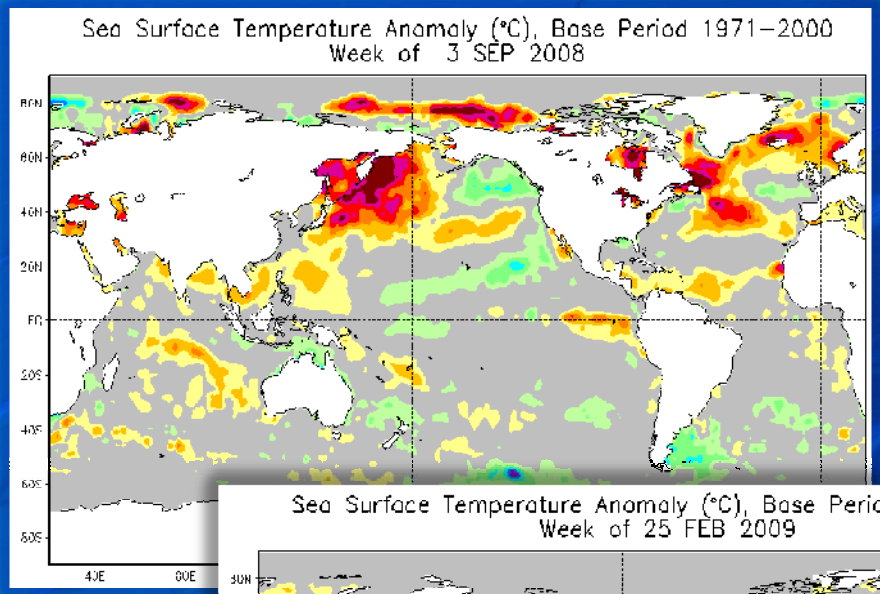
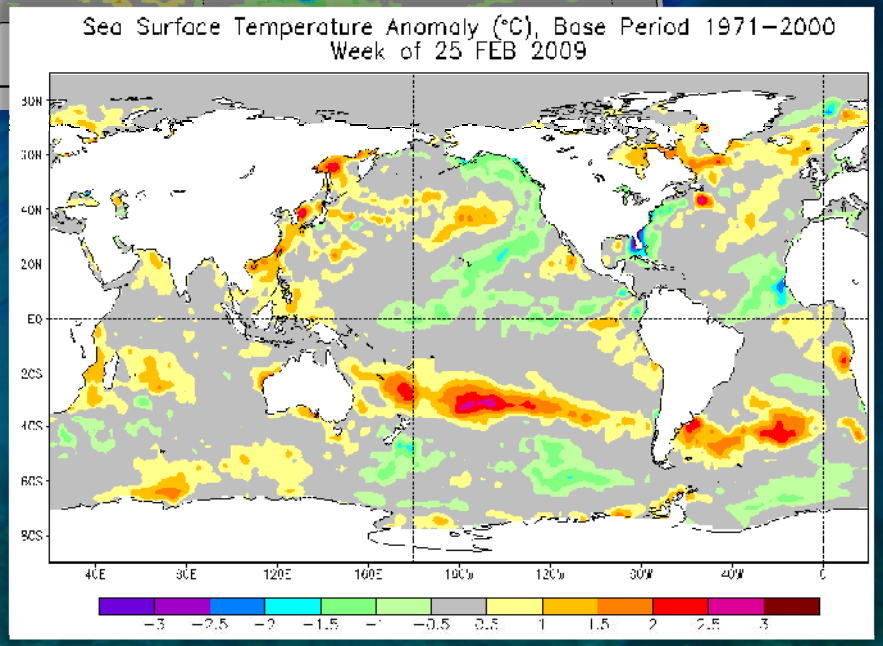
How might climate affect these factors?

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

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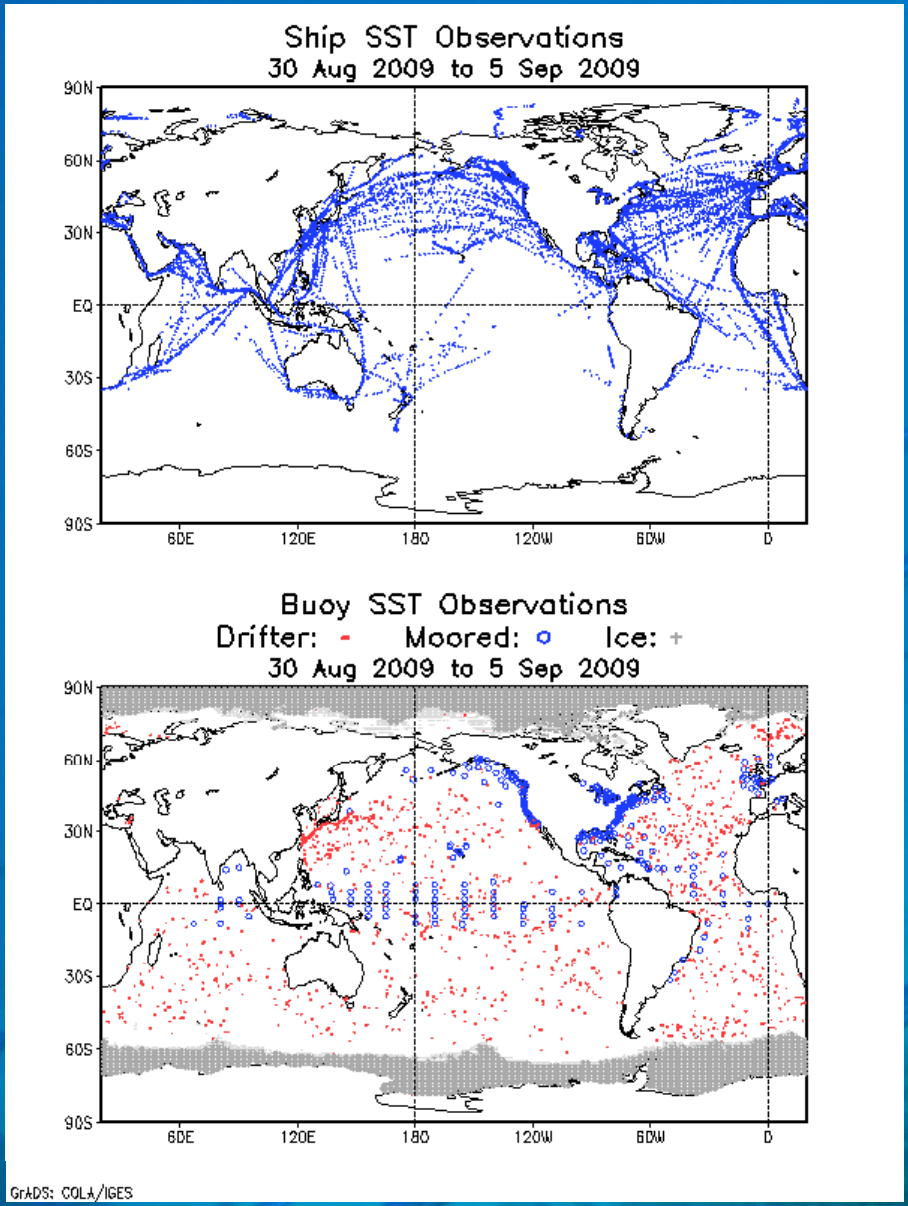
It might surprise you (*or not*) to learn that until recently …

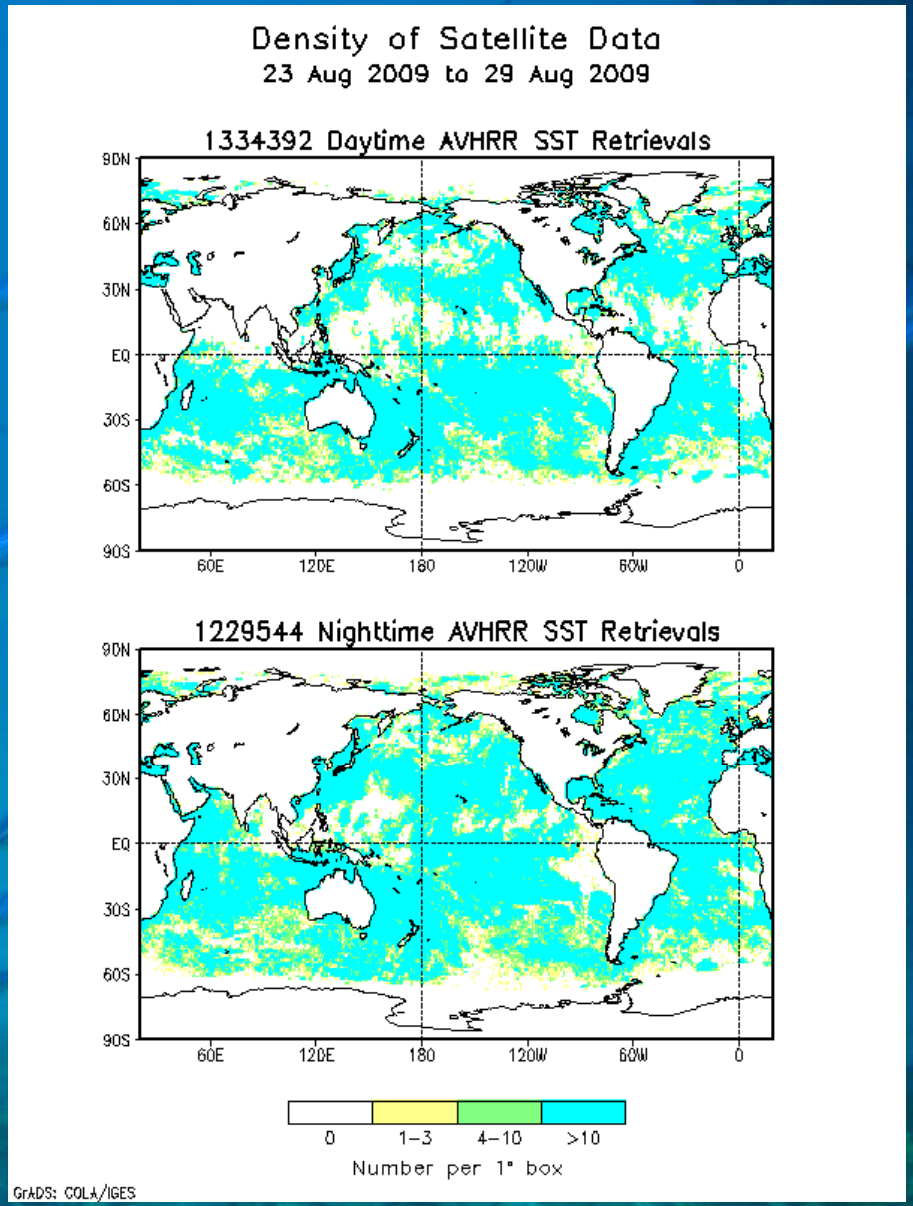
- Climatology was not considered a primary purpose of most weather observations.
- Global climate change was considered only in the context of ice ages.
- Observational techniques varied widely …

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

How much data is out there?





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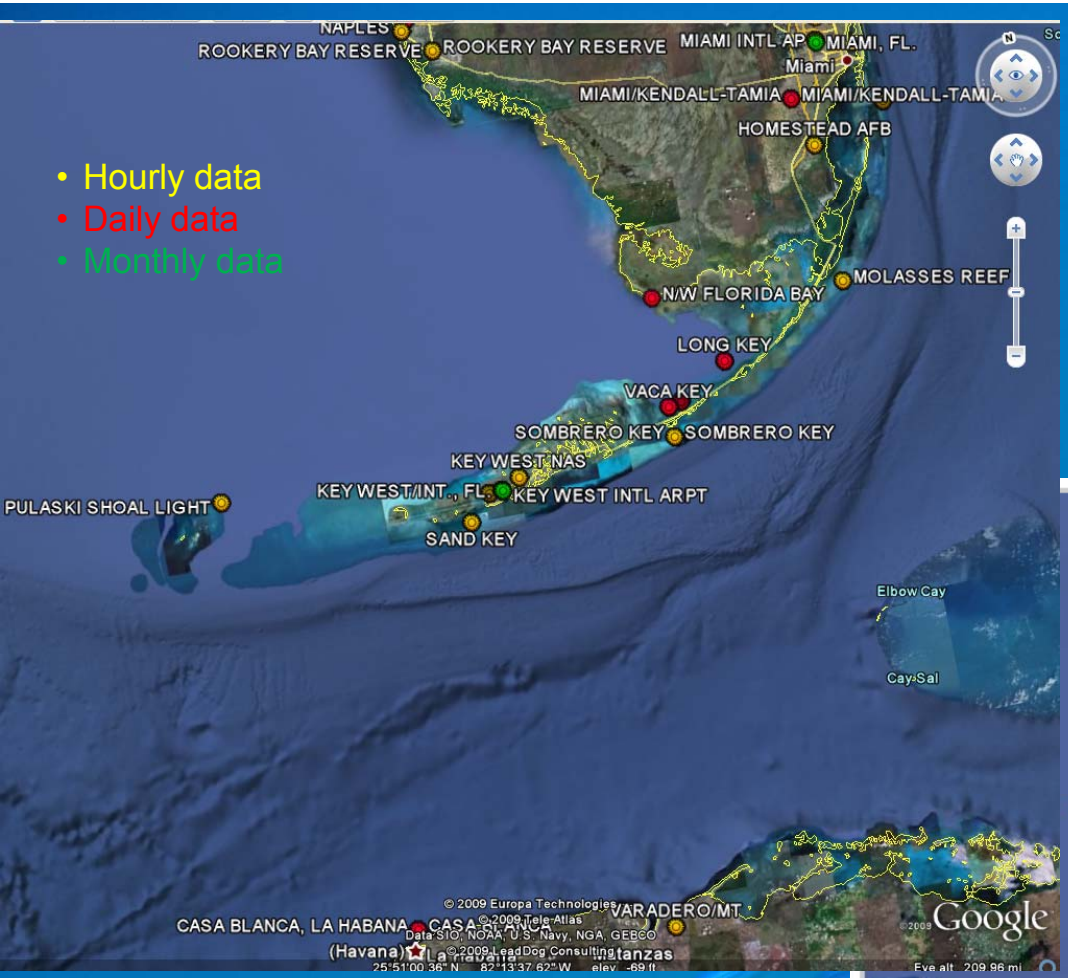
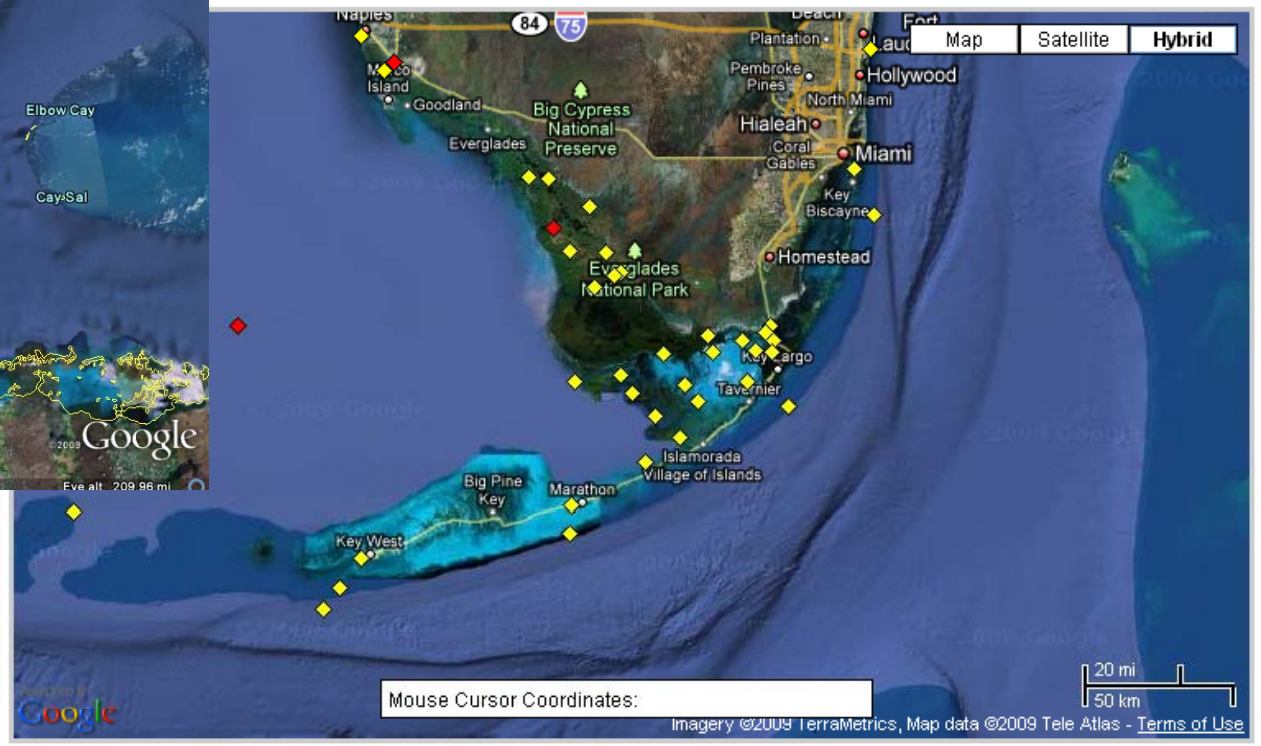
Met stations around the FKNMS

- 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
871 have reported in the past 8 hours

Disclaimer

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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

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

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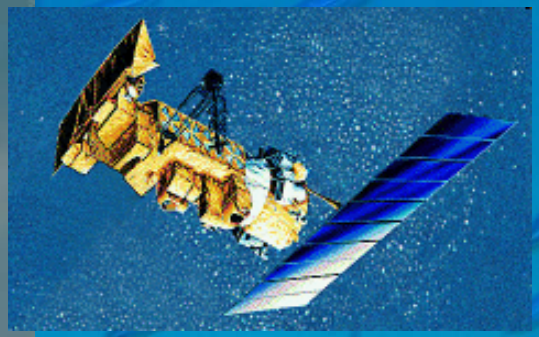
Climate Data at NCDC

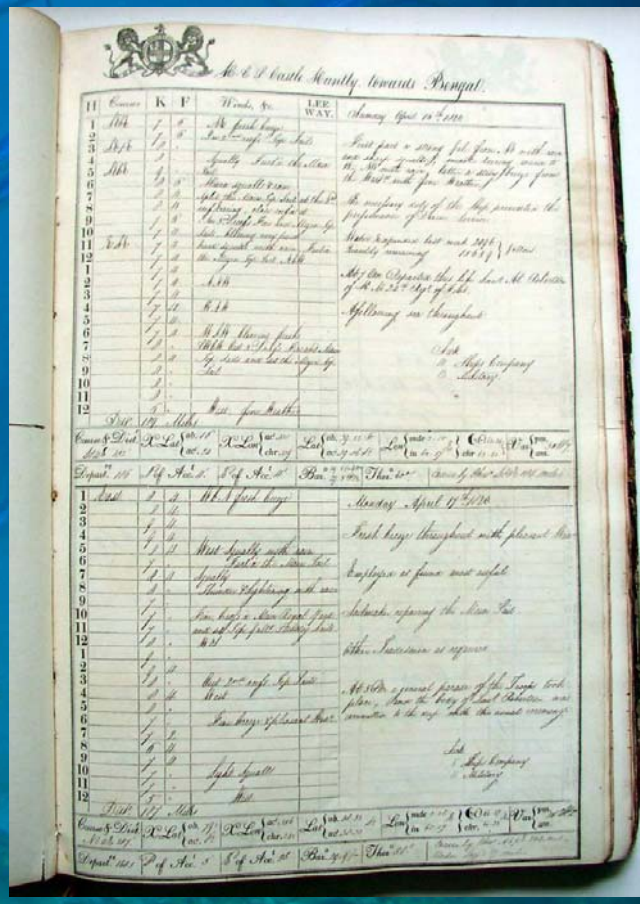
- Remotely Sensed Data
  - Satellites (sfc & u/a)
  - Radar (sfc & u/a)
  - Profilers (u/a)



- 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)

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



Once you have the data, what then?

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      UPPER AIR CALCULATIONS AND PLOTTING (Ver 5.50-LINUX-X11)

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WMO ident:  72201
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Elevation:   6.00
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LEV	PRES mb	HGHT m	TEMP C	DEWP C	RH %	DD C	WETB C	DIR deg	SPD knt	THETA K	THE-V K	THE-W K	THE-E K	W g/kg
SFC	1012	6	28.0	23.0	74	5.0	24.3	175	3	300.1	303.4	297.1	352.1	17.74
1	1000	123	27.2	22.9	77	4.3	24.0	185	4	300.4	303.6	297.2	352.7	17.85
2	953	549	24.0	22.8	93	1.2	23.2	221	4	301.3	304.7	298.0	356.2	18.64
3	925	810	22.2	18.8	81	3.4	19.8	250	4	302.0	304.8	295.7	346.0	14.93
4	878	1262	18.8	18.2	96	0.6	18.4	270	7	303.0	305.8	296.2	347.9	15.15
5	850	1541	17.6	15.1	85	2.5	15.9	270	8	304.6	307.0	295.0	342.8	12.80
6	757	2525	12.6	6.6	67	6.0	9.0	263	6	309.4	311.0	292.9	334.3	8.10
7	700	3179	8.8	2.8	66	6.0	5.4	240	6	312.2	313.5	292.6	333.1	6.70
8	657	3701	5.6	-1.4	61	7.0	2.0	274	4	314.3	315.3	292.0	331.0	5.26
9	647	3827	4.8	0.9	76	3.9	2.7	292	4	314.8	316.0	293.0	334.7	6.33
10	636	3967	4.6	-5.4	48	10.0	-0.2	311	4	316.1	316.9	291.5	329.1	4.02
11	628	4070	3.8	0.6	80	3.2	2.1	325	4	316.4	317.6	293.4	336.6	6.38
12	619	4187	3.0	0.4	83	2.6	1.6	341	4	316.8	318.0	293.6	337.0	6.38
13	559	5008	-1.3	-11.3	46	10.0	-5.5	349	4	321.0	321.6	291.9	330.6	2.88
14	530	5431	-3.3	-13.3	46	10.0	-7.3	328	5	323.6	324.1	292.3	332.3	2.59
15	513	5689	-5.3	-11.3	63	6.0	-7.8	315	5	324.2	324.8	293.0	334.7	3.14
16	509	5750	-5.7	-14.7	49	9.0	-9.2	312	5	324.4	324.9	292.4	332.6	2.40
17	500	5890	-6.7	-13.7	57	7.0	-9.4	305	5	324.9	325.4	292.7	333.8	2.65
18	497	5937	-7.1	-11.2	72	4.1	-8.8	306	5	324.9	325.6	293.3	335.9	3.27
19	483	6159	-8.3	-23.3	29	15.0	-12.8	310	5	326.1	326.4	291.8	330.4	1.21
20	472	6338	-9.3	-18.3	48	9.0	-12.4	310	5	327.0	327.4	292.7	333.7	1.92
21	466	6436	-10.1	-11.9	87	1.8	-10.8	310	5	327.3	327.9	293.9	338.4	3.30
22	454	6637	-10.7	-12.2	89	1.5	-11.3	310	5	328.9	329.6	294.4	340.2	3.31
23	418	7268	-14.9	-18.1	77	3.2	-16.0	310	5	331.4	331.9	294.1	339.1	2.20
24	407	7469	-15.5	-23.5	50	8.0	-17.8	310	5	333.2	333.5	293.9	338.3	1.41
25	400	7600	-16.1	-24.1	50	8.0	-18.4	310	5	334.1	334.3	294.1	339.0	1.36
26	389	7809	-17.5	-22.5	65	5.0	-19.0	299	5	334.9	335.2	294.5	340.7	1.62
27	381	7964	-18.3	-27.3	45	9.0	-20.5	289	5	335.8	336.1	294.3	339.8	1.07
28	359	8405	-21.9	-26.1	69	4.2	-22.9	262	4	336.8	337.0	294.7	341.4	1.27
29	356	8466	-22.1	-32.1	40	10.0	-24.1	258	4	337.3	337.5	294.3	340.1	0.73
30	351	8570	-22.9	-34.9	33	12.0	-25.1	252	4	337.6	337.7	294.3	339.7	0.56
31	324	9151	-27.1	-41.1	25	14.0	-29.0	215	3	339.6	339.7	294.6	340.9	0.32
32	300	9700	-31.7	-44.7	27	13.0	-33.1	220	3	340.7	340.7	294.7	341.7	0.24
33	250	10960	-42.7	-51.7	37	9.0	-43.2	210	6	342.6	342.6	295.1	343.1	0.13

Done Now: Mostly Cloudy and 72°F Today: 73°F

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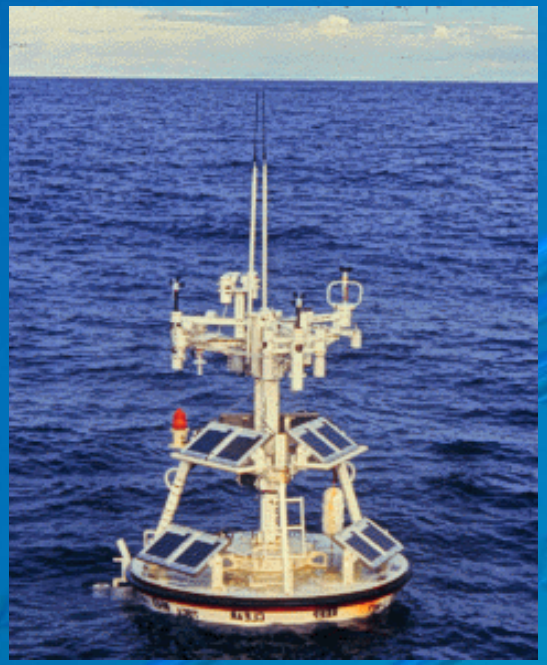
Not all data is created equally



How has SST been observed through time

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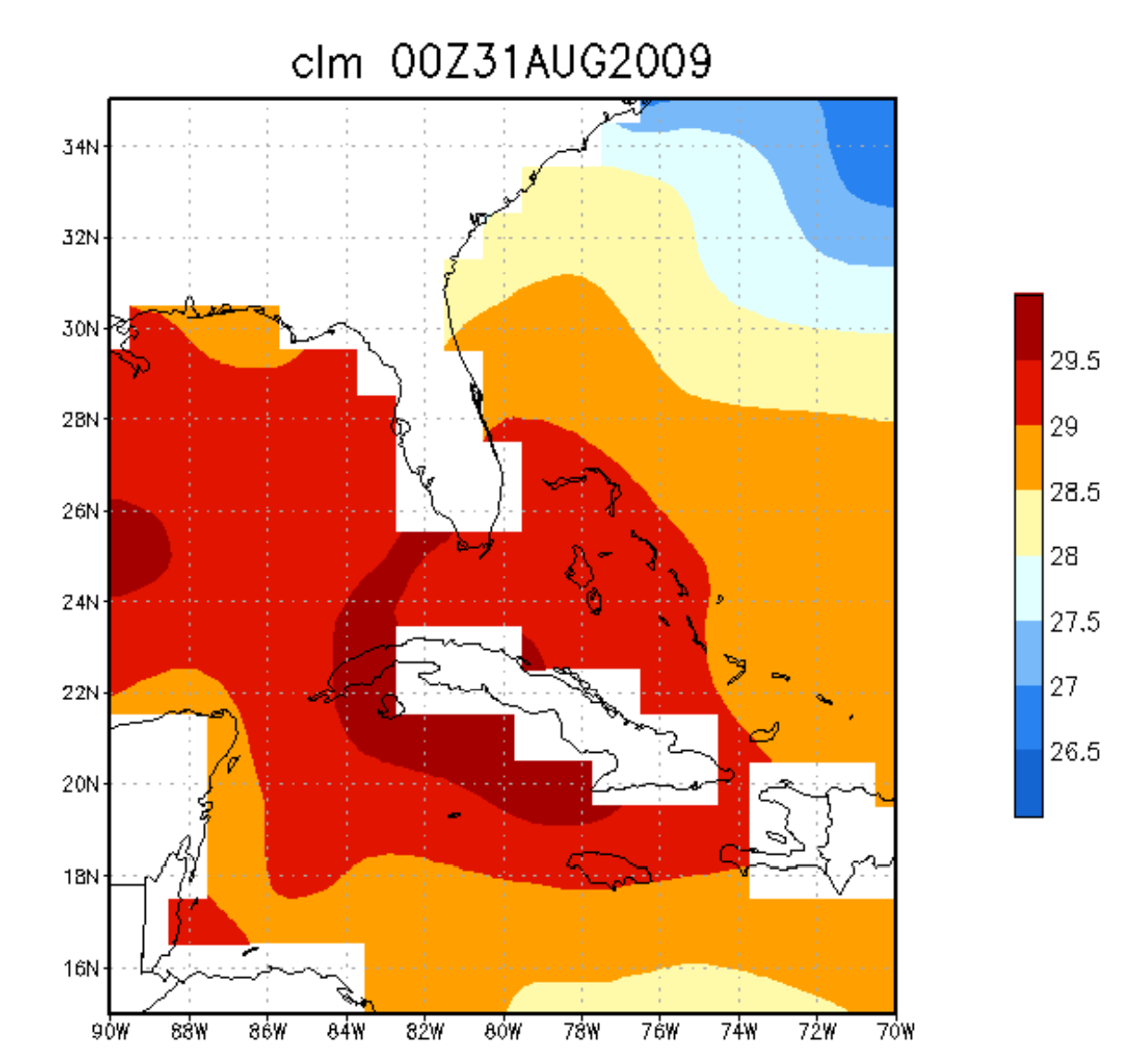
Climate Data and Information

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.

Land Masks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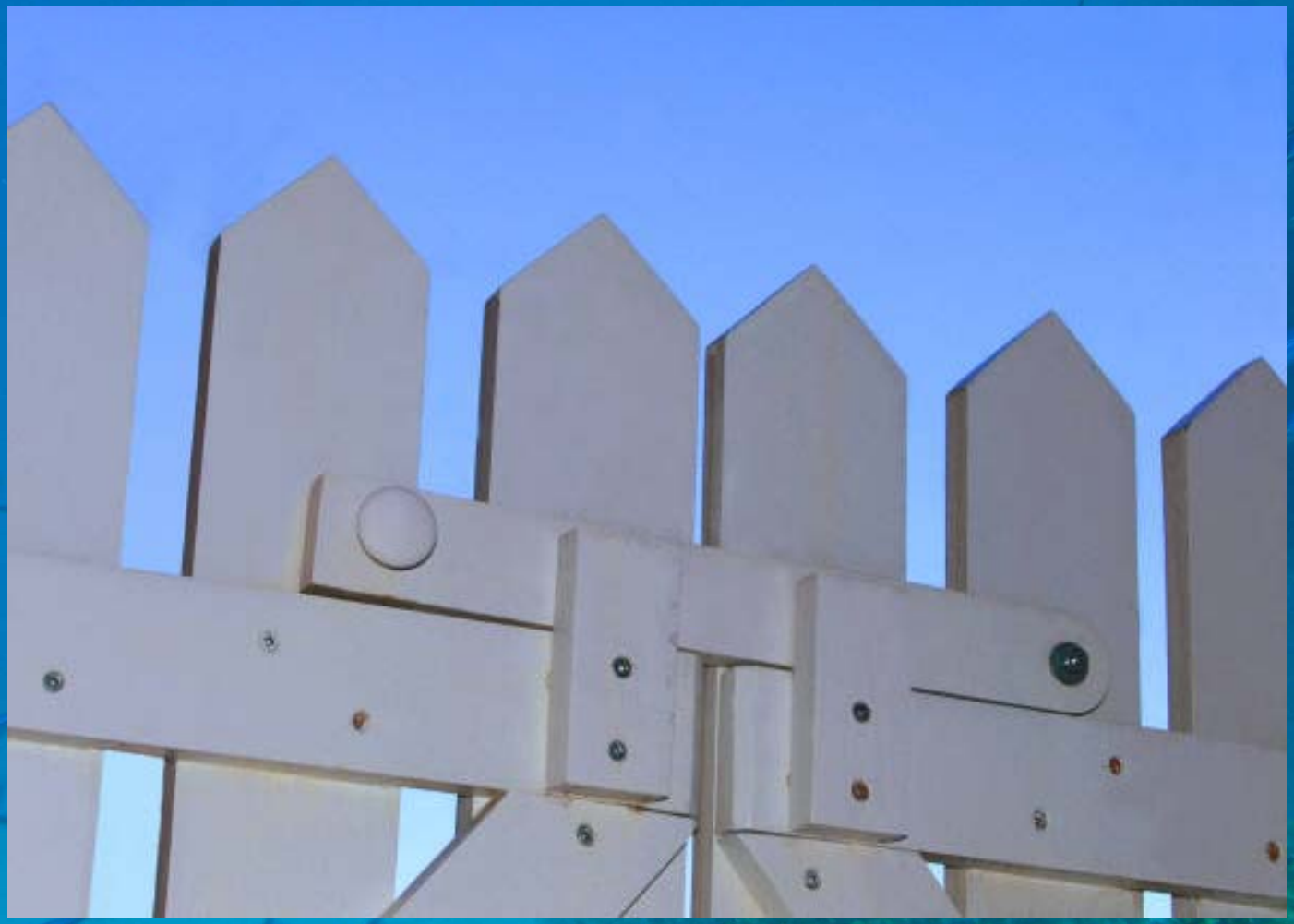
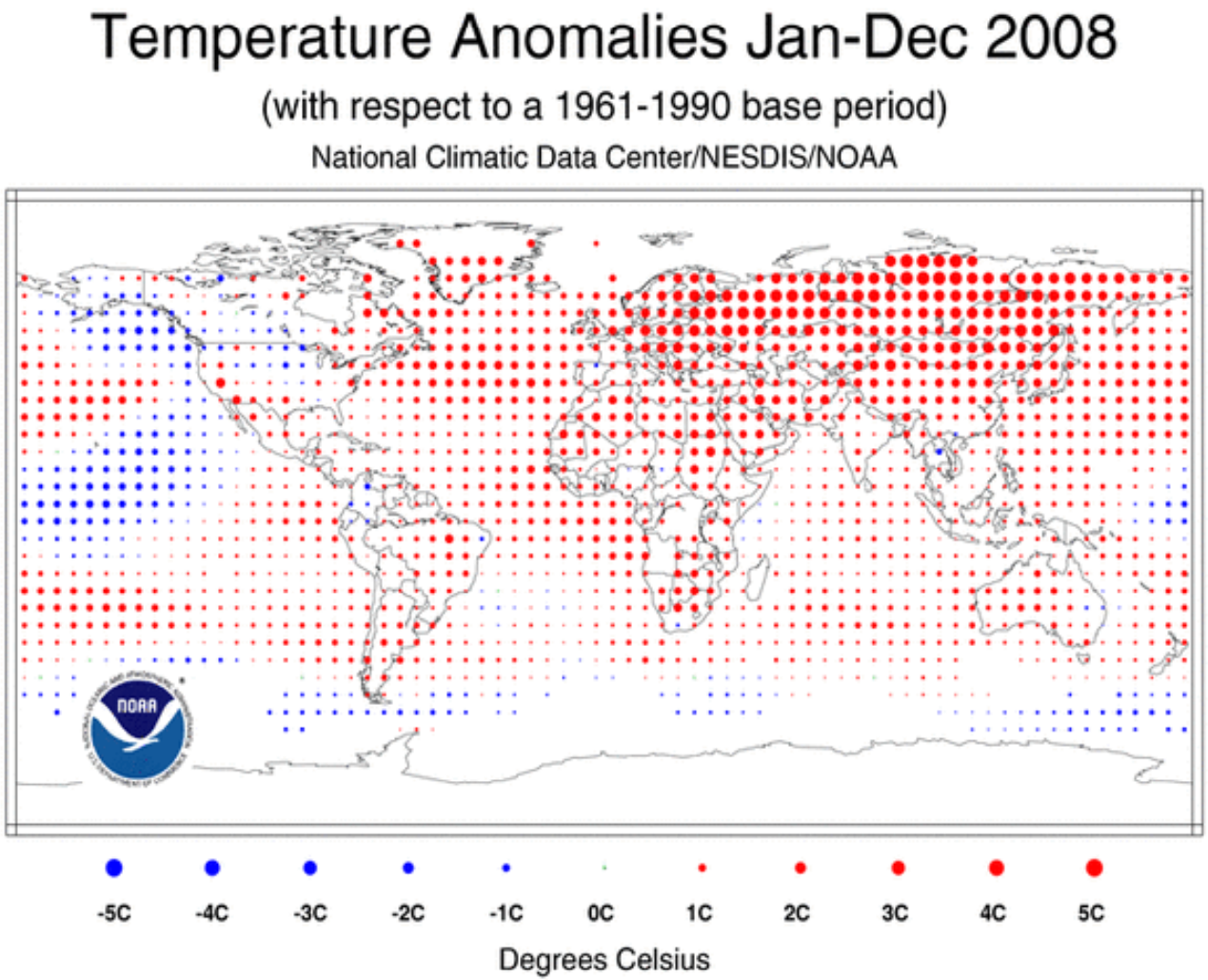
Climate Products

Research



Application

Climate summaries
(buying off the rack?)



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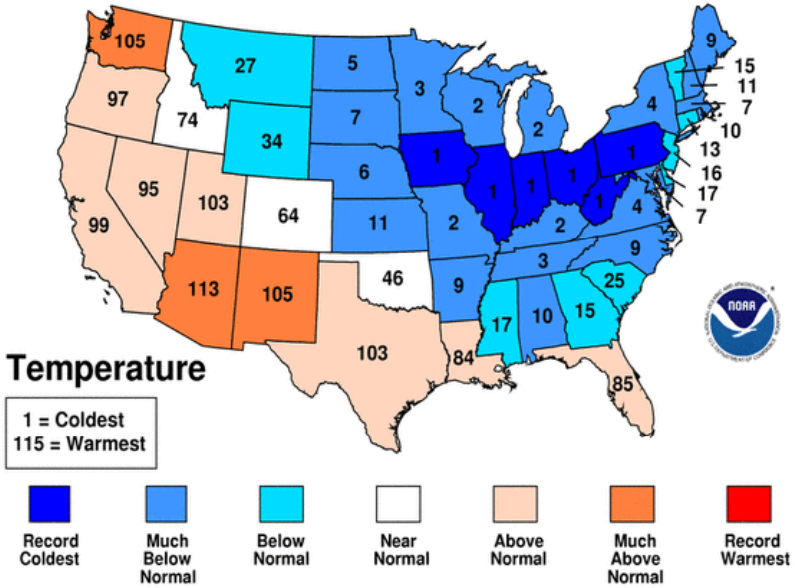
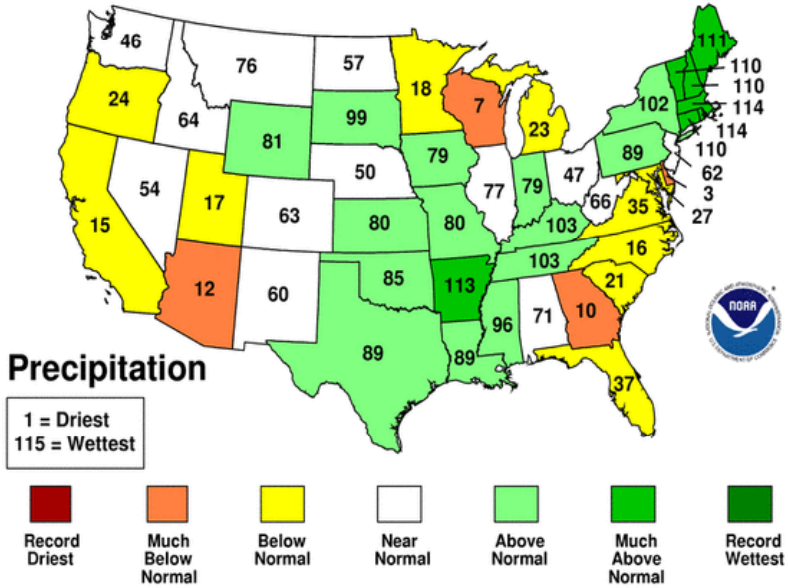
July 2009 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



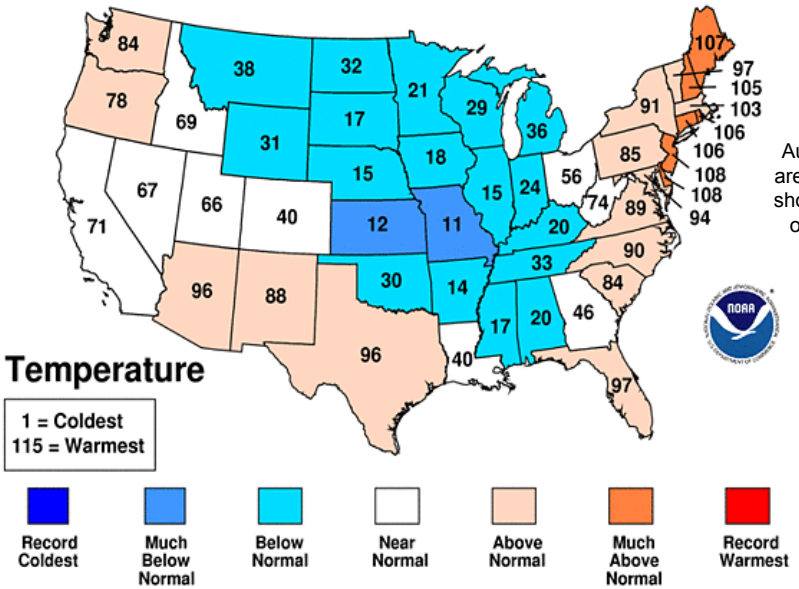
July 2009 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



August 2009 Statewide Ranks

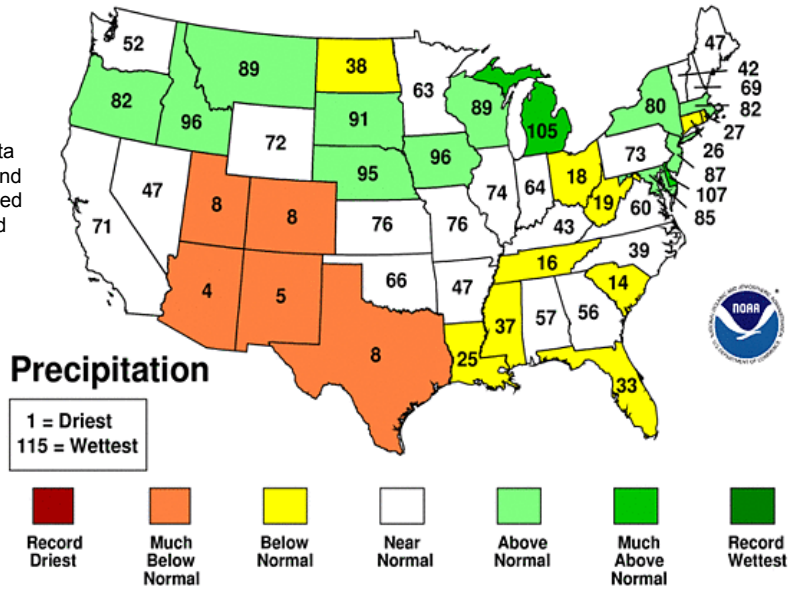
National Climatic Data Center/NESDIS/NOAA



August 2009 data are preliminary and should not be citied or disseminated until 9/10/09.

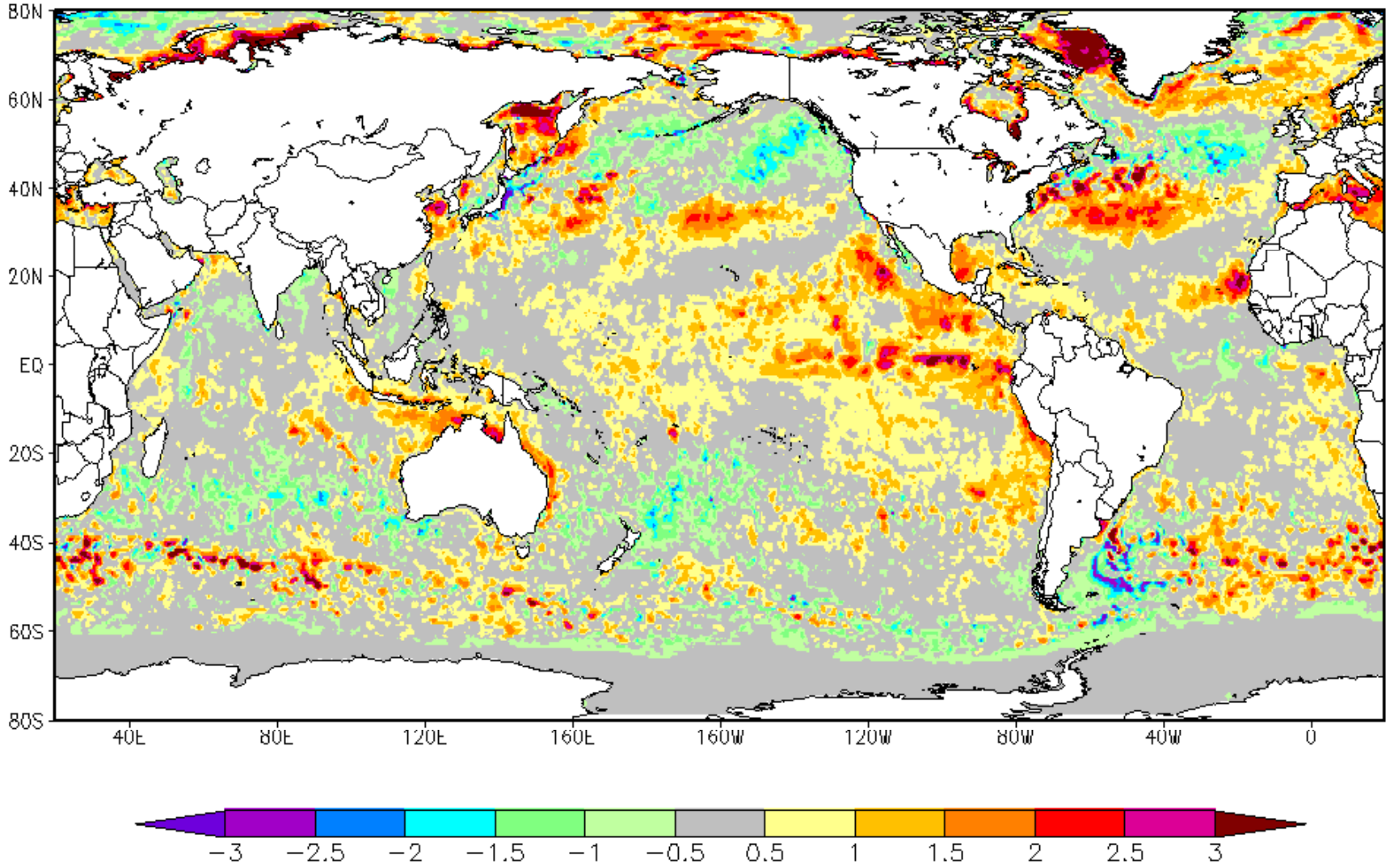
August 2009 Statewide Ranks

National Climatic Data Center/NESDIS/NOAA



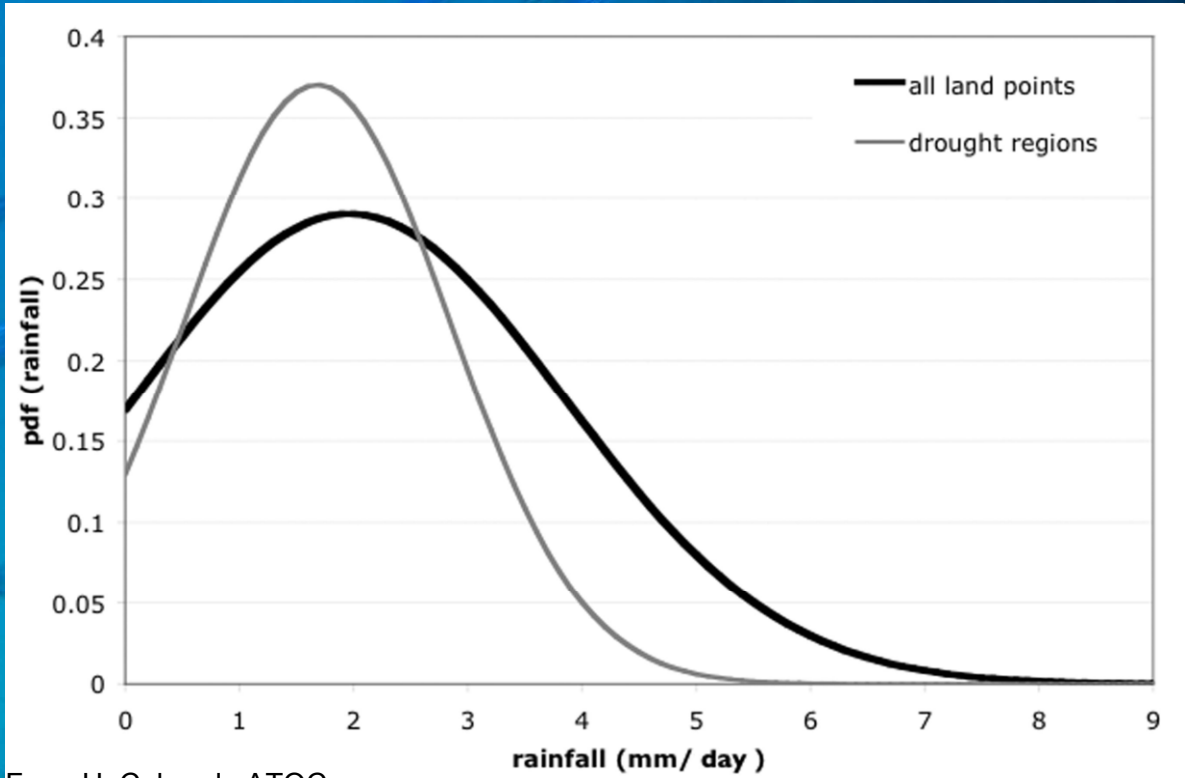
Daily OISST Anomaly Intv2: 06SEP2009

AMSR + AVHRR



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

A crude case study

Work in Progress

Coral Bay, St. John, US Virgin Islands

Anegada
Prickly Pear Island
Little Jost Van Dyke
Great Thatch
Saint Thomas
San Juan
Isla de Culebra
Puerto Rico
Saint Croix

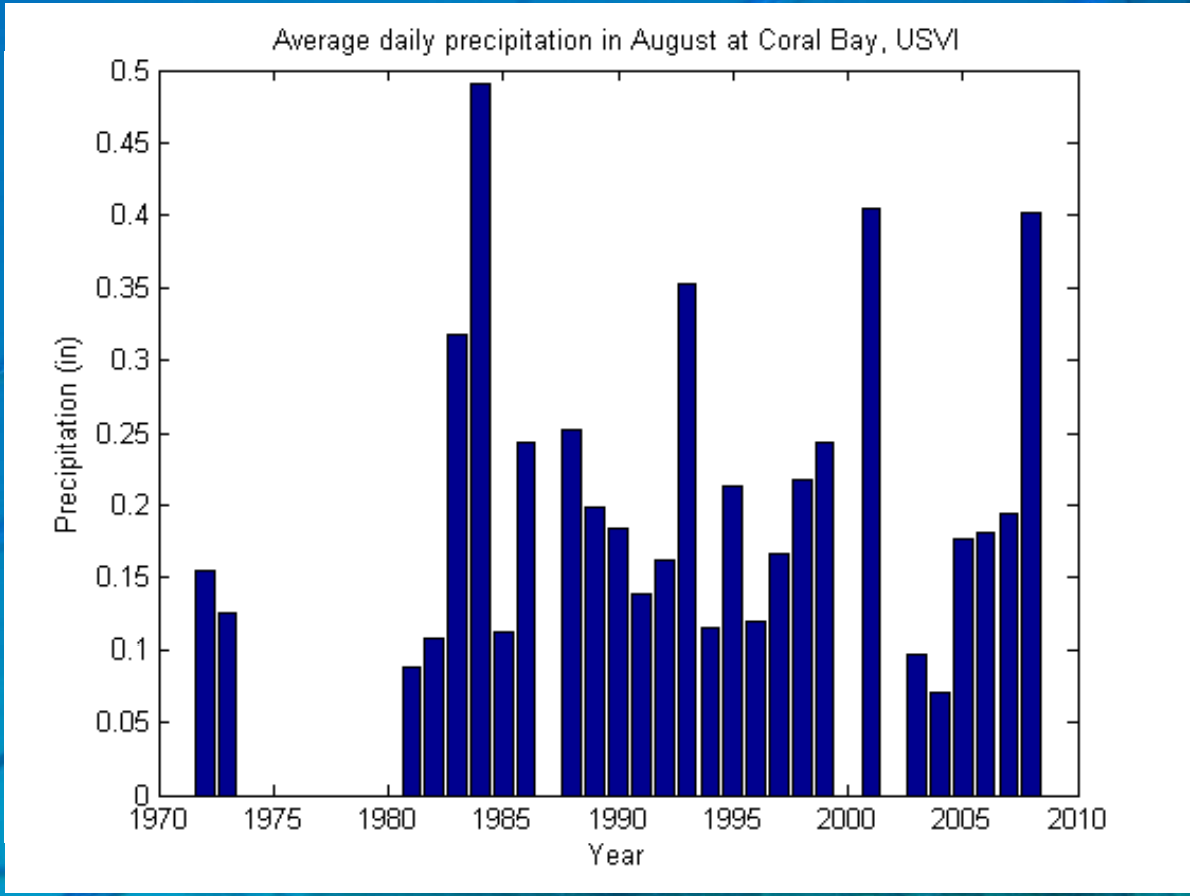
Annaberg
Hermitage
East End
Coral Bay
Saint John
Adrian
Bordeaux
Calabash Boom
Contant
Fish Bay

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

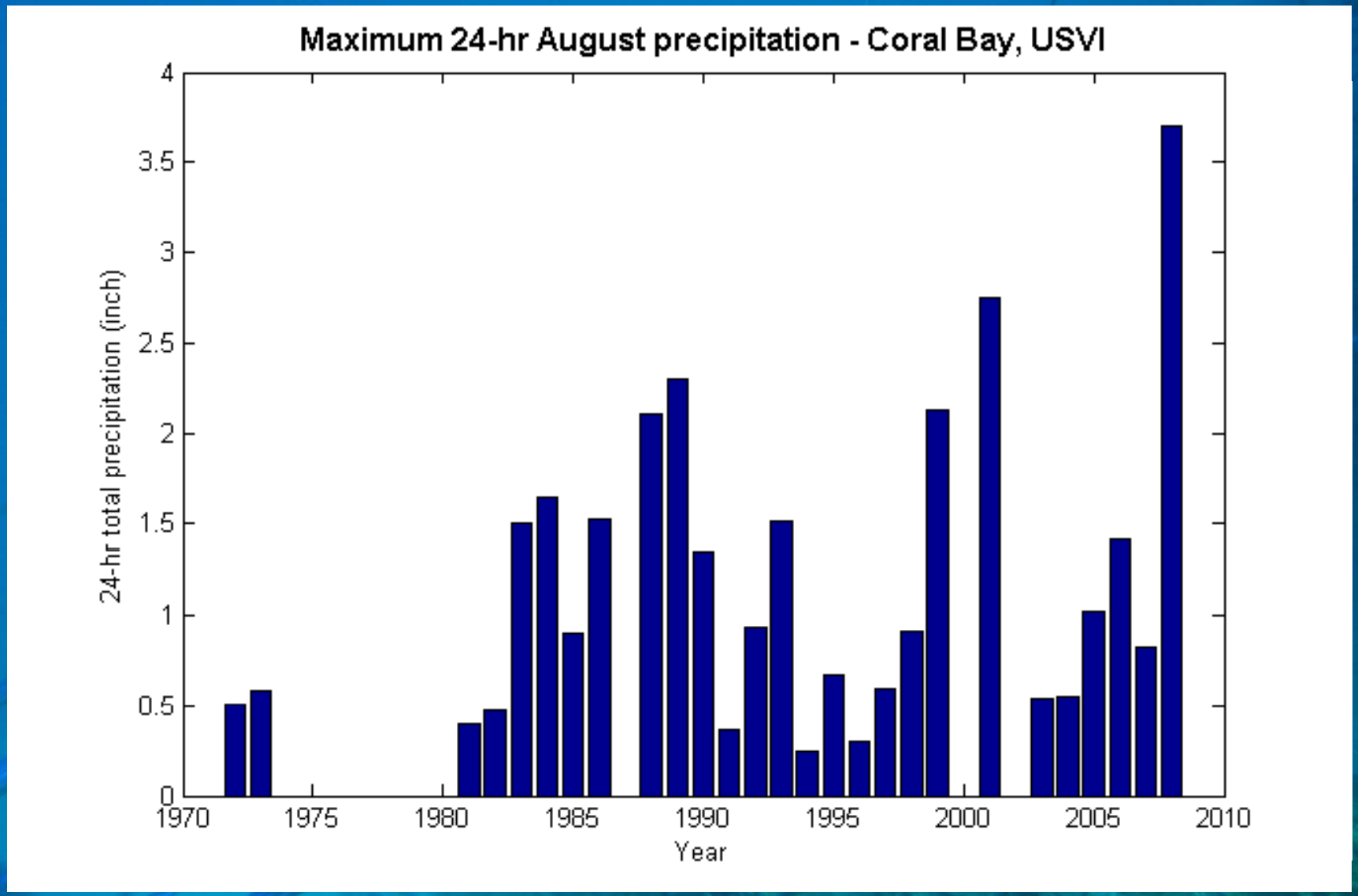
A temporal look at precipitation

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

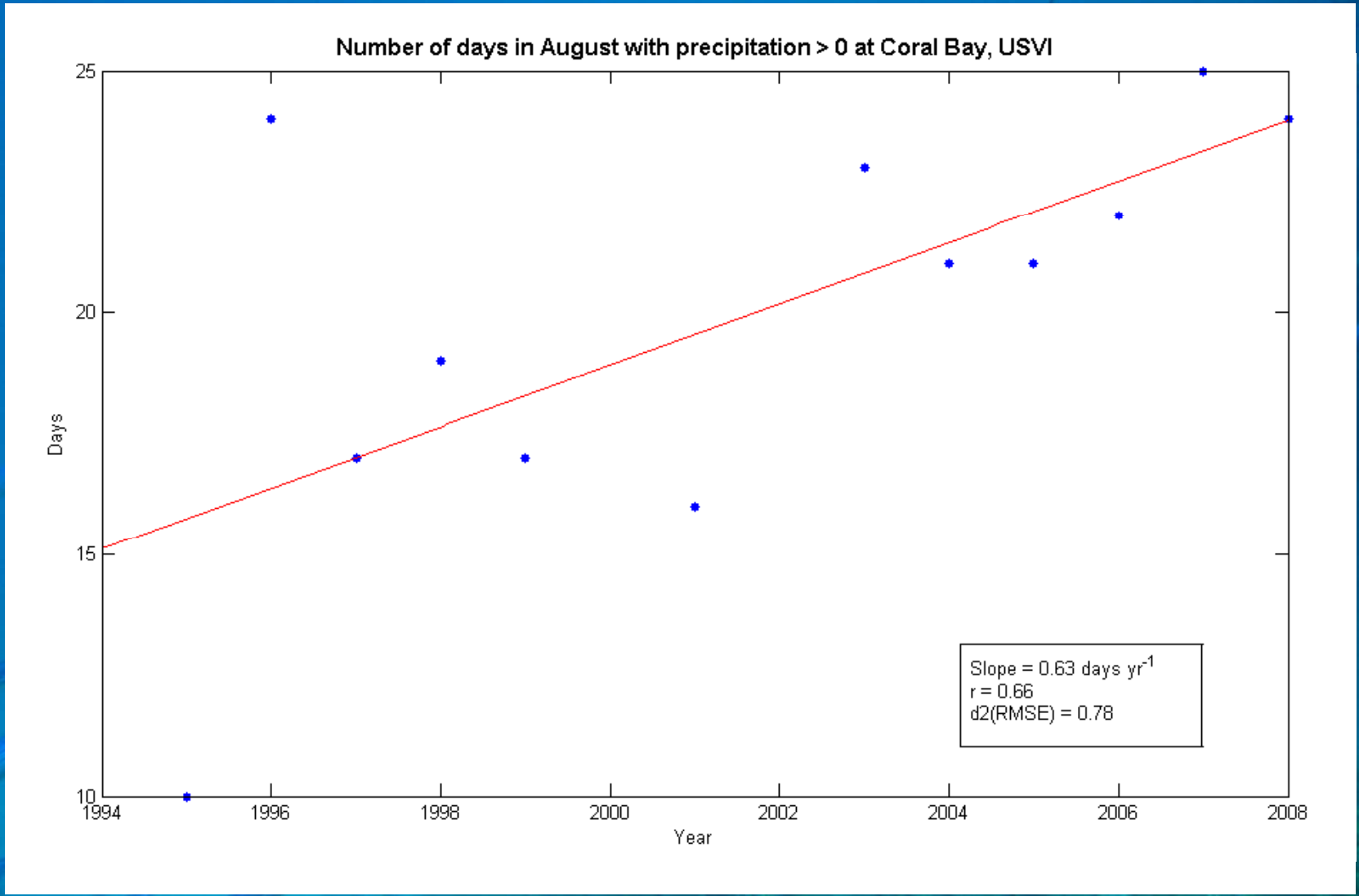


NOAA National Climatic Data Center
http://www.ncdc.noaa.gov

Looking at maxima



Precipitation Frequency



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.

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?

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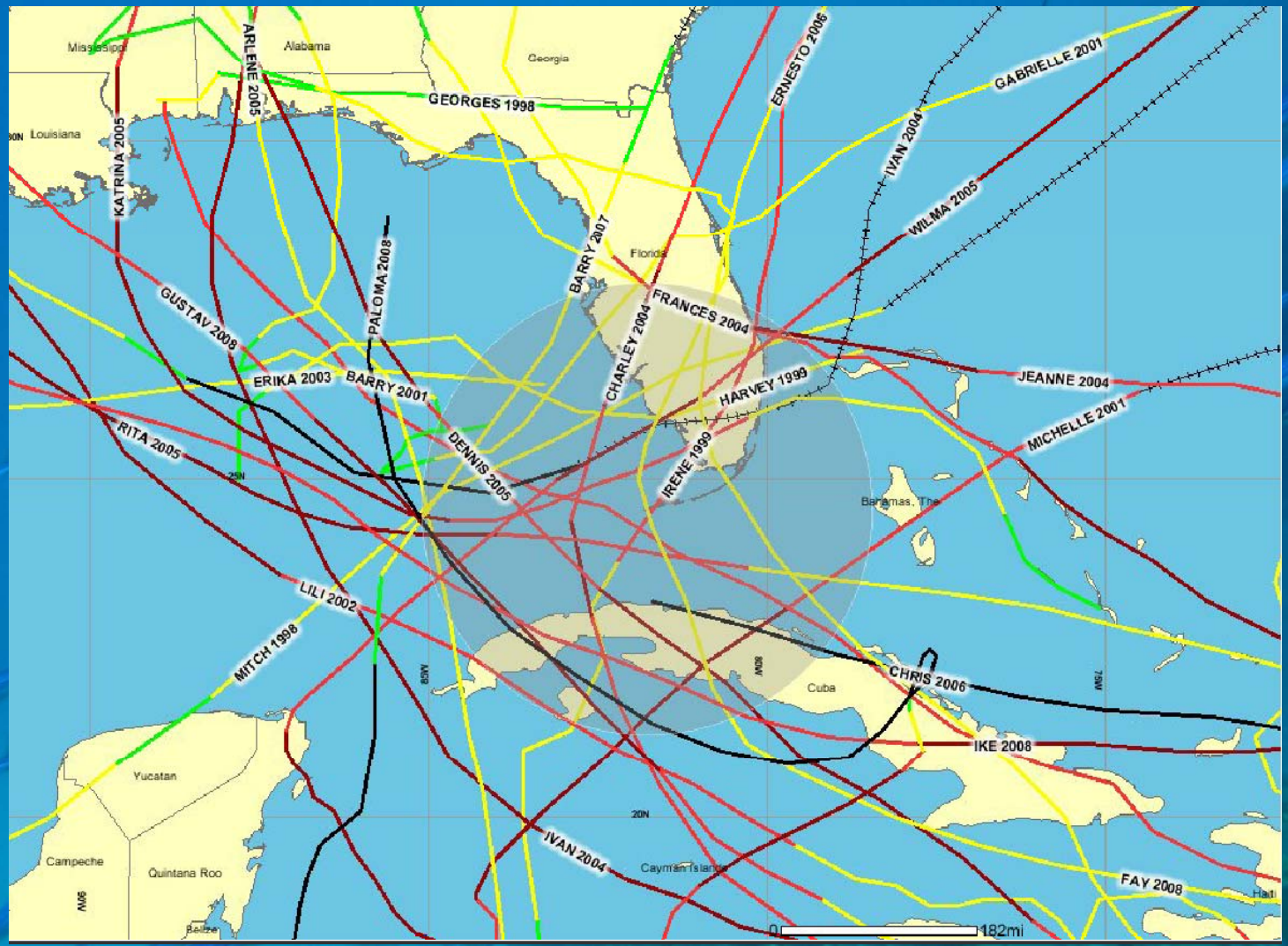
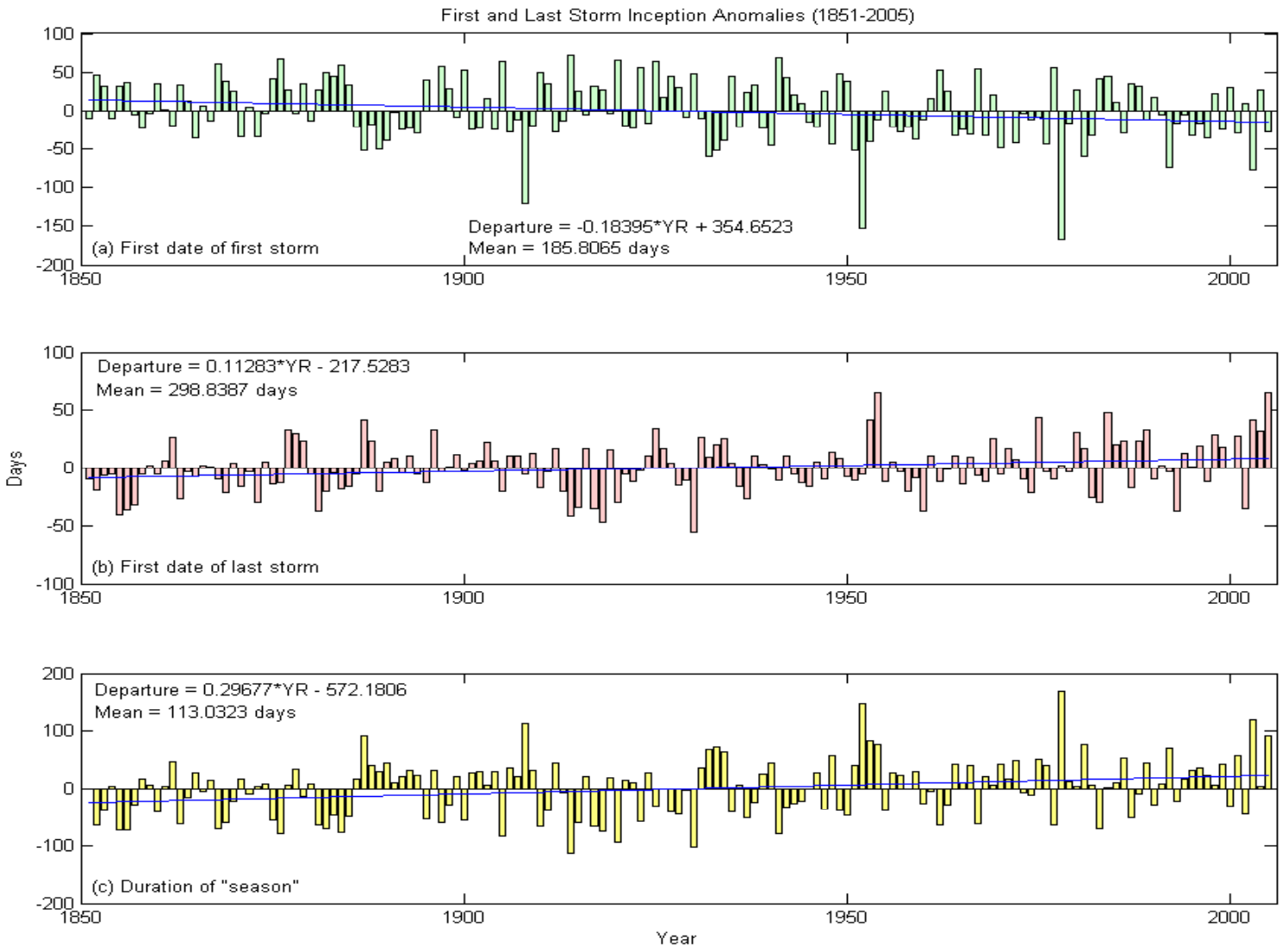
Hurricane Tracks near the FKNMS (1998-2008)



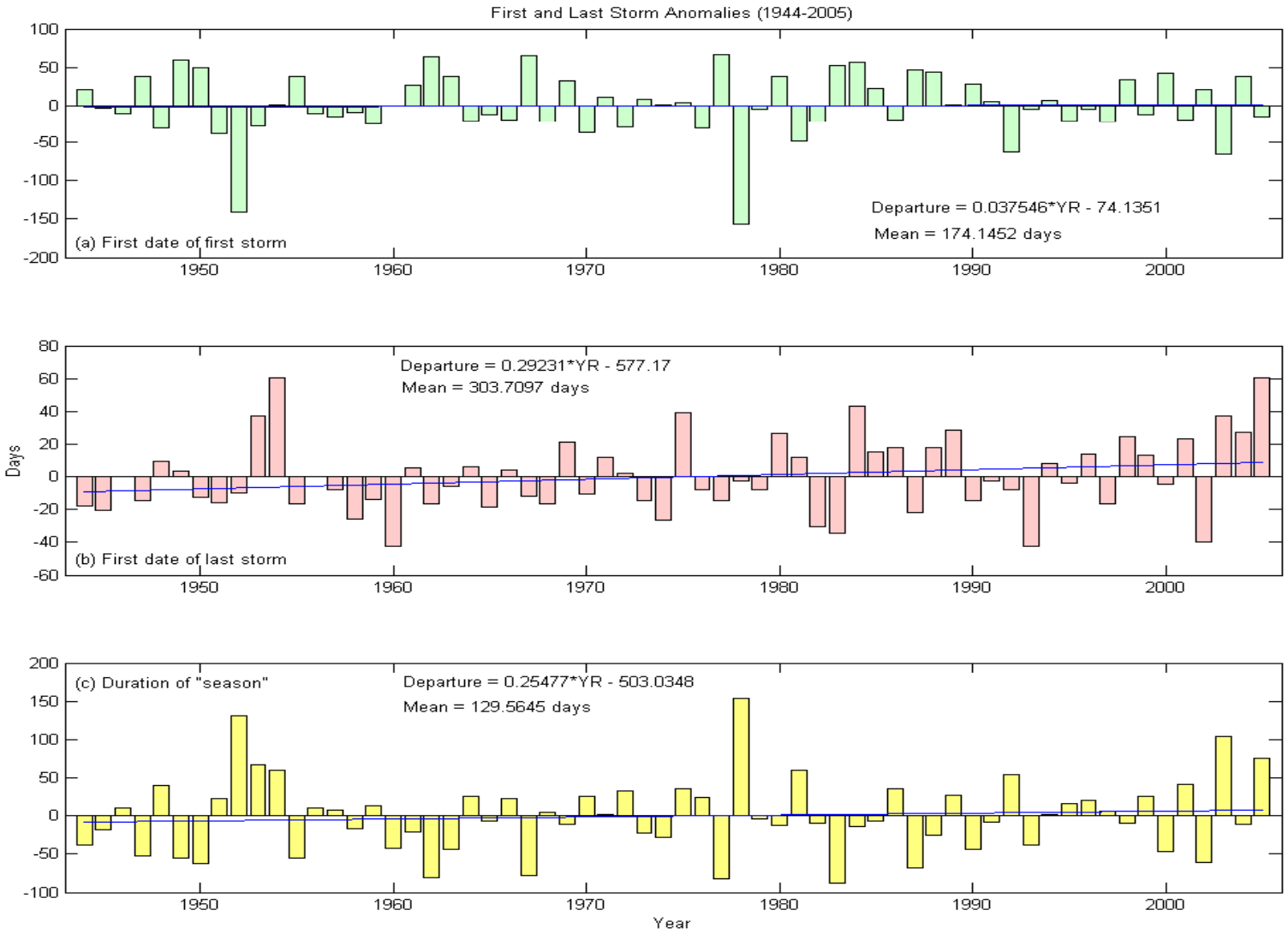
Thanks to J. Schittone (ONMS) for the graphic.

NOAA National Climatic Data Center
http://www.ncdc.noaa.gov

Atlantic/Caribbean TC Season

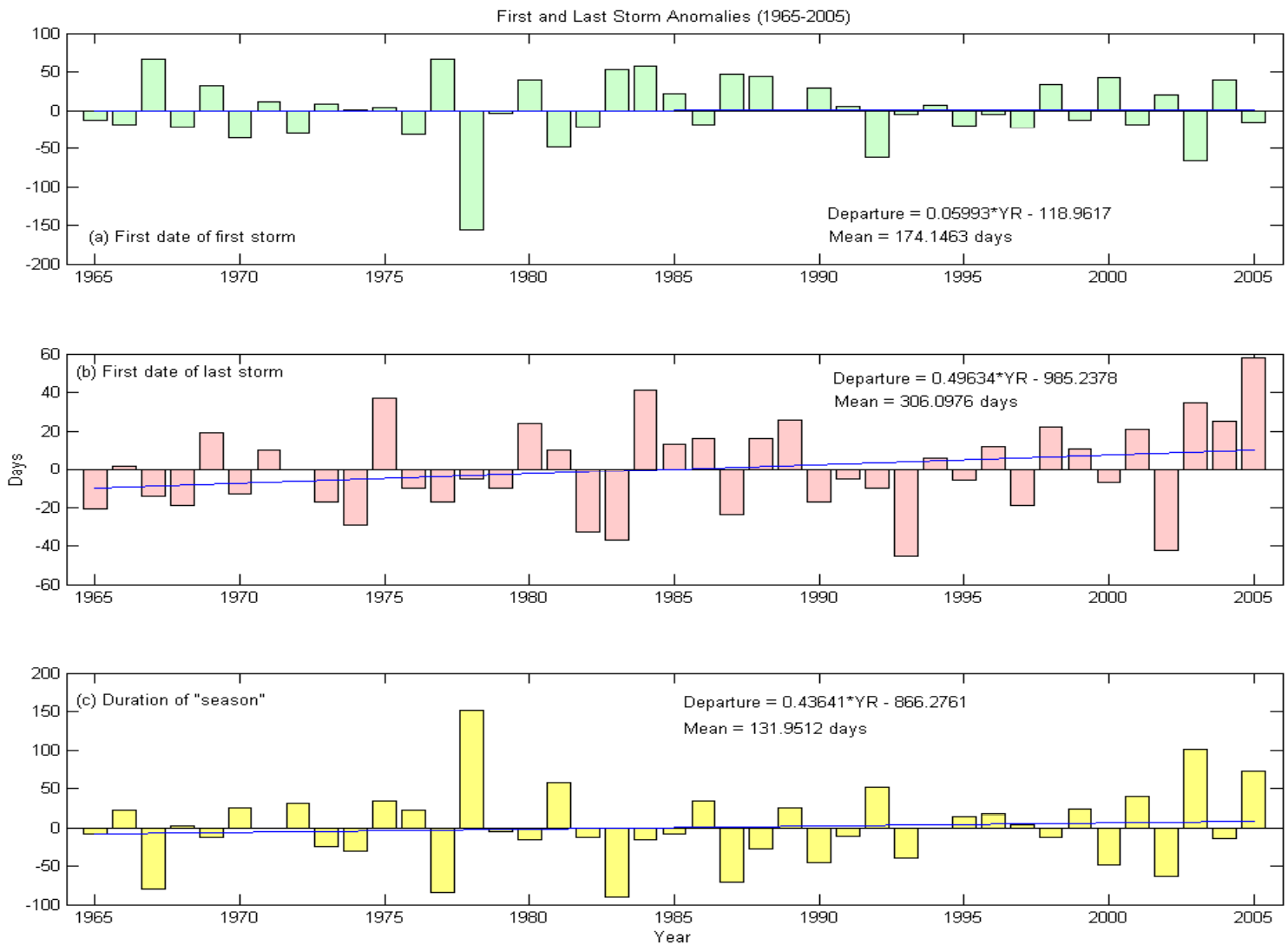


Atlantic/Caribbean TC Season



Approx: 16 day increase from 1944-2005

Atlantic/Caribbean TC Season



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

Thunderstorm over FKNMS

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.

Thank You!

Questions?

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