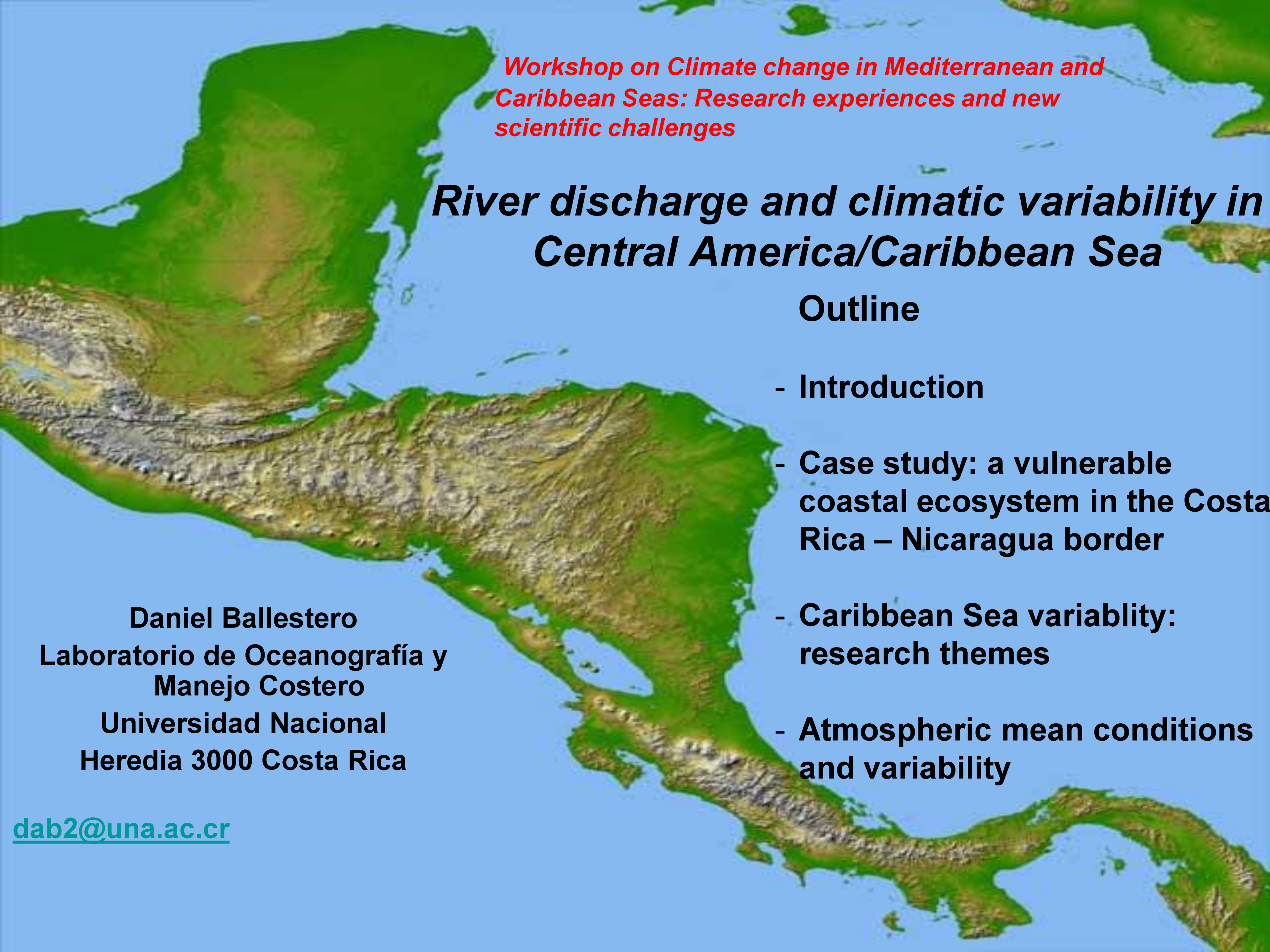

Workshop on Climate change in Mediterranean and Caribbean Seas: Research experiences and new scientific challenges

River discharge and climatic variability in Central America/Caribbean Sea

Outline

- Introduction
- Case study: a vulnerable coastal ecosystem in the Costa Rica – Nicaragua border
- Caribbean Sea variablity: research themes
- Atmospheric mean conditions and variability

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- Deep (2200 m average, 7100 m in the Cayman trench)
- 20 000 Km2 of coral reefs (7 %) with 22 % degraded by human activity (sewage, agricultural and industrial pollution, erosion and fishing)
- Volume: 6.48 3 106 km^3
- Area: 2.52 3 106 km^2

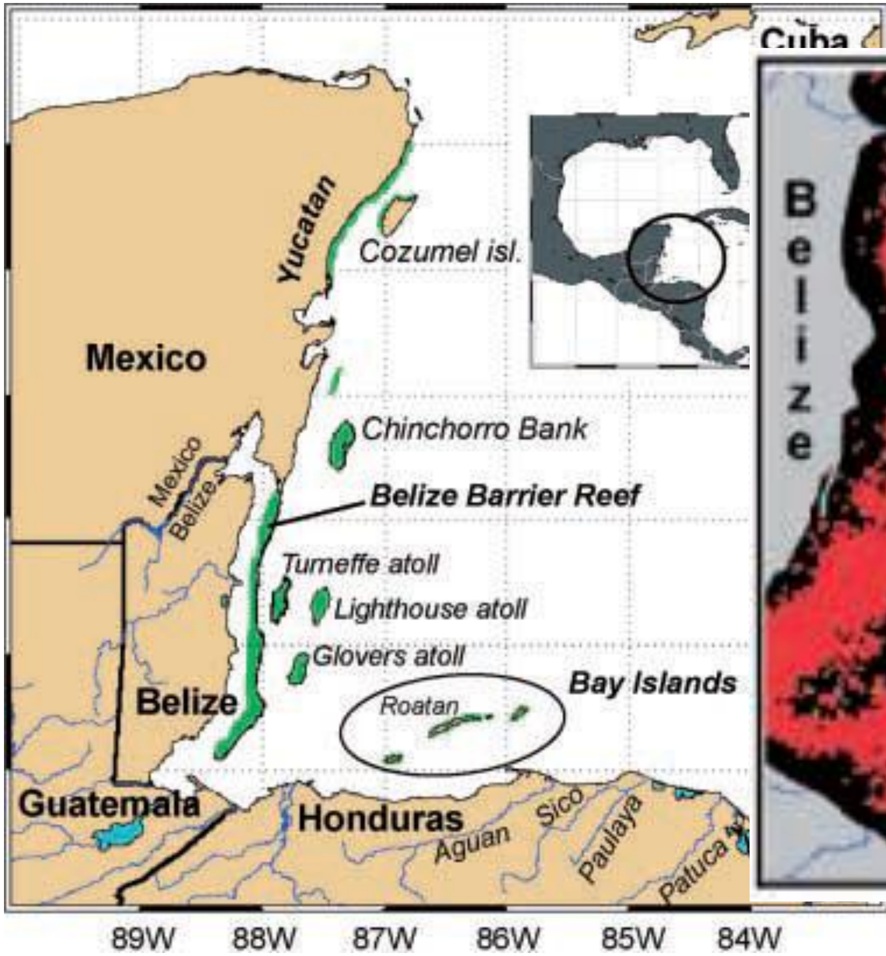
Rivers

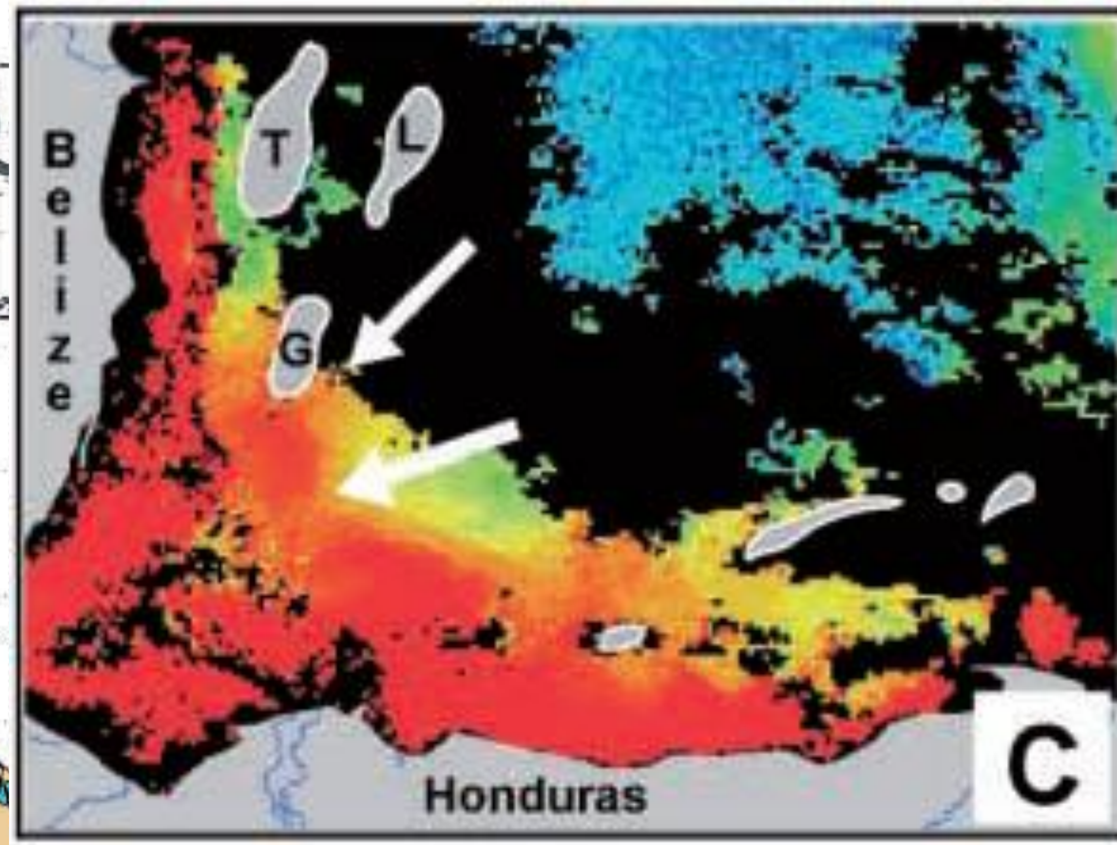
Magdalena (7.5 x 103 m3/s)
Orinoco (3.9 x 104 m3/s)
Amazon River (1.7 x 105 m3/s)

Estimations of sediment discharge (Caribbean region, tonnes/year):

Mississippi River 320 000 000
Rivers that flow into the Gulf of Mexico 121 000 000
Rivers form Central America and the Antilles 300 000 000
Magdalena River 235 000 000
Orinoco River 85 000 000
Other rivers from Colombia and Venezuela 50 000 000

Hurricane Mitch (late October 1998)





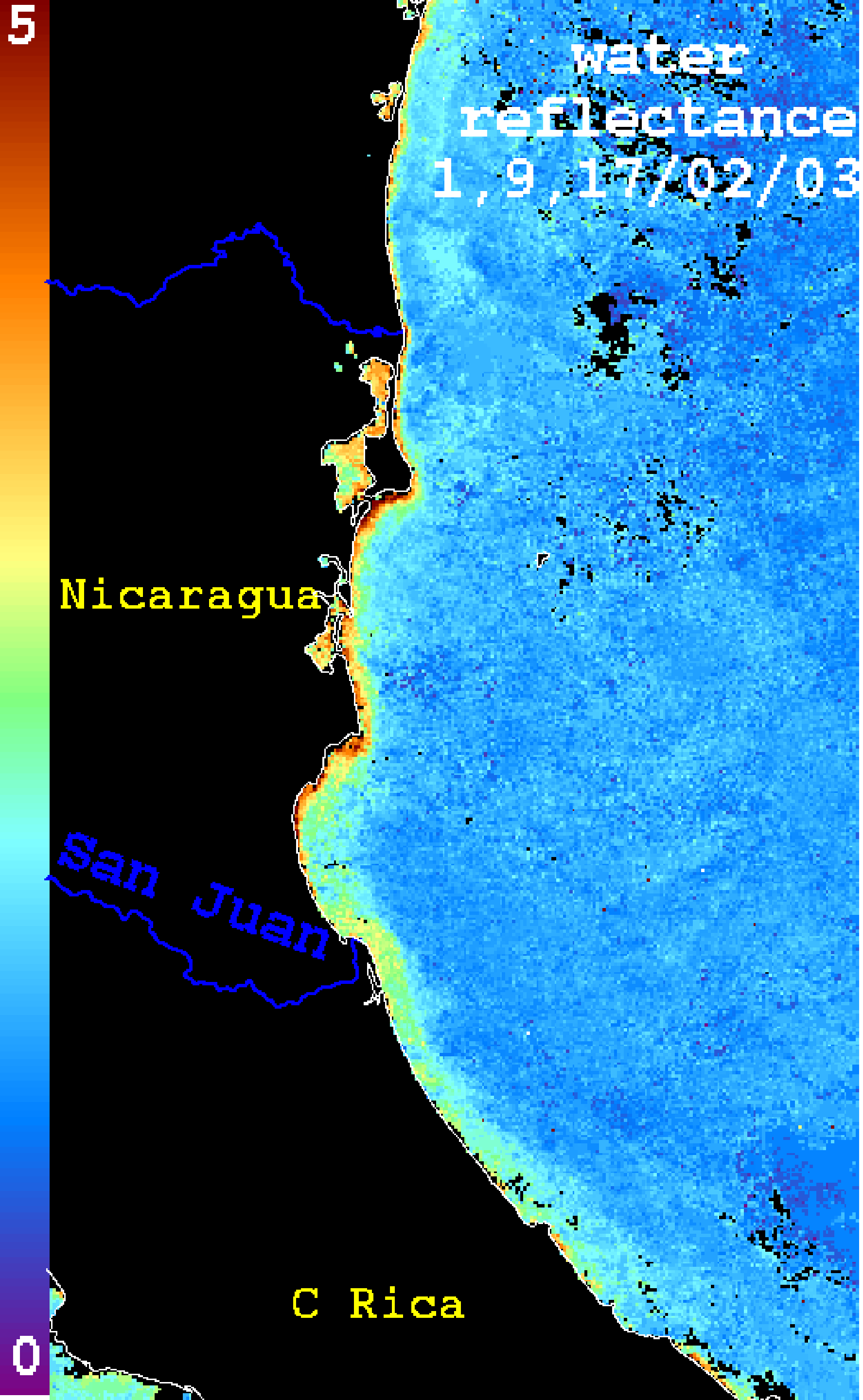
S. Andrefouet et al. (2002)

Meso-American barrier Reef System

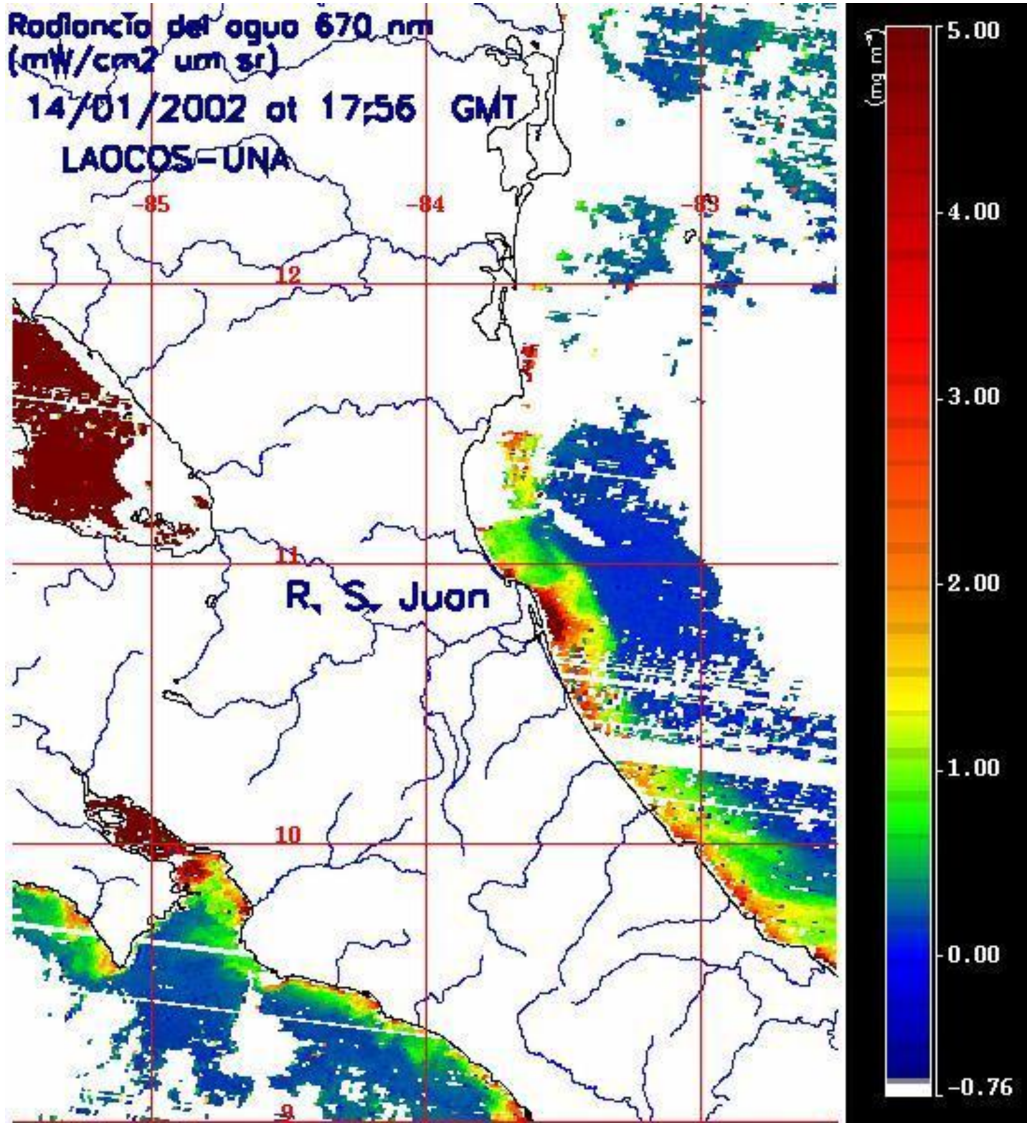
Sedimentation pl… …n

	…o	San Juan
	…0	10
	…00	< 20
	…200	1:80
…wave-energy level	1.2 Short period, low …e waves	4.3
	…0	25
	… 7.4	4 – 5.4
	…vial	Marine (wave dominated)
	…gle …uding …nnel	Straight coast, deflected distributaries

…al. 1978



5
water
reflectance
1,9,17/02/03
Nicaragua
San Juan
C Rica
0



Radiancia del agua 670 nm
(mW/cm2 um sr)
14/01/2002 at 17:56 GMT
LAOCOS-UNA
-85
-84
-83
12
11
10
9
R. S. Juan
(mg m-3)
5.00
4.00
3.00
2.00
1.00
0.00
-0.76

PRESENT AND EMERGING ENVIRONMENTAL PROBLEMS

- Accelerating Degradation of Ecosystems, stemming from inadequate wastewater treatment, migratory agriculture, overgrazing, deforestation, unregulated ecotourism, and the introduction of aggressive exotic species; emerging problems include the increasing use of small hydropower plants without regard for environmental considerations

- **Overexploitation of Valuable Natural Resources, due to farming of hillsides and wetlands, construction of poorly designed roads, unregulated fishing, excessive exploitation of valuable moist tropical forest species, and destruction of plant cover in fragile areas**

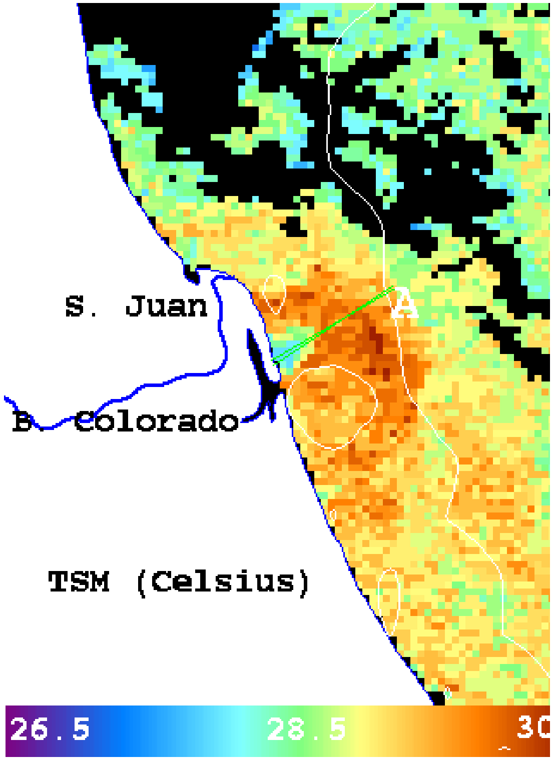
PRESENT AND EMERGING ENVIRONMENTAL PROBLEMS

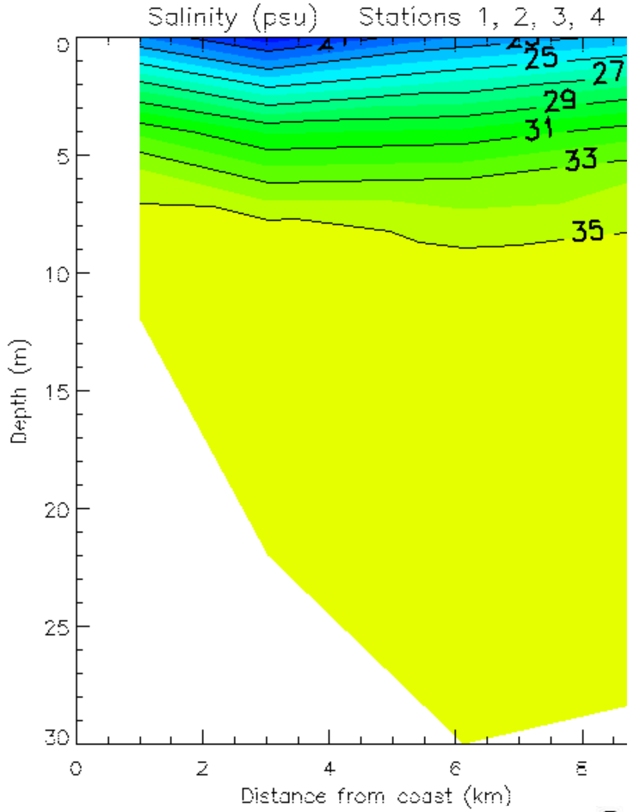
- **Soil Degradation and Increasing Sedimentation, caused primarily by inappropriate agricultural practices, inadequate road construction, and deforestation; emerging problems include open-pit mining and extraction of construction materials**

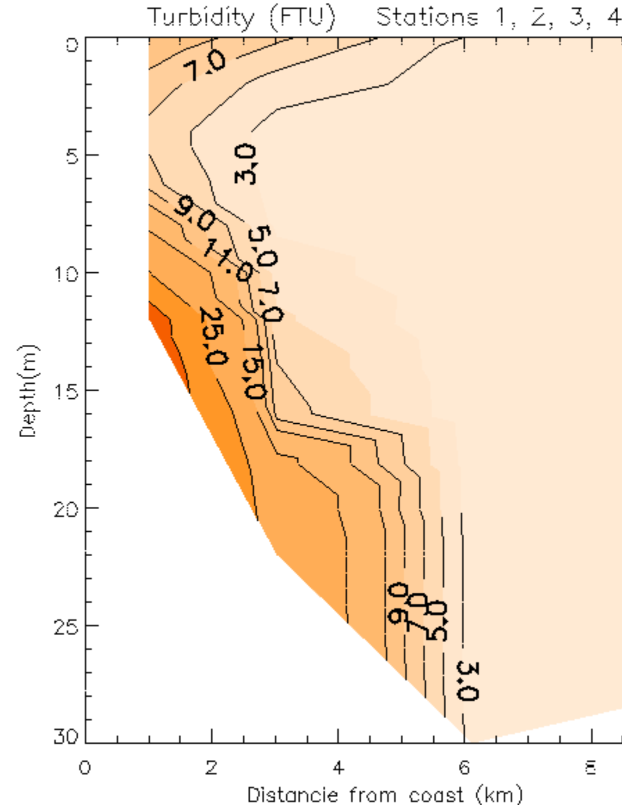
- Pollution of Water Bodies, caused by the indiscriminate use of pesticides and fertilizers and by uncontrolled agroindustrial waste discharges

PRESENT AND EMERGING ENVIRONMENTAL PROBLEMS

- High Vulnerability to Natural Hazards, as a result of poor infrastructure, farming on previously forested land, fragile soil, and areas exposed to landslides caused by hurricanes, tropical storms, and seismic or volcanic activity



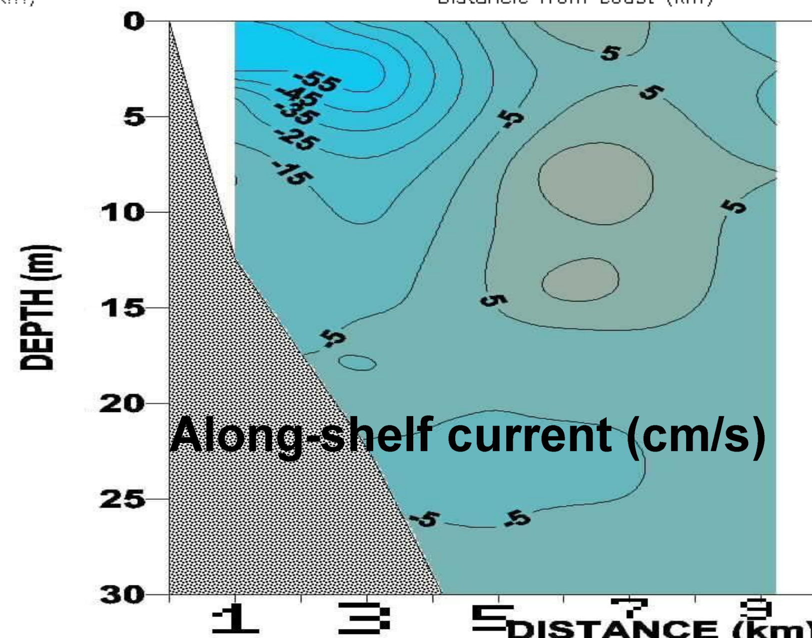


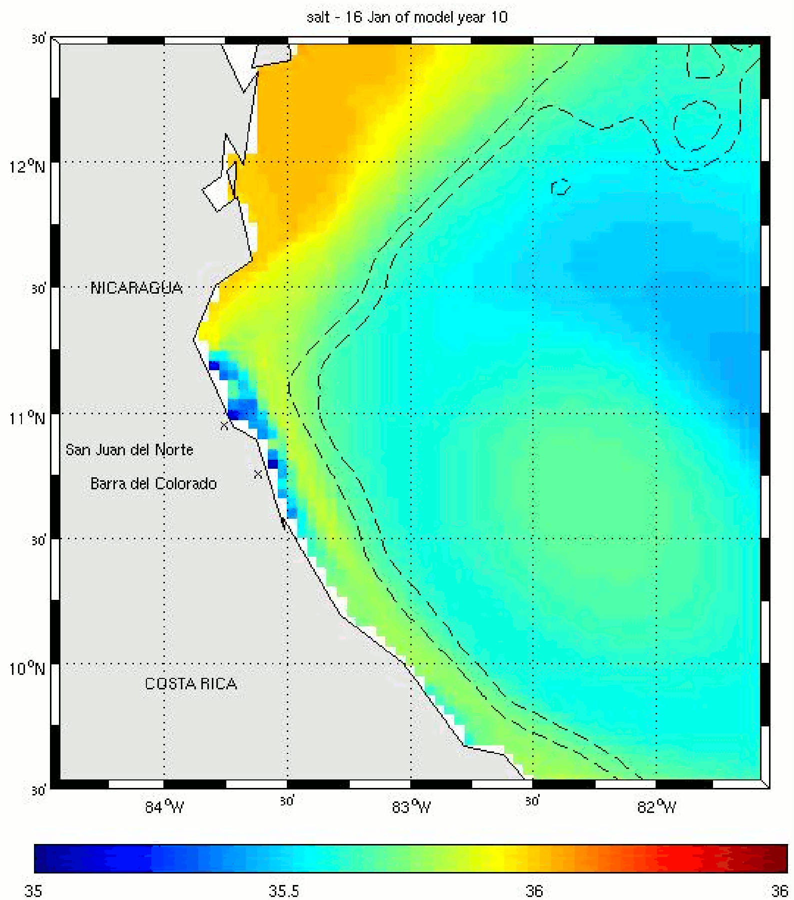


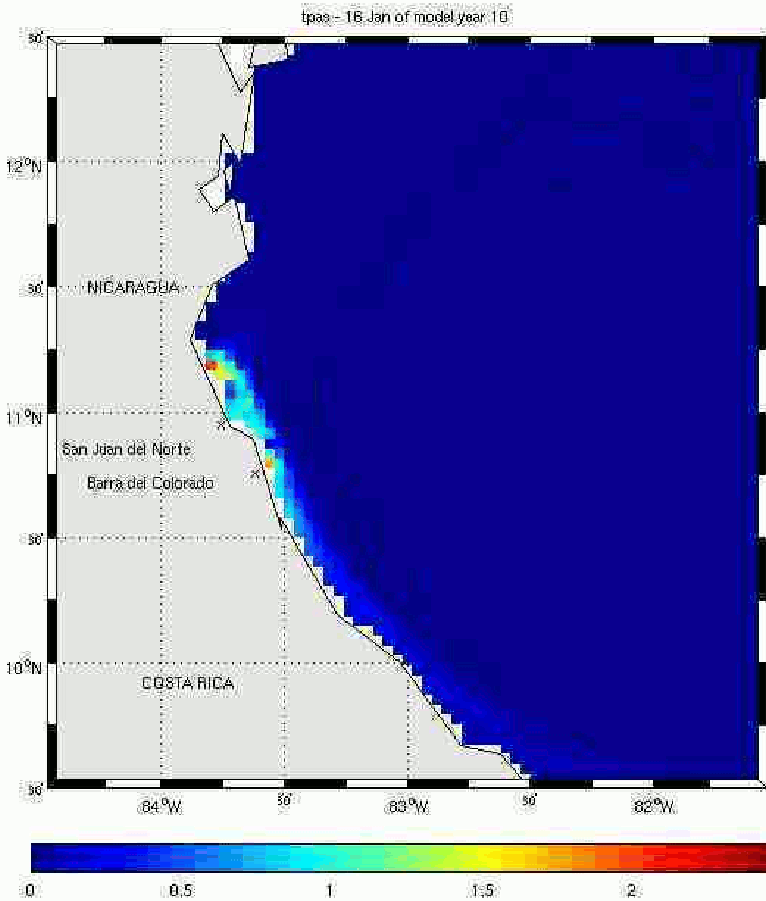
- the turbid water of the CBL can extend beyond the 200 m isobath

- anticyclonic (clockwise) deflection is observed in the coastal boundary layer

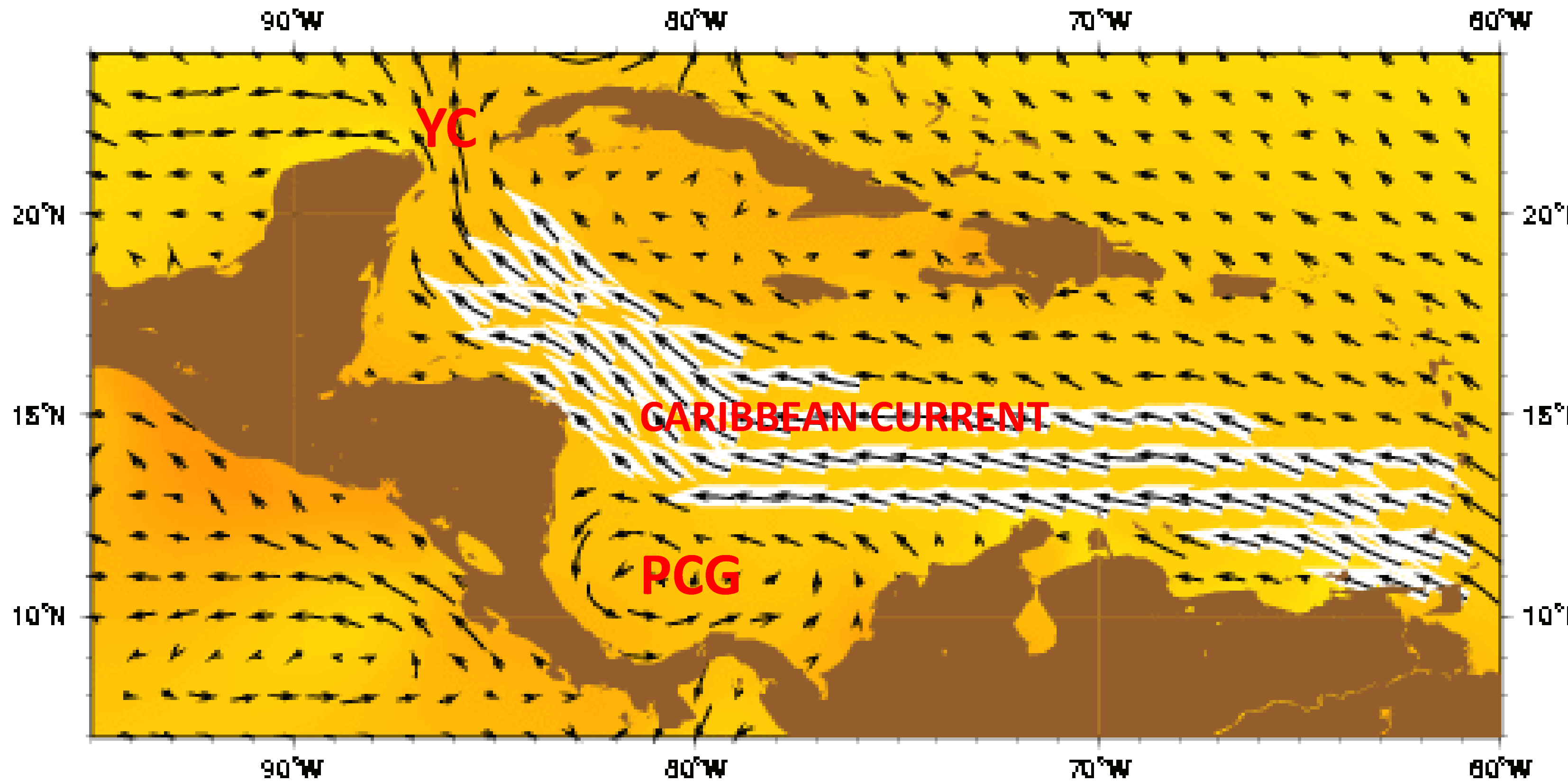
- southward transport in the CBL







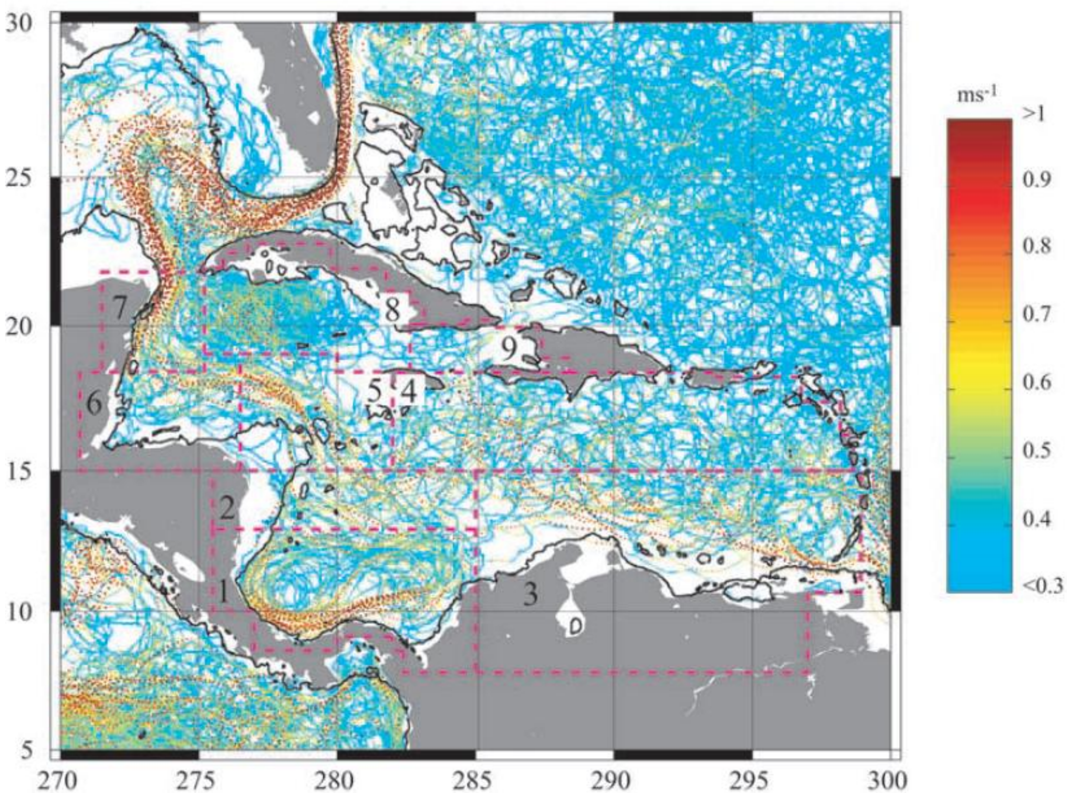
Regional Ocean Modeling System



- 30 Sv enter through several passages in the Antilles

-Tropical Atlantic water: 28 °C, 36 ppt

http://oceancurrents.rsmas.miami.edu/caribbean



Centurioni & Niiler (2003)

- Maximum GC in the CC of 1.28 m/s (from altimetry), maximum mean of 0.69 cm/s (from drifters)
- > 70 cm/s along the Panama coast, instantaneous > 90 cm/s
- Persistent western PCG, eastern side variable with seasons
- Cayman basin current mean of 0.3-0.61 m/s (instantaneous up to 1.16 m/s from drifters)

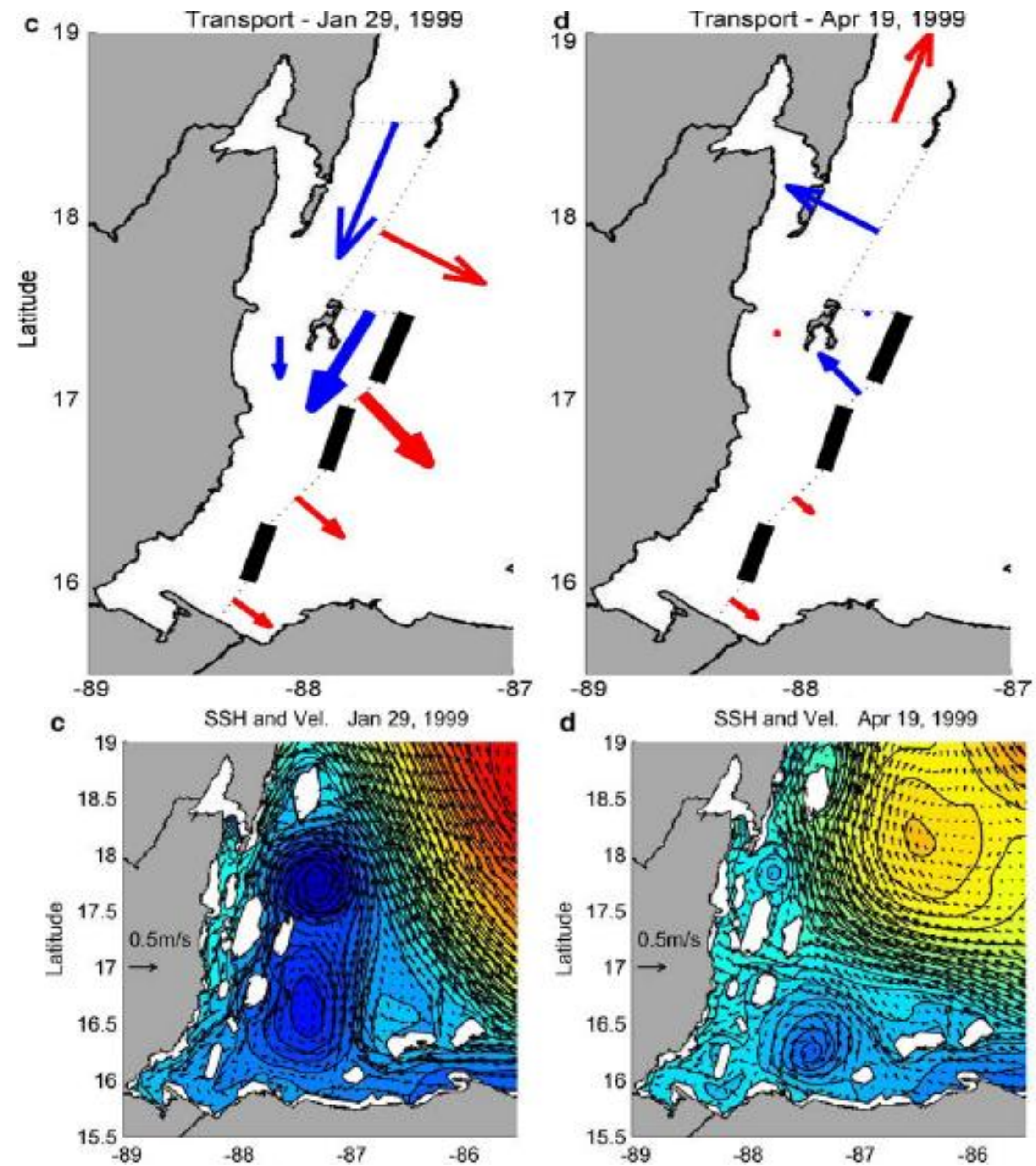
Caribbean eddies

- strong eddy activity

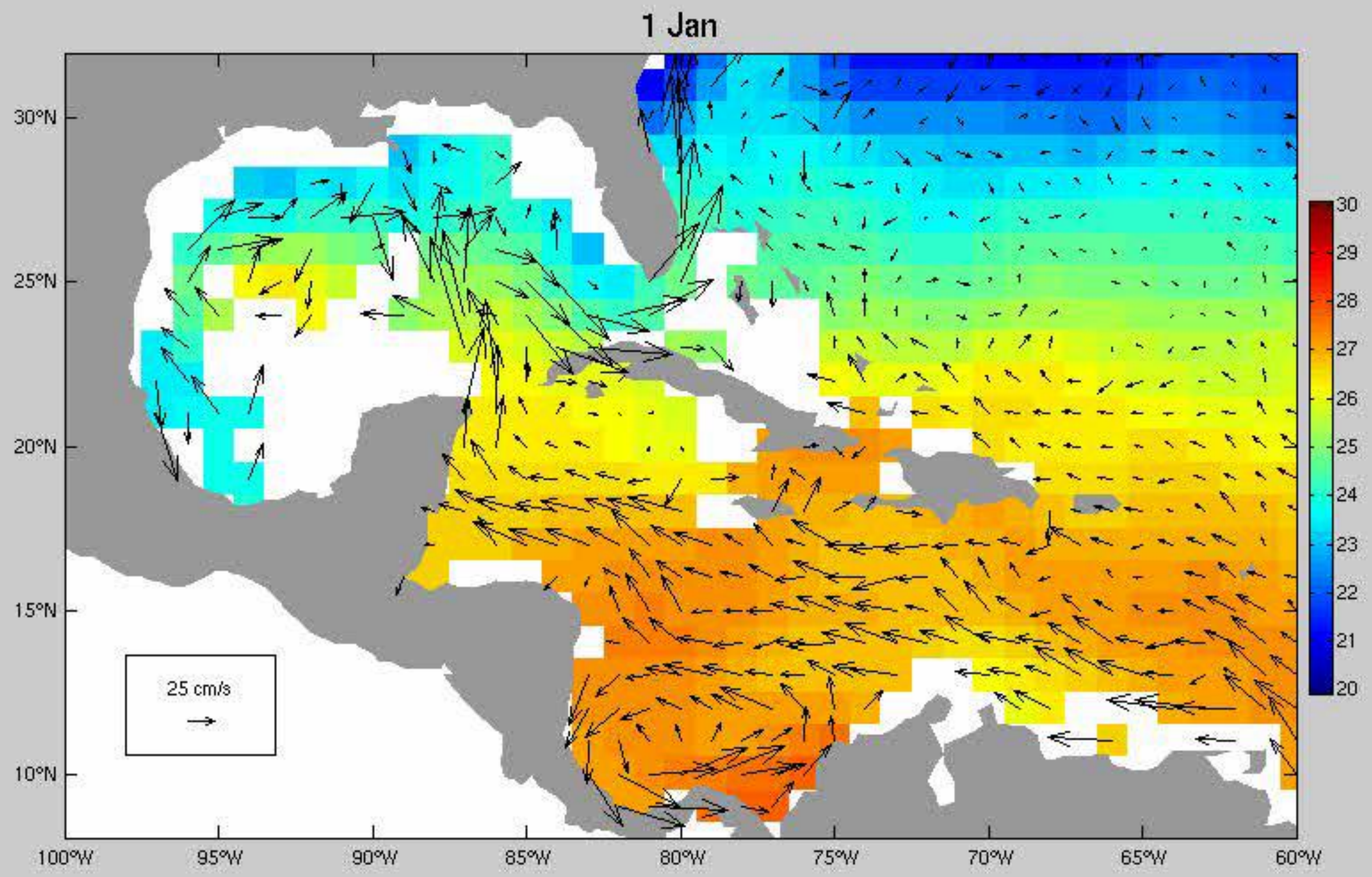
- 3 month timescales, 250-km spatial scales

- **westward propagation with speeds of 12 cm/s (180 days to cross the basin)**
- **4.3 – 5.7 eddies per year**

Impact of eddies in the circulation of the Gulf of Honduras



T. Ezer et al. (2005)



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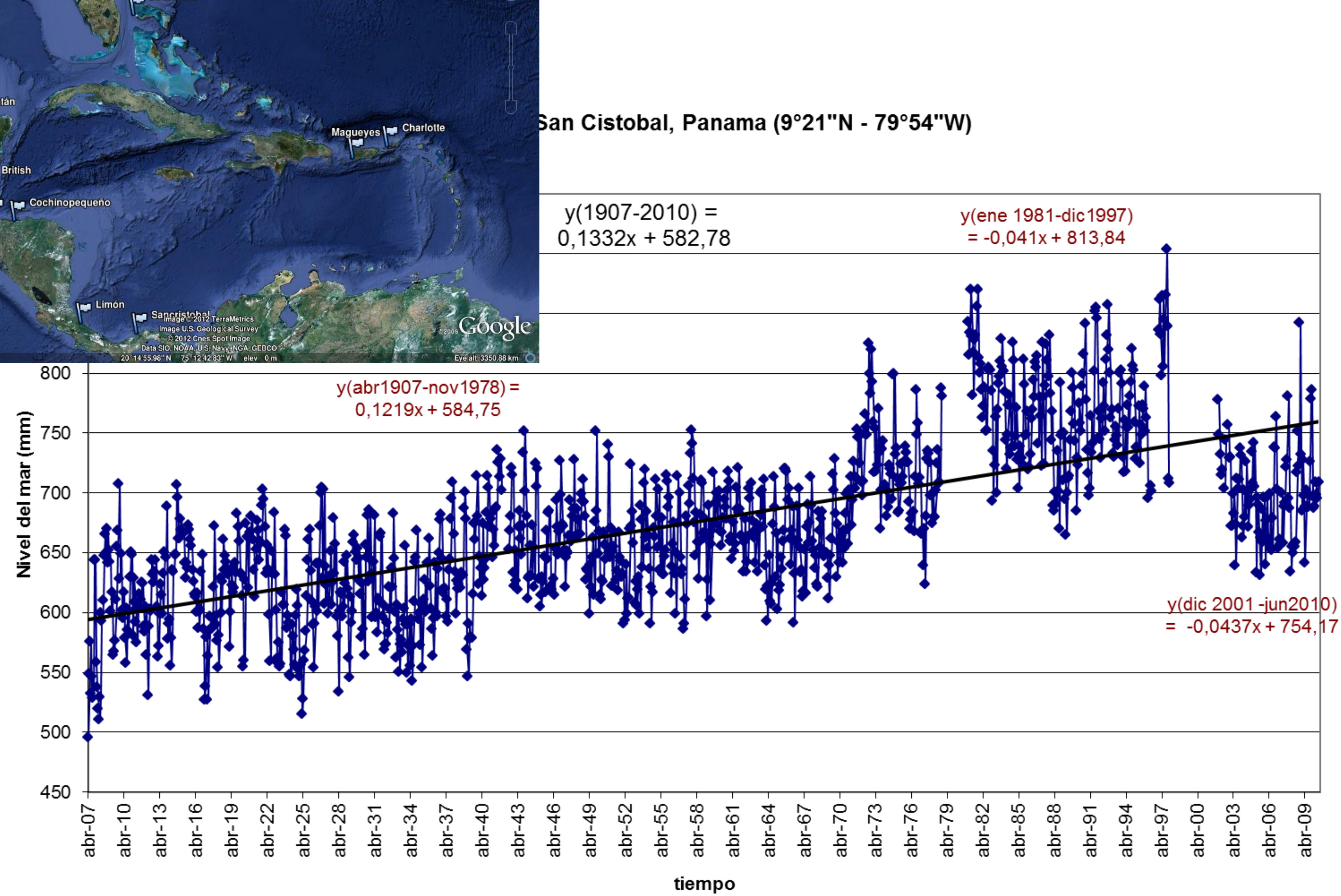

San Cistobal, Panama (9°21"N - 79°54"W)
Magueyes
Charlotte
British
Cochinopequeño
Limón
Sancristobal
Image © 2012 TerraMetrics
Image U.S. Geological Survey
© 2012 Cnes Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
y(1907-2010) =
0,1332x + 582,78
y(ene 1981-dic1997)
= -0,041x + 813,84
y(abr1907-nov1978) =
0,1219x + 584,75
y(dic 2001 -jun2010)
= -0,0437x + 754,17
Nivel del mar (mm)
800
750
700
650
600
550
500
450
abr-07
abr-10
abr-13
abr-16
abr-19
abr-22
abr-25
abr-28
abr-31
abr-34
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abr-43
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abr-61
abr-64
abr-67
abr-70
abr-73
abr-76
abr-79
abr-82
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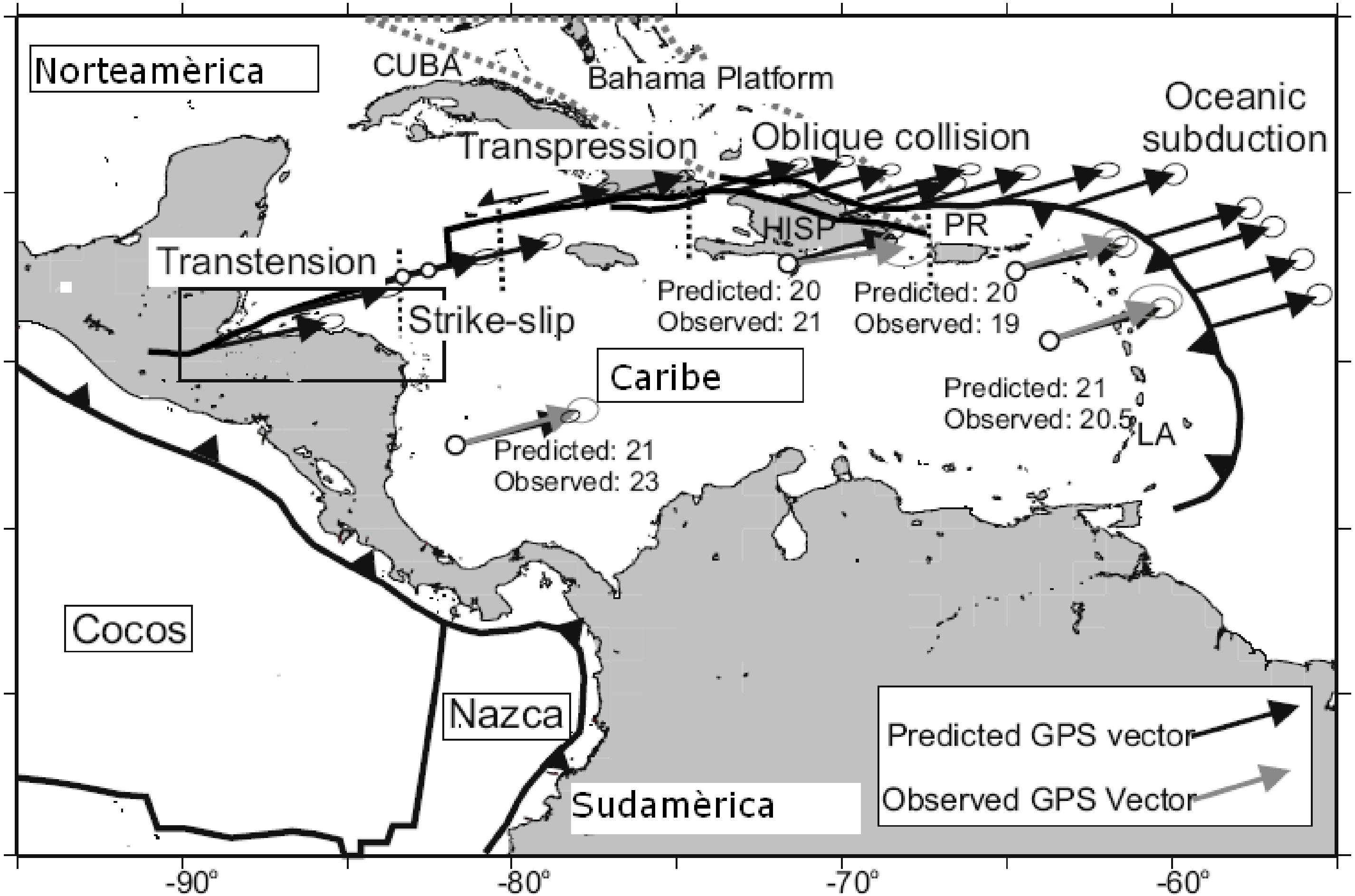
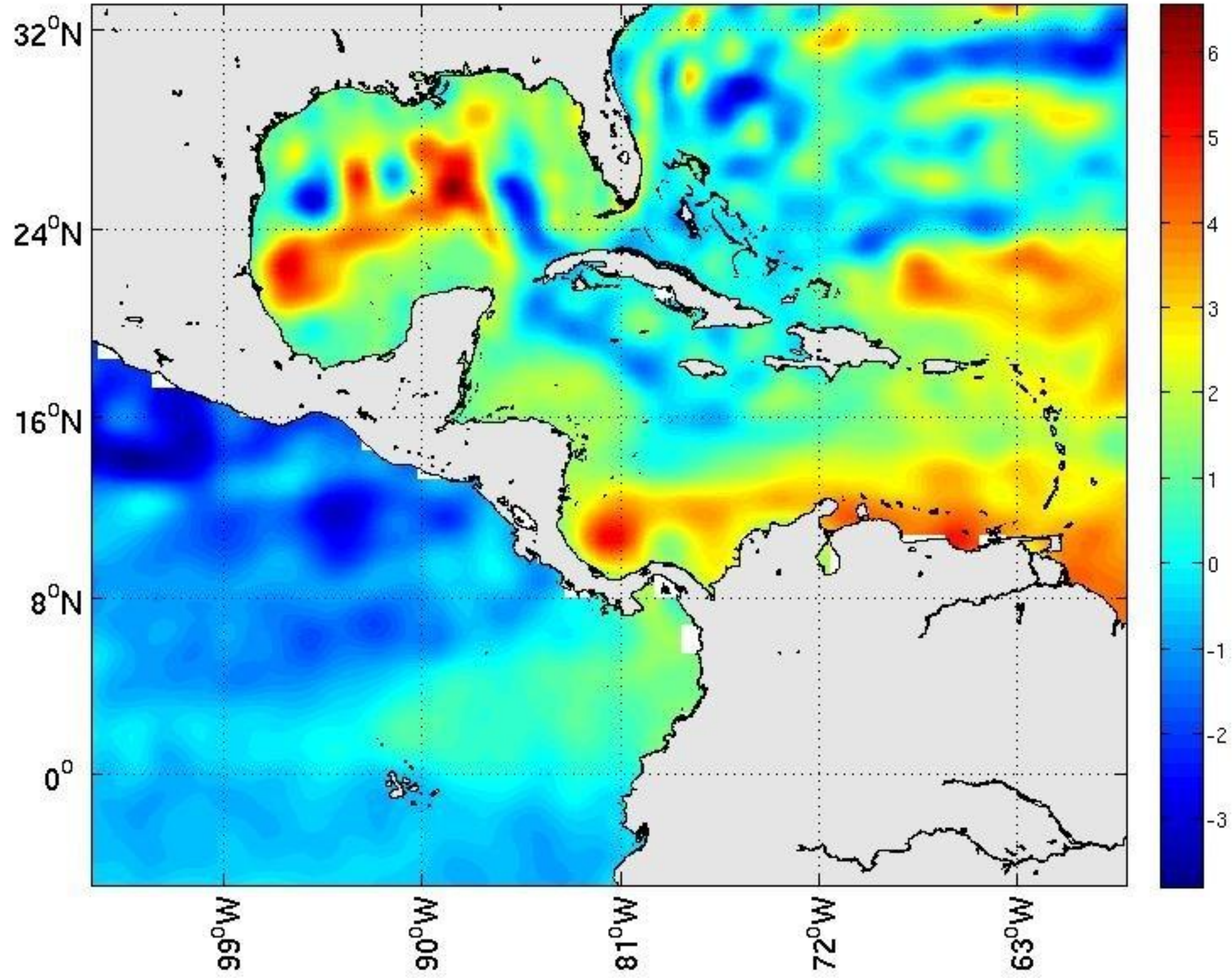
abr-06
abr-09
tiempo

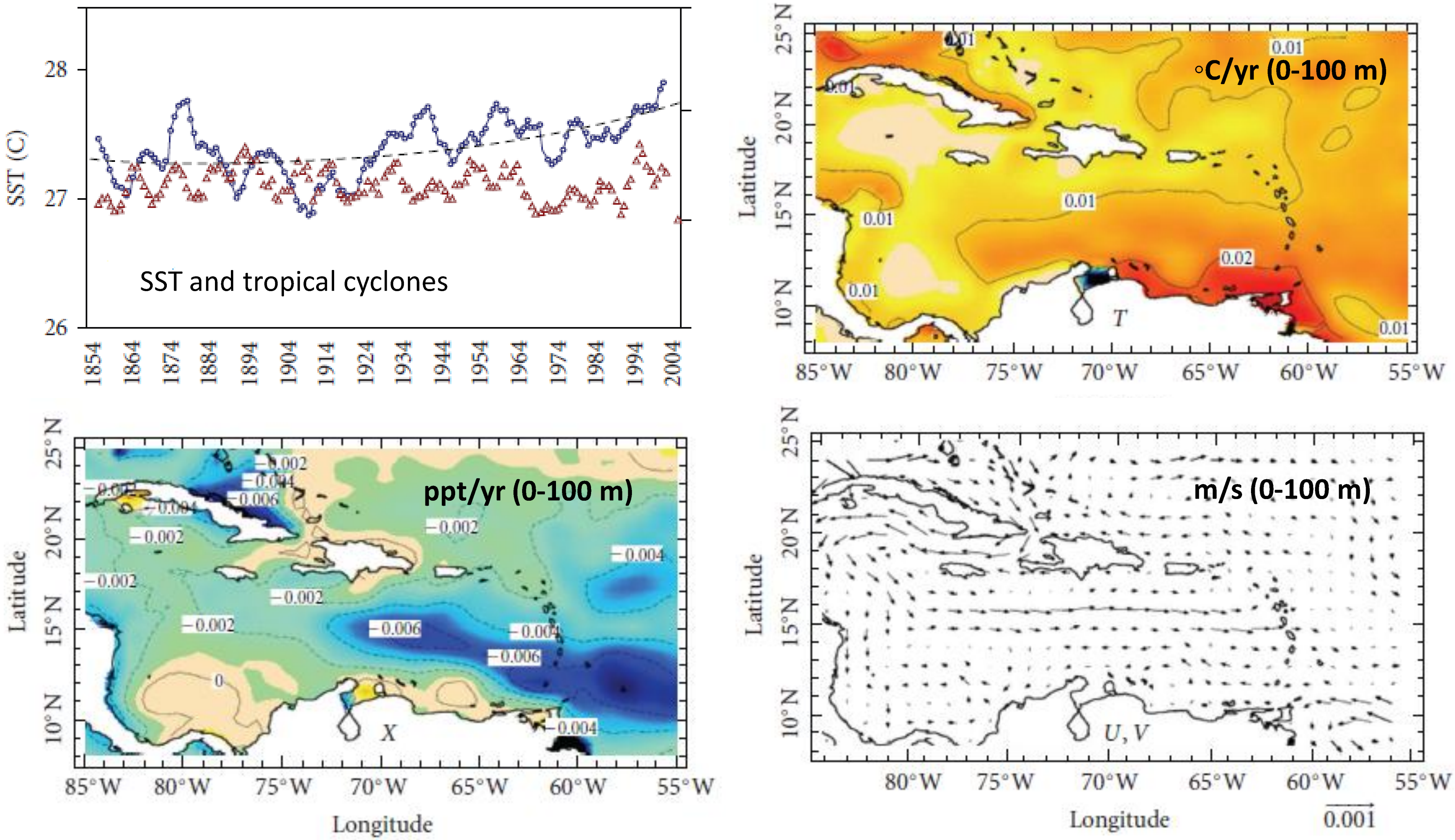


Norteamèrica
CUBA
Bahama Platform
Oceanic subduction
Oblique collision
Transpression
HISP
PR
Transtension
Strike-slip
Predicted: 20
Observed: 21
Predicted: 20
Observed: 19
Caribe
Predicted: 21
Observed: 20.5
LA
Predicted: 21
Observed: 23
Cocos
Nazca
Sudamèrica
Predicted GPS vector
Observed GPS Vector
20°
10°
0°
-90°
-80°
-70°
-60°

Sea level trend (mm/year)



www.aviso.oceanobs.com



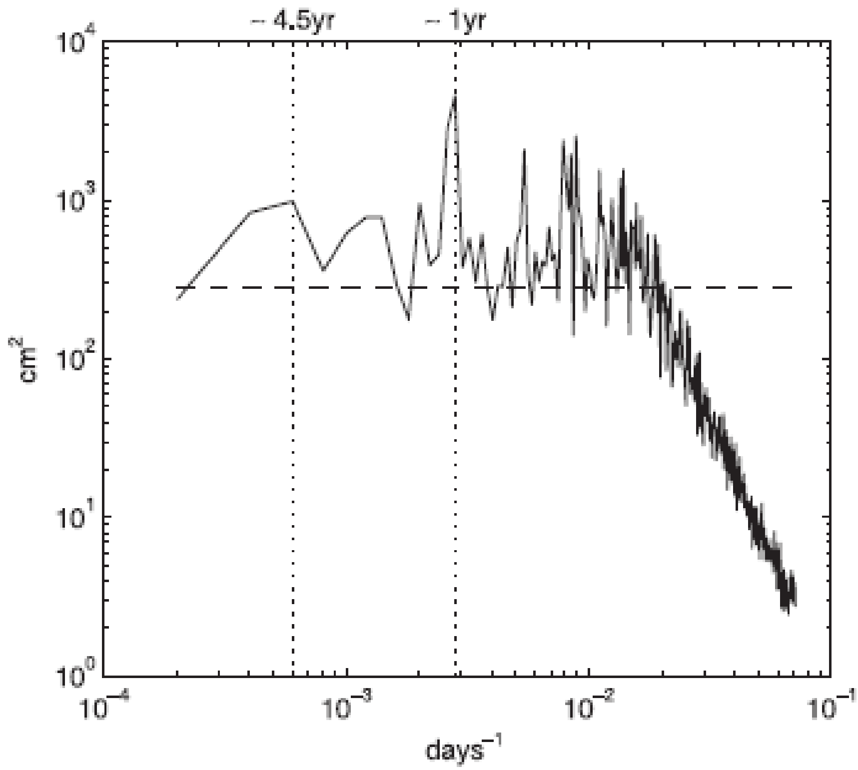
M. Jury 2011

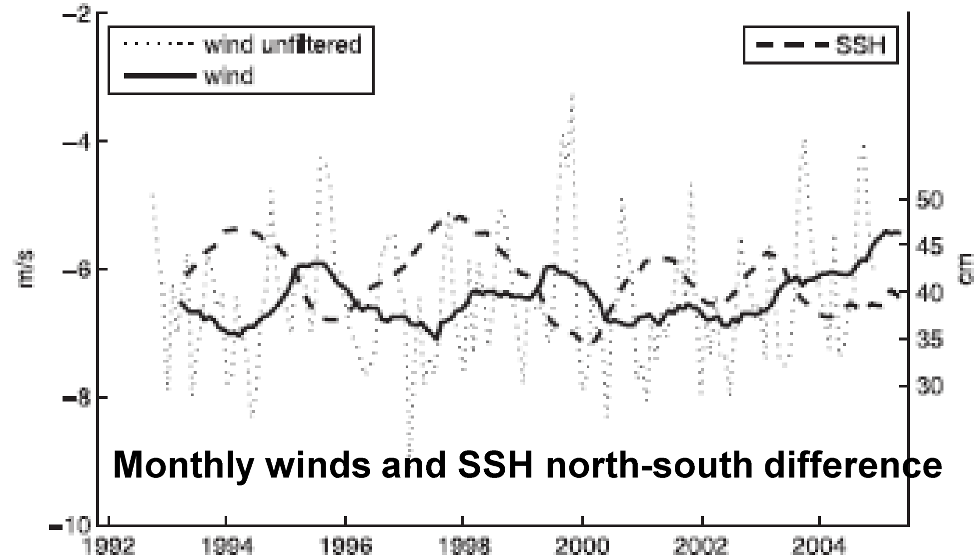
-Warming of upper layer accelerating in recent years

-Fresher upper layer, particularly in the Caribbean Current

-Reduced inflow from the SE Caribbean and increased inflow from the Windward Passage

-Reduced outflow toward Yucatan

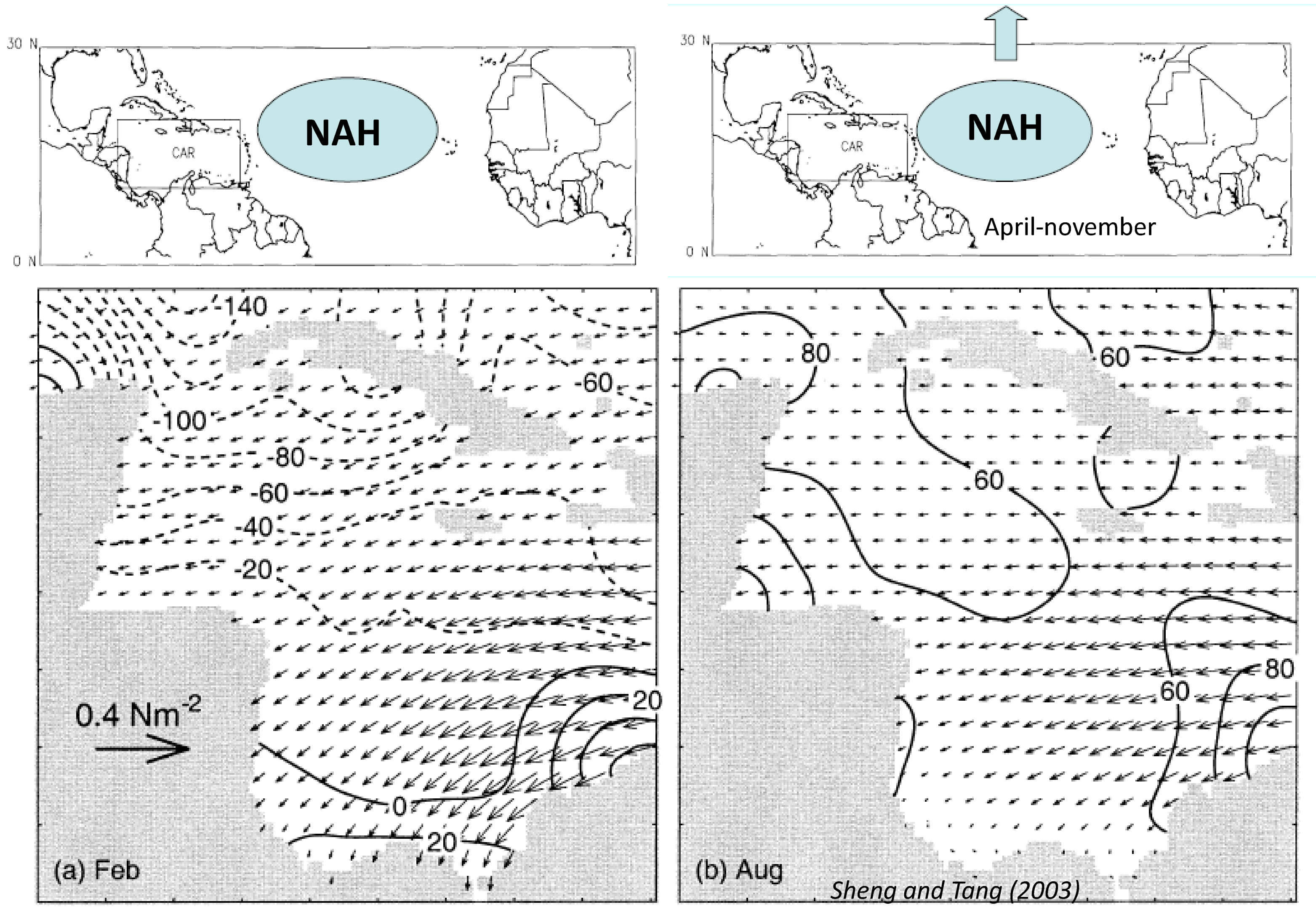




Alvera-Azcarate et al. (2009)

ENSO?

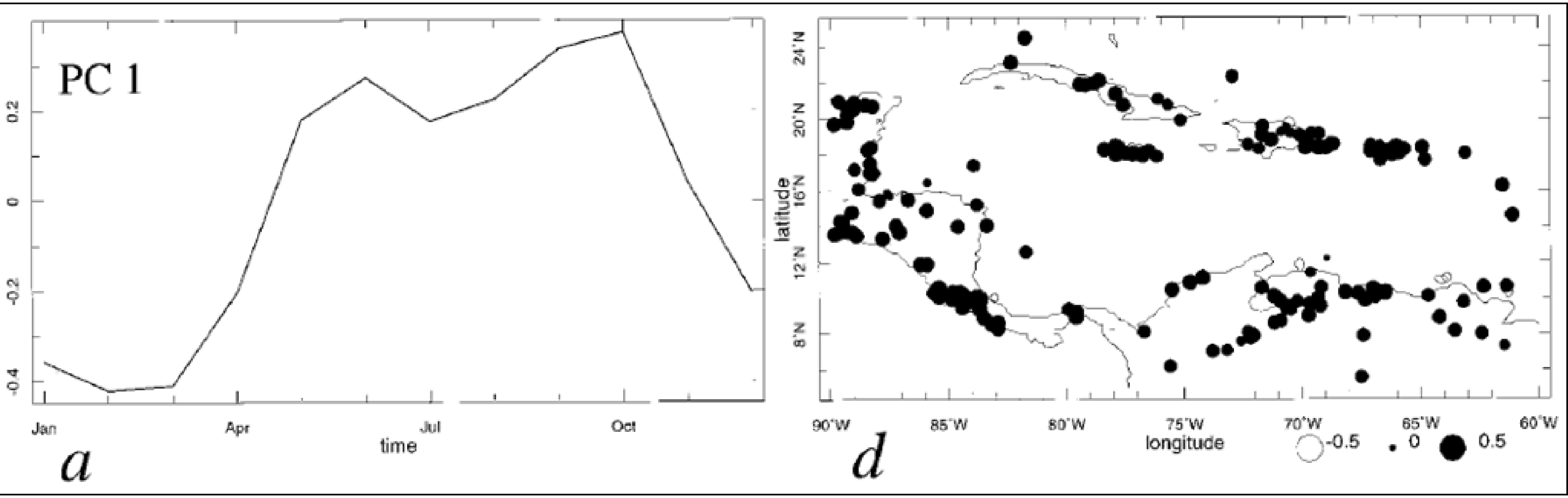
Atmosphere-annual cycle



-Persistent (3.5 – 10 m/s) NA trade winds
-tropical storms and hurricanes (summer-autumn)
-cold fronts from north America (winter)

Atmosphere-annual cycle

-Mean annual rainfall: 1618 mm/year (> 2000 mm/y in CR and Honduras)
-Mean rainy season peaks in may-june and septembre-october with a relative minimum in july

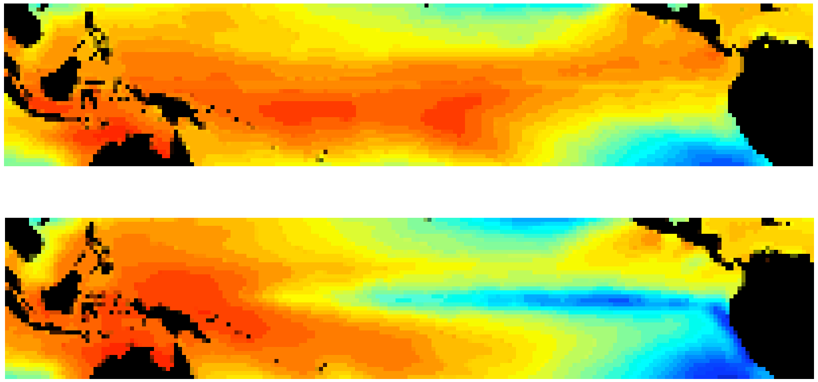


Giannini et al (2000)

-may-october: warm SST, deep, unstable boundary layer, convergence of winds towards the basin from the ETP and Atlantic, easterly propagating disturbances
-mid-summer break: intensification of the NAH strengthens subsidence over the basin
-november-april: subsidence dominates during the cold season

Atmosphere – interannual/interdecadal variability

Caribbean is affected by climate variability in the NA (NAO) and Pacific (ENSO)



ENSO Warm episode:

-low SLP in the ETP, higher than average SLP in the equatorial Atlantic → meridional SLP gradient diminished in the TNA → diminished trade winds → increasded SST

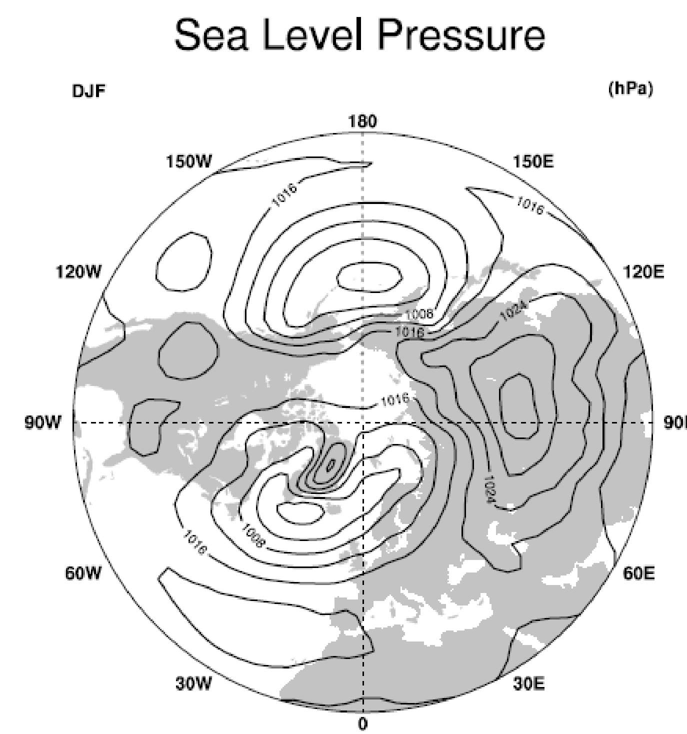
-rain decreases at first, then increases in the following rainy season (due to lagged SST increase)

- **NAO and ENSO events oppose each other**
- **NAO and ENSO impact the Caribbean independently (in phase or out of phase)**

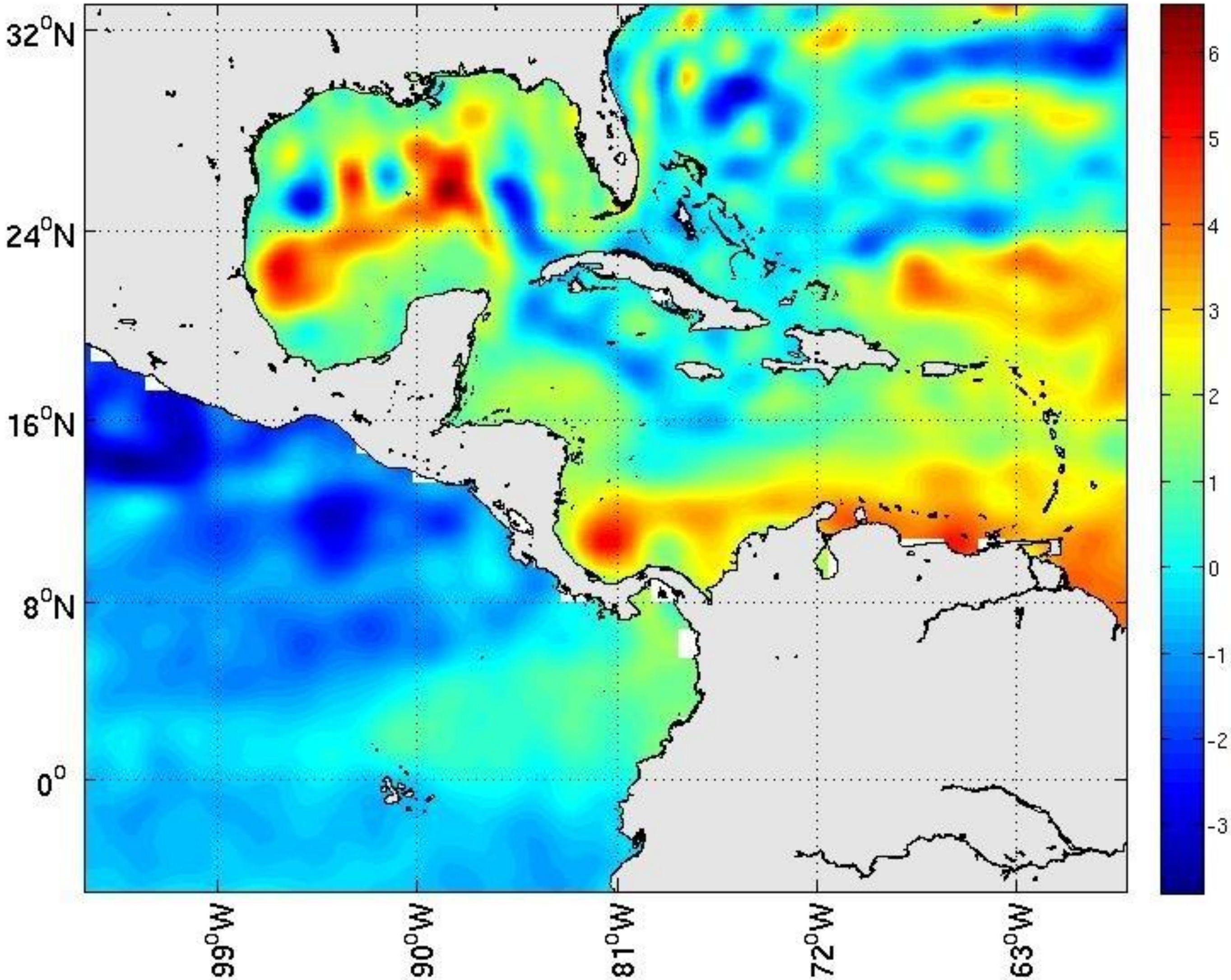
Positive NAO:

A stronger than average wintertime NAH increases the meridional SLP → increased trade winds → decreased NTA SST.

The cooling persists from winter to the beginning of the rainy season in spring (maximum impact in May-June).



Sea level trend (mm/year)



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