Weather and climate strongly influence salinity, water quality, and circulation of south Florida coastal waters and bays

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Weather and climate affect south Florida coastal waters and bays over a wide range of geographic space and time scales. The coastal system, made up of waters from the Gulf of Mexico, Atlantic Ocean, Florida Bay, Biscayne Bay, and other estuaries, is highly coupled. As a result, local meteorological processes, such as precipitation, evaporation, wind events, and direct inflows of freshwater through streamflow and runoff, strongly influence the salinity, water quality, and circulation of coastal waters.

Seasonal weather patterns

The south Florida climate is subtropical, with a relatively small annual temperature range but pronounced wet (summer/fall) and dry (winter/spring) seasons. During the wet season, showers occur virtually daily with the afternoon sea breeze, and tropical cyclones with counterclockwise winds are transient occurrences. During the dry season, cold fronts pass through the region approximately weekly with accompanying increased wind speeds and clockwise-rotating wind directions. This annual wet season/dry season pattern causes noticeable changes in the regional sea surface salinity, most pronounced in the coastal zone along the Southwest Florida Shelf near the river mouths and along the onshore edges of Florida and Biscayne Bays.

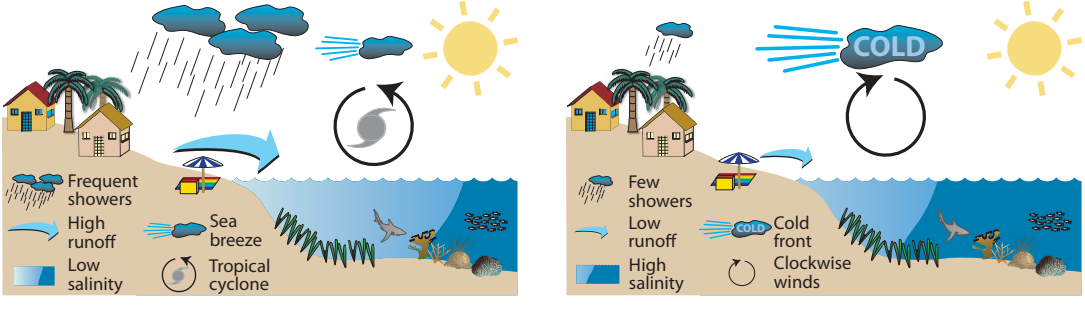
The seasonally changing regional winds, in conjunction with the geometry and bottom topography of the south Florida coastline, cause changes in the surface currents through direct forcing and by their effect on sea-level slopes. This subtidal circulation in response to the wind tends to be southward toward the Florida Keys in winter/spring, northwestward toward the Gulf of Mexico in the summer, and southwestward toward the Dry Tortugas in the fall. These seasonally episodic transport processes can affect the water quality of the Florida Keys coral reefs by delivering excessively warm, salty water to the reef tract from Florida Bay through the Keys passages in the spring and early summer, whereas relatively cold, turbid intrusions can occur in the winter.

Interannual to multidecadal weather patterns

Superimposed on the annual climatic cycle of south Florida are changes induced by longer-term and larger-scale influences, such as the interannual global phenomena known as the El Niño Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO), and the Atlantic Multidecadal Oscillation (AMO).

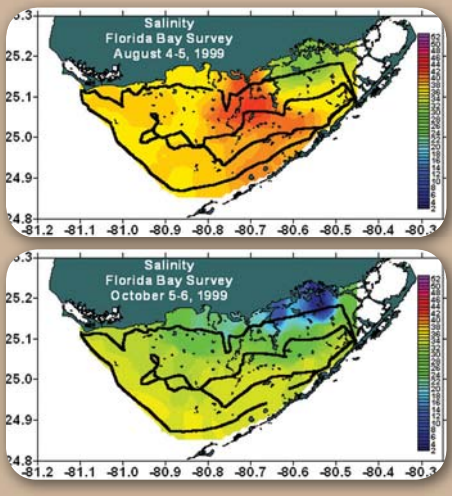
El Niño Southern Oscillation

The ENSO is a global ocean-atmosphere



Wet season (left) and dry season (right) variations in south Florida weather patterns.

Hurricanes and tropical storms



The most extreme meteorological events that affect south Florida are, as all Floridians well know, hurricanes and tropical storms. These episodic events cause rapid changes in barometric pressure; air and sea temperature; wind speed and direction; wave and swell amplitude, frequency, and direction; sea level height and slope; and coastal current speeds and directions. These changes also are accompanied by increased precipitation, more or less extreme depending on the size of the storms and the time that they spend over any given area of land or sea. All of these factors cause dramatic changes in oceanographic properties, including salinity of south Florida coastal waters, and tend to dominate time series records of meteorological and oceanographic parameters.

Surface salinity in Florida Bay before Hurricane Irene (1999) (top) and after Hurricane Irene (bottom). Red/orange shades indicate high salinities, and blue/green shades indicate low salinities.

phenomenon characterized by anomalously warm equatorial Pacific Ocean waters. It occurs roughly every 2 – 7 years. During its warm phase (El Niño), south Florida tends to experience a reversal of the normal wet/dry season and has cooler, rainier winters than usual. Conversely, during the opposite phase of ENSO (La Niña), when the equatorial Pacific is anomalously cool, south Florida tends to have warmer, drier conditions that often result in droughts and wildfires.

North Atlantic Oscillation

The NAO is an interannual north-south fluctuation in the sea level pressure difference between the Icelandic Low and the Azores High pressure systems. The NAO can cause noticeable variability in wind speed and direction, air and sea surface temperature, precipitation patterns, and the frequency and severity of storms.

Atlantic Multidecadal Oscillation

The AMO is a mode of sea surface temperature variability that occurs in the North Atlantic on a multidecadal time scale. The AMO is correlated with air temperature and precipitation variability over much of Europe and North America as well as with drought patterns and hurricane severity.

The ENSO, NAO, and AMO affect south Florida primarily by altering the usual seasonal temperature and precipitation cycles and have been shown to correlate with such variables as Florida stream flows, water depths in Lake Okeechobee, and coastal surface salinities.

Global climate change and implications for south Florida

Long-term changes in sea surface temperature, sea-level rise, hurricane severity and frequency, and other more recently discovered phenomena, such as a rise in ocean acidification, are expected to occur as a result of natural and anthropogenic global climate variability. South Florida likely will be dramatically affected by these changes due to its low elevation, high coastal population density, and unique sensitive ecosystems including the Everglades and the coral reefs. It remains to be seen how and to what extent the salinity, water quality, and coastal circulation of south Florida coastal waters, bays, and estuaries will be affected by global climate change.