The Onset of the Wet and Dry Seasons in East Central Florida- A Subtropical Wet-Dry Climate?

by Randy Lascody
March 2002

1. Introduction

East central Florida experiences seasons that differ from most of the remainder of the country. Rather than the four seasons of winter, spring, summer and fall, east central Florida exhibits a distinct Wet (warm) Season and Dry (cooler) Season. This duality of seasons is similar to the Monsoon or Wet-Dry climates that other regions of the world experience. While the general onset of the Wet and Dry Seasons is known by most, a quantitative determination has not been previously accomplished for east central Florida.

The Wet Season

The Wet Season is typically considered to begin in the latter part of May and resembles "summer" across much of the remainder of the country. Warm temperatures (mid to upper 80s) begin earlier, but usually do not coincide with the beginning of frequent summer-like rains. The primary difference between summers in east central Florida and those at higher latitudes is that the heat and humidity are relentless (i.e. there are no synoptic scale fronts that bring significant cooling and drying). Though it does not rain every day during the summer, the ***frequency*** of rainfall usually begins to increase in late May. The start of the Wet Season is occasionally delayed until June and in rare cases, even as late as early July (e.g. 1998).

The Dry Season

The Dry Season usually begins in October as the first synoptic scale cold front brings drier and slightly cooler air into the area. This first front sometimes results in a significant rain event. Tropical systems, additional fronts and gale centers can bring periods of heavy rain through November, but the ***frequency*** of rain almost always decreases after the first significant frontal passage.

Fronts continue to push through the area during the traditional "meteorological winter" months of December, January and February. Cold frontal passages during this time period will sometimes be preceded by a line of showers and thunderstorms, but the occurrence of rainfall is much less frequent than the summer. The greatest coverage of rainfall during the winter months often occurs when one of these fronts moves back northward as a warm front. Some winters have more frequent frontal passages, which can result in much above normal rainfall. The most recent occurrence was the 1997-1998 winter when a strong El Nino resulted in significant severe weather episodes and flooding across the Florida peninsula.

For east central Florida, late February through March might be the time period that most closely resembles typical Spring weather in the higher latitudes. Large swings in temperatures often occur along with occasional severe weather episodes, but rainfall is usually ***infrequent***. April is often the driest month of the year as fronts become weaker and yield less rainfall, yet manage to pass through the area and reinforce the dry and stable air mass. Temperatures warm through May with average maximum readings reaching the upper 80s by the end of the month. Rainfall frequency increases compared to April, with the most notable increase usually beginning late in the month.

2. Methodology

Biedinger and Lushine[1] conducted a study to determine the onset/end of the Rainy Season in southeast Florida. Their methodology was to determine when the minimum temperature and surface dew point first began to equal or exceed 70 degrees. This constituted the beginning of the Wet Season. The end of the Wet Season was then logically determined to be when minimum temperatures and surface dew points began to fall below 70 degrees. The frequency of rainfall almost always increased (decreased) as dew points remained above (below) 70 degrees.

This method was deemed inappropriate for determining the onset of the Wet Season in east central Florida since the frequency of rainfall often increases before dew points and minimum temperatures stay above 70 degrees. This is most likely due to the lower sea surface temperatures adjacent to east central Florida. The Gulf Stream being farther offshore compared to south Florida is the primary reason for the delay in the near shore sea surface temperature rise. Another minor factor for the delay in heating of the waters is a slightly lower sun angle compared to south Florida. Heating of land areas in east central Florida is also affected by the sun angle. In some years this may be a small factor that delays the destabilization of the atmosphere and the associated onset of more frequent showers and thunderstorms along the Gulf of Mexico and Atlantic sea breeze boundaries.

The onset of the Dry Season was also not always associated with the first fall in dew points/minimum temperatures below 70 degrees. In fact, ***average*** temperatures start to fall below 70 degrees in early October. A better measure of the onset of the Dry Season correlates to when a front drops temperatures below 60 degrees for the first time.

Two different methodologies were used in this study to determine the onset of the Wet and Dry Seasons. The first method involved a laborious inspection of Local Climatological Data (LCD) from Orlando and Daytona Beach. Data from the Orlando Herndon Airport (now Orlando Executive Airport) was examined from 1949 to 1974 while Orlando International Airport data was used during the 1975-2000 period. This data was inspected from the National Climate Data Center's (NCDC) website. A local archive of data from Daytona Beach was available for the 1935-2001 period. The second method used online meteorological data from the University Corporation for Atmospheric Research (UCAR). The data utilized in this method was the rainfall rate and precipitable water averaged over a one degree by one degree area between 28-29N latitude and 81-82W longitude.

Method 1 -- Wet Season

For Orlando, data for the period 1949-2001 was examined. Minimum temperatures in the 67-70 degree range were found to coincide with the onset of the "humid" season. This usually occurred a few days before the start of more frequent showers/thunderstorms. The median date for the onset of the Wet Season at the Orlando Airports (International Airport and the old Herndon Airport) was found to be May 24 (Table 1).

For Daytona Beach, the 1935-2001 period of record showed that there were more frequent intrusions of drier air after the apparent beginning of the humid/wet season. Nevertheless, the median date for the start of the Wet Season in Daytona Beach was determined to be May 27 (Table 1), which is similar to Orlando.

It must be stated that a purely objective analysis is not possible since the exact onset of the Wet Season is difficult to determine in some years. There were classic years when dew points and minimum temperatures rose to around 70 in mid/late May, a rainy period ensued shortly thereafter and continued through the summer. Some years saw the start of showers/storms in late May, followed by several weeks of little/no rain, and then the onset of frequent rains once again in late June.

Attempts to objectively pick the date when dew points/minimum temperatures remained above 70 degrees failed, since many years had brief periods of readings in the 60s through the month of June. This would have resulted in the median date for the onset of the Wet Season not correlating with a reasonable person's perception, and being much too late in the season.

Method 1 -- Dry (Cool) Season

Orlando: The median date for the onset of the Dry Season was found to be October 15.

Daytona Beach: The expanded period of record from 1935-2001 yielded the same median date for the onset of the Dry Season, October 15.

Table 2 summarizes the subjectively determined dates of the Dry Season onset for each year.

Exact dates for the onset of the Dry Season are difficult to determine in some years. Average minimum temperatures remain in the 70s throughout the wet (warm) season, and start to slip into the upper 60s during early October. There are classic years where a front lowers dew points and minimum temperatures below 60 degrees during the first or second week of October and rainfall frequency sharply diminishes.

However, some years may see a cold frontal passage during late September or early October, followed by a period with little/no rain, then see rainfall frequency increase through the rest of October. A strong cold front will usually dry things out significantly in early November. For this type of scenario, one person analyzing the data might pick late September as the onset of the Dry Season, but another might choose early November.

Rainfall frequency in a few years actually decreased ***before*** humidities lowered. Therefore it was concluded that a purely objective determination of the Dry Season onset is not possible. A subjective analysis was necessary for many years.

To bring more objectivity to this study, the date of the first minimum temperature below 60 degrees was determined for the late September to early November period. In many years, this was the air mass that put an end to the Wet Season. However, sometimes this cool/dry air mass would occur very early (i.e. September 20, 1981), then temperatures would warm back up and the air mass would moisten, leading to a period of summer like weather with more frequent rainfall. This also occurred in 2001 when a frontal passage on September 30 apparently put an end to the Wet Season, but very warm temperatures returned after about 5 days. Rainfall returned over portions of east central Florida between two more cold fronts that passed through during October. Finally, one last warm up occurred in early November along with some rainfall (partially influenced by Hurricane Michelle). The dry and cool air behind this system resulted in a prolonged period with no rain. A coastal low pressure center produced another rain event during the middle of

November, then a dry and stable pattern closed out the month. Table 3 summarizes the dates for the first temperature below 60 degrees at Daytona Beach and Orlando.

The median date for the start of the "cooler" season was found to be October 16 at Daytona Beach and October 19 at Orlando.

Method 2

Inspection of two variables was accomplished in the second method, Precipitable Water and Precipitation Rate for the 1960-2000 time period. The areal average of these parameters was attained for a one degree by one degree area that covered Cape Canaveral, Orlando and Daytona Beach. A chart of the average Precipitable Water in May (Figure 1) shows a sharp upward trend starting about May 20. A plot of the Precipitation Rate (Figure 2) shows a pronounced rise beginning about May 22. This corresponds rather well with the median dates determined above in Method 1 (May 24-27). The small differences in the dates determined by the two methods is likely due to the different time periods that were examined.

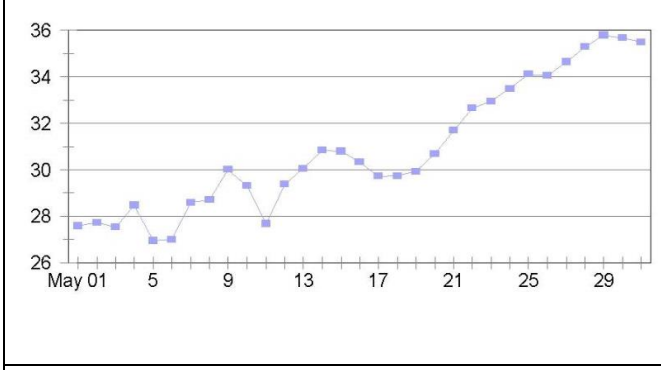

Figure 1. May Precipitable Water (mm) averaged over 28-29N/81-82W area. Clear upward trend is noted starting on the 21st. Time period for data is 1961-2000.

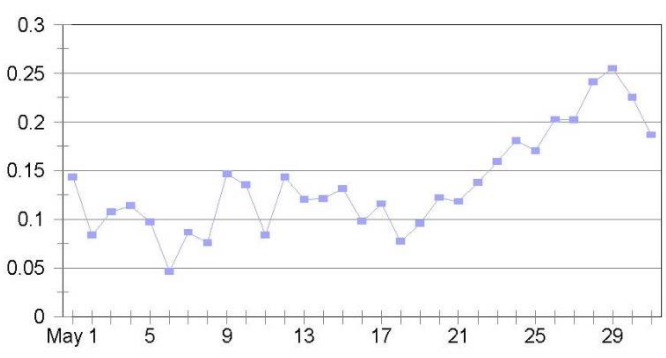

Figure 2. May Precipitation Rate (inches/day) averaged over 28-29N/81-82W area. Clear upward trend is noted starting on the 22nd. Time period for data is 1961-2000.

Figure 3 shows the average October Precipitable Water. Values start off the month near 39 mm (1.5 inches). The first pronounced fall occurs on the 11th. Figure 4, which is a plot of the October Precipitation Rate, shows a corresponding decrease on the 11th. This is assumed to be due to fronts that bring dry air into the area, and matches very closely the median date determined above (October 15) using temperature and rainfall data from Daytona Beach and Orlando. As noted above a few minor increases occur later in the month and are likely attributable to major rainfall events associated with fronts or tropical systems.

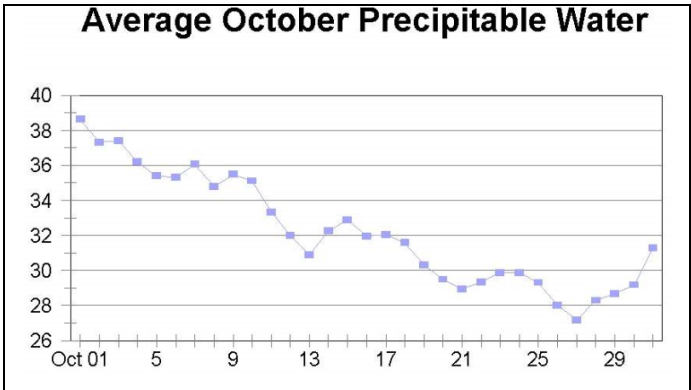

Figure 3. October Precipitable Water (mm) average over 28-29N/81-82W area. First sharp downward trend is noted starting on the 11th. Time period for data is 1961-2000.

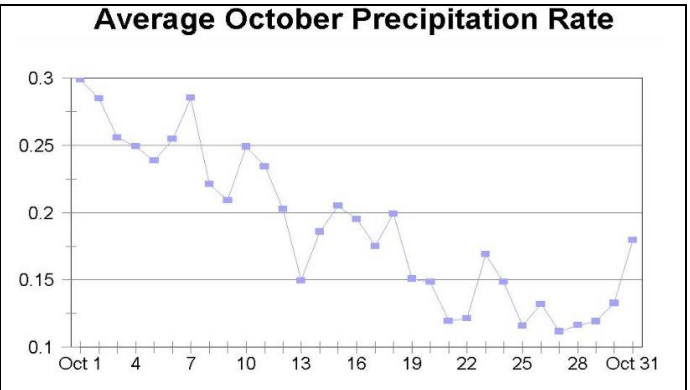

Figure 4. October Precipitation Rate (inches/day) average over 28-29N/81-82W area. Downward trend on the 11th corresponds to the first sharp decrease in Precipitable Water shown in Figure 3. Time period for data is 1961-2000.

3. Climate Classification of East Central Florida

The Glossary of Meteorology [2] defines a monsoon climate as one in which the wind flow reverses itself during the course of the year and there is a distinct winter dry season. Data examined in this study clearly indicates that there is a duality of seasons for east central Florida, with the cooler season being significantly drier than summer. Additionally, the mean wind during most of the east central Florida Wet Season is southeast (tropical) while the mean wind during much of the Dry Season is northwest to north (continental).

The Wet Season is marked by a daily inland progression of the Atlantic and Gulf of Mexico sea breezes as a low pressure trough develops across the peninsula due to surface heating. Showers and thunderstorms occur most days along the sea breezes and become numerous when these boundaries collide. While the low pressure trough that produces this sea breeze circulation is not on the same scale as the large heat lows that drive monsoon circulations elsewhere in the world, there is enough regularity to suggest some similarity. Trewartha (1968)[3] refers to the daily sea breeze circulation as a "diurnal monsoon."

The classic monsoon climate, of which India is the best example, has a "hot season" prior to the onset of the rains. Though this does not occur every year in east central Florida (and hence is not climatological), the hottest temperatures of the season sometimes occur in May or June, prior to when rainfall frequency increases. In fact, the hottest month on record in Melbourne occurred in June 1998 when the area was in the midst of a prolonged dry spell. India also has a secondary maximum in temperature right after the Rainy Season. This does not occur in east central Florida since there is a strong marine influence, and temperatures are modified in September/October as the prevailing wind flow becomes more easterly.

In Trewartha (1968) the Koppen Climate Classification System designates north/central Florida as a Subtropical Humid climate (**Cf**) with a year-round distribution of rainfall. This places east central Florida in the same climate classification as Memphis, Tennessee! Clearly, Memphis and Melbourne should not have the same climate classification.

The **Cw** classification is a Subtropical Humid Wet-Dry climate with a monsoonal influence (dry winter). This classification requires the climatologically wettest month to have ten times more rainfall than the driest month. East central Florida does not meet this requirement since the driest month averages around 2 inches, and there is no location in the state which averages 20 inches in a month! An alternate to the 10:1 ratio is that 70% of the yearly rainfall must occur during the six warm season months. Rainfall for Daytona Beach during the months of May-October is about 64% of the yearly total, while Orlando and Melbourne were 68%, and Vero Beach was 66%.[4]

So it can be seen that **east central Florida does not meet the strict definition of a Cw climate**. However, during any given year, there is most always a month that is ten times wetter than another in east central Florida, since rainfall less than one inch is quite common during at least one of the Dry Season months. In fact, examination of Orlando rainfall from 1927-2001 showed that there were only 9 years when the 10:1 ratio was not met. This is the nature of statistics in which the average or "normal" conditions mask the extremes.

The **Cs** classification (Mediterranean Climate) occurs where there are dry summers and the wettest winter month has at least 3 times as much rain as the driest summer month. Trewartha states that in the **Cf** classification, the difference between the rainiest and driest months is less than for **Cs**. Yet, the climatologically wettest month in east central Florida has a little greater than 3 times the rainfall of the driest month.[4] Therefore, **east central Florida also does not meet the strict definition of a Cf climate.**

The southern tip of Florida is an **Aw** (Tropical Wet-Dry) climate. The requirement for this designation is that the coolest month averages above 64.4 degrees Fahrenheit. East central Florida does not meet this requirement. However it is interesting to note that the rainfall requirements to receive a Tropical Wet-Dry designation are far less stringent when compared to the 10:1 ratio for the **Cw** (Subtropical Humid Wet-Dry) classification. The requirements are only that there must be a "marked seasonal rhythm" of rainfall and at least one month must have less than 2.4 inches. Both of these rainfall requirements are met for most of east central Florida.

A rainfall formula is used within the Tropical (**A**) classification to determine whether the climate is Monsoon (**Am**) or Wet-Dry (**Aw**). According to this formula, rainfall in east central Florida does not meet the Monsoon classification, but it does fit that of a Tropical Wet-Dry (**Aw**) climate. As noted above, rainfall requirements for Humid Subtropical Wet-Dry (**Cw**) are not achieved in east central Florida. Therefore, the Wet-Dry sub-categories of the **A** and **C** climate classifications appear to have a discrepancy with regard to the rainfall requirements.

So while it cannot be technically stated that this area has a Monsoon or a Wet-Dry climate, most years exhibit a monsoonal influence with distinct wet and dry seasons. **The east central Florida climate fits more closely with the Cw classification than it does with Cf.**

4. Conclusions.

Two different data sets for both Orlando and Daytona Beach were inspected in order to define the Wet and Dry Seasons. Once appropriate criteria were established, definitive dates were picked each year for the onset of the wet and Dry Seasons.

Data showed that the median date for the onset of the Wet Season is May 24 in Orlando and May 27 in Daytona Beach, while the median date for the onset of the Dry Season is October 15 at both locations. The average Wet Season lasts about 5 months (146 days for Orlando and 143 days for Daytona Beach), and provides about 61% of the total annual rainfall for Orlando and 55% for Daytona Beach. The median date for the onset of the "Cooler" Season (first temperature below 60 degrees) is October 19 at Orlando and October 16 at Daytona Beach.

The Wet Season across southern sections may start (end) slightly earlier (later) due to the closer proximity of the warm Gulf Stream waters. This is supported by the findings of Biedinger and Lushine, which show that the average south Florida Rainy Season extends from May 21 to October 17.

The Wet Season in east central Florida is commonly referred to as the "Rainy Season." Though not as dramatic as the Monsoon circulations elsewhere in the world, the Florida peninsula has many of the same climate characteristics and certainly can be classified as "Monsoon-like" or "Monsoonally influenced" with a distinct wet-dry seasonal rhythm. The east central Florida climate does not have an appropriate classification in the Koppen scheme but fits close to the Subtropical Humid Wet-Dry (**Cw**) category.

5. References

[1] Biedinger, R., and J. B. Lushine, 1993: *Duration of the Summer Season in South Florida*. NOAA/NWS. Available [on-line] http://www.weather.gov/media/mlb/climate/summer_season.pdf

[2] American Meteorological Society, 1959: *Glossary of Meteorology*. Amer. Met. Soc., 638 pp.

[3] Trewartha, G. T., 1968: *An Introduction to Climate*. McGraw-Hill, 408 pp.

[4] 1971-2000 Climate Normals. Available [on-line] http://www.weather.gov/mlb/1971-2000_normals

Table 1

Approximate Onset of the Wet Season at Daytona Beach and Orlando, Florida (Updated through 2010)

Daytona Beach Median Date = May 29
Orlando Median Date = May 27

	Daytona Beach	Orlando
1935	6/11	
1936	5/20	
1937	6/4	
1938	5/23	
1939	6/13	
1940	5/29	
1941	6/5	
1942	5/29	
1943	5/15	

Table 2

Approximate Onset of the Dry Season at Daytona Beach and Orlando, Florida
(Updated through 2010)

Daytona Beach & Orlando Median Date = October 15

	Daytona Beach	Orlando
1935	10/18	
1936	10/18	
1937	10/21	
1938	10/22	
1939	10/22	
1940	9/30	
1941	11/3	
1942	10/2	
1943	10/9	
1944	10/10	

Table 3

Onset of the "Cooler" Season at Daytona Beach and Orlando, Florida (First Temperature Below 60°) (Updated through 2010)

Daytona Beach Median Date = October 16
Orlando Median Date = October 19

	Daytona Beach	Orlando
1935	11/2	
1936	10/30	
1937	10/21	
1938	9/21	
1939	10/24	
1940	10/1	
1941	11/3	
1942	10/12	

1944	6/4	
1945	6/18	
1946	5/12	
1947	5/21	
1948	5/23	
1949	5/28	5/30
1950	6/4	5/27
1951	6/4	6/6
1952	5/17	5/17
1953	6/4	6/2
1954	5/25	5/27
1955	6/10 *	6/11 *
1956	5/24	5/25
1957	5/11	5/11
1958	5/21	5/22
1959	5/12	5/17
1960	6/2	5/26
1961	6/7	6/7
1962	6/1 *	5/21
1963	5/19	5/21
1964	5/31	5/30
1965	6/4	5/29
1966	5/3	5/5
1967	6/2	6/3
1968	5/24	5/24
1969	5/14	5/14
1970	5/24	5/24
1971	6/7	6/3
1972	5/8	5/7
1973	5/24	5/24
1974	5/12	5/12
1975	5/14	5/9
1976	5/22	5/23
1977	5/23	5/24
1978	5/31	6/1
1979	5/30	5/30
1980	5/14	5/15
1981	5/26	5/26
1982	5/20	5/21
1983	5/29	5/30
1984	5/23 & 6/11	5/22 & 6/11
1985	6/8	5/20
1986	5/31	6/2
1987	5/9	5/9
1988	6/5	6/5
1989	6/4	5/28
1990	6/3	5/27

1945	10/14	
1946	11/13	
1947	10/30	
1948	10/13	
1949	10/15	10/15
1950	10/5	10/4
1951	10/23	10/24
1952	10/22	10/21
1953	10/10	10/10
1954	10/15	10/15
1955	10/14	10/14
1956	10/18	10/18
1957	10/6	10/6
1958	10/20	10/20
1959	10/25	10/25
1960	10/21*	10/22*
1961	10/15	10/15
1962	10/19	10/19
1963	10/19	10/19
1964	10/16*	10/16*
1965	10/8	10/18
1966	10/11	10/12
1967	9/29	9/29
1968	10/20	10/20
1969	11/3	11/3
1970	10/31*	10/31*
1971	11/4	11/7
1972	10/6	10/7
1973	10/24*	10/24
1974	10/1	10/1
1975	10/19	10/19
1976	10/1	10/1
1977	10/4*	10/4
1978	10/7	10/7
1979	10/5	10/5
1980	10/4	10/4
1981	10/15	10/15
1982	10/15	10/15
1983	10/25	10/25
1984	10/1	10/1
1985	11/2	11/4
1986	10/16	10/16
1987	10/2	10/2
1988	10/8	10/7
1989	10/19	10/18
1990	10/24	10/25
1991	10/7	10/7
1992	10/12*	10/12

1943	10/16	
1944	10/10	
1945	10/16	
1946	11/14	
1947	11/1	
1948	10/10	
1949	10/23	11/1
1950	11/1	11/4
1951	10/11	10/11
1952	10/29	10/21
1953	10/11	10/11
1954	10/16	10/16
1955	10/14	10/14
1956	9/26	9/27
1957	10/25	10/25
1958	10/21	10/20*
1959	10/25	10/25
1960	10/23	10/23
1961	10/16	10/15
1962	10/20	10/20
1963	10/12	10/29
1964	10/7	10/7
1965	10/23	10/23
1966	10/12	10/20
1967	10/11	10/19
1968	10/25	10/25
1969	11/4	11/4
1970	11/2	11/2
1971	10/11	11/8*
1972	10/9	11/9
1973	10/26	10/27
1974	10/19	10/4
1975	10/20	10/21
1976	10/2	10/3
1977	10/13	10/13
1978	10/8	10/8
1979	10/6	10/6
1980	10/5	10/12
1981	9/19	9/19
1982	9/27	10/17
1983	10/25	10/27
1984	10/2	10/2
1985	10/7	11/4
1986	10/17	11/21*
1987	10/3	10/5
1988	10/8	10/8
1989	10/19	10/19
1990	10/25	10/25

1991	5/13	5/13
1992	5/27	5/27
1993	6/12	6/12
1994	5/29	5/28
1995	5/20	5/20
1996	5/21	5/21
1997	5/19	5/19
1998	7/6	7/6 *
1999	5/27	5/27
2000	6/22	6/11
2001	5/30	5/22
2002	6/7	6/6
2003	6/2	6/2
2004	6/1	6/3
2005	5/30	5/30
2006	6/11	6/11
2007	6/6	6/6
2008	6/10	6/9
2009	5/17	5/17
2010	5/30	5/30

Table 1. Dates for the onset of the Wet Season as determined by rainfall and temperature data. * Indicates dates from original study that were re-evaluated.

Data Sources:

Orlando	Herndon Airport 1949-1974	International Airport 1975-present
Daytona Beach	International Airport 1935-present	

1993	10/11*	10/11*
1994	10/17	10/17
1995	10/18	10/19
1996	10/9	10/9
1997	10/19	10/19
1998	10/22*	10/22
1999	10/22	10/22
2000	10/9	10/9*
2001	9/30	9/30
2002	10/16	10/16
2003	10/15	10/15
2004	10/14*	10/14*
2005	10/14	10/15
2006	9/27	9/27
2007	11/3	11/3
2008	10/14	10/14
2009	9/30	9/30
2010	9/30	9/30

Table 2. Dates for the onset of the Dry Season as determined by temperature and rainfall data.
* Indicates dates from original study that were re-evaluated.

Data Sources:

Orlando Herndon Airport 1949-1974	International Airport 1975-present
Daytona Beach International Airport 1935-present	

1991	10/12	10/17
1992	10/12	10/5
1993	10/29	10/13
1994	11/2	11/2
1995	10/21	10/21
1996	10/10	10/11
1997	10/19	10/19
1998	10/24	10/24
1999	10/22	10/23
2000	10/9	10/9
2001	10/1	10/2
2002	10/17	10/18
2003	10/15	10/16
2004	10/15	10/15
2005	10/24	10/24
2006	10/9	10/15
2007	11/3	11/3
2008	10/26	10/19
2009	10/1	10/17
2010	10/6	10/6

Table 3. Dates for the onset of the "Cooler" Season as determined by temperature data.
* Indicates dates from original study that were corrected.

Data Sources:

Orlando	Herndon Airport 1949-1974	International Airport 1975-present
Daytona Beach	International Airport 1935-present	