



# Extreme Weather Events & the Onset of Psychotic Depression

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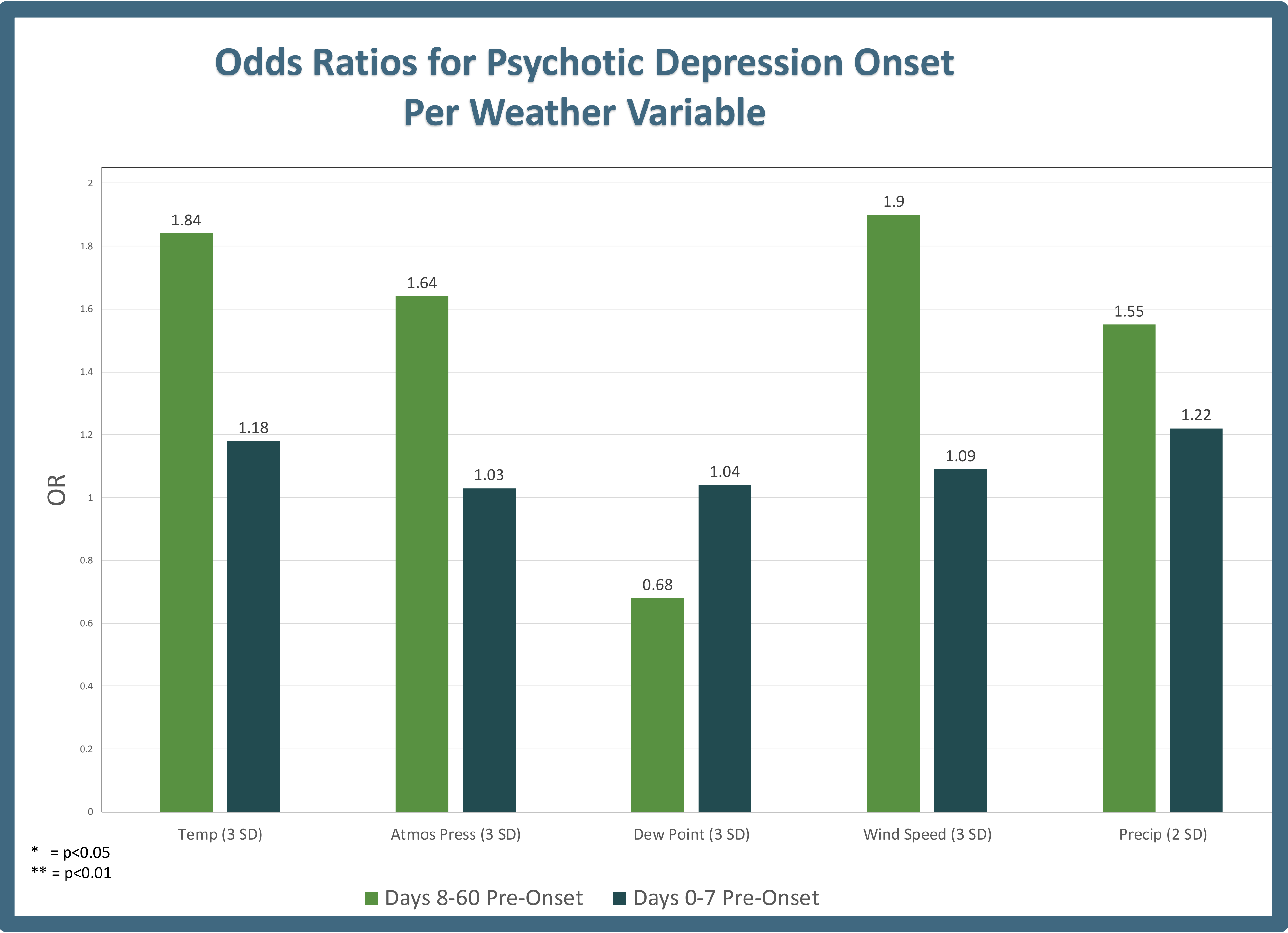
## Introduction

Weather parameters are known to influence mood, behavior, and symptom severity in various disease states. Seasonal Affective Disorder is a well-established phenomenon. Additionally, a small number of investigators have found that admission rates for bipolar disorder (Shapira, 2004, *Bipolar Dis* 6:1) and suicide frequency (Maes,1994, *Acta Psych Scand* 90:5) both positively correlate with ambient temperature, while violent acts and emergency psychiatric visits both correlate with lowered barometric pressure as seen in advancing storm fronts (Schory, 2003, *Can J of Psych* 48:9.) A single European investigator found an association between lowered barometric pressure and the incidence of psychotic depression, a severe form of depression with psychotic symptoms present during the period of mood disturbance. (Radua, 2010, *Psych Res* 175:3.) The purpose of this study is to evaluate further the effects of various changing weather parameters on the onset of psychotic depression.

## Methods

- Study Sample: 259 subjects with psychotic depression who participated in the National Institute of Mental Health STOP-PD (The Study of Pharmacotherapy of Psychotic Depression) between December 2002 and June 2007. Weather events were examined in relation to these subjects' onset dates.
- Weather data was obtained from the National Oceanic and Atmospheric Administration (NOAA).
- Daily mean weather variables (temperature, dew point, barometric pressure, wind speed, precipitation) were calculated for each of the 60 days prior to a patient's onset.
- Extreme weather events (defined as 2 or 3 standard deviations from the daily historical mean (from 1980-1999) to control for seasonality and patient acclimatization) were then tabulated for each patient's pre-onset period.
- Longitudinal logistic regression models, implemented with general estimating equations (GEE), were used to determine the effect of a specific weather predictor event (such as local temperature exceeding the average temperature by 3 standard deviations on a particular day) on the outcome (episode onset), separating (through interaction terms) the effects of the weather predictor event during a longer term period (8 to 60 days before the depressive episode) and the effects of the occurrence of the weather predictor event in the immediate seven days before episode onset.
- Odds ratios were calculated from the GEE model parameter estimates to represent the effect of the weather events on the outcome.
- SAS 9.4 (SAS Institute, Cary, NC) was used for all analyses.

## Results



Results are expressed as odds ratios for onset of psychotic depressive episodes when proceeded by the occurrence of extremes in five weather variables (temperature, atmospheric pressure, dew point/humidity, wind speed, and precipitation.) The weather variables were classified as 2, 3, or 4 standard deviations (SD) above/below a historical average. Light green denotes the exposure period of 8 days prior to 60 days prior to onset. Dark green denotes the exposure period of 1 week prior to onset. Note that ORs are smaller and p values are larger for the dark green exposure period due to fewer extreme weather events during this shorter period. ***The longer pre-onset time models for temperature (3 SD), atmospheric pressure (3 SD), wind speed (3 SD), and precipitation (2 SD) all showed that the condition deviation from average had a subsequent effect of increasing the probability of an episode significantly. In addition, a 2 SD from the average in precipitation during the week prior also significantly increased the probability of an episode.***

	OR	p-Value
<b>Temperature</b>		
8-60d Pre-Onset	1.84	0.0038
0-7d Pre-Onset	1.18	0.0881
<b>Atmosph. Pressure</b>		
8-60d Pre-Onset	1.64	0.0287
0-7d Pre-Onset	1.03	0.7276
<b>Dew Point</b>		
8-60d Pre-Onset	0.68	0.2438
0-7d Pre-Onset	1.04	0.8305
<b>Wind Speed</b>		
8-60d Pre-Onset	1.90	0.0004
0-7d Pre-Onset	1.09	0.2698
<b>Precipitation</b>		
8-60d Pre-Onset	1.55	0.0157
0-7d Pre-Onset	1.22	0.0276

## Discussion

Understanding the mechanism of how weather parameters influence psychotic depression in particular and psychiatric conditions in general may provide clues regarding the underlying pathophysiology of these conditions.

Of note, weather parameters are also known to influence onset and symptom severity in various neurological conditions. For example, increased ambient temperature is a common trigger for many ailments, including those psychiatric, in multiple sclerosis and other neuroinflammatory conditions. This is thought to be due to Uhthoff's Phenomenon, the observation that heat decreases the speed of nerve conduction, especially in areas of demyelination (Frohman 2013, *Nature Rev Neuro* 9:9.) Low barometric pressure also induces migraines in susceptible individuals (Kimoto 2011, *Int Med* 5:18.) While a pressure mechanism is far from clear, it is known that healthy individuals such as pilots, climbers and divers exposed to pressure extremes may experience a wide array of neuropsychiatric symptoms (Blanchet 1997, *Stress Med* 13; Etzion 1999, *Euro J Physio* 437; Rostain 1975, *Physio & Med of Diving*.) As such, the role of barometric pressure in this study and elsewhere should not come as a complete surprise. While there is little scientific evidence to support a wind speed effect, many cultures use conditions of high winds to explain unusual behavior, eg the Sirocco Winds of Italy & the Santa Ana "Devil Winds" of Southern California.

Further directions for this research are many:

- Determining directionality of weather parameters.
- Exploring different time periods of susceptibility.
- Analyzing how weather affects remission status, need for hospitalization, and whether suicide was attempted or completed, all of which are surrogates for severity of psychotic depression.
- Investigating effects of age and gender.
- Considering synergistic effects between variables which may help to identify a perfect storm that pushes an otherwise susceptible brain into psychosis and depression.

Potential limitations of these analyses include relying on patients' reported onset dates, lack of directionality regarding the change in weather parameter, a wide pre-onset period of susceptibility, and failure of statistical models to produce meaningful results for rapid changes in weather parameters, which are likely to play a role.

## Conclusions

Psychiatric disorders are known to be multifactorial. These results demonstrate that extreme weather events are a factor in the onset of psychotic depression. In particular, an individual is 1.84 times more likely to experience a psychotic depression if he or she is exposed to a 3 SD temperature event in the time period of 8 to 60 days prior to onset. Similarly, during this same time period, an individual is 1.64 times more likely to experience an episode if exposed to a 3 SD barometric pressure event, 1.9 times more likely to experience an episode if exposed to a 3 SD wind speed event, and 1.55 times more likely to experience an episode if exposed to a 2 SD precipitation event. Additionally, an individual is 1.22 times more likely to experience an episode if exposed to a 2 SD precipitation event during the week prior to onset.

While the mechanism at this point is largely speculative and the implications for the treatment of psychiatric illness require further research, the present results support the role of environmental factors in the onset of psychiatric illness. Given the known role of temperature in nerve conduction and the variety of neuropsychiatric symptoms seen at pressure extremes, these results also support a physiological, neurological and neuroinflammatory basis for psychotic depression.

## Contact Information

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