Research Work Unit 4401

Atmospheric Disturbance Climatology

Fire Weather Patterns

It has long been recognized that atmospheric conditions play a critical role in affecting the behavior and severity of wildland fires as well as the probability of their occurrence. Fire managers rely heavily on current observations and forecasts of local, regional, and synoptic atmospheric conditions to prepare for fire suppression and prescribed fire activities. Understanding the relationships of large-scale upper and middle atmospheric processes to regional-scale fire-weather systems is critical for establishing reliable forecasts of fire-weather and for assessing how potential large-scale changes resulting from a globally changed climate might influence fire occurrence and severity in the US.

One of the most comprehensive observational studies of atmospheric synoptic-scale linkages with high fire danger was performed by Schroeder et al (1964). Through subjective analyses, they were able to identify specific surface and 500 mb circulation patterns conducive for high fire load index values for 14 different regions of the US. As an extension of this study, a statistically based classification of middle atmospheric circulation patterns and lower atmospheric temperature and moisture patterns prevalent at the onset of severe wildland fires in different regions of the continental US has been performed. Although many factors in addition to atmospheric conditions prior to and during a wildland fire determine the probability of a severe fire occurrence, this study addresses only the synoptic-scale atmospheric circulation, temperature, and moisture fields as forcing mechanisms for fire occurrence.

Archived US wildland fire data for the period 1971-1991 were obtained for fires that burned more than 1000 acres. Fire occurrence data were organized according to the geographic locations of the fires. For those days when wildland fires occurred in each defined region, the 1200 GMT 500 mb geopotential height fields, the 0000 GMT 850 mb temperature fields, and the 0000 GMT lower atmospheric relative humidity fields were extracted from the National Center for Environmental Prediction's (NCEP) Limited Fine Mesh (LFM) Model initialization fields data base. Gridded geopotential height anomaly fields were calculated by subtracting the appropriate 1971-1991 gridded monthly averages of 500 mb geopotential heights from the extracted LFM initialization

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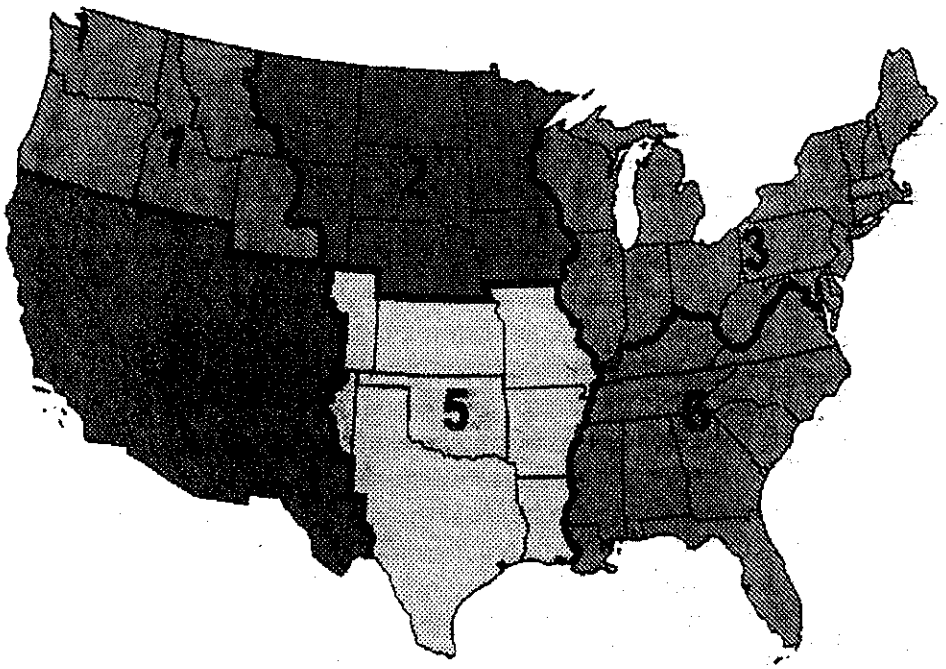
fields. These anomaly fields provided the basis for determining the prevalent circulation patterns at the onset of severe fires in each of the six defined regions.

The 500 mb geopotential height anomaly fields were subjected to empirical-orthogonal-function (EOF) analyses to determine the principal components of the anomaly fields. Those EOFs accounting for the most variance in the observed geopotential height anomaly fields were used as guidance in establishing a set of synoptic 500 mb circulation pattern classifications that characterize the atmosphere at the onset of most severe fires in each of the six defined regions. Average gridded 850 mb temperature and lower atmospheric relative humidity anomaly fields associated with each of the synoptic 500 mb circulation patterns were also determined from the LFM data base.

Results from the EOF analyses indicate that there are typically two or three specific middle atmospheric (500 mb) synoptic circulation patterns associated with severe wildland fire occurrence in each of the six regions. These circulation patterns lead to specific lower atmospheric (850 mb) synoptic temperature patterns and lower atmospheric (surface to 700 mb) synoptic relative humidity patterns.



Region 1 (NW) **Region 2 (NC)** **Region 3 (NE)**
Region 4 (SW) **Region 5 (SC)** **Region 6 (SE)**

The 500 mb circulation patterns and the associated lower atmospheric temperature and moisture patterns over the US can influence the Lower Atmospheric Severity Index (LASI), also known as the Haines Index. This atmospheric index represents the potential for severe wildfire occurrence based

solely on lower atmospheric temperature and moisture conditions. Current and forecasted LASI values can be obtained from the University of Wisconsin *Nonhydrostatic Modeling System*.

A variety of atmospheric-related information can be obtained from The Unisys Weather Processor, including:

Current Pattern	Forecasted Patterns
500 mb Circulation	500 mb Circulation
850 mb Temperature	850 mb Temperature
Surface Dew Point	Lower Atmospheric Moisture

Publications can be obtained from your local library, the appropriate journal, or the authors, if supplies remain.

- **Synoptic circulation and temperature patterns during severe wildland fires.** Heilman, W. 1995. In: *Proceedings of the Ninth Conference on Applied Climatology*, Jan 15-20 1995, Dallas TX. American Meteorological Society, Boston MA. p 346-351.
- **Synoptic weather types associated with critical fire weather.** Schroeder, M; Glovinsky, M; Hendricks, V; Hood, F; Hull, M; Jacobson, H; Kirkpatrick, R; Krueger, D; Mallory, L; Oertel, A; Reese, R; Sergius, L; Syverson, C. 1964. Pacific Southwest Forest and Range Experiment Station, Berkeley CA. 492 pp.

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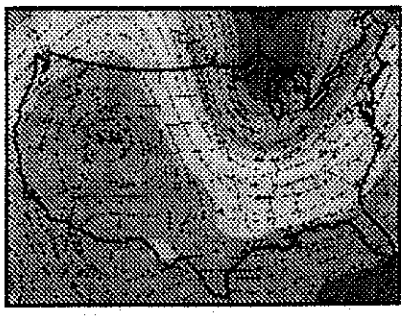
Region 1 Fires

Synoptic Circulation, Temperature, and Moisture Patterns

Severe wildland fires (>1000 acres) in the Northwestern region of the US typically occur during the months of July, August, and September. Analyses suggest there are three synoptic circulation patterns associated with the onset of severe wildland fires in this region. Each figure depicts the 500 mb height contour pattern (in meters) along with the 500 mb streamlines which portray wind directions. Higher wind speeds occur in regions where the 500 mb height contours are more closely packed together.

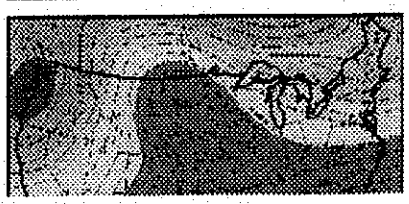


Circulation Pattern 1

Strong 500 mb ridge centered over the Western US and Southwestern Canada, with a 500 mb trough centered over the Eastern or Central regions of the US.

Circulation Pattern 2

Zonal flow over the Northwestern region of the US accompanying a northward shift of the jet stream over much of the US. Northeastern US and Southeastern Canada dominated by prominent ridge or trough.



Circulation Pattern 3

500 mb ridge centered over the Northern Great Plains and South-central Canada, with

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the extreme Northwestern and Northeastern US dominated by 500 mb troughs.

Associated with these 500 mb circulation patterns are typical lower atmospheric temperature and moisture (relative humidity) patterns. The figures below depict average 850 mb temperature anomalies (°C) and lower atmospheric relative humidity anomalies (%) associated with each of the three circulation patterns that were present during past severe wildland fire episodes in Region 1 (1971-1991).

Circulation	Temperature Anomalies	Relative Humidity Anomalies
Pattern 1	x	x
Pattern 2	x	x
Pattern 3	x	x

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Region 2 Fires

Synoptic Circulation, Temperature, and Moisture Patterns

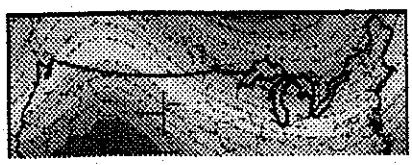
Severe wildland fires (>1000 acres) in the North-central region of the US typically occur during the months of March and April, and then again during the months of June, July, and August. Analyses suggest there are three synoptic circulation patterns associated with the onset of severe wildland fires in this region. Each figure depicts the 500 mb height contour pattern (in meters) along with the 500 mb streamlines which portray wind directions. Higher wind speeds occur in regions where the 500 mb height contours are more closely packed together.

Circulation Pattern 1

Strong 500 mb ridge centered over the Central Plains and extending northward into Canada, with the Eastern and Western regions of the US dominated by troughs. Classic "Omega" blocking pattern.

Circulation Pattern 2

500 mb ridge centered over the Eastern half of the US, with the Western States dominated by a 500 mb trough. Southwesterly flow over the Northern Great Plains.



Circulation Pattern 3

Strong northwesterly flow at 500 mb over

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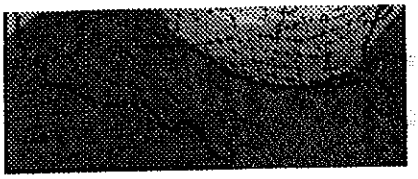

the Northern Great Plains in response to a strong ridge and trough over the Western and Eastern US, respectively.

Associated with these 500 mb circulation patterns are typical lower atmospheric temperature and moisture (relative humidity) patterns. The figures below depict average 850 mb temperature anomalies (°C) and lower atmospheric relative humidity anomalies (%) associated with each of the three circulation patterns that were present during past severe wildland fire episodes in Region 2 (1971-1991).

Circulation	Temperature Anomalies	Relative Humidity Anomalies
Pattern 1	x	x
Pattern 2	x	x
Pattern 3	x	x

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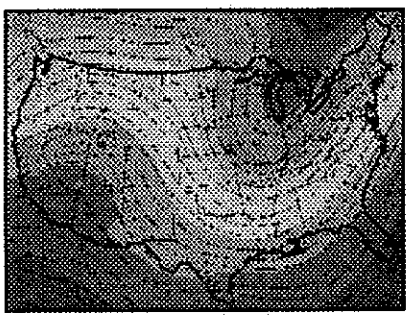
Region 3 Fires

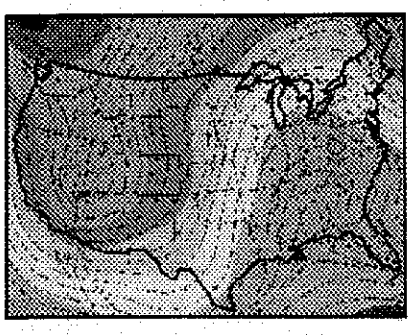
Synoptic Circulation, Temperature, and Moisture Patterns

Severe wildland fires (>1000 acres) in the Northeastern region of the US typically occur during the months of April and May, and then again during the months of October and November. Analyses suggest there are two synoptic circulation patterns associated with the onset of severe wildland fires in this region. Each figure depicts the 500 mb height contour pattern (in meters) along with the 500 mb streamlines which portray wind directions. Higher wind speeds occur in regions where the 500 mb height contours are more closely packed together.



Circulation Pattern 1

500 mb ridge over the Western half of the US accompanied by a prominent trough over the Eastern half of the US and Southeastern Canada, resulting in the transport of cool dry air into the Northeastern US.



Circulation Pattern 2

Strong 500 mb ridge over the Eastern half of the US or off the Eastern US coast, with the Western and/or Central States dominated by a 500 mb trough.

Associated with these 500 mb circulation patterns are typical lower atmospheric temperature and moisture (relative humidity) patterns. The figures below depict average 850 mb temperature anomalies (°C) and lower

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below depict average 850 mb temperature anomalies (°C) and lower atmospheric relative humidity anomalies (%) associated with each of the two circulation patterns that were present during past severe wildland fire episodes in Region 3 (1971-1991).

Circulation	Temperature Anomalies	Relative Humidity Anomalies
Pattern 1	x	x
Pattern 2	x	x

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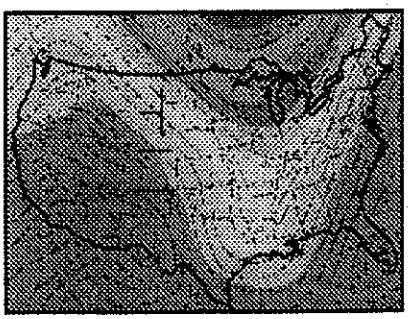
Region 4 Fires

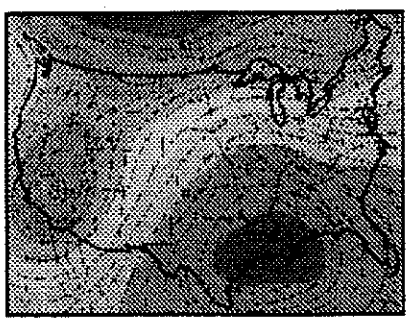
Synoptic Circulation, Temperature, and Moisture Patterns

Severe wildland fires (>1000 acres) in the Southwestern region of the US typically occur during the months of June through September. Analyses suggest there are three synoptic circulation patterns associated with the onset of severe wildland fires in this region. Each figure depicts the 500 mb height contour pattern (in meters) along with the 500 mb streamlines which portray wind directions. Higher wind speeds occur in regions where the 500 mb height contours are more closely packed together.



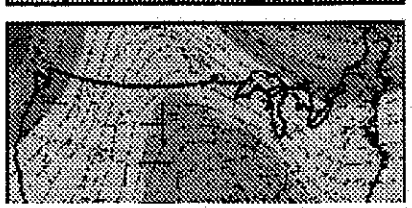
Circulation Pattern 1

Strong 500 mb ridge centered over the Western US and Southwestern Canada, with a 500 mb trough centered over the Eastern or Central regions of the US. Upper atmospheric support for the Santa Ana winds.



Circulation Pattern 2

Strong 500 mb trough over the Western States with a ridge over the Eastern US or Western Atlantic, resulting in cooler than normal conditions over much of the Western US but drier than normal conditions over the extreme Western States.



Circulation Pattern 3

500 mb ridge centered over the Central and Northern Great Plains, with troughs

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dominating the Eastern and Western US and drier than normal conditions over the Western and Eastern sections of the region.

Associated with these 500 mb circulation patterns are typical lower atmospheric temperature and moisture (relative humidity) patterns. The figures below depict average 850 mb temperature anomalies (°C) and lower atmospheric relative humidity anomalies (%) associated with each of the three circulation patterns that were present during past severe wildland fire episodes in Region 4 (1971-1991).

Circulation	Temperature Anomalies	Relative Humidity Anomalies
Pattern 1	x	x
Pattern 2	x	x
Pattern 3	x	x

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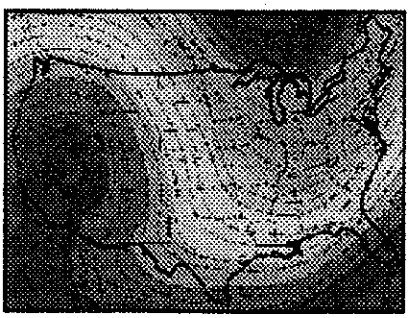
Region 5 Fires

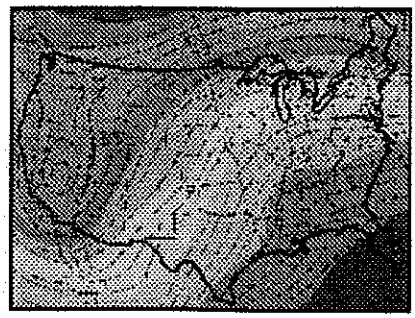
Synoptic Circulation, Temperature, and Moisture Patterns

Severe wildland fires (>1000 acres) in the South-central region of the US typically occur during the months of March and April. Analyses suggest there are three synoptic circulation patterns associated with the onset of severe wildland fires in this region. Each figure depicts the 500 mb height contour pattern (in meters) along with the 500 mb streamlines which portray wind directions. Higher wind speeds occur in regions where the 500 mb height contours are more closely packed together.



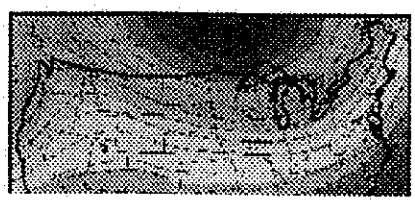
Circulation Pattern 1

500 mb ridge over the Western half of the US accompanied by a prominent trough over the Eastern half of the US or off the Eastern US coast, resulting in dry conditions and northwesterly flow over the South-central US.



Circulation Pattern 2

500 mb trough over the Western States with a ridge over the Eastern US, resulting in a warm, dry southwesterly flow over the South-central US.



Circulation Pattern 3

Relatively strong 500 mb zonal flow over most of the US. Portions of the region can

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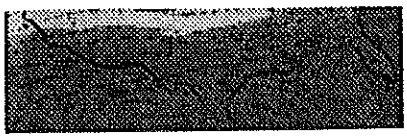

experience Chinook winds from westerly flow over the Eastern slopes of the Rockies.

Associated with these 500 mb circulation patterns are typical lower atmospheric temperature and moisture (relative humidity) patterns. The figures below depict average 850 mb temperature anomalies (°C) and lower atmospheric relative humidity anomalies (%) associated with each of the three circulation patterns that were present during past severe wildland fire episodes in Region 5 (1971-1991).

Circulation	Temperature Anomalies	Relative Humidity Anomalies
Pattern 1	X	X
Pattern 2	X	X
Pattern 3	X	X

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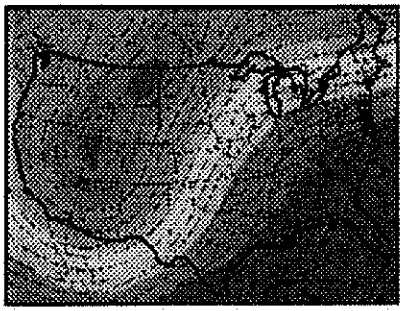
Region 6 Fires

Synoptic Circulation, Temperature, and Moisture Patterns

Severe wildland fires (>1000 acres) in the Southeastern region of the US typically occur during the months of March through June, and then again during the month of November. Analyses suggest there are three synoptic circulation patterns associated with the onset of severe wildland fires in this region. Each figure depicts the 500 mb height contour pattern (in meters) along with the 500 mb streamlines which portray wind directions. Higher wind speeds occur in regions where the 500 mb height contours are more closely packed together.

Circulation Pattern 1

500 mb ridge over the Western half of the US accompanied by a prominent trough over the Eastern half of the US or off the Eastern US coast. Cool dry air from Canada moves into the Eastern States.



Circulation Pattern 2

500 mb ridge over the Eastern half of the US with the Western and/or Central States dominated by a 500 mb trough. Warm and dry conditions dominate much of the Southeastern and Northeastern US.

Circulation Pattern 3

Zonal flow over the Southern regions of the US, accompanied by larger than normal 500 mb heights over the Southern US and

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Northern Mexico, and a 500 mb trough over the Northwestern US and Southwestern Canada.

Associated with these 500 mb circulation patterns are typical lower atmospheric temperature and moisture (relative humidity) patterns. The figures below depict average 850 mb temperature anomalies (°C) and lower atmospheric relative humidity anomalies (%) associated with each of the three circulation patterns that were present during past severe wildland fire episodes in Region 6 (1971-1991).

Circulation	Temperature Anomalies	Relative Humidity Anomalies
Pattern 1	x	x
Pattern 2	x	x
Pattern 3	x	x

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