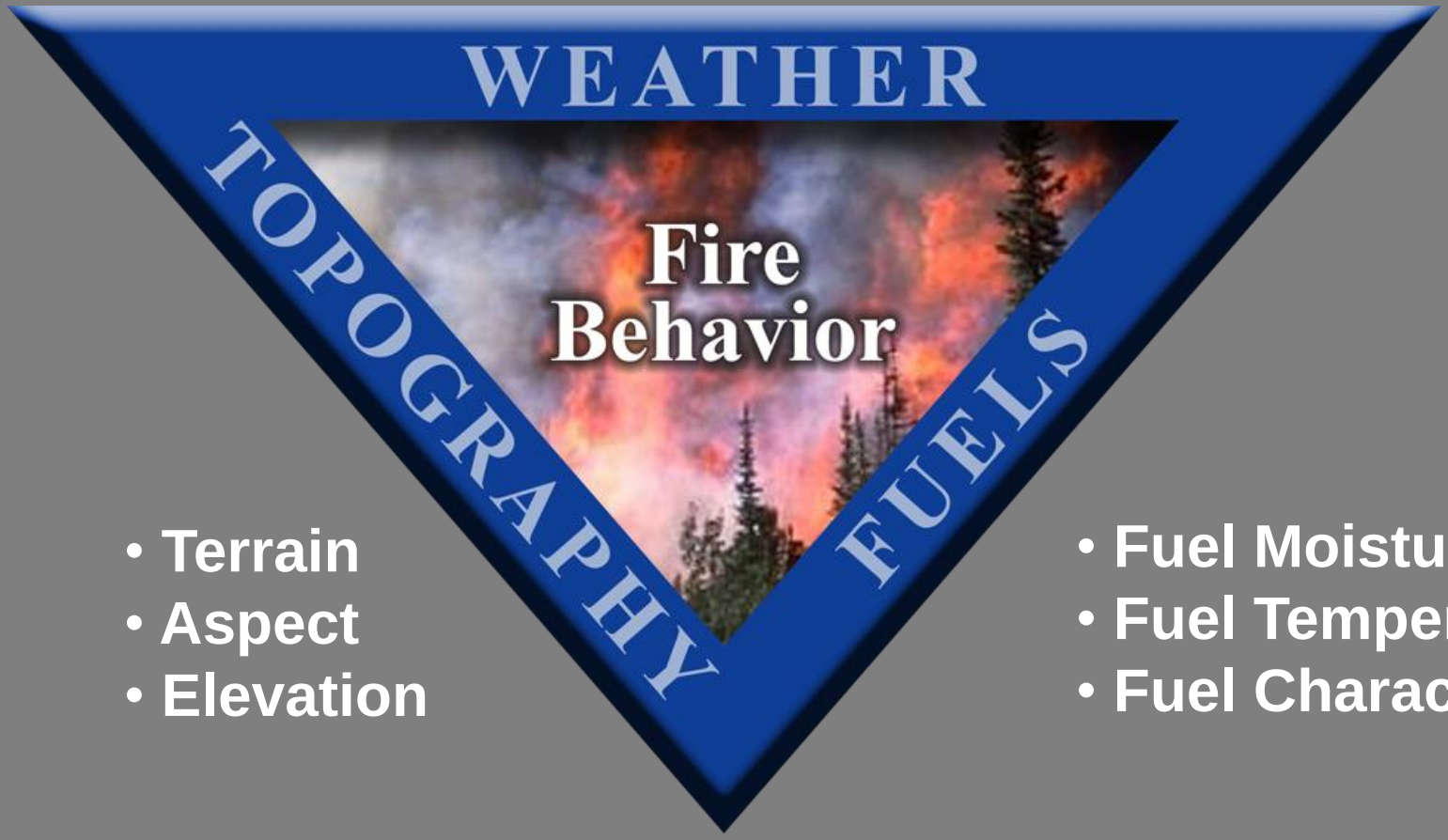

2.4
Fire Weather

The second "fire triangle": the fire behavior triangle

- Larger scale than combustion
  - 1 m^2 – 10 km^2
- Longer time scales
  - Minutes to days, even weeks
- How fire spreads through a grassland or stand of forest, to landscape scale
- The three legs of the fire behavior triangle:
  - **FUELS**
  - **WEATHER**
  - **TOPOGRAPHY**

The second “fire triangle”: the Fire Behavior Triangle

- Wind, Atmospheric Stability, Temperature, Humidity



- Terrain
- Aspect
- Elevation

- Fuel Moisture
- Fuel Temperature
- Fuel Characteristics

Q: What Is Weather?

A: Short-term variations of the atmosphere.

- **Air pressure**
- **Air temperature**
- **Humidity**
- **Wind**
- **Clouds**
- **Precipitation**

THEN WHAT IS "FIRE WEATHER"

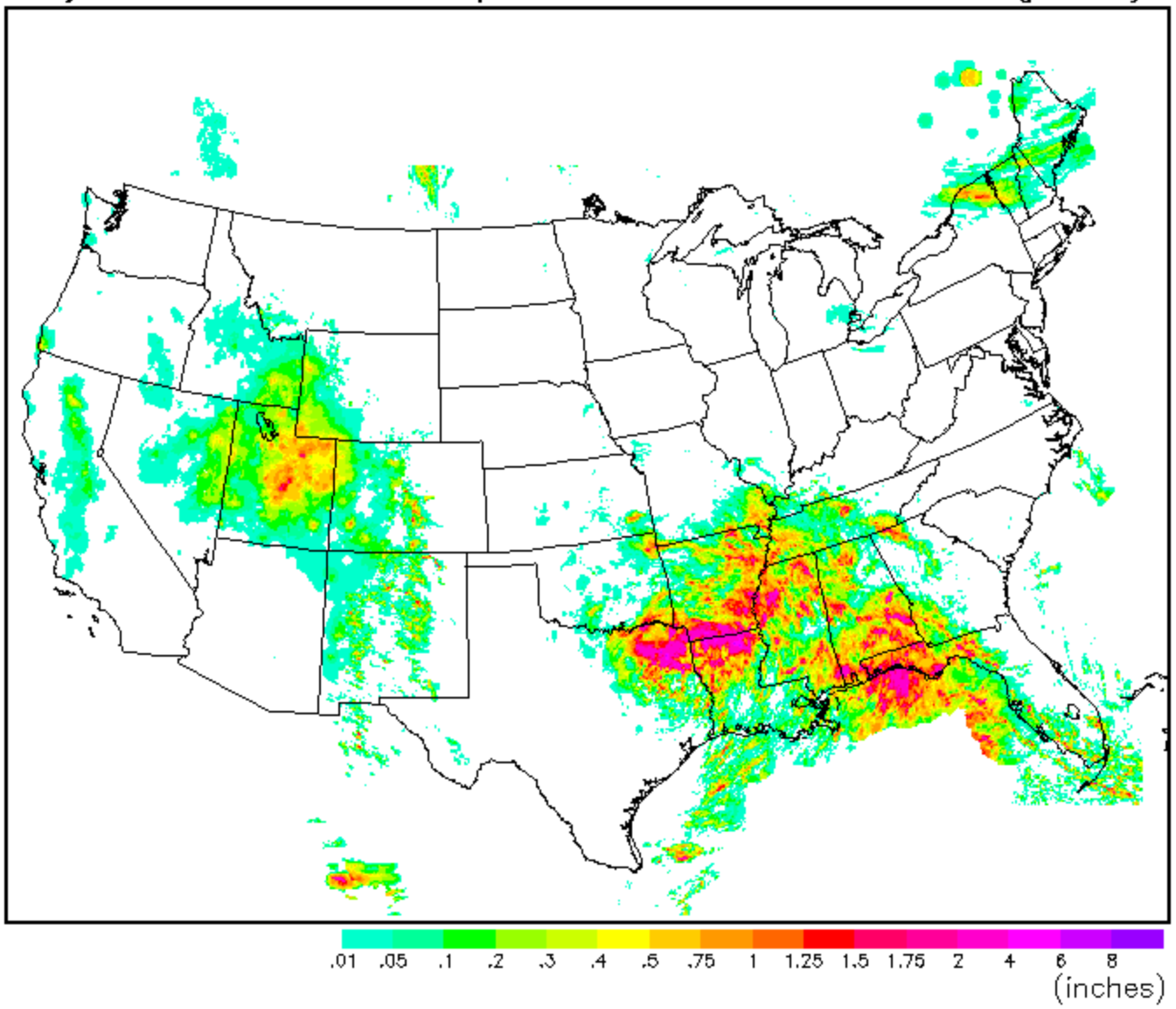
A: Weather conditions conducive to the initiation and spread of wildfire.

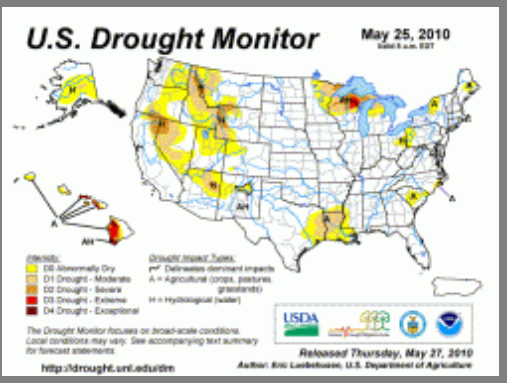
What's the difference between "weather" and "climate"?

1. "Climate is what you expect; weather is what you get."

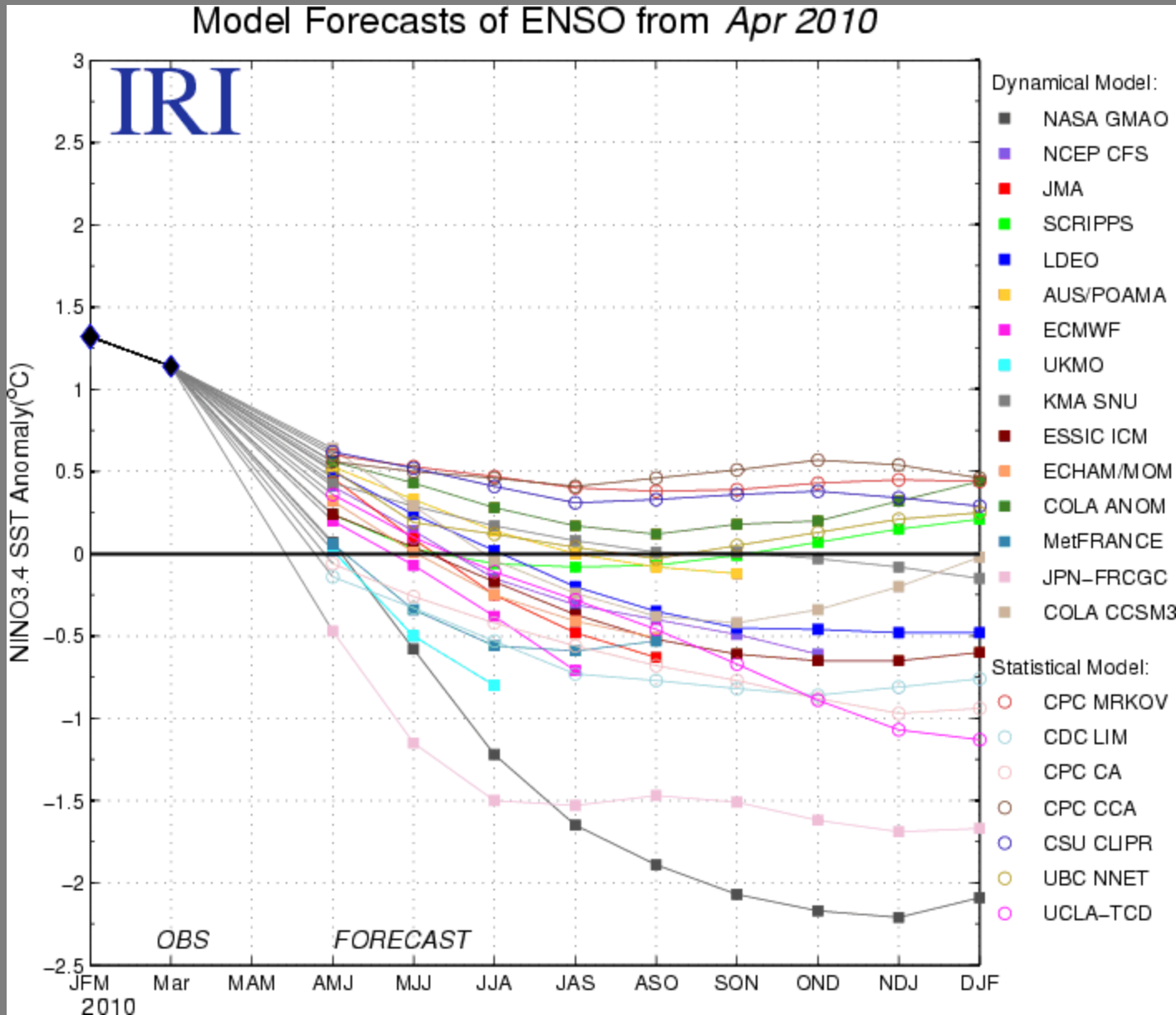
2. "Weather is how you decide what clothes to wear today. Climate tells you what to have in your closet."

Past 24-hour accumulated precip. (water equiv inches)



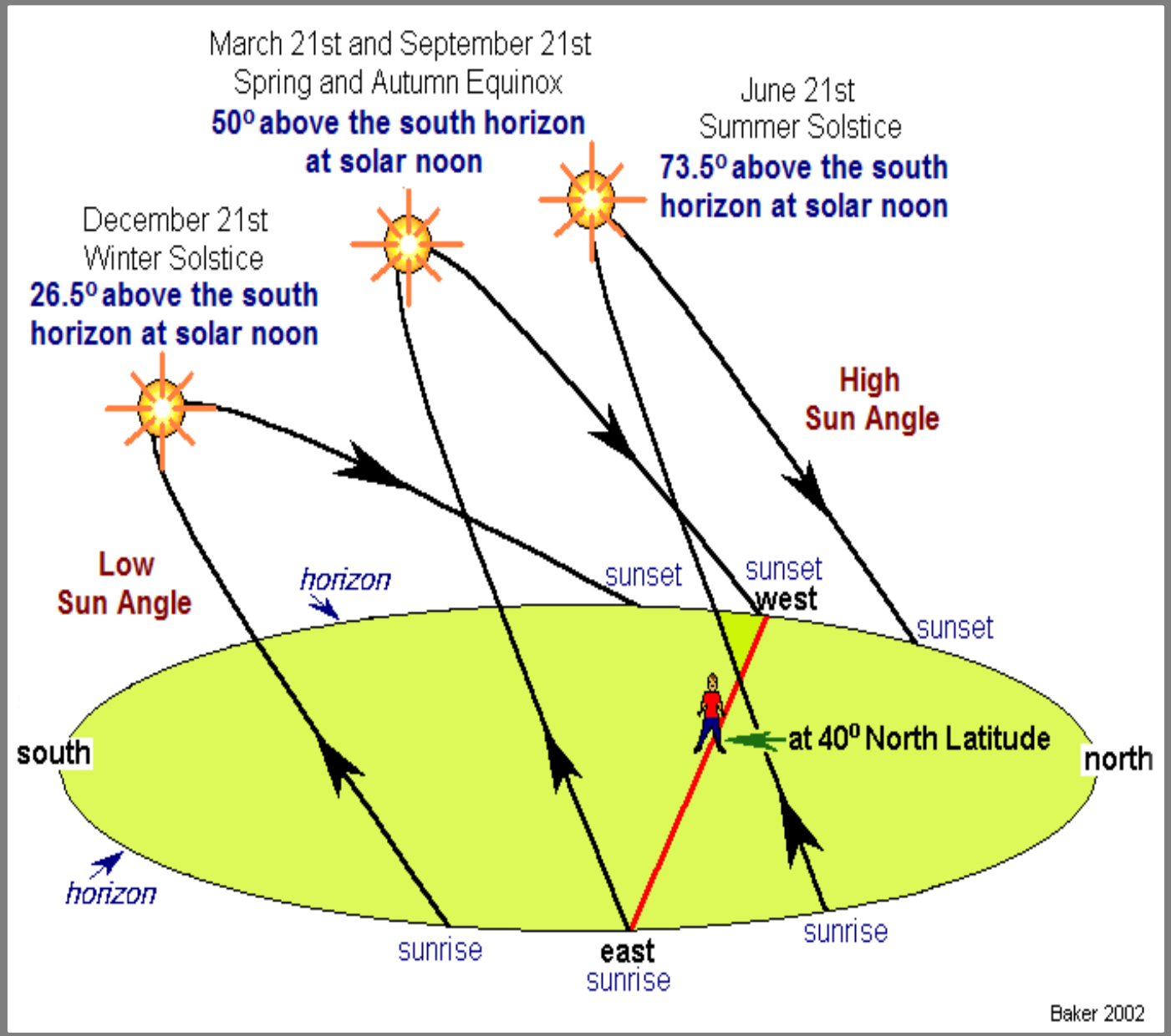

U.S. Drought Monitor
May 25, 2010
Released Thursday, May 27, 2010
http://drought.unl.edu/dm


U.S. Seasonal Drought Outlook
Drought Tendency During the Valid Period
KEY:


Model Forecasts of ENSO from Apr 2010
IRI
NINO3.4 SST Anomaly(°C)
OBS
FORECAST
JFM
2010
Mar
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND
NDJ
DJF
Dynamical Model:
NASA GMAO
NCEP CFS
JMA
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
ESSIC ICM
ECHAM/MOM
COLA ANOM
MetFRANCE
JPN–FRCGC
COLA CCSM3
Statistical Model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
UCLA–TCD

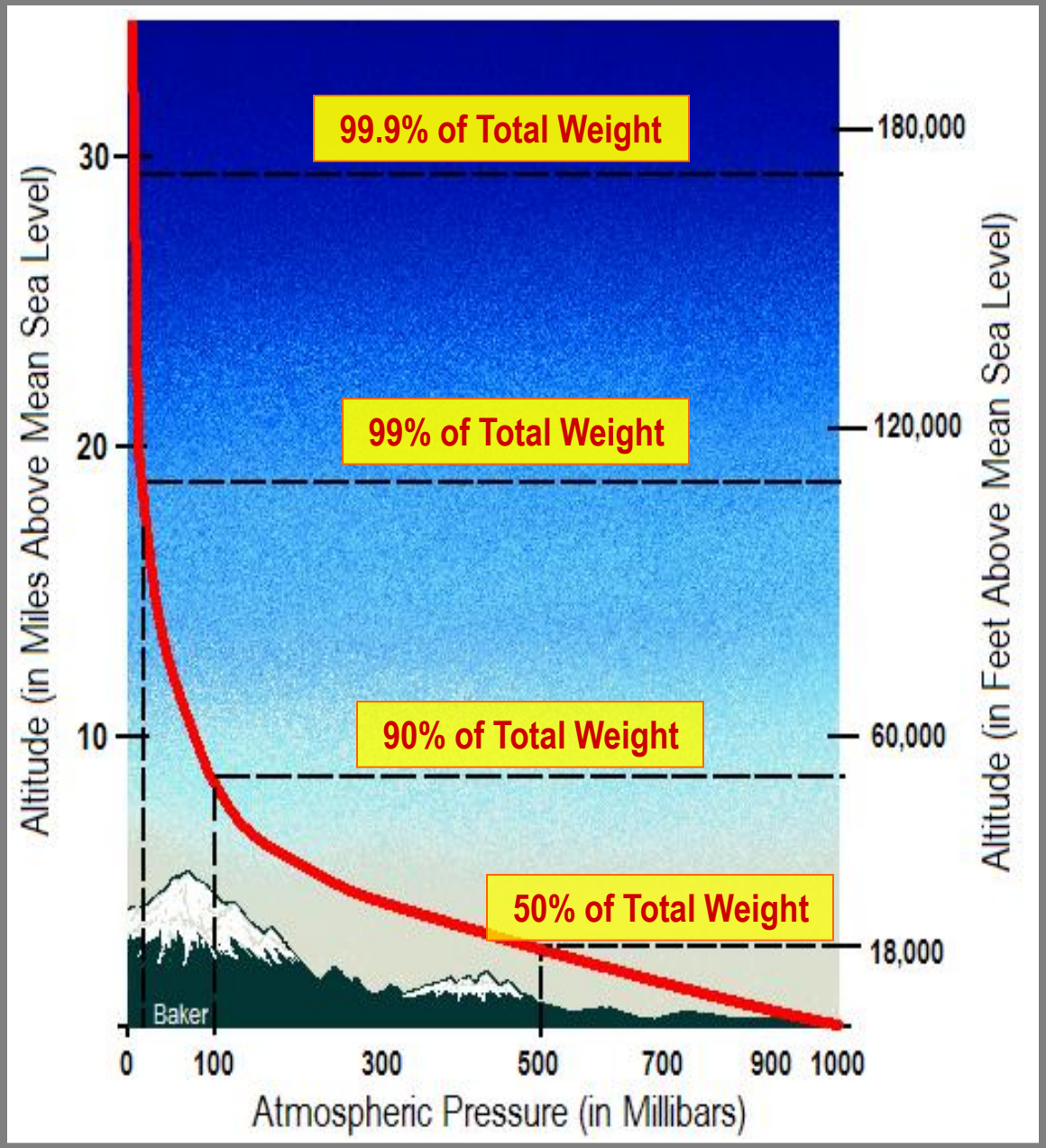
Earth's Atmosphere

- Encircling the earth is a blanket of gases bound to it by gravity.
- Similar to the oceans, the atmosphere is in constant motion.
- Atmospheric circulation is driven by energy differentials



Seasonal Change In Solar Angle

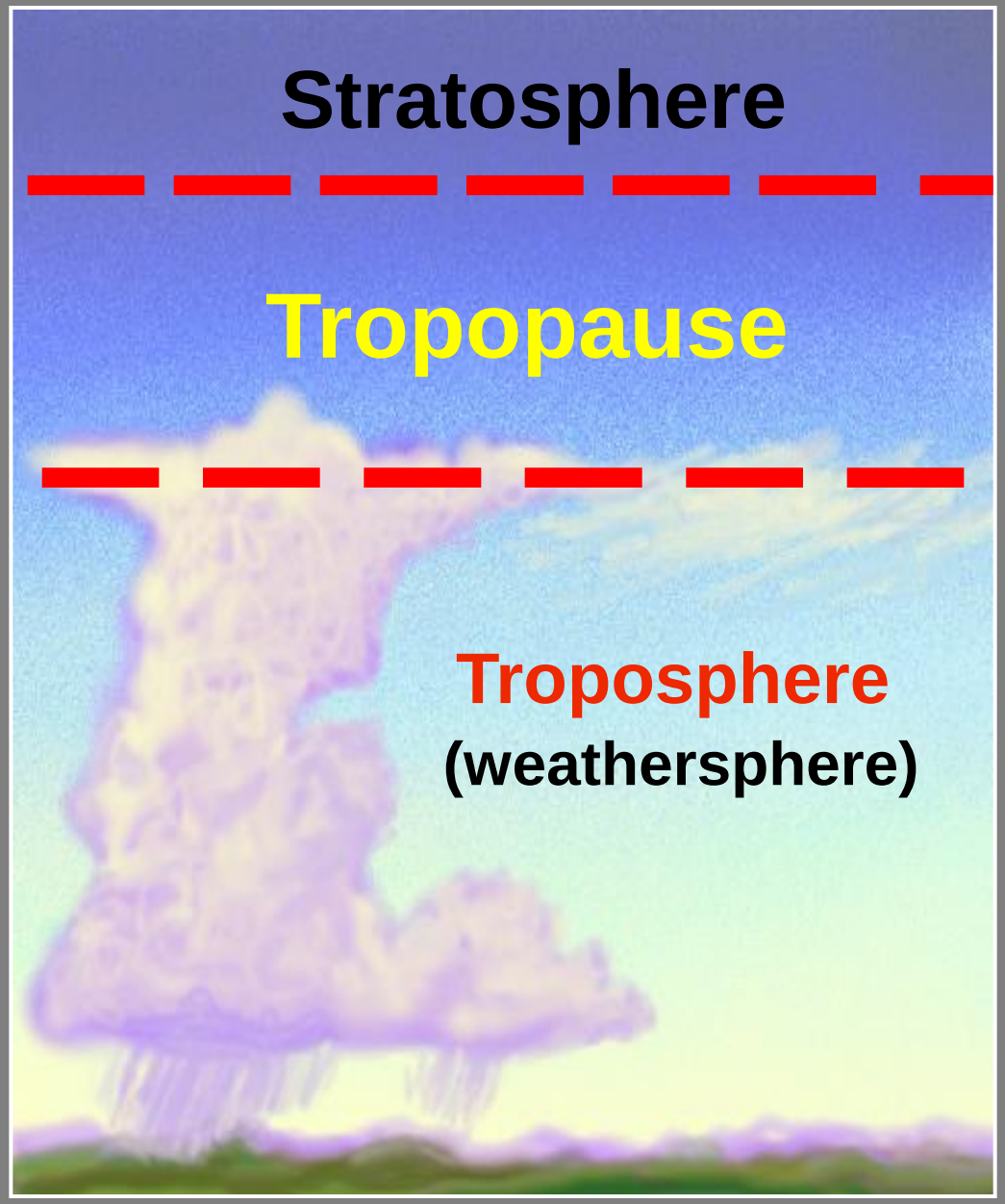
At 40°N Latitude



Atmospheric pressure *always* decreases with increasing altitude.

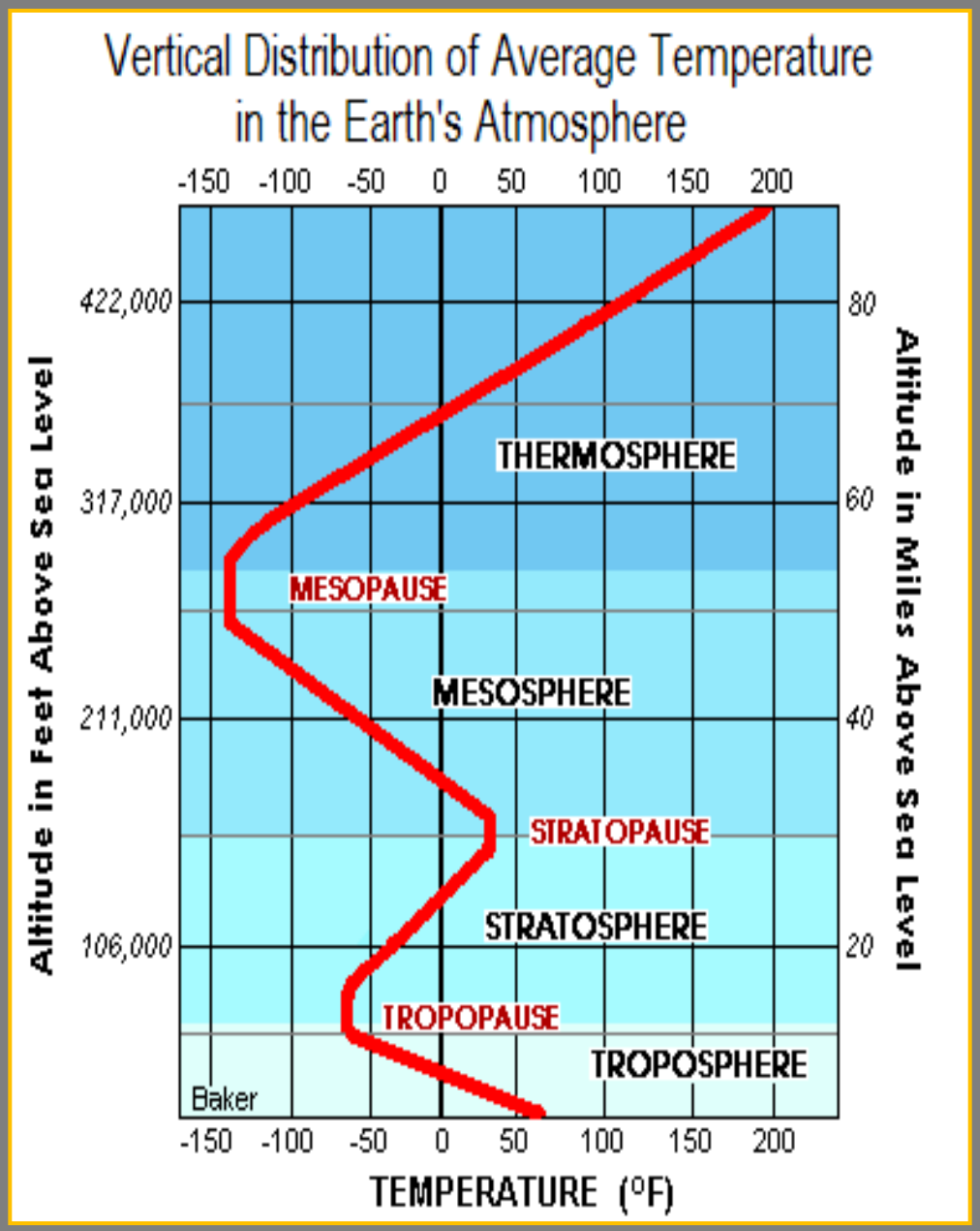
In this figure, note that *50 percent of all gases are concentrated within the lowest 18,000 feet (5 km) of the atmosphere.*

The "millibar" is the most common pressure unit used.



The Tropopause

- Separates the troposphere from the stratosphere, and marks the upper limit of nearly all weather in our atmosphere.
- Where air ceases to cool with height, and becomes almost completely dry.
- The region of the atmosphere where the environmental lapse rate changes from positive to negative.



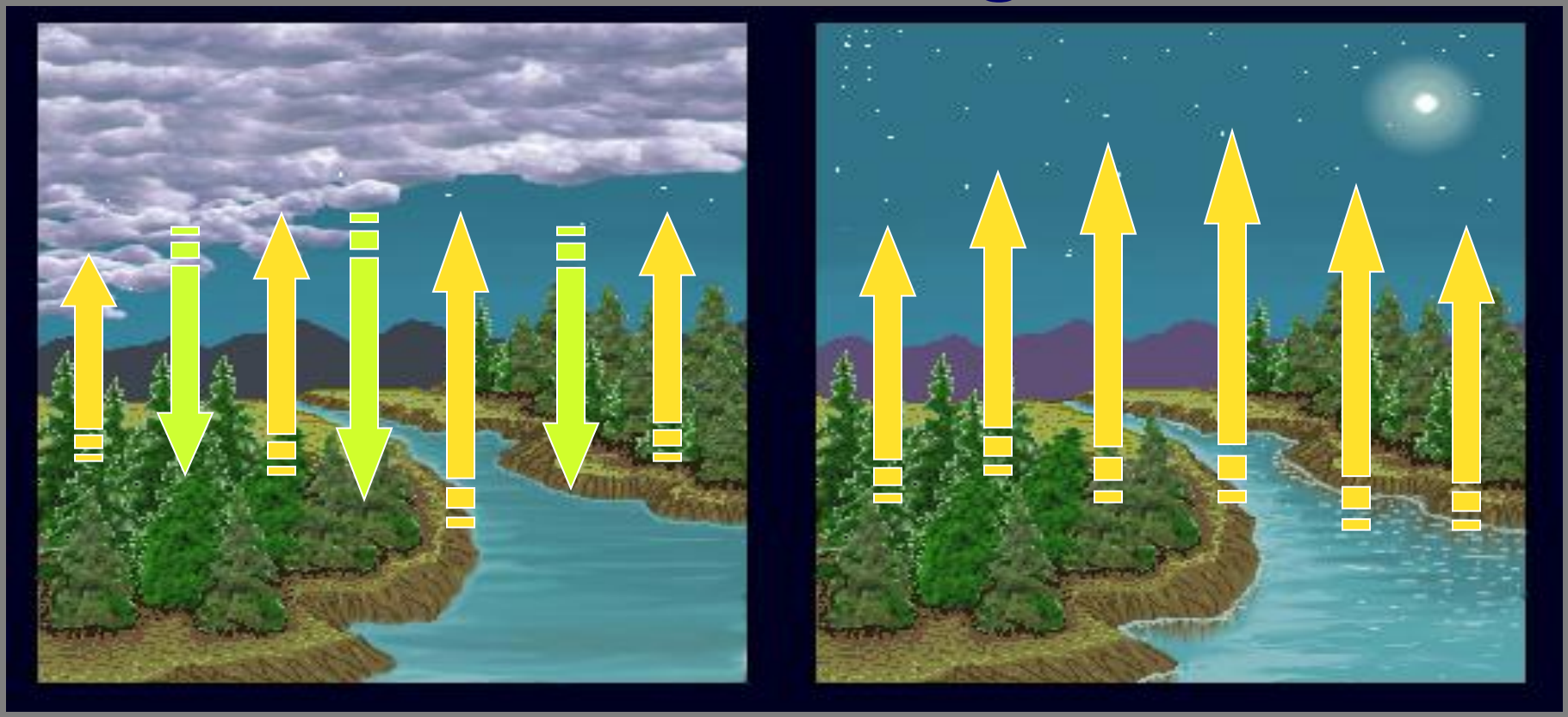
Near the Earth's surface, temperature decreases with increasing altitude in the troposphere, which is the layer where the majority of "weather" takes place.

The rate at which air cools with elevation is the lapse rate.

Lapse rates

- Because air pressure decreases with elevation, for a given volume of air, temperate decreases (according to the fundamental gas law).
- Dry adiabatic lapse rate is ~ one degree Celsius of cooling for every 100 meters (~1°C/100m). This applies to unsaturated air.
- Saturated air adiabatic lapse rate (also known as wet adiabatic lapse rate) is ~0.5°C/100 m
- Lapse rates play a huge role in fire weather (Santa Ana winds, cooling effects at higher elevations, etc.).

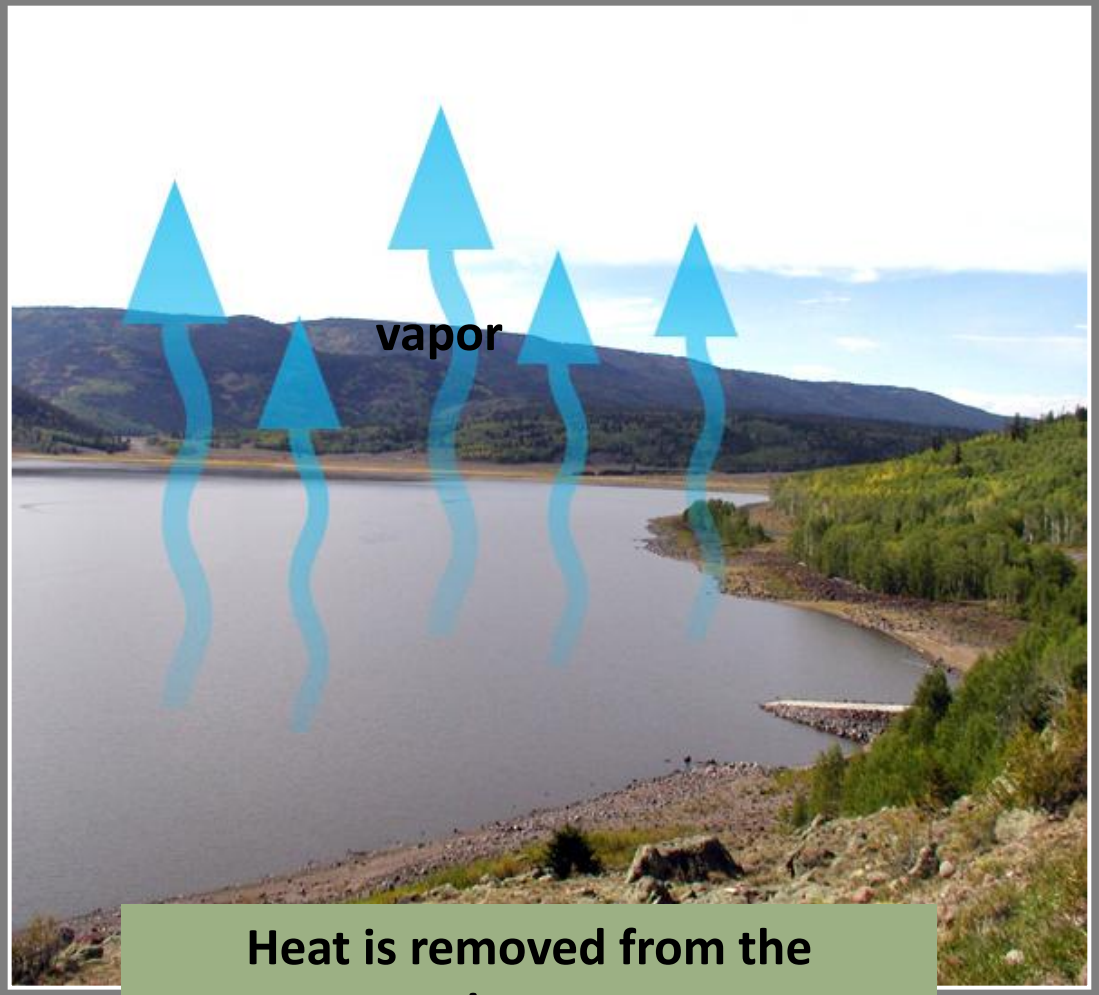
Heat Loss At Night



Cloudy nights tend to be warmer and damper than clear nights because of the insulating effect of cloud cover.

Clear nights tend to be cooler and dryer than cloudy nights because terrestrial heat is allowed to escape freely to space.

Evaporation



Heat is removed from the environment

The process where liquid changes to vapor or gaseous state.

During this process, heat energy is removed from the environment.

Thus, evaporation is a cooling and moistening process for the atmosphere.

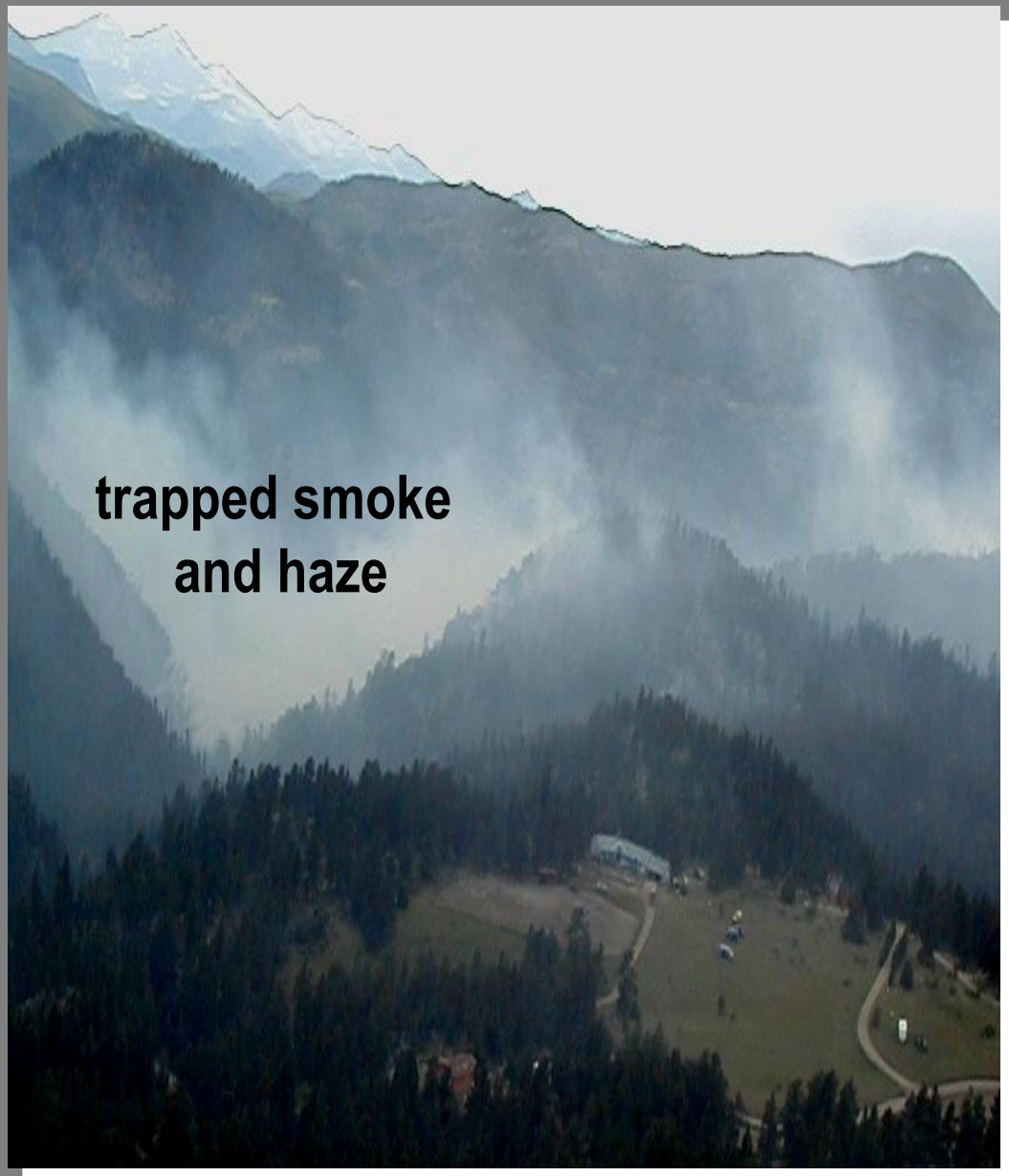
Haines Index

A combination of
stability and dryness

Indicates potential for large plume-dominated fire growth.

The Haines Index

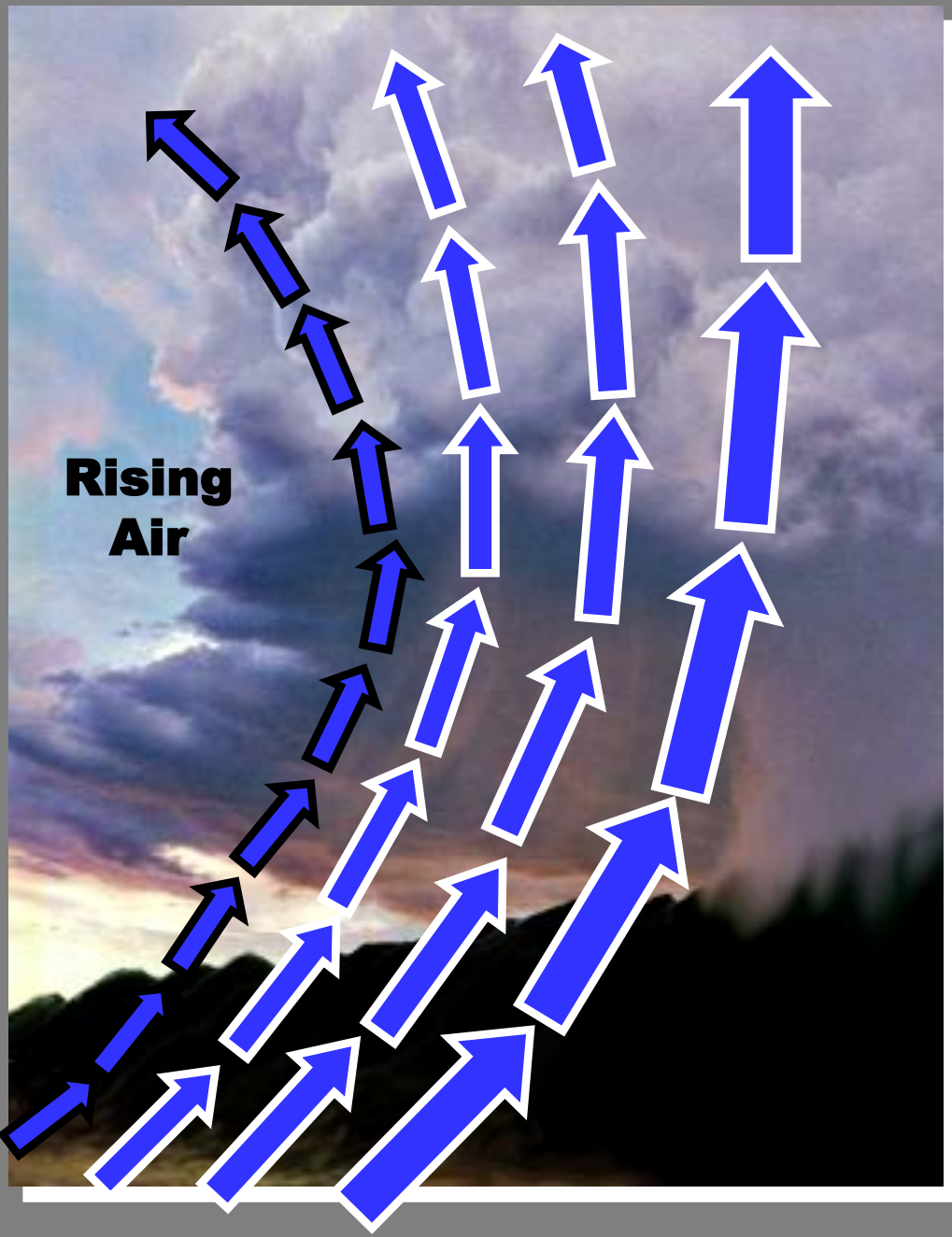
- A measure of vertical atmospheric (in)stability
- Low index (1) means the atmosphere is stable, so little vertical air movement – leads to moderate fire behavior
- A high index (6) means the atmosphere is unstable, so very rapid vertical air movement – leads to extreme fire behavior



Stable Atmosphere

Light winds and poor smoke dispersal from poor vertical mixing

A stable atmosphere will tend to suppress or reduce wildland fire behavior.

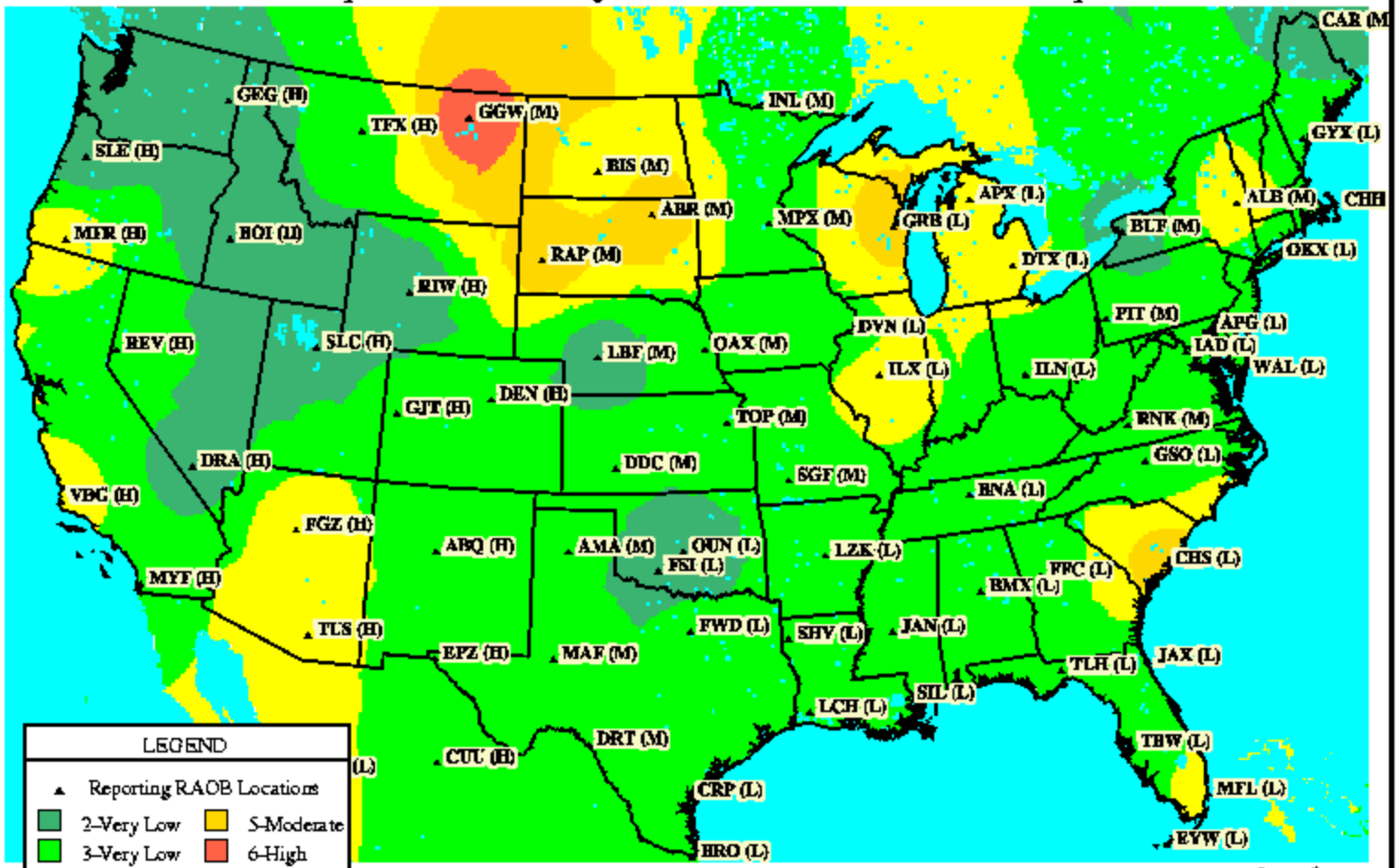


Unstable Atmosphere

Promotes the formation and growth of vertically developed clouds, thunderstorms and tall smoke columns

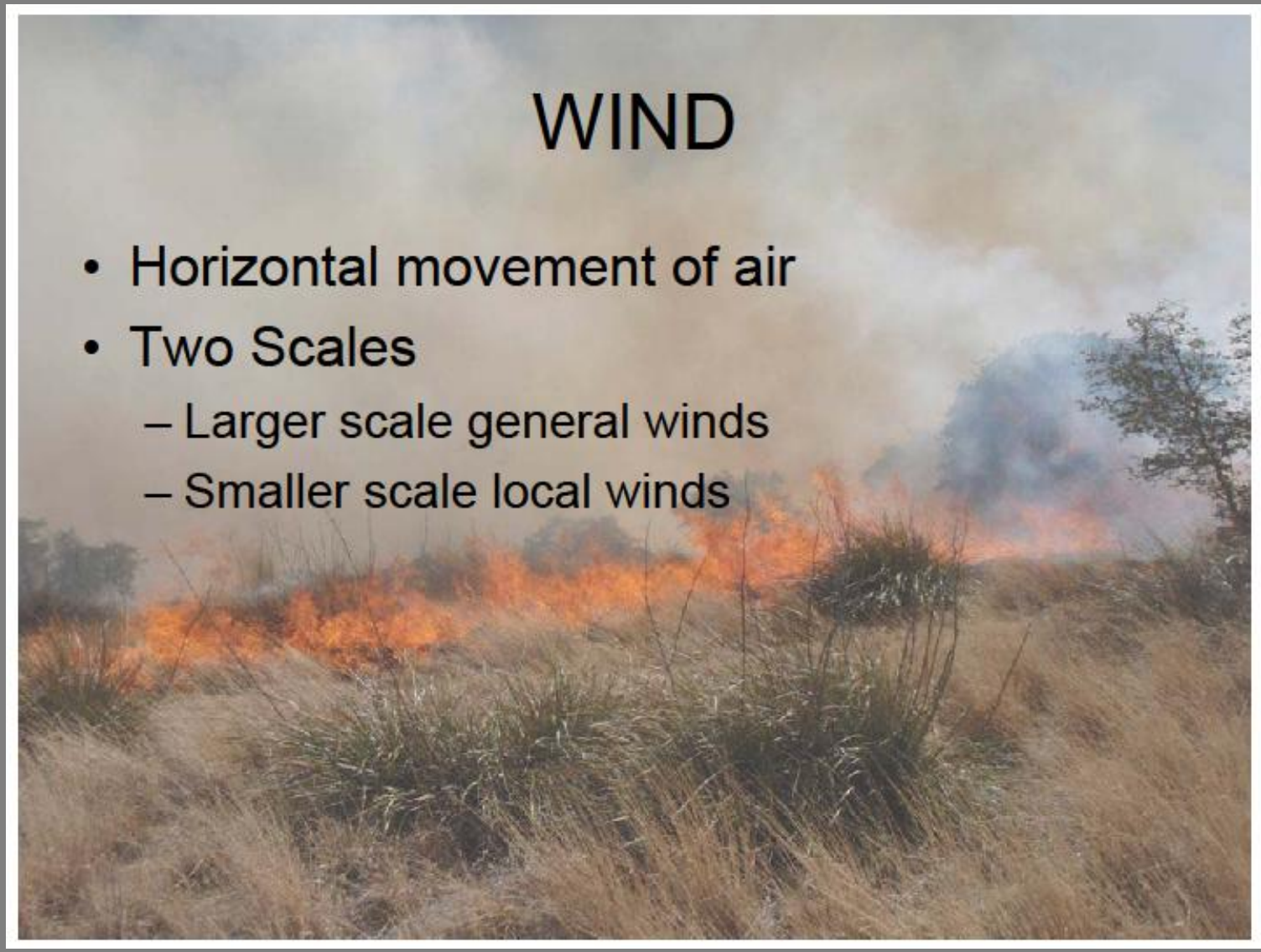
An *unstable atmosphere* (high Haines Index) is often associated with critical or extreme wildland fire behavior.

Lower Atmosphere Stability (Haines) Index: 16-Sep-09 -12Z



(Inv. Dist.^{2} Interp.)

WFAS-MAPS Graphics FIRE BEHAVIOR RESEARCH MISSOULA, MT


WIND
• Horizontal movement of air
• Two Scales
– Larger scale general winds
– Smaller scale local winds

WIND

- Winds of more importance in the fire environment include:
  - Cold front winds that bring thunderstorm activity
  - High velocity foehn winds such as the Santa Ana winds
  - Thunderstorm downdrafts resulting in gusty surface winds
  - Strong winds of micro-bursts

WIND

- Local winds are smaller-scale winds caused by local temperature differences
  - Daily winds often reach a peak in the afternoon
  - Influenced by terrain features such as mountains
  - Upslope-downslope winds, down valley winds, land-sea winds


Great
Basin
Sierra Nevada
San Francisco
Santa Ana
Winds
San
Gabriel
Mts.
Los Angeles
San
Bernardino Mts.
San Diego

Weather Indicators of Extreme Fire Behavior

1. Strong wind, sudden changes in wind direction and velocity
2. High fast moving clouds (may indicate unusual general winds)
3. Unexpected calm may indicate wind shift
4. Thunderstorms above or close to the fire
5. Unusually high temperature and low relative humidity
6. Evidence of unstable atmosphere
7. Bent smoke column

“Red Flag” conditions

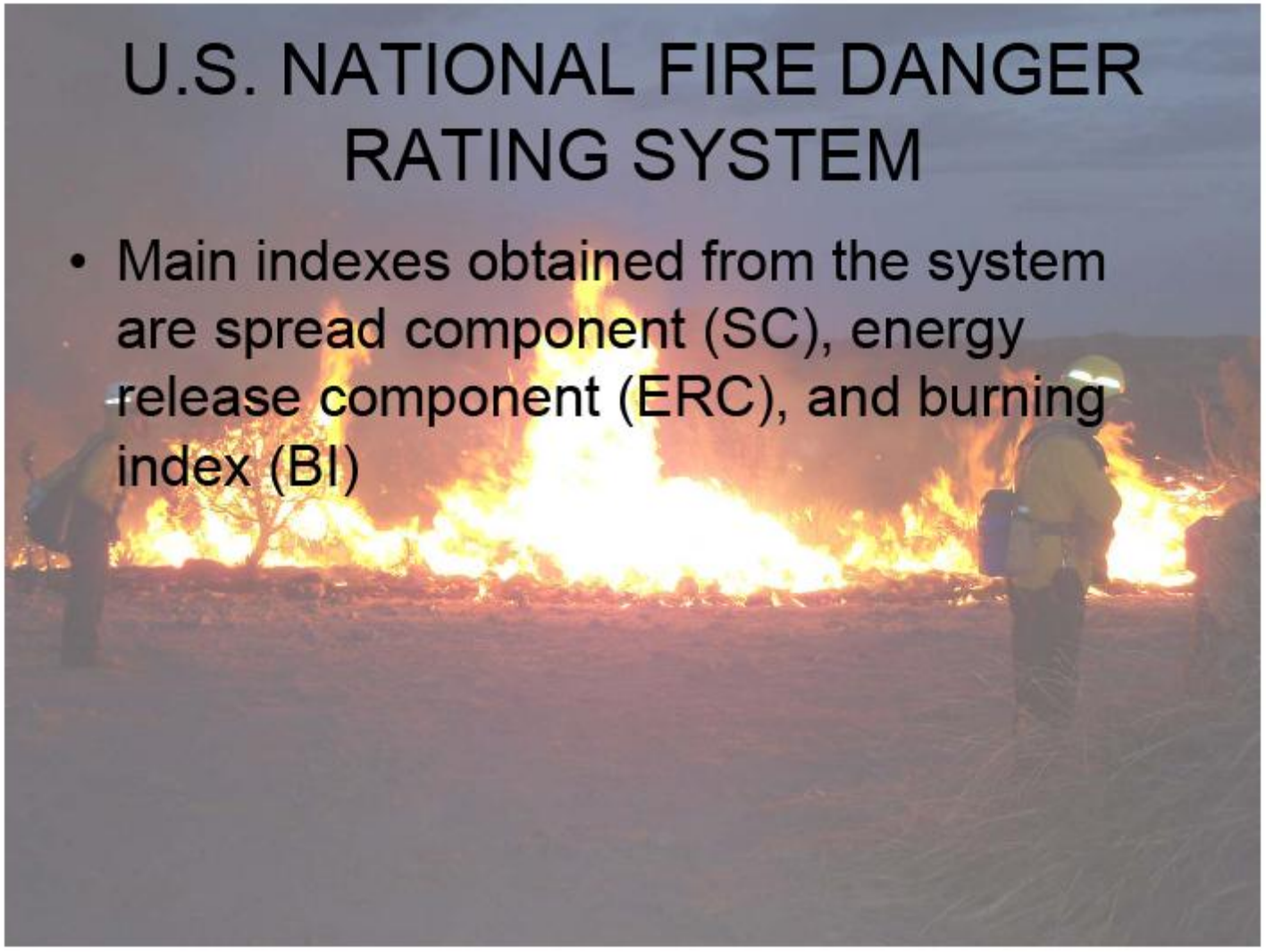
1. A Red Flag Warning is a forecast issued by the National Weather Service conditions are ideal for wildland fire ignition and rapid spread.
2. Red Flags are most common during drought conditions, when humidity is very low, and especially when high or erratic winds which may include lightning are a factor.
3. Firefighting agencies alter their resources and strategies to accommodate the elevated risk.
4. To the public, a Red Flag Warning means high fire danger with increased probability of a quickly spreading fire.

U.S. NATIONAL FIRE DANGER RATING SYSTEM

- Indication of fire potential over large administrative areas
- National fire danger rating system is a set of computer algorithms that allow land management agencies to estimate today's or tomorrow's fire danger for a given rating
- The NFDRS will not predict how every fire will behave. It is intended to provide short range planning guidance and evaluates near upper limit of the behavior of fires that might occur on a rating area during the rating period.

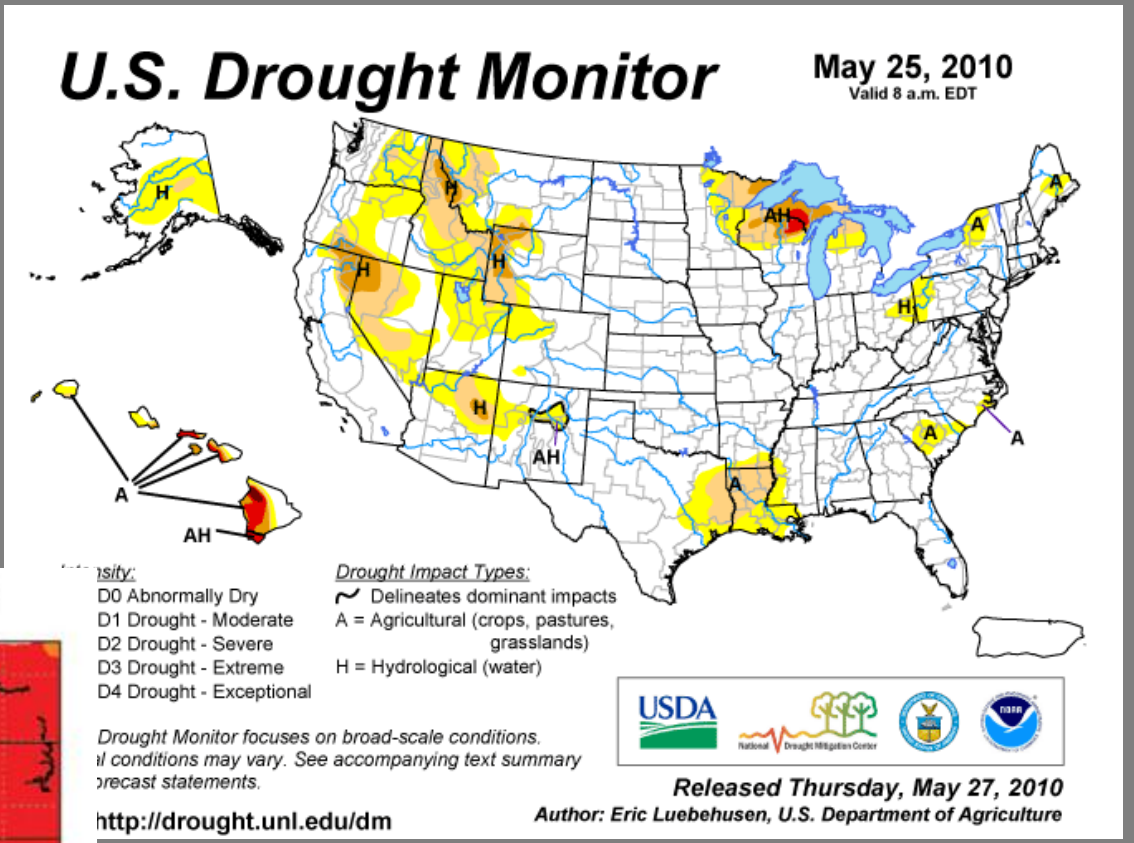
U.S. NATIONAL FIRE DANGER RATING SYSTEM

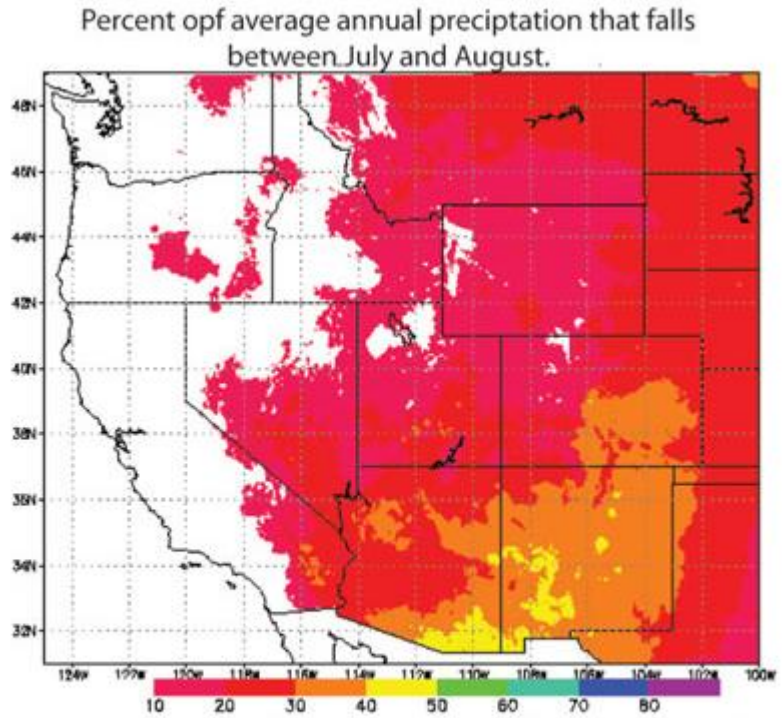
- Main indexes obtained from the system are spread component (SC), energy release component (ERC), and burning index (BI)



Bottom line, remember the big weather drivers of fire behavior:

1. **Temperature** (degrees)
2. **Relative humidity** (percent)
3. **Windspeed and direction** (km/hr)
4. **Precipitation** (mm)
5. **Atmospheric stability** (Haines Index)

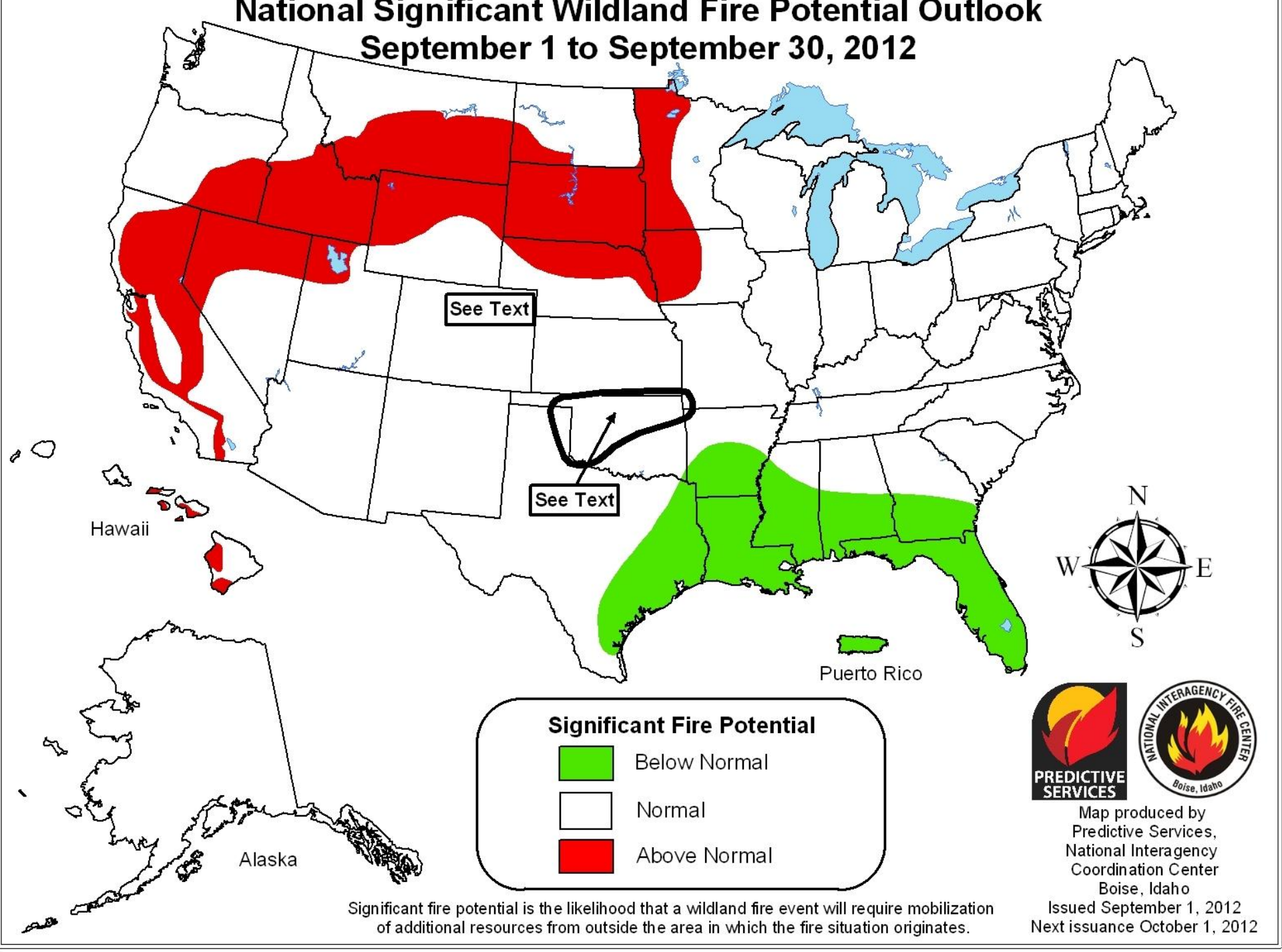




Figures courtesy of Western Regional Climate Center and based on PRISM data produced by the PRISM Climate Group at Oregon State University

http://droughtmonitor.unl.edu/

National Significant Wildland Fire Potential Outlook
September 1 to September 30, 2012



Significant fire potential is the likelihood that a wildland fire event will require mobilization of additional resources from outside the area in which the fire situation originates.

Map produced by
Predictive Services,
National Interagency
Coordination Center
Boise, Idaho
Issued September 1, 2012
Next issuance October 1, 2012

NATIONAL AND REGIONAL FIRE WEATHER INFORMATION

http://gacc.nifc.gov/swcc/index.htm