**FEWG – A WORKING GROUP FOR NCDFR MTM**

**NC SMP Technote 13 – January 4th, 2009**

**Updated February 1, 2013**

## Weather Conditions Conducive for Smoke Induced Fog or "Super-Fog"

Fog is a low cloud that restricts visibility at ground level. RH is the single most important weather variable that contributes to fog formation. At high RHs some of the water vapor in the air converts into fine liquid droplets that remain suspended in the air. These water droplets scatter the light and cause a reduction in visibility. However, water vapor requires a compatible small particle suspended in the air (i.e. smoke) to form a liquid fog droplet. Smoke serves as this convenient nucleus to induce fog formation. To make informed decisions natural resource fire practitioners, prescribed or wildfire, need to be knowledgeable of favorable weather conditions that can generate smoke induced fog. These include:

1) **Atmospheric Dispersion Index (ADI) – ADI value of <10**
2) **Low Visibility Occurrence Risk Index (LVORI) – Max value ≥ 7**
3) **Turner Stability (also called Pasqual Stability) – E, F, or G value**
4) **Surface Air Temperature - ≤ 70°**
5) **RH**
    a. **At > 70% in the presence of smoke will begin to severely reduce visibility.**
    b. **At RH > 80% smoke induced fog formation can be expected, and**
    c. **At RH > 90% for more than 5hrs, natural fog formation can be expected**
6) **Low surface 20 ft. wind speed ( <7 mph or calm or light winds)**
7) **Lack of clouds – Cloud cover less than 60% (clear skies facilitates rapid cooling)**
8) **Rapid cooling at the surface (2 to 3 degrees per hour for 3 to 6 hours following sunset)**

These values, along with and an added way to validate wind profiles and upper air moisture, are summarized in an easy to follow "check off sheet" on page 3 of this Technote.

It should be specially noted that bodies of water are an added source of moisture where drier air can become quickly saturated. When wind trajectory is over nearby sources of water (ponds as large as or greater than 1 acre) and continues to areas designated smoke sensitive areas, this situation needs to be taken into consideration.

The Southern Guidebook recommends against burning when Transport Wind (TW) is < 9 mph and the Mixing Height (MHT) is < 1640 ft. The NC Smoke Management Program (NC SMP) at its inception adopted this same position. The NC SMP began solely under the Ventilation Index System (VIS). Burning under these minimal TW and MHT is not recommended. Under these weather values from midmorning to around sunset ensures an Atmospheric Dispersion Index (ADI) of ≥ 16. However, an ADI of < 20 indicates poor dispersion and use of prescribed fire needs to be considered for another day. Low MHT, TW, and ADI indicate poor plume height, dilution and dispersion. Thus smoke buildup and the probability of smoke problems are highly likely.

The NC SMP is now incorporating the use of atmospheric dispersion models (ADM) to assist in formulating a Go or No go decision to burn. The use of natural resource prescribed fire under these weather conditions is only permissible when an accepted ADM (i.e. Hysplit) is used. An ADM provides the fire practitioner a tool that evaluates the local atmospheric conditions more finely. NCFS Research Burns conducted under the Operational Research Evaluation Burn Project validated the use of ADM. It was also observed that ADI values of 27 were adequate for smoke dispersion.

- **Atmospheric Dispersion Index (ADI)** – ADI is derived from the mixing height and stability class. Forecasted by the National Weather Service (NWS) in their Fire Weather Forecast (FWF).

**Dispersion Index Values; Lavdas 1986**

| Dispersion Index | Interpretation |
|---|---|
| >100 | Very good (but may indirectly indicate hazardous conditions) |
| 61-100 | Good (typical-case burning weather values are in this range) |
| 41-60 | Generally good (climatological afternoon values in most inland forested areas of the U.S. fall in this range) |
| 21-40 | Fair (stagnation may be indicated if accompanied by persistent low windspeeds) |
| 13-20 | Generally poor; stagnation if persistent (although better than average for a night value) |
| 7-12 | Poor; stagnant at day (but near or above average at night) |
| 1-6 | Very poor (very frequent at night; represents the majority of nights in many locations) |

- **Low Visibility Occurrence Risk Index (LVORI)** - LVORI is calculated from the ADI and relative humidity. For an in depth look at LVORI, see NC FEWG Technote 12 located on the NC Forest Service website **http://ncforestservice.gov**.

- **Turner Stability (Pasqual Stability) –** Stability is measured through radiosondes and is related to the change of temperature with height (the lapse rate) and wind speed.

  **A –** Very Unstable
  **B –** Unstable
  **C –** Slightly Unstable
  **D –** Neutral
  **E –** Stable
  **F –** Very Stable

- **Surface Wind Speed –** NWS FWF winds are 20 foot wind speeds. To convert NWS FWF wind speed to a fire danger station wind speed multiply FWF wind speeds by a .3 reduction factor and subtract this value from FWF wind speed. Conversely to convert a fire danger station wind to NWS FWF 20 foot wind speed multiply the fire danger wind speed by a 1.4 factor and add this value to the fire danger station wind speed. To convert NWS FWF wind speeds to "eye level" wind speeds you need to multiply those winds by the pre-determined fire behavior standard fuel model wind reduction factors.

- **Surface Air Temperature, Rh Recovery, & Cloud Cover all should be self- explanatory**

| Variables to Evaluate (Sunrise to Sunset) | Do the variables reach critical threshold values? Present | What hrs.? | Overlap Hrs. Hrs. in sync | | Comments Are different weather models in sync? (WRF, MM5, NAM) |
|---|---|---|---|---|---|
| **ADI** (< 10) | | | | | |
| **LVORI** (max ≥ 7) | | | | | |
| **Turner Stab.** (E, F, or G) | | | | | |
| **Surface Air Temp** (≤ 70° F) | | | | | |
| **RH Recovery** (> 90 % for 5 hrs.) | | | | | |
| **Surface Wind Speed** (20 ft. < 7mph) | | | | | |
| **Cloud Cover** (< 60 %) | | | | | |
| **Sonde T Lapse Rate** (950 to 850mb ≤ 6°C) | **AM** | **PM** | **Value** | **Value** | |
| | | | | | |
| **Sonde Dewpt. Depr.** ( > 5°C DD <10°C @ 850MB) | **AM** | **PM** | Value | Value | |
| | | | | | |

- ADI, LVORI, Surface Air Temperatures, RH, Wind Speed, and Cloud Cover can all be obtained from NWS FWF or spot weather forecast requests
- Stability can be obtained from NOAAs Air Resources Laboratory website http://www.arl.noaa.gov/ or by requesting that information in NWS spot weather forecast.
- Soundings are not timely & therefore are used mainly for validation checks of what may happen with wind profiles & upper air moisture