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| | **General Characteristics** | |
| 1 | **Abstract of Model Capabilities** | Model calculates wind fields and additional planetary boundary layer parameters (e.g., temperature, $U_*$, Richardson number, P-law exponent) over complex terrain including the effects of the presence of land morphological features such as vegetation and clusters of buildings. The model/code can provide high resolution inputs to wind-influenced applications such as the transport and dispersion of aerosols, emergency response/HAZMAT situations, aerosol spray events, wildfire events, downwind transport of spores, etc. |
| 2 | **Sponsor and/or Developing Organization** | Ronald M. Cionco<br>US Army Research Laboratory (ARL)<br>2800 Powder Mill Road<br>Adelphi, MD 20783<br>(301) 394-1794 (301) 394-4797 **Fax**<br>rcionco@arl.mil **sponsoring organization**<br>rcionco@arl.mil **developing organization** |
| 3 | **Last Custodian/ Point of Contact** | Ronald M. Cionco<br>US Army Research Laboratory (ARL)<br>2800 Powder Mill Road<br>Adelphi, MD 20783<br>(301) 394-1794 (301) 394-4797 **Fax**<br>rcionco@arl.mil **primary individual**<br>rcionco@arl.mil **secondary individual** |
| 4 | **Life-Cycle** | 1974: USA ARL, WSMR facilitated the development of a wind model of flow over complex terrain. 1978/80/82: USA ARL, WSMR further improved the flow physics and added more analyses including turbulence parameters and calculating the vertical profiles of wind at each x,y coordinate. 1989/92: Evaluated model//code with two data bases. Recent enhancements: adding flow above and within canopies and in and about clusters of buildings. |
| 5 | **Model Description Summary** | HRW is a diagnostic, two-dimensional, micro-alpha scale, surface layer wind simulation model. The model produces high-resolution grided calculations of airflow as well as turbulence properties over a limited area taking into account the airflow interaction with changing terrain, changing land morphology features, and thermal structure. HRW applies Gauss' Principle of Least Constraints to mass and momentum conservation accounting for terrain configuration and thermal forcing upon the wind field. Based upon an initial objective estimate, results are obtained by direct variational relaxation of the wind field in the surface layer to minimize the constraints imposed by changing terrain, thermal structure, and airflow continuity. This procedure requires the forces to be minimized in order to satisfy the equations of motion. The initialization of the code requires, as a minimum, wind speed and direction, temperature, and pressure from one local surface station at 10 meters and one upper air sounding of temperature- pressure/height profiles to estimate the atmospheric stability of the domain as well as digitized terrain elevation data. The code output consists of u,v wind components and their vector field, derived streamline fields, air temperature, friction velocity, Richardson number, power law exponent etc. |
| 6 | **Application Limitation** | Limited to domains about 20 km x 20 km and vertically up to about 100 m. |
| 7 | **Strengths/ Limitations** | **Strengths:** Evaluated very well.<br>**Limitations:** Limited to microscale. |
| 8 | **Model References** | Contact R. M. Cionco for several references on this model/code. |
| 9 | **Input Data/Parameter Requirements** | Data from one meteorological station at 10 meters:<br>- wind speed and direction<br>- air temperature<br>- air pressure (2 meters or 10 meters)<br>One upper air sounding: temperature versus height/pressure.<br>Digitized terrain elevation.<br>Optional: digitized land morphology features (e.g., vegetation and buildings). |
| 10 | **Output Summary** | x,y coordinate fields with nominal 100 meter resolution:<br>- u,v components, vector field, and derived streamlines.<br>- temperature.<br>- friction velocity.<br>- Richardson number.<br>- Power law exponent.<br>- vertical wind component normal to terrain slope<br>and contoured terrain map (with or without land features). |

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| 11 | **Applications** | x,y coordinate fields with nominal 100 meter resolution:<br>- u,v components, vector field, and derived streamlines.<br>- temperature.<br>- friction velocity.<br>- Richardson number.<br>- Power law exponent.<br>- vertical wind component normal to terrain slope<br>and contoured terrain map (with or without land features). |
| 12 | **User-Friendliness** | Data reader that extracts terrain data from CD-ROM (DMA); Code that creates digitized terrain data file for input; Code that prepares input file of meteorological data; Graphics package to plot and view x,y coordinate fields |
| 13 | **Hardware-Software Interface Constraints/ Requirements** | **Computer operating system:** DOS and UNIX<br>**Computer platform:** Pentium PC (& SGI Reality Engine)<br>**Disk space requirements:** 2 MB<br>**Run Execution Time:** No information provided.<br>**Programming language:** FORTRAN 77<br>**Other computer peripheral information:** No information provided. |
| 14 | **Operational Parameters** | **Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:** Some diagnostic messages are available.<br>**Set up time for: . Typical times are:** ***first-time user:*** 2 h ***experienced user:*** 10 min |
| 15 | **Surety Considerations** | **All quality assurance documentation:** User Guide<br>**Benchmark runs:** yes<br>**Validation calculations:** yes<br>**Verification with field experiments that has been performed with respect to this code:**<br>MADONA<br>PROJECT WIND |
| 16 | **Runtime Characteristics** | 50 MHZ, 486 Lap Top PC: about 1:20 minutes<br>166 MHZ Pentium PC: About 10 seconds<br>SGI Reality Engine - one processor < 10 seconds |

**Specific Characteristics**

**Part A: Source Term Submodel Type**

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| A1 | **Source Term Algorithm?** | __YES ✔ NO |

**Part B: Dispersion Submodel Type** (No Information Provided.)

**Part C: Transport Submodel Type** (No Information Provided.)

**Part D: Fire Submodel Type** (Not Applicable)

**Part E: Energetic Events Submodel Type** (Not Applicable)

**Part F: Health Consequence Submodel Type** (No Information Provided.)

**Part G: Effects and Countermeasures Submodel Type** (No Information Provided.)

**Part H: Physical Features of Model** (No Information Provided.)

**Part I: Model Input Requirements** (See Item 9.)

**Part J: Model Output Capabilities**

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| J10 | **Other** | x,y coordinate fields with nominal 100 meter resolution:<br>- u,v components, vector field, and derived streamlines.<br>- temperature.<br>- friction velocity.<br>- Richardson number.<br>- Power law exponent.<br>- vertical wind component normal to terrain slope<br>and contoured terrain map (with or without land features). |

**Part K: Model Usage Considerations** (See Items 5 - 7.)