

**Final Report to the Joint Fire Science Program
Project # 03-4-2-05**

Project Title: Strengthening Application of the Ventilation Climate Information System (VCIS) for Multiple-Scale Planning, Documentation and Risk Assessment

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Overview:

The Ventilation Climate Information System (VCIS) provides a web interface to a twice-daily, 40-year database of wind speed, mixing height and ventilation index for the United States at a spatial resolution of approximately 5km (Ferguson et al. 2003). This provides smoke managers with an invaluable tool for making climatological assessments of smoke impacts on daily to seasonal time scales. The original version of VCIS was completed with Joint Fire Science Program support in 2000 under a 1998-2000 project called, "Assessing Values of Air Quality and Visibility at Risk from Wildland Fires."

Air quality and visibility remain critically at risk from wildland fires, especially with the increased use of prescribed fire, the increased threat of wildfire, and the encroaching urban interface. While VCIS proved to be of great value in assessing potential risk of negative smoke impacts from fire, it failed to provide some basic tools that would greatly assist in documenting National Environmental Policy Act (NEPA) requirements and demonstrating alternatives in smoke management planning. With the completion of this project, VCIS has been upgraded and improved. Access to additional statistics have been included to better determine the frequency of exceeding or limiting threshold values of surface wind, mixing height, and/or ventilation index, allowing better planning for alternative scenarios. The quality and accuracy of the supported data layers were improved, as well as the export capability and access to the raw data. The web interface was improved and redesigned for easier use. An online tutorial was added to the web site, and a 1-hour lesson plan and ½ day workshop curriculum were developed to facilitate technology transfer.

It is important to note some unique challenges that were encountered. Dr. Sue Ferguson, the original Principal Investigator and creator of the project, became very ill and was compelled to retire (passing away shortly thereafter). At this point, Jeanne Hoadley, then of the AirFire Team, assumed the responsibility as lead PI for this

project. Ms. Hoadley also left to accept another position elsewhere in the Forest Service. Consequently we requested and were given a no-cost extension to complete the project, which we were able to do under the guidance of Dr. Narasimhan Larkin.

Additionally, while the bulk of the components of this project were accomplished, some aspects could not be effectively completed with the existing tools available (see below for further explanation). As these needed tools are completed the remaining tasks will be finalized.

Summary of Accomplishments:

Modified VCIS Website – Easier to Use

The VCIS website has been modified (see Figure 1) to have the look and feel of the BlueSkyRAINS web site (the BlueSkyRAINS web site for the northwestern US can be found at www.airfire.org/bluesky), with an improved selection menu for choosing data layers and drop-down windows for viewing the desired parameter and month. This provides a familiar web interface for those in the smoke management community who are currently using the BlueSky smoke modeling framework. The GIS software that drives the mapping application on the VCIS web site has been updated to the latest version (version 9) of ArcIMS. Additional data layers include Class I Airsheds, and PM2.5 and PM10 non-attainment areas, as well as improved terrain layers.

Improved Statistics

The previous version of VCIS provided only pre-determined statistics for each grid cell, including medians, quartiles, maxima, and minima for daily and monthly values of wind speed, mixing height, and ventilation index. Wind roses provide information on predominant wind directions for each month of the year at specified locations. In addition to these pre-defined statistics for each grid cell, several new statistics were created for this project.

Annual time series and tables of summary statistics have been added to the suite of statistical graphs available once a location is selected. In addition, airshed statistics were created for the several hundred United States Geological Survey hydrologic unit code (HUC) level 2 areas across the continental U.S. For each, average mixing height and wind time series were created and then combined into ventilation index values. These statistics are accessed exactly the same way that the grid cell statistics are. After selecting a specific location, the user can then switch their view from the single grid cell to the larger airshed average.

Also of interest are user-defined ranges of wind speed, mixing height, and ventilation index, and how frequently these prescription ranges are met (or not met). User ranges

of wind speed, wind direction, mixing height, and ventilation index in any combination can be entered. Users can then obtain information on the relative frequency of this prescription window occurring, the length of runs where the window is met for multiple days in a row, and other statistical measures.

Improved Quality and Accuracy of Data Layers

The supporting data layers on the VCIS website have been updated with those of higher quality and accuracy. A quality assurance check was done on the data layers to ensure accuracy. In addition to base map data layers (roads, cities, political boundaries, etc.) there is a full suite of sensitive receptors which can be viewed. These include not only PM2.5 and PM10 non-attainment areas and Class I Airsheds, but schools, hospitals, tribal areas, and other populated areas (based on the 2000 census data). The terrain layers have also been upgraded to include more detailed gray and color shaded relief elevation models. Layers depicting 2nd, 3rd, and 4th level HUC boundaries were also added.

Improved Export Functionality and Access to Raw Data

The VCIS data are now downloadable through the website. Point location or airshed timeseries data can be downloaded from the statistics page. The data are in comma separate value format, a standard of spreadsheet and data analysis programs.

Online Tutorial

The new version of the VCIS website now includes an online tutorial to aide users in navigating the web site and using the new features. The tutorial is accessible from the VCIS main web page. It includes narration and screen shots, and walks the user through all the features of the web site, including how to view the maps, query for statistics, and access the verification data.

1-hour Lesson Plan and a ½ Day Workshop

A 1-hour lesson plan and half day workshop curriculum have been developed and are available from <http://www.airfire.org/jfsp>. Additionally, a Powerpoint presentation has been prepared for use in the smoke management portion of RX 410 and other training sessions.

Improved Boundary Layer Representation and 30-meter Sub-domains

There were two proposed tasks that, after additional investigation, we determined could not be accomplished with the existing tools available. The first was the proposal to improve the boundary layer representation. Currently mixing heights are interpolated between upper-air sounding stations. Where there is high terrain between sounding stations, the interpolated mixing heights can be below ground level. Because the ventilation index cannot be computed without a non-zero positive mixing height, and because mixing is assumed to be good in those cases, somewhat arbitrary mixing heights were set at 1000m AGL for the morning, and 4000m AGL for the afternoon cases. We determined there are currently no physically reasonable methodologies for estimating mixing heights where sounding data are not available. We will be able to address this deficiency in the near future with the Air Quality Impacts Planning Tool (AQUIPT) currently under development by the AirFire Team. AQUIPT is a web-based strategic planning tool for anticipating air quality impacts from localized emission sources, and uses a 30-year climatological database of 3-D meteorological and dispersion modeling output, from which mixing heights can be directly computed. Eventually these data will be available at a 12-km resolution, making the interpolation to the VCIS 5-km grid relatively straightforward.

Related to the improved boundary layer representation was the ability to downscale and create 30-meter sub-domains. While we have successfully used the CALMET kinematic model (Scire and Robe 1997) to downscale winds to a 30-meter resolution, without the finer-scale mixing height data, there is no practical value (and no additional information) gained from interpolating the existing data to a higher resolution grid. Additionally, discussions with users have pointed to the need for fine scale data but only at the airshed level, not at a 30-meter grid. From the user perspective, it is important to resolve complex topography, but only down to the project or airshed level. Once the AQUIPT data is available, finer resolution airshed statistics may be feasible.

Deliverables Crosswalk Table:

Proposed	Delivered	Status
Improved statistics including annual time series and user defined prescription windows	http://www.airfire.org/vcis	Complete
Improve quality and accuracy of data layers	http://www.airfire.org/vcis	Complete
Query options on geographic and political layers	http://www.airfire.org/vcis	Complete
Overlay maps of wilderness and non-attainment areas	http://www.airfire.org/vcis	Complete
Airshed statistics	http://www.airfire.org/vcis	Complete
Improved boundary layer representation	See Note #1 below.	In progress

Web interface that allows access to the raw data	http://www.airfire.org/vcis	Complete
Online tutorial	http://www.airfire.org/vcis	Complete
1-hour lesson plan	http://www.airfire.org/jfsp/vcis	Complete
½ day workshop curriculum	http://www.airfire.org/jfsp/vcis	Complete
Conference presentations	See Note #2 below	Complete
Journal article	See Note #3 below	In progress

Notes:

1. This was determined to be infeasible with current tools. A new database being developed for the AQUIPT project may allow this to be done in 2008.
2. VCIS was presented in a number of conference talks. Instead of a conference proceeding, a journal manuscript is being prepared in order to maximize visibility.
3. A Fire Management Today article is being prepared for submission and will be submitted in late 2007 / early 2008.

References:

- Ferguson, S.A., S.J. McKay, D.E. Nagel, T. Piepho, M.L. Rorig, C. Anderson, and L. Kellogg. 2003. Assessing values of air quality and visibility at risk from wildland fires. Res. Pap. PNW-RP-550. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 59 p.
- Scire, J. S. and F. R. Robe. 1997. Fine-scale application of the CALMET meteorological model to a complex terrain site. EarthTech, 196 Baker Avenue, Concord, MA 01742, Rep. 97-A1313. 15 pp.
- Seaber, P.R., F.P. Kapinos, and G.L. Knapp. 1987. Hydrologic units maps. Water Supply Paper 2294. Reston, VA: U.S. Geological Survey. 63 p.

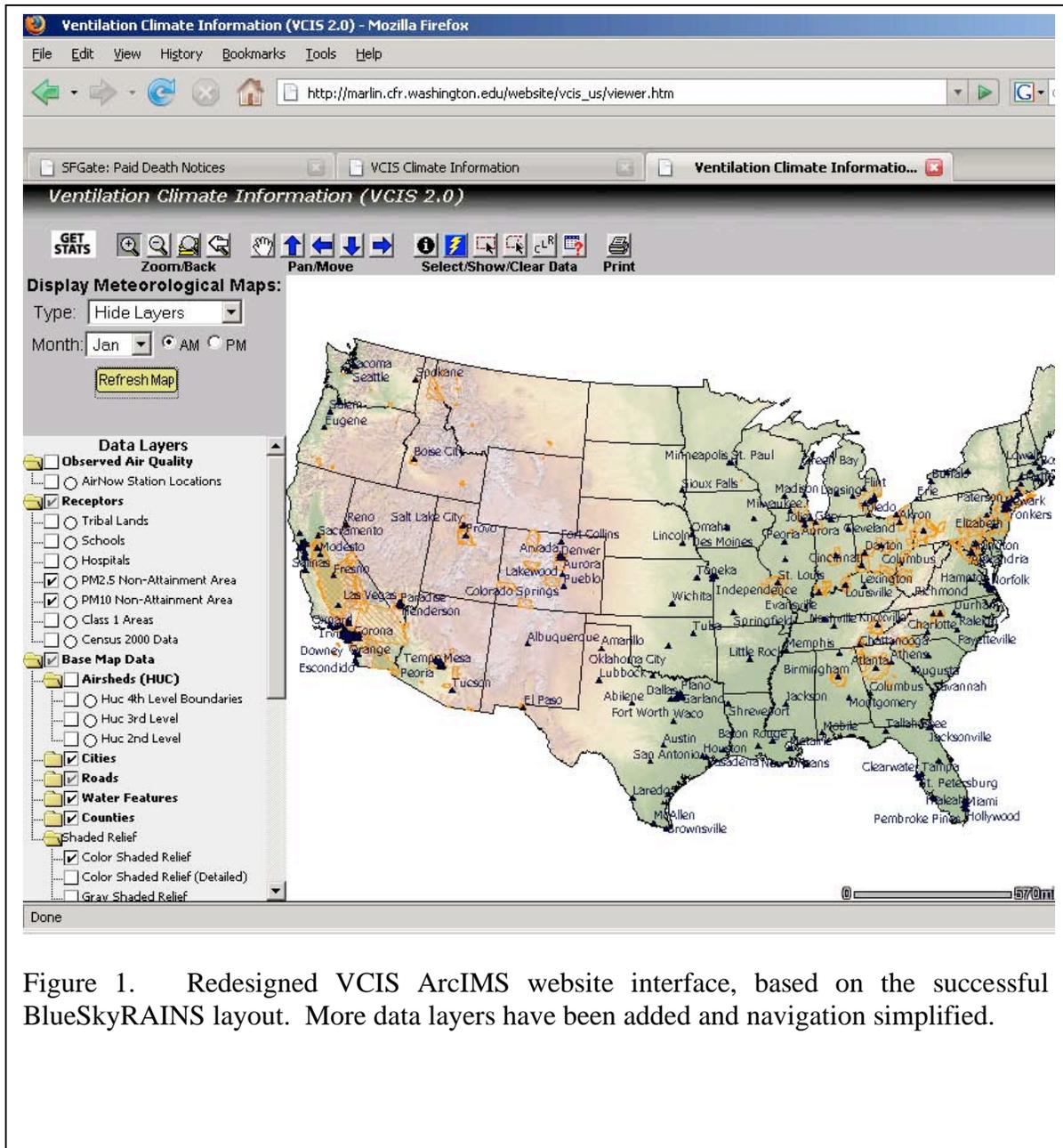


Figure 1. Redesigned VCIS ArcIMS website interface, based on the successful BlueSkyRAINS layout. More data layers have been added and navigation simplified.

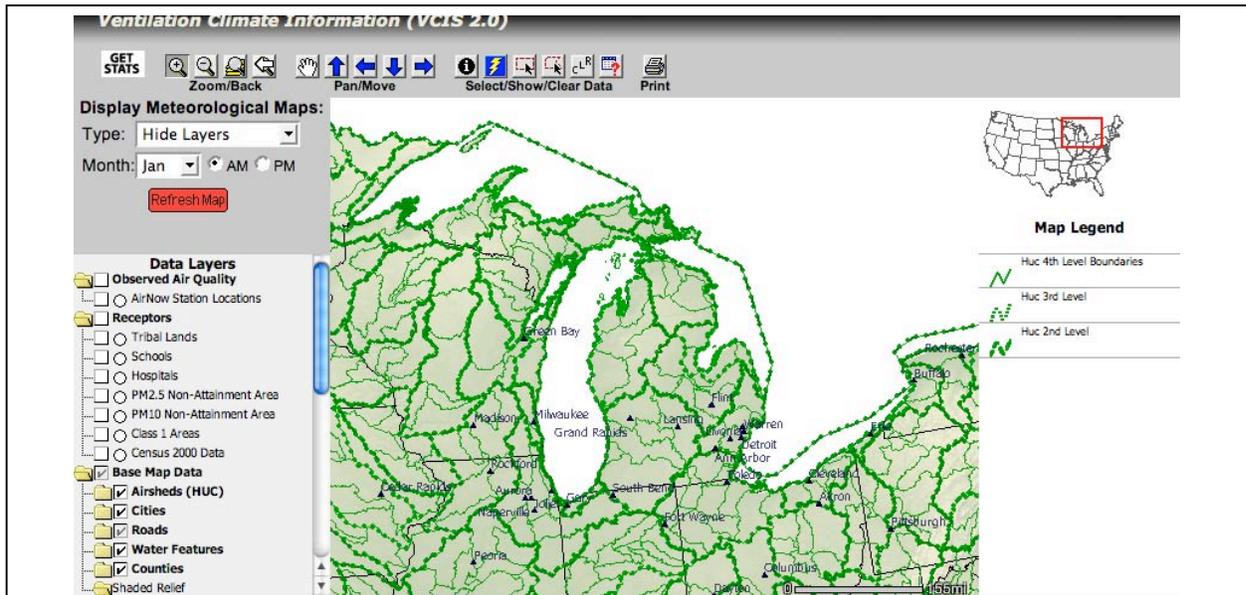


Figure 2. A close-up of the great-lakes area showing the HUC Level 1, 2, and 3 boundaries. HUC Level 2 region average timeseries and statistics are now available in a similar fashion to the grid cell data.

Airshed Statistics

[View Point Statistics](#) | [View Prescription Probabilities](#)

 **Click on a circle to view statistics**

[Click here to print full sized graphic\(s\)](#)

Latitude: ° ' '' N Longitude: ° ' '' W

Units: ▾

Note: The coordinates are referenced to the WGS 1984 datum.

Graphics		Surface Wind How to read this plot	Mixing Height How to read this plot	Ventilation Index How to read this plot	Summary Table How to read this plot
Annual Ave.	AM				
	PM				
Jan	AM				
	PM				
Feb	AM				
	PM				
Mar	AM				
	PM				
Apr	AM				
	PM				
May	AM				
	PM				
Jun	AM				
	PM				
Jul	AM				
	PM				
Aug	AM				
	PM				
Sep	AM				
	PM				
Oct	AM				
	PM				
Nov	AM				
	PM				
Dec	AM				
	PM				
Download Data	AM	download	download		
	PM	download	download		

Figure 3: Statistics main page. Here shown for the airshed statistics. Graphics are viewable by selecting a circle. Data can be downloaded directly from here. Also prescription probability calculators can be accessed from here.

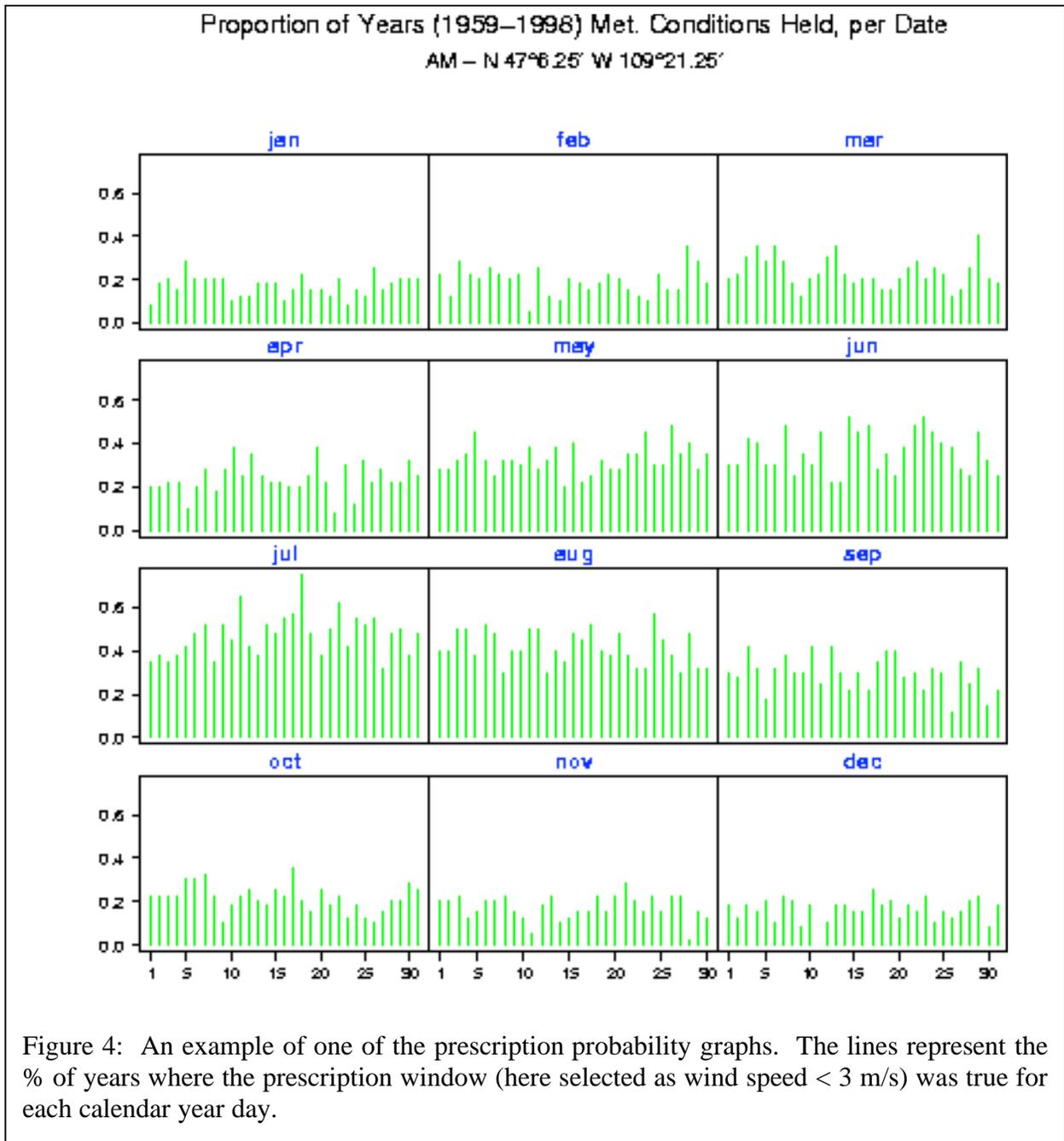


Figure 4: An example of one of the prescription probability graphs. The lines represent the % of years where the prescription window (here selected as wind speed < 3 m/s) was true for each calendar year day.