Wind Characterization Modeling

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Project Overview

- Wind is:
  - A non-deterministic variable
  - Vitally important for correctly calculating a bullet's path
- For military applications, wind deflection is perhaps most important for long-range sniper applications

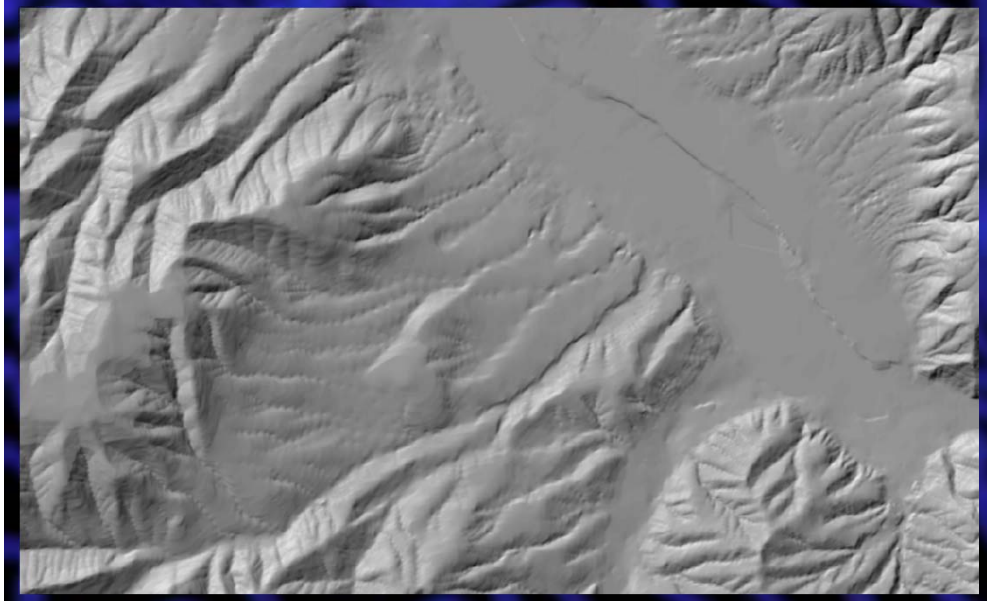
Project Overview (cont'd)

- While *knowing* wind velocity and direction along a bullet's flight path is not possible
- Predicting wind velocity and direction along the patch *is* possible
- Hence, the focus of this project

Wind Characterization Modeling

- We have titled this project a characterization model because:
  - Characterization: wind velocity and direction can not be known precisely. Rather it will be estimated based on real-world observation/measurement events
  - Model: this project --when applied in the field-- will predict wind based on past observations

Study Approach (page 1)
Site Selection



- Select two study sites
  - Flat (or nearly so)
  - Hilly
- Each site will be 100m x 1000m

Study Approach (page 2)
Data Collection

- Deploy 15 recording anemometers (e.g., Kestrel wind meters) along a sampling array

		Range (m)										
		0	100	200	250	400	500	600	750	800	900	1000
	50	1		4			7		10			13
shooter's location		2		5			8		11			14
	50	3		6			9		12			15

- Use a laser range finder for assistance
- Collect the location using GPS

Study Approach (page 3)
Data Collection

- Conduct a minimum of three (3) sampling sessions at each site. Each session will:
  - Last at least one hour with measurements recorded at 5 second intervals
  - Be accompanied by video footage for training use (the entire session will not be recorded)
  - Random locations will be monitored for validation purposes
- Sessions will capture variable wind patterns and be opportunistically selected

Data Collection

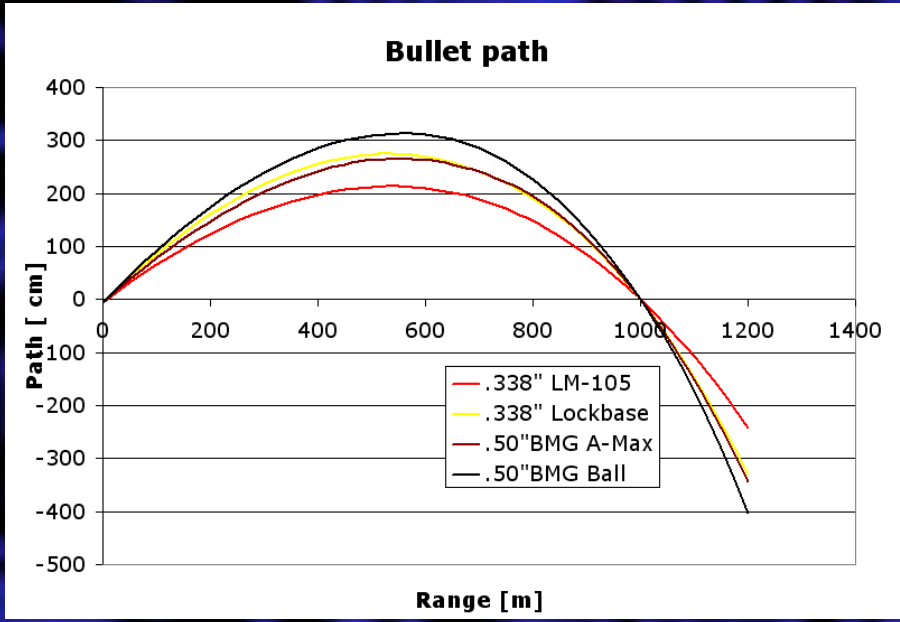
- These data represent the horizontal data array collection (HDAC)

Study Approach (page 4)
Data Collection

- An additional session will collect changes in wind velocity at different heights above ground.
- This is because a bullet fired over long-range will traverse not only 1000 m of air across a horizontal surface, but also up to 8 meters of air across the vertical rise/fall of its trajectory

Data Collection

- These data represent the vertical data collection (VDC)



What to do with all these data?

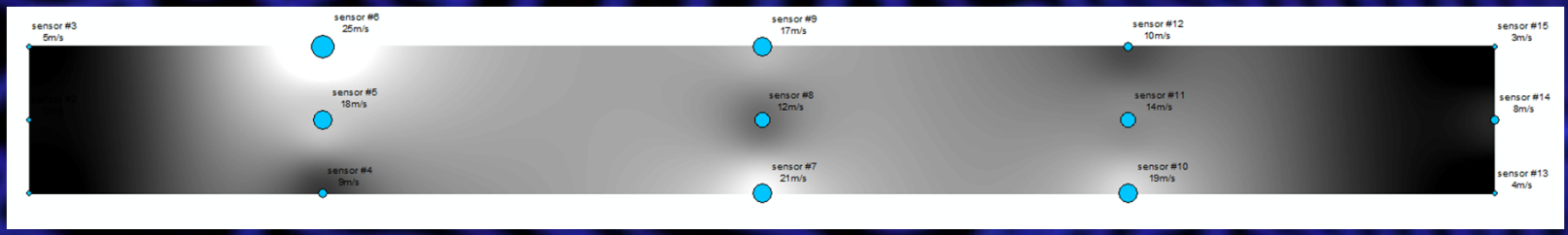
- The HDAC will collect approximately
  - 720 measurements at each sensor
  - 10,800 measurements at each array
  - 32,400 measurements at each site
  - 64,800 measurements for the study

What to do with all these data?

- These data will be imported into a geodatabase with synchronized date/time tags
- In GIS software these data will be reviewed

Spatial Data Analysis

- To make the data meaningful, we will use spatial interpolation, to convert the discrete measurements into a wind characterization model (WCM) with 1m resolution

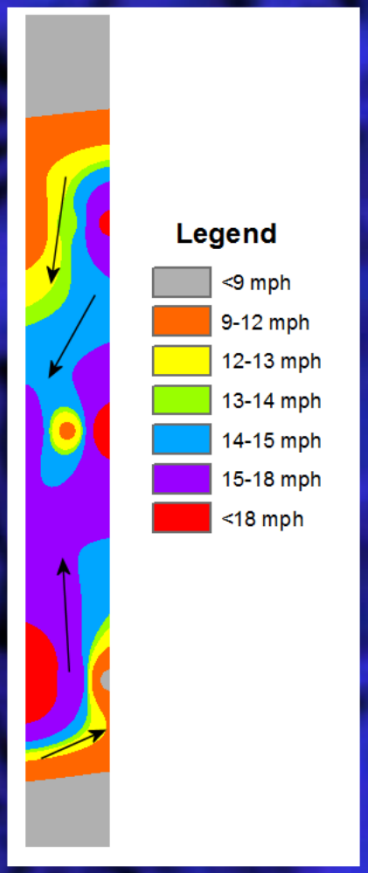


WCM

- Each WCM will:
  - Be validated using the random measurements collected earlier
  - Contain up to 1000 *useable* data points along a bullet's flight path

WCM

- Numerous WCM's could be produced (64,800 actually)
- This is not necessary however because:
  - Many will describe similar/same wind events
  - It is unmanageable by the sniper
  - It is unnecessary for proof of concept



What Proof of Concept?

- That's our Big question…
  - Can a wind characterization model improve sniper efficiency and effectiveness?

Let’s put the WCMs to work

- To answer our Big question…
  - Approximately six WCMs will be selected which characterize a variety of conditions
  - Each will be accompanied by a brief video and descriptive narrative for training purposes

Calculating an improved firing solution

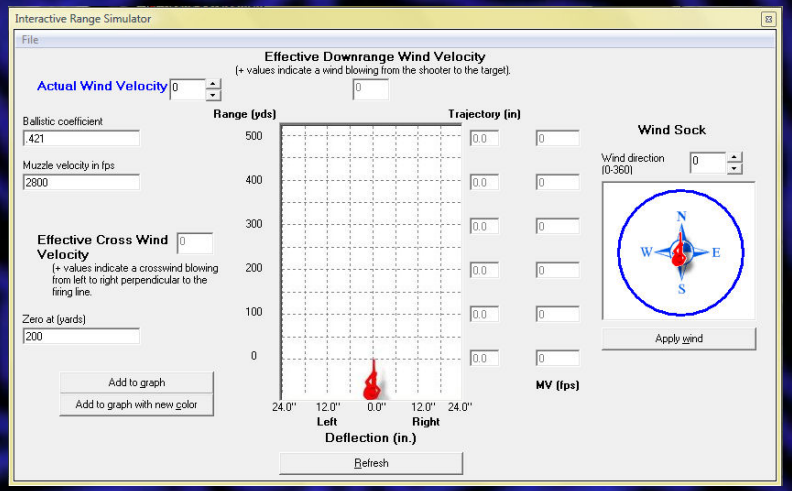
- Select the WCM that best matches current field conditions
- Incorporate results from VDC analysis
  - How much does wind velocity change with height above ground?
- Input current wind velocity and direction

Calculating an improved firing solution

- Iteratively derive the wind-deflection solution
  - Use current conditions to ‘seed’ the selected WCM
  - For m = 0 to 1000 (m = meters from bore)
    - At step m, retrieve wind velocity/direction from the WCM
    - Adjust wind velocity based on VDC results
    - Calculate wind-deflection at m
    - Sum total wind-deflection
  - Next n

In the field

- Sniper team selects a WCM and enters current wind speed/ direction
- OK



OR

Validation Trial

- We plan to test the WCM system
- Experienced long-range shooters will be asked to volunteer (ideally 30 shooters)
  - Fire a 10-shot group at 1000 m using standard wind-doping
  - Receive training on the WCM system
  - Fire a 10-shot group at 1000 m using the WCM system
- Statistically compare results

- We hypothesize the WCM system will improve sniper efficiency and effectiveness
- Questions?