Ski / Sled tracks as an expression of avalanche risk

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Black Diamond

Majestic HeliSki, Alaska
(Hank de Vre Photography, 2014)

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Decision making

- We take a geo-spatial approach to understand avalanche risk.
- Travel in backcountry avalanche terrain is a classic example of decision making in a **high risk / low probability settings**.

- Here is another example:
- https://www.youtube.com/watch?v=baVPKqBydro

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“Top of the cliff”

- Most accident analysis looks at the result.
  - i.e. When the risk margin was exceeded
- Our approach is trying to understand the reasons and the patterns of risk behavior
- Result in targeted education

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Overview

- Risk is a function of:
  - Probability – Function of terrain and snow conditions
  - Consequence – Function of terrain
  - Exposure – Function of terrain
  - Vulnerability – Not terrain (transceivers, airbags etc)
  - Decision making – Function of group / gender / etc / ???
- ***If the snowpack is your problem = terrain is the solution***
- **Ski / sled tracks as geographic expression of risk**

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Overview

- Safe winter backcountry travel is the effective reduction of risk, and is a combination of:
  - **Education, experience, judgment & technology**

- Trip information that documents all of this is largely anecdotal or nonexistent.
- In many cases, despite reasonable knowledge of the snowpack, people are still having accidents due to poor decisions / poor risk management.

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Crowdsourcing tracks in 2013/14 (and 14/15 → 15/16)

- Crowd-sourced data collection campaign:
  - **Use a smartphone application called SkiTracks to track people more easily and enable rapid sharing of data.**
  - **Smartphone optimized survey tool to allow for easy and rapid completion of the daily post trip survey.**
  - **Expand pilot study and more heterogeneous group**
- We collected hundreds of tracks and survey responses from all around the World:
  - **USA, Canada, Norway, France, Slovakia, New Zealand**

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7-Day Forecast for L... | Google | Google Maps - BZN | Bridger

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- Undergraduate Program
- Graduate Program

Department of Earth Sciences
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P.O. Box 173480

Understanding Trave
A Crowd Sourced Ap

Contact Information:

Email: tracks@montana.edu
Website: http://www.montana.edu/snowscie

Overview:

This project aims to collect GPS location inf
terrain decision we make. Our focus is on b
participate in this research.

Participation:

If you are interested in taking part in this pro
easy steps below (or download this PDF):

1. Sign-up to participate

www.surveymonkey.com/s/PreseasonParticipantS

2. Download "SkiTracks" by CoreCoders

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1. Sign-up to participate

www.surveymonkey.com/s/PreseasonParticipantSurvey

2. Download "SkiTracks" by CoreCoders

App Store | Google play

Step 1 and 2 only need to be completed once

More information:

If you want to learn more about our project aims, research questions and approaches, please visit our web pages:
www.montana.edu/snowscience/tracks

Or scan our QR code:

If you are interested in taking part in this project, then follow the easy steps below:

- **Step 1 and 2 only need to be completed once.**
- **Steps 3-5 need to be completed for every trip you want to submit to us.**

3.Track your trips

Send your GPX file to:
tracks@montana.edu

4. Automatic reply

Autoreply from
tracks@montana.edu
with link to post-trip survey

5.Complete a short, post-trip survey

www.surveymonkey.com/s/daytripsurvey

Steps 3-5 need to be completed for every trip you want to submit to us.

Ski Tracks

- Smart phone based application to track you trips
- Easy tracking (Cell or GPS)
- Optimized battery usage
- **Easy sharing!**
- Accepted **GPX** files from other sources
- Emailed to tracks@montana.edu

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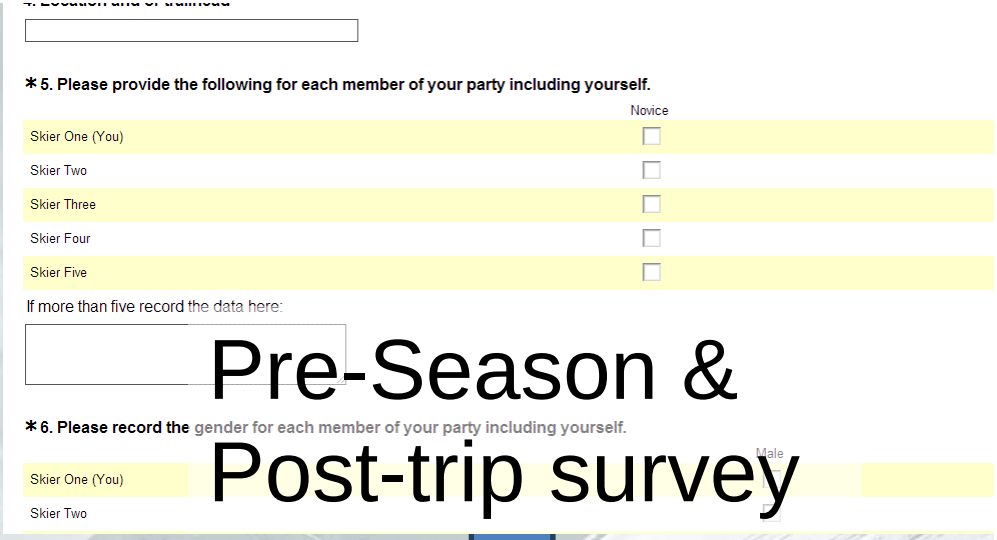
Tracks



5. Please provide the following for each member of your party including yourself.

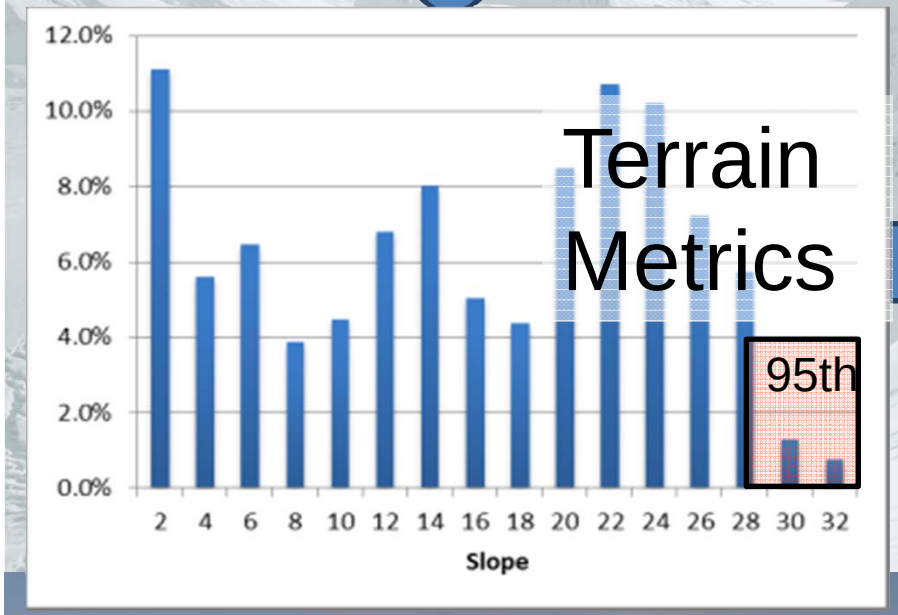
	Novice
Skier One (You)	☐
Skier Two	☐
Skier Three	☐
Skier Four	☐
Skier Five	☐

If more than five record the data here:

6. Please record the gender for each member of your party including yourself.

	Male
Skier One (You)	
Skier Two	

Pre-Season &
Post-trip survey



Terrain
Metrics

Decision making

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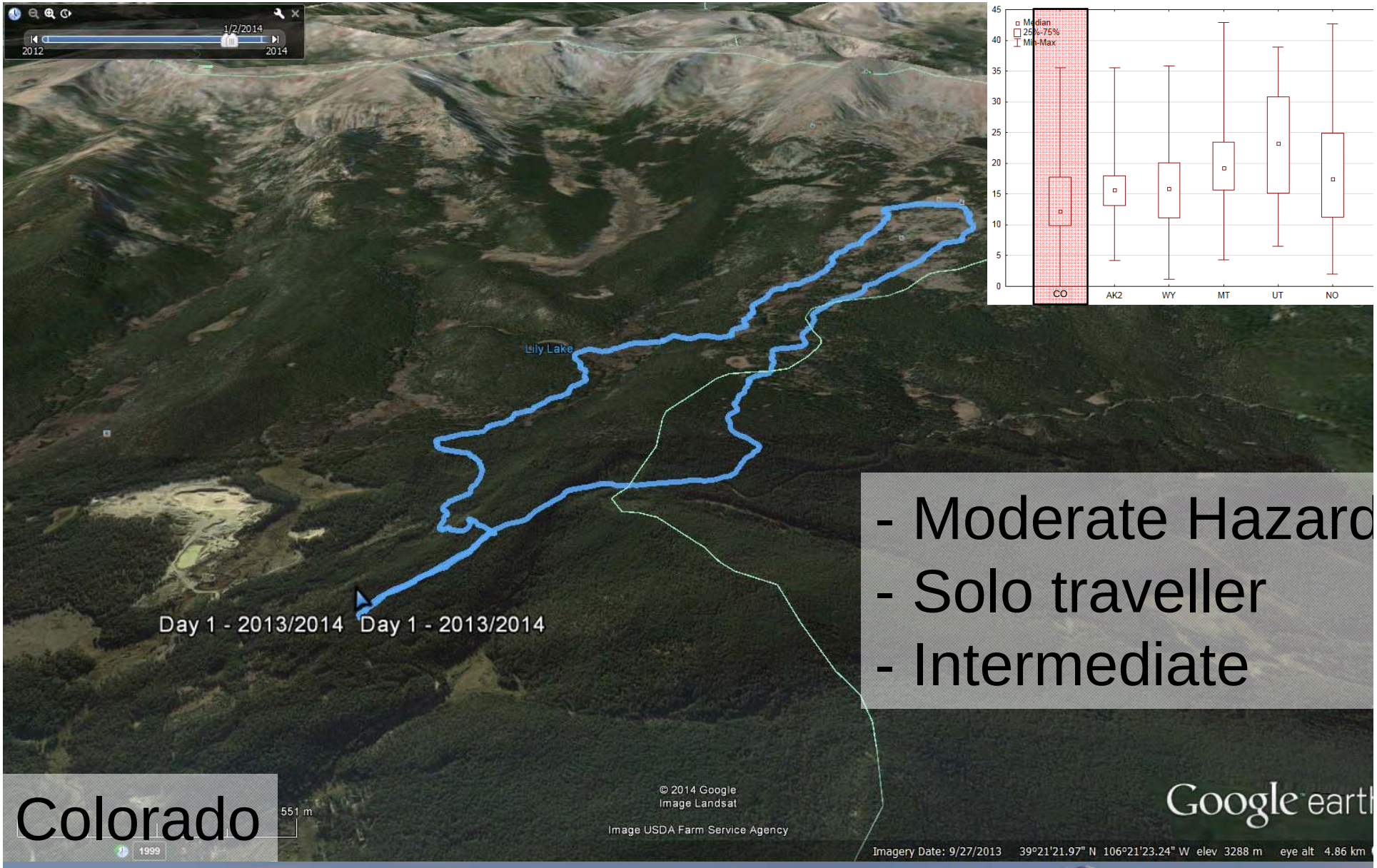

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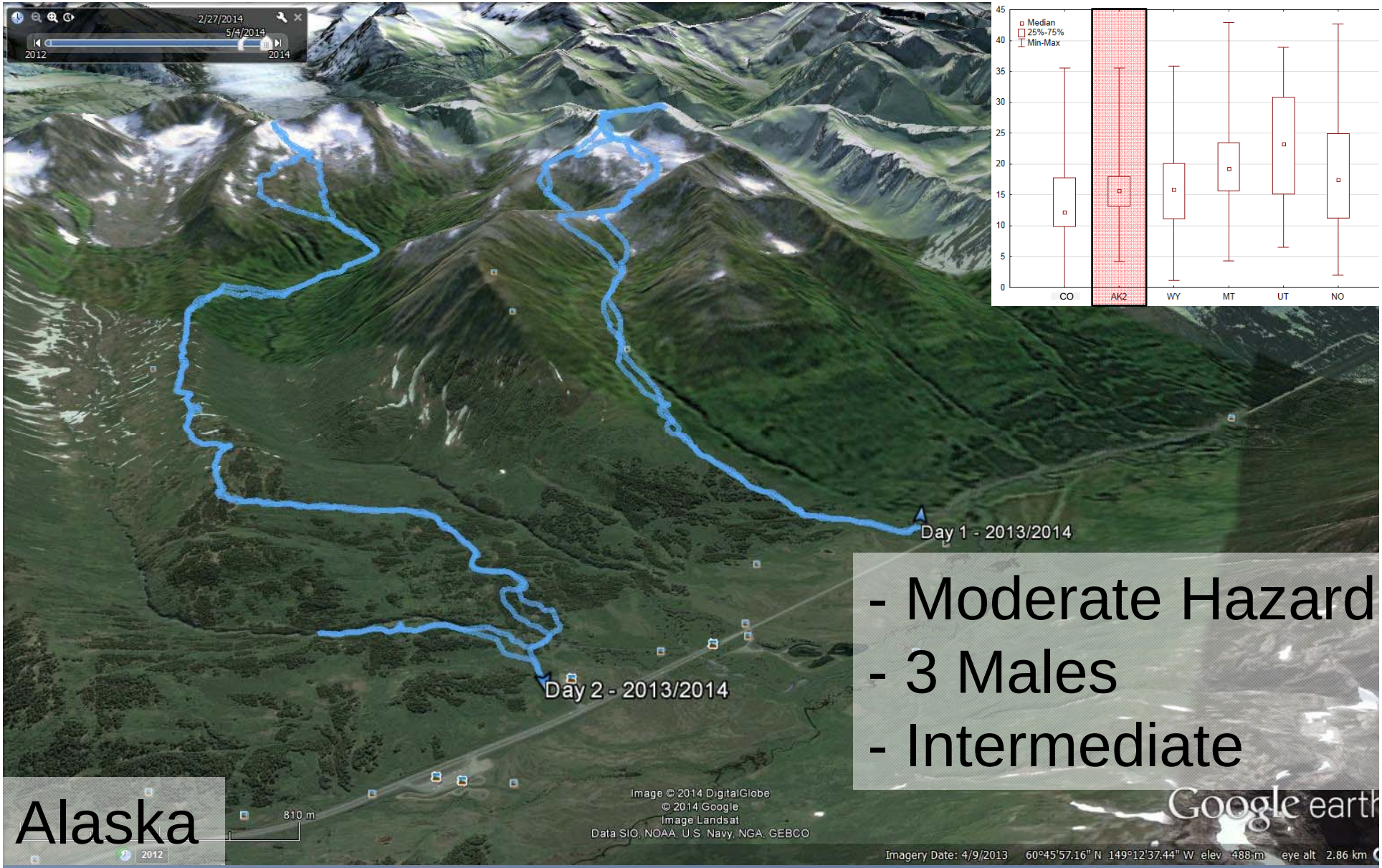

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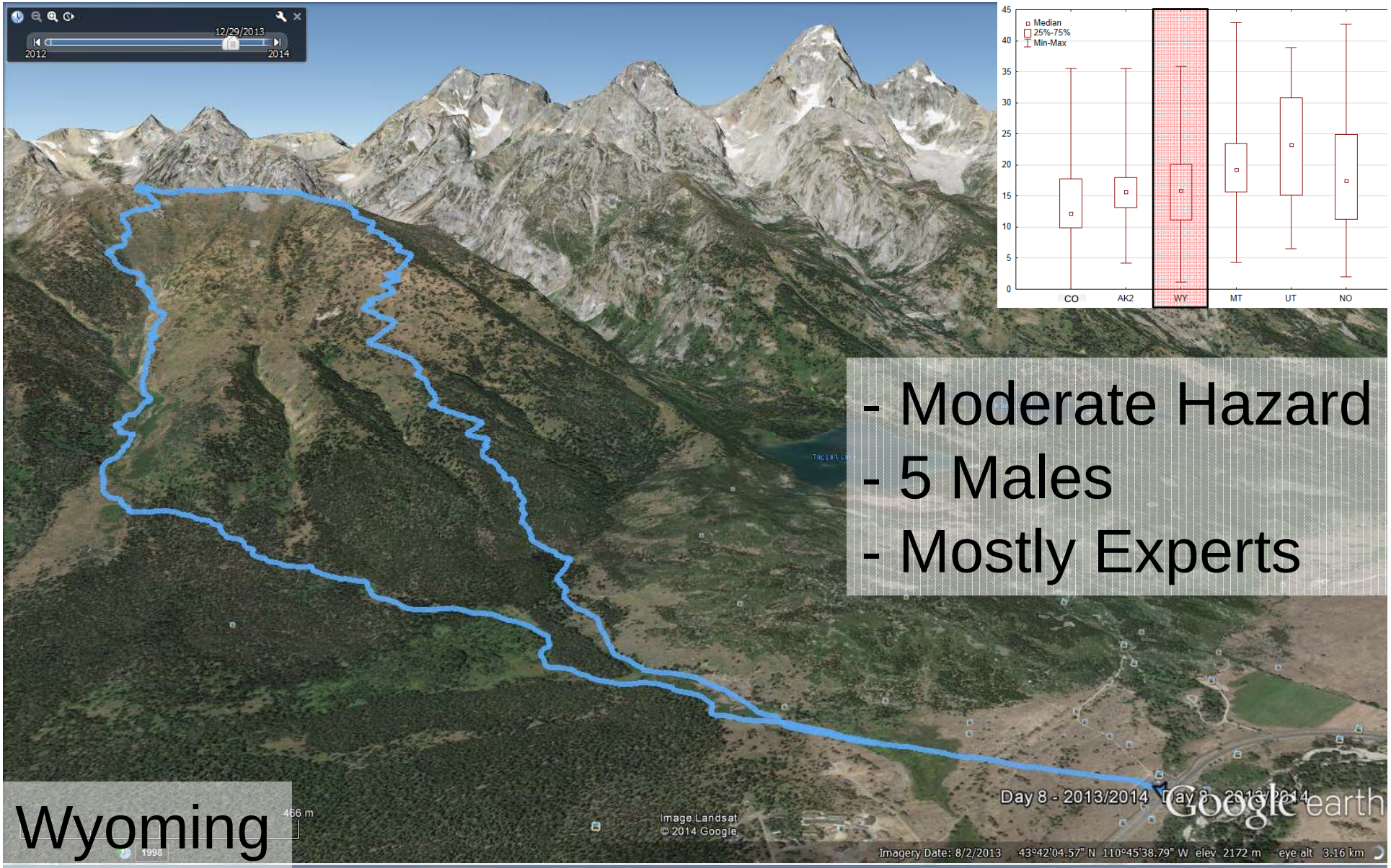

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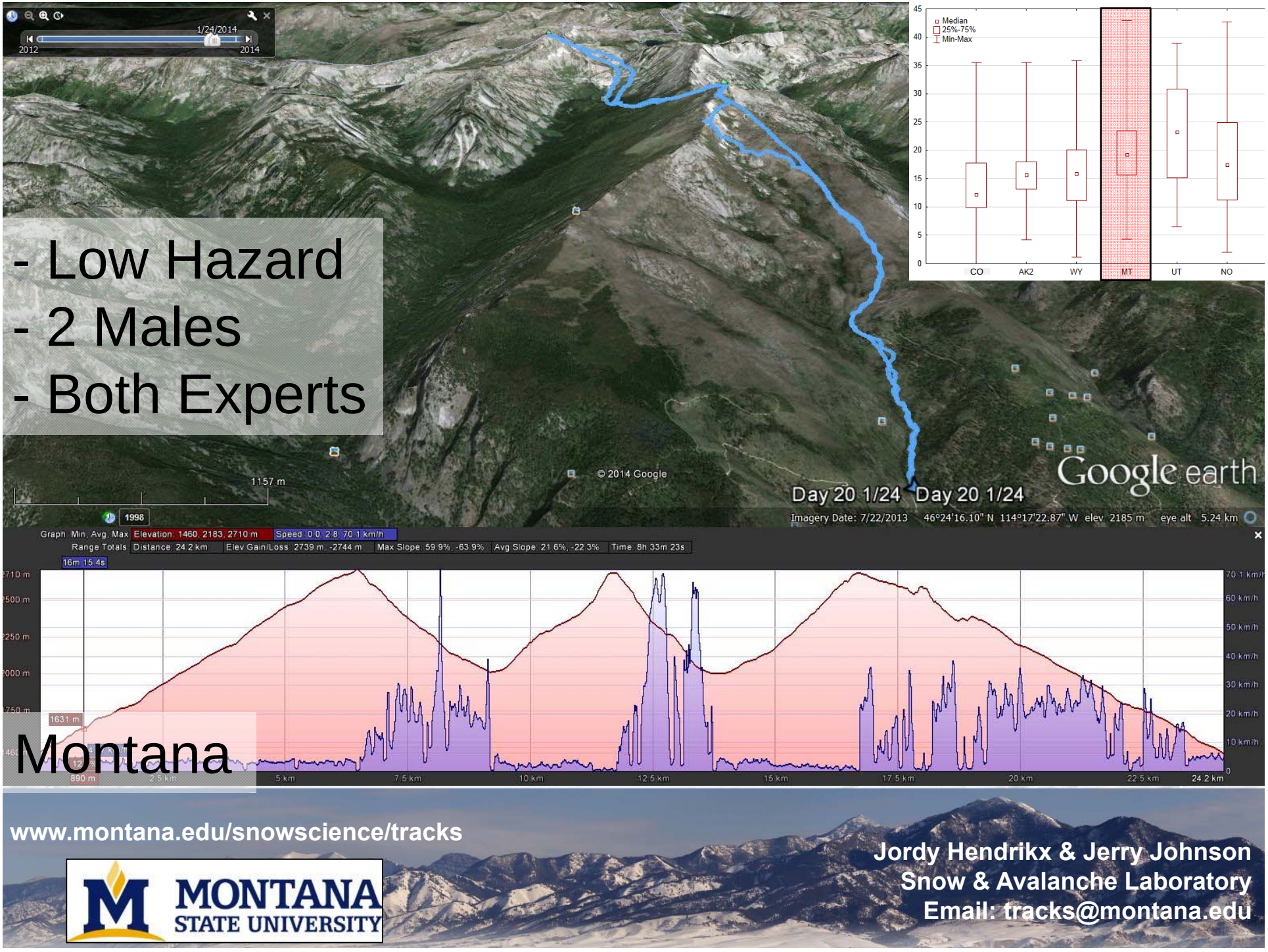

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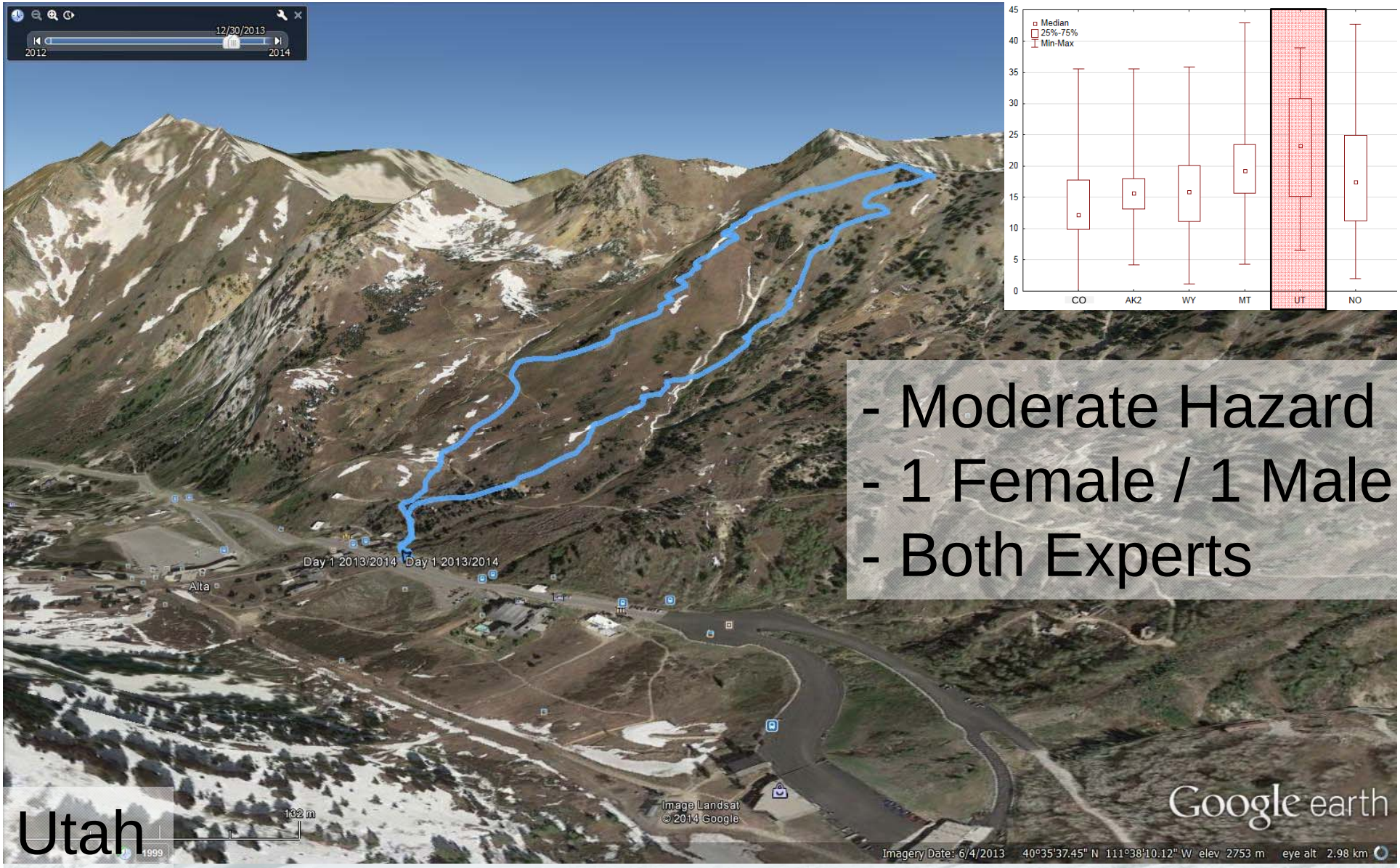

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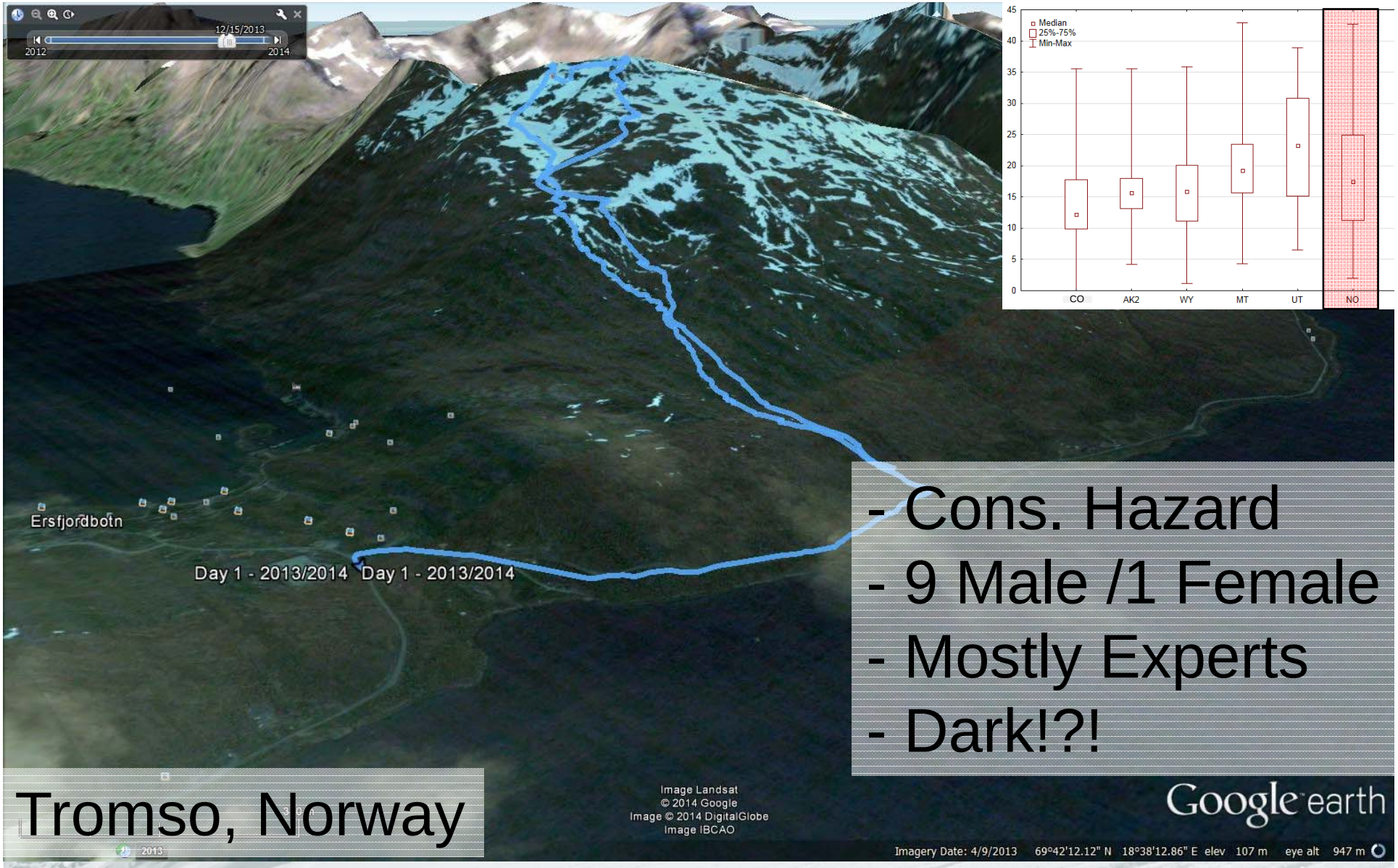

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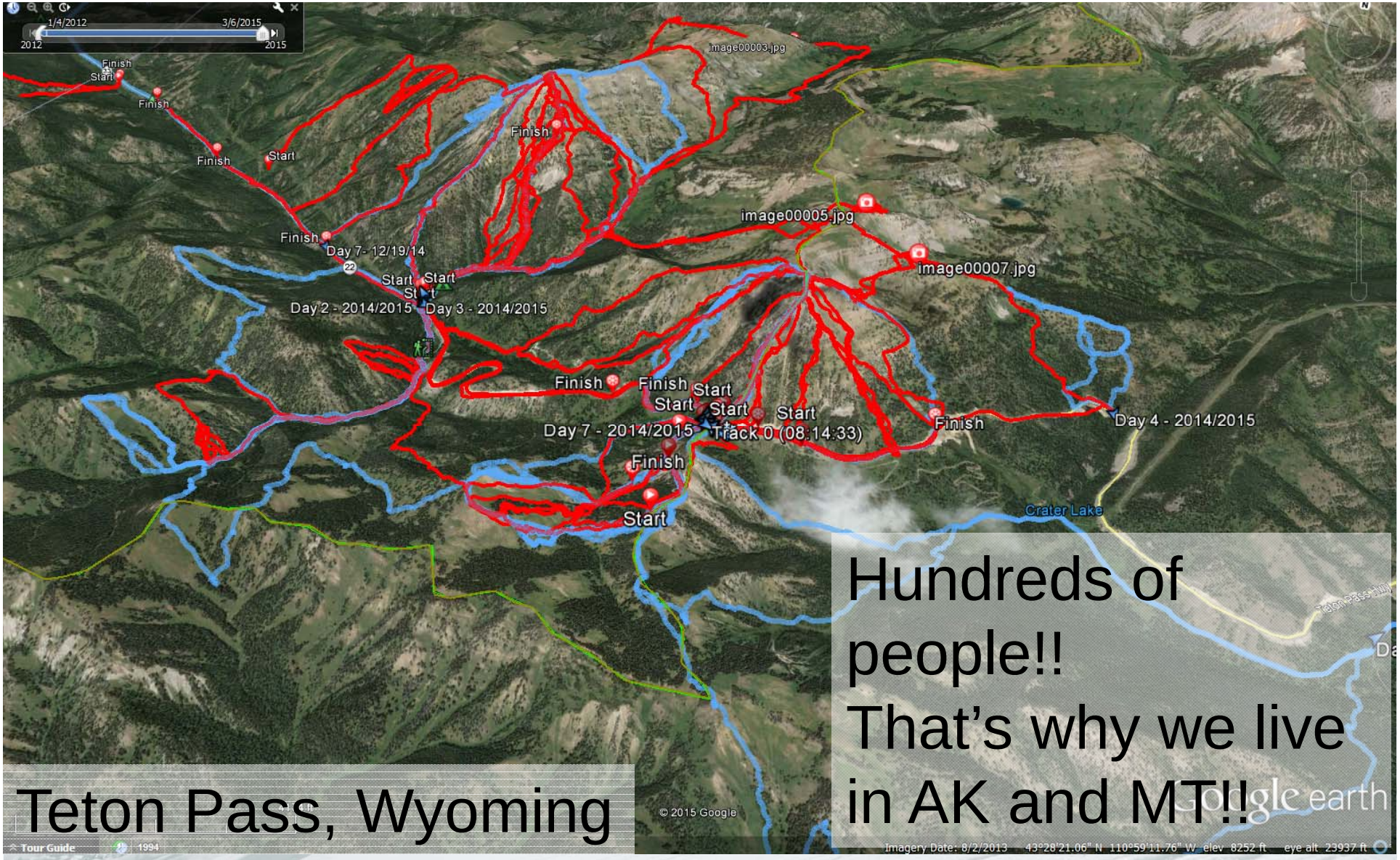

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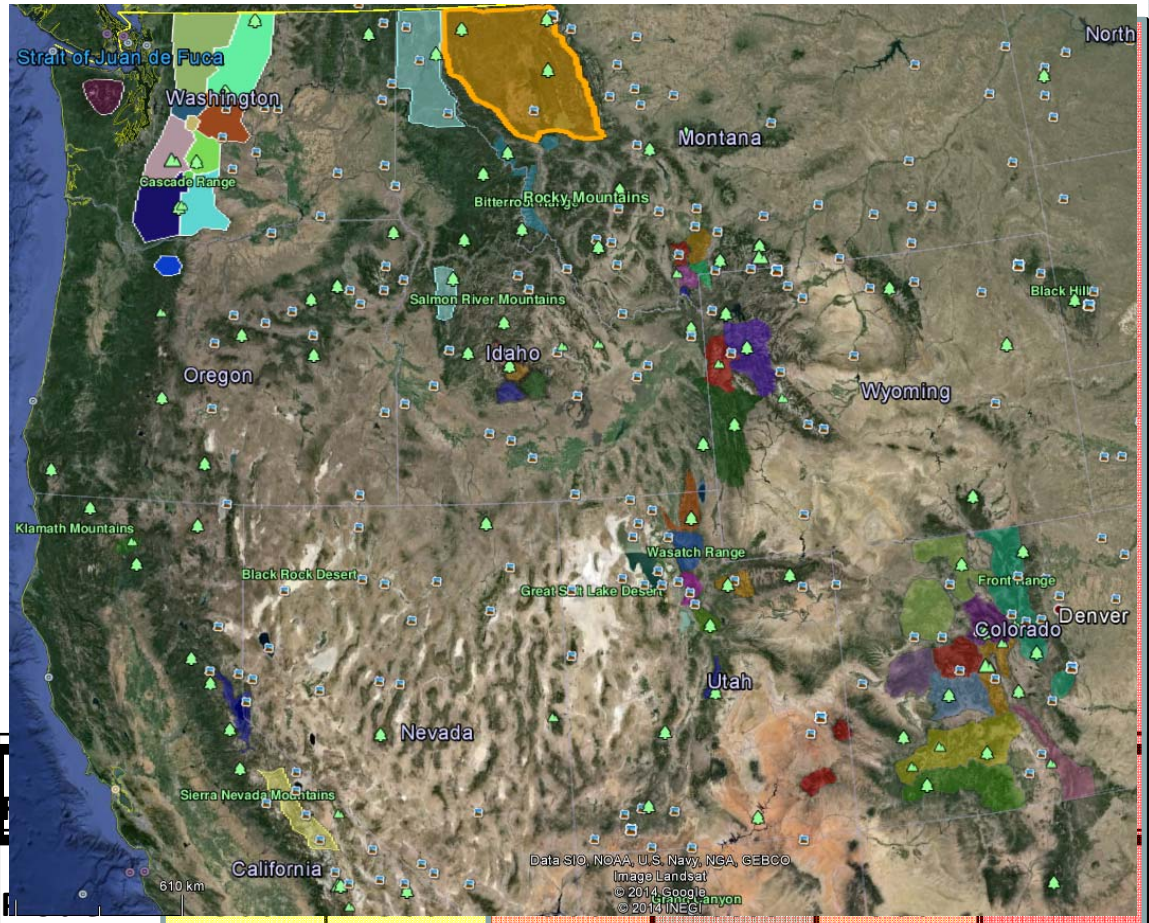

Group	Solo	3 Males	5 Males	2 Males	Male / Female	9 Male / 1 Female
Experience	Int	Int	Expert	Expert	Expert	Expert
Max Slope	33.4	35.5	31.7	43.0	39.0	42.7

Data Analysis

- Data grouped by:
  - **Group / Gender**
  - **Experience**
  - **Forecast**
  - **Problem**
  - **Region**
- Compared to terrain metrics
  - **Slope / aspect / ridge / curvature**

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Results - Who

- WHO:
  - Male (84%) aged 26-35 (40%)
  - Has a bachelor's degree+ (79%)
  - Employed full time working 40 or more hours per week
  - Has no children
  - Participated in other outdoor sports, e.g. hiking, downhill skiing, mountain biking, trail running and rock climbing.

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Results – Group vs Terrain

- Gender:
  - **Some evidence to suggest that gender is important**
  - **All male groups used much steeper terrain (i.e. greater exposure) than all female groups.**

- Avalanche Forecast:
  - **Steeper terrain used under LOW hazard.**
  - ***No difference* in terrain used between Moderate, Considerable and High hazard**

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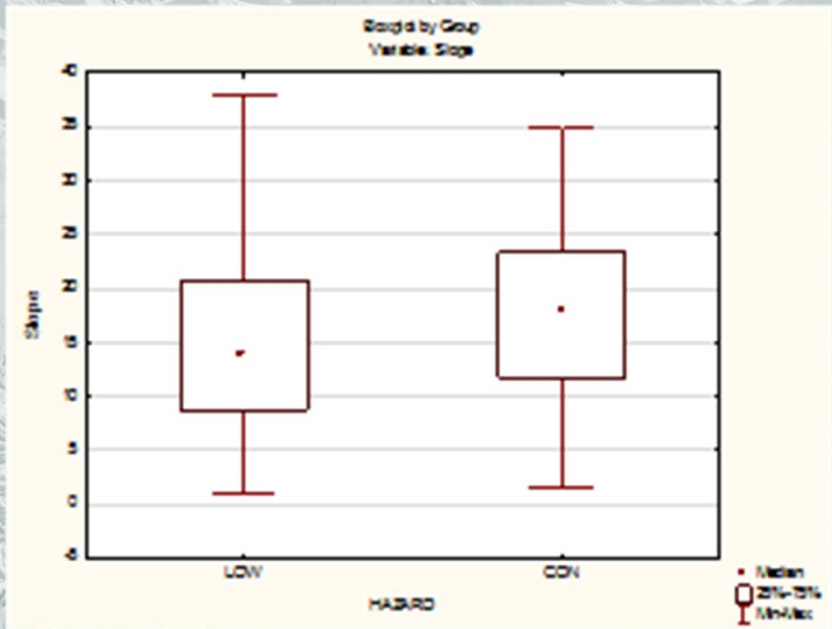
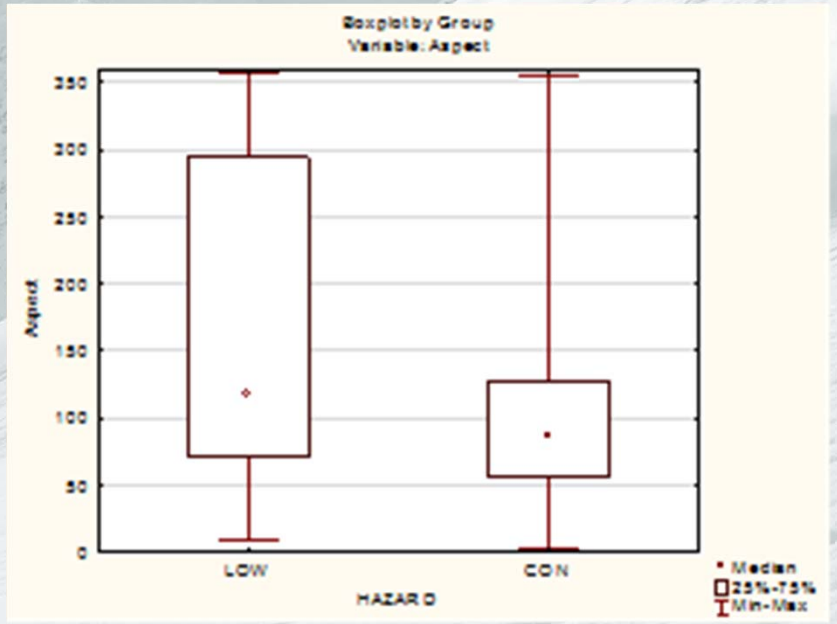
Results - Terrain

- Terrain use in detail (2 days by Expert):
  - Same slope angles on LOW and CONSIDERABLE
  - Mitigated by Aspect





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Results – Group vs Terrain

- Experience:
  - **Majority identified as Experts (53%) & Intermediate (43%)**
  - **Statistically significant difference between Experts and Intermediates:**
    - **30 years of skiing (Experts) / 20 years (Intermediate)**
    - **Terrain management skills**
    - **Level of avalanche education**
- Group:
  - **Weak evidence to show that group size is important.**
  - **Bigger groups on steeper terrain**
  - **26% of all data from solo travelers – ALL EXPERTS**

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Results – Experience vs Terrain

- Terrain Usage:
  - **Statistical differences between Experts and Intermediates:**
    - **Steepest terrain used**
    - **Length of trip**
    - **Duration of trip**
  - **Expert BC travelers expose themselves to more severe terrain.**
  - **Also have higher levels of avalanche education, experience, better decision making, and self assessed levels of avalanche terrain management ability.**
  - **Evidence of risk homeostasis?**

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Skiers compared to sledders

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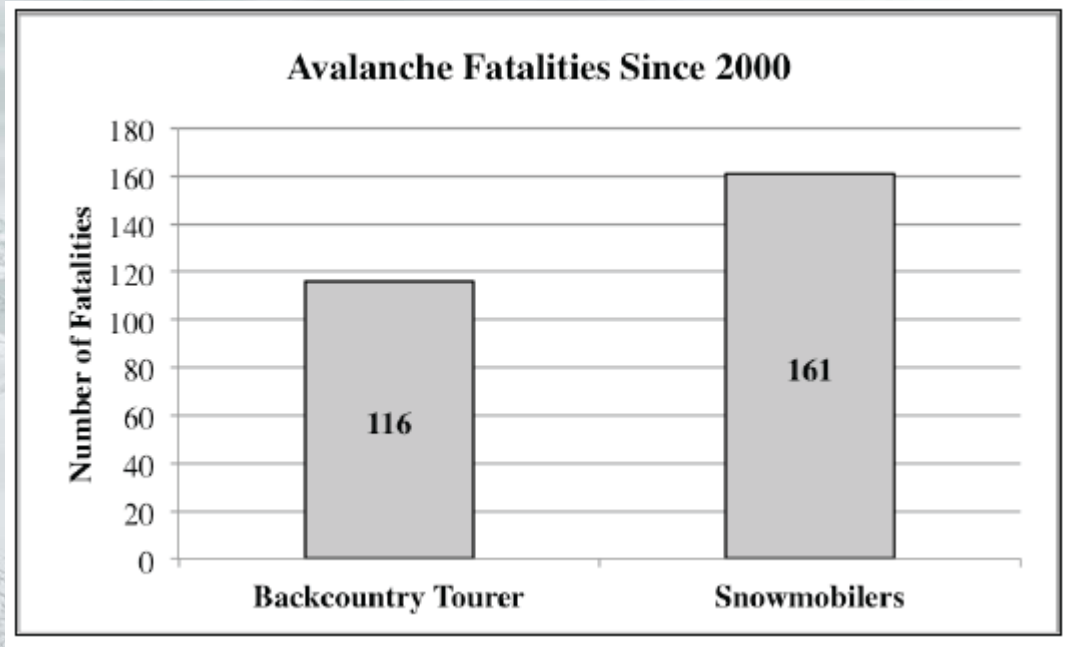
Skiers compared to sledders



- **Number of avalanche fatalities in the US by activity (CAIC, 2015)**

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Skiers compared to sledders

- Sledders cover way more terrain than skiers!
- Sledders are in much more avalanche terrain than skiers!
- But do they?
  - **Depends on how you think about this.**
  - **Certainly more terrain**
  - **But more avalanche terrain?? …. Maybe not…**

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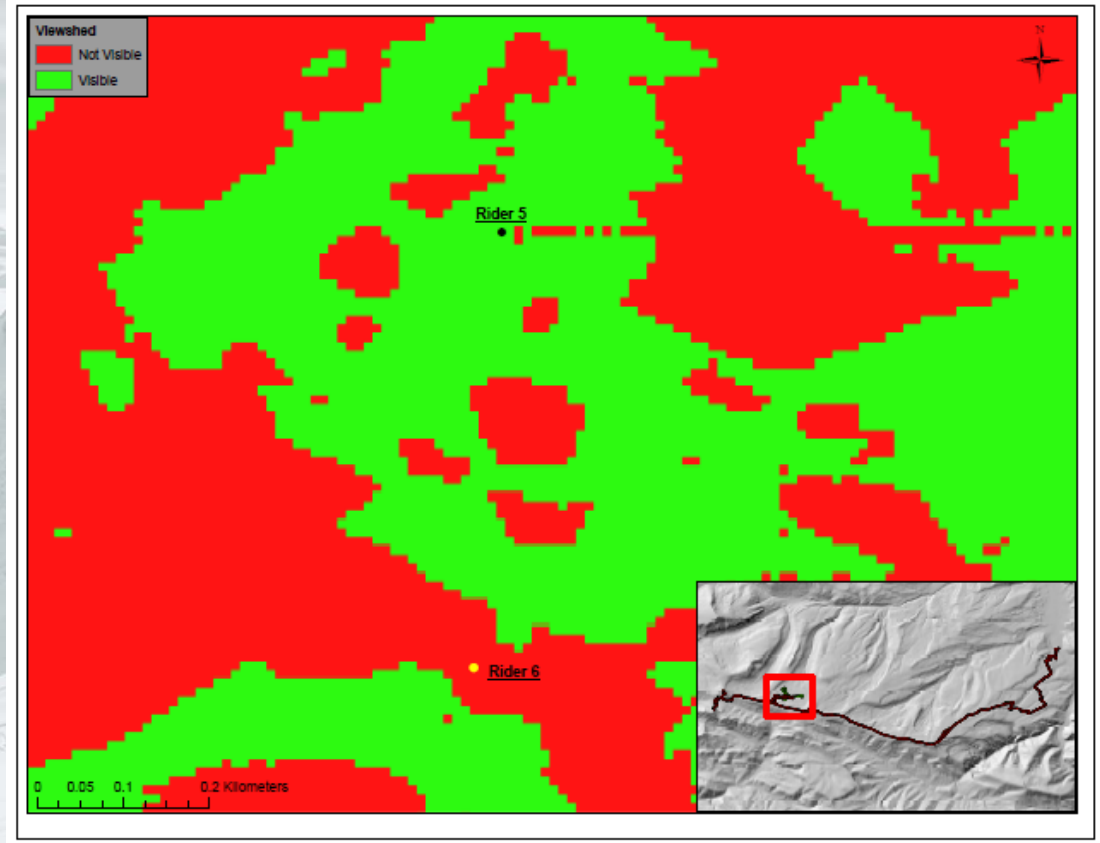
Skiers compared to sledders

- Red = Not visible
- Green = visible
- Large periods of time riders were not visible to one another.
  - Vulnerability
  - Consequence



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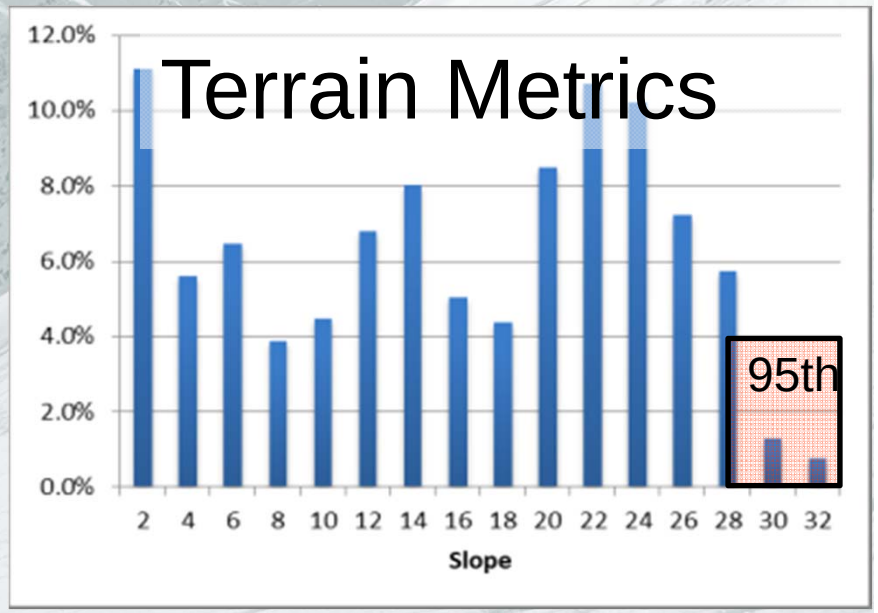
Skiers vs Sleds

- Sled tracks – x10 to x40+ longer
- Generally on lower slopes
- Generally less % of track in avalanche terrain
- But on **more features** than skiers.
- Exposure a function of the # of “chances” on individual features
- Consequence & vulnerability a function of visibility



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Heli-skiing

- Heli-ski guiding = prime example of high stress, high consequence decision making in avalanche terrain.
- Heli-skiing is an exciting experience
  - But also results in a high pressure scenario that demands consistently high quality decisions by guides and operators to mitigate avalanche risk
- Terrain is key to mitigation!

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Heli-skiing

- We used GPS tracking of heli-ski guides to enable quantification of terrain use. Four questions:
  - Use of lower(or higher) slope angles or different aspects, under higher avalanche hazard conditions or specific avalanche problems?
  - Variation in terrain use (i.e. slope and aspect) between different lead guides when working with similar groups under the same conditions?
  - Do guides who ski with the same group over time shift terrain use (i.e. familiarity)
  - Can these changes in terrain preferences, if evident, be seen at differing scales of terrain usage?

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Heli-skiing

- When we consider the data from 18 days of heli-ski guiding and look at terrain metrics by groups as defined by;
  - (1) the avalanche hazard; (2) the avalanche problem (3) the lead guide; or (4) the number of days skiing with a group,
- Do not observe any strong statistically significant differences between the slopes or aspects used
  - **?? Is there really no difference in terrain usage by a lead guide on a low hazard day, compared with a considerable hazard day ??**

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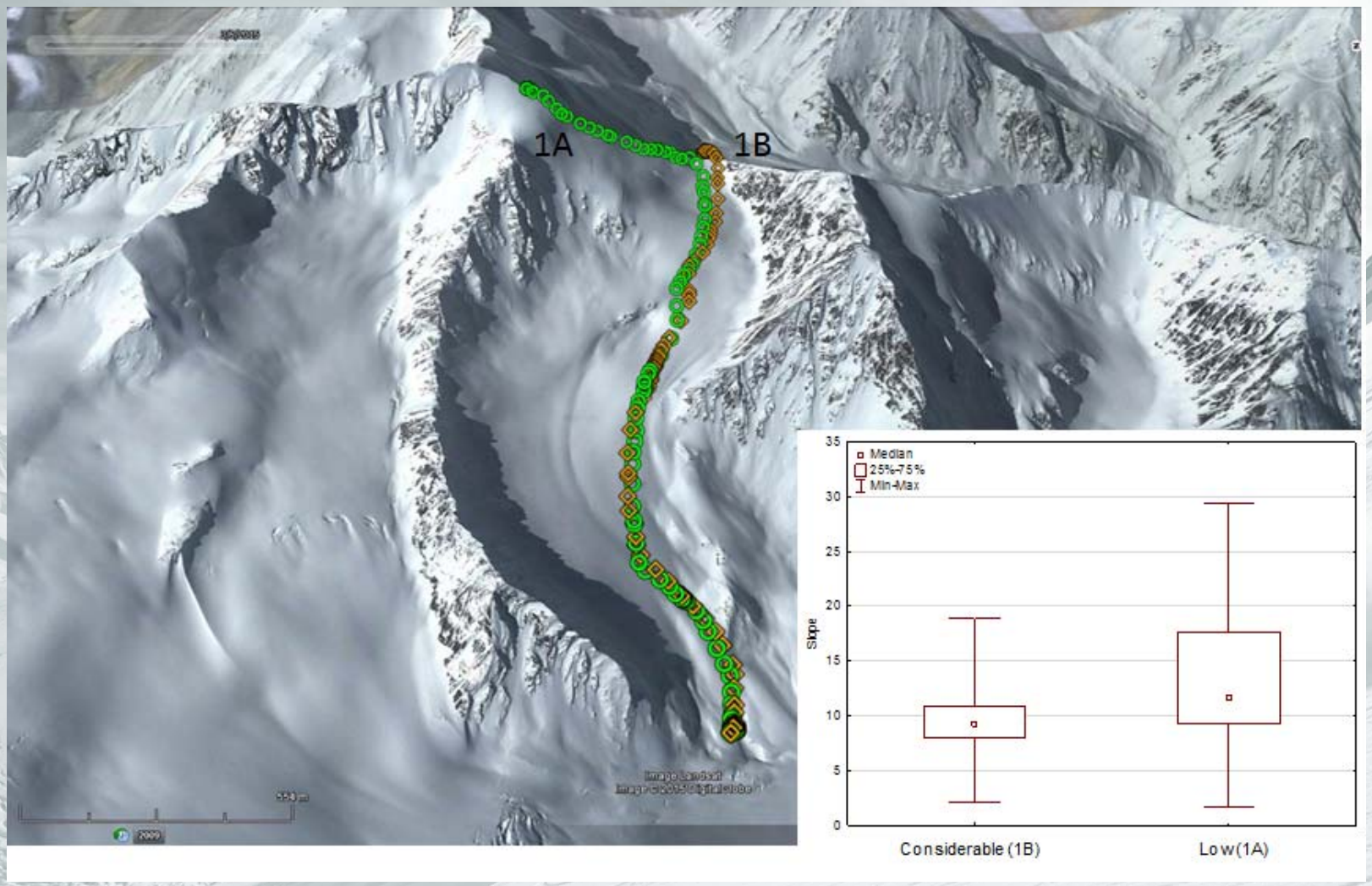

It all comes down to scale!

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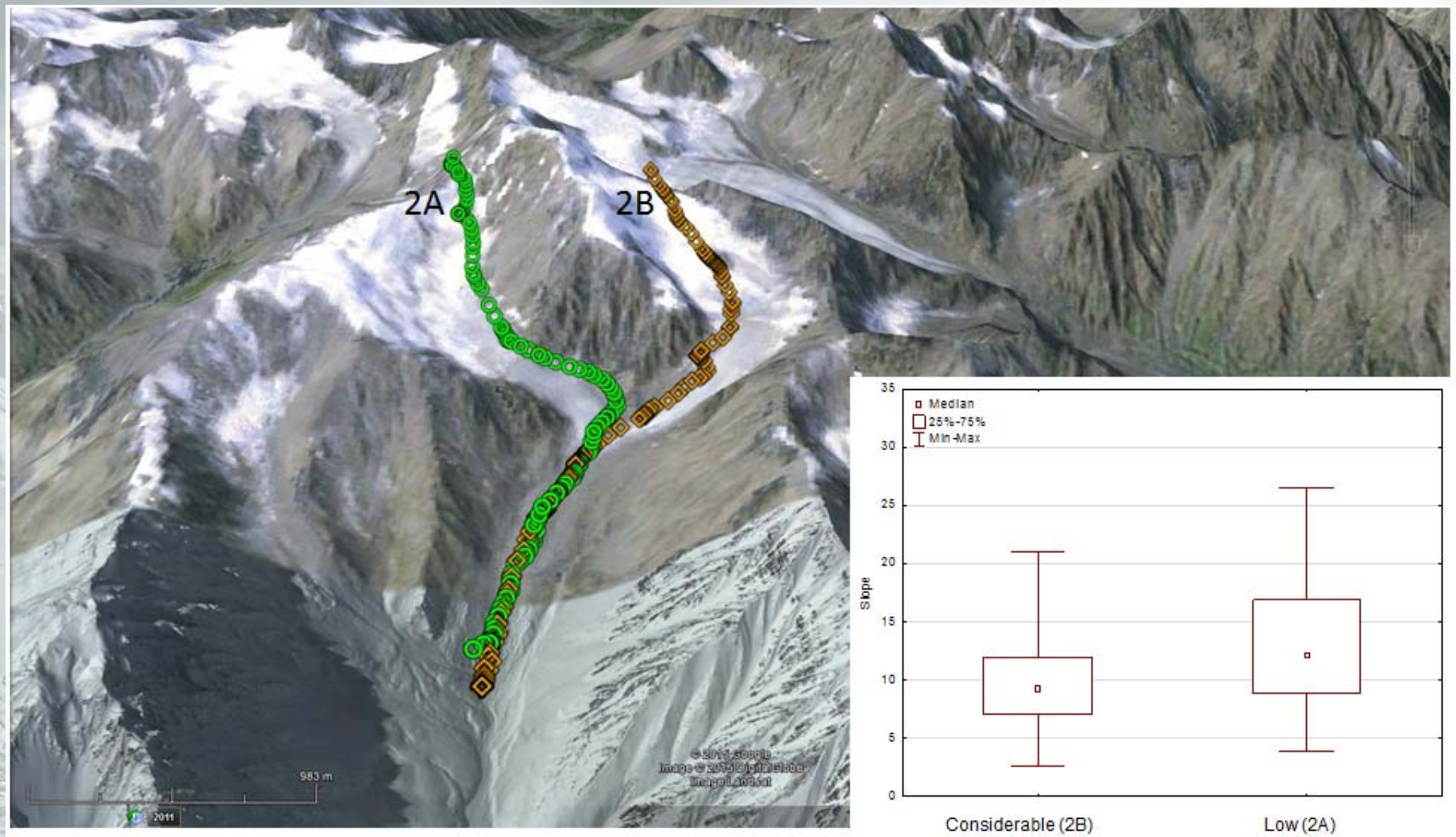

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Heli-skiing

- No difference in terrain metrics when considered for an entire day under varying circumstance
  - **BUT:** Differences when the SAME terrain was considered under varying conditions
  - Highlights the opportunity for heli-ski companies to move around within permit area to still ski steep lines!
  - Reminds us that safe travel in a winter backcountry setting is a game of small scale thinking about the immediate terrain.
  - Potential to use method for internal / external auditting

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Conclusions

- Risk is a function of:
  - **Probability**
  - **Consequence**
  - **Exposure**
  - **Vulnerability**
  - **Group decision making**
- Consider our ski / sled tracks as geographic expression of risk
  - ***If the snowpack is your problem = terrain is the solution***
  - **Tracks are often influenced by factors which include group size, gender, experience, and motivations rather than just snow stability and terrain.**

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Conclusions

- Crowdsourcing data collection was fairly successful:
  - **Showed that methods can collect meaningful data**
  - **Terrain analysis relatively simplistic, but showed results based on a number of groupings.**
  - **Need resources and time to develop smarter terrain algorithms & mine our survey data more deeply.**
- We have also applied methods to other settings:
  - **E.g. Tracking Heli-Ski Guides – could provide a means of tracking / auditting (internal / external)?**
- **BUT - Overall we need more DATA!!**

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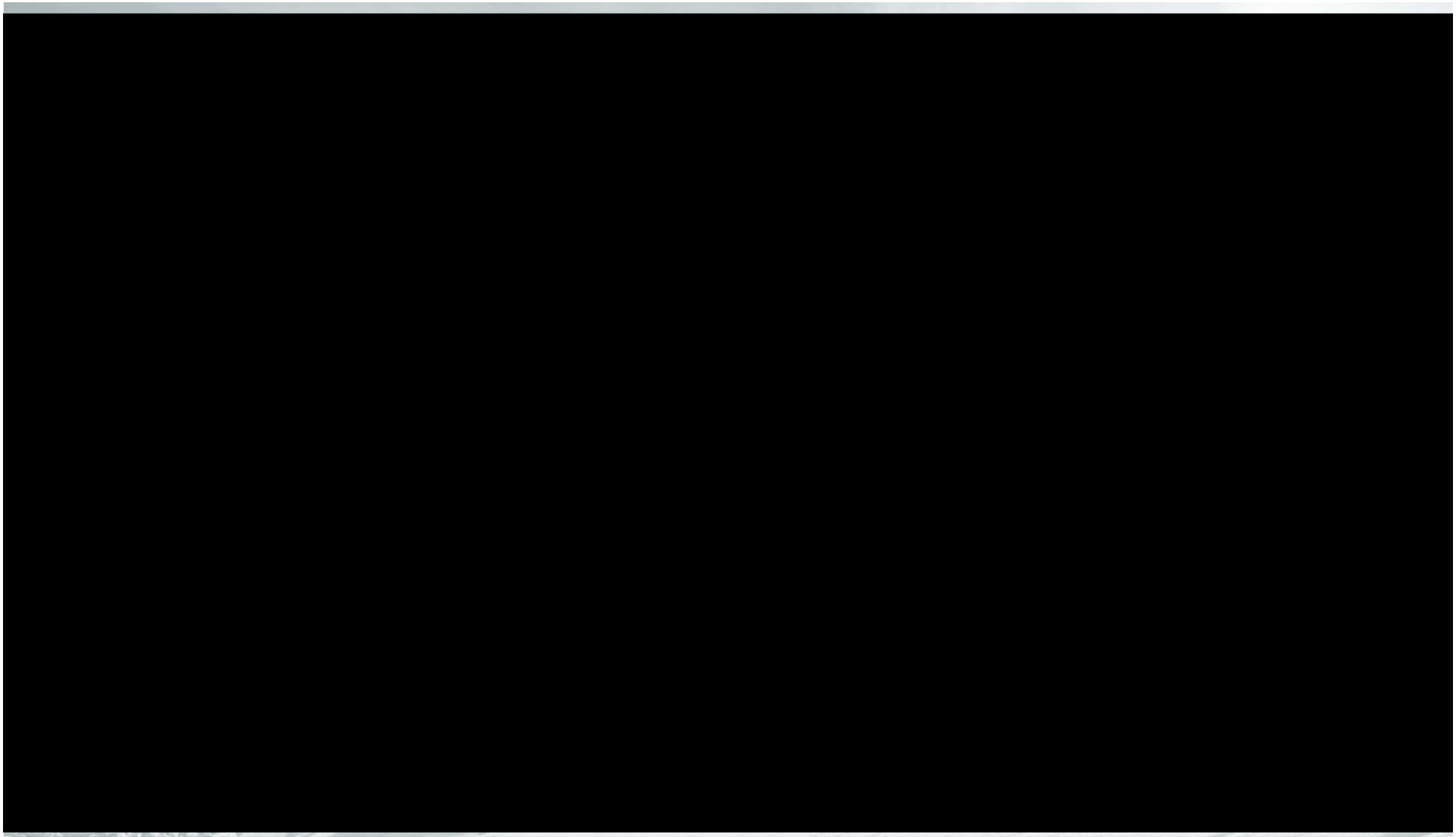

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Global data collection 2015/16

- **WE NEED YOU!**

- We hope to collect hundreds, maybe thousands of tracks from all around the World for this season
- Sign-up and participate
- Let others know!

Sign up:

www.montana.edu/snowscience/tracks

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Acknowledgments

- All of our **volunteers** that tireless tracked their ski tours and completed their surveys.
- We also want to thank **Mazamas** and **Montana State University** for research grants to support the pilot study.
- Montana State University **Undergraduate Scholar Program** for supporting Ellie Southworth & Kyla Sturm to help with the data analysis.
- **Black Diamond Equipment** for spot prize donations for the 13/14 and 14/15 season

YOU!

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MAZAMAS

Black Diamond

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MSU Snow Avalanche Workshop "MSUSAW"

- November 11, at MSU in Bozeman.
- **FREE to all**
- Topics include:
  - **Trip planning and communication** (Kirk Bachman); **Digging** (Doug Chabot); **Backcountry Panel**; **Snow-up close** (Prof Ed Adams); **BC Medicine and avalanche accidents** (Nadia Kimmel); **Industry Panel**.
- Please register:

www.montana.edu/snowscience/workshop/index.html

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Human Factor 2.0

- Multi-media production by Powder Magazine and Black Diamond:
  - Decision making
  - Consequences
  - Risk / Reward / loss
  - Case studies

http://features.powder.com/human-factor-2.0/chapter-1

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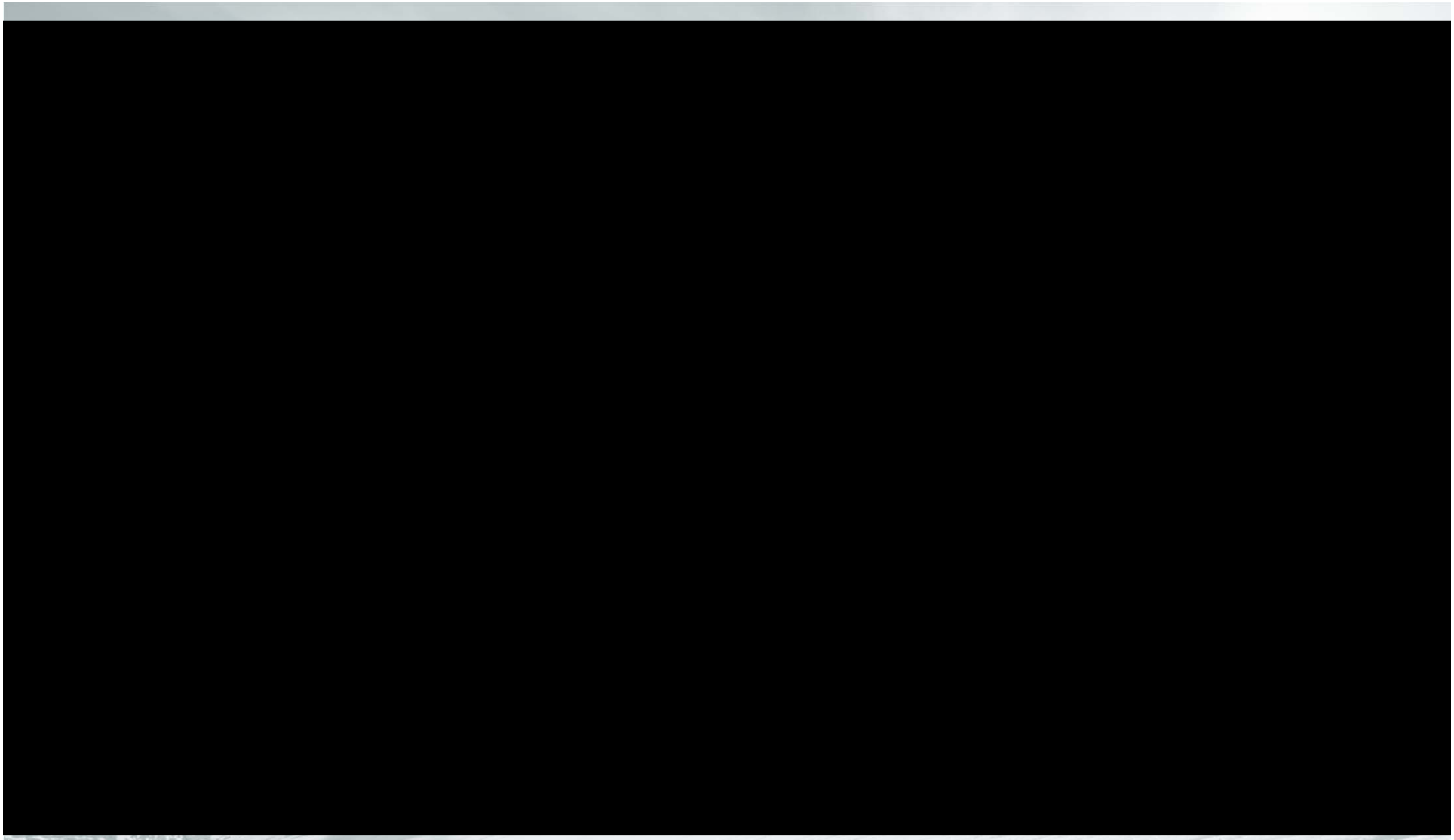

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Questions?

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