

Adventure, Tourism, Hospitality and Sports

Avalanche Forecasting for Large Mountain Areas

Presented By: Mike Wiegele

Assistance by Bill Mark



Mike Wiegele
Helicopter Skiing



Introduction

- As a practitioner who works and plays in the mountains I have to act responsibly to measure and manage the risk.
- My thoughts and actions are to follow the **5 step checklist concept**:
 - *A mental structured approach in a systematic and methodical system in order to determine the desired end result.*

Nature's Complexity & Chaos

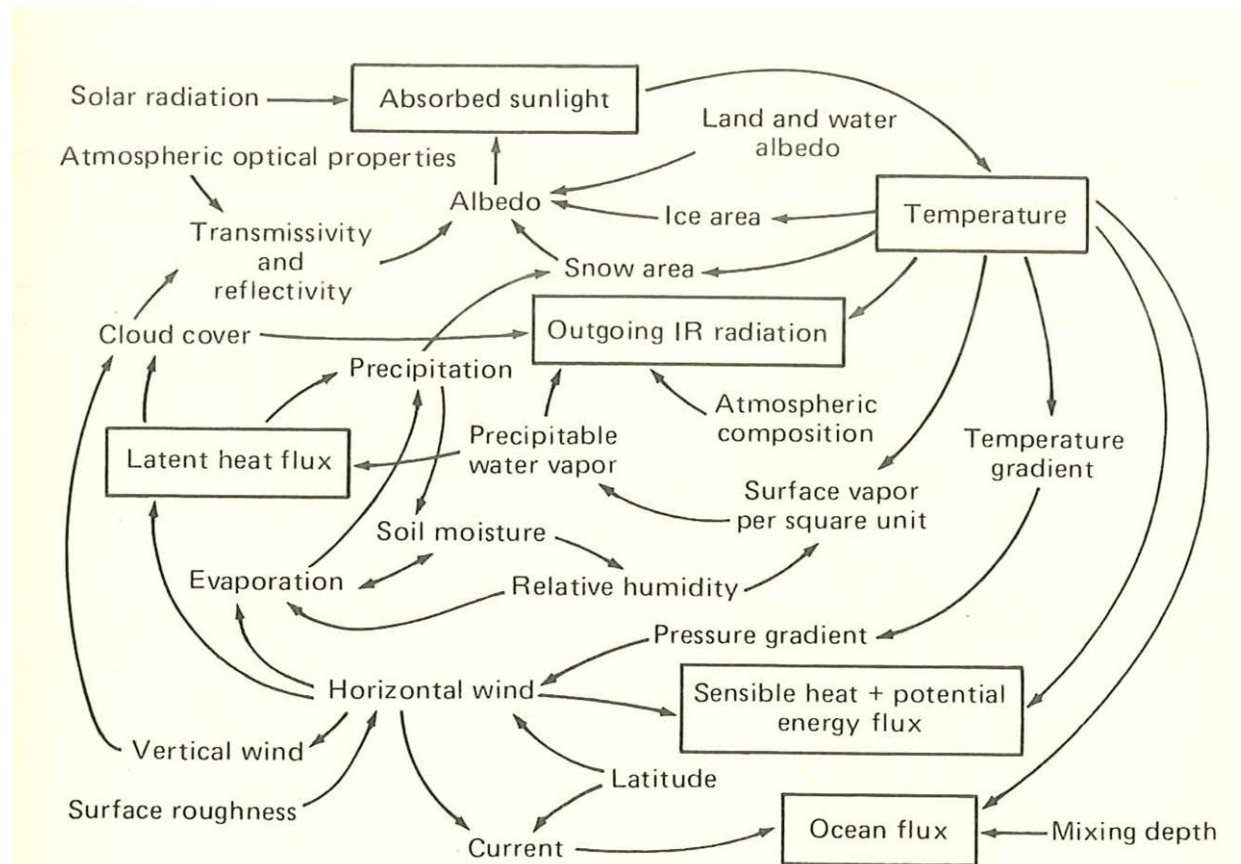


Figure 1.1. A model of the weather and climate machine illustrating its complex and intricate feedback mechanisms. The influence of several of the feedback processes are comparable in magnitude but opposite in direction. It is clear that variations in the energy input parameter at the top left may affect several of the meteorological parameters within the machine. From Kellogg and Schneider (1974).



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Our Goal

1. Our organization:

- consists of experts in the field that have the highest current international safety standards

2. The Law and legal liability:

- We must adhere to the Canadian law
- We are responsible for people when we take them on high risk activities
- **Duty of Care**



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Risk Management Plan for Loss Prevention



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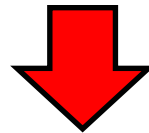


Warnings
Early detection
Prevention

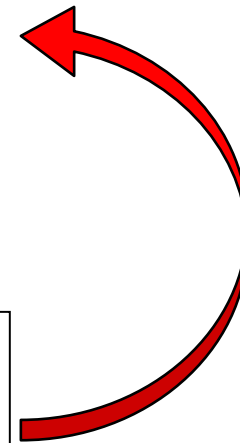
The 5 Step Checklist

5 steps stability rating system

1. Daily weather data
2. Graphs
3. Snow Profile observations
4. Field observations
5. Ski test and stability ratings



Ski terrain choice & use of guiding procedures



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Step 1 Daily Weather Data

MW DAILY WEATHER DATA MW

CARIBOO MONASHEE
 0 0 2000m MTK. WIND
 0 NECL 3000m

DATE 06/04/82
 FREEZING LEVEL 5000' DPS 0 VISIBILITY 12
 BAR P. 101.97 CEILING 7000' SKY ⊕

	Blue River	Mount St. Anne	Hroch Peak	Upper Level 9000'		
	2240'	6300'	8500'	Fr. George	Kelowna	Annette
Temperature	0	-6	-9	-15	-13	-14
Temperature max	0	-	-	-	-	-
Humidity	97	-	96	96	79	100
Humidity (avg)	2	-	-	-	-	-
Precip. HW	2	-	-	-	-	-
H ₂ O mm (HW)	18	-	-	-	-	-
Density kg m ⁻³	-	-	-	-	-	-
Ht. of Snow (ft)	-	5	5	-	-	-
				LOAD CALCULATION		
				Snow (mm)	-	
				Wind (24hr run/30)	-	
				Total	-	
				MAXIMUM WIND GUSTS		
				St. Anne	km/h -	
				Hroch Peak	km/h -	
				48	52	18 18 26
				5W	S	NW SW NW
				632	-	-
				Solar Cycle		
				Mod. 705-720	High ~	
				LAST LIFT: 11:00		

SYNOPSIS
 Ridge of Pressure Building Body + Top LAST UNTIL MID WEEK.

FORECAST
 Today: Clearing, then Sunny ☺
 Tomorrow: Mooney ☺

IN SNOW TEMPERATURES



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		Cariboos		Monashees		
		s20		s26	2000m	
		s46		s57	3000m	
		mm/dd/yy				
Date:	3/12/2010	Time:	06.00	WX F/caster: Jason		
Freezing level:	sfc	DPS:	0	Sky: ⊕ overcast		
Ceiling:	6600	Visibility:	16	Bar P: 100.6 ↓		
	BlueRiver	St.Anne	Roche	Upper Level 9000'		
	2240'	6300'	8500'	PG	Kelowna	Annette
Temperature	-1	-6	-10	-15	-12	-18
Temp Range <small>Mid</small>	6 / -1	-6 / -9	-5 / -17			
Humidity	99	97	95	81	90	83
Hum Range <small>Low</small>	99 / 61	97 / 95	98 / 88			
Dew Point	-1					
Precip (HN)	trace	18	HNW	5.8		
H20mm (HNW)	~	5.8	Ann WRun /30	32		
Density kg/m ³	~	32	Equals Load	38		
HT. Snow (HS)	35	300	Anne maxGust/DIR/h	79	S	1226
Settlement	3	-11	Roche maxGust/DIR/h	82	SSW	1204
Wind in Knots				35	40	25
Wind Speed	Calm	38	13	64	73	46
Wind Direction	0	S	SSW	sw	sw	sw
Wind Run	~	964	782			
		Mod	1110-1410	High	0	
Last Lift:	1600	Cycle Time:	1500-1600			
Forecast Notes:						

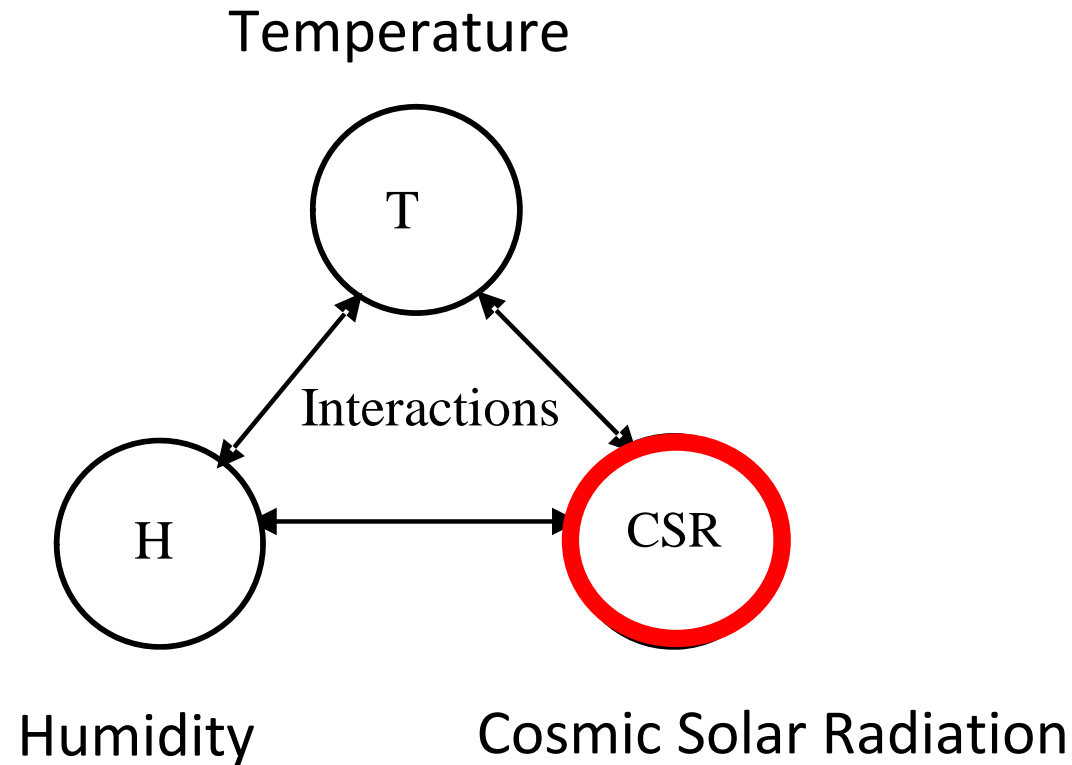


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	2240'	6300'	8500'	PG	Kelowna	Annette
Temperature	-1	-6	-10	-15	-12	-18
Temp Range <small>MAX</small>	6 / -1	-6 / -9	-5 / -17			
Humidity	99	97	95	81	90	83
Hum Range <small>Low #</small>	99 / 61	97 / 95	98 / 88			
Dew Point	-1	Water				
Precip (HN)	trace	18	HNW	5.8		
H20mm (HNW)	~	5.8	Ann WRun /30	32		
Density kg/m ³	~	82	Equals Load	38		
HT. Snow (HS)	35	300	Anne maxGust/DIR/h	79	S	1226
Settlement	3	-11	Roche maxGust/DIR/h	82	SSW	1204
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Wind Speed	Calm	38	13	64	73	46
Wind Direction	0	S	SSW	sw	sw	sw
Wind Run	~	964	782			
				1110-1410	High	0
				1500-1600		
Last Lift:	1600	Cycle Time:				
Forecast Notes:						

Contributory Factors



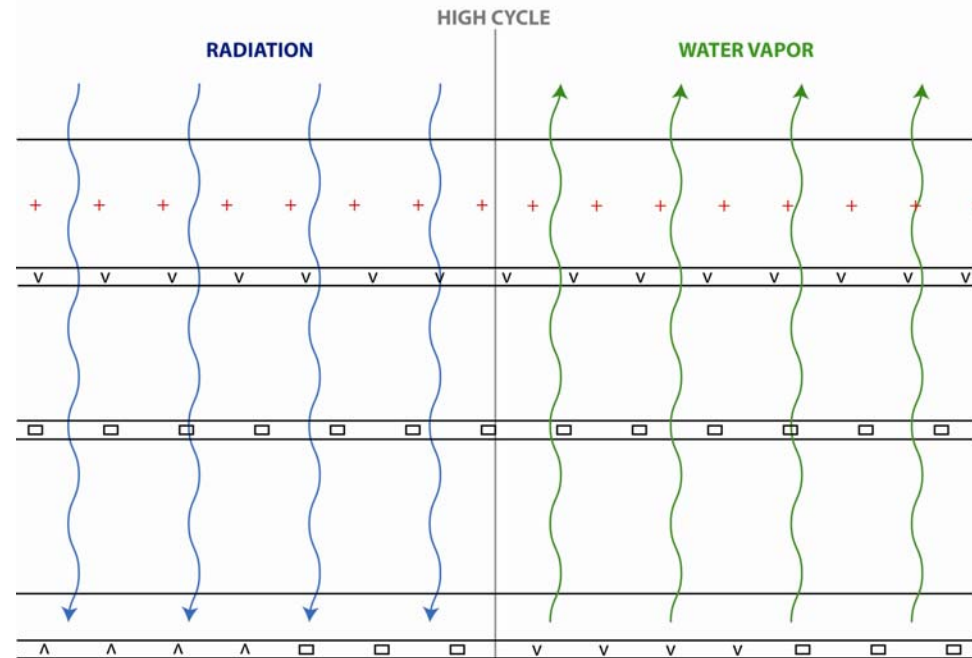
- Cosmic Solar Radiation is a major player

Cosmic Solar-Lunar Radiation

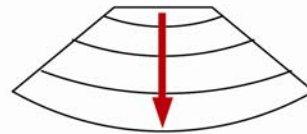
- Inflow of cosmic and solar radiation occurs in the high cycle related to the tidal chart
- The universal system works in a well-organized and perfect manner
- Cosmic rays are a stream of penetrating high speed atomic nuclei that enters the Earth's atmosphere
- Energy is transmitted as electronic fields of waves or moving particles and **is invisible**



COSMIC SOLAR RADIATION



A snow layer may lift during atmospheric pressure during high cycle. Snowpack is now saturated with water vapor causing downward tension.



The water vapor then returns to the surface, deteriorating the strength of the snow layers and ice, causing tension and creeping of snowpack - more so in high cycles - increasing the probability of snow pack failure and for natural of skier interference avalanches



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MW
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Observations

- We have observed worldwide that most avalanches, ice falls and fatalities occur during high cycle

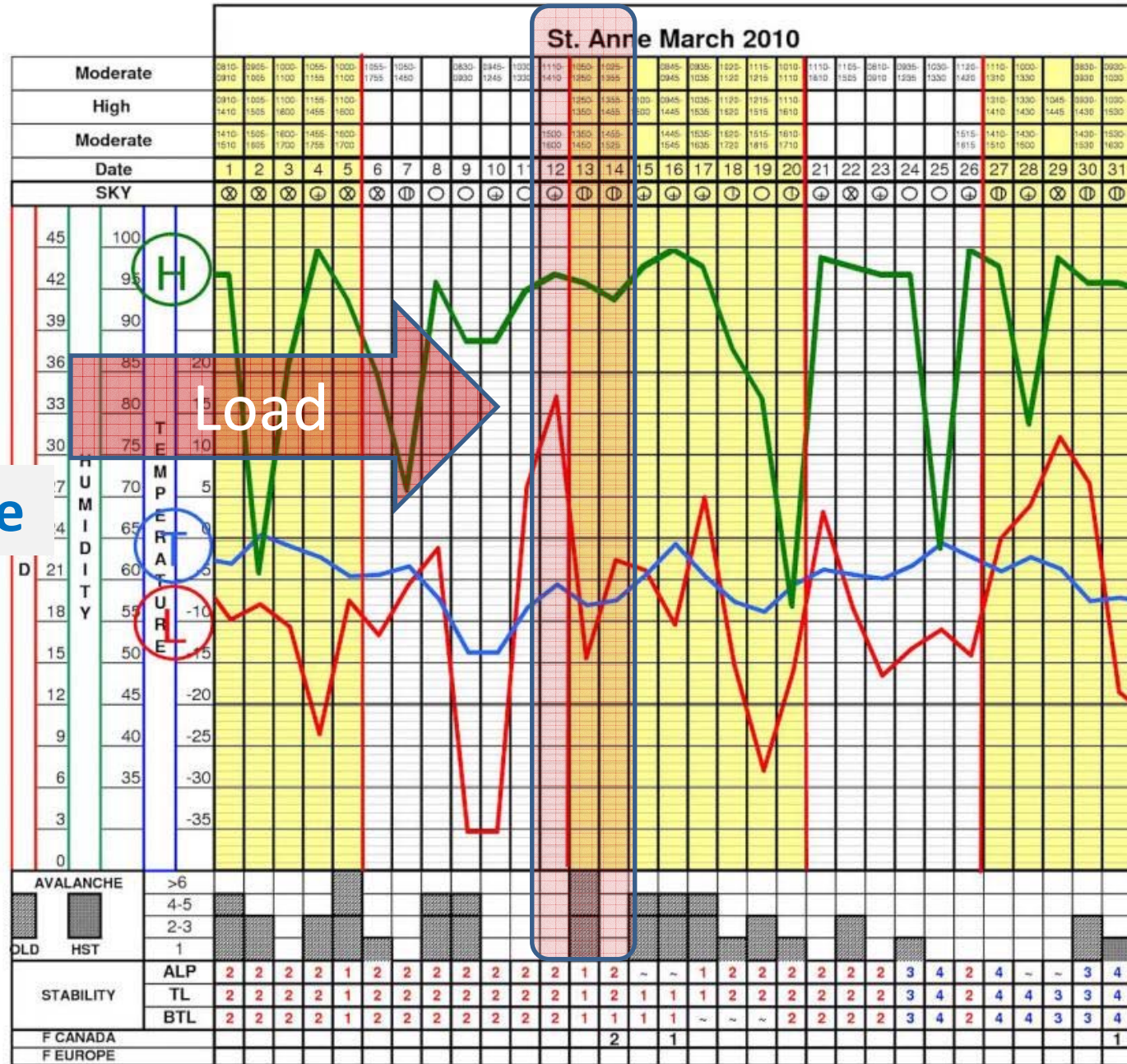


Step 2 Graphs

Humidity

Temperature

Load



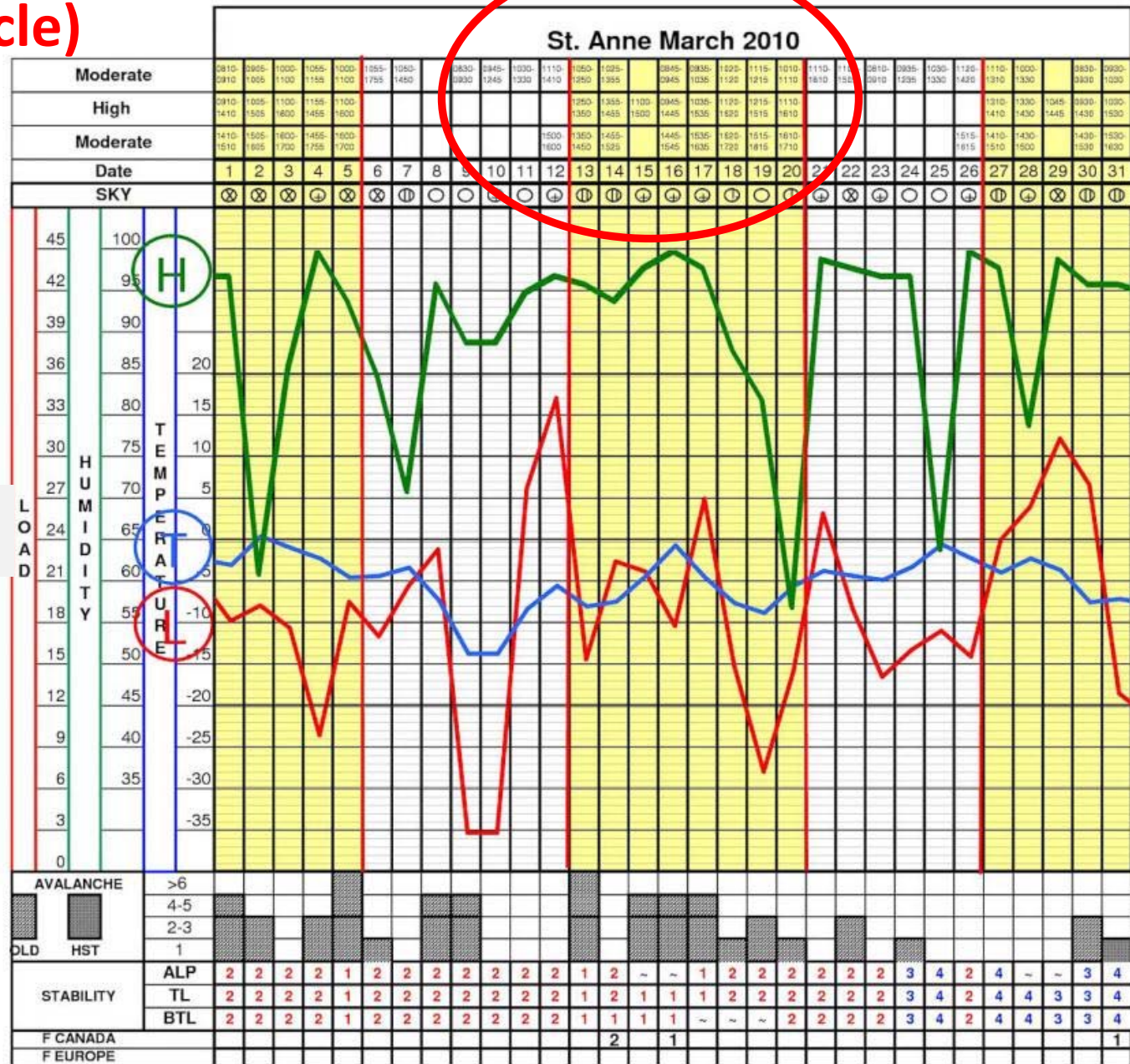
CSR (high cycle)

St. Anne March 2010

Humidity

Temperature

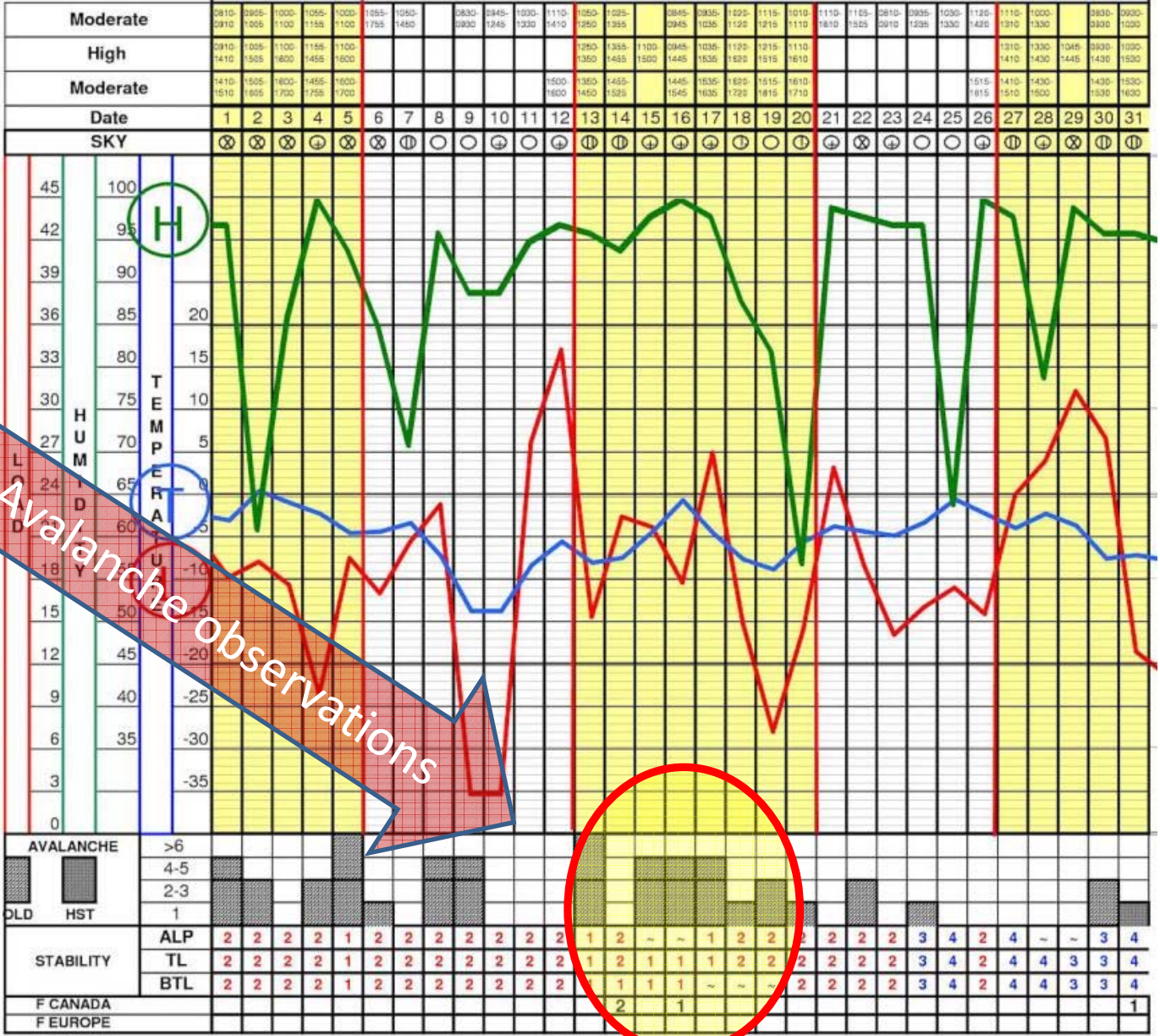
Load



St. Anne March 2010

0905-1005	1000-1100	1055-1155	1000-1100	1055-1755	1050-1450		0830-0930	0945-1245	1030-1330	1110-1410	1050-1250	1025-1355		0845-0945	0935-1035	1020-1120	1115-1215	1010-1110	1110-1810	1105-1505	0810-0910	0935-1235	1030-1330	1120-1420	1110-1310	1010-1310	
1005-1505	1100-1600	1155-1455	1100-1600								250-350	1355-1455	1100-1500	0945-1445	1035-1535	1120-1820	1215-1515	1110-1610							1310-1410	1310-1410	
1505-1605	1600-1700	1455-1755	1600-1700							1500-1600	1350-1450	1455-1525		1445-1545	1535-1635	1620-1720	1515-1615	1610-1710							1515-1615	1410-1510	1410-1510
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
⊗	⊗	⊕	⊗	⊗	⊕	○	○	⊕	○	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊗	⊕	○	○	⊕	⊕	○	

St. Anne March 2010



Avalanche observations

13 14 15 16 17
 2 2 2 2 2
 1 1 1 ~ ~
 2 1



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Step 3 Snow Pack Profiles

“If you don’t dig, you don’t know”

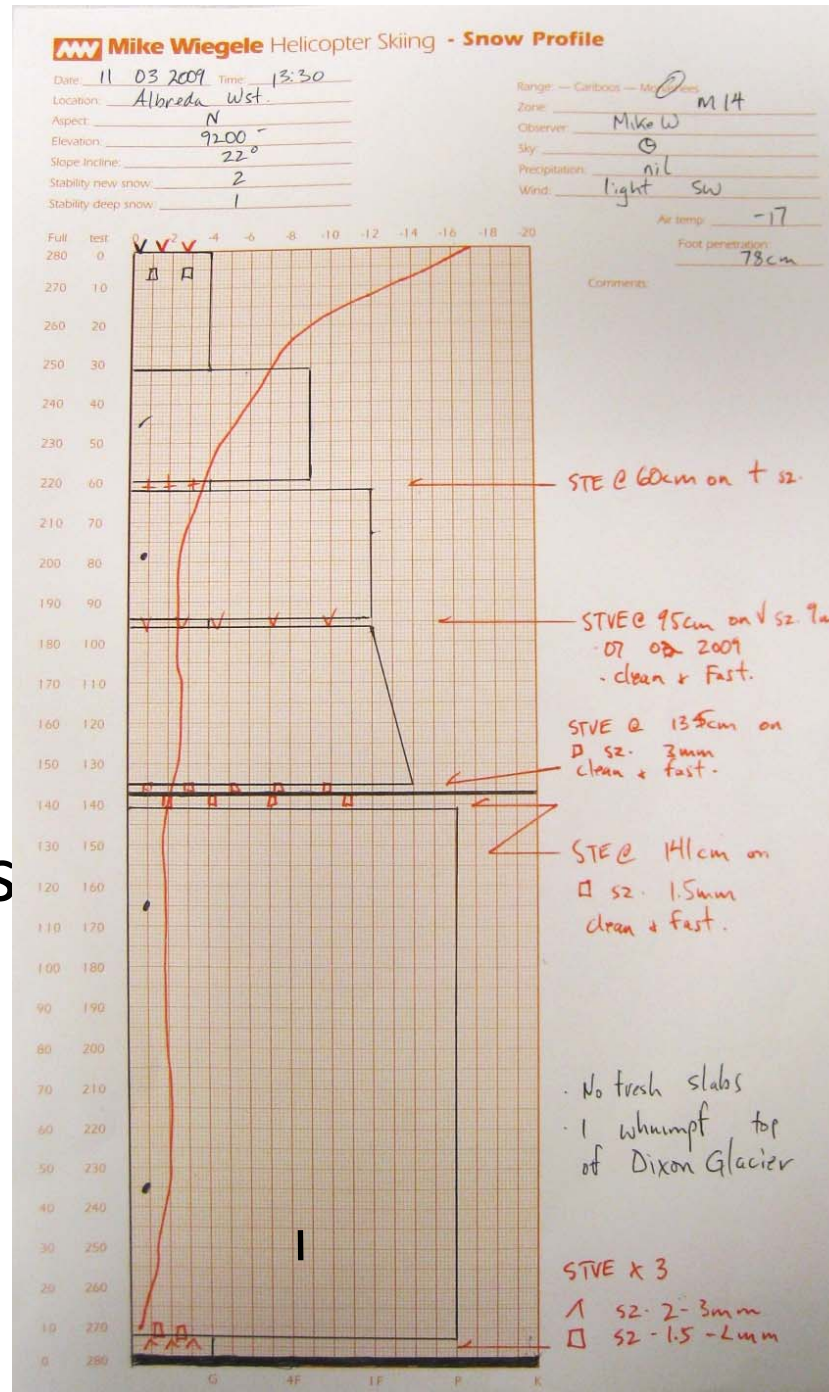


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Major Gliding Layers

- Depth hoar (Λ)
- Surface hoar (V)
- Facets (□)
- Ice (_____)
- New snow crystals (powder) (+)



Shovel shear test



- Most reliable and effective method for measuring stability and ratings



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Classification of Shear Test Ratings

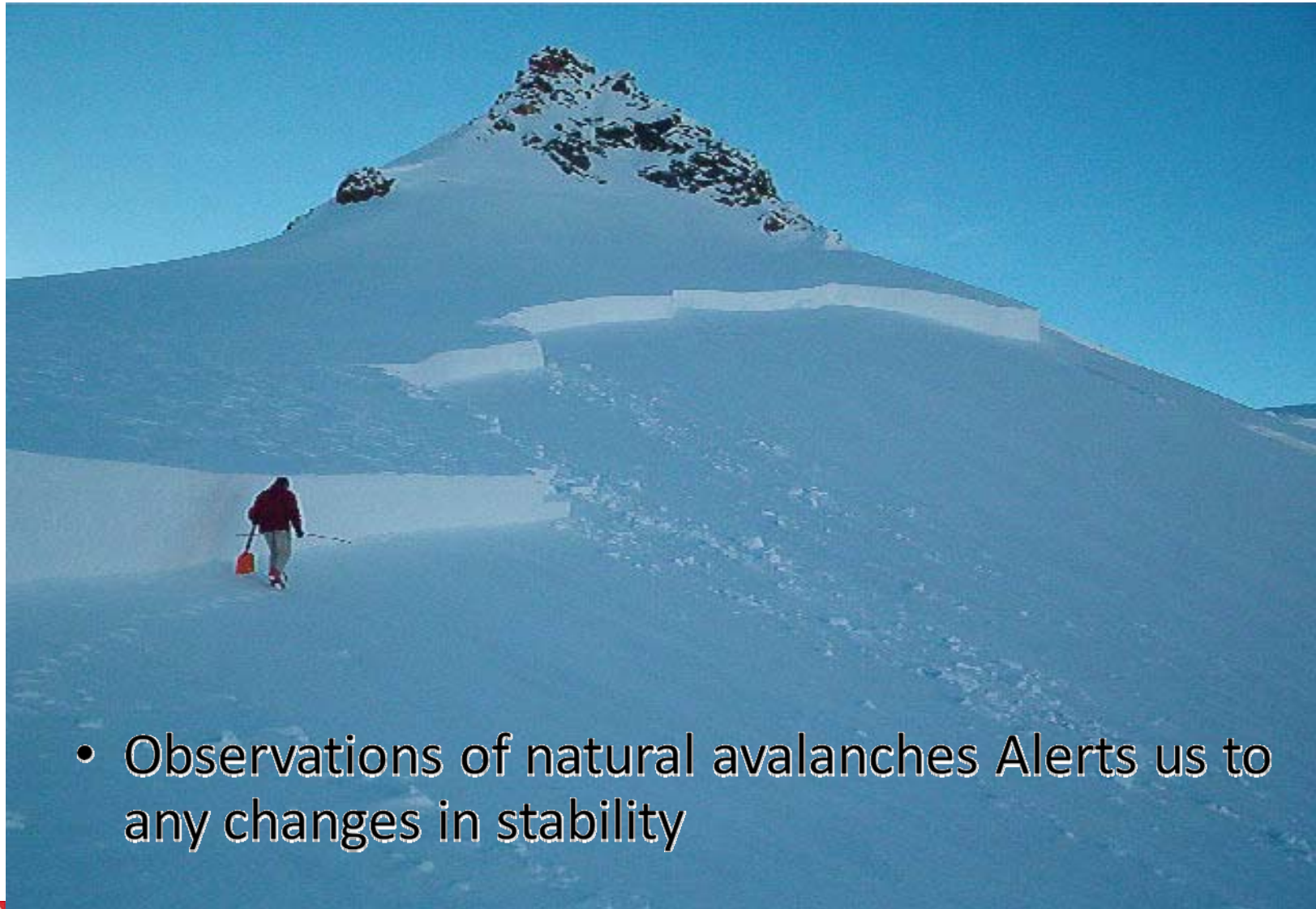
From 1-7

Very Easy	Easy	Easy Moderate	Moderate	Moderate Hard	Hard	Very Hard
VE	E	EM	M	MH	H	VH
1	2	3	4	5	6	7

- When the stability rating indicates a **4** (moderate) rating you must substantiate your findings with 3 to 5 tests
- Recent observed natural avalanches overrules all other tests
- Fair ratings** are commonly used in the industry and are misleading and have created a false sense of security



Step 4 Field Observations



- Observations of natural avalanches Alerts us to any changes in stability



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Step 4 Field Observations



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Step 4 Field Observations



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Step 4 Field Observations

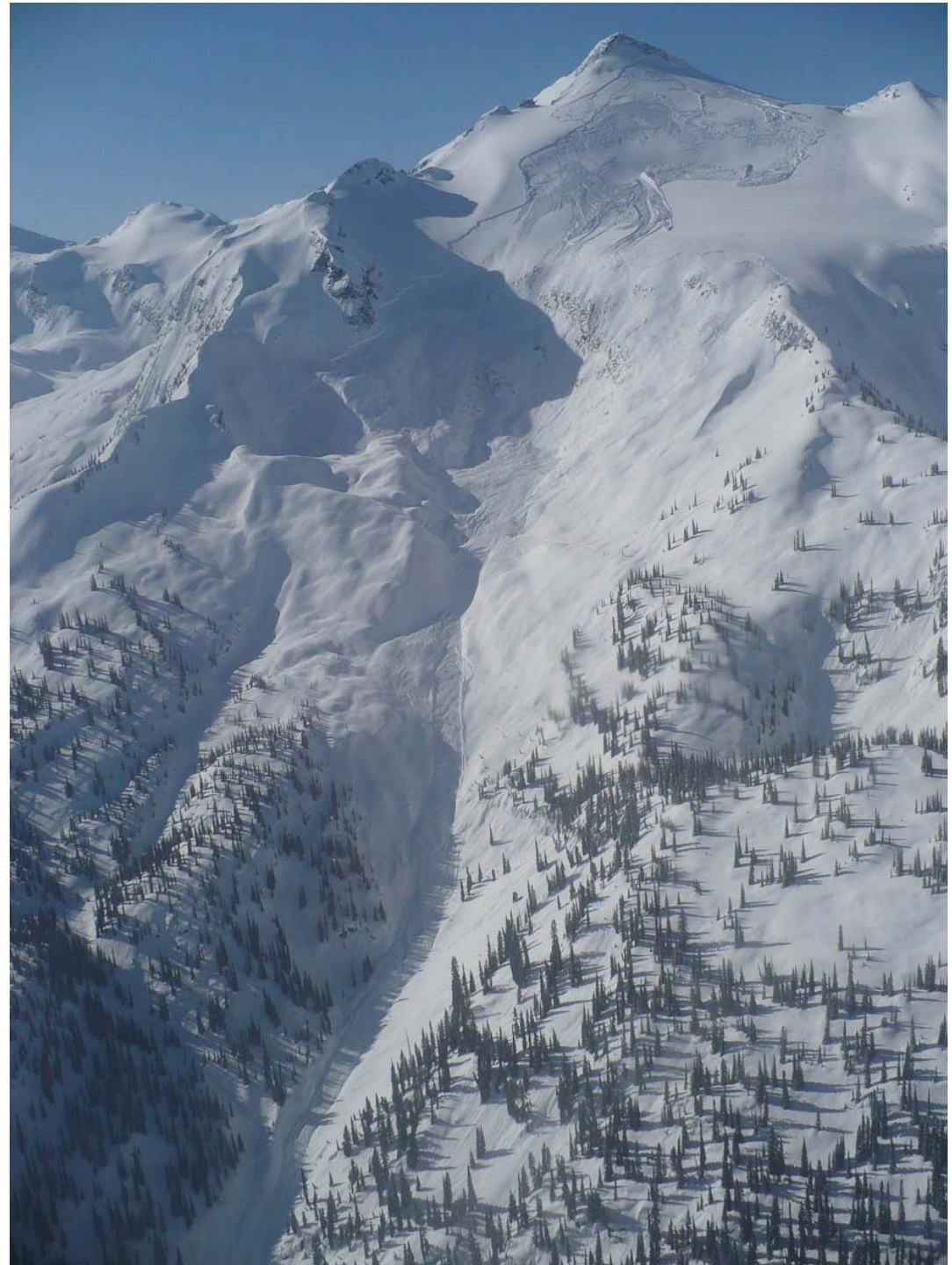


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Step 4 Field Observations

Natural observations override snow profile observations



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Step 5

Stability Rating and Ski Tests



Every turn is a ski test



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5

MV SNOW STABILITY FORECAST



DATE 051226

HIGH CYCLE

FORECASTER BILL M.

#3	PROFILE	LAYERS	CM LOAD	#4	SHEARS	#5	STABILITY RATING				GUIDES COMMENTS	
							N	S	E	W		
ALP		<ul style="list-style-type: none"> □ V DEC 20 □ DEC 9 □ NOV 25 □ A 	<ul style="list-style-type: none"> 100 120-130 130-140 270 		<ul style="list-style-type: none"> NO NEW OBS. NO NEW OBS. STM-STH 		2	2	2	2	STORM	<p>FIRST DAY OF SEILING -</p> <ul style="list-style-type: none"> PROFESSIONAL TRAINING + INSTRUCTIONS WARM UP RUNS REGROUP @ CONDIT
							2	2	2	2	OLD	
							4	4	4	4	DEEP	
TL		<ul style="list-style-type: none"> / DEC 21 □ V DEC 20 V DEC 12 □ V NOV 25 	<ul style="list-style-type: none"> 50-70 70-80 90-100 		<ul style="list-style-type: none"> STVE-STE STE STE-M STE-M 		2	2	2	2	STORM	<p>CHANGE</p> <ul style="list-style-type: none"> SEE CUT ALL ROLLS OBSERVATIONS
							2	2	2	2	OLD	
							4	4	4	4	DEEP	
BTL		<ul style="list-style-type: none"> V DEC 20 V DEC 12 □ NOV 25 	<ul style="list-style-type: none"> 50-70 70-80 90-100 		<ul style="list-style-type: none"> STE STE STE-M 		2	2	2	2	STORM	
							2	2	2	2	OLD	
							4	4	4	4	DEEP	

ISOLATED AREAS WITH SPECIFIC SNOW PACK CHARACTERISTICS



Step 5 Stability Rating

- We then rate aspects and elevations

ALP (7,500 – 11,600 ft)				
N	S	E	W	
				Storm
				Old
				Deep

TL (6,500 – 7,500 ft)				
N	S	E	W	
				Storm
				Old
				Deep

BTL (2,230 – 6,500 ft)				
N	S	E	W	
				Storm
				Old
				Deep

- This allows us to focus on details of terrain and assists in our terrain choice and guiding procedures



7 Stage Stability Rating

Very Easy	Easy	Easy Moderate	Moderate	Moderate Hard	Hard	Very Hard
1	2	3	4	5	6	7
Very Poor	Poor	Poor- Moderate	Moderate	Moderate- Good	Good	Very Good

- Focus on most important middle ground
- Where decision making is most difficult
- Where we spend most of our winter
- Better assists us in **terrain** selection and **guiding** procedure

Stability Rating Values

Conventional Stability Rating 5 Steps

1	2	3	4	5	6	7
VP	Poor	Poor –Mod	Mod	Mod - good	Good	VG
VP	Poor	Fair			Good	VG
1	2	3			4	5

- ***Fair*** rating is too wide for **practitioners** in the field
- We spend a large proportion of winter in ***Fair***
- We need to better refine ***Fair*** for practitioners
- Divide ***Fair*** into 3 sections



7 stage stability rating

1	2	3	4	5	6	7
VP	Poor	Poor –Fair	Fair	Fair - good	Good	VG

- We ***strongly encourage*** you to try dividing ***Fair*** into 3 parts
- Use the 7 stage stability rating

Conclusion

- By using the system every day, we can maintain consistent and better choices



Thank you!



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