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Avalanche Problem Toolbox

Concept Fall 2013 by Drew Hardesty, UAC and Wendy Wagner, CNFAC and presented at 2014 ISSW (International Snow Science Workshop) with Abstract below. Full paper can be found here -

ABSTRACT: The following paper presents a new public forecasting tool designed to communicate travel advice specific to each of the established Avalanche Problems. Avalanche Problems have become a mainstay, not only for forecast centers but also for avalanche education throughout North

America. Among professionals, it is widely agreed that the type of avalanche conditions determines one's choice of terrain. Many of our users are only beginning to understand this concept. Therefore, we seek to expand the current descriptions by adding terrain management advice specific to each of the nine Problems. In order to accomplish this, a set of five metrics was established to determine each Problem's inherent manageability. Compiled into a short paragraph, the advice will be displayed in a pop-up window along with additional information including a photo, video, graphics and associated definition. The pop-up window will be accessed from the daily avalanche advisory webpage through a subscript 'i' hyperlink located near the icon(s) for the day's Problem(s). This paper concludes with a discussion of the many challenges encountered.

EXTRA CAUTION

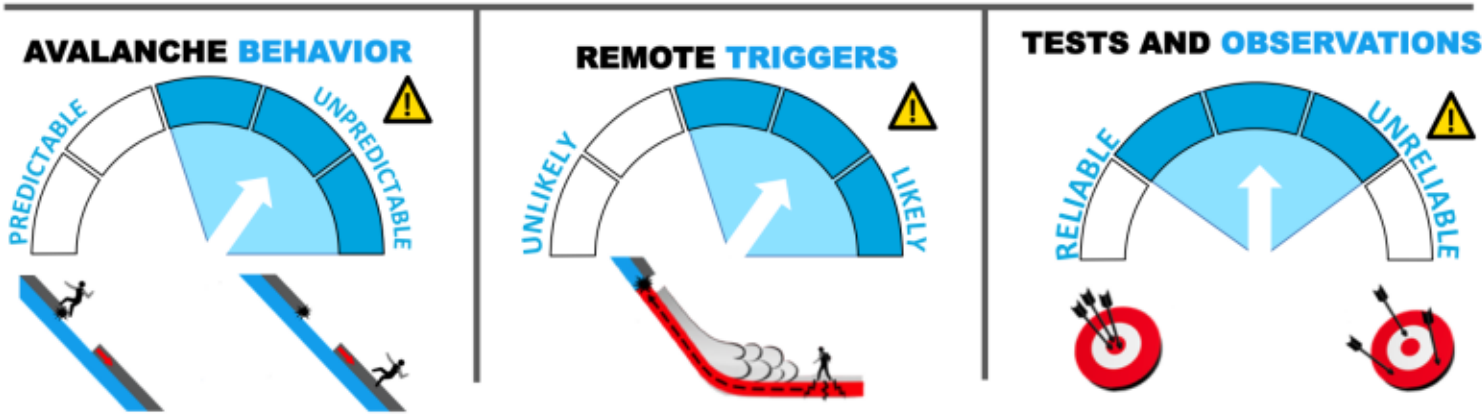
PERSISTENT SLABS

Release of a cohesive layer of soft to hard snow (a slab) in the middle to upper snowpack, when the bond to an underlying persistent weak layer breaks. Persistent layers include: surface hoar, depth hoar, near-surface facets, or faceted snow. **Persistent weak layers can continue to produce avalanches for days, weeks or even months, making them especially dangerous and tricky.** As additional snow and wind events build a thicker slab on top of the persistent weak layer, this avalanche problem may develop into a Persistent, Deep-Slab.

TRAVEL ADVICE

INHERENTLY DANGEROUS AND UNPREDICTABLE AVALANCHE CONDITIONS. AVOID TERRAIN WITH THESE CONCERNS.

- Typically confined to particular aspects and elevations (as mentioned in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness with nothing steeper above or adjacent. Slabs have potential to pull back to lower angle terrain.**
- Remote triggering possible to common, even from flat terrain below. Give runout zones a wide berth.
- With stiff slabs or several days to weeks after a storm - test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to be less reliable.



EXTRA CAUTION

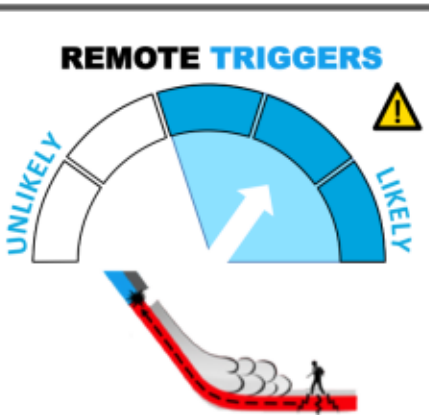
DEEP SLABS

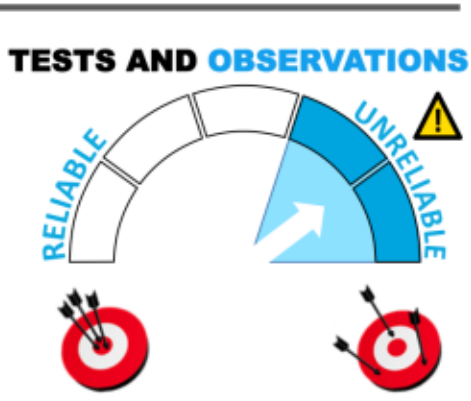
Release of a thick cohesive layer of hard snow (a slab), when the bond breaks between the slab and an underlying persistent weak layer, deep in the snowpack or near the ground. The most common persistent weak layers involved in deep, persistent slabs are depth hoar, deeply-buried surface hoar, or facets surrounding a deeply-buried crust. **Persistent, Deep-Slabs are typically hard to trigger, are very destructive and dangerous due to the large mass of snow involved, and can persist for months once developed.** They are often triggered from areas where the snow is shallow and weak, and **are particularly difficult to forecast for and manage**. They commonly develop when Persistent Slabs become more deeply-buried over time.

TRAVEL ADVICE

INHERENTLY DANGEROUS AND UNPREDICTABLE AVALANCHE CONDITIONS. AVOID TERRAIN WITH THESE CONCERNS.

- Typically confined to particular aspects and elevations (as mentioned in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness with nothing steeper above or adjacent to you. Slabs can pull back to lower angle terrain.**
- Remote triggering possible to common, even from flat terrain below. Give run out zones a wider berth as they may run beyond historic path boundaries. **Due to their large size - traumatic injury, deep burial, or death is likely.**
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops are unreliable.





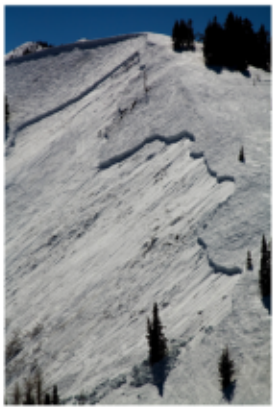
EXTRA CAUTION

WET SLABS

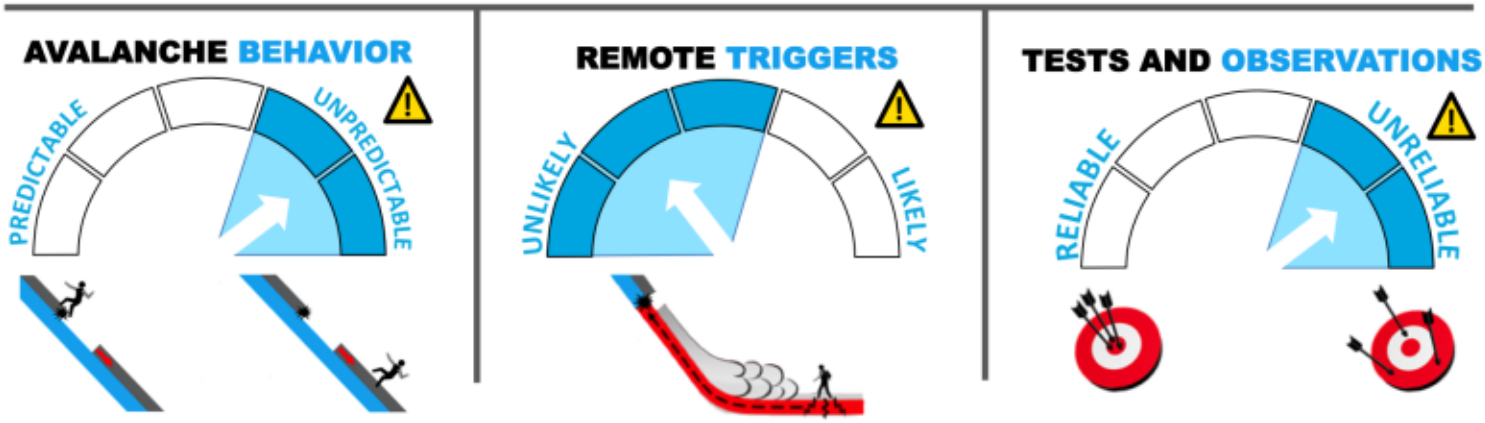
Release of a cohesive layer of snow (a slab) that is generally moist or wet when the flow of liquid water weakens the bond between the slab and the surface below (snow or ground). They often occur during prolonged warming events and/or rain-on-snow events. **Wet slabs can be very destructive.**

TRAVEL ADVICE

INHERENTLY DANGEROUS AND UNPREDICTABLE AVALANCHE CONDITIONS. AVOID TERRAIN WITH THESE CONCERNS.



- **As conditions may be affected by sun, rain, or warm temps, avoid terrain mentioned in the advisory or choose slopes gentler than 30 degrees in steepness with nothing steeper above.** Timing before the onset of significant sun/warmth is key.
- Remote triggering possible, even from the valley below. Give runout zones a wider berth than usual as wet slabs may run beyond historic path boundaries. **Due to potential size - traumatic injury, deep burial, or death is likely.**
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to be unreliable.



EXTRA CAUTION

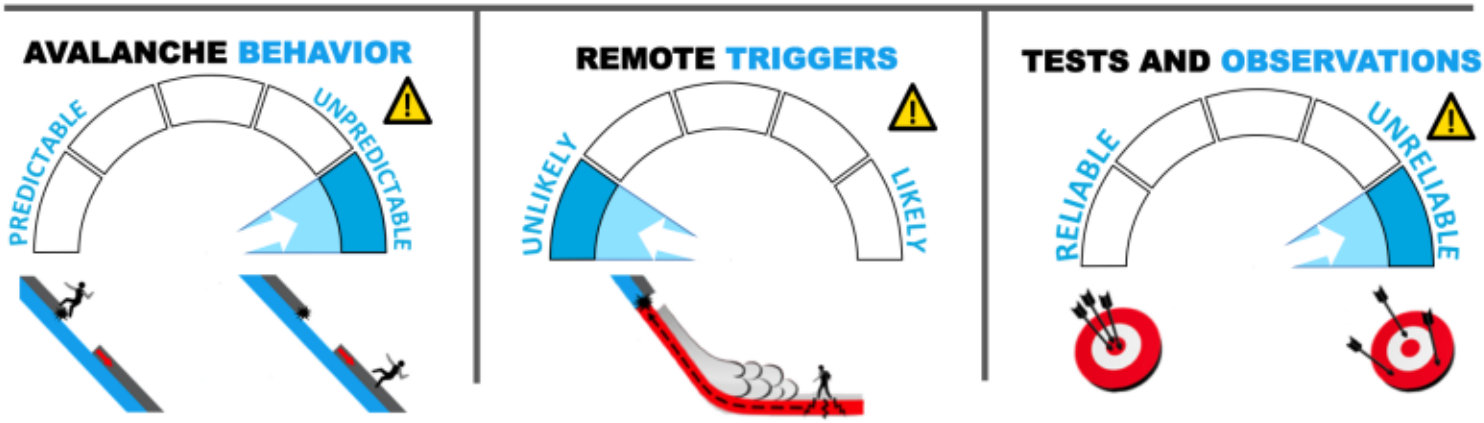
GLIDE AVALANCHE

Release of the entire snow cover as a result of gliding over the ground. Glide avalanches can be composed of wet, moist, or almost entirely dry snow. They typically occur in very specific paths, where the slope is steep enough and the ground surface is relatively smooth. The are often proceeded by full depth cracks (glide cracks), though the time between the appearance of a crack and an avalanche can vary between seconds and months. Glide avalanches are unlikely to be triggered by a person, are **nearly impossible to forecast, and thus pose a hazard that is extremely difficult to manage.**

TRAVEL ADVICE

INHERENTLY DANGEROUS AND UNPREDICTABLE AVALANCHE CONDITIONS. AVOID TERRAIN WITH THESE CONCERNS.

- Typically confined to particular aspects and elevations or terrain types (as mentioned the current forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness with nothing steeper above.**
- Give runout zones a wide berth. **Due to potential size - traumatic injury, deep burial, or death is likely.**
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops are unreliable.



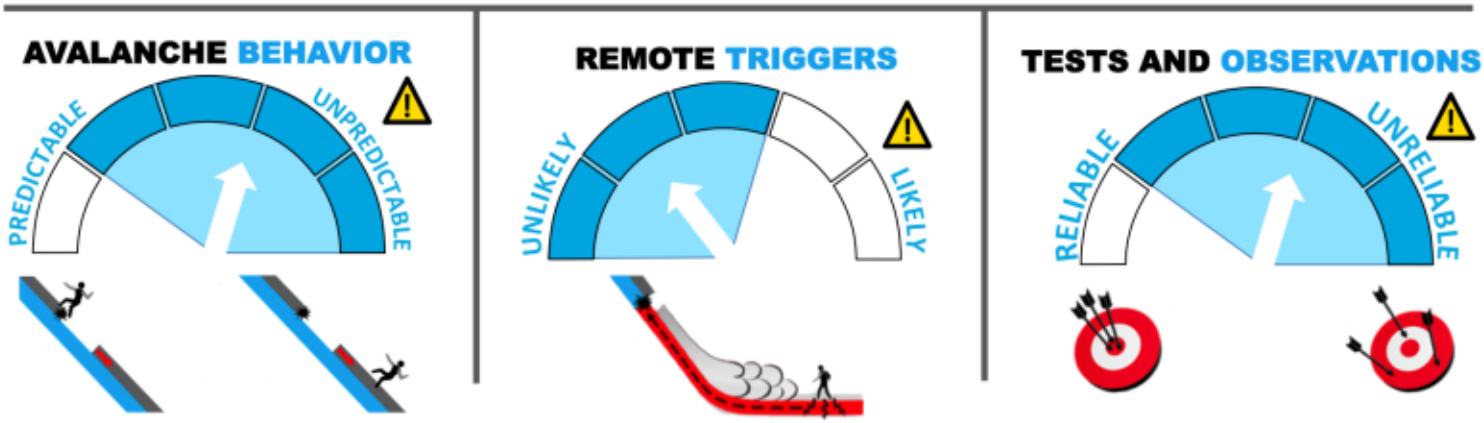
NORMAL CAUTION

CORNICE FALL

Release of an overhanging mass of snow formed by wind deposits. They range from small wind lips of soft snow to large overhangs of hard snow that are 30 feet (~10 meters) or taller. **They can pull back onto the ridgeline and well into the flat ground above the slope. Even small cornices can have enough mass to be destructive and deadly.** Cornice fall can entrain loose surface snow or trigger slab avalanches.

TRAVEL ADVICE

- **Prevalent along the wind-exposed ridgelines** at the mid and higher elevations above particular aspects (as depicted in the current avalanche forecast).
- **Cornices may release remotely on approach. Avoid traveling along corniced ridgelines as cornices may break back further than expected.** Rapid warming and/or significant loading events often heighten the potential for cornice fall.
- Give a wide berth below steep slopes when natural cornice fall is likely, when cornice fall may trigger avalanches below, or when others may be traveling above you.



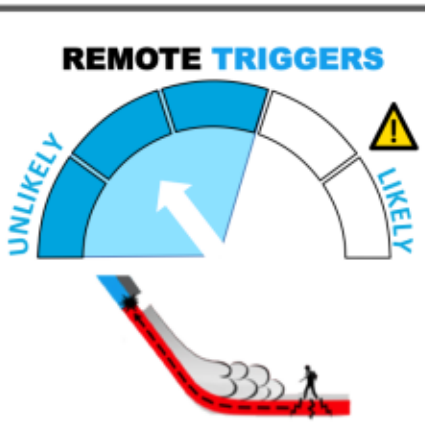
NORMAL CAUTION

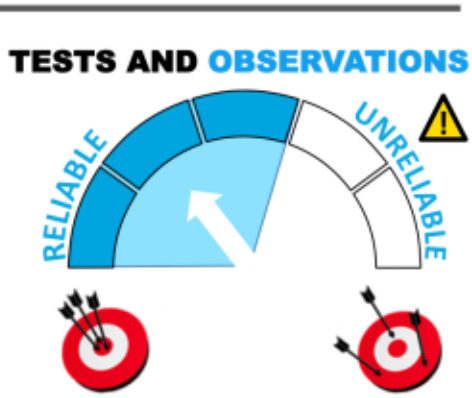
WIND SLABS

Release of a cohesive layer of snow (a slab) formed by the wind. Wind typically erodes snow from the upwind sides of terrain features and deposits snow on the downwind side. **Wind slabs are often smooth and rounded and sometimes sound hollow, and can range from soft to hard**. Wind slabs that form over a persistent weak layer (surface hoar, depth hoar, or near-surface facets) may be termed *Persistent Slabs* or may develop into *Persistent Slabs*.

TRAVEL ADVICE

- **Range from predictable to unpredictable snow behavior due to slab stiffness and spatial variability.**
- Avoid avalanche terrain with recent wind deposits or choose slopes gentler than 30 degrees in steepness. Tend to stabilize within a few days unless deposited on a persistent weak layer.
- Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you. Remotely triggered slides are possible during heavy loading events.
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide some level of information on stability.





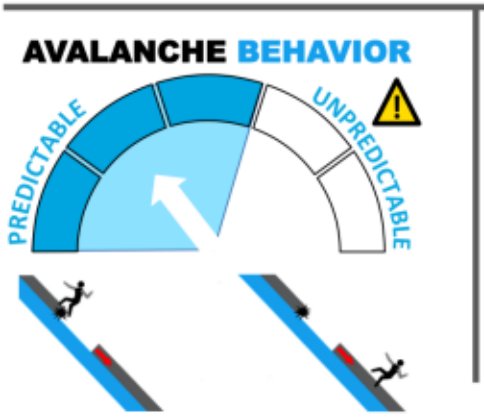
NORMAL CAUTION

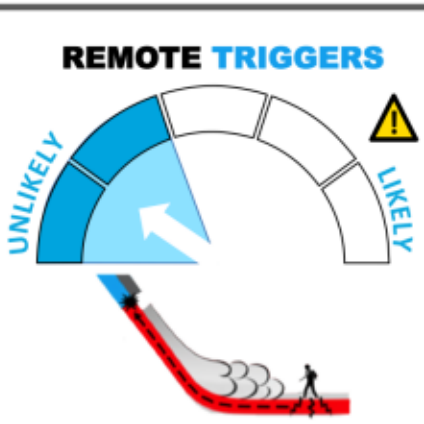
STORM SLABS

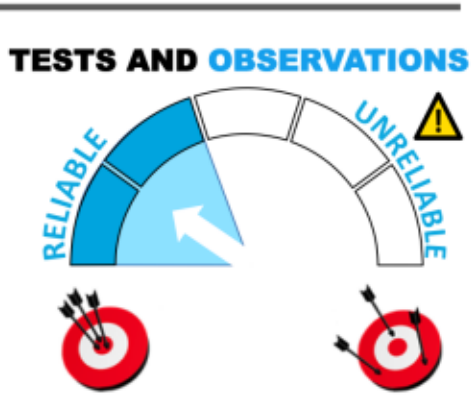
Release of a soft cohesive layer (a slab) of new snow which breaks within the storm snow or on the old snow surface. Storm-slab problems typically last between a few hours and few days. Storm-slabs that form over a persistent weak layer (surface hoar, depth hoar, or near-surface facets) may be termed *Persistent Slabs* or may develop into *Persistent Slabs*.

TRAVEL ADVICE

- Avalanche conditions associated with more predictable snow behavior for experienced snow travelers.
- **More prevalent at the higher elevations on all aspects** (as mentioned in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 30 degrees in steepness.** Tend to settle out and stabilize within a few days unless deposited on a persistent weak layer.
- Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you. Remote triggering is possible during periods of heavy snowfall.
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide some level of information on stability.







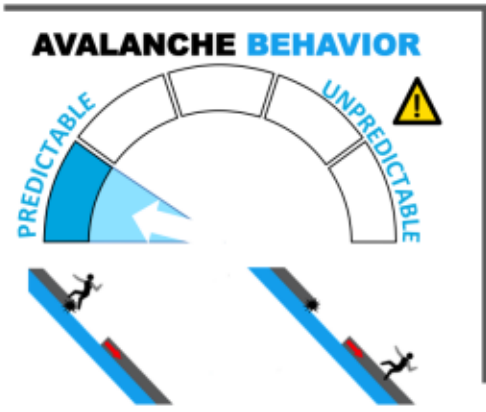
NORMAL CAUTION

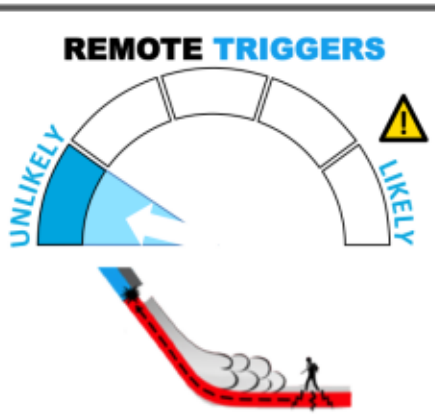
LOOSE DRY SNOW

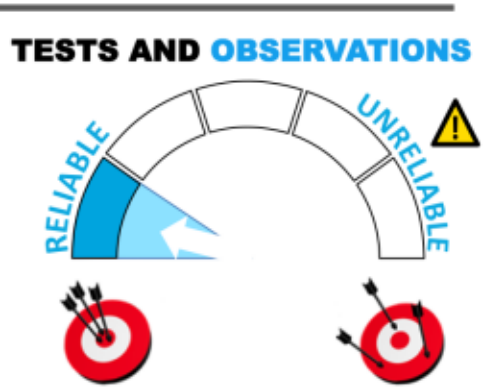
Release of dry unconsolidated snow. These avalanches typically occur within layers of soft snow near the surface of the snowpack. Loose-dry avalanches start at a point and entrain snow as they move downhill, forming a fan-shaped avalanche. Other names for loose-dry avalanches include point-release avalanches or sluffs. Loose-dry avalanches can trigger slab avalanches that break into deeper snow layers.

TRAVEL ADVICE

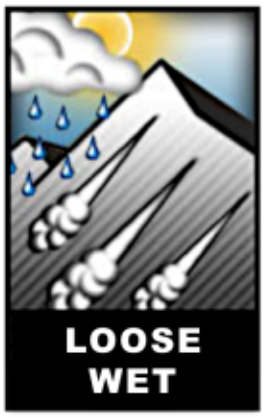
- Usually predictable snow behavior.
- **More prevalent on steep slopes at the higher elevations** (as mentioned in the current avalanche forecast). **Avoid this terrain or choose slopes gentler than 35 degrees in steepness.** Problematic during heavy snowfall events.
- Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you.
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide good information on snow stability.







NORMAL CAUTION

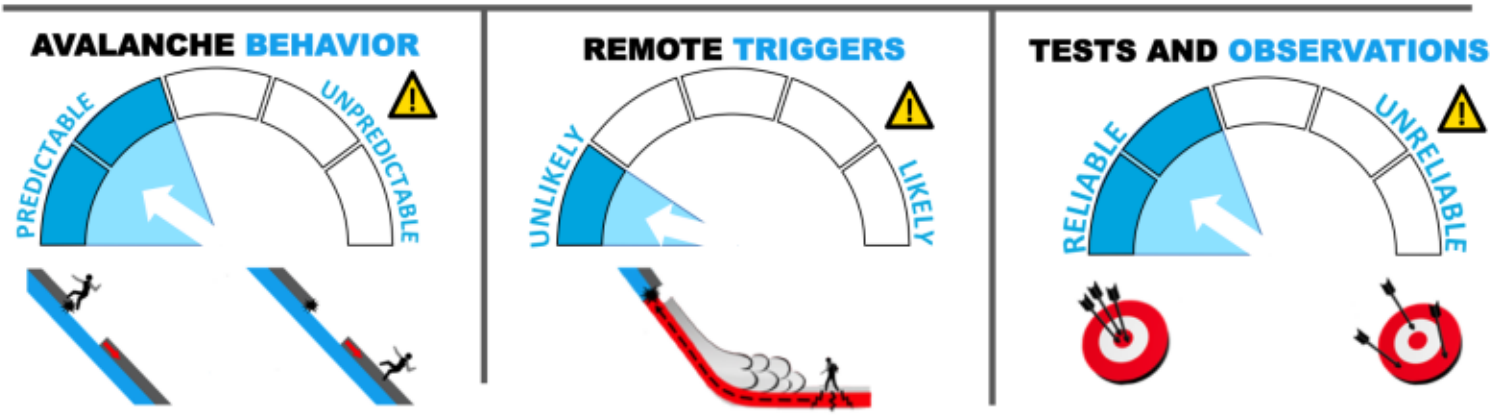


LOOSE WET SNOW

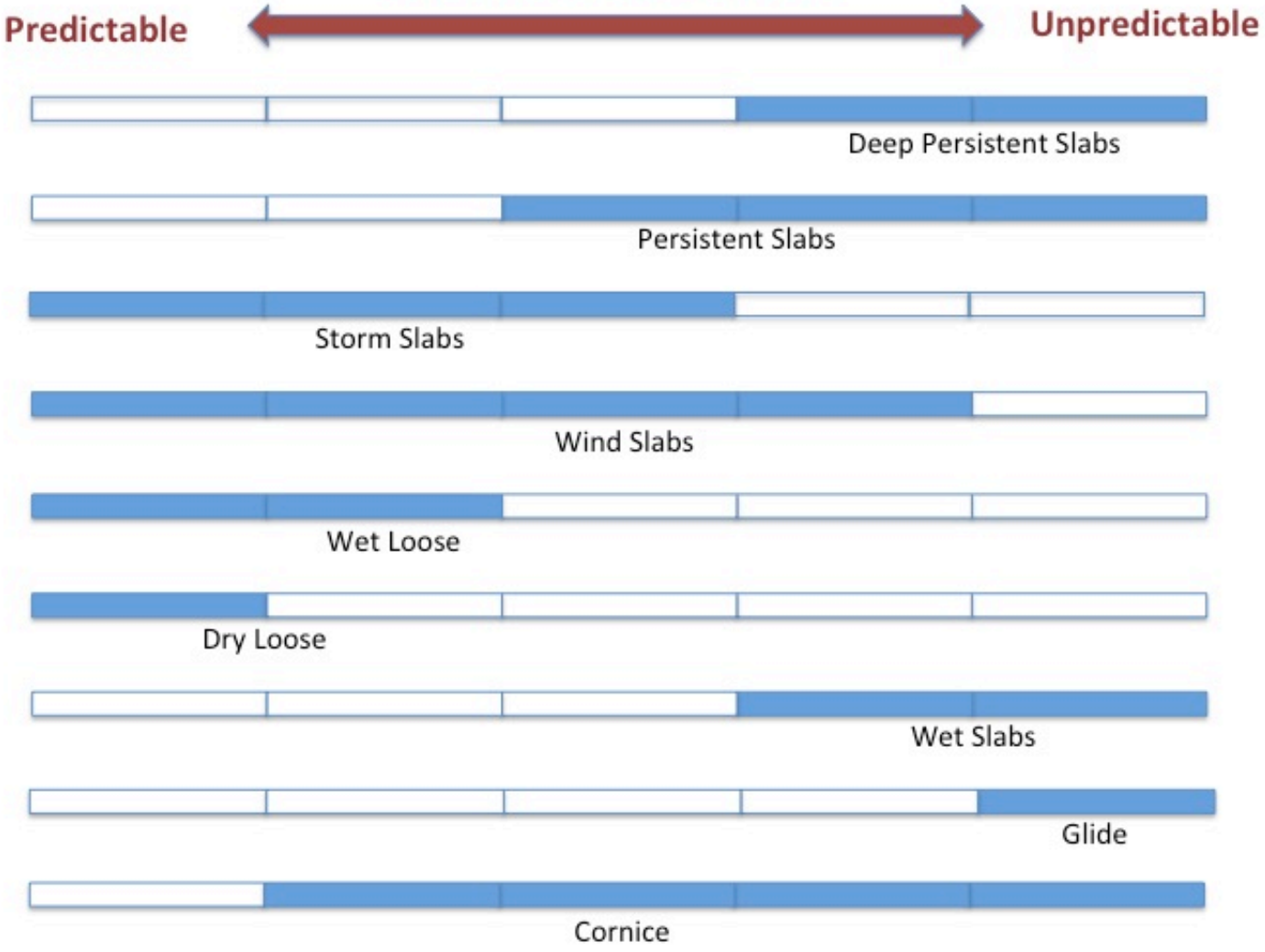
Release of wet unconsolidated snow or slush. These avalanches typically occur within layers of wet snow near the surface of the snowpack, but they may quickly gouge into lower snowpack layers. Like Loose-Dry Avalanches, they start at a point and entrain snow as they move downhill, forming a fan-shaped avalanche. **They generally move slowly, but can contain enough mass to cause significant damage to trees, cars or buildings.** Other names for loose-wet avalanches include point-release avalanches or sluffs. Loose-wet avalanches can trigger slab avalanches that break into deeper snow layers.

TRAVEL ADVICE

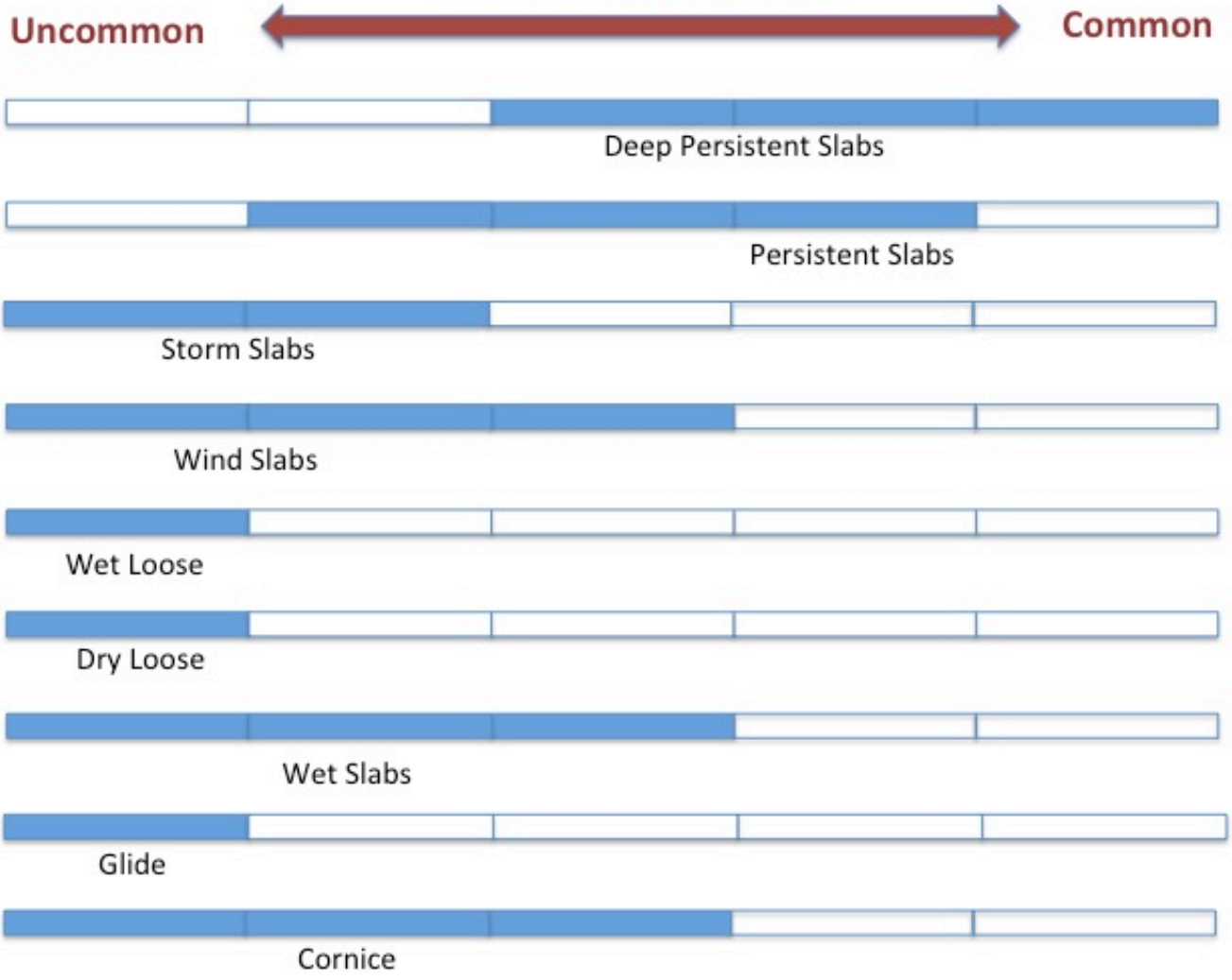
- Usually predictable snow behavior.
- As conditions may be affected by sun, rain, or warm temps, avoid terrain mentioned in the advisory or **choose slopes gentler than 30 degrees in steepness.**
- Give runout zones a wide berth when natural avalanches are expected or when others may be traveling above you.
- Test slopes, snow pits, slope cuts, previous tracks, and cornice drops tend to provide good information on stability. Tests are time sensitive due to sun/heating.

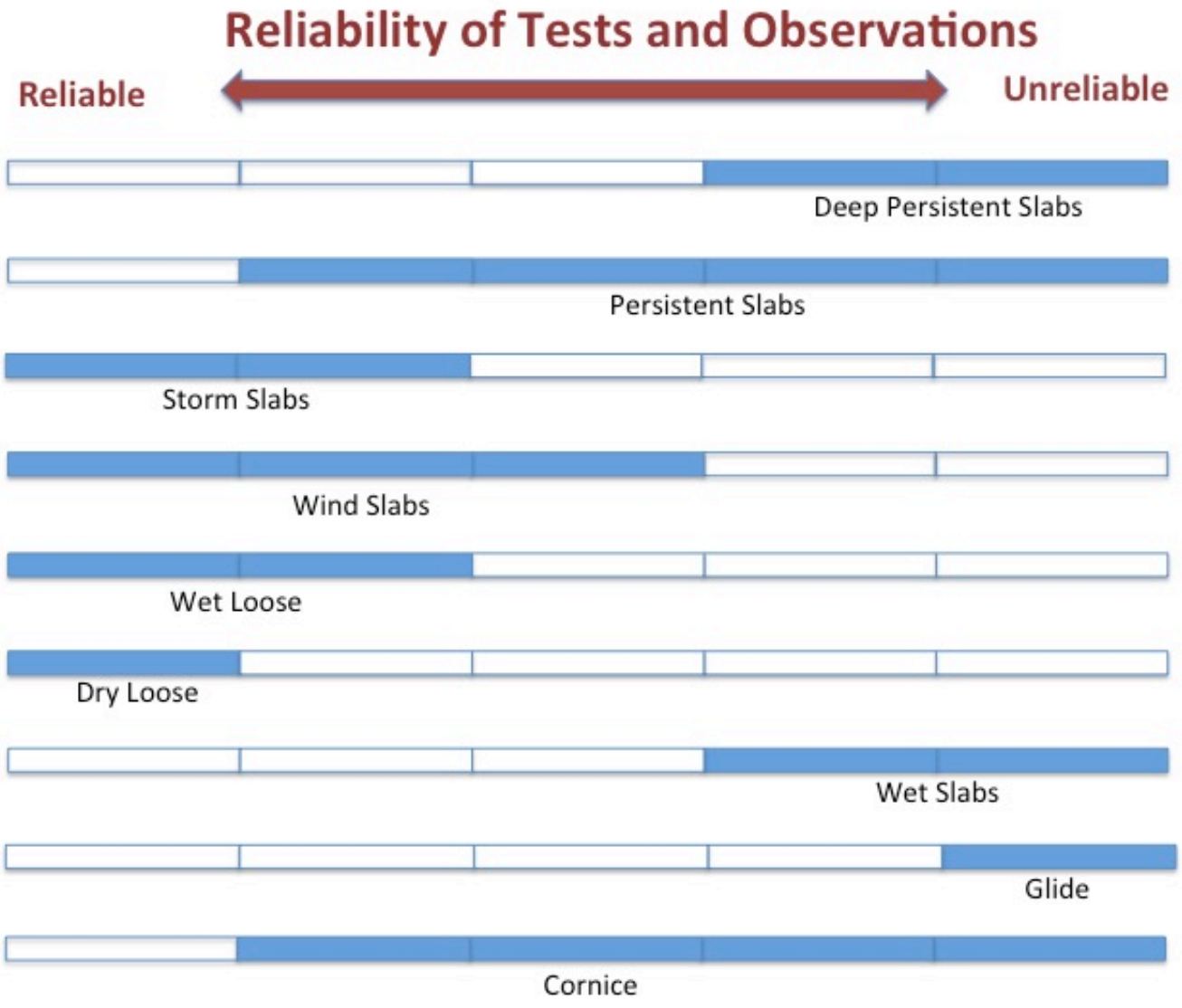


Avalanche Behavior



Remote Triggers





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