Mountain Wave Conditions and Hazards

Go or No Go?

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Introduction to Mountain Wave Formation

- The Sierra Nevada Mountains
  - Present a great challenge to Western Pilots
  - Highest mountains in the 48 states
  - Mt. Whitney and surroundings are well over 14,000'. (Mt. Whitney is 14,496')
  - Wave formation is common over these mountains. Wave formation occurs leeward of the Rocky and Appalachian Mountains also.

Introduction Continued

- Soaring altitude record is held by Bob Harris who on Feb. 22, 1986 flew to 49,009 ft. using mountain wave condition. He departed California City and encountered temperatures as low as -104° F. The aircraft he used was a Grob 102. No more record attempts in the altitude category are allowed due to the danger involved.

Introduction Continued

- The Sierra Nevada present a tall line of mountains 400 miles long, that run NW (330°) to SE (150°) on the eastern side of California.
- Geostrophic Winds commonly flow from the west producing mountain wave.
- Winds aloft speeds over 25 kts. and within 30° of perpendicular to the Sierra can be hazardous to light planes.

What is Mountain Wave?

- Mountain Wave is a laminar flow across a mountain barrier.
- Air flowing on the windward side is smooth.
- Waves remain nearly stationary while the wind blows through them rapidly.
- A wave pattern may extend well over 100 miles to the lee of the mountain barrier and wave crests may penetrate into the stratosphere.

Forecasting Rotor

- Rotors are the most destructive effect of standing mountain wave.
- The winds aloft report is your best source to predict rotor. Essentially, high wind speeds perpendicular to a mountain barrier will form a rotor. Plot the winds on a sectional map.
- Rotors form below the wave crests and often form just to the lee of the mountain at or just below the highest elevation of the mountain.

Rotors Continued

- Most rotors are invisible, but are high speed. Similar in effect to a tornado lying on its side.
- Rotor clouds form in the same place as rotor. Rotor clouds occur if there is enough moisture available. As these are visible they are less dangerous assuming you don’t fly through them.
- Rotor clouds may look like long, parallel sets of tubes, underlying standing lenticular clouds.

Standing Lenticular Clouds

- Standing lenticular clouds are unique in shape!
  - They have been reported as UFOs by the unsuspecting public.
  - They may be stacked, one above the other, for many layers and tens of thousands of feet in height.
  - Standing lenticular clouds form at the wave crests of mountain wave.

UFO Sighting?

Source: **www.unmuseum.org/ ifonat.htm**

Stacked Lenticulars

Source: **spaceplace.jpl.nasa.gov/ cloudsat_puz2.htm**

You don’t want to go under this and you can’t get over it!

Source: http://www.afterimagegallery.com/barnbaumlenticular.htm

Soaring in Mountain Wave

- Gliders or Soar Planes make use of wave phenomenon to great advantage, so flying in wave is possible.
- Gliders fly into wave by thermaling or by being towed into it.
  - When being towed the tow plane pilot tries to avoid the rotor.
  - Thermaling into wave is a difficult, but not impossible process.
  - Lift from wave is on the windward side of each wave.
  - Glider pilots will often fly along the face (windward side) of a mountain wave. In the Sierra Nevada this can give the pilot a ride along much of the length of the mountain range in unbelievably smooth air.
  - Before penetrating 18,000 feet the pilot must call a ground base to open a “wave window,” in order to enter Class A airspace.

Supplemental Oxygen Requirements for Wave Soaring

(FAR 91.211)

- Required if above 12,500’ MSL for over 30 minutes. Required above 14,000’ MSL for pilot. Above 15,000’ MSL passenger(s) must have oxygen.
- Oxygen Systems
  - Nasal Canulas can be used up to 18,000’.
  - Continuous-flow systems (uses a rebreather mask and bag) may be used up to 25,000 feet.
  - Diluter-demand: automatically dilutes the oxygen with atmospheric air and supplies the mixture when inhaled. At 32,000’ the regulator is supplying 100% oxygen. May be used to 35,000’.
  - Pressure-demand: A special regulator forces oxygen into lungs with positive pressure. This type of mask forms a seal against the face. Adequate up to 45,000’.

Source: Soaring Flight Manual, Jeppesen Sanderson, Inc. 1984.

Wave Window Requirements

- Northern Sierra
  - 3 wave windows exist: Minden West, Minden Central, and Minden East.
  - Glider Pilots must contact one of the two soaring FBOs on the field to request that Oakland Center opens a wave window.
  - Oakland Center does not want to communicate with glider pilots.
  - Oakland Center will not provide separation services between gliders in the wave window.
  - Glider pilots must remain inside of the wave window via ground reference.
  - Visual reference to the ground must be maintained at all times and visibility must be at least 5 miles.
  - The entire Wave Window agreement can be found at:

    http://www.mindensoaringclub.org/pages/fly_minden/wave_window.htm

Go or No Go?

- Geostrophic Wind Speeds of 25 – 40 kts.
  - Moderate turbulence may exist up to 5000’ above ridge level.
  - Severe turbulence may exist in the immediate lee of a ridge
- Geostrophic Wind Speeds of >50 kts.
  - Extreme turbulence may exist in the immediate lee of a ridge
  - Severe turbulence may exist up to 5000’ above ridge tops.
  - Moderate turbulence may exist up to 10,000’ above ridge level.
- How high can you safely fly? Got Oxygen?

Rules of Thumb for Wave Flight

http://www.mountainflying.com/mountain_wave2.htm

- Cross the mountainous terrain at ½ the height of the peaks plus their height. In the Sierra Nevada there are peaks over 14,000’ that jut above the surrounding terrain by 4,000’ to 5,000’, so add 2,000 to 2,500’ to the 14,000’ for an altitude of at least 16,000’. You should easily avoid the lee rotor.
- Approach the mountains with at least a 45° angle. This will give you an escape route in case of serious down draft!
- When flying parallel to wave, fly on the updraft (windward) side.
- Don’t fly near ragged-looking lenticulars. They are very turbulent.
- Climb in lift and dive in sink. The higher airspeed produced by diving in sink will move you out of it faster, and thus you will be in it much less time that trying to maintain altitude in a nose-up (slow) atitude.