Can You Read the Wave?

By Jim Herd, Minden, Nevada, USA

Based on Article in American Bonanza Society Magazine January 2015

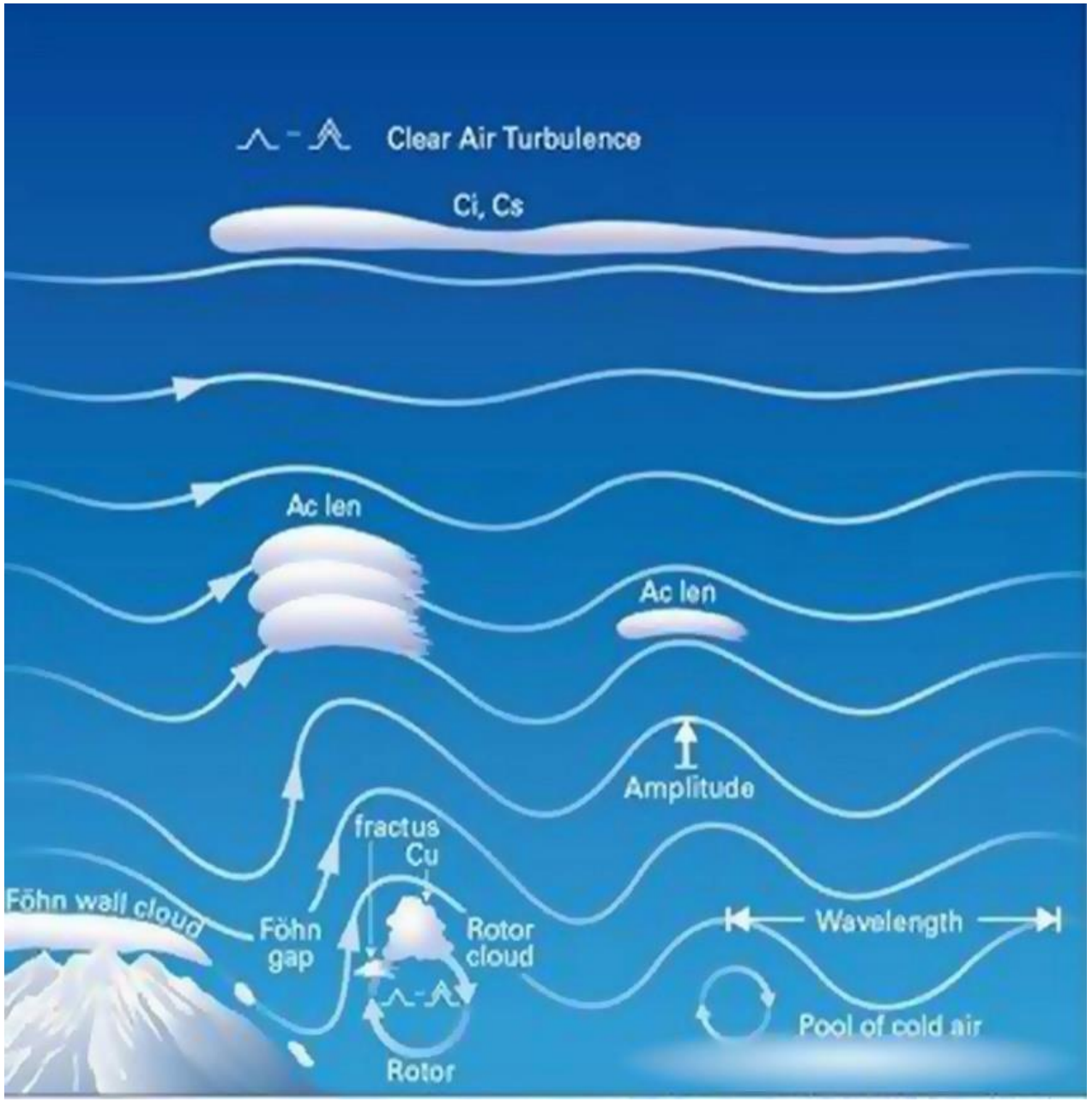
Jim Herd

- Mechanical & Industrial Engineering Degree – Luton University, England
- Post-grad Fellowship – 2 years at Kettering University, Flint, Michigan
- Tau Beta Pi National Engineering Honor Society
- Hang gliding – 19 years and 2,000 hours
- Sailplane – 16 years and 2500 hours
- Power plane – 14 years and 1200 hours
- Flying in and around mountains in the western USA, Europe, and New Zealand
- Retired Silicon Valley executive

Context for Presentation

- Targeted at small power plane pilots
- Beech Baron accident in Colorado
  - Pilot flew in wave ALONG the sink bar at 18,000 feet
  - Plane found crashed into trees – couldn’t escape sink
  - Pilot dead and plane destroyed!
- Easy Solution – turn 90 degrees to find lift bar
- Power plane pilots almost never taught the basic theory of mountain wave
- Serious safety omission!

Idealized Mountain Wave Schematic



The Sierra Wave from a glider at FL 280 over Lone Pine, CA.
Wave clouds are caused by Sierra Nevada, out of view, left side.

Simplified Wave Theory

- Power pilots need only a rudimentary understanding & visualization
- Two primary factors – steep terrain and strong winds
  - When in place – READ THE WAVE
- Visualize water flowing in a shallow rocky stream – similar dynamic
- WAVE appears to “detach” from terrain with major downwind effects
- Wavelength is variable – longer with stronger winds
- More prevalent in winter – not disturbed by instability & thermals
- Low-powered and low-speed aircraft demand extra vigilance
- Five principle threats to understand and beware ……..

1. Threat: Strong Winds Aloft

- Exaggerated effects on aircraft endurance, range, and track/heading
- Avoid getting blown downwind into Lenticulars – crab upwind
- Respect weather briefing, including PIREPs
- Clear Air Turbulence
  - Rare, but keep seat belts tight
  - Often invisible
  - Most prevalent at high altitude

2. Threat: Major Lift & Sink Areas

- Wave bars may or may not have Lennies – always parallel and downwind of steep lee terrain
- Beware “ripples” with wave bars repeated far downwind
- Lift always adjacent & upwind of Lennies
- Sink always adjacent & downwind of Lennies
- Seductively smooth
- Vertical speed can exceed 2000 feet per minute
- Watch Vertical Speed Indicator (VSI) and airspeed
- Visualize the macro picture
- Consider flight path detours in sink
- Cross the sink bars perpendicularly
- Downwind is faster – but watch terrain
- Use appropriate engine power and airframe configurations
- Lift bars offer “free” height/speed – but avoid overspeed and busting altitude limits

3. Threat: Rotor Turbulence

- Most prominent in the Lee shadow – predictable location
- Usually small and isolated area
- Bad place in a power plane!
- Distinctly separate from wave bars
- Rotor clouds (if present) often look wispy/angry – stay away!
- Never fly close to terrain on the Lee side
- Remain 2000 feet above upwind terrain
- If rotor encountered – speed in green arc (below Va), control attitude, turn away
- Escape downwind and away from terrain
- Rotor sometimes exists below secondary/tertiary wave bar
- Rounded terrain won’t usually generate much rotor

4. Threat: Mechanical Effects

- Flowing air close to terrain
  - similar to shallow stream with rocky bottom
  - “babbling brook”
- Widespread “choppy air”
- Minimum 2000 feet terrain clearance – even flat terrain
- Cross ridge lines minimum 2000 feet above – with escape route

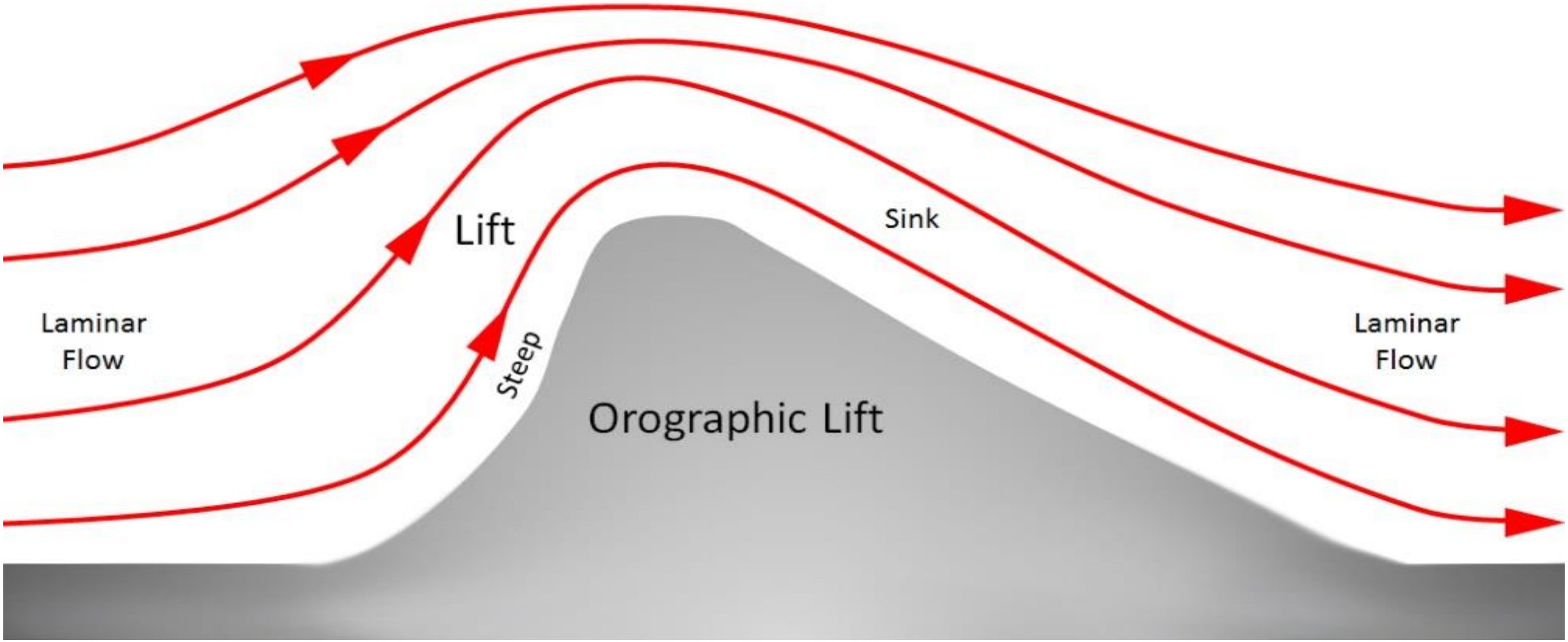
5. Threat: Landing and Take-off

- Critical if close-in, downwind of big terrain
- Highly variable winds – velocity, direction, gusts, and “holes”
- Extreme changes in just a few seconds
- Lee side rotor reaches to the ground randomly
- Anticipate sudden and extreme wind shift – worst case, uncontrolable
- Observe winds for 15 minutes before any flight decision – landing or take-off
- Landing – consider an alternate airfield
- Take-off – consider a delay or cancel the flight
- Speak with local experts in real time
- When in climb or descent – seek assist from lift or sink bars

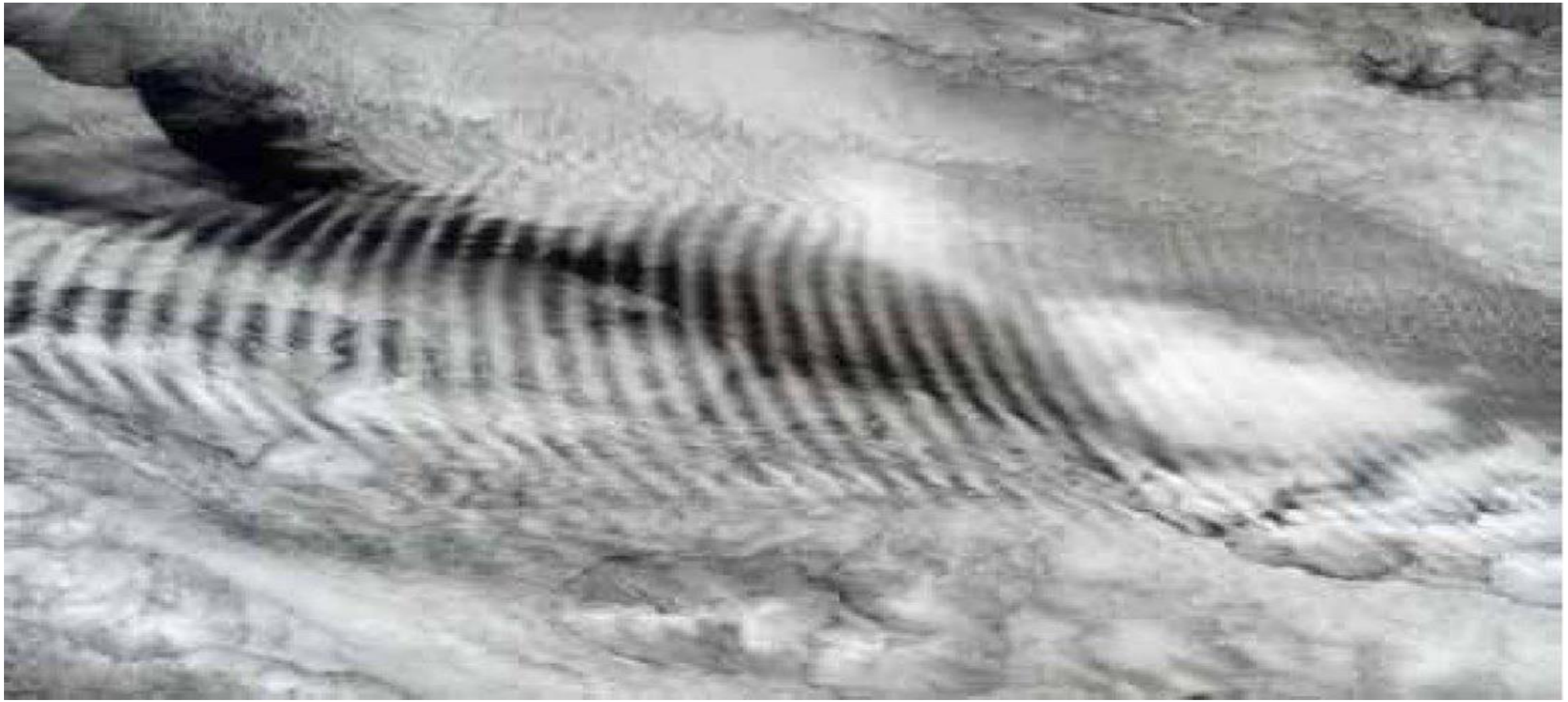
Orographic Ridge Lift

- Often confused with mountain wave lift – very different
- Always directly upwind and close-in to steep terrain
- Lift on the upwind side – sink downwind
- No propagation further downwind
- Upwind side not usually turbulent
- Remain 2,000 feet clear

Orographic Lift is directly tied to the terrain.



Satellite view of wave bars
propagated far downwind of the mountain source.



(Photo courtesy of NOAA)

Recommendations for Power Pilots

- Tremendous benefit from glider add-on rating
- Seek a fully qualified wave instructor
- Or – take a glider ride in wave conditions
- Or – take a fully qualified wave instructor in your power plane
- Some soaring businesses offer specific training programs
- Learn to READ THE WAVE! (Beware of the FIVE THREATS!)
- Fear of unknown “bad air” almost vanishes
- Know when/where to go – when NOT to go
- Set personal limits
- Ridgetop winds above 40/50 knots – I stay on the ground!
- Exploring the wave can be safe, comfortable, confident and fun!

Classic Lenticular over Minden, NV recently.
Very workable for aviation.

(Photo courtesy of Jennifer Ware)

Lenticular clouds developing over associated rotor clouds at Minden, Nevada. Note blowing dust.

(Photo courtesy of Jennifer Ware.)

“Disclaimer”

- Things are not always “textbook”
- Extreme power of nature – respect it
- Disorganized/oblique mountains – airflow may be “confused”
- Set personal limits based on skill, equipment, terrain, and wind conditions
- Start with wide safety margins and explore tentatively
- Seek qualified flight training

Contributions and Endorsements:

- Sean D. Tucker – perhaps the most internationally-recognized contemporary air show acrobatic pilot.
- Terry Delore – many world records in gliders in Mountain Wave around the world, and partner with Steve Fossett for most of his soaring records.
- Gordon Boettger – active ATP and wave soaring expert based at Minden, Nevada.
- Gavin Wills – internationally-recognized Mountain Wave instructor and proprietor of the premiere soaring school in New Zealand – Glide Omarama. Also a pioneer power pilot in the New Zealand Southern Alps on wheels and skis.

For further study:

- SoaringNV: www.soaringnv.com
- Glide Omarama: http://www.glideomarama.com/
- OSTIV: http://mwp.flightplanner.info/Beschreibengl.htm
- Perlan Project: http://www.perlanproject.org/
- Exploring the Monster by Robert F. Whelan
- Meteorology for Glider Pilots by C.E. Wallington