On The Need For Mountain Wave Forecasts

Turbulence Mitigation Workshop IV

Nov 9, 2021

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* *Retired (2010) NWS Meteorologist 42 years*
* *Manager / CWSU Aviation Support*
* *Contest Forecaster – Discus 2A: 4500+ hours*
* *Barron Hilton Cup – West U.S. Winner 2008*
* *Numerous World and U.S. gliding contests forecast support*
* *Perlan Met support 2018, 2019 – 76k msl altitude record*
* *Soaring Society R12 Director – So California*

On The Need For Mountain Wave Forecasts

Waves as a *Phenomena* or *Environment*

on is difficult… better education?

elated NWS forecast products?

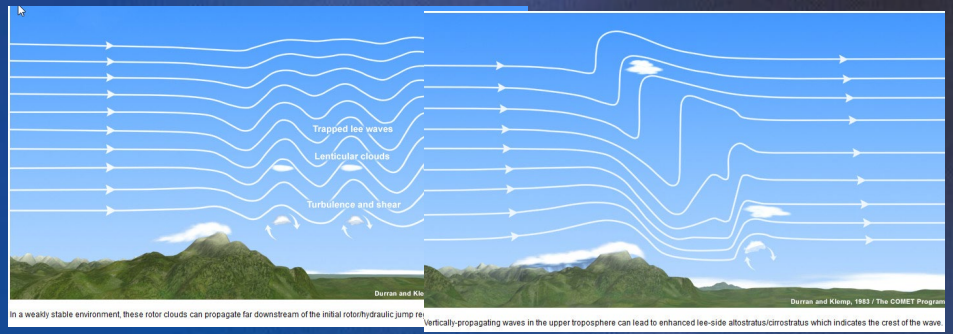
Downdrafts vs. Turbulence…

MW *Phenomena* – HiRes Operational NWP and the

and MW's – History and Example Flights

Mountain Waves as a *Phenomena* or *Environment*

Vertically Propagating and Trapped MW's are traditionally identified by



In a weakly stable environment, these rotor clouds can propagate far downstream of the initial rotor/hydraulic jump re

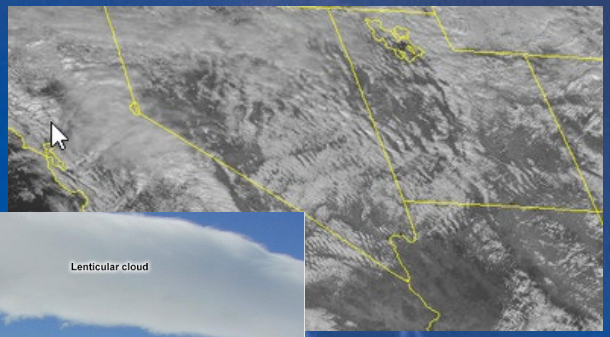
Vertically-propagating waves in the upper troposphere can lead to enhanced lee-side altostratus/cirrostratus which indicates the crest of the wave.

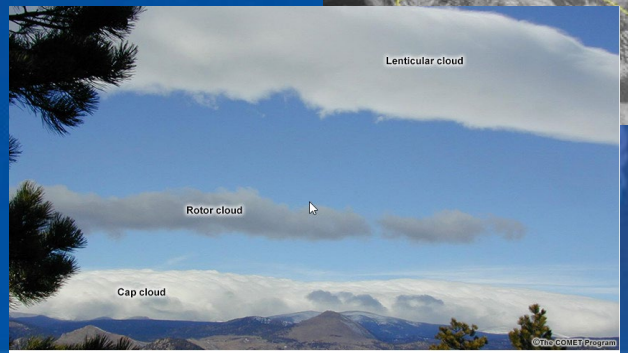
Mountain damaging surface
network access

Mid Level Water Vapor
channel images

ult

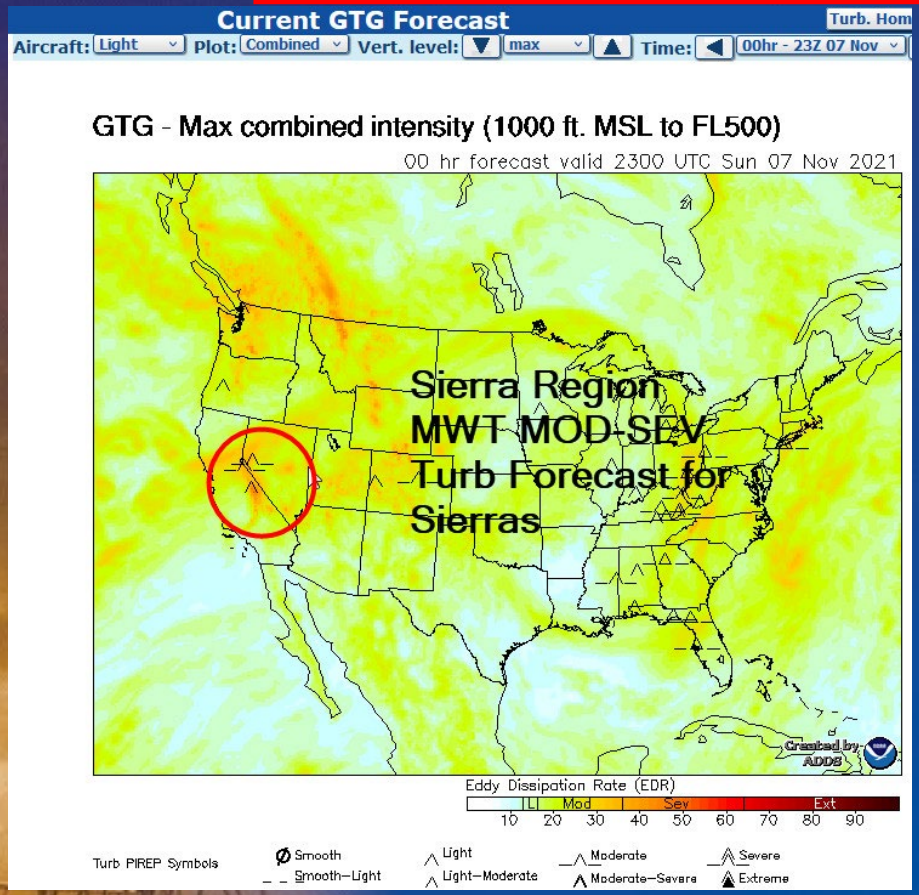
ots to build the
It even takes training for the pro

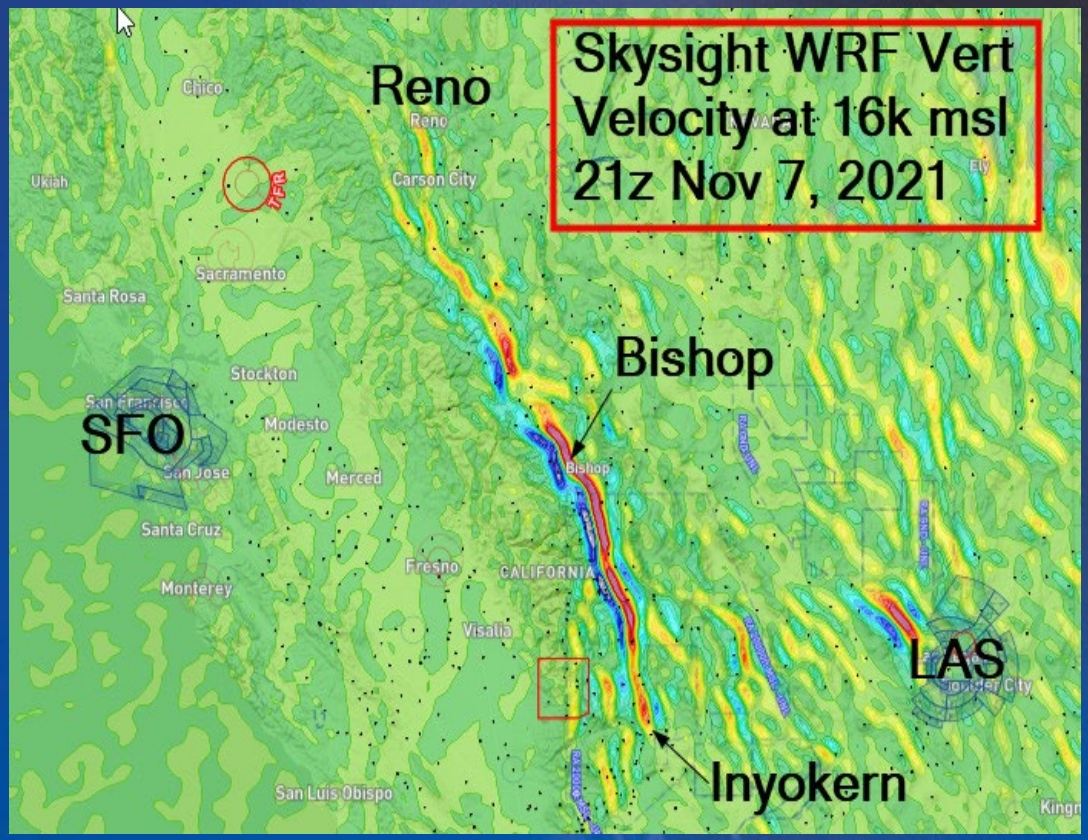




Are there MW Related NWS forecast products?

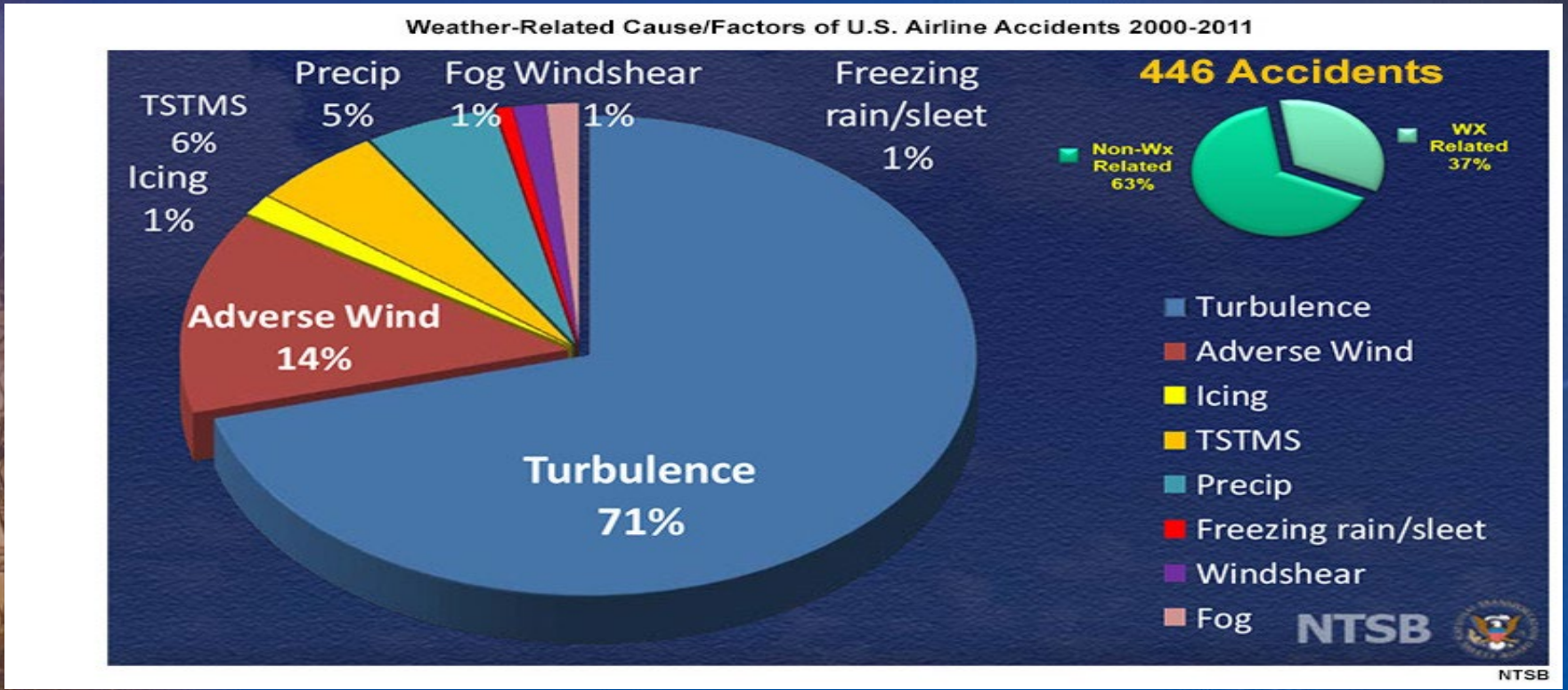
Not Really! The Graphical Turbulence Guidance (GTG) does include a





Severe MW Downdrafts vs. Turbulence…

Statistics from NTSB regarding GA accidents caused by severe MWA downdra



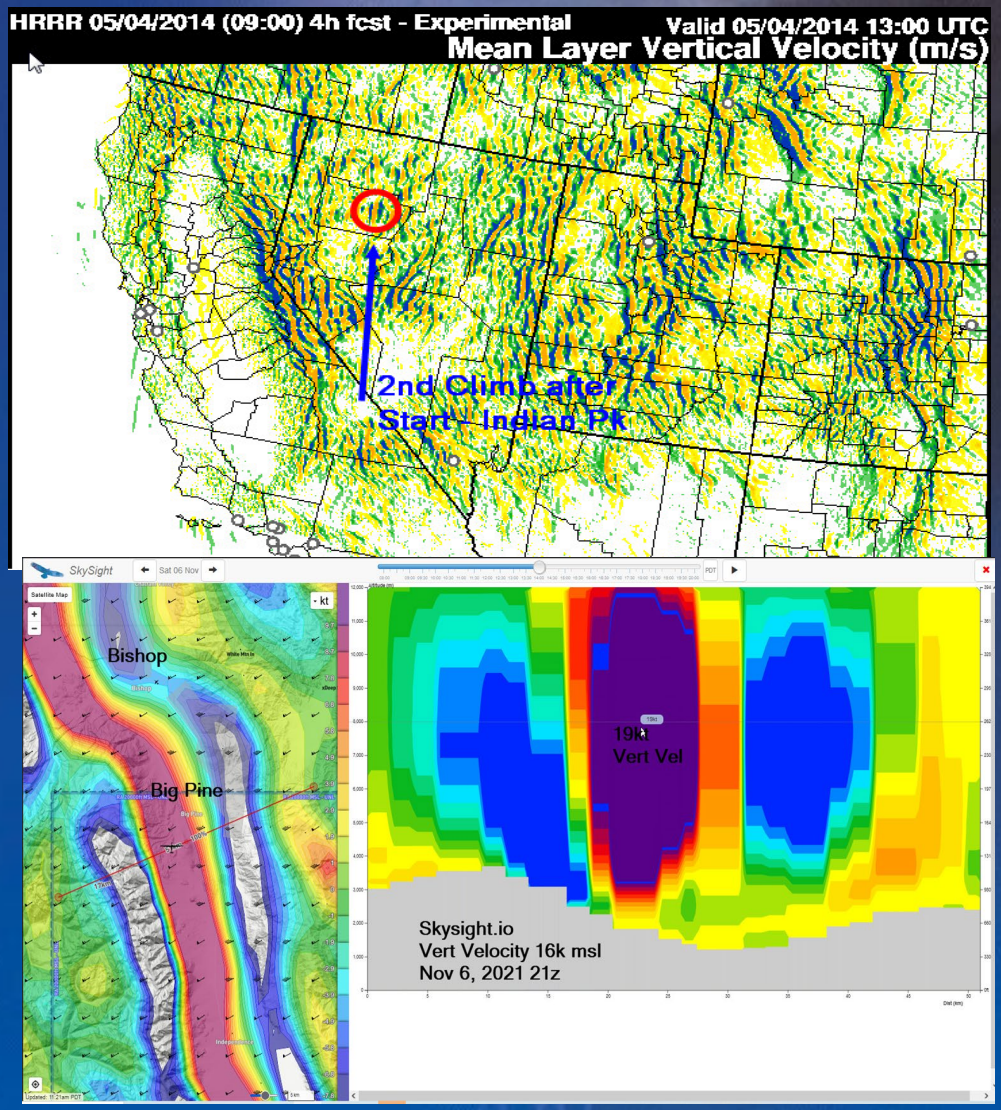
Identifying MW *Phenomena* HiRes Operational NWP and the HRRR

le experimentally

MW Vert Velocity
tional use of HRRR in 2014

appears "good
ght planning for gliding

RF framework
ring forecasts in 2015…



Skysight.io

SkySight

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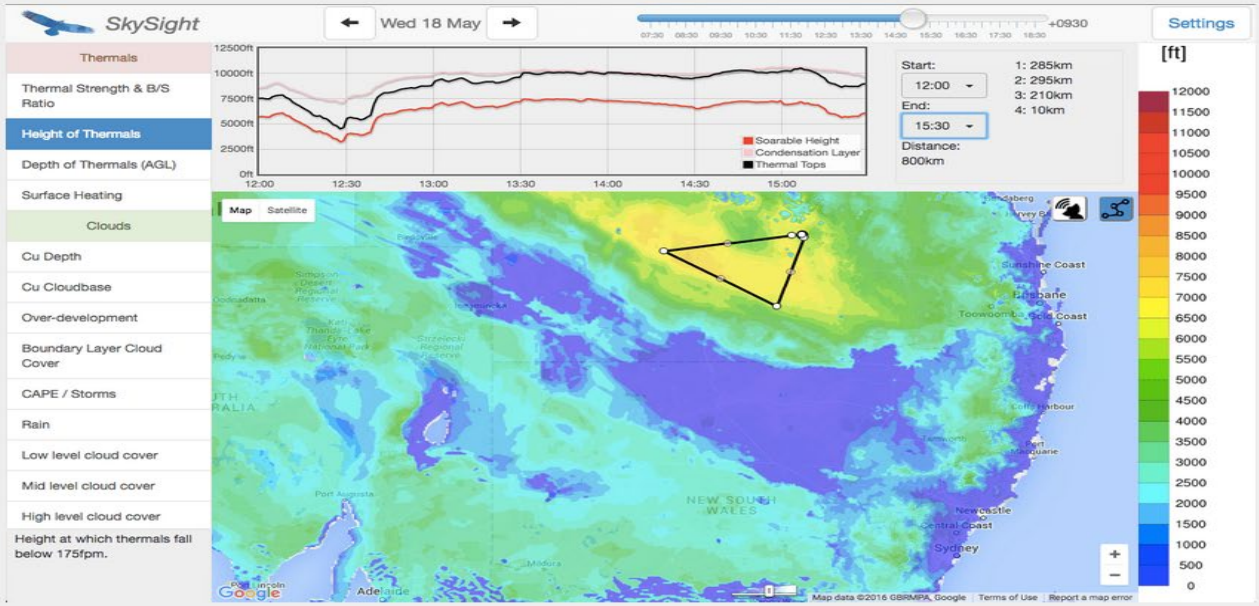
SkySight is the next generation soaring weather forecast for Australia, South Africa, Europe and North America

- 5+ days forecast range
- Half-hourly time steps
- High resolution forecasts
- Route forecasts
- SkewT forecasts
- Modern user interface
- Phone & Tablet friendly



Matthew Scutter is the lead developer of SkySight, a soaring weather forecast service used aroun

Sailplanes and MW's Flights
Dr Kuettner's & Others

lights:

shop to Flagstaff, AZ – 600km 19Mar 1952

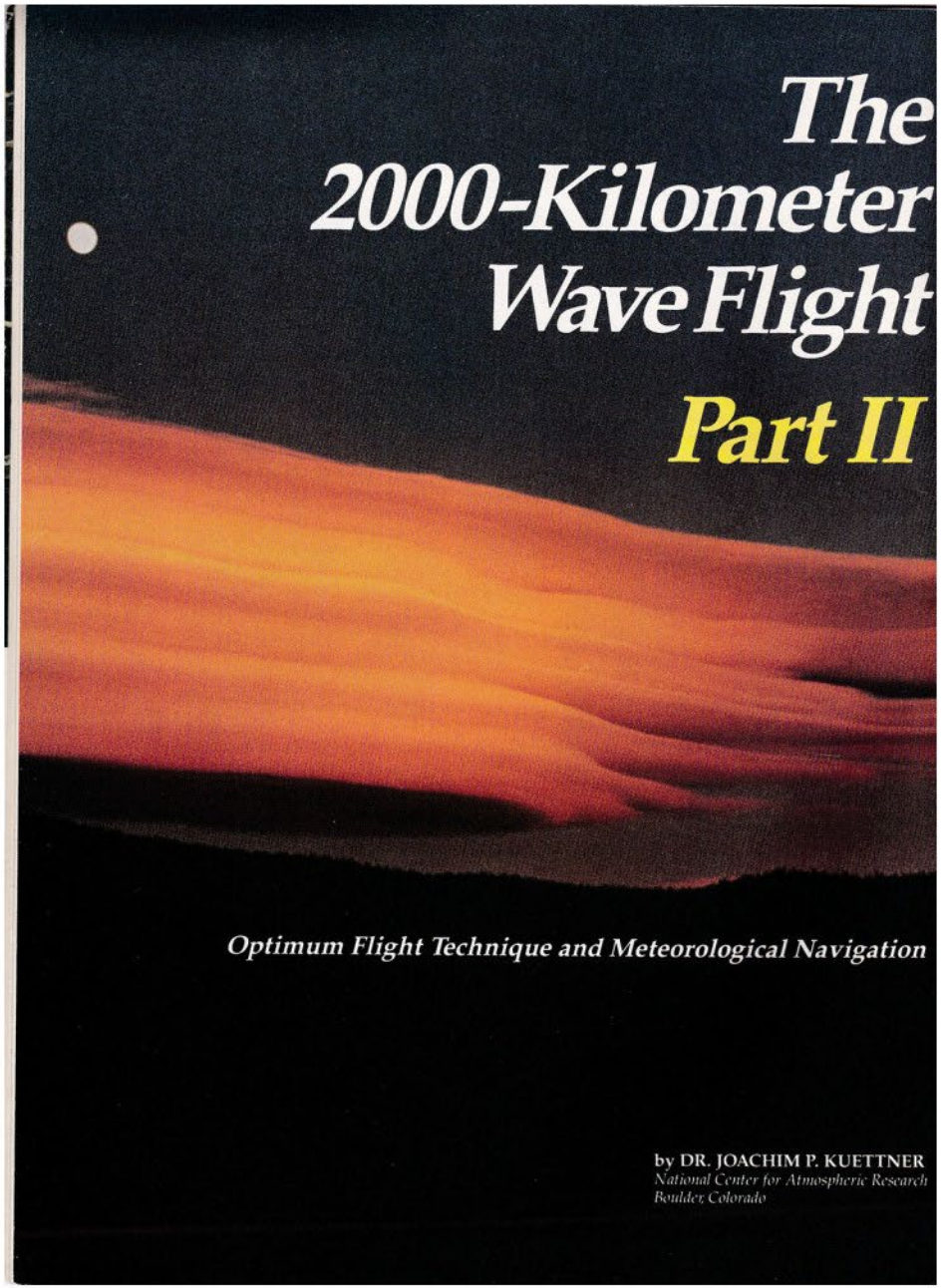
Calif City to Seminole, TX – 1452km 14Apr 1984

– Minden to Hulett, WY – 1411km 05May 2014

s:

country flights in lee of Sierras… 1000 to 2900km

Sailplanes and MW's Flights
Dr Kuettner & Others



It seems that the time has come to bring long distance wave soaring to a similar level of sophistication as thermal soaring, where flight techniques are highly developed as shown by the many publications on "optimum speed to fly," "dolphin" techniques and the various on-board computers. What is needed now is to combine our latest knowledge of wave and wind characteristics with the aerodynamic behavior of high performance sailplanes in the upper atmosphere. As will be shown, the results are markedly different from those of thermal cross-country flight.

In a previous article[1] (to be called Part I in this paper) scenarios for a 2000 km wave flight were described, and it was stated that 50:1 (or better) sailplanes now in existence have made this a realistic possibility. In the meantime, Mike Koerner has shown that, even under somewhat mediocre[2] conditions, a highly experienced wave pilot can fly 1452 km with a 43:1 sailplane at moderate heights (**Figure 1**). This article will give some of the reasoning behind the statements made in Part I.

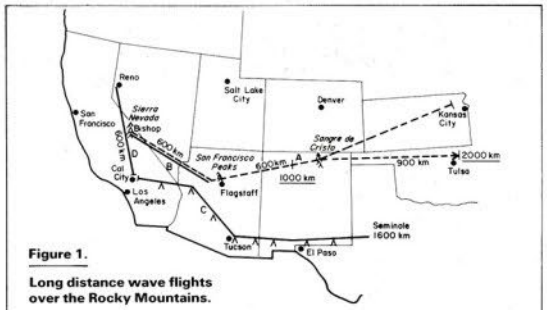


Figure 1.

Long distance wave flights over the Rocky Mountains.

***Track A* (dashed) is a possible 2000 km flight as suggested in Part I of this article.**

***Track B* is the author's 600 km flight of 19 March 1952.**

***Track C* is Mike Koerner's 1452 km flight of 19 April 1984. Used lift areas are marked by ^**

***Track D* is the well-known 600 km track along the Sierras between Reno and California City.**

Basic Differences Between Wave and Thermal Flight

The first thing necessary is to fully comprehend the fundamental differences between a long-distance wave flight at more than 30,000 feet and the conventional thermal cross-country flight. The accompanying Table lists the more important differences and their consequences.

It was stated in Part I that a downwind flight with maximum glide ratio over ground is superior to flying at optimum cruising speed. The reasons for this conclusion will become clear if we recall a few basic facts about these two flight techniques.

It is well known that the optimal speed in thermal cross-country flight (the "MacCready speed") has to take into account the downdraft during glide and the (expected) updraft during climb (ring setting), but, somewhat surprisingly, not the wind. This is by no means obvious, but it can be

1. *Soaring*, May '84, p. 14–19.

2. April 19, 1984, California City, CA to Seminole, TX in a 17-meter *Kestrel*. Strong SW crosswinds, no lenticulars, only roll clouds.

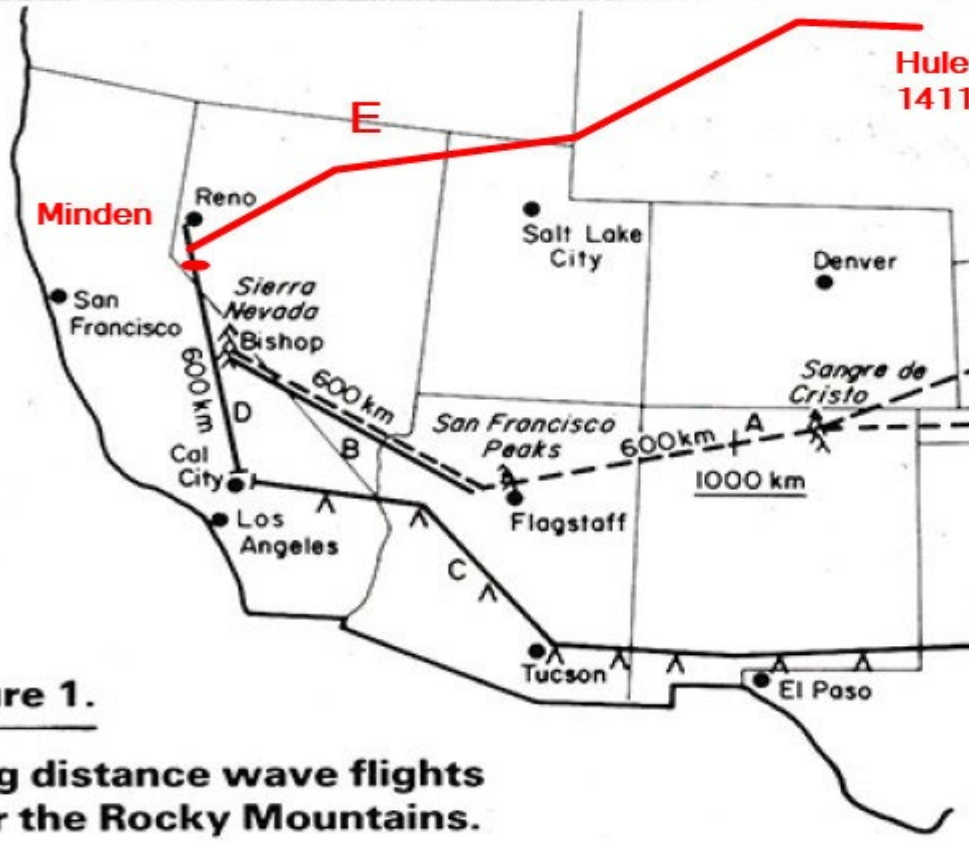
TABLE A

	Wave Flight Difference from Thermal Flight	Consequences
1.	Lift areas don't move with wind	MacCready speed becomes wind dependent; cruising speed reduced.
2.	High initial altitude	Multiple effects on flight polar, ground speed and glide ratio over ground.
3.	High upper winds	Wind becomes main factor for navigation
4.	Strong vertical wind shear	Determines best operating level; standard "speed-to-fly" laws become invalid
5.	Large distances between main lift areas	strong changes in altitude and wind during glide.
6.	Lift dependent on mountain shape	Difficulty in estimating next updraft strength.
7.	Lift decreasing with height	Factor in choosing top altitude.
8.	Different relation between up and down drafts	Downdrafts equal or stronger than updrafts; downdraft and updraft areas about equal.
9.	Frequent oscillations of atmosphere between mountain ranges	Permits downwind dolphin flight with increase in glide ratio over ground.
10.	Large total length of flight in West-East direction	Cyclonic turning of wind becomes factor; reduction in length of daylight.

Facing page photo Karl Tiefert

Soaring Magazine
Mar 1985

Sailplanes and MW's Flights
Dr Kuettner & Others



From Dr Kuettner's Mar 1985 Soaring Magazine Article

Figure 1.

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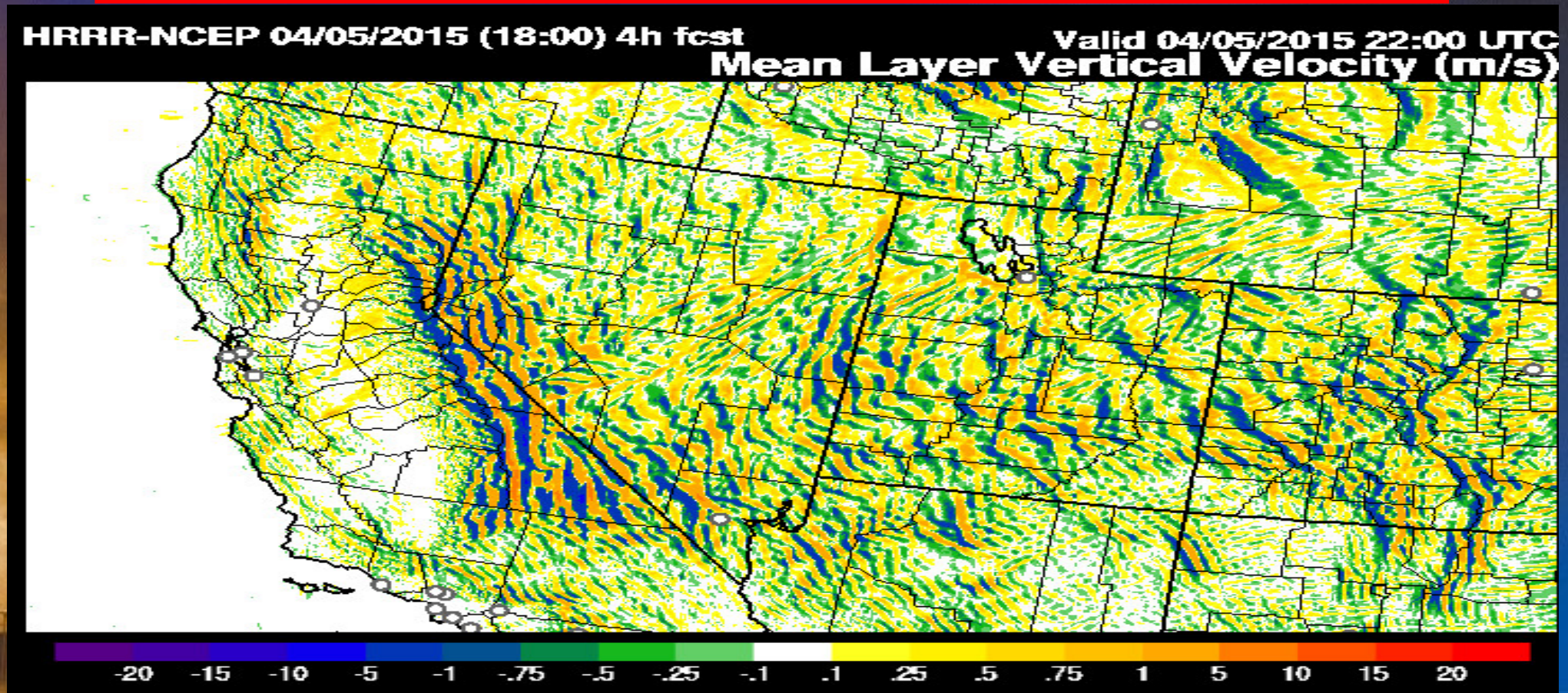
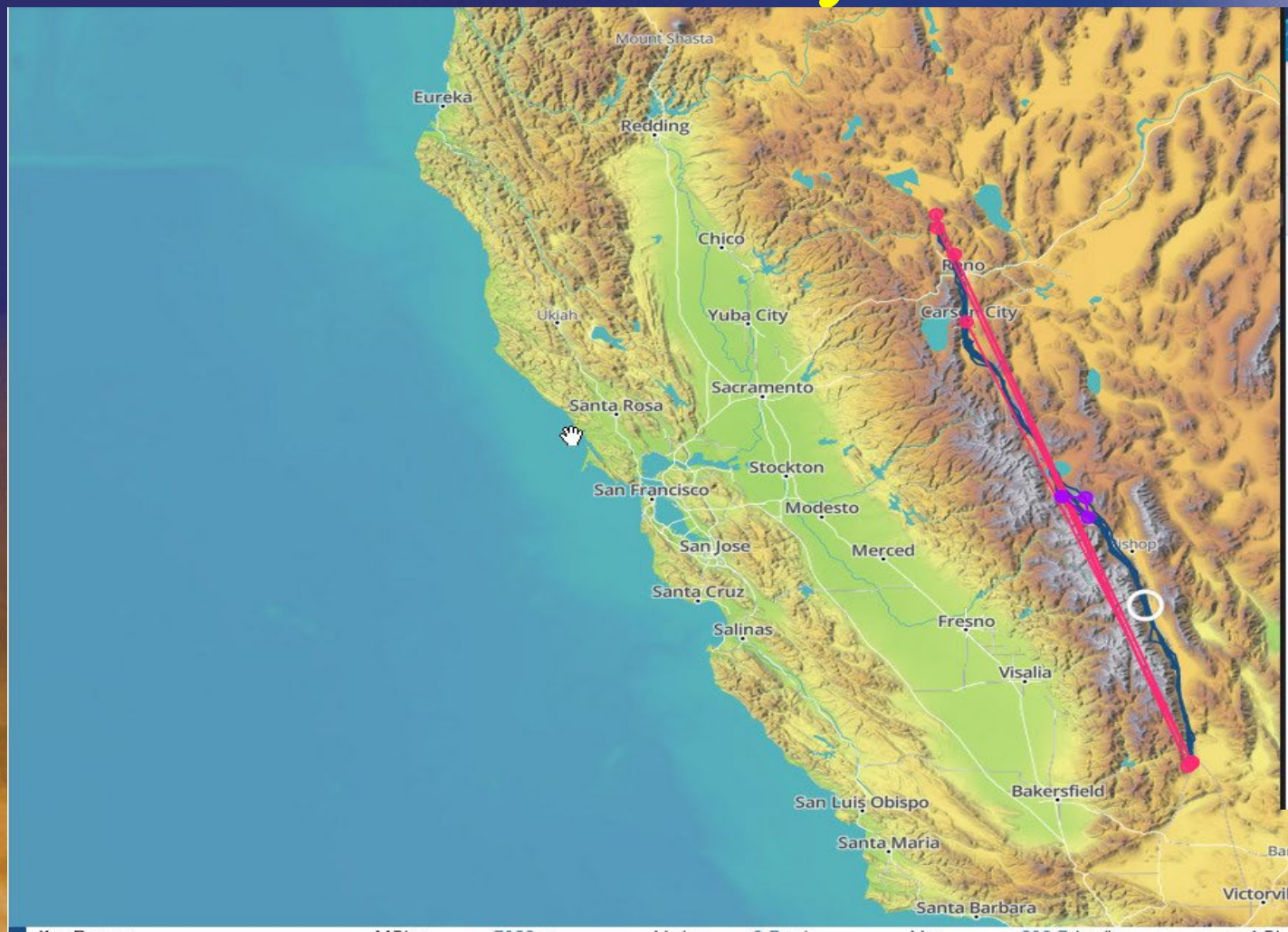
Track E is Gordon Boettger's 1411km flight of 05 May 2014 in a Duo Discus

Sailplanes and MW's Flights
Dr Kuettner's & Others

Jim Payne holds many records for gliding including in the Online Contest (OLC), World Altitude



Sailplanes and MW's Flights
Jim Payne 2908 km



OLC INNOVATIONS FOR SOARING

Scoringregion | Period | OLC-Scoring

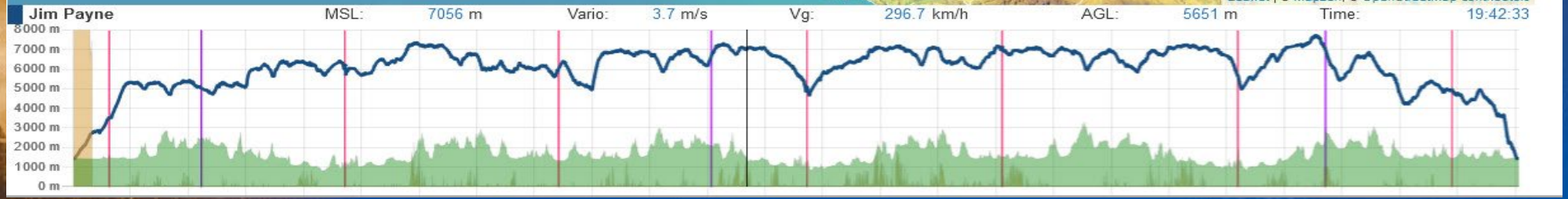
Flight information - Jim Payne

Copilot: Alan Coombs (US), Type of glider: Arcus M, Tak

OLC-Plus | Speed/League | Destination

Flight details

		Classic
Points for the flight	2566.29	2,550.41
scoring distance		2,907.5 km
Speed		249.8 km/h
Duration		11:38:16
Scoring class	double	
Scoring start	14:02:02	
Scoring end	02:23:35	
Index:	114.0	
Club	Perlan Project	
Date of claim	06.04.2015 05:26:13	
state	IGC-File: V Flight: S	



General Aviation MW Downdraft Accidents

The first two accident cases occurred while I was manager at the Los Angeles ART

ndraft Cases

- SE of Tehachapi Mtns NW bound; flight instructor
ight. Downdraft "...aircraft failed to maintain separation

General Aviation MW Downdraft Accidents

At 4:27pm PST on Feb 13, 2021… a high performance single engine Piper Mali

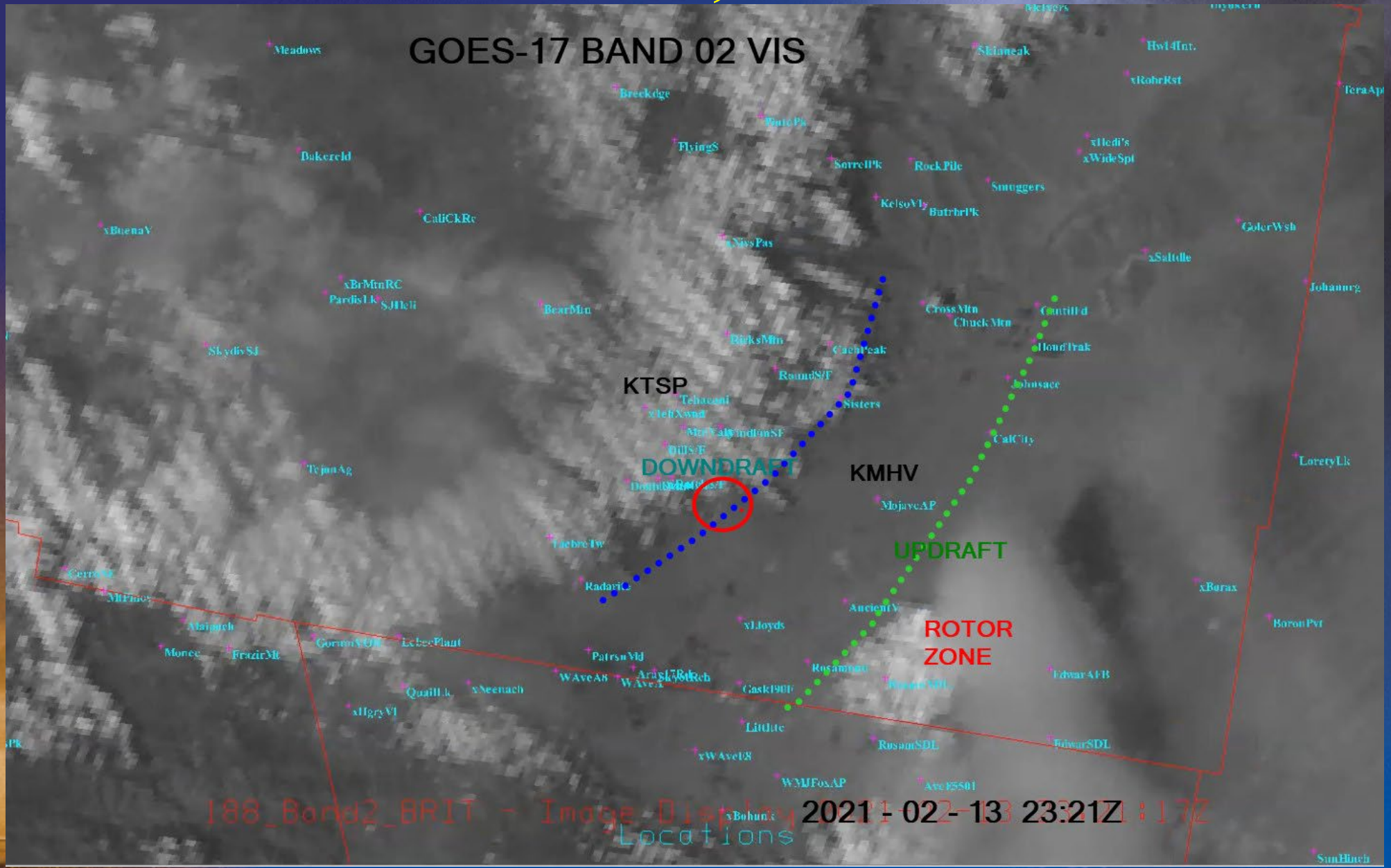
gating MW

ce of mountains peaks

kts at 7300 msl – Skysight WRF

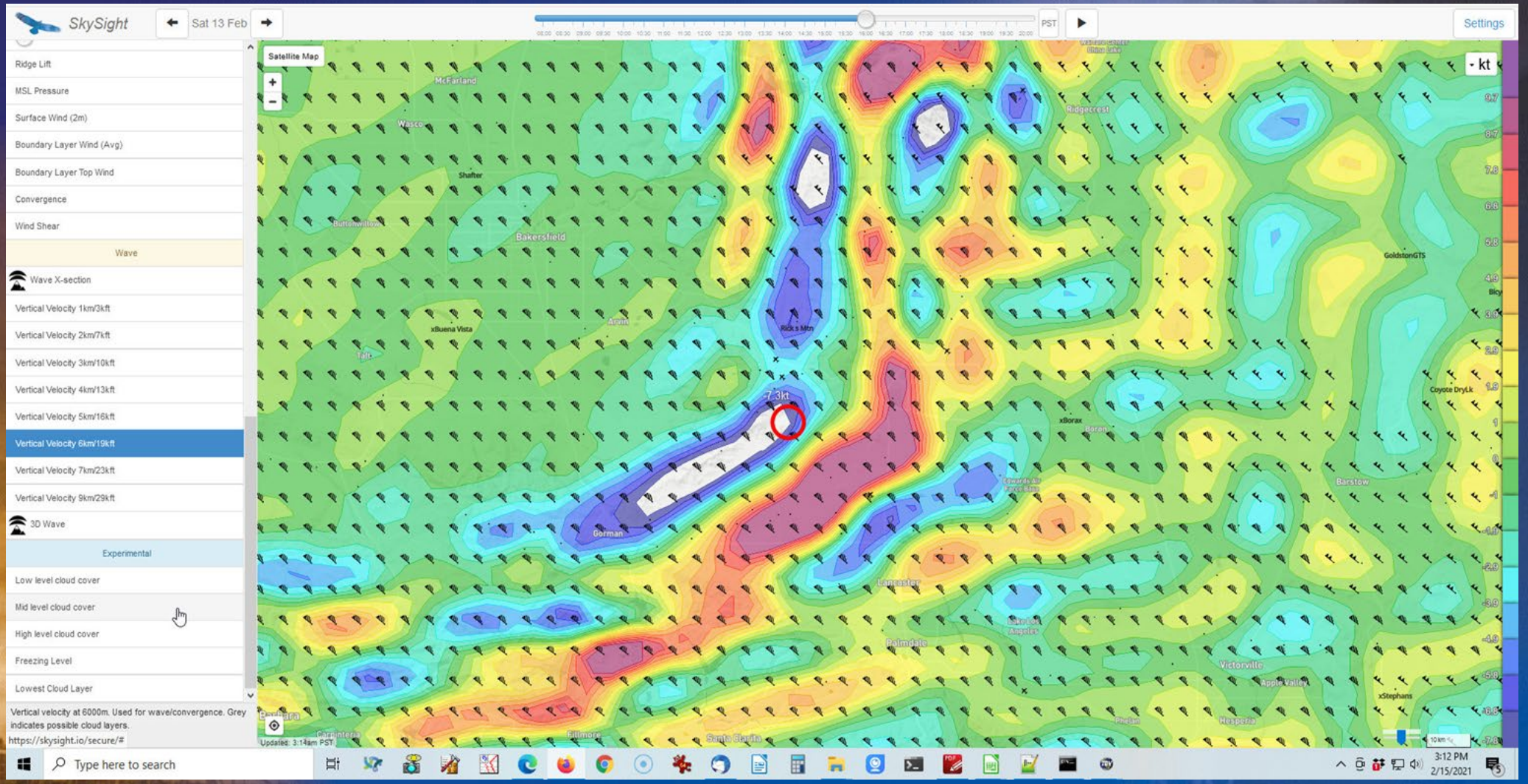
timated 50+ kts

Piper Malibu Accident
Feb 13, 2021

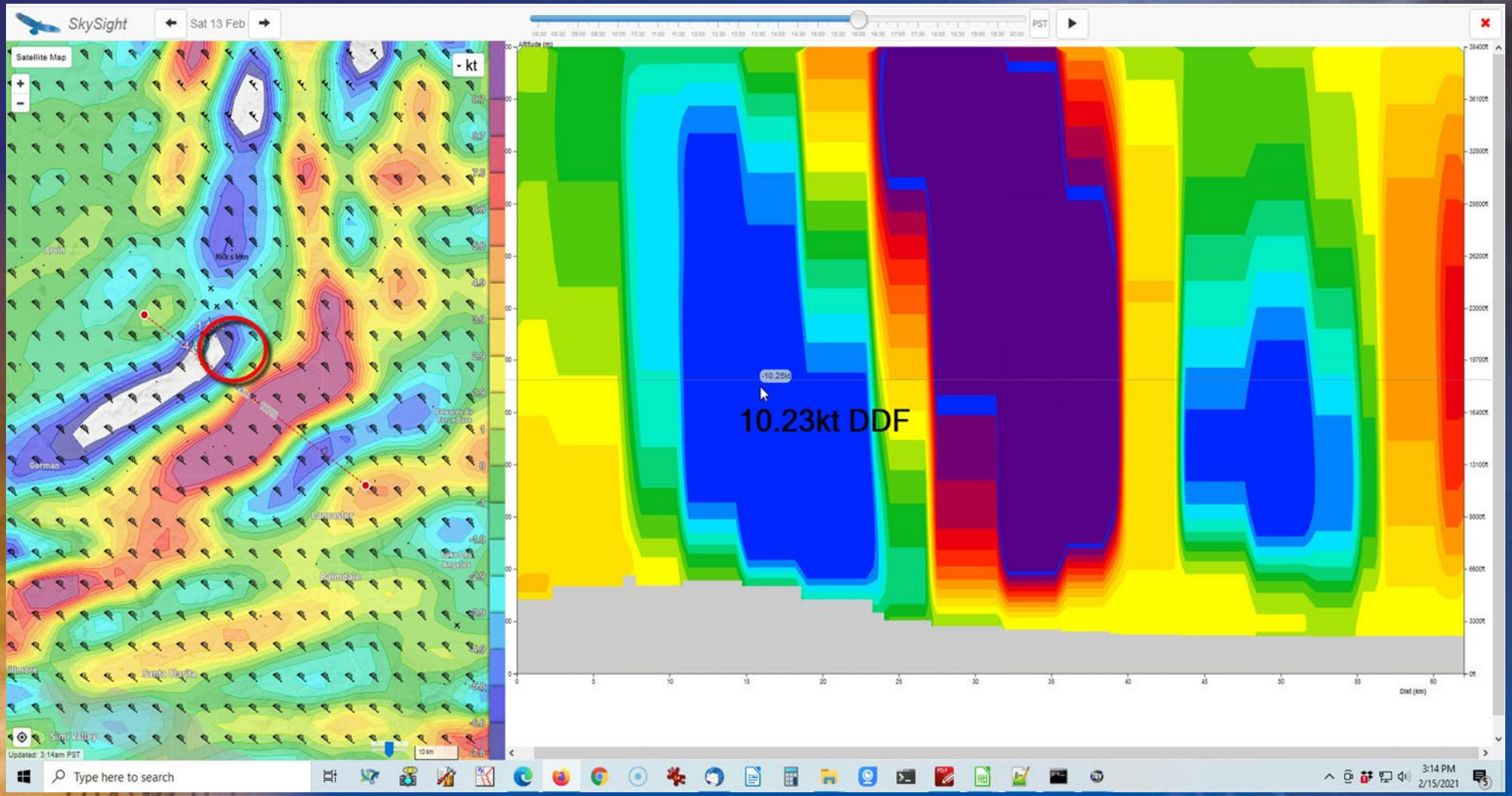


Piper Malibu Accident
Feb 13, 2021

6000meter Winds NW 85kts – Skysight 1600 PST



Piper Malibu Accident
Feb 13, 2021



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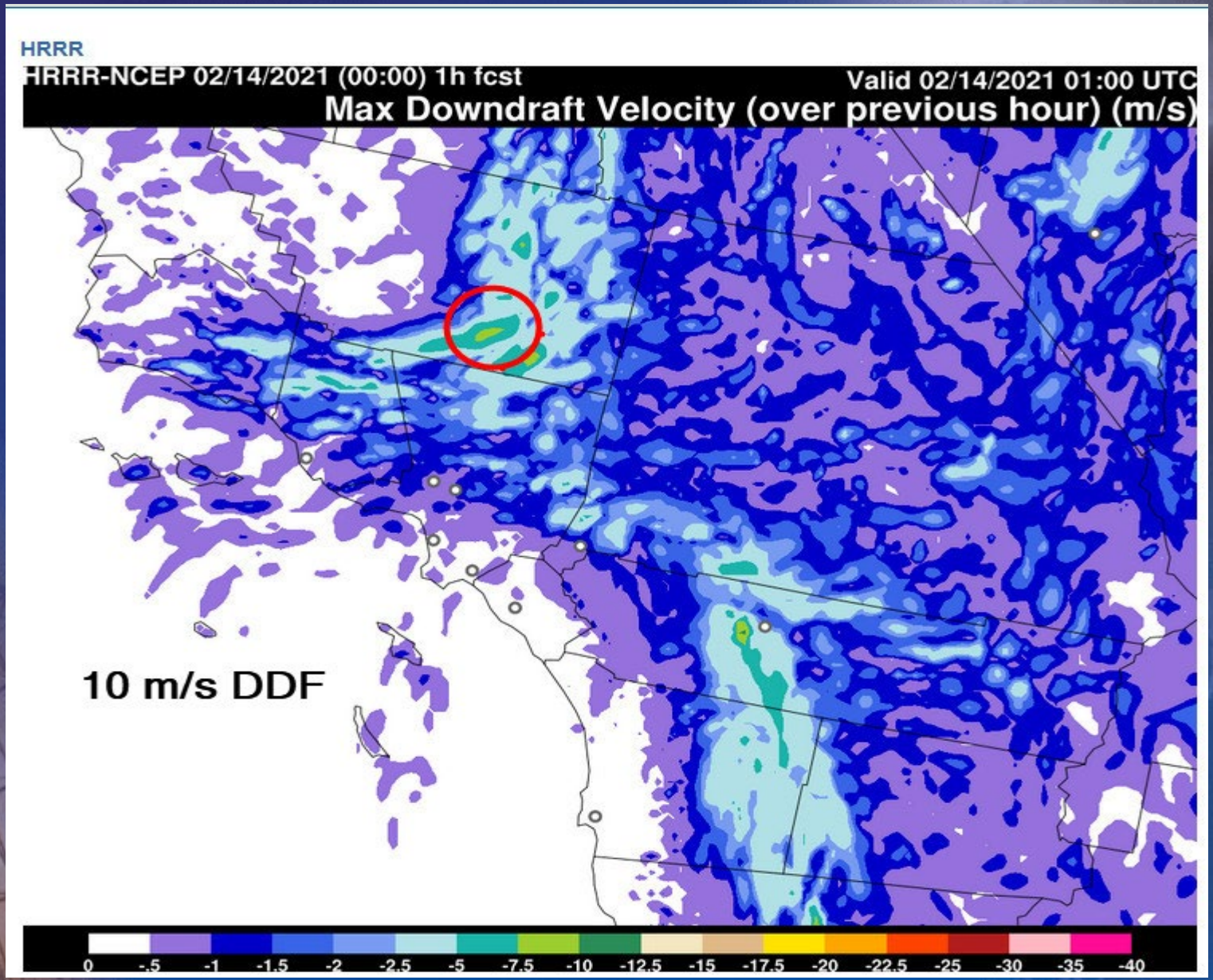
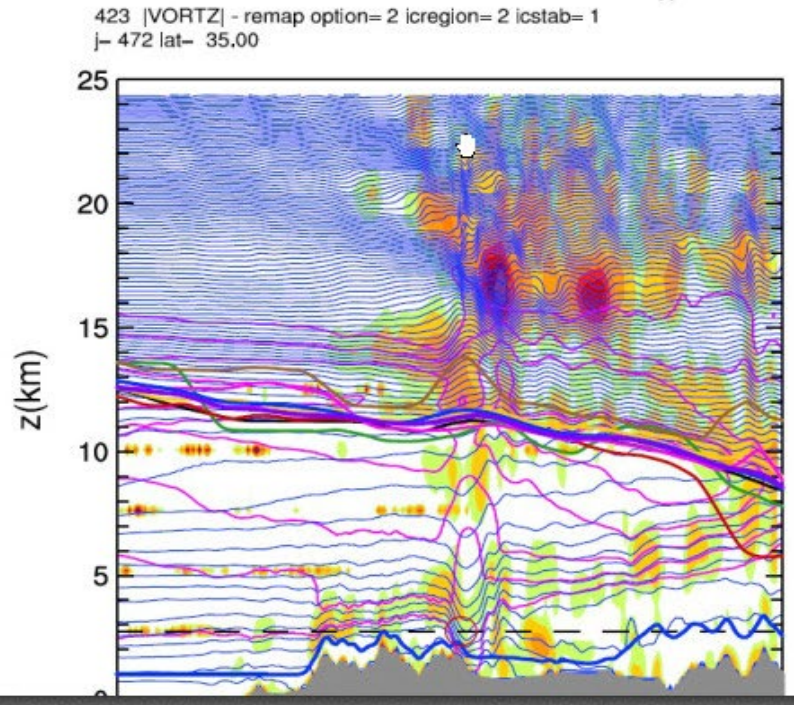
Feb 13, 2021

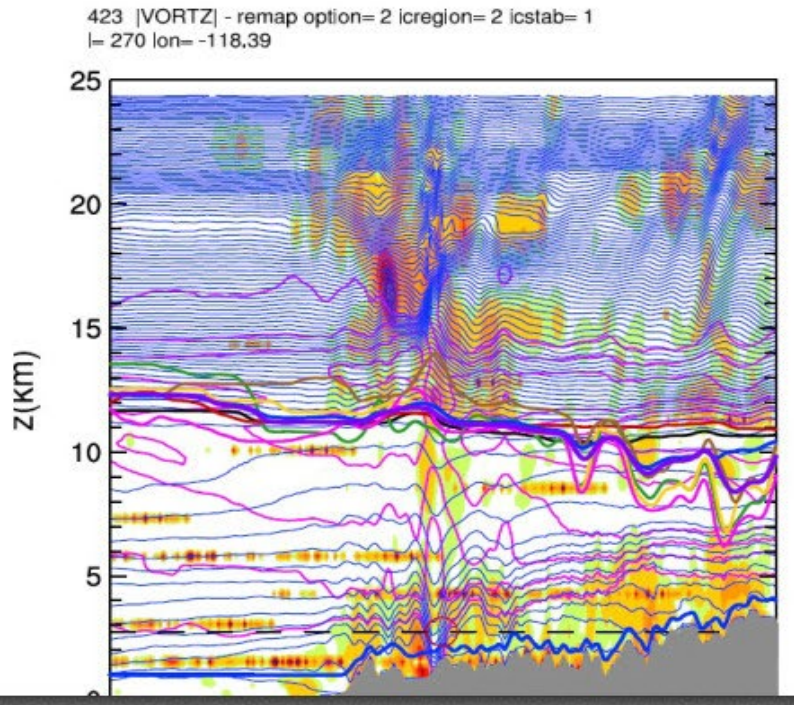


Piper Malibu Accident
Feb 13, 2021

HRRR vertical vorticity magnitude cross sections

- W-E cross section thru accident location (left) shows strong wave in vicinity of accident that propagates to very high levels. Shown are boundary layer height (thick blue), terrain (grey), various measures of tropopause height, isentropes (light blue) and wind speed (magenta).
- S-N cross section thru accident location (right)
- Note small wavelength disturbances of unclear origin (mainly upstream)





SUMMARY

The identification of imminent or existing MWA is critical because of the adv

draft accident fatalities for GA and business aircraft
occur

on of MWA remains challenging for pilots with the
ervations and tools available

chieving records have long understood MWA
nd been able to utilize vertical motion for extending

CONCLUSION

Thank you...

Walter Rogers

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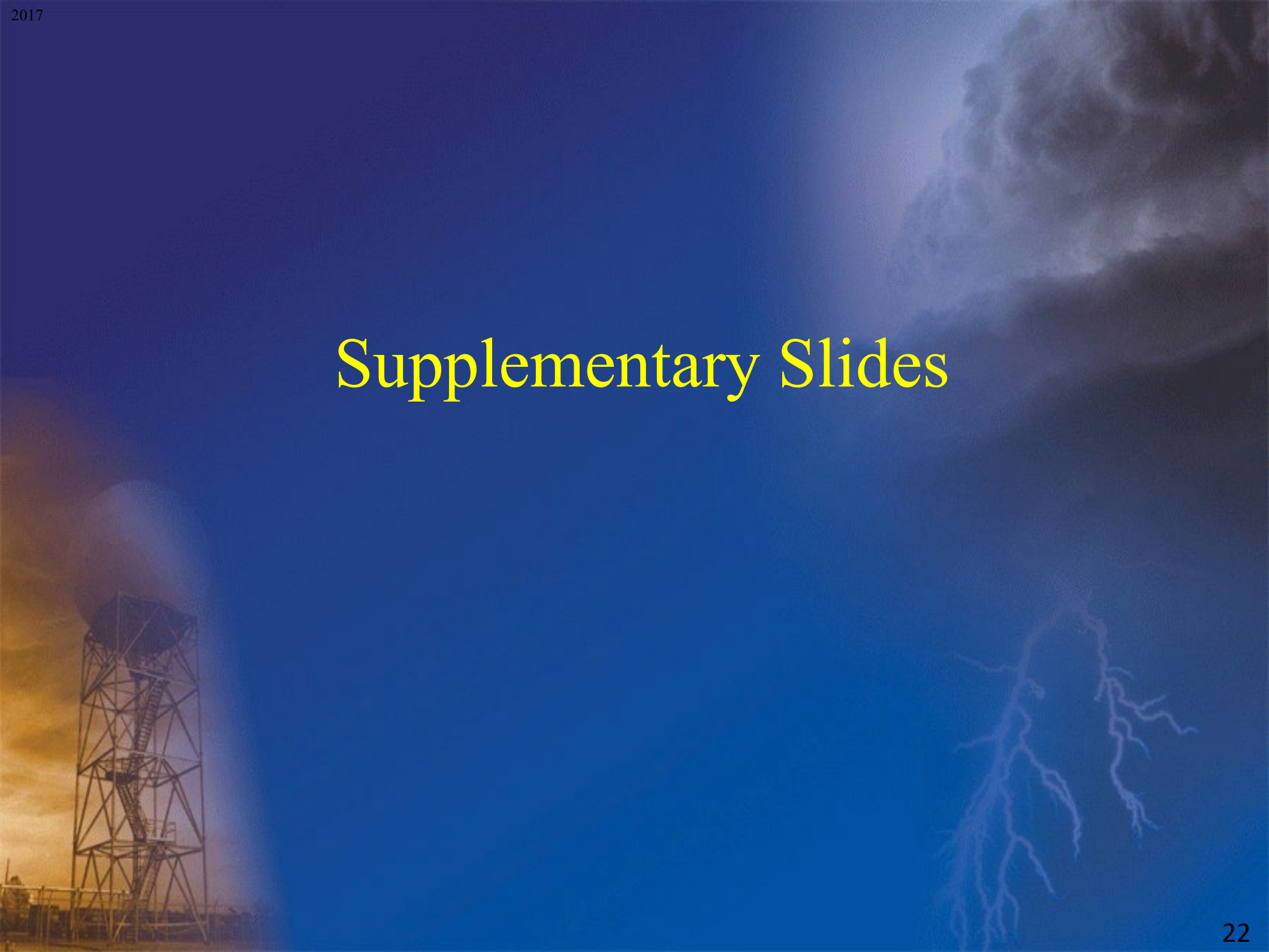
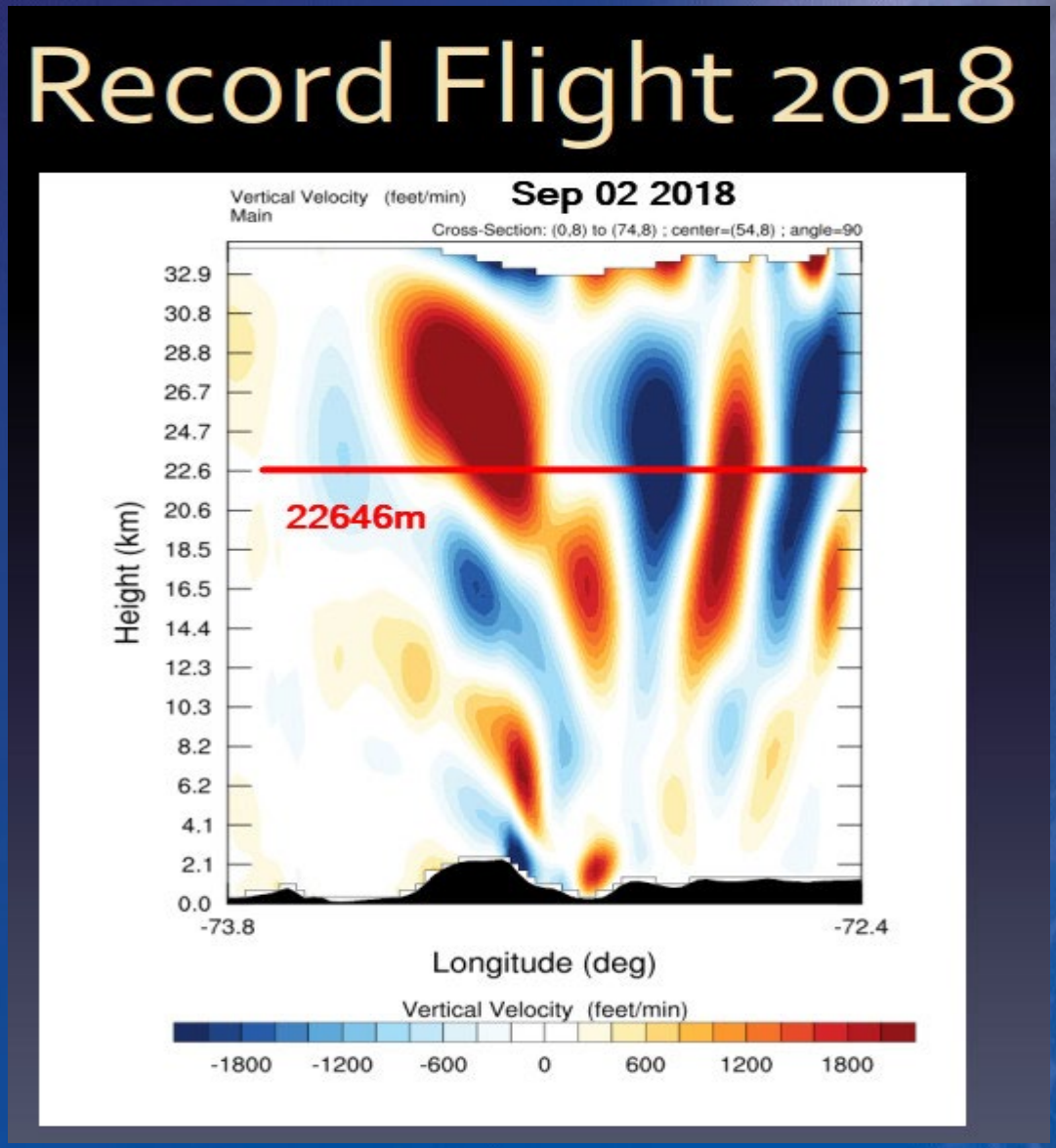


Supplementary Slides

Supplementary Slides
Perlan – WRF Vert Velocity



Supplementary Slides
Perlan – Radiosonde Sep2 2018