Preparations for High Altitude Wave Flights

Keith Schwab

schwabkeith@protonmail.com

12 Jan 2021

Flying Bio

Started flying in 10/2014

Trained at Crystal (Southern California Soaring Academy, Llano, CA)

Solo 6/2015
Check ride 6/2016
Purchased N303DG (DG303, 1996) 4/2017

First cross country flight in Sierra 6/2017

Gold Badge #2745 7/2017

Diamond Badge #1064 11/2017

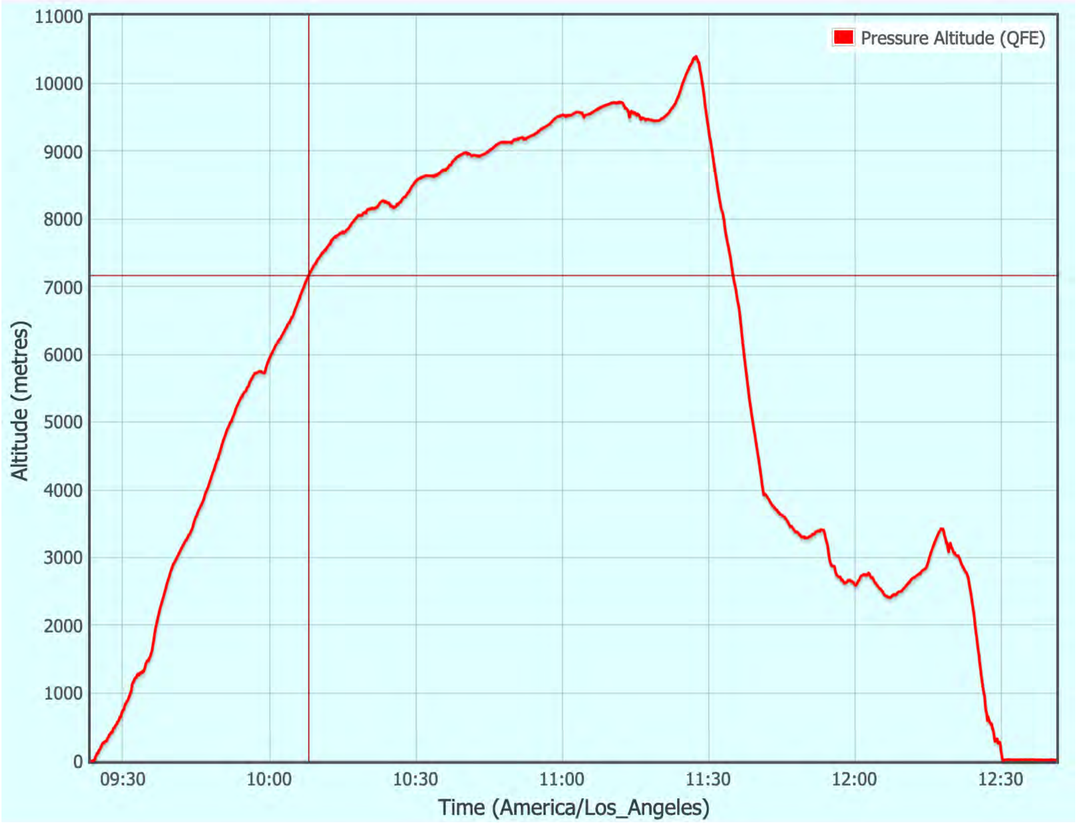
Symons Memorial Award
- Single Lennie #1949 9/2018
- Double Lennie #128 12/2020

As of 1/2021: 300 hrs, 280 flights

17 Dec 2020
KIYK (Inyokern)

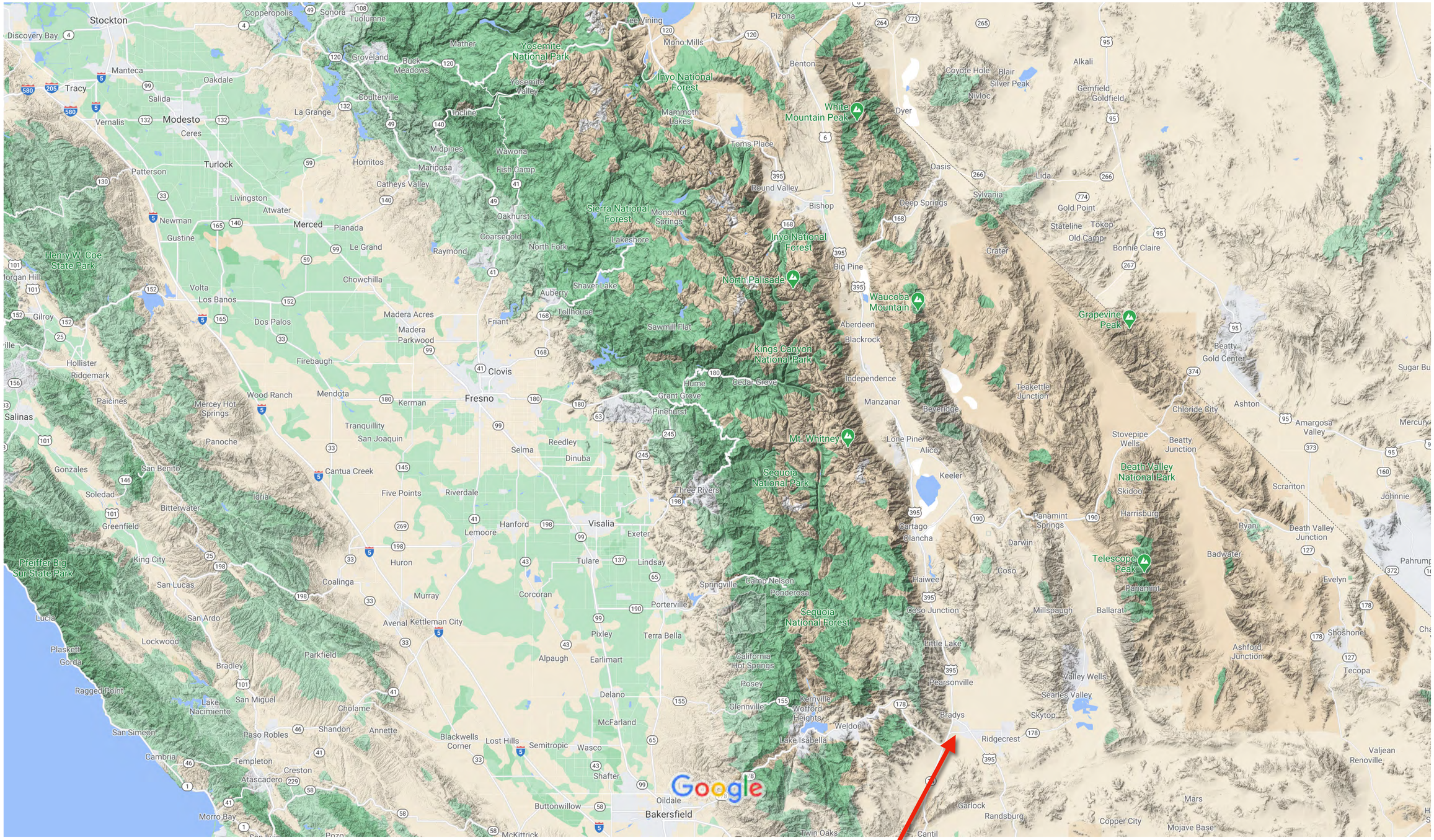
flight time 3 hrs
36,630 ft max altitude

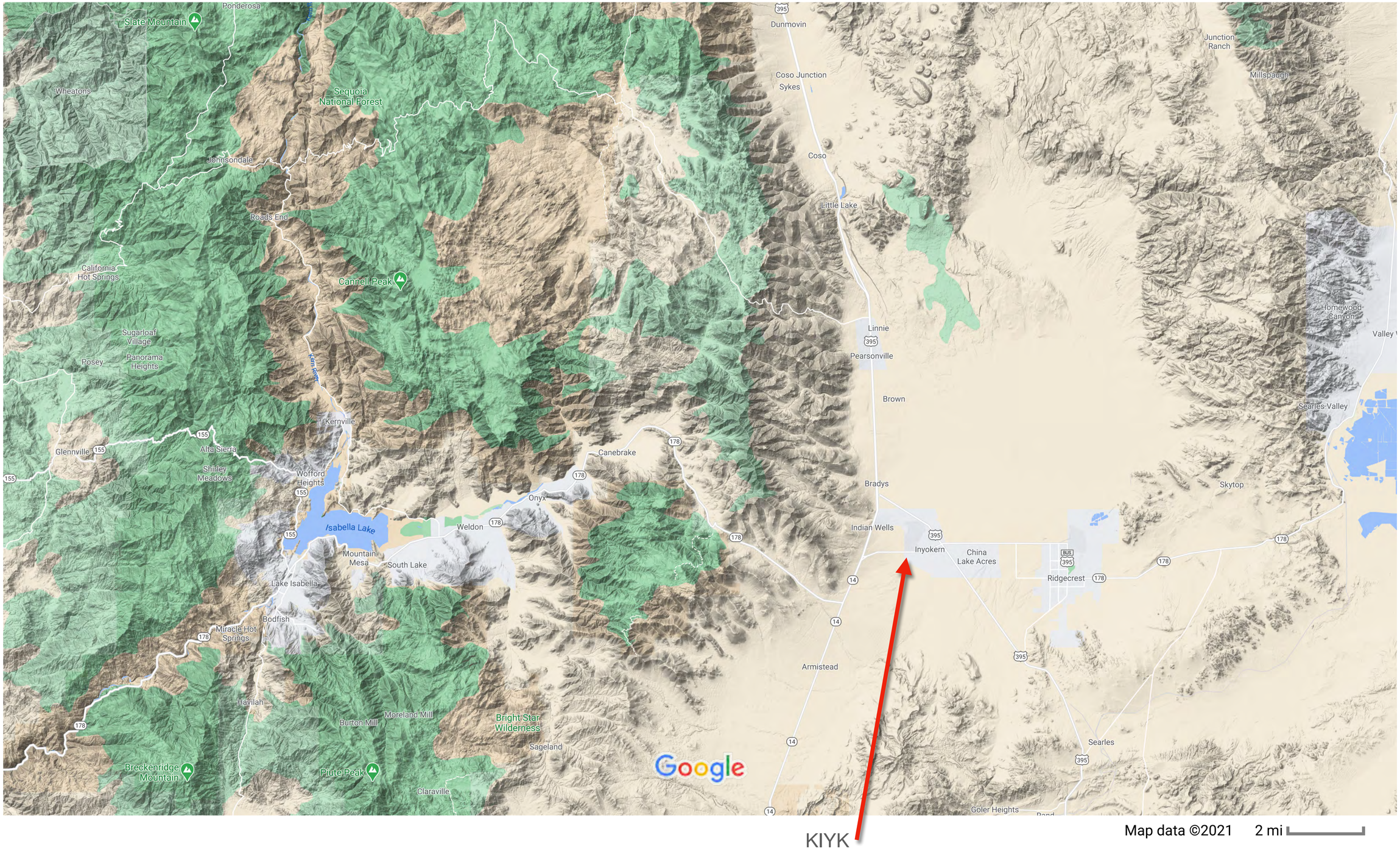
Symons Wave Memorial Award
Double Lennie #128

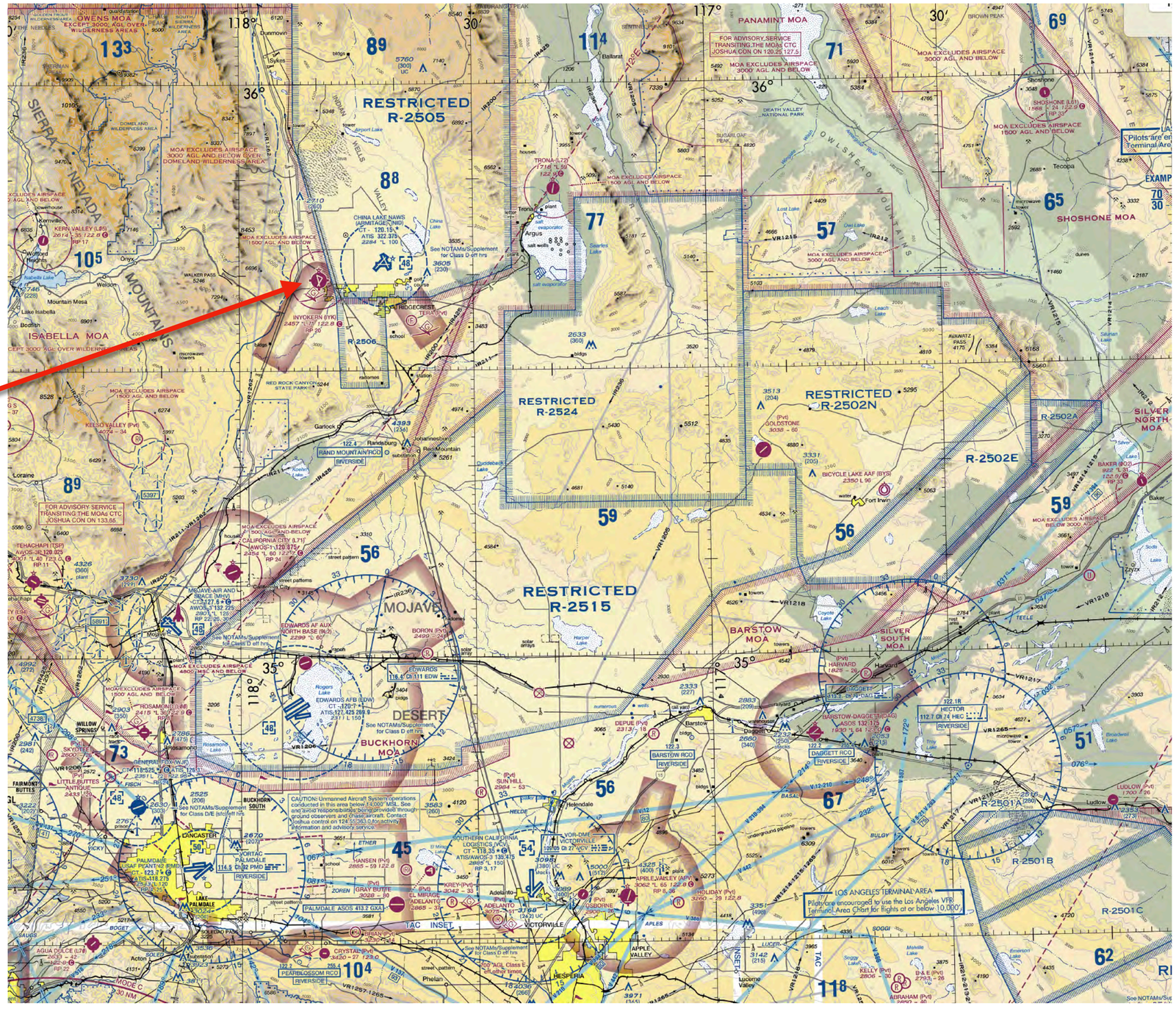


Altitude vs Time

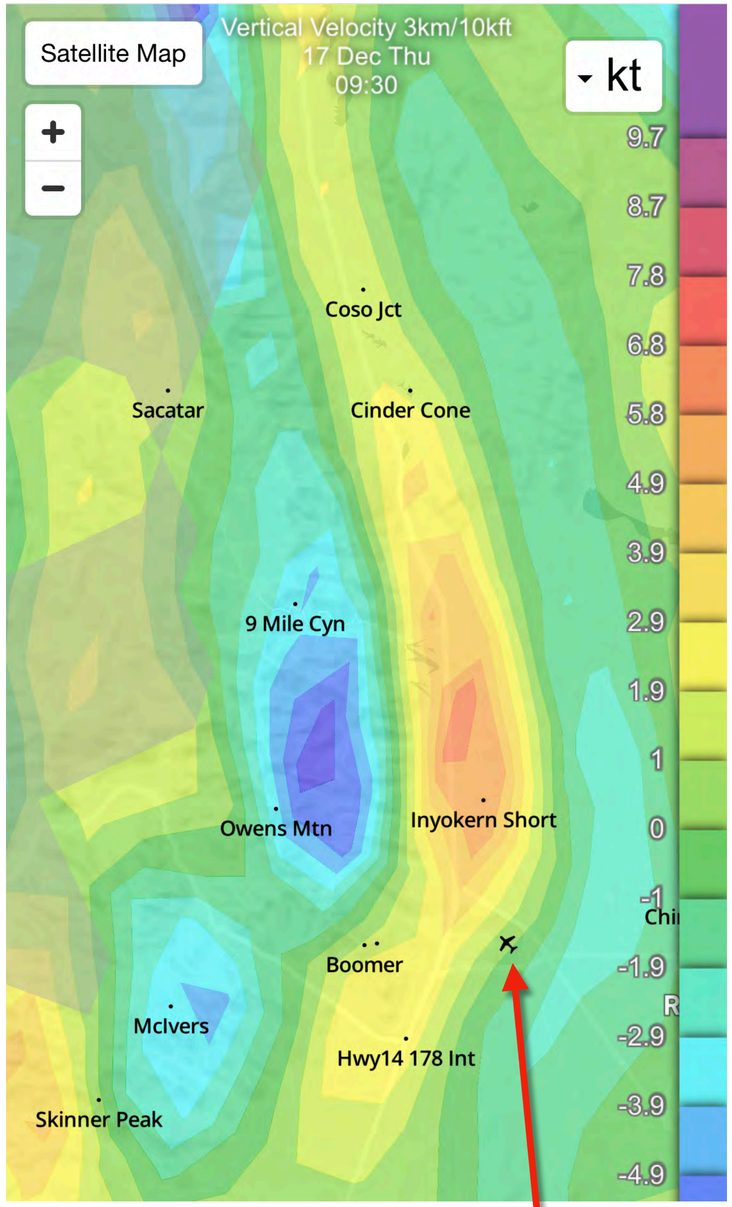
Bonehead Comm-it helmet, MBU-20/p mask, canopy frost shield


Stockton
Modesto
Tracy
Manteca
Turlock
Merced
Fresno
Clovis
Visalia
Bakersfield
Yosemite National Park
Inyo National Forest
Sierra National Forest
Kings Canyon National Park
Sequoia National Forest
Death Valley National Park
White Mountain Peak
North Palisade
Waucoba Mountain
Grapevine Peak
Mt. Whitney
Telescope Peak
KIYK
Google
Map data ©2021 Google
10 mi


Slate Mountain
Ponderosa
Wheatons
Sequoia National Forest
Johnsondale
Roads End
California Hot Springs
Cannell Peak
Sugarloaf Village
Posey
Panorama Heights
Kern River
Kernville
Glennville
Alta Sierra
Shirley Meadows
Wofford Heights
Isabella Lake
Mountain Mesa
South Lake
Lake Isabella
Bodfish
Miracle Hot Springs
Havilah
Moreland Mill
Burton Mill
Bright Star Wilderness
Sageland
Breckenridge Mountain
Piute Peak
Claraville
Canebrake
Onyx
Weldon
Dunmovin
Coso Junction
Sykes
Coso
Little Lake
Linnie
Pearsonville
Brown
Bradys
Indian Wells
Inyokern
China Lake Acres
Ridgecrest
Armistead
Searles
Goler Heights
Junction Ranch
Millspaugh
Homewood Canyon
Searles Valley
Skytop
Google
KIYK
Map data ©2021
2 mi

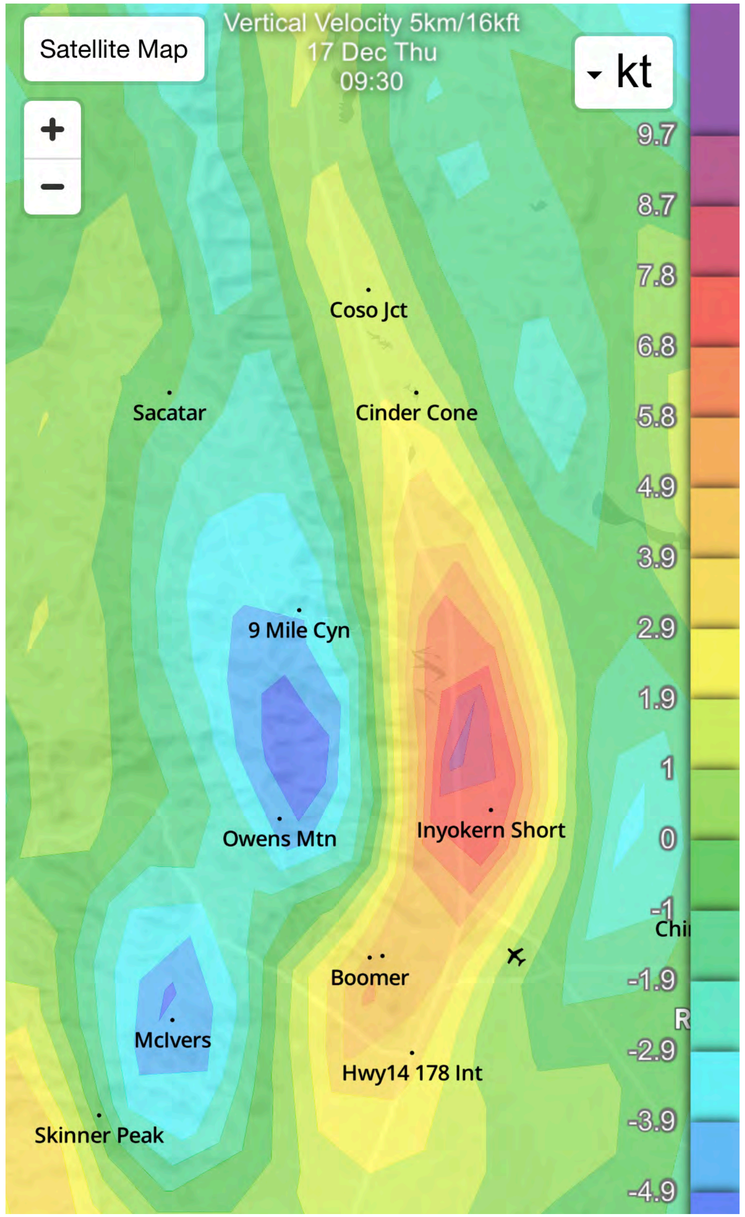

KIYK
RESTRICTED R-2505
RESTRICTED R-2524
RESTRICTED R-2502N
RESTRICTED R-2515
R-2506
R-2502E
R-2502A
R-2501A
R-2501B
R-2501C
PANAMINT MOA
OWENS MOA
ISABELLA MOA
SHOSHONE MOA
SILVER NORTH MOA
SILVER SOUTH MOA
BARSTOW MOA
MOJAVE
DESERT
BUCKHORN MOA
INYOKERN (IYK)
TRONA (TRM)
RAND MOUNTAIN (RCO)
EDWARDS AFB (EDW)
BARSTOW-DAGGETT (DAG)
VICTORVILLE
TAC INSET
LOS ANGELES TERMINAL AREA

Skysight Forecast

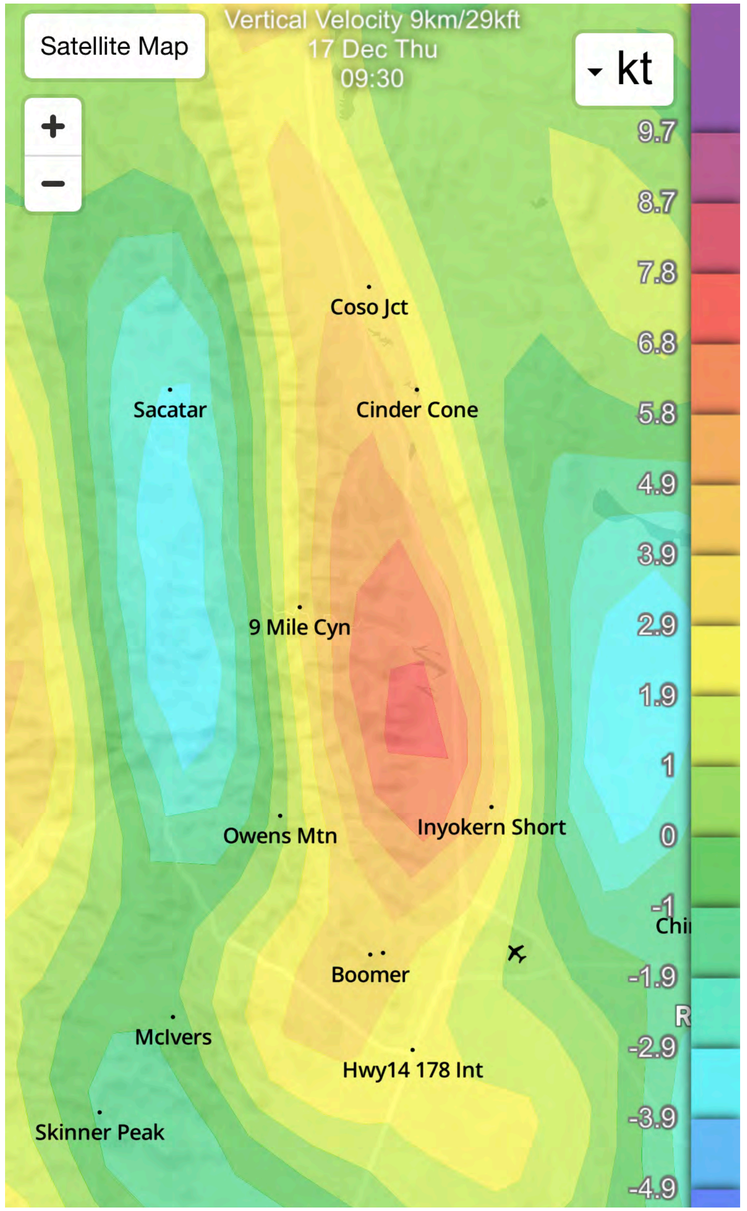


10,000’ 9:30am

KIYK



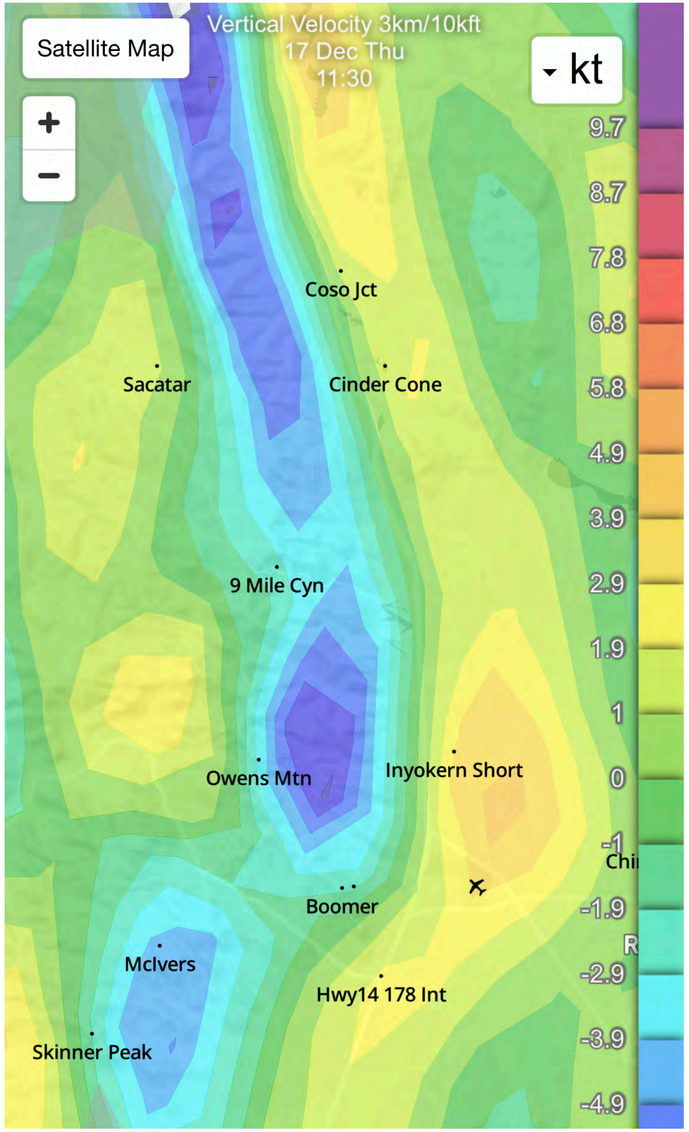
16,000’ 9:30am



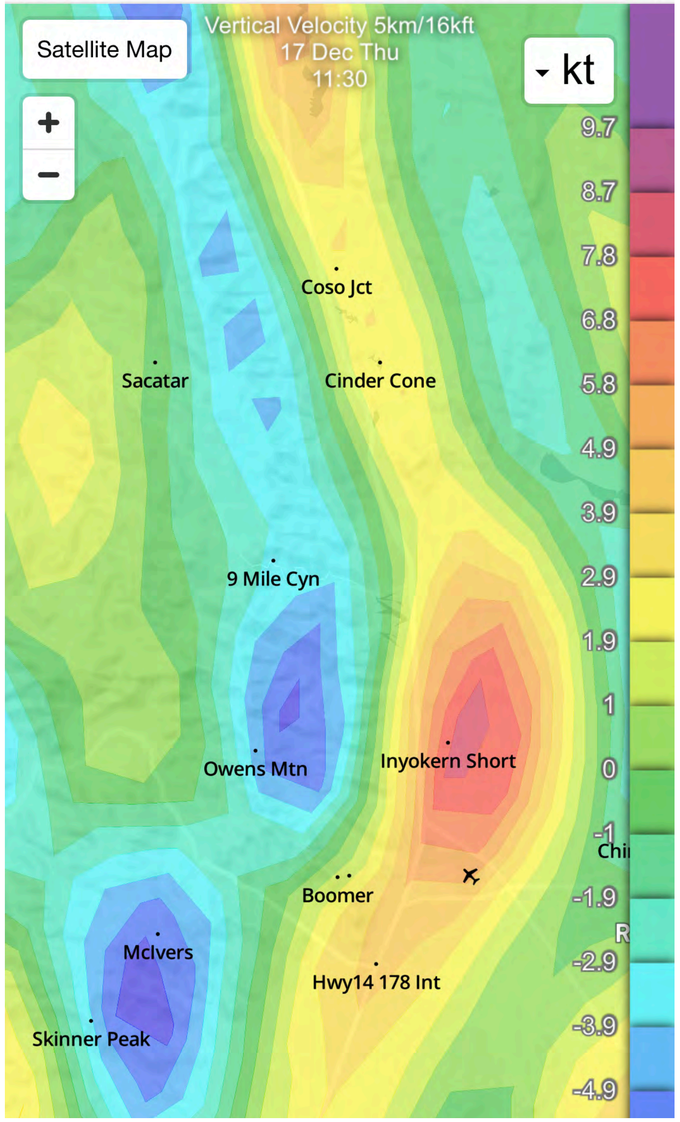
29,000’ 9:30am

Skysight Forecast

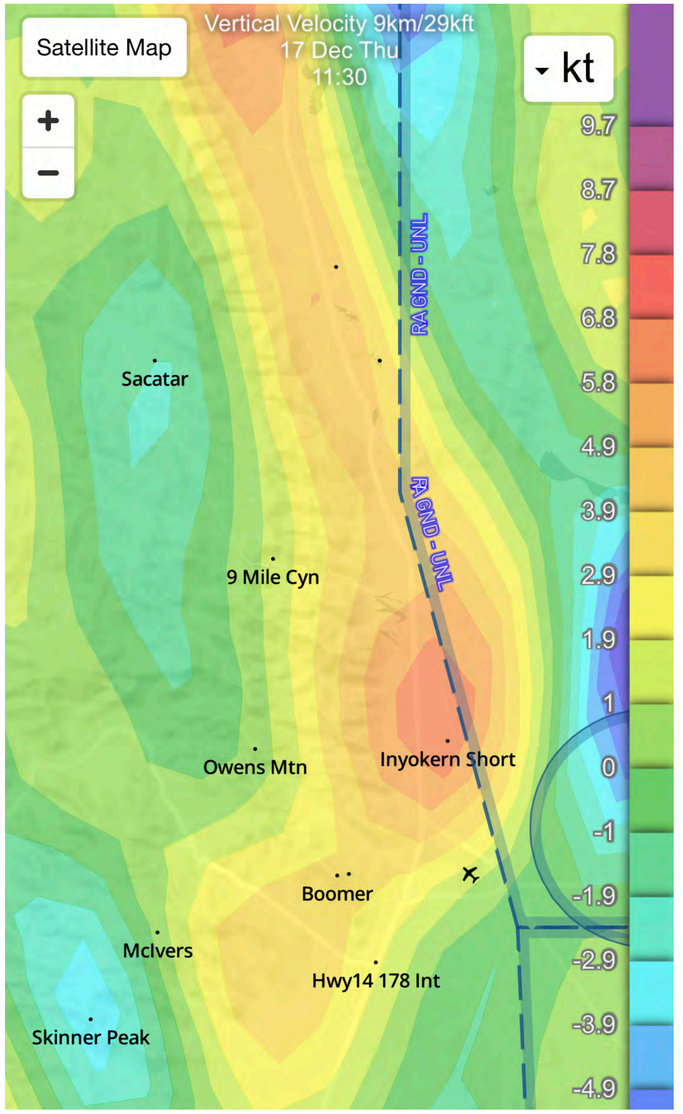
R2506 Airspace - China Lake



10,000’ 11:30am



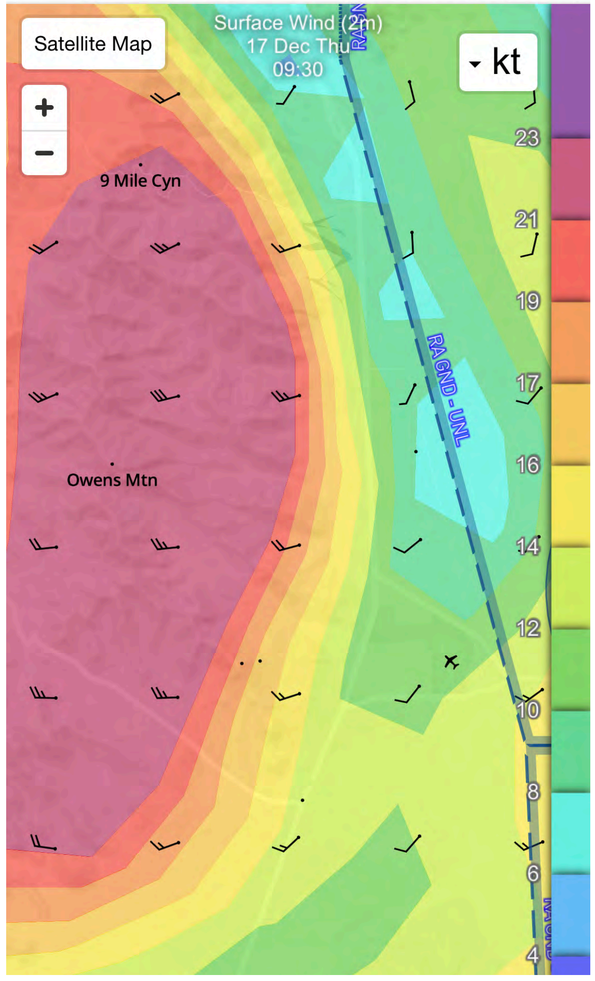
16,000’ 11:30am



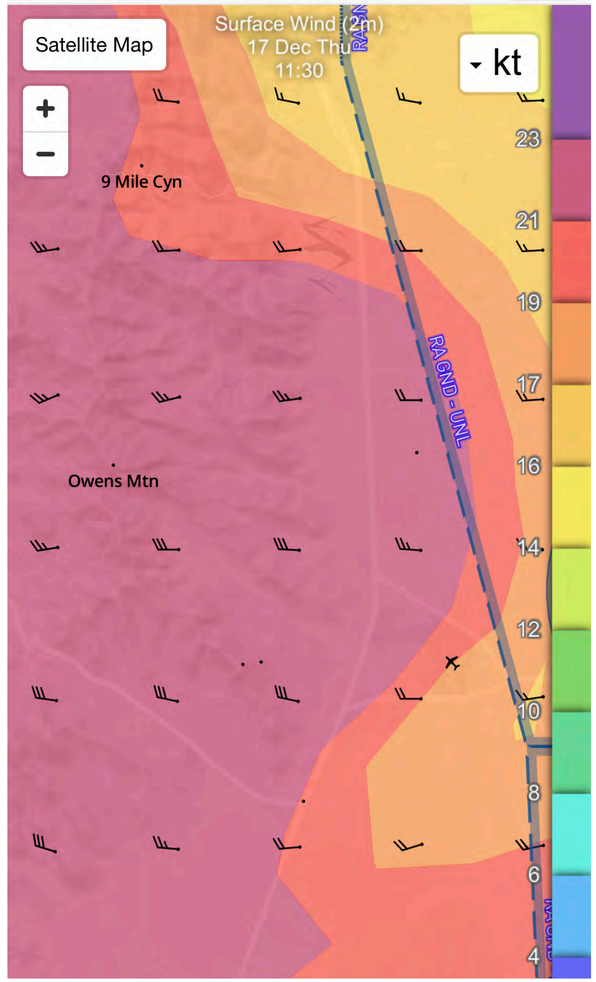
29,000’ 11:30am

Skysight Forecast

Surface Winds

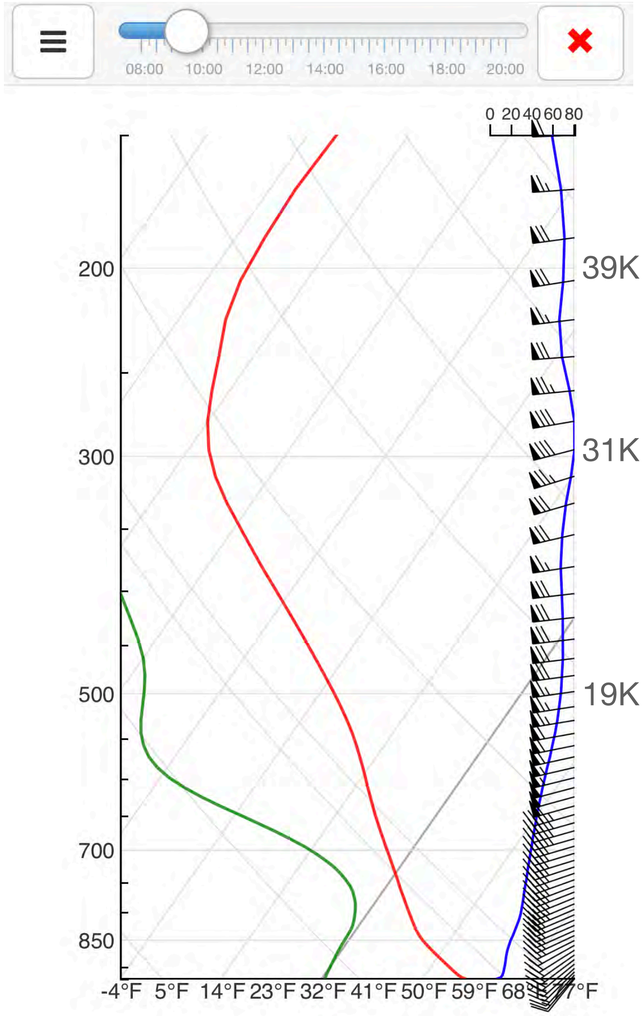


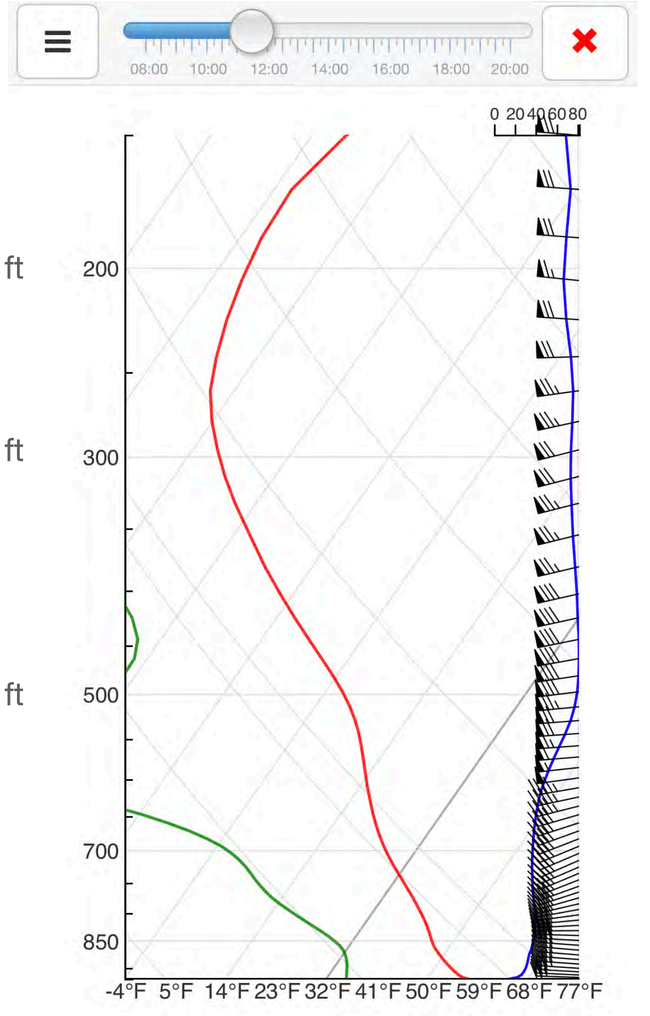
Surface Winds at 9:30am



Surface Winds at 11:30am

Skew-T





Effective Performance Time and the *Time of Useful Consciousness* are two broad and interchangeable terms used to describe the time/hypoxia limit. **Time of Useful Consciousness (TUC)** is described as the period of time from interruption of the oxygen supply or exposure to an oxygen-poor environment to the time when an individual is no longer capable of taking proper corrective and protective action. **Effective Performance Time (EPT)** is described as the amount of time an individual is able to perform flying duties efficiently in an environment with inadequate oxygen supply. The following table will show the TUC/EPT for various altitudes:

ALTITUDE	TUC/EPT
18,000	20 - 30 Min
22,000	10 Min
25,000	3 - 5 Min
28,000	2.5 - 3 Min
30,000	1 - 2 Min
35,000	.5 - 1 Min
40,000	15 - 20 Sec
43,000	9 - 12 Sec
50,000	9 - 12 Sec

(TABLE 9)

OXYGEN REQUIREMENTS

AIRCRAFT ALTITUDE in feet	BAROM. PRESS mm Hg	BODY H2O PRESS. mm Hg	TRACH. PRESS mm Hg	%O2 INSP. AIR	TRACH. PRESS. pO2	AVEOLAR pCO2 / pO2 mm Hg	%O2 SAT. Hb.	% SUPPLEM. O2 REQUIR. INSP. AIR	TRACH. PRESS. pO2	%O2 SAT. Hb.
SEA LEVEL	760	47	713	.21	149	40 / 103	96%	21%	149mm	96%
5000	632	47	585	.21	122	38 / 78	94%	25%	149mm	96%
10,000	523	47	476	.21	100	36 / 61	90%	31%	149mm	96%
15,000	429	47	382	.21	80	33 / 46	70%	40%	149mm	96%
20,000	349	47	302	.21	63	30 / 33	62%	49%	149mm	96%
25,000	282	47	235	.21	49			63%	149mm	96%
				TOTALLY INADEQUATE FOR METABOLIC REQUIREMENT						
30,000	225	47	178	100%	37	40 / 103	96%	84%	149mm	96%
35,000	179	47	132	100%	28	39 / 93	95%	100%	132mm	95%
40,000	141	47	94	100%	20	35 / 59	87%	100%	94mm	87%
PRESSURE/DILUTER DEMAND OXYGEN EQUIPMENT										
40,000	141	47	94	.21	20	INADEQUATE				
				(x 1.00)	94	35 / 59	87%	100%	94mm	87%
				(+ 8mm Hg)	102	36 / 66	92%	100% + PP	102mm	92%
42,000	128	47	81	.21	17	INADEQUATE				
				(x 1.00)	81	33 / 48	71%	100%	81mm	
				(+ 16mm Hg)	97	36 / 61	90%	100% + PP	97mm	90%
45,000	111	47	64	.21	13	INADEQUATE				
				(x 1.00)	64	30 / 34	62%	100%	64mm	
				(+ 33mm Hg)	97	36 / 61	90%	100% + PP	97mm	90%
50,000	87									

Note: Breathing pure 02 at ambient pressure give blood 87% 02sat at 40,000 ft

Note: above 40,000 ft one needs pressure breathing to keep %02sat high and safe.

TABLE 3

ALTITUDES FOR EQUIVALENT ARTERIAL OXYGEN SATURATION WHEN BREATHING AIR, OXYGEN, AND OXYGEN UNDER PRESSURE*

Arterial O_2 Saturation	Breathing Air	Breathing O_2 (10% mask leak)**	Breathing O_2 (no leak)	Pressure Breathing O_2	Pressure (inches water)
95%	3,000 ft.	33,000 ft.	35,000 ft.	38,000 ft.	2
90%	10,000 ft.	37,500 ft.	40,000 ft.	42,000 ft.	4
85%	13,000 ft.	39,000 ft.	41,500 ft.	44,500 ft.	8
80%	15,000 ft.	40,000 ft.	42,500 ft.	45,500 ft.	8
75%	17,000 ft.	41,000 ft.	43,500 ft.	46,000 ft.	8
70%	18,000 ft.	41,500 ft.	44,000 ft.	49,000 ft.	12

* The figures in this table are combined from calculated and observed data.[6]

** Assuming that leaks up to 10% are to be expected with the simple demand system, the use of pressure breathing raises the ceiling from 4-5000 feet before serious anoxia begins to set in. In producing this result, the elimination of the effects of mask leakage is at least as important as the increase in alveolar O_2 tension.

"Pressure Breathing," AP Gagge, et al., J Aviat Med, (1945).

Note: at and above 44,500 ft even pressure breathing is not able to keep blood oxygen above 90%.

Look how rapidly blood 02 is dropping as you go just 1000ft higher: at 45,500 ft blood 02 drops to 80%, another 500 ft higher to 46,000 ft 02 drops to 75% saturation.

In my opinion, 42,000 ft with pressure breathing, yielding 90% 02 saturation is the max safe altitude.

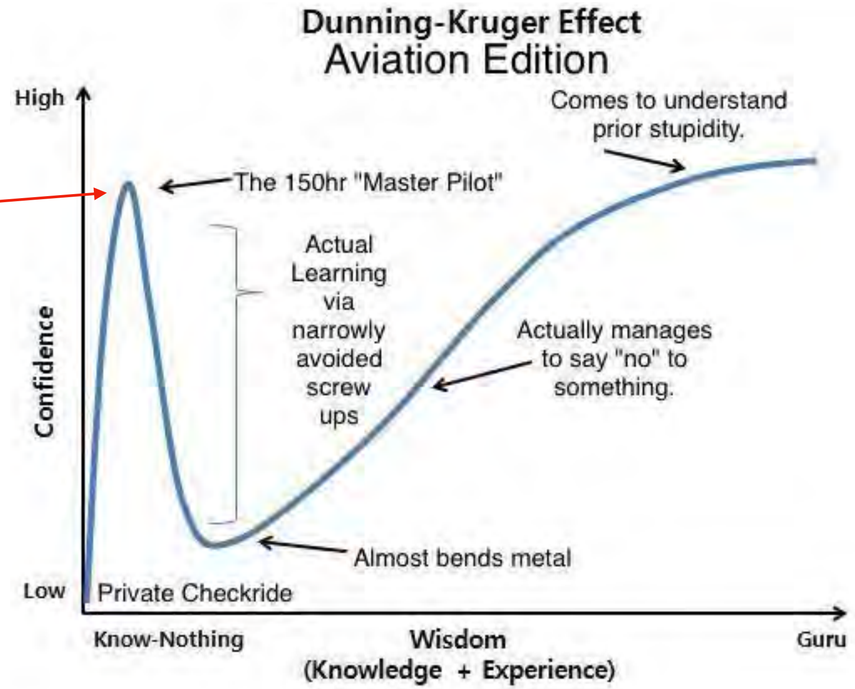
This is a dangerous activity with possible fatal consequences.

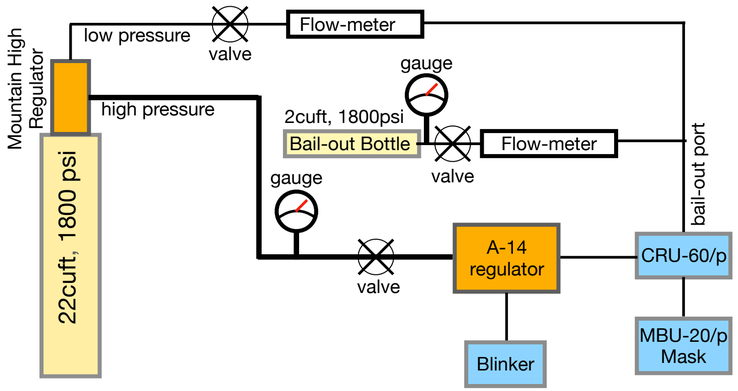
High altitudes are an unforgiving environment.

Carefully think about what you are doing.

Is this risk worthwhile? (“no” is a respectable answer)

Challenge is to get over “Mt. Stupid” alive.





Oxygen circuit: A-14, with fixed-flow and bail-out bottle for backup.

Decision tree:

If blood 02 sufficiently saturated and pressure in main 02 tank is OK, then use A-14 system, continue ascent.

If A-14 is failing and main 02 tank is OK, then switch OFF A-14 valve and switch ON fixed flow valve. Rapid descent.

If A-14 is failing and main 02 tank is not OK, then switch OFF A-14 valve and switch ON bail-out bottle valve. Rapid descent.


DILUTER DEMAND OXYGEN REGULATOR
PRESSURE BREATHING
NORMAL
WITH
NORMAL OXYGEN
100% OXYGEN
OXYGEN,
COMPRESSED
AVIATOR BREATHING
UN 1072
Distributed by:
AEROX AVIATION OXYGEN SYST
25190 BERNWOOD DRIVE
BONITA SPRINGS, FLORIDA
207-637-2331
NEXT REQUIRED DOT
HYDROSTATIC TEST DUE
WARNING
HIGH PRESSURE OXIDIZING
VIGOROUSLY ACCELERATES
KEEP OIL AND GREASE AWAY. USE ON
MENT DESIGNED FOR AND CO MPATIBL
AND RATED FOR CYLINDER PRESSUR
AFTER EACH USE. KEEP AWAY FROM

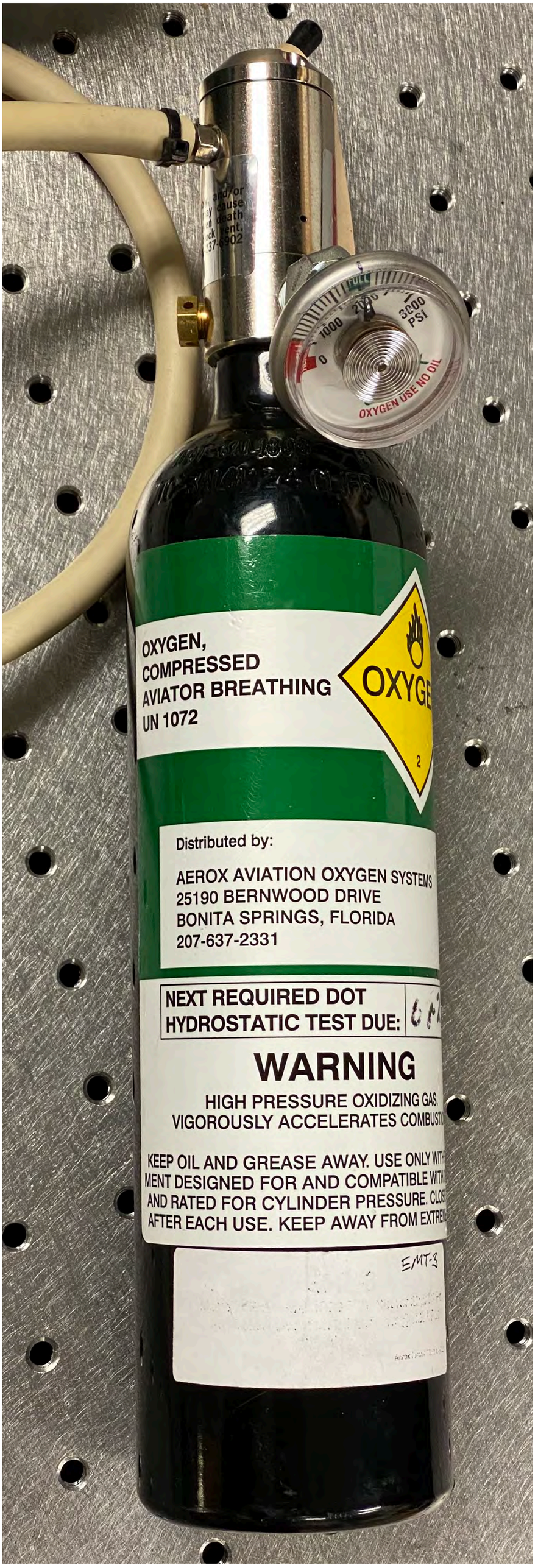
A-14, Fluid Power Inc, (Hudson Ohio)

Blinker (Oxygen Flow Indicator)

A-14, high pressure hose, valve, and gauge installed in glider.

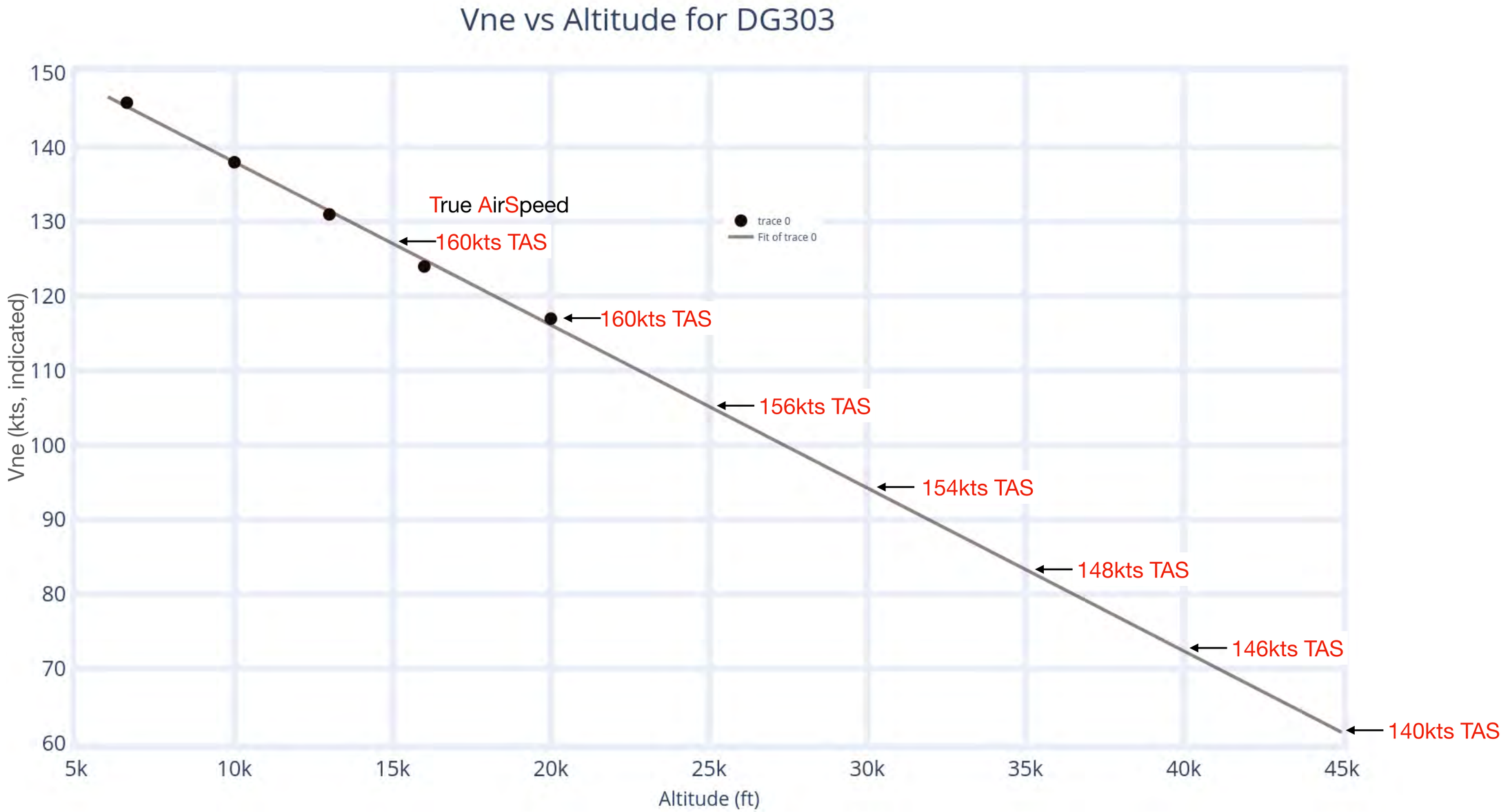
CRU-60/p

MBU-20/p mask, Gentex, PA-101 microphone interface



Bail-out bottle, EMT-3m Aerox Aviation Oxygen System

Frost Shield: 1/16” thick polycarbonate, sealed against canopy with weather stripping.


Vne vs Altitude for DG303
Vne (kts, indicated)
150
140
130
120
110
100
90
80
70
60
5k
10k
15k
20k
25k
30k
35k
40k
45k
Altitude (ft)
trace 0
Fit of trace 0
True AirSpeed
160kts TAS
160kts TAS
156kts TAS
154kts TAS
148kts TAS
146kts TAS
140kts TAS

What issues did I have?

Major

Stick became very stiff above ~30,000 ft

-frozen grease?

-A&P says that white lithium grease ages, degrades, and dries out from paste to white powder.

-considering taking apart control mechanisms and regressing with Molykote 33

-considering spraying inaccessible mechanisms with Molykote D321

-possible binding due to thermal contraction between metallic control mechanisms and composite glider?

No response from DG when asked if they had any information

(they apparently will not answer email requests unless you pay for a maintenance subscription—very classy)

Minor

Flight computer (OUDIE IGC) was not setup properly, could not see trail marked with lift/sink

-I probably wasted 30-45min in weak lift, one should minimize time to minimize risk.

How accurate is pressure gauge which is calibrated at room temperature and then taken to -70F?

does the zero of the gauge change? replacing this with gauge known to be unaffected to -65F.

What about any o-rings in the oxygen system…are they rated for low temperatures?

-buna-n is rated to -30F

-fluorosilicone o-rings are rate to -80F

Sole heaters would have been helpful. Temperature at 40,000 ft was recently shown to be -95F

I was surprised by difficulty to exhale when MBU-12/p or MBU-20/p mask is fed with fixed flow system.

Test this yourself.

Be prepared to put a finger under the mask to exhale.

A Double Lennie Flight is a community achievement

Flight instruction
- Southern California Soaring Academy
- Dale Masters CFIG
- Stewart Ayote CFGI

Advice on purchase of ship
- Michael Marshall

Cross country mentorship and community
- Sierra Soaring Club
- Tehachapi-Skylark North
- Michael Marshall
- Tom Serkowski
- Britton Bluedorn

Advice on oxygen system
- Britton Bluedorn
- Jim Payne

Tow Pilots
- Mike Malis
- Justin Inman
- Jeff Montgomery

Ground support on day of flight
- Matthias Bastler

Britton Bluedorn and myself after the flight, (17 Dec 2020, Inyokern, CA)

For more details, manufacturers, part selection, part numbers, etc:
https://kschwabresearch.com/wave-notes