Forecasting Gliding FAI Records and FlightTest

SAWS X   - Feb 21, 2023
Rancho Cucomonga, CA

Walter Rogers "WX"   wrogerswx@gmail.com

* *Retired NWS Meteorologist 42 years*
* *Manager / ZLA CWSU Aviation Support*
* *SSA Regional Director (SoCal) Region 12*
* *Contest Forecaster – Discus 2A: 4550+ hours*
* *Barron Hilton Cup – West U.S. Winner 2008*
* *WGC Met Support – 1983, Walter1991, 2012*
* *Perlan Met support 2018, 2019*
* *Voyager Flight Team – 1986*
* *HAPS Solar Powered Flight Test*

PRESENTATION SUMMARY

- My Career in NWS, Gliding and Sport/Flight Test Aviation Forecasting
  - What Motivated me to get into Weather – Pre 2000
  - How things changed after the Internet era around 2000
- Notable Projects
  - Voyager Flight Weather Team – 1986
  - World Gliding Championships – USA 1983, 1991 and 2012
  - Perlan Glider World Altitude Record 2018 – FL 760
  - Forecaster Dispatcher – Down Wind Glider two place record 877 miles – Gordon Boettger Duo-Discus – May 2014
  - HAPS Solar Powered Stratospheric HAWK30 Aircraft
  - Advocate Adviser of Mountain Wave Hazards Forecasting
- Computer Tools and Data Sources – publicly available

My Career in Weather ...
Early Years

- I was a weather nerd at 7 or 8 yrs old
- "Weather Man of the day" High School
- Hung out at AF local weather station – Mentored by Lt Pyke (UCLA Phd cand.)
- Disney "Boy Who Flew with Condors" intro'd me to gliders
- Summer NWS Intern 1968
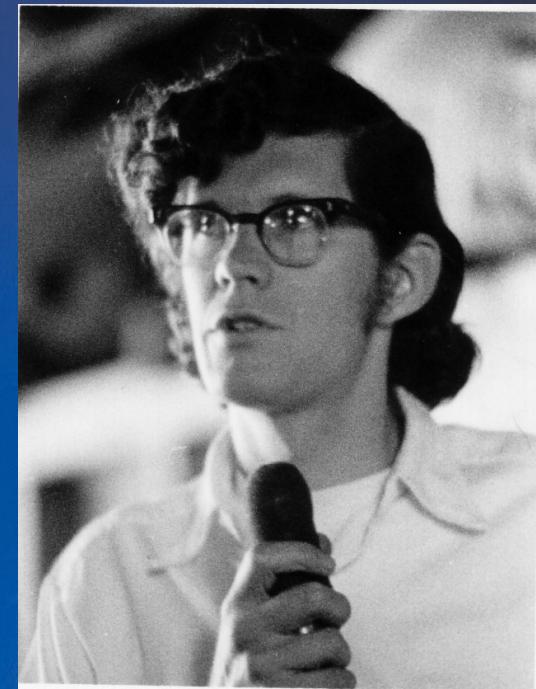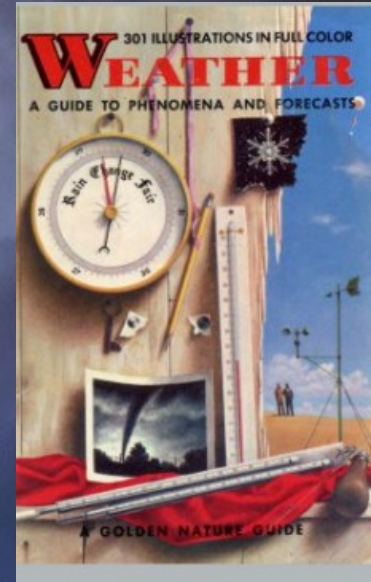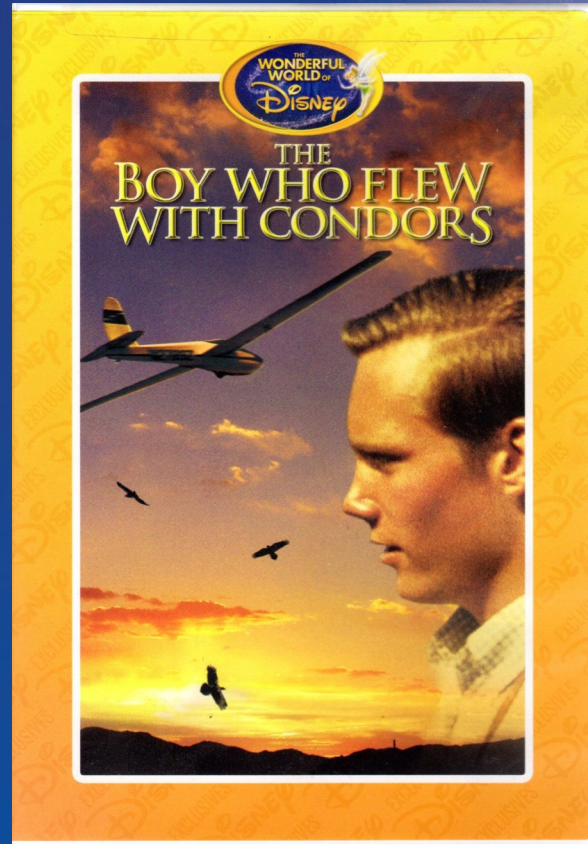
My Career in Weather ... Early NWS Years

- Fax Maps, Teletype room, changing messy ribbons... the old days at LA NWS

- Public service shifts... occasional intern forecaster duties

- Relief... University Assignment 1977,79 Madison. Learned BL Meteorology

- Started CWSU at ZLA (Palmdale, CA) 1980

My Career in Weather...
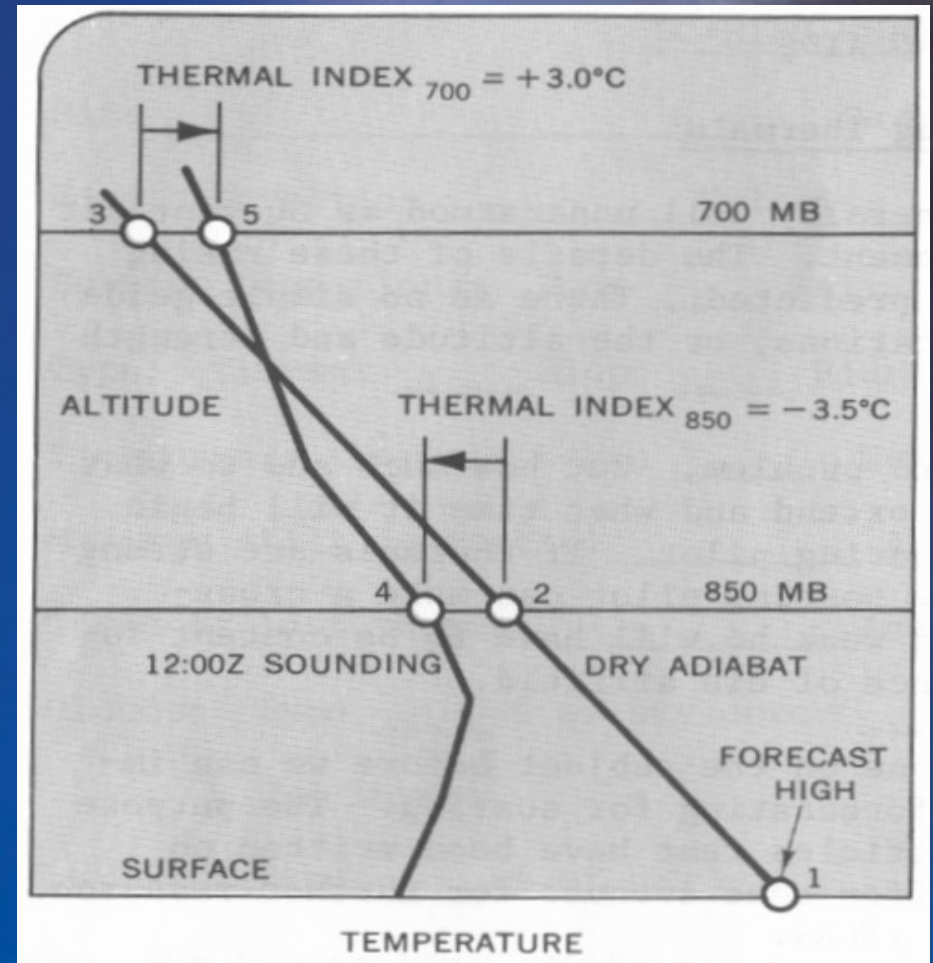# Calculating Thermal Heights

- Radiosonde Obs
  - Use 12z or 00z local sounding
  - Estimate max temp for day
  - Find and interpolate nearest raob
  - Used the Skew-T plot to forecast thermal heights
  - Not a very good soaring forecast solution

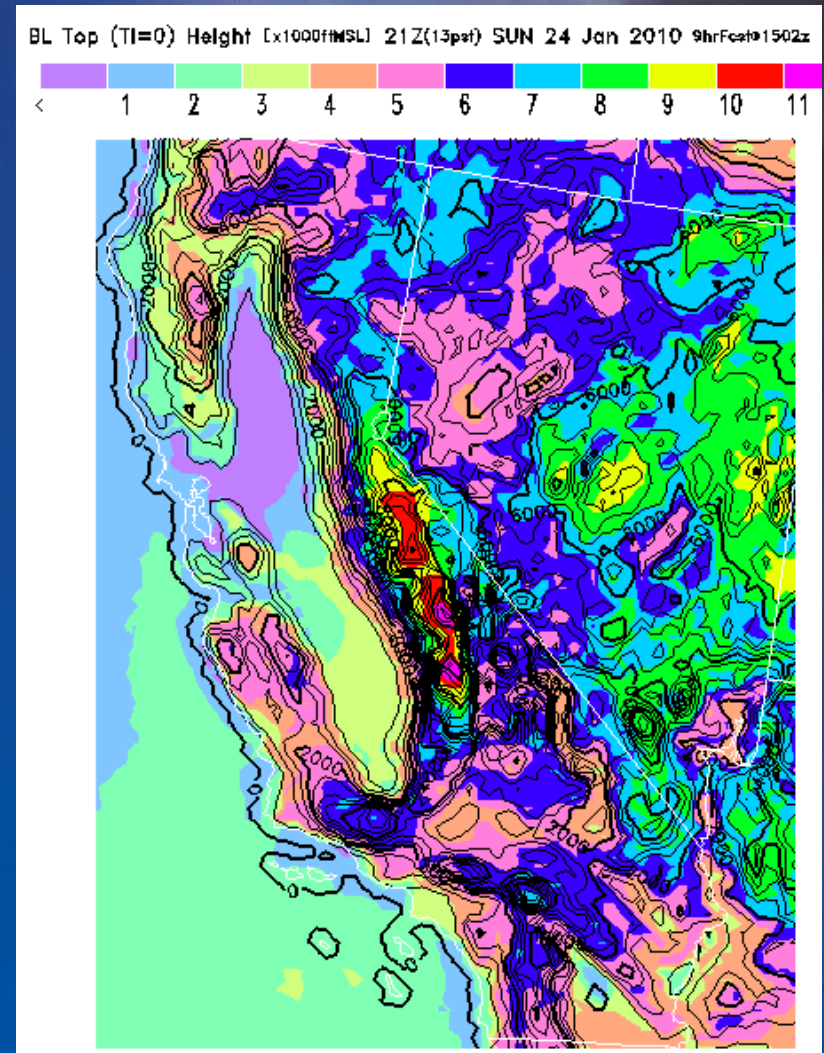# My Career in Weather... Calculating Thermal Heights

- Plotting Radiosonde's – Skew T Analysis
- Thermal Index
  - John Williams – Soaring 1955
  - Harry Higgins – Soaring 1963
  - Charles Lindsay – Soaring Meteorology for Forecasters - 1972

My Career in Weather...
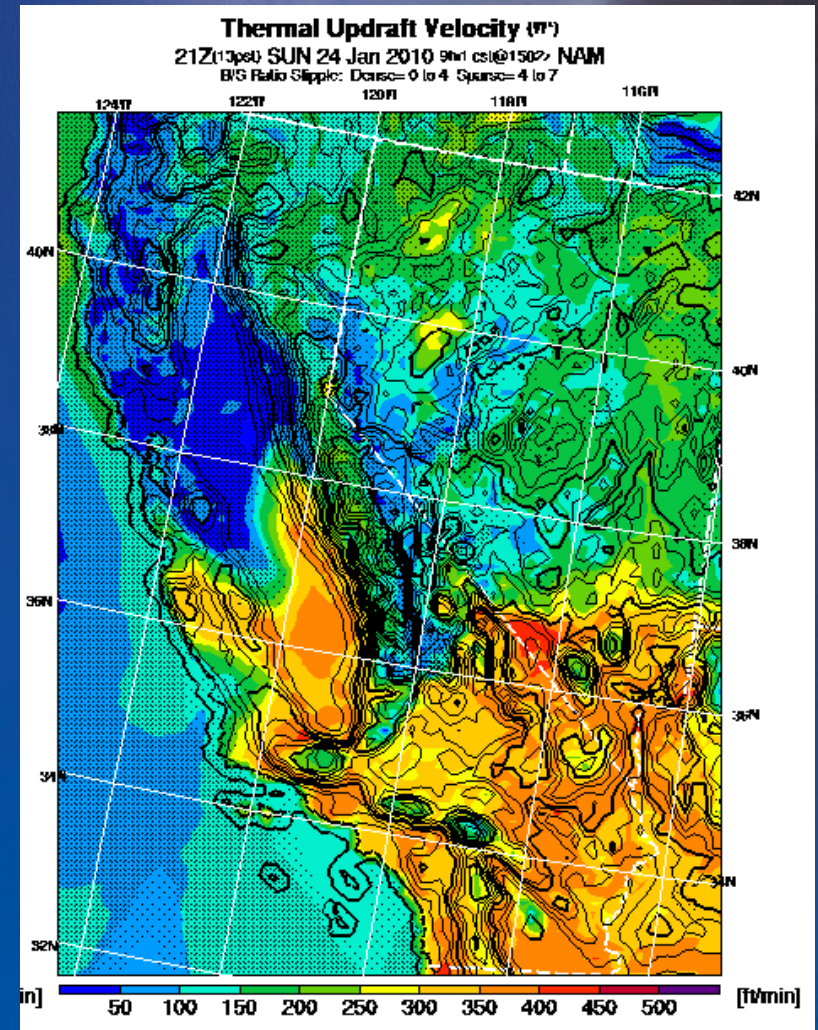# Web Soaring Services >2000

- DrJack.net
  - Started 2000
  - First to use surface heat flux for thermal strength
  - BLIPMAP BLIPSPOT RASP
  - Many other parameters
- XCSkies.com
  - Started 2005 – Paraglider pilots
  - Google Maps type Interface

BL Top (TI=0) Height [x1000ftMSL] 21Z(13pst) SUN 24 Jan 2010 9hrFcst@1502z

My Career in Weather... Dr Jack BLIPMAP and RASP

- First to...
  - Get 3D Raw output from NOAA meteorological models (RUC/NAM)
  - Map display at 13-20km grid resolution. Shows horizontal details of thermal heights, cu cloud base, buoyancy/shear, etc
  - Compute "soaring" parameters from "meteorological" variables: Top of lift, thermal strength...
  - W-star "convective velocity" for thermal strength
  - RASP – Packaged community WRF Numerical Prediction model – outputs 1-4km nested soaring parameters

Thermal Updraft Velocity (W*)
21Z(13psu) SUN 24 Jan 2010 9hr cst@1502z NAM
B/S Ratio Stipple: Dense= 0 to 4 Sparse= 4 to 7

My Career in Weather… Soaring Web Services 2023

- Skysight – Full service commercial soaring forecasts, task planning and analysis

- XCSkies – Commercial soaring forecast service

- TopMeteo – Full service commercial supported soaring forecasts

- RASP – Volunteer supported soaring forecasts based on DrJack.info parameters

- DrJack.info – Original Web Soaring Service by Jack Glendening. Free access with registration. Software frozen… not being developed

NWP Models Soaring Forecasts Table Summary - 2023

bit.ly/3IAMQWH
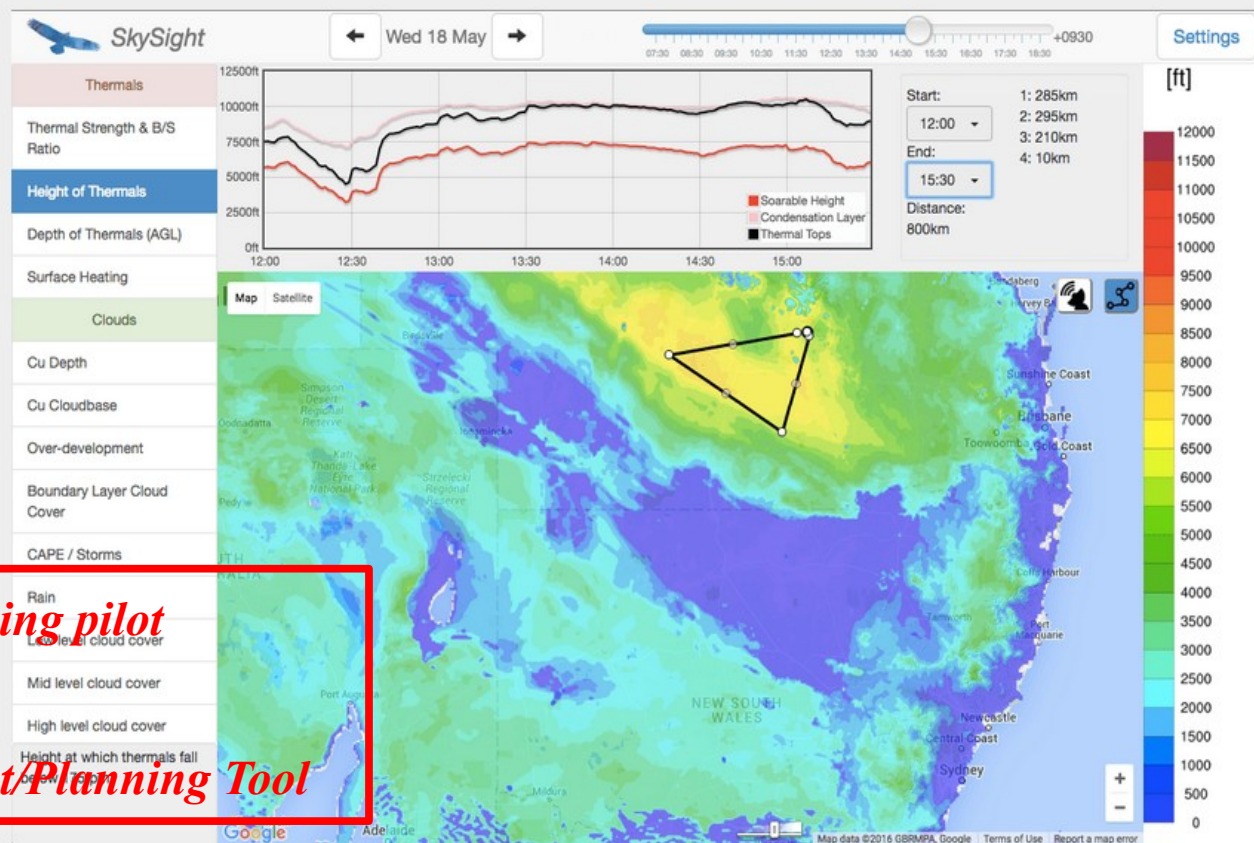
Soaring Web Services Features – Skysight

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

Matthew Scutter – Australian racing pilot
 - Started in U.S. March 2017
 - $10/month or $79/year
 *- Full Featured Soaring Forecast/Planning Tool*

Soaring Web Services Features – Skysight

Many NEW Features since 2018

- WRF models "Run in the Cloud" over several regions around world.. once each soaring day 8am-9pm local (plus one in evening for next day). ~2-3km grid for high resolution results
- Alternate view HRRR model soaring parameters 0-48hrs
- Skysight WRF forecast 6 days out
- Significantly modified from original RASP framework and User Interface. Fast rendering of contours, tiled zoom/pan, Skew-T point soundings, Time series plot for 3 days at one point
- Excellent in the mountains… convergence lines, mountain wave depiction
- Forecasts and observed satellite/radar data every 30 minutes
- Upcoming features: enhanced Land Surface Model and ensembles of models depicting uncertain "?" of forecasts.
- Create tasks, optimize for best weather, custom *.cup file waypoints, view airspace, uploads, notifications, overlay igc flights, etc

Soaring Forecast Process Analysis and Delivery

Windy.com - Great for Large overview

500mb Heights Winds
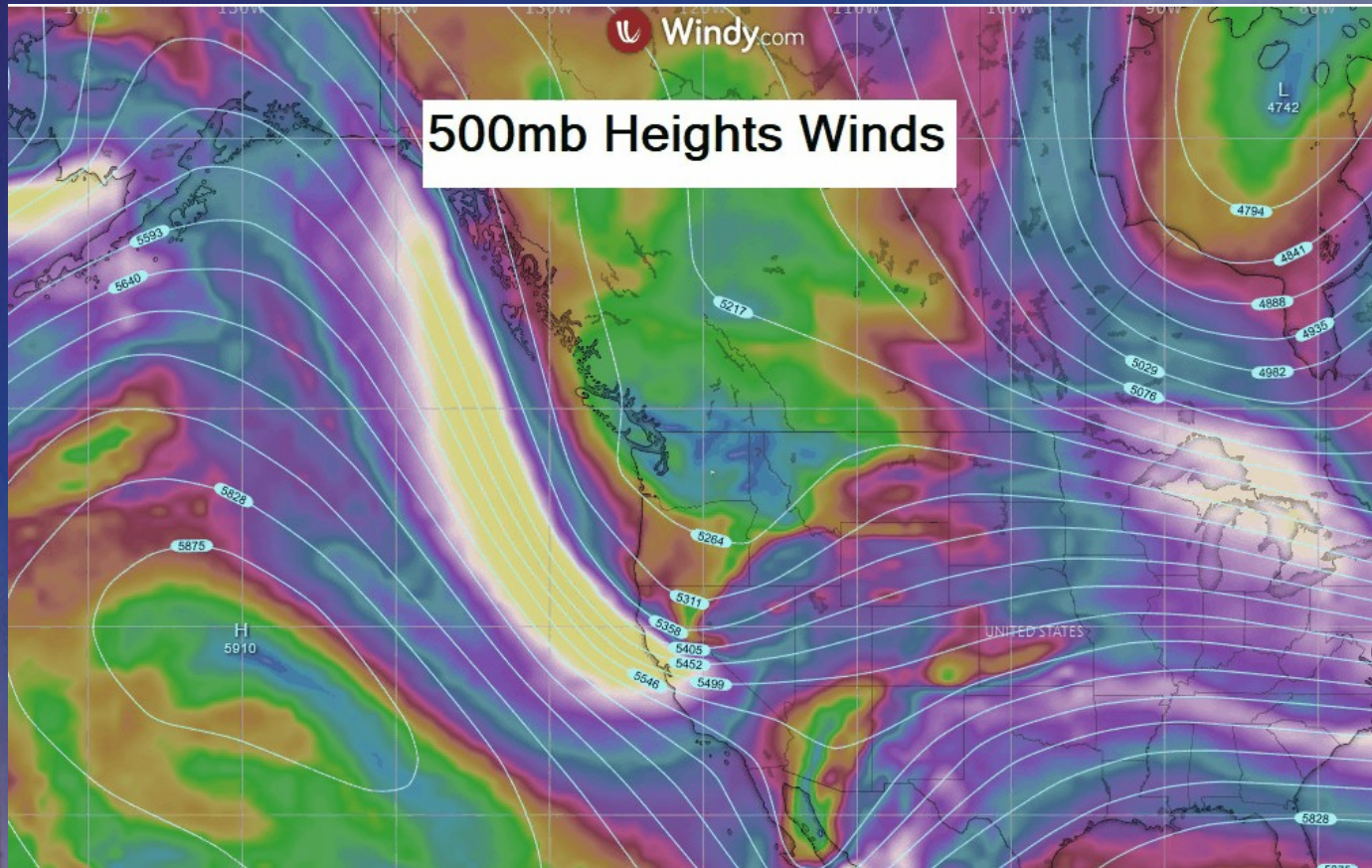
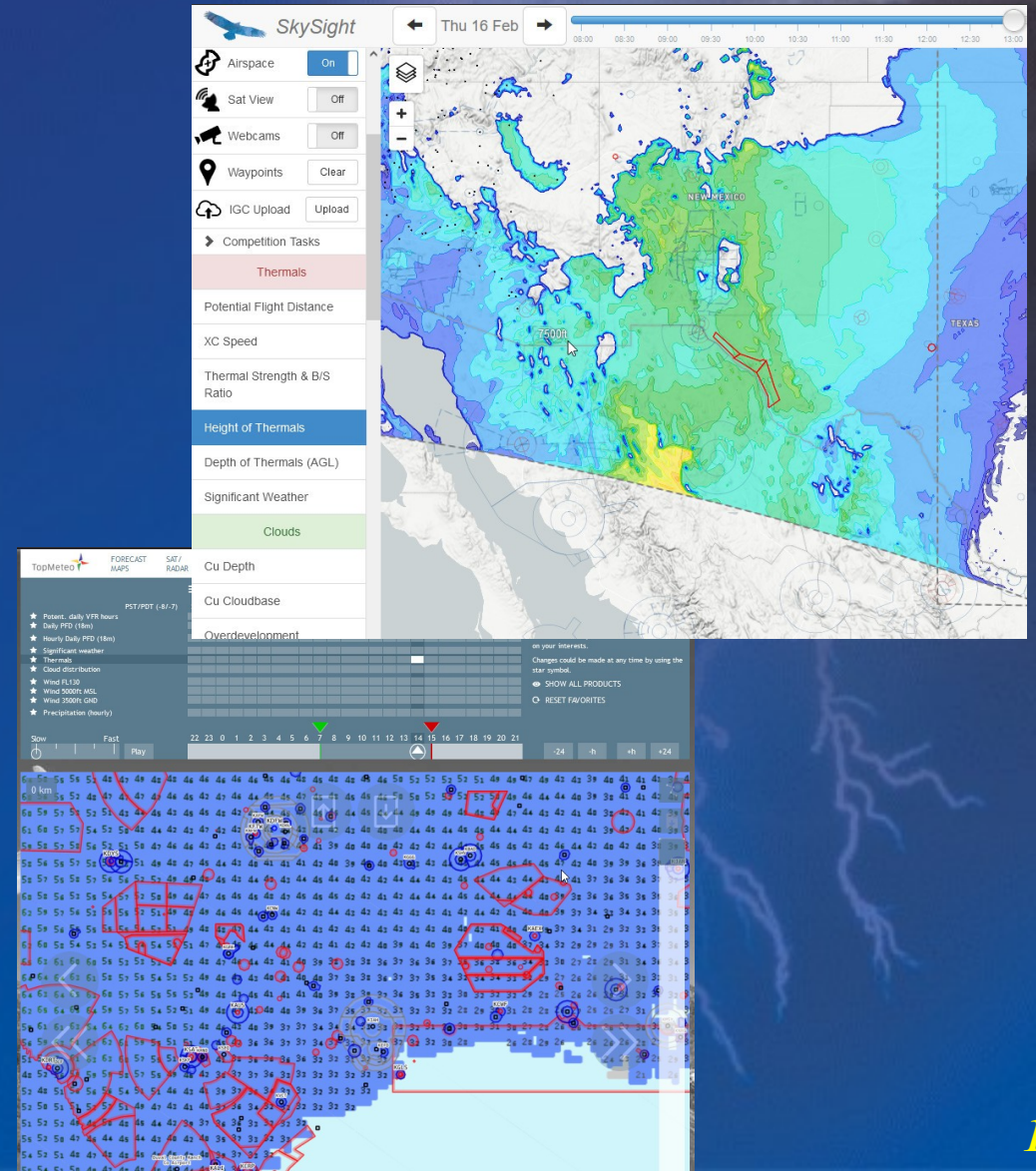*Video 8minute overview HowTo use Windy: bit.ly/3KD0DxF*

Soaring Forecast Process Analysis and Delivery

Follow up with Skysight or TopMeteo

- The last step for a soaring briefing is to follow up with your Soaring Web Service of choice
- Thermal heights, cu cloud bases, overdevelopment, single point meteograms, winds, convergence, rain/thunderstorm areas, or mountain wave

Soaring Forecast Process Analysis and Delivery

Prepare Presentation

- My preference is to use Markdown instead of Slides with rich text, graphics and videos – Hedgedoc.org
- A SYNOPSIS, TERMINAL WEATHER, and TASK AREA text discussion at top of document
- Creating scrollable document with media minimizes the complexity of formating inside the slide… It's a lot faster!
- Screen captures and videos files are placed in contest daily Dropbox.com folders
- Weather Briefing is transmitted to pilots as a URL to the document (email and text message). Corrections and updates on the server show up almost immediately
- Example…

Soaring Forecast Process Analysis and Delivery
U.S. Team Brief – WGC France Aug 15, 2021

Hedgedoc.org Markdown document… text, graphics, videos. Try viewing this with your Smartphone. It works better on a Notebook with larger screen:

bit.ly/3SgEbvN

Voyager Flight Weather Team 1986 Non-Stop Around World

- First aircraft to fly around world without stopping or refueling
- Dick Rutan & Jeana Yeager
- Edwards AFB...EDW 26,359sm
- 9 days 4 minutes
- 7011 lbs fuel ... at landing 106 (18gals)
- 112 mph (9.77mph tail wind). 5000-10000 msl
- Lead by WR NWS Len Snellman and 13 others (4 from ZLA CWSU)
- An amazing IDSS Decision Support achievment from the weather team!
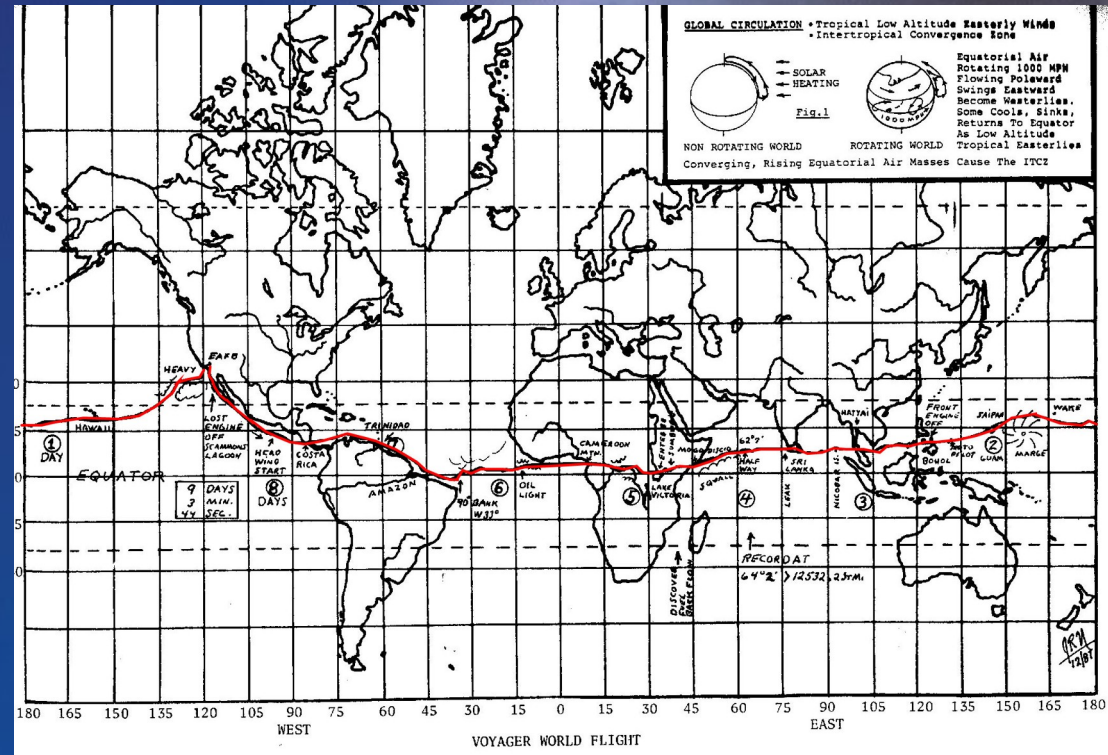
Dick Rutan and Jeana Yeager celebrate after the Voyager landing. (Courtesy photograph)

Model 76 Voyager

Voyager returning from its flight

16

World Gliding Championships 2012 Uvalde, TX 2012

- Tasking support to contest director
- 115 gliders of 3 classes
- 14 days in August 2012
- Weather Team of Walt Rogers and Dan Gudgel
- Utilized Dr Jack web services BLIPMAP thermal forecasts
- BUFKIT model soundings from RAP, NAM and HRRR
- GOES 1km vis imagery
- Radiosonde from Del Rio
- NEXRAD and COSPA for convective forecasts

Surface Obs Radars Raobs Sites
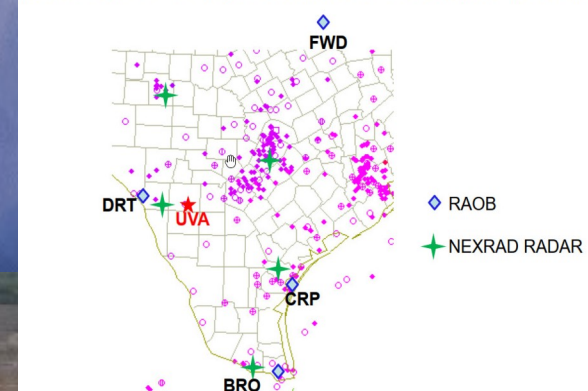
FWD

DRT

UVA

◇ RAOB

✦ NEXRAD RADAR

CRP

BRO

Perlan II – 2018 *"The Vision"*

"I think there is evidence of a stratospheric wave structure that can lift a sailplane to 100,000 feet, a completely unknown, unexpected, significant structure," Einar Enovouldson said in 1992
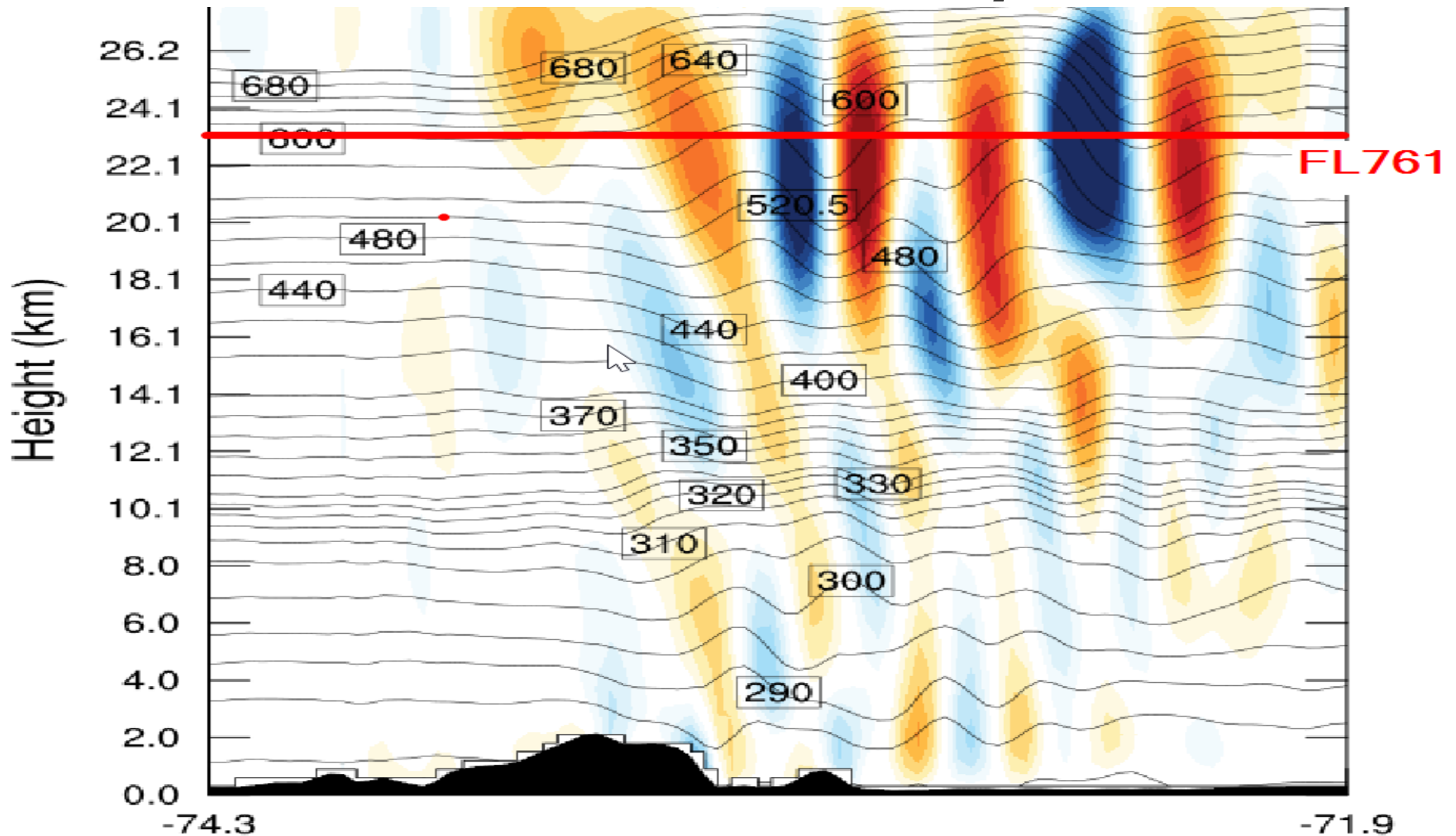
We have succeeded. On September 2, 2018 our glider became the highest flying, manned, subsonic airplane in history. The Airbus Perlan II reached 76,100 feet pressure altitude exceeding the altitude of the U-2 Dragon Lady
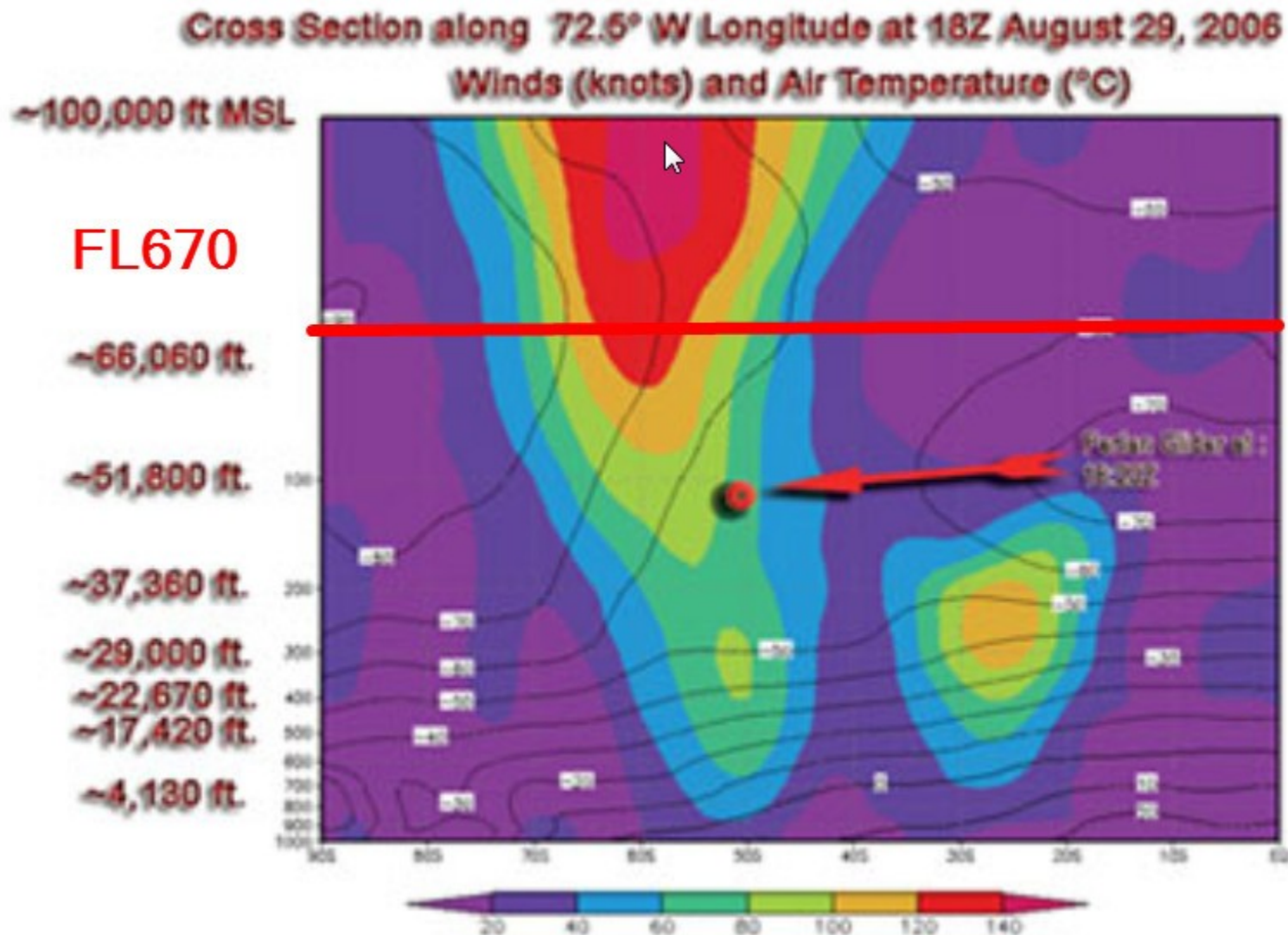
Perlan II - "*The Weather*"
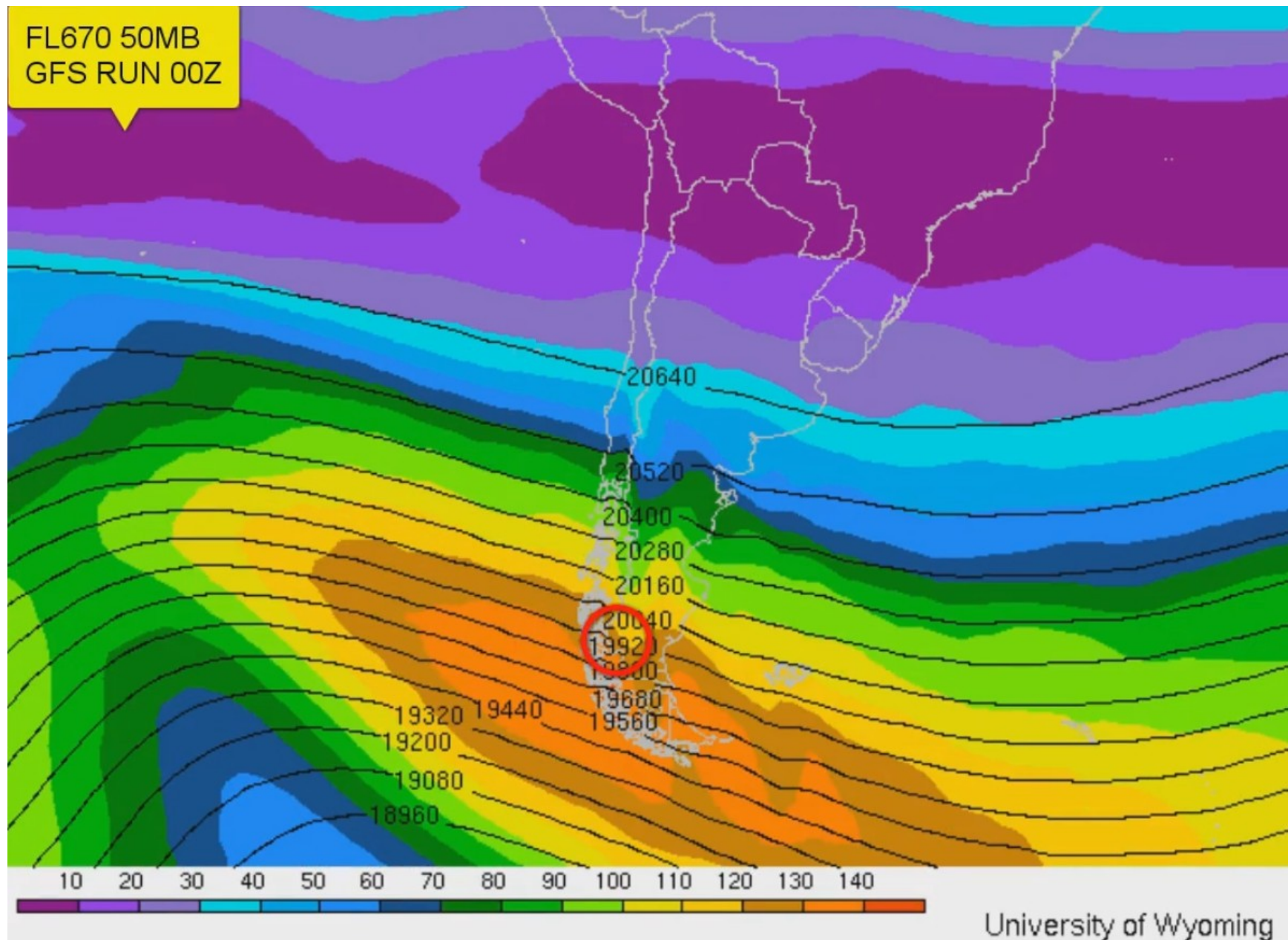## *Computer Models Simulations Showing Mountains Waves In Stratosphere*

Perlan II - "*The Weather*"

Polar Vortex Cross Section

Cross Section along 72.5° W Longitude at 18Z August 29, 2006
Winds (knots) and Air Temperature (°C)

~100,000 ft MSL

FL670

~66,060 ft.

~51,800 ft.

~37,360 ft.

~29,000 ft.
~22,670 ft.
~17,420 ft.

~4,130 ft.

Perlan II - "*The Weather*"

Polar Vortex 2D Map - FL670
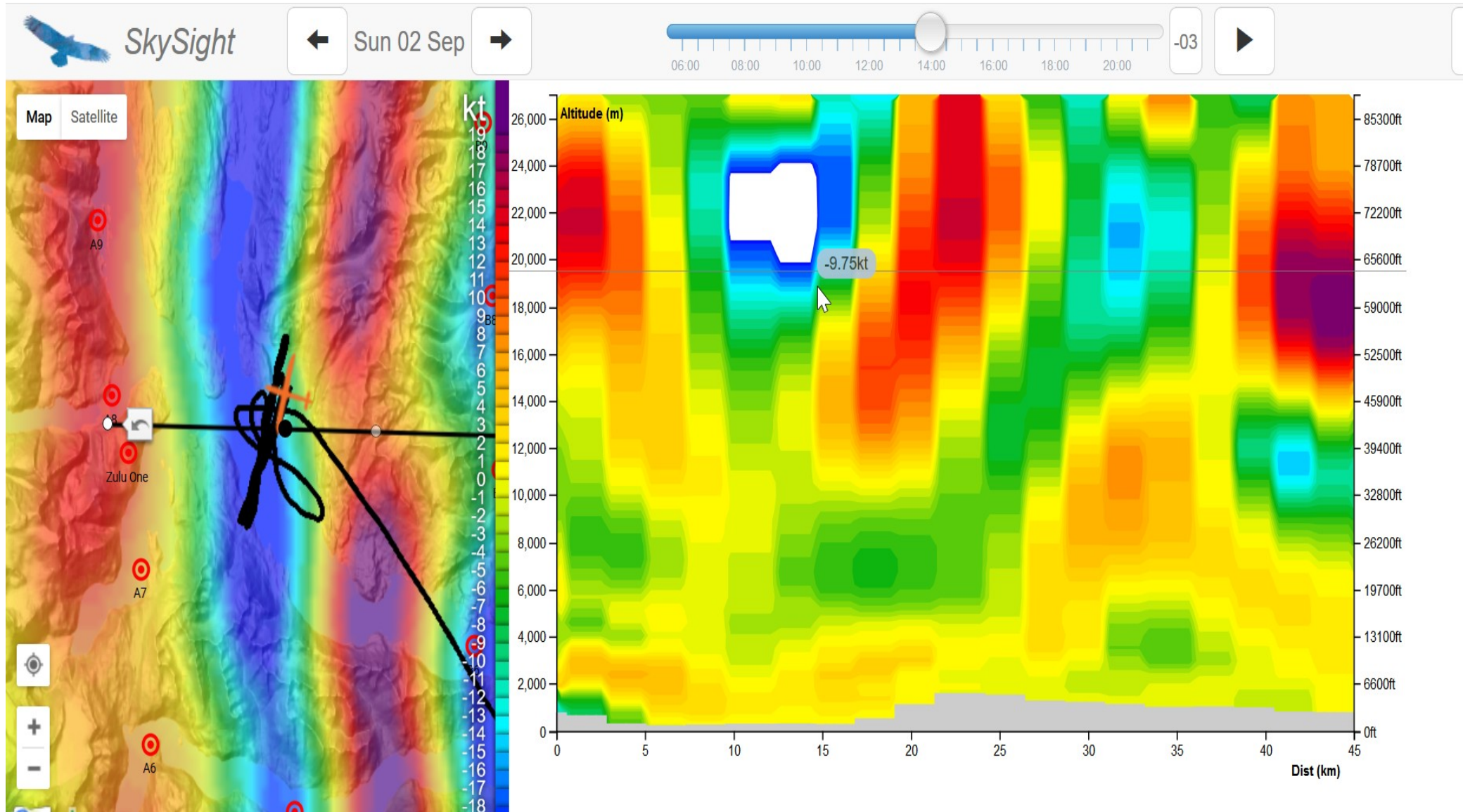
Perlan II - "*The Weather*"

Balloon Sounding – Showing Up/Down drafts
The only independent verification of Stratospheric Waves
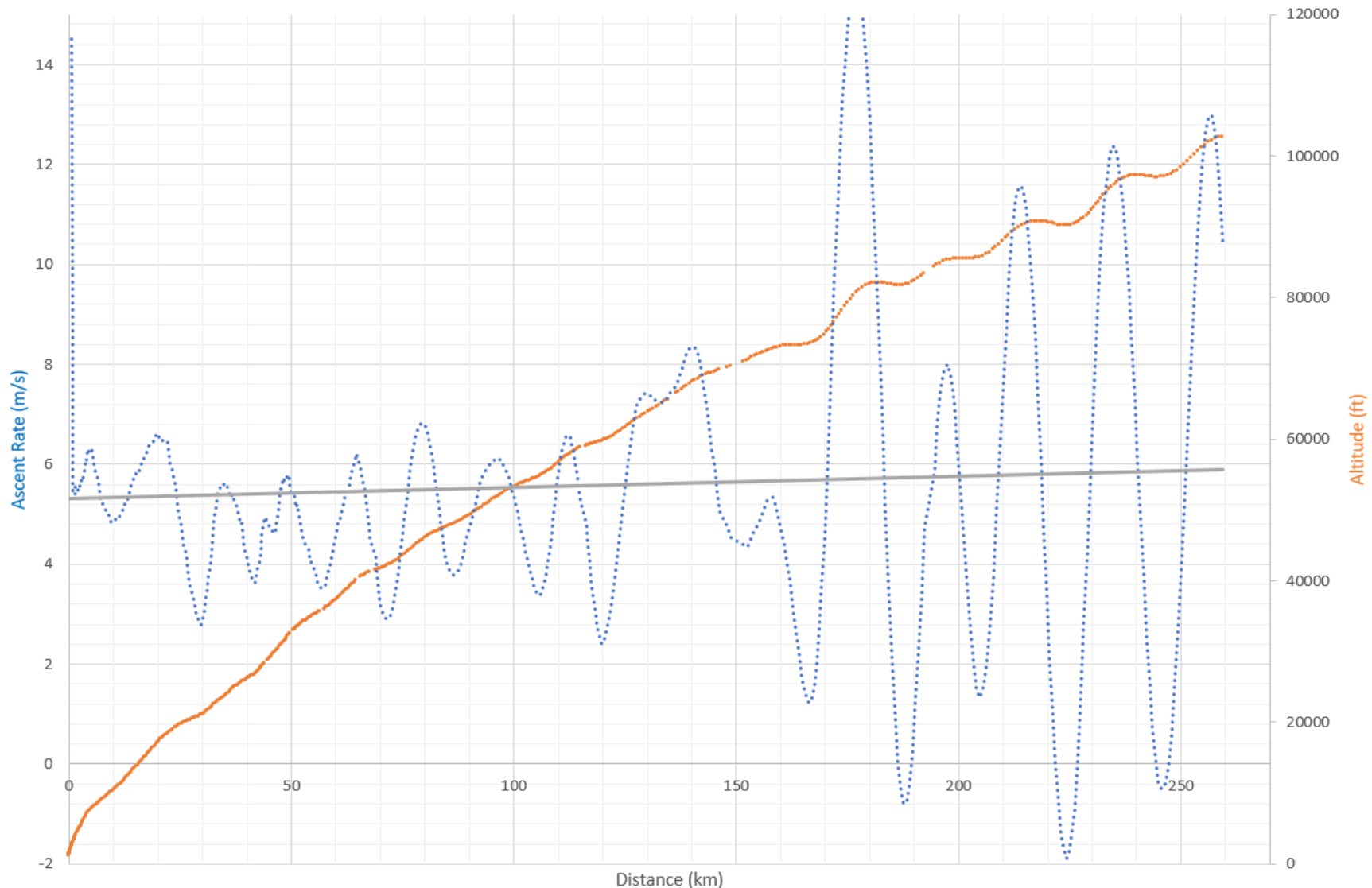
Perlan II - "The Weather"

2D Maps of Skysight.io Showing Stratospheric Waves Up/Down Drafts with glider track
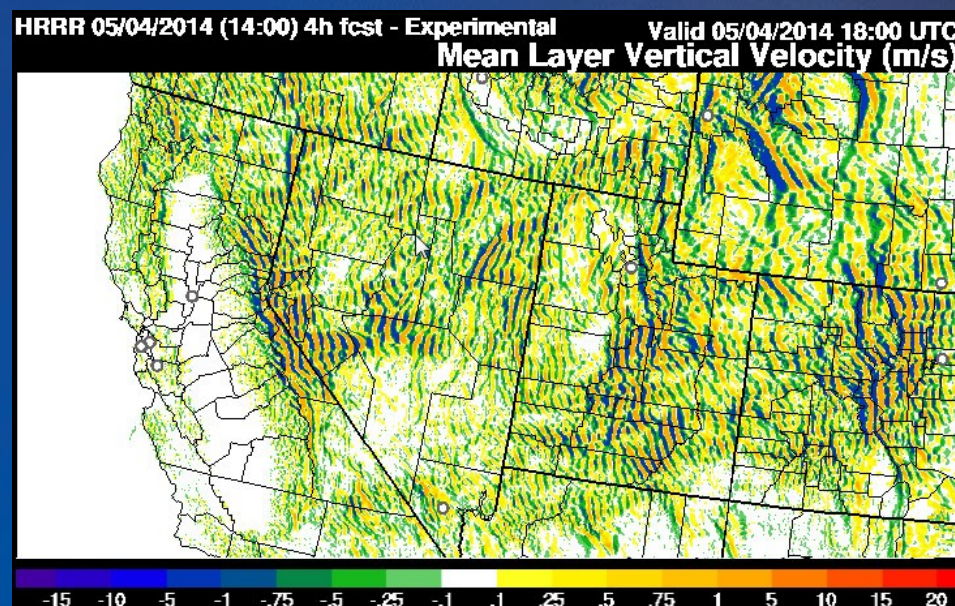
Perlan II - "*The Weather*"

Dan Gudgel and Walt Rogers – Briefing Challenges

- Find a day with a "Polar Vortex" Jet Increasing wind speeds at altitude above FL600

- Look for Stratospheric Waves from high resolution models

- MW's in Troposphere (<FL350) at least weak to moderate

- Avoid IMC (clouds) and rain below FL350... also cross winds or high winds takeoff/landing

- Let the "Egret" towplane take Perlan to FL450!

Two Place Glider 877 mi Record Boettger – May 2014

- 20meter Duo-Discus two place glider
- Gordon Boettger and Hugh Bennett
- Walt Rogers acted as "Flight Dispatcher" and weather consultant
- Tracked GOES imagery
- HRRR model Mountain Wave patterns
- Communicated by Iridium Satellite Phone
- BLOG QR Code:

Gordon Boettger and Hugh Bennett
Duo Discus May 5, 2014 Destination
Hulett, WY 877sm

HRRR 05/04/2014 (14:00) 4h fcst - Experimental   Valid 05/04/2014 18:00 UTC
Mean Layer Vertical Velocity (m/s)

-15 -10 -5 -1 -.75 -.5 -.25 .25 .5 .75 1 5 10 15 20

HAPS Solar Powered Stratospheric HAWK30 Aircraft

- Consulting weather support for flight test
- July Aug 2019
- Space Port America, NM
- Aerovironment HAWK30
  - ~22kt IAS
  - 260ft wing span
- Mission: to loiter in lower stratosphere ~65k msl
- Weather Challenges:
  - Wnd shear <10kts per 500ft
  - 10kts head; 3kts cross wind
  - VFR; free of TSTMs
  - Minimal low lvl turb
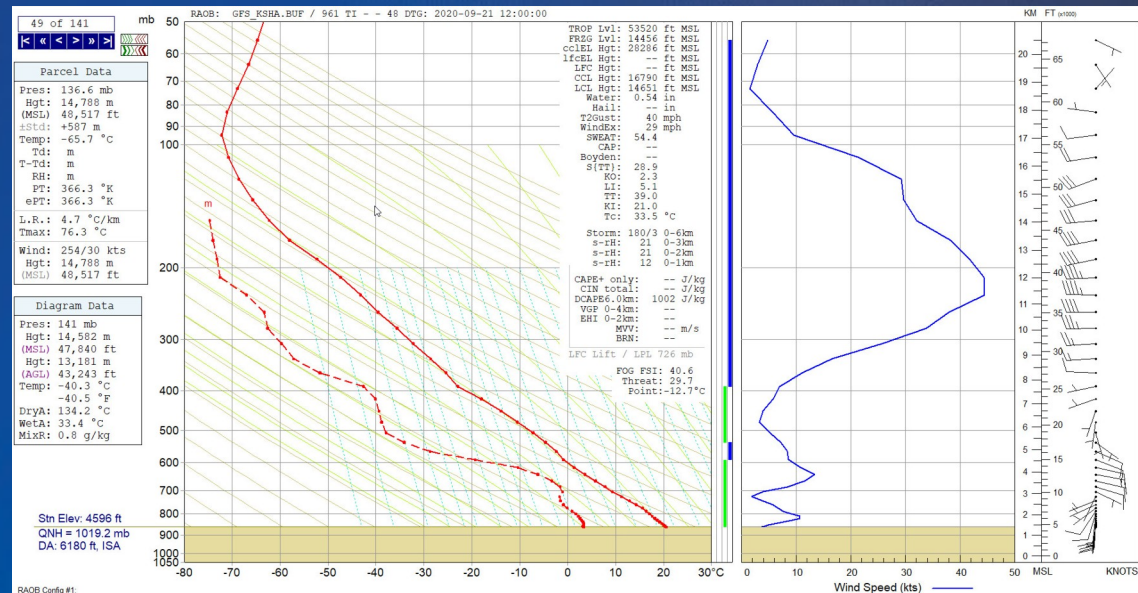
Mountain Waves (MW)

- On Nov 2021, I presented: "On The Need for Mountain Wave Forecasts" to the FAA at research conference with NCAR and FAA
- Severe MW's difficult to detect by pilots with conventional obs
- NWP HiRes forecasts i.e. Skysight and HRRR have been identifying it for last 10yrs
- Highlighted history of MW Soaring since 1950's
- Case Study: Malibu PA46 fatality Tehachap Feb 13, 2021
- SUMMARY:
  - Better training required for all pilots
  - NWS and Aviation products/warning inadequate for MW hazards especially severe downdrafts
  - Operational NOAA NWP HiRes models can adequately describe much of the MW structure

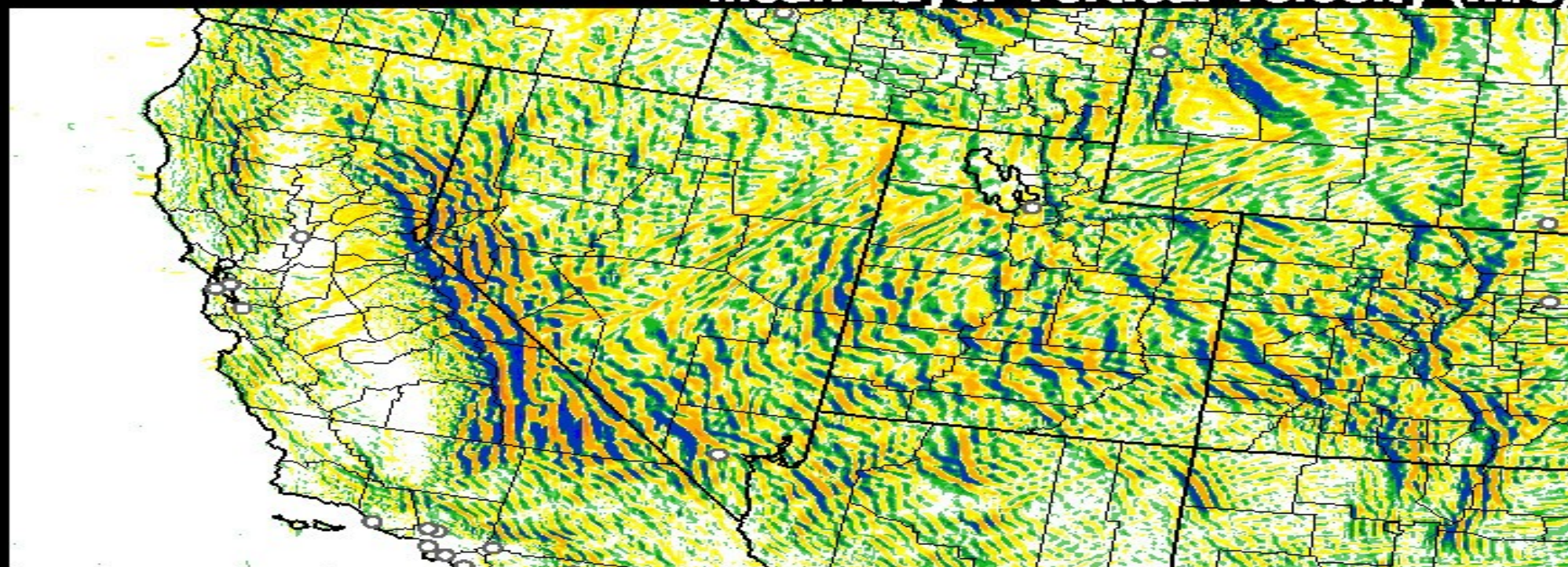*TURB Mitigation Mtg 11-09-21*

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

Jim Payne holds many records for gliding including in the Online Contest (OLC), World Altitude Record 76,100ft msl El Calafate, Argentina… and this one: 2908 km 250km/hr on Apr 06 2015. Below is the HRRR model depicting mean vertical velocity. Note the strong vertically propagating waves in the lee of the Sierras and trapped waves extending downwind. Use of the HRRR model for wave flight was just beginning to gain attention at this time.

HRRR-NCEP 04/05/2015 (18:00) 4h fcst   Valid 04/05/2015 22:00 UTC
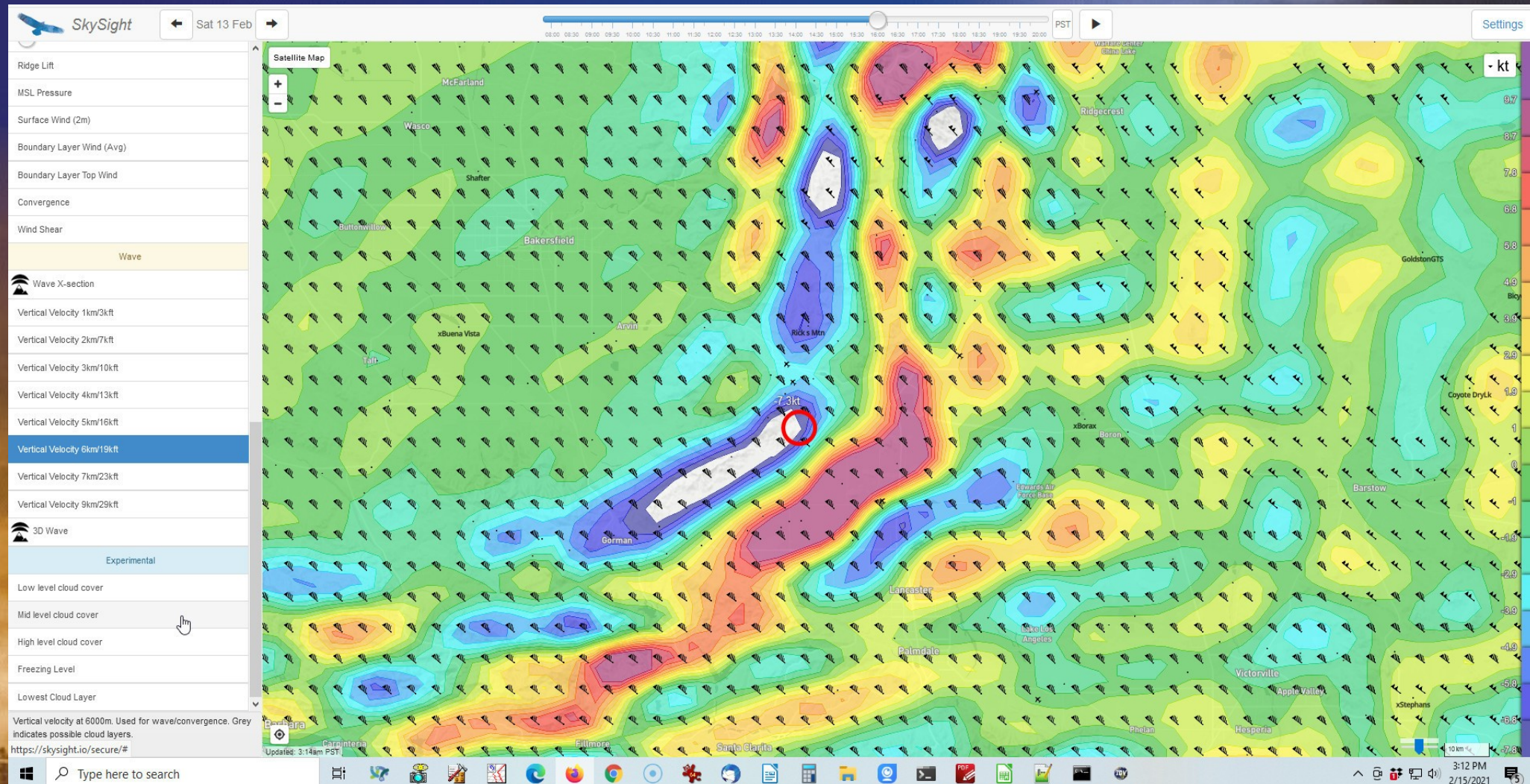Mean Layer Vertical Velocity (m/s)

Piper Malibu Accident
Feb 13, 2021

GOES-17 BAND 02 VIS

KTSP

DOWNDRAFT

KMHV

UPDRAFT

ROTOR ZONE

2021-02-13 23:21Z

Piper Malibu Accident
Feb 13, 2021

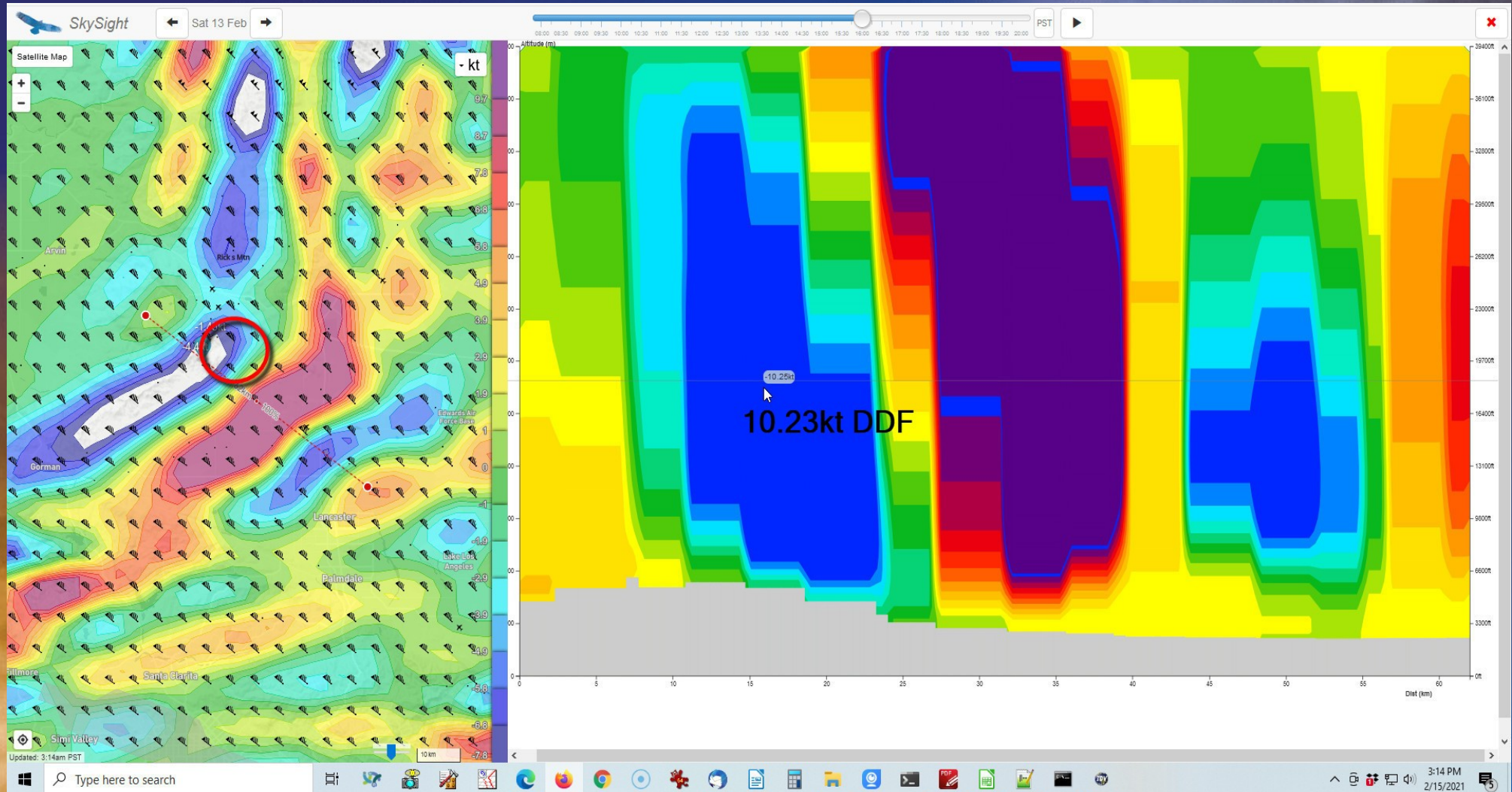## *6000meter Winds NW 85kts – Skysight 1600 PST*

Piper Malibu Accident
Feb 13, 2021

SUMMARY

The identification of imminent or existing MWA is critical because of the adverse operating conditions that are sometimes associated with it. Hazards posed by MWA to airborne aircraft are not limited to severe or extreme turbulence or adverse wind near the surface (NTSB Safety Recommendation A-14-017-021) 2014

- Severe downdraft accident fatalities for GA and business aircraft continue to occur
- Identification of MWA remains challenging for pilots with the current observations and tools available
- Glider pilots achieving records have long understood MWA structures and been able to utilize vertical motion for extending flights
- Better training and education is still needed for the rest of the pilot community
- NWS warning products do not adequately advise pilots of MWA or the hazards of severe downdrafts
- Operational NWP HiRes Models can adequately describe much of the MWA structure.

Forecast Tools and Software Sounding Viewers Update 2023

- Complete survey SSA Convention 2016 Presentation. Video tutorials available
- NOAA GSL Skew-T interactive viewer
- BUFKIT – Model forecasts only
- RAOB.com – Model forecasts and observed
- University of Wyoming - Radiosondes
- Windy.com – Forecasts and current Radiosonde
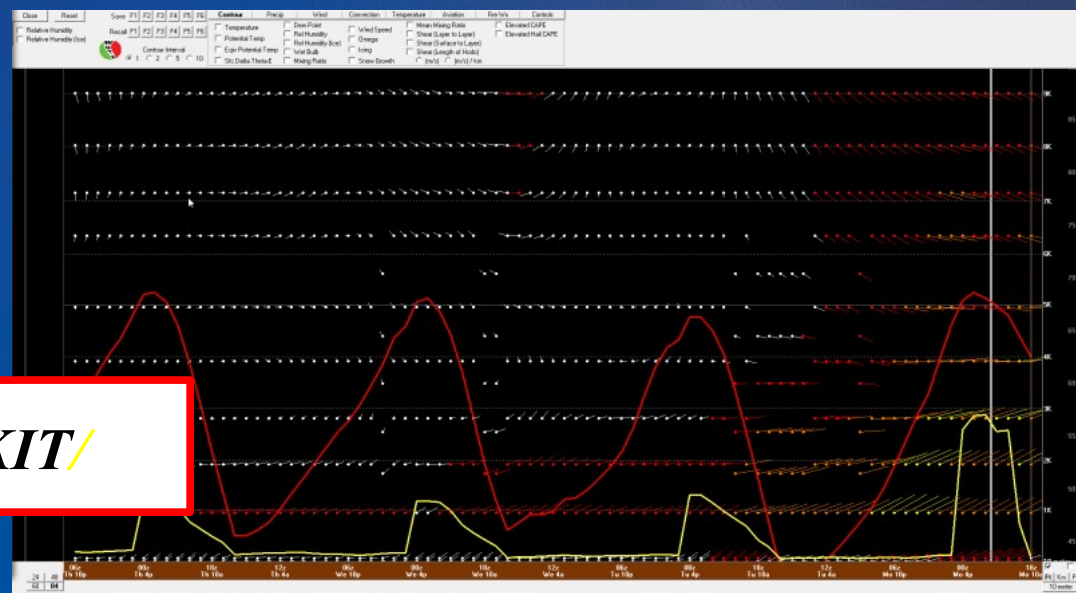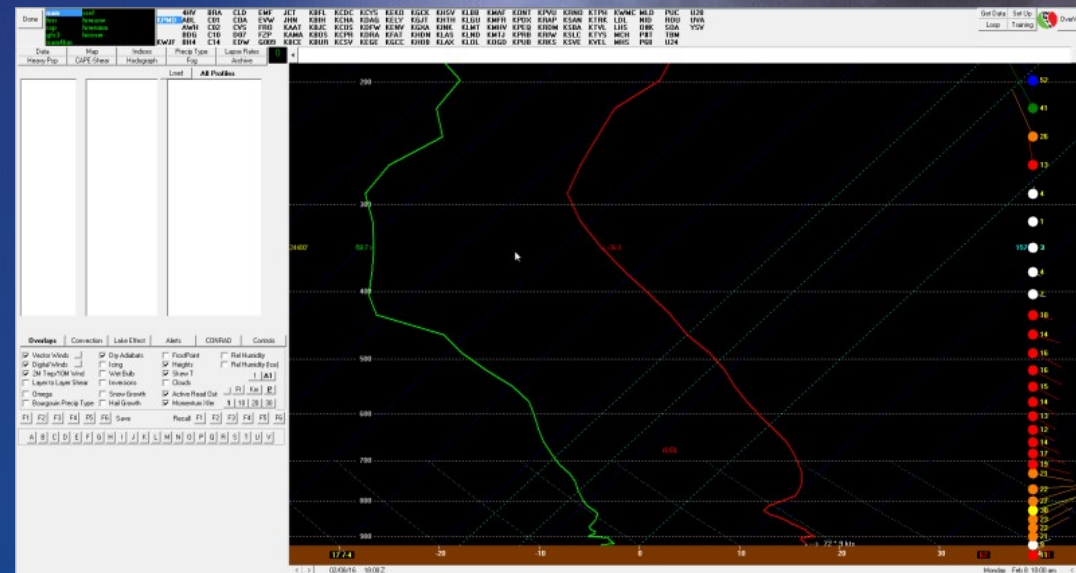
SSA Convention 2016 Weather: bit.ly/3KnQEMu

Notes for this SSA Presentation 2023: bit.ly/3kbSPYG

Forecast Tools and Software
BUFKIT Sounding Viewer

- High resolution modelsoundings HRRR,NAM,RAP,GFS, NAM3km
- Two Windows – PROFILE view and OVERVIEW time series
- 600+ sites in U.S. BUFKIT
- Mixed Layer (thermal) Height; T, Td, RH, Winds,Precip
- Strange user interface… but useful for detail forecast soundings
- Software nearing end of life – Visual Basic

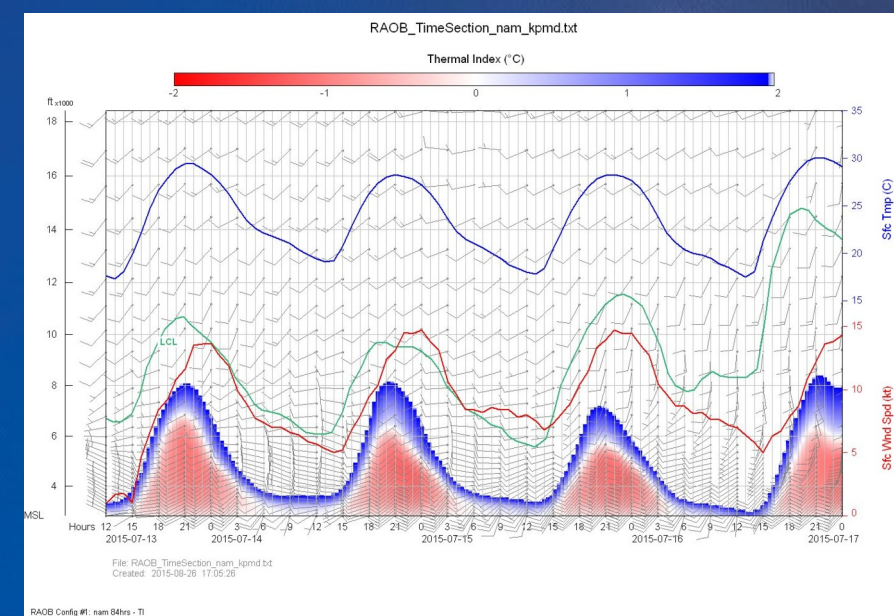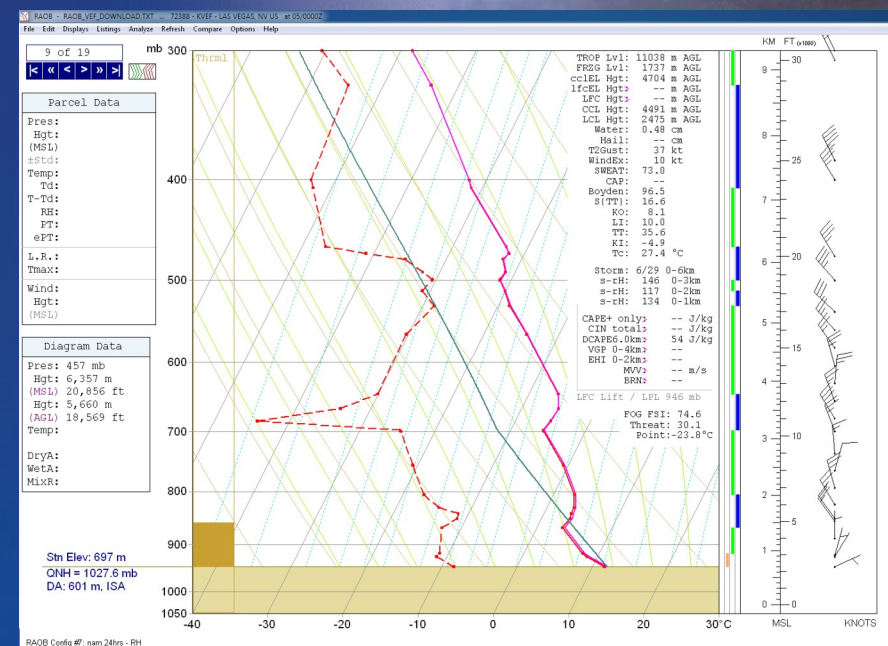*http://www.wdtb.noaa.gov/tools/BUFKIT/*
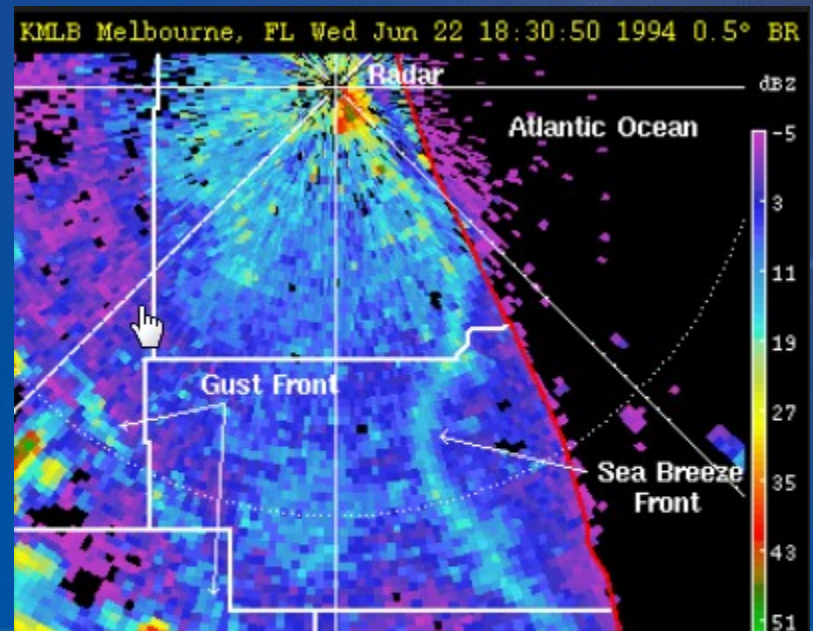
Forecast Tools and Software RAOB.com

- Most complex RAOB sounding analysis tool available
- Produces beautiful time series thermal plot graphics
- Commercial product
- Outstanding technical support
- Basic Program - $100; Analytic Module - $50; Cross Section Module - $120 – Total $270
- Steep learning curve
- Batch commands – semi-automatic production of graphics
- Software nearing end of life – Visual Basic

Observaton Tools and Software
RadarScope – PDA App

- Low Latency High Res Data!
- You can see clear air outflow boundaries, sea breeze fron and sometimes shear lines
- Precip hydrometeor types including hail
- Lightning data animation...
- Shows NWS warning polygon
- Great tool for after landing... Decide on "boxing it up"

In my opinion, RADARSCOPE is the best PDA app for gliding… It will use GPS to Display current location. Can import JSON custom waypoints

Radarscope.app

Observation Tools and Software Mosaiced Radar - MRMS

- MRMS - Multiple Radar Multiple Sensors mosaics, numerous products, great quality control
- NOAA's National Server Storm Laboratory system for NWS, FAA and commercial companies
- Publicly available viewer
- Can view history… back months or years. Time steps 2mins, 30mins, hourly, etc
- On going research to provide the best mosaiced NEXRAD system around
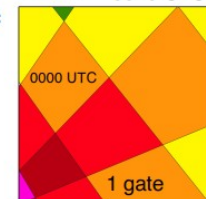- Publicly available grib2 files for incorporating into you own products
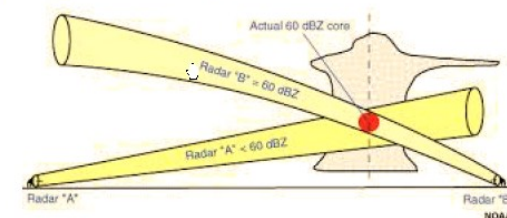
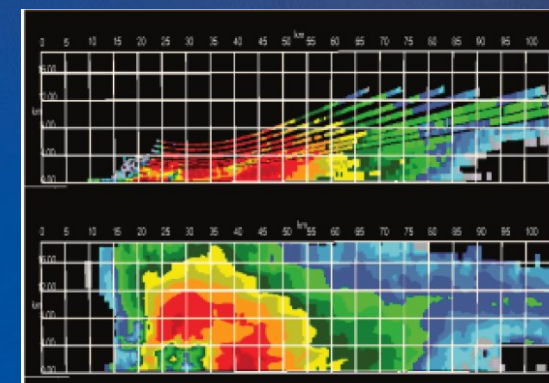**3 sources of uncertainty**
1) Beam-broadening effects
2) Interpolation to the mosaic
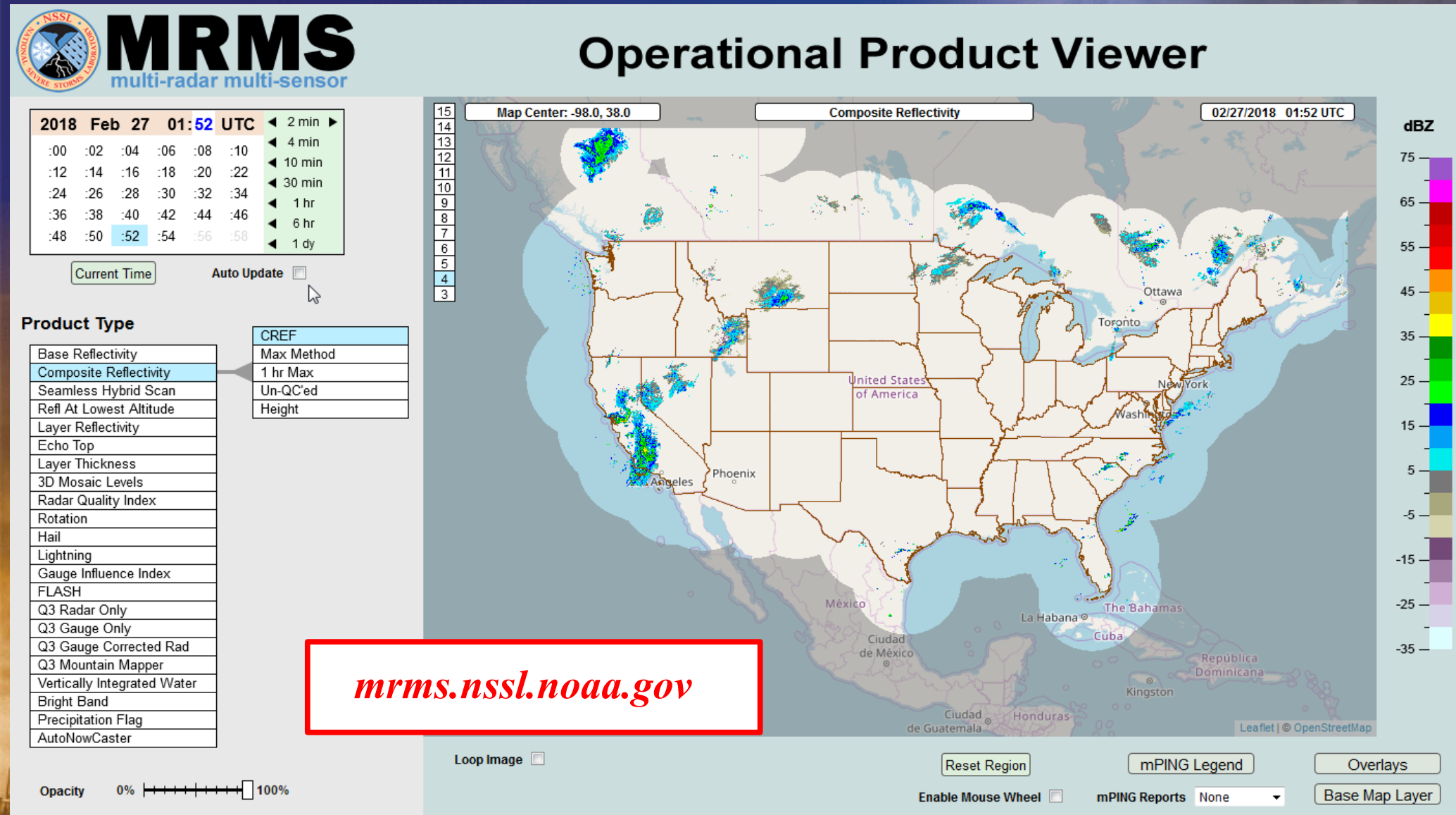3) Offset in time

By combining data from adjacent radars, the Multi-Radar Multi-Sensor system gives forecasters a more detailed picture of a thunderstorm's intensity. The top image is data from a single radar compared with data from the Multiple Radar system in the bottom image. and hydrometeorology forecasts.

Observation Tools and Software
Mosaiced Radar - MRMS

mrms.nssl.noaa.gov

Observations
UAS Copter Sondes

- Operational models need low level pbl soundings
- A 3D Mesonet concept is being developed to use quad copter for 1-3km vertical soundings
- Testbeds are in operation last 3yrs around world
- Biggest challenge is airspace... FAA.
- Univ Oklahoma testing one with mm radar geofence
- Meteomatics has a commercial automated system

With our Meteodrones, we now reach an altitude of 6000 metres. By continuously improving the airframe, reducing the weight of the components and using the latest battery technology, we now offer two powerful systems whose different characteristics allow them to be used for different applications.

Drone Models

The Meteodrone MM-641/SSE is the smaller, lighter drone that can fly at higher speeds. The Meteodrone MM-670 (ML), on the other hand, is more suitable for commercial use or reconnaissance missions and can be adapted with different instruments to fit custom requirements if necessary.

Sensors and Measures
- Temperature
- Pressure
- Relative humidity
- Dew point
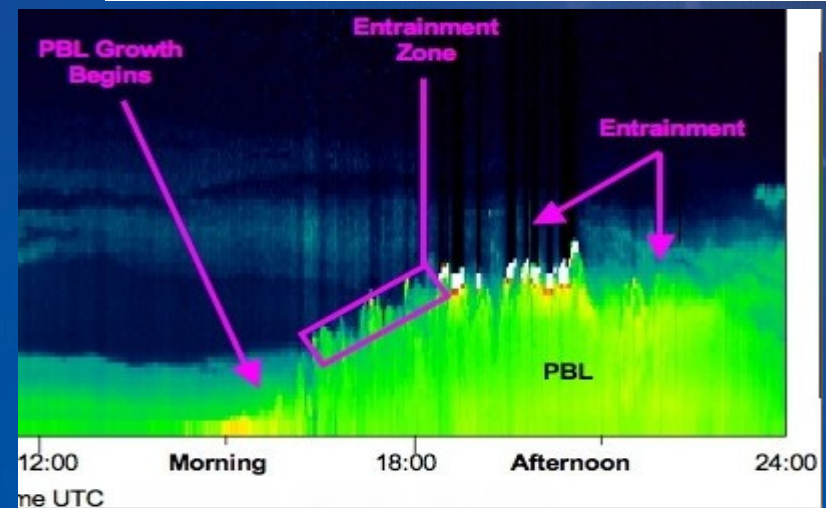- Wind speed and direction

Meteodrone MM-641/SSE
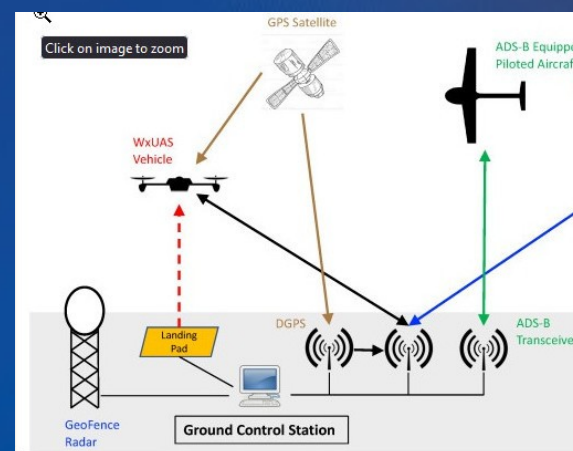
Meteomatics White Paper: bit.ly/3IFZune

Observations Ceilometer Lidar

- Ceilometers have long used LIDAR to detect cloud cover for ASOS, AWOS
- Newer Vaisala CL51 CL61 models have a data port to show backscatter of aerosols that detect pbl
- Research to operations managers in the meteor community see this as another way to measure pbl
- Uvalde's AWOS may be able to upgrade to one of these newer ceilometers

CL61 lidar ceilometer with de[tection]
Filling the gap between research instruments and

PBL Growth Begins — Entrainment Zone — Entrainment — PBL

12:00   Morning   18:00   Afternoon   24:00

40

Software Visualization Tools Unidata IDV and AWIPS II

- Unidata's Integrated Data Viewer (IDV) is a freely available 3D geoscience visualization and analysis tool
  - NWP grids, GOES, NEXRAD
  - Time/height displays
  - UI steep learning curve
- AWIPS II Workstation
  - Unidata gives access to EDEX data server on "JetStream"
  - Easier and more familiar for operational forecasters
  - Publicly available software

Investigating use of this running on a VM machine desktop PCs

The End...
Spectacular Soaring!

Walter Rogers
wrogerswx@gmail.com

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* WGC Met Support – 1983, Walter1991, 2012
* Perlan Met support 2018, 2019
* Voyager Flight Team – 1986
* HAPS Solar Powered Flight Test

Hello… my name is Walter Rogers… also known as "WX" when in my Discus 2a. It's been 56 years since I started gliding at El Mirage Field. I've been watching the weather since I was a kid… always interested in meteorology. After numerous cross country hours in gliders, Regional and National championships… and 42 years with NWS … many of this in aviation weather…I've learned a thing or two about soaring weather

PRESENTATION SUMMARY

- My Career in NWS, Gliding and Sport/Flight Test Aviation Forecasting
    - What Motivated me to get into Weather – Pre 2000
    - How things changed after the Internet era around 2000
- Notable Projects
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- Computer Tools and Data Sources – publicly available

2

This talk will look at how I started out in Meteorology… and the path taken to providing soaring forecasts and other sport aviation activities. It was all in parallel with my professional career at NWS from 1968 to retirement in 2010. Most of my NWS career was as manager of the ZLA CWSU Palmdale, CA

My Career in Weather ... Early Years

- I was a weather nerd at 7 or 8 yrs old
- "Weather Man of the day" High School
- Hung out at AF local weather station – Mentored by Lt Pyke (UCLA Phd cand.)
- Disney "Boy Who Flew with Condors" intro'd me to gliders
- Summer NWS Intern 1968
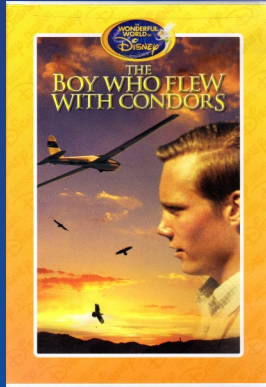
Logged daily weather observations with my home station, instrument shelter, max/min Taylor thermometer and home made rain gage

Mentors included other weather enthusiasts. Monitored aviation weather broadcast observations from low frequency broadcasts on a Zenith Navigator portable radio.

My high school principle knew I was a "weather nut" and got the LA Schools Unified District "weather man of the day" title to visit NWS. That got me noticed at the LAX forecast office. Naturally, I was selected as a NWS summer intern shortly after graduating while at UCLA

 • Forecast Office Los Angeles – Public Service Unit. More Fax Maps, Teletype paper posting, ribbon smudged fingers! Probably my Tinnitus hearing loss is due to the machine room noise
 • Intern Forecaster into the mid 1970s.
 • UW Madison University Assignment 1977-1979 – Intro to BL Meteorology

.

My Career in Weather …
Early NWS Years

- Fax Maps, Teletype room, changing messy ribbons… the old days at LA NWS
- Public service shifts… occasional intern forecaster duties
- Relief… University Assignment 1977,79 Madison. Learned BL Meteorology
- Started CWSU at ZLA (Palmdale, CA) 1980

These were the days working operational shifts, 1970s… interrupted by a University Assignment at Madison, Wisconsin 1977-79 where I was introduced to Boundary Layer (BL) meteorology

Returned briefly to Sacramento NWS (WSO) where my boss, Gimo Yakubovsky allowed me to help Doug Armstrong (NWS Reno) support the National Gliding Championships summer '79 (on per diem!). That kick started me into competition soaring and I bought a glider with the per diem earned working (going to school).

NWS was liberal with it's support at gliding events during those times. Conflict of interest with the private sector forced NWS (Pres Reagan) to stop that somewhere in the late 80s early 90s. Forecasted for numerous regional and national glider competitions 1980s and 90s including WGC Hobbs, New Mexico in 1983.

 The beginning of modern weather workstation began in the early 1990s. With the WGC in Uvalde, TX in 1991… NSSFC (Fred Mosher Severe Storm Forecast Center) provided a McIdas workstation with 1km GOES imagery. This was also the beginning of using NWP models with their thermal layer (PBL) height information.

My Career in Weather...
Calculating Thermal Heights

- Radiosonde Obs
    - Use 12z or 00z local sounding
    - Estimate max temp for day
    - Find and interpolate nearest raob
    - Used the Skew-T plot to forecast thermal heights
   - Not a very good soaring forecast solution

Back in the day... one had to decode WMO encoded teletype bulletins containing the radiosonde observation and manually plot on Skew-T forms.

- Calculating thermals heights involved estimating max temperatures and using the "parcel method" to run a line up a dry adiabat line... intersecting the sounding.

- There was a lot of guessing, rules of thumb and "gut feeling" to how the soaring day would turn out.

My Career in Weather...
Calculating Thermal Heights

- Plotting Radiosonde's – Skew T Analysis
- Thermal Index
  - John Williams – Soaring 1955
  - Harry Higgins – Soaring 1963
  - Charles Lindsay – Soaring Meteorology for Forecasters - 1972
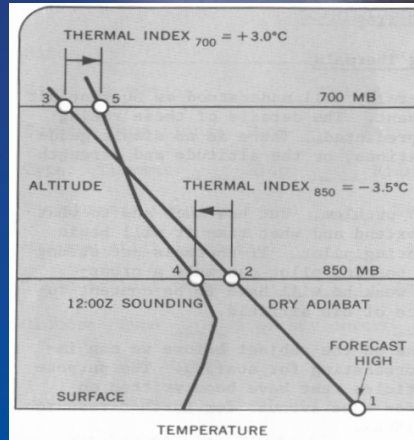
Ti -3 or less = very good chance for reaching this alt
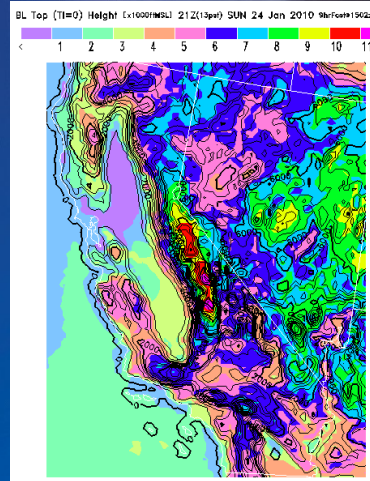
Dry thermals; no clouds

My Career in Weather...
Web Soaring Services >2000

- DrJack.net
  - Started 2000
  - First to use surface heat flux for thermal strength
  - BLIPMAP BLIPSPOT RASP
  - Many other parameters
- XCSkies.com
  - Started 2005 – Paraglider pilots
 - Google Maps type Interface

7

Big changes occurred after 2000... as the Internet took off. A Navy NRL researcher, Dr Jack Glendening... created a web service that displayed boundary layer (thermal height/strength) and other soaring information from the RAP and NAM models at that time. Chris Ghali, University of Utah, with his paraglider friends did the same with his web framework, XCSkies in 2005.

My Career in Weather...
Dr Jack BLIPMAP and RASP

- First to...
  - Get 3D Raw output from NOAA meteorological models (RUC/NAM)
  - Map display at 13-20km grid resolution. Shows horizontal details of thermal heights, cu cloud base, buoyancy/shear, etc
  - Compute "soaring" parameters from "meteorological" variables: Top of lift, thermal strength...
  - W-star "convective velocity" for thermal strength
  - RASP – Packaged community WRF Numerical Prediction model – outputs 1-4km nested soaring parameters
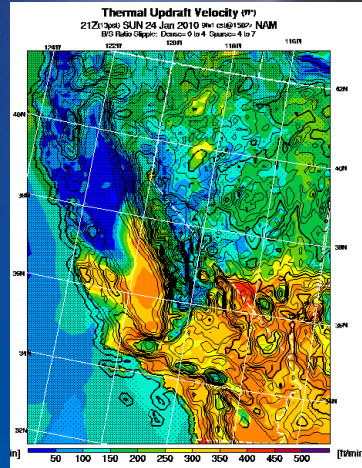
Dr Jack's framework for soaring forecasting over the United States made a huge difference for the gliding community.

Around 2005, Dr jack packaged a framework for generating his "soaring parameters" and running your own local version of the NWP WRF model on desktop PCs.

My Career in Weather…
Soaring Web Services 2023

- Skysight – Full service commercial soaring forecasts, task planning and analysis
- XCSkies – Commercial soaring forecast service
- TopMeteo – Full service commercial supported soaring forecasts
- RASP – Volunteer supported soaring forecasts based on DrJack.info parameters
- DrJack.info – Original Web Soaring Service by Jack Glendening. Free access with registration. Software frozen… not being developed

NWP Models Soaring Forecasts Table Summary - 2023

bit.ly/3IAMQWH

Here is a quick review of current (2023) Soaring Web Services.

Dr Jack still maintains his original NAM and RAP model soaring forecasts at: Drjack.info at no charge, although the code is frozen and no further development is expected.

Skysight has improved to the point of being the leading web soaring service, in my opinion, with many features added since 2018. TopMeteo, though has added features like an improved UI, better Sat and Radar… including mount wave forecast for Europe.

Not much has changed with XCSkies in the last 4 years (German global model ICON added). The site is maintained and continues to be tuned for snappy performance
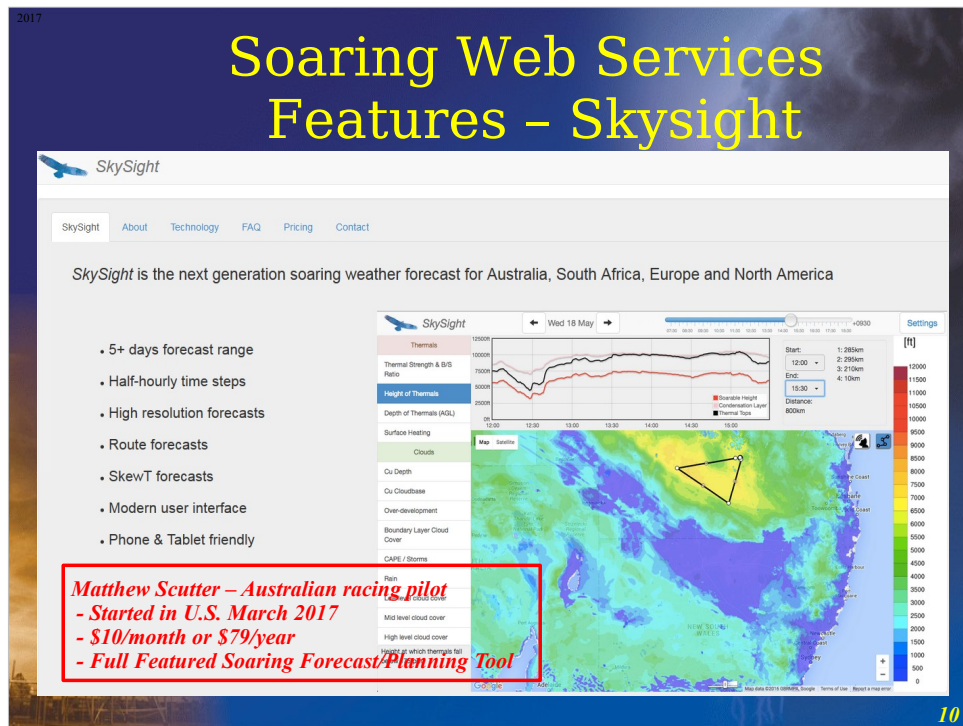
Matthew Scutter's Skysight.io has improved enormously from 2017.

Although at one time it used much of the RASP framework, Matthew has greatly enhanced the UI and many other details on how his WRF is configured. His past experience as a Google software engineer handling "Big Data" in the cloud projects has served him well deploying Skysight. Now, he has the time to glide, since maintaining Skysight can be monitored and configured remotely.

In his spare time, Matthew, races his Dianna 2 FES and travels to other International competitions. He placed 3rd in the WGC 2021 15m class and has won several Electric Glide contests.

Soaring Web Services Features – Skysight

Many NEW Features since 2018

- WRF models "Run in the Cloud" over several regions around world.. once each soaring day 8am-9pm local (plus one in evening for next day). ~2-3km grid for high resolution results
- Alternate view HRRR model soaring parameters 0-48hrs
- Skysight WRF forecast 6 days out
- Significantly modified from original RASP framework and User Interface. Fast rendering of contours, tiled zoom/pan, Skew-T point soundings, Time series plot for 3 days at one point
- Excellent in the mountains... convergence lines, mountain wave depiction
- Forecasts and observed satellite/radar data every 30 minutes
- Upcoming features: enhanced Land Surface Model and ensembles of models depicting uncertain "?" of forecasts.
- Create tasks, optimize for best weather, custom *.cup file waypoints, view airspace, uploads, notifications, overlay igc flights, etc
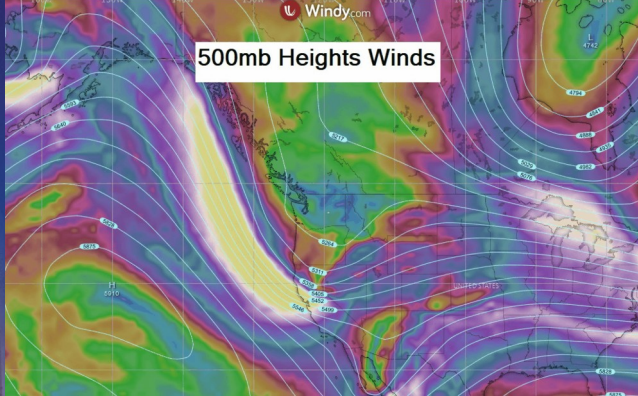
11

Skysight is far more than a soaring parameters forecasting service. It has evolved into providing task selection, optimization and analysis of flights.

Soaring Forecast Process
Analysis and Delivery
Windy.com – Great for Large overview

500mb Heights Winds

Video 8minute overview HowTo use Windy: bit.ly/3KD0DxF

Windy.com has grown and expanded into an outstanding NWP viewing service for many atmospheric parameters. In particular, it has excellent high resolution European model (ECMWF) global forecasts out to around 10 days.

Comparison with other global NWP models include the GFS and German ICON… including regional models such as the 3km HRRR and NAM over the U.S.

I especially appreciate the cloud forecasts from the ECMWF and others along with precip and thunderstorms for soaring forecasts. Ceiling, visibility, low, mid, high clouds make Windy a great tool for general aviation planning out to 10 days.

My forecast process now recommends use of Windy.com to understand the large scale before using the commercially available soaring web services.
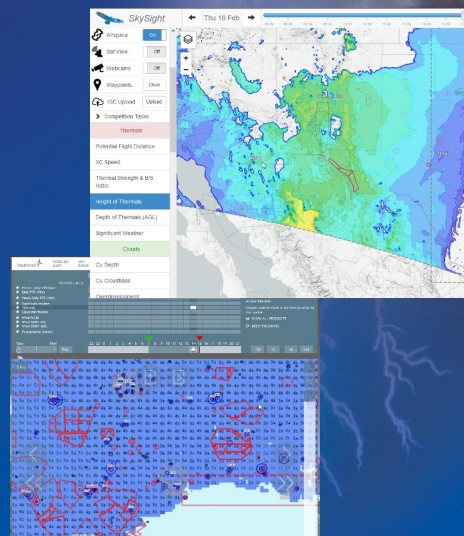
Web soaring service are specialized and do a great job of forecasting fair weather soaring conditions. But, when there are transitory weather systems, it really useful to check with other models to assess the timing and intensity. This is particularly true for patches of clouds cover, cirrus and developing convective (thunderstorm) systems.

Soaring Forecast Process
Analysis and Delivery
Prepare Presentation

- My preference is to use Markdown instead of Slides with rich text, graphics and videos – Hedgedoc.org
- A SYNOPSIS, TERMINAL WEATHER, and TASK AREA text discussion at top of document
- Creating scrollable document with media minimizes the complexity of formating inside the slide... It's a lot faster!
- Screen captures and videos files are placed in contest daily Dropbox.com folders
- Weather Briefing is transmitted to pilots as a URL to the document (email and text message). Corrections and updates on the server show up almost immediately
- Example...

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Over the last 4 years... I have migrated away from using slide presentations briefings (Libreoffice Impress or Powerpoint). Time is critical in preparing operational forecasts and the formatting to fit information into a screen is time consuming.

My delivery format of choice is now Markdown... creating a free flowing document of text, simple markup such as lists, images and with a bit of html short video animations to illustrate time sequences.

A Hedgedoc.org server allows rapid creation of a document with images/video stored in the "cloud" with something like Dropbox.

Delivering a briefing is simply providing a URL link making a beautiful document easily used on smartphones, tablets and PCs. After issuance, it's easy to make corrections for all to see.

Here my point is to show what a "Markdown rich media graphics and video" brief looks like. This was one of many briefing I deliver for the U.S. Soaring team in France 2021.

Voyager Flight Weather Team 1986 Non-Stop Around World

- First aircraft to fly around world without stopping or refueling
- Dick Rutan & Jeana Yeager
- Edwards AFB...EDW 26,359sm
- 9 days 4 minutes
- 7011 lbs fuel ... at landing 106 (18gals)
- 112 mph (9.77mph tail wind). 5000-10000 msl
- Lead by WR NWS Len Snellman and 13 others (4 from ZLA CWSU)
- An amazing IDSS Decision Support achievment from the weather team!
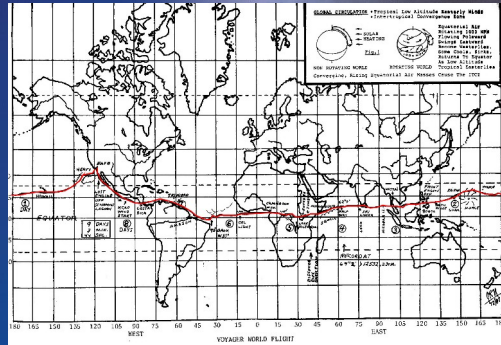
A truly amazing flight based on volunteers and donations of labor, time and equipment. The flight departed EDW AFB Dec 14, 1986... landing back on the dry lake 9 days later. I was there at touch down.

Basically navigating westbound and staying near the Equator between 5,000 and 10,000... they picked up 9.77mph of tail wind and dodged many thunderstorms and TCU (almost being flippped 90deg at night when flying through one). There were many dramatic moments throughout the flight.

The weather team was crucial to guiding the track. Three of us... Larry Burch, Hector Vasquez, Ken Modlin and myself worked around CWSU shift hours. I managed the DWIPS Satellite Display system (Clarence Boice). The ops center was served with dedicated leased phone lines driving several facsimile machines generating weather maps.

For the feat, Yeager, the Rutans, and crew chief/builder Bruce Evans received the 1986 Collier Trophy

World Gliding Championships
2012 Uvalde, TX 2012

Surface Obs Radars Raobs Sites

◇ RAOB
✚ NEXRAD RADAR

- Tasking support to contest director
- 115 gliders of 3 classes
- 14 days in August 2012
- Weather Team of Walt Rogers and Dan Gudgel
- Utilized Dr Jack web services BLIPMAP thermal forecasts
- BUFKIT model soundings from RAP, NAM and HRRR
- GOES 1km vis imagery
- Radiosonde from Del Rio
- NEXRAD and COSPA for convective forecasts

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This was the second World Gliding Championships (WGC) held at Uvalde, the previous one in 1991. Dan Gudgel and myself provided forecasts for both of these events.

Use of Soaring Web Services from DrJack.net aide in thermal forecasting. FAA's COSPA mosaiced radar, lightning data and Sat imagery provided short term convective forecasts from the HRRR model.

Soaring weather was spectacular during the event. Scattered cu were based at 9000-11000 ft msl. The only upsets to flying large tasks from 350-600 km each day… were when the sea breeze moving in from the Gulf Coast triggering thunderstorms.

Our "Decision Support" work day started around 0430 local time followed by a 0730 briefing of the Task Director… and then conducting a large pilot meeting around 9am.

Perlan II – 2018 *"The Vision"*

"I think there is evidence of a stratospheric wave structure that can lift a sailplane to 100,000 feet, a completely unknown, unexpected, significant structure," Einar Enovouldson said in 1992

We have succeeded. On September 2, 2018 our glider became the highest flying, manned, subsonic airplane in history. The Airbus Perlan II reached 76,100 feet pressure altitude exceeding the altitude of the U-2 Dragon Lady

Einar Enevouldson was a NASA Edwards AFB test pilot and specialized in high altitude aircraft. The turbo prop "Egret" used to tow to FL450 was test flown by Einar many years ago for the Grob manufacturer.

Einar was a contemporary of Paul Bikle at NASA. He is an old friend of Region 12 soaring… flying some competitions in his Diamant sailplane in the 1970s.

Perlan II - "*The Weather*"
Computer Models Simulations Showing
Mountains Waves In Stratosphere
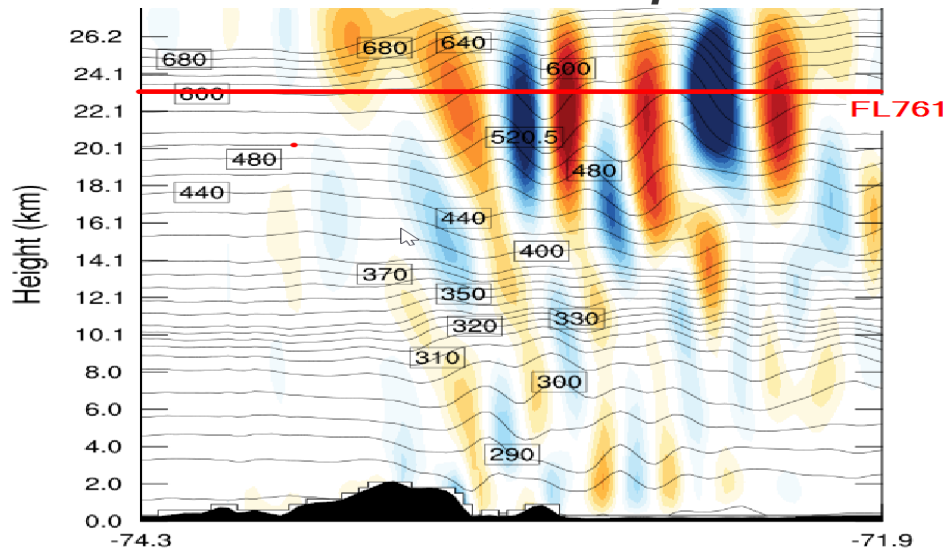
First, lets' view this 2:30 video summarizing the operations of Perlan

Forecasting "Weather" and when Stratospheric waves are occurring is one of the main challenges on the mission.

Here we see a WRF computer simulation of vertical velocity (m/sec) … along a cross section E-W over El Calafate. Red indicate strong "lift" up to 2500 fpm.

Perlan II - "*The Weather*"
Polar Vortex Cross Section
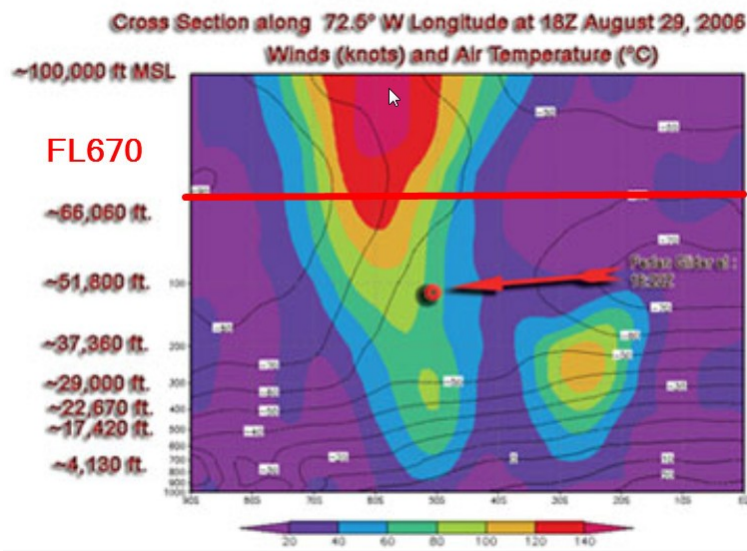
The key to why we are so far south… -50.2 Deg lattitude… is the existence of the Polar Vortex jetstream. Strong westerly winds circumnavigate the hemisphere in the winter season with wind maximums up to 200kts.

This chart shows a cross section … altitude to 100,000feet along a N-S line from the equator to the pole. That bright red area shows winds near 200kts coming out of the screen.

Stratospheric waves are excited by more conventional mountain waves from the troposphere. But, when the wind profiel/speeds increase with altitude...we see strong wave action.
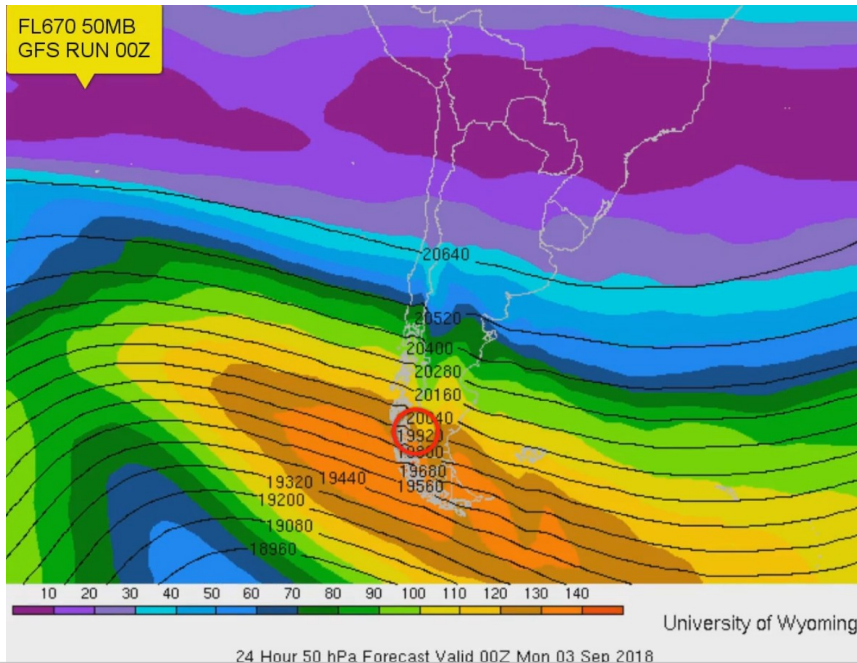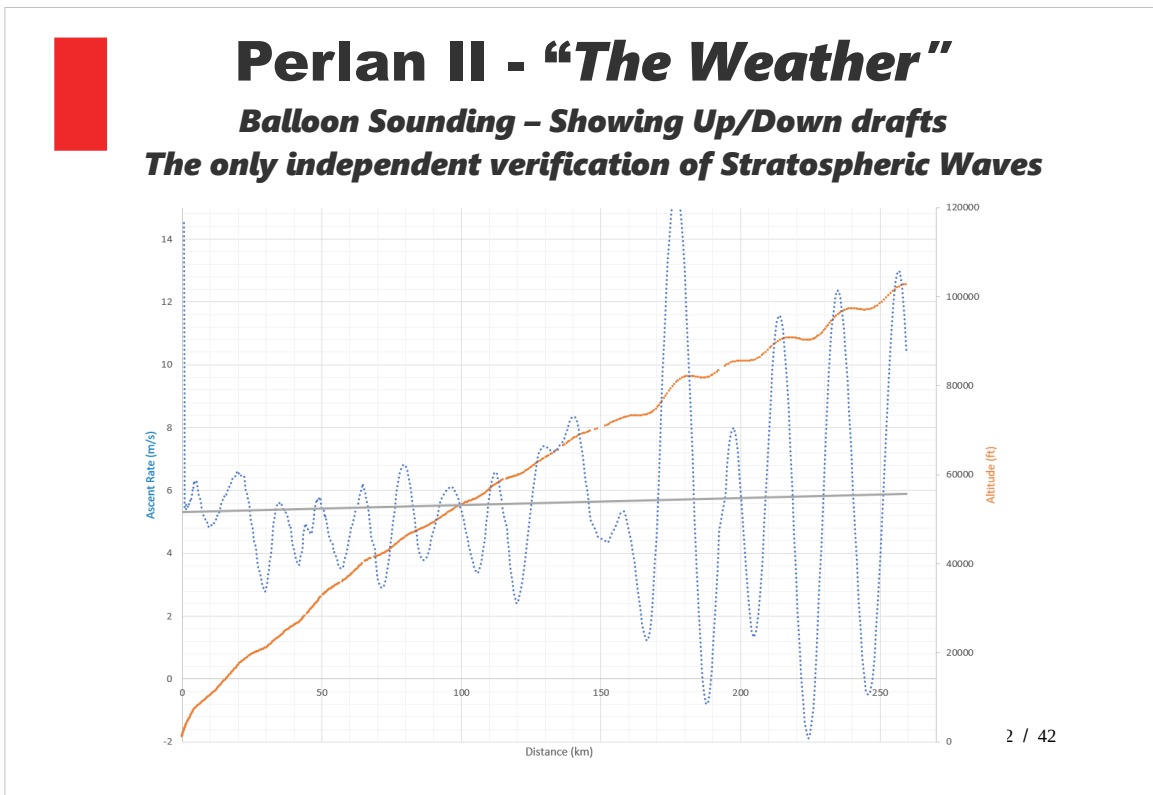
As meteorologist for Perlan, I constantly monitored global numerical models for the "Polar Vortex" jets… looking for when they would be over El Calafate.

Perlan II - "*The Weather*"

Balloon Sounding – Showing Up/Down drafts
The only independent verification of Stratospheric Waves

Radiosonde… or balloon soundings… were taken on most days. This chart shows the accent rate of the balloon (red/orange line) correlating with altitude on the right vertical label.

Blue dotted lines show the deviation from the mean ascent rate of around 5 m/sec.

The wide swings plus/minus show up/down drafts to 1800 fpm once the balloon reaches FL700 and above. The balloon breaks at around 80,000 to 115,000 feet.

These balloon soundings are one of the only independent indications of strong stratospheric waves.

Perlan II - "*The Weather*"

2D Maps of Skysight.io Showing Stratospheric Waves Up/Down Drafts with glider track
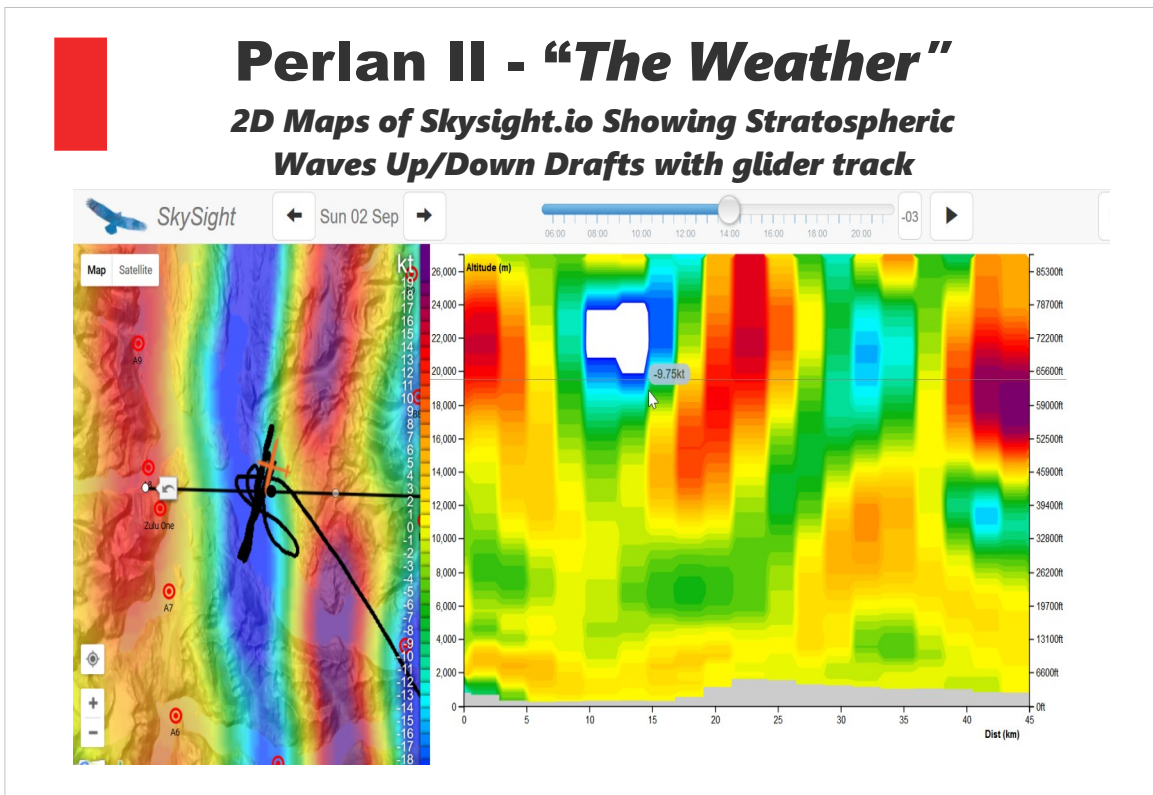
The Skysight.io soaring web site provided excellent stratospheric indications of these waves. Here, the red areaa are vertical updrafts … both on a 2D and vertical cross section.

Real time tracks of Perlan were available at the operations center (Capcom) and to the pilots on an Ipad in real time.

Matthew Scutter's Skysight was invaluable to helping located the optimum locations for climbing high into the stratosphere.

Perlan II - *"The Weather"*

Dan Gudgel and Walt Rogers – Briefing Challenges

- Find a day with a "Polar Vortex" Jet Increasing wind speeds at altitude above FL600
- Look for Stratospheric Waves from high resolution models
- MW's in Troposphere (<FL350) at least weak to moderate
- Avoid IMC (clouds) and rain below FL350… also cross winds or high winds takeoff/landing
- Let the "Egret" towplane take Perlan to FL450!

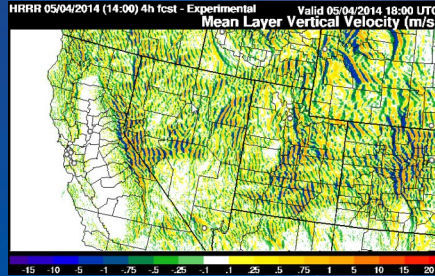This summarizes the job of the weather men delivering briefings.

High altitude tows from the "Egret" towplane allowed both Dan and I to concentrate less on the normal weather, clouds, tropospheric mountain waves… and more on finding the optimum days for strong stratospheric waves.

In previous campaigns, much more time was required for Prlan to climb in Tropospheric mountain waves.

Two Place Glider 877 mi Record
Boettger – May 2014

- 20meter Duo-Discus two place glider
- Gordon Boettger and Hugh Bennett
- Walt Rogers acted as "Flight Dispatcher" and weather consultant
- Tracked GOES imagery
- HRRR model Mountain Wave patterns
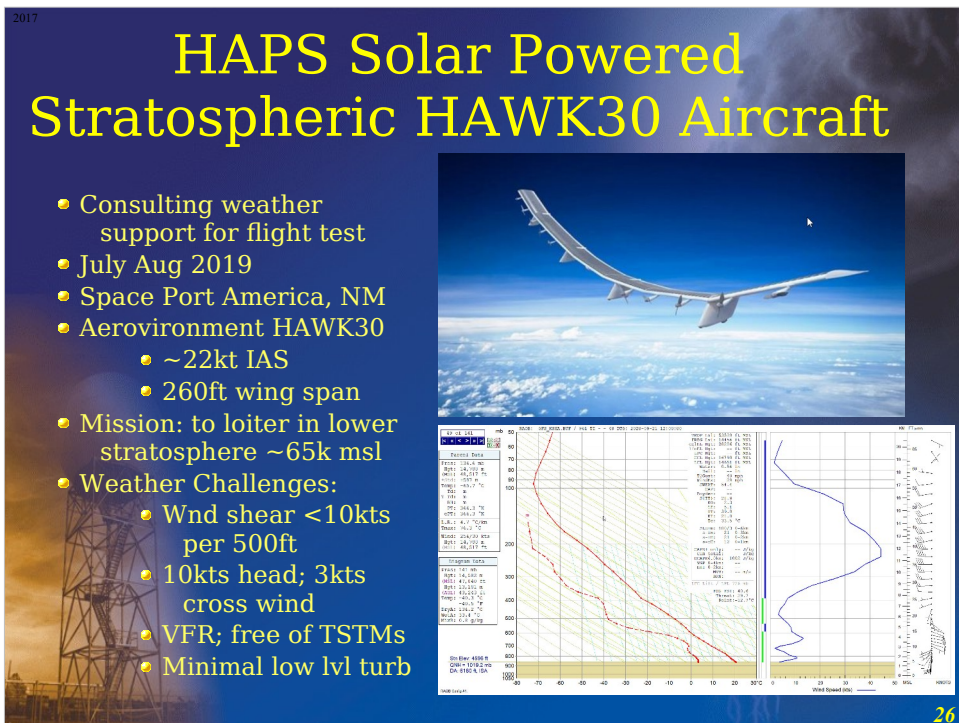- Communicated by Iridium Satellite Phone
- BLOG QR Code:

Over the last 4 years... I have migrated away from using slide presentations briefings (Libreoffice Impress or Powerpoint). Time is critical in preparing operational forecasts and the formatting to fit information into a screen is time consuming.

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Delivering a briefing is simply providing a URL link making a beautiful document easily used on smartphones, tablets and PCs. After issuance, it's easy to make corrections for all to see.

For weather support I utilized all the tools used for soaring event forecasts... Model soundings from HRRR and GFS, Skysight.io WRF modeling for turbulence forecasts, local winds and convective (TSTM) forecasts.

A morning radiosonde observation was separately contracted by Aerovironment.

Long term planning on the wind profile to 70,000msl was displayed as a time series forecast out 5 days based on RAOB.com and a GFS model sounding.

The strength of the jetstream wind profile was important for flight planning.

Very low level... <500agl... drainage winds at sunrise in the river valley sometimes generated localized wind shear turbulence from "drainage" gravity flows.
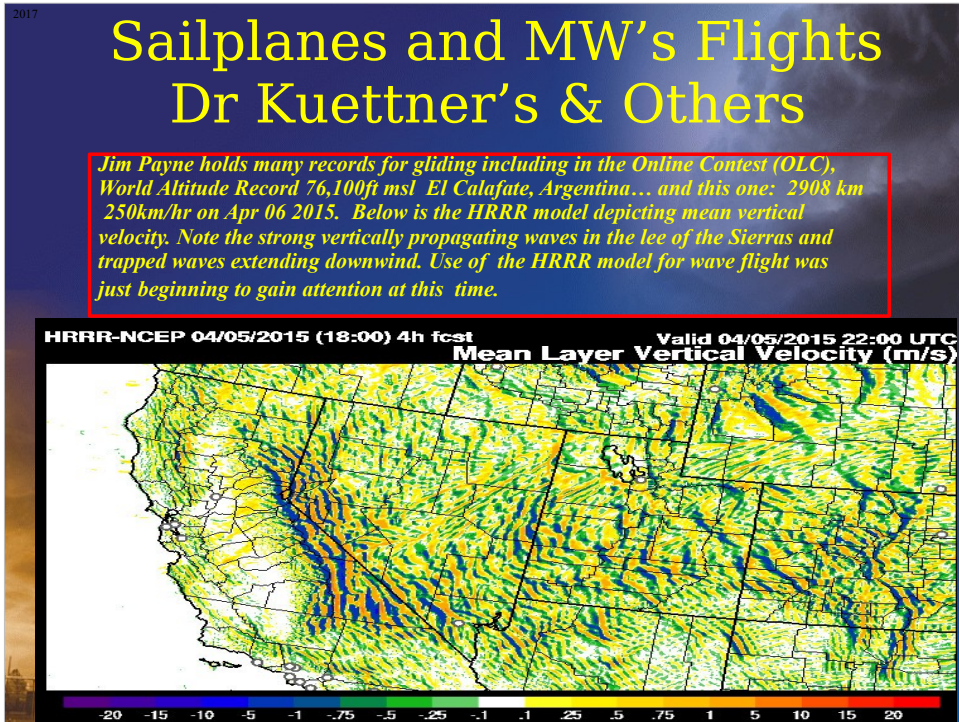
Mountain Waves (MW)

- On Nov 2021, I presented: "On The Need for Mountain Wave Forecasts" to the FAA at research conference with NCAR and FAA
- Severe MW's difficult to detect by pilots with conventional obs
- NWP HiRes forecasts i.e. Skysight and HRRR have been identifying it for last 10yrs
- Highlighted history of MW Soaring since 1950's
- Case Study: Malibu PA46 fatality Tehachap Feb 13, 2021
- SUMMARY:
  - Better training required for all pilots
  - NWS and Aviation products/warning inadequate for MW hazards especially severe downdrafts
  - Operational NOAA NWP HiRes models can adequately describe much of the MW structure

The objective of this presentation was to educate senior scientists and FAA managers about the hazards of MW's. Dr Sharman is the chief expert for the FAA for developing NWS's (Aviation Weather Center) Turbulence Products.

MW's are not considered turbulence…none-the-less are significant hazards to aviation

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

Jim Payne holds many records for gliding including in the Online Contest (OLC), World Altitude Record 76,100ft msl El Calafate, Argentina… and this one: 2908 km 250km/hr on Apr 06 2015. Below is the HRRR model depicting mean vertical velocity. Note the strong vertically propagating waves in the lee of the Sierras and trapped waves extending downwind. Use of the HRRR model for wave flight was just beginning to gain attention at this time.

HRRR-NCEP 04/05/2015 (18:00) 4h fcst   Valid 04/05/2015 22:00 UTC
Mean Layer Vertical Velocity (m/s)

-20 -15 -10 -5 -1 -.75 -.5 -.25 -.1 .1 .25 .5 .75 1 5 10 15 20

Jim Payne holds many national and world records for gliding including multi year Online Contest (OLC.org) championships. On this particular day in 2015, Jim achieved "three laps" multi segments setting the OLC record for the U.S. at 2908 km. The flight started in Minden, Nevada and included turnpoints near Inyokern or Mojave, California.
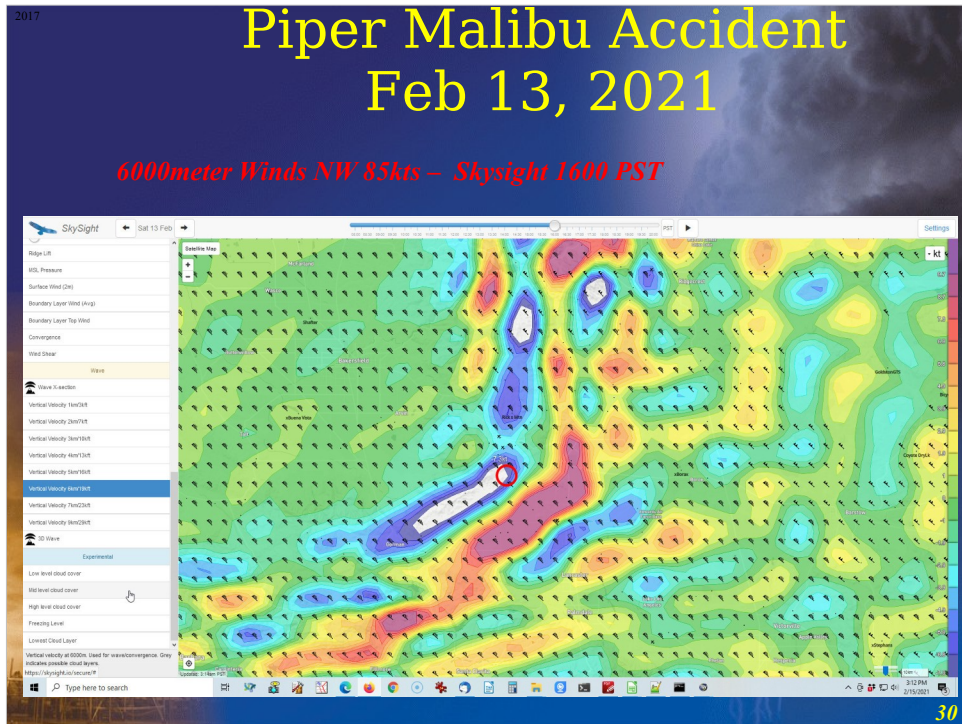
The HRRR model clearly shows the near continuous wave along the Sierras.

Jim, who is with us today in the workshop… is also the holder of the World Altitude record … not only for gliders.. but all subsonic aircraft.. 76,100msl (Perlan II project). If we have more time, I'll show two interesting supplementary graphics of this Stratospheric MW from WRF modeling.. and a radiosonde balloon ascent rate oscillation. The goal of reaching 90,000msl appears achievable. With the world recordf light, Perlan was climbing at 500fpm (equivalent to 1500fpm due to density altitude) when the climb stopped due to flight test restrictions. The WRF model shows the stratospheric wave getting stronger above 76,000ft.
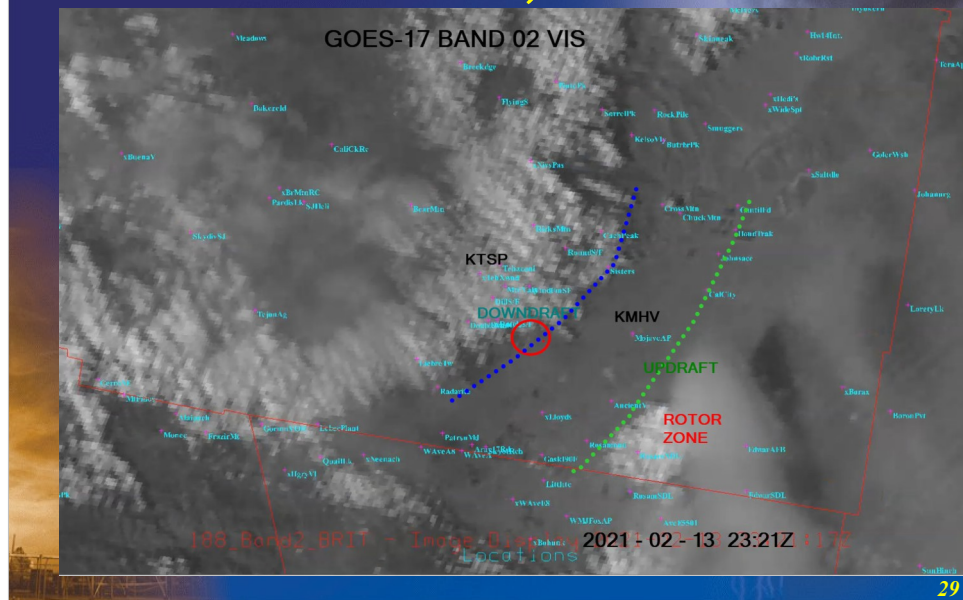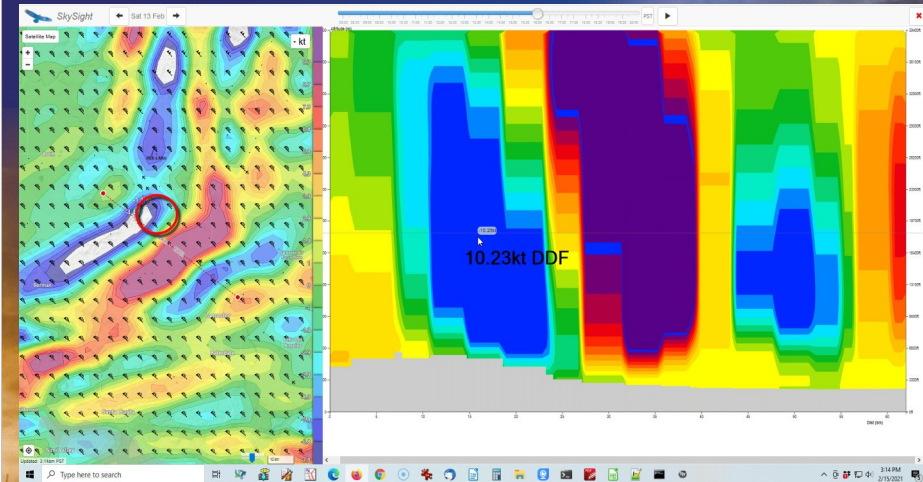
This is the GOES-17 BAND 02 (0.5km visible) image at the time of the accidnet. The high based standing lenticulars are well downwind to the SE with rotor clouds below. A green line estimate the region of strong updrafts. The blue dashed line is the approximate location of the severe downdraft… overlying the red circle accident site.

Here's the Skysight 2D vertically velocity at 6000m indicating the strong downdraft near the accident site (red circle; blue indicates downard motion).

Skysight allows interactive locating of cross sections for the mountain wave vertical velocity. This graphic shows the severe downdraft with an estimated velocity of 1000fpm.

It is clear to me that operational NWP high resolution models can adequately identify MW's, their intensity and approximate location. Turbulence forecasts from these models continue to be a challenge due to their sensitivity to modeling numerics, parameterization and our scientific understanding.

My recommendation is to add a Mountain Wave Advisory guidance product to the GTG suite. It will provide much enhanced situational awareness to all pilots. Forecasts of severe downdrafts in an advisory format could also be added further bringing pilot awareness of mountain wave activity.

Investigating individual Skew-T soundings can consume precious time during a soaring analysis and forecast preparation. In recent years, I've been primarily creating time/height series plots of thermal heights, wind and clouds. My instances of actually looking at a sounding have decreased in frequency.

Radiosondes are infrequent (every 12hrs) and sparse even in the United States. Windy's model forecast soundings do not have much details. That's why I still occasionally use BUFKIT high resolution soundings either in the BUFKIT viewer or RAOB.com

Forecast Tools and Software
BUFKIT Sounding Viewer

- High resolution modelsoundings HRRR,NAM,RAP,GFS, NAM3km
- Two Windows – PROFILE view and OVERVIEW time series
- 600+ sites in U.S. BUFKIT
- Mixed Layer (thermal) Height; T, Td, RH, Winds,Precip
- Strange user interface... but useful for detail forecast soundings
- Software nearing end of life – Visual Basic

http://www.wdtb.noaa.gov/tools/BUFKIT/

I still use BUFKIT for viewing model soundings. You can read a lot more about it in my 2016 SSA presentation... including some video tutorials.

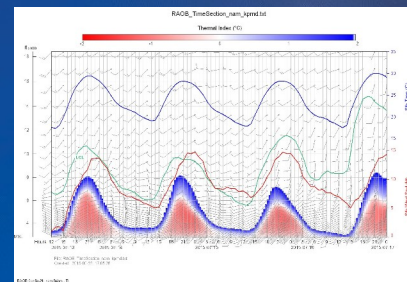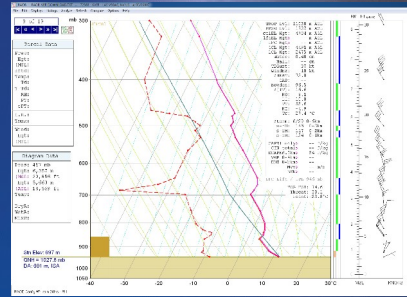Time Series Plots of thermal height... and many other parameters

Learning BUFKIT is not too steep... but installing, setting it up and collecting the high resolution BUFKIT sounding files and can be challenging. I use some custom scripts to access the BUFKIT files.

NWS is looking for a replacement to BUFKIT because the software written in Visual Basic is really beyond end-of-life.

2017

Forecast Tools and Software
RAOB.com

- Most complex RAOB sounding analysis tool available
- Produces beautiful time series thermal plot graphics
- Commercial product
- Outstanding technical support
- Basic Program - $100; Analytic Module - $50; Cross Section Module - $120 – Total $270
- Steep learning curve
- Batch commands – semi-automatic production of graphics
- Software nearing end of life – Visual Basic

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There have been only very minor changes in RAOB.com for my use in soaring forecasting over the last 5 years… like these BUFKIT examples and time series plots of thermal height.

Because of my custom scripts and setup, it's relatively fast to generate these graphics. I'm not planning on documenting my work. It's highly dependent on your PC environment and skills.

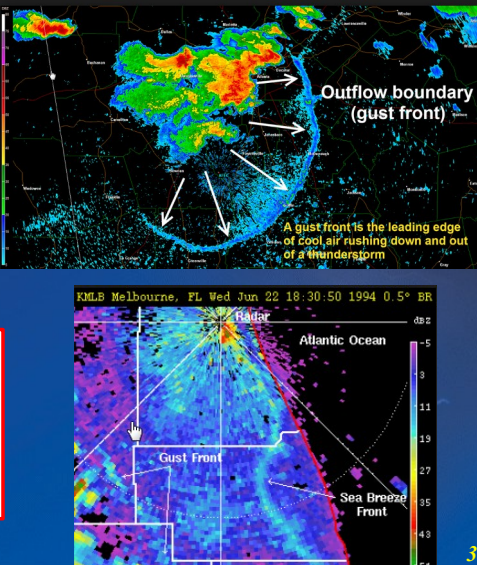My scripts are bash shells running in Linux on Win 10 with WSL2… accessing Dropbox folders for the station files.

Observaton Tools and Software
RadarScope – PDA App

- Low Latency High Res Data!
- You can see clear air outflow boundaries, sea breeze fron and sometimes shear lines
- Precip hydrometeor types including hail
- Lightning data animation…
- Shows NWS warning polygon
- Great tool for after landing… Decide on "boxing it up"

In my opinion, RADARSCOPE is the best PDA app for gliding… It will use GPS to Display current location. Can import JSON custom waypoints

Radarscope.app

It's great for pre-takeoff and post-landing decision support … "Do I de-rig tonight. ?"

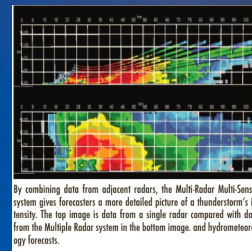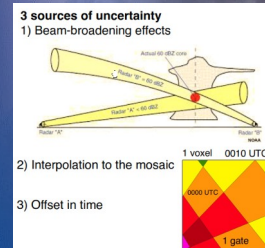Never have used it in the cockpit … probably because things are already getting too busy there. It's now possible to load customized waypoints using a JSON file.

No comparable commercial Radar app for professional use with it's level of detail

With low thresholds of radar intensity (reflectivity) it can see features like these… sea breeze front and outflow boundaries around showers or thunderstorms

Observation Tools and Software
Mosaiced Radar - MRMS

- MRMS - Multiple Radar Multiple Sensors mosaics, numerous products, great quality control
- NOAA's National Server Storm Laboratory system for NWS, FAA and commercial companies
- Publicly available viewer
- Can view history... back months or years. Time steps 2mins, 30mins, hourly, etc
- On going research to provide the best mosaiced NEXRAD system around
- Publicly available grib2 files for incorporating into you own products

3 sources of uncertainty
1) Beam-broadening effects

Actual 60 dBZ core
Radar "B" > 60 dBZ
Radar "A" < 60 dBZ
Radar "A"   Radar "B"
NOAA
1 voxel   0010 UTC

2) Interpolation to the mosaic

0000 UTC

3) Offset in time

1 gate

By combining data from adjacent radars, the Multi-Radar Multi-Sensor system gives forecasters a more detailed picture of a thunderstorm's intensity. The top image is data from a single radar compared with data from the Multiple Radar system in the bottom image, and hydrometeorology forecasts.

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This is one of the best systems around … developed around 2017 from NOAA for mosaicing radars into a variety of products. Now all the agencies, NWS, FAA, and most commercial companies rely on it.

It's called Multi Radar Multipe Sensors (MRMS).
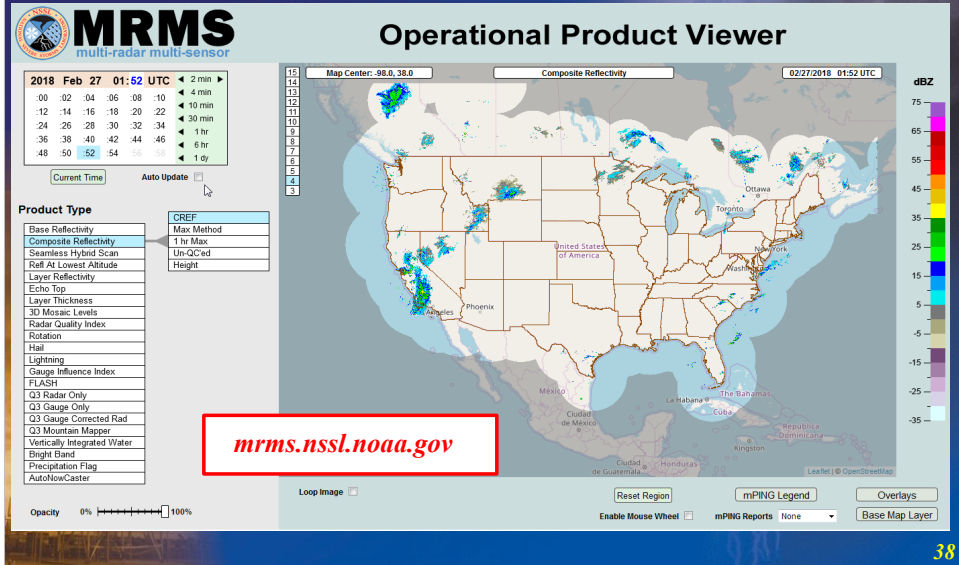
With the public viewer one can go back days, months or years to view radar imagery at a variety of of time steps.

And… for you aspiring developers… there are publicly available grib2 (gridded data) available

The best quality control… and very low latency for use in real-time

Here's what the Operational Product Viewer of MRMS looks like

Observations
UAS Copter Sondes

- Operational models need low level pbl soundings
- A 3D Mesonet concept is being developed to use quad copter for 1-3km vertical soundings
- Testbeds are in operation last 3yrs around world
- Biggest challenge is airspace... FAA.
- Univ Oklahoma testing one with mm radar geofence
- Meteomatics has a commercial automated system

With our Meteodrones, we now reach an altitude of 6000 metres. By continuously improving the airframe, reducing the weight of the components and using the latest battery technology, we now offer two powerful systems whose different characteristics allow them to be used for different applications.

Drone Models

The Meteodrone MM-64/SSE is the smaller, lighter drone that can fly at higher speeds. The Meteodrone MM-670 (ML), on the other hand, is more suitable for commercial use or reconnaissance missions and can be adapted with different instruments to fit custom requirements if necessary.

Sensors and Measures
- Temperature
- Pressure
- Relative humidity
- Dew point
- Wind speed and direction

Meteodrone MM-64/SSE

*Meteomatics White Paper: bit.ly/3IFZune*

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In order to improve all kinds of NWP forecasts... from global models of climate change all the way down to thunderstorm forecasts and soaring weather, much better vertical observations are need in the pbl <3km agl. That's why there has been an increased interest in these UAS Coptersonde vehicles.

I'm hoping that we could use one for the Uvalde 2024 WGC

Observations
Ceilometer Lidar

- Ceilometers have long used LIDAR to detect cloud cover for ASOS, AWOS
- Newer Vaisala CL51 CL61 models have a data port to show backscatter of aerosols that detect pbl
- Research to operations managers in the meteor community see this as another way to measure pbl
- Uvalde's AWOS may be able to upgrade to one of these newer ceilometers

CL61 lidar ceilometer with d
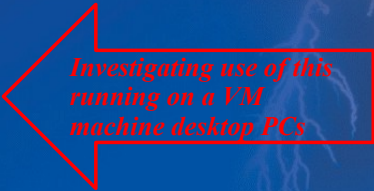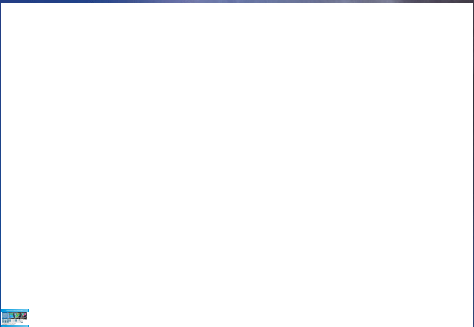Filling the gap between research instruments an
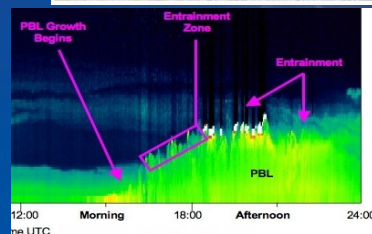
Europe has a ceilometer network not just for cloud cover at their METAR sites. They have taken the next step to access pbl height from the backscatter of aerosols.

Hmmm…. Maybe that's because of all the glider activity. No plans for National Weather Service to do this, yet. But, research programs are certainly exploring options for setting up an operational network.

Software Visualization Tools
Unidata IDV and AWIPS II

- Unidata's Integrated Data Viewer (IDV) is a freely available 3D geoscience visualization and analysis tool
  - NWP grids, GOES, NEXRAD
  - Time/height displays
  - UI steep learning curve
- AWIPS II Workstation
  - Unidata gives access to EDEX data server on "JetStream"
  - Easier and more familiar for operational forecasters
  - Publicly available software

Investigating use of this running on a VM machine desktop PCs

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Unidata's AWIPS II software is now in BETA testing a CAVE (Display client) running on a VMWARE (freely available) virtual machine. Their "Jetstream" cloud hosts the EDEX server (for data, satellite, radar, models grids).

I just recently tested this on my Win10 desktop, and it was very easy to install and setup. There are some limitations regarding use of special features requiring an Nvidia GPU. It wasn't immediately obvious what the limitation is.

It is possible to install the CAVE software directly on a Linux box running Centos 7 with an Nvidia GPU... avoiding (reportedly) those limitations.

I think this may be a good solution for supporting projects like the ones discussed in this presentation.

The End...
Spectacular Soaring!

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