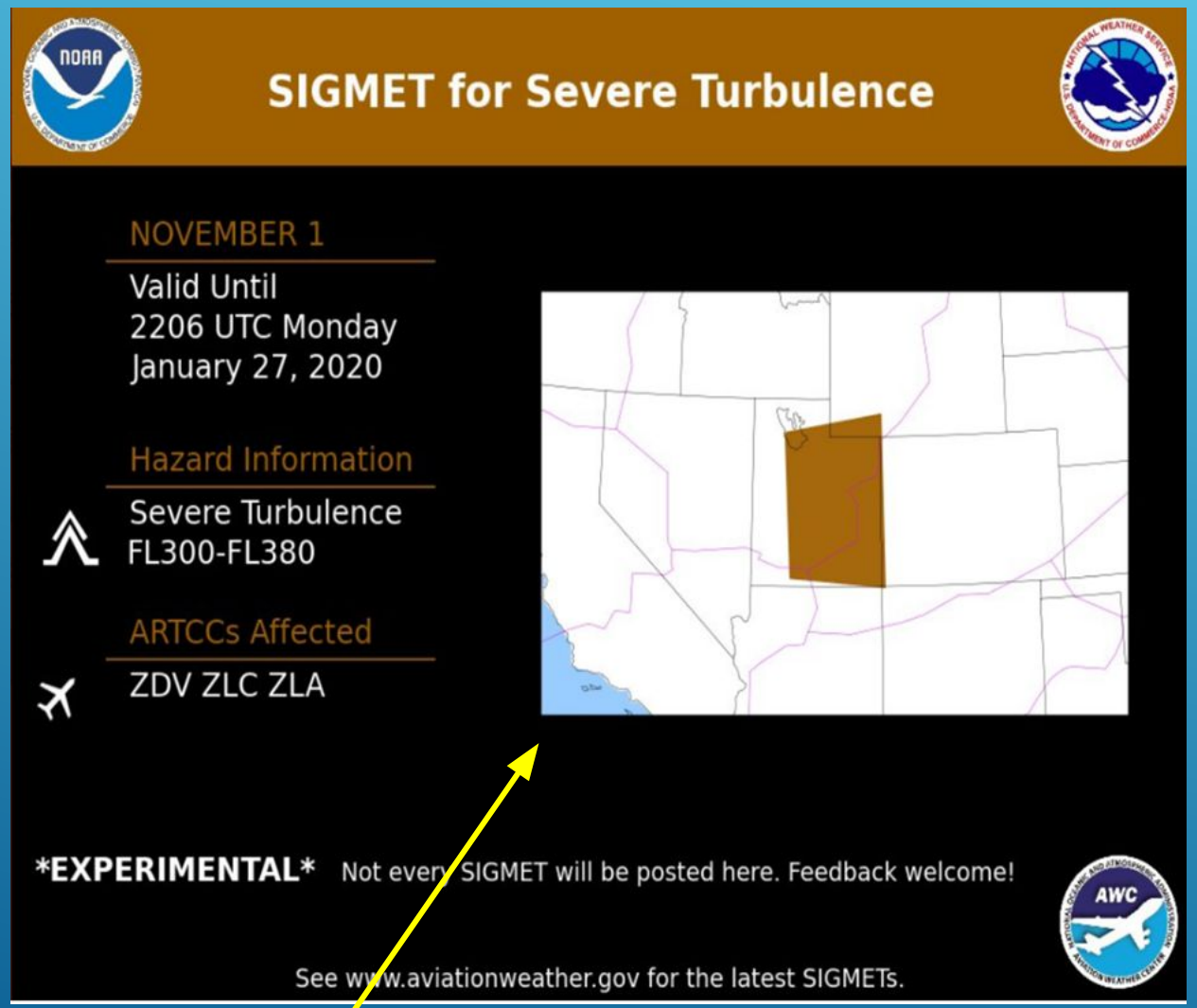
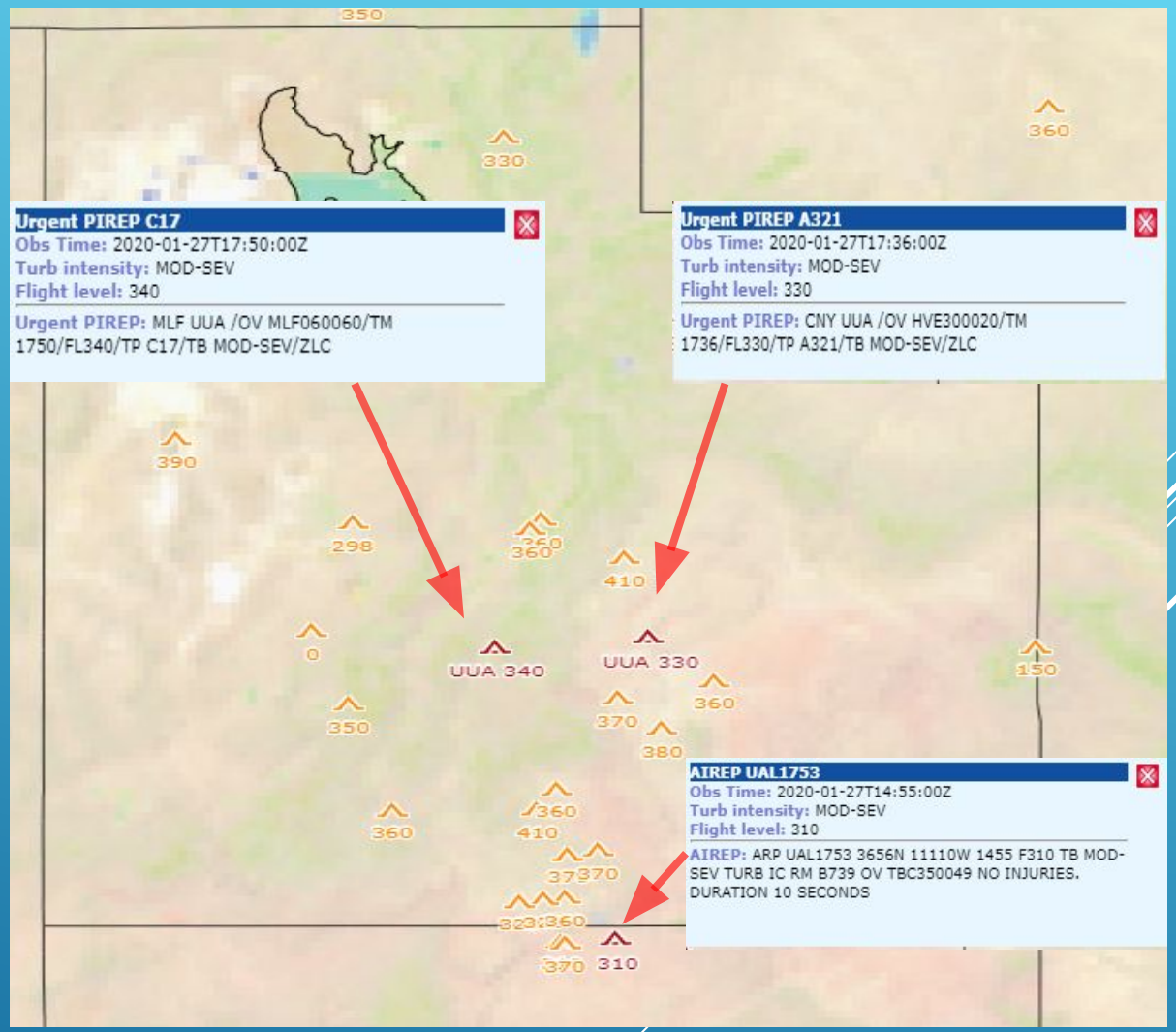
JAN 27th, 2020 MOUNTAIN WAVE SEVERE TURBULENCE EVENT





Automated graphics on NWS AWC Twitter. You can follow on Twitter "@NWSAWC"

These multiple severe pireps reinforce the issuance of the NOVEMBER #1 SIGMET for SEVERE TURBULENCE.

THE UPCOMING SHEAR TURBULENCE INDICES SUPPORT THE DECISION FOR EXTENDING NOVEMBER #1 SEVERE TURB SIGMET.

SIGMET for Severe Turbulence

NOVEMBER 1

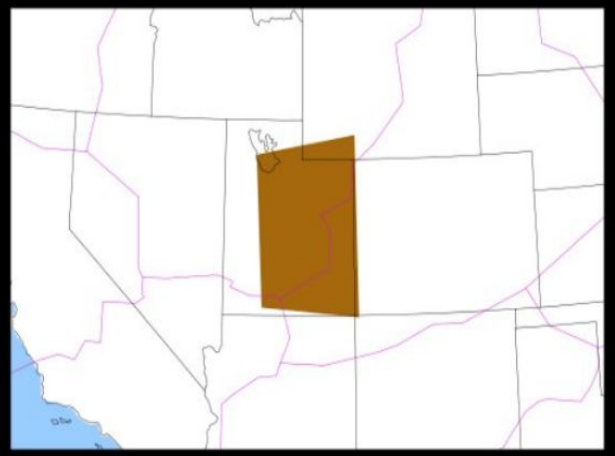
Valid Until
2206 UTC Monday
January 27, 2020

Hazard Information

Severe Turbulence
FL300-FL380

ARTCCs Affected

ZDV ZLC ZLA



EXPERIMENTAL Not every SIGMET will be posted here. Feedback welcome!

See www.aviationweather.gov for the latest SIGMETs.

SIGMET for Severe Turbulence

NOVEMBER 2

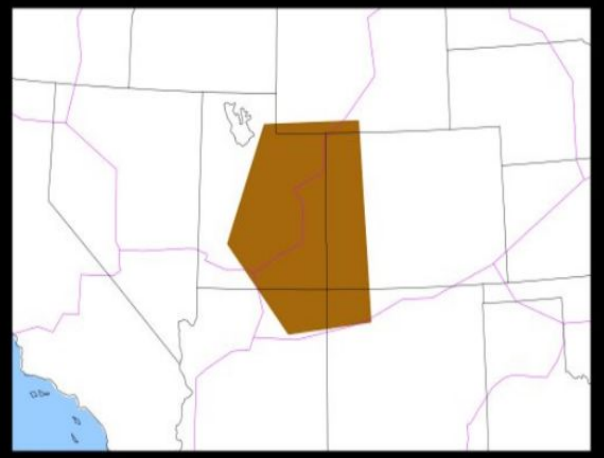
Valid Until
0203 UTC Tuesday
January 28, 2020

Hazard Information

Severe Turbulence
FL300-FL380

ARTCCs Affected

ZDV ZLC ZLA

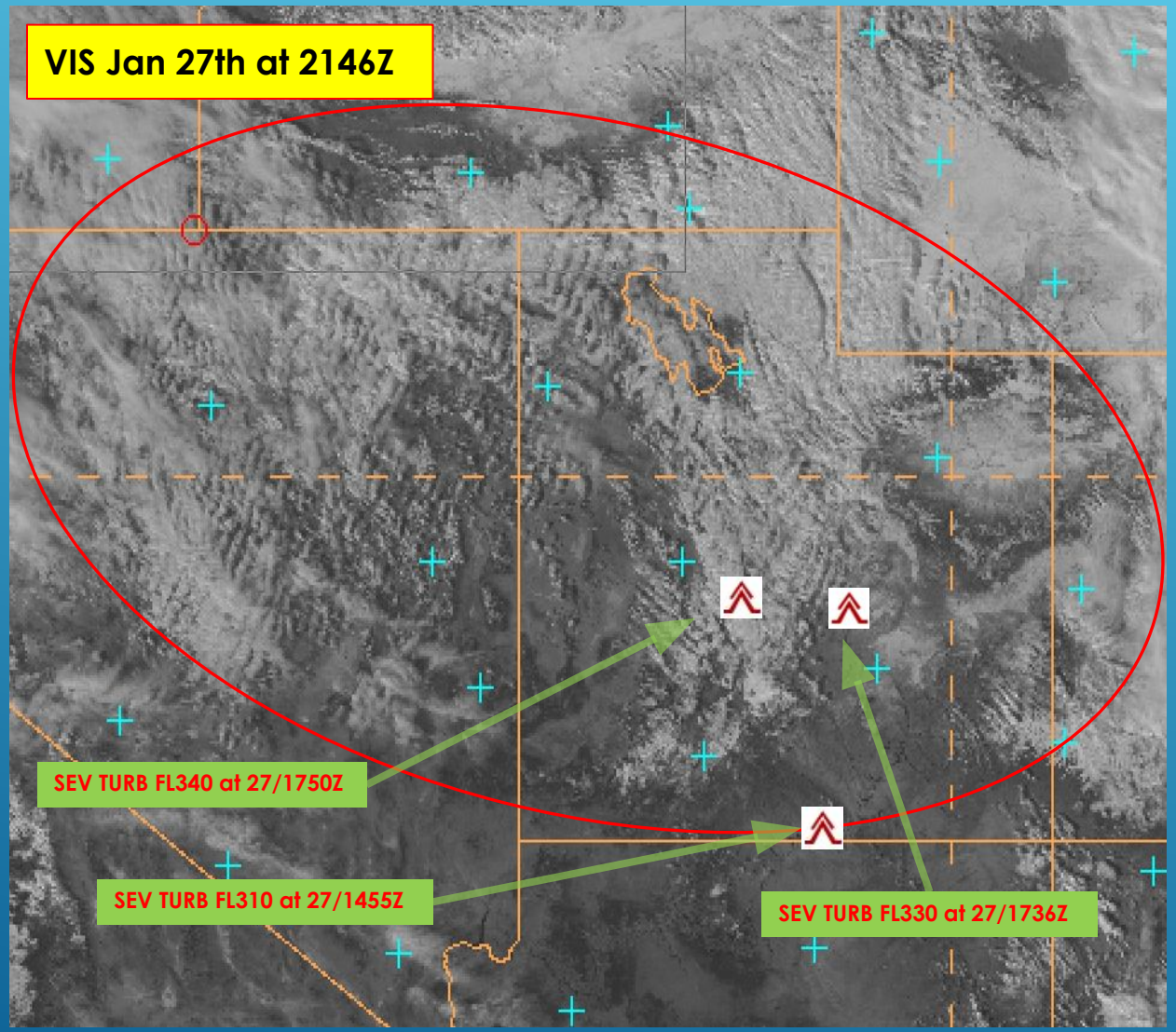


EXPERIMENTAL Not every SIGMET will be posted here. Feedback welcome!

See www.aviationweather.gov for the latest SIGMETs.

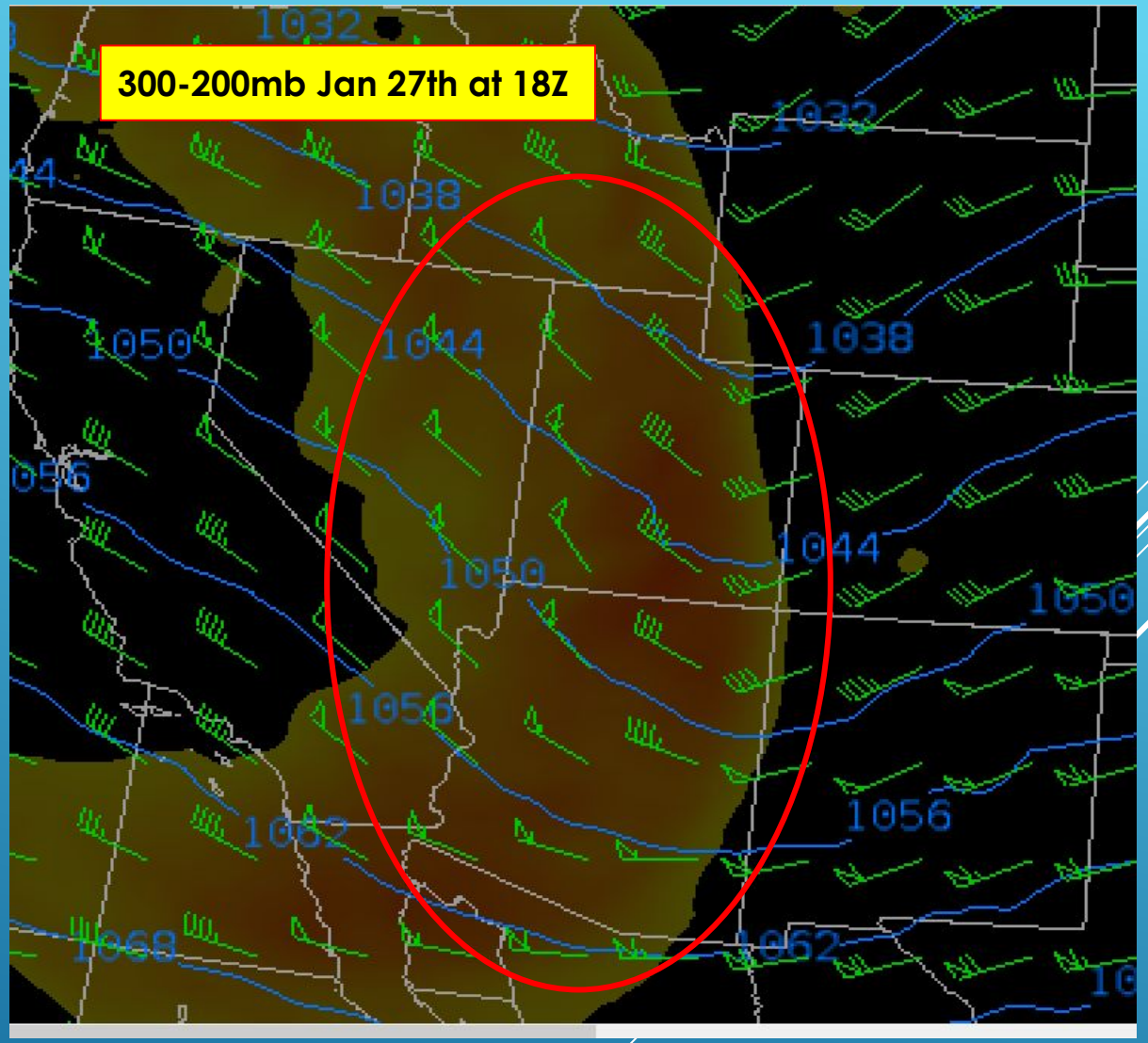
Automated graphics on NWS AWC Twitter. You can follow on Twitter "@NWSAWC"

GOES16 VIS 0.64um Red Jan 27th, 2020 at 2146Z



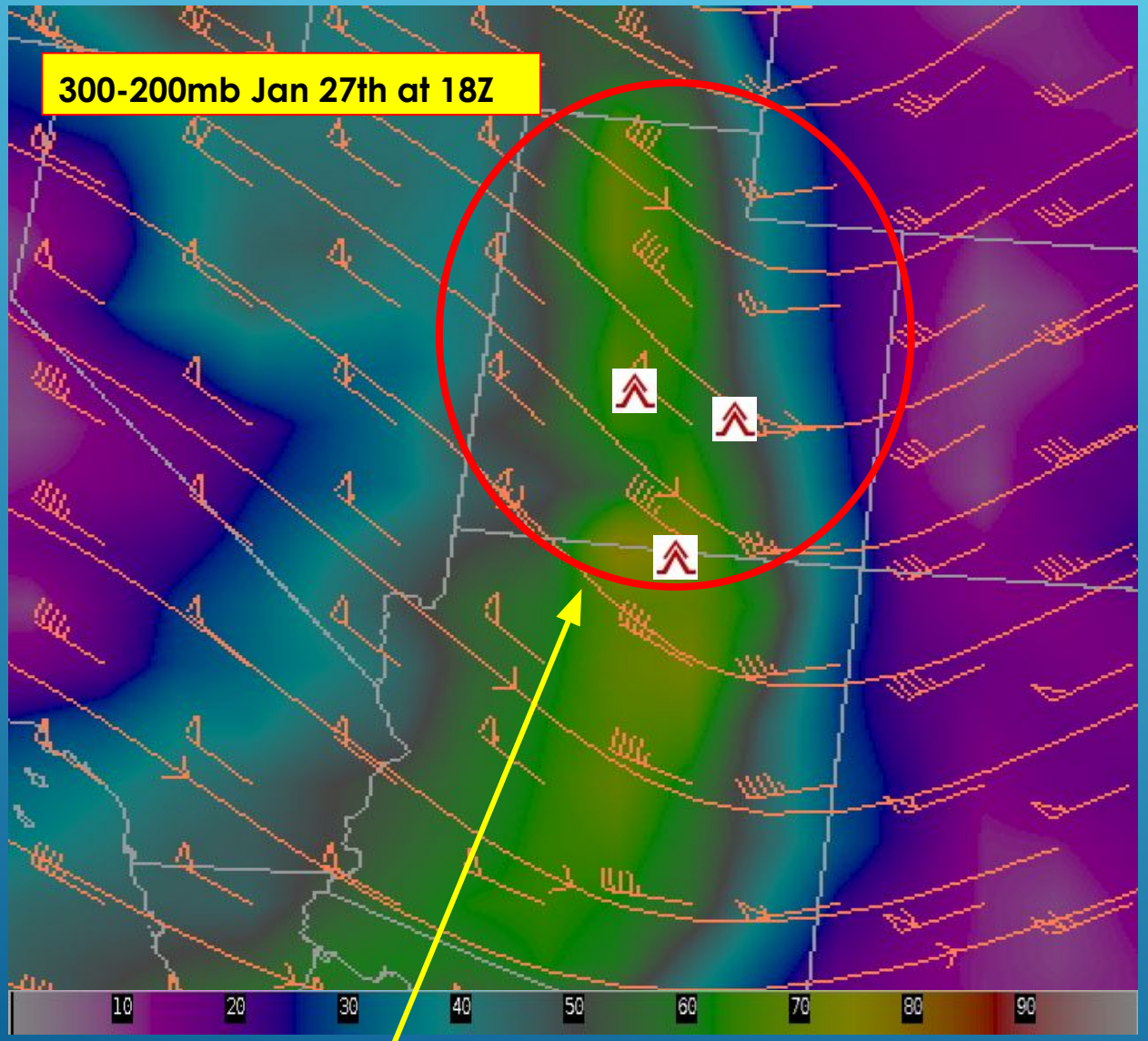
The red oval depicts trapped lee mountain waves throughout the Southwest region.

GFS20 300-200mb Shear Mag Img/Wnd Speed/Hgts Jan 27th, 2020 at 18Z



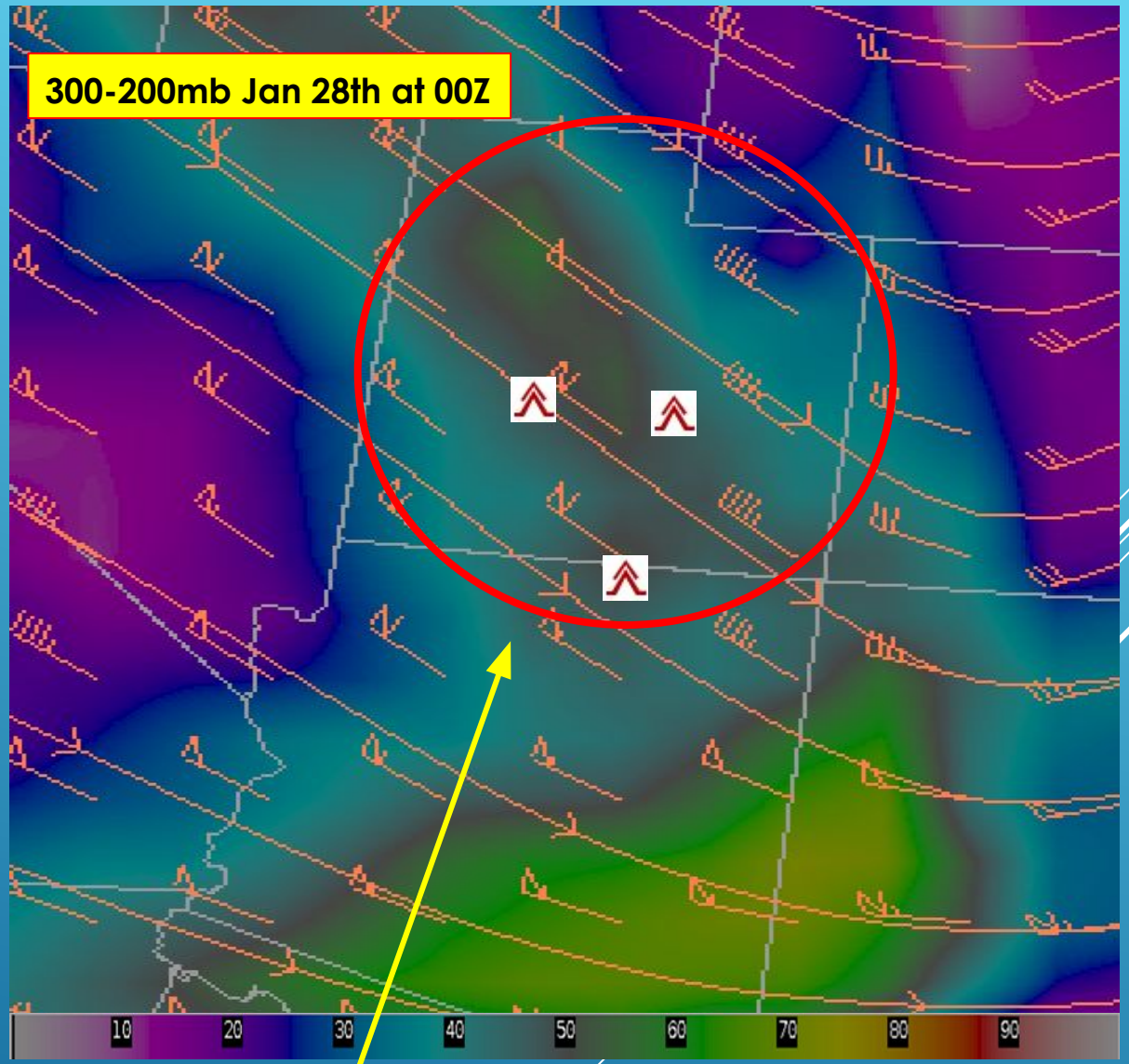
The red oval displays upper level trof and coincides with large swath of shear moving thru the region.

NAM80 300-200mb Bulk Shear Mag Img/Wnds/Streamlines Jan27th, 20 at 18Z



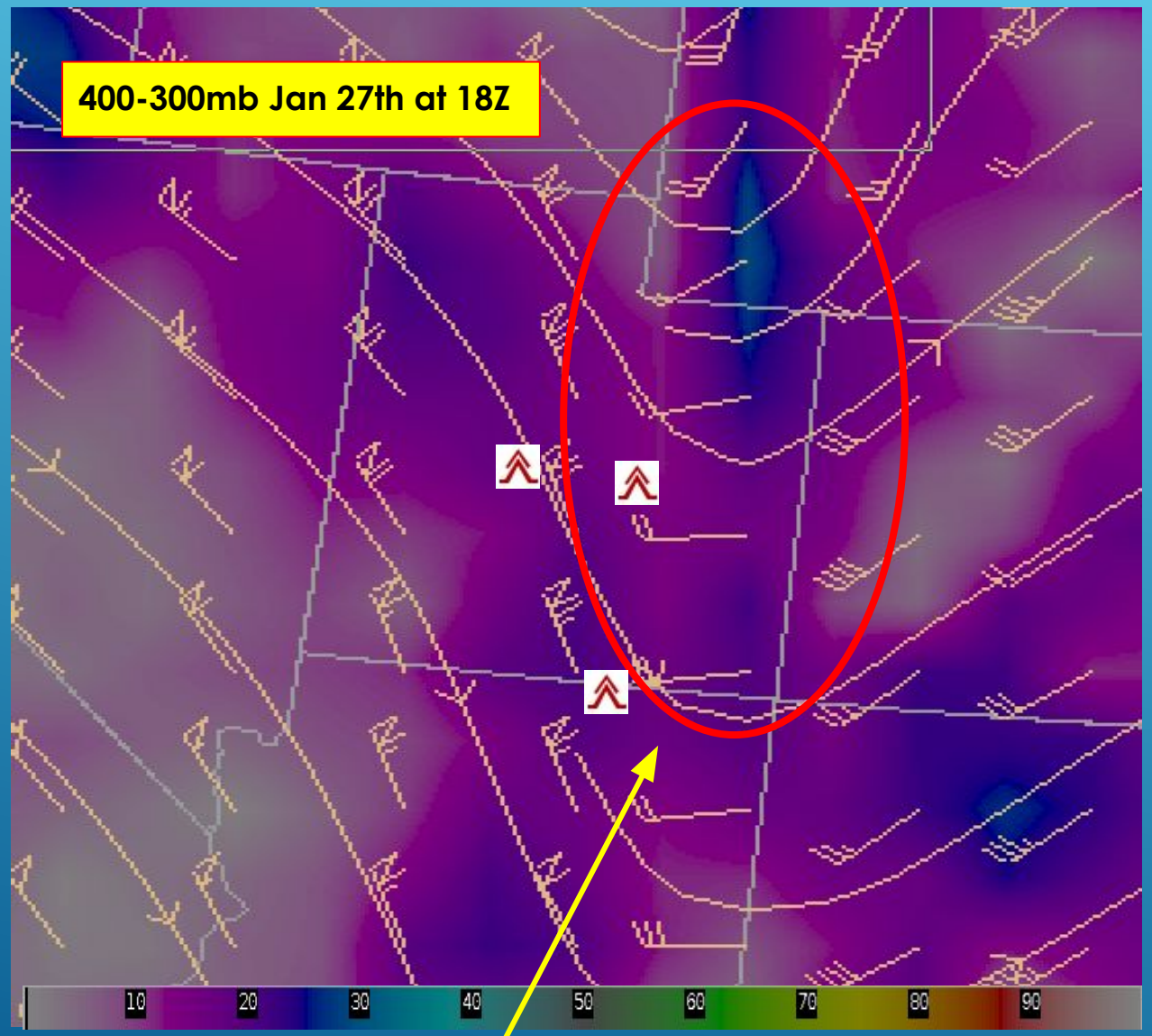
The Bulk Shear Mag Image in the red oval is showing good potential for severe turb. As well, the streamlines are depicting a trof axis over the region..

NAM80 300-200mb Bulk Shear Mag Img/Wnds/Streamlines Jan 28th, 20 at 00Z



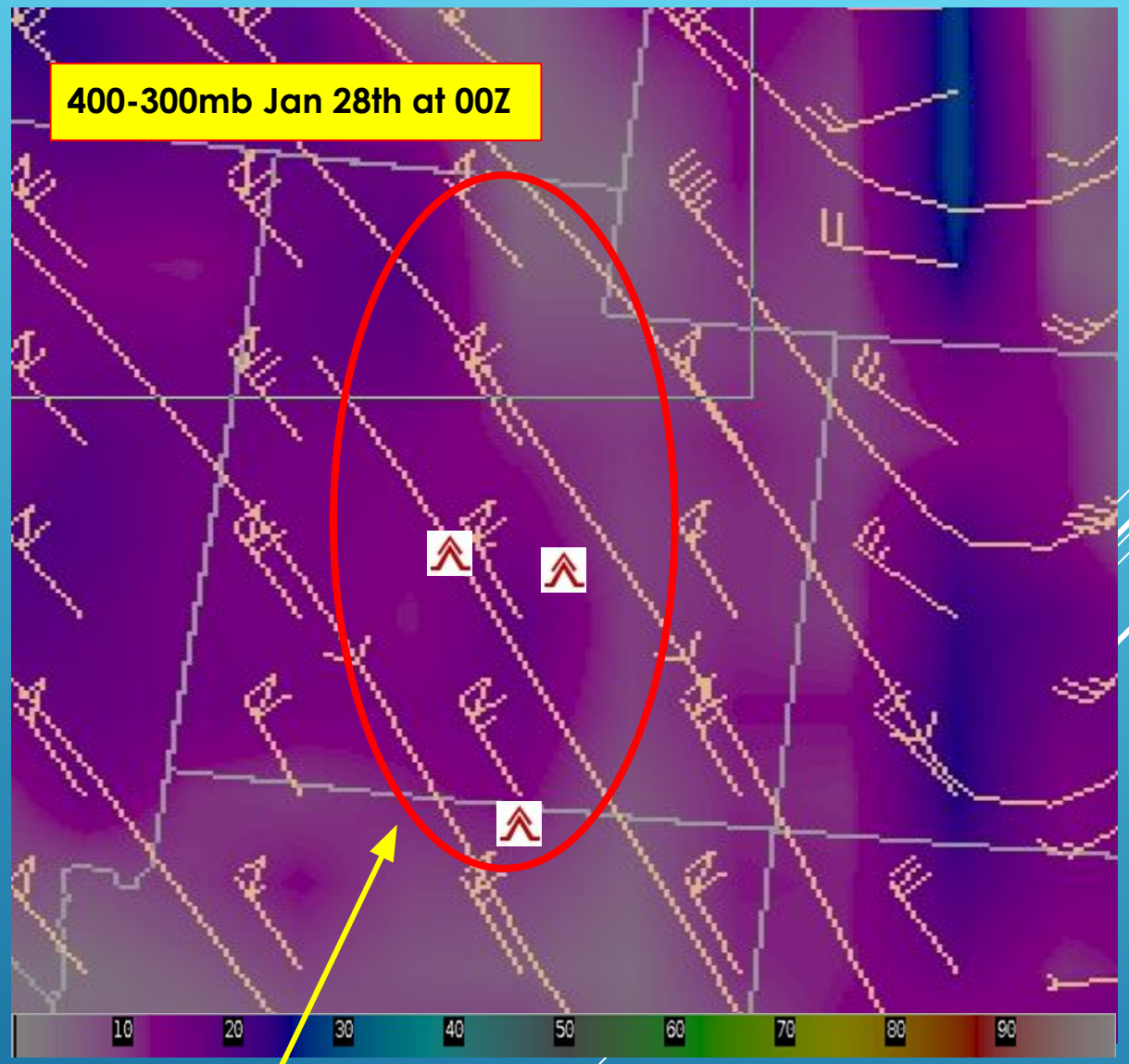
The Bulk Shear Mag Image by 28th at 00Z still shows good shear and wind direction for favorable cross-barrier flow.

NAM80 400-300mb Bulk Shear Mag Img/Wnds/Streamlines Jan 27th, 20 at 18Z



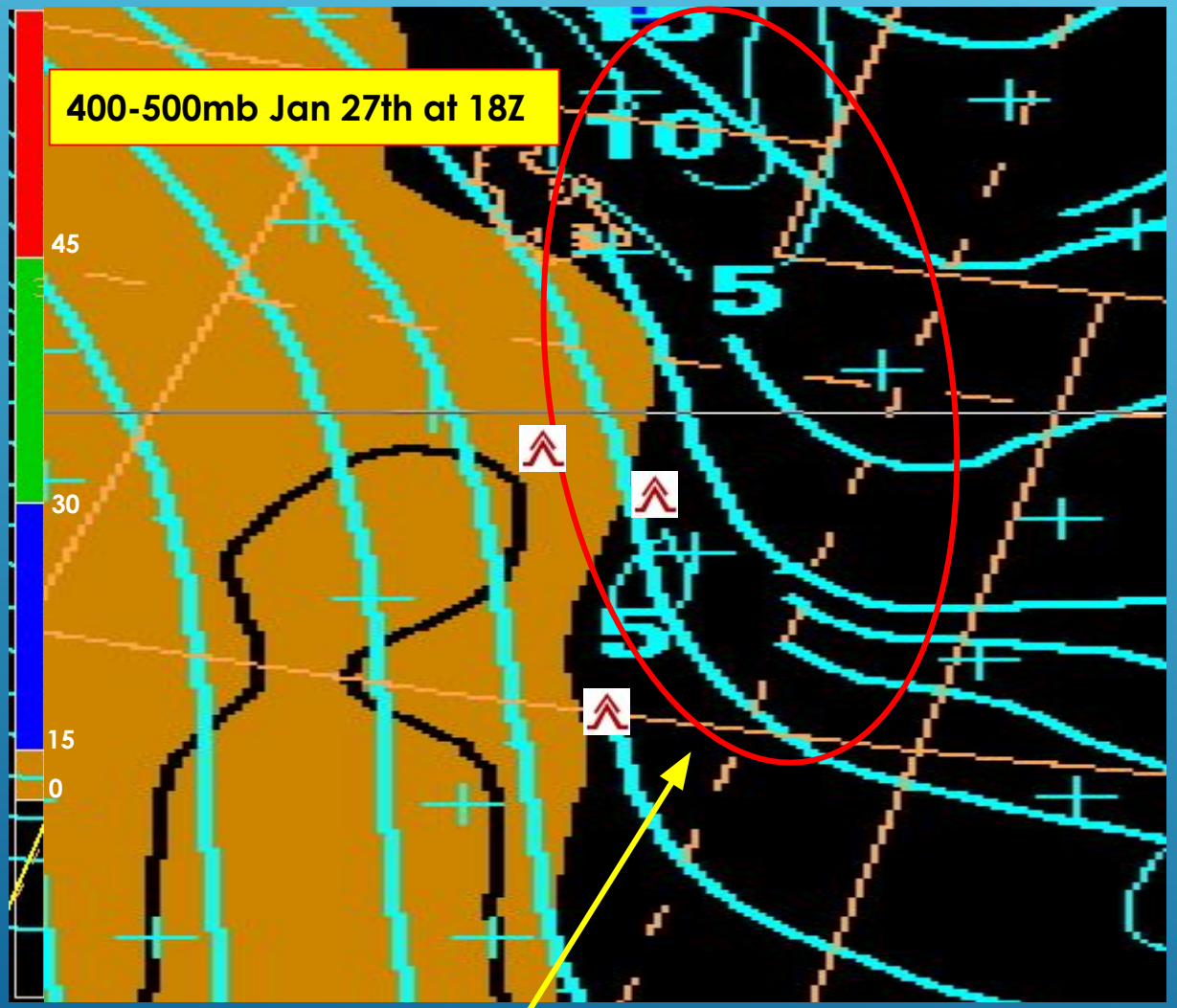
The Bulk Shear Mag Image depicts weak shear, but the winds are showing a good speed shear zone.

NAM80 400-300mb Bulk Shear Mag Img/Wnds/Streamlines Jan 28th, 20 at 00Z



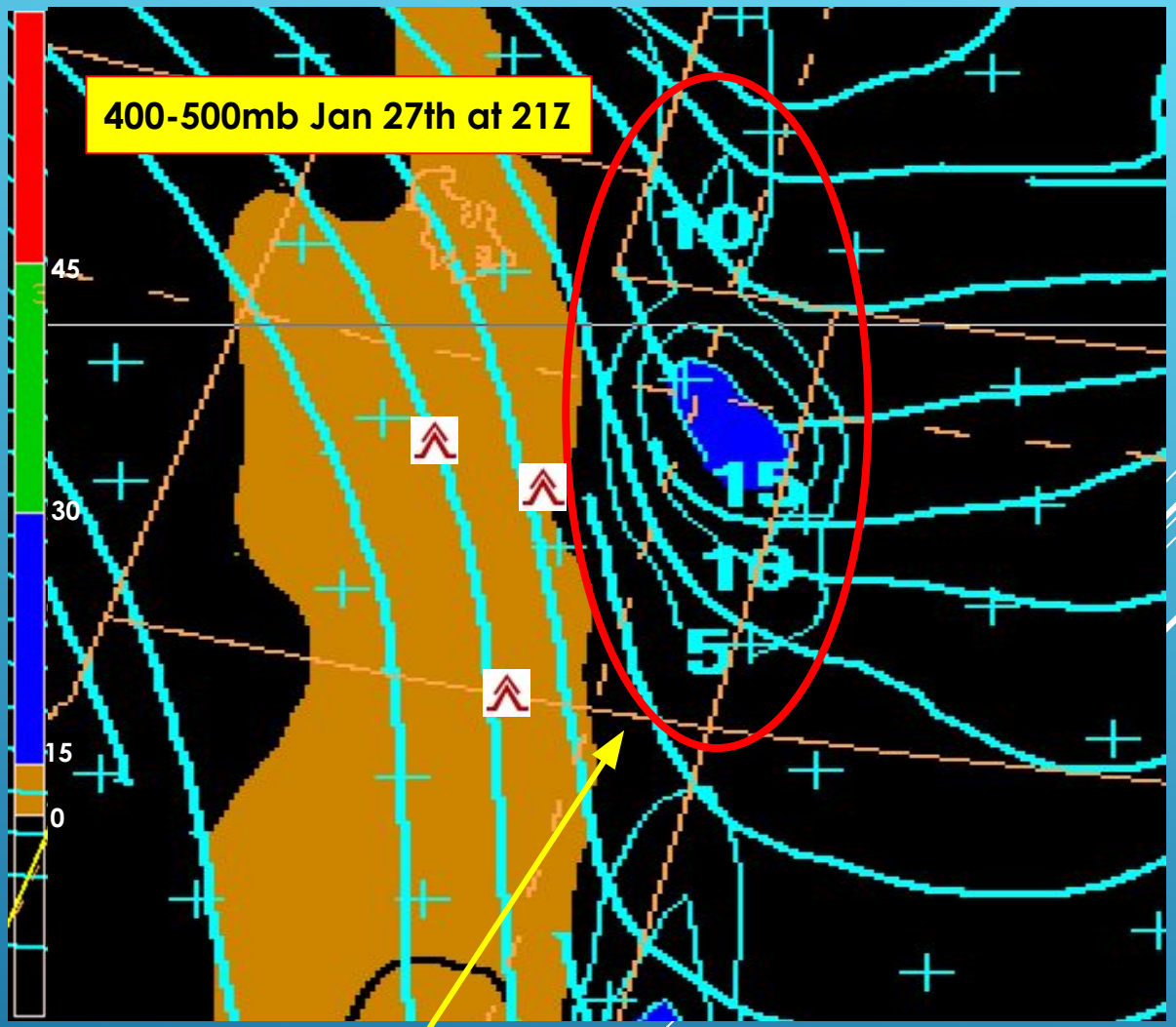
The Bulk Shear Mag Image shows really weak shear on 28th/00Z, but the wind direction remains in good cross-barrier flow.

NAM 400-500mb TKE Shear Buoy Prod/Dissipation Jan 27th, 20 at 18Z (FL180-240)
NAM 500mb Streamlines & Wind Jan 27th, 20 at 18Z



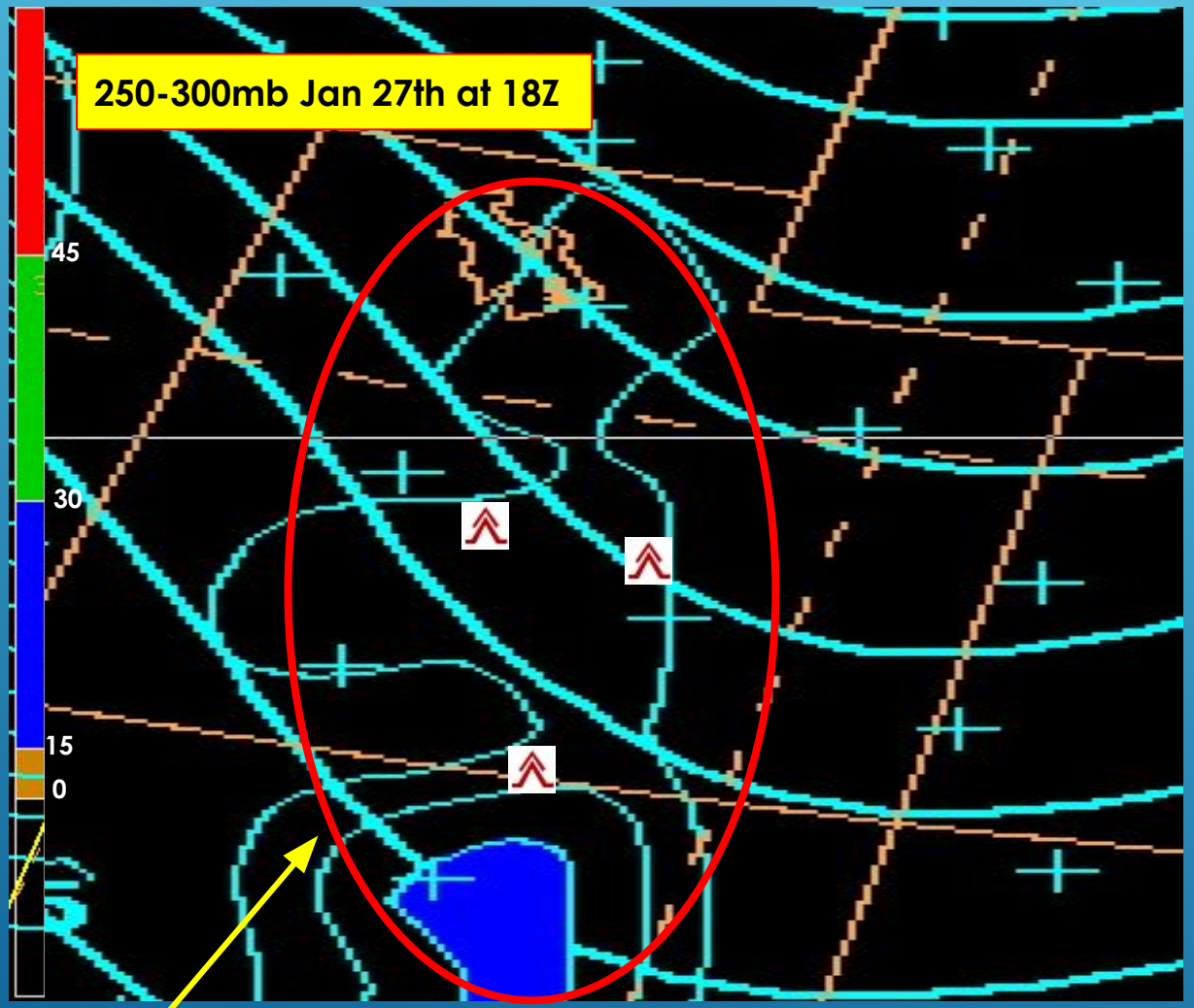
The Shear Buoy Prod/Dissipation depicts really weak shear, but the the Streamlines depict a trof axis over the eastern Utah region. This weak shear in the lower levels will help the vertical wave to propagate upward to upper levels.

NAM 400-500mb TKE Shear Buoy Prod/Dissipation Jan 27th, 20 at 21Z (FL180-240)
NAM 500mb Streamlines & Wind Jan 27th, 20 at 21Z



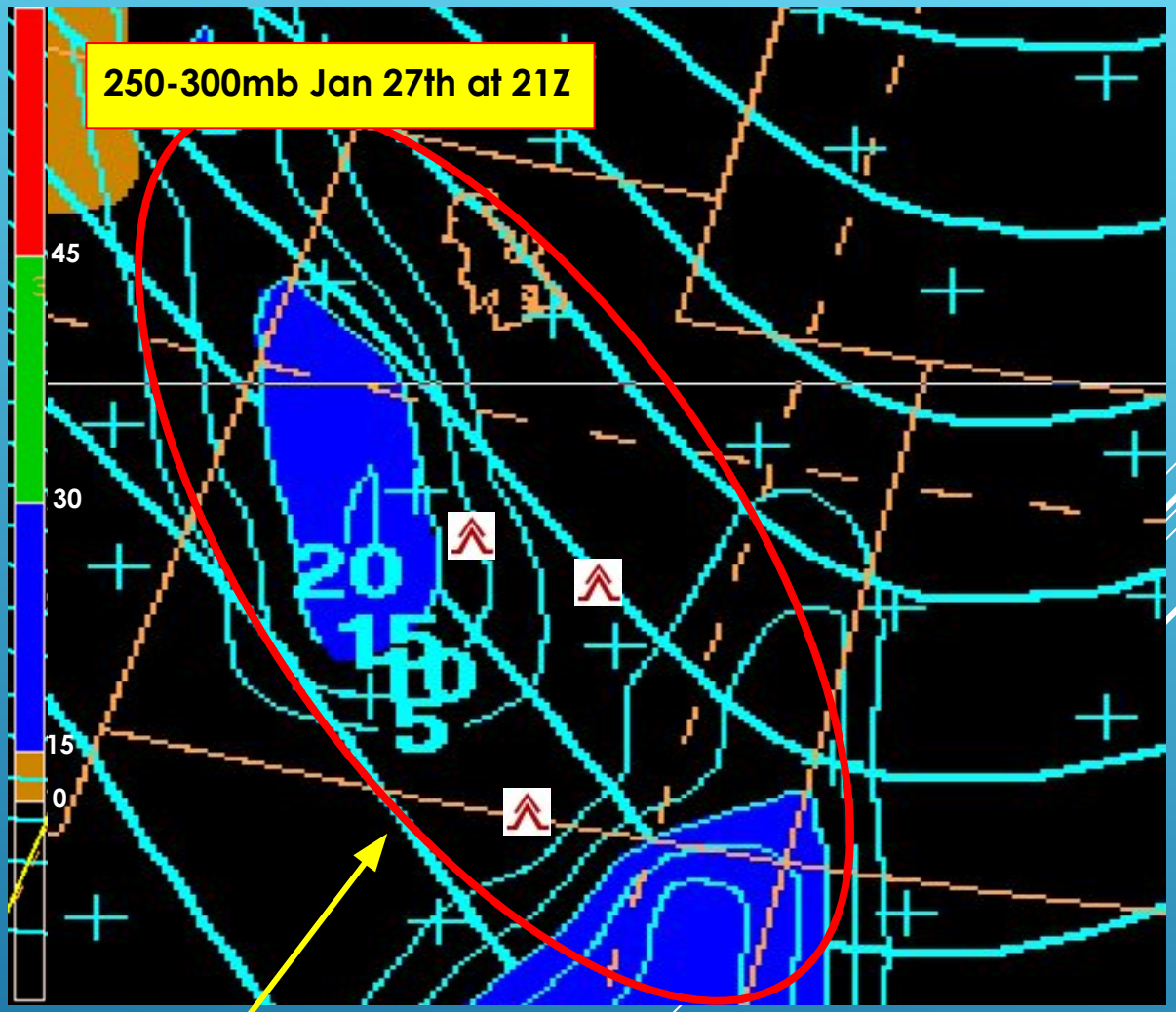
The TKE Shear Buoy Prod/Dissipation shows the shear increasing, but still is minimal. This weak shear will continue to enhance the ability for the vertical propagating waves by not tearing the wave apart.

NAM 250-300mb TKE Shear Buoy Prod/Dissipation Jan 27th, 20 at 18Z (FL300-340)
NAM 250mb Streamlines & Wind Jan 27th, 20 at 18Z



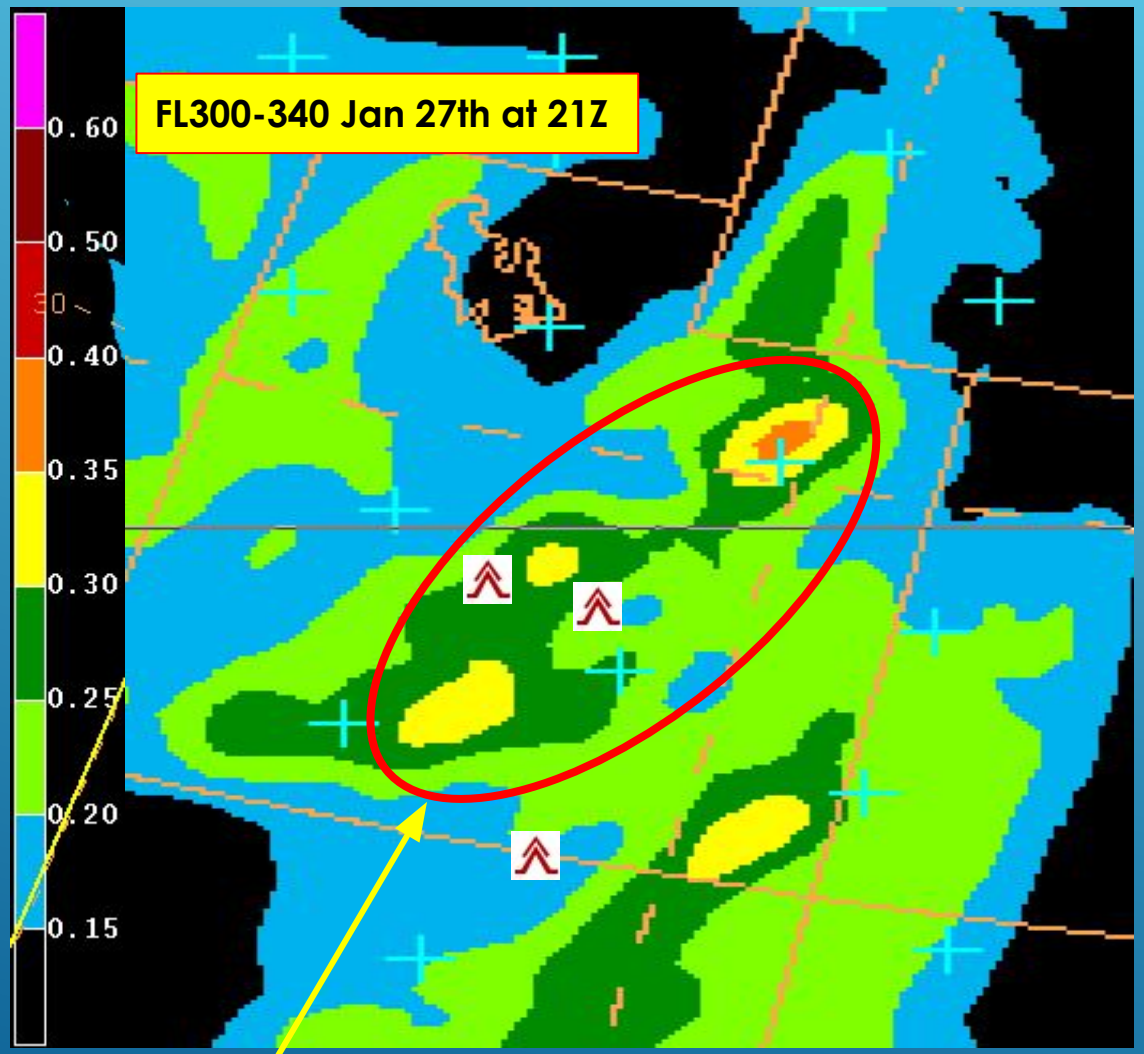
The TKE Shear Buoy Prod/Dissipation depicts marginal shear and streamlines showing trof axis over eastern Utah.

NAM 250-300mb TKE Shear Buoy Prod/Dissipation Jan 27th, 20 at 21Z (FL300-340)
NAM 250mb Streamlines & Wind Jan 27th,20 at 21Z

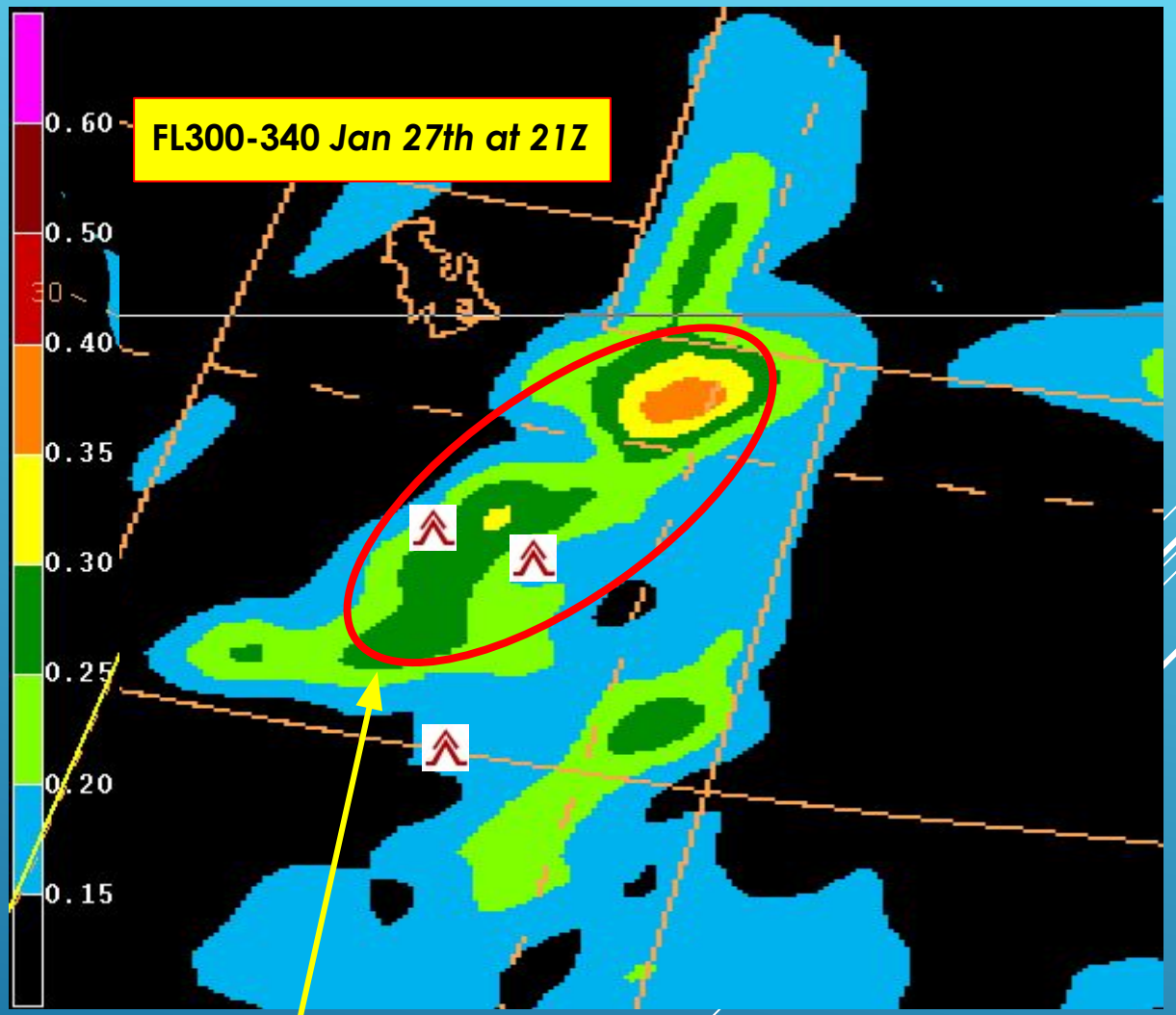


The TKE Shear Buoy Prod/Dissipation shows increasing shear through 21Z. The trof axis has moved over to Utah/Colorado border.

RAPGTG CATEDR COMPOSITE Jan 27th, 20 at 21Z (FL300-340)

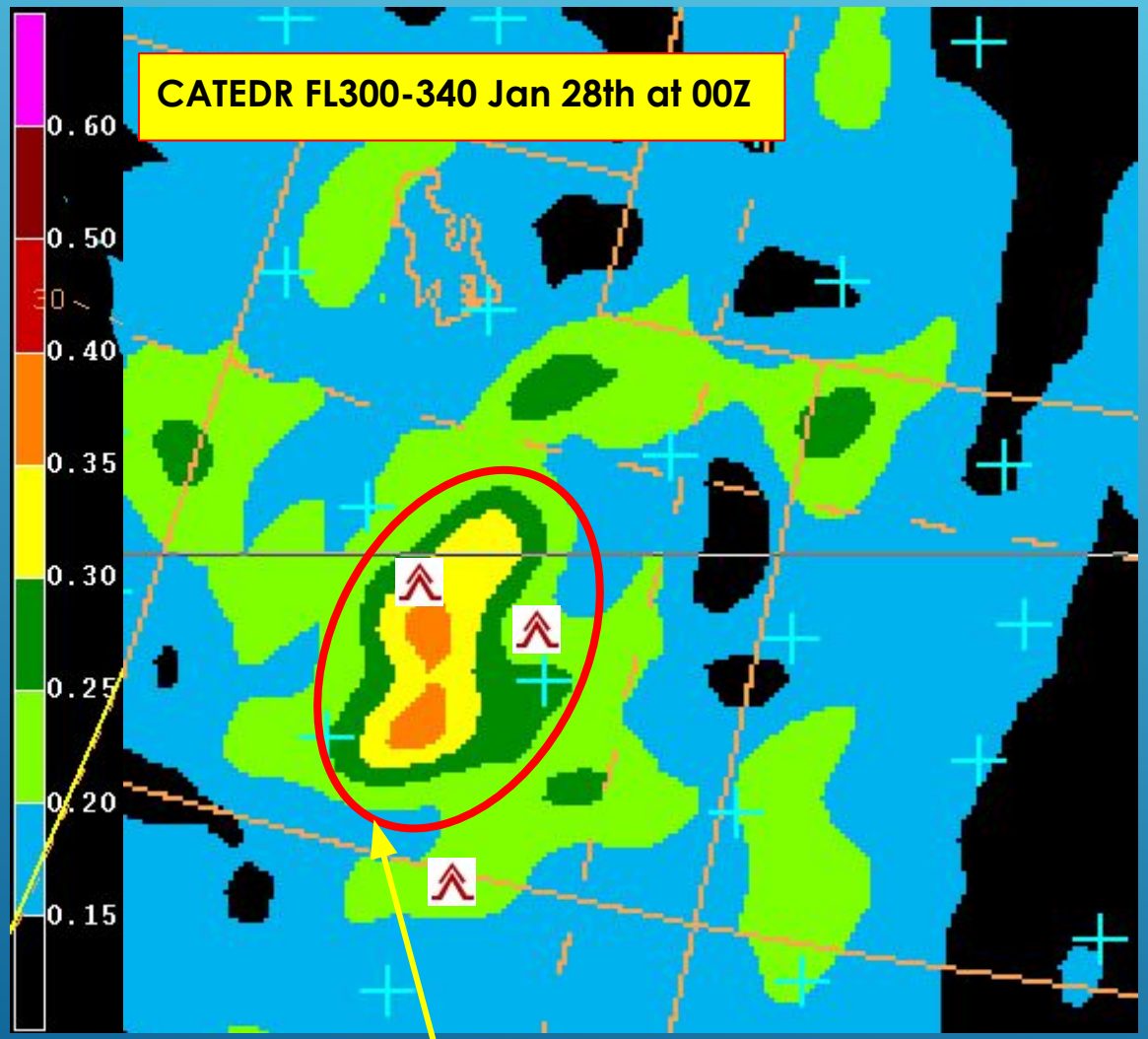


RAPGTG MTNWV COMPOSITE Jan 27th, 20 at 21Z (FL300-340)

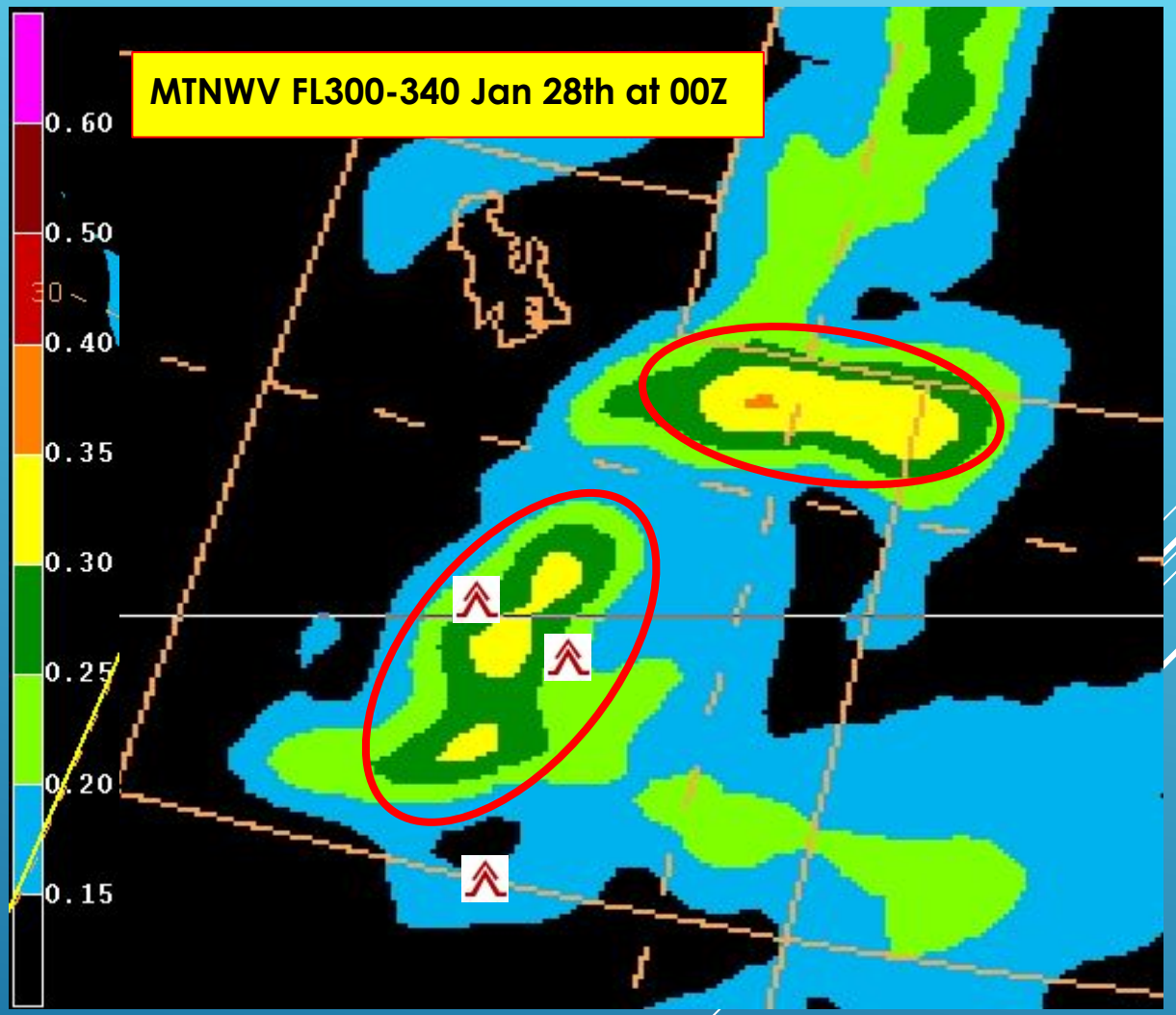


The RAPGTG CATEDR "Clear Air Turbulence (CAT) Eddy Dissipation Rate (EDR)" and RAPGTG "MTNWV" Composite indicate the same strength/vicinity of potential severe turbulence depicted in the red ovals.

RAPGTG CATEDR COMPOSITE Jan 28th, 20 at 00Z (FL300-340)

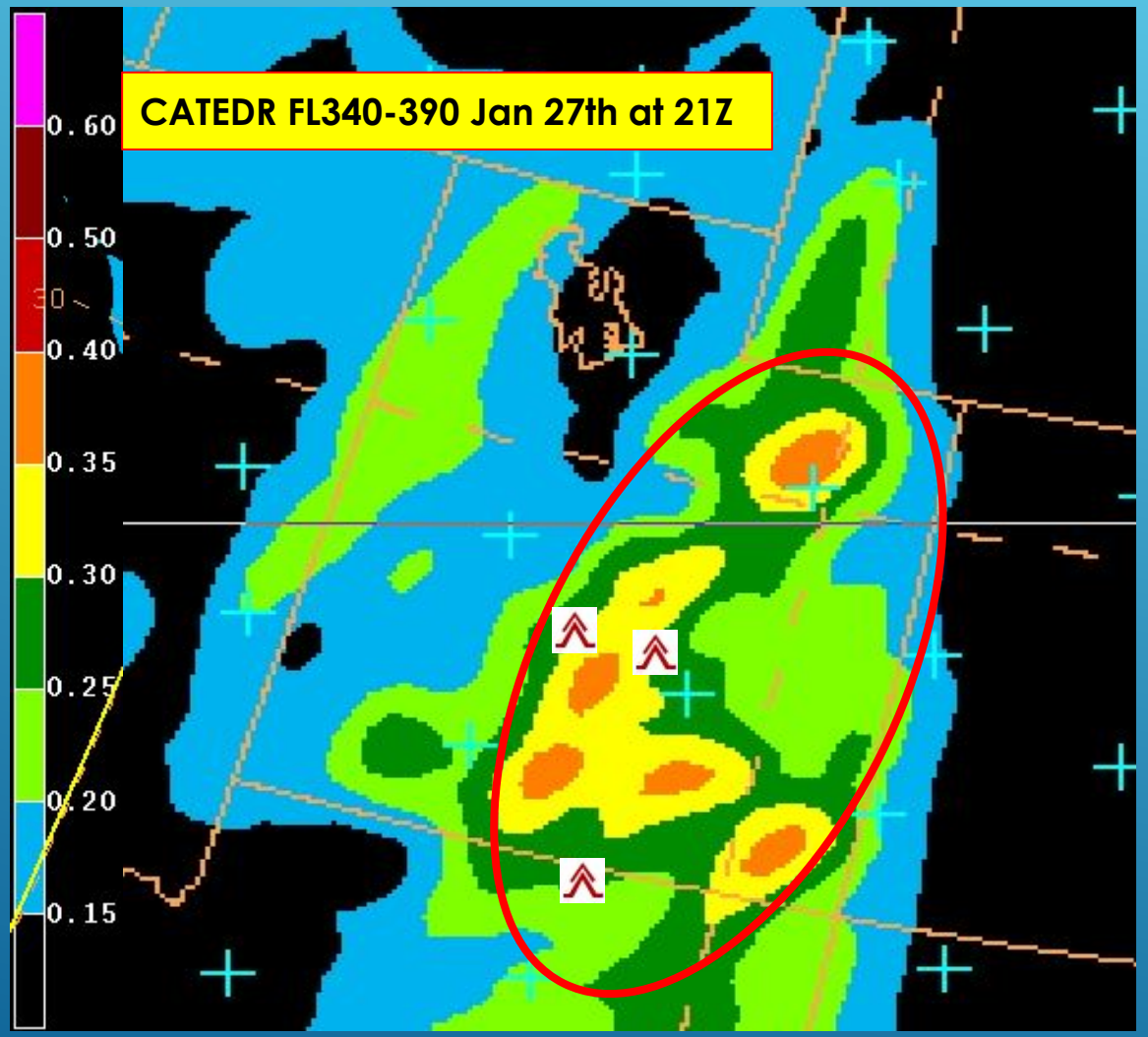


RAPGTG MTNWV COMPOSITE Jan 28th, 20 at 00Z (FL300-340)

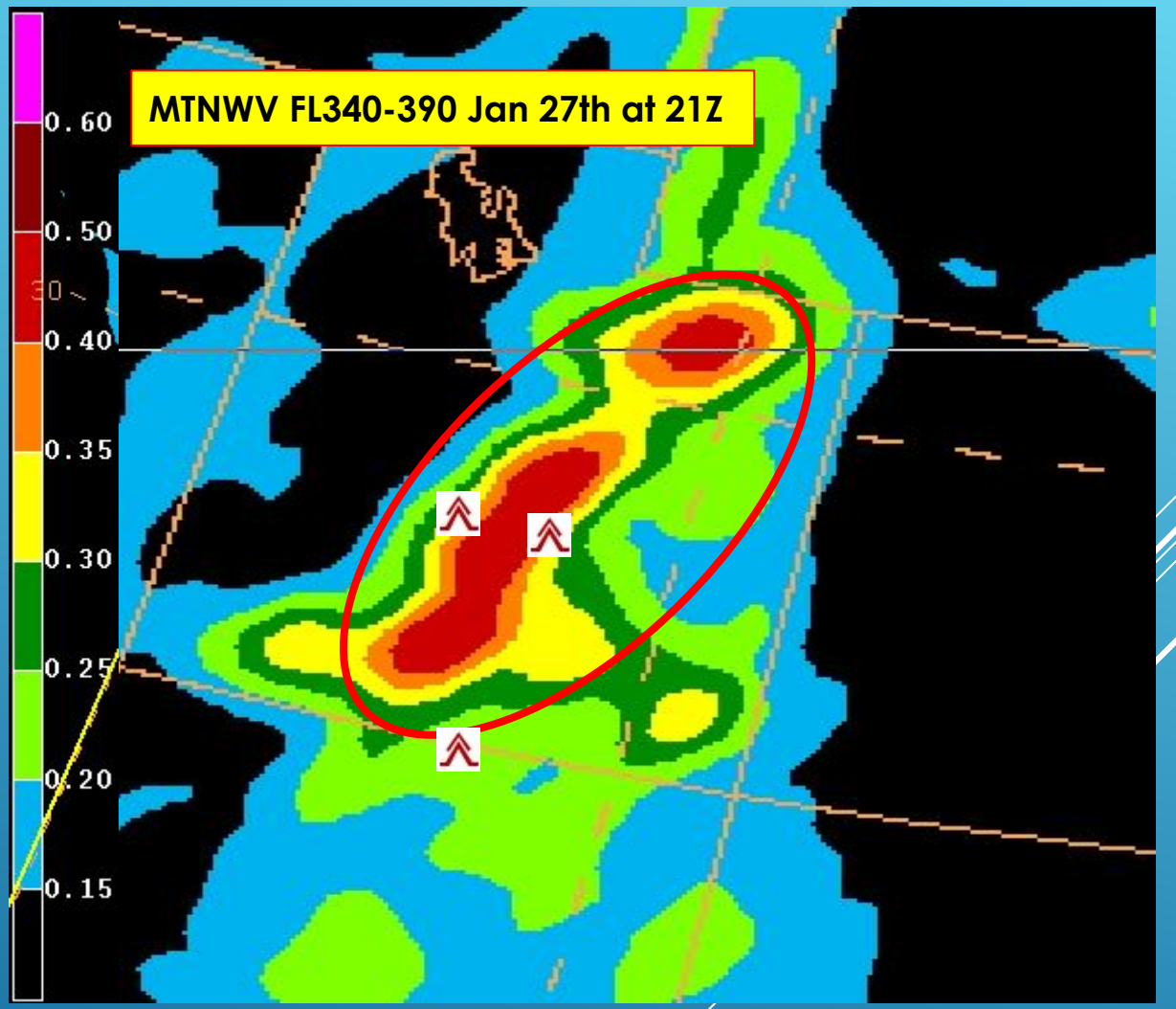


The RAPGTG CATEDR Composite continues to indicate potential for severe turb and has slightly stronger indices than the MTNWV Composite. While both RAPGTG Composite's continue to indicate potential for severe turbulence.

RAPGTG CATEDR COMPOSITE Jan 27th, 20 at 21Z (FL340-390)

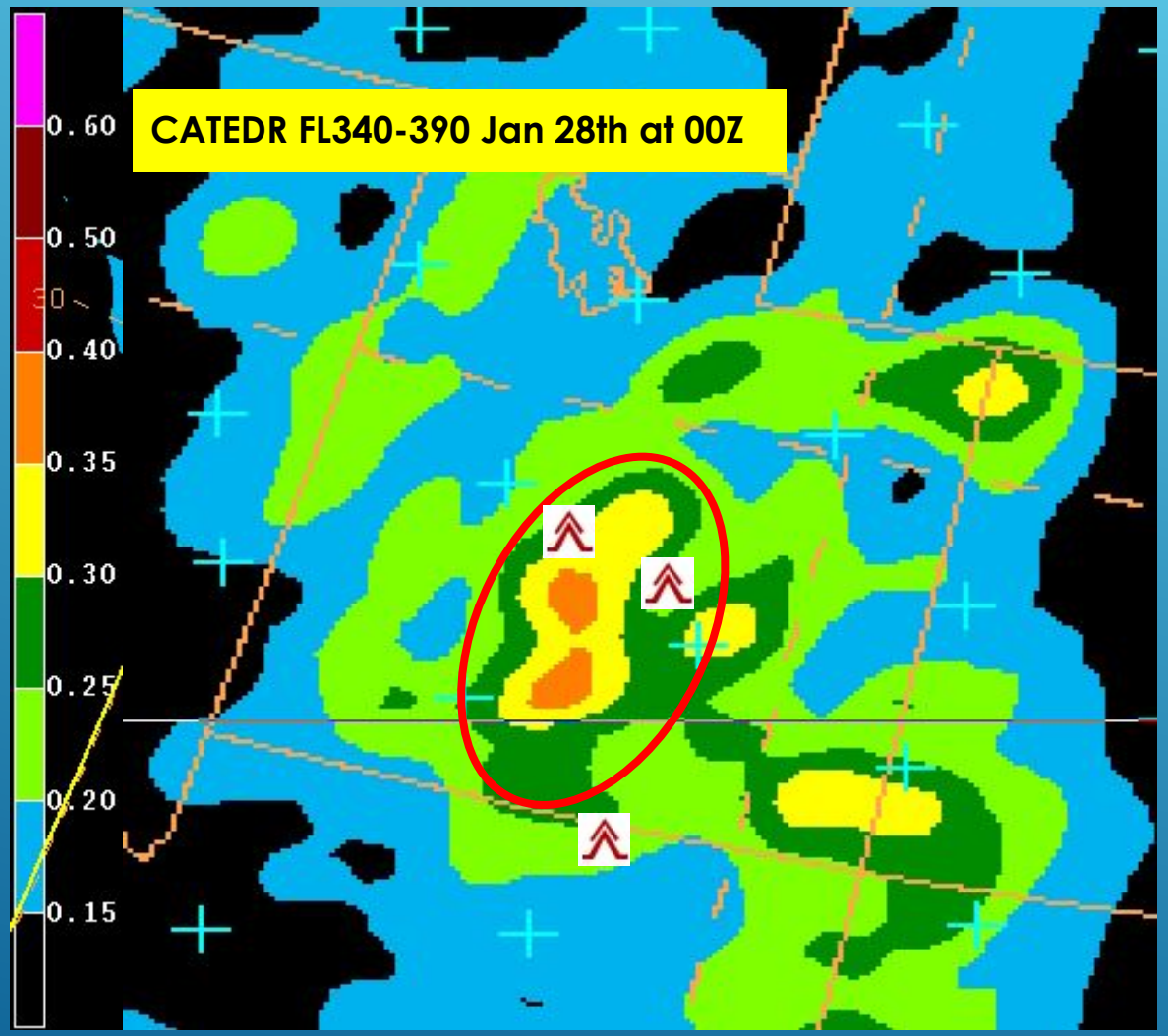


Jan27th,20 RAPGTG MTNWV COMPOSITE 21zv00z FL340-390

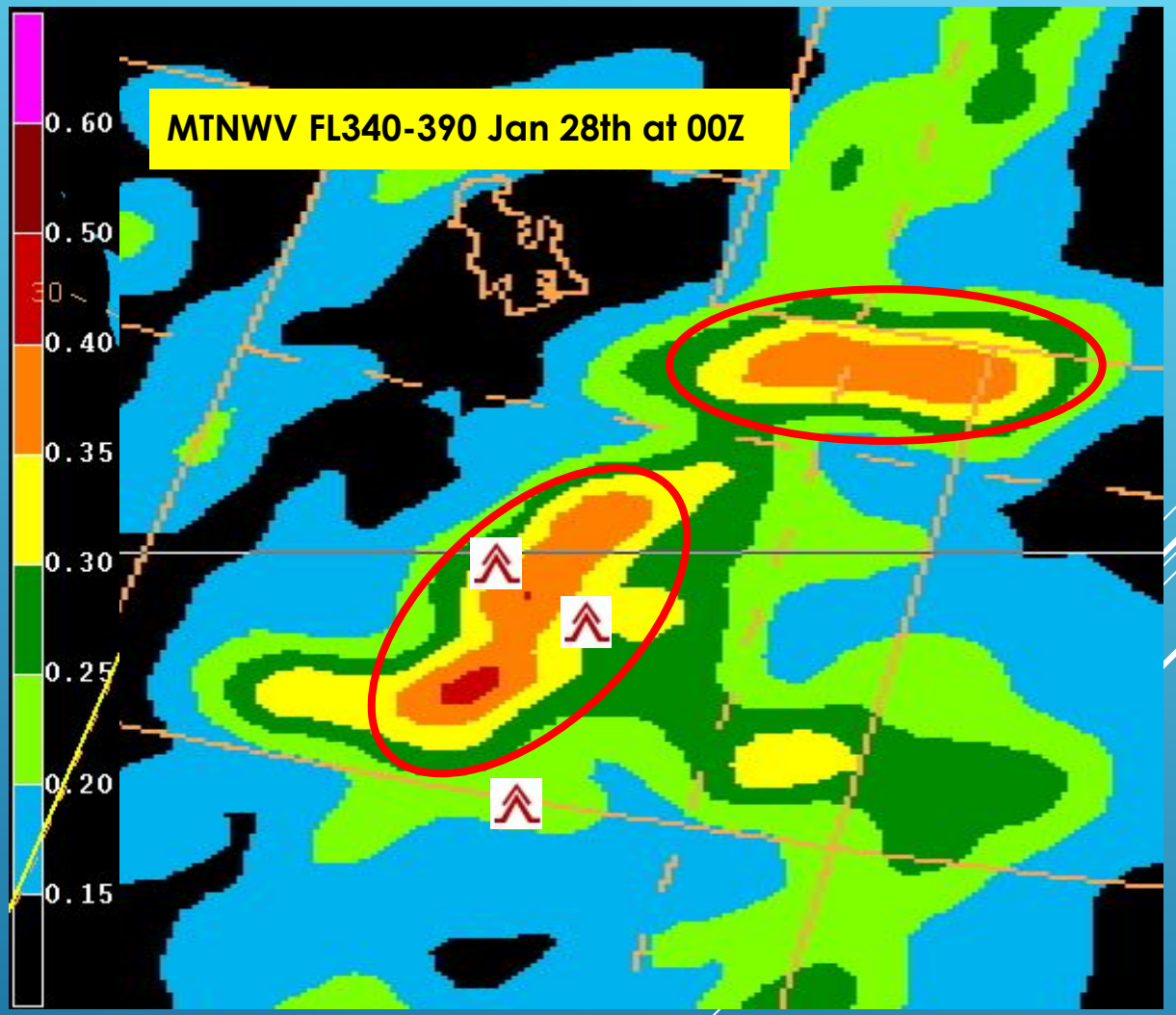


Comparing "RAPGTG CATEDR" vs. "RAPGTG MTNWV to reported SEV TURB PIREP's...both RAPGTG CATEDR and MTNWV depict excellent potential for severe turbulence.

RAPGTG CATEDR COMPOSITE Jan 28th, 20 at 00Z (FL340-390)

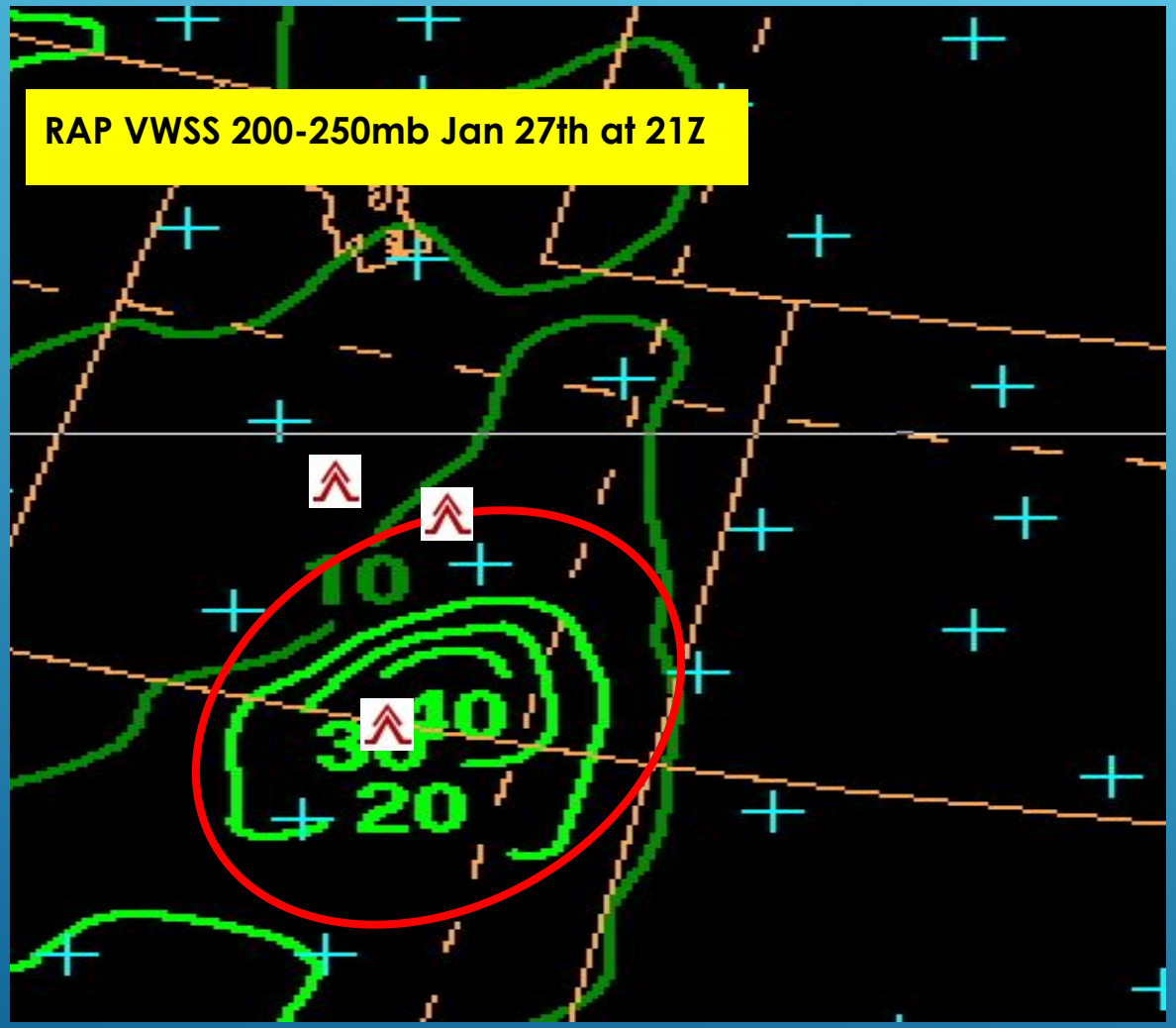


RAPGTG MTNWV COMPOSITE Jan 28th, 20 at 00Z (FL340-390)

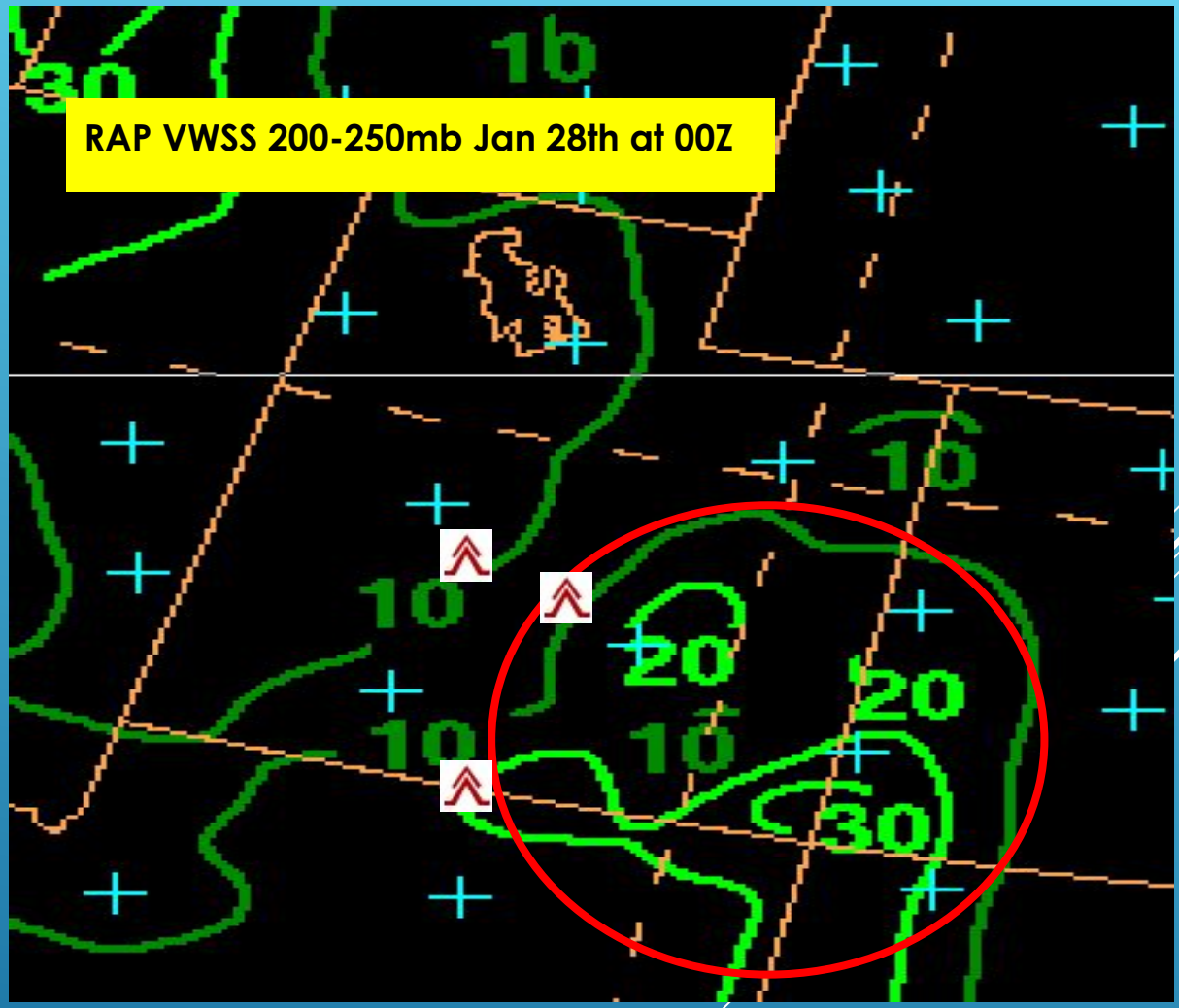


Comparing RAPGTG CATEDR vs. RAPGTG MTNWV to SEV TURB pireps depicted using "SEV TURB symbols." Both diagnostics show excellent potential for severe turbulence.

RAP Vertical Wind Shear Squared 200-250mb Jan 27th, 20 at 21Z

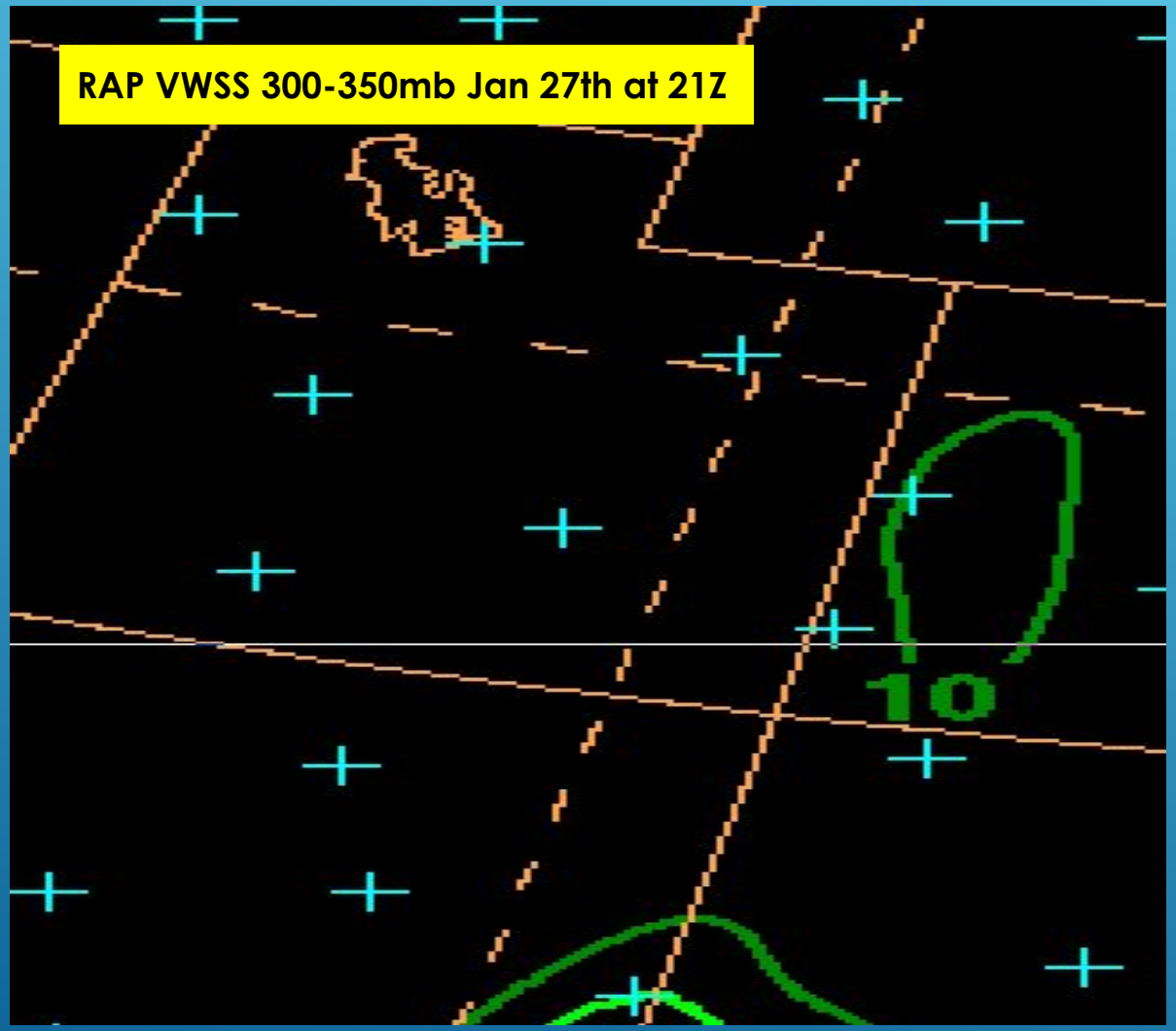


RAP Vertical Wind Shear Squared 200-250mb Jan 28th, 20 at 00Z

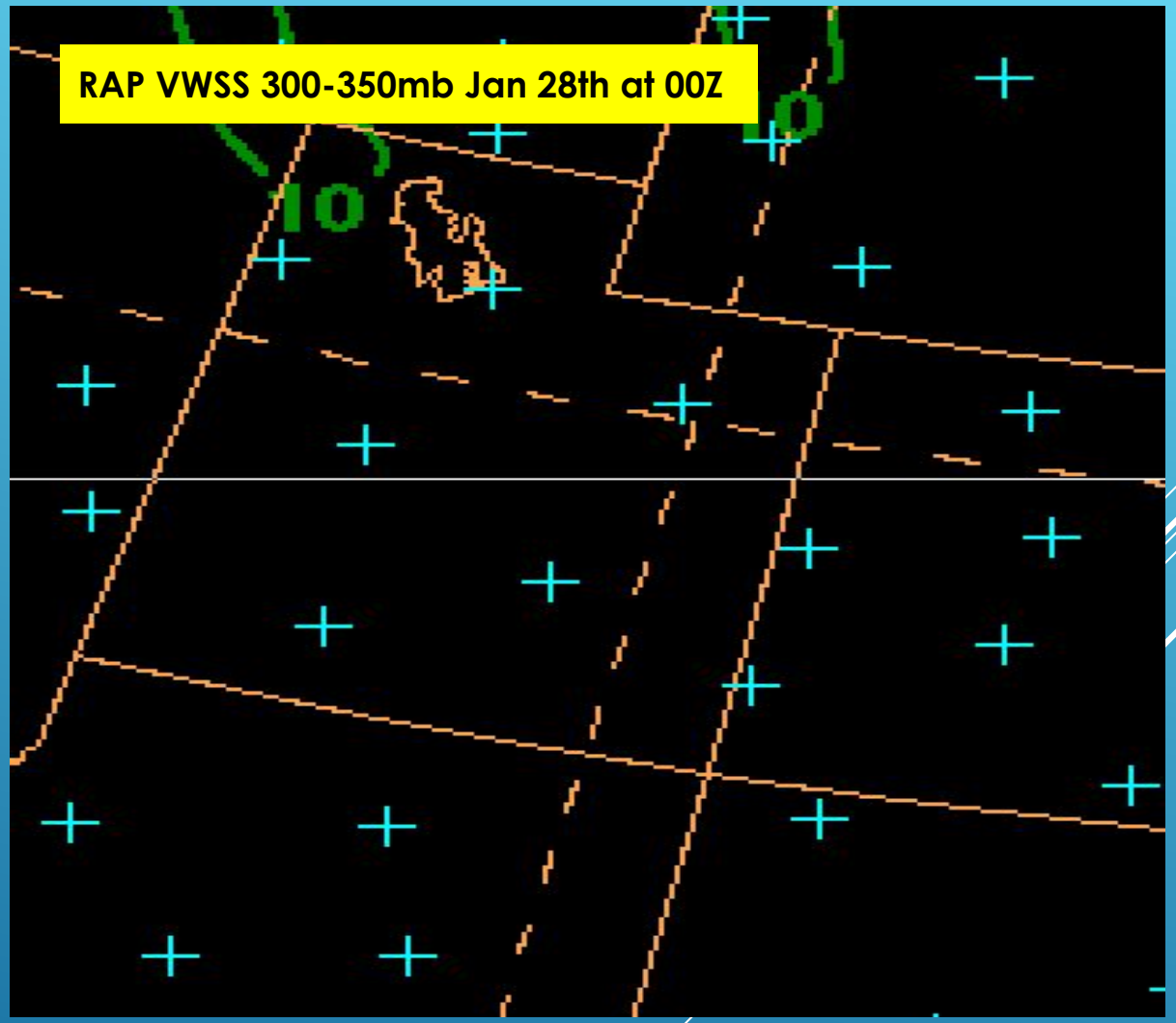


The RAP Vertical Wind Shear Squared images are both indicating good potential for mod-SEV turbulence as the upper level trof moves eastward during this mountain wave event.

RAP Vertical Wind Shear Squared 300-350mb Jan 27th, 20 at 21Z

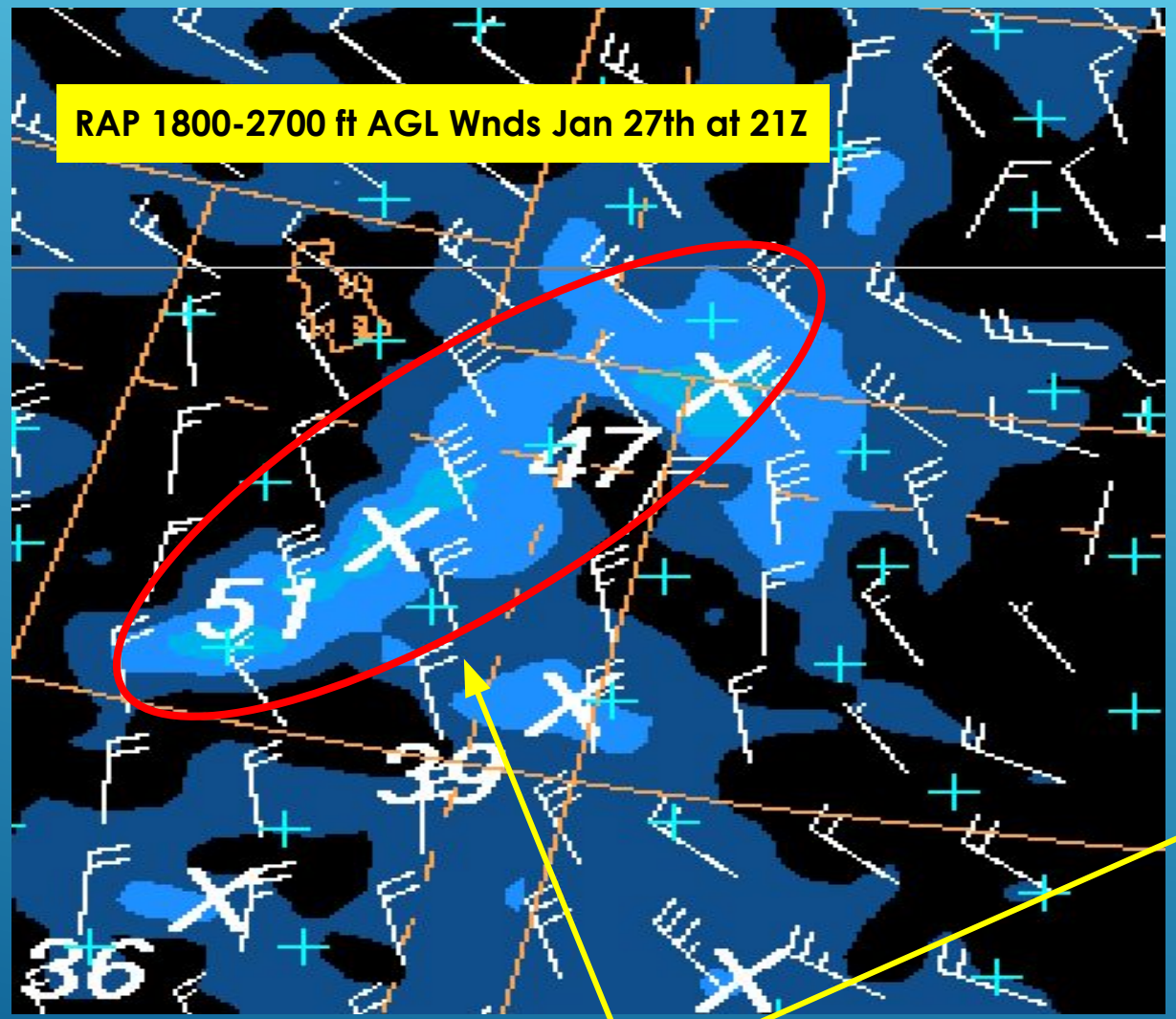


RAP Vertical Wind Shear Squared 300-350mb Jan 28th, 20 at 00Z

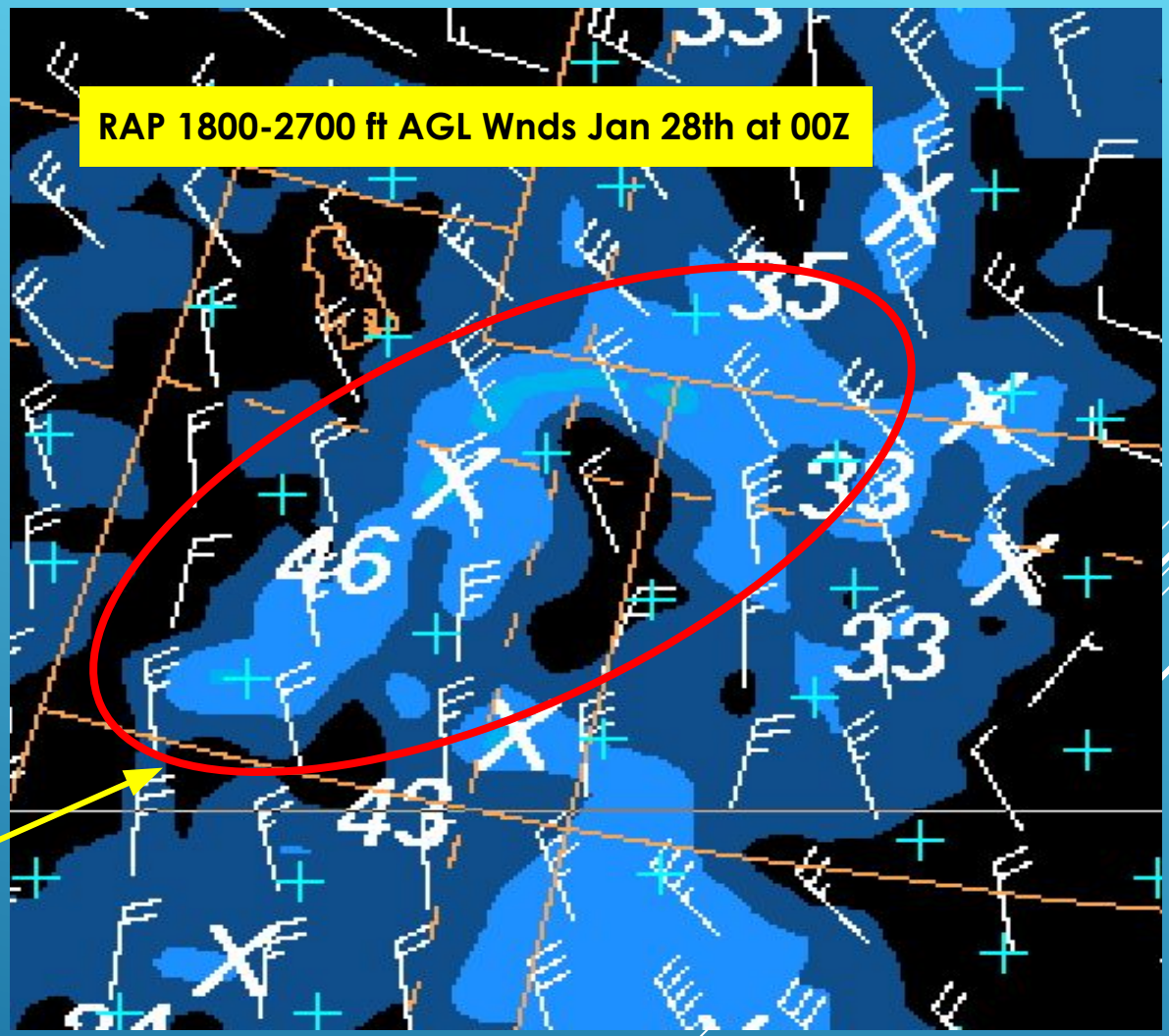


The RAP Vertical Wind Shear Squared through 00Z Jan 28th, 2020 depicts hardly any shear.

RAP 1800 to 2700 ft AGL Winds & Barbs/Isotachs >20kts Jan 27th, 20 at 21Z



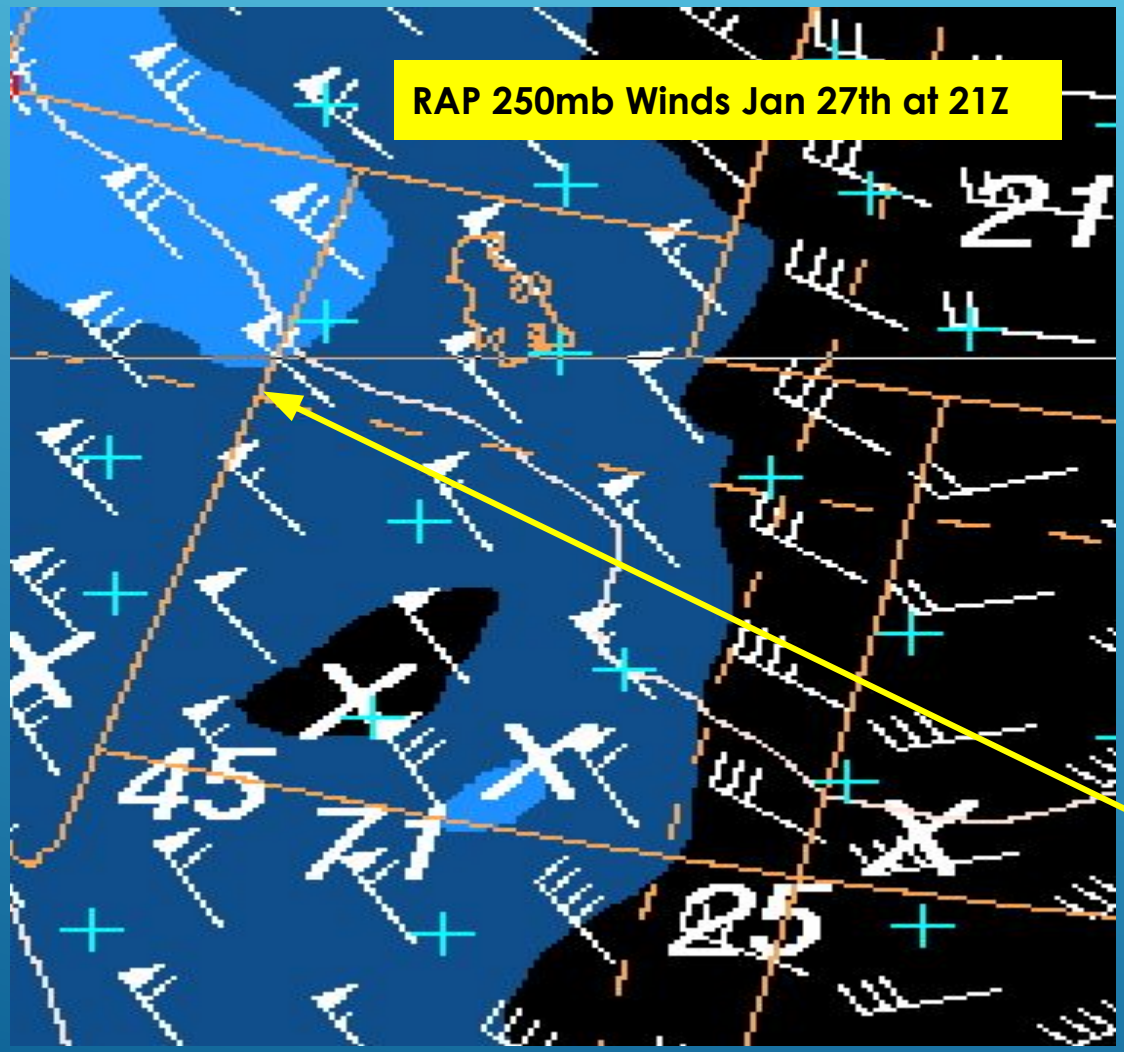
RAP 1800 to 2700 ft AGL Winds & Barbs/Isotachs >20kts Jan 28th, 20 at 00Z

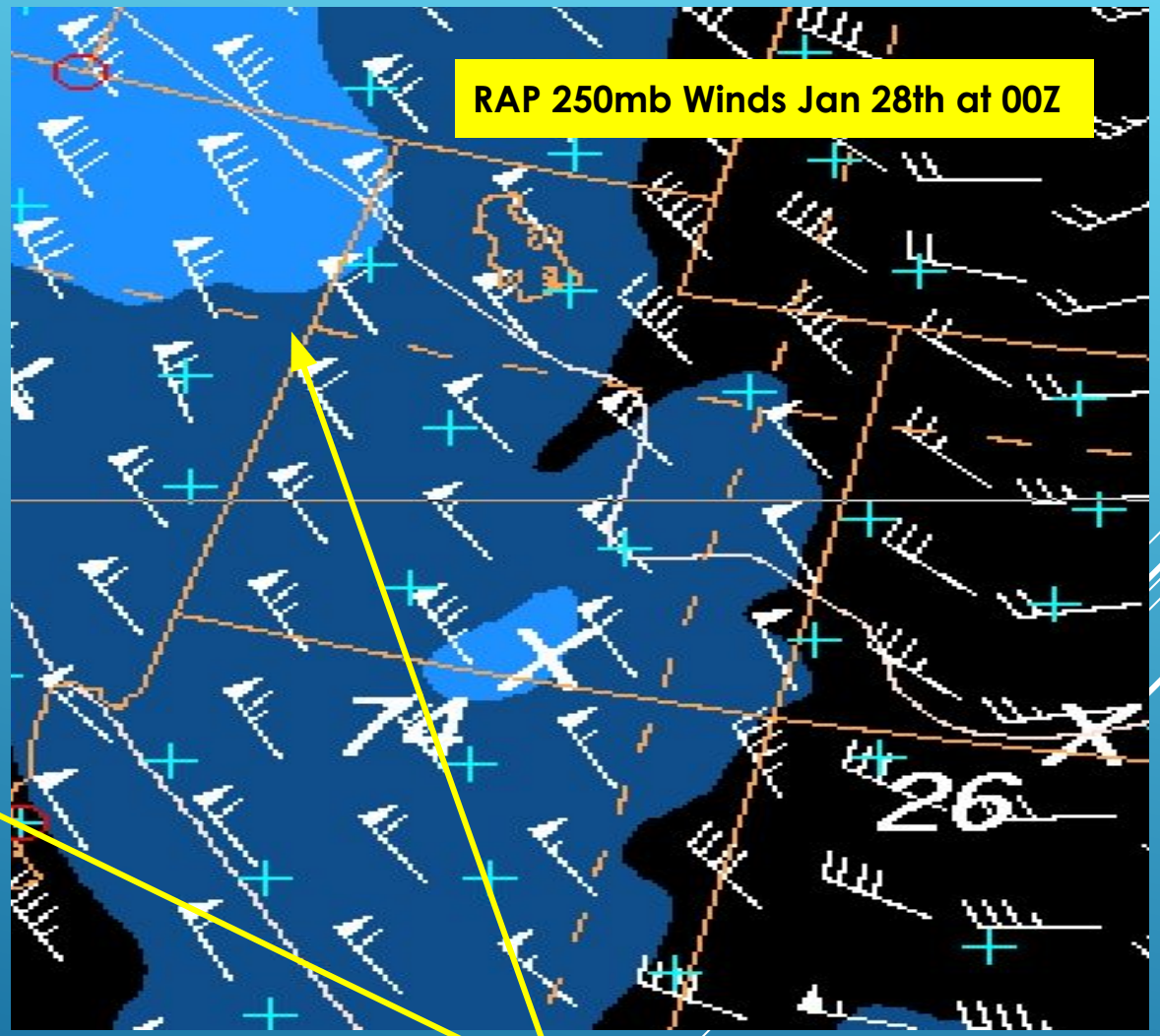


The red oval depicts strong wind maxima above the ridge top and indicates ridge-top acceleration of the flow. This mountain ridge top flow acceleration is an excellent forcing mechanism for vertically propagating waves.

RAP 250mb Winds & Barbs/Isotachs >50kts Jan 27th, 20 at 21ZZ

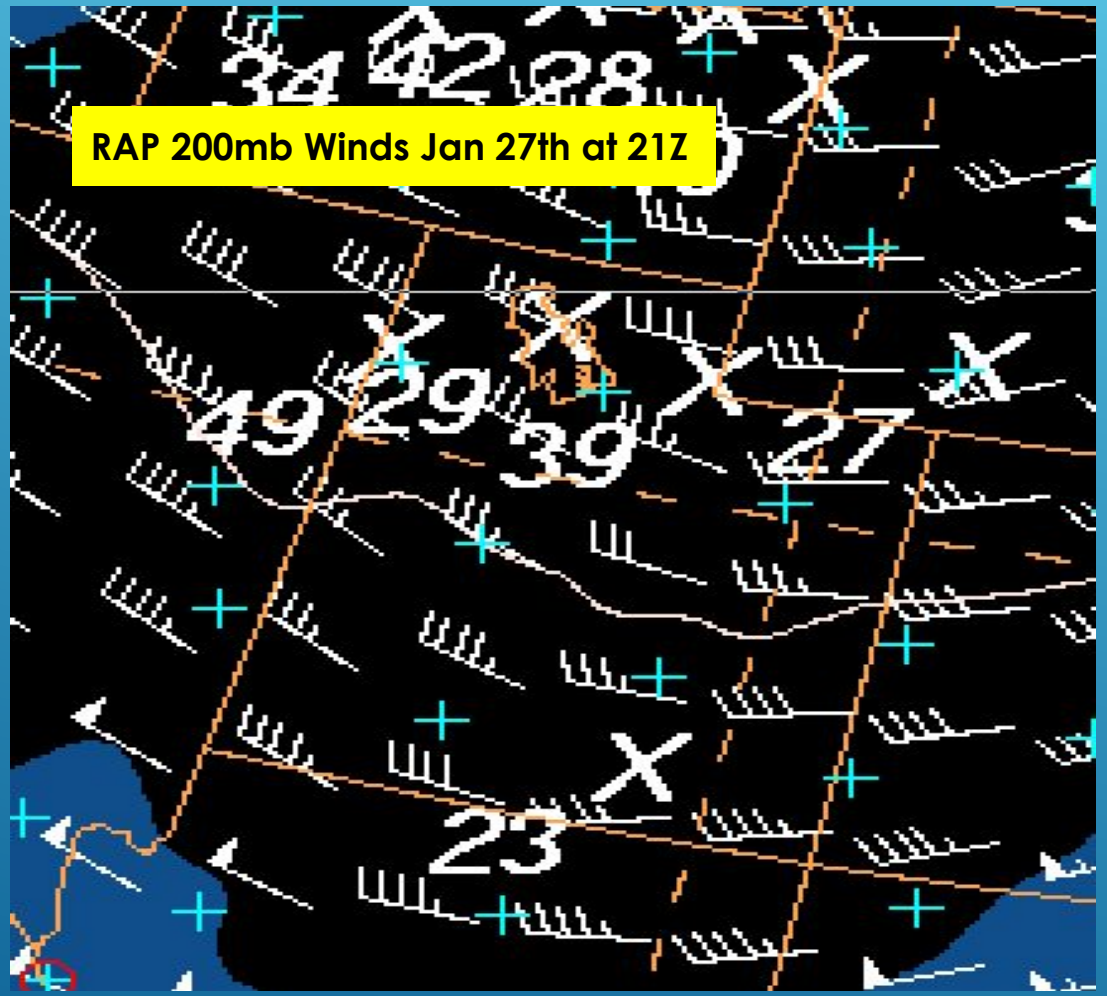
RAP 250mb Winds & Barbs/Isotachs >50kts Jan 28th, 20 at 00Z



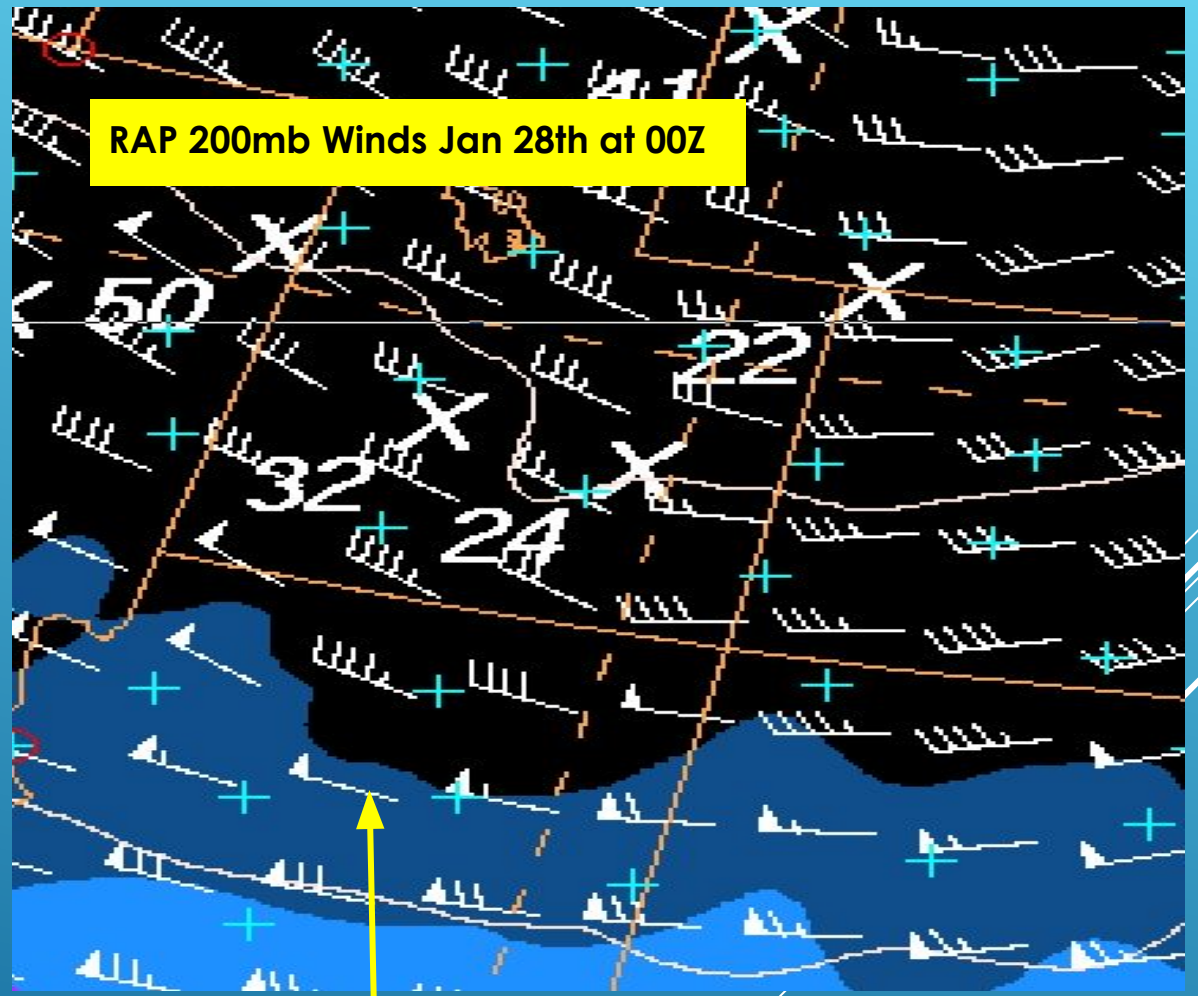


RAP 250mb wind for both times depict strong northwesterly flow with the nose of a right-front quadrant jetcore approaching the northwest border of the Utah/Arizona region.

RAP 200mb Winds & Barbs/Isotachs >50kts Jan 27th,20 at 21ZZ

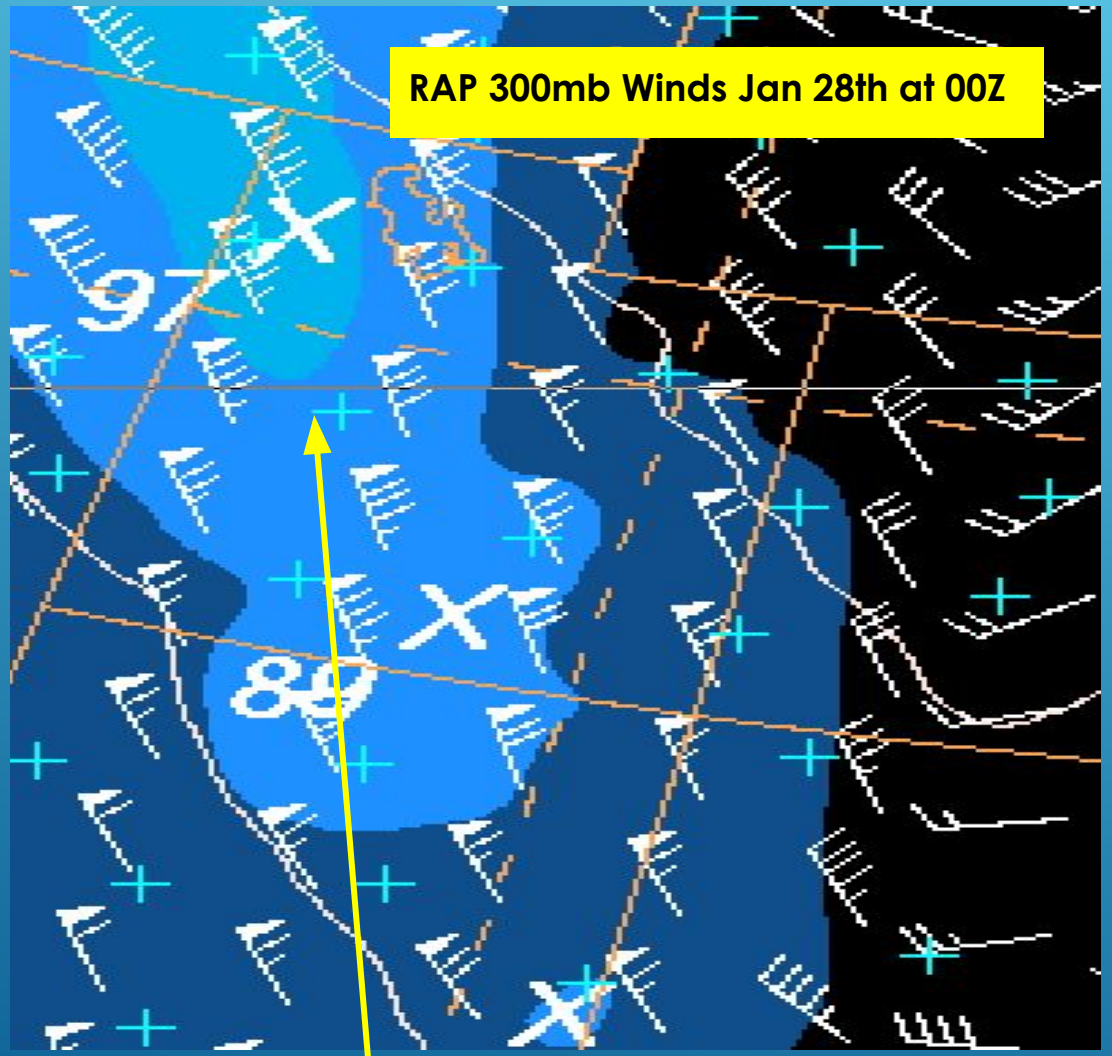


RAP 200mb Winds & Barbs/Isotachs >50kts Jan 28th, 20 at 00Z



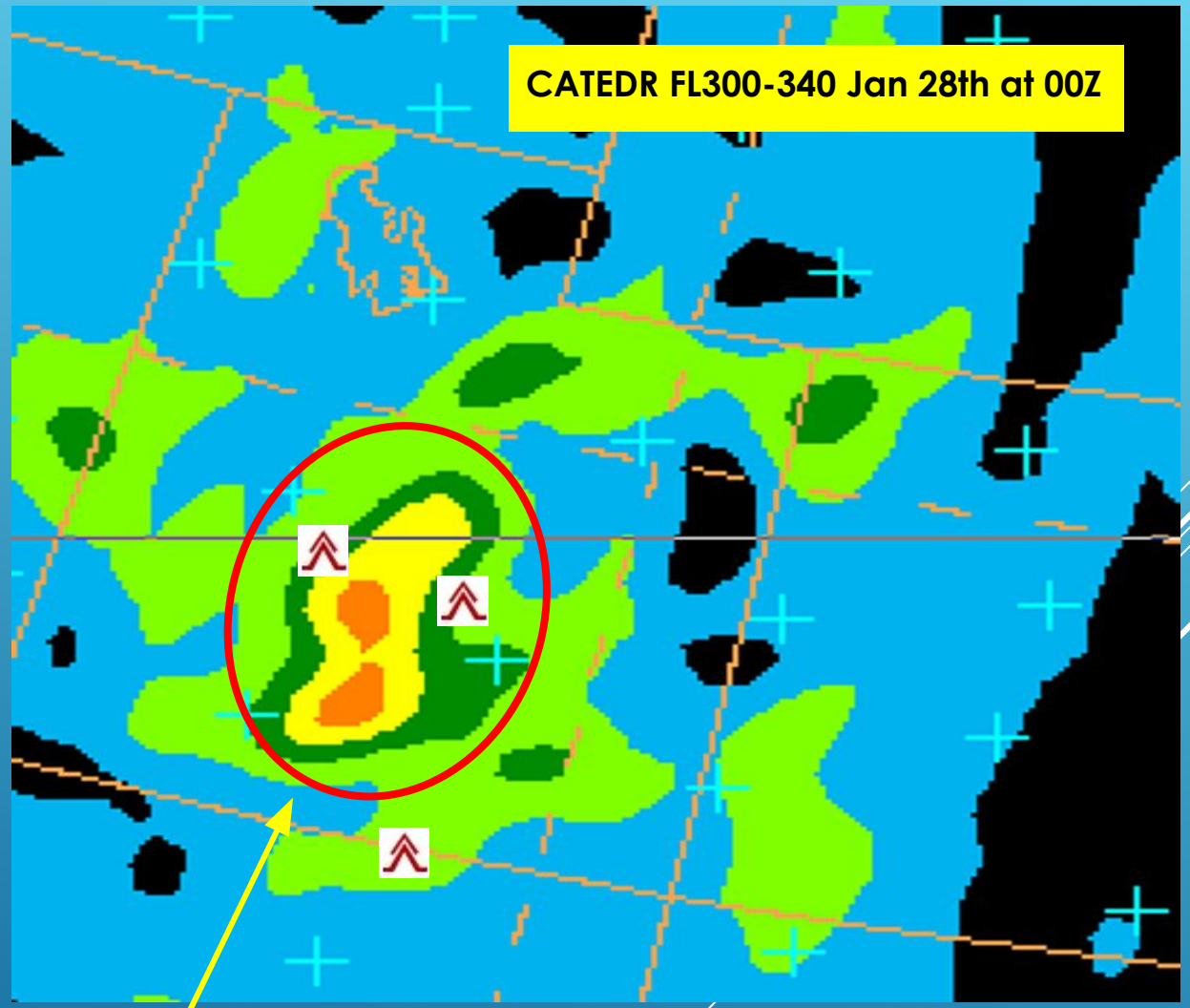
RAP 200mb wind depicts weakening westerly flow. Stronger flow by 00Z time-frame southward of the Utah/Arizona border.

RAP 300mb Winds & Barbs/Isotachs >50kts Jan 28th, 20 at 00Zv04Z

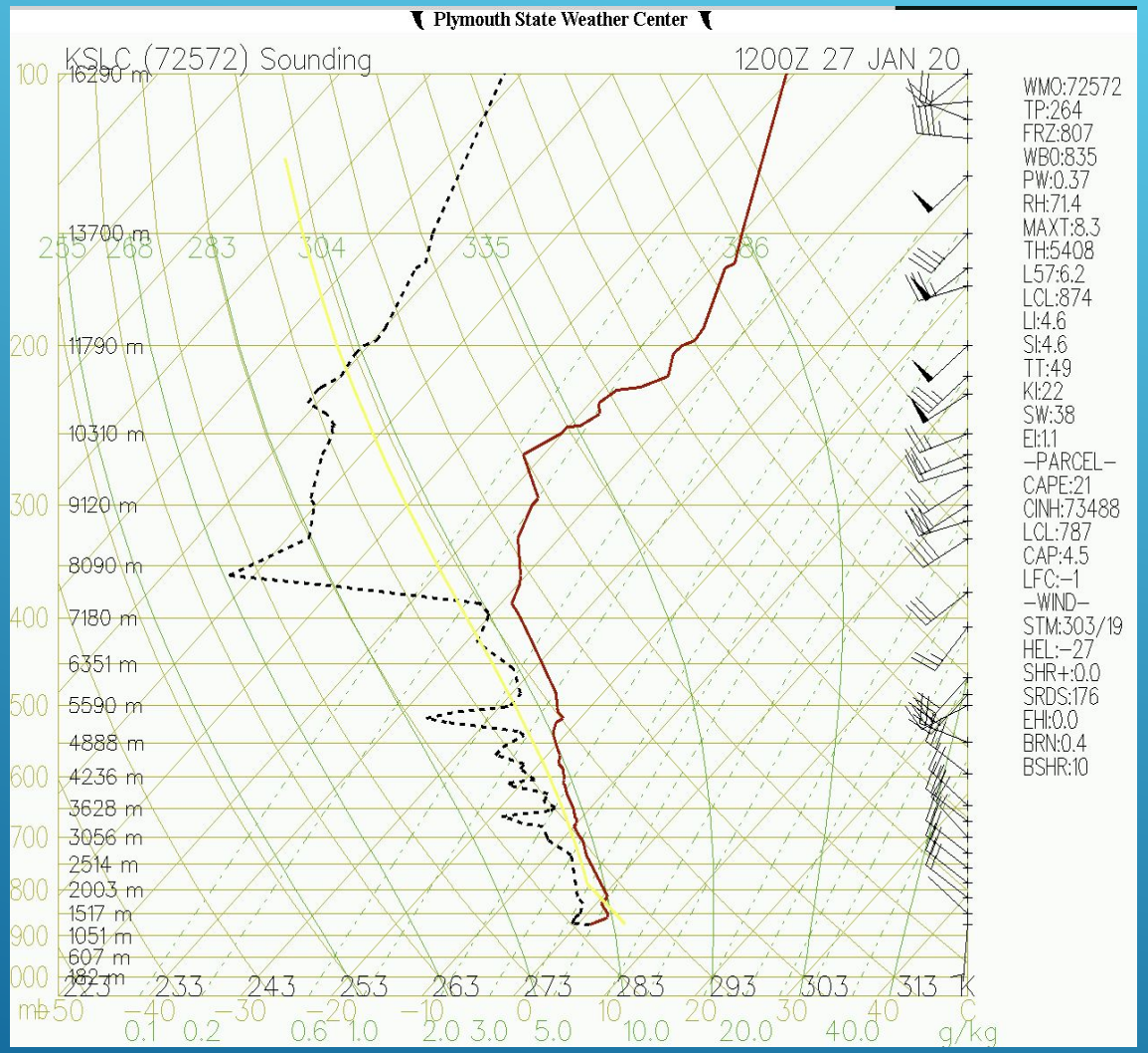


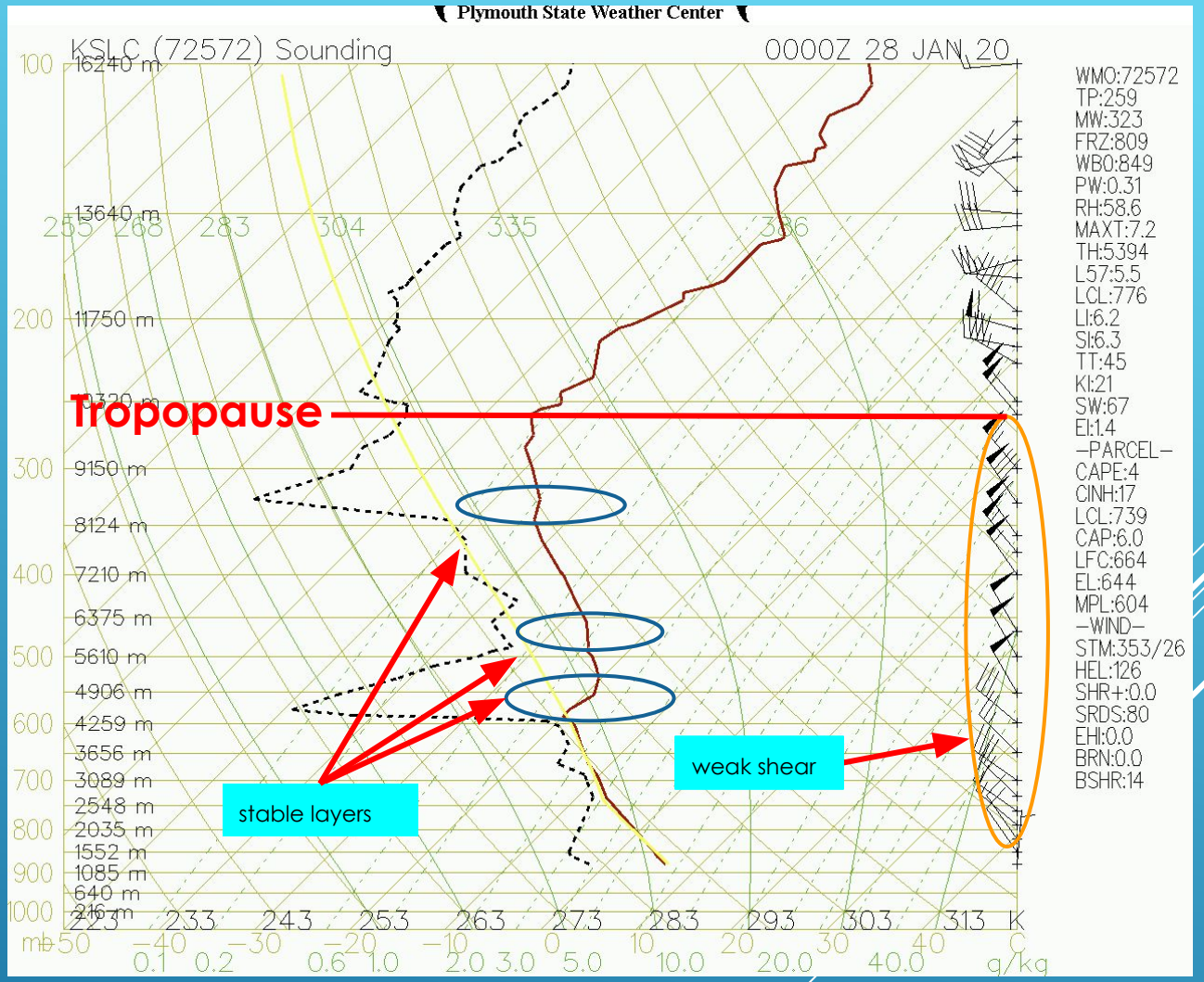
The 300mb wind shows strong northwesterly cross-barrier flow and strong nose of jetcore moving through northwest Utah.

RAPGTG CATEDR COMPOSITE Jan 28th, 20 at 00Z (FL300-340)

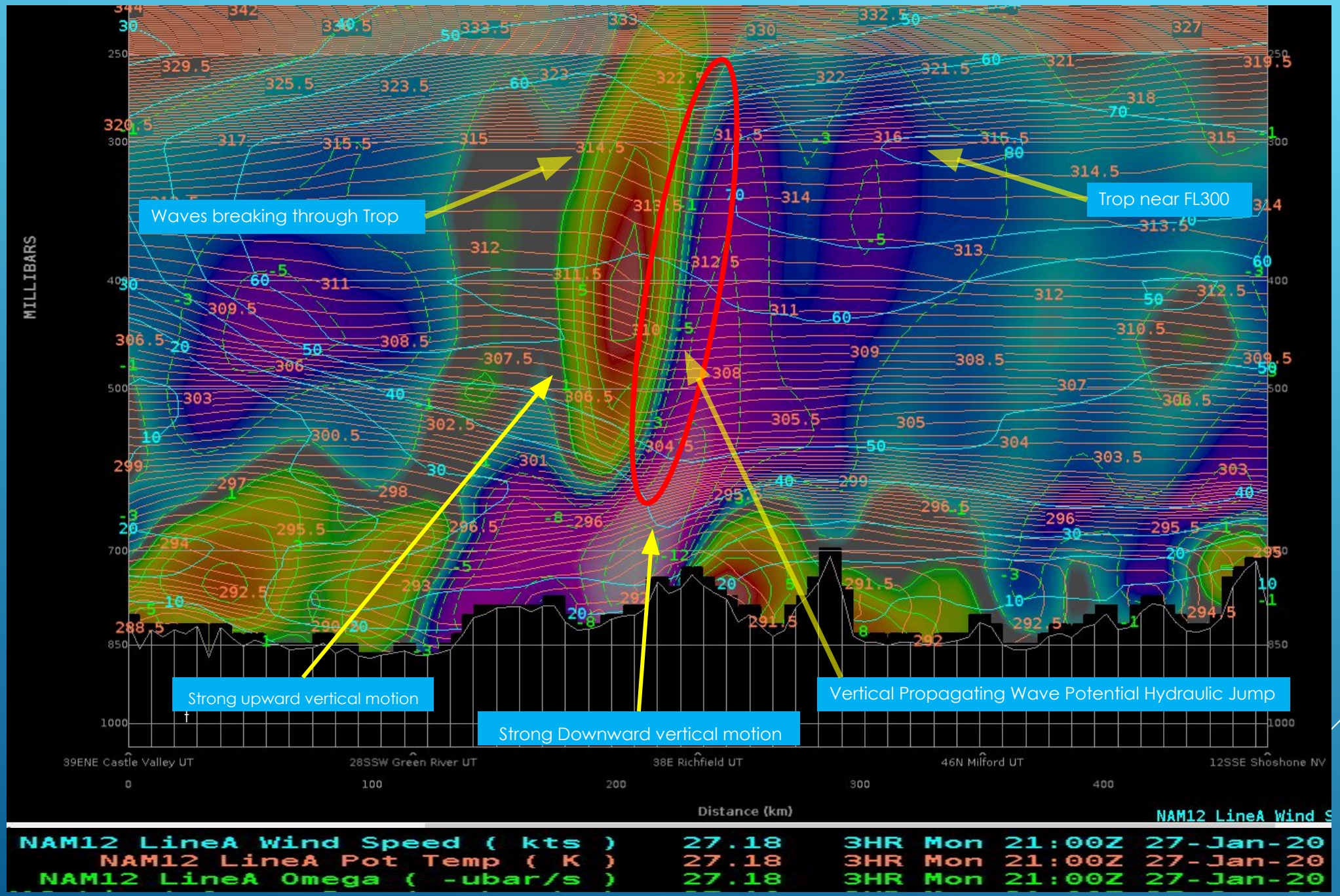


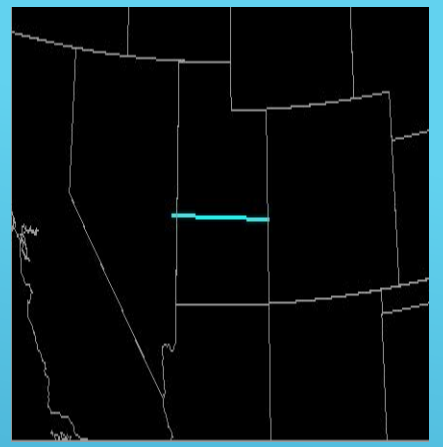
Red oval depicts RAPGTG CATEDR showing good potential for mod-SEV turbulence where SEV PIREPS are observed.





KSLC sounding from 12Z shows very weak vertical wind shear. By 00Z, the KSLC sounding shows a forward shear turbulence profile. Even though this is not the exact soundings of the cross-sections, it's still directly upstream with the same dynamic-synoptic regime. The 00Z sounding has several layers of stronger static stability, which leads to trapped waves. The layer between the ridge top and tropopause is characterized by weak shear - this is key in allowing the vertical propagating wave to reach and punch through the tropopause without being torn apart.

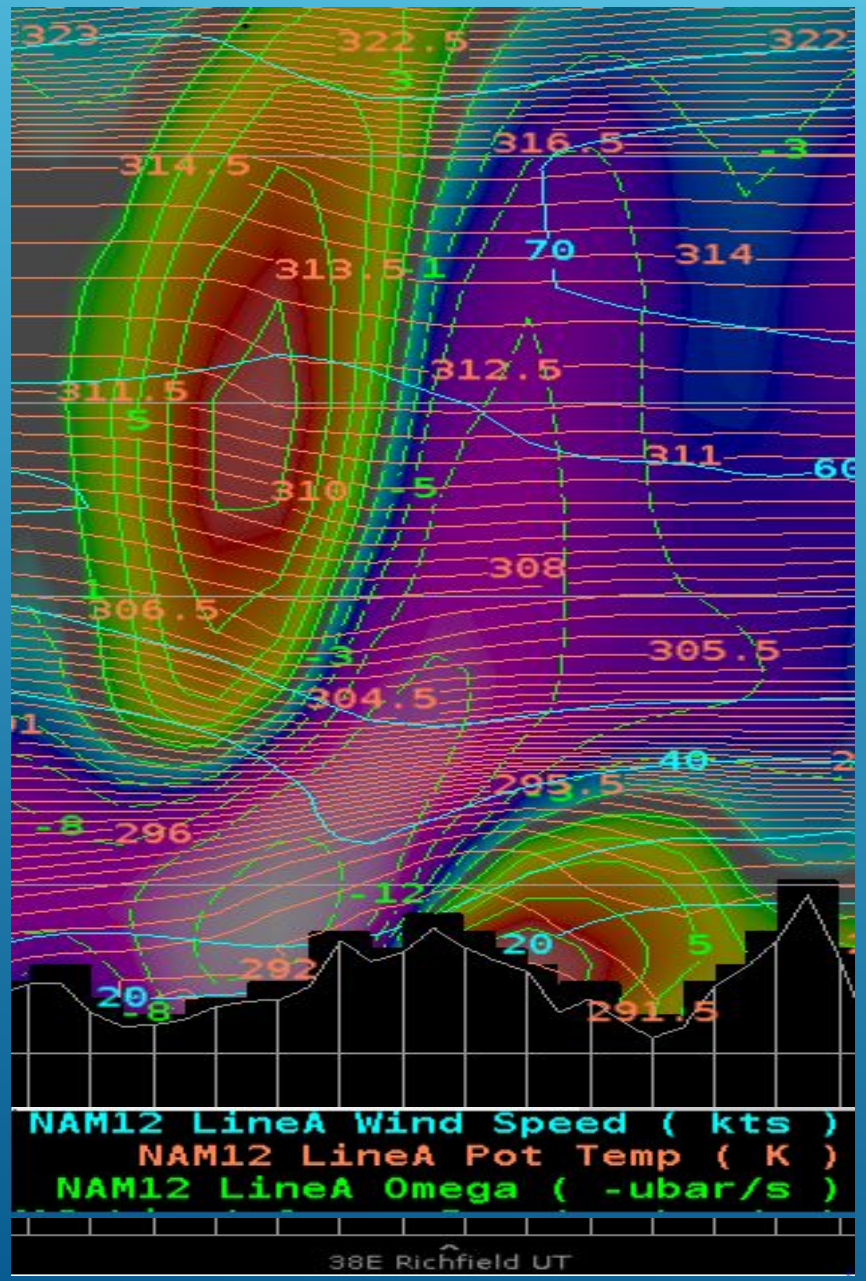




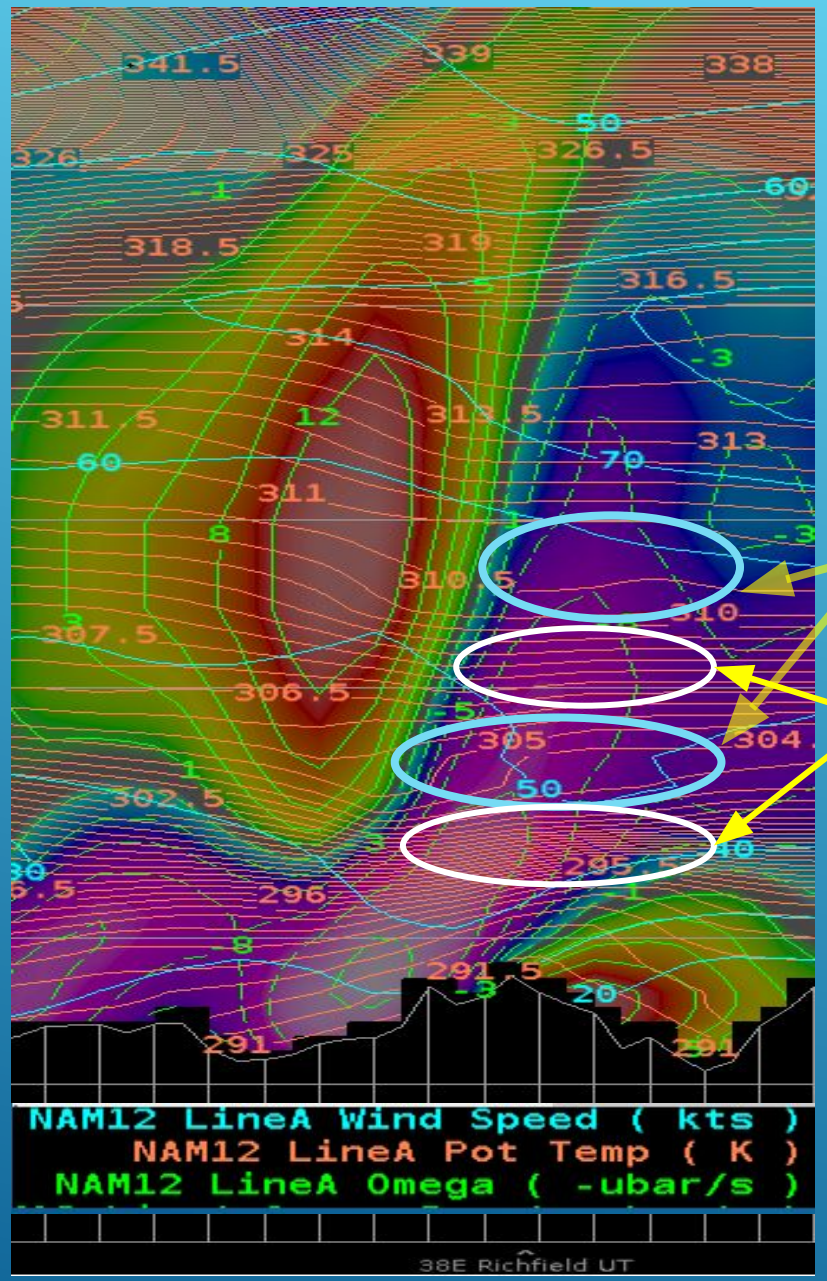
Cross-section over the southern Utah region displays the strong up/downward vertical motion and the vertical propagating wave.

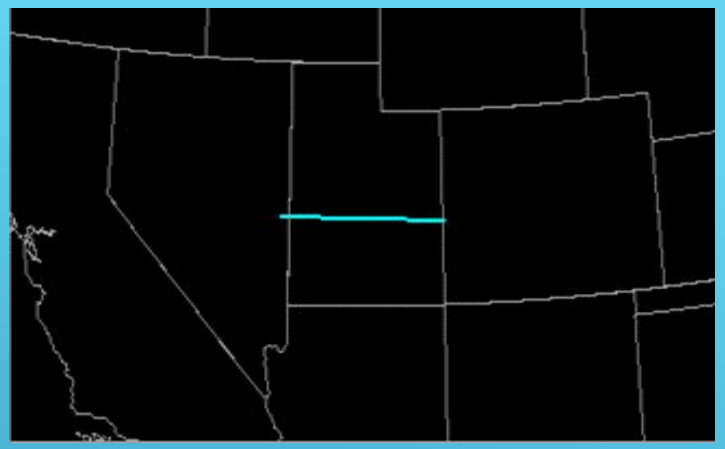
-Where the wave breaks through the tropopause is a good indicator of where to expect SEVERE TURBULENCE.

Cross-Section Jan 27th, 20 at 2100Z



Cross-Section Jan 28, 20 at 0000Z

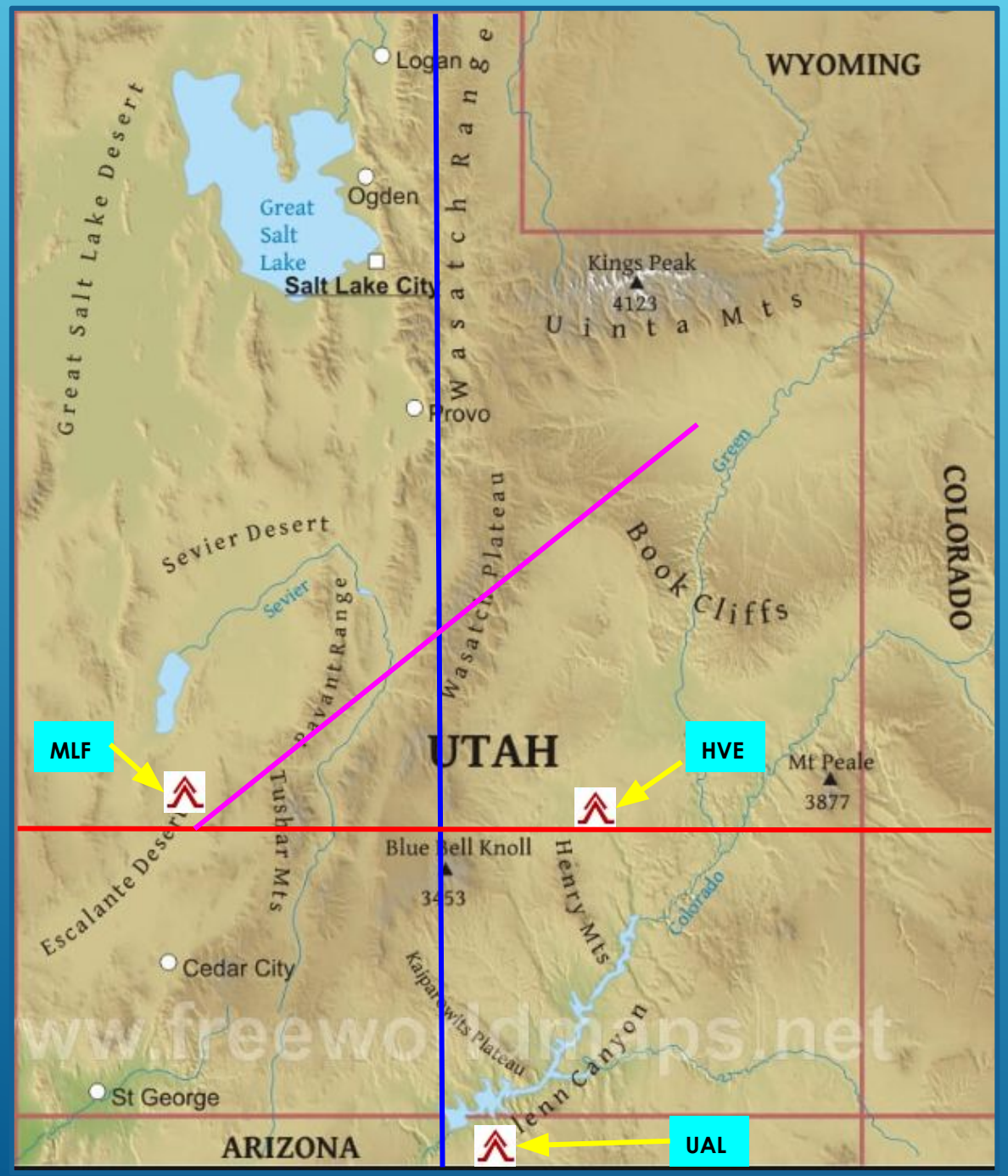




Comparing the Utah Cross-section from Jan 27th, 2020 at 21Z…to Jan 28th, 2020 at 00Z …the blue ovals are possibly showing the Hydraulic jump.

The white ovals indicate layers of trapped stability between 2 layers of instability. These transitions will potentially have excellent shear zones.

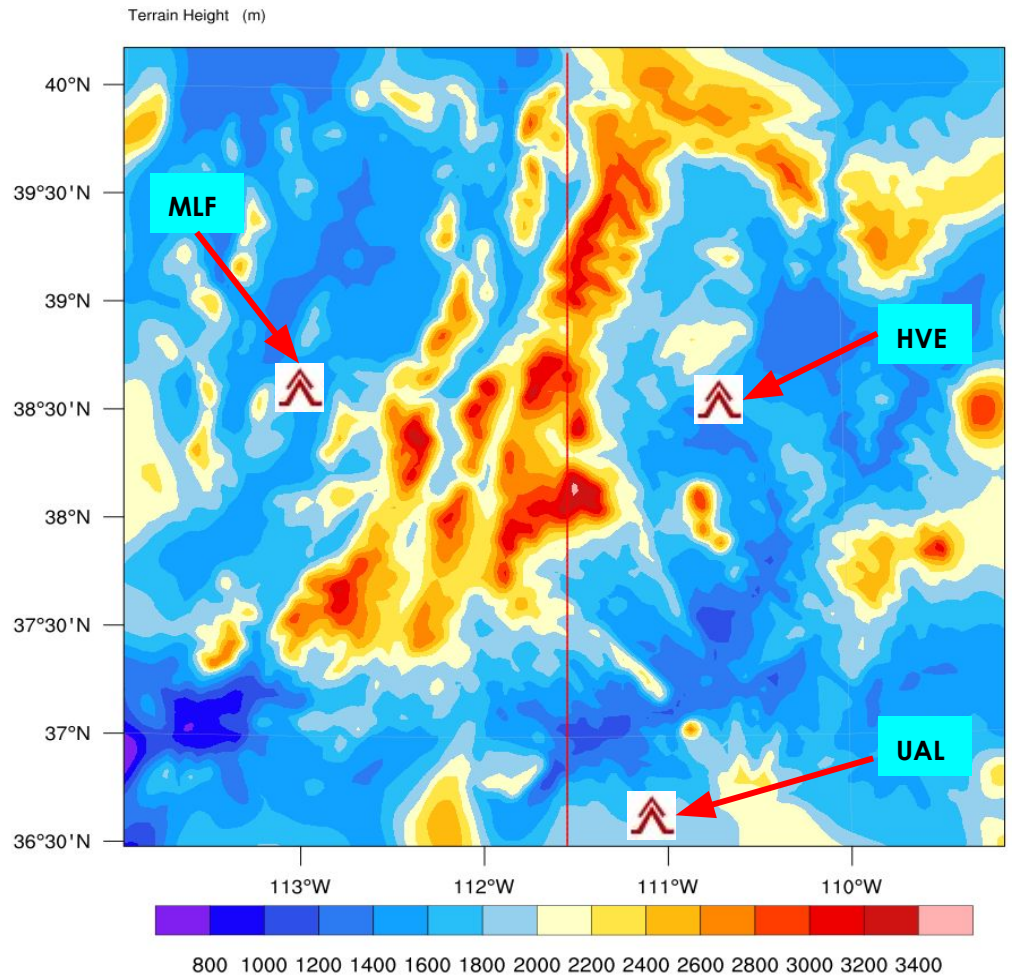
Christa Jacobs did a great job on issuing NOVEMBER SIGMET #1, and then Amy Macpherson issuing NOVEMBER SIGMET #2.



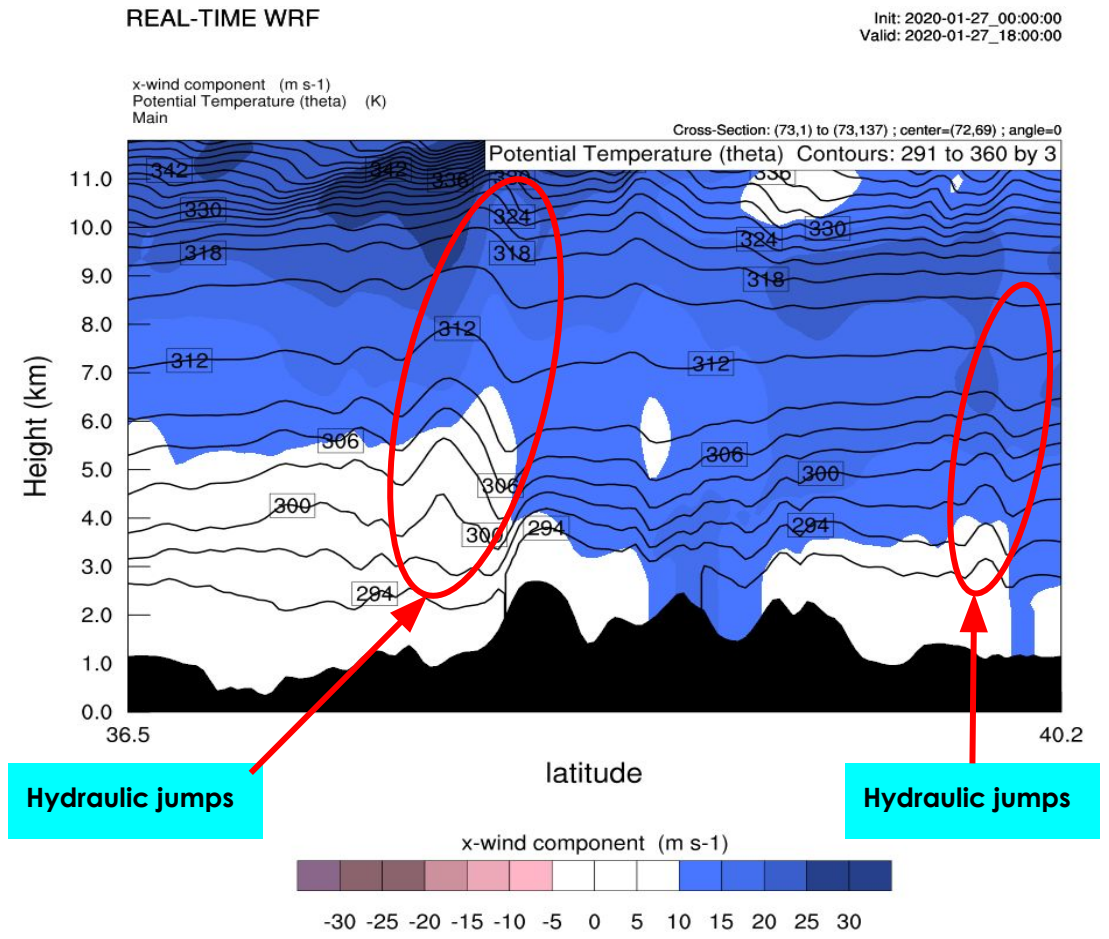
The Upcoming Slides are WRF 3km Model Displaying:

- N-S Topography Cross-Section at "111.6 W" on Jan 27th, 2020
- E-W Topography Cross-Section at "38.3N " on Jan 27th, 2020
- SW-NE Topography Cross-Section from "113.1W-110W" on Jan 27th, 2020

WRF 3km N-S Topography Cross-Section: “111.6 W” on Jan 27th, 20



WRF 3km N-S Cross-Section: “111.6 W” on Jan 27th, 20 at 1800Z



MLF - Milford, Utah “38.39N 113.01W”
HVE - Hanksville, Utah “38.37N 110.7W”
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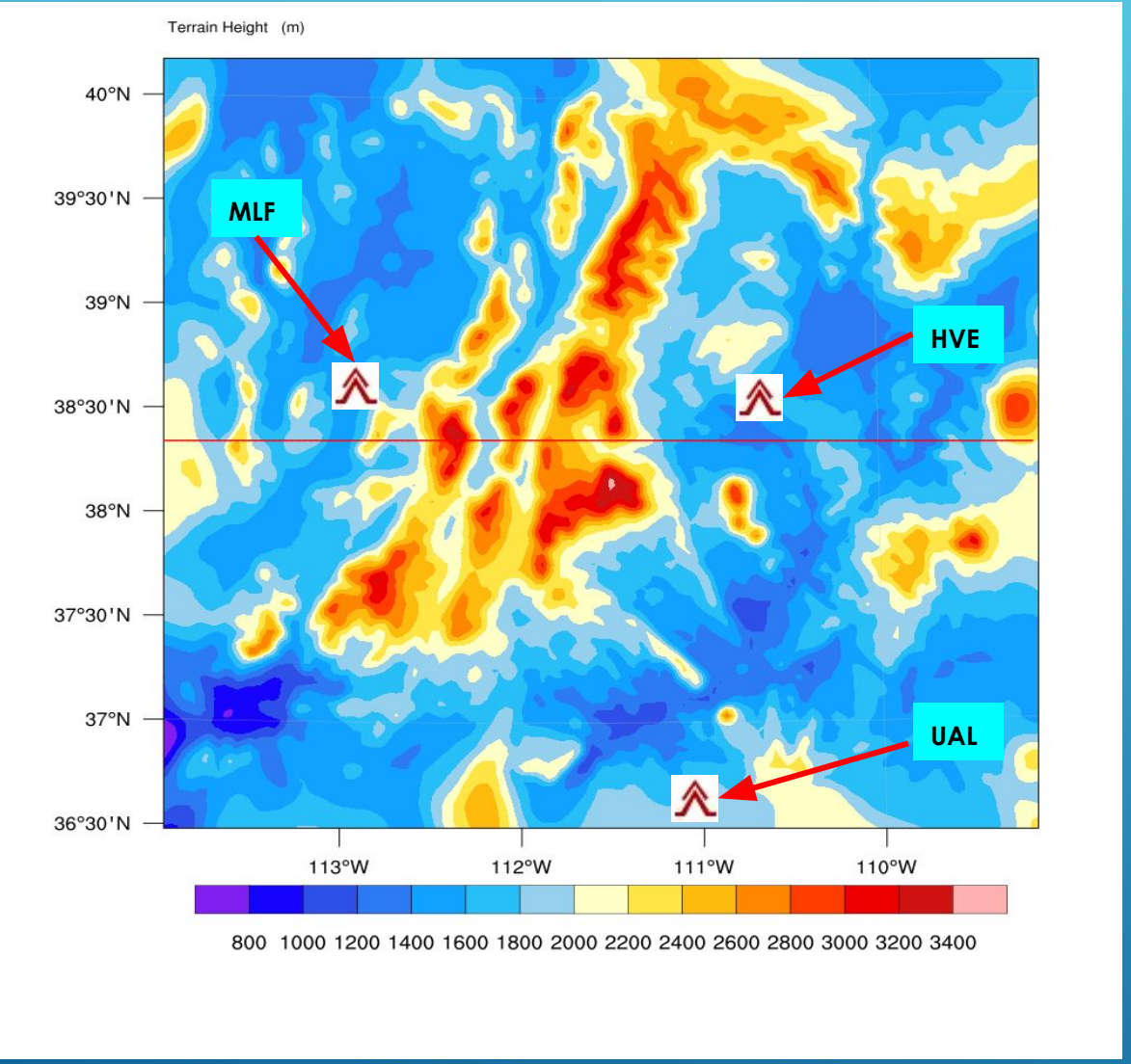
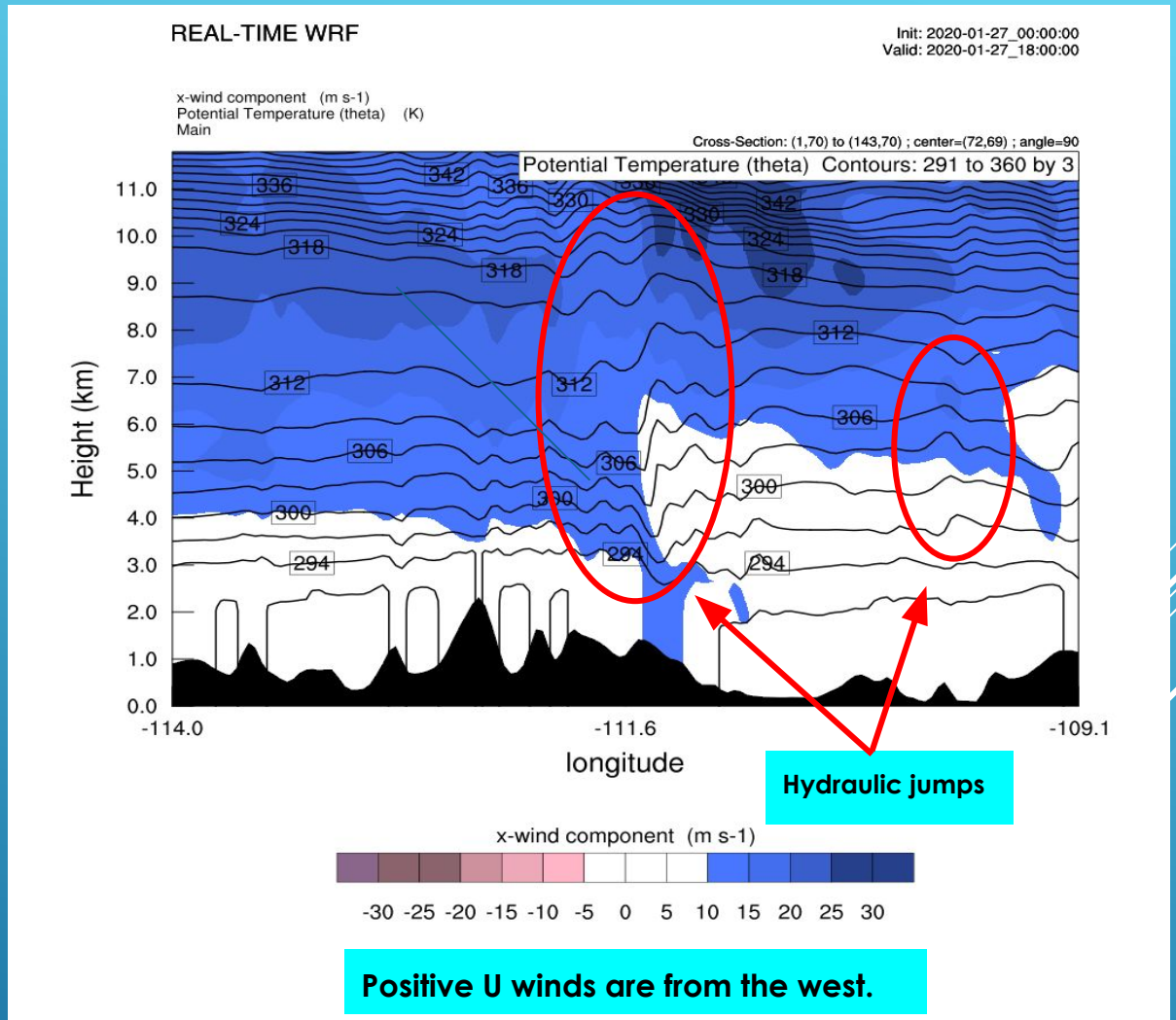
WRF 3km E-W Topograhy Cross-Section: "38.3N" on Jan 27th, 20



WRF 3km E-W Cross-Section: "38.3N" on Jan 27th, 20 at 1800Z



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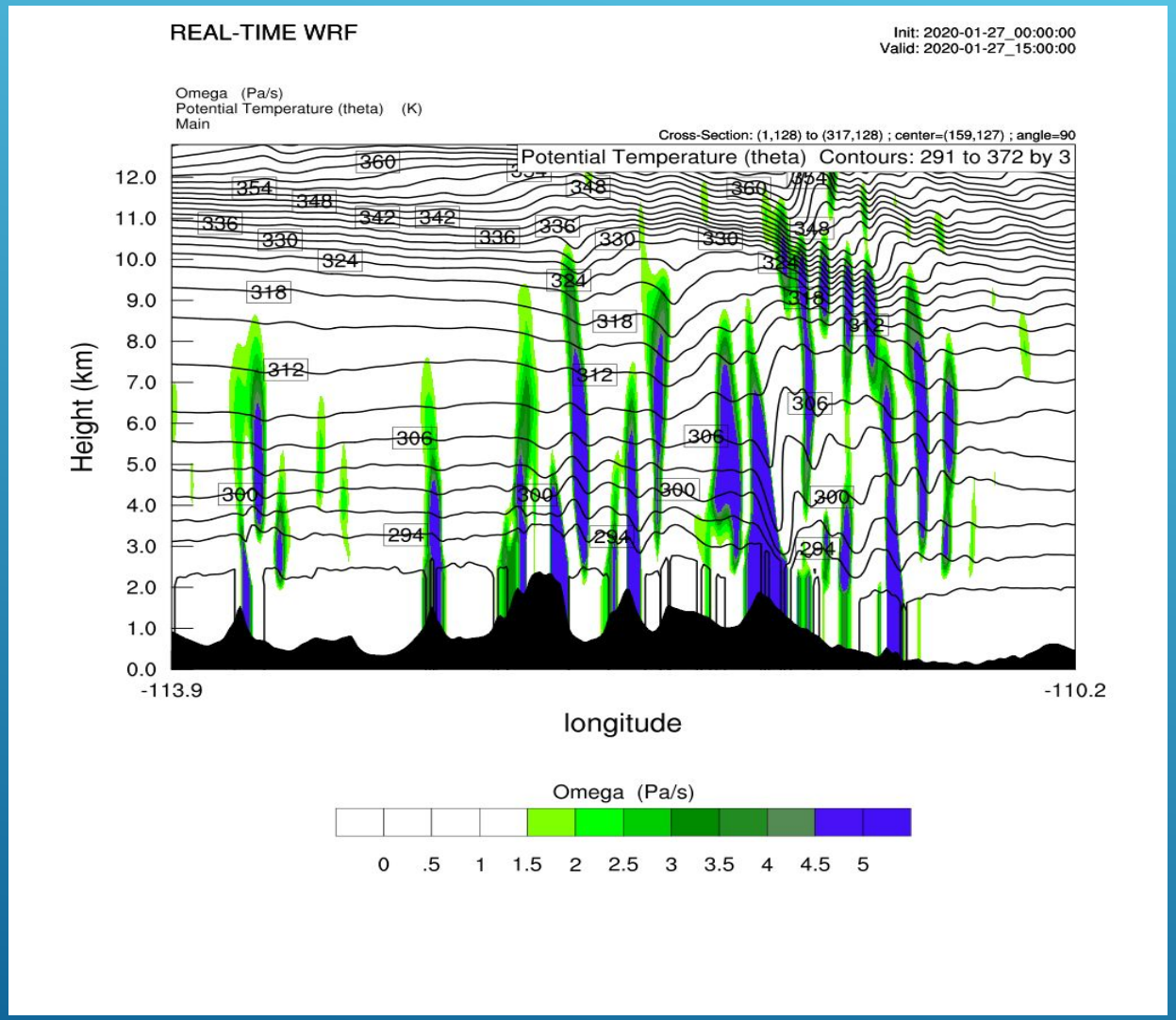
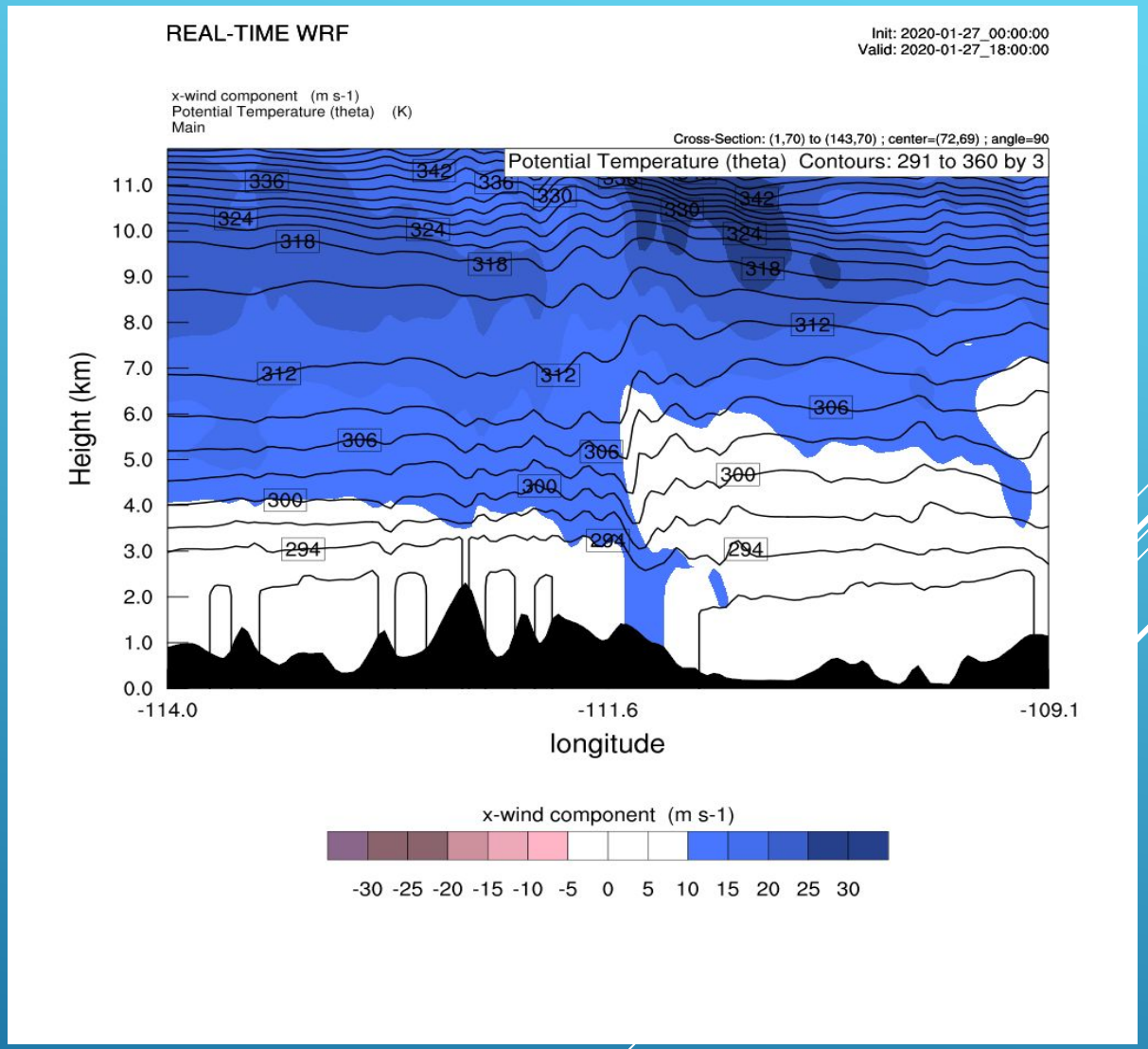
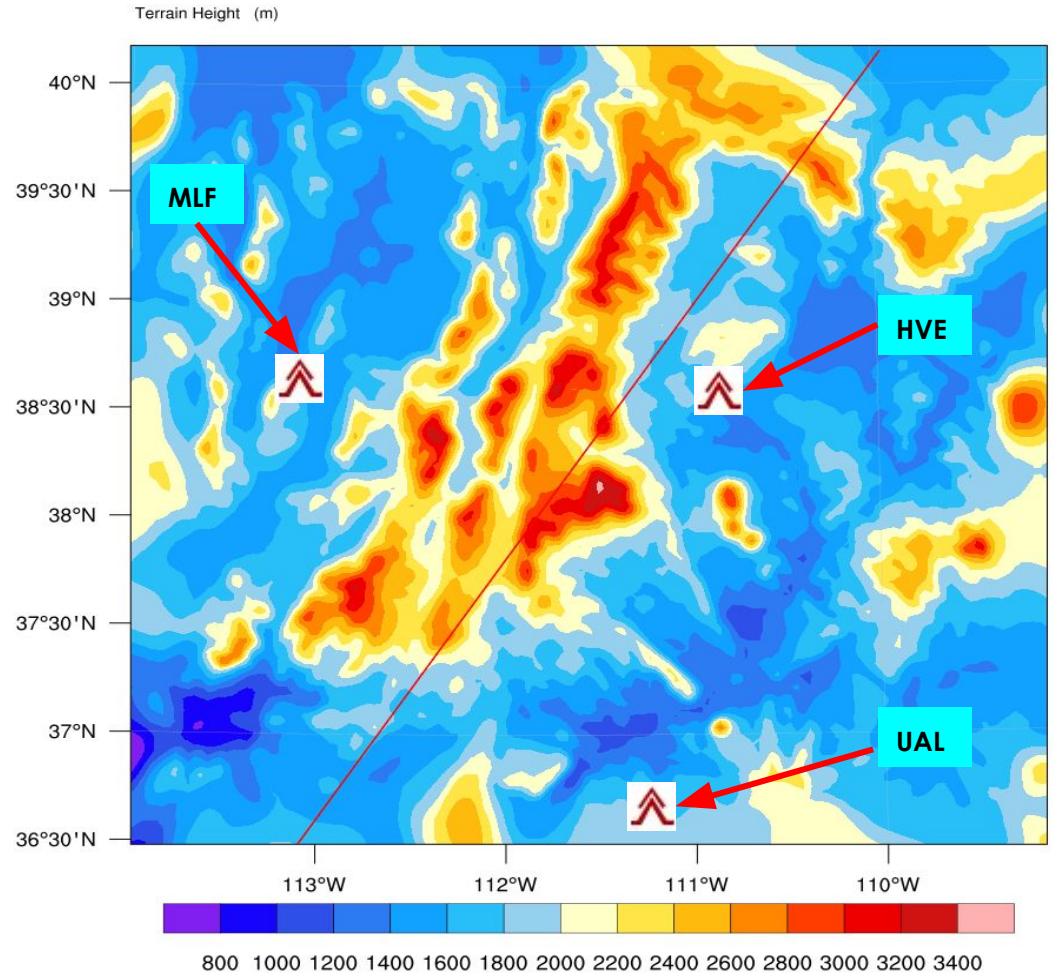
WRF 1km E-W Cross-Section: "38.3N" on Jan 27th, 20 at 1500Z



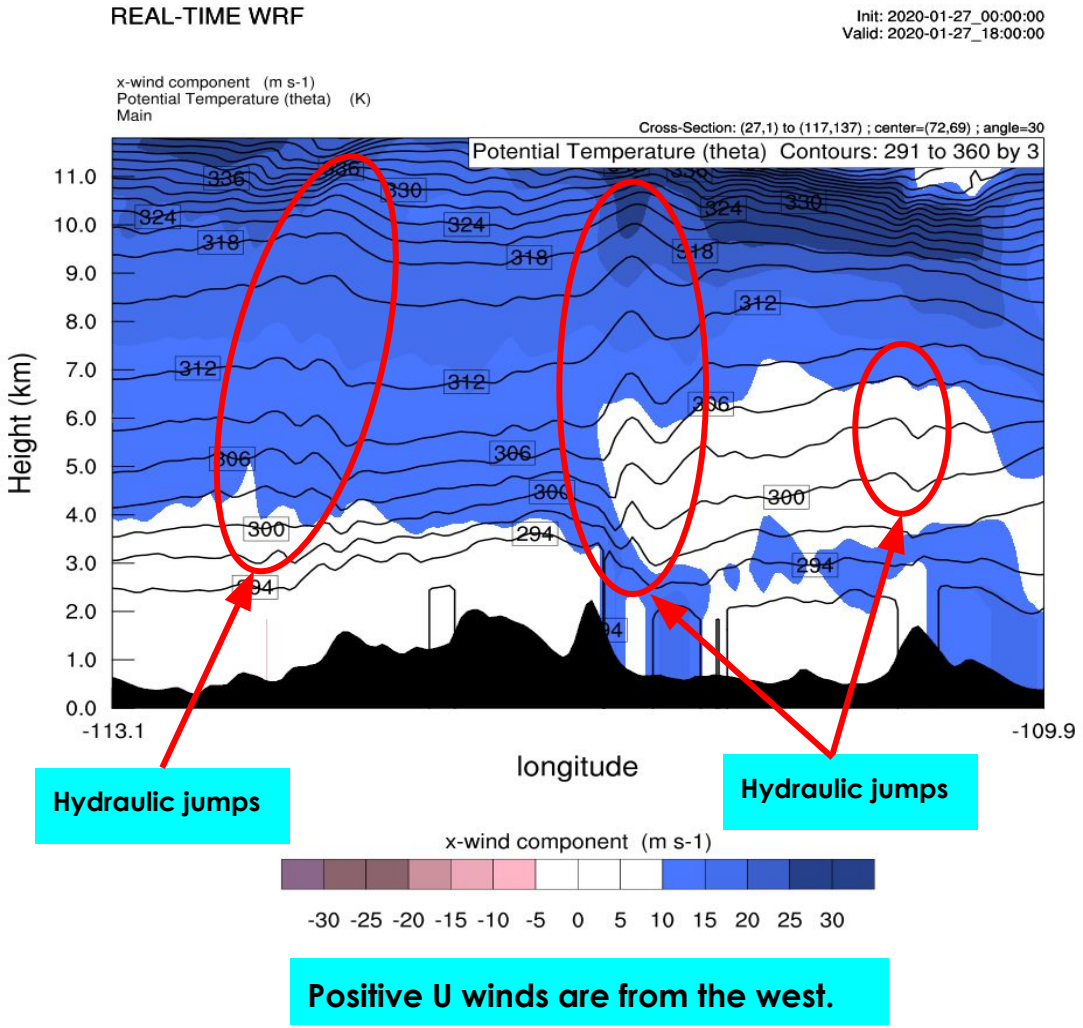
WRF 3km E-W Cross-Section: "38.3N" on Jan 27th, 20 at 1800Z



WRF 3km SW-NE Topograhy Cross-Section: “113.1-110W”on Jan 27th, 20



WRF 3km SW-NE Cross-Section: “38.3N” on Jan 27th, 20 at 1800Z



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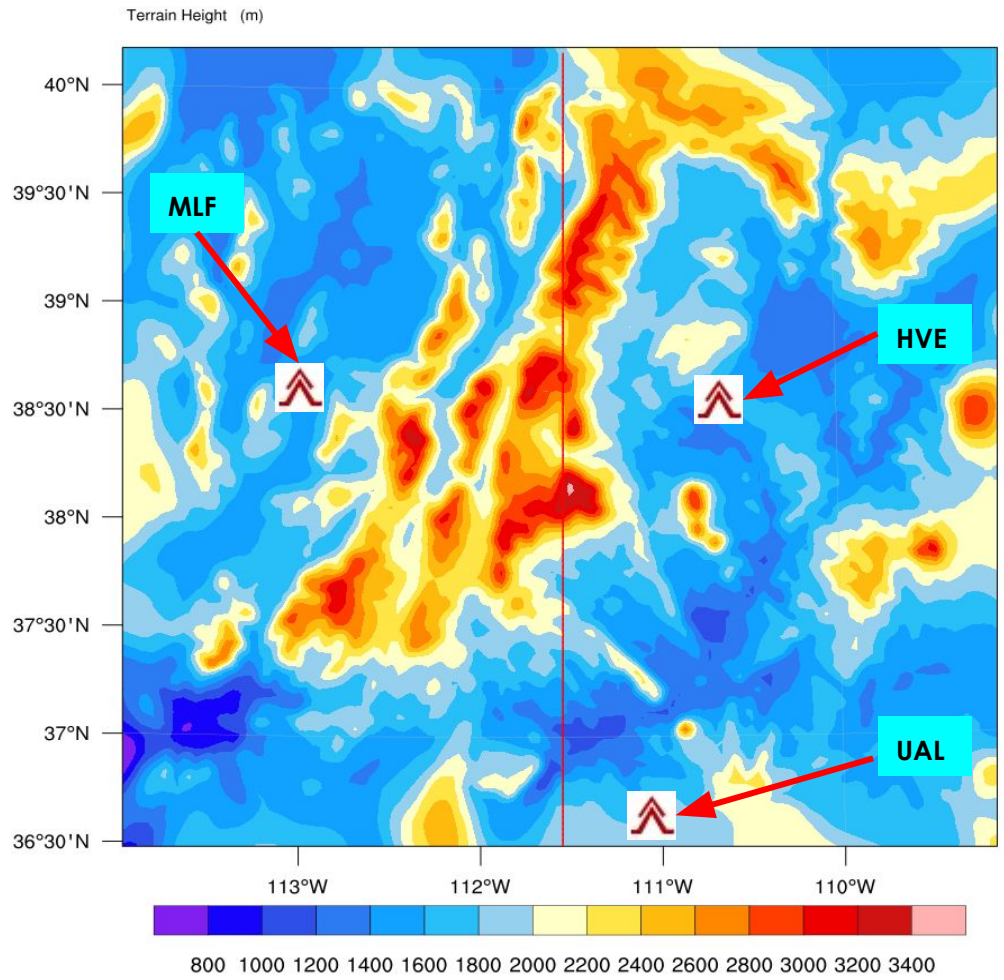
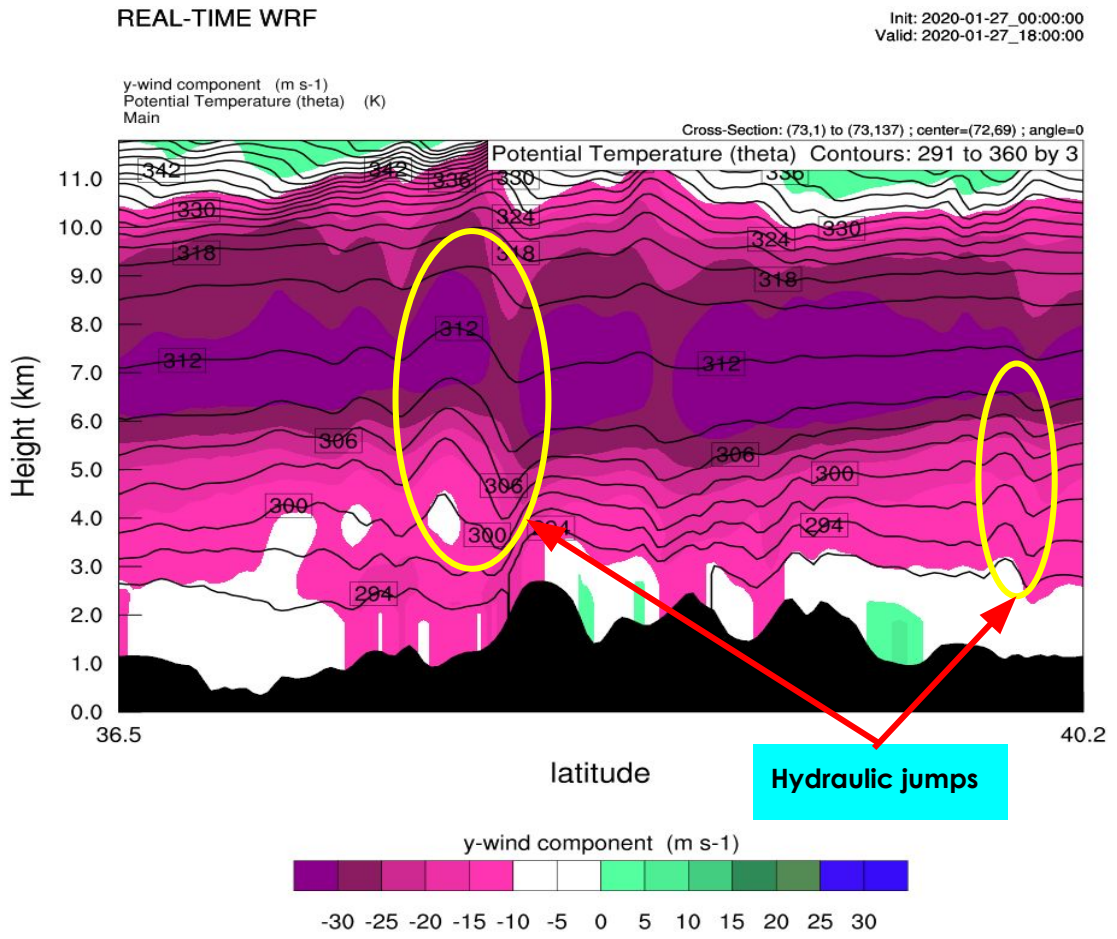
WRF 3km N-S Topograhy Cross-Section: “111.6 W” on Jan 27th, 20



WRF 3km N-S Cross-Section: “111.6 W” on Jan 27th, 20 at 1800Z



“Y-Wind Comp.”

Positive V winds are from the south.

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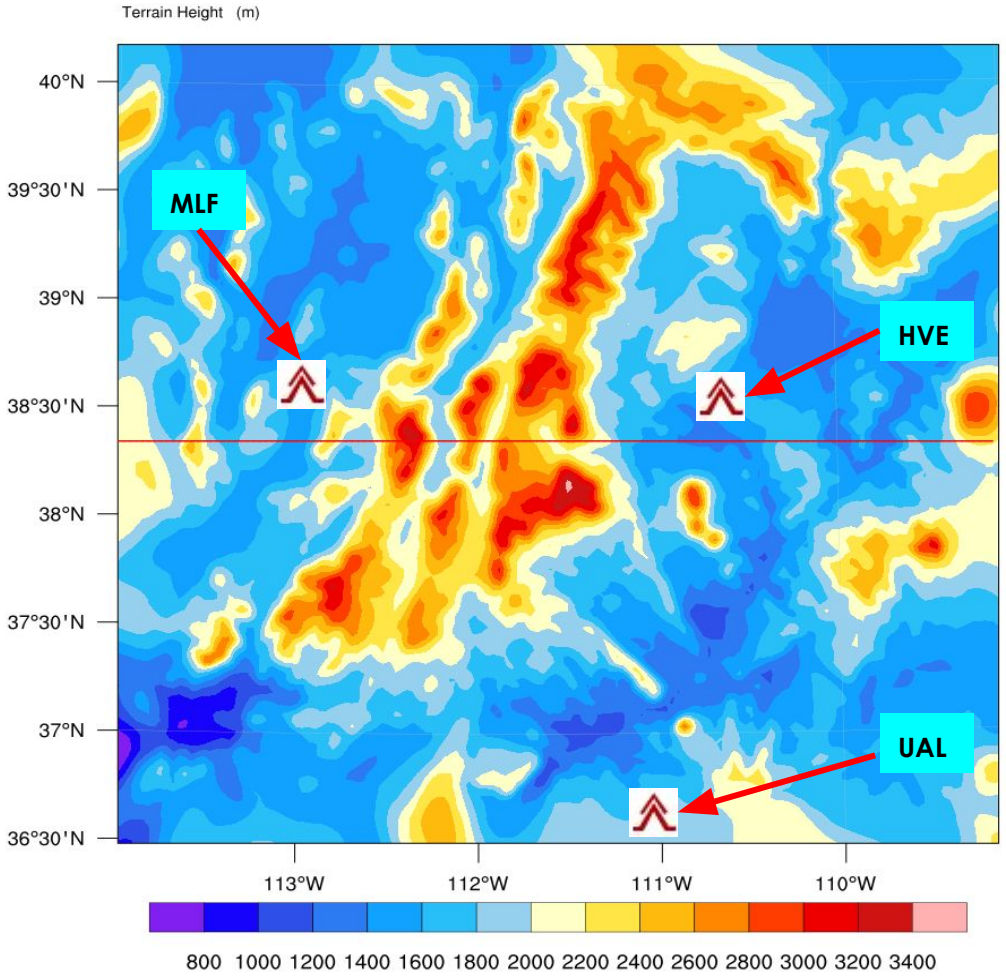
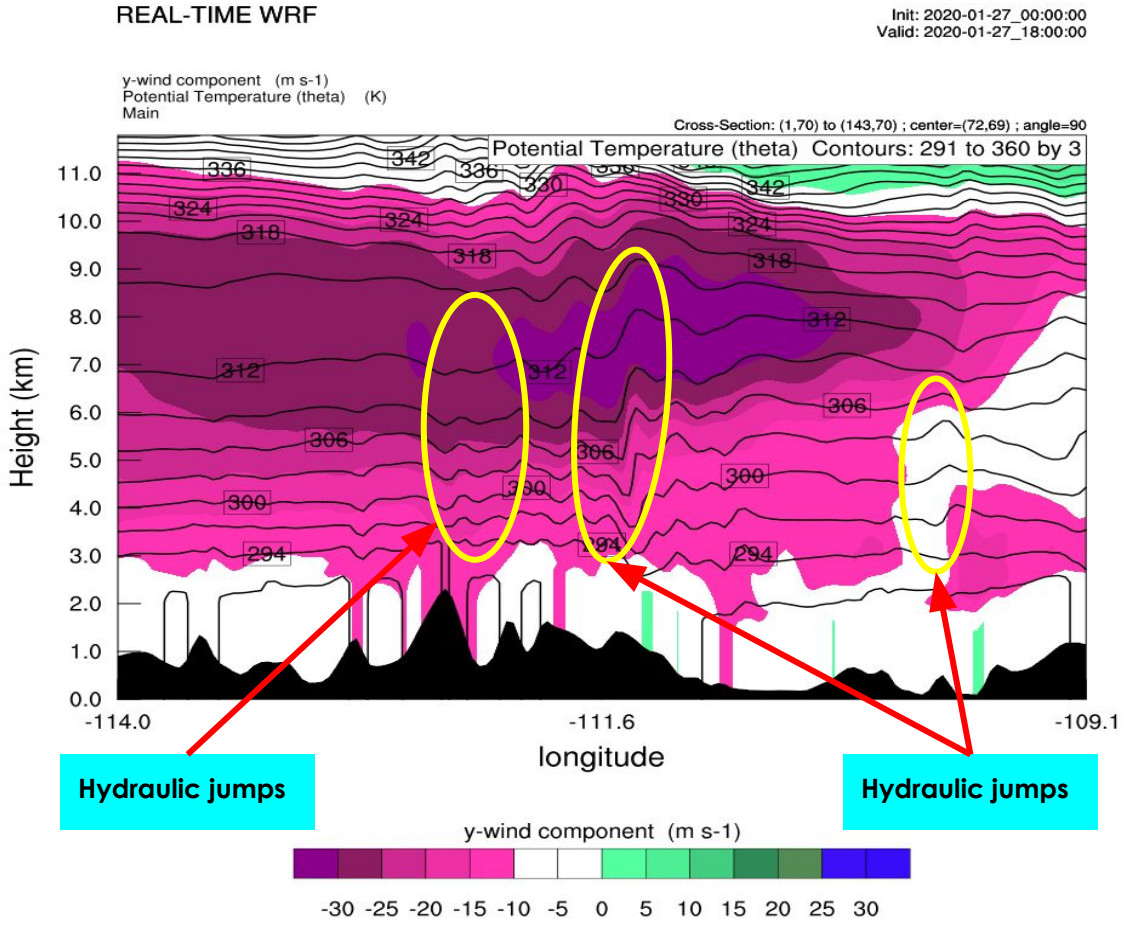


WRF 3km E-W Cross-Section: “38.3N” on Jan 27th, 20 at 1800Z



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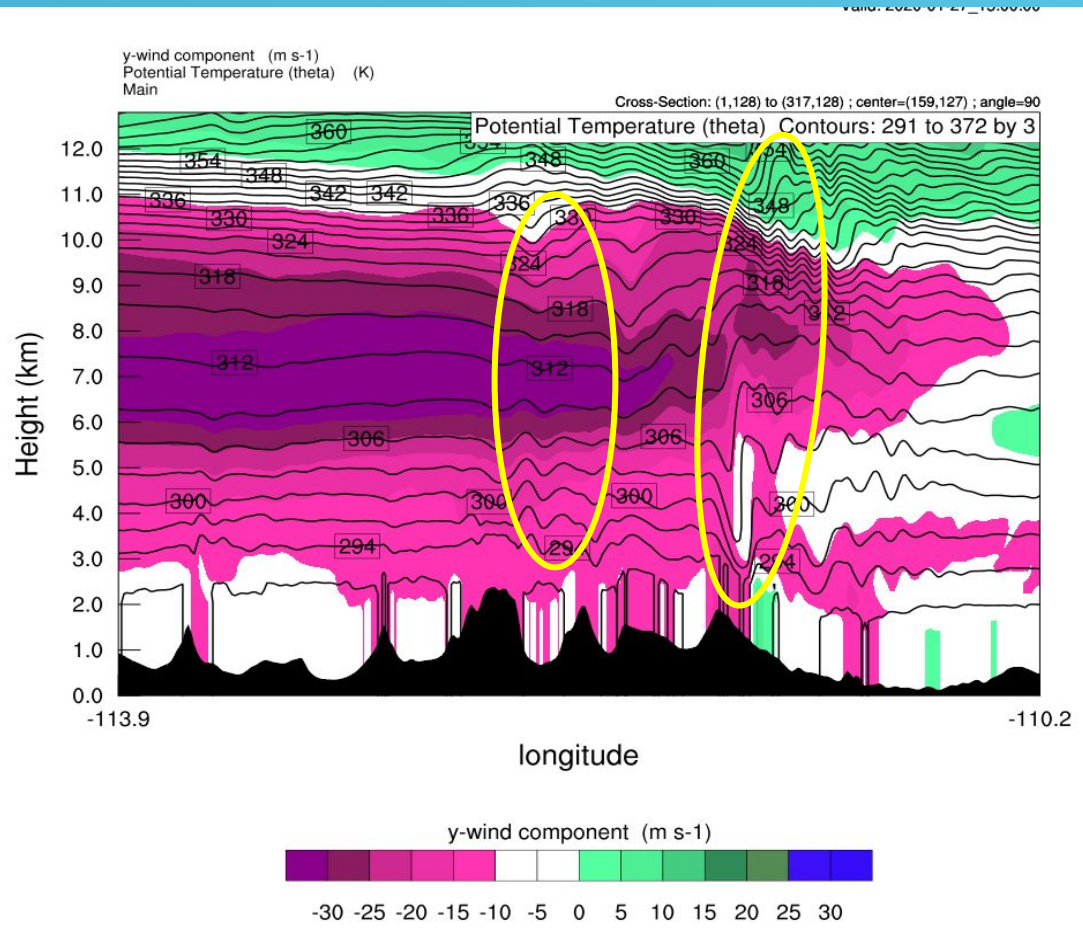
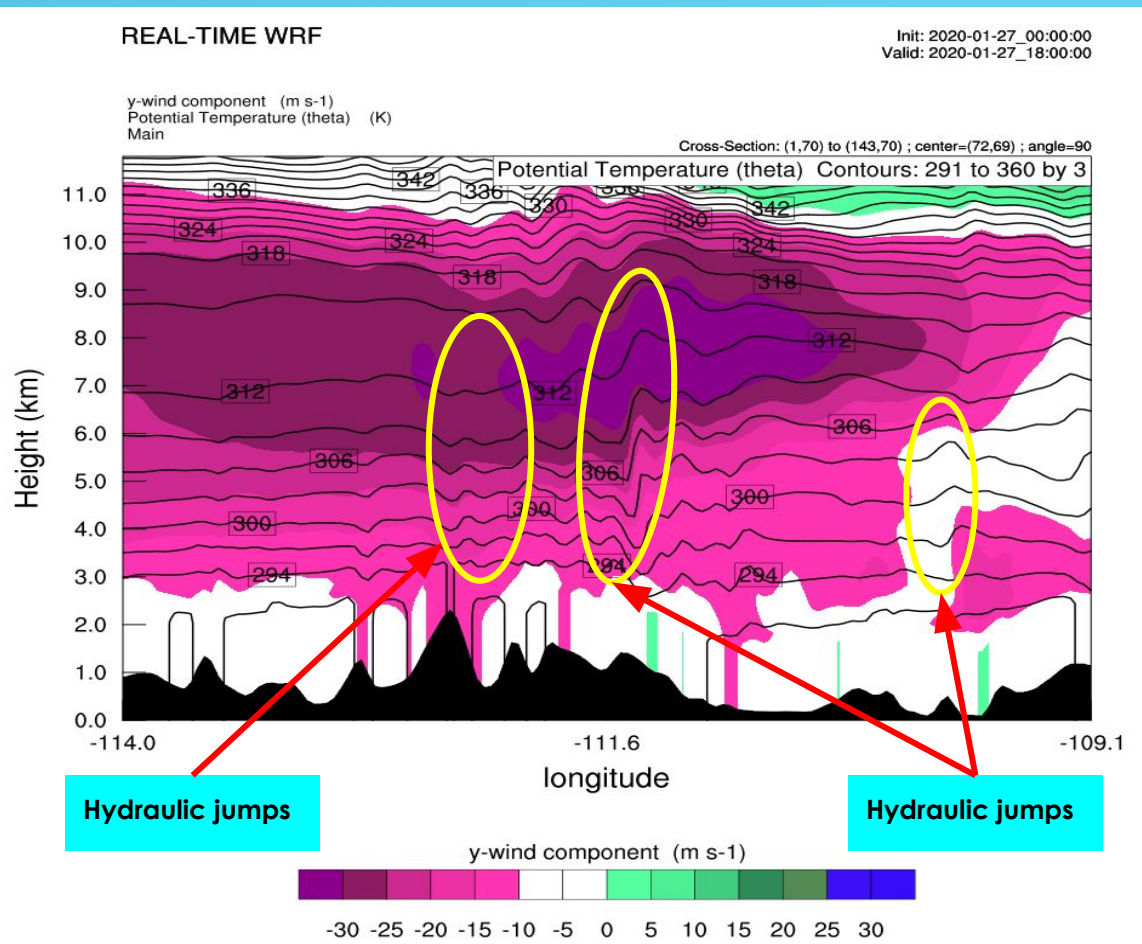
WRF !km E-W Cross-Section: "38.3N" on Jan 27th, 20 at 1500Z



WRF 3km E-W Cross-Section: "38.3N" on Jan 27th, 20 at 1800Z



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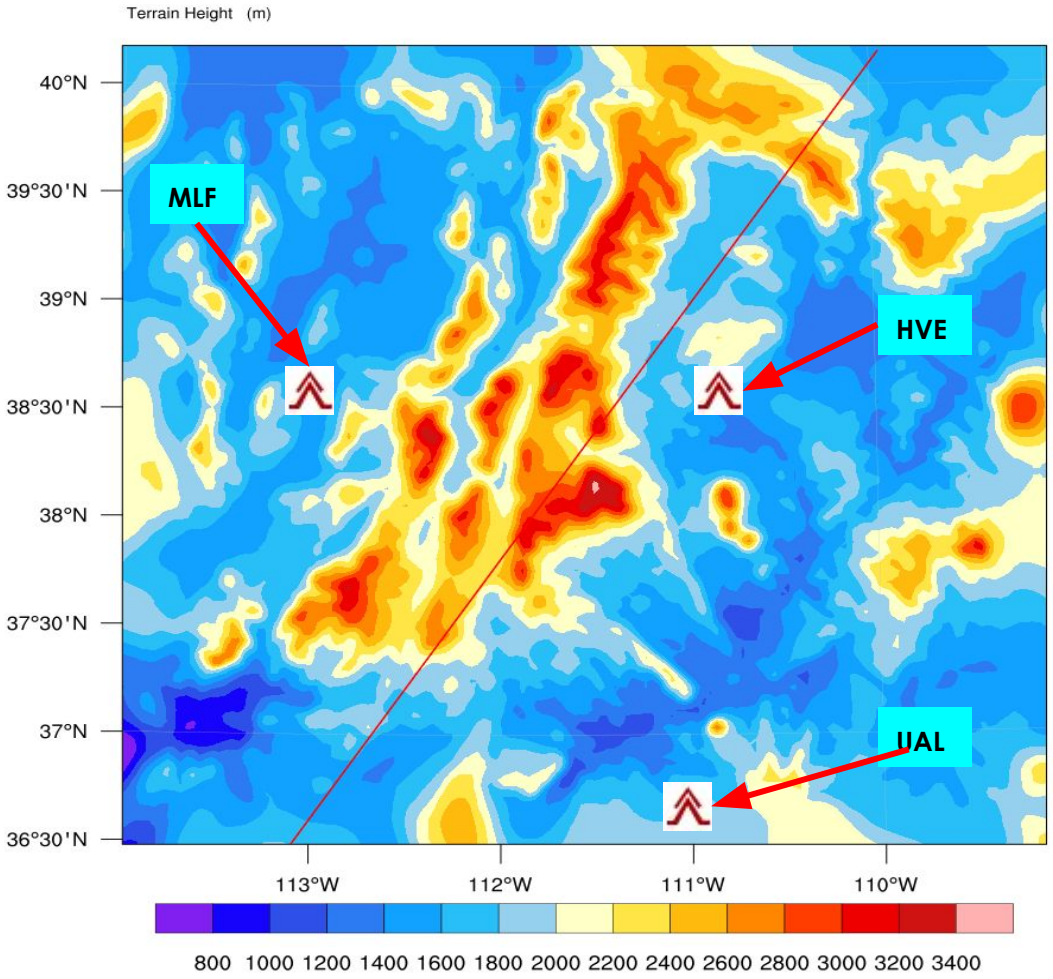
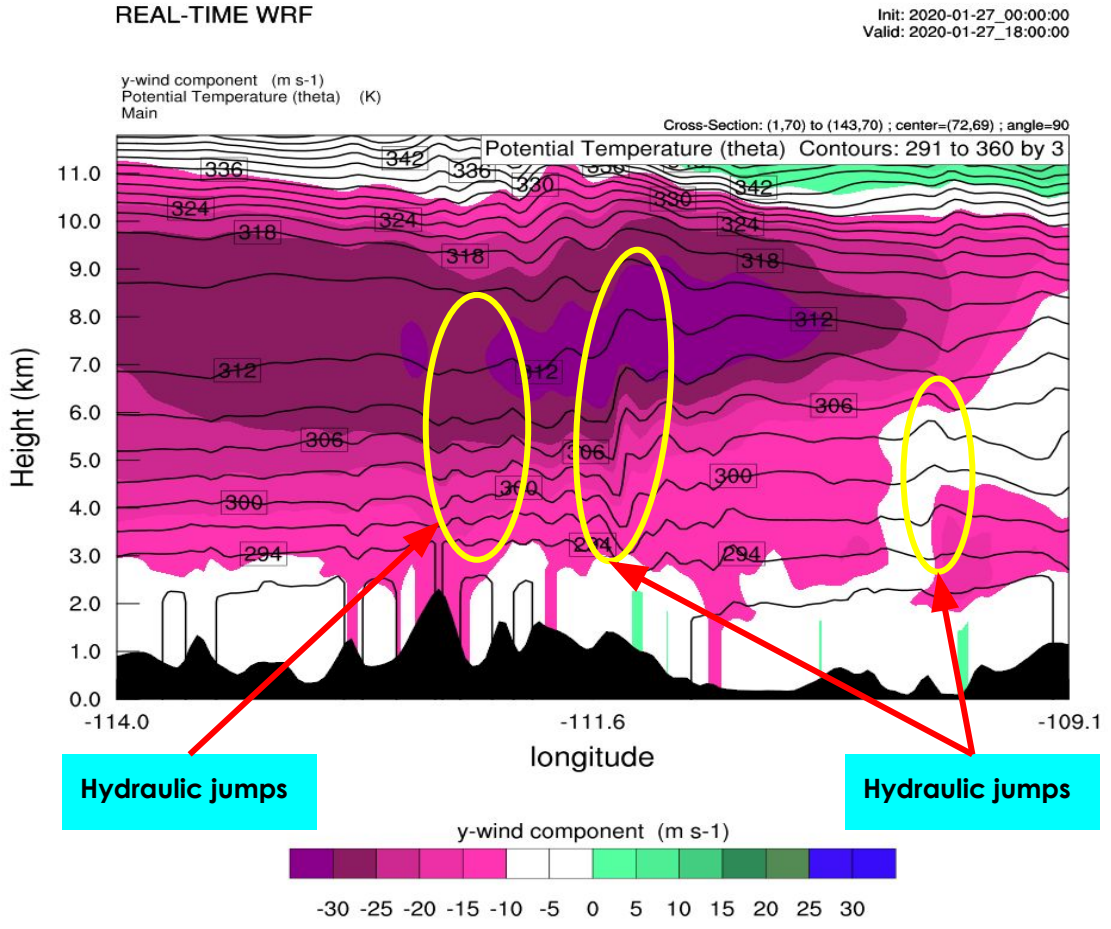


WRF “3km” SW-NE Cross-Section: “38.3N” on Jan 27th, 20 at 1800Z



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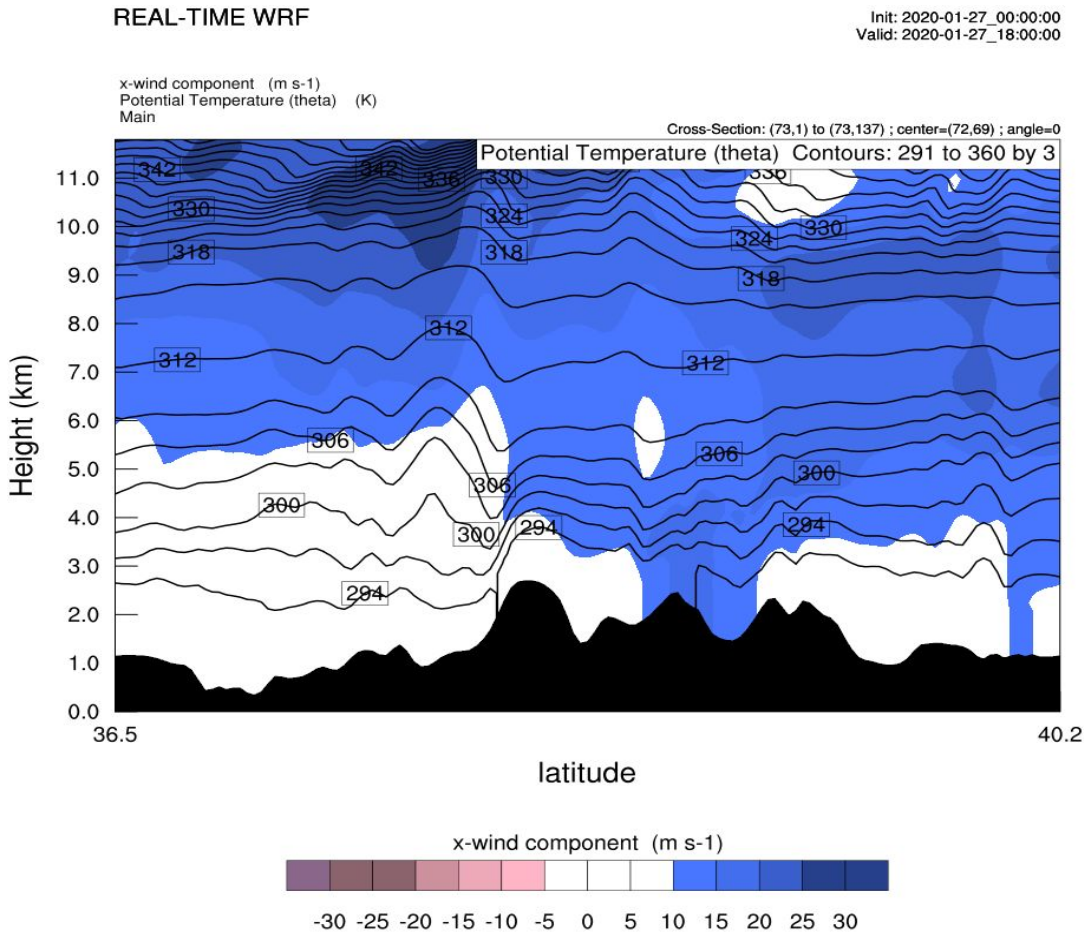
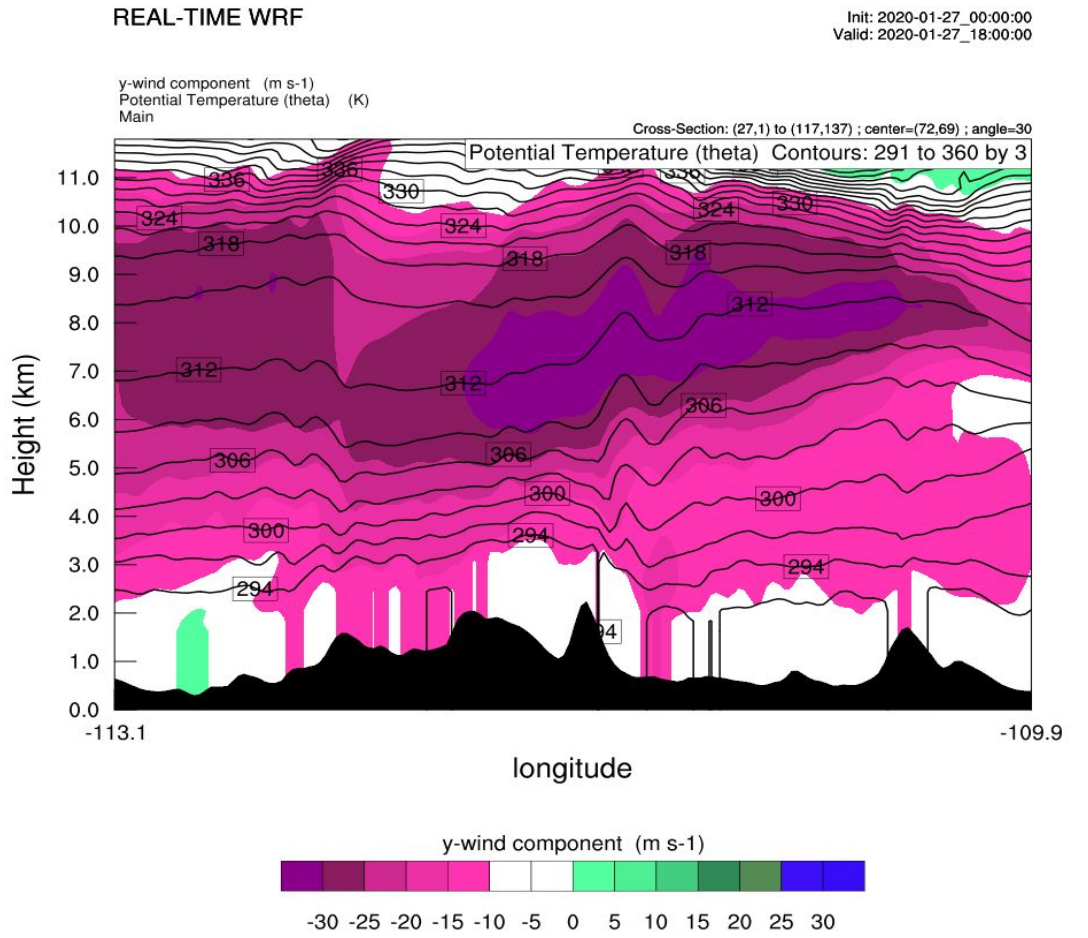
WRF 3km N-S Cross-Section: "111.6W" on JAN 27th, 20 at 1800Z



"X-Wind Comp." | Positive U winds are from the west.

WRF 3km N-S Cross-Section: "38.3N" on Jan 27th, 20 at 1800Z



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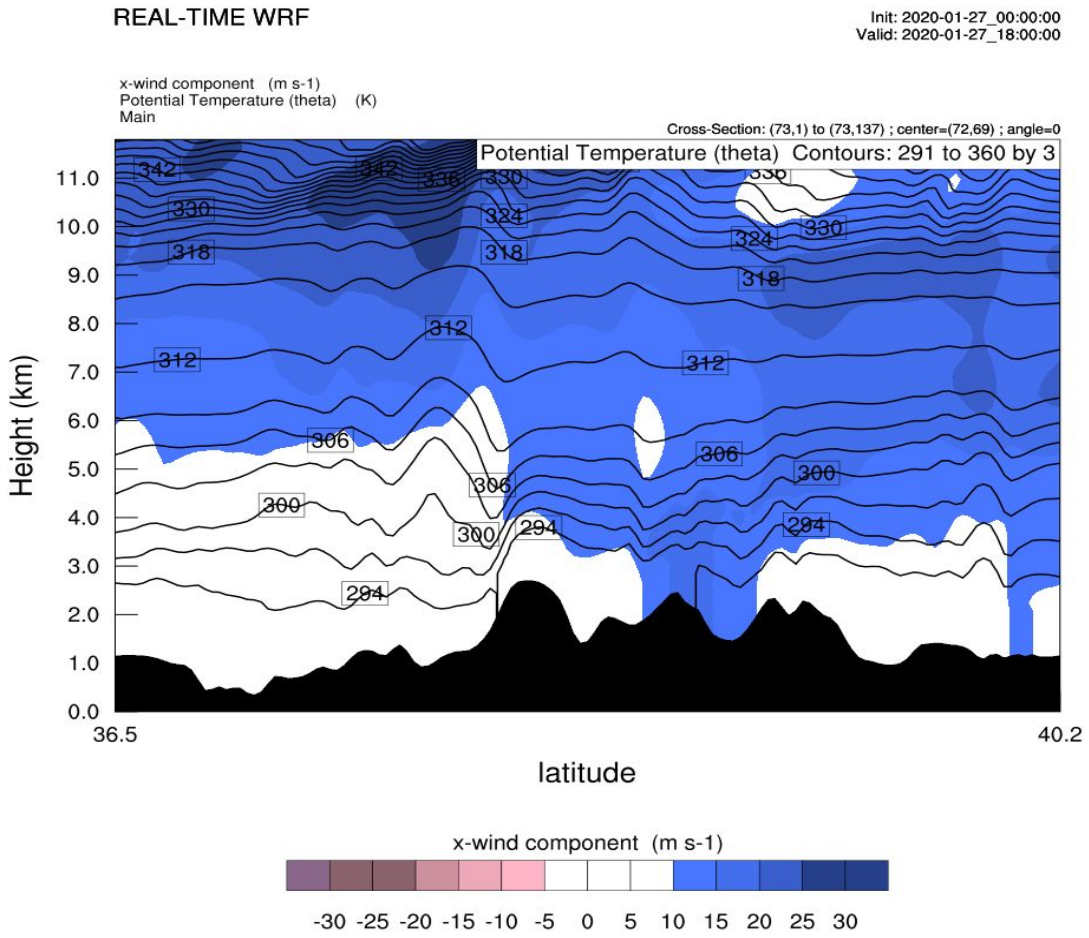

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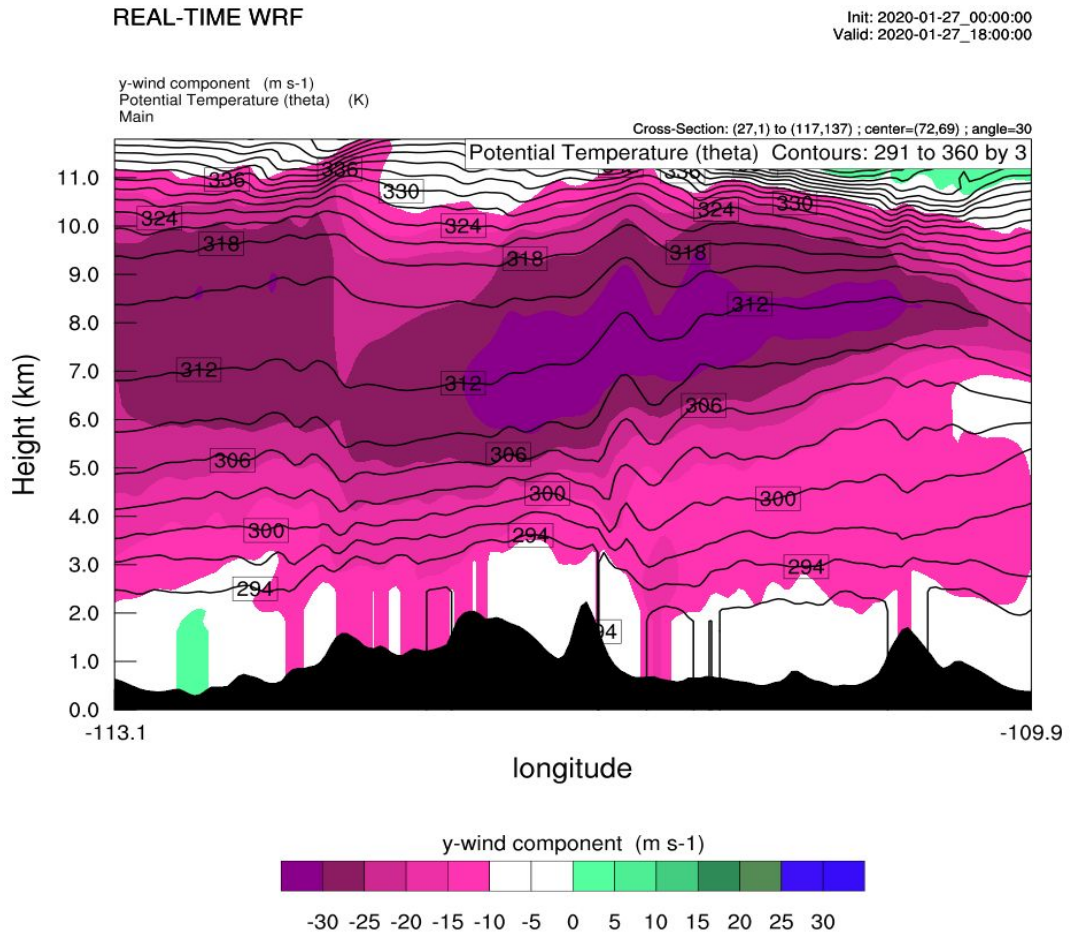

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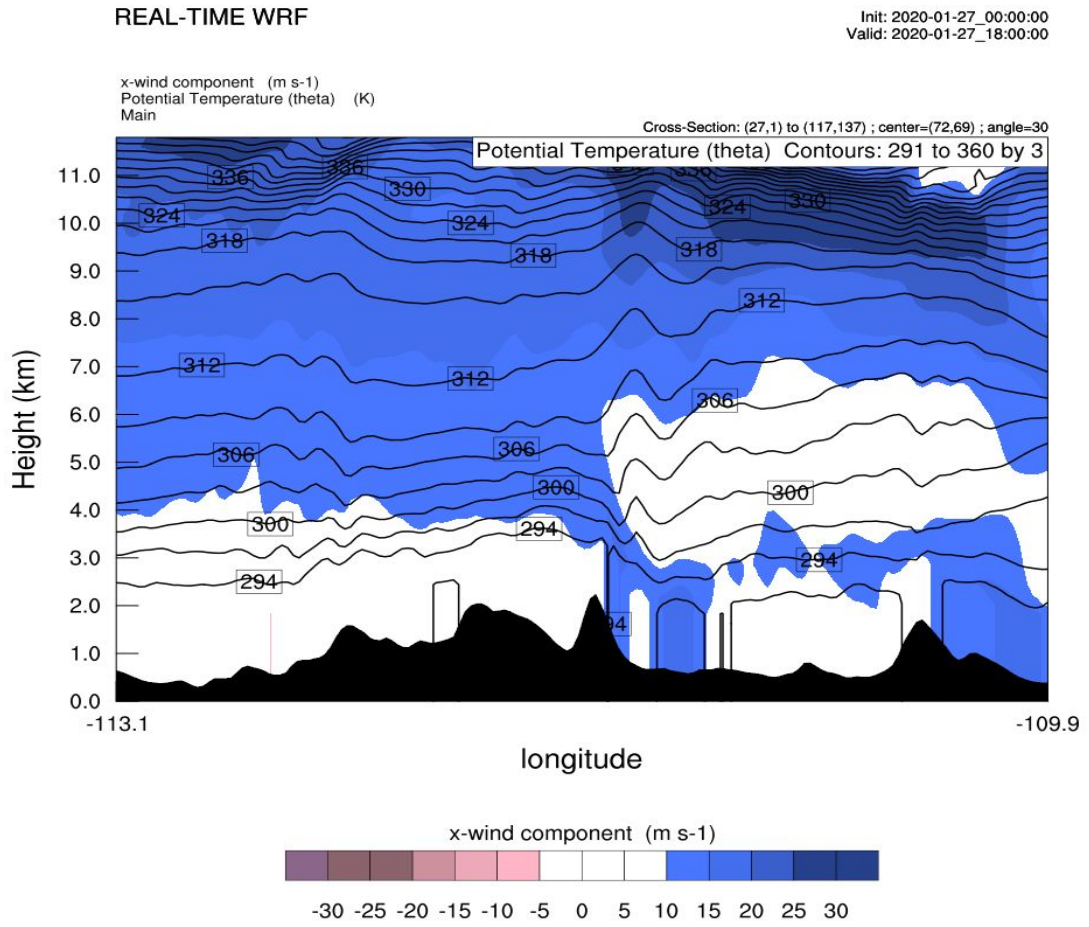

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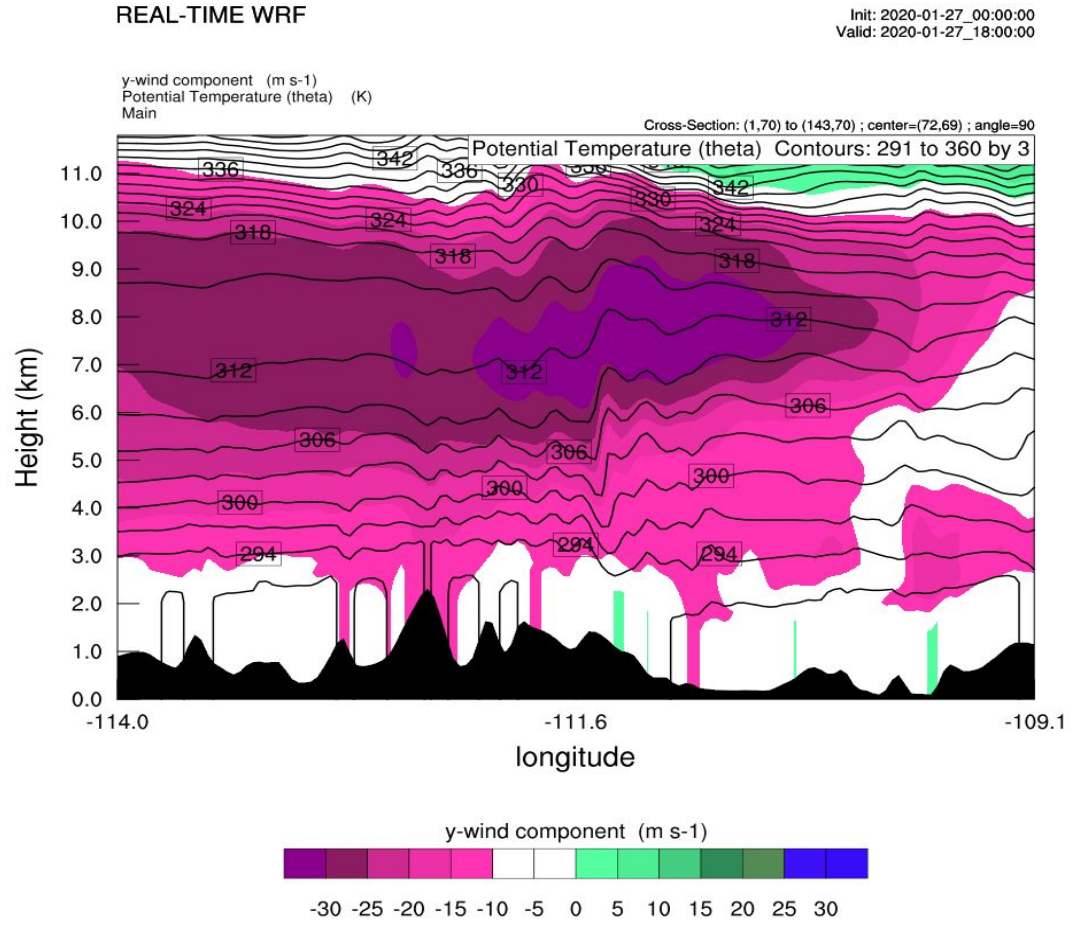

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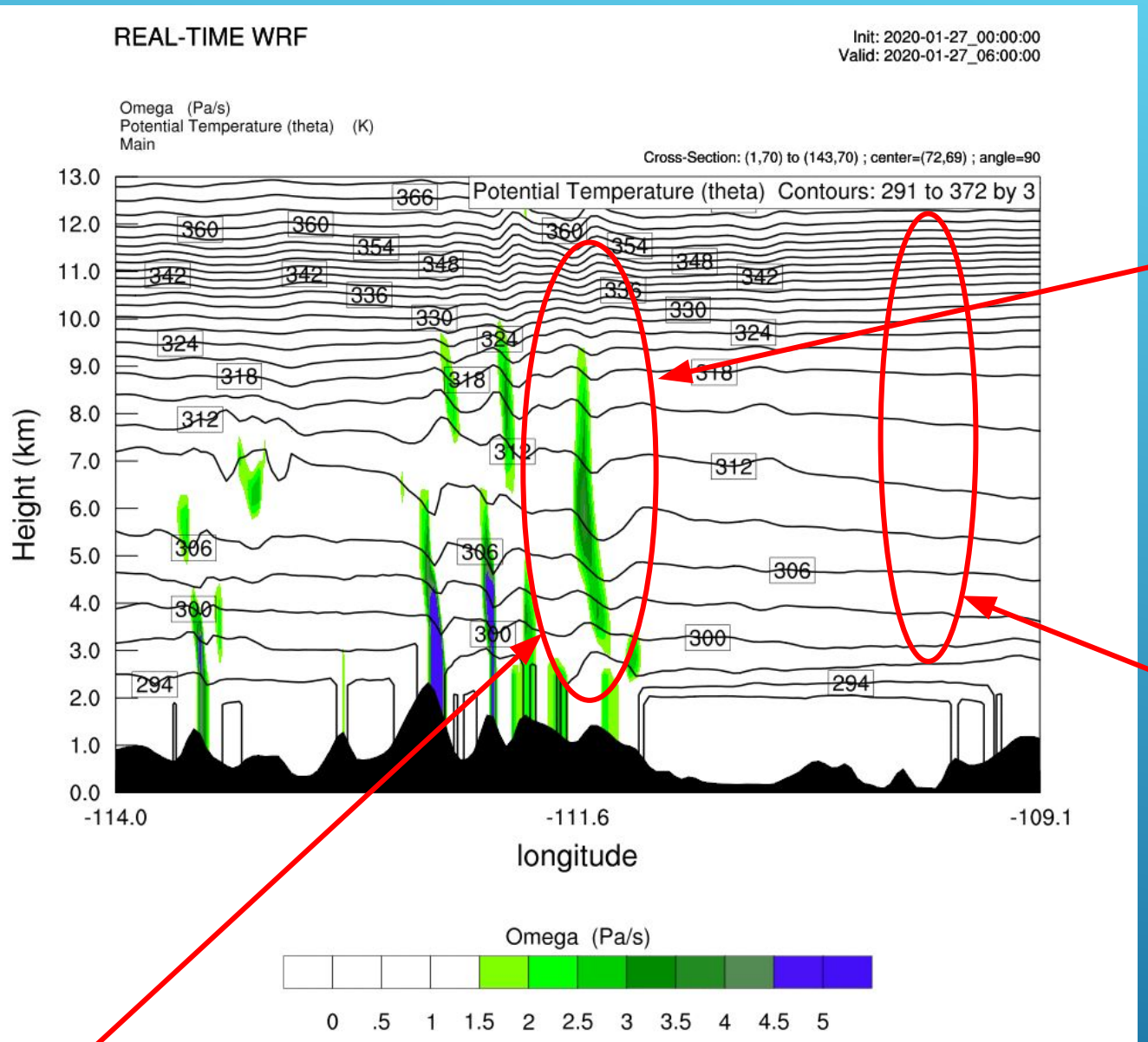

WRF "3km" E-W OMEGA & POTENTIAL TEMPS LOOP
Cross-Section: at "38.3N"
TIMES: 01/27/20 from 0600Z - 01/28/20 at 0000Z.

AIREP UAL1753
Obs Time: 2020-01-27T14:55:00Z
Turb intensity: MOD-SEV
Flight level: 310
AIREP: ARP UAL1753 3656N 11110W 1455 F310 TB MOD-SEV TURB IC RM B739 OV TBC350049 NO INJURIES. DURATION 10 SECONDS

UAL

Urgent PIREP C17
Obs Time: 2020-01-27T17:50:00Z
Turb intensity: MOD-SEV
Flight level: 340
Urgent PIREP: MLF UUA /OV MLF060060/TM 1750/FL340/TP C17/TB MOD-SEV/ZLC

MLF

Urgent PIREP A321
Obs Time: 2020-01-27T17:36:00Z
Turb intensity: MOD-SEV
Flight level: 330
Urgent PIREP: CNY UUA /OV HVE300020/TM 1736/FL330/TP A321/TB MOD-SEV/ZLC

HVE

The next two moderate-severe turb pireps occur over MLF & HVE at 1750Z & 1736Z

The start of first hydraulic jump begins by 12Z and major hydraulic jump occurs at 15Z. This coincides with the moderate-to-severe turb pirep at "FL310" at 1455Z over UAL.

MLF - Milford, Utah "38.39N 113.01W"
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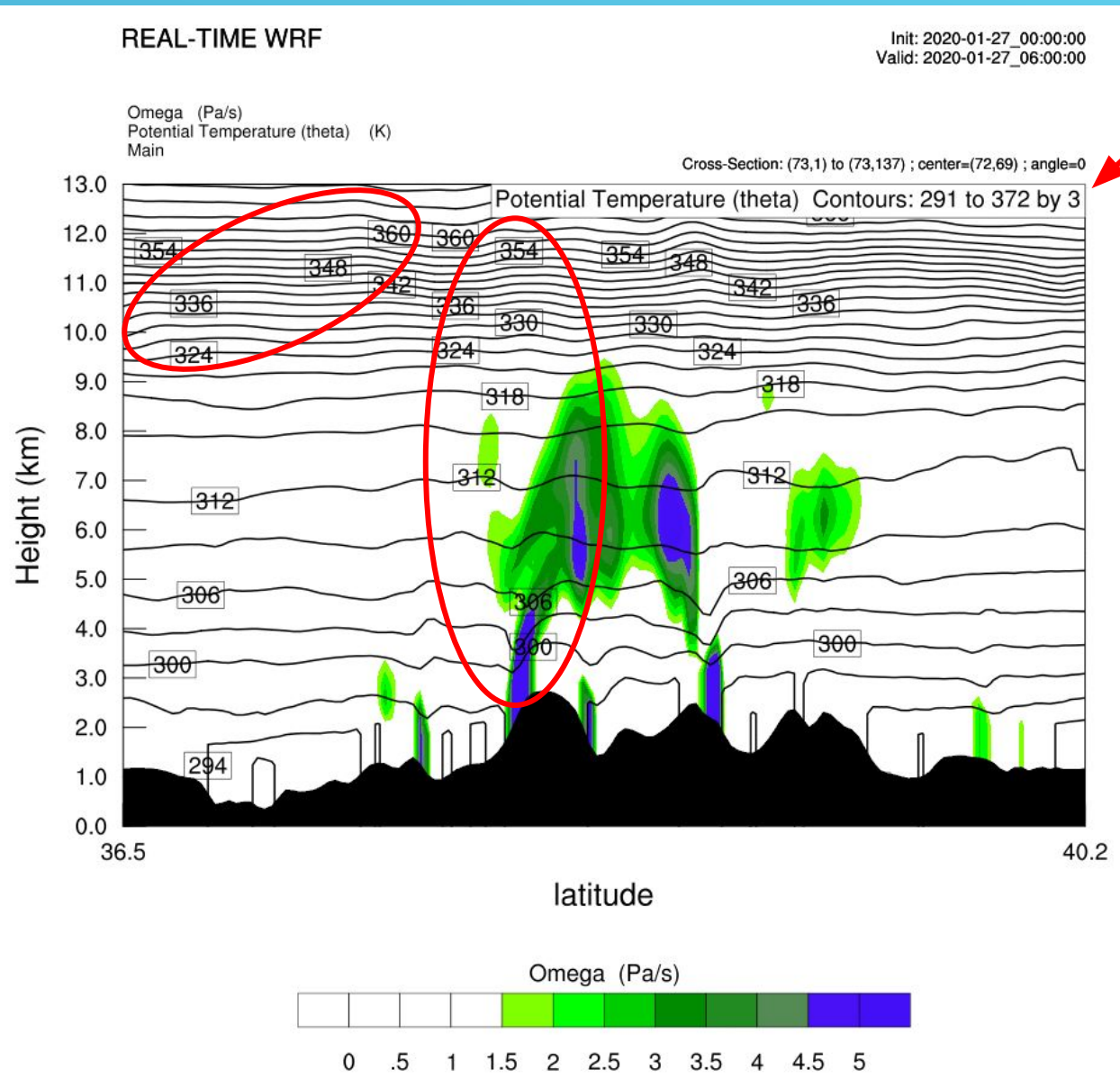
UAL - "36.56N 111.10W"



WRF "3km" N-S OMEGA & POTENTIAL TEMPS LOOP
Cross-Section: at "111.6 W"
TIMES: TIMES: 01/27/20 from 0600Z - 01/28/20 at 0000Z. .

AIREP UAL1753
Obs Time: 2020-01-27T14:55:00Z
Turb intensity: MOD-SEV
Flight level: 310
AIREP: ARP UAL1753 3656N 11110W 1455 F310 TB MOD-SEV TURB IC RM B739 OV TBC350049 NO INJURIES. DURATION 10 SECONDS

UAL

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Obs Time: 2020-01-27T17:50:00Z
Turb intensity: MOD-SEV
Flight level: 340
Urgent PIREP: MLF UUA /OV MLF060060/TM 1750/FL340/TP C17/TB MOD-SEV/ZLC

MLF

Urgent PIREP A321
Obs Time: 2020-01-27T17:36:00Z
Turb intensity: MOD-SEV
Flight level: 330
Urgent PIREP: CNY UUA /OV HVE300020/TM 1736/FL330/TP A321/TB MOD-SEV/ZLC

HVE

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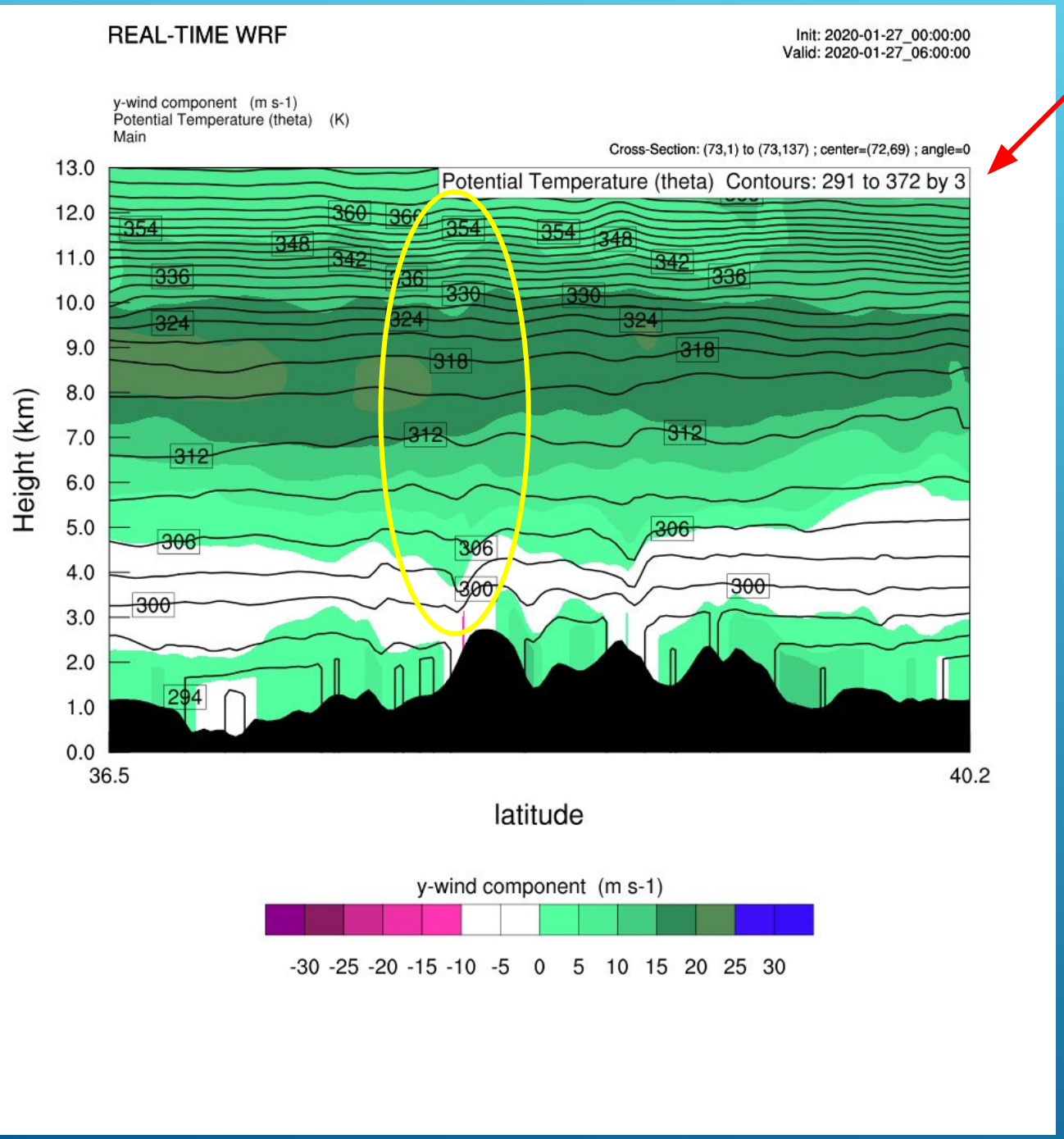
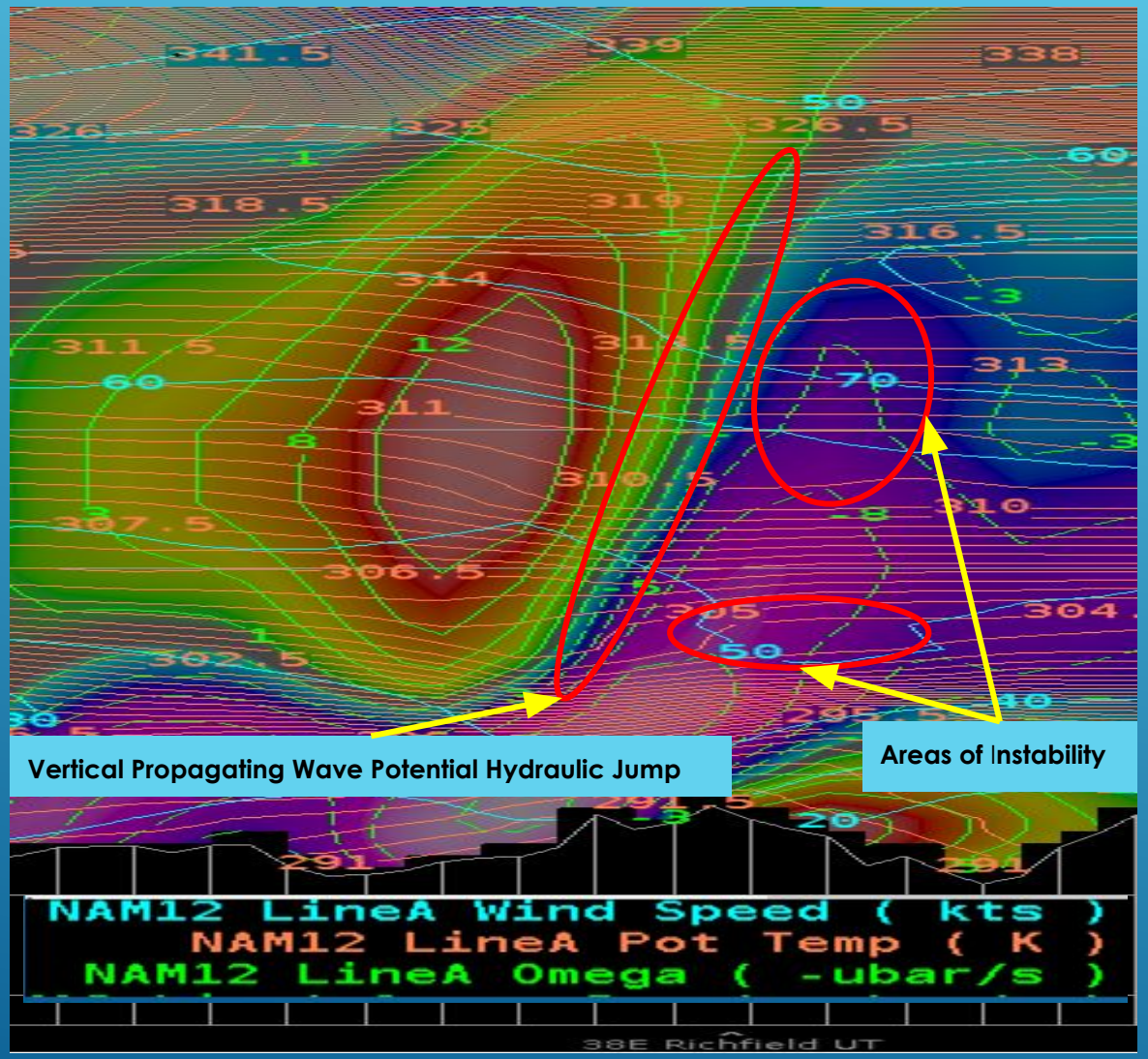


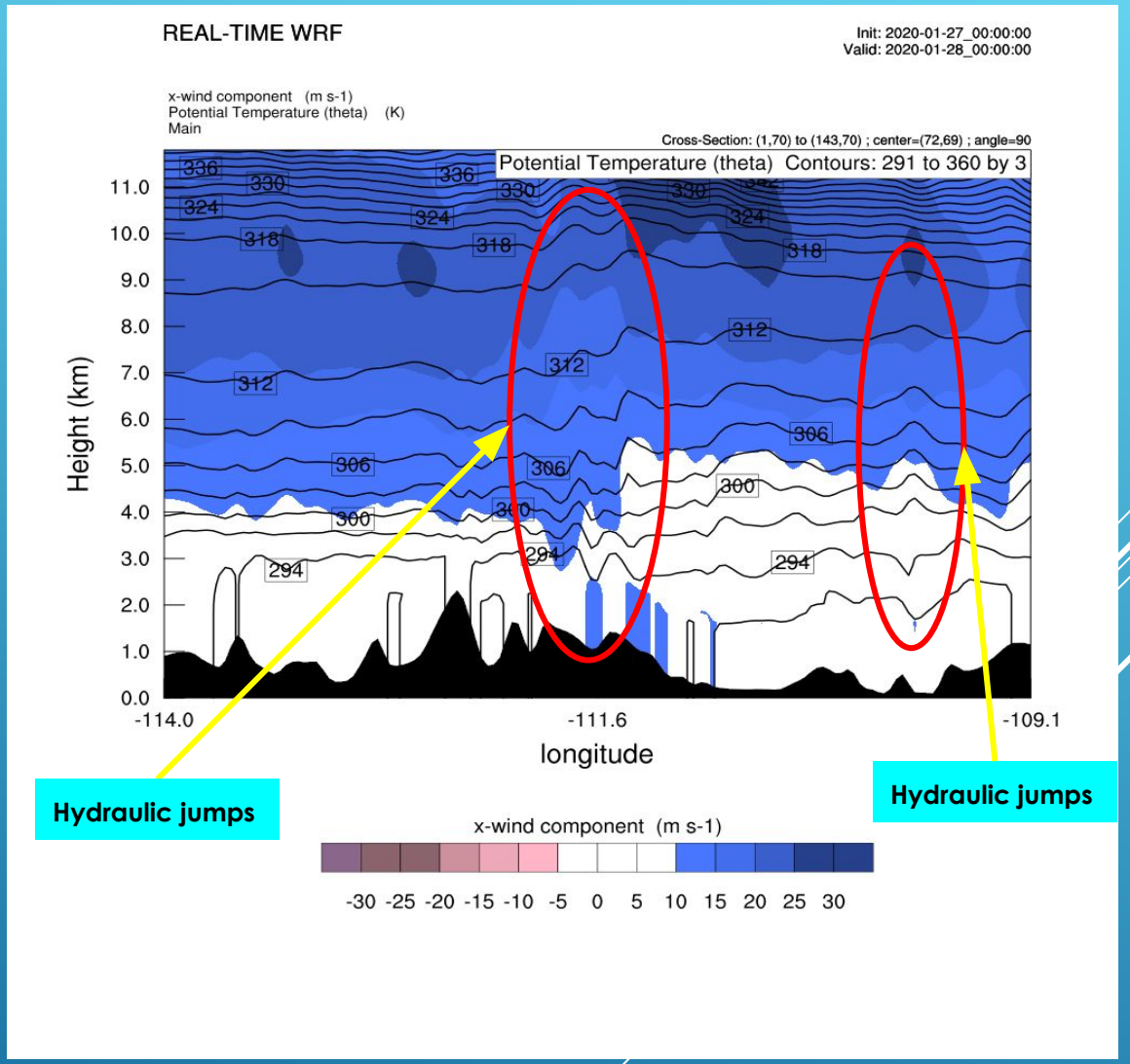
WRF "3km" N-S "Y-WIND COMPONENT & POTENTIAL TEMP LOOP
Cross-Section: at "111.6 W"
TIMES: 01/27/20 from 0600Z - 01/28/20 at 0000Z.

NAM12 “4-5km” Resolution Cross-Section Jan 28th, 20 at 0000Z



NAM12 struggles with showing hydraulic jumps but instead just shows areas of instability.

WRF “3km” E-W Cross-Section at 38.2N Jan 28th, 20 at 0000Z



WRF shows excellent hydraulic jumps or breaking gravity waves.

CONCLUSION:

- Good cross-barrier flow in northwesterly flow. Typically prefer to see perpendicular flow across the mountain ridges.
- Forward Wind Shear as the wind increased with height.
- Several strong stability layers between instability layers displayed in cross-section - indicated trapped waves (as observed on the visible satellite imagery), and the 1.6 rule of thumb with 200mb winds 1.6 greater than ridge-top winds.
- Shear between the ridge top and tropopause was weak. Allowed the vertically propagating wave to eventually punch through the tropopause.
- Northwesterly orientated 250 & 300 hPa jet-core with right-front quadrant moving over Utah from the west. Provided:
  - Highly favorable area for subsidence
  - Mountain-waves
  - Downslope winds, and downward vertical motion
- Cross-section using Omega, Potential Temperature, wind speed, and depicted:
  - Rise/fall couplets
  - Stable layers aloft
  - Vertically propagating waves
  - Near 300mb is where the wave punched through the Tropopause, and indicates where you would expect severe turbulence to occur.
- Thanks for those who helped complete this mountain-wave research:
  - Ryan Solomon, Brian Pettegrew, Jesse Sparks, Jonathan Leffler, Emily Neibuhr, Steven Silberberg
- Questions?