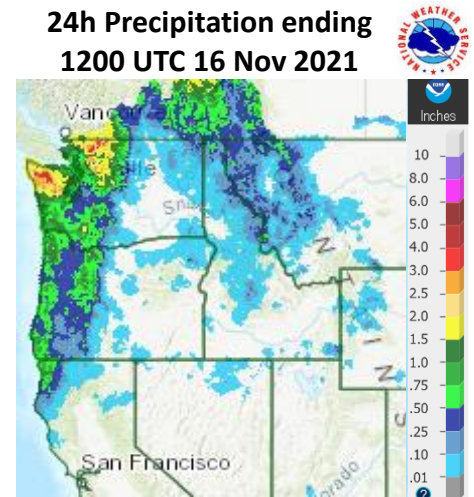
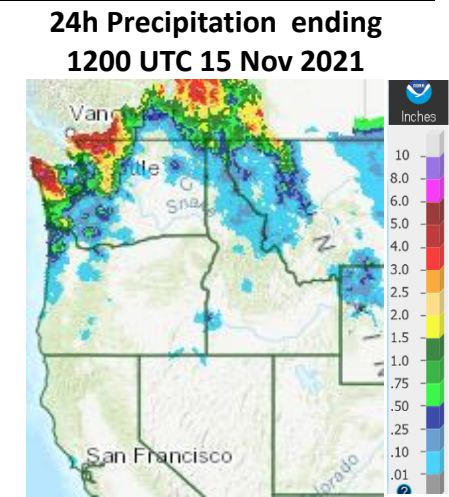
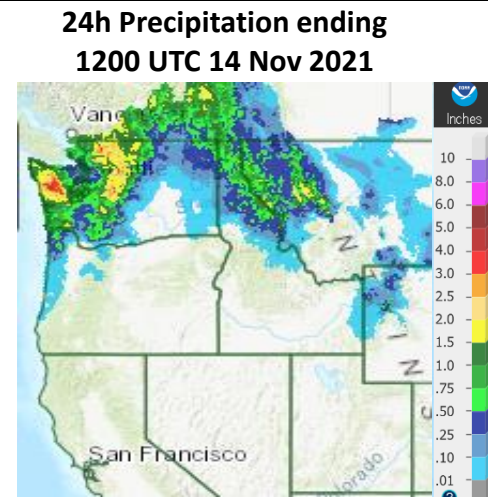
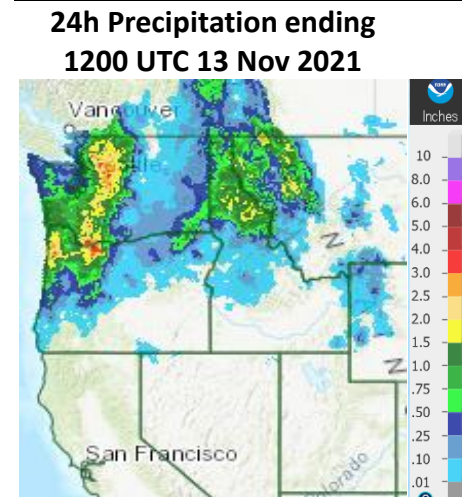
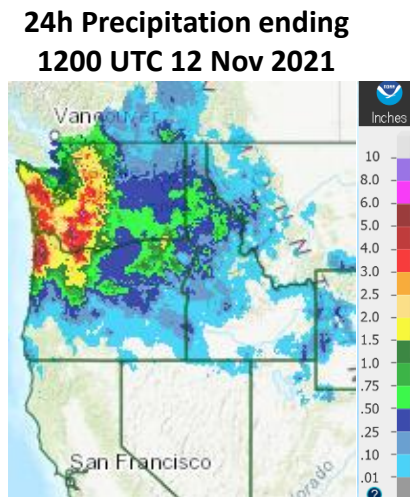
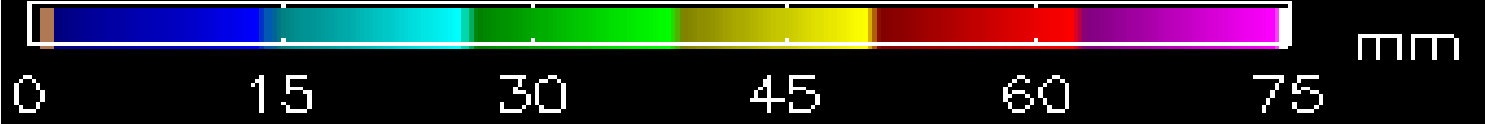
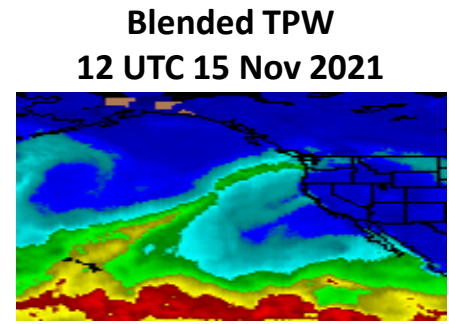
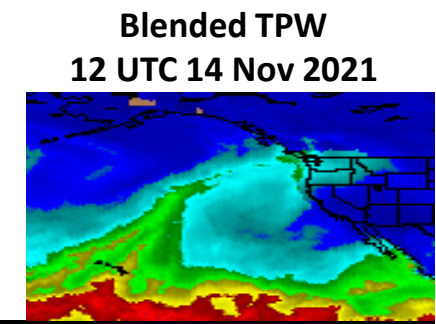
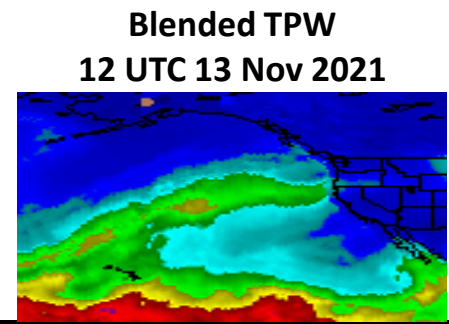
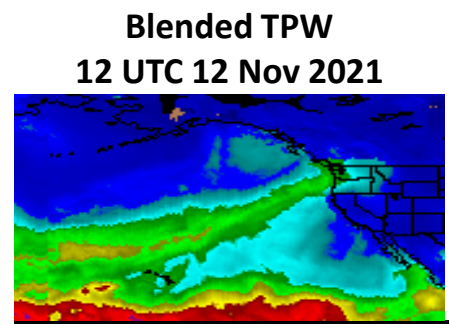
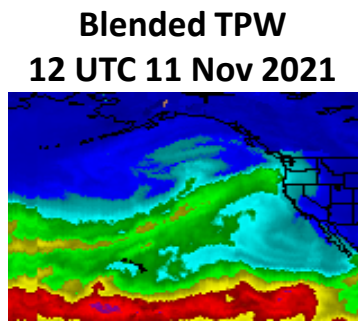
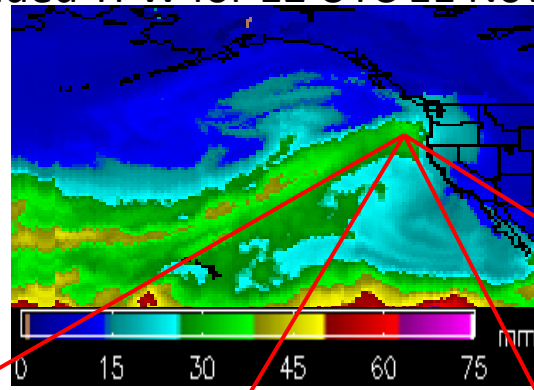


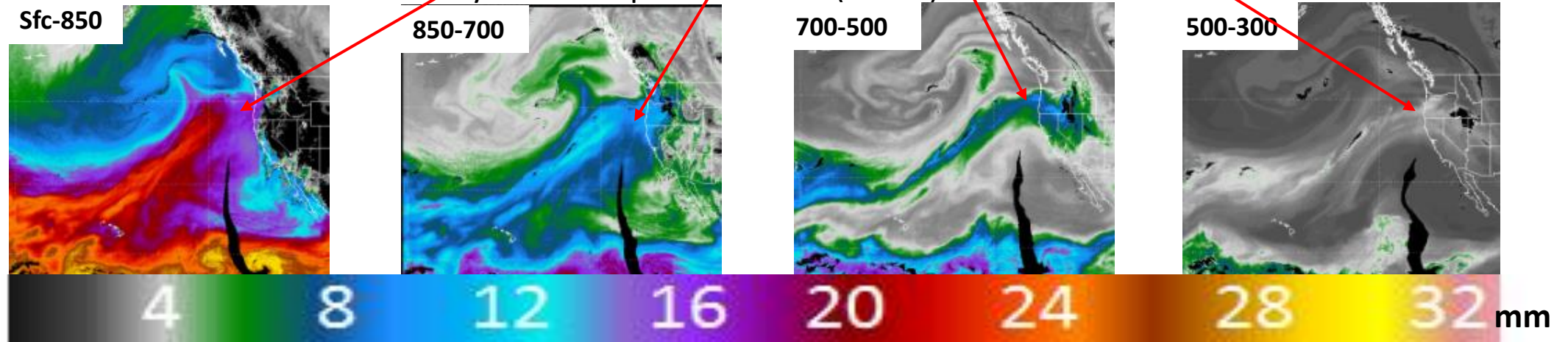
Earlier this year the Pacific Northwest and British Columbia baked with record breaking heat. Then later in the summer parts of the same area fried with wildfires. Now, the period from November 11 through 15 will likely go down as one of the longest and wettest periods in many years with extensive flooding in parts of British Columbia and western Washington. Below, are images of NOAA/NESDIS Blended Total Precipitable Water (top) on five consecutive days showing the narrow but long fetch “atmospheric river” (AR) of moisture that helped produced the heavy precipitation during each of the following 24 hours (just below the Blended TPW images). The precipitation amounts reached a peak during the later part of the event to help produce the catastrophic flooding across parts of western Washington and southern British Columbia.



Blended TPW for 12 UTC 11 Nov 2021



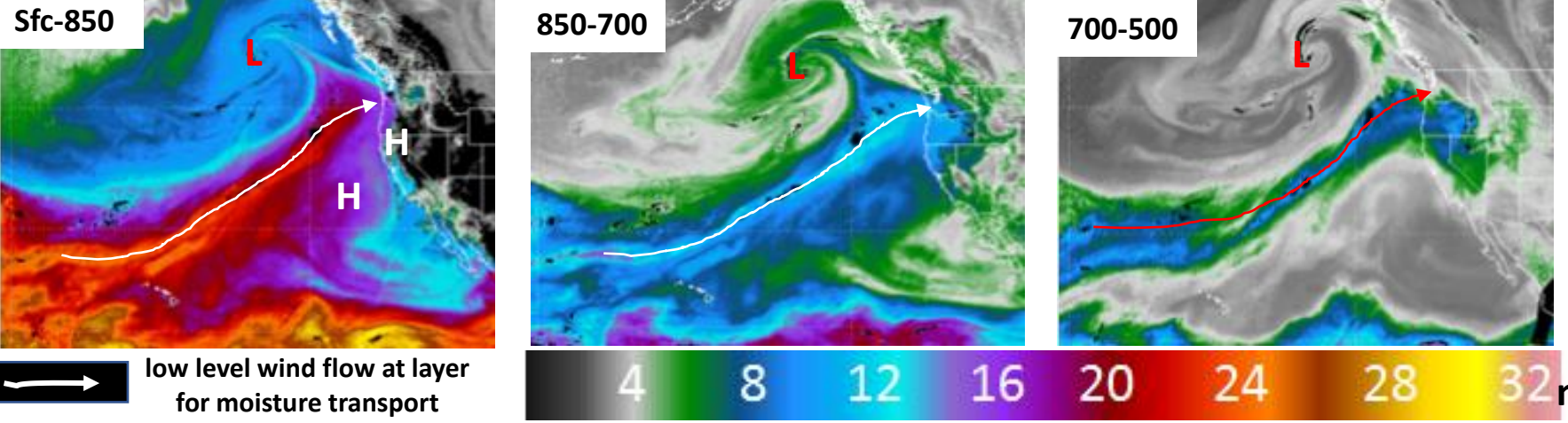
CIRA Advected Layered Precipitable Water (ALPW) for 12 UTC 11 Nov 2021



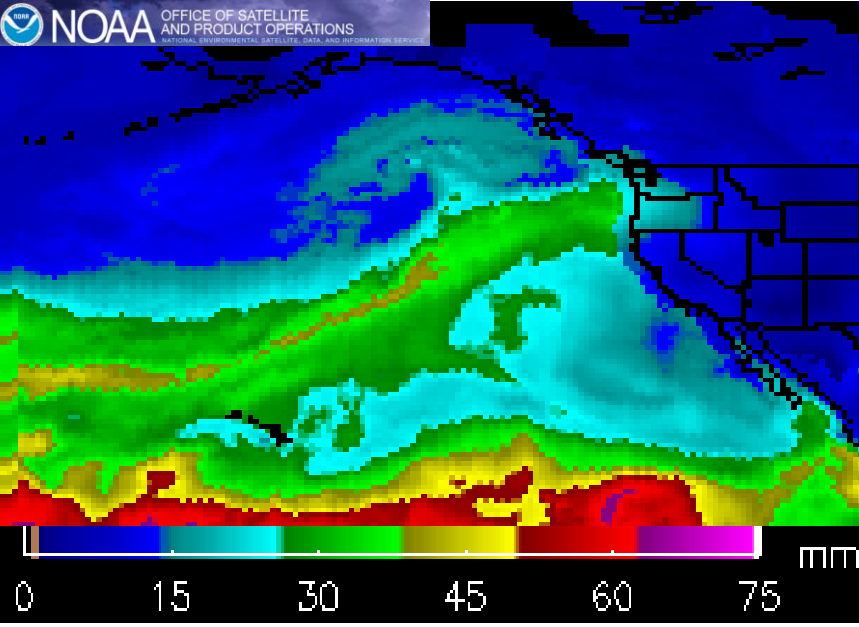
To supplement and complement the satellite derived Blended Total Precipitable Water (TPW), the CIRA Advected Layered Precipitable Water (ALPW) was developed to provide more detail. The detail comes by separating the Blended TPW product into four distinct layers of the atmosphere, surface to 850 hPa, 850 to 700 hPa, 700 to 500 hPa and 500 to 300 hPa, to produce the ALPW product. This allows forecasters to see more of the detail of the amount of precipitable water at each of the four layers. The following shows the four distinct layers of the ALPW product with analyzed average wind flow at each layer. There is also a Blended TPW image for the same time as the particular ALPW images, preliminary precipitation amounts for the following 24 hours ending at 12 UTC the next day, an hourly ALPW loop for part of the following 24 hours and some commentary on each day's ALPW and Blended TPW analysis.

# CIRA Advected Layered Precipitable Water (ALPW) for 1800 UTC 11 November 2021

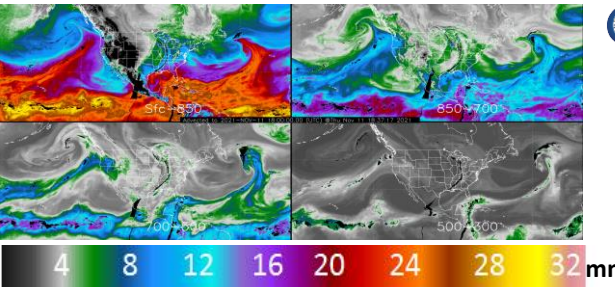
Analysis by Sheldon Kusselson



## NOAA/NESDIS Blended Total Precipitable Water (TPW) for 1800 UTC 11 November 2021

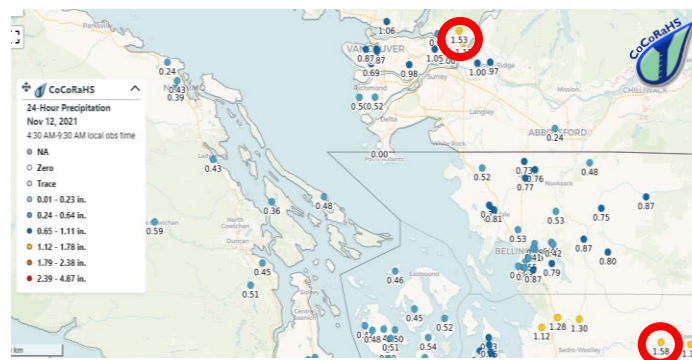
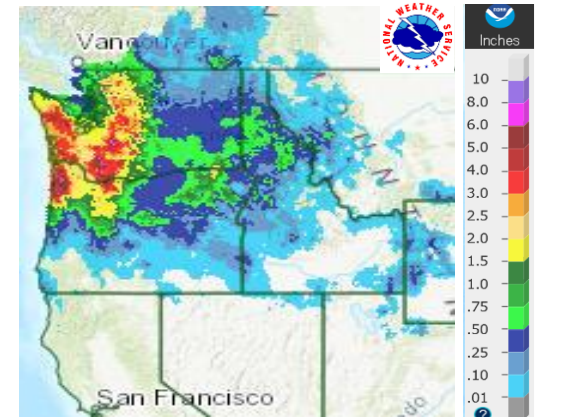


## CIRA Advected Layered PW Loop for 18 UTC 11 Nov to 04 UTC 12 Nov 2021



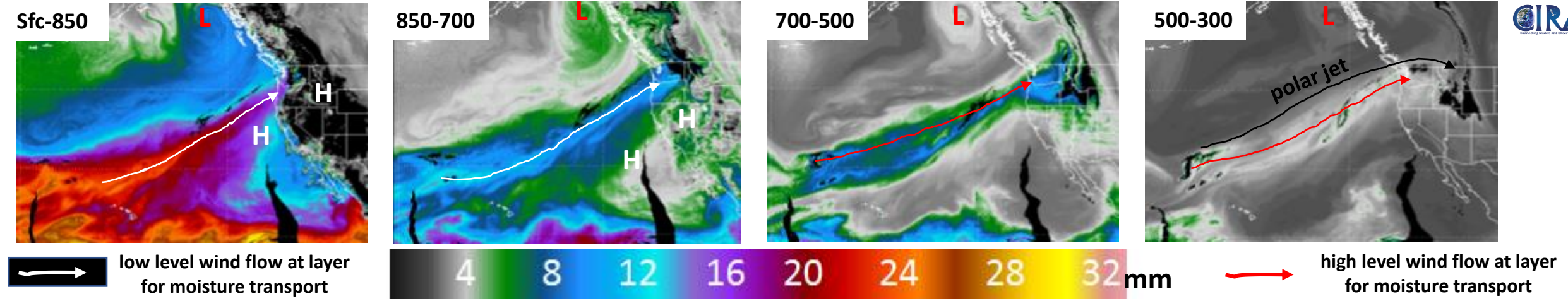
**Start of a long 5-day “Atmospheric River” (AR) event for the Pacific NW into SW Canada. Very good long fetch moisture transport at four layers that help give the first initial shot of heavy precipitation on November 11 into the 12<sup>th</sup> mostly to western Washington and northern Oregon.**

## Stage IV Precipitation 24h Ending at 12 UTC 12 Nov 2021

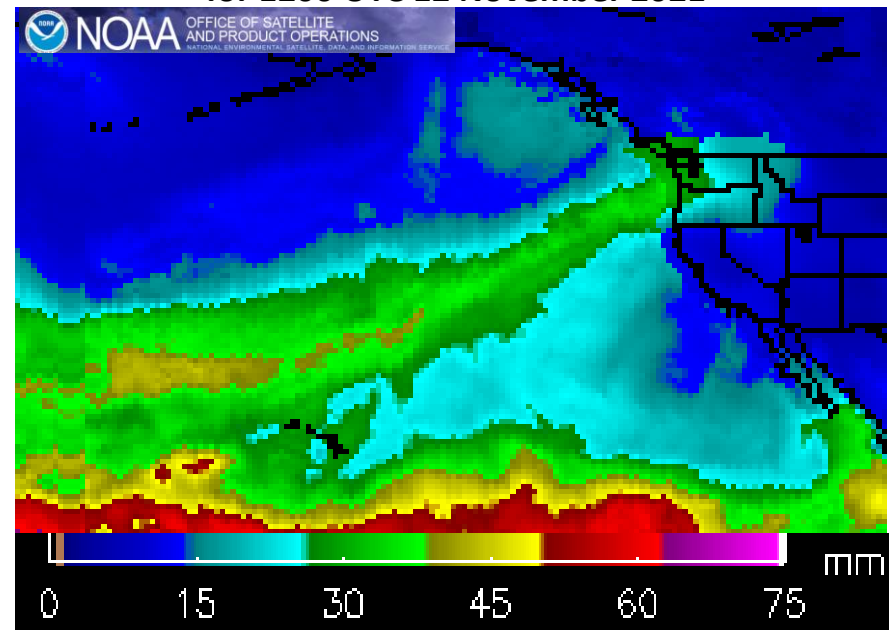


# CIRA Advected Layered Precipitable Water (ALPW) for 1200 UTC 12 November 2021

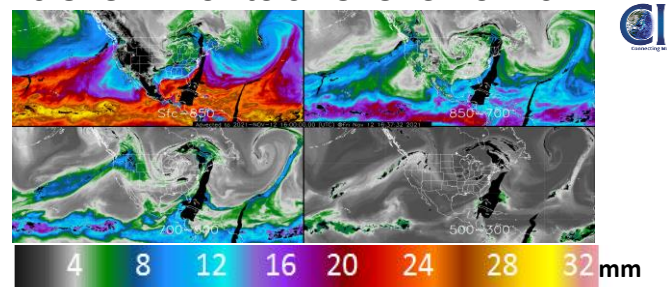
Analysis by Sheldon Kusselson



## NOAA/NESDIS Blended Total Precipitable Water (TPW) for 1200 UTC 12 November 2021

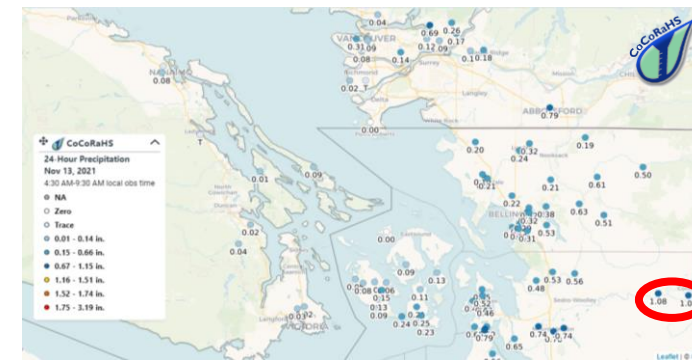
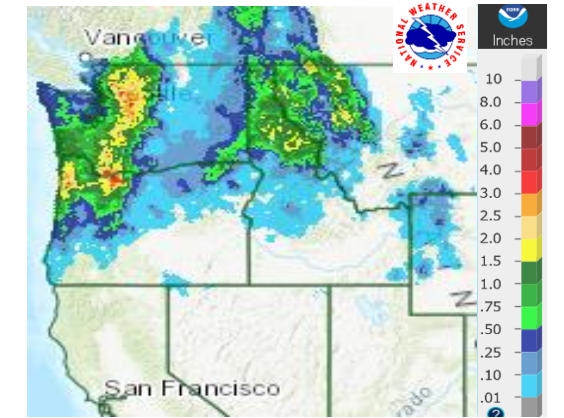


## CIRA Advected Layered PW Loop for 16 UTC 12 Nov to 02 UTC 13 Nov 2021



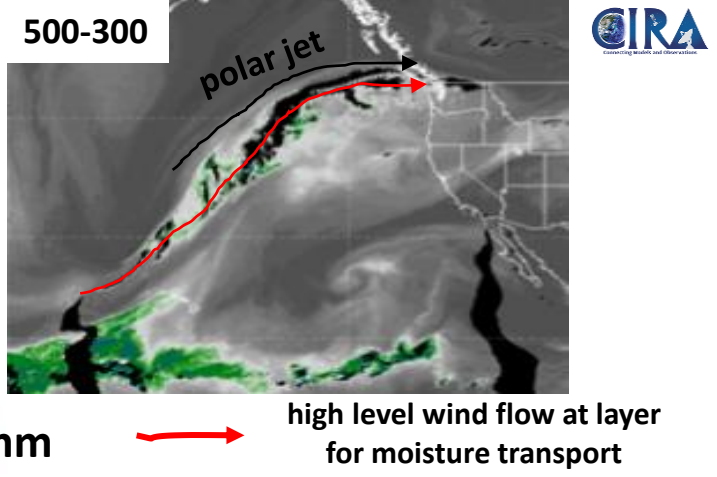
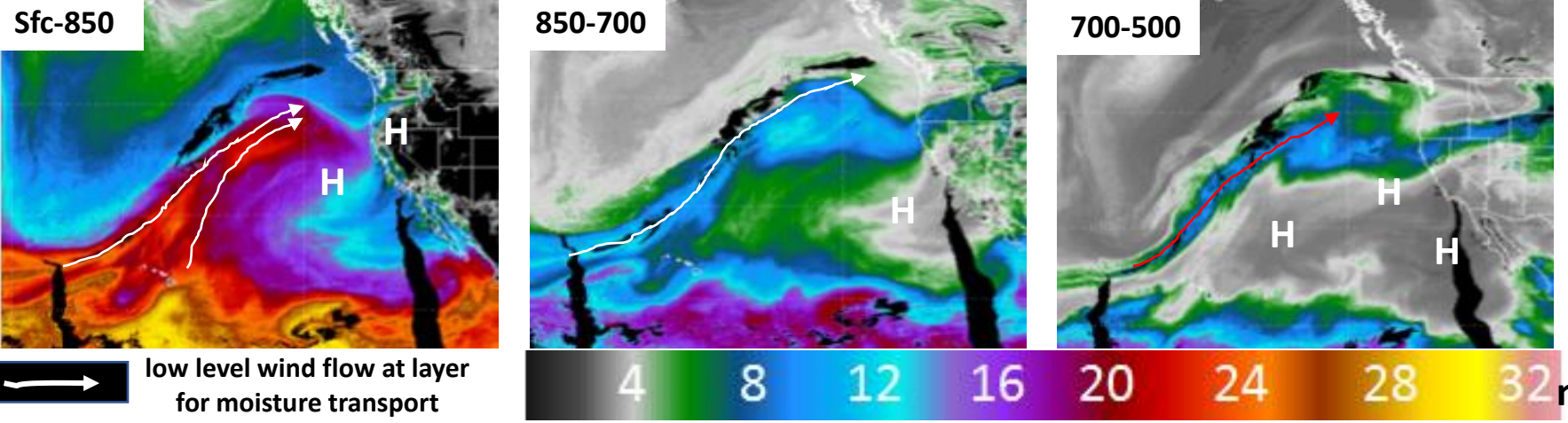
**Very good long fetch moisture transport at four layers into NW Oregon and the Central and North Cascades. High level moisture pointed more toward the northern Cascades and low level moisture more toward NW Oregon and the Central Cascades.**

## Stage IV Precipitation 24h Ending at 12 UTC 13 Nov 2021

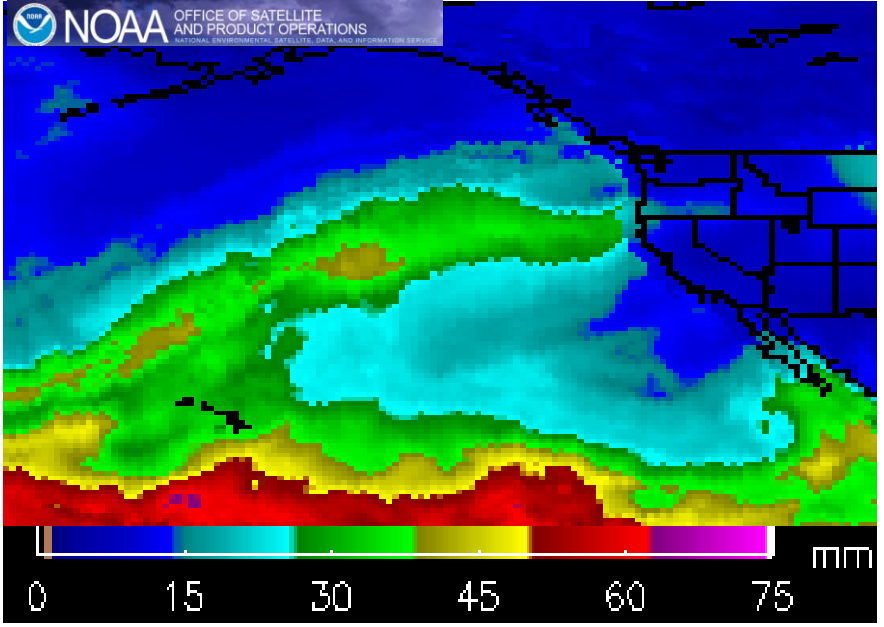


# CIRA Advected Layered Precipitable Water (ALPW) for 1200 UTC 13 November 2021

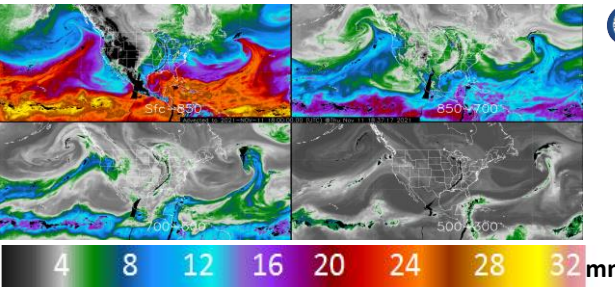
Analysis by Sheldon Kusselson



## NOAA/NESDIS Blended Total Precipitable Water (TPW) for 1200 UTC 13 November 2021

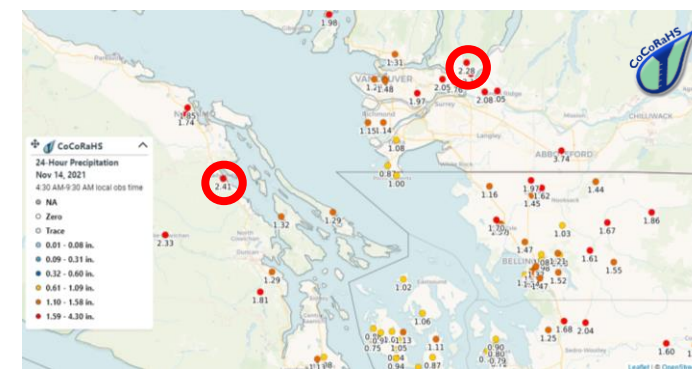
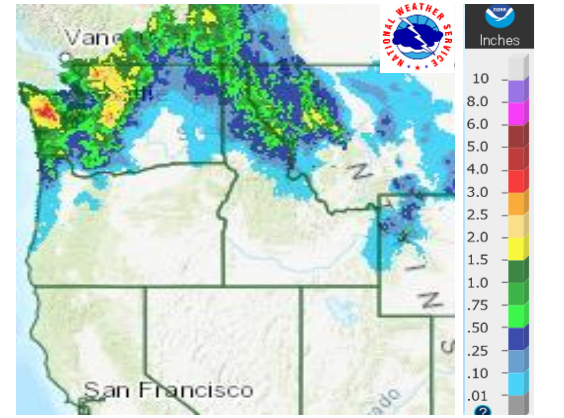


## CIRA Advected Layered PW Loop for 13 to 23 UTC 13 Nov 2021



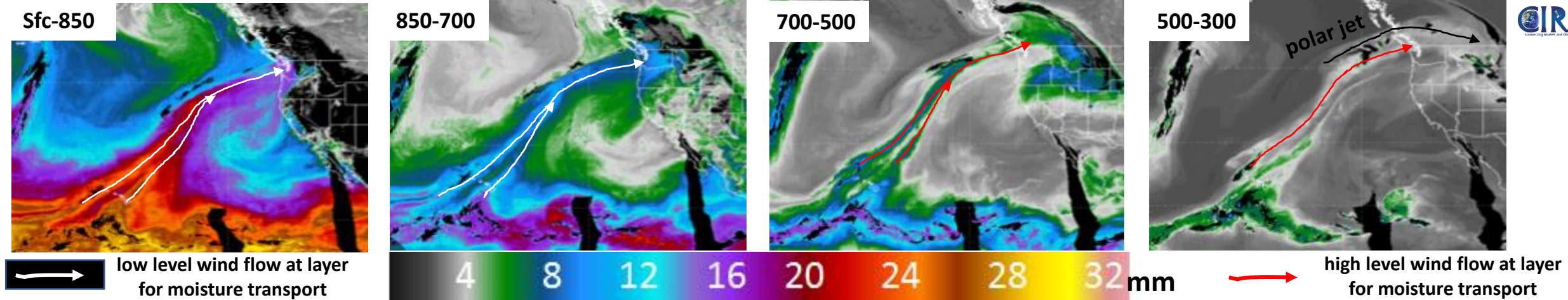
First wave forcing moves well east of Northwest US. Still moist with orographic precipitation Olympics and northern Cascades, but less than previous days. Brief "Atmospheric River" (AR) demise with stability Oregon/N California with little or no rain. Next wave and AR reloading offshore.

## Stage IV Precipitation 24h Ending at 12 UTC 14 Nov 2021

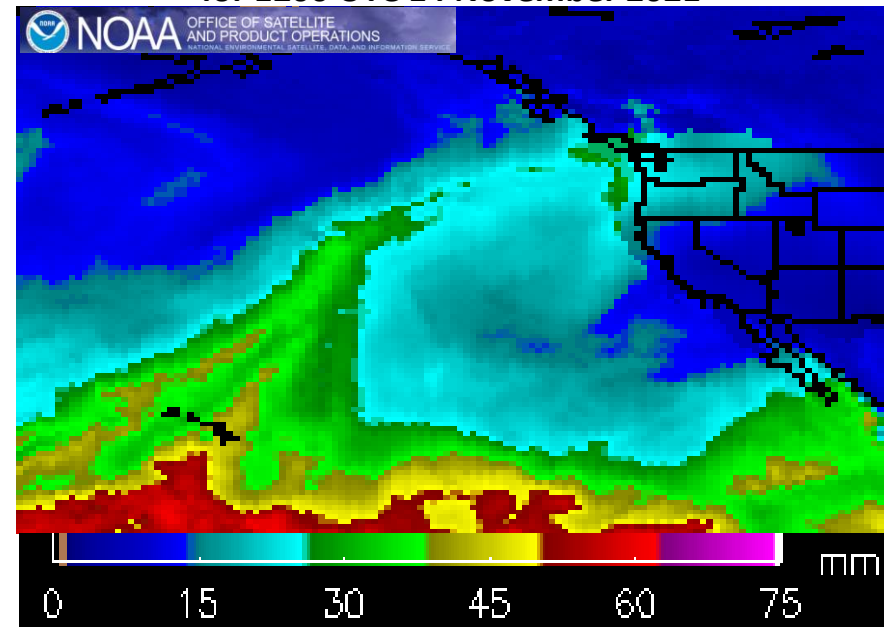


# CIRA Advected Layered Precipitable Water (ALPW) for 1200 UTC 14 November 2021

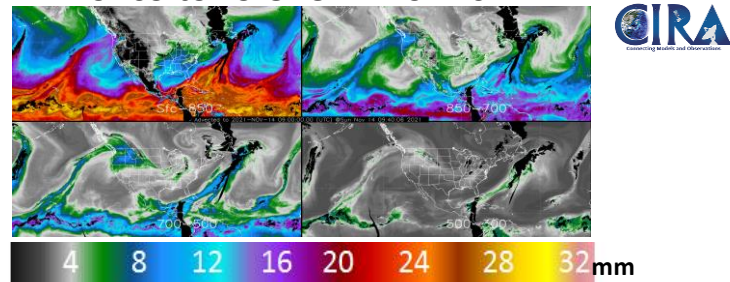
Analysis by Sheldon Kusselson



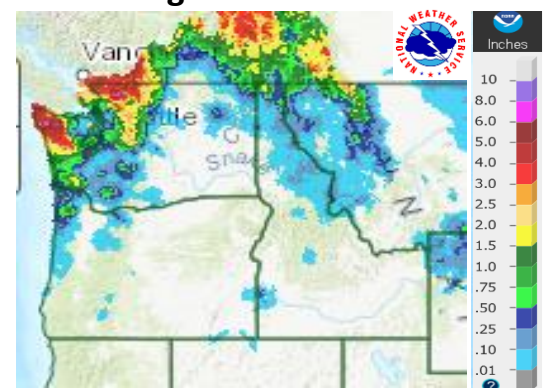
## NOAA/NESDIS Blended Total Precipitable Water (TPW) for 1200 UTC 14 November 2021



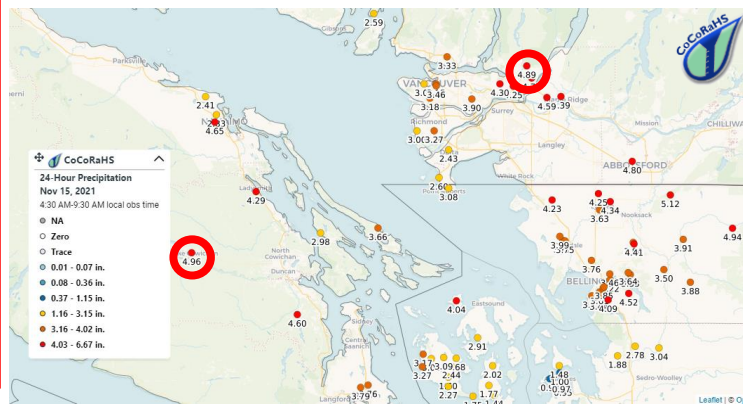
## CIRA Advected Layered PW Loop for 09 to 19 UTC 14 Nov 2021



## Stage IV Precipitation 24h Ending at 12 UTC 15 Nov 2021

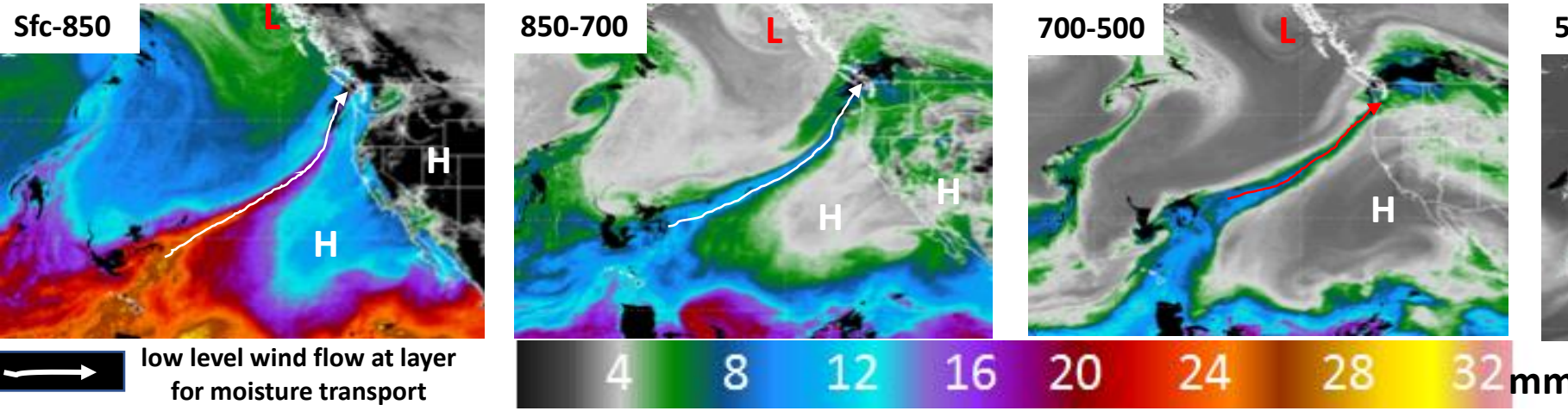


The Blended TPW would make you believe there was only one "Atmospheric River" (AR) of moisture. But the Advected Layered PW product, at three layers and having more detail, showed one main AR and a smaller one, just to the east, that converged with the main one, for added moisture transport into NW Washington and British Columbia, Canada for excessive precipitation the next 24 hours.

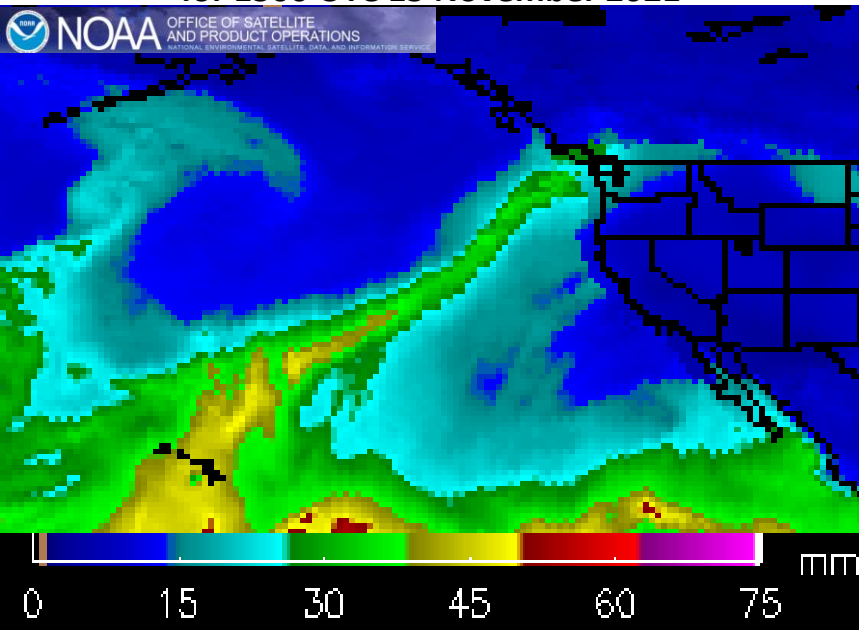


# CIRA Advected Layered Precipitable Water (ALPW) for 1500 UTC 15 November 2021

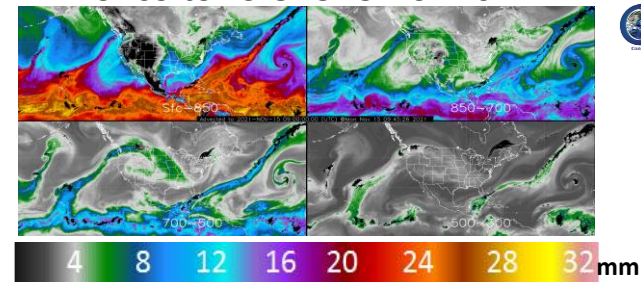
Analysis by Sheldon Kusselson



## NOAA/NESDIS Blended Total Precipitable Water (TPW) for 1500 UTC 15 November 2021

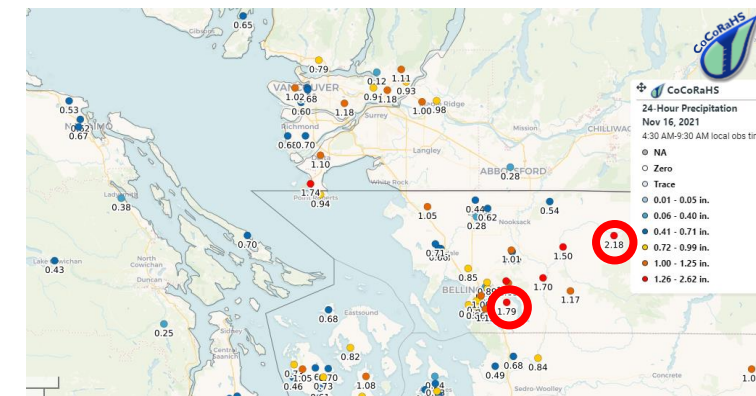
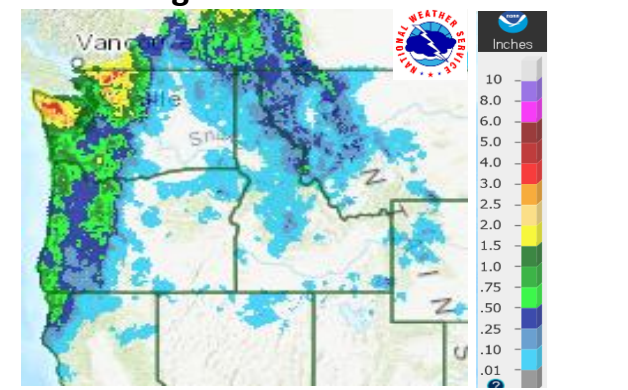


## CIRA Advected Layered PW Loop for 09 to 19 UTC 15 Nov 2021



The end is near. Even though the AR is visible on Blended TPW and for at least three layers of ALPW, it has definitely narrowed. The ARs are no longer aligned at all layers of ALPW, indicating a lowering of the depth of the moisture and thus lowering of max precipitation amounts from the day before.

## Stage IV Precipitation 24h Ending at 12 UTC 16 Nov 2021



## Internet Stories on this Pac NW and BC of Canada Event

<https://www.theguardian.com/environment/2021/nov/17/pacific-north-west-flooding-british-columbia-washington-state-canada>

<https://earthobservatory.nasa.gov/images/149100/severe-flooding-in-the-pacific-northwest>

[https://en.wikipedia.org/wiki/November\\_2021\\_Pacific\\_Northwest\\_floods](https://en.wikipedia.org/wiki/November_2021_Pacific_Northwest_floods)

<https://earthobservatory.nasa.gov/images/149100/severe-flooding-in-the-pacific-northwest>

<https://www.accuweather.com/en/winter-weather/pineapple-express-pummels-northwest-british-columbia/1047699>

<https://www.cnn.com/2021/11/18/weather/pacific-northwest-flooding-thursday/index.html>

<https://www.usnews.com/news/us/articles/2021-11-17/northwest-storm-devastating-flood-damage-1-dead-in-bc>

<https://www.reuters.com/world/americas/receding-waters-help-flood-hit-canadian-town-avoid-disaster-2021-11-18/>

<https://www.nytimes.com/2021/11/21/canada-flooding-climate-change.html>

<https://www.npr.org/2021/11/16/1056133993/washington-pacific-northwest-flooding-mudslides-storms>

<https://scitechdaily.com/severe-flooding-in-the-pacific-northwest-torrential-rain-spurs-deadly-floods-and-mudslides/>

<https://www.theatlantic.com/photo/2021/11/photos-record-rainfall-floods-british-columbia-and-washington-state/620733/>