

# CW3E Event Summary: 22–24 September 2024

## Strong Atmospheric River Produced Heavy Rain in Southeast Alaska and British Columbia

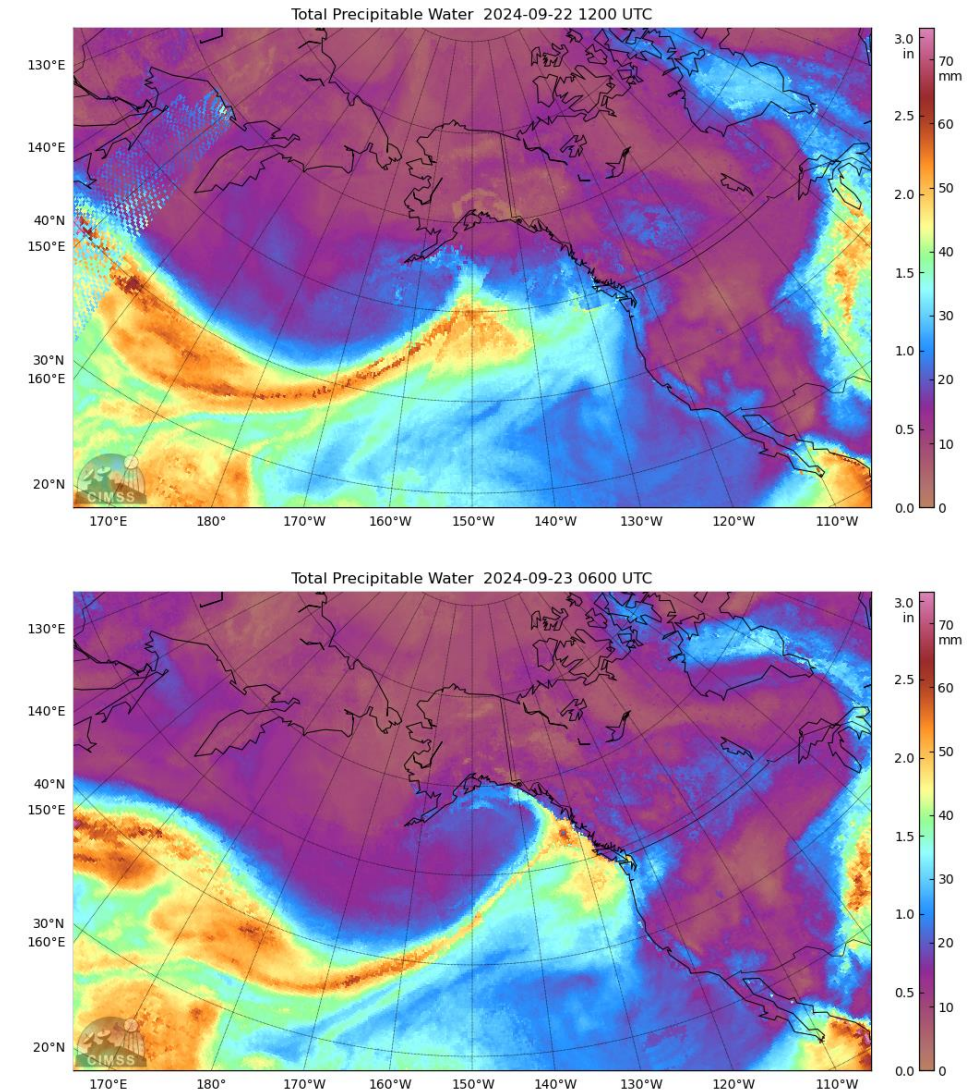
- A very strong atmospheric river (AR) associated with an area of low pressure and a trans-Pacific moisture plume brought widespread precipitation to Southeast Alaska and British Columbia between September 22 and 24.

### The AR:

- The AR developed within the trans-Pacific moisture plume south of the intensifying low-pressure system, eventually making landfall over Southeast Alaska and British Columbia on September 22.
- On September 22 12 UTC, GFS IVT was  $> 2100 \text{ kg m}^{-1} \text{ s}^{-1}$ , exceeding values based on MERRA2 and GEFSv12 Reforecast between 2000–23.
- AR4–5 conditions (based on the Ralph et al. 2019 AR Scale) were observed in southern Southeast Alaska and coastal British Columbia.

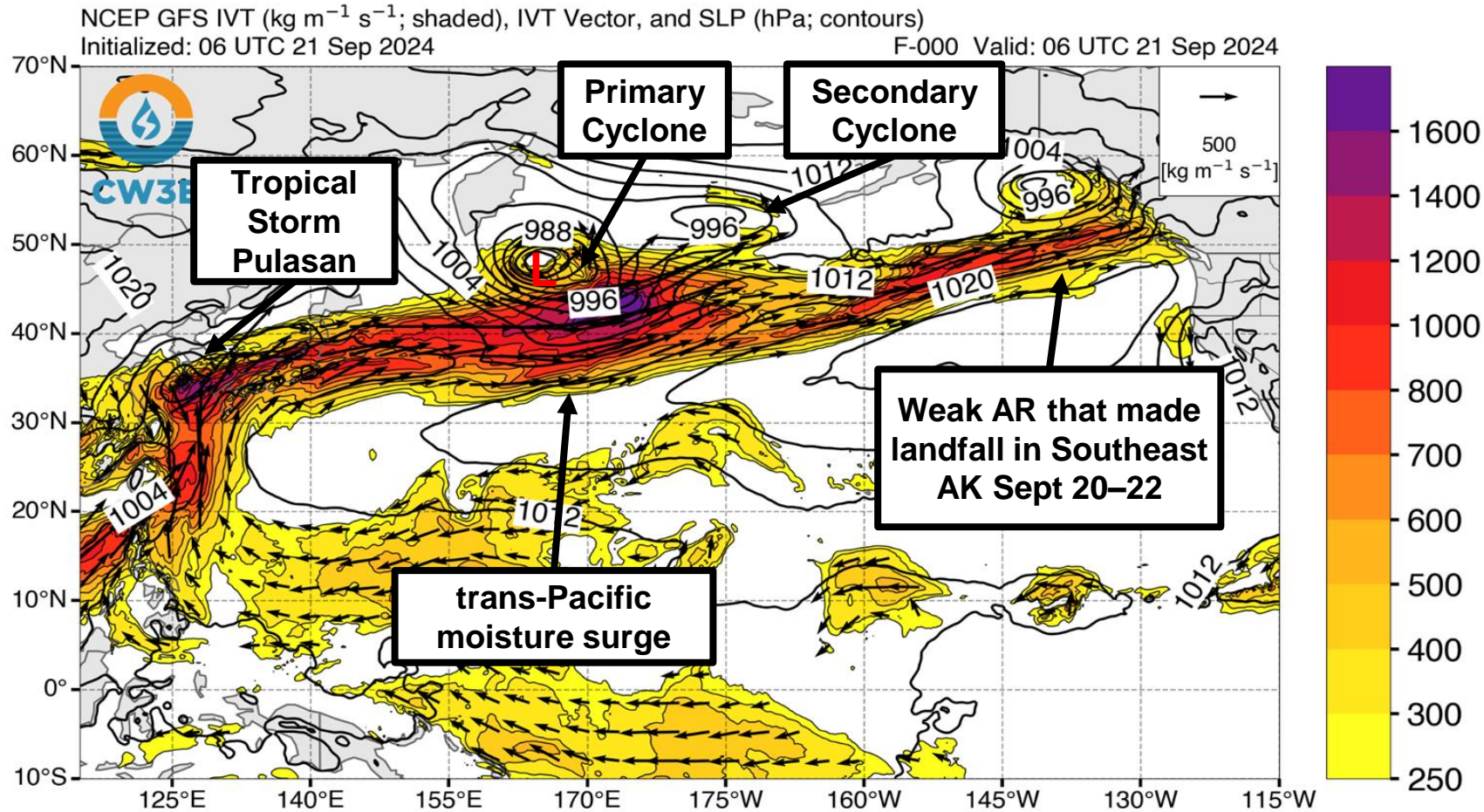
### Impacts:

- The heaviest precipitation occurred in the Coast and Hazelton Mountains in British Columbia and Glacier Bay National Park, AK, with more than 6 inches in some locations.
- Heavy rain falling caused minor riverine flooding in the Telkwa River, British Columbia (flow exceeded 20 year return interval).
- Rainfall in the southern region of Southeast Alaska ranged between 1–3 inches, (roughly a 1–2 year return interval).



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## GFS Model Analyses: Valid 6 UTC 21 Sept 2024



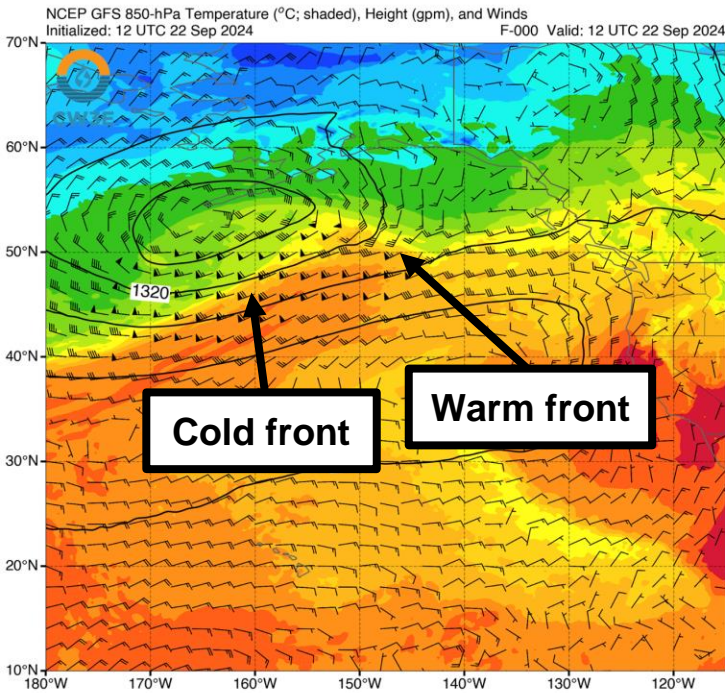
- A weak AR made landfall in Southeast Alaska between Sept 20–22.
- Meanwhile, in the Northern Pacific, a surface cyclone deepened below 980 hPa, interacting with a trans-Pacific zonal moisture plume on 21 Sept.
- The primary cyclone merged with a smaller, secondary cyclone and continued across the Pacific, with the moisture ahead of the cold front intensifying into a strong AR ( $\text{IVT} > 1600 \text{ kg m}^{-1} \text{s}^{-1}$ ) on Sept 22.



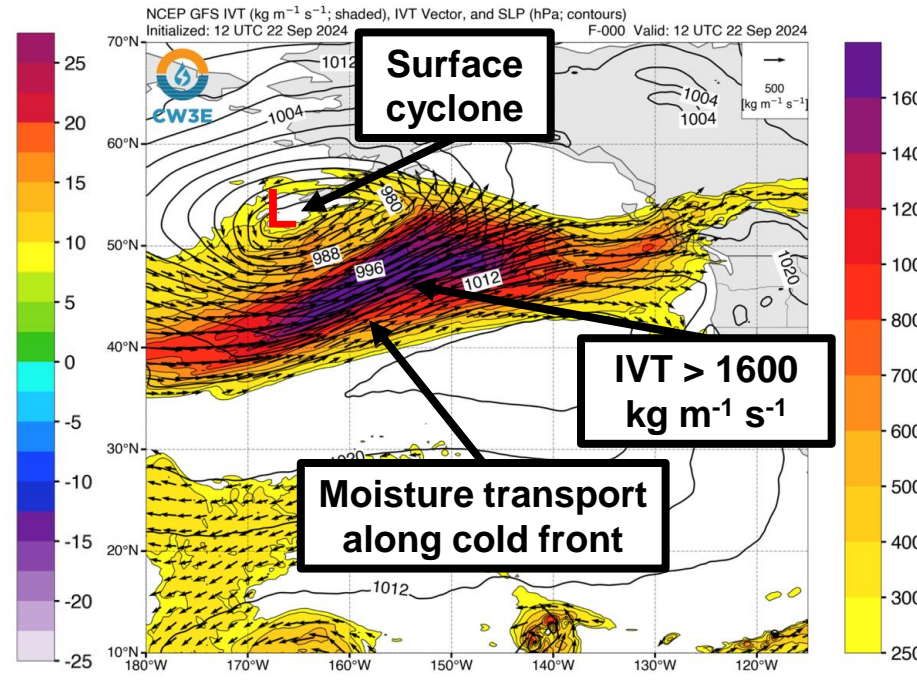
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## GFS Model Analyses: Valid 12 UTC 22 Sep 2024

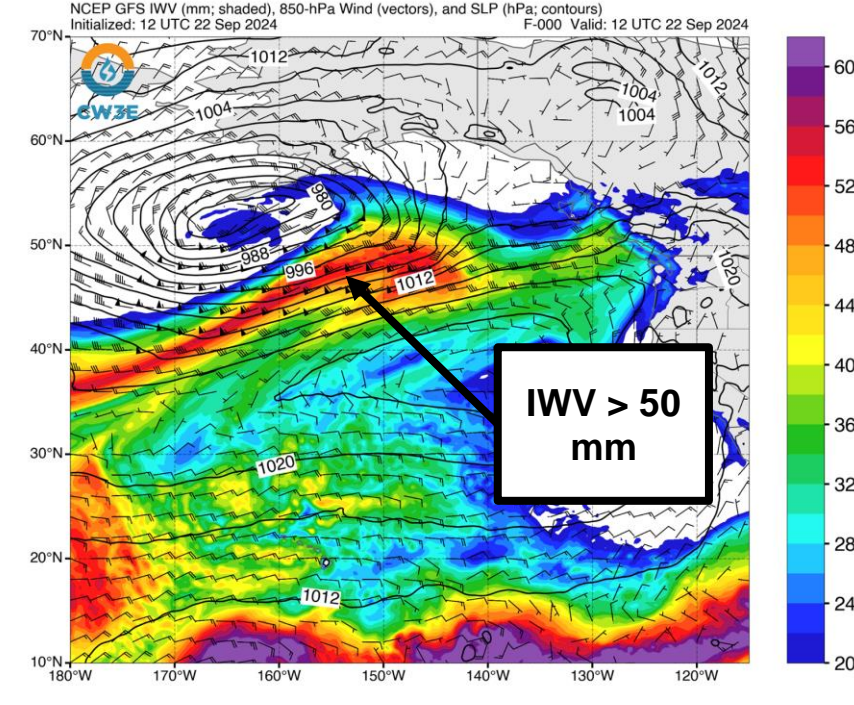
### 500-hPa Vorticity, Height, and Wind



### IVT and SLP



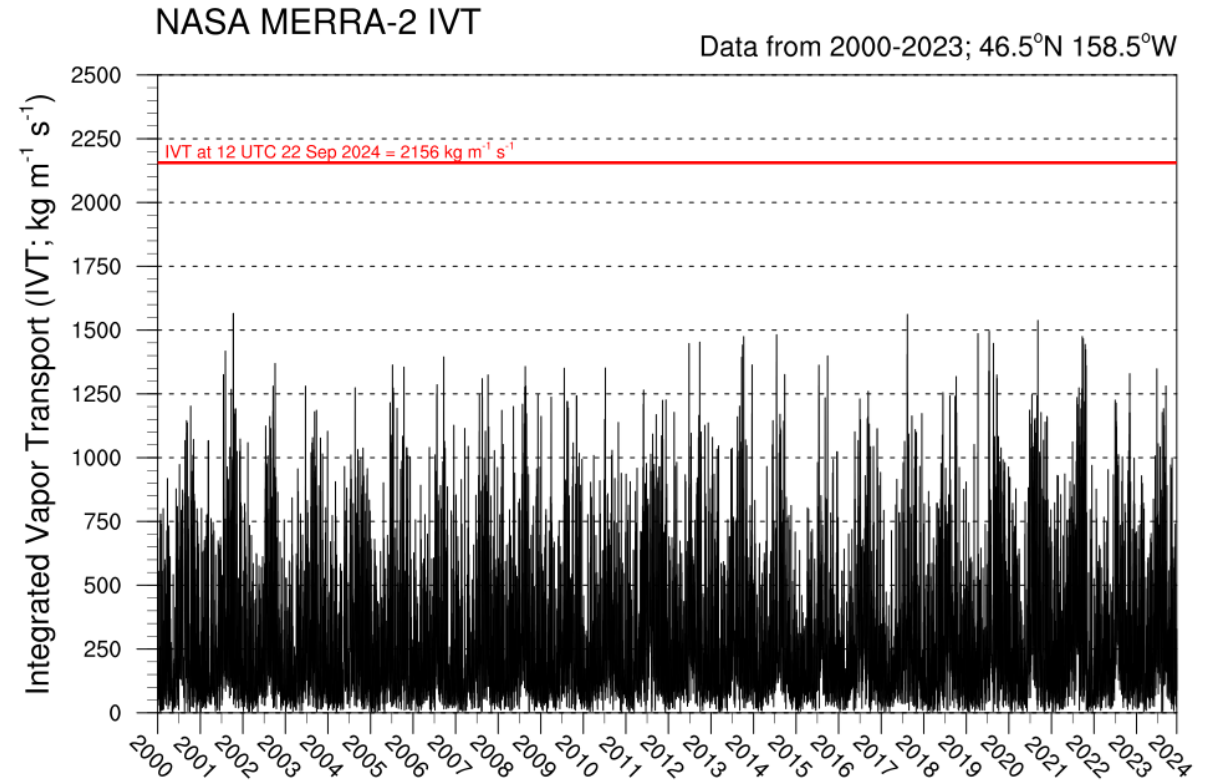
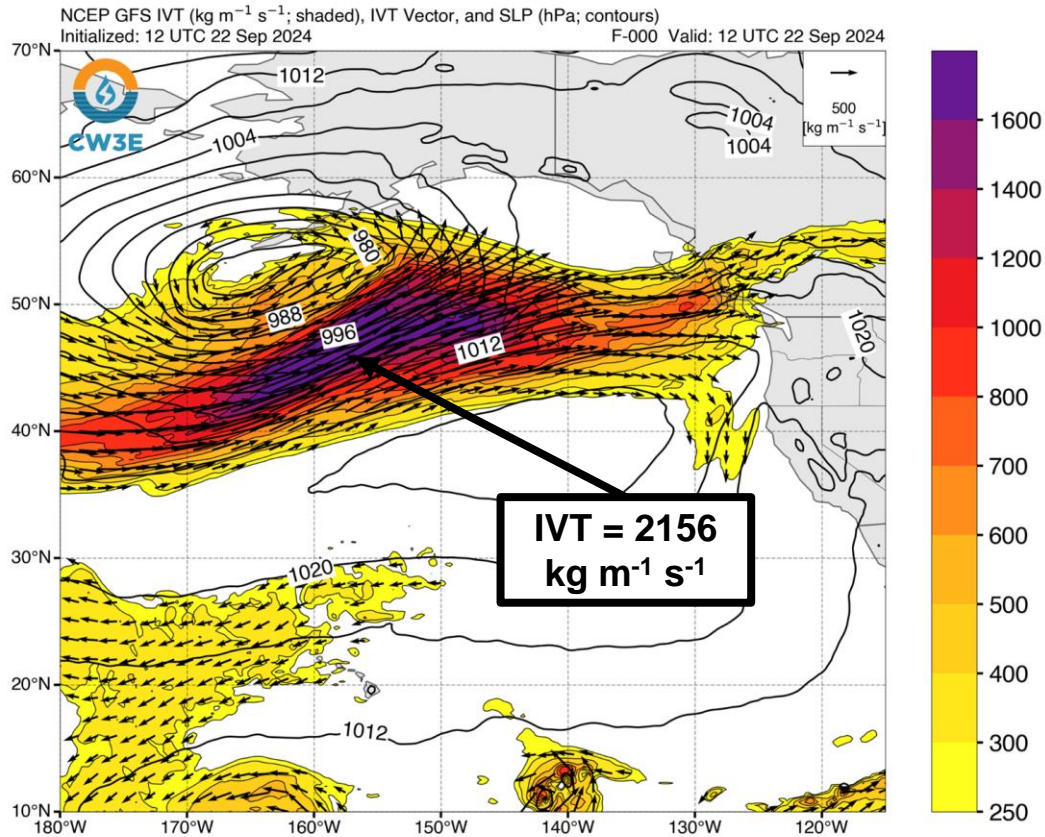
### IWV and 850-hPa Wind



- A low pressure that formed in the western North Pacific on 20 Sept propagated eastward and intensified into a surface cyclone.
- The cyclones interacted with trans-Pacific zonal moisture surge, leading to a region of enhanced moisture transport ahead of the cold front, culminating in an AR landfall over Southeast Alaska and British Columbia.

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## GFS and MERRA2 Climatology Analysis



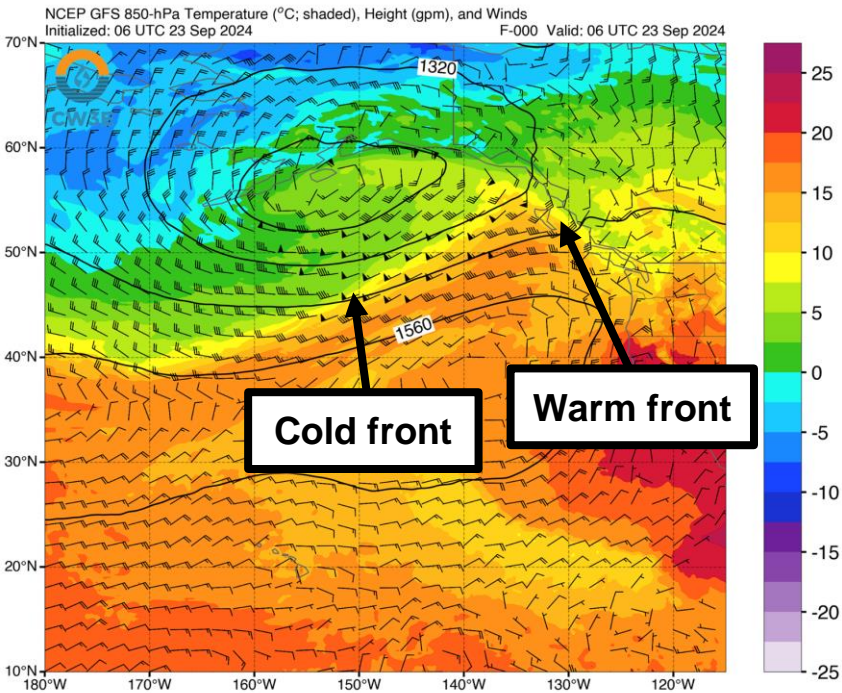
- On 12 UTC 22 Sept, the maximum IVT based on GFS analysis was 2156  $\text{kg m}^{-1} \text{s}^{-1}$  at 46.5°N 158.5°W.
- For that grid point it is by far the highest value at that location over the last 24 years when compared to MERRA2 (the max at this grid point in the MERRA2 record from 2000–2023 is 1564  $\text{kg m}^{-1} \text{s}^{-1}$ ).



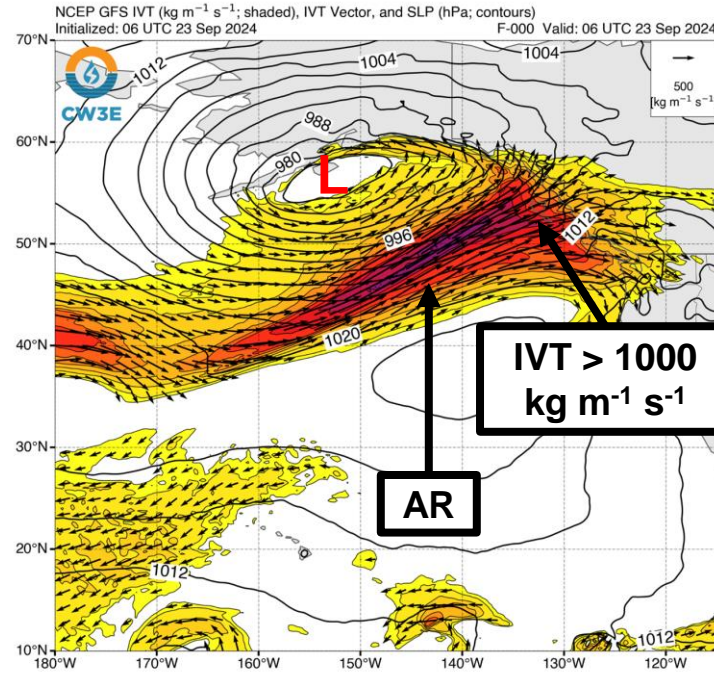
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## GFS Model Analyses: Valid 6 UTC 23 Sept 2024

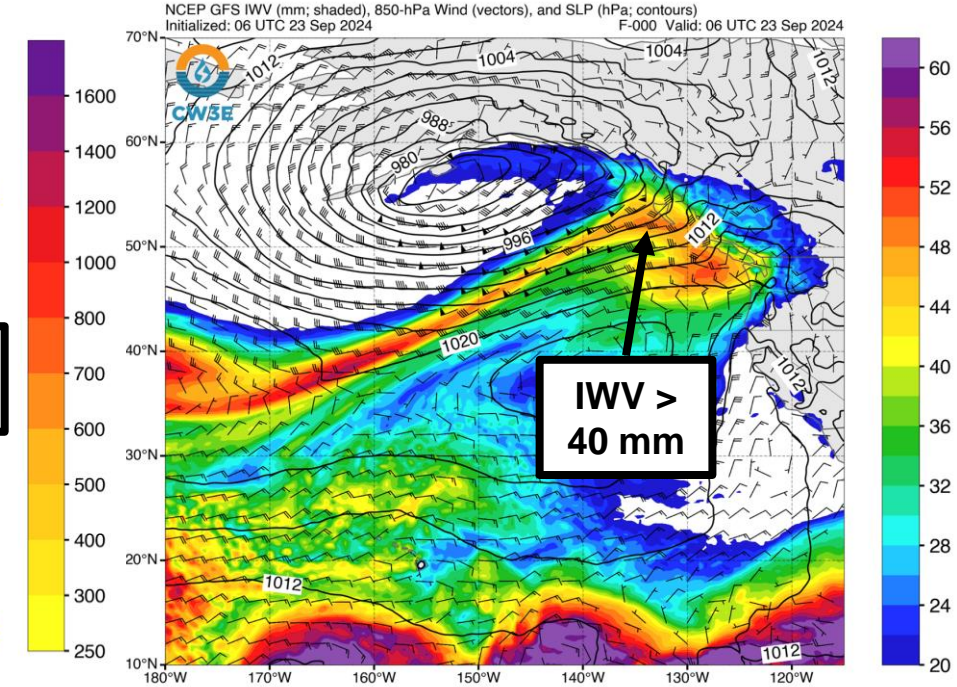
### 500-hPa Vorticity, Height, and Wind



### IVT and SLP



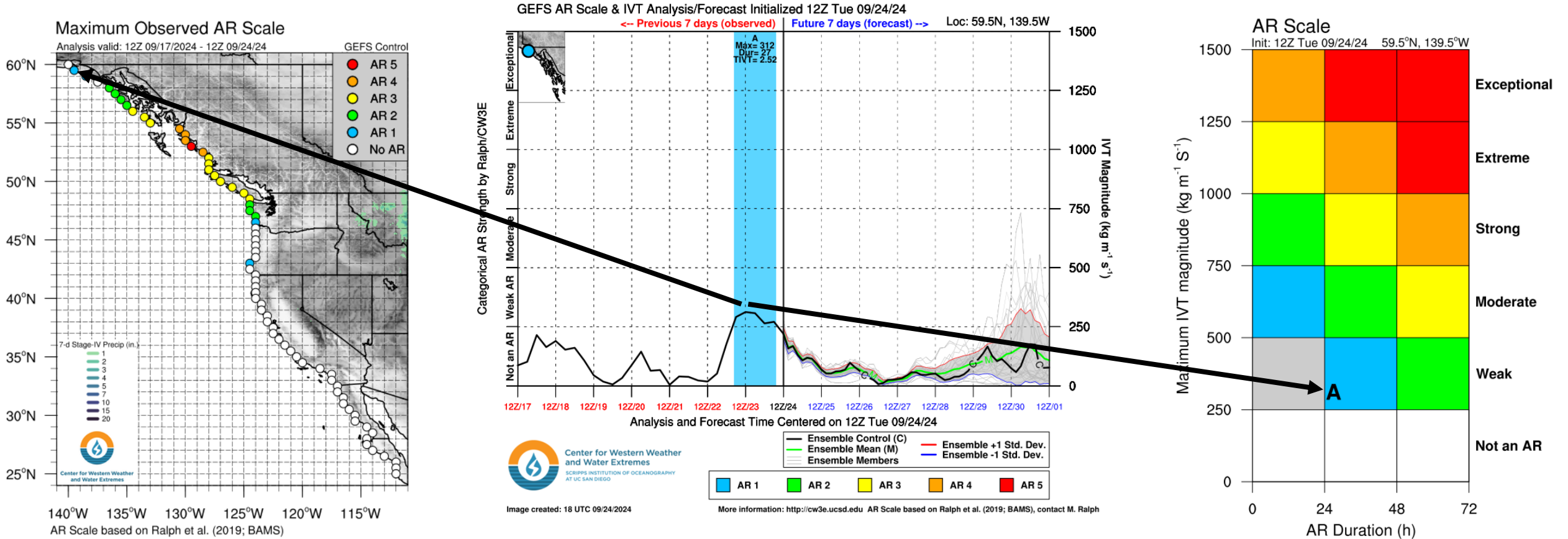
### IWV and 850-hPa Wind



- The AR made landfall around 00Z 23 Sept, bringing strong AR conditions ( $\text{IVT} > 750 \text{ kg m}^{-1} \text{s}^{-1}$ ) to southern Southeast Alaska, and extreme AR conditions ( $\text{IVT} > 1000 \text{ kg m}^{-1} \text{s}^{-1}$ ) to British Columbia.
- Although there was ample moisture and strong low-level winds, the westerly flow was not ideal for the orographic lift near the coast, and most locations in Southeast Alaska received less than 2 inches of precipitation (1–2 year return intervals).

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## GEFS AR Scale Analysis

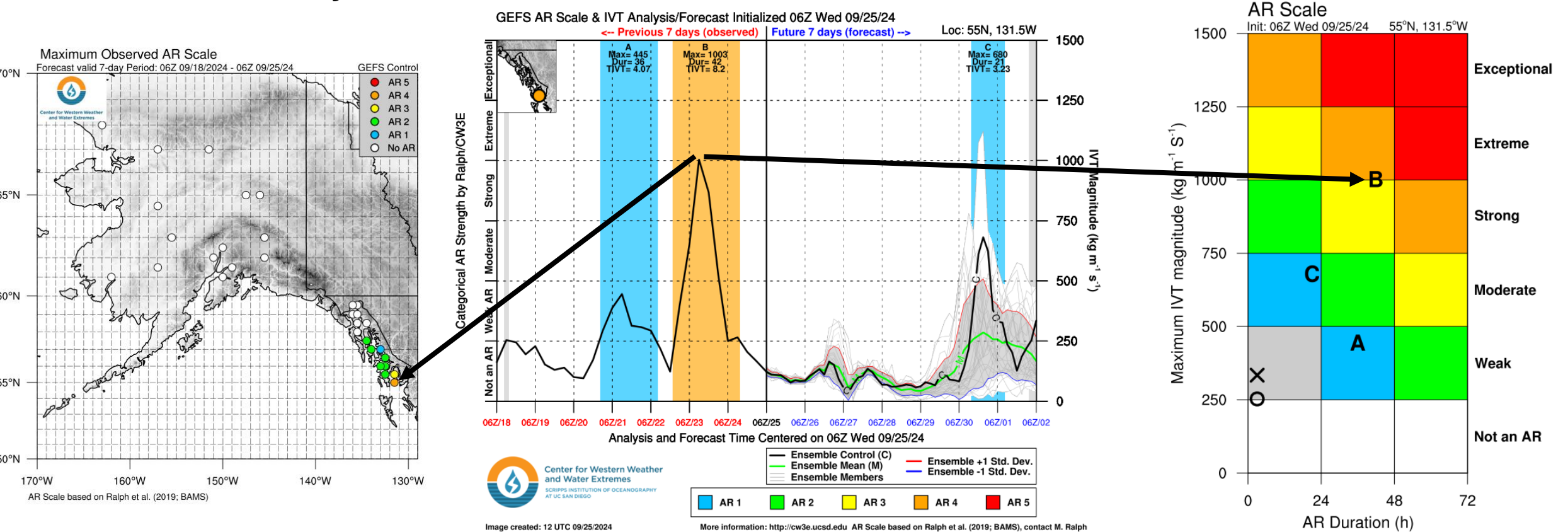


- Based on the GEFS analysis, this AR produced AR1-2 conditions over most of Southeast Alaska.
- An AR duration of 27 hours and a maximum IVT of  $312 \text{ kg m}^{-1} \text{s}^{-1}$  (i.e., an AR1) were observed in Yakutat, AK.



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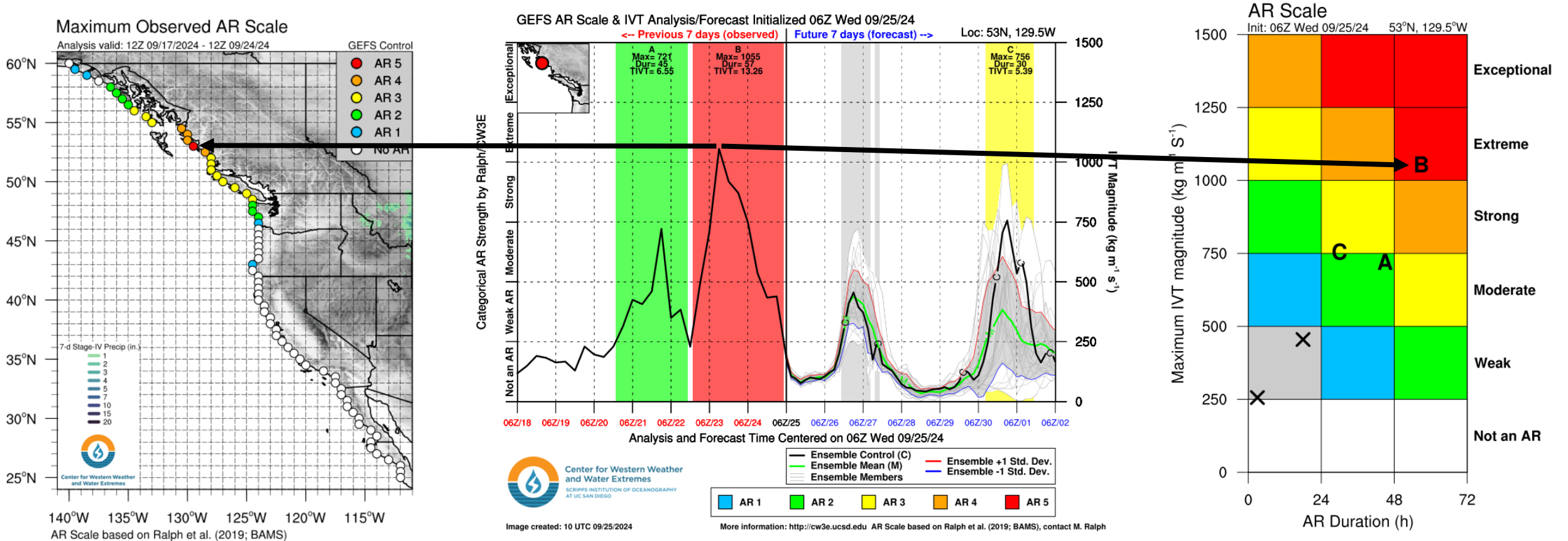
## GEFS AR Scale Analysis



- Based on the GEFS analysis, this AR produced AR3–4 conditions over far southeastern Alaska.
- An AR duration of 42 hours and a maximum IVT of 1003 kg m<sup>-1</sup> s<sup>-1</sup> (i.e., an AR4) were observed on Annette Island, AK.

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## GEFS AR Scale Analysis

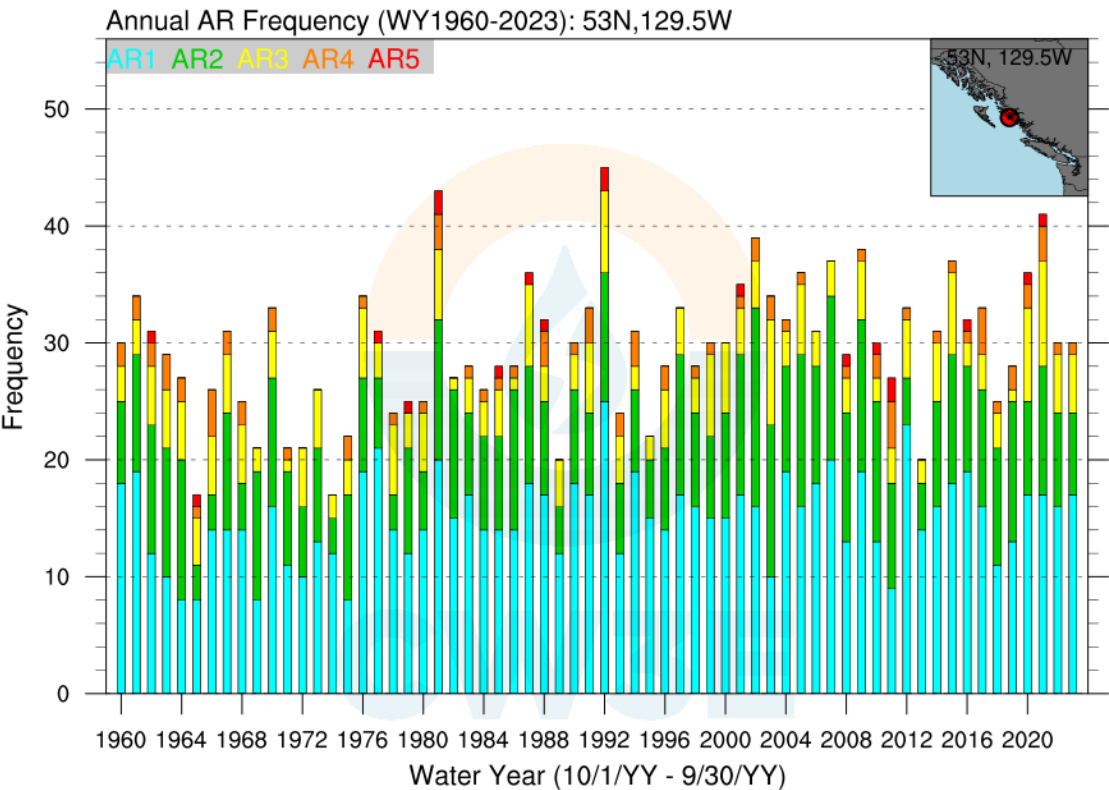


- Based on the GEFS analysis, this AR produced AR3-5 conditions over most of British Columbia.
- An AR duration of 57 hours and a maximum IVT of  $1055 \text{ kg m}^{-1} \text{s}^{-1}$  (i.e., an AR5) were observed near Prince Rupert, BC.

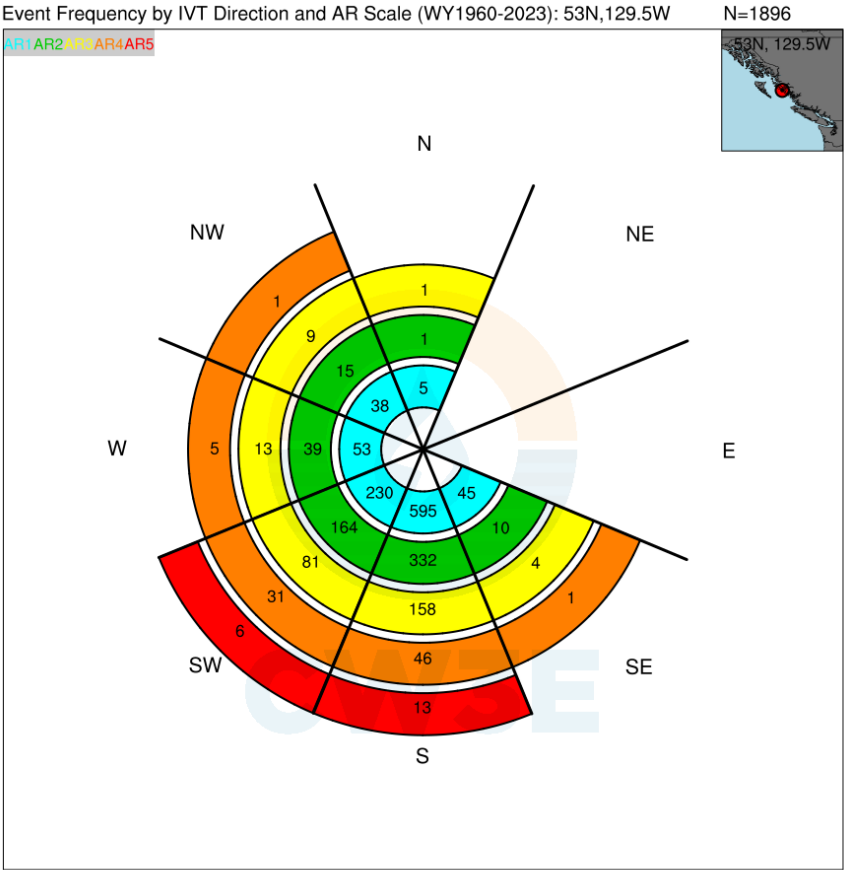


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## ERA5 AR Scale Climatology Analysis



Analysis supports FIRO and California AR Programs at CW3E. For use please cite CW3E. Data source: ECMWF ERA5



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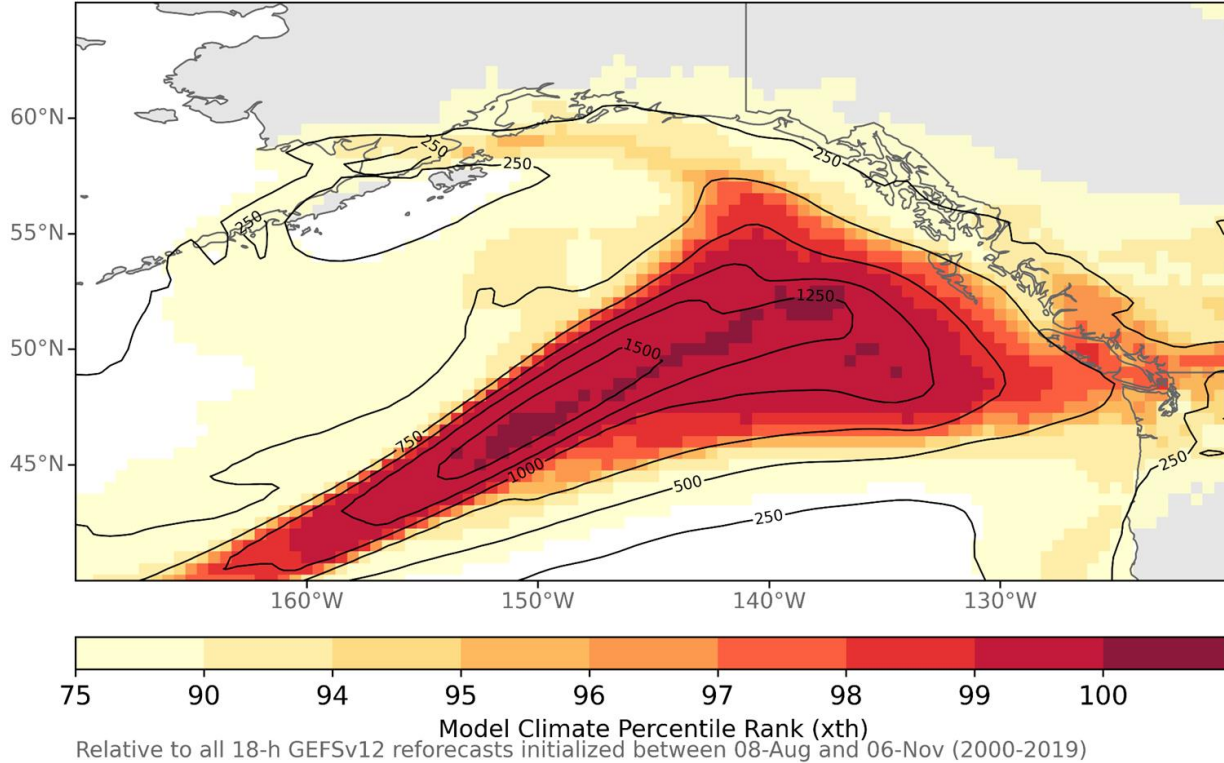
- Based on the ERA5 analysis, less than 20 AR5 events have been observed between 1960 and 2023 near Prince Rupert, BC.
- All of the historical AR5 events have had either southwesterly or southerly IVT.

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## GEFSv12 Reforecast Analysis

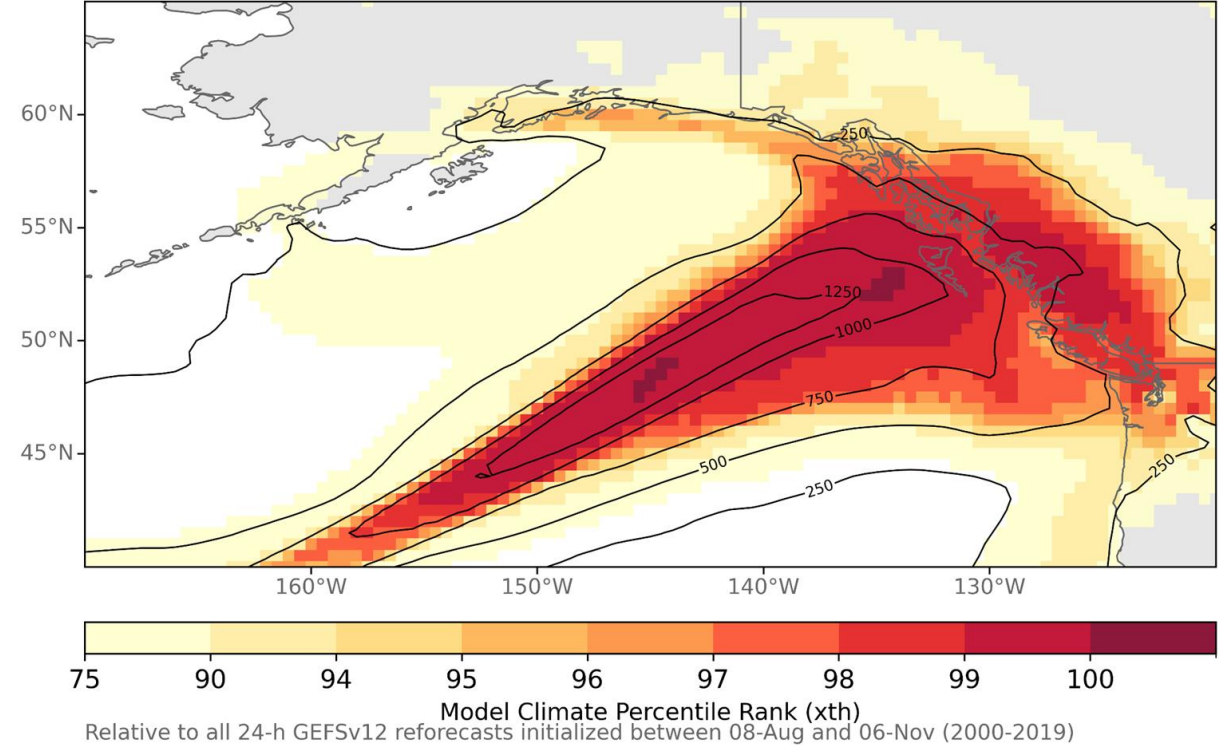
Initialized: 06Z 22 Sep 2024

F-18 | Valid: 00Z 23 Sep 2024



Initialized: 06Z 22 Sep 2024

F-24 | Valid: 06Z 23 Sep 2024

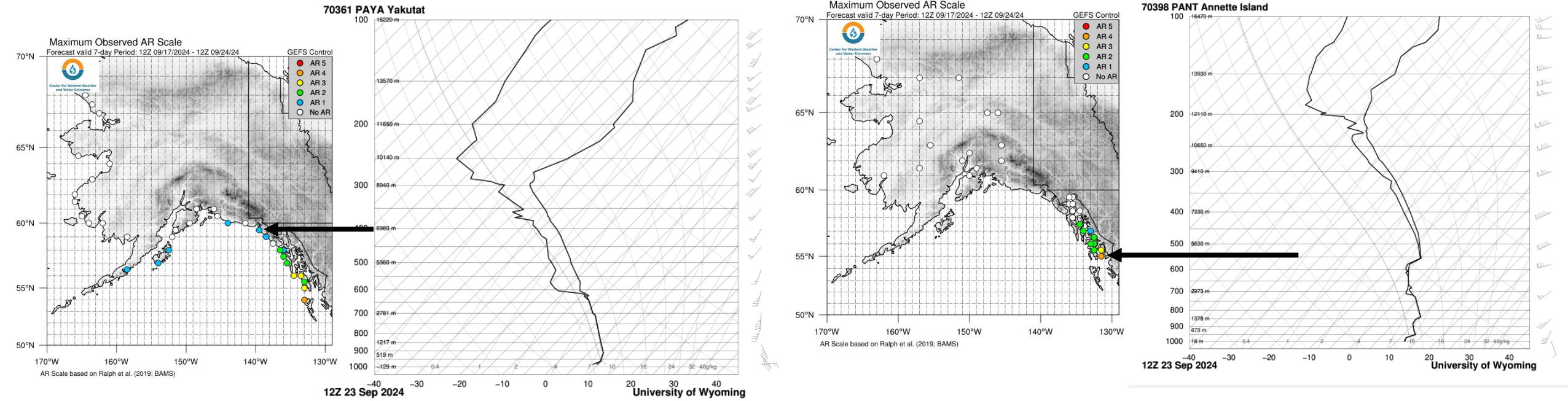


- IVT values observed in the Northern Pacific during this event exceeded the maximum percentile of GEFSv12 reforecast (2000-2019) IVT for similar lead times and time of year.
- However, the westerly flow of IVT was not ideal for orographic lift near the coast. Extreme precipitation in Southeast Alaska is more likely to occur when IVT is southerly or southwesterly.



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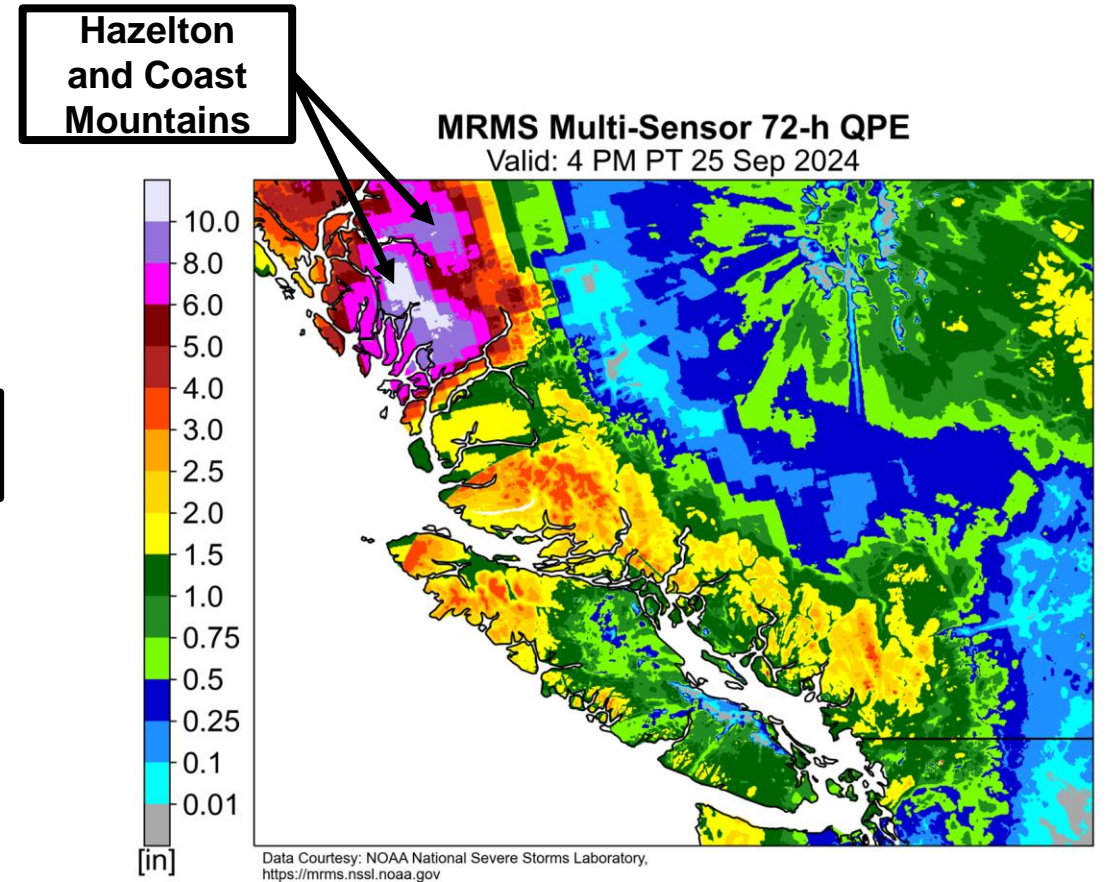
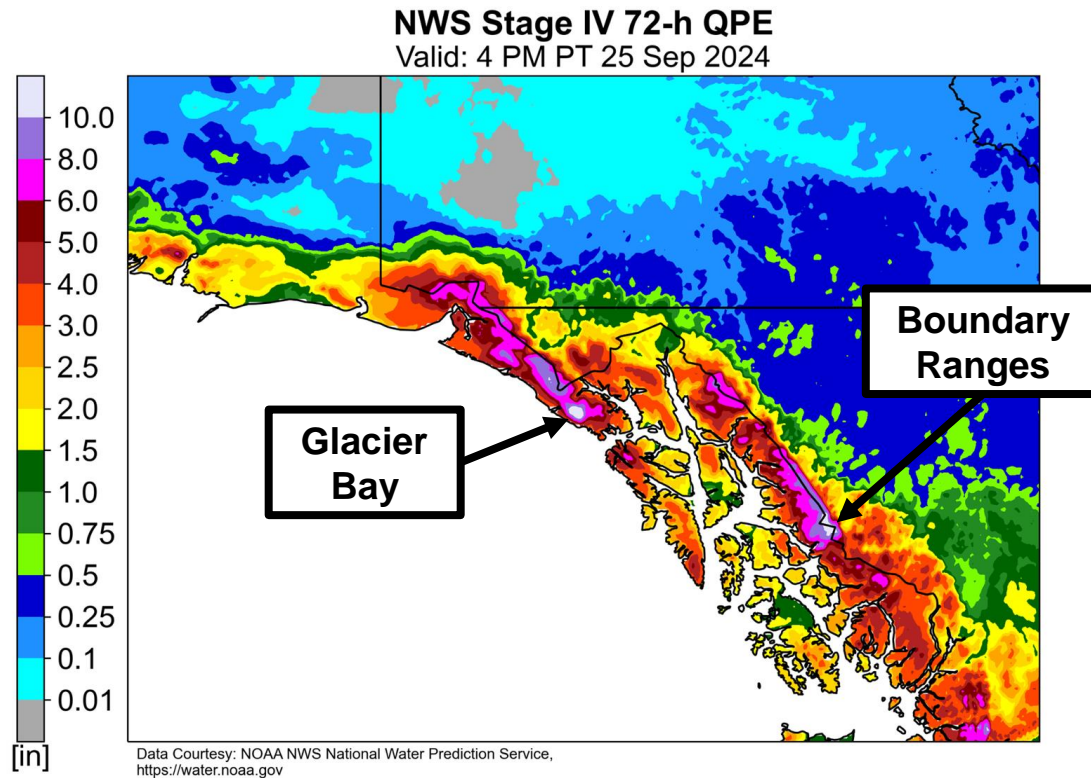
## Observations: Radiosondes



- Radiosonde data from the University of Wyoming from the PAYA (Yakutat) and PANT (Annette Island) stations
  - A max IVT of  $312 \text{ kg m}^{-1} \text{ s}^{-1}$  and ~27 hours of continuous AR conditions (i.e., an AR1) were observed at Yakutat.
  - A max IVT of  $1003 \text{ kg m}^{-1} \text{ s}^{-1}$  and ~42 hours of continuous AR conditions (i.e., an AR4) were observed at Annette Island.
- During this event, the PANT (Annette Island) station recorded the second highest precipitable water value (1.54 inches) since 1948 during the month of September.

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## Storm-Total Precipitation

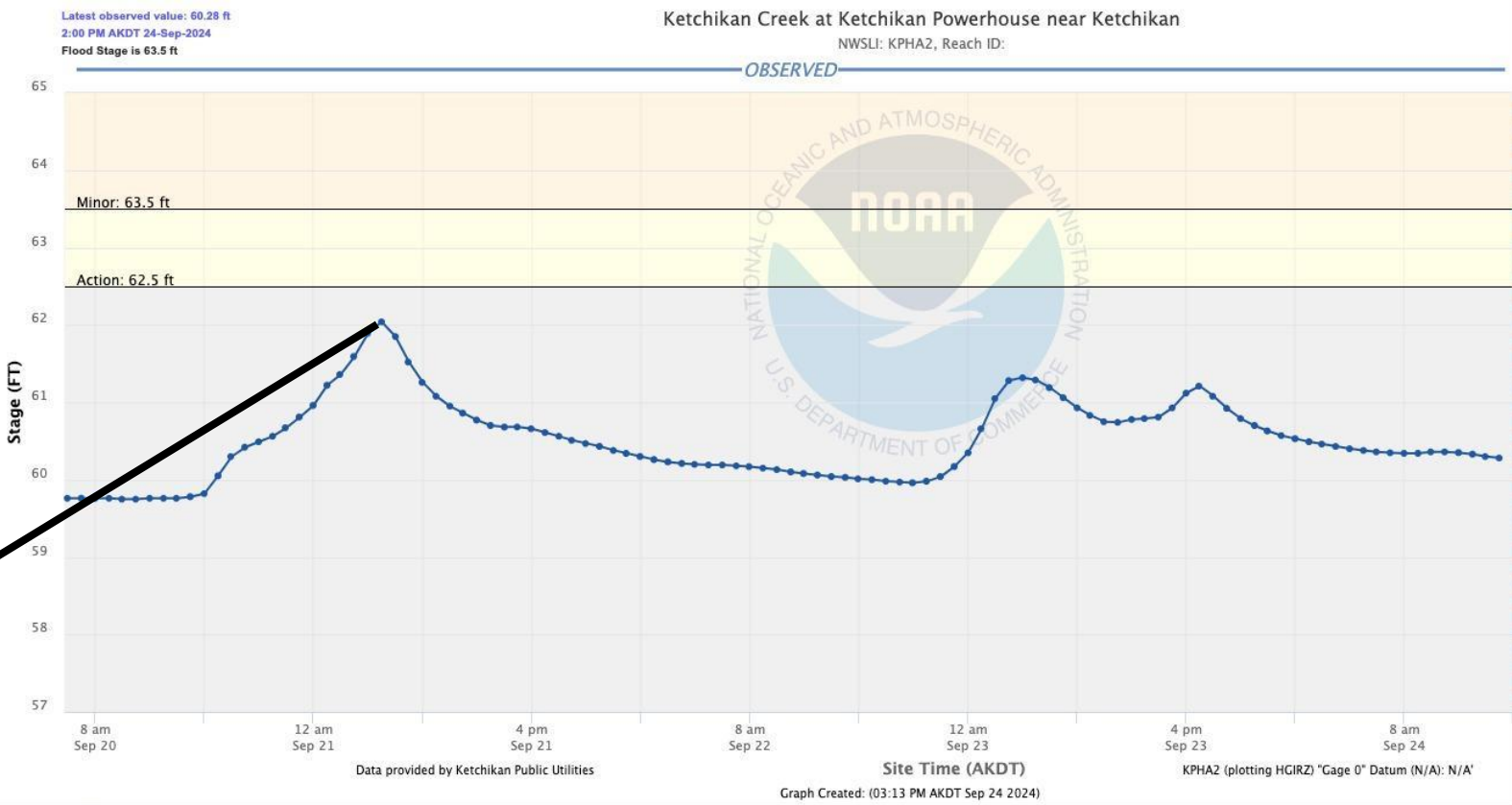
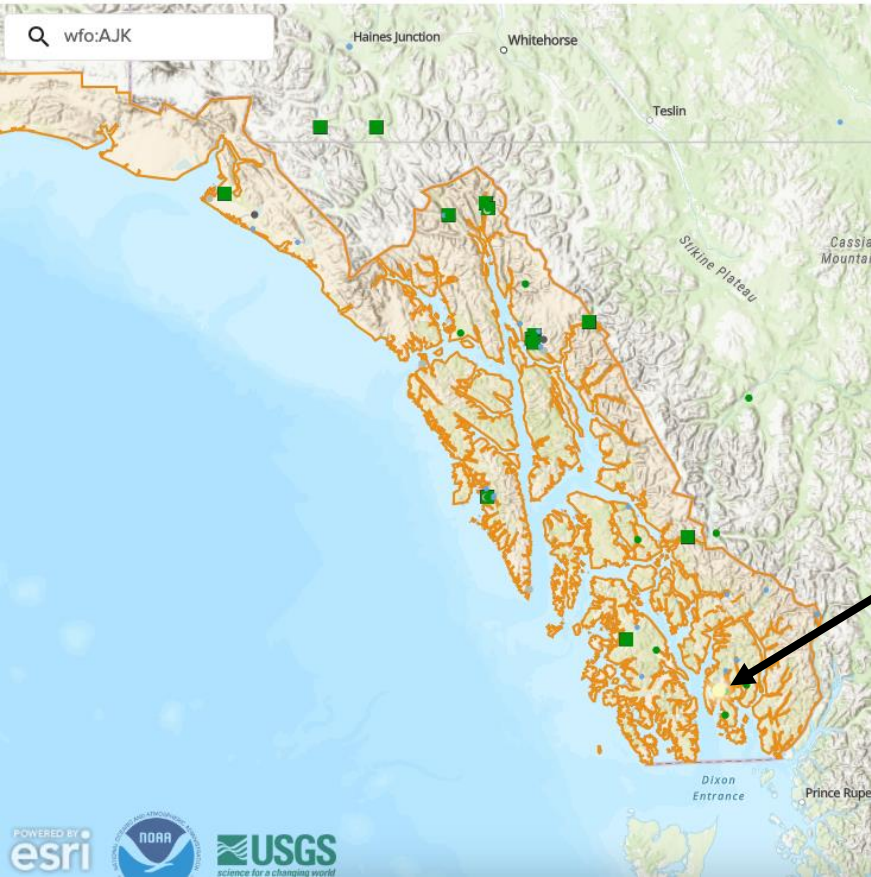


- Although the IVT direction wasn't ideal, upslope moisture flux still likely contributed to orographic enhancement over the higher terrain.
- This AR produced widespread precipitation over Southeast Alaska and British Columbia with the highest amounts (at least 6–10 inches) in Glacier Bay National Park in Alaska, the Boundary Ranges, and the Hazelton Coast Mountains in British Columbia.
- Most coastal locations in Southeast Alaska and British Columbia received less than 4 inches of total precipitation.



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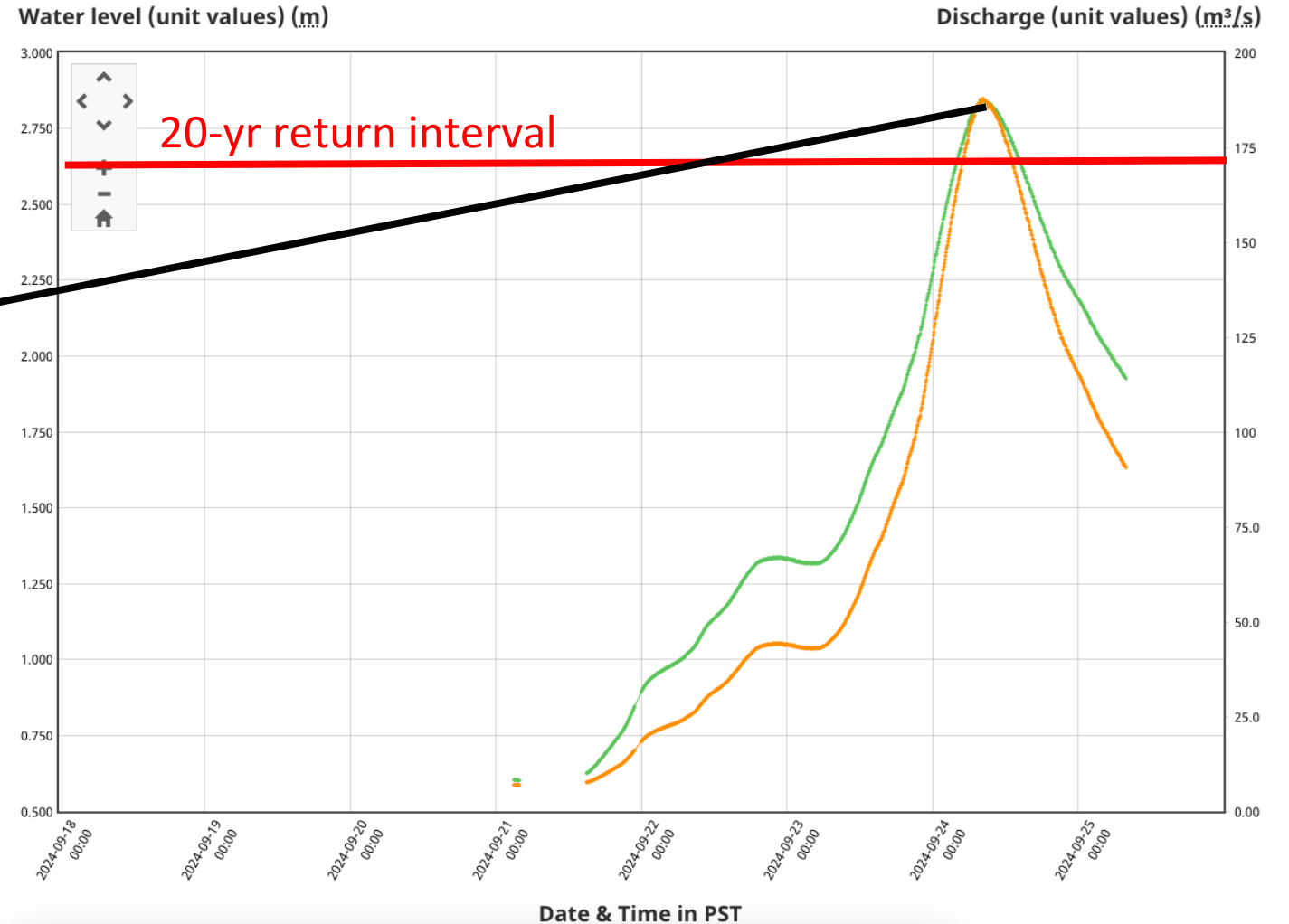
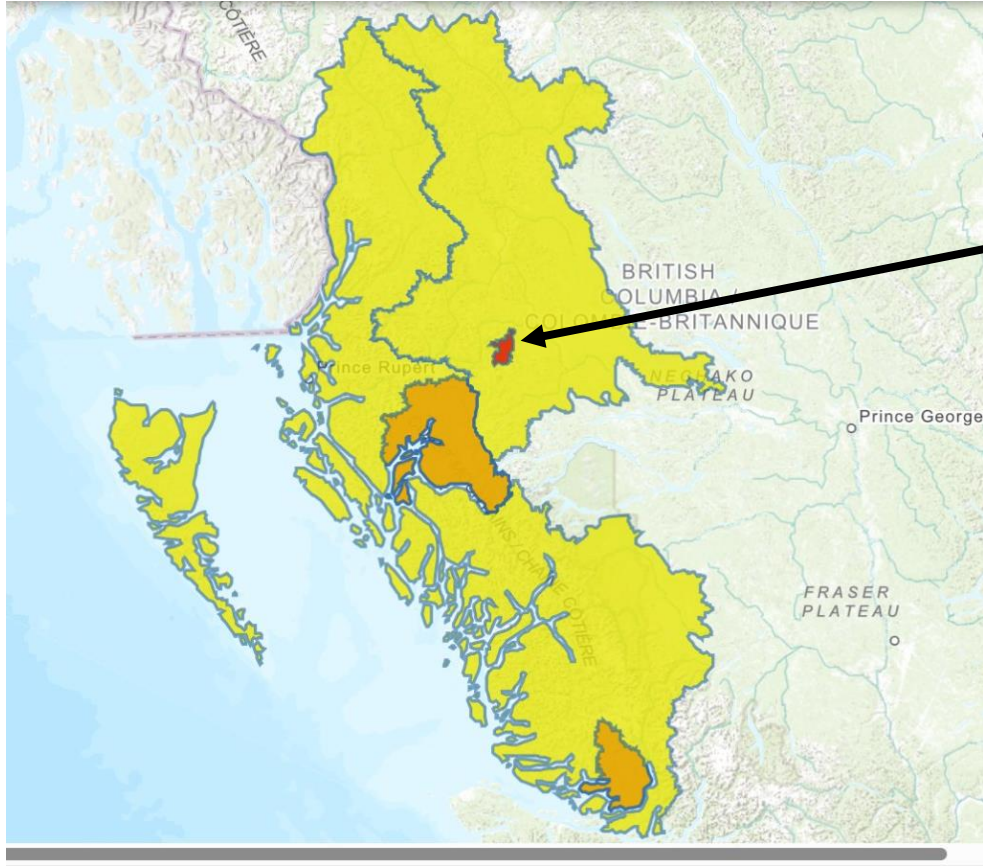
## Hydrologic Impacts



- Rain during 20–21 Sept caused Ketchikan Creek at Ketchikan Powerhouse to rise just below action stage, reaching a peak of 62.04 ft.

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## Hydrologic Impacts



- Rain during 22–24 Sept caused Telkwa River in British Columbia to flow greater than 170  $\text{m}^3/\text{s}$ , close to a 20-year return period flow.
- A flood warning was issued on September 24, 2024