S78: Orographic Precipitation Over the Olympic Mountains - A Comparison of Rain Patterns at Two Weather Stations

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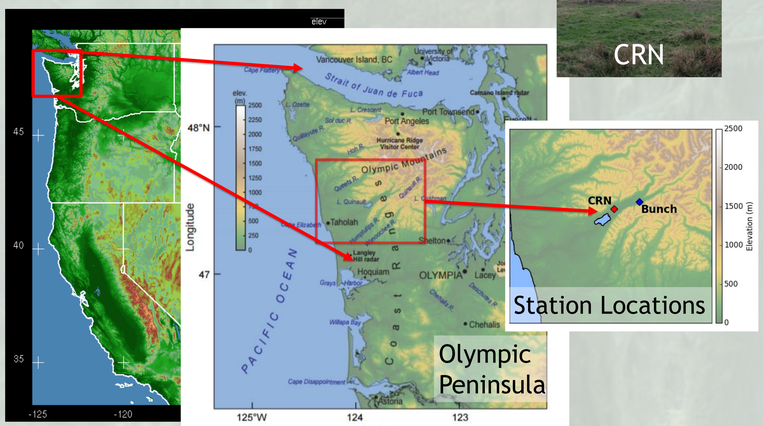
Overview

- The OLYMPEX field campaign took place during the fall and winter 2015-2016 to examine orographic precipitation and validate the core satellite of the Global Precipitation Measurement (GPM).
- During the campaign, two locations at the same elevation and located only 10.2km apart had drastically different rainfall totals.

Bunch Field [elev. 115.8m] : Installed and maintained by National Park Service, typically receives more rainfall, further up the Quinault Valley

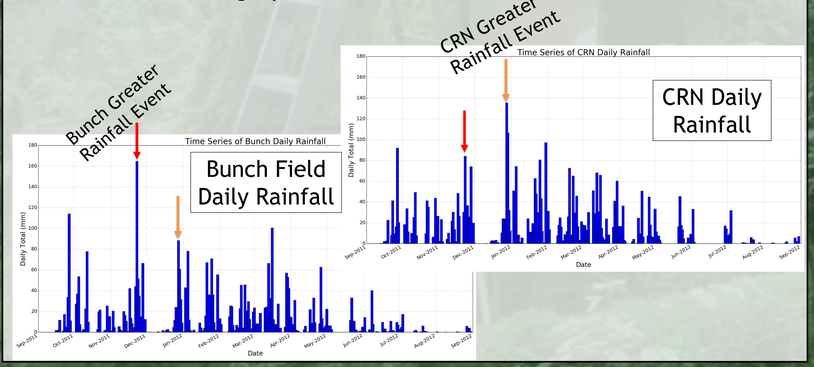
Photos: Joe Zagrodnik

Climate Reference Network (CRN) [elev. 86.7m] : Installed and maintained by NOAA, typically receives less rainfall over the course of the water year (Diamond et al. 2013).



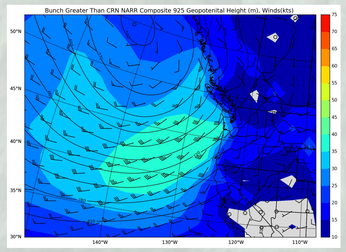
Motivation

- One of OLYMPEX's primary goals is to validate the GPM in complex terrain so that better precipitation estimates can be applied to hydrologic applications such as flood forecasting
- Olympic Mountain Range is an excellent region to study orographic enhancement
- A common assumption is that locations at higher elevations and closer to the interior show greater the orographic enhancement under all conditions.
- We will show that synoptic scale patterns affect/determine the location of orographic enhancement

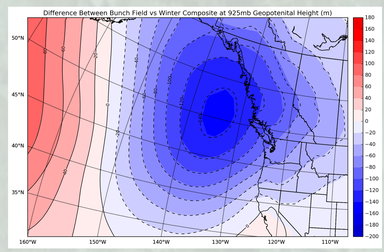


Synoptic Flow When Bunch Field Has Greater Precipitation

Composite Average

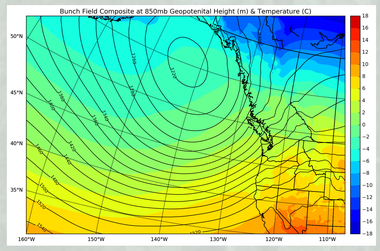


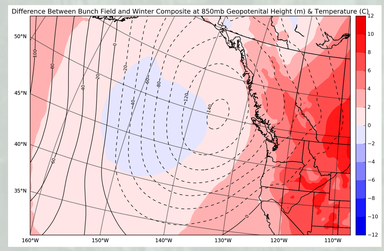
Anomaly



925 hPa Heights, Wind

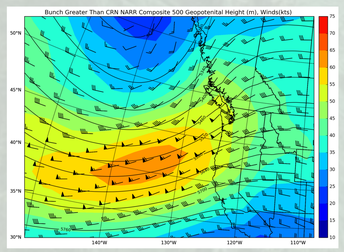
- Anomalous Trough offshore
- Strong Southerly Winds on the coast

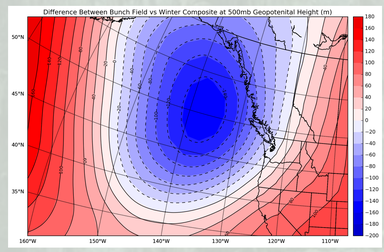




850 hPa Heights, Temp

- Southwesterly onshore flow
- Anomalously warm temperatures over entire west





500 hPa Heights, Wind

- Strong Southwesterly Jet
- Significant offshore trough

Method

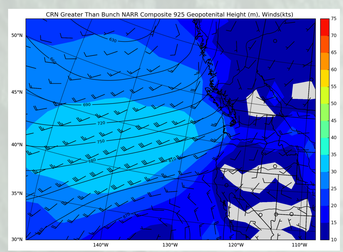
- Compared daily rainfall data at CRN and Bunch Field over 10 winter seasons (Sept 1 - Mar 31) from Oct 2006 through Dec 2015.
- Only used period when each station received at least 25 mm day^{-1}
- Identified periods where one station exhibited 'significantly more' precipitation than the other station
- A 'significant difference' in rainfall is defined as one site receiving more than 20 mm precipitation than the other in a 24 hour period
- Made composite synoptic maps using the NCEP North American Regional Reanalysis data for dates when CRN exhibited higher rainfall totals and for when Bunch exhibited higher rainfall totals.
- Made anomaly maps for each situation by subtracting the composite maps from winter climatology maps.
- The winter climatology was calculated by averaging the monthly mean fields (based on 1979 – 2000) for the months Sept – March.

Acknowledgements

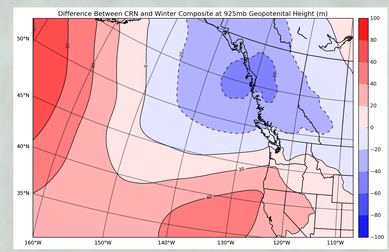
Thanks to Bill Baccus of the Olympic National Park for maintaining the Bunch Field Site. This work was supported by NASA Grant NNX16AK05G.

Synoptic Flow When CRN Has Greater Precipitation

Composite Average

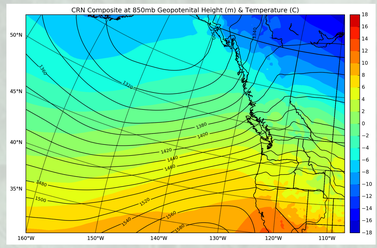


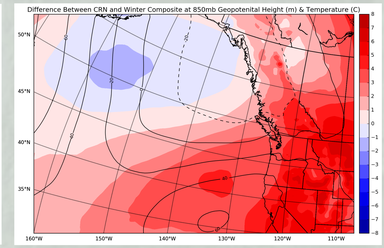
Anomaly



925 hPa Heights, Wind

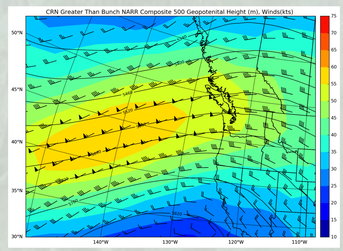
- Strong WSW nearly zonal flow
- High pressure to the South

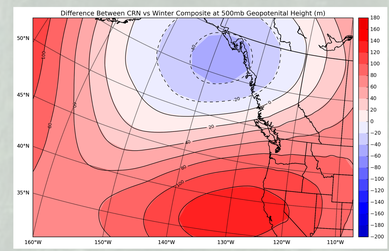




850 hPa Heights, Temp

- Baroclinic Temperature Gradient
- Much warmer temperature anomaly than Bunch Field composite





500 hPa Heights, Wind

- Significant WSW jet
- Anomalous high to south and low to the north and strong flow into Olympic Mountains

Conclusions

- CRN receives more rain when:
  - Flow is strong from WSW at all levels
  - Flow aligns with Quinault Valley orientation
  - Anomalously warm events
- Bunch Field receives more rain when:
  - Flow is more southerly
  - When storms exhibit typical baroclinic structure
- Found 63 cases of CRN with significantly more rainfall, compared to 39 cases with Bunch Field dominating
- Data suggests synoptic scale flow pattern has an effect on where greatest precipitation occurs – important implications for potential flooding situations

References

NCEP Reanalysis data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/

Diamond, H. J., T. R. Karl, M. A. Palecki, C. B. Baker, J. E. Bell, R. D. Leeper, D. R. Easterling, J. H. Lawrimore, T. P. Meyers, M. R. Helfert, G. Goodge, and P. W. Thorne, 2013: U.S.Climate Reference Network after one decade of operations: status and assessment. Bull. Amer. Meteor. Soc., 94, 489-498.