Atmospheric Rivers in Alaska – Yes they do exist, and are usually tied to the biggest and most damaging rain-generated floods in Alaska

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Abstract

The largest and most damaging floods in Alaska, outside of the ice jamming processes during breakup season, can usually be tied to a single causative event, atmospheric rivers(ARs) in the extratropical atmosphere. ARs can develop over the North Pacific any time of the year and generate a significant amount of rainfall or snowfall depending on the time of year. These events also impact communities with flooding, large debris flows, disruption to transportation and can result in casualties.

AR events have been well documented and monitored for years, especially in the West Coast of the continental United States. ARs impact the entire west coast of North America from British Columbia to the Alaska Panhandle through southern Mainland Alaska including Prince William Sound and the Cook Inlet region, into the west coast of Alaska.

From a forecasting perspective, in a region accustomed to frequent strong synoptic storms, the lack of calibrated/"normalized" Integrated Water Vapor Transport (IVT) values and lack of available AR detection algorithms for observational data make discerning significant AR events very difficult. In addition, steep and complex coastal terrain, proximity to arctic air masses, and significant data sparsity cause atmospheric models to struggle in general with expected results in the short term...which affects the ability of the forecaster to provide accurate and timely impact-based decision support to communities and other core partners.

We will review recent AR events in Alaska and propose future research, including a regional classification scheme and climatology for specific fields. Included events span from 2012-2015 and range from the Gulf of Alaska and southern interior portions of Alaska to the panhandle of southeast Alaska.

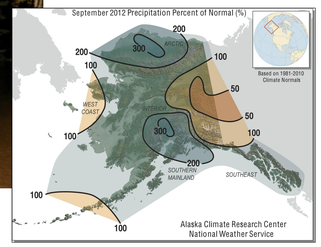
Left: Map of Alaska with locations of case studies (red boxes). (Map courtesy of USGS)

(1) September 19-24, 2012, South-Central Alaska

A wet start to the month saturated soils in advance of an extreme 5 day period of storms during the 2nd half of the month:

- Monthly rainfall totals 200-300% above normal across a large area of southern Alaska
- 5-day rain totals in excess of 25 inches along the coast and 6-12 inches inland
- Many large rivers and small streams flooded dramatically. $23 million in direct flood damages, and one flooding-related fatality
- Roads and bridges affected
- Railroad shut down for six days
- 60 homes severely damaged or destroyed and over 700 received minor damage
- Seward-area roads, schools, and airport closed due to flooding and/or mudslides
- Much of the city of Talkeetna was flooded and evacuated

Above: Overnight evacuation from flooded home near Wasilla, Alaska. Photo courtesy of Alaska Dispatch News.



Right: Monthly precipitation as a percent of normal across Alaska. Photo courtesy of Alaska Climate Research Center

(3) December 10-14 2013, Ketchikan

Flooding resulted from:

- 5 days of heavy precipitation (wettest 5 day period since 1902) ranging from 13 to 23 inches, with one day totals from 3 to 5 inches
- Spillways on many area dams released water uncontrollably into Ketchikan Creek and produced flooding -- Area dams rose 7 to 14 ft with at least 2 ft over spillway

Flooding of campground at Ward Lake above Lake Connell Lake, courtesy of US Forest Service.

Flooding of home on Ketchikan Creek, courtesy of Ketchikan Public Utility.

Flooding of home on Ketchikan Creek, courtesy of Ketchikan Public Utility.

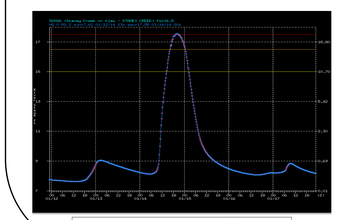
(4) January 14, 2014, Sitka and Prince of Wales Island (POW)

Flooding and Mudslides resulted from:

- Very moist antecedent soil conditions – nearly continuous rainfall over previous month (17"-37"), with record daily rainfall amounts on Jan 14 of 2.5"-3.5"
- Strong wind gusts (greater than 45 mph) which helped to generate widespread mudslides along steep and deforested terrain on POW

Flooding and impacts:

- Highest ever stage and flow ever recorded on Staney Creek, 17.55 ft
- Numerous roads were flooded and impassable, along with debris flows over roadways isolated several communities disrupting transportation
- Debris flows also caused loss of power and damaged structures
- Storm water drainage pumps became clogged with debris



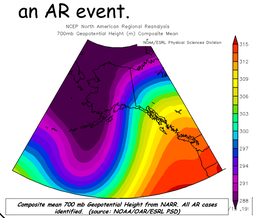
Stoney Creek river gauge showing record crest of 17.55 feet, moderate flood stage is 17.5 feet (source: NWS)

Home in the Hollis area caught in landslide, along with some flooding, courtesy of state troopers.

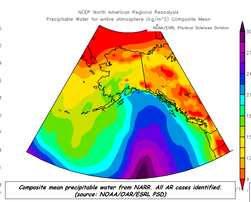
Landslide on the Klawock-Hollis Highway, courtesy of state troopers.

Synoptic AR set-up for Alaska

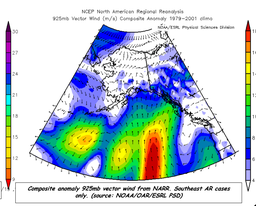
Over the years several atmospheric river events have been classified by individuals working at the National Weather Service in Alaska. In 2011, Papineau and Holloway described the necessary ingredients for heavy rain events in Alaska that ranged from coastal, interior and a "hybrid" of the coastal and interior. Within this report, coastal and coastal-interior events were associated with extended plumes of moisture originating in the lower latitudes, that may or may not meet the commonly accepted definitions of ARs. Looking at a simple average from the North American Regional Reanalysis (NARR) dataset of the 700mb geopotential heights of these events as well as more recent episodes, it is readily apparently that a high amplitude anomalous trough/ridge couplet is needed. Furthermore, a composite mean of the precipitable water for the entire atmosphere exposes the influx of moisture from the lower latitudes. Lastly, the presence of a dramatic coastal mountain range creates additional orographic lift that results from strong onshore winds that typically accompany an AR event.



Composite mean 700 mb Geopotential Height from NARR. All AR cases identified. (source: NOAA/OAR/ESRL PSD)



Composite mean precipitable water from NARR. All AR cases identified. (source: NOAA/OAR/ESRL PSD)



Composite anomaly 925mb vector wind from NARR. Southeast AR cases only. (source: NOAA/OAR/ESRL PSD)

(2) November 20-25, 2015, Susitna Valley

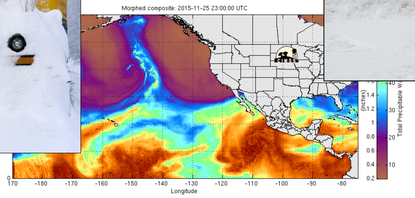
Atmospheric river event moves moisture and warm air into southern Alaska from lower latitudes:

- Antecedent cold airmass kept precipitation as snow in the northern Susitna Valley
- 2 day snow totals exceeded 40 inches and 5 day totals exceed 60 inches
- The Parks Highway is closed due to dangerous driving conditions and avalanche mitigation work
- Alaska Railroad train is caught in an avalanche. Crew is rescued, but railroad remains closed for 2.5 days

Left: Alaska Railroad train covered in snow from avalanche. Photo courtesy of Alaska Railroad

Middle: Total Precipitable Water in November 2015 showing atmospheric river impacting southern Alaska. Image courtesy of CIMMS

Right: Heavy equipment works to dig out buried train cars and clear the tracks during a multi-day closure after an avalanche. Photo courtesy of Alaska Railroad



Future research needs and goals

- Derive a regional and seasonal classification scheme: non-AR, AR, and Strong AR
- Compute AR event analogs for pattern and strength of moisture transport
- Climatology of specific fields: Integrated water transport, Precipitable water values, and boundary-layer winds
- Increase sustainable surface based observation network and improve remote sensing capabilities to improve atmospheric model output
- Expand AR portal to include Alaska on all detection and prognostic products

Acknowledgements/references

Papineau J., E. Holloway, 2011: The Nature of Heavy Rain and Flood Events in Alaska. Paper found at http://www.weather.gov/afc/

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