Recent Updates to Objective Atmospheric Detection Techniques and Resulting Implications for Atmospheric River Climatologies

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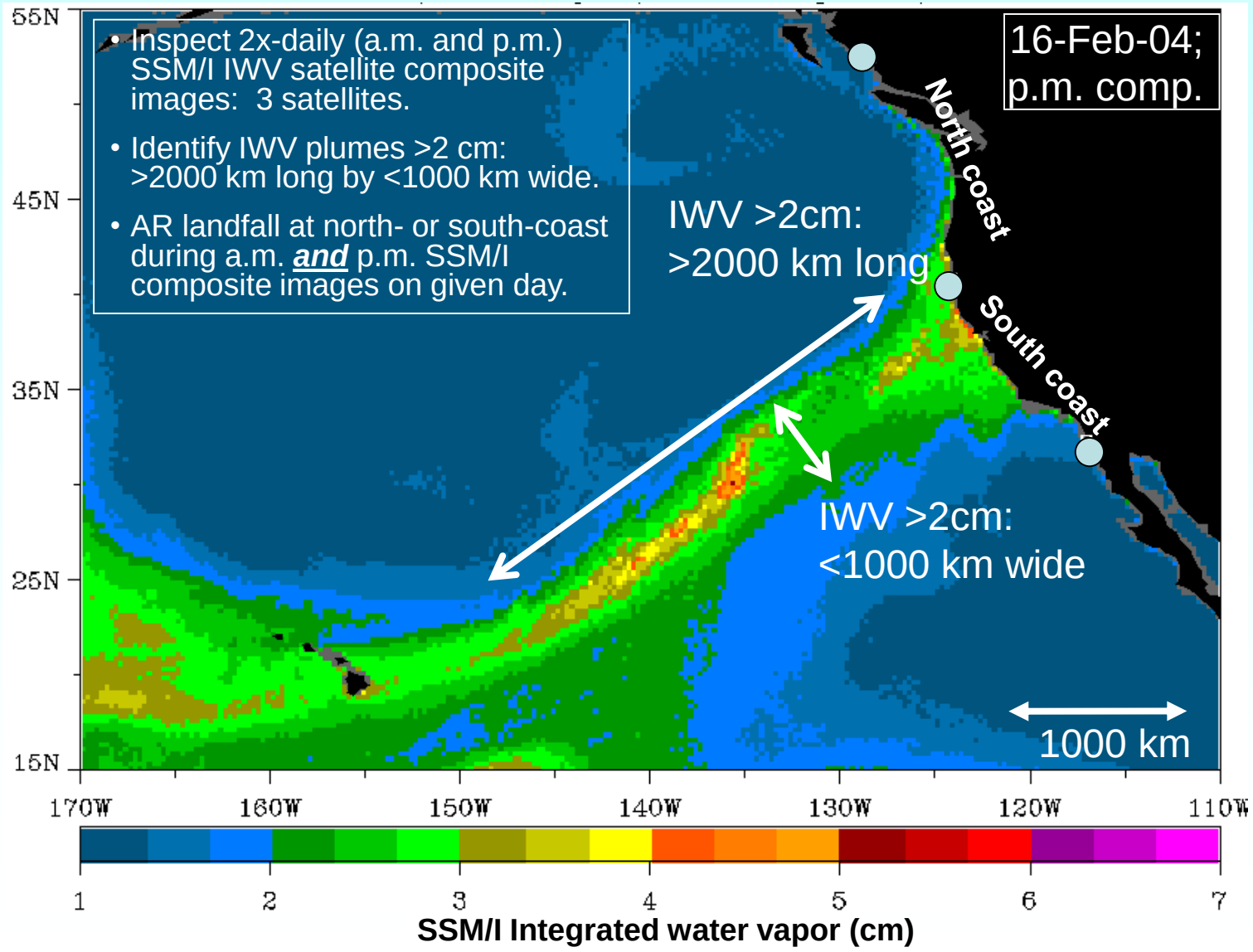
Outline

- Background
- Initial Application to Integrated Water Vapor (IWV)
- Extension to Integrated Vapor Transport (IVT)
- Differences and impacts on climatology
- Conclusions

Visual Detection



Motivation for Automated Detection Approach

- Comparison/validation of model representations
- Construction of climatologies
- Real-time forecast tools

IWV

- Supports independent validation of forecast and analysis products
- Consistent with early body of work

IVT

- More representative of underlying phenomena

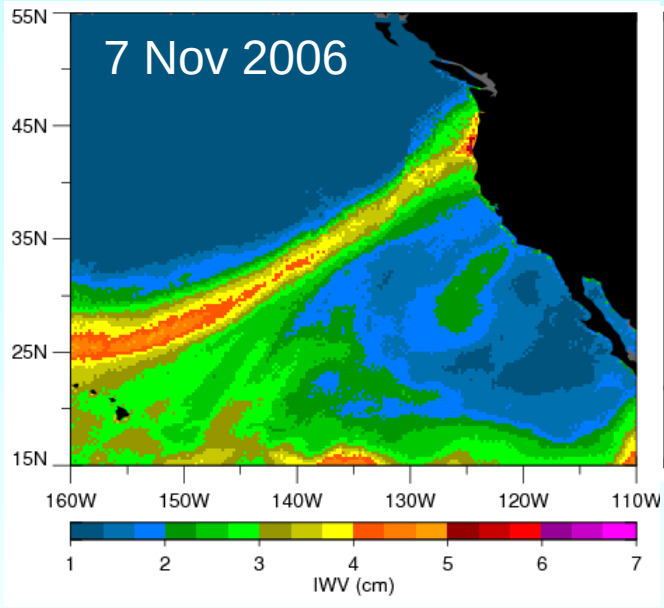
Broad Classification of Approaches

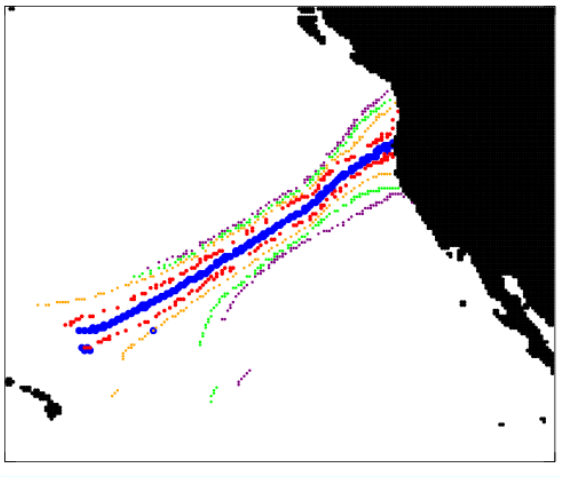
- Thresholding and connectivity
  - Absolute and percentile thresholds
  - Lavers et al. 2012
  - Rutz et al. 2014
- Additional geometric constraints
  - Regional IWV: Wick et al. 2013
  - Regional IVT: Wick et al. 2014
  - Global IVT: Guan and Waliser 2015
- Alternate approaches
  - Segmentation: Sellars
  - Drainage networks: Yang

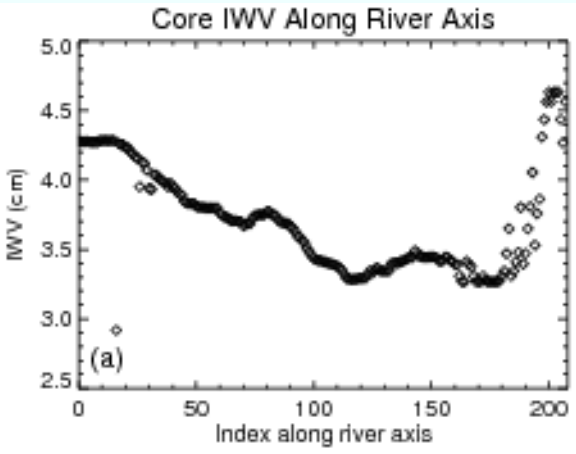
Automated AR Detection Tool-IWV

- Automated tool developed for detection of AR events in observed and modeled IWV fields
- Based on thresholds for width, length, and IWV content of ARs
- Validated against manually identified landfalling events over 5 cool seasons
  - 92.8% critical success index
  - 98.1% POD
- Procedure returns core IWV, AR width, and orientation along length of AR

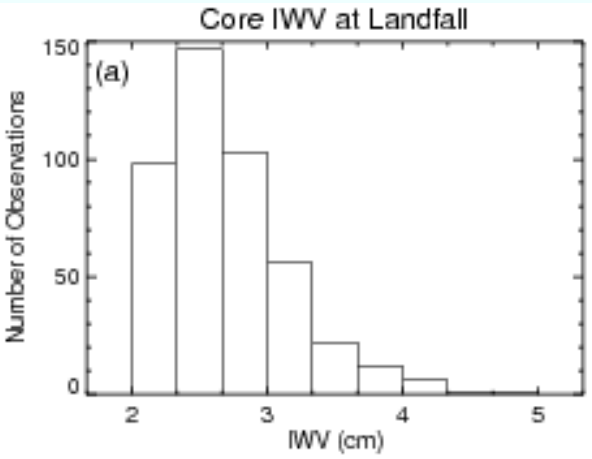
Wick et al., TGRS, 2013







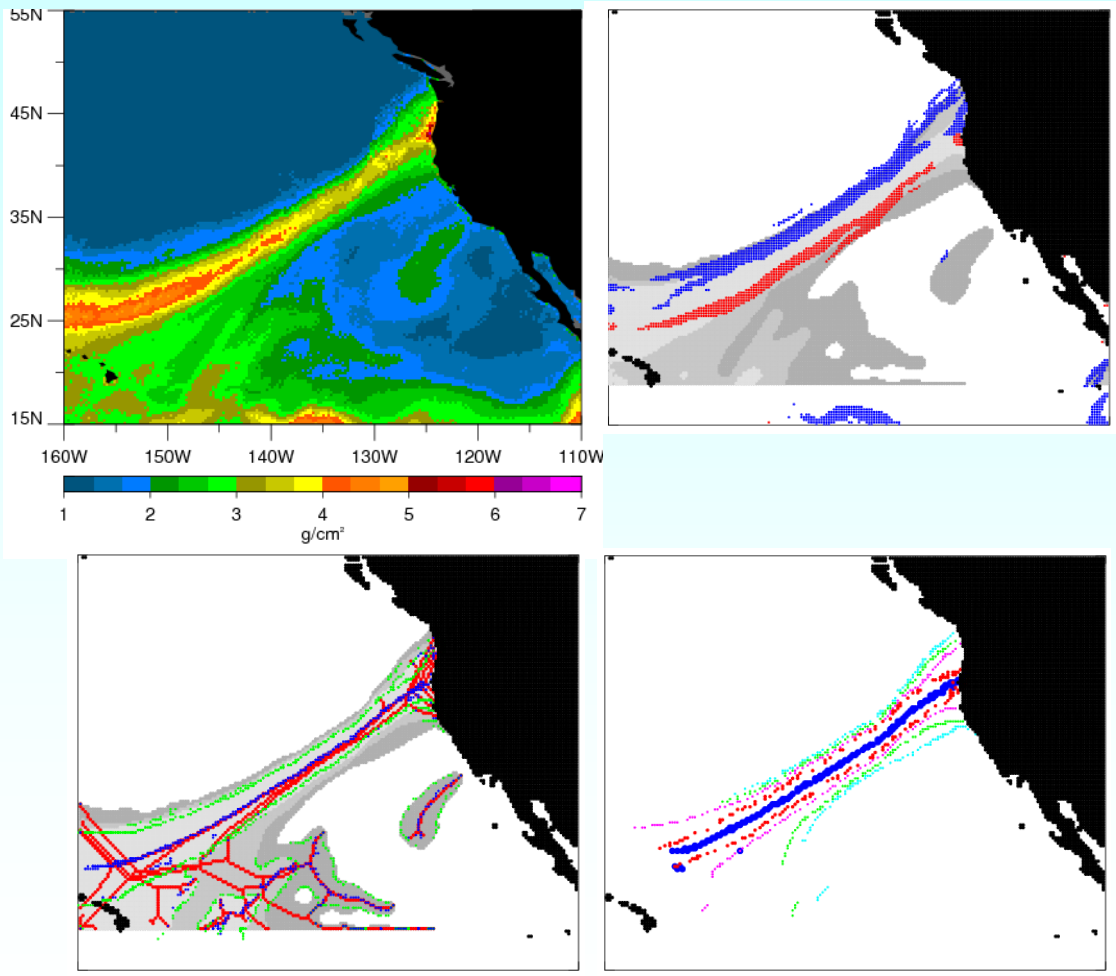
Extracted IWV along axis of above AR. Index runs SW-NE



Extracted IWV near landfall for winter events from 2003-7

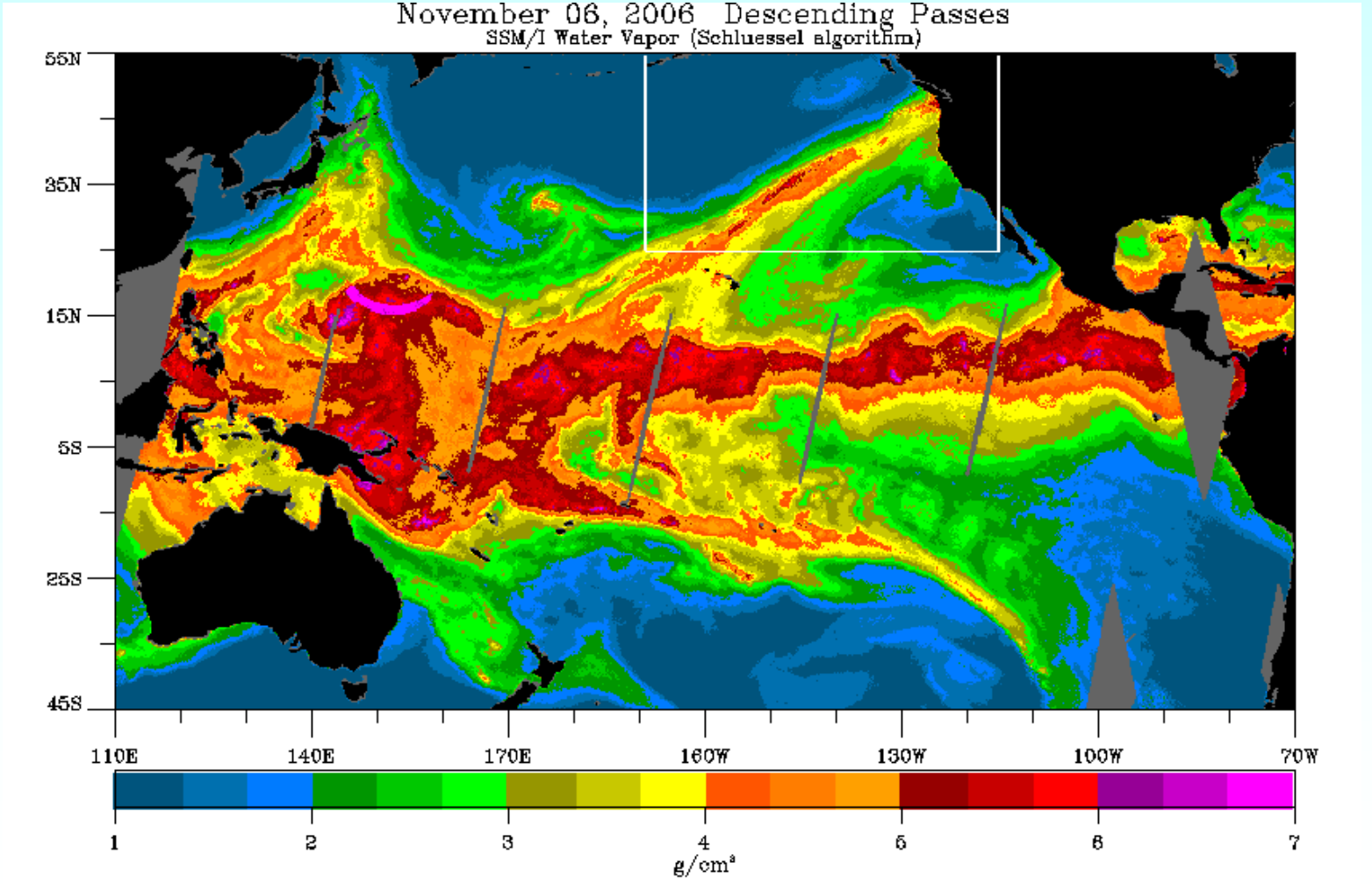
Objective River Identification Procedure

- Isolate top of the tropical water vapor reservoir
- Threshold IWV values at multiple levels and compute gradients
- Cluster points above thresholds and compute skeleton to estimate axis
- Identify points satisfying width criteria
- Cluster center points to identify segments of sufficient length
- Extract AR characteristics
- Determine if AR intersects land or is potentially influenced by data gaps



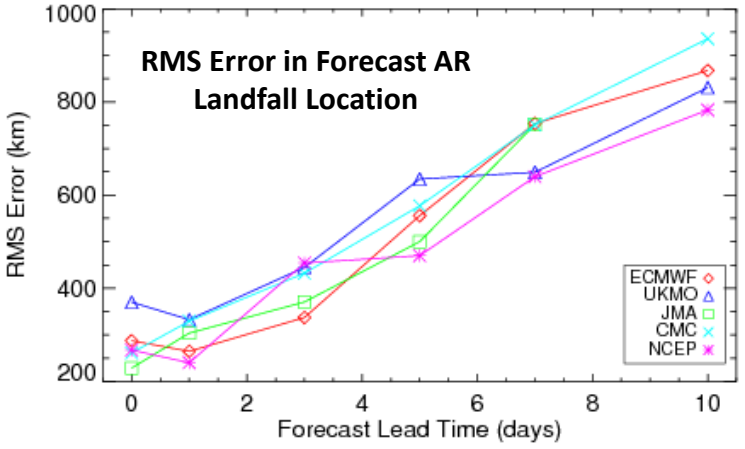
Example from November 7, 2006

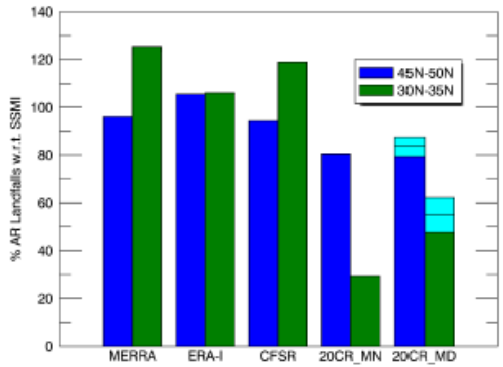
Atmospheric River?

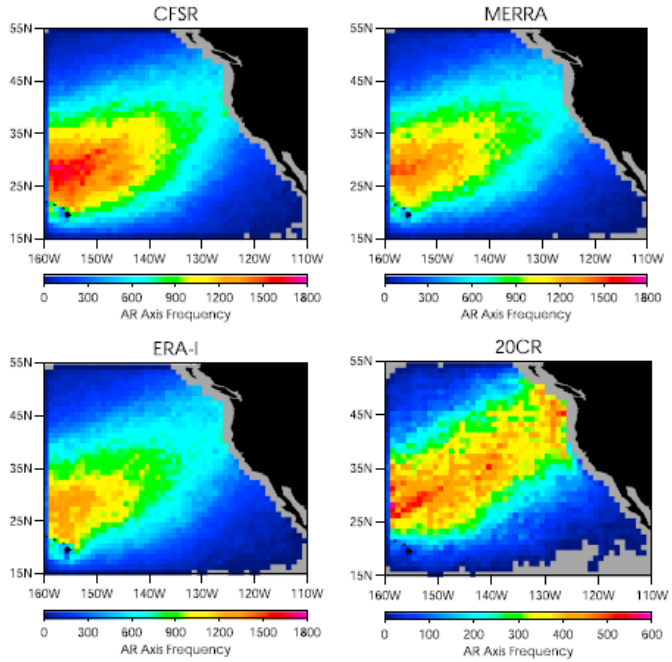


Application to Model Verification

- Forecast models
  - Wick et al. 2013
  - Occurrence well forecast but errors in location
- Reanalyses
  - Jackson et al. 2016
  - Overall landfall agreement within 5%
  - Specifics depend on products assimilated







IWV to IVT

Conceptually easier due to “anomalous” nature of features

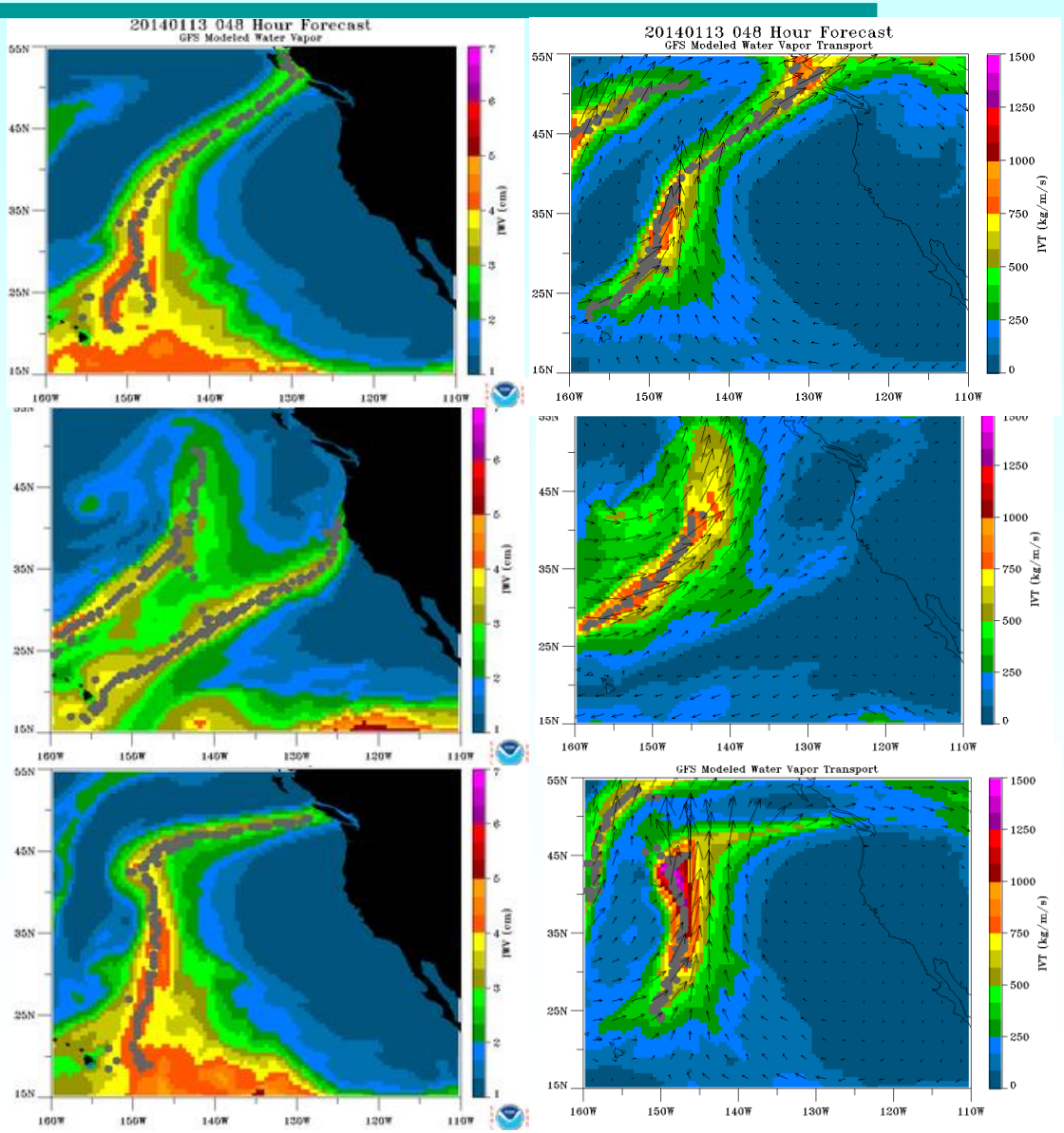
- Simplest possible modification of ARDT-IWV with continuation of “river” analogy
- Not necessarily ideal, but allows direct comparison of thresholding approaches

- IWV > 2 cm (multiple thresholds)
- Width < 1000 km (for one threshold)
- Length > 2000 km

- IVT > 250 kg/m/s (multiple thresholds)
- Width < 1500 km (for one threshold)
- Length > 2000 km
- IVT “aligned” with axis of detected feature
- Linearity constraint

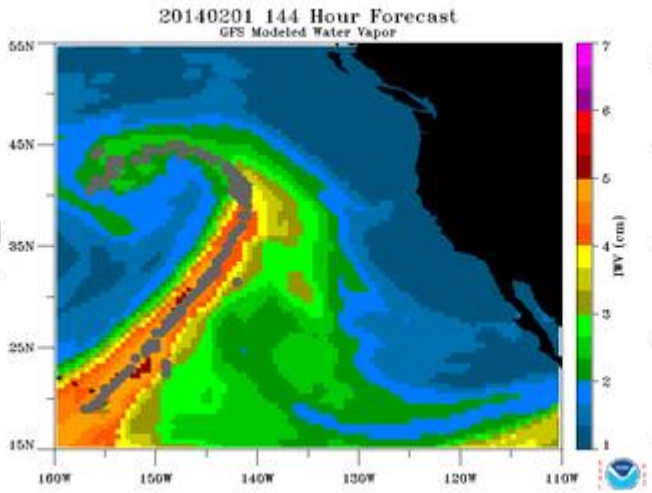
Comparison of Results

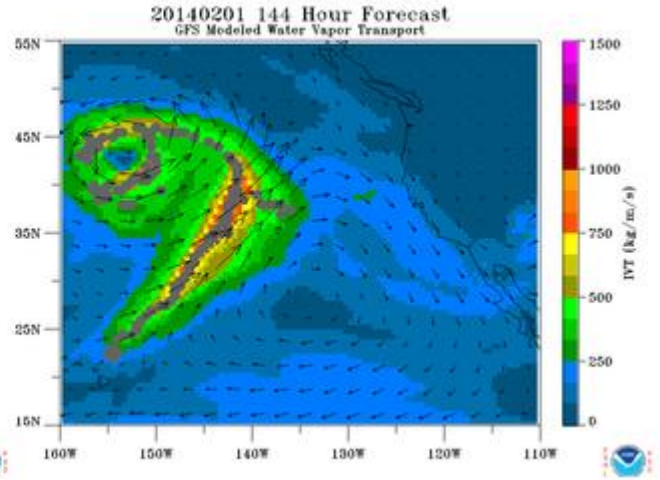
- Results similar in many cases
- Are cases with significant differences
- More opportunities to filter results

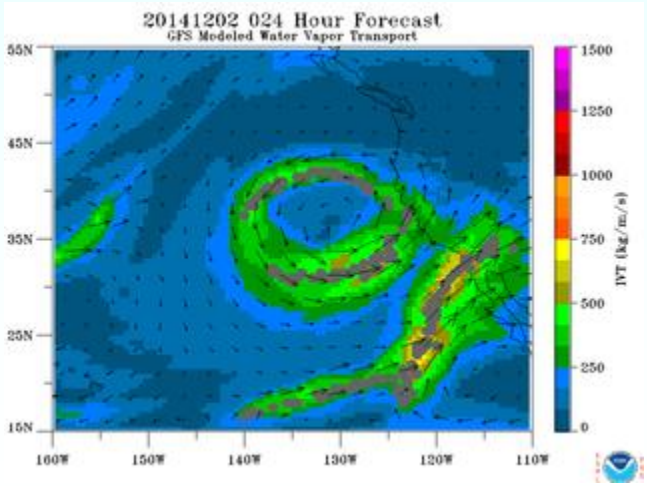


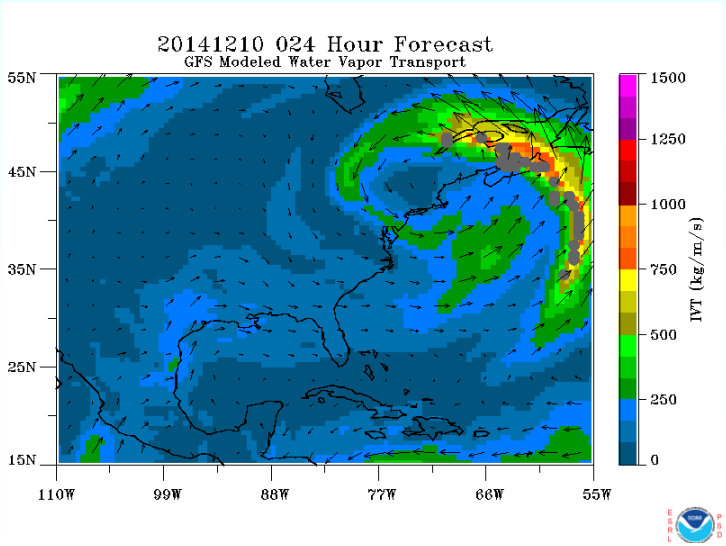
Potential Issues

6-Day Forecast Valid
12 Z on 2014-02-07



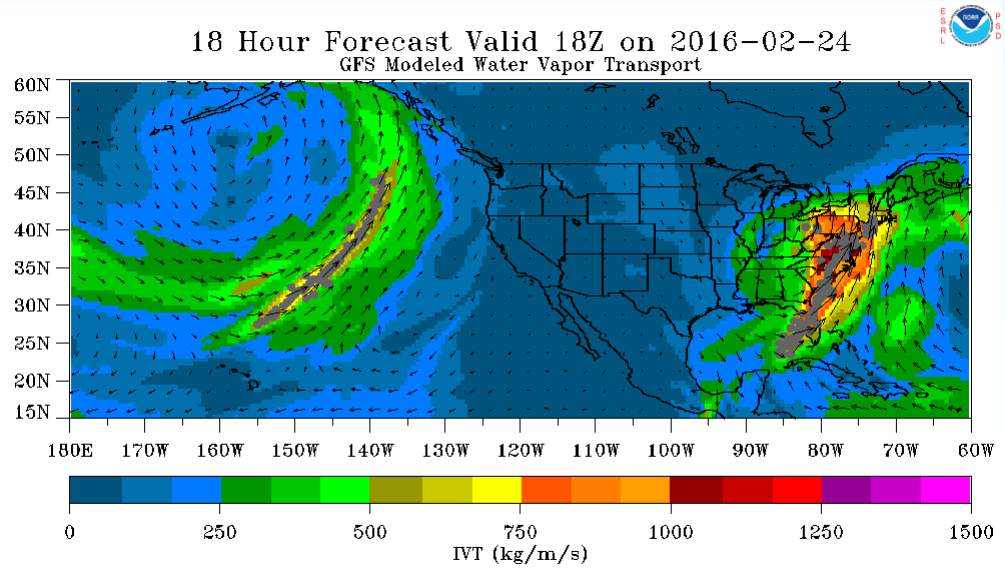




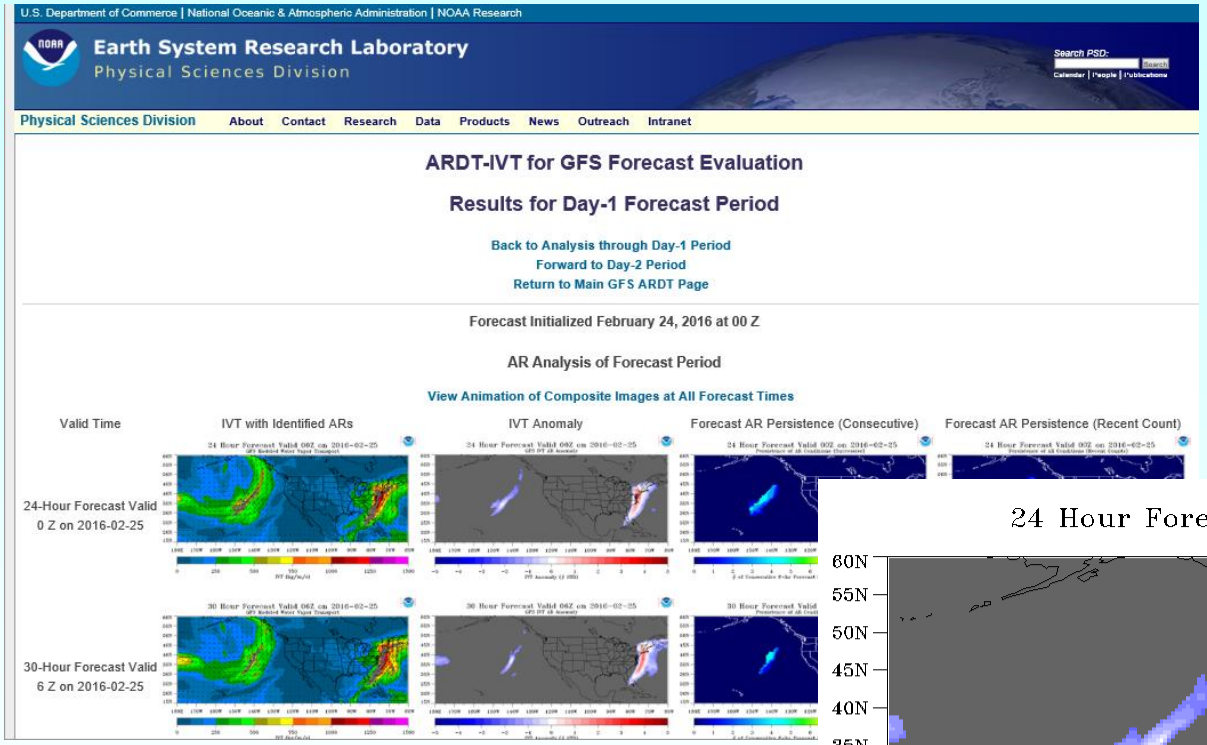


Current Implementation

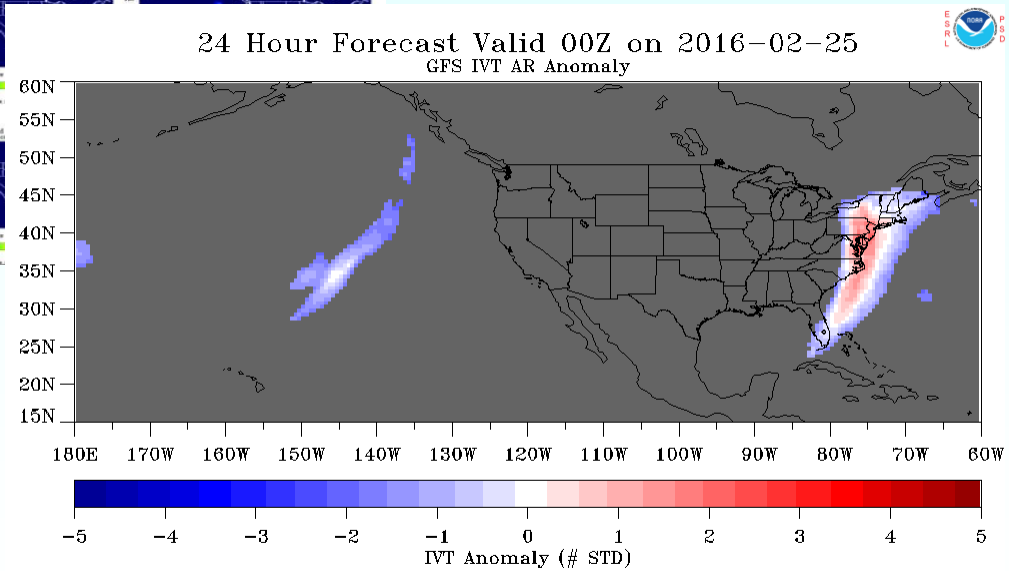
- Expanded region
- Applied to CFSR, 1981-2012
  - Developed climatology
  - Multiple thresholds: IVT and length
- Real-time GFS application
  - Forecasts to 7 days
  - WPC demonstration



Real-Time Display



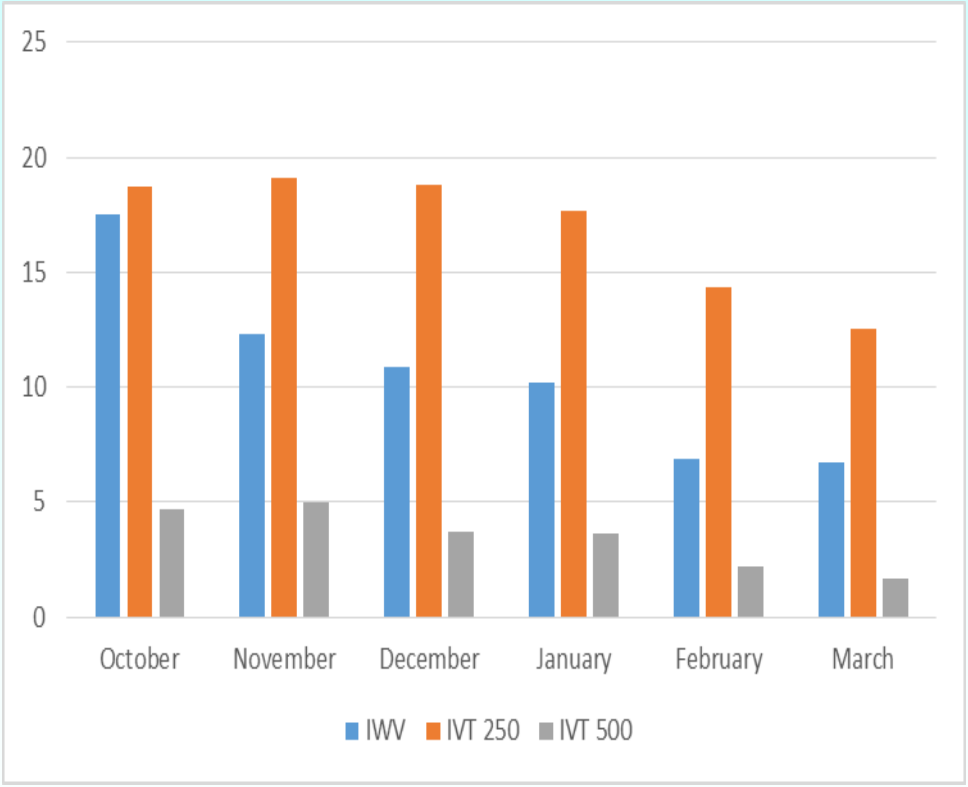
Running since last November



http://www.esrl.noaa.gov/psd/psd2/coastal/satres/data/html/ardt_gfs.php

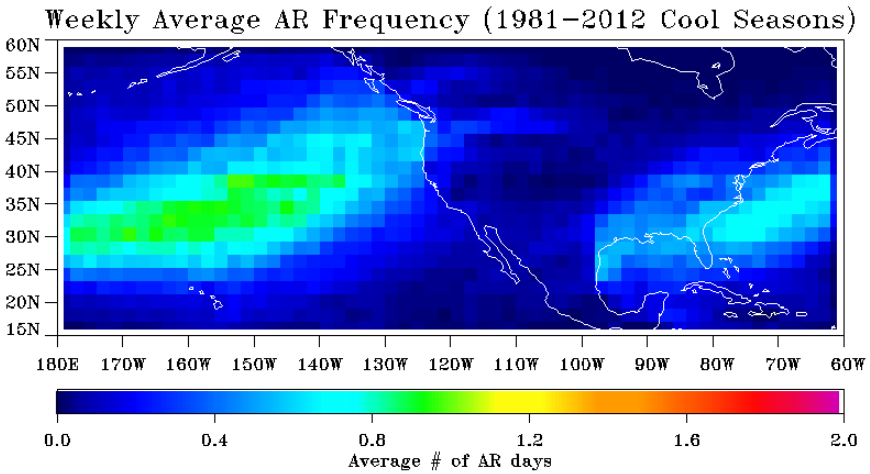
Comparison of Frequency of Detected ARs

- Applied to 31 cool seasons from CFSR
  - 1981-2 through 2011-2
  - 00 and 12 Z analyses
- Compared thresholding for:
  - IWV > 2 cm
  - IVT > 250 units
  - IVT > 500 units
- Compared average monthly counts of ARs making landfall
- Landfall considers US West Coast and into BC

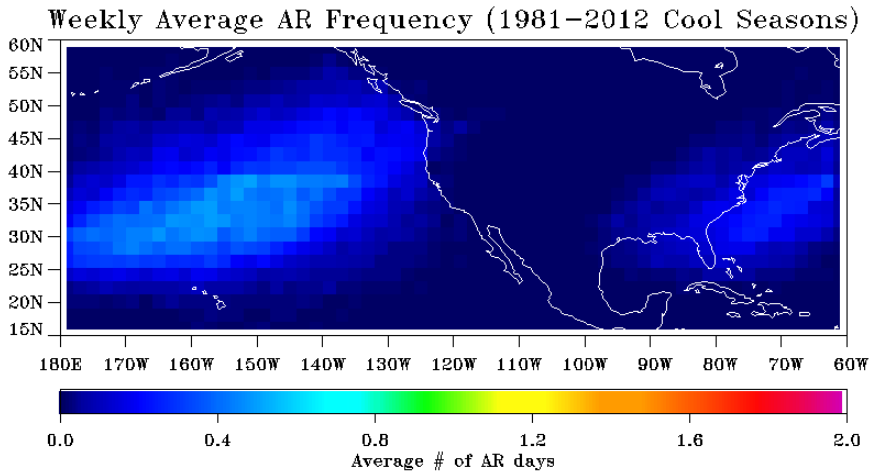


Spatial Comparison of Detected ARs

IVT > 250

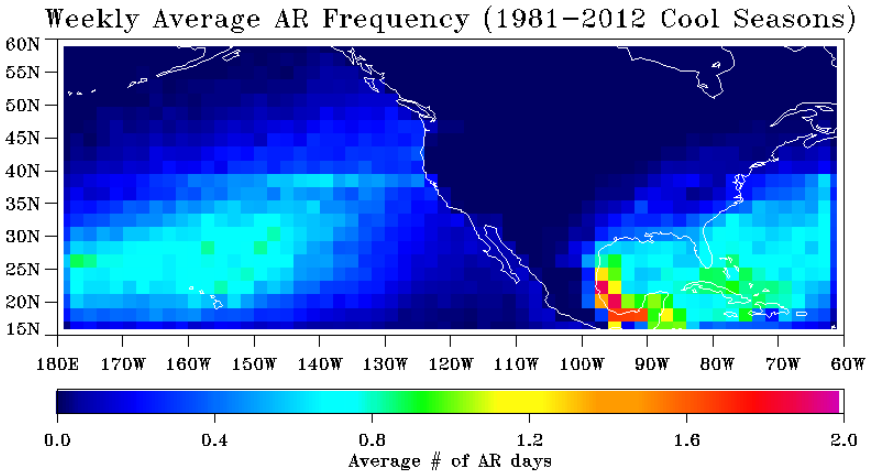


IVT > 500



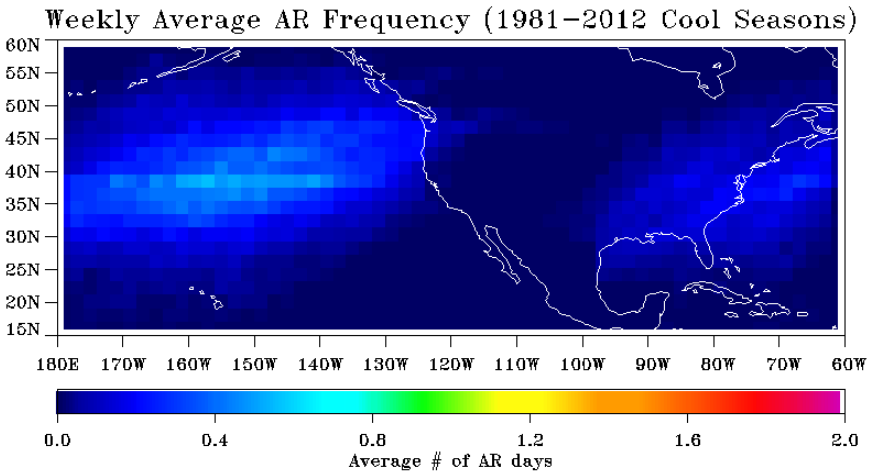
January results shown

IWV > 2 cm

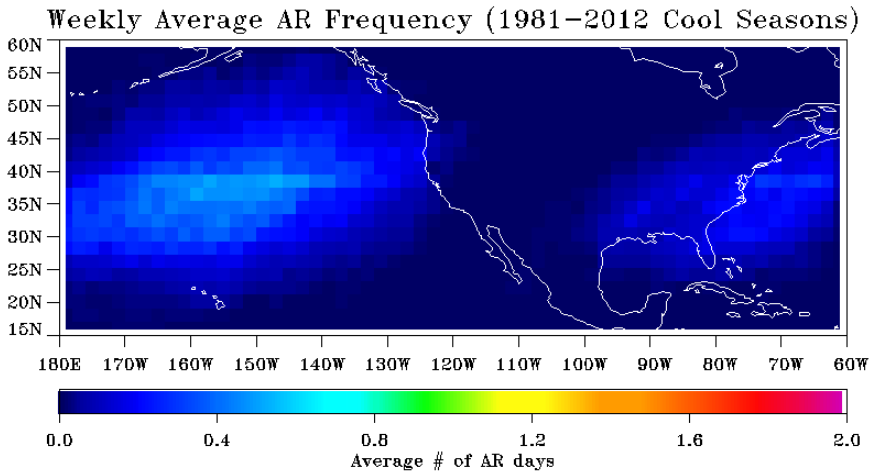


Monthly Variation – IVT > 500

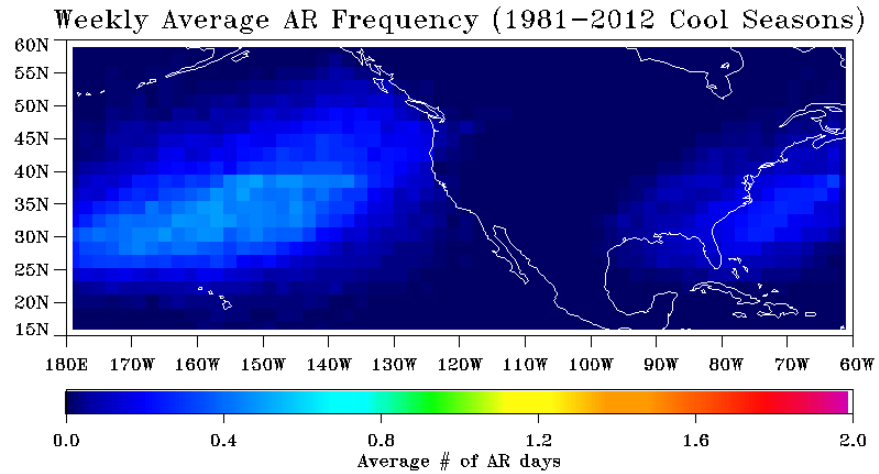
November



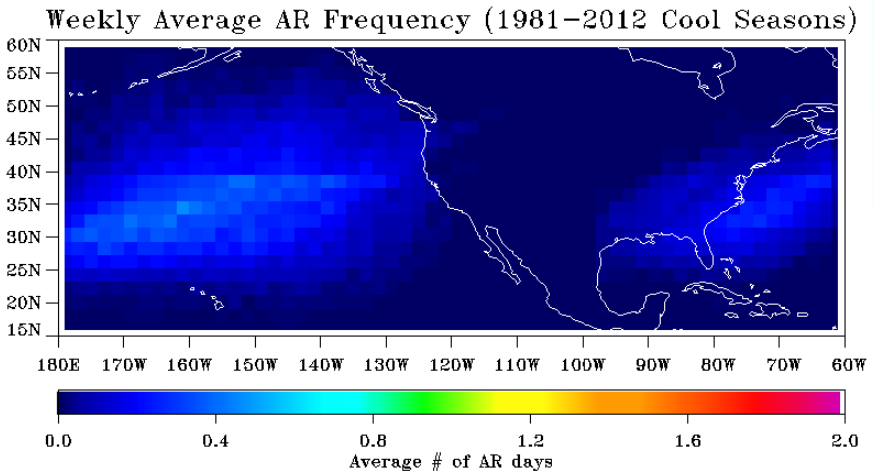
December



January



February



Summary

- Automated Atmospheric River Detection Tool (ARDT) available for parallel application to both IWV and IVT fields
- Reliability demonstrated relative to visual analysis
- Successful applications to forecast evaluations
- Potential utility for documenting impact of identification criteria on resulting climatologies