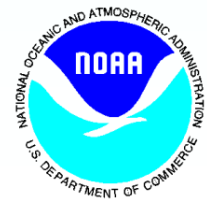


# Recent Updates to Objective Atmospheric Detection Techniques and Resulting Implications for Atmospheric River Climatologies

Gary Wick  
NOAA ESRL PSD

With help from: P. Neiman, M. Ralph, D. Jackson,  
D. Reynolds, M. Dettinger



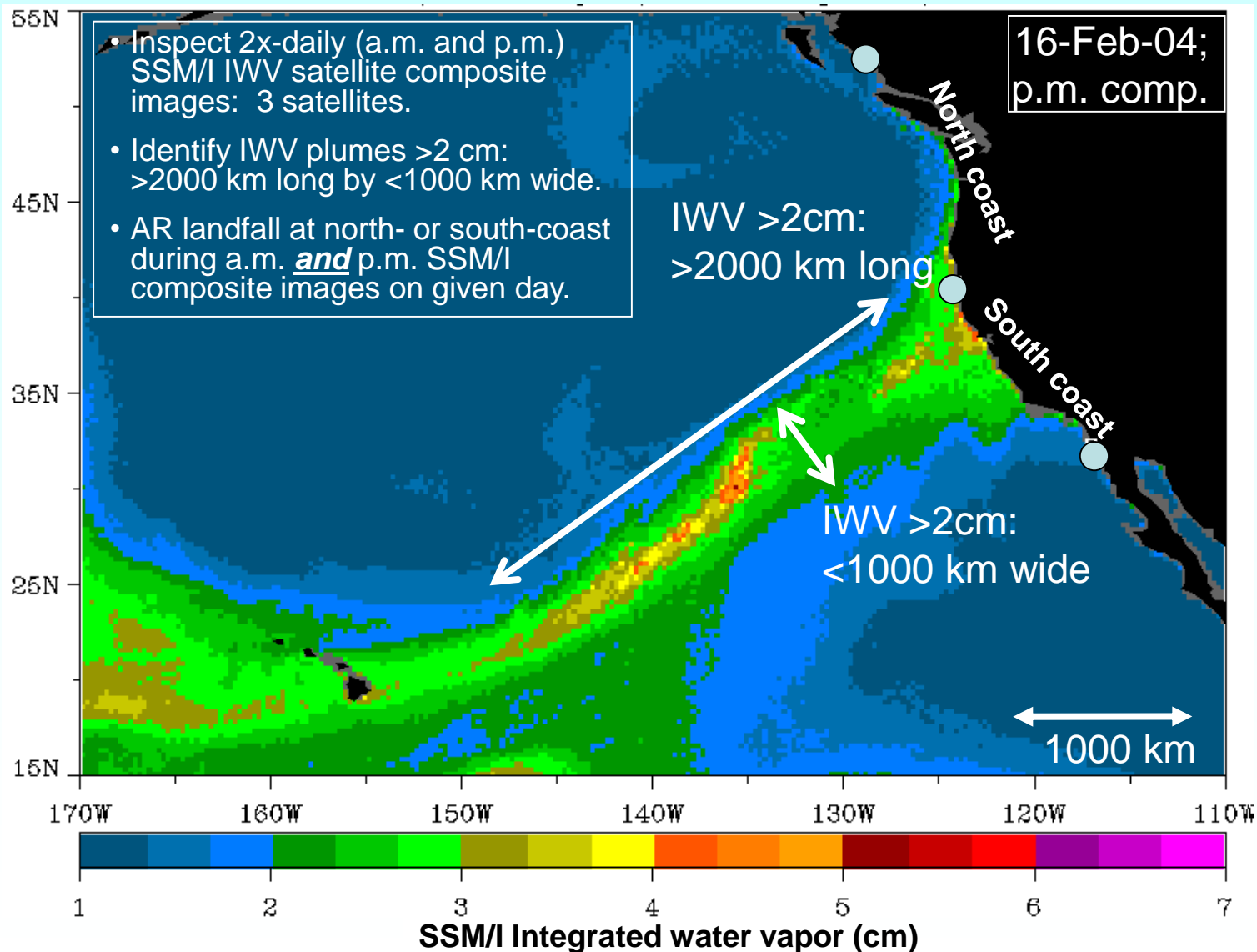
# Outline

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- 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

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- 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

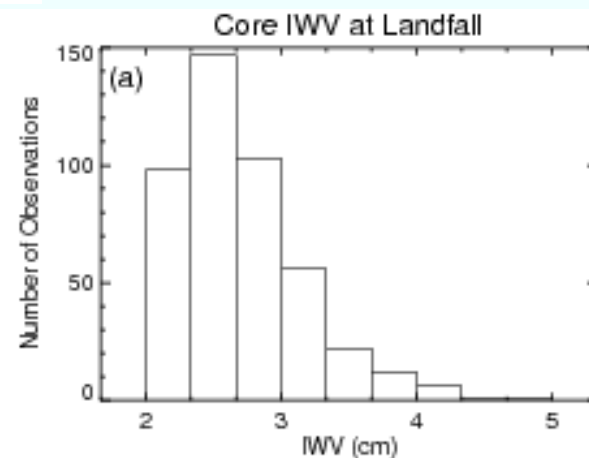
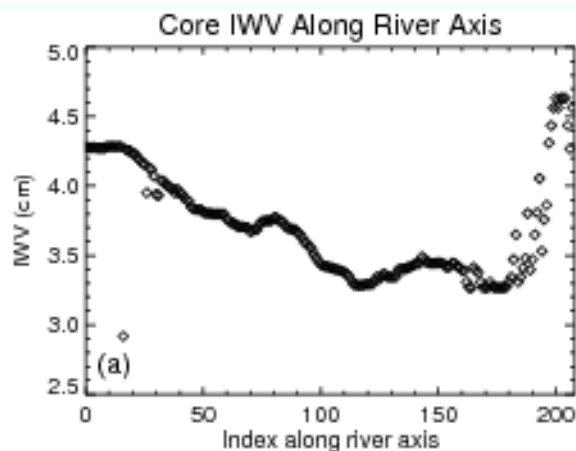
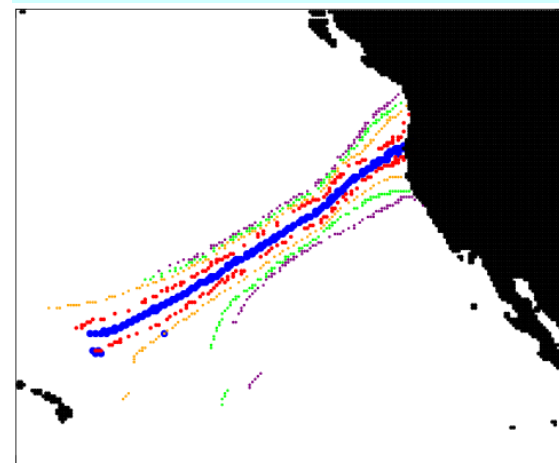
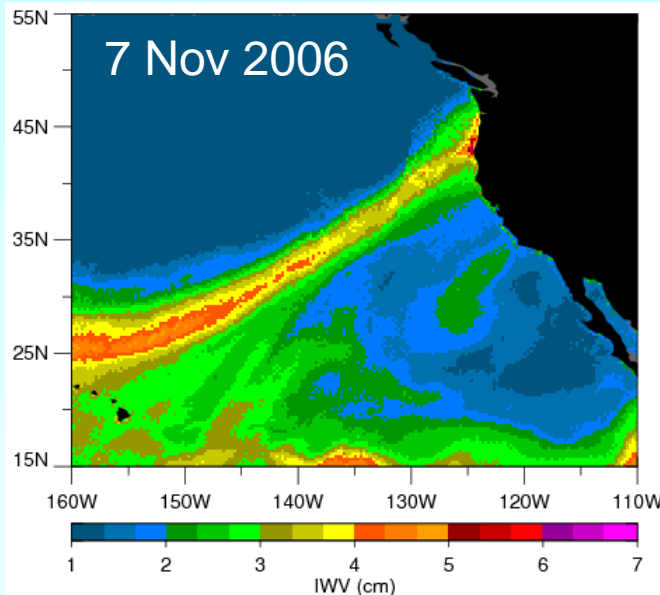
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- Thresholding and connectivity
  - Absolute and percentile thresholds
  - Lavers et al. 2012
  - Rutz et al. 2014
- Additional geometric constraints
  - Regional IWV: Wick et al. 2013
  - Regional IVT: Wick et al. 2014
  - Global IVT: Guan and Waliser 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

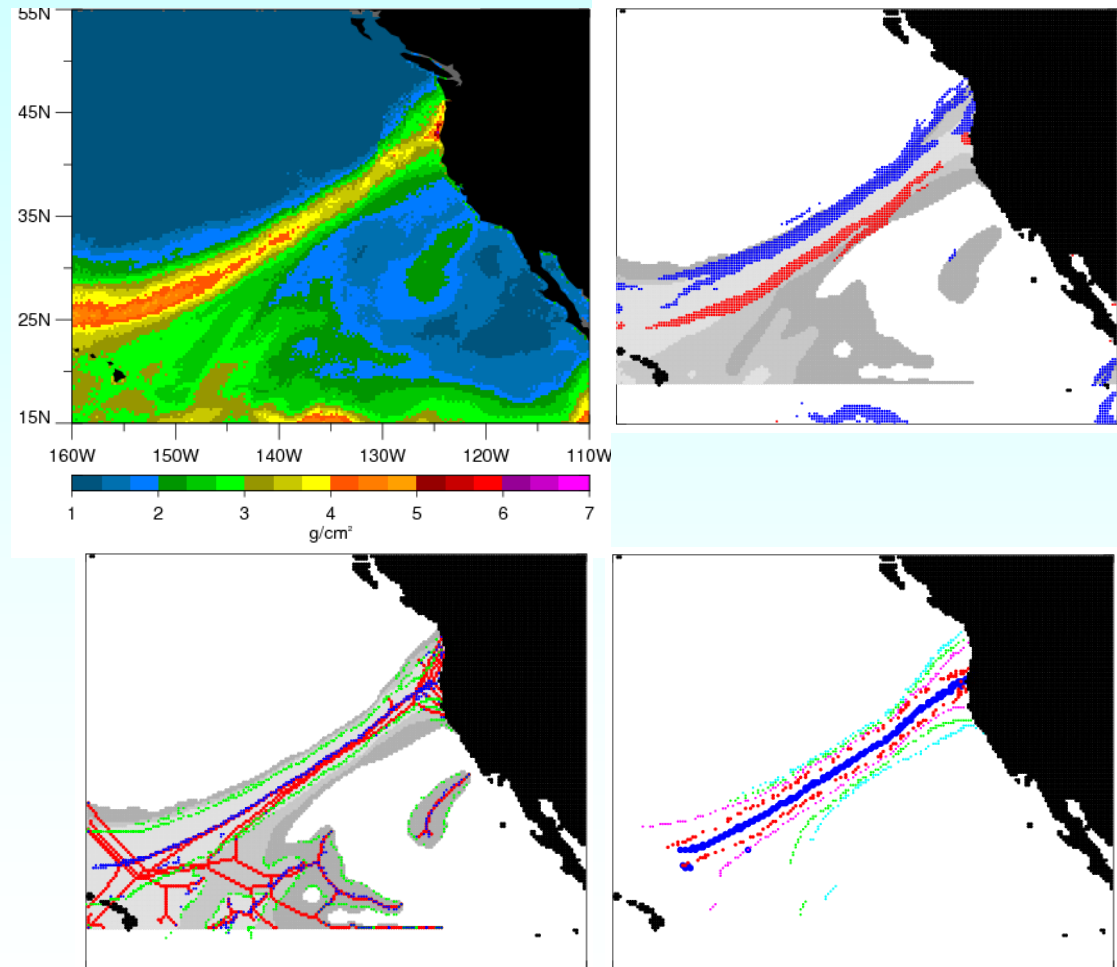
Extracted IWV along axis of above AR. Index runs SW-NE

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

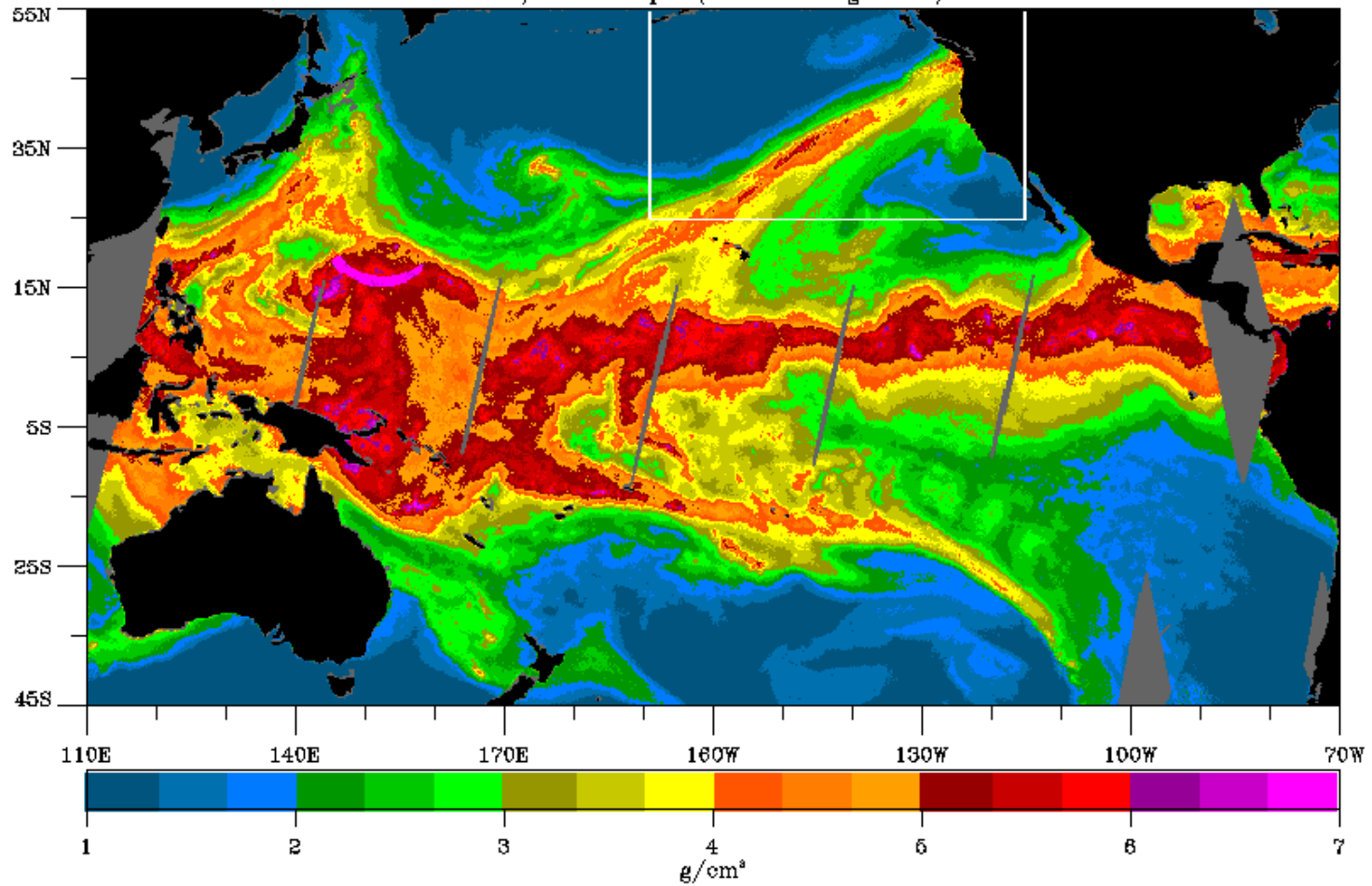


Example from November 7, 2006

# Atmospheric River?

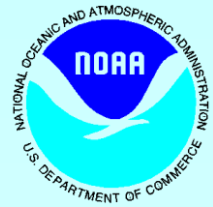


November 06, 2006 Descending Passes  
SSM/I Water Vapor (Schlüssel algorithm)

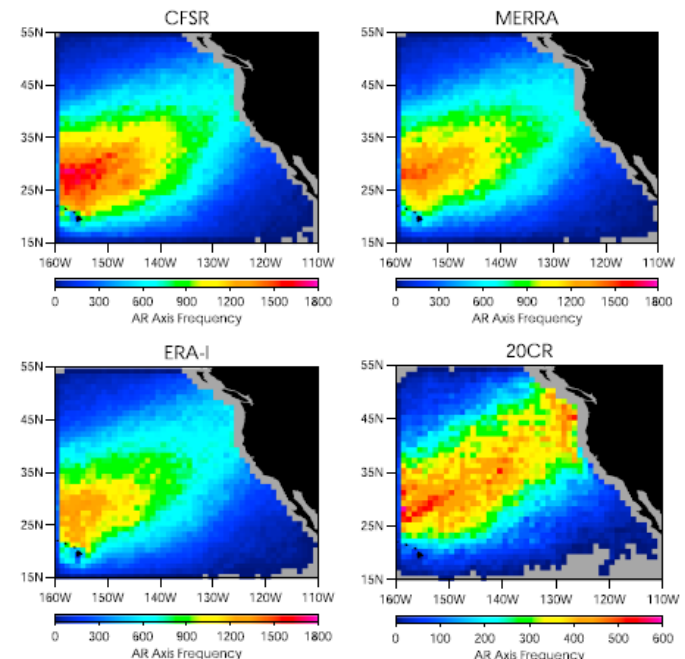
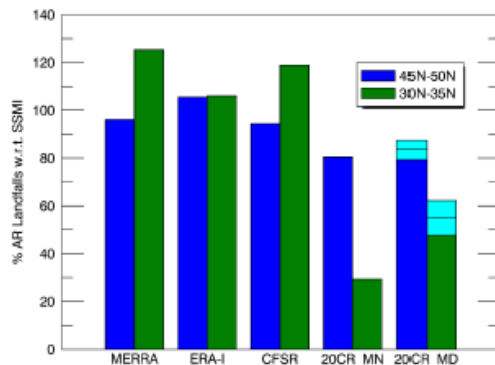
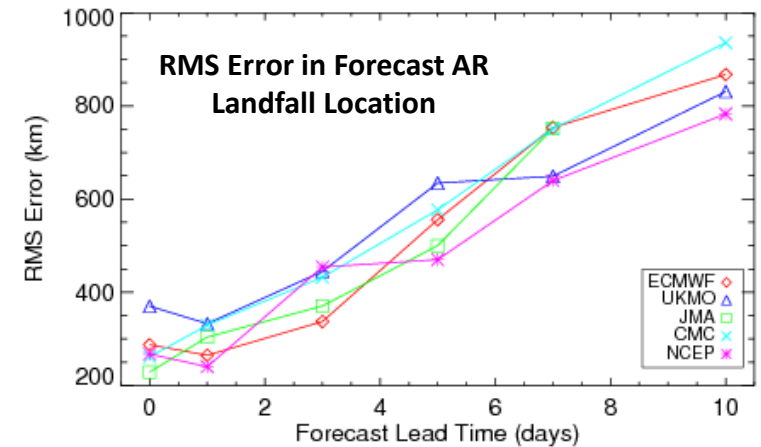




# Application to Model Verification



- 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

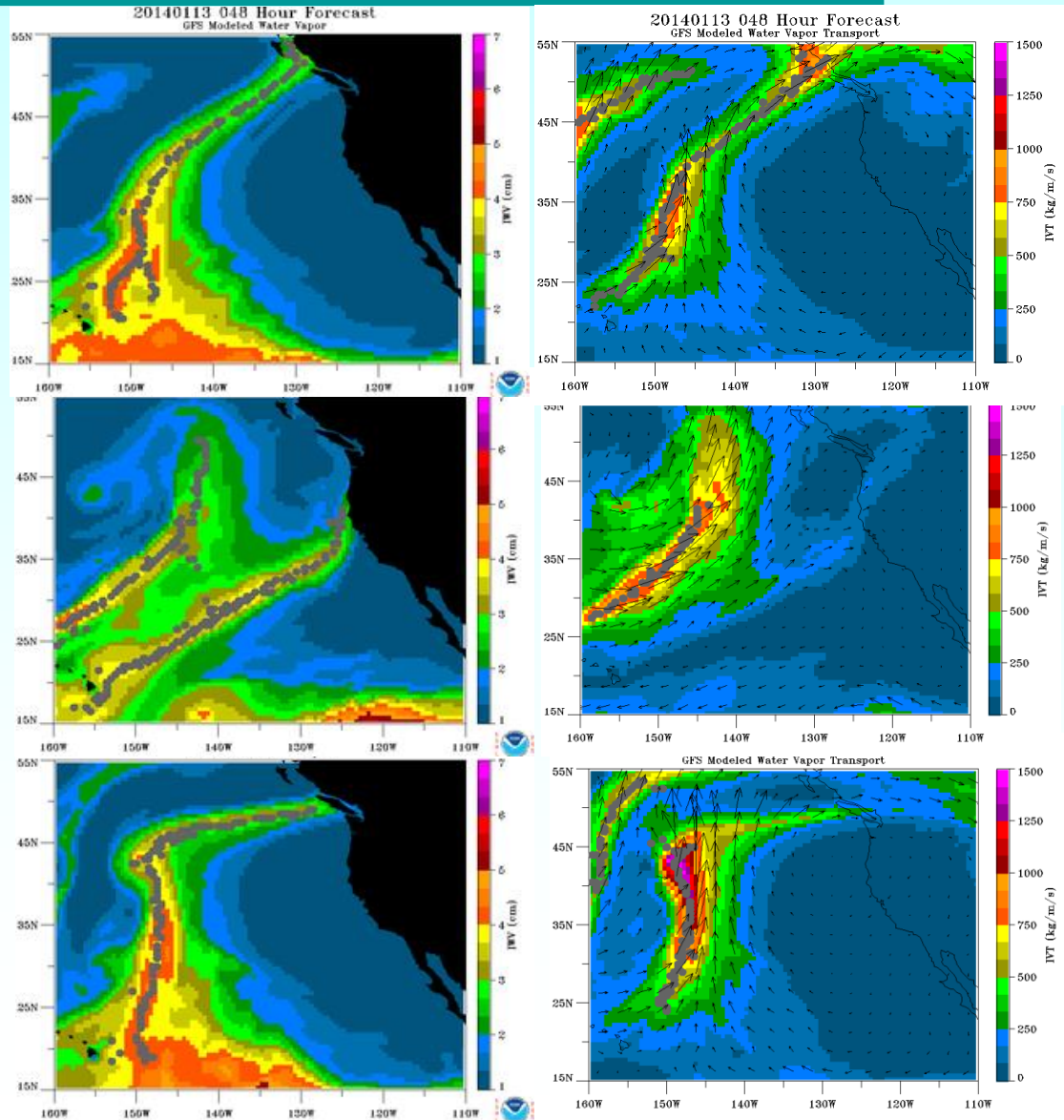


## Conceptually easier due to “anomalous” nature of features

- 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

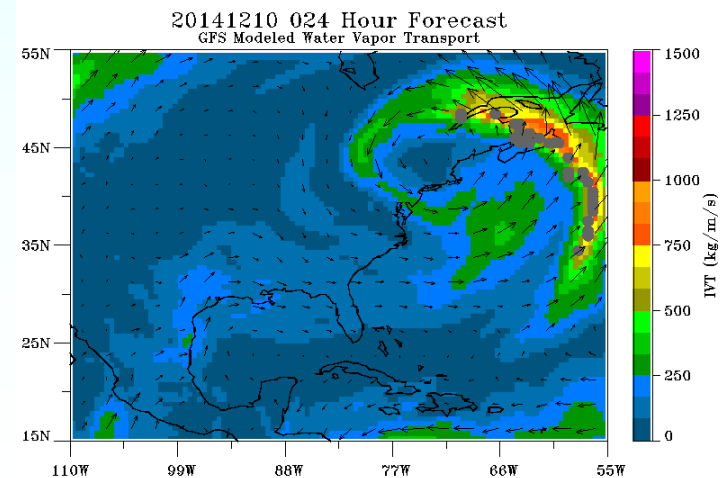
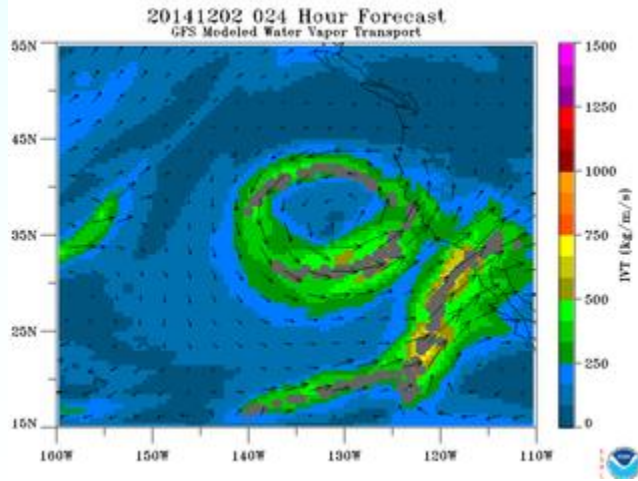
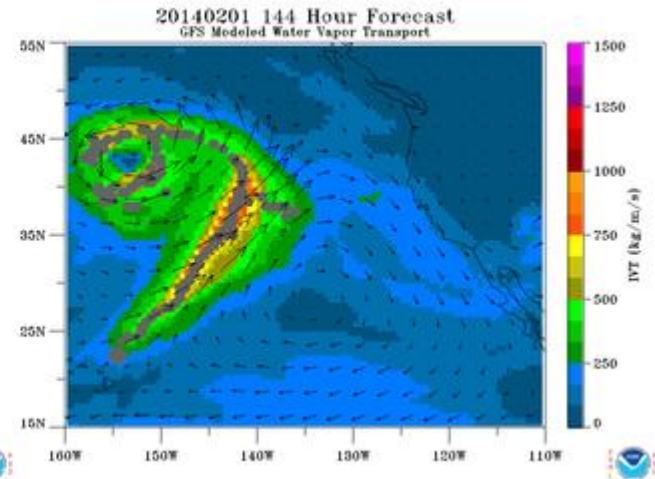
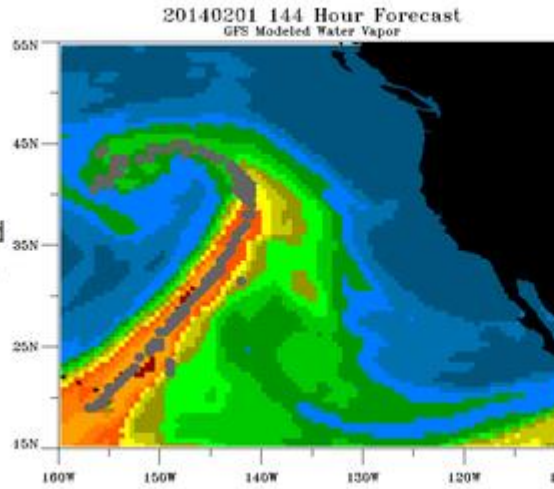
# Comparison of Results

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



# Potential Issues

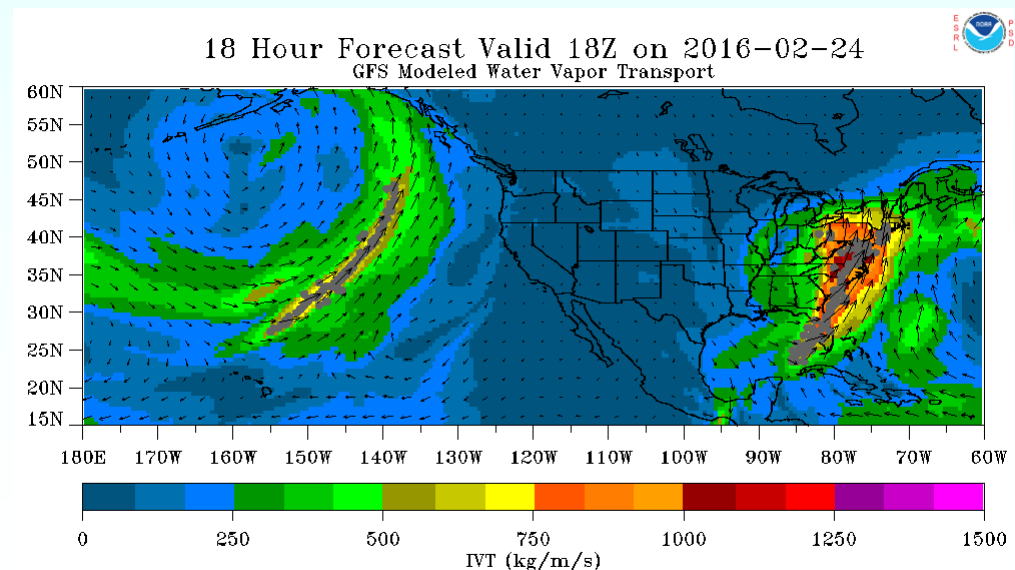
6-Day Forecast Valid  
12 Z on 2014-02-07



# 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



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### ARDT-IVT for GFS Forecast Evaluation

#### Results for Day-1 Forecast Period

[Back to Analysis through Day-1 Period](#)  
[Forward to Day-2 Period](#)  
[Return to Main GFS ARDT Page](#)

Forecast Initialized February 24, 2016 at 00 Z

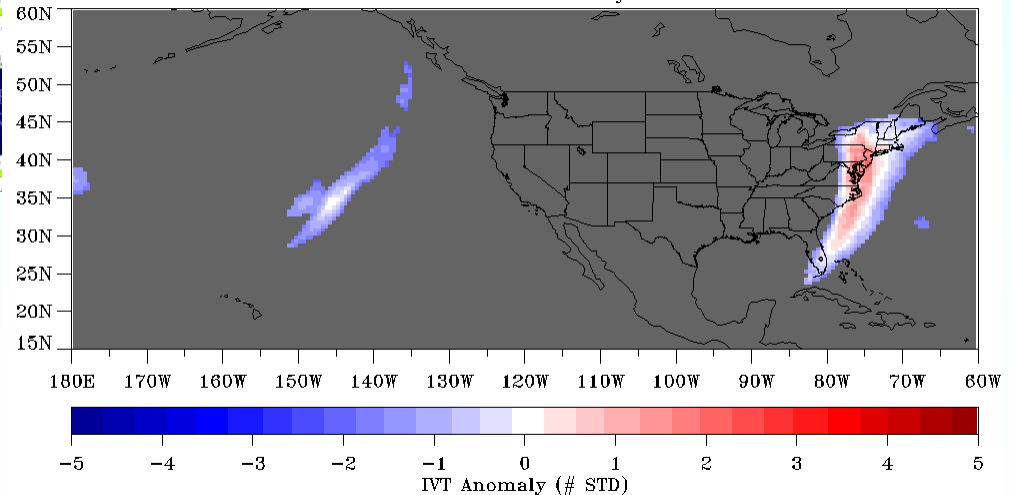
#### AR Analysis of Forecast Period

[View Animation of Composite Images at All Forecast Times](#)

Valid Time	IVT with Identified ARs	IVT Anomaly	Forecast AR Persistence (Consecutive)	Forecast AR Persistence (Recent Count)
24-Hour Forecast Valid 0 Z on 2016-02-25				
30-Hour Forecast Valid 6 Z on 2016-02-25				

Running since last November

24 Hour Forecast Valid 00Z on 2016-02-25  
GFS IVT AR Anomaly



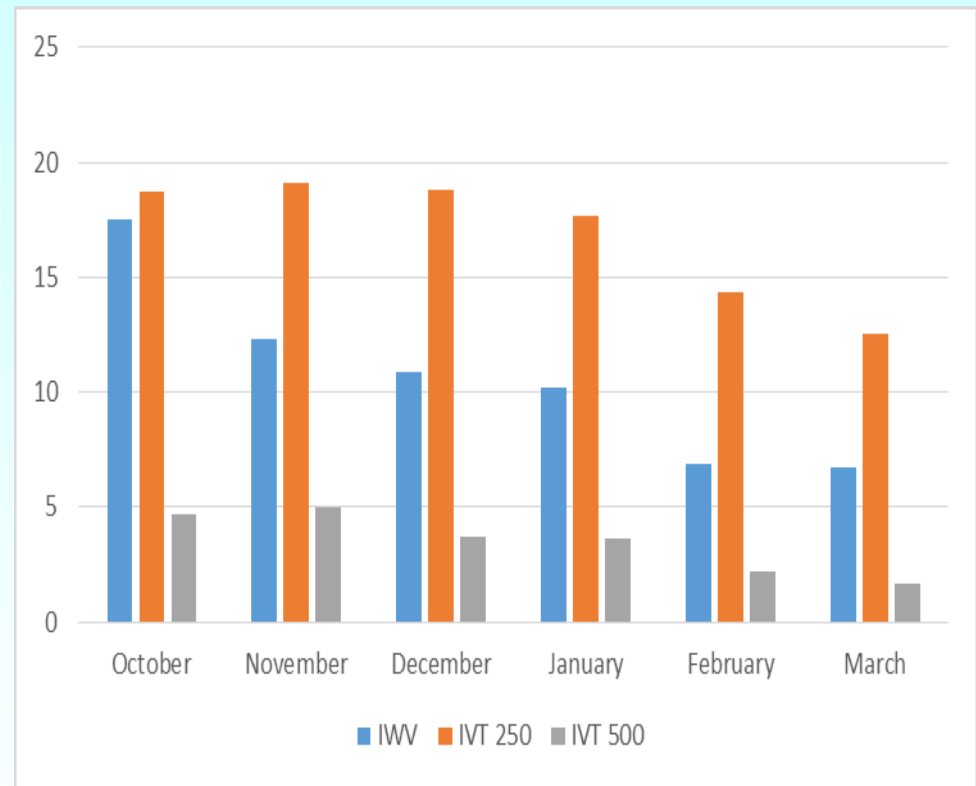
[http://www.esrl.noaa.gov/psd/psd2/coastal/satres/data/html/ardt\\_gfs.php](http://www.esrl.noaa.gov/psd/psd2/coastal/satres/data/html/ardt_gfs.php)



# 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

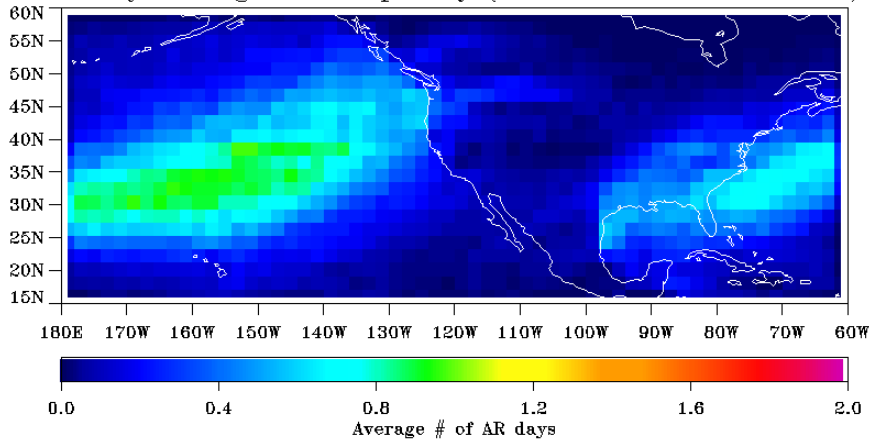


# Spatial Comparison of Detected ARs



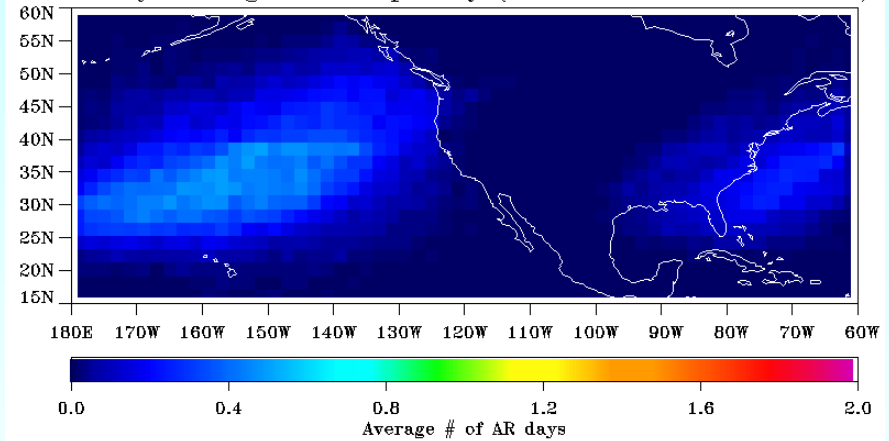
## IVT > 250

Weekly Average AR Frequency (1981–2012 Cool Seasons)



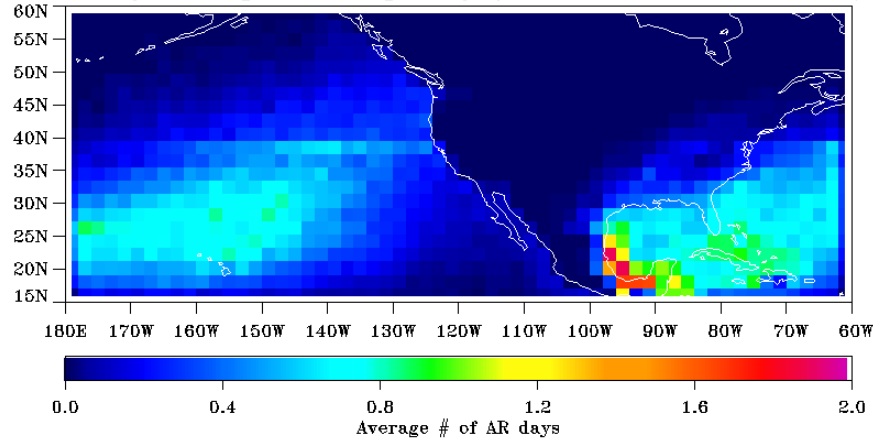
## IVT > 500

Weekly Average AR Frequency (1981–2012 Cool Seasons)



## IWV > 2 cm

Weekly Average AR Frequency (1981–2012 Cool Seasons)



January results shown

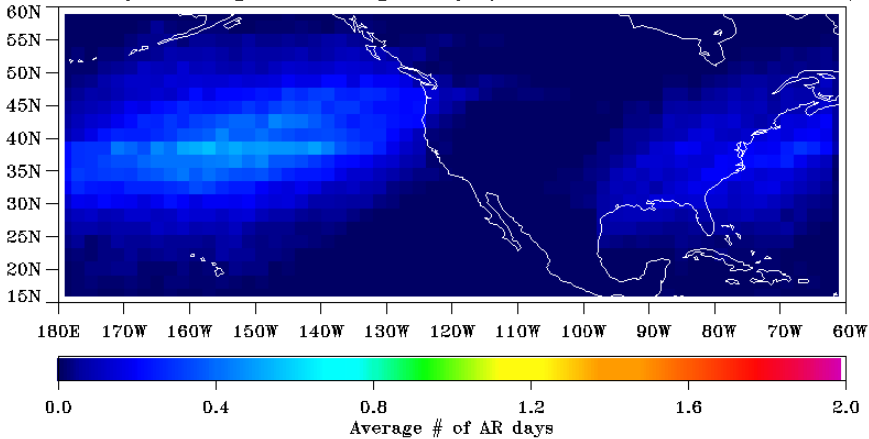


# Monthly Variation – IVT > 500



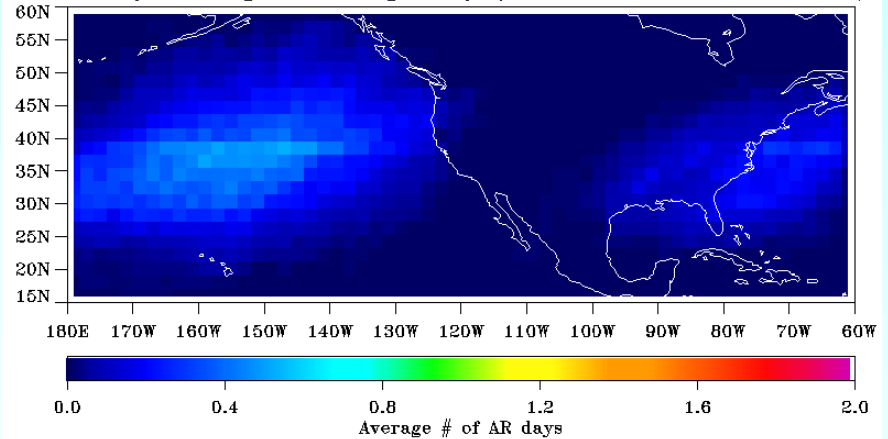
## November

Weekly Average AR Frequency (1981–2012 Cool Seasons)



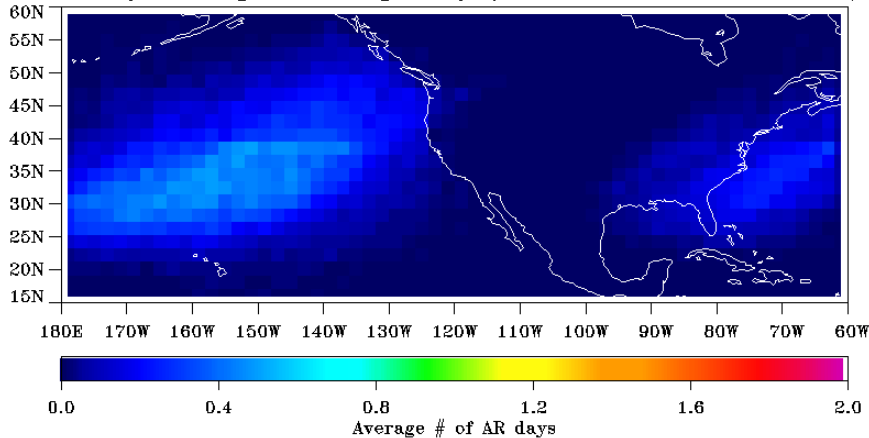
## December

Weekly Average AR Frequency (1981–2012 Cool Seasons)



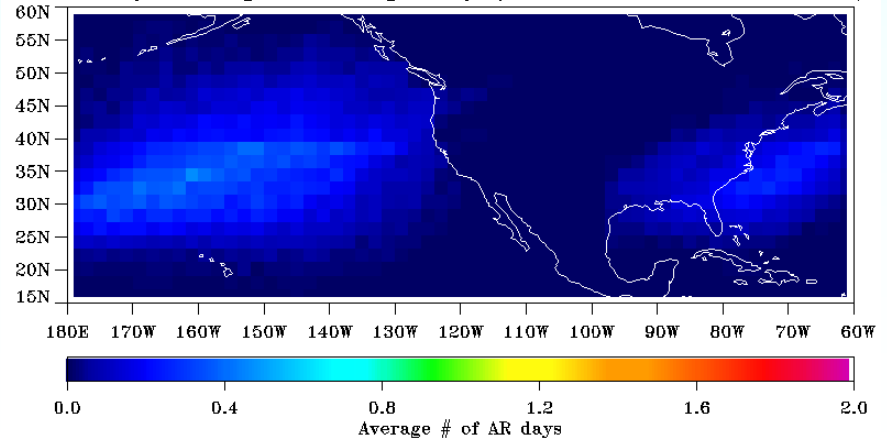
## January

Weekly Average AR Frequency (1981–2012 Cool Seasons)



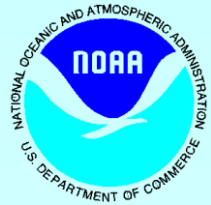
## February

Weekly Average AR Frequency (1981–2012 Cool Seasons)



# Summary

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- 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