Atmospheric River Tracking Method Intercomparison Project (ARTMIP): Experimental Design, Goals, and Current Status

Christine A. Shields (NCAR) (*co-chair*)
Jonathan Rutz (*co-chair*)
Ruby Leung, Michael Wehner, and Mary Ralph (*committee*)

Plus, many, many others….

Outline

- ❑ What is ARTMIP?
- ❑ ARTMIP Science Goals
- ❑ Example Metrics
- ❑ Some Results
- ❑ Where are we now?
- ❑ Take aways …

Atmospheric River Tracking Method Intercomparison Project (ARTMIP): Project Goals and Experimental Design

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ARTMIP Participants

ARTMIP Participants

Name	Role	Institution
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Christine Shields	*Co-Chair*	NCAR
Michael Wehner	*Committee*	LBNL
Ruby Leung	*Committee*	PNNL
Marty Ralph	*Committee*	UCSD / Scripps
Elizabeth Barnes	Participant	CSU
Swen Brands	Participant	Meteogalicia
Allison Collow	Participant	NASA GSFC MERRA-2 Team
Alexander Gershunov	Participant	UCSD / Scripps
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Hyemi Kim	Participant	Stony Brook University
Harinarayan Krishnan	Participant	LBNL
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Phu Nguyen	Participant	UC Irvine
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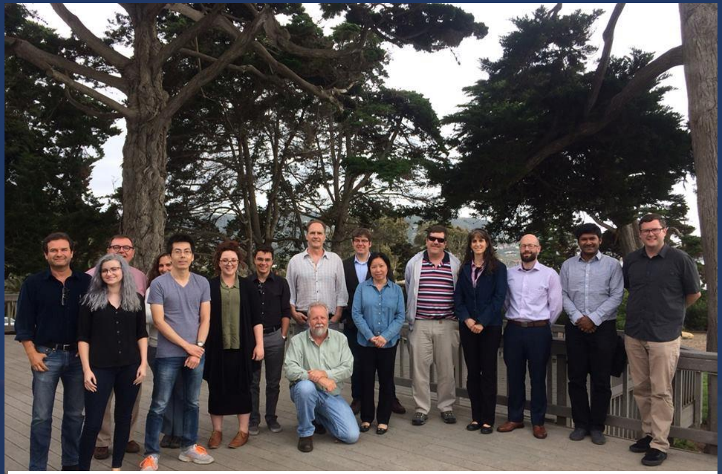
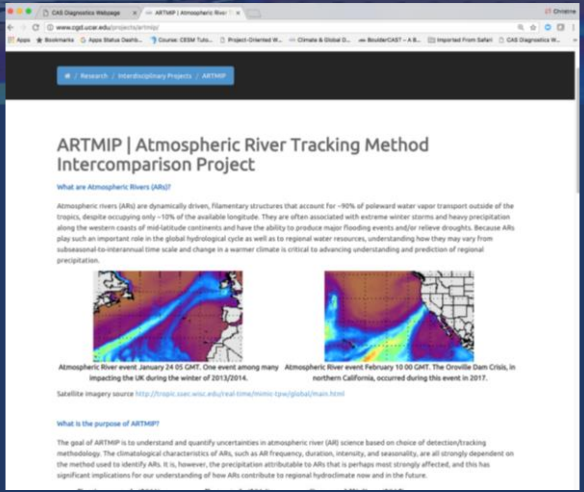
Aneesh Subramanian	Participant	UCSD / Scripps
Ricardo Tome	Participant	Univ. Lisbon
Paul Ullrich	Participant	UC Davis
Maximiliano Viale	Participant	Univ. Chile
Duane Waliser	Participant	JPL
Daniel Walton	Participant	UCLA
Gary Wick	Participant	NOAA
Anna Wilson	Participant	UCSD / Scripps
Yang Zhou	Participant	Stony Brook University



1st ARTMIP Workshop, May 2017

2nd ARTMIP Workshop, April 2018



/ Research / Interdisciplinary Projects / ARTMIP

ARTMIP | Atmospheric River Tracking Method Intercomparison Project

What are Atmospheric Rivers (ARs)?

Atmospheric rivers (ARs) are dynamically driven, filamentary structures that account for ~90% of poleward water vapor transport outside of the tropics, despite occupying only ~10% of the available longitude. They are often associated with extreme winter storms and heavy precipitation along the western coasts of mid-latitude continents and have the ability to produce major flooding events and/or relieve droughts. Because ARs play such an important role in the global hydrological cycle as well as to regional water resources, understanding how they may vary from subseasonal-to-interannual time scale and change in a warmer climate is critical to advancing understanding and prediction of regional precipitation.

Atmospheric River event January 24 05 GMT. One event among many impacting the UK during the winter of 2013/2014.

Atmospheric River event February 10 00 GMT. The Oroville Dam Crisis, in northern California, occurred during this event in 2017.

Satellite imagery source http://tropic.ssec.wisc.edu/real-time/mimic-tpw/global/main.html

What is the purpose of ARTMIP?

The goal of ARTMIP is to understand and quantify uncertainties in atmospheric river (AR) science based on choice of detection/tracking methodology. The climatological characteristics of ARs, such as AR frequency, duration, intensity, and seasonality, are all strongly dependent on the method used to identify ARs. It is, however, the precipitation attributable to ARs that is perhaps most strongly affected, and this has significant implications for our understanding of how ARs contribute to regional hydroclimate now and in the future.

What is ARTMIP?

The goal of ARTMIP is to understand and quantify uncertainties in atmospheric river (AR) science based on choice of detection/tracking methodology.

http://www.cgd.ucar.edu/projects/artmip/

Tier 1

Participants run their algorithms on a common dataset and adhere to a common format.

Data set: MERRA v2 Reanalysis
Time period for study: January 1980 - June 2017

What is ARTMIP?

The goal of ARTMIP is to understand and quantify uncertainties in atmospheric river (AR) science based on choice of detection/tracking methodology.

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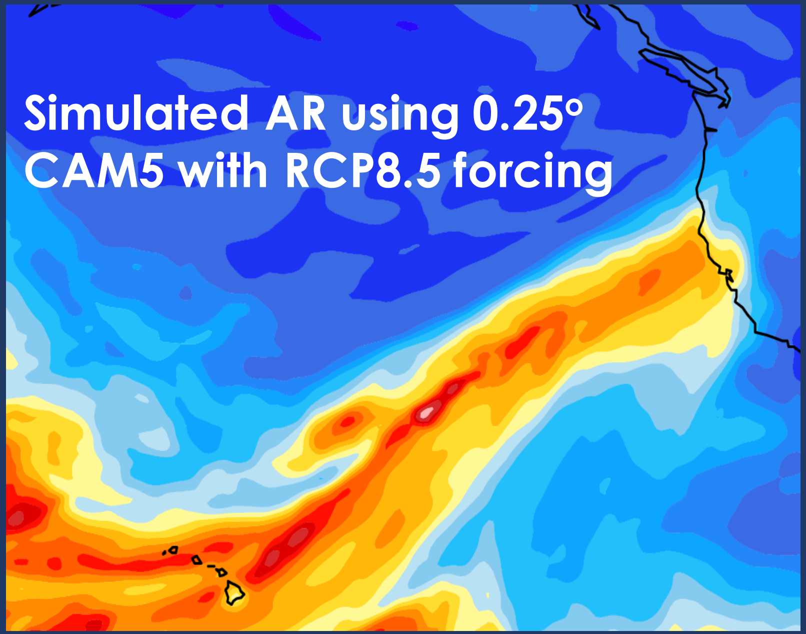
Tier 2

Run algorithms for (any or all):

- Cross-reanalysis sensitivity studies
- Climate (modern and future) C20C+ (CAM5 High-res courtesy of LBNL)
- CMIP5 data



Datasets for precipitation comparisons for Tier 1 and Tier 2 will be regional specific and include TRMM, PERSIANN, GPCP, Livenh, or E-OBS.

What is ARTMIP?

Diverse algorithmic choices

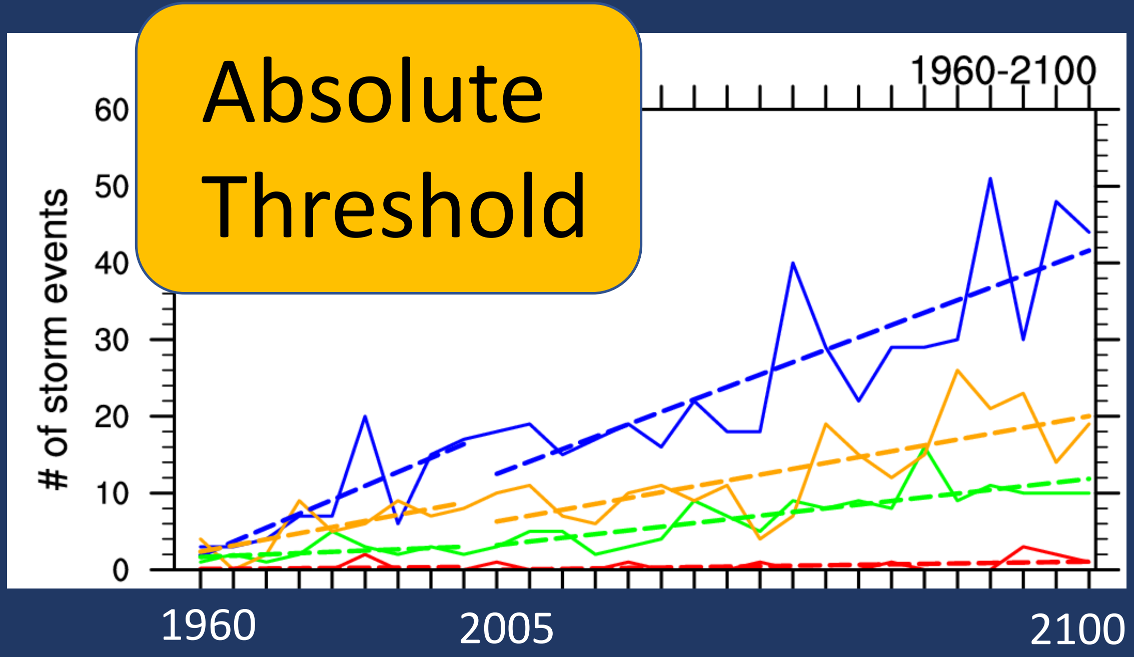
Parameter Type →

Parameters Choices ↓

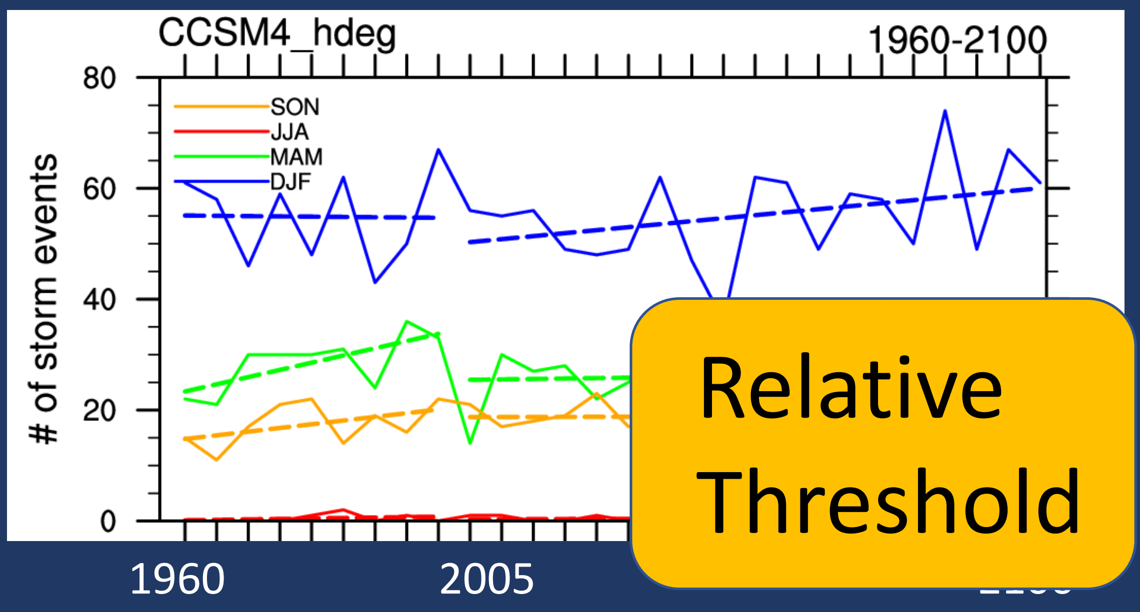
Computation Type	Geometry Requirements	Threshold Requirements	Temporal Requirements	Regions (Examples)
Condition If conditions are met, then AR exists for each time instance at each grid point. This counts time slices at a specific grid point.	Length	Absolute Value is explicitly defined.	Time slice Consecutive time slices can be counted to compute AR duration, but it is not required to identify an AR.	Global
Tracking Lagrangian approach: if conditions are met, AR object is defined and followed across time and space.	Width	Relative Value is computed based on anomaly or statistic.	Time stitching Coherent AR object is followed through time as a part of the algorithm.	North Pacific Landfalling
	Shape	No thresholds (object only)		North Atlantic Landfalling
	Axis or Orientation			Southeast U.S.
				South America
				Polar

Science Goals

- How robust are AR metrics such as climatology, storm duration, and relationship to extreme precipitation?
- What are the uncertainties in AR science based on detection algorithm alone? Can these uncertainties be bound? What are the implications of these uncertainties?
- How are AR metrics in future climate projections impacted by choice of algorithm?
- Can we provide guidance to the scientific community on what algorithms are most appropriate for specific science questions and/or region of interest?
- What types of process level and impact studies can be informed by a diverse set of catalogues?



CA Coast



Science Goals

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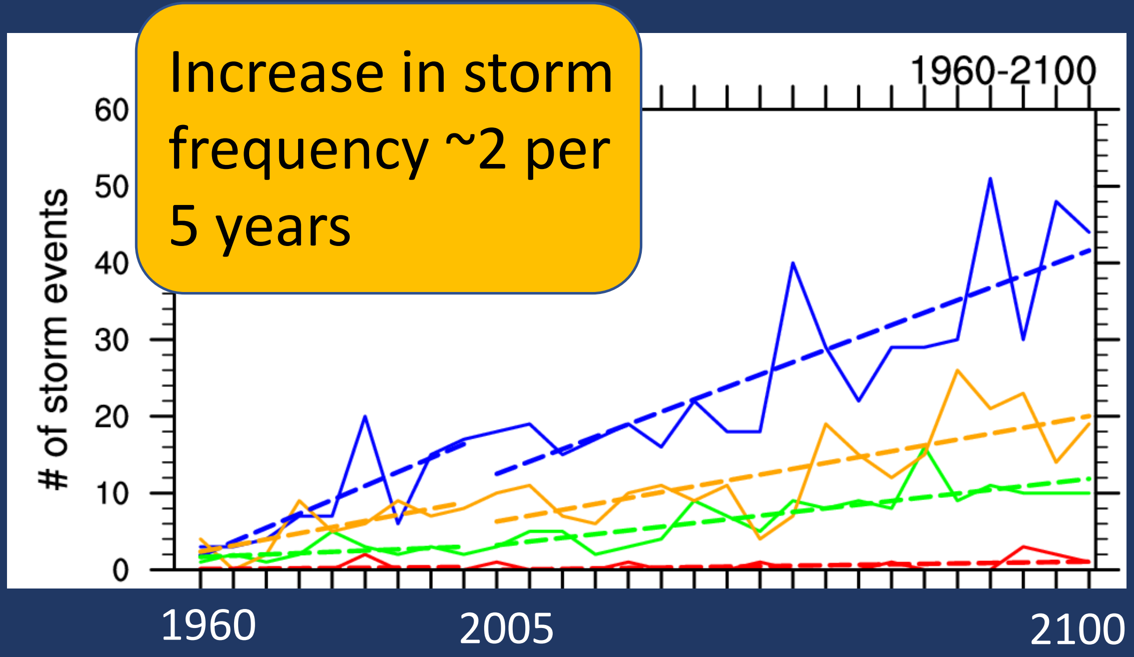
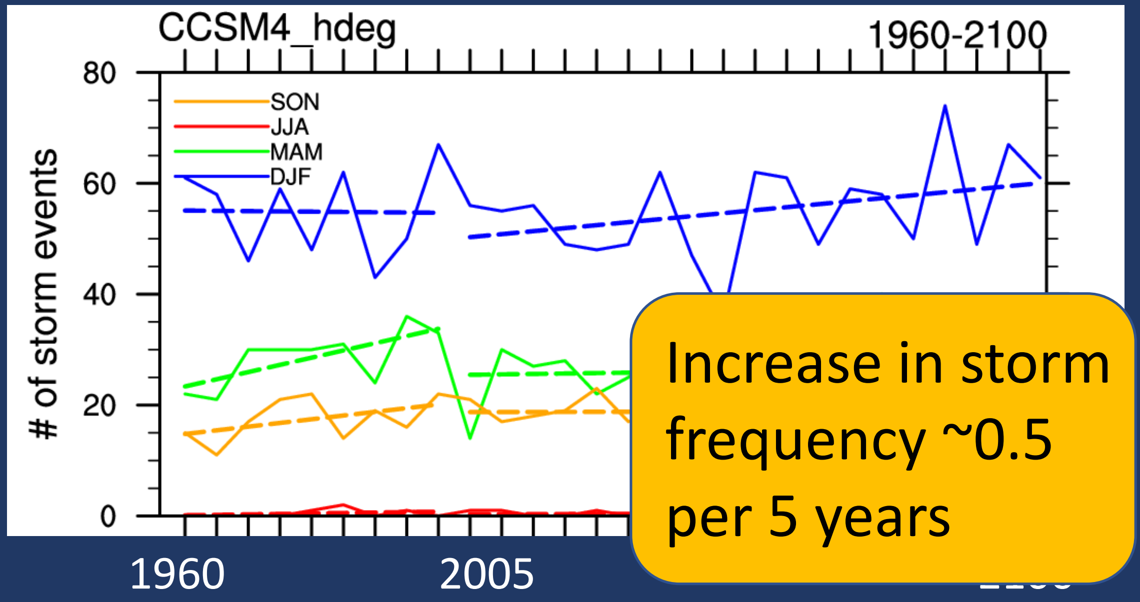


CA Coast

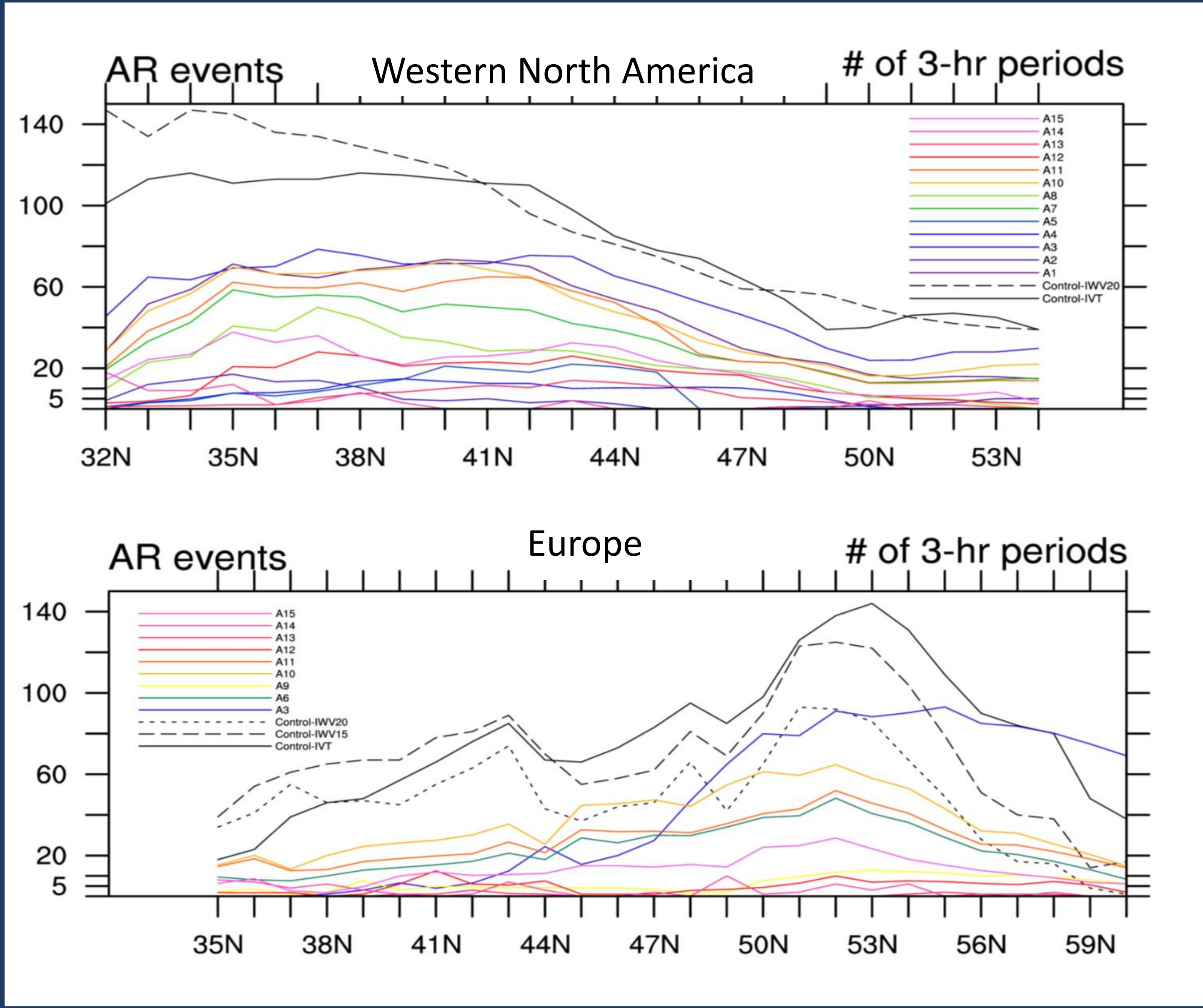


Example Metrics

- ❑Frequency
- ❑Intensity
- ❑Storm Duration
- ❑Relationship to Precipitation

Some Results…

- February 2017 :High number of ARs impacting the U.S. West Coast
- Colors = different AR detection methods
- Black lines = "Human" controls, i.e. visual inspection
- Controls do NOT equal truth (subjective), but included in comparisons as another "detection" method.

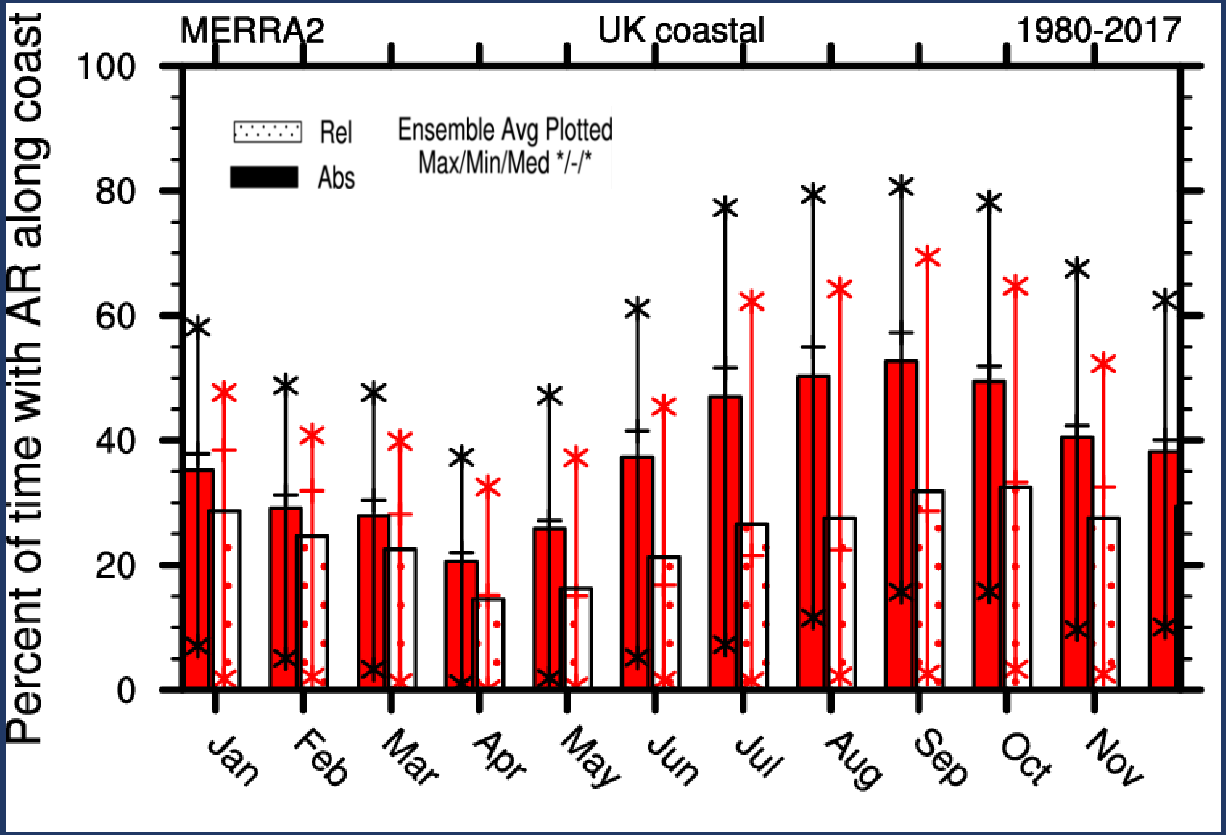


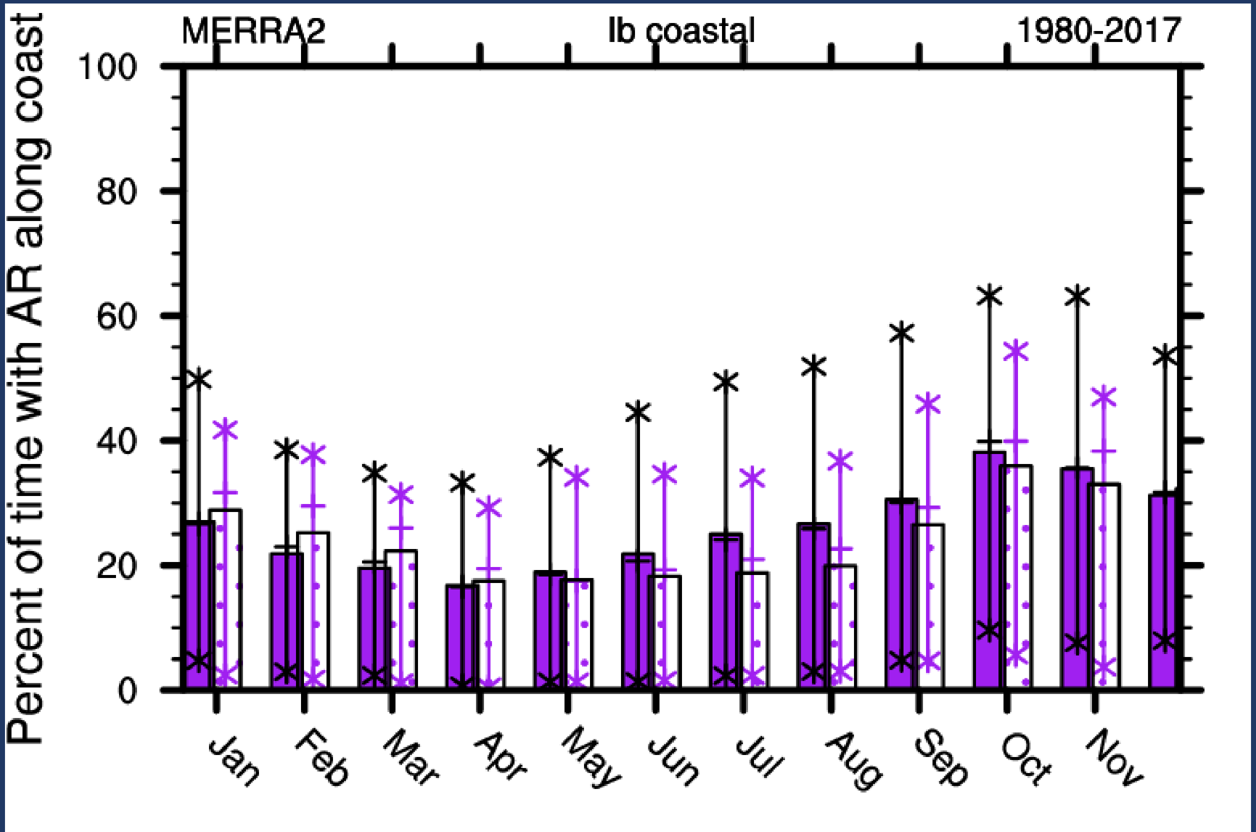
Some Results… classification

# of methods for each type	8/10/1	3/16	14/5	4/15	7/12	6/13	5/14
Method	**Abs/Rel**	**Axis/No**	**Length/No**	**Object/No**	**Stich/Slice**	**Track/Condition**	**Width/No**
Brands	relative	no	length	no	slice	condition	nowidth
CONNECT500	absolute	no	no	object	stitch	track	nowidth
CONNECT700	absolute	no	no	object	stitch	track	nowidth
Gershunov	absolute	no	length	no	stitch	track	nowidth
Goldenson	absolute	no	length	object	slice	condition	width
Guan_Waliser	relative	axis	length	no	slice	condition	width
Lavers	relative	no	length	no	slice	condition	nowidth
Lora_global	relative	no	length	no	slice	condition	nowidth
Lora_NPac	relative	no	length	no	slice	condition	nowidth
Mundhenk	relative	axis	length	no	slice	condition	width
Payne	relative	no	length	no	stitch	condition	nowidth
PNNl1_hagos	absolute	no	length	no	slice	condition	width
PNNl2_lq	absolute	no	no	no	slice	track	nowidth
Ramos	relative	no	length	no	stitch	condition	nowidth
Rutz	absolute	no	length	no	slice	condition	nowidth
Shields	relative	axis	length	no	slice	condition	width
TDA_ML	nothresh	no	no	object	slice	condition	nowidth
Tempest	absolute	no	no	no	stitch	track	no
Walton	relative	no	length	no	stitch	track	nowidth

Some Results… Absolute vs Relative

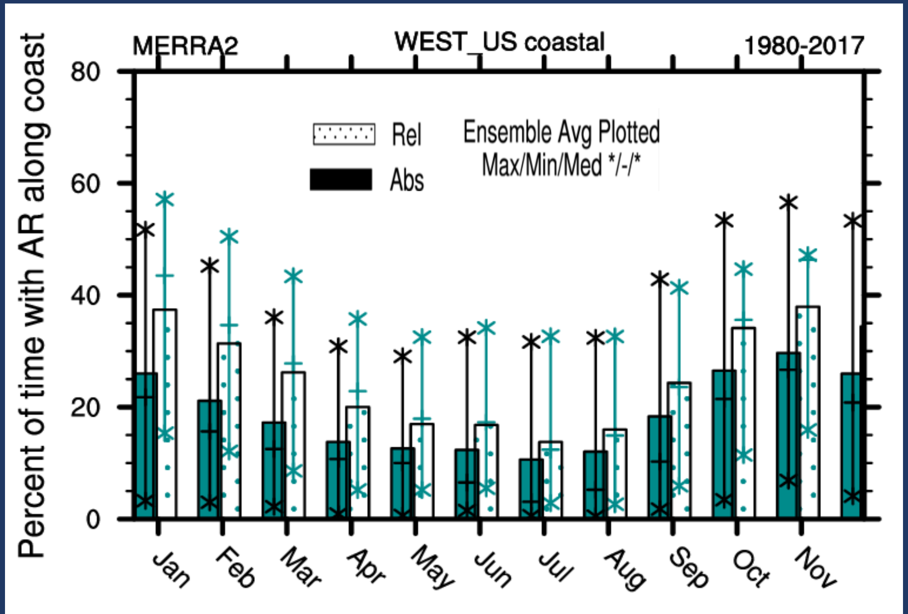
North Atlantic ARs





Absolute methods in North Atlantic detect more ARs along the coast than relative methods.

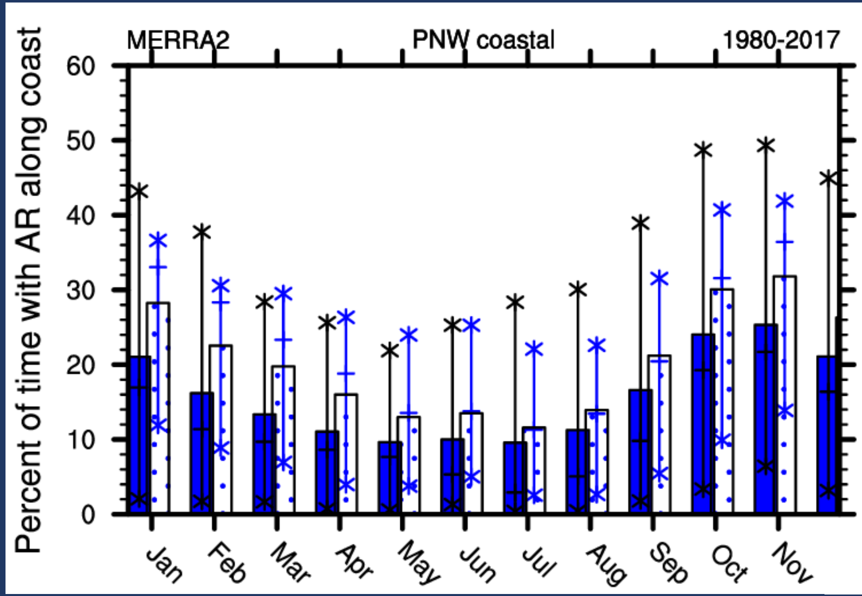
Some Results… Absolute vs Relative

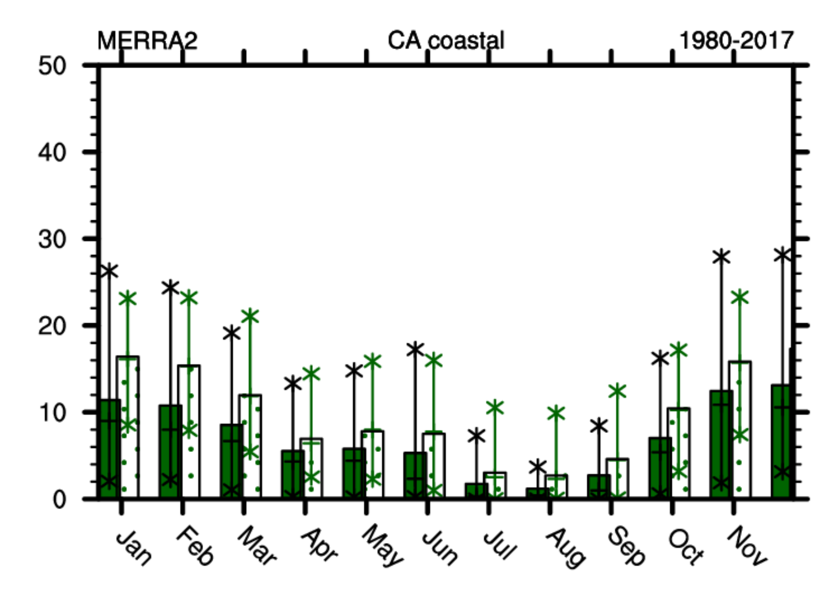


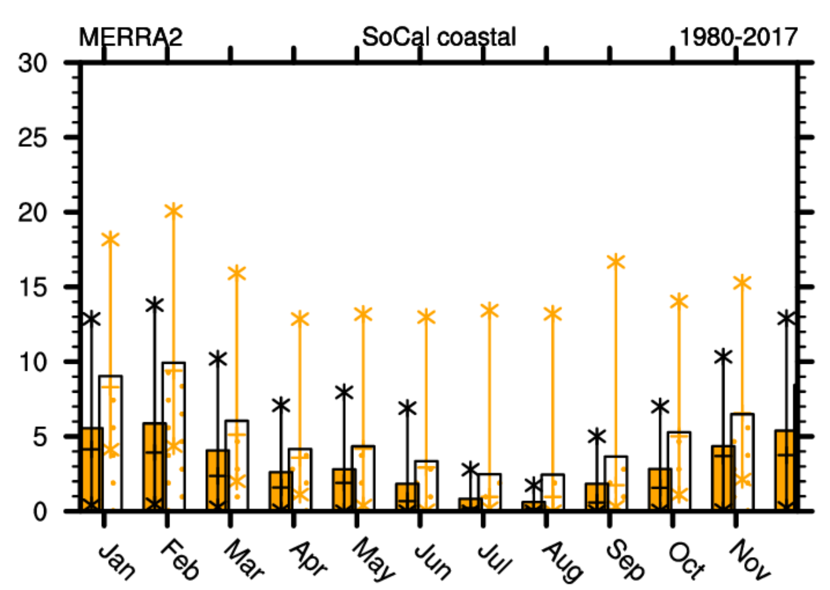
Northeast Pacific ARs

The reverse happens for the Northeast Pacific ARs. Relative methods detect more ARs along the coast than absolute methods.

Potentially explained by climatology? Absolute methods may detect more ARs closer to the mean storm track where the climatological IVT is higher, (N. Atlantic). Relative methods may detect more ARs further from the mean storm track where the climatological IVT is lower (N. Pacific).





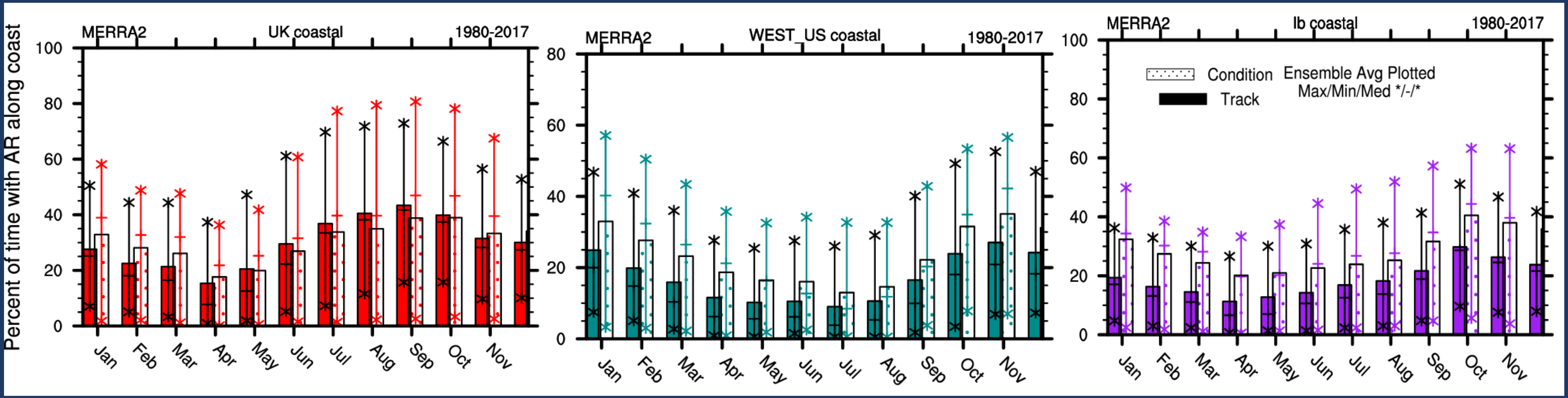


Some Results… Track vs Condition

Tracking (Lagrangian-styled object following) methods tend to detect less ARs compared to condition methods along the coast for Iberian Peninsula and U.S. West Coast.

For UK ARs these relationship does not hold for summer and fall ARs.

Jet related? Subtropical versus eddy-driven?



Where are we now?

Tier 2 Climate Change, both high resolution CAM5 AMIP runs and CMIP5 data are available for participants/catalogues! *(Thanks to M. Wehner)*

ARTMIP Timeline

Completed targets are in bold.

Target Date	Activity
May 2017	**1st ARTMIP Workshop**
August/September 2017	**1-Month Proof of Concept Test**
November 20 2017	**Full Tier 1 Catalogues Due**
January 2018	**Last Call Tier 1 Catalogues (to be included in Tier 1 results paper)**
April 23-24, 2018	**2nd ARTMIP Workshop**
Spring 2018	**Tier 2 High Resolution Climate Catalogues Begin**
Spring/Summer/Fall 2018	Continue Tier 1 Analysis and Scientific Papers
Fall/Winter 2018	Tier 2 High Resolution Climate Catalogues due, Overview paper
Winter 2018/2019	Tier 2 CMIP5/6 Catalogues Begin
Summer 2019	Tier 2 CMIP5/6 Catalogues due, Overview paper
Winter 2019/2020	Tier 2 Reanalysis Catalogues and Analysis

- ❑ Jon Rutz is leading Tier 1 Overview paper
- ❑ Ashley Payne leading High Resolution Climate Change Overview

Take aways….

- Available Now: Tier 1 ARTMIP Catalogues and source dataset (MERRA-2).
- Experimental Design paper (includes February 2017 comparison results) is now published in GMD (Shields et al, 2018).
- Tier 1 overview paper in progress, Jon Rutz leading. See next presentation for more results and analysis!
- Tier 2 in progress: Ashley Payne leading method comparison on high-resolution-climate-change-model-data. Michael Wehner and Travis O’Brien are leading comparison using CMIP5 model data.
- Other planned Tier 2 activities: Reanalysis comparison and CMIP6 model data.
- Other Tier 1 and Tier 2 analysis projects lead by various ARTMIP participants are beginning…
- Interest in ARTMIP? Contact C. Shields or J. Rutz