The Atmospheric River Tracking Method Intercomparison Project (ARTMIP): Quantifying the Uncertainties in Atmospheric River Climatology and Impacts

Jon Rutz – June 26th, 2018
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ARTMIP Committee, ARTMIP Participants
### Why ARTMIP?

Atmospheric river (AR) science has taken off in recent years. Dozens of AR identification and tracking methods are in use by researchers and documented in peer-reviewed journals.

### Parameter Types

<table>
<thead>
<tr>
<th>Computation Type</th>
<th>Geometry Requirements</th>
<th>Threshold Requirements</th>
<th>Temporal Requirements</th>
<th>Regions (Examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Length</td>
<td>Absolute</td>
<td>Time slice</td>
<td>Global</td>
</tr>
<tr>
<td></td>
<td>Width</td>
<td>Relative</td>
<td>Consecutive time slices can be counted to compute AR duration, but it is not required to identify an AR.</td>
<td>North Pacific Landfalling</td>
</tr>
<tr>
<td>Tracking</td>
<td>Shape</td>
<td>Relative</td>
<td>Time stitching</td>
<td>North Atlantic Landfalling</td>
</tr>
<tr>
<td></td>
<td>Axis or Orientation</td>
<td>No thresholds (object only)</td>
<td>Coherent AR object is followed through time as a part of the algorithm.</td>
<td>Southeast U.S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>South America</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Polar</td>
</tr>
</tbody>
</table>

- **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.
- **Tracking**: Lagrangian approach: if conditions are met, AR object is defined and followed across time and space.
Why ARTMIP?

Different methods result in some methods identifying ARs at specific geographic locations and observation times, whereas other methods do not. This results in uncertainty regarding the AR climatology (e.g., frequency, duration, intensity, seasonality), and how it relates to precipitation and water supply.
Why ARTMIP?

The methods used to identify and track ARs greatly affect how precipitation is attributed to ARs. Given their role in high-impact weather and hydroclimate, it is critical to understand how AR-related contributions to precipitation will change in the future.

ARTMIP exists to quantify the uncertainty in AR climatology, the relationship between ARs and precipitation, and how these may change in the future. ARTMIP also aims to offer recommendations regarding which methods are best suited to answer which questions.
Key AR Metrics

• The ARTMIP “Tier 1” Analysis is focused on quantifying the uncertainties in a few key metrics that arise as a result of different AR identification and tracking methods…

  – AR Frequency

  – AR Duration / Method Overlap

  – AR Seasonality

  – AR Intensity / Efficiency

  – AR-Related Precipitation (not yet done)
Avg storm duration (min=12hr) at coastlines

MERRA-2 Tier

West

East

Duration normalized from 0 to 1

North/Threshold median

Rel-max

Abs-max

Rel-min

Abs-min

Rel-mean

Abs-mean

Rel-median

Abs-median
New Year’s Day Flood (Dec 29 – Jan 3 1997)

AR Method “Overlap”

Peak IVT along coastline

Duplicate placeholder
AR Method “Overlap”

Time series of IVT along coastline and hits by each algorithm

Composites of each event
# of Methods that Agree on Max Month

MERRA-2 Tier 1 (1980-2017)

West

Month of maximum frequency

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

32.0  36.0  40.0  44.0  48.0  52.0

1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17

East

MERRA-2 Tier 1 (1980-2017)

Month of maximum frequency

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

35.0  40.0  45.0  50.0  55.0  60.0

15W  10W  5W  0
Meridional (Poleward) IVT

Zonally-averaged meridional IVT within ARs

- Maximized at mid-latitudes (~30-50° N/S)
- Larger (smaller) for absolute (relative) methods
- Larger (smaller) for less (more) restrictive methods
Zonal (Eastward) IVT

Zonally-averaged zonal IVT within ARs

- Maximized at mid-latitudes (~30-50° N/S)
- Larger (smaller) for absolute (relative) methods
- Larger (smaller) for less (more) restrictive methods
Zonally-averaged spatial area of ARs

- Maximized at mid-latitudes (~30-50° N/S), but variable with method
- Larger (smaller) dependence on latitude for absolute (relative) methods
Meridional IVT “Efficiency” (vIVT / Area)

Zonally-averaged meridional IVT “efficiency” (vIVT / area) of ARs

- Maximized at high latitudes (~ >60° N/S), but variable with method
- Larger at high (low) latitudes for absolute (relative) methods
- Larger (smaller) dependence on latitude for absolute (relative) methods
Zonally-averaged meridional IVT “efficiency” (vIVT / area) of ARs

- Generally, more (less) restrictive methods are more (less) “efficient”… in other words, they don’t include lower-intensity portions of storms that contribute less to transport
Summary

Results
• When normalized from 0 to 1, most methods show good agreement on AR frequency and duration along the West Coasts of North America and Europe
• Duration or seasonality
• Methods vary widely in AR spatial footprint, zonal and meridional water vapor transport, and “efficiency” of water vapor transport
• Key metrics for absolute (relative) methods generally exhibit larger (smaller) variation as a function of latitude

To-Do List
• Analyze, compare, and contrast precipitation fractions attributable to ARs as a function of different AR identification and tracking methods
• Begin writing “Tier 1” Summary Paper
ARTMIP Information

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