Precipitation origin in atmospheric rivers from a global perspective: first steps

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Introduction

Atmospheric rivers (ARs) are filaments of enhanced moisture in the atmosphere, usually located in subtropical zones and mid-latitudes over oceanic areas. They transport huge water vapor amounts, which can eventually cause catastrophic damage when the AR makes landfall and the water vapor is forced upwards generating heavy precipitation.

One of the most studied and debated ARs properties in recent years is the origin of the moisture feeding them. Despite numerous attempts to address this issue, moisture sources in ARs have not yet been studied from a global and climatological perspective, using a validated and consistent moisture tracking methodology.

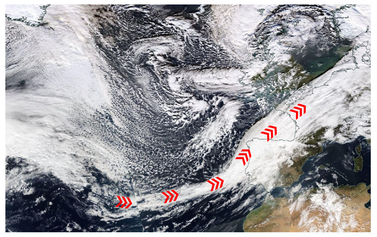


Figure 1. AR arriving at the Iberian Peninsula on 15th January 2015. Satellite image from NASA Worldview, https://worldview.earthdata.nasa.gov

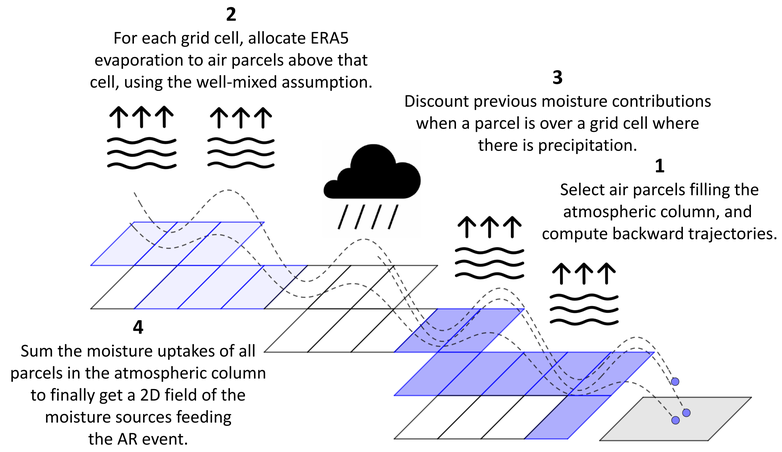
Objective

To assess moisture sources in different AR events across the globe

Methodology

In order to calculate moisture sources in ARs we use a Lagrangian methodology, based on backward tracking of individual air parcels with the **Lagrangian particle dispersion model FLEXPART** [1]. Only air parcels arriving in the area where ARs make landfall are considered. FLEXPART is forced with **data from the ERA5 reanalysis**.

Once the air parcel trajectories have been calculated, the moisture sources are attributed following the methodology used by [2] and [3]. In addition, en-route precipitation is discounted as proposed by [4]. See the diagram on the right for more details.



Conclusions

- The representation of precipitable water fields can lead to wrong conclusions when attributing moisture sources: a moisture tracking tool is needed!
- Although, the vast majority of moisture in ARs is uptaken over the ocean, we found that in some cases there may be a relevant contribution from continental sources.
- The water vapor in ARs can be supplied by tropical or extratropical moisture sources, matching the definition of AR.
- **The contribution from the tropical sources is smaller than usually assumed**.

Results

1. AR selection

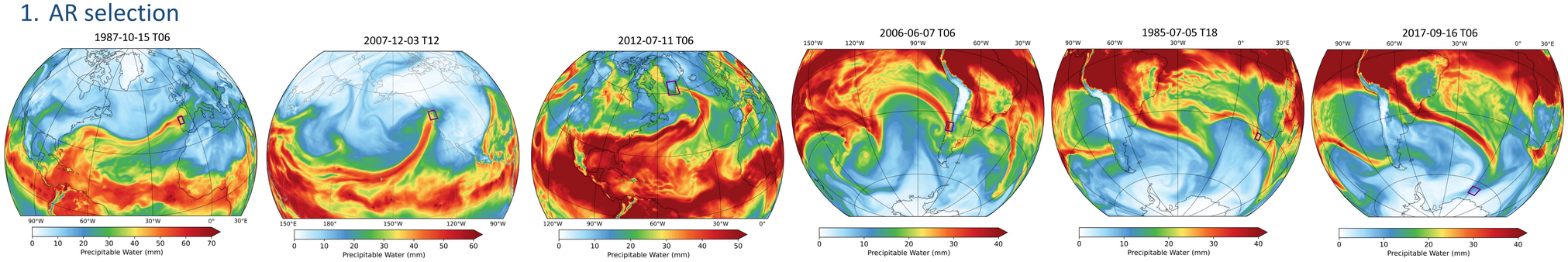


Figure 2. Precipitable water (mm) for the six studied ARs. The purple boxes represent the regions in which the different ARs make landfall, and thus where the Lagrangian parcels are released to calculate the origin of the moisture feeding them.

2. Moisture origin

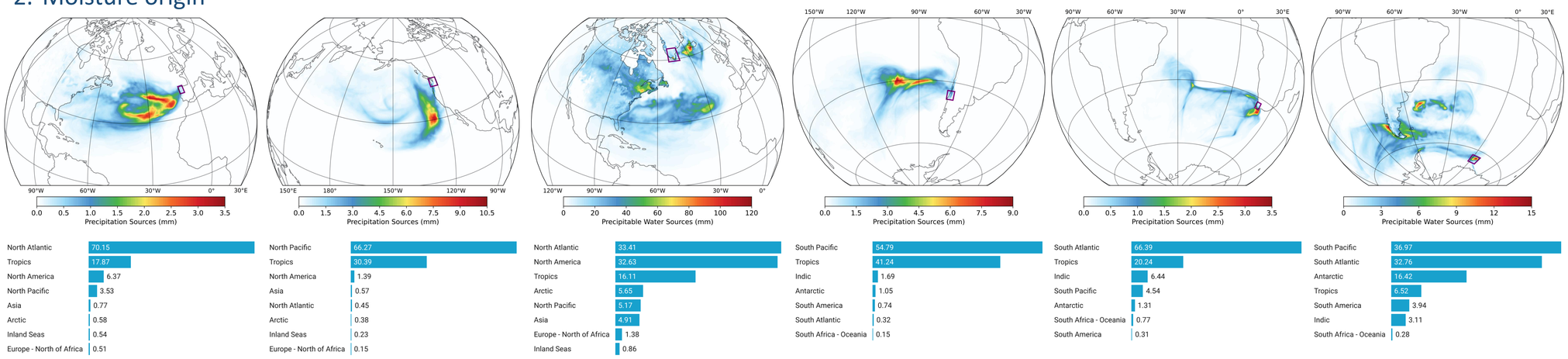


Figure 3. Moisture contribution to precipitation (mm) for the selected AR cases, together with the quantitative contributions from different sources (blue bars below). For those ARs making landfall in mid-latitudes regions we calculate the moisture sources for precipitation, while for those ARs impacting polar regions, we work with the origin of precipitable water, not precipitation.

Future work

- To relax the well-mixed assumption in the Lagrangian methodology.
- To use an Eulerian moisture tracking tool to validate the results.
- **To create a global climatology of moisture sources for ARs simulating a much larger number of cases across the globe**.

References

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