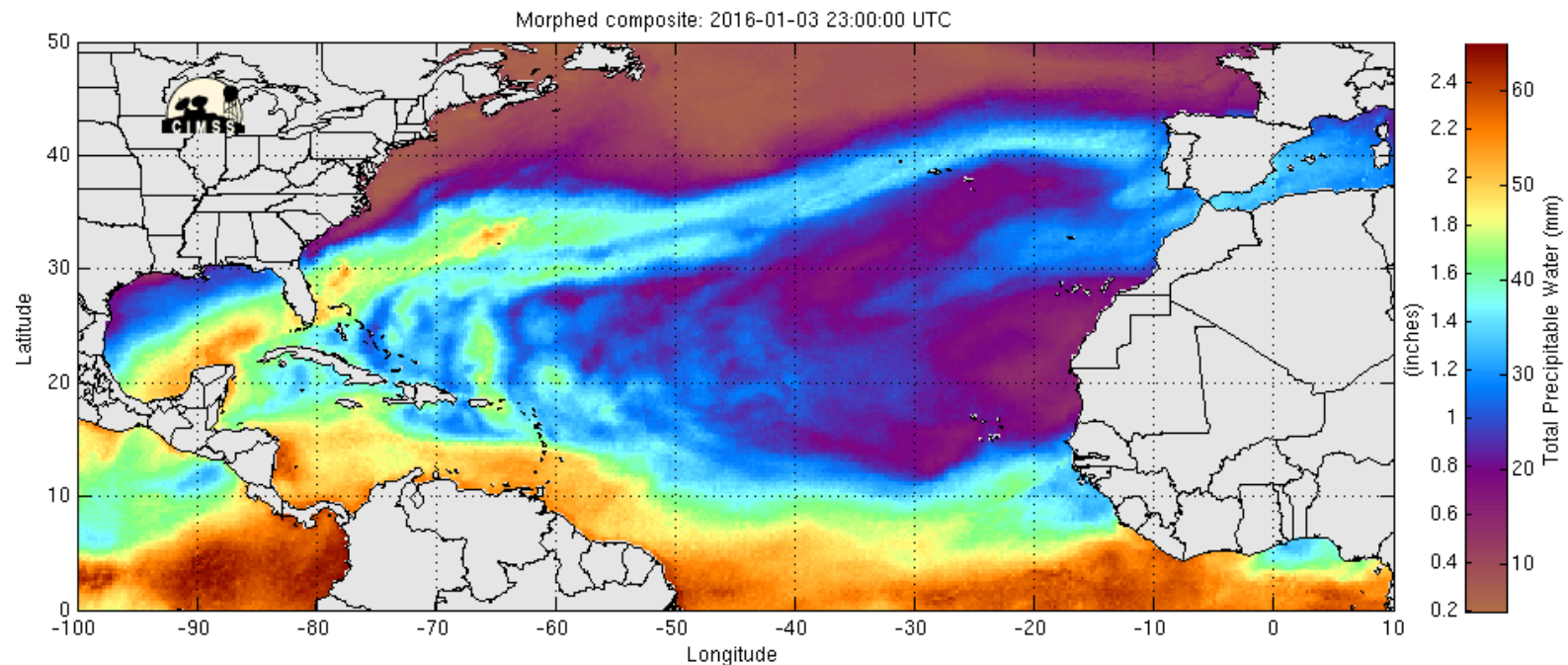
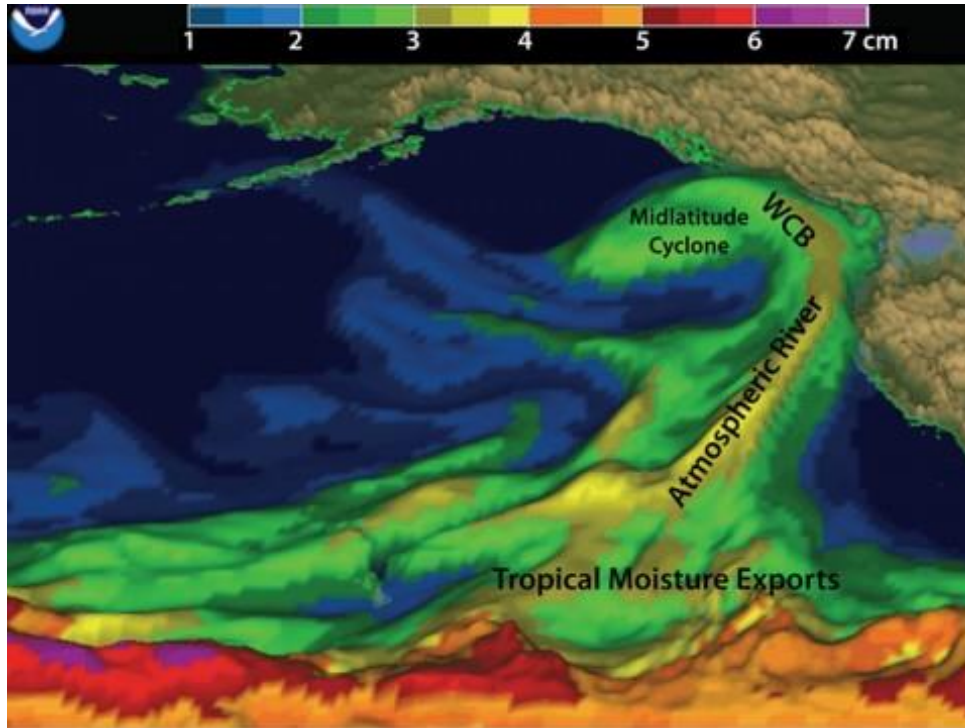


Atmospheric rivers: a new look into the global water cycle, and their role on extreme weather events

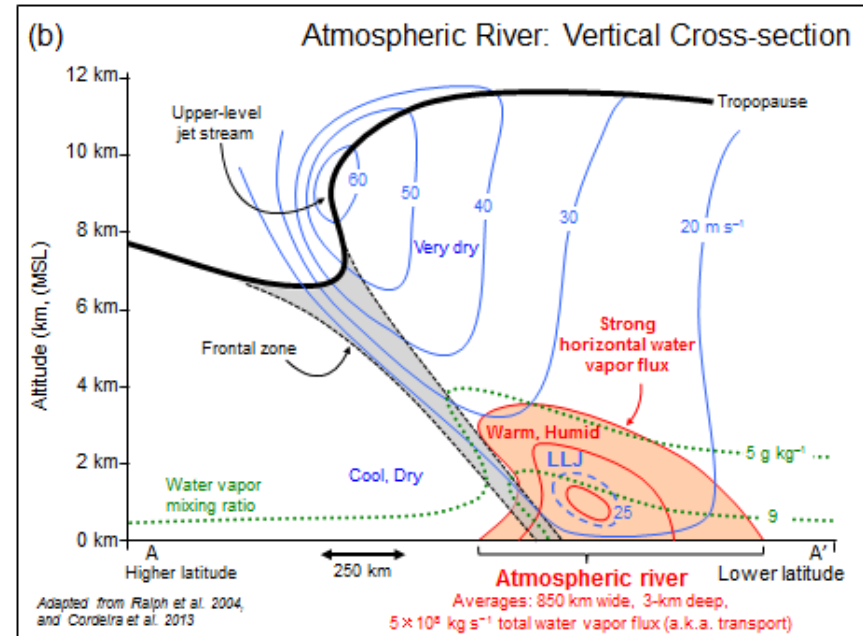
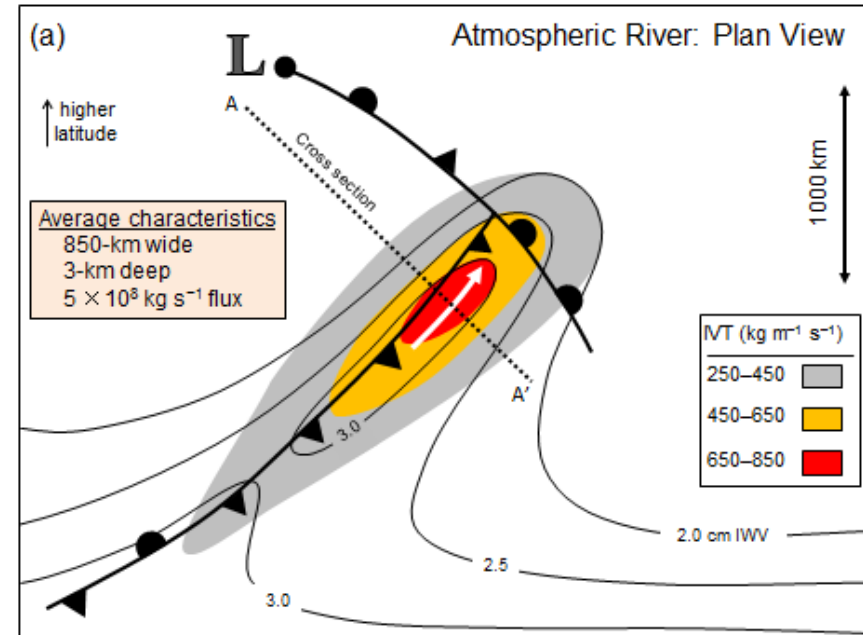


Alexandre M. Ramos

Atmospheric Rivers

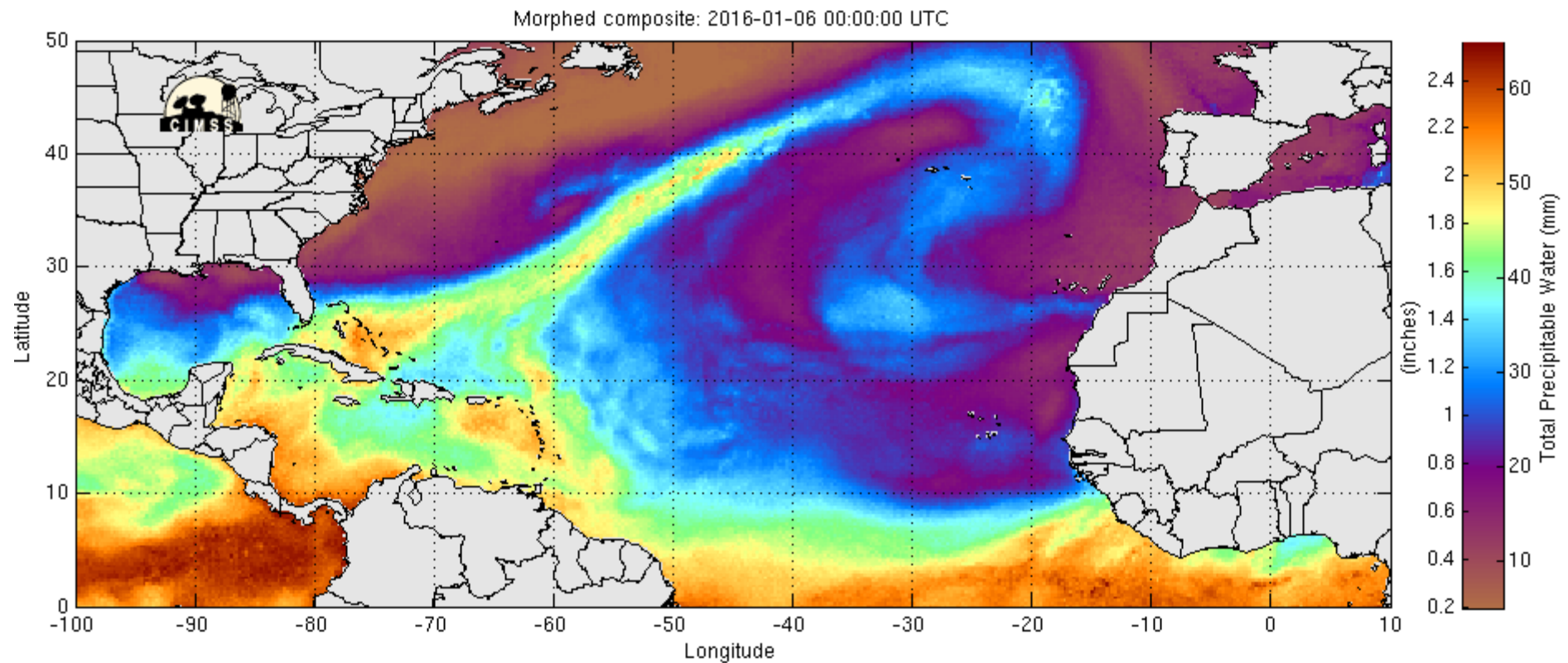


A long (2000km), narrow (850km), and transient corridor of strong horizontal [water vapor](#) transport that is typically associated with a [low-level jet](#) stream ahead of the [cold front](#) of an [extratropical cyclone](#). The water vapor in atmospheric rivers is supplied by tropical and/or extratropical moisture sources. **Atmospheric rivers** frequently lead to heavy [precipitation](#) where they are forced upward—for example, by mountains or by ascent in the warm conveyor belt.



Atmospheric Rivers

SSMI/SSMIS/AMSR2-derived Total Precipitable Water



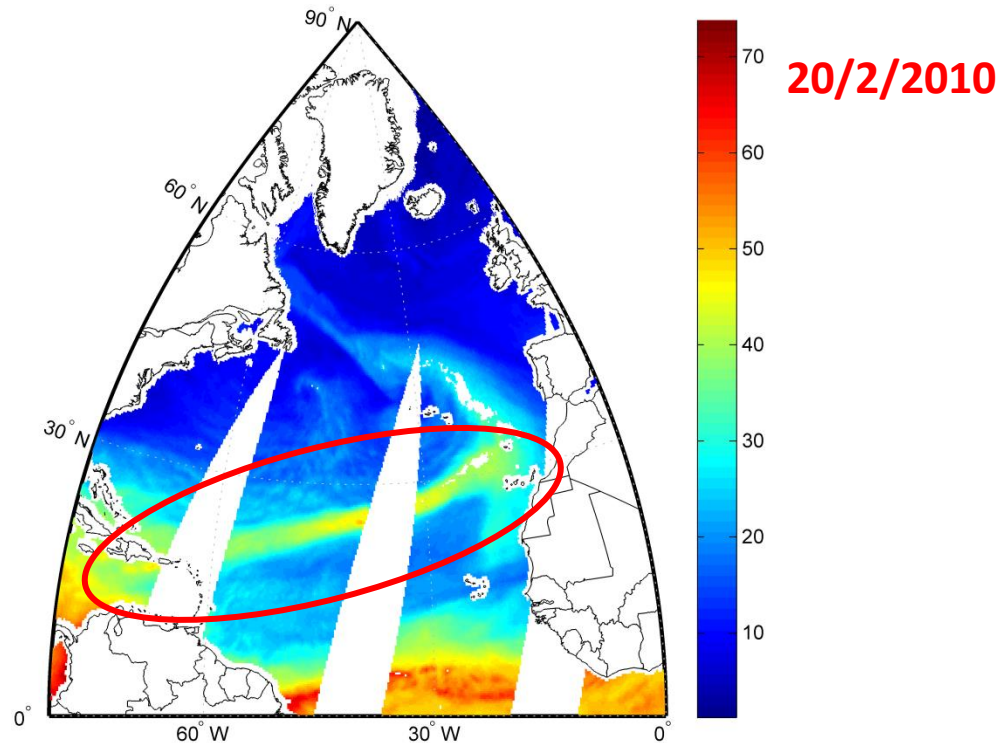
<http://tropic.ssec.wisc.edu/real-time/mimic-pw/natl/main.html>

Atmospheric Rivers - Detection

There are two main approaches used to detect ARs:

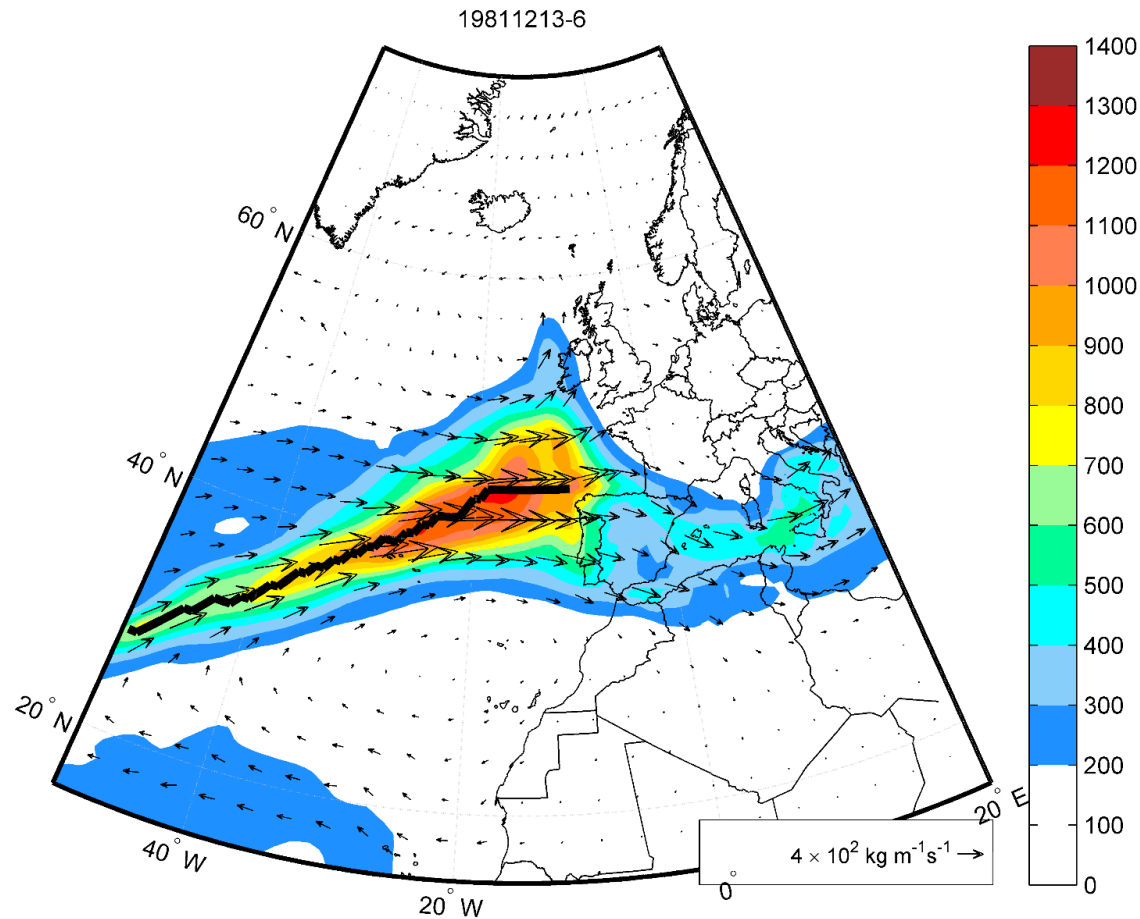
- (i) by using **Integrated Water Vapor (IWV)** from satellite measurements, reanalyses or climate models.

Integrated Water Vapor (mm)

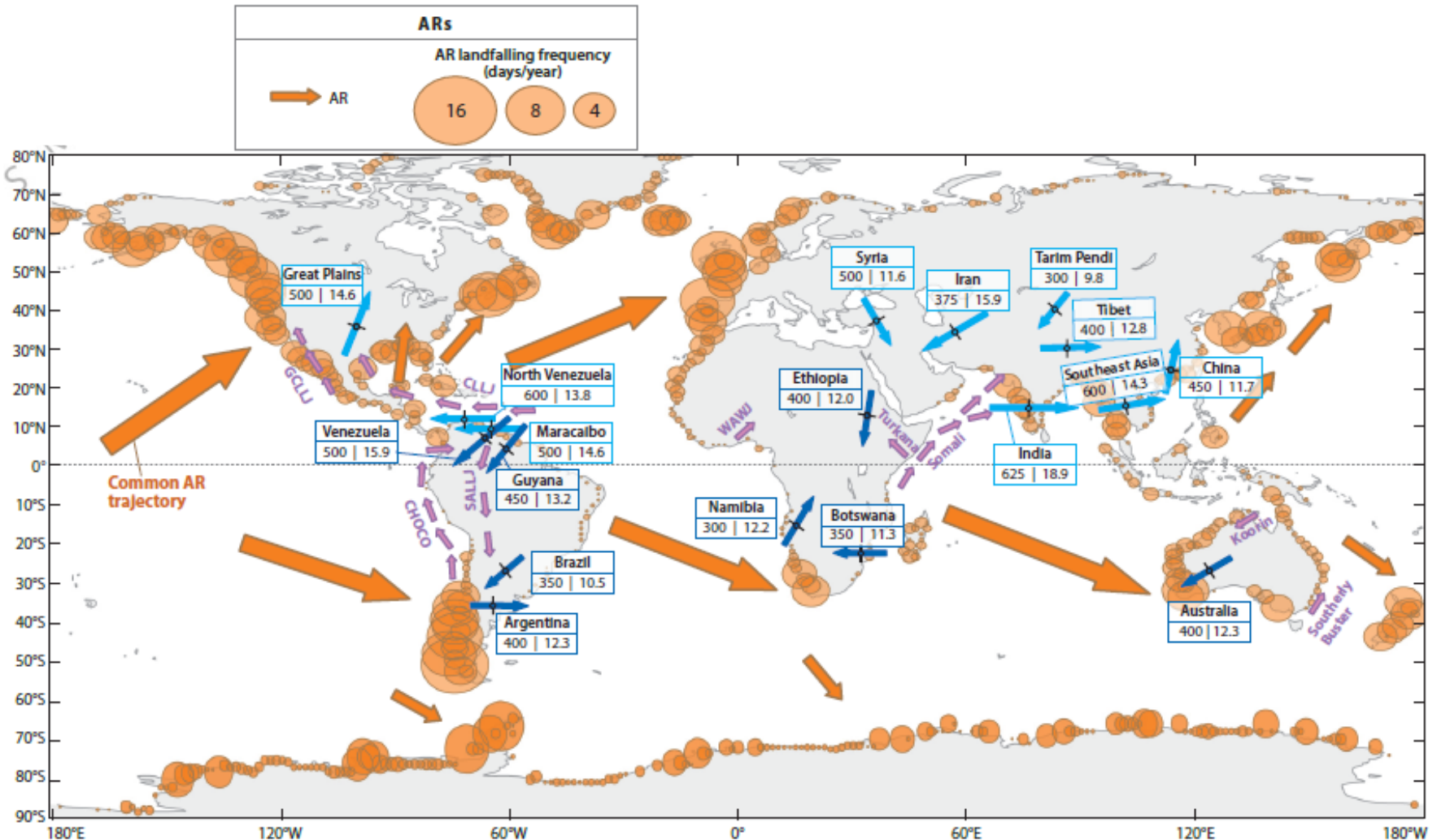


Atmospheric Rivers - Detection

(ii) methods using the **vertically integrated horizontal water vapor transport (IVT)** from atmospheric reanalyses or climate models and then to employ also certain thresholds on IVT to define an AR.

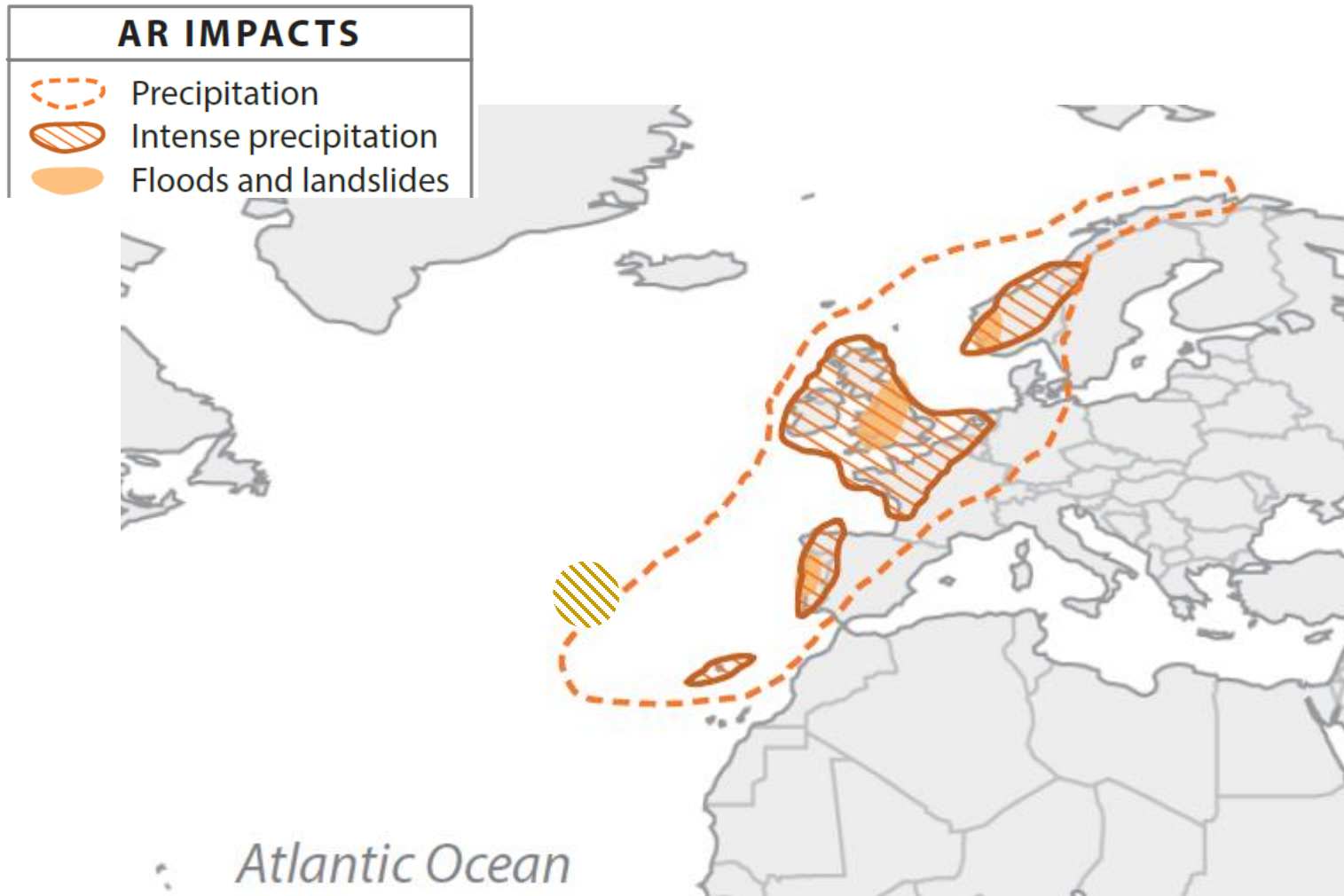


Atmospheric Rivers – Global Overview

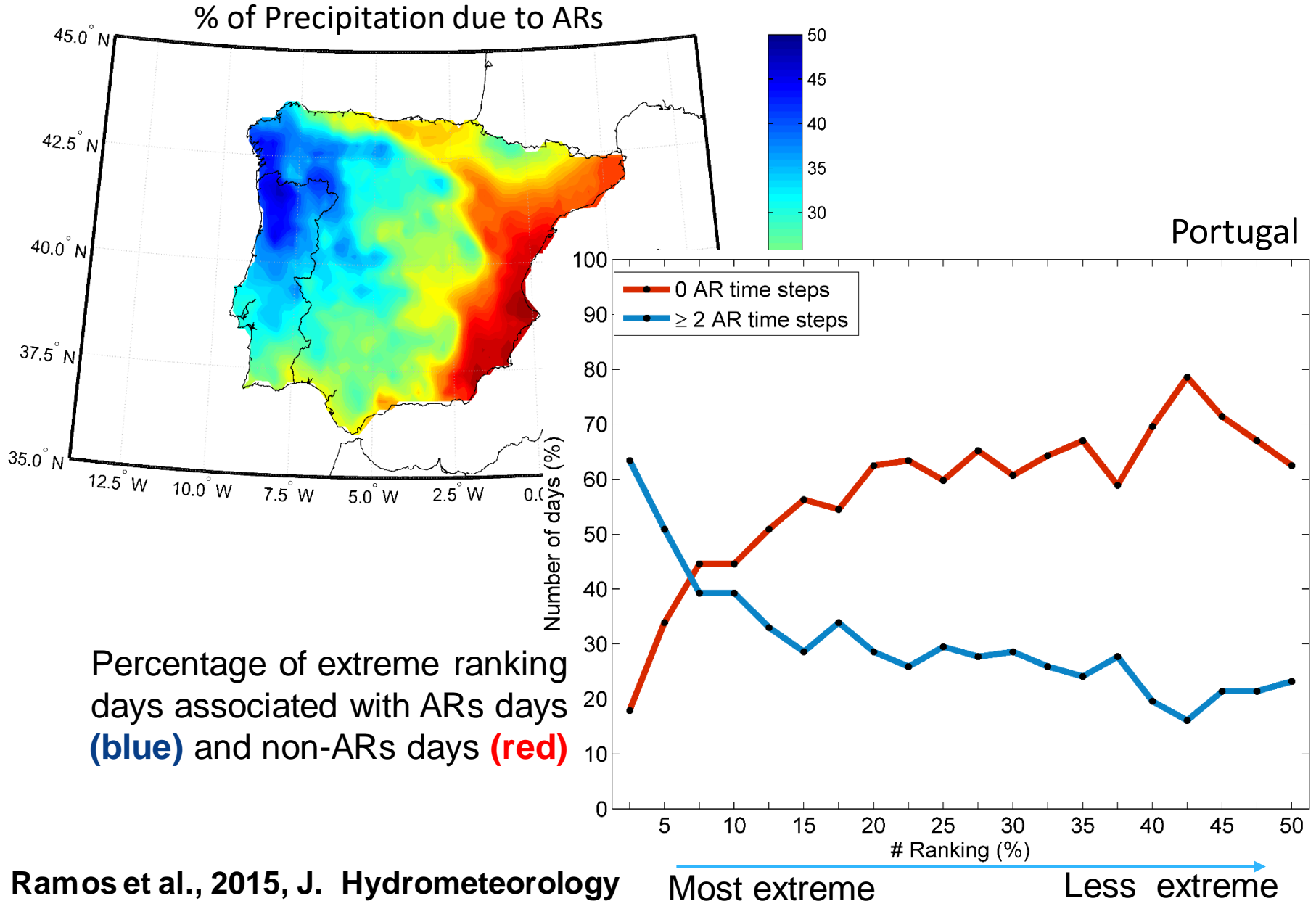


The global geographical position of **atmospheric rivers (ARs)** and low-level jets (LLJs). ARs climatology provided by Guan and Waliser, 2015.

Atmospheric Rivers – Impacts



Atmospheric Rivers – Impacts Iberia Peninsula



Atmospheric Rivers – Dec. 1909 historical case

Example - 20-28 December 1909

Largest floods in 200 years in Douro



D. Luís Bridge



Ribeira

Total affected people: 3876

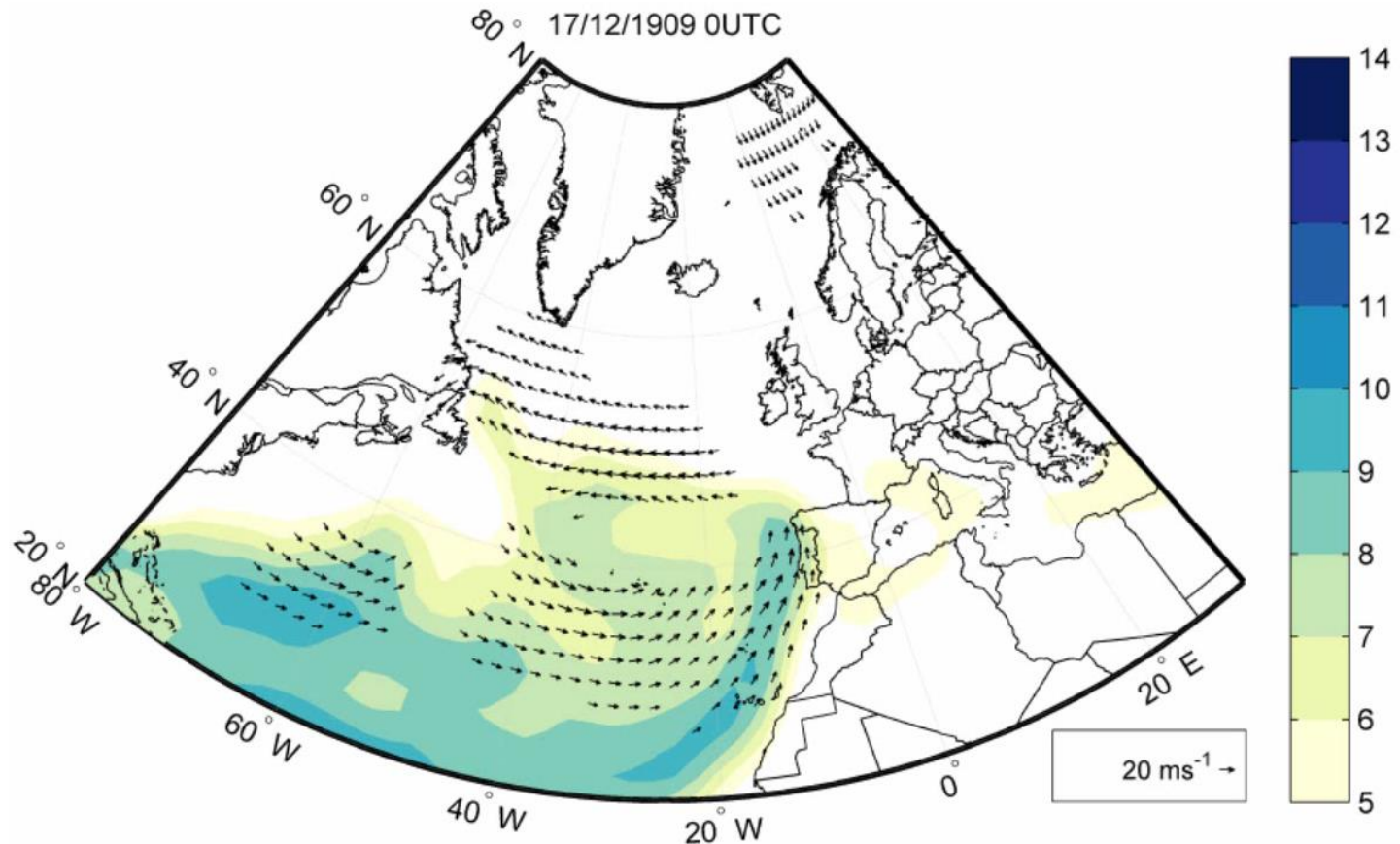
Total fatalities 89 (57 floods and 32 landslides)

Atmospheric Rivers – Dec. 1909 historical case

Specific humidity 900hPa (g/kg)
wind 900hPa (m/s)

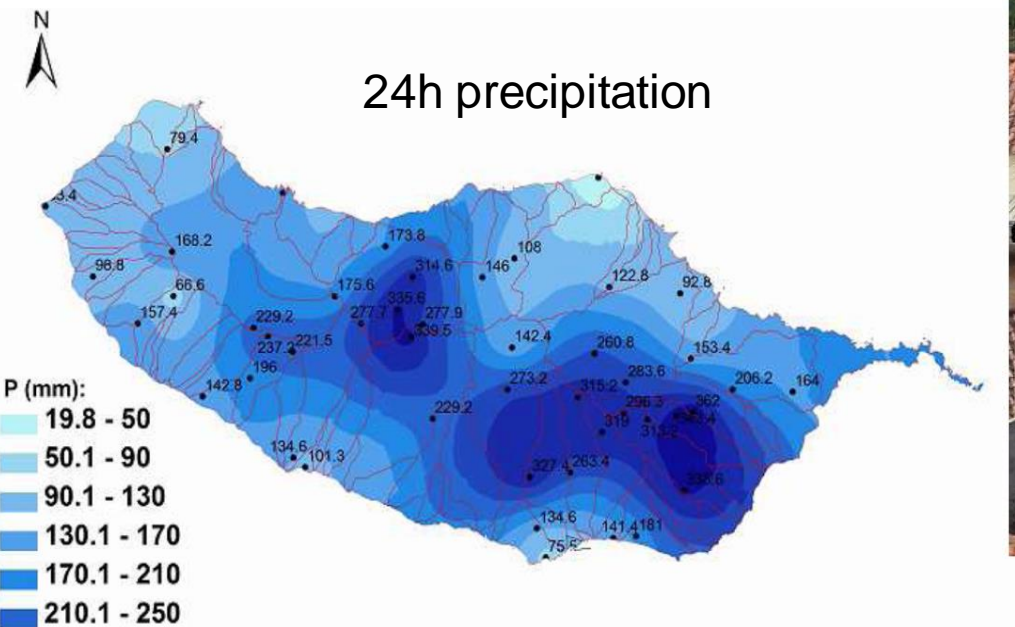
Winds shown only above 12.5m/s

20CR



Atmospheric Rivers – Madeira 2010

Flash Flood Event in Madeira 20 February 2010



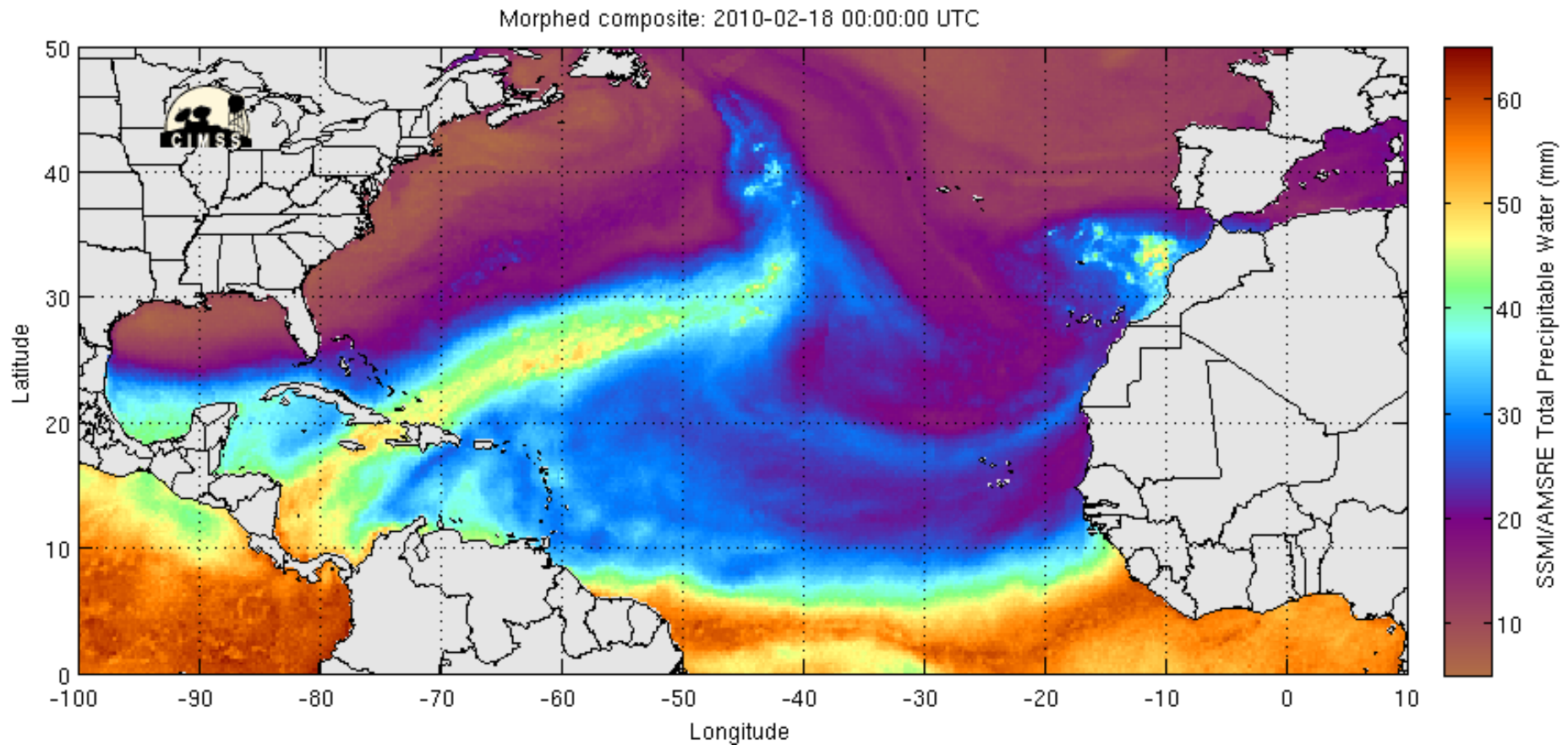
5 10 Km



Atmospheric Rivers – Madeira 2010

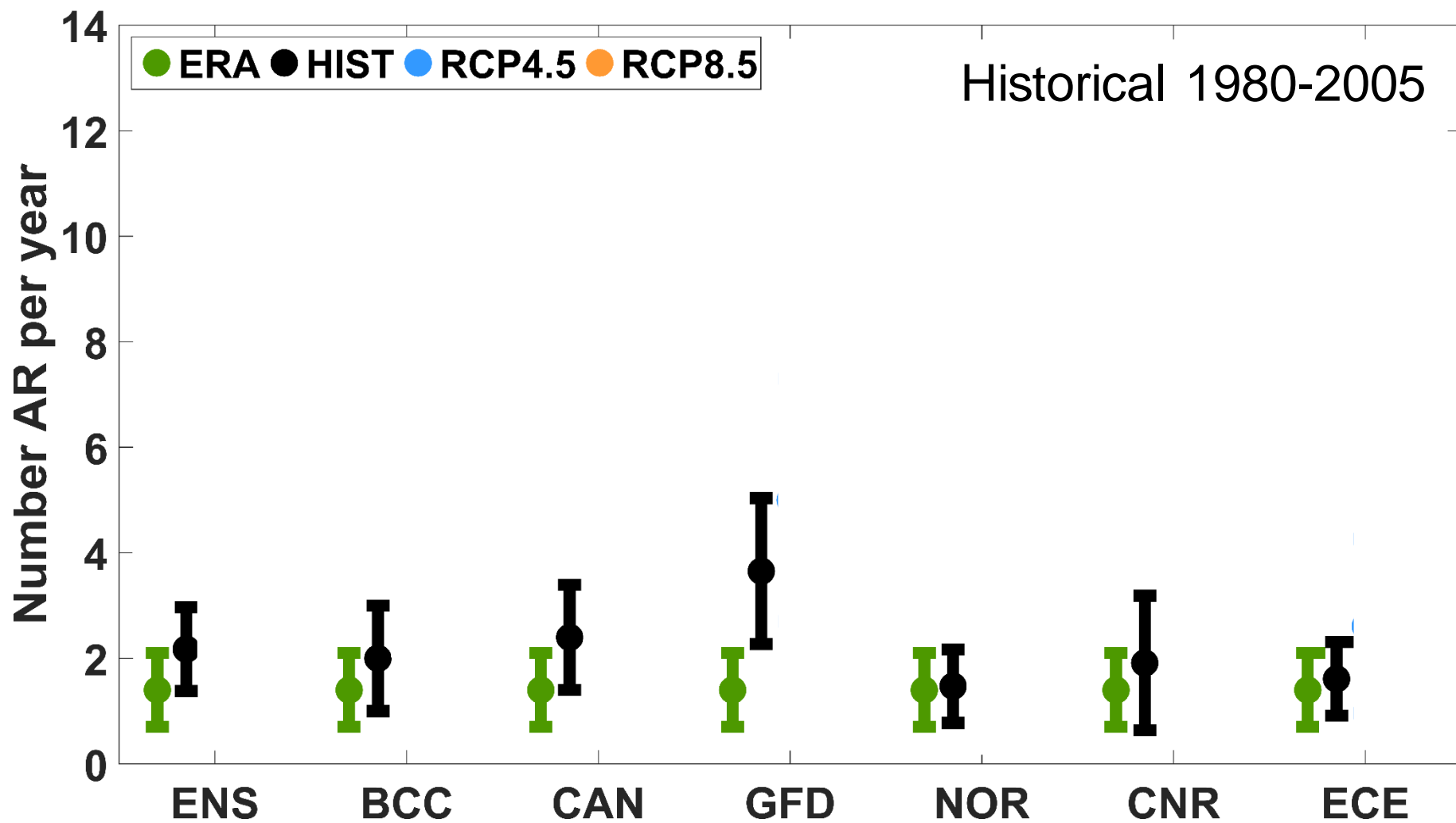
Flash Flood Event in Madeira 20 February 2010

45 fatalities, 6 missed people



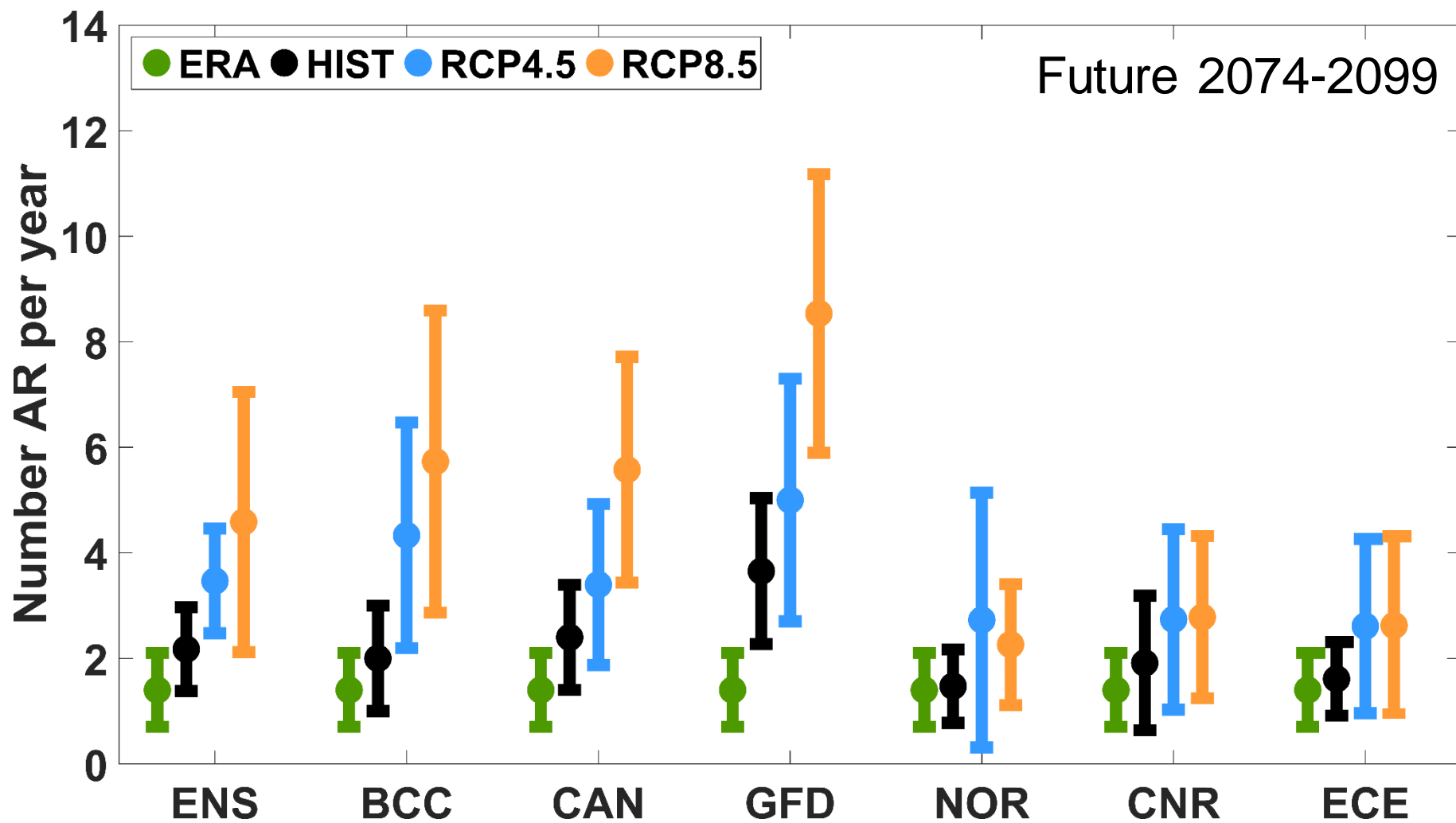
Atmospheric Rivers – Future Scenarios

Iberian Peninsula – ARs frequency



Atmospheric Rivers – Future Scenarios

Iberian Peninsula – ARs frequency



Conclusions

- ARs have different areas of influence in Europe **with major socio-economic impacts** specially in western Europe;
- **ARs** produce **high-impact weather** in the **Iberian Peninsula** as shown in the case studies presented (1909; 2010).
- The **frequency and intensity** of ARs increases along the European Coast in both RCP scenarios, particularly for **RCP8.5**; The increase in the number of ARs is **projected to double on average** in the Iberian Peninsula compared to the historical period.

Ramos et al., 2014 , Atmos Science Letters
Ramos et al., 2015, J. Hydrometeorology
Gimeno et al., 2016, Annu. Rev. Environ. Resou

Ramos et al., 2016, Earth System Dynamics
Pereira et al., 2016, Nat. Hazards Earth Syst. Sci
Ramos et al., 2016, Geo Res Lett

Thank you for your attention!

Acknowledgments

- **Alexandre M. Ramos** was supported through a postdoctoral grant (SFRH/BPD/84328/2012) from the FCT.



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