Twentieth-century atmospheric river activity along the west coasts of Europe and North America: Algorithm formulation, reanalysis uncertainty and links to the leading modes of low frequency variability in atmosphere and ocean

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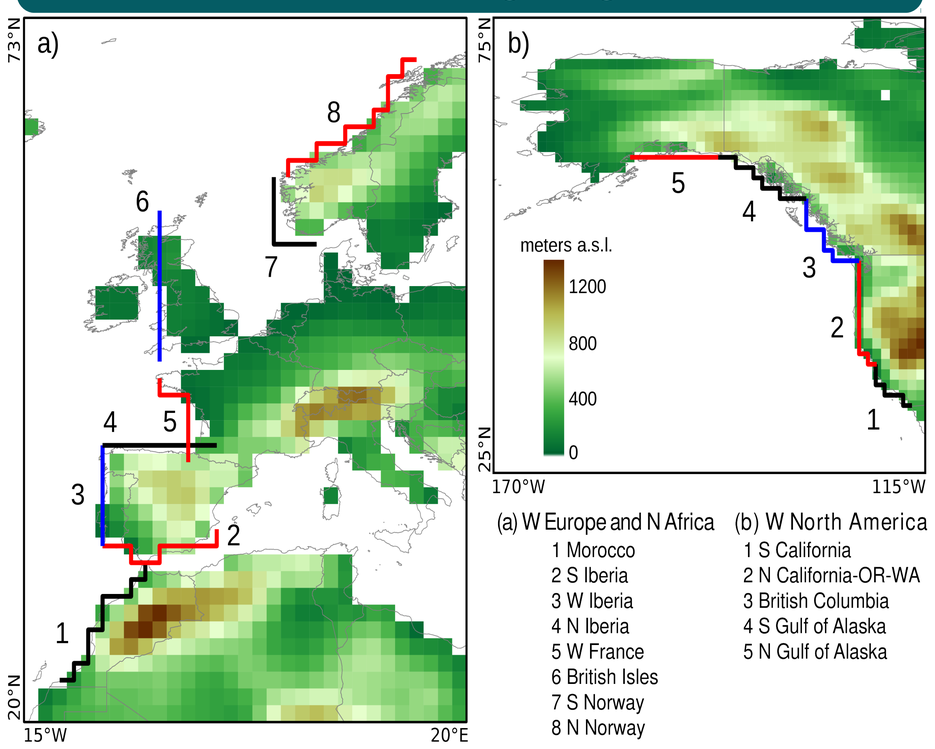
Visit the 1900-2014 AR-archive at: http://www.meteo.unican.es/atmospheric-rivers

Abstract

A new atmospheric-river (AR) detection and tracking scheme based on the magnitude and direction of integrated water vapour transport is applied over 13 target regions covering Europe and the west coast of North America. This is done separately for four distinct reanalyses, two of which cover the entire 20th-century (ECMWF ERA-Interim and ERA-20C, NCEP/NCAR reanalysis 1 and NOAA-CIRES 20th-century reanalysis v2). Comparing the AR-counts from the two 20th-century reanalyses with a running 31-year window looping through 1900-2010 reveals differences in the climatological mean and inter-annual variability which, at the start of the century, are much more pronounced in western North America than in Europe. Correlating European AR-counts with the North Atlantic Oscillation (NAO) reveals a dipole pattern which, during the course of the 20th-century, first shifted to the North and thereafter back to the South. The January-through-March AR-counts in British Columbia and the October-through-December counts in northern Iberia and western France are significantly linked to SSTs in the Niño 3.4 region. These links, however, are non-stationary. From British Columbia to Alaska, the October-through-March counts are significantly linked to the PDO. The long-term tendencies (1950-2010) are either not significant or largely vary from one reanalysis to another. In other words, consistently positive trends are absent. Visual support for this study is provided by an exhaustive historical AR archive, publicly available at: http://www.meteo.unican.es/atmospheric-rivers**.** For the respective data files, please contact the authors.

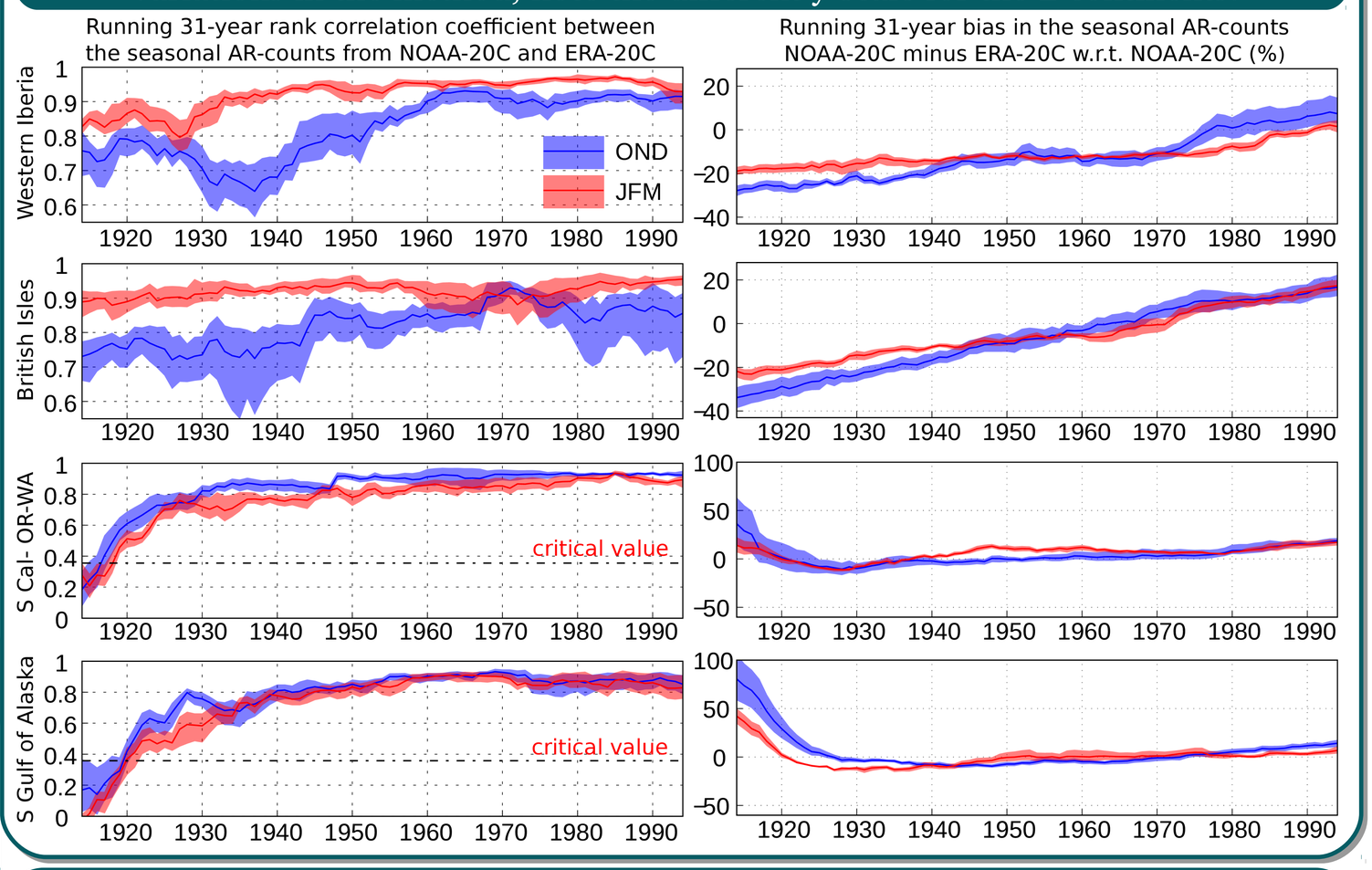
Considered target regions



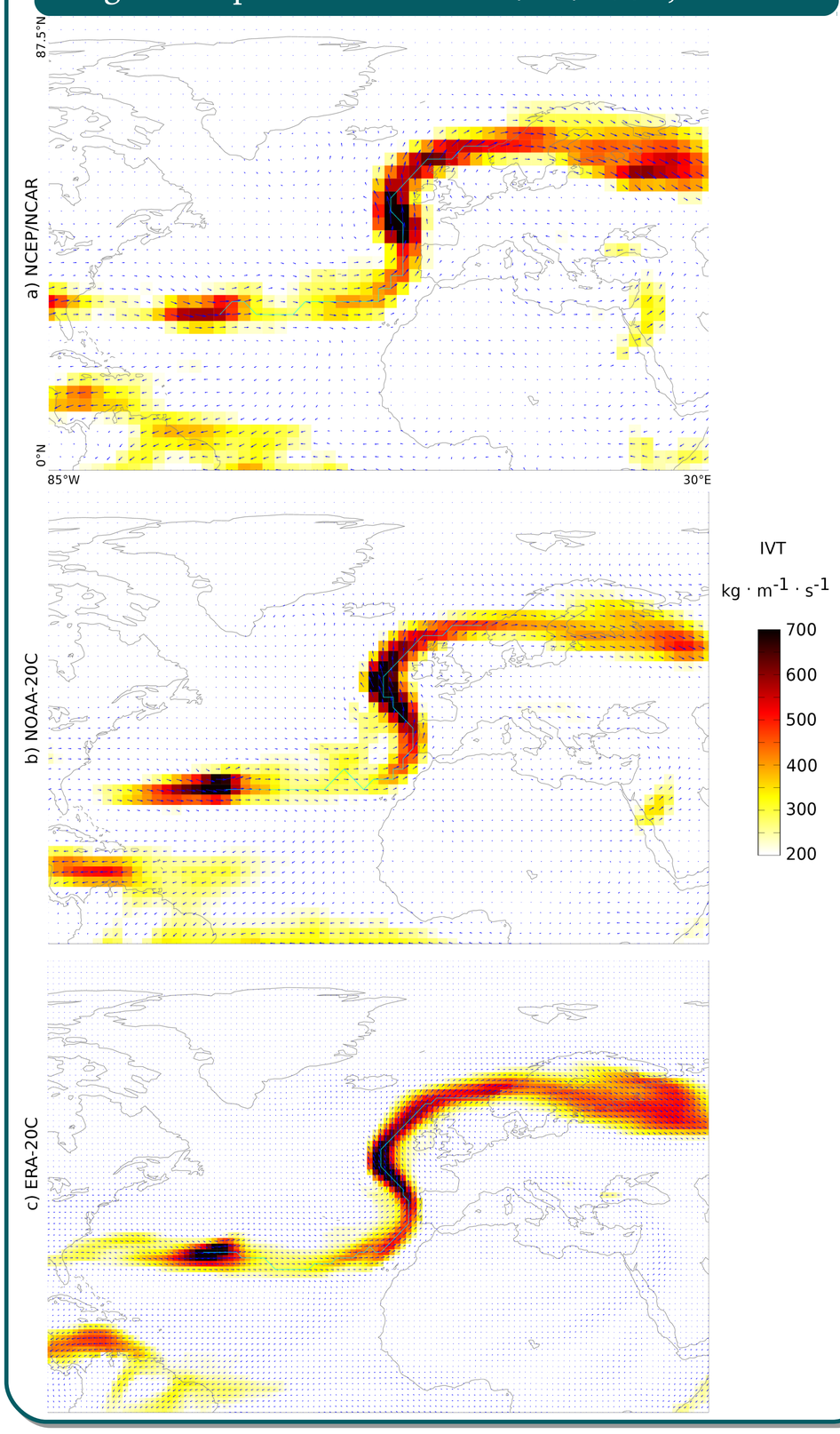
(a) W Europe and N Africa
1 Morocco
2 S Iberia
3 W Iberia
4 N Iberia
5 W France
6 British Isles
7 S Norway
8 N Norway

(b) W North America
1 S California
2 N California-OR-WA
3 British Columbia
4 S Gulf of Alaska
5 N Gulf of Alaska

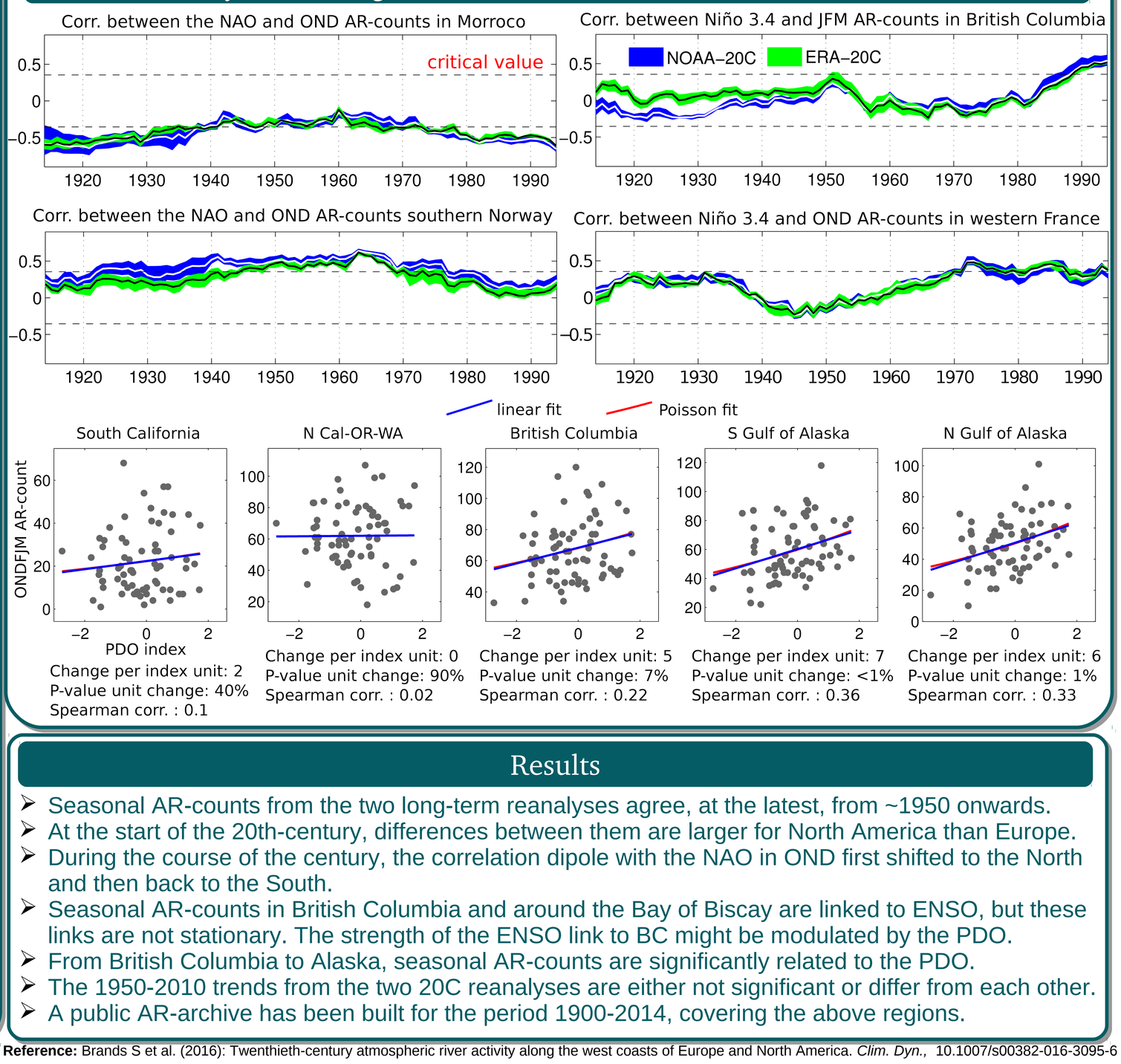
Differences between NOAA-CIRES 20C and ERA-20C, shading =sensitivity due to variations in the method, note the different y-scale for the 2 continents!



Algorithm performance on 11/01/1971, 00 UTC



Selected 31-year running teleconnections and links to the PDO (1940-2010)



Results

- Seasonal AR-counts from the two long-term reanalyses agree, at the latest, from ~1950 onwards.
- At the start of the 20th-century, differences between them are larger for North America than Europe.
- During the course of the century, the correlation dipole with the NAO in OND first shifted to the North and then back to the South.
- Seasonal AR-counts in British Columbia and around the Bay of Biscay are linked to ENSO, but these links are not stationary. The strength of the ENSO link to BC might be modulated by the PDO.
- From British Columbia to Alaska, seasonal AR-counts are significantly related to the PDO.
- The 1950-2010 trends from the two 20C reanalyses are either not significant or differ from each other.
- A public AR-archive has been built for the period 1900-2014, covering the above regions.

Reference: Brands S et al. (2016): Twenthieth-century atmospheric river activity along the west coasts of Europe and North America. *Clim. Dyn.,* 10.1007/s00382-016-3095-6