Impact of an Abrupt Arctic Sea Ice Loss on the Extreme Precipitation Events in the Midlatitudes (A53J-3002)

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Introduction

The retreat of Arctic sea ice, largely due to the increase of the anthropogenic greenhouse gases [1], has been proposed as a key driver of **Arctic Amplification (AA)** through changes in albedo. The AA could induce a change in the polar jet stream, in the storm tracks and in the planetary waves [2], which alters the climate on the midlatitudes mainly during winter (Fig 1).

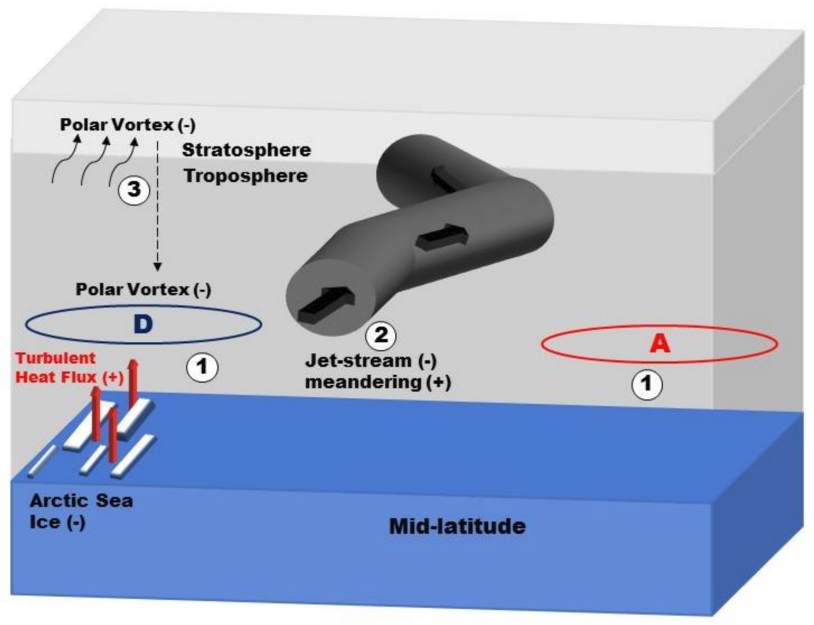

Figure 1: Three main climatic processes associated to Arctic sea-ice loss reported in the literature.

Recently, few mid-latitude extreme events, such as cold spells and **droughts**, have been linked to sea ice loss. Indeed, AA favors persistent weather, increasing the risk of extreme events [3]. The recent winter California drought (2011-2014) is due to a persistent high pressure, known as a blocking, over the north-eastern Pacific. Several studies found that Arctic sea ice loss can lead to atmospheric drying over western North America in winter, but no clear consensus has emerged. Except the climate responses over the Arctic, almost all the midlatitude responses produced by a reduction in sea ice extent are debatable [4].

Experiments

- ECMWF-IFS (LR and HR), CNRM-CM6 (LR)
- Control run (CTRL): constant forcing of 1950.
- Perturbation runs (PERT)
  - Same as CTRL but with ice albedo = 0,066
  - 40 members of 15 months long (short timescale responses)

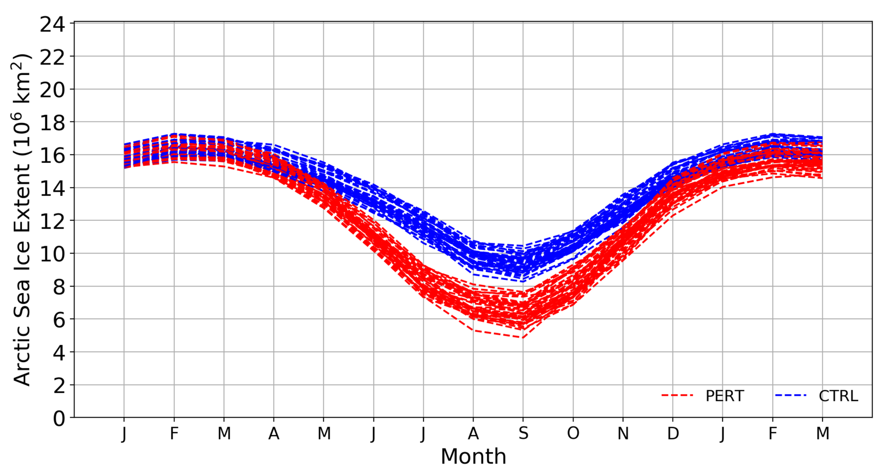

Figure 2: Arctic sea ice extent in the ECMWF-IFS-HR exp.

Results

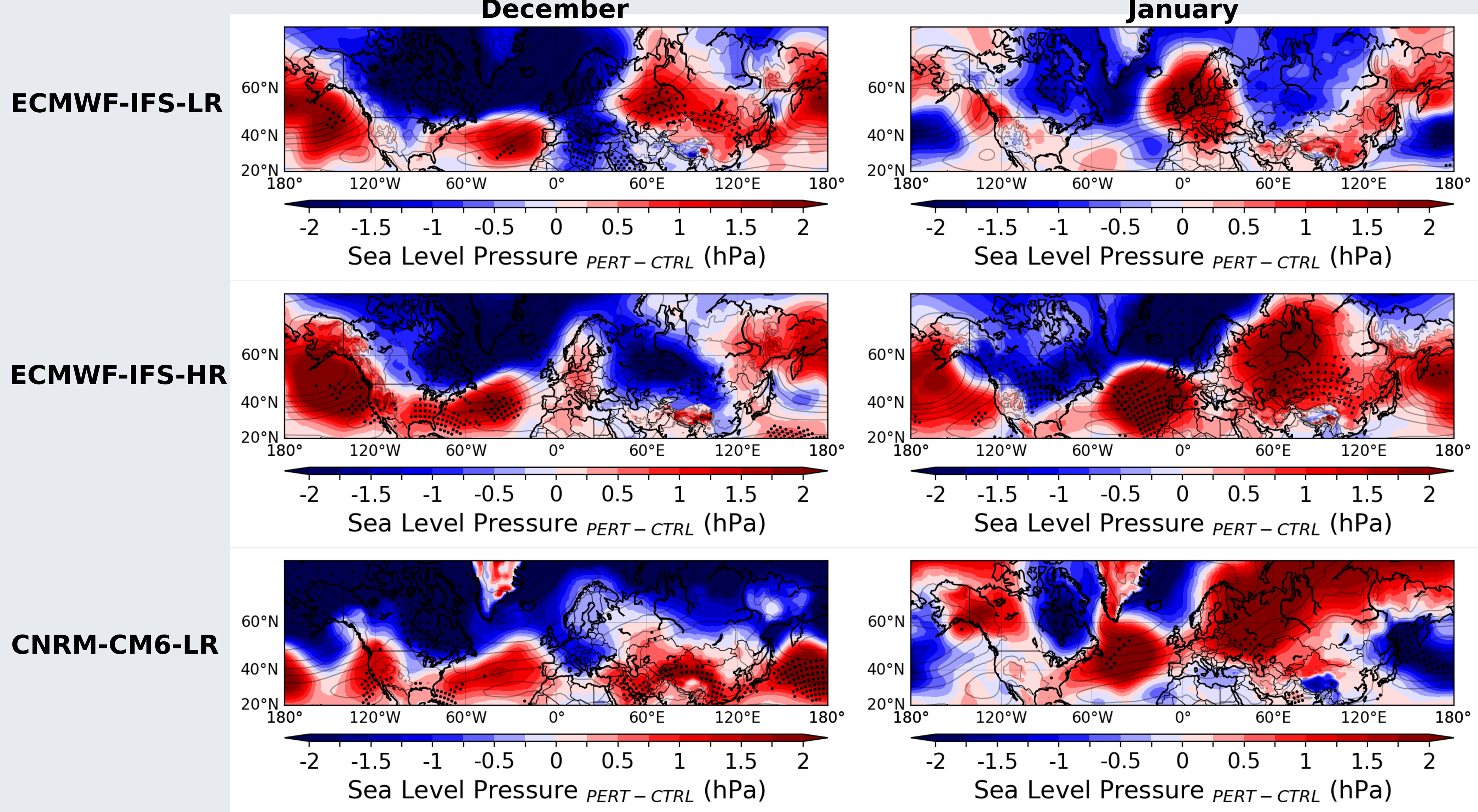

Figure 3: Difference between PERT and CTRL for sea level pressure in December (left) and in January (right). Top: ECMWF-IFS-LR. Middle: ECMWF-IFS-HR. Bottom: CNRM-CM6. Stippling indicates where the response is significant at a 90% level

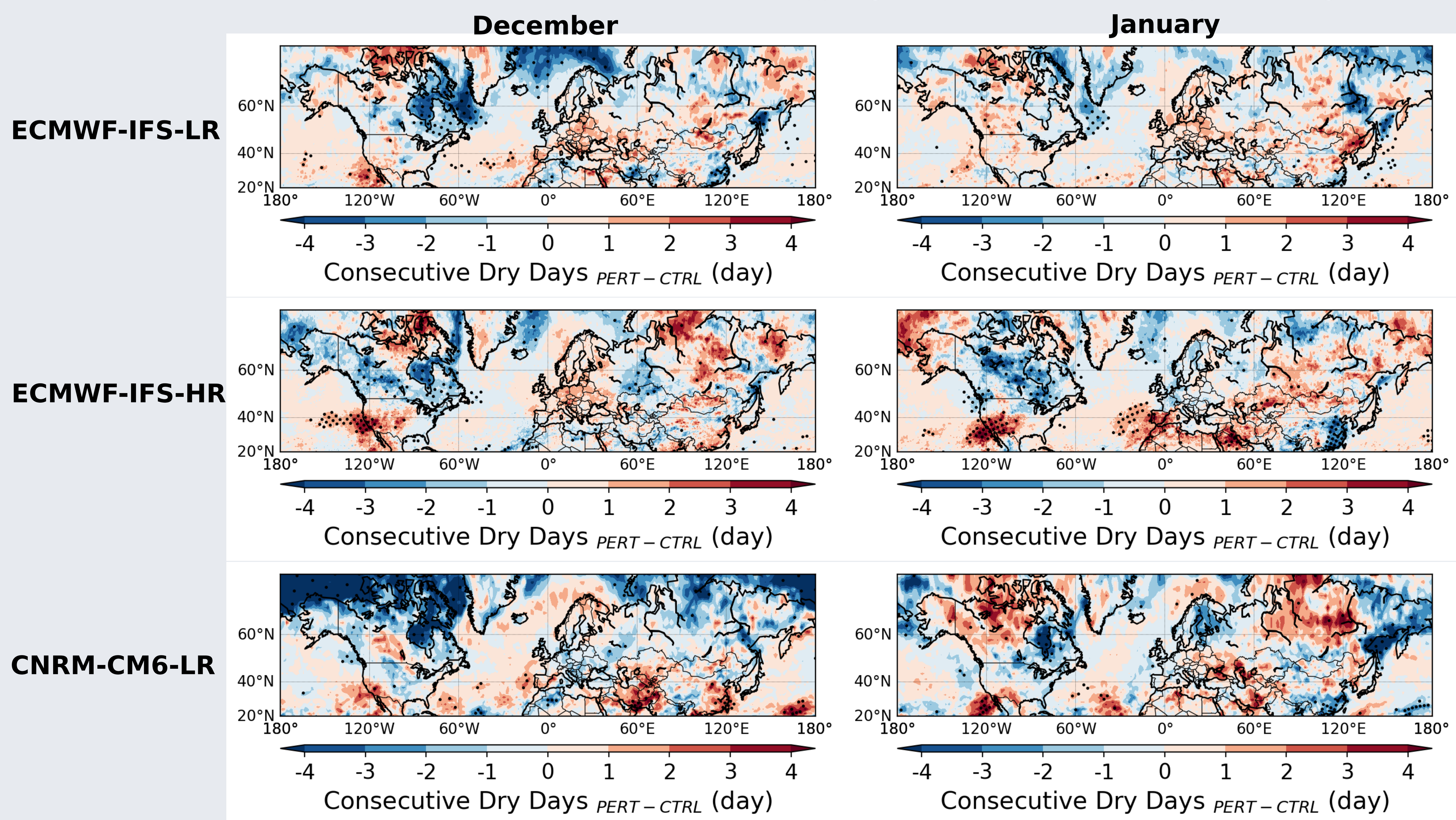

Figure 4: Same as Fig 3 but for the longest Consecutive Dry Days (CDD) period.

In December, the pattern of the circulation change (Fig 3) is similar in the 3 different models. Indeed, a positive anomaly is observed over North Pacific and North Atlantic, going north-eastward in January for the latter region. A negative anomaly is observed in Northeast America and remains there during 2 months. This change in circulation, probably due to the sea ice loss, may produce an increase in **extreme precipitation** events over some regions. **The drought duration** (Fig 4) increases in PERT (low sea ice case) over the southwestern North America both months, but mainly in December. Except ECMWF-IFS-HR, the northeast shift of the Atlantic High does not generate an increase of drought duration over Western Europe. A decrease of this variable is observed where the sea ice disappears such as in the Labrador and the Okhotsk sea.

An enhancement of the zonal wind and the storm track activity is observed over the northeast Pacific and the North Atlantic in December in ECMWF-IFS-HR (Fig 5). Moreover, a vertical wave activity is produced over these two regions.

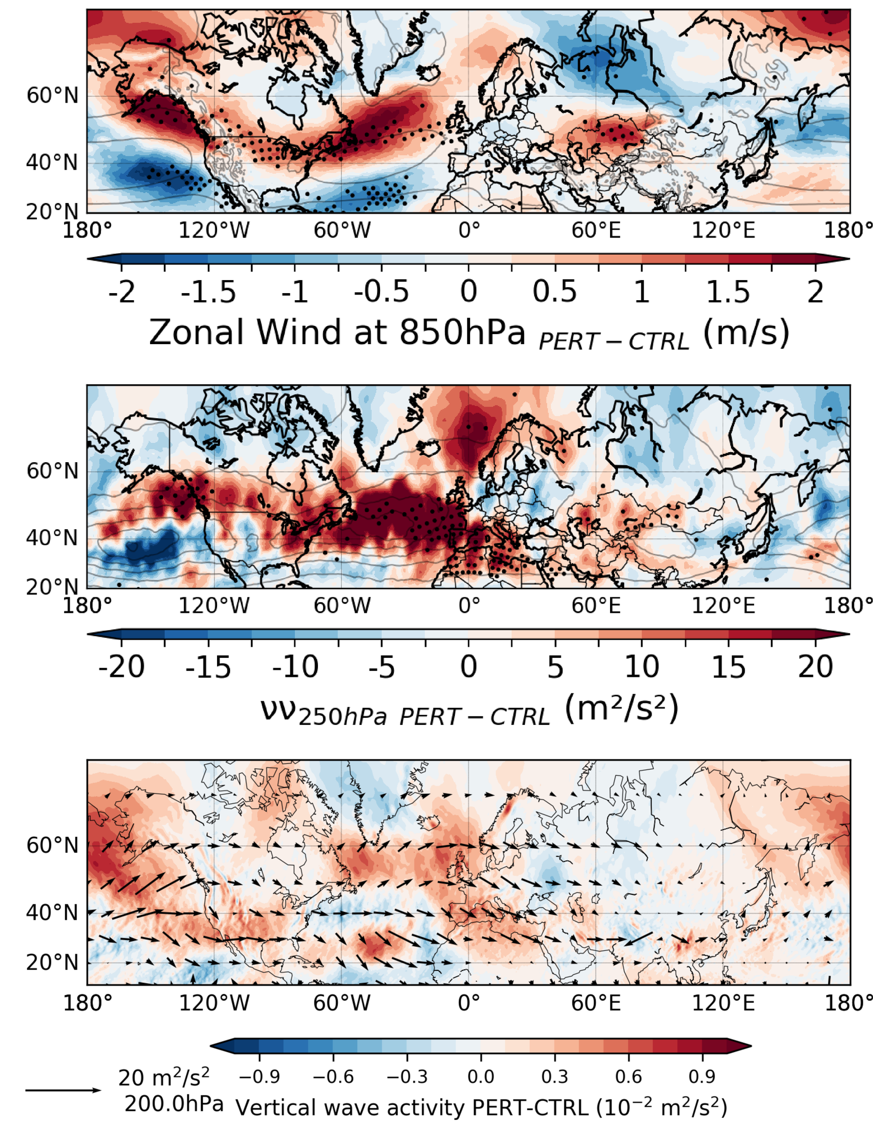

Figure 5: Same as Fig 3 but only in December in ECMWF-IFS-HR. Top: Zonal wind at 850hPa, climatology (contours). Middle: Storm track activity at 250hPa. Bottom: Horizontal wave activity (arrows) and vertical wave activity (shading) at 200hPa.

Conclusion

These results show that with a **sudden Arctic sea ice loss**, a change in the circulation occurs that can produce **extreme events** in some mid-latitude regions such as an **increase of the drought duration** in the southwestern of North America the following winter. For further research, a better understanding between these 2 processes will be studied.

References

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[2] Judah Cohen, James A. Screen, Jason C. Furtado, Mathew Barlow, David Whittleston, Dim Coumou, Jennifer Francis, Klaus Dethloff, Dara Entekhabi, James Overland, and Justin Jones. Recent Arctic amplification and extreme mid-latitude weather. *Nat. Geosci.*, 7(9):627–637, September 2014.

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[4] Elizabeth A Barnes and James A Screen. The impact of Arctic warming on the midlatitude jet-stream: Can it? has it? will it? *Wiley Interdisciplinary Reviews: Climate Change*, 6(3):277–286, 2015.

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