Do subseasonal forecasts take advantage of windows of opportunity related to a precursor phenomenon?

EGU General Assembly 2022 – S2S session - May 27, 2022

Damien Specq

Contribution : Lauriane Batté

Météo-France, Centre National de Recherches Météorologiques

What are windows of opportunity?

- A concept acknowledging that S2S predictability is intermittent (Mariotti et al. 2020)

- **Climatological window of opportunity**: time span for which a phenomenon occurring at day D constrains the distribution of a climate variable at day D+n (towards an extreme value)
  → **purely observational**

- **Model window of opportunity**: time span during which the issued forecasts will perform better at lead time n
  → **model-dependent**

- **Are forecasts initialized during a climatological window of opportunity better at predicting extreme events than those initialized without any signal?**

A reminder on contingency table metrics

	Event observed (1)	Event not observed (0)
Event forecast (1)	a	b
Event not forecast (0)	c	d

- *Base rate* = observed frequency of the event = (a+c)/(a+b+c+d). Does not depend on forecasts
- *Forecast rate* = forecast frequency of the event = (a+b)/(a+b+c+d). Does not depend on obs
- *Hit rate* = forecast frequency of the event knowing that the event occurred = a/(a+c)
- *False alarm rate* = forecast frequency of the event knowing that the event did not occur = b/(b+d)
- *Peirce Skill Score* = trade-off between hits and false alarms = a/(a+c) - b/(b+d)

Case 1: the Madden-Julian Oscillation and heavy tropical precipitation

- Heavy precipitation = **upper quintile** (80th percentile) of **weekly precipitation** at grid point in GPCP v1.3

- **ECMWF S2S reforecasts** for the November-to-April seasons from 2000-2001 to 2019-2020: 1040 start dates

- Start dates are **stratified according to the initial MJO phase**: 8-1, 2-3, 4-5, 6-7 or inactive (see e.g Marshall et al. 2011, Vitart 2014, Ferranti et al. 2018)

- **One-to-one comparisons** of the 5 contingency table indicators: **specific active MJO phase vs inactive MJO** (with bootstrap significance testing at the 90% level)

Received: 13 October 2021 | Revised: 7 January 2022 | Accepted: 10 January 2022

DOI: 10.1002/asl.1078

RESEARCH ARTICLE

Atmospheric Science Letters RMetS

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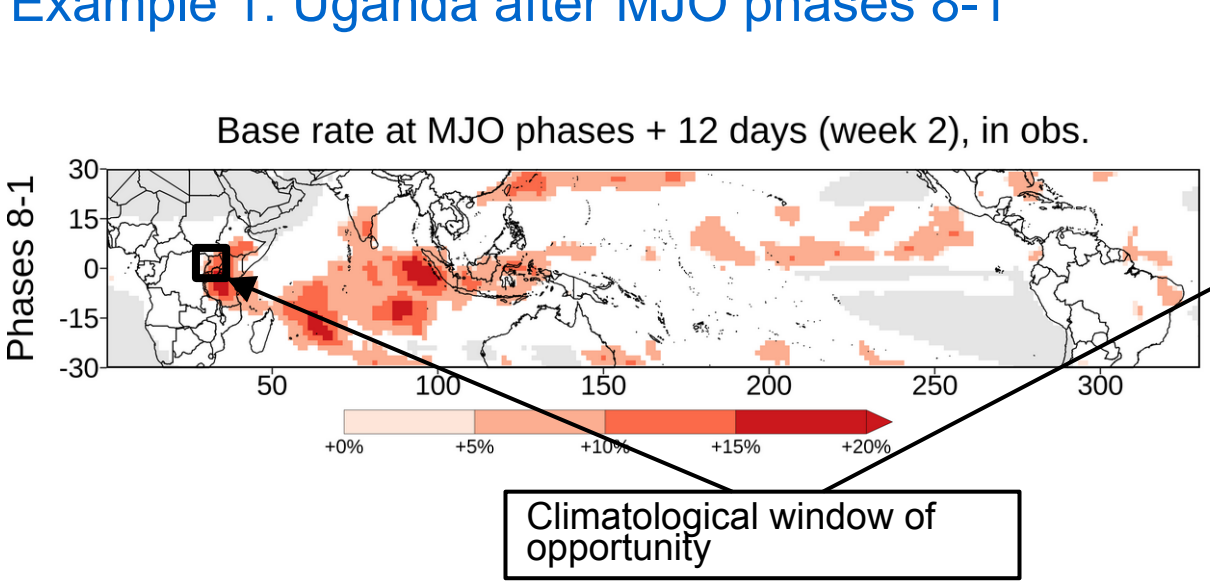
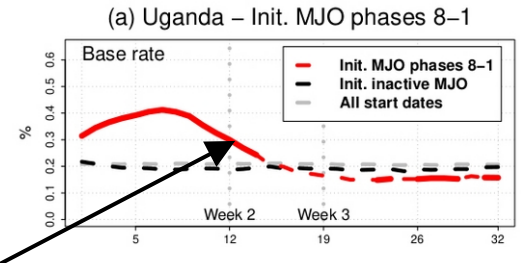
Damien Specq | Lauriane Batté

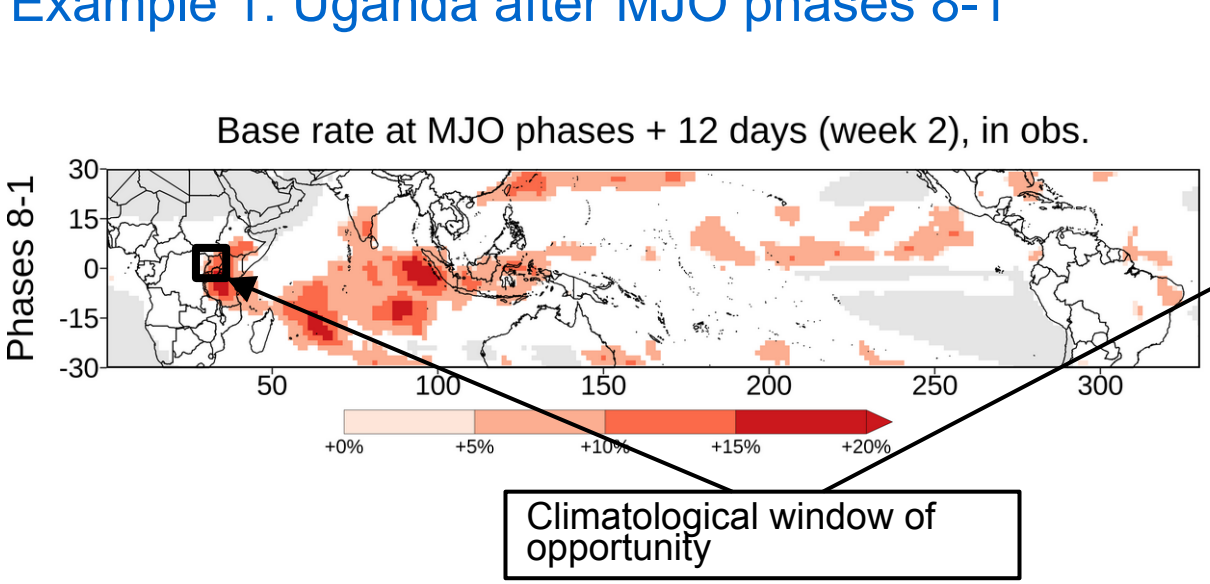
Example 1: Uganda after MJO phases 8-1

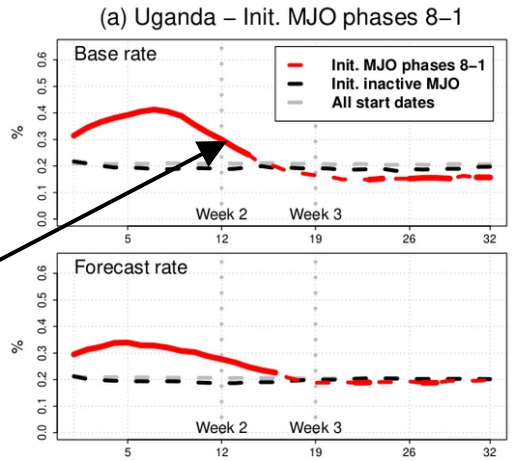




Climatological window of opportunity

Example 1: Uganda after MJO phases 8-1





Climatological window of opportunity

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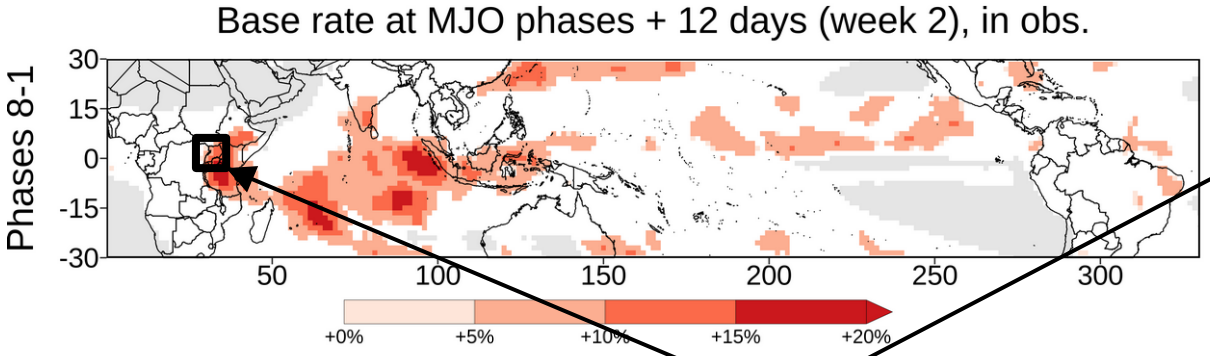

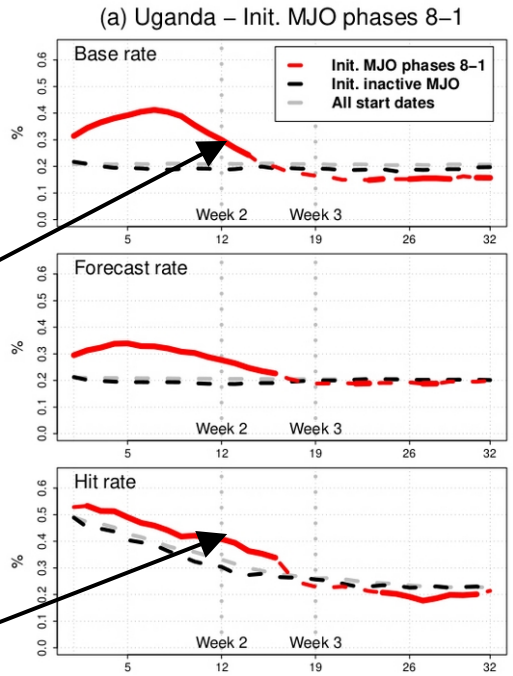

Climatological window of opportunity

Increase in hit rate

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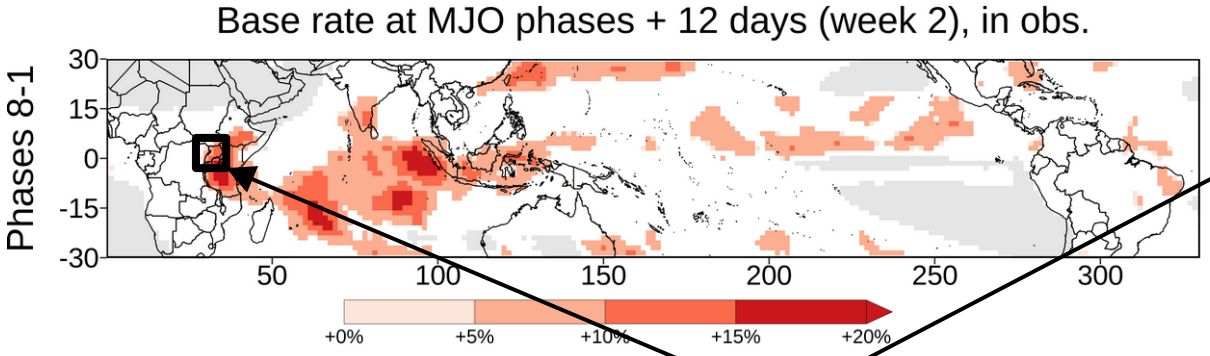
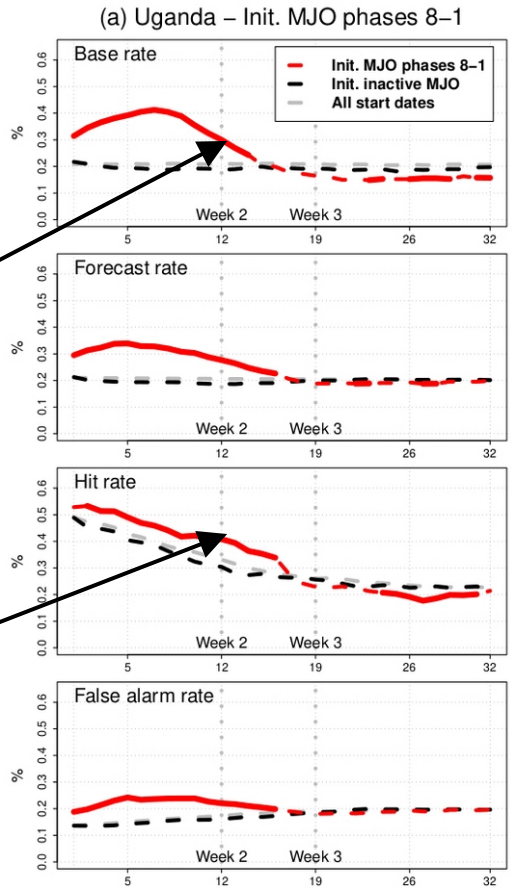


Climatological window of opportunity

Increase in hit rate



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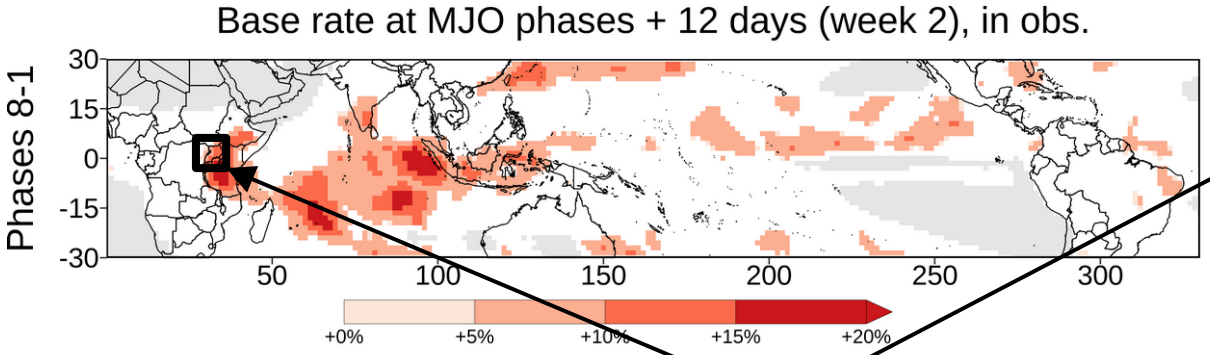
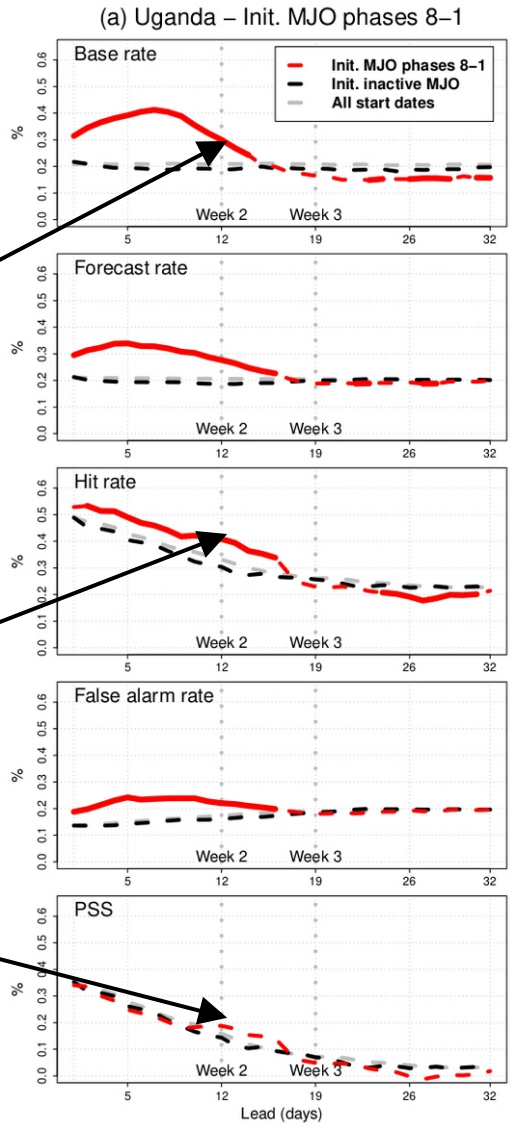


Climatological window of opportunity

Increase in hit rate

Increase in PSS



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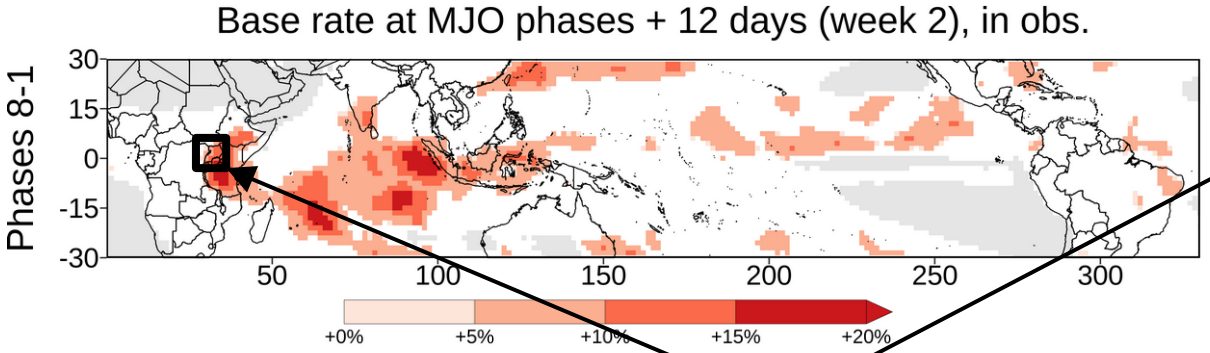
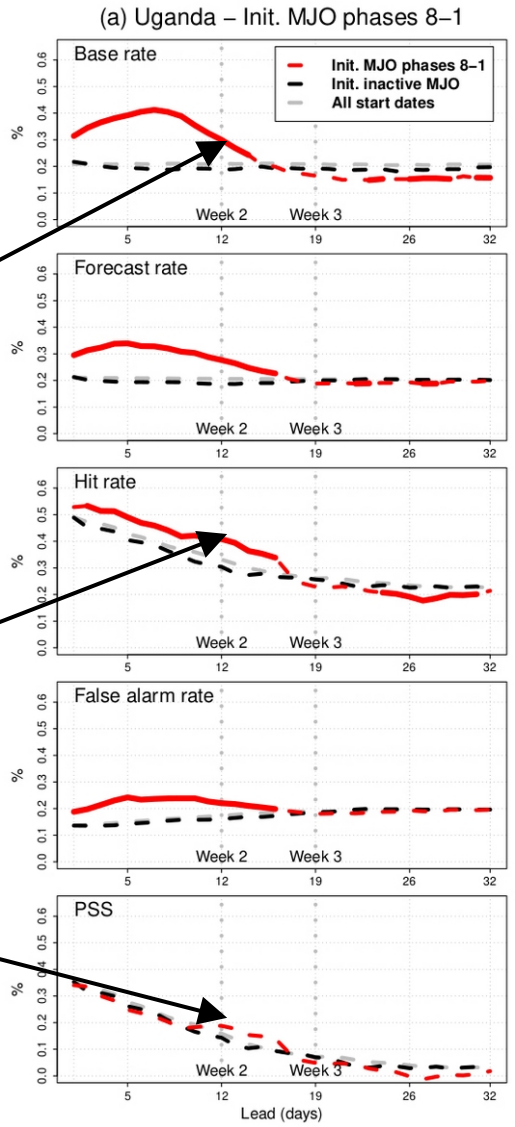


Climatological window of opportunity

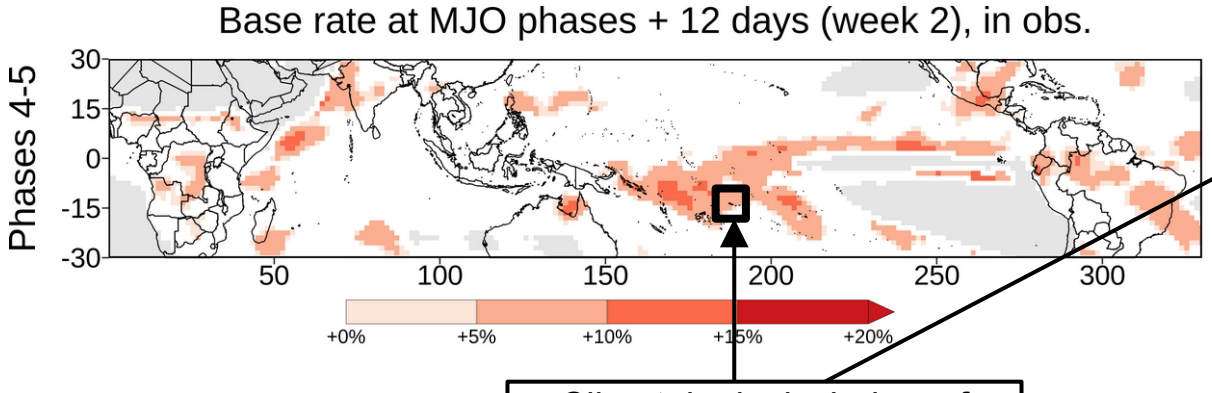
Type 1 "Model window of opportunity"

Increase in hit rate

Increase in PSS



Example 2: Samoa after MJO phases 4-5

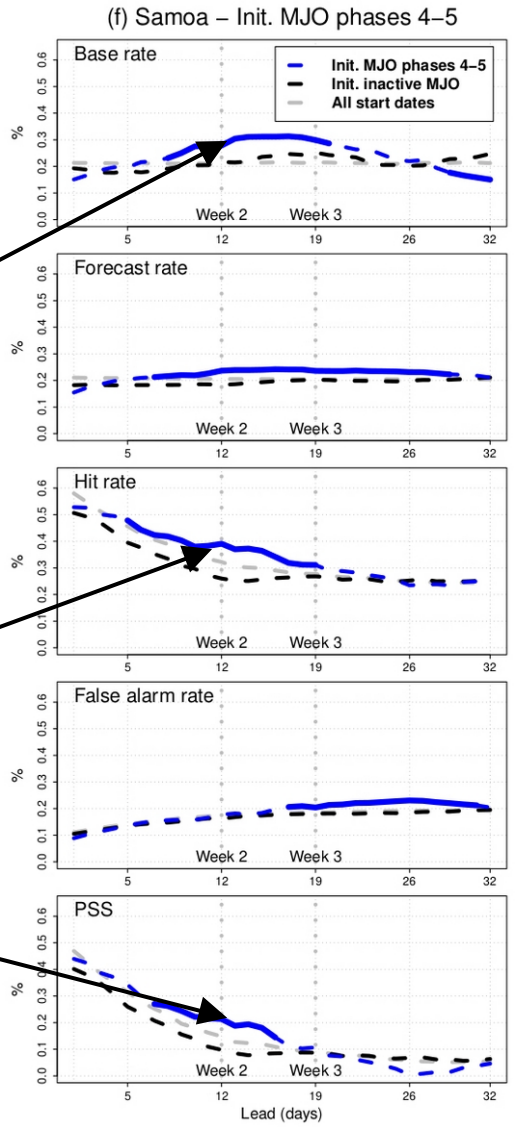


Climatological window of opportunity

Type 2 "Model window of opportunity"

Increase in hit rate

Increase in PSS



Case 2: Sudden Stratospheric Warmings and European cold spells

- SSWs are known to precede and favor cold spells over Eurasia (King et al. 2019, Domeisen et al. 2020)

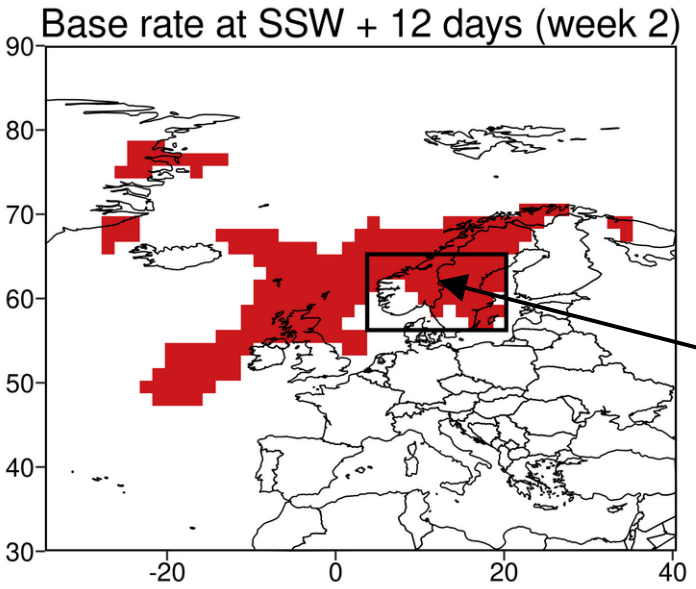
- Cold spell = **lower quintile** (20th percentile) of **21-day average temperature** at grid point in ERA5

- **ECMWF S2S reforecasts** for the November-to-April seasons from 2000-2001 to 2019-2020: 1040 start dates

- Start dates are compared between **“no-SSW years” vs “closest to SSW central date”**

- 9 downward-propagating SSWs (Karpechko et al. 2017) in the 20-year period

Example: Southern Scandinavia

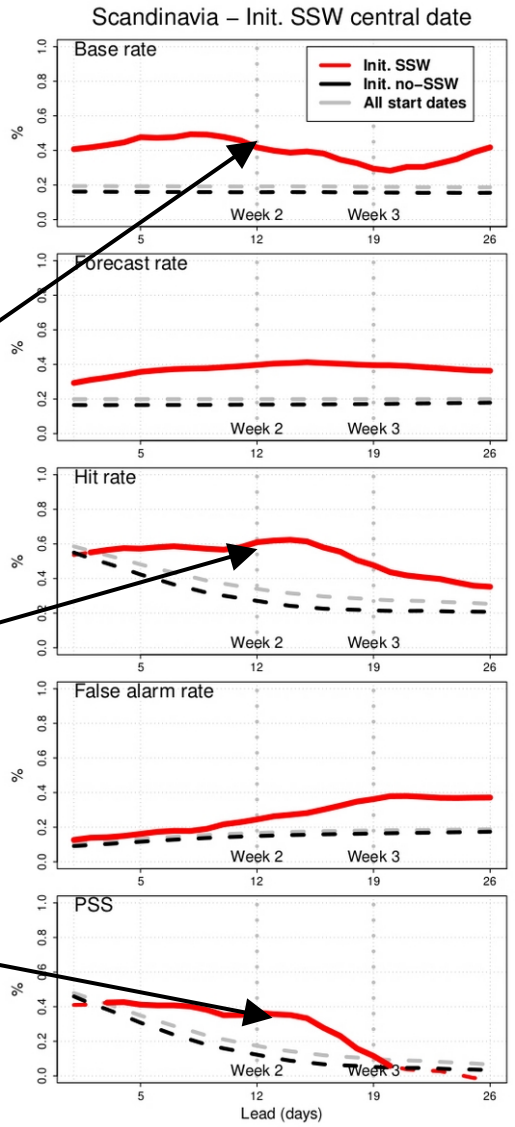


Climatological window of opportunity

Increase in hit rate

Increase in PSS

Type 2 "Model window of opportunity"



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SUMMARY

- An **opportunity-oriented verification framework**:
  Increase in climatological probability → Better detection of actual events? → Better skill score?

- **Type 1 model window of opportunity:** significantly better hit rate but too many false alarms

- **Type 2 model window of opportunity:** significantly better hit rate and PSS

- Forecasts do not always show increased skill (i.e PSS) when there is a precursor signal, as **more hits are often offset by more false alarms**.

Thank you for your attention!

Specq, D., L. Batté (2022). Do subseasonal forecasts take advantage of Madden-Julian oscillation windows of opportunity? *Atmospheric Science Letters* https://doi.org/10.1002/asl.1078

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