# Rapid Arctic sea ice loss events : Predictability

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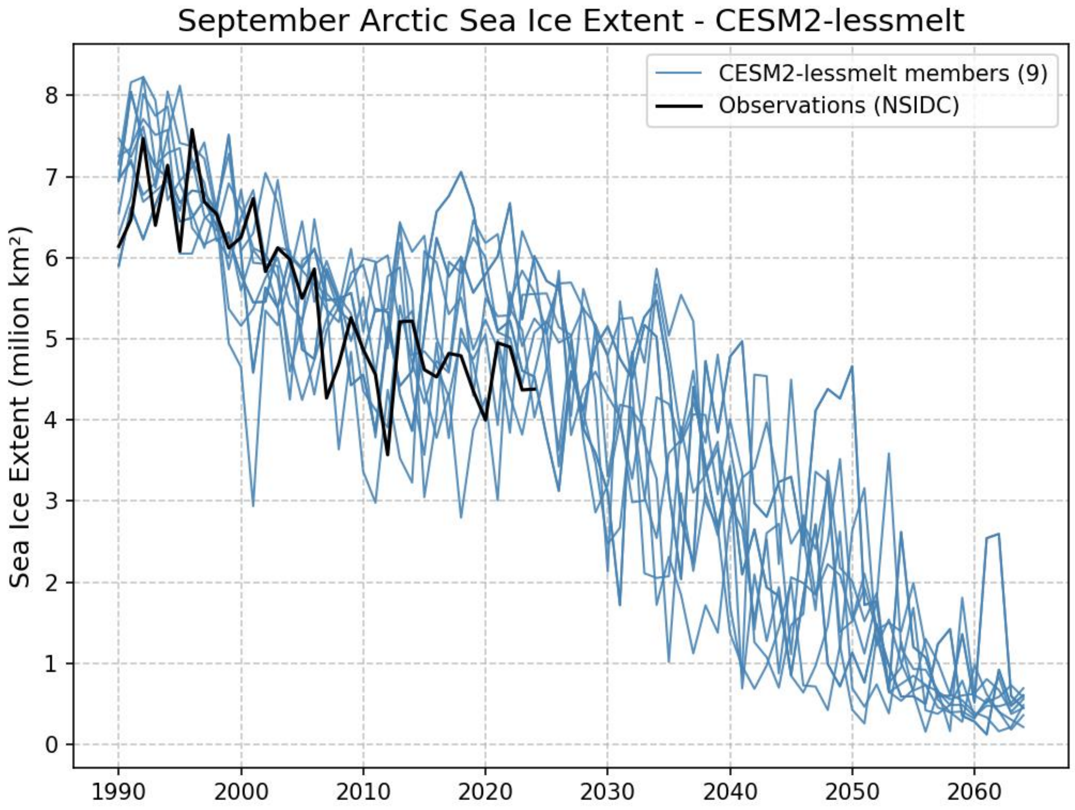
# Future Arctic sea ice decline will be erratic rather than smooth

**Rapid Ice Loss Events (RILEs) :** reductions in sea ice extent that occur at a much faster rate than expected from the forced contribution.

**According to Auclair & Tremblay 2018 (AT18)** : sequence of at least 4 consecutive years for which the trend in the 5-yr smoothed SIE is less than -0.3 million km²/year.




September sea ice extent trajectory according to CESM2-lessmelt (**Kay et al.,2022**) historical simulation (1990-2014) and future simulation (2015-2065) following SSP3-7.0 scenario.

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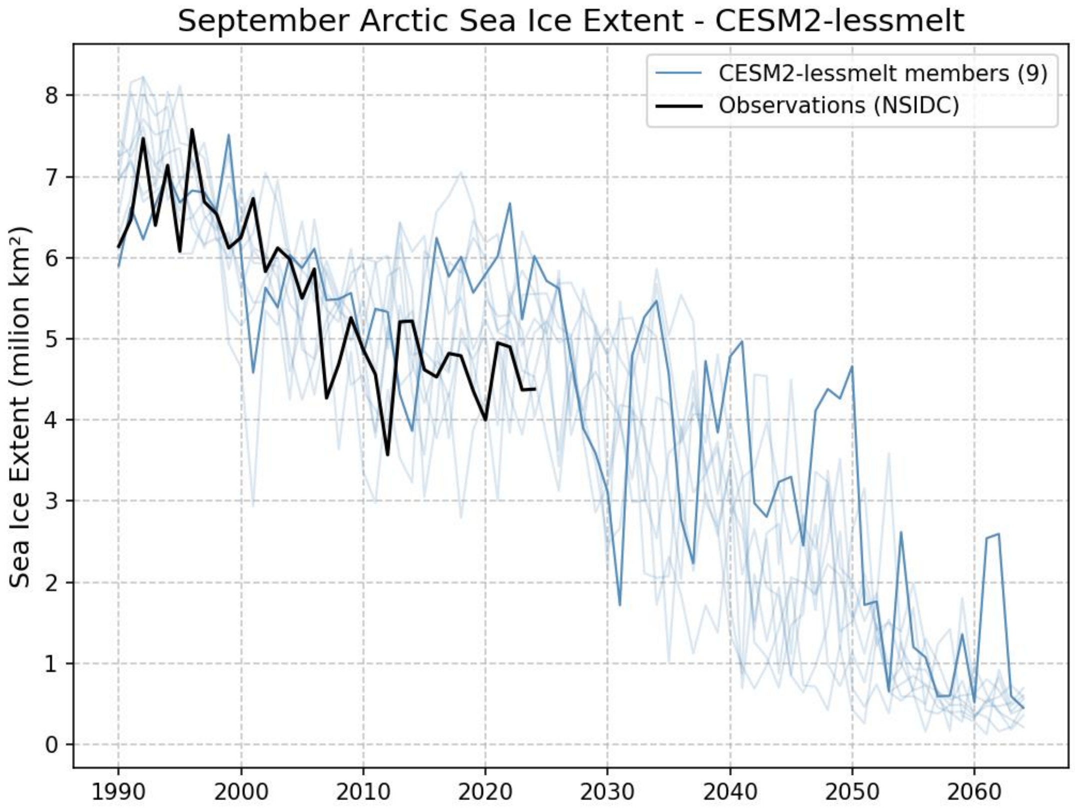


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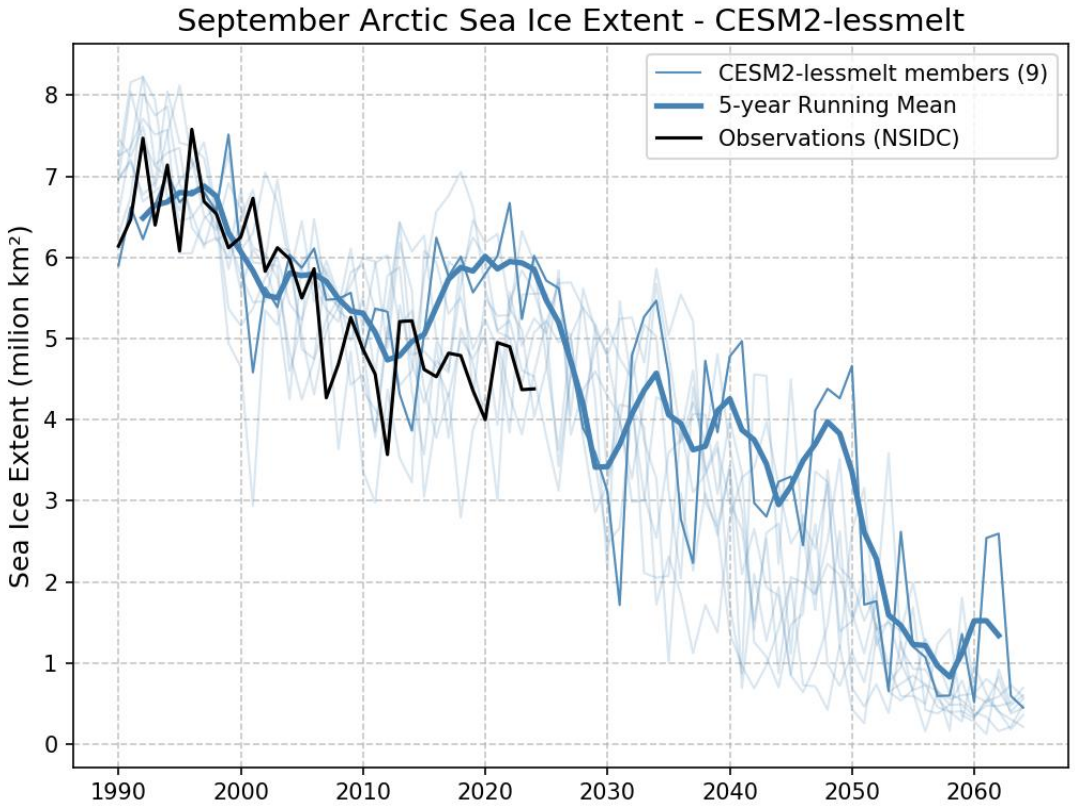


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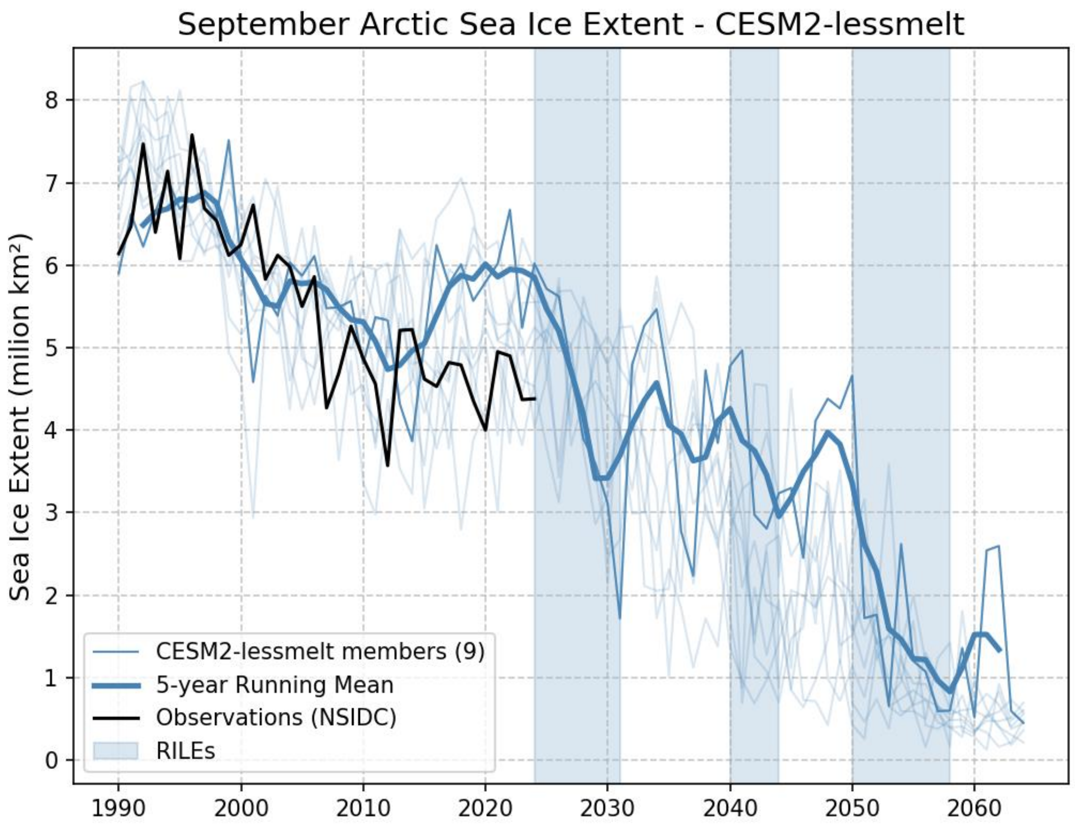


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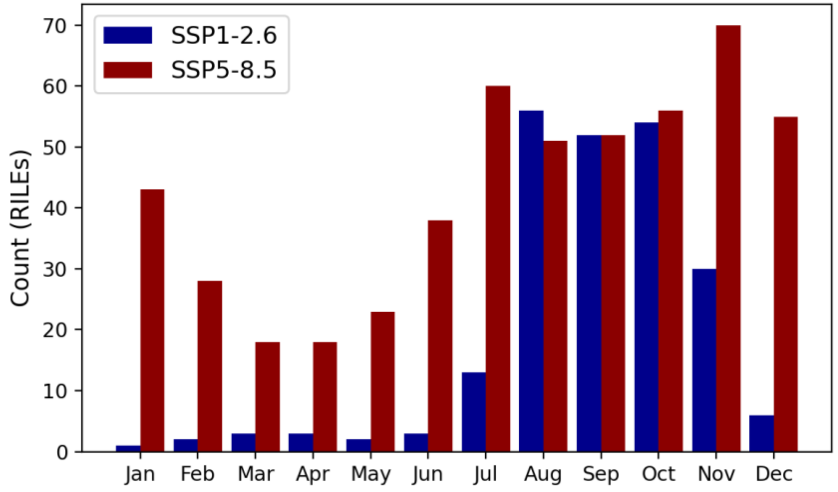
# Rapid Ice loss Events will become the rule rather than the exception according to CMIP6 models

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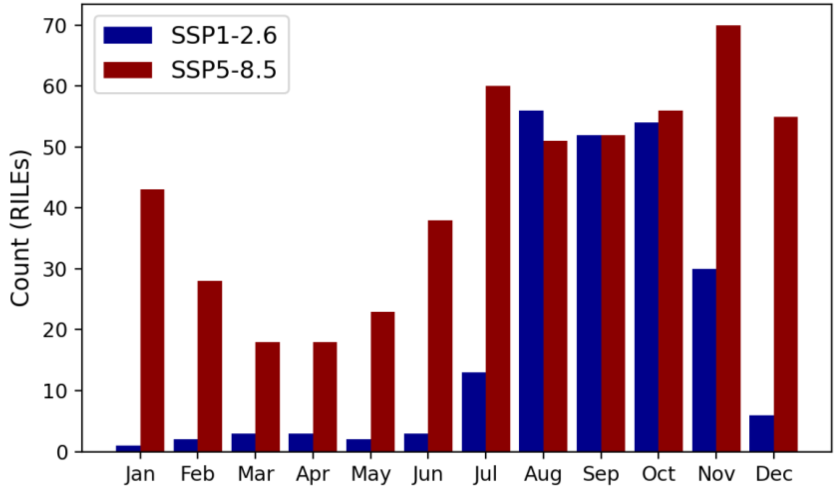


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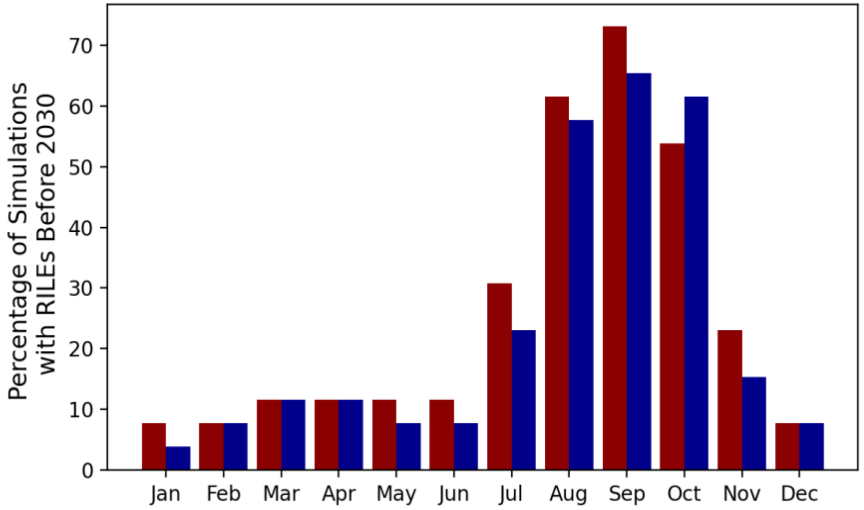


The probability of observing a RILE in the CMIP6 multi-model ensemble by 2030 is up to 70% in the summer season, regardless of the chosen scenario.

# Are there mechanisms of sea ice predictability for RILEs in the Arctic?

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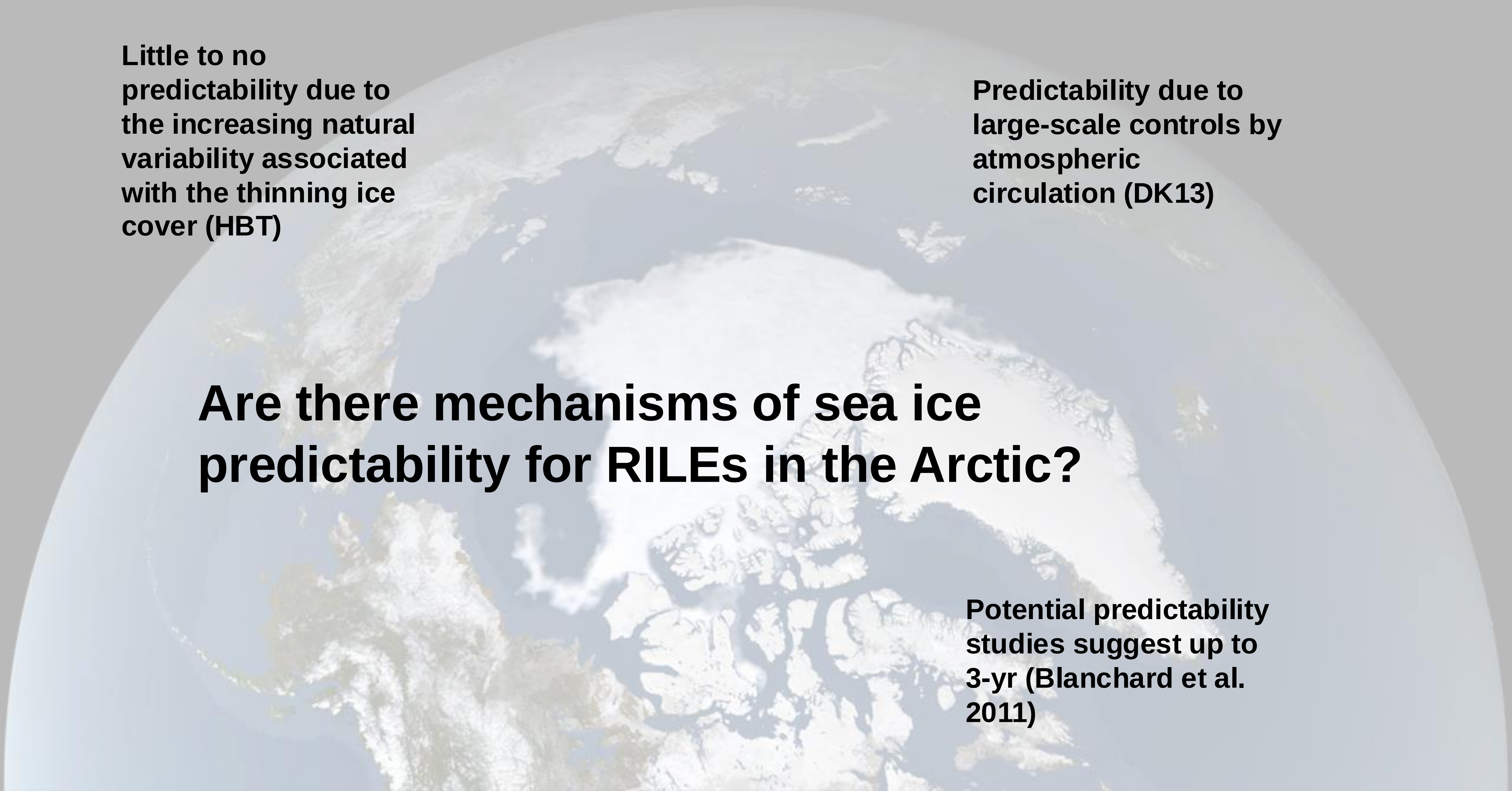

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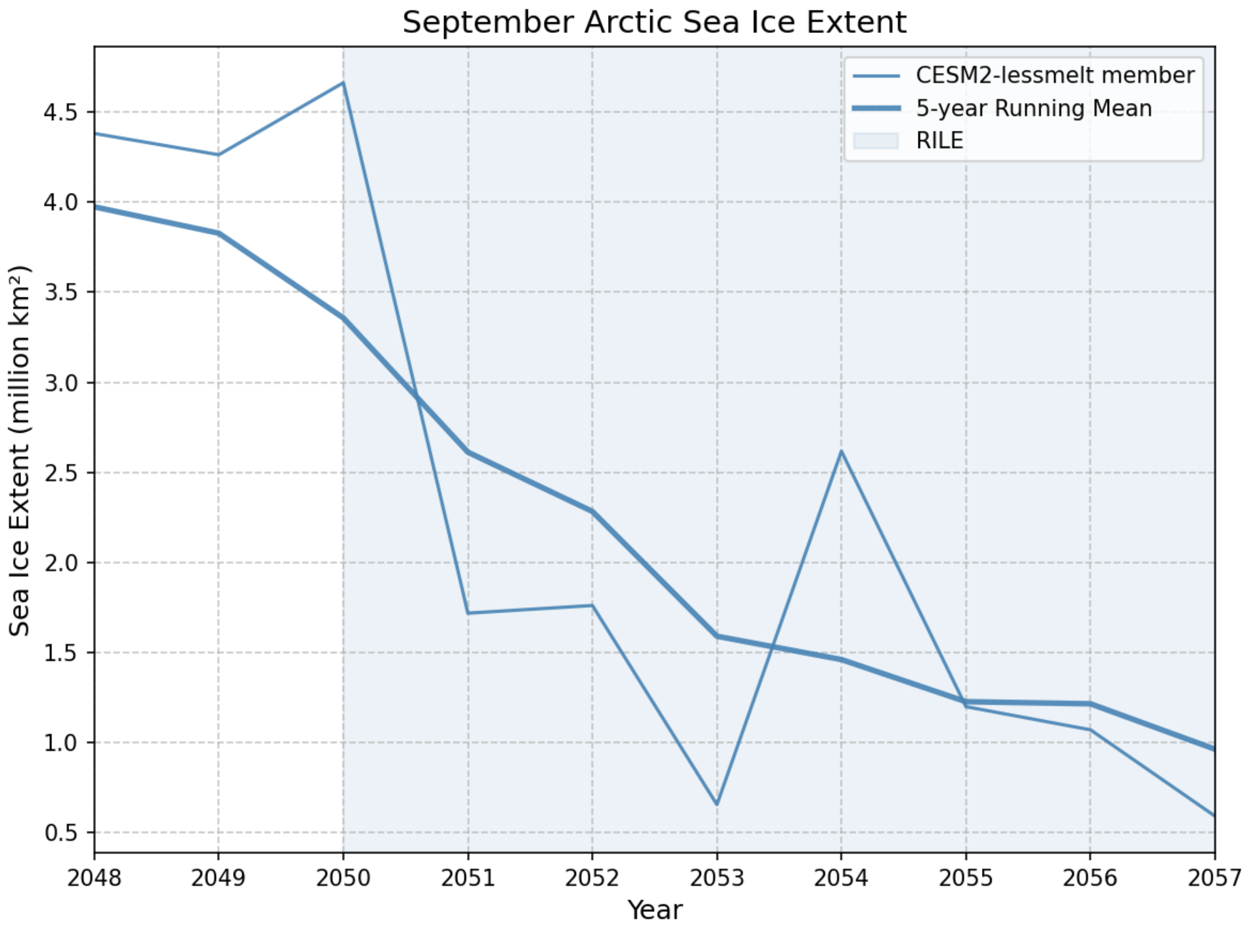
Potential predictability studies suggest up to 3-yr (Blanchard et al. 2011)

# Sensitivity Simulations with CESM2-lessmelt




**Investigating Key Factors in RILE Onset:**

- Internal Variability
- Initial Sea Ice Conditions
- External Forcing

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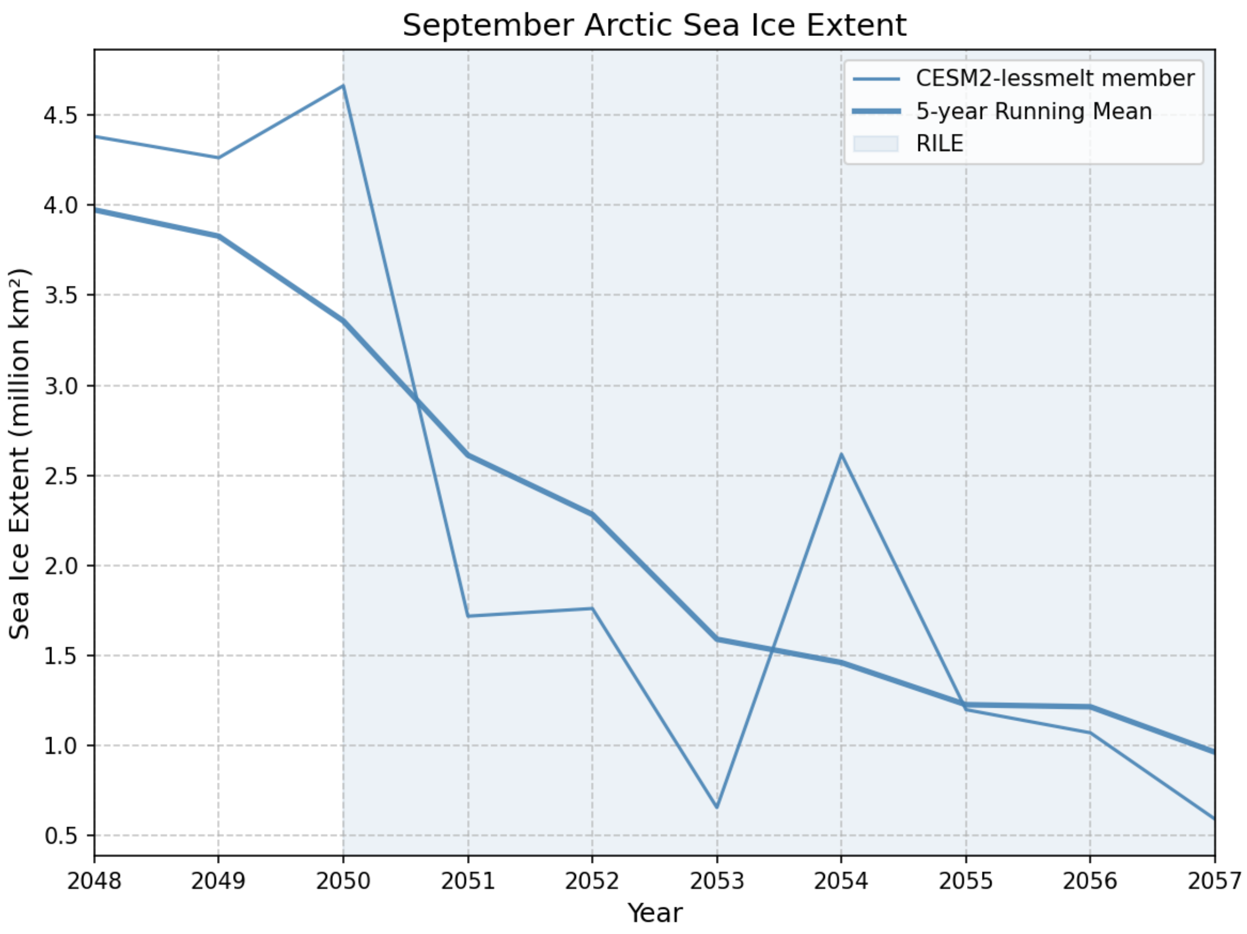


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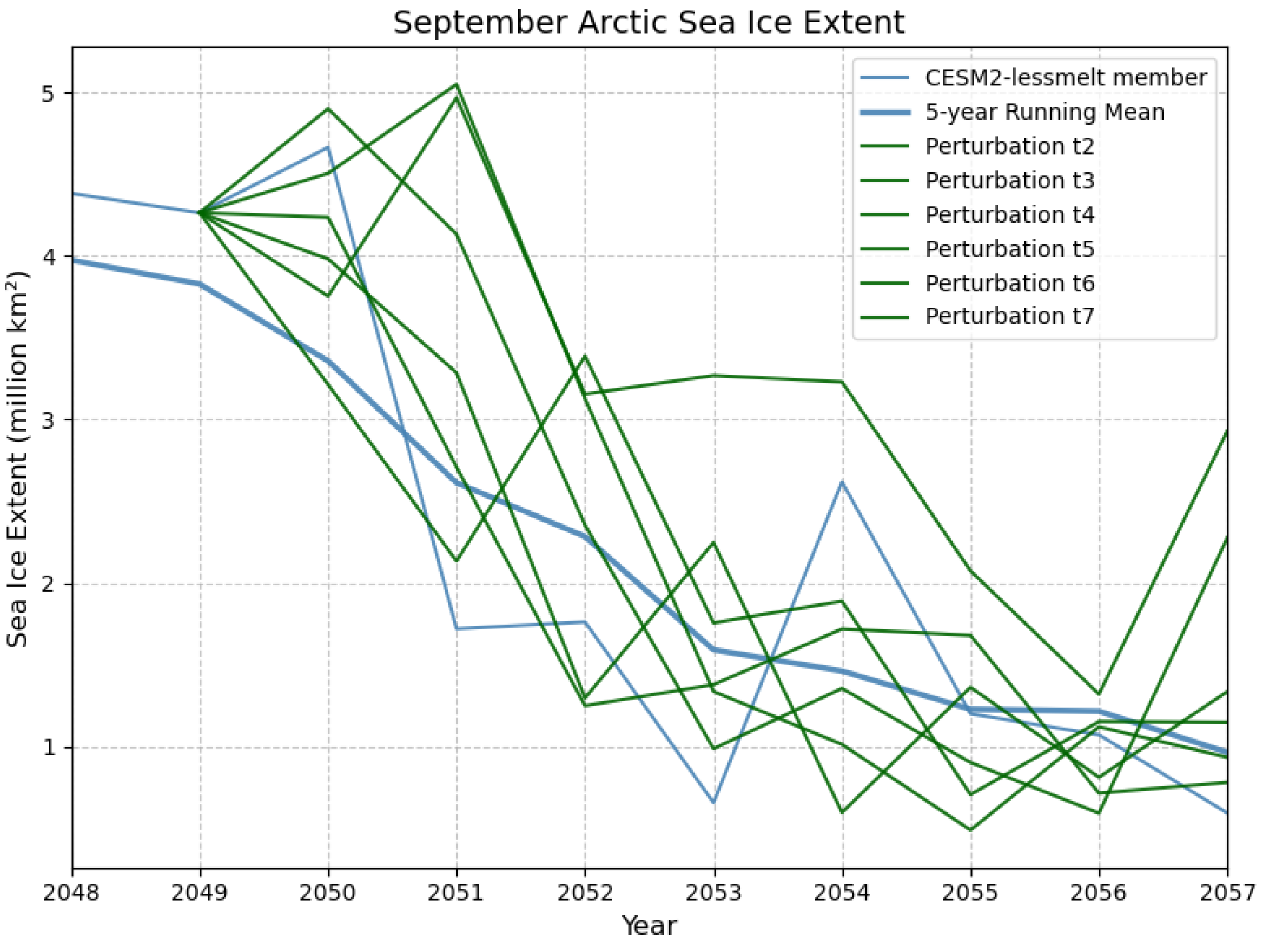
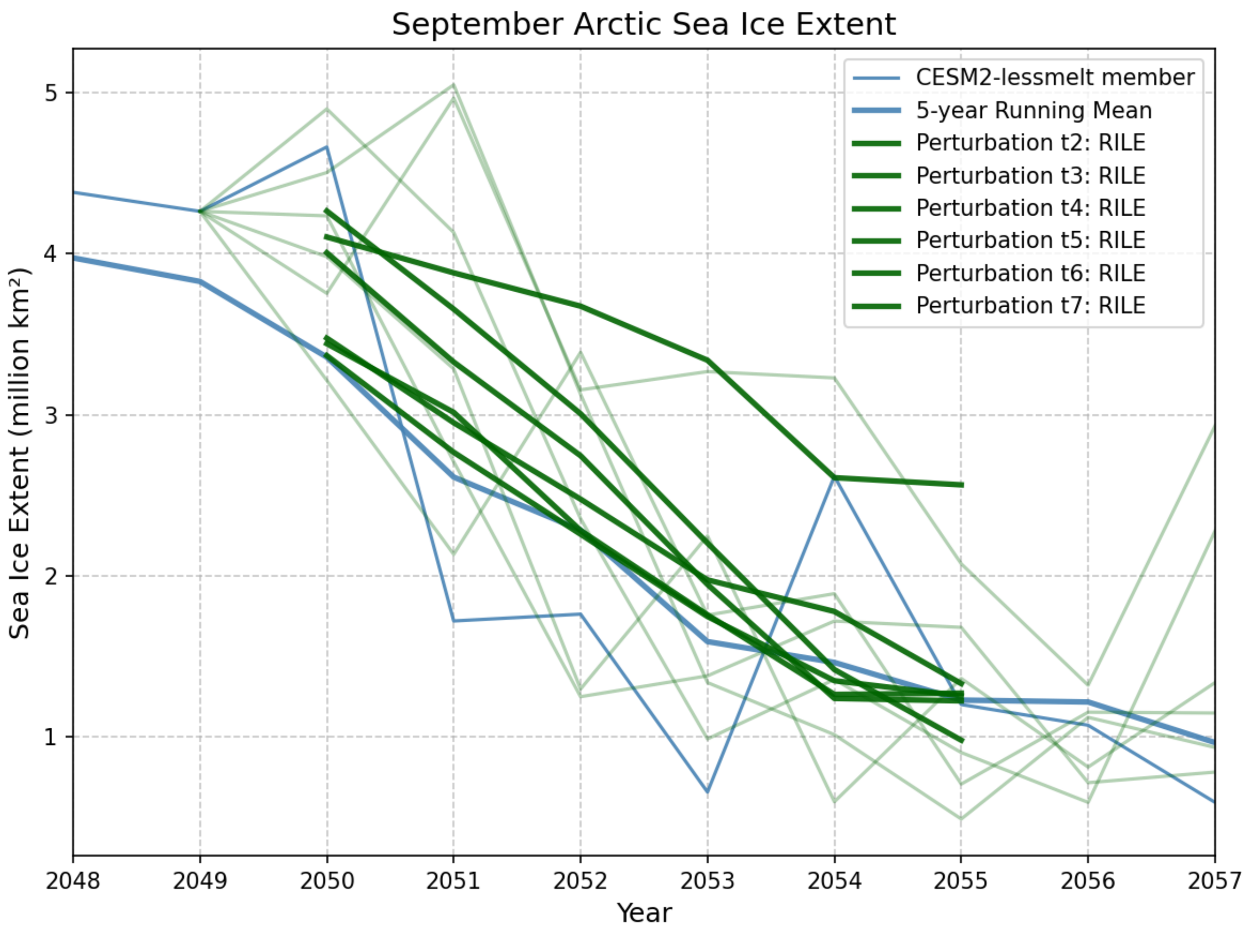
# Role of Internal Variability



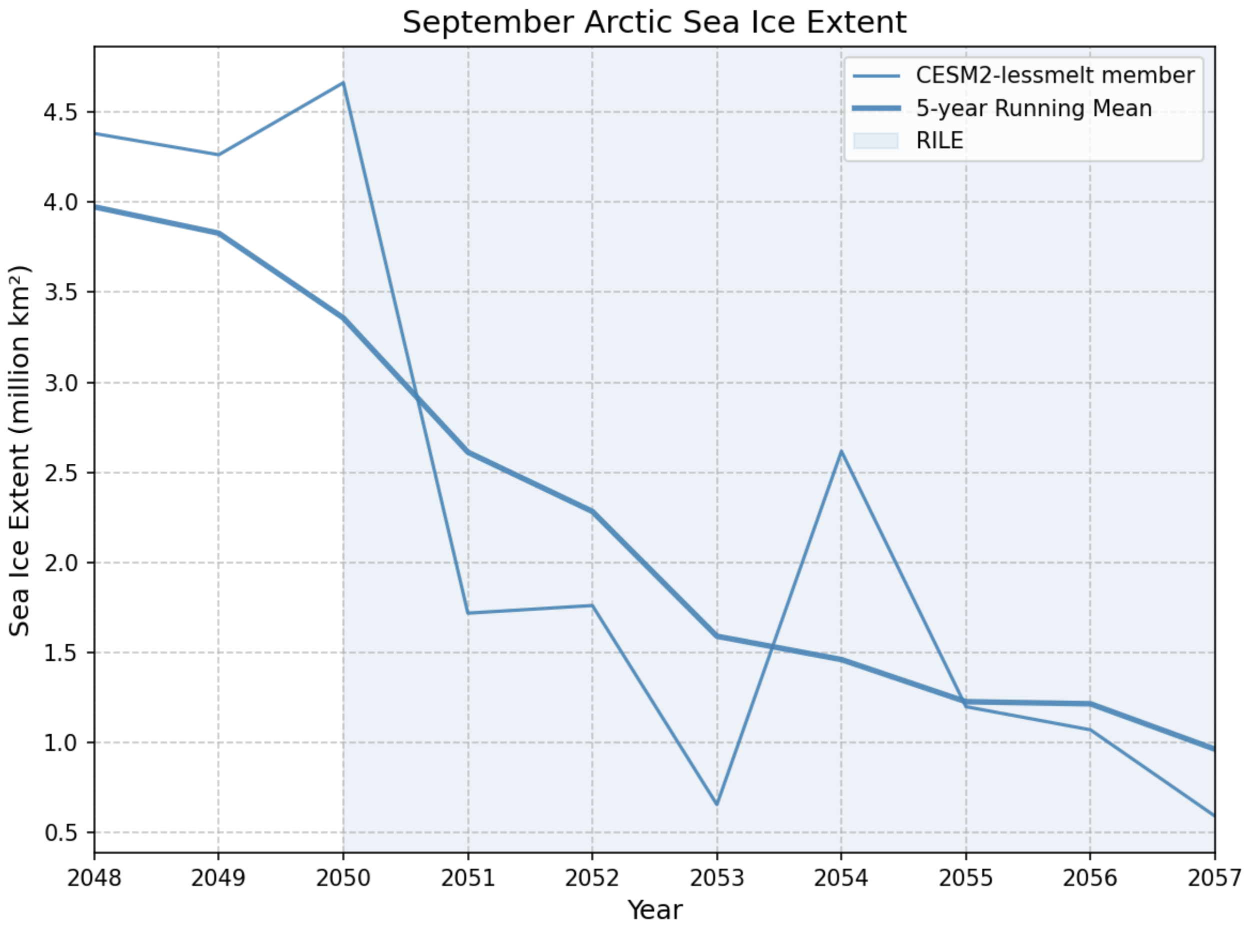

To assess the role of internal variability, we introduced perturbations on January 1st, 2050, the year of the RILE onset, by applying a small rounding-level change to air temperature.

# Role of Internal Variability




In this small ensemble, internal variability does not appear to play a dominant role, as **all simulations show a RILE** in September

# Sensitivity Simulations with CESM2-lessmelt

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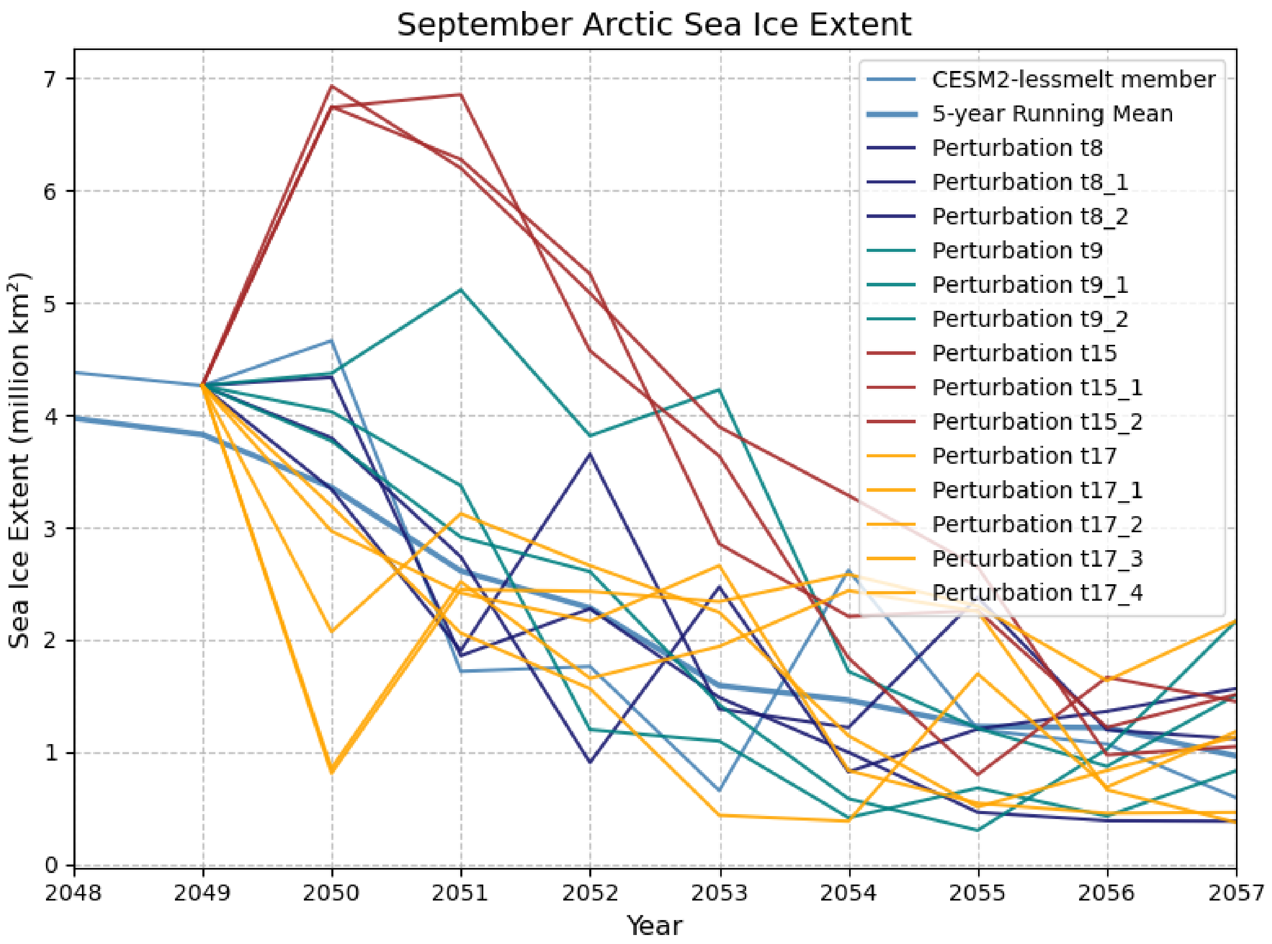
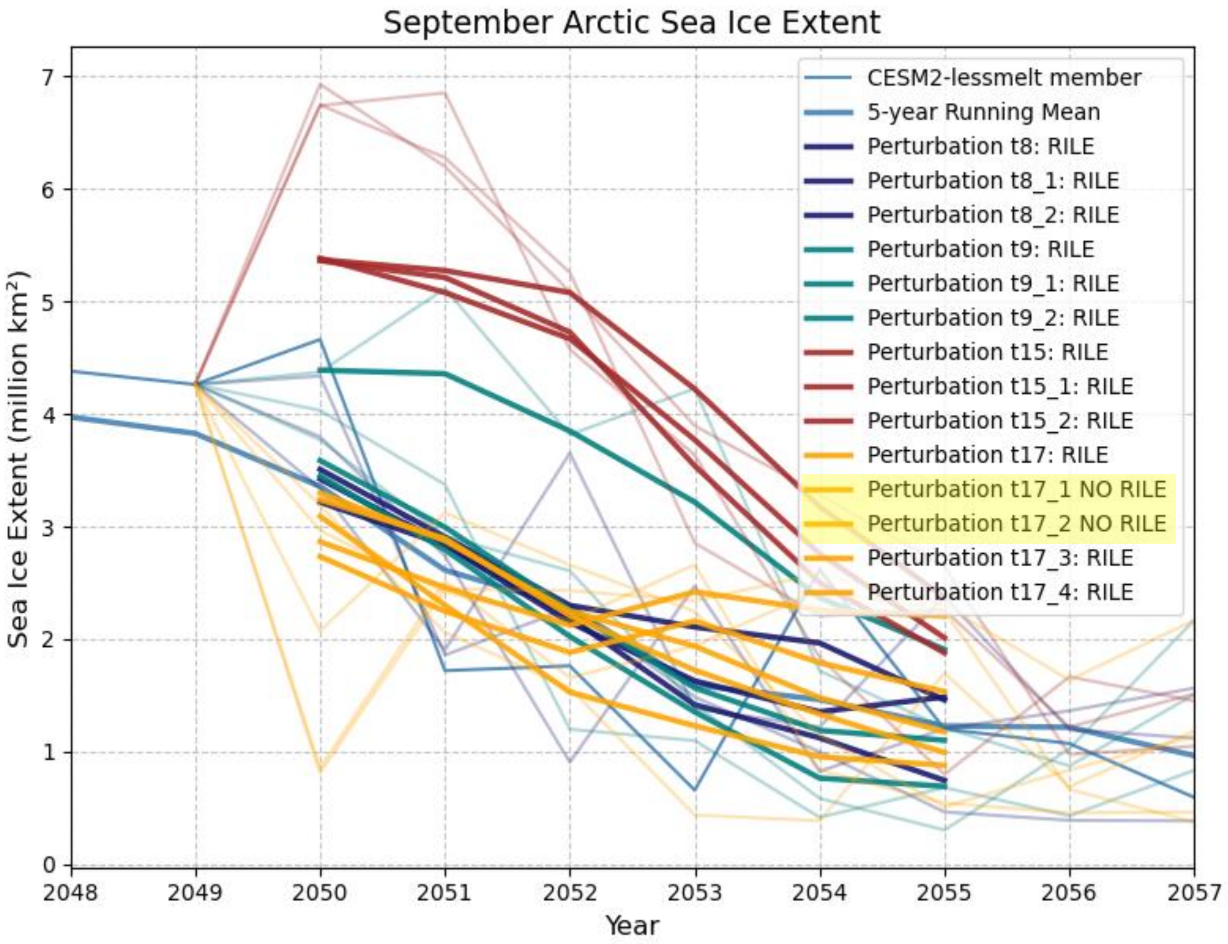
# Role of Sea Ice Initial State




- **Similar SIE/SIV initial state** but taken from a different year and a different simulation (t8-t9_2).
- **Higher SIE initial state** (~7 million km²) from 1980 within the same simulation (t15-t15_2).
- **Lower SIE initial state** (~2 million km²) from 2050 in a different simulation (t17-t17_4).

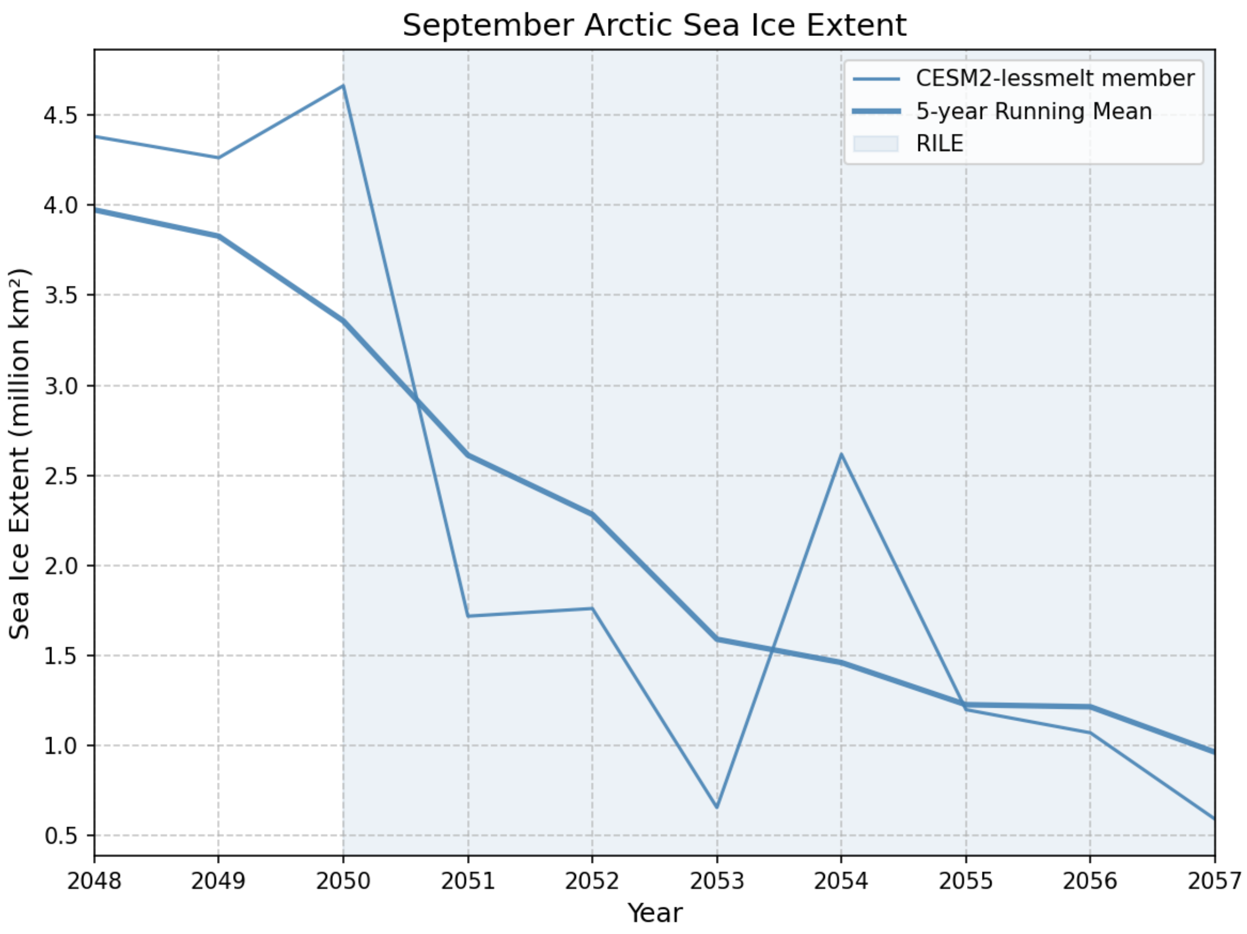
# Role of Sea Ice Initial State




In 85% of simulations with a different sea ice initial state, a RILE still occurs in September.

In the remaining 15% of simulations, which were initialized with a lower sea ice state, sea ice increased during the first year before stabilizing, preventing a RILE.

# Sensitivity Simulations with CESM2-lessmelt

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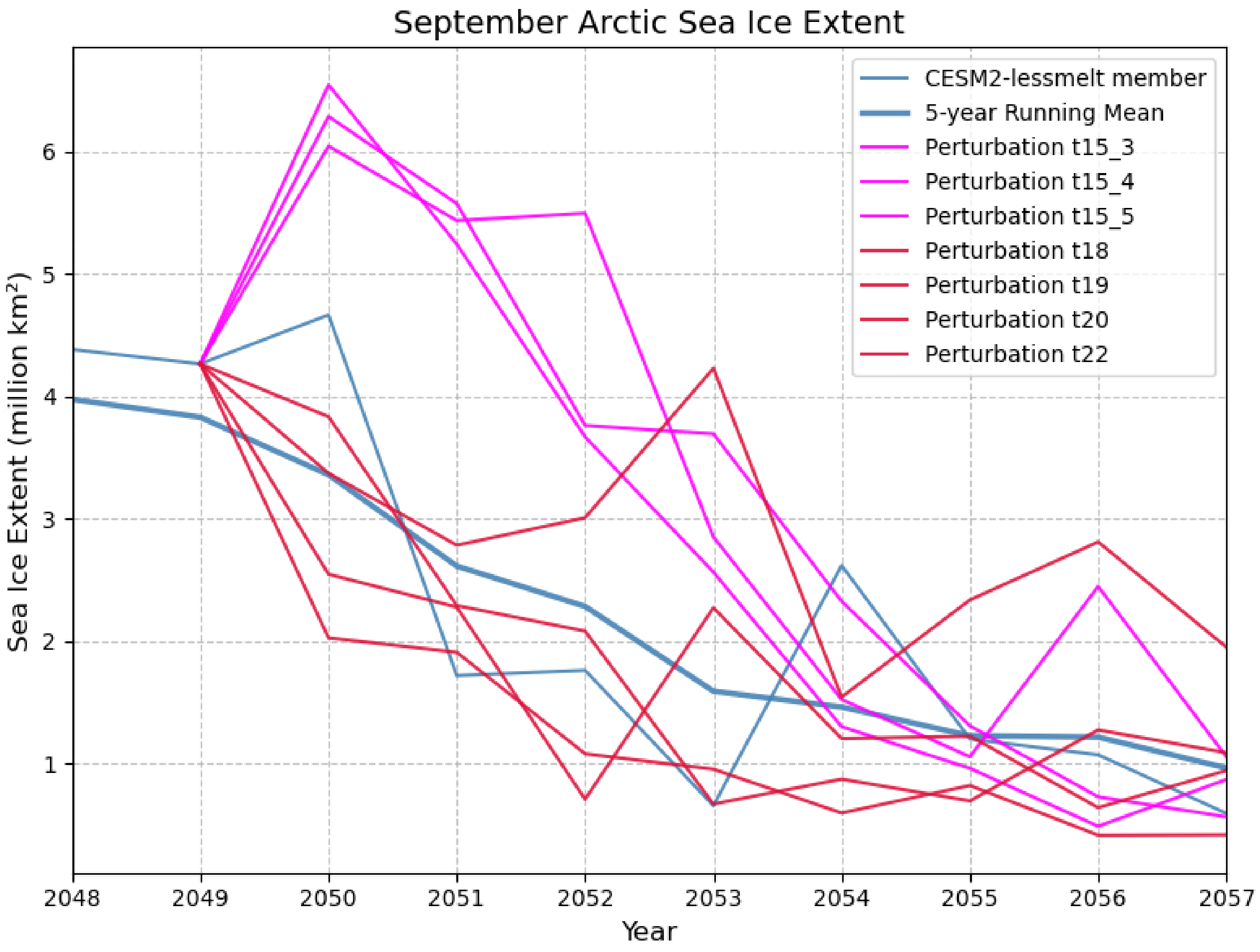
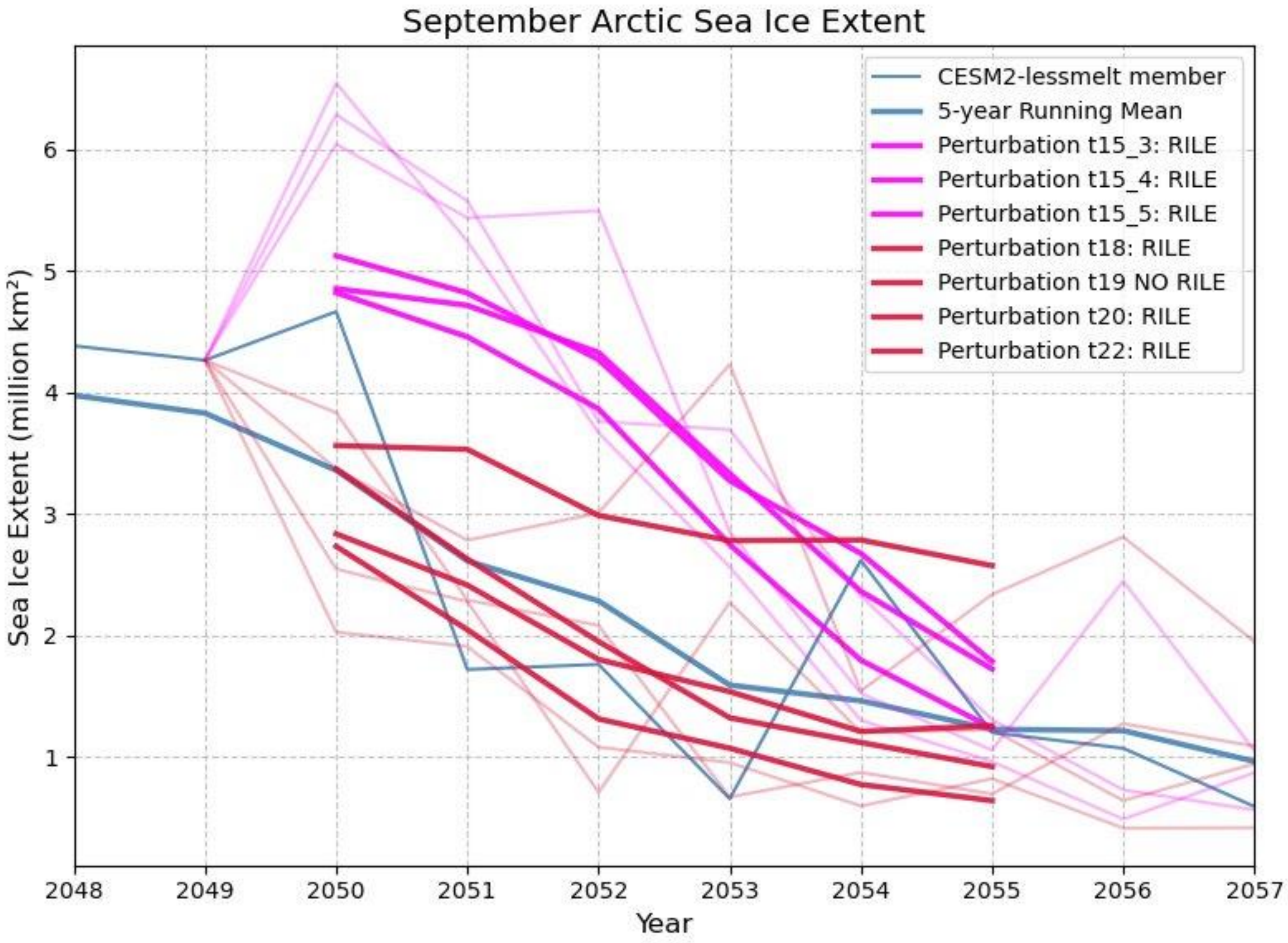
# Role of Forcing




- Switch the scenario for a lower external forcing (SSP1-2.6) in the year of the RILE onset (t18-t22).

- Initiated with a higher initial state of SIE/SIV, and the switch to a lower forcing (SSP1-2.6) in 2050 (t15_3-15_5).

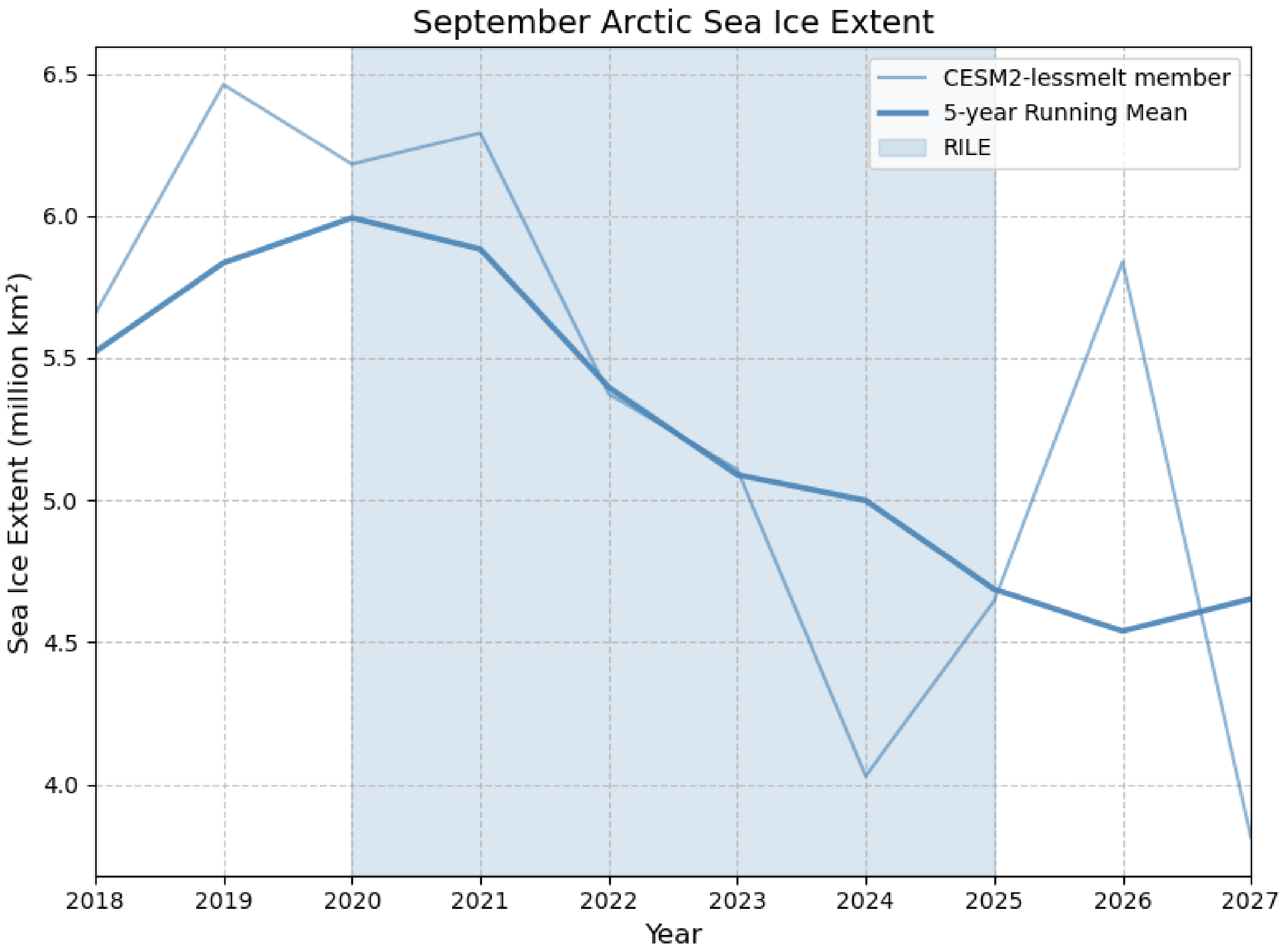
# Role of Forcing




The majority of simulations (7 out of 8) still exhibit a RILE in September.

However, even in the SSP1-2.6 scenario, the forcing in 2050 may still be strong enough to drive SIE to an extreme event.

# What about an earlier RILE?




As in the first simulations, we introduced perturbations on January 1st, 2020— RILE onset year from another simulation from CESM2-lessmelt

At that time, the external forcing in SSP3-7.0 remains similar to the external forcing observed today

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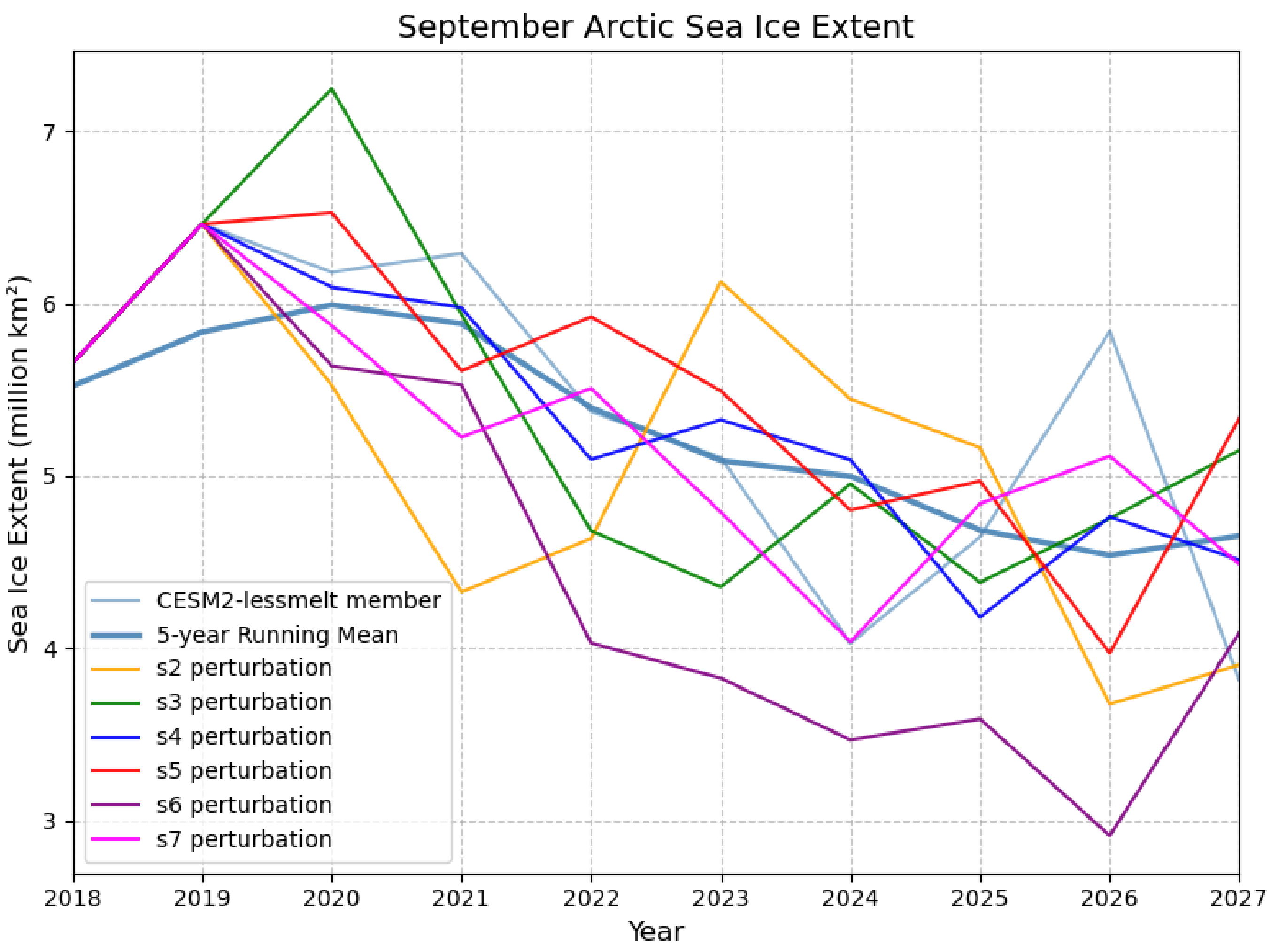


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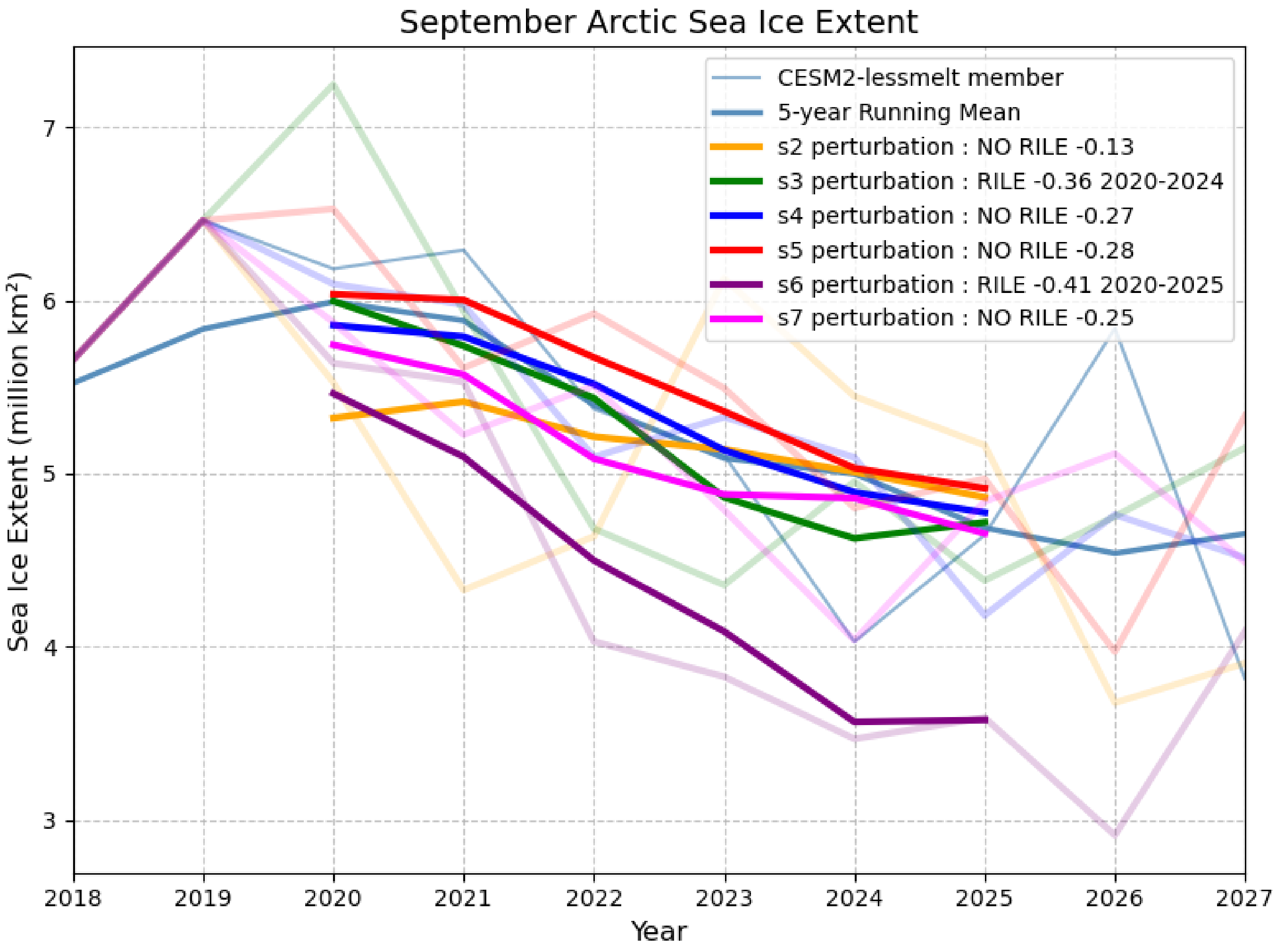


Two out of six simulations showed a RILE in September. Internal variability appears to play a more dominant role in years with lower external forcing.

# Conclusion

By 2050, the forcing—regardless of the chosen future scenario—could be strong enough to drive sea ice towards rapid ice loss events, irrespective of the initial sea ice or ocean state.

Or the mean state of September sea ice extent in this member being significantly higher compared to other members in 2050 could explain that the majority of the simulations show a RILE.

# Next Work

- Does predictability is in the atmospheric state prior to these extreme events?
- **Assess the sea ice mass budget** during the RILE period to determine for example whether these events are driven by excess melt or a deficit in growth.
- **Investigate the mechanisms** driving RILEs in this ensemble, considering factors such as autumn air temperature anomalies, ocean heat content, and other potential contributors.