Recent Arctic sea ice loss from the perspective of a Rapid Ice Loss Event (RILE) using CMIP5

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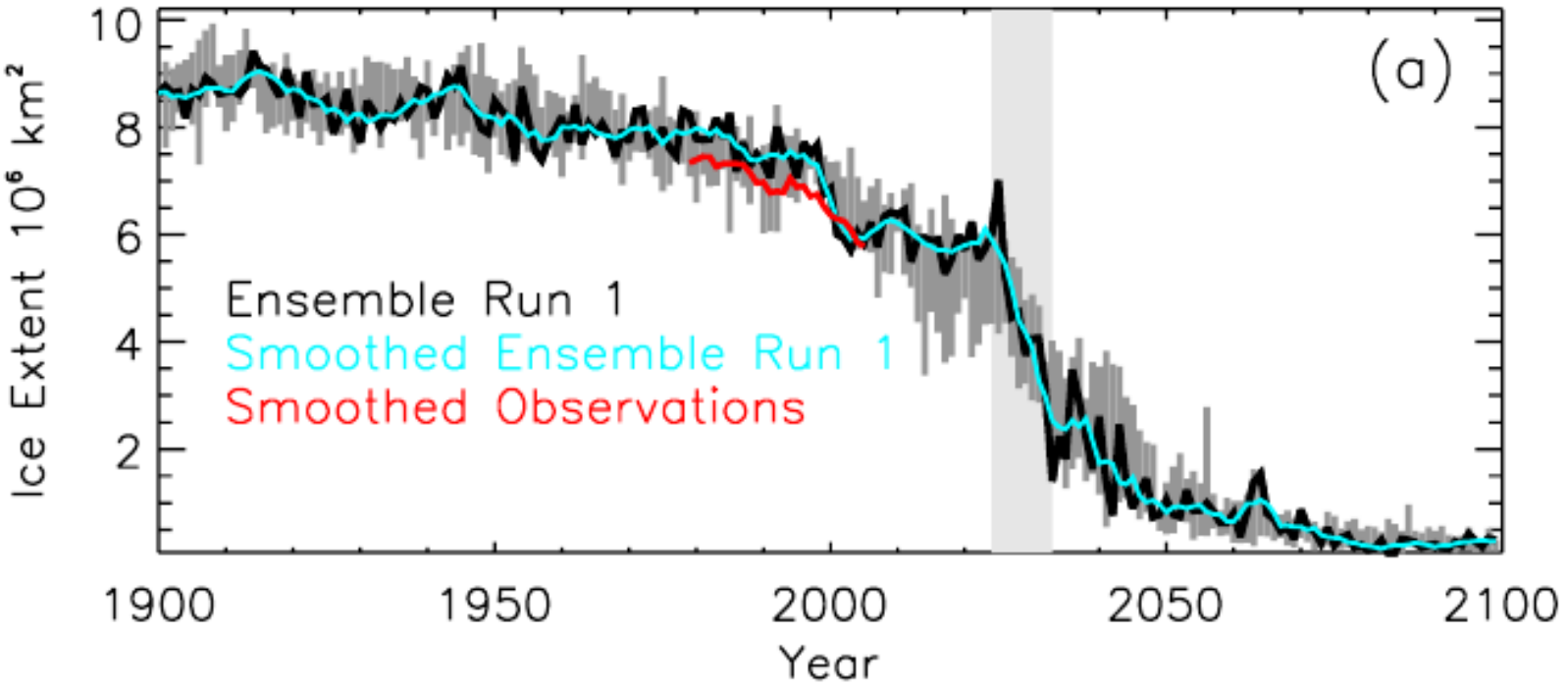
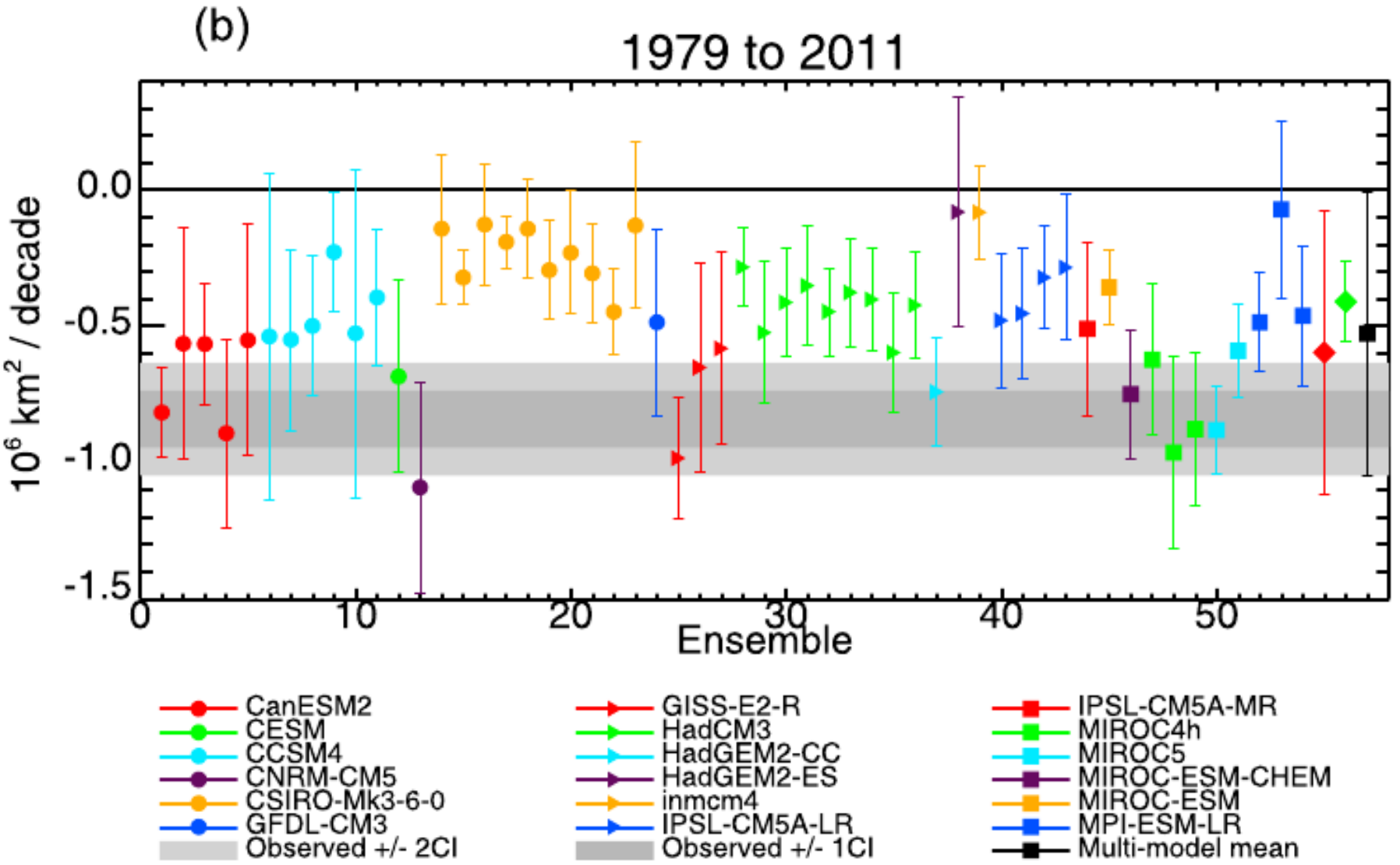
Holland, Bitz, Tremblay, 2006, GRL



- Rapid Ice Loss Events (RILEs)
  - Abrupt September sea ice extent reductions characteristic in CCSM3 ensemble
  - Short term events: ~ 5 years
  - Similar events in CMIP3 models

CMIP5 September Arctic Sea Ice Trends



Stroeve et al, 2012 GRL

Rapid ice loss events (RILEs) in CMIP5

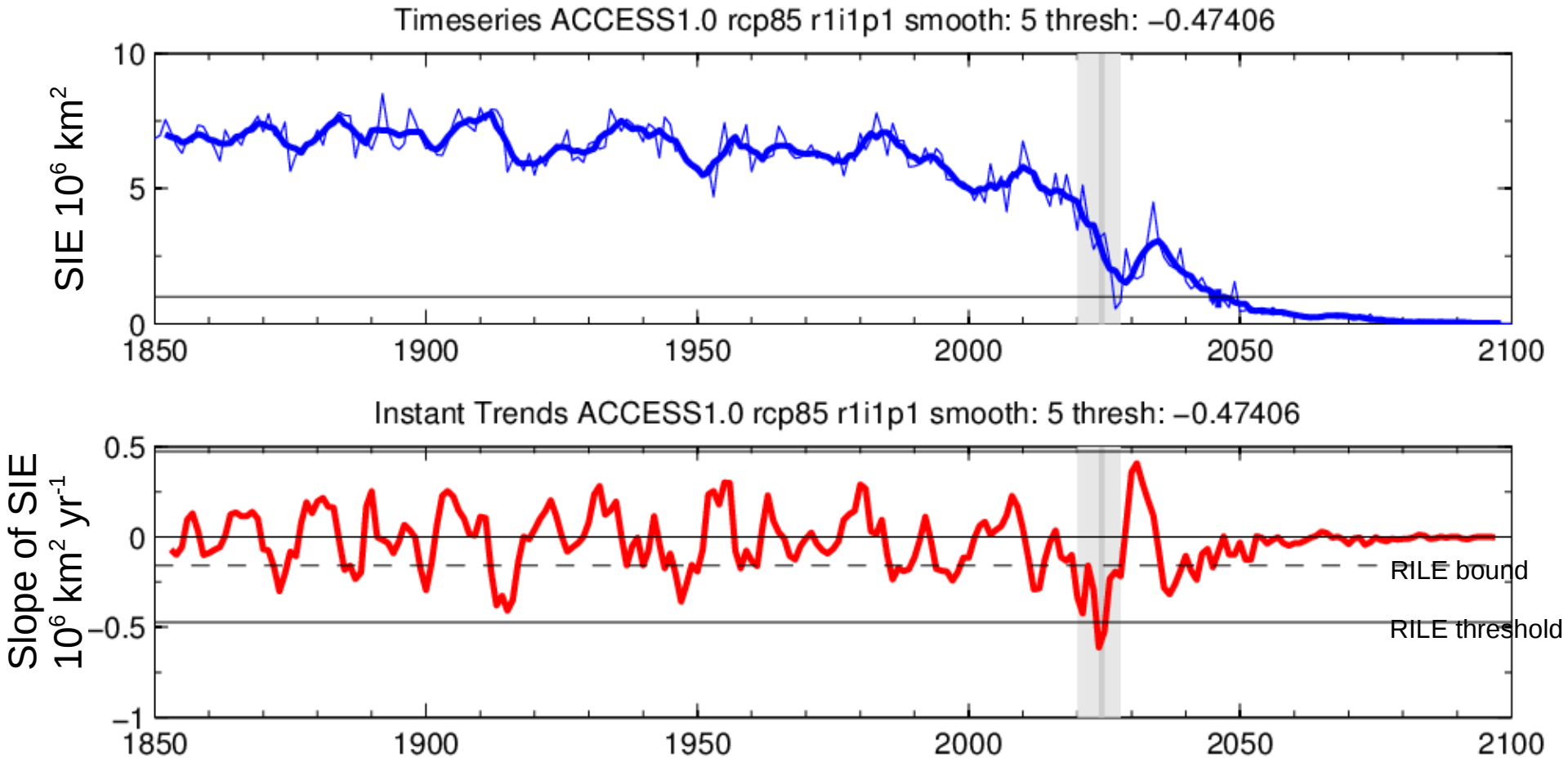
- How prevalent are RILE events in CMIP5?
  - Probability
  - Absolute timing
  - Timing related to ice-free condition threshold

- If nature is currently in a RILE
  - Can we predict short term sea ice trajectory?

RILE definition

- Use derivative (slope) of 5-yr running mean Sept. SIE
- Determine 3σ event threshold using detrended slopes for 1850-1990
- Find all slopes >3σ in derivative of 5-yr running mean SIE timeseries
- Bound events at 1/3 of threshold (1σ)

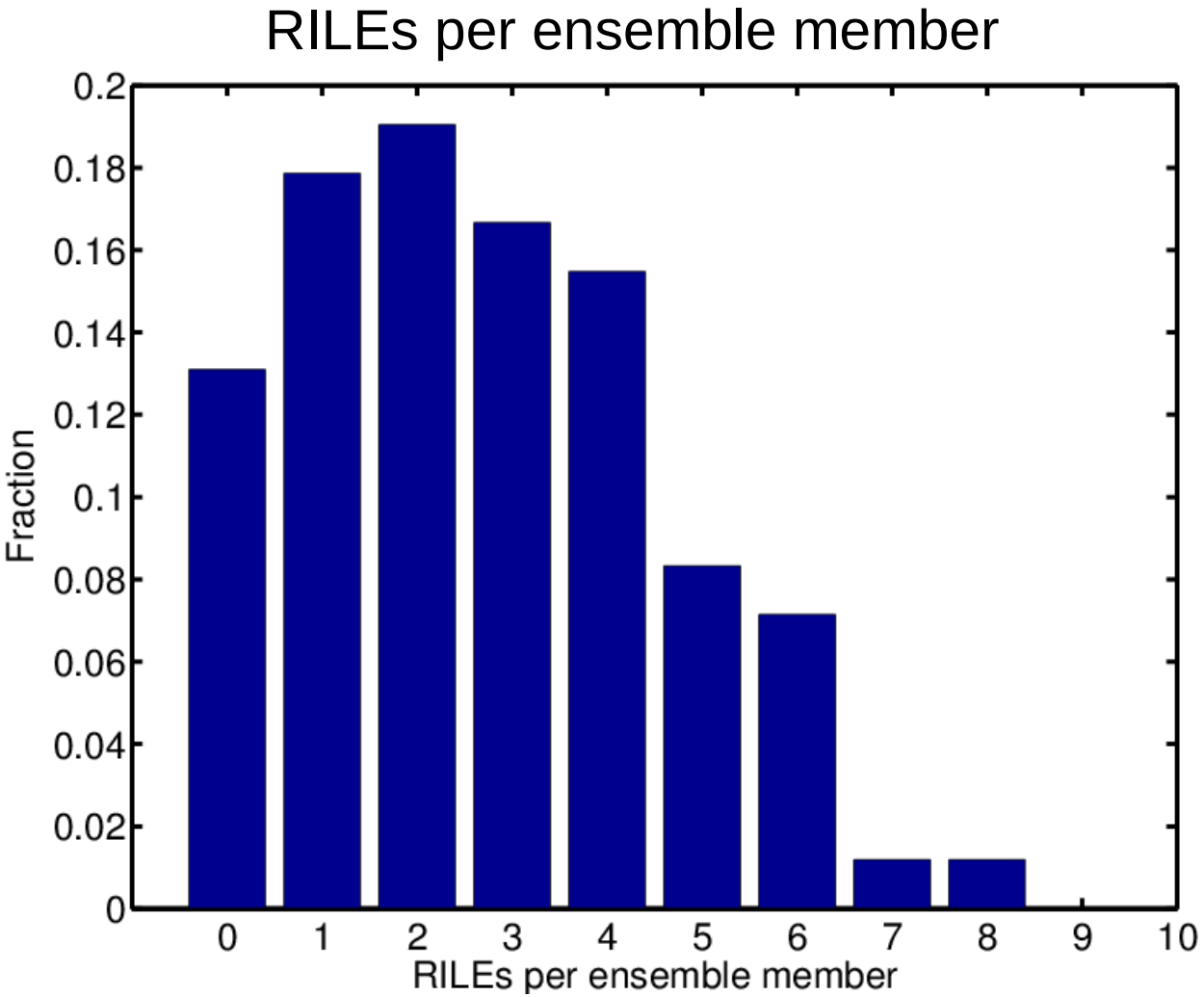
Time series with 1 RILE



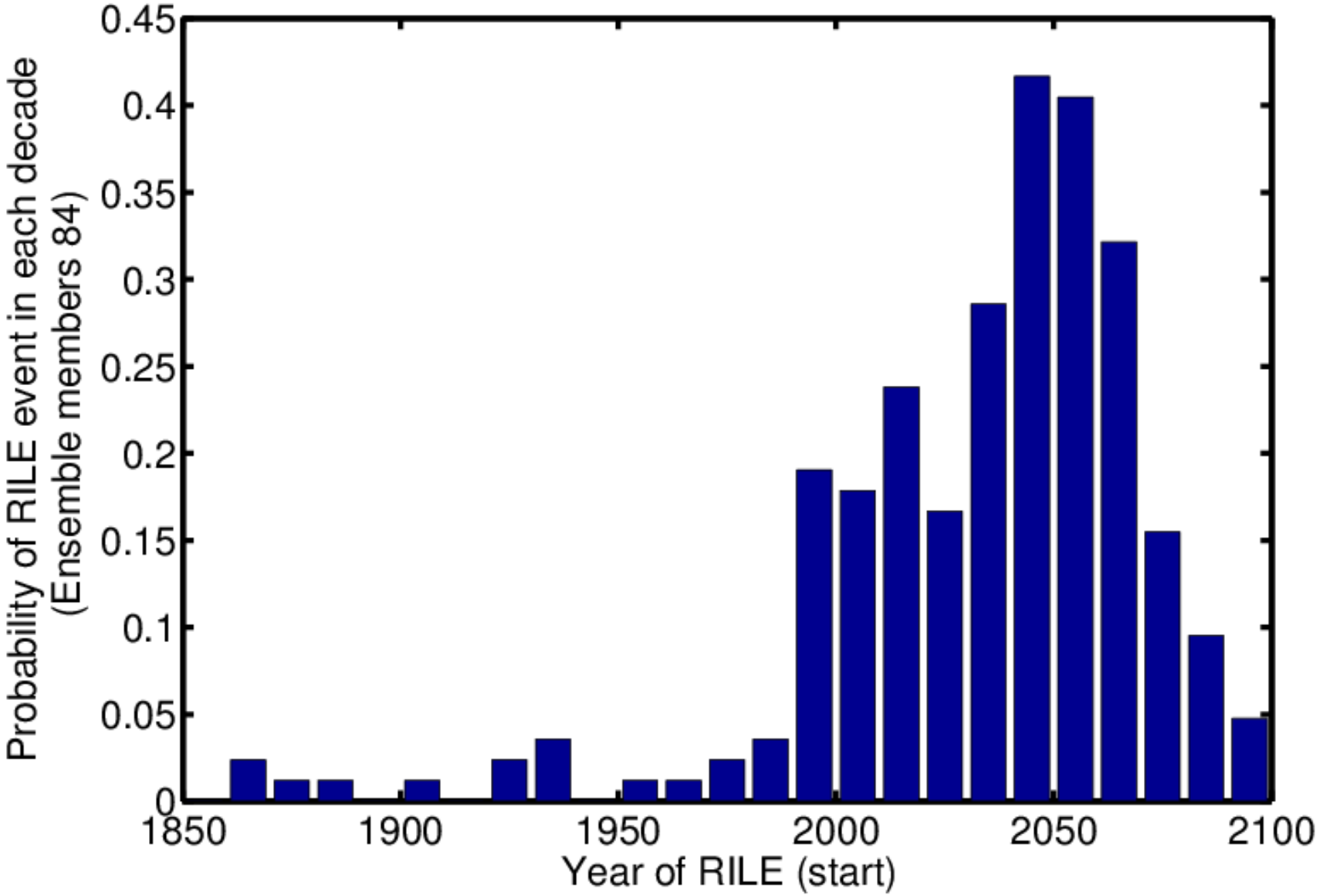
RILE events summary

- 84 ensemble members. 73 have at least 1 RILE.
- 227 RILE events.
- Mean threshold:

  -0.34 x10^6 km^2/yr
- 3/4 members increase variance of instantaneous trends by >20%;
- 3/8 members increase variance by >50%

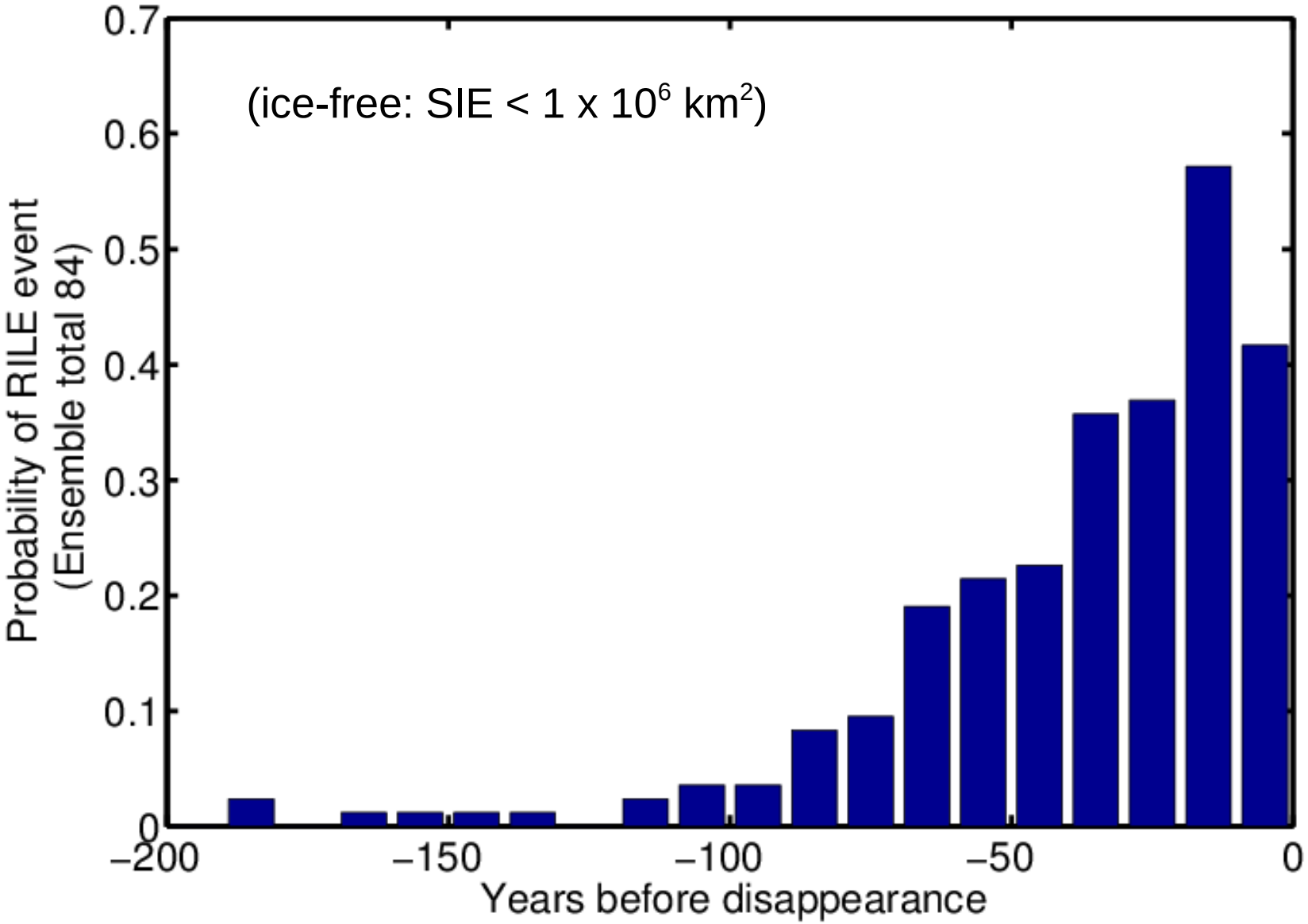


Probability of RILE in 10 year period

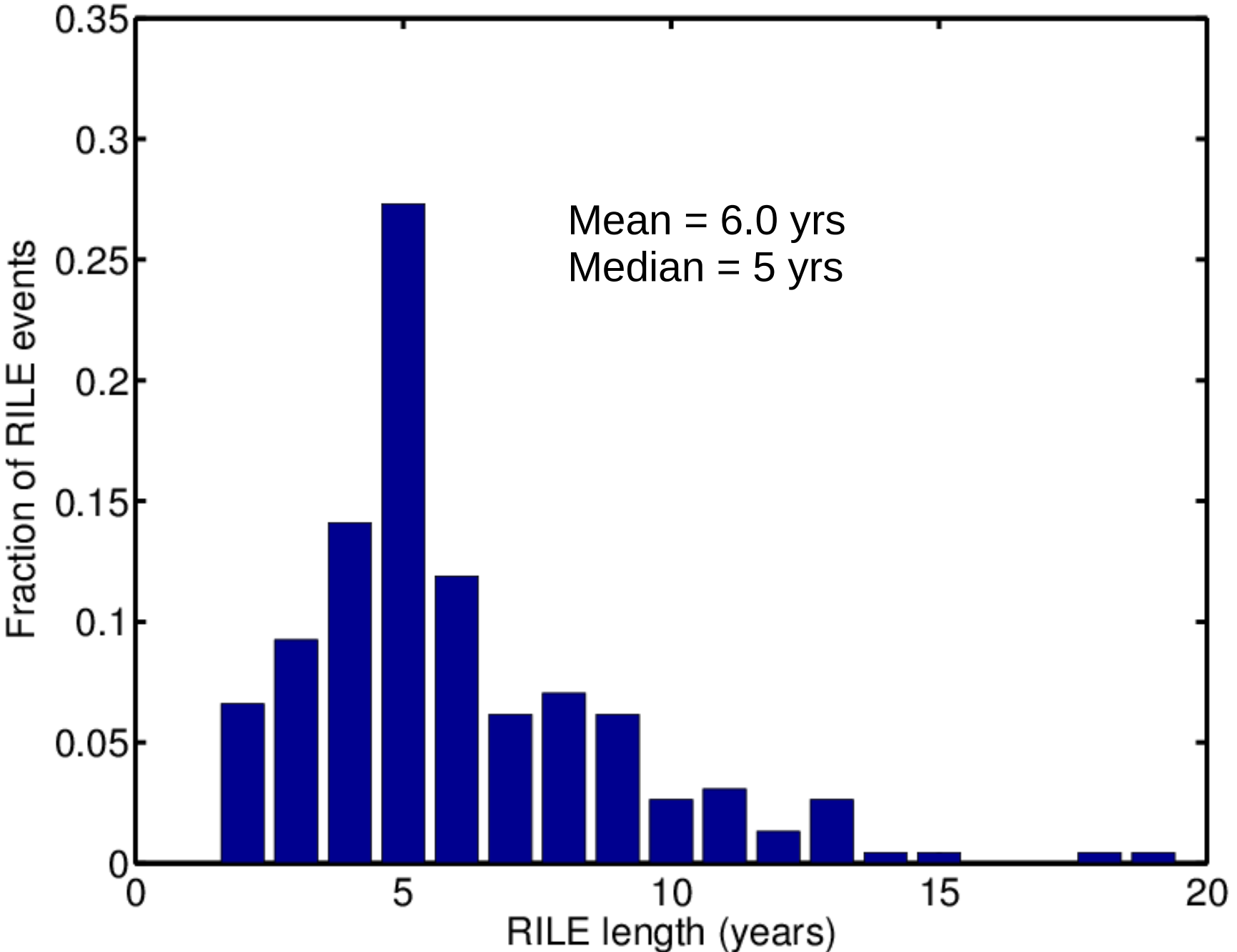


Probability of RILE in 10 year period

- Increasing likelihood as closer to ice-free conditions

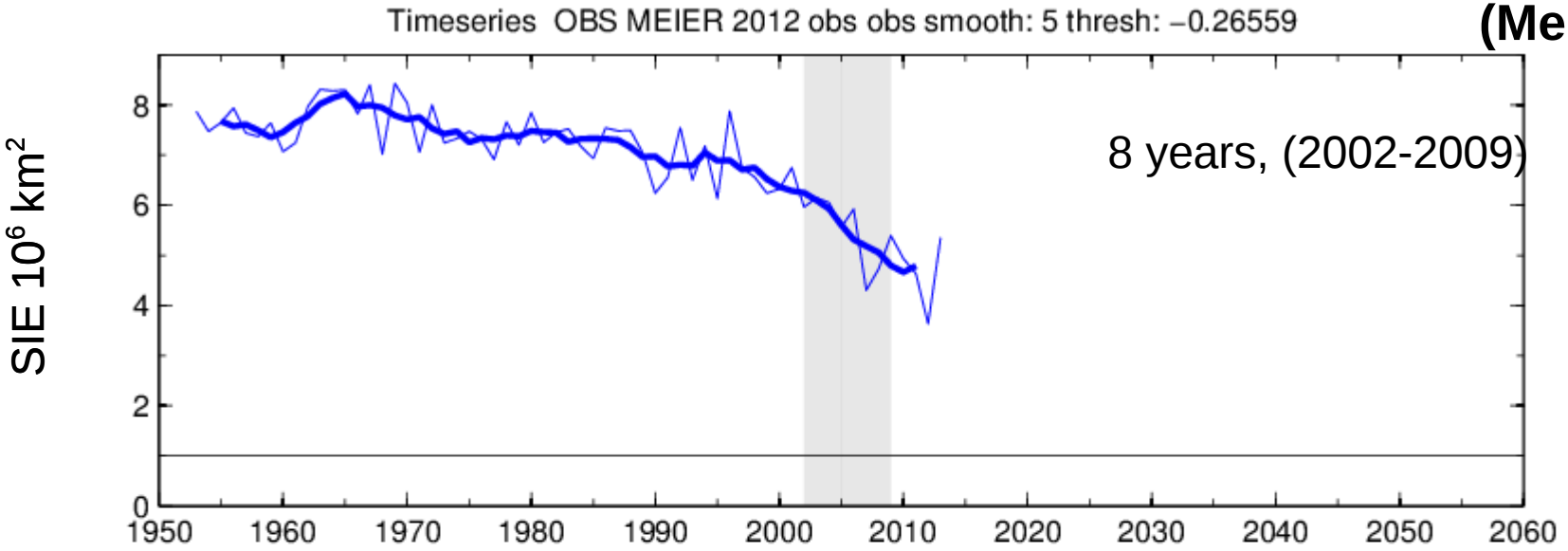


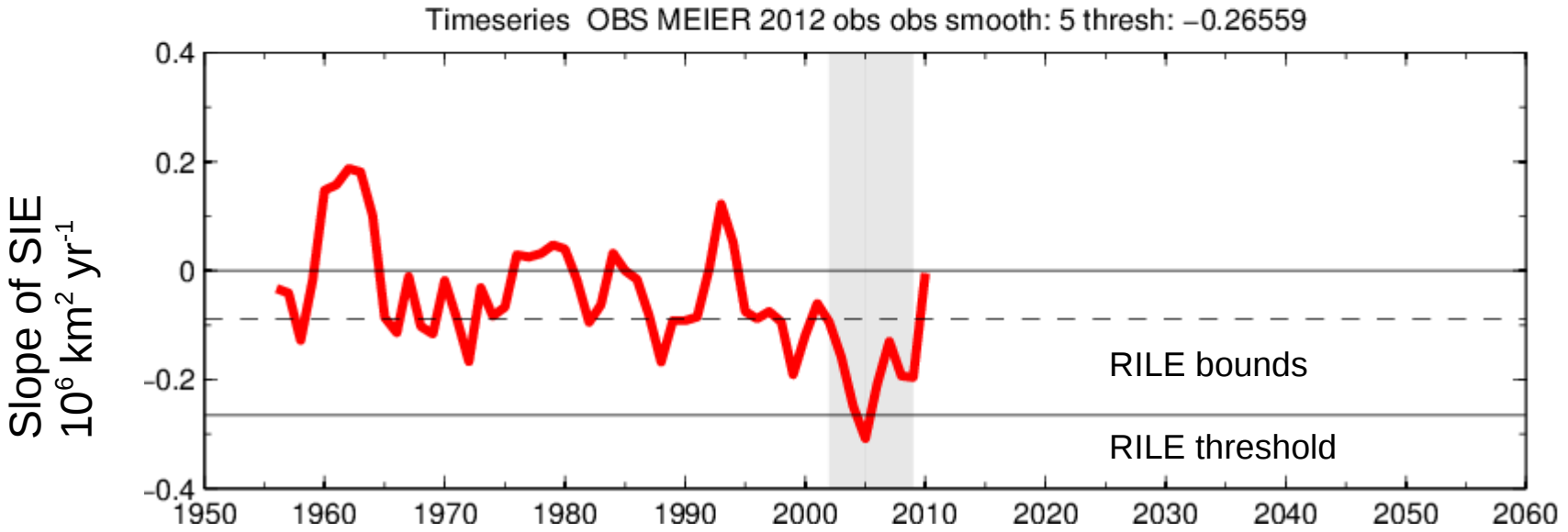
PDF of RILE lengths



Sea ice extent time series: Observations

(Meier 2012)



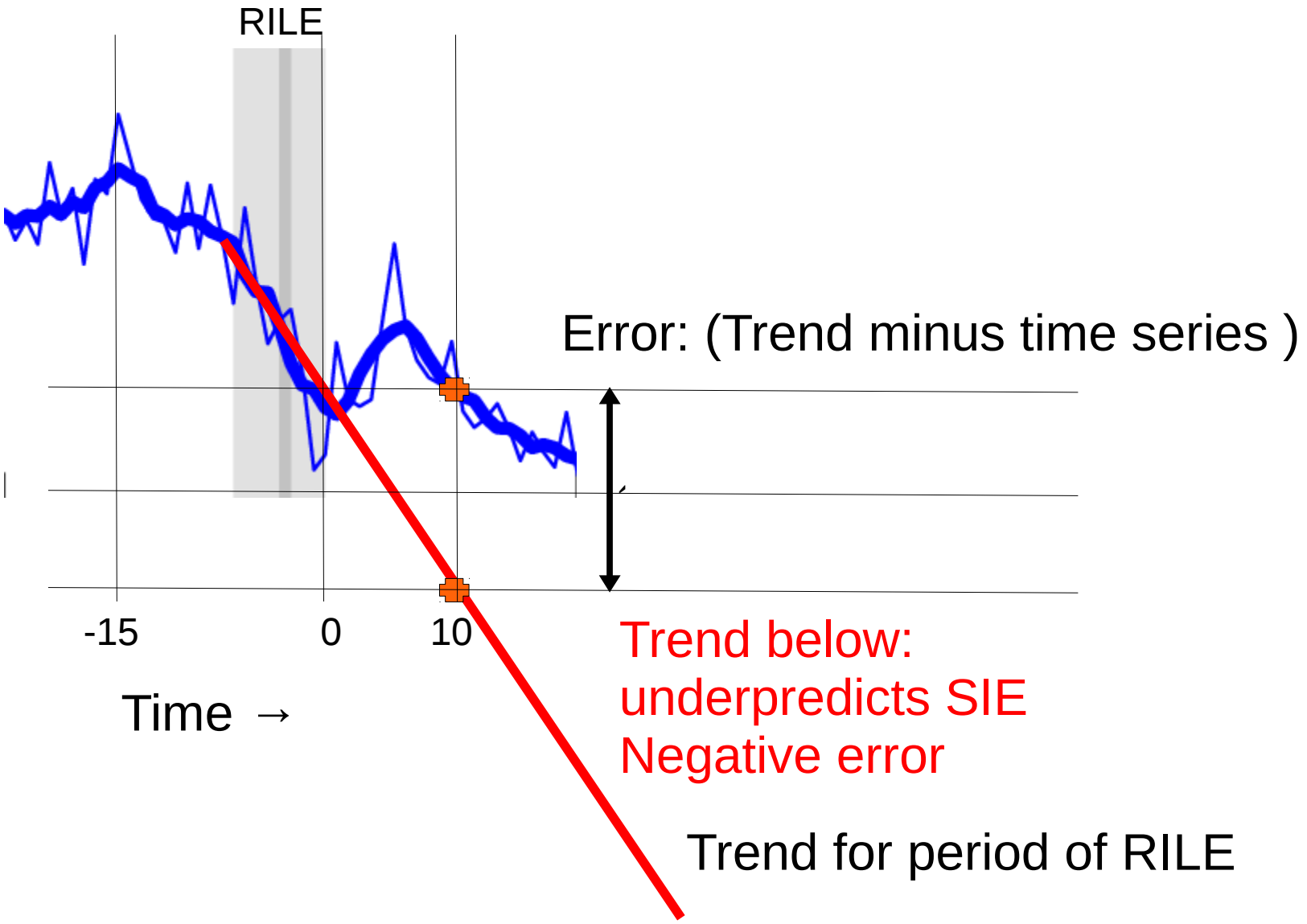


RILE occurrence in CMIP5

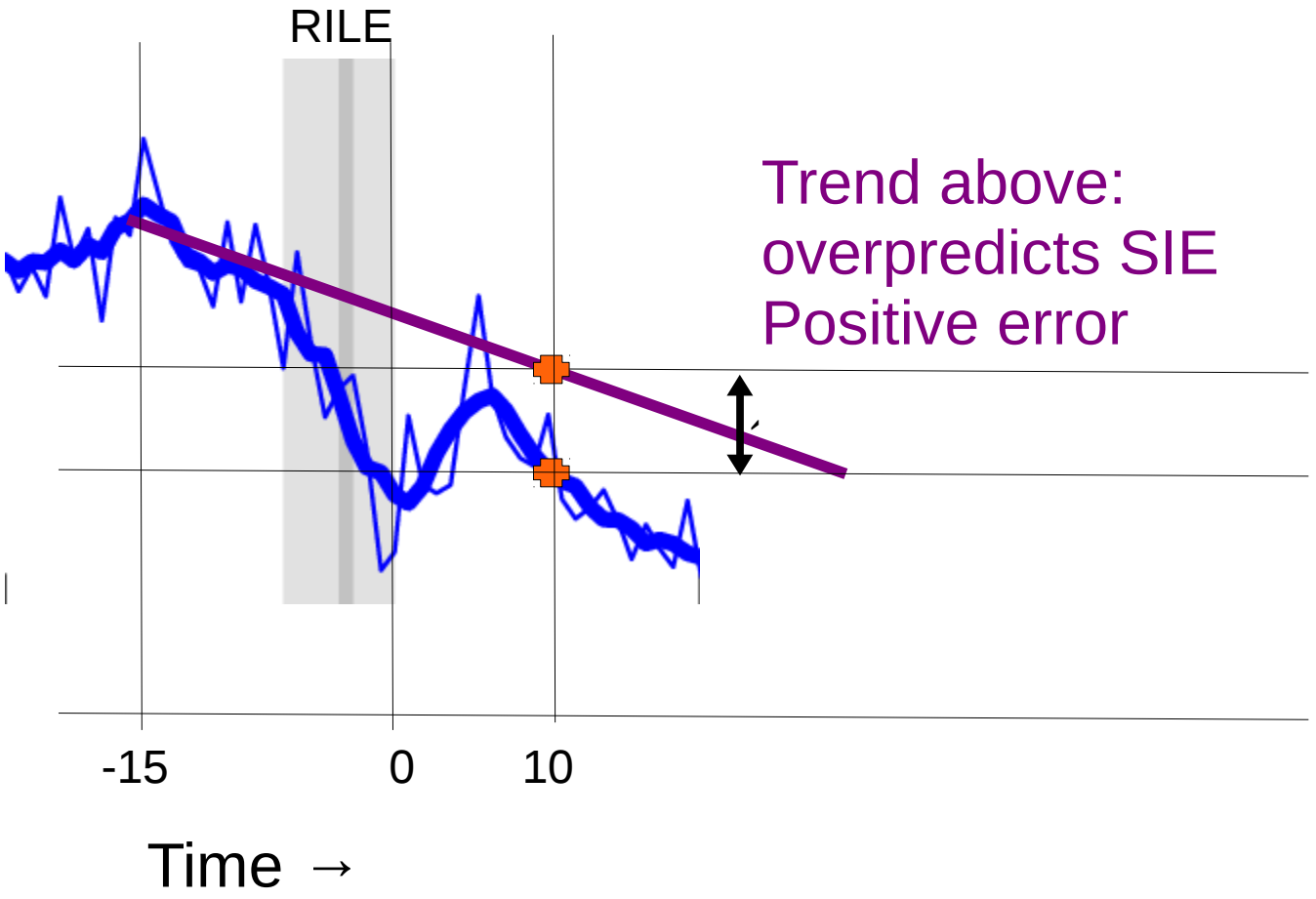
- RILEs not uncommon in CMIP5 after 1990
- Increasing probability after 1980 or as approach ice free conditions
- Recent SIE observations independently confirm RILE -
- Arctic could plausibly be considered to be in a RILE

- What is expected about short-term SIE after a RILE?

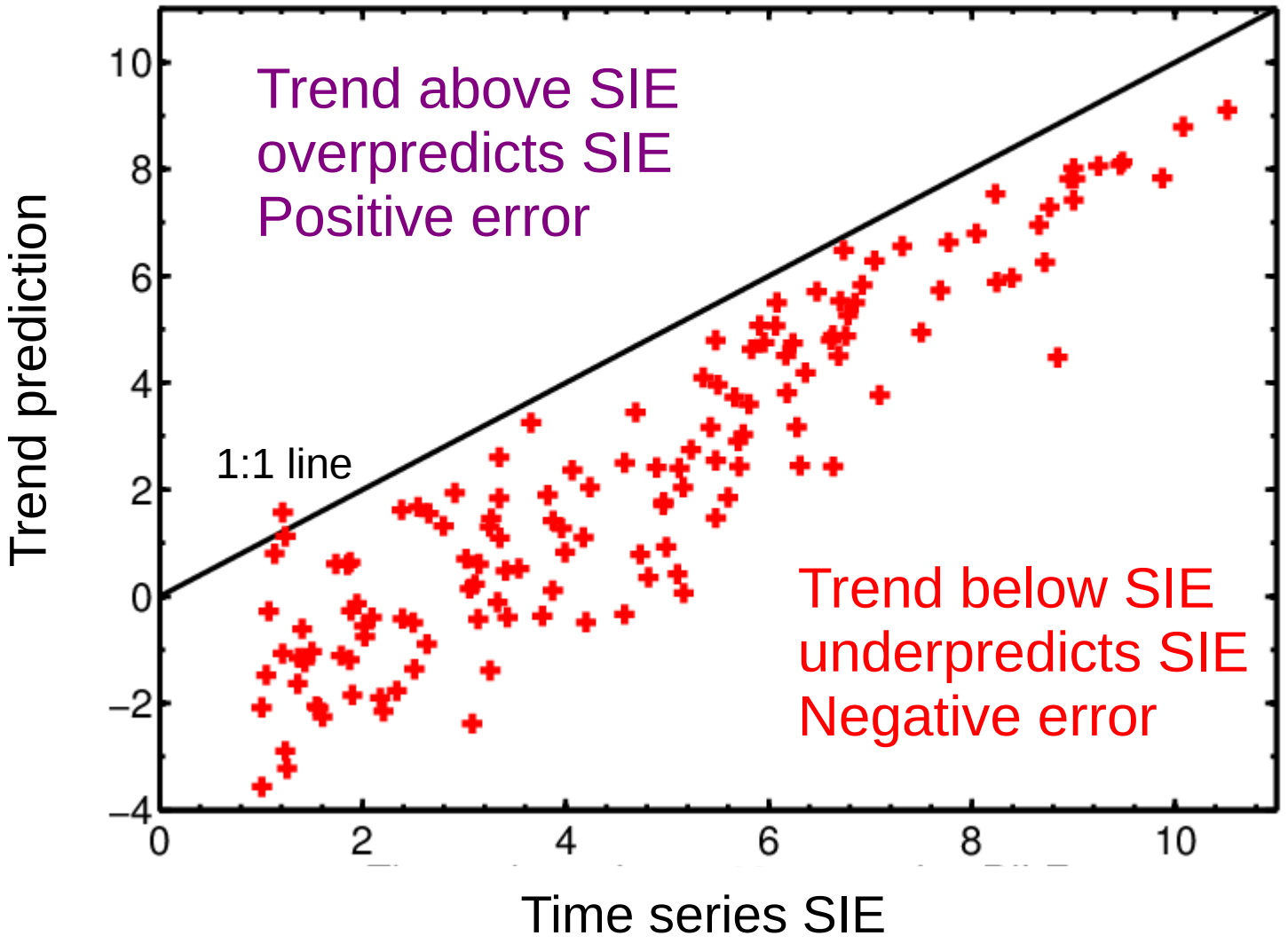
Compare trend (prediction) to time series



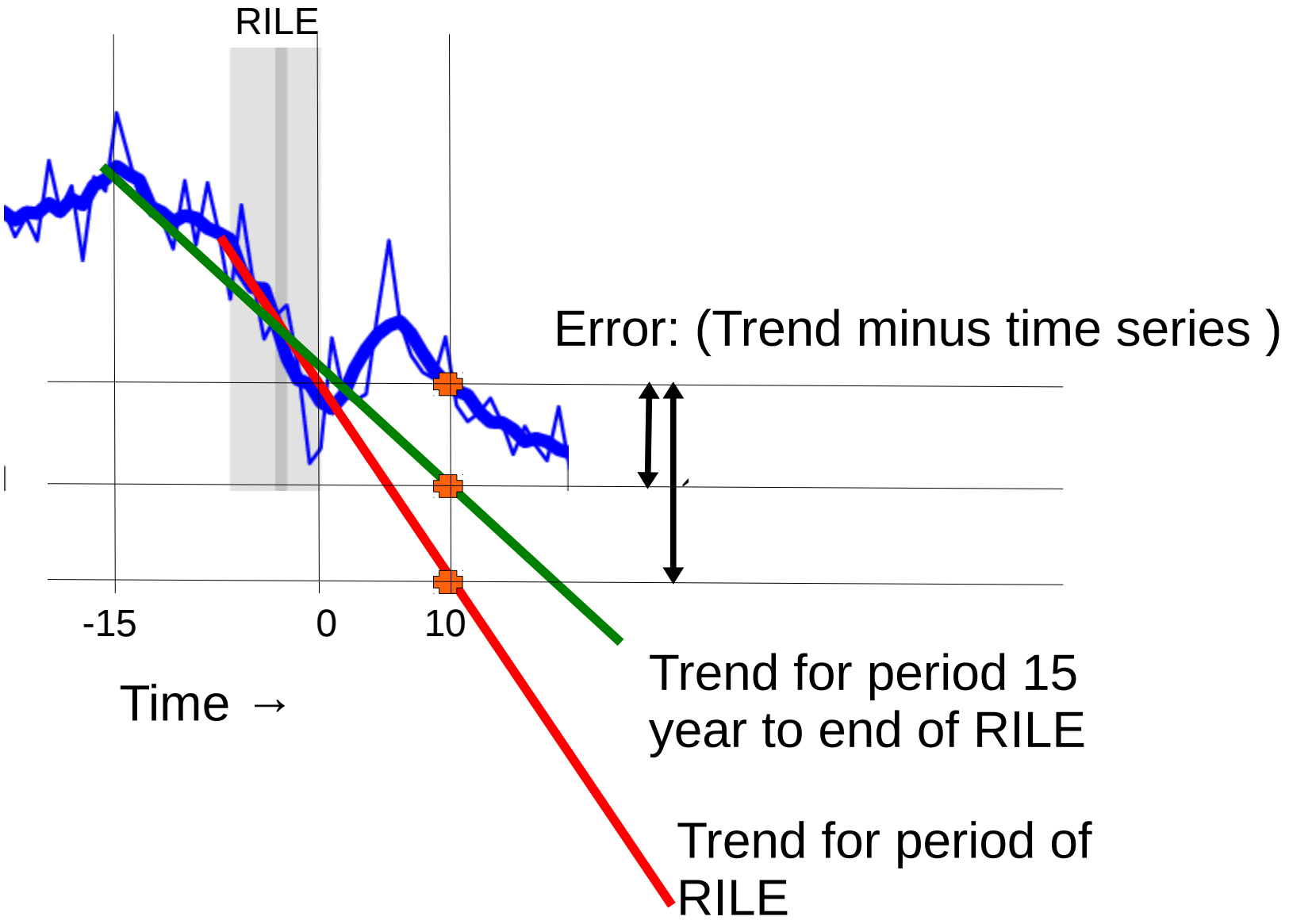
Compare trend (prediction) to time series



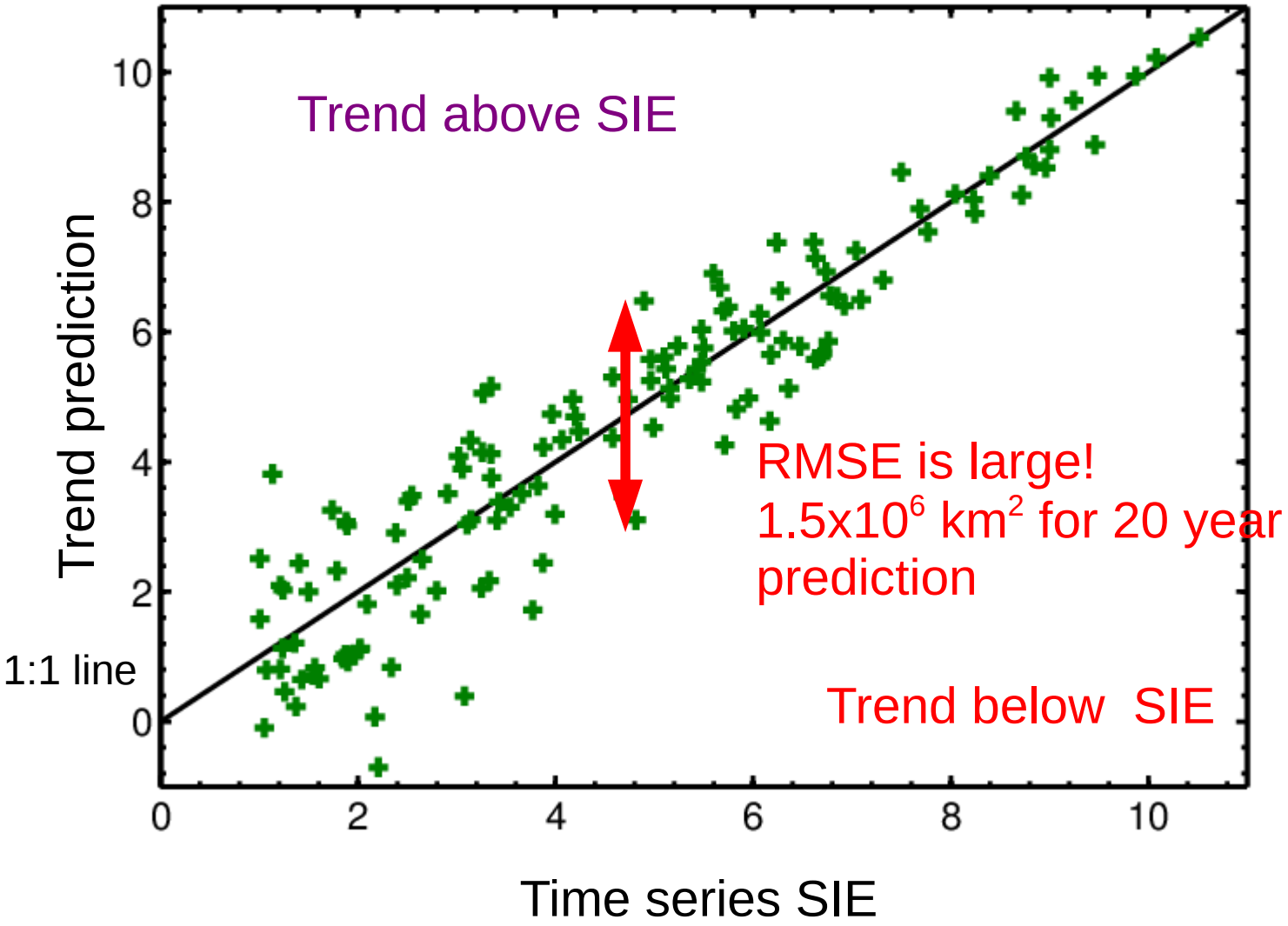
TREND from RILE (start to end) after 10 years underpredicts SIE compared to SIE time series



Compare trend (prediction) to time series



Trend from 15 yrs prior to RILE agrees with simulated SIE (on average)

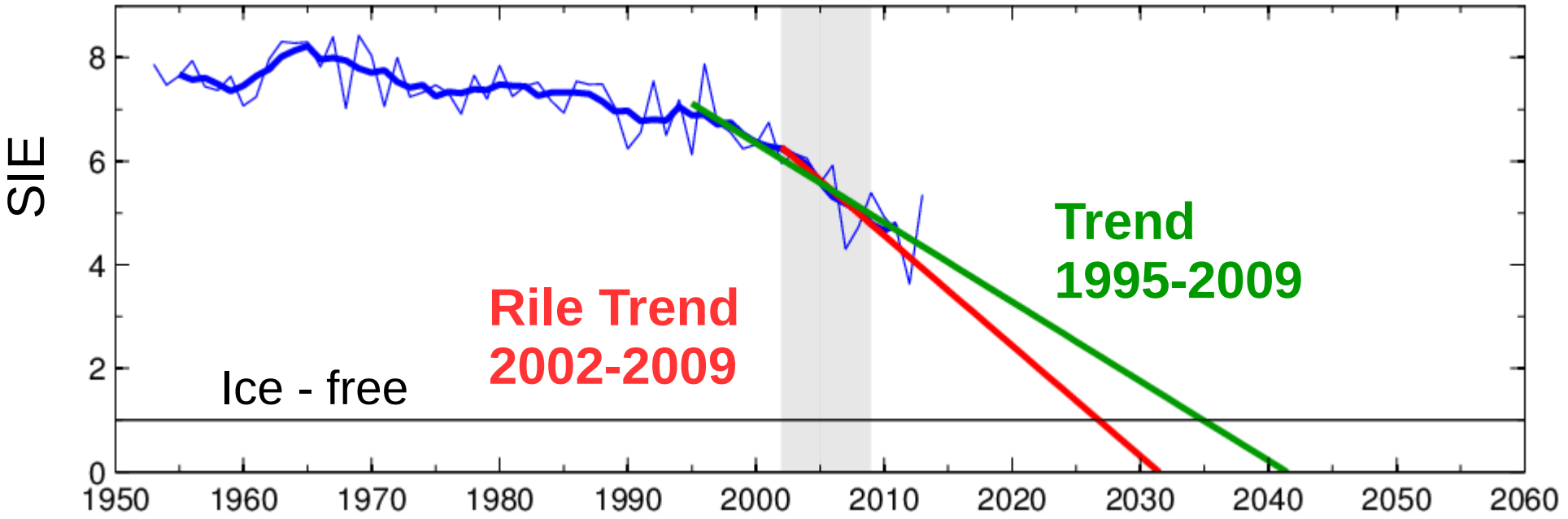


After a CMIP5 RILE

- Linear trends from only RILE period drastically **underpredict** SIE at all time horizons
- 15-year trend to end of RILE ***on average*** **predict** SIE up to ~20 years (slight **overpredict** after 25+ years) Caveat: RMSE is large!

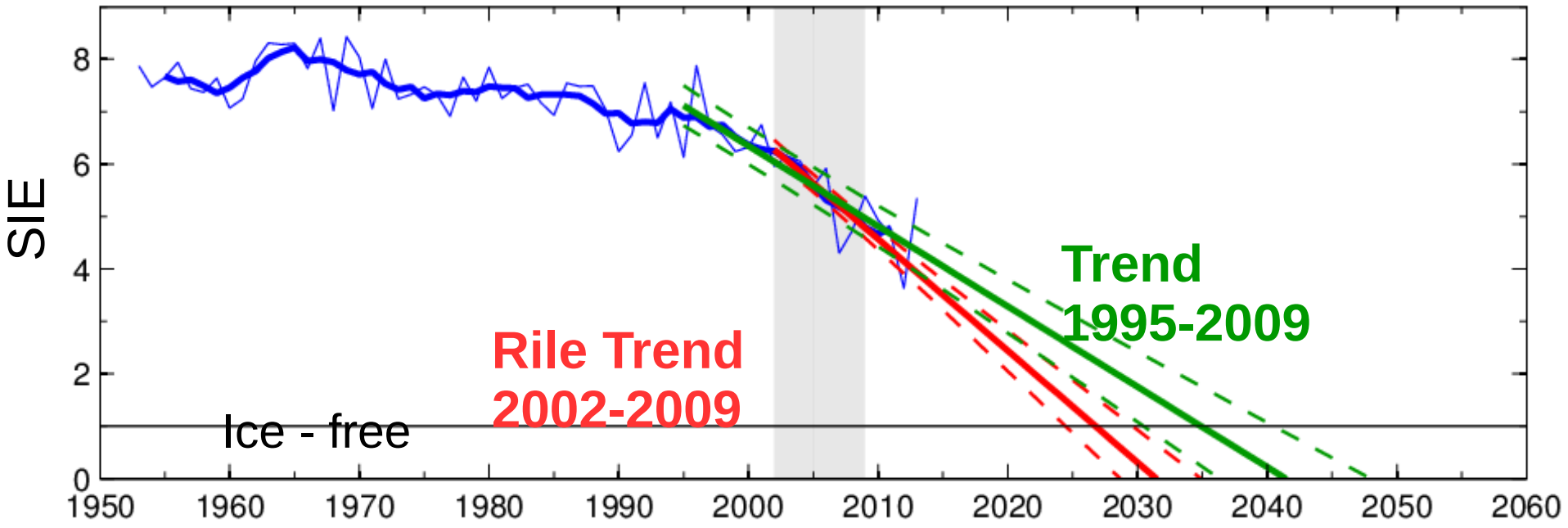
Outlook for observations

- Trends from observations for two periods



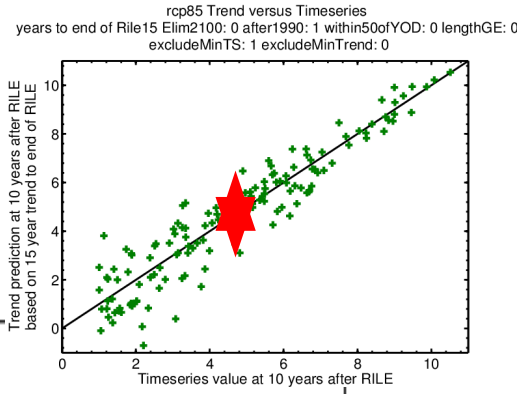
Outlook for observations

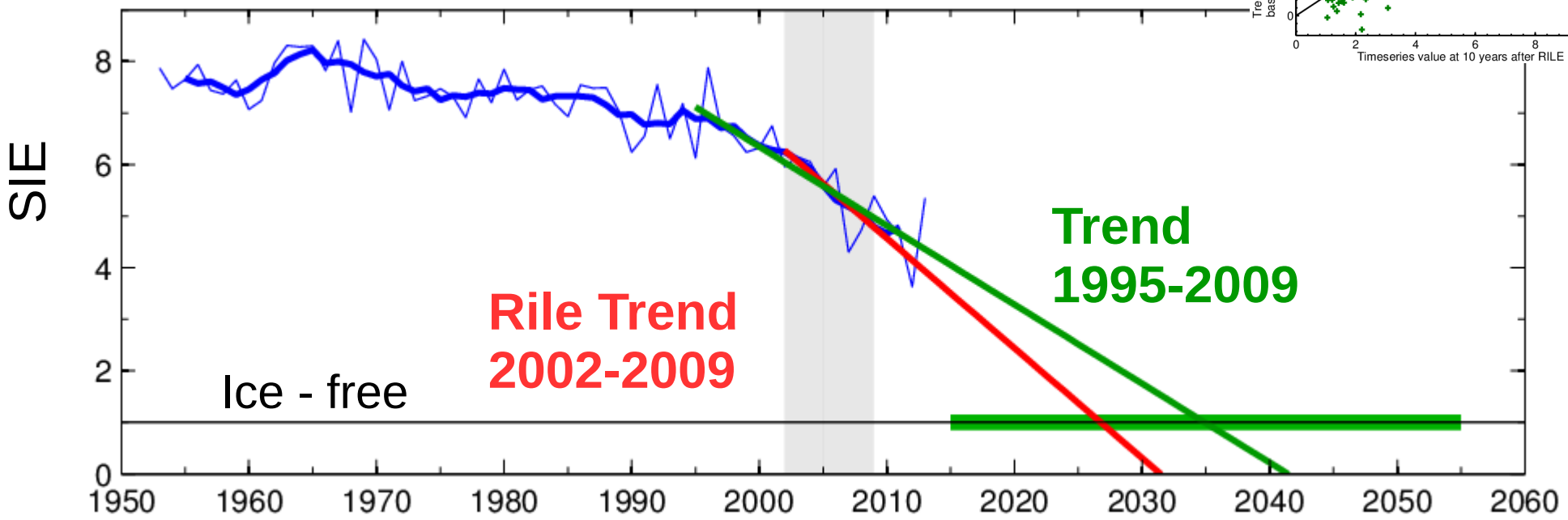
- Dashed lines are uncertainties associated with determining trend itself (i.e. Santer 2008)



Outlook for observations

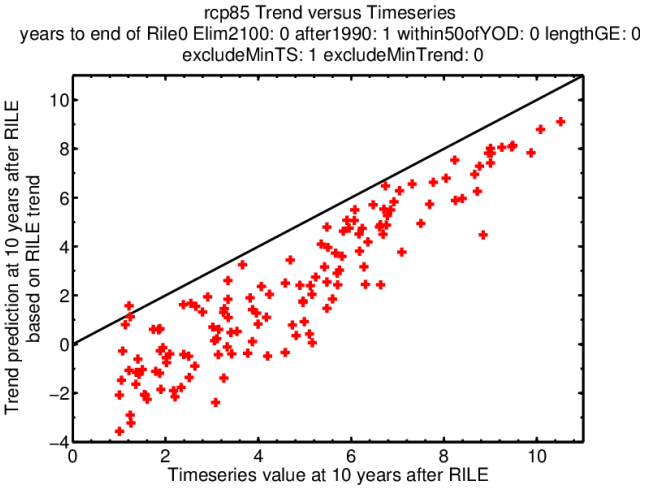
- Incorporate uncertainty associated with mean error between trends and time series (2-sigma); RMSE (1-sigma) ~ 1.5 to 1.7 x 10^6 km^2





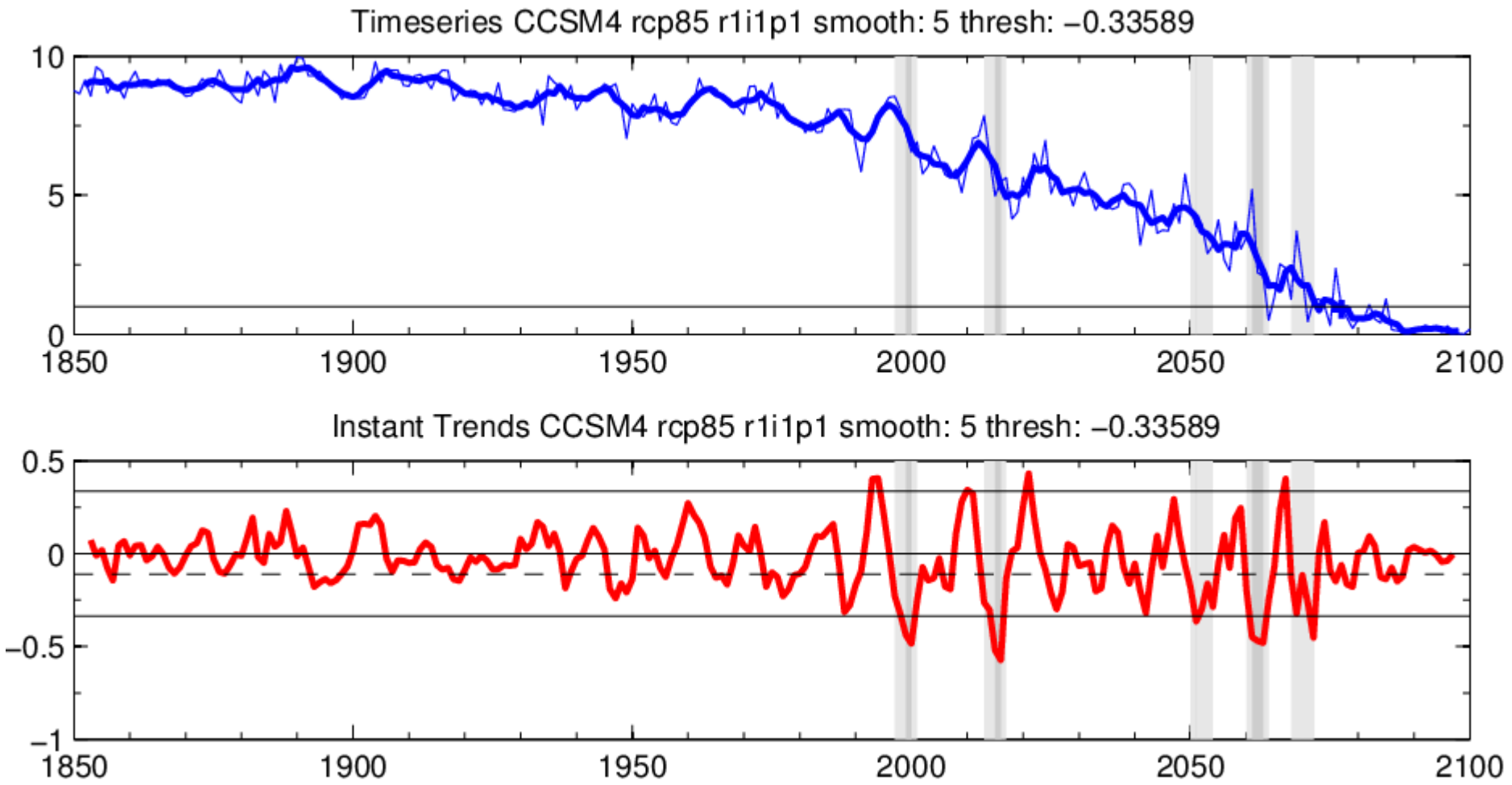
Conclusions

- CMIP5 shows a RILE is entirely possib`le in the current period, and increasingly likely into the future
- Observations independently show a RILE
- 15-year trend to end of RILE ***on average*** **predict** SIE up to ~20 years (slight **overpredict** after 25+ years) – but uncertainties may make such predictions less useful
- Linear trends from only RILE period drastically **underpredict** SIE at all time horizons – more confidence that SIE will not cross ice-free conditions before 2026



END

CCSM4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Instant Trends CCSM4 rcp85 r1i1p1 smooth: 5 thresh: −0.33589
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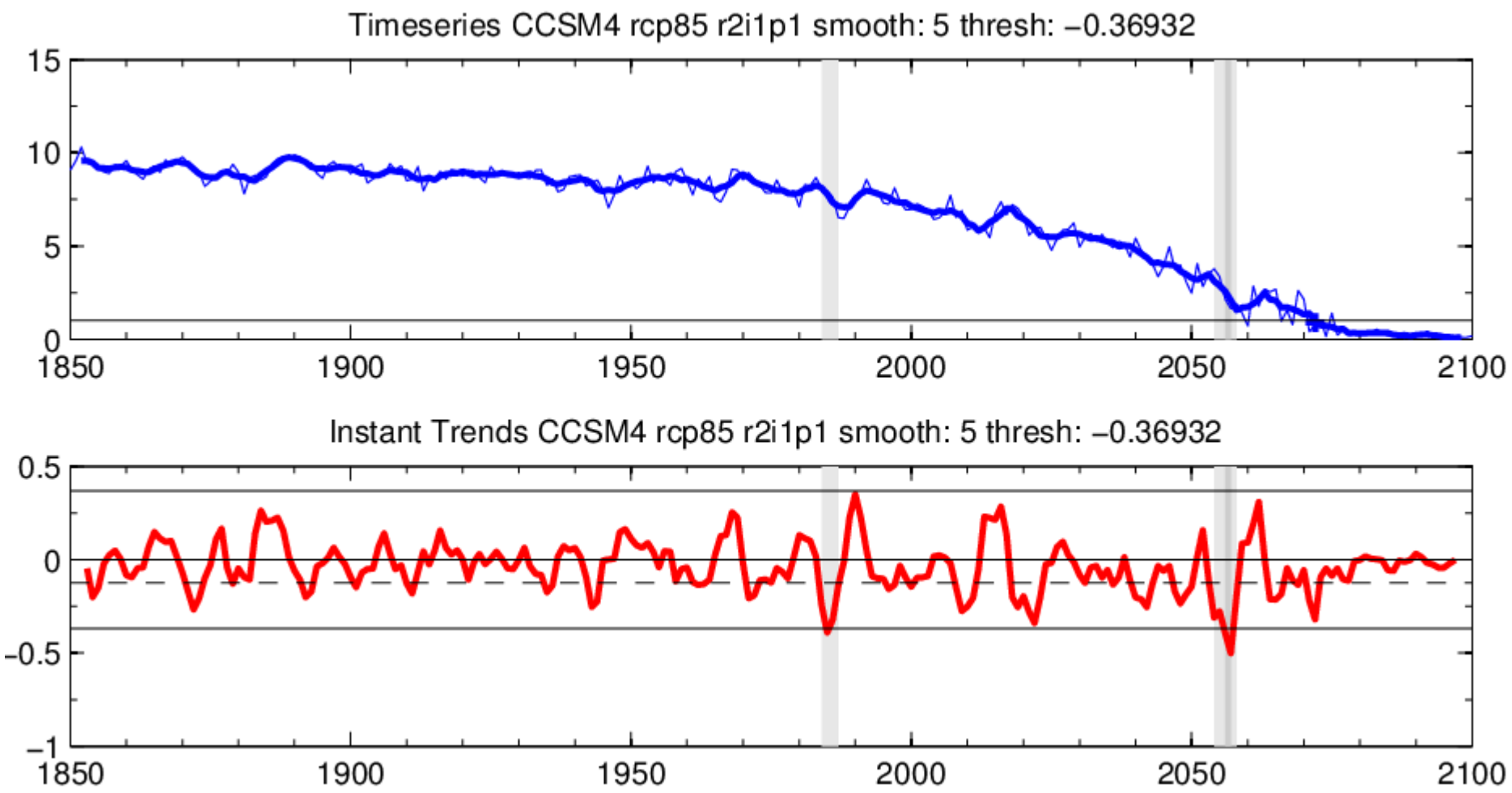
CCSM4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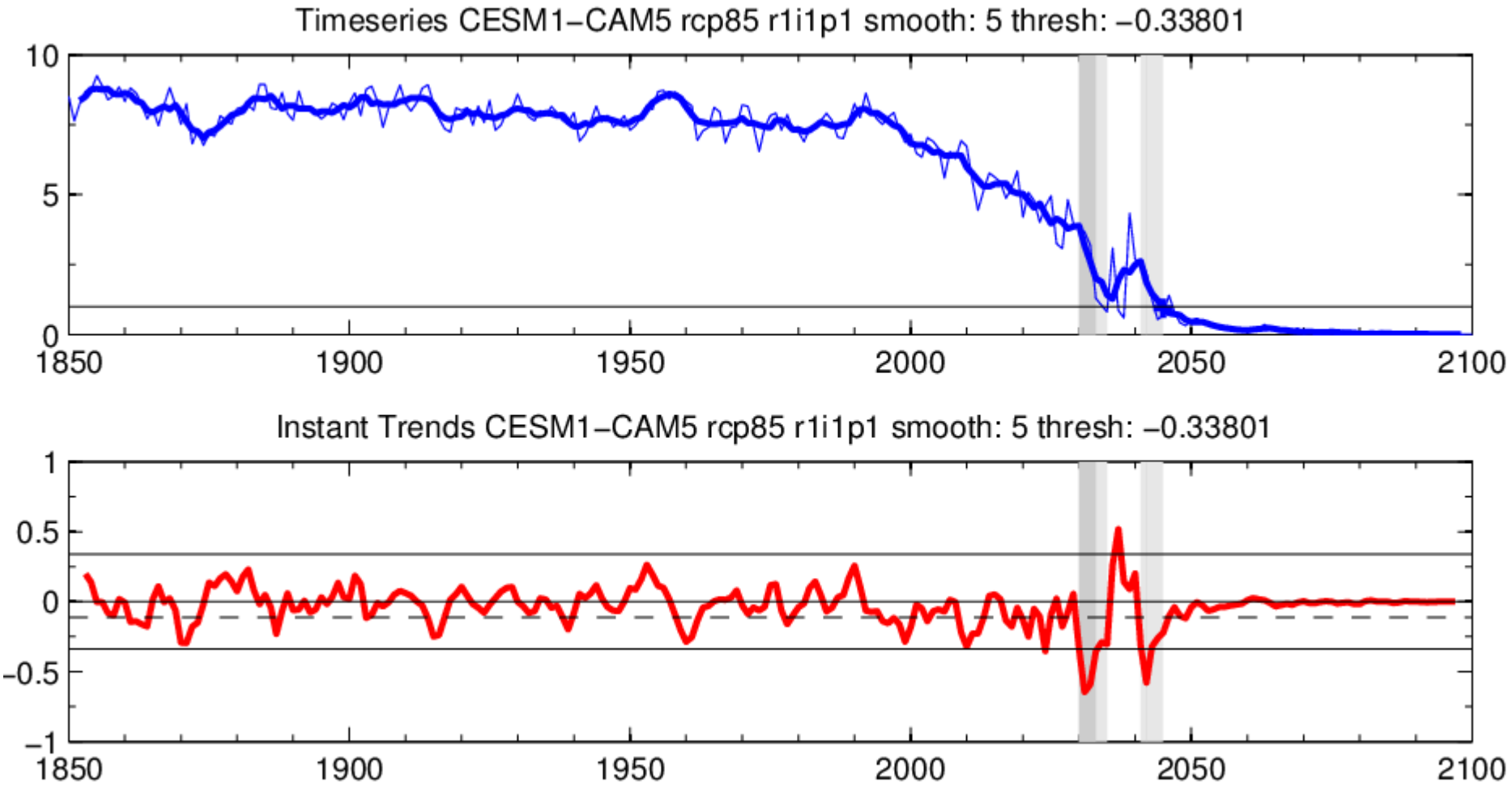
CESM1-CAM5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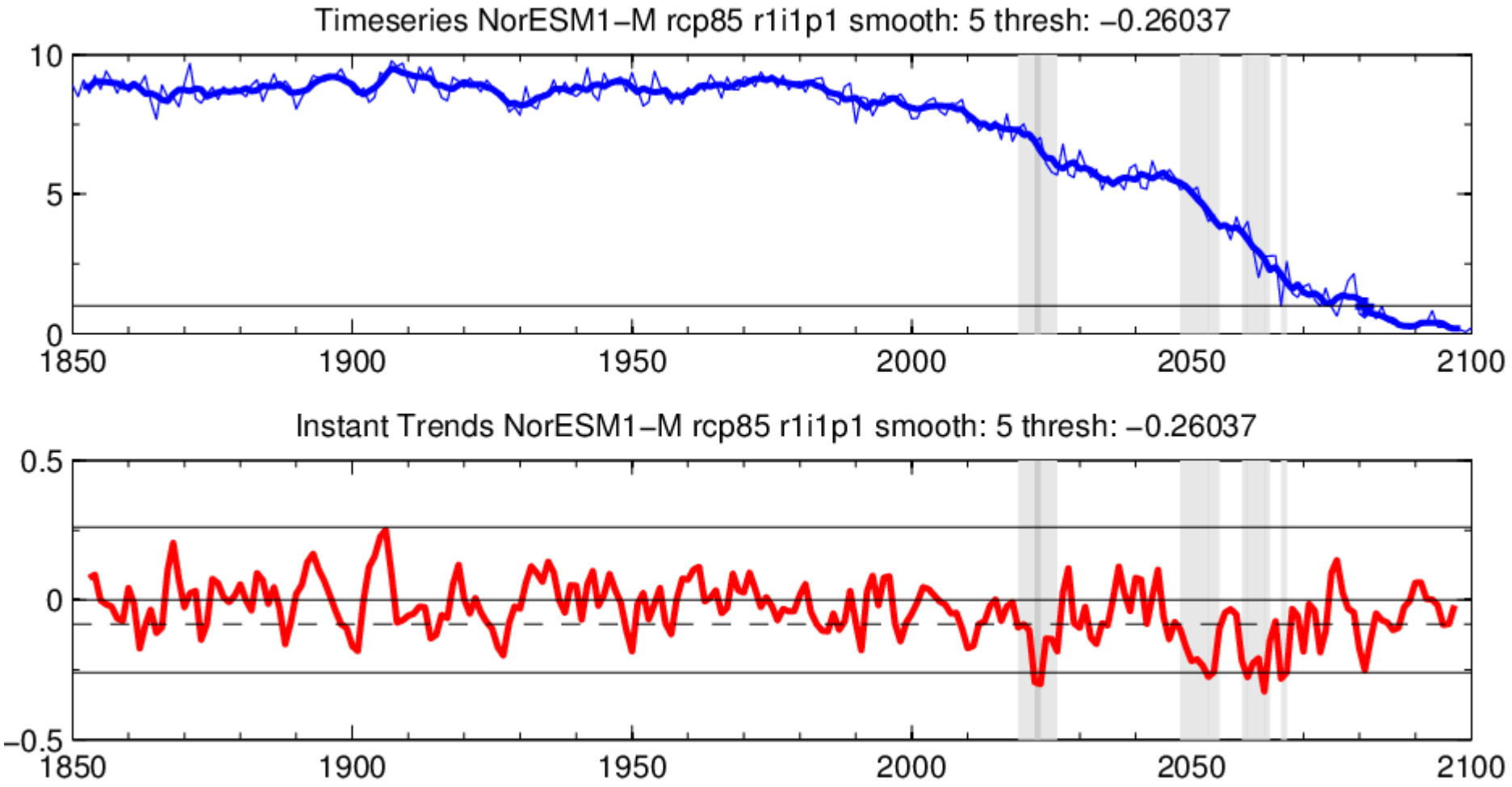
NorESM1-M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Instant Trends NorESM1–M rcp85 r1i1p1 smooth: 5 thresh: –0.26037
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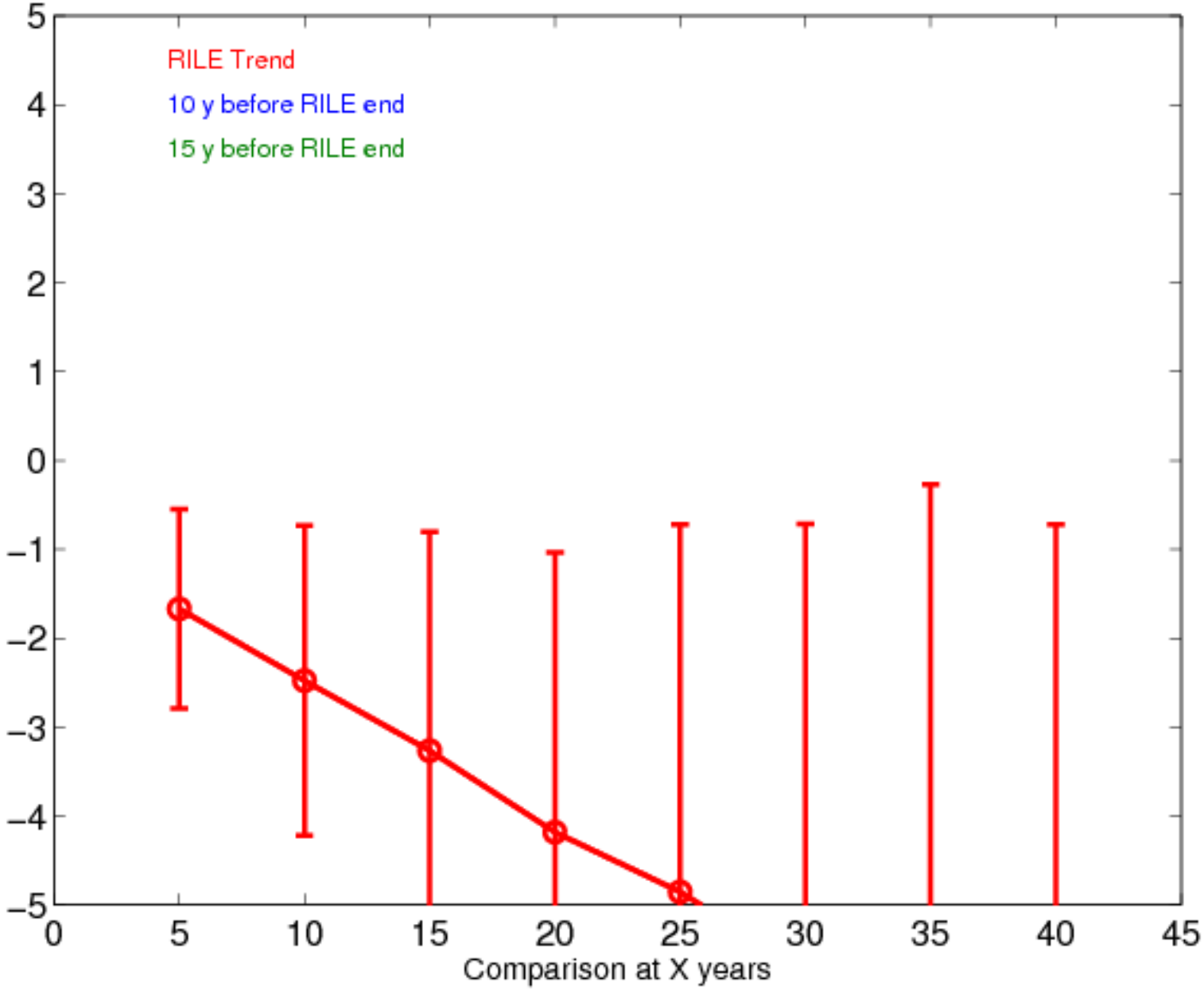
Prediction from RILE trend only



Prediction from 15 years through end of RILE