Two-year dynamical predictions of ENSO event duration during 1954–2015

Xian Wu[1,2], Yuko Okumura[1], Clara Deser[2], and Pedro DiNezio[1,3]

1 The University of Texas at Austin
2 National Center for Atmospheric Research
3 University of Colorado Boulder

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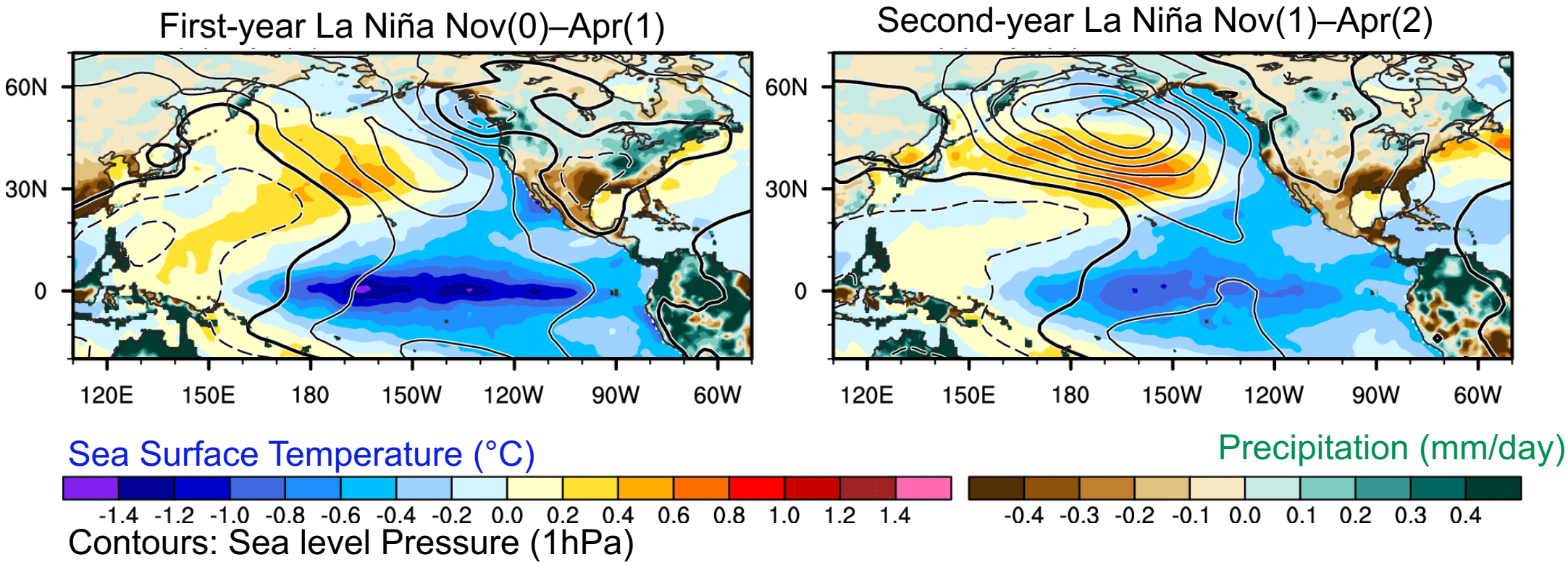
INSTITUTE FOR GEOPHYSICS
JACKSON SCHOOL OF GEOSCIENCES

Motivation: Multiyear ENSO events could prolong their climate impacts

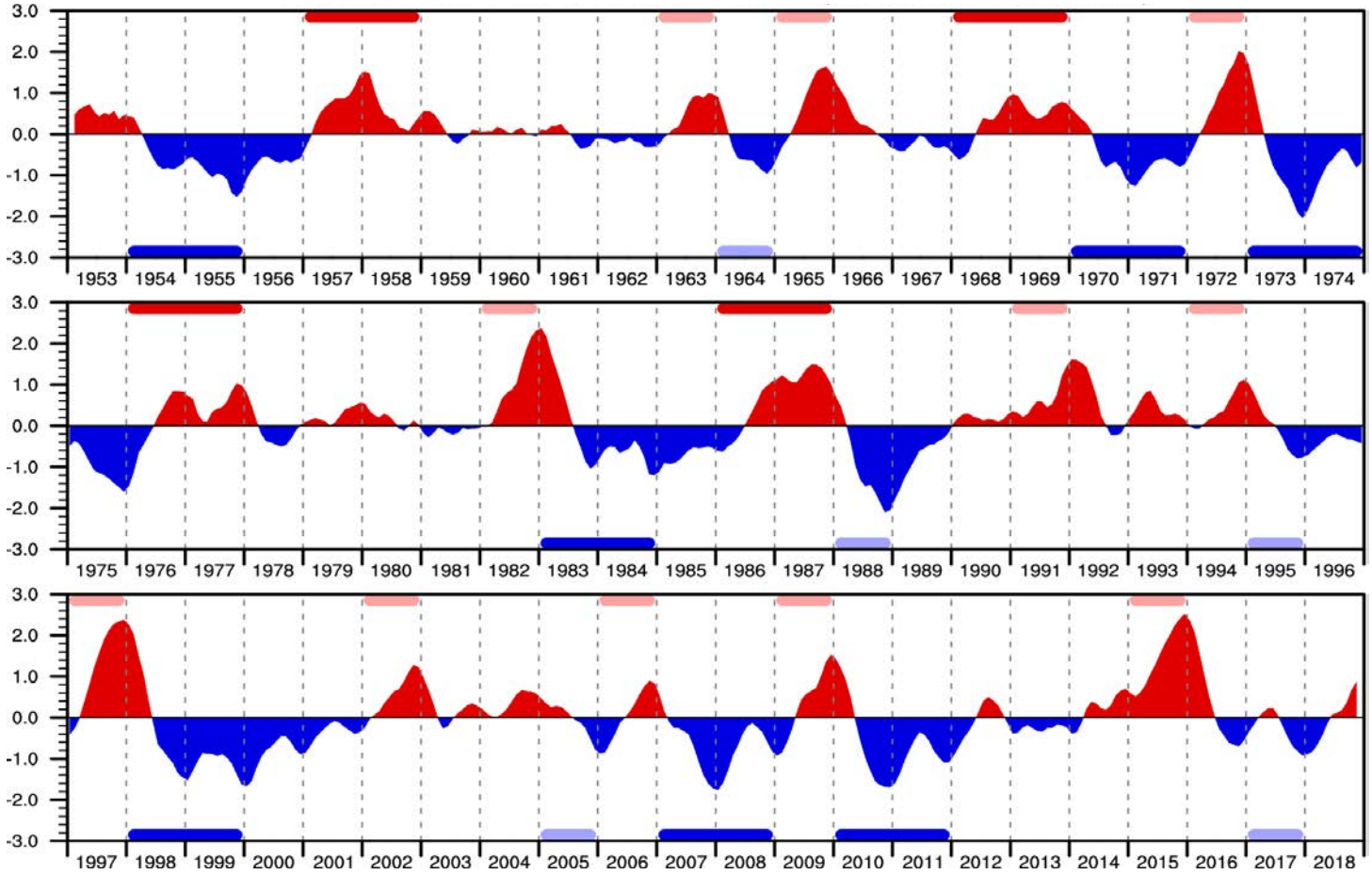
Multi-year La Niña events & Southern US drought conditions, 1901–2012



(Okumura et al. 2017, GRL)

Diverse temporal evolution of El Niño and La Niña events

Niño-3.4 Index, HadISST 1953–2018



Horizontal bars:
1-year El Niño, 2-year El Niño, 1-year La Niña, 2-year La Niña

2-year El Niño: ~30%
2-year La Niña: ~50%

Mechanisms
(Observational and model analyses)
(Wu et al. 2019)

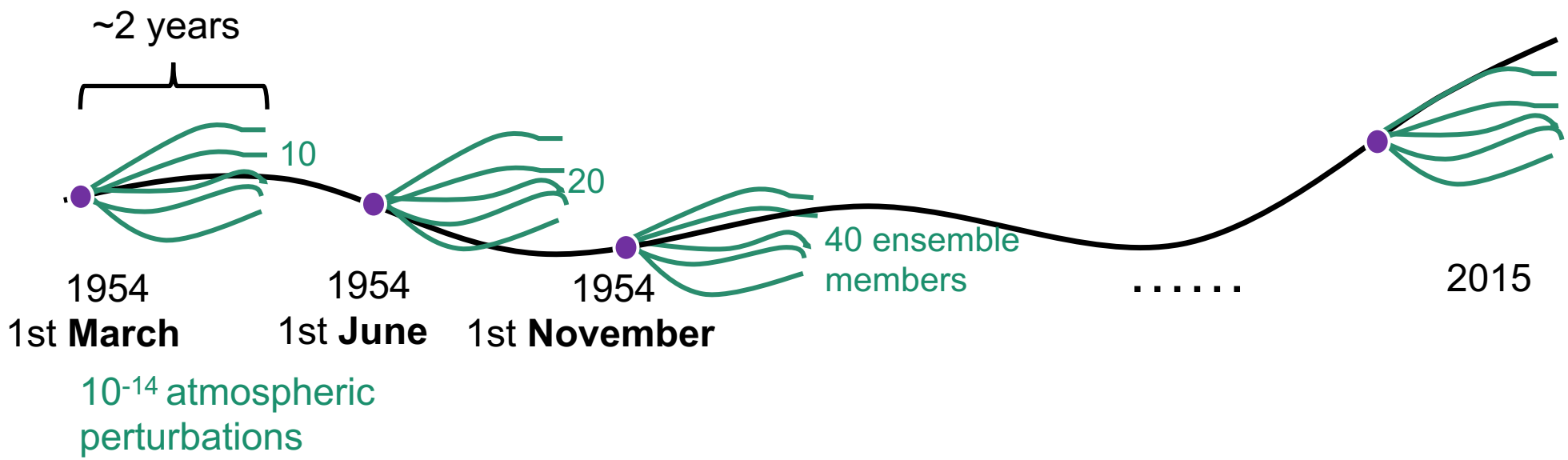
2-year lead **potential predictability**
(Perfect model prediction experiments)

(DiNezio et al. 2017a;
Wu et al. 2021a)

Real-world prediction skill?

(DiNezio et al. 2017b;
Wu et al. 2021b)

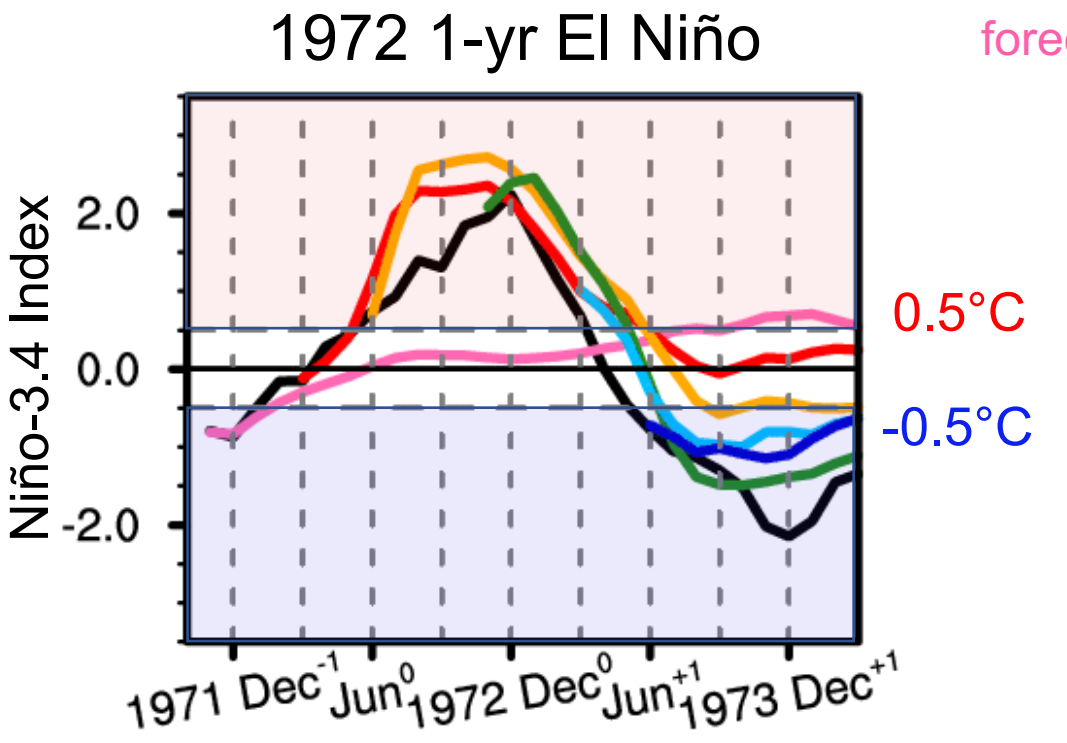
Two-year lead CESM1 forecasts during 1954–2015



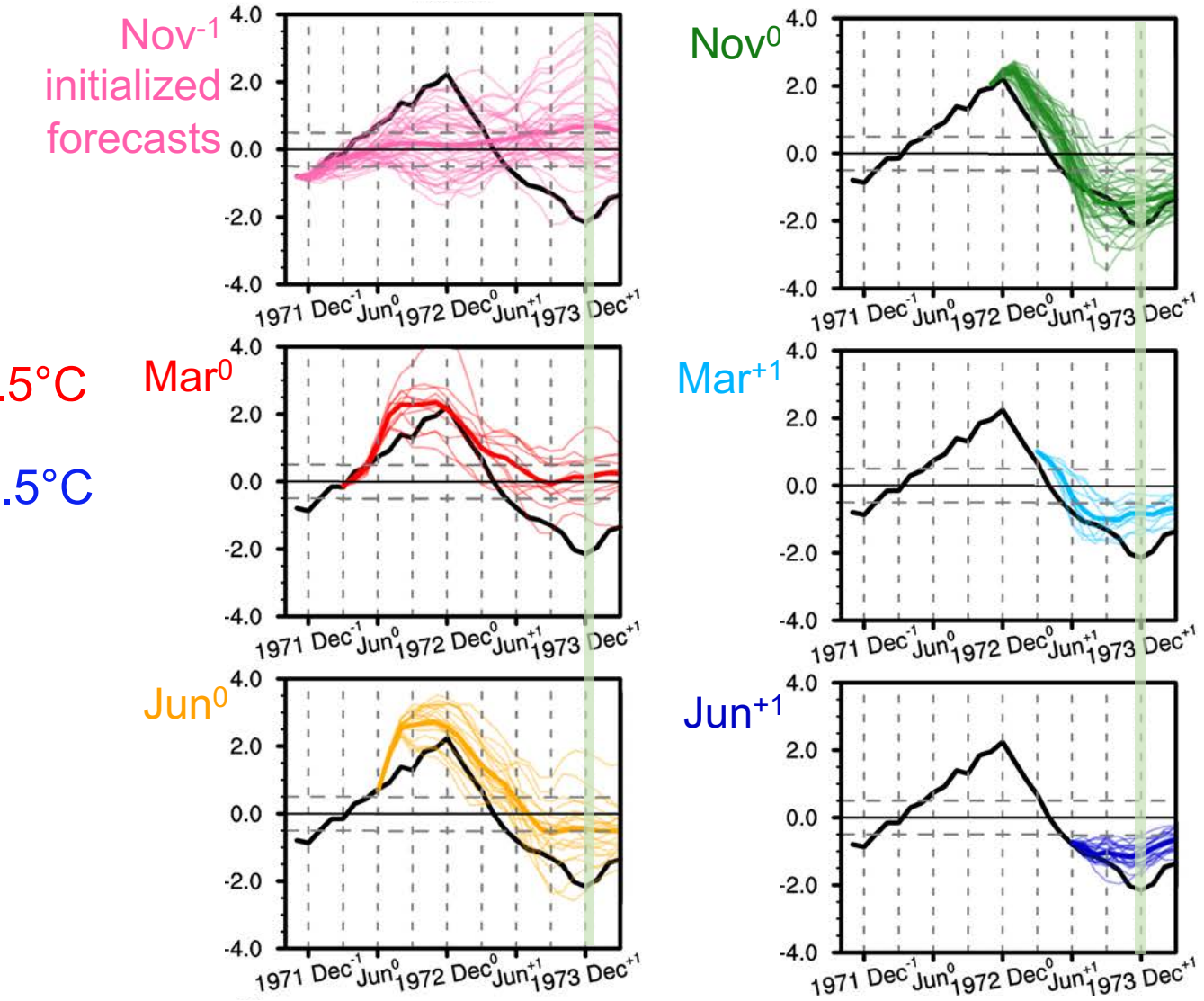
Initialization: ‘observed’ oceanic and sea ice states estimated by Forced Ocean Sea Ice Simulation (FOSI)

+ CMIP5 radiative forcing (Historical 1954–2005 & RCP8.5 2006–2015)

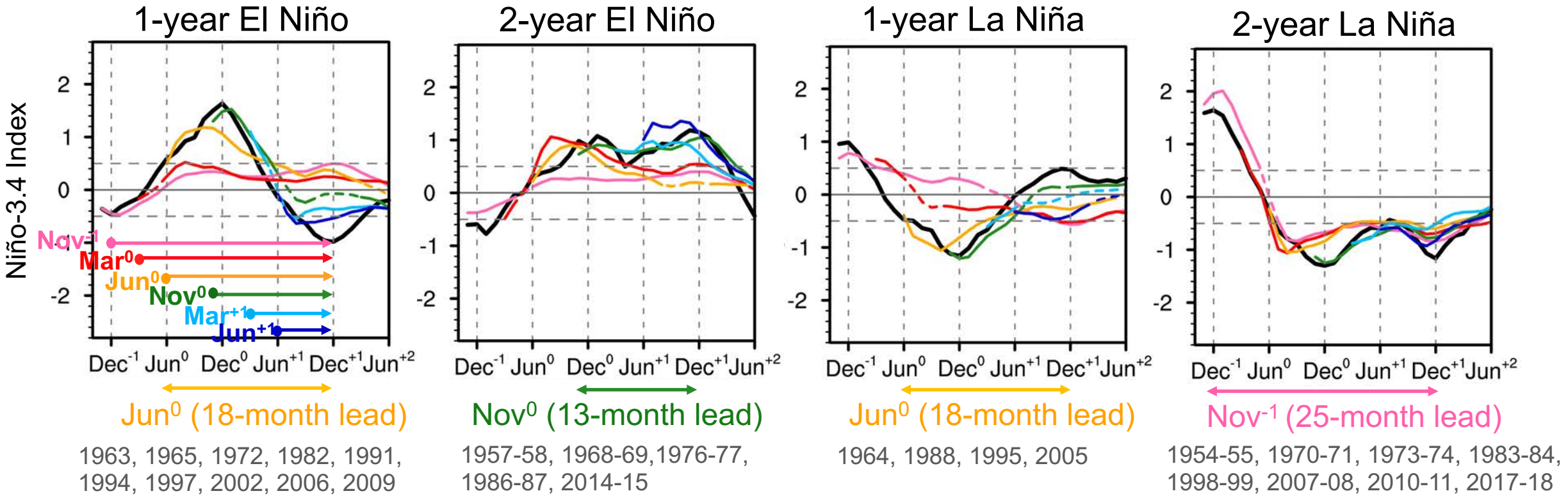
Two-year forecast example of 1972 El Niño



25, 21, 18, 13, 9, 6 lead months
relative to Dec^{+1}



Composite forecasts of 1-year vs. 2-year ENSO events



1963, 1965, 1972, 1982, 1991, 1994, 1997, 2002, 2006, 2009

1957-58, 1968-69,1976-77, 1986-87, 2014-15

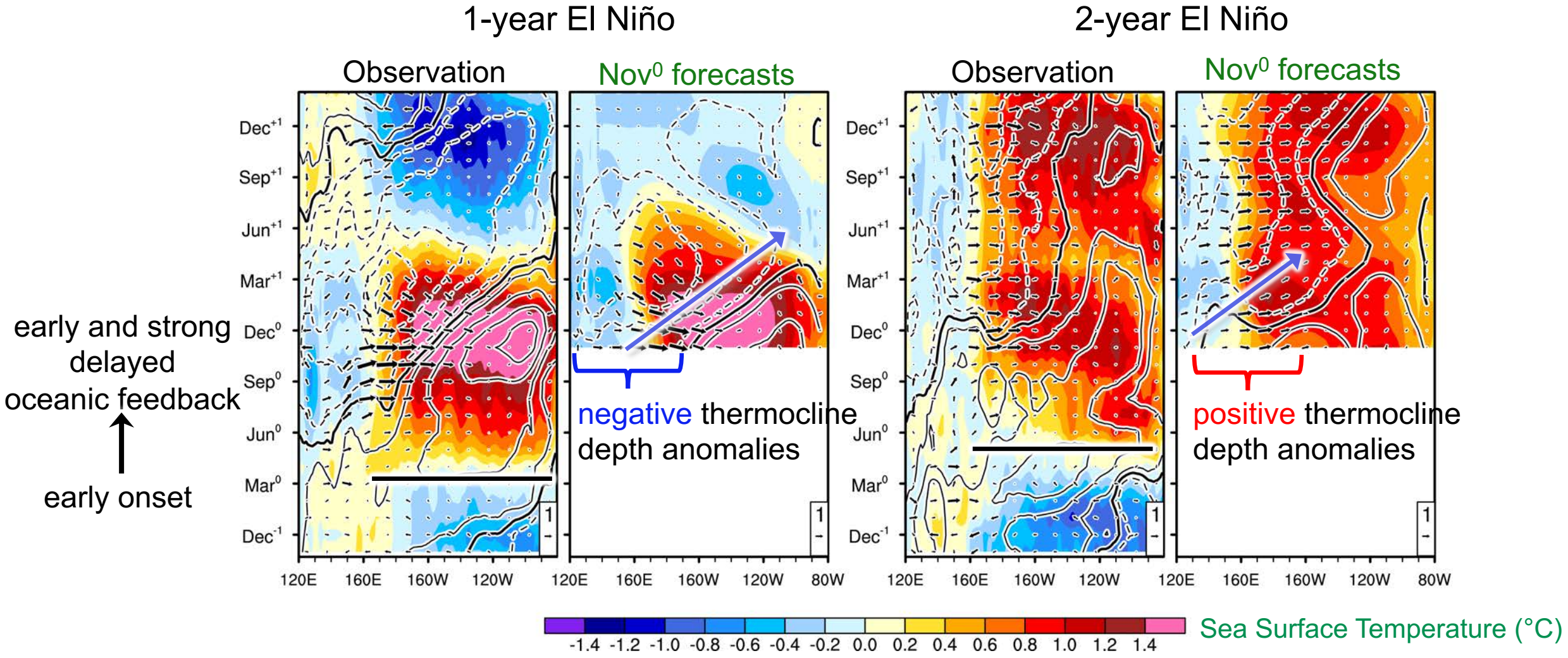
1964, 1988, 1995, 2005

1954-55, 1970-71, 1973-74, 1983-84, 1998-99, 2007-08, 2010-11, 2017-18

Nov^{0} forecasts can predict the duration of both El Niño and La Niña with 13-month lead.
Nov^{-1} forecasts can predict multi-year La Niña with 25-month lead.

Nov^0 forecasts: oceanic precursors in the equatorial Pacific

Sea Surface Temperature, Thermocline Depth, and Surface Wind Anomalies, 3°S–3°N



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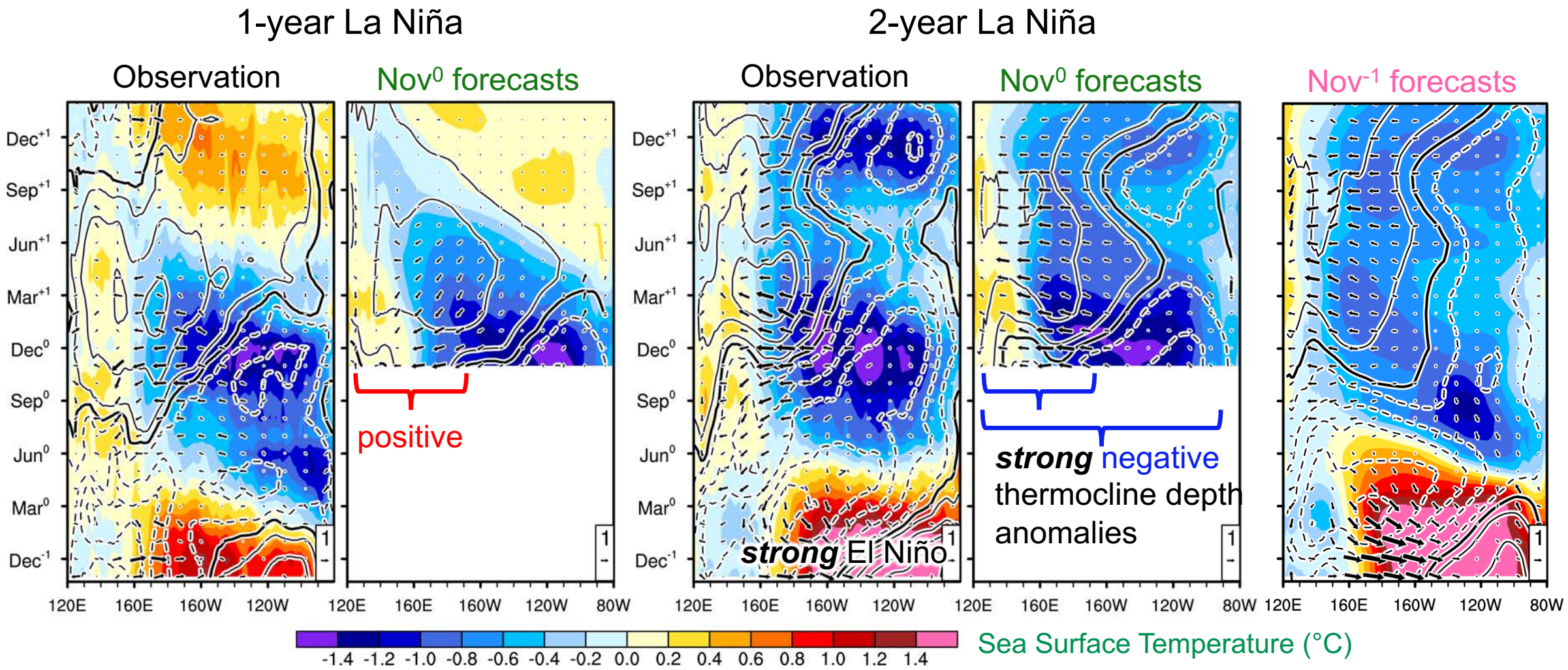

Summary

- The CESM1 shows **high skills** in predicting the duration of El Niño and La Niña events with lead times ranging from **6 to 25 months**.

- **Predictability** arises from 1) **initial thermocline depth** anomalies in the equatorial Pacific 2) **initial SST** states the tropical Pacific as well as in the North Pacific/tropical Indian/Atlantic Oceans.

- **Forecast ensemble spread** shows dependency on lead times and ensemble mean state and mainly originates from the atmospheric variability over the North Pacific.

- Two-year predictability of ENSO event duration indicates potential of **extending current operational ENSO forecasts** to two years and may provide a source of **predictability for associated climate impacts**.

Wu, X., Y. M. Okumura, C. Deser, and P. N. DiNezio, 2021b: Two-year Dynamical Predictions of ENSO Event Duration during 1954–2015. *J. Climate.* 34, 4069–4087, https://doi.org/10.1175/JCLI-D-20-0619.1.

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