SOUSEI Program for Risk Information on Climate Change
気候変動リスク情報創生プログラム

Human influence on extreme events: new approach by Probabilistic Event Attribution (PEA)

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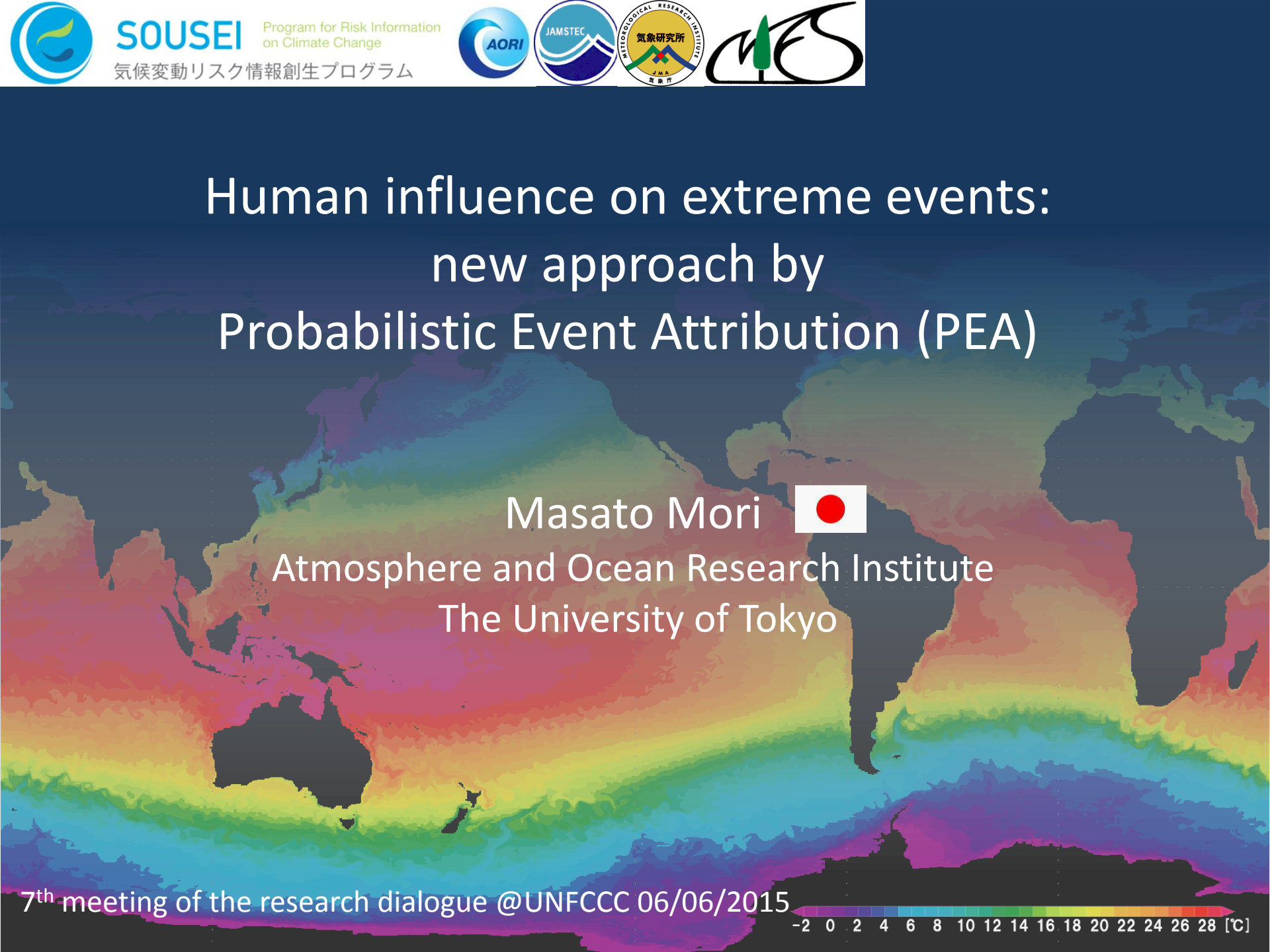


7th meeting of the research dialogue @UNFCCC 06/06/2015

Probabilistic Event Attribution (PEA)

Public : "Did the global warming cause this extreme event?"

Scientist: "It is difficult to answer
because extreme events can occur without anthropogenic forcing".

but

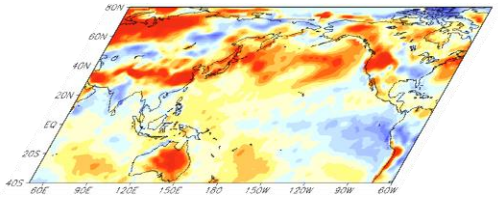
Comparisons between observations and large-ensemble simulations (*) are making it possible to evaluate **how anthropogenic forcing affected probability of occurrence of individual extreme events.**

This is called *probabilistic event attribution* (PEA)

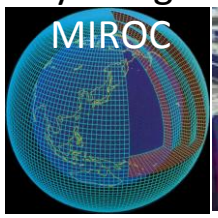
(*) running two types of simulations on atmospheric circulation by supercomputer 100 times each

Probabilistic Event Attribution (PEA)

observation
of an extreme event



by using



ALL-run

simulations (x100)

the world at the time

observed SST & sea ice w/ anthropogenic warming

natural forcing

e.g. volcano

anthropogenic forcing

e.g. GHG

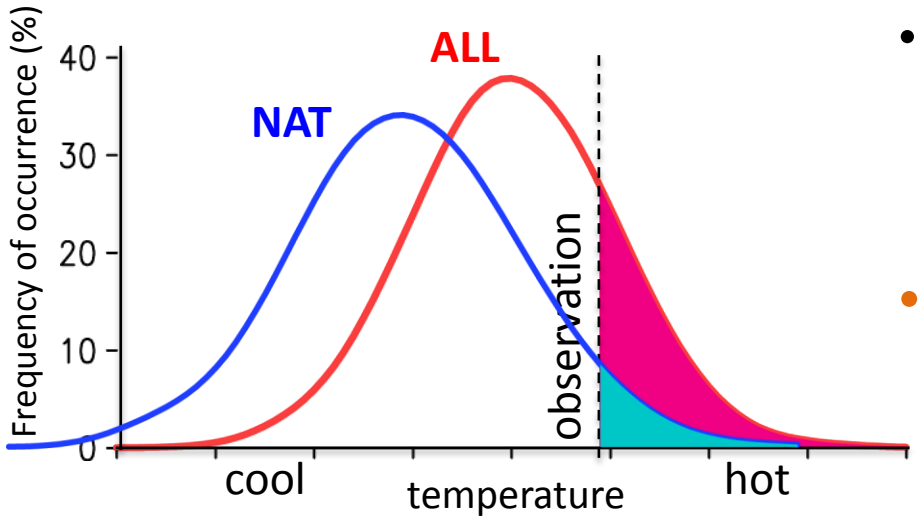
NAT-run

simulations (x100)

the world without global warming

SST & sea ice w/o anthropogenic warming

SST: sea surface temperature



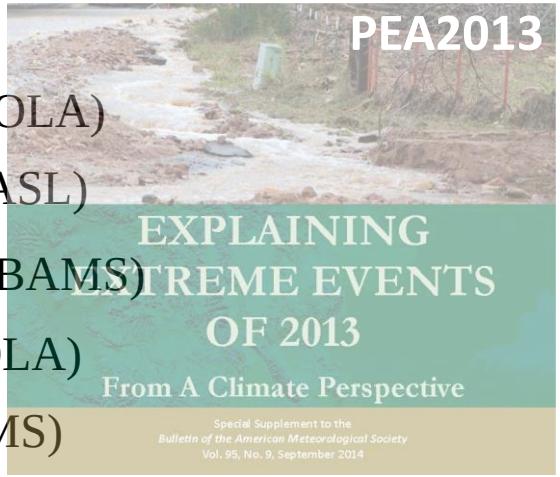
- Large ensemble makes it possible to quantify a probability of occurrence of individual events.
- **The global warming increased the risk of the severe event by XX %** (red – blue area).

Attribution Studies in Our Group

time scale of attribution: Individual events → Long-term change

Probabilistic Event Attribution (PEA)

- 2010 Russian heat wave (Watanabe et al. 2013, SOLA)
- 2010 drought in Amazon (Shiogama et al. 2013, ASL)
- 2012 heavy rainfall in Japan (Imada et al. 2013, BAMS)
- 2013 heat wave in USA (Shiogama et al. 2014, SOLA)
- 2013 heat wave in Japan (Imada et al. 2014, BAMS)

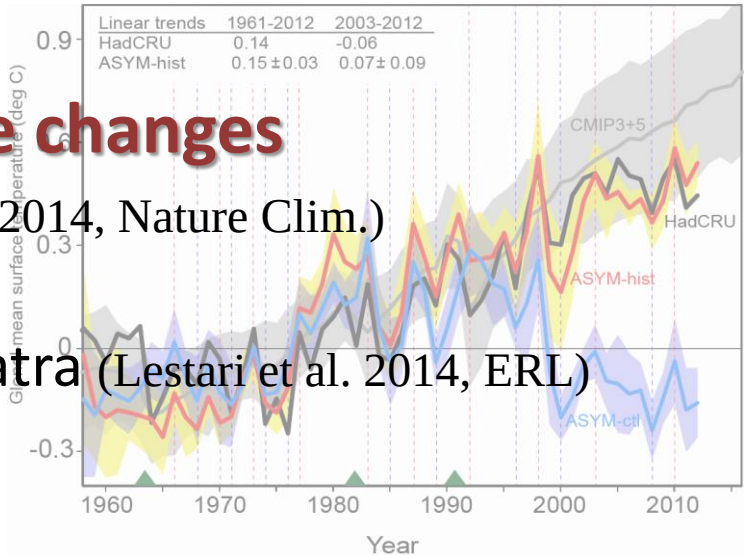


Attribution of recent Arctic sea-ice loss

- Recent Eurasian cold winters (Mori et al. 2014, Nature Geo.)

Attribution of long-term climate changes

- Global warming hiatus (Watanabe et al. 2014, Nature Clim.)
- NH heat waves (Kamae et al. 2014, GRL)
- Increasing biomass burning in Sumatra (Lestari et al. 2014, ERL)



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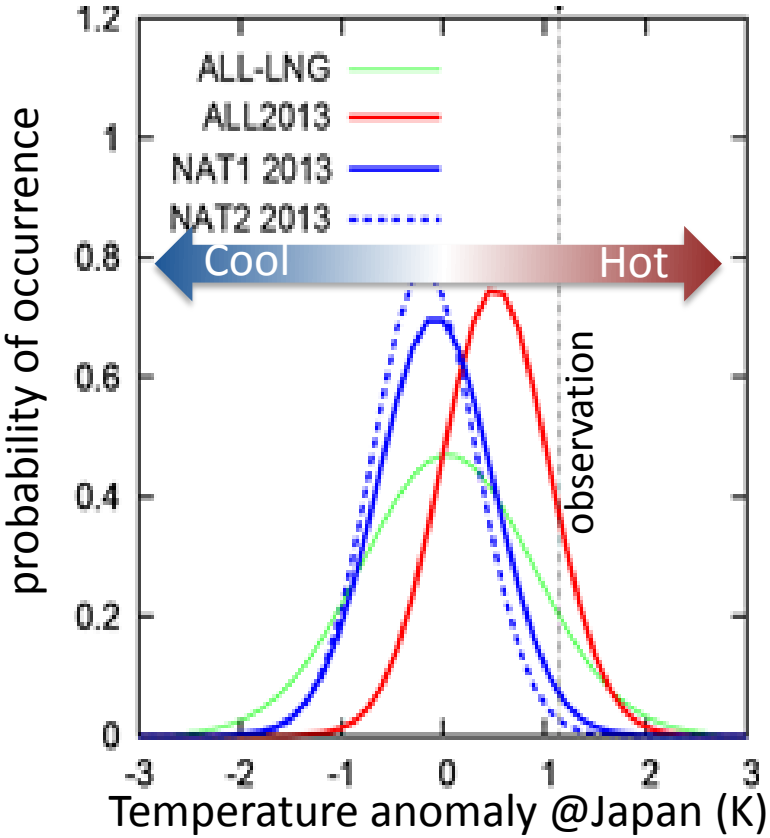
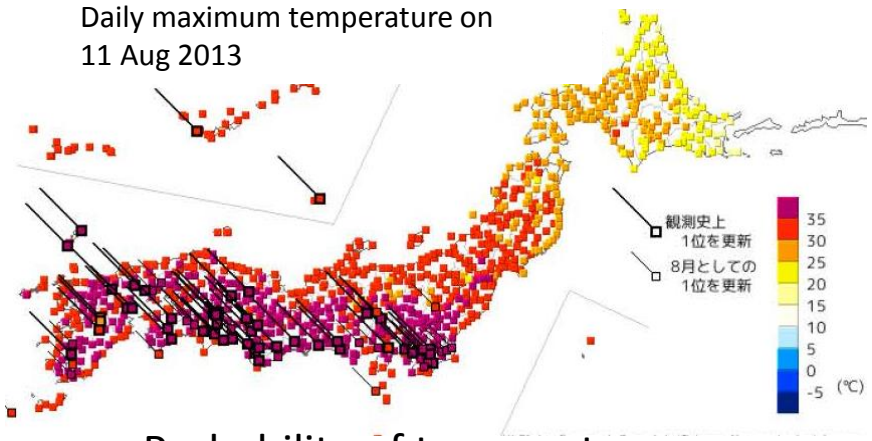
Case 1: Heat Wave in the South Japan in Jul-Aug 2013





Probability of temperature exceeding the 2013 record

ALL	NAT
12.4%	0.5 – 1.73%

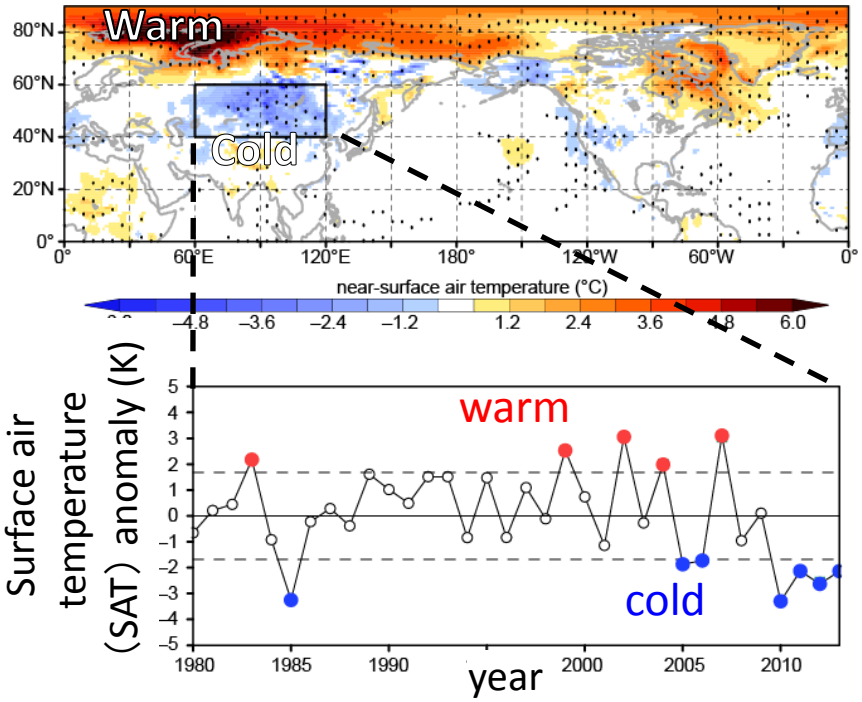
The global warming increases the risk of the severe event by approx. 10 %

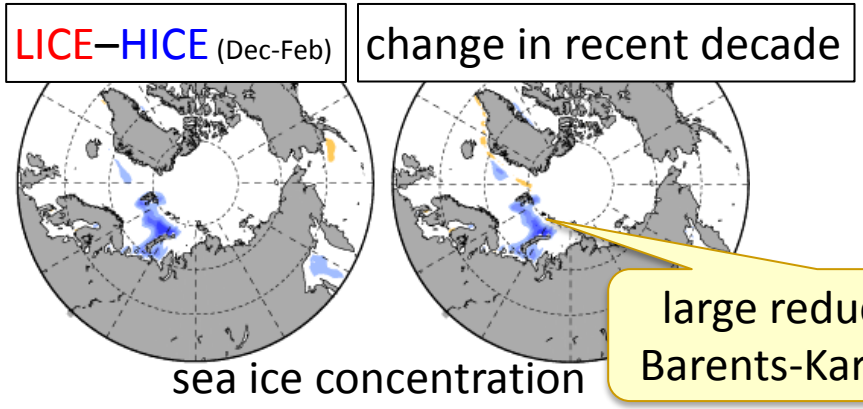
- Anthropogenic forcing played a significant role in increasing the risk of the heat wave.
- The value of quantified percentiles may have some sensitivity to assumed SST & sea ice boundary conditions in NAT-run.

Imada et al. (2014, BAMS)

Case 2: Impacts of Arctic Sea-Ice Loss on Recent Eurasian Severe Winters (Introduction)

Differences in average winter (Dec-Feb) temperature between 1994-2003 and 2004-2013 (10-year means).





large reduction over Barents-Kara sea (BKS)

Background

- Observational studies
  The cold Eurasian winters were induced by Arctic sea-ice decline.
- Modelling studies
  A robust atmospheric response has not been found yet.

Is the cause of recent cold winters natural fluctuations? Or response to the sea-ice reduction?

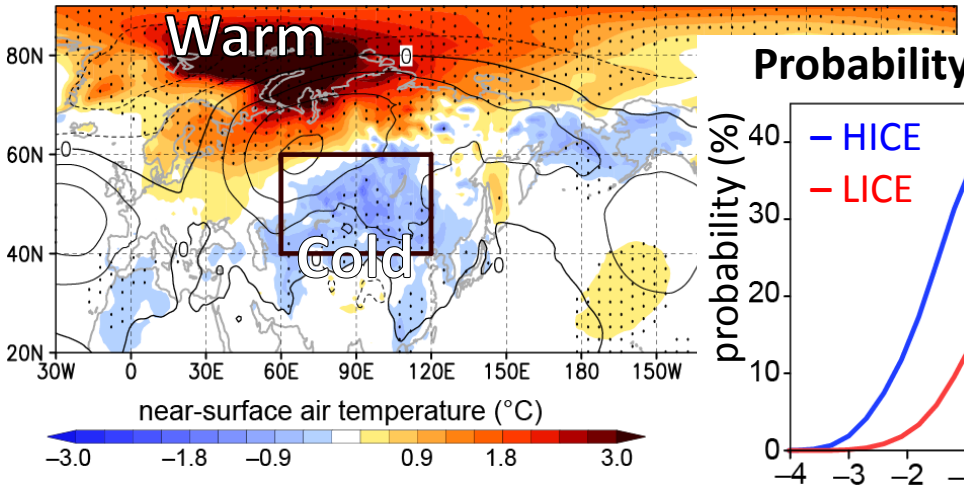
large-ensemble simulations:
the extent of sea ice is
Large (HICE) vs. small (LICE)

Mori et al. (2014, Nature Geo.)

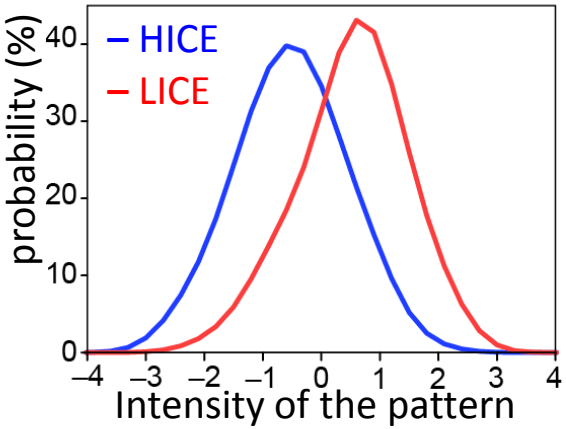
Case 2: Results

- Arctic sea-ice loss tends to increase the probability of occurrence of the atmospheric circulation pattern shown below.

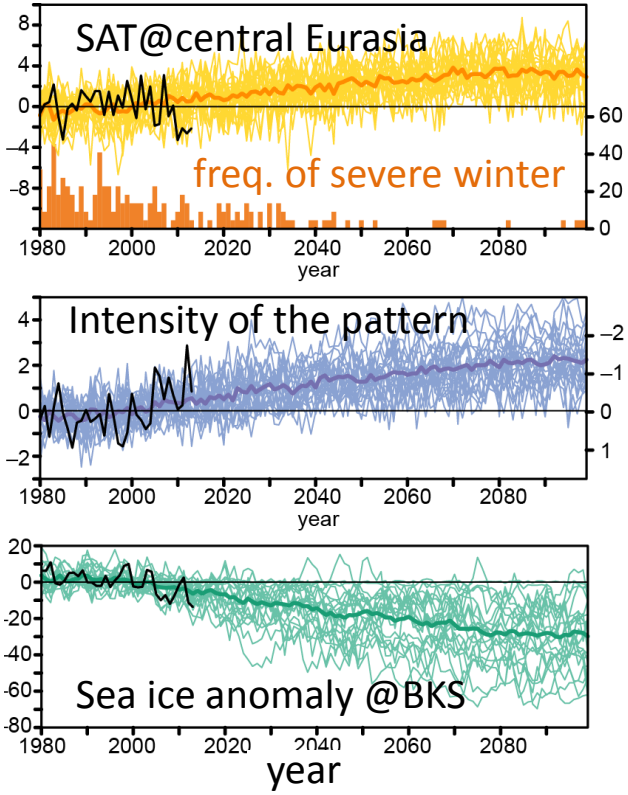
Pattern of surface air temperature anomalies associated with sea-ice loss (Dec-Feb)



Probability of occurrence



Future projections by CMIP5:



- As a result, over the central Eurasia, the probability of severe winter is more than doubled when the extent of sea ice is small (LICE) (14.4%), compared to when it is large (HICE) (6.2%).

- However, an influence from natural variability is also important for the occurrence of severe winters observed over the central Eurasia.

- The frequent occurrence of severe winters may be a temporary phenomenon in a transitional phase of eventual global warming.

Mori et al. (2014, Nature Geo.)

Summary

- Our group in SOUSEI program has actively worked on attribution of individual extreme weather events as well as recent climate changes

- The outcomes from PEA have been and will be beneficial for:
  - ✓ Physical understanding of ever-changing climate
  - ✓ Risk assessment of future extreme weather events
  - ✓ Better adaptation for a possible climate change

- The PEA could be useful and informative for public and UNFCCC

- Challenges remain:
  - ✓ The amount of change in risk by anthropogenic forcing may depend on how we evaluate the world without global warming (Method & Model performance)