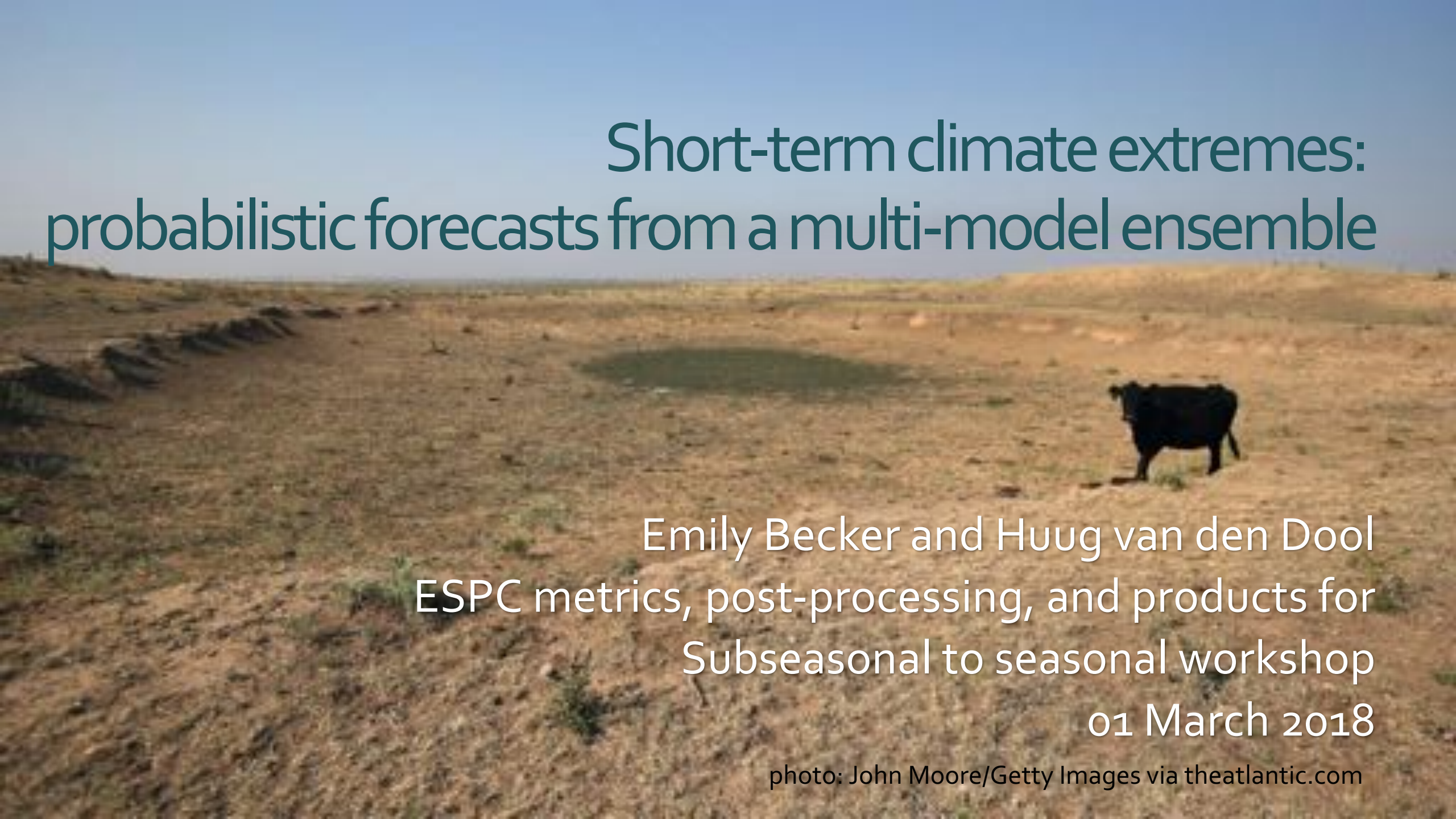
Short-term climate extremes: probabilistic forecasts from a multi-model ensemble



Emily Becker and Huug van den Dool

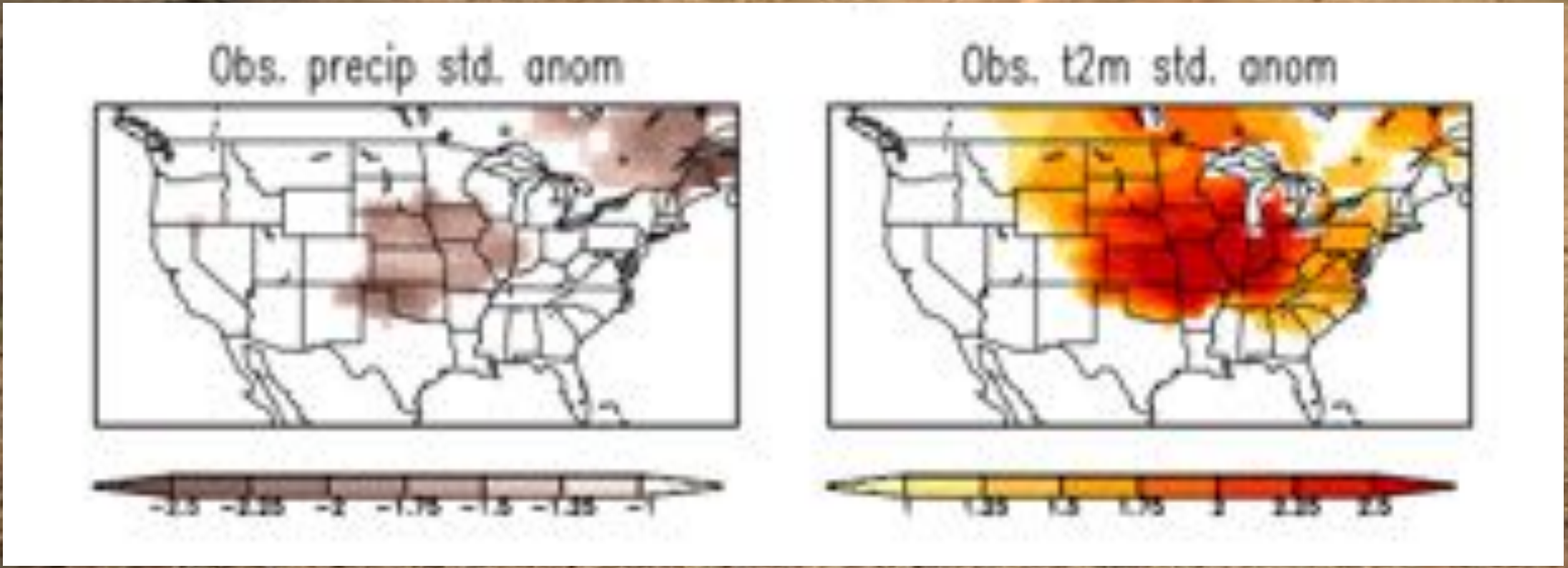
ESPC metrics, post-processing, and products for Subseasonal to seasonal workshop

01 March 2018

photo: John Moore/Getty Images via theatlantic.com

Early warning systems for climate extremes

July 2012: extreme heat and drought in midwest

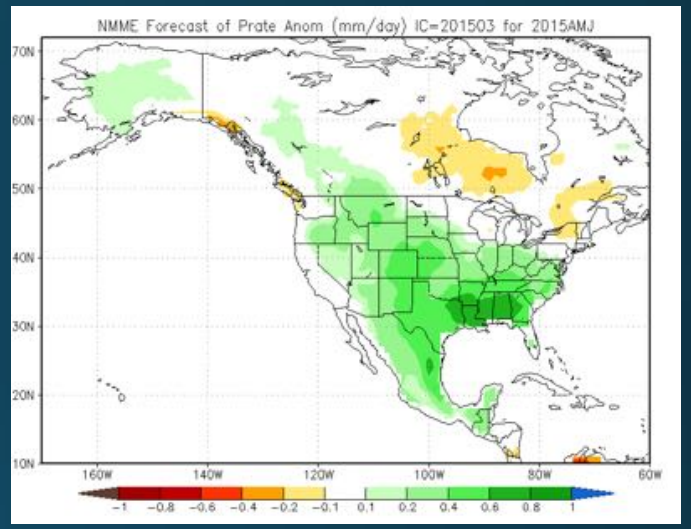


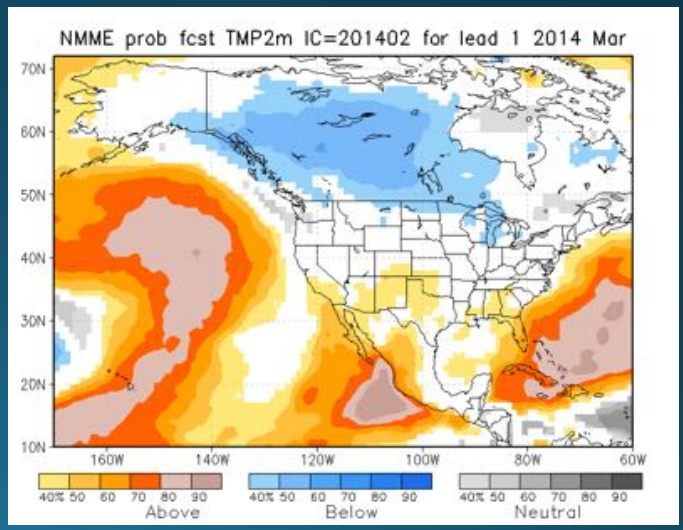
NMME

The North American Multi-Model Ensemble

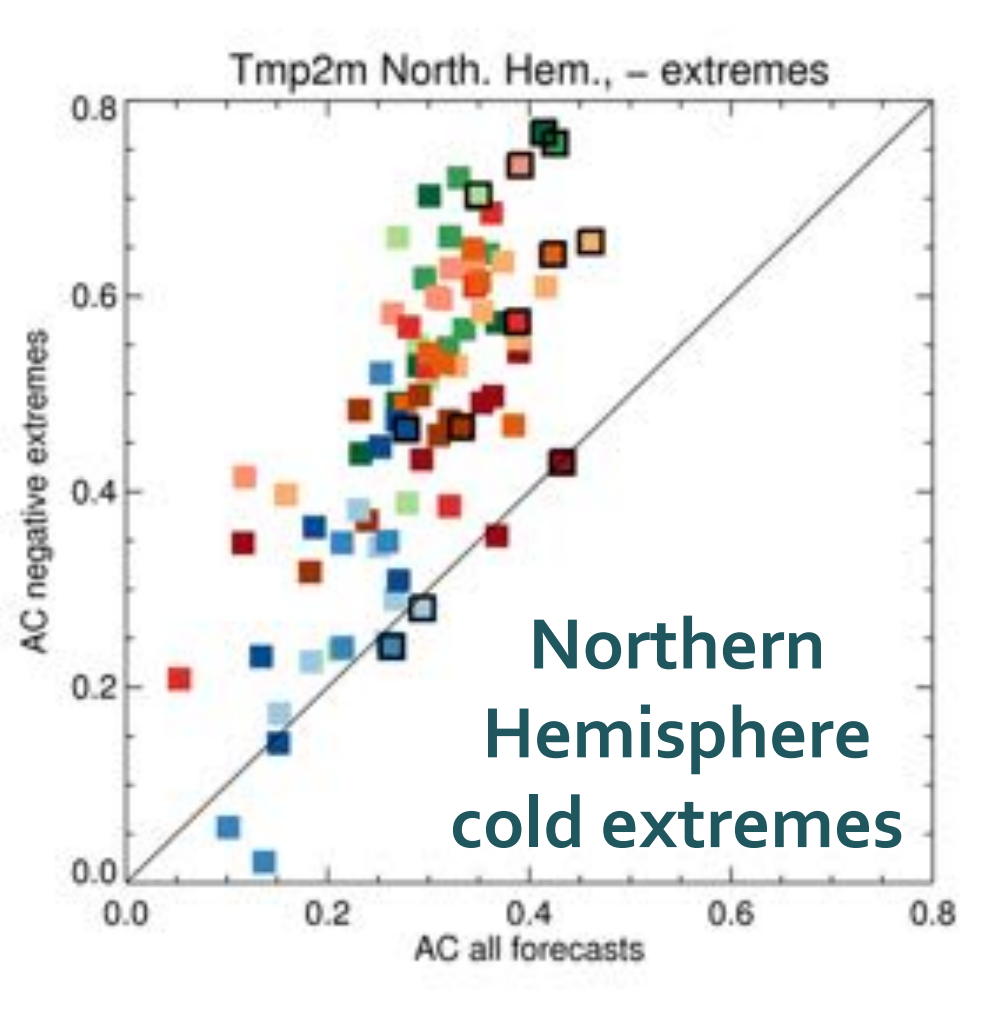
- NMME (North American Multi-Model Ensemble) is an unprecedented MME system intended to improve intra-seasonal to interannual (ISI) operational predictions based on the leading US and Canada climate models.
- Seasonal forecasting guidance available monthly, following CPC operational sched. since Aug. 2011.
- All participating models strictly follow the same protocol.
- All data (hindcast and forecast) is archived and available to the public.

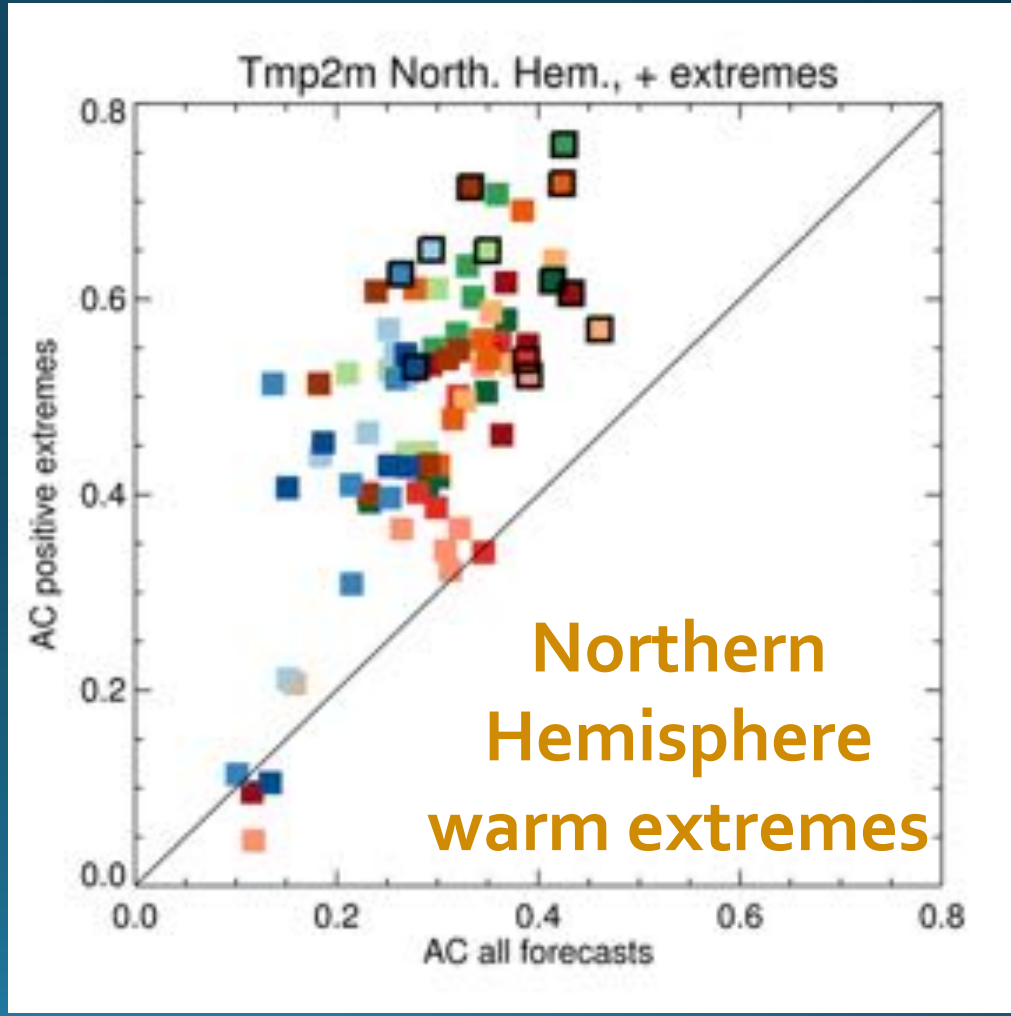
http://www.cpc.ncep.noaa.gov/products/NMME





Earlier work: forecasts for extremes are more skillful than forecasts for "all events"





Becker, E. 2017

How skillful are *probabilistic* forecasts for extremes from the NMME?

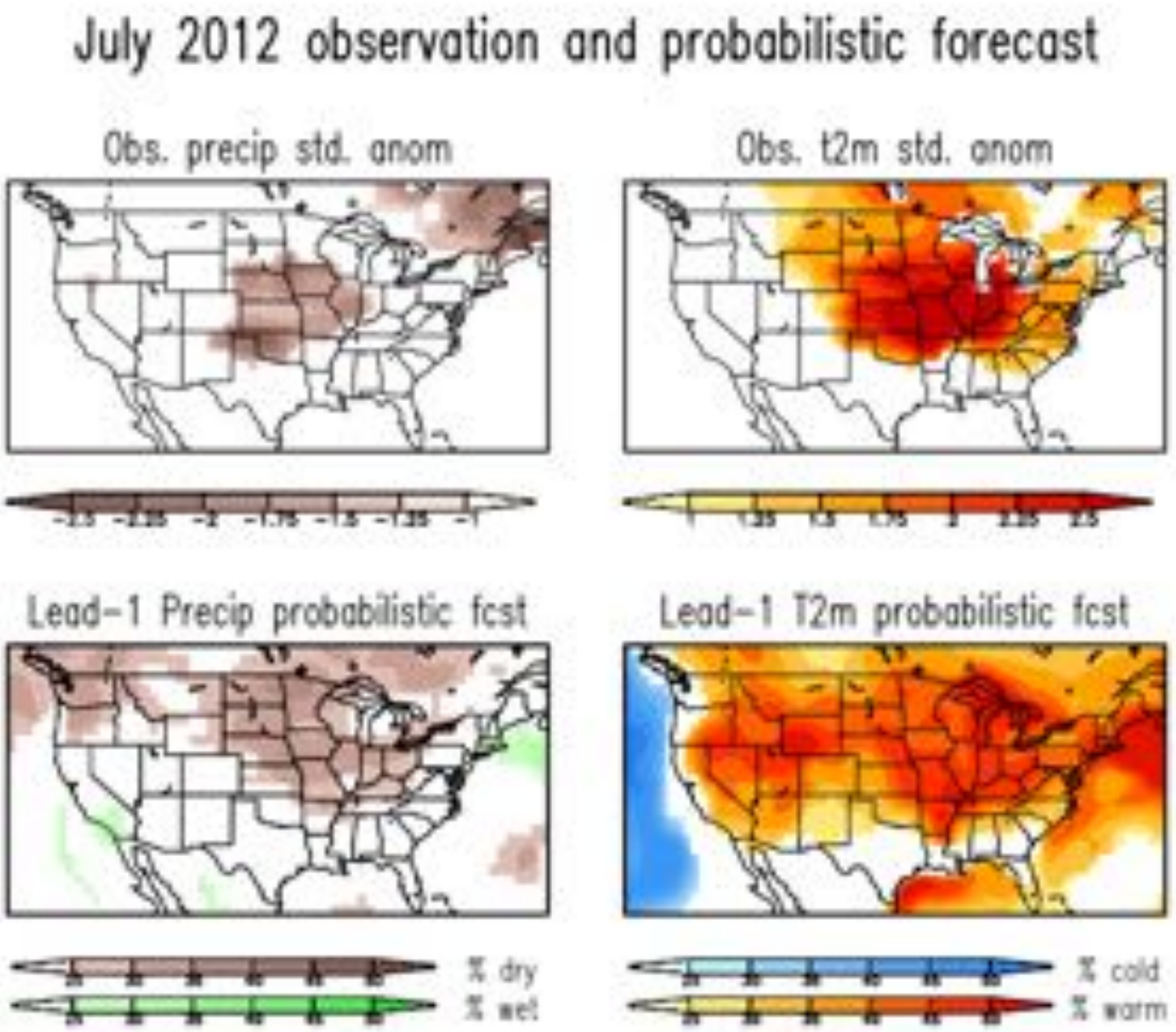
- Temperature and precipitation
- 7 models in current real-time suite: CFSv2, CanCM3/4, NASA-GEOS5, GFDL-CM2.1/FLOR, NCAR-RSMAS-CCSM4.
- Short-term climate extreme: > 1 σ or < -1σ
- Probabilities for < -1σ / >1 σ (very close to 15^{th}/85^{th} percentile) use count of ensemble members
- 1982-2016 analysis period; climatology and percentiles determined using 1982-2010
- Brier skill score, reliability, Heidke skill score, Log skill score

July 2012 example

- Short-term climate extreme:

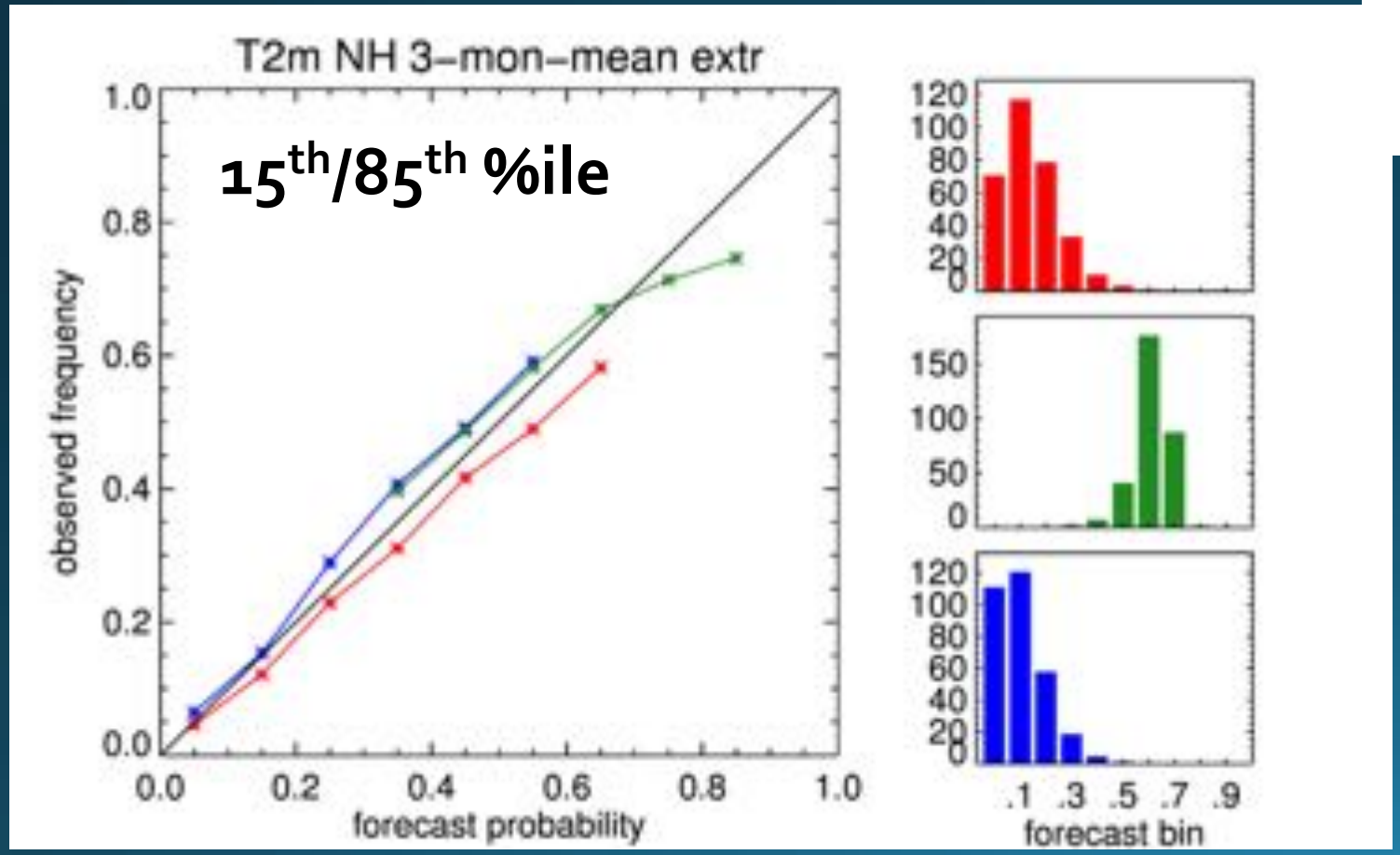
  > 1 σ or < -σ

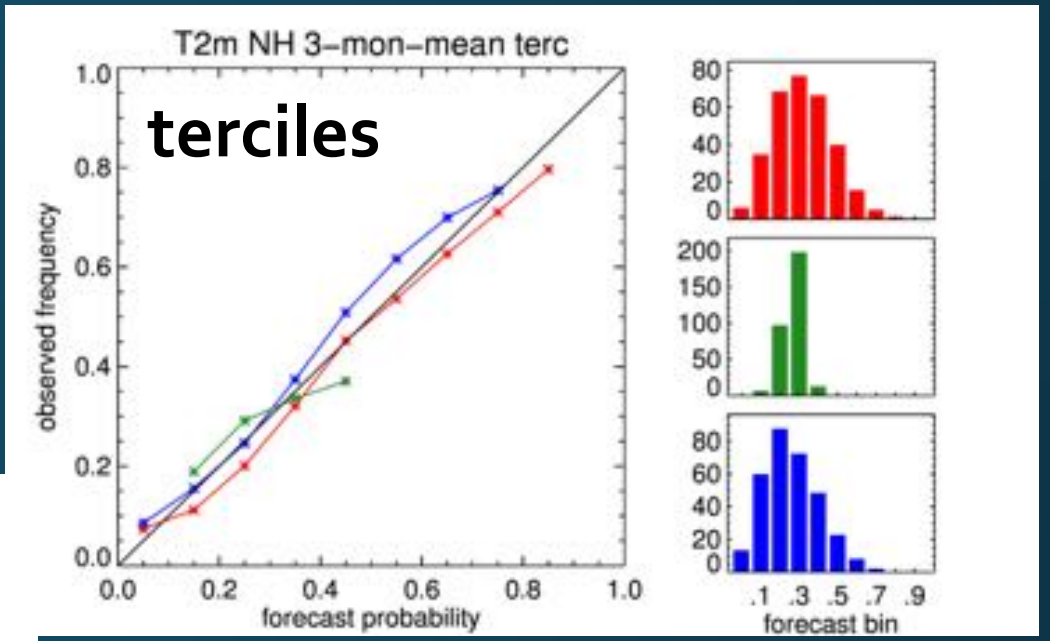
- NMME prediction Jul 2012 midwest:
  - >30% probability of extreme dry
  - 40-50% probability of extreme warm
- NMME spatial coverage is high



T2m: Reliability

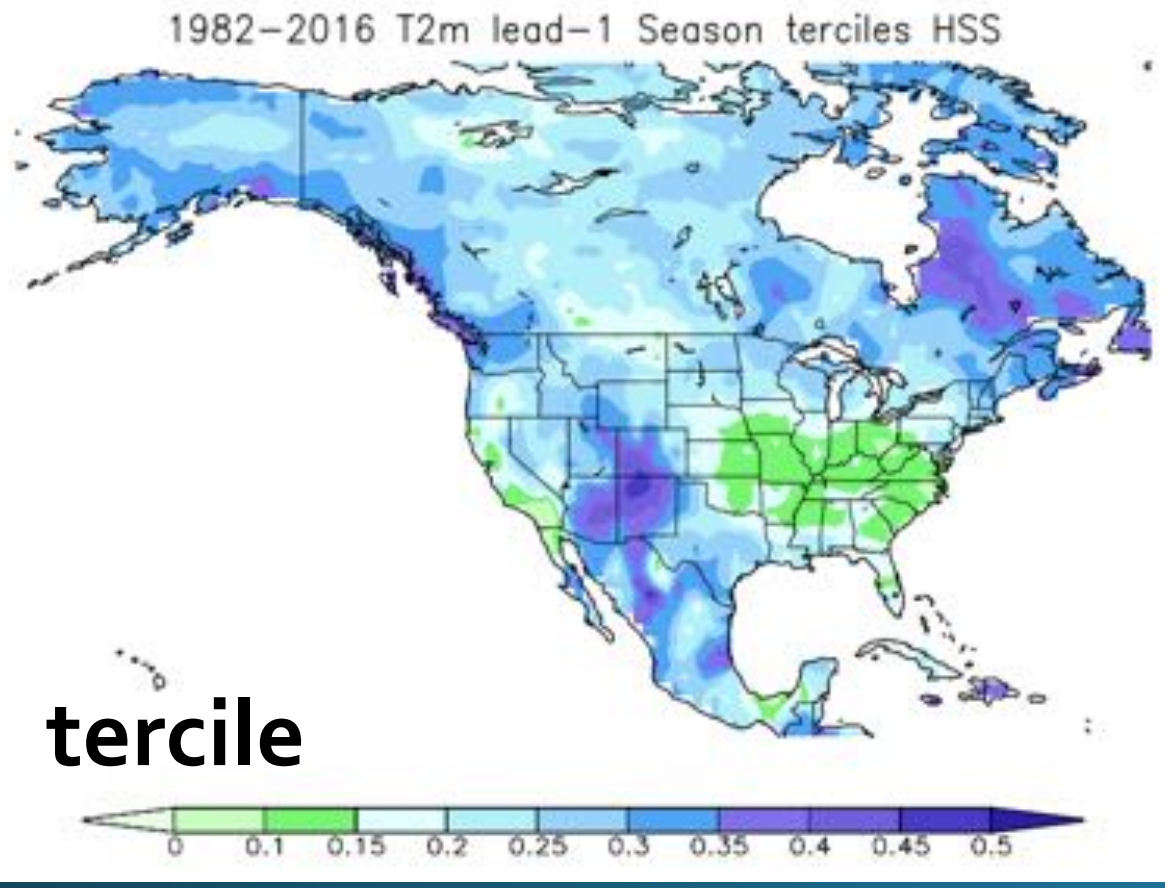
Reliability for Northern Hemisphere, lead-1, seasonal mean, all 12 ICs,82-2016, land only



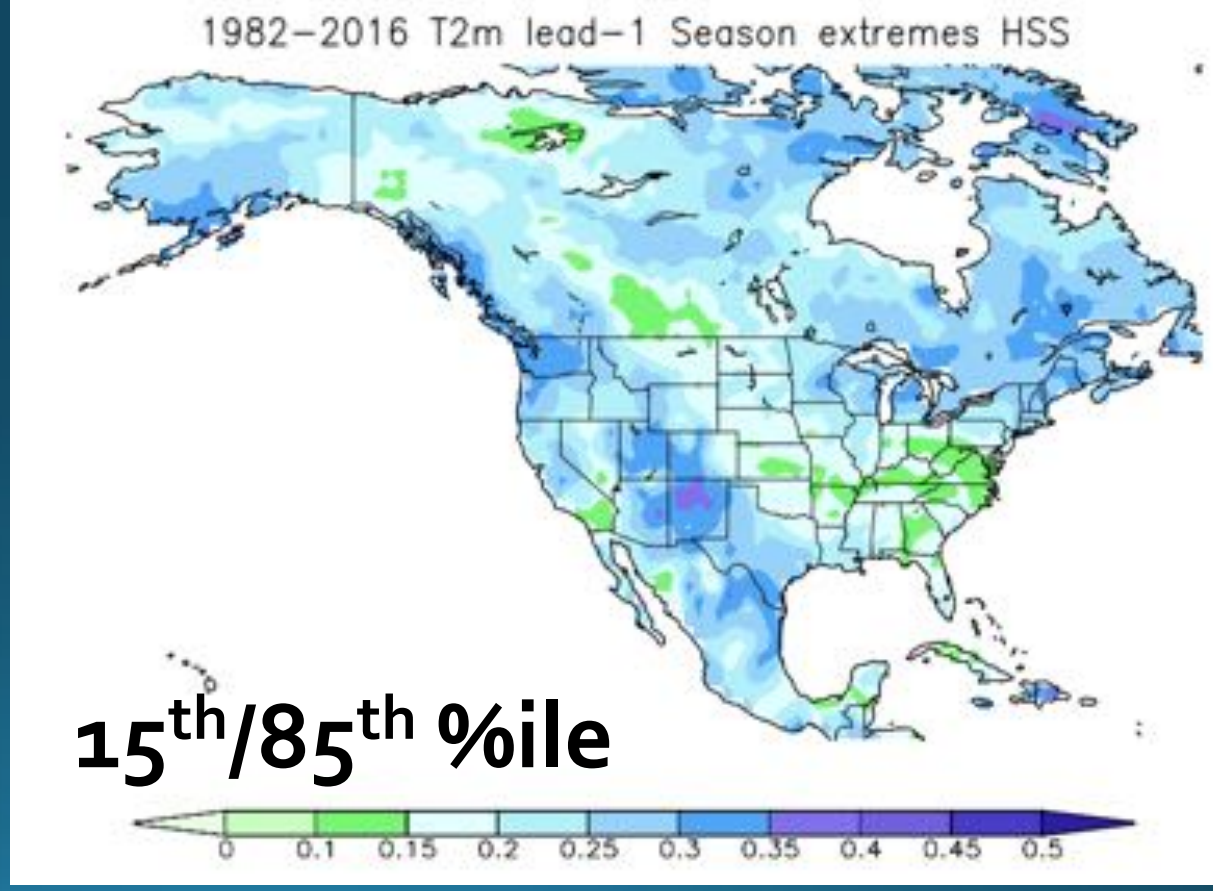


- Cool extreme slightly underforecast; warm slightly overforecast
- Similar patterns to tercile

T2m Heidke Skill Score



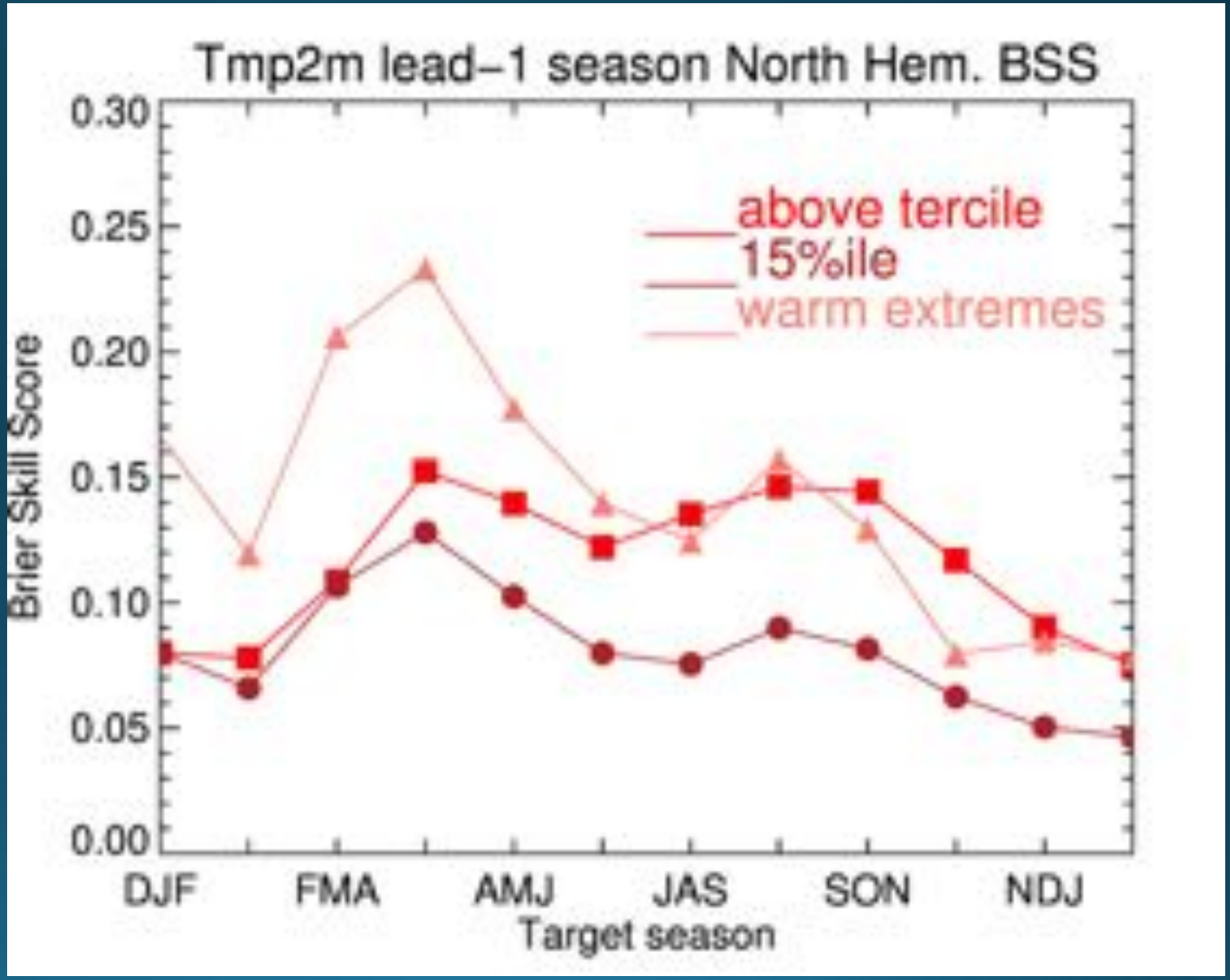
tercile



$15^{th}/85^{th}$ %ile

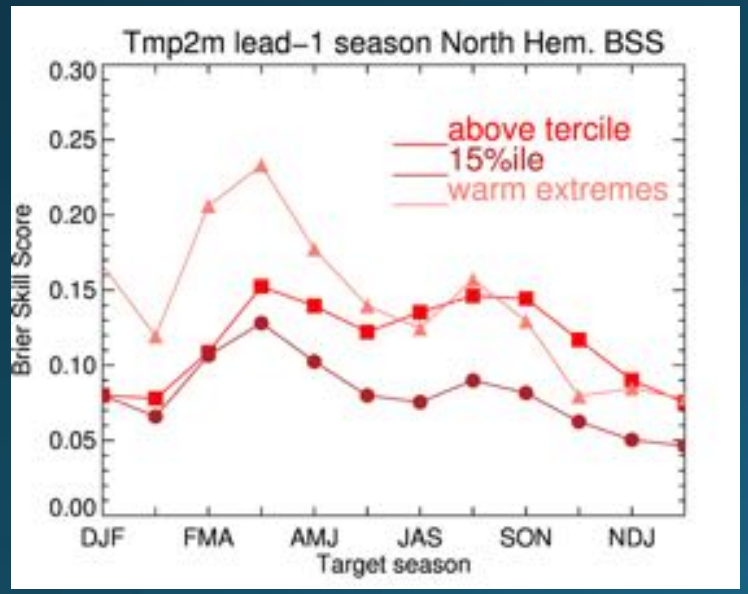
T2m: Brier Skill Score

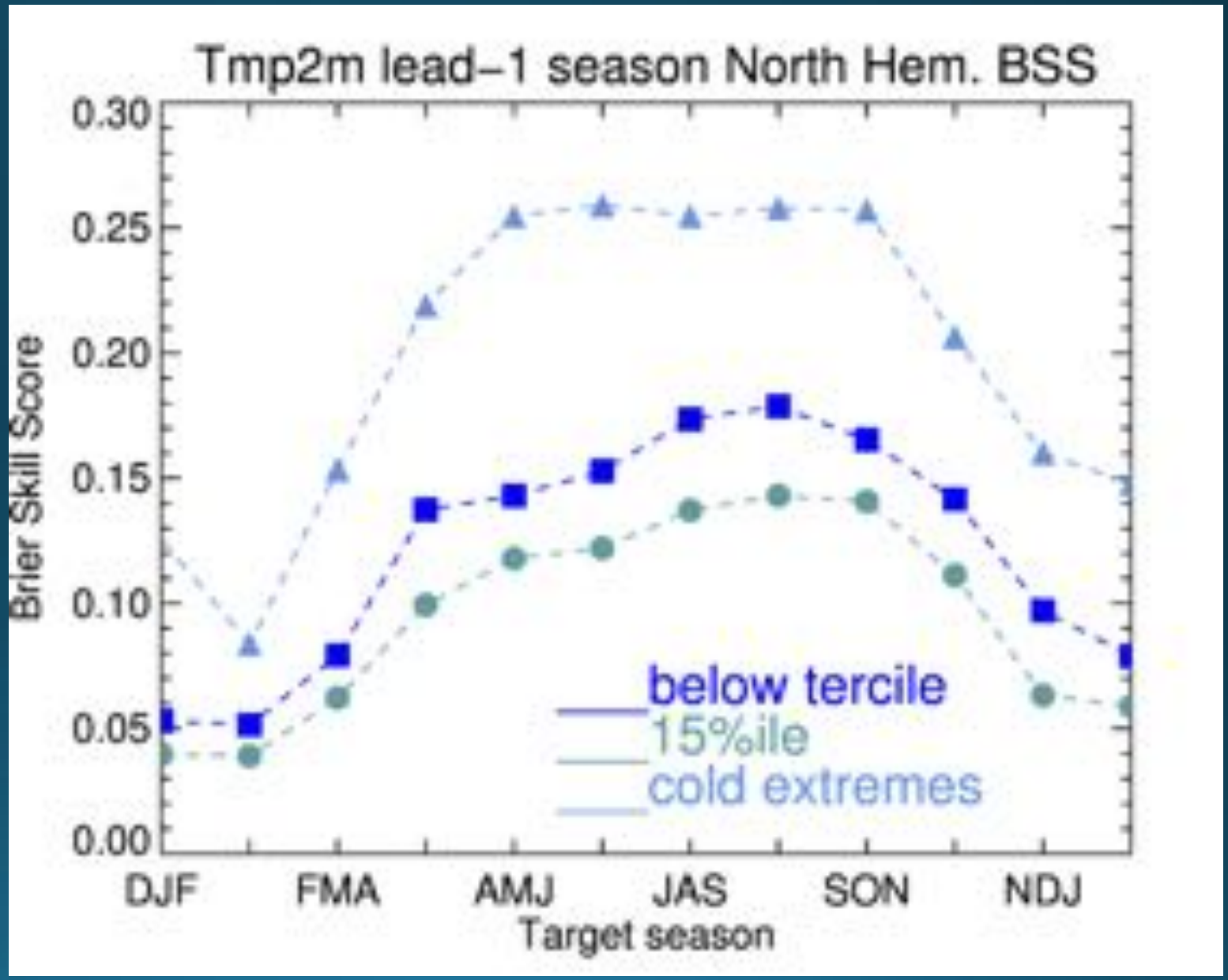
- Overall BSS for 85th percentile are lower than for above normal tercile (66.7th percentile)
- When forecasts for "extreme" are isolated, meaning anomaly forecast is >1 σ, BSS is higher (similar to behavior of anom. corr.)



T2m: Brier Skill Score

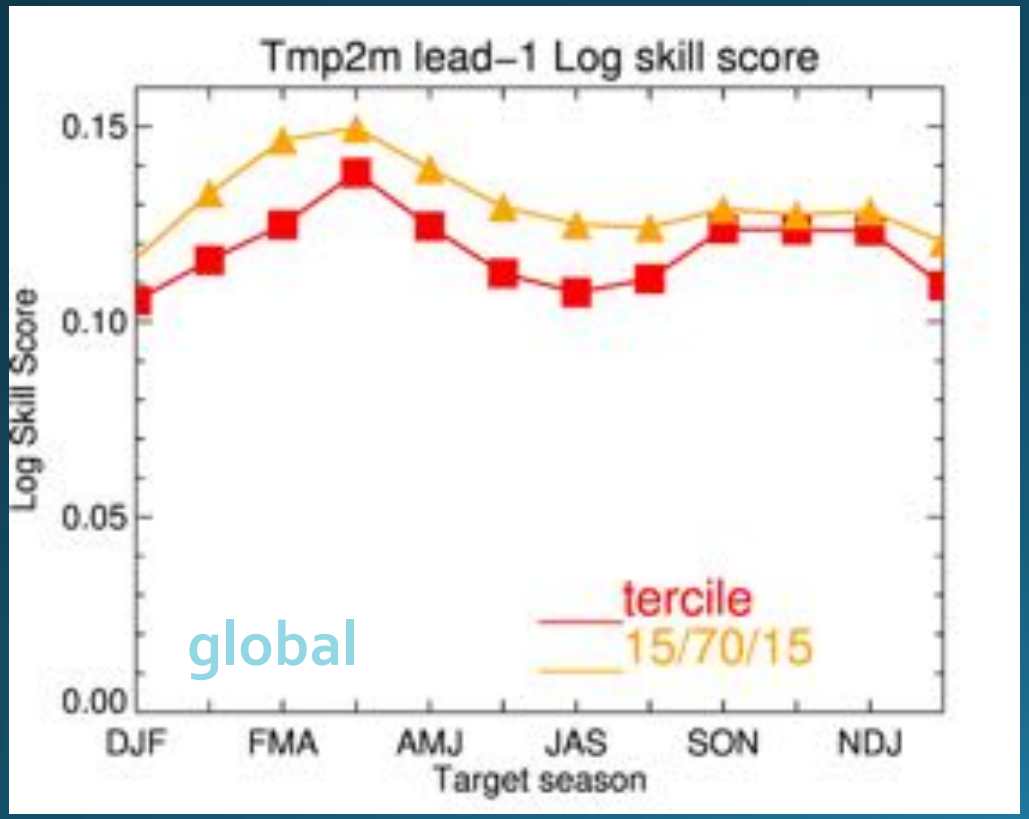
- Spring/summer/fall below-normal and cold extremes more skillful than winter

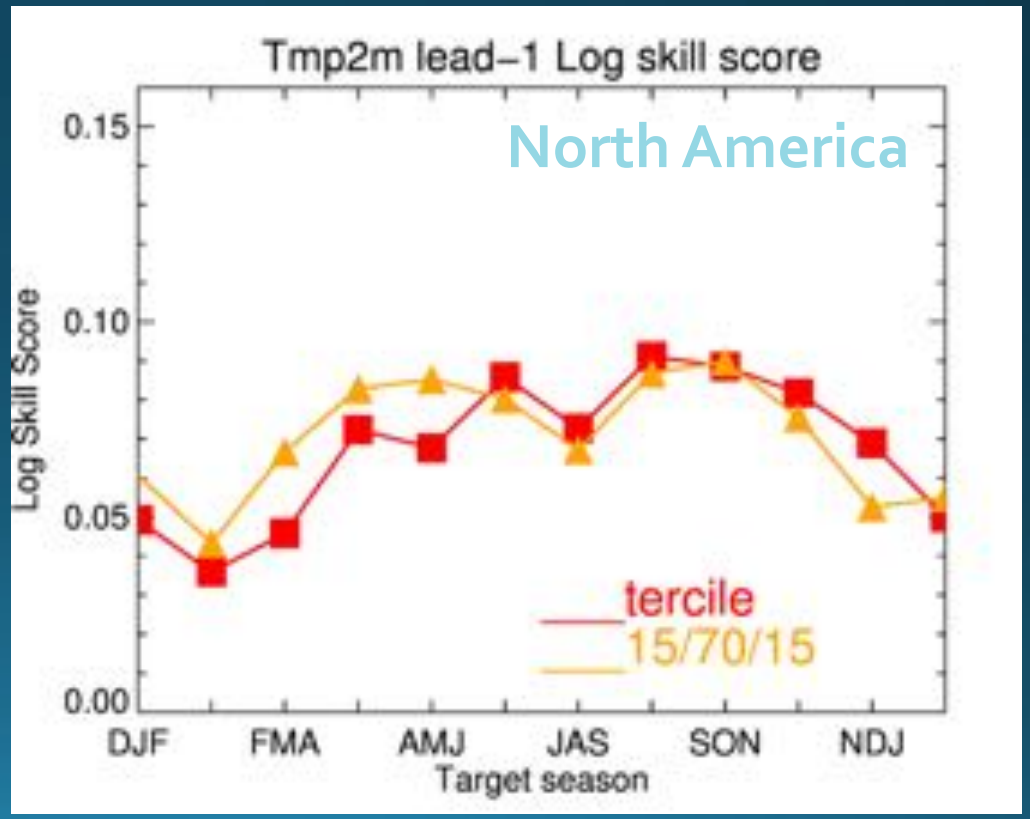




T2m Log skill score

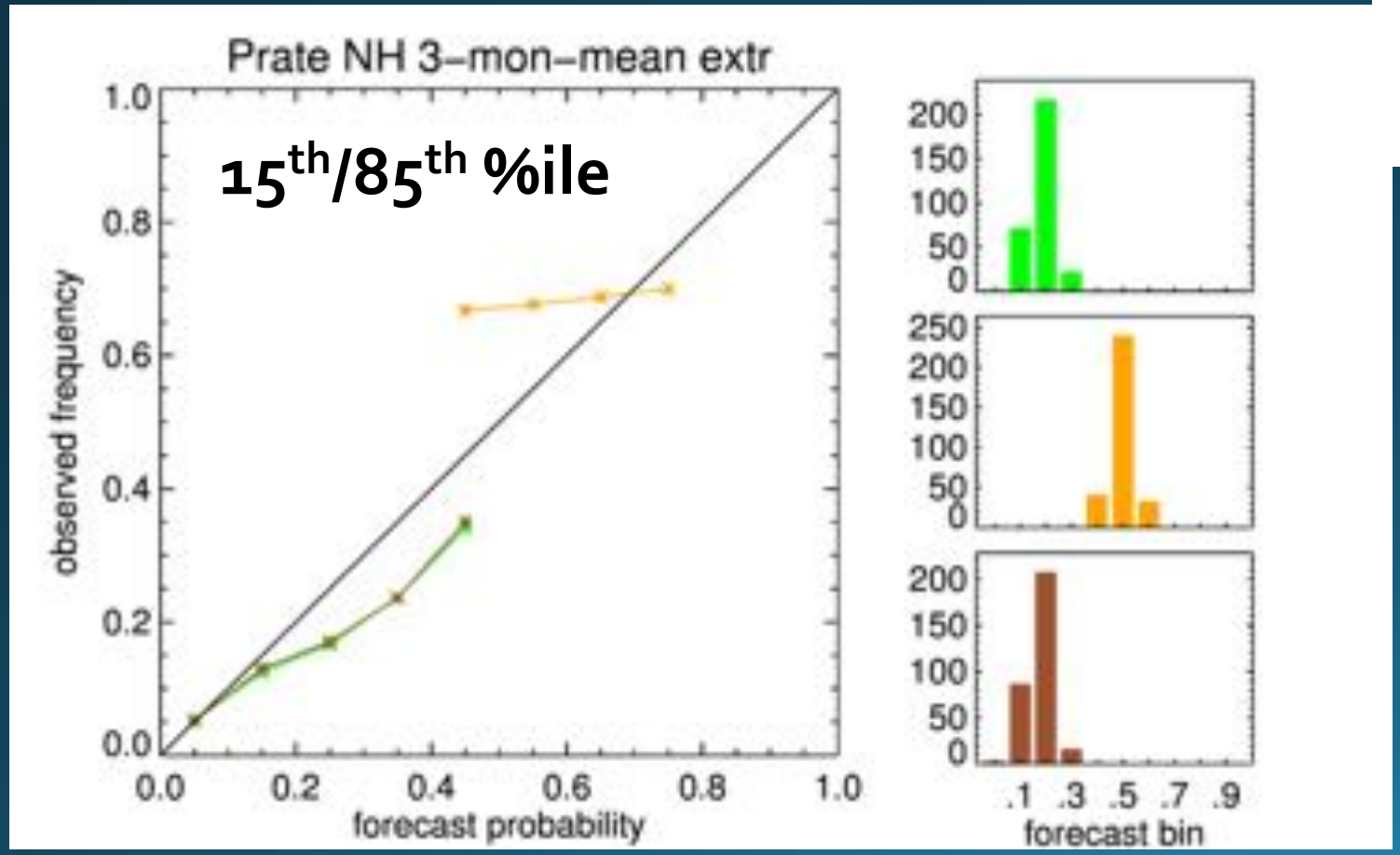
- Log score = log of forecast probability of the observed category
- "local score" – does not depend on probability in other categories
- $LSS=LS-LS_{ref}$

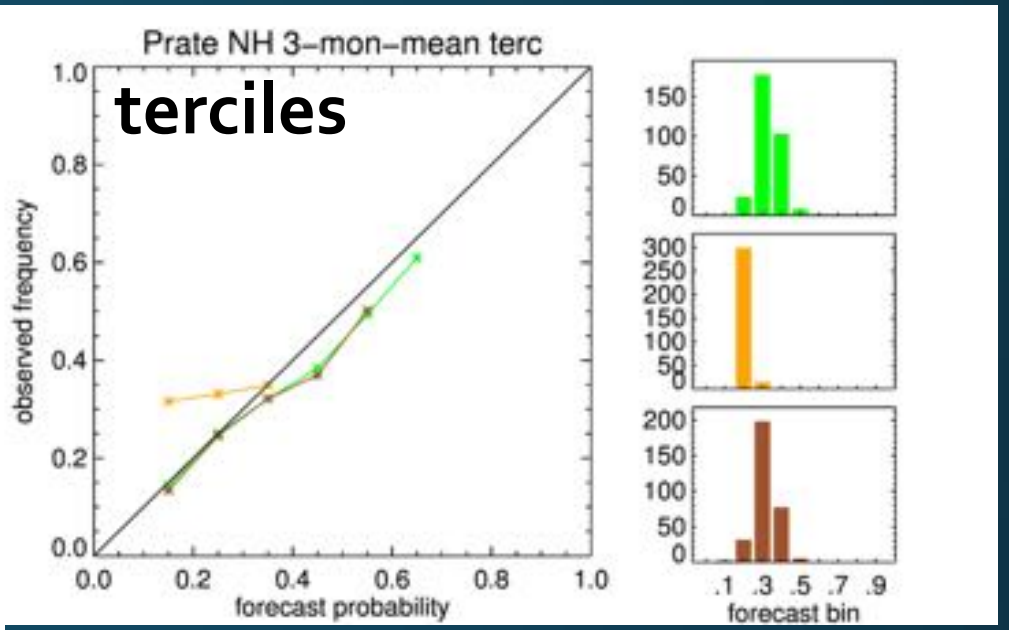




Precip: Reliability

Reliability for Northern Hemisphere, lead-1, seasonal mean, all 12 ICs,82-2016, **land only**

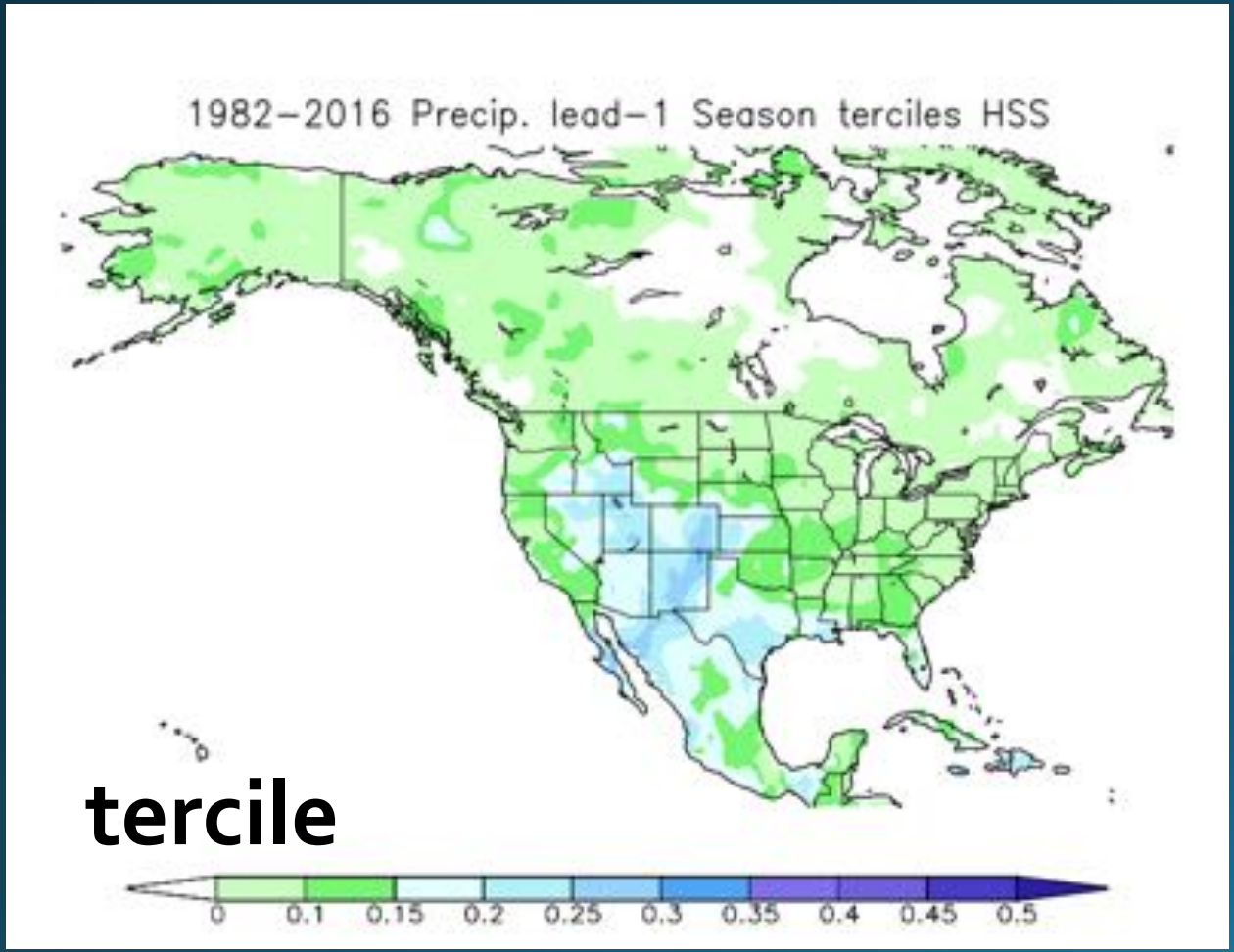




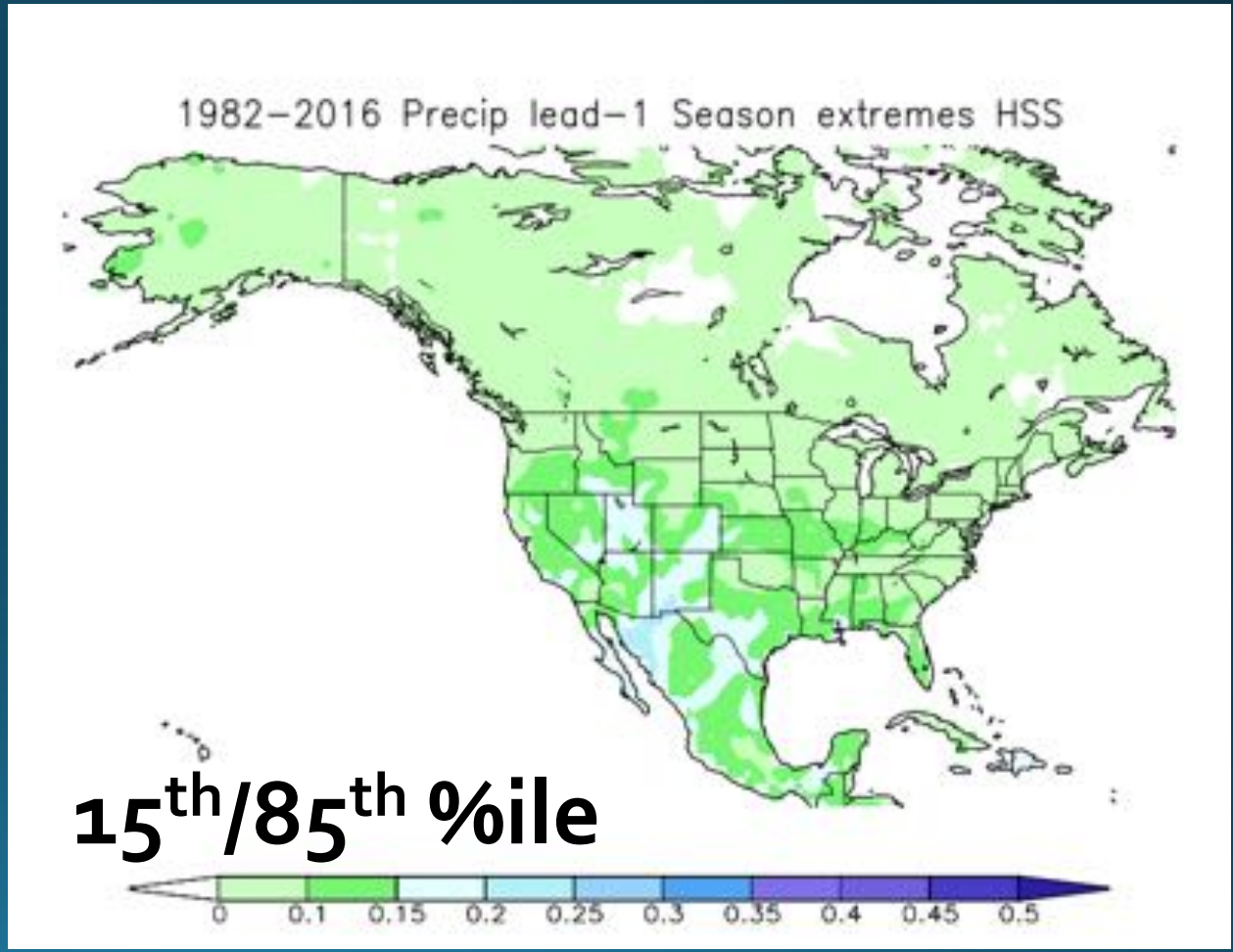
- Precip is transformed by ^(1/4) before distribution fitting
- Reliability and sharpness are generally poor
- Above/below and 15th/85th are very similar to each other

Precip Heidke Skill Score

Annual average, lead-1, seasonal mean, 1982-2016

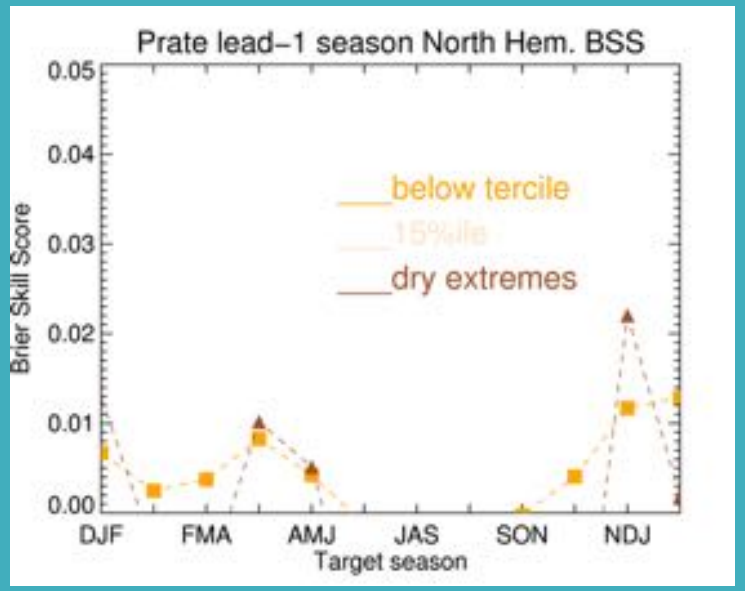


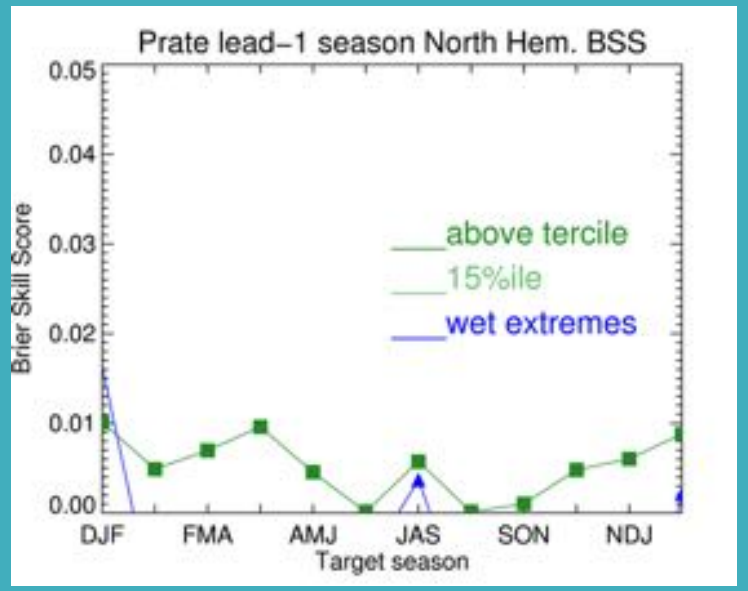
tercile



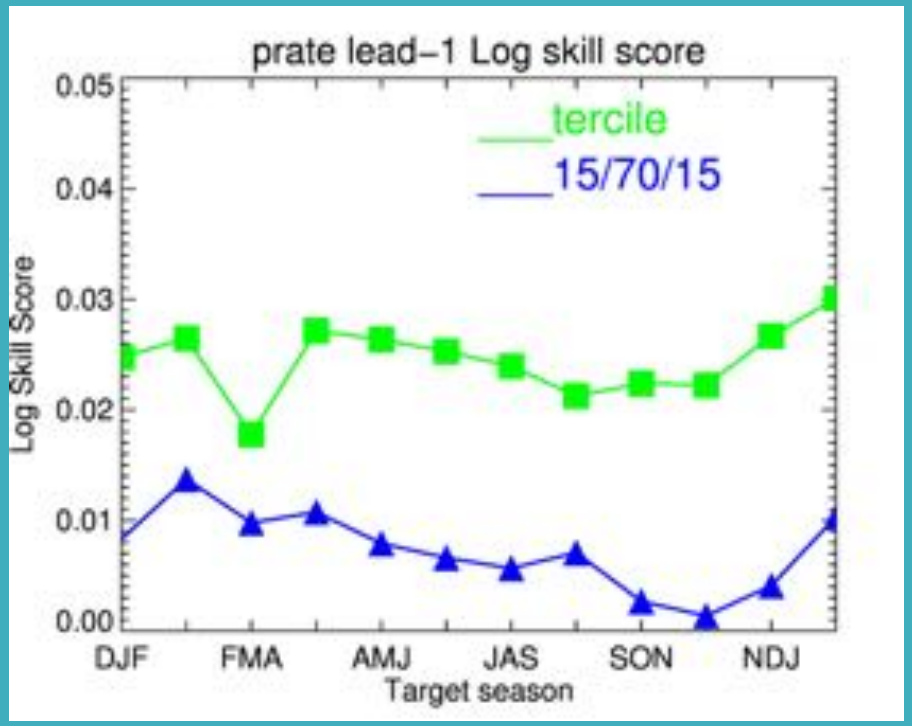
$15^{th}/85^{th}$ %ile

Precip Brier & Log skill scores





Northern hemisphere



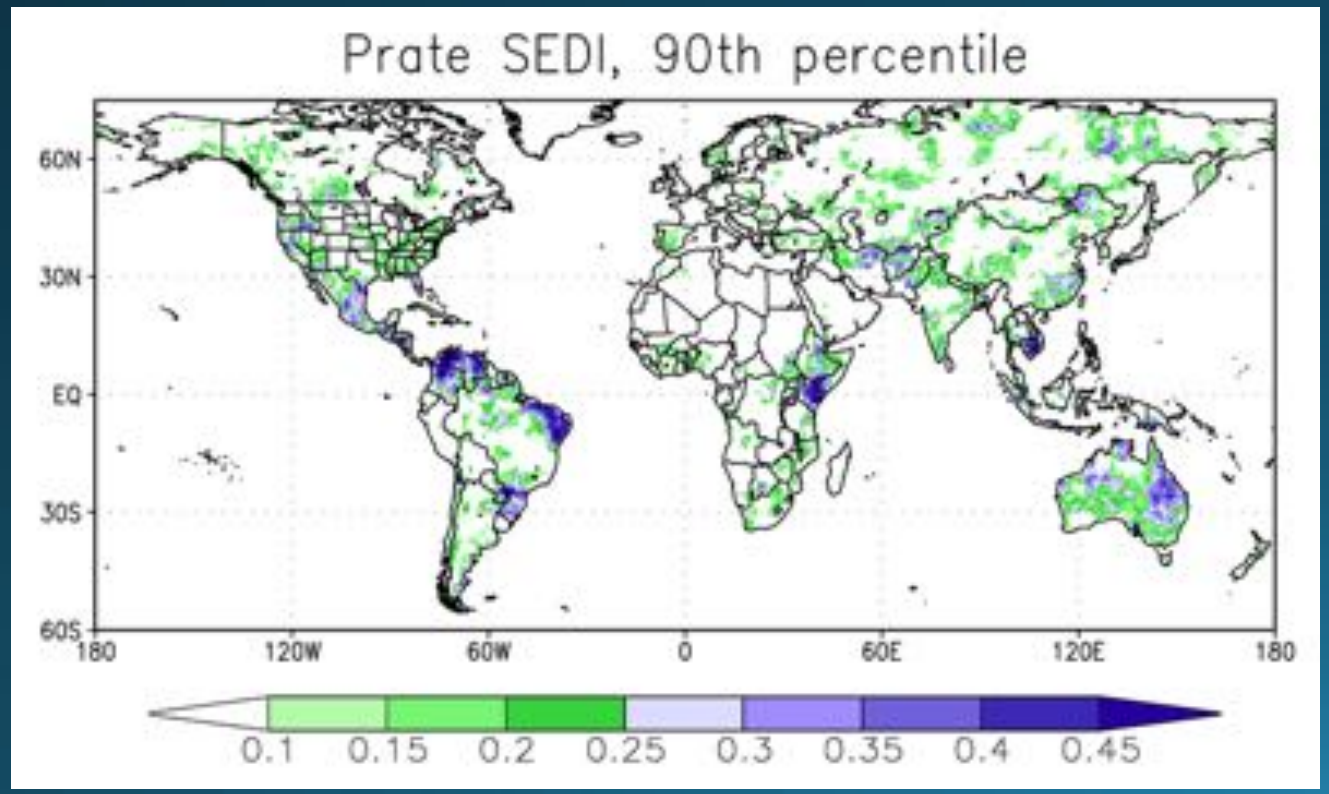
global

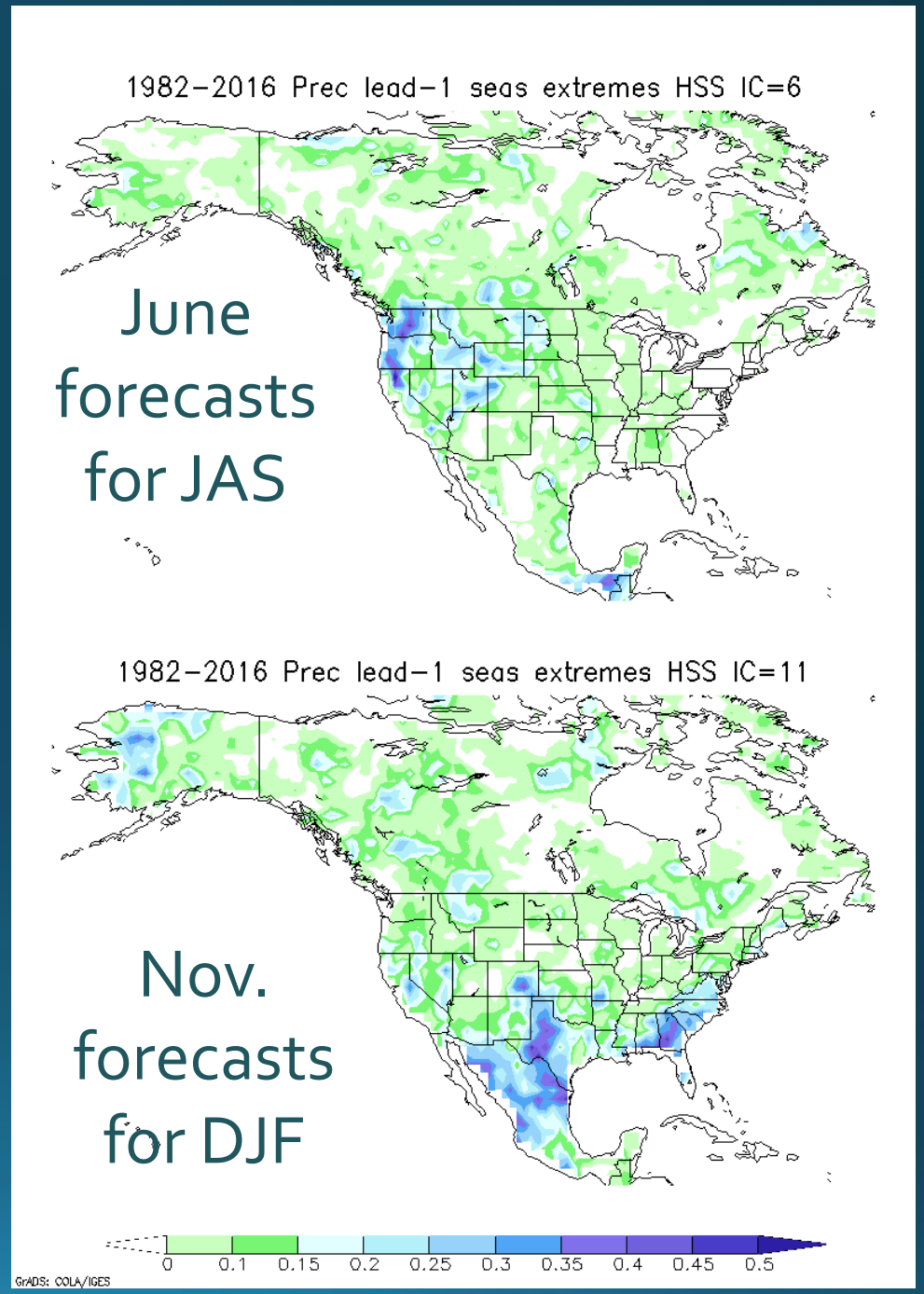
lead-1 seasonal mean, ICs,82-2016, **land only**

We may need a different approach for precipitation extremes

Precipitation

- Seasonality; windows of opportunity
- Area aggregates; characteristics
- Proxies





Summary & Comment

- Potential for an S2S extremes forecast tool based on NMME for temperature
- Any official outlook would require substantial R&D, including social science input
  - Threshold probability?
- Precipitation extremes will need some creativity to find skill. However, an outlook for extremes could be issued infrequently and still be useful
- Relationship between temperature and precipitation…?