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Near-term Hydroclimate outlooks based on the Community Earth System Model (CESM) Decadal Prediction Large Ensemble (DPLE)

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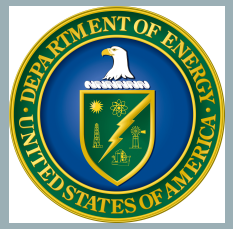
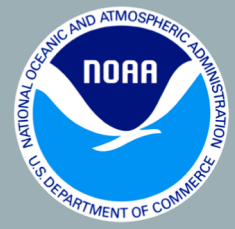




The CESM Decadal Prediction Large Ensemble

Experiment Name	CCSM4-DP	CESM-DP-LE
Model **-atm** **-ocn** **-ice** **-lnd**	CCSM4 CAM4 (FV 1°, 26lvl) POP2 (1°, 60lvl) CICE4 (1°) CLM4	**CESM1.1** **CAM5** (FV 1°, **30lvl**) POP2 (1°, 60lvl) **w/ BGC** CICE4 (1°) CLM4
Uninitialized Ensemble (UI)	6-member CCSM4 20th century ensemble (Meehl et al., 2012)	**40-member CESM 20th century Large Ensemble** (Kay et al., 2015)
Forcing	-2005: CMIP5 historical 2006-: CMIP5 RCP 4.5	-2005: CMIP5 historical 2006-: CMIP5 **RCP 8.5**
Initialization **-method** **-atm** **-ocn** **-ice** **-lnd**	 full field UI CORE-forced FOSI CORE-forced FOSI UI	 full field UI **CORE*-forced FOSI** **CORE*-forced FOSI** UI
Ensembles **-ensemble size** **-start dates** **-ensemble generation** **-simulation length**	 10 annual; Jan. 1st 1955-2014 (N=60 Variable January start days + round-off perturbation of atm initial conditions 120 months	 **40** annual; **Nov. 1st 1954-2015 (N=62)** round-off perturbation of atm initial conditions 122 months

CMIP5-era (2011) CMIP6-era (2017)

★ Active ocean biogeochemistry

★ More robust assessment of the skill derived from external forcing

★ Improved ocean initial conditions (reduced shock)

★ Large ensemble size

Now extended to 2017

OUTLINE

- Global overview of skill at predicting seasonal precipitation over land
  - Impact of initialization

- Focused examination of some select regions/seasons:
  - African Sahel (JAS)
  - Northern Europe (JAS)
  - Pacific Northwest (JAS)
  - Scandinavia (JFM)
  - Pacific NW (JAS)

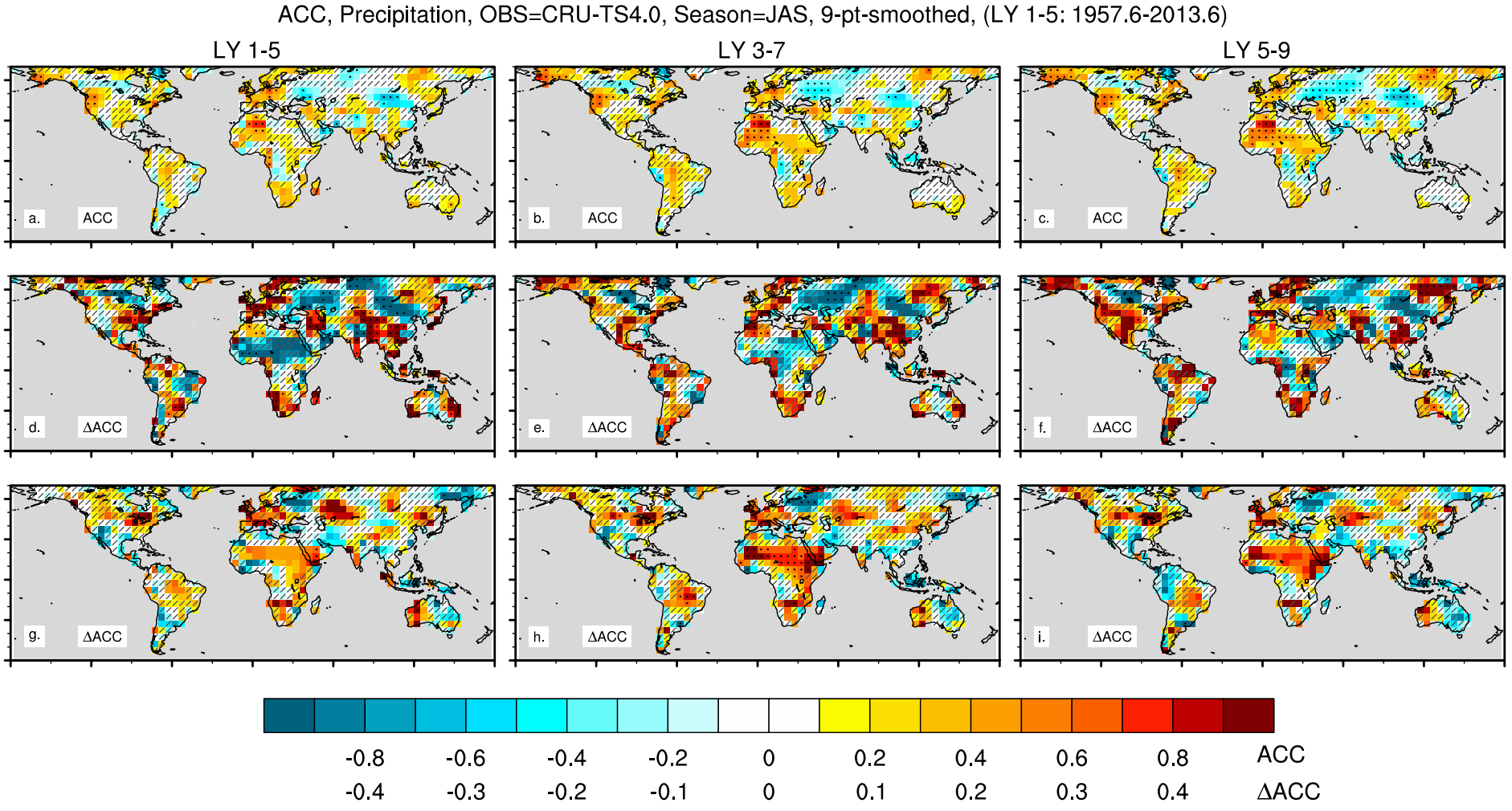
- Towards an improved understanding of regional precipitation skill:
  - Skill (skill improvement) dependence on ensemble size
  - Skill dependence on lead time
  - What can be learned from skill spread?

Yeager et al., 2018: Predicting near-term changes in the Earth System: A large ensemble of initialized decadal prediction simulations using the Community Earth System Model, *Bull Amer Meteorol Soc*, in press, doi: 10.1175/BAMS-D-17-0098.1

CESM-DPLE: Boreal Summer (JAS) Precip

- 40-member-, pentadal-means
- Land-only data
- 5°x5° grid with 9-pt spatial smoother (each grid point represents 15°x15°)

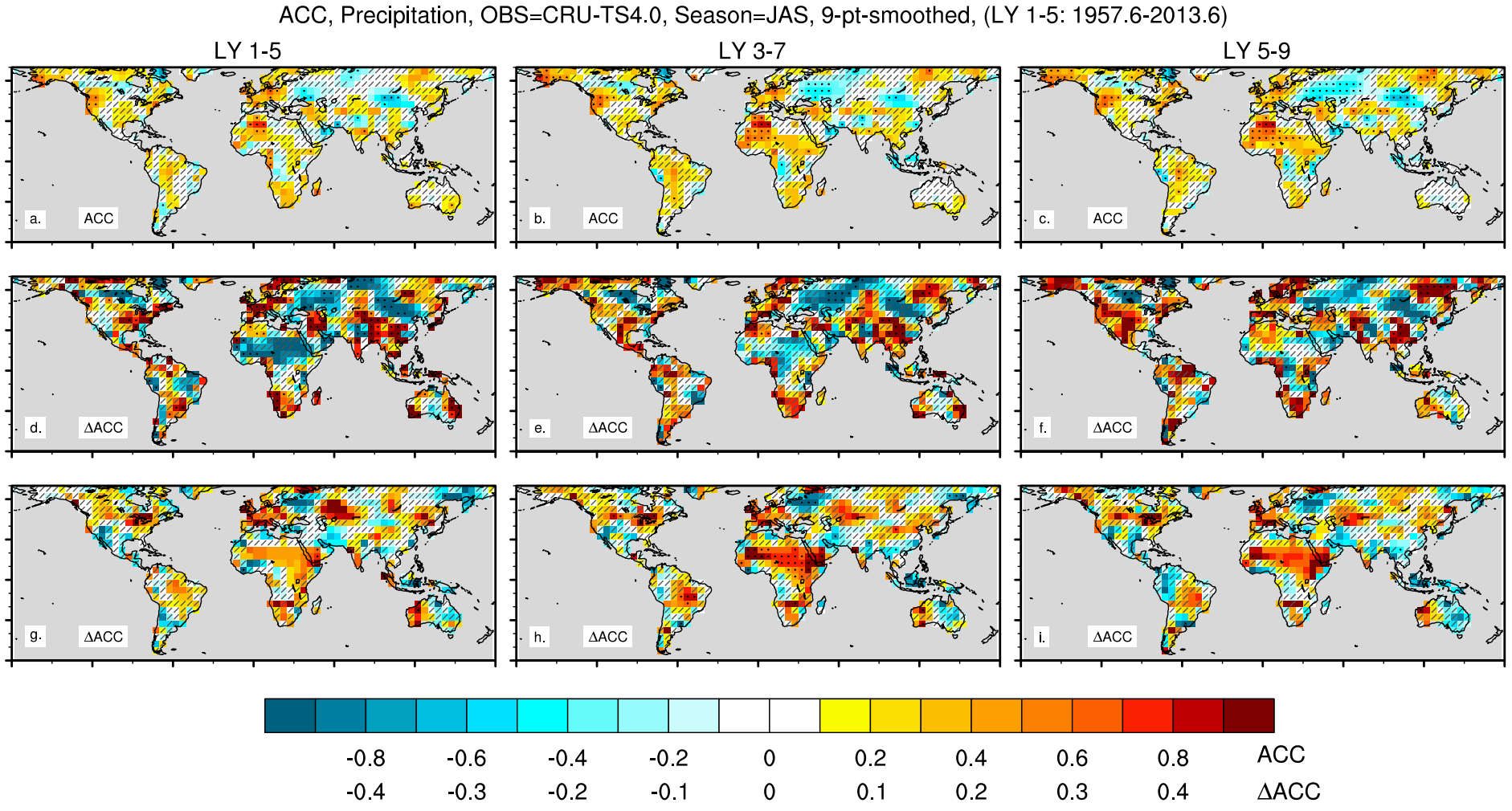
- OBS = CRU-TS4.0 (Harris et al. 2014, *Int J Climatol*)
- Top row: ACC(DPLE,OBS)
- Middle row: ΔACC relative to persistence
- Bottom row: ΔACC relative to 40-member LE



Yeager et al. (2018)

CESM-DPLE: Boreal Summer (JAS) Precip

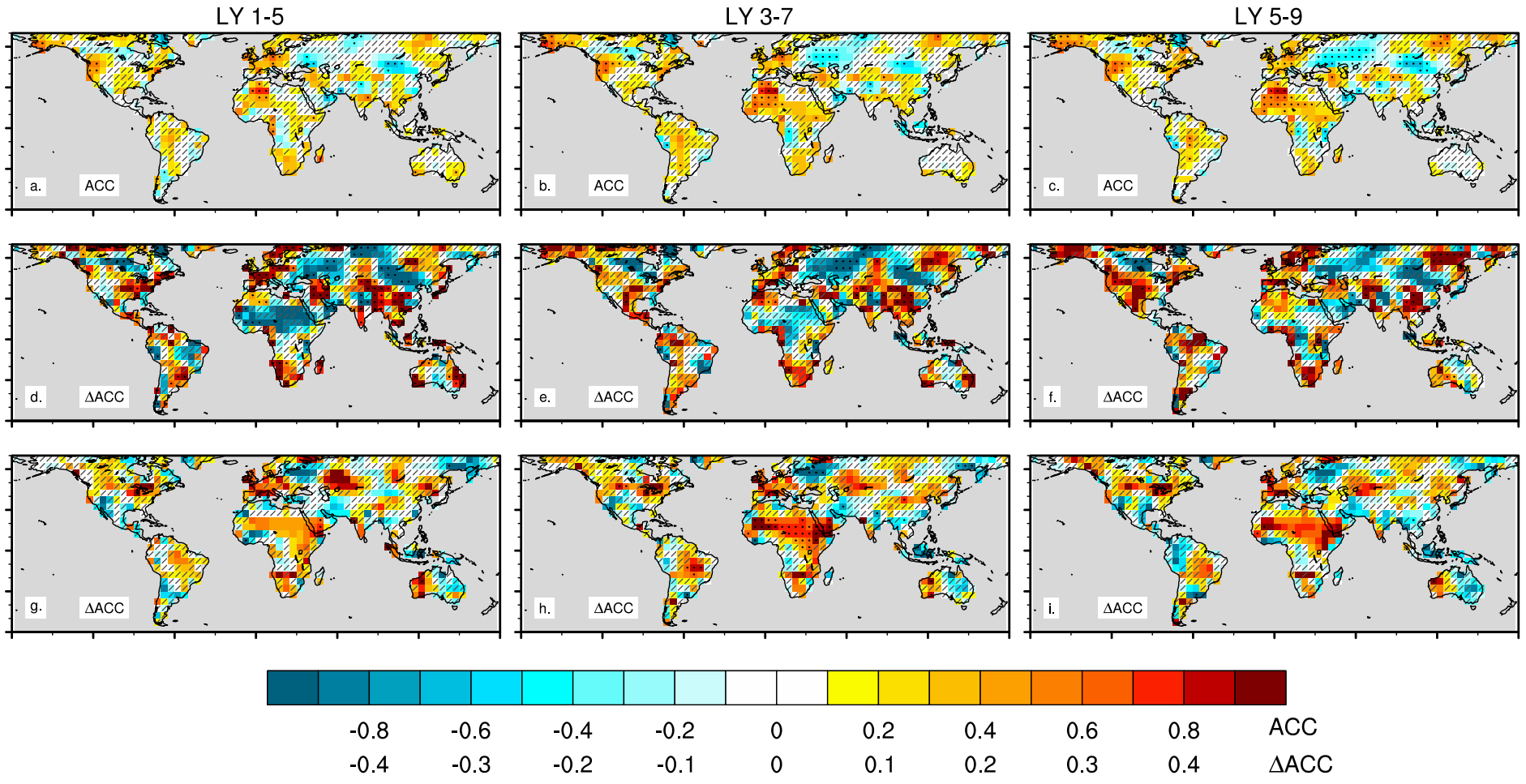
- Local p values determined using block bootstrap resampling across time/member (Goddard et al. 2013)
- p>0.1 (not significant) indicated by "/"
- Global field significance (p<<0.1) using False Discovery Rate method (Wilks 2016) indicated by "•"



Yeager et al. (2018)

CESM-DPLE: Boreal Summer (JAS) Precip

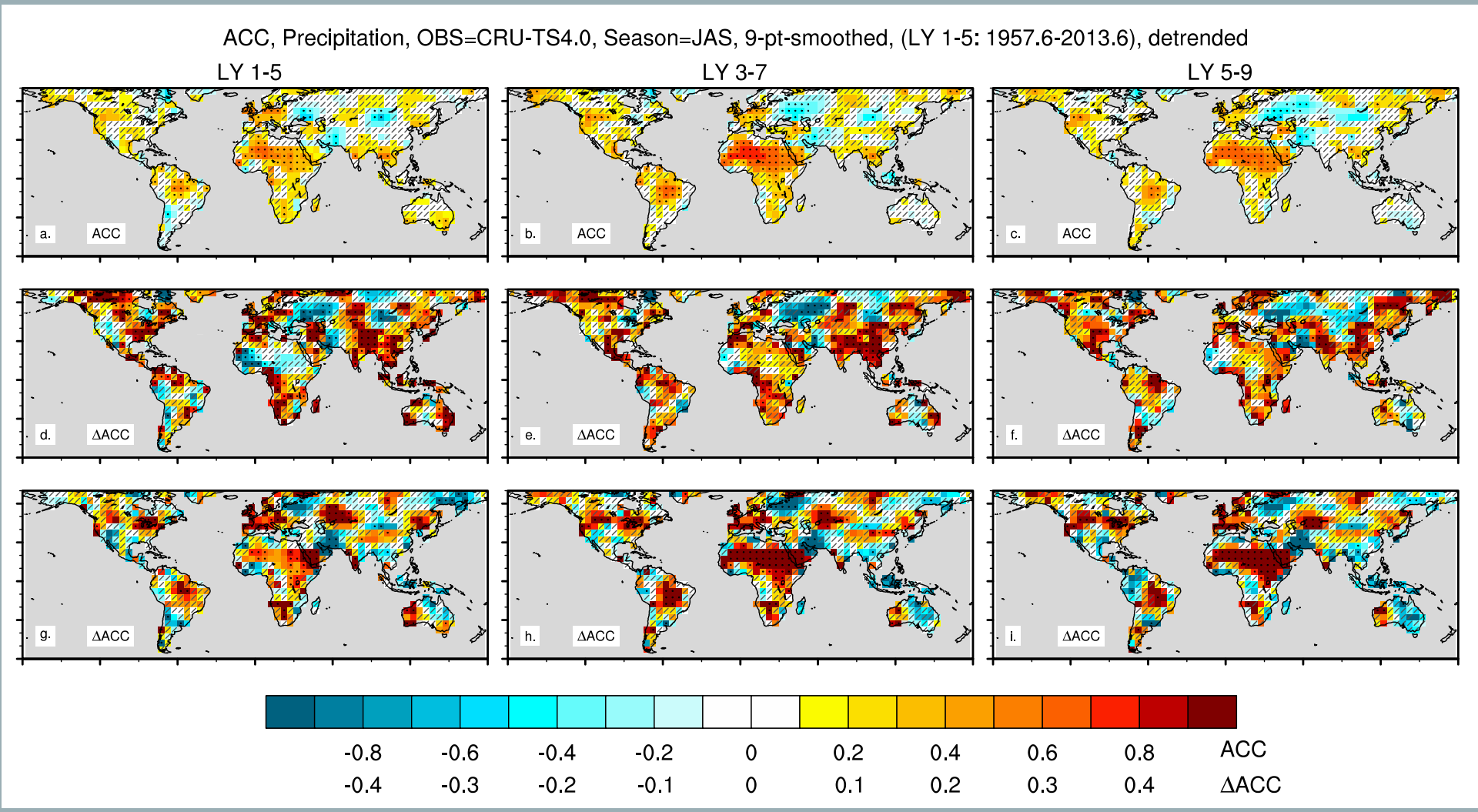
- Complex picture requiring region-by-region scrutiny
- Overall, positive impact of initialization
- Noteworthy regions: African Sahel, W Europe, NW North America, S Africa, W Australia
- Increasing skill with lead time in many regions



Yeager et al. (2018)

CESM-DPLE: Boreal Summer (JAS) Precip (detrended)

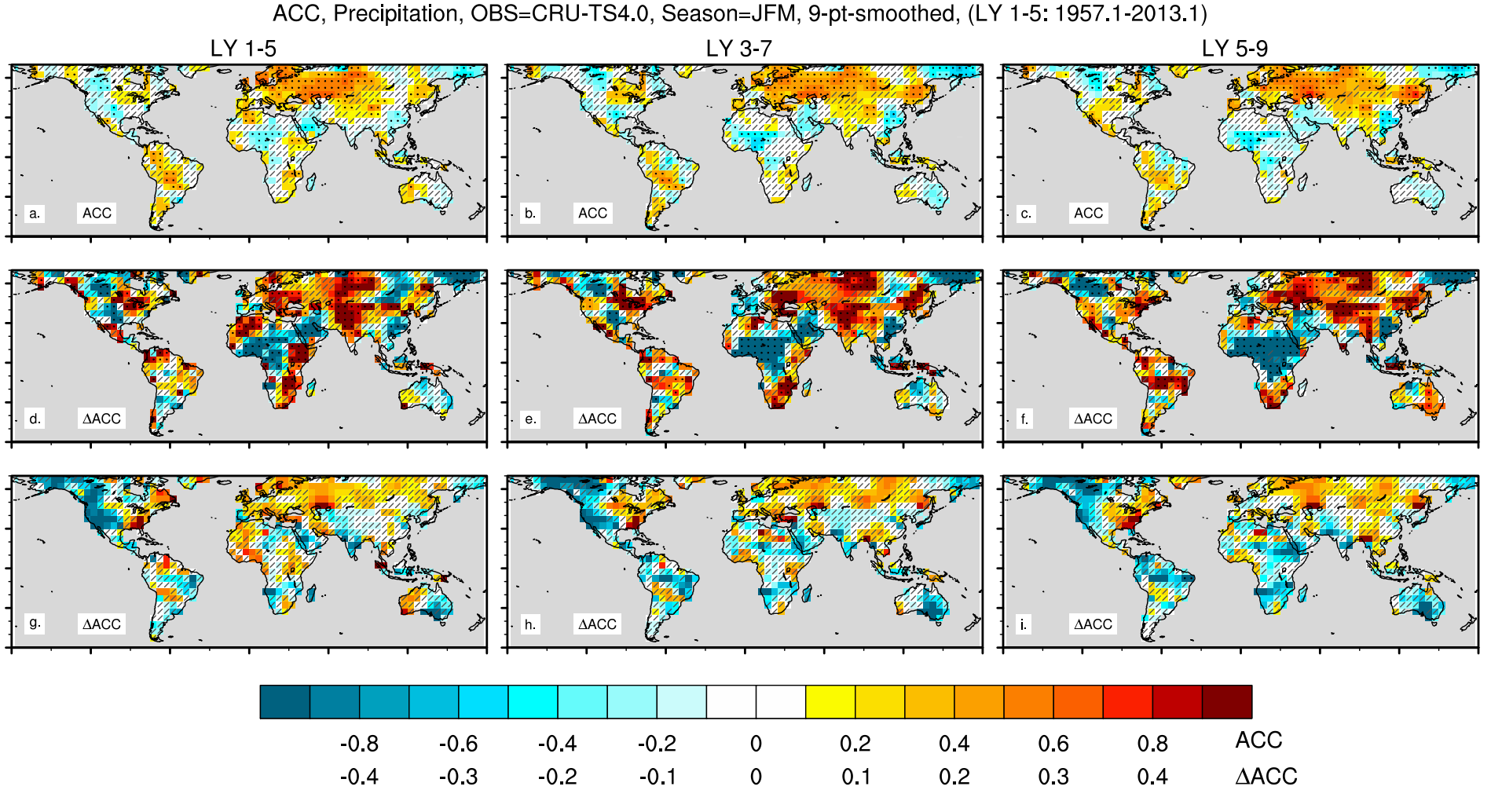
- Skill (and skill difference from UI) largely resilient to detrending ➔ not simply an artifact of trend bias correction
- Increased skill in Africa, Saudi Arabia, South Asia, Brazil



Yeager et al. (2018)

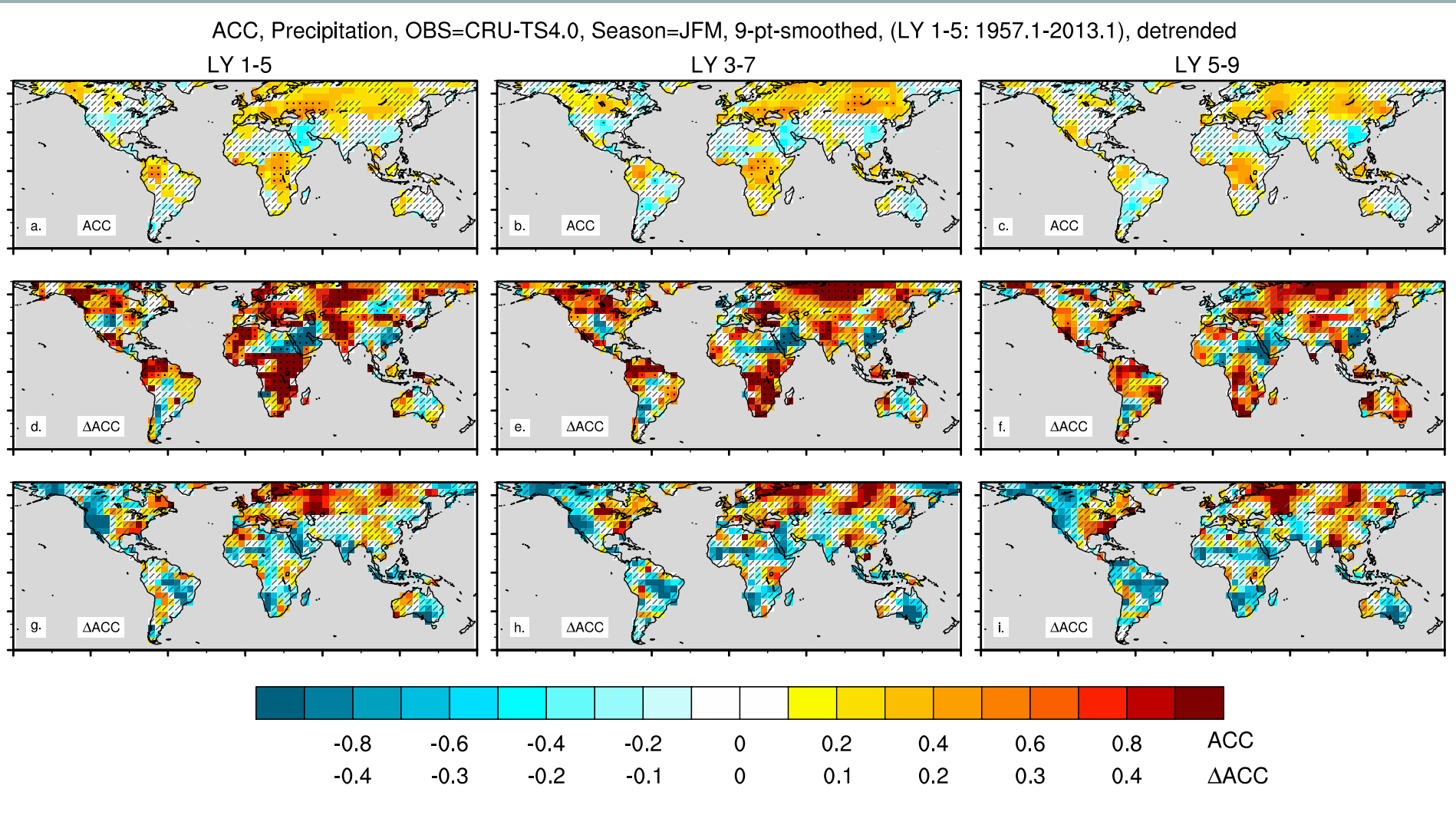
CESM-DPLE: Boreal Winter (JFM) Precip

- Mixed impact of initialization
- Some increase of skill with lead time: East Asia, Western US
- Noteworthy skill/skill enhancement: N Europe & Eurasia, E Africa, W Australia

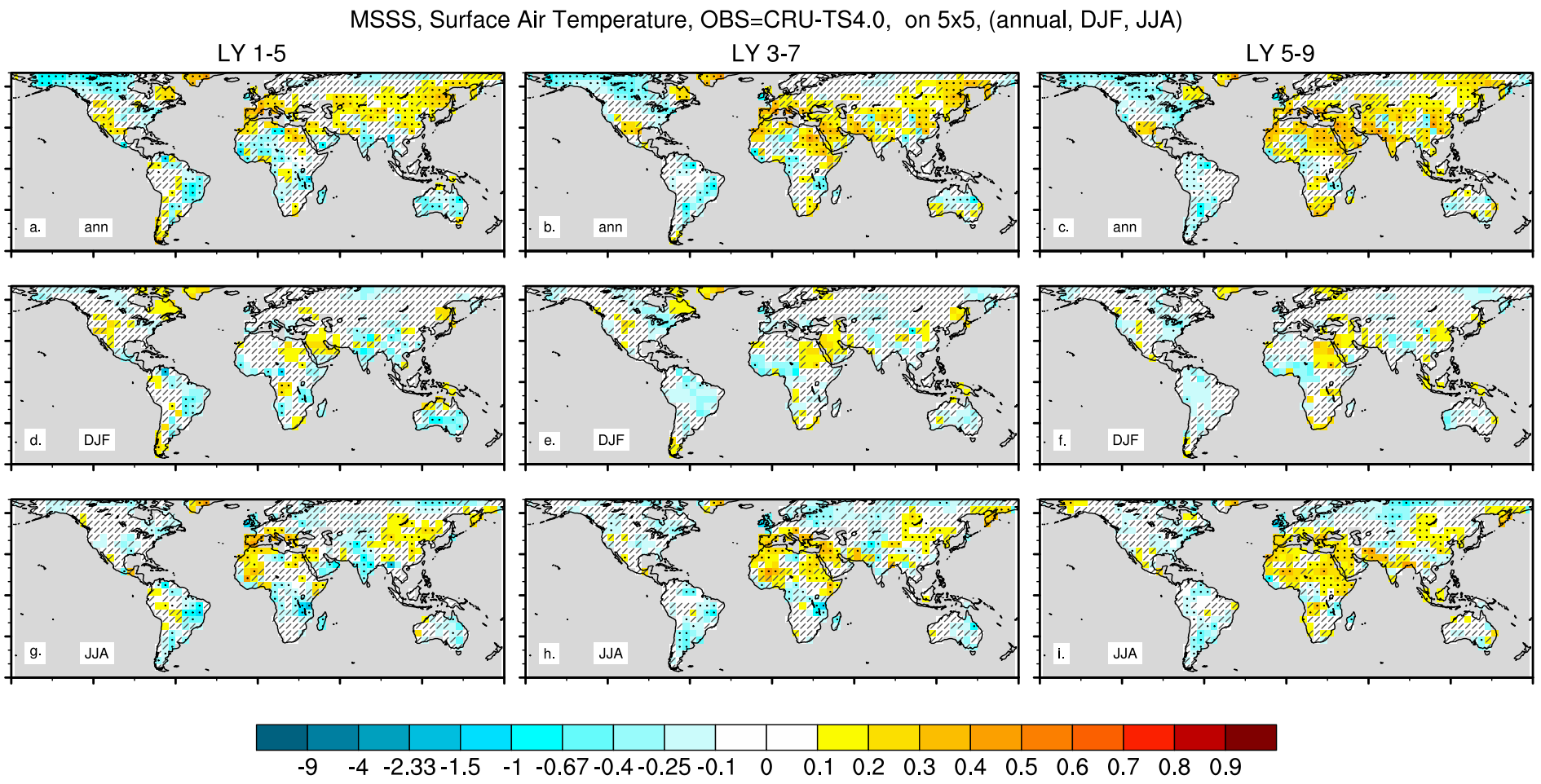


CESM-DPLE: Boreal Winter (JFM) Precip (detrended)

- Skill (and skill difference from UI) largely resilient to detrending
- Increased skill in central Africa



CESM-DPLE: Surface Air Temperature



Yeager et al. (2018)