CISL Accelerated Scientific Discovery

Predicting Near-Term Changes in the Likelihood of Climate Extremes: Initialized Decadal Climate Prediction Using Large Ensembles
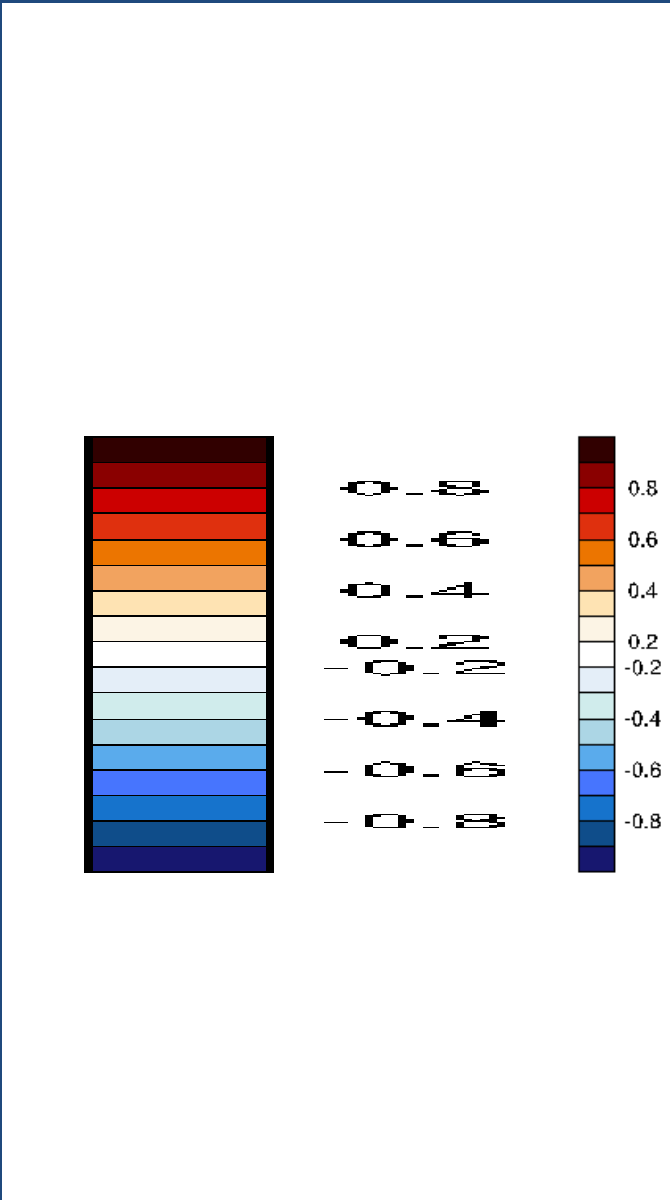
Project Overview

- Title: Predicting Near-Term Changes in the Likelihood of Climate Extremes: Initialized Decadal Climate Prediction Using Large Ensembles

- Award: 35.4M Cheyenne core-hours, 5K Geyser core-hours, 250TB glade space, 2 PB HPSS space

- Team: S. Yeager, N. Rosenbloom, G. Strand, S. Bates, G. Danabasoglu, A. Karspeck, K. Lindsay, M. Long, M. Holland, G. Meehl, C. Tebaldi, K. McKinnon, C. Zarzycki, W. Kim, H. Teng, P. Di Nezio, Y.-O. Kwon…

- Science Questions:

  1. How does ensemble size impact the assessment of decadal prediction skill?

  2. Are there predictable shifts in the probability of extreme weather events (e.g., heat waves, cold spells, floods, hurricanes) associated with interannual-to-decadal sea surface temperature and sea ice extent variations?

- Method: Expand an existing CESM1 initialized decadal prediction ensemble from 10 to 40 members
  - ➔ ~19,000 simulation years using CESM at nominal 1° resolution
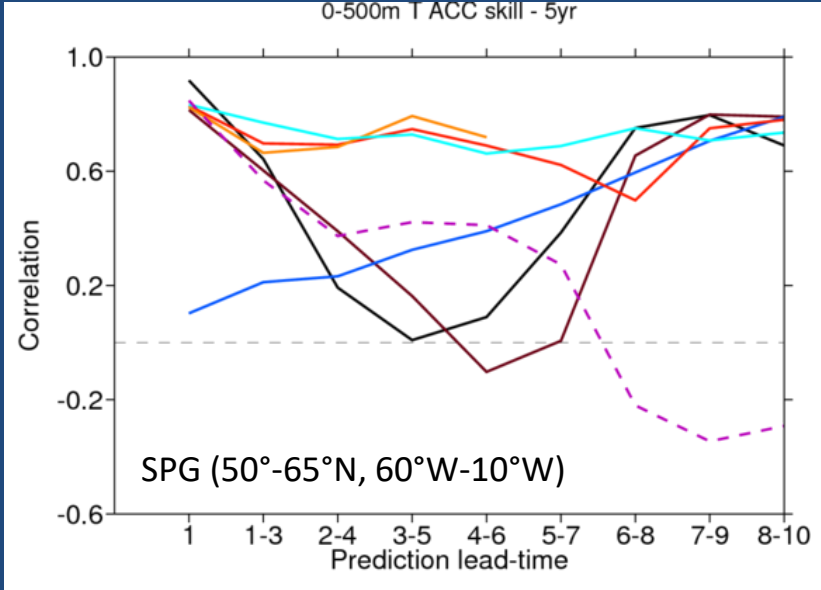
CESM Decadal Prediction (DP) Simulations

	OLD (completed early 2011)	NEW (completed late 2015)
Model -atm -ocn -ice -lnd	CCSM4 CAM4 (FV 1deg, 26 lvl) POP2 (1deg, 60 lvl) CICE4 (1deg) CLM4	CESM1.1 (LENS tag) CAM5 (FV 1deg, 30 lvl) ★ POP2 (1deg, 60 lvl) w/ BGC ★ CICE4 (1deg) CLM4
Start Dates	Jan. 1, 1955-2014 (N=60)	Nov. 1, 1954-2015 ★ (N=62)
Sim. Length	120 months	122 months
Ensemble Size	10	10 **+30**
Ensemble Generation	variable Jan. start days + Round-off perturbation of atm ic	Round-off perturbation of atm ic
Initial Conditions	ocn/ice: CORE-forced POP-CICE atm/lnd: CESM1 20C ensemble	ocn/ice: CORE*-forced POP-CICE ★ atm/lnd: CESM-LE of 20C
Initialization Procedure	Full field	Full field
External Forcings	Full CMIP5 20C + RCP4.5	Full CMIP5 20C + RCP8.5
Uninitialized Complement	6-member CCSM4 20C/RCP4.5	40+ member CESM1-LE 20C/RCP8.5

N. Atlantic heat content skill

T295:

CESM1-DP   EC-Earth (full field, low-res)
HadCM3   EC-Earth (anomaly, low-res)
HiGEM   EC-Earth (high-res)
MPI   IPSL
Persistence

0-500m T ACC skill - 5yr

SPG (50°-65°N, 60°W-10°W)

(Figure courtesy Jon Robson)

➔ High N. Atlantic heat content skill in existing 10-member CESM1-DP underpins winter sea ice predictability (Yeager et al., 2015, *GRL*, doi:10.1002/2015GL065364)

Project Status

- **Jan. 13:** Simulations commenced on Cheyenne

- **Feb. 24:** 2/3 Complete
  - Members 11-30 ~99% finished (run & post-processed)
  - Members 31-40 ~0% finished

- **Mar. 10:** Projected finish date

- **Data volume:**
  - ~810TB model output generated
  - ~275TB timeseries archived to HPSS

- **Special thanks to:**

Nan Rosenbloom   Gary Strand

Jim Edwards, Sheri Mickelson, Alice Bertini, Shiquan Su, & **CISL**

Early Results: Surface Air Temperature (JJA)

10-member   30-member
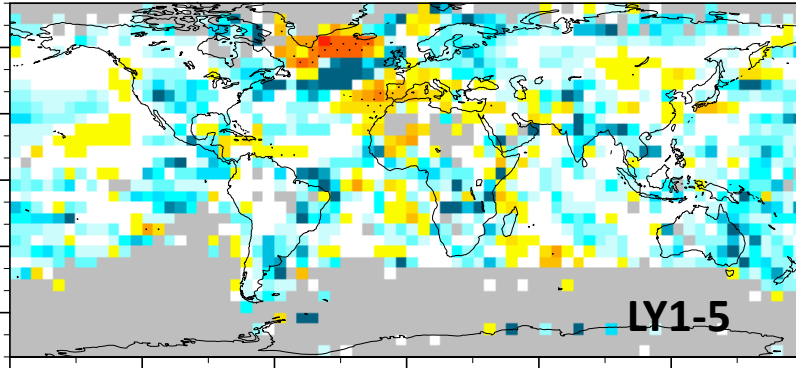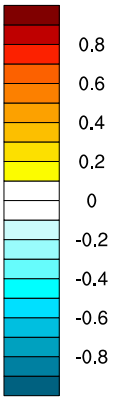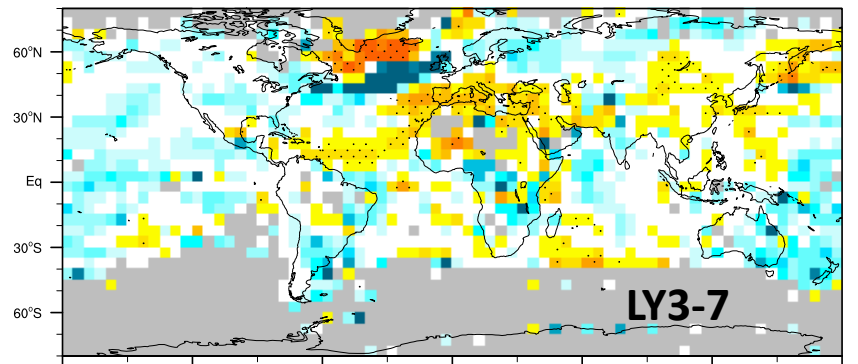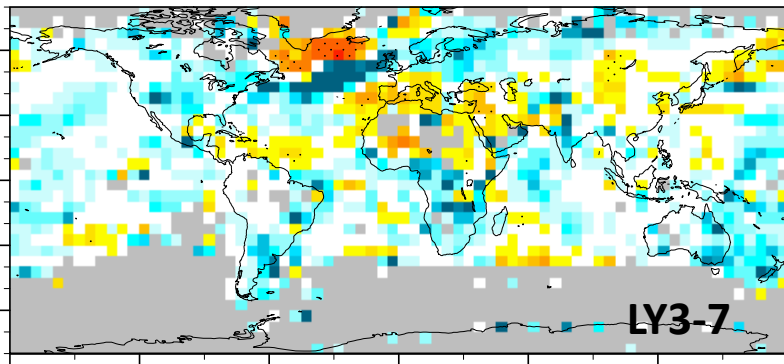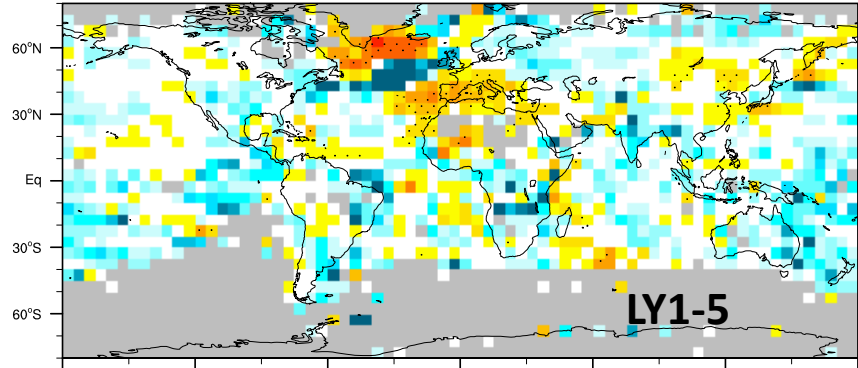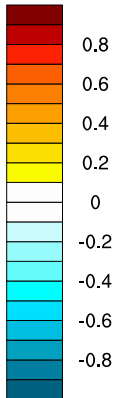

- MSSS using 30-member CESM-LE ensemble average as reference forecast

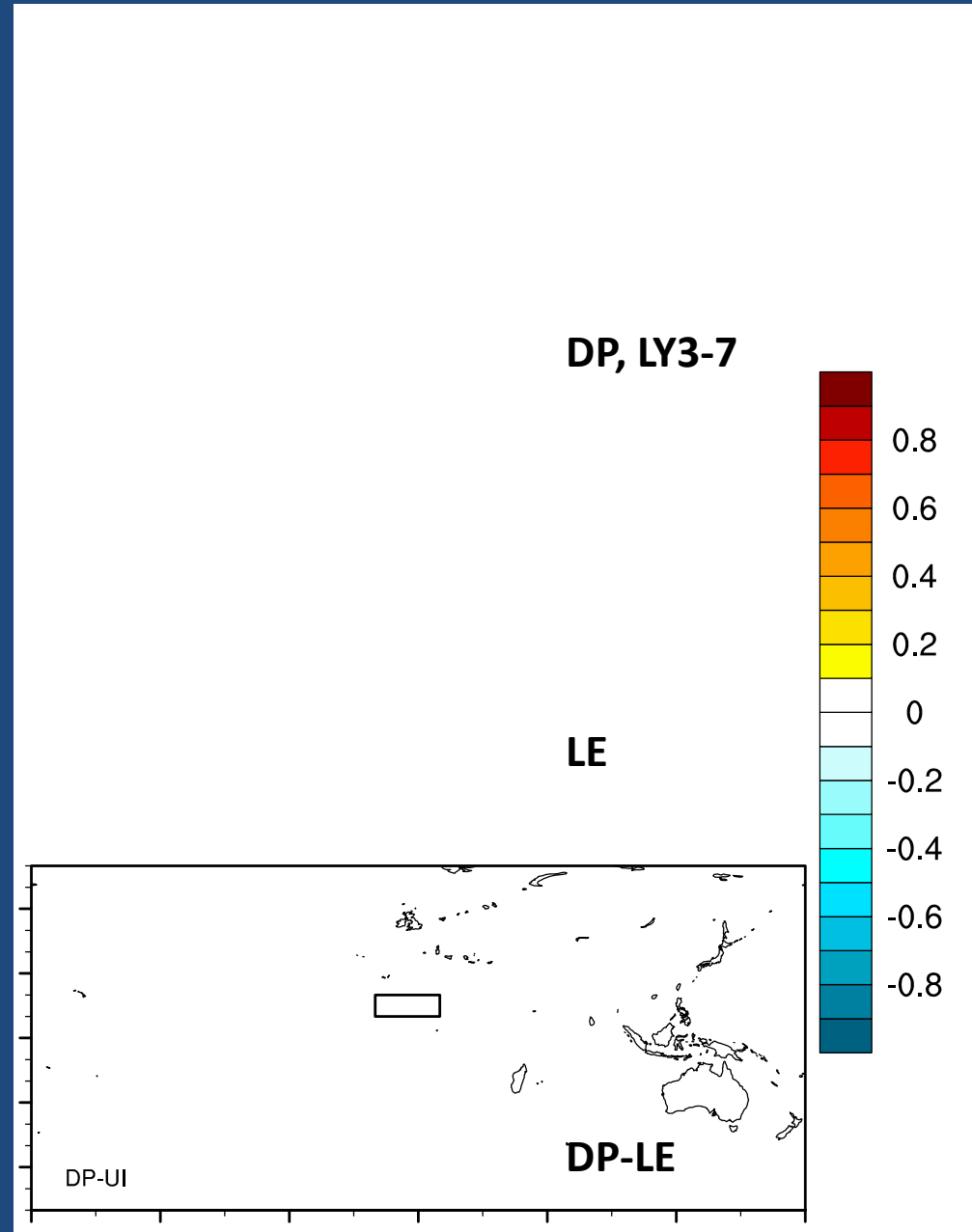# Early Results: Surface Air Temperature (DJF)
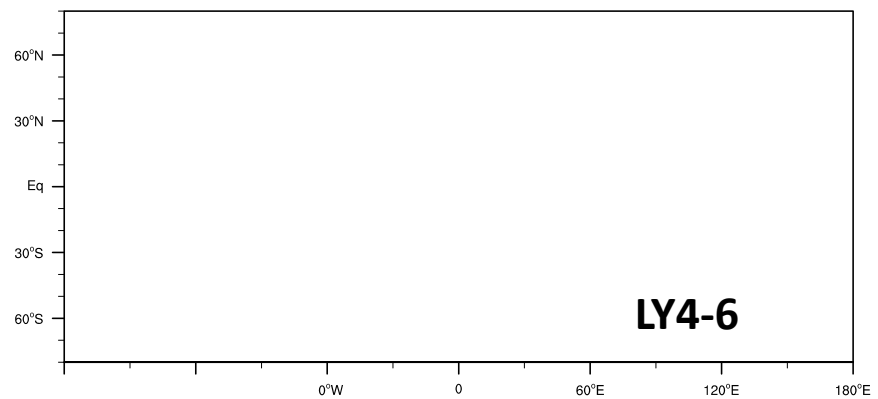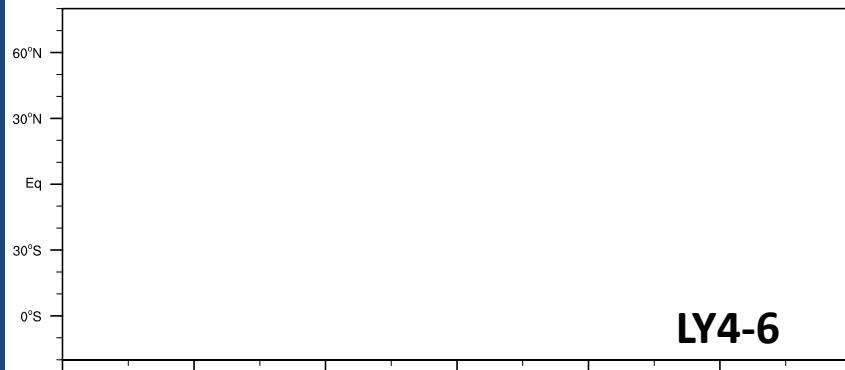
10-member

30-member

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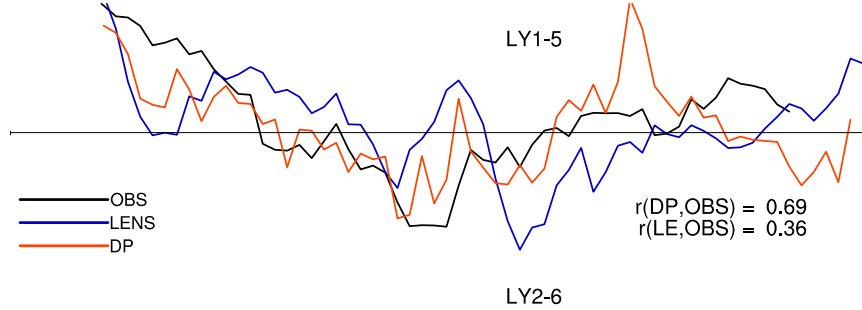
Early Results: Precipitation (JJA)

30-member

- Correlations of 5-year running mean PREC with CRU observations.

- Large skill improvements in Brazil and Sahel regions associated with ocean/sea-ice initialization.
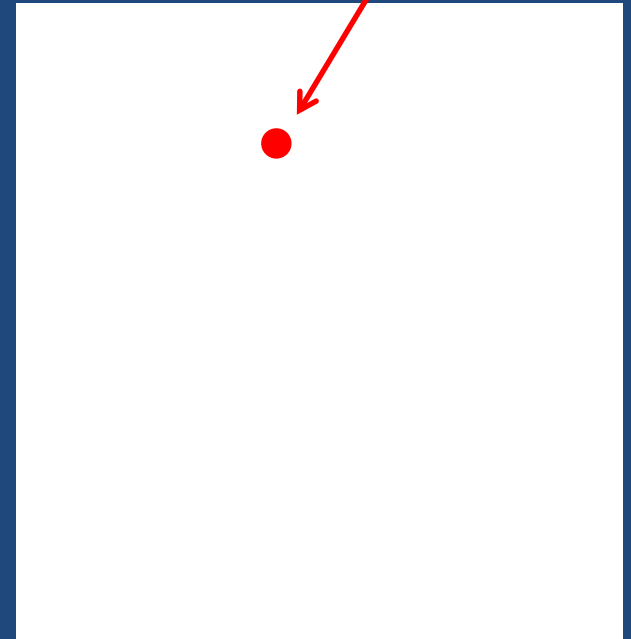
Early Results: Sahel Precipitation (JJA)

JAS Precipitation, SAHEL, Mem1-30

LY1-5

OBS
LENS
DP

r(DP,OBS) = 0.69
r(LE,OBS) = 0.36

LY2-6

r(DP,OBS) = 0.79
r(LE,OBS) = 0.28

81

30-member CESM1-DP

* Martin & Thorncroft, 2014: Sahel rainfall in multimodel CMIP5 decadal hindcasts, *Geophys. Res. Lett.*, doi: 10.1002/2014GL059338.

Data Availability

- **Members 1-10:**
  - Run on DOE machine
  - Data archived at NERSC. Time series available upon request.

- **Members 11-40:**
  - Run on Cheyenne
  - HPSS: /CCSM/csm/CESM1-CAM5-DP/

- **Select 6-hourly/daily/monthly time series, including ocean BGC:**
  - See http://www.cgd.ucar.edu/ccr/strandwg/CESM1-CAM5_decadal_prediction_ASD/

- **Near future:**
  - Data set to be advertised/documented at http://www.cesm.ucar.edu/experiments/ (Special Community Projects)
  - 40-member DP set uploaded to Earth System Grid

- **Contact me if interested: yeager@ucar.edu**

Early Results: Surface Air Temperature (DJF)
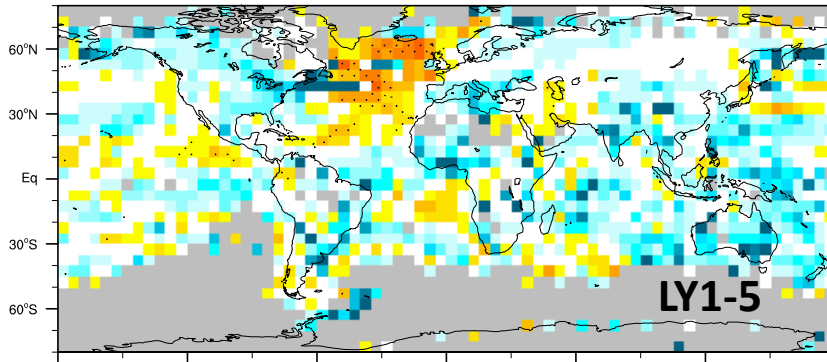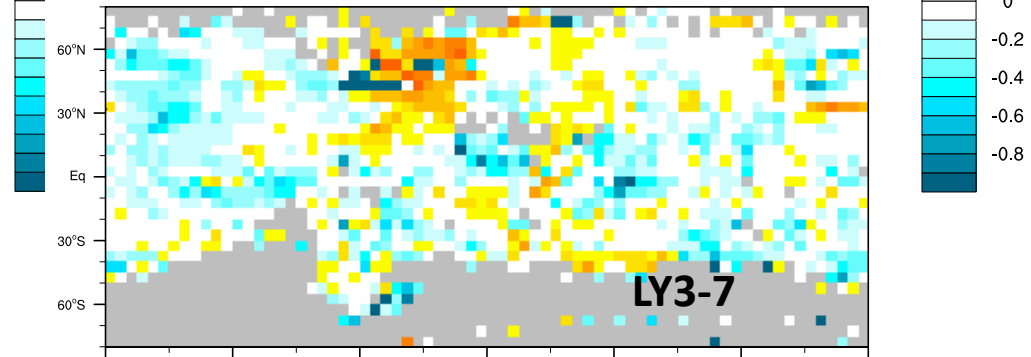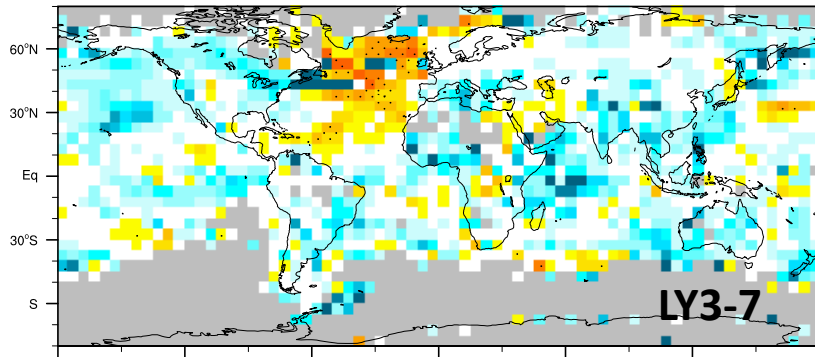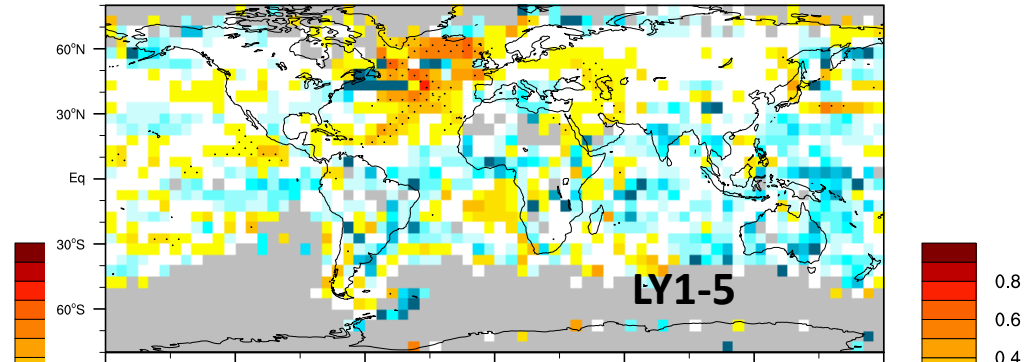
10-member
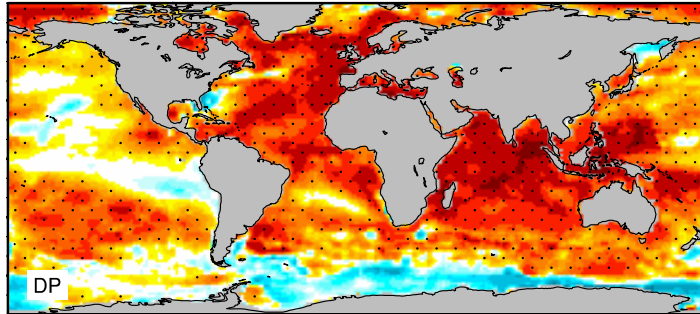
30-member

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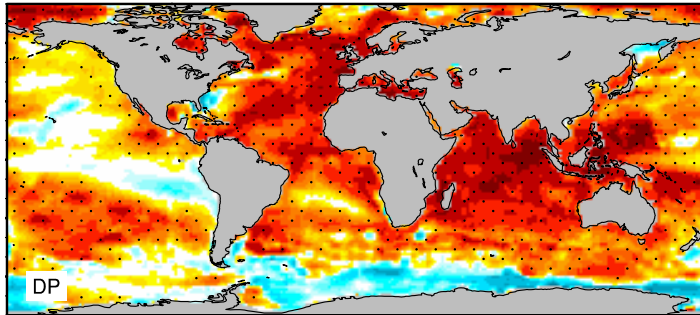
Early Results: SST (Annual)

10-member

DP

LE

DP-LE
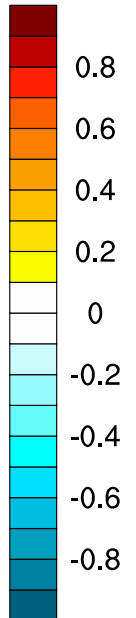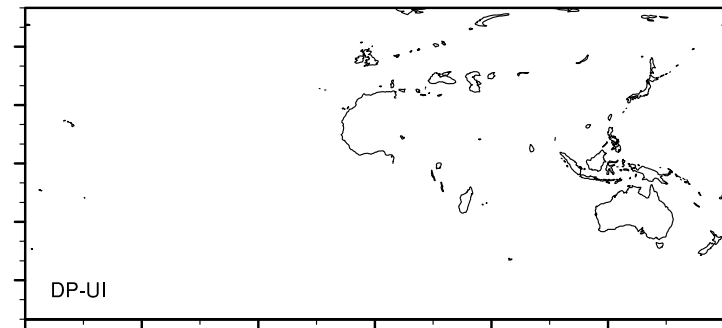
Early Results: SST (Annual)

30-member

DP

LE

DP-LE