

Probabilistic Forecasting with NMME

also a brief “Year 3 in NMME” review

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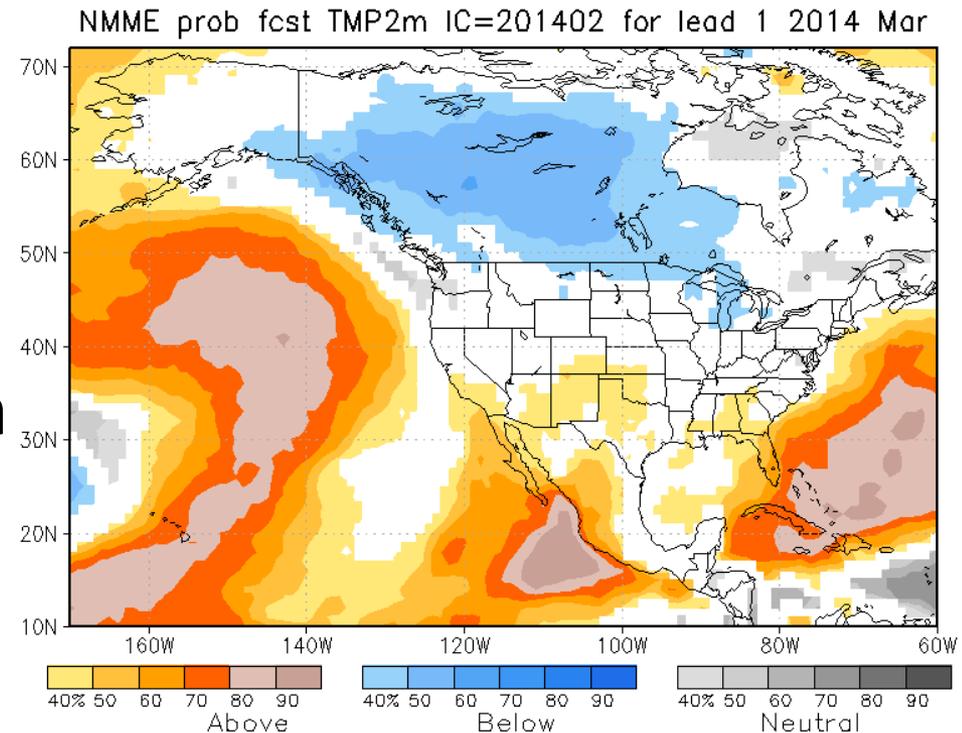
21 October 2014 39th CDPW, St. Louis, MO.

Probabilistic forecasts

- Provide measure of forecast confidence/characterize uncertainty
 - CPC climate outlooks published in probabilistic format
 - Multi-model ensembles, with high number of members, lend themselves to probabilistic forecasting strategies
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- Assess retrospective forecast skill and reliability
 - Test different combinations of models: ensemble size, or diversity?

NMME realtime probabilistic forecasts

- Terciles (above, near-normal, below)
- Tercile thresholds determined using parametric fits on the hindcasts of individual models
- **Above: $> \text{mean} + 0.43\sigma$**
- **Below: $< \text{mean} - 0.43\sigma$**
- Forecast members are assigned to terciles; number of members in each class is counted
- Realtime forecast: > 100 members

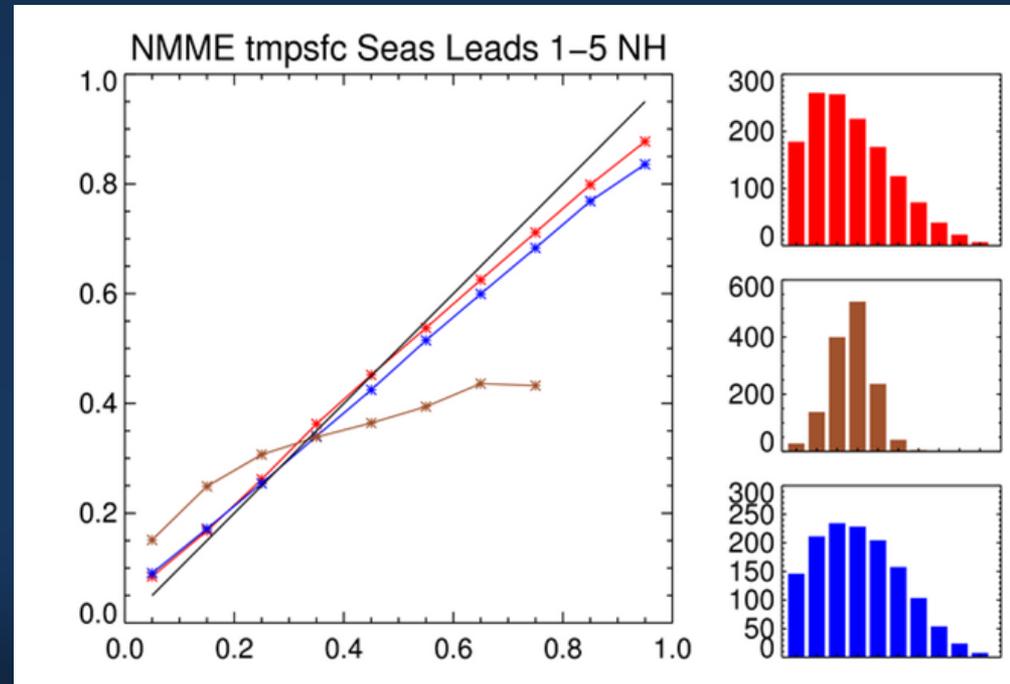


Application to hindcasts

- 6 models with consistent (1982-2010) hindcast records: CFSv2, CanCM3&4, NASA-GEOS5, GFDL-CM2.1, NCAR-CCSM3
- 71 members (75 in November)
- 4 combinations
 - **NMME**: all models, all members
 - **Mini-NMME**: all models, 4 members each
 - **CFSv2**: 24 members
 - **Mini-CFSv2**: 6 members

Verification statistics

- **Anomaly correlation:**
 - Measures relationship between forecast anomaly and observed anomaly
 - Deterministic forecasts
- **Brier skill score:**
 - Ratio of error of the probability forecast to error of climatology forecast (33% chance)
- **Reliability and sharpness diagrams**
 - Reliability: ratio of event frequency to forecast probability
 - Sharpness: frequency of use of each forecast category



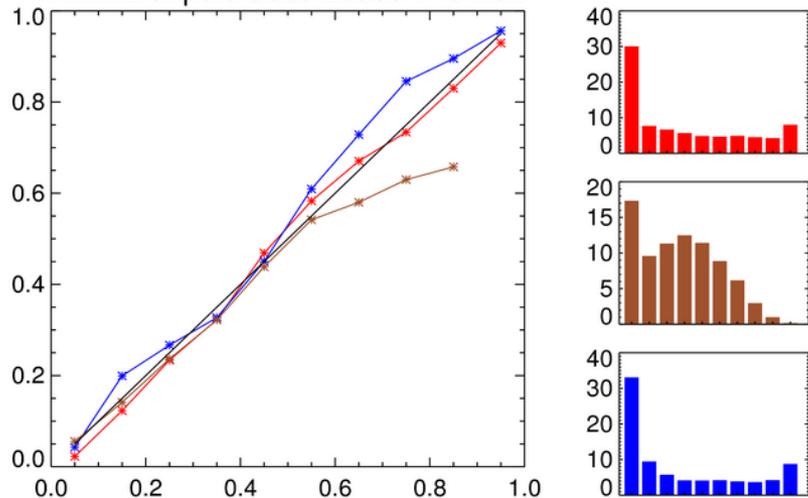
SST in the Niño3.4 region (lead-1)

a. SST Niño 3.4 Region				
	A	N	B	AC
NMME	0.61	0.25	0.58	0.89
mini-NMME	0.60	0.24	0.59	0.89
CFS	0.45	0.05	0.43	0.82
6-mem CFS	0.41	-0.02	0.41	0.81

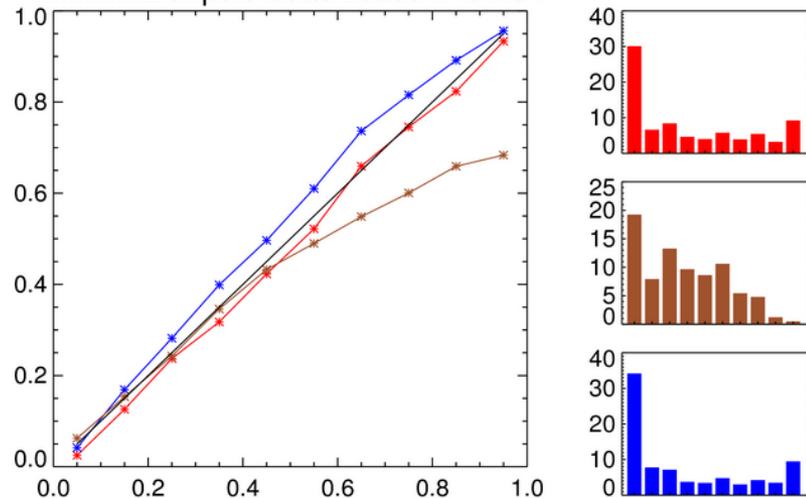
- $A \sim B$
- multi-model scores higher than CFS
- N category has some skill in MME
- even reduced CFS has high skill scores

SST in Nino3.4 region

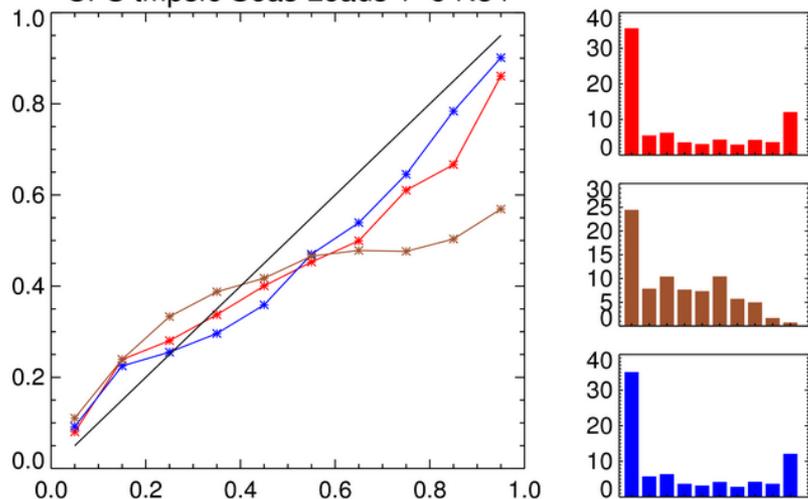
NMME tpsfc Seas Leads 1-5 N34



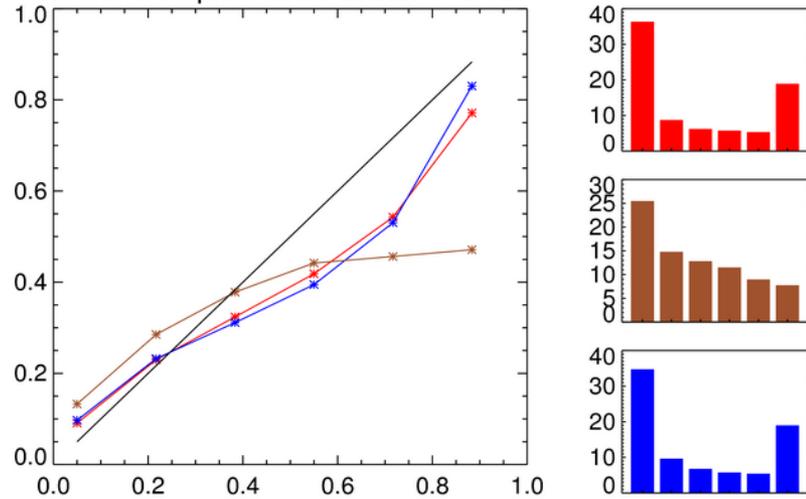
miniMME tpsfc Seas Leads 1-5 N34



CFS tpsfc Seas Leads 1-5 N34



miniCFS tpsfc Seas Leads 1-5 N34



SST in Northern Hemisphere

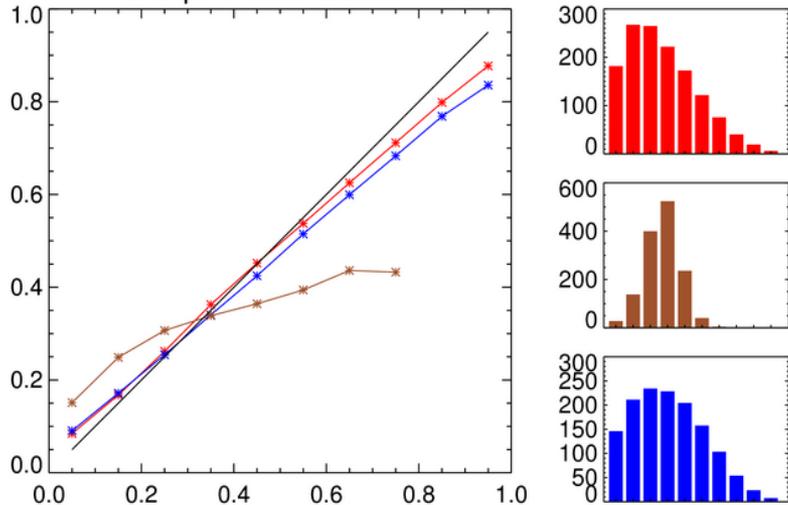
b. SST Northern Hemisphere

	A	N	B	AC
NMME	0.21	0.01	0.19	0.50
mini-NMME	0.18	-0.02	0.16	0.50
CFS	0.13	-0.04	0.13	0.41
6-mem CFS	0.05	-0.16	0.05	0.39

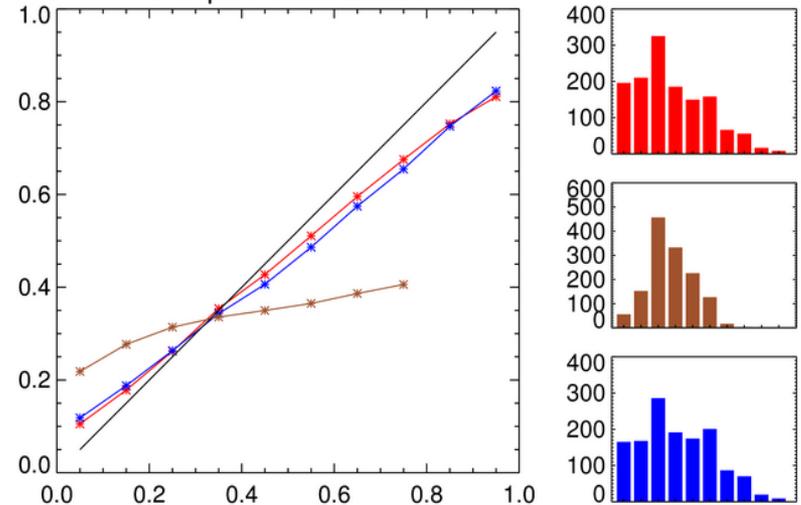
- All ocean gridpoints 23°N - 75°N
- AC shows little dependence on # of members
- BSS somewhat increased by # of members, more by model diversity

SST in Northern Hemisphere

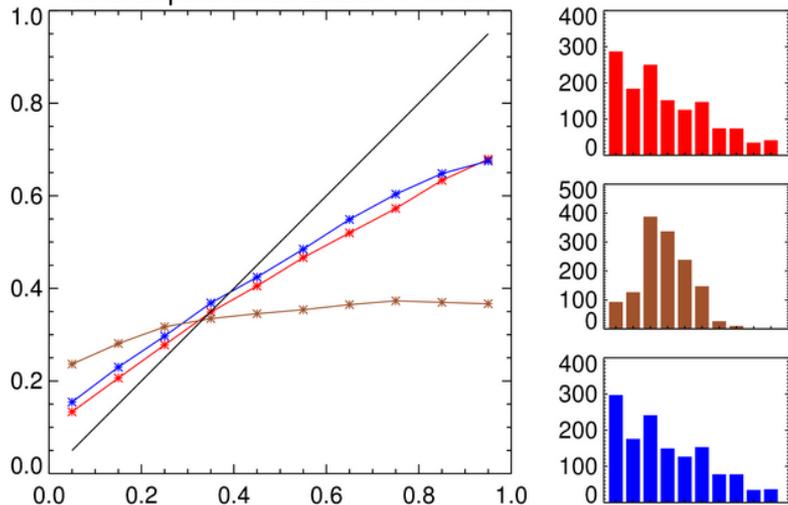
NMME tmpsfc Seas Leads 1-5 NH



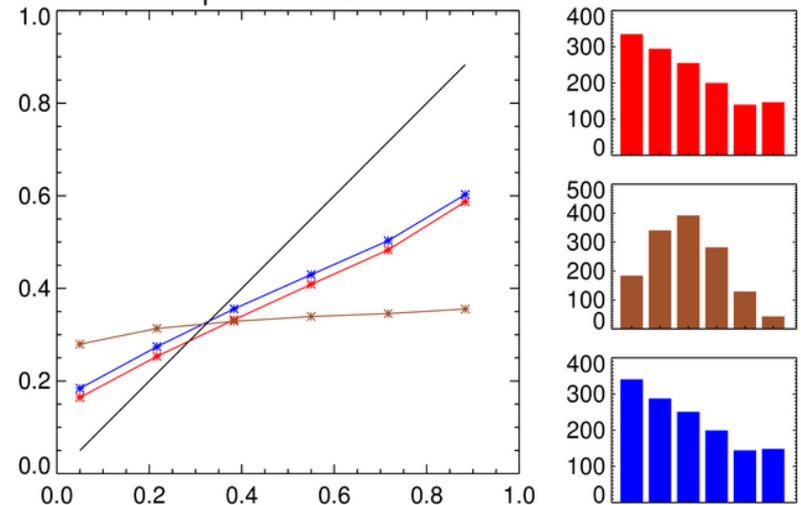
miniMME tmpsfc Seas Leads 1-5 NH



CFS tmpsfc Seas Leads 1-5 NH



miniCFS tmpsfc Seas Leads 1-5 NH



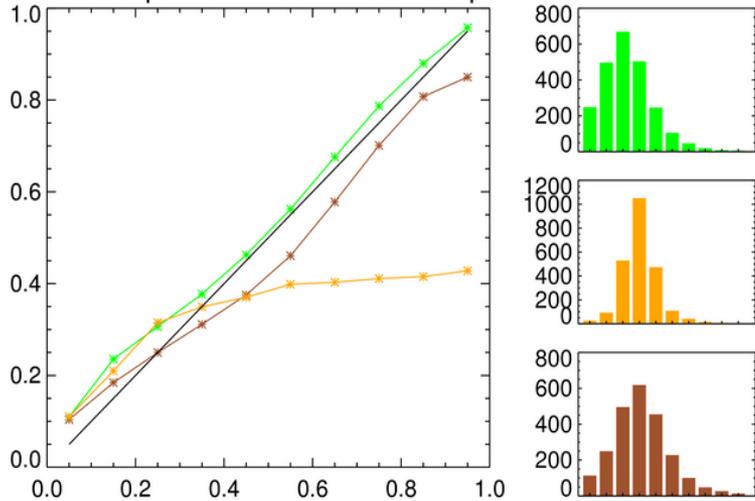
Precip rate in the tropics (land+ocean)

c. Prate Tropics				
	A	N	B	AC
NMME	0.11	-0.01	0.11	0.55
mini-NMME	0.09	-0.03	0.09	0.54
CFS	0.04	-0.08	0.00	0.47
6-mem CFS	-0.05	-0.19	-0.10	0.43

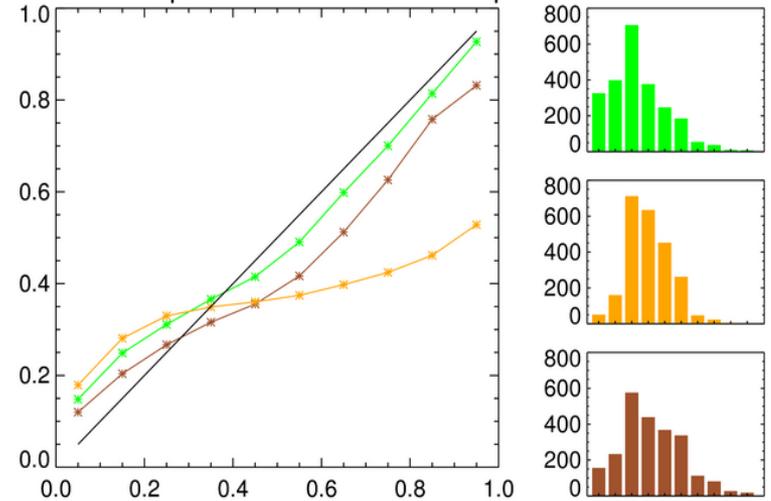
- pattern correlation relatively high
- NMME combinations are only prob fcsts with positive BSS

Precip rate in the tropics (land+ocean)

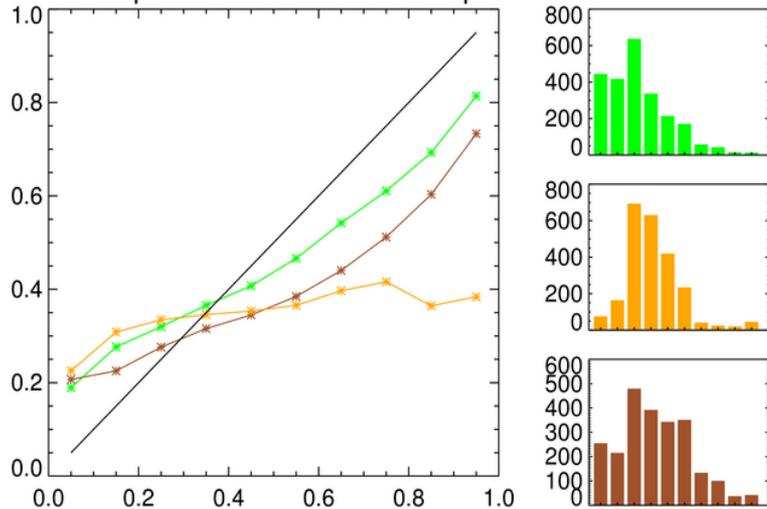
NMME prate Seas Leads 1-5 Trop



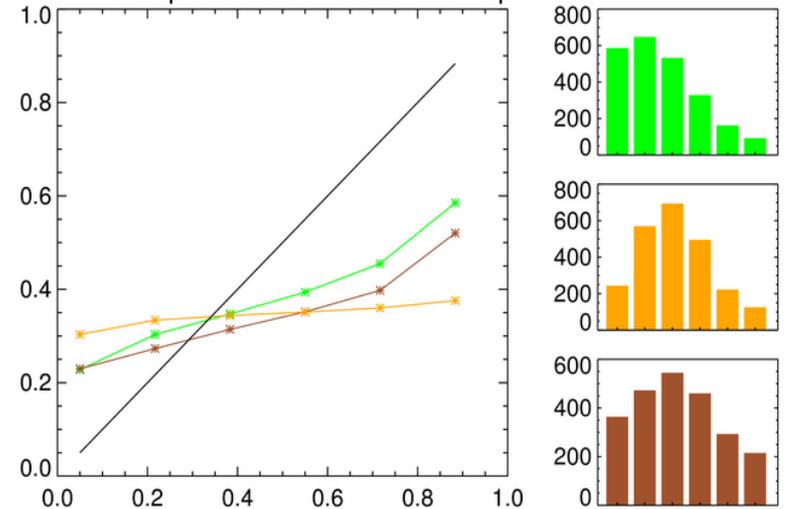
miniMME prate Seas Leads 1-5 Trop



CFS prate Seas Leads 1-5 Trop



miniCFS prate Seas Leads 1-5 Trop



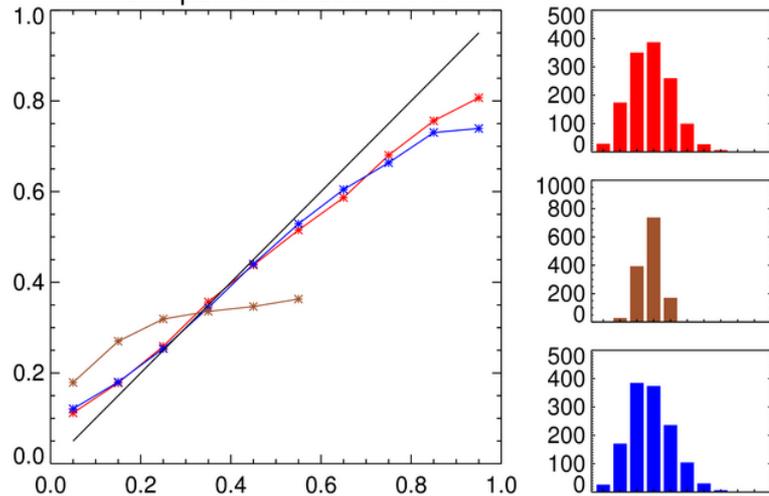
T2m in the Northern Hemisphere (land only)

d. T2m Northern Hemisphere				
	A	N	B	AC
NMME	0.07	-0.01	0.08	0.30
mini-NMME	0.05	-0.04	0.05	0.28
CFS	0.03	-0.04	0.04	0.30
6-mem CFS	-0.07	-0.17	-0.06	0.25

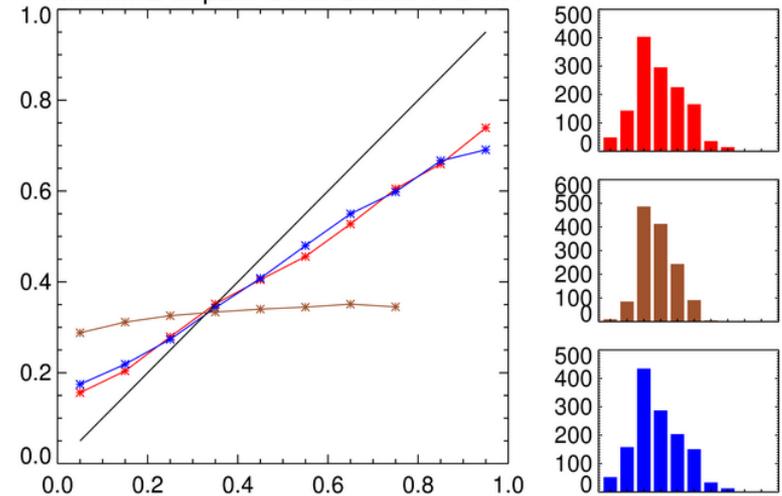
- CFS equivalent to NMME for deterministic fcsts
- NMME BSS > CFS

T2m in Northern Hemisphere

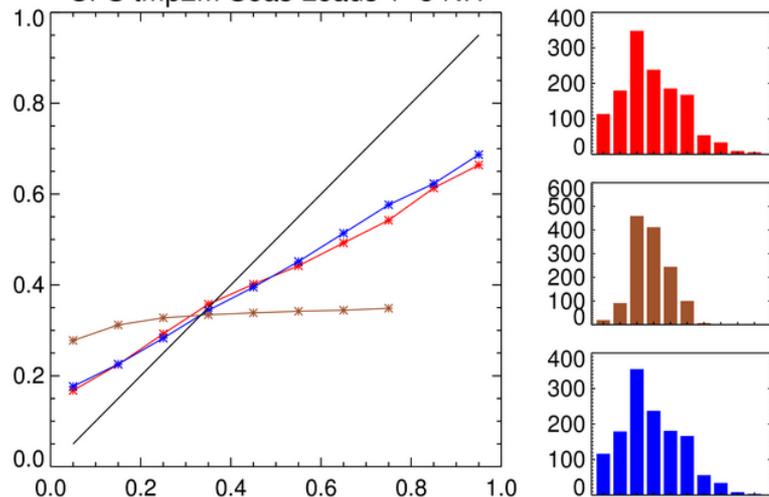
NMME tmp2m Seas Leads 1-5 NH



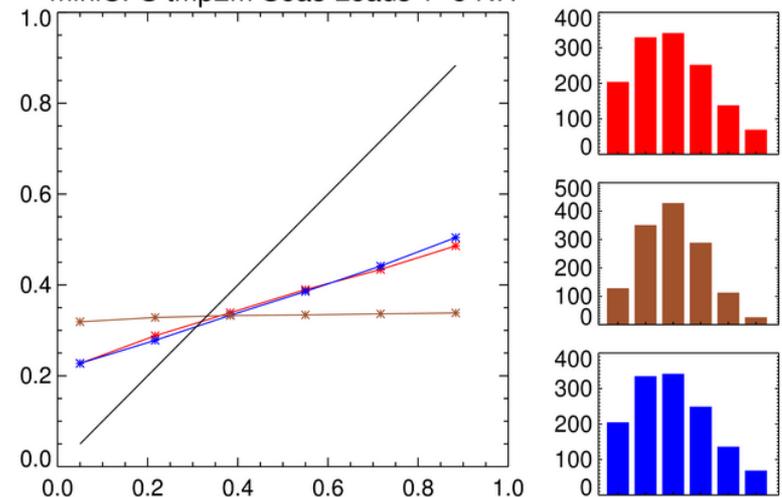
miniMME tmp2m Seas Leads 1-5 NH



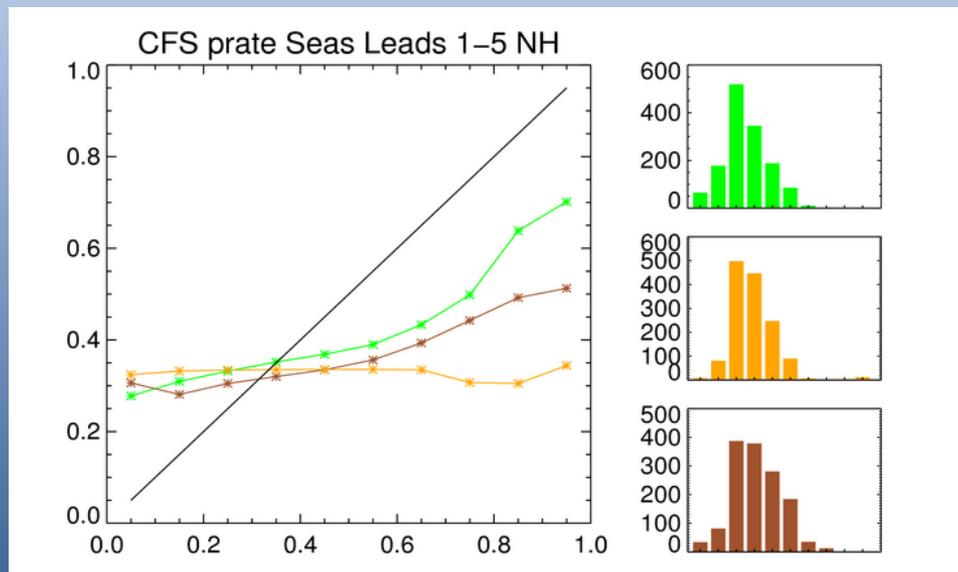
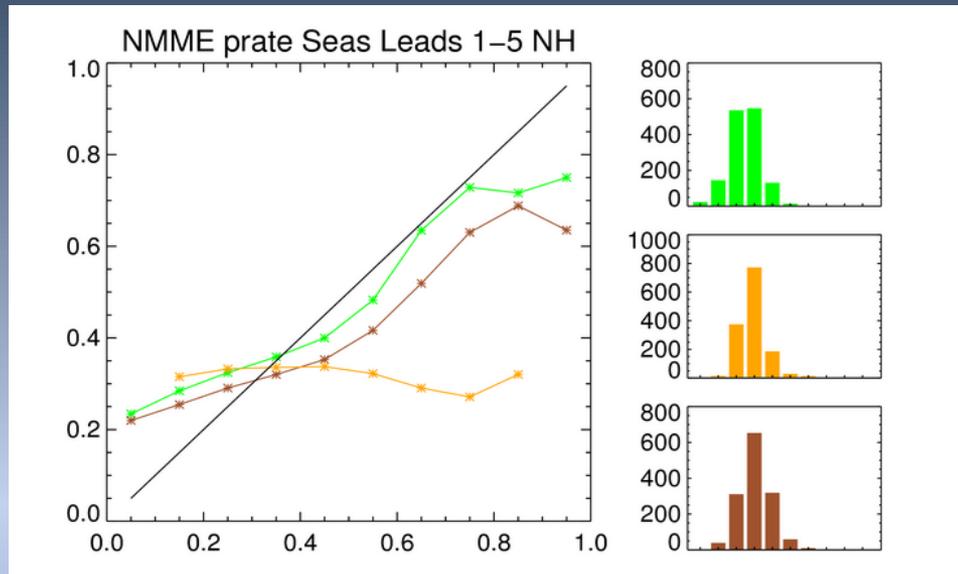
CFS tmp2m Seas Leads 1-5 NH



miniCFS tmp2m Seas Leads 1-5 NH



Prate in Northern Hemisphere



Summary and comments

From this study...

- NMME forecasts have high reliability in hindcasts
- “Near normal” tercile is a very hard target to hit
- Ensemble size and model diversity have different contributions depending on field/region

More stuff to do...

- Cross-validation
- Experiment with parametric fit to forecast
- Probability anomaly adjustments
- More calibrations
- Size/diversity study



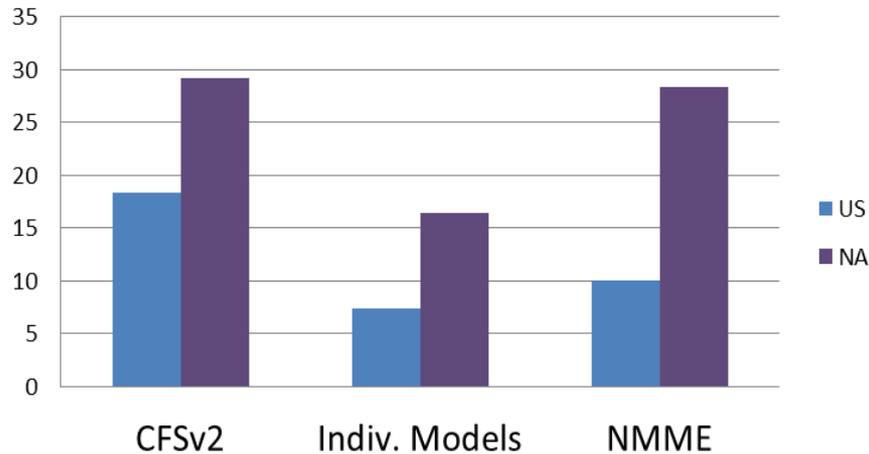
NMME Year 3 (Aug 2013 – Jul 2014) review

- Four models continue from year 1
 - CFSv2, GFDL CM2.1, NASA GEOS5, NCAR CCSM3
- Two models continue from year 2
 - EC's CanCM3, CanCM4
- GFDL's FLORa06 and b01 introduced in March
 - Combined into one for RT forecasts starting May 2014
- NCAR CCSM4 introduced in May

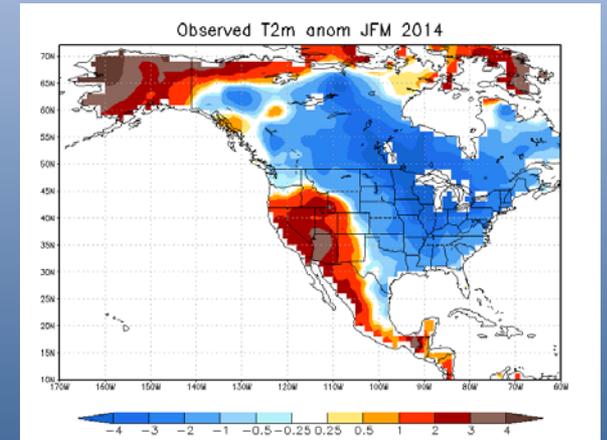
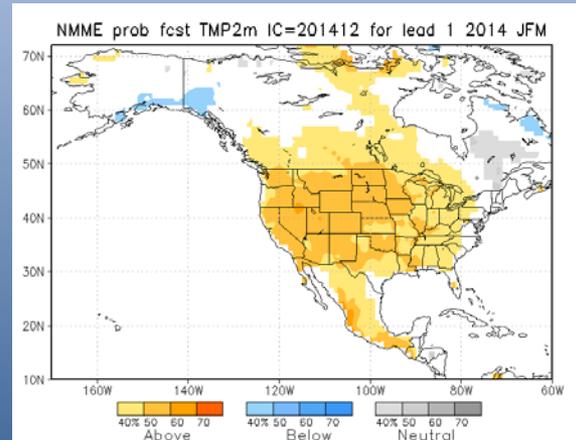
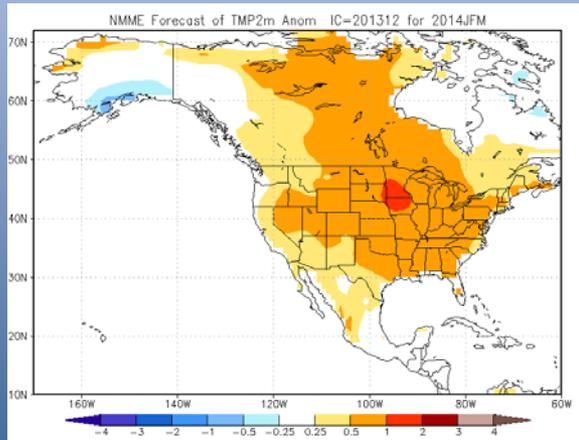
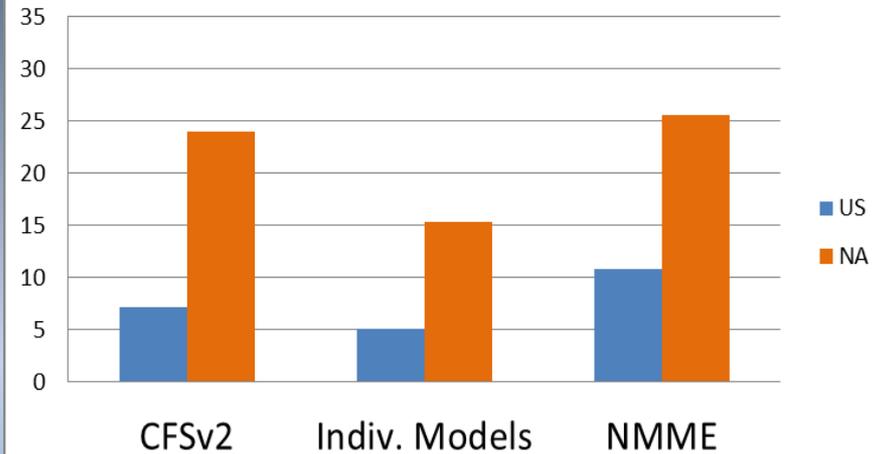
www.cpc.ncep.noaa.gov/products/NMME

Year 3 verification – T2m anomalies

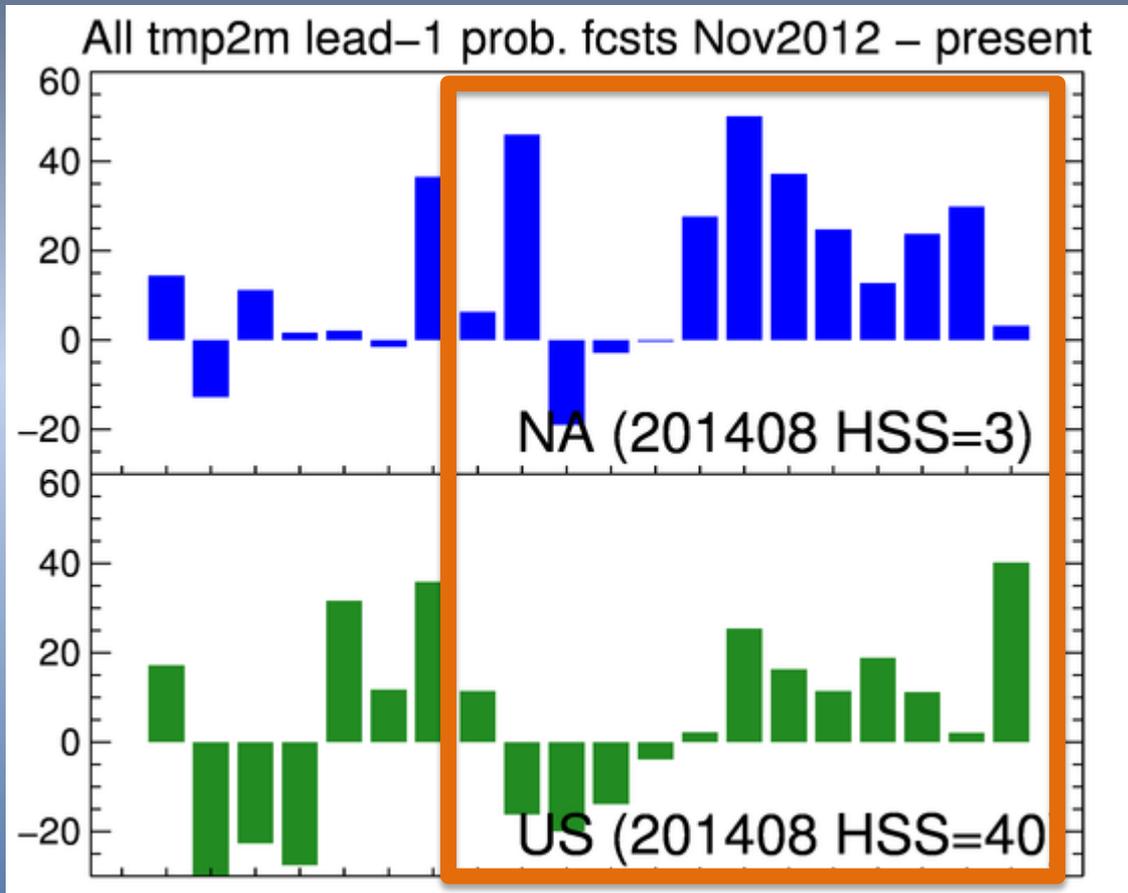
T2m Lead 1 AC, Year 3



T2m Season-1 AC, Year 3



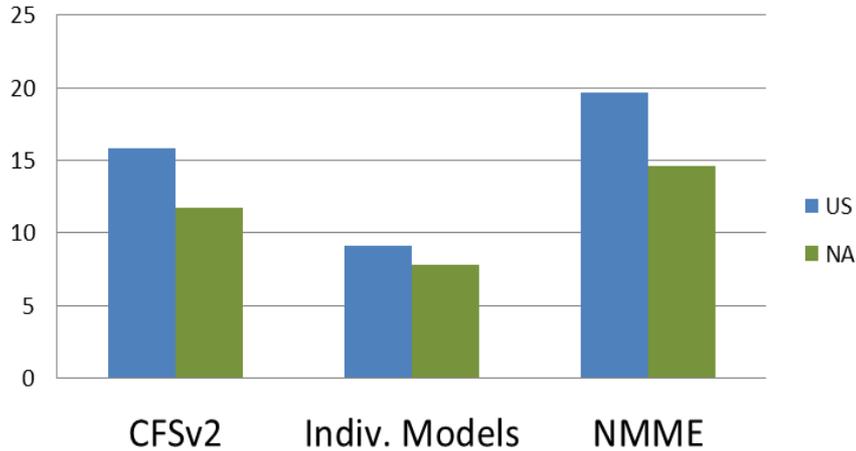
Year 3 verification – T2m prob fcsts



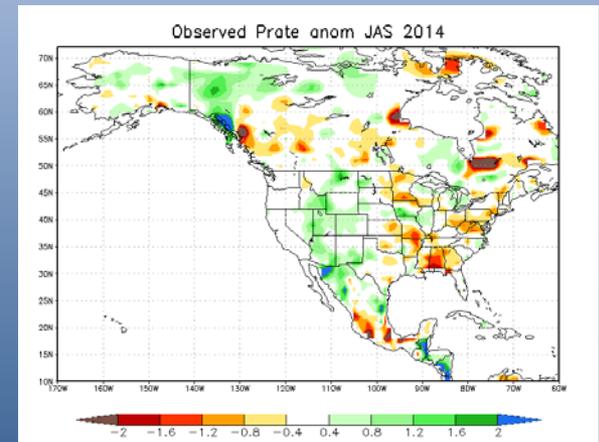
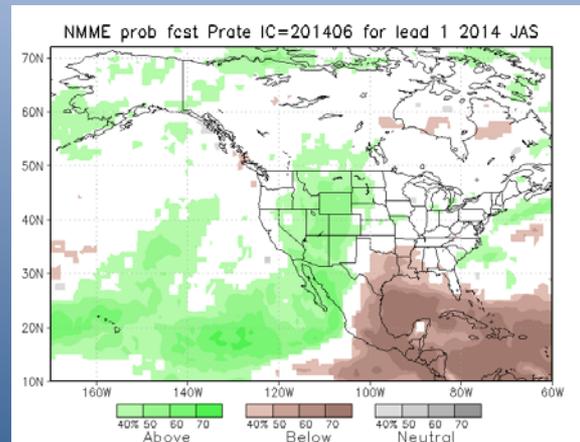
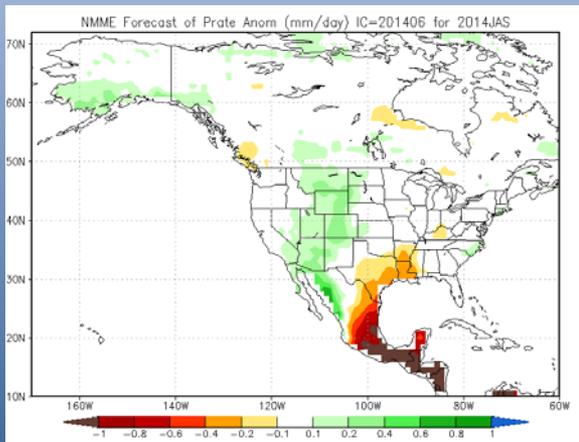
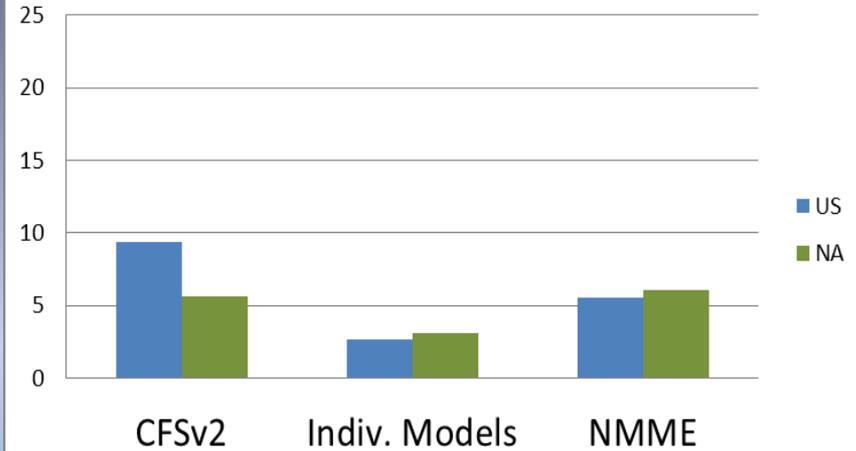
- NA: Lead 1
HSS=14.25
- Seas 1 HSS=18.5
(not shown)
- US: Lead 1
HSS=4.18
- Seas 1 HSS=1.37
(not shown)

Year 3 verification – Prate anomalies

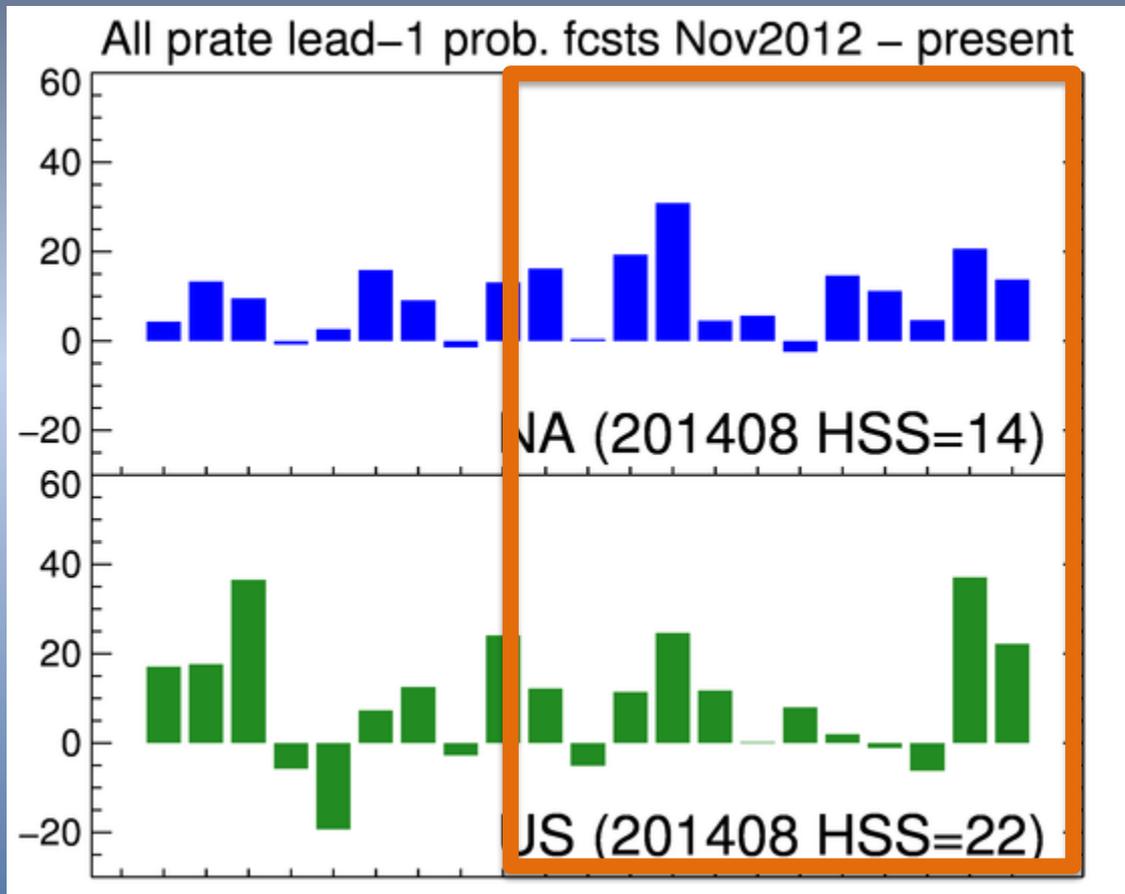
Prate Lead1 AC, Year 3



Prate Season-1, Year 3



Year 3 verification – prate prob fcsts



- NA: Lead 1
HSS=9.72
- Seas 1 HSS=8.0
(not shown)
- US: Lead 1
HSS=9.73
- Seas 1 HSS=7.87
(not shown)

September IC forecasts for OND Nino3.4 index 1982 - 2013

