Short-term climate extremes in NMME

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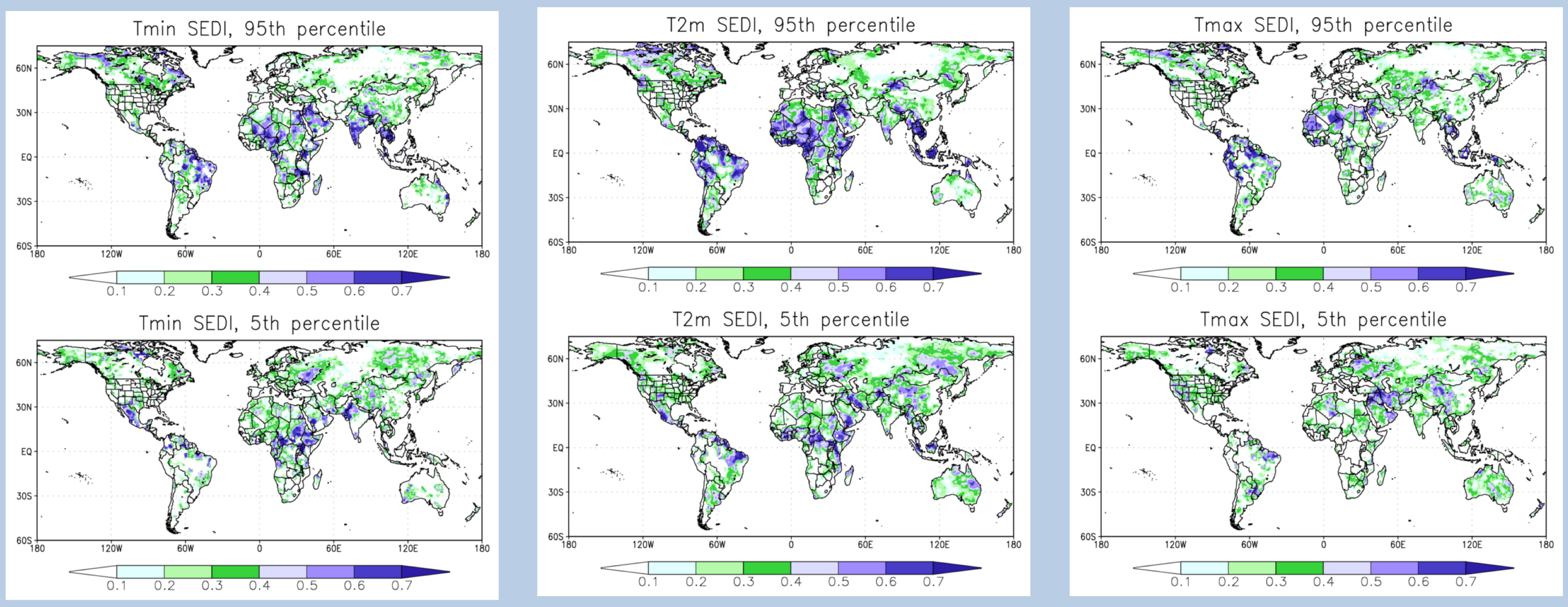
Early warning systems for short-term climate extremes (STCE; a monthly or seasonal mean substantially above/below normal) are desired by many users of climate information. Here, we detail an assessment of the skill of STCE prediction by the North American Multi-Model Ensemble (NMME), including maximum, minimum, and mean 2 m temperature (seasonal), and mean precipitation rate (one-month mean). Various definitions of “extreme” are considered, and the viability and options of a probabilistic MME forecast tool for extremes are examined.

Assessment of the forecast skill for extremes using hit rate metrics reveals several geographic areas where model forecasts are substantially more skillful than a climatological forecast. Deterministic forecasts for extremes are more skillful than for non-extremes, and demonstrate clear seasonal patterns that differ from non-extremes. Precipitation scores are low, but positive for the lead-1 monthly mean. Preliminary development of a probabilistic extremes forecast tool reveals potential, but many avenues must be explored before a format could be finalized.

Lead-1 seasonal temperature

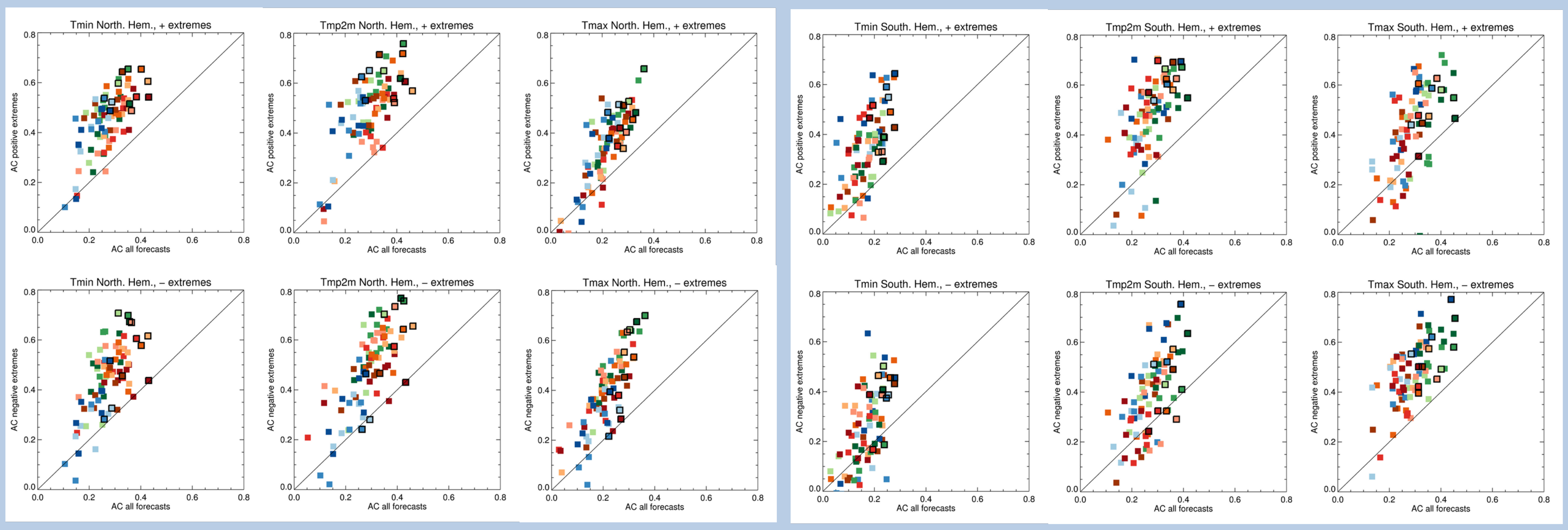
minimum T2m | mean T2m | maximum T2m



Symmetric Extremal Dependence Index (SEDI) for seasonal forecasts of extreme 2 m temperature: SEDI for forecasts of positive extremes (95th percentile events) in upper panels, negative extremes (5th percentile events) in lower panels.

Northern Hemisphere — minimum T2m, mean T2m, maximum T2m

Southern Hemisphere — minimum T2m, mean T2m, maximum T2m

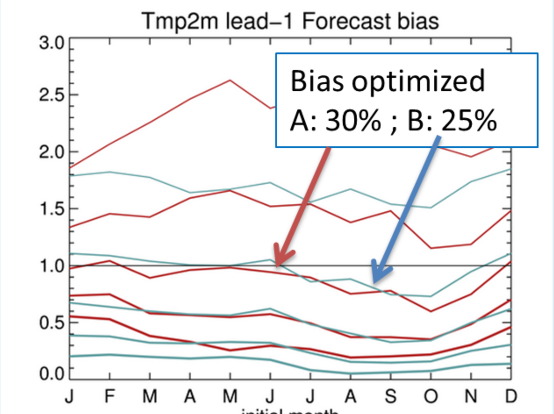


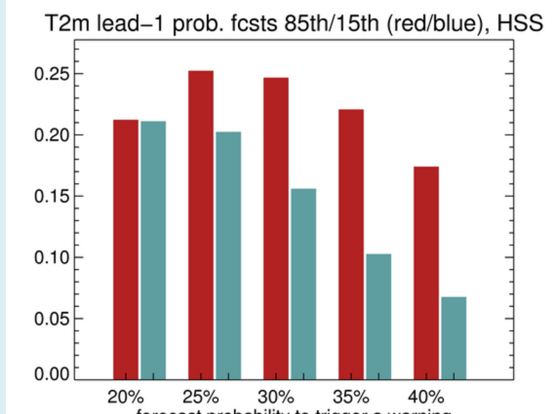
Anomaly correlation (AC) for lead-1 seasonal forecasts of minimum temperature (Tmin, left), mean 2 m temperature (Tmp2m, center), and maximum temperature (Tmax, right), area-aggregated over Northern Hemisphere extratropics (23°N - 75°N) land from 6 individual models and NMME multi-model ensemble mean (denoted with black outlines). AC for all forecasts on horizontal axis; AC for forecasts of extremes on vertical axis. Results are shown for positive extremes (95th percentile events) in the top row, negative extremes (5th percentile events) in lower row. Colors indicate season: Green = spring seasons (FMA, MAM, AMJ), red = summer, orange = autumn, and blue = winter.

What would a probabilistic forecast for an extreme look like?

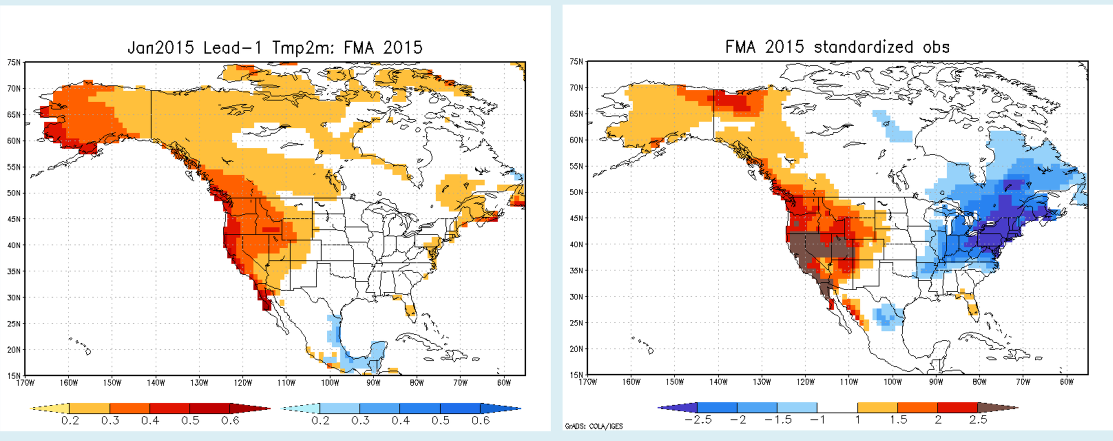
Many decision points in creating a forecast tool for extremes. Threshold for issuing a warning… 20% chance? 30%? Etc.

- We tried out five thresholds to see where forecast bias was minimized and HSS maximized: 20, 25, 30, 35, 40%
- Forecast bias <1 = forecast less often than occurs, >1 forecast more often than occurs



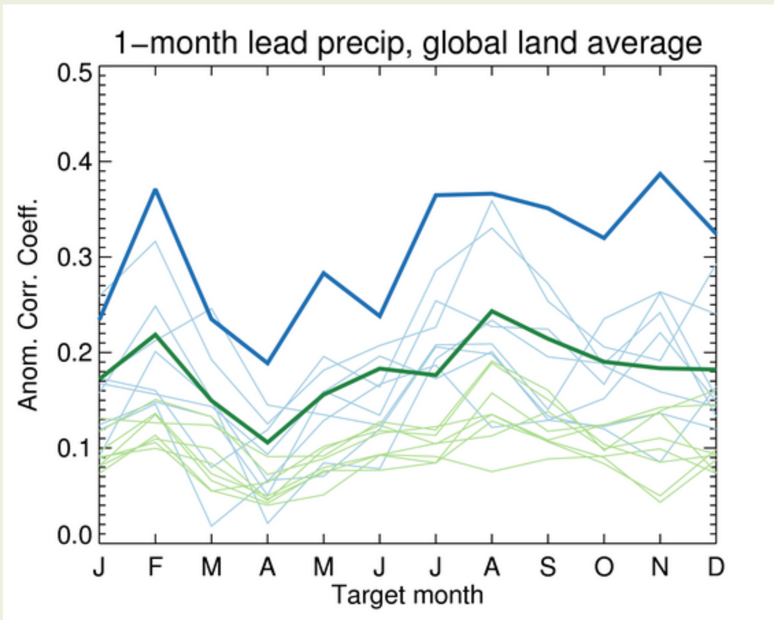


T2m Jan2015 Lead-1 forecast for FMA



25% thresh	Hits	False alarm	Misses	HSS
Warm extr.	599	168	174	0.67
Cold extr.	1	3	584	0

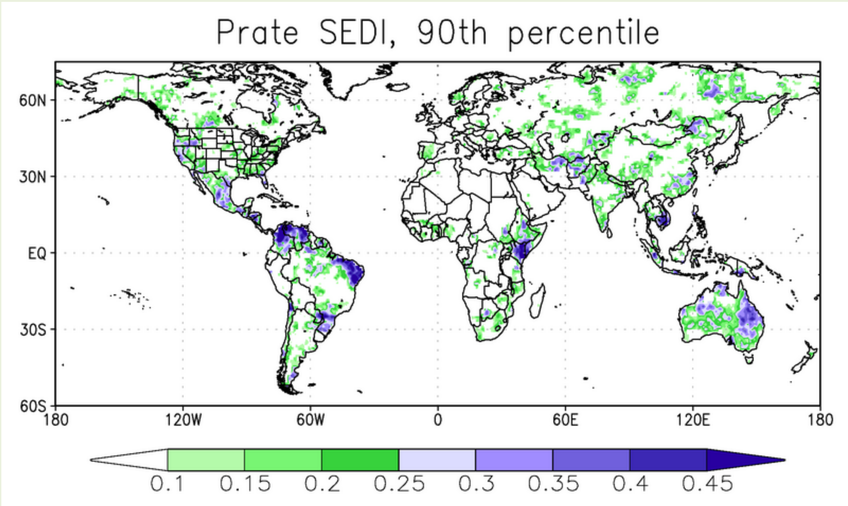
Lead-1 monthly precip.



Anomaly correlation for one-month-mean NMME forecasts of upper-tercile (green) and upper-decile (blue) precipitation, aggregated for global land excluding Antarctica. Thin lines indicate individual model results, thick lines the NMME multi-model mean. One-month lead forecasts are shown by target month: e.g., forecasts for January are made in the beginning of December.

	Hit Rate	False Alarm Rate	Forecast Bias	ORSS
Above normal (66th %ile)	0.39	0.31	0.98	0.17
Upper decile (90th %ile)	0.14	0.09	0.95	0.24

Results from a contingency table analysis of NMME multi-model mean forecasts for the 66th and 90th percentile of precipitation. Domain is all global land gridpoints, excluding Antarctica. ORSS is the odds ratio skill score.



Symmetric Extremal Dependence Index (SEDI) for NMME multi-model mean forecasts of 90th %ile precip at one-month lead. Results aggregated over all 12 initial conditions.

Model	Hindcast Period	No. of Members	Arrangement of Members	Lead (month)	Model resolution (atmos)	Model resolution (ocean)	Reference
Active							
NCEP/CFSv2	1982-2010	24 (28)	4 members (0, 6, 12, 18z) every 5th day	0-9	T126L64	MOM4L40 .25deg Eq	Saha et al (2010)
GFDL/CM2.1	1982-2010	10	All 1st of the month 0Z	0-11	2x2.5degL24	MOM4L50 .3deg Eq	Delworth (2006)
GFDL/CM2.5 (FLOR)	1982-present	24	All 1st of the month 0Z	0-11	C18L32 (50km)	MOM5 L50 0.30 deg Eq 1degPolar1.5	Vecchi et al (2014)
CMC1-CanCM3	1981-2010	10	All 1st of the month 0Z	0-11	CanAM3 T63L31	CanOM4L40 .94deg Eq	Merryfield et al (2013)
CMC1-CanCM4	1981-2010	10	All 1st of the month 0Z	0-11	CanAM4 T63L35	CanOM4L40 .94deg Eq	Merryfield et al (2013)
NCAR/CCSM4	1982-2010	10	All 1st of the month 0Z	0-11	0.9x1.25degL26	POPL60 .25deg Eq	Kirtman et al. (in prep)
NASA/GEOS5	1981-2010	11	4 mems every 5 days; 7 mems on last day of last month	0-9	1x1.25 deg L72	MOM4L40 .25deg Eq	Vernieres et al (2012)

References

Becker, E. J., H. van den Dool, and M. Peña, 2013: Short-Term Climate Extremes: Prediction Skill and Predictability. *J. Climate*, **26**, 512–531.

Becker, E. J., 2016: Prediction of Short-Term Climate Extremes with a Multi-Model Ensemble. "Patterns of Climate Extremes", S-Y Wang and J-H Yoon, Eds. American Geophysical Union

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