Recent changes to the IRI Net Assessment

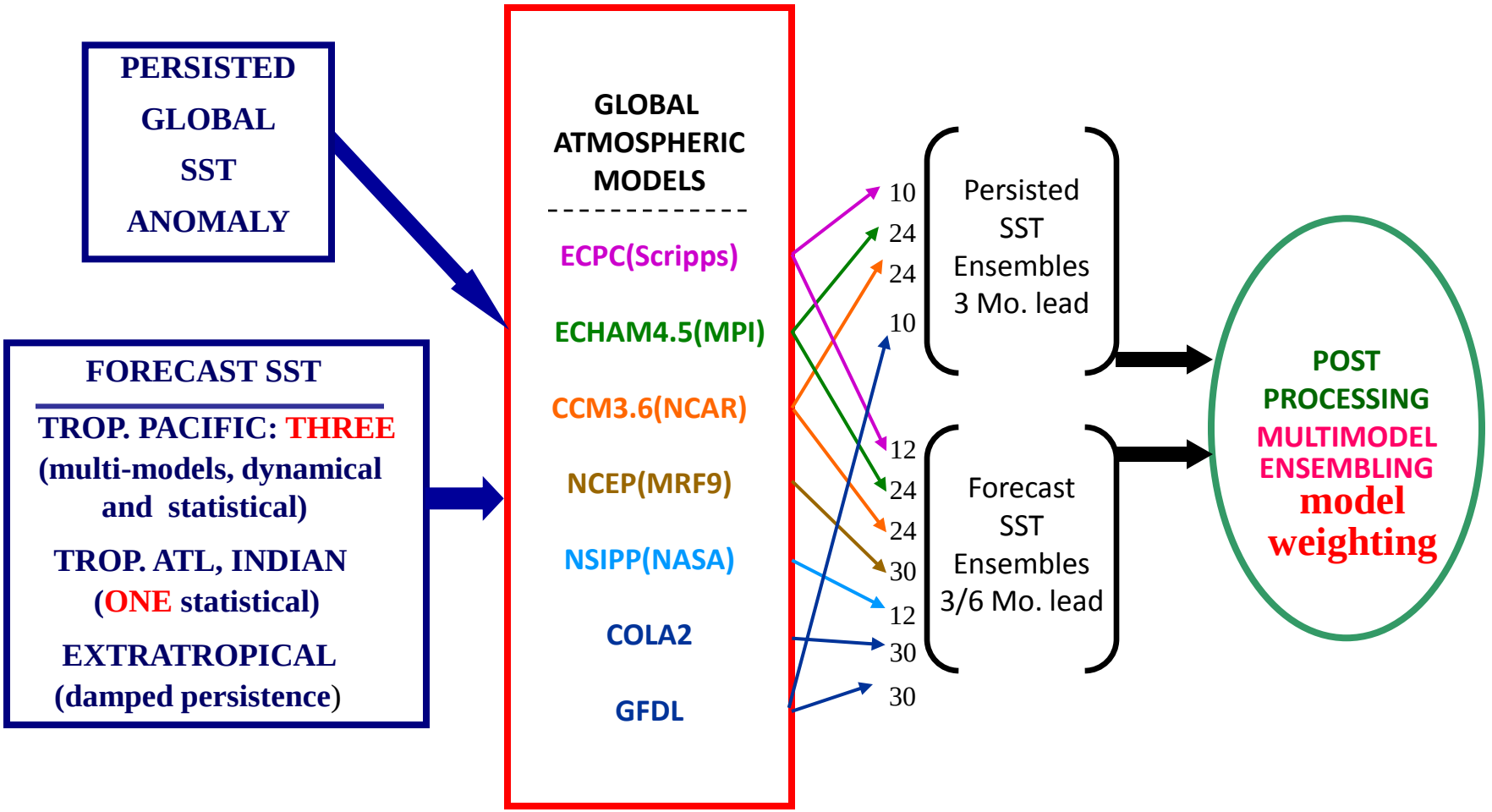
Michael K. Tippett, Tony Barnston, Lisa Goddard,
Simon Mason, Dave DeWitt

International Research Institute for Climate and Society
Columbia University, USA

IRI DYNAMICAL CLIMATE FORECAST SYSTEM

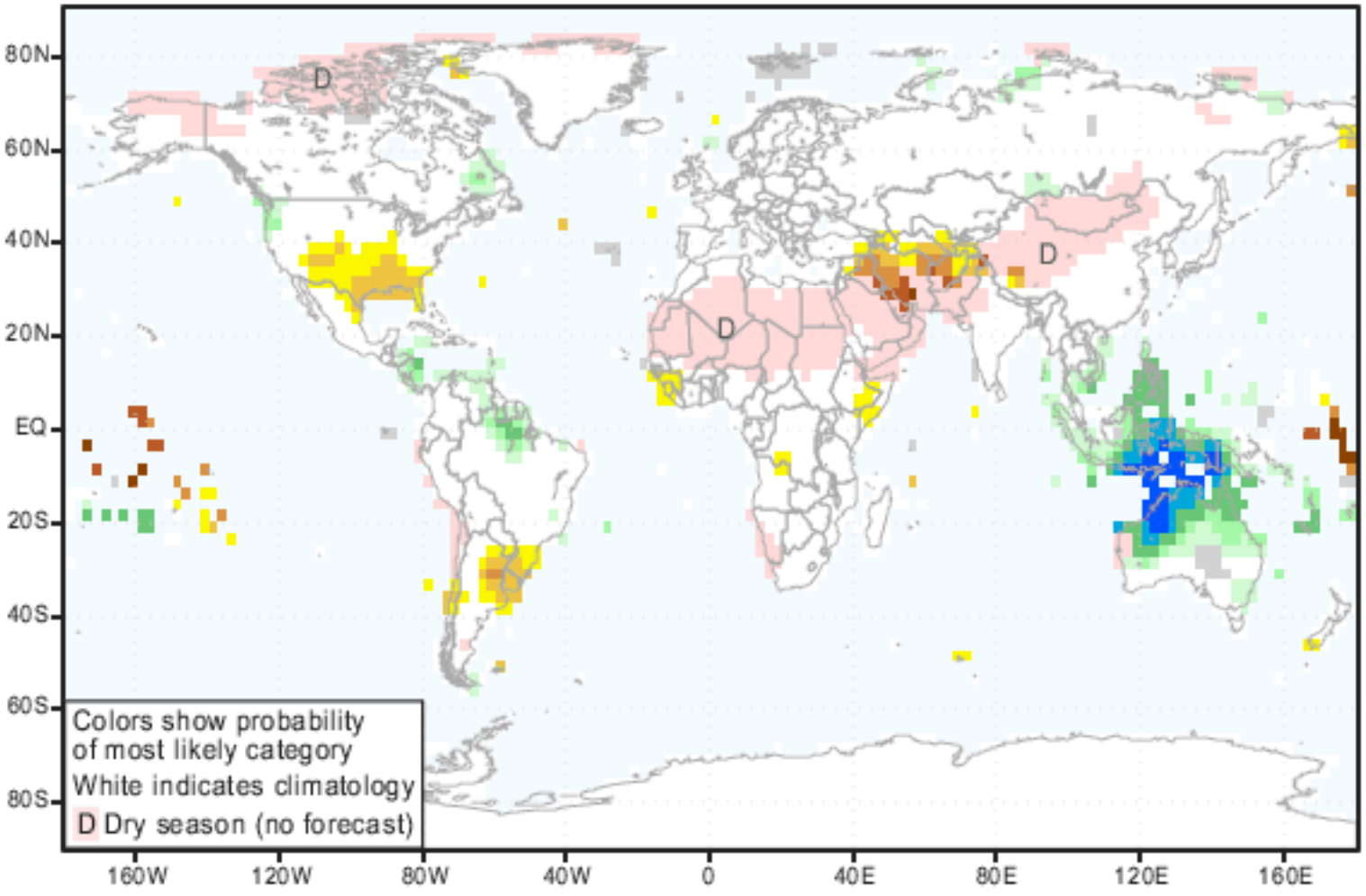
2-tiered

OCEAN **ATMOSPHERE**

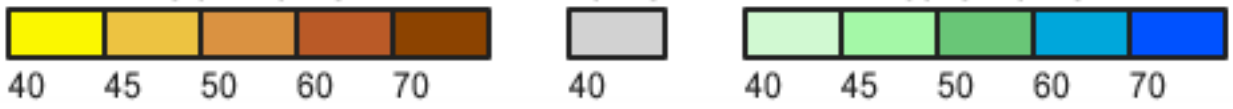


c. late 2008

IRI Multi-Model Probability Forecast for Precipitation for October-November-December 2011, Issued September 2011



Probability (%) of Most Likely Category



Changes

- Ocean forcing
  - LDEO + CA + CFSv1 mean and
  - 2 additional scenarios based on historical errors
- AGCM models
  - NCEP MRF 9 discontinued late 2008
  - NSIPP model being discontinued late 2011
- Post-processing
  - Subject of today's talk …

Extract as much useful information as possible from model forecasts

Previous post-processing

- Weigh individual model tercile probabilities against climatology.
- Weigh model tercile probabilities against each other.

Deficiencies:

- Weights computed from AMIP-style simulations.
- Gridpoint procedure.
- Limited to tercile probabilities.

Current post-processing

- Calibration using hindcasts
  - Forecast SST: CA, CFSv1, ECMWF
- Pattern-based calibration
  - EOF regression.
- Complete PDF for t2m and prcp
  - Develop from regression statistics.
- Updated climate normals 1981-2010
  - Changes in calibrations data sets

Key Issues

- Are regression forecasts reliable?
  - Theory
  - Practice
- How to select predictor patterns?
- Flexible Forecast Format

Are *regression forecasts* reliable?

- Predictor = model forecast = f
- Predictand = observation = o
- Regression: E[o|f] = expected value of observation given the forecast
  - Perfect model -- E[o|f] = f
  - No skill – E[o|f] = climatology
- Var[o|f] = variance of the observation given the forecast
  - Perfect model -- Var[o|f] < climatological variance
  - No skill – Var[o|f] = climatological variance
- Linear regression (Gaussian)
  - E[o|f] = a f + c = linear function of f.
    - Estimate parameters from data.
  - Var[o|f] = error variance.
    - Estimate from data

Are regression forecasts *reliable*?

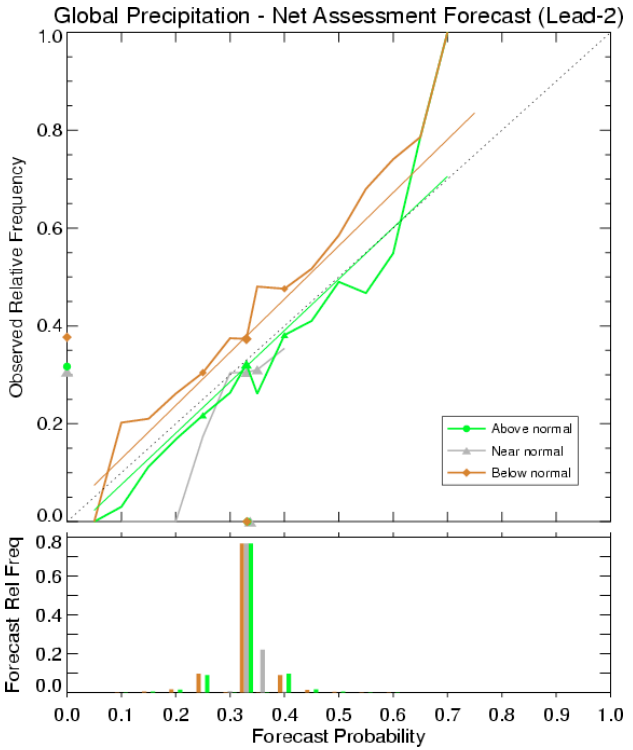
- Reliability diagram (Categorical forecasts)
  - P = forecast probability of an event A (above)
    - A = 1 if the event happens and 0 otherwise
  - Plot E[A|P] vs. P
    - Reliable if 45 degree line
  - Regression = conditional expectation
  - If P comes from regression

    P = E[A|P]

    plotting E[A|P] vs E[A|P]

Reliable by "construction"

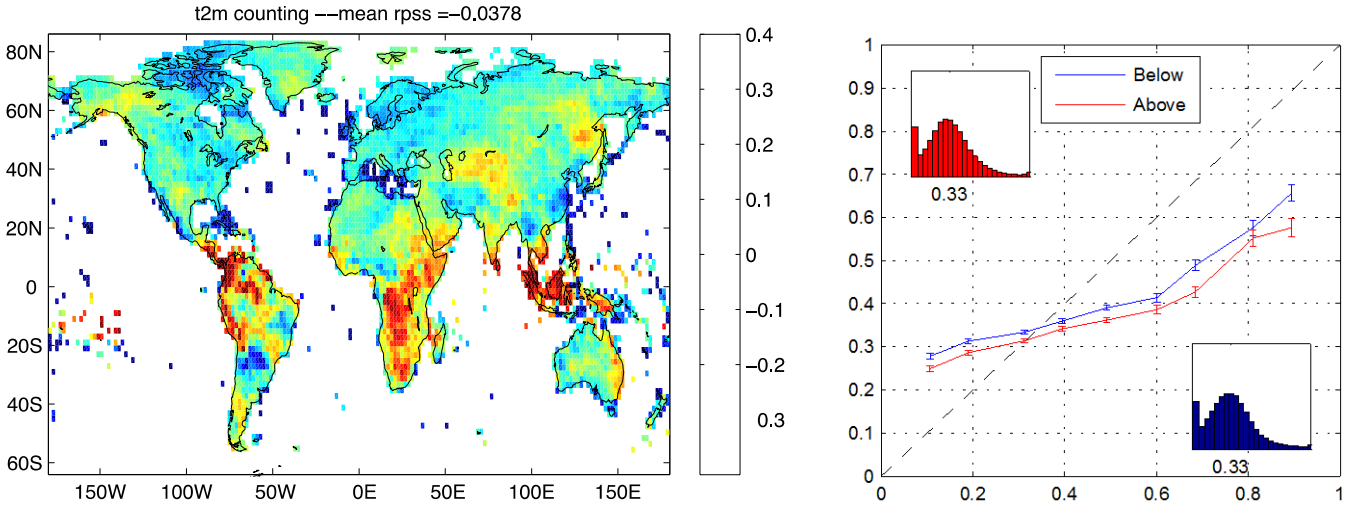
… in theory



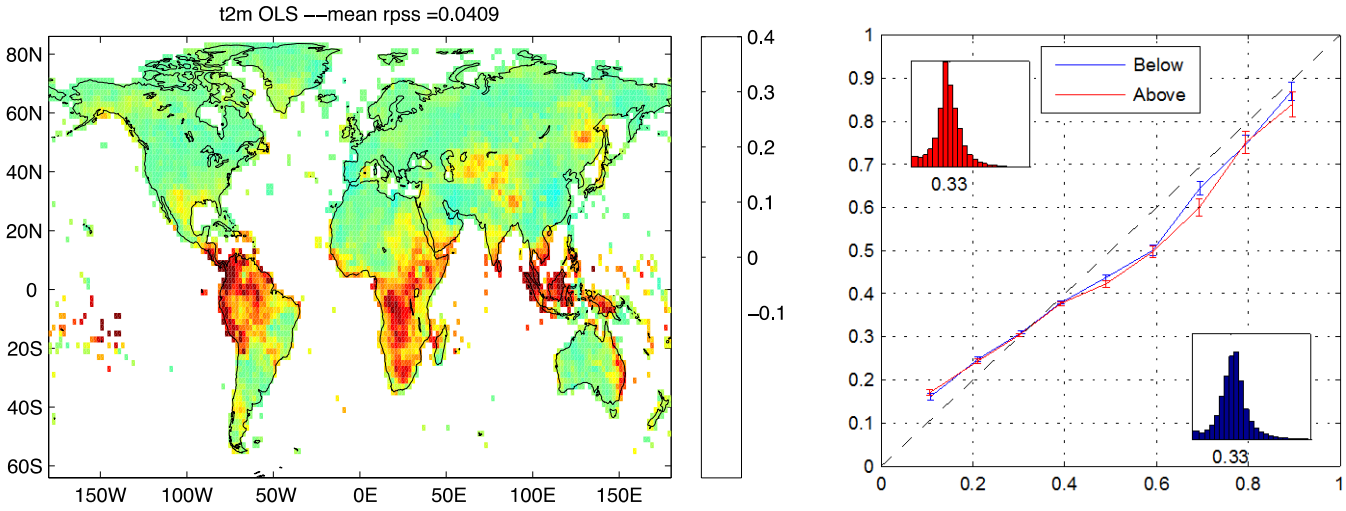
Are regression (gridpoint) forecasts reliable in practice?

DJF t2m
Nov 1
start

Ensemble
Frequency



Linear
regression

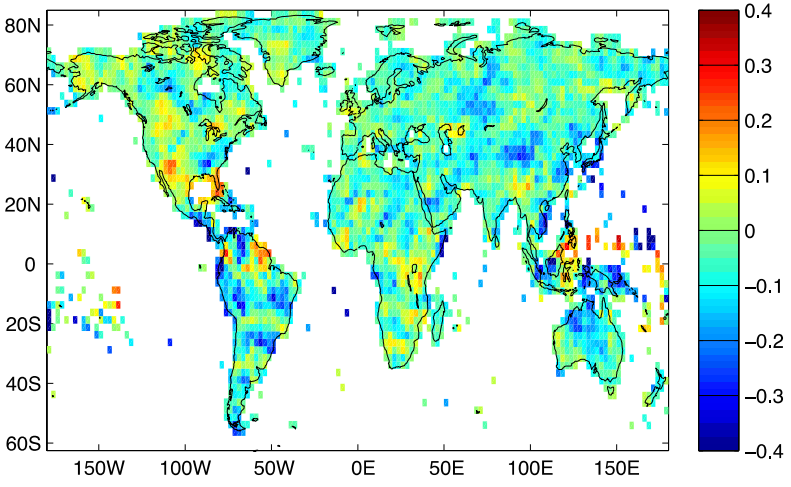


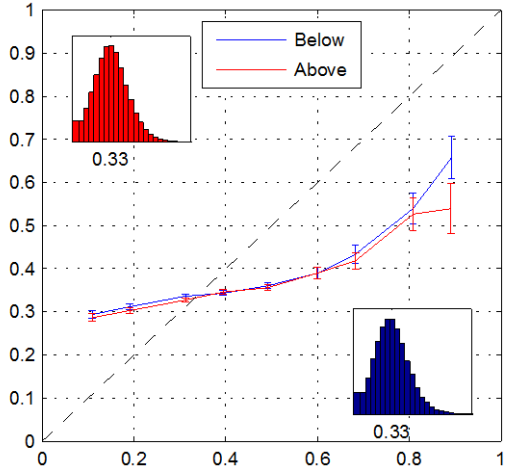
Are regression (gridpoint) forecasts reliable in practice?

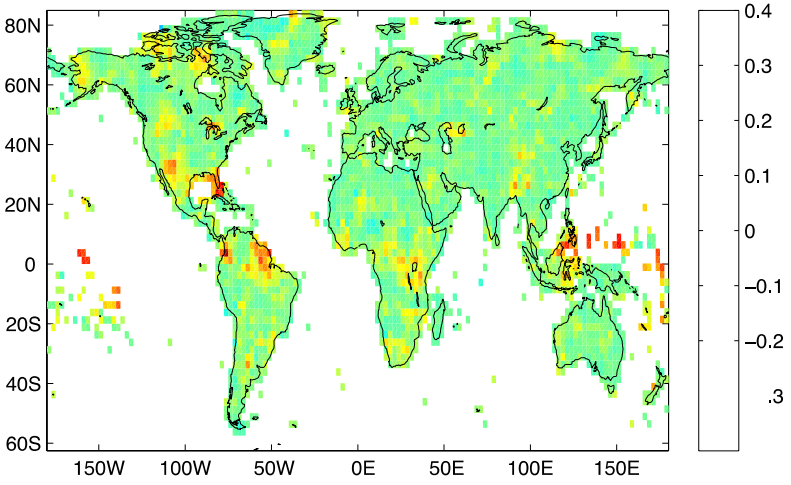
DJF prcp
Nov 1

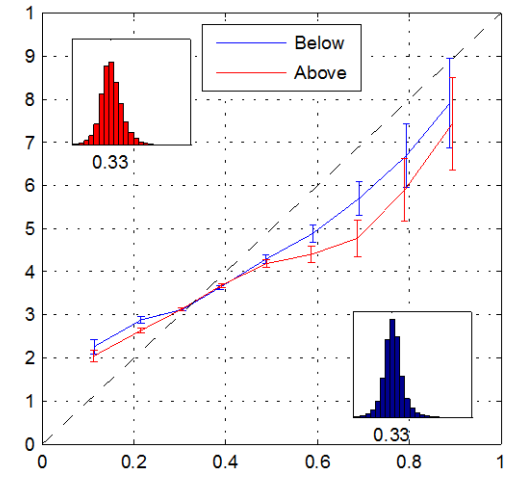
Ensemble
Frequency

Linear
regression







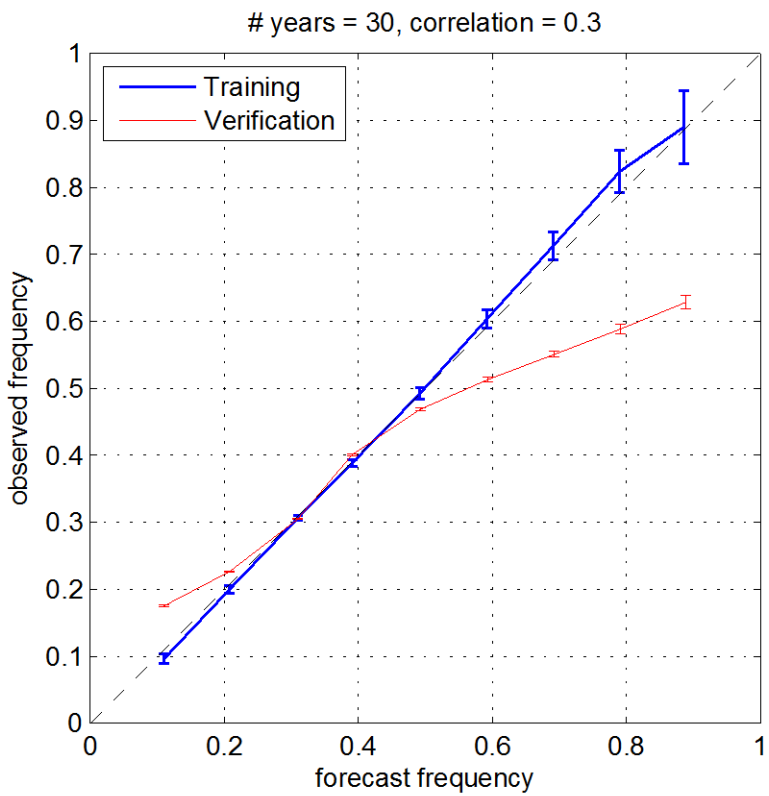


What is the gap between theory and practice?

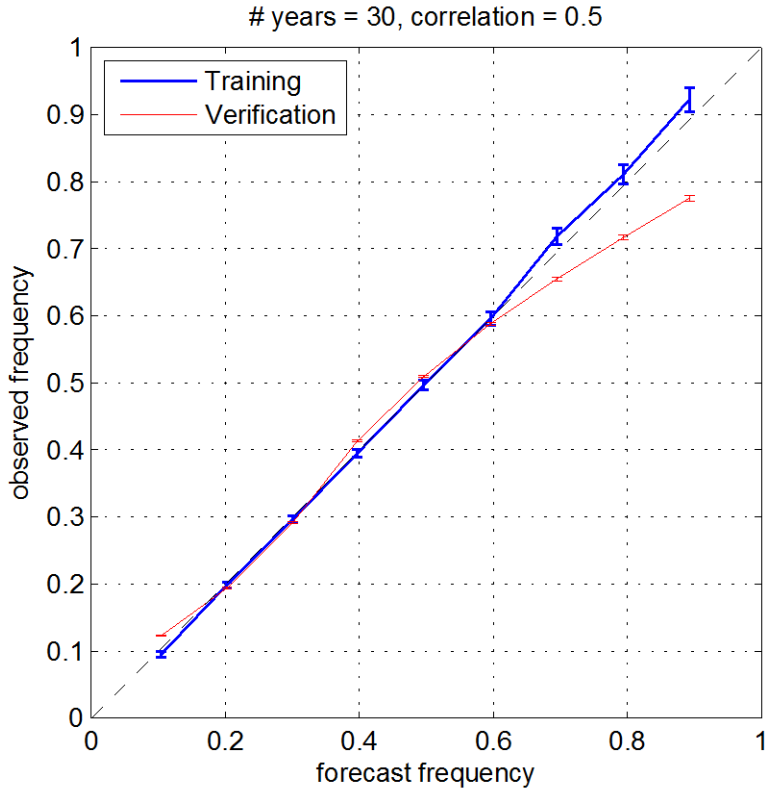
Reliability exposes issues correlation does not.

- Correct signal strength
- Correct uncertainty

Synthetic data



R = 0.3



R = 0.5

Training / Verification

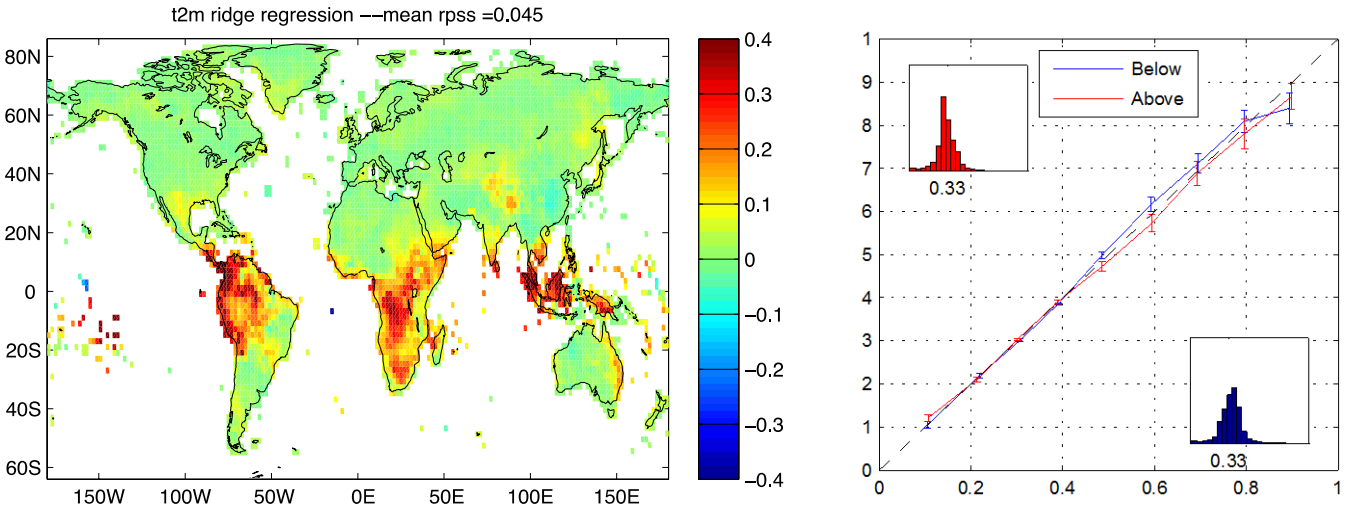
Why over-confident?

- Spread too small? No.
- Signal too strong? Yes.
- MOS = a f + c
  - Correct signal variance = a^2 Var (f)
  - Signal variance in practice

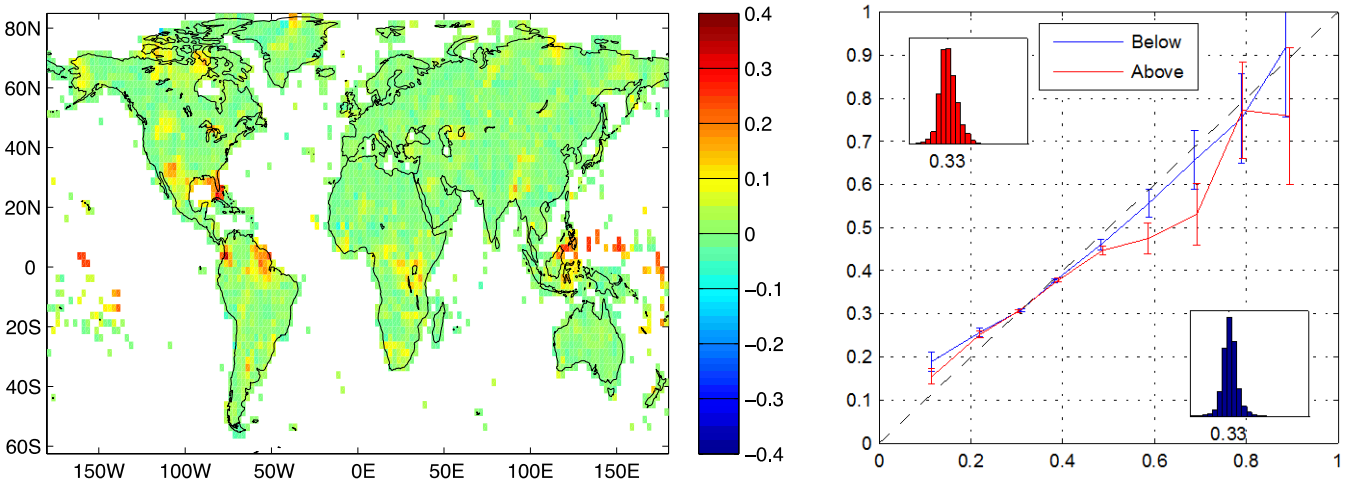
    (a^2 + sampling variance) Var(f) > true sig. var.

Shrinkage

Ridge



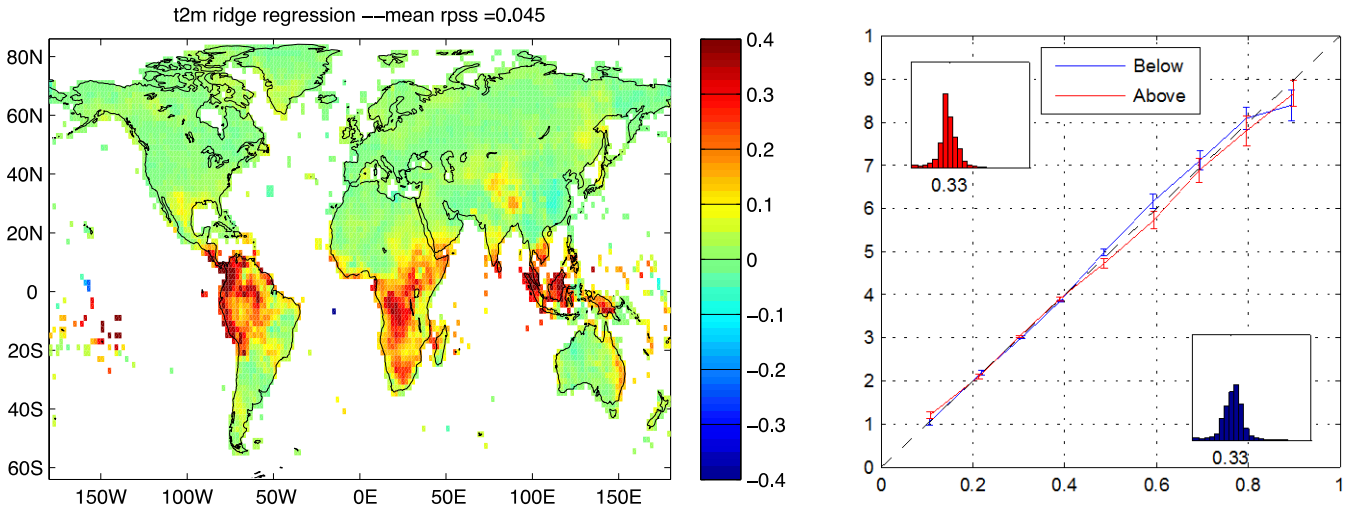
Lasso



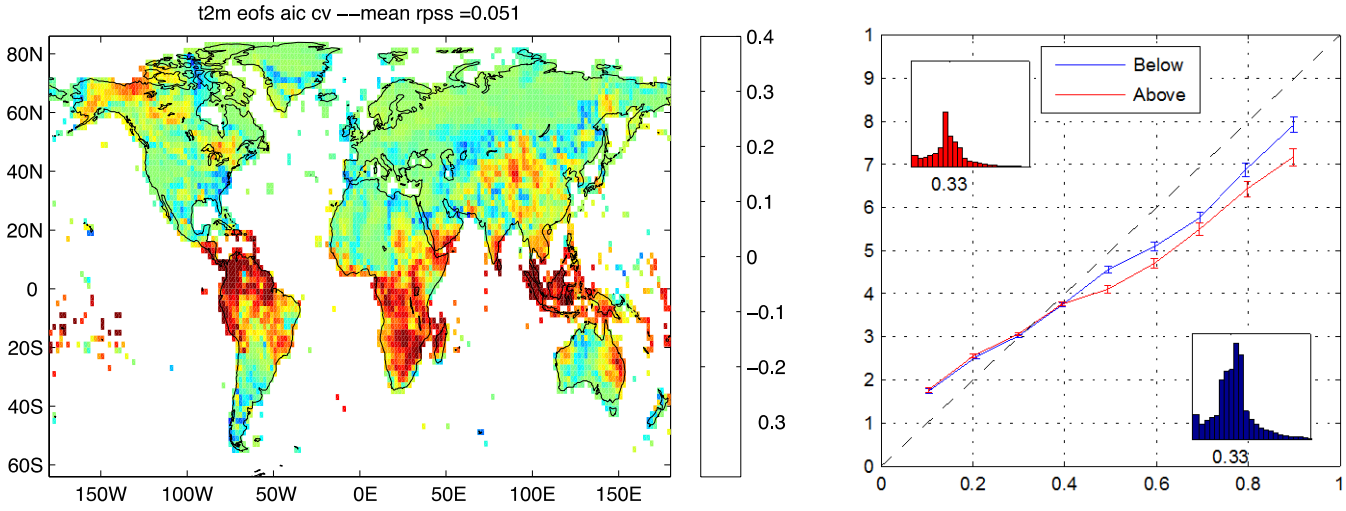
How to select predictor patterns?

Selecting predictor patterns

Ridge

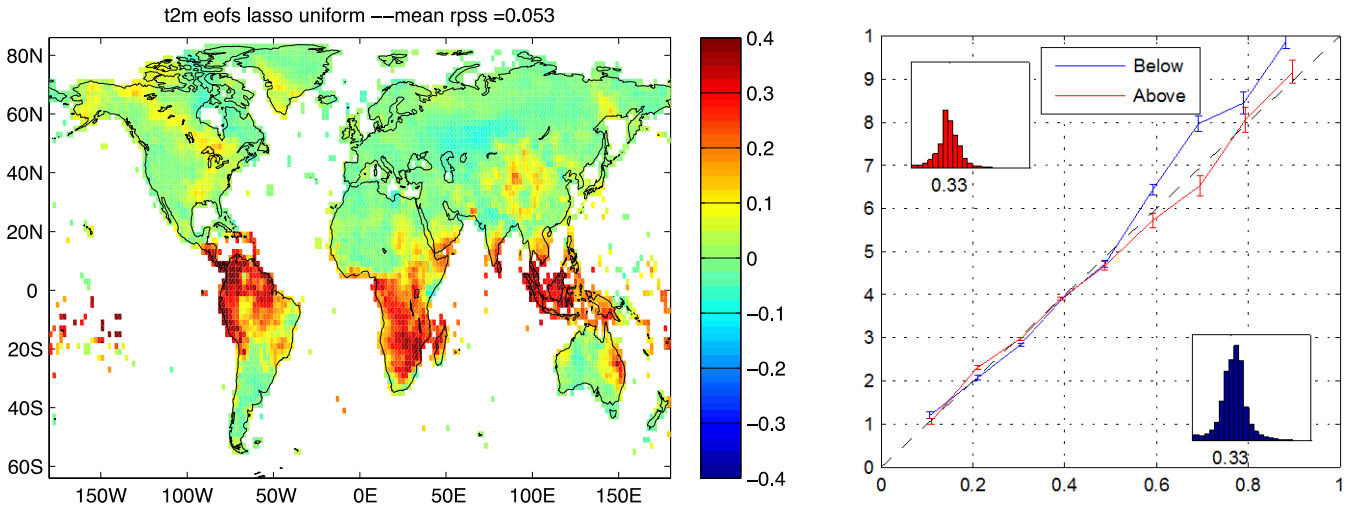


EOFs #
by AIC (or CV)

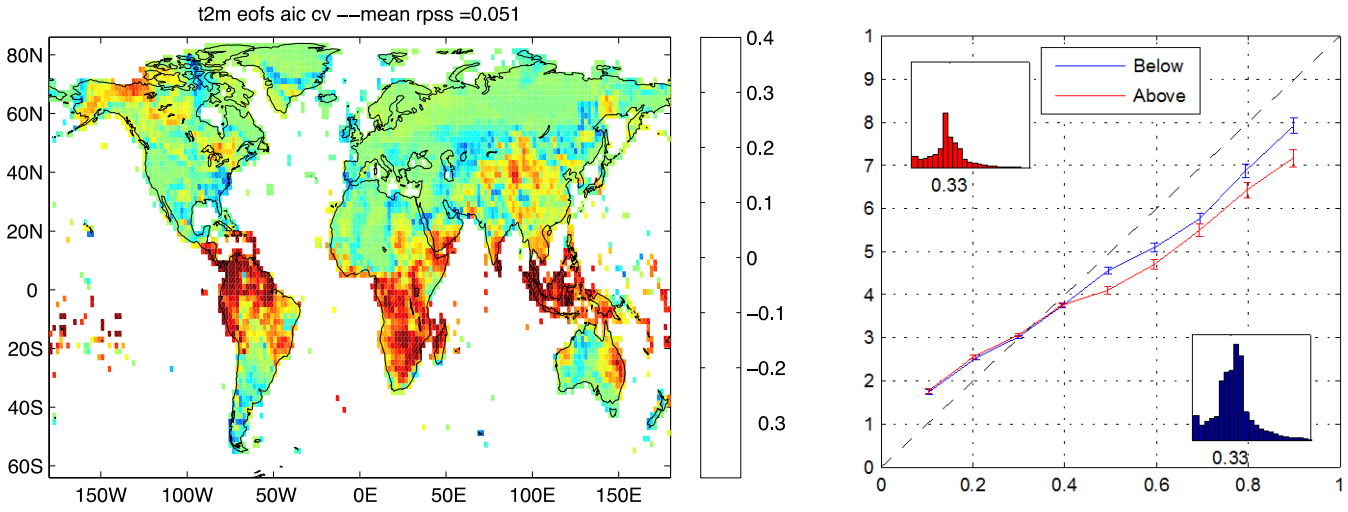


Selecting predictor patterns

EOFs+
lasso



EOFs #
by AIC (or CV)

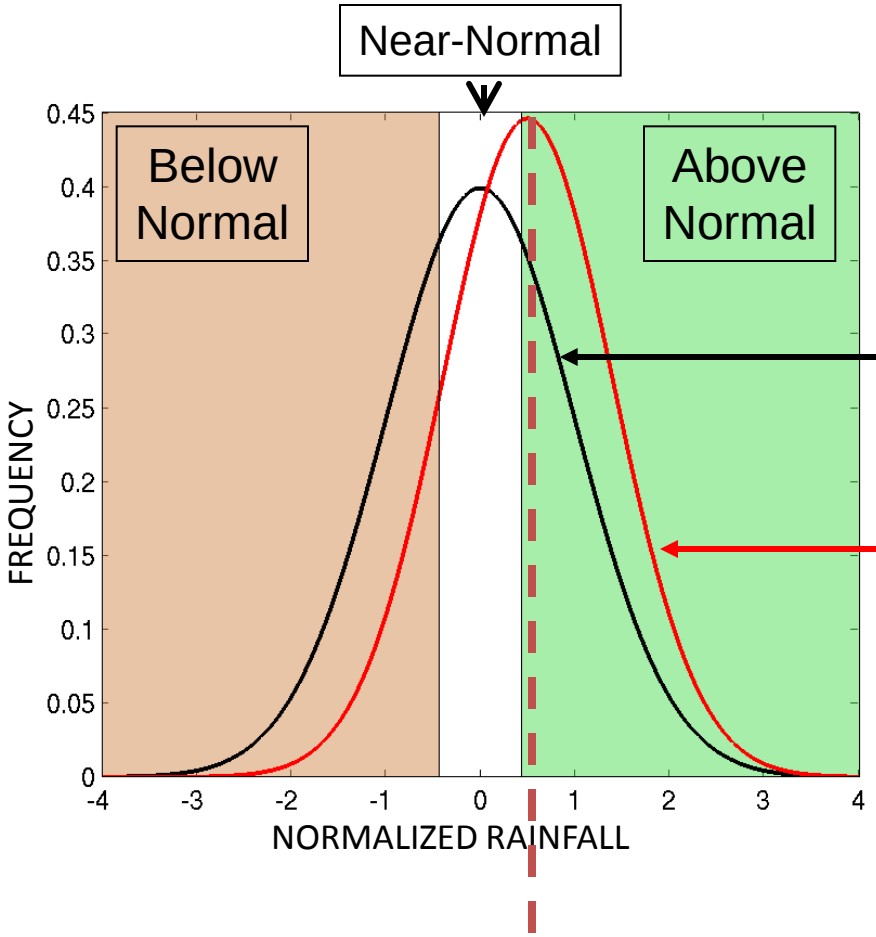


T2m since Dec 2009

Prcp since June 2010

Constructing forecast probabilities beyond tercile categories

Shifted Gaussian

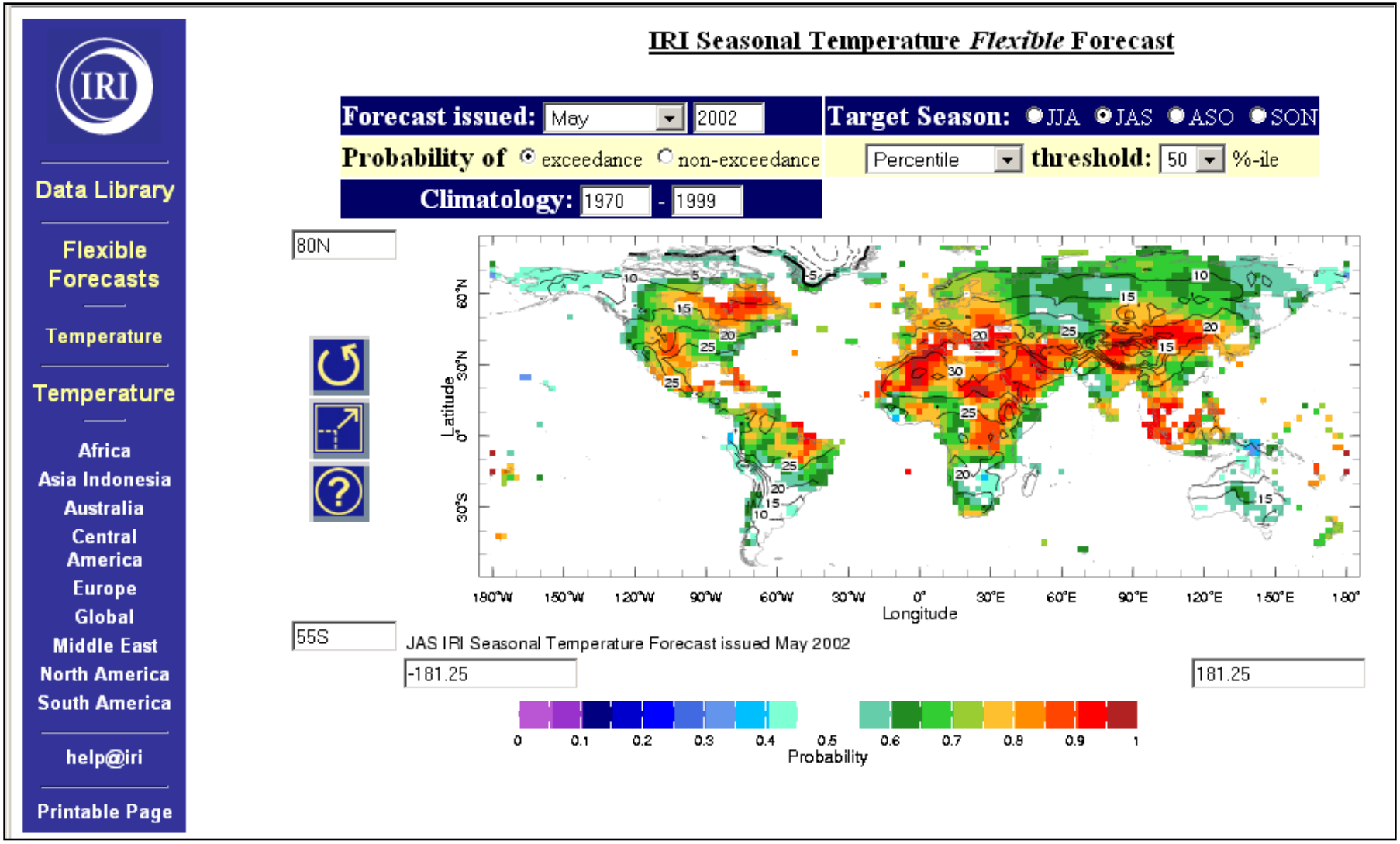


Historical distribution
(climatological distribution)
(33.3%, 33.3%, 33.3%)

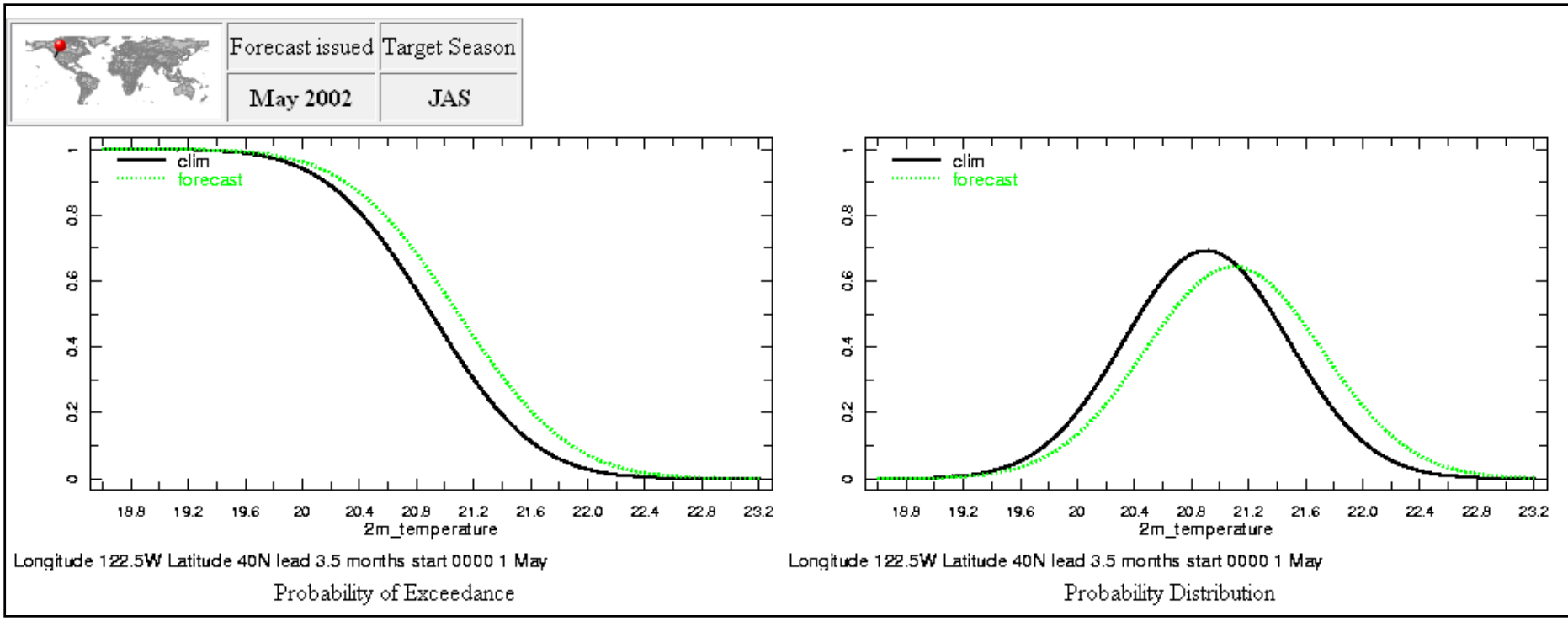
Forecast distribution
(15%, 32%, 53%)

model output

Flexible format map room



Flexible format map room

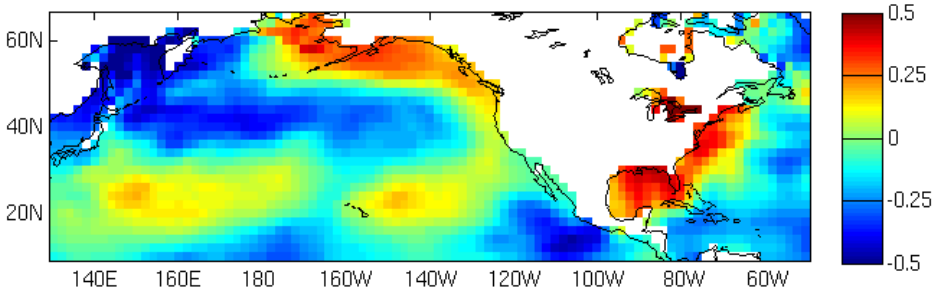


Summary

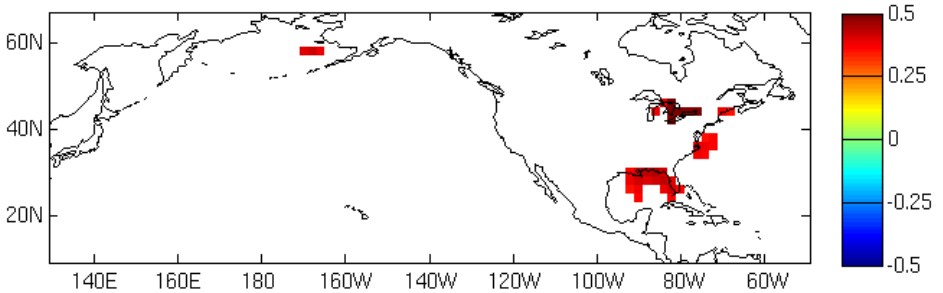
- Shrinkage improves reliability of regression forecasts
- Penalty methods can be used to choose predictors
- Forecast pdfs can be constructed from regression models.
- Complete forecast information provided.

IRI Forecast Methodology

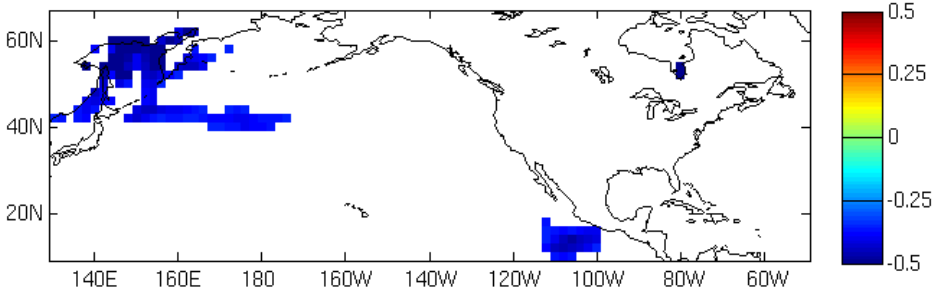
- Atmospheric GCMs forced with forecast SST scenarios
  - Mean of CFSv1, CA and LDEO
  - Positive and negative scenarios based on historical error
- Pattern-based correction of ensemble means.
  - Regression based on historical model runs
    - Forecast SST (CA)
  - Spread estimate from historical forecasts with forecast SST.
- Equal weighting of corrected models
- Forecast probabilities
  - Gaussian distribution for temperature
  - Transformed Gaussian for precipitation



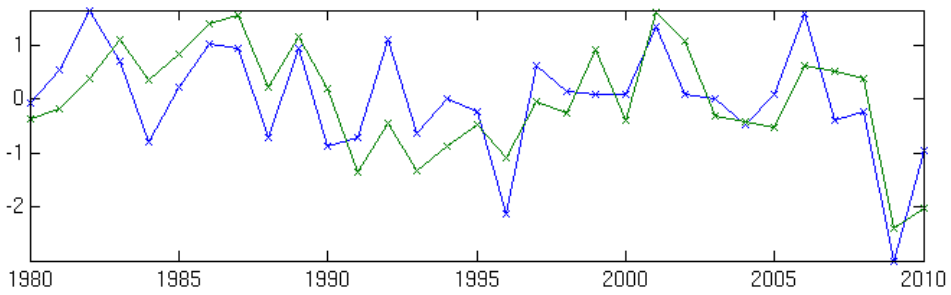
Correlation with Feb SST 1980-2010



Positive sig. correlations



Negative sig. correlations



Observations of a Chicago social index
Integrated Mar-Sep value

Cross-validated regression with
Feb SST as predictors

R = 0.69