Beyond Climate Predictions

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Beyond Climate Predictions

Many Thanks to Walter Baethgen, Remi Cousin, Paula Gonzalez, Arthur Greene, Andy Robertson, Simon Mason, Mike Tippett
Temperature
Most of the variability in the globally-averaged temperature is contained in the slowly varying climate change component. (Greene, Goddard & Cousin, 2010, EOS)

Time Scales Decomposition Map Room
http://iridl.ldeo.columbia.edu/maproom/Global/Time_Scales/
Temperature Trends: % of total variance
20th Century Gridded Observations -- Annual Means

http://iridl.ldeo.columbia.edu/maproom/Global/Time_Scales/
Precipitation Trends: % of total variance

20th Century Gridded Observations -- Annual Means

http://iridl.ldeo.columbia.edu/maproom/Global/Time_Scales/

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Climate Variability & Change in Colorado

Temperature

Most of the variability in the globally-averaged temperature is contained in the slowly varying "climate change" component.

Annual Mean Temperature

- 12%
- 21%
- 65%

Seasonal-to-Interannual Forecasts

- Longer Timescales

Precipitation

- 1% 19%
- 75%

Time Scales

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Example of 3-Category Seasonal Rainfall Forecast

- Regional
- 3-month average
- Probabilistic
What probabilistic forecasts represent

Historically, the probabilities of above and below are 0.33. Shifting the mean by half a standard-deviation and reducing the variance by 20% changes the probability of below to 0.15 and of above to 0.53.

(Courtesy of Mike Tippett)
Multi-model ensembling

Probabilistic skill scores (RPSS for 2m Temperature (JFM 1950-1995))

Combining models reduces deficiencies of individual models
Reliability!
Forecasts should “mean what they say”.

A Major Goal of Probabilistic Forecasts

Time Scales
Seasonal-to-Interannual Forecasts
Longer Timescales
Model Calibration (spatial): Based on model performance

RPSS for forecasts of DJF 2m-temperature

“Raw” counting --- mean rpss = -0.0378

“Lasso Regression”

t2m ridge regression --- mean rpss = 0.045

t2m eofs --- mean rpss = 0.0362

“Lasso Regression”

t2m eofs lasso grid bma --- mean rpss = 0.0652

(Tippett et al., in prep)
Need for more flexible forecast information: **Agriculture**

**Climate Information Relevant to Agricultural Decision Making in Uruguay**

Probability that Yields of a Maize Hybrid (Medium Cycle) Planted in October in SW Uruguay Fall Below 80% of Expected Yields Versus DJF Precipitation Anomalies (Logistic Regression. DJF Climatology: 311mm)

![Graph showing the probability of yields falling below 80% of expected values versus DJF precipitation anomalies.](image)

*Marginal Effect = -0.0082*

On average, a 10 percent increase in the anomaly will reduce the chance of falling below 80% of the expected yield by 0.82%.

*(Courtesy of Miguel Carriquiry)*

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Need for more flexible forecast information: **Health**

Seasonal Climate Forecasts for Malaria Control Planning in Southern Africa

Relevant categories for malaria planning are 25%-ile tails (i.e. probability of climate being in wettest/driest 25% of years)

(Courtesy of Simon Mason)

(Thomson et al. 2006, Nature)
Temperature Flexible Seasonal Forecast

This seasonal forecasting system consists of probabilistic temperature seasonal forecasts based on the full estimate of the probability distribution. Probabilistic seasonal forecasts from multi-model ensembles through the use of statistical recalibration, based on the historical performance of those models, provide reliable information to a wide range of climate risk and decision making communities, as well as the forecast community. The flexibility of the full probability distributions allows to deliver interactive maps and point-wise distributions that become relevant to user-determined needs.

The default map shows globally the seasonal temperature forecast probability (colors between 0 and 1) of exceeding the 50th percentile of the distribution from historical 1981-2010 climatology. The quantitative value of that percentile is indicated by the contours. The forecast shown is the latest forecast mode (e.g. Sep 2012) for the next season to come (e.g. Oct-Dec 2012). Five different seasons are forecasted and it is also possible to consult forecasts made previously. What makes the forecast flexible is that underlying the default map is the full probability distribution for the forecast and climatology. Therefore, the user can specify the historical percentile or a quantitative value (here temperature in °C) for probability of exceedance or non-exceedance. The climatological reference

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(Cousin et al. in prep)
Regional Scale Decadal Predictions?

Climate Change Projections cannot deliver predictions of decadal variability

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CMIP5 Experimental Prediction Design

- 10-year hindcast & prediction ensembles: initialized 1960, 1965, ..., 2005
- 30-year hindcast and prediction ensembles: initialized 1960, 1980 & 2005
- additional predictions initialized in '01, '02, '03 ..., '09
- hindcasts without volcanoes
- 100-yr "control" & 1% CO2
- prediction with 2010 Pinatubo-like eruption
- alternative initialization strategies
- prescribed SST time-slices
- atmos. chemistry & for aerosols & for regional air quality
- extend ensembles from O(3) to O(10) members

http://www.clivar.org/organization/wgcm/references/Taylor_CMIP5.pdf
Decadal Predictions: *Skill still to be demonstrated*

Multi-model Ensemble (12 models: Equal Weighting)

Mean Squared Skill Score

Correlation

(based on Goddard et al. 2013, *Climate Dynamics*; See also [http://clivar-dpwg.iri.columbia.edu](http://clivar-dpwg.iri.columbia.edu))
STOCHASTIC SIMULATION FRAMEWORK

Input
- Detrending
- Natural variability

Diagnosis
- Inferred local response
- Systematic components? (Not present here)

Random VAR(1)

Simulate (VAR)

Resample (k-NN)

Future Trends

Project using CMIP5

Ensemble generation

Output

Simulated annual-to-decadal

Simulated subannual

ACRU

Equilibrium model...


Time Scales  Seasonal-to-Interannual Forecasts  Longer Timescales

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Decadal Variability

STOCHASTIC SIMULATIONS: 2 Ensemble Members
Climate Information for Adaptation, Resilience & Decision Support

1 – Consider all timescales
   ... for establishing resilience, for informing management, and for planning, evaluation

2 – Presentation can be as important as quality

3 – Good quality observations are critical

4 – Strive for “informed uncertainty”
   (won’t get that straight from models)
There are no answers, only choices.

*Stanislaw Lem/Steven Soderbergh (Solaris)*
Thank You

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