SEASONAL CLIMATE FORECASTING TO BENEFIT BUSINESS AND SOCIETY

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Presentation Structure

1. Seasonal Climate Prediction
2. Impacts of Seasonal Weather on Business and Society
3. Skill Examples:
   ENSO, Hurricanes, UK Temperature
4. Winter Forecast for 2001/02
5. Future Developments

Weather and Climate

Weather - Day to day change in temperature, rainfall, windiness etc

Climate - Average state of the weather over periods from months to centuries

- Seasonal Climate
- Decadal Climate
- Multi-Decadal Climate

Limits of Weather Prediction

"Claims of skilfull predictions of day-to-day weather beyond 1-2 weeks have no scientific basis and are either misinformed or calculated misrepresentations of true capabilities".

American Meteorological Society Policy Statement, 2001

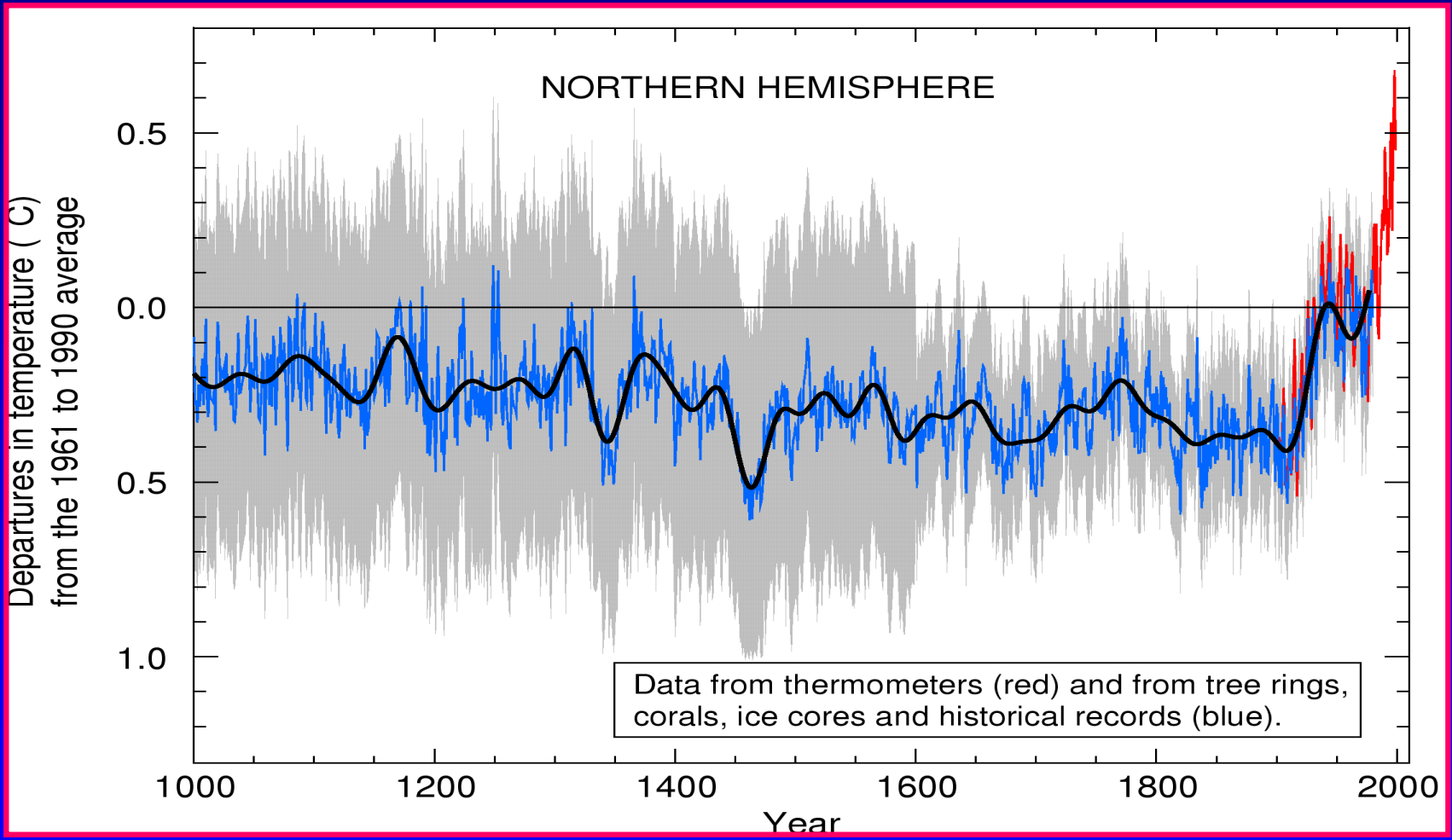
Seasonal Weather Prediction

- The prediction of anomalies in climate over seasonal (1-3 months) periods of time.
- Skill possible because atmosphere is forced by large scale (and predictable) anomalies in sea surface temperature which evolve slowly.
- A major focus of MSSL Climate Physics Research:

See: http://forecast.mssl.ucl.ac.uk
http://www.tropicalstormrisk.com

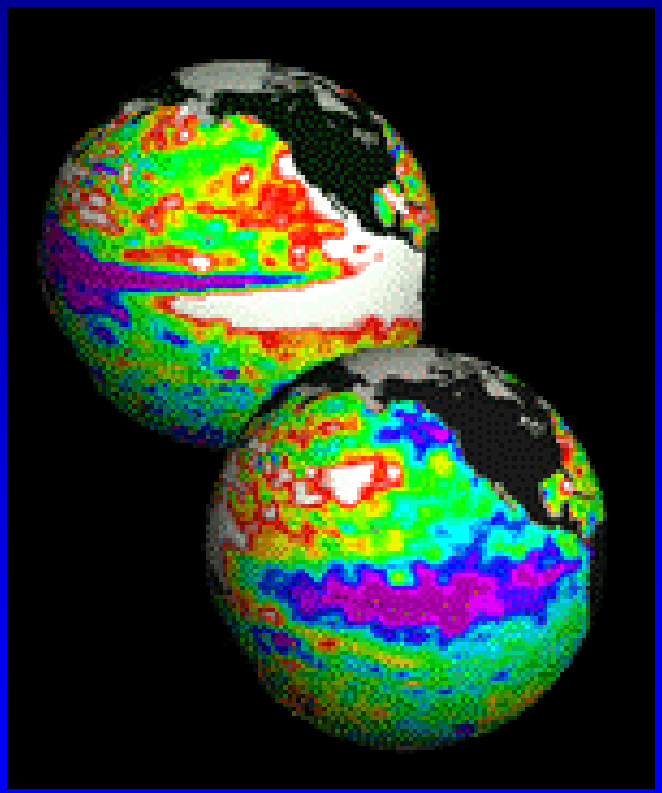
Earth's Surface Temperature Record

The Past 1,000 Years



(Adapted from IPCC, 2001)

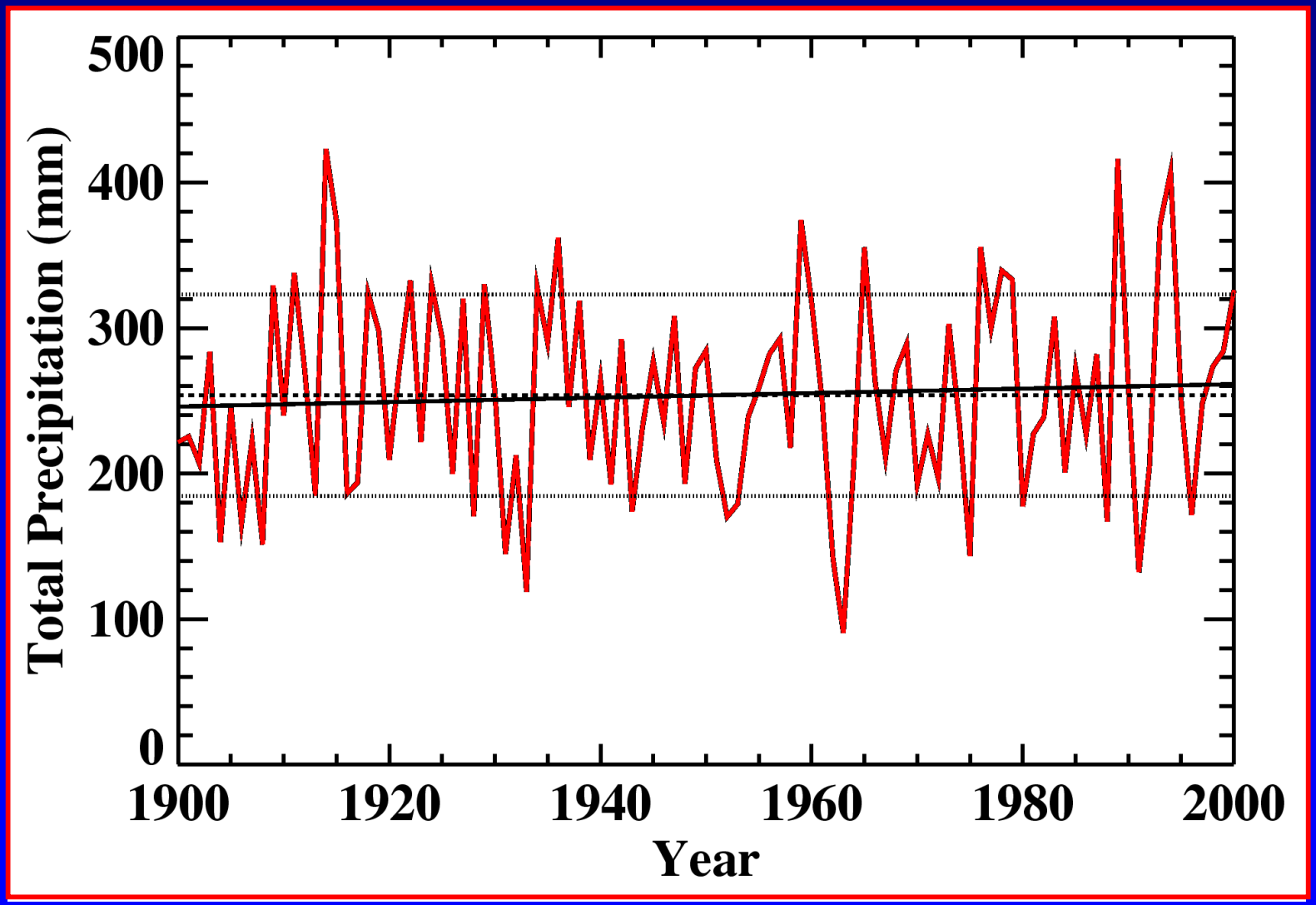
Interannual Changes - ENSO



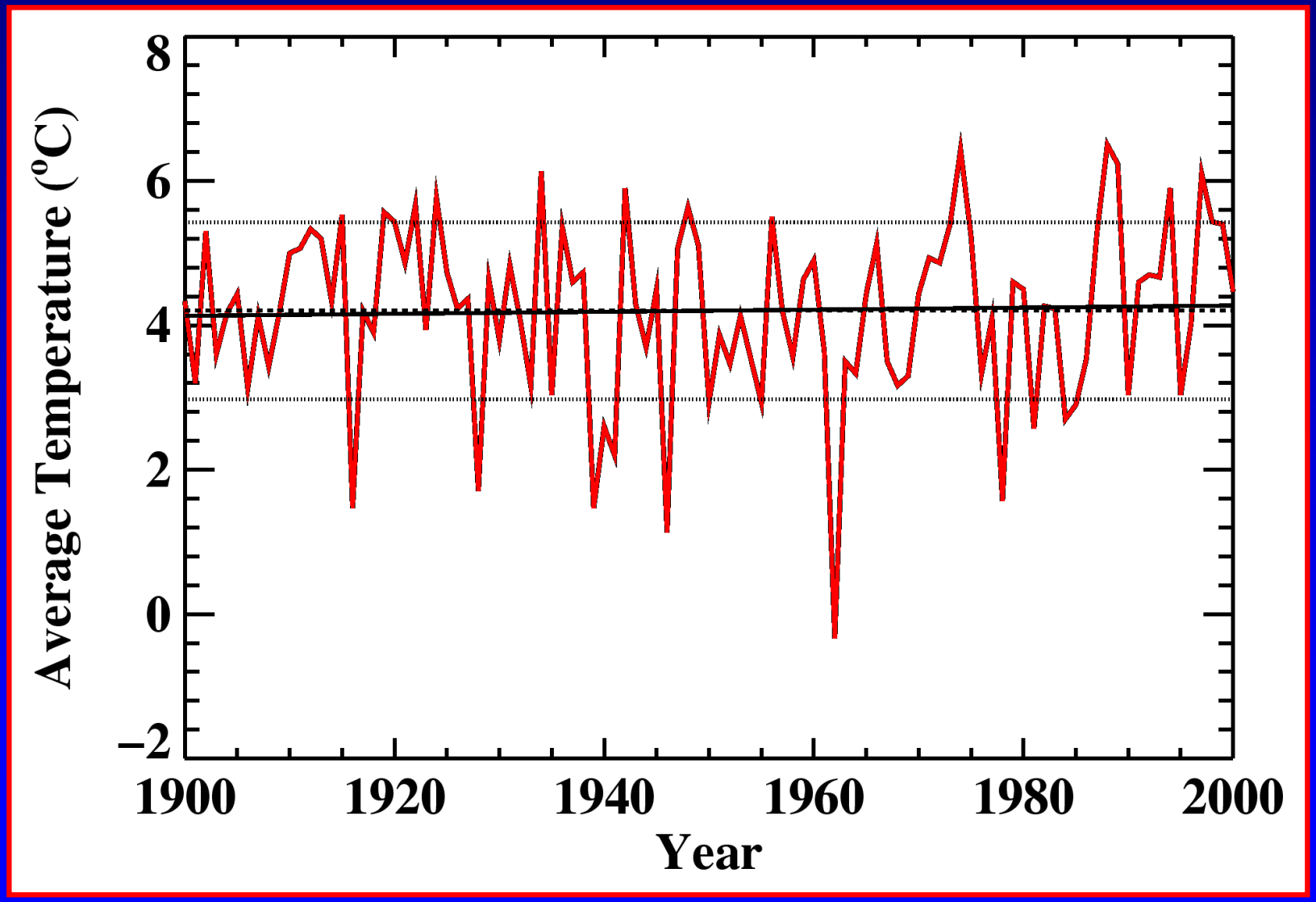
(Courtesy JPL)

- Occurring for >15,000 years
- El Niño = Warm ENSO
  La Niña = Cold ENSO
- 1997/98 major El Niño cost > £20 bn

England and Wales Winter Rainfall 1900/01-2000/01



Central England Winter Temperature 1900/01-2000/01



2. Impacts of Seasonal Weather on Business and Society

Industries Affected

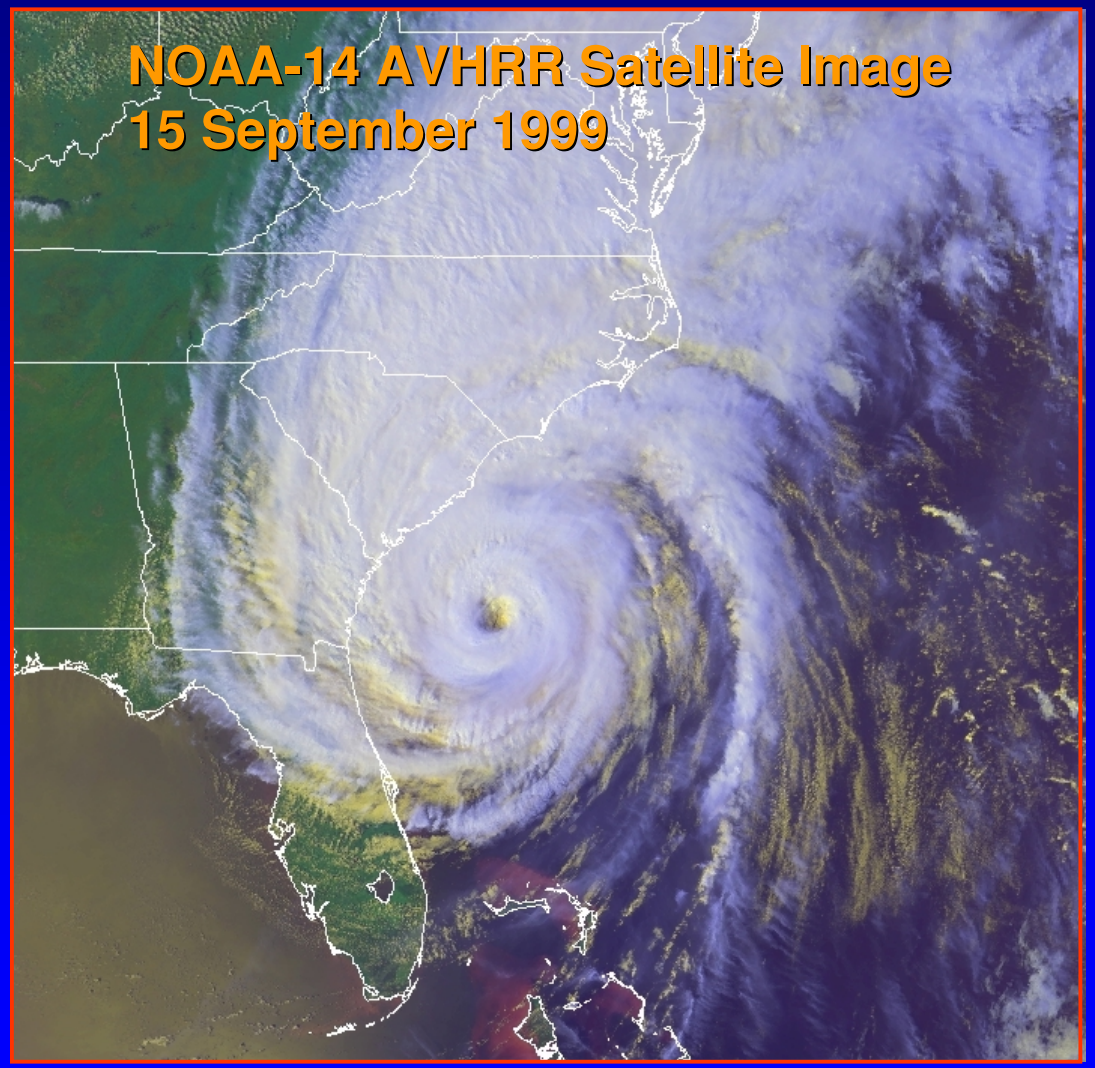
- Anomalous seasonal weather affects the financial performance of 70% of business and industry. Sectors affected include:

  Insurance, power, construction, farming, tourism, retail, manufacturing and travel.

- Anomalous weather also affects our health.

Atlantic Hurricanes

- Rank as the largest cause of US catastrophe loss (£3.5 bn per year 1925-2000)
- Floyd (pictured) had a damage bill of £3.3 billion.



European Winter Storms

- European windstorms caused damages of £1.9 bn per year 1990-1999
- Rank as the 2nd highest cause of global insured losses after US hurricanes

Porthleven, Cornwall: 4 Jan 1998 (Courtesy, Simon Burt)

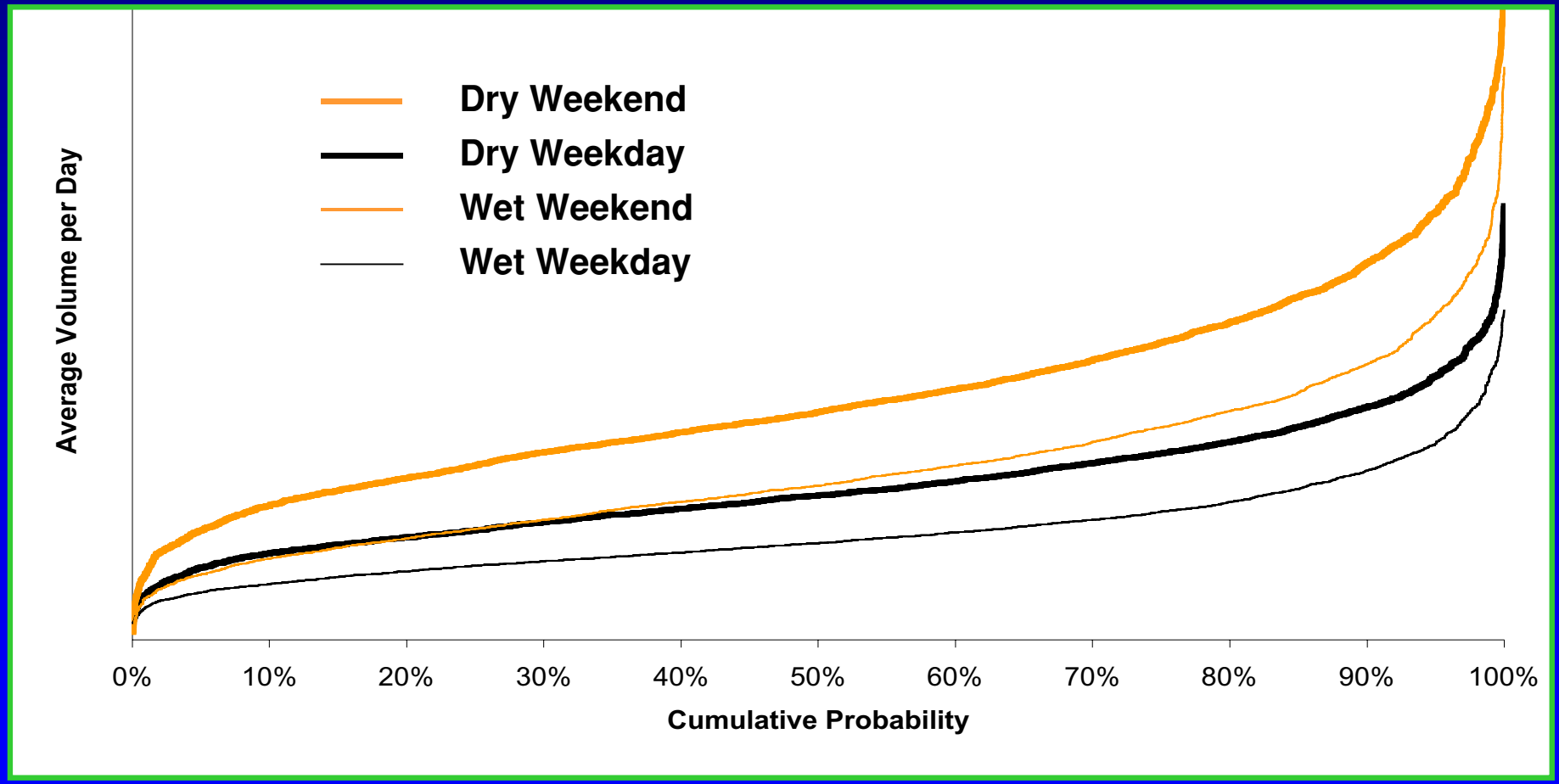
UK Winter Temperature

For each 1°C the mean daily temperature for England and Wales drops below 18°C the National Grid supplies £200,000 worth of additional power.

Scarborough: 9/2/1991 (Image courtesy of "PA" News).

England and Wales Rainfall

Impact on Car Wash Sales



(Figure Courtesy of Lance Garrard, MetRisk)

3. Skill Examples

Methodology

Forecast Models

Statistical principal component analysis of modes of sea surface temperature variability.

'True' hindcast skill for 1986-2000 assessed by constructing models always with prior data.

Leads from 0 to 12 months examined.

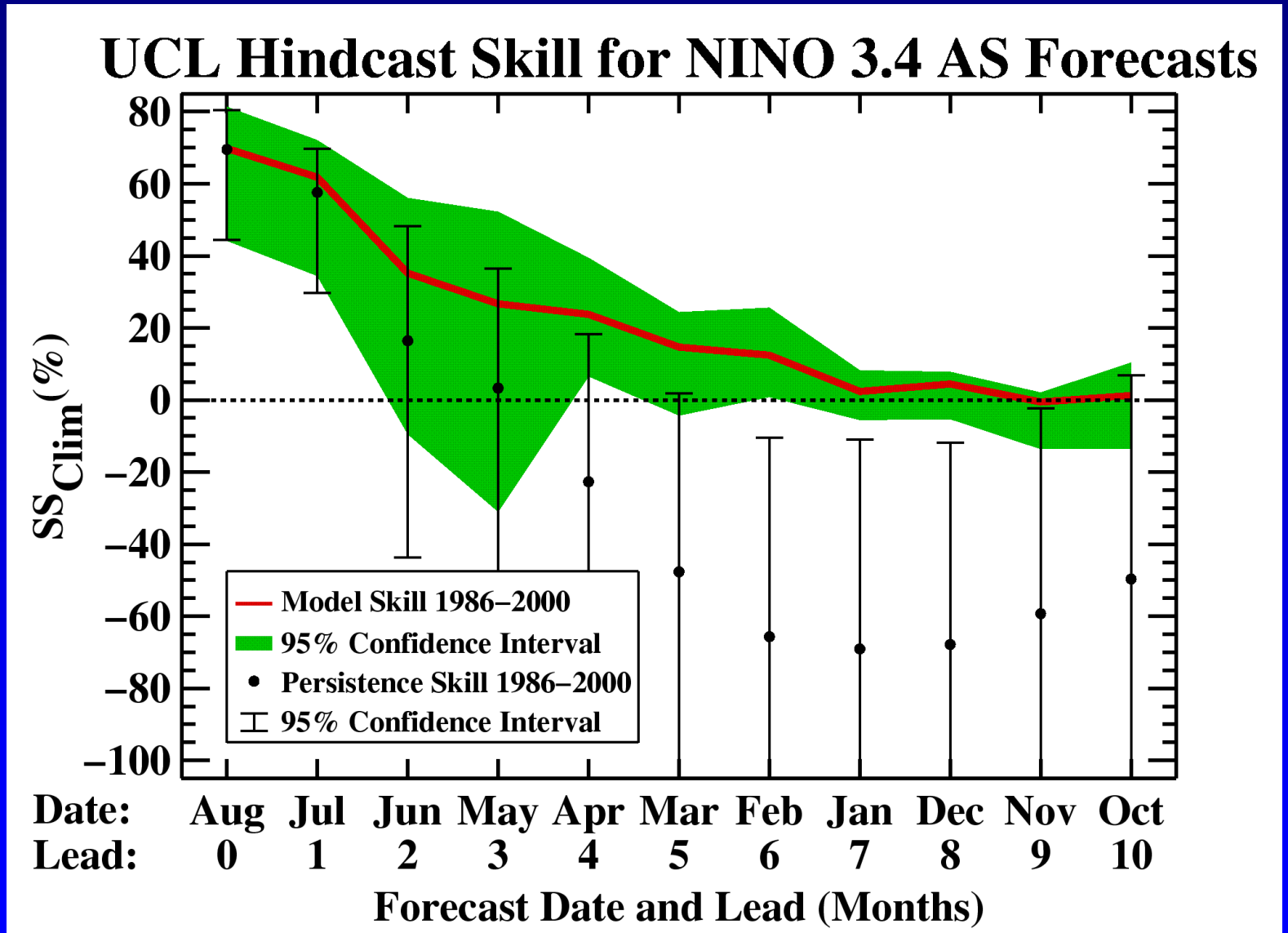
Skill Score and Uncertainty

Employ percentage improvement in RMSE over a climatological forecast (SS_{Clim} (%)):

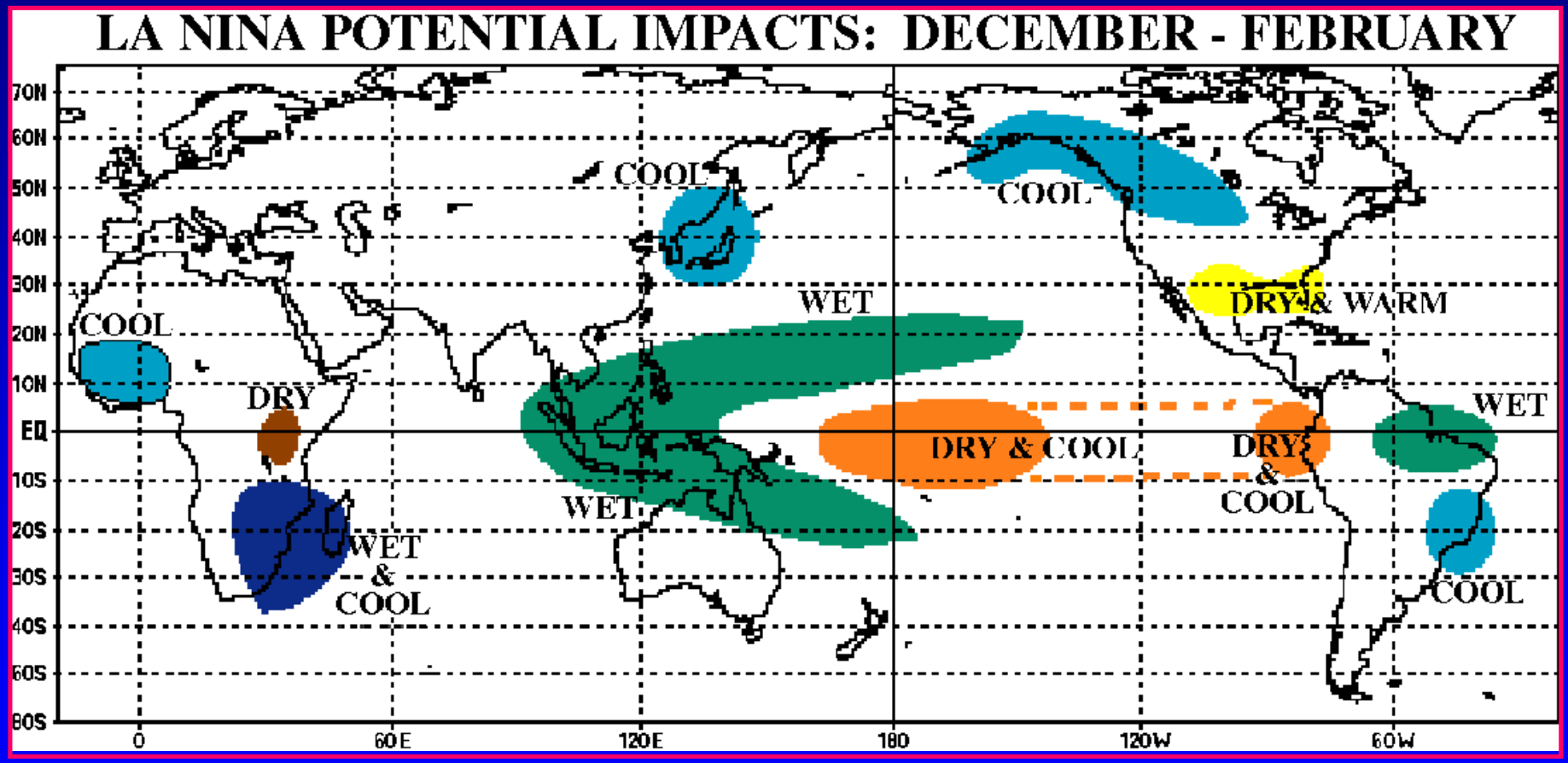
$$SS_{Clim} = (1 - RMSE_{Fore}/RMSE_{Clim}) \times 100$$

Compute 95% confidence intervals on skill using the bootstrap method.

ENSO Forecast Skill for AS

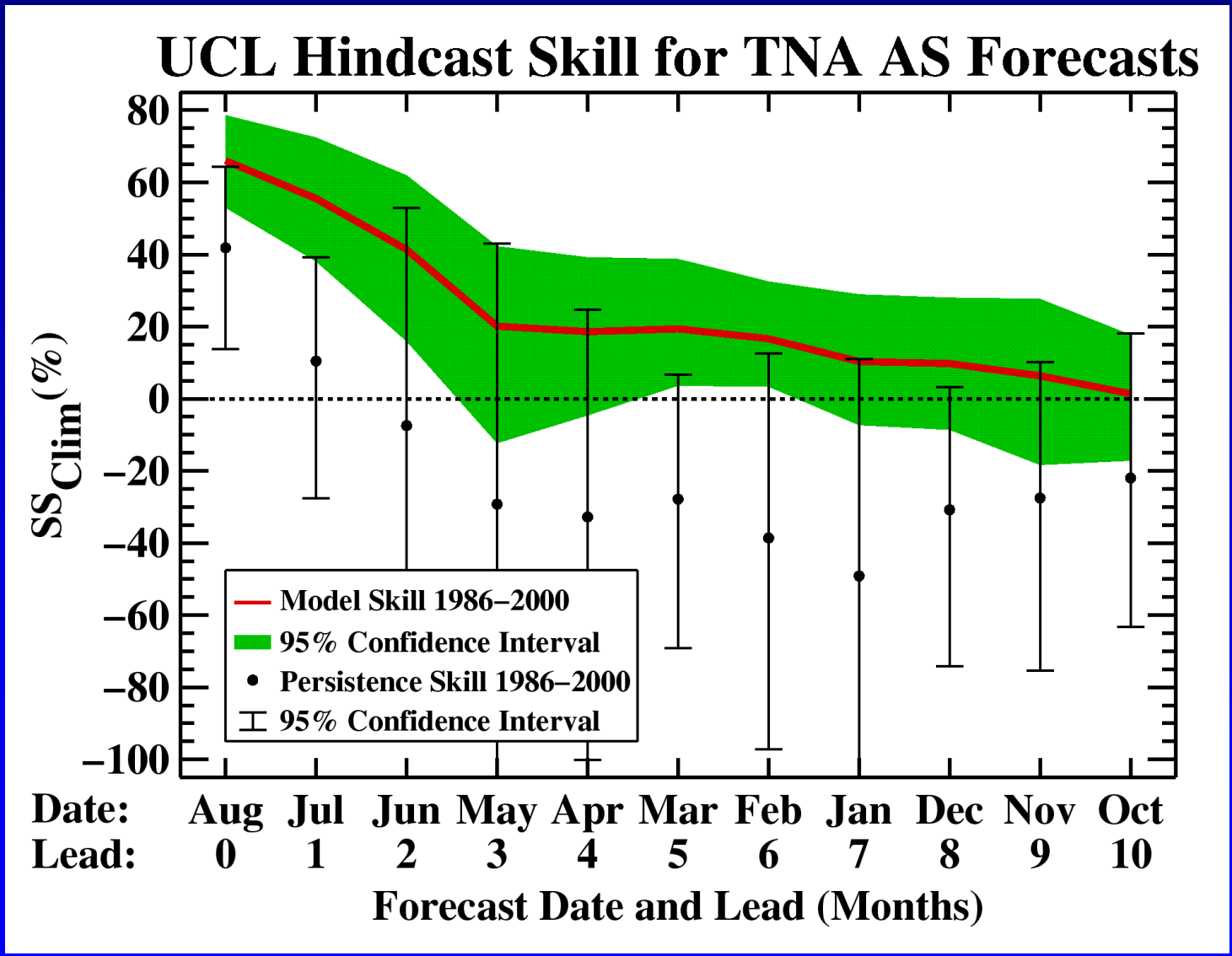


La Niña Impacts

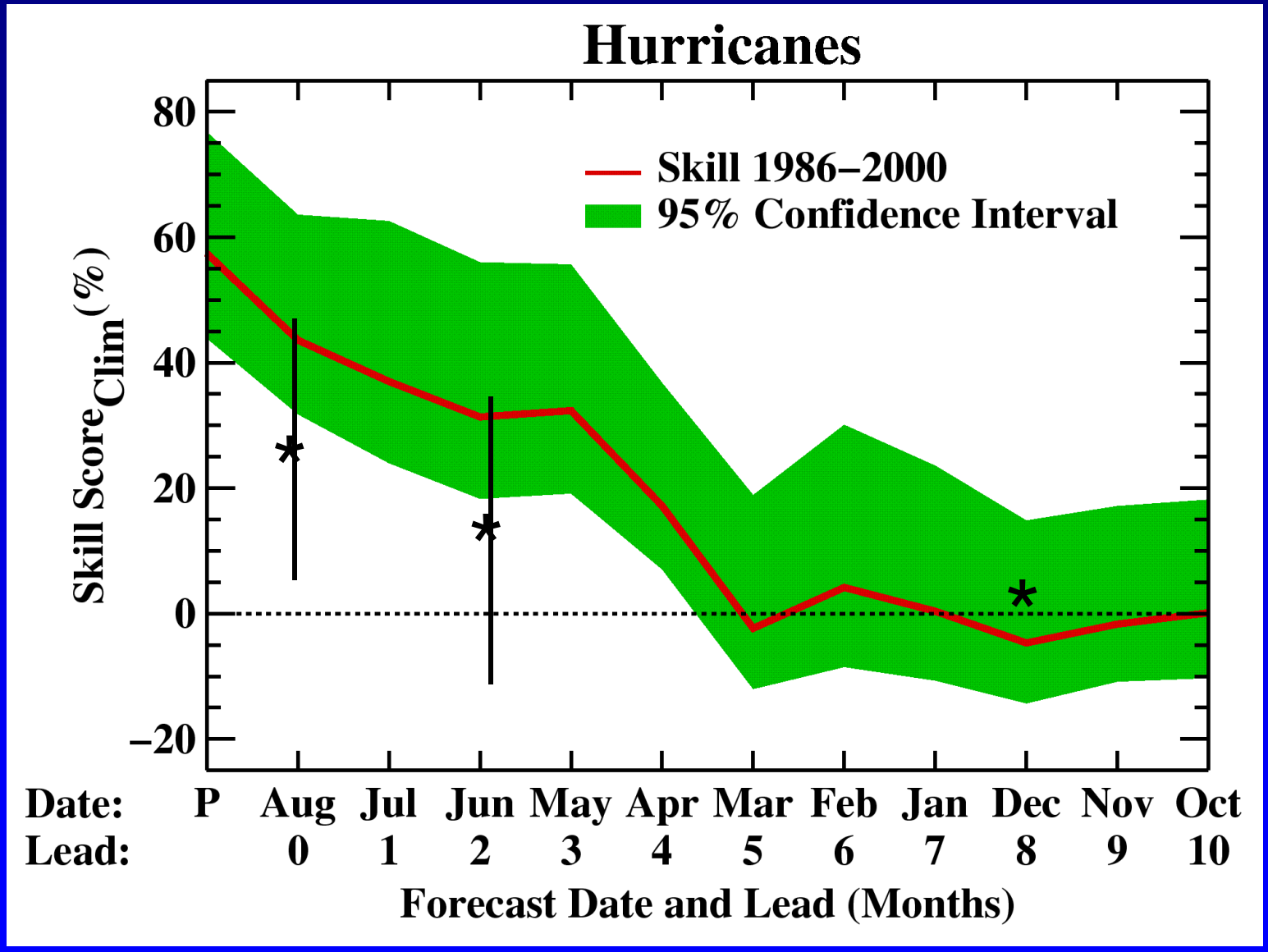


(Image Courtesy, NOAA)

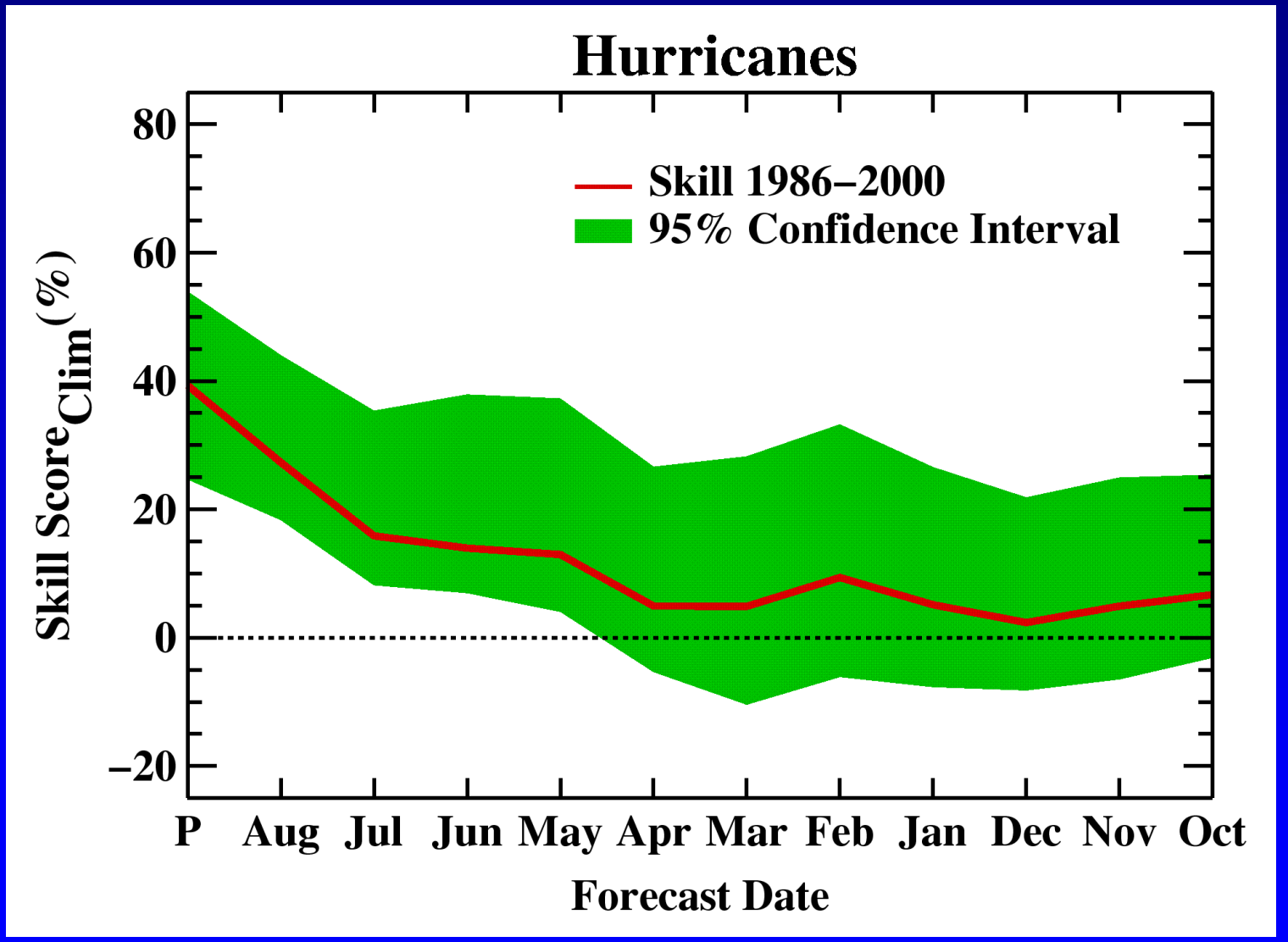
Tropical North Atlantic Forecast Skill for AS



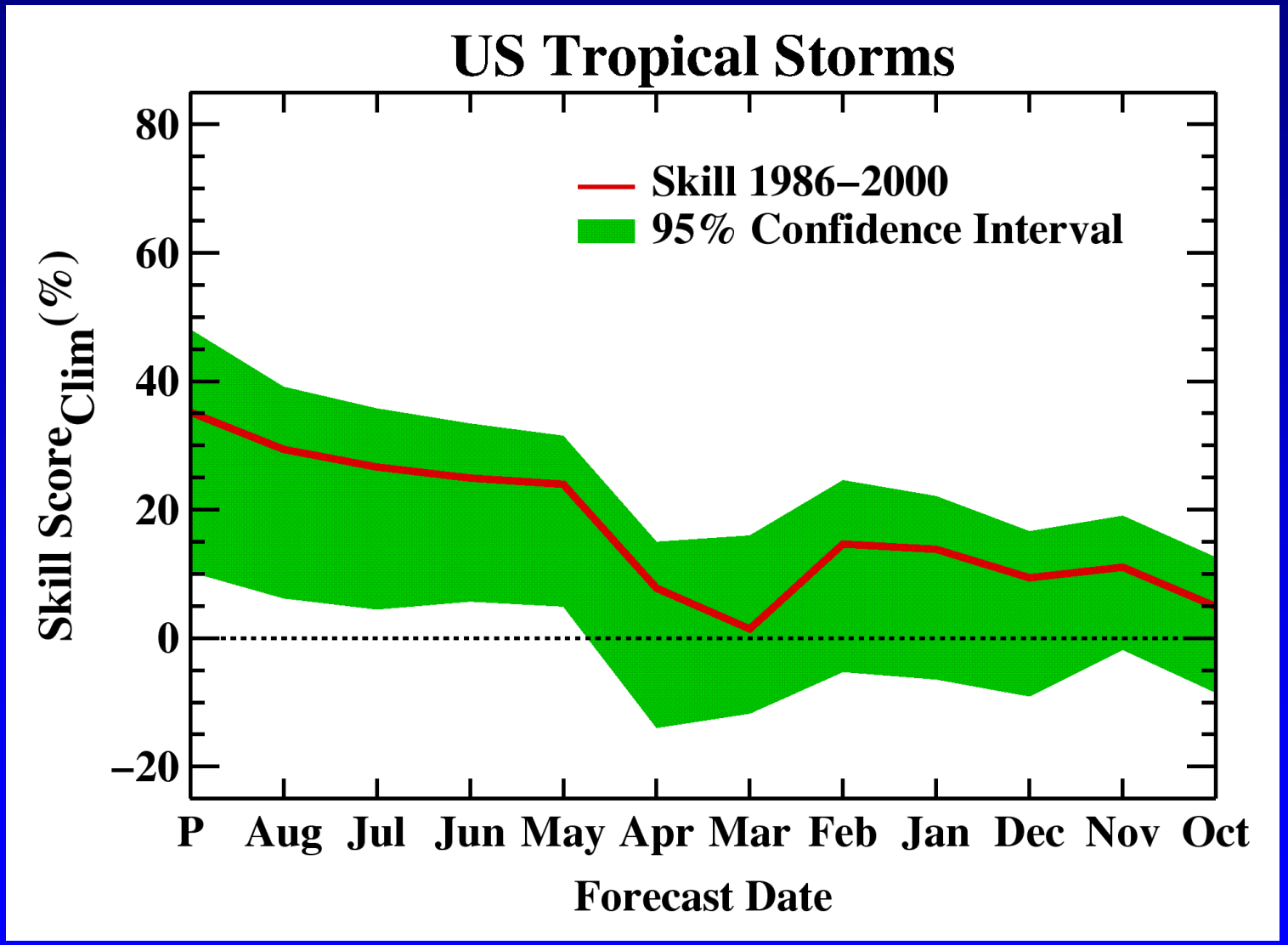
Hurricane Seasonal Skill



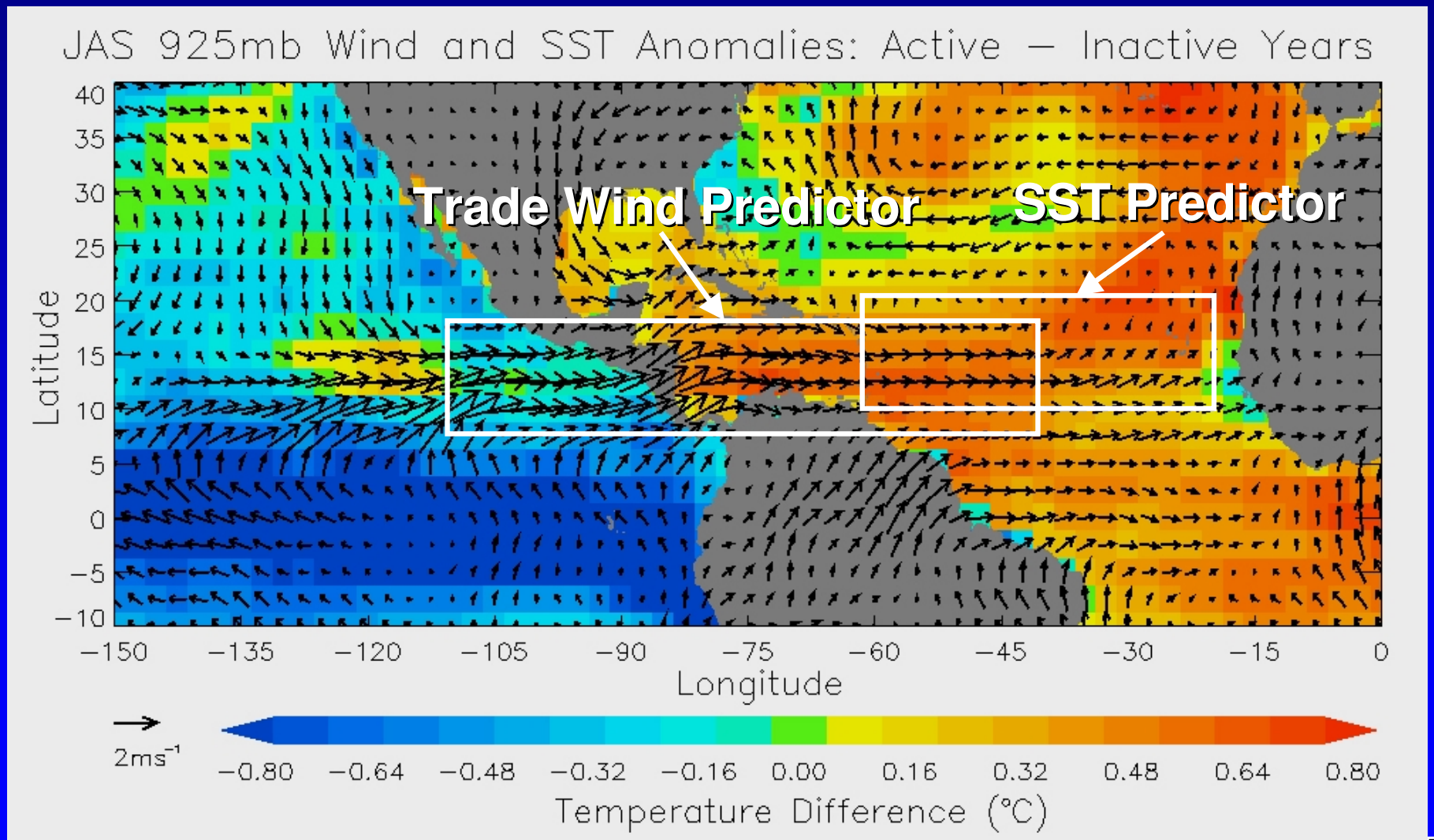
Lesser Antilles Strikes



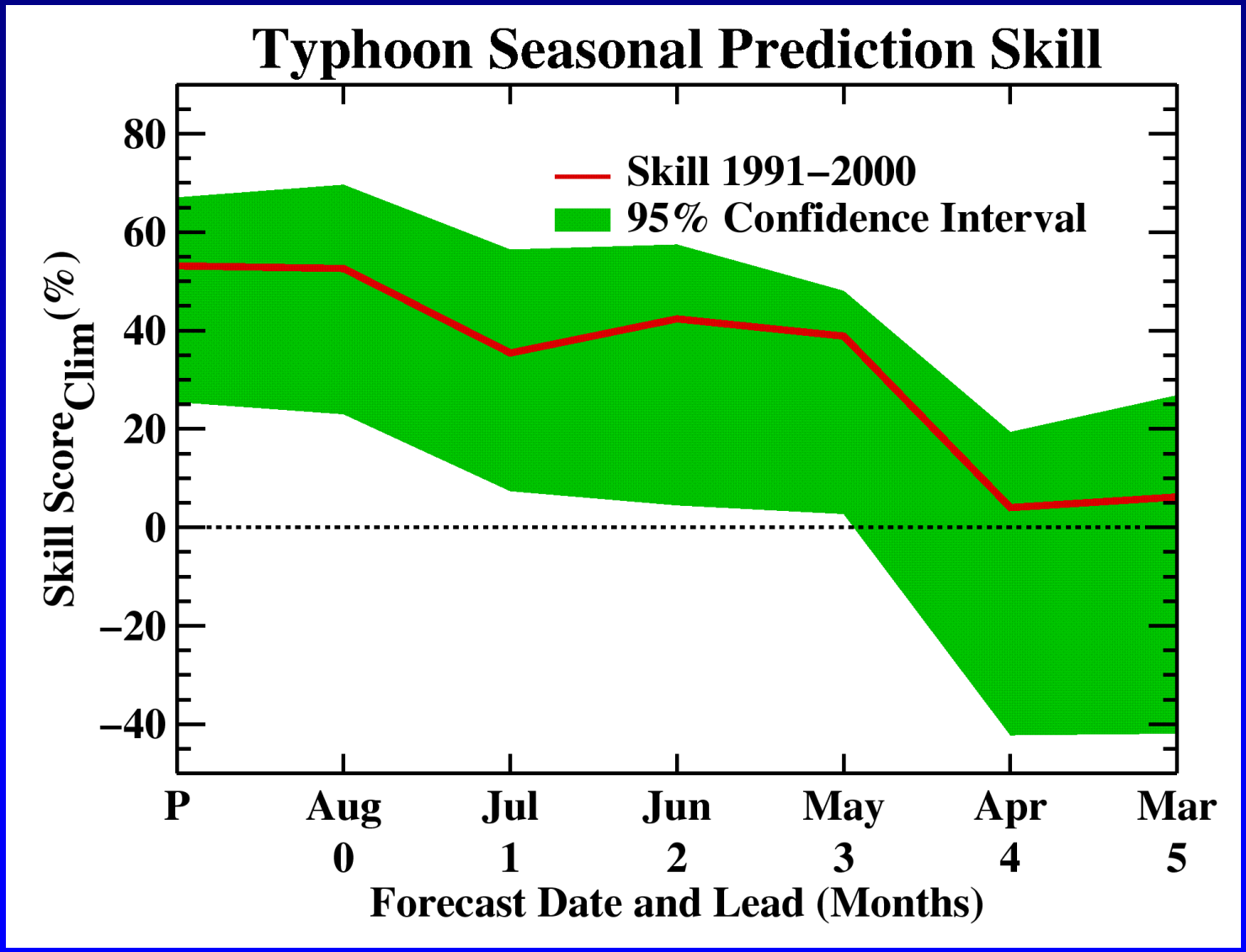
USA Strikes


US Tropical Storms
Skill 1986–2000
95% Confidence Interval
Skill Score Clim (%)
80
60
40
20
0
–20
P
Aug
Jul
Jun
May
Apr
Mar
Feb
Jan
Dec
Nov
Oct
Forecast Date

Key Factors Behind Atlantic Hurricane Activity



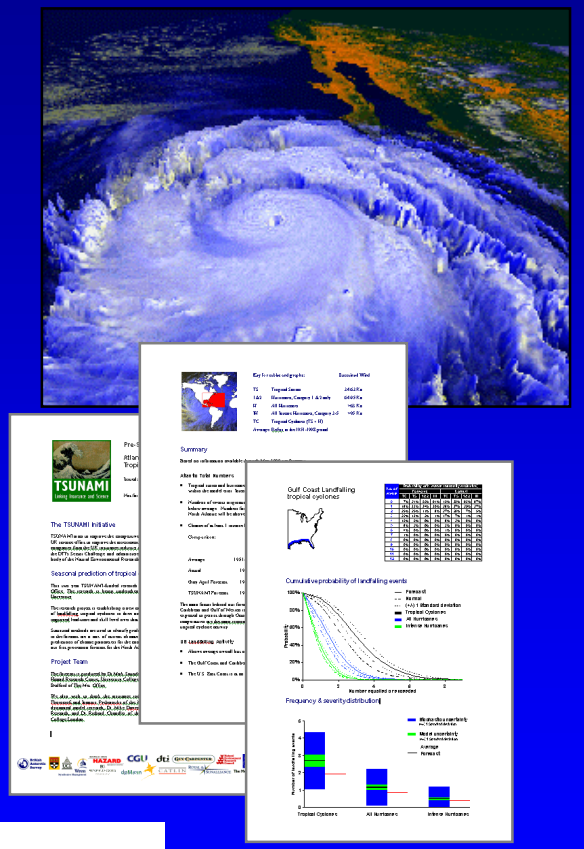
Seasonal Typhoon Activity Skill vs Lead Time



Tropical Storm Risk (TSR)

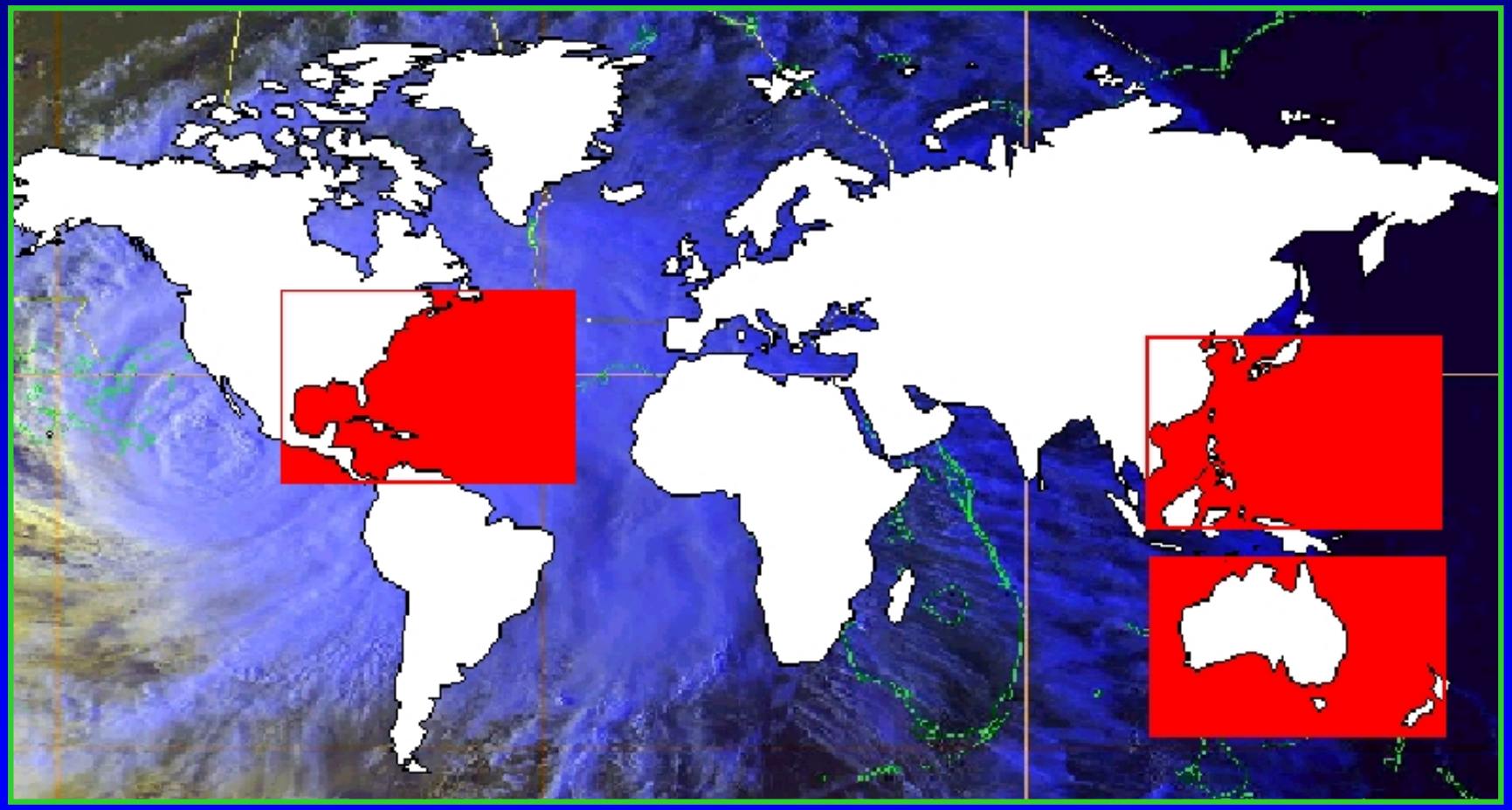
"Seasonal Prediction of Tropical Cyclones"

- Three ocean basins
- New statistical and dynamical model techniques
- Land-falling tropical cyclones
- Useful lead time
- Increase skill level
- Frequency and severity
- Spatial results



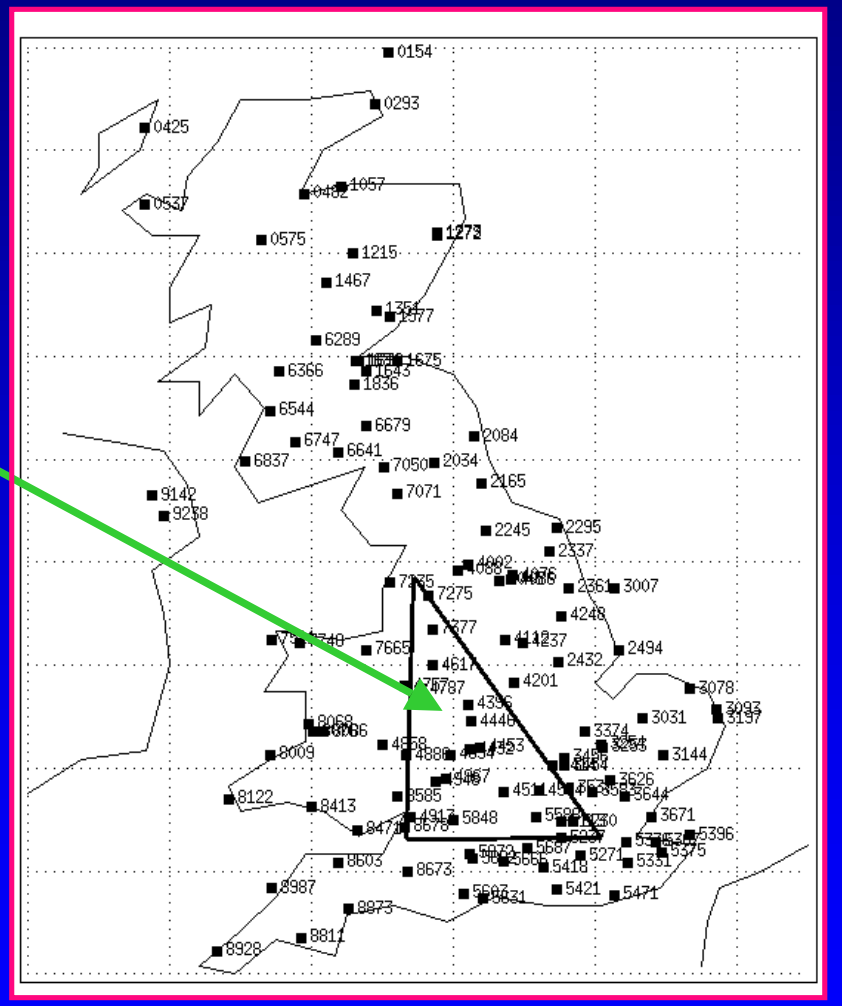
UCL BENFIELD GREIG HAZARD RESEARCH CENTRE · Met Office · BG BENFIELD GREIG GROUP PLC · ROYAL & SUNALLIANCE CGNU

Basins Under Research by TSR



Central England Temperature

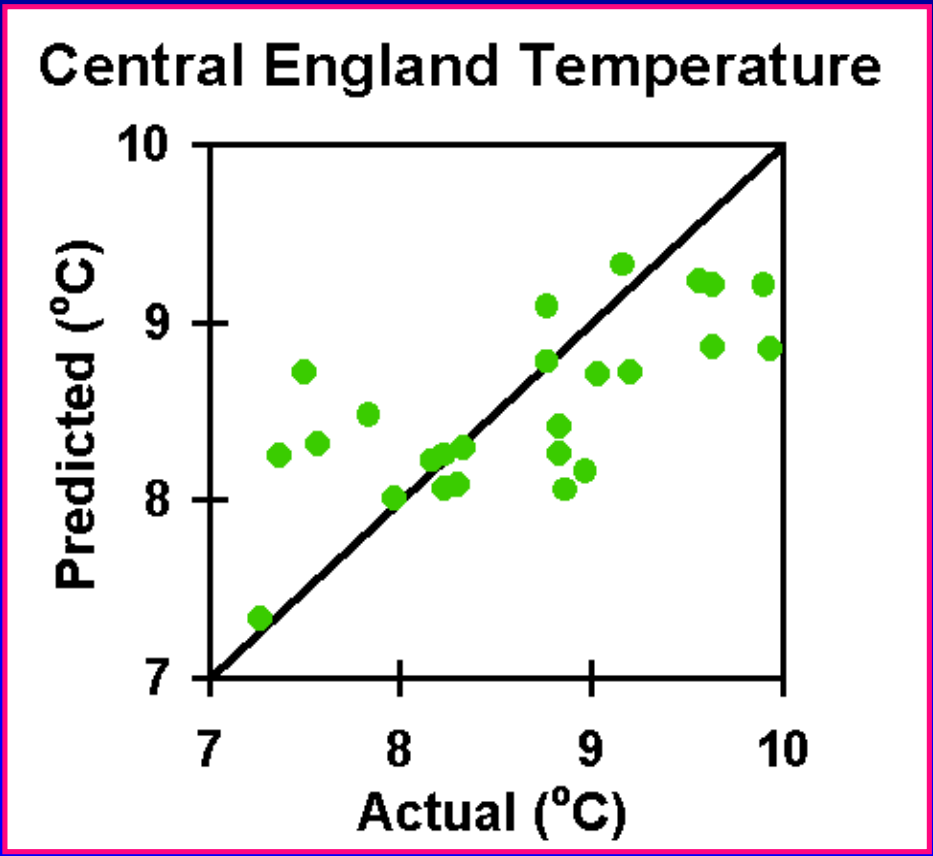
Central England Temperature (*Monthly Time Series from 1665*)



Central England Temperature Seasonal Forecast for MAM 2001

Forecast Verification		
	Period	CET (°C)
Forecast (± SD)	MAM 2001	8.59 ± 0.56
Actual	MAM 2001	8.50
Average (± SD)	MAM 1971-2000	8.55 ± 0.78

Scatter Plot and Skill of MAM CET Hindcasts 1976-2000



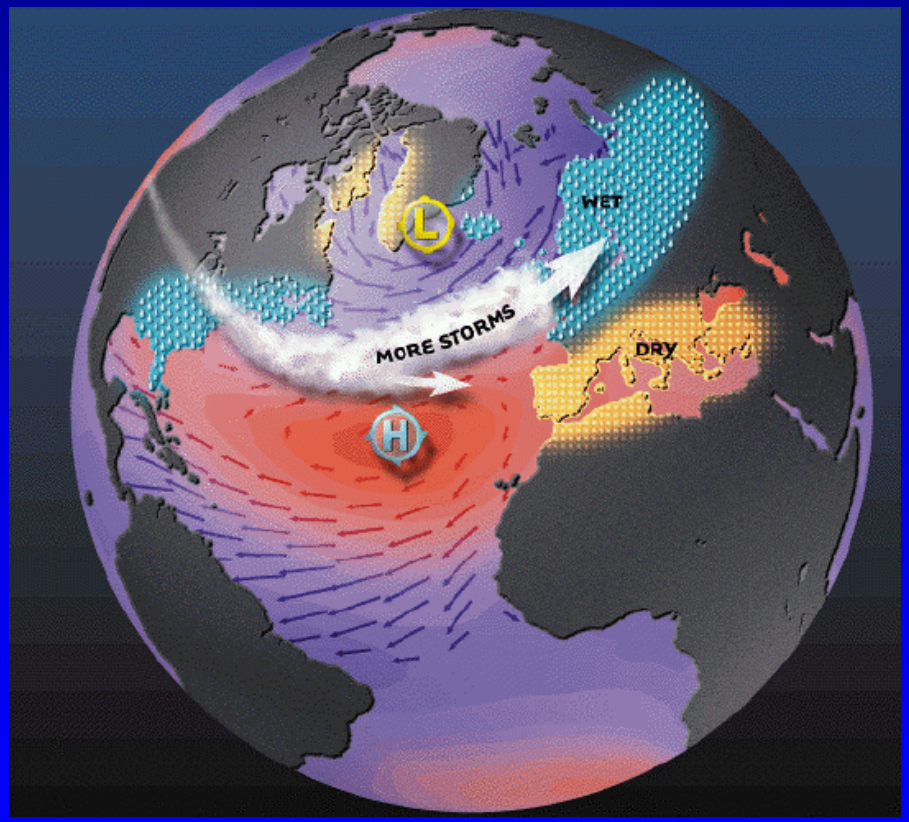
MAM CET Model Skill 1976-2000

$PRMSE_{CL}$	32%
$PMAE_{CL}$	35%
PVE	48%

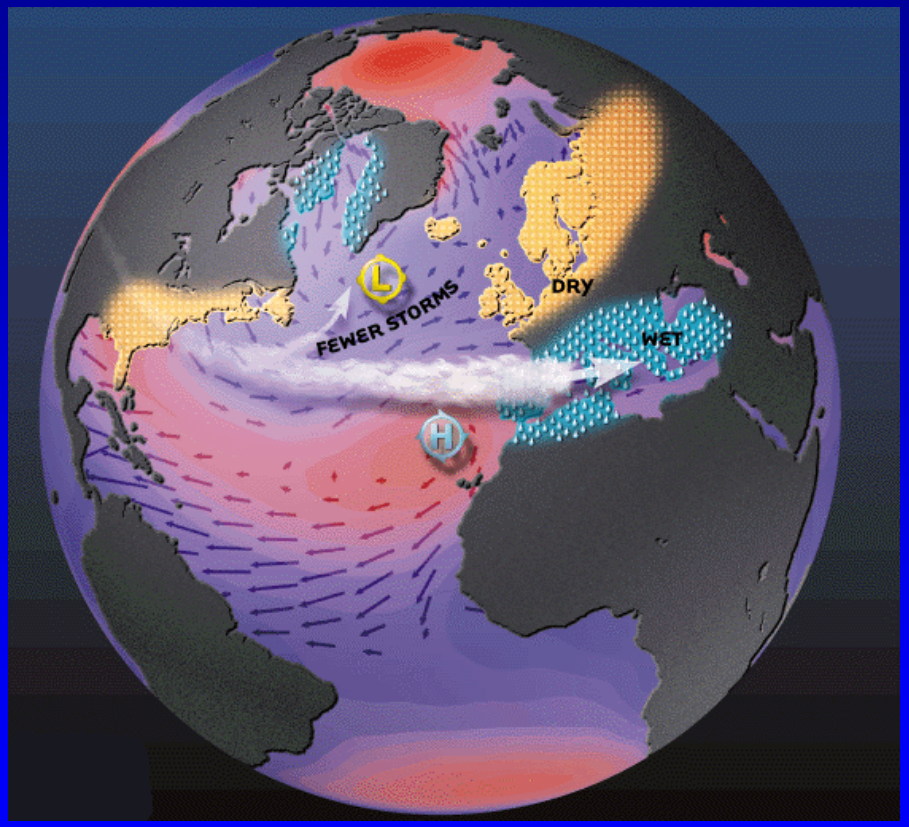
4. Winter 2001/02 Seasonal Forecast

North Atlantic Oscillation

+ve NAO

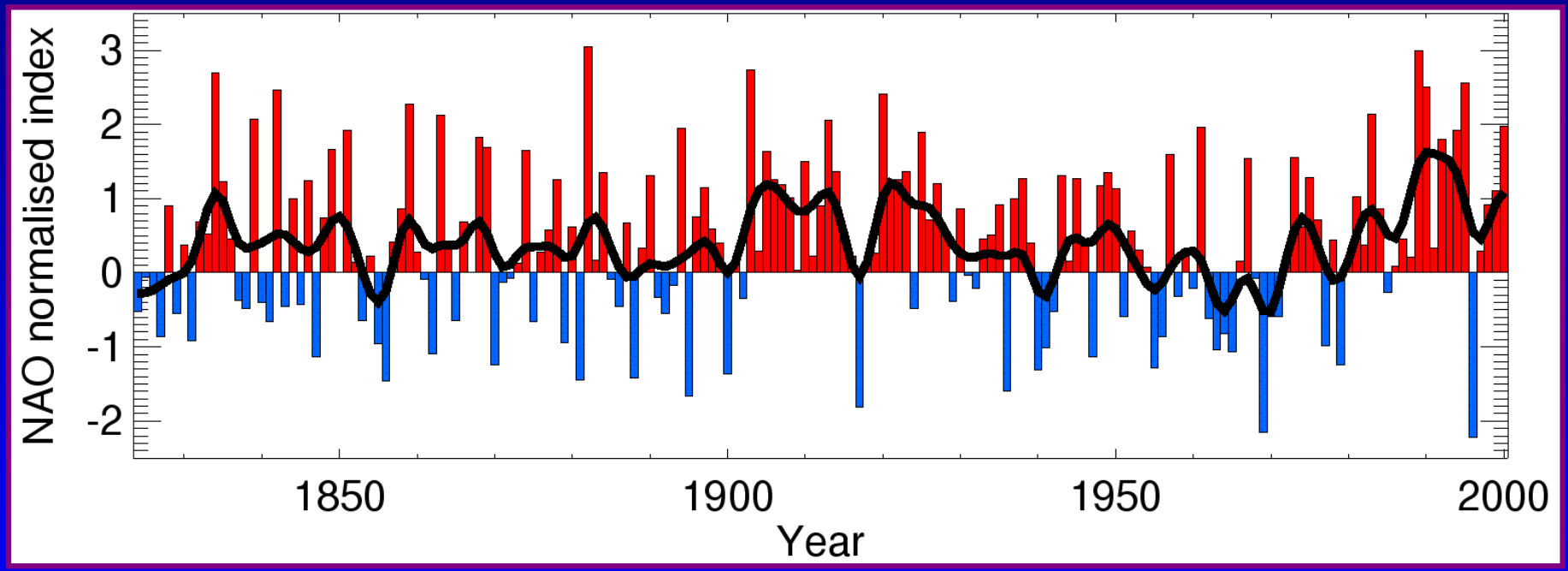


-ve NAO



(Figures Courtesy of Martin Visbeck, Columbia University)

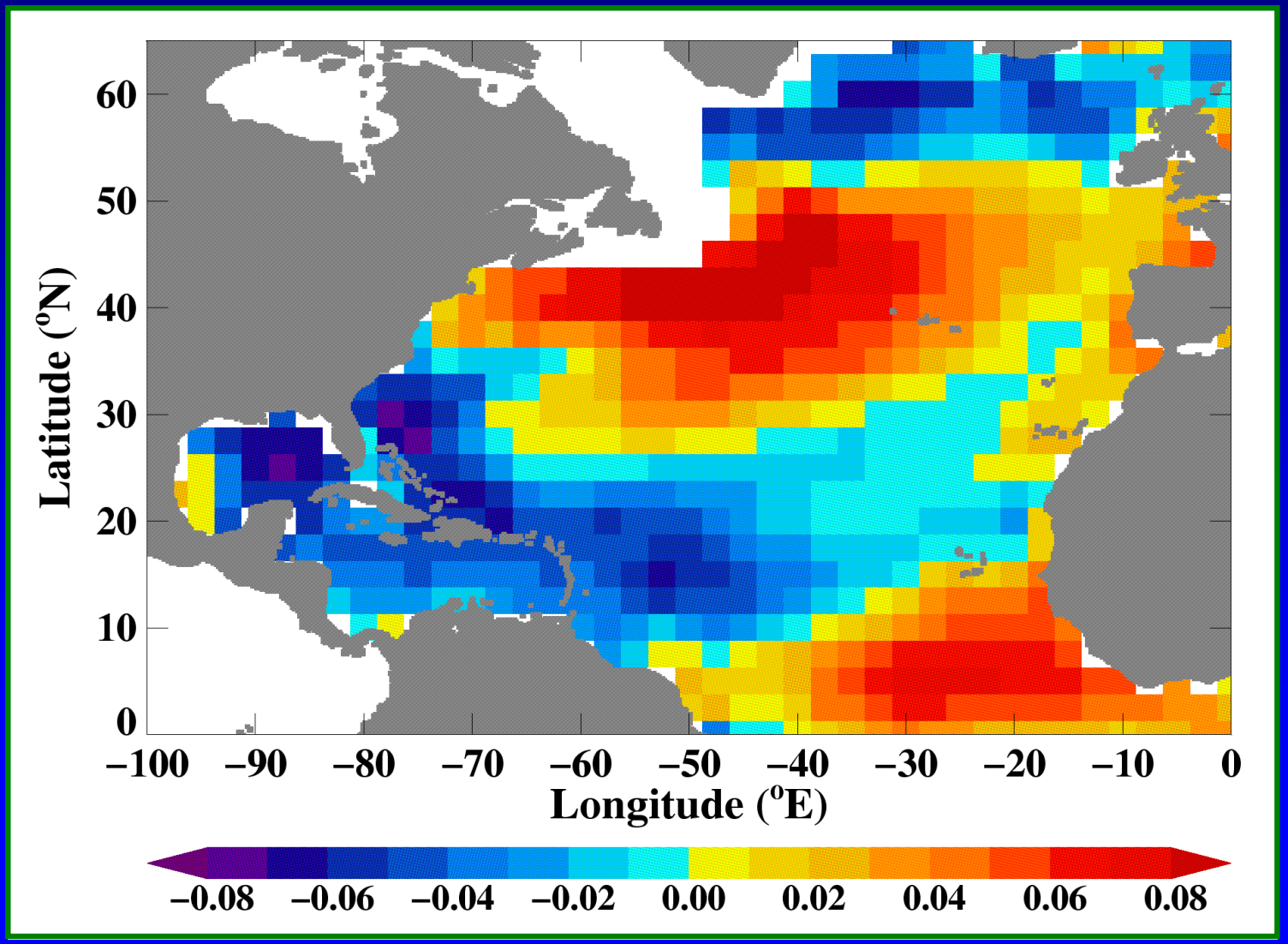
NAO Winter Index 1825-2000



(Figure Courtesy of Tim Osborn, University of East Anglia)

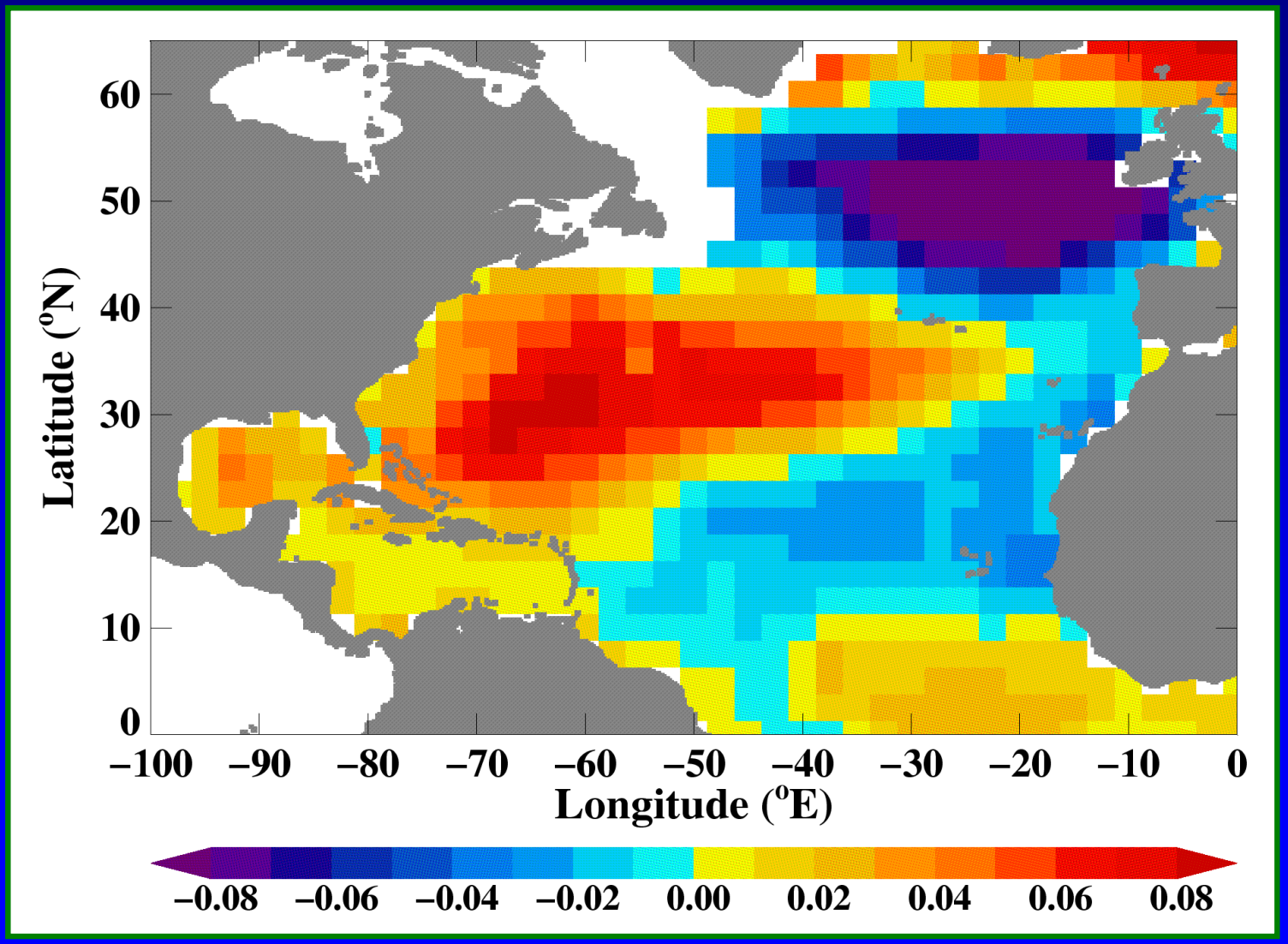
Predictor Mode 1 (PC2)

r (SST PC2, NAO, n=51) = 0.43

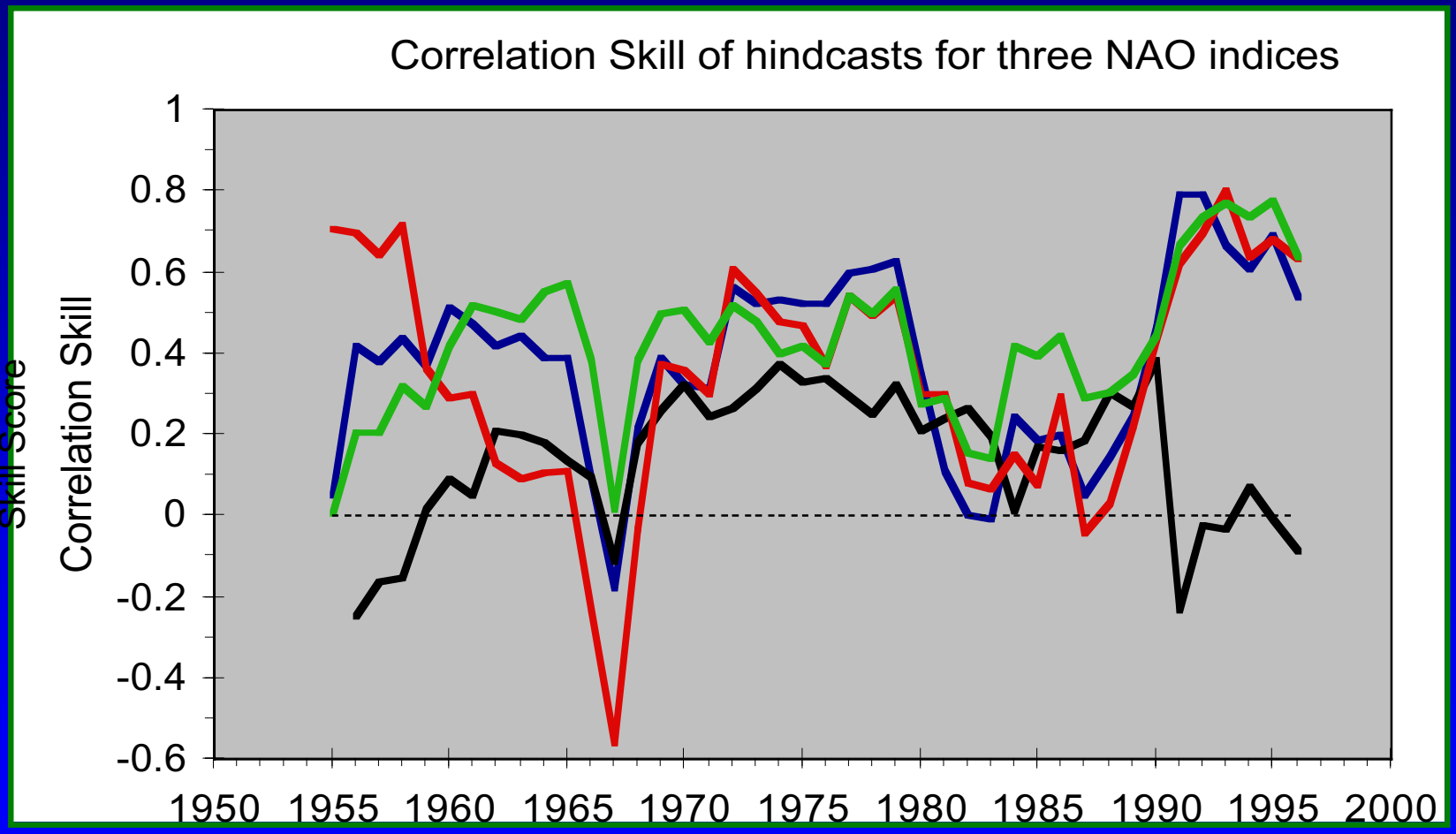


Predictor Mode 2 (PC5)

r (SST PC5, NAO, n=51) = 0.38



Seasonal NAO Predictability 1950/1 -2000/01



Seasonal NAO Predictability 1986/7 -2000/1

Correlation Skill for Independent Forecasts

	CRU NAO	CPC NAO	MSLP NAO
October	0.51	0.65	0.57
November	0.52	0.69	0.48

Winter 2001/02 NAO Forecast

CRU NAO Index = 0.7 +/- 1.0

Thus the coming winter is expected to be a neutral NAO winter with temperature and rainfall close to the last 10-year average.

Conclusions

- Seasonal climate prediction is an innovation in meteorology.
- Forecast skill is already significant at leads of a few months.
- There are sound grounds for expecting this skill will improve with further research.
- With the earnings of 70% of industry sensitive to seasonal weather, business executives will be well advised to monitor developments in seasonal forecasting over the next few years.