TYPHOONS IN ASIA - FORECASTING AND TRENDS

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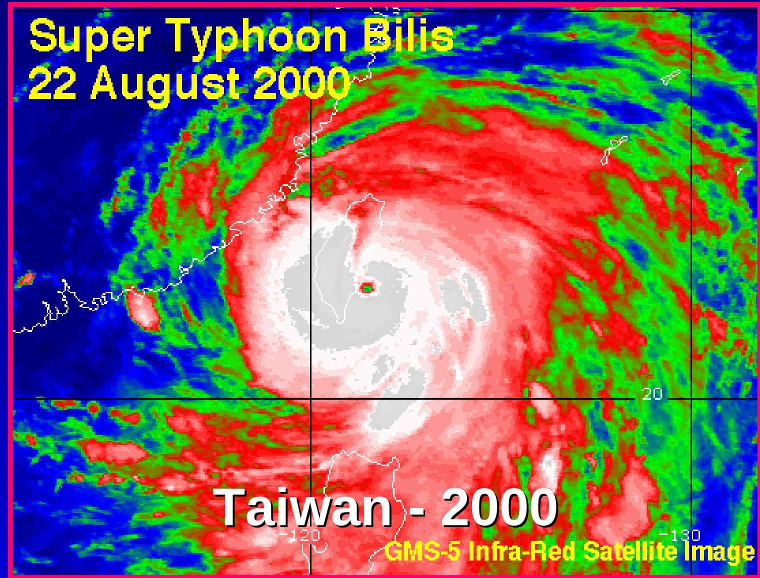
BENFIELD GREIG HAZARD RESEARCH CENTRE

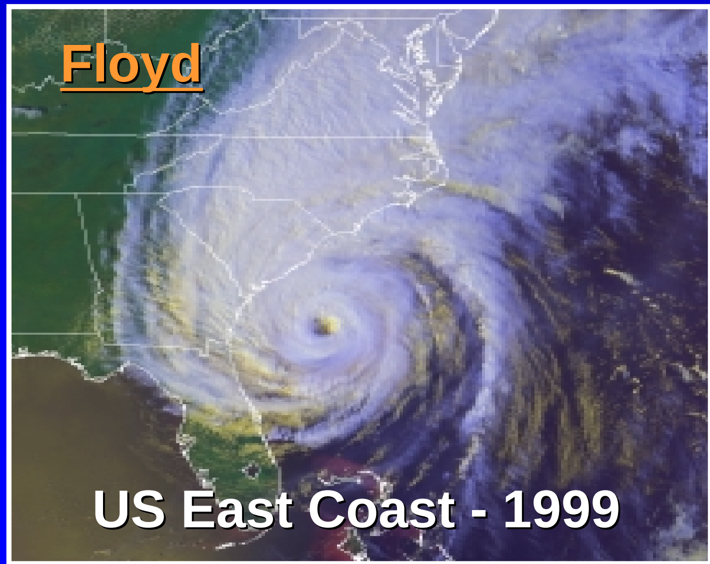
Tropical Cyclone Impacts

- **Asia.** Rank as the **most costly and deadly natural disaster** affecting much of Japan, South Korea, Taiwan, the Philippines, and coastal areas in other SE Asian countries.
- **USA and Caribbean.** Rank as the United States' **costliest natural disaster.**
- **Australia and SW Pacific.** Rank as a significant cause of natural disaster loss.

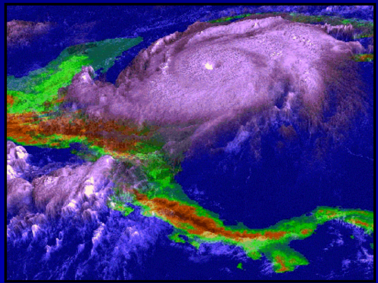
Loss and Fatality Rates

- **Asia.** **Typhoon annual damage bill (1990-1999) is US $3.3Bn. (at 2000 $).**
- **Asia.** **Typhoon annual fatality rate is 740 deaths (1990-1999).**
- **USA.** **Hurricane annual damage bill 1925-2000 is estimated as US $ 5.1Bn (at 2000 $).**





Relevance to the Insurance Industry



- **Tropical cyclones cause 30% of global insurance losses.**
- **1991 Typhoon Mireille (Japan) caused US $7.1Bn insured damage.**
- **1999 Typhoon Bart (Japan) caused US $4.2Bn insured damage.**
- **1992 Hurricane Andrew cost insurers US $18Bn and bankrupted more than 10 insurers.**
- **1926 Miami Hurricane would cost US $80Bn today.**

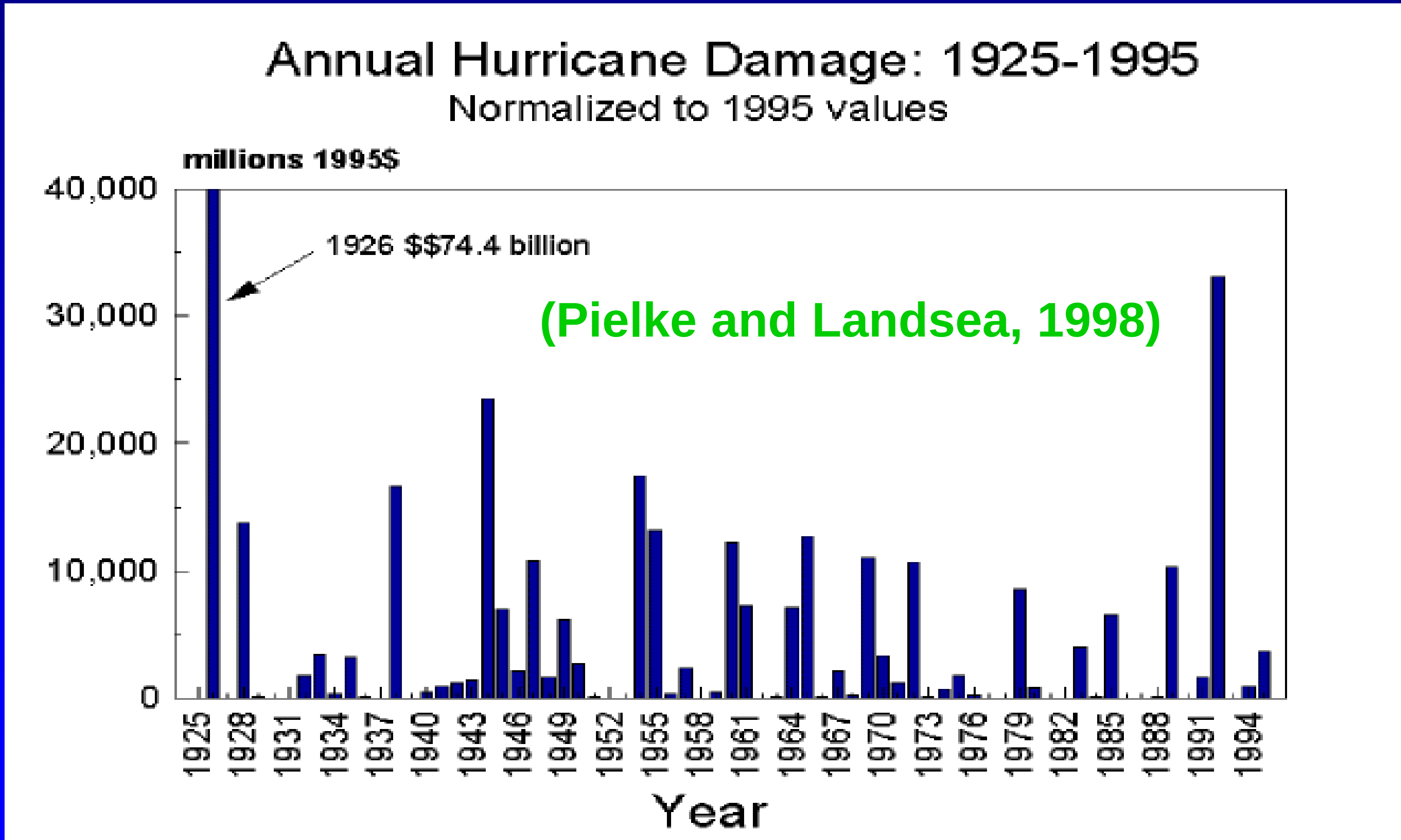
Why Forecast Tropical Cyclones?

Because……..

1 **Substantial Interannual Variability Exists in Regional Tropical Cyclone Losses.** **In 1999 and 1997, for example, the US experienced losses of US $ 8.2 Bn and just US $ 0.16 Bn respectively.**

2 **The Impacts of Climate Change are Uncertain.** **With the firm conclusion that global climate change is happening (*Shanghai meeting of the IPCC, 2000*) what resulting trends can we expect in regional tropical cyclone numbers?**

Interannual Variability in Losses



Benefits of Forecasting

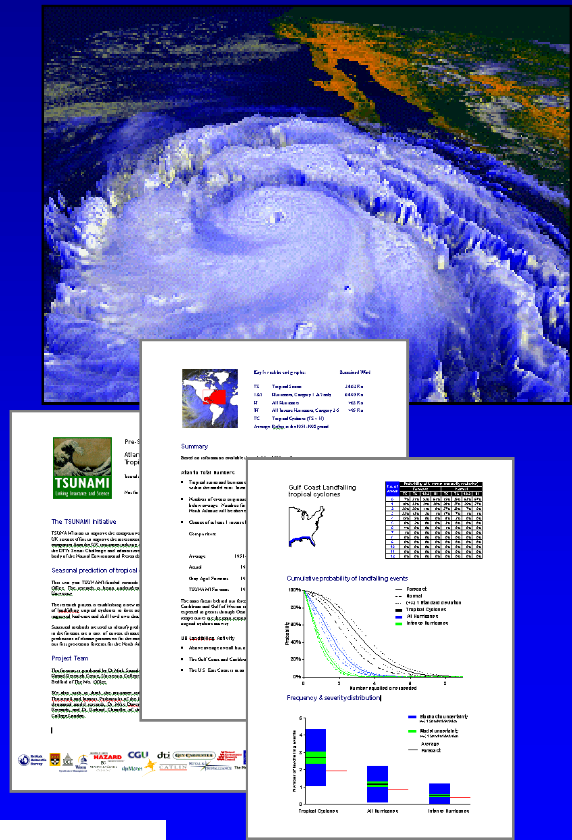
Skilful long-range forecasts of seasonal tropical cyclone strike numbers will benefit society, business and government by……..

Reducing risk, uncertainty and financial volatility inherent to varying active and inactive storm seasons.

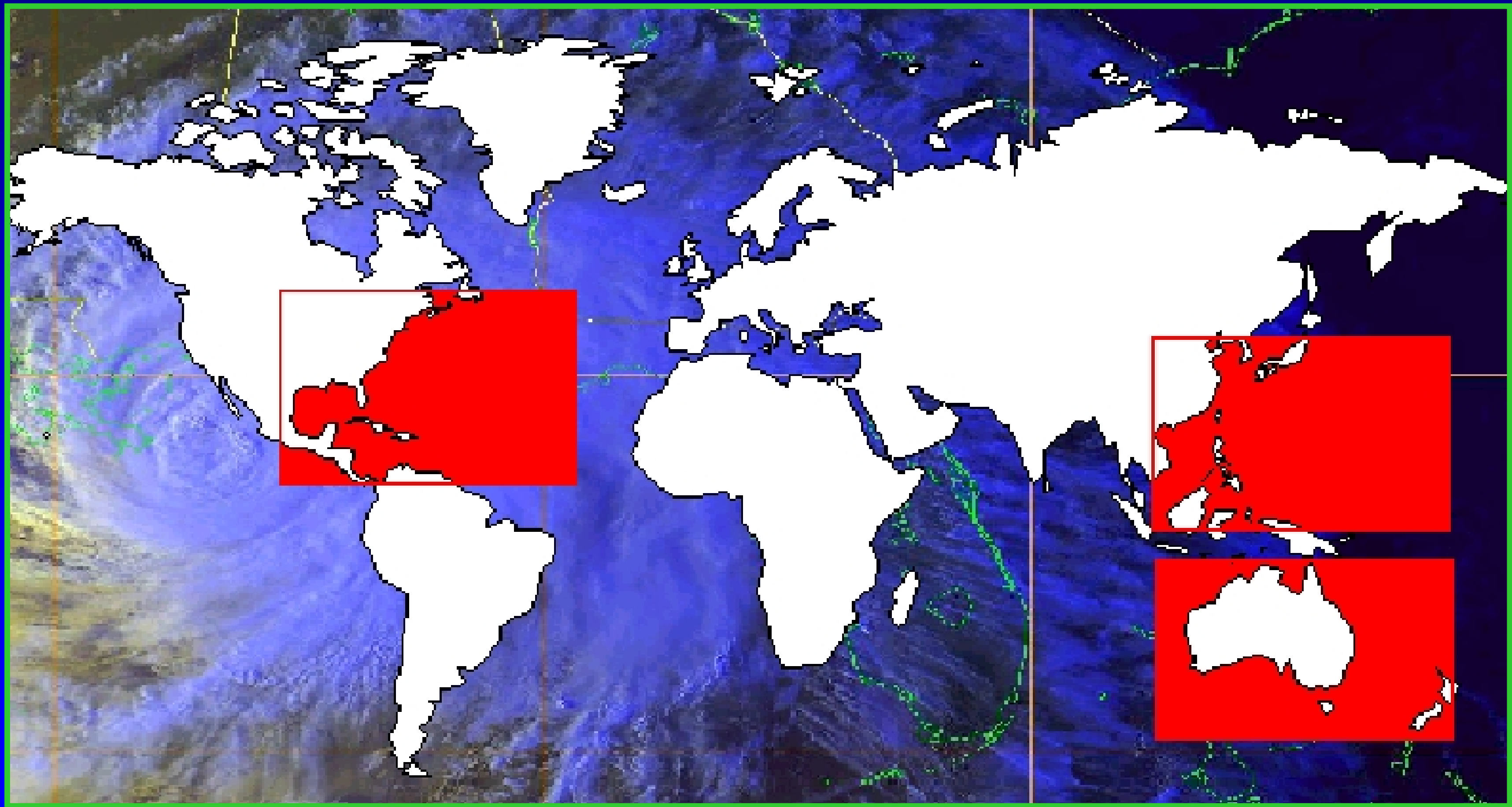
Tropical Storm Risk (TSR)

"Seasonal Prediction of Tropical Cyclones"

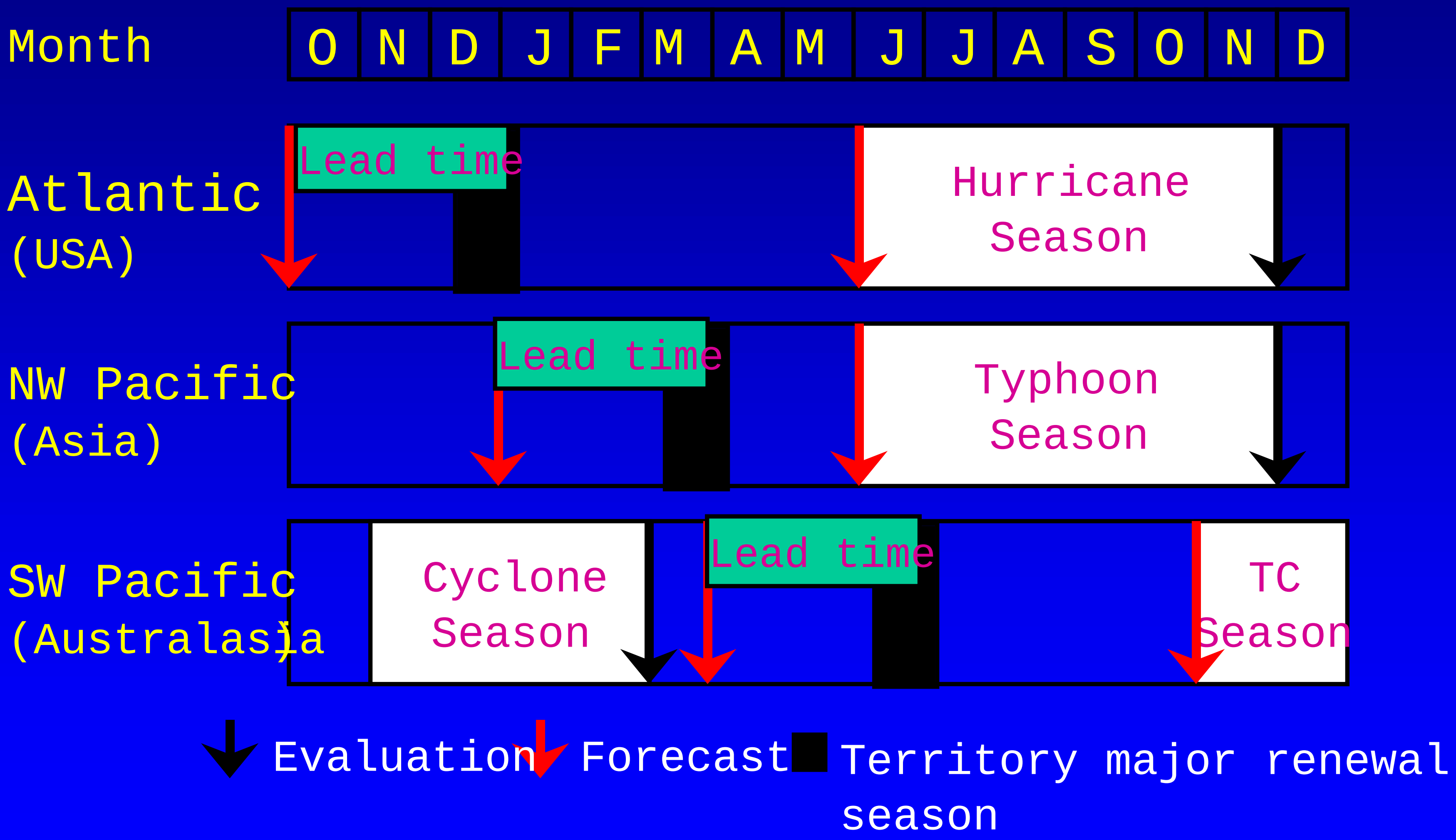
- Three ocean basins
- New statistical and dynamical model techniques
- Land-falling tropical cyclones
- Useful lead time
- Increase skill level
- Frequency and severity
- Spatial results



Basins Under Research by TSR



TSR Public Forecasts



TSR Forecast ‘Firsts’ for Typhoons in Asia

- First ever **extended range forecast** for NW Pacific tropical cyclone activity.
- First ever seasonal forecast for typhoon **strike numbers on Japan**.
- 2000 Japan typhoon strikes (and NW Pacific basin activity) **precisely predicted**.

Typhoon Definitions

Definitions

Tropical Cyclone Type	Category	Peak Sustained Wind (1-min average)		Minimum-Pressure (mb)
		knots	mph	
Tropical Storm	TS	34-63	39-73	-
Typhoon	1	64-82	74-95	>980
Typhoon	2	83-95	96-110	965-980
Typhoon*	3	96-113	111-130	945-965
Typhoon*	4	114-135	131-155	920-945
Super Typhoon*	5	>135	>155	<920

* Denotes Intense Typhoon Strength (Category 3 and Above)

Forecast Verification for 2000

Japan Landfalling Numbers 2000		
	Tropical Storms	Typhoons
Average Number (± SD) (1971-2000)	4.1 (±1.7)	2.5 (±1.5)
Actual Number 2000	4	2
TSR Forecast (± SD) 26 May 2000	3.1 (±1.8)	1.8 (±1.4)

Forecast Verification for 2000

NW Pacific Total Numbers 2000			
	Tropical Storms	Typhoons	Intense Typhoons
Average Number (± SD) (1971-2000)	27.2 (±4.6)	17.0 (±4.1)	8.2 (±3.4)
Actual Number 2000	25	14	7
TSR Forecast (± SD) 26 May 2000	25.3 (±3.2)	14.1 (±2.5)	7.0 (±2.2)
Chan Forecast (± SD) End June 2000	28 (±3)	16 (±2)	-

Extended Range Forecast 2001

Japan Landfalling Numbers - 2001 Forecast		
	Tropical Storms	Typhoons
Average Number (± SD) (1971-2000)	4.1 (±1.7)	2.5 (±1.5)
Actual Number 2000	4	2
TSR Forecast (± SD) 5 February 2001	4.0 (±1.3)	2.5 (±1.3)

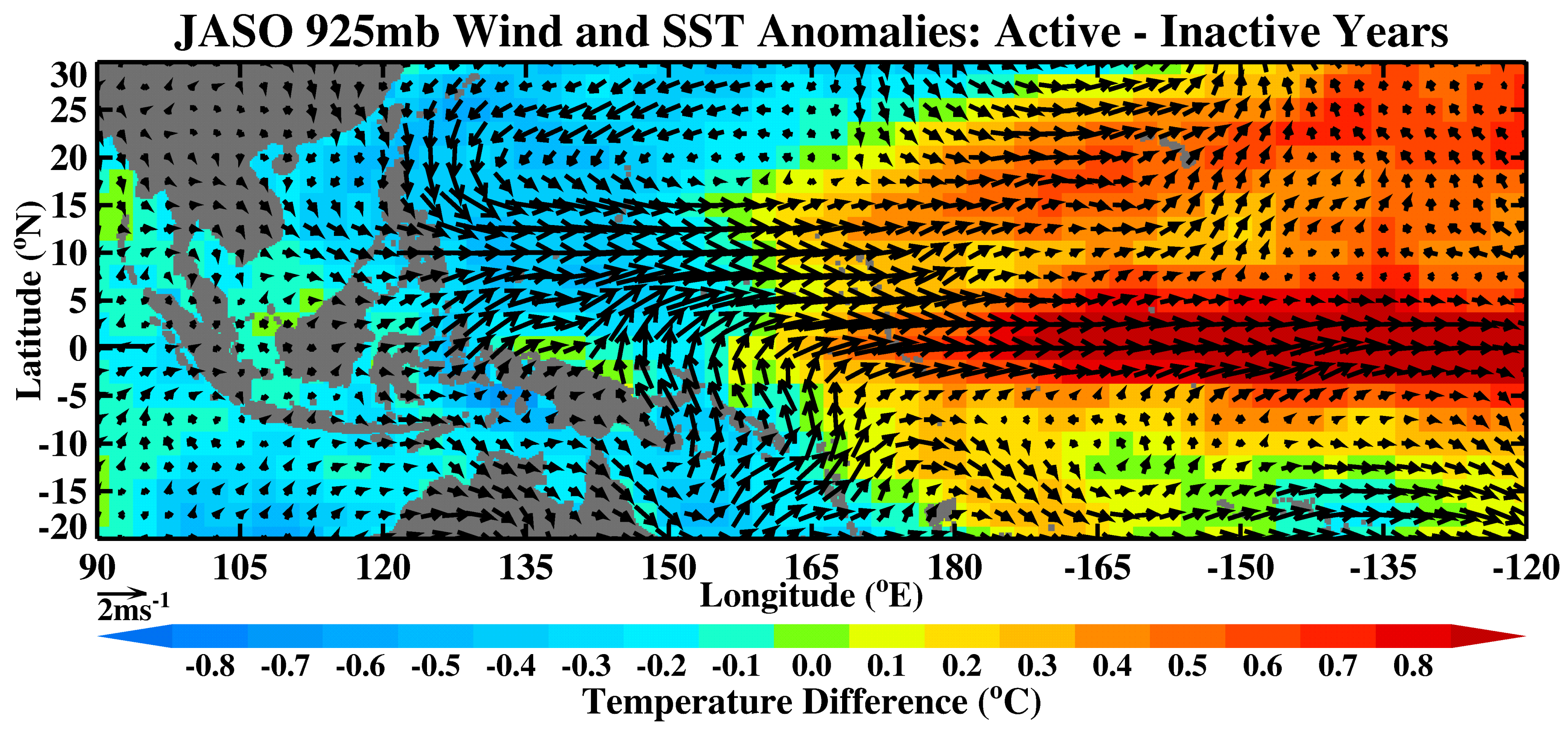
Japanese landfalling tropical storm and typhoon numbers are expected to be average in 2001.

Extended Range Forecast 2001

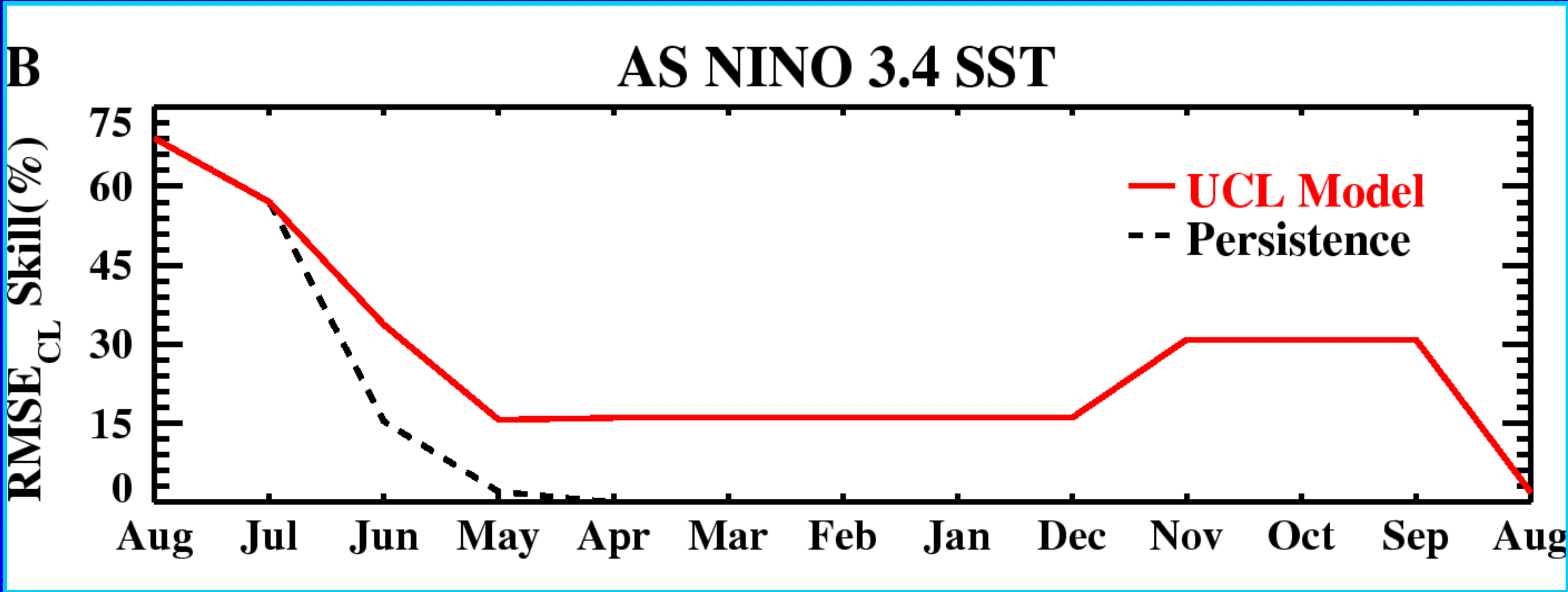
NW Pacific Total Numbers - 2001 Forecast			
	Tropical Storms	Typhoons	Intense Typhoons
Average Number (± SD) (1971-2000)	27.2 (±4.6)	17.0 (±4.1)	8.2 (±3.4)
Actual Number 2000	25	14	7
TSR Forecast (± SD) 5 February 2001	28.1 (±2.9)	16.2 (±2.7)	6.6 (±2.2)

NW Pacific typhoon and intense typhoon numbers are expected to be slightly below average in 2001.

Key Factors Behind NW Pacific Typhoon Activity



TSR Forecast Skill 1986-2000 for Summer ENSO



- Hindcasts performed in true independent forecast mode.
- Skill assessed using robust skill measure - percentage RMSE improvement over 30-year climatology.

Methodology

- **Statistical Model**

  Interannual variability in typhoon numbers is modelled using a Gaussian distribution.

- **Predictor Selection Process**

  AUG-SEP contemporaneous and lagged SST predictors identified using careful persistence and stability tests.

- **Typhoon Predictors Used**

  Forecast Niño 3.4 AUG-SEP SST
  Lagged MAR-APR SSTs.

Methodology (2)

- **SST Forecast Model (UCL 1)**

  - Forecasts SST at leads from 0 to 12 months

  - Model exploits initial conditions and trends in global SSTs.

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

- **Assessing Typhoon Forecast Skill**

  Use only prior data. Compute average skill for 1986-2000.

- **Forecast Format**

  Deterministic and Probabilistic.

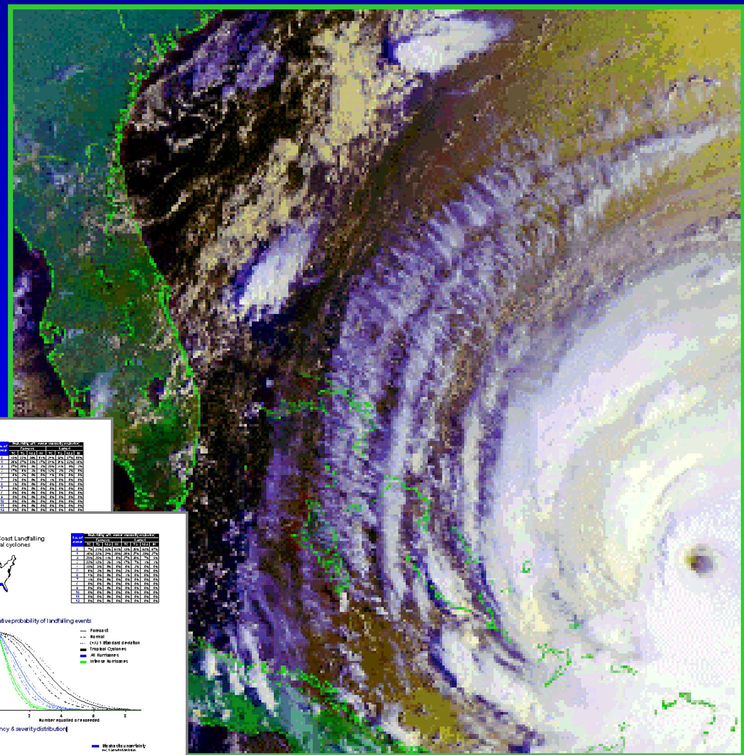
Comparison of Gray and TSR Forecast Skill

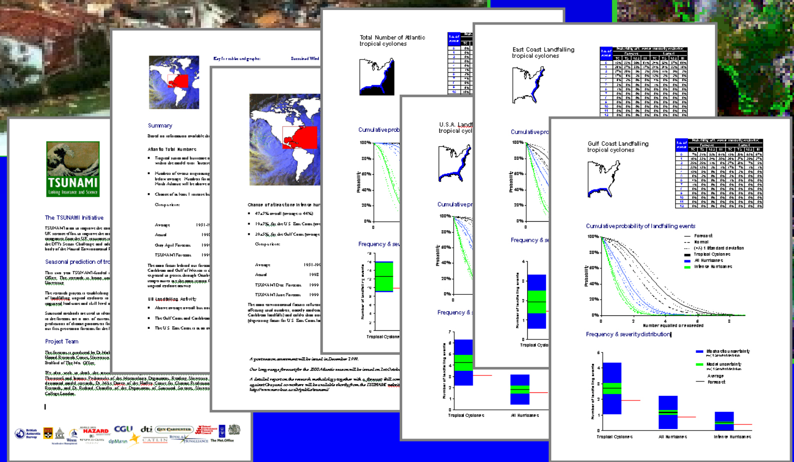
Strength	Lead (months)	Start Year	End Year	Gray Skill (%)				UCL Skill (%)			
				PVE	PAC	$PRMSE_{CL}$	$PMAE_{CL}$	PVE	PAC	$PRMSE_{CL}$	$PMAE_{CL}$
TC	0	1986	2000	63	46	42	41	78	59	46	56
H	0	1986	2000	46	37	27	32	77	60	52	56
IH	0	1990	2000	49	35	28	28	59	51	38	45
TC	2	1986	2000	32	22	23	22	47	30	20	26
H	2	1986	2000	23	27	14	23	45	35	24	31
IH	2	1990	2000	17	19	12	11	61	47	37	43
TC	8	1992	2000	5	1	12	3	0	12	7	13
H	8	1992	2000	0	12	6	13	7	12	10	13
IH	8	1992	2000	11	17	11	18	11	8	12	7

0 month lead = Forecast issued at beginning of August
2 month lead = Forecast issued at beginning of June
8 month lead = Forecast issued at beginning of previous December

Forecast Access

http://www.TropicalStormRisk.com





The Future

- Monthly updated forecasts for any territory, landfalling area, and TC strength category.
- Incorporate Met Office dynamical weather prediction data into the TSR models.
- Extend scope of forecasts to include landfalling TCs in other Asian territories.
- Input regional TSR forecasts into Catastrophe Models.

Coming Next

- **Early May 2001**

  Extended Range Forecast for Australian 2001/02 Tropical Cyclone Season.

- **Early June 2001**

  Preseason Forecasts for NW Pacific and Atlantic Tropical Cyclone Seasons.

IPCC Conclusions for Storm and El Niño Extremes

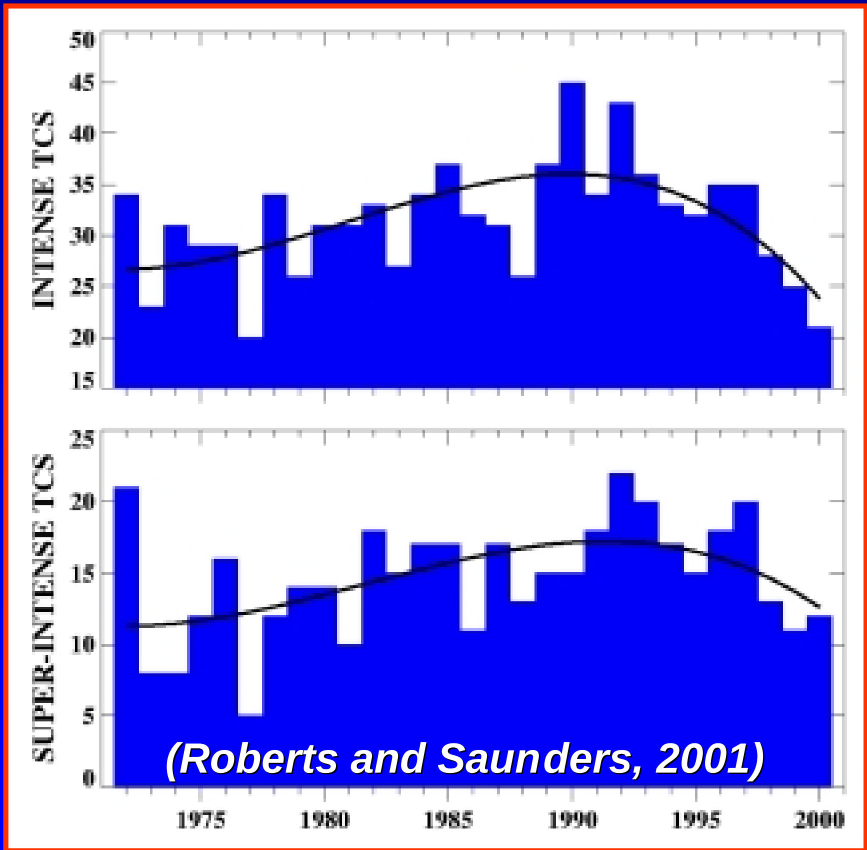
	Observed (20th Century)	Modeling (End of 21st Century)
Storm and El Niño Extremes		
More tropical storms	Unlikely	Possible
More intense tropical storms	Unlikely	Possible
More intense mid-latitude storms	Possible	Possible
More intense El Niño Events	Possible	Possible
More common El Niño-like conditions	Likely	Likely*

*No direct model analyses but expected based on other simulated model changes

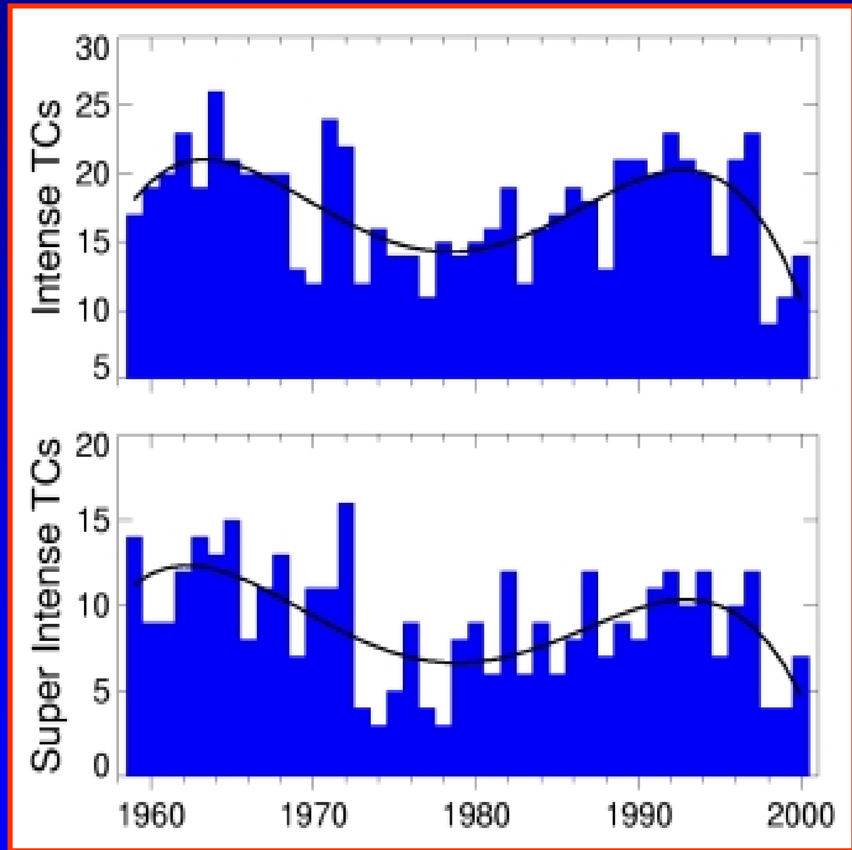
Probability Levels			
Virtually Certain	> 99%	Unlikely	10 to 33%
Very Likely	90 to 99%	Very Unlikely	1 to 10%
Likely	67 to 90%	Improbable	< 1%
Possible	33 to 66%		

Trends in Intense Tropical Cyclone Numbers

Northern Hemisphere 1972-2000



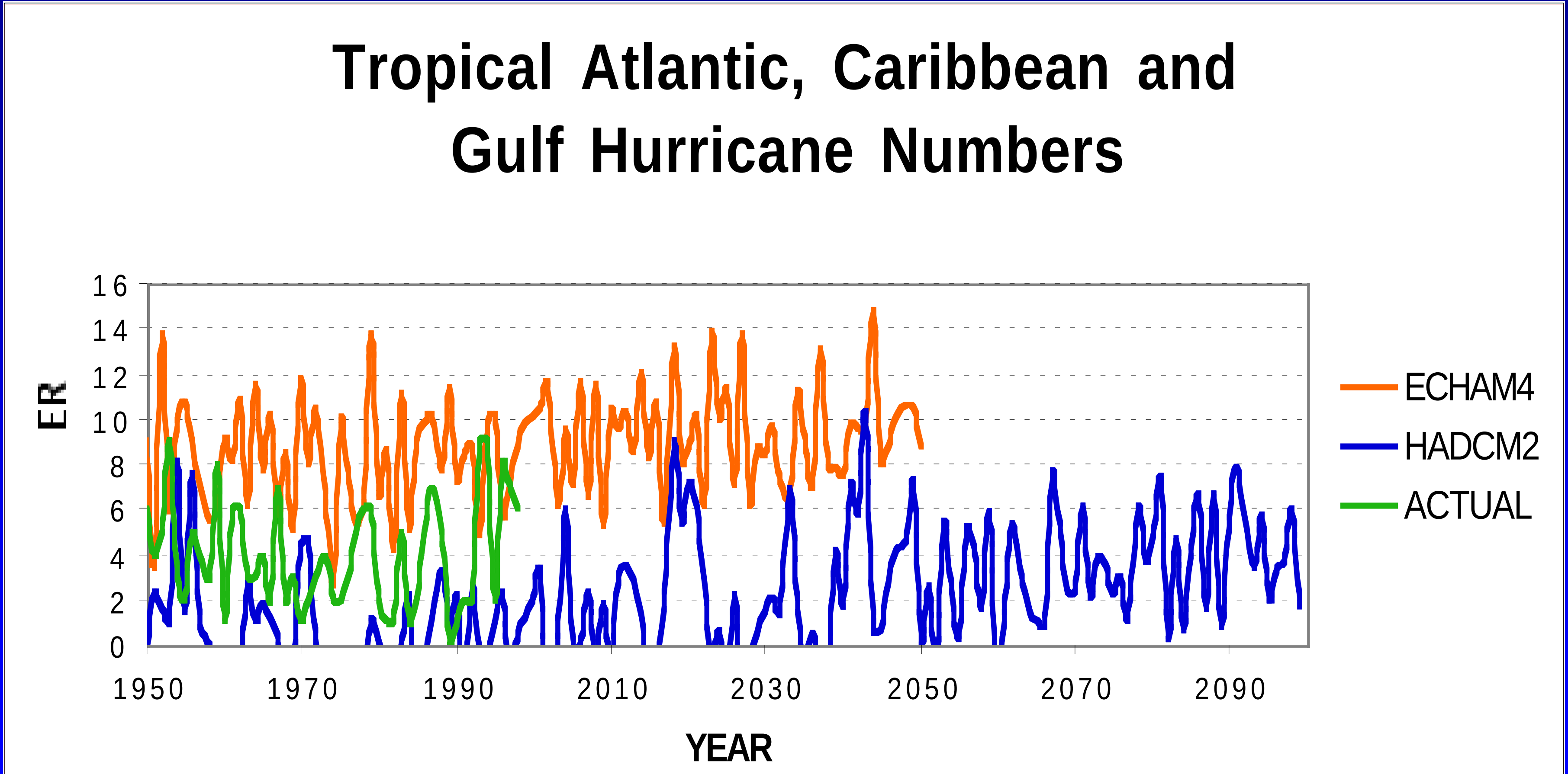
NW Pacific Basin 1959-2000



Intense TCs = 1-min Sustained Winds > 73 mph

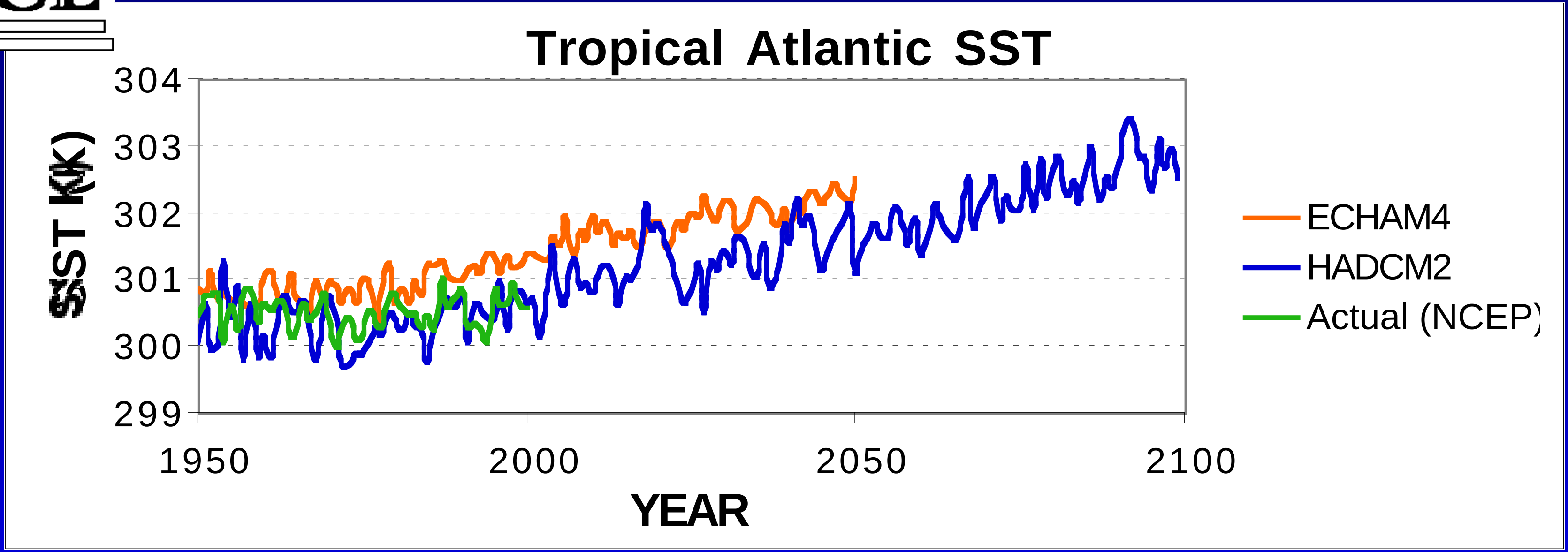
Super Intense TCs = 1-min Sustained Winds > 110 mph

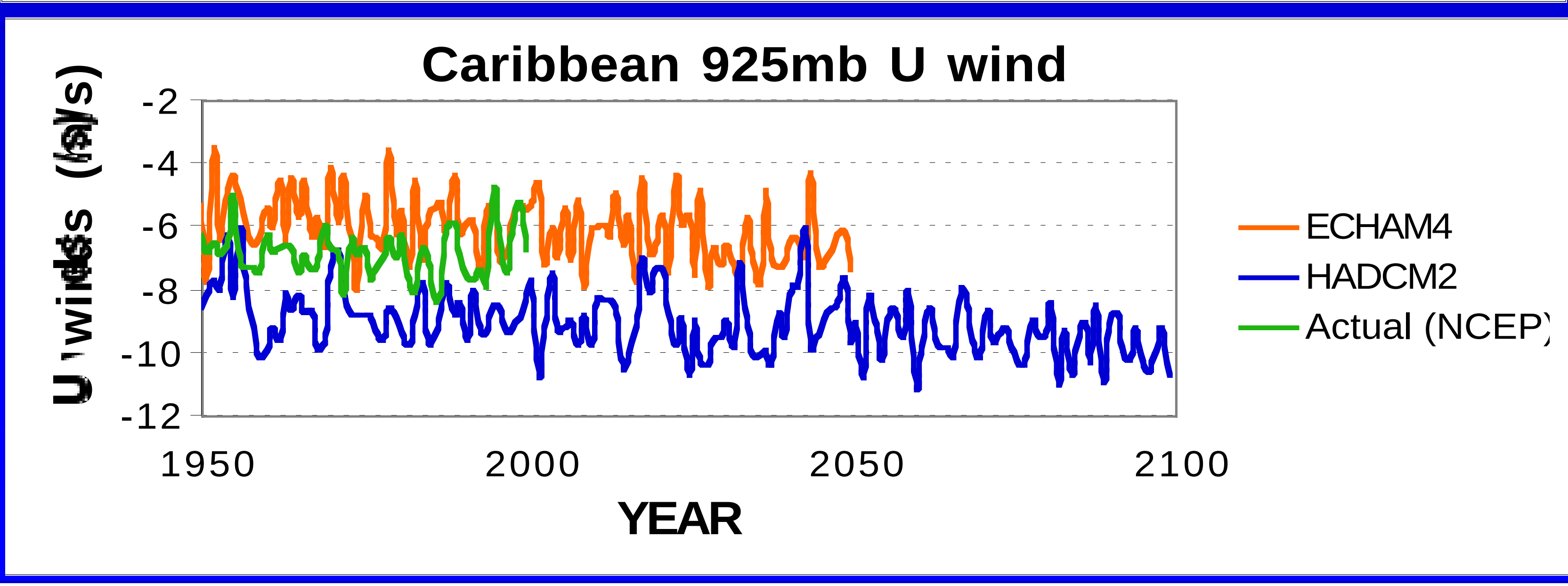
Future Projections for Atlantic Hurricane Numbers



(Roberts and Saunders, 2001)

Key Predictors: Verification and Future Values





Conclusions

- **TSR has built an enviable reputation for the accuracy of its seasonal forecasts and robustness of its methodology in its short life to date.**

- **By applying and enhancing proven forecasting methods to the Pacific cyclone basins, it will help Asian catastrophe insurers better understand the risks they face.**

- **UCL novel work on future trends in Atlantic hurricane and NW Pacific typhoon numbers suggests an increase (compared to 1971-2000 climatology) of 10-20% by 2050.**