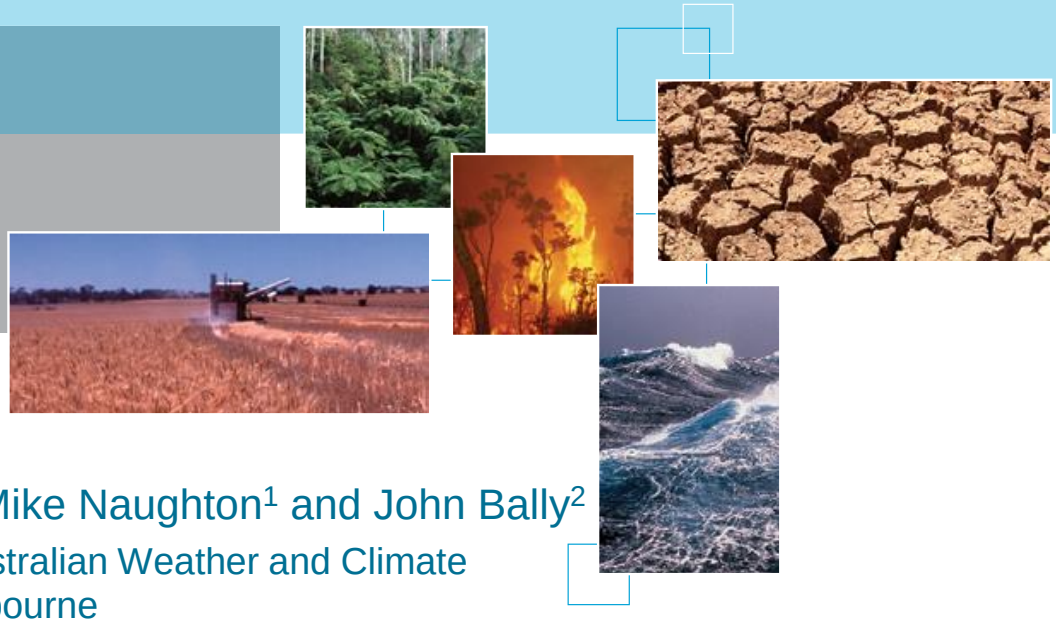
Managing severe weather – progress and opportunities

www.cawcr.gov.au



Jeff Kepert[1] Mike Naughton[1] and John Bally[2]

[1] Centre for Australian Weather and Climate Research, Melbourne

[2] Bureau of Meteorology, Tasmania

AFAC, Sept 2014

Australian Government
Bureau of Meteorology

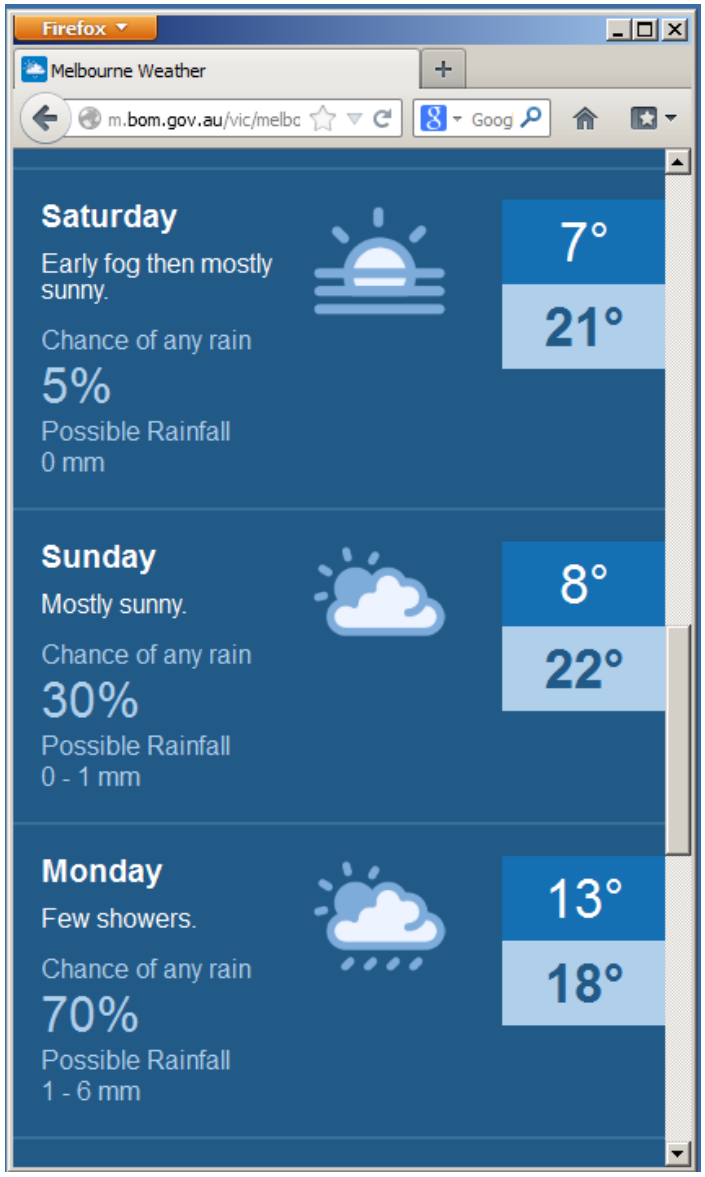
The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

New Orleans after Hurricane Katrina

Gulf Coast after Hurricane Ike

Dealing with uncertainty

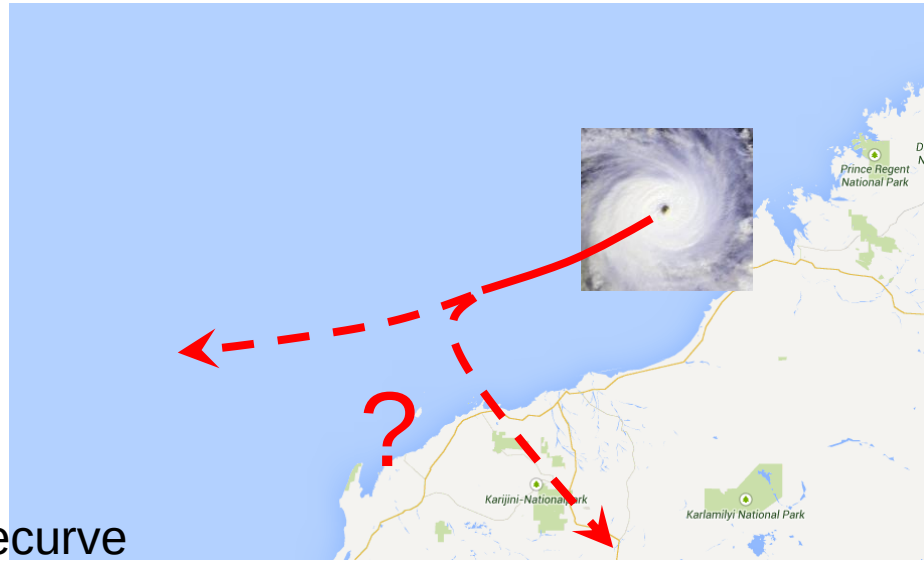


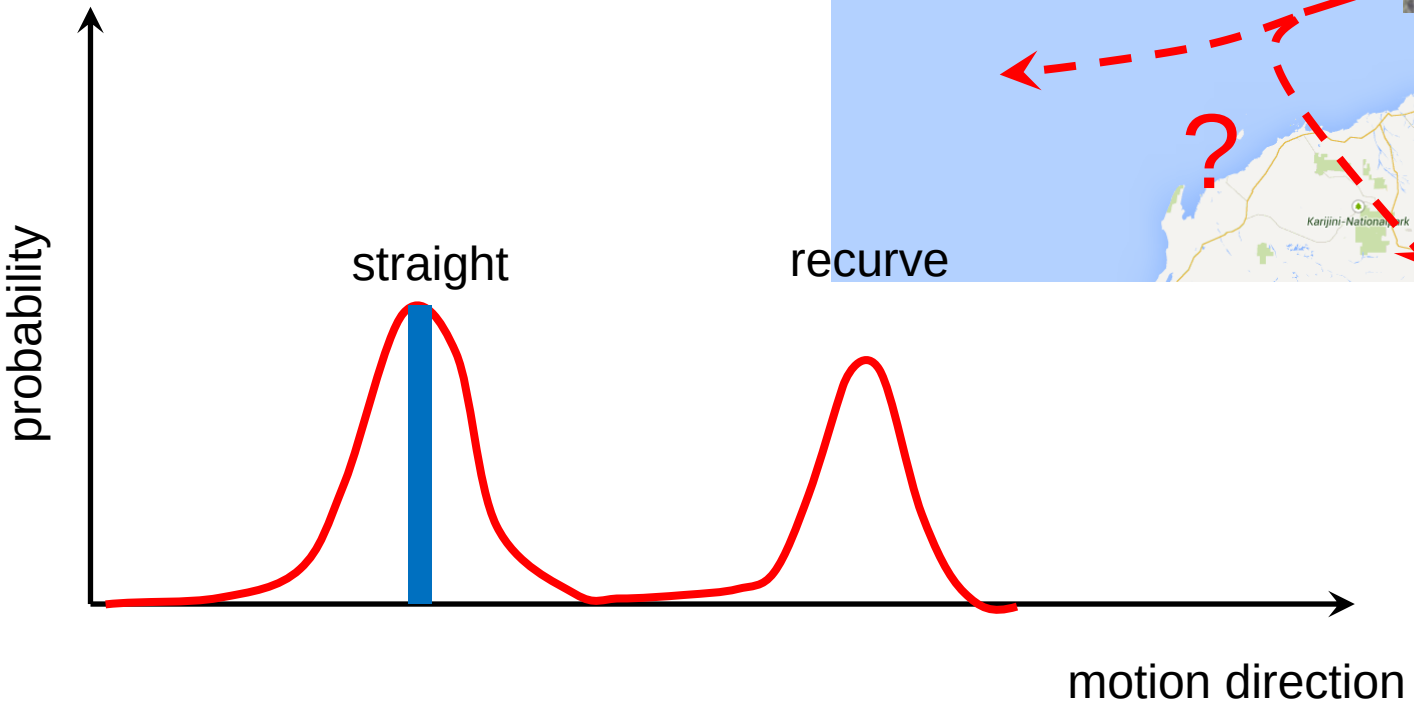
- Weather forecasts will never be exact.
- How do we deal with this uncertainty?
- Bureau of Meteorology mobile website m.bom.gov.au

Tropical cyclone recurvature

Tropical cyclone recurvature

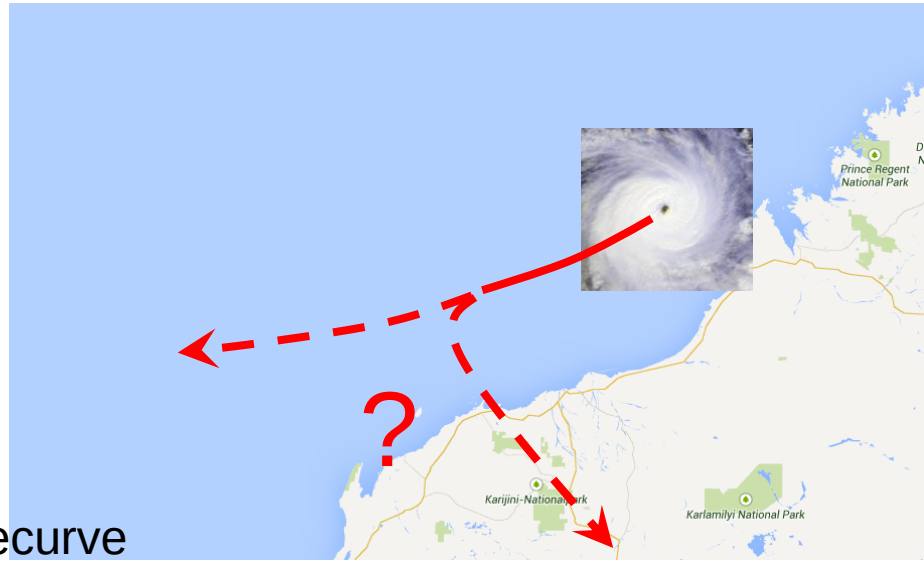
- Deterministic forecast is often the mode (most likely) – the cyclone runs straight

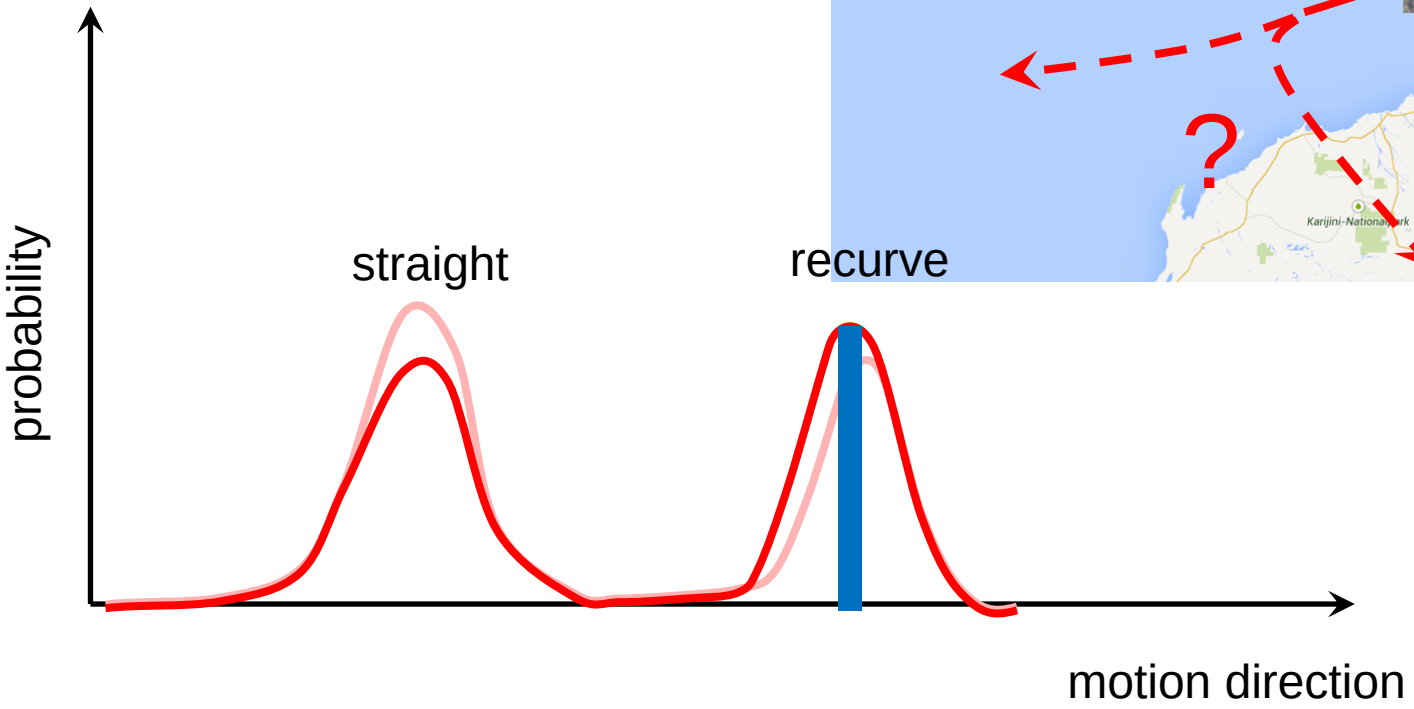




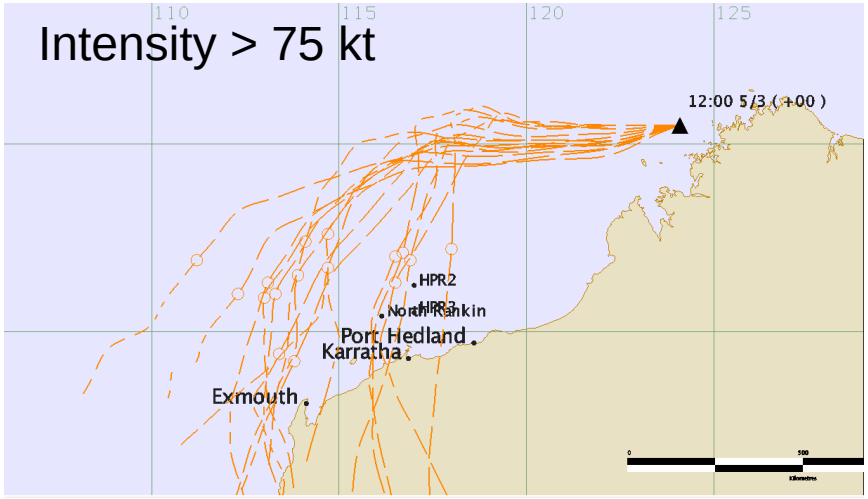
A later forecast …

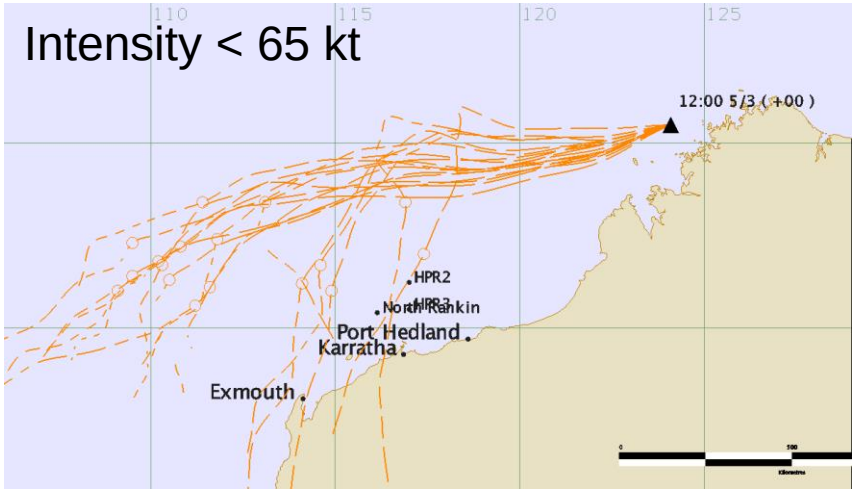
- Deterministic forecast is now recurvature – a forecast flip
- flips … flip-flops … flip-flop-flips …





The value of ensemble prediction

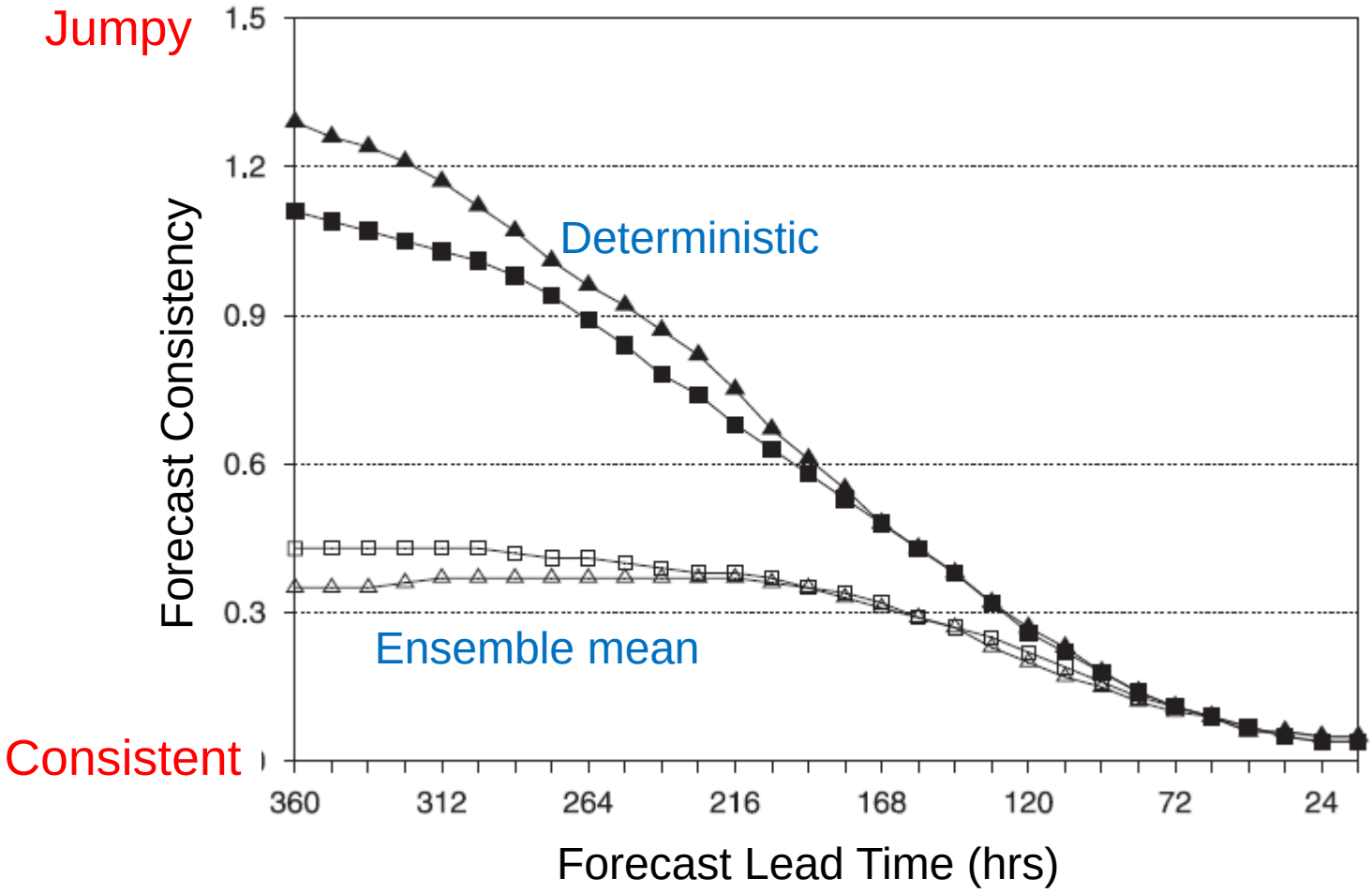




- TC George
  - Recurvature and landfall was not predicted by deterministic models
  - Ensemble system showed landfall was a distinct possibility, especially if intensity was high
  - Ensemble also provides a strong indication of risk to offshore and onshore assets
  - Three deaths

Courtesy Grant Elliott

The ensemble mean is more consistent



Zsoter et al. (2009 QJRMS)

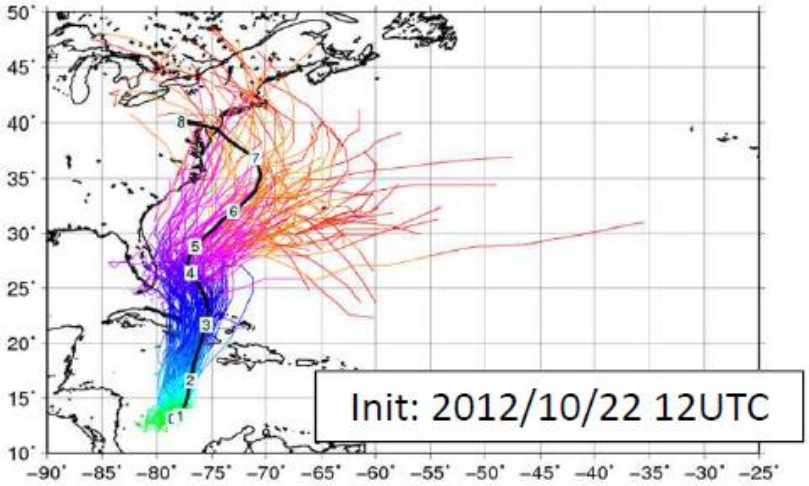
Hurricane Sandy

Research
teorology

CSIRO

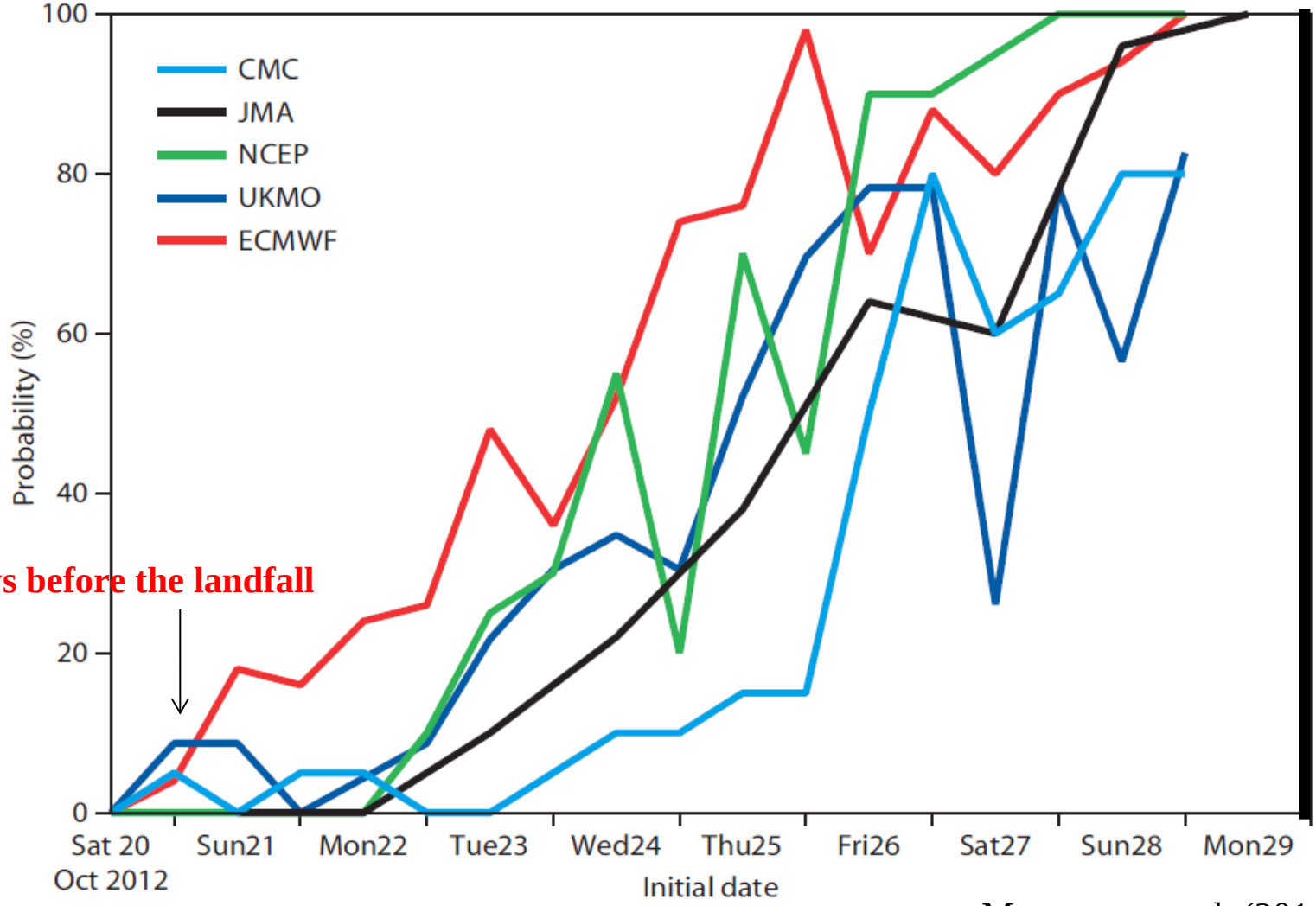
Hurricane Sandy (2012)

MCGE−4



Evaluation of forecasts of Hurricane Sandy

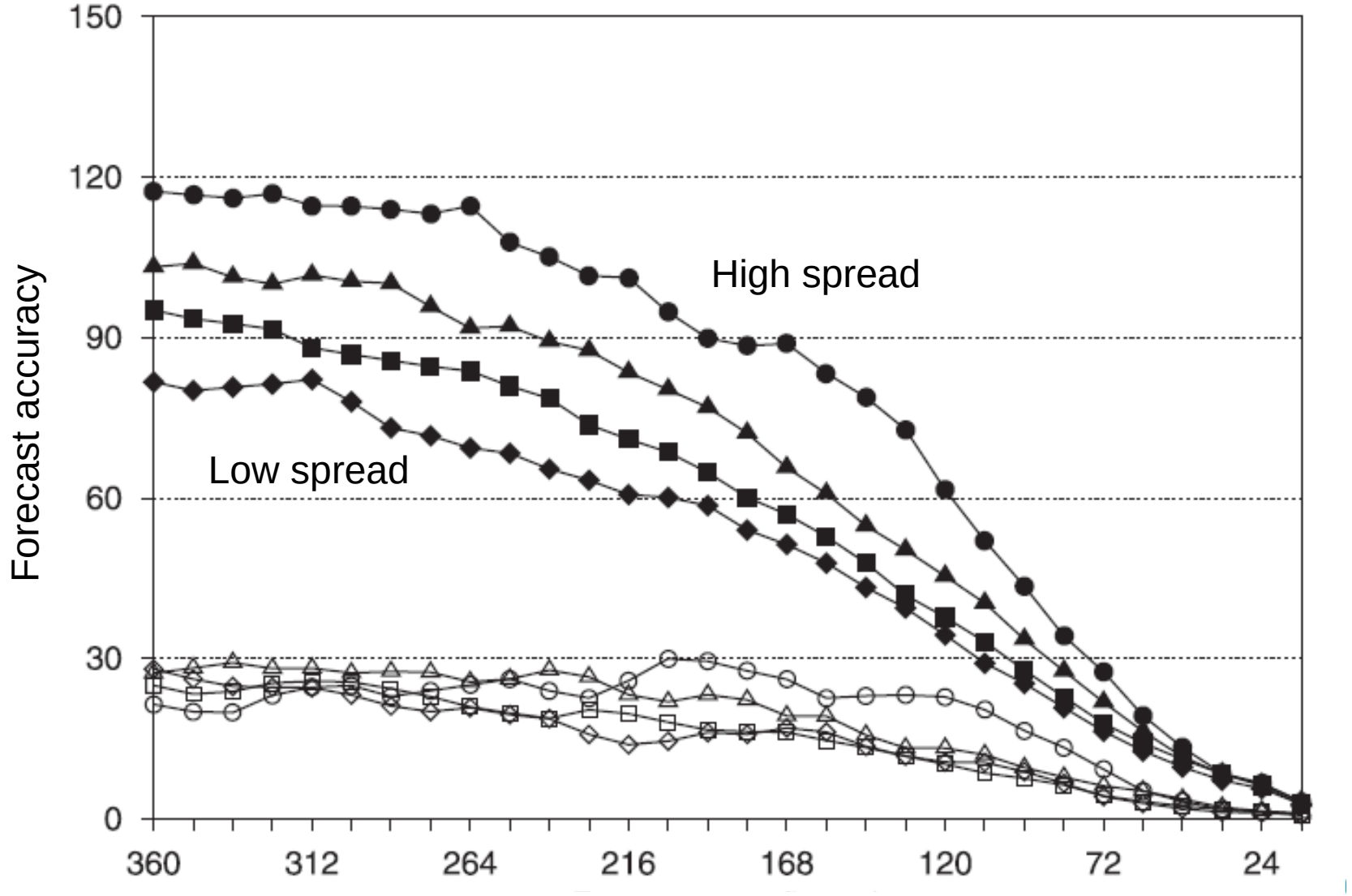
Probability (%) of 850 hPa wind speed greater than 38 m/s somewhere inside a radius of 100 km for New York Harbour between 2012-10-29 12z and 2012-10-30 12z.



9 days before the landfall

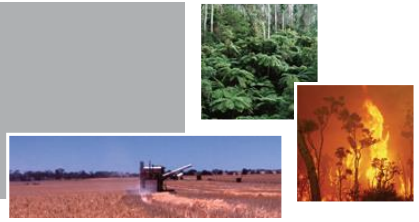
Magnusson et al. (2014, MWR)

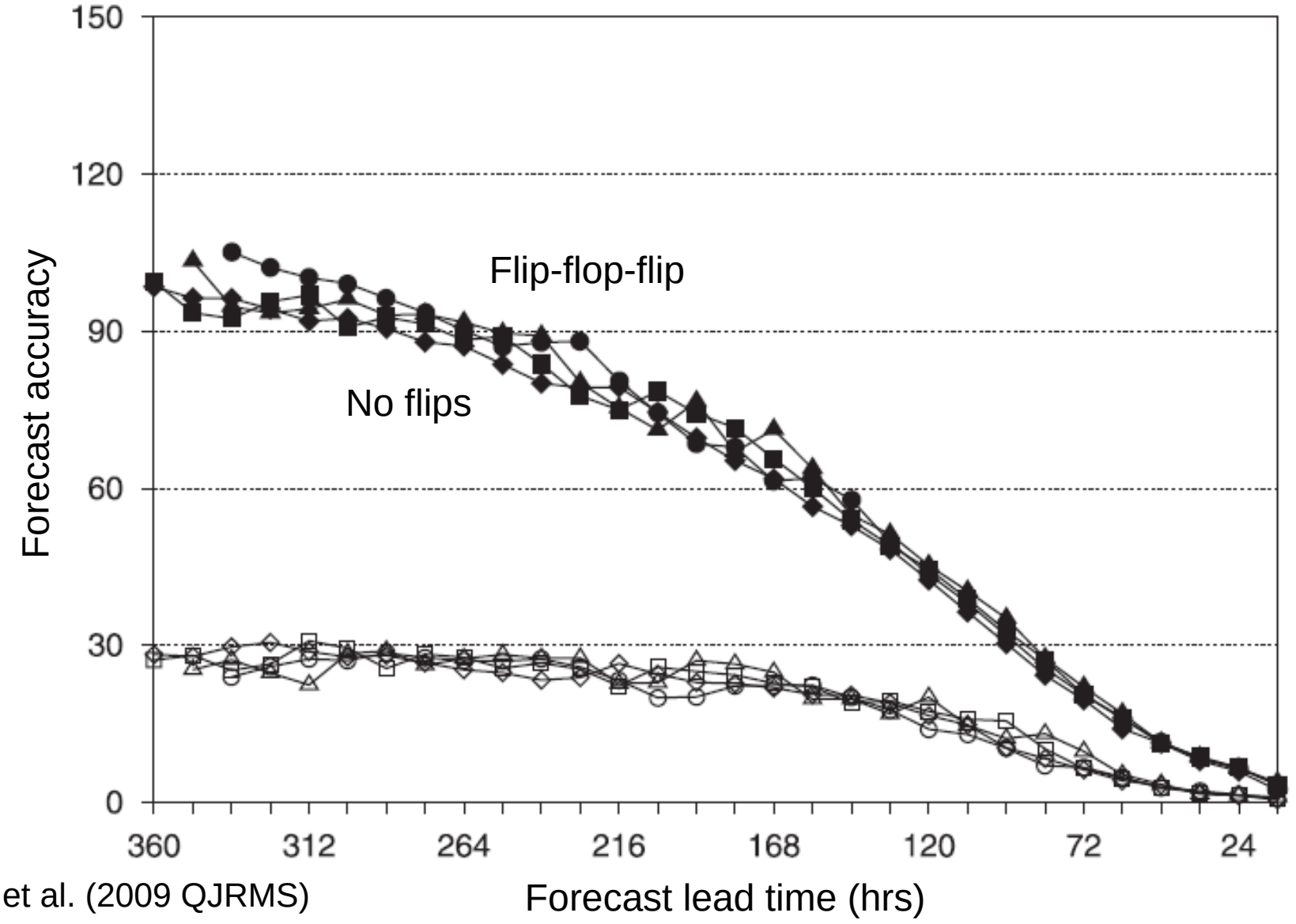
Ensemble spread vs accuracy



Zsoter et al. (2009 QJRMS)

"Flippiness" vs forecast accuracy

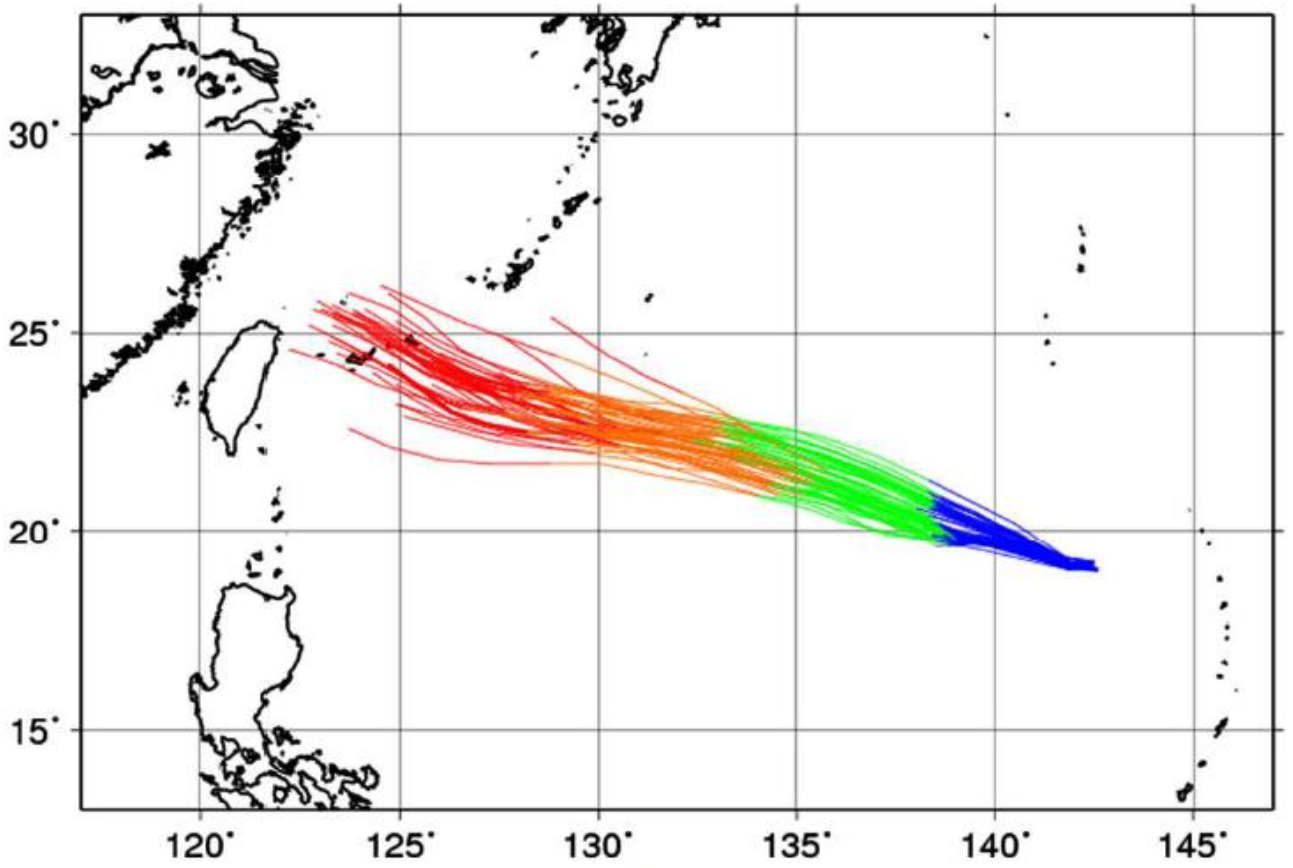




Zsoter et al. (2009 QJRMS)

Track Prediction for Typhoon SOULIK (2013)

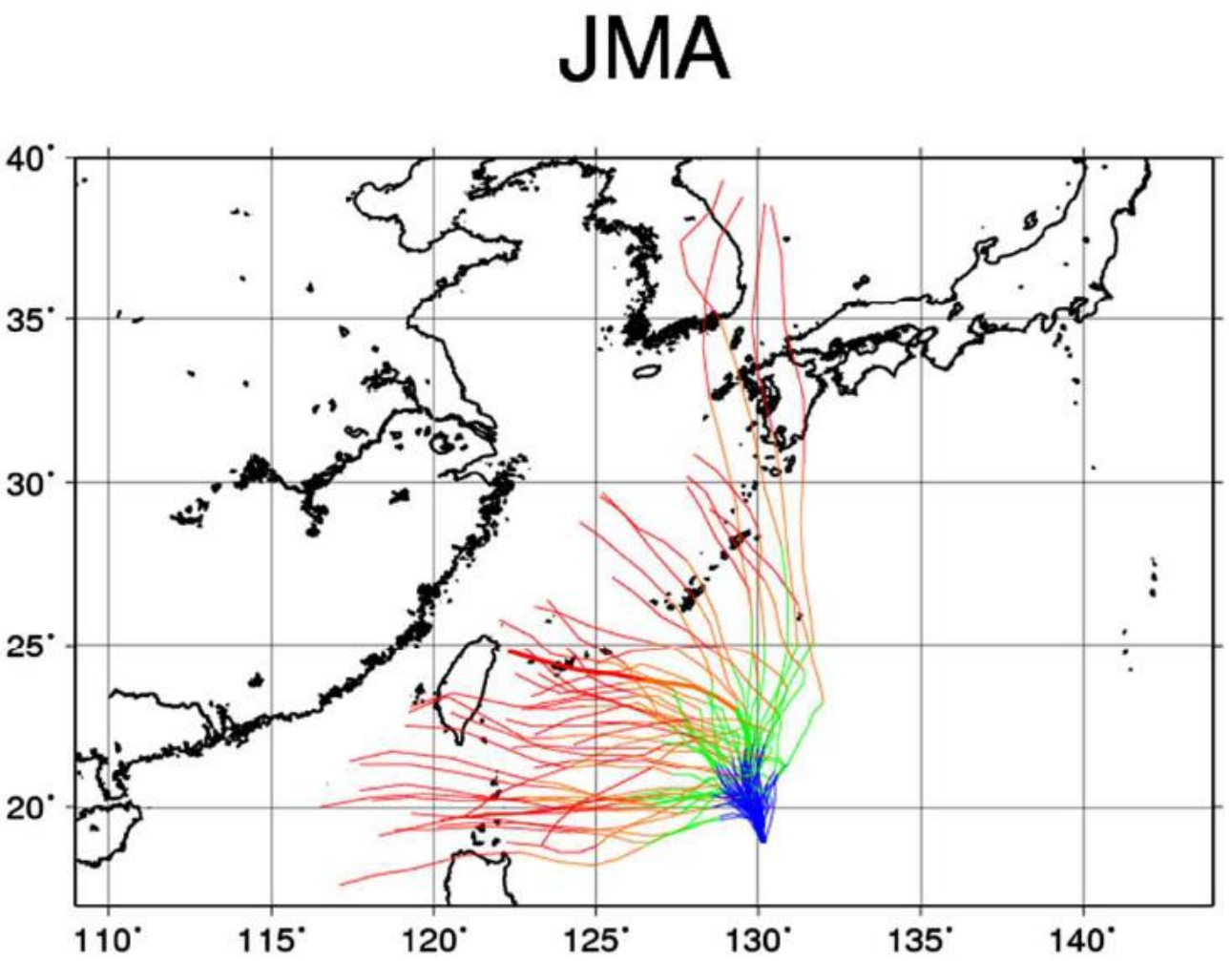
JMA



Blue portion of the tracks is the **Day 1** forecast and the **green**, **orange**, and **red** portions are **the Day 2, Day 3, and Day 4** forecasts.

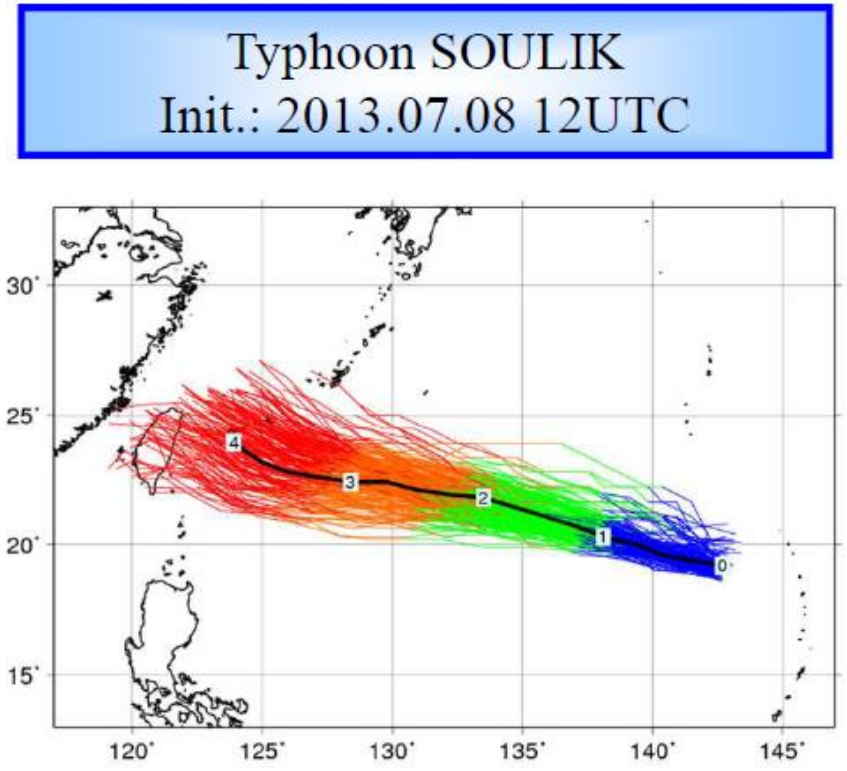
de courtesy of Munehiko Yamaguchi

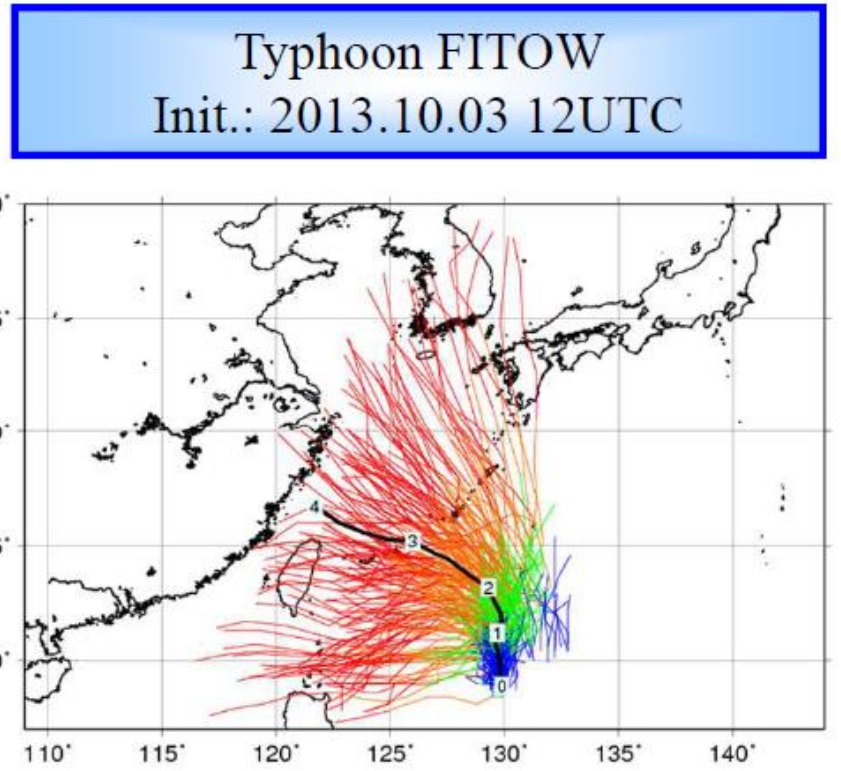
Track Prediction for Typhoon FITOW (2013)



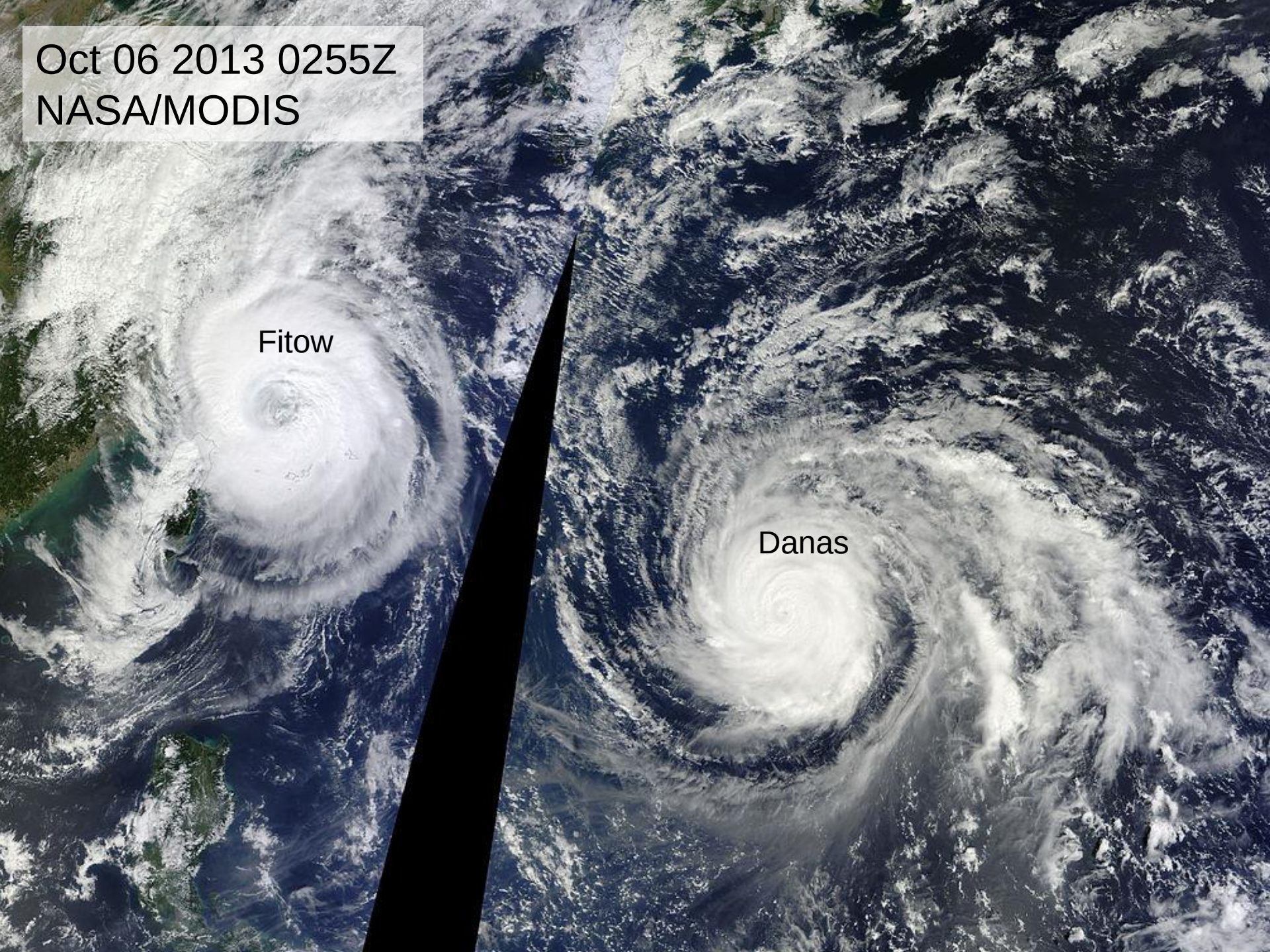
de courtesy of Munehiko Yamaguchi

Emergency response implications





- Should the emergency response be the same for these two cases?
- Are these differences believable?


Oct 06 2013 0255Z
NASA/MODIS
Fitow
Danas

Forecasting and decision-making

		Event Occurs	
		Yes	No
Take action	Yes	C + L - δL	C
	No	L	0

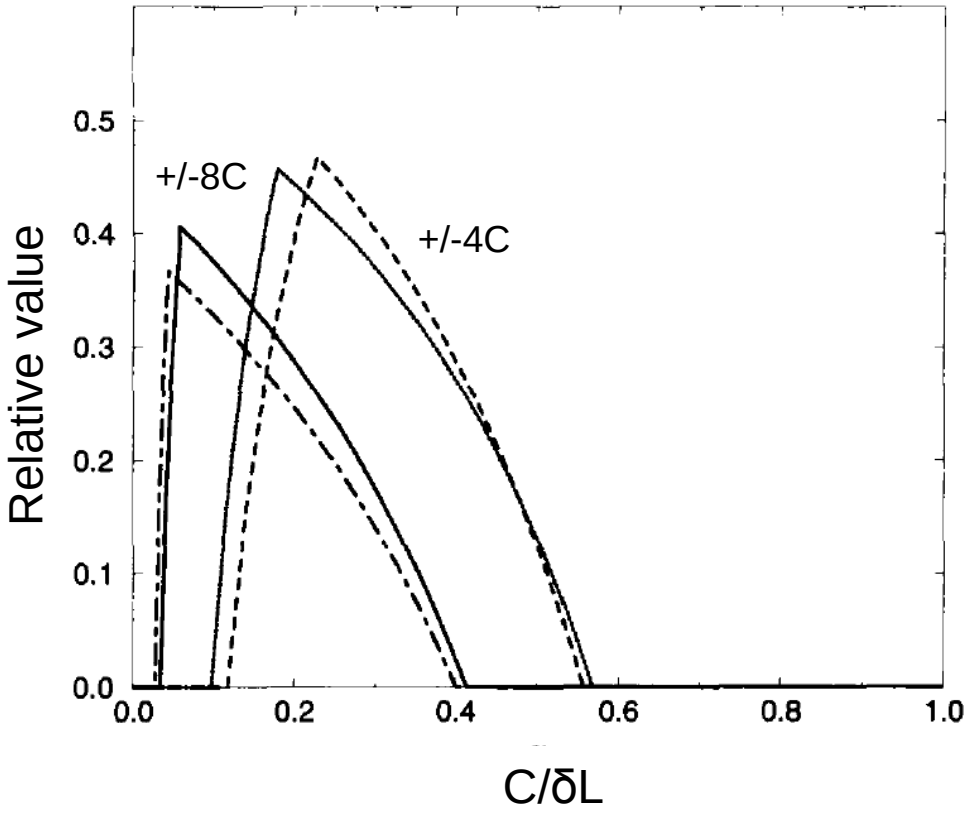
C = cost of taking action
L = losses from the event if no action taken
δL = savings as a result of action

When should we take action?

Richardson 2000 QJRMS

Value of deterministic forecasts

- Value of forecast depends
  - on C/δL (cost-loss ratio)
  - on the event
  - on the frequency of event
  - on model accuracy
- Value is measured relative to a perfect forecast

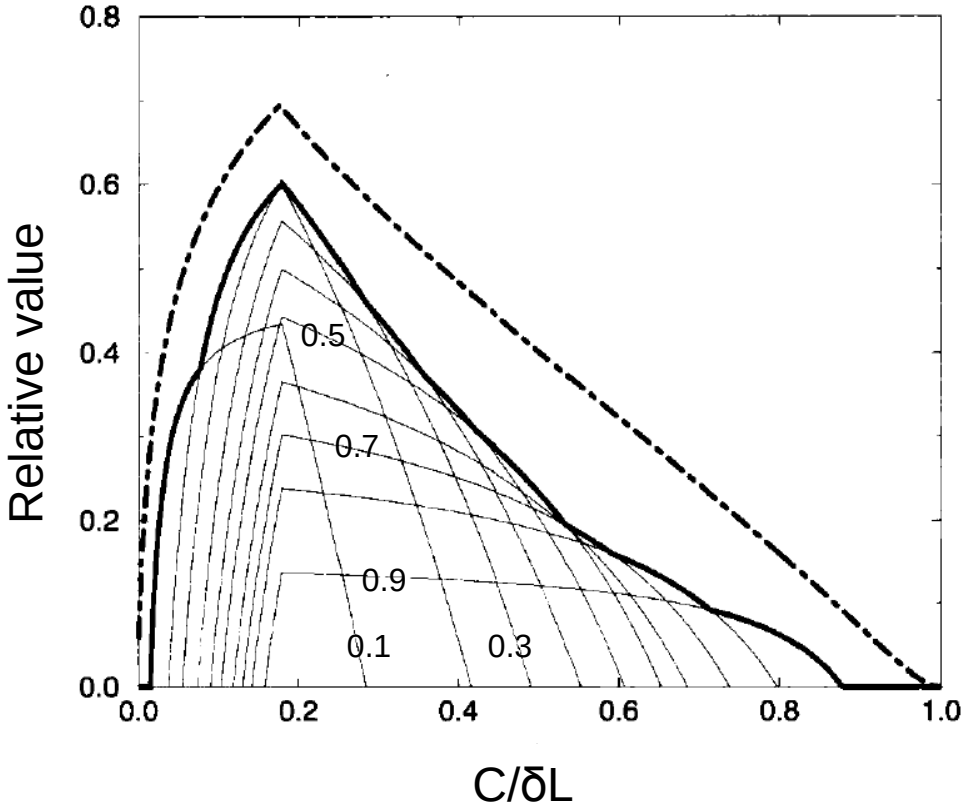


Relative value of deterministic forecasts of four different temperature thresholds over Europe, Jan/Feb 1998

Richardson 2000 QJRMS

Value of ensemble forecasts

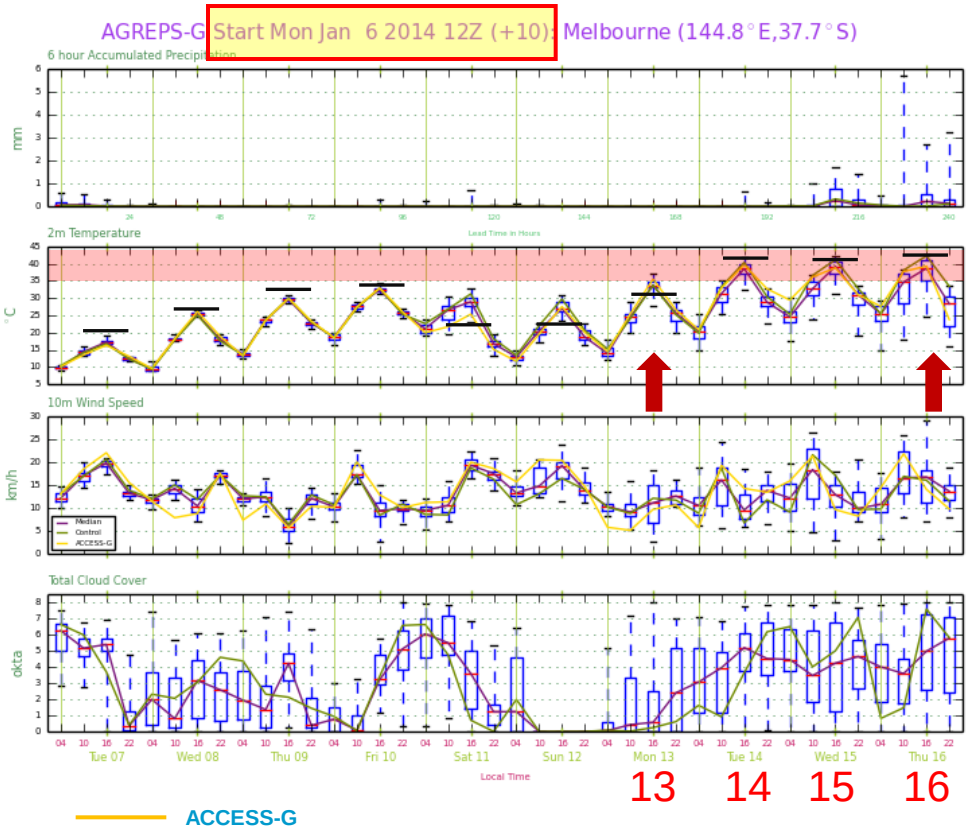
- Decide to act when probability exceeds a threshold p_t
- Value of the ensemble depends
  - on this threshold
  - and factors in last slide
- Value can be maximised by good choice of p_t
- **Value is greater than for the deterministic forecast**
- **i.e. You (or your agency) end up richer**

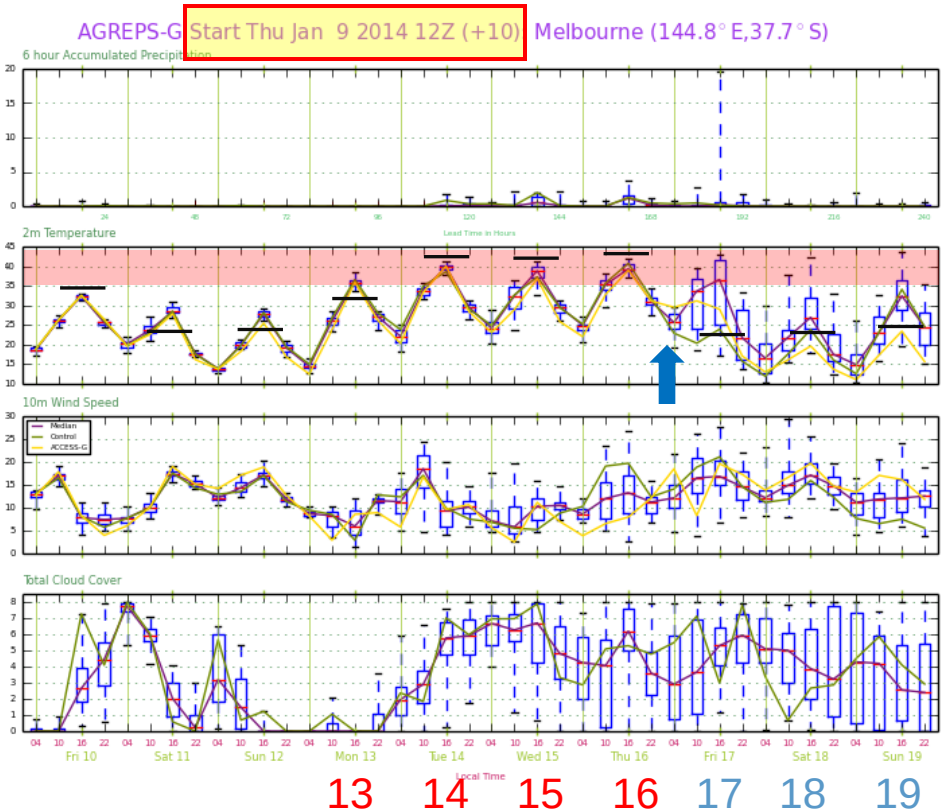


Relative value of ensemble forecasts of +4C temperature anomalies for various decision thresholds

Richardson 2000 QJRMS

Victoria Heatwave
January 13-16 2014





ACCESS-G

E-Control

E-Median

Heat wave

Cool change

Australian Government
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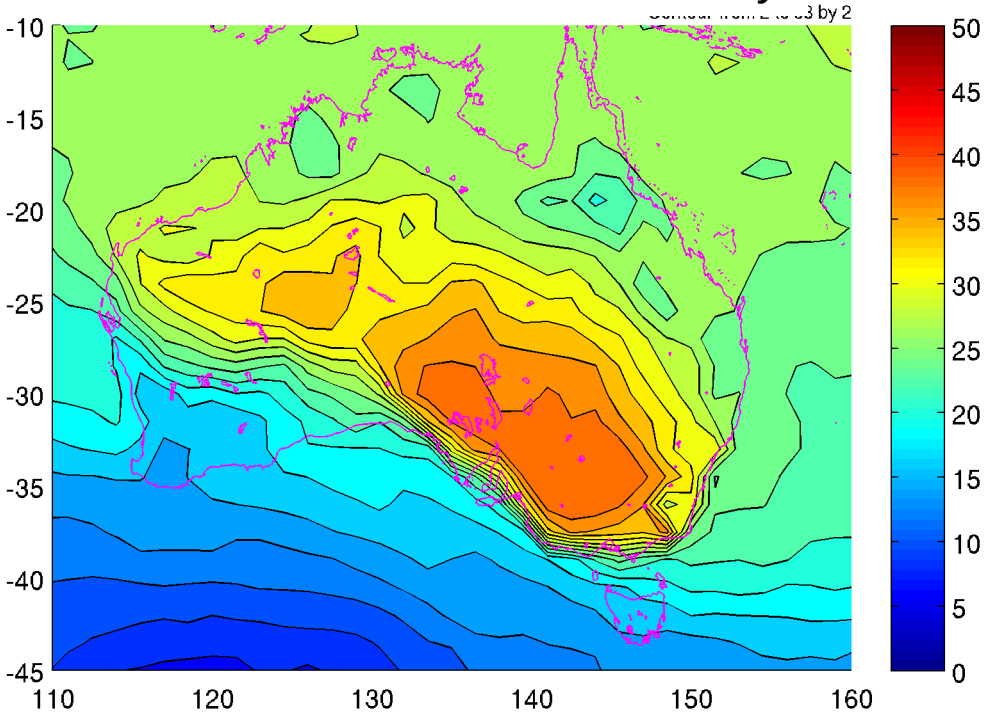
The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

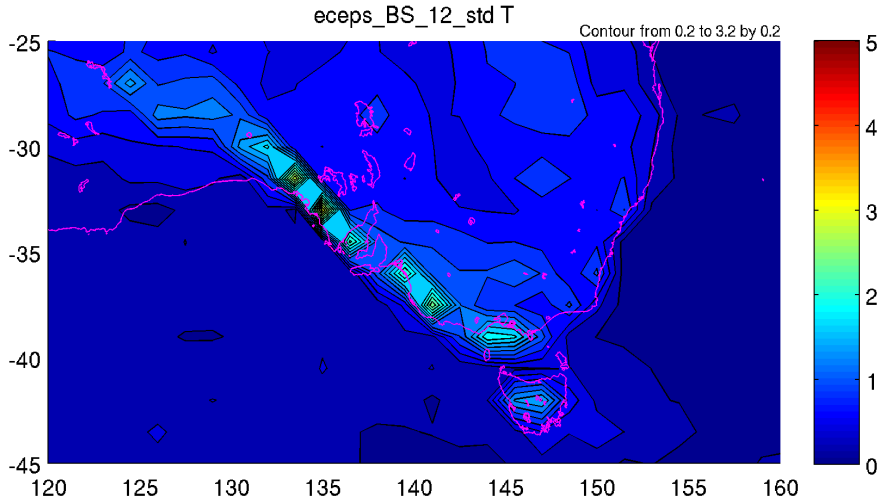
Forecast uncertainty for Black Saturday

Valid 11 am EDT, Black Saturday

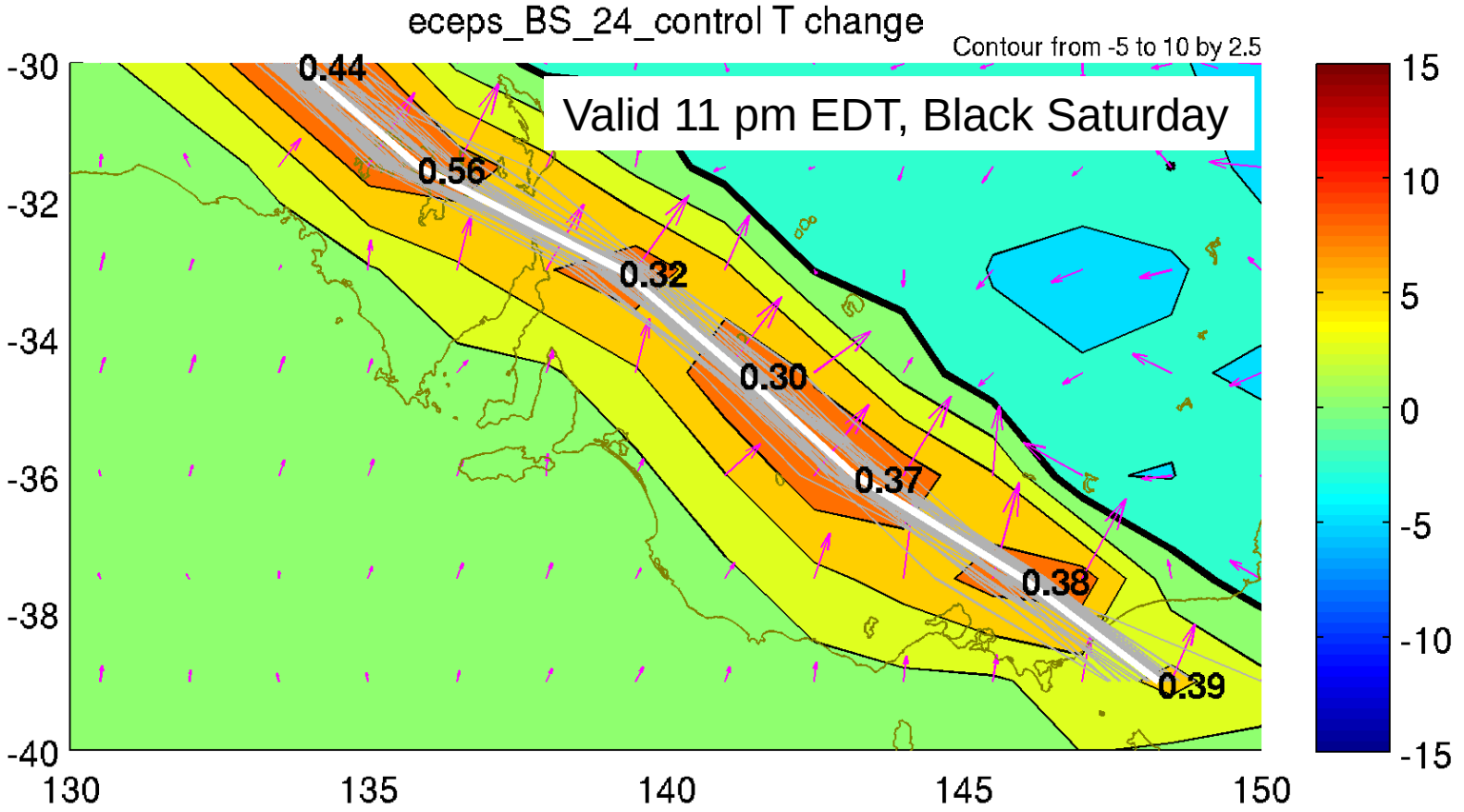


Ensemble-mean temperature forecast

Ensemble-standard deviation temperature forecast



Forecast uncertainty in the change position



Shading: NW component of temperature gradient (max = front position)
Arrows: Temperature gradient
Grey lines: front position in ensemble members
White line: front position in control forecast
Numbers: standard deviation of front position (degrees longitude)

The value of ensemble prediction

Ensemble prediction systems:

- can be used to **assess the predictability** of the atmosphere
- give an estimate of the **probability distribution** of the forecast
- are **more valuable** than single forecasts
- are **more consistent** than single forecasts
- provide the tools to properly **manage risk**

Challenge: to make best use of this newish data stream