Informing anticipatory humanitarian action

A framework for using ECMWF forecasts effectively

Dr Erica L Thompson
Centre for Analysis of Time Series, LSE

Using ECMWF Forecasts, Reading, 4 June 2019

Context

- Start Network: 42 NGOs, working together to release funding for humanitarian efforts before, during and after crises
- Challenge: difficulties in making use of forecasts due to
  - Not knowing where to find forecast
  - Not knowing how to interpret forecast / confidence
  - Group communication tricky with short lead times
  - Information filtered through one or two key people
  - Difficulty balancing the lead time of confidence versus lead time for action

Example: heatwave in Pakistan, 2017

CATS CENTRE FOR THE ANALYSIS OF TIME SERIES

- Network members spotted forecast for heatwave but were unsure how to act or whether the forecast justified action
- Start encouraged submission of an alert for heatwave
- Difficulty with pre-event communication between network members: no clear framework or consistent language
- Alert note eventually submitted with heatwave already under way
- Committee did not release funding

Example: cyclone in Philippines, 2016

CATS CENTRE FOR THE ANALYSIS OF TIME SERIES

- Only one anticipatory alert note for cyclone has ever been submitted to the Start Network

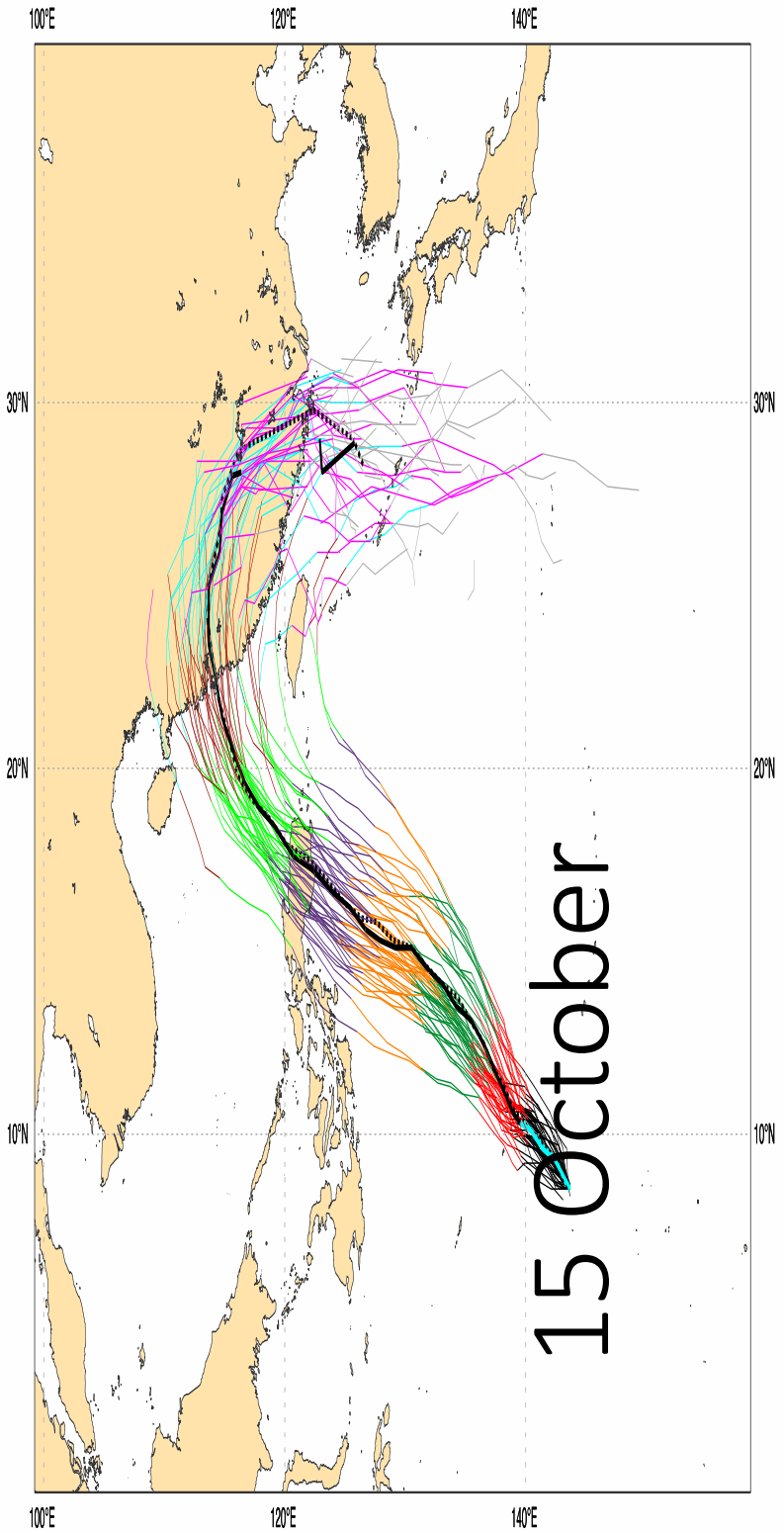
- Network members spotted cyclone Haima/Lawin approaching
- Alert note submitted on 18th Sept
- Cyclone made landfall on 19th Sept

Date 20161015 00 UTC @**ECMWF**

Individual trajectories for **HAIMA** during the next **240** hours

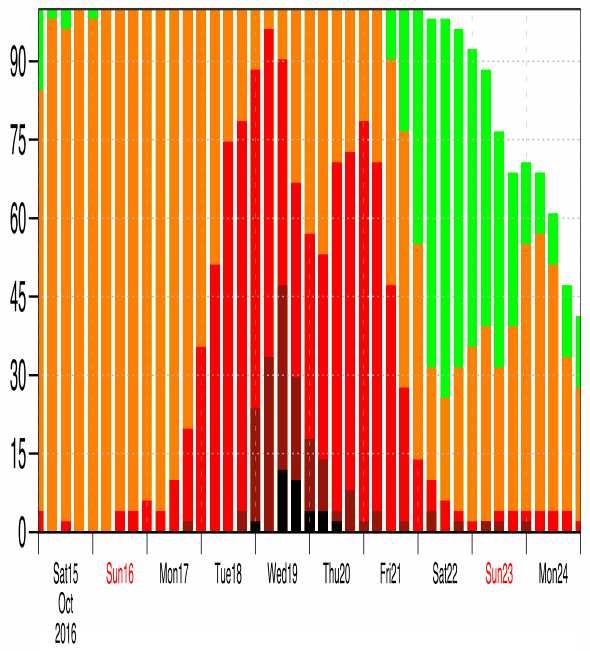
tracks: **thick solid**=HRES; **thick dot**=CTRL; **thin solid**=EPS members [coloured]

0-24h **24-48h** **48-72h** **72-96h** **96-120h** **120-144h** **144-168h** **168-192h** **192-216h** 216-240h

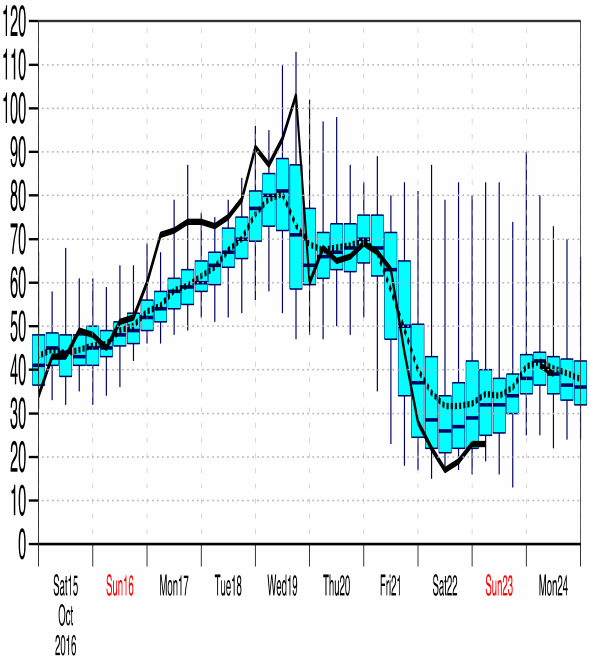


Probability (%) of Tropical Cyclone Intensity falling in each category

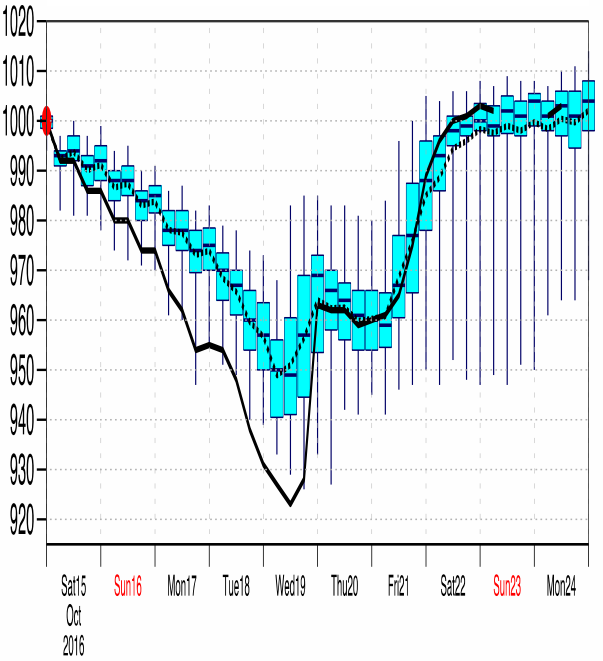
TD[up to 33] TS [34-63] HR1[64-82] HR2 [83-95] **HR3** [> 95 kt]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] **HR3**[> 95 kt]

+024 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+048 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+072 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+096 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+120 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+144 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+168 h : hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

+192 h : hr ct 01 02 04 05 06 07 08 09 10 11 12 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 32 33 34 35 36 37 38 40 41 42 43 44 45 46 47 48 49 50

+216 h : ct 04 05 07 08 10 12 14 15 16 17 18 19 20 22 23 25 26 27 28 30 31 32 33 34 35 36 38 40 41 42 43 45 46 48 50

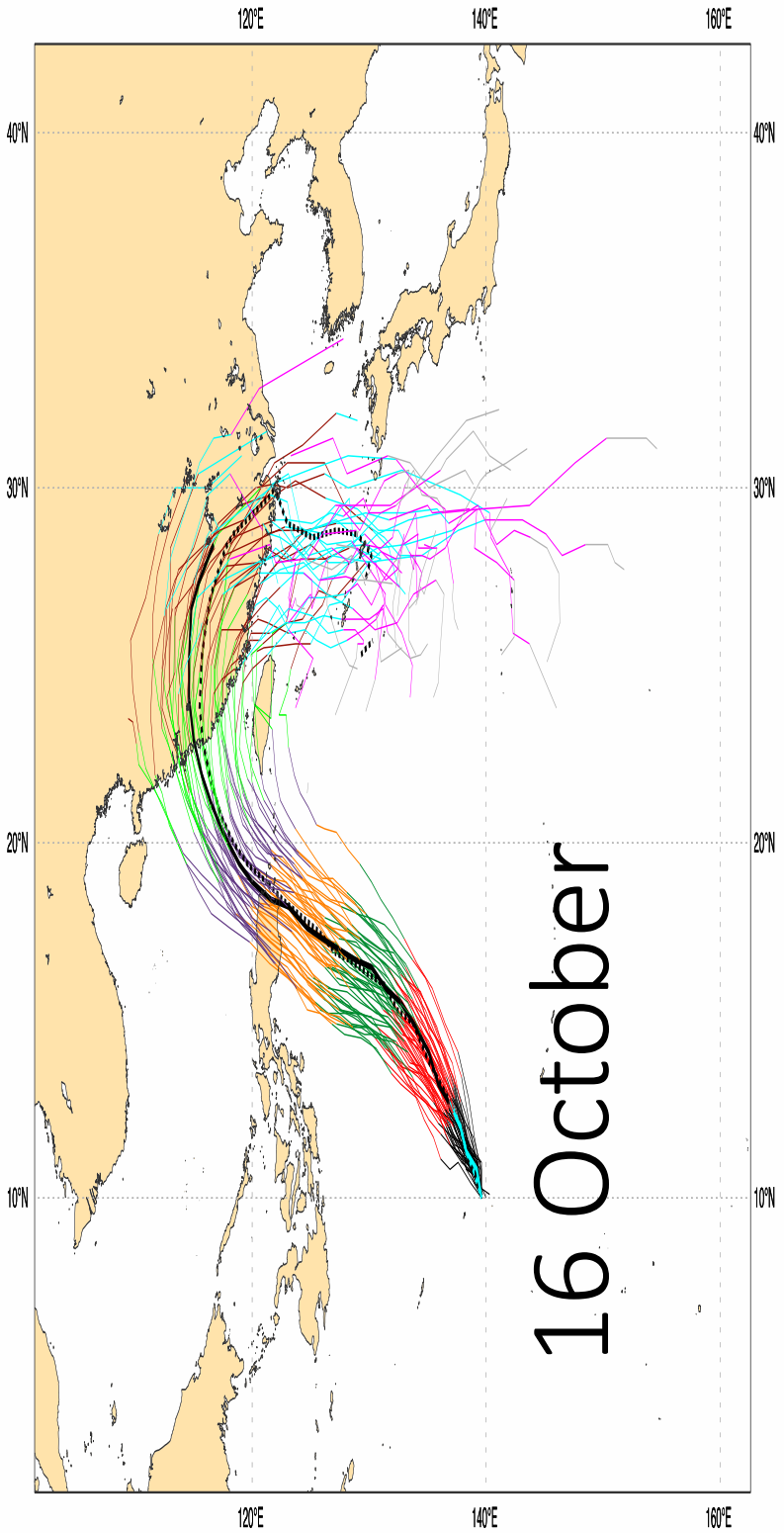
+240 h : hr 02 04 05 08 10 12 14 18 19 20 22 23 29 30 31 32 33 35 36 42 43

Date 20161016 00 UTC @**ECMWF**

Individual trajectories for **HAIMA** during the next **240** hours

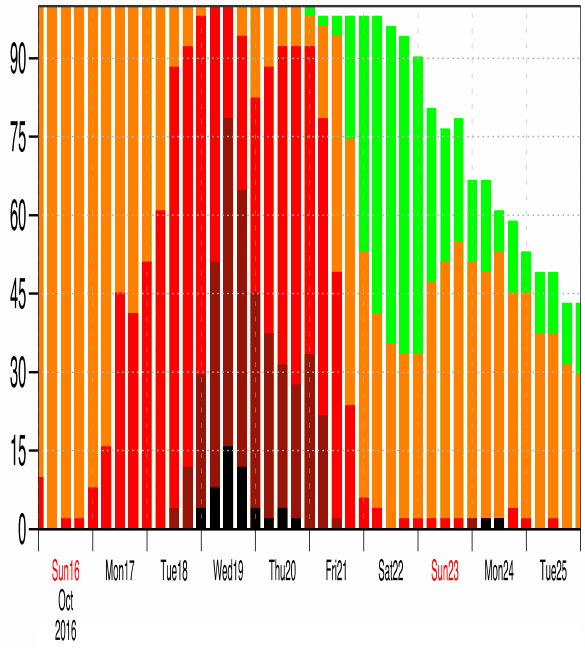
tracks: **thick solid**=HRES; **thick dot**=CTRL; **thin solid**=EPS members [coloured]

0-24h **24-48h** **48-72h** **72-96h** **96-120h** **120-144h** **144-168h** **168-192h** **192-216h** 216-240h

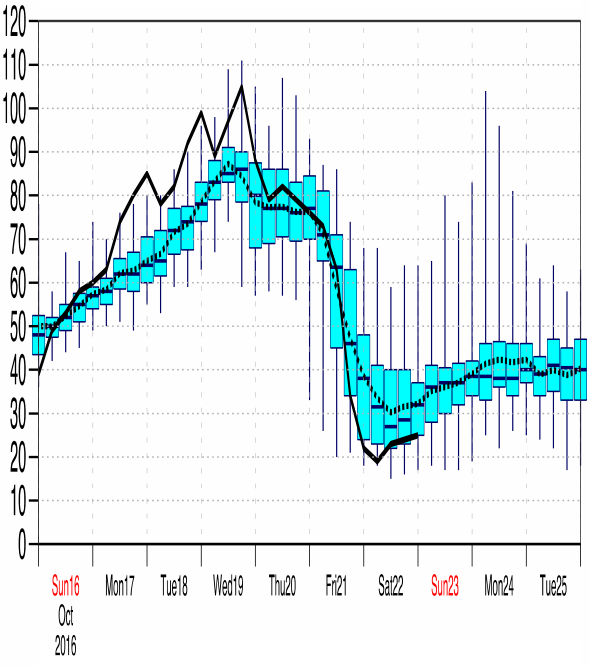


Probability (%) of Tropical Cyclone Intensity falling in each category

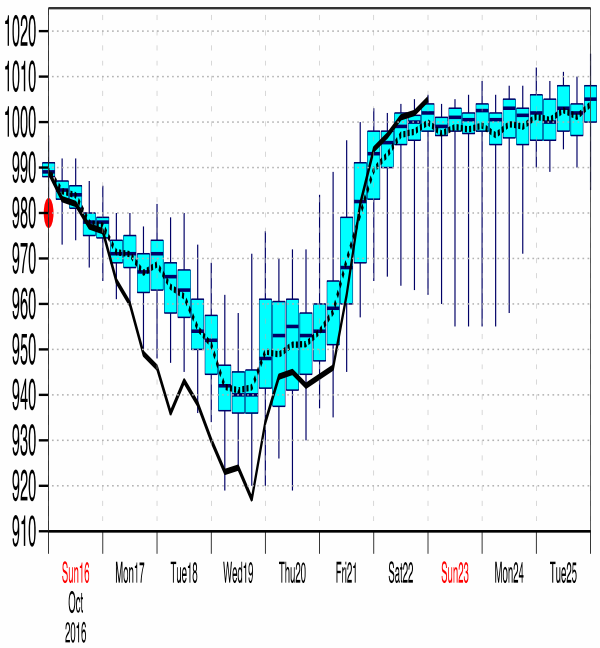
TD[up to 33] TS [34-63] HR1[64-82] HR2 [83-95] **HR3** [> 95 kt]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] **HR3**[> 95 kt]

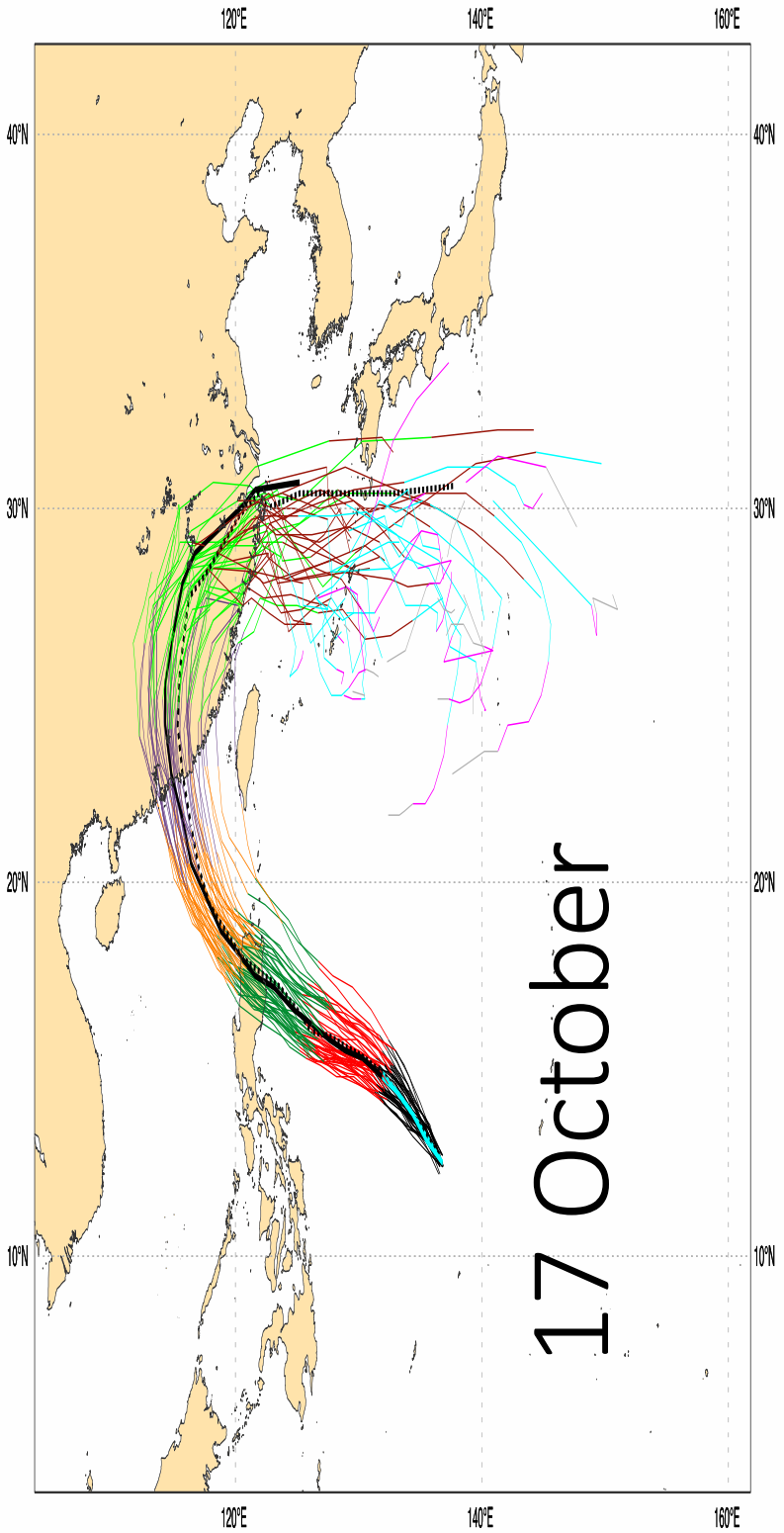
| | | |

Date 20161017 00 UTC @**ECMWF**

Individual trajectories for **HAIMA** during the next **240** hours

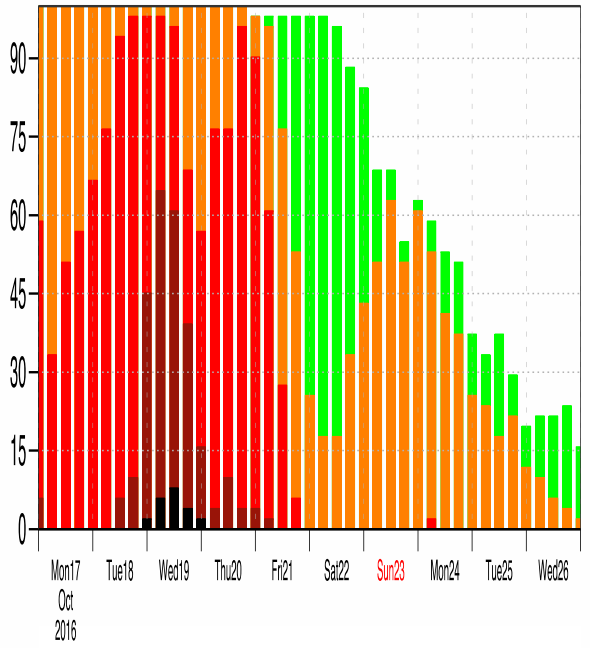
tracks: **thick solid**=HRES; **thick dot**=CTRL; **thin solid**=EPS members [coloured]

0-24h **24-48h** **48-72h** **72-96h** **96-120h** **120-144h** **144-168h** **168-192h** **192-216h** 216-240h

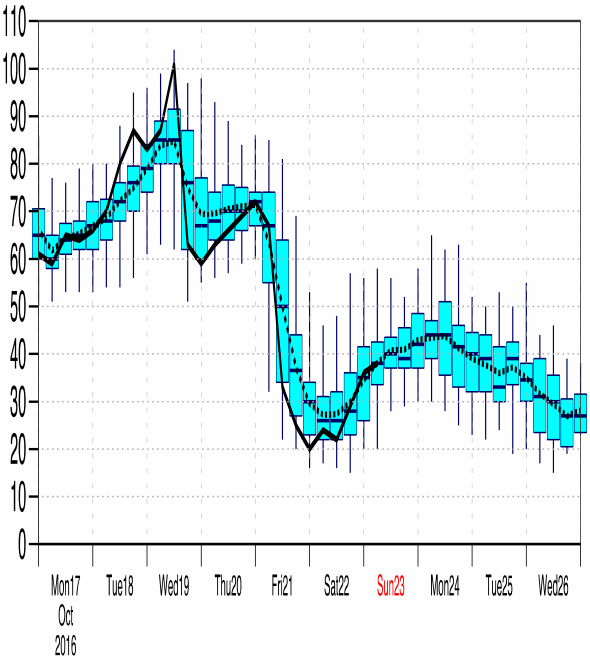


Probability (%) of Tropical Cyclone Intensity falling in each category

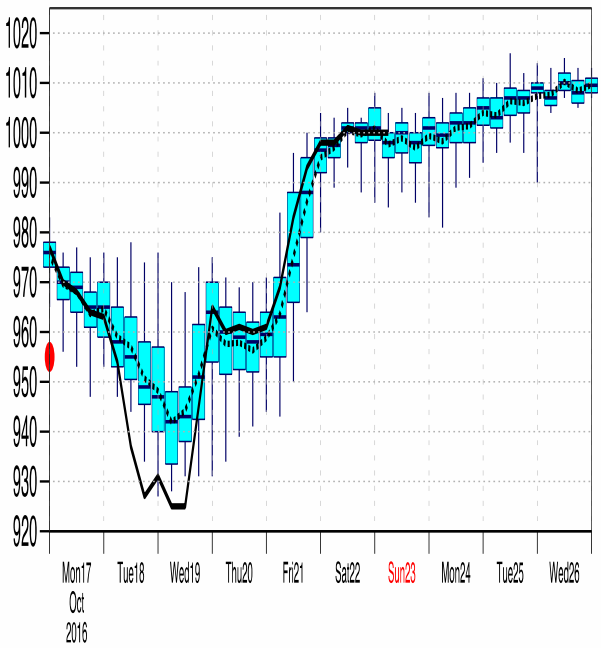
TD[up to 33] TS [34-63] HR1[64-82] HR2 [83-95] **HR3** [> 95 kt]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] **HR3**[> 95 kt]

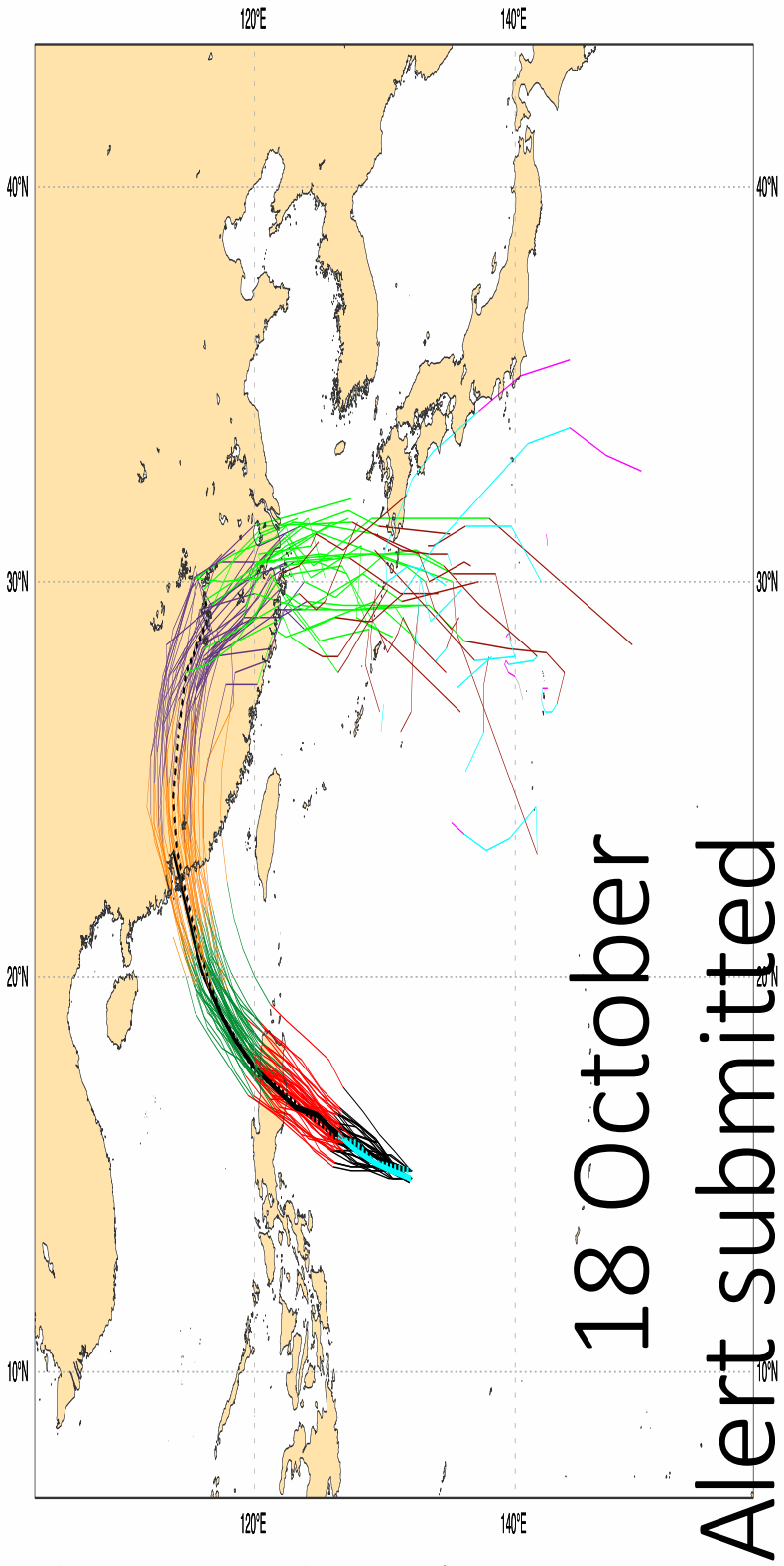
| | | |

Date 20161018 00 UTC @**ECMWF**

Individual trajectories for **HAIMA** during the next **240** hours

tracks: **thick solid**=HRES; **thick dot**=CTRL; **thin solid**=EPS members [coloured]

0-24h **24-48h** **48-72h** **72-96h** **96-120h** **120-144h** **144-168h** **168-192h** **192-216h** 216-240h

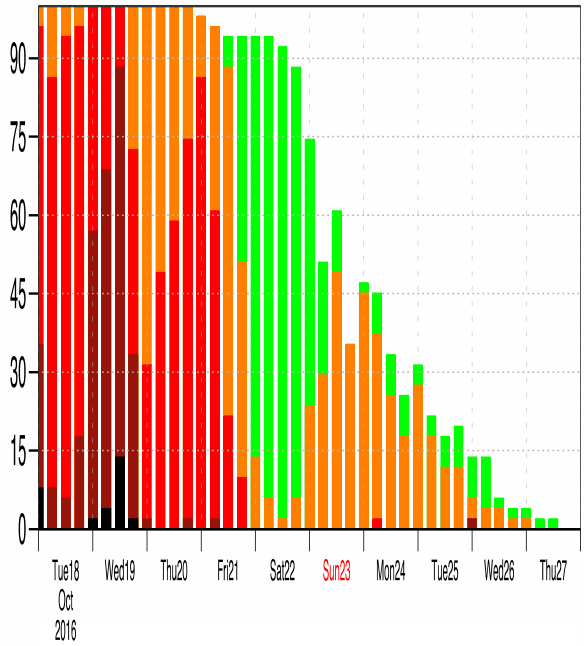


18 October

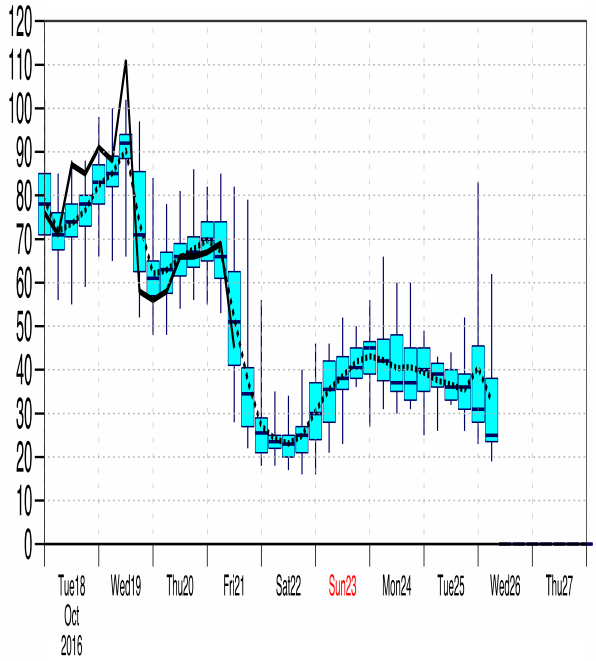
Alert submitted

Probability (%) of Tropical Cyclone Intensity falling in each category

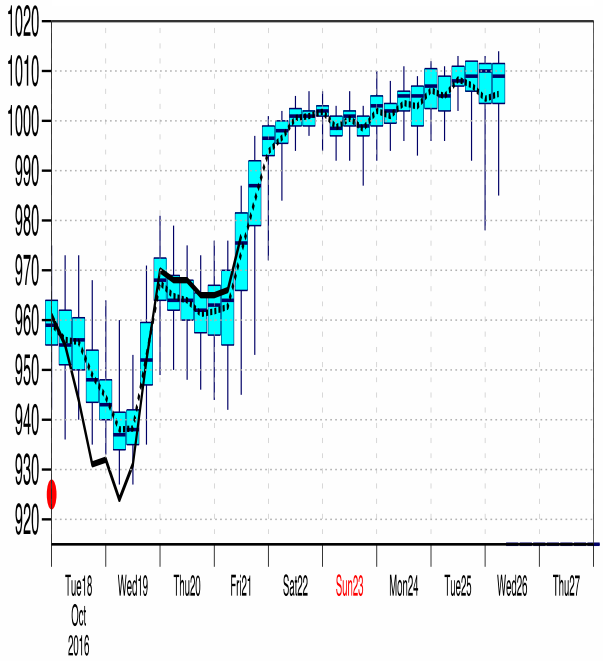
TD[up to 33] **TS** [34-63] **HR1**[64-82] **HR2** [83-95] **HR3** [> 95 kt]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 kt]

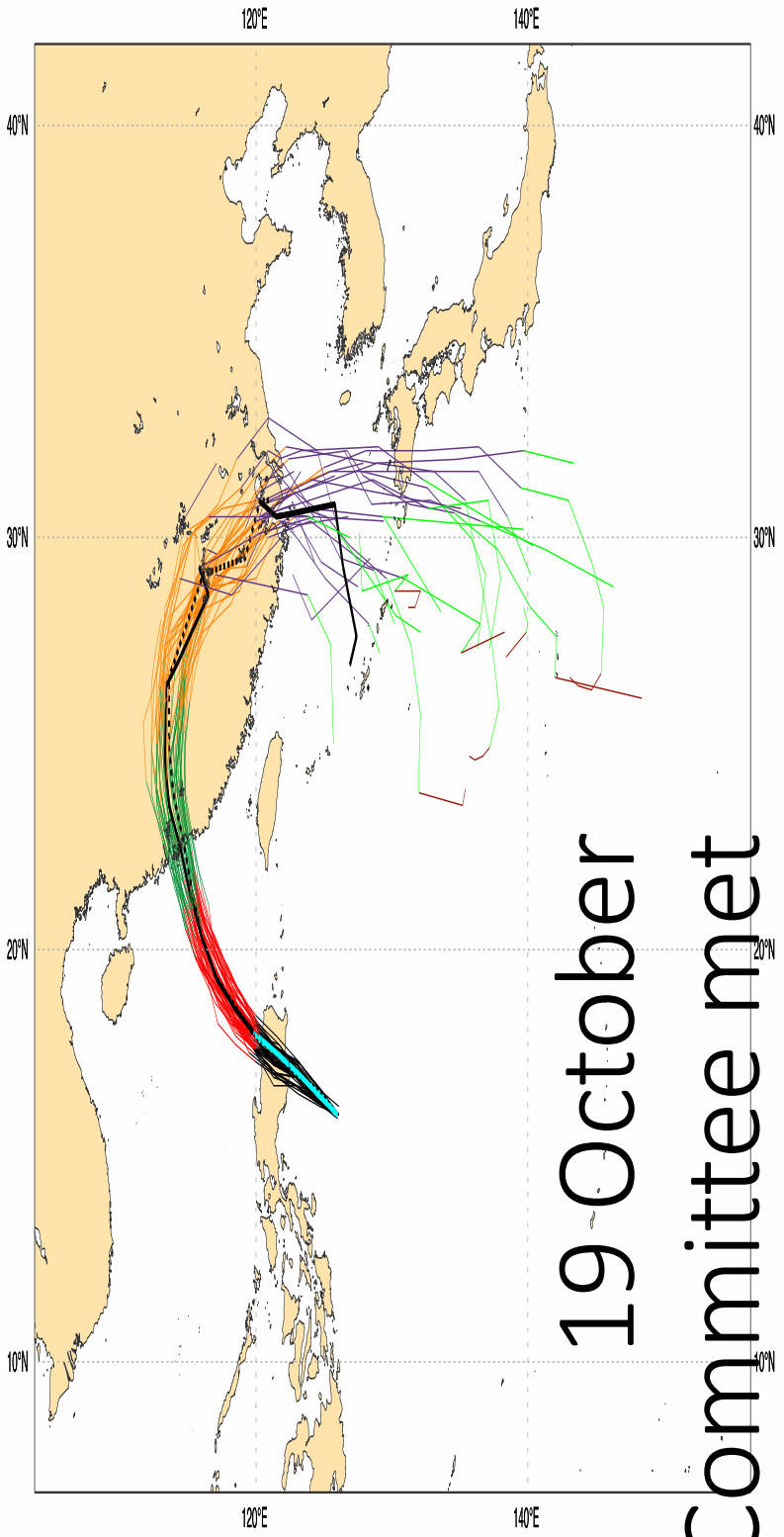
+024 h :	hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
+048 h :	hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
+072 h :	hr ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
+096 h :	ct 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 25 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 47 48 49 50
+120 h :	01 02 03 04 05 06 07 08 09 10 11 12 13 14 17 18 19 20 23 25 27 28 29 30 31 32 34 35 36 37 39 41 42 43 45 48 49 50
+144 h :	02 03 04 05 06 07 08 10 11 13 17 18 20 22 27 28 30 34 36 41 42 45 48 49
+168 h :	01 02 04 05 07 08 13 20 25 27 41 43 45 48 49 50
+192 h :	02 08 20 25 43 45 49
+216 h :	03 45
+240 h :	

Date 20161019 00 UTC @**ECMWF**

Individual trajectories for **HAIMA** during the next **240** hours

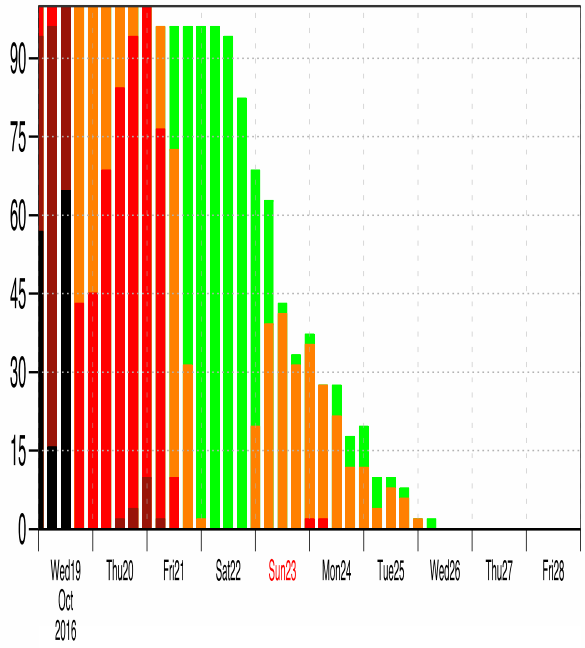
tracks: **thick solid**=HRES; **thick dot**=CTRL; **thin solid**=EPS members [coloured]

0-24h **24-48h** **48-72h** **72-96h** **96-120h** **120-144h** **144-168h** **168-192h** **192-216h** 216-240h

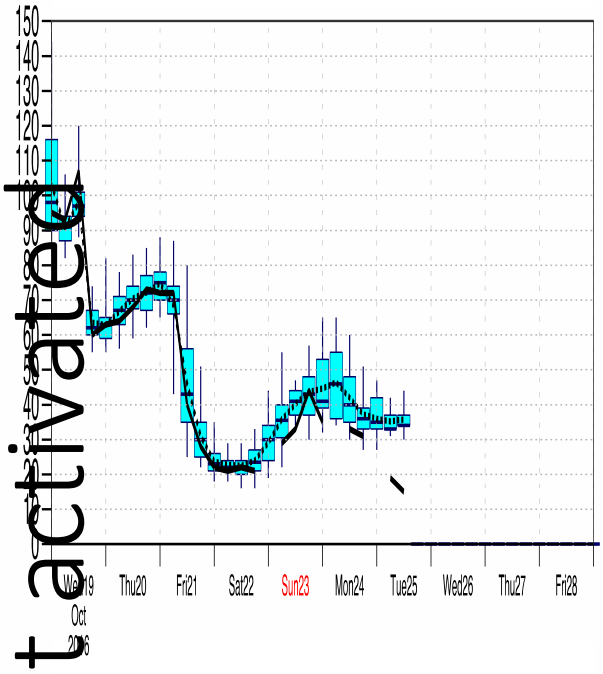


Probability (%) of Tropical Cyclone Intensity falling in each category

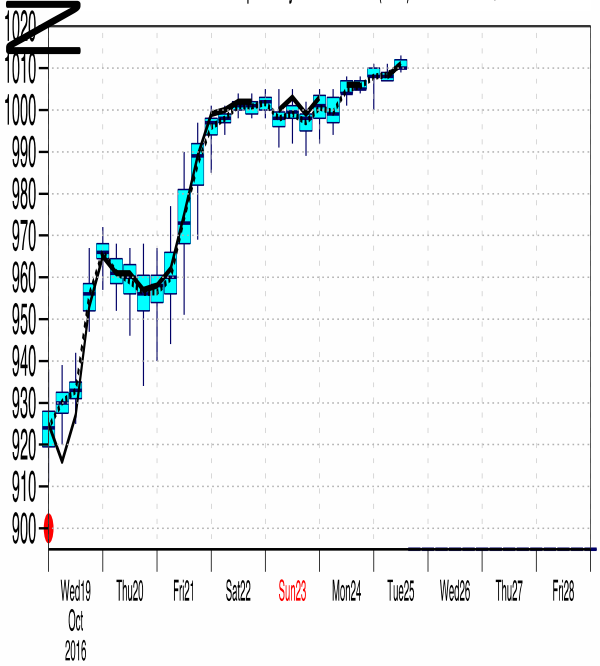
TD[up to 33] **TS** [34-63] **HR1**[64-82] **HR2** [83-95] **HR3** [> 95 kt]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



Not activated

19 October

Committee met

List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 kt]

| | | |

Aims

The aims:

- Clarity about lead time for confidence in forecast versus lead time of useful and feasible actions
- Equipping many members to contribute to decisions, not just a few
- Suggesting ways to improve the alert and activation process
- Keep it simple!

Not the aims:

- Fully automated alert/activation procedure (cf Red Cross)
- Decision based solely on forecast

Complementary to Red Cross scheme

Start Network Anticipation Window	Red Cross Forecast-based Financing (FBF)
More “subjective” procedure	More “objective” procedure
Funding is released by a committee	Triggers for release of funding are predefined
(Can be) more flexible	(Can be) quicker to act
Some level of forecast understanding or analysis is required in real time	Forecast understanding/analysis can be subcontracted out pre-event
Easier to integrate other relevant factors such as recent political or physical events	Other factors contributing to vulnerability need to be pre-defined as well
Less reliance on technical experts	Greater use of technical forecast information

Total effort involved?

Risk to charitable funds?

Trust in process?

Success in meeting own objectives?

Missed events?

Improving the procedures

- The forecast itself is only one part of the challenge here
- Works best with simple, general understanding of forecast confidence (is this an oxymoron?!)
  - Too much info: at best makes process longer, at worst causes decision paralysis
  - Need messages to be tailored by event type
- Timescales are necessarily short
- Anticipation implies lack of certainty, implies missed events **will** happen
  - Heatwave: a “missed” heatwave is likely still a very hot day
  - Cyclone: what does a “miss” entail? Depends how targeted the action is towards strong wind and storm surge hazards (very localized to track position) rather than flooding/landslides/etc (often much wider spread)

Improving the procedures

- Especially important here for the forecast users to feel ownership/ confidence/familiarity
- Concept:
  1. Look at previous occurrences of the event of interest: is this definitely well-related to the humanitarian impact? (/are previous humanitarian events generally experienced at the same time as the extreme weather?)
  2. Evaluate previous forecasts of the event of interest: what levels of confidence are found at which lead times?
  3. What lead times allow for **useful**, **feasible** actions?
  4. What degree of forecast confidence at each lead time allows for **reasonably confident funding allocation**? (depends also on cost of action/s)
  5. Can the funding procedures take into account any particular characteristics of the event or forecast?

Heatwave in Pakistan

CATS CENTRE FOR THE ANALYSIS OF TIME SERIES

1. Previous events	Yes: heatwaves regularly cause significant excess deaths across Pakistan
2. Previous forecasts	Yes: there is good predictability on the timescale of 7-10 days in the region
3. Useful lead times	Limited to actions which complement government activity: primarily awareness and public information campaigns. A few days are needed to print materials etc.
4. Forecast confidence	Because a “missed event” is still a hot day in a hot season, in a particularly hot country, a very high level of confidence is not super-important
5. Improve procedures	Mainly communicating where to monitor best information, that the forecasts are reliable, the downsides of a “miss” are low anyway, and that there should be a window of around a week for anticipation activity.

Example: heatwave in Pakistan, 2018

CATS CENTRE FOR THE ANALYSIS OF TIME SERIES

- Network members spotted forecast for heatwave in an already-hot region (Sindh province) and during observance of Ramzan (Ramadan)
- Internal discussions identified communities at risk and monitored forecast
- Alert note written and submitted on 22nd May, activated on the 23rd
- Projects began on 26th May, including targeted educational materials and “heatwave camps” providing water, shade, seating and info, plus demonstrations on first aid related to heat stroke.

Cyclone in the Philippines

1. Previous events	Yes: cyclones regularly cause damage and loss of life in the Philippines. Impact related to rainfall as much as to high wind (eg recent Tropical Depression Usman was unexpectedly damaging).
2. Previous forecasts	Varies: some cyclones have much more confident forecasts than others but the ensemble is generally a good guide to uncertainty
3. Useful lead times	Nothing later than 24h in advance due to evacuation protocols. Could pre-prepare post-crisis actions but this is not covered by anticipatory funding.
4. Forecast confidence	Communication of average track errors tends to make forecast look very uncertain. Focusing on potential rainfall (flooding, landslide) instead of forecast position gives a longer lead time for confident action.
5. Improve procedures	Awareness of ECMWF ensemble forecast is low but examples clarify its use. Since the alert process takes time, consider writing an early alert with an option to confirm or withdraw after a further 24 or 48h. Committee can meet in 12h if needed.

Note: RSMC forecast takes precedence over model guidance

Take-homes

CATS CENTRE FOR THE ANALYSIS OF TIME SERIES

- Facilitating genuine real-time use of the forecast is about more than just making a good forecast;
- One size doesn't fit all: the risk profile of the forecast user affects what they able to do at different confidence levels, and they may not be able to quantify those confidence levels a priori;
- We started with the easier event types, where sufficient confidence is often available close enough to the event to be able to take action before it occurs (in general this often may not happen)
- Don't jump in at the deep end: a hand-hold through the basics may be more helpful than detailed technical analysis.

Dr Erica L Thompson
Centre for Analysis of Time Series, LSE

E.Thompson@lse.ac.uk
@h4wkm0th

Using ECMWF Forecasts, Reading, 4 June 2019