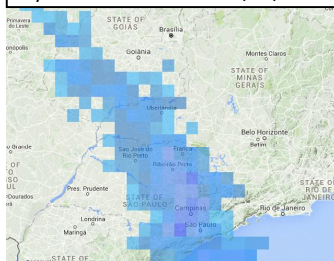# Global Hazard Map

- Aims to summarise the risk of high-impact weather across the globe in the next 7 days using global multi-model ensemble forecasts

  - Precip / Wind / Snow

  - Tropical Cyclones

  - Heatwave and Coldwaves

- Web Map Service – easy to overlay info, zoom/pan, flexible format for data layers

- Symbol-based summary map, coloured by lead time, gives 'at a glance' view of all hazards

- Can then drill down to particular variables / days / models / areas of interest

- Can overlay vulnerability and exposure layers to give information on likely impact

  - Population density

  - Fragile State Index

  - Soil moisture

  - Recent earthquakes

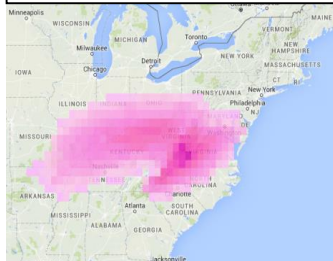# GHM forecast layers and identifying high-impact weather events

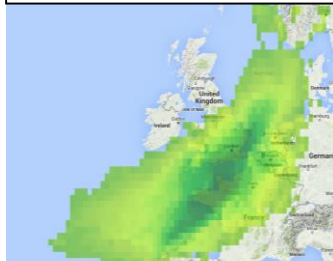ECMWF ENS; MOGREPS-UK; **Multi-Model**

Day 3 forecast from 00Z 09/03/2016 | Day 4 forecast from 00Z 19/01/2016 | Day 4 forecast from 00Z 25/03/2016
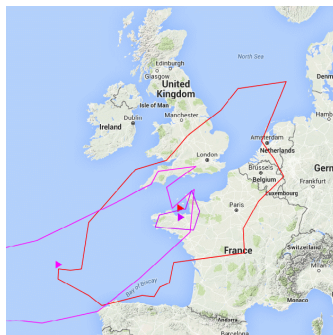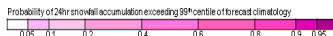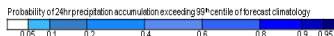
24hr Precipitation Accum. | 24hr Snowfall Accum. | 24hr Max. Wind Gust

For each of these it shows the probability of exceeding the 99th centile of forecast climatology

Probability of 24hr precipitation accumulation exceeding 99th centile of forecast climatology
0.05 0.1 0.2 0.4 0.6 0.8 0.9 0.95

Probability of 24hr snowfall accumulation exceeding 99th centile of forecast climatology
0.05 0.1 0.2 0.4 0.6 0.8 0.9 0.95

Probability of maximum wind gust exceeding 99th centile of forecast climatology
0.05 0.1 0.2 0.4 0.6 0.8 0.9 0.95

Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7
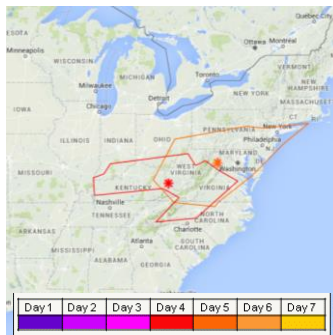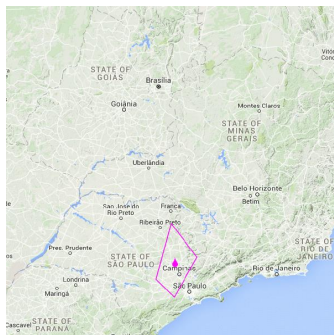
Summary polygons, coloured by lead time, show the areas where the probabilities are > 0.4

ECMWF ENS only

Day 5 forecast from 12Z 15/06/2015 | Day 6 forecast from 00Z 15/06/2015
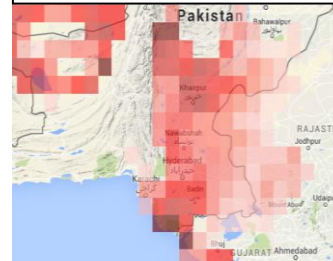
Excess Heat Factor (EHF) | Excess Cold Factor (EHF)

Probability of a heatwave (as defined by the EHF (Excess Heat Factor) methodology)
0.05 0.1 0.2 0.4 0.6 0.8 0.9 0.95

Probability of a coldwave (as defined by the ECF (Excess Cold Factor) methodology)
0.05 0.1 0.2 0.4 0.6 0.8 0.9 0.95
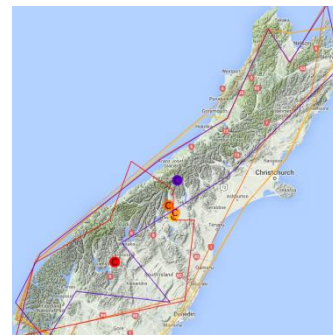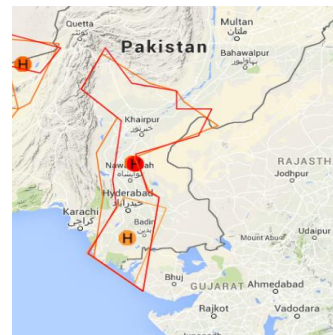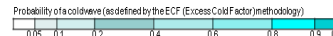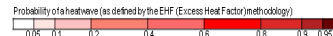
Currently only available in 'Test' version

GHM Heatwave layer: Pakistan Heatwave June 2015

- The GHM heatwave layers display the probability of a **"Severe heatwave"** as defined by Nairn and Fawcett (2015) using the "Excess Heat Factor" measure

- Between the 20th June and 24th June 2015, **more than 7,000 people were treated for heat stroke** with **at least 744 fatalities**

	0.4-0.6	0.6-0.8	0.8-1.0
Tropical cyclone			
Precipitation			
Wind gust	▶	▶	▶
Snow	✳	✳	✳
Heatwave	Ⓗ	Ⓗ	Ⓗ
Coldwave	ⓒ	ⓒ	ⓒ

Symbol size varies with probability and colour indicates forecast day

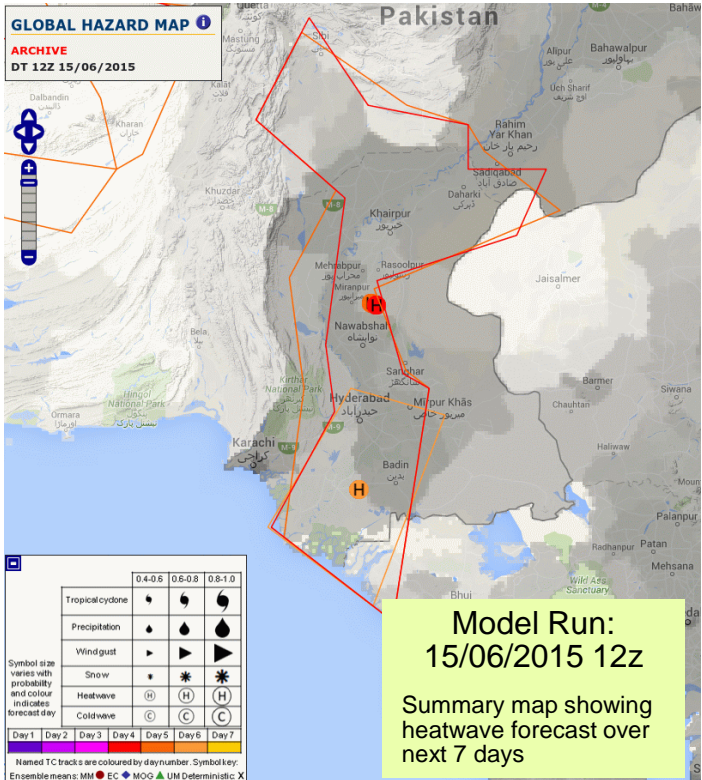| Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 |

Named TC tracks are coloured by day number. Symbol key:
Ensemble means: MM ● EC ◆ MOG ▲ UM Deterministic X

Model Run: 15/06/2015 12z

Summary map showing heatwave forecast over next 7 days

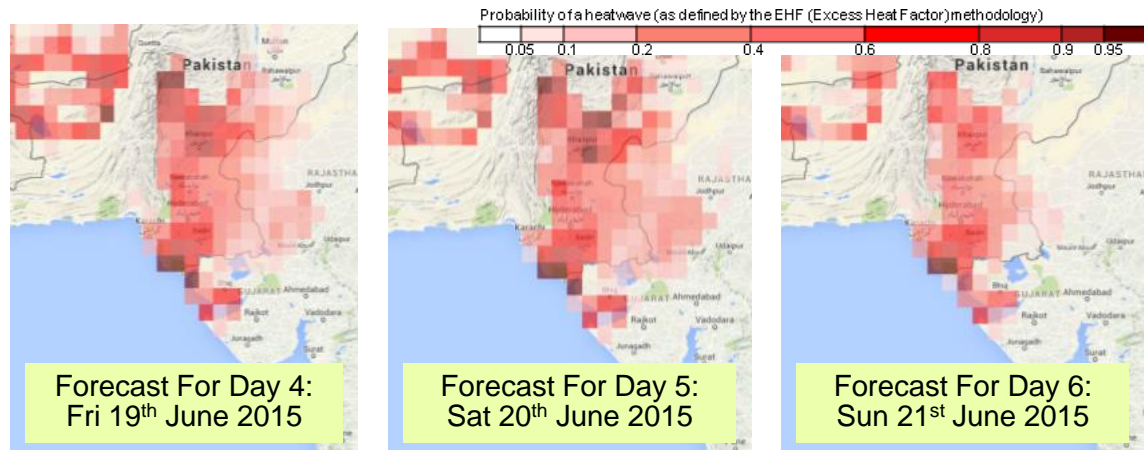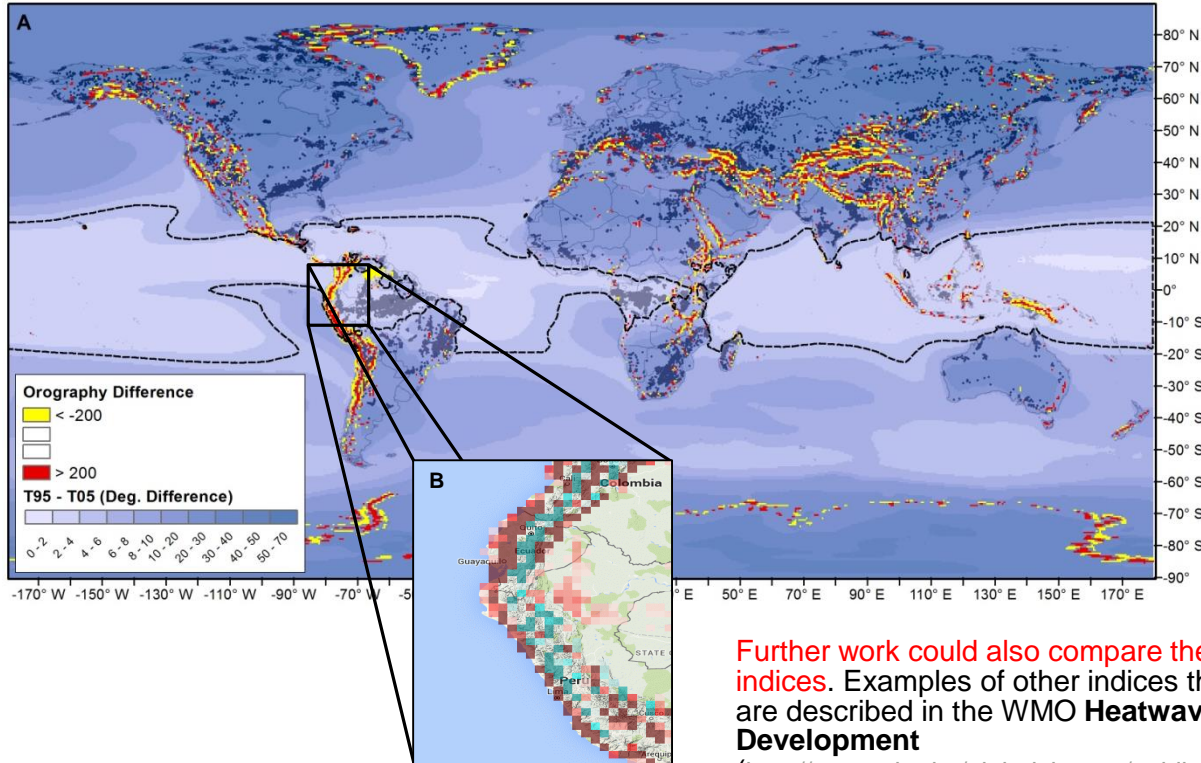| **Excess Heat Factor** *Heatwave measure combining the effects of Excess Heat and Heat Stress, Nairn and Fawcett (2013; 2015). Severe heatwave threshold is then defined as 85th centile of +EHF climatology.*	$EHF = EHI_{sig} \times \max(1, EHI_{accl})$
Excess Heat *How hot a 3-day period is with respect to the 95th centile of the daily mean temperature climatology*	$EHI_{sig} = (T_i + T_{i+1} + T_{i+2})/3 - T_{95}$
Heat Stress *How hot a 3-day period is with respect to the previous 30-days*	$EHI_{accl} = (T_i + T_{i+1} + T_{i+2})/3 - (T_{i-1} + \ldots + T_{i-30})/30$

Probability of a heatwave (as defined by the EHF (Excess Heat Factor) methodology)

0.05   0.1   0.2   0.4   0.6   0.8   0.9   0.95

Forecast For Day 4: Fri 19th June 2015

Forecast For Day 5: Sat 20th June 2015

Forecast For Day 6: Sun 21st June 2015

Heatwave & Coldwave Evaluation & Recommendations

Investigation of heatwave forecasts (where probability was greater than 40%) globally.

- Have seen some over-forecasting in the tropical regions
- Have also observed rippling heatwave and coldwave banding (see insert plot)

We have identified a mismatch between the climate (30-yrs of ERA-Interim data) and forecast system (ECMWF ENS) orography which has introduced some unwanted effects.

Future work aims to address unwanted affects in the forecast by developing a new 30-year climatology with similar coastal and topographic projection.

Further work could also compare the EHF and ECF to other heatwave and coldwave indices. Examples of other indices that could be considered for such an assessment are described in the WMO **Heatwaves and Health: Guidance on Warning-System Development** (http://www.who.int/globalchange/publications/WMO_WHO_Heat_Health_Guidance_2015.pdf)

Heatwave & Coldwave Evaluation & Recommendations

Heatwave & Coldwave Database
- Spatial_ID (entry ID)
- Event_ID (hazard event ID)
- Record Date
- Start Date
- End Date
- Hazard Type ('Heatwave' or 'Coldwave')
- Country Name
- Region/State/Province Name
- Region/State/Province Latitude
- Region/State/Province Longitude
- Settlement Name
- Settlement Latitude
- Settlement Longitude
- Impact Information
- Impact Categorisation
- References
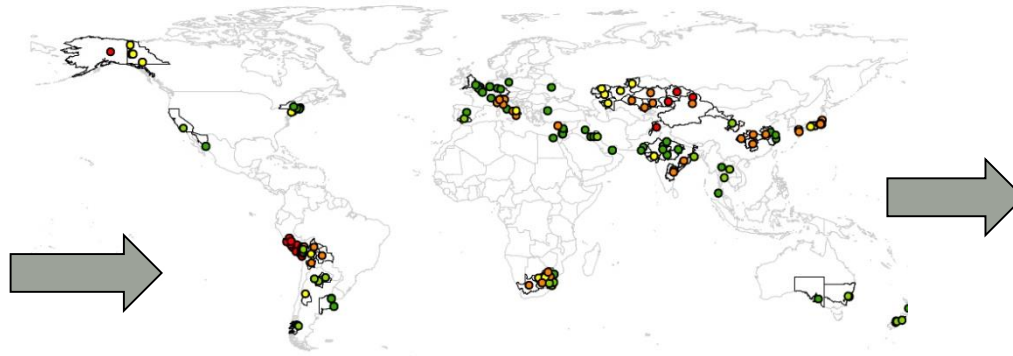
Heatwave & Coldwave socio-economic impacts database for period April 2015 to December 2015.
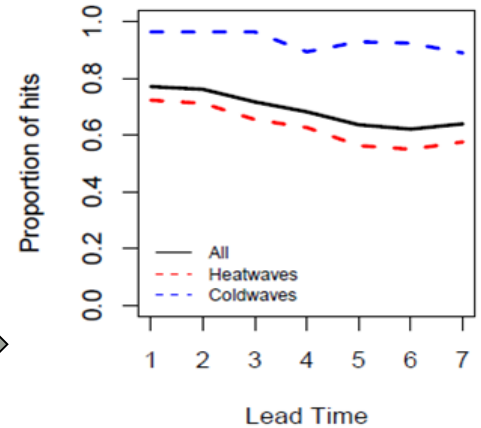
Plot showing **proportion of hits** obtained by comparing intersects between impact polygons and GHM forecast summary polygons, for matching occurrence ('observed') and validity ('forecast') dates.

Possible future work for socio-economic impact anaysis:

- Continue producing socio-economic impact databases and compare against the annual spatial distribution of EHF and ECF forecasts. This would allow review of how GHM heatwave/coldwave forecasts and impacts vary under different global-scale teleconnections (e.g. ENSO). It would also enable tracking and assessment of trends.

- Identify method for assessing false alarm rate of heatwave and coldwave forecasts, based on the socio-economic impact evaluation method.

- Assess approaches for including information on vulnerability and exposure associated with heatwave and coldwave events (i.e. demography, population density, urban v's rural)
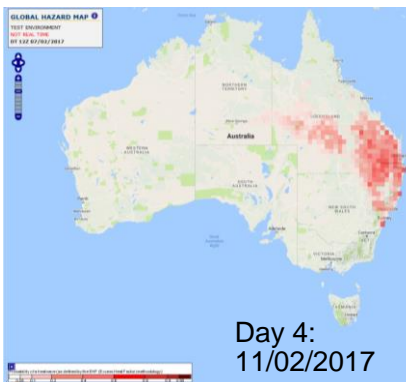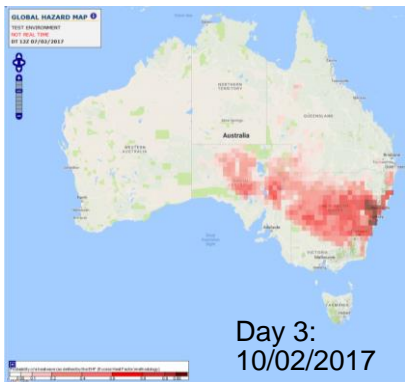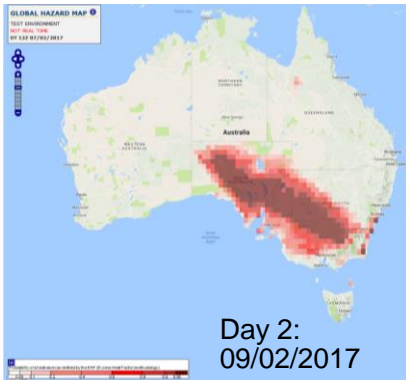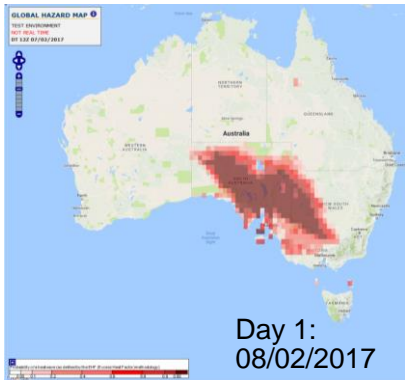
GHM Heatwave & Coldwave forecasts: Ongoing & future work

• Continue to look at approaches which could improve EHF/ECF forecasts in GHM, based on recommendations from evaluation report (Titley & Robbins, 2016) – i.e. integration of vulnerability/exposure into the production of summary symbols

• Extend collaboration with Australian Bureau of Meteorology:

> • Continued liaison between ourselves, John Nairn (Heatwave pilot project in Australia) and Debra Hudson (predictability of Heatwaves at S2S timescales)

> • Make GHM available to collaborative partners

• Submitting abstract & paper to the 21st International Congress of Biometeorology – evaluating global heatwave/coldwave forecasts & improving global impact recording

> • 'Challenges of verifying global heatwave and coldwave forecasts: Can emerging technology help?' – which will include contributions from BoM and the University of Tasmania who have produced 'AirRater' – a smartphone app which disseminates information about current atmospheric conditions and forecasts of heat and cold waves. The app also collects clinical symptom reports from registered users enabling subsequent epidemiological analyses of the effects of atmospheric conditions

• Work to improve socio-economic impact evaluation method to include additional verification metrics – following improvements to impact recording & methods for defining high-impact events

GHM Heatwave layer:
Australian Heatwave
February 2017

Forecast Run: 07/02/2017 12Z

Day 1: 08/02/2017

Day 2: 09/02/2017

Day 3: 10/02/2017

Day 4: 11/02/2017

Day 5: 12/02/2017

Day 6: 13/02/2017