A3

Use of Subseasonal-to-Seasonal Predictions for Extreme Temperature Forecasts over Singapore and the Surrounding Region

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Introduction

Singapore experienced 6 'heatwaves'* since records began during the March to May inter-monsoon seasons. These episodes coincided with strong El Niño years during its decaying phase (Table 1).

Despite the strong link to El Niño, subseasonal processes are also important to explain the variability of warm conditions on a week-to-week basis.

This study presents the recent 2016 case study and assesses the skill of S2S predictions for temperature around Singapore and the surrounding region.

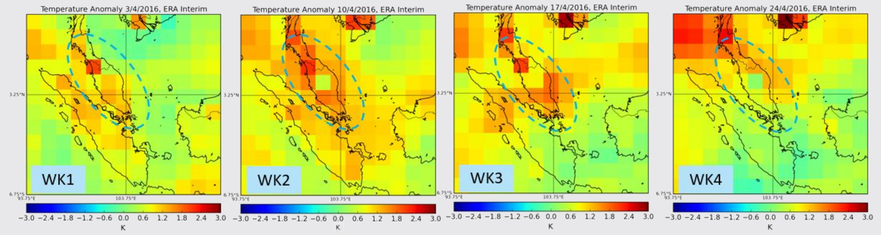
Year	Episodes
1983	March 10-14 March 24-28 April 9-21
1998	March 20-29
2010	March 6-9
2016	April 17-19

Table 1: Past 'heatwave' episodes in Singapore during the March-May inter-monsoon from 1979 onwards.

Data and Methods

Daily average temperature from **ECMWF S2S model hindcast** of 11 ensemble members (2 runs per week) was used to calculate the weekly average temperature forecast anomalies with respect to the model climatology period 1998 - 2016.

Figure 1: ERA-Interim Weekly Temperature anomalies for Apr 2016; warming from Week 1 to Week 3. Warm temperatures recede northwards from the western coast of the Peninsular Malaysia from Week 3 onwards.



Weekly average of ERA-Interim reanalysis T2m dataset (Figure 1) was used as observational reference and also for verification against ECMWF S2S hindcast anomalies using mean squared skill score (MSSS), calculated based on lead-dependent climatology over the 1998-2016 period.

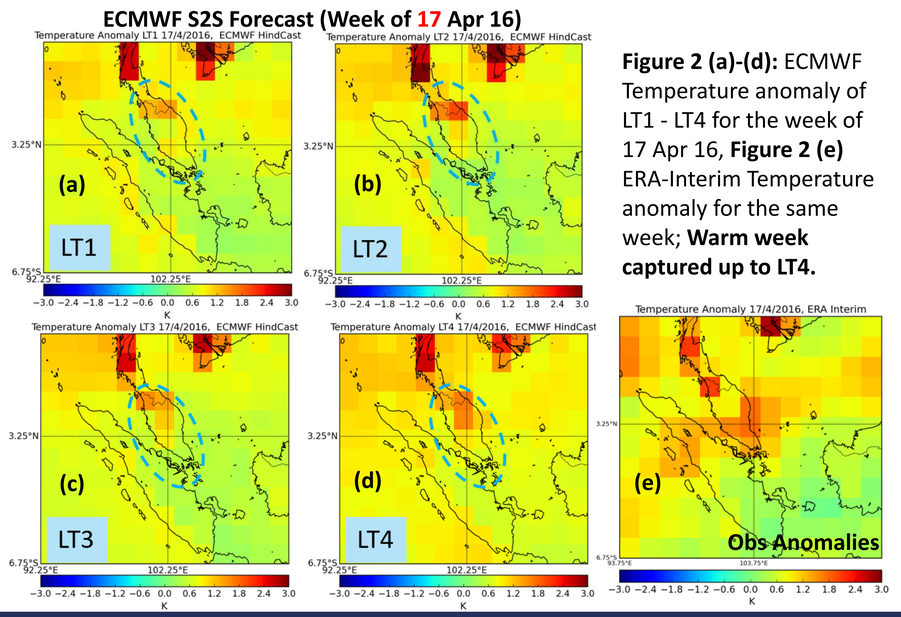


Figure 2 (a)-(d): ECMWF Temperature anomaly of LT1 - LT4 for the week of 17 Apr 16, **Figure 2 (e)** ERA-Interim Temperature anomaly for the same week; **Warm week captured up to LT4.**

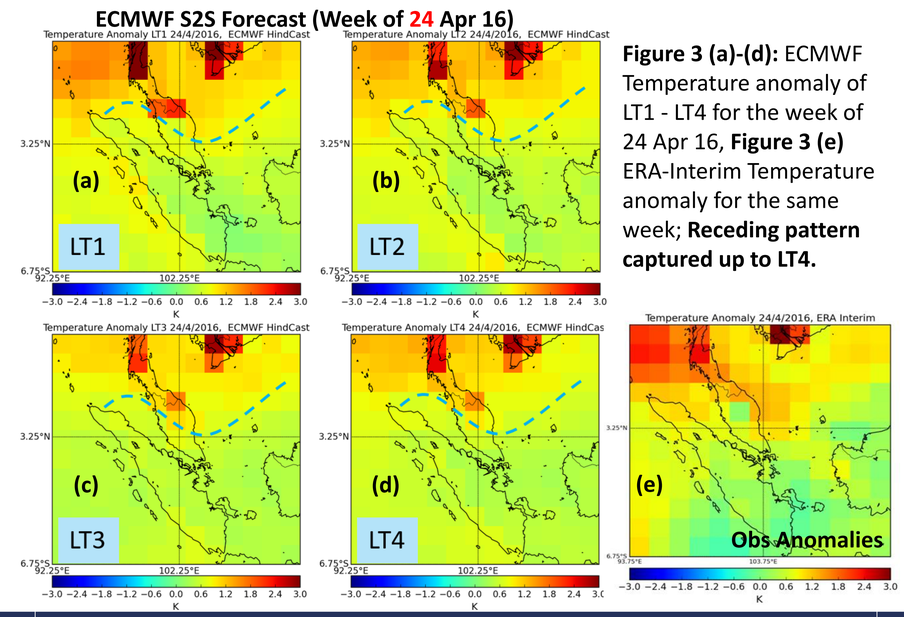


Figure 3 (a)-(d): ECMWF Temperature anomaly of LT1 - LT4 for the week of 24 Apr 16, **Figure 3 (e)** ERA-Interim Temperature anomaly for the same week; **Receding pattern captured up to LT4.**

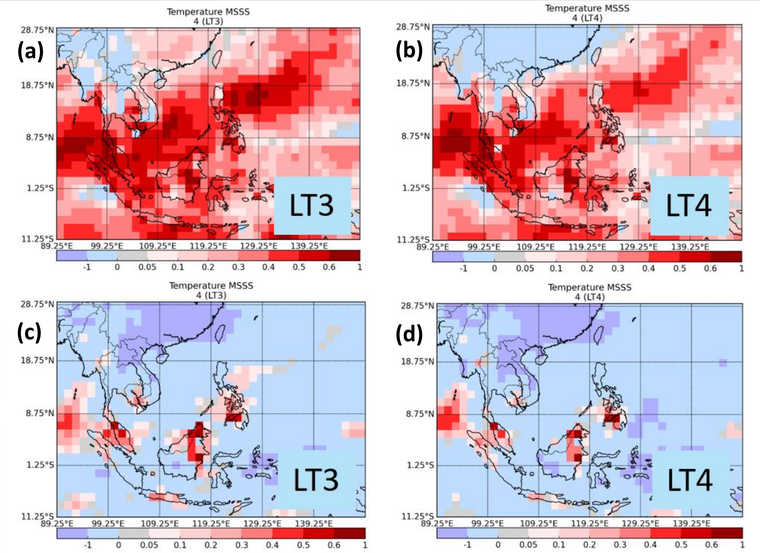


Figure 4: MSSS comparison between ECMWF S2S hindcast model **(a,b)** and persistence **(c,d)** for month of April against ERA-Interim for LT3 - LT4.

Results

- Warm week of 17 Apr 2016 is predicted by the ECMWF S2S model up to a lead time (LT) of 4 weeks (Figure 2a-d), albeit more representative in north/central Peninsular Malaysia.
- Receding heatwave spatial pattern for the week of 24 Apr 2016 was also captured by the model up to a LT of 4 weeks (Figure 3a-d).
- Relatively high skill for the region: MSSS for ECMWF model (Figure 4a-b) ranges between 0.3 and 0.7 up to a LT of 4 weeks, compared to the MSSS persistence 'forecast' (Figure 4c-d) which is between -1 and 0.5.
- Differences of up to 2°C between ERA-Interim data and local station highlights the limitation in using reanalysis datasets in quantifying extremes (results not shown here).

Conclusions

- The 2016 heatwave case study demonstrates the ability of the ECMWF S2S model to forecast the week-to-week variations in temperature, including the peak and cessation of the warmest temperatures.
- Demonstrates the potential benefit of S2S predictions for Singapore and the surrounding region and the opportunity to provide **products for worsening and/or improving extreme temperature conditions**.
- Will have important implications in public's preparedness against heat exhaustion between the weather (days) and seasonal (months) timescales.

Future Works

1. To investigate the ECMWF S2S operational 51 ensemble members' spread for the northern and southern parts of Peninsular Malaysia for the 2016 case study (dipole signal index).
2. To investigate sources of predictability (synoptic conditions such as sea surface temperature and wind flow anomalies over South China Sea).

- In Singapore, a heatwave is defined as occurring when the daily maximum temperature is at least 35°C on 3 consecutive days, and the daily mean temperature throughout the period is at least 29°C.