Improving WRF-Hydro Runoff Predictions of Heavy Floods Through Higher Spatio-Temporal Sea Surface Temperature Products

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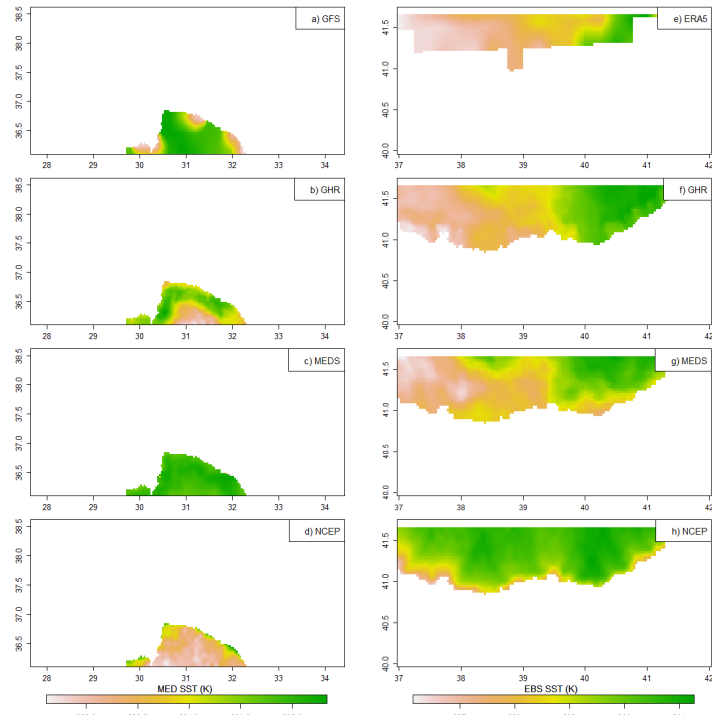
[1]Middle East Technical University
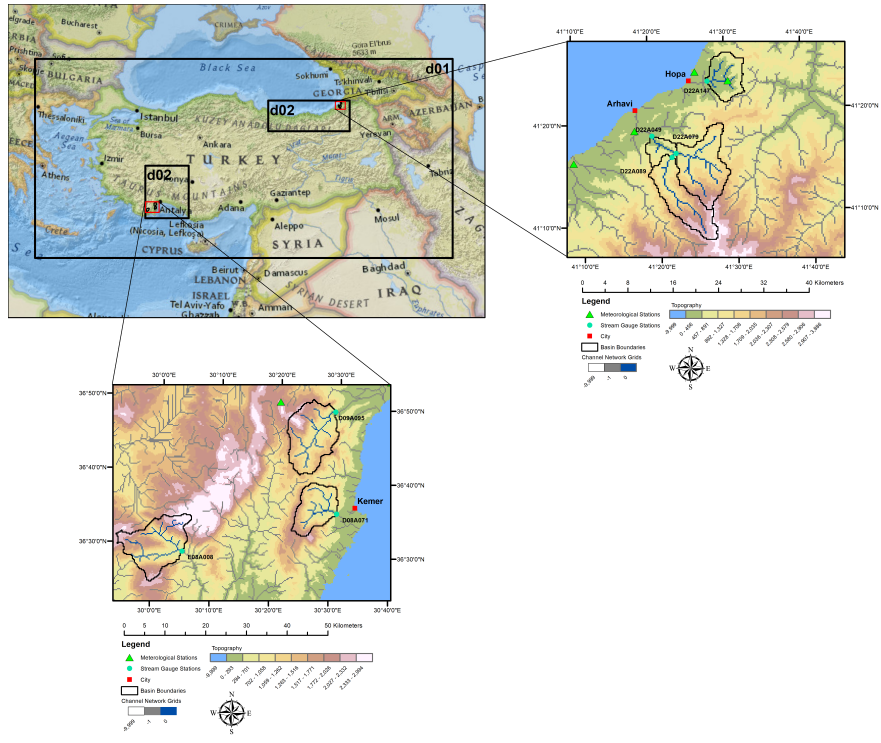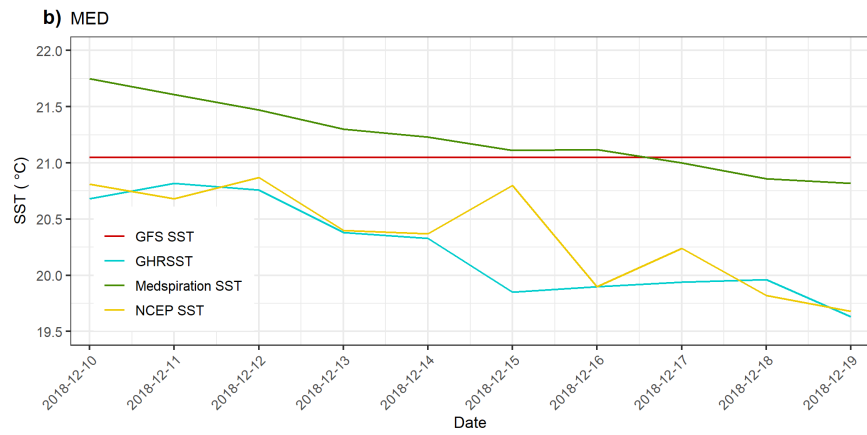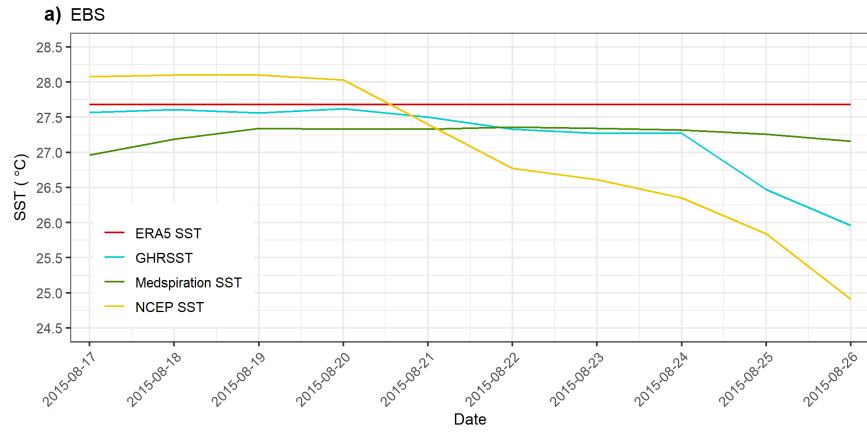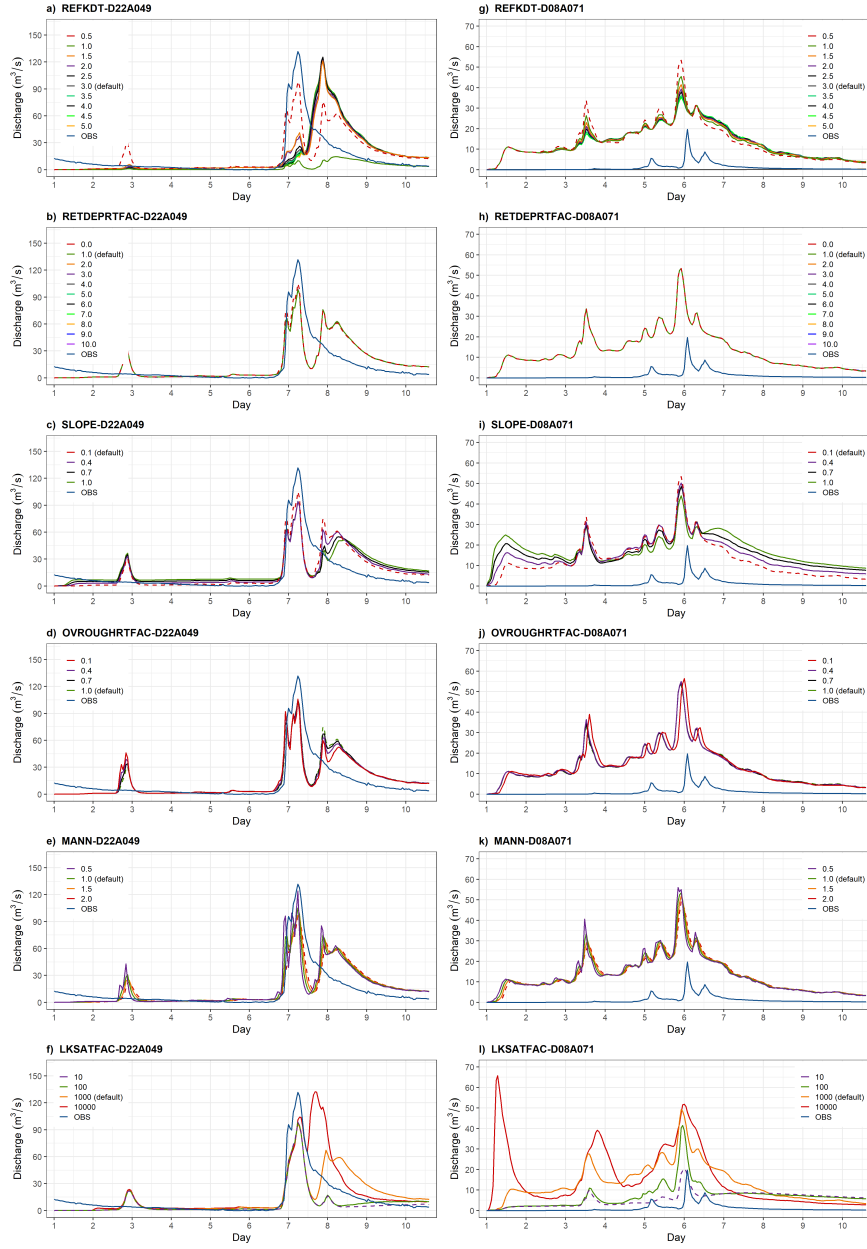[2]Orta Dogu Teknik Universitesi

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Abstract

In this study, the impact of spatio-temporal accuracy of four different sea surface temperature (SST) datasets on the accuracy of the Weather Research and Forecasting (WRF)-Hydro system to simulate hydrological response during two catastrophic flood events over Eastern Black Sea (EBS) and Mediterranean (MED) regions of Turkey is investigated. Three time-varying and high spatial resolution external SST products (GHRSST, Medspiration, and NCEP-SST) and one coarse-resolution and invariable SST product (ERA5- and GFS-SST for EBS and MED regions, respectively) already embedded in the initial and boundary condition dataset of WRF model are used in deriving near-surface weather variables through WRF. After the proper event-based calibration performed to the WRF-Hydro using hourly and daily streamflow data of small catchments in both regions, uncoupled model simulations for independent SST events are conducted to assess the impact of SST-triggered precipitation on simulated extreme runoff. Some localized and temporal differences in the occurrence of the flood events with respect to observations depending on the SST representation are noticeable. SST products represented with higher temporal and spatial correlation revealed significant improvement in flood hydrographs for both regions. The higher spatial and temporal correlations of GHRSST dataset show RMSE reduction up to 20% and increase in correlation from 0.3 to 0.8 with respect to the invariable SST (ERA5) in simulated runoffs over the EBS region. The error reduction with GHRSST reached 35% after the calibration of hydrological model parameters compared to not calibrated model. The use of both GHRSST and Medspiration SST data characterized with high spatiotemporal correlation resulted in runoff simulations exactly matching the observed runoff peak of 300 m3/s by reducing the overestimation seen in not calibrated runs over the MED region.

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a) EBS

b) MED

a) D22A147 08/17/2015-08/27/2015
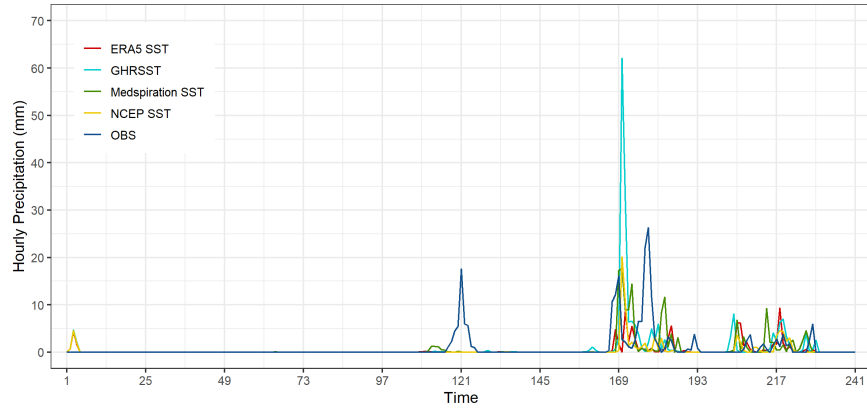
b) D08A071 12/10/2018-12/20/2018

a) Station　　　　　　　　　**08/24/2015**

Legend

▲ Meteorological Stations　　Channel Network Grids
● Stream Gauge Stations　　☐ -9,999
☐ Basin Boundaries　　　　■ -1
　　　　　　　　　　　　　■ 0

b) ERA5 - SST　　　　　　**08/24/2015**

c) GHR - SST　　　　　　**08/24/2015**

d) MED - SST　　　　　　**08/24/2015**

e) NCEP - SST　　　　　　**08/24/2015**

Daily Precipitation (mm)

0 - 4　5 - 8　9 - 13　14 - 18　19 - 23　24 - 28　29 - 31　32 - 35　36 - 39　40 - 44　45 - 50　51 - 55　56 - 60　61 - 66　67 - 71　72 - 76　77 - 80　81 - 84　85 - 90　91 - 95　96 - 100　101 - 106　107 - 111　112 - 118　119 - 124　125 - 130　131 - 140　141 - 153　154 - 169　170 - 186

a) Station   12/16/2018 17:00:00

Legend

▲ Meteorological Stations   Channel Network Grids

● Stream Gauge Stations   ☐ -9,999

☐ Basin Boundaries   ☐ -1

       ☐ 0

b) GFS - SST   12/16/2018 17:00:00

c) GHR - SST   12/16/2018 17:00:00

d) MED - SST   12/16/2018 17:00:00

e) NCEP - SST   12/16/2018 17:00:00

Hourly Precipitation (mm)

0 - 0 | 1 - 2 | 3 - 3 | 4 - 4 | 5 - 5 | 6 - 6 | 7 - 8 | 9 - 9 | 10 - 10 | 11 - 12 | 13 - 13 | 14 - 14 | 15 - 15 | 16 - 17 | 18 - 18 | 19 - 20 | 21 - 22 | 23 - 25 | 28 - 28 | 29 - 31 | 32 - 36 | 37 - 41 | 42 - 48 | 49 - 62

7

a) D22A147

b) D22A147 (Calibrated Model)

a) D08A071

b) D08A071 (Calibrated Model)