FFGS Data Ingest and Quality Control

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HYDROLOGIC RESEARCH CENTER
23 May 2018
## Example Data-Related User Interfaces

**Observed Data and Data Quality Controlled Derivative Products**

<table>
<thead>
<tr>
<th>DT</th>
<th>RADAR Precipitation</th>
<th>MWGHE Precipitation</th>
<th>GHE Precipitation</th>
<th>Gauge MAP</th>
<th>Merged MAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 hr</td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
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<tr>
<td>03 hr</td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
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<tr>
<td>06 hr</td>
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<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
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<tr>
<td>24 hr</td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
<td><img src="URL" alt="Image" /></td>
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</tr>
</tbody>
</table>
## Example Data-Related User Interfaces

### Observed On-Site Gauge Data

**Surfnet Gauge Observations at 2018-05-11 06:00 UTC**

<table>
<thead>
<tr>
<th>Station Identifier</th>
<th>Station Name</th>
<th>Accumulated Precipitation (mm/24h)</th>
<th>Average Temperature (°C)</th>
<th>Snow Depth (cm)</th>
<th>Snow Cover (Percent)</th>
<th>Rainfall</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation</th>
<th>Enable Precipitation</th>
<th>Enable Temperature</th>
<th>Enable Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>12092</td>
<td>Vahm</td>
<td>0.00</td>
<td>16.20</td>
<td>No Report</td>
<td>No Report</td>
<td>42.9942</td>
<td>22.8525</td>
<td>31</td>
<td>Enabled</td>
<td>Enabled</td>
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<tr>
<td>12302</td>
<td>Loevuk</td>
<td>0.10</td>
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<td>No Report</td>
<td>42.1893</td>
<td>24.7098</td>
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<td></td>
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<tr>
<td>12502</td>
<td>Ramgrad</td>
<td>1.40</td>
<td>13.00</td>
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<td>No Report</td>
<td>42.8401</td>
<td>28.5074</td>
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<tr>
<td>12522</td>
<td>Uzuns</td>
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<td>16.12</td>
<td>No Report</td>
<td>No Report</td>
<td>42.2182</td>
<td>27.9222</td>
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<tr>
<td>12090</td>
<td>Sharpmak</td>
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<td>5.23</td>
<td>No Report</td>
<td>No Report</td>
<td>42.8333</td>
<td>29.8033</td>
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<td>Enabled</td>
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<tr>
<td>12014</td>
<td>SdcS</td>
<td>0.80</td>
<td>13.49</td>
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<td>No Report</td>
<td>42.6223</td>
<td>23.3347</td>
<td>250</td>
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<td>Enabled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Additional Surfnet Gauge Observations from Site "USA" within the past 30 days**

<table>
<thead>
<tr>
<th>Station Identifier</th>
<th>Observation Date &amp; Time</th>
<th>Precipitation (mm/24h)</th>
<th>Temperature (°C)</th>
<th>Snow Depth (cm)</th>
<th>Snow Cover (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T7201</td>
<td>2018-05-12 06:00-00-00</td>
<td>0.30</td>
<td>10.30</td>
<td>No Data</td>
<td>No Data</td>
</tr>
<tr>
<td>T7204</td>
<td>2018-05-12 06:00-00-00</td>
<td>0.30</td>
<td>10.30</td>
<td>No Data</td>
<td>No Data</td>
</tr>
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Example Data-Related User Interfaces

Dashboard – For Data and Server Status and Health
Example Data-Related User Interfaces

Processing LOGS - Warnings, Errors and Processing Summaries

BSMEFFG - Black Sea Middle East Flash Flood Guidance System

<table>
<thead>
<tr>
<th>Selected Hourly Logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>20180611-150205_92158_export_product_image_gridded_precip_gbm.exe_bsmeffg_20180611-150218_export_product_image_gridded_precip_gbm.exe_20180611-1500</td>
</tr>
<tr>
<td>20180611-150300_99999_BSMEEFG-c3_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named ‘FV3G Modular AGREES’</td>
</tr>
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<tr>
<td>20180611-150300_99999_BSMEEFG-c3_process_sequence_models_cron_log.txt:WARNING: could not get flag value for environment variable named ‘FV3G Modular AGREES’</td>
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This is a collection of all logged WARNING messages for the current day and for any date within the TEMPO processing directories.

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Data and Model Flow Diagram
Delineations Worldwide

SRTM 90m versus ASTER 30m

(1) Istanbul Region
(2) Mediterranean Coast
(3) Mediterranean Inland
(4) Black Sea Coast
(5) Region South of Ankara
(6) South Mediterranean Coast
(7) Southern Arid Region
Delineations Worldwide

Before Finalizing Shapefiles Reviewed by Countries and Appropriate Adjustments are Made at HRC
Current Multi-Sensor Strategy

**Global Data**
NESDIS GLOBAL HYDROESTIMATOR (IR, MODEL, OROGRAPHY) – Short Latency
CMORPH (MW-BASED) – Longer latency

**Regional and Local Data**
OPERATIONAL RADAR CAPPI (IF IN DIGITAL FORM) – Short latency
OPERATIONAL PRECIPITATION GAUGES – Short Latency

**Initial Quality Control**
- Requires historical data
- Requires NMHS Agency Collaboration
  - Snow Mask for CMORPH (IMS)
  - Radar CAPPI Analysis to develop Radar Mask of Invalid Data for Application
  - Raingauge data analysis for persistent errors and unrealistic values

**Bias Adjustments**
- Requires historical data
- Requires NMHS Agency Collaboration
  - CMORPH + GHE → MWGHE (gridded)
  - MWGHE, Radar Data, Raingauge Data → MWGHE, Radar, Raingauge MAP
  - MWGHE MAP + Raingauge MAP → Bias Adj MWGHE MAP
  - RADAR MAP + Raingauge MAP → Bias Adj RADAR MAP

**Merging:**
- Bias Adj RADAR MAP – Bias Adj MWGHE MAP - ....
Example Positive Rainfall Frequency

C-band (1 degree beam width) Radar at ~3 km altitude; 4km CAPPI

Gauges with < 20% of time missing data used for reference
Satellite Precipitation – NESDIS Global Hydroestimator (GHE)

- IR based (10.7 µm)
- Short latency

Rain Rate = Function of brightness temperature

Enhanced for:
1. Atmospheric moisture effects
2. Orography (upslope/downslope)
3. Convective Equilibrium Level (warm-top convection)
4. Local pixel T difference with surroundings
5. Convective core/no-core region
Bias and Log-Bias Factors

\[
\beta_t = \ln \left( \frac{\sum_{j=1}^{N_g} R_g(t, j)}{\sum_{j=1}^{N_g} R_s(t, j)} \right)
\]

Bias (B)
Climatological Adjustment Using Gauges and Corresponding Satellite Pixel Data

• Historical Data for regions of uniform hydroclimatology, terrain and gauge density
• Usually done for a given month or season
• Result is bias factor for each region and month/season

Bias Factor computed from:

1. Mean values
2. Probability matching considerations

For Range of Satellite Rainfall (0.7-0.9) in (mm/h), Bias: 0.8

Middle East

[Graph showing probability matching for various regions in the Middle East]
Dynamic Bias Adjustment
Basics

\[
\beta_t = \ln \left( \frac{\sum_{j=1}^{N_g} R_g(t, j)}{\sum_{j=1}^{N_g} R_s(t, j)} \right)
\]

\[
\beta_{t+1} = \beta_t + w_{t+1}
\]

\[
z_{t+1} = \beta_{t+1} + v_{t+1}
\]

Kalman Filter
Stochastic Approximations

- N pairs of consecutive values
- At least 20% raingauges with rain
- Conditional Mean > Threshold (mm/h)
  (satellite/radar and gauge)

Bias (B)

Important issue:
Gauge data quality control
Multi-Spectral Satellite Rainfall

**HE**
- IR – Based
- 30-min latency in operations
- Based on measurements of top cloud brightness temperature

**CMORPH**
- MW – Based
- 18-26 hour latency in operations
- Based on measurements of microwave scattering from raindrops

New global FFGS product combines IR-based HE rainfall with MW-based CMORPH rainfall
Multi-Spectral Satellite Rainfall for FFG Systems

Window of 3 days

CMORPH Latency

IRA(t-n-1) IRA(t-n) IRA(t-n+1) B(t-2) B(t-1) B(t)

IR Rain IR Rain IR Rain

CMORPH CMORPH CMORPH

Raingauge Raingauge Raingauge

IRA IRA IRA

IRA(t-n) IRA(t-n) IRA(t-n+1) B(t-2) B(t-1) B(t)
Examples from BSMEFFG

Original GHE

Adjusted GHE
Evaluation from SARFFG

Low Level stratiform rain

2013/1 - 2014/3

UM Adjusted HE

CSI(>0)=0.12

MWGHE

CSI(>0)=0.18
Challenges FFGS Had to Overcome

Data and Information Focus

1. **Data Ingest** (format type variety, public versus private, asynchronous, variable space-time resolution)

2. **Measurement /Forecast Uncertainty** (climatological vs time varying, short records for reliability fine-tuning)

3. **Timely Product/Warning Generation** (computer and comm. requirements and constraints, timely forecaster adjustment and response)

4. **Products Easily Accessible and Searchable by NMHSs** (interface and database requirements, local versus regional data storage, requirement to use free and open source software for developing countries)

5. **Education and Training in Product Interpretation and Communication with DMAs** (diverse backgrounds, inter- and multi-disciplinary focus, cultural diversity in the perceived value of and the response to warnings)
The strong support of the country National Meteorological, Hydrological and Disaster Management Services has been essential for the useful operational utilization of the regional FFG systems.