सत्यमेव जयते

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

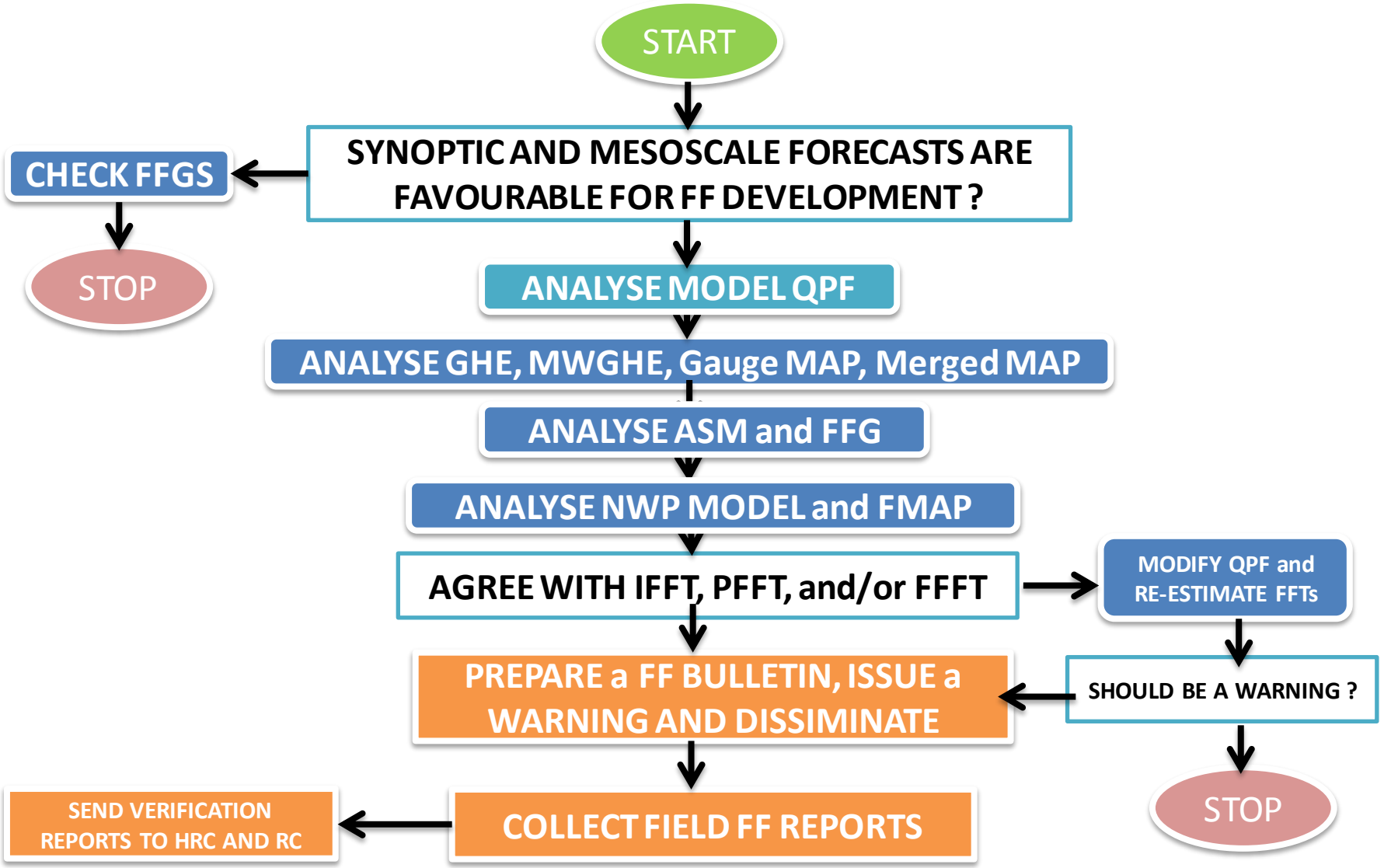
Guidance for Preparation of Flash Flood Warnings

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale

Guidance for Preparation of Flash Flood Warnings

- In flash flood forecasting, forecasters should use all available tools to better understand weather situation in particular region, use locale knowledge and experience, and current situation from field.
- As usual, forecasters should first do synoptic scale analysis, mesoscale analysis and finally small scale analysis, and interpretation of FFGS products.
- As part of nowcast process forecasters should use satellite images, radar products and information from station.
- It is very important to take in consideration past weather events (few days) so one can get better images about soil moisture and stage of rivers.
- Also, flash floods can cause two different types of weather: big frontal system with heavy and steady rain and convective heavy rain with fast development.

FFGS Flash Flood Analysis Flowchart



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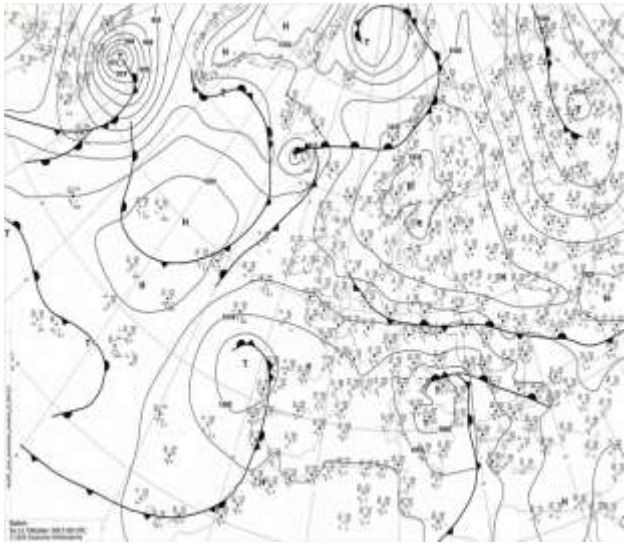
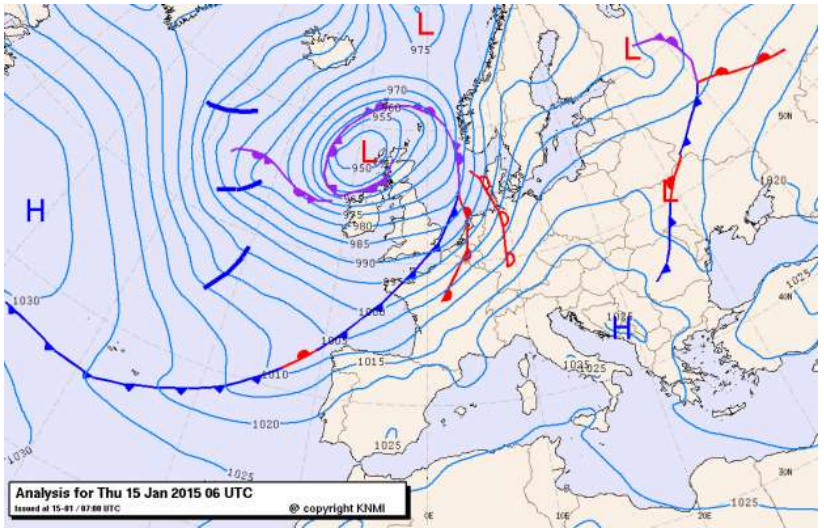
Synoptic Analysis

- **Synoptic Analysis should contain:**

- **Surface analysis:**
  - Current weather
  - Low pressure systems and frontal systems and their movement in time
  - Winds
  - Precipitation types and amounts





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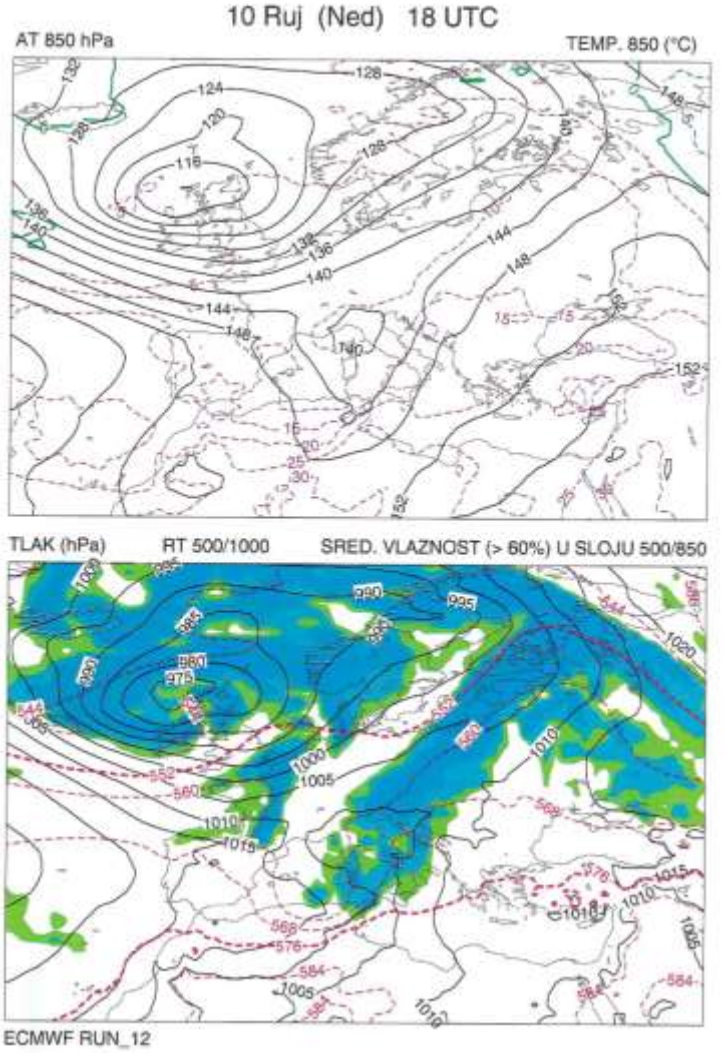
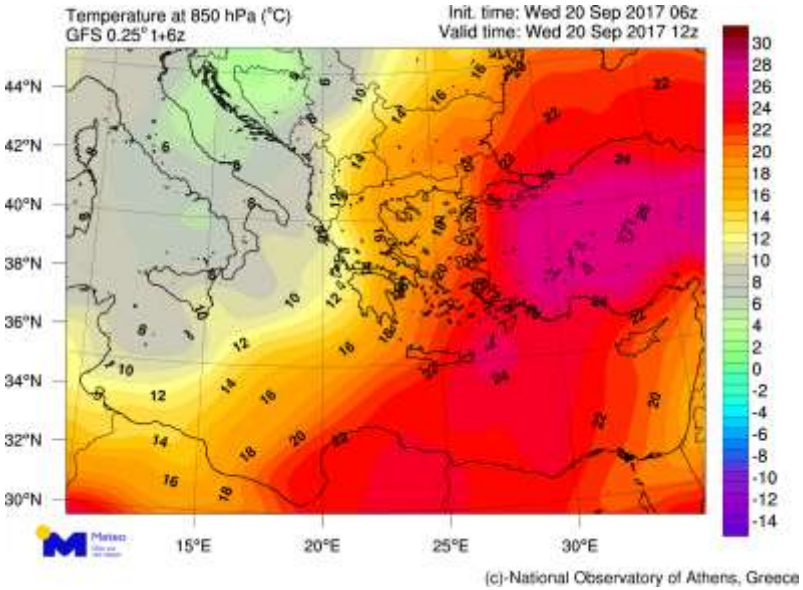
Synoptic Analysis

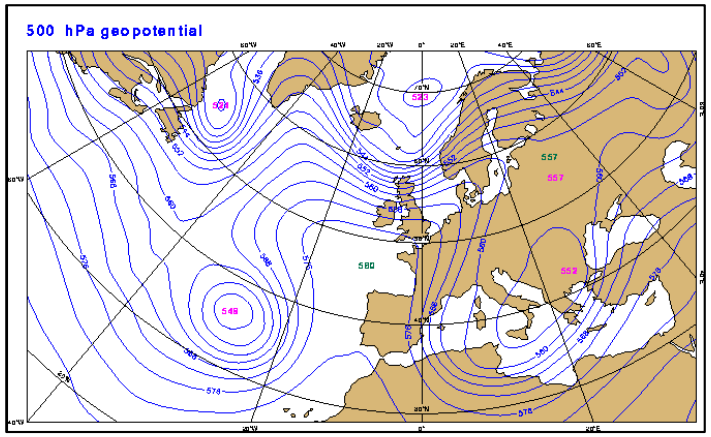
- **850 hPa analysis:**
  - Trough and ridges
  - Warm and cold air advection
  - Low level convergence
  - Wind
  - Humidity

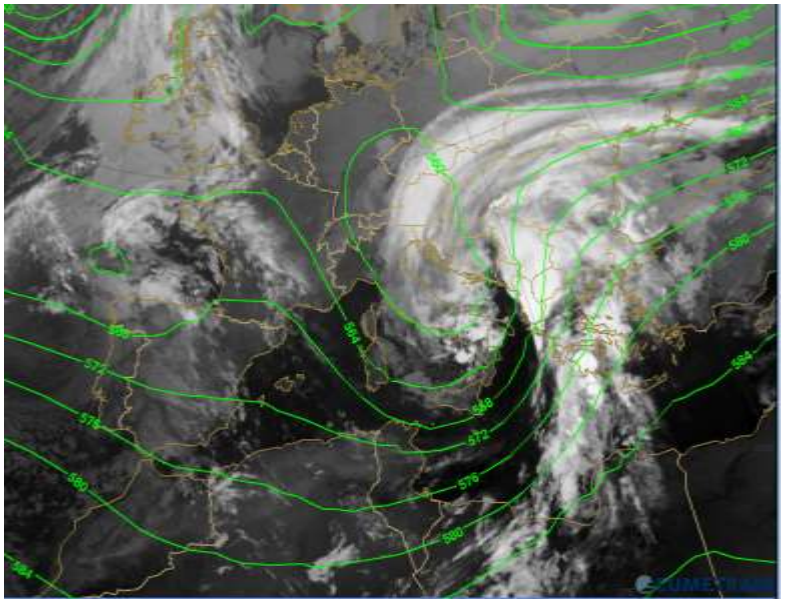


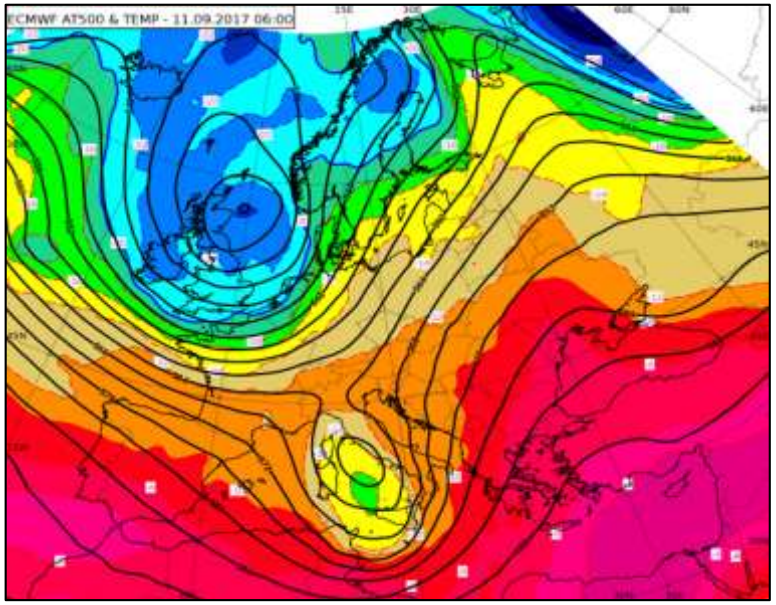


Synoptic Analysis

- **500 hPa analysis:**
  - Trough and ridges
  - Warm and cold air advection
  - Convergence and divergence areas
  - Wind
  - Vertical motions







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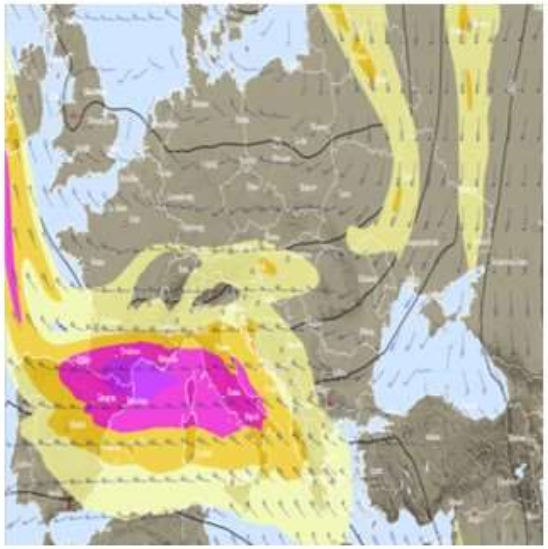
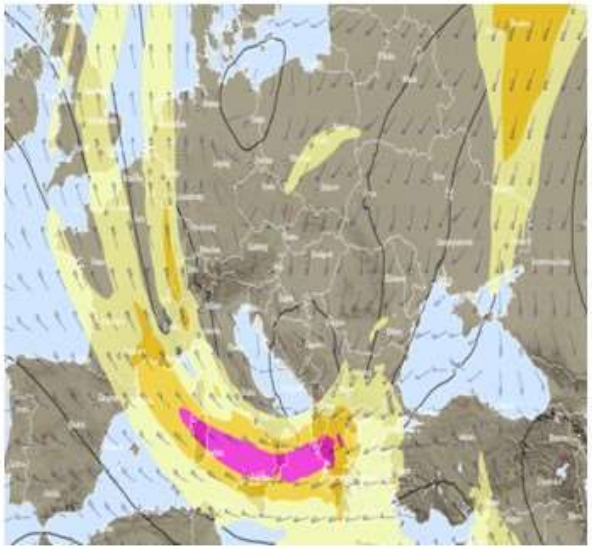
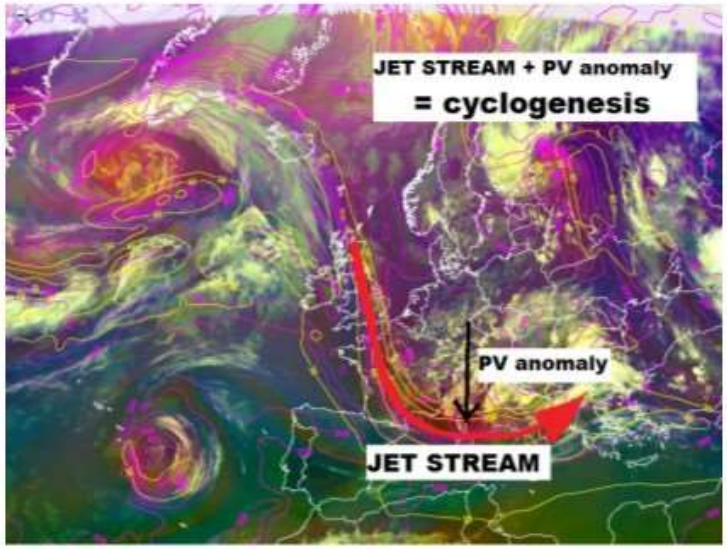
Synoptic Analysis

- JET stream locations and movement in time
- Satellite images
- Various LAM models





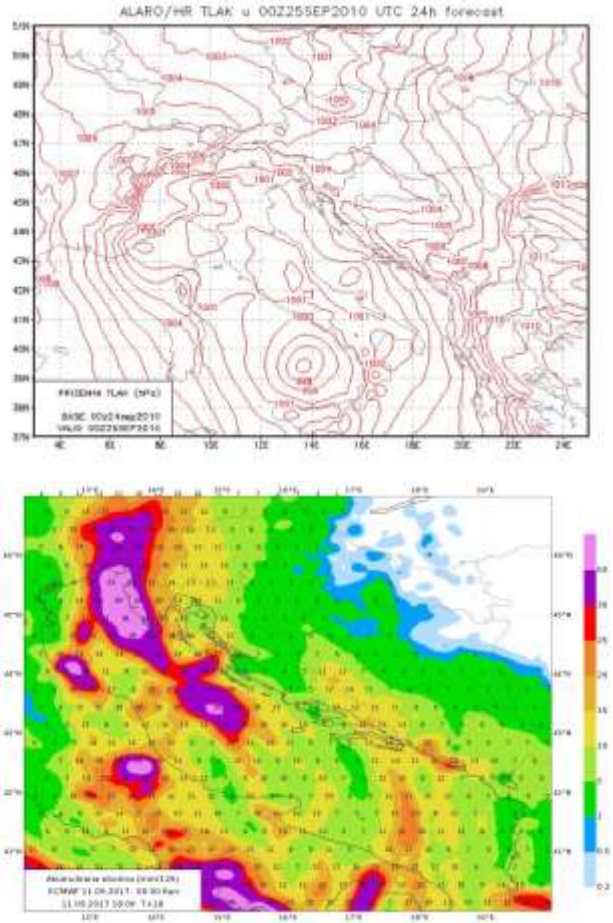


Mesoscale Analysis

Mesoscale weather analysis should be more detailed with focus on local areas.

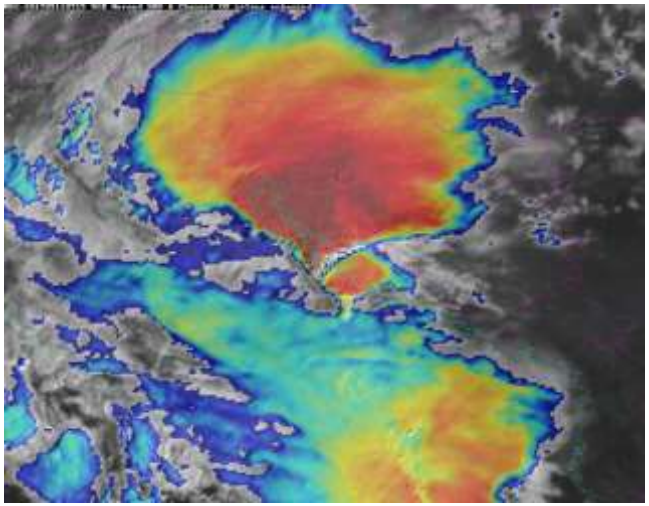
Mesoscale Analysis should contain:

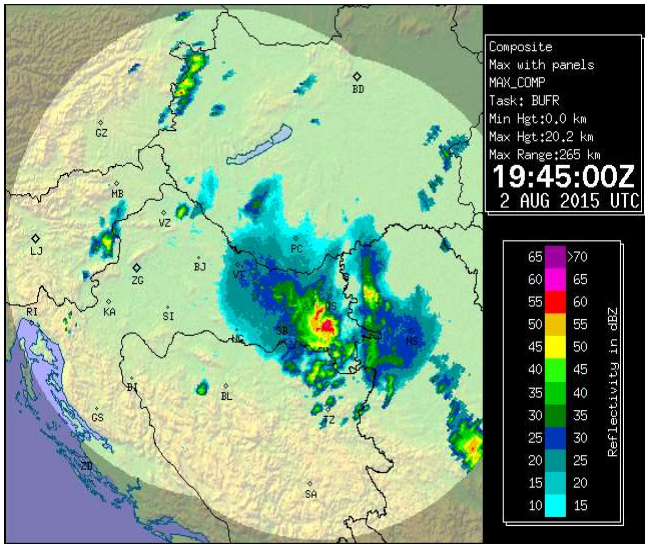
- Detailed surface analysis
- Dry line
- Gust fronts
- Instability
- Satellite images



Nowcasting Analysis

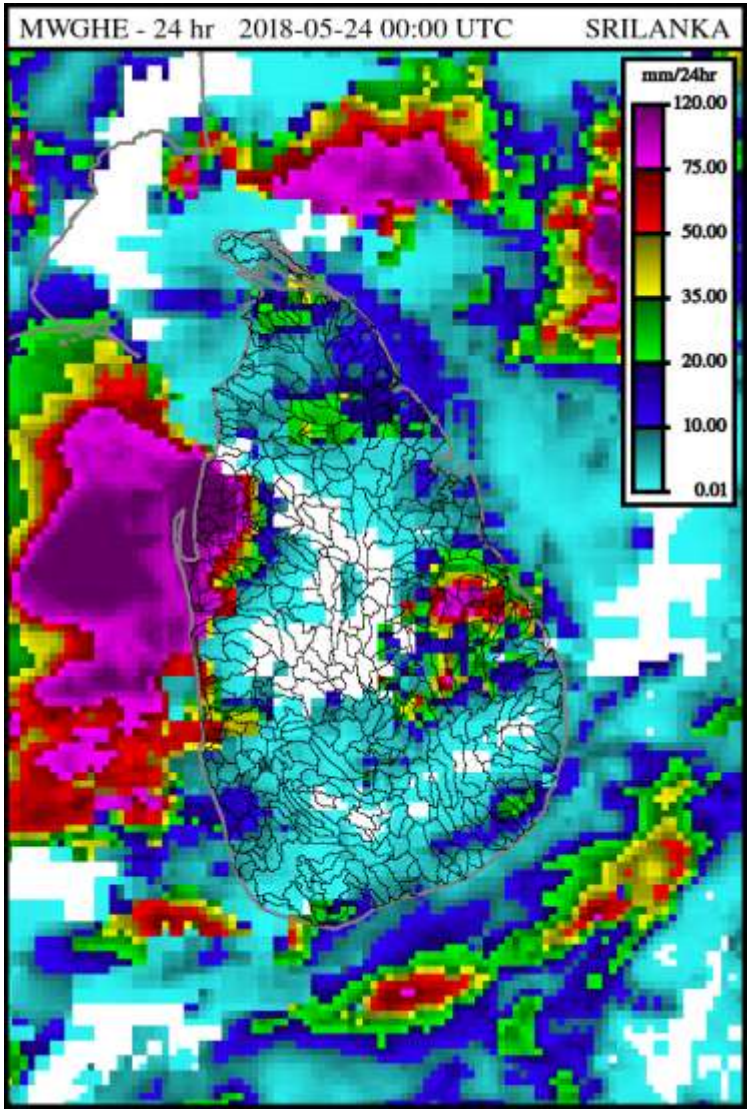
- Nowcasting is very short forecasting with high resolution spatial features.
- Analysis depends of available data and tools for better tracking of precipitation, thunderstorms development and movement.
- In nowcast analysis time is very important and every new information or radar/satellite scan can give us crucial information of potential dangerous weather.
- **Nowcasting Analysis should contain:**
- Instability analysis
- Precipitation analysis and forecast
- Ground observations
- Satellite images
- Radar images
- Lightning detections



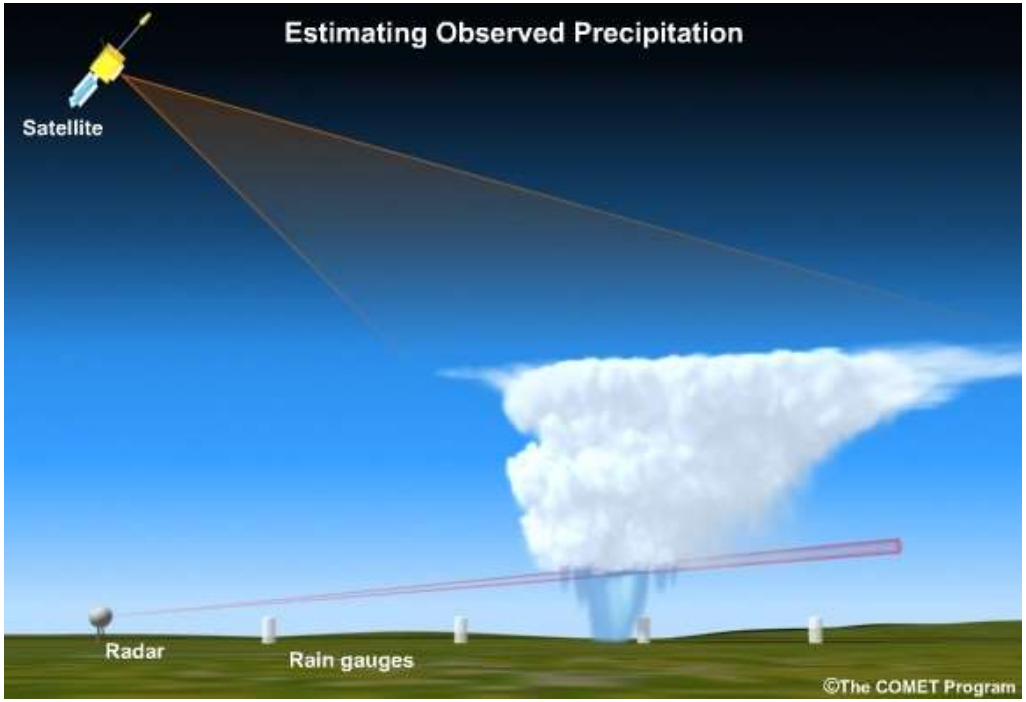


Interpretation of FFGS Products

- First, FFGS **Diagnostic Products** need to be analysed to investigate hydrological response of the catchments.



Satellite Precipitation Estimates



Conceptualized image of three main precipitation estimation technologies: a satellite, radar and a network of ground-based rain gauges

- The big advantage of the meteorological satellites is that they are **covering the entire globe**, which is very important in regions with sparse coverage by traditional gauge or radar networks.
- The relatively **high spatial and temporal resolution** is critical since heavy rain often covers a relatively small area and can change very quickly.
- In addition, because of short latency, data can be made available to the forecasters in less than half an hour. These are all reasons why satellite rainfall estimates form is an important part of the FFGS.

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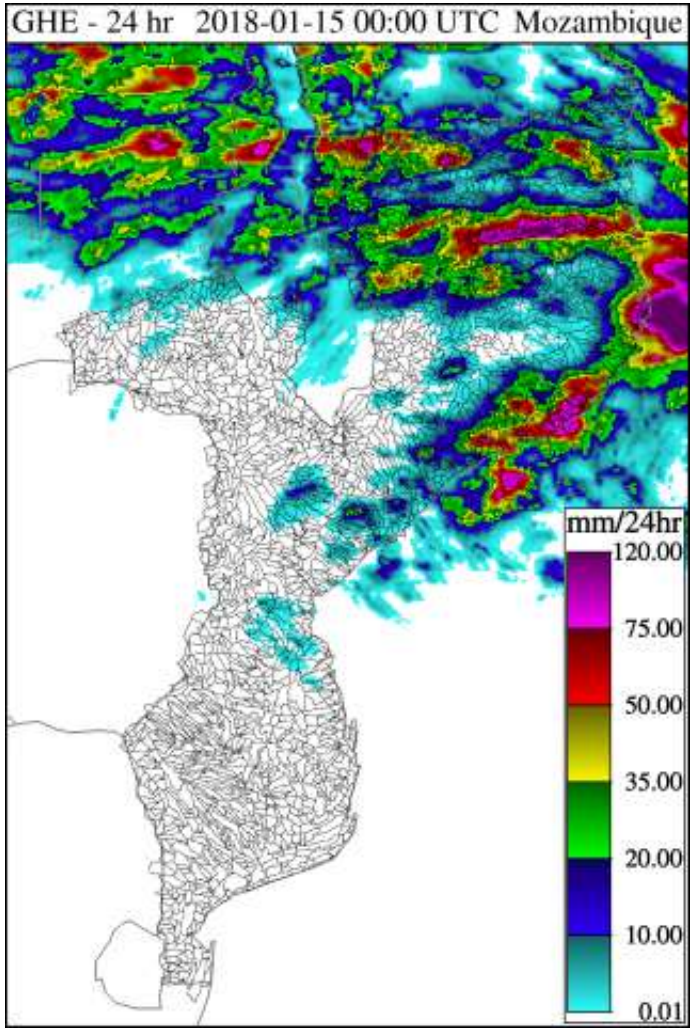
Satellite Precipitation Estimates

- Forecasters should be aware **that satellite can over- or under- estimate precipitation estimates** depending on the time of year, type of weather system (e.g., convective or stratiform) so they must carefully analyse satellite precipitation estimate distribution in their particular regions.

- Satellite products and images can provide a lot of information to forecaster who pay attention to precipitation as well as storm developments and synoptic and mesoscale features.

Global Hydro Estimator (GHE)

- GHE: (infrared based) satellite-based NOAA NESDIS product provides accumulations of precipitation (mm)
- The images and text provide grided 1, 3, 6, 24-hr accumulations of satellite-based rainfall estimates ending on the current hour from NOAA NESDIS Hydroestimator
- The data products are updated every hour with latency of approximately 25 minutes and are not bias corrected.
- The GHE prec. Algorithm estimates precipitation by using cloud top T called Brightness temperature from the IR window.



Global Hydro Estimator (GHE)

There are three basic assumptions that are used for estimating rainfall using infrared data from satellites:

Cloud-top brightness temperature is inversely related to cloud-top height: colder clouds have higher tops and warmer clouds have lower tops.

Second, cloud-top height is related to the strength of the convective updraft (higher-topped clouds have stronger updrafts).

Third, clouds with stronger updrafts are transporting moisture upward more rapidly and thus producing heavier rain than clouds with weaker updrafts.

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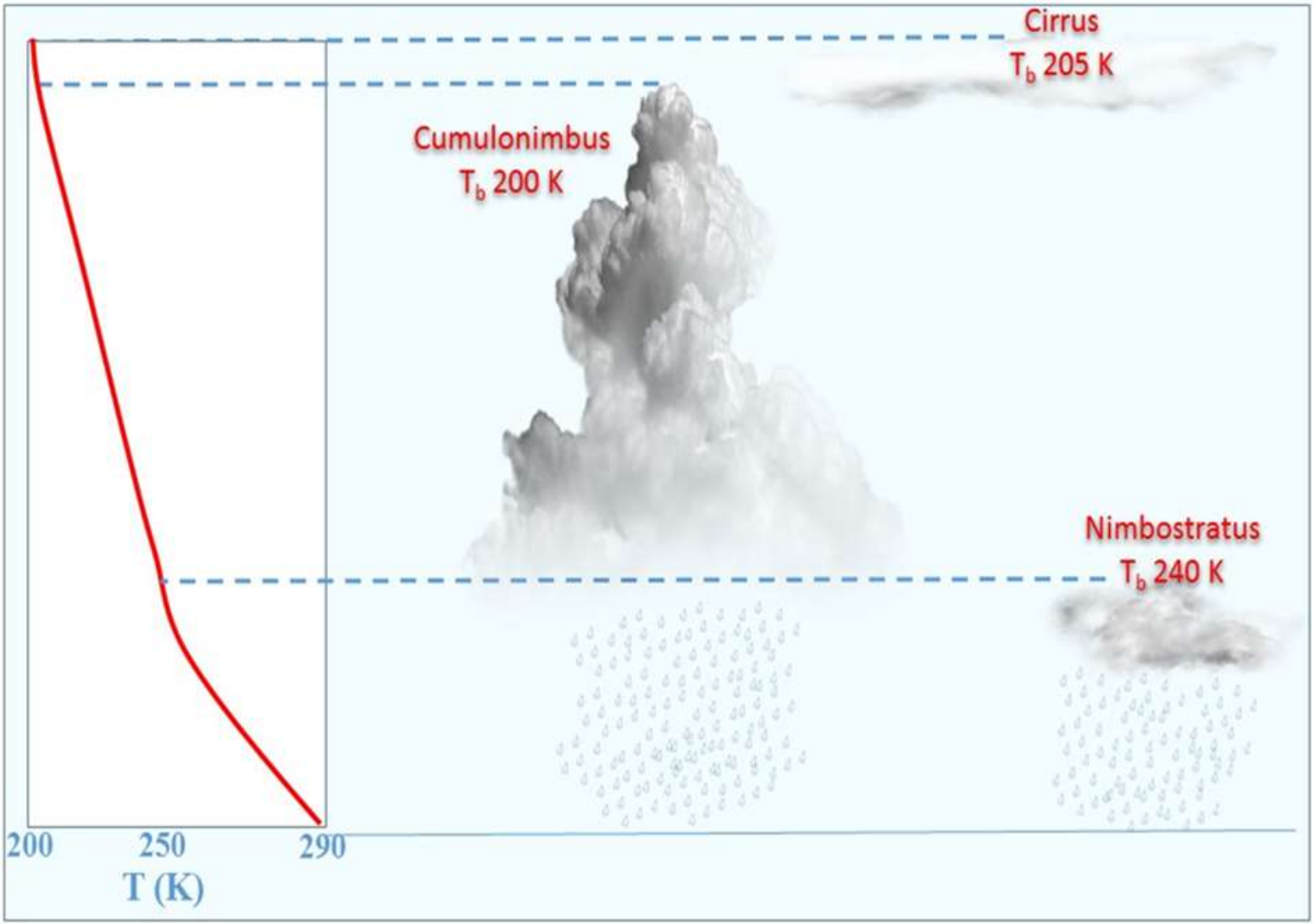
Global Hydro Estimator (GHE)



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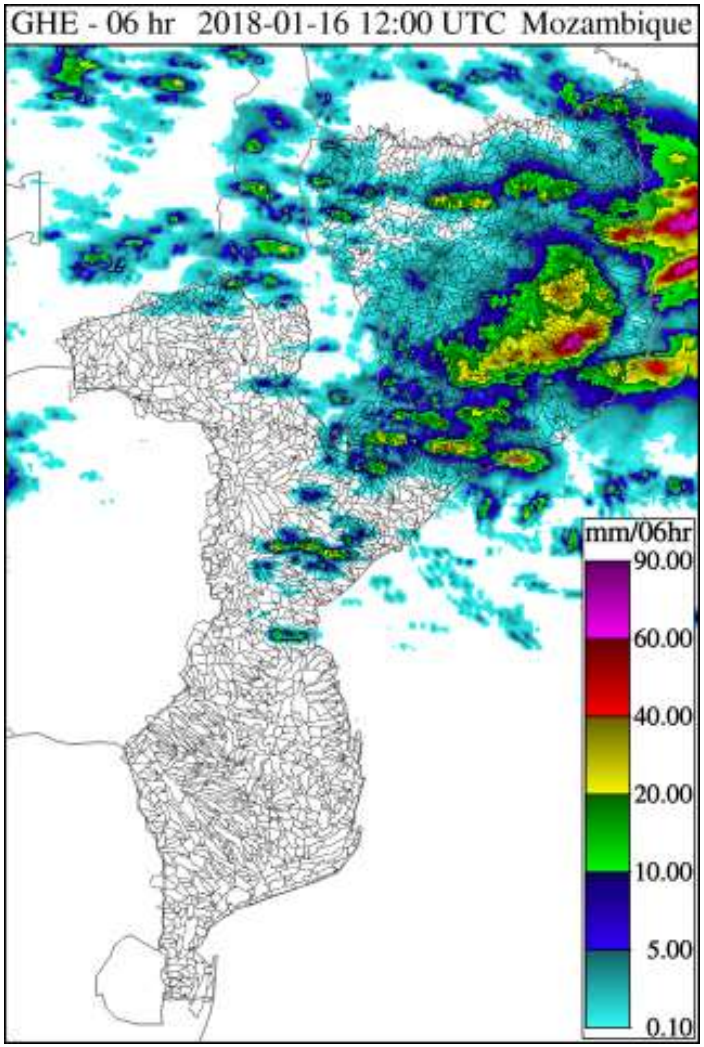
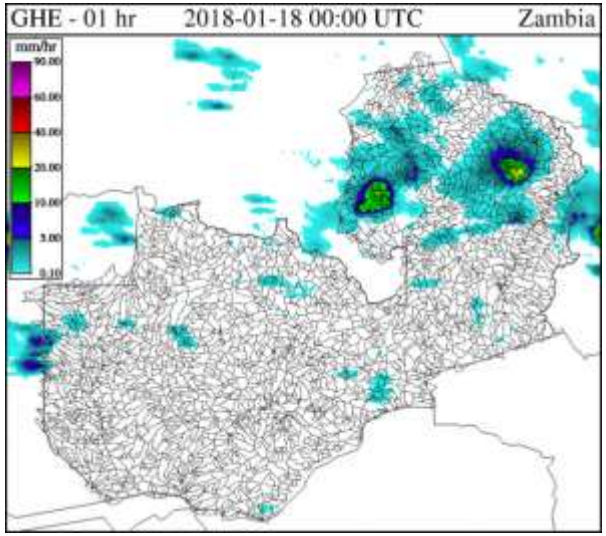
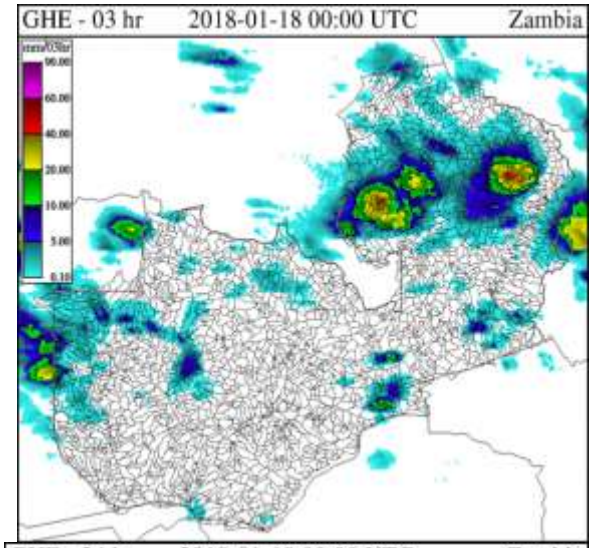
Global Hydro Estimator (GHE)

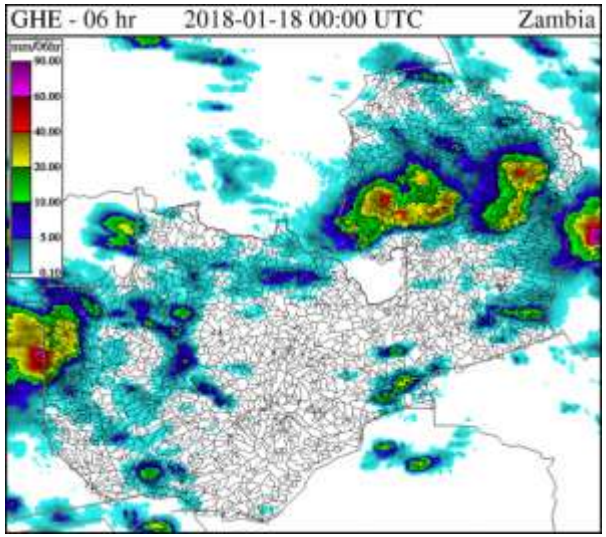
- Each of the 3-, 6- and 24-hour GHE accumulations are produced from the 1-hour GHE rainfall input products summed over the corresponding interval, ending on the navigation hour.
- Each of these accumulations requires the availability of at least 50% of the 1-hour GHE observations over the corresponding interval.
- If more than 50% of the 1-hour GHE observations are missing or unavailable over any accumulation interval, a grey image is shown to indicate insufficient 1-hr satellite input data were available.

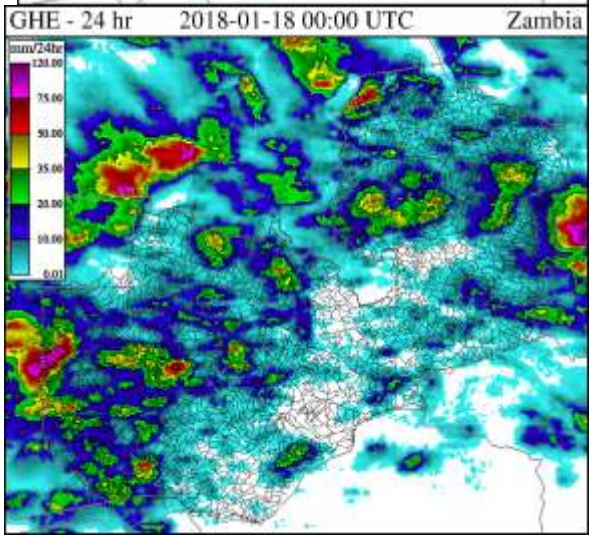


Accumulations of rainfall estimates from the GHE over the last 1,3,6,24-hr:









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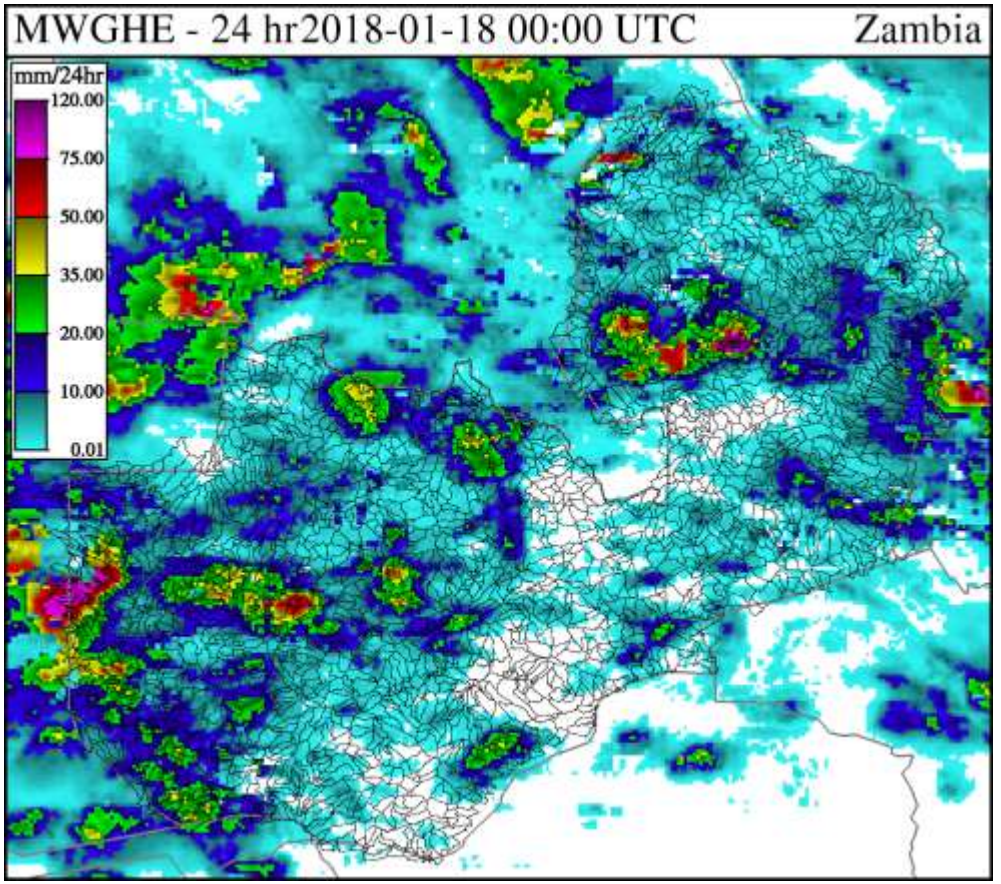
Microwave adjusted Global Hydro Estimator (MWGHE)

- This product provides GHE satellite-based acccumulated rainfall estimates (IR) adjusted by available microwave-based satellite rainfall estimate to improve the GHE accuracy.
- The images and text provide gridded 1-hour, 3-hour, 6-hour and 24-hour accumulations of satellite-based rainfall estimates (mm) ending on the current hour from the NOAA-NESDIS GHE (IR-based) and adjusted by the NOAA-CPC CMORPH MW-based satellite rainfall product.
- Updated every hour with a latency of 45 min and are not bias corrected



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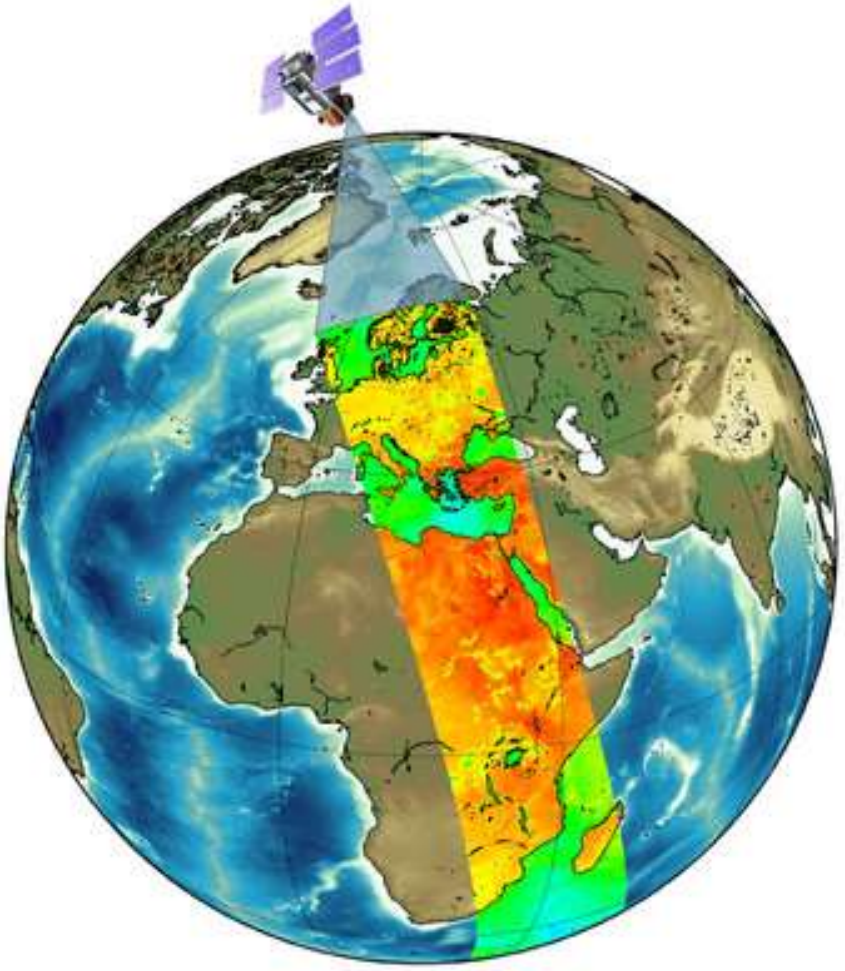
Microwave adjusted Global Hydro Estimator (MWGHE)

- MW satellite sensors like Advanced Microwave Sounding Unit (AMSU) have fundamentally changed how we discern cloud properties and measure precipitation from satellites because they directly detect precipitation particles in and below clouds - an advantage over IR-techniques.



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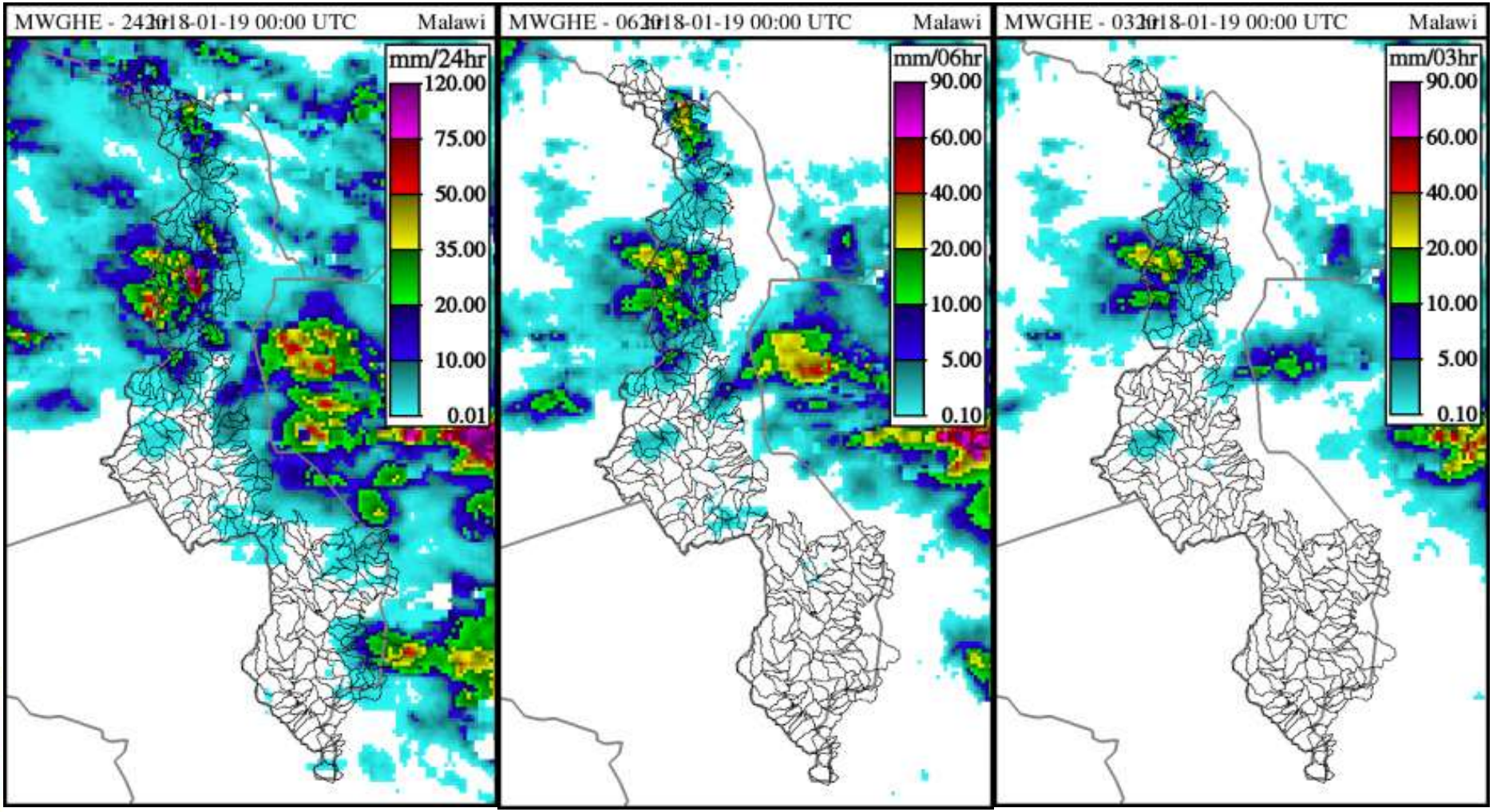
Accumulations of rainfall estimates from the MWGHE over the last …



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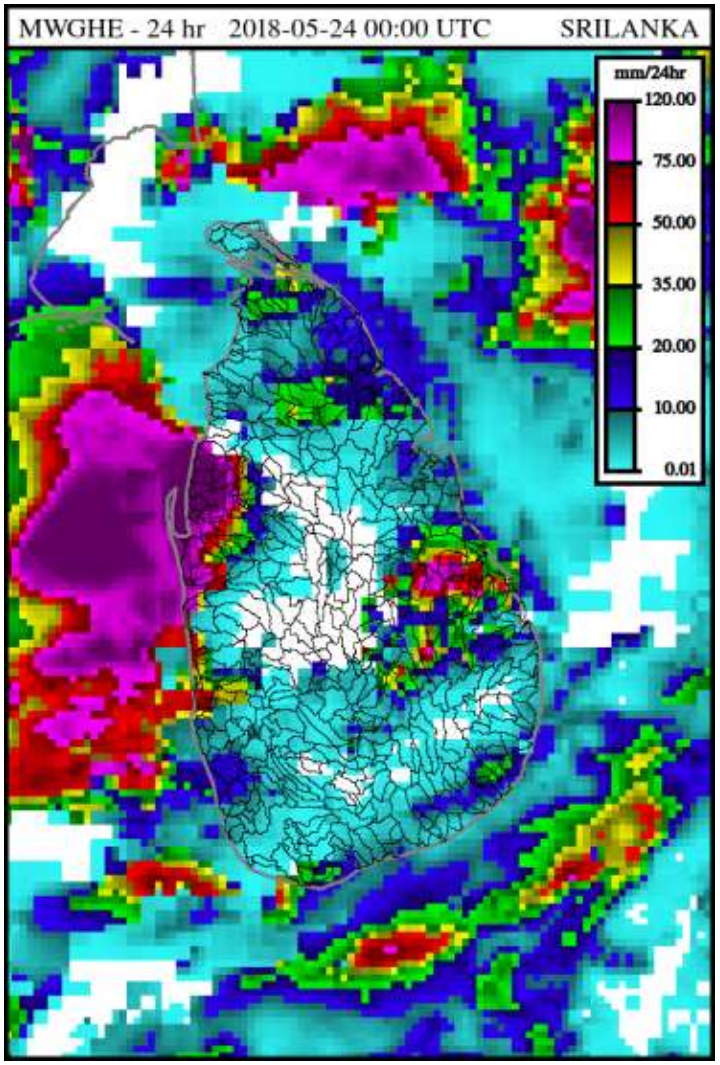
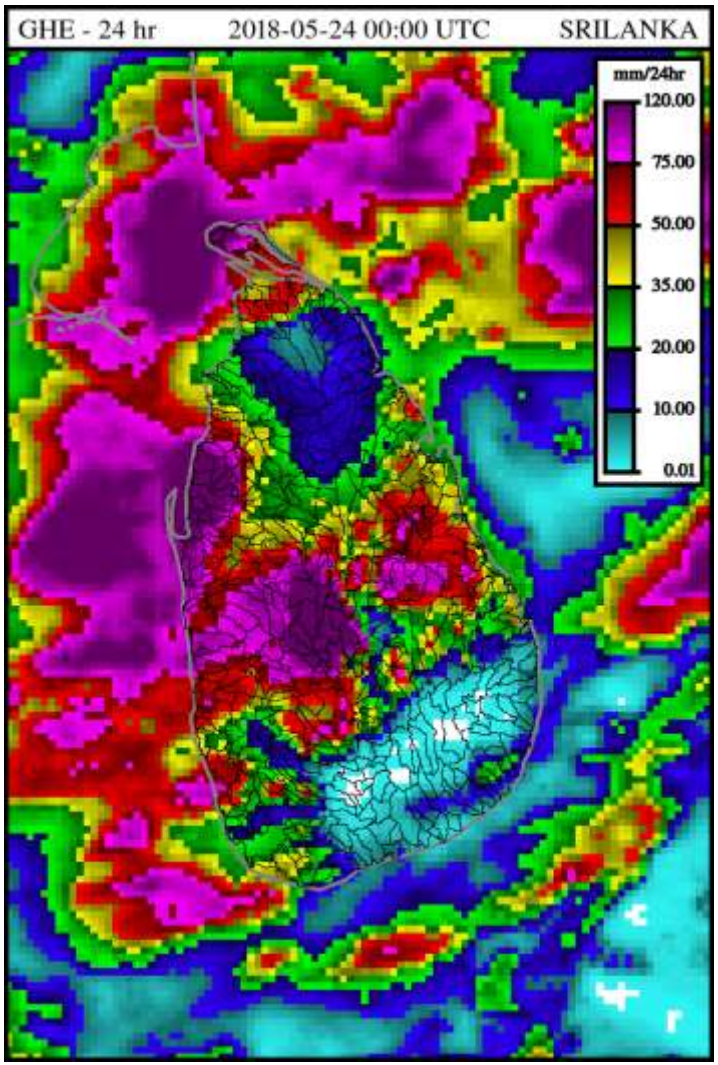
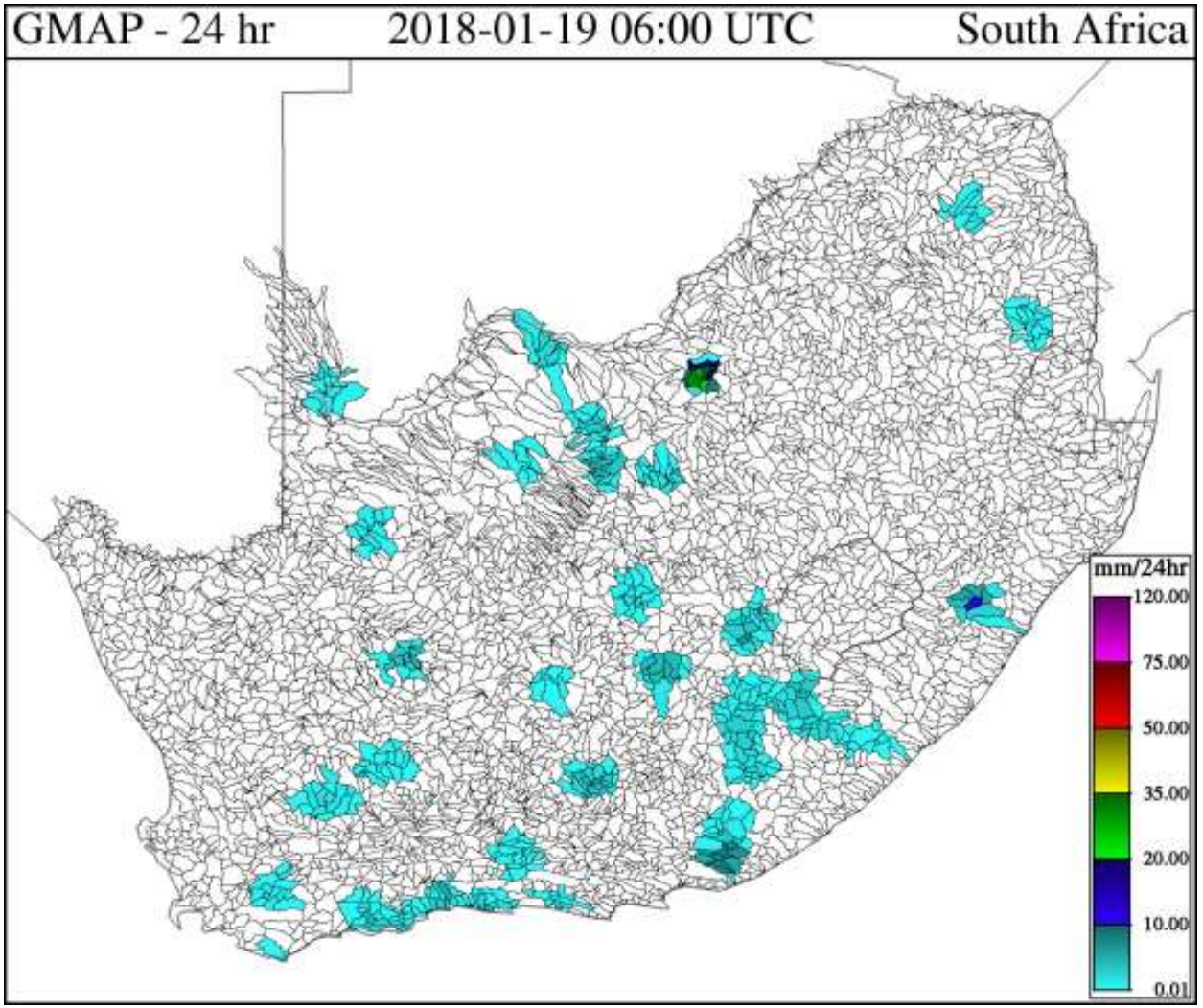
Difference between GHE and MWGHE





Gauge MAP

- Gauge MAP is generated by using synoptic observations that are disseminated through the WMO Global Telecommunication System (GTS).



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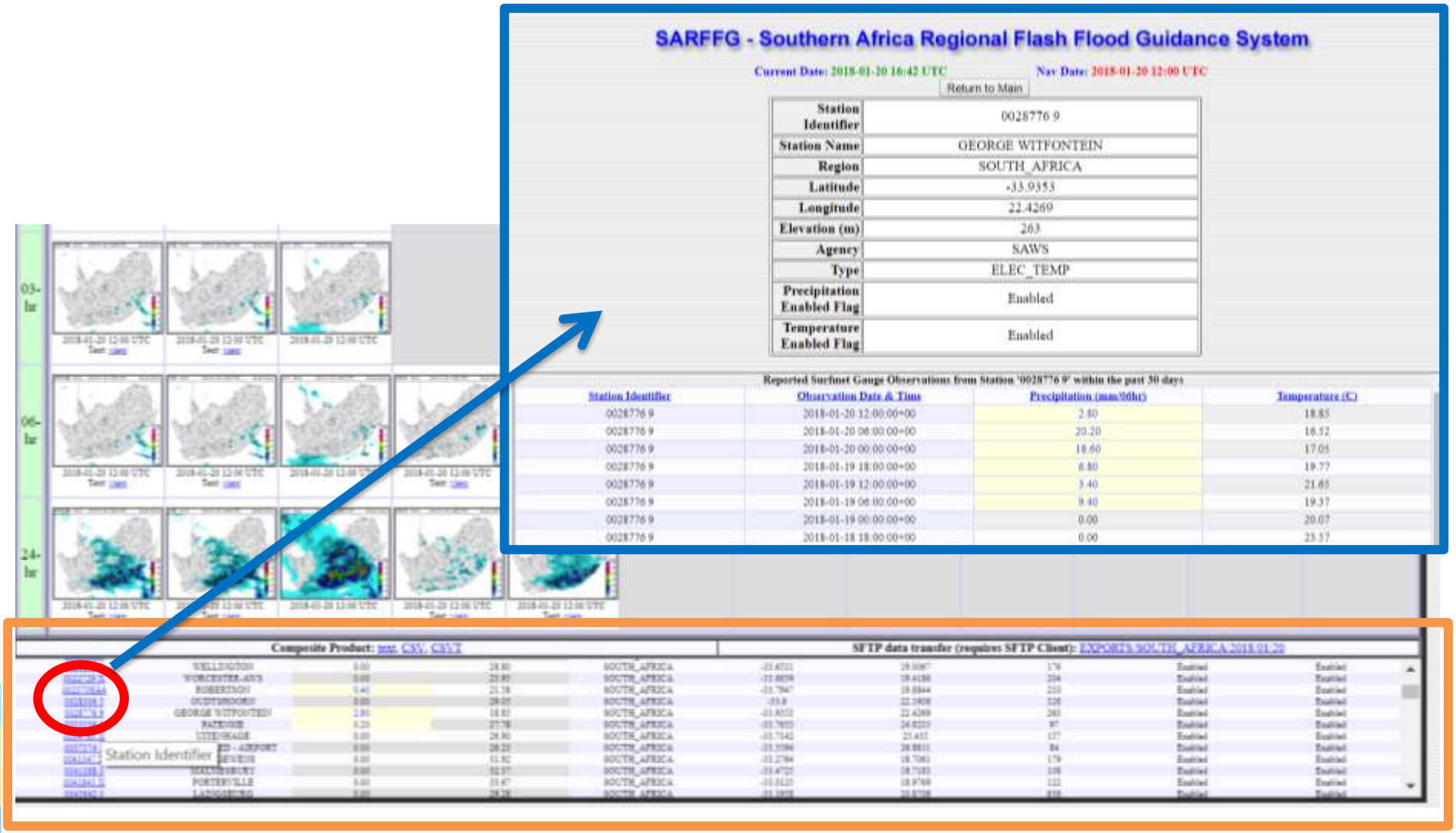
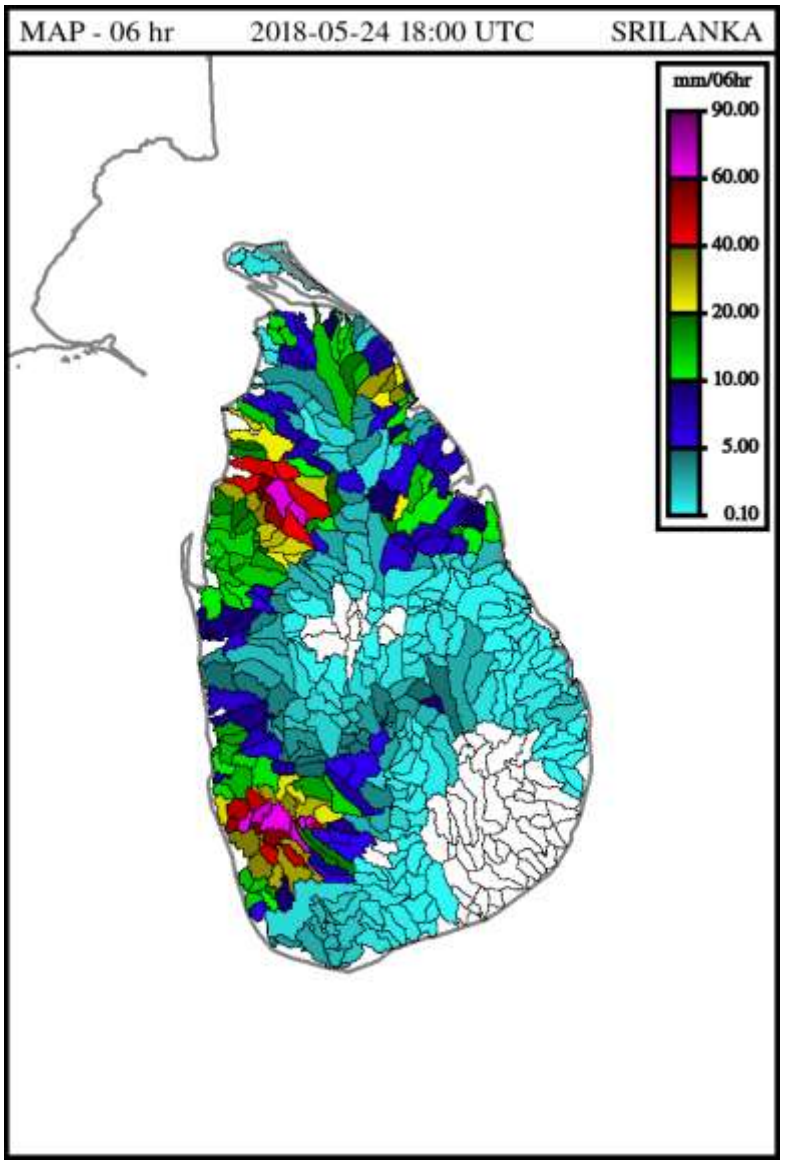
Gauge MAP

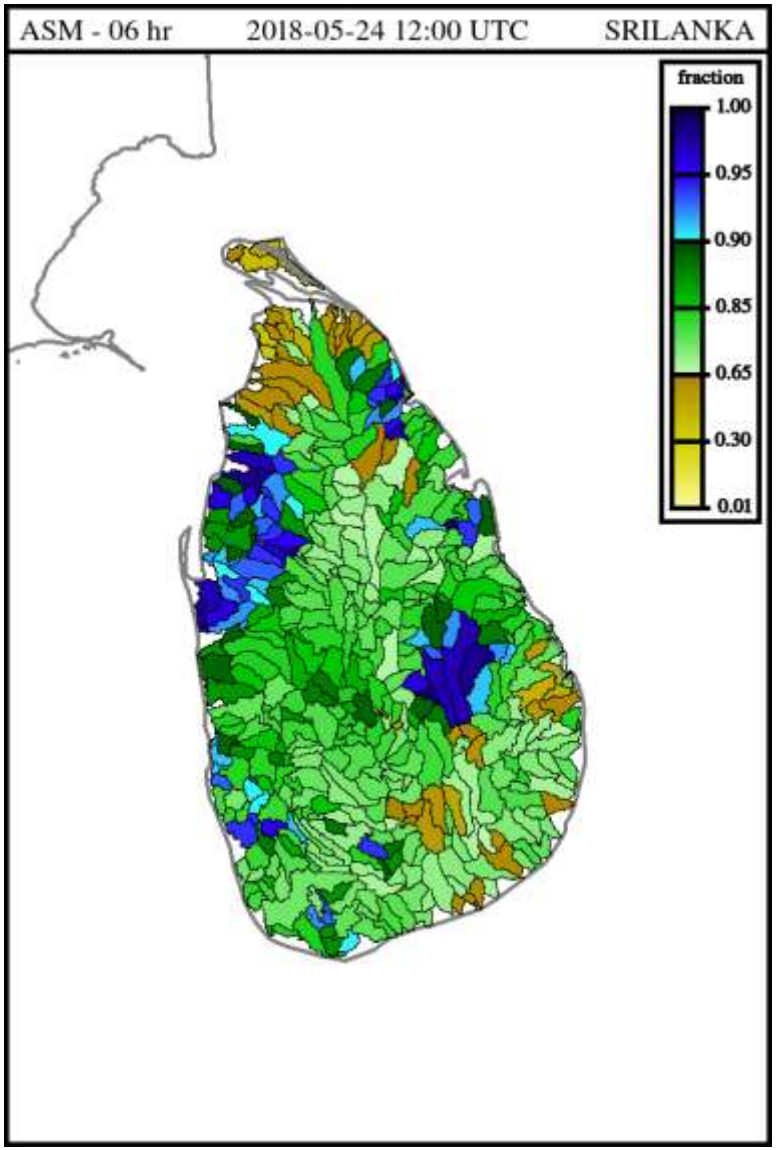

SARFFG - Southern Africa Regional Flash Flood Guidance System
Current Date: 2018-01-20 16:42 UTC
Nav Date: 2018-01-20 12:00 UTC
Return to Main
Station Identifier 0028776 9
Station Name GEORGE WITFONTEIN
Region SOUTH_AFRICA
Latitude -33.9353
Longitude 22.4269
Elevation (m) 263
Agency SAWS
Type ELEC_TEMP
Precipitation Enabled Flag Enabled
Temperature Enabled Flag Enabled
Reported Surfnet Gauge Observations from Station '0028776 9' within the past 30 days
Station Identifier
Observation Date & Time
Precipitation (mm/06hr)
Temperature (C)
0028776 9 2018-01-20 12:00:00+00 2.80 18.85
0028776 9 2018-01-20 06:00:00+00 20.20 16.52
0028776 9 2018-01-20 00:00:00+00 18.60 17.05
0028776 9 2018-01-19 18:00:00+00 6.80 19.77
0028776 9 2018-01-19 12:00:00+00 3.40 21.65
0028776 9 2018-01-19 06:00:00+00 9.40 19.37
0028776 9 2018-01-19 00:00:00+00 0.00 20.07
0028776 9 2018-01-18 18:00:00+00 0.00 23.37
03-hr
06-hr
24-hr
Composite Product: text, CSV, CSVT
SFTP data transfer (requires SFTP Client): EXPORTS/SOUTH_AFRICA/2018.01.20
Station Identifier

Merged MAP

- Merged MAP in FFGS provides bias-corrected, best estimates of 1, 3, 6 and 24-hr precipitation accumulations over each of FFGS basins.



Average Soil Moisture (ASM)



The Average Soil Moisture (ASM) product shows soil water saturation fraction (dimensionless ratio of contents over capacity) for the upper zone tension and free water contents (20-30 cm depth) of the SAC-SMA for each of the sub-basins.

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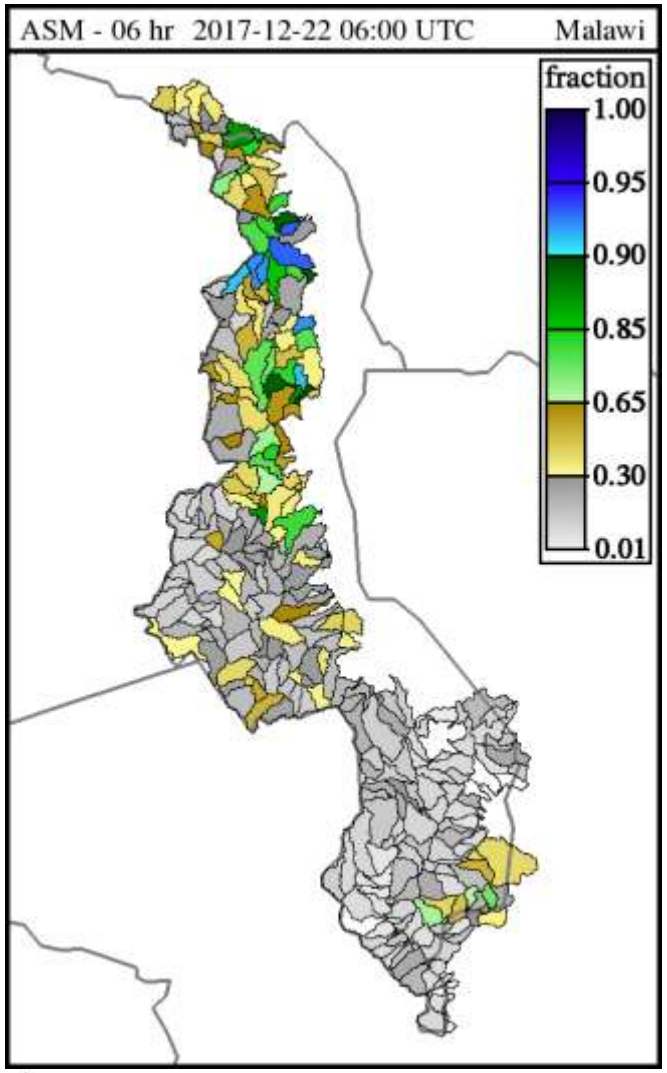
Average Soil Moisture (ASM)



- The ASM products are updated **every 6 hours** at the model-processing hour at 00, 06, 12 and 18 UTC.

They can significantly reduce soil infiltration rate and increase surface runoff, especially during intense convective rainfall.

Average Soil Moisture (ASM)

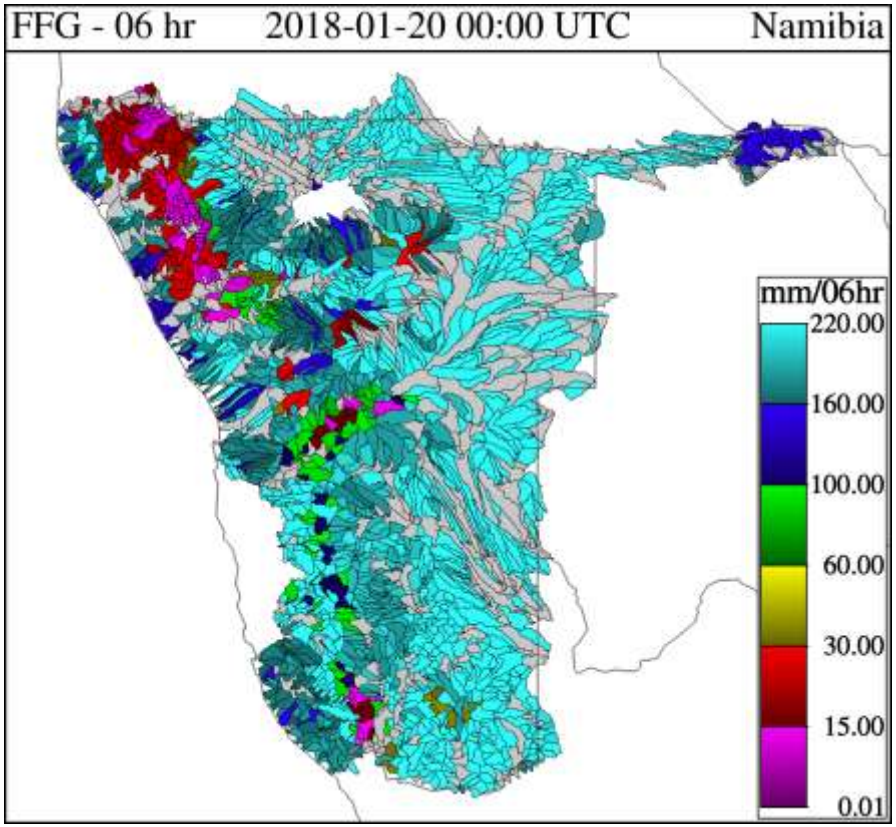
- Real time input parameters for SAC-SMA model is **precipitation**, while **soil**, **terrain** and **land cover** are ingested into the model as a priori parameters.

- Since ASM indicates the upper soil moisture content, its temporal variation is quite rapid, **depending on the precipitation intensity and duration**.

- If upper soil moisture saturation fraction is quite high, and meteorological models show continuation of rainfall for this region, FF occurreence can be a concern, depending **on rainfall amounts, duration and FFG values**.

Flash Flood Guidance (FFG)

- The FFG is defined as the amount of **actual rainfall** of a given duration (e.g. 1, 3 or 6 hours) that is just enough to cause **bankfull flow** at the outlet of the catchment.

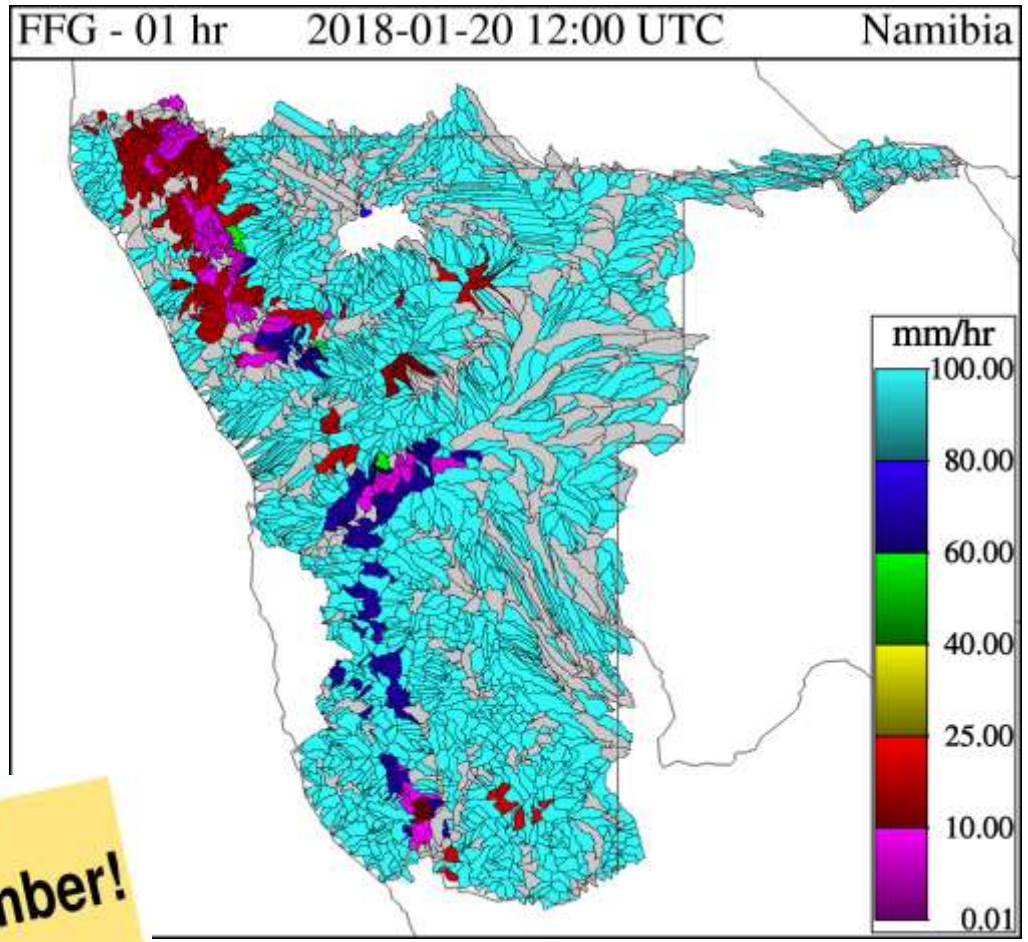


- The FFG then is an index that indicates how much rainfall is needed to overcome soil and channel storage capacities and to cause minimal flooding in a basin.
- The FFG is calculated and updated at every six hours at the model processing hour of 00, 06, 12 and 18 UTC and is valid for the next 1, 3 and 6 hours.

Flash Flood Guidance (FFG)

- Forecasters are advised to pay attention to the **inverse relationship** between possibility of flash flood occurrence and FFG values.

- The **lower FFG**, the **higher possibilitv of flash flood occurrence**.



Remember!

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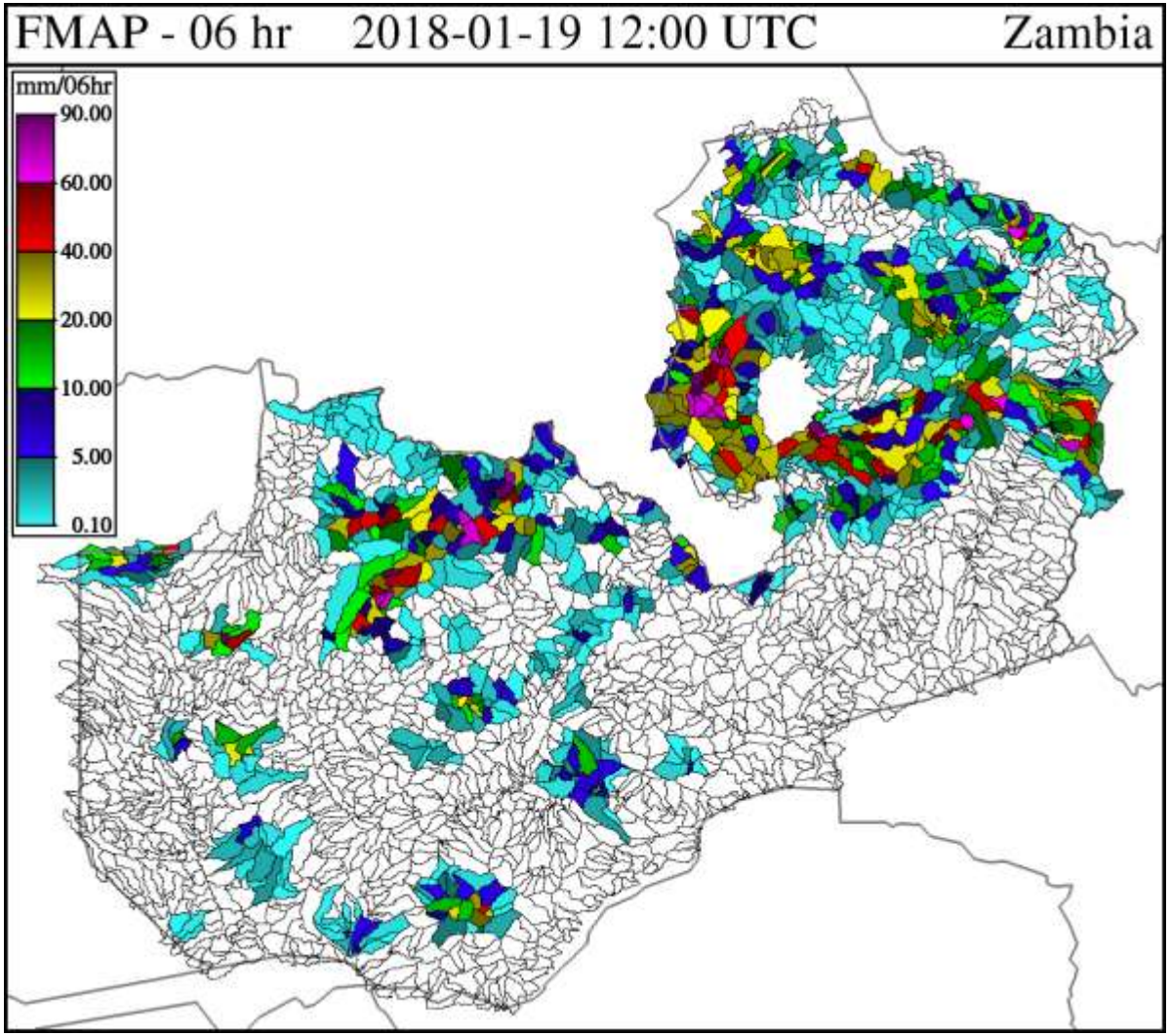
Forecast Mean Areal Precipitation (FMAP)

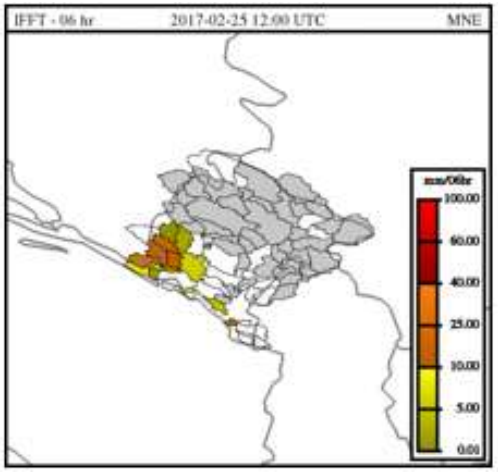
- FMAP products are generated from the NWP precipitation forecasts for each catchment for 1-hour, 3-hours, 6-hours and 24-hours.



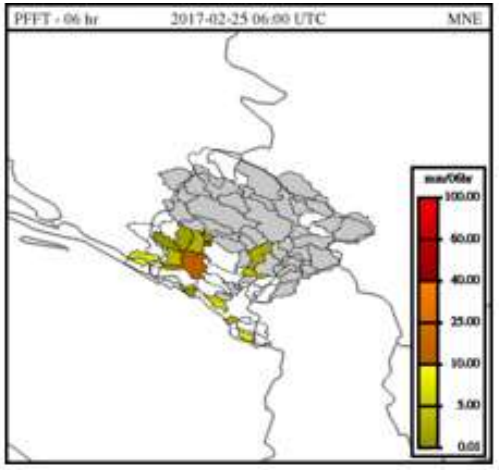
Flash Flood Threats

- FFT are amounts of rainfall of a given duration in excess of the corresponding Flash Flood Guidance value (existing/past or forecast) rainfall

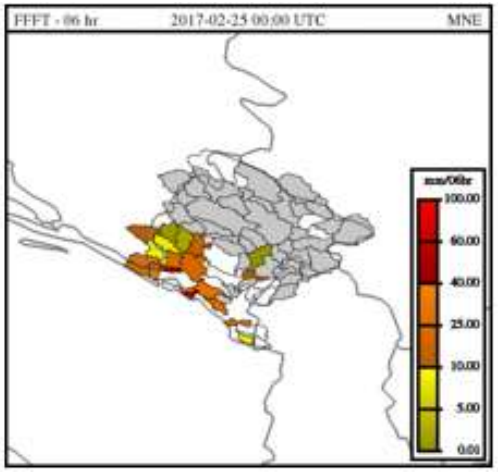
- Like FFG, FFT products are computed for 1-, 3-, and 6-hour durations and updated every 6 hours.



Imminent Flash Flood Threat (IFFT)



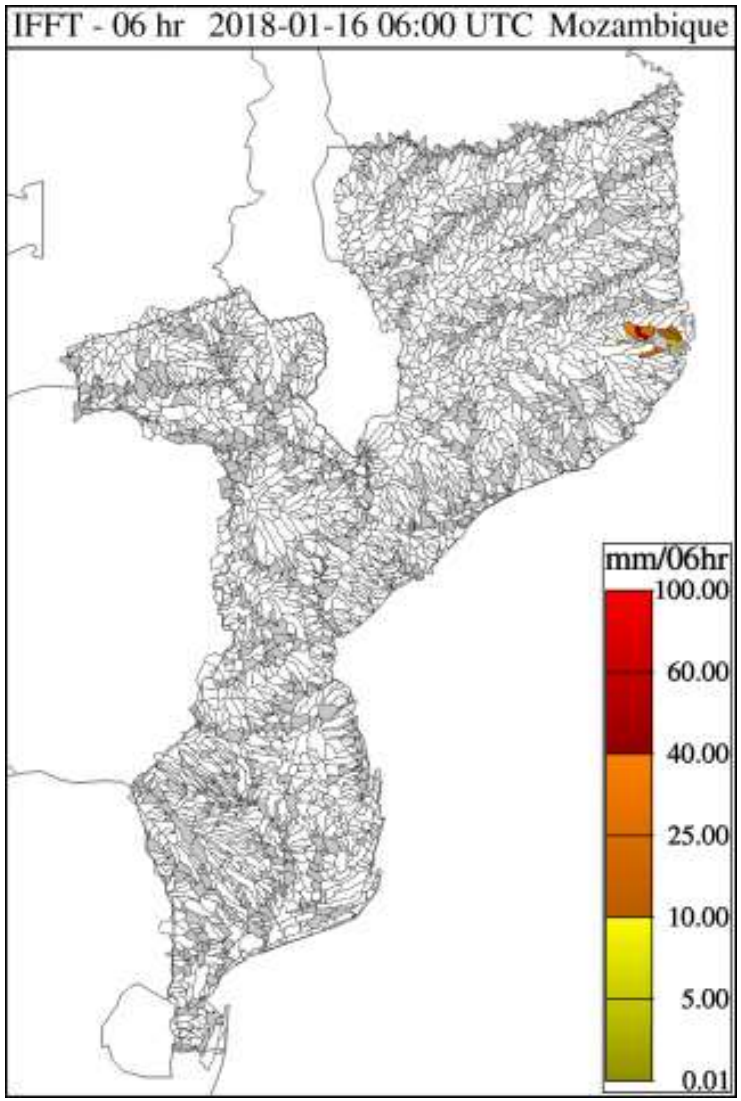
Persistent Flash Flood Threat (PFFT)



Forecasted Flash Flood Threat (FFFT)

Imminent Flash Flood Threat (IFFT)

- IFFT indicates that flash flood is happening now or is about to happen very soon (imminent).
- The values indicate the difference of the Merged MAP of a given duration and the corresponding past model processing hour FFG of the same duration for a given sub-basin.
- It should be noted that this product concerns the past rainfall and should be evaluated before using for warnings.
- Each IFFT product is updated every six hours.



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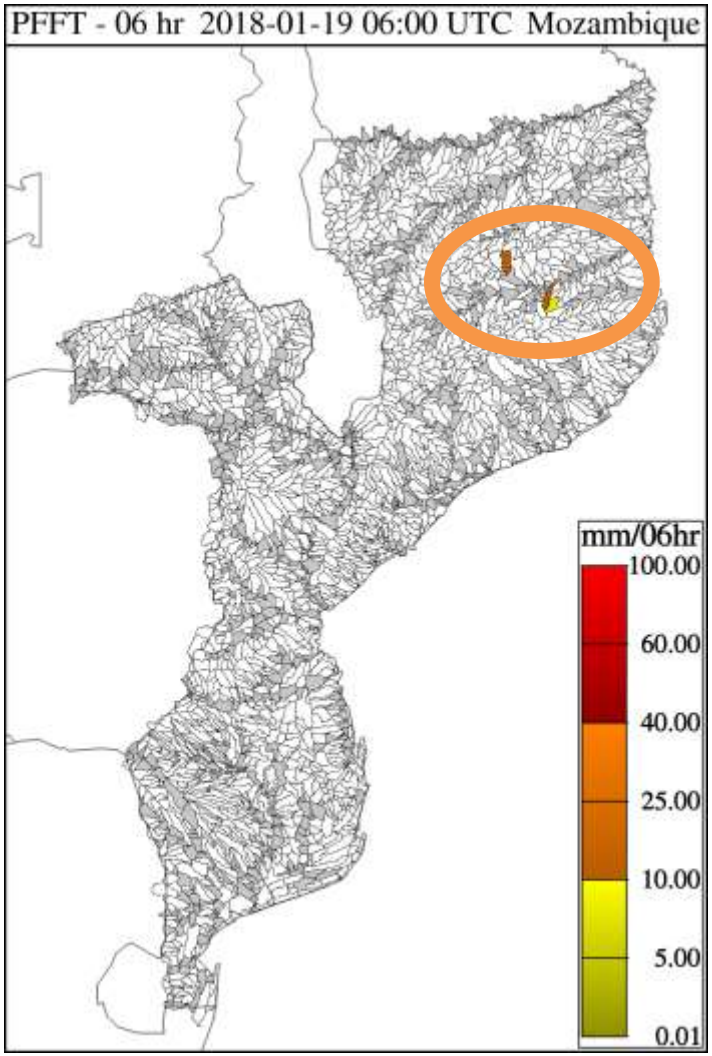
Persistent Flash Flood Threat (PFFT)

- PFFT is the difference between the merged MAP estimated and updated at the FFG model runtime and the corresponding FFG value. 1-hour, 3-hour and 6-hour Persistence Flash Flood Threat products are estimated and updated at 00 UTC, 06 UTC, 12 UTC and 18 UTC.
- The concept of PFFT is that previous precipitation of a given duration will persist for the same duration into the future.
- Uses a crude rainfall forecast and contains large uncertainties and because of that, forecasters should be very careful with this product.



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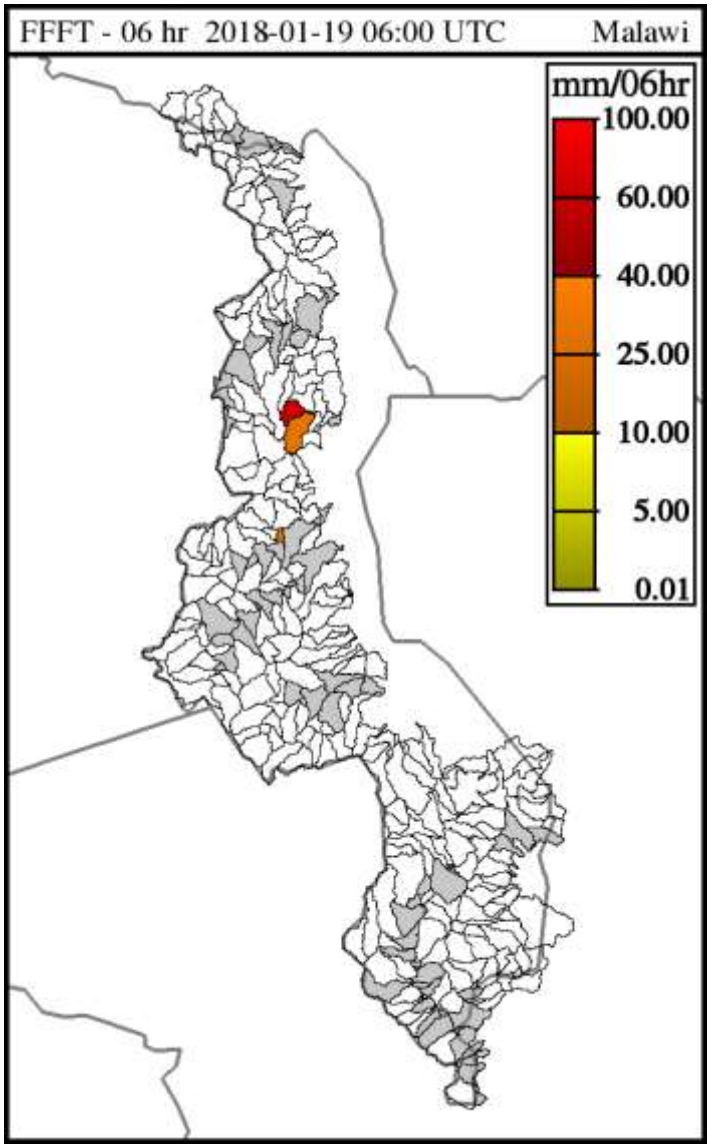
Forecast Flash Flood Threat (FFFT)

- FFFT provides the forecaster with an idea of regions forecasted to be concern for flash flooding based on the difference of **FMAP** and the corresponding current FFG.
- In the computation of FFFT products the 1-, 3-, and 6-hour FMAP products are all considered with current corresponding FFG products.
- These products are updated at 00-hr, 06-hr, 12-hr and 18-hr UTC.



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Flash Flood Threats

- Forecasters should note that Flash Flood Threat itself is not a flash flood warning product but a **guide to forecasters using Flash Flood Guidance System products and hydrometeorological analysis** to make decision whether to issue watches or warnings.

- Therefore, a **forecaster's input is essential** for the success of the warning process.

Thank you

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For more information please visit:	**http://www.wmo.int/ffgs**
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