Case Study I (GFMS): Flood Event in Mozambique

NASA Applied Remote Sensing Training Program (ARSET)

Using Satellites for Improved Flood Monitoring and Prediction
World Bank, Washington D.C, March 7th, 2013

The objective of this exercise is to visually analyze flood event of January 2013 in Mozambique with the focus on heavy rain responsible for flooding rivers such as River Limpopo and Save, and their tributaries.

==========

There are four parts to this exercise.

1) Analyze flood detection/intensity over Mozambique for selected days
2) Analyze stream flow and stream flow above a threshold over Mozambique for selected days
3) Analyze rainfall (Instantaneous, 1-day accumulation, 3-day accumulation, 7-day accumulation) over Mozambique for selected days
4) Search for any current flood events

You will be using the following web-tool for this exercise:

University of Maryland (UMD) **Global Flood Monitoring System (GFMS)** uses satellite rainfall information, a land-surface model and a routing model to estimate the occurrence of floods over most of the globe in near real-time. Results from the new version of the system may be viewed at:
http://flood.umd.edu

A short description of the new system:

The GFMS is a NASA-funded experimental system using real-time TRMM Multi-satellite Precipitation Analysis (TMPA) precipitation information as input to a quasi-global (50°N - 50°S) hydrological runoff and routing model running at 1/8th degree latitude/longitude grid. Flood detection/intensity estimates are based on 13 years of retrospective model runs with TMPA input, with flood thresholds derived for each grid location using routed runoff statistics (95th percentile plus parameters related to basin hydrologic characteristics). The intensity value is the calculated water depth above the flood threshold. Calculations of stream flow are also shown as well as stream flow values above a flood threshold determined from retrospective model runs. In addition, the latest maps of instantaneous precipitation and totals from the last day, three days and seven days are displayed. All the calculations are updated every three hours. Users can zoom in to regional areas, time sequence the maps over the last few days or months and plot time sequences of data at a point. GFMS data (only Flood Detection/Intensity for now) are available for download.

The flood model is based on the University of Washington Variable Infiltration Capacity (VIC) land surface model (Liang et al., 1994) coupled with the University of Maryland Dominant River Tracing Routing (DRTR) model (Wu et al., paper in preparation). The flood detection algorithm is described in Wu et al. (2012). The real-time TMPA precipitation data product (Huffman et al., 2010) is obtained from the NASA Goddard TRMM/GPM Precipitation Processing System (PPS).

References

Liang, X., D. P. Lettenmaier, E. F. Wood, and S. J. Burges, 1994: A Simple hydrologically Based Model of Land Surface Water and Energy Fluxes for GSMs, J. Geophys. Res., 99(D7), 14,415-14,428.
Wu H., R. F. Adler, Y. Hong, Y. Tian, and F. Policelli (2012), Evaluation of Global Flood Detection Using Satellite-Based Rainfall and a Hydrologic Model. J. Hydrometeor, 13, 1268.1284.
Huffman, G.J., R.F. Adler, D.T. Bolvin, E.J. Nelkin, 2010: The TRMM Multi-satellite Precipitation Analysis (TMPA). Chapter 1 in Satellite Applications for Surface Hydrology, F. Hossain and M. Gebremichael, Eds. Springer Verlag, ISBN: 978-90-481-2914-0, 3-22.

==========

Part 1: 3-hourly Flood Detection/Intensity

Go to the home page for GFMS:
http://flood.umd.edu

Exercise 1a

Go to the first figure displaying **Flood detection/intensity (depth above threshold, in mm)** map. Figure shows a global map with current model calculations for flood detection/intensity.

On the right hand side of the figure, 'Pan the map', select green arrows to move up and down, and zoom in/out to a selected area of interest.

Spatial map
Area of Interest: **Mozambique**
Zoom in to:
Latitude: -20 S, -26 S
Longitude: 17E, 35 E

Current time is set to be the latest 3-hr model output time. Click on 'Previous time step' below the figure to choose a previous time. Click on 'Next time step' below the figure to go back to initial time.

Exercise 1b

Choose time period below to define start and end time for figure animation:

Temporal

Start time: 00Z18Jan2013
End time: 00Z28Jan2013

Click 'Animate'

Exercise 1c

To change a displayed variable on the map click below 'Plot different variable:' and choose one of the variables: Flood detection (depth), Stream flow, Stream flow above threshold, Rainfall (Inst.), Rainfall (1-day), Rainfall (3-day), Rainfall (7-day).

Click 'Plot'

Save the figures in a folder on your desktop.

To reset displayed zoomed area to initial global map, click on 'Reset'.

Exercise 1d

Time series plot:

Select on the right hand side of the figure below the green arrows a window with: 'Plot time series for an individual point (lat, lon):'

Add a location point of interest (lat/lon): **Limpopo River outlet**

Lat: -25.1 S
Lon: 33.5 E

Select time period:

Start time: T1 = 00Z01Jan2013
End time: T2 = 00Z31Jan2013

Click 'See time series'.

To reset displayed time series to initial global map, click on 'Reset'.

Questions:

1) How many peaks are there in the time series? Note down the day and maximum values of variable for these times.

Part 2: 3-hourly Stream Flow

Exercise 2a

Go below to the second figure displaying **Stream flow 12 km res. (in m^3/s)** map. Figure shows a global map with current model calculations for stream flow.

On the right hand side of the figure, 'Pan the map', select green arrows to move up and down, and zoom in/out to a selected area of interest.

Spatial map
Area of Interest: **Mozambique**
Zoom in to:
Latitude: -20 S, -26 S
Longitude: 17E, 35 E

Current time is set to be the latest 3-hr model output time. Click on 'Previous time step' below the figure to choose a previous time. Click on 'Next time step' below the figure to go back to initial time.

Exercise 2b

Choose time period below to define start and end time for figure animation:

Temporal
Start time: 00Z18Jan2013
End time: 00Z28Jan2013

Click 'Animate'

Exercise 2c

Time series plot:
Select on the right hand side of the figure below the green arrows a window with: 'Plot time series for an individual point (lat, lon):'

Add a location point of interest (lat/lon): **Limpopo River outlet**
Lat: -25.1 S
Lon: 33.5 E

Select time period:
Start time: T1 = 00Z01Jan2013
End time: T2 = 00Z31Jan2013

Click 'See time series'.

To reset displayed time series to initial global map, click on 'Reset'.

Questions:

1) How many peaks are there in the time series? Note down the day and maximum values of variable for these times.

Part 3: Stream Flow above Flood Threshold

Exercise 3a

Go below to the third figure displaying **Stream flow above flood threshold (in m^3/s)** map. Figure shows a global map with current model calculations for stream flow above flood threshold.

On the right hand side of the figure, 'Pan the map', select green arrows to move up and down, and zoom in/out to a selected area of interest.

Spatial map
Area of Interest: **Mozambique**
Zoom in to:
Latitude: -20 S, -26 S
Longitude: 17E, 35 E

Current time is set to be the latest 3-hr model output time. Click on 'Previous time step' below the figure to choose a previous time. Click on 'Next time step' below the figure to go back to initial time.

Exercise 3b

Choose time period below to define start and end time for figure animation:

Temporal
Start time: 00Z18Jan2013
End time: 00Z28Jan2013

Click 'Animate'

Exercise 3c

Time series plot:
Select on the right hand side of the figure below the green arrows a window with: 'Plot time series for an individual point (lat, lon):'

Add a location point of interest (lat/lon): **Limpopo River outlet**
Lat: -25.1 S
Lon: 33.5 E

Select time period:
Start time: T1 = 00Z01Jan2013
End time: T2 = 00Z31Jan2013

Click 'See time series'.

To reset displayed time series to initial global map, click on ‘Reset’.

Questions:

1) How many peaks are there in the time series? Note down the day and maximum values of variable for these times.

Part 4: Current Floods

Exercise 4a

Go back to the first figure displaying **Flood detection/intensity (depth above threshold, in mm)** map. Figure shows a global map with current model calculations for flood detection/intensity.

Look on the global map if there is a current flood event happening anywhere today.

On the right hand side of the figure, ‘Pan the map’, select green arrows to move up and down, and zoom in/out to a selected area of interest.

Spatial map
Area of Interest: **???**
Zoom in to:
Latitude: TBD
Longitude: TBD

Exercise 4b

To change a displayed variable on the map click below ‘Plot different variable:’ and choose one of the variables: Flood detection (depth), Stream flow, Stream flow above threshold, Rainfall (Inst.), Rainfall (1-day), Rainfall (3-day), Rainfall (7-day).

Click ‘Plot’

To reset displayed zoomed area to initial global map, click on ‘Reset’.

Case Study II (MODIS): Flood Event in Mozambique

Go to the NRT MODIS Flood Mapping Tool
http://oas.gsfc.nasa.gov/floodmap/

Exercise IIa

> Go to global map and click anywhere on Africa

> Select by clicking on the square-tile labeled: 030E
020S

> Above the map note:
1) Calendar on the left-hand side with month and dates
2) A Table with products available for download in the center
3) Arrows to navigate the map on the right
4) The color boxes on the left showing legend

> Navigate (use the arrows above) to the east and locate Xai-Xai near the mouth of River Limpopo (approximately 33° E, 25° S)

> Go to the calendar and using the arrows go to the month of January

> Select by clicking on date 26 January from the calendar and see the flood map for this day

> By clicking on the map zoom in and note where flooding is present (red color shows flooding conditions)

> Using the browser back arrow go back and select dates 27 to 31 January one by one and note how the extent of flooding varies

> On the day that you see maximum extent, navigate westward to see other parts of Limpopo River. Do you see any flooding?

Questions:

i) What does the white color shading show on the map (see the legend on the left)?
ii) Does the flood map you got from MODIS match the map you got in Exercise 1?
iii) Do both GFMS and MODIS maps show the same quantity? (to be discussed)

Rainfall Analysis (Optional)

Exercise a

Go below to the fourth figure displaying **Rainfall (Instantaneous) (in mm/hr)** map. Figure shows a global map with current model calculations for instantaneous rainfall.

On the right hand side of the figure, 'Pan the map', select green arrows to move up and down, and zoom in/out to a selected area of interest.

Spatial map
Area of Interest: **Mozambique**
Zoom in to:
Latitude: -20 S, -26 S
Longitude: 17E, 35 E

Current time is set to be the latest 3-hr model output time. Click on 'Previous time step' below the figure to choose a previous time. Click on 'Next time step' below the figure to go back to initial time.

Exercise b

Choose time period below to define start and end time for figure animation:

Temporal
Start time: 00Z18Jan2013
End time: 00Z28Jan2013

Click 'Animate'

Exercise c

Time series plot:
Select on the right hand side of the figure below the green arrows a window with: 'Plot time series for an individual point (lat, lon):'

Add a location point of interest (lat/lon): **Limpopo River outlet**
Lat: -25.1 S
Lon: 33.5 E

Select time period:
Start time: T1 = 00Z01Jan2013
End time: T2 = 00Z31Jan2013

Click ‘See time series’.

To reset displayed time series to initial global map, click on ‘Reset’.

Questions:

1) Where is the region of heavy rainfall (lat-lon or geographical region)? What is the maximum rainfall (in mm)?

Exercise d

Go below to the fifth figure displaying **Rainfall (1-day accum.) (in mm)** map. Figure shows a global map with current model calculations for 1-day accumulated rainfall.

Repeat Exercises a-c for the 1-Day accumulated Rainfall.

Exercise e

Go below to the sixth figure displaying **Rainfall (3-day accum.) (in mm)** map. Figure shows a global map with current model calculations for 3-day accumulated rainfall.

Repeat Exercises a-c for the 3-Day accumulated Rainfall.

Exercise f

Go below to the seventh figure displaying **Rainfall (7-day accum.) (in mm)** map. Figure shows a global map with current model calculations for 7-day accumulated rainfall.

Repeat Exercises a-c for the 7-Day accumulated Rainfall.