Using CREST to Model Floods for the Upper Missouri Basin

By

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EXT. SCENE – Still picture
Introduce team member through still pictures with their names shown on the screen

EXT. SCENE. DAY – Building 33 at GSFC
It is a late afternoon close to the end of the workday at GSFC. The three participants, PAUL, LUCIANO, and DAVID of NASA's DEVELOP GSFC Program are sitting by their workstation in Building 33. All are dressed in business casual clothing.

SHOT – FULL

PAUL
Good day to you all!

DAVID
Howdy y'all!

LUCIANO
¡Hola hombres!

PAUL
We are part of the NASA DEVELOP Applied Sciences National Program here at Goddard Space Flight Center in Greenbelt, Maryland. My name is Paul, I am here with my team members David and Luciano.

SHOT – PPT INTRO SLIDE

PPT of Title.

DAVID (VOICE OVER)
Our Summer 2012 Project is titled Using CREST to Model Floods for the Upper Missouri Basin

EXT. SCENE. DAY. BACK IN THE OFFICE

LUCIANO (VOICE OVER)
We worked under the guidance of our science advisors, and would like to thank Frederick Policelli, Dr. Dimitar Ouzounov, John David, and the Upper Missouri Team at Goddard Space Flight Center.

PAUL
We would also like to acknowledge our end users: National Oceanic and Atmospheric Administration and University of Oklahoma

SHOT - SHOW FOOTAGE TO DEMONSTRATE FLOODS IN MISSOURI
// talk about the background

DAVID (Voice Over)
In 2011, the Missouri River flooded due to record snowfall in the Rocky Mountains of Montana and Wyoming analogous with record rainfall in central and eastern Montana. The six major dams in the Missouri River released record amounts of water to preclude

flooding endanger many cities and towns from Montana to Missouri. The National Weather Service reported that the second half of the month of May 2011 consisted of a year's rain.

// end flood scene

SHOT – Goddard Space Flight Center, various photos that relate to voice over

PAUL (Voice Over)

As stated before, the Upper Missouri River Disasters teams works here at Goddard Space Flight Center. The team's project consists of using Tropical Rainfall Measuring Mission (TRMM) precipitation data as an input into the Coupled Routing and Excess STorage (CREST) hydrological model to flood forecast in near real time. The goal is to use remotely sensed data instead of in situ ground gauge data for flood forecasting. CREST is able to produce simulated flood extent maps while floods occur. This is different from MODIS flood extent maps, which cannot penetrate clouds and thus gives no visual aid to floods when they actually occur. To calibrate the model, the Upper Missouri River Disasters team chose the Missouri basin as its study location.

SHOT – front of bldg 33 with Luciano as "tour guide"

LUCIANO

Here is building 33, where all the magic happens. Let's go inside and take a look at the team and their project!!!!!!!

SHOT – cut to room location, David and Paul working

LUCIANO

Hello gentlemen, what are we up to today?

DAVID

Hey Luciano, I'm just calibrating the CREST model. Wanna check it out?

LUCIANO

Of course man, show us what you're working with.

SHOT – Video demonstration of CREST calibration

DAVID (Voice Over)

As you can see, we access our servers and run the model from there. The input parameters include potential evapotranspiration data, Digital Elevation Models that were resampled from 90m to 1km, Flow Direction which was derived from the DEM, and Flow Accumulation which was derived from the Flow Direction. There are also a number of parameters that we must watch throughout the life of the program. We keep a running comma separated file which pops out statistics at each given run time.

SHOT – ERROR message

DAVID (Voice Over)

Oh no!!!!! What is going on?!?!?!? CREST seems to be confused

SHOT – back to Luciano and David

LUCIANO

It seems that there's something wrong with the input data. Hmm, do you think it has something to do with the lack of snowmelt?

PAUL (finally makes his presence felt)

I would assume so, looks like snowmelt plays a much larger role in the Missouri basin's hydrology than we gave it credit for. David, do you remember that graph you made which compared the snowmelt vs. the precipitation in the Missouri basin?

DAVID

Why yes I do, let me pull up that graph for you.

SHOT – graph of snowmelt vs. precipitation data

DAVID (Voice Over)

As you can see, the precipitation data is highlighted in red and the snowmelt data is highlighted in blue. The snowmelt levels are significantly higher than the levels of the precipitation.

SHOT – back to room

LUCIANO

So what you're saying is that we need to incorporate snowmelt into the CREST input data.

DAVID

Exactly! But how?

PAUL

Fortunately for us, I found some snowmelt simulation data from the NOAA National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) known as SNODAS which stands for SNOw Data Assimilation System. All I need to do is some quick data processing through Python and the SNODAS data will be good to go as an input into the CREST model. Specifically, I have to convert the SNODAS data into usable raster formats, then clip to the extent of the Upper Missouri basin, then export the rasters into ASCII files.

LUCIANO

Hey guys, we should probably also select another region to test the CREST model. Currently, there are no implementations of CREST that can account for snowmelt so we are pushing into new territory here.

DAVID

I agree, how about the San Bernard watershed in Texas? It meets the conditions for an ideal test location for CREST. We can cross compare the two regions and see how CREST operates in ideal settings and whether or not CREST will be able to successfully account for snowmelt in its modeling.

SHOT – Backdrop "10 Minutes Later"

PAUL

Hey guys, I got the SNODAS data ready to go!

LUCIANO

Perfect! Let's get this baby going again. David, will you have the honors?

DAVID

Most certainly!

SHOT – Backdrop "After Successful Calibration"

DAVID

Hey guys, the statistics are looking very promising. Unfortunately our Nash Coefficients are where they need to be in order to consider everything a success. The closer the NSCE is to 1, the better the model is calibrating. In reality, scientists accept a NSCE level of .6-.7. Our data has only reached the NSCE of ___. Ideally, the Nash Coefficient is the biggest indicator of capturing major flood events. Also the bias is important as well because it indicates how precise the flow rate is.

LUCIANO

Don't worry David. There were some inherent uncertainties with our work. As mentioned before, there are no implementations of CREST which account for snowmelt, this alone put our project to the test. Also, resampling the Digital Elevation Models limited the accuracy of our data and potentially threw off the model's behavior.

PAUL

Indeed, but sometimes that's science for you! We may not have gotten everything we want, but we have most certainly made strides towards developing a near-real time flood forecasting system based on remotely sensed data as opposed to in situ data, and we are even one of the first groups to implement snowmelt into the CREST model! Future work will consist of further research into snowmelt and possibly innovate the CREST source code to account for the physics behind snowmelt. We hope to hand off our findings to our project partners, the University of Oklahoma and the National Oceanic and Atmospheric Administration who will

then further develop the CREST model and potentially implement the near real time flood forecasting system using remotely sensed data

EXT. SCENE DAY
Ending pip pip cheerio