



## Questions & Answer Session 1

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Amita Mehta ([amita.v.mehta@nasa.gov](mailto:amita.v.mehta@nasa.gov)) or Kel Markert ([kel.markert@nasa.gov](mailto:kel.markert@nasa.gov)) your question(s).

Question 1: Can I use the VIC for reservoir management? Is there source code of reservoir module is available for us? I want to apply VIC in my study area. but area having 4 reservoirs. then how can I do simulation

Answer 1: Theoretically you can - we didn't touch on this in s1 since the first session was focused on a brief overview. But you can specify lakes and wetlands within the model. This is a little more advanced topics within the model since it takes more ... it was added in as a follow on development to the original model. Yes, you can use it for reservoir management and there are plenty of papers that use VIC model streamflow as input parameters to the reservoir and calculate reservoir change management and everything like that.

Question 2: What of areas in the tropics where SNOW is not experienced? Is it possible to turn this off?

Answer 2: Short answer: no - you can't turn off the snow model. The snow model is really important to calculate energy & water balances especially in high altitudes and mountainous regions. If you're modeling a basin in the tropics, say the Lower Mekong Basin - the temperature is too warm and theoretically no snow falls, so there will be no snow accumulation within the model.

Question 3: What is meant by lapsed temperature?

Answer 3: Lapse rate in atmosphere science is a decrease of temperature in relation to elevation increases - we use elevation bands and say here is our mean temp for our grid cell, our mean elevation for our grid cell. If we move our elevation up 100m, what's the change in temp from that mean elevation 100 m up. That's what we mean by lapsed temperature

Question 4: Is this model useful if there are groundwater springs and a river since it doesn't look at channel flow or groundwater below soil level 2?

Answer 4: It depends on the type of spring you have - if the spring is an ephemeral spring that is fed by base flow then yes, the model will capture that. If the spring is, say



an aquifer spring, then the model will not capture that since it doesn't consider that deep ground water.

Question 5: What do you mean by climate sensitive areas?

Answer 5: This was in reference to talking about parameterizations. So - in climate sensitive regions, e.g. in high latitudes, there's a lot of difference processes that occur that the model will need specific parameterizations to capture. So, when you're simulating an area that is pretty sensitive to precipitation or temperature forcings e.g., the high latitudes are pretty sensitive to temp, like permafrost - sensitive to a few changes in degrees temperature - we need detailed parameterizations to capture those processes

Question 6: Can we take help from you (or elsewhere) regarding VIC?

Answer 6: VIC itself was developed by Univ. Washington and they have source code, they have a users forum, and you can get help from them re: VIC model. What we're trying to do is take VIC as-is, and Kel has shown us the processes and next week we'll talk about how to get input data from NASA remote sensing. So, the main purpose is that you take the VIC from Univ. Washington, download code, install on your computer - but it isn't always easy to get input data for VIC over all water basins or watersheds, so this is an instance here you can use remote sensing to force VIC and look at the output. We can help with this in the sense that you'll have presentations and recordings for reference on how to run tVIC. For VIC modeling itself- you can contact Univ. Washington, they have a help forum.

They have a help forum where you can sign up and send an email, and it'll send an email out to everyone. Typically the Univ of Washington people answer quickly or someone else using the model will answer. So if you want help with the VIC model, sign up for that email listserv.

Question 7: Is VIC capable of run on lower powered CPU such as Single core 2.0 GHz CPU?

Answer 7: I think - I'm pretty sure it is. The VIC model is a pretty efficient model when you look at the code. I don't think it should run out of memory. It may just take longer to run. Another consideration to have is that the VIC model is pretty heavy on data storage - so you have to have a lot of data storage space to run some of the models. Depending on the size of your grid cell and basin.

Question 8: Do we need samples for soil sample?



Answer 8: Assuming we mean, do we need field samples and collect soil samples. You can do that. I think that will definitely help with parameterizing the model, what you can use - there's a lot of datasets out there you can use to parameterize the model on the soil side. They do a fairly good job. Amita will talk next week about some of the data we've used to parameterize soil in the model. With the caveat that you have to calibrate some of those parameters. Going in the field will help you initially estimate those parameters, but we can also calibrate those parameters as well.

Question 9: What are the NLDAS and GLDAS models?

Answer 9: These are North American Land Data Assimilation System and Global Land Data Assimilation System. If you want more info, go to the ARSET website and watch the pre-recorded webinar, Fundamentals of Remote Sensing Session 2B -- you can find more information from <https://ldas.gsfc.nasa.gov>. VIC is part of both these models.

Question 10: This means VIC has limitations for baseflow?

Answer 10: Not sure what you mean by "limitations." The model as we saw has somewhat of a simplistic representation for baseflow. Baseflow is a function of soil moisture at the lowest soil layer. But when you parameterize the model, you can specify the max amount of baseflow that can occur within a day. What you do is - you set that max baseflow and the model will scale how much baseflow occurs per day based on that maximum base flow. Theoretically there are no limitations - you could say 100 mm/day - that's a lot - but when you specify that much and specify low soil moisture, you're going to get low baseflow values. The base flow - parameterizing the point at when nonlinear baseflow occurs is pretty important - one of the main parameters you calibrate for the model

Question 11: About the soil column in slide 18 or 19, what if the case study area has permafrost?

Answer 11: I didn't talk about this since this gets into the more advanced VIC model topics. VIC has a scheme to calculate frozen soil - typically you don't have to play around with parameters that much to tune the frozen soil model. Again, this is part of that energy transfer. The soil is going to hold or release energy depending on moisture and other parameters. So when you're in a permafrost region, it'll calculate there's frozen soil and that affects the infiltration, surface runoff, and baseflow. Because your moisture flow within that soil column will be hindered by that frozen part.

Question 12: If I understand correctly the VIC model combines both saturation excess runoff and infiltration excess runoff?



Answer 12: Assuming what you mean there by saturation excess runoff is that your soil has become saturated, you have ponding on the surface, and what's leftover is considered runoff - if that's the case, then yes! That's essentially how the variable infiltration curve works. Infiltration excess runoff - assuming you mean within the soil column - if that's the case then yes, we do have infiltration. If there's excess soil moisture within the column we have more baseflow occurring. That baseflow is also called sub-surface runoff.

Question 13: I have window o/s. Can i practice this model using this o/s?

Answer 13: Yes you can. The model was built in a linux system so I would highly suggest if you are able to use a Linux operating system you use that. If you have a windows machine you can compile and run the model using a program that called CYGWIN then make sure when you install the program you have the GCC compilers installed along with it.

Question 14: How we can connect this model with regional climate model?

Answer 14: Short answer - you have to couple the models and I don't have experience with that. There are examples of this (Univ. of Washington's Regional Arctic System Model project) - coupling the VIC model with a WRF model and producing outputs for the arctic region.

Because VIC is grid-based, it's somewhat easier to couple with a climate model. If you look at [ldas.gsfc.nasa.gov](http://ldas.gsfc.nasa.gov) - they show - a climate model is used as forcing whatever comes out of a regional climate model is used for the VIC model. Using VIC with climate model output is relatively easier. You have to take care of certain physics, which is beyond the scope of this webinar. If you look at NLDAS and GLDAS-based publications you can get that information.

Question 15: Does VIC has a routines to simulate tile drainage typically found in the Midwestern US, reservoirs, wetlands and agricultural activities?

Answer 15: No - the VIC model as is simulates a natural system and man-made processes like irrigation or tile drainage need to added to the original model. There is a specific instance of the VIC model that simulates irrigation for your reference to see how this is done.

Question 16: How does VIC model couple with GCM models?

Answer: Touched on that for - just like in NLDAS and GLDAS, if you visit their website you'll get more information. It is really - any GCM will provide inputs for VIC. All that



can be specified or can come from a climate GCM. The coupling part you feed back to the climate model, that requires a lot of work and skill both. So the best way to review that is to review NLDAS and GLDAS and how they do it.

Question 17: Can you show some exercise with rough data?

Answer: We're planning to do that in the next 2 sessions. Start with downloading data that will go into VIC then the last session - Kel will use how these data are input in to VIC and how the model itself is run. We'll use the Mekong River basin as an example for that. One clarification: what we are showing here - if you want to use VIC for water budget estimation for water estimation or water resources management or monitoring flood or drought you can use it stand alone without having to couple to any regional or climate models. You can get forcing data from NASA Earth science system models and remote sensing satellites. That's the major part of this session - without coupling with any GCM or climate model, how can you run VIC by itself getting forcing from satellites and models. Third way: you can quickly look at water budget components over your area of interest and look at the history of your region and look at flux coming out of VIC see if it's flooding or drought conditions or excess or deficit of water.

Question 18: Is possible to run the model with regional or local data?

Answer: Most definitely yes. You can pre-process your data like precipitation data or what have you and use that. We're showing you how to use NASA data as input into the model. In particular for data sparse regions. Part of SERVIR is working in developing regions and we focus on producing data where there is no data. That's part of why we're using NASA satellite data inputs into the VIC model.

Question 19: Are you recommend a particular virtual machine software to run the VIC model on windows (10) platform?

Answer: Personal favorite because it's free and open source is Virtual Box - they have some nice features and it has a nice interface and there's online resources and everything. VMware is another virtual machine software but I haven't used it much.

Question 20: Do we have to download the VIC model prior to the next session?

Answer: You don't have to - we're just demoing. This is an introductory webinar - from Q&A we received earlier - many people have used VIC before but some have heard but not used it. The idea here is to learn how to get input data and analyze output. The emphasis is using input data and if you use in situ data and you have well-calibrated regional model that gives you forcing, that's good. If you don't have in situ data, or are in data sparse region then you can still run VIC with NASA data



Question 21: Since VIC conducts an energy budget at the surface, does it mean NASA provides a net radiation product?

Answer: NASA does provide net radiation product from remote sensing platforms that is not related

Question 22: Is there any Python integrated version of VIC available?

Answer: Yes, the Univ. of Washington recently released a version of VIC with Python bindings

(<http://vic.readthedocs.io/en/master/Documentation/Drivers/Python/PythonDriver/> )

The Python version is still under development so use with caution...

Question 23: How to decide soil column depth in parameterize?

Answer: Initially, you guess the soil column depths based on regional knowledge. The soil depth parameters are typically calibrated though.

Question 24: How accurately this model can work and what can be the maximum area of water body in which it can be applied accurately?

Answer: The model can be very accurate for a very fine tuned regional application. A SERVIR project has a very finely calibrated flood application down to 30 cm. Although, accuracy can depend on input data (garbage in = garbage out) so having accurate input data really helps with model accuracy.

Question 25: Please mention some applications of VIC model with examples.

Answer: Please see the following link for a list of journal articles that have used the VIC model for specific applications:

<http://vic.readthedocs.io/en/master/Documentation/References/#selected-application-references>

Question 26: Can VIC be used to examine water quality induced by land use change at watershed level?

Answer 26: Not for water quality.

Question 27: Is there any limitation for the model if we work in arid or semi arid area like North Africa/Egypt?

Answer 27: No. No real limitations because you can parameterize it for your region. We have seen the model work well in semi-arid regions.



Question 28: Is VIC model is useful for reconstruction of paleo hydrology?

Answer 28: Yes, it is dependent on the input data though. The physics in the model should work independent of time (paleo). You may have to calibrate the model using current conditions are assume the calibrated parameters best represent the model for the paleo time period.

Question 29: Since VIC will run cell by cell, how could we effectively calibrate the lots of parameters at the grid scale? Could you kindly elaborate on how the calibration was done in your previous experiences.

Answer 29: There a many calibration strategies out there. The cascading basin approach. An outlet for a watershed. Calibrate for the upper portion of the watershed. Calibrate stepwise down each sub watershed, including specific parameters for each sub-portion.

Question 30: Can the VIC model be run at monthly time step?

Answer 30: No. The lowest temporal resolution is daily. But you can aggregate those daily outputs into a monthly.

Question 31: Can VIC be used to estimate water availability and appropriate these for multiple/various uses within a watershed?

Answer 31: Yes.

Question 32: To which extend does VIC enable to parameterization for inferring underground water storage?

Answer 32: There are 2 components to groundwater storage. Up to 2 meters: VIC estimates that. The deep water reservoir is not considered in the model. But methods exist for GW recharge estimations based on baseflow and soil moisture.

Question 33: Can VIC model be used to determine water scarcity area?

Answer: 1) Within an area, yes. 2) to determine water scarce areas, yes, but inferred (evaporative stress). An aridity index (availability versus demand).

Question 34: If I would like running vic model image driver in specific watersheds in Peru forcing by WRF climate outputs to evaluate extreme climate impacts events, What could you recommend to as Best strategy to manage data inputs and calibration procedures in this complex geography?



Introduction to Using the VIC Hydrologic Model with NASA Earth  
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Answer 34: Managing data inputs for VIC, netCDF datasets are used because of its compression levels. Calibration procedures will be important here especially for the snow processes such as snowfall temperature thresholds, snow albedo, and snow roughness.