# Overview and literature review of Forest Hydrological model (ForHyM)

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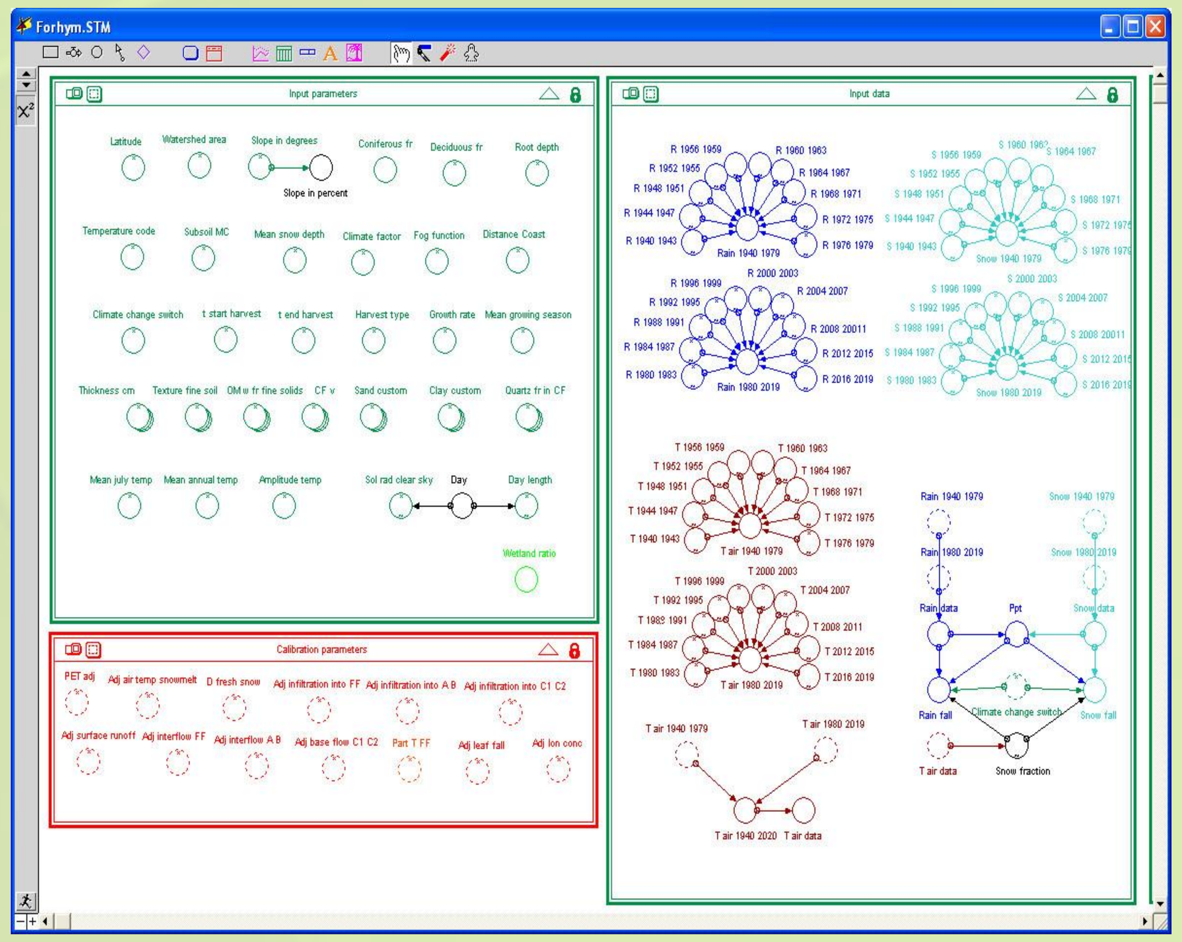
## INTRODUCTION

Understanding how forest hydrology is affected by forest management has been one of the leading incentives in developing models that accurately mimic and predict natural hydrological flows. This poster examines the Forest Hydrological Model (ForHyM) created at the University of New Brunswick.

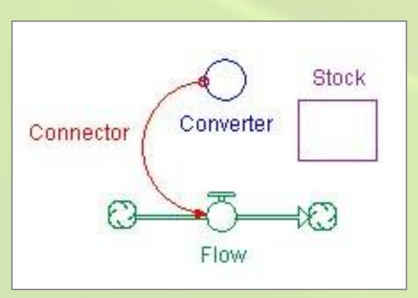
The Stella-based model, ForHyM, was originally designed to model thermal and hydrological flows in a forest (Yin and Arp, 1993). It utilizes daily precipitation (snowfall and rain in cm) and temperature inputs along with soil and catchment characteristics (latitude, slope, area, soil depth, etc…) to predict various aspects forest hydrology and nutrient cycles on a non-spatial level.



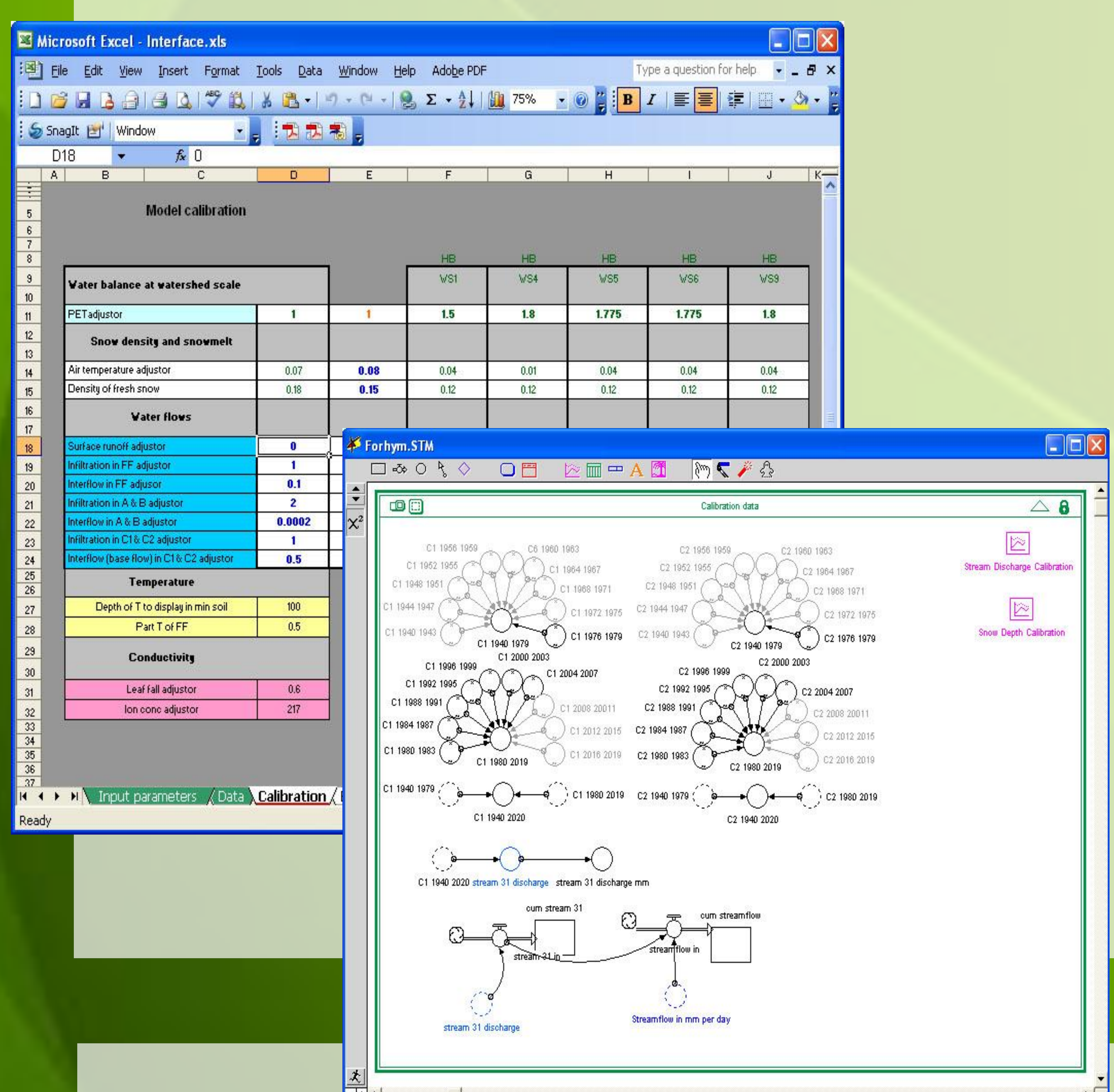
*Stella model input interface*

## STELLA MODEL INTERFACE

ForHyM uses STELLA, a computer modeling software that enables users to create dynamic interfaces which simulate realistic systems, to predict temperature and hydrological flows in nature. STELLA makes use of 4 basic building blocks: stocks, flows, connectors and converters. Each block has a specific function which enable the model to run automatically over various amounts of time.




**STOCK:** function used to represent things that accumulate (i.e. reservoirs, water in forest floor).
**CONVERTER:** function that creates an output value during each time interval (i.e. temperature, stream flow)
**FLOW:** functions representing activities that lead to inputs and outputs to stocks (i.e. thaw and freeze of forest floor)
**CONNECTOR:** transmits information to adjust flows.



*Calibration interfaces in Excel and Stella*

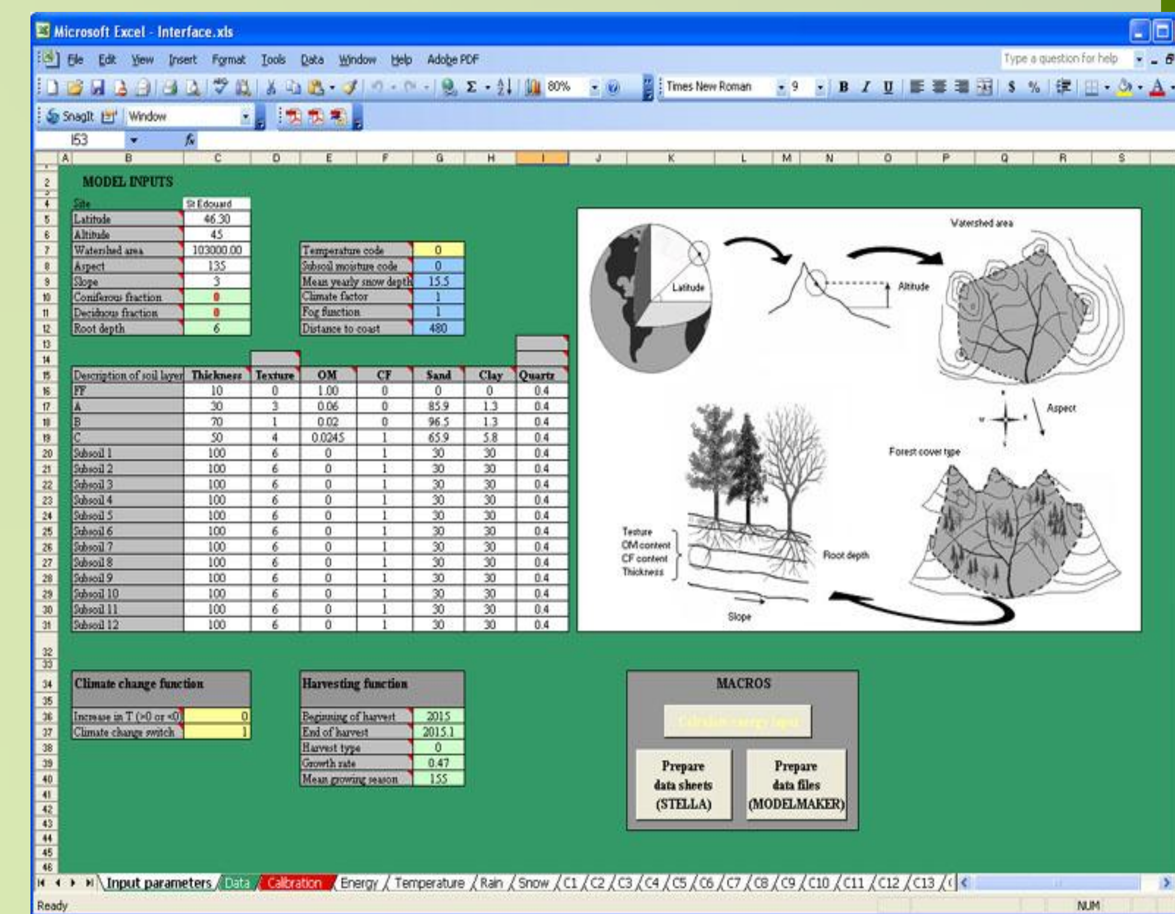
## LITERATURE and PAST USES

Hydrological modeling using ForHyM consists of deriving new algorithms, which enable users to find relations between different variables. For instance, Chi (2008) used ForHyM to relate stream temperature to measured air and soil temperatures. She was also able to connect levels of dissolved oxygen with measured or simulated stream temperature and discharge rate. Balland (2002) revised the model to be able to calculate snow density and the amount of ions which are released from melting snow. Yanni (1996) used the model to observe the correlation between soil ion concentrations and stream water ion concentration flux ratios. In some cases the model was used to show the direct affects of forest management on important forest variables. Steeves's (2004) work looked at the effects of canopy removal on soil temperature and the direct correlation of soil temperature to groundwater temperature fluctuations.

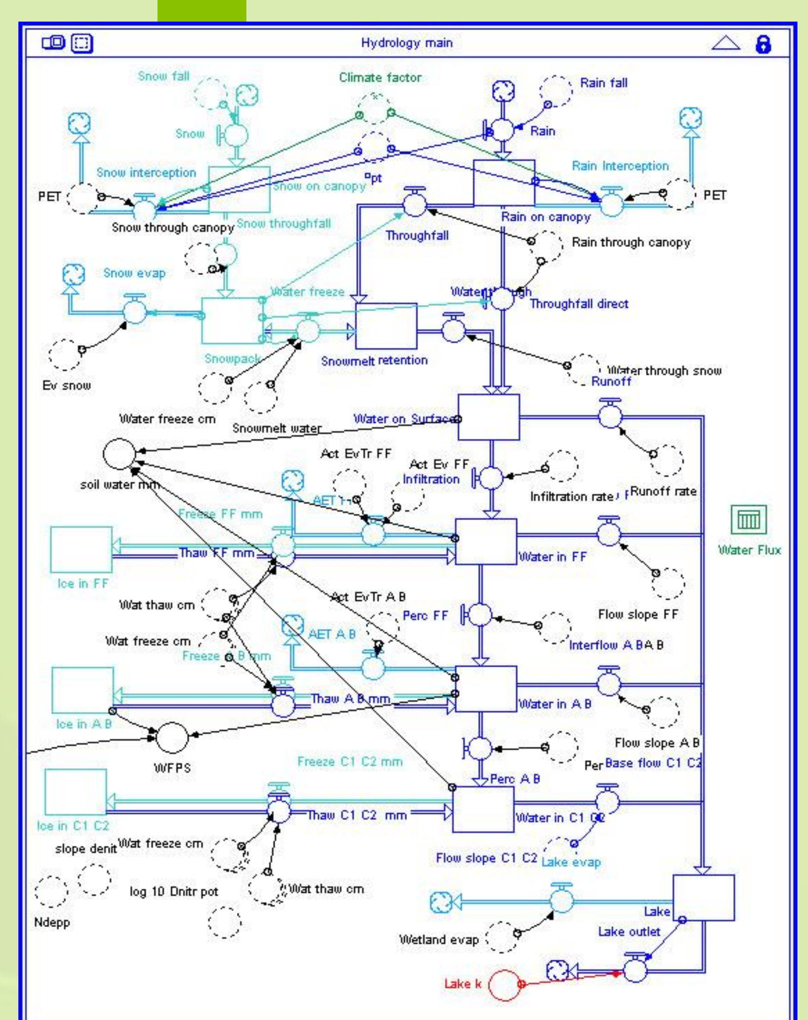
## EXCEL MODEL INTERFACE

An interface in Excel was created to facilitate the input of data in a "user-friendly" way. The Excel interface is connected to the STELLA interface through the use Macros, which converts the data into a suitable format for use by STELLA. This enables the users to input the raw data in a logical and organized way and opens the door to potential users who would be otherwise put-off by the complexity of the STELLA interface.

Calibration settings have been integrated into both the Excel and Stella interfaces. The Excel interface provides 9 parameters for water flow, snow density and snow melt which can be adjusted to calibrate the calculated data. Graphs in Stella are used in conjunction with the parameter inputs in Excel to optimize data calibration.



*Excel "user-friendly" interface*

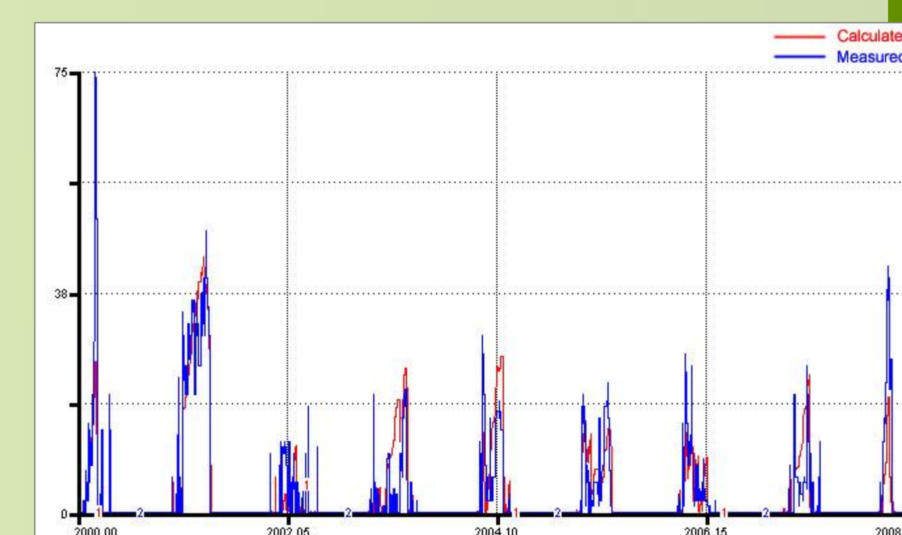


*Main hydrology module*

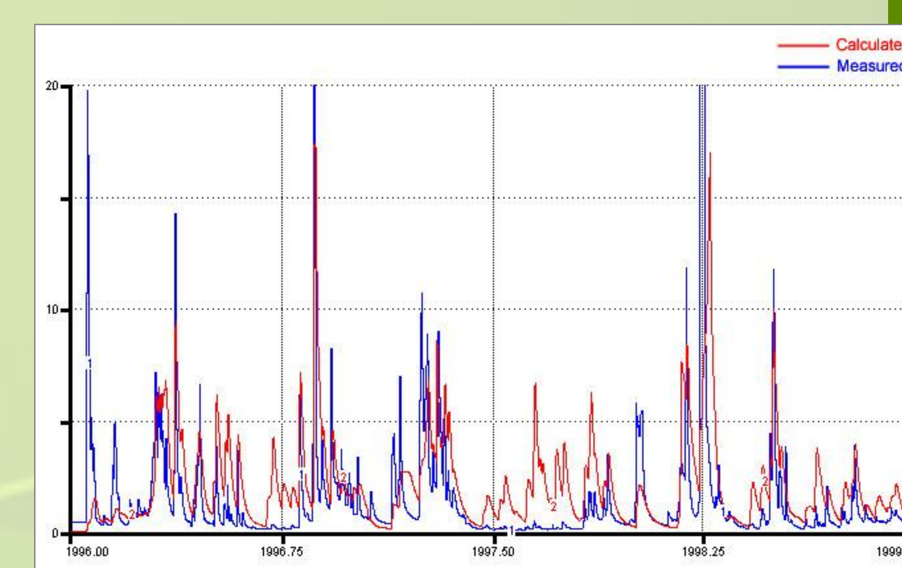
## MODULES

ForHyM uses modules as representations of natural processes. For instance, one of the first modules to be developed in ForHyM is the hydrology module. It's purpose is to calculate water flow and retention in a system. Using ForHyM you can monitor the movement of water down through the forest canopy, and track it as it infiltrates down through the soil. Over the years many other modules were created in ForHyM including: stream conductivity, stream pH, snowpack levels, dissolved oxygen and ion levels.

ForHyM has proven to be a useful tool to forest and non-forest operations as it produces valuable simulations and verified data for thermal and hydrological flows.




*Example of snowpack outputs*




*Example of stream flow outputs*

## REFERENCES

Balland, V. 2002. Hydrogeological watershed modeling with special focus on snow accumulation and snowmelt, including retention and release of major ions. MSc thesis, University of New Brunswick: 169pp.
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