Hydrological Modeling Technical Memo: Upper French Broad Basin

1. Basin & Gauge Map

The Upper French Broad basin, spanning a latitudinal range from 35.0° to 36.0° and a longitudinal range from -83.0° to -82.0°, is characterized by its diverse topography and significant hydrological features. The basin covers an area of 4867.99 km² and includes key USGS gauge stations such as #03455000 located at (35.981611, -83.161088). The centroid of the basin is positioned at coordinates (35.6077°, -82.6728°), reflecting its geographical balance. The watershed boundary is distinctively outlined in red, showcasing the basin's topographic variation.

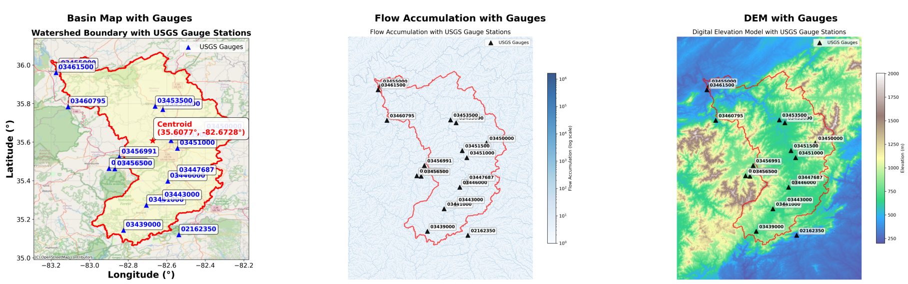

Figure 1: Basin & Gauge Map

2. Fundamental Basin Data

- **Digital Elevation Model (DEM):** The basin exhibits a varied relief, with elevations ranging from 250 m to over 2000 m. This substantial elevation gradient suggests diverse hydrological processes and potential for varied runoff behaviors.
- **Flow Accumulation Map (FAM):** Flow accumulation is shown on a log scale, indicating significant flow paths and converging stream networks within the basin. This highlights potential areas of concentrated flow.
- **Drainage Direction Map (DDM):** The DDM illustrates the drainage patterns, with multiple direction classes indicating a complex drainage network. The drainage density seems relatively high, suggesting efficient water conveyance across the basin.

3. Simulation vs Observation

The hydro-simulation results for gauge #03455000 indicate three primary curves:

- **Simulated Discharge:** The black curve indicates the simulated dis-

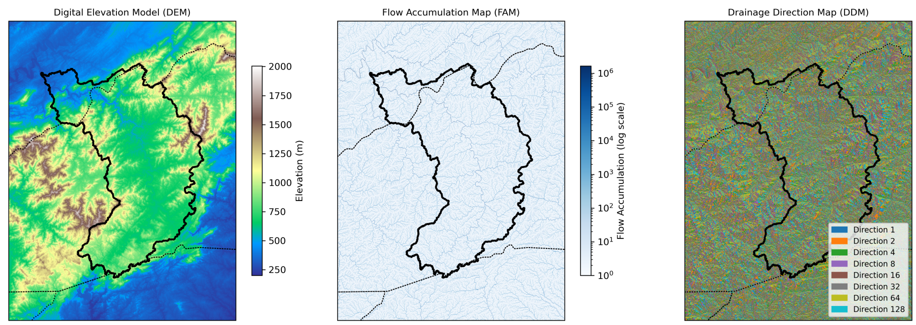

Figure 2: Fundamental Basin Data

charge over time, generally capturing the hydrograph trends but occasionally underestimating peak flows.

- **Observed Discharge:** The red dots represent observed discharge data. Notably, the peaks reach values above 800 m^3/s during significant events, suggesting the simulation slightly underpredicts the intensity of these peaks.
- **Precipitation:** Displayed in blue, precipitation events align with peaks in discharge but show some temporal lag in the simulated response.

Overall, the simulation provides a reasonable fit to observed data but tends to underestimate the magnitude of higher peak events, indicating a need for model calibration to decrease predictive bias during these events. Temporal lags in peak discharge suggest potential improvements in capturing storage and release processes within the basin.

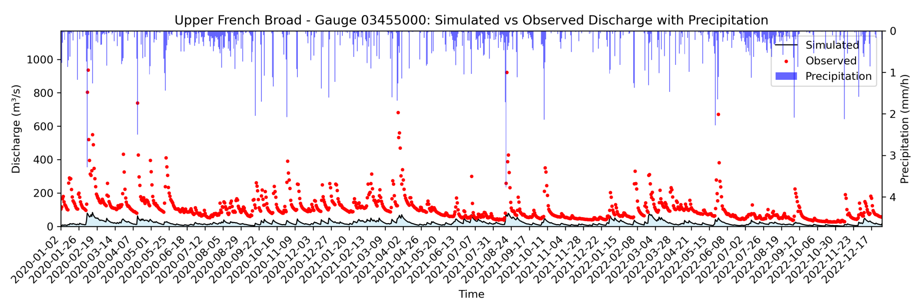

Figure 3: Simulation vs Observation

4. Model Performance Metrics

Metric	Value
Nash-Sutcliffe Coefficient of Efficiency (NSCE)	-0.881
Kling-Gupta Efficiency (KGE)	-0.223
Correlation Coefficient	0.651
Bias (m^3/s)	-90.97 (-81.2%)
Root Mean Square Error (RMSE) (m^3/s)	121.26

5. CREST Parameters

Water Balance Parameters

Parameter	Value
Water capacity ratio (WM)	150.0
Infiltration curve exponent (B)	5.0
Impervious area ratio (IM)	0.1
PET adjustment factor (KE)	0.5
Soil saturated hydraulic conductivity (FC)	75.0
Initial soil water value (IWU)	25.0

Kinematic Wave (Routing) Parameters

Parameter	Value
Drainage threshold (TH)	100.0
Interflow speed multiplier (UNDER)	1.0
Interflow reservoir leakage coefficient (LEAKI)	0.1
Initial interflow reservoir value (ISU)	0.0
Channel flow multiplier (ALPHA)	1.2
Channel flow exponent (BETA)	0.7
Overland flow multiplier (ALPHA0)	1.0

6. Discussion

Model Performance Evaluation

The model's performance, as indicated by the NSCE and KGE values, suggests room for improvement. The negative values indicate that the model predictions are less accurate than using the mean of the observed data as a predictor. The correlation coefficient of 0.651 shows moderate agreement between observed and simulated streamflow, but the significant bias and RMSE highlight the need for calibration.

Warmup Period Considerations

Given the bias of -90.97 m^3/s (-81.2%), it is crucial to consider extending the warmup period or adjusting initial conditions to better align the model with observed conditions, particularly at the start of the simulation period.

Recommendations for Simulation Period and Next Steps

To enhance model accuracy, it is recommended to: - Conduct a sensitivity analysis to identify key parameters influencing model performance. - Refine model calibration, focusing on reducing bias and improving peak flow predictions. - Consider incorporating additional data sources or refining spatial resolution to better capture basin heterogeneity. - Evaluate the impact of land use changes and climate variability on hydrological processes within the basin.

This report provides a comprehensive overview of the hydrological modeling conducted for the Upper French Broad basin, highlighting key findings and areas for further investigation to improve model reliability and predictive capabilities.