***Chemical turnover time***

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| **Parameter** | **Where It's Set** | **Description** |
| **Number of tributaries** | river\_initial\_monac\_code.py | Defines how many major tributaries flow into the Yukon main stem (e.g., Pelly, Tanana, Koyukuk). |
| **Main stem and tributary length** | river\_initial\_monac\_code.py | Total length of the main river and each tributary; includes distances to confluence points. |
| **Confluence point locations** | river\_initial\_monac\_code.py | Distance along main stem where each tributary joins (used for dilution and mixing simulations). |
| **Flow velocity** | river\_initial\_monac\_code.py | Average flow velocity for main river and tributaries. |
| **Dilution factors** | river\_initial\_monac\_code.py | Confluence dilution factors based on river discharge from main stem and tributaries. |
| **Initial DOC concentration** | river\_initial\_monac\_code.py | Based on average soil organic carbon at each headwater, converted to DOC using empirical relationships. |
| **Chemical fractions of DOC** | river\_initial\_monac\_code.py | Defines macromolecular composition of DOC (e.g., proteins, polysaccharides, humics). |
| **Chemical turnover times** | river\_initial\_monac\_code.py | Residence/decay time for each DOC component. |
| **Initial macromolecular production** | river\_initial\_monac\_code.py | Set baseline production rates for each DOC macromolecule type. |
| **Monte Carlo setup** | river\_initial\_monac\_code.py | Sets number of simulation runs and generates random parameters within defined ranges. |
| **Boundary condition ranges** | river\_initial\_monac\_code.py | Parameter limits for random sampling in Monte Carlo runs. |

**Model Input Data and it’s location**

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| Parameter | Definition Source | Data Source |
| **Number of tributaries** | Hardcoded in script | River maps, literature |
| **Main stem and tributary length** | Defined numerically from shapefile | Natural Earth, published river datasets |
| **Confluence point locations** | GIS-derived, inserted manually | Literature and maps |
| **Flow velocity** | Manually inserted from literature/station data | USGS, literature |
| **Dilution factors** | Derived from observed discharge and inserted manually | River discharge data |
| **Initial DOC concentration** | Converted from soil organic carbon values and inserted manually | Soil Organic Carbon Data, Polygon Shape files of tributary watersheds, Soil moisture data, Soil temperature data |
| **Chemical fractions of DOC** | Expert judgement/literature-derived proportions | Literature and expert judgment, past model estimates |
| **Chemical turnover times** | Calibrated from literature values | Literature and expert judgment, past model estimates |
| **Initial macromolecular production** | Model assumption | Expert judgement and model assumptions |
| **Monte Carlo setup** | Number of runs decided via sensitivity test | Model Sensitivity test |
| **Boundary condition ranges** | Defined from Arctic ranges and adjusted via sensitivity | Based on expert range and literature |