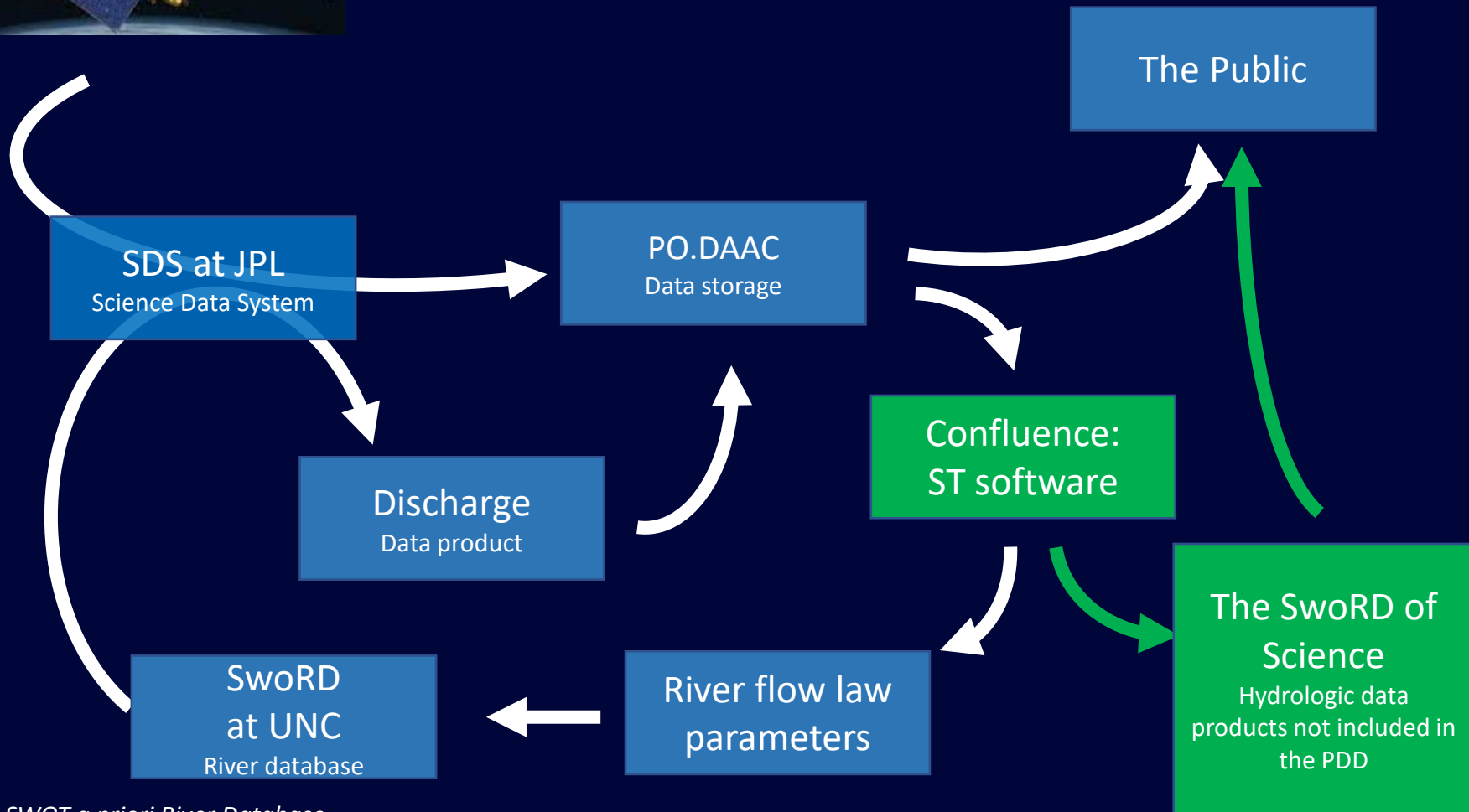


An aerial photograph showing a river confluence in a suburban area. The river flows from the top center towards the bottom left, where it meets a larger body of water. The surrounding area is densely packed with houses and streets, with some green spaces and trees interspersed. The text 'Confluence: ST discharge software' is overlaid in white at the top of the image.

Confluence: ST discharge software

Colin Gleason
Nikki Tebaldi
UMass Amherst

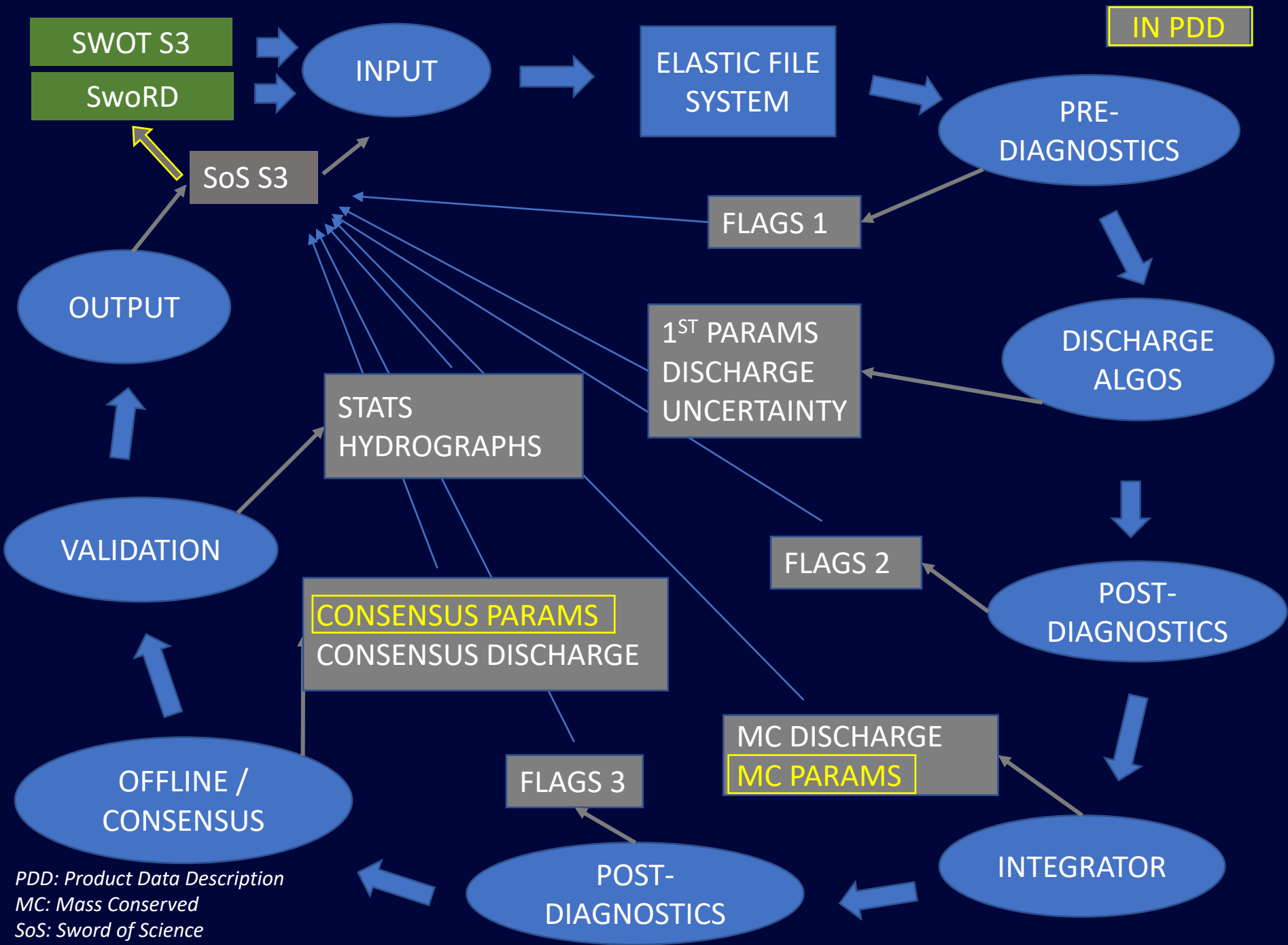
What is Confluence?



SwoRD: SWOT a priori River Database

SDS: Science Data System

ST: Science team



IN PDD

SWOT S3
SwoRD

INPUT

ELASTIC FILE SYSTEM

PRE-DIAGNOSTICS

SoS S3

FLAGS 1

OUTPUT

1ST PARAMS
DISCHARGE
UNCERTAINTY

DISCHARGE ALGOS

STATS
HYDROGRAPHS

FLAGS 2

VALIDATION

POST-DIAGNOSTICS

CONSENSUS PARAMS
CONSENSUS DISCHARGE

MC DISCHARGE
MC PARAMS

OFFLINE /
CONSENSUS

FLAGS 3

INTEGRATOR

POST-DIAGNOSTICS

INPUT

PRE

FLPE

POST

INTEG.

POST

OFFLINE

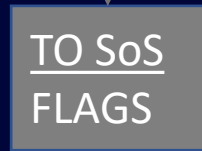
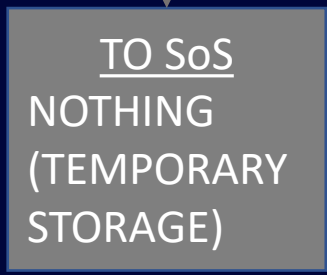
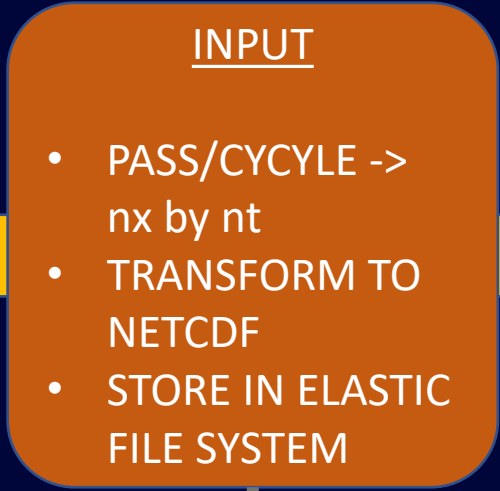
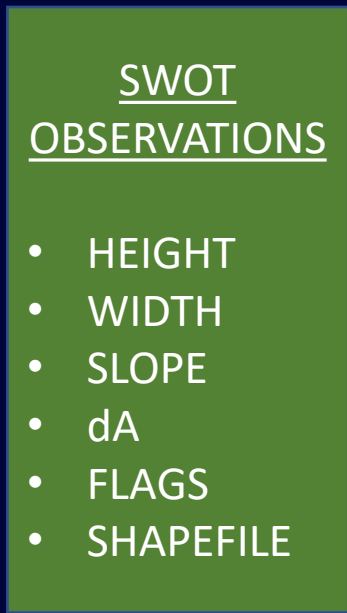
OUTPUT

Amazon Web Services (AWS) Infrastructure

- Amazon Simple Storage Service (S3) buckets
- Amazon Elastic File System(s) (EFS)
- Docker containers
- AWS Batch

Confluence workflow

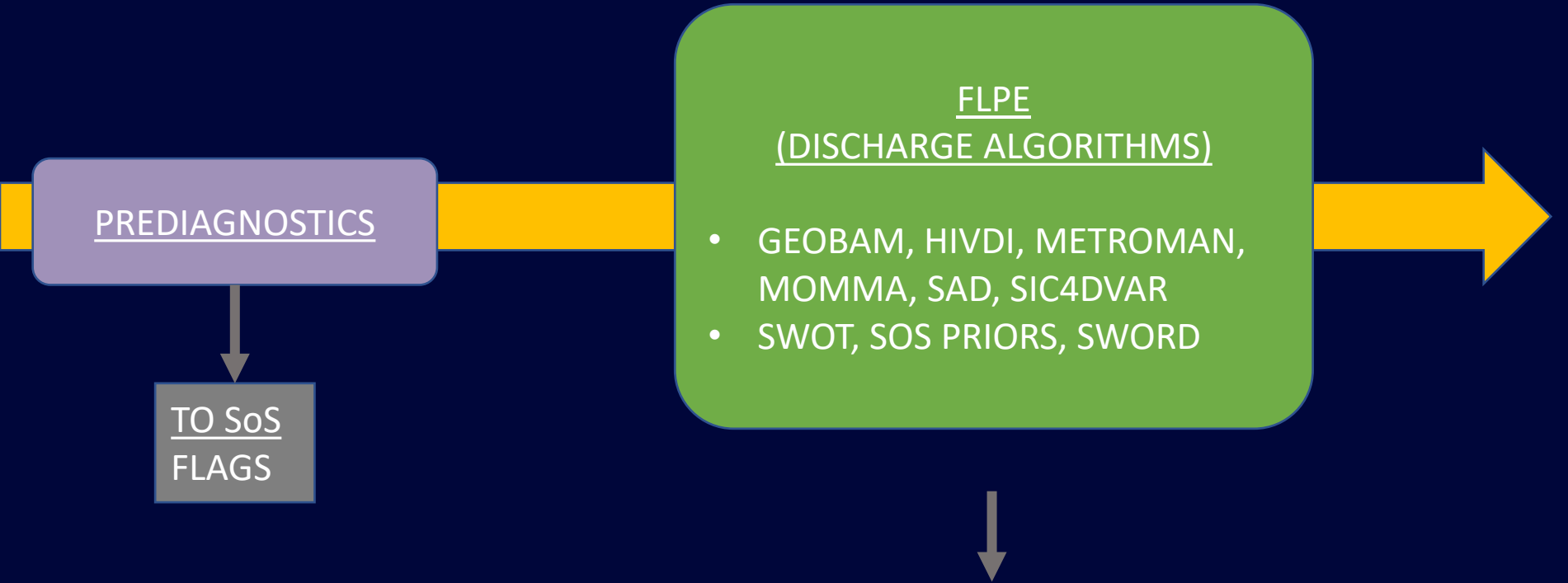
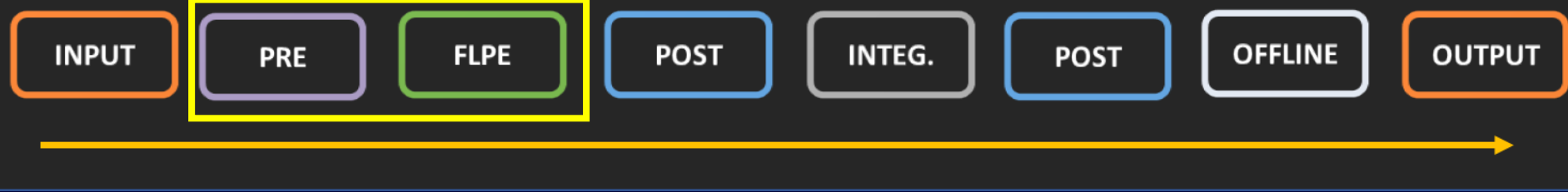
- Program that creates and orchestrates jobs
- The workflow is made up of stages
- Each stage has one or more modules
- A module is considered a job



*dA: change in river cross section area
 nx: number of spatial units
 nt: number of observations
 Sesame Street: outlier filter
 SoS: Sword of Science*

*Contributors:
 Nikki Tebaldi
 Steve Coss*

*Contributors:
 Nikki Tebaldi
 Colin Gleason*



FLPE
(DISCHARGE ALGORITHMS)

- GEOBAM, HIVDI, METROMAN, MOMMA, SAD, SIC4DVAR
- SWOT, SOS PRIORS, SWORD

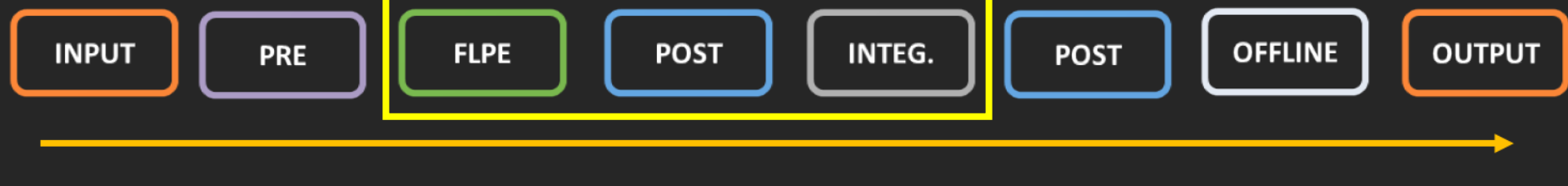
PREDIAGNOSTICS

TO SoS
 FLAGS

TO SoS
 INDIVIDUAL PARAMETERS
 DISCHARGE TIMESERIES
 ALGORITHM UNCERTAINTY

*Contributors:
 Kostas Andreadis, Colin Gleason, Craig Brinkerhoff, Kevin Larnier, Rob Dudley, Dave Bjerklie, Mike Durand, Hind Oubanas, Pierre-Olivier Malaterre, Callum Tyler*

*FLPE: Flow Law Parameter Estimation (Discharge algorithm)
 Parameters: discharge parameters as described in PDD*



FLPE
(DISCHARGE
ALGOS)

TO SoS
PARAMETERS
TIMESERIES
UNCERTAINTY

POSTDIAGNOSTICS

- COMPARE TO PREVIOUS CONFLUENCE RUN
- REALISM CHECK

TO SoS
FLAGS

*Contributors:
Nikki Tebaldi
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INTEGRATOR (MOI)

- FORCES MASS CONSERVATION
- USES RIVER NETWORKS
- DEFINES UNCERTAINTY

TO SoS
MC DISCHARGE
TIMESERIES
MC PARAMS
MC UNCERTAINTY

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Mike Durand*

IN PDD

*MOI: Mean Optimization Integrator
MC: Mass Conserved*



INTEGRATOR
(MOI)

POSTDIAGNOSTICS

- INTEGRATED VS FLPE
- REALISM FILTER
- COMPARE TO PREVIOUS INTEGRATED CONFLUENCE RUN

OFFLINE

- SDS DISCHARGE COMPUTATION
- RUNS CONSENSUS ALGO
- PREVIEWS THE DISCHARGE PRODUCT

TO SoS
MC DISCHARGE
MC PARAMS
MC UNCERTAINTY

TO SoS
FLAGS

TO SoS
CONSENSUS PARAMS
CONSENSUS DISCHARGE

*FLPE: discharge algorithm
MOI: Mean Optimization Integrator
SDS: Science Data System*

*Contributors:
Nikki Tebaldi
Colin Gleason*

*Contributors:
Rui Wei, Renato Frasson*

IN PDD



OFFLINE

TO SoS
**CONSENSUS
 PARAMS**
 CONSENSUS
 DISCHARGE

VALIDATION

- COMPARES TO GAUGES
- CALCULATES ERROR STATS
- GENERATES HYDROGRAPHS

TO SoS
 STATS
 HYDROGRAPHS

*Contributors:
 Steve Coss*

OUTPUT

- WRITE TO S3
- VERSION CONTROL

*Contributors:
 Nikki Tebaldi*

SwoRD OF SCIENCE
 S3 BUCKET

- PUBLIC ACCESS
- UNIQUE VERSION FOR EACH RUN

TO SwoRD
**PARAMS
 UNCERTAINTY**

*Contributors:
 Nikki Tebaldi*

IN PDD

What's next?

- Move to release versions
- Optimize SoS
- Handle exceptions and job failures
- Optimize modules for runtime and cost
- Test!!!

Recap

- Confluence produces global discharge for DAWG
- We want to share
- Working Beta in AWS
- Containerized and open source
- Run often (ideally weekly) after launch
- Consider costs- without additional support, only UMass can run this, and only locally

The DAWG will be ready for launch

INPUT

PRE

FLPE

POST

INTEG.

POST

OFFLINE

OUTPUT

Input

Description: Takes SWOT observation data and transforms shapefile data into time series NetCDF files with one file per reach.

Input: SWOT shapefiles

Output: Time series data (width, height, slope, dA, and flags) in NetCDF format

Prediagnosics

Description: Parses the SWOT observation data formatted by the Input module to track quality indicators and perform consistency checks. Replaces flags with missing values.

Input: SWOT NetCDF files

Output: Overwrites SWOT NetCDF files and outputs flags.

Reach-level Flow Law Parameter Estimation (FLPE)

Description: Take the SWOT observation data formatted by the Input module and processed by the Prediagnosics module as well as SoS priors and SWORD data to produce discharge and discharge parameters.

Input: SWOT NetCDF files, SoS NetCDF files, SWORD NetCDF files

Output: Discharge parameters, discharge time series, uncertainty as NetCDF files.

INPUT

PRE

FLPE

POST

INTEG.

POST

OFFLINE

OUTPUT

Postdiagnostics FLPE

Description: Compares previous and current discharge values while also performing a realism check on the results of each FLPE algorithms' execution.

Input: FLPE algorithm NetCDF files and SoS NetCDF files

Output: Flags produced from comparisons and stored in NetCDF files

Integrator (MOI)

Description: Takes the formatted SWOT observation data and reach-level FLPE output and integrates the results. It uses river network topology to force mass conservation and also defines uncertainty.

Input: SWOT NetCDF files

Output: Discharge time series for each FLPE algorithm, mass conserved parameters, mass conserved uncertainty stored in NetCDF files.

Postdiagnostics Integrator

Description: Compares FLPE and integrated discharge values while also performing a realism check on the results of Integrator execution. Also compares previous and current discharge.

Input: MOI NetCDF files and SoS NetCDF files

Output: Flags produced from comparisons and stored in NetCDF files

INPUT

PRE

FLPE

POST

INTEG.

POST

OFFLINE

OUTPUT

Offline

Description: Executes the RiverObs SWOT Algorithm that will be run by the Science Data System (SDS) to produce discharge for each FLPE algorithm and executes a consensus algorithm.

Input: SWORD NetCDF files

Output: Discharge values, consensus parameters and consensus discharge stored in NetCDF files

Validation

Description: Compares the results of FLPE and integrator algorithms to gages, calculates stats and creates hydrographs.

Input: FLPE algorithm NetCDF files, Integrator algorithm NetCDF files, SoS NetCDF files

Output: Statistics stored in NetCDF files and hydrographs

Output

Description: Appends the results of all stages and modules to a new version of the SoS.

Input: NetCDF files from every stage

Output: SoS NetCDF file uploaded to SoS S3 bucket