


# Estimation of Rainfall by Integrating a Satellite-Based Algorithm and Rain Gauge Networks



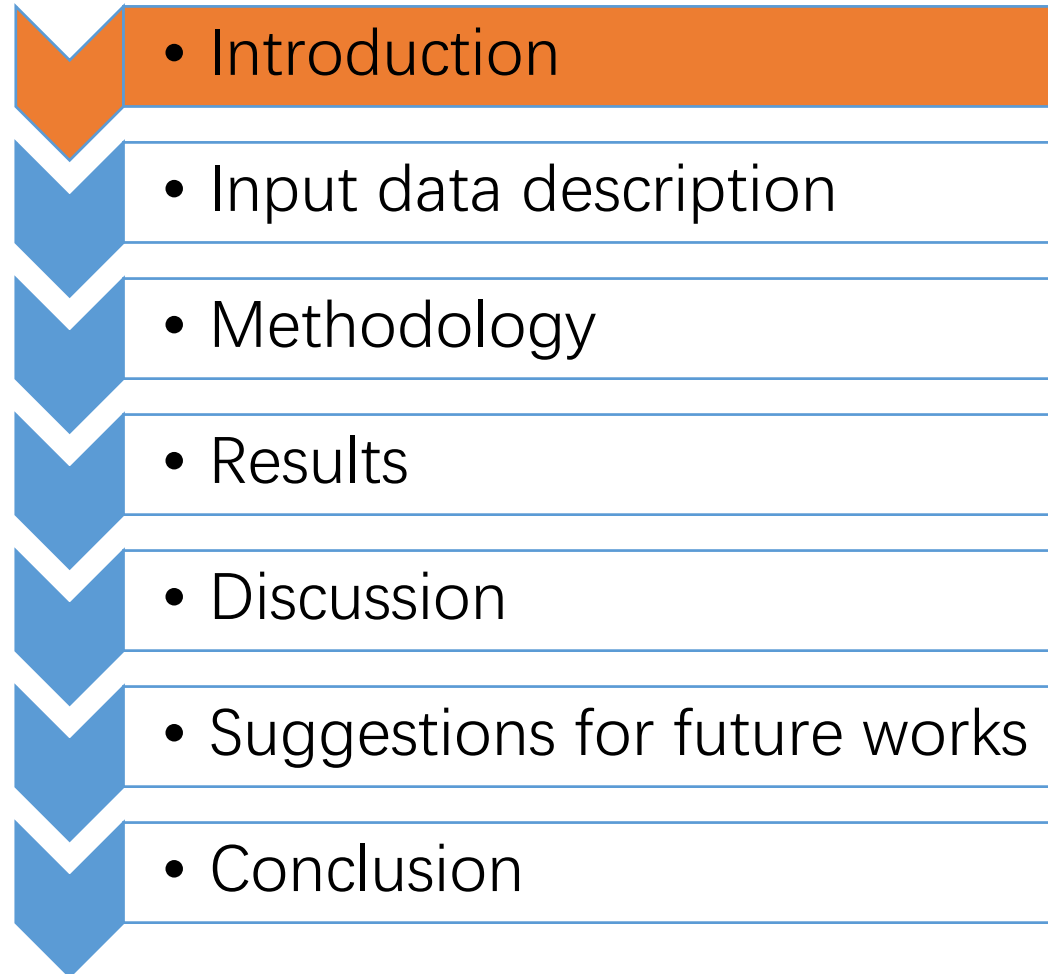
Qiao Ren

ITC Water Resources Department (WRS)  
and Geo-Information Processing Department (GIP)

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- Introduction
  - Input data description
  - Methodology
  - Results
  - Discussion
  - Suggestions for future works
  - Conclusion

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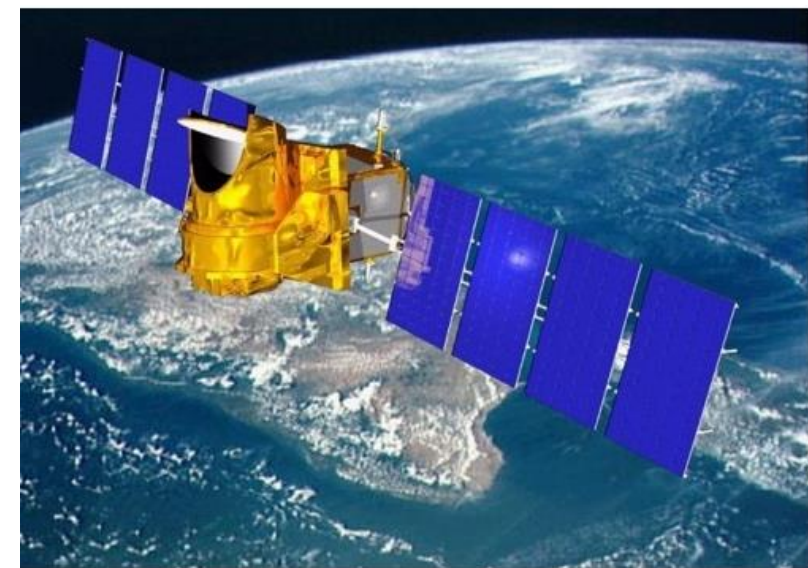


Accurate  
Precipitation  
Estimation

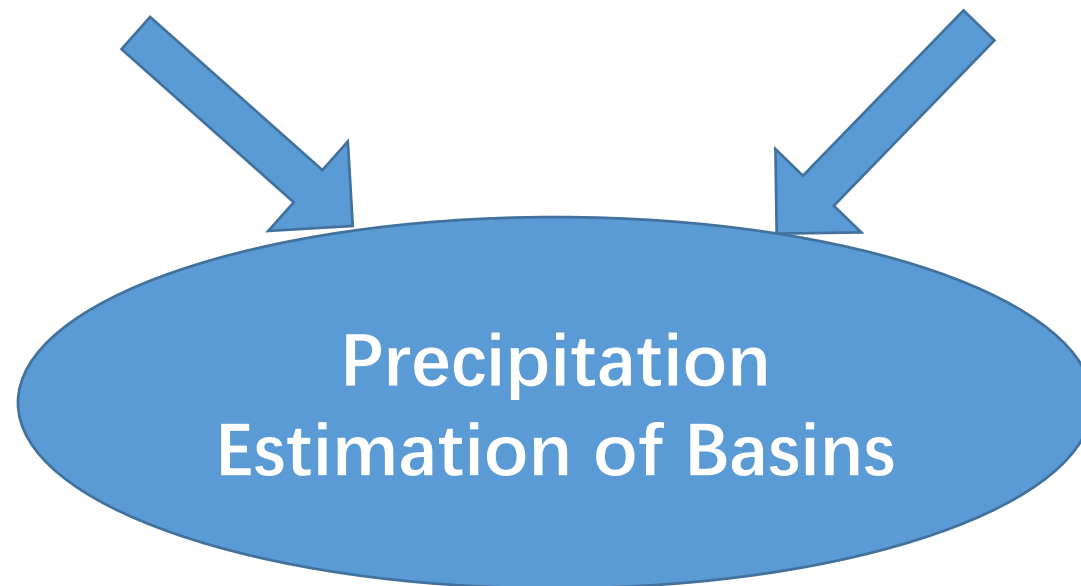




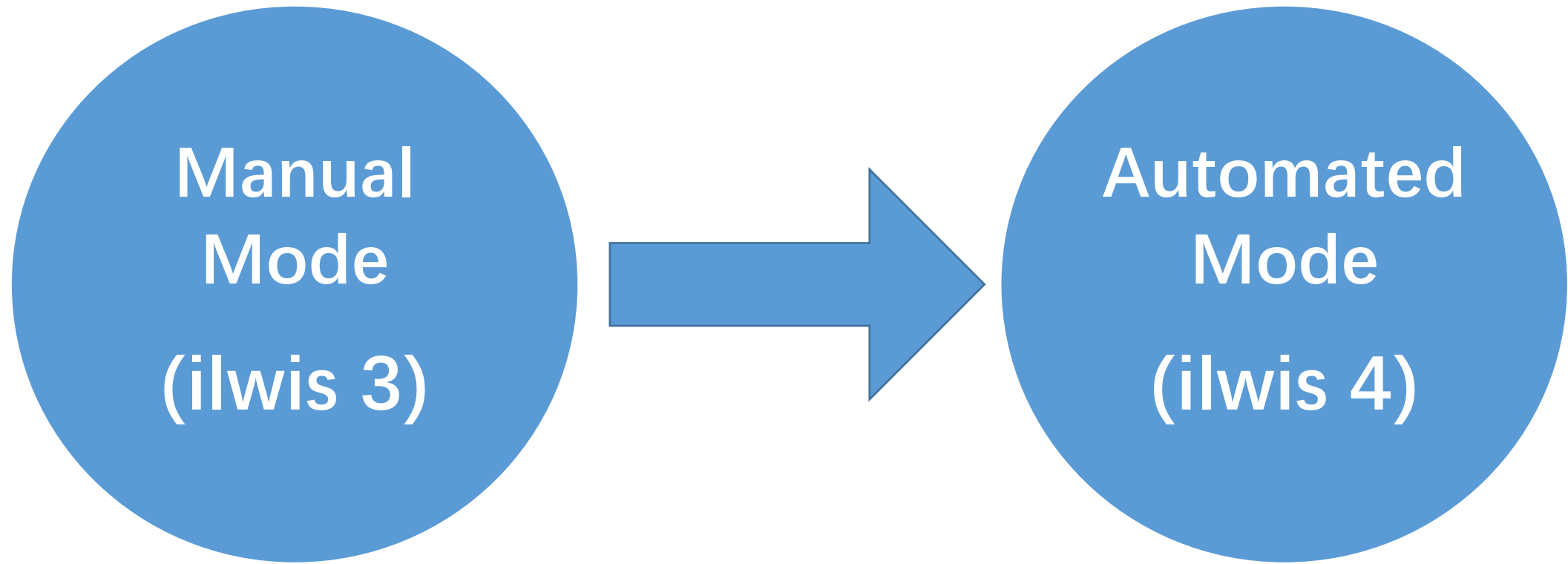
	Gauge-based rainfall observation	Satellite-based rainfall estimation (by hydroestimator algorithm)
Accuracy	High	Low
Area Coverage	Limited	Very Big



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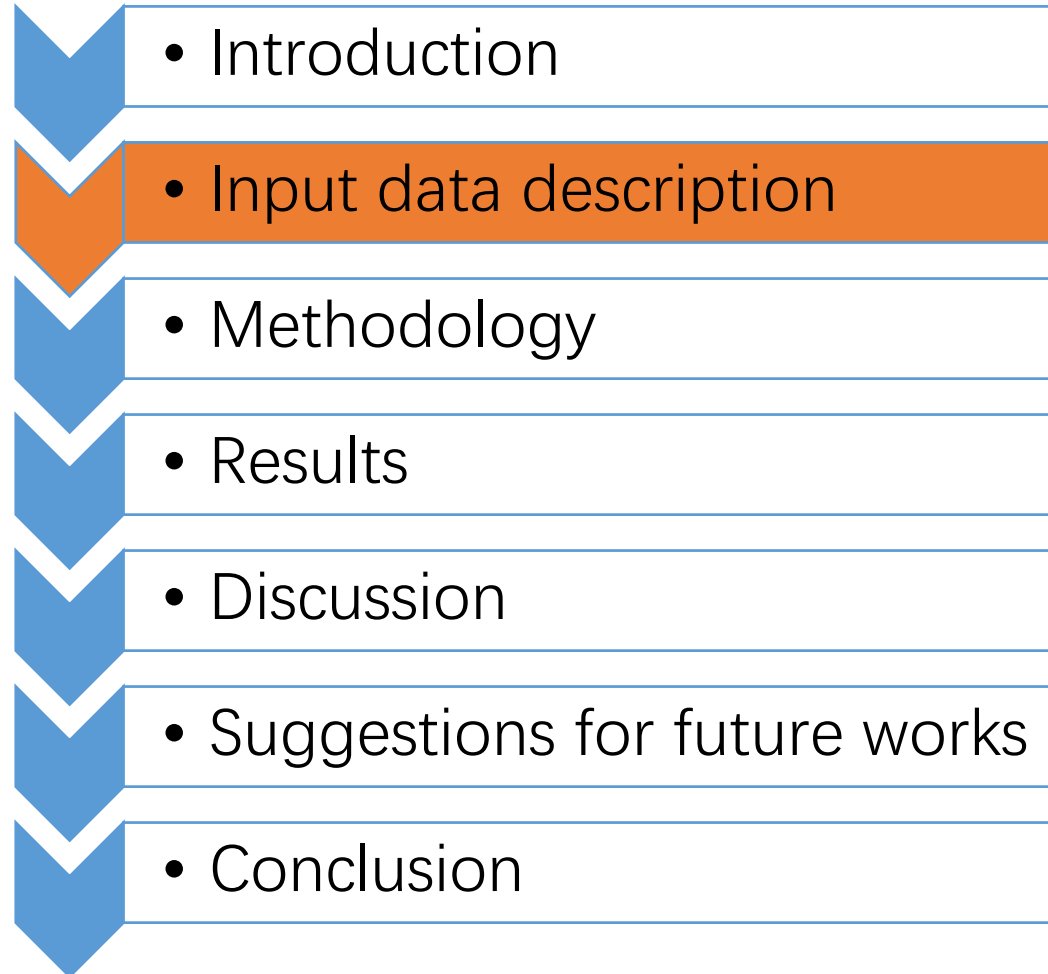
# Problem Definition

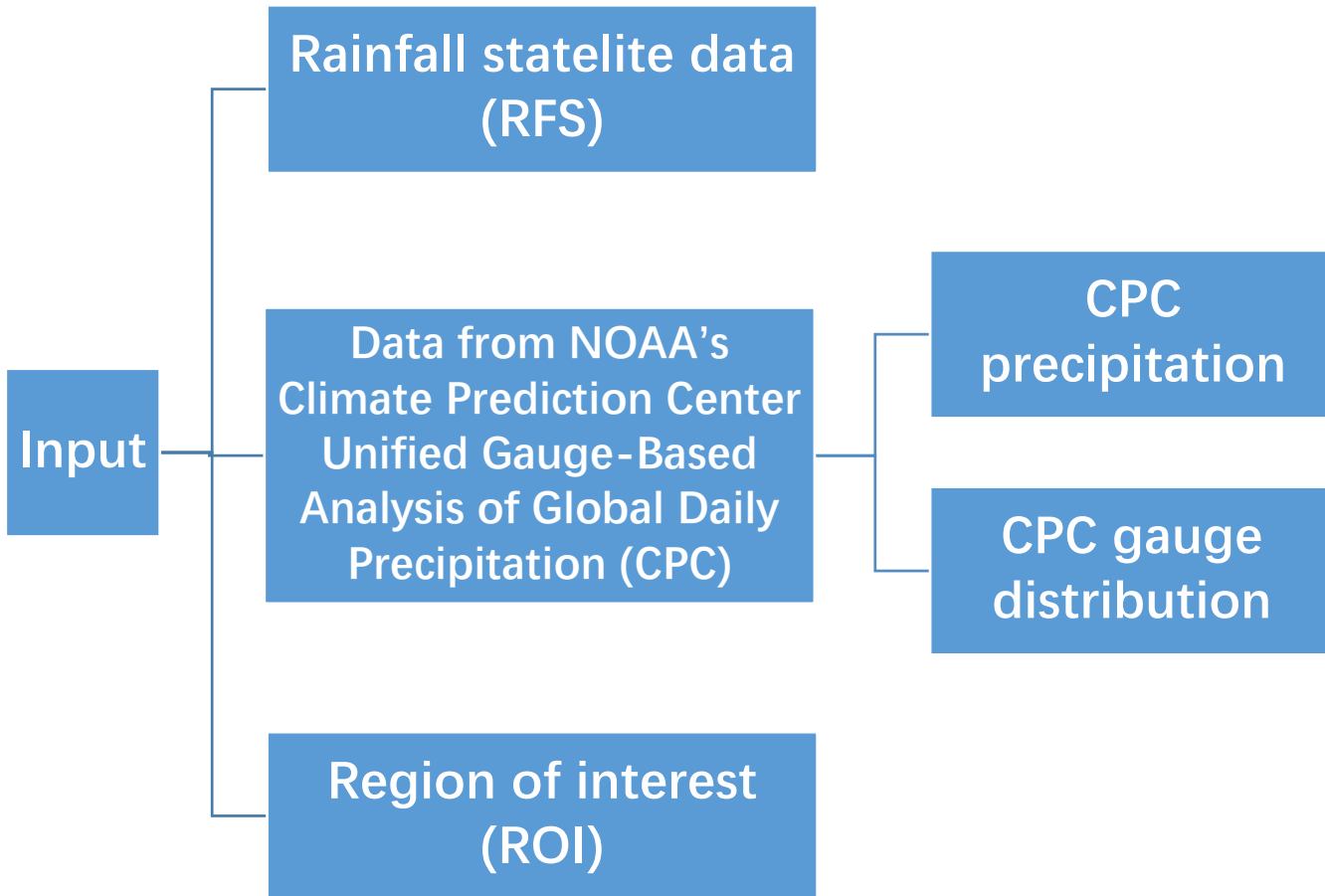


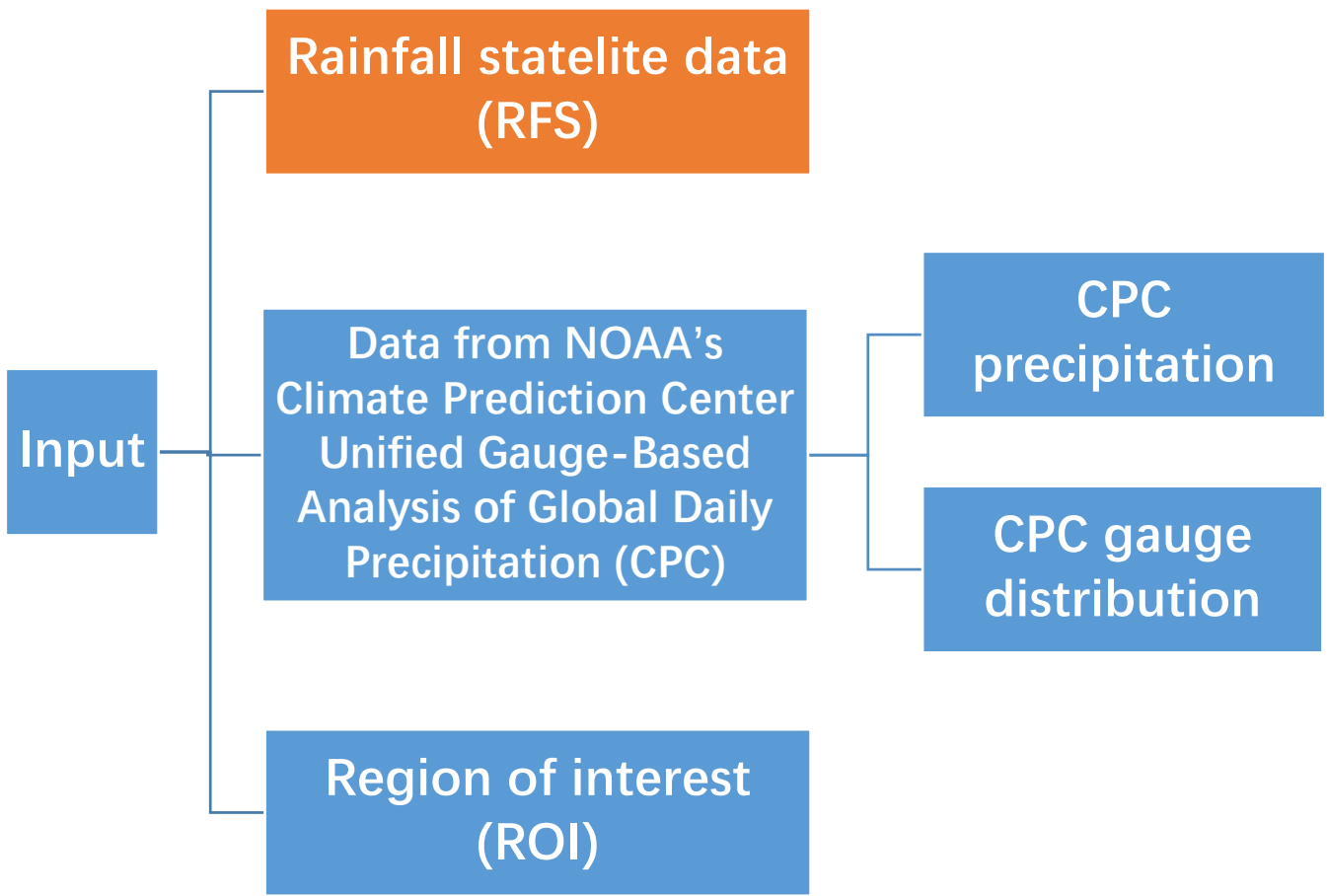
- **Goal:**
  - Main goal: Develop scripts that automate and execute the Combined Scheme technique using ILWIS-Python extensions.
  - Secondary goal: Produce precipitation estimations, for the use of Affrialliance project.
- **Hypothesis:** improve the efficiency
- **Assumption:** gauge-based rainfall observation prevail over any satellite retrievals
- **Two cases:**
  - Latin America case
  - Africa case



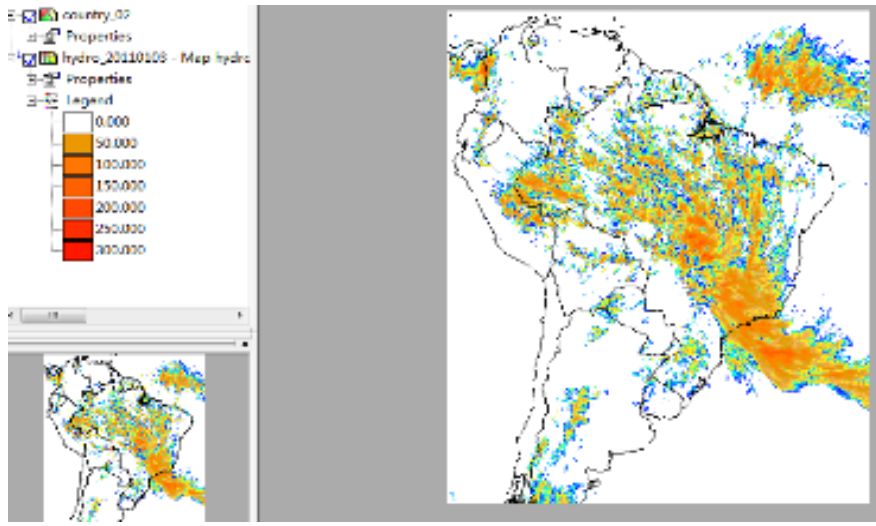
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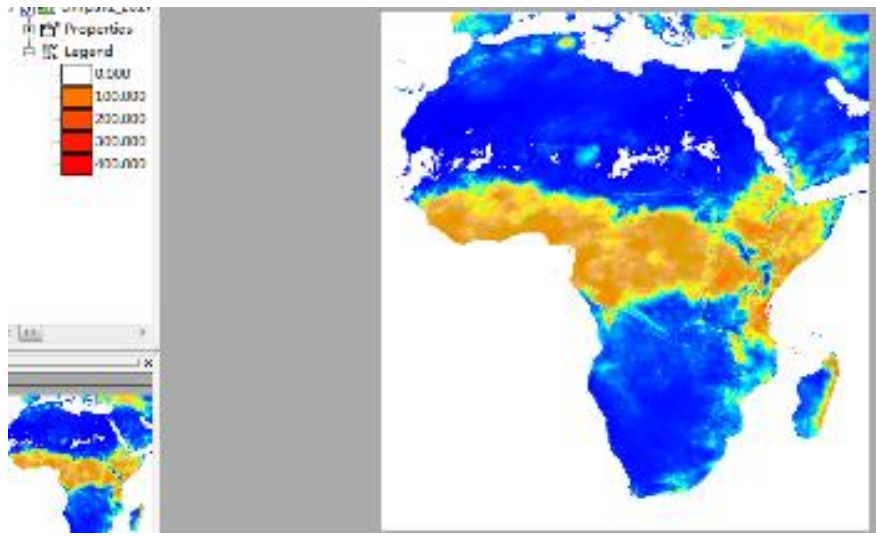


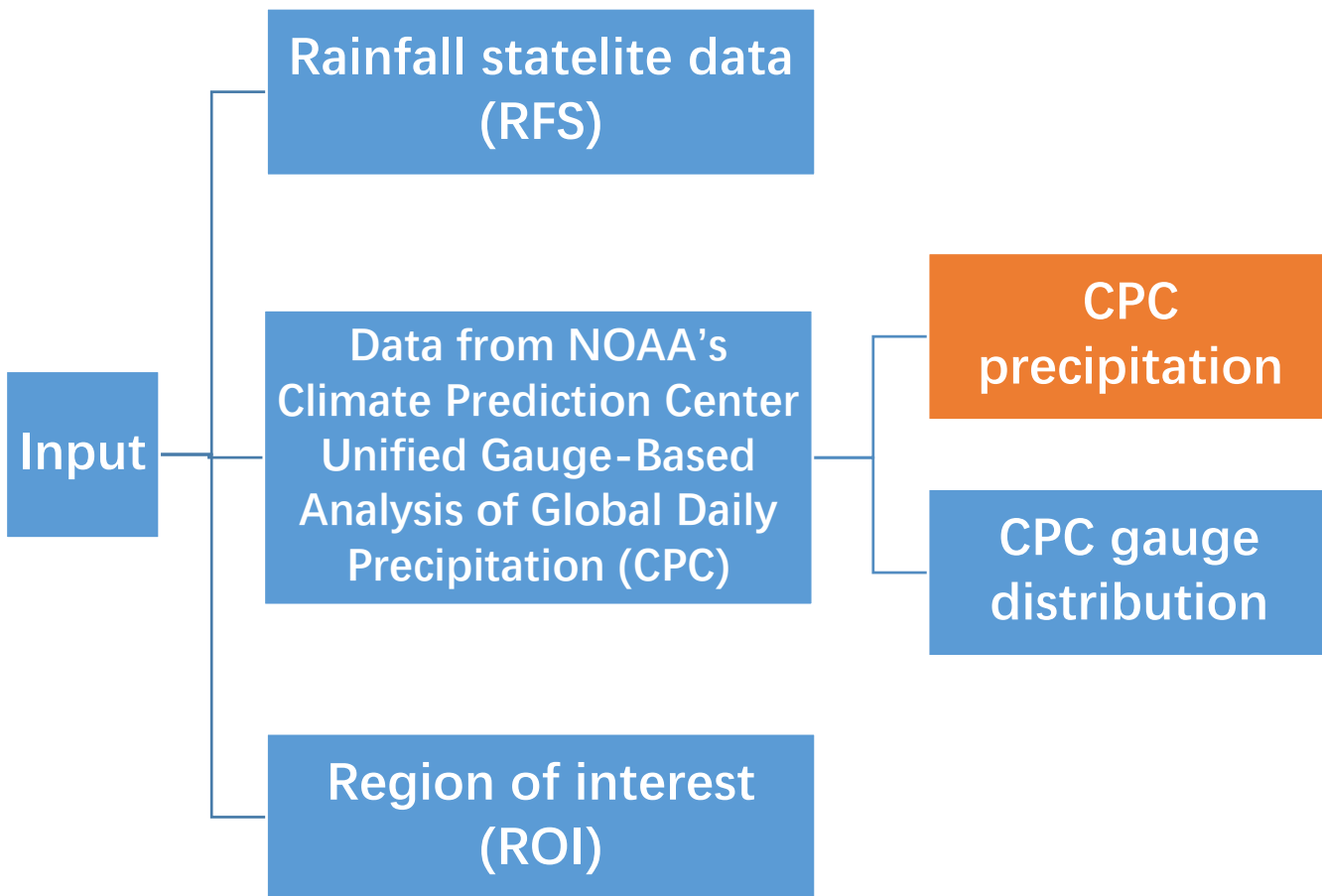


Latin America Case (daily)

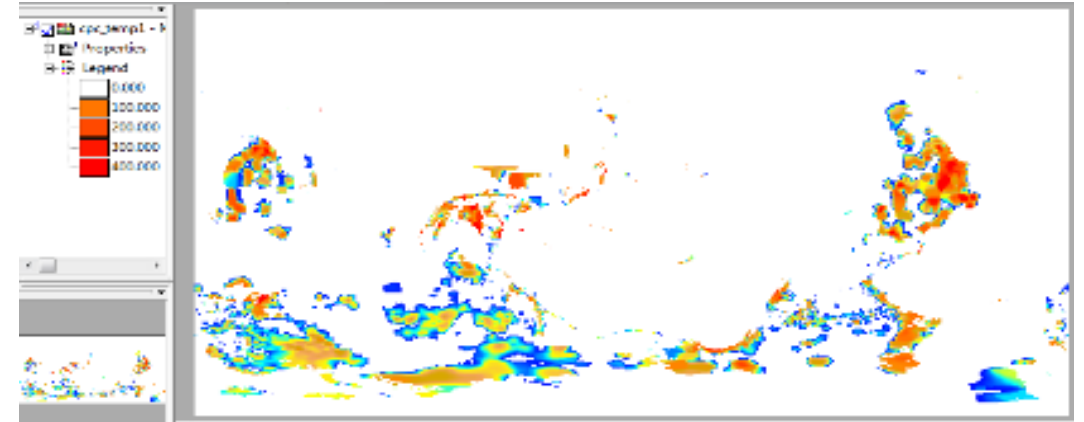


Africa Case (pentad)

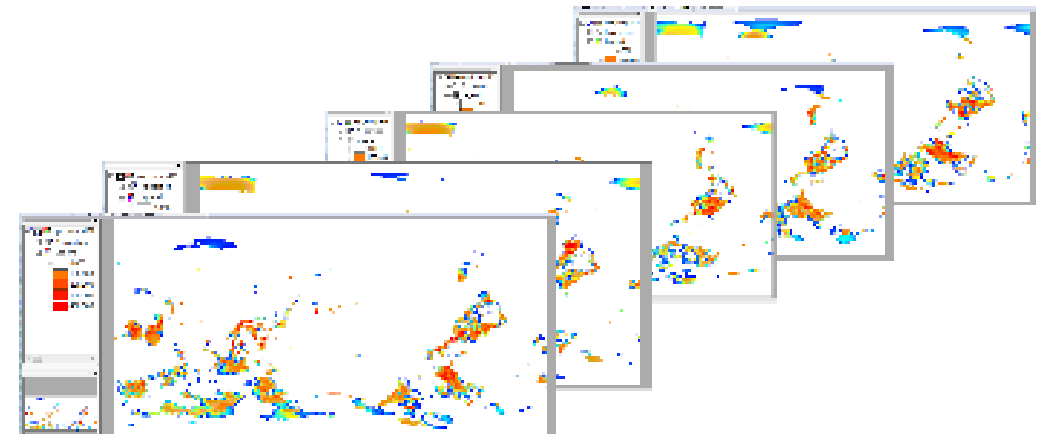


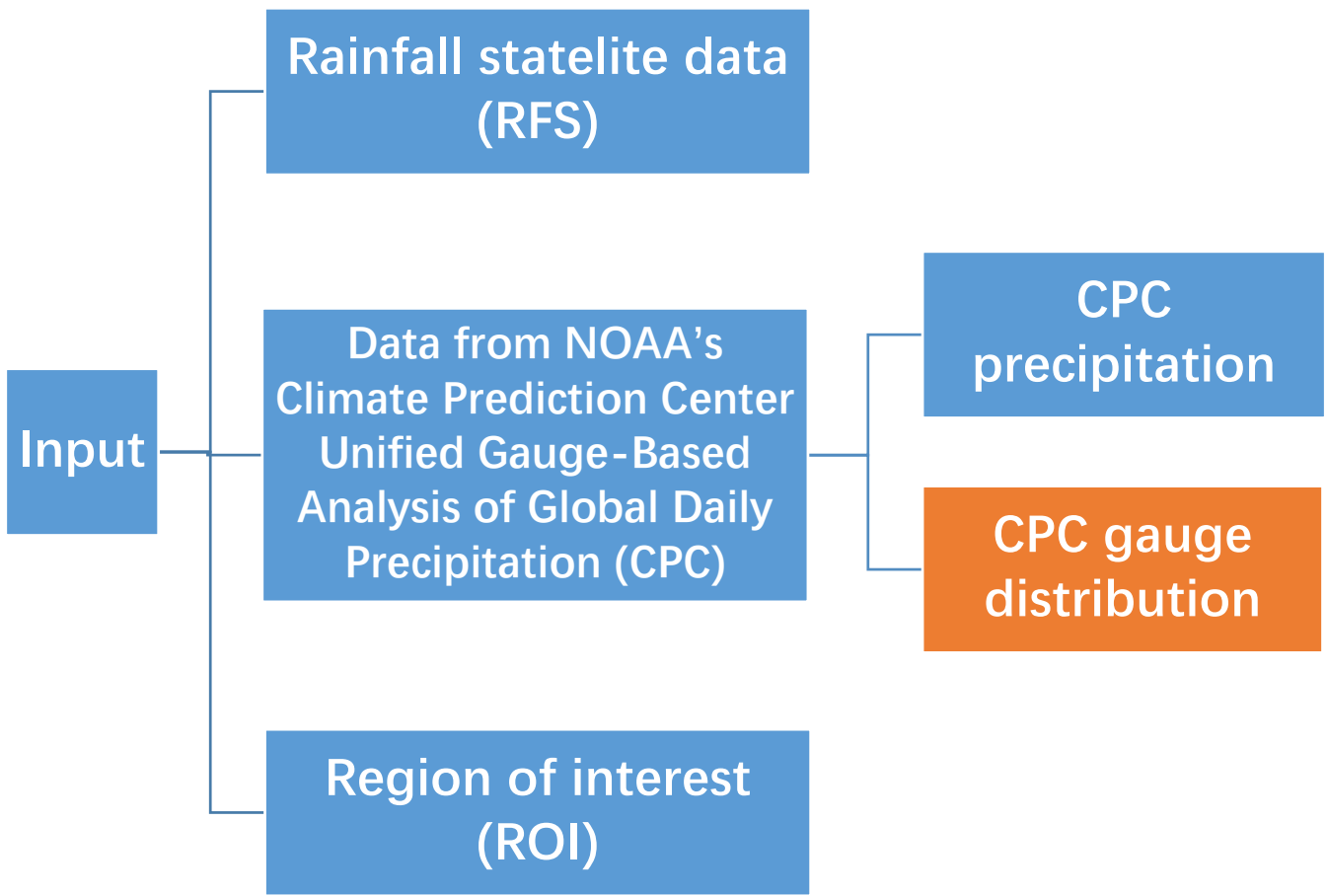


Latin America Case (daily)

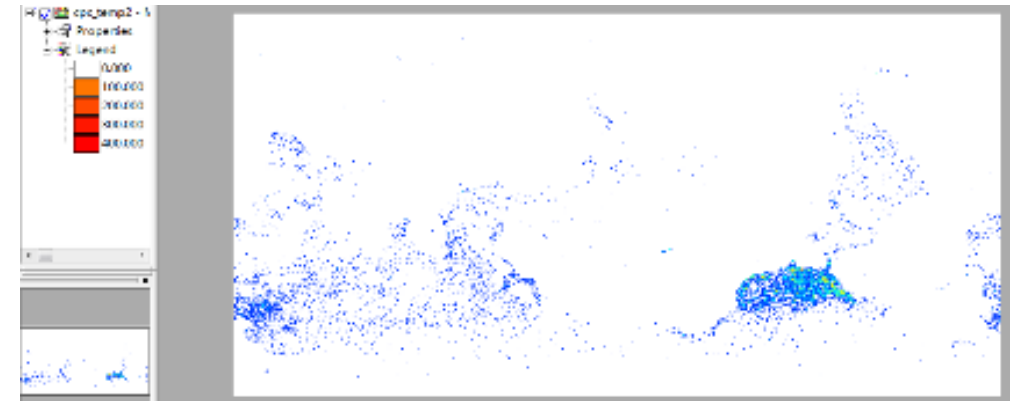


Africa Case (5-day sums or pentad)

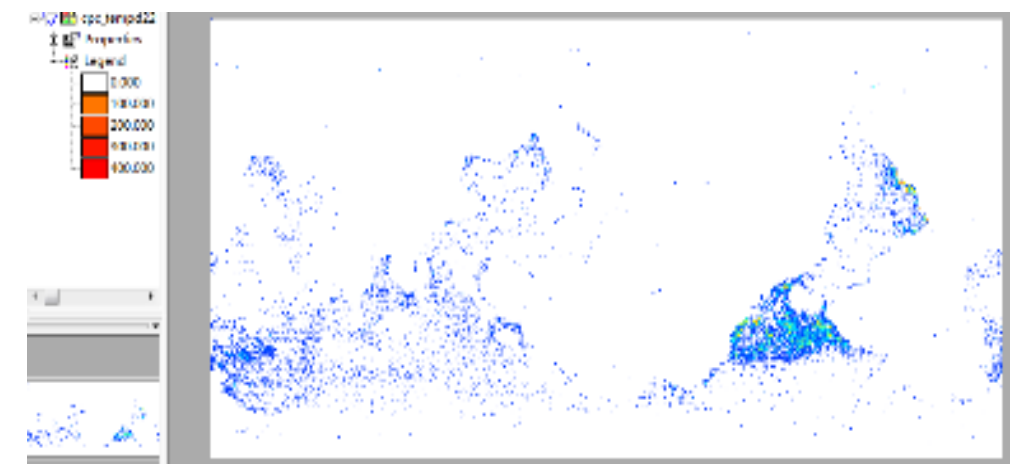


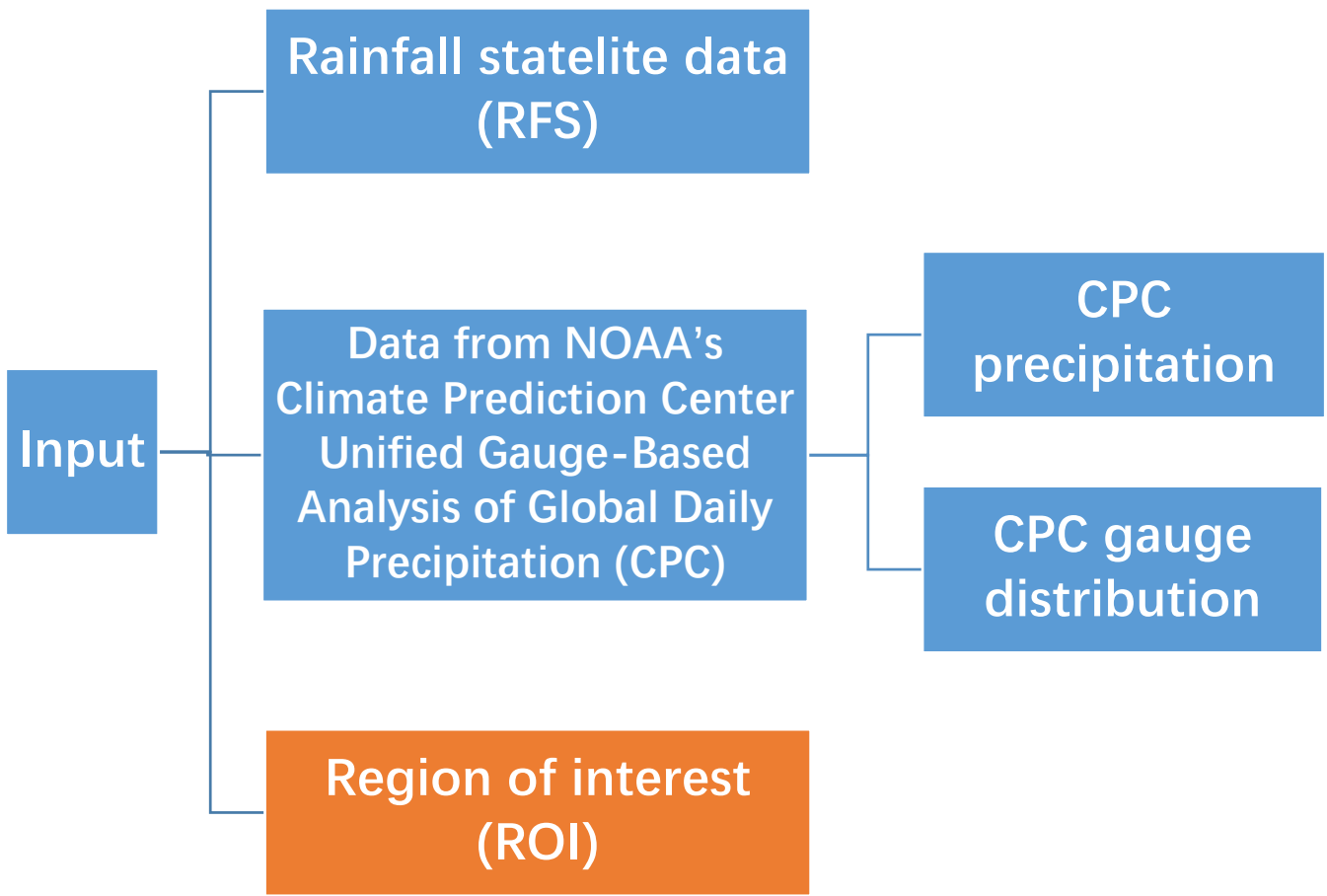


Latin America Case

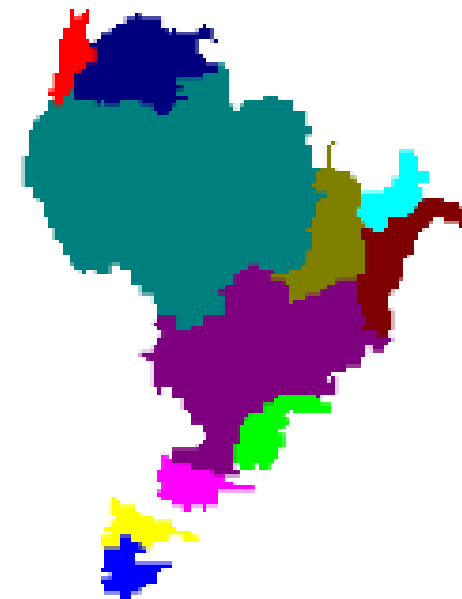


Africa Case



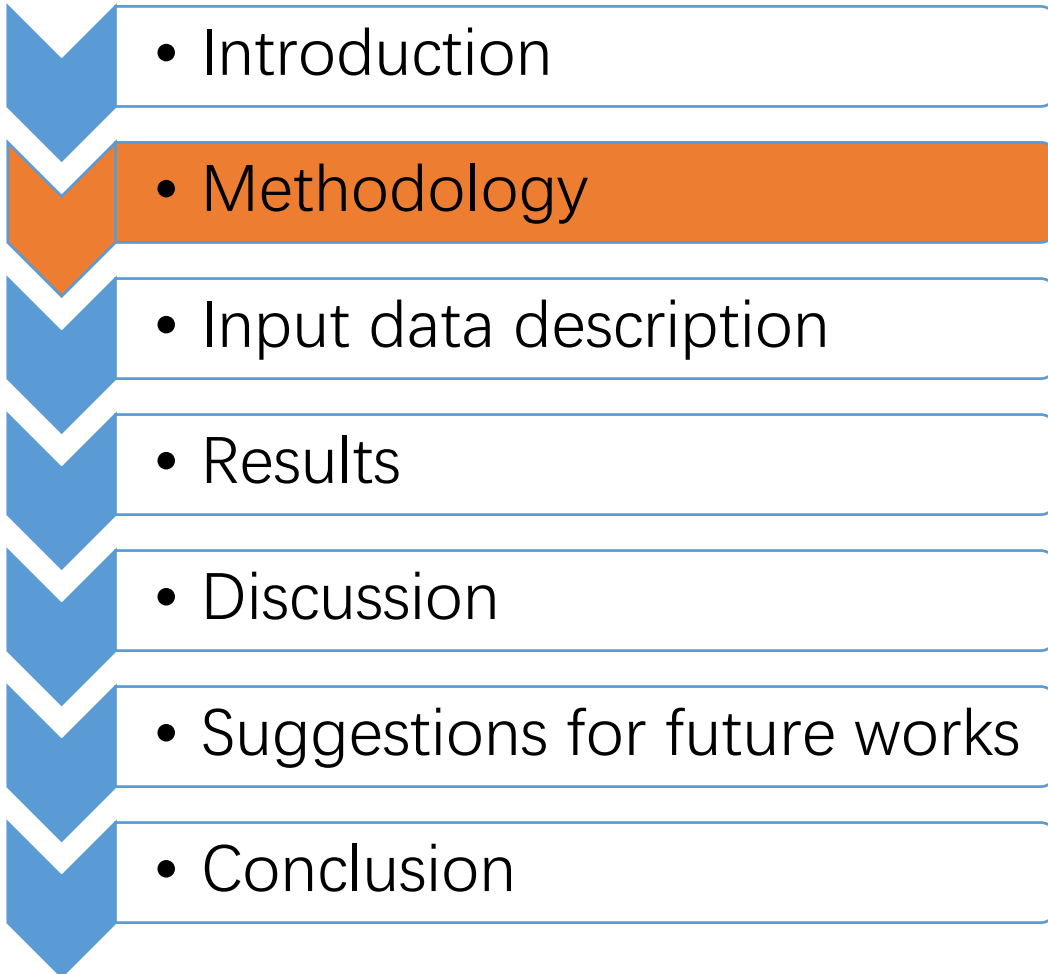


Latin America Case



Africa Case





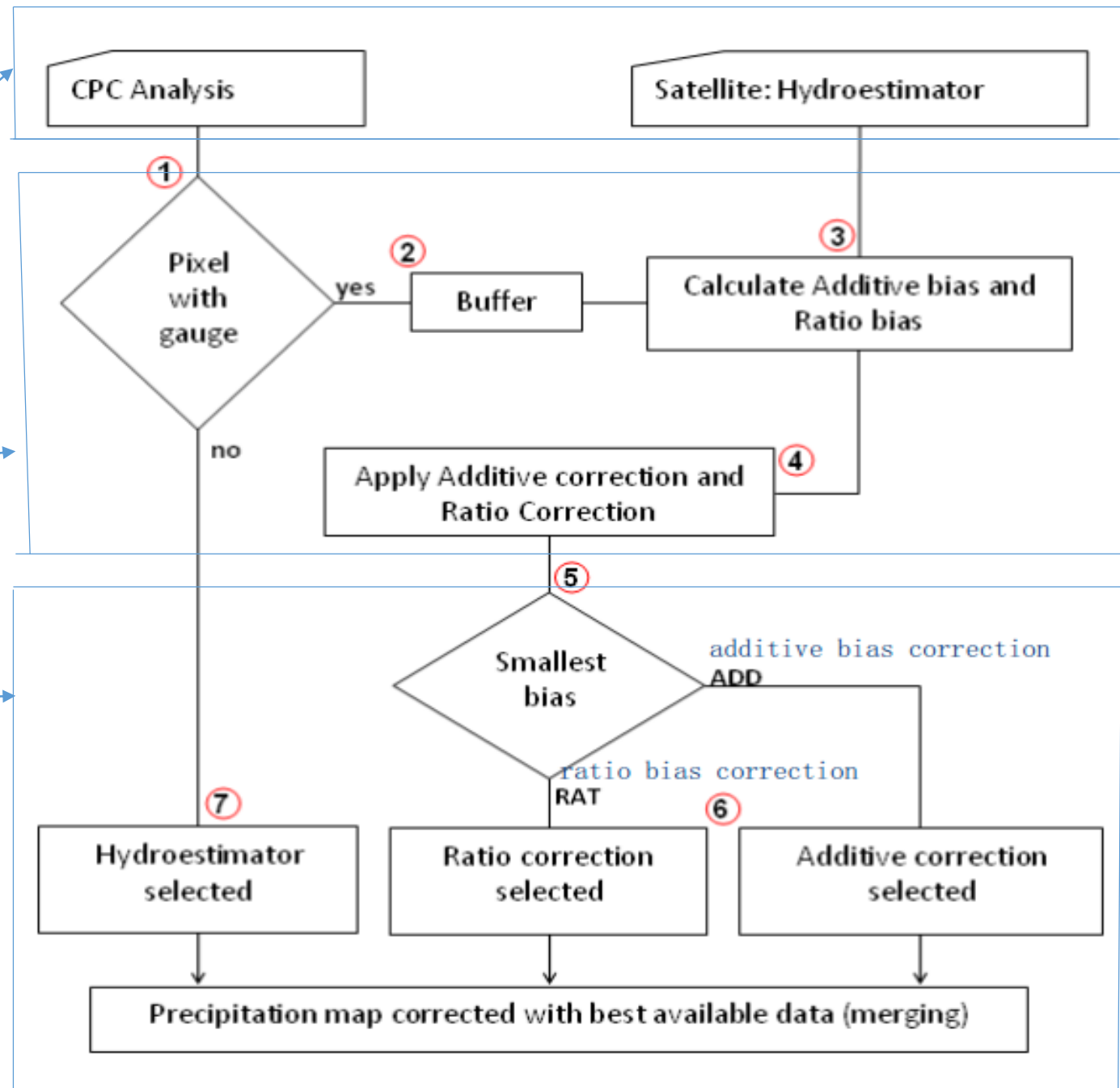


Stage 1 data collection and data pre-processing

Stage 2 calculation of additive bias and ratio bias between the satellite-based precipitation and ground-based precipitation

Stage 3 the decision process and calculation of the combined scheme

Stage 4 retrieving rainfall statistics for basin management

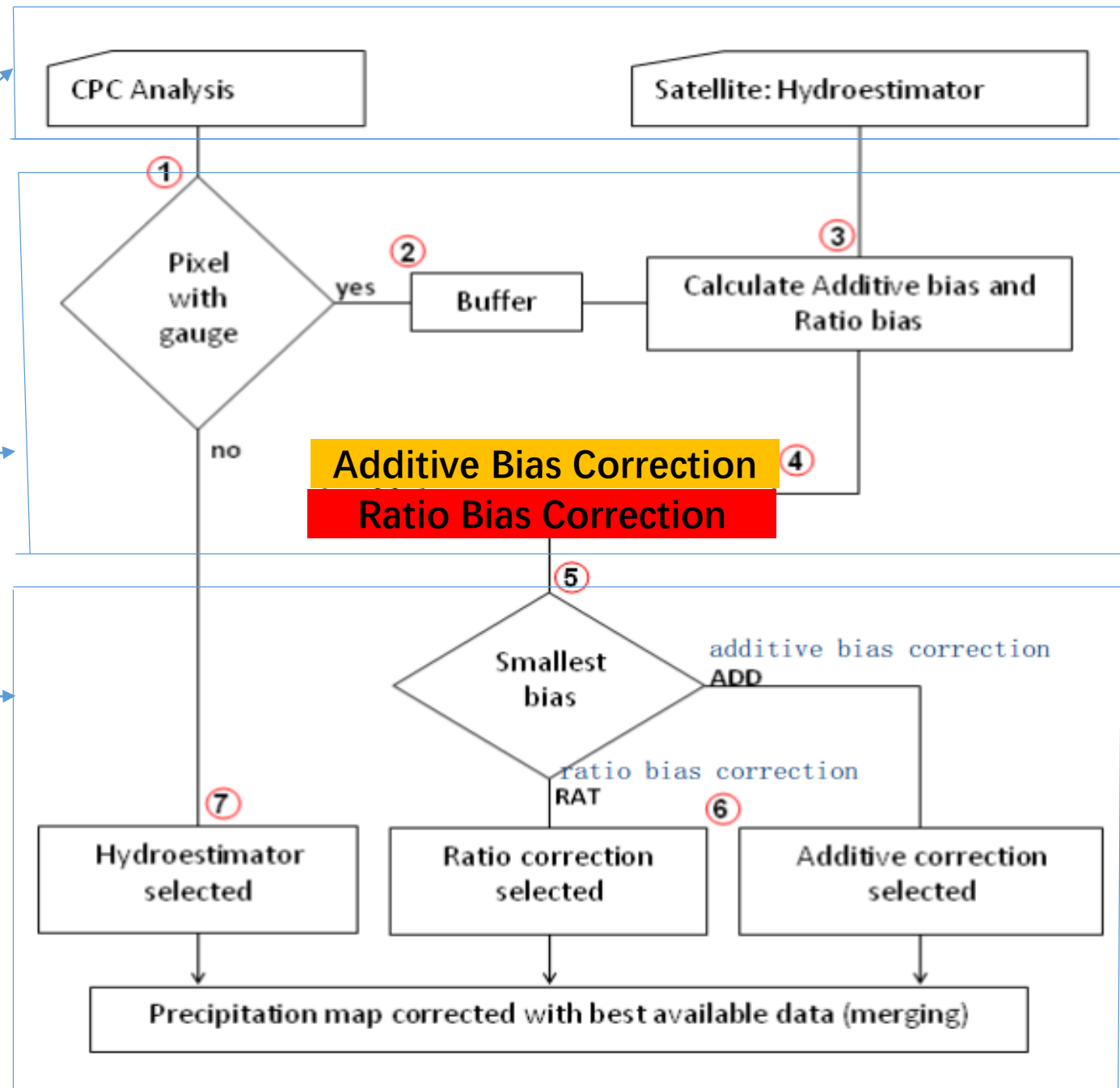


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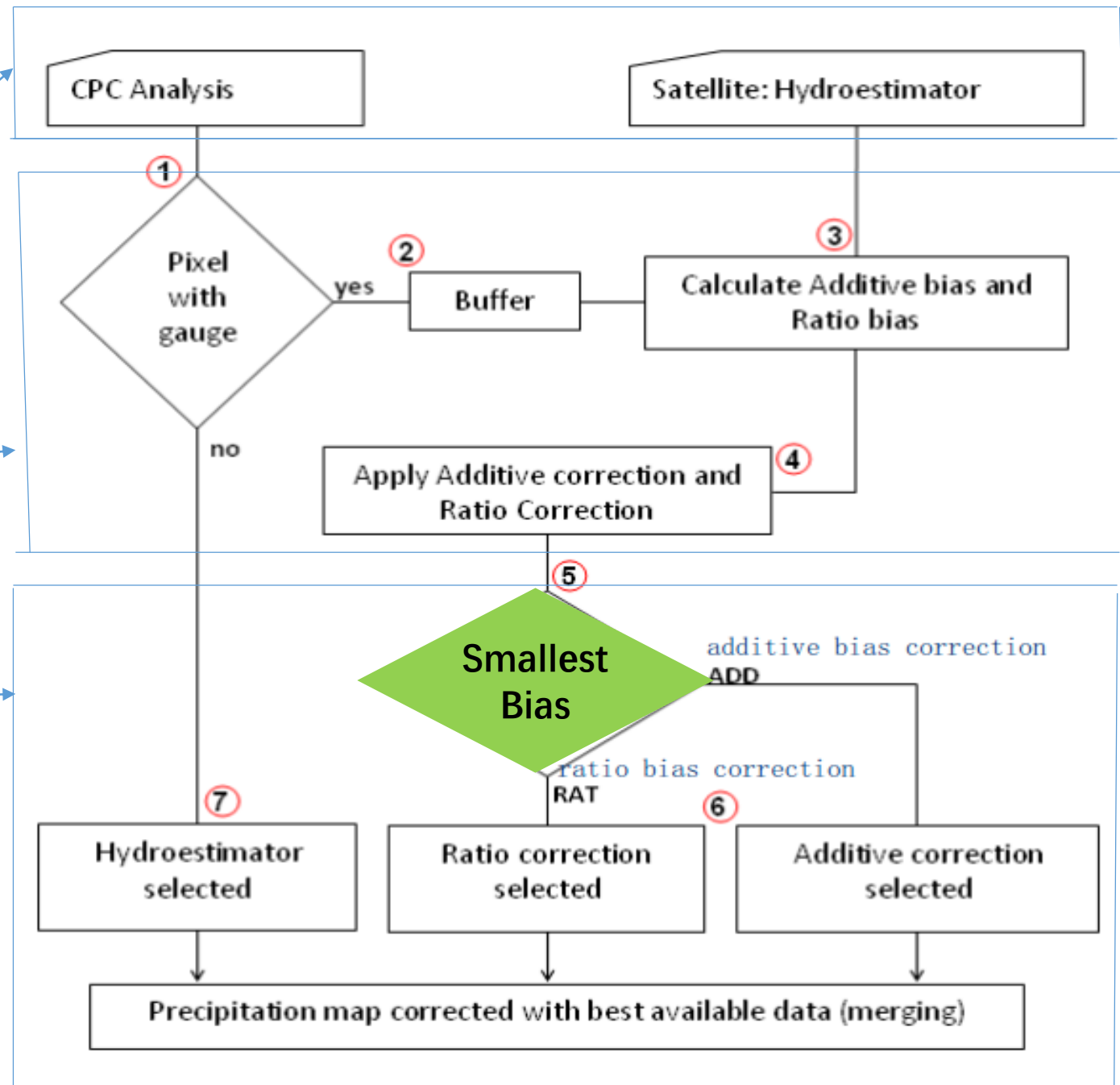


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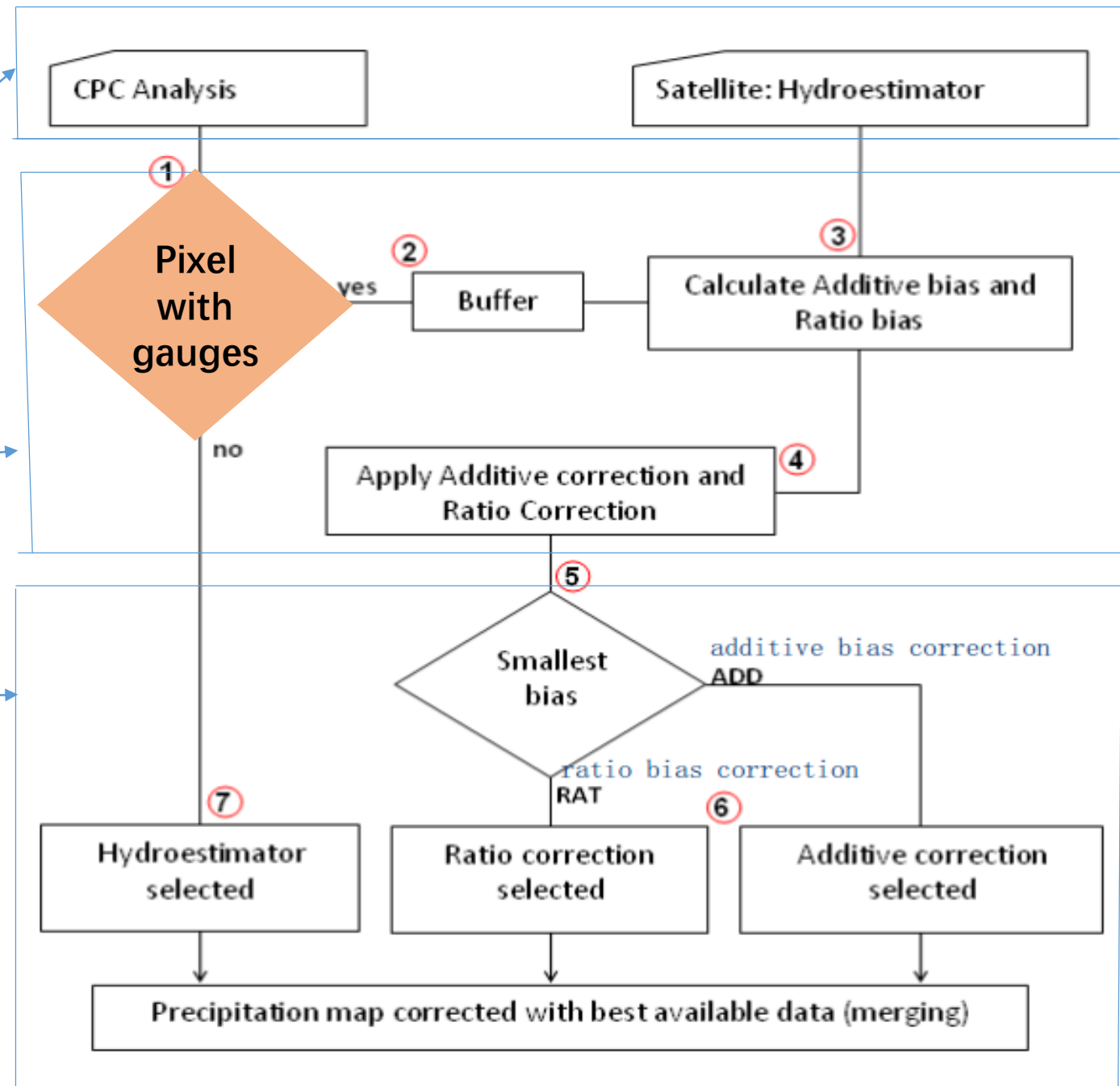


Stage 1 data collection and data pre-processing

Stage 2 calculation of additive bias and ratio bias between the satellite-based precipitation and ground-based precipitation

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# Two ways of masking the precipitation on the gauge precipitation data

0	0	0
a	b	
0	1	c
f	e	d
0	0	0

mask the gauge location without filter applied.



**precipitation map**

1	1	1
a	b	
1	1	c
f	e	d
1	1	1

mask the gauge location with filter applied



**precipitation map\_big**

Stage 1 data collection and data pre-processing



Stage 2 calculation of additive bias and ratio bias between the satellite-based precipitation and ground-based precipitation



Stage 3 the decision process and calculation of the combined scheme

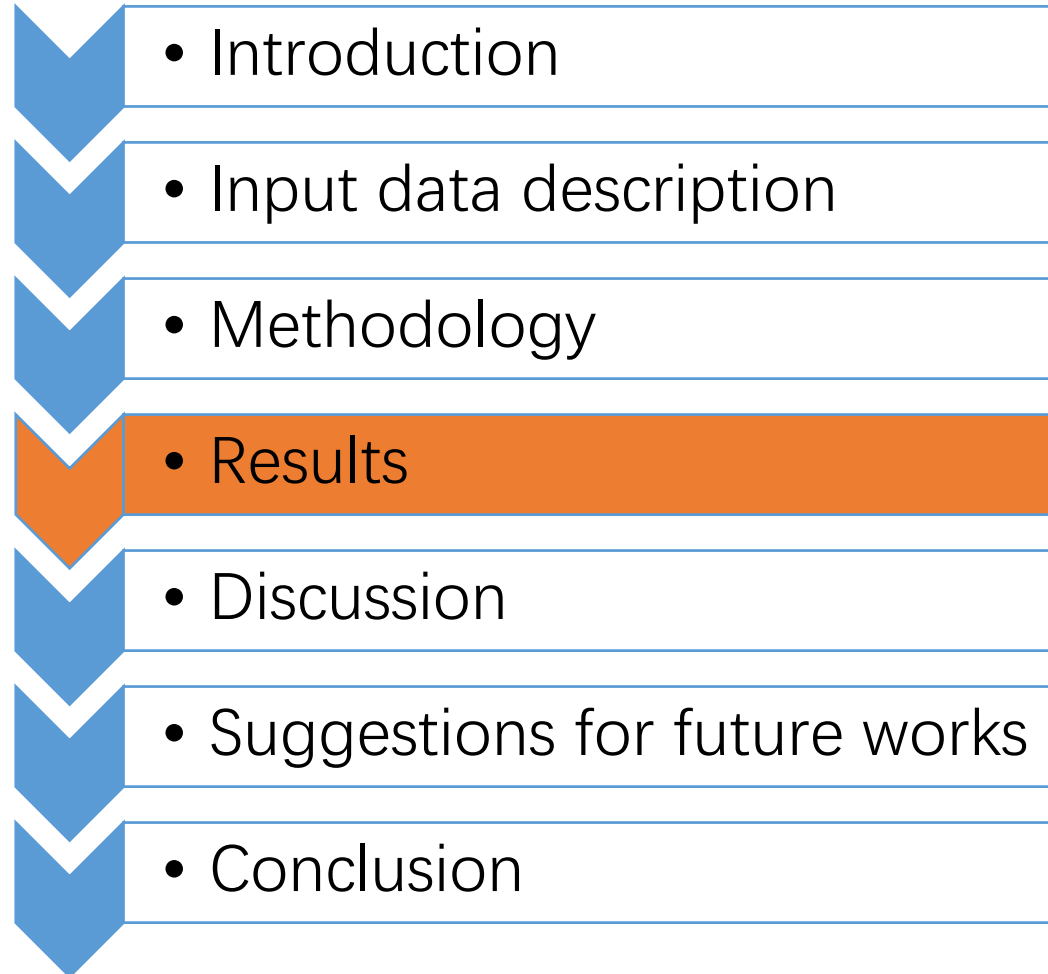


Stage 4 retrieving rainfall statistics for basin management

Statistics of Each Basin in a certain time period

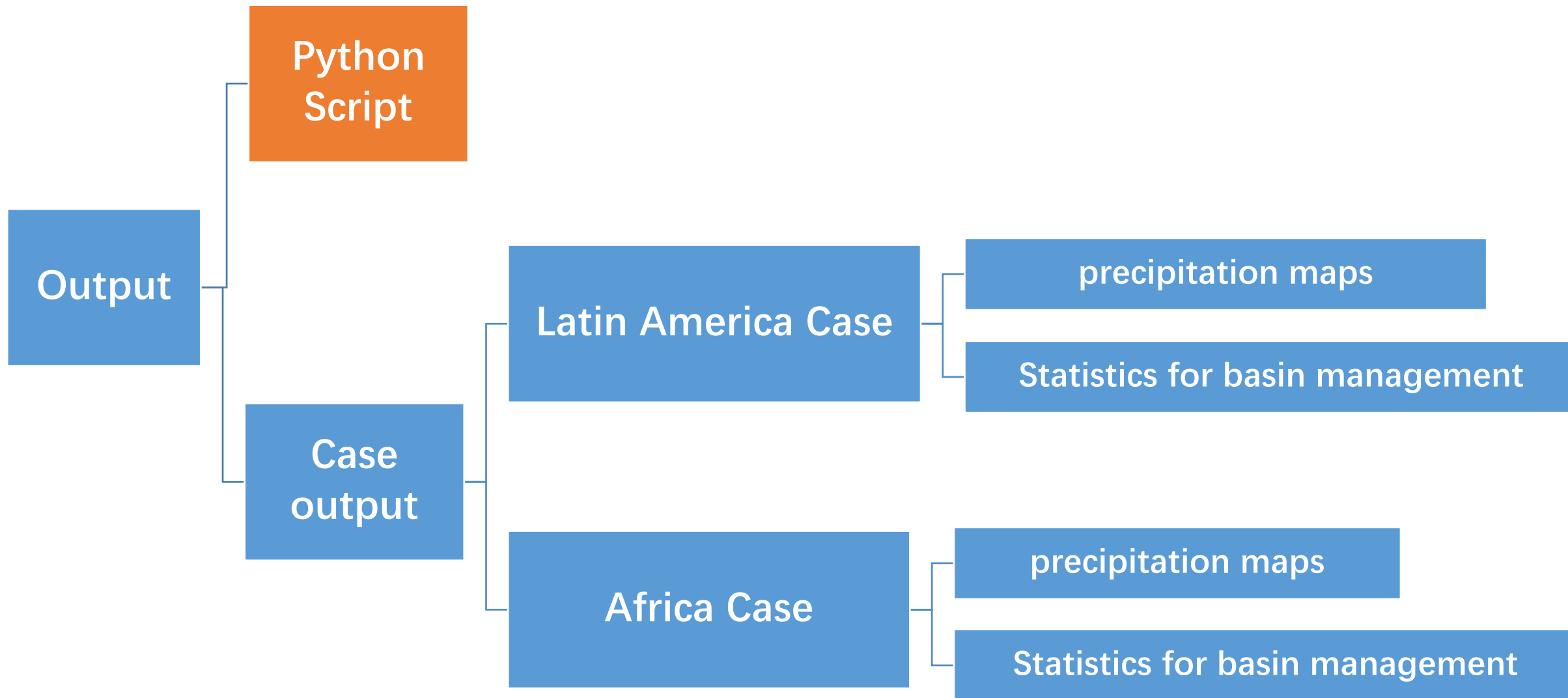
- Mean, for all rainfall values
- Mean, only for rainfall  $\geq 1\text{mm}$
- Maximum
- The percentage of the area which has precipitation  $\geq 1\text{mm}$  among the total area

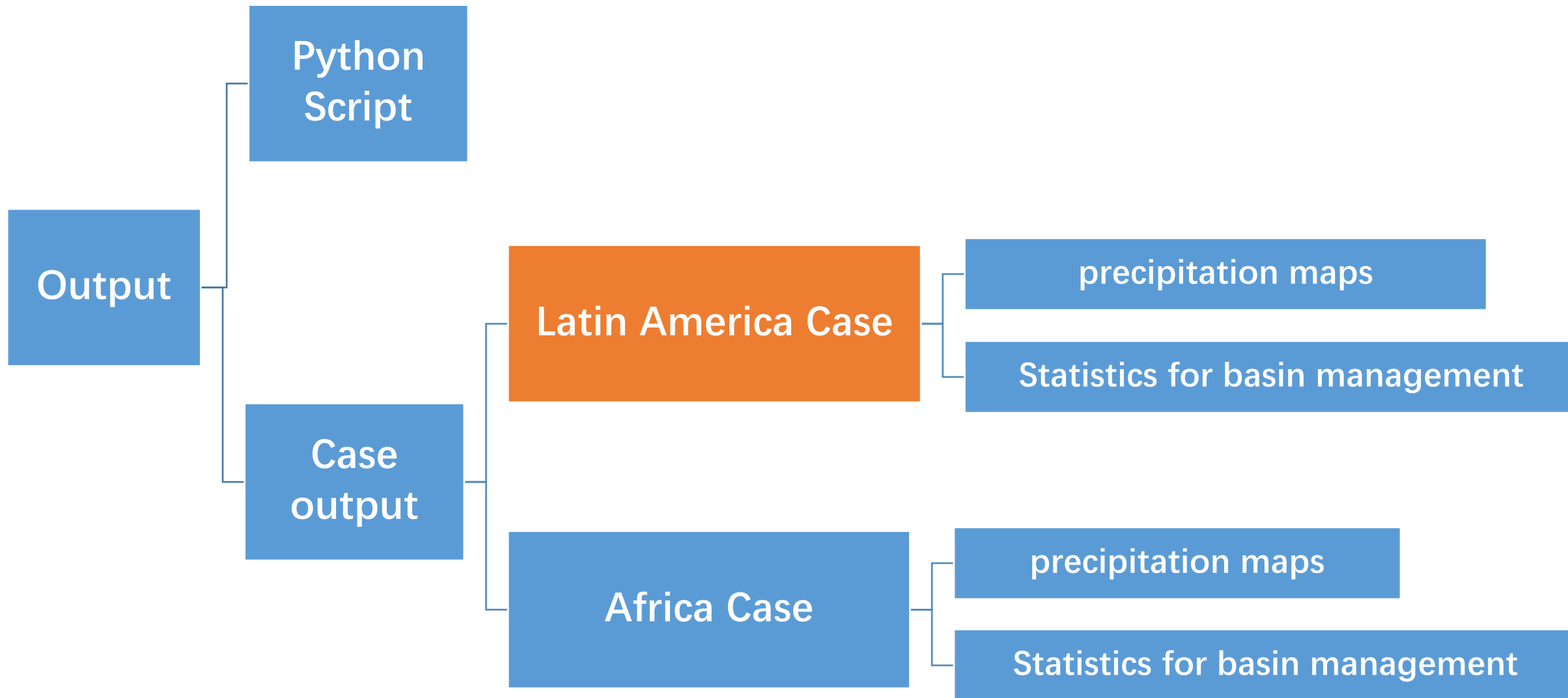
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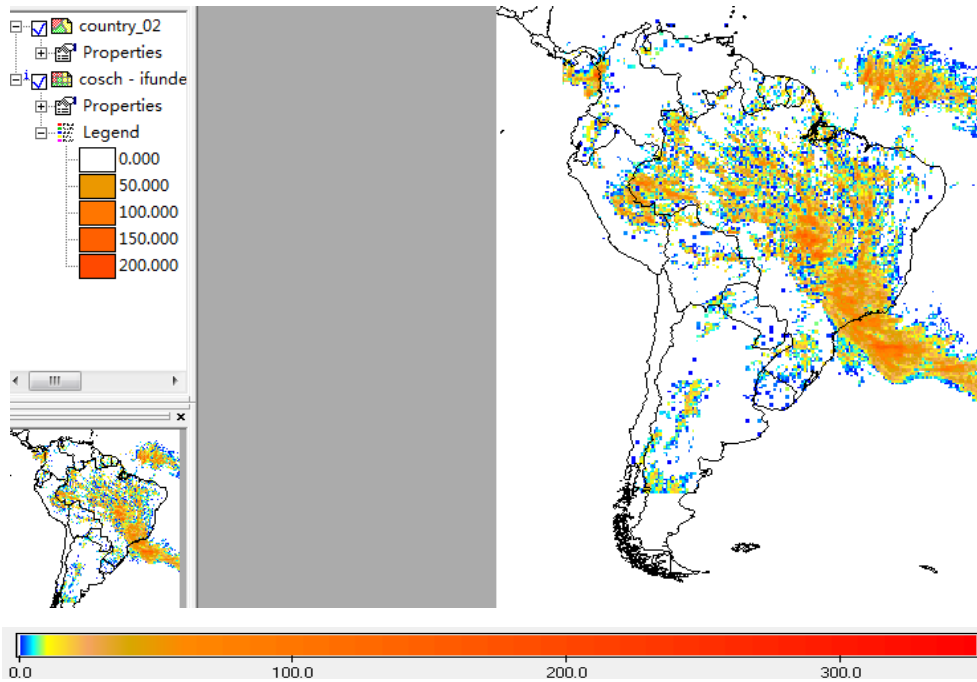


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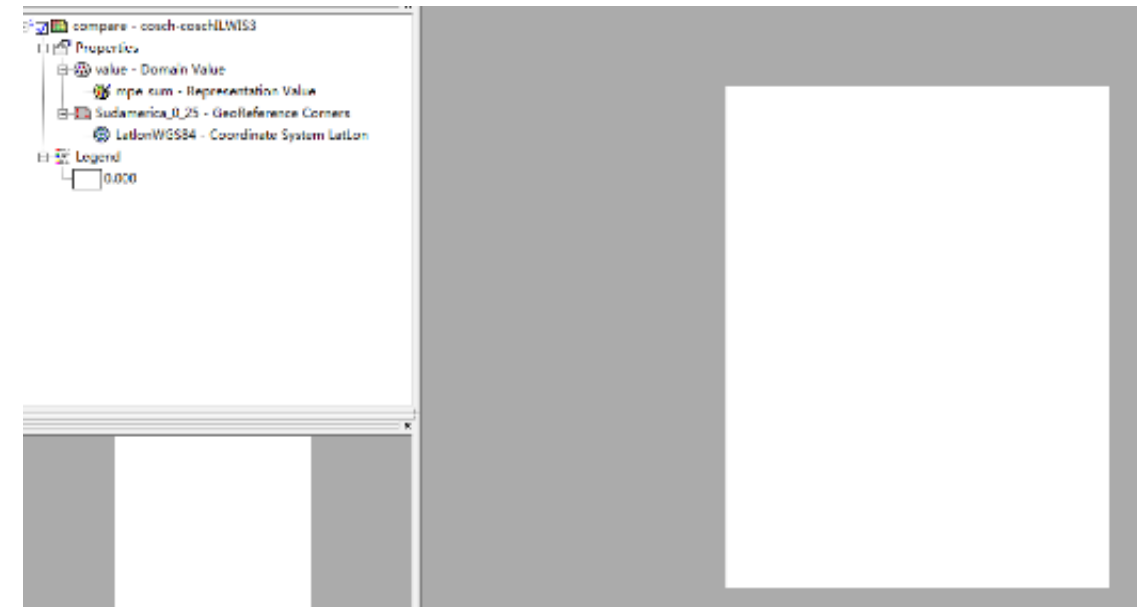




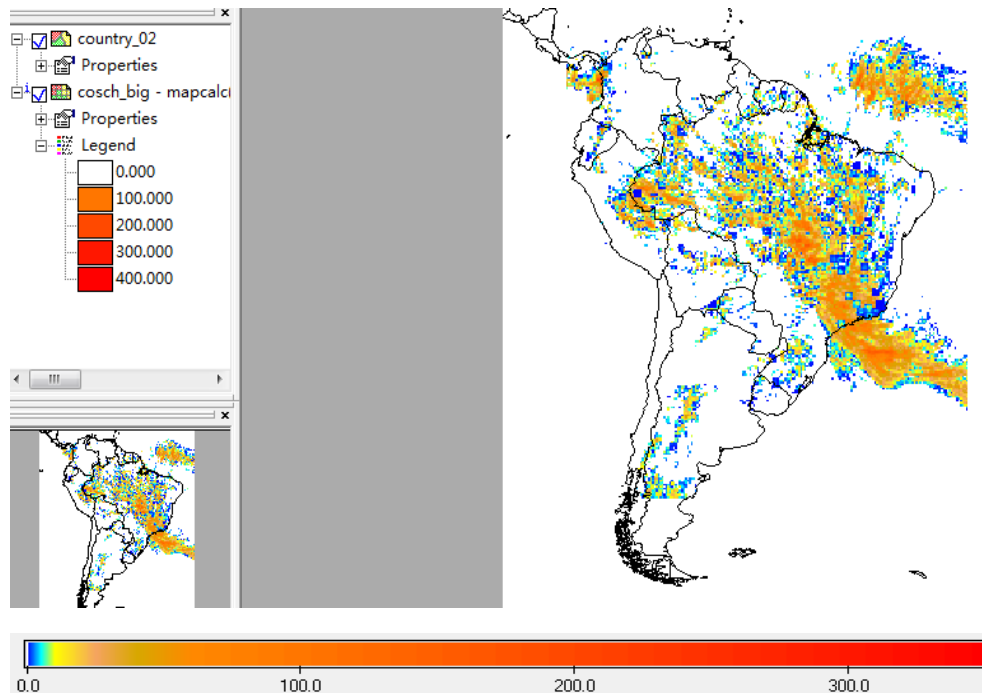




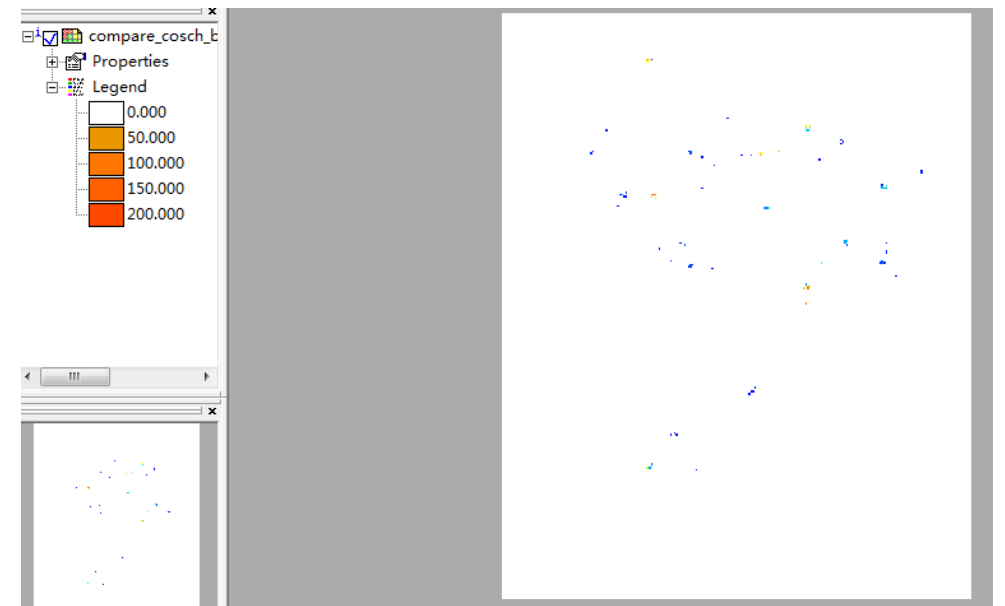
rainfall estimates which has been corrected by the combined scheme without filter applied (cosch), in Latin America case



cosch\_ilwis4 – cosch\_ilwis3



rainfall estimates which has been corrected by the combined scheme with filter applied (cosch\_big), in Latin America case



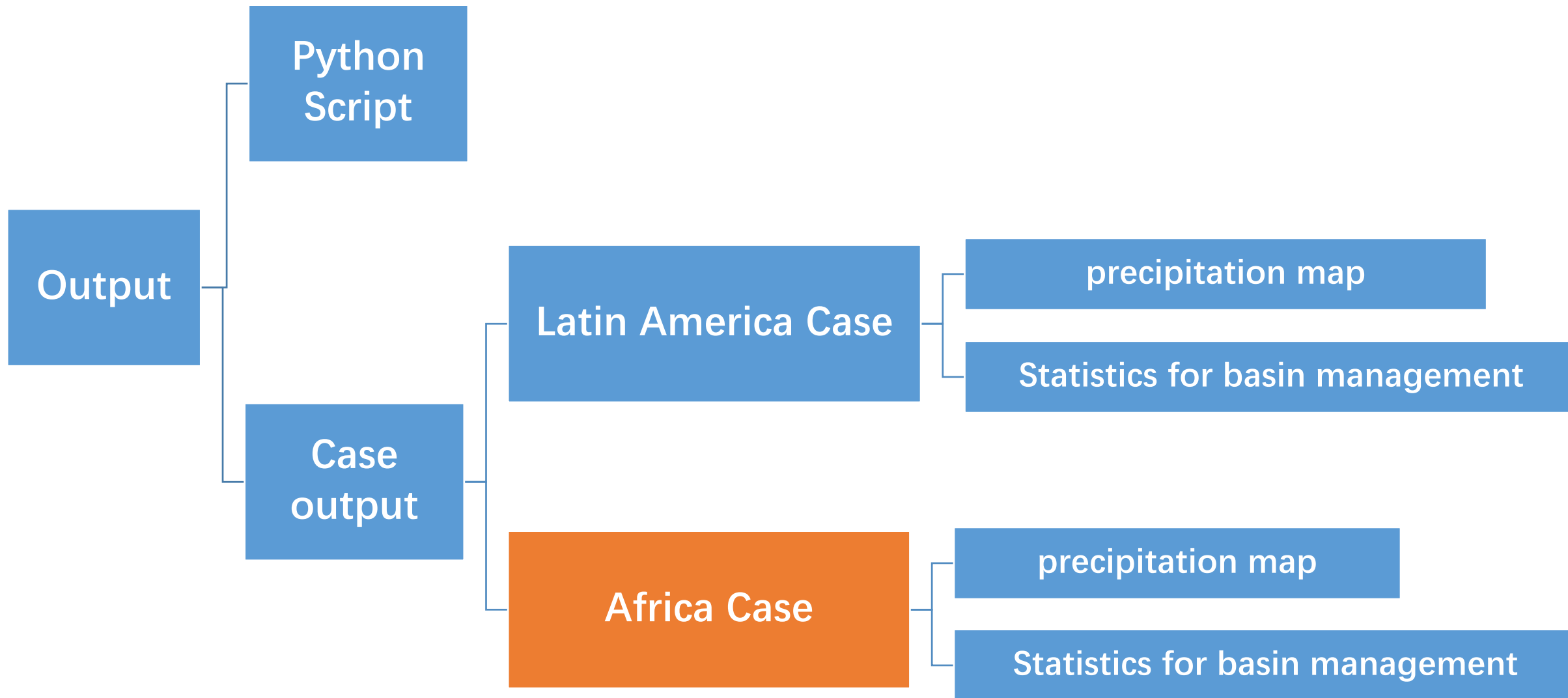
$\text{cosch\_big\_ilwis4} - \text{cosch\_big\_ilwis3}$

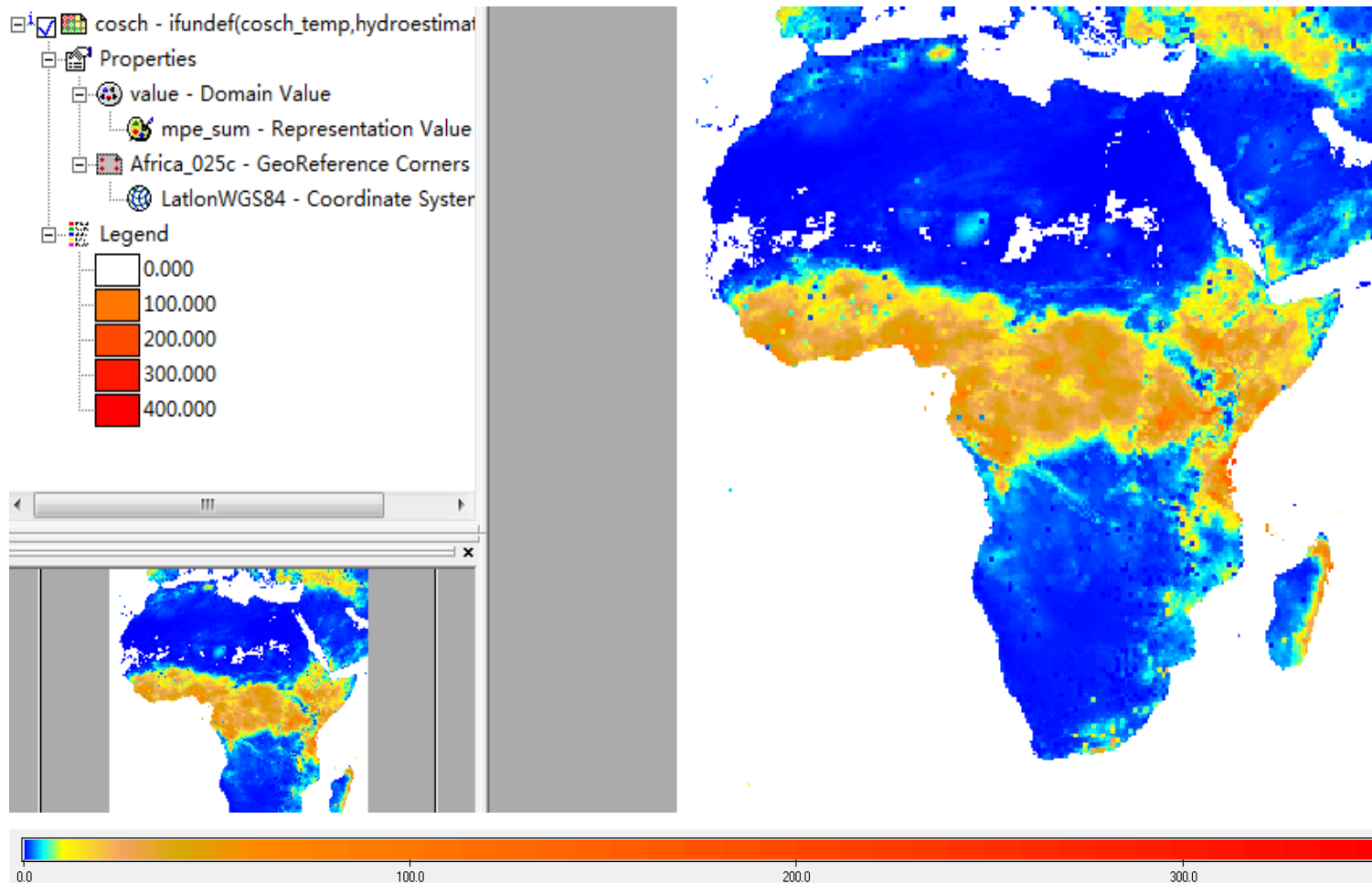
# Intermediate result of Statistics for basin management (Latin America Case)

Succeeded in:

- Select rainfall  $\geq 1\text{mm}$
- Select Npix, when rainfall  $\geq 1\text{mm}$

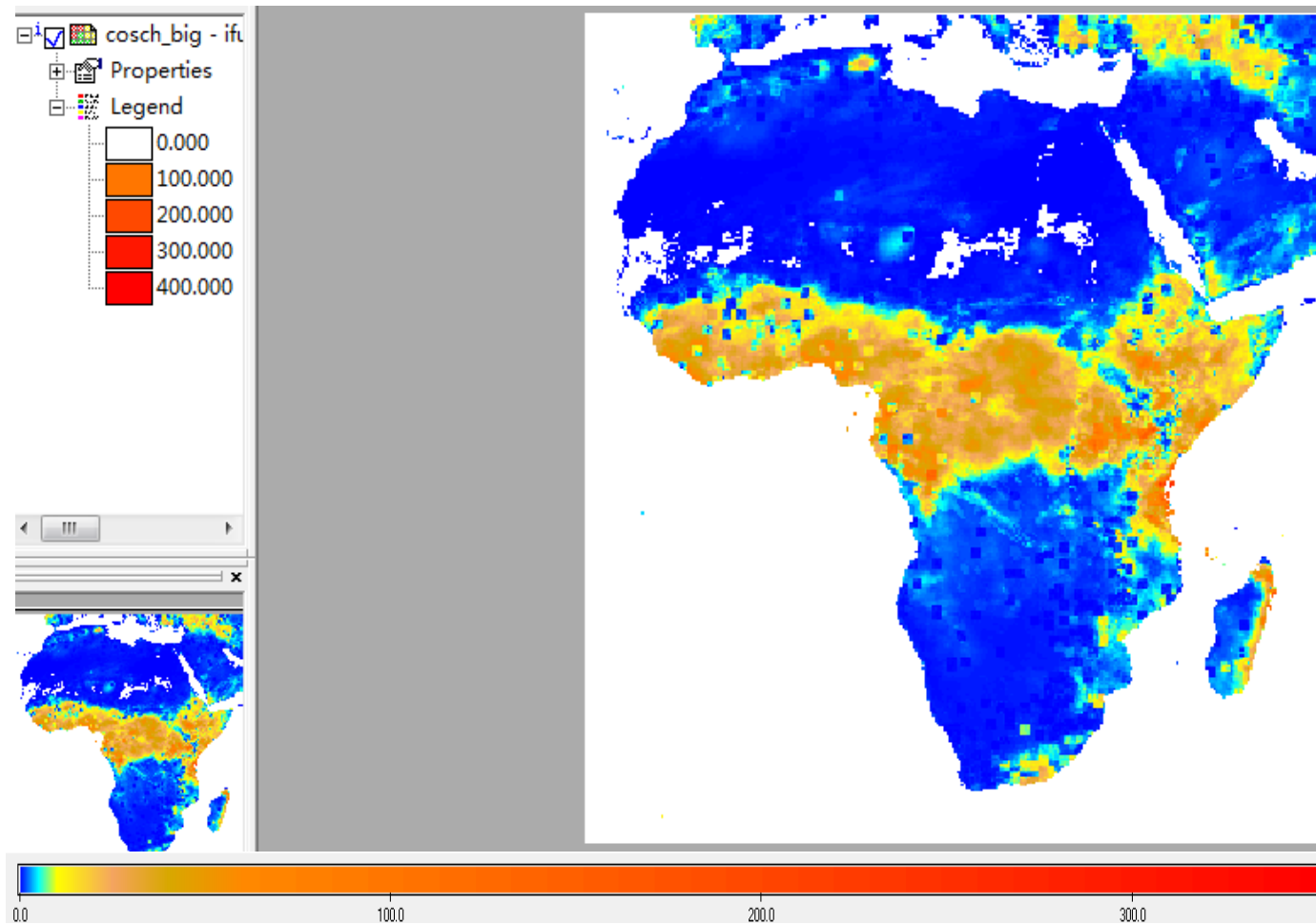
	NPix	cosch	Area	rain_basin_cross_forpython	coschGE1mm	NPixGE1mm
1	293	0.000	18.3	Magdalena * 0.0	?	0.000
2	1279	0.000	79.9	Orinoco * 0.0	?	0.000
3	1	1.772	0.1	Magdalena * 1.8	1.772	1.000
4	2	2.060	0.1	Orinoco * 2.1	2.060	2.000
5	1	2.576	0.1	Orinoco * 2.6	2.576	1.000
6	3	1.980	0.2	Orinoco * 2.0	1.980	3.000
7	1	2.444	0.1	Orinoco * 2.4 #4332	2.444	1.000
8	1	1.660	0.1	Orinoco * 1.7	1.660	1.000
9	1	2.362	0.1	Orinoco * 2.4	2.362	1.000
10	1	4.238	0.1	Orinoco * 4.2	4.238	1.000
11	2	5.580	0.1	Orinoco * 5.6	5.580	2.000
12	1	4.796	0.1	Orinoco * 4.8	4.796	1.000
13	4	0.420	0.3	Orinoco * 0.4	?	0.000
14	1	6.104	0.1	Orinoco * 6.1 #3563	6.104	1.000
15	3	8.200	0.2	Orinoco * 8.2	8.200	3.000
16	1	7.676	0.1	Orinoco * 7.7	7.676	1.000
17	1	2.771	0.1	Magdalena * 2.8	2.771	1.000
18	1	6.227	0.1	Orinoco * 6.2	6.227	1.000
19	1	8.211	0.1	Orinoco * 8.2 #3837	8.211	1.000
20	1	2.324	0.1	Orinoco * 2.3	2.324	1.000
21	1	4.809	0.1	Magdalena * 4.8	4.809	1.000
22	1	10.800	0.1	Magdalena * 10.8	10.800	1.000
23	1	12.930	0.1	Orinoco * 12.9	12.930	1.000
24	1	3.778	0.1	Magdalena * 3.8 #1191	3.778	1.000
25	2	3.770	0.1	Magdalena * 3.8	3.770	2.000
26	2	4.517	0.1	Magdalena * 4.5	4.517	2.000
27	2	5.263	0.1	Magdalena * 5.3	5.263	2.000
28	2	6.010	0.1	Magdalena * 6.0 #1691	6.010	2.000
29	4	1.300	0.3	Orinoco * 1.3	1.300	4.000
30	4	0.070	0.3	Magdalena * 0.1	?	0.000
Min	1	0.000	0.1		1.002	0.000
Max	3720	185.752	232.5		185.752	5.000
Avg	2	19.420	0.2		20.731	0.979
StD	55	21.032	3.5		21.127	0.363
Sum	17576	*****	1354.0		141176.712	7128.000





rainfall estimates which has been corrected by the combined scheme without filter applied (cosch), in Africa case



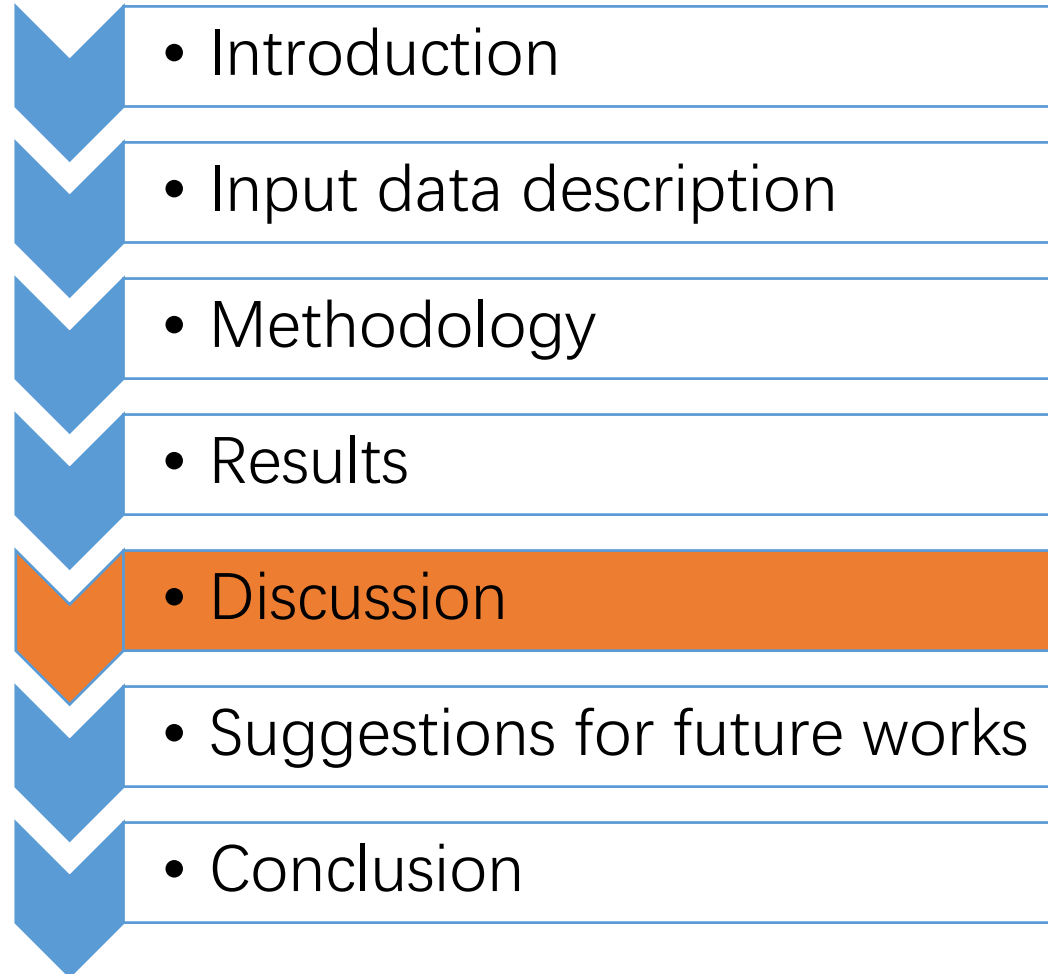


rainfall estimates which has been corrected by the combined scheme with filter applied (cosch\_big), in Africa case

# Statistics for basin management (Africa Case)

Statistics of the Africa Case				
MAJ_NAME	MEAN	MEANGE1MM	MAXIMUM	AREA_GE_1MM
Africa, East Central Coast	17.472045	18.007334	244.718063	96.94
Africa, Indian Ocean Coast	4.082019	4.479101	16.297643	89.80
Africa, North Interior	0.413799	1.934405	24.888346	10.27
Africa, North West Coast	0.647076	2.124052	6.542029	25.92
Africa, Red Sea - Gulf of Aden Coast	9.045799	11.521371	94.471497	77.96
Africa, South Interior	0.848201	1.549539	3.897462	30.11
Africa, West Coast	26.967134	30.997785	100.236694	86.94
Angola, Coast	2.854775	3.178310	34.690468	87.67
Congo	18.359983	19.292260	146.860594	94.97
Gulf of Guinea	32.046546	32.046546	103.812454	100.00
Lake Chad	3.166867	8.546683	55.569080	34.51
Limpopo	1.364725	2.092676	6.536041	51.55
Madagascar	8.366974	9.271424	156.412903	89.55
Mediterranean South Coast	1.375005	3.233033	26.668756	33.07
Namibia, Coast	0.487304	1.336515	2.671052	4.96
Niger	10.902757	17.484648	73.396217	61.48
Nile	10.493799	17.884820	145.848456	58.01
Orange	0.719639	2.451876	8.974089	12.67
Rift Valley	17.101591	17.610655	106.059006	96.98
Senegal	2.109591	7.086404	33.709650	28.24
Shebelli - Juba	27.236863	27.313543	138.652486	99.71
South Africa, South Coast	3.952605	4.848354	41.797702	79.11
South Africa, West Coast	0.590634	1.727000	2.660919	11.26
Volta	20.664070	20.664070	60.829803	100.00
Zambezi	1.760678	2.516631	57.997898	59.40

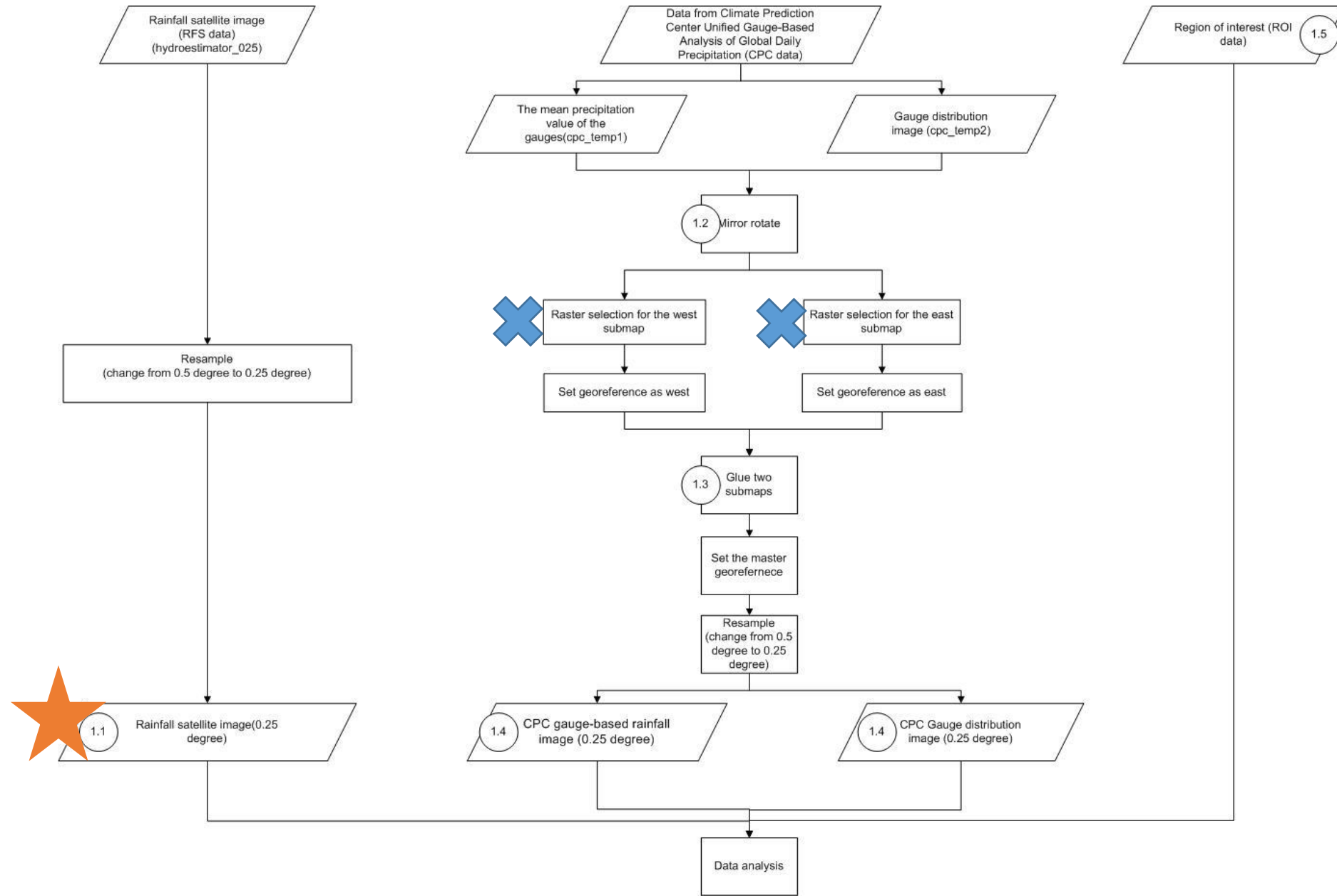
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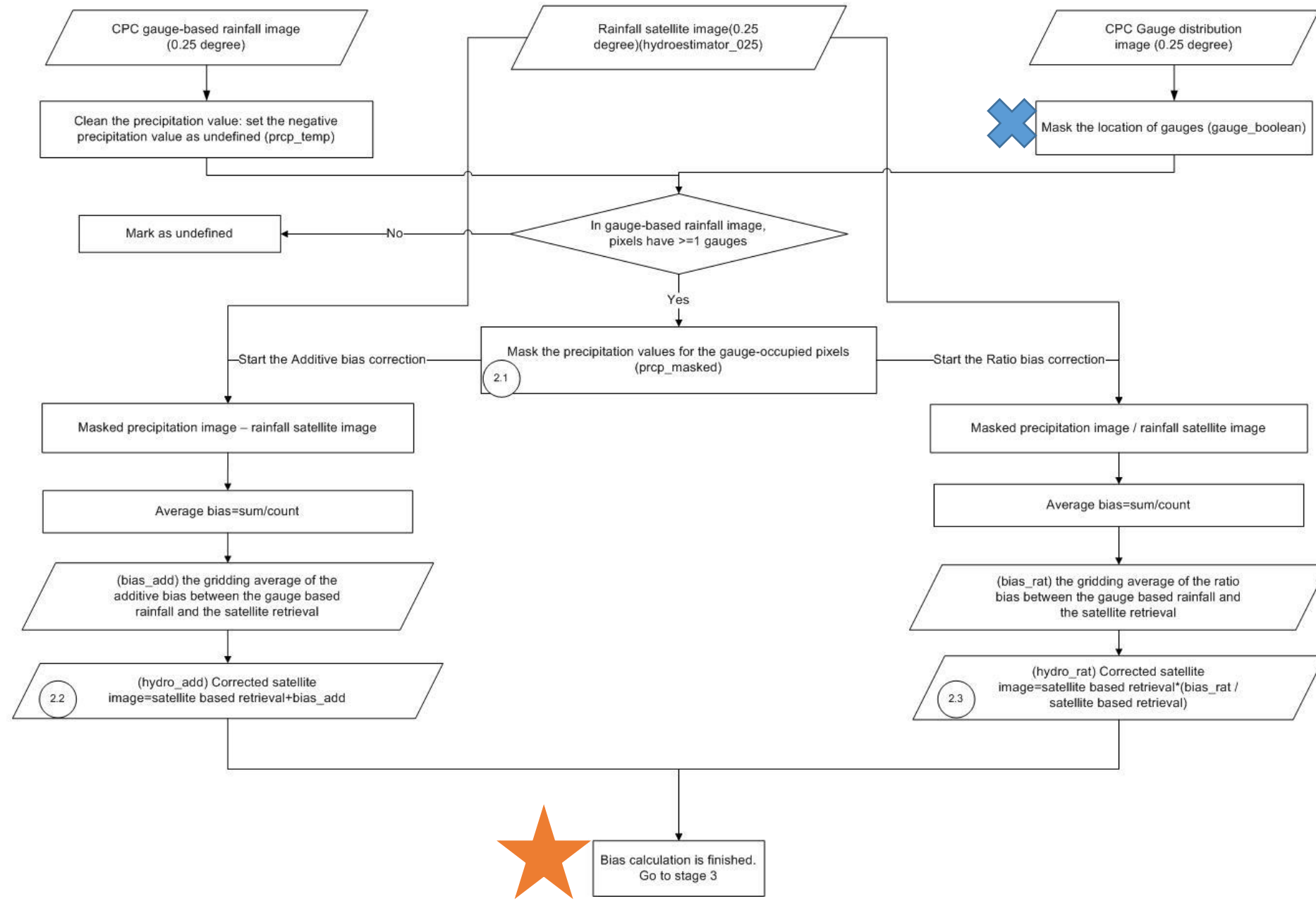
# Discussion

- Ilwis 4 language problems
  - Solved: if-else, setting values as undefined, mirror rotate, ...
  - Unsolved:
    - Raster selection
    - Glue two submaps
    - Table cross
    - Group by
    - Checking two values are equal or not, in two columns in a table
    - Saving a cross table
- Incomplete Syntax Manual of Ilwis v.4-python
- Alternative ways to overcome ilwis v.4 language problem

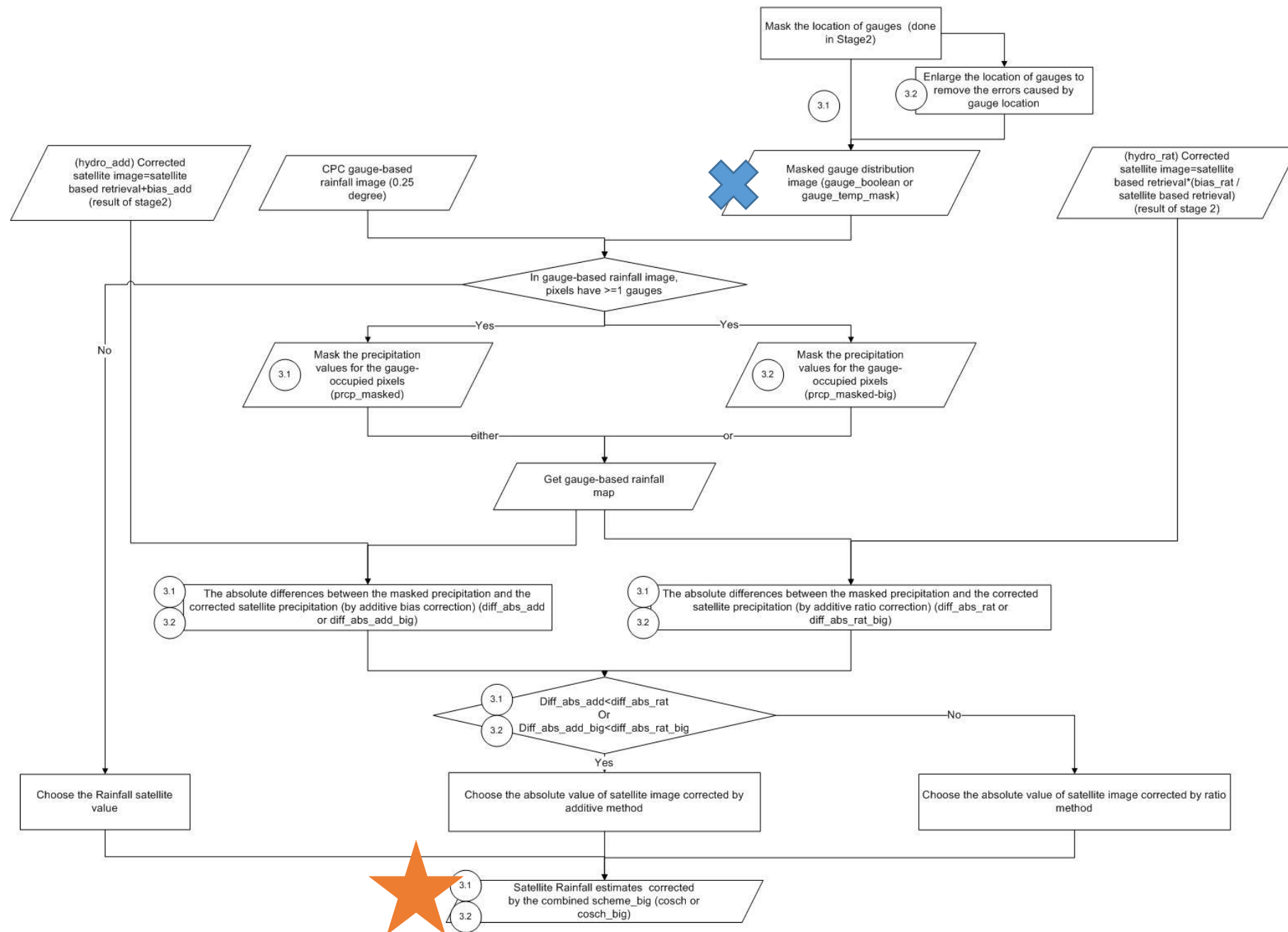
## Stage 1 data collection and data pre-processing



## Stage 2 calculation of additive bias and ratio bias between the satellite-based-precipitation and the ground-based-precipitation

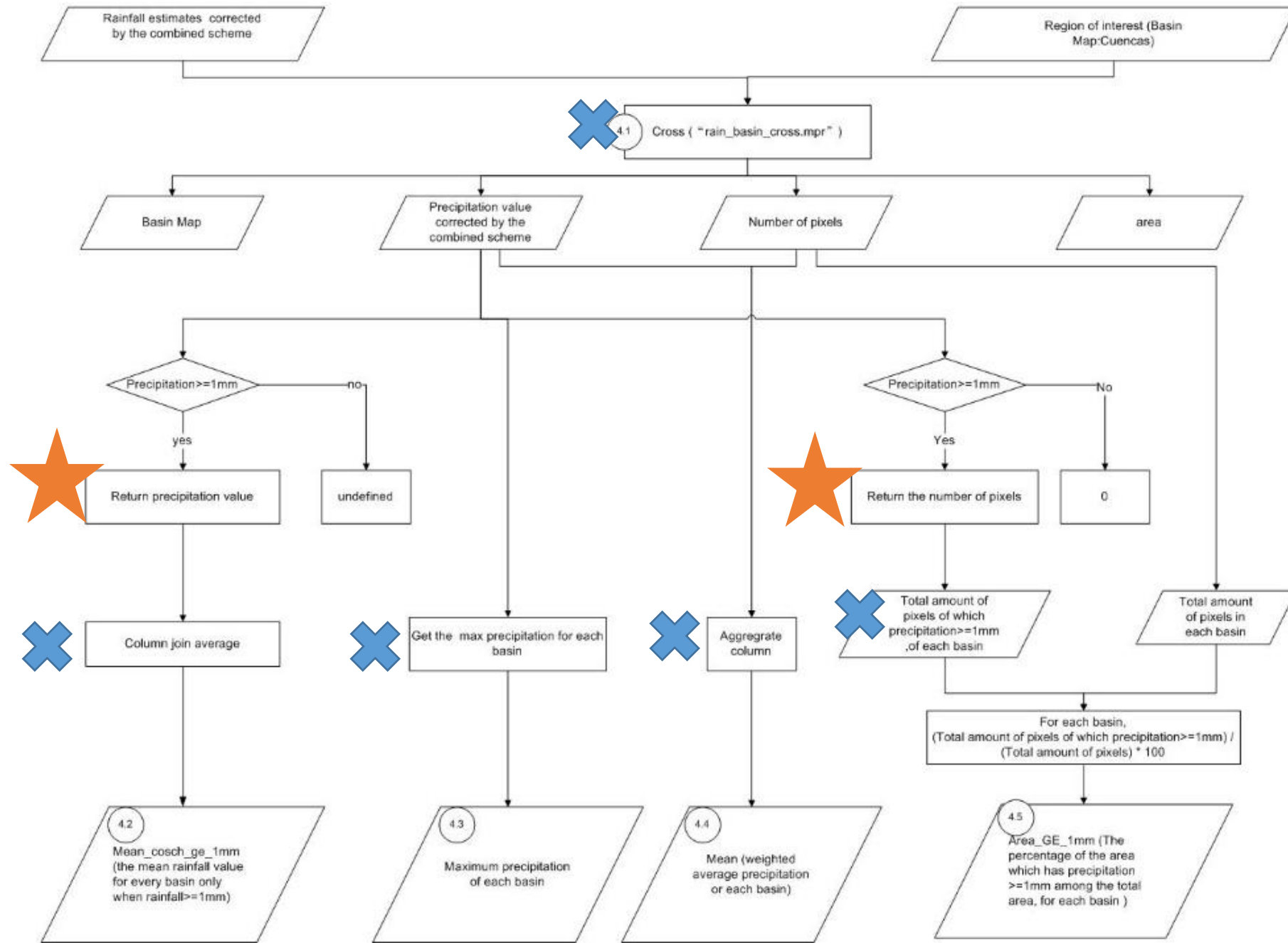


### Stage 3 the decision process and calculation of the combined scheme





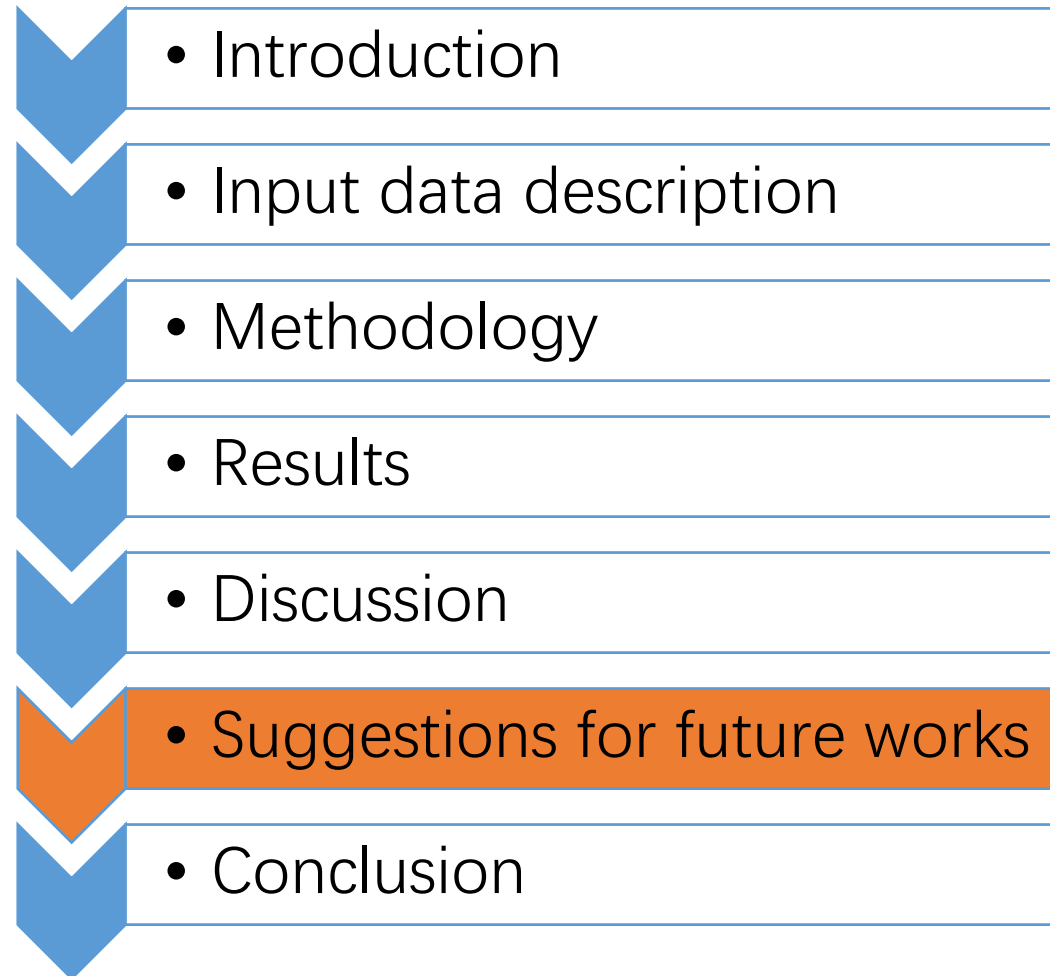
## Stage 4 retrieving rainfall statistics for basin management



# Discussion

- Ilwis 4 language problem
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    - Saving a cross table
- Incomplete Syntax Manual of Ilwis v.4-python
- Alternative ways to overcome ilwis v.4 language problem
- Script is not generalized enough
- Precipitation map\_big (with filter applied) is produced but not used

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# Suggestions For Future work

- Solve language problems in ilwis 4
- Complete the manual of python syntax in ilwis v.4
- Use precipitation map\_big
- Increase the amount of extreme cases
- Test and compare the efficiency of automation mode and manual mode
- Develop a user interface
- Unzip input files

**User Interface of Producing Combined-Scheme-Corrected Satellite Precipitation Image and Statistics**

Give your input data

Input RFS data

Input CPC data

Input the frequency of CPC data that you aim at

Input ROI data

Input other data (for example georeferences...)

Set your requirement

The name of output combined-scheme-corrected satellite precipitation image (without filter)

The format of output combined-scheme-corrected satellite precipitation image (without filter)

The name of output combined-scheme-corrected satellite precipitation image (with filter)

The format of output combined-scheme-corrected satellite precipitation image (with filter)

The name of output statistics table

The format of output statistics table

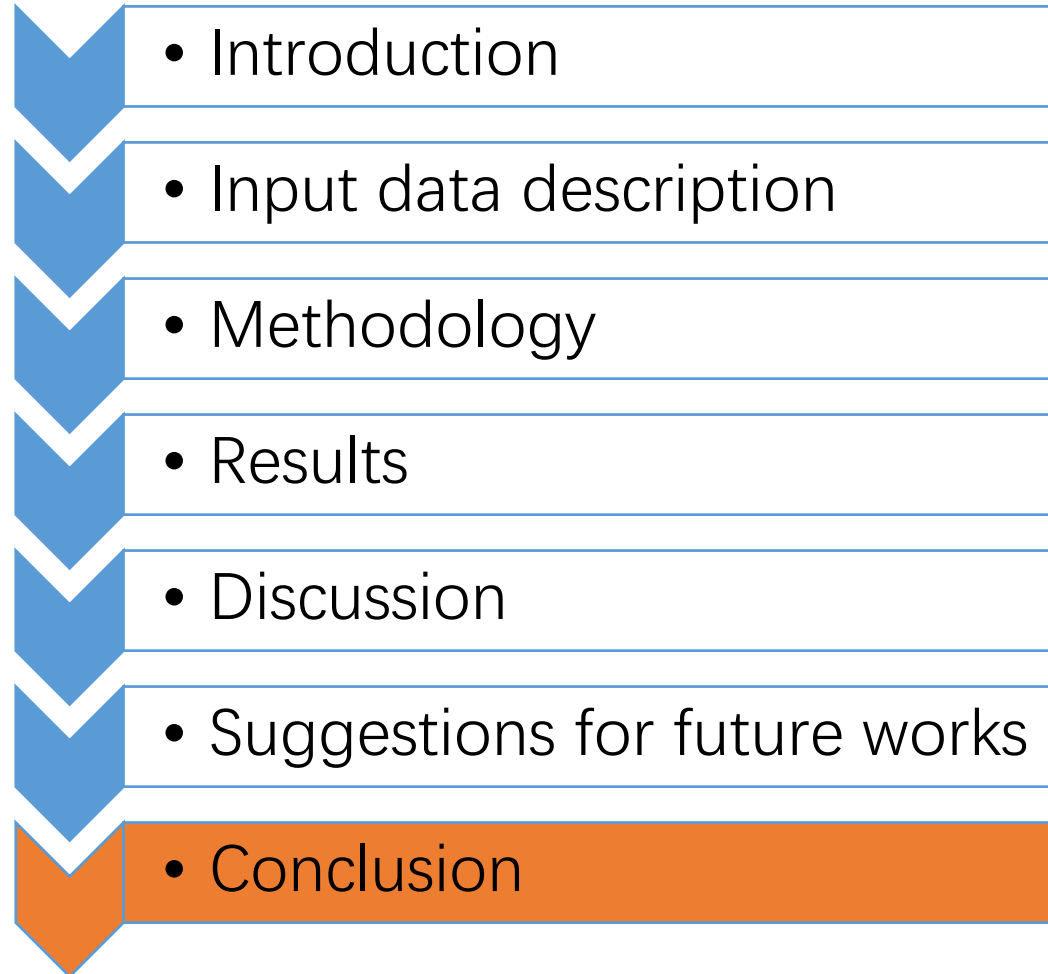
Display the output

Display the combined-scheme-corrected satellite precipitation image (without filter)

Display the combined-scheme-corrected satellite precipitation image (with filter)

Display the statistics table

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# Conclusion

- Script in python: big contribution to automated-mode application
- Precipitation map in Africa case: useful in Affrialliance project

Thank you for your attention