近未来チーム:　水災害影響評価班

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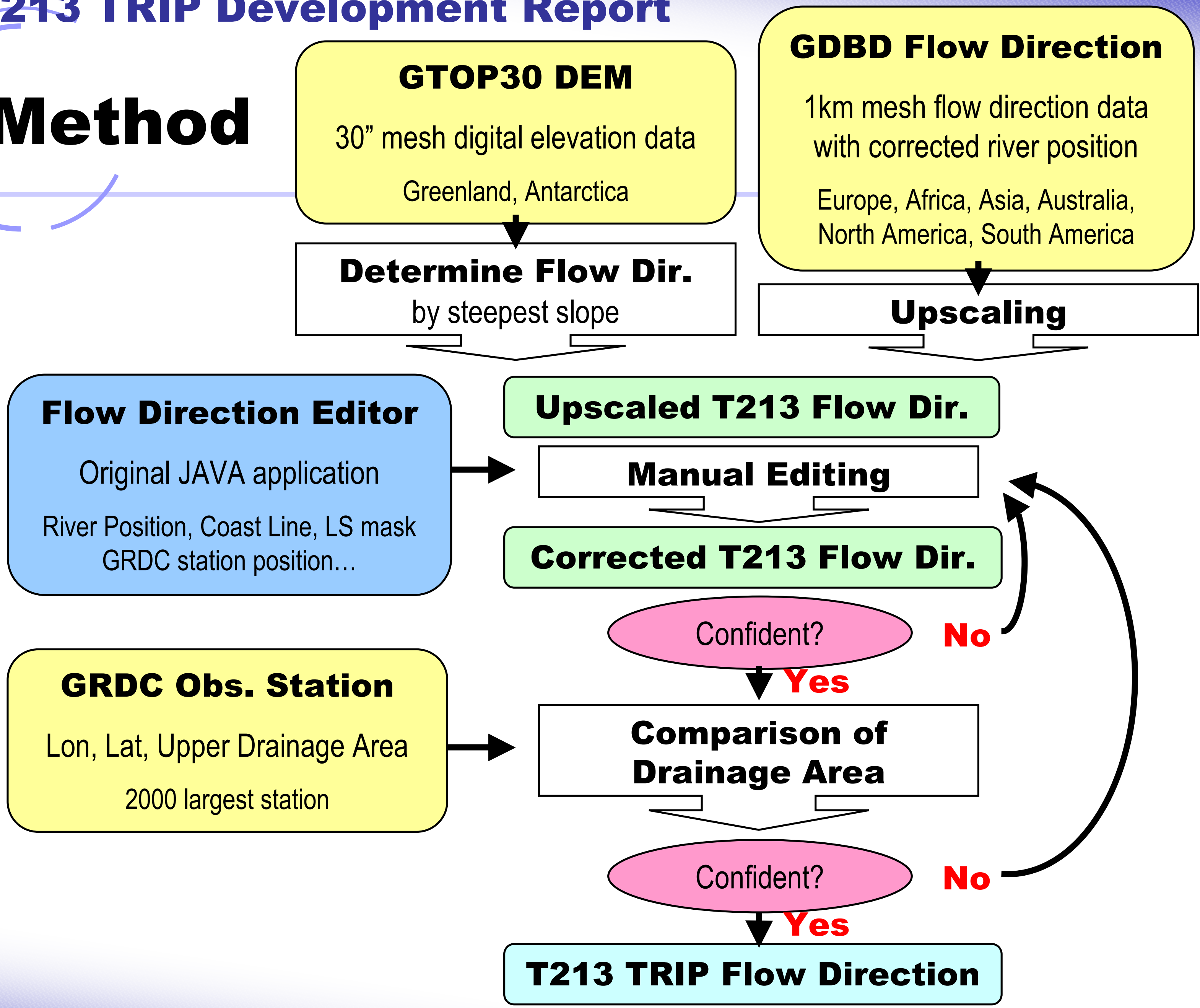
内容

- **T213** の**MIROC**に合わせた**T213**全球河川網データを作りました。
- 河川流量をシミュレーションする計算スキームを、旧来の**TRIP-1**から**TRIP-2**へと**version up**しました。
  これまで以上に日々の変化が出るようになり、極値の再現性の向上が期待されます。
- 水害影響評価のための、世界水害データベースの整備を開始しました。
- 旧来の**TRIP-1**、**1**度グリッドで洪水・渇水の変化の計算をし(←ここまでは昨年度までの結果)、その際、統計的優位性や、過去の洪水のトレンドでの検証など、これまでに足りなかった要素の研究開発を進めました。

Part 1: T213河川網開発

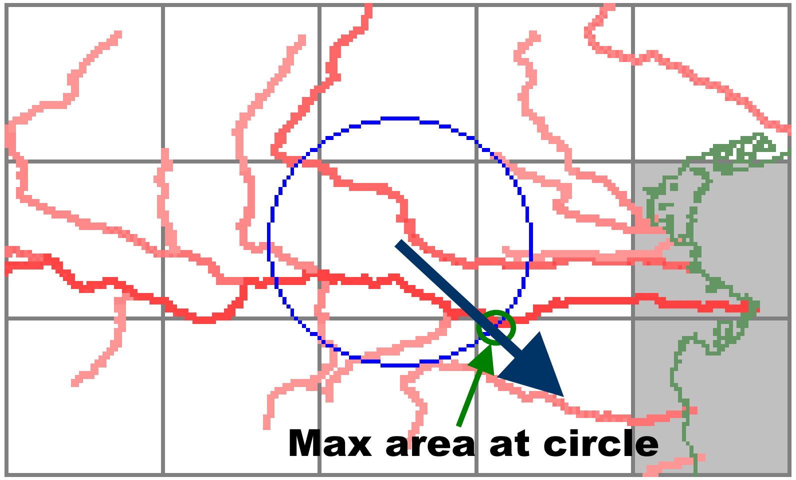
（Yamazaki et al. 論文執筆中）

Method

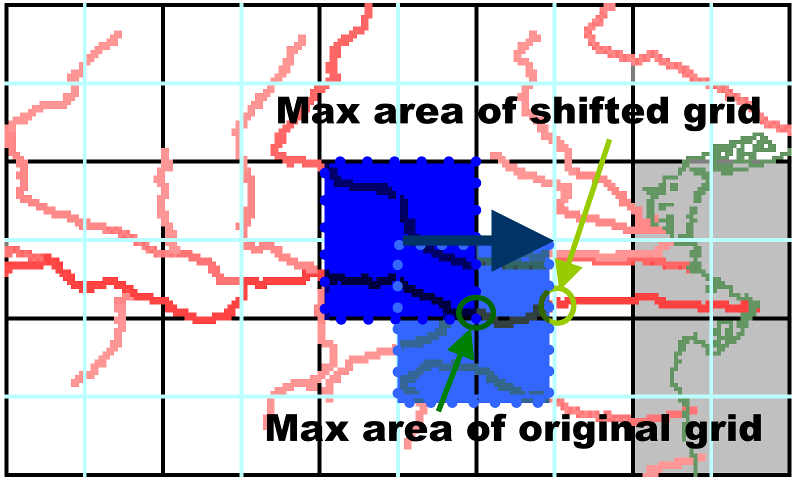

GTOP30 DEM
30” mesh digital elevation data
Greenland, Antarctica
GDBD Flow Direction
1km mesh flow direction data
with corrected river position
Europe, Africa, Asia, Australia,
North America, South America
Determine Flow Dir.
by steepest slope
Upscaling
Upscaled T213 Flow Dir.
Flow Direction Editor
Original JAVA application
River Position, Coast Line, LS mask
GRDC station position…
Manual Editing
Corrected T213 Flow Dir.
Confident?
No
Yes
GRDC Obs. Station
Lon, Lat, Upper Drainage Area
2000 largest station
Comparison of
Drainage Area
Confident?
No
Yes
T213 TRIP Flow Direction

Upscaling Methods

- Okada (2000) **directly trace HYDRO1k**, and decide flow direction by installing **circle out method**.
- Olivera (2002) also trace HYDRO1k, and developed **double maximum method** (DMM) to avoid side direction preference.



Circle Out Method (Okada, 2000)



Double Maximum Method (Olivera, 2002)

Preference of side direction can be avoid, but **flow direction is sometimes unrealistic**.

DMM can represent relatively accurate river ways, but **it still has problems…**

Flow Direction Editor

- **Upscaled initial flow direction have some errors, and we should remove those errors manually.**
- **Flow Direction Editor is JAVA based GUI tool. It visualize geographical information and promise easier manual editing.**

Flow Direction
Editable with Mouse

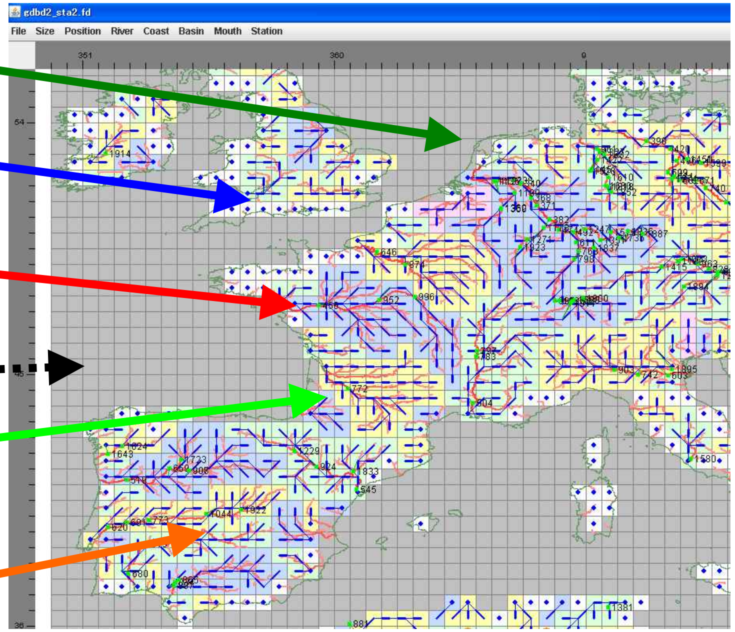
Coastline

River Position
Up & Down Stream information

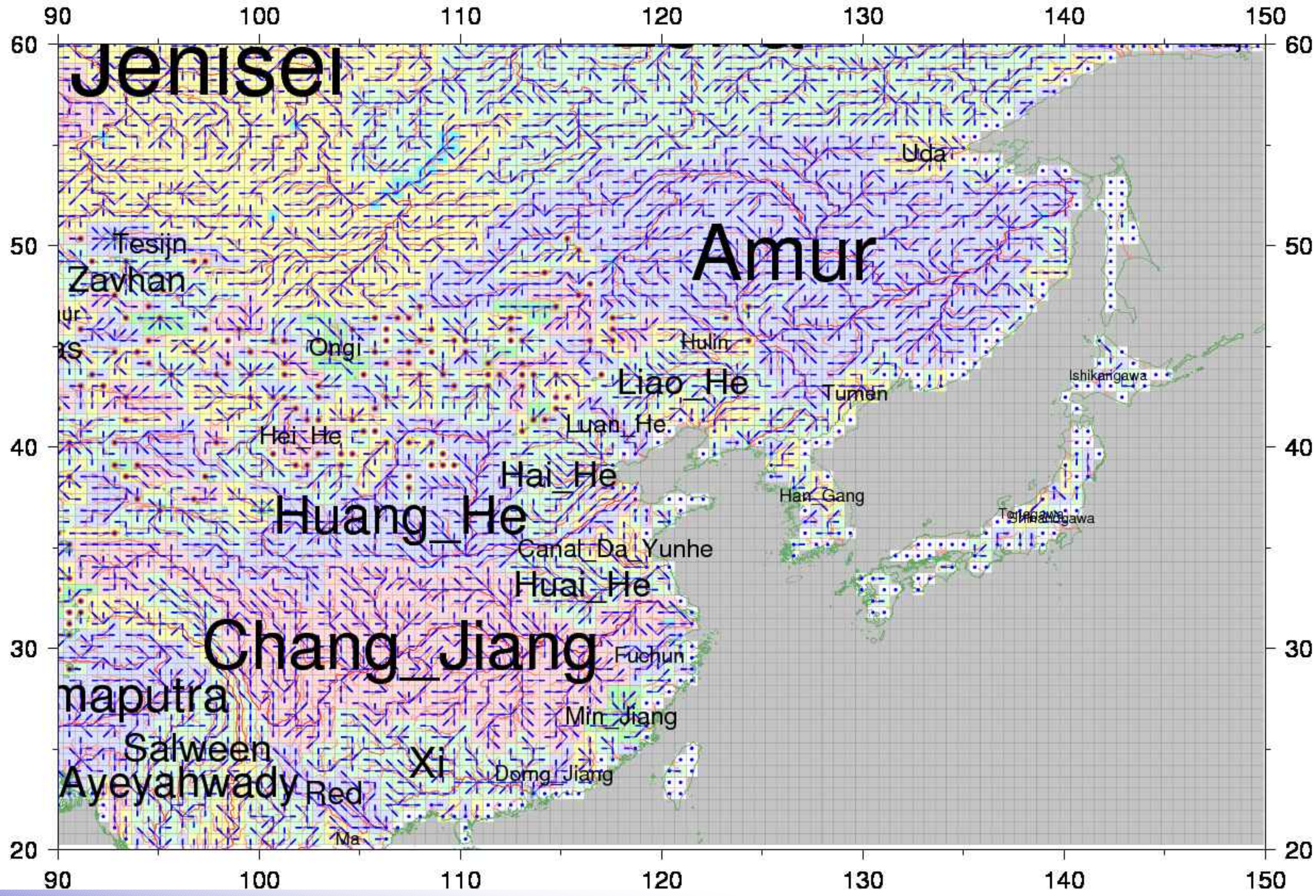
Land Surface Type, Elevation
Now Developing

GRDC Station Info.
Lon, Lat, ID

LS-Mask, Basin
With error alert system

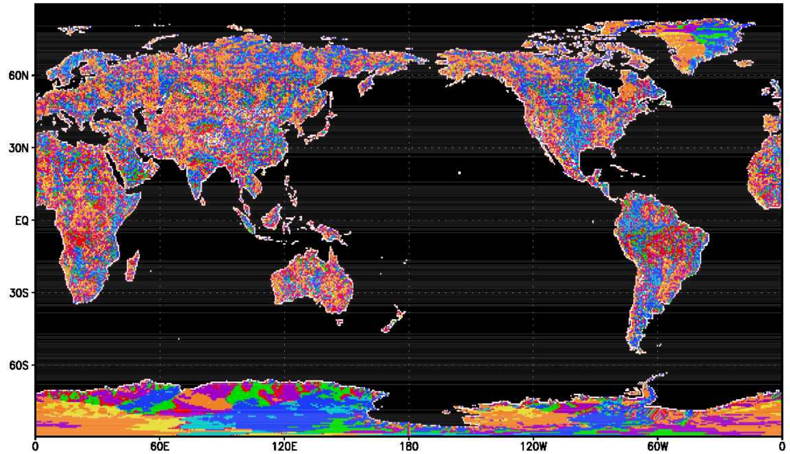


T213 TRIP Dataset

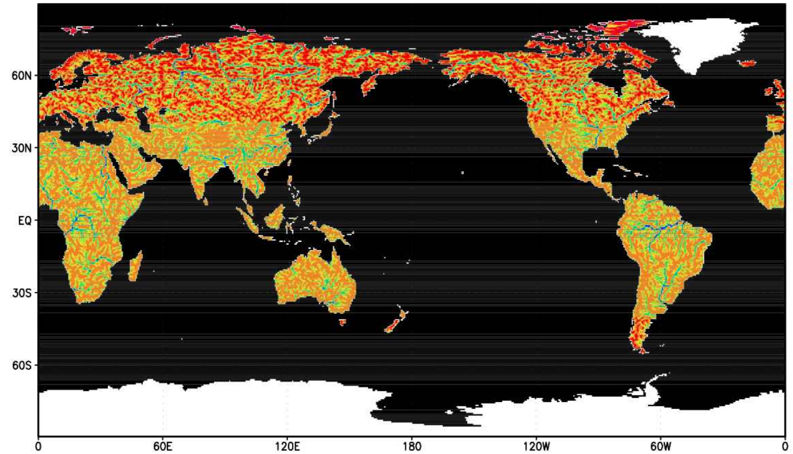


T213 TRIP Dataset

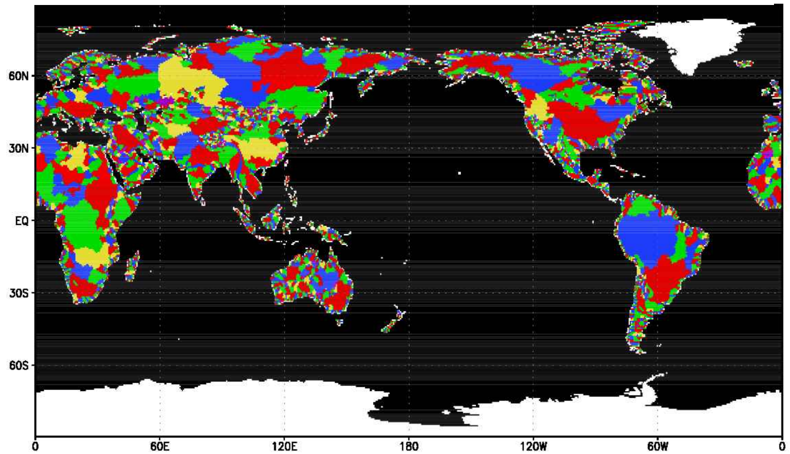
Flow Direction



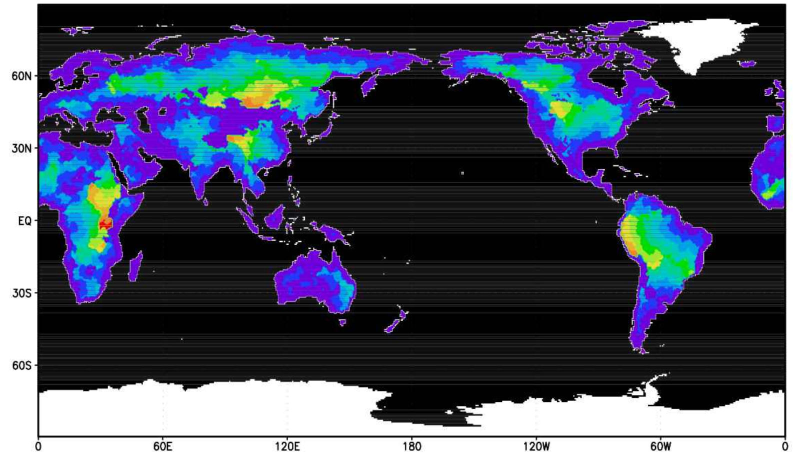
Upper Drainage Area



Basin Information

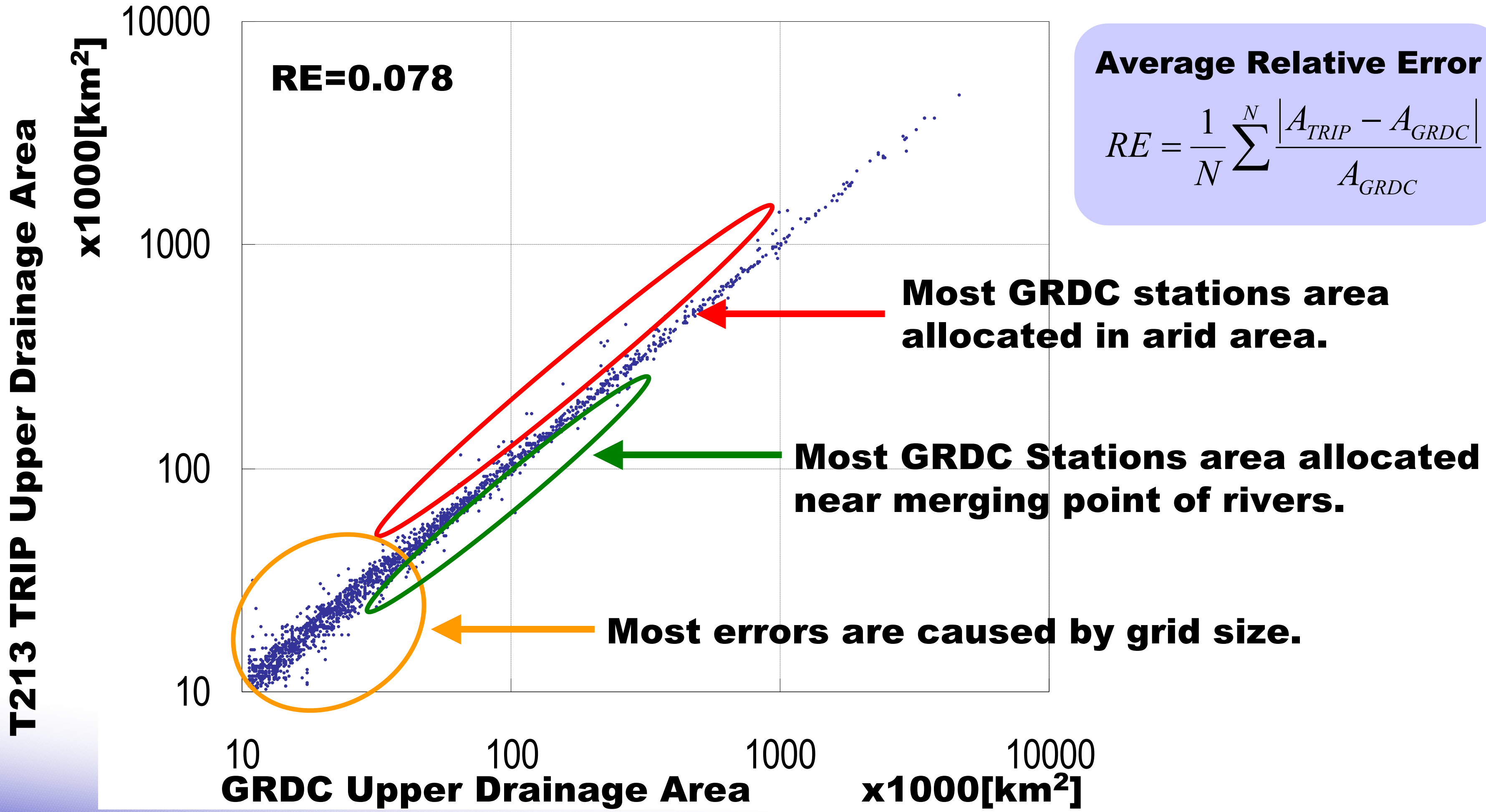


Distance From Sea



Validation of T213 TRIP

- **Comparison of Drainage Area with 2000 GRDC obs. Station.**

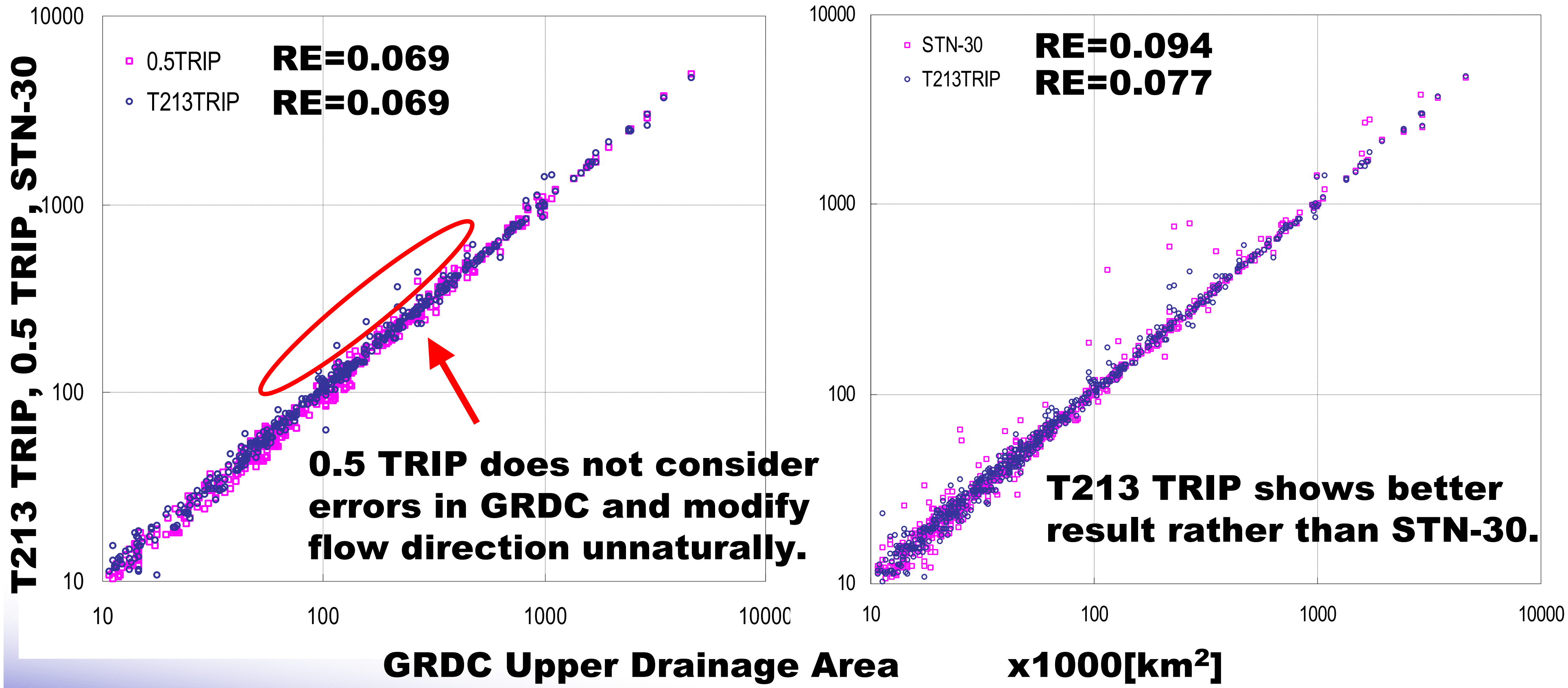


Average Relative Error

$$RE = \frac{1}{N}\sum^{N}\frac{\left|A_{TRIP} - A_{GRDC}\right|}{A_{GRDC}}$$

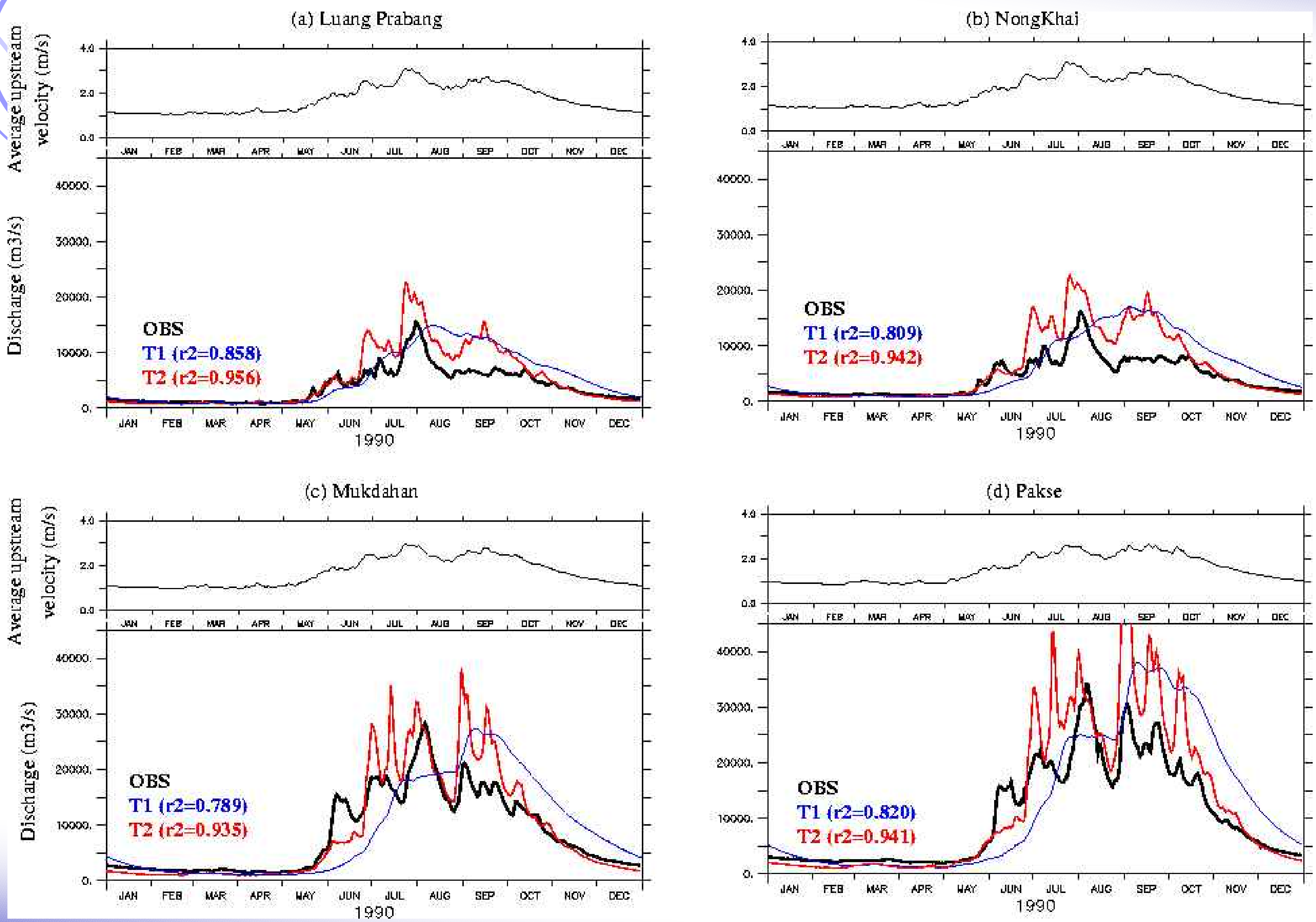
Validation of T213 TRIP

- **Comparison of Drainage Area with 0.5° TRIP and STN-30.**



Part 2：TRIP-2

（Ngo-Duc et al. *HESS*, submitted）



(a) Luang Prabang
(b) NongKhai
(c) Mukdahan
(d) Pakse
Average upstream velocity (m/s)
Discharge (m3/s)
OBS
T1 (r2=0.858)
T2 (r2=0.956)
OBS
T1 (r2=0.809)
T2 (r2=0.942)
OBS
T1 (r2=0.789)
T2 (r2=0.935)
OBS
T1 (r2=0.820)
T2 (r2=0.941)
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1990

Flow routing model – Continental scale

- **Vorosmarty et al. (1989):** water transport model for South America. Resolution 0.5 by 0.5 degree. Flow is modeled using the continuity equation and a linear reservoir storage function

• **Miller et al (1994)**: 2.0 by 2.5 degree, define the minimum storage of each cell. Flow in excess of this minimum storage is transmitted from a cell to a neighboring cell by a linear storage function.

• **Coe (1999)** : HYDRA for 5’ by 5’: represent the monthly/seasonal variations of discharge, lake and wetland, direct representation of manmade.

Hagemann and Dumenil (1998): cascade of linear reservoirs. Within each cell, three separate flow paths are defined

Arora and Boer (1999): Manning equation for Canadian rivers

Ducharne et al. (2003): RiTHM, the transfer time from a cell to the outlet depends on topography, and on a basin-wide parameter

TRIP 2.0 – variable velocity approach

- **Different approach**
  - Variable velocity based on the Manning equation: $v = n^{-1} \times R^{2/3} \times S^{1/2}$
  - Manning coefficient is globally estimated used *Dingman and Sharma* [1997] relationship

$$n = \frac{1}{1.564} A^{-0.173} R^{0.267} S^{0.5+0.0543\log S}$$

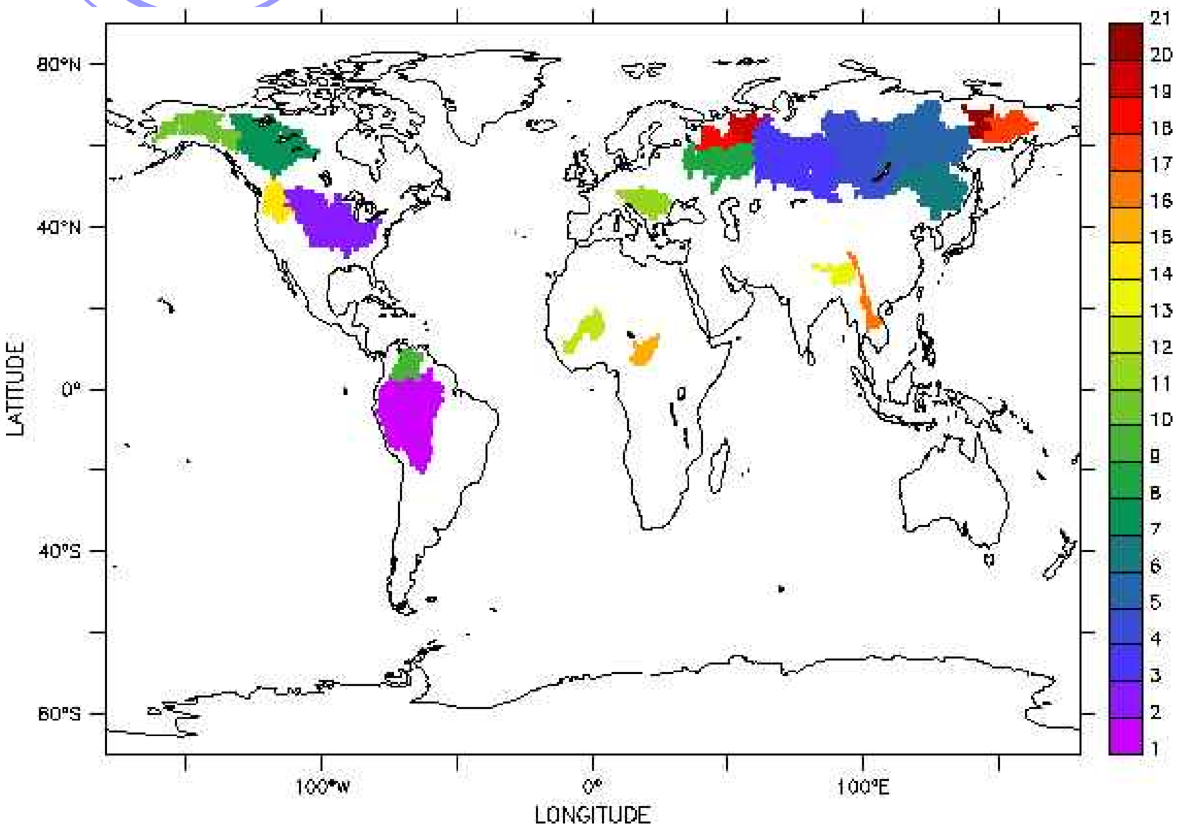
A: cross section area
R: hydraulic radius
S: river slope

River width: $W = \max(10, (6.0 + 10^{-4} \times Q_{m.mouth}) \times Q_m{}^{0.5})$

- **Add ground water scheme**

$$S_g(t+dt) = e^{-dt/T_g} S_g(t) + (1 - e^{-dt/T_g}) T_g D_{LSMg}(t+dt)$$

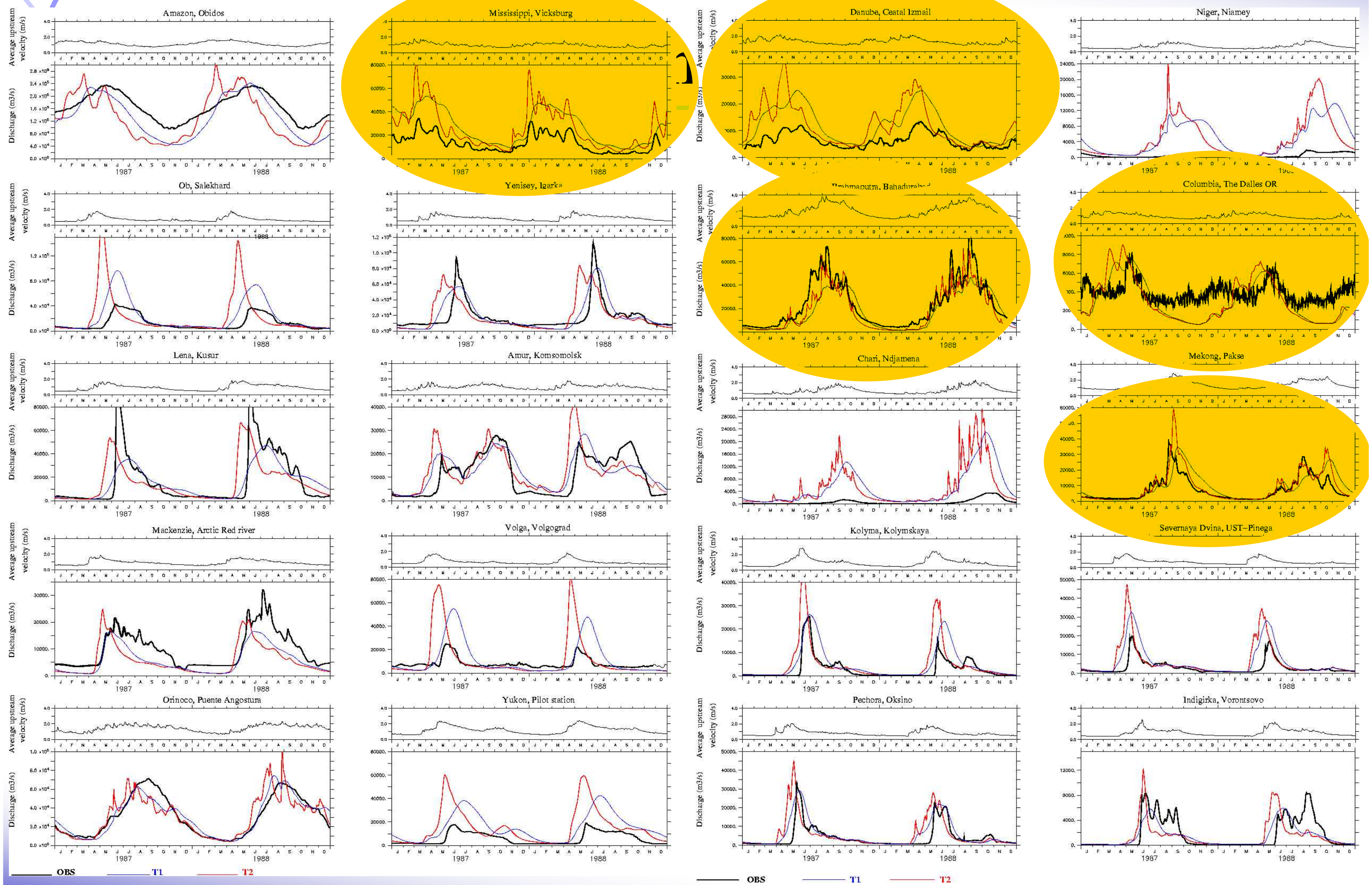
3. TRIP 2.0 – Over the 20 largest basins



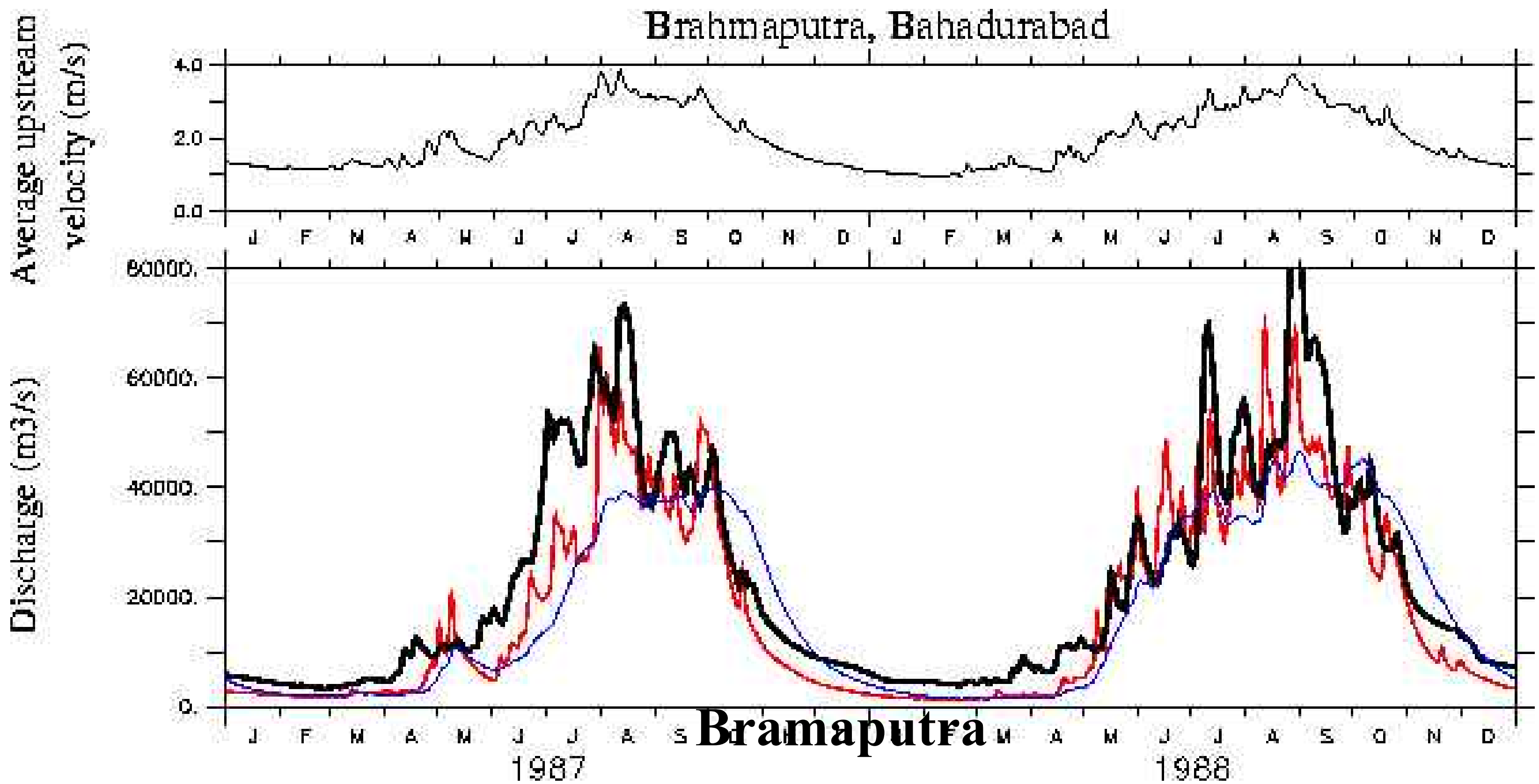
- Stations which have upstream drainage area greater than 300,000 km2.

- Stations with a minimum observed period of 4 years which overlaps the GRDC 1986-1995 period.

- The most downstream station (i.e. maximum upstream drainage area) among the available ones on a river which fit the 2 above conditions.



Amazon, Obidos
Mississippi, Vicksburg
Danube, Ceatal Izmail
Niger, Niamey
Ob, Salekhard
Yenisey, Igarka
Columbia, The Dalles OR
Lena, Kusur
Amur, Komsomolsk
Chari, Ndjamena
Mekong, Pakse
Mackenzie, Arctic Red river
Volga, Volgograd
Kolyma, Kolymskaya
Severnaya Dvina, UST–Pinega
Orinoco, Puente Angostura
Yukon, Pilot station
Pechora, Oksino
Indigirka, Vorontsovo
Average upstream velocity (m/s)
Discharge (m3/s)
1987
1988
OBS
T1
T2


Brahmaputra, Bahadurabad
Average upstream velocity (m/s)
4.0
2.0
0.0
J F M A M J J A S O N D J F M A M J J A S O N D
Discharge (m3/s)
80000.
60000.
40000.
20000.
0.
J F M A M J J A S O N D J F M A M J J A S O N D
1987
1988

Bramaputra

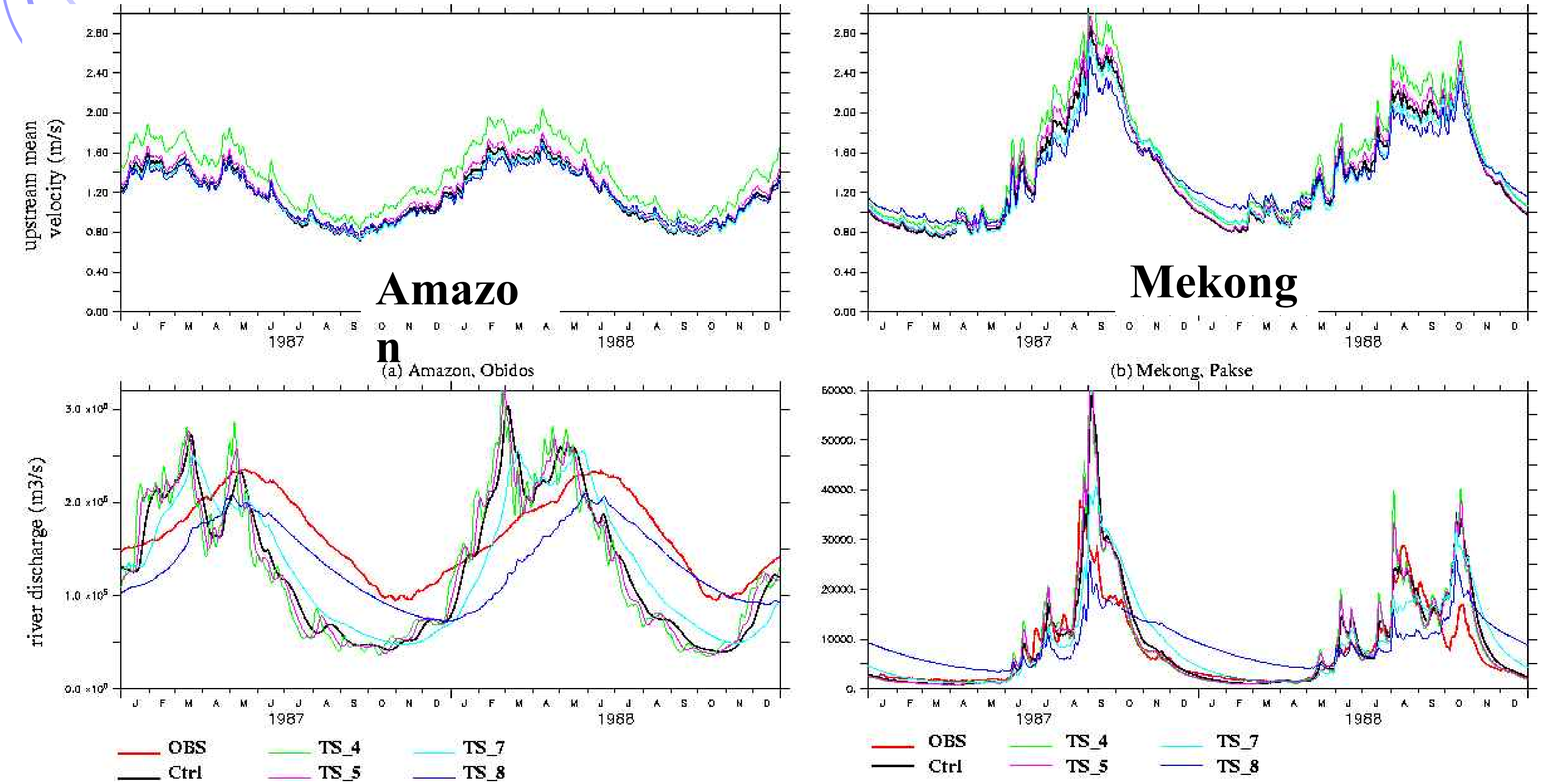
TRIP 2.0 –minimum river slope - sensitivity

- **Experiments:**
  - Ctrl : 10^{-6} m/m
  - TS_4 : 10^{-4} m/m
  - TS_5 : 10^{-5} m/m
  - TS_7 : 10^{-7} m/m
  - TS_8 : 10^{-8} m/m

- **Stations to study:** Obidos of the Amazon and

  Pakse of the Mekong
- **Periods:** 1987, 1988
- **Discharge observations:** daily from GRDC

TRIP 2.0 –minimum river slope - sensitivity



Smin decreases ➔ better discharge over the Amazon: flat basin

➔ worse over the Mekong: mountainous basin

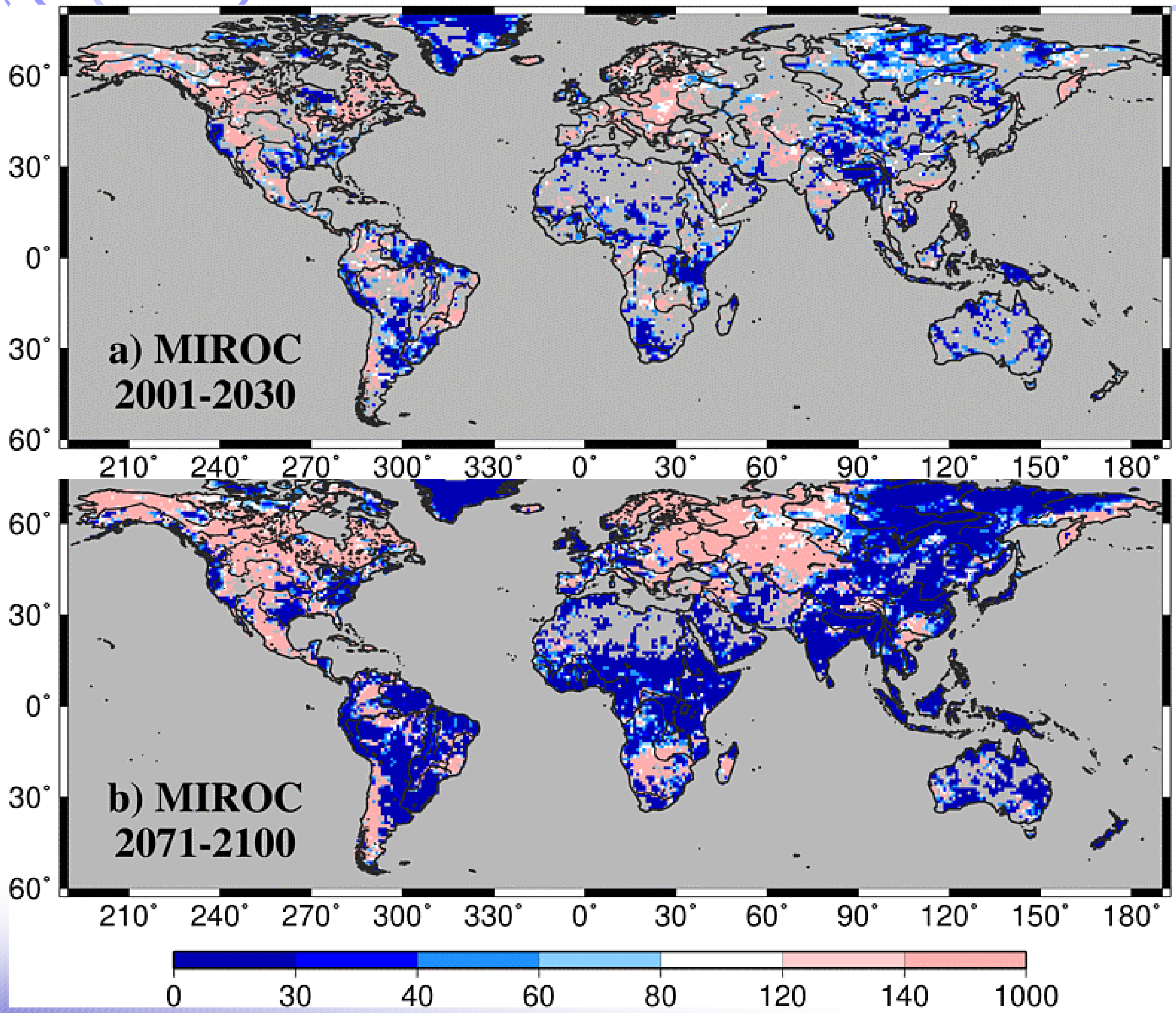
Part 3: 世界水害データベース
（来年度、お見せしたいと思います）

（修士論文として追い込み中）

Part 4: K-1洪水研究の発展

（Hirabayashi et al. *Hydro. Sci. J.*, in revision）

洪水増加地域
MIROC A1bシナリオ



20世紀に100年に1度の洪水→何年に1度？

※95％有意でない地域は除く

Hirabayashi et al. 2007, submitted to HSJ

	流域面積 10^4km^2	経度	緯度	再現期間 観測値	再現期間 MIROC 20世紀	洪水増減 (1:増加 2:減少) 観測値	洪水増減 (1:増加 2:減少) MIROC	ダム影響 (1:あり 0:なし)	
1159500	12.1	24.6036	-28.4986	204.983	104.3775	2	0	1	
2910300	5.7	84.92	56.5	16448.3	87.9558	2	1	1	
4113300	7.8	-97.03	47.93	10.11607	45.1261	1	0	1	
4115100	1.89	-123.04	44.94	3000.75	169.158	2	0	1	
4115221	1.96	-120.41	45.59	34.1469	73.1712	1	0	1	
4115300	1.88	-119.46	48.63	555.427	122.635	0	1	1	
4115345	2.77	-115.09	47.3	251.427	125.769	2	2	1	
4116330	3.51	-116.32	45.75	57.8704	125.769	0	2	1	
4118410	1.3	-116.2	40.6	12.5355	56.3885	1	0	1	
4118850	1.34	-112.04	39.37	3.08804	27.8247	1	0	1	
4119080	1.62	-92.64	45.4	226.738	35.3565	0	0	1	
4119250	3.24	-91.18	41.17	39.516	109.234	0	2	1	
4119260	1.68	-91.67	41.97	77.1618	1423.85	0	2	1	
4119280	3.64	-91.96	40.72	62.7756	109.234	0	2	1	
4119281	1.41	-93.99	42.25	97.1899	864.003	0	0	1	
4119310	1.33	-88.19	41.34	24.5008	60.9102	1	0	1	
4120950	17.9	-104.15	47.68	8244.33	155.924	2	0	1	
4122700	15.47	-94.96	38.98	3620.46	3612.67	0	0	1	
4125801	11.32	-97.06	37.05	27.369	619.726	1	0	1	
4133200	1.56	-88.2	44.32	2475.61	55.317	0	0	1	
4147010	1.66	-68.65	45.24	30.7874	76.9579	1	0	1	
4147600	1.76	-74.78	40.22	424.02	1913.9	2	2	0	ダムなし
4150500	11.66	-95.76	29.58	281.346	244.256	0	0	0	ダムなし
4150680	2.06	-94.09	30.35	21845.3	72.8652	2	0	1	
4152300	1.12	-110.92	33.62	72.4223	156.956	0	0	1	
4152460	6.24	-109.29	38.81	119.206	60.1571	2	2	1	
4152550	11.62	-110.15	38.99	375.472	90.6117	2	2	1	
4207900	21.7	-121.45	49.38	993.97	109.593	2	2	1	
4213250	5.65	-110.68	50.05	74.1027	114.078	2	0	1	
4213400	14.1	-106.65	52.13	8.38861	E+0684.48	2	0	1	
4213550	34.7	-101.18	53.83	11610.5	92.2712	2	0	1	
4213590	6.03	-99.68	49.6	860.767	505.018	0	0	1	
4213650	15.3	-97.4	49.87	41425.2	644.262	2	0	1	
4213680	10.4	-97.22	49	560.698	42.5611	0	0	1	
4213800	12.6	-95.57	50.22	98.8273	39.3371	0	0	1	
6435060	17.97	6.11	51.84	38.9757	214.279	1	0	1	
6730500	1.42	28.05	70.07	134.944	119.436	0	0	1	
6731400	4.02	11.07	59.36	40.2289	36.0904	0	0	1	
6854600	1.41	25.43	65.32	50.3666	474.804	0	2	0	ダムなし
6970500	5.92	45.62	65	648.42	55.0091	0	0	0	ダムなし

•1901-1980と1981-2000の年最大日流量(high-flow)のトレンドを解析

•1901-1980のうち60年以上、1981-2000のうち15年以上日流量観測がある40流域

•36流域で観測流量データに統計的な不連続を検出

•High-flowの有意な減少が見られた13地点では全て統計的な不連続を検出
→ダムによるpeak-cut？

•観測でhigh-flowの増加が見られた8地点では、MIROCのトレンドは見られない

•ダムの影響のない4地点のうち、小流域の1地点を除く3地点では観測とMIROCのトレンドが一致

空振りor 不一致
見逃し
一致（トレンド無し）
一致（両方減少）

「100年に一度」の洪水がn（0-10,10-25,50-75,75-100）年に一度に変化する地域の総人口（単位：10億人）