中山大學 大气科学学院
SUN YAT-SEN UNIVERSITY School of Atmospheric Sciences

Exploring the ENSO Impact on Basin-Scale Floods toward Better Monthly-to Seasonal Flood Forecast

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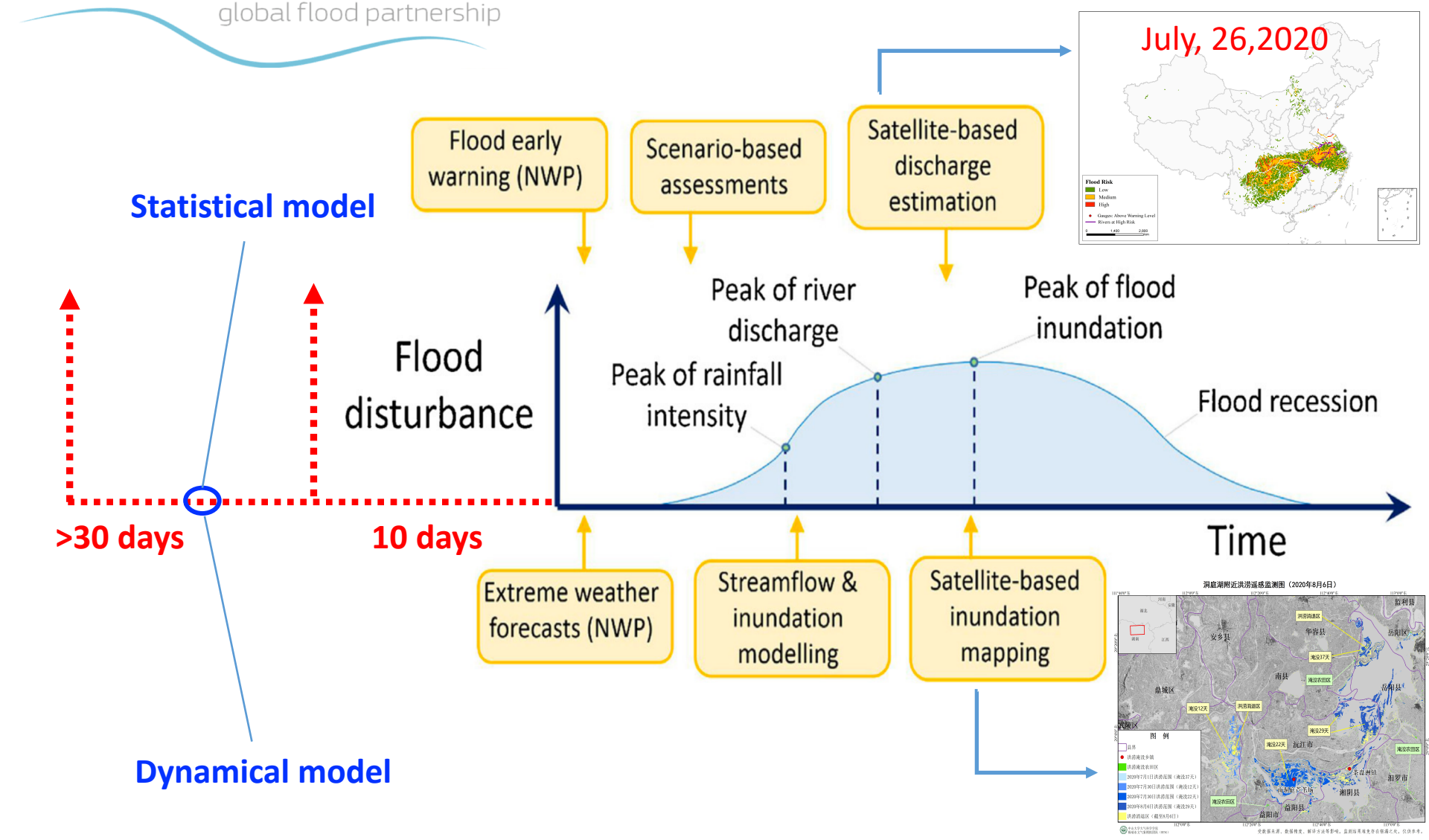
GFP, Guangzhou, June 10-13, 2019

GFP global flood partnership

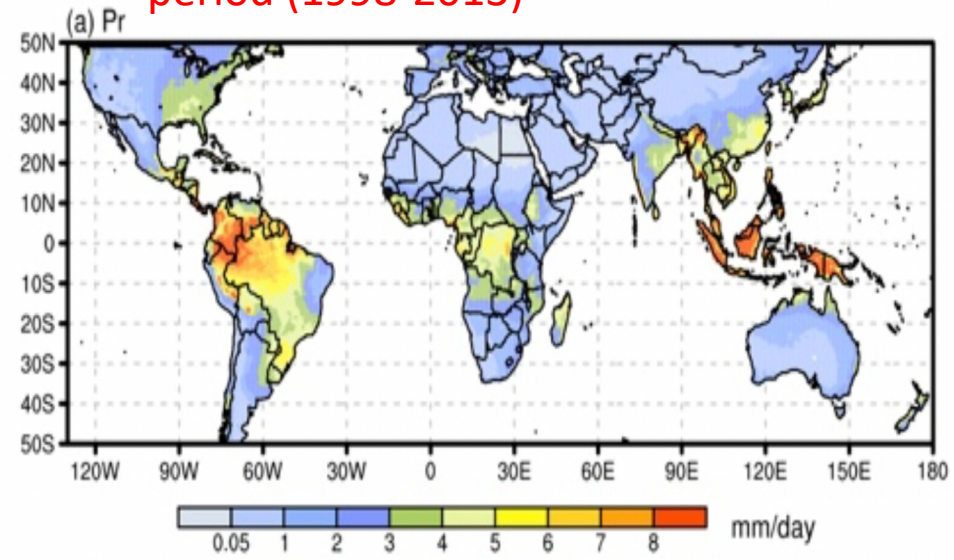
A global network for operational flood risk reduction

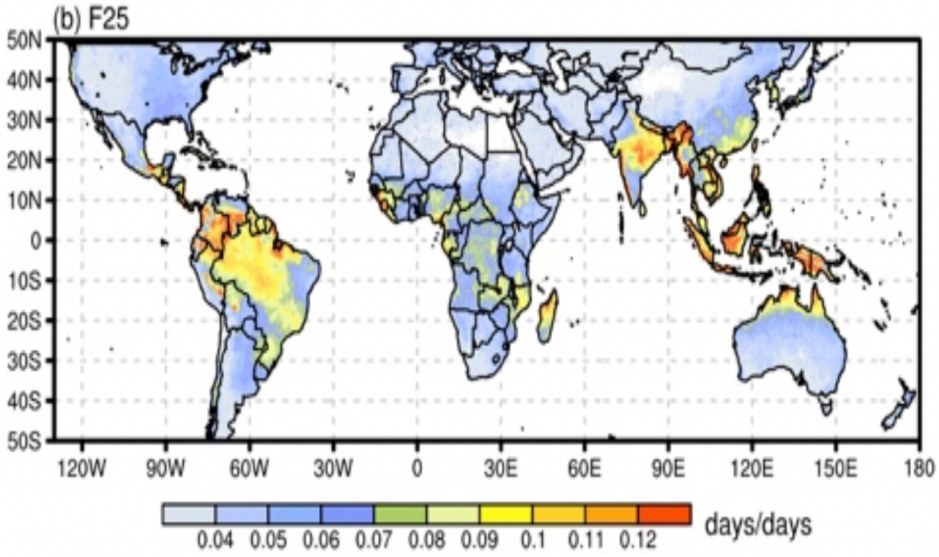
Alfieri et al., *Environmental Science and Policy, 2018*

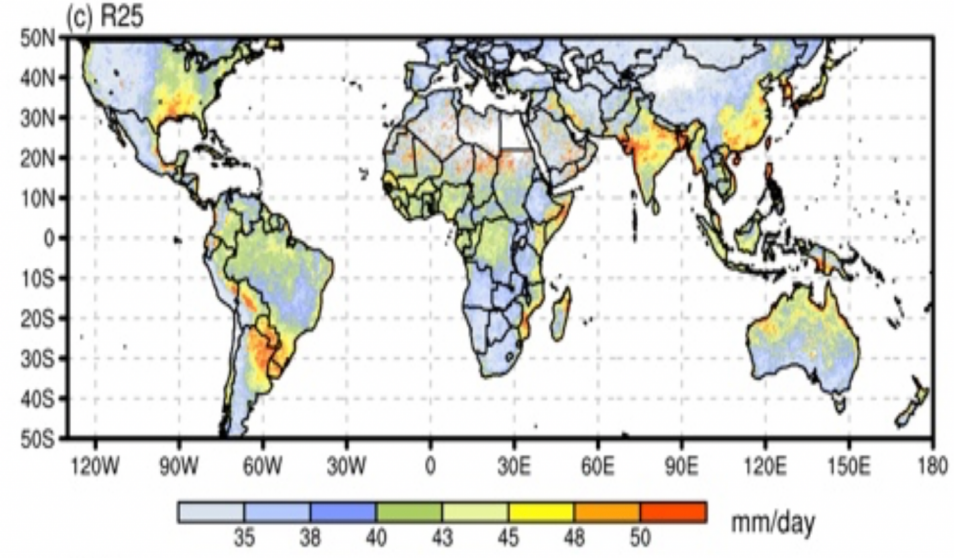


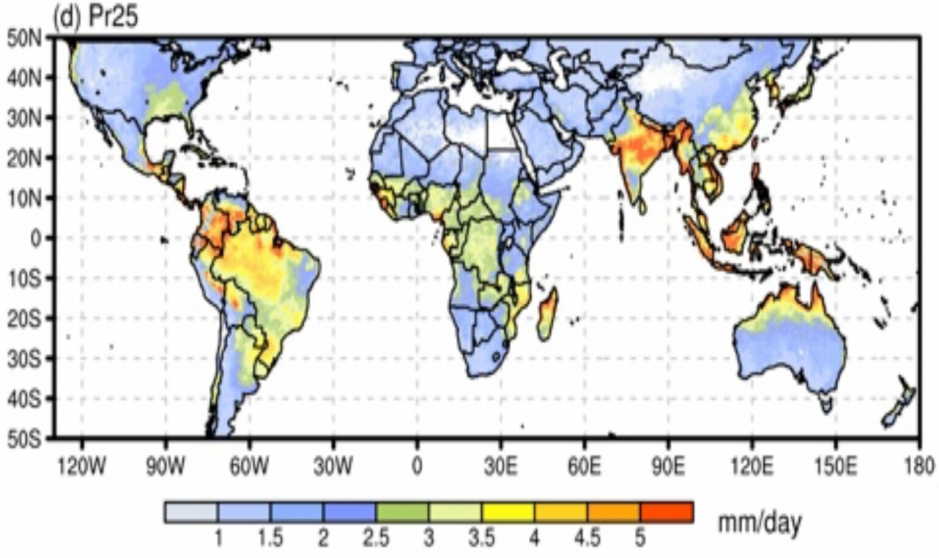
Precipitation-related flood-generation mechanisms

Spatial distributions of the four climatological precipitation indices during the TRMM period (1998-2013)









Three objectives of this study:

(1) Furnish a climatological quantification of global floods (frequency, duration, and intensity) during the TRMM period (1998-2013)

(2) Quantify the likely relationships between flood events and various aspects of precipitation;

(3) Assess the possible impact of climate modes specifically the ENSO on both precipitation and floods.

AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE
10.1002/2013WR014710

Key Points:
- Coupled VIC with a physically based routing model for real-time flood estimation
- GFMS gives promising flood estimation with satellite-based

Real-time global flood estimation using satellite-based precipitation and a coupled land surface and routing model

Huan Wu[1,2], Robert F. Adler[1,2], Yudong Tian[1,2], George J. Huffman[2], Hongyi Li[3], and JianJian Wang[1,2]

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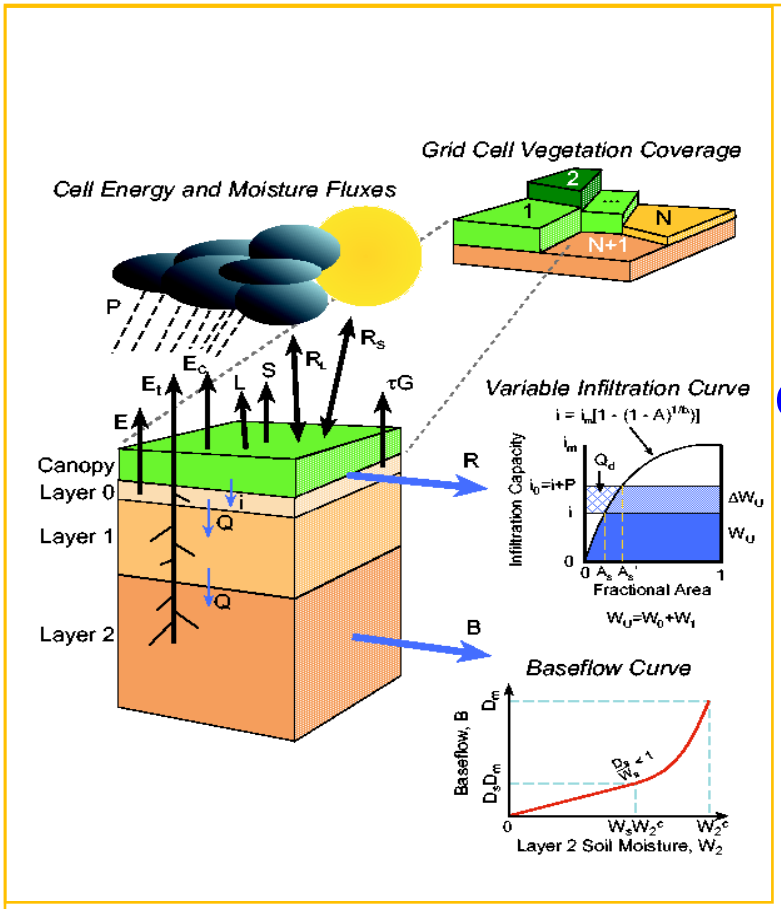
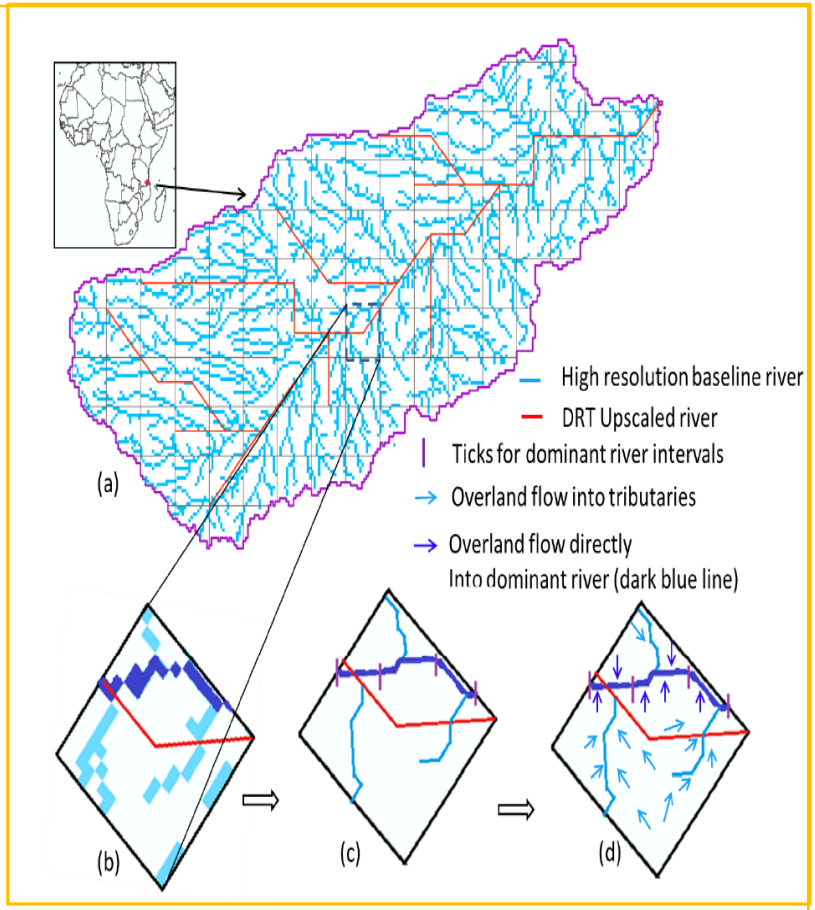


Coupled



Dominant river tracing-Routing Integrated with VIC Environment (DRIVE) model

(Wu et al., 2011, 2012, 2014 *Water Resources Research; Wu et al., 2017, JHM; Wu et al., 2018, 2019 Wu et al. RSE; Jiang et al., 2020, RS;*)

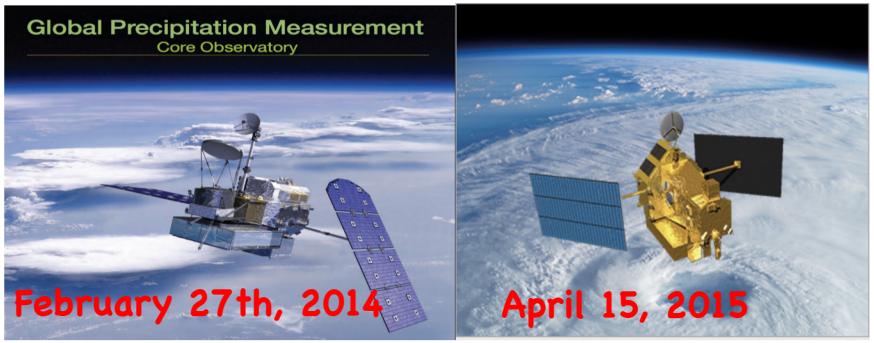
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION | GODDARD SPACE FLIGHT CENTER

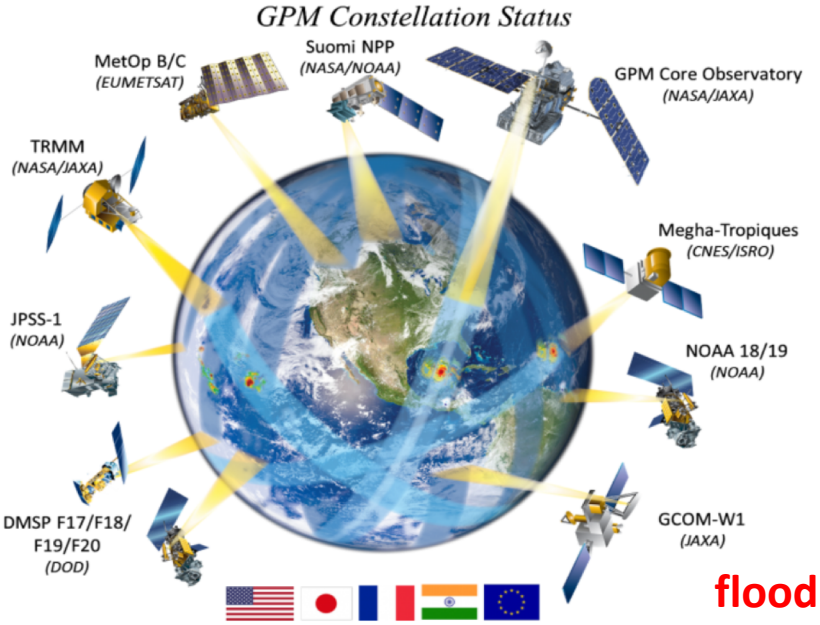
GFMS from TRMM to GPM

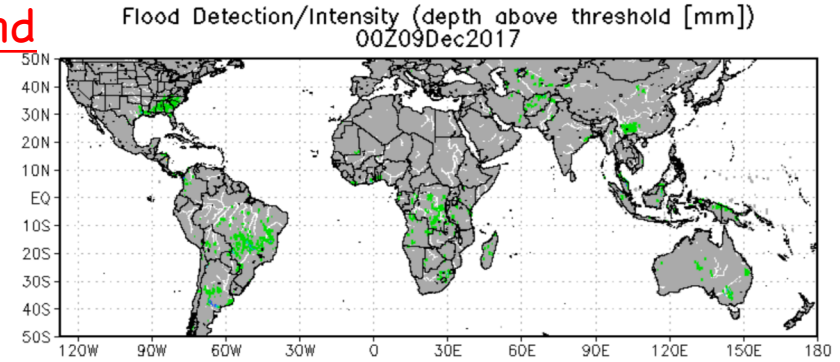
Search

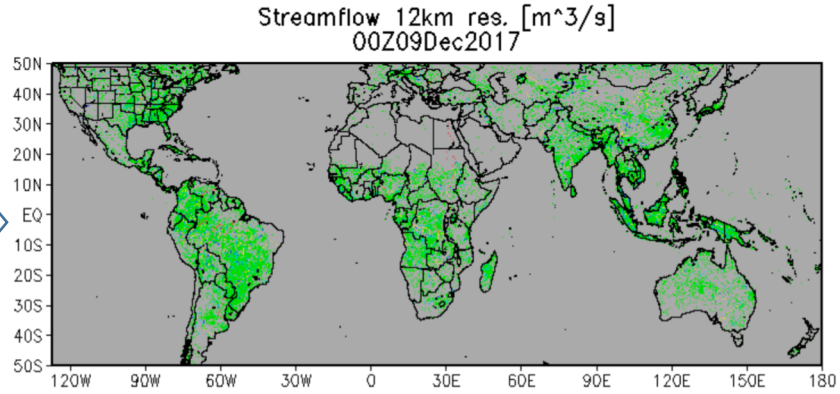
PRECIPITATION MEASUREMENT MISSIONS

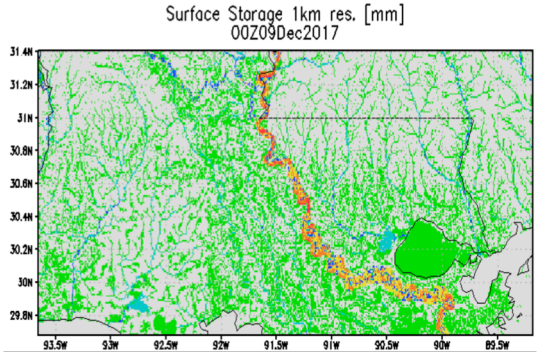
3-hourly, 8th and 1km global flood detection and inundation mapping with hydrological model

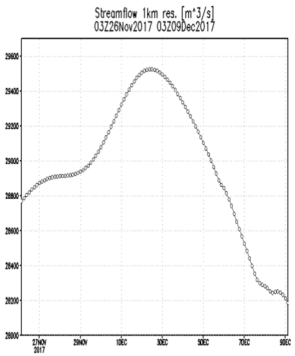












flood.umd.edu

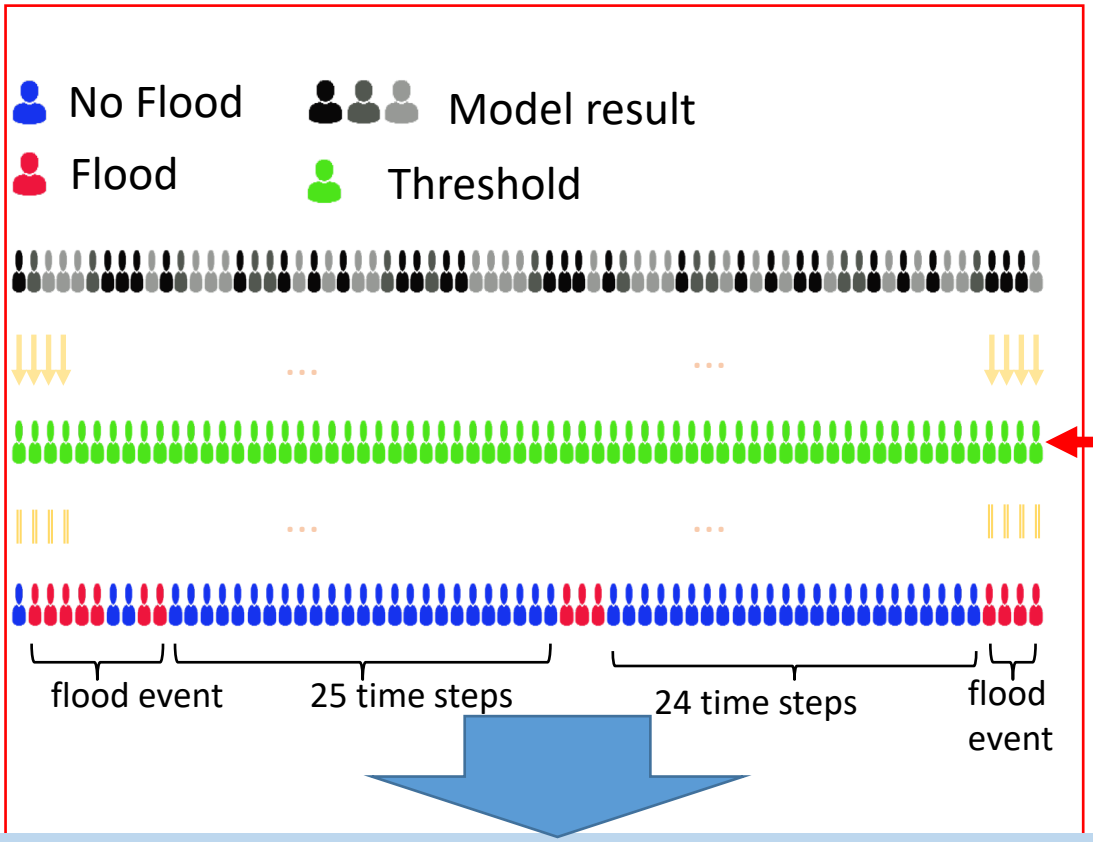
Global Flood Monitoring System (GFMS) with data since 1998

Flood event identification and flood indices

Evaluation of Global Flood Detection Using Satellite-Based Rainfall and a Hydrologic Model

AMS American Meteorological Society

Huan Wu *and* Robert F. Adler
Earth System Science Interdisciplinary Center, University of Maryland, College Park, College Park, and NASA Goddard Space Flight Center, Greenbelt, Maryland



Flooding at a point

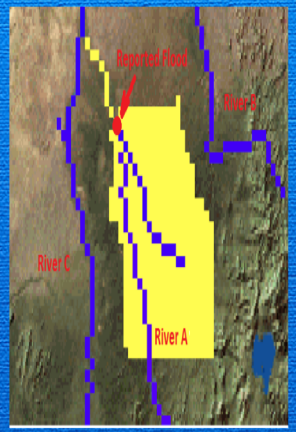
$R > P_{95} + \delta$ and $Q > 10\ m^3/s$

R: routed runoff (mm)
P_{95}: 95th percentile value of routed runoff
δ: temporal standard deviation of routed runoff
Q: discharge (m^3/s)

Matching floods between simulated and reported

Temporal window: ±1 days

Spatial window: all upstream basin area within ~200 km & ~100 km downstream stem river



Flood Frequency (FF) ; Flood Duration (FD)
Average flood intensity (FI); Total flood intensity (FTI)

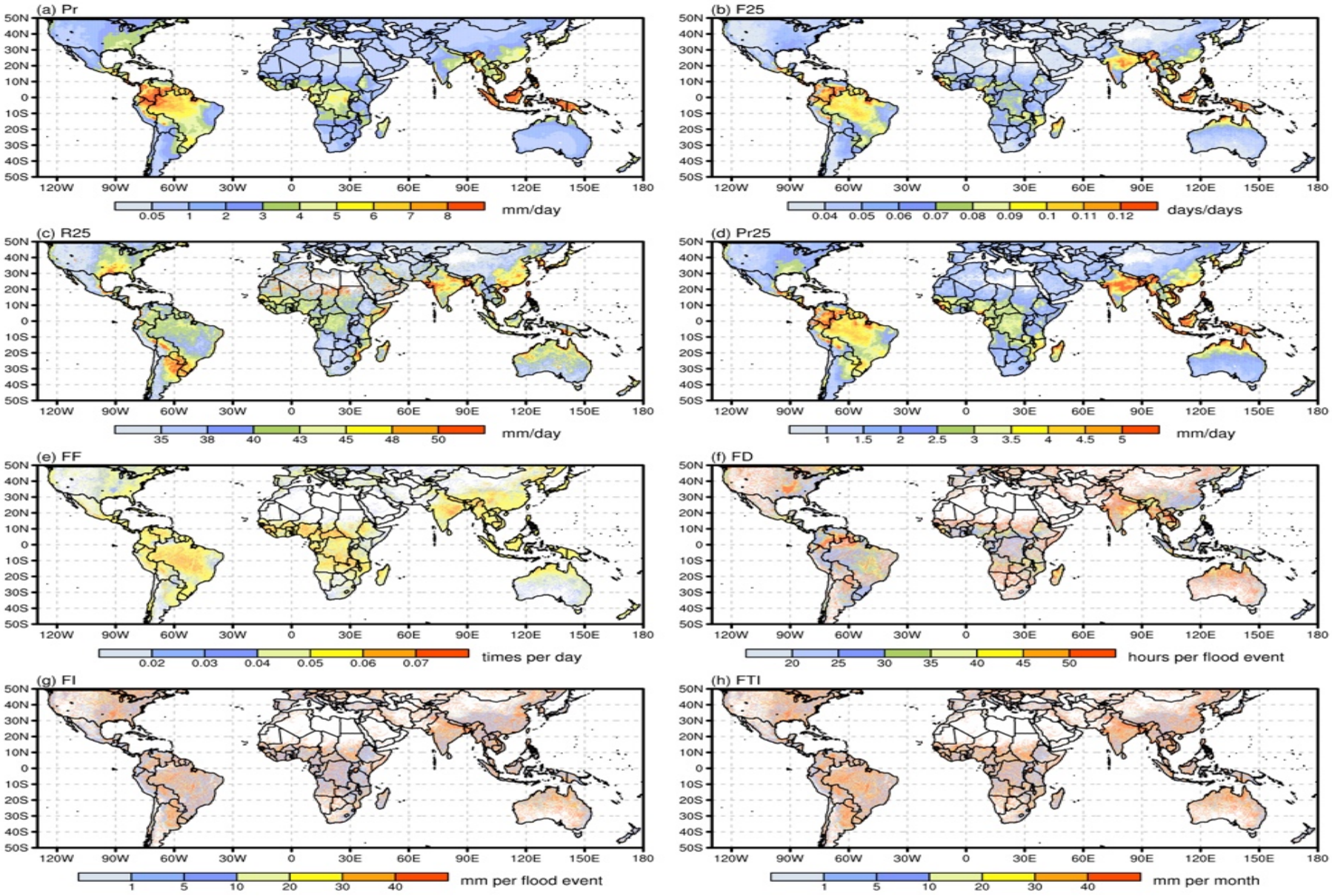
Wu et al., JHM 2012, 2014

Precipitation indices

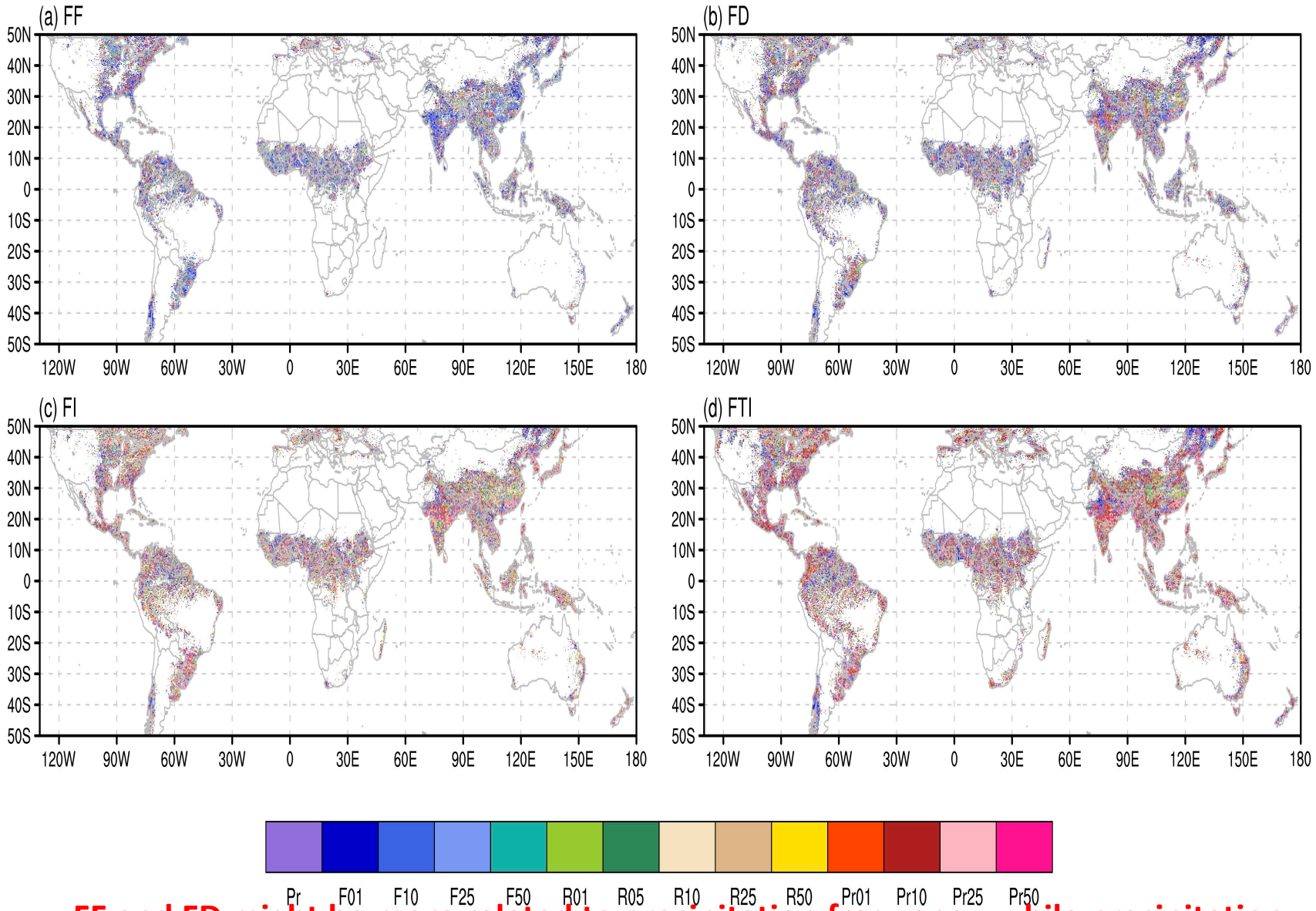
14 precipitation/extreme precipitation indices:

Pr (mm/day)	Monthly precipitation rate
F01 (days/days)	Total rainy days (R≥1 mm day^{-1}) / total days in a month
F10 (days/days)	Total rainy days (R≥10 mm day^{-1}) / total days in a month
F25 (days/days)	Total rainy days (R≥25 mm day^{-1}) / total days in a month
F50 (days/days)	Total days with R≥50 mm day^{-1} / total days in a month
R01 (mm/day)	Total R≥1 mm day^{-1} precipitation / days with R≥1 mm day^{-1} in a month
R10 (mm/day)	Total R≥10 mm day^{-1} precipitation / days with R≥10 mm day^{-1} in a month
R25 (mm/day)	Total R≥25 mm day^{-1} precipitation / days with R≥25 mm day^{-1} in a month
R50 (mm/day)	Total R≥50 mm day^{-1} precipitation / days with R≥50 mm day^{-1} in a month
Pr01 (mm/day)	Total R≥1 mm day^{-1} precipitation / total days in a month
Pr10 (mm/day)	Total R≥10 mm day^{-1} precipitation / total days in a month
Pr25 (mm/day)	Total R≥25 mm day^{-1} precipitation / total days in a month
Pr50 (mm/day)	Total R≥50 mm day^{-1} precipitation / total days in a month

Climatological mean precipitation and floods (1998-2013)

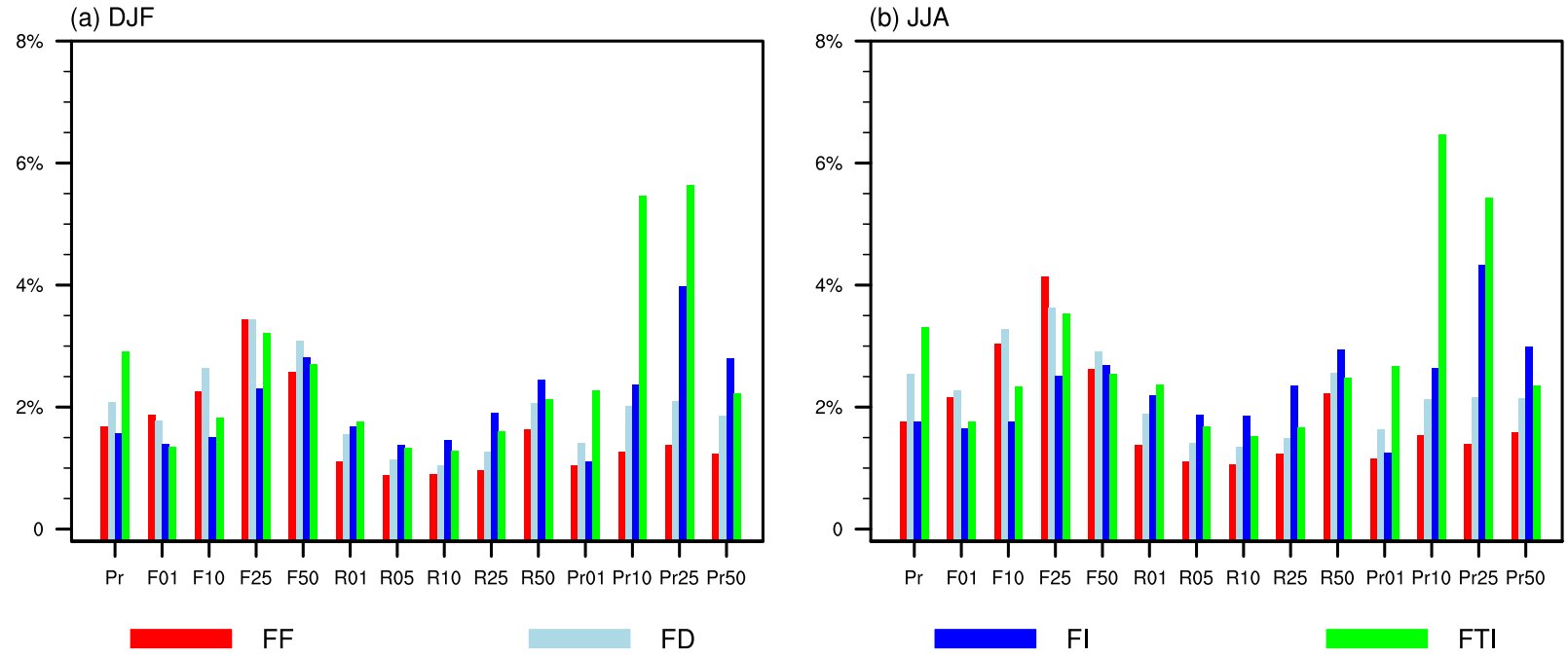


Max correlated precipitation indices with FF/FD/FI/FTI in JJA.



FF and FD might be more related to precipitation frequency, while precipitation amount and/or intensity tend to be more relevant to FI and FTI.

The ratios of grids with the largest correlations and the total grids

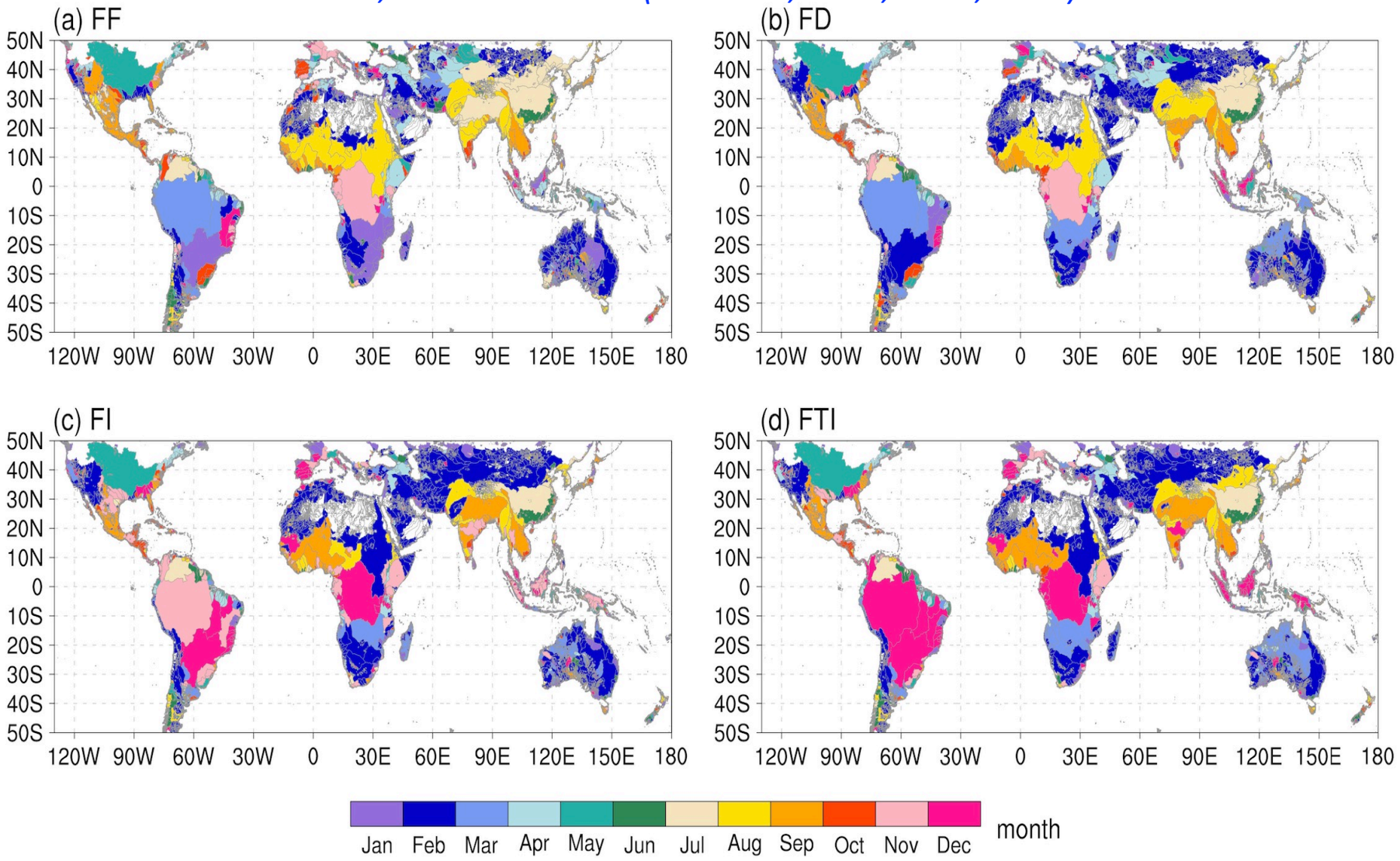


- **The dominant role of the frequency of extreme precipitation events in the occurrence and duration of of floods.**
- **Flood intensity (FI and FTI) tends to be more associated with total precipitation volume especially for those extreme precipitation events.**

Yan, Y., H. Wu et al., Journal of Climate, 2020

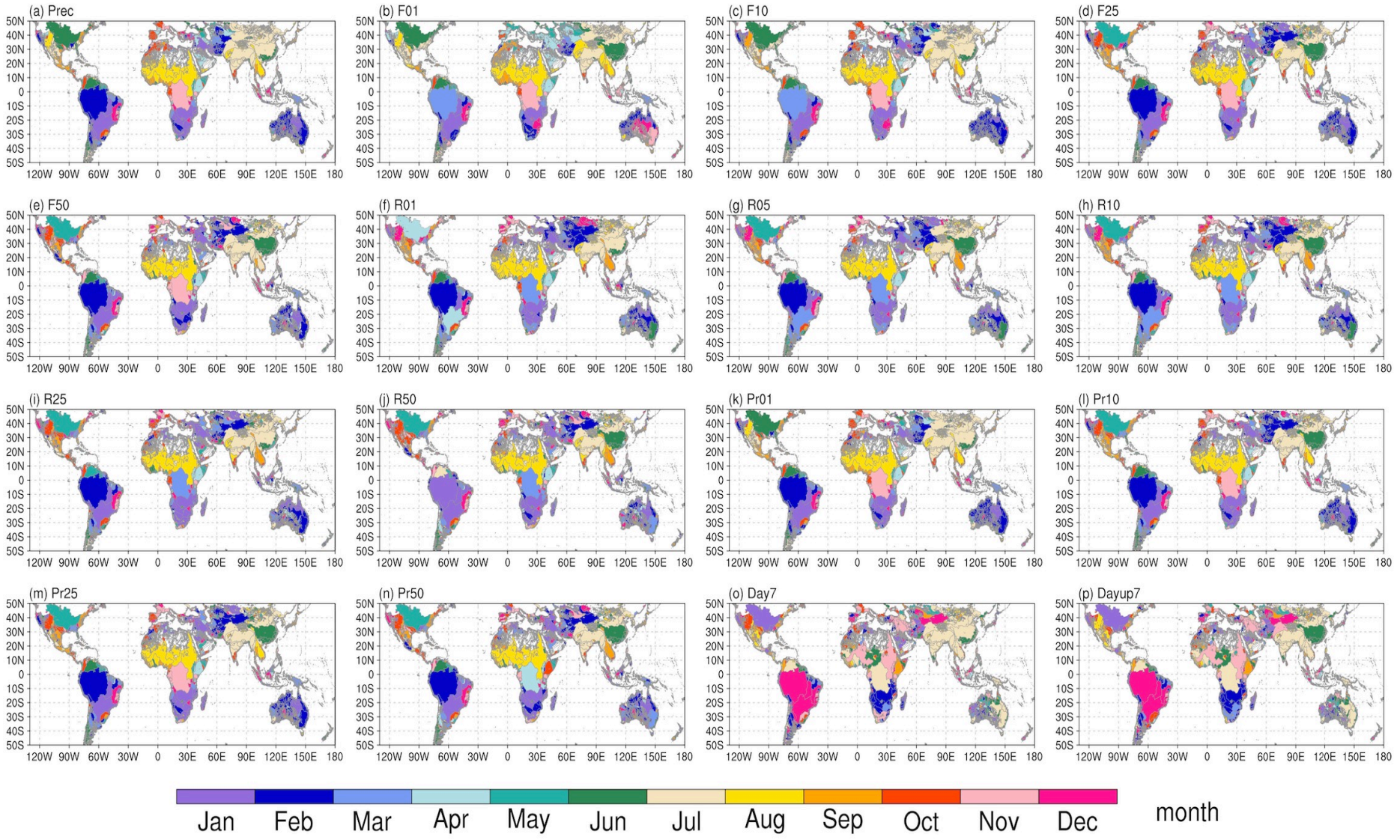
Peak months of flood indices

49,101 River Basins (Wu et al., 2011, 2012, WRR)



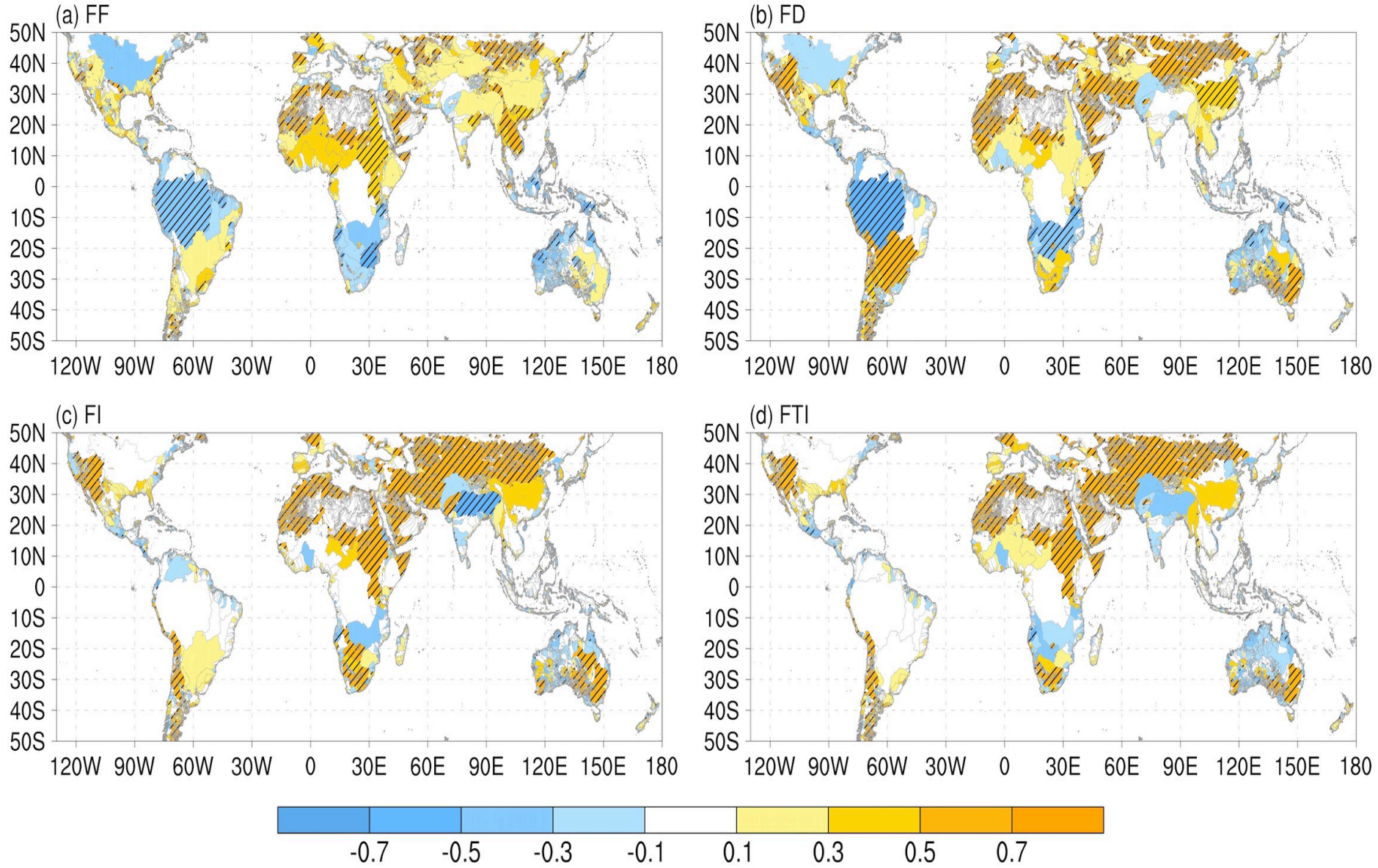
The most frequent flood month for a river basin might not necessarily be the month with those (most) intense flood events.

Peak months of precipitation indices



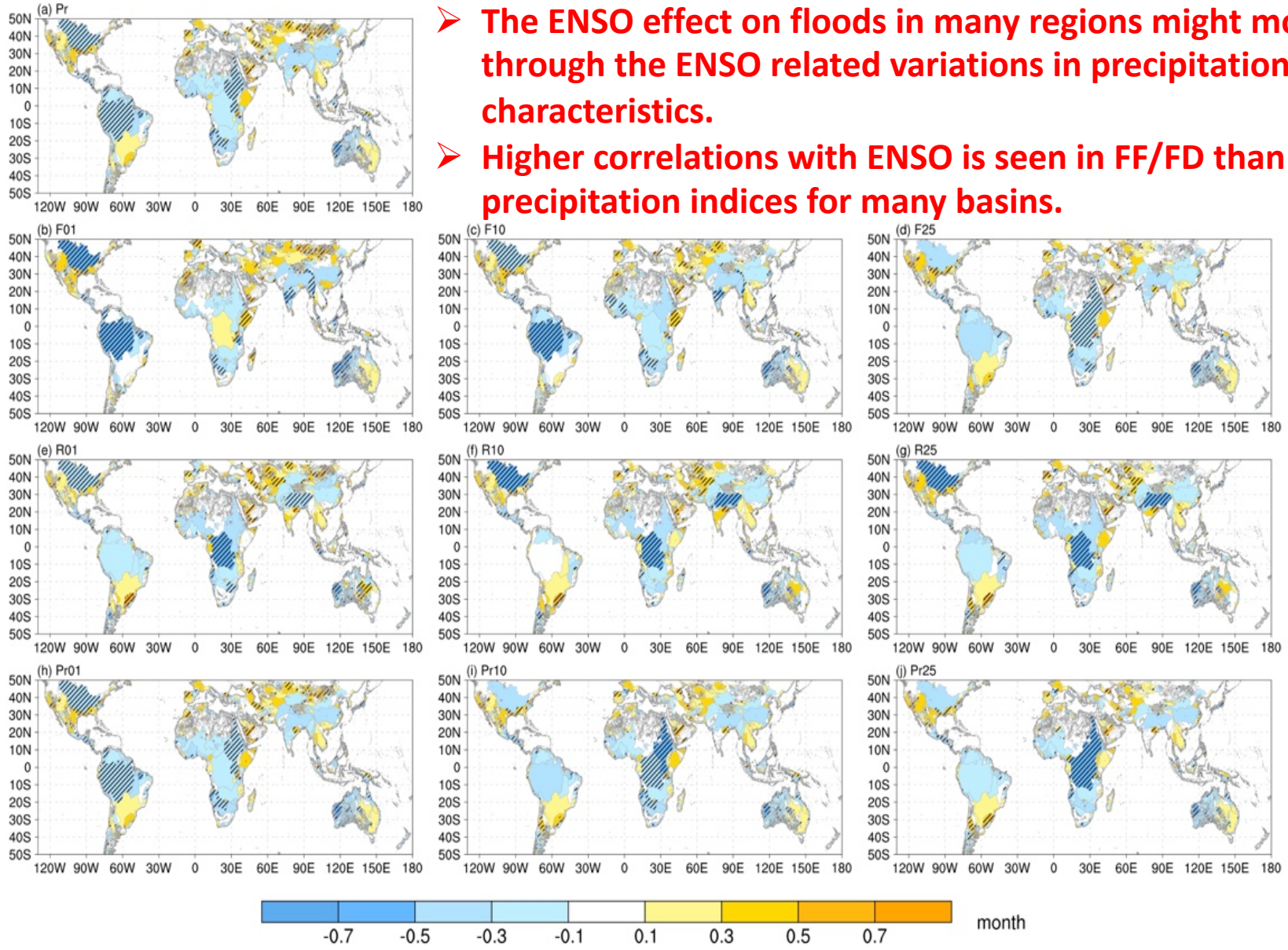
The existence of different effects on floods of these precipitation indices, representing various precipitation characteristics (Yan et al., 2020).

Simultaneous correlations between flood indices and Nino 3.4 in the respective peak months

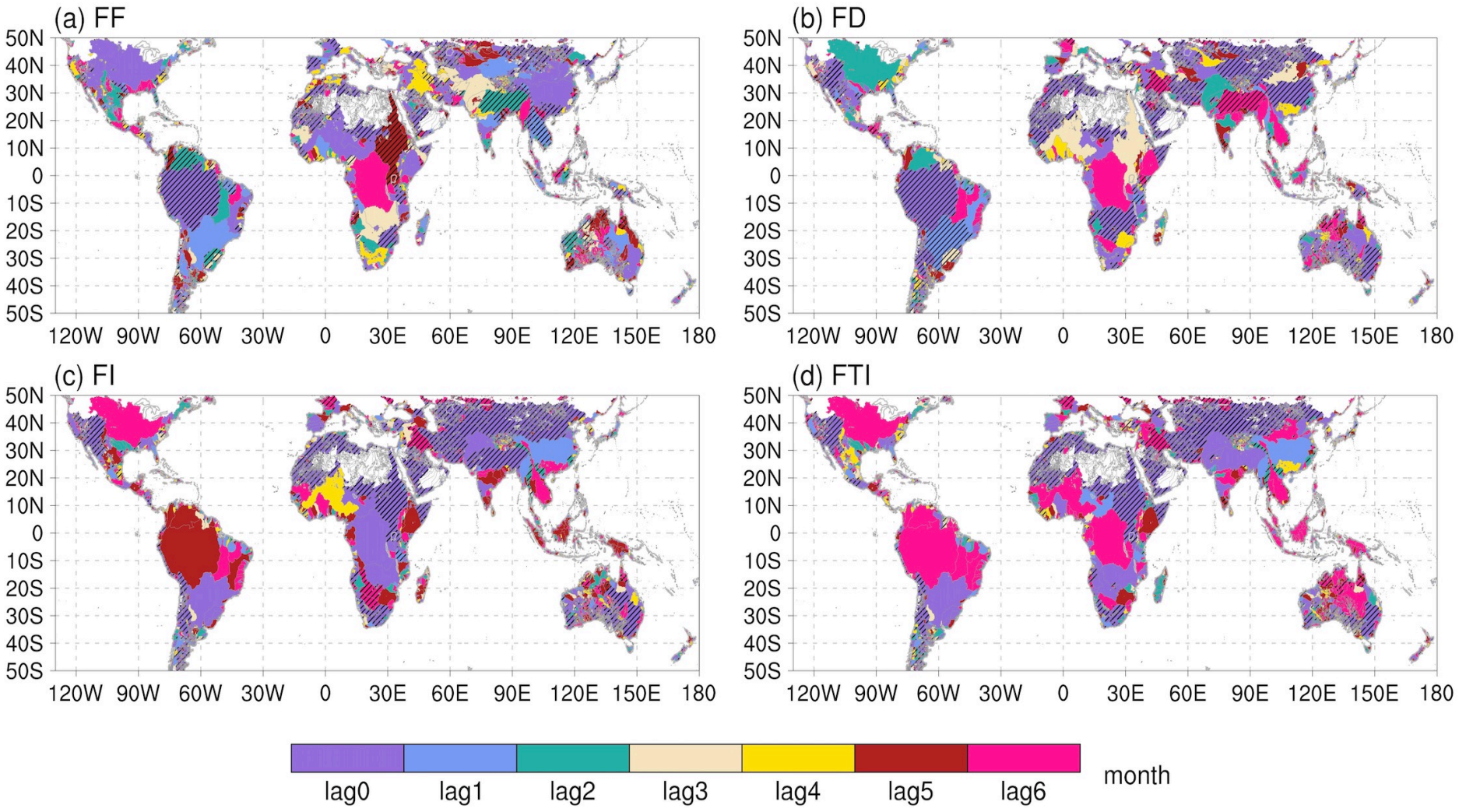


Simultaneous correlations between precipitation indices and Nino 3.4

- The ENSO effect on floods in many regions might mostly go through the ENSO related variations in precipitation characteristics.
- Higher correlations with ENSO is seen in FF/FD than in precipitation indices for many basins.

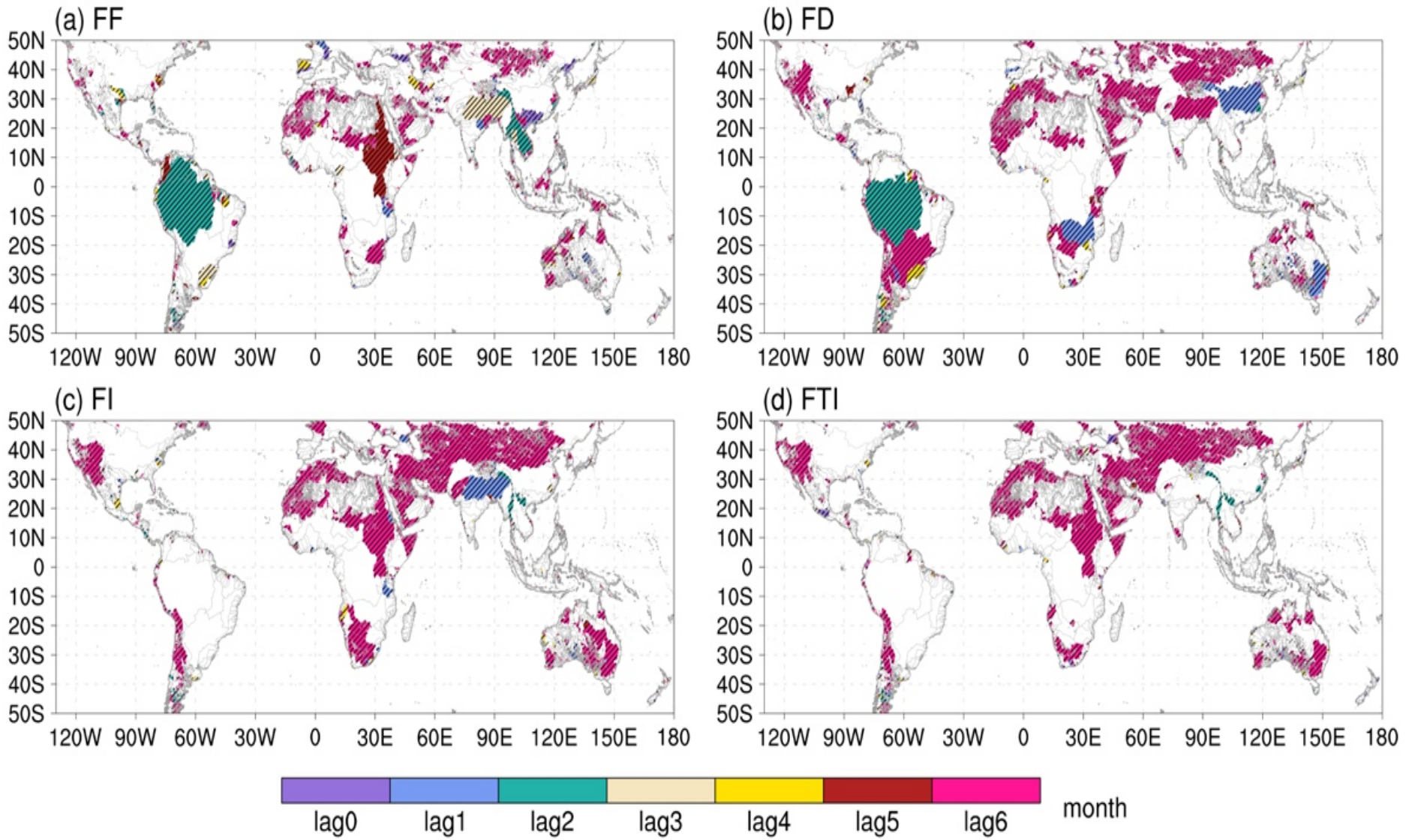


The Nino 3.4 leading-months with the highest correlations between Nino 3.4 and flood indices



Maximum correlations with Nino 3.4 leading Flood indices by one to five months appear in many river basins and can reach the 90% confidence level.

The maximum Nino3.4 leading months with significant correlations between Nino3.4 and Flood indices



Take home messages

- **Flood frequency (FF) and duration (FD) tend to be more related to daily precipitation frequency** globally especially to the mid-to-high-end daily frequencies (F10, F25, F50)**. Flood intensity (FI and FTI) tend to be more associated with daily precipitation volume corresponding to those extreme precipitation events (>Pr10)**, while with a weak relation to daily precipitation intensity except the very high end one (R50) .

- **Significant simultaneous correlations and ENSO-leading-floods relations** between flood indices and Nino 3.4 appear in many flood-prone river basins across the world.

- The ENSO impact on floods can sometimes be traced back to the modulation of various characteristics of precipitation events by ENSO, which **further confirms the ENSO-precipitation relations in these regions/river basins**.

- The ENSO-floods-relations especially the ENSO-leading-floods relations identified here for river basins/catchments of interest can greatly enhance our understanding of how floods may vary on the interannual time scale and can further be applied to **improve monthly-to-seasonal flood forecasting**.

References

Yan, Y., H. Wu*, G. Gu, Z. Huang, L. Alfieri, X. Li, N. Nanding, X. Pan, and Q. Tang, 2020: Climatology and Interannual Variability of Floods during the TRMM Era (1998–2013). J. Climate, 33, 3289–3305, https://doi.org/10.1175/JCLI-D-19-0415.1

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Wu, H., R. F. Adler, Y. Tian, G. J. Huffman, H. Li, and J. Wang (2014), Real-time global flood estimation using satellite-based precipitation and a coupled land surface and routing model, Water Resour. Res., 50, 2693–2717, doi:10.1002/2013WR014710.

Thanks!

HENG
Hydrometeorological Extremes simulatioN Group