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Process-based Evaluation Strategy for Satellite Precipitation Product

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Object Oriented Validation Strategy

1. Inter-comparison of Multiple Products in Various Scale [FY2013]

2. Decomposition of Precipitation Based on Mechanisms [FY2014]

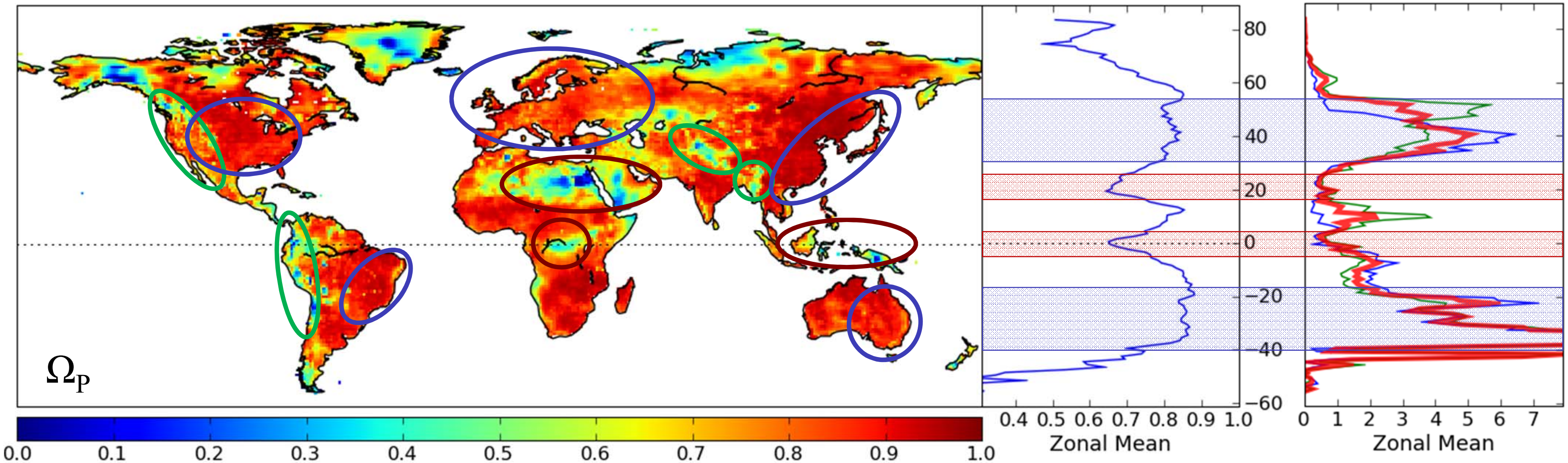
Extratropical Cyclone (Center, Front)	Baiu	Tropical Cyclone	Development of Objective Detection Algorithm
JMA Weather Chart		Best Track	Generation of Validation Data

3. Component-wise Evaluation [FY2015]

Compare with In-situ Measurements ◀ Decomposed Precipitation (E.C. | B | T.C.) ▶ Land Surface Model

Downscaled RA (R | T | Q | W | P) → Land Surface Model ▶ Validate with In-situ Measurements and GRACE

Similarity between Ensemble Precipitation Forcing

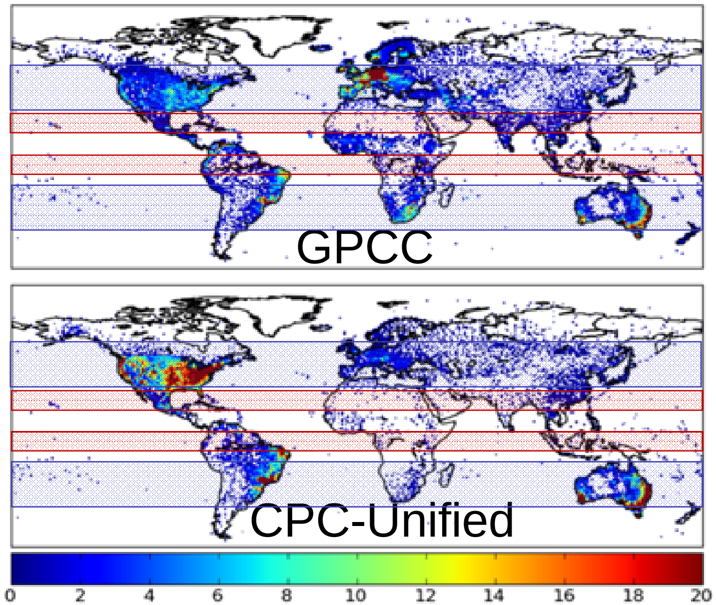


1. Non-uniform Rain Gauge Distributions

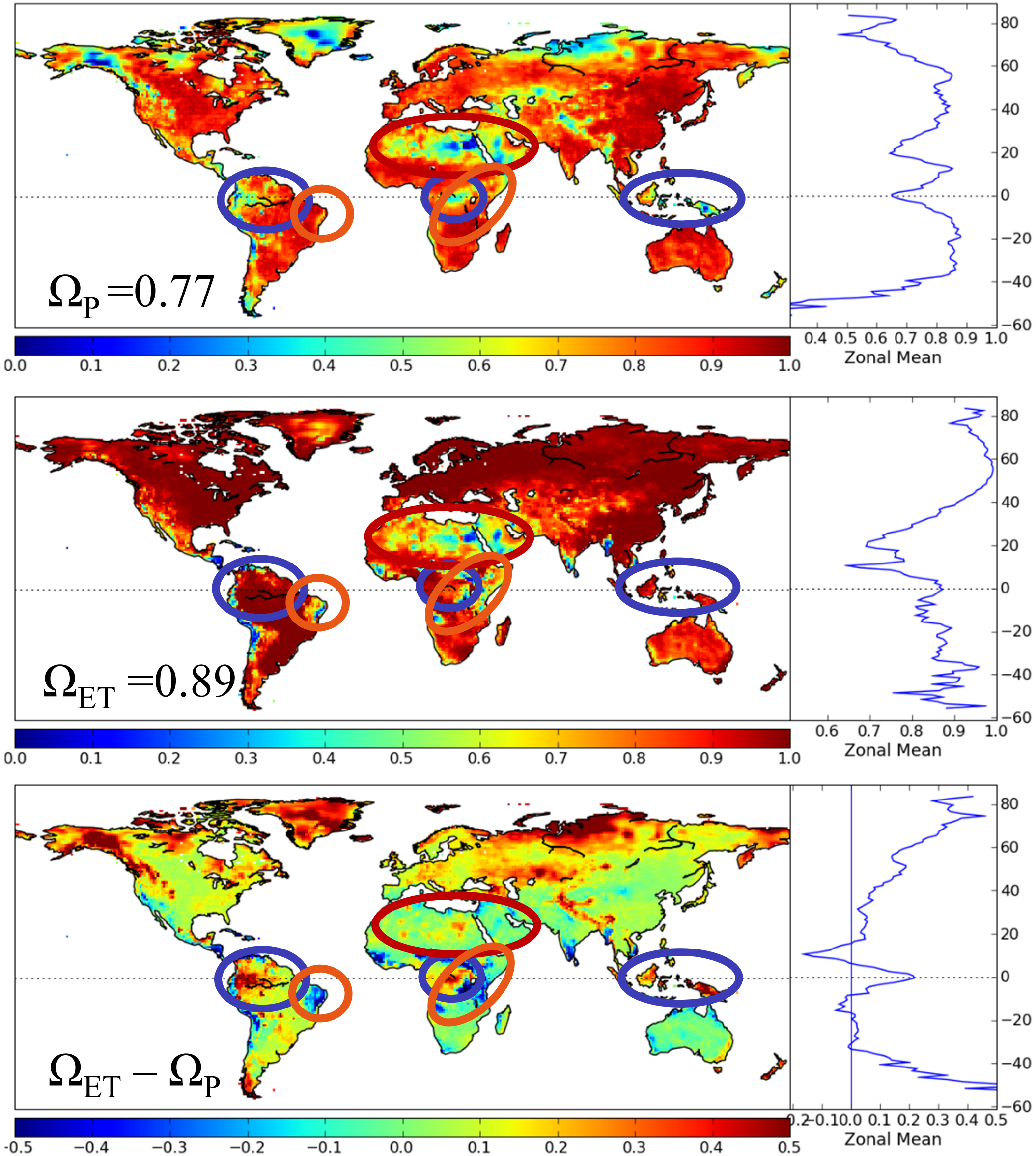
Minimum rain gauge density is required to prevent the effect of poor forcing precipitation [*Oki et al., 1999*]

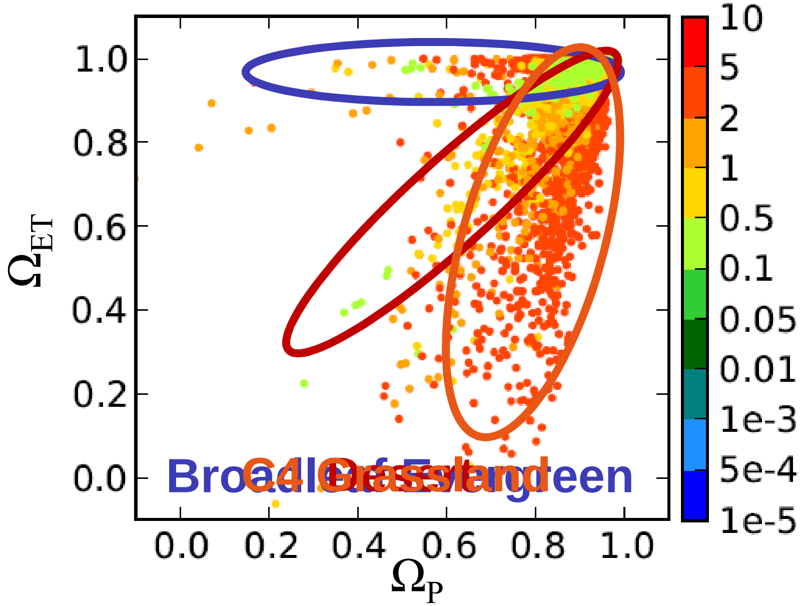
2. Different Methodologies

Effects of spatial resolutions, measurement types, and interpolation schemes are emphasized in complex terrain.



Similarity between Simulated Evapotranspiration Ensemble





<u>Wet region</u> (*Energy constrained*)

Ω_{ET} is ***insensitive*** to Ω_P

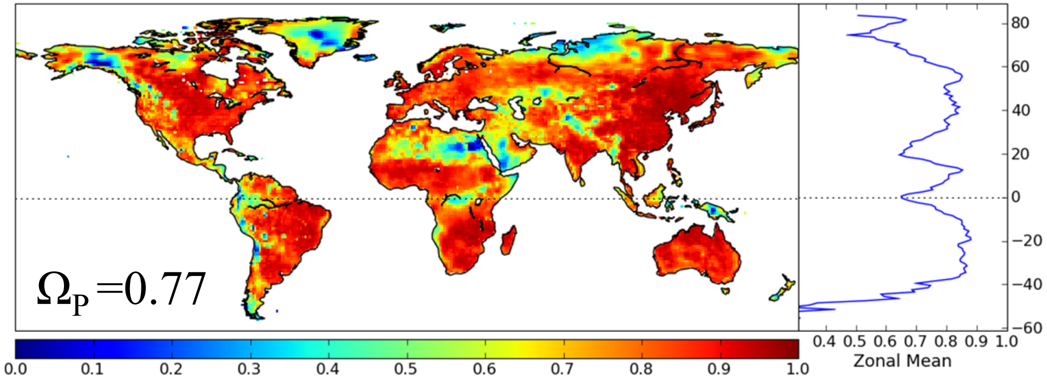
<u>Dry region</u> (*Water constrained*)

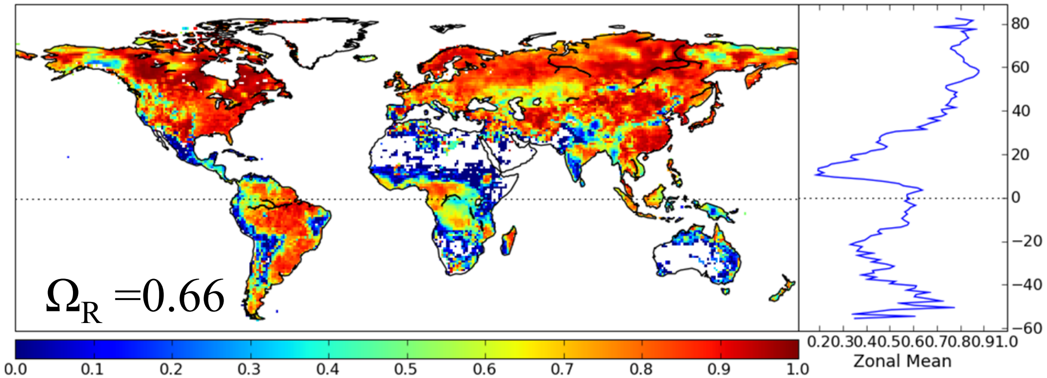
Ω_{ET} is ***proportional*** to Ω_P

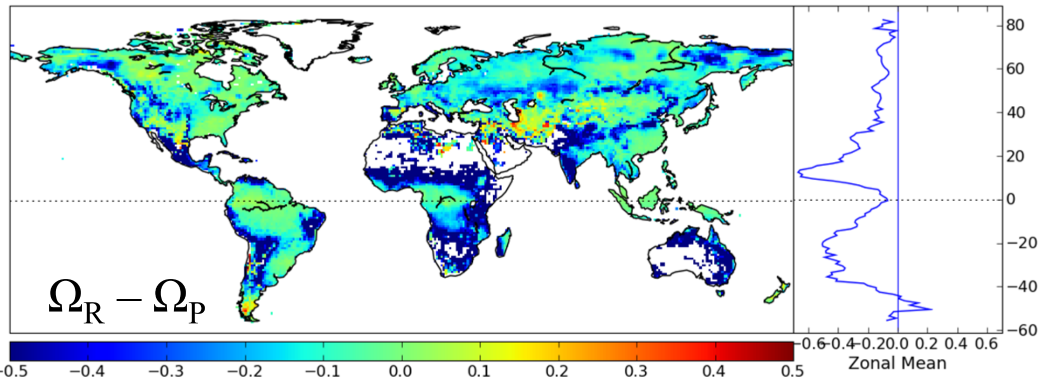
<u>Semi-arid region</u>

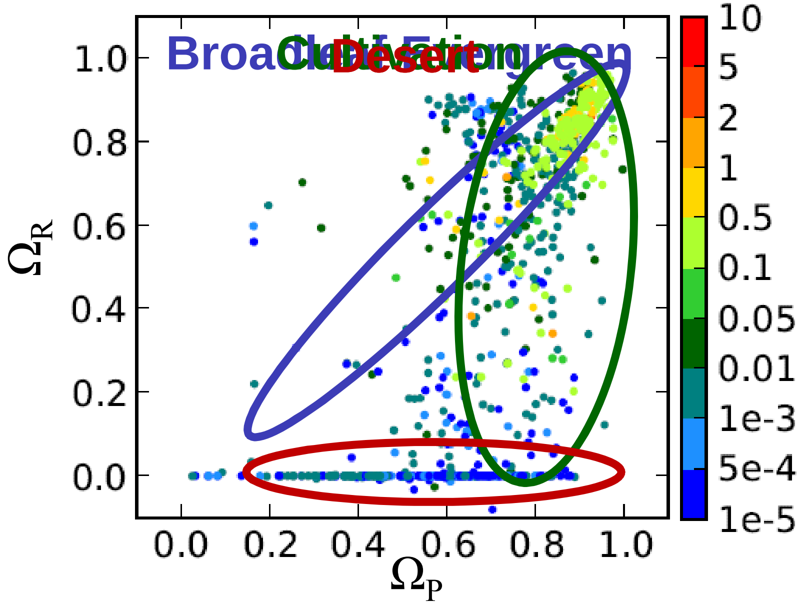
Ω_{ET} is ***sensitive*** to Ω_P

Similarity between Simulated Runoff Ensemble









Wet region (*High soil moist.*)

Ω_R is ***proportional*** to Ω_P

Very dry region (*Low soil moist.*)

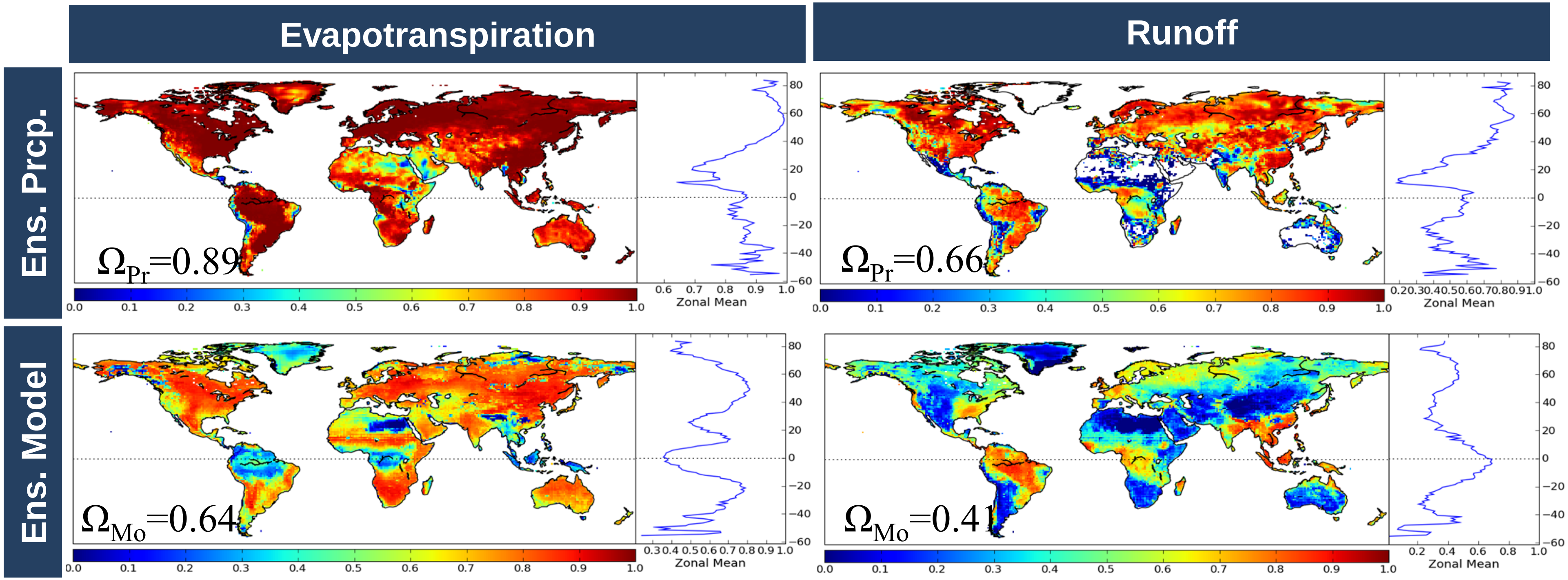
Ω_R is ***insensitive*** to Ω_P

Moderate region

Ω_R is ***very sensitive*** to Ω_P

Similarity in Simulations between Ensemble Precipitations and Models

Uncertainty from Different Sources

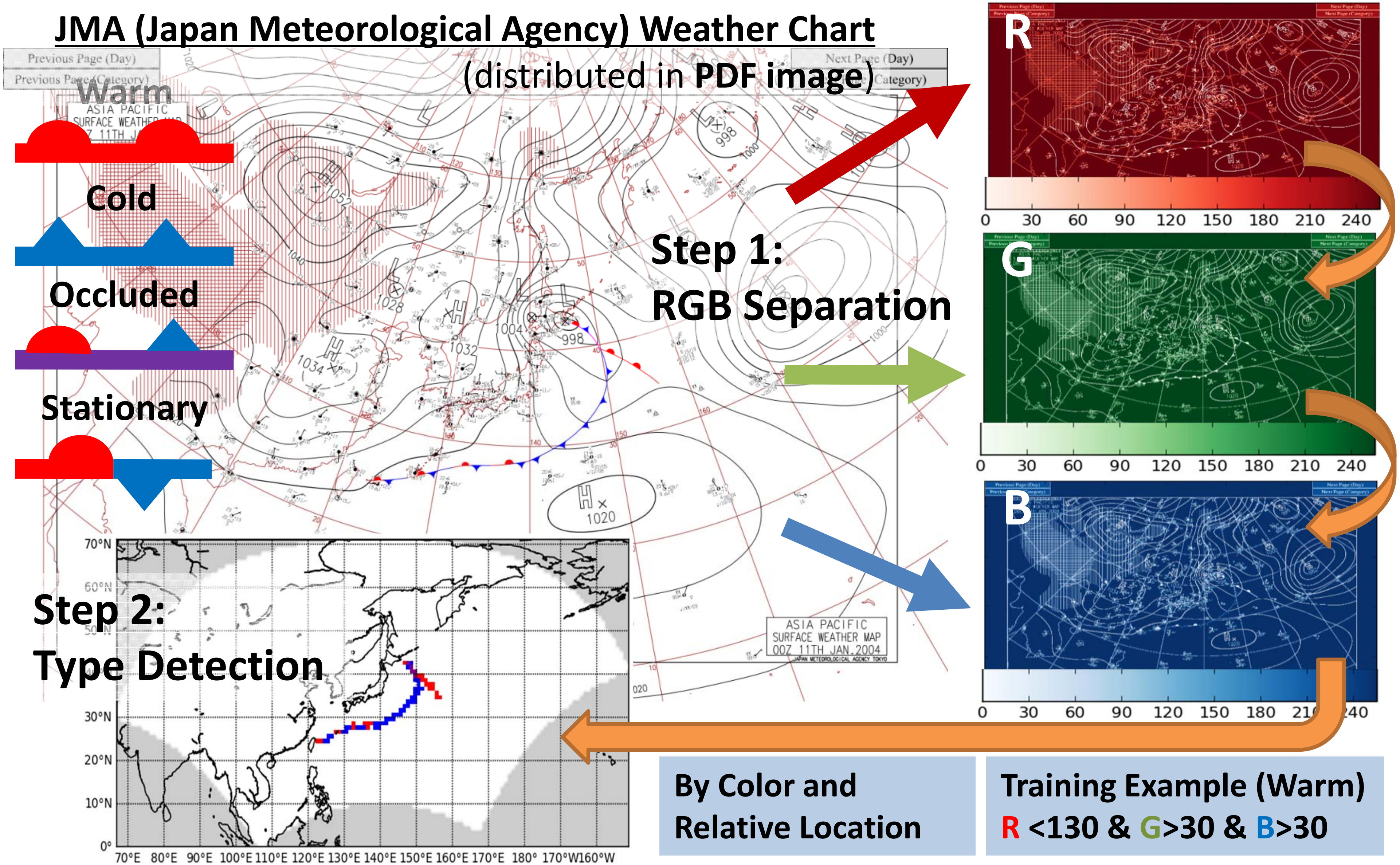


Uncertainty in simulated evapotranspiration and runoff introduced by **different land surface schemes** in GSWP2 are **larger than** **precipitation uncertainty-induced** uncertainty by 28% and 40% in the similarity index (Ω) globally.

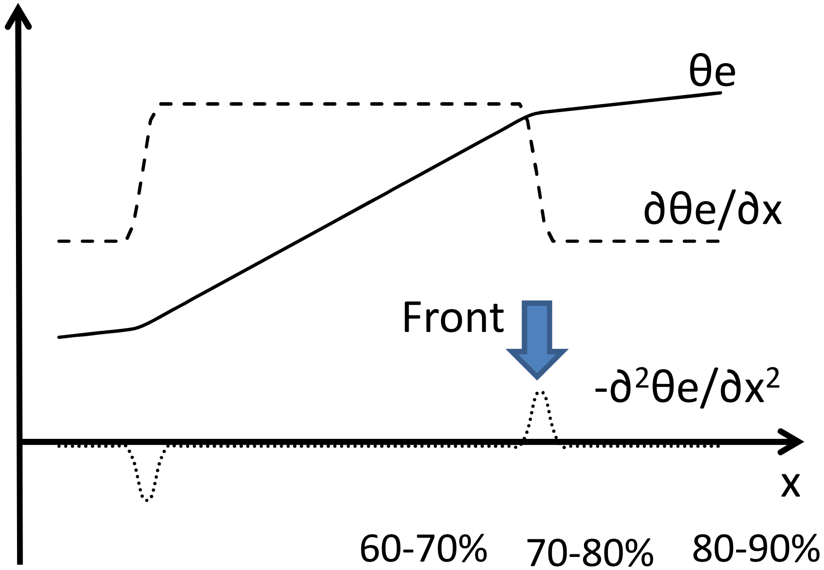
Precipitation uncertainties propagation have similar zonal profile, but uncertainties induced by model physics shows different patterns.

Extract atmospheric fronts from weather chart

Methods



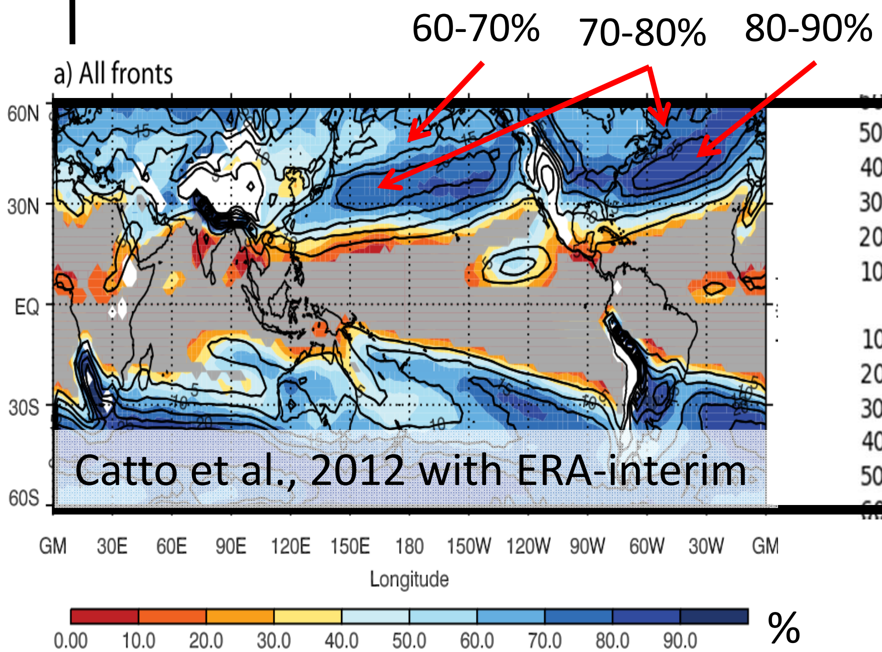
Objective detection method for fronts

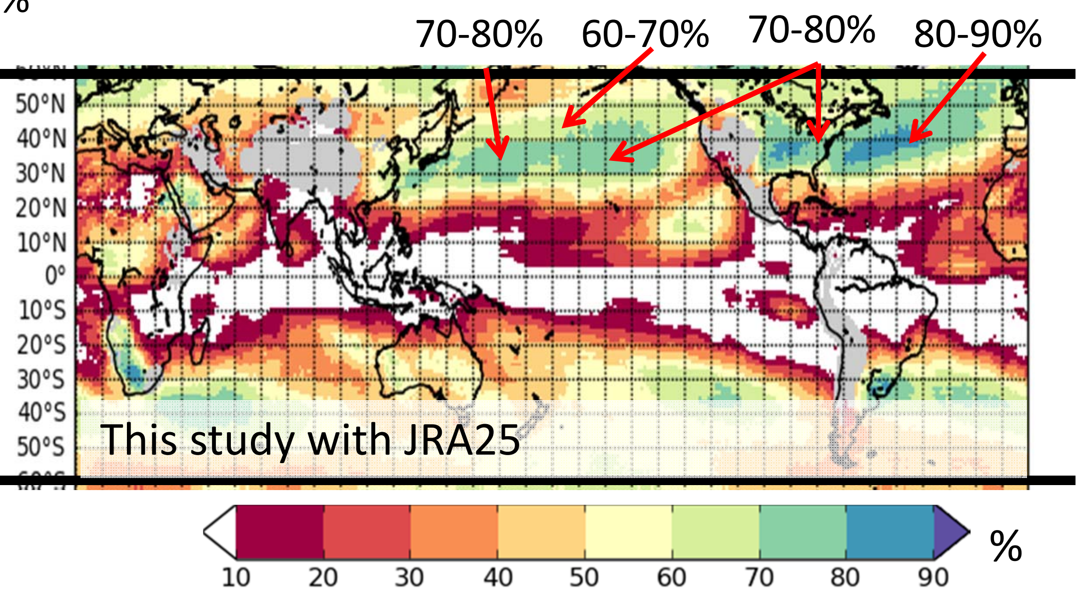


- Fronts are detected based on equivalent potential temperature (θ_e) field.
- The method is applied to the reanalysis dataset

Hewson (1998)

Front is detected at the higher θe end of the θe gradient zone





Proportion to annual precipitation (GPCP-1DD)

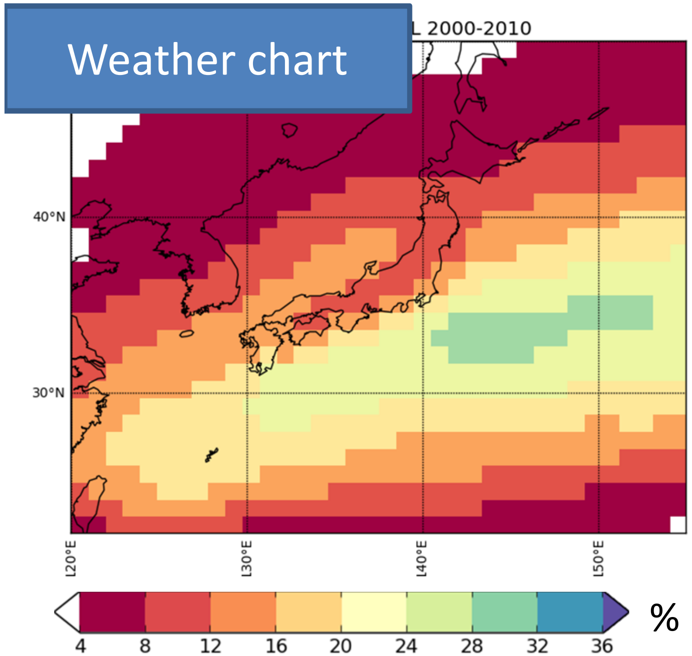
Validation of objectively detected fronts

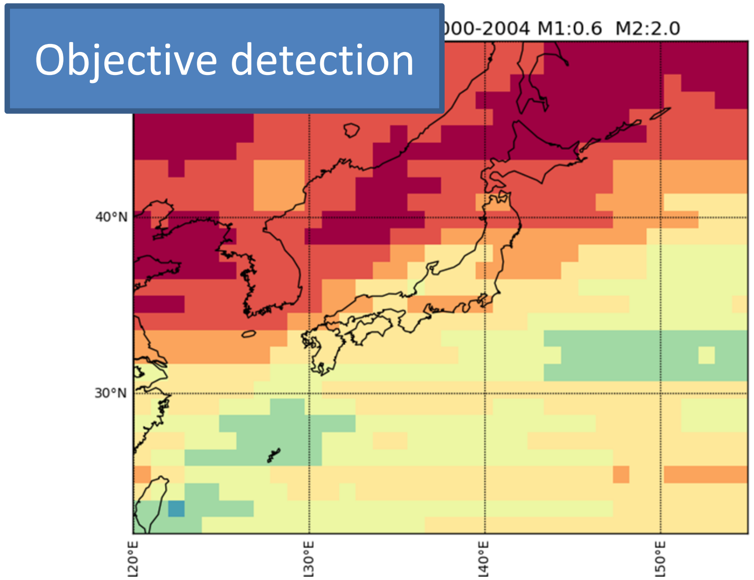
Application

Objective detection of fronts:
Method to detect fronts from the gridded atmospheric field (e.g. GCM output, Reanalysis data)

Previous studies for objective front detection tried to validate the detected fronts manually using daily weather chart.
(Hewson, 1998; McCann and Whistler, 2001; Berry et al.,2011) → **The new dataset make it possible to validate the climatology of objectively detected fronts.**

Existence probability of fronts (%)

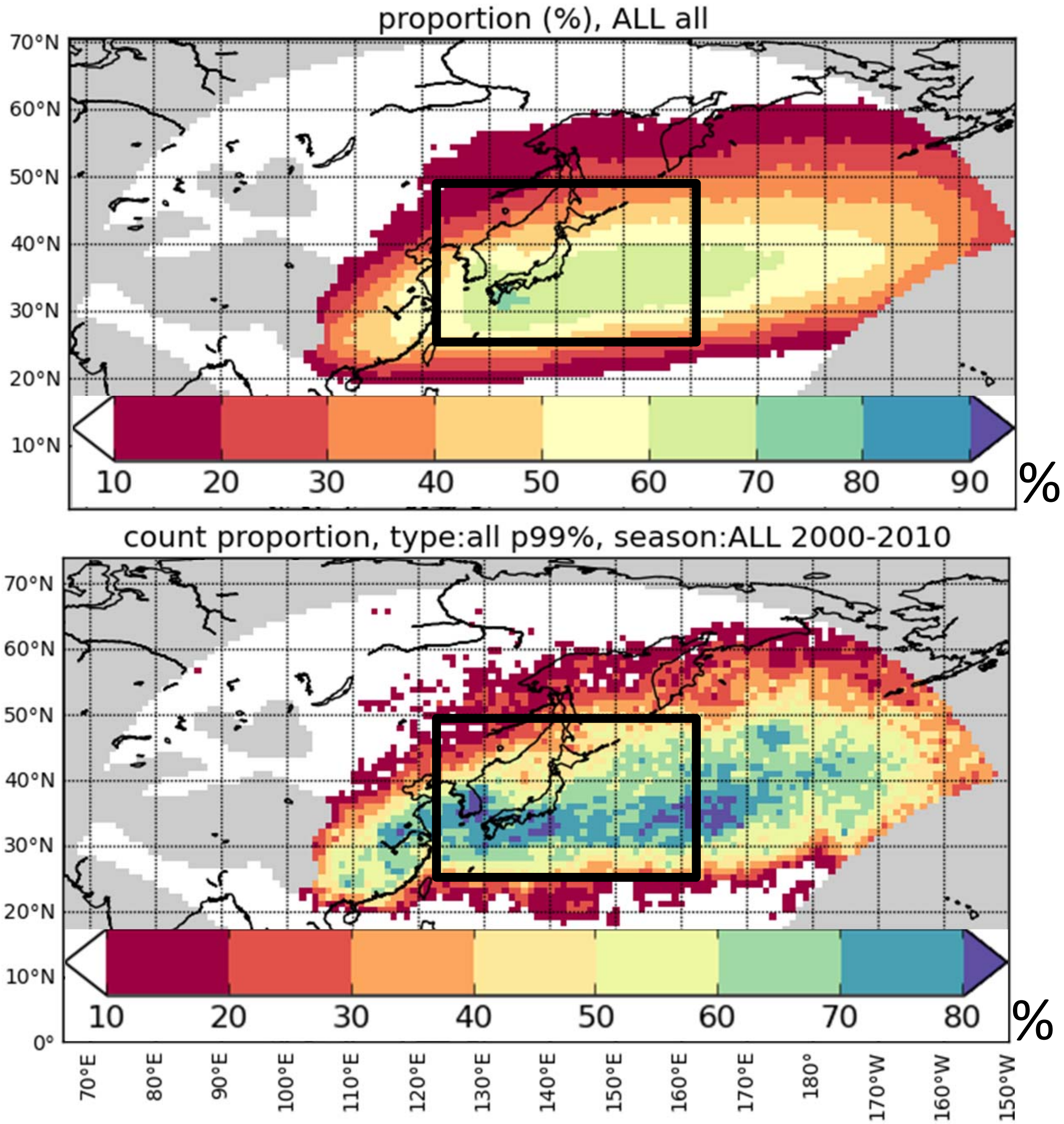




Detection method: Hewson 1998

Climatology of frontal precipitation

Application



Precipitation product: GPCP-1DD
Precipitation within 500km from front was considered

Ex1:
Proportion of frontal precipitation to total annual precipitation.

Ex2:
Proportion of the number of frontal events to extreme precipitation events.

Extreme precipitation:
99th percentile daily precipitation

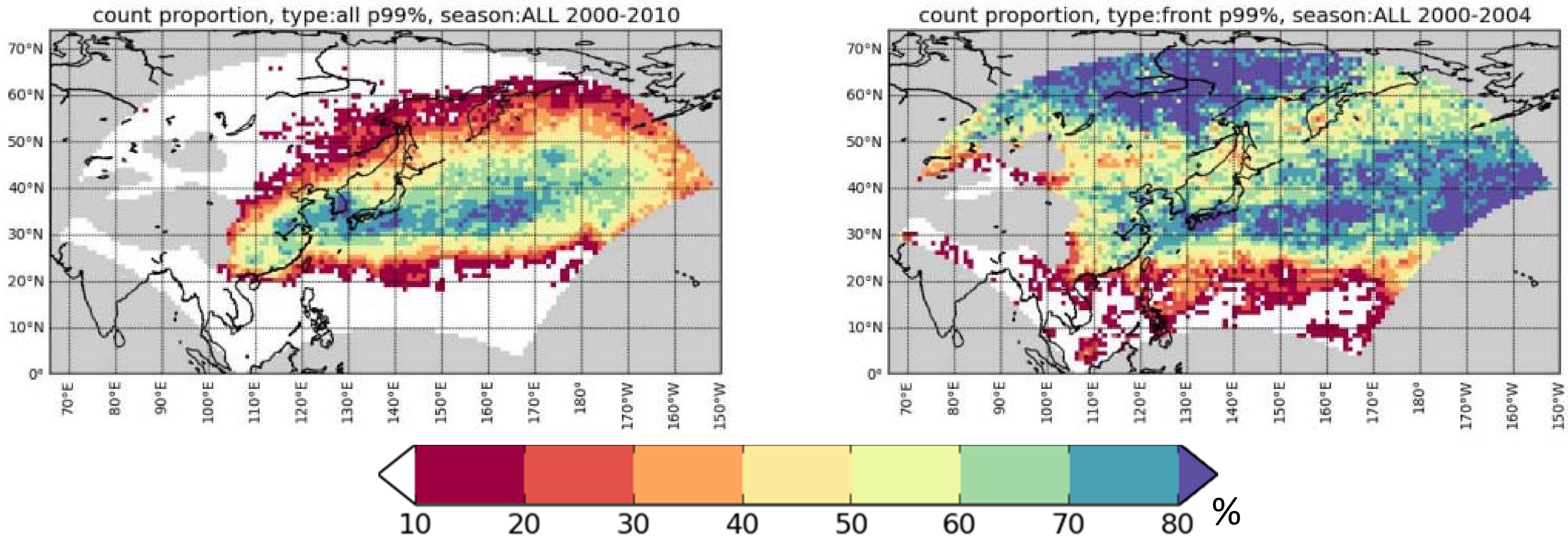
Relative Frequency of Extreme Precipitation Event

Method

Relative frequency of
extreme precipitation event associated with fronts
to the total extreme precipitation event

JMA chart front

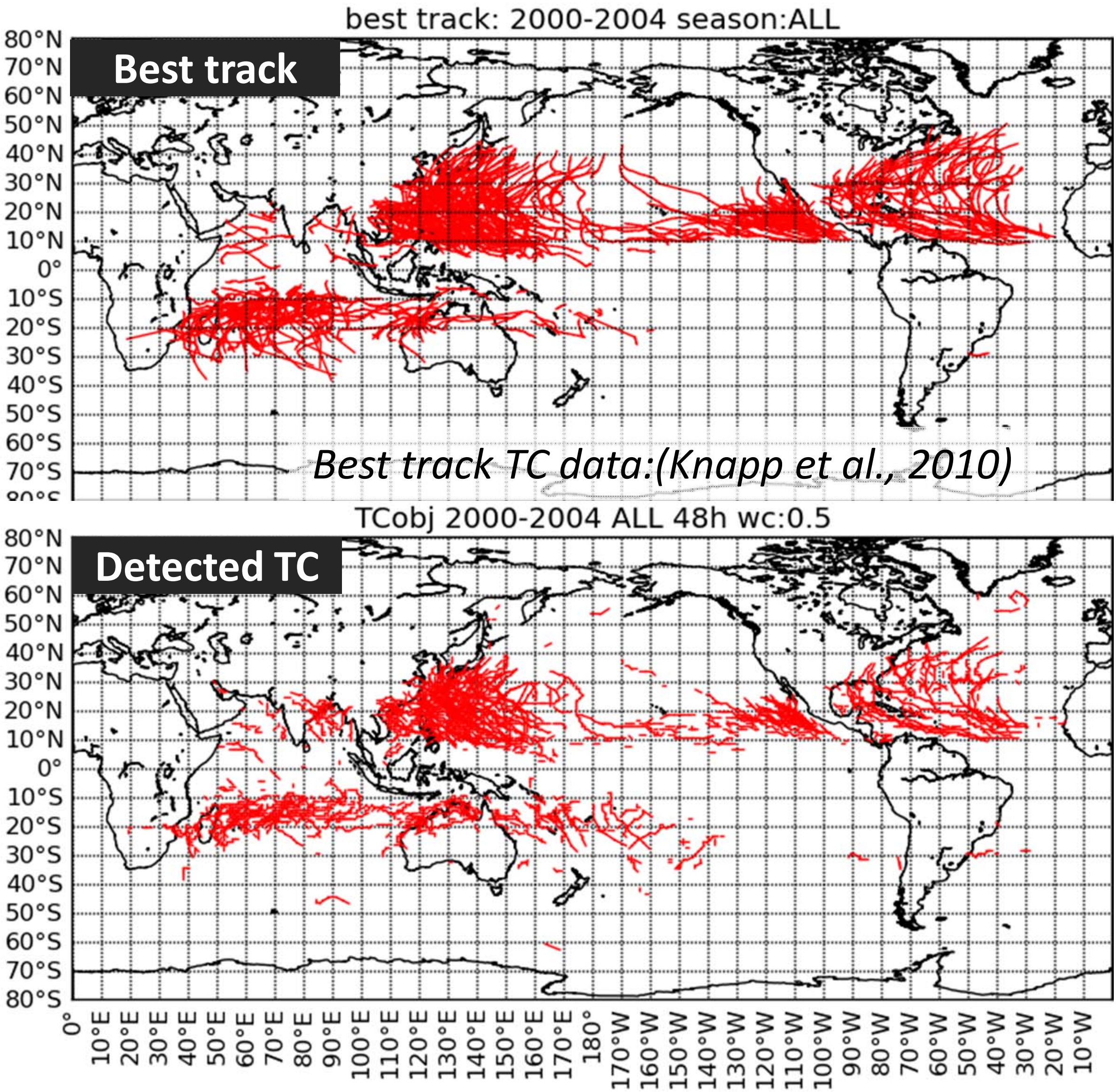
Objective front (ALL)



Extreme precipitation event:
Days with 99th % or higher daily precipitation.

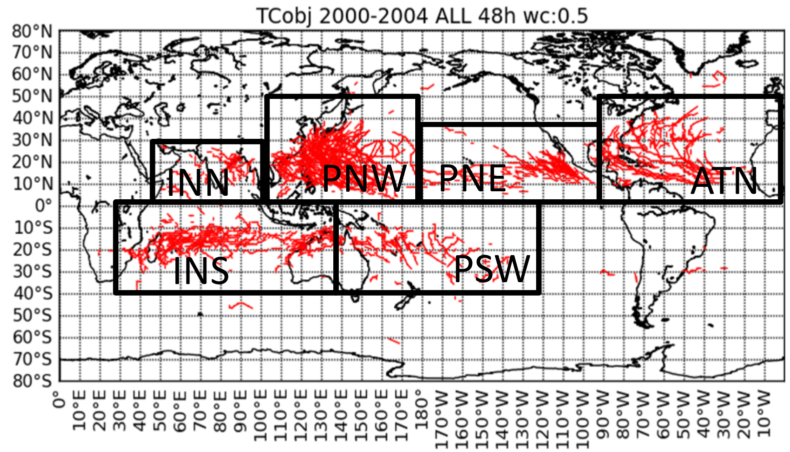
Detection of tropical cyclones

Method

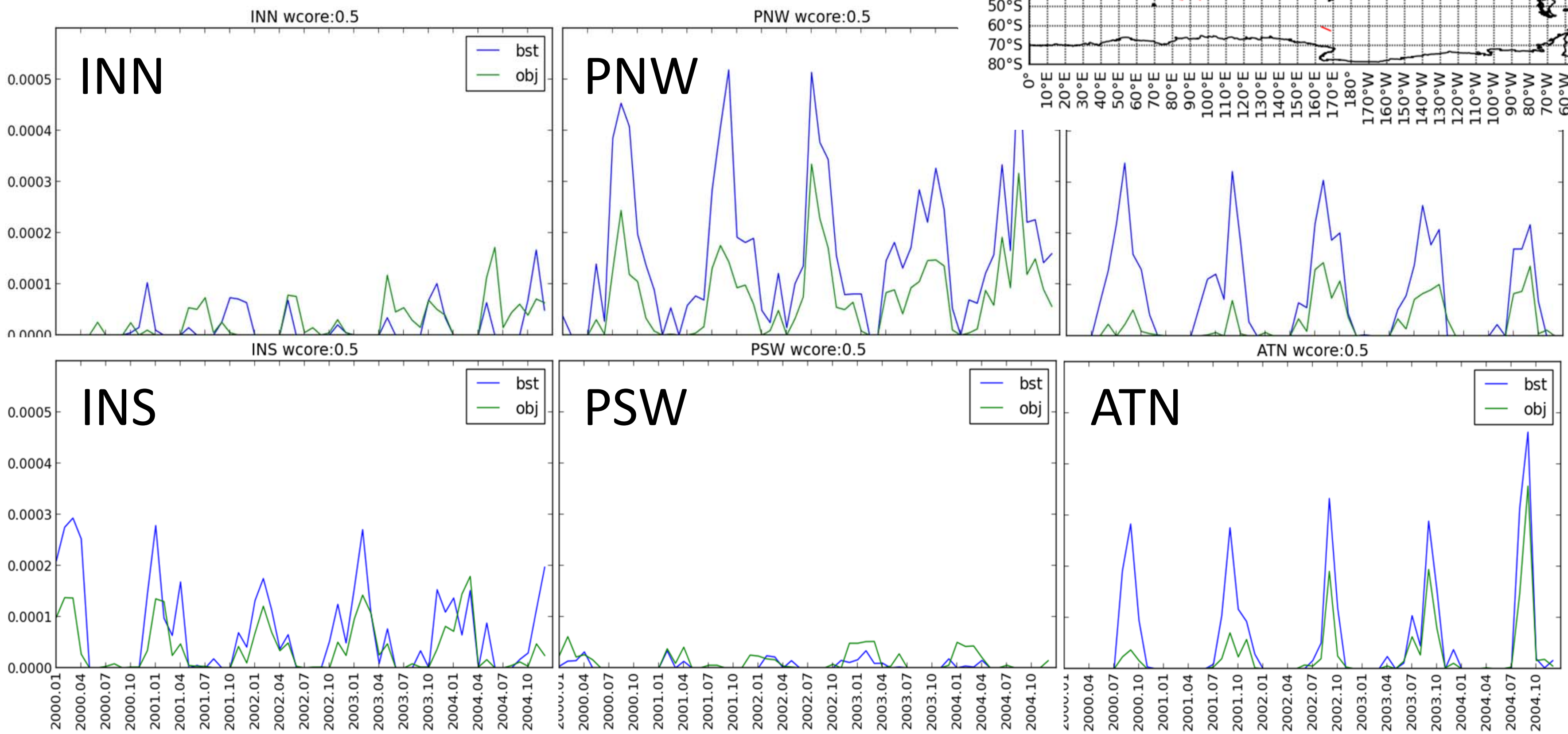


This study
Surface pressure: ~1.125deg Other variables: 2.5deg All variables were intepolated to 1.0deg
Local minimum of surface pressure
relative vorticity @850hPa exceeds 3.5x10−5(s−1)
"maximum" wind speed @850hPa >= 15(m s−1)
"mean" wind speed at 850hPa >"mean" wind speed at 250hPa
Sum of dT (=center grid temperature − mean surrounding temperature) at 250hPa, 500hPa, 850hPa > 0.5K
>=48
TC genesis latitude is between 35S and 35N

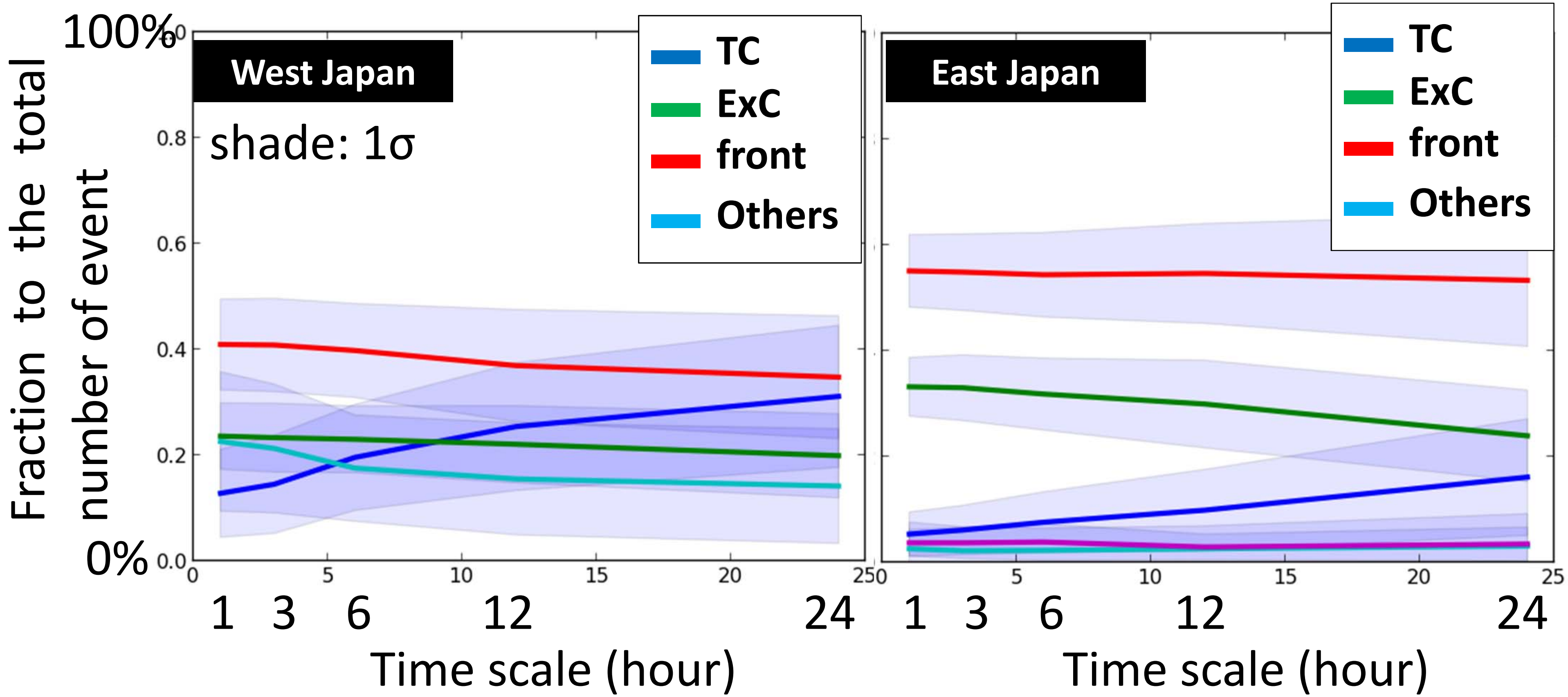
Frequency of Tropical Cyclones in Each Basins



— Best Track — Detected



Relative Contributions to Extreme Precipitation

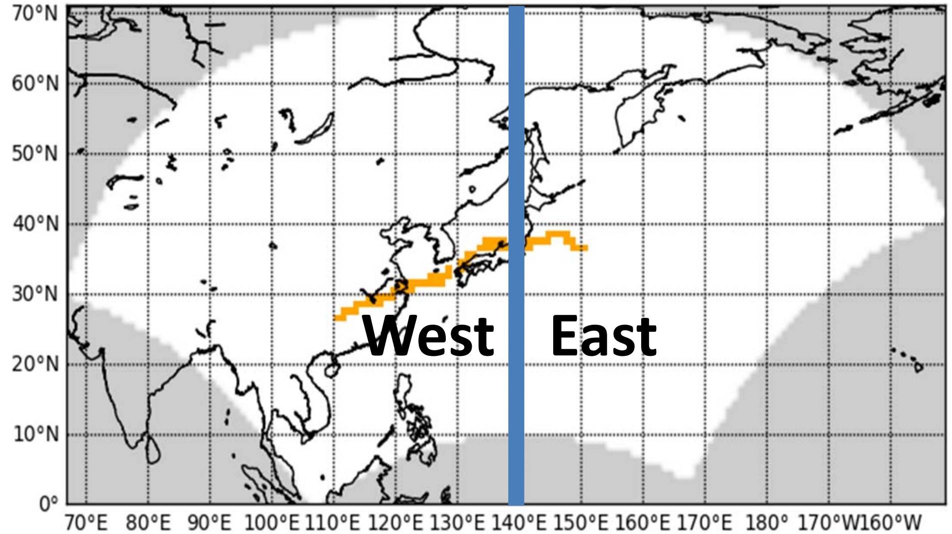


TC: Larger impact in the longer timescales

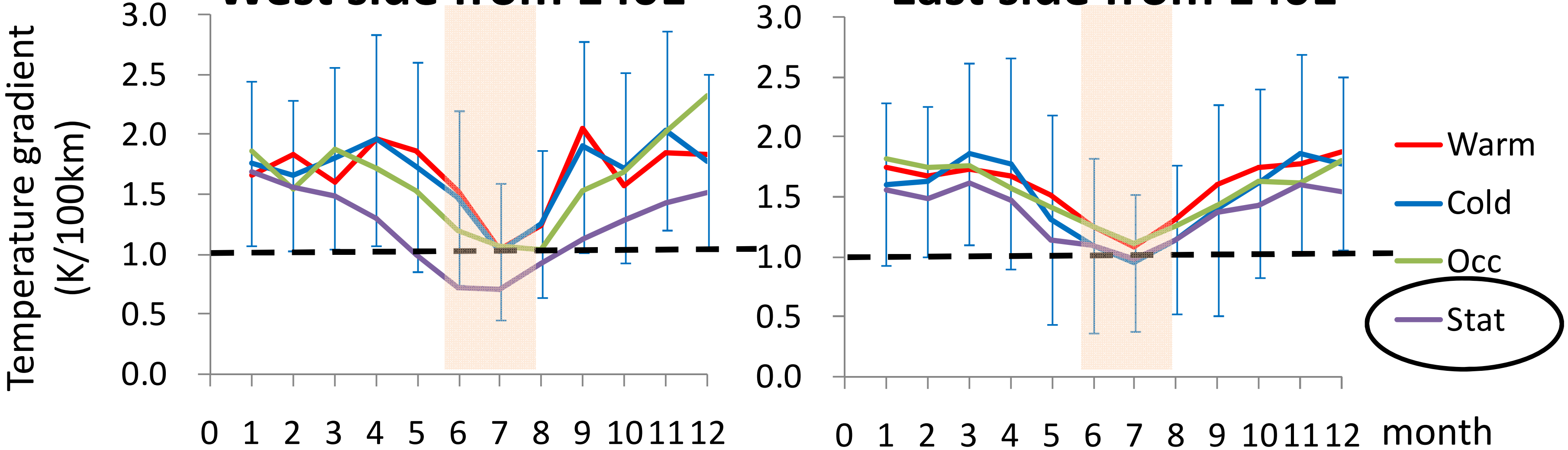
ExC + Front: Dominant causal system around Japan

Temperature gradient at the Baiu front zone

Previous case (Ding and Chan, 2005) studies pointed out that the temperature gradient around the Baiu front zone is:
Weak @Western section of Baiu front
Strong @Eastern section of Baiu front



West side from 140E **East side from 140E**



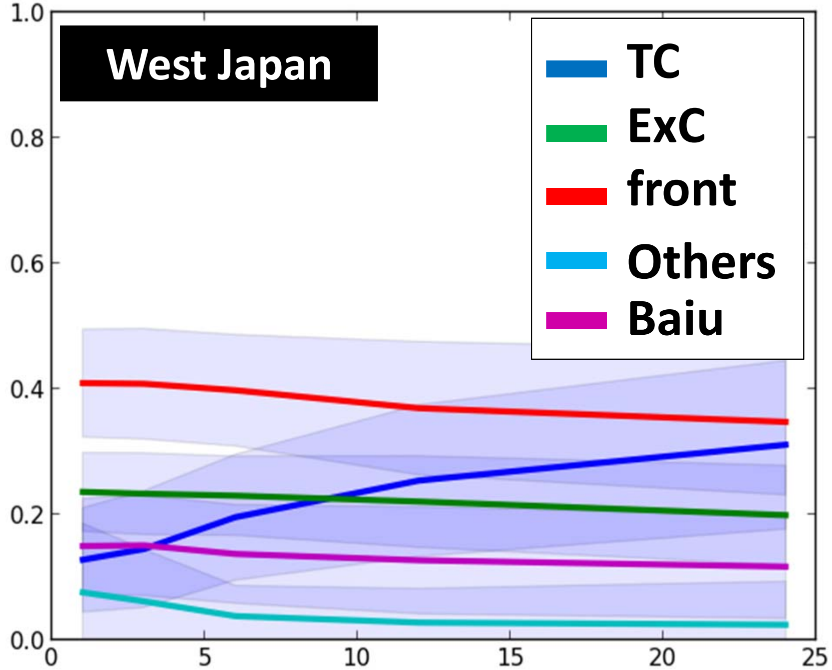
Weaker gradient !! **Stronger gradient!!**

- Baiu front is one of the measure cause of the water disasters in Japan, especially in **western region**.
- Baiu front has different characteristics from usual fronts

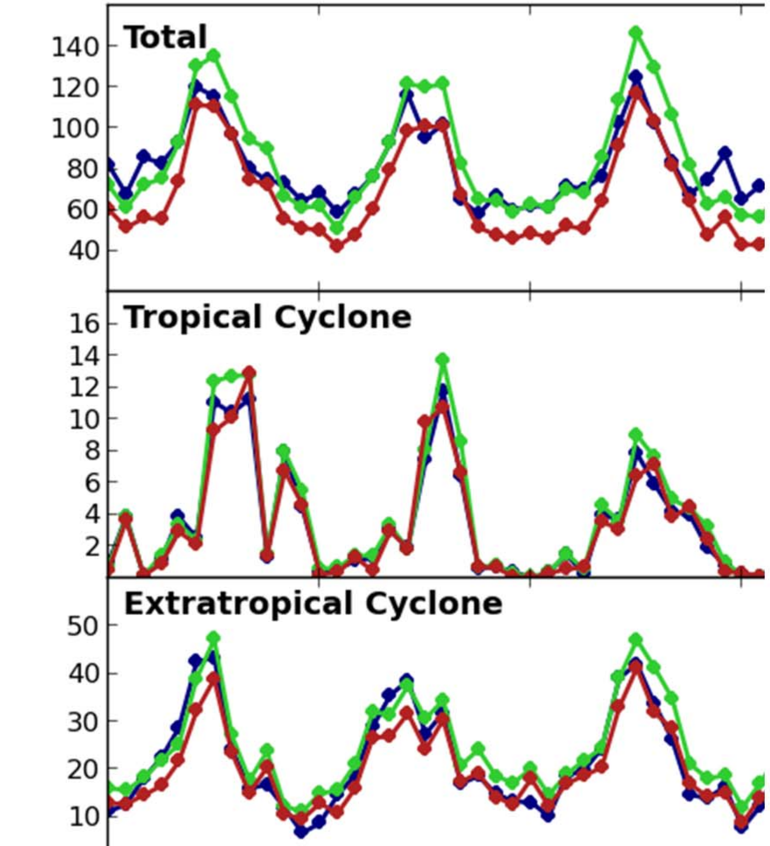
  →*Small temperature gradient & large moisture gradient*
- Baiu front is included in “others”, not in “front”

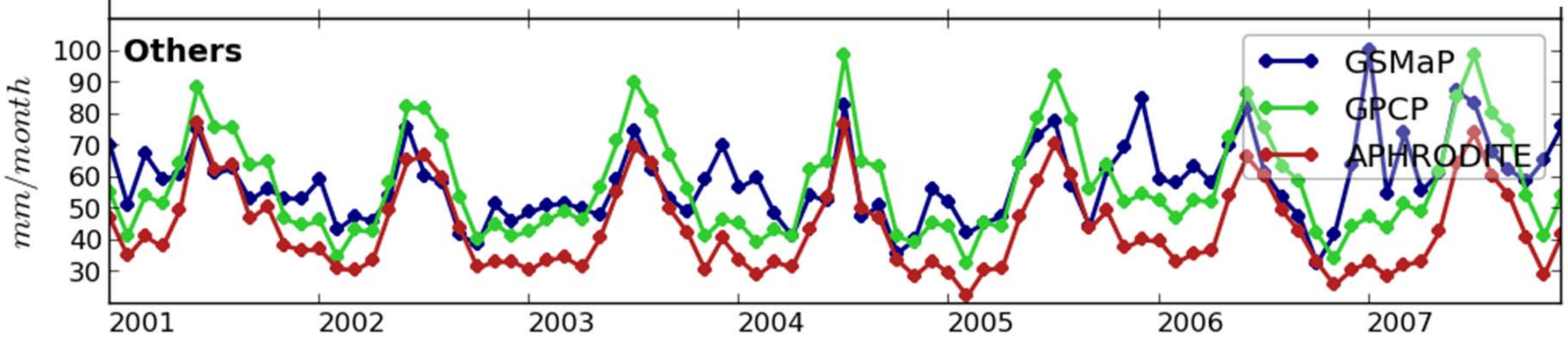
If front like structure with large moisture gradient (and small temperature gradient) is regarded as Baiu front..

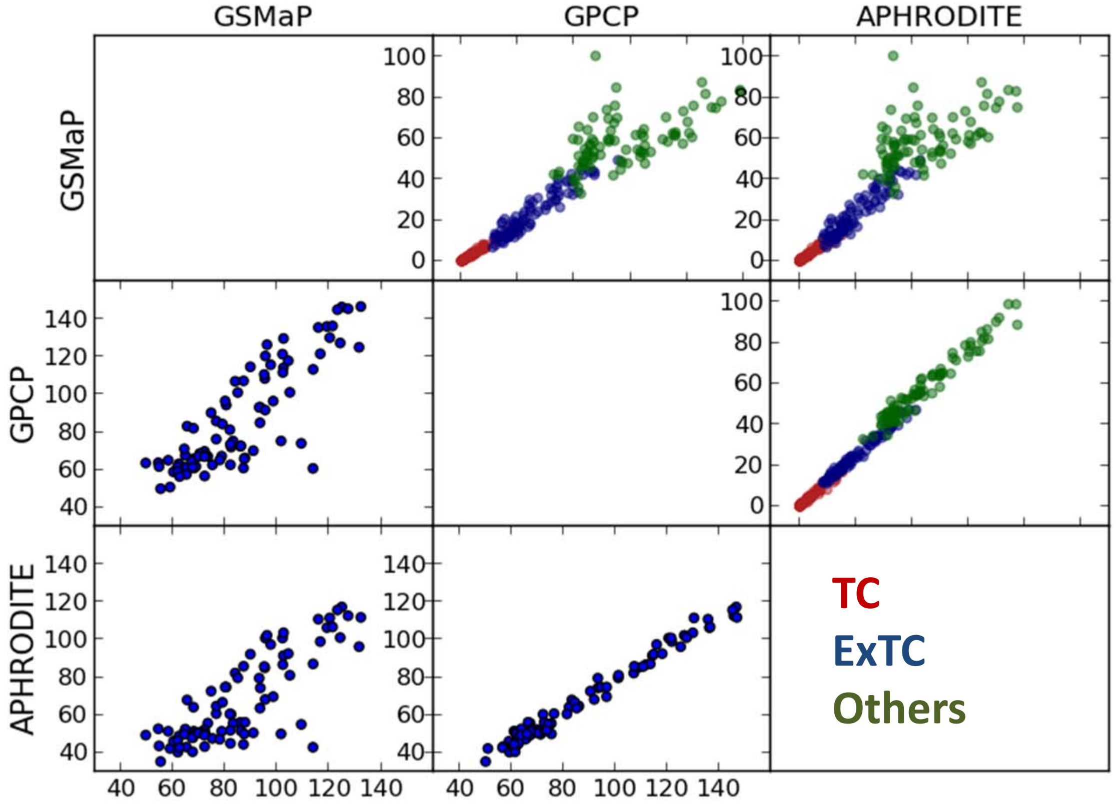
Baiu front contributes ~15% of the extreme events

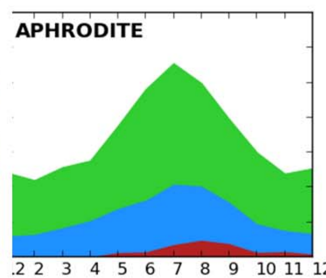


Comparisons of Relative Contributions









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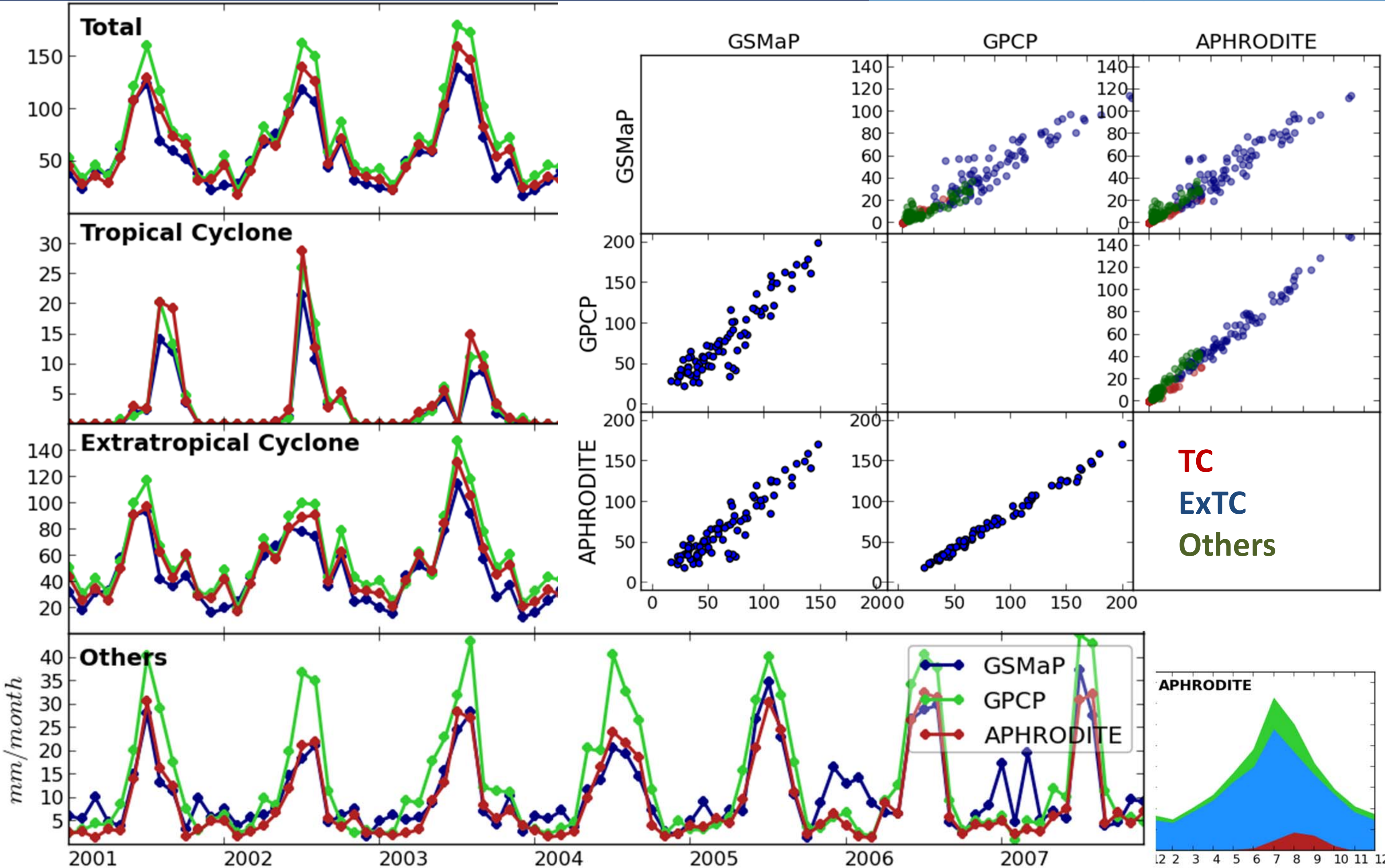
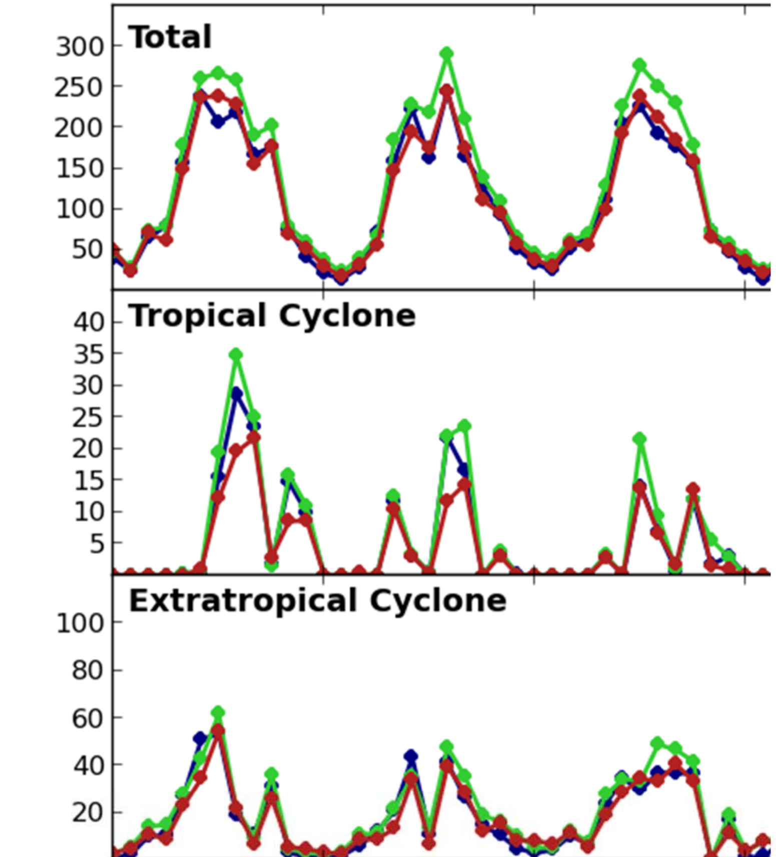
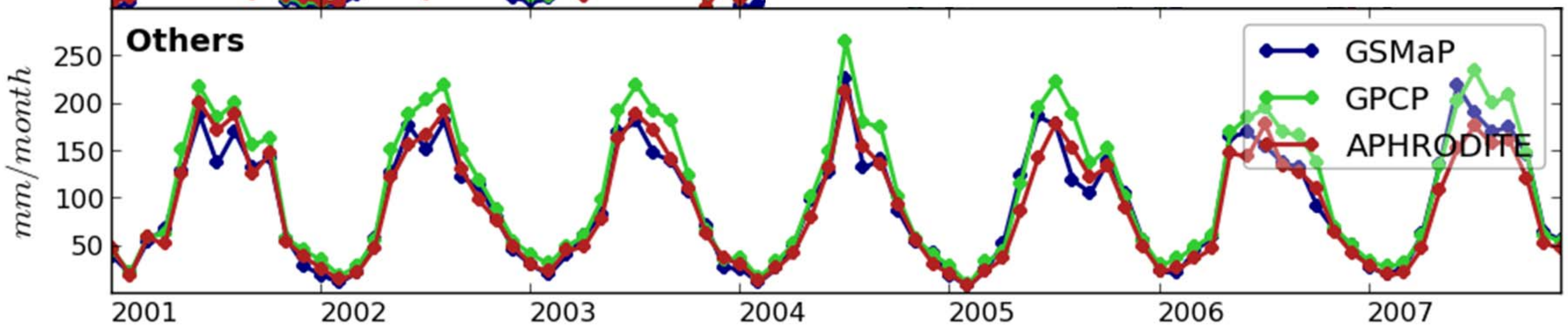
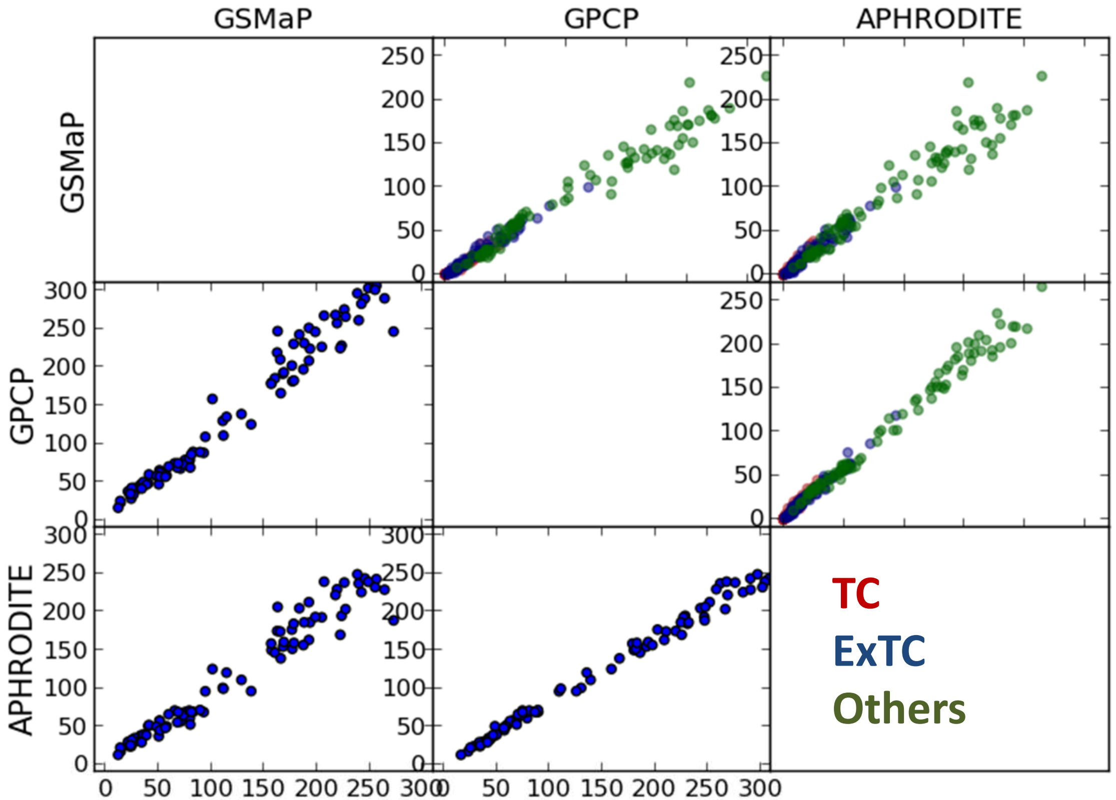


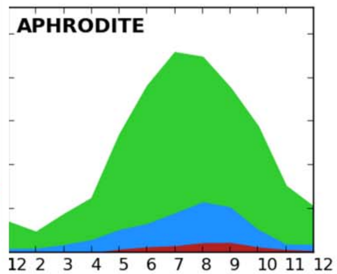
Comparisons of Relative Contributions

Result









Thank you!