

Filtering suspicious large values in ITE233_2A25 “extreme rain”

A. Hamada & Y. N. Takayabu (AORI, The Univ. of Tokyo)

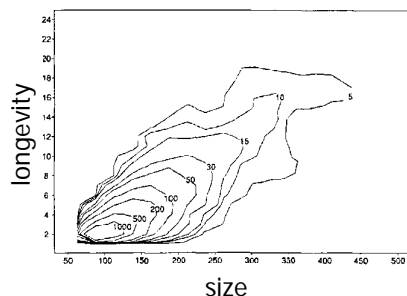
Introduction

- ▶ Objectives
 - ▶ Investigate unrealistic “extreme rain” occasionally observed in ITE233_2A25 e_SurfRain
 - ▶ Make and test a simple filter that removes erroneous profiles and enables the analysis of extreme events
- ▶ Data
 - ▶ 2A25 in V6 and ITE233; 3 years 2000,2001,2008; 60-150E, 15S-40N
 - ▶ ‘Extreme rain’ is defined by heavy rain over 99.9 percentile in the region (next slide; Murayama 2011)
- ▶ Procedure
 - ▶ Judge if the “extreme rain” is normal or erroneous by visual inspection (1503 extreme cases (e_SurfRain > 100 mm/h) in year 2001,2008)
 - Erroneous profiles are found to be classified into three types
 - ▶ Make a filter removing the erroneous profiles, based on normal extreme characteristics

Definition of extreme rain (Murayama 2011)

Definition considering TRMM observed rainfall as rain system

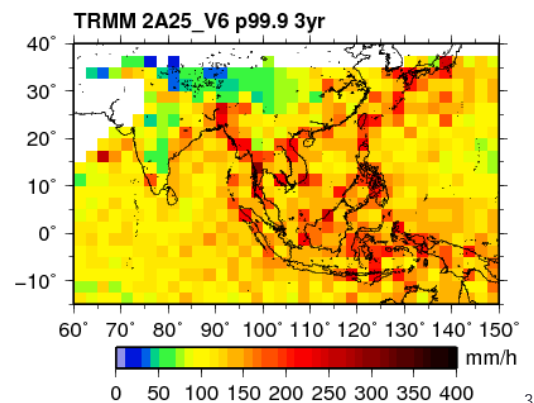
1. Pick up the maximum rain rate of 'rain area' defined as connected area with $2A25\ e_SurfRain > 0.3\text{ mm/h}$
 2. Define 'extreme rain' by region as heavy rainfall over 99.9 percentile of max. rain rate in that region
- By considering rain system (not each instantaneous rainfall) observed by TRMM, spatial scale of rain system is expected to alternate its temporal scale



Relationship between the size and longevity of tropical convective systems (Chen and Houze 1997, QJRM)

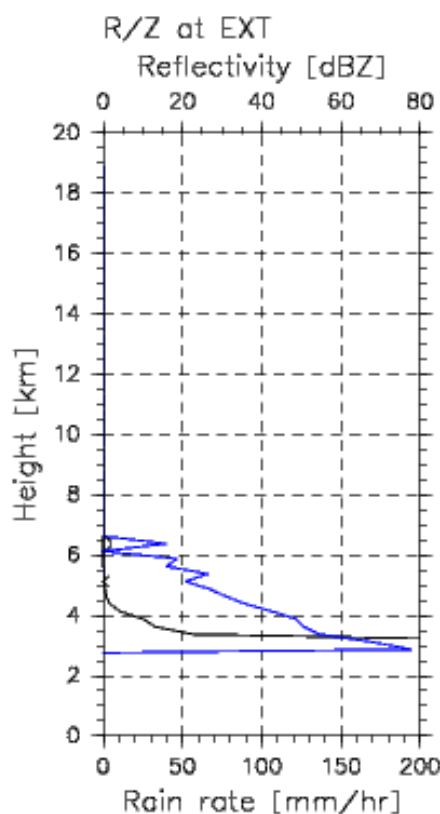
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Extreme map with V6 data (grid average)



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Erroneous profile: Type 1



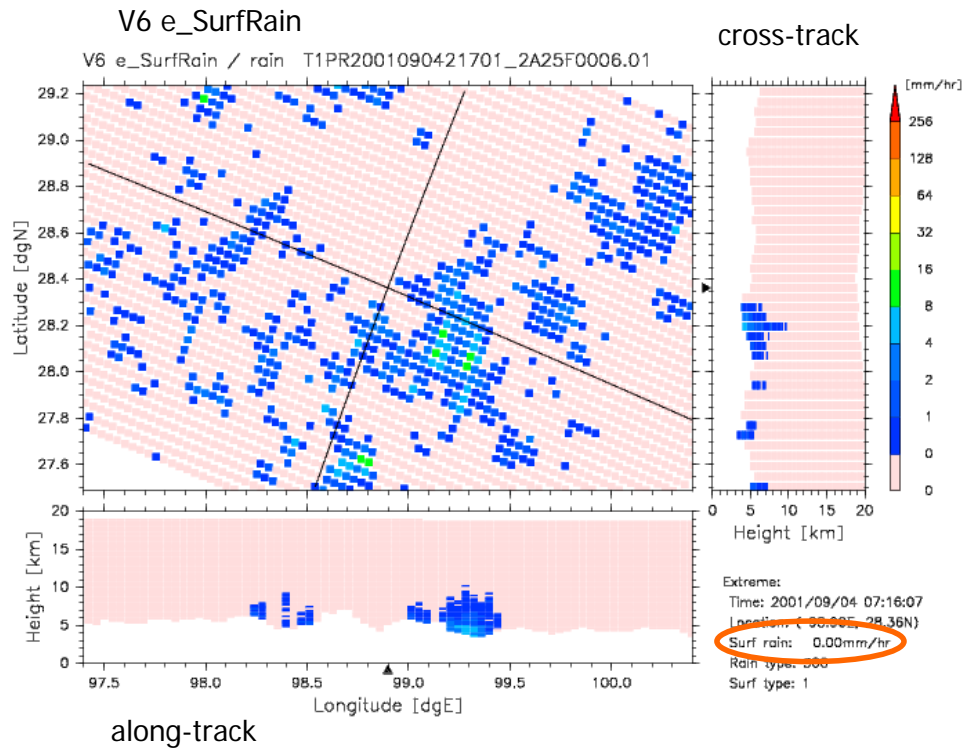
Blue: Reflectivity
Black: Rain rate
Dashed: V6
Solid: ITE233

- Maybe contamination of ground clutter
- No rain in V6_2A25, but large rain in ITE233
- Surface height of ITE233 is lower than that of V6 ITE233 by up to a few kilometers
- Appear mostly in at only 1 pixel
- Most are 300mm/h, but often have smaller value ~100mm/h

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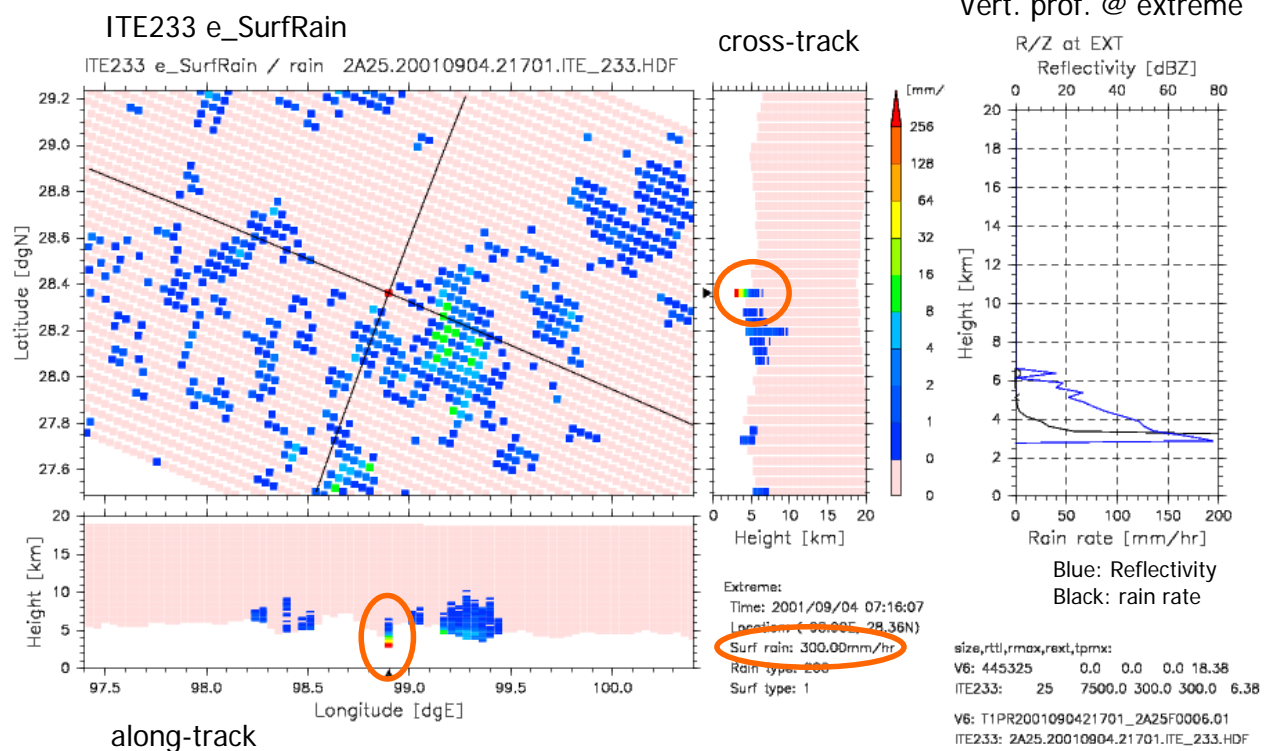
Type 1 example



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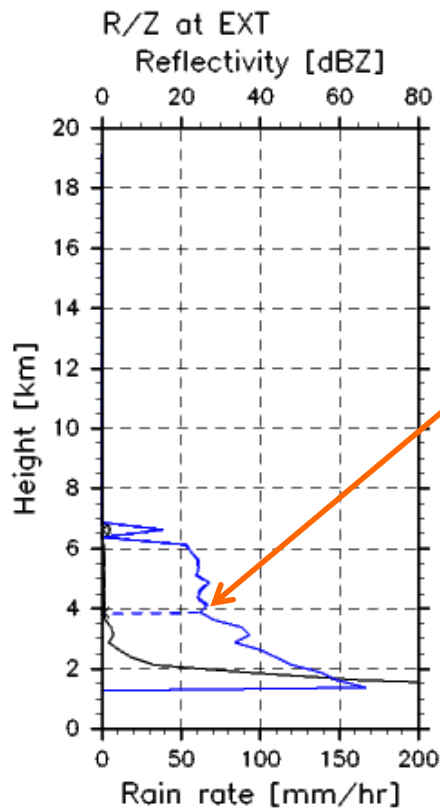
Type 1 example (contd.)



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Type 2

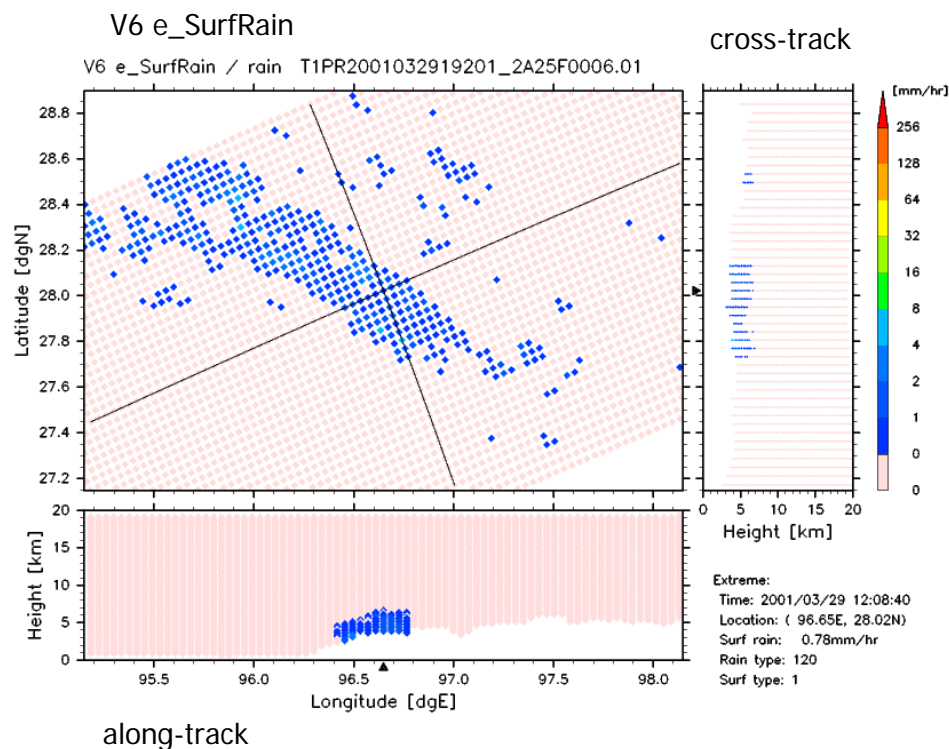


- ▶ Maybe contamination of ground clutter
- ▶ Both of V6 and ITE233 have non-zero value, but ITE233 has even larger value
- ▶ Echo bottom height of ITE233 is lower than that of V6 ITE233 by up to a few kilometers
- ▶ Reflectivities at the bottom of V6 profile are almost the same
- ▶ Often has smaller value of e_SurfRain ~100mm/hr

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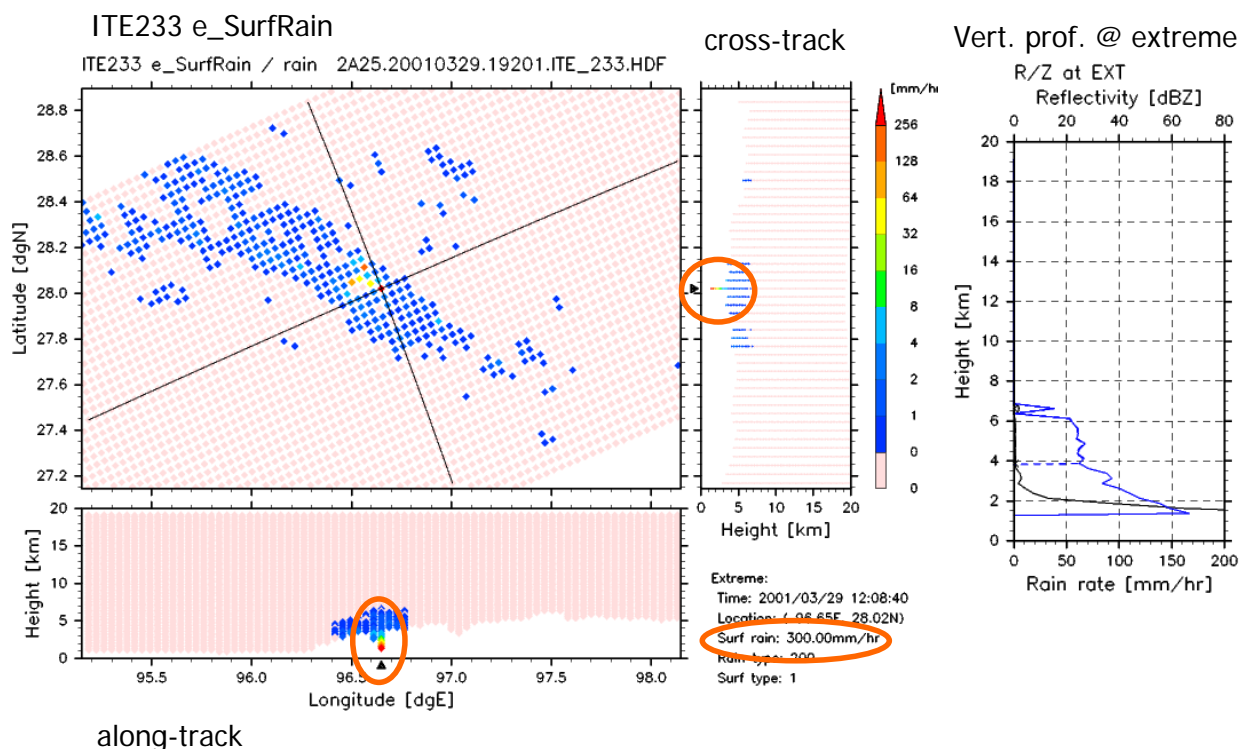
Type 2 example



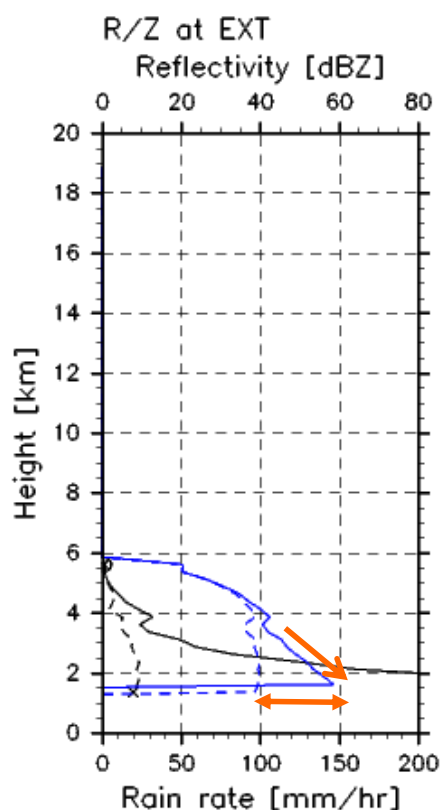
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Type 2 example (contd.)



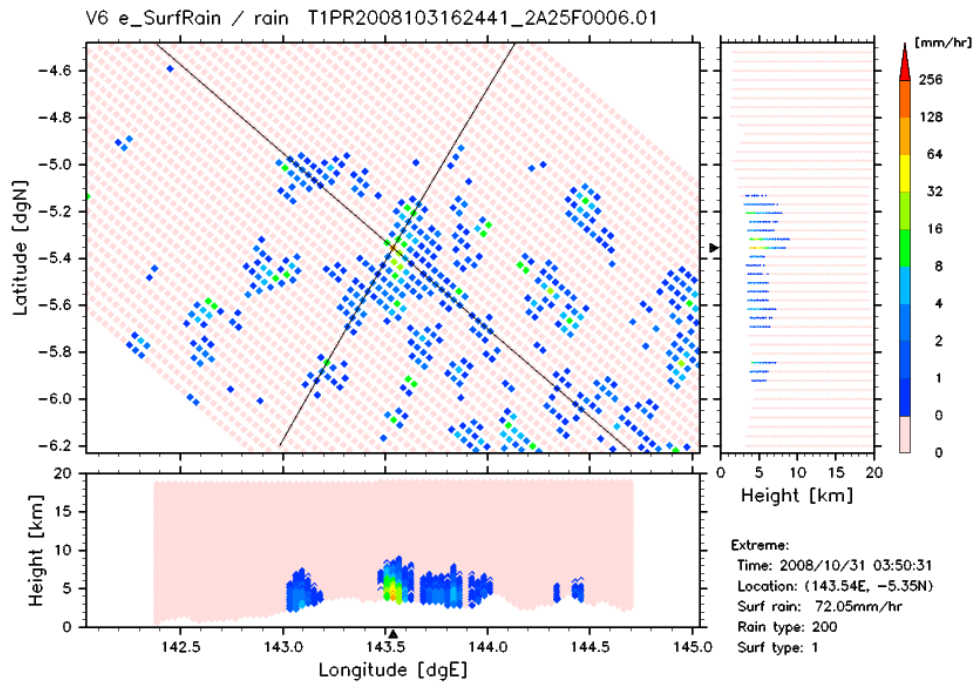
Type 3



- ▶ Both of V6 and ITE233 have non-zero value, but ITE233 has even larger value
- ▶ Reflectivity in ITE233 increase toward the bottom, larger than V6 by >10 dBZ
 - ▶ Profiles with the increase < 10 dBZ are classified into Type 4
- ▶ Echo-bottom heights in V6 and ITE233 are almost the same (within 1 km)
- ▶ No such correction was made neighboring pixels
- ▶ NOTE: Many in Type 3, 4 are difficult to judge subjectively

Blue: Reflectivity
Black: Rain rate
Dashed: V6
Solid: ITE233

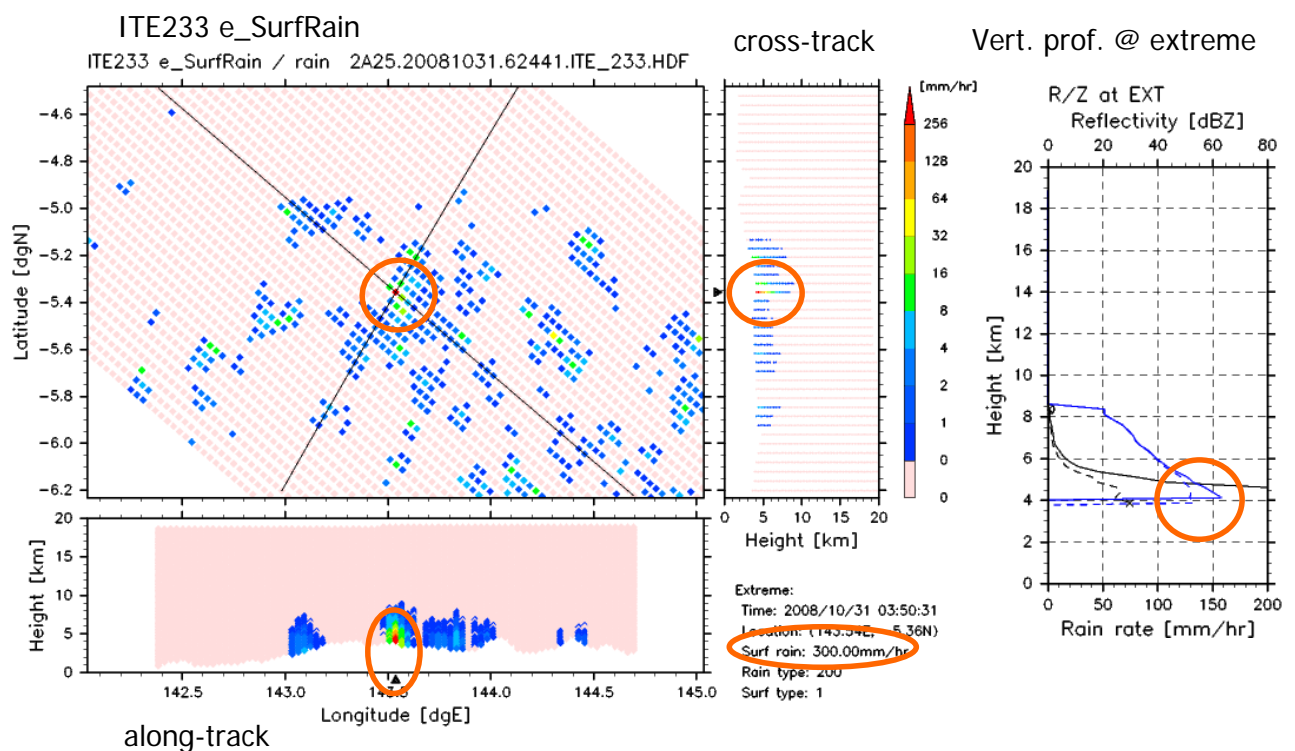
Type 3 example



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Type 3 example (contd.)

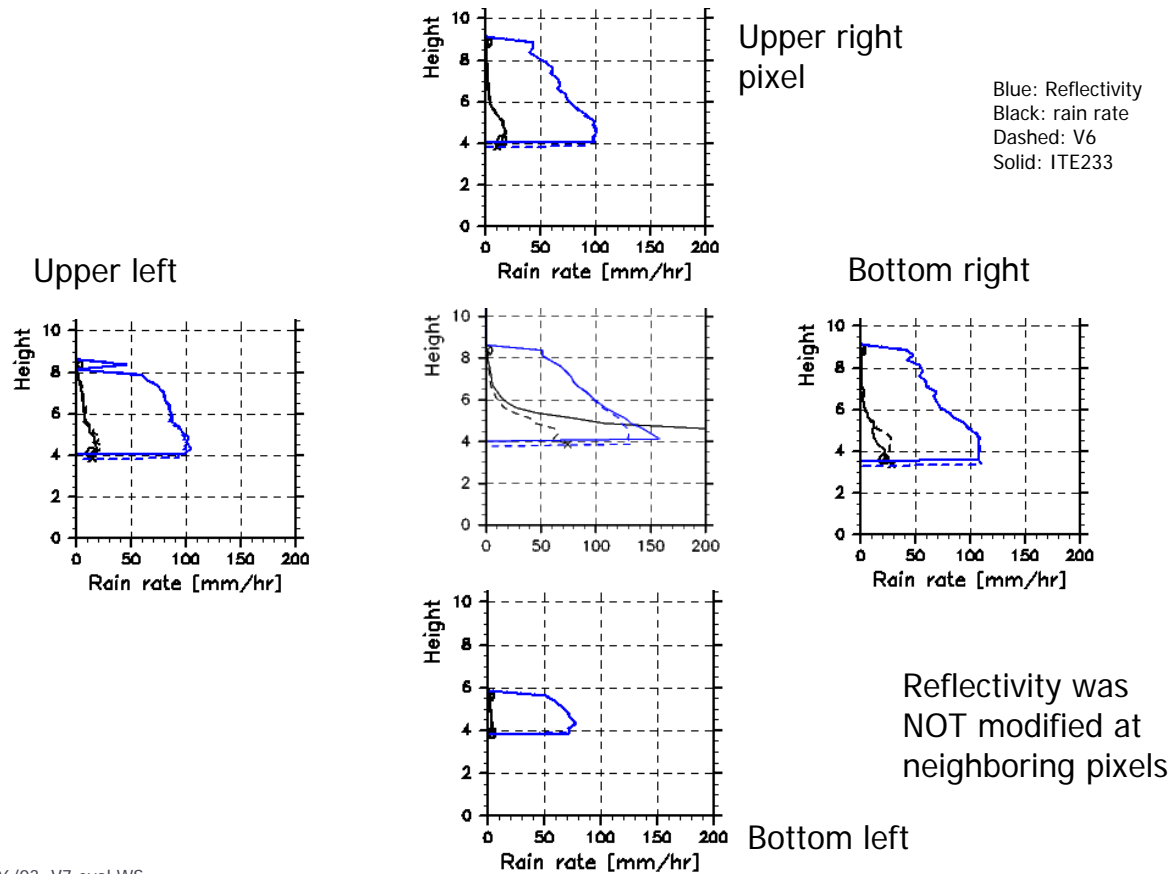


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Next: profiles at 4-neighbors

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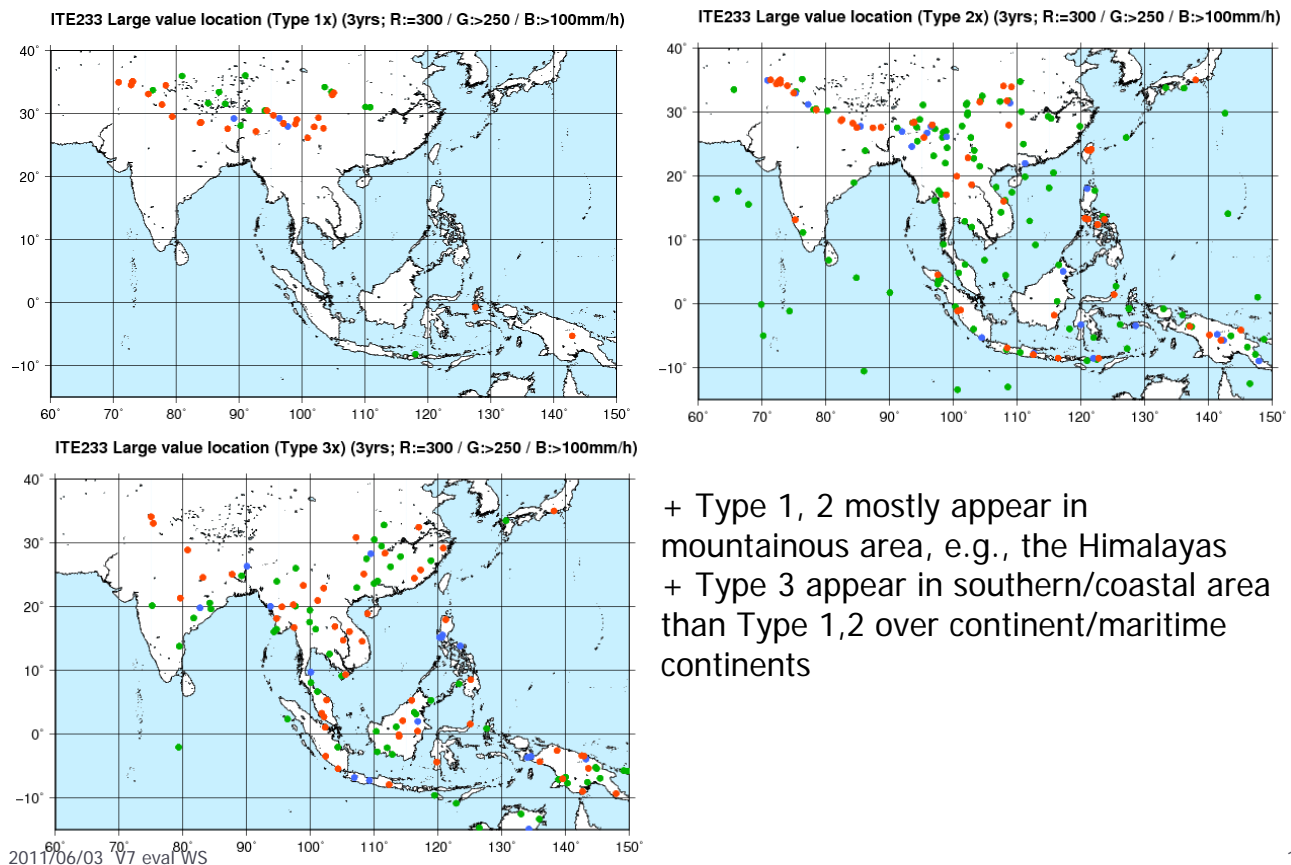
Type 3 example (contd.)



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Distribution of erroneous extremes by type



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of extremes by type and rain rate

Type	#(total)	#(=300)	#(>200)	#(>100mm/h)
1	46	28	5	13
2	189	52	56	81
3	130	51	37	42
1—3 total	365	131	98	136
4	249	10	47	192
0	131	2	19	110
0,4 total	380	12	66	302
Total	745	143	164	438
Not checked (part of <160mm/h)	758	0	0	758

↑ erroneous

↓ normal

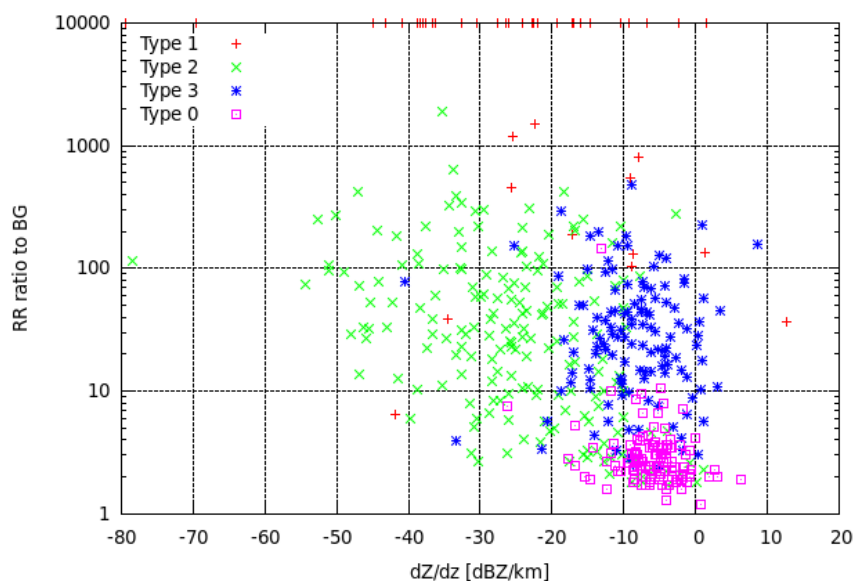
*Type 0 is the case judged as normal

- ▶ About half of checked extreme rain are likely to be erroneous
- ▶ Erroneous profile often have smaller value ~100mm/h
- ▶ When sorted by the size of rain area including extreme rain (not shown)
 - Seem not to be related with size, although Type 1 mostly appears in 1 pixel

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Horizontal isolation of rain and vertical gradient of Z



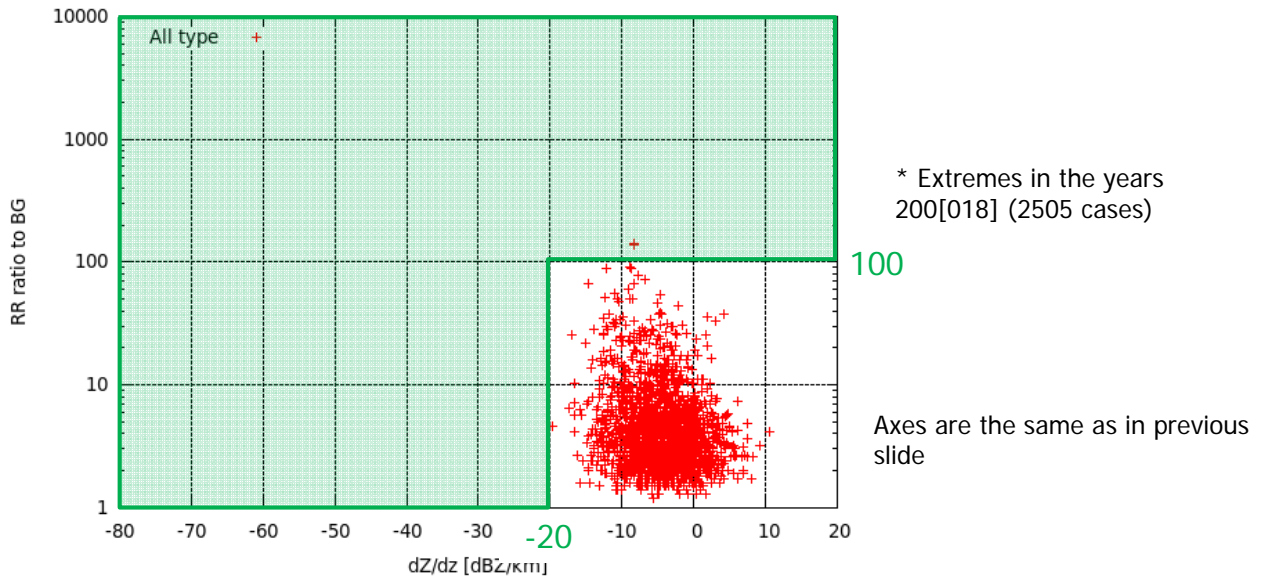
Hor. axis: $d(\text{reflectivity})/dz$
calculated from lowermost bins
Vert. axis: Ratio of e_{SurfRain} to
its average for surrounding 4px

- ▶ Many cases in Type 1-3 have even larger values compared to Type 0 (normal) cases
 - Suggesting an efficacy of using a filter with these two values

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Making a simple filter based on V6 data



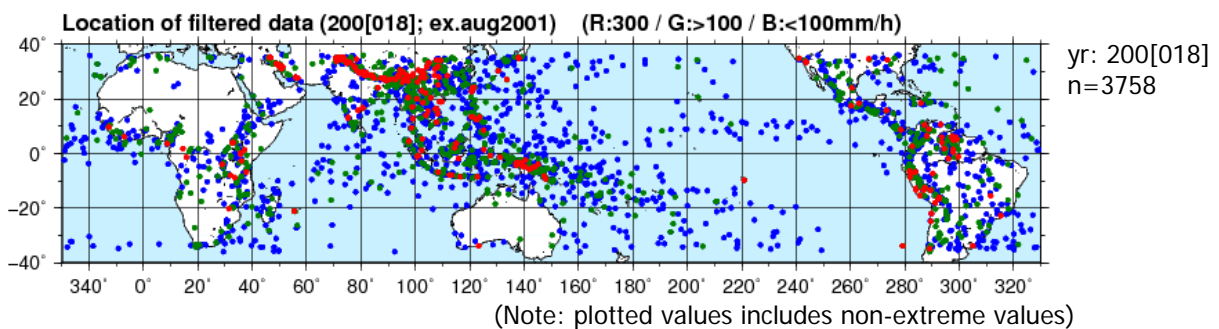
- ▶ Make a simple filter that removes profiles with following condition:
 - + Ratio of e_SurfRain to the average of neighboring pixels > 100, and
 - + Vertical gradient of lowermost reflectivity < -20 [dBZ/km]
- ▶ 3758 cases were detected during the yrs 200[018] in all of the ITE233_2A25 data (NOTE not only extremes)
 - ▶ ~0.0015% of total rain certain pixels

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Check validity of filter

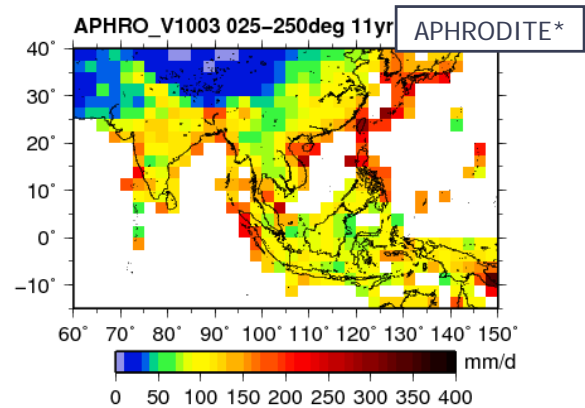
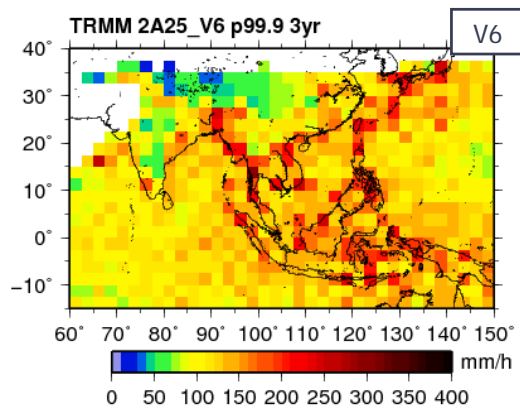
- ▶ Visual inspection of randomly selected 100 filtered data
 - ▶ Type1=37, type2=56, type3=7, type4=0, type0=0
- ▶ Distribution of filtered data
 - ▶ Concentrated in mountainous area (e.g., Himarayas, rim of the Tibetan plateau, Zagros Mts., the Andes)



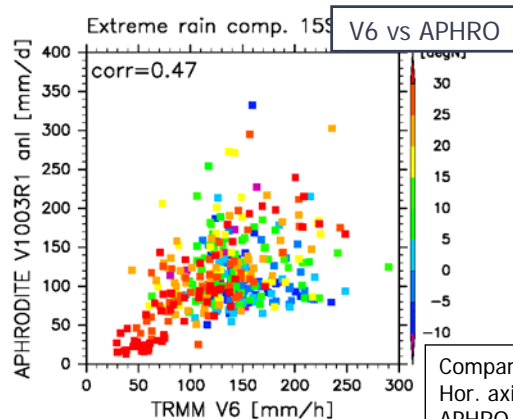
- ▶ Impact on mean value
 - ▶ Change little in annual & zonal mean (land < -1%, ocean < -0.3%; similar for convective/stratiform)

→ validity of the filter confirmed

Effects of filter on extreme map



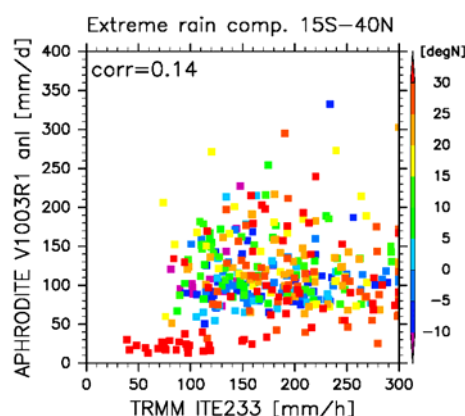
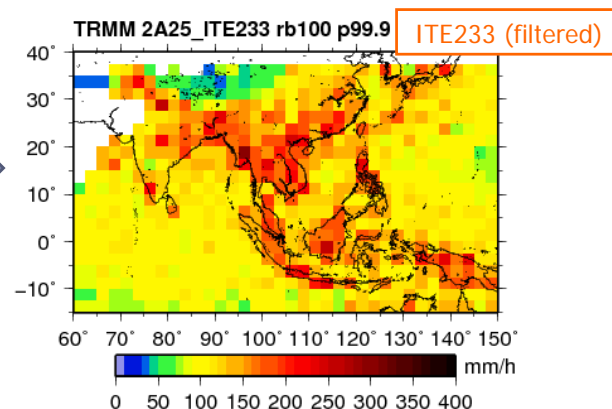
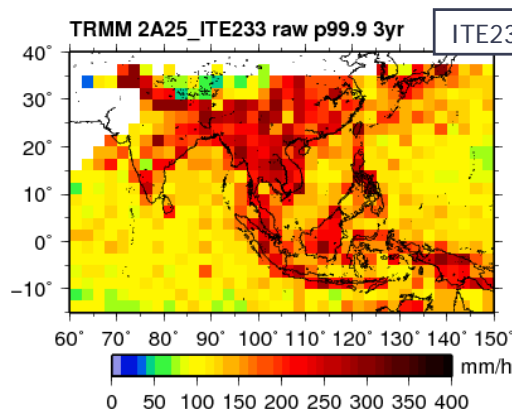
*Rain gauge-based daily precipitation grid data
(Yatagai et al. 2009, SOLA)



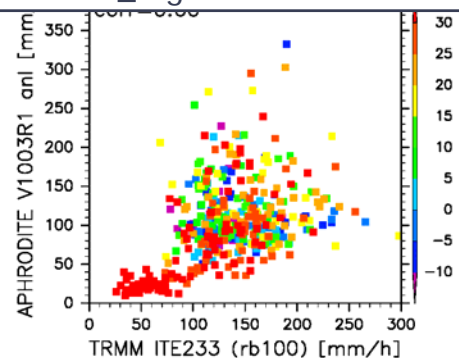
- ▶ Murayama (2011, master thesis)
- ▶ Although simple comparison cannot be made, there is a relationship between instantaneous rain rate in TRMM and daily precipitation in APHRODITE

Comparison between grid values
Hor. axis: 2A25; Vert. axis:
APHRO
Color: latitude

Effects of filter on extreme map (contd.)



Unnatural distribution in
ITE233_org is almost dissolved



Summary

- ▶ Erroneous extreme profiles observed in ITE233_2A25 were investigated
 - ▶ Erroneous profiles were found to be classified into three types
 - ▶ Many are 300mm/h, but often have smaller value ~100mm/h
 - ▶ Appear mostly in at only 1 pixel and no such correction is made neighboring pixels
 - ▶ Type 1, 2 mostly appear in mountainous area (e.g., the Himalayas)
- ▶ A simple filter removing the erroneous profiles was proposed, based on the characteristics of erroneous profiles
 - ▶ Unnatural distribution in original ITE233 is almost dissolved

Supplementary figures & tables

of extremes by rain area and rain rate

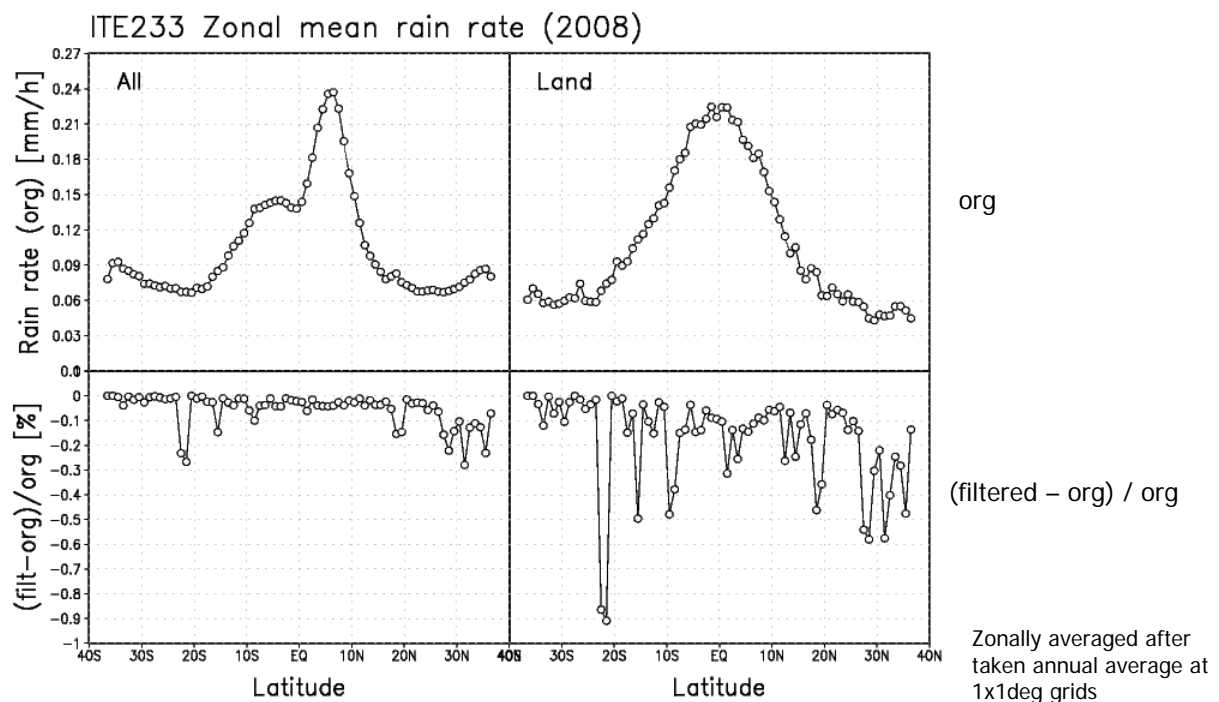
Type	#(total)	#(=1px)	#(<10)	#(<100)	#(>=100)
1	46	34	10	1	1
2	189	0	18	56	115
3	130	0	16	63	51
1--3計	365	34	44	120	167
4	249	0	3	41	205
0	131	0	0	5	126
0,4計	380	0	3	46	331
0--4計	745	34	47	166	498
Not checked (part of <160mm/h)	758	0	0	37	721

- ▶ Rain area: the connected (4-connection) area with $e_SurfRain > 0.3$ including extreme rain
- ▶ Type 1 mostly appears in 1 pixel
- ▶ Type 2,3 seem not to be related with size
 - ▶ Type 4 not considered due to the possibility of inclusion of normal profile

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Change in mean value by filtering



- ▶ Little change in annual & zonal mean
- ▶ The same is true when divided into convective/stratiform rain (not shown)

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of extreme rains

