climate extremes

ARC centre of excellence

Intercomparison of rainfall extremes in global in situ, space-based and reanalysis products

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BoM R&D workshop, 23rd Nov 2020

IPCC summary assessment

- There are *likely* more land regions where the number of heavy precipitation events has increased than where it has decreased

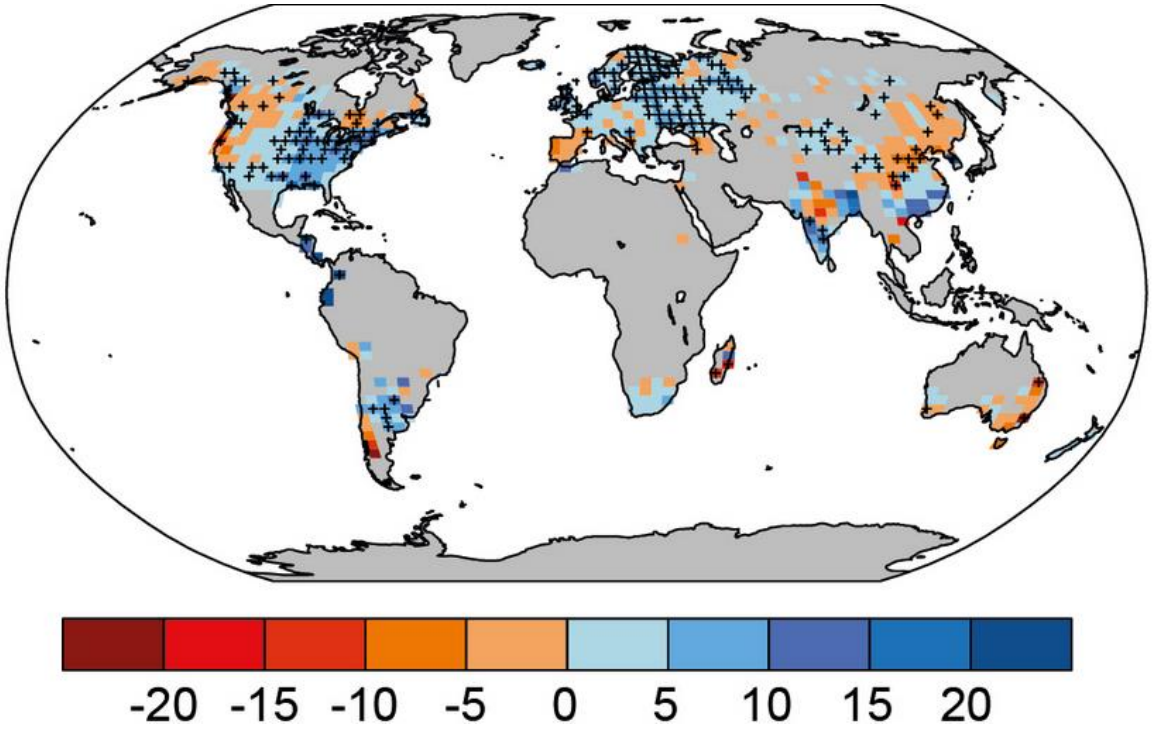
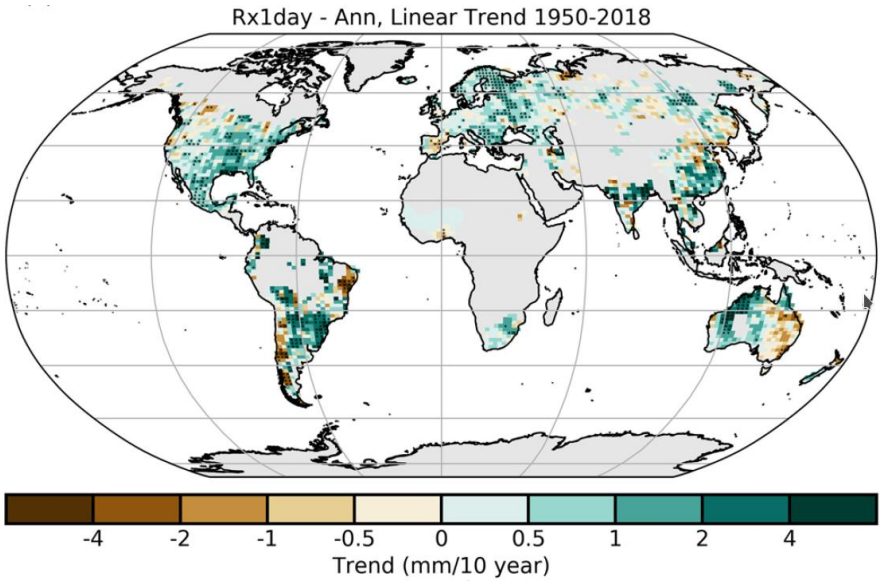
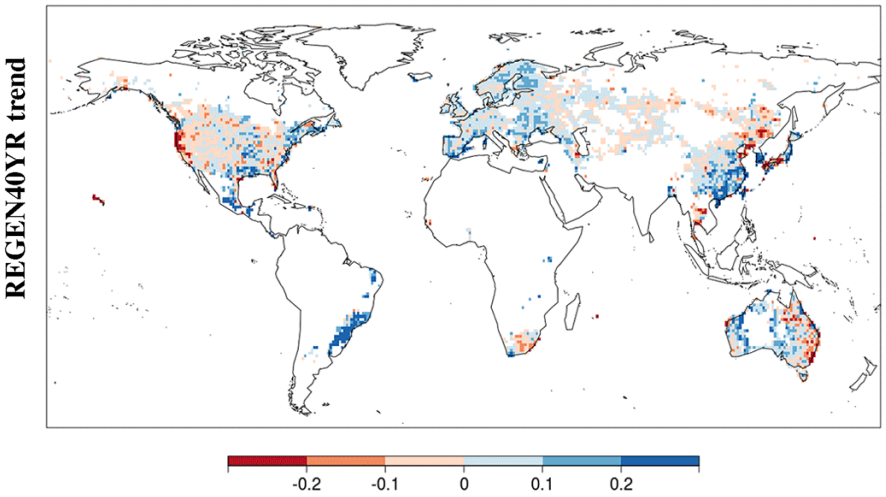


Fig. 2.33 IPCC AR5 2013

Updated data and new products



HadEX3: Dunn et al. (2020), JGR-Atmos



REGEN: Contractor et al. (2020), HESS

In situ data have been the main source of observational evidence

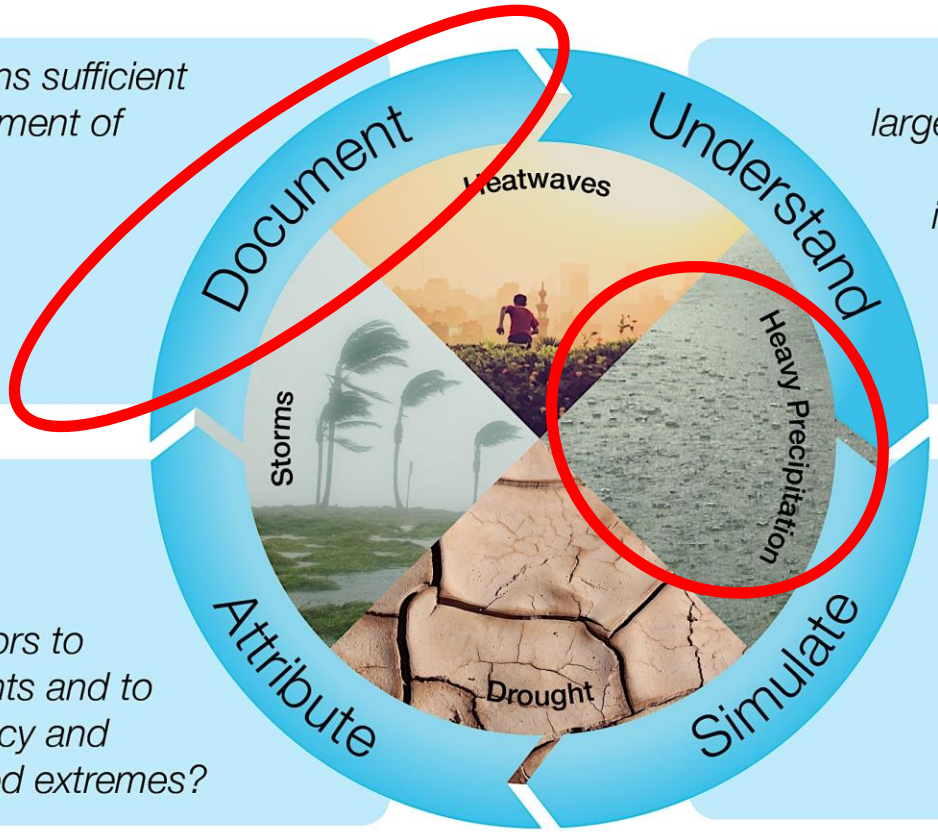
WCRP Grand Challenge on

Weather and Climate Extremes

4 main extremes, 4 overarching themes

Are existing observations sufficient to underpin the assessment of extremes?

What are the relative roles of large-scale, regional and local scale processes, as well as their interactions, for the formation of extremes?



What are the contributors to observed extreme events and to changes in the frequency and intensity of the observed extremes?

Are models able to reliably simulate extremes and their changes, and how can this be evaluated and improved?

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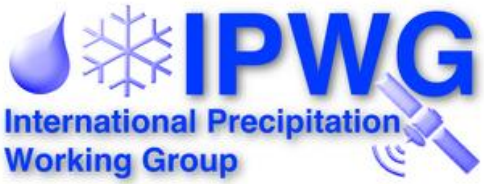
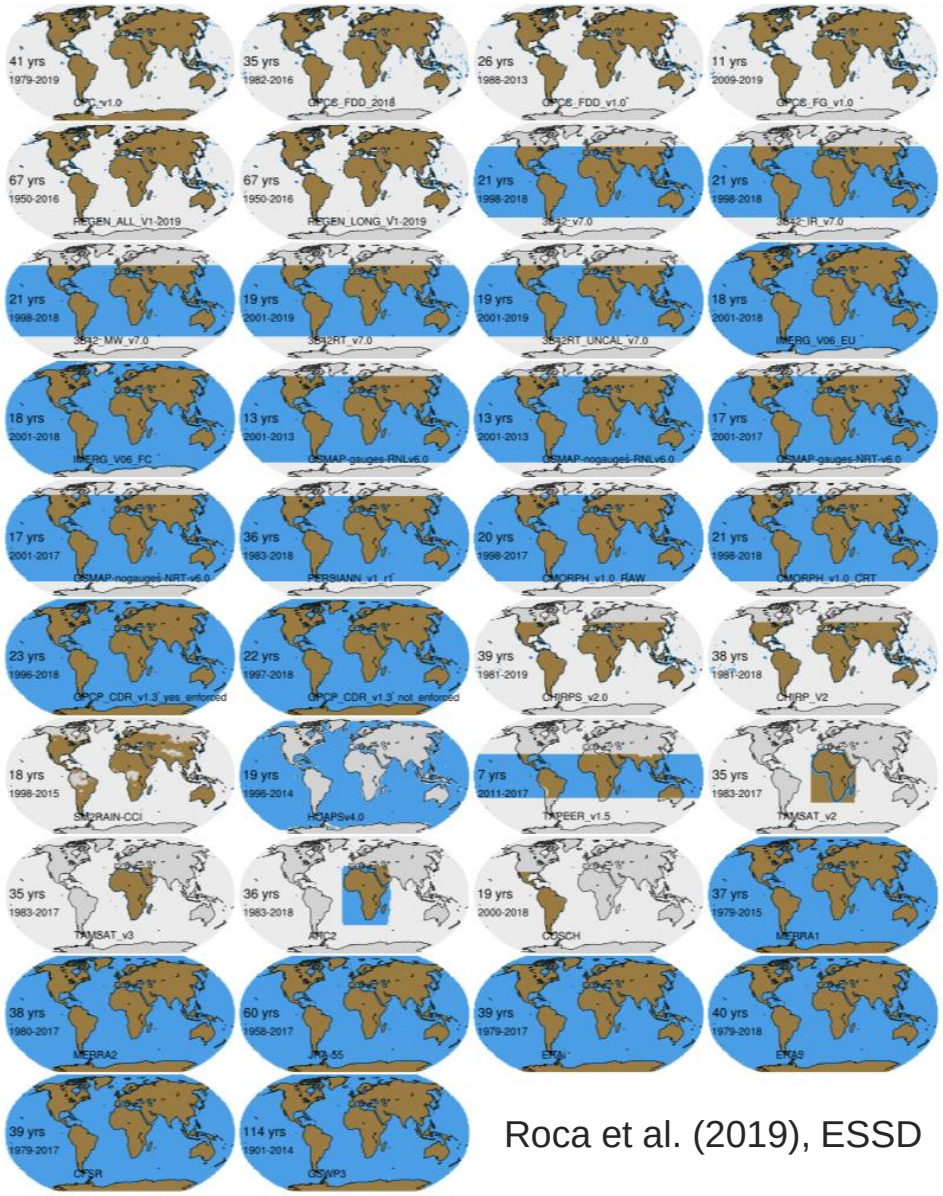
Global precipitation products assessment



In 2018, WCRP GC Extremes and GEWEX GDAP/IPWG joined forces to begin an intercomparison and assessment of global precipitation extremes

Frequent Rainfall on Grids (FROGs) database



Roca et al. (2019), ESSD

- 40 products of observations
- daily data on a 1x1° grid

- In situ-based
- Satellite with correction to rain gauges
- Satellite without correction to rain gauges
- Reanalyses

http ://frogs.prod.lamp.cnrs.fr/

↓

Focus on Extreme Precipitation Observations and Process Understanding

in *Environmental Research Letters*

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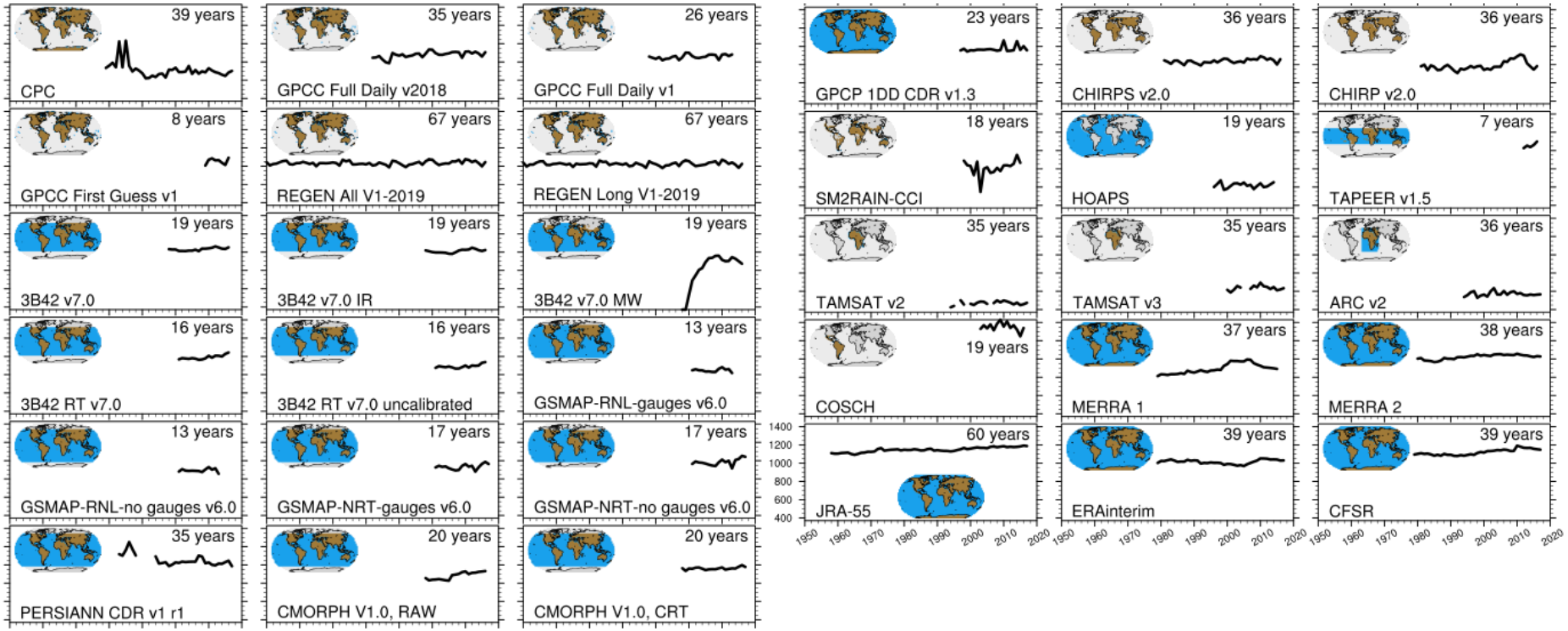
Spatial and temporal coverage



2001-2013

22 products quasi-global land

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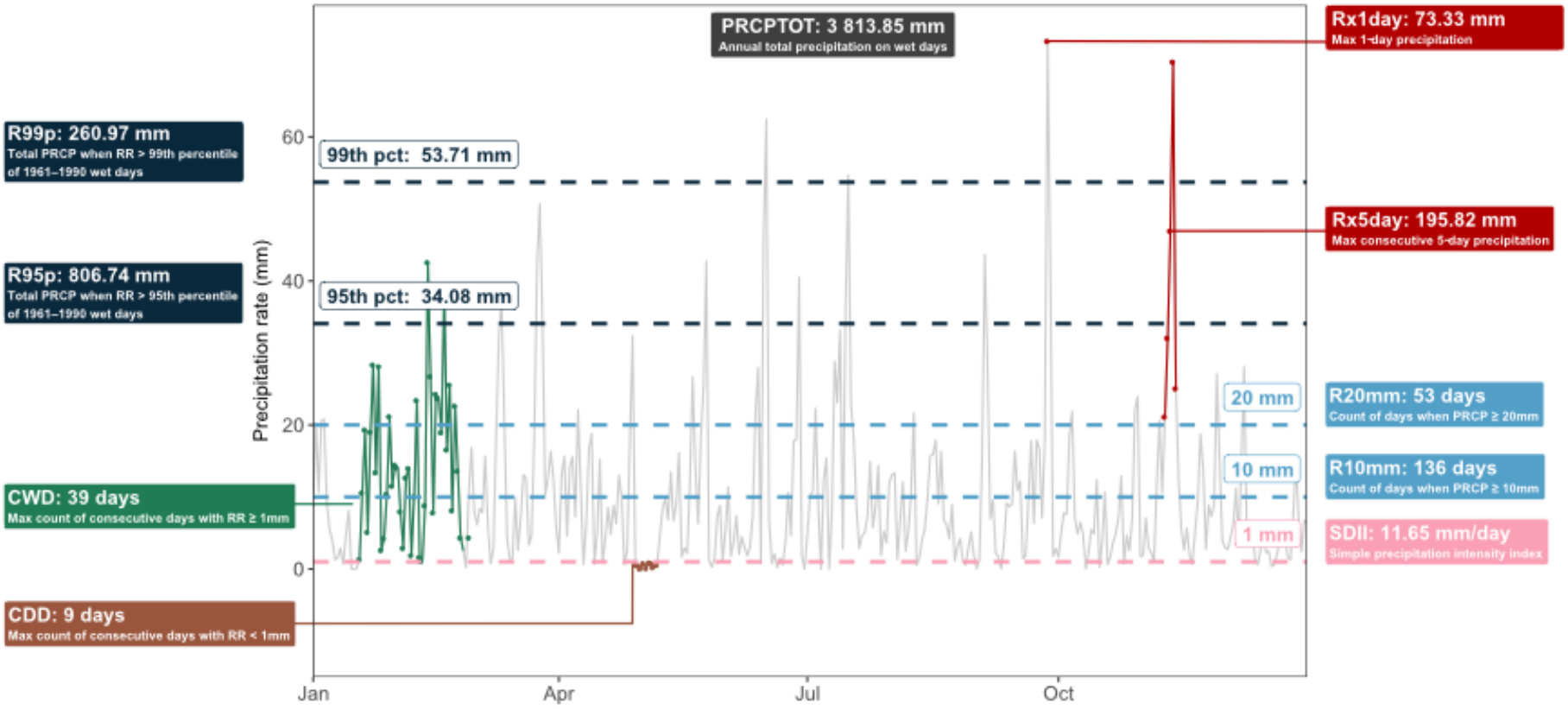
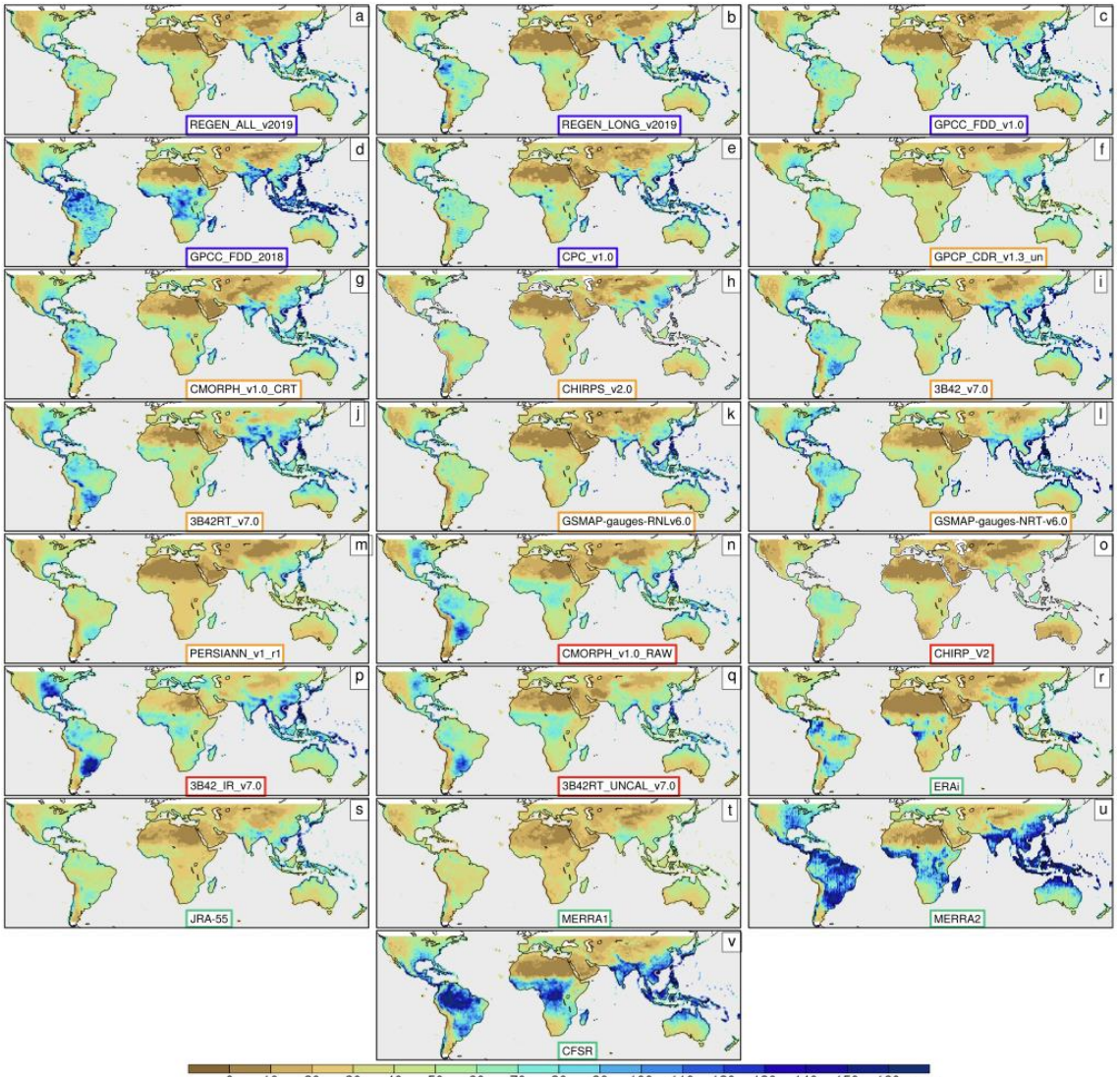
Indices were used for intercomparison



Frequency, intensity, duration (and 'moderately extreme')

'Classic' ETCCDI
Alexander et al. 2019. ERL

Global land climatology – Rx1day



2001-2013 clim

in situ-based

sat. with correc.

sat. uncorrec.

reanalyses

Bador et al. (2020) "Diverse estimates of annual maxima daily precipitation in a variety of quasi-global land observations" ERL

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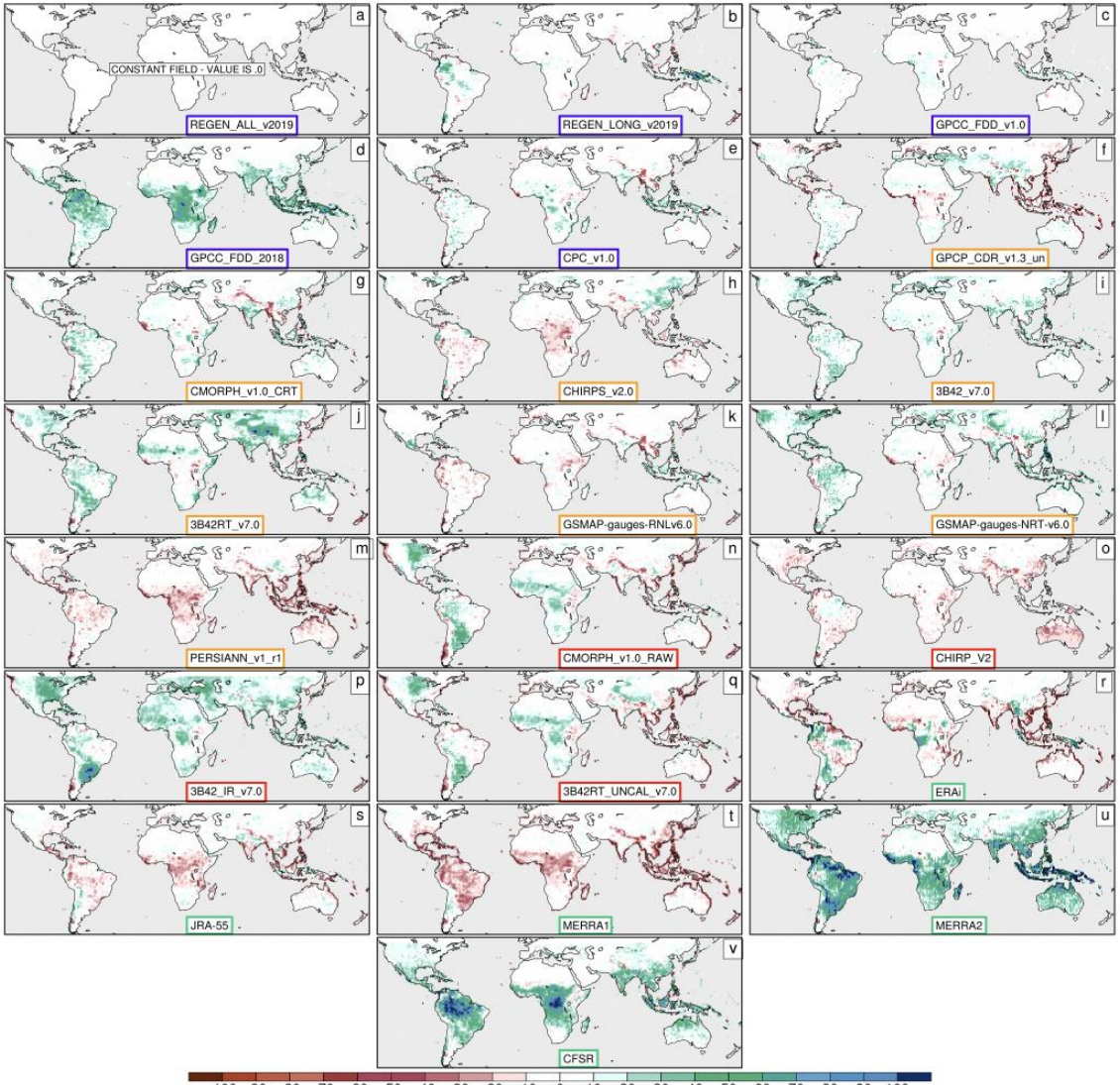
Wettest day differences



2001-2013 clim

in situ-based

sat. with correc.

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reanalyses

Bador et al. (2020) "Diverse estimates of annual maxima daily precipitation in a variety of quasi-global land observations" under review in ERL

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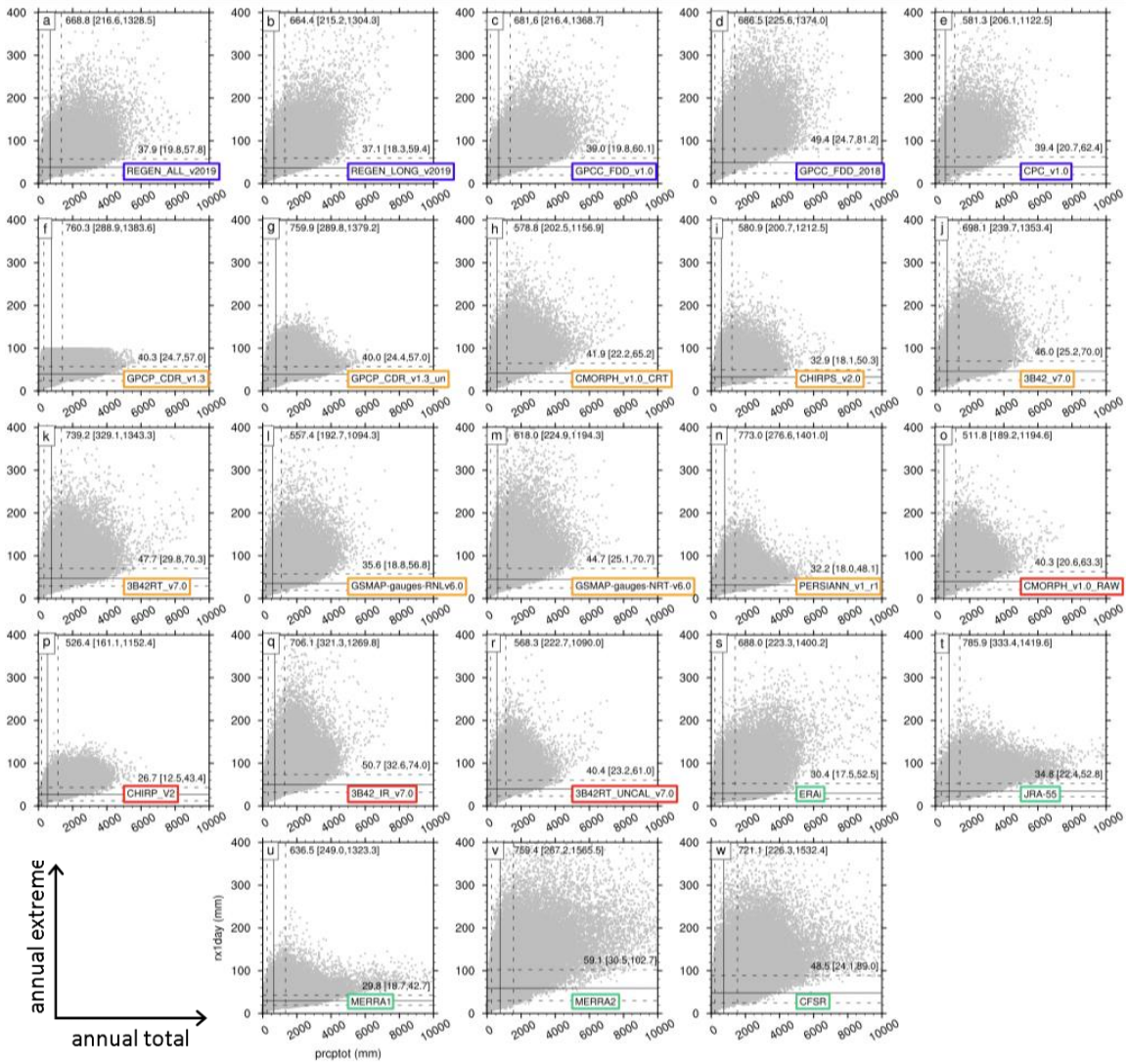
Distribution differences



2001-2013 clim

in situ-based

sat. with correc.

sat. uncorrec.

reanalyses

Bador et al. (2019) "Diverse estimates of annual maxima daily precipitation in a variety of quasi-global land observations" under review in ERL

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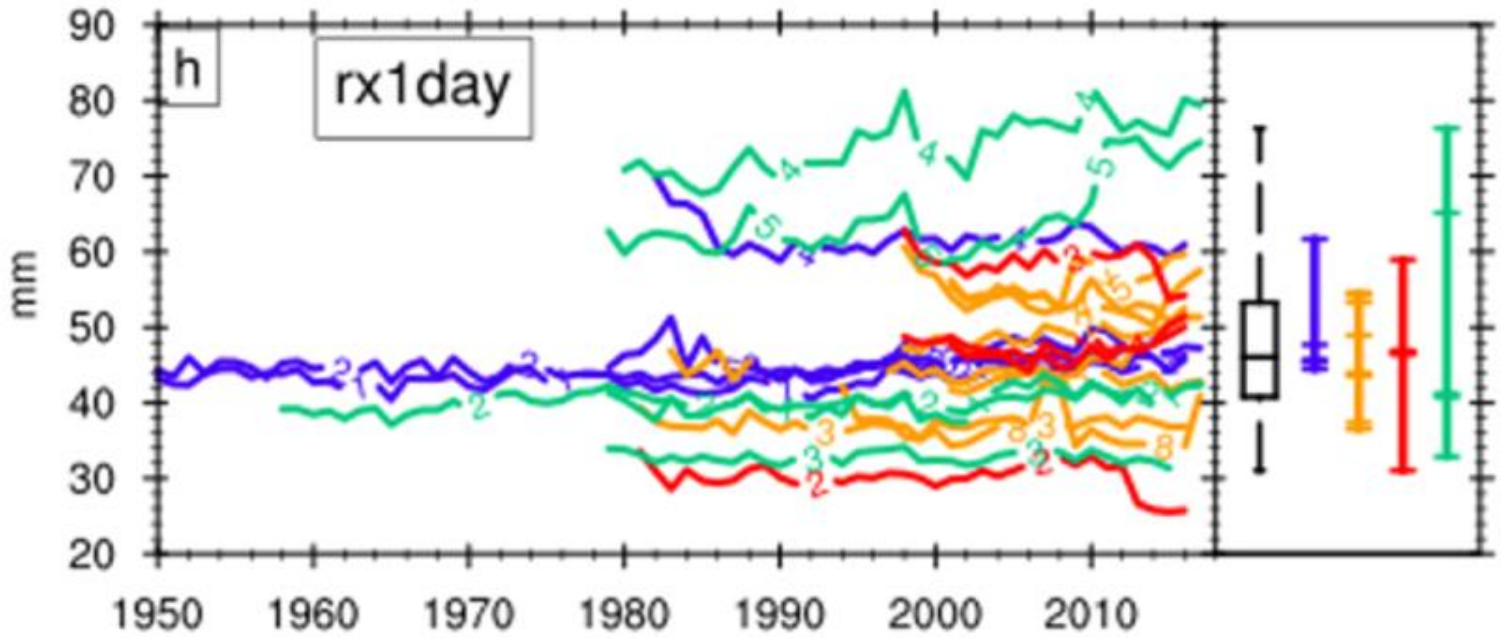
Timeseries



Alexander et al. (2020) ”Intercomparison of precipitation extremes over global land areas from in situ, space-based and reanalysis products ” to be submitted to ERL

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Multiple indices

	Dataset name	SDII	PRCPTOT	Rx1day	Rx5day	R95p	R99p	R10mm	R20mm	CDD	CWD
in situ-based	REGEN_ALL_v2019	7	11	9	13	13	12	12	13	6	14
	REGEN_LONG_v2019	6	10	10	14	15	16	8	9	4	15
	GPCC_FDD_v1.0	8	13	11	15	16	15	15	15	1	13
	GPCC_FDD_2018	22	15	20	20	20	20	11	21	7	1
	CPC_v1.0	12	3	14	9	8	10	4	8	11	2
satellite with correction to *in situ*	GPCP_CDR_v1.3_un	20	14	7	11	6	2	20	19	21	4
	CMORPH_v1.0_CRT	13	6	15	10	9	9	5	10	3	7
	CHIRPS_v2.0	9	7	4	3	1	1	9	5	8	10
	3B42_v7.0	18	12	16	16	17	14	14	17	15	9
	3B42RT_v7.0	19	18	18	18	19	17	18	20	18	12
	GSMAP-gauges-RNLv6.0	5	2	8	8	7	8	1	4	12	11
	GSMAP-gauges-NRT-v6.0	17	8	17	17	12	13	6	14	10	6
	PERSIANN_v1_r1	4	17	3	5	10	7	19	7	19	16
Satellite uncorrected	CMORPH_v1.0_RAW	14	5	13	7	5	6	7	11	5	8
	CHIRP_V2	1	4	1	1	2	3	3	3	2	19
	3B42_IR_v7.0	21	9	19	19	18	18	10	16	22	3
	3B42RT_UNCAL_v7.0	11	1	12	6	3	4	2	6	16	5
reanalyses	ERAi	3	19	6	4	11	19	17	1	13	20
	JRA-55	10	20	5	12	14	11	22	12	17	18
	MERRA1	2	16	2	2	4	5	13	2	20	22
	MERRA2	16	22	22	22	22	22	16	22	14	21
	CFSR	15	21	21	21	21	21	21	18	9	17

2001-2013

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

Driest ---------- Wettest

Alexander et al. (2020) ”Intercomparison of precipitation extremes over global land areas from in situ, space-based and reanalysis products ” ERL

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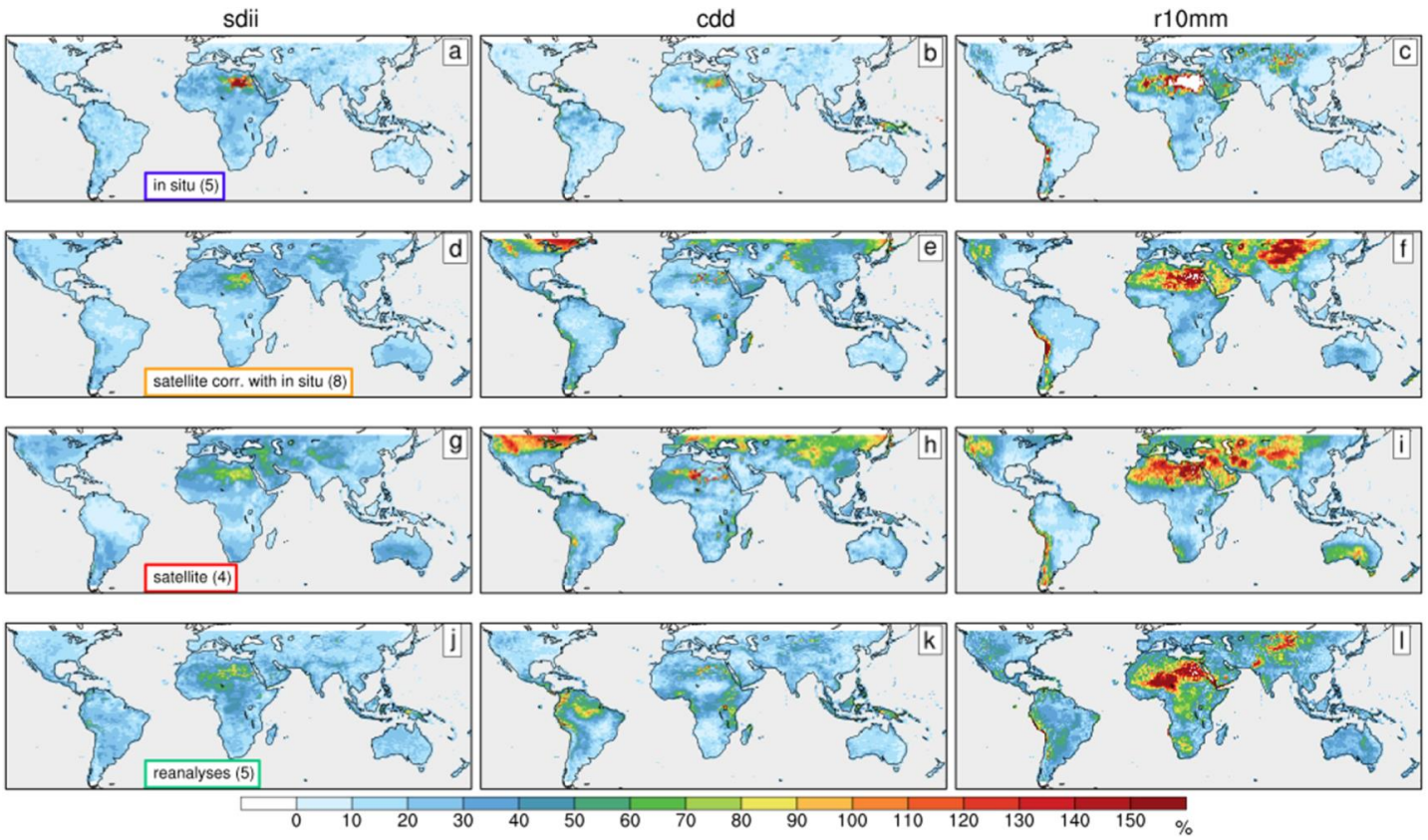
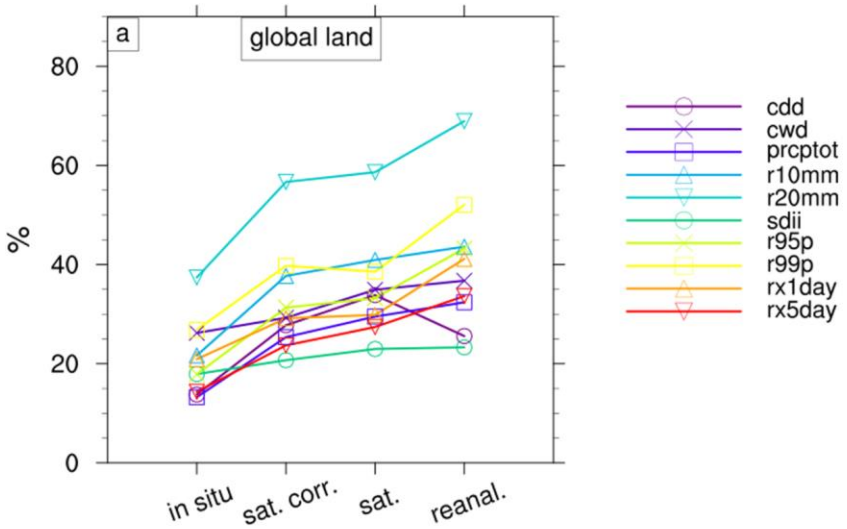
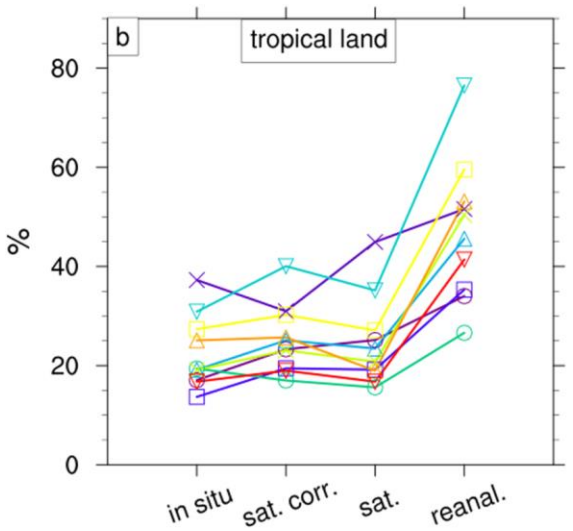
Differences are index dependent

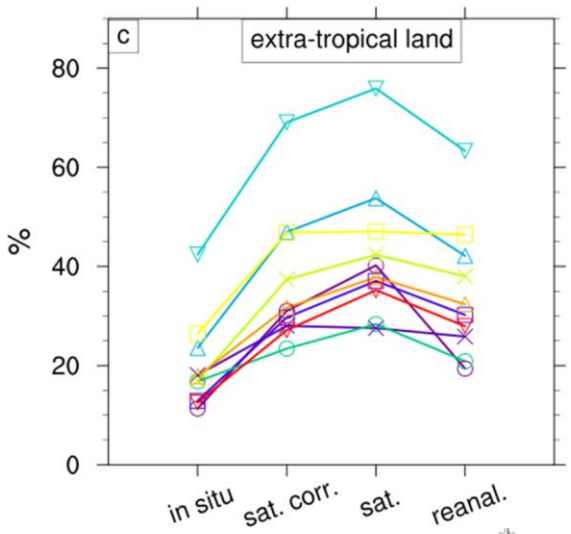


Frequency-based precipitation indices less robust across products than intensity-based measures

In situ-based datasets show least variation







Reanalyses have highest coefficient of variation (except in extra-tropical land regions)

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Summary

- The Frequent Rainfall on GridS (FROGS) database has enabled intercomparison of multiple rainfall products on a common format
- Precipitation indices have been used to identify commonalities and differences and highlight idiosyncrasies of some products
- Some indices are more sensitive than others but there are families of ‘dry’ and ‘wet’ products
- The update of GPCC has produced a dataset with more extreme rainfall than its predecessor
- In situ products have least variation whilst reanalyses have highest
- Some cautiously promising results for using satellite products to help fill data gaps
- Moving forward much more work to be done in understanding product differences

clex

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Australian Government
Australian Research Council

www.climateextremes.org.au

Thank you

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Australian National University

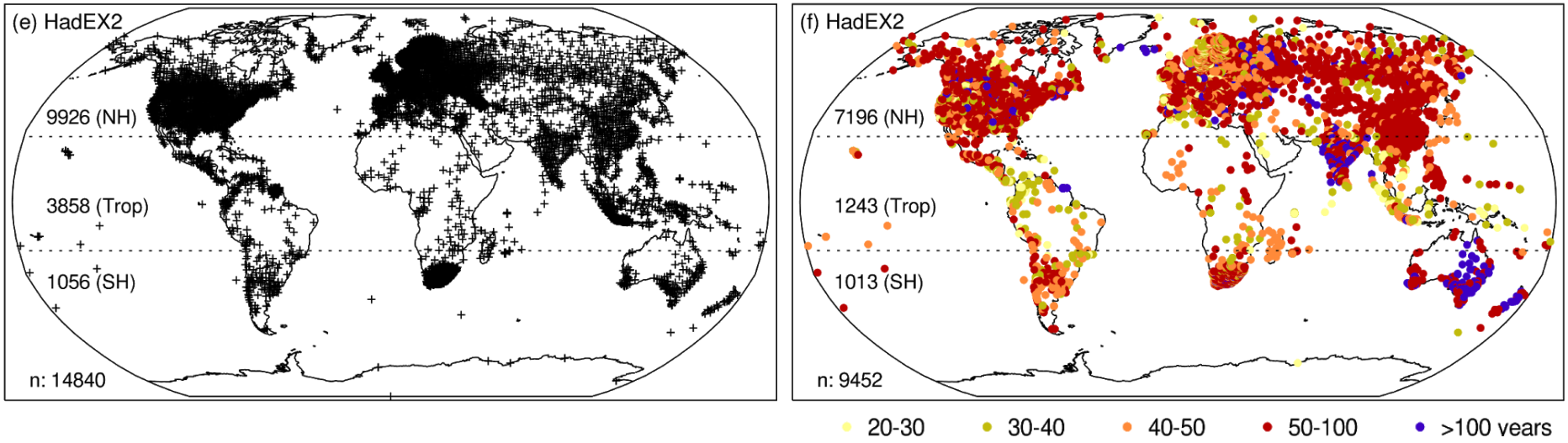
MONASH University

THE UNIVERSITY OF MELBOURNE

UNIVERSITY of TASMANIA

The value of indices

Rx1day – wettest day



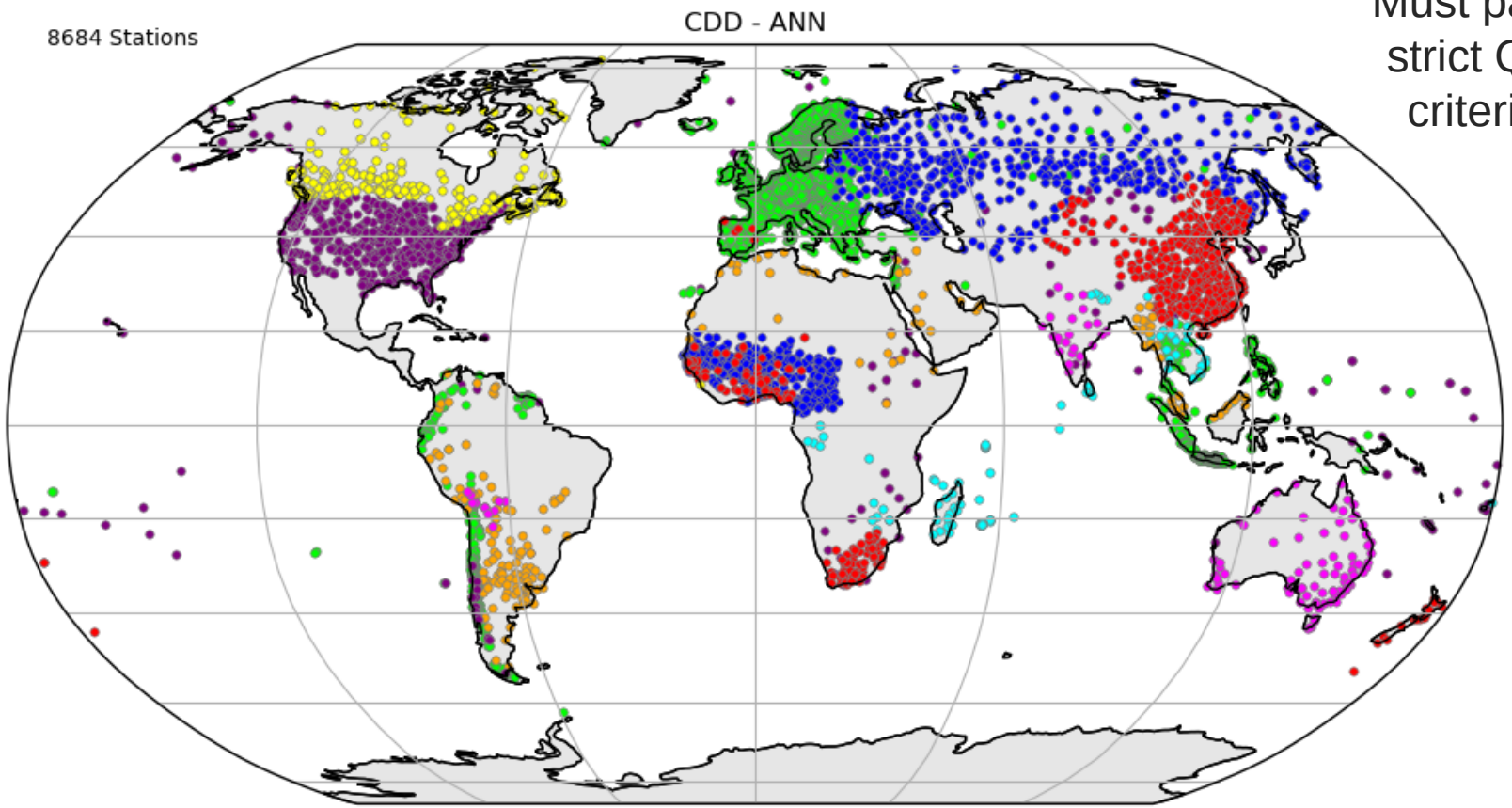
Generally few barriers to data exchange

Maintain reasonable coverage in Tropics and data sparse regions

Much of the data exchange coordinated through regional workshops

QC and homogenisation is done primarily at source

Improve data coverage for AR6



Must pass strict QC criteria

- Pacific (35)
- New Zealand (19)
- GHCND (671)
- ECAD (4518)
- LACAD (497)
- SACAD (804)
- HadEX2 (108)
- Russia (445)
- South America (126)
- West Africa 1 (606)
- West Africa 2 (63)
- Australia (81)
- Arabia Long (15)
- Arabia All (23)
- ACRE (1)
- Spain (5)
- Chile (14)
- Canada (222)
- DECADE (10)
- South Africa (58)
- India (23)
- Malaysia (15)
- China (309)
- Myanmar (16)

Current status of stations for HadEX3

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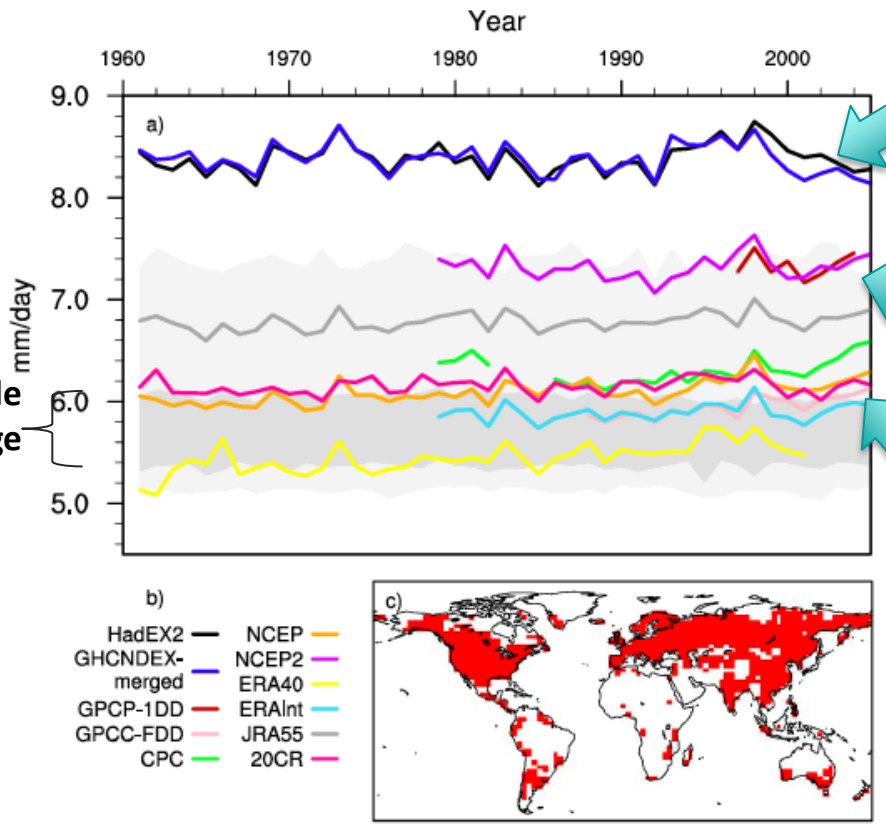
Rainfall intensity over land

Full obs/rea nalyses **range**

Full CMIP5 range

Interquartile CMIP5 range



HadEX

GPCP

GPCC

~3mm/day difference

in annual estimates of daily precipitation intensity

Source: Herold et al. 2016

Dataset choice somewhat arbitrary