An Econometric Approach to Amazon Landscapes and Assessing Their Hydroclimatological Impacts

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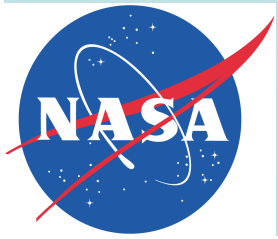


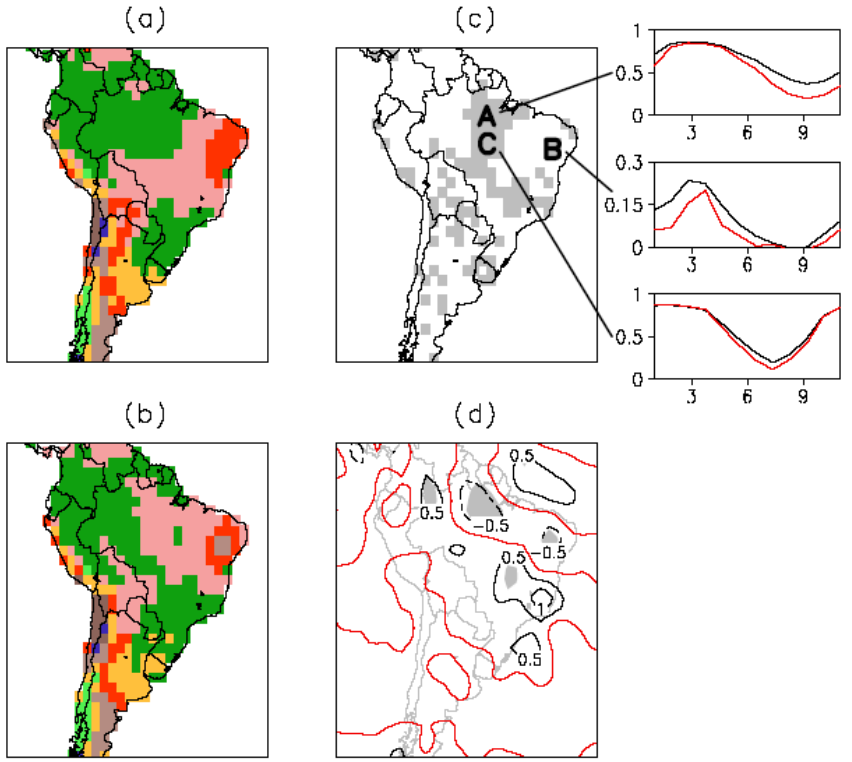
Road Map

1. Motivation
2. Method
3. Examples of Generated Land Cover
4. Aspects of Model Configuration
5. Results
6. Conclusion

1.Motivation

- Oyama & Nobre coupled modeling: (CPTEC/COLA AGCM)

2 potential equilibria



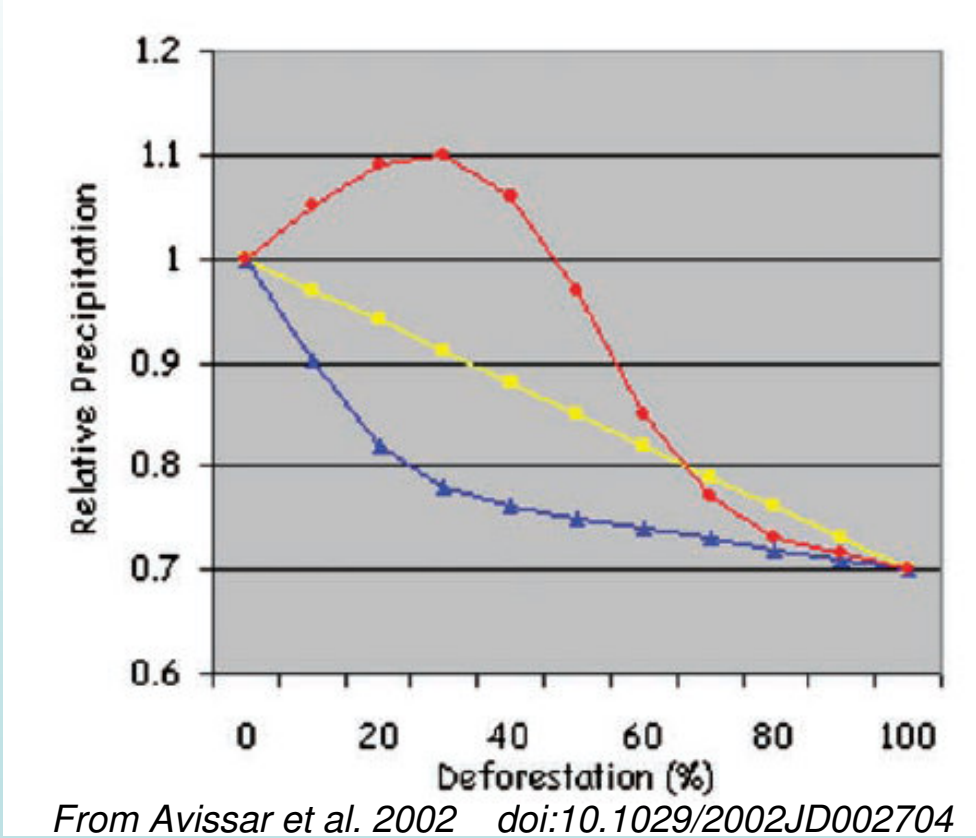
From Oyama & Nobre 2003 *doi:10.1029/2003GL018600*

"If sustainable development and conservation policies are not able to halt this increasing environmental degradation, then land use changes could, *per se*, tip the biome-climate system towards a ***new alternative drier stable equilibrium state*** with savannization of parts of Amazonia and desertification of the driest area of Northeast Brazil."

1.Motivation

- Avissar et al. 2002, *JGR*

Many possible trajectories—
Which trajectory
will the Amazon follow?



From Avissar et al. 2002 doi:10.1029/2002JD002704

Question:

- How will different patterns of land cover development in Amazonia alter precipitation, surface temperature, and the surface energy budget?
- Ultimate Question: How is uncertainty in landscape heterogeneity and external forcings represented in Amazon climate outcomes?

2. Method

No one has future observations— so we must model the future

→ Great uncertainty in predictions

Important goal: **Represent the Uncertainty**

Assume two fundamental sources of uncertainty:

1. actual landscapes (stochastic)
2. external forcings

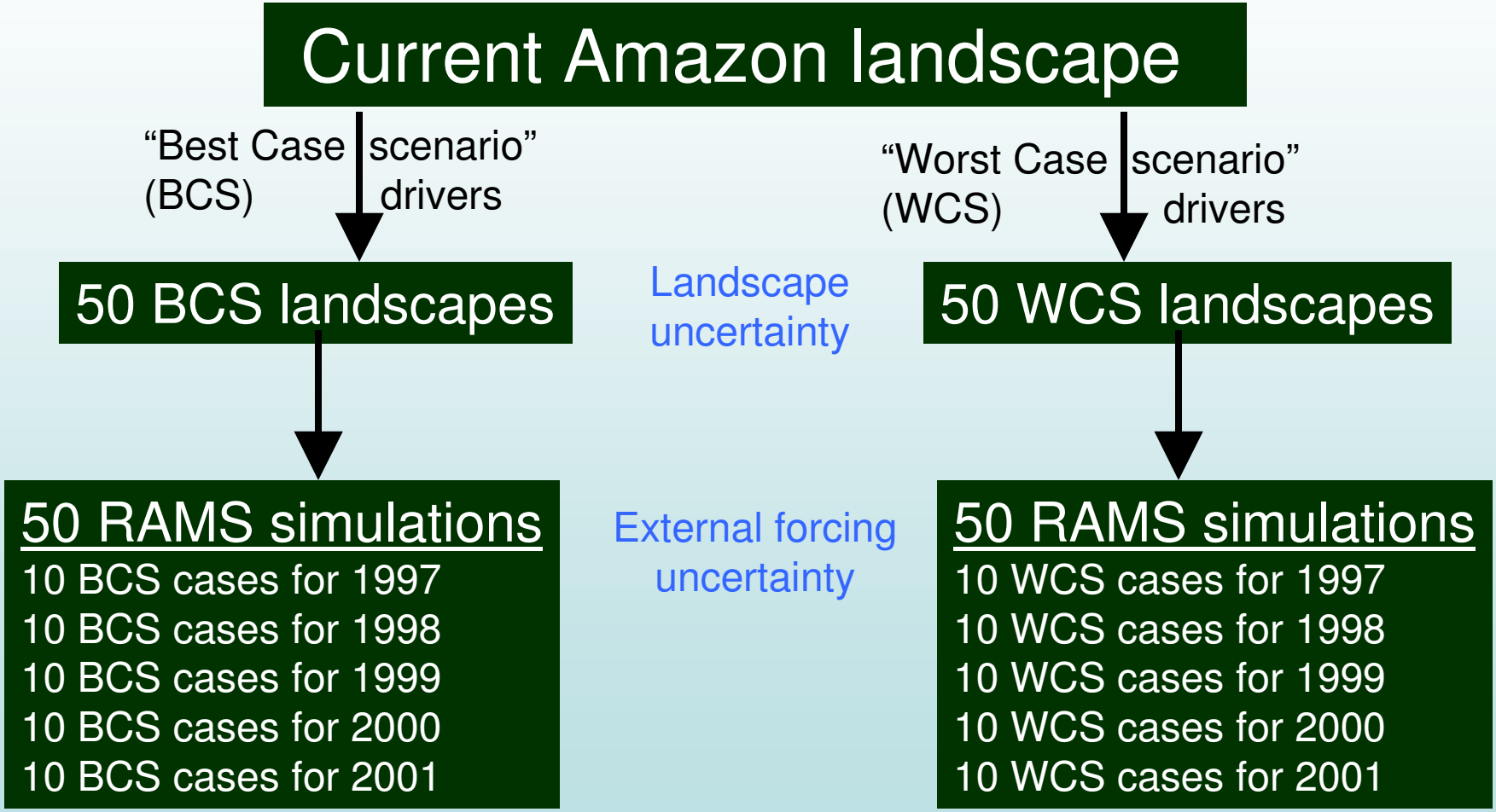
2. Method

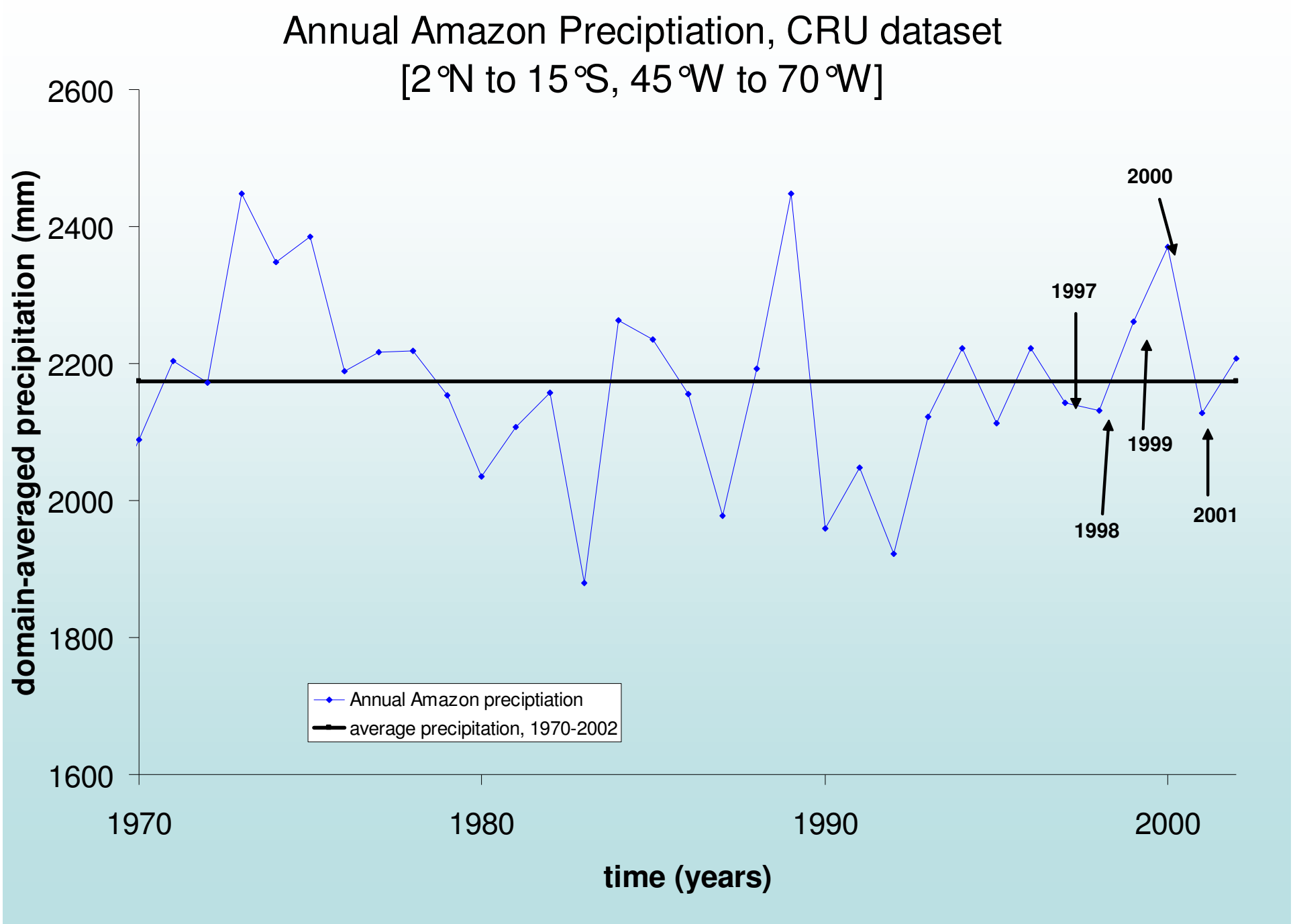
How we deal with these uncertainties:

1. use econometric model for landscapes (bernoulli trials)

2. use variety of atmospheric conditions across the spectrum of wet/normal/dry

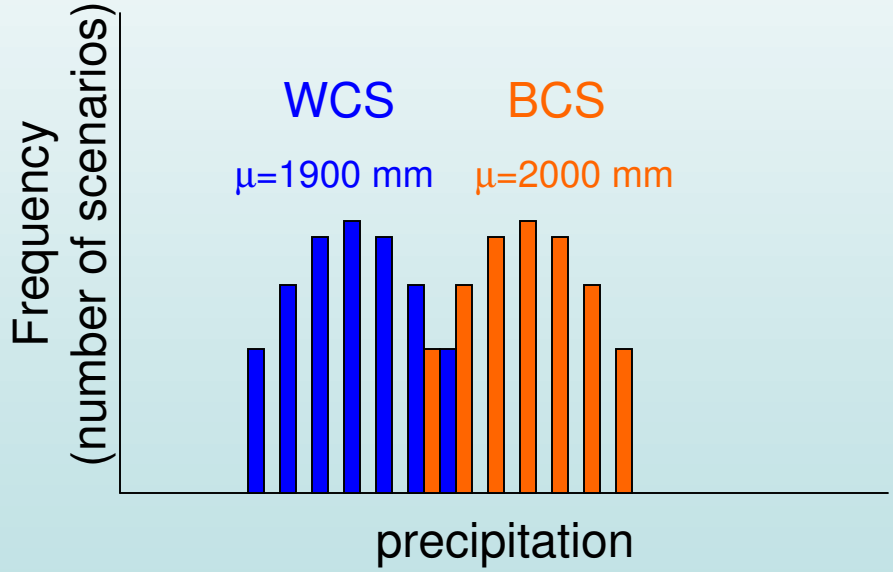
2. Method, continued




Annual Amazon Preciptiation, CRU dataset
[2°N to 15°S, 45°W to 70°W]
domain-averaged precipitation (mm)
2600
2400
2200
2000
1800
1600
1970
1980
1990
2000
time (years)
Annual Amazon preciptiation
average precipitation, 1970-2002
1997
2000
1998
1999
2001

Long-term Goal

- to produce ***actual estimates of uncertainty*** based on probability distributions.
- We hypothesize that it might look something like



•No iterations to this point for feedback yet…

Technical Considerations

- 4.1 T of data (and counting…)
- 100 year-long simulations (50 BCS, 50 WCS)
- 1 sim month : 6 real days

Postprocessing:

  - Only retained a subset of variables
  - TRMM, MODIS LST available for validation

Current status

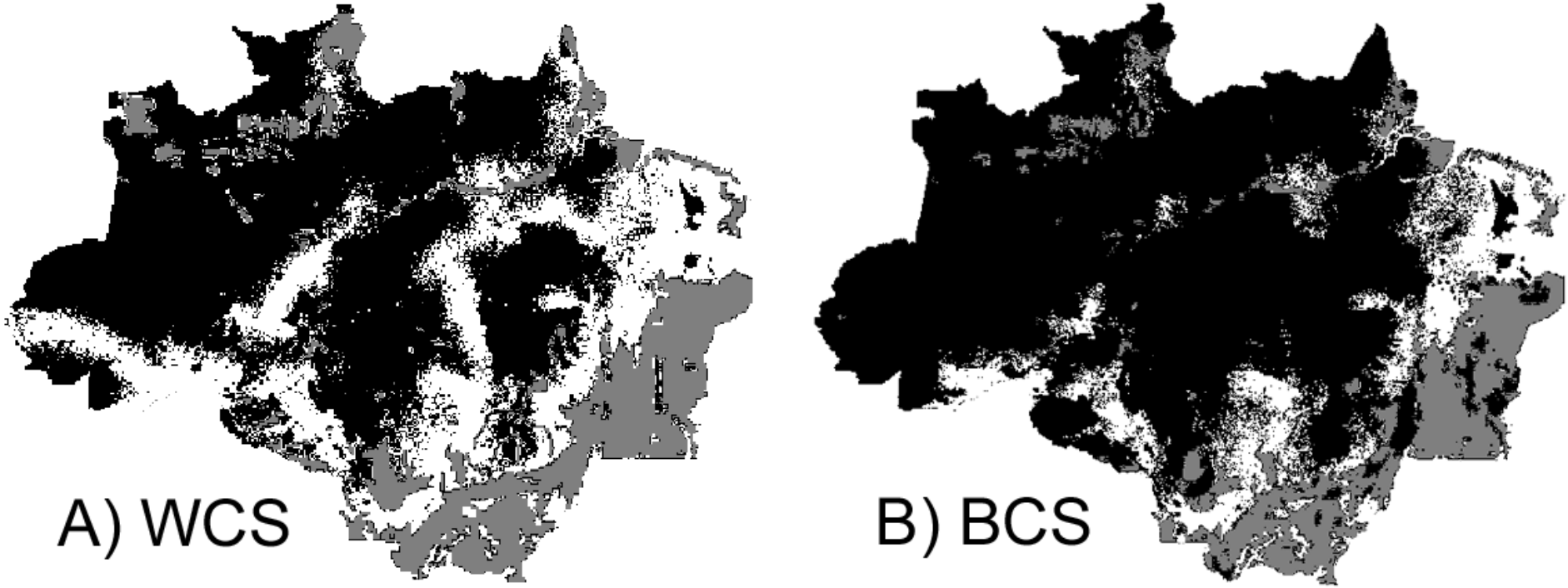
- About 60% to 6 months completed

	BCS	WCS
2001	01,02,03,04,05	01,02,03,04,05
	26,27,28,29,30	26,27,28,29,30
2000	06,07,08,09,10	06,07,08,09,10
	31,32,33,34,35	31,32,33,34,35
1999	11,12,13,14,15	11,12,13,14,15
	36,37,38,39,40	36,37,38,39,40
1998	16,17,18,19,20	16,17,18,19,20
	41,42,43,44,45	41,42,43,44,45
1997	21,22,23,24,25	21,22,23,24,25
	46,47,48,49,50	46,47,48,49,50

blue=not to July yet

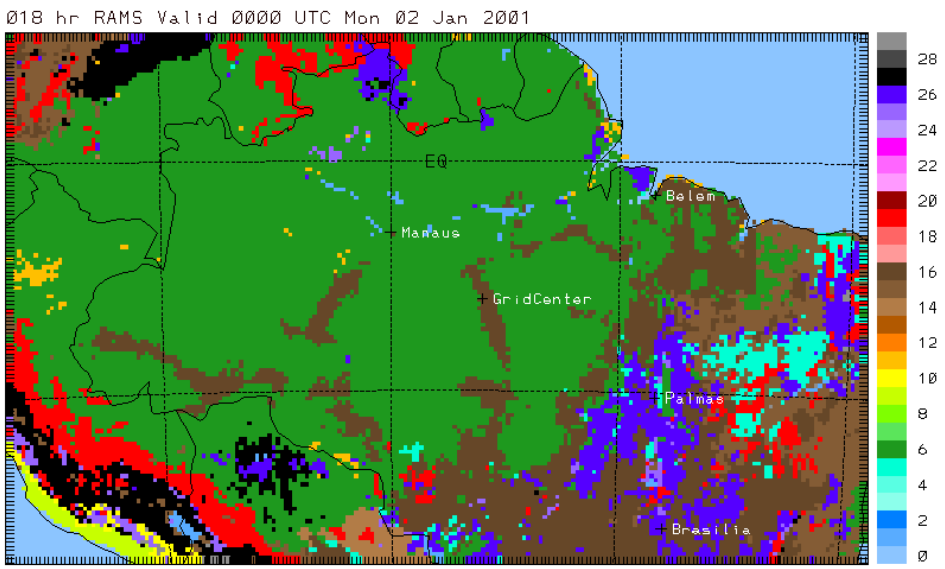
3. Examples of Generated Land Cover

1) Econometric Model creates potential landscape

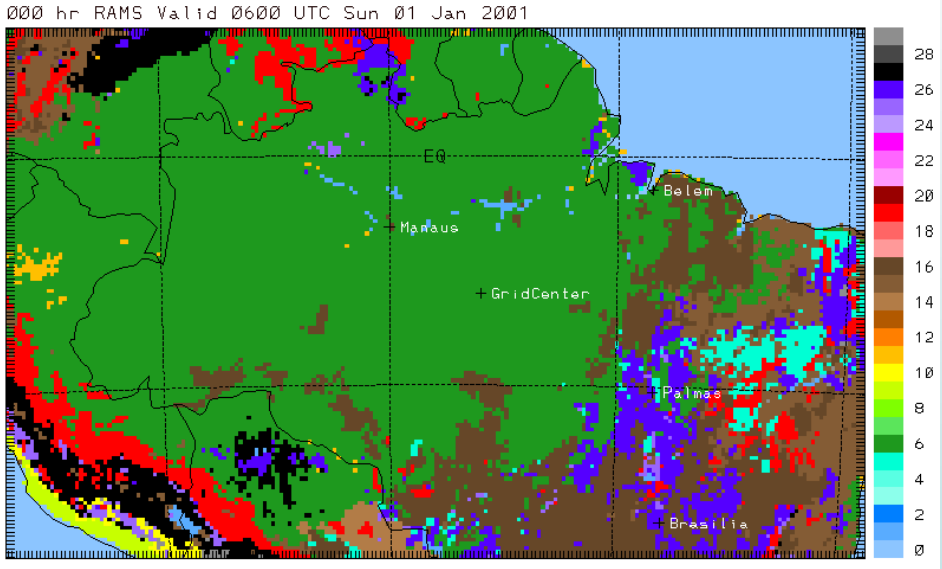


Black = forest white = converted to pasture grey = other class

2) Represent these maps in the RAMS Climate Model



WCS in RAMS

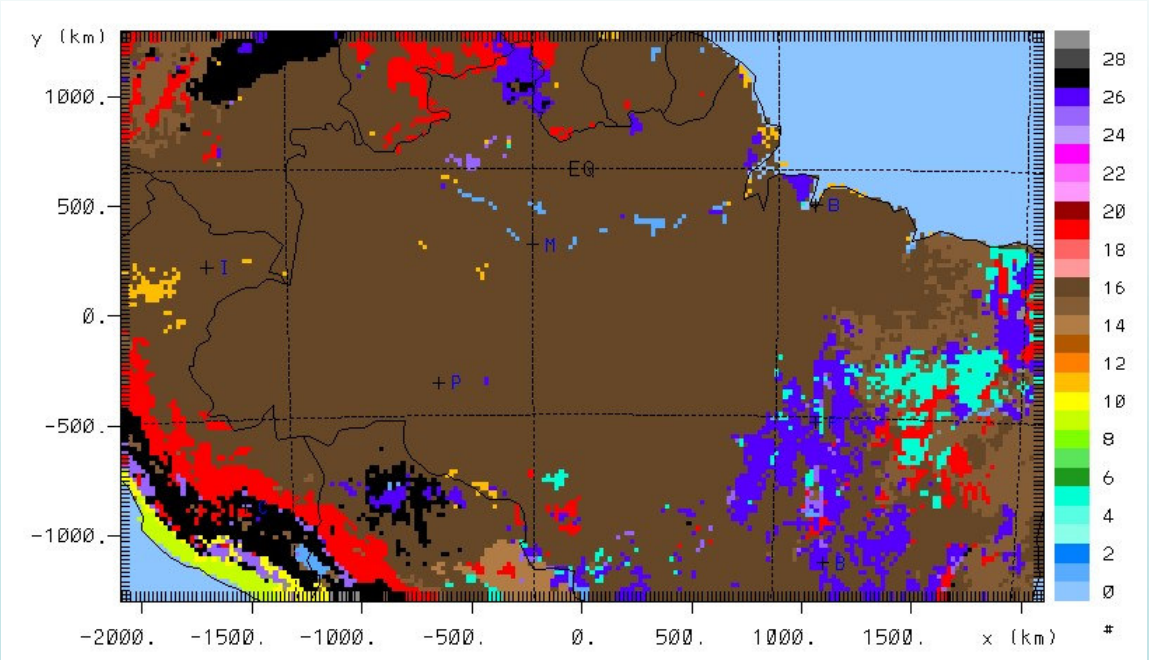


BCS in RAMS

Aggregated to 20 km (model grid spacing)
Classes from GLC2000

Also did Total Deforestation

(sensitivity test)

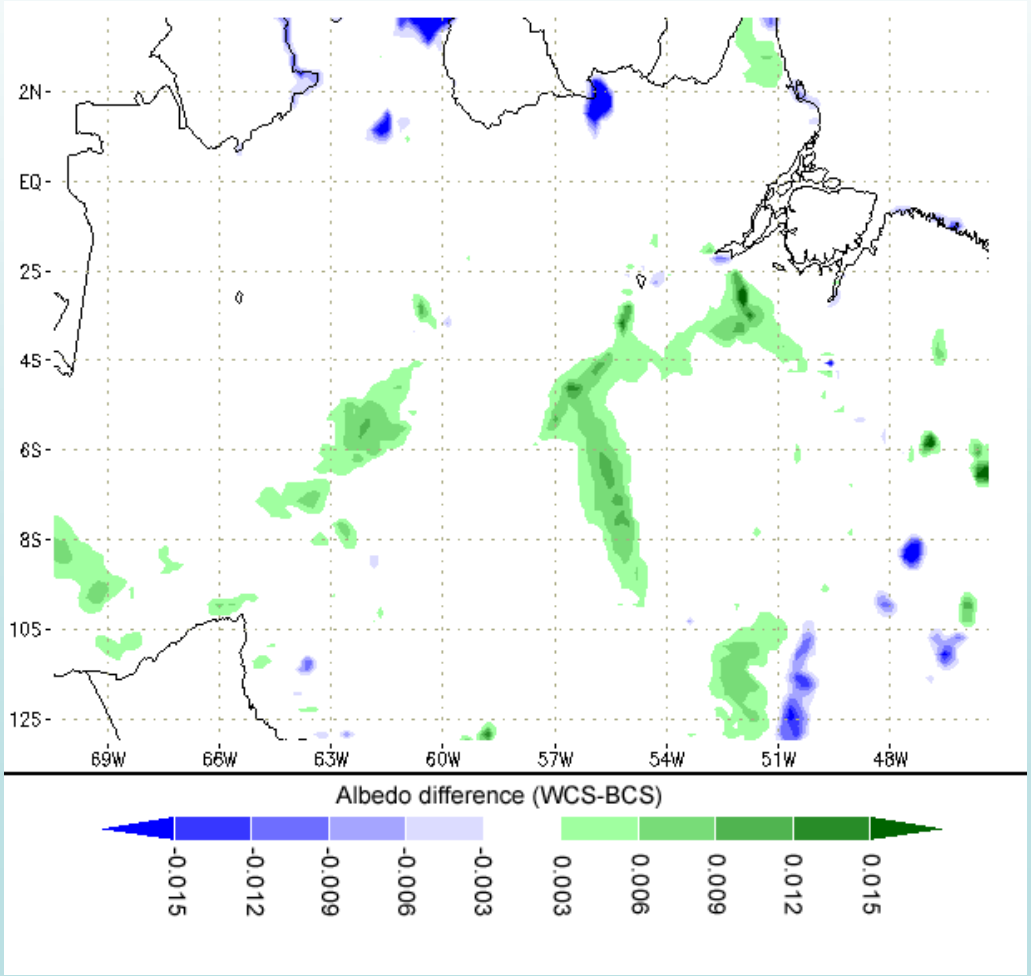


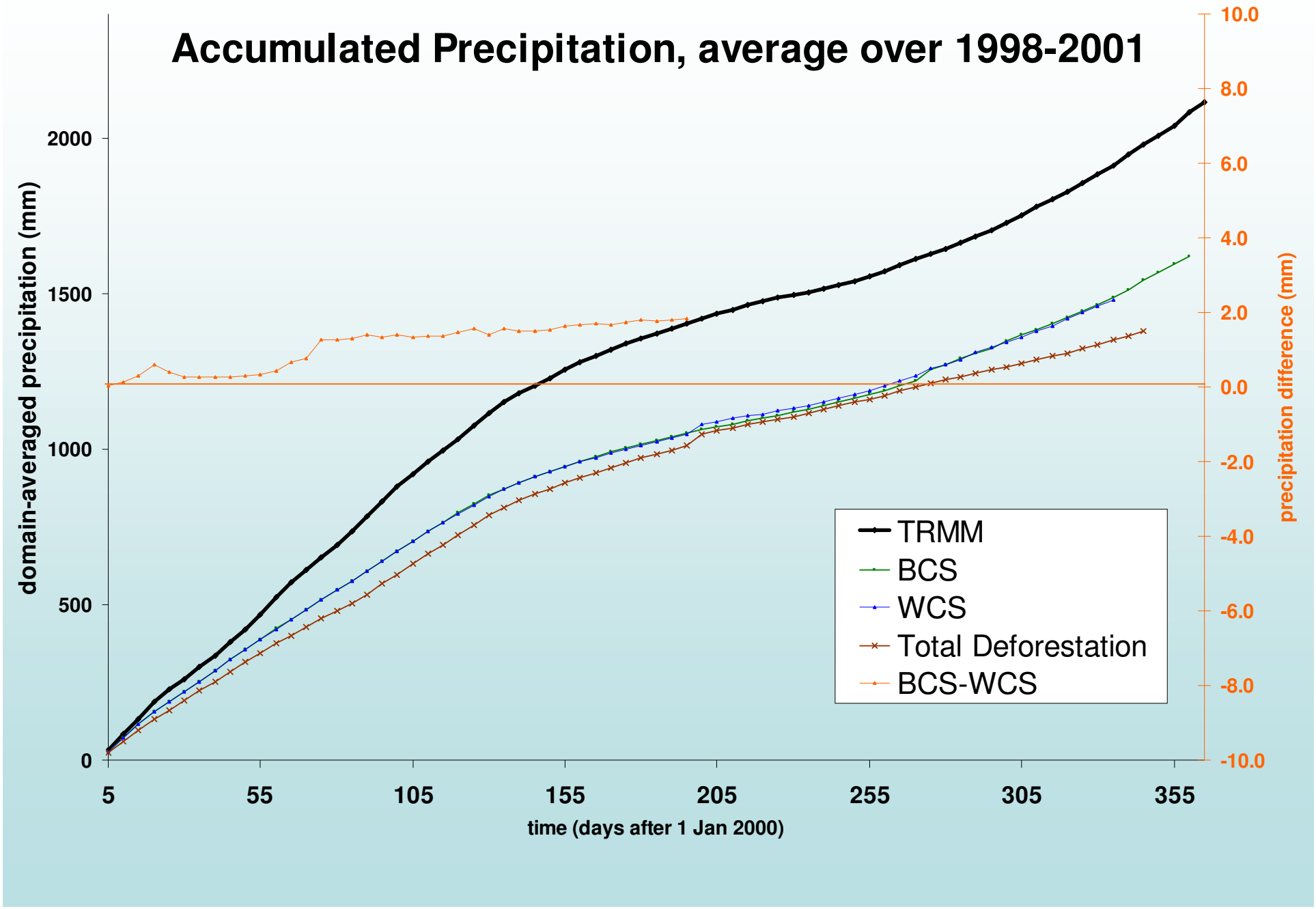
4. Aspects of Model Configuration

- 20 km grid spacing (c.f. Ramos da Silva & Avissar 2006)
- 30 vertical levels
- Kain-Frisch convective parameterization
- LEAF-2 (Walko et al. 2000) biophysical characteristics
- Chen radiation scheme
- Mellor-Yamada diffusion
- Soil levels = -4.0, -2.0, -1.0, -.8, -.6, -.4, -.2, -.1, meters

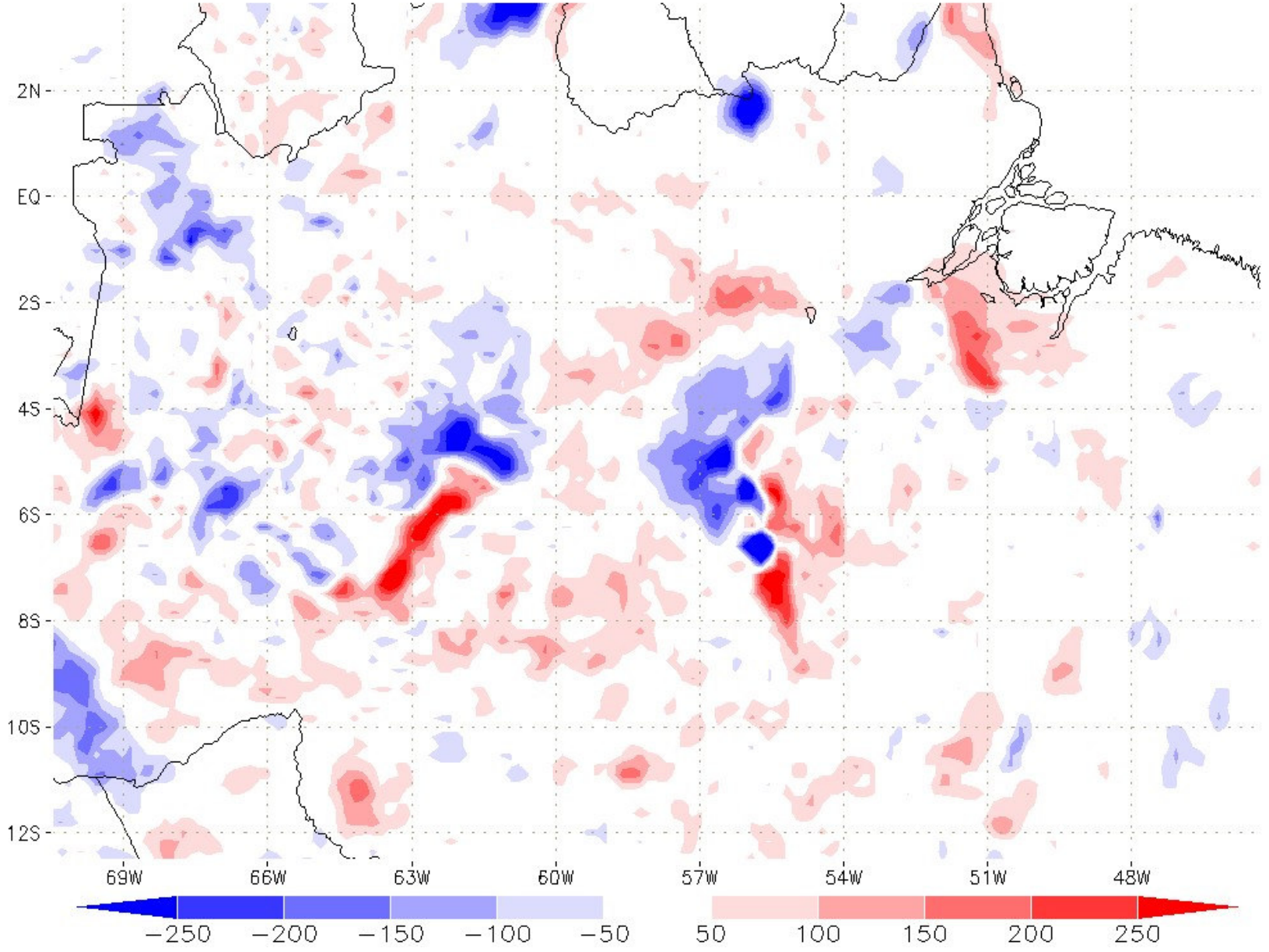
5. Results

Pasture has mostly grass → brighter albedo




Accumulated Precipitation, average over 1998-2001
domain-averaged precipitation (mm)
precipitation difference (mm)
time (days after 1 Jan 2000)
0
500
1000
1500
2000
5
55
105
155
205
255
305
355
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
TRMM
BCS
WCS
Total Deforestation
BCS-WCS

Rainfall Distribution, Jan to June (averaged)



Additional Comments

- No confidence intervals
- Only single cases for each scenario-year completed for this presentation

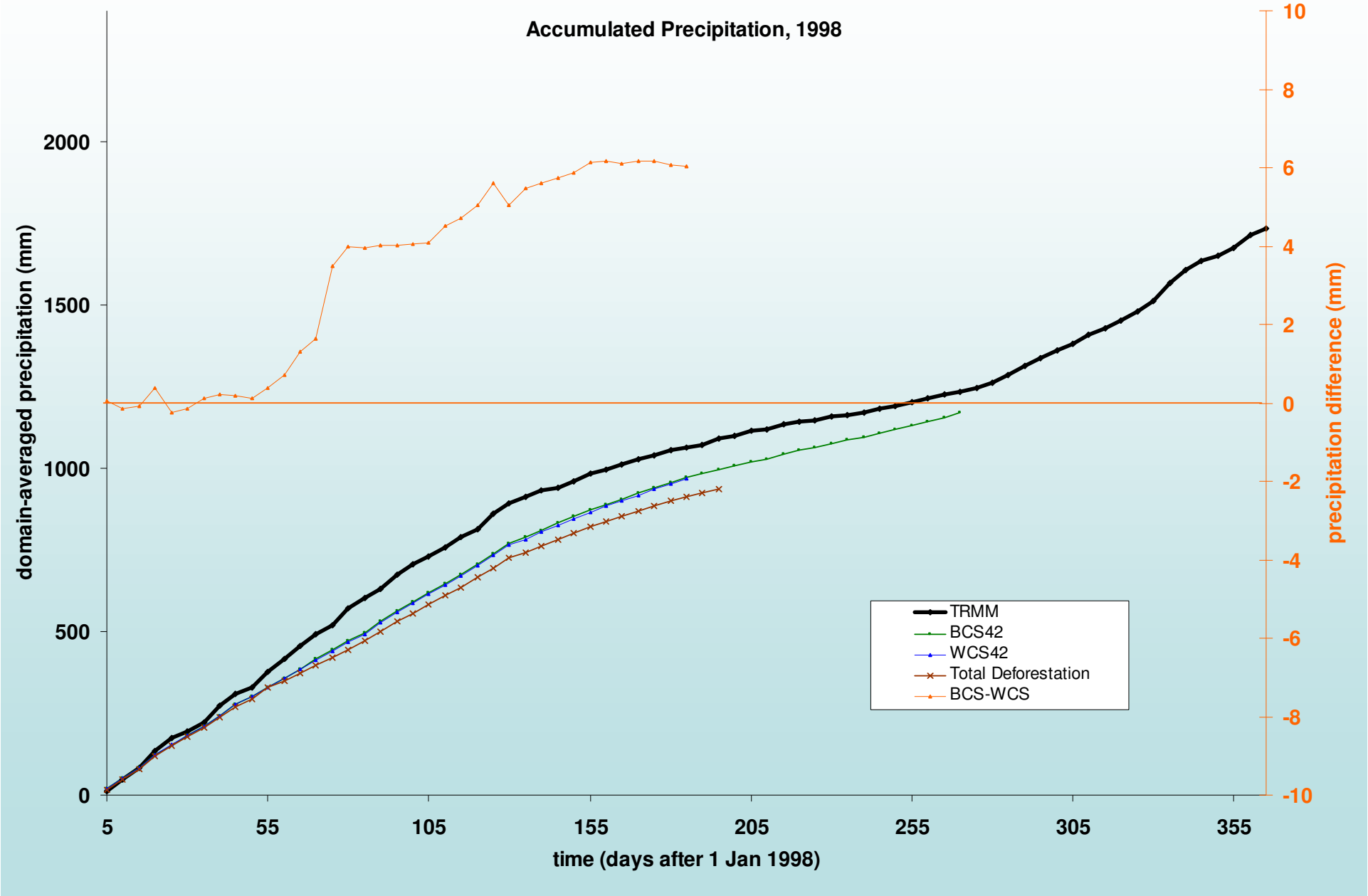
- Seasonality?
- Distribution
- Domain-avgd masks the spatial character
- Policy: optimal arrangement/farm size?

Major Advancements

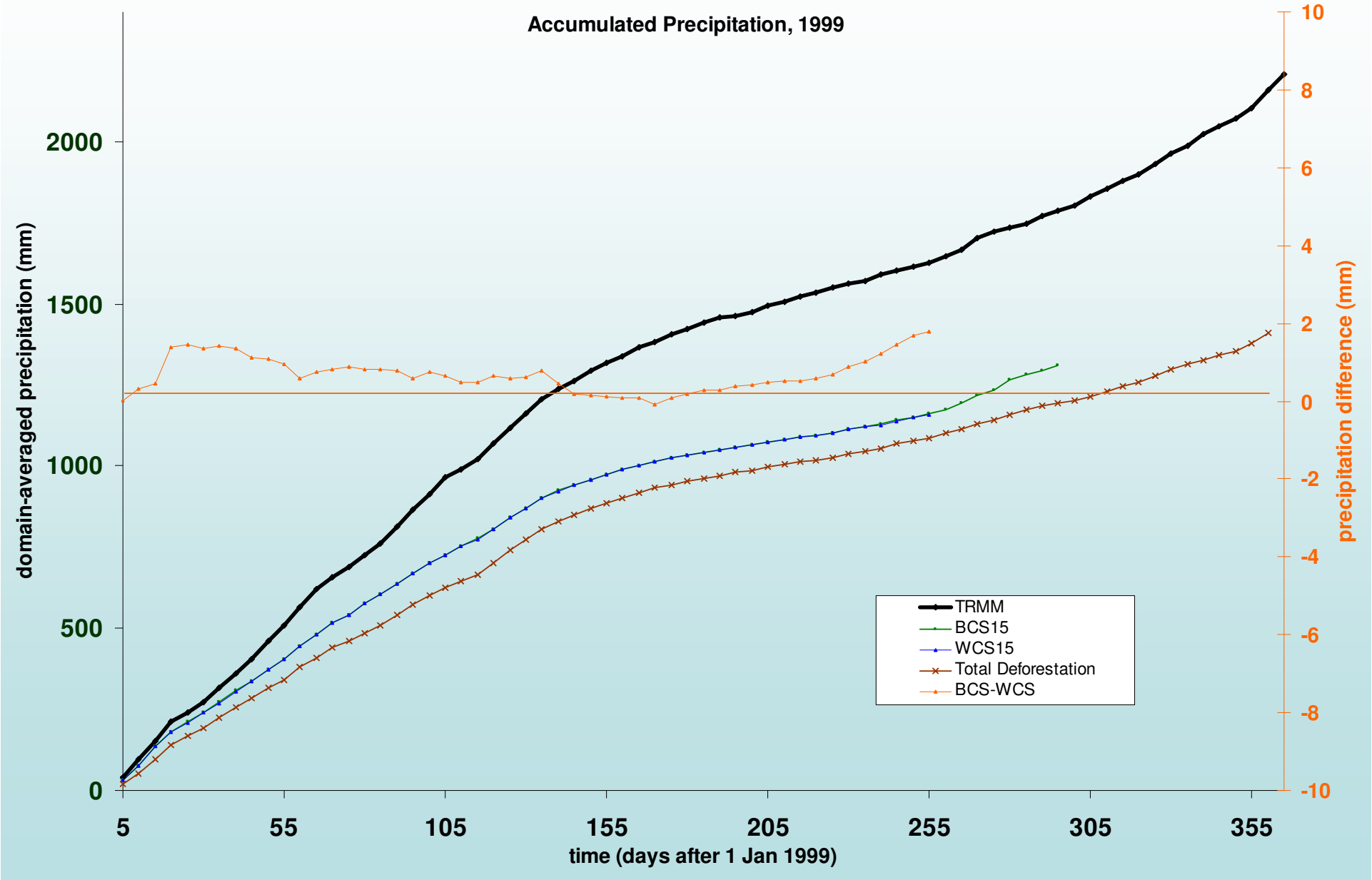
- Treatment of uncertainty
- Spatial representation of threatened areas
- Span over wet-dry transition

(Extra Stuff)

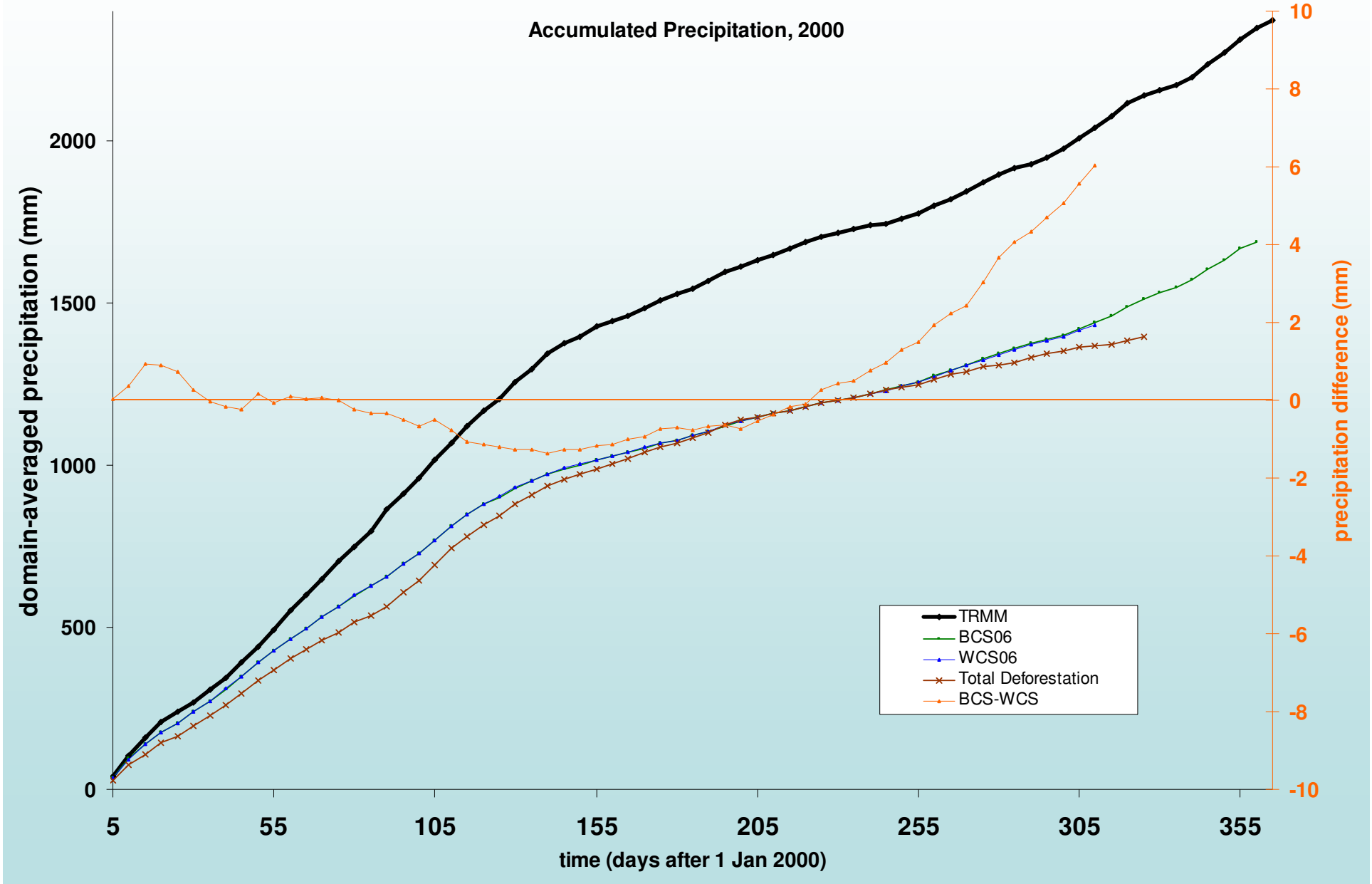
Climate Impacts – Rainfall Amounts



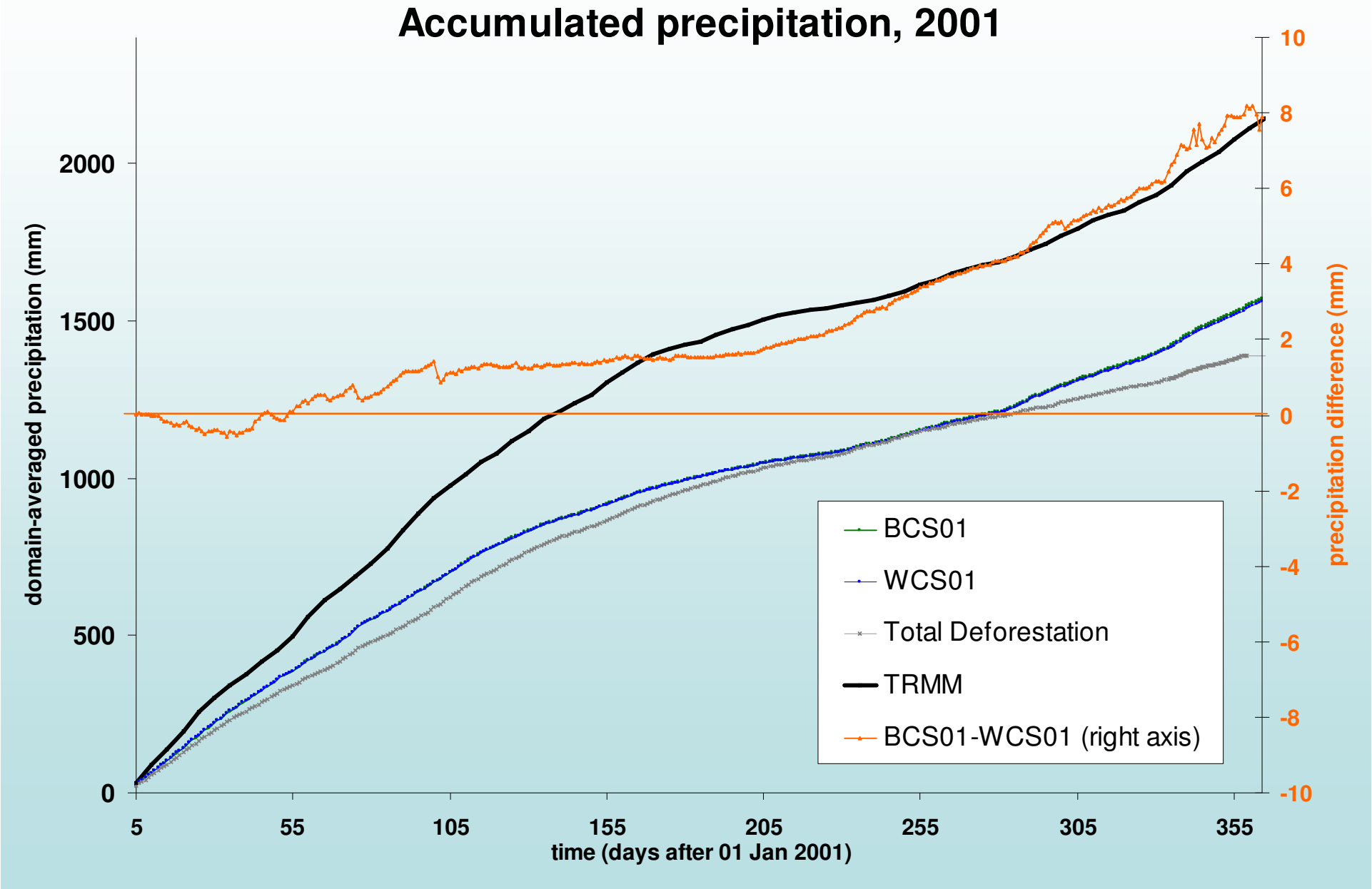
Climate Impacts – Rainfall Amounts



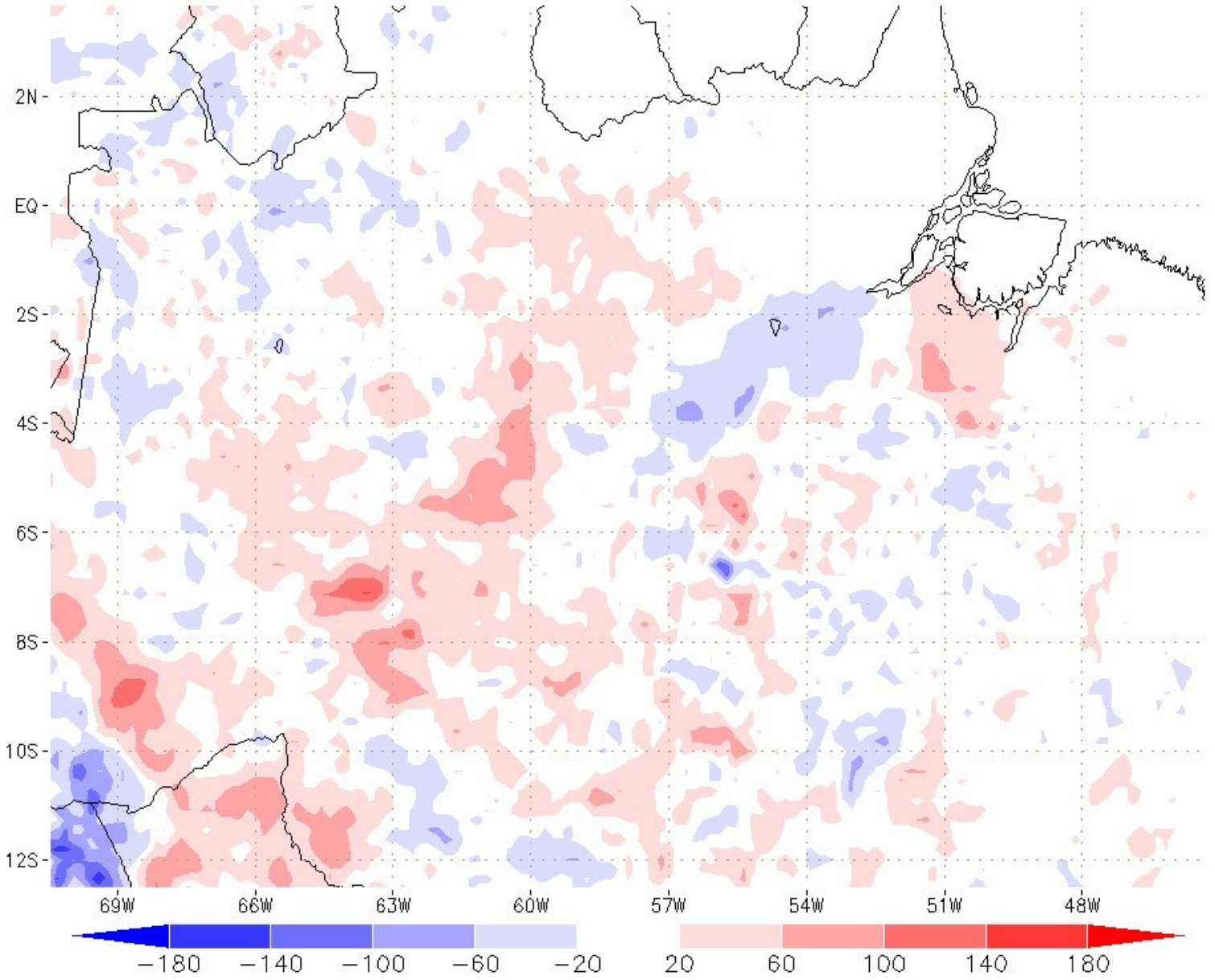
Climate Impacts – Rainfall Amounts



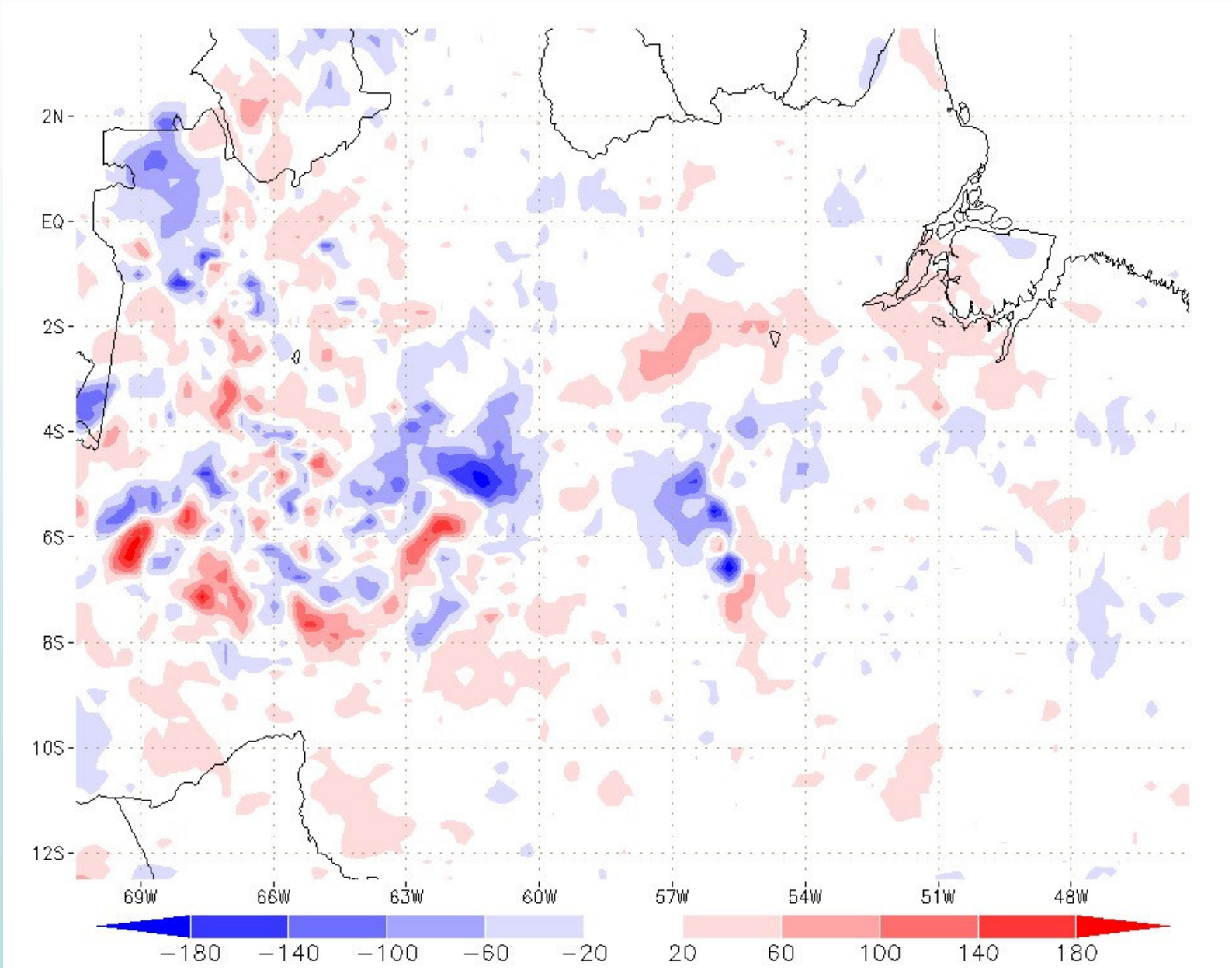
Climate Impacts – Rainfall Amounts



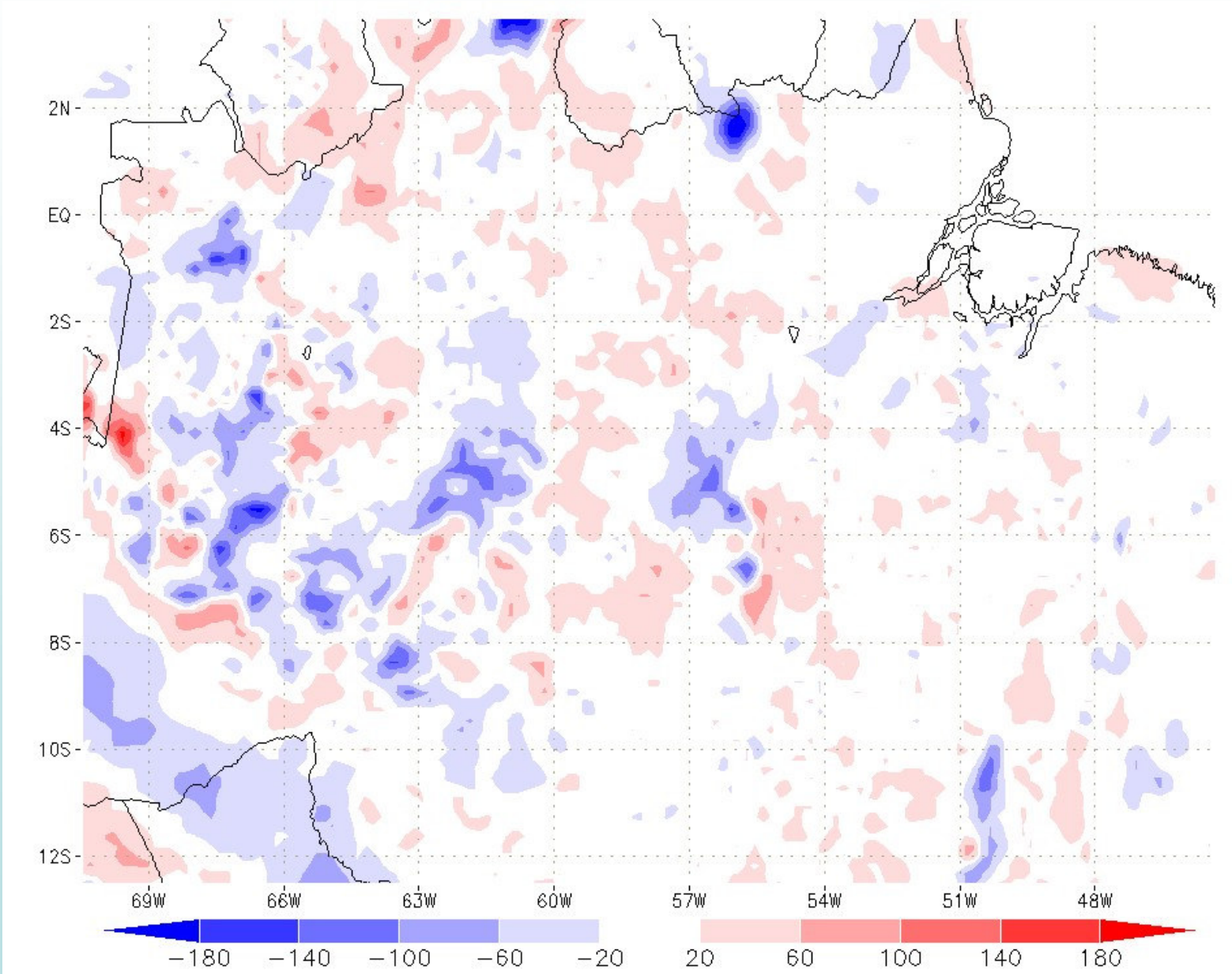
Rainfall Distribution, Jan to June 1998



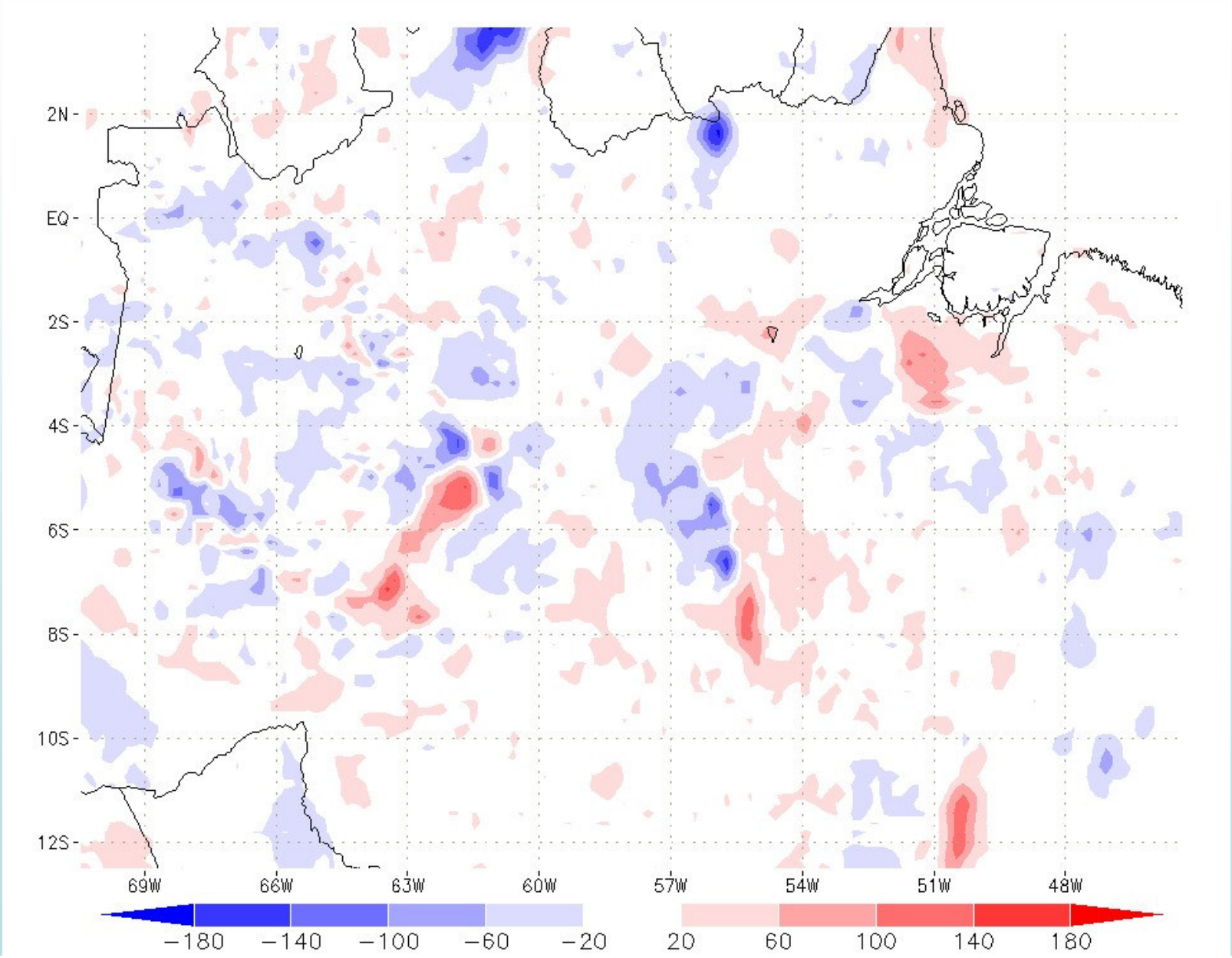
Rainfall Distribution, Jan to June 1999

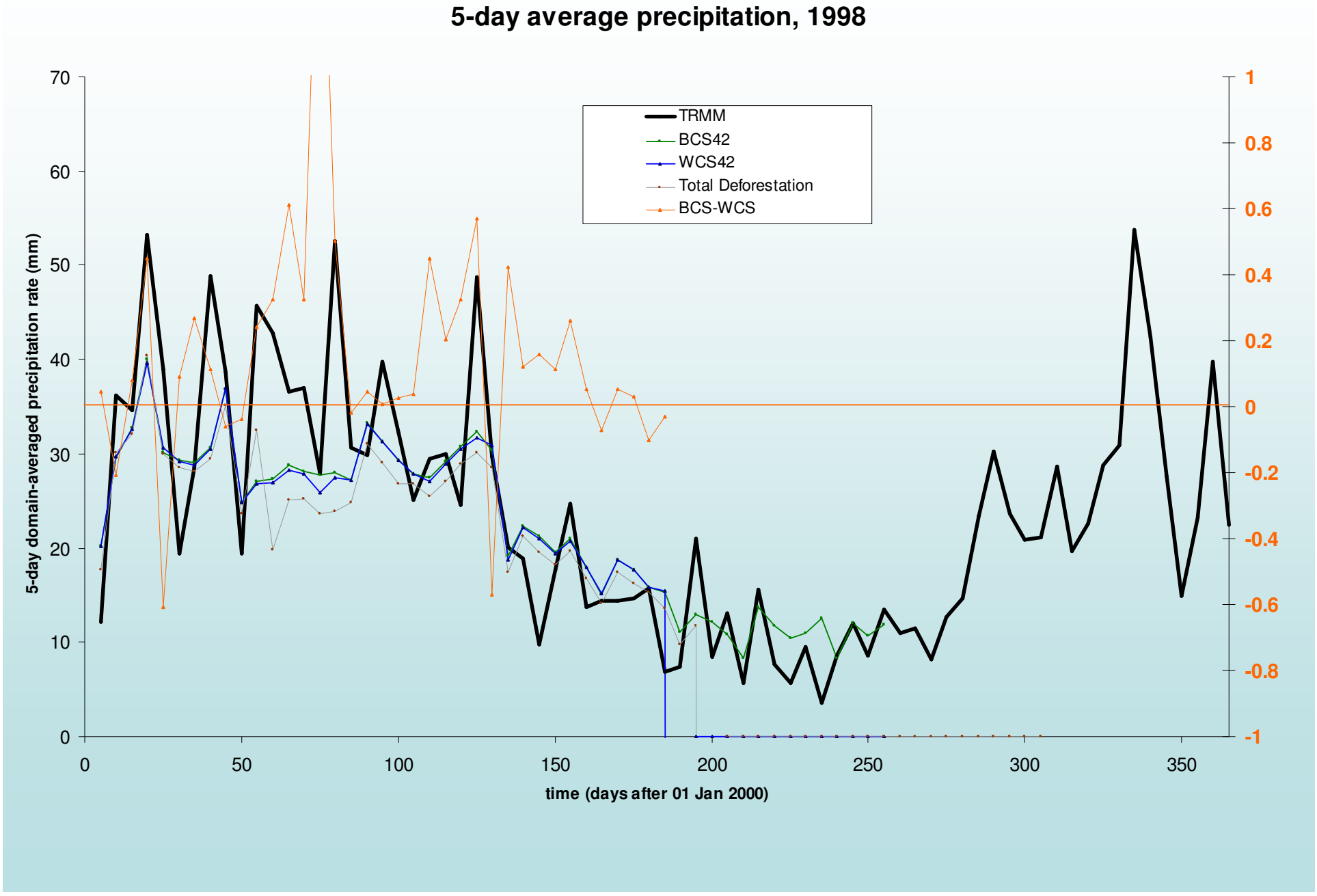


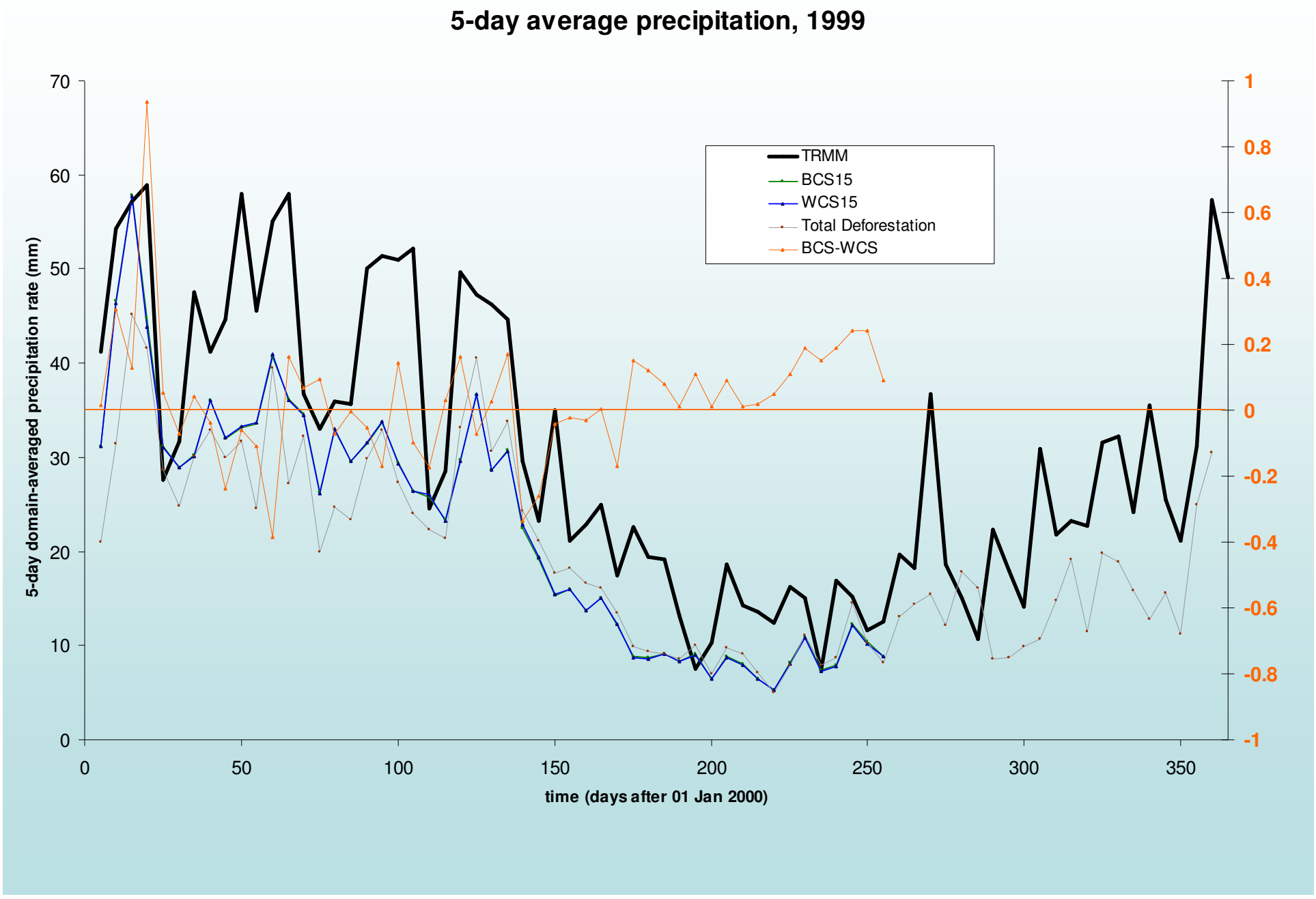
Rainfall Distribution, Jan to June 2000

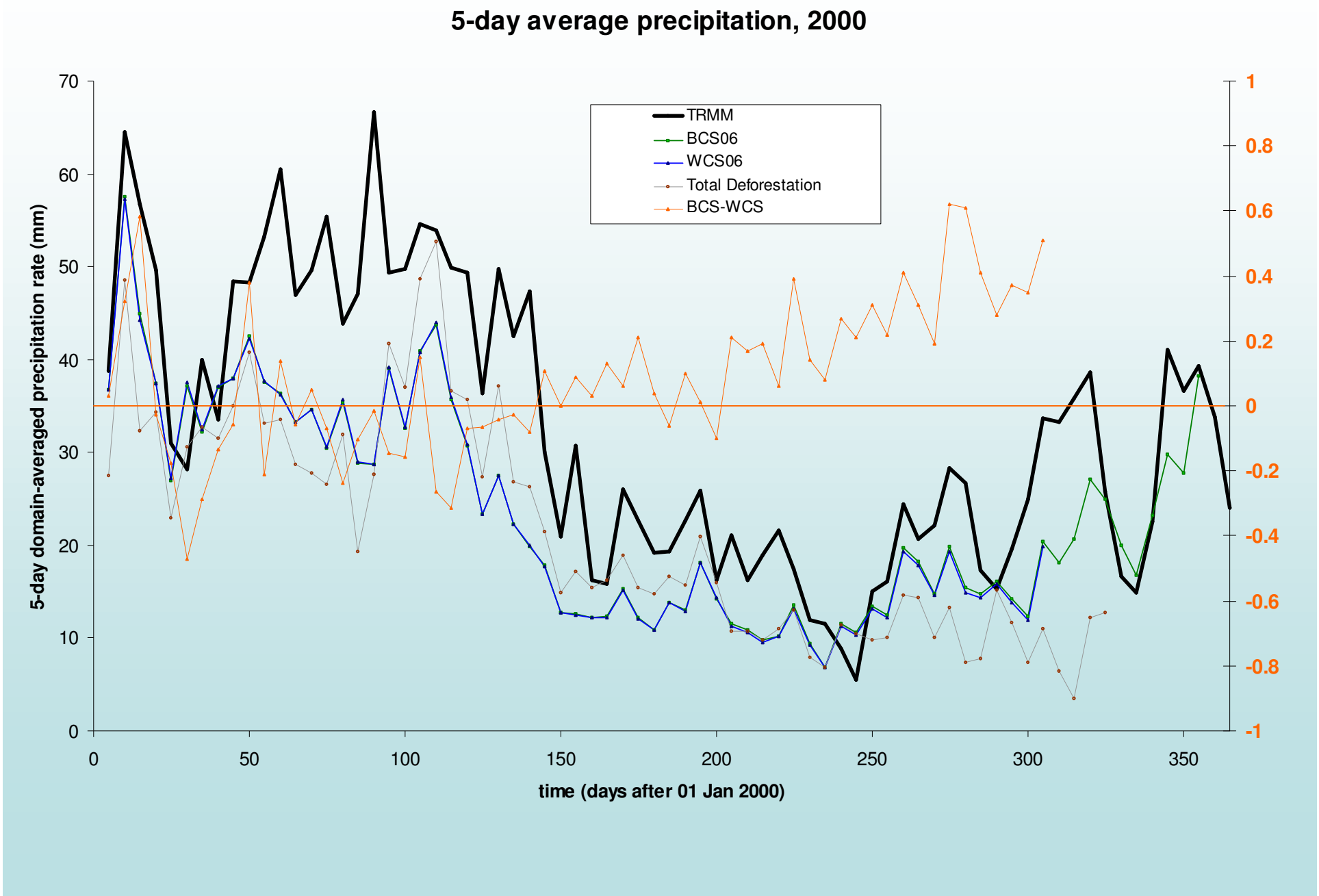


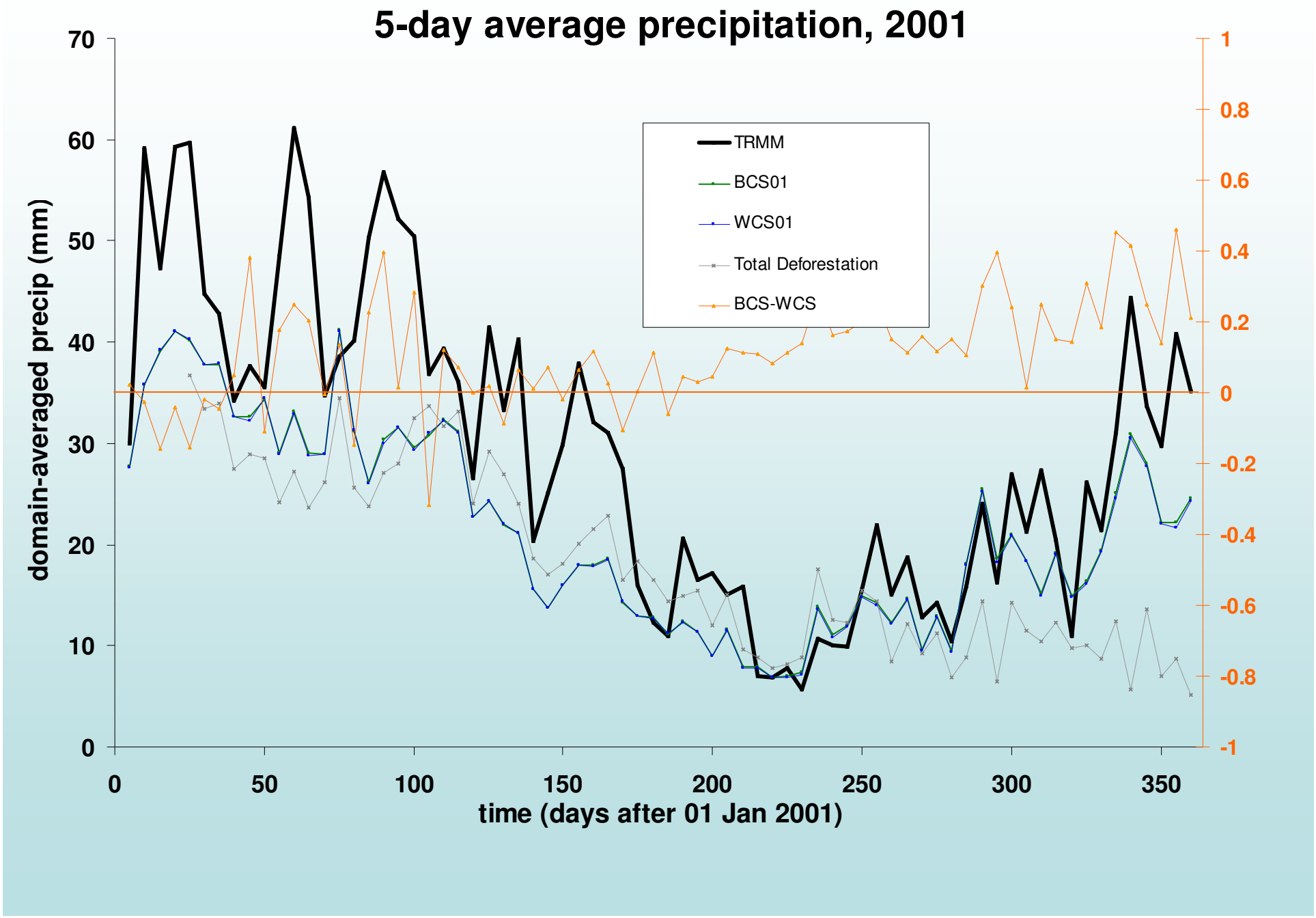
Rainfall Distribution, Jan to June 2001




5-day average precipitation, 1998
TRMM
BCS42
WCS42
Total Deforestation
BCS-WCS
5-day domain-averaged precipitation rate (mm)
time (days after 01 Jan 2000)
0
10
20
30
40
50
60
70
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
0
50
100
150
200
250
300
350


5-day average precipitation, 1999
5-day domain-averaged precipitation rate (mm)
time (days after 01 Jan 2000)
TRMM
BCS15
WCS15
Total Deforestation
BCS-WCS
0
10
20
30
40
50
60
70
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
0
50
100
150
200
250
300
350


5-day average precipitation, 2000
TRMM
BCS06
WCS06
Total Deforestation
BCS-WCS
5-day domain-averaged precipitation rate (mm)
time (days after 01 Jan 2000)
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


5-day average precipitation, 2001
domain-averaged precip (mm)
time (days after 01 Jan 2001)
TRMM
BCS01
WCS01
Total Deforestation
BCS-WCS
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1