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Tradeoffs between global warming and day length on the vegetation carbon uptake period

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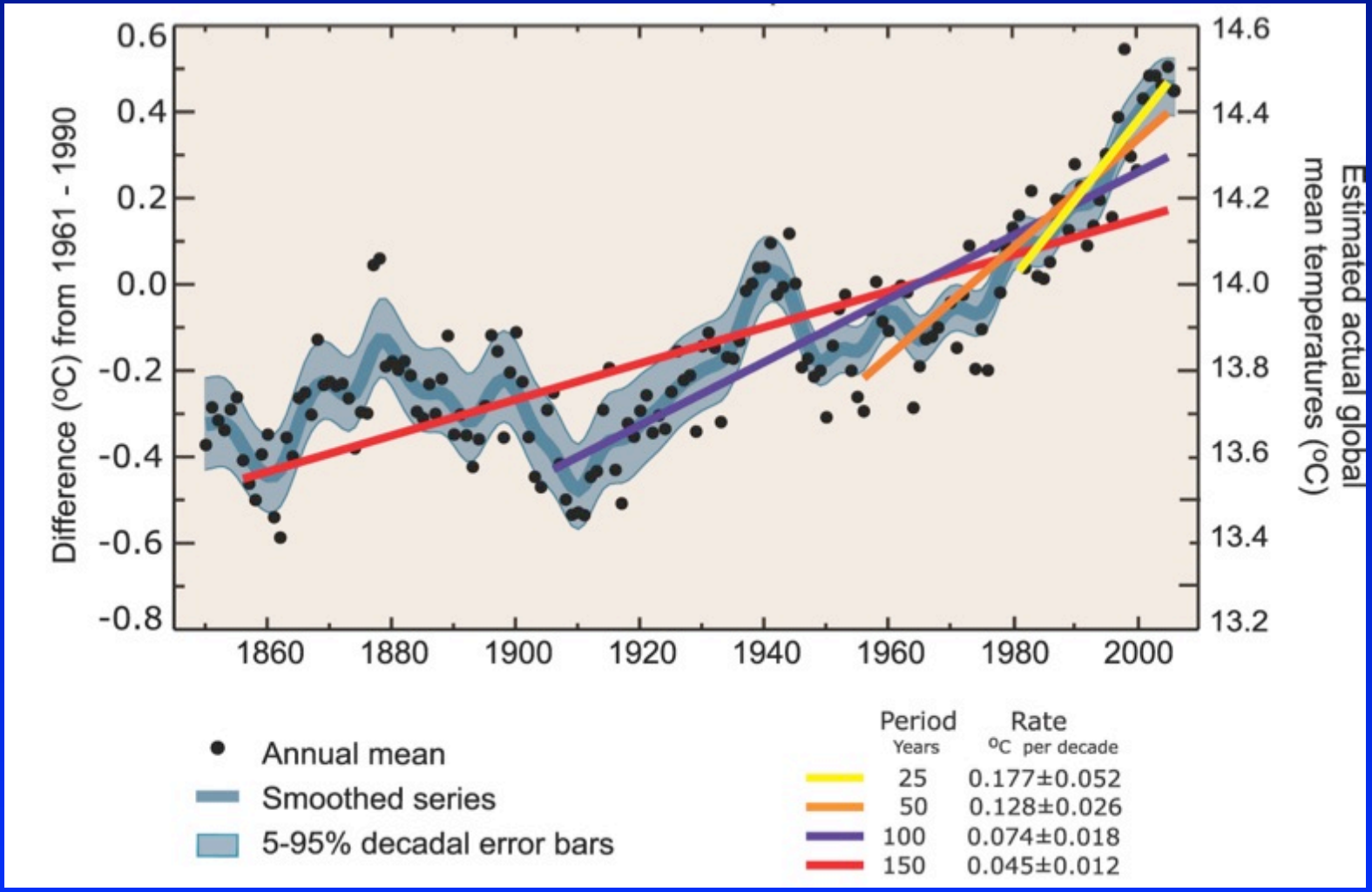
Warming up ...



FAQ 3.1 Fig. 1, WG1 IPCC, 2007

... associated decrease in snow cover

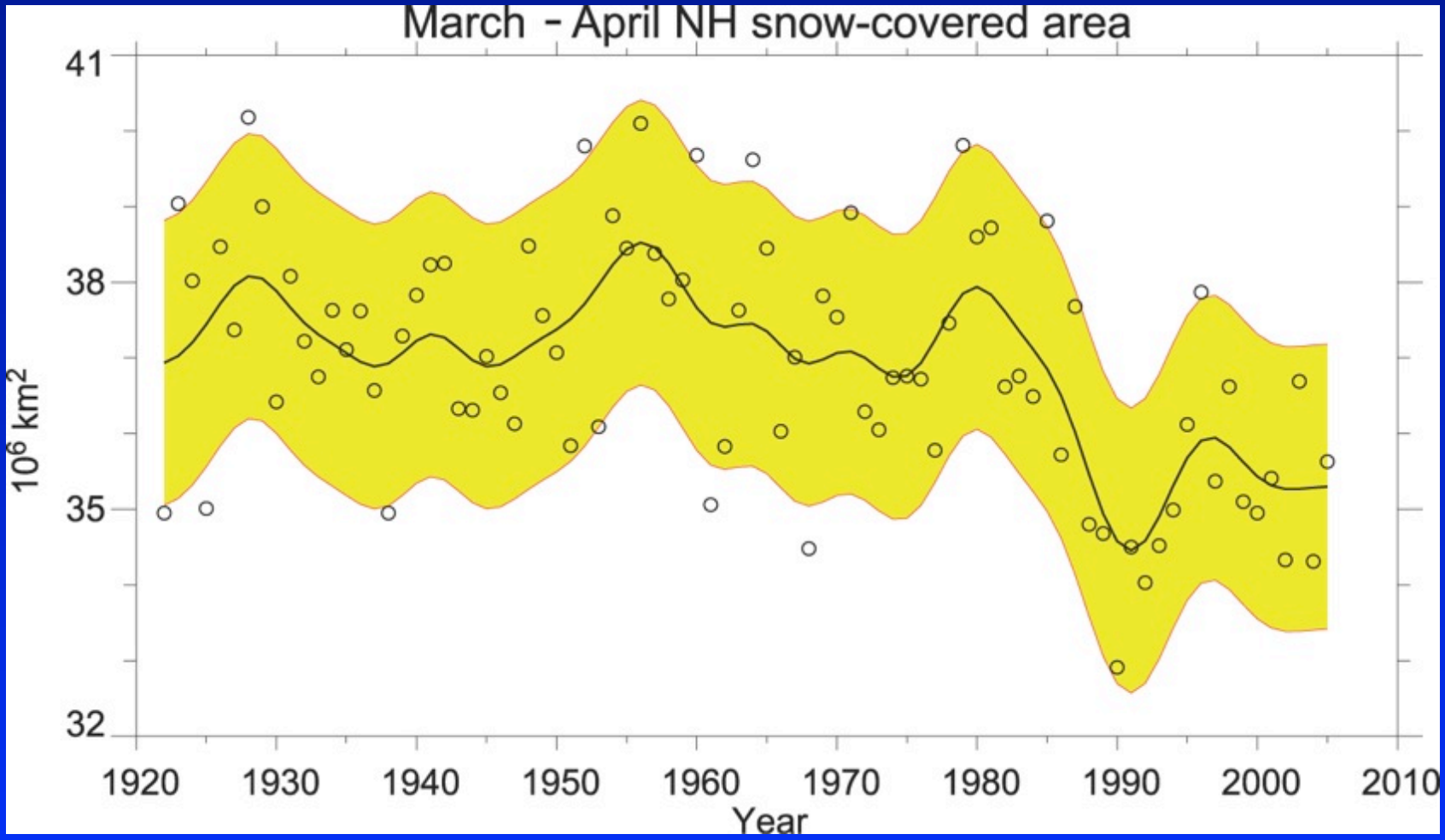
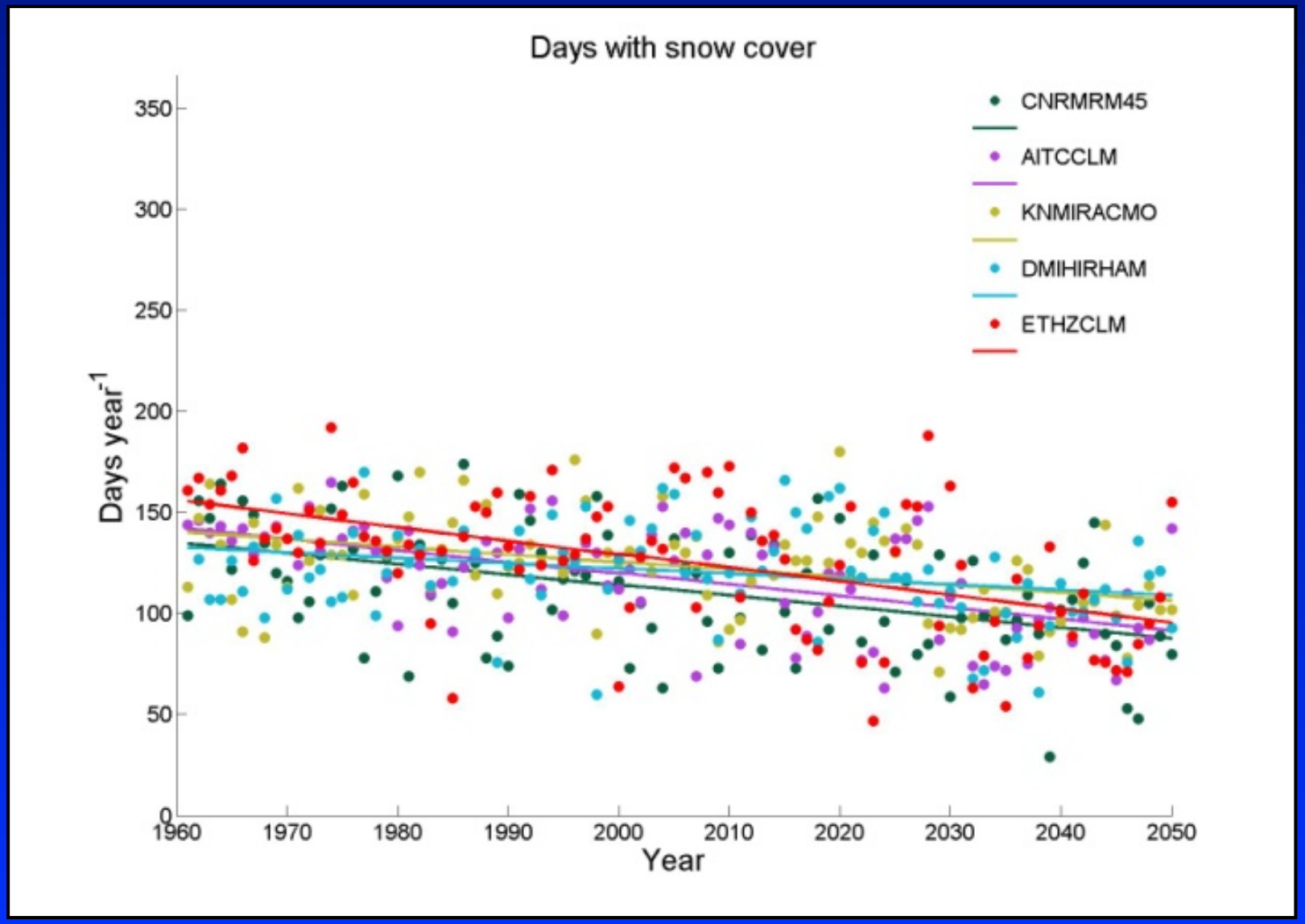


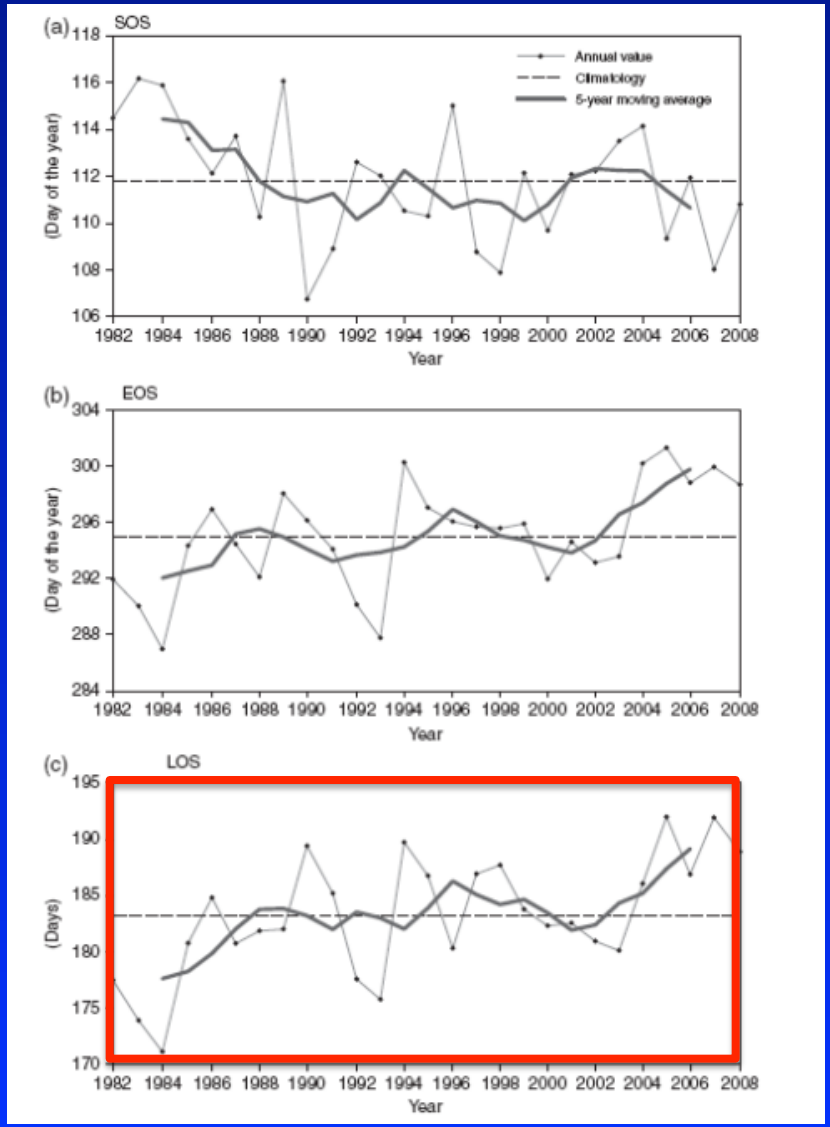
Fig. 4.3, WG1 IPCC, 2007

... and snow duration



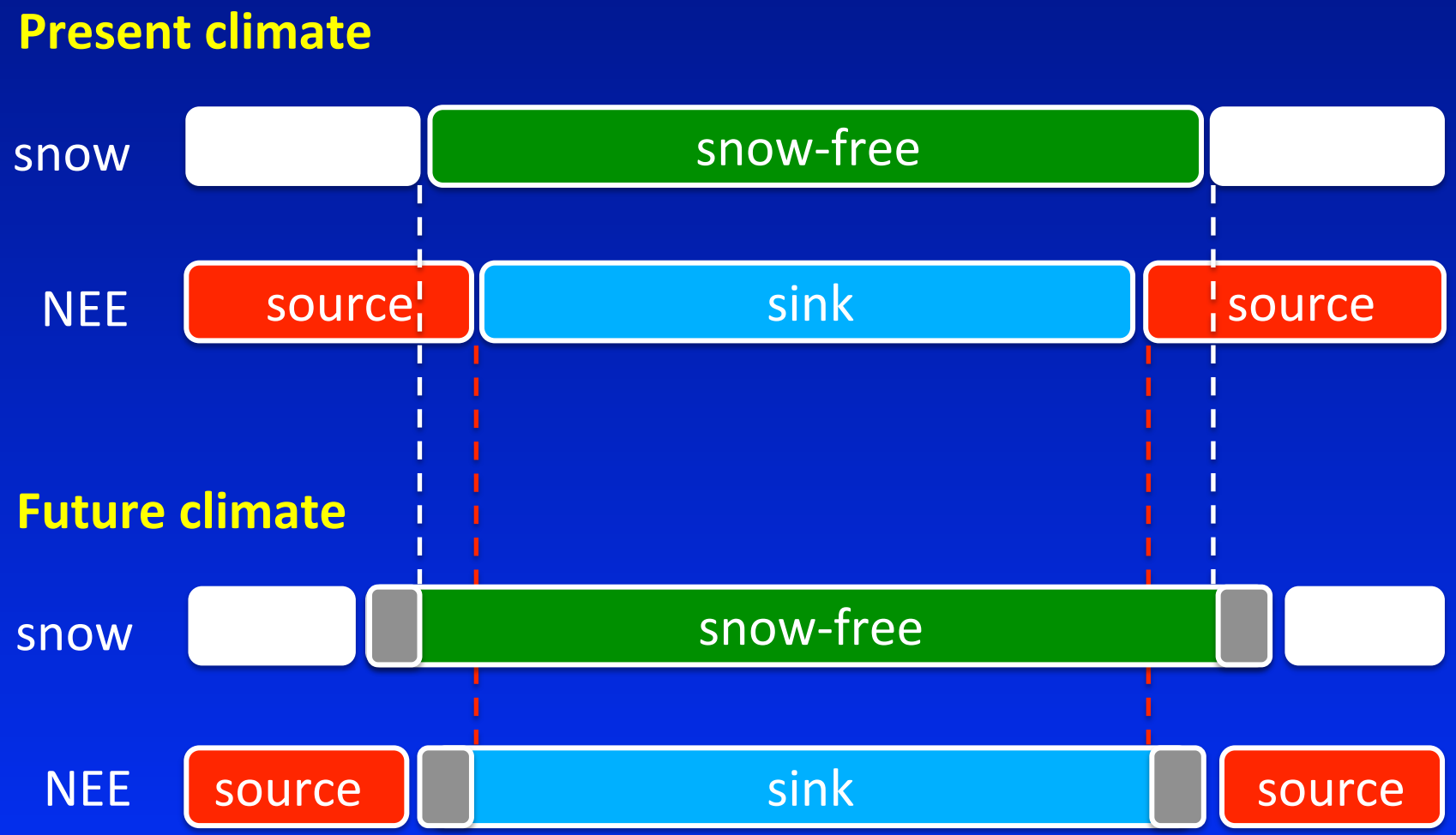
Hammerle et al. (in preparation)

Changes in onset, end and duration of growing season

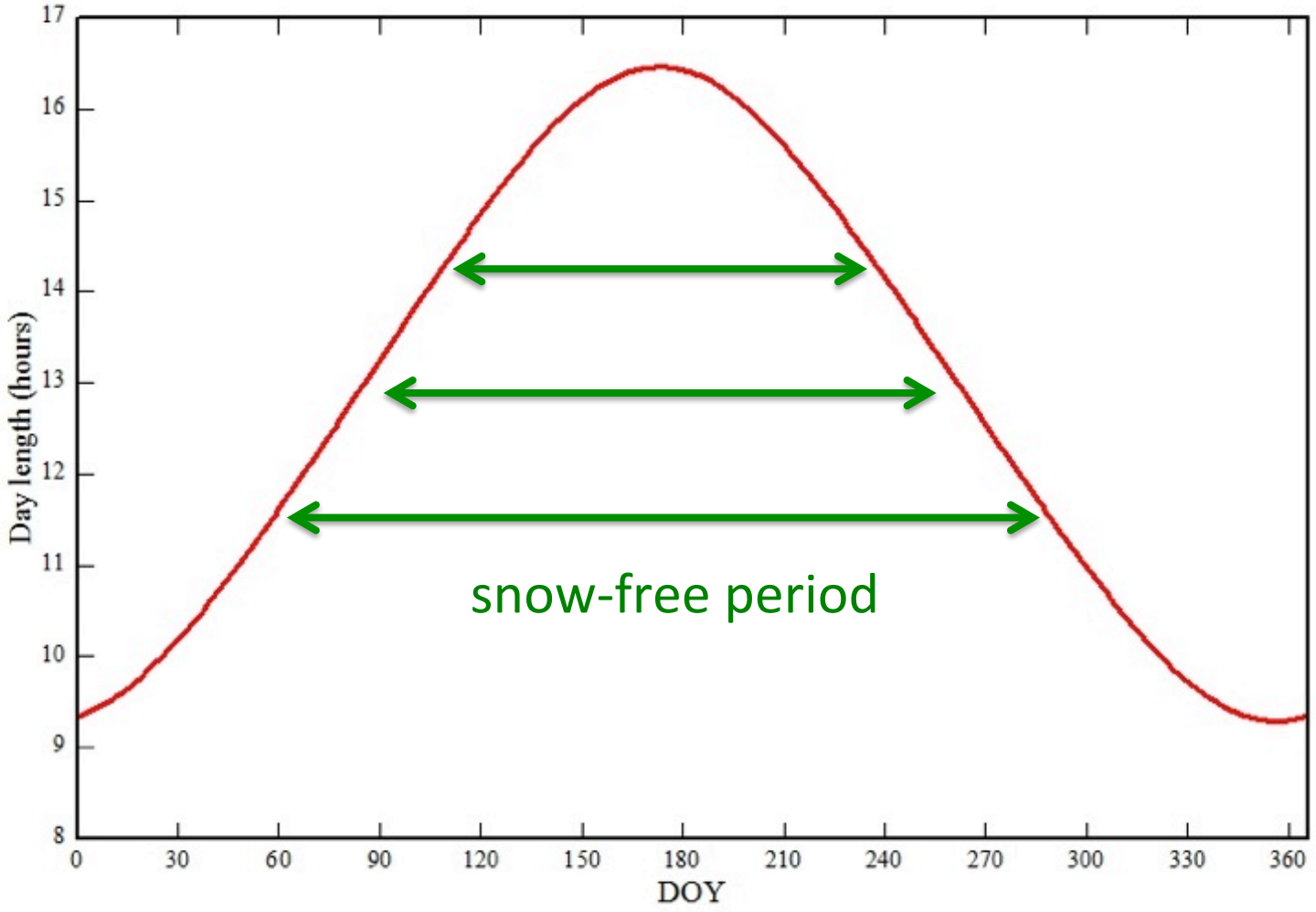


Jeong et al. (2011)

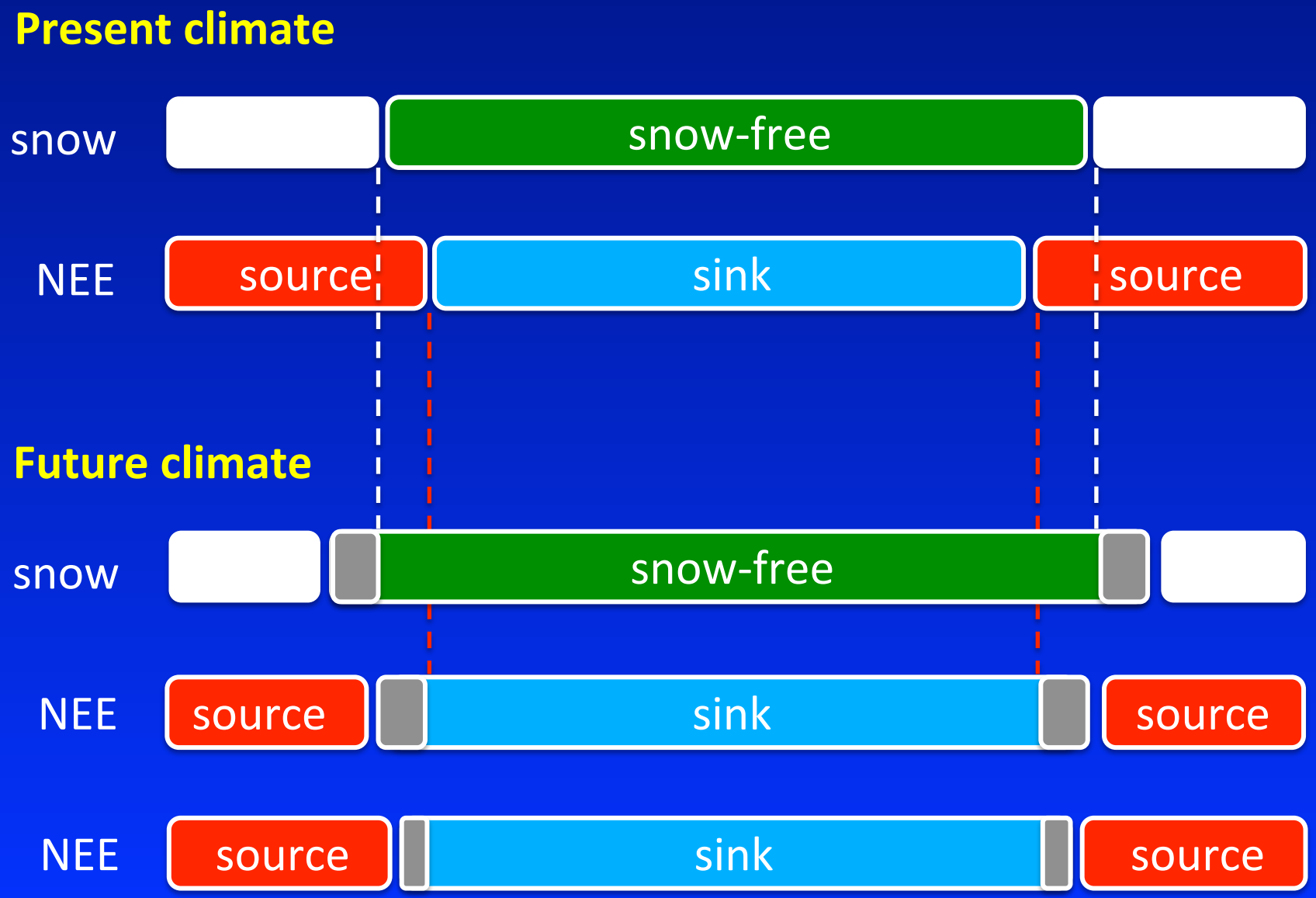
Does this lead to more net CO_2 uptake?



Day length


17
16
15
14
13
12
11
10
9
8
Day length (hours)
0
30
60
90
120
150
180
210
240
270
300
330
360
DOY
snow-free period

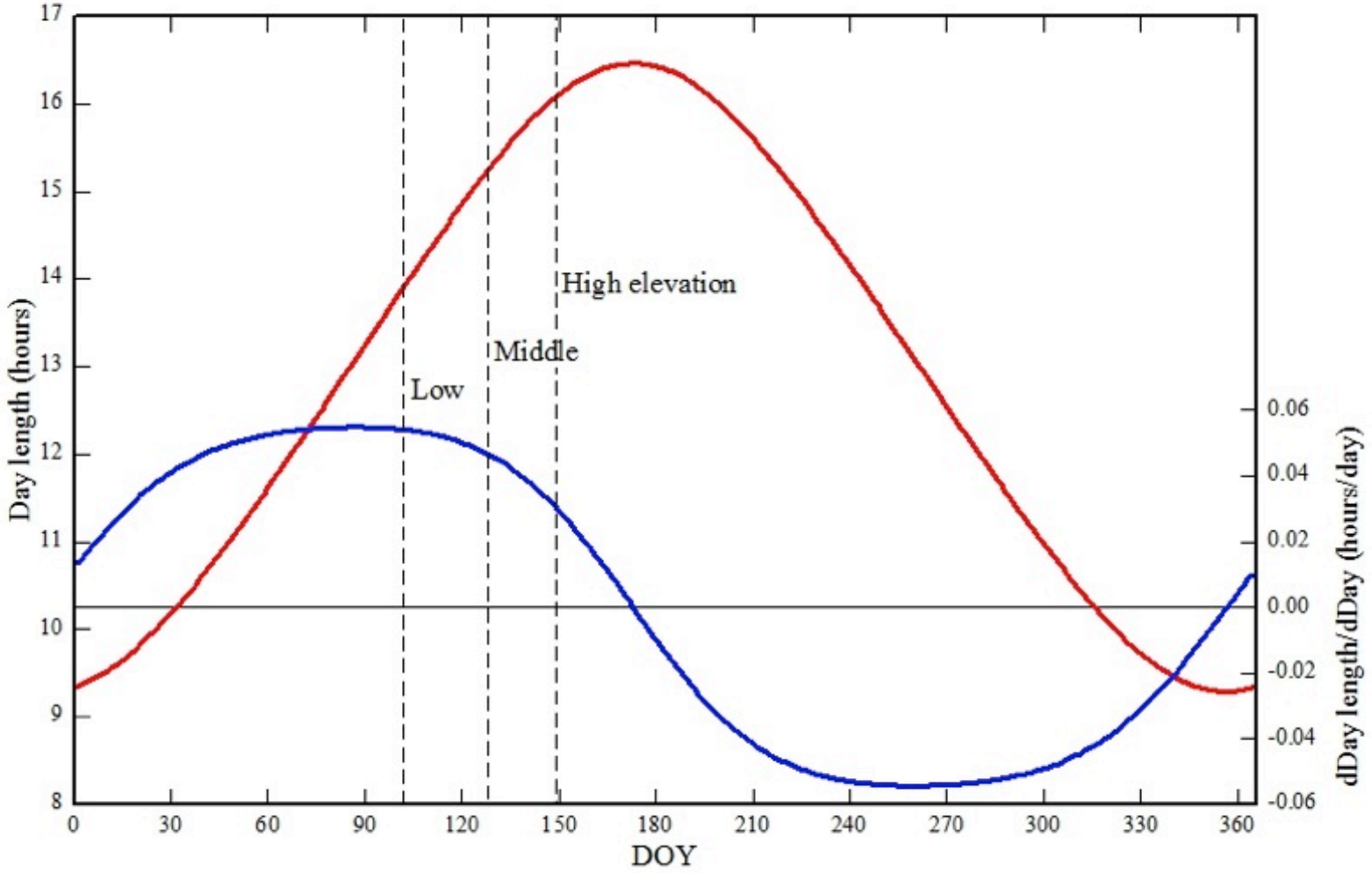
Does this lead to more net CO_2 uptake?



Hypothesis

- Shorter day length associated with earlier snow melt reduces carbon gain that can be realised with lengthening of snow-free period.

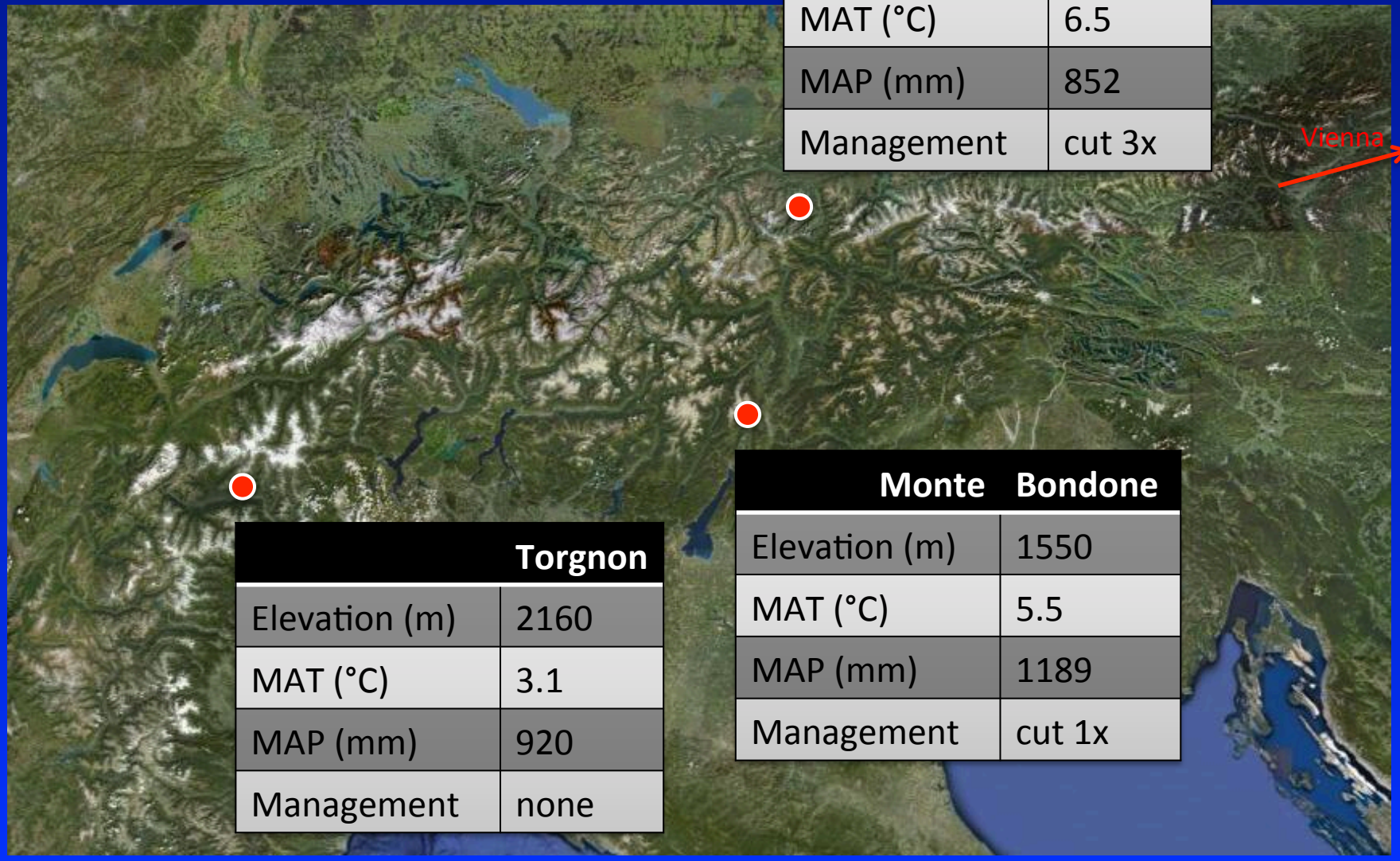
Day length


Day length (hours)
dDay length/dDay (hours/day)
DOY
High elevation
Middle
Low
17
16
15
14
13
12
11
10
9
8
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
0
30
60
90
120
150
180
210
240
270
300
330
360

Hypothesis

- Shorter day length associated with earlier snow melt reduces carbon gain that can be realised with lengthening of snow-free period.
- At same latitude this effect is more pronounced at low elevation sites where snow melt occurs around the spring equinox, when day length changes fastest, as opposed to high elevation sites where snow melt occurs closer to the summer solstice, when changes day length are minimal.

Study sites



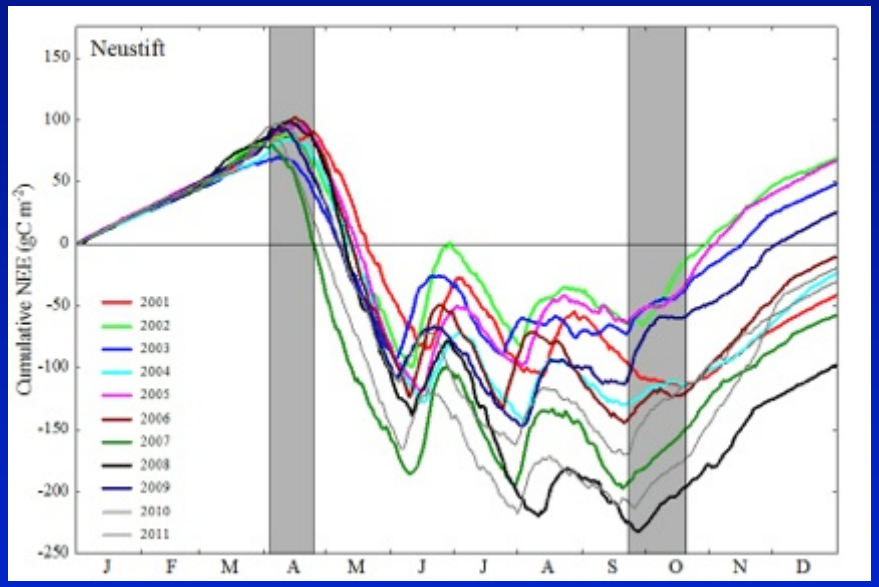
	Neustift
Elevation (m)	970
MAT (°C)	6.5
MAP (mm)	852
Management	cut 3x

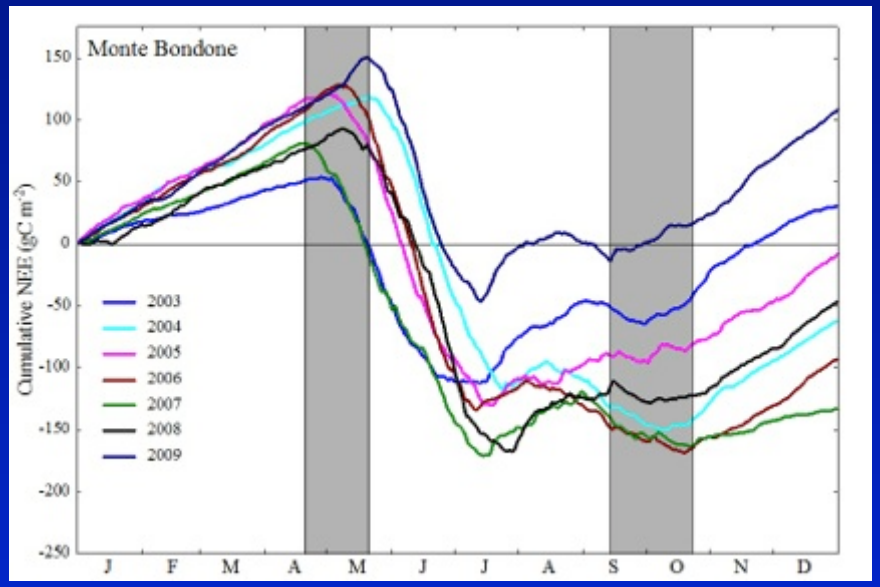
	Torgnon
Elevation (m)	2160
MAT (°C)	3.1
MAP (mm)	920
Management	none

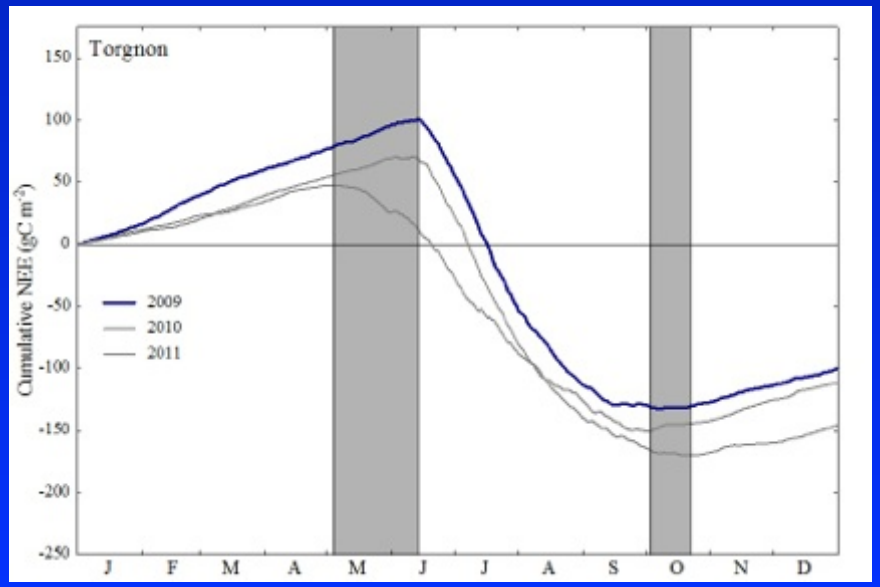
	Monte Bondone
Elevation (m)	1550
MAT (°C)	5.5
MAP (mm)	1189
Management	cut 1x

Methods

Overview of NEE







Simulating NEE during CUP transition

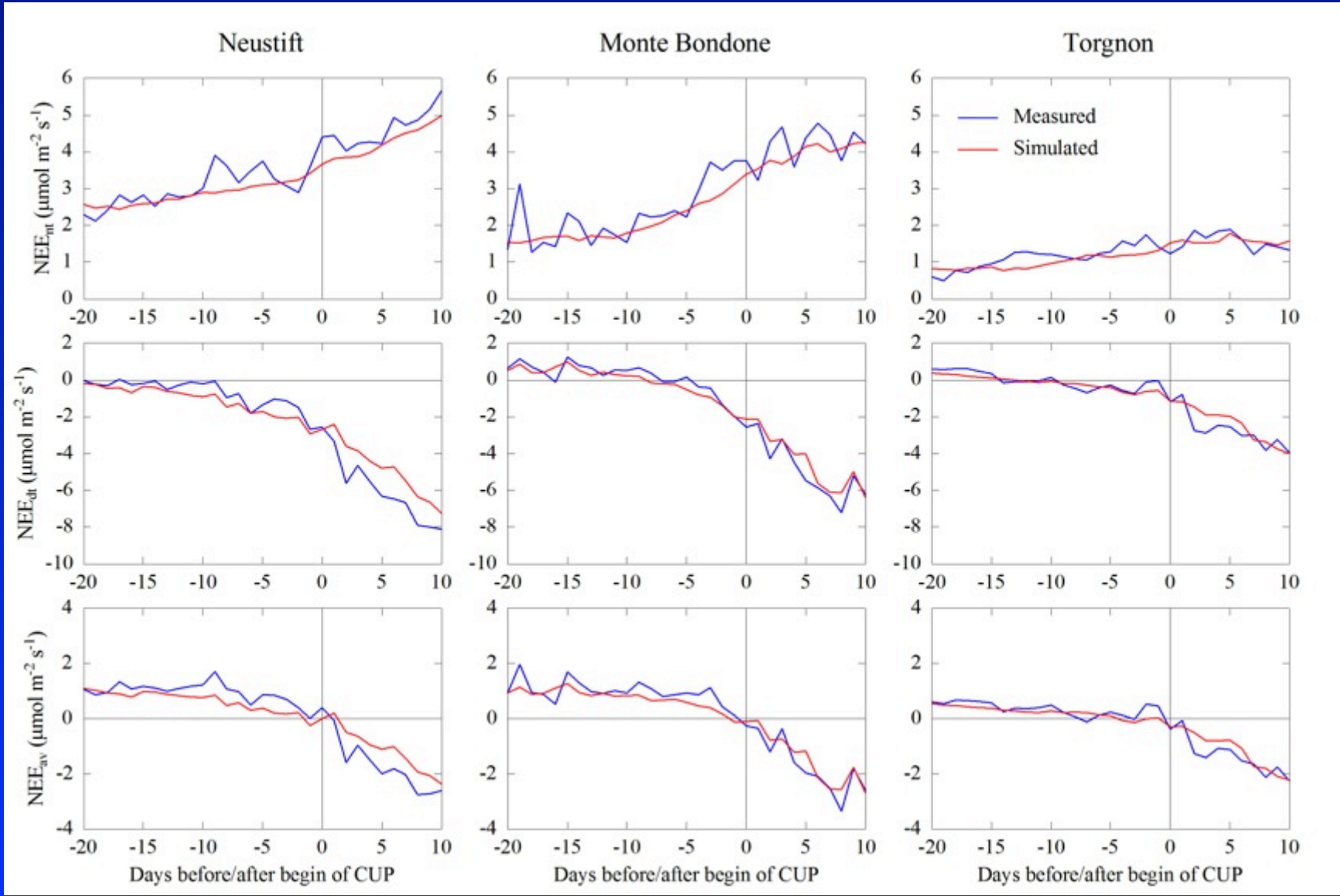
$NEE_d = NEE_{dt} * f_{dl} + NEE_{nt} * (1-f_{dl})$

$NEE_{dt} = -GEP + ER$
$NEE_{nt} = ER$

GEP = f(PAR, GDD)
ER = f(TA, GDD)

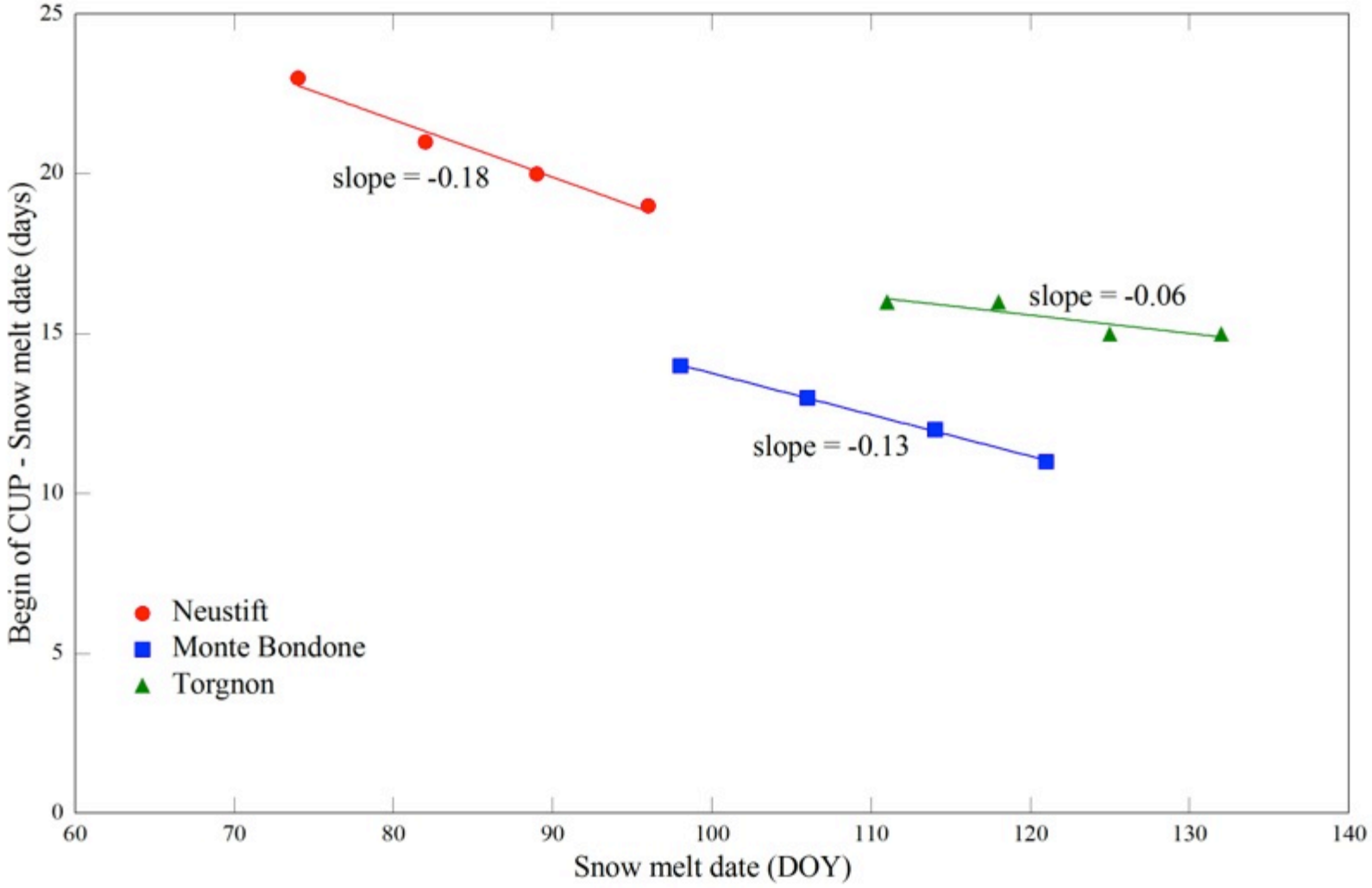
Snow cover = f(TA, PPT, GDD)

Model validation



Results

Response to simulated warming

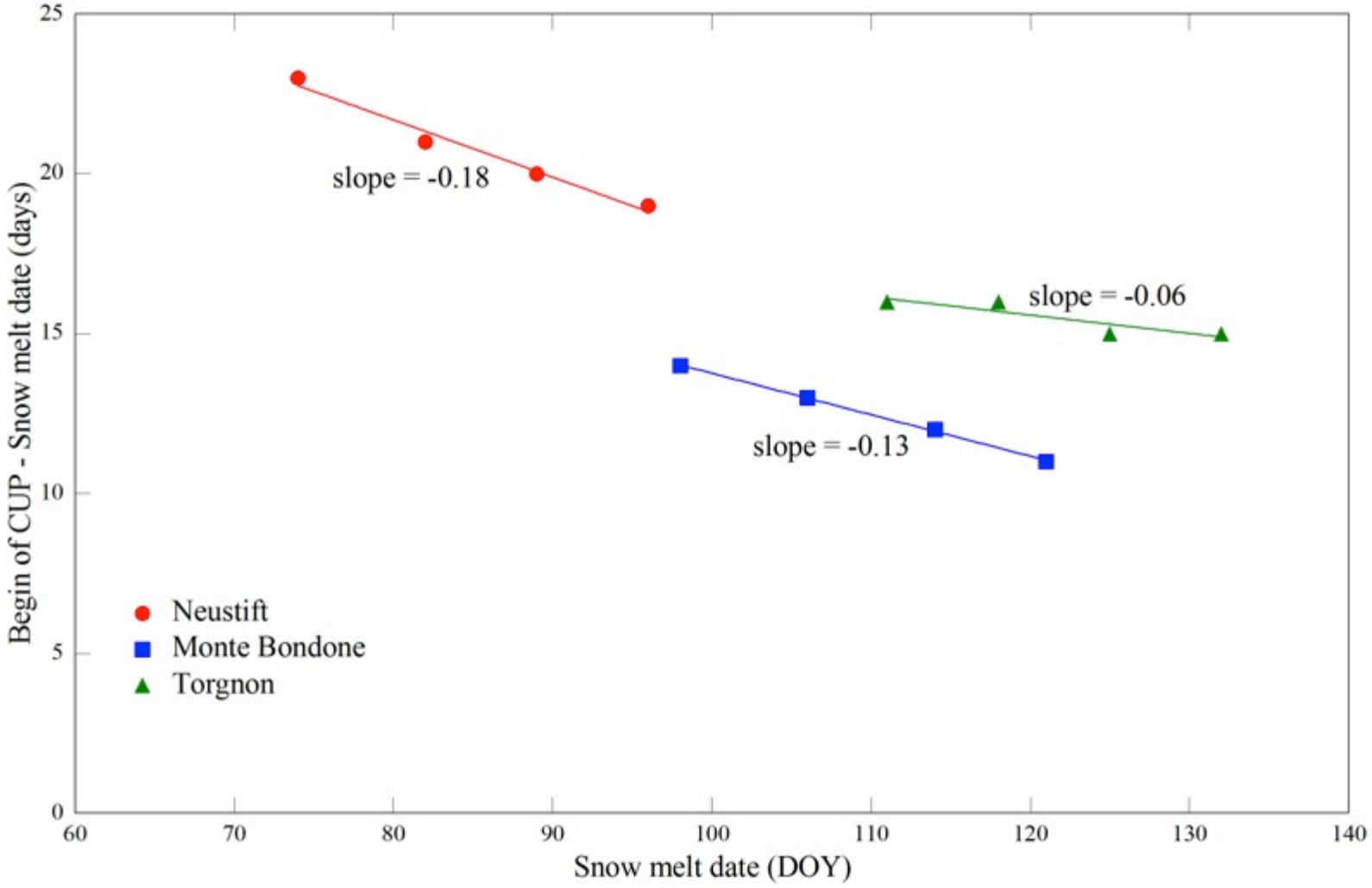


Take-home message

- Earlier snow melt associated with warming does not translate into a one-to-one earlier start of the CUP due to concurrent reductions in day length.

Results

Response to simulated warming



Take-home message

- Earlier snow melt associated with warming does not translate into a one-to-one earlier start of the CUP due to concurrent reductions in day length.
- This effect is more pronounced at sites that experience snow melt around the spring equinox, as opposed to those where snow melt occurs closer to the summer solstice.
- We conclude that higher elevation sites will be better able to take advantage of warming associated earlier snow melts in terms of carbon gain.

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