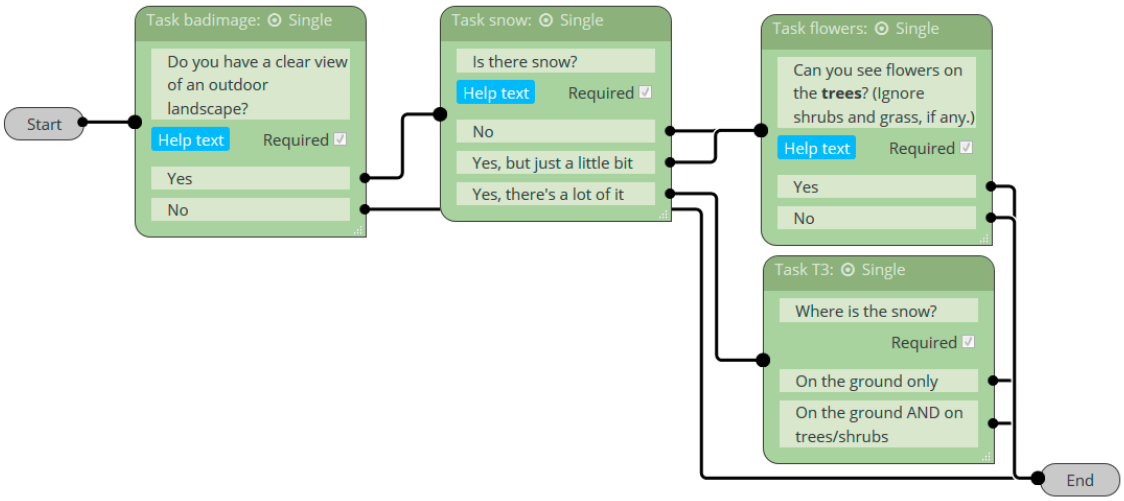
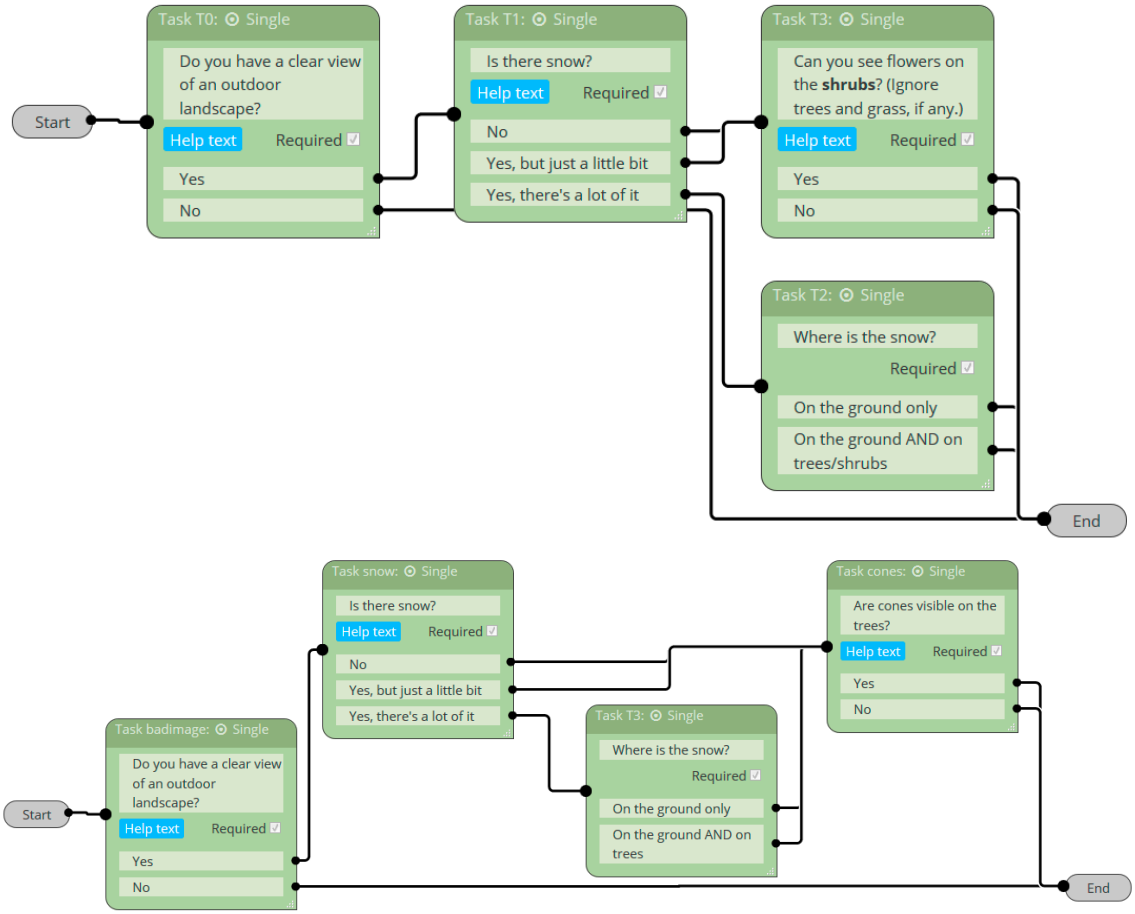
Supplementary Materials: Season Spotter: Using Citizen Science to Validate and Scale Plant Phenology from Near-Surface Remote Sensing

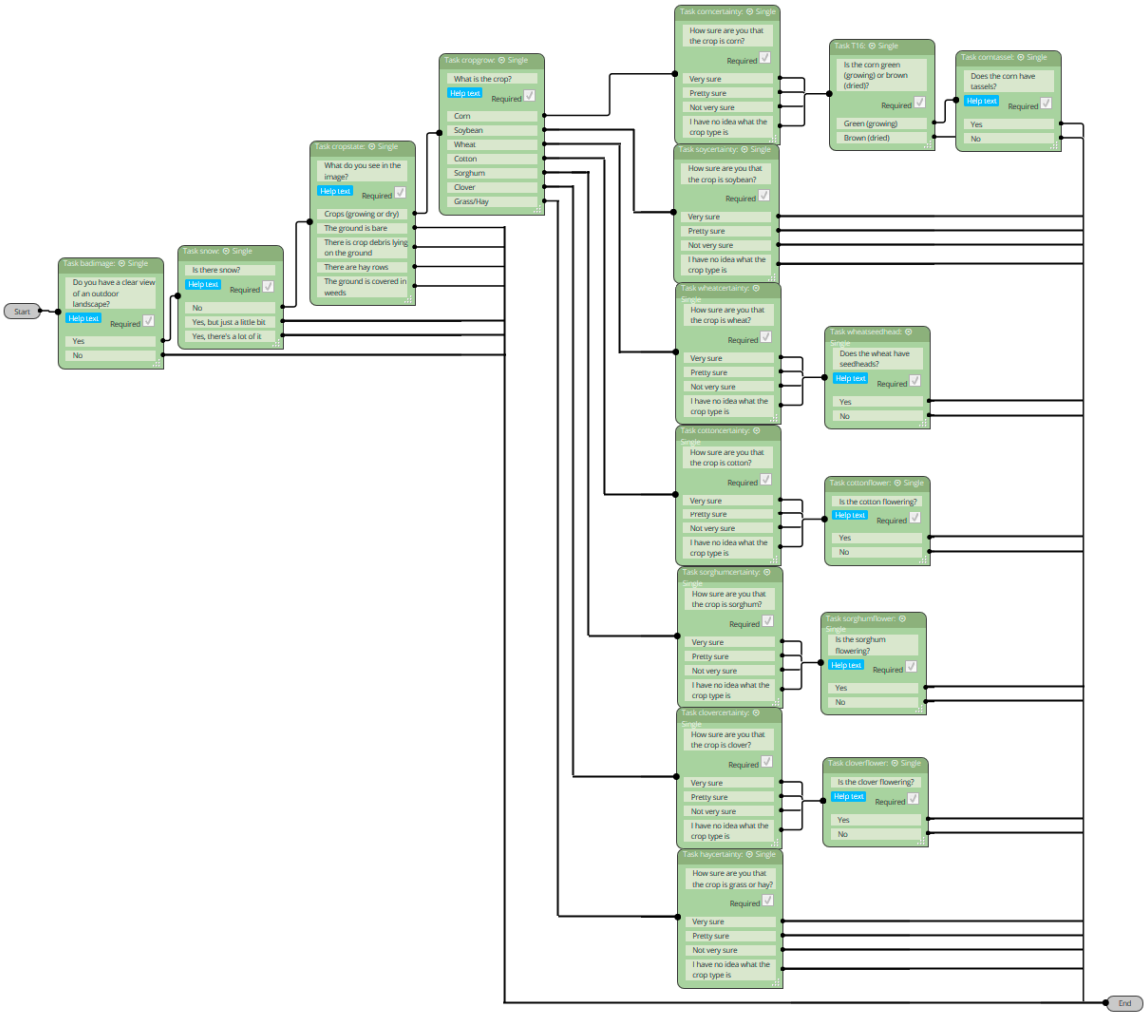
Margaret Kosmala, Alycia Crall, Rebecca Cheng, Koen Hufkens, Sandra Henderson and Andrew D. Richardson

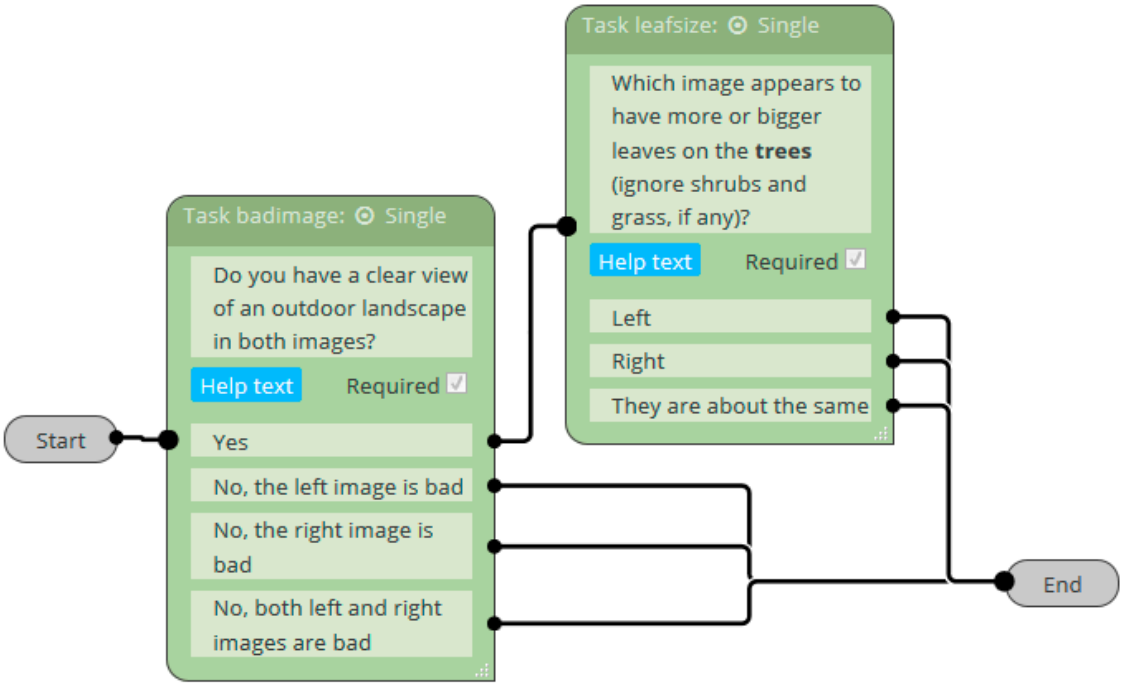
Table S1. Parameters used in the DBSCAN clustering algorithm.

Site	Date Range	No. of Shapes	Mean Area (Pixels)	*Minimum Samples*	*Distance* (Pixels)
alligatorriver	22 May 2012 to 30 September 2012	218	34,360	3	34
alligatorriver	1 December 2012 to 31 December 2014	492	25,498	5	29
arbutuslake	22 July 2008 to 23 August 2011	491	43,545	5	38
arbutuslake	1 December 2011 to 31 December 2014	487	41,936	5	37
bartlettir	3 March 2010 to 31 December 2014	1617	29,460	10	31
bostoncommon	7 June 2010 to 31 December 2014	1066	47,977	8	40
caryinstitute	7 May 2008 to 31 December 2014	716	86,200	6	54
harvard	7 May 2008 to 31 December 2014	733	31,062	6	32
howland1	3 March 2010 to 31 December 2014	607	29,671	6	31
mountranier	15 October 2004 to 16 April 2010	445	6751	5	15
mountranier	17 April 2010 to 31 December 2014	280	7054	4	15




Start
Task T0: Single
Do you have a clear view of an outdoor landscape?
Help text
Required
Yes
No
Task T1: Single
Is there snow?
Help text
Required
No
Yes, but just a little bit
Yes, there's a lot of it
Task T3: Single
Can you see flowers on the **shrubs**? (Ignore trees and grass, if any.)
Help text
Required
Yes
No
Task T2: Single
Where is the snow?
Required
On the ground only
On the ground AND on trees/shrubs
End
Start
Task badimage: Single
Do you have a clear view of an outdoor landscape?
Help text
Required
Yes
No
Task snow: Single
Is there snow?
Help text
Required
No
Yes, but just a little bit
Yes, there's a lot of it
Task T3: Single
Where is the snow?
Required
On the ground only
On the ground AND on trees
Task cones: Single
Are cones visible on the trees?
Help text
Required
Yes
No
End




Task leafsize: Single
Which image appears to have more or bigger leaves on the **trees** (ignore shrubs and grass, if any)?
Help text
Required
Left
Right
They are about the same
Task badimage: Single
Do you have a clear view of an outdoor landscape in both images?
Help text
Required
Start
Yes
No, the left image is bad
No, the right image is bad
No, both left and right images are bad
End

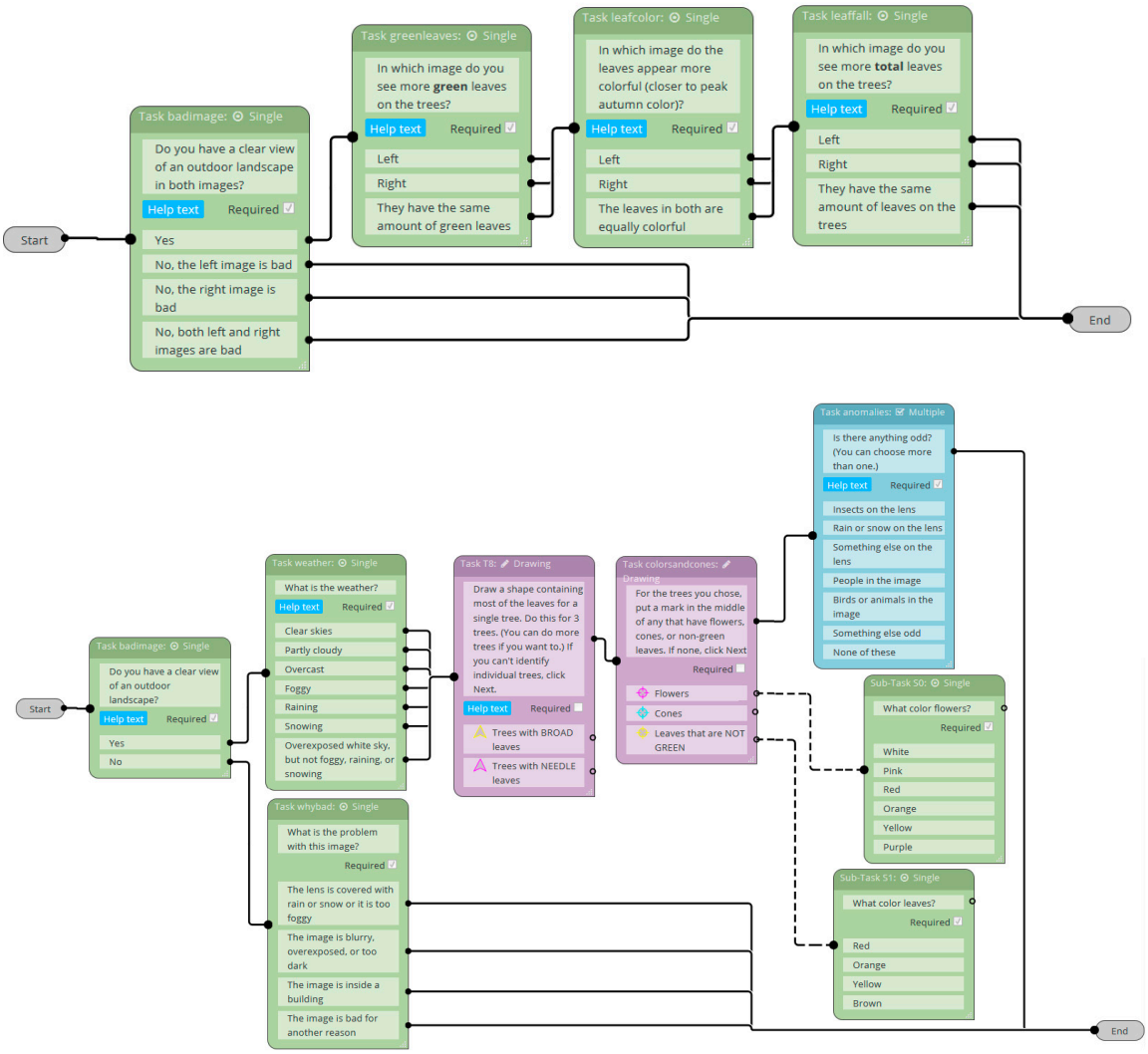


Figure S1. Season Spotter Workflows. Volunteers work through the tasks in each workflow based on the image presented. Workflows are for (from top to bottom) sites with deciduous trees; sites with shrubs; sites with coniferous trees; sites that are cropland; spring paired images; autumn paired images; and tree demarcation.

Figure S2. Midday image from the *harvardhemlock* site (8 January 2012) showing cones visible.

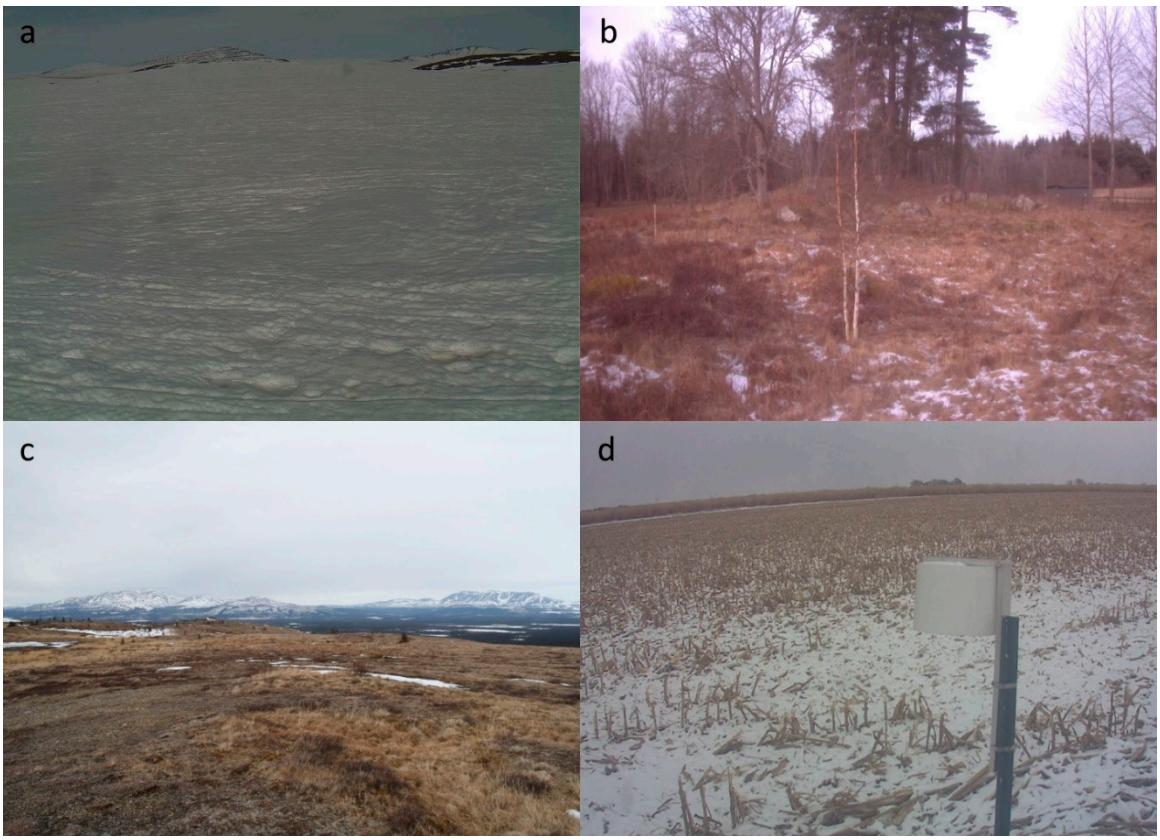


Figure S3. Examples of images classified as having snow.

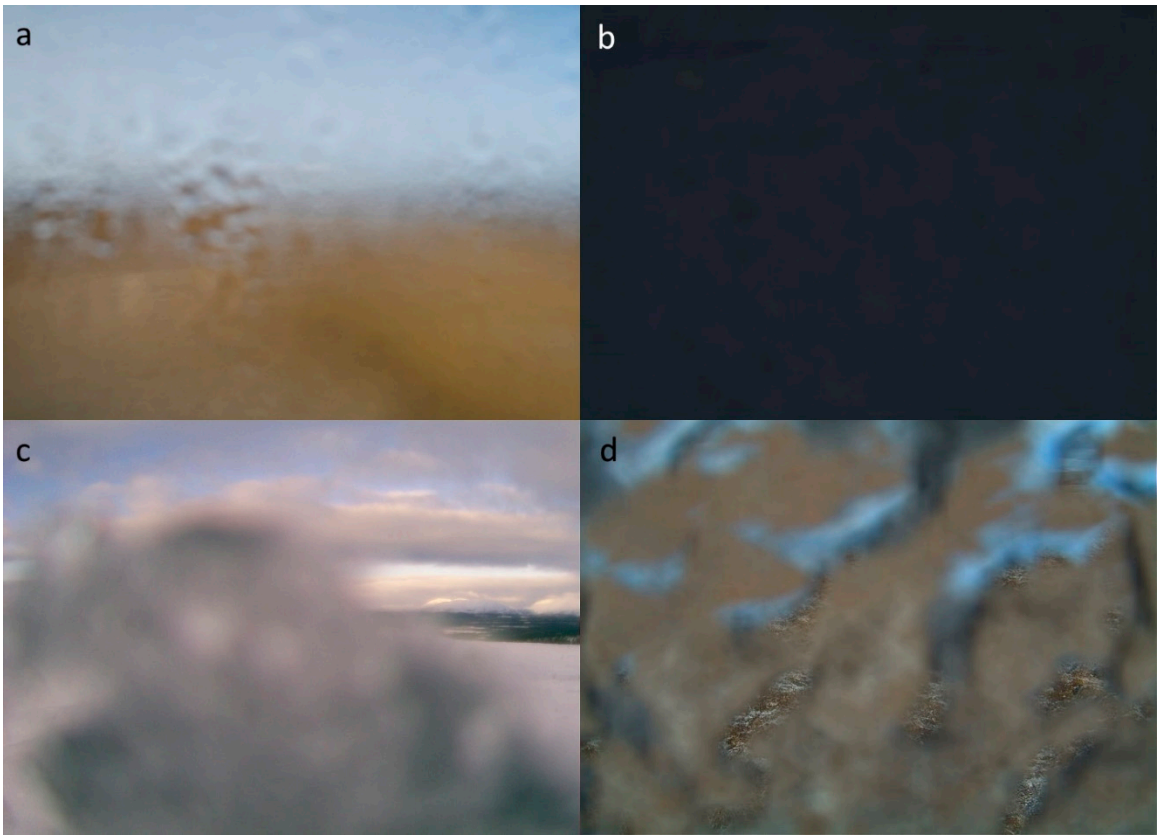
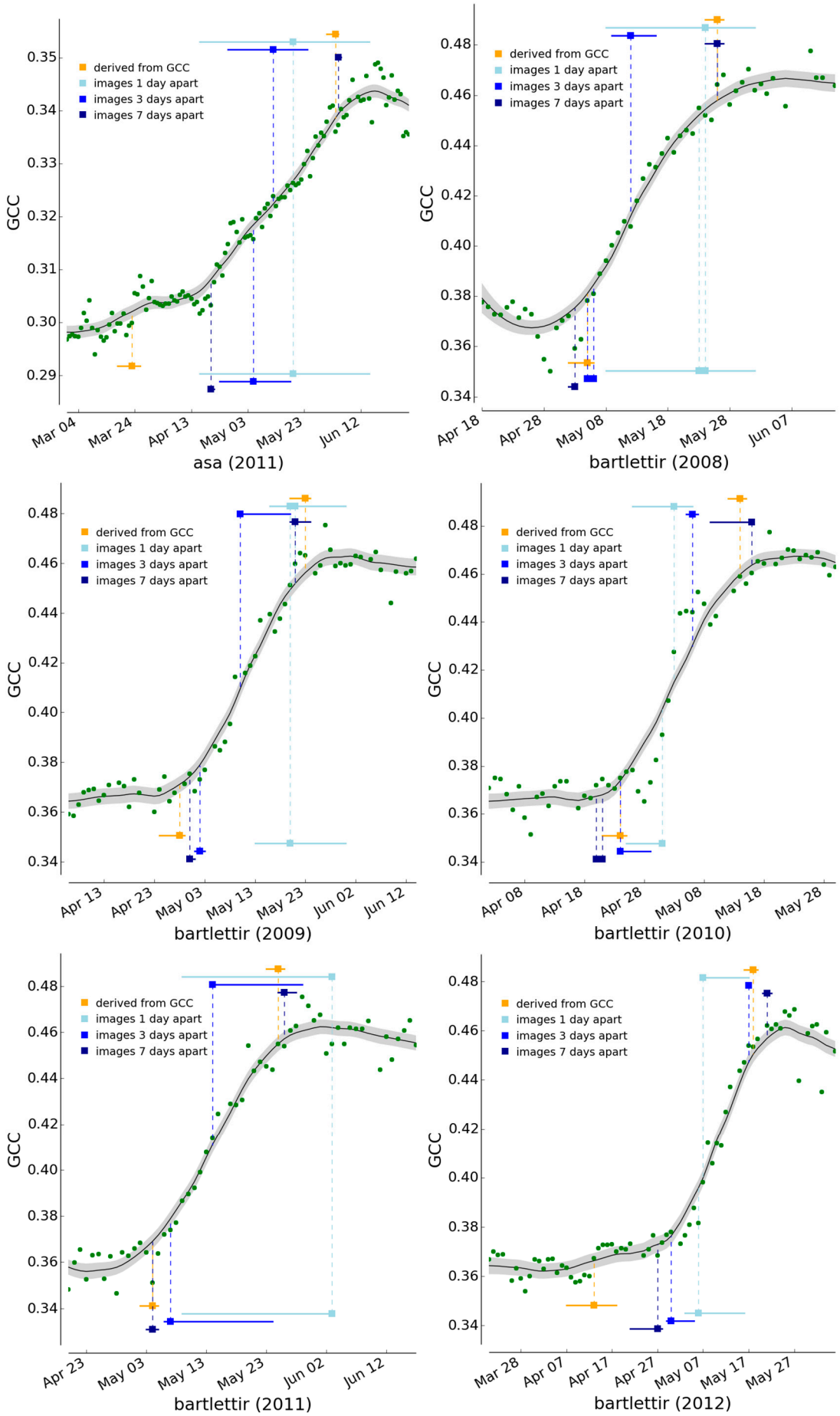
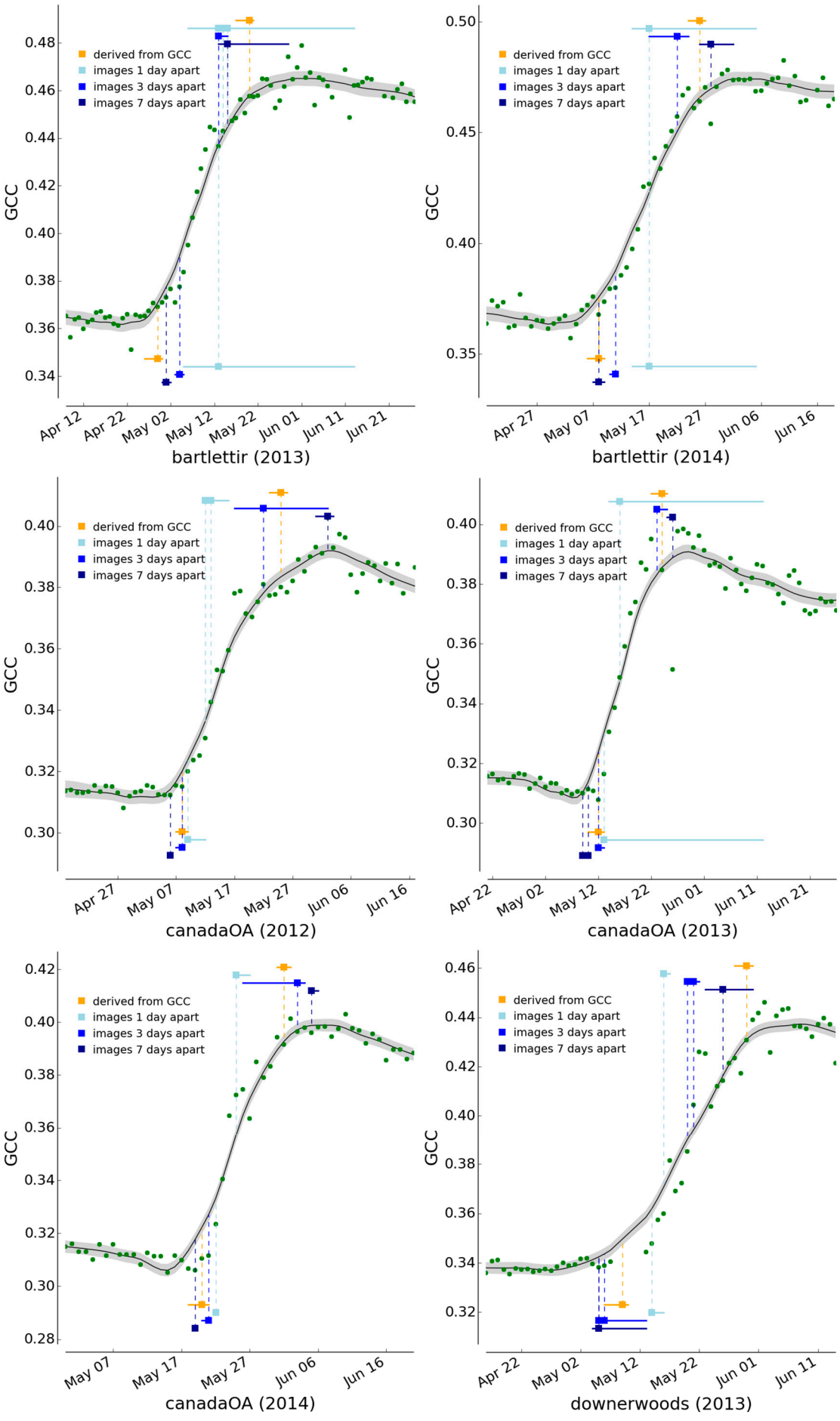
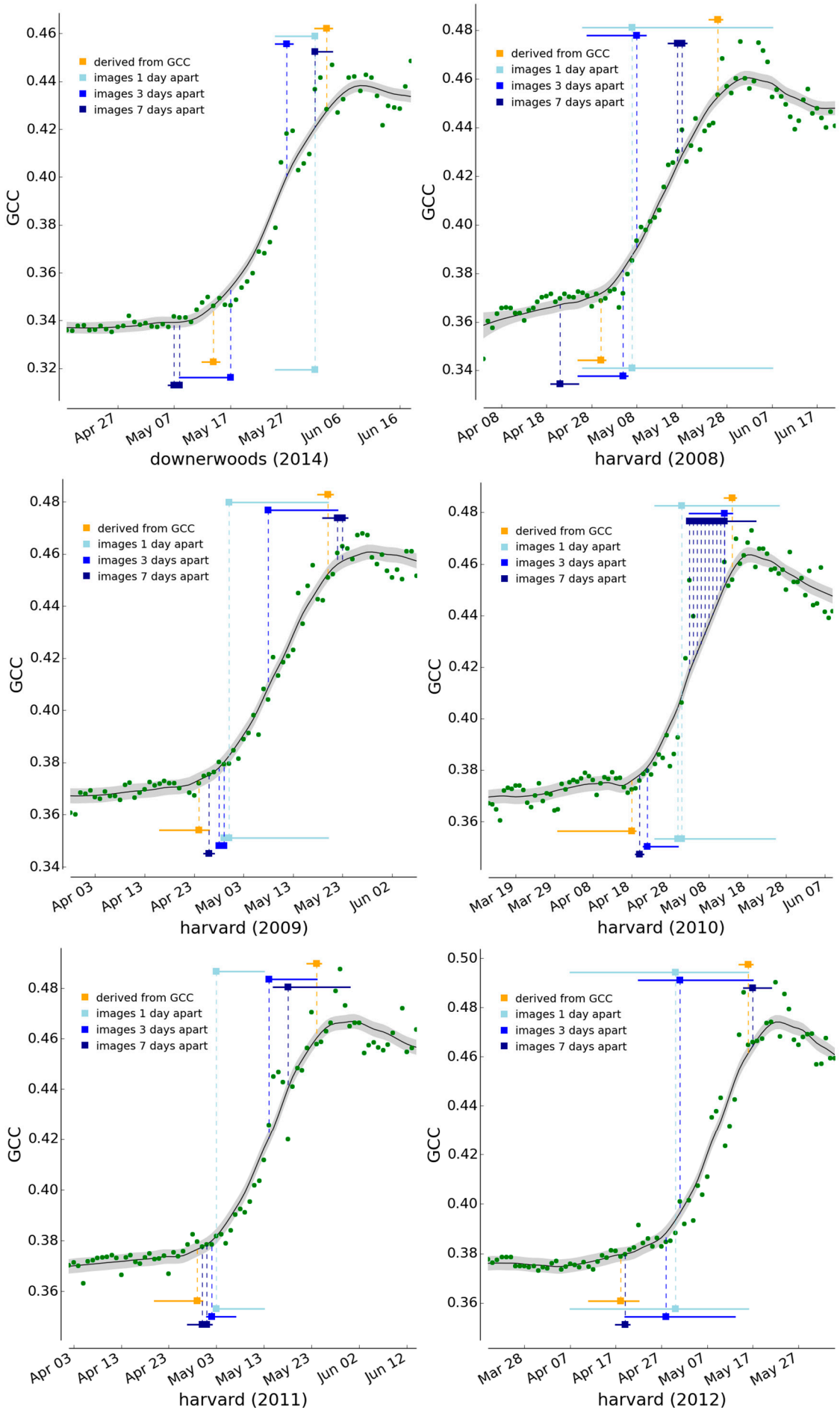
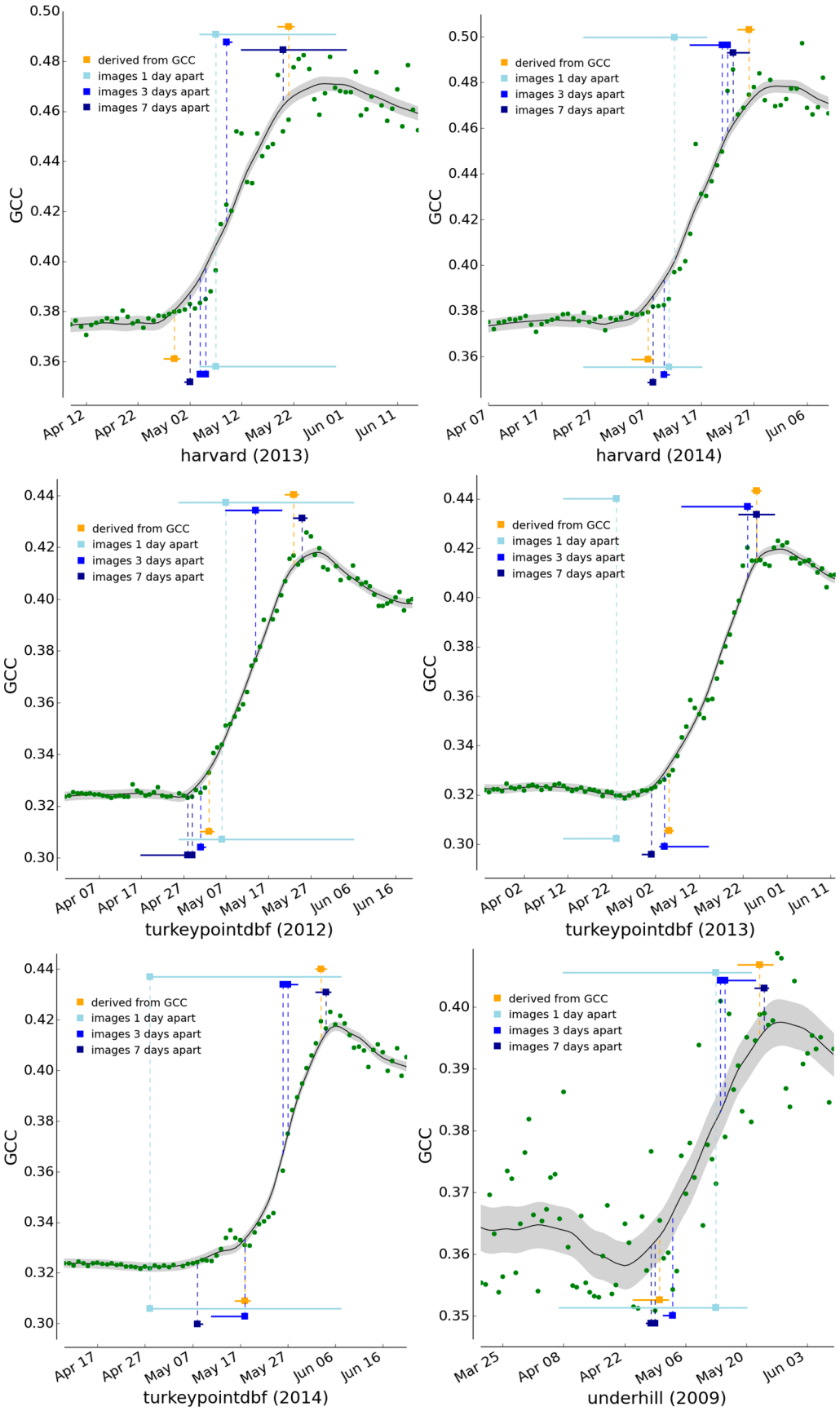


Figure S4. Examples of images classified as "bad image". Scene is obstructed in (**a**), (**c**), (**d**) and (**a**) black image was produced by camera malfunction in (**b**).


derived from GCC
images 1 day apart
images 3 days apart
images 7 days apart
GCC
asa (2011)
bartlettir (2008)
bartlettir (2009)
bartlettir (2010)
bartlettir (2011)
bartlettir (2012)


derived from GCC
images 1 day apart
images 3 days apart
images 7 days apart
GCC
bartlettir (2013)
bartlettir (2014)
canadaOA (2012)
canadaOA (2013)
canadaOA (2014)
downerwoods (2013)


derived from GCC
images 1 day apart
images 3 days apart
images 7 days apart
GCC
downerwoods (2014)
harvard (2008)
harvard (2009)
harvard (2010)
harvard (2011)
harvard (2012)


derived from GCC
images 1 day apart
images 3 days apart
images 7 days apart
GCC
harvard (2013)
harvard (2014)
turkeypointdbf (2012)
turkeypointdbf (2013)
turkeypointdbf (2014)
underhill (2009)

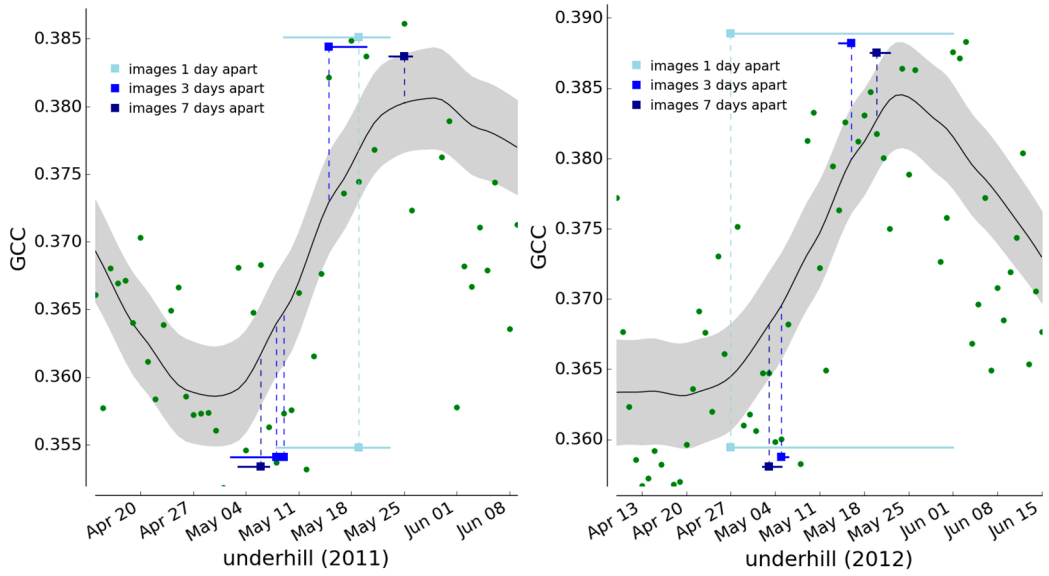
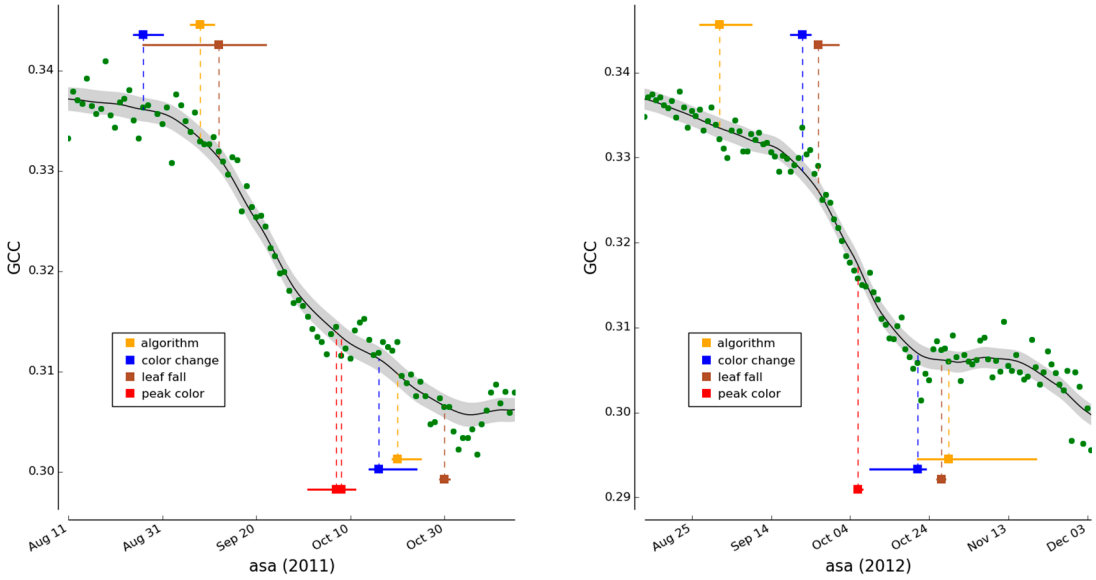
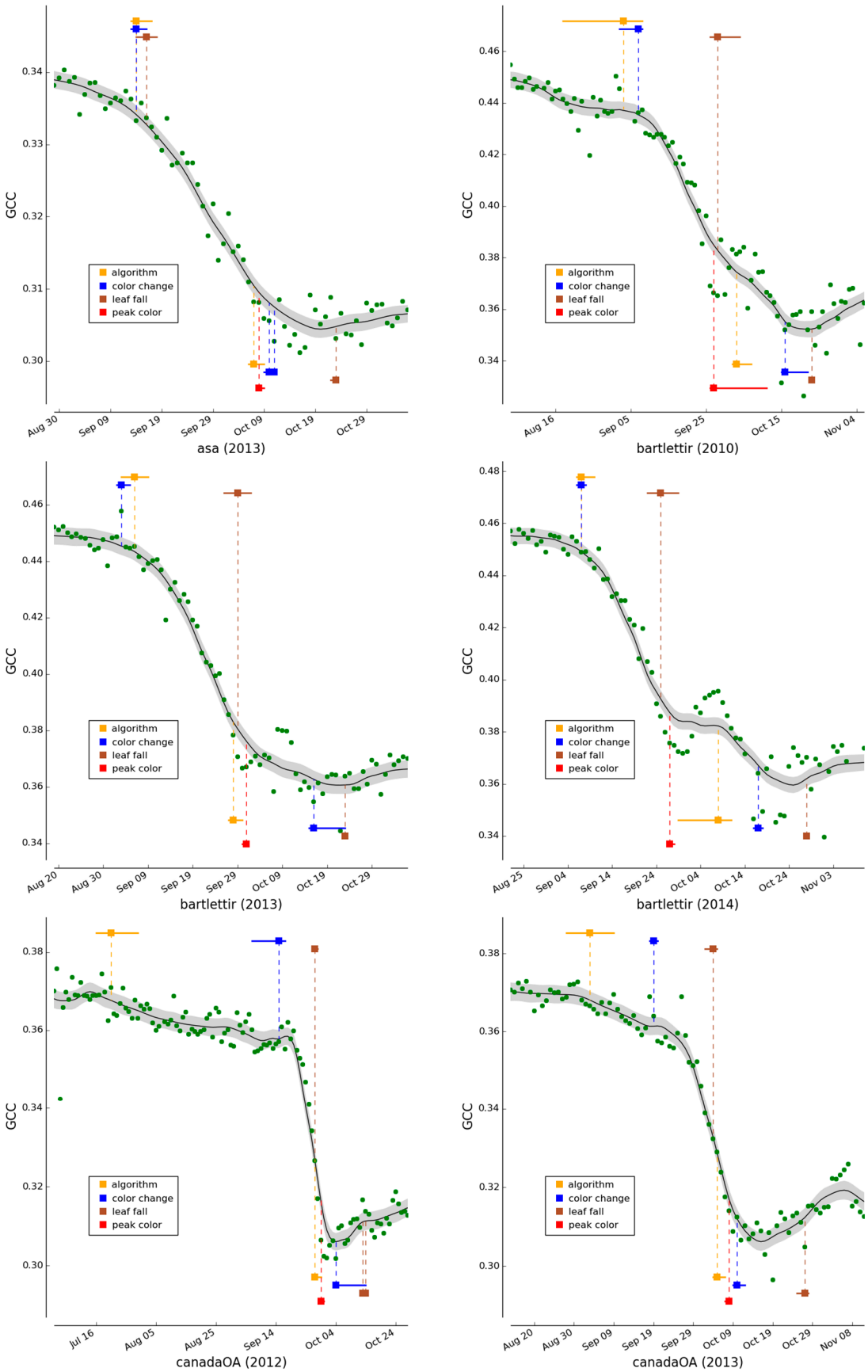
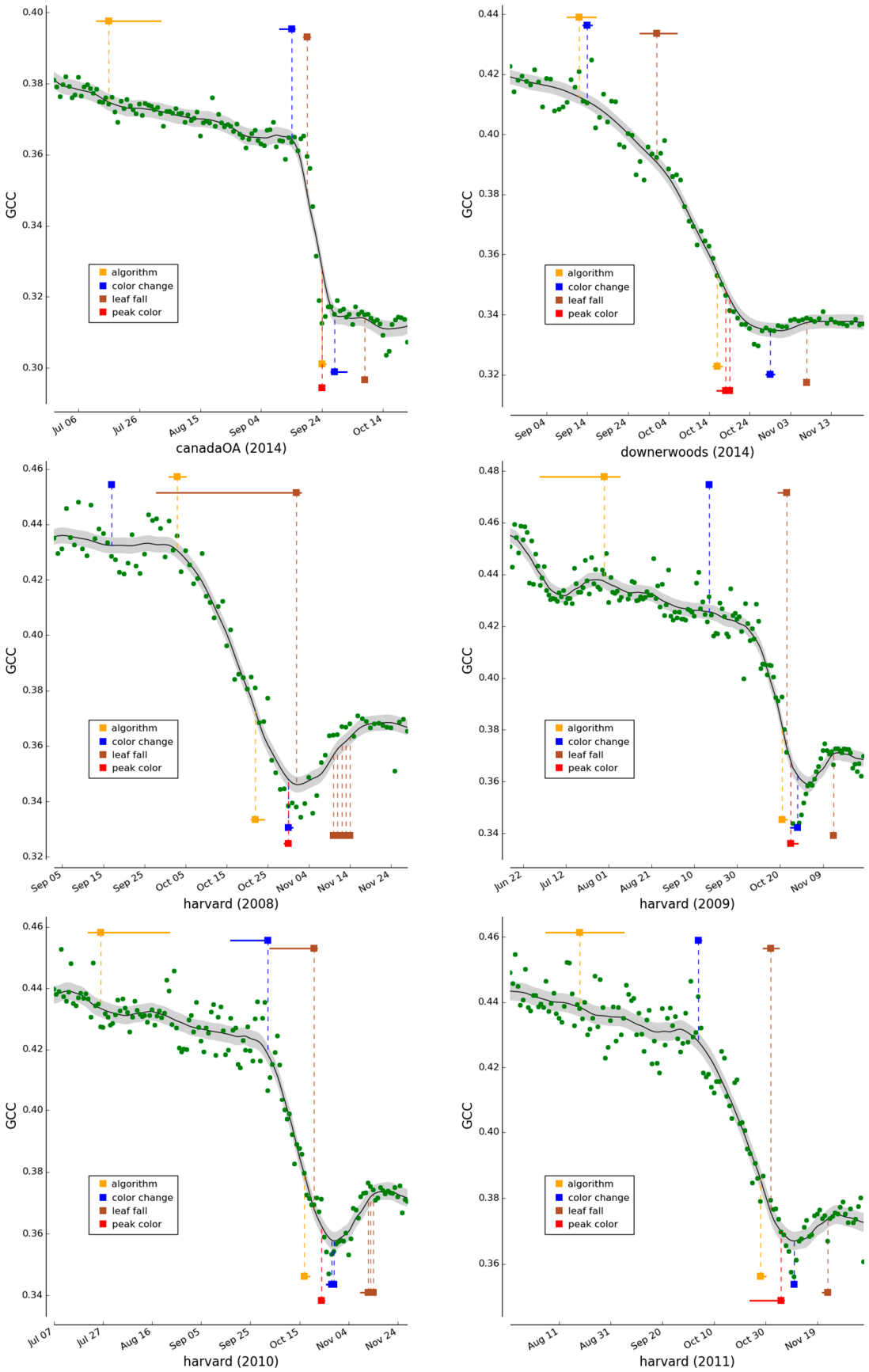


Figure S5. Estimates of start and end of spring from Season Spotter based on image pairs one (light blue), three (medium blue), and seven (dark blue) days apart, as well as estimates derived from Gcc values (orange). Green circles indicate daily Gcc values, the black line is the fit curve to the Gcc values, and the gray region represents the uncertainty in the curve. Blue and orange squares indicate date estimates. Multiple adjacent squares indicate an equal likelihood for those days. Horizontal lines through squares are 95% certainty ranges.




GCC
algorithm
color change
leaf fall
peak color
asa (2013)
bartlettir (2010)
bartlettir (2013)
bartlettir (2014)
canadaOA (2012)
canadaOA (2013)


GCC
algorithm
color change
leaf fall
peak color
canadaOA (2014)
downerwoods (2014)
harvard (2008)
harvard (2009)
harvard (2010)
harvard (2011)

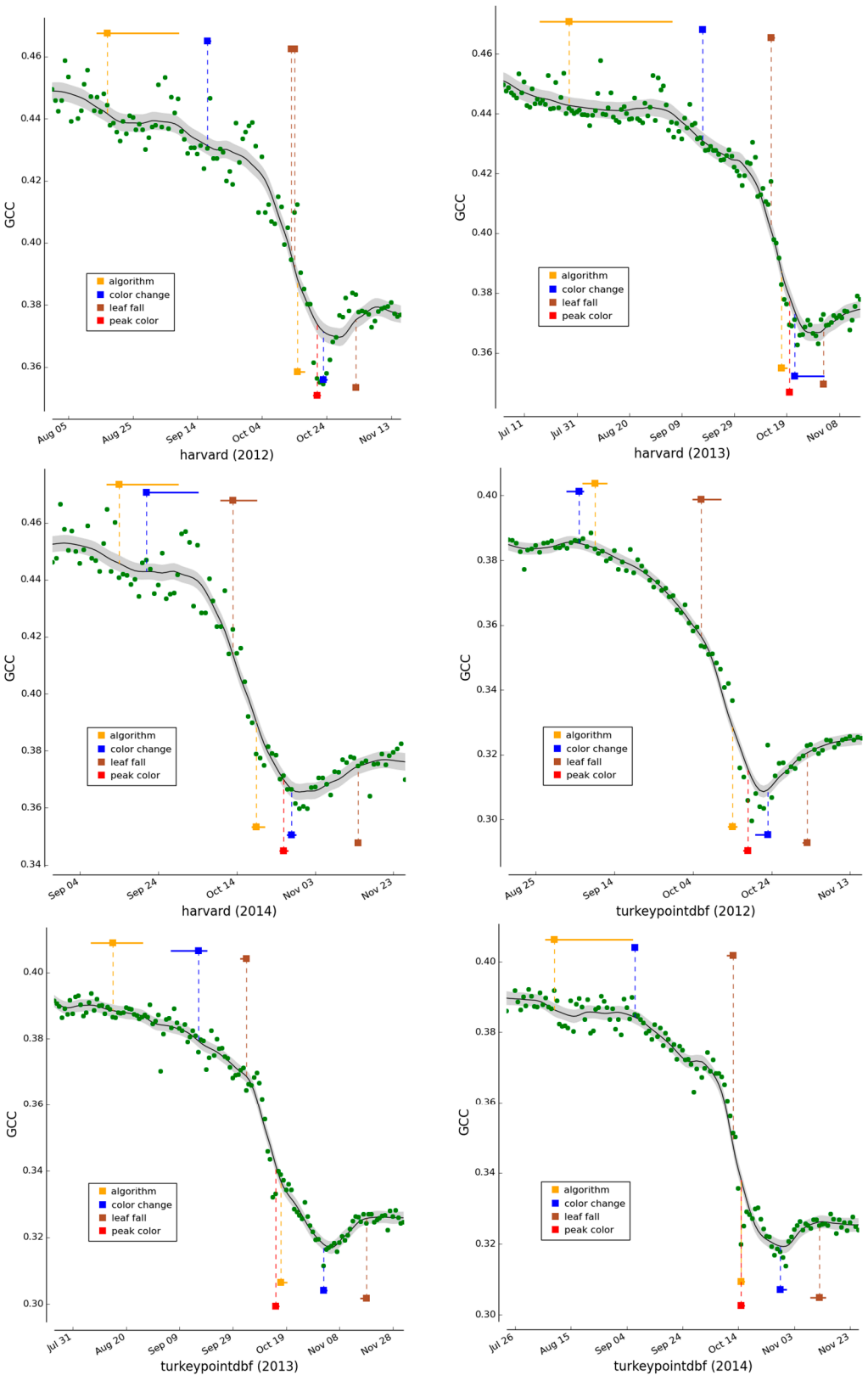


Figure S6. Estimates of start and end of autumn color change (blue), start and end of autumn leaf fall (brown) and peak color (red) from Season Spotter based on image pairs seven days apart, as well as estimates of the start and end of autumn derived from Gcc values ("algorithm"; orange). Green circles indicate daily Gcc values, the black line is the fit curve to the Gcc values, and the gray region represents the uncertainty in the curve. Blue, brown, red, and orange squares indicate date estimates. Multiple adjacent squares indicate an equal likelihood for those days. Horizontal lines through squares are 95% certainty ranges.

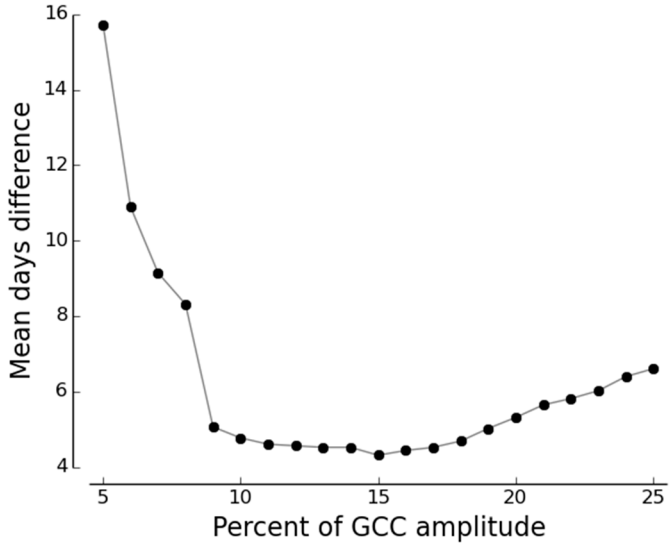


Figure S7. Mean days difference between estimates of start of spring derived from GCC values and calculated from Season Spotter data as a function of the amplitude used in the GCC-derived estimate.