

## *Leptidea sinapis* (LINNAEUS, 1758) / *reali* REISSINGER, 1990 (complex) – Wood White



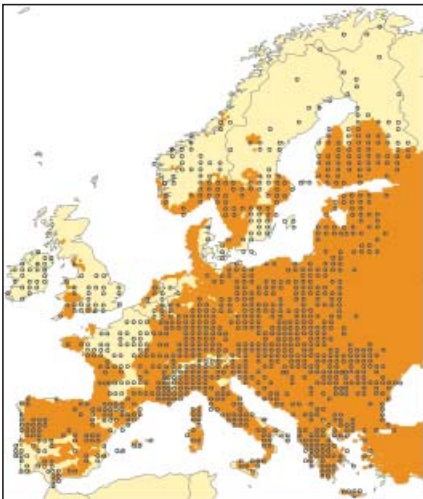
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		Full dispersal	No dispersal
2050	SEDG	1829 (10.09%)	-2394 (-13.21%)
	BAMBU	236 (1.3%)	-2733 (-15.08%)
	GRAS	97 (0.54%)	-3575 (-19.72%)
2080	SEDG	2744 (15.14%)	-3709 (-20.46%)
	BAMBU	1117 (6.16%)	-5664 (-31.25%)
	GRAS	795 (4.39%)	-7192 (-39.68%)

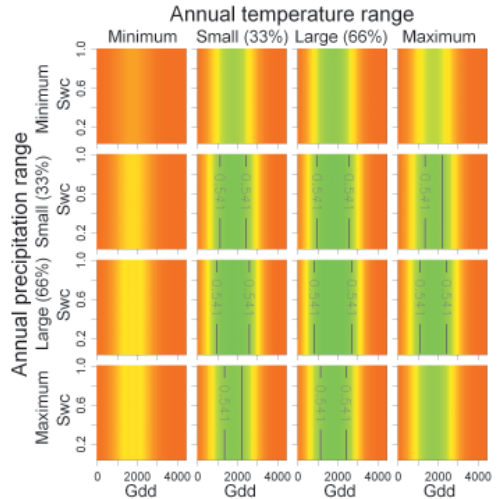
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 18126 cells)

At present, the Wood White is divided into two species, *L. sinapis* (LINNAEUS, 1758) and *L. reali* REISSINGER, 1990, which are indistinguishable in the field. Their distribution is not yet entirely clear. Their life cycles are similar. These fragile butterflies occur on damp, warm grassland near bushes and scrub. They lay their thin, spindle-shaped eggs on different sorts of *Lathyrus* and birdsfoot-trefoil (*Lotus* spp.). Cream, turning to bright yellow as they mature, they are easy to find. The pupa is pale-green, and the winter is spent in this stage. In the north of its range, it is single-brooded, but in the middle it has two generations a year, and in the south sometimes three.

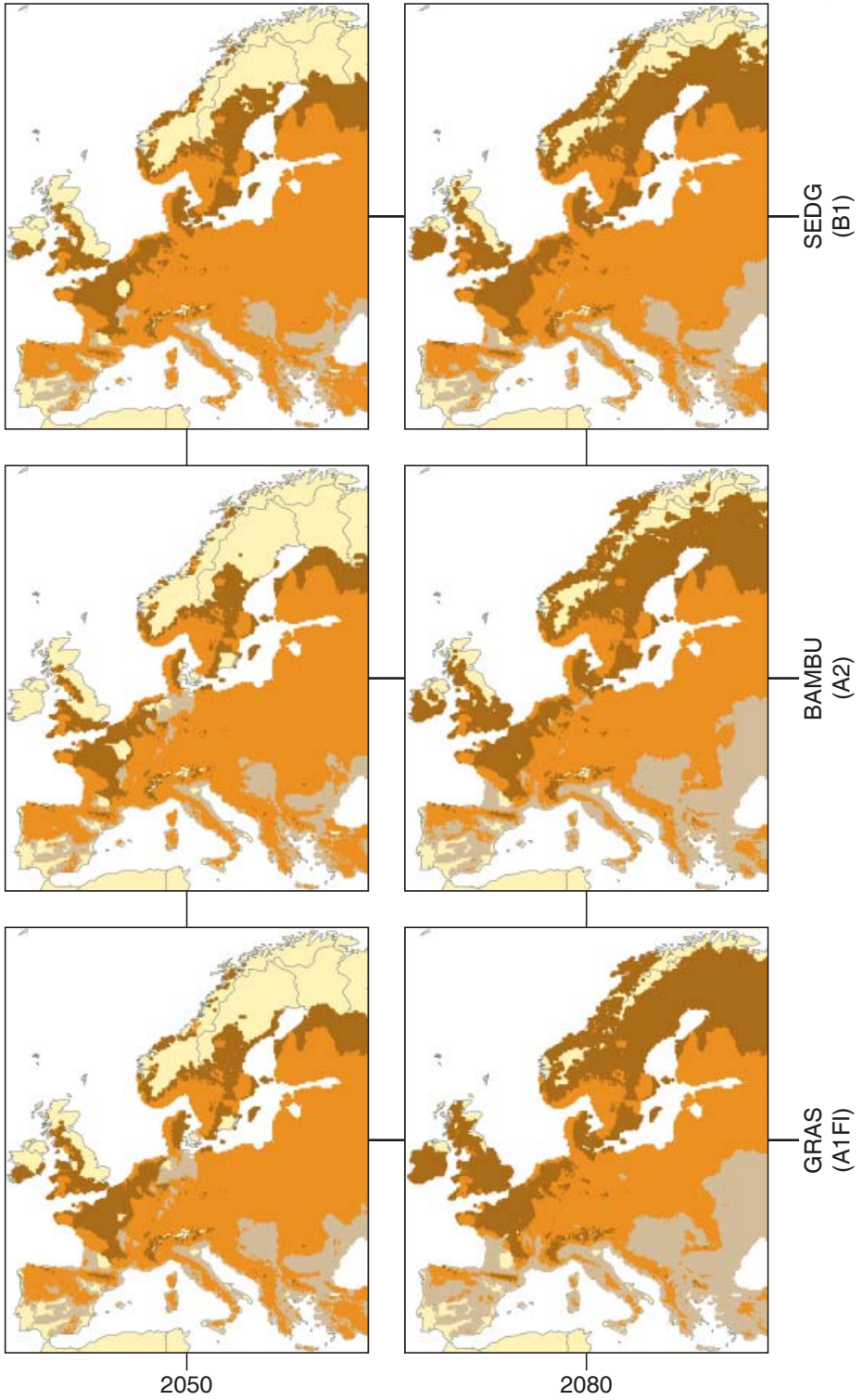
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.63). Climate risk category: PR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Leptidea duponcheli* (STAUDINGER, 1871) – Eastern Wood White



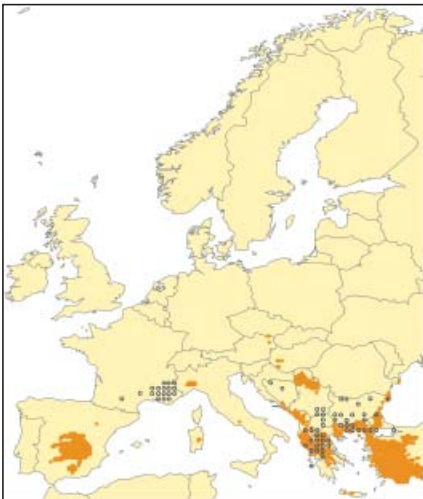
© Albert Vliegenthart

		Full dispersal	No dispersal
2050	SEDG	221 (19.79%)	-712 (-63.74%)
	BAMBU	-186 (-16.65%)	-812 (-72.69%)
	GRAS	22 (1.97%)	-856 (-76.63%)
2080	SEDG	32 (2.86%)	-782 (-70.01%)
	BAMBU	-628 (-56.22%)	-1009 (-90.33%)
	GRAS	-594 (-53.18%)	-1066 (-95.43%)

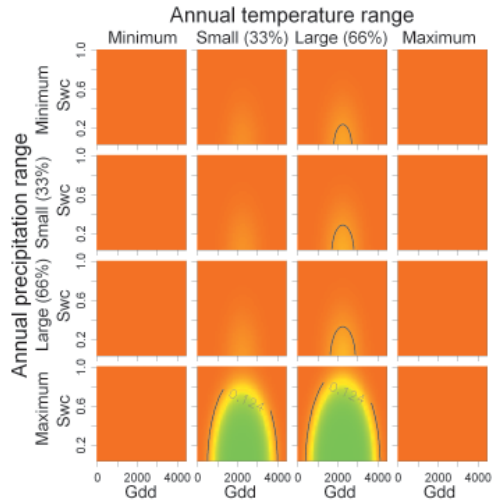
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 1117 cells)

The Eastern Wood White occurs on dry grassland, often where scattered trees or bushes are growing, and also in open woods. It is found on both calcareous and non-calcareous soils. The habitats of the Eastern Wood White are drier and warmer than those of the Wood White (*L. sinapis* complex). The eggs are laid on the leaves of Meadow Vetchling (*Lathyrus pratensis*), Yellow Vetchling (*L. aphaca*) and birdsfoot-trefoils (*Lotus* spp.), mostly on plants growing in the shade. The caterpillars feed on the leaves of the foodplant. The Eastern Wood White is double-brooded and hibernates in the pupal stage.

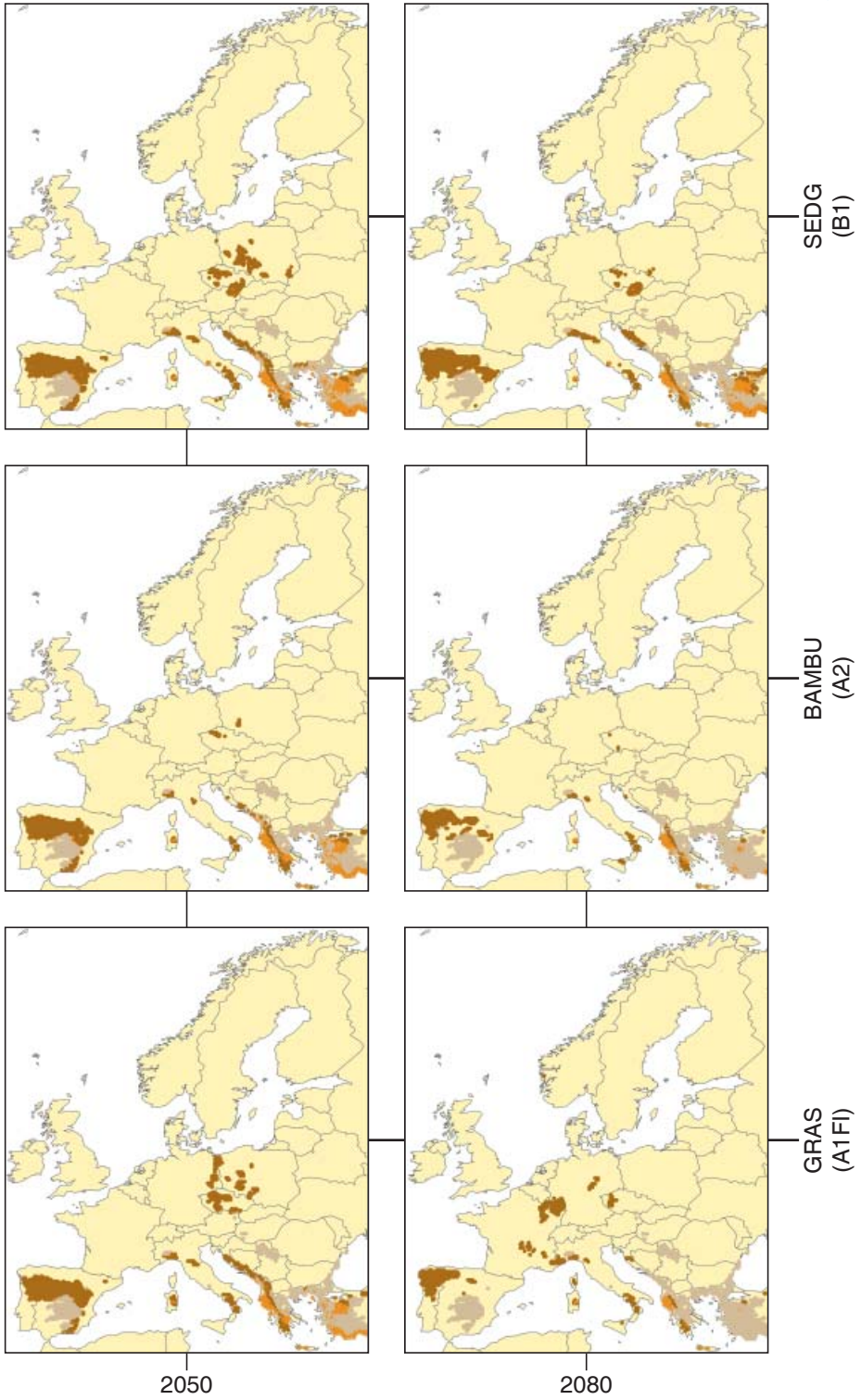
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.69). Climate risk category: PR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Leptidea morsei* (FENTON, 1881) – Fenton’s Wood White



© Helmut Höttinger

		Full dispersal	No dispersal
2050	SEDG	188 (12%)	-1154 (-73.64%)
	BAMBU	761 (48.56%)	-988 (-63.05%)
	GRAS	370 (23.61%)	-893 (-56.99%)
2080	SEDG	293 (18.7%)	-1416 (-90.36%)
	BAMBU	196 (12.51%)	-1328 (-84.75%)
	GRAS	-133 (-8.49%)	-1198 (-76.45%)

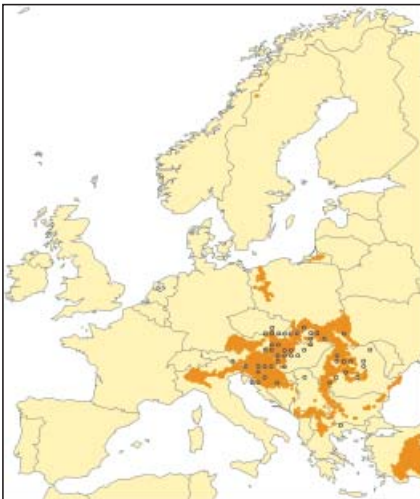
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 1567 cells)

Apart from its greater size and slightly falcate forewings the species can be separated from the other Wood Whites by conspicuous gliding flight sometimes displayed by males. The habitat of Fenton’s Wood White is almost exclusively highly structured deciduous woodland. The only confirmed food plant of this species in Europe is Black Pea (*Lathyrus niger*). This butterfly is double-brooded and hibernates in the pupal stage.

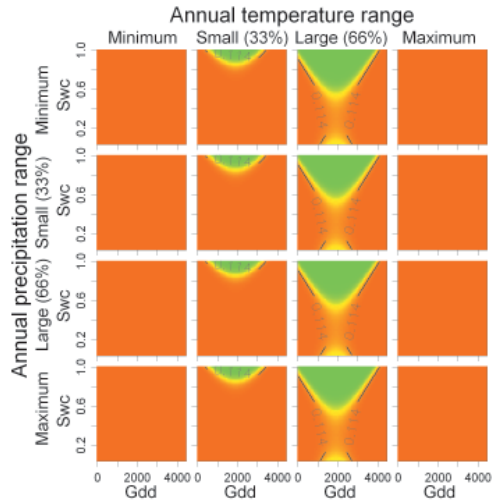
This species is listed in Annexes II and IV of the Habitats’ Directive.

Present distribution can be well explained by climatic variables (AUC = 0.92).

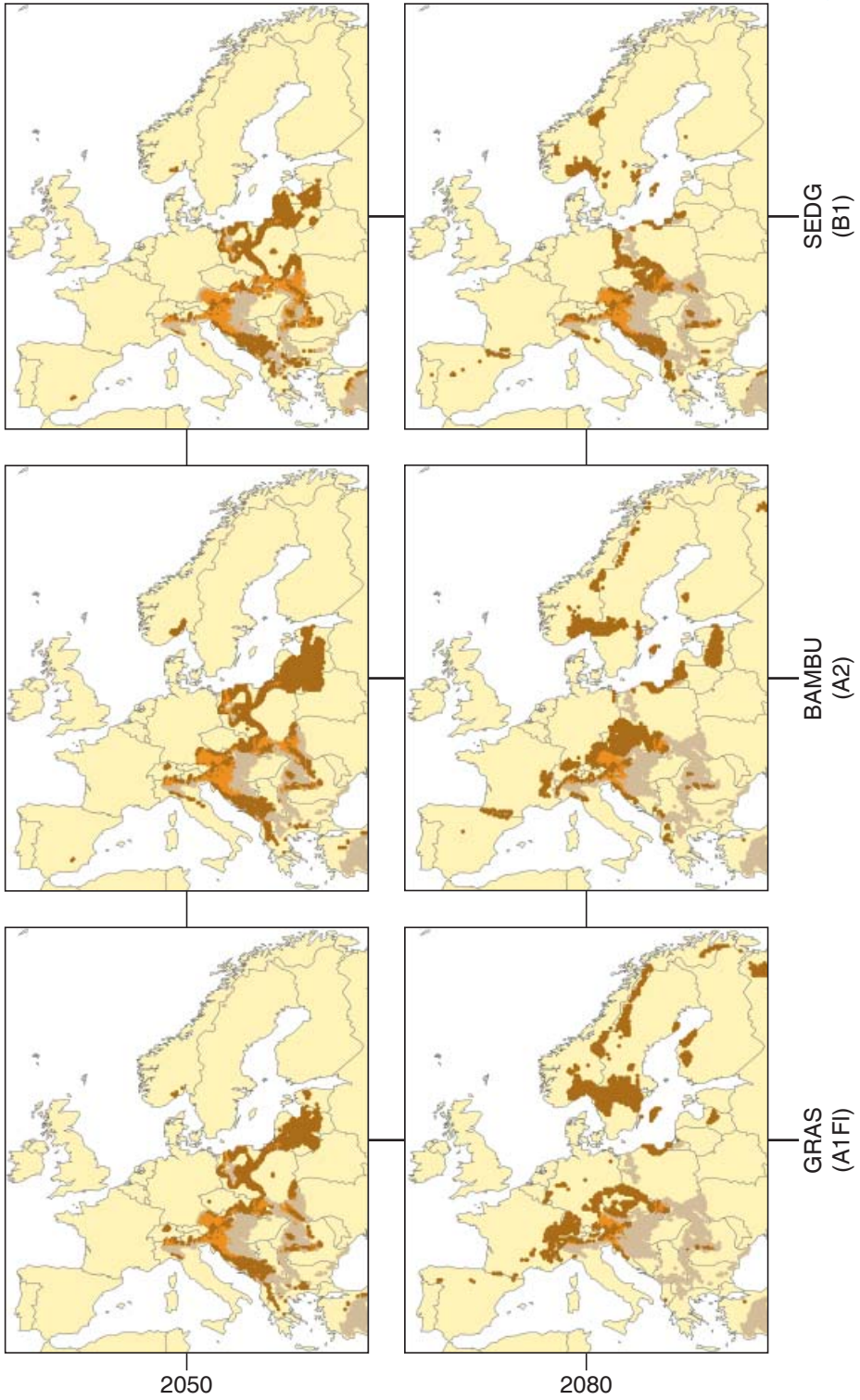
Climate risk category: HHR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Anthocharis cardamines* (LINNAEUS, 1758) – Orange-tip



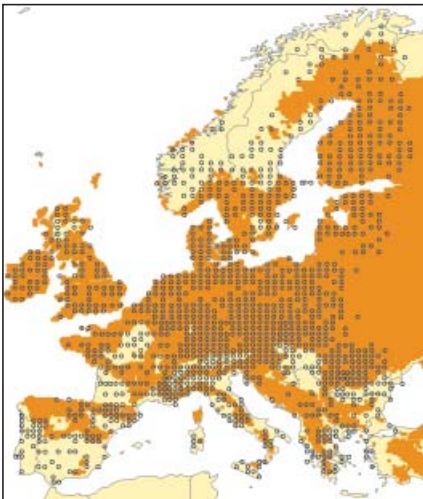
© Chris van Swaay

		Full dispersal	No dispersal
2050	SEDG	-1416 (-7.53%)	-3168 (-16.86%)
	BAMBU	-2021 (-10.75%)	-3707 (-19.72%)
	GRAS	-2928 (-15.58%)	-4787 (-25.47%)
2080	SEDG	-2159 (-11.49%)	-4447 (-23.66%)
	BAMBU	-4765 (-25.35%)	-7476 (-39.78%)
	GRAS	-6918 (-36.81%)	-10040 (-53.42%)

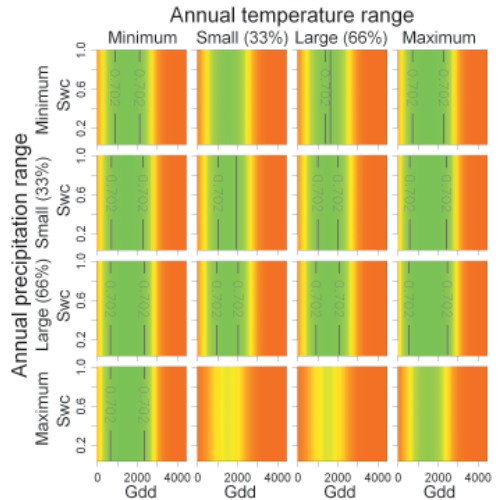
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 18795 cells)

In Western Europe, the first Orange-tip gives us the feeling that spring has arrived. However, high in the mountains, these butterflies only appear in early summer. The Orange-tip occurs in damp to quite wet grasslands at the edge of woods, or near thickets. The eggs are laid singly on flowerheads of different crucifers. At first, the caterpillars feed on the flowerbuds of the foodplant and later on the fruits. They live alone, which accords with their cannibalistic nature. When ready to pupate, they move into rough vegetation, climbing up a little twig and turning into an attractive light-brown pupa, suspended from the plant by a silken girdle. The Orange-tip hibernates in this stage and has one generation a year.

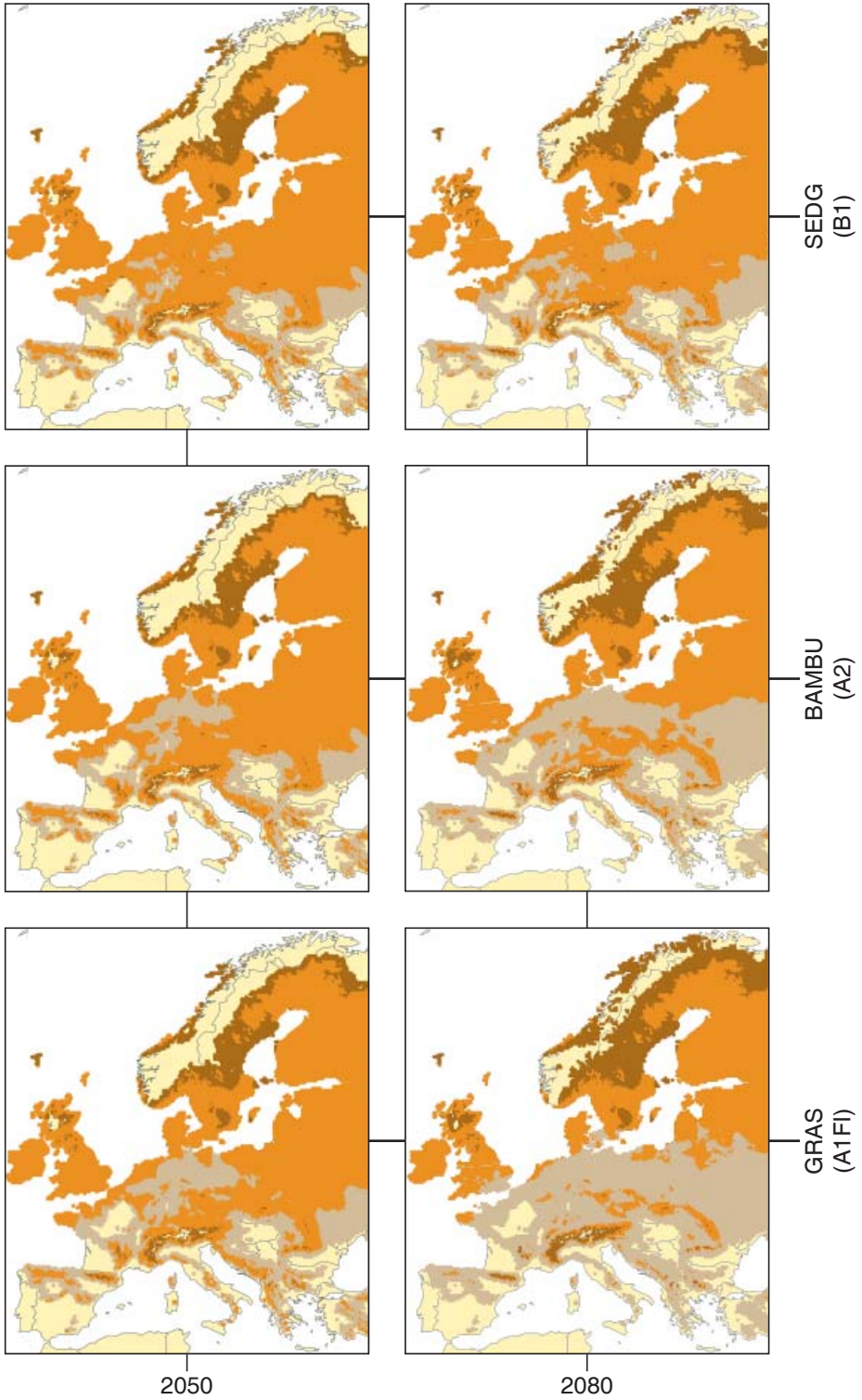
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.7). Climate risk category: PR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Anthocharis euphenoides* STAUDINGER, 1869



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		Full dispersal	No dispersal
2050	SEDG	-989 (-33.3%)	-1744 (-58.72%)
	BAMBU	-1299 (-43.74%)	-1763 (-59.36%)
	GRAS	-1374 (-46.26%)	-2012 (-67.74%)
2080	SEDG	-1313 (-44.21%)	-2309 (-77.74%)
	BAMBU	-1948 (-65.59%)	-2614 (-88.01%)
	GRAS	-1956 (-65.86%)	-2887 (-97.21%)

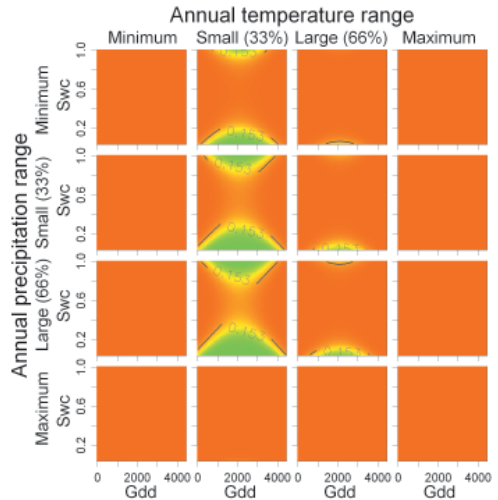
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 2970 cells)

This butterfly inhabits warm, dry places with flower-rich, grassy vegetation and scattered bushes. Eggs are laid one by one on the flowerbuds of various crucifers, such as the buckler mustards *Biscutella laevigata* and *B. auriculata*, London Rocket (*Sisymbrium irio*), and Hedge Mustard (*S. officinale*). The caterpillars feed mainly on ovaries, but at times are also cannibalistic. This species hibernates as a pupa and has one generation a year.

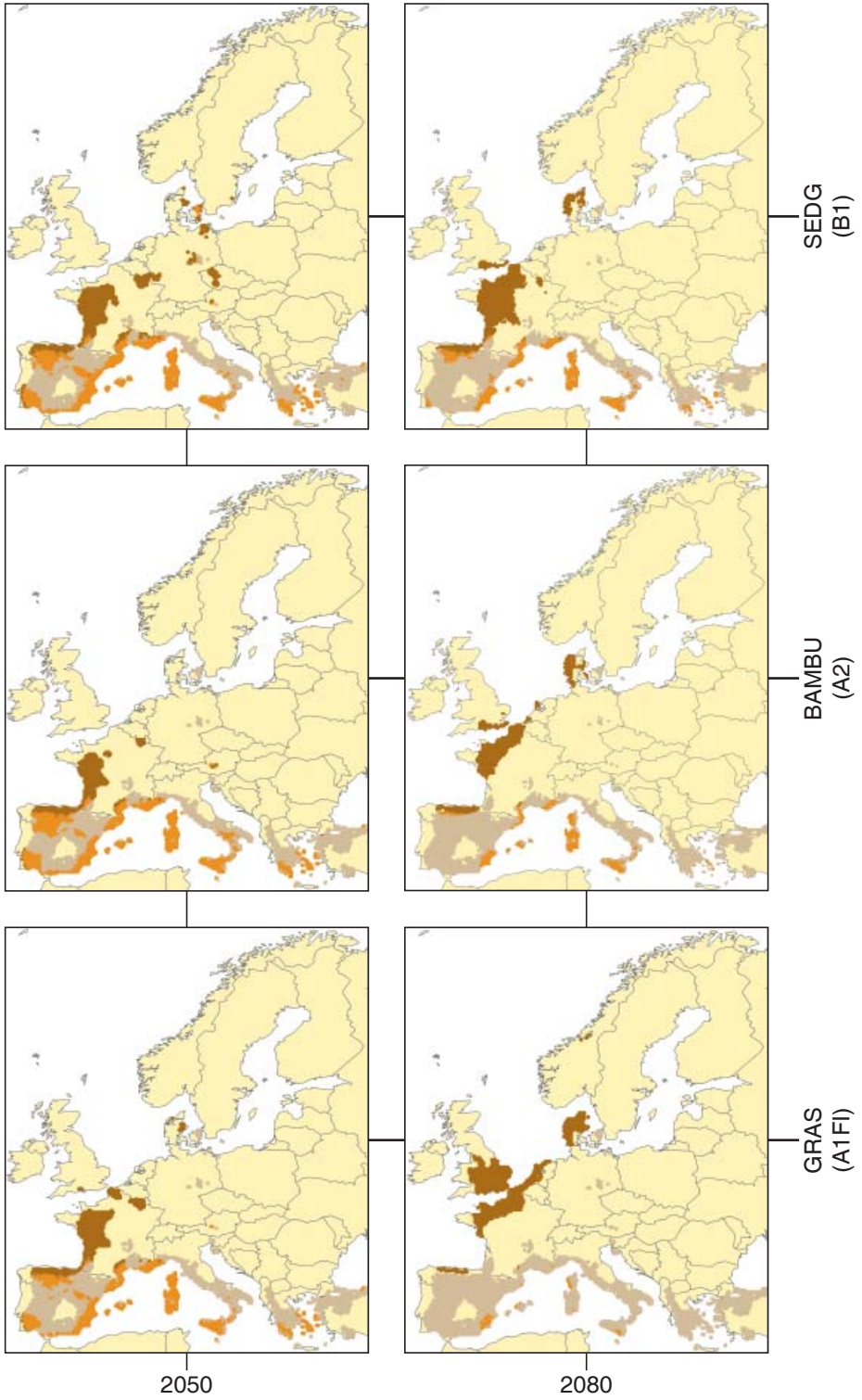
Present distribution can be well explained by climatic variables (AUC = 0.91).  
Climate risk category: HHHR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Anthocharis gruneri* HERRICH-SCHÄFFER, 1851 – Gruner’s Orange-tip



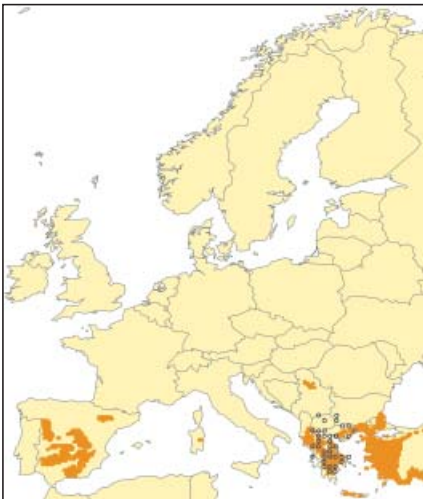
© Albert Vliegenthart

		Full dispersal	No dispersal
2050	SEDG	-266 (-26.68%)	-613 (-61.48%)
	BAMBU	-330 (-33.1%)	-648 (-64.99%)
	GRAS	-356 (-35.71%)	-696 (-69.81%)
2080	SEDG	-224 (-22.47%)	-695 (-69.71%)
	BAMBU	-666 (-66.8%)	-888 (-89.07%)
	GRAS	-773 (-77.53%)	-971 (-97.39%)

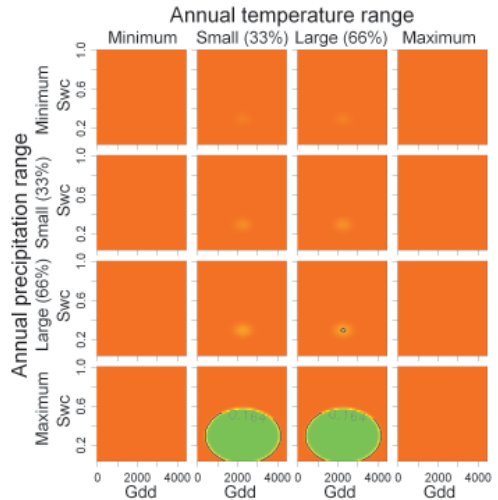
Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 997 cells)

Gruner’s Orange-tip lives on dry, open grasslands, on rocky, often calcareous slopes, scrub and clearings in dry woodland. The eggs are laid on *Aethionema* species, including Burnt Candytuft (*A. saxatile*) and *A. orbiculatum*, the caterpillars eating both the leaves and ripening seeds. It is single-brooded and the pupa hibernates.

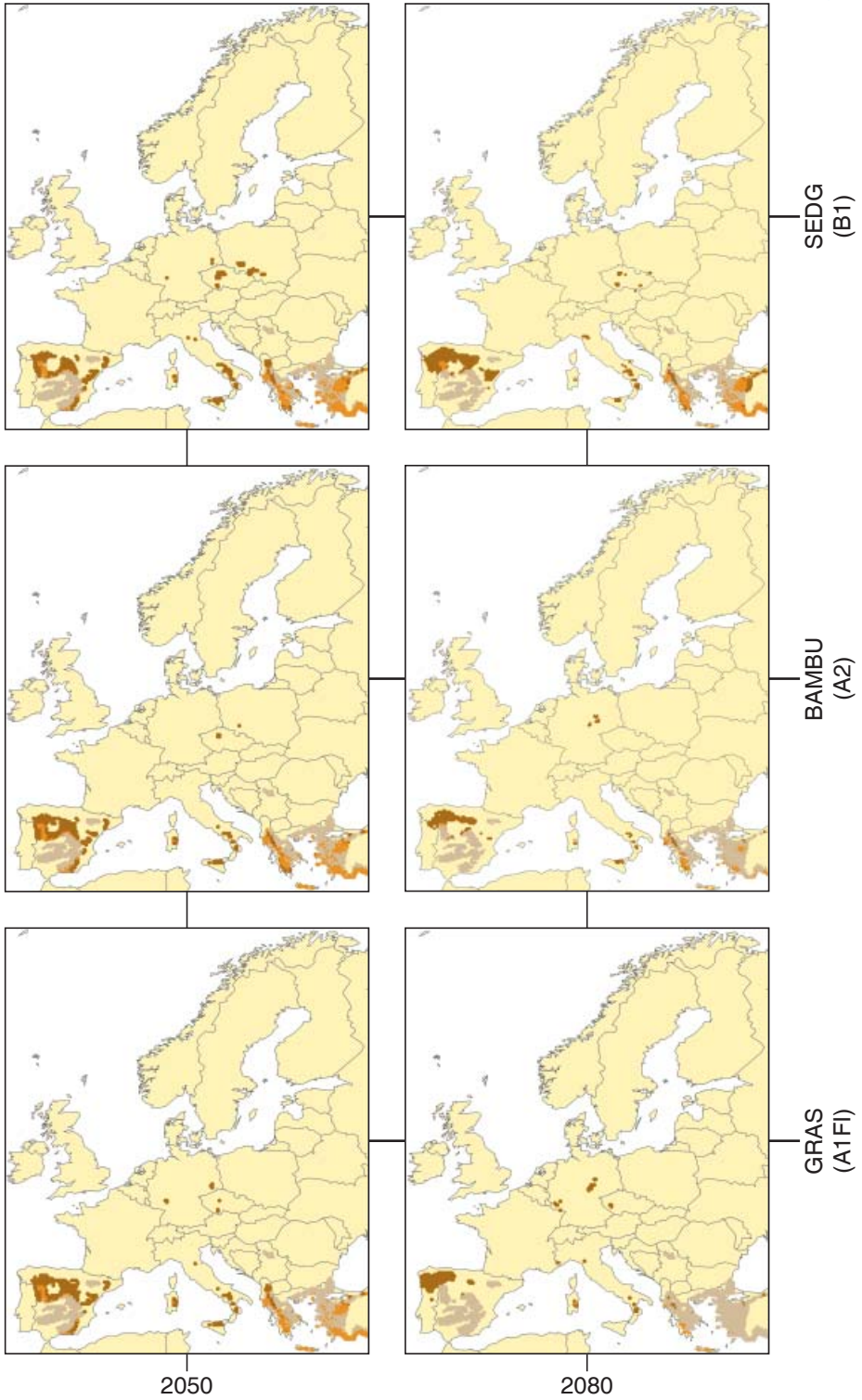
Present distribution can be well explained by climatic variables (AUC = 0.92).  
Climate risk category: HHHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## Zegris eupheme (ESPER, 1805) – Sooty Orange-tip



© Neil Thompson

		Full dispersal	No dispersal
2050	SEDG	-411 (-47.9%)	-520 (-60.61%)
	BAMBU	-536 (-62.47%)	-562 (-65.5%)
	GRAS	-456 (-53.15%)	-580 (-67.6%)
2080	SEDG	-765 (-89.16%)	-766 (-89.28%)
	BAMBU	-837 (-97.55%)	-837 (-97.55%)
	GRAS	-849 (-98.95%)	-849 (-98.95%)

Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 858 cells)

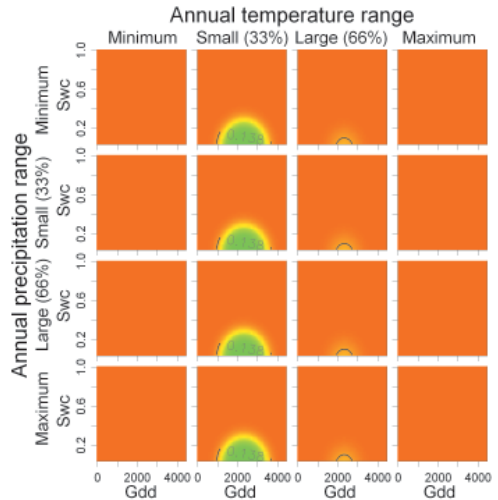
The Sooty Orange-tip is mostly seen in dry, flower-rich places, waste ground, and abandoned agricultural land. Crucifers, such as London Rocket (*Sisymbrium irio*), the buckler mustard *Biscutella auriculata*, Hoary Mustard (*Hirschfeldia incana*), and radishes (*Raphanus* spp.), are usually abundant in its habitat. They are used by the butterflies for their nectar and as larval foodplants. The butterflies have a quick, zigzagging flight. The Sooty Orange-tip hibernates as a pupa. This pupal stage may last for one, two, or three years. It is single-brooded.

Present distribution can be very well explained by climatic variables (AUC = 0.97).

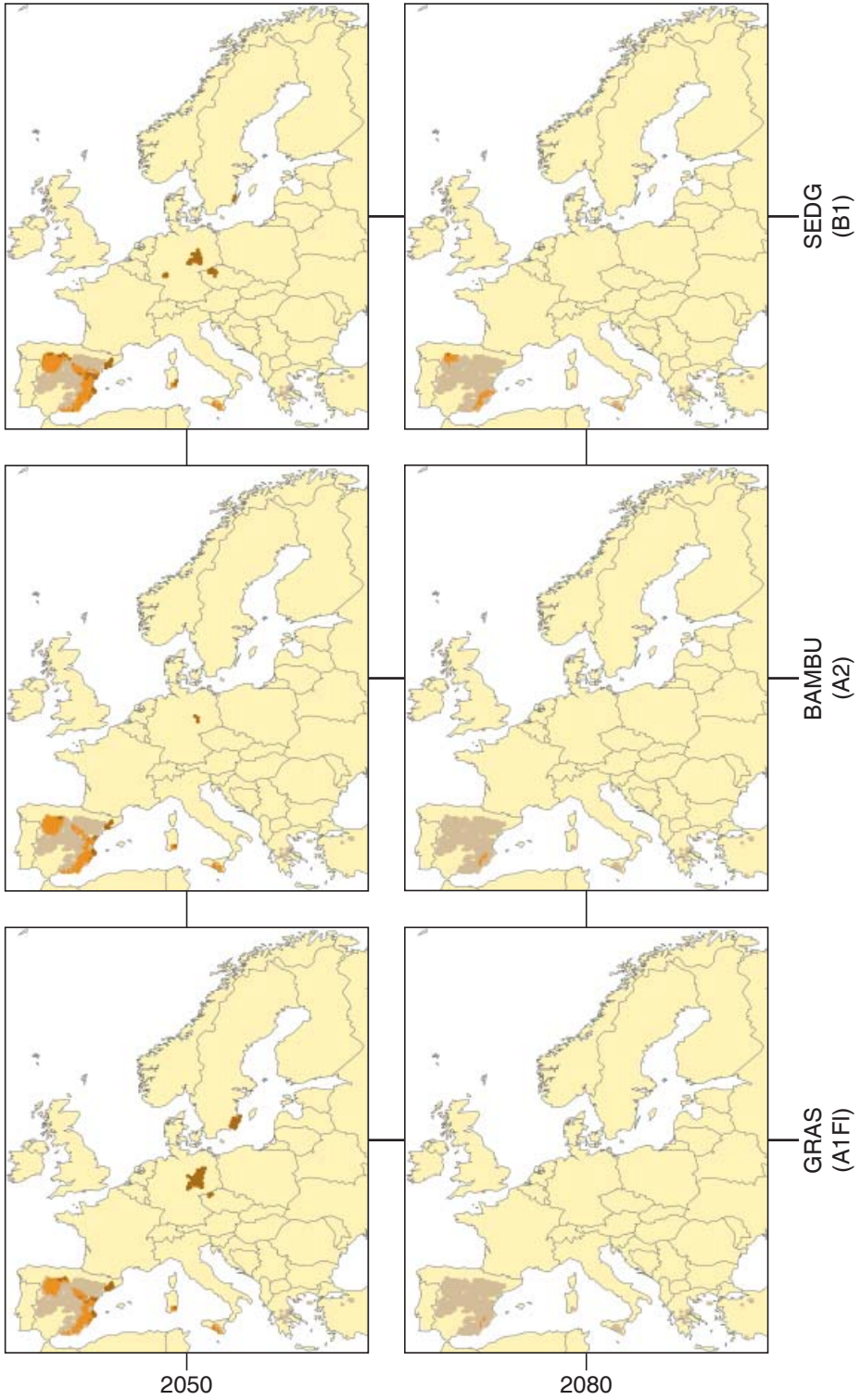
Climate risk category: HHHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Euchloe belemia* (ESPER, 1798) – Green-striped White



© Albert Vliegenthart

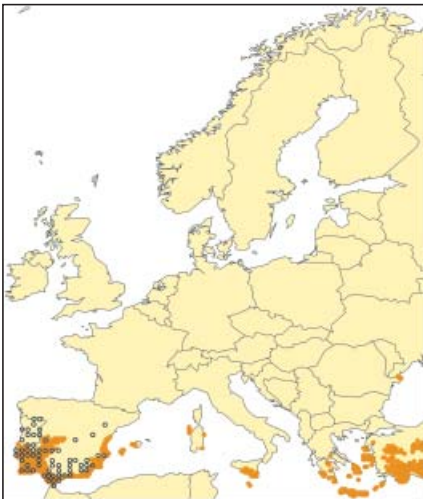
		Full dispersal	No dispersal
2050	SEDG	-289 (-41.58%)	-377 (-54.24%)
	BAMBU	-424 (-61.01%)	-432 (-62.16%)
	GRAS	-400 (-57.55%)	-446 (-64.17%)
2080	SEDG	-338 (-48.63%)	-495 (-71.22%)
	BAMBU	-607 (-87.34%)	-626 (-90.07%)
	GRAS	-649 (-93.38%)	-670 (-96.4%)

Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 695 cells)

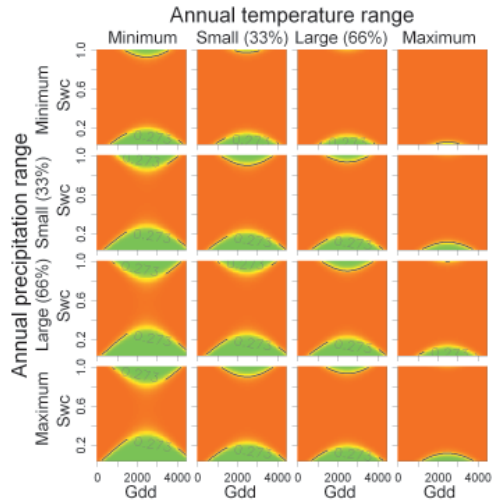
The Green-striped White occurs in flower-rich places, between bushes, on waste ground, and on abandoned agricultural land. It occurs locally, but can be numerous in its flight area. The butterfly flies quickly and close to the ground. The caterpillars eat the ripening seeds of different crucifers, such as the buckler mustard *Biscutella auriculata*, candytufts (*Iberis* spp.) including Annual Candytuft (*I. amara*), and rockets (*Sisymbrium* spp.). The Green-striped White has two broods a year in the spring, and passes the winter as a pupa.

Present distribution can be very well explained by climatic variables (AUC = 0.96).

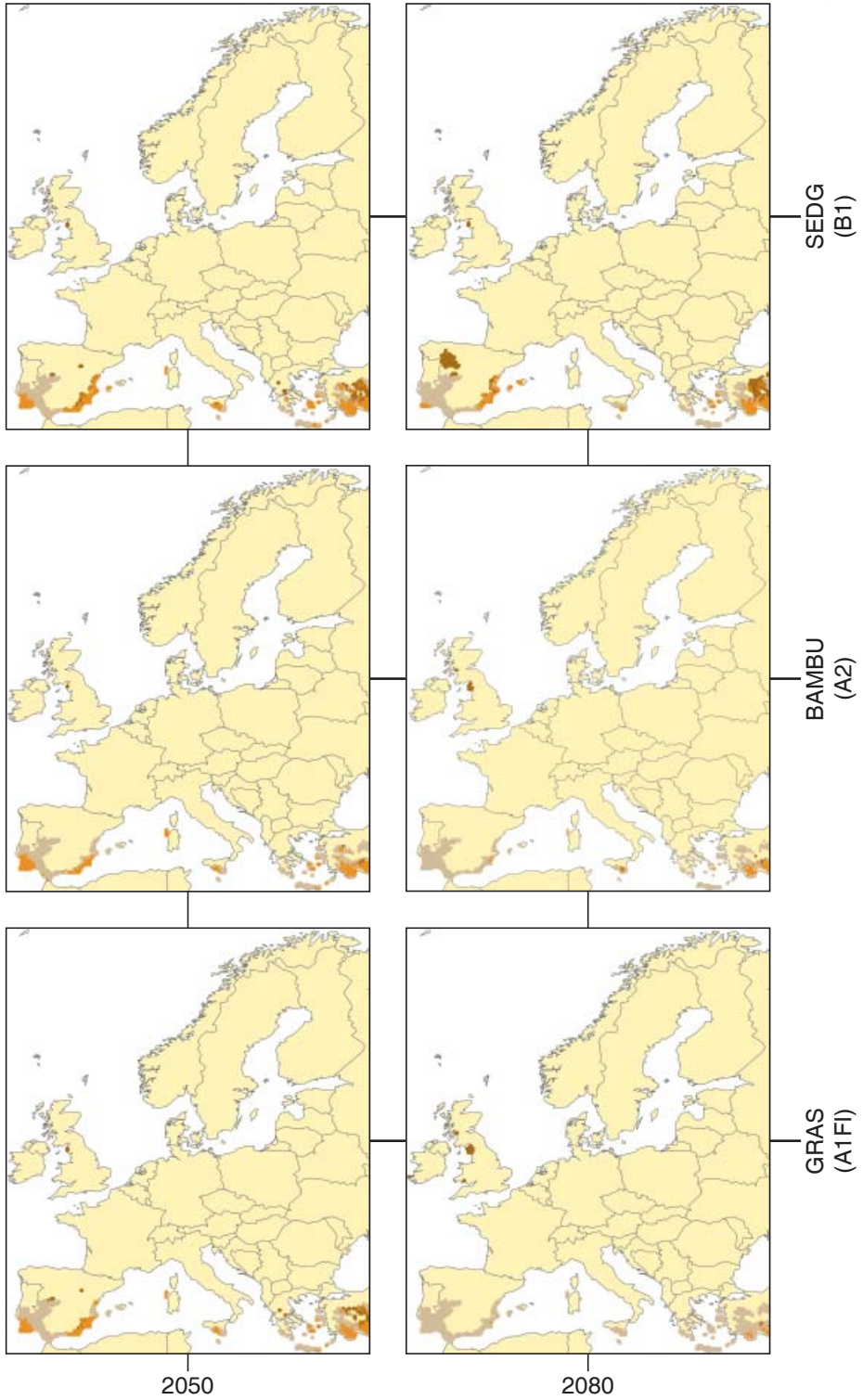
Climate risk category: HHHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Euchloe ausonia* (HÜBNER, 1806) (complex) – Dappled White



© Chris van Swaay

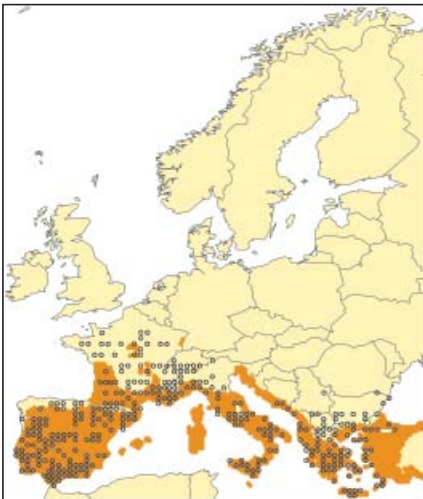
		Full dispersal	No dispersal
2050	SEDG	742 (16.55%)	-802 (-17.89%)
	BAMBU	-91 (-2.03%)	-1080 (-24.09%)
	GRAS	586 (13.07%)	-1029 (-22.95%)
2080	SEDG	338 (7.54%)	-1439 (-32.1%)
	BAMBU	-327 (-7.29%)	-2058 (-45.91%)
	GRAS	-265 (-5.91%)	-2472 (-55.14%)

Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 4483 cells)

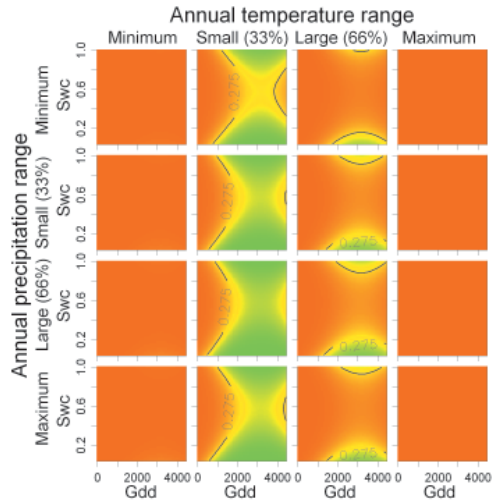
Due to data availability we here treat *Euchloe ausonia* (HÜBNER, 1806), *Euchloe simplonia* Freyer, 1829, and *Euchloe crameri* BUTLER, 1869, as the Dappled White species complex, knowing that they are normally being treated as distinct species.

The Dappled Whites are species of warm, dry places. They occur on flower-rich grasslands and waste ground, along hedges and the edges of woods. Various crucifers are used as larval foodplant, such as a Charlock (*Sisymbrium arvensis*), Woad (*Isatis tinctoria*), buckler mustards (*Biscutella* spp.), Evergreen Candytuft (*Iberis sempervirens*), and Crested Bunias (*Bunias erucago*). The caterpillars feed on the flowers and ripening seeds. They are double-brooded and hibernate as pupa.

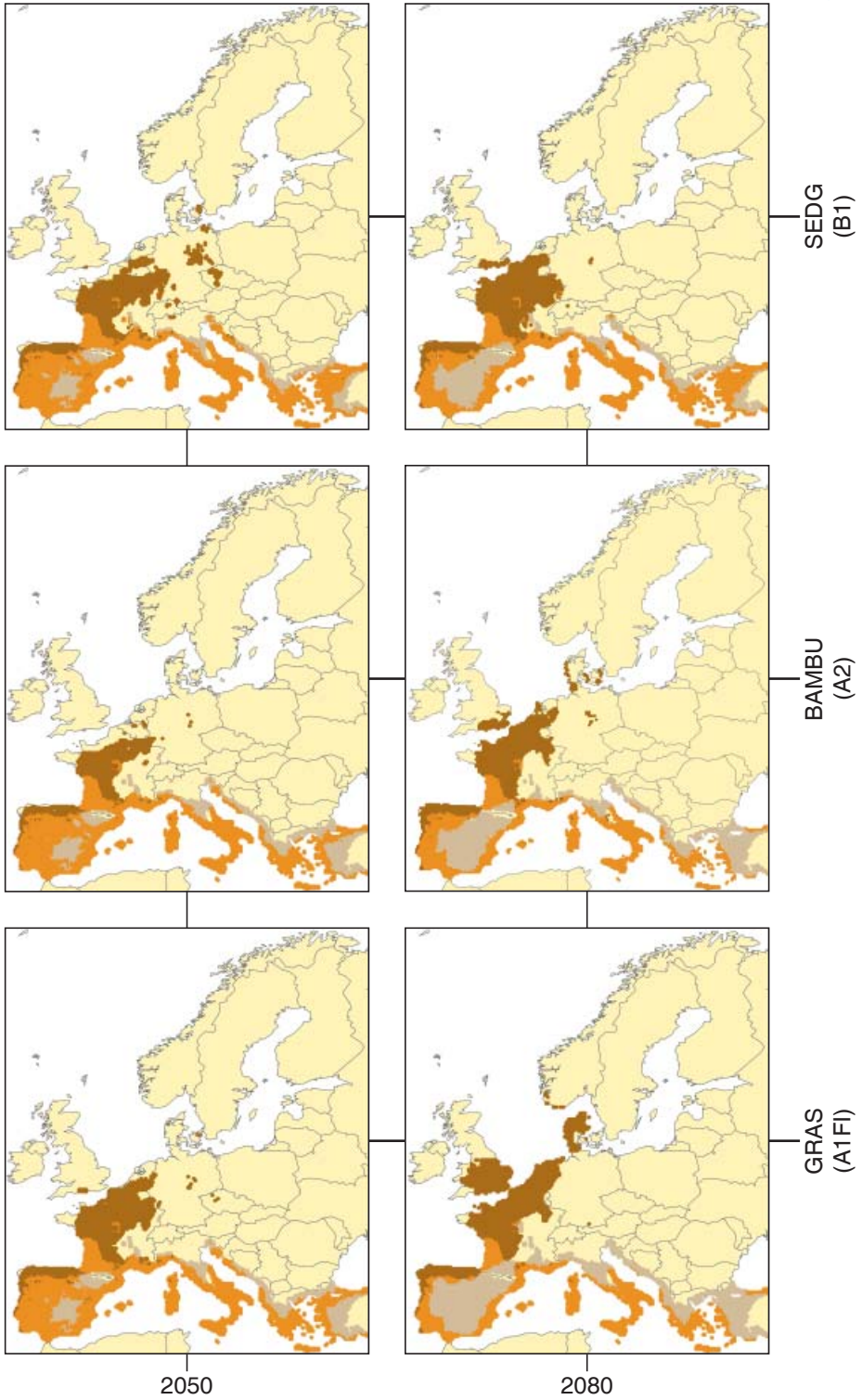
Present distribution can be explained by climatic variables to a moderate extent (AUC = 0.85).  
Climate risk category: R.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Euchloe tagis* (HÜBNER, 1804) – Portuguese Dappled White



© Jean Delacre

		Full dispersal	No dispersal
2050	SEDG	-590 (-18.72%)	-1537 (-48.76%)
	BAMBU	-999 (-31.69%)	-1507 (-47.81%)
	GRAS	-794 (-25.19%)	-1692 (-53.68%)
2080	SEDG	-920 (-29.19%)	-1943 (-61.64%)
	BAMBU	-1535 (-48.7%)	-2350 (-74.56%)
	GRAS	-1749 (-55.49%)	-2743 (-87.02%)

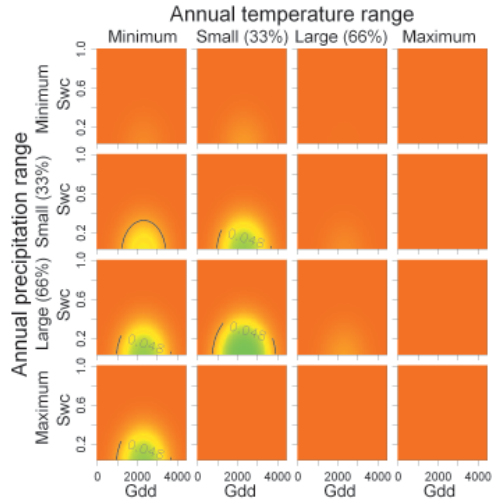
Changes in climatic niche distribution  
(in 10<sup>7</sup> × 10<sup>7</sup> grid cells; present niche space: 3152 cells)

This butterfly owes its specific name to the River Tagus in Portugal, along the banks of which it was first found. The Portuguese Dappled White is found on warm, dry rocky places with patches of flower-rich grassy vegetation, in dry scrub, and on abandoned agricultural land. Various crucifers are used as foodplant, such as candytufts (*Iberis* spp.), including *I. ciliata*, *I. saxatilis* and Annual Candytuft (*I. amara*), and buckler mustards (*Biscutella* spp.). The caterpillars eat the ovaries and flowers. It has one brood a year and hibernates as a pupa.

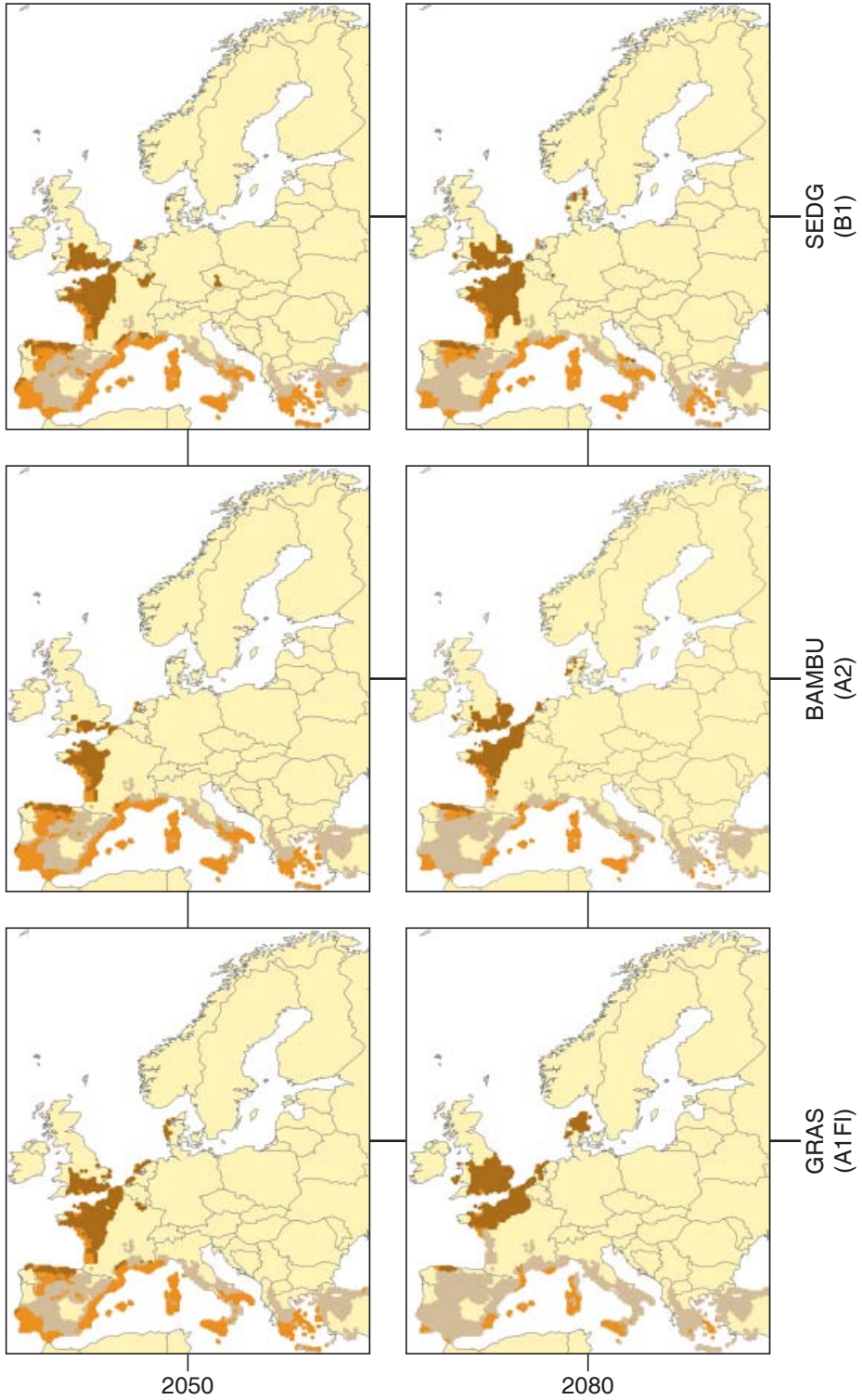
Present distribution can be well explained by climatic variables (AUC = 0.86).  
Climate risk category: HHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Aporia crataegi* (LINNAEUS, 1758) – Black-veined White



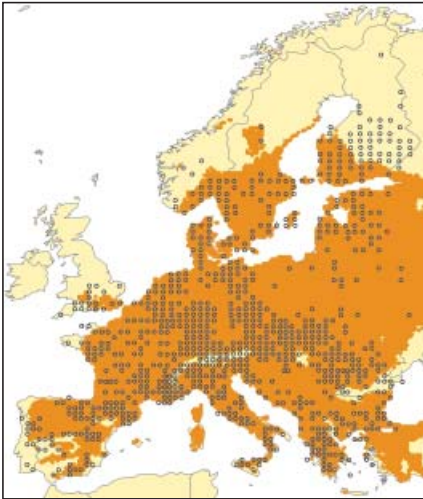
© Kars Veling

		Full dispersal	No dispersal
2050	SEDG	-661 (-3.52%)	-2426 (-12.91%)
	BAMBU	-703 (-3.74%)	-2451 (-13.05%)
	GRAS	-1530 (-8.14%)	-3266 (-17.39%)
2080	SEDG	-1604 (-8.54%)	-4323 (-23.01%)
	BAMBU	-2410 (-12.83%)	-6143 (-32.7%)
	GRAS	-3323 (-17.69%)	-8101 (-43.12%)

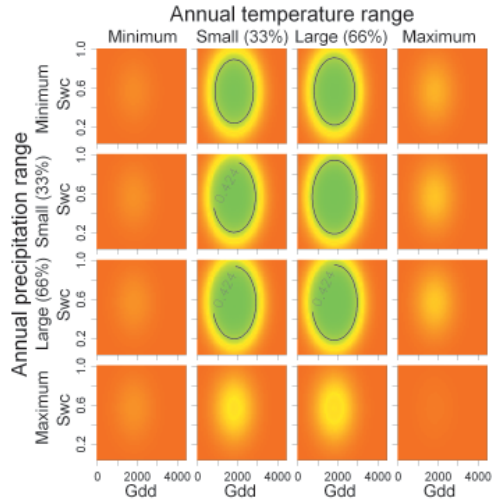
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 18785 cells)

The Black-veined White can be found on many different sorts of vegetation in a variety of landscapes, but seems to prefer habitats in the neighbourhood of woods or scrub. Numbers of this migratory species can fluctuate greatly and the reasons for this are not well understood. The species may build up huge populations at unusual places such as hedges along motorways, but also disappear from large areas for many years. The eggs are laid in large clusters of often sixty or more, on the leaves of trees and bushes of the rose family (Rosaceae), such as hawthorn (*Crataegus* spp.), Blackthorn (*Prunus spinosa*), Cherry (*Prunus* spp.), Apple (*Malus* spp.), also in orchards. The caterpillars spend their time in a communal silken nest until they pupate, the nest in which they hibernate being more substantial. When they are ready to pupate, they disperse over the foodplant. The yellow pupa with black spots suspends in a silken girdle. The Black-veined White has one brood a year.

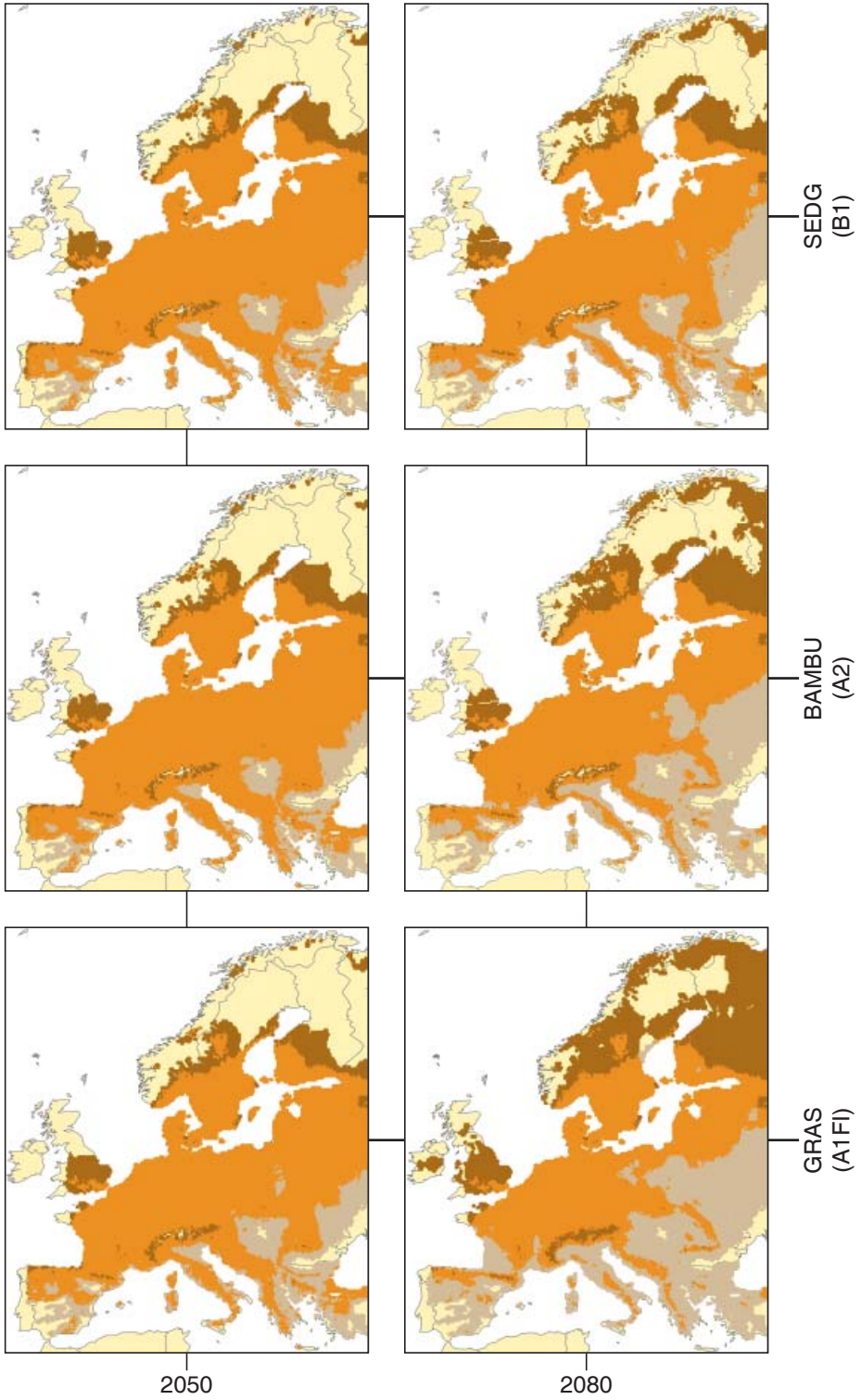
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.69). Climate risk category: PR.



Observed species distribution (50 x 50 km² UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Pieris brassicae* (LINNAEUS, 1758) – Large White



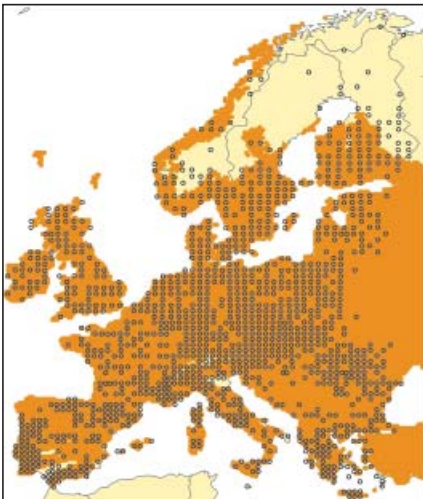
© Albert Vliegenthart

		Full dispersal	No dispersal
2050	SEDG	-1904 (-8.11%)	-3228 (-13.75%)
	BAMBU	-3133 (-13.34%)	-4027 (-17.15%)
	GRAS	-3241 (-13.8%)	-4419 (-18.82%)
2080	SEDG	-3429 (-14.6%)	-5640 (-24.02%)
	BAMBU	-6368 (-27.12%)	-8473 (-36.08%)
	GRAS	-8906 (-37.93%)	-11751 (-50.04%)

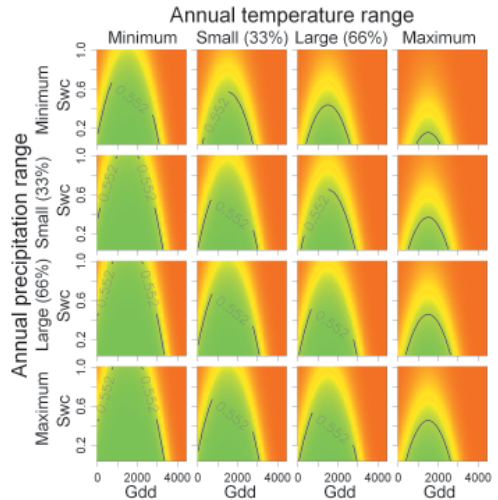
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 23482 cells)

You can come across the Large White almost everywhere. It lays its eggs singly or in small clusters on the underside of the foodplants, which are mainly broad-leaved Brassicaceae (like *Brassica*, *Crambe*, *Lunaria*, *Cakile*) that offer enough food for the gregarious caterpillars, but also species of the introduced genus *Tropaeolum* (Tropaeolaceae) which also contains glucosinolates. On such a nutritious diet, the caterpillar grows very quickly, reaching the pupal stage in three to six weeks. The attractive white pupa is suspended in a silken girdle from the foodplant. The Large White has several generations a year, the number depending on the geographical location and latitude of the flight area, and the length of the summer.

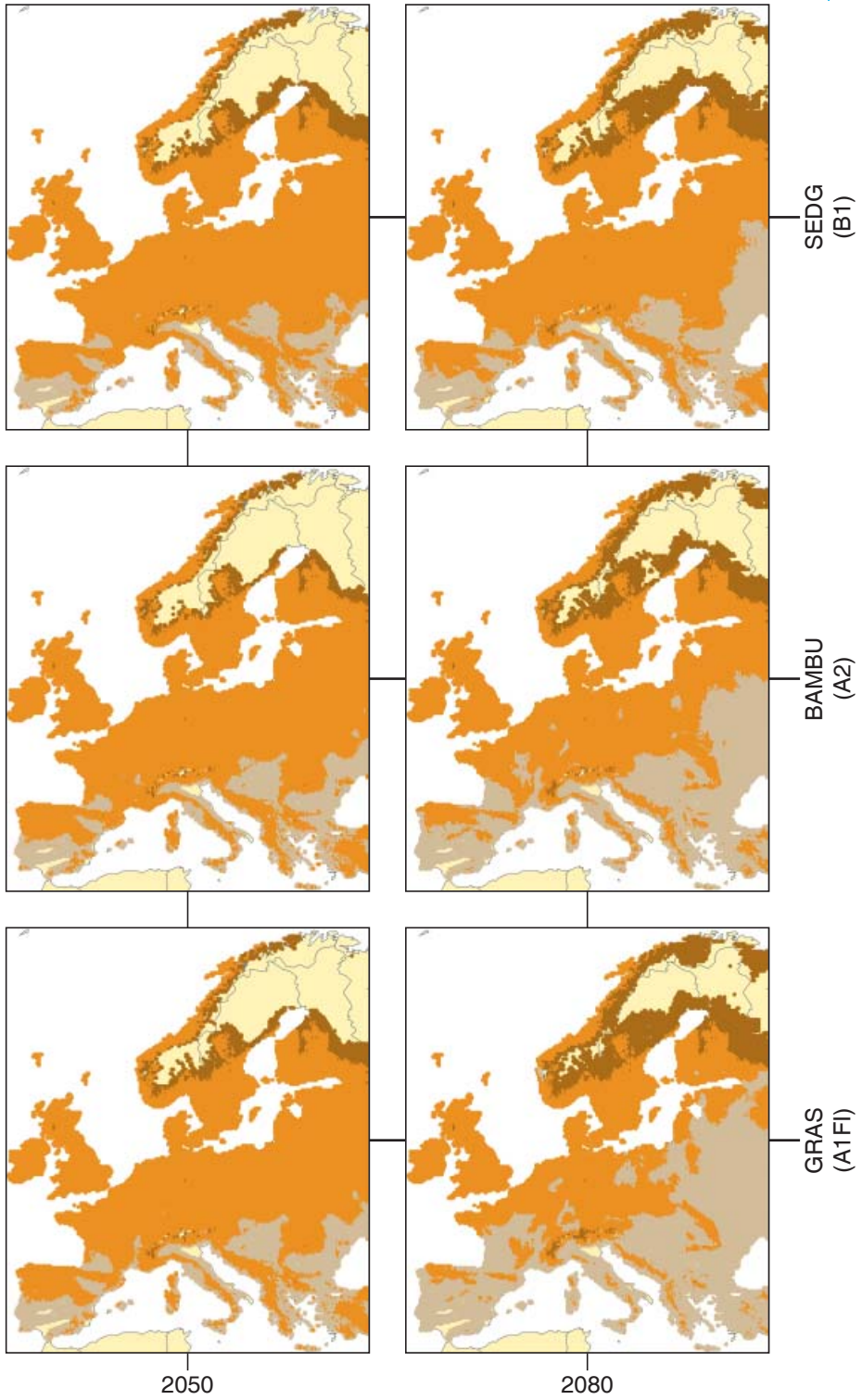
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.66). Climate risk category: PR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





### *Pieris krueperi* (STAUDINGER, 1860) – Krüper’s Small White



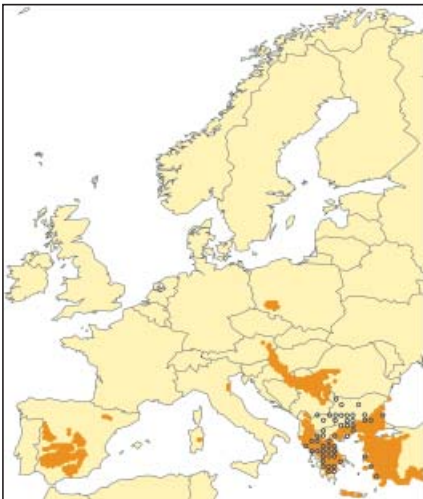
© Rudi Verovnik

		Full dispersal	No dispersal
2050	SEDG	216 (16.44%)	-619 (-47.11%)
	BAMBU	11 (0.84%)	-604 (-45.97%)
	GRAS	-25 (-1.9%)	-698 (-53.12%)
2080	SEDG	446 (33.94%)	-748 (-56.93%)
	BAMBU	-141 (-10.73%)	-900 (-68.49%)
	GRAS	36 (2.74%)	-1033 (-78.61%)

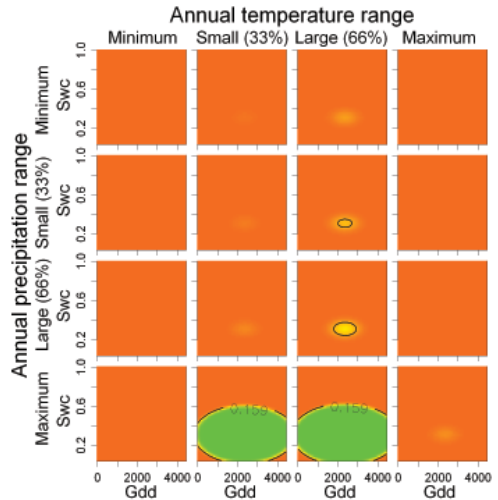
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 1314 cells)

Krueper’s Small White occurs in warm, dry places on calcareous, rocky slopes with scattered low, herbaceous vegetation. Eggs are laid on the sepals of Golden Alyssum (*Alyssum saxatile*), and *A. montanum*. The caterpillars feed on the ovaries. It hibernates as a pupa and has two or more generations a year.

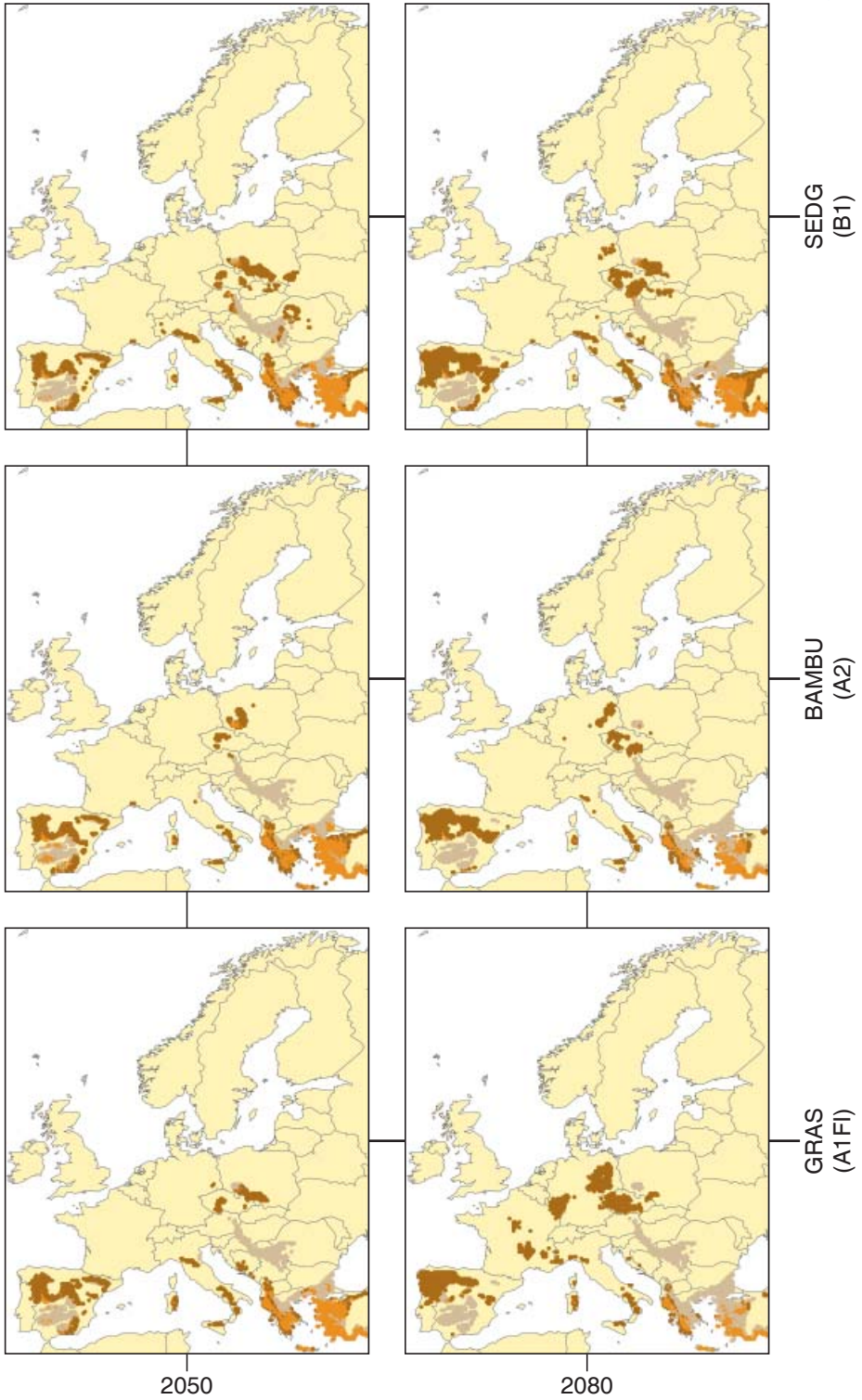
Present distribution can be well explained by climatic variables (AUC = 0.91).  
Climate risk category: HR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Pieris mannii* (MAYER, 1851) – Southern Small White



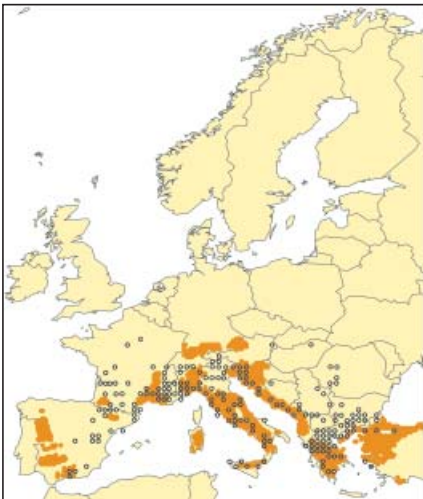
© Martin Wiemers

		Full dispersal	No dispersal
2050	SEDG	214 (12.51%)	-572 (-33.45%)
	BAMBU	221 (12.92%)	-716 (-41.87%)
	GRAS	222 (12.98%)	-803 (-46.96%)
2080	SEDG	616 (36.02%)	-968 (-56.61%)
	BAMBU	639 (37.37%)	-1318 (-77.08%)
	GRAS	711 (41.58%)	-1497 (-87.54%)

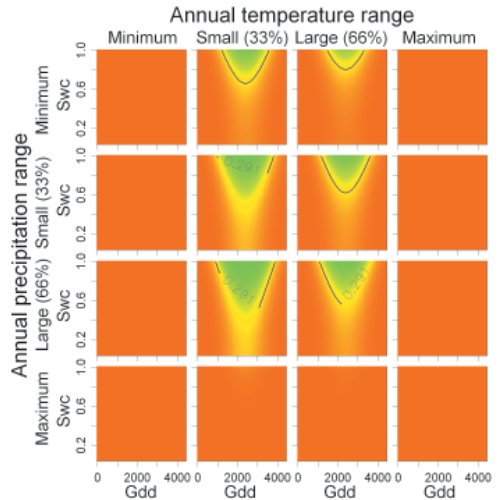
Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 1710 cells)

The Southern Small White, which looks very much like the Small White (*P. rapae*), occurs on both calcareous and non-calcareous dry, grassy vegetation, in open scrub and open woodland. The most important larval foodplants are the candytufts Evergreen Candytuft (*Iberis sempervirens*) and *I. saxatilis*, although other crucifers, such as *Abyssoides utriculata*, and mustards (*Sinapis* spp.) are also used. The eggs are laid singly or in small groups on the uppersides of the leaves. The caterpillars feed on the leaves. It has several generations a year, pupating on plant stalks and stones. It overwinters as a pupa, and the butterflies emerge in the spring.

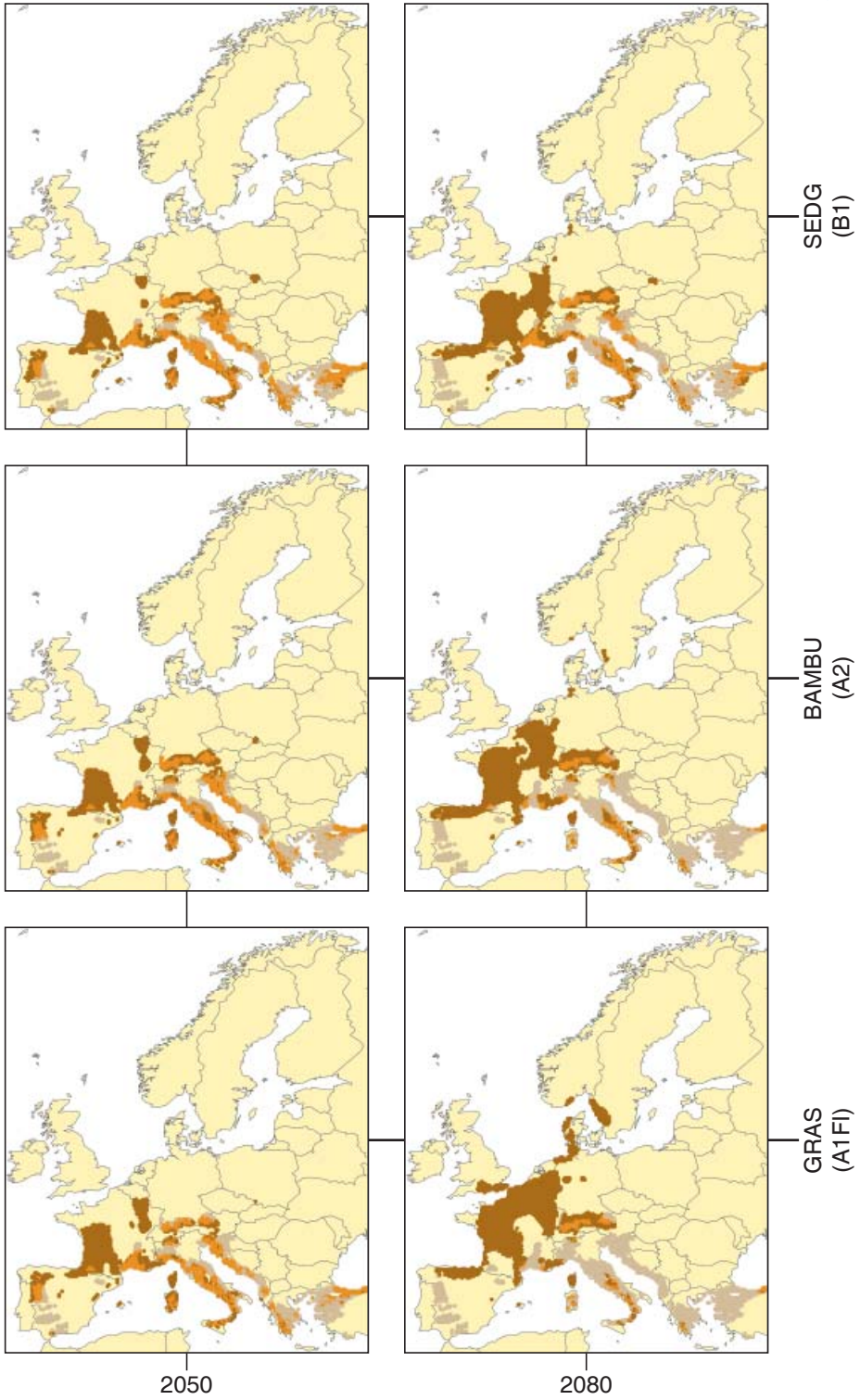
Present distribution can be explained by climatic variables to a moderate extent (AUC = 0.76).  
Climate risk category: HHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Pieris rapae* (LINNAEUS, 1758) – Small White



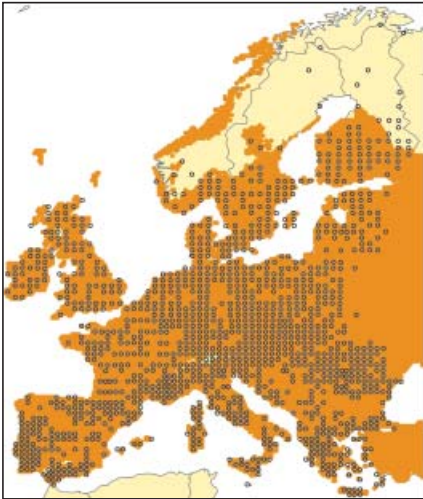
© Chris van Swaay

		Full dispersal	No dispersal
2050	SEDG	82 (0.34%)	-1502 (-6.22%)
	BAMBU	-690 (-2.86%)	-1742 (-7.22%)
	GRAS	-891 (-3.69%)	-2258 (-9.35%)
2080	SEDG	-670 (-2.78%)	-3296 (-13.65%)
	BAMBU	-3119 (-12.92%)	-6008 (-24.89%)
	GRAS	-4088 (-16.93%)	-8043 (-33.31%)

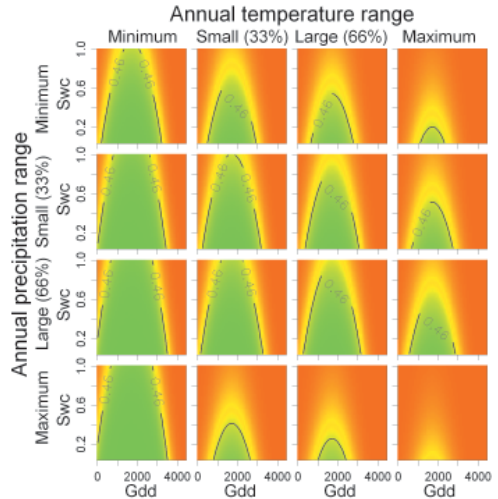
Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 24143 cells)

The Small White is found in any sort of habitat where its larval foodplants grow, such as gardens, parks, grasslands, heathland and woodland. The eggs are laid on the underside of the leaves of a wide variety of crucifers, including cultivated brassicas, and also on *Reseda* species, such as Wild Mignonette (*R. lutea*). The caterpillars grow very rapidly, sometimes pupating after two weeks. The pupa hangs in a silken girdle, normally on vertical surfaces, and hibernates in this stage. The Small White has several generations a year, depending on the geographical position and altitude of the flight area, and the length of the summer.

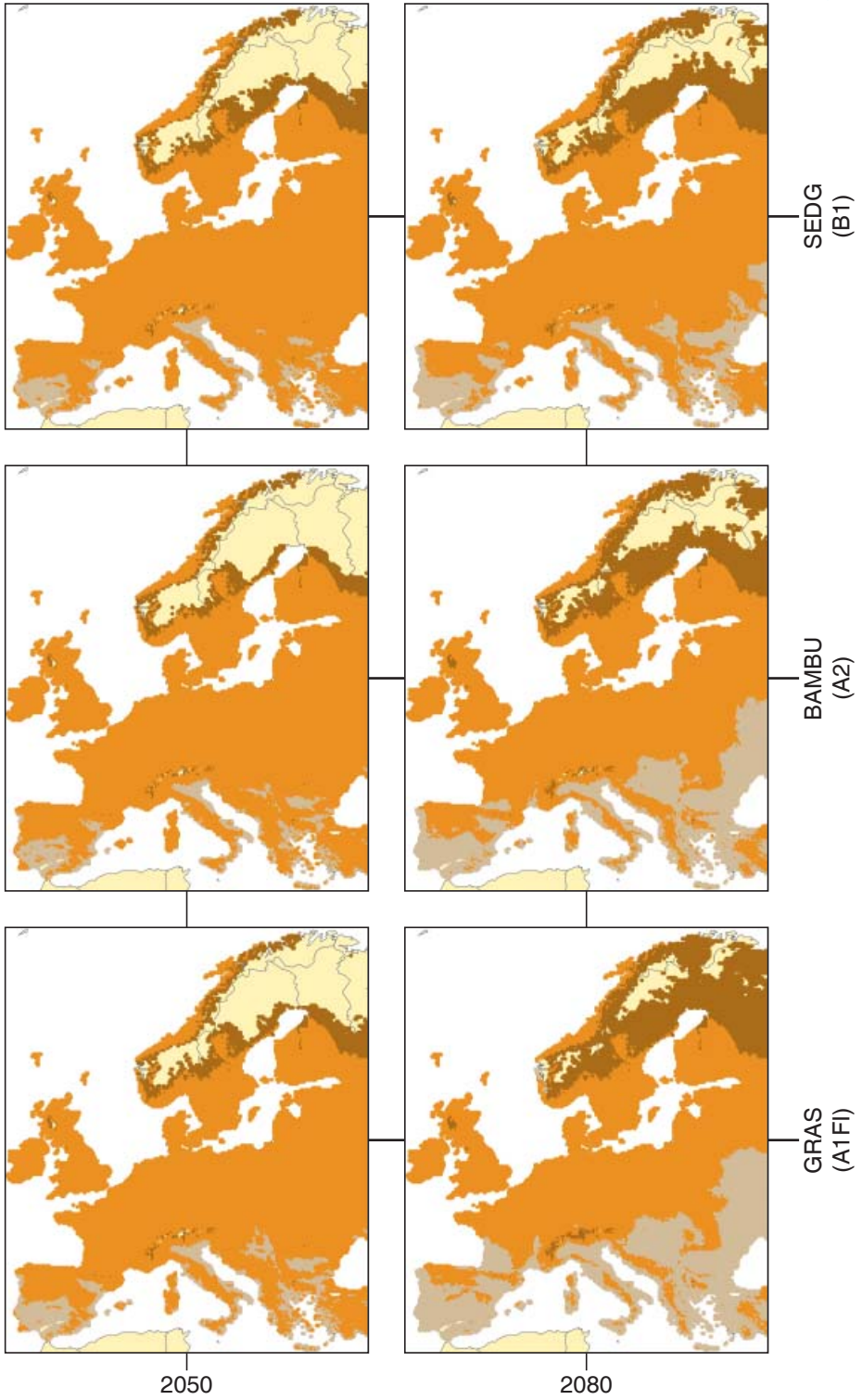
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.69). Climate risk category: PR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Pieris ergane* (GEYER, 1828) – Mountain Small White



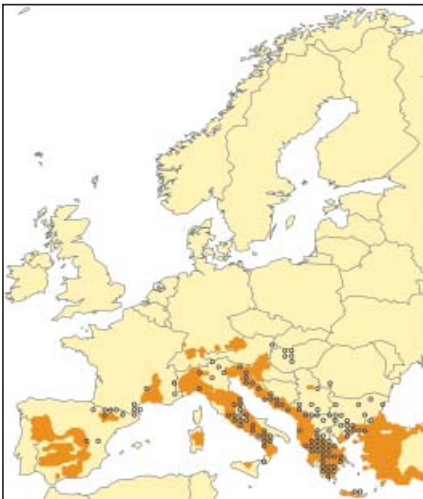
© Rudi Verovnik

		Full dispersal	No dispersal
2050	SEDG	94 (4.38%)	-786 (-36.63%)
	BAMBU	-101 (-4.71%)	-932 (-43.43%)
	GRAS	-90 (-4.19%)	-1043 (-48.6%)
2080	SEDG	527 (24.56%)	-1157 (-53.91%)
	BAMBU	223 (10.39%)	-1684 (-78.47%)
	GRAS	519 (24.18%)	-1894 (-88.26%)

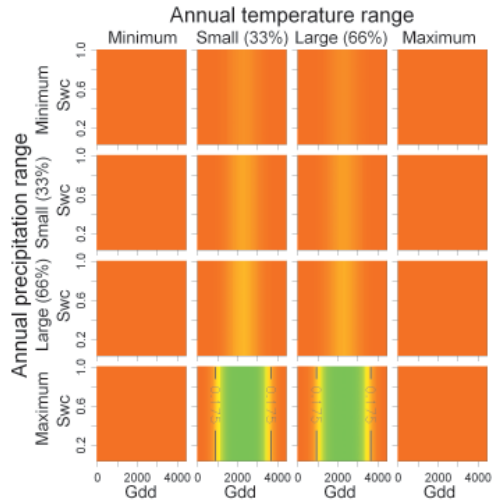
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 2146 cells)

The Mountain Small White likes warm and dry places, and is found on dry, poor grasslands, in rocky places, in open scrub and in large clearings in woods. The flight areas are usually on calcareous soil. The males can sometimes be seen in large groups on damp ground. Compared to other whites, this butterfly has a slow and measured flight. The main larval foodplant is Burnt Candytuft (*Aethionema saxatile*), but *A. orbiculatum* and Woad (*Isatis tinctoria*) are also used. The eggs are laid singly. The pupa is normally fixed to stones and rocks. There are two or three generations a year, and the pupa of the autumn generation hibernates.

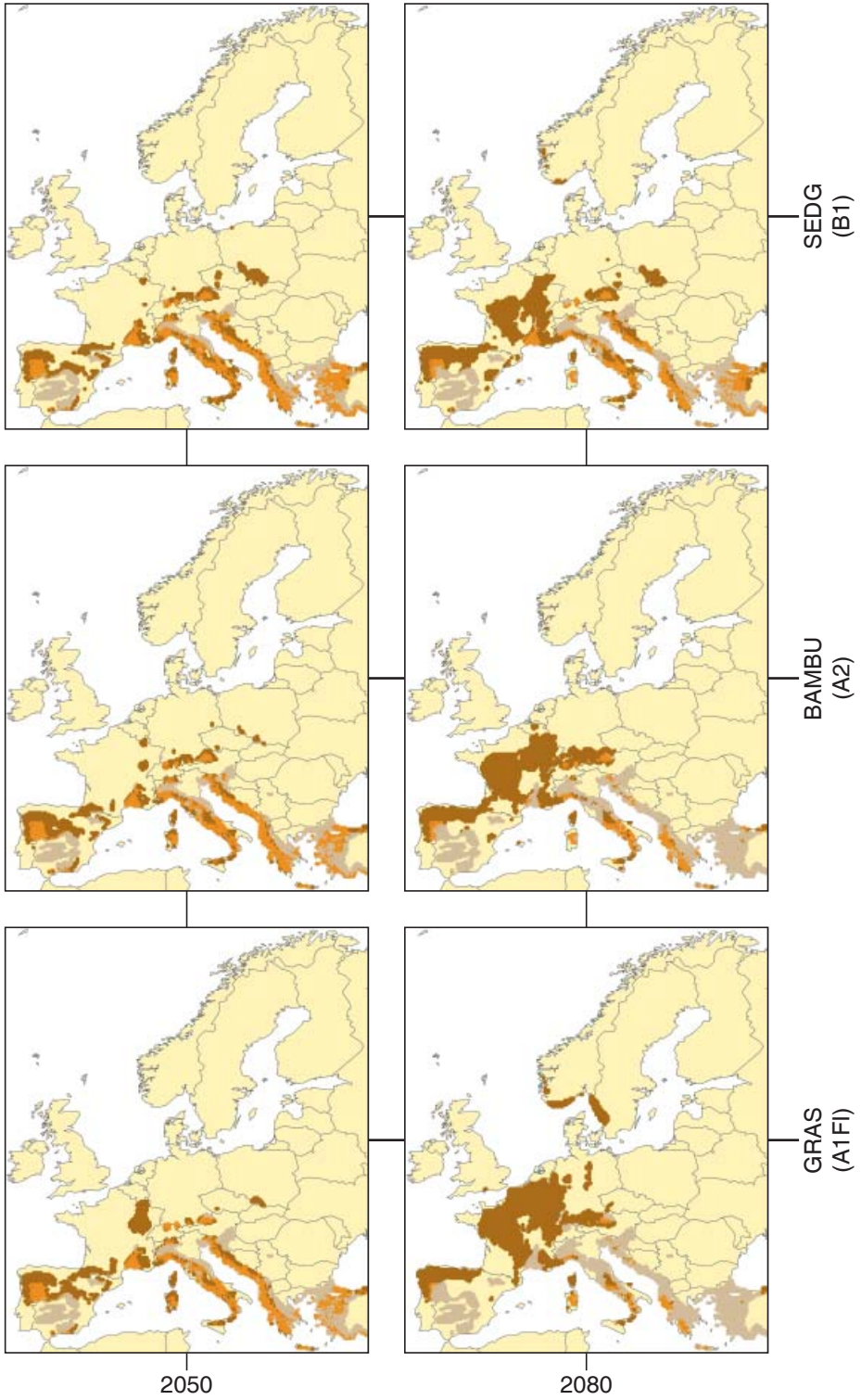
Present distribution can be explained by climatic variables to a moderate extent (AUC = 0.84).  
Climate risk category: HHR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Pieris napi* (LINNAEUS, 1758) – Green-veined White



© Chris van Swaay

		Full dispersal	No dispersal
2050	SEDG	-2543 (-9.61%)	-3045 (-11.51%)
	BAMBU	-2497 (-9.44%)	-3022 (-11.42%)
	GRAS	-3275 (-12.38%)	-3819 (-14.43%)
2080	SEDG	-3817 (-14.43%)	-4424 (-16.72%)
	BAMBU	-5386 (-20.36%)	-6063 (-22.91%)
	GRAS	-7583 (-28.66%)	-8253 (-31.19%)

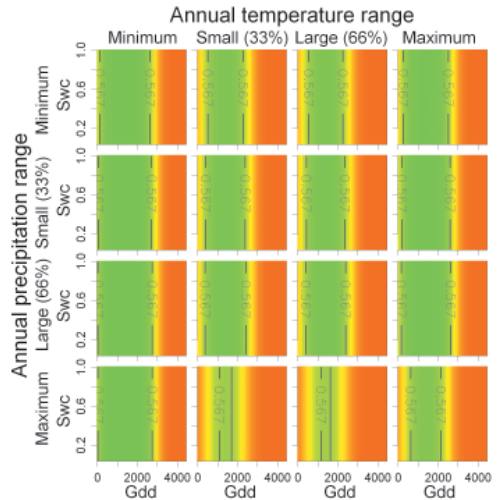
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 26459 cells)

The Green-veined White occurs in many different habitats and landscapes with varying amounts of shelter. It can be found on all types of grasslands and heathlands in open or more closed landscapes. However, a too dry habitat is not favourable. This butterfly is very variable in appearance, having several forms and subspecies. The eggs are laid singly or in small numbers on many, mostly wild, crucifers. It pupates on a stalk and overwinters in this stage. The Green-veined White has several broods a year, the number depending on the geographical location and altitude of the flight area, and the length of the summer.

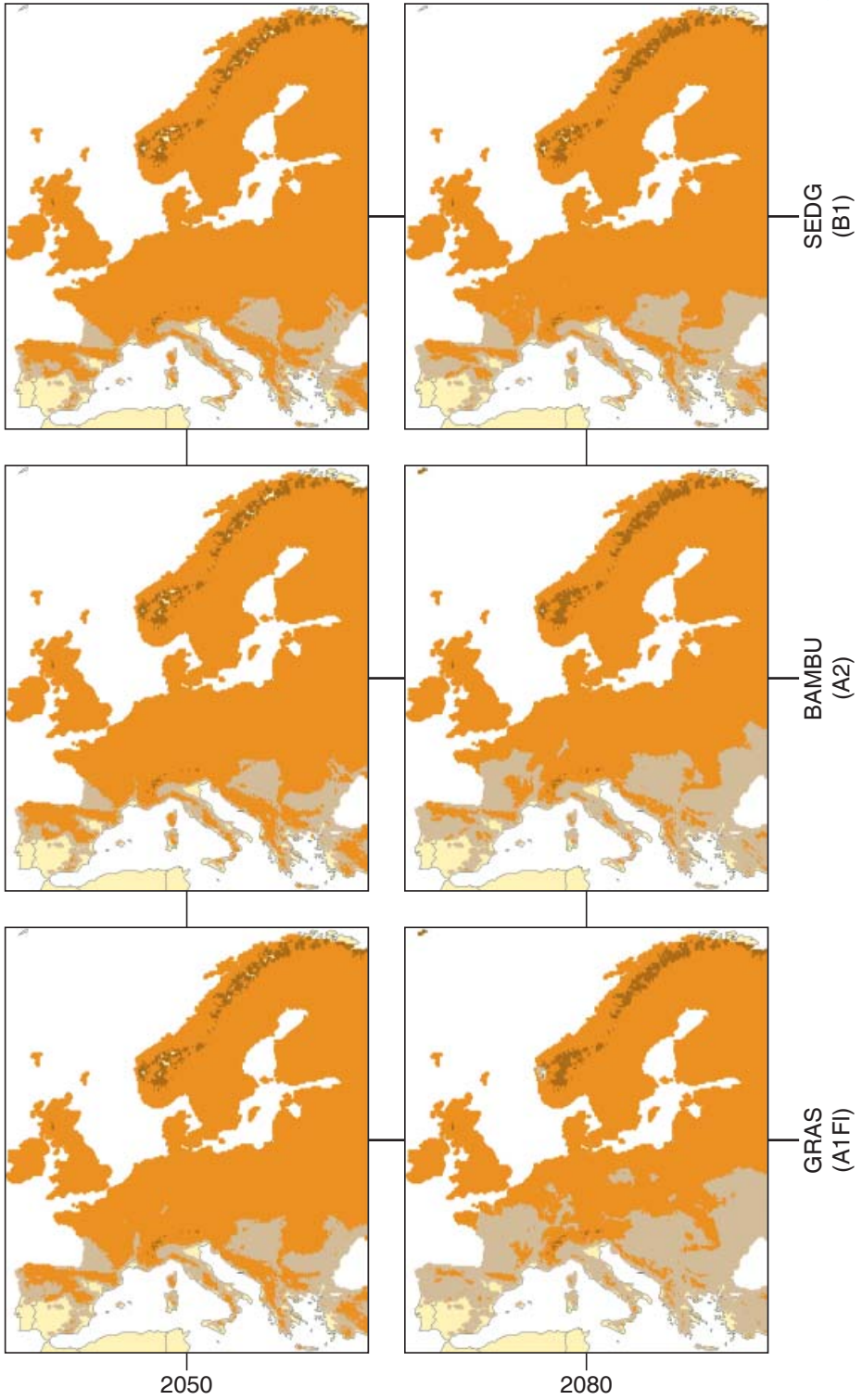
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.73).  
Climate risk category: PR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Pieris bryoniae* (HÜBNER, 1791) – Mountain Green-veined White



© Kars Veling

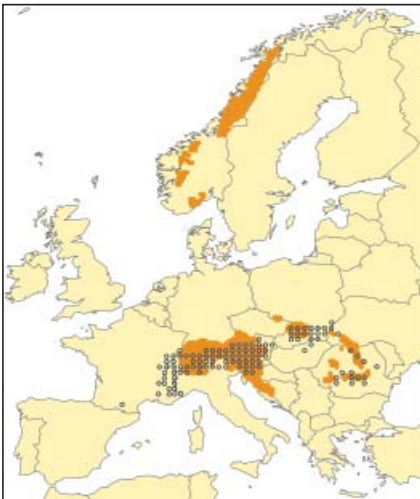
		Full dispersal	No dispersal
2050	SEDG	-421 (-35.59%)	-520 (-43.96%)
	BAMBU	-320 (-27.05%)	-418 (-35.33%)
	GRAS	-521 (-44.04%)	-594 (-50.21%)
2080	SEDG	-312 (-26.37%)	-637 (-53.85%)
	BAMBU	-197 (-16.65%)	-655 (-55.37%)
	GRAS	-303 (-25.61%)	-844 (-71.34%)

Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 1183 cells)

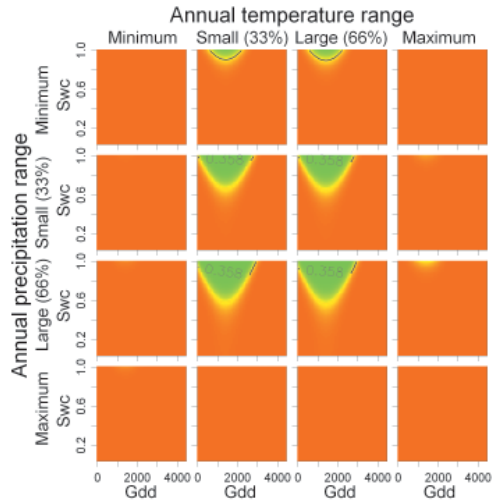
The butterfly of the Mountain Green-veined White strongly resembles that of the Green-veined White (*P. napi*). The eggs, caterpillars and pupae are also almost indistinguishable. In some places, such as in the Alps and the Jura Mountains, these species occur together. The Mountain Green-veined White is found in flower-rich grasslands along river banks, and at woodland edges. Buckler Mustard (*Biscutella laevigata*), pennycresses (*Thlaspi* spp.) and bittercresses (*Cardamine* spp.) are used as foodplants. The female, heavily dusted on her upperside with yellow or grey, lays her eggs singly on the flowers or leaves of the larval foodplant. She shows a preference for smaller plants growing on poor ground. It has one or two generations a year and hibernates in the pupal stage. In areas where this species occurs together with *P. napi* (like in the SE Alps), one may often find hybrids of both species.

Present distribution can be well explained by climatic variables (AUC = 0.92).

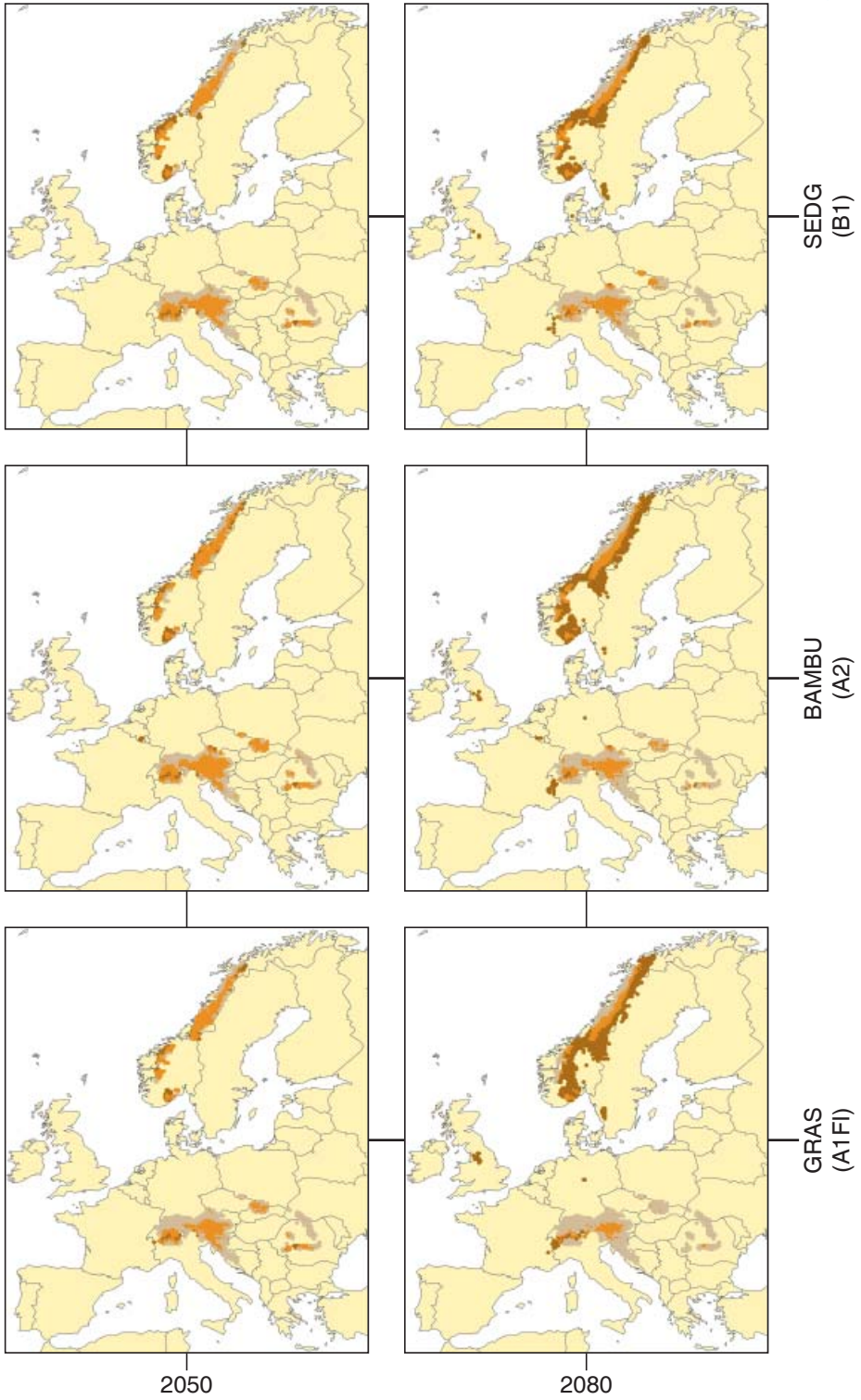
Climate risk category: HR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Pontia callidice* (HÜBNER, 1800) – Peak White



© Kars Veling

		Full dispersal	No dispersal
2050	SEDG	-182 (-20.43%)	-347 (-38.95%)
	BAMBU	-97 (-10.89%)	-296 (-33.22%)
	GRAS	-211 (-23.68%)	-370 (-41.53%)
2080	SEDG	-452 (-50.73%)	-639 (-71.72%)
	BAMBU	-280 (-31.43%)	-509 (-57.13%)
	GRAS	-481 (-53.98%)	-682 (-76.54%)

Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 891 cells)

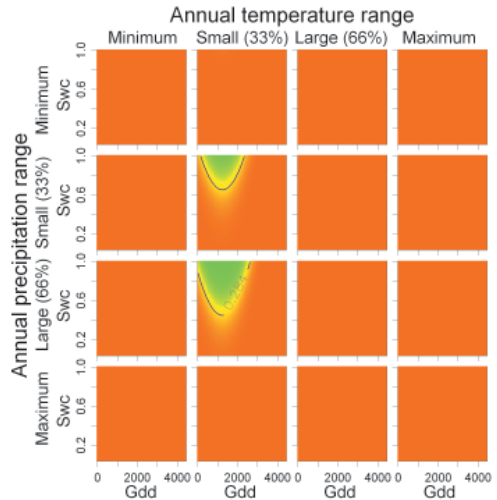
The Peak White is found high in the mountains in flower-rich grasslands. The eggs are laid singly on Alpine Bittercress (*Cardamine bellidifolia* ssp. *alpina*), *Hutchinsia alpina*, *Erysimum helveticum*, and *Reseda glauca*, especially on those growing on open stony patches. The caterpillars mostly eat the lower leaves, and hide under stones when the weather is bad. In the Alps, the Peak White usually has only one generation a year and hibernates as a pupa. However, in good summers or at lower altitudes, a partial second generation is sometimes produced that passes the winter as a caterpillar. In the Spanish Pyrenees, two generations a year are usual, and it hibernates either as a pupa or a caterpillar.

Present distribution can be very well explained by climatic variables (AUC = 0.98).

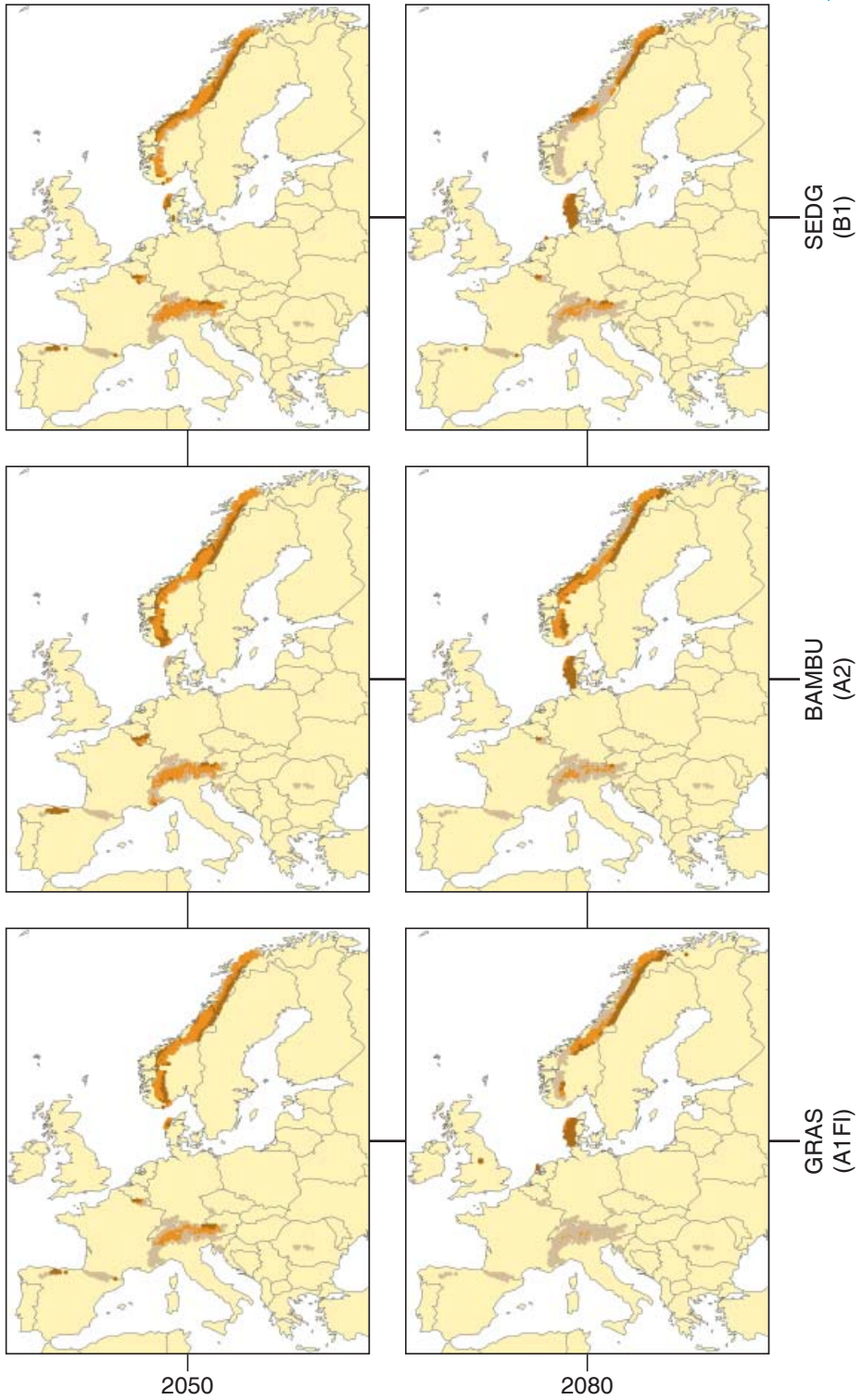
Climate risk category: HR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Pontia daplidice* (LINNAEUS, 1758) / *edusa* (FABRICIUS, 1777) (complex) – Bath White



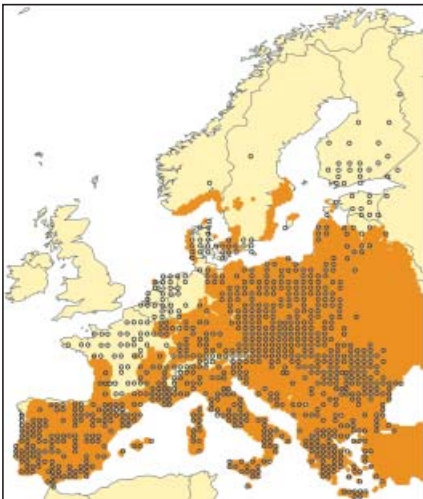
© Peter Ginzinger

		Full dispersal	No dispersal
2050	SEDG	4490 (29.33%)	-364 (-2.38%)
	BAMBU	1973 (12.89%)	-918 (-6%)
	GRAS	3493 (22.82%)	-842 (-5.5%)
2080	SEDG	3091 (20.19%)	-2391 (-15.62%)
	BAMBU	-157 (-1.03%)	-5708 (-37.28%)
	GRAS	-1327 (-8.67%)	-7478 (-48.84%)

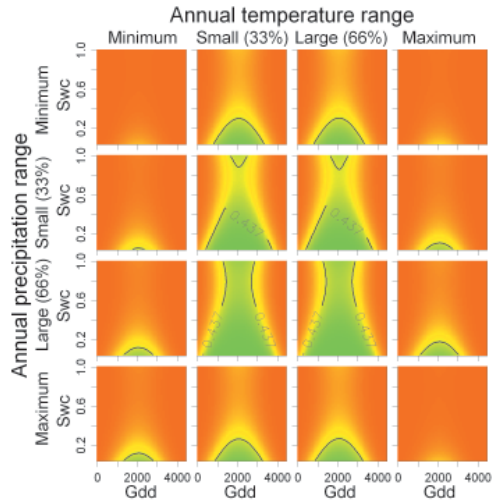
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 15310 cells)

The Bath White complex has been split into two species in the 1980s, *P. daplidice* (LINNAEUS, 1758), which mainly occurs in the Western Mediterranean, and *P. edusa* (FABRICIUS, 1777), which is distributed over the rest of Europe. However, these two species cannot be distinguished in the field. Their life cycles are also very similar. The adult butterflies are very mobile, fast flying and migrate northwards and westwards in warm years. They occur in warm, stony places; often disturbed ground, such as road verges, abandoned agricultural land or quarries. The females lay their eggs on such crucifers as mustards (*Sinapis* spp.), *Alyssum* spp., and also on mignonettes (*Reseda* spp.). The caterpillars feed mainly on the flowers and seeds. Pupation takes place on the stalk of the foodplant. These species have two or more broods a year and hibernate as pupae.

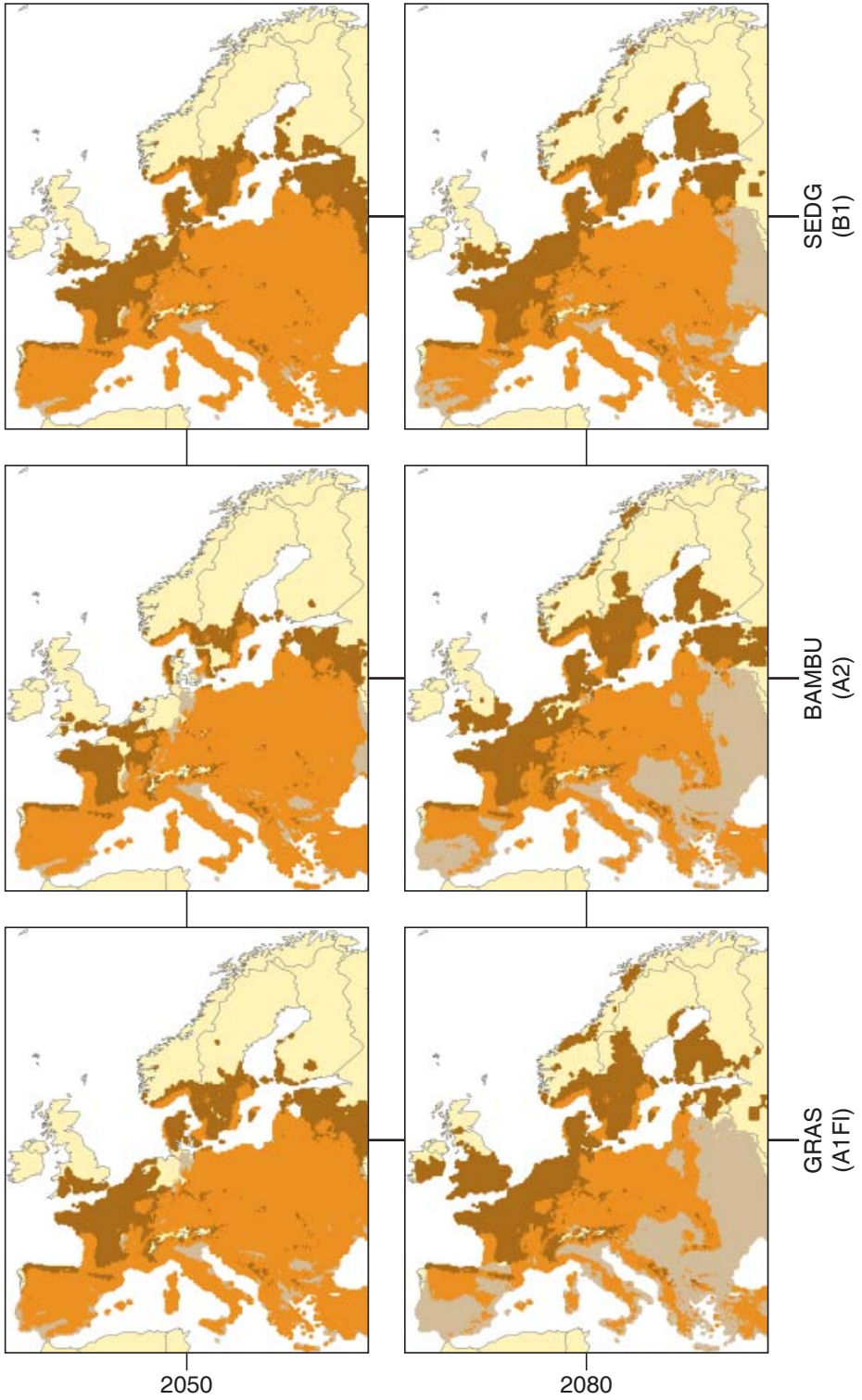
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.72). Climate risk category: PR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Colias phicomone* (ESPER, 1780) – Mountain Clouded Yellow



© Albert Vliegthart

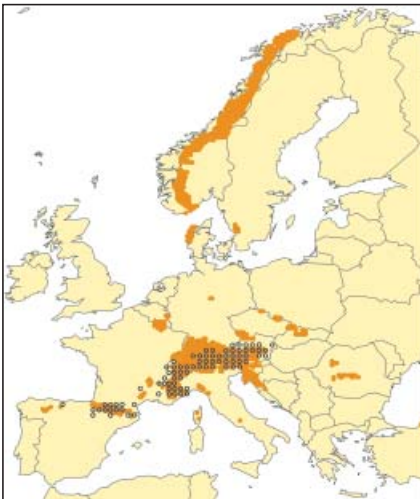
		Full dispersal	No dispersal
2050	SEDG	-306 (-21.5%)	-513 (-36.05%)
	BAMBU	-209 (-14.69%)	-450 (-31.62%)
	GRAS	-432 (-30.36%)	-611 (-42.94%)
2080	SEDG	-562 (-39.49%)	-890 (-62.54%)
	BAMBU	-426 (-29.94%)	-781 (-54.88%)
	GRAS	-665 (-46.73%)	-1017 (-71.47%)

Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 1423 cells)

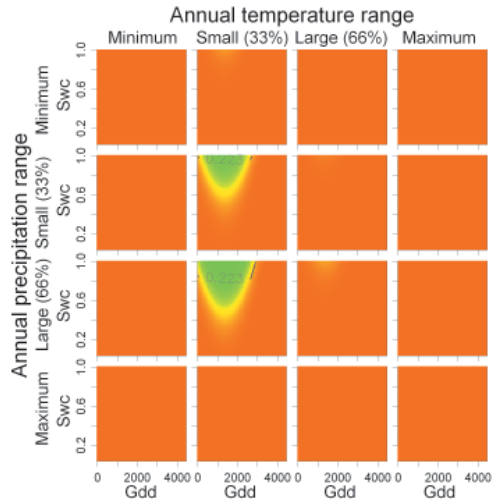
The Mountain Clouded Yellow has its breeding ground in flower-rich alpine meadows. Although they are quick, strong flyers, they are not migrants and do not leave their habitat. Various leguminous plants are used as larval foodplant, including Horseshoe Vetch (*Hippocrepis comosa*), White Clover (*Trifolium repens*), Common Birdsfoot-trefoil (*Lotus corniculatus*), and vetches (*Vicia* spp.). This butterfly species usually only has one generation a year, but in some years there is a partial second brood. The caterpillars hibernate after their second moult.

Present distribution can be very well explained by climatic variables (AUC = 0.96).

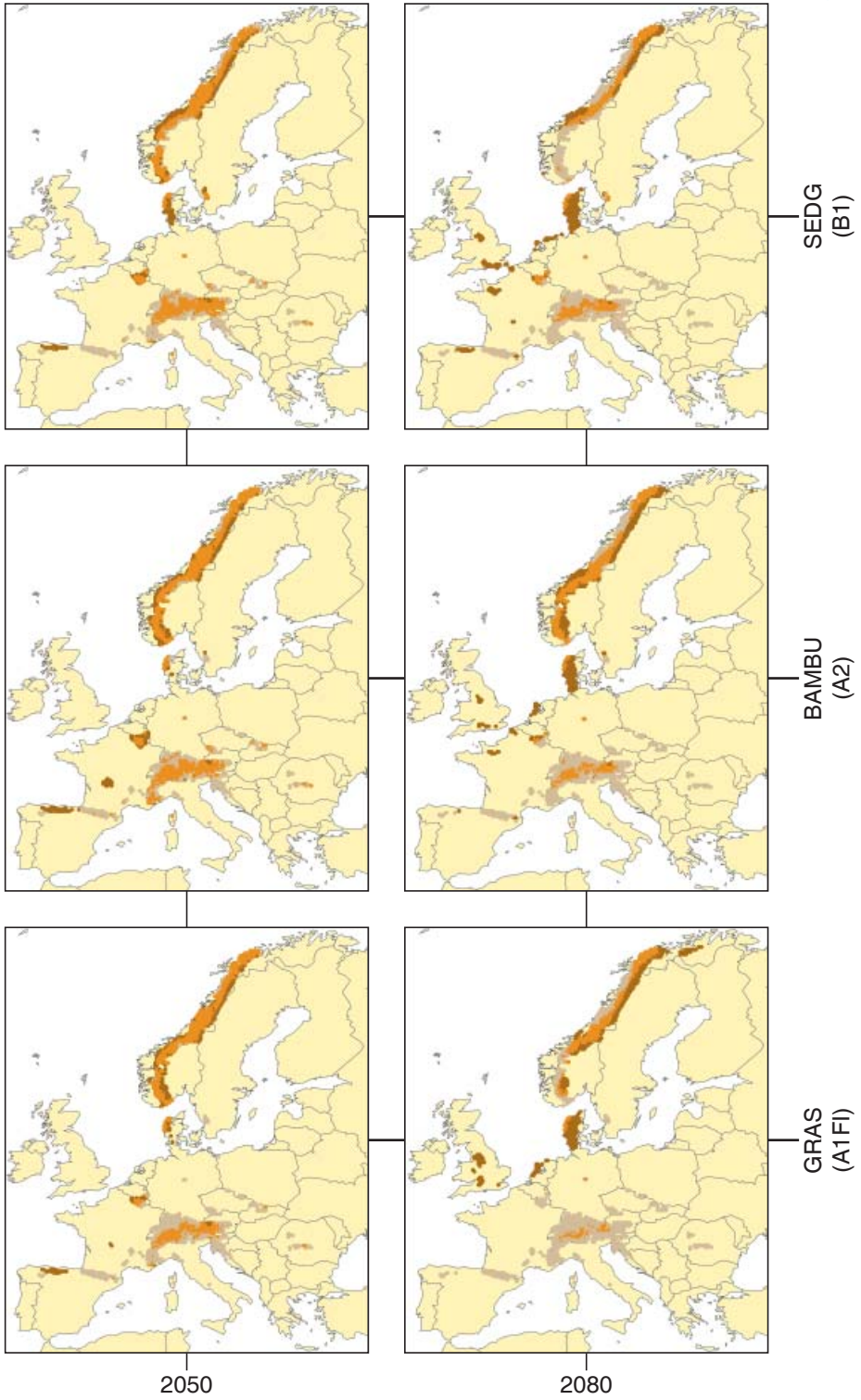
Climate risk category: HR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Colias palaeno* (LINNAEUS, 1758) – Moorland Clouded Yellow



© Albert Vliegenthart

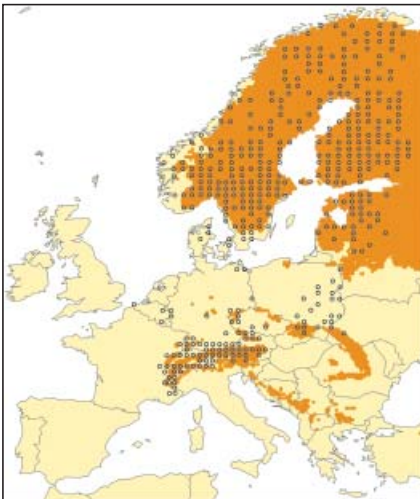
		Full dispersal	No dispersal
2050	SEDG	-2875 (-29.08%)	-3210 (-32.47%)
	BAMBU	-2799 (-28.31%)	-3063 (-30.98%)
	GRAS	-3095 (-31.31%)	-3361 (-34%)
2080	SEDG	-3370 (-34.09%)	-3889 (-39.34%)
	BAMBU	-4202 (-42.5%)	-4562 (-46.15%)
	GRAS	-5087 (-51.46%)	-5433 (-54.96%)

Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 9886 cells)

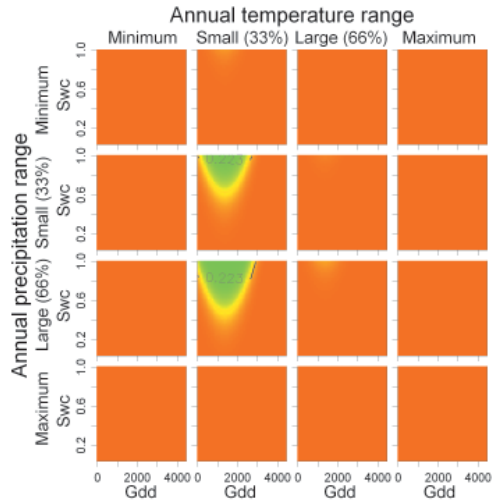
The Moorland Clouded Yellow occurs at the edges of raised bogs, and also on blanket bogs. At high altitudes, it is found in drier habitats. Eggs are laid singly on Bog Whortleberry (*Vaccinium uliginosum*). At first, the caterpillars only eat the upper layers of the leaf, producing “windows”, but later, the whole leaf is eaten. The caterpillars hibernate among the dry leaves of the litter layer, and the next spring feed and grow further, before finally pupating on a branch of the foodplant. It has one generation a year.

Present distribution can be well explained by climatic variables (AUC = 0.9).

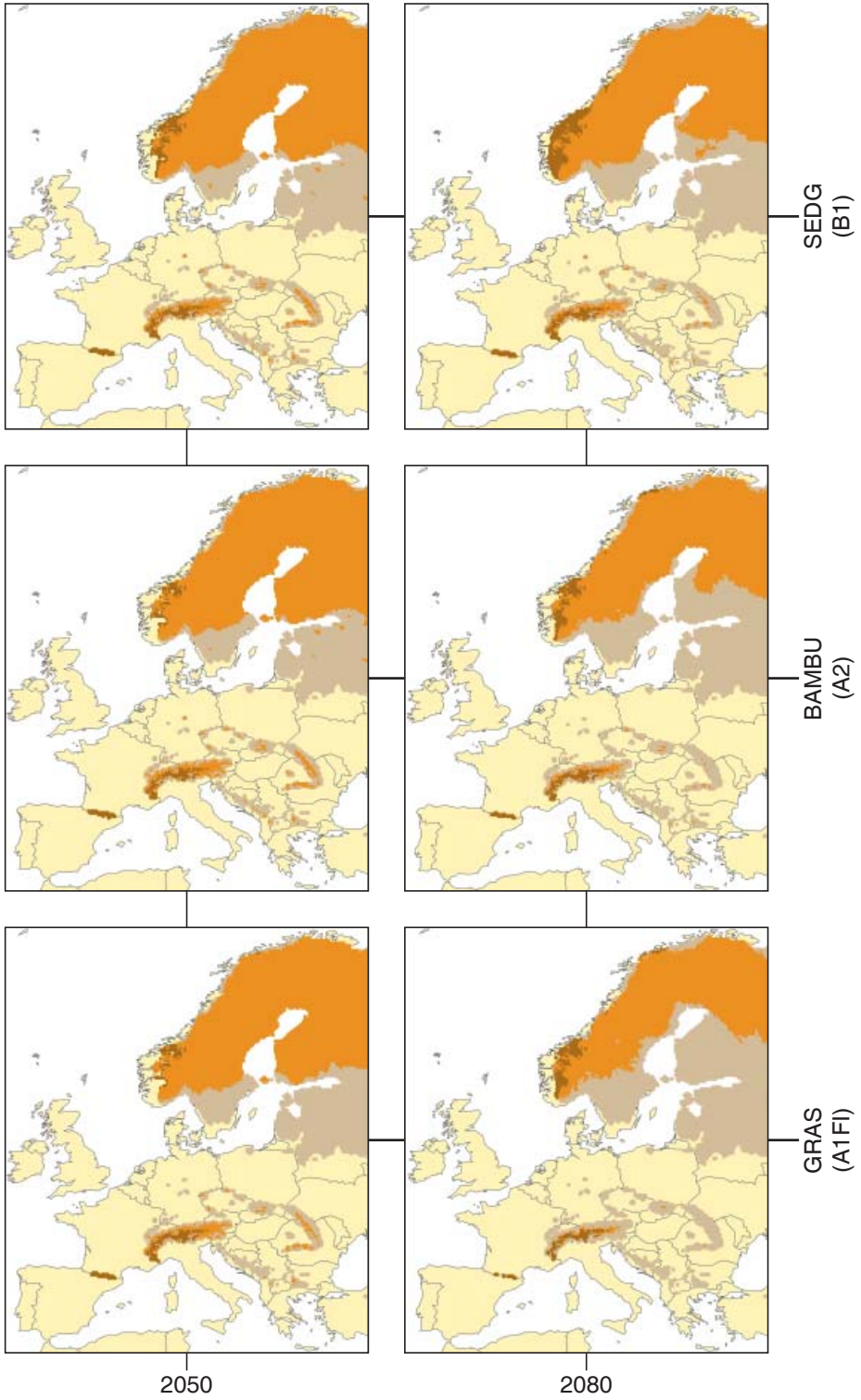
Climate risk category: R.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Colias erate* (ESPER, 1805) – Eastern Pale Clouded Yellow



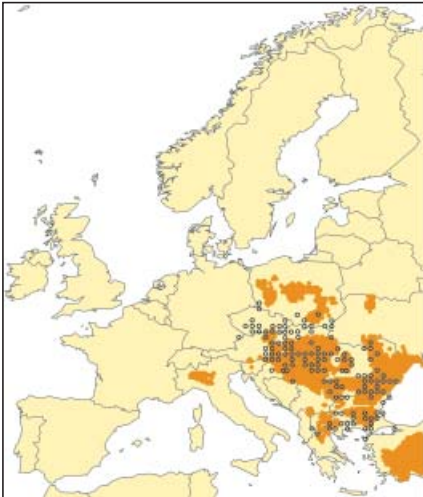
© Kars Veling

		Full dispersal	No dispersal
2050	SEDG	2797 (116.83%)	-331 (-13.83%)
	BAMBU	815 (34.04%)	-1199 (-50.08%)
	GRAS	1982 (82.79%)	-989 (-41.31%)
2080	SEDG	1379 (57.6%)	-1160 (-48.45%)
	BAMBU	-317 (-13.24%)	-2059 (-86.01%)
	GRAS	44 (1.84%)	-2260 (-94.4%)

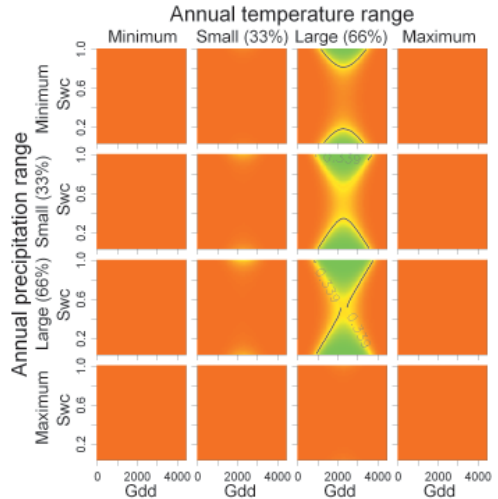
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 2394 cells)

The Eastern Pale Clouded Yellow is a very mobile species and can therefore be seen in all sorts of places. This species greatly extended its range during the 1970s and 80s. 50 years ago this mainly Asian species was known in Europe only from the Black Sea coast. Lucerne (*Medicago sativa*) is its most important larval foodplant and they are most numerous in areas where it is grown. The caterpillars can also be found on other leguminous plants. This species has several generations a year; three to five have been reported from Bulgaria and Romania. This species passes the winter as a caterpillar (probably without diapause).

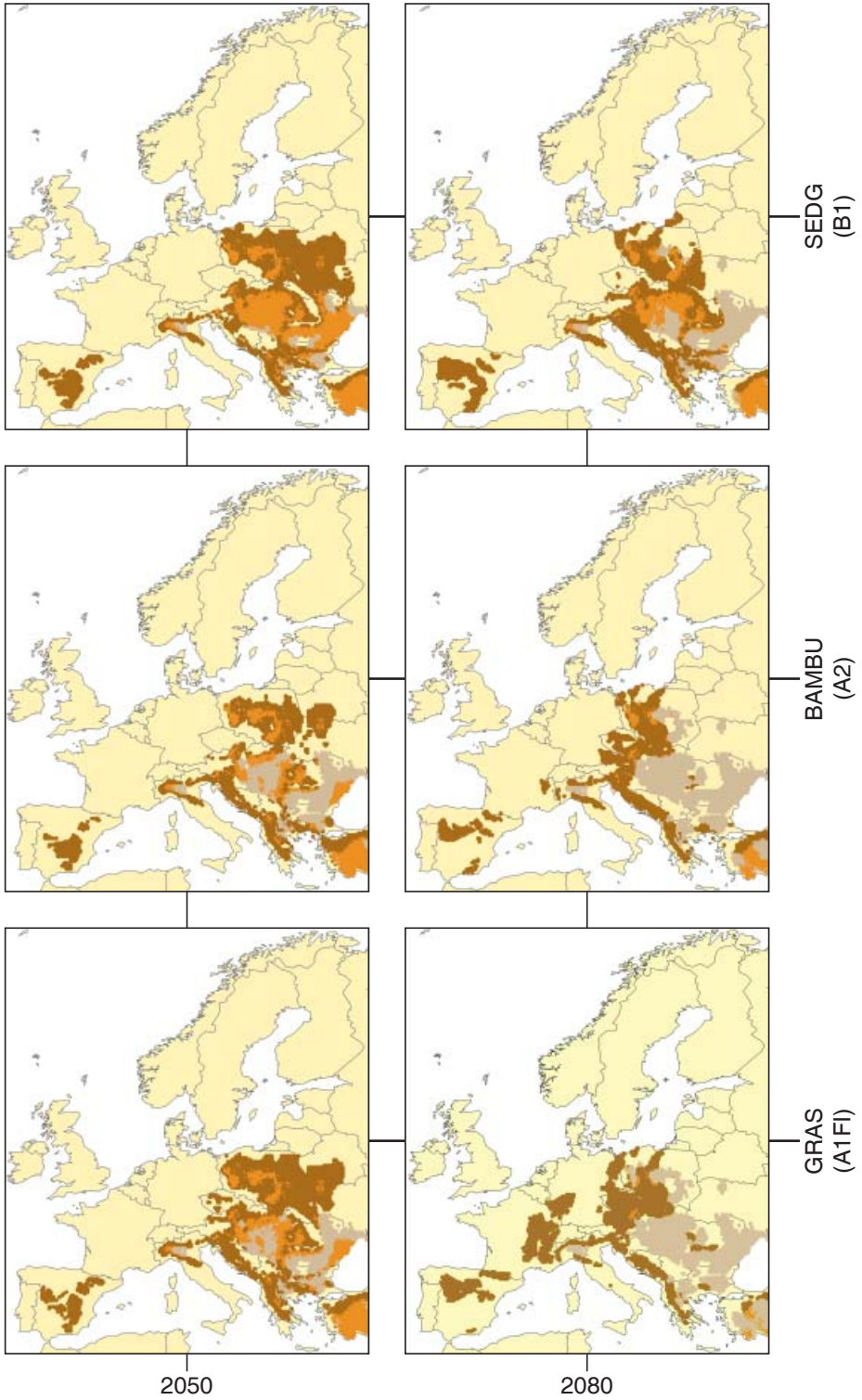
Present distribution can be well explained by climatic variables (AUC = 0.92).  
Climate risk category: HHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Colias croceus* (GEOFFROY, 1785) – Clouded Yellow



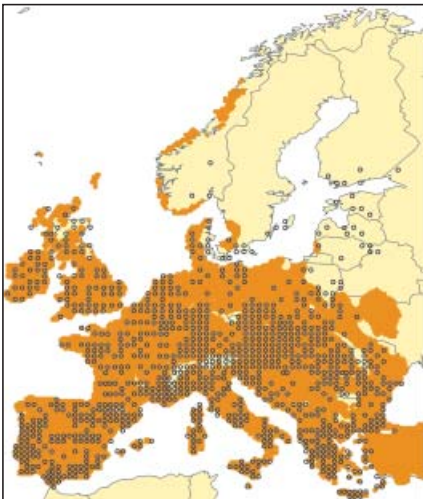
© Chris van Swaay

		Full dispersal	No dispersal
2050	SEDG	1037 (6.41%)	-1750 (-10.81%)
	BAMBU	-123 (-0.76%)	-2525 (-15.6%)
	GRAS	-420 (-2.59%)	-2931 (-18.11%)
2080	SEDG	-962 (-5.94%)	-3518 (-21.74%)
	BAMBU	-3091 (-19.1%)	-5896 (-36.43%)
	GRAS	-4329 (-26.75%)	-7460 (-46.09%)

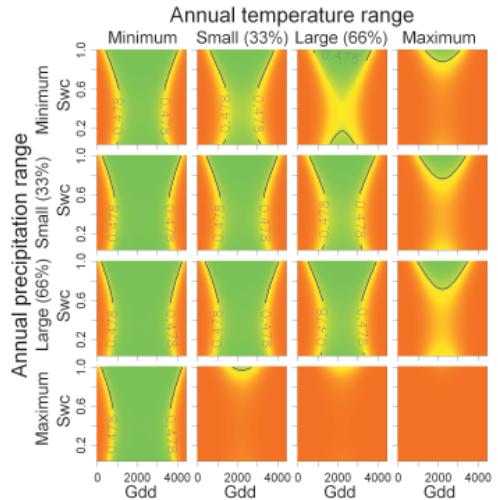
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 16185 cells)

In good summers, the Clouded Yellow is a very fast flyer and can be seen practically over the whole of Europe, often on fields of clover or lucerne, or other flower-rich vegetations. It lays its eggs one by one, on the leaves of such leguminous plants as Lucerne (*Medicago sativa*), clovers (*Trifolium* spp.), and vetches (*Vicia* spp.). It pupates, suspended in a silken girdle on the foodplant. In the south, it usually passes the winter as a caterpillar. In the north, because it cannot tolerate the cold, it only appears as a summer migrant, recolonizing from the south. This species has four to six broods a year.

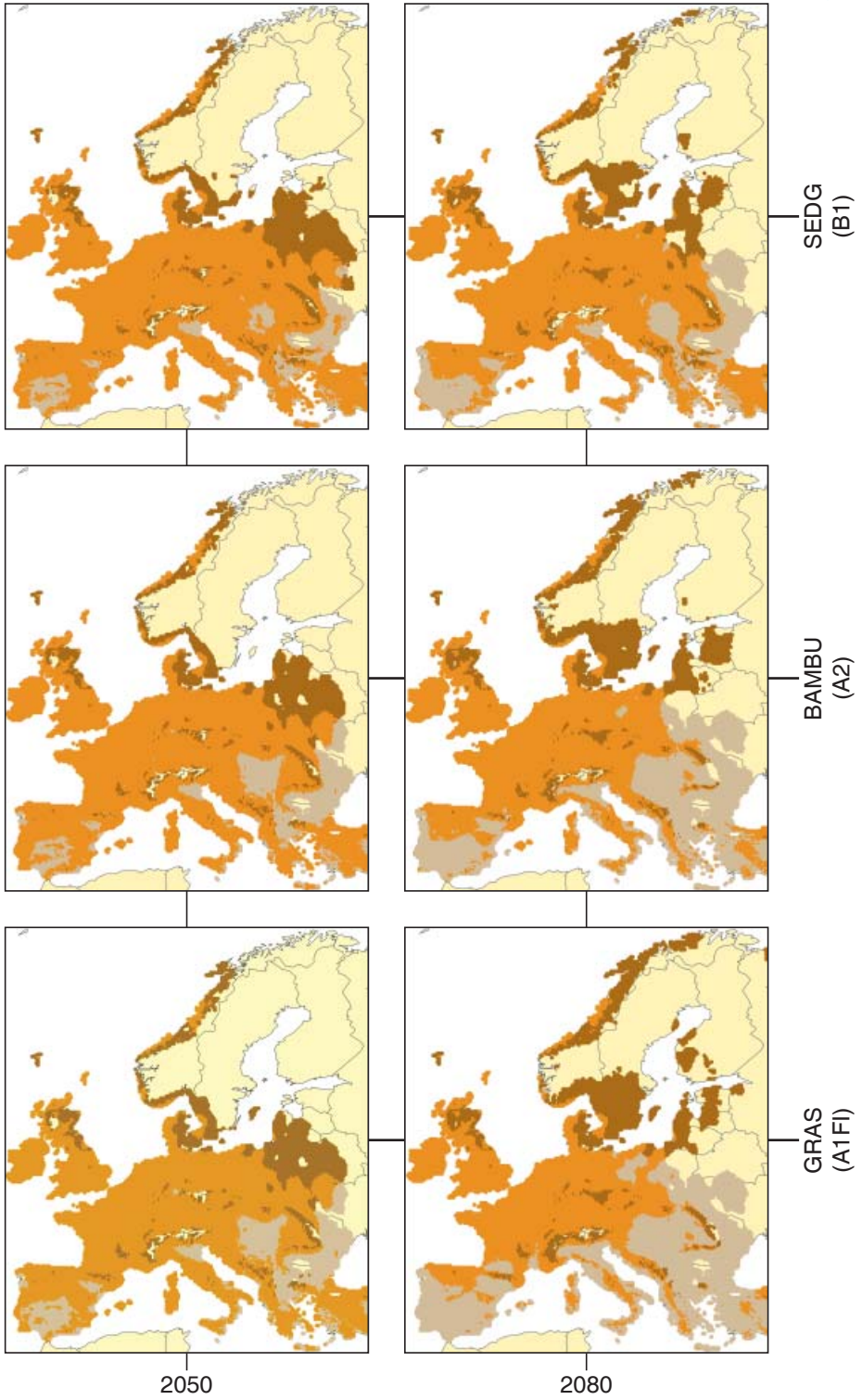
Present distribution can be explained by climatic variables to a moderate extent (AUC = 0.76). Climate risk category: LR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Colias hecla* LEFEBVRE, 1836 – Northern Clouded Yellow



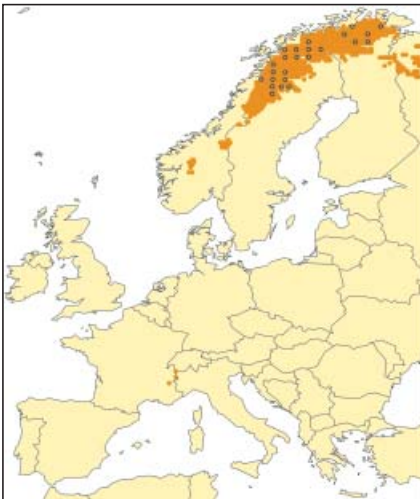
© Jostein Engdal

		Full dispersal	No dispersal
2050	SEDG	-736 (-75.1%)	-785 (-80.1%)
	BAMBU	-767 (-78.27%)	-791 (-80.71%)
	GRAS	-784 (-80%)	-805 (-82.14%)
2080	SEDG	-828 (-84.49%)	-879 (-89.69%)
	BAMBU	-931 (-95%)	-949 (-96.84%)
	GRAS	-963 (-98.27%)	-964 (-98.37%)

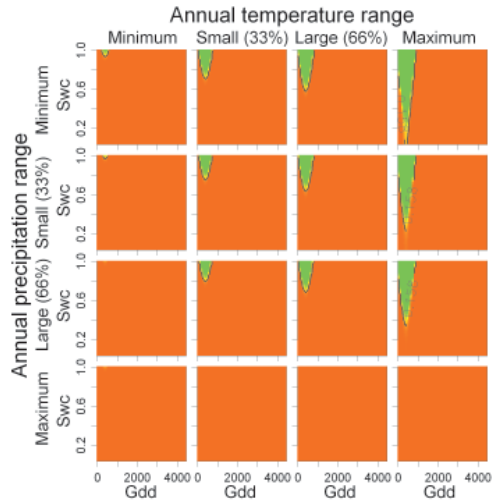
Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 980 cells)

The Northern Clouded Yellow occurs in the mountains of Lapland above the birch zone, on open, grassy meadows, and stony slopes. The butterflies fly very quickly and are difficult to approach. Eggs are laid singly or in small groups on the larval foodplants, or on neighbouring plants. Alpine Milk-vetch (*Astragalus alpinus*) is the most important foodplant, but other milk-vetches (*Astragalus* spp.) may also be used. The caterpillars feed on the flowers, leaves and stems, sometimes taking two years to complete their life-cycle. Hibernation can take place as a caterpillar or a pupa.

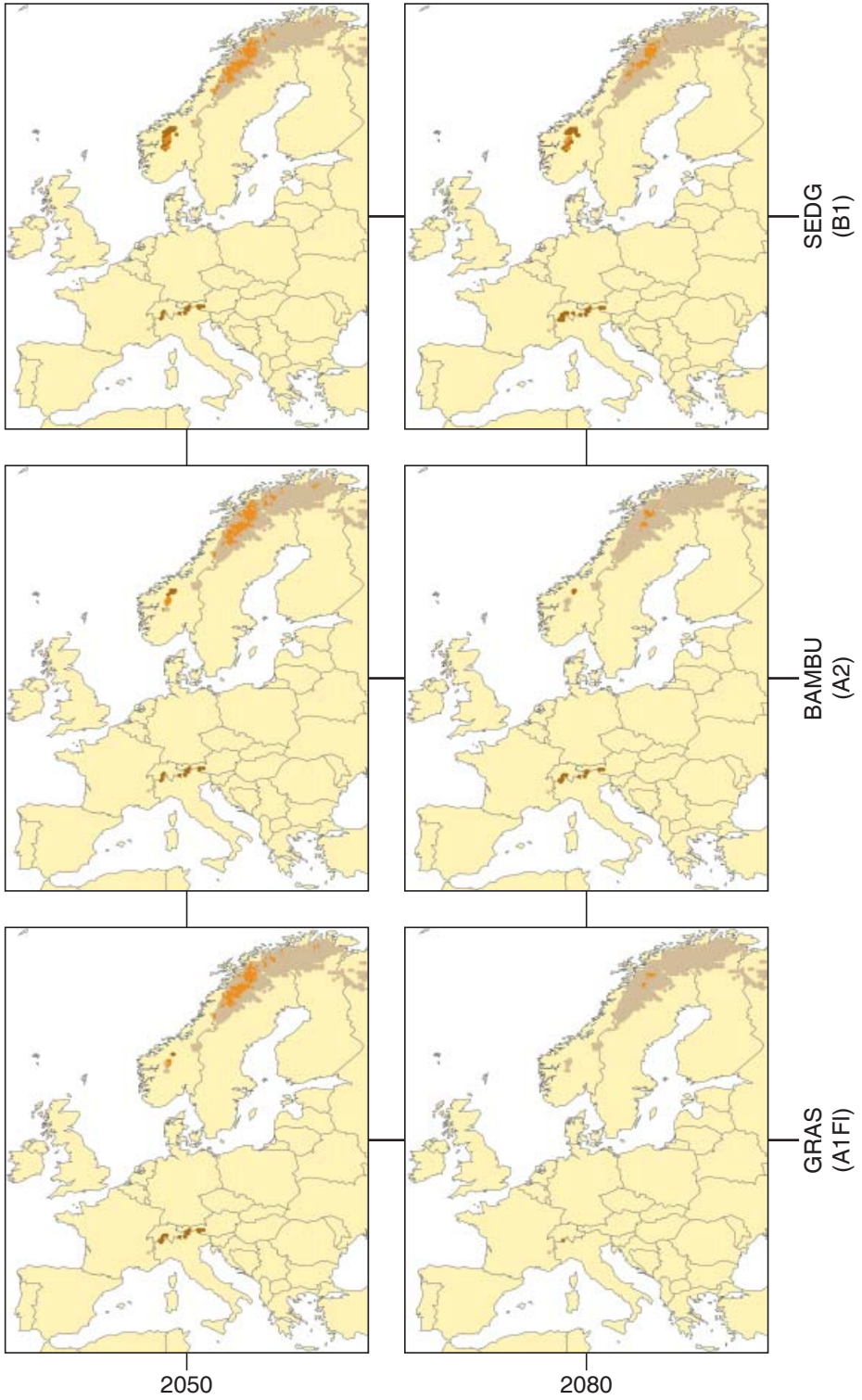
Present distribution can be very well explained by climatic variables (AUC = 0.99). Climate risk category: HHHH.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Colias myrmidone* (ESPER, 1780) – Danube Clouded Yellow



© Martin Wiemers

		Full dispersal	No dispersal
2050	SEDG	-329 (-7.74%)	-1351 (-31.77%)
	BAMBU	-2181 (-51.29%)	-2616 (-61.52%)
	GRAS	-1528 (-35.94%)	-2196 (-51.65%)
2080	SEDG	-1896 (-44.59%)	-3193 (-75.09%)
	BAMBU	-2971 (-69.87%)	-3887 (-91.42%)
	GRAS	-2667 (-62.72%)	-4048 (-95.2%)

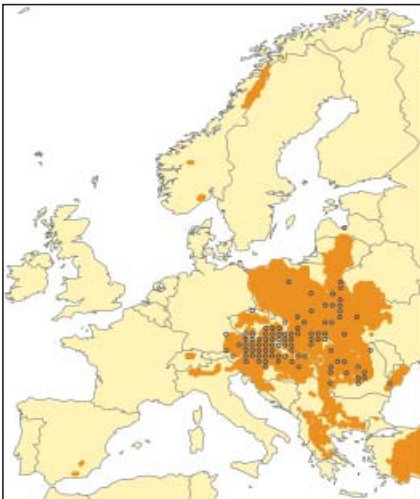
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 4252 cells)

The Danube Clouded Yellow occurs in dry, warm grassland where its foodplant, the broom *Chamaecytisus ratisbonensis*, *C. supinus*, *C. capitatus*, *C. austriacus* are abundant. However, the amount of shelter from bushes can vary considerably. The female lays her eggs on the foodplant, the caterpillars hibernate in the litter layer. It has two to three broods a year. In contrast to the Eastern Pale Clouded Yellow, this species has disappeared from most of its former locations in Central Europe and is now extinct in several countries.

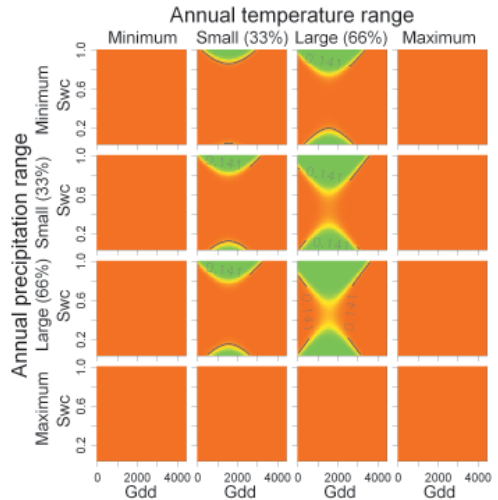
This species is listed in Annexes II and IV of the Habitats' Directive.

Present distribution can be well explained by climatic variables (AUC = 0.92).

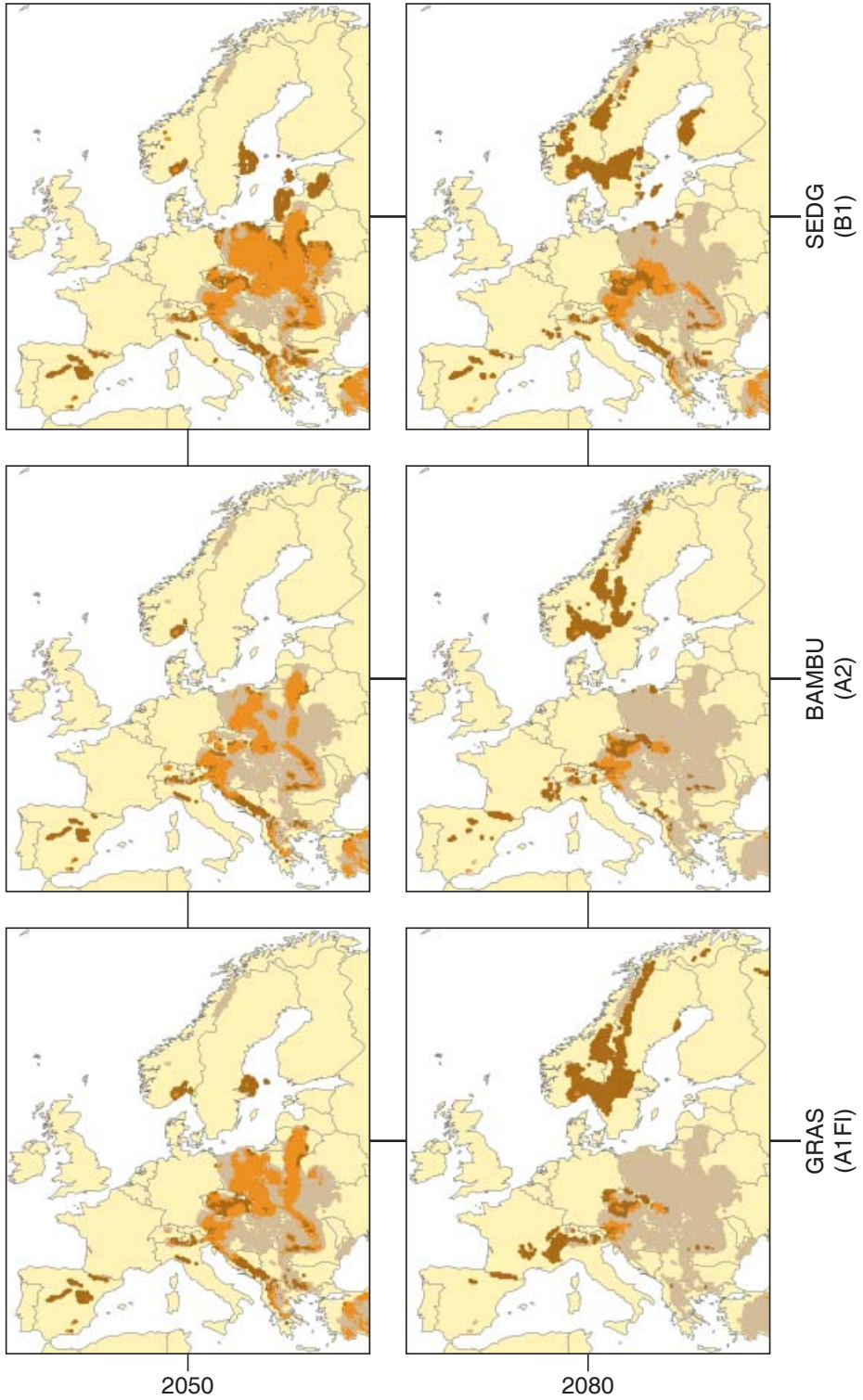
Climate risk category: HHHHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Colias chrysotheme* (ESPER, 1780) – Lesser Clouded Yellow



© Chris van Swaay

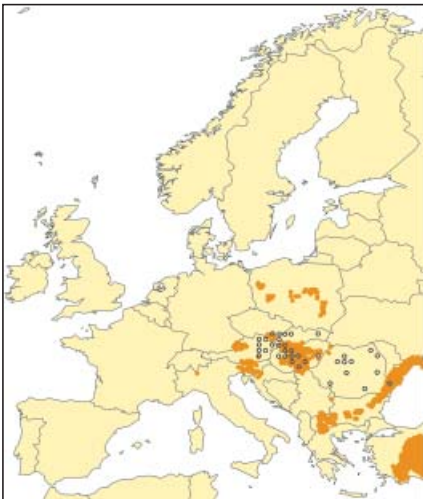
		Full dispersal	No dispersal
2050	SEDG	416 (55.32%)	-489 (-65.03%)
	BAMBU	-246 (-32.71%)	-565 (-75.13%)
	GRAS	463 (61.57%)	-559 (-74.34%)
2080	SEDG	-519 (-69.02%)	-665 (-88.43%)
	BAMBU	-490 (-65.16%)	-707 (-94.02%)
	GRAS	-550 (-73.14%)	-733 (-97.47%)

Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 752 cells)

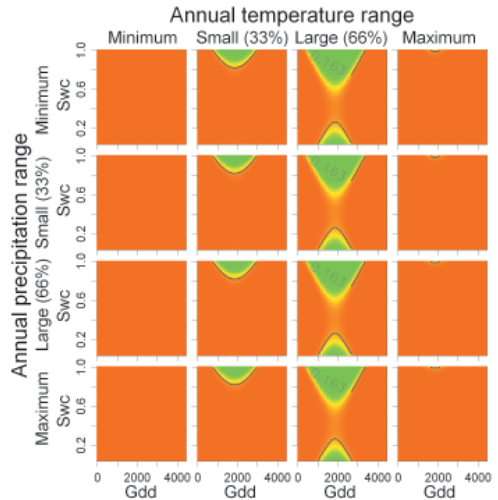
The Lesser Clouded Yellow is found on open, dry, steppe-like grassland and rocky slopes. Its main foodplant is the Milk-vetch (*Astragalus austriacus*), but Milk-vetch (*A. glycyphyllos*) and vetches (*Vicia* spp.) are also used. This species has three to four broods a year and hibernates as a caterpillar.

Present distribution can be well explained by climatic variables (AUC = 0.89).

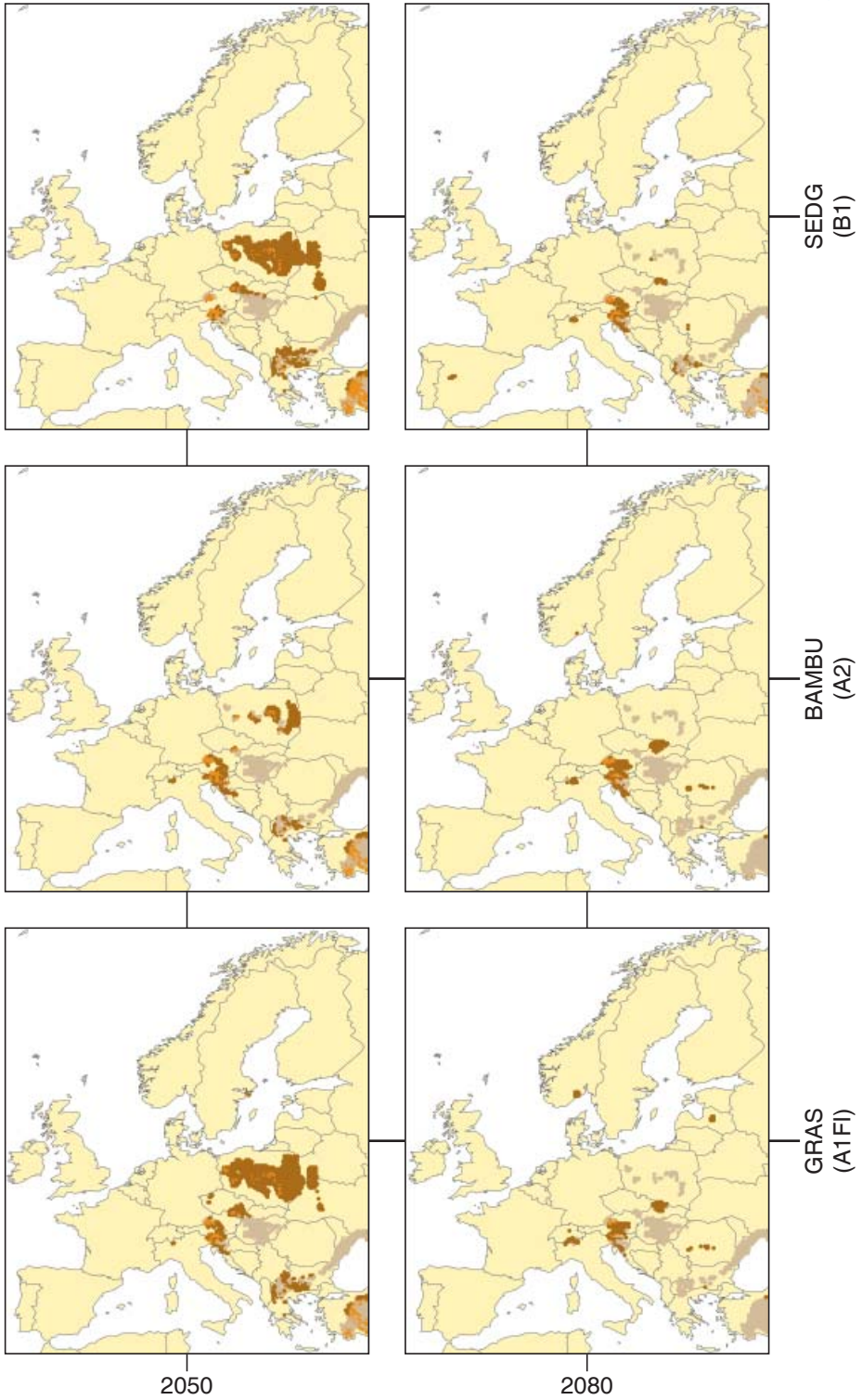
Climate risk category: HHHR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Colias hyale* (LINNAEUS, 1758) – Pale Clouded Yellow



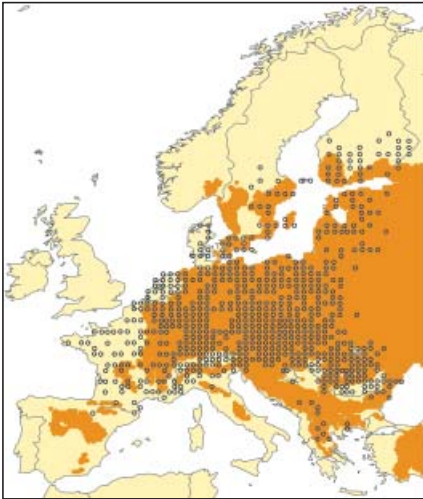
© Rudi Verovnik

		Full dispersal	No dispersal
2050	SEDG	-437 (-3.49%)	-2793 (-22.28%)
	BAMBU	-305 (-2.43%)	-2961 (-23.62%)
	GRAS	-786 (-6.27%)	-3393 (-27.07%)
2080	SEDG	-905 (-7.22%)	-5229 (-41.72%)
	BAMBU	-1777 (-14.18%)	-7208 (-57.5%)
	GRAS	-3035 (-24.21%)	-9284 (-74.06%)

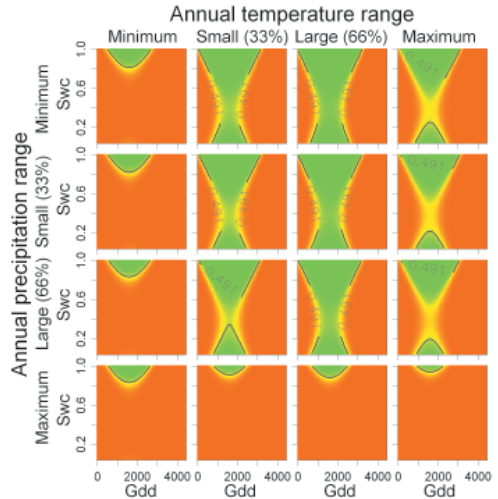
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 12535 cells)

The Pale Clouded Yellow is mostly found on fields of clover or lucerne, but also on meadows that are lightly grazed where many leguminous plants are growing. It prefers open landscapes with few trees or bushes. Eggs are laid singly on many species of Leguminosae. The caterpillar feeds on young leaves and overwinters as half-grown caterpillar. It pupates, suspended in a girdle from a stalk on the foodplant. The Pale Clouded Yellow has two or three generations a year. In the northern part of its range, it is a migrant species, but in most of Central Europe it is a resident. The adult Pale Clouded Yellow is very hard to distinguish from Berger's Clouded Yellow (*Colias alfacariensis*), while the larvae are very different.

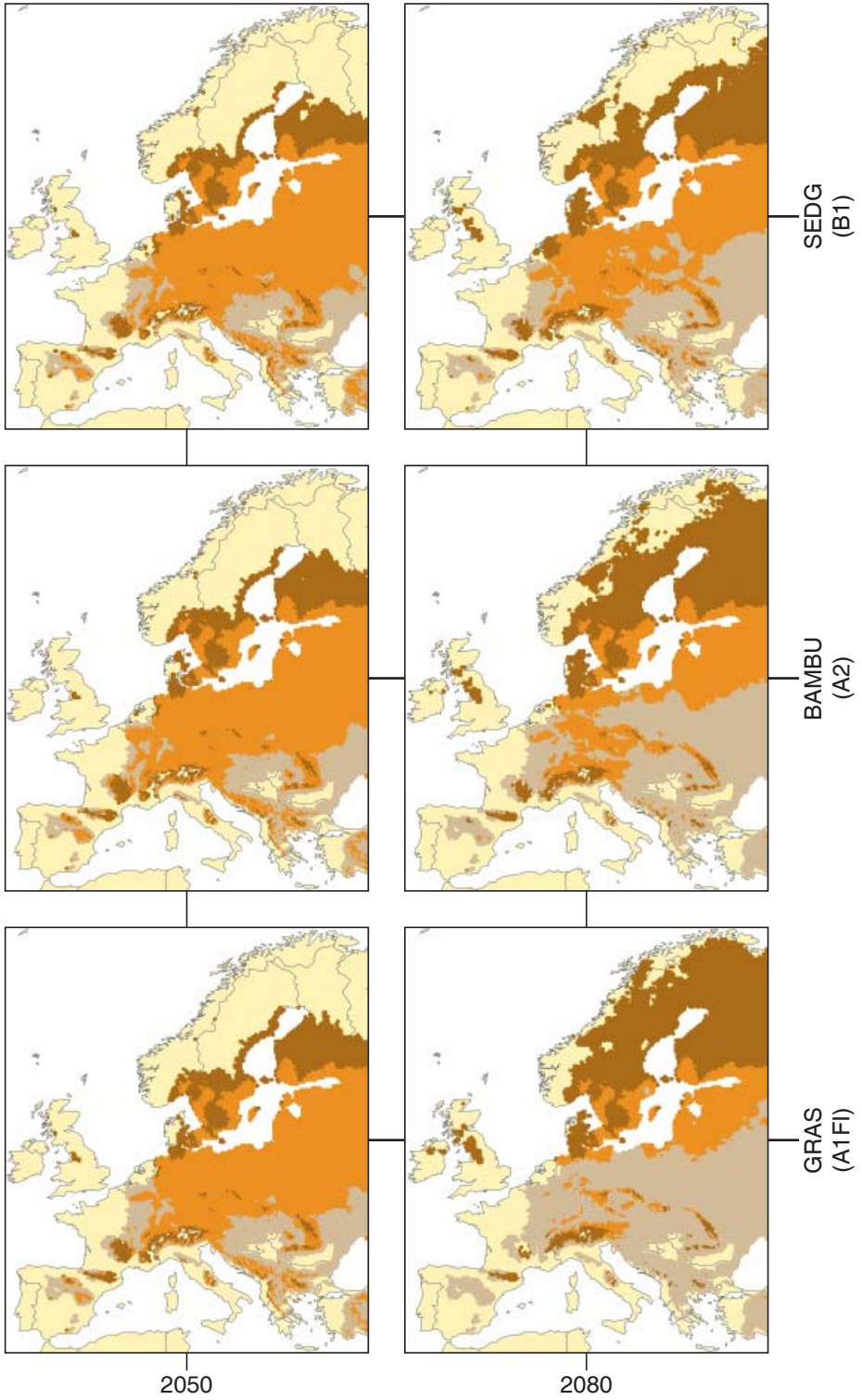
Present distribution can be explained by climatic variables to a moderate extent (AUC = 0.84). Climate risk category: HR.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Colias alfacariensis* RIBBE, 1905 – Berger’s Clouded Yellow



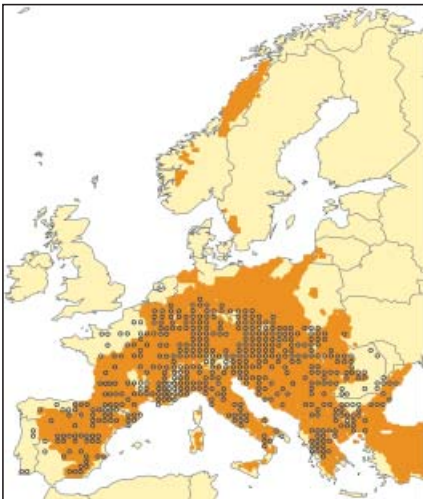
© Kars Veling

		Full dispersal	No dispersal
2050	SEDG	983 (10.19%)	-2101 (-21.78%)
	BAMBU	32 (0.33%)	-2997 (-31.06%)
	GRAS	-144 (-1.49%)	-3278 (-33.98%)
2080	SEDG	-812 (-8.42%)	-4054 (-42.02%)
	BAMBU	-1547 (-16.03%)	-5409 (-56.06%)
	GRAS	-2461 (-25.51%)	-6649 (-68.92%)

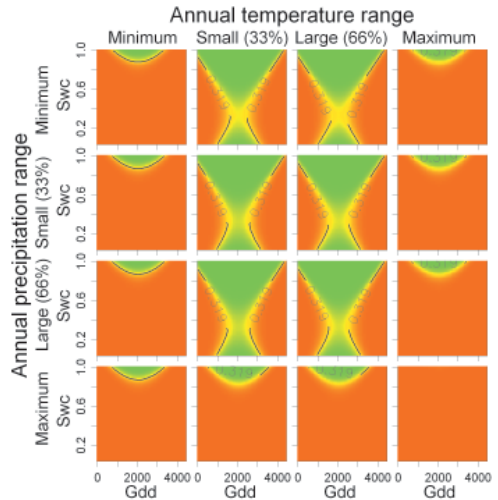
Changes in climatic niche distribution  
(in 10<sup>4</sup> × 10<sup>4</sup> grid cells; present niche space: 9648 cells)

The Berger’s Clouded Yellow is a butterfly of dry, open grasslands on calcareous soils. In the northern part of its distribution range, it often occurs on the south-facing slopes of hills or mountains. Eggs are mostly laid on Horseshoe Vetch (*Hippocrepis comosa*), also on Crown Vetch (*Coronilla varia*). Hibernation takes place on the foodplant, or on the ground in the litter layer. For pupation the caterpillar attaches itself to a foodplant, turning into a pupa, suspended by a silken girdle. This species has two or three broods a year. The adult Berger’s Clouded Yellow and Pale Clouded Yellow are so similar that it is not possible to identify them with certainty, while this is easy for the caterpillars.

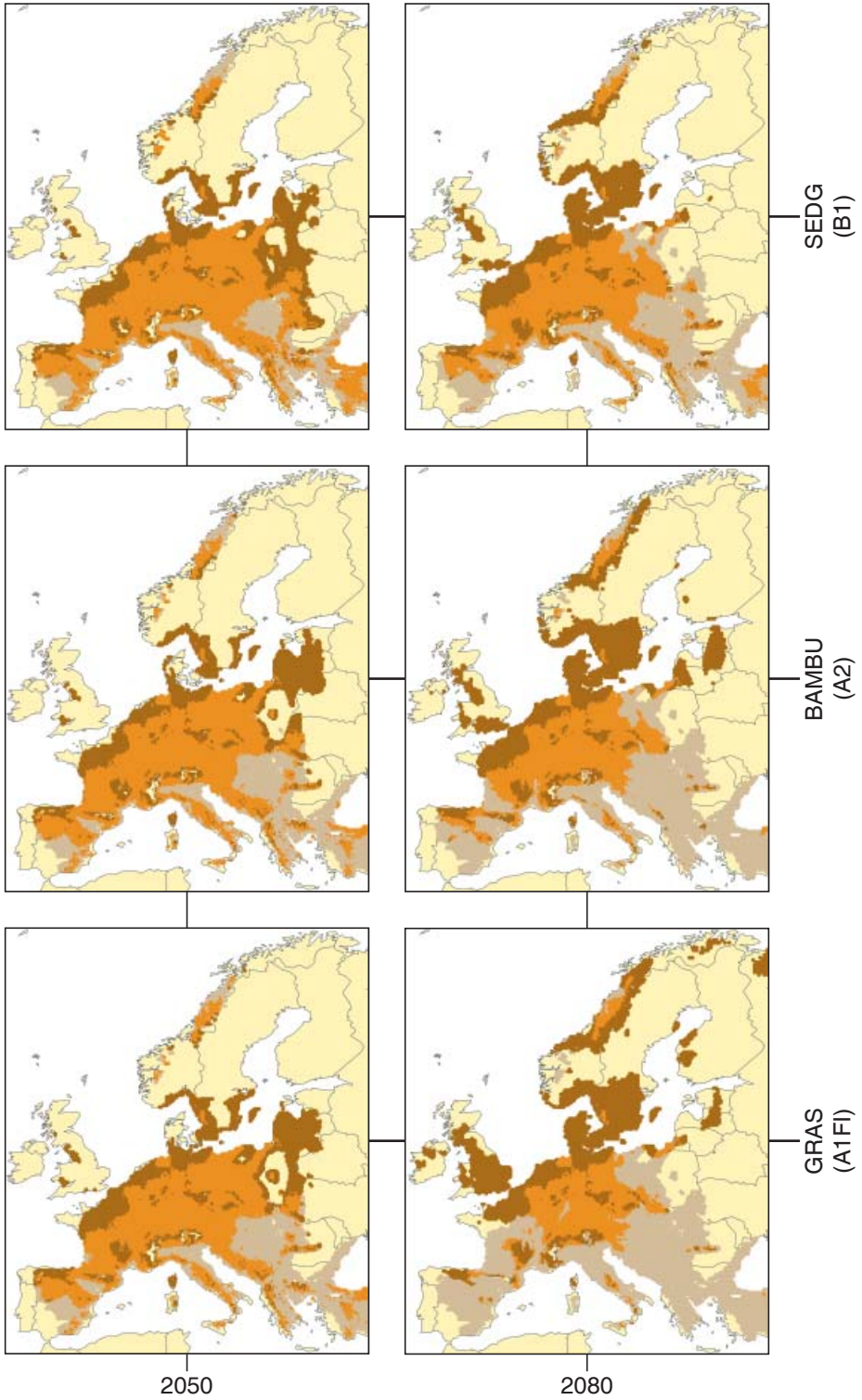
Present distribution can be explained by climatic variables to a moderate extent (AUC = 0.84). Climate risk category: R.



Observed species distribution (50 × 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Gonepteryx rhamni* (LINNAEUS, 1758) – Brimstone



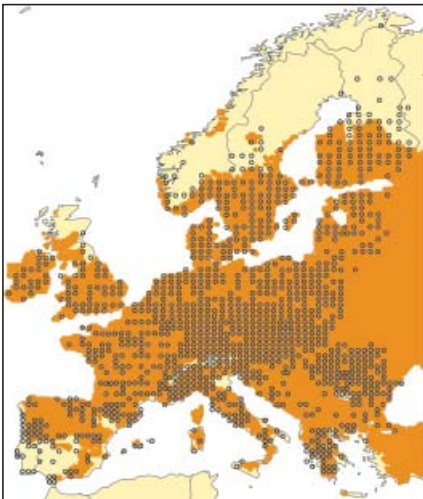
© Peter Ginzinger

		Full dispersal	No dispersal
2050	SEDG	-1084 (-5.26%)	-3228 (-15.67%)
	BAMBU	-1593 (-7.73%)	-3440 (-16.7%)
	GRAS	-1973 (-9.58%)	-4092 (-19.87%)
2080	SEDG	-1165 (-5.66%)	-4835 (-23.47%)
	BAMBU	-2555 (-12.4%)	-7022 (-34.09%)
	GRAS	-4146 (-20.13%)	-9486 (-46.05%)

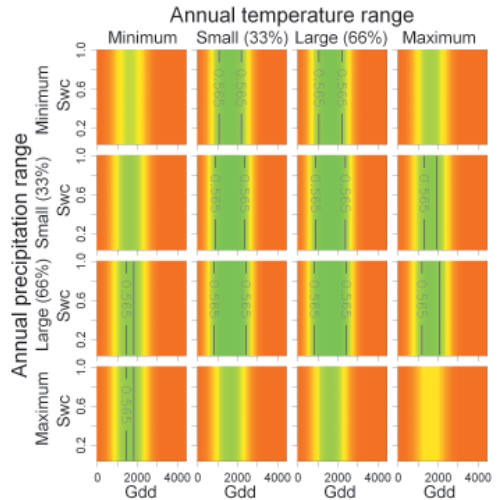
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 20599 cells)

For many, the Brimstone is the first sign of spring. The butterflies hibernate in heaps of twigs or grass tussocks, and on any warm day, even in January, the males appear. The females, that are paler in colour, are seen a little later. The eggs are laid apart on the young branches and leaves of buckthorns (*Rhamnus* spp.). The caterpillars feed on the young leaves. They pupate, suspended from the underside of a twig or nerve of a leaf. In the summer, when the butterflies emerge, they do not mate but instead may become inactive for quite long periods before they hibernate. Courtship and mating do not take place until the spring. The Brimstone always has just one generation a year.

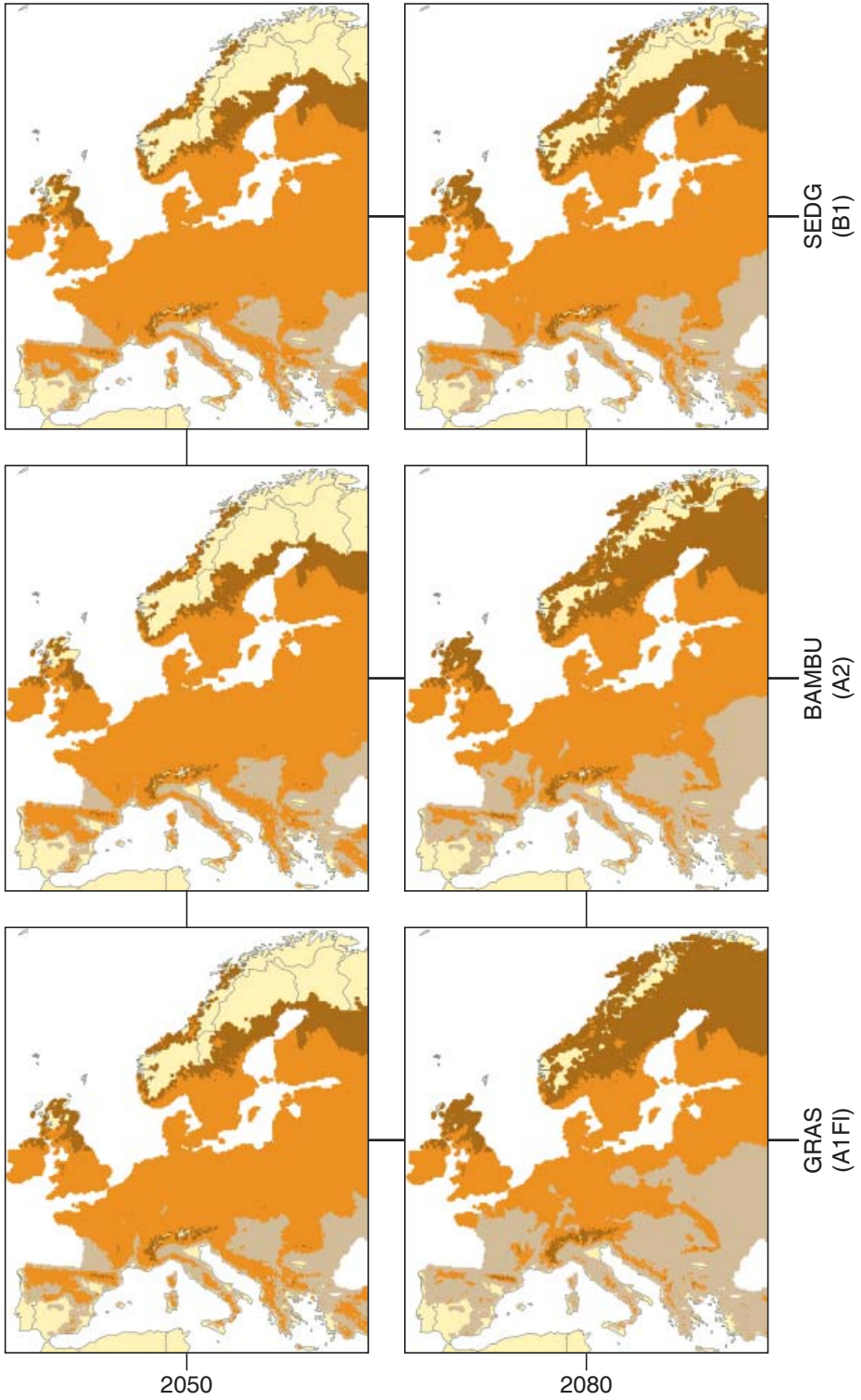
Present distribution can be explained by climatic variables to only a limited extent (AUC = 0.73). Climate risk category: PR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold





## *Gonepteryx farinosa* ZELLER, 1847 – Powdered Brimstone



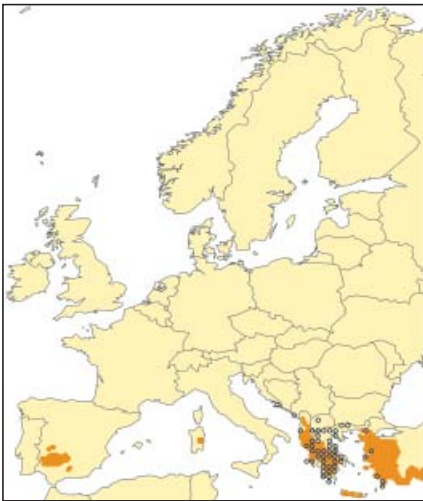
© Heiner Ziegler

		Full dispersal	No dispersal
2050	SEDG	89 (13.8%)	-189 (-29.3%)
	BAMBU	75 (11.63%)	-188 (-29.15%)
	GRAS	84 (13.02%)	-231 (-35.81%)
2080	SEDG	334 (51.78%)	-210 (-32.56%)
	BAMBU	-27 (-4.19%)	-369 (-57.21%)
	GRAS	-144 (-22.33%)	-519 (-80.47%)

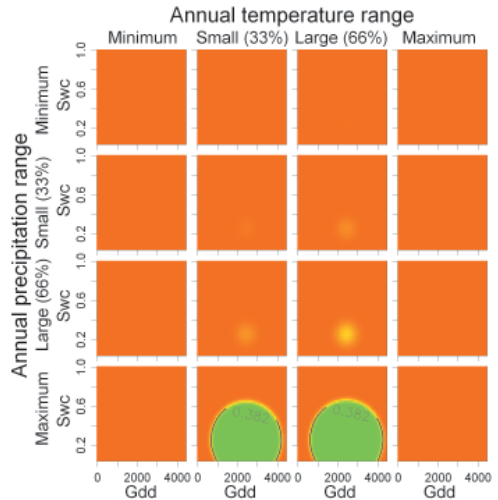
Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 645 cells)

The Powdered Brimstone larvae feed on the prickly Christ's Thorne (*Paliurus spina-christi*) and on various buckthorns, such as *Rhamnus alpinus*, *R. sibirhorpianus* and *R. lycioides*. They are therefore often seen on bushy vegetation, namely in warm, dry places and on rocky slopes. However, in their search for nectar, they also fly in other places. It has one generation a year and, like other brimstones, hibernates as a butterfly.

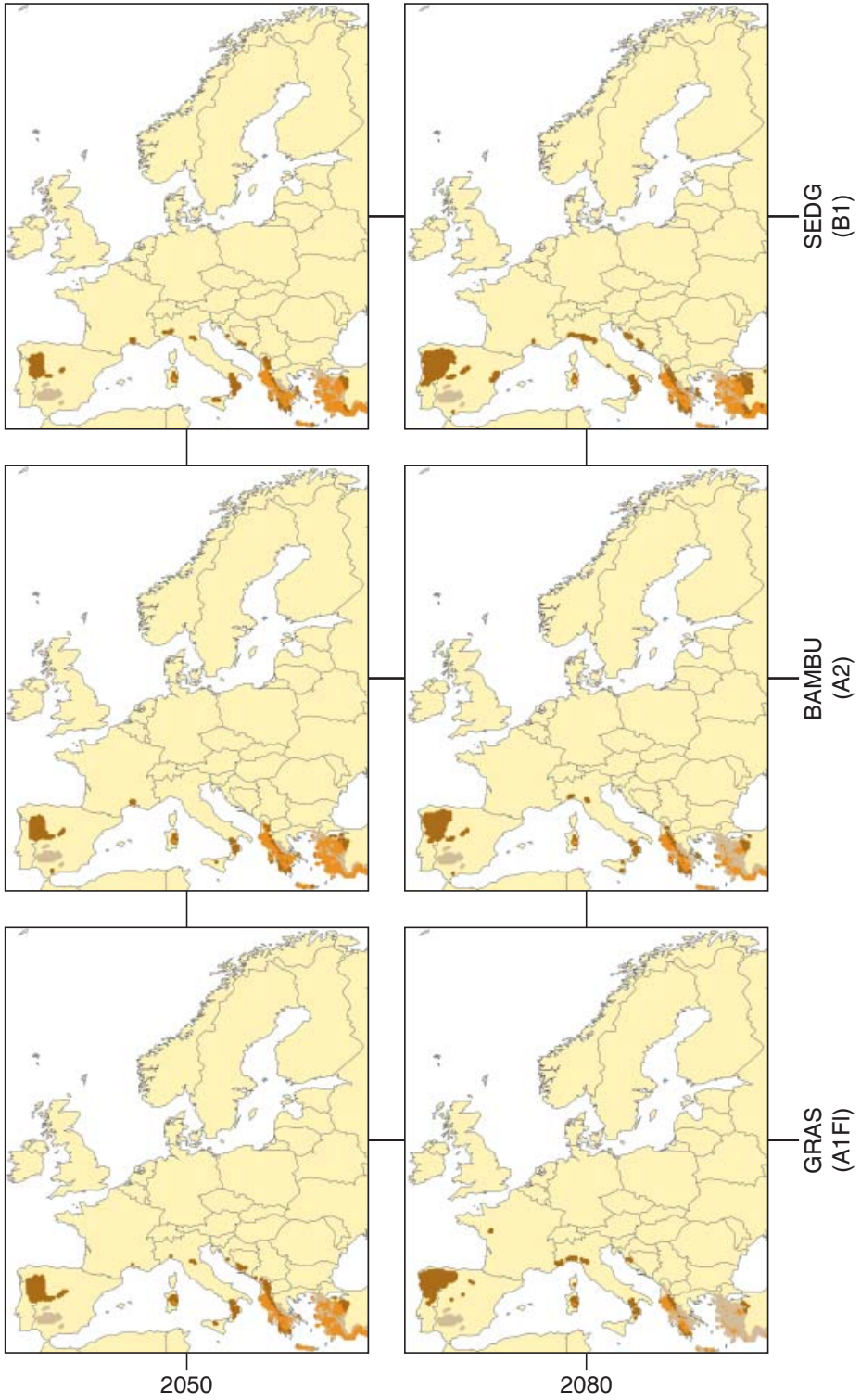
Present distribution can be well explained by climatic variables (AUC = 0.94).  
Climate risk category: HR.



Observed species distribution (50 x 50 km² UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold



## *Gonepteryx cleopatra* (LINNAEUS, 1767) – Cleopatra



© Peter Ginzinger

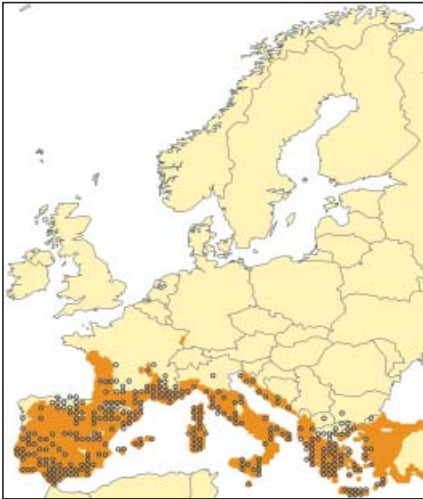
		Full dispersal	No dispersal
2050	SEDG	-17 (-0.4%)	-1417 (-33.35%)
	BAMBU	-595 (-14%)	-1527 (-35.94%)
	GRAS	-31 (-0.73%)	-1653 (-38.9%)
2080	SEDG	-143 (-3.37%)	-1918 (-45.14%)
	BAMBU	-1013 (-23.84%)	-2621 (-61.69%)
	GRAS	-1293 (-30.43%)	-3250 (-76.49%)

Changes in climatic niche distribution  
(in 10'x10' grid cells; present niche space: 4249 cells)

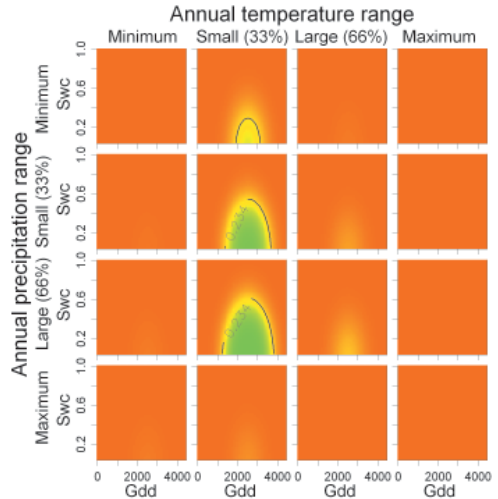
The Cleopatra is found in light woodland, woodland edges and open bushy places. The males are easily recognized in flight by the orange patches on their forewings; the female looks very much like an ordinary brimstone. They are strong flyers that sometimes roam outside their breeding area. The eggs are laid on the young leaves of various buckthorns, such as Buckthorn (*Rhamnus catharticus*), Mediterranean Buckthorn (*R. alaternus*), and Alpine Buckthorn (*R. alpinus*). The caterpillars feed on the leaves, and pupate on the twigs of the foodplant. The Cleopatra hibernates as an adult butterfly, and therefore can be seen flying for most of the year. Probably, it has only one generation a year.

Present distribution can be well explained by climatic variables (AUC = 0.92).

Climate risk category: HR.



Observed species distribution (50 x 50 km<sup>2</sup> UTM grid; black circles) and modelled actual distribution of climatic niche (orange areas)



Multidimensional climatic niche. Occurrence probability defined by accumulated growing degree days until August (Gdd) and soil water content (Swc) for combinations of minimum, lower tercile, upper tercile and maximum values of annual temperature range and annual precipitation range. Climatic conditions: orange – unsuitable; green – hostile; black line – modelled threshold

