Searching for grapevine (*Vitis vinifera* L.) optimal stomatal traits using the FSPM HydroShoot

Megan BARTLETT
Viticulture and Enology Dept., UC Davis, USA

Rami ALBASHA
INRAE, UMR759 LEPSE, Montpellier, France
itk, Clapiers, France

Background and objective

Climate change will increase water and heat stress in many wine growing regions **(Hannah et al., 2013)**. Stomatal conductance plays a pivotal role in adapting viticulture to these adverse conditions **(Bartlett and Sinclair 2021; Dayer et al., 2022)**. We examined the maximum stomatal conductance ($g_{s,\,max}$) and water potential at 50% stomatal closure ($\mathbf{g_{s\ \Psi 50}}$) that optimize grapevine performance historical and future climatic conditions for economically important wine regions in California, using the FSPM HydroShoot **(Albasha et al., 2019)**.

Procedure

1. Meta-analysis of published grapevine traits

Residual stomatal conductance

Maximum stomatal conductance

Leaf water potential at 50% stomatal closure

	g_{res} mol m^{-2} s^{-1}	$g_{s,\,max}$ mol m^{-2} s^{-1}	m_0 -	$g_{s\ \Psi 50}$ Mpa	Source
baseline	0.01145	0.426	5.06	-1.27	Bartlett & Sinclair (2021)[1]
high_gmax	0.01145	0.586	7.04	-1.27	
low_gsp50	0.01145	0.426	5.06	-1.54	
low_gmax	0.01145	0.155	1.72	-1.27	
high_gsp50	0.01145	0.426	5.06	-0.93	
elite	0.01165	0.087	0.8925	-0.85	Dayer et al. (2022)[2]

Water saving

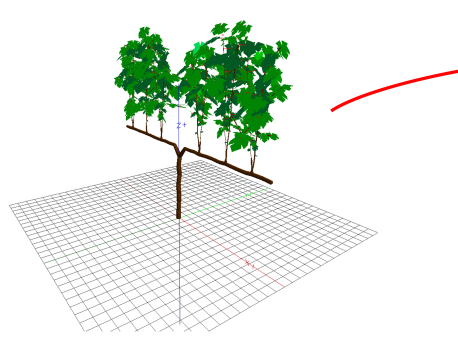
[1] For each variable, the values correspond to the 5th, 50th, and 95th percentile values compiled from the literature for 21 field-grown winegrape cultivars. The value of m_0 is deduced from $g_{s,\,max}$.
[2] Parameter values correspond to "Super Elite" ideotypes.

2. FSPM simulations

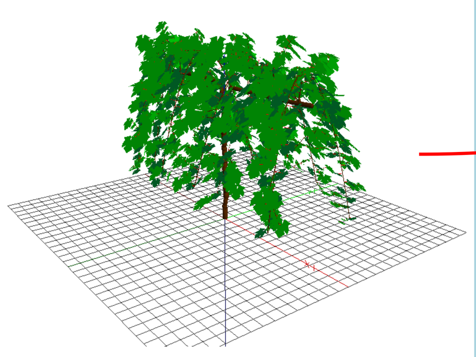
Jointly simulate the hydraulic structure, leaf gas and energy exchange rates using **HydroShoot**.

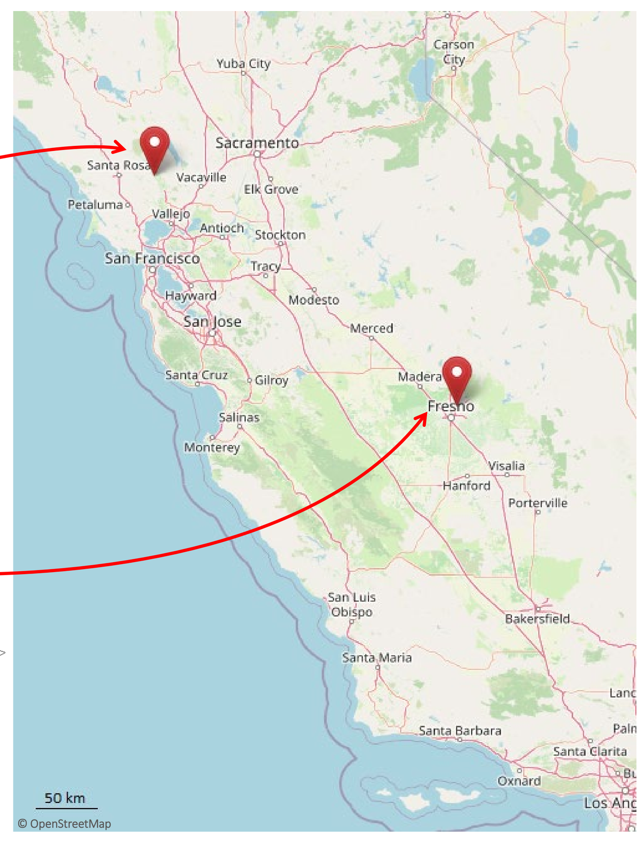
2 sites

Oakville
Napa Valley
Vertical Shoot-Positioned
Clay Loam soil



Fresno
San Joaquin Valley,
Sprawl training system
Clay Loam soil





3 Climate scenarios

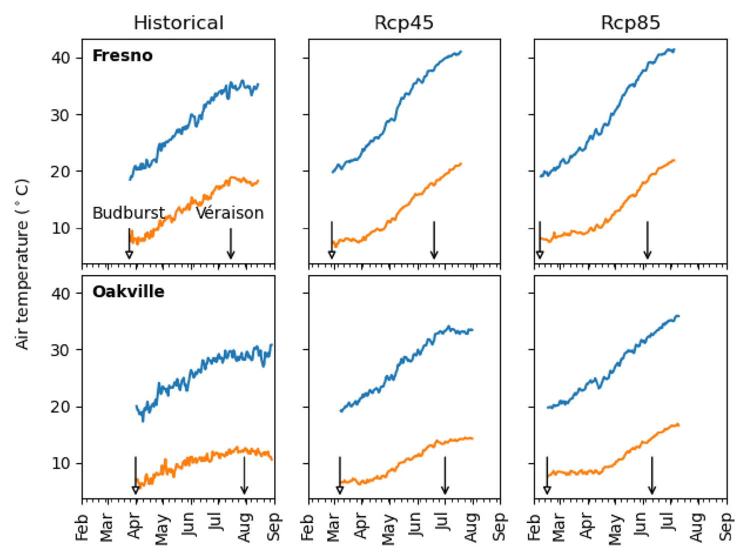
Historical (1990 – 2010)
RCP 4.5
RCP 8.5

3 Row orientations

North-South
NorthEast-SouthWest
East-West

6 Stomatal trait groups

(cf. table above)



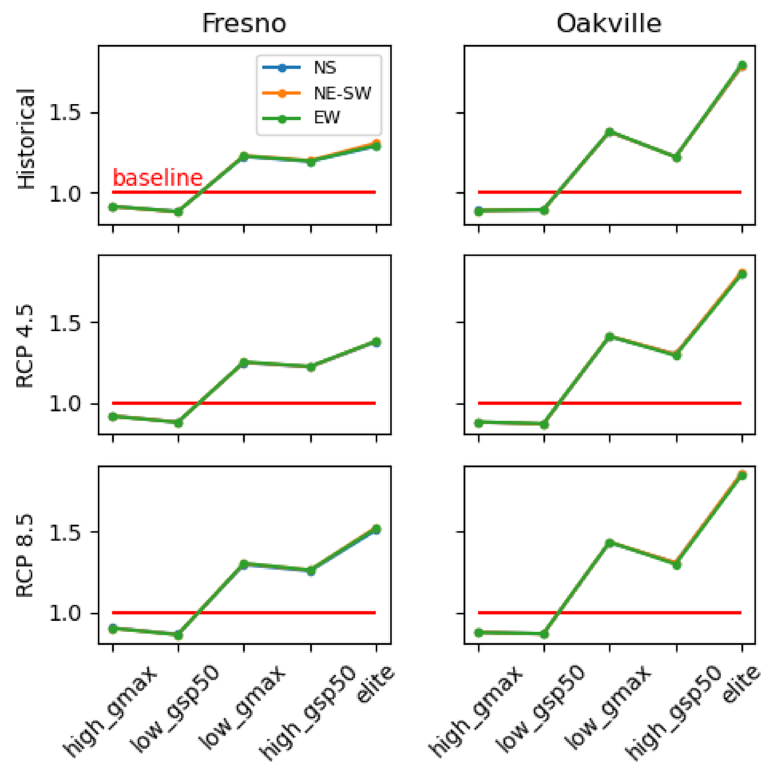
Simulations run during the month following Veraison.

Irrigation was triggered once per week to supply 60% of transpired water.

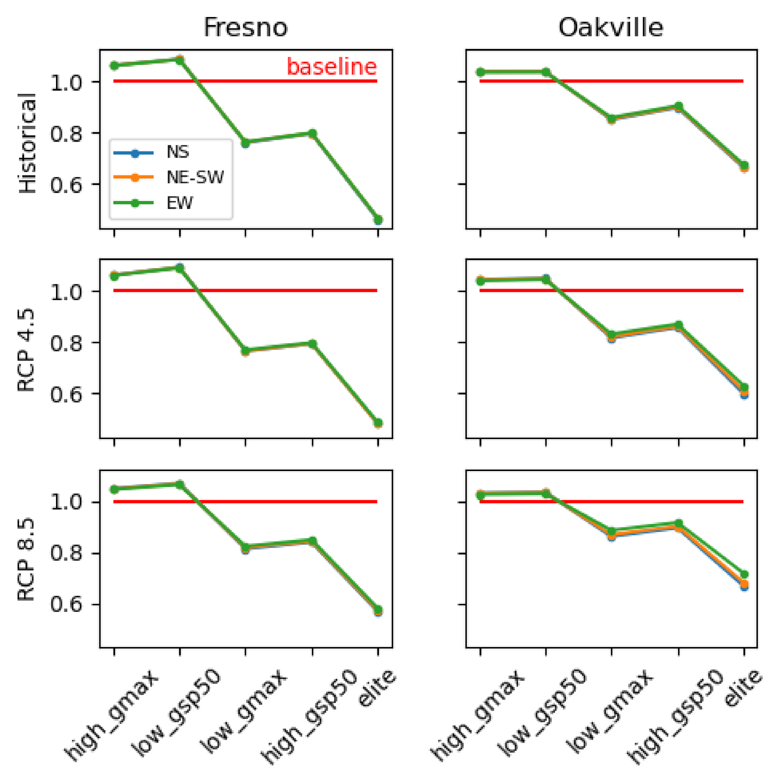
Results

Water saving traits are likely to increase water use efficiency.

$$(WUE = \frac{Canopy\ Net\ Carbon\ Assimilation}{Canopy\ Transpiration})$$



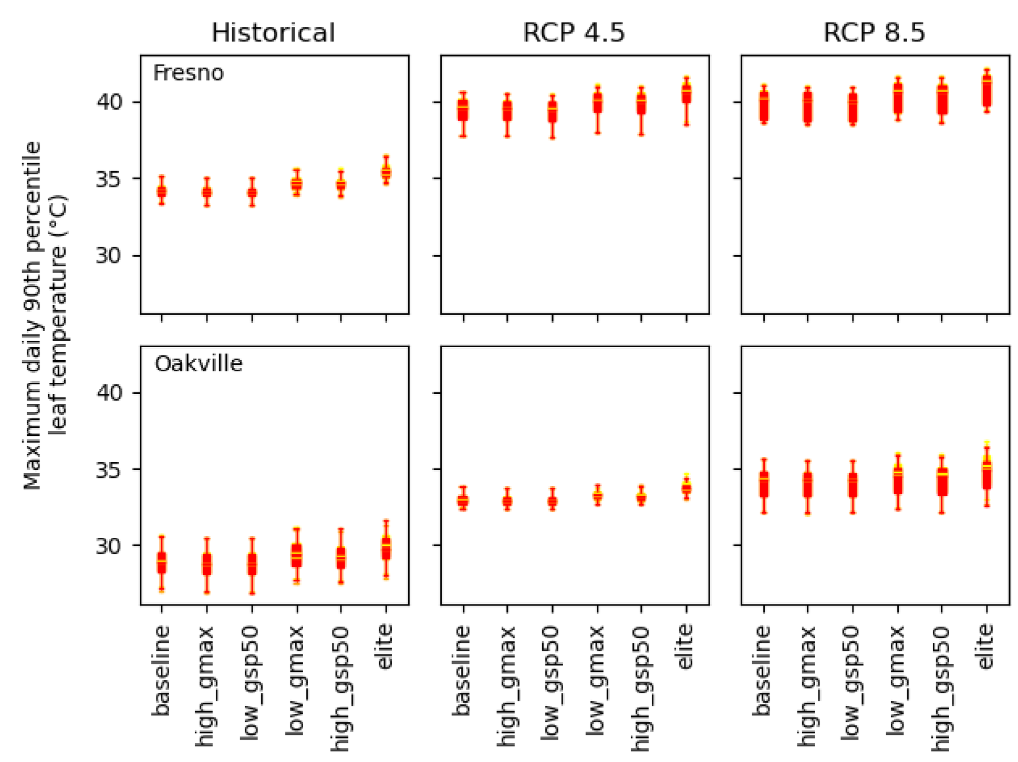
Water use efficiency of each trait group reported to its value with the baseline traits.



Most water-use-efficient traits (elite) would lead to 50% drop in net carbon assimilation

Net carbon assimilation of each trait group reported to its value with the baseline traits.

Leaf temperature increase with water-saving traits is likely to be limited to +2 °C compared to baseline traits under all examine climatic conditions..



Conclusion and Perspectives

Shifting stomatal traits to more water-saving values would improve water-use efficiency. Our results suggest that breeding should however avoid targeting extremely weak stomatal conductance values (i.e. *elite* traits) and rather focus on varieties having a higher sensitivity to water stress (i.e. higher $g_{s\ \Psi 50}$).

More work is needed to evaluate whether the benefits for water savings outweigh the consequences of minor declines in carbon gain for ripening, especially for high-production wine regions.

Albasha et al., 2019, in silico Plants 1, doi: 10.1093/insilicoplants/diz007
Bartlett and Sinclair, 2021. J. Exp. Bot. 72, doi: 10.1093/jxb/eraa577
Dayer et al., 2022. Plant Physiology 190, doi: 10.1093/plphys/kiac361
Hannah et al., 2013, Proc. Natl. Acad. 110, doi: 10.1073/pnas.1210127110

Poster

HydroShoot documentation