General framework for coexistence including phenotypic plasticity: the model ***MountGrass***

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Abstract

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1. Introduction

Global change has been subject of a large, and still growing, number of studies. Yet, because the complexitiy of ecological system coupled with the uncertainty around the future of climate and management, a lot of work is remaining to predict the state of natural and semi-natural systems in the future. Vegetation communities are of particular interest as they provide both economic value and ecosystem services. If a large part of plant community ecology is foccused on forests, the presumed vulnerability to global change of mountain grasslands has led scientists to study them. If their actual vulnerability is still discussed (phd of sandra, ecoveg 2015), mountain grasslands will certainly be exposed to increasing temperature and droughts, but also to changes in management practices with a reduction of grazing (ask greg, see ref in ceres baros first paper). To better understand and predict the effect of global change in these ecosystems of mountain grasslands, empiricall studies and experiments have been set. (see

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Jena, leca and Levine). These studies and others (Violle, albert, jung) highlight the importance of intra-specific variations in community ecology. Intra-specific variations represent around 20 and 30 percent of total variation in grasslands (see albert) and could greatly alter the species interactions and community response to abiotic factors. Considering intra-specific variations is important to better understand community dynamics (violle) and in models because they favour coexistence (Clark, Jung, Courbaud) and modify community responses (Jung). Such effects are succeptible to greatly influence the dynamic of communities facing global change by mitigating species level response, soften plant niches frontier, altering species competition. Another argument is the fact that intra-specific changes may alter directly the community response to a stress (Jung).

Moreover the role of long term evolutionary and ecological processes cannot be easilly assessed in such designs. Moreover, considering the multiplicity of climatic and management scenarios scales up the work to a limiting point.

To overcome these limitations and difficulties, modelling approaches has been developped (fate-h, samsara, taubert, lohier ...). They are either used for the retrospective studies long term dynamics from time series data, the prediction of community dynamics along different scenarios, or to interogate the underlying mecanisms of community dynamics (gemini). These models, to be able to account for changing condittions are all based on strong plant functioning processes at the scale of interest and are supported by field data through parametrisation.

Most of these models feature a fixed plant functioning where the dynamic of the community is mostly driven by, 1) the abiotic conditions, 2) the relative competitiveness of species/group specific parameters or direct competion coefficients. If 1) is essential in the context of climate change, the point 2) as main mecanism of plant interaction can be discussed as it relies on differences between species specific physiological parameters. Physiological or competition parameters are generaly estimated by direct measures or derived from dta through calibration. Both methods give estimators in what we have good confidence, however they do not allow them to vary within the group (plant functional type, species or population) they haved been difined for. The estimator produce good results and generally follow fundamental or ecological trade-offs. Yet, they do not allow for variations within the group for these parameters, as they are not strictly constraint by said trade-offs and could lead to darwinian demons, or would require calibration of this variation space. More efforts must be done in the representation of the link between chemical, anatomical and morpholocical traits and physiological traits that drive plant growth and plant interactions. Defining such link would authorise variations within a group while maintaining strong trade-offs between physiological traits and allowing variation and search in the strategy space... (not clear).

We stressed the importance of considering intra-specific variations, ann highlight the necessity for a link between chemical and anatomical traits to functioning traits. Not clear what is genetic variation and selection/evolutionary processes or phenotypic plasticity. Phenotypic plasticity in models: theoretical: 2 species interactions, not at community model. (Heritability ?)

There is a need for community models capable of reproducing diverse plant communities. To investigate the effect of climate change it has to incorporate mechanism of response and individual level.

Such mechanism is called phenotypic plasticity

2. Methods

2.1. Model overview

2.2. Calibration data

2.3. Simulation setup

3. Results

3.1. Growth of diverse species

calibration

sensitivity analysis

1d gradient: distribution of as and memory of surviving species.

niche

3.2. Plasticity in this framework

compare algorithm.

effect of tau on growth (same parameters but with no plasticity cost)

plastic calibration

4. Discussion

5. Conclusion

using fundamental "deep" traits and memory: able to reproduce a diversity of resource use strategies. Possibility to

This framework is compatible with phenotypic plasticity

plasticity change the niche shape (and probably interactions) and may have an impact on community dynamics.

References

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Appendices

6. *MountGrass* description

7. State variables, traits and parameters

7.1. State variables

7.2. Species specific traits

7.3. Parameters

8. Simulations