MINUTES

FORHOT – 3rd formal project meeting in the Lorentz Center, Leiden, Netherlands

and from a following workshop entitled "*Joint ecosystem assessment of warming impacts*" 10-14/2

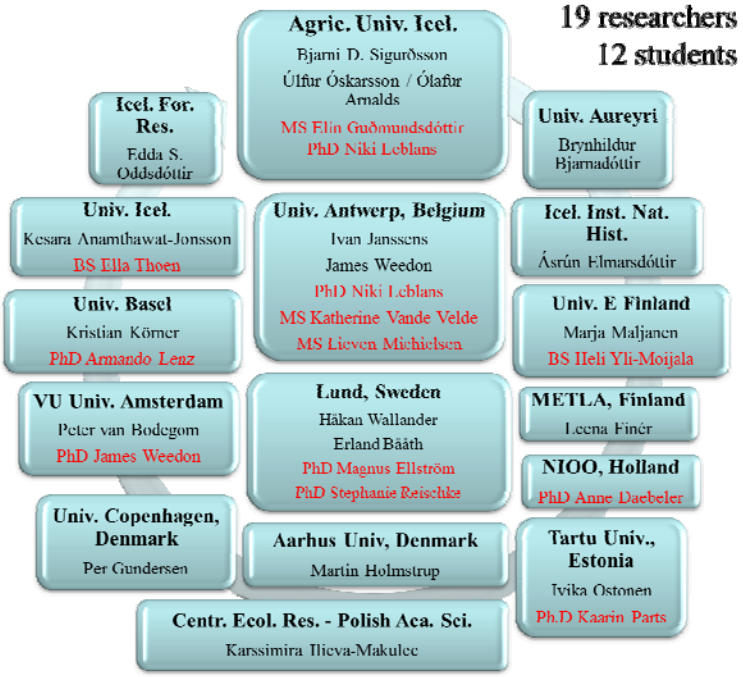
Attending:

BDS = Bjarni Didrik Sigurdsson (Agric. Univ. Icel. / AUI),
ESO = Edda Sigurdís Oddsdóttir (Icel. For. Res. / IFR)
IJ = Ivan Janssens (Univ. Antwerpen, Belgium / UA)
JW = James Weedon (UA)
NL = Niki Leblans (UA)
LX = Lieven Michielsen (UA)
KVV = Katherine vander Velde (UA)
PvB = Peter van Bodegom (VU Univ. Amsterdam /VU)
HW = Håkan Wallander (Lund Univ., Sweden / Lund)
EB = Erland Bååth (Lund)
MM = Marja Maljanen (Univ. Eastern Finland / UEF)
IO = Ivika Osonen (Tartu Univ., Estonia / TU)
KP = Kaarin Parts (TU)
AL = Armando Lenz (Basel Univ./BU)
HE = Howard Epstein (Univ. Virginia, USA) – invited guest.

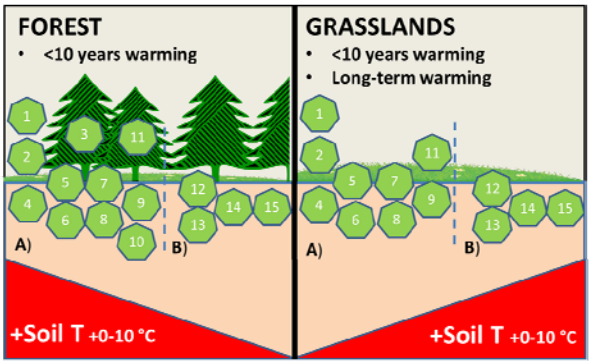
Agenda

1. ForHot project and participant overview
2. ForHot's main happenings in the past (2011-2013)
3. Recent project news
4. Project status now and next steps in field research at ForHot
5. First publications from ForHot are coming soon
6. New funding possibilities
7. The workshop: "*Joint ecosystem assessment of warming impacts*"
8. Howard Epstein's synthesis at the end of the workshop
9. Other issues/decisions

ForHot project and participant overview (2013)



And currently the project consists of 15 different work packages, which are carried out on 75 permanent plots divided over soil temperature gradients in three different ecosytems: i) GN: Grassland warmed since 2008, ii) FN: Forest warmed since 2008 and iii) GO: Grassland with long-term warming.



Main work packages within FORHOT. A) Ecosystem structure and C-dynamics: 1) Monitoring of soil and air T and soil water status; 2) Ground vegetation growth, composition, phenology; 3) Tree growth and phenology; 4) Fine-root production 5) Litter production abovegrund and belowground; 6) Litter-bag study on decomposition; 7) Soil and litter organic matter; 8) Soil fauna composition and amounts; 9) Soil microbe composition and amount; 10) Ectomycorrhyza on tree roots; 11) Carbon fluxes (CO_2, CH_4). B) Nutrient cycle interactions and other issues: 12) Plant and soil N stocks and nutrient uptake rates 13) NH_3 mineralization and Archaebacteria; 14) N_2O fluxes; 15) C and N-isotope studies.

The list of active participants of the ForHot project is as follows for 2014:

Agric. Univ. of Iceland

- Prof. Bjarni D. Sigurdsson (coord.)
- Prof. Ólafur Arnalds
- Dr. Úlfur Óskarsson
- M.Sc. Helena M. Stefansdottir
- Elín Guðmundsdóttir (M.Sc. student)
- Hanna André (B.S. student from SLU)
- Agnes Bondesson (B.S. student from SLU)

Icelandic Forest Research – Mogilsa

- Dr. Edda S. Oddsdóttir

Univ. Akureyri

- Dr. Brynhildur Bjarnadóttir

Univ.of Iceland

- Prof. Kesara Anamthawat-Jónsson.

Univ. of Antwerp - Belgium

- Prof. Ivan Janssens
- Dr. James T. Weedon (Post-doc)
- Niki Leblans (Ph.D. student)
- Katherine Vande Velde (M.Sc. student)
- Lieven Michielsen (M.Sc. student)
- NN PhD student 1
- NN PhD student 2.
- NN and NN B.Sc. students

Cardinal Stefan Wyszynski Univ., Poland

- Dr. Krassimira Ilieva-Makulec

Icelandic Inst. Nat. Hist

- M.Sc. Ásrún Elmarsdóttir

Basel University, Switzerland

- Prof. Kristian Körner
- Dr. Armando Lenz (post-doc)

Vrije Univerity, Amsterdam, NL

- Prof. Peter van Bodegom,
- Benjamin Hearn (M.Sc. student)

Univ. Eastern Finaland

- Dr. Marja Maljanen
- Heli Yli-Moijala (M.Sc. student)

Lund University

- Prof. Håkan Wallander
- Prof. Erland Bååth

METLA, Finland

- Prof. Leena Finér

Tartu Univ., Estonia

- Dr. Ivika Ostonen
- Kaarin Parts (Ph.D. student)

Copenhagen Univ.

- Prof. Per Gundersen

Aarhus Univ.

- Prof. Martin Holmstrup

In total:
21 researchers/postdocs
13 graduate, MS and PhD students

ForHot's main happenings 2011-2013

- ClimMani conference in Iceland in June 2011 – Bjarni/Edda launch the project idea.
- Autumn 2011
  - Temperature mapping of the recently warmed FN (Bjarni, Edda)
  - Tree growth (Armando & Bjarni)
  - Fine roots/mycorrhyza (Ella, Kesera & Edda)
  - Litter bags (Edda & Helena).
- May-Oct 2012
  - Adding GN: Recently warmed grassland (Bjarni, Úlfur, Elín)
  - N2O/CH4 fluxes (Marja)
  - Soil respiration (Bjarni)
  - Soil bacteria and fungi (James, Håkan, Erland)

  - Niki starts her PhD with Ivan/Bjarni
- April-Nov 2013
  - Adding GO: Grasslands with long-term warming (Niki, Ivan, Bjarni)
  - 75 new permanent plots – 25 in FN, GN and GO (Niki/Elín)
  - Soil nematodes (Krassimira)
  - More N2O/CH4 (Marja/Heli)
  - More soil fungi (Håkan/Magnus)
  - Tree root morphology (Ivika /Kaarin)
  - More FN soil gas exchange and growth (Bjarni)
  - Carbon and nutrient stocks, NDVI, plant traits, PRS-probes (Niki/Katherine/Lieven)

Recent project news

i) Peter van Bodegom hosted a very fruitful ForHot workshop in Leiden, NL during 10-14 Feb, with 14 ForHot participants + one invited guest (prof. Howard Epstein).

ii) We got some funding from NorFA to add WP on **leaching** w. Per Gundersen (Copenhagen Univ., Dk). Will be installed in the spring.

iii) Ivan/James got funding for two new FWO/UA PhD projects at ForHot.
   - **Nutrient additions** to the warming effects... *Sp: Is the Ts repsonse* mainly *a N-cycle resp?* Joint PhD with Ivan/Bjarni
   - **Soil microbial responses** to Ts and nutrient add? AU PhD. Joint PhD with Ivan/James

iv) Morten Holmstrup from Aarhus Univ. joints the project and will initiate more studies on **soil fauna.**

v) We did NOT get funding from Icel. Res. Council (again top evaluation (A3) but no money). Send it in the 3rd time May 30 2014? This was accepted by all participants.

vi) There are two ForHot applications pending now (Feb 2013):
   - Pending: application in DK to add WP on more soil fauna with Morten Holmstrup. Danish Res. Council.
   - Pending: application on SOC issues (Icel., Rum, Norway) – EES funding.

vii) Armando and Magnus will defend their PhD theses within few weeks from now and Armando will continue at Basel on a post-doc for one year. Steph already finished her PhD and is currently doing a post-doc in USA.

viii) Anne Daebeler has moved to Vienna and expects to defend her thesis later this year.

ix) Heli will start a M.Sc. with Marja and use isotopic work and more measurements of N_2O and CH_4 fluxes at ForHot for her thesis.

x) Krassimira has changed affiliation; now she is at Cardinal Stefan Wyszynski University, Warsaw, Poland

Project status and happenings in 2014

1. **Database.** Bjarni had got all measured data from all participants and put it into a common ForHot database, which was distributed at the workshop in Leiden.

   NOTE: In relation to that the following rules (based on what is in the MoU) were accepted.

As a participant in the ForHot project you have agreed:

* That all who use unpublished data from other ForHot participants from the common database will seek approval from the data owner (supervisor of the relevant sub-project and the student involved) and the steering committee **before** the data are used to write up any publication.

* The same applies (i.e. a priory agreement with the data owner is needed) if any unpublished data from the database is to be shared with anyone outside the ForHot project group.

*By this we want to guarantee an agreement on the authority of the relevant data and potential co-authorships **before** it will be written into a first draft of a manuscript.

* That B.Sc., M.Sc. and Ph.D. students doing their research within the ForHot project should normally be allowed to use common unpublished data in their theses (if they make a monograph) with a reference to data owner(s) in the acknowledgements. They should, however, always ask for permission from the relevant data owner. When (later) publishing their thesis-work, students should principally follow their university's policy regarding authorship. Only other researchers within the ForHot project that significantly contribute to the writing of his/her paper(s) or own previously unpublished data used in the paper should be offered a co-authorship.

PLEASE NOTE THAT PART OF THE DATA FOUND IN THE DATABASE ARE STILL PRELIMINARY - - THEREFORE THE DATABASE IS NOW MORE FOR GIVING OVERVIEW ON WHAT IS AVAILABLE AND FOR FIRST CHECK OF PRELIMINARY RELATIONSHIPS BETWEEN VARIABLES.

2. Niki will be in Iceland from April-November and this will be her second (and last) field season in ForHot. The main topic this year is to get more insights into the C-processes at FN, GN and GO. Focus to make 13C labelling studies, PRS-probes, NDVI measurements, albedo, Ta, PAR, Volumetric water content. She will also install second Ts loggers into all permanent plots and establish additional plots for N-addition studies and +20 °C warming in GN and GO (to include T-thresholds).
3. Kaarin and Ivika will continue with morphology and check the anatomy of EcM roots along warming gradient in FN to find something predicting die-back.
4. Edda will take root samples for Ivika and Kaarin in the FN at the same time as Bjarni will take samples for TNC from C+1 needles of spruce (April).
5. Håkan, Edda et al. will run root tip samples from 2011 through PSC to identify changes in EcM fungi – and then discuss with Ivika/Kaarin about if to include their samples from 2013 in such analysis.
6. Ivika, in cooperation with Håkan, will use SOM fractionation equipment to get different physical SOM fractions for all the Ts gradients at ForHot. This will either be done in Estonia or Sweden. In Estonia it would by the method of Dr. Luisella Celi (from Italy). Samples for this will be taken sometime during 2014.
7. Bjarni and Brynhildur will have two B.Sc. students from SLU in Sweden (Agnes Bondesson and Hanna André) in April and May who will work on gas exchange measurements (tree photosynthesis and gs

response to warming) in the spruce canopy and tree phenology and on GPP/NEE/RE fluxes in the three ecosystems. They will also build three canopy towers in FN.

8. Peter will send a M.Sc. student (Benjamin Hearn) in April-June who will work on reasons for mortality thresholds in the FN (shoot and root respiration, TNC profiles, frost hardiness, etc.)
9. Edda will install root ingrowth bags in GN, FN and GO in April/May.
10. Bjarni will measure potential decomposition by TBI in GN, FN and GO in June-Aug.
11. Per Gundersen and Bjarni will install suction cups in different plots at FN, GN and GO in May/June.
12. Martin Holmstrup will come to Iceland to sample soil fauna in FN, GN and GO in May/June.
13. Håkan will come in July to collect fungal ingrowth bags at FN, GN and GO.
14. Heli will come to Iceland this summer to continue measurements on N2O and CH4 fluxes and 13C and 16N isotopes in CO2 and N2O fluxes.
15. Two B.Sc. students from Antwerp will come in July to take new soil samples down to the bedrock in GN, FN and GO.
16. New PhD student (PhD2) will be hired in July and will come to Iceland to start the work on N-addition plots.
17. Albert Rivas from UA will probably come in July/Aug to take samples of different tree species to study the environmental vs genetic effects on stoichiometry and metabolomics.
18. Edda, Niki and PhD2 will start a litter-bag study with four litter types in September.
19. **It would be appreciated if <u>you</u> could notify Bjarni if there are some additional measurements planned within ForHot in 2014 that are not listed here.**

First publications from ForHot are coming soon

Opinion paper on the potential to use geothermal systems for simulating warming, where ForHot is presented in one box, has been submitted to GCB ➔

1. 2014. Eoin J. O'Gorman, Jonathan P. Benstead, Wyatt F. Cross, Nikolai Friberg, James M. Hood, Philip W. Johnson, **Bjarni D. Sigurdsson**, and Guy Woodward. (2014) Climate change and geothermal ecosystems: natural laboratories, sentinel systems, and future refugia. **Global Change Biology** (semi-Accepted)

Other manuscripts planned in 2014.

2. 2014. Sigurdsson et al. (all participants at the workshop + other data owners). Descriptive paper on FN and GN – where distribution of dieback areas is shown.
3. 2014. Lenz, et al. and Sigurdsson: Effects of soil warming on tree growth, ANPP and mortality at FN. Global Change Biology.
4. 2014. Weedon, Bååth, et al.. Warming effects on soil bacterial community structure in FN and GN.
5. 2014. Bååth, Weedon, et al. Effects of soil warming on microbial community growth.
6. 2014. Oddsdottir, Maljanen, et al., and Sigurdsson. Effects of soil warming on decomposition rates measured with different methods.
7. 2014. Parts, Ostonen et al. Effects of soil warming on root tip morphology at FN.
8. 2014. Wallander, Oddsdottir, Ostonen, et al. Mycorrhyza paper.
9. 2014. Leblans et al.Effects of soil warming on SOC at GO and GN
10. 2014. Michielsen, Gudmundsdottir, et al. Effects of warming on vascular plant species composition and shifts.

Manuscripts planned in 2015

11. Leblans et al. Janssens. Soil warming effects on NDVI and phenology. Description of GO.
12. Leblans et al. 13C labelling and C-allocation in GN and GO.
13. Maljanen, et al. Sigurdsson. Changes in CO2, N2O and CH4 fluxes in FN, GN and GO.
14. Maljanen et al. Geothermal sources of 13C and 16N fluxes with CO2, N2O and CH4 fluxes from FN, GN and GO.
15. Vande Velde et al. Effects of soil warming on NPP in GN, GO and FN
16. Sigurdsson??, Leblans, Michielsen, et al. Janssens Effects of soil warming on leaf nutrient stoichiometry in FN, GN and GO.

New funding possibilities

We will send in an application to Icel. Res. Council once more (deadline June 1). Lead by Bjarni. All PIs at the meeting accepted to be co-proposers.

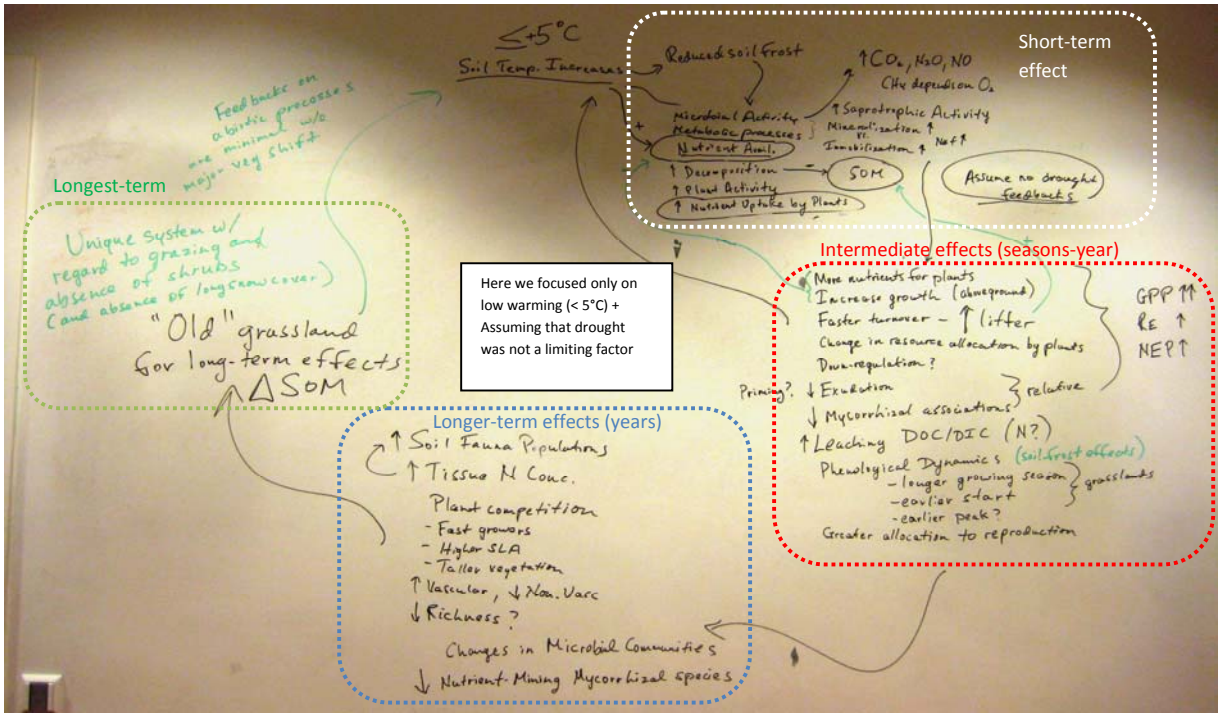
Bjarni is going to lead an application for ITN (Innovative Training Network - deadline April 9). Partners with AUI will be UA, VU, Lund, UEF, TU and one non-academic partner (KWR in NL). Apply for 6-8 PhD students, who all will be at least partly linked with ForHot work.

The workshop: "Joint ecosystem assessment of warming impacts"

The participants used two days to show the results of different WPs. The overheads will be made available on the ForHot homepage (on a locked page) in few weeks.

Then they used two days to discuss what we know now about how the soil warming affects ecosystem processes and function (see next page) – and planned the key-papers that could come out of the ForHot experiment in the next 2-4 years.

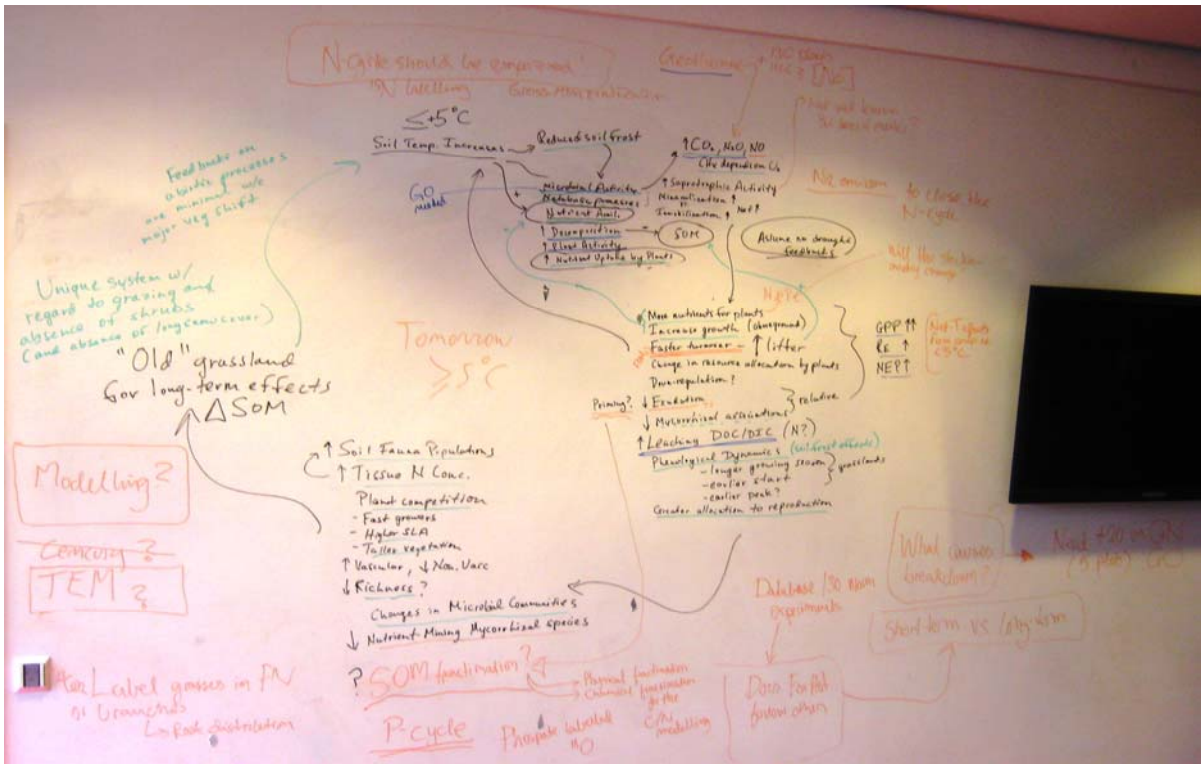
In the discussions we divided the warming effects between: a) short term (within a week), b) intermediate (within a year) and c) longer term (annual scale):



Then we tried to identify:

1) what information we have already (green lines under words)
2) what needs urgently to be studied more (blue lines under words)
3) what information is missing (red lines under words)

Then we had a discussion on what were the most unique possibilities we have with the large Ts gradients at ForHot (sentences and boxes in red) (see next page)

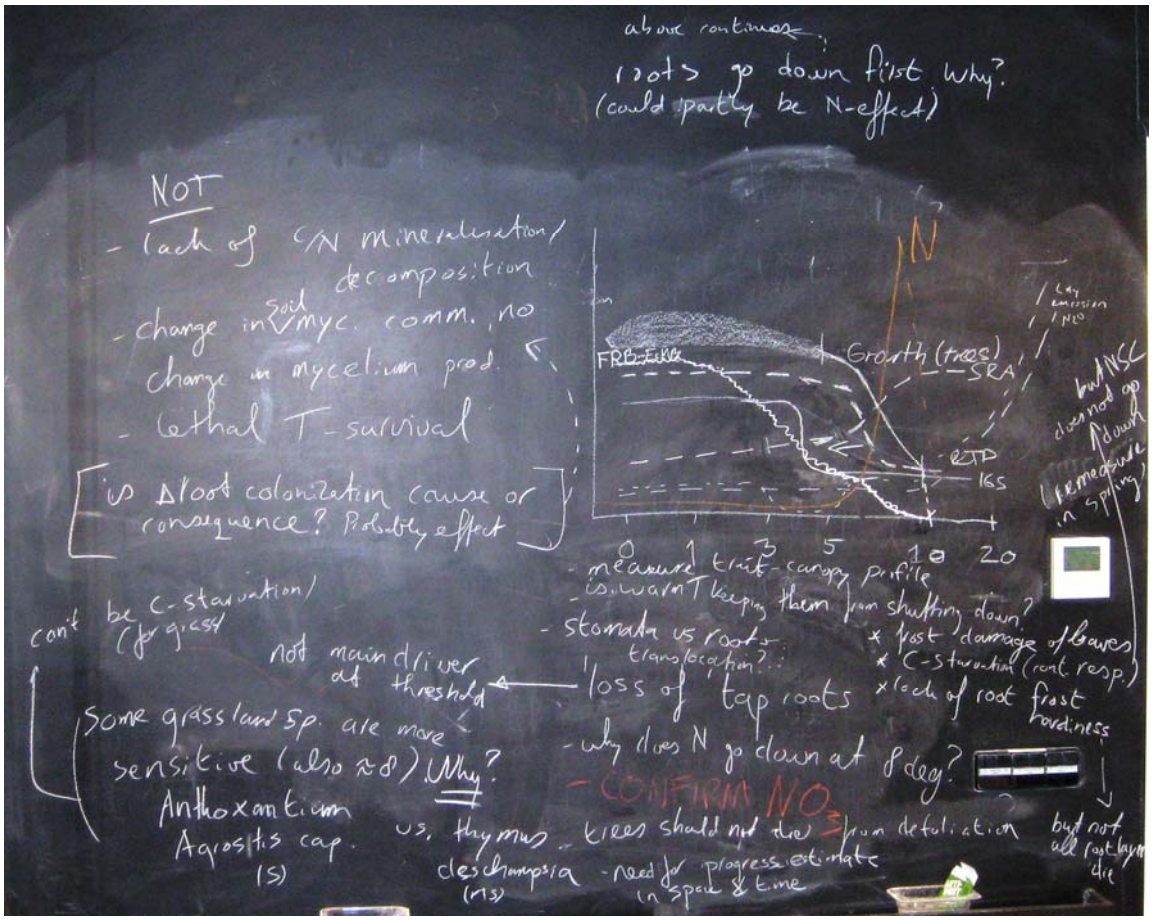


During the workshop the participants discussed what would be the most interesting synthesis articles that would come from the ForHot consortium and could be published in the highest-level journals:

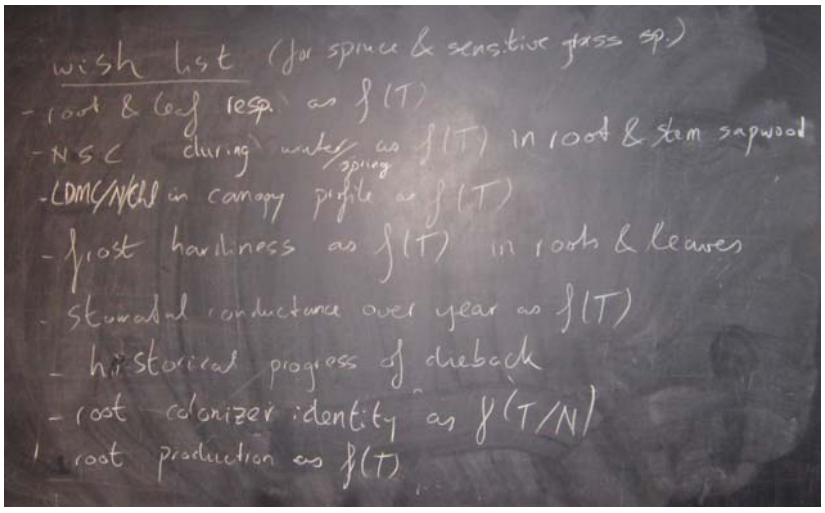
Synthesis question 1:
Led by Peter van Bodegom: Are there warming thresholds for ecosystem structure and function in different ecosystems (FN, GN) - - do they occur at the same temperature for different processes/properties?

Most of the discussion on this issue was about the forest (FN) and why trees are dying at relatively low temperatures…

- Caused by a mismatch in belowground and aboveground temperature controls?
    - Loss of frost hardiness of either roots or needles
- Caused by C-starvation because on enhanced tree respiration but unchanged photosynthesis.



Then the participants made a “wish-list” of which variables needed to be measured across the Ts-gradients to give answers to these questions:

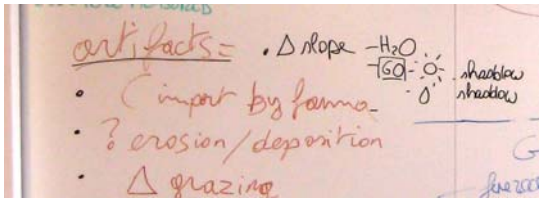


One thing that came out of this was that because some of the thresholds do not occur until >10 °C warming in GN and GO, it would be a high priority to add 5 plots with ca. +20-30 °C Ts-varming in each Ecosystem. (Which would increase the number of permanent plots in ForHot from 75 to 85)

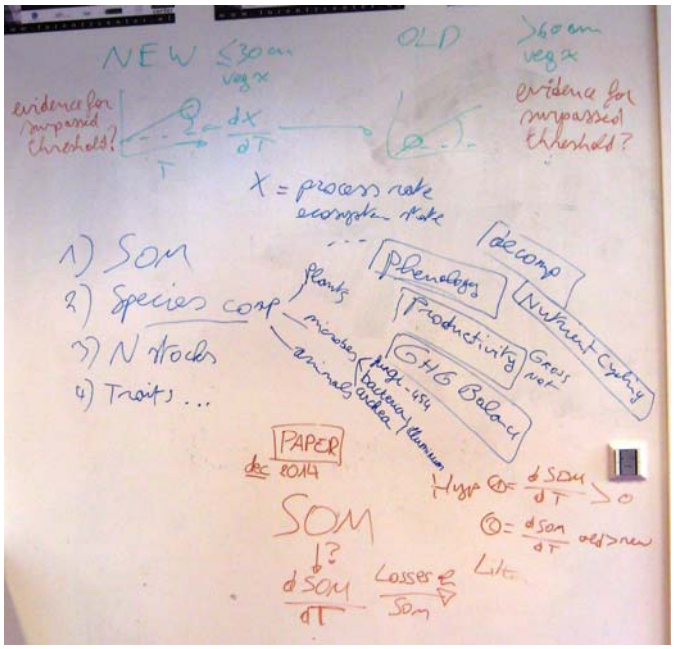
Synthesis question(s) 2:
Led by Ivan Janssens: Does duration of warming matter? and then why?
This can be addressed by comparing GN with GO

It should be kept in mind that there are differences between GN and GO – they are ca. 2 km apart and in different valleys. Therefore some of their properties (e.g. soil depth) are not directly comparable.

Differences (artifacts) between GN and GO:



But PROCESS RESPONSES to warming can be compared between GN and GO!! Differences should indicate "acclimation" to warming.
Variables which can be compared include e.g. SOM processes, species composition, plant traits, N stocks, …



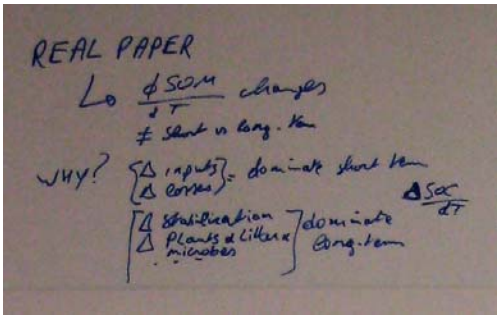
Erosion processes are an issue. T-transects both within GO and GN are laid out so the warmest levels are upslope in some transects, but downslope in some. This helps!

PAPER II : The REAL PAPER would then address why (which processes) lead to the differences shown in Paper I.

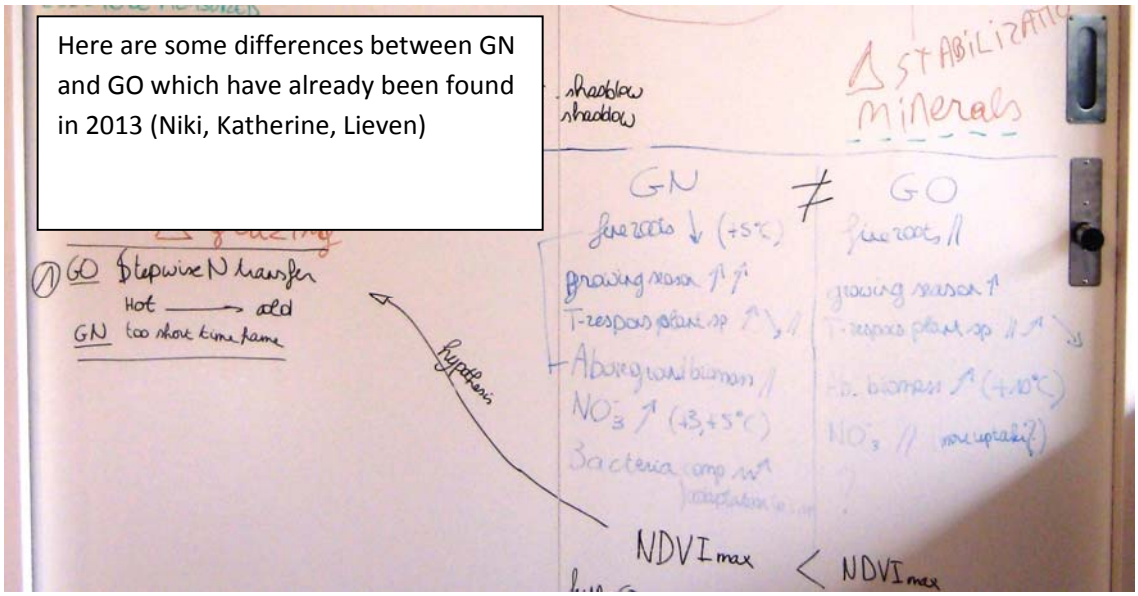
It was suggested that the first focus in analysing differences between short-term and long-term warming would be put on Soil Organic Matter (SOM)

PAPER I (2014/2015):
Ho1: warming should enhance decomposition more than photosynthesis: i.e. induce more and more losses of SOC as Ts is warmed.

Ho2: GO which has been exposed longer to warming should show steeper decline in SOM with warming.



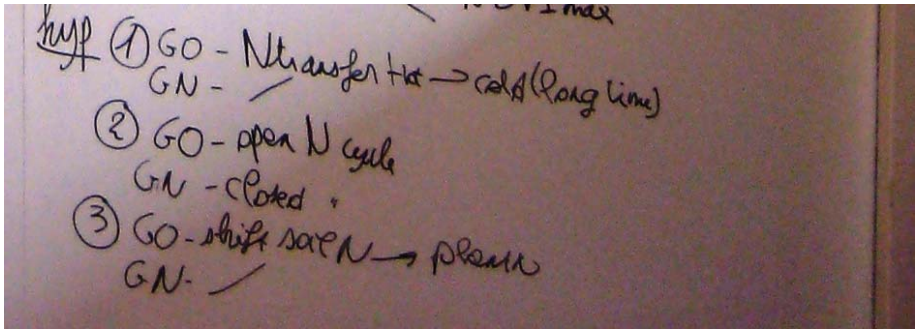
Here is the overview the group produced for potential reasons for the expected differences between GN and GO in SOM dynamics:



Issues that have to be kept in mind that could cause differences (artefacts) between Ts-level at each of the GO and GN site include:

- Erosion
- Long-term grazing effects that can move N between Ts-levels
- C-input by animals (e.g. if they graze most at Ts+10 °C, but give inputs randomly over the whole area)
- Transports of DOC and DON by soil water
- N-tranfer by extending roots from warm to cold plots…

There should also be differences in the N-cycle between GN and GO



Ho1: There was a N-transfer with roots from “hot” to cold - - more apparent on GO than GN because of the effect accumulates over time

Ho2: GO has more open N-cycle than GN

Ho3: Larger part of the Ecosystem N stock is found in plant biomass in GO vs. GN

The group made the following diagram to attempt to describe their understanding on what were the key variables/processes behind the change in SOM dynamics:

What we are not studying at all at present is e.g.:

1) **Soil aggregates!**

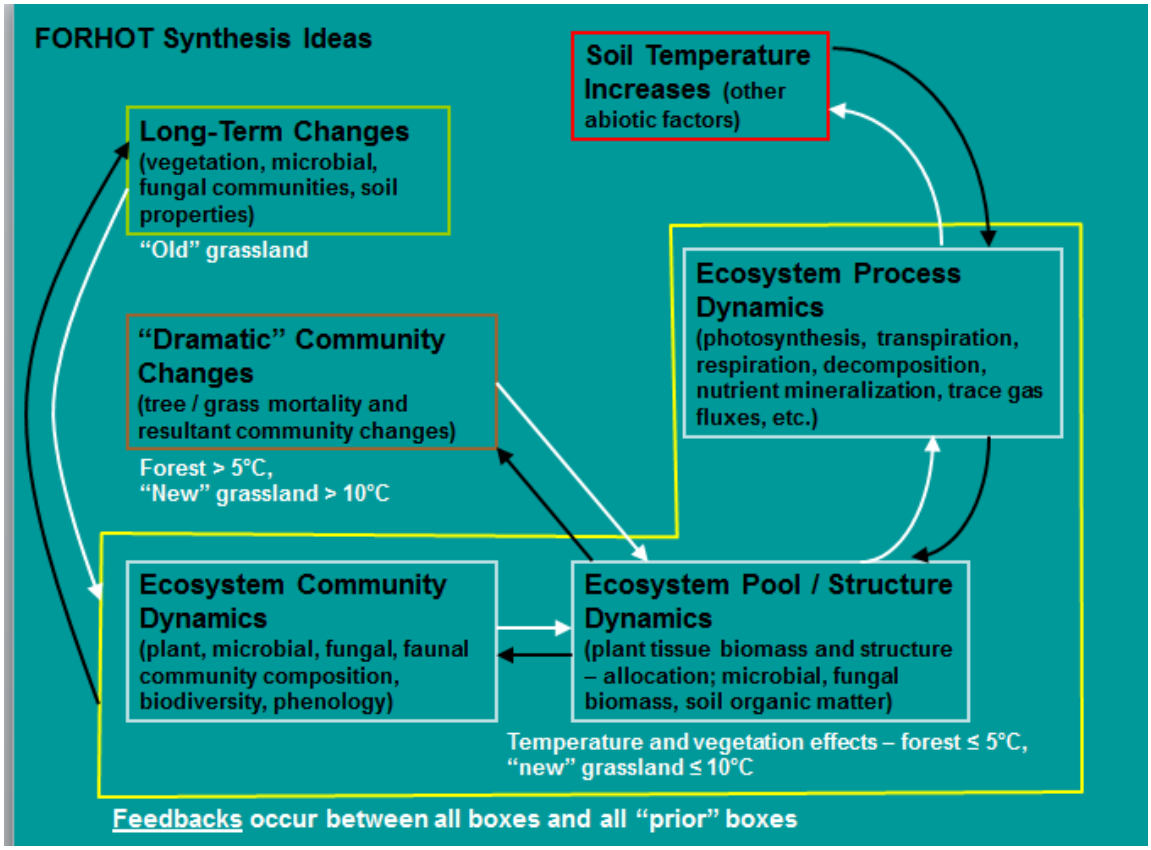
Priority to measure aggregate amounts at different Ts-levels and if possible, aggregate turnover…
Ivika has a PhD student that has trained in Italy to do physical aggregate separation… Much discussion what gives more relevant information; physical fractionation techniques (i.e. Ivika) vs chemical fractination (i.e. Peter – says they give more relevant information for the modelling of the C/N cycle…).

2) **Minerals/OM and nutrient immolation**

Håkan is interested in the Ts-effect on weathering rates and mineralogy etc.
We should maybe use the ITN to address this issue??
or not… This would be enough for a new project…

Howard Epstein's synthesis at the end of the workshop

ForHot synthesis ideas:



Howie's comments on the ForHot project:

1) The ForHot system is a unique one:
- **uses natural geothermal soil warming (strong gradient of warming)**
- **volcanically-derived soils**
- **wet system with minimal drought feedbacks**
- **high-latitude ecosystem with minimal seasonal snow and long-term effects of grazing on shrub cover**
- **multiple vegetation types and "ages" of the temperature gradient**

2) Unique opportunities for looking at the effects of soil warming on ecosystem processes and properties:
- **between forested and grassland systems**
- **leading up to and following resultant vegetation mortality**
- **between recent and long-term warmed grasslands**

3) Numerous investigators measuring many system variables presents a great opportunity for whole system understanding and synthesis

Howie's views on some of the key issues of ForHot:

1) The hypothesized system dynamics are dependent on increased nitrogen availability for vegetation and micro-organisms. So make sure that you get the N-cycle right.

2) Carbon is obviously a "hot" topic, so a strong focus on the mechanisms of carbon sinks versus sources would go a long way.

3) Incorporate modeling – TEM seems like a nice idea, as it combines both vegetation community dynamics with ecosystem processes, and can allow for longer-term projections. You are collecting way more variables than are presently used in the model, but that doesn't necessarily mean you need to add all of these things to the model. Most valuable scenarios are when the model doesn't match the data.

4) Avoid the "IBP" effect – lots of variables being measured, all with uncertainty, errors propagate. Don't lose sight of some of the big picture.

5) Put a "body" on synthesis – things like standardizing the independent variable and statistical analyses are not trivial. Also, depth of temperature effect vs. depth of response variable.

Other issues / decisions

1. Decided that BDS should add a keyword protected page to the www.forhot.is homepage, where updated version of the database will be kept, overheads with sensitive unpublished results, applications, etc.
2. Decided to try to add one Ts level to the permanent plot system of ForHot, at least in the GN and GO. Important for those that want to address the "thresholds"…
3. Bjarni will make an effort to get all available information about the true "age" of the GO!
4. The Ta will be measured at 10 cm height (at all plots?) in both grasslands (Niki/Bjarni design radiation shelter).
5. Bjarni will also add Ta measurements at different height in the tree canopy at FN
6. Decided to add one Ts logger into each of the permanent plots of ForHot – Should be put at 20 cm (or as deep as possible if soil is shallower).
7. Grazing exclusion at GO was the right decision in 2013; impossible to do this study otherwise.
8. It was discussed that if apparent acclimation in plant traits is found between GO and GN, then somebody should transplant grasses from different Ts-levels at GN and GO to the same Ts level and compare their response (or expose them to different temperatures in a greenhouse). Only this way could it proven that there was an "adaptation" (=genetic) that was the cause for the difference in GO.
9. Put gps coordinates of all permanent plots into the database (Niki/Bjarni).
10. Bjarni/Niki will work on getting better Ts values for all plots into the database (mean annual Ts-elev, seasonal, max etc.)
11. Bjarni will also put all available Ts10 measurements into the database
12. Ivika will do physical fractionation on soil samples from ForHot; in cooperation with Ivan/Peter…
13. It was discussed during the last day that such ForHot workshops should be repeated (annually?); no question about how beneficial this one was for all participants.

Meeting ended at 14-02-2014 at 11:00.