way how direct quantification of photosynthesis may reduce uncertainties to predict plant mediated exchange processes.
This presentation will be given on behalf of the Mission Assessment Group of ESA that is currently orchestrating the scientific activities around FLEX.

PS23.5
Warm simulated autumn growth conditions do not increase photosynthetic carbon gain but increase the dissipation of excess energy in Jack pine

F Busch (University of Western Ontario), N Hüner (University of Western Ontario), I Ensminger (Max-Planck-Institut für Molekulare Pflanzenphysiologie)

The seasonal development of trees of the boreal forest might be affected by climate change, as the trees will experience naturally decreasing daylength during autumn, while warmer air temperature will maintain photosynthesis and respiration. Working with controlled environments, we used a factorial design to assess the impact of photoperiod and temperature on the down-regulation of photosynthetic gas exchange and the mechanisms involved in the dissipation of energy in Jack pine (*Pinus banksiana*). Control treatments of plants grown under 16-h photoperiod and 22°C (representing warm summer conditions) and plants grown under 8-h/7°C (cool autumn) were compared to plants grown under warm autumn (8-h/22°C) and cool summer conditions (16-h/7°C). Assimilation and respiration rates under warm autumn conditions were only approximately half of those of the summer control and comparable to the cool autumn control. Different treatments appeared to govern different strategies for dissipating excess energy. Zeaxanthin did not appear to be a major contributor to safe dissipation of excess energy in the warm autumn treatment as it was the case in the other three treatments. Instead a strong alternative electron sink appeared to consume electrons by oxidizing the plastoquinone pool. We conclude that photosynthetic downregulation due to photoperiod appears to negate any potential for an increased carbon gain in connection with an extended growing season. Under warm autumn conditions, excess energy appears to be dissipated by a unique, as yet unidentified, mechanism which is not detected in pine seedlings grown under either normal warm summer or normal cold autumn conditions.

PS23.6
Effects of an extended drought period on grasslands at various altitudes in Switzerland

U Feller (University of Bern), C Signarbieux (University of Bern)

From recent investigations it can be concluded that extreme events (e.g heat waves, extreme drought periods) will become more relevant in Central Europe during the next decades (Schär et al., Nature 427, 332-336, 2004). The effects of an artificial drought period (installation of rain shelters for 10 weeks) on physiological traits of representative grassland species was investigated at two altitudes (400 and 1000 m a.s.l.) in Switzerland. The net assimilation rate (A_n) and stomatal conductance (g_s) were affected in *Phleum pratense* and in other gramineae at both altitudes, while these effects were in dicots (*Rumex obtusifolius*, *Trifolium repens*) relevant only at the higher altitude. The decline of A_n was paralleled by a decrease of g_s, but the intrinsic efficiency of photosystem II was not affected by the treatment. The still high A_n of Rumex in lowlands under drought may explain the dominance of this plant at the end of the drought period. Differences in the species composition and differences in reversible and irreversible damages caused by drought in the various species may contribute to the overall response of grasslands in a site-specific manner.

PS23.7
Relative importance of acclimation in respiration and photosynthesis in black spruce grown at high temperatures

D Way (University of Toronto), R Sage (University of Toronto)

Black spruce (*Picea mariana*) is a dominant North American boreal species and its response to climate warming will determine the future of the boreal forest. We investigated how growth temperature affects photosynthesis, using CO_2 response curves, temperature response curves, O_2 sensitivity, and estimates of respiration for seedlings grown at cool (22/16°C) and warm (30/24°C) day/night temperatures. Below 30°C, warm-grown seedlings had lower net and gross CO_2 assimilation rates than cool-grown seedlings, due to reduced V_{cmax} and J_{max}. Above 30°C, warm-grown seedlings had slightly higher net CO_2 assimilation rates than cool-grown trees; however, gross CO_2 assimilation rates were identical because respiration acclimated in the warm-grown seedlings, resulting in lower dark and day respiration rates. Trees grown at high temperatures were significantly smaller and shorter than cool-grown seedlings, with lower net CO_2 assimilation rates at their growth temperature. Higher growth temperatures will therefore likely have direct, negative impacts on the growth rate and carbon uptake of black spruce, and may reduce the carbon sink potential of the North American boreal forest.

PS23.8
$_{CO2}$ on growth and photosynthetic characteristics of chickpea

M Singh (Indian Agricultural Research Institute, New Delhi, India), S Talwar (Indian Agricultural Research Institute, New Delhi, India), S Khetrapal (Indian Agricultural Research Institute, New Delhi, India), P Deshmukh (Indian Agricultural Research Institute, New Delhi, India)

The concentration of CO_2 in the atmospheric has increased almost 30% to a present level of about 379 µl l^{-1}. Such an increase in CO_2 may affect the growth and productivity of C_3 crop species. There are no reports available on the response of chickpea (*Cicer arietinum* L.). to elevated CO_2 and this investigation is the first attempt to study the effect of rising CO_2 on growth and photosynthetic characteristics of this crop. The plants of chickpea cultivar *Pusa* 1108 were raised inside the open top chambers using earthen pots and exposed to ambient (370±20 µl l^{-1}, CA) and elevated (550±50 µl l^{-1}, CE) CO_2 levels from germination till maturity of the crop. CE showed significant increase in shoot length, number of branches & leaves and leaf surface area per plant. Significant increase in dry weight of above and below ground plant parts was observed under CE. The concentration of starch, reducing and non-reducing sugars was more in plant grown under CE. Sucrose content was higher along with increased sucrose phosphate synthetase activity. Total carbon content increased and nitrogen content decreased, which resulted in higher C/N ratio. The soluble protein content decreased and the magnitude of reduction was almost similar at all the durations of CO_2 exposure. There was no effect of CE on Rubisco activity or its activation state and on expression of rbc L but the expression of rbcS decreased marginally. The study concludes that rising CO_2 in near future will be beneficial for chickpea crop.

PS23.9
Acclimation of photosynthesis in maize plants to high CO_2

A Prins (University of Pretoria), S Driscoll (Rothamsted Research), J Muchwezi (University of Pretoria), P Verrier (Rothamsted Research), C Foyer (Rothamsted Research)