Geophysical Research Abstracts, Vol. 7, 04606, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04606

Effects of an experimental increase of temperature and drought on isoprenoid emissions from Mediterranean ecosystems

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To study the effects of climate change on terrestrial ecosystems, a plant community of different functional groups and life forms was grown from seeds since fall 2002 in thirty $1m^2$ field plots under three temperature treatments (ambient, +1.5˚C, +3˚C) combined with two water treatments (normal and 30% reduced water availability). The community included respectively two and three provenances of the Mediterranean oaks *Quercus pubescens* (*QP*, deciduous, isoprene emitter) and *Quercus ilex* (*QI* ,evergreen, monoterpene emitter), as well as four pairs of congeneric annual/perennial herbaceous plant species consisting of C3 and C4 monocotyledons (*Lolium* spp., *Setaria* spp.) and C3 and C4 dicotyledons (*Artemisia* spp., *Amaranthus* spp.). Treatment effects on isoprenoid emissions from oak saplings were assessed during late spring/summer by determining *in situ* leaf emission rates at ambient (AER) and at standard (SER) conditions (i.e. 30 ˚C leaf temperature and 1000 μmol m^{-2} s^{-1} incident photon flux density) together with measurements of CO_2, H_2O gas exchange and chlorophyll content, and by monitoring seedling establishment in terms of growth, phenology and plant survival rate. Besides, the herbaceous species were screened for isoprenoid emissions, among which only *Artemisia* spp. were found to be significant emitters of mono and sesquiterpenes. Isoprenoid emissions from oaks were significantly affected by temperature treatments. On average, AER was increased at elevated temperatures (*QP*: 1.8 times, *QI*: 1.7 times) but not SER, which largely scattered in both species. SER as well as AER positively scaled with stomatal opening, photosynthesis and chlorophyll content revealing that isoprenoid emissions during summer were restrained in all treatments by acute and long term stress effects. When these stress effects were factored out, SER of *QP* and *QI* grown under warmer climate were

about 1.5 times increased. Under warmer climate, the leaf unfolding occurred earlier and the senescence later in the year, which, in the case of *QP*, resulted in up to 20% prolonged leaf life span. However, as evidenced by comparison with oak saplings grown in monoculture, growth and survival rates of *QP* and *QI* were strongly reduced at elevated temperatures due to the competition with herbaceous species. The findings suggest that on short time scales, global warming will increase isoprenoid emissions from oak woodlands, but, over longer terms, emissions may drop due to the lack of forest regeneration leading to the proliferation of steppe like plant communities dominated by non-emitting annual and perennial herbaceous species.