

**B11A MC: 122 Monday 0830h**  
Biological Processes and the Isotopic  
Composition of the Atmosphere I  
(joint with A)

**Presiding:** D E Pataki, University of  
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**B11A-01 0830h**

**Carbon Storage and Isotopes in the  
Terrestrial Biosphere Over the last  
21000 Years**

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Analysis of ice-core [CO<sub>2</sub>] and  $\delta^{13}\text{C}$  indicates that the terrestrial biosphere may be in part responsible for variability in atmospheric composition over the Holocene. We performed a series of experiments with a dynamic global vegetation model (DGVM) to simulate global terrestrial carbon storage, vegetation distribution, and carbon isotope composition for the last 21000 years. The DGVM experiments were driven by an atmospheric GCM climatology at 1000 year intervals, and also interpolated through time to make a continuous simulation. At the Last Glacial Maximum C<sub>4</sub> vegetation dominated tropical and subtropical latitudes and terrestrial carbon storage was approximately 700 Gt smaller than today. Terrestrial NPP was ca. 30% less than present. The isotopic composition of global terrestrial carbon was enriched by ca. 1 per mil compared to present because of increased aridity and greater C<sub>4</sub> plant cover. In the late Pleistocene and early Holocene, vegetation expanded rapidly into formerly glaciated areas. Terrestrial NPP increased to near present levels, sustaining a steady increase in terrestrial carbon storage which persisted throughout the Holocene. The isotopic composition of carbon in tropics was most depleted in <sup>13</sup>C in the early Holocene (ca. 10 kya) and later became slightly more enriched as C<sub>4</sub> dominated grasslands and savannas expanded in response to climate changes. However northern hemisphere isotopic composition became more depleted throughout the Holocene and global isotopic composition changed little. These results cannot account for the Holocene changes in atmospheric [CO<sub>2</sub>] and <sup>13</sup>C observed in ice cores, which may instead be driven by very slow changes in ocean chemistry.

**B11A-02 0845h**

**Interannual variability in the  $\delta^{13}\text{C}$  of  
tropical biomass burning**

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Changes in the spatial distribution of fires may contribute to interannual variability in the atmospheric budget <sup>13</sup>C with subsequent impacts on land/ocean carbon sink partitioning. We used Tropical Rain Monitoring Mission satellite fire products and fractional maps of C<sub>4</sub> vegetation to identify regional scale changes in the isotopic composition of fires in 1998, 1999, and 2000. A new version of the CASA model that included fires and variable allocation to woody and herbaceous vegetation was used to estimate aboveground biomass and total C emissions. We find that tropical C emissions in 1998 were substantially higher than in 1999 and 2000 and that fires in C<sub>3</sub> areas had greater interannual variability as compared with fires in C<sub>4</sub> areas.

**B11A-03 0900h**

**Modeling carbon isotope fluxes and  
concentration profiles over a  
temperate deciduous forest across a  
spectrum of time scales with a  
biophysical model, CANOAK**

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Fluxes and concentrations of carbon dioxide and its isotopes provide information on the partitioning of CO<sub>2</sub> among respiratory sources and photosynthetic sinks. A classic way to interpret carbon isotope concentration measurements is via the Keeling plot. This method is potentially problematic when applied over forest canopies as it ignores the potential consequences of counter-gradient transfer and intermittent turbulence. In addition, <sup>13</sup>CO<sub>2</sub> measurements are labor intensive, so available data sets on diurnal and seasonal variations on <sup>13</sup>CO<sub>2</sub> concentration profiles and canopy-atmosphere fluxes are scarce.

The biophysical model, CANOAK, couples algorithms that predict photosynthesis and stomatal conductance. These algorithms are driven by submodels that produce information on the canopy microclimate using theory that considers Lagrangian diffusion and the radiative transfer of photons through the vegetation. The model has been validated with four years of data, showing an ability to produce accurate fluxes across a spectrum of time scales.

We recently adapted the CANOAK model to compute concentration profiles and fluxes of <sup>13</sup>CO<sub>2</sub>. Here we demonstrate the ability of the CANOAK model to simulate fluxes and concentration of <sup>13</sup>CO<sub>2</sub> using test data from Bowling et al (1999). We then apply the CANOAK model to investigate how fluxes and concentration profiles of <sup>13</sup>CO<sub>2</sub> vary on diurnal and seasonal time scales.

**B11A-04 0915h**

**Partitioning Ecosystem Respiration  
Using Stable Carbon Isotopes in a  
Mixed C<sub>3</sub> Annual Grassland**

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The stable carbon isotope ratio ( $\delta^{13}\text{C}$ ) of respired CO<sub>2</sub> has been used to partition soil respiration into root and microbial components by exploiting the different  $\delta^{13}\text{C}$  signals from C<sub>3</sub> plants growing in a previously C<sub>4</sub> dominated system (Rouchette, Angers and Flanagan 1999). We extend this approach and present data that attempts to partition ecosystem respiration using  $\delta^{13}\text{C}$  analyses of all of the ecosystem compartments in a mixed C<sub>3</sub> annual grassland that has not experienced recent C<sub>4</sub> inputs. From December 2000 to February 2001 we measured  $\delta^{13}\text{C}$ -CO<sub>2</sub> respired from leaves, roots and sieved soil collected from a winter-active grassland near Iona, California. Two-source mixing models were used to calculate the contribution of each source to total system respiration by comparing their isotope signals to those from whole ecosystem respiration and soil surface efflux. Isotope ratios were measured on 10mL air samples in septum-capped vials using a Finnigan MAT Delta PlusXL IRMS/Gas Bench II interfaced to an autosampler (after Tu et al. 2001). The vials were filled with sample air in the field using a double-holed needle connected in a closed loop to a LI-6200 IRGA and a bottle containing the isolated samples (leaf, root, sieved soil, etc.). Leaves were clipped at ground level and roots and soil were separated by sieving soil cores. Sample  $\delta^{13}\text{C}$ -CO<sub>2</sub> signatures were determined by plotting the change in  $\delta^{13}\text{C}$  against the inverse of CO<sub>2</sub> concentration. On average, CO<sub>2</sub> respired from sieved soil (-27.4o/oo±1.4) was slightly more depleted than that from leaves (-27.2o/oo±0.5), but much more depleted than the whole ecosystem (-24.9o/oo±0.6), the soil surface efflux (-23.8o/oo±0.9), and plant roots (-20.5o/oo±0.8). Based on these isotope values, leaf respiration comprised 33% of ecosystem respiration with 36% from roots and 31% from soil microbial respiration. Thus, over two-thirds of ecosystem respiration was autotrophic (plant-based) in origin with roughly one-third being heterotrophic. Belowground respiration, comprised of both autotrophic

(root) and heterotrophic (microbial) components, accounted for nearly two-thirds of total ecosystem respiration. Root and microbial respiration each contributed to nearly half of total belowground respiration (53% and 47%, respectively). Similarly, plant respiration was divided nearly equally between that from roots (52%) and leaves (48%). Partitioning using natural abundance stable carbon isotope ratios was made possible because of the relatively large differences in  $\delta^{13}\text{C}$  values among the various sources in this entirely C<sub>3</sub> system. To our knowledge, such large isotopic differences in respired CO<sub>2</sub> among different plant tissues and belowground components have not been documented before. Further research is needed to determine how such differences may arise and to establish if similar differences exist in other ecosystems or at different times of the growing season. Our results also imply that interpretation of above-canopy Keeling plot intercepts may be complicated by both multiple and isotopically distinct sources and by isotopic fractionation that occurs either during the respiration process itself or during the transfer of carbon compounds prior to respiration.

**B11A-05 0930h**

**Isotopic (<sup>13</sup>C) response of ponderosa  
pine ecosystem respiration to  
atmospheric stress events**

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The carbon isotopic composition of ecosystem respiration ( $\delta^{13}\text{C}_R$ ) reflects several biological and physical factors influencing ecosystem physiology. Recent experiments in several Oregon coniferous forests have shown a link between annual precipitation, short-term atmospheric moisture deficit, air temperature, and  $\delta^{13}\text{C}_R$ . This link appears to be driven by changes in photosynthetic discrimination associated with changes in soil or atmospheric moisture deficit (or both), and suggests there can be substantial variation in  $\delta^{13}\text{C}_R$  on a time scale of days.

Our objective was to investigate the response of ecosystem respiration to the passage of synoptic-scale air masses and accompanying weather changes, to see if such short-term changes occur. We examined the carbon isotopic content of ecosystem respiration every night for 13 consecutive nights (summer 2001), at the Metolius AmeriFlux site, a 50-250 year old ponderosa pine forest in central Oregon, USA. Additionally, the <sup>13</sup>C contents of the soil and branch components of the ecosystem respiration flux were measured with soil chambers and branch bags.

Mean daytime atmospheric moisture deficit during this period ranged from minimal to very dry (0.36 to 3.3 kPa), and minimum nocturnal air temperature varied from 0.2 to 16.4 C. A single near-freezing event was followed by enriched  $\delta^{13}\text{C}_R$  for several days afterwards, moderating the expected humidity response.  $\delta^{13}\text{C}_R$  changed only marginally (-25.1 to 25.9 o/oo), but the soil and branch fluxes showed larger night-to-night variation (-23.8 to 25.3 and 23.5 to 26.4 o/oo, respectively). Based on preliminary analyses, both the soil flux and branch flux were more enriched in <sup>13</sup>C than the whole-ecosystem flux, indicating an inconsistency in terms of mass conservation. Possible reasons for this contradiction will be discussed. These data will be further evaluated relative to meteorological and eddy flux data collected during the same time period.

**B11A-06 0945h**

**Oxygen-18 Content of Ecosystem  
Respiration Across a Climatic  
Gradient in Oregon.**

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The oxygen-18 content of ecosystem respiration (d18OR) was estimated using the Keeling plot approach in 1996, 1997, 2000, and 2001 across a steep climatic gradient in Oregon, USA. Six coniferous forests located from the Pacific coastal region to the east side of the Cascade Mountains were studied, with species dominance by *Picea sitchensis* (two sites), *Pseudotsuga menziesii* (two sites), *Pinus ponderosa* and *Juniperus occidentalis* (one site each). Precipitation and leaf area index ranged from 2760 mm per year and >10.0 m<sup>2</sup> m<sup>-2</sup> in a coastal *Picea* forest to 227 mm per year and <1.0 m<sup>2</sup> m<sup>-2</sup> in the eastern *Juniperus* woodland. There were pronounced differences in d18O of water pools and respired carbon dioxide between the west and east side of the Cascade Mountains. Stem water d18O showed a continental pattern consistent with precipitation isotope patterns, being most enriched on the coast and most depleted on the east side of the Cascades. Bulk soil water d18O (top 10 cm) was depleted in the winter and became enriched in the summer, with the degree of enrichment greater on the east side than the west side of the mountains. During summer drought, d18OR was consistently more enriched on the east side (1997 and 2000 mean of 33.87 ‰) than the west side of the mountains (1997 and 2000 mean of 21.84 ‰); however, during the rainy period this pattern disappeared (19.88 and 22.89 ‰ for the west and east sides, respectively). The more enriched d18OR on the east side during drought occurs despite the fact that annual precipitation is more negative on the east side, suggesting that greater enrichment of leaf and soil water occurs on the east side of the mountains. Indeed, for the east side sites, d18OR was strongly correlated with the daily average vapor pressure deficit summed (Sum-vpd) since the last rainfall. There was no correlation between d18OR and Sum-vpd on the west side. Possible explanations for the lack of Sum-vpd response on the west side include 1) d18O variability in precipitation may obscure the vpd-d18OR relationship, or 2) leaf-respired d18O, which is probably insensitive to Sum-vpd over multiple days, is a much greater contributor to ecosystem respiration on the west side than the east side of the mountains. In an intensive experiment at the *Pinus* forest, d18OR was positively correlated with daily vpd and inversely related to soil water content for the first five days after a precipitation event, and then each stabilized for the following eight days. It appears that precipitation control over d18OR is mediated by vpd in hot, dry climates, while in moist, cool climates d18OR may be much more coupled to the d18O of precipitation.

#### B11A-07 1000h

##### Influence of Land Use Change on the <sup>18</sup>O in Atmospheric CO<sub>2</sub>: Comparison of Preindustrial, Modern and Future Scenarios

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Understanding the governing influences on the concentration of CO<sub>2</sub> continues to be of importance for climate change investigations. Attribution of atmospheric CO<sub>2</sub> signals to various source components is also crucial for fully understanding the carbon cycle. As the isotopic composition of atmospheric CO<sub>2</sub> is dependent upon the processes active at the source region there is the possibility of estimating the importance of various conditions at the source region by examining the isotopic signature. In particular, the stable isotope CO<sub>2</sub> ratio of atmospheric CO<sub>2</sub> reflects the isotopic state of the soil water of the terrestrial biosphere and the equilibrium and kinetic fractionation processes during both soil respiration and leaf photosynthesis. To better understand the impact of changes in the biosphere on the global CO<sub>2</sub> signal, physically based modeling of the hydrologic and physiological processes is employed. To this end, an atmospheric general circulation model (GCM) is adapted to predict the concentration of <sup>18</sup>O in meteoric water vapor and the precipitation resulting from condensation. This is coupled to a land surface model adapted to trace isotopic ratios of precipitation entering the soil, uptake by the roots and exchange of the heavy <sup>18</sup>O with plant and soil CO<sub>2</sub> fluxes. As such, the isotopic ratio of the photosynthetic uptake and respiratory loss of CO<sub>2</sub> from various ecosystem types can be mechanistically simulated. The resulting fluxes are fed back to the atmospheric component at each model time step as a passive tracer. In this manner, the isotopic concentration of the atmospheric CO<sub>2</sub> is eventually found prognostically from

the time integration of the model. The importance of variations in land use on the <sup>18</sup>O of CO<sub>2</sub> is explored with this isotopic GCM. With this approach, simulations reflecting pre-industrial, modern, and future land use conditions are compared to provide a physical basis for interpretation the potential impacts of biosphere changes on the <sup>18</sup>O signal in the observational record.

#### B11A-08 1035h

##### Changes in Turnover Rates and Pool Sizes of Soil Organic Matter Under Elevated CO<sub>2</sub> on the Shortgrass Steppe

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Elevated atmospheric CO<sub>2</sub> generally stimulates plant growth if other nutrients are not limiting, but its influence on soil C dynamics is more complex. On the shortgrass steppe in northeastern Colorado, above-ground and below-ground biomass production were enhanced by 15 to 35 percent under elevated CO<sub>2</sub>, with greater response seen in drier years. We investigated the influence of enhanced C inputs on soil C cycling using long-term laboratory incubations on soils exposed to elevated CO<sub>2</sub> for 1 to 3 years. Microbial respiration rates were fit to a negative exponential model to calculate the sizes and turnover rates of the active and slow C pools. On average, the active pool size was roughly doubled under elevated CO<sub>2</sub>, but the turnover rate of the active pool was not changed. The slow pool size was not changed under elevated CO<sub>2</sub>, but turnover rates of slow C were 10-15 percent faster. This finding is consistent with field evidence showing enhanced decomposition of SOM under elevated CO<sub>2</sub>.

Stable isotopic partitioning allowed us to follow "new" inputs of C into soil pools and to estimate turnover rates on all treatments because of a disequilibrium of <sup>13</sup>C between currently growing plants and existing soil organic matter. As with total soil C, turnover rates of "new" C in the active pool were not altered by elevated CO<sub>2</sub>, and turnover rates of "new" C in the slow pool were 10 percent faster under elevated CO<sub>2</sub>. High C:N ratios of particulate organic matter found under elevated CO<sub>2</sub> may shift the balance of microbial decomposition toward utilization of older SOM in these low-nutrient soils. Over the course of these nearly year-long incubations, changes in the d13C of respired CO<sub>2</sub> were observed. These were likely caused mainly by changes in the proportion of fresh, <sup>13</sup>C-depleted organic matter used by microbes. However, fractionation during decomposition, and/or the use of different compounds such as lignin at the end of the experiment, cannot be ruled out.

#### B11A-09 1050h

##### Examining the Role of Multiple Carbon Sources in Isoprene Synthesis in Plants Using Stable Isotope Techniques

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The carbon source for phytochemical isoprene is an issue with important ramifications for both atmospheric and biological science because of its impact on the isotopic signature of isoprene and its oxidation products and because it lends insight into the function that isoprene serves within leaves. Although recently assimilated carbon is believed to be the primary carbon source for isoprene production in plants, variation in diurnal and seasonal isoprene fluxes that cannot be explained by temperature, light, and leaf development have led to the suggestion that alternative carbon sources may contribute. Stable isotopes of carbon can be used to identify changes in carbon partitioning into isoprene synthesis, and mixing models can assess the relative importance of each source. In preliminary studies, we

document an additional 8-10 ‰ discrimination in isoprene emitted in the absence of photosynthesis. This change in signature suggests that the carbon source is switched from recently obtained photosynthate to a source more depleted in <sup>13</sup>C. We propose that intermediates from carbohydrate degradation and/or re-fixation of CO<sub>2</sub> from mitochondrial respiration and photorespiration can contribute to isoprene production. In addition, we expect alternative carbon sources to be most important when photosynthate is limiting (e.g. during water stress events). Photosynthesis, respiration, and isoprene emission measurements are used to calculate the isotopic signatures of the three potential carbon pools: photosynthate derived from ambient CO<sub>2</sub>, photosynthate derived from respired CO<sub>2</sub>, and carbohydrate-derived intermediates.

#### B11A-10 1105h

##### Extending records of the isotopic composition of atmospheric N<sub>2</sub>O back to 1900 A. D. from air trapped in snow at South Pole

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High resolution records of various atmospheric constituents have recently been constructed from measurements of the composition of air trapped in the interstitial spaces of snowpack on large ice sheets (better known as firn air). The firn air is reasonably well mixed in the upper 2-5m by wind and atmospheric pressure changes. Below 5m, the air mixes solely by diffusion. Atmospheric compositional changes are propagated down into the firn with a timescale that scales with the diffusion of the atmospheric constituent in question. At Pole, the average age of the air just above the bubble close-off region is ~90 years. As you move up the firn column, the age of the air decreases rapidly between 123 and 115m and then more slowly from 115m to the surface. The composition of the air at any depth in the firn is therefore dependent on the atmospheric history and the diffusion processes that control the movement of each constituent down into the firn [Battle et al., 1996].

We have measured 32 flasks of air that were filled from 18 different depths in two 123m holes located 20m apart. Surface values averaged 8.3±0.4‰ and 44.1±0.3‰ for the δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> measurements respectively. Both δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> values increased with depth with the highest values (9.9‰ and 45.4‰) observed in the deepest samples just above the bubble close-off region.

We utilized 25 measurements of δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> from shallow ice samples from the GISP II ice core with gas ages ranging from 1785 A.D. to 1990 A.D. for boundary conditions for modeling the firn air profiles. Results of five preanthropogenic ice samples with gas ages between 1785 and 1819 A.D. provided δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> values of 9.9±0.5‰ and 47.2±1.0‰ respectively. Model results of the δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> results vs depth are in good agreement with the measured values. Our best-fit atmospheric histories suggest atmospheric δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> values have decreased by 1.6‰ and 3.1‰ respectively over the past 200 years. These results are in good agreement with [Rahn and Wahlen, 2000] who predicted atmospheric δ<sup>15</sup>N<sub>bulk</sub> and δ<sup>18</sup>O<sub>bulk</sub> changes (1.9‰ and 2.4‰) using characteristic isotope signatures for each of the major N<sub>2</sub>O sources and the most recent estimate of the changes in the major emissions over the past 200 years. Our results are therefore consistent with a substantial increase in agricultural N<sub>2</sub>O emissions which currently make up ~30% of global emissions.

##### References

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B11A-11 1120h

**Observations of Concentration and  $\delta D$  of Atmospheric  $H_2$  in an Alaskan Boreal Forest**

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Molecular hydrogen is the second most abundant reduced gas in the atmosphere with a seasonally dependent mixing ratio averaging  $\sim 0.5$  ppmv; the budget is thought to be controlled by sources from photo-oxidation of hydrocarbons, biomass burning and anthropogenic emissions and sinks dominated by soil uptake and oxidation by OH radicals. We are examining the isotopic signatures of these processes using a new method of  $H_2$  recovery and mass spectrometry on sub-liter-sized air samples (i.e.,  $< 20$  nmol  $H_2$ ). Our work is motivated by the need to characterize and monitor the global  $H_2$  cycle before and during the anticipated rise in anthropogenic emissions associated with a developing hydrogen fuel cell economy. In addition, since soil uptake is the principal sink of  $H_2$  and since soil conditions are dependent on climatic influences, particularly in mid to high latitudes, observations of  $H_2$  and  $\delta D$  of  $H_2$  hold the potential to serve as proxies for observing global climate change. We report here the results of a study of the stable isotope systematics of  $H_2$  in east central Alaskan boreal forests during July and August of 2001.

Flask samples were collected during nighttime inversions in both mature spruce forest and in young mixed forest; concurrent sampling of  $CO_2$  concentration was performed in the field with a LiCor 6200 IR analyzer. An additional series of samples was collected over a period of 24 hours at a tower site in a 14 year old mixed forest; samples were collected at 4 hour intervals at ground level (0.8 m) and above canopy (10 m).

Samples collected during nighttime inversions exhibited vigorous  $H_2$  uptake and were negatively correlated with respiring  $CO_2$  ( $-0.8$  to  $-1.2$  ppb  $H_2$ /ppm  $CO_2$ ). Decreases in  $H_2$  concentration are correlated with increases in  $\delta D$ , indicating that one or more steps in the process of hydrogen consumption (presumably either diffusion into the soil or microbial utilization) is isotopically fractionating. Based on these data, we derive a fractionation factor,  $\alpha = D/H_{residual}/D/H_{consumed} = 0.960,01$ . This value is within the range of previous flux-chamber experiments [Gerst and Quay, 2001]. Data from the 24 hour time series yielded a similar nighttime draw down of  $H_2$  and elevated  $CO_2$  (observable even above canopy) and comparable fractionation factors for D/H. Unexpectedly, samples collected during daylight hours when the canopy was well flushed (evidenced by background  $CO_2$  levels) exhibited a modest positive correlation between hydrogen concentration and its deuterium content. We speculate that these enrichments may be the first observational verification of photochemically induced enrichment during oxidation of methane and non-methane hydrocarbons such as that proposed by Gerst and Quay [2001].

Gerst, S. and P. Quay, *J. Geophys. Res.*, 106, 5021-5031, 2001.

B11A-12 1135h

**The Triple Isotopic Composition of Atmospheric  $O_2$  as a Tracer of the Rate of Global Photorespiration**

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The triple isotopic composition of atmospheric  $O_2$  is controlled by different signatures of biological and stratospheric processes. Ultraviolet induced interactions in the stratosphere cause an equal depletion of  $^{17}O$  and  $^{18}O$  of atmospheric  $O_2$  (mass-independent fractionation). This equal lowering is in contrast to biological processes, and most terrestrial processes, in which the discrimination against  $^{17}O$  is about half of the discrimination against  $^{18}O$  relative to  $^{16}O$  (mass-dependent fractionation). Thus,  $O_2$  that was produced

by photosynthesis and was affected only by biological consumption will have excess  $^{17}O$  relatively to atmospheric  $O_2$  with the same delta  $^{18}O$ . In previous interpretations of changes in the triple isotopic composition, it was assumed that the ratio of discrimination against  $^{17}O$  to the discrimination against  $^{18}O$  is identical for all biological processes. In the present study, we evaluated this ratio, for the first time, for some of the most important oxygen consumption processes: The cytochrome and alternative pathways of dark respiration, and photorespiration. The value for the dark respiration processes was evaluated in dark incubation experiments, and inhibitors were used to separate the two pathways. The value for photorespiration was evaluated from experiments in airtight terrarium containing soil, plant and water. We have found similar discrimination ratio for the cytochrome and alternative pathways, but considerably lower ratio for photorespiration. One important conclusion derived from this finding is that much of the change in the atmospheric  $^{17}O$  depletion during the LGM can be related to an increase in the global rate of photorespiration. The increased rate of photorespiration during the LGM was the result of lower atmospheric  $CO_2$  concentrations. Previous interpretations of the  $^{17}O$  depletion change in the LGM attributed it only to changes in global productivity, and in stratospheric processes. Another important conclusion is that the current global rate of photorespiration can be evaluated from the parameters we provide, and from published data about the rate of mass-independent processes in the stratosphere.

B12A MC: Hall D Monday 1330h

**Biological Processes and the Isotopic Composition of the Atmosphere II**

(joint with A)

**Presiding:** D E Pataki, University of Utah; J Ehleringer, University of Utah

B12A-0096 1330h POSTER

**The Carbon Isotope Composition of Ecosystem Respiration in North and South America**

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Measurements of the isotopic composition of atmospheric carbon dioxide have become a critical tool for understanding the role of terrestrial ecosystem processes in the carbon cycle. Photosynthesis and respiration impart distinct isotopic signatures to the atmosphere that may be used to constrain carbon source/sink estimates and partition ecosystem fluxes. These applications require an understanding of the processes that influence isotopic discrimination of whole canopies and ecosystems. The "Keeling plot" method is a common approach used in determining the isotopic composition of ecosystem fluxes and estimating ecosystem discrimination. An increasing amount of information is becoming available from numerous ecosystems around the world on the isotopic composition of ecosystem respiration ( $d_{13}CR$ ) over short and long time scales. In this presentation we synthesize emergent patterns in  $d_{13}CR$  by analyzing 146 Keeling plots constructed at numerous sites across North and South America as part of the Biosphere-Atmosphere Stable Isotope Network (BASIN). We calculated  $d_{13}CR$  uniformly for all sites in order to analyze the environmental controls on  $d_{13}CR$  temporally and across the landscape. We did not find differences in mean  $d_{13}CR$  between tropical, temperate broadleaf, temperate coniferous, and boreal forest biomes, indicating that fac-

tors other than species/functional type and temperature were driving canopy discrimination. Rather, we found that precipitation was a major driver of both temporal and spatial variability of  $d_{13}CR$ , illustrating the importance of water availability as a key control of ecosystem function. These results highlight the potential of  $d_{13}CR$  as a useful tool for integrating environmental effects on dynamic canopy processes.

B12A-0097 1330h POSTER

**Integrating and Testing a Mechanistic Model of  $H_2^{18}O$  and  $CO^{18}O$  Ecosystem Fluxes in a Coupled Land Surface and Global Climate Model**

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We describe a mechanistic model that simulates  $H_2^{18}O$  and  $CO^{18}O$  fluxes between ecosystems and the atmosphere. The model is integrated into the land surface model LSM, which in turn is coupled to a version of the CCM3 GCM that simulates  $H_2^{18}O$  in precipitation and water vapor to allow transient simulations of vegetation, soil, and atmospheric mechanisms important in ecosystem isotope fluxes. The land surface isotope model comprises modules to compute canopy vapor, leaf water, and vertically resolved soil water  $H_2^{18}O$  content; leaf photosynthetic and retro-diffusive fluxes of  $CO^{18}O$ ; root and microbial production of  $CO_2$ ; soil diffusive fluxes of  $CO_2$  and  $CO^{18}O$  and equilibration of  $CO_2$  with  $^{18}O$  in soil water; and abiotic soil exchanges of  $CO^{18}O$ . Off-line model testing in a  $C_4$  dominated tallgrass prairie in Oklahoma will be presented. We then apply the model to better understand the impact on ecosystem  $CO^{18}O$  fluxes of the (a) soil abiotic flux; (b) carbonic anhydrase distribution within the soil; (c)  $C_3$  versus  $C_4$  mixtures and variations in carbonic anhydrase activity within each photosynthetic type; and (d) method used to compute surface  $H_2^{18}O$  fluxes. Sensitivity analyses of ecosystem  $H_2^{18}O$  and  $CO^{18}O$  fluxes to model parameters will also be presented. Preliminary results indicate that the near-surface soil moisture isotopic composition is strongly dependent on the  $H_2^{18}O$  surface flux method used; the opposite is true for deeper soil layers. The resulting ecosystem  $CO^{18}O$  flux is less dependent on the method of computing the  $H_2^{18}O$  surface flux. The carbonic anhydrase concentration in the soil also impacts the isotopic composition of the evolved  $CO_2$  flux. Finally, we present simulation results for selected ecosystem types from the coupled GCM and isotope model and a method to simplify the  $CO^{18}O$  surface flux calculation.

B12A-0098 1330h POSTER

**Measuring and Modeling the Component Influences of Soil, Vegetation and the Atmospheric Source on the Isotopic Composition of Canopy Air**

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