Carbon Cycling - Production Processes

• GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE
  – GPP = net photosynthetic input of C to ecosystems
    • Net (not gross) photosynthesis due to $R_{\text{foliage}}$ during the day
  – NPP = Net C gain (or loss) by vegetation (primary producers)
    • NPP = GPP - $R_{\text{plant}}$
Carbon Cycling - Production Processes

- **GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE**
  - NEP = net accumulation (or loss) of C by an **ecosystem**
    - Balance between C entering and leaving
  - NEP = NPP - $R_{\text{heterotr}}$
    - $R_{\text{heterotr}} = R_{\text{microbe}} + R_{\text{animal}}$
  - NEP = GPP - $R_{\text{ecosyst}}$
    - $R_{\text{ecosyst}} = R_{\text{plant}} + R_{\text{heterotr}}$
  - Time scale of 1 to several yrs

![Graph showing carbon exchange over time with peaks for GPP and NEP and a trough for $R_{\text{ecosyst}}$.]
Carbon Cycling - Production Processes

• GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE
  – But what about fluxes of C other than $R_{\text{ecosyst}}$?
    • leaching, lateral transfers, VOCs, and disturbances
    • DICs and DOCs
    • Time scales of decades to centuries
  – NEP = GPP - $R_{\text{ecosystem}}$ (or NPP - $R_{\text{hetero}}$)

≠

NEP = (NPP - $R_{\text{heterotr}}$) ± $F_{\text{lateral}}$ - ($F_{\text{disturb}} + F_{\text{leach}} + F_{\text{emiss}} + F_{\text{CH}_4}$)
Carbon Cycling - Production Processes

• GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE
  – Net Ecosystem C Balance (Chapin et al. 2006)
  – NECB = NEP ± $F_{\text{lateral}} - (F_{\text{disturb}} + F_{\text{leach}} + F_{\text{emiss}} + F_{\text{CH4}})$
    • Largely driven by $F_{\text{disturb}}$ in most ecosystems
    • Tend to be infrequent and large vs. frequent and small
    • In either case, can be a significant C flux over 10s to 100s yrs
  • NECB ≈ NEP - $(F_{\text{disturb}} + F_{\text{leach}})$
    – Where other components are not important, which is common
    – Net C gain by an **ecosystem** over long times (decades to centuries)
    – Not the same as NEP (short temporal scales)
Carbon Cycling - Production Processes

• GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE
  – Net Biome Productivity (NBP)
    • NECB integrated at large spatial scales
    • …spatial and temporal average of NECB over a heterogeneous landscape. (Chapin et al. 2006)

(Walker & Steffen 1997)
Carbon Cycling - Production Processes

- **GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE**

- **Net Ecosystem Exchange (NEE)**
  - Net exchange of CO₂ from ecosystems to the atmosphere (a negative value = ecosystem C uptake)
  - What is measured by eddy flux towers
  - \( \text{NEE} \approx \text{GPP} - \text{R}_{\text{ecosyst}} \approx \text{NEP} \) (over a year)

Hollinger et al. 2004
Carbon Cycling - Production Processes

• GPP vs. NPP vs. NEP vs. NECB vs. NBP vs. NEE
  – In order to interpret data, you have to know what was actually measured!
    • Confusion in the literature and often is not clear
    • Over short time scales and in the absence of disturbance events, \( \text{NEP} \approx \text{NECB} \approx \text{NEE} \)
    • Over longer time scales and/or in the presence of disturbance events, \( \text{NEP} \neq \text{NECB} \neq \text{NEE} \)