post4.5 CLM-CROP

Sam Levis et al.

NCAR
a CLM grid cell
(CROP option off)

<table>
<thead>
<tr>
<th>lake</th>
<th>wetland</th>
<th>glacier</th>
<th>urban</th>
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- soil with unmanaged vegetation
- C3 crop
a CLM grid cell (CROP option **on**)

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<td>soil with unmanaged vegetation</td>
<td>C3 crop</td>
<td>Temperate corn</td>
<td>Temp. cereals</td>
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<tr>
<td></td>
<td></td>
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} crop-specific phenology* + C allocation (Kucharik & Brye 2003)
a CLM grid cell
(CROP option **on**)

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- soil with unmanaged vegetation
  - C3 crop
  - Temperate corn
  - Temp. cereals
  - Temp. soybean

**crop-specific phenology** + C allocation
(Kucharik & Brye 2003)

*phenology refers to appearance*: here the processes of *leaf emergence, grain fill, and maturity*; influenced by: weather and management (e.g., planting, harvesting, fertilizing, irrigating)
CLM4
Temp. corn
Temp. cereals
Temp. soybean
effects on atm.
Levis et al. (2012)
CLM4

Temp. corn
Temp. cereals
Temp. soybean
effects on atm.
Levis et al. (2012)

CLM4.5

w/ options to
fertilize (Drewniak, ANL)
irrigate (Sacks, NCAR)

Oleson et al. (2013)
enhanced soil C
decomposition
Levis et al. (2013)
CLM4
Temp. corn
Temp. cereals
Temp. soybean
effects on atm.
Levis et al. (2012)

CLM4.5
w/ options to
fertilize (Drewniak)
irrigate (Sacks)
Oleson et al. (2013)
enhanced soil C
decomposition
Levis et al. (2013)

post4.5
adding...
Trop. corn
Trop. soybean
Sugarcane
Rice
Cotton
A. Badger (GMU)
CLM4 & 4.5:
Ramankutty and Foley (1998)
Portman et al. (2010)

post4.5:
Portman et al. (2010)

all crops:
Portman et al. (2010)
CLM4 & 4.5:
Ramankutty and Foley (1998)
Portman et al. (2010)

post4.5:
Portman et al. (2010)

all crops:
Portman et al. (2010)

...still missing
Canada foddergrass
Russia sunflower and foddergrass
India sorghum, pulses, millet, pnuts
Development steps: post4.5 crop data

1. **Downloaded** 5’ rainfed & irrigated areas for **ALL CROPS** (Portmann et al. 2010)

2. Made **“raw dataset”** for clm’s mksurfdata tool with 78 instead of 24 pfts

3. Made **0.5° surfdata file** with the mksurfdata tool with 78 instead of 24 pfts
1. "needleleaf evergreen temperate tree
2. "needleleaf evergreen boreal tree
3. "needleleaf deciduous boreal tree
4. "broadleaf evergreen temperate tree
5. "broadleaf evergreen boreal tree
6. "broadleaf deciduous tropical tree
7. "broadleaf deciduous temperate tree
8. "broadleaf deciduous boreal tree
9. "broadleaf evergreen shrub
10. "broadleaf deciduous temperate shrub
11. "broadleaf deciduous boreal shrub
12. "c3 arctic grass
13. "c3 non-arctic grass
14. "c4 grass
15. "c3 crop
16. "c3 irrigated
17. "temperate corn
18. "irrigated temperate corn
19. "spring wheat
20. "irrigated spring wheat
21. "winter wheat
22. "irrigated winter wheat
23. "temperate soybean,
24. "irrigated temperate soybean
25. "barley
26. "irrigated barley
27. "winter barley
28. "irrigated winter barley
29. "rye
30. "irrigated rye
31. "winter rye
32. "irrigated winter rye
33. "cassava
34. "irrigated cassava
35. "citrus
36. "irrigated citrus
37. "cocoa
38. "irrigated cocoa
39. "coffee
40. "irrigated coffee
41. "cotton
42. "irrigated cotton
43. "date palm
44. "irrigated date palm
45. "fodder grass
46. "irrigated fodder grass
47. "grapes
48. "irrigated grapes
49. "groundnuts
50. "irrigated groundnuts
51. "millet
52. "irrigated millet
53. "oil palm
54. "irrigated oil palm
55. "potatoes
56. "irrigated potatoes
57. "pulses
58. "irrigated pulses
59. "rapeseed
60. "irrigated rapeseed
61. "rice
62. "irrigated rice
63. "sorghum
64. "irrigated sorghum
65. "sugar beet
66. "irrigated sugar beet
67. "sugarcane
68. "irrigated sugarcane
69. "sunflower
70. "irrigated sunflower
71. "miscanthus
72. "irrigated miscanthus
73. "switchgrass
74. "irrigated switchgrass
75. "tropical corn
76. "irrigated tropical corn
77. "tropical soybean
78. "irrigated tropical soybean
Development steps: post4.5 crop data

4. clm_params file now includes 78 pfts with A. Badger’s parameters for
   – Tropical corn
   – Tropical soybean
   – Sugarcane
   – Rice
   – Cotton

   planting temperatures & dates
   growing degree days & max maturity
   fertilization
   max LAI & height
   albedo & transmissivity
   ELSE mergetoclmpft
Development steps: post4.5 crop code

- CLM can now read 78 pfts from the input data
- Tropical corn & soybean use temperate corn & soybean code
- Sugarcane uses temperate corn code
- Rice and Cotton use spring wheat code
Simulations w/ post4.5 crop model

- Global
- Irrigation: OFF
- CO$_2$ fertilization: ON

1973 CRUNCEP 2005 RCP 8.5 2100
Simulations w/ post4.5 crop model

• Global
• irrigation: OFF
• CO₂ fertilization: ON

in the context of Brian O’Neill’s EaSM2 on linking Human System Models and Earth System Models to assess regional impacts and adaptation
Tropical Latin America (SH)
N fertilizer

Figure courtesy of Cindy Nevison
Yield: all CLM crops

Latin America

2004 obs (tons ha^{-1})

Botswana 0.3
... USA 6.9
... Belgium 9.2

http://data.worldbank.org

= C_{grain} \{g \text{ m}^{-2}\} \times 0.85 \times 10^4 \{\text{m}^2 \text{ ha}^{-1}\} \times 2.22 \times 10^{-6} \{\text{tons g}^{-1}\}
Next steps

Working with
• Xiaolin Ren (NCAR) Integrated Assessment Modeling

Will work with
• Peter Hess (Cornell) manure fertilizer data and code

Interested in working with
• Crop-model developers on sharing parameterizations