DEVELOPMENT OF WINTER WHEAT MODEL IN CLM4.5

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Winter wheat yield

Spring wheat yield


WINTER WHEAT SITES

ARM SGP Main site (US-ARM)
- Site measured NDVI and LAI
- Planting date
- Well documented Land management

Single point CLM45 simulations
- CLM45BGCCROP (crop on)
- CLM45SP (crop off)
Three cross validation sites: Flux, LAI, yield

1. Ponca city site, OK, US (US-Pon)
2. Lonzee site, Belgium (BE-Lon)
3. Merzenhausen, Germany
Phase 1: Planting:
- $T_{\text{min}5} < 5^\circ C$
- days $> Sep 1$
- $\text{GDD}_{020} > 50$

Phase 2: Leaf emergence:
- $\text{GDD}_{tsoi} > 3\% \text{GDD}_{\text{mat}} = 51$
- Base temperature is 0$^\circ C$
- Leaf, stem, root carbon increasing

Phase 3: Grain fill:
- $\text{GDD}_{\text{plant}} > 40\% \text{GDD}_{\text{mat}} = 680$
- base temperature is 0$^\circ C$
- Leaf and stem carbon decreasing
- Grain carbon increasing

Phase 4: Harvest:
$\text{GDD}_{\text{plant}} > \text{GDD}_{\text{mat}} = 1700$
VERNALIZATION

winter crops must expose to low, nonfreezing temperatures to enter the reproductive stage.

A generalized vernalization function for winter wheat (Streck et al., 2003)

Vernalization begin after germination end before flowering

Minimum temperature : -1.3 °C
Optimum temperature : 4.9 °C
Maximum temperature : 15.7 °C

\[ \text{GDD}_{\text{plant}} = \text{vf} \times \text{GDD}_{\text{plant}} \]

\[ \text{agrain} = \text{vf} \times \text{agrain} \]
FROST TOLERANCE AND DAMAGE

LT50

The Lethal temperature at 50% of the individuals are damaged (Bergjord et al., 2008)

Survival rate

representing the likelihood that an individual is damaged by exposure to a certain temperature (Vico et al., 2014)

WDD > 1
Reduce leaf and stem carbon by a factor of mean survival rate

Weighted killing degree days (vico et al., 2014)
Winter wheat growth at ARM site

**US-ARM LAI**

![Graph showing LAI (leaf area index) over time for US-ARM site with data points for observed and simulated values.]

**US-ARM Yield**

![Graph showing wheat yield over time for US-ARM site with data points for observed and simulated values.]

- **Yield (bu/ac)**:
  - Observed (orange line)
  - CLM45BGCCROP (green line)

- **Years**: 2003 to 2010
Improved latent heat fluxes compared to prescribed crop

**US-ARM Latent heat flux**

**US-ARM Sensible heat flux**

- **obs**
- **CLMSP**
- **CLM45BGCCROP**
Not well represent the winter wheat growth in the three cross validation sites, especially at the two European sites
Very small LAI and yield simulations at BE-Lon site

**BE-Lon LAI**

![Graph showing LAI (m²/m²) comparison between observations (obs) and CLM45BGCCROP from DOY 1 to 365 with peaks in 2009, 2010, and 2011.]

**BE-Lon Yield**

![Bar chart showing yield (bu/ac) for CLM 2005, 2007, 2009, and 2011 with observed values.]
Why such poor simulation at the two European sites?
Regional CLM offline simulation in US
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