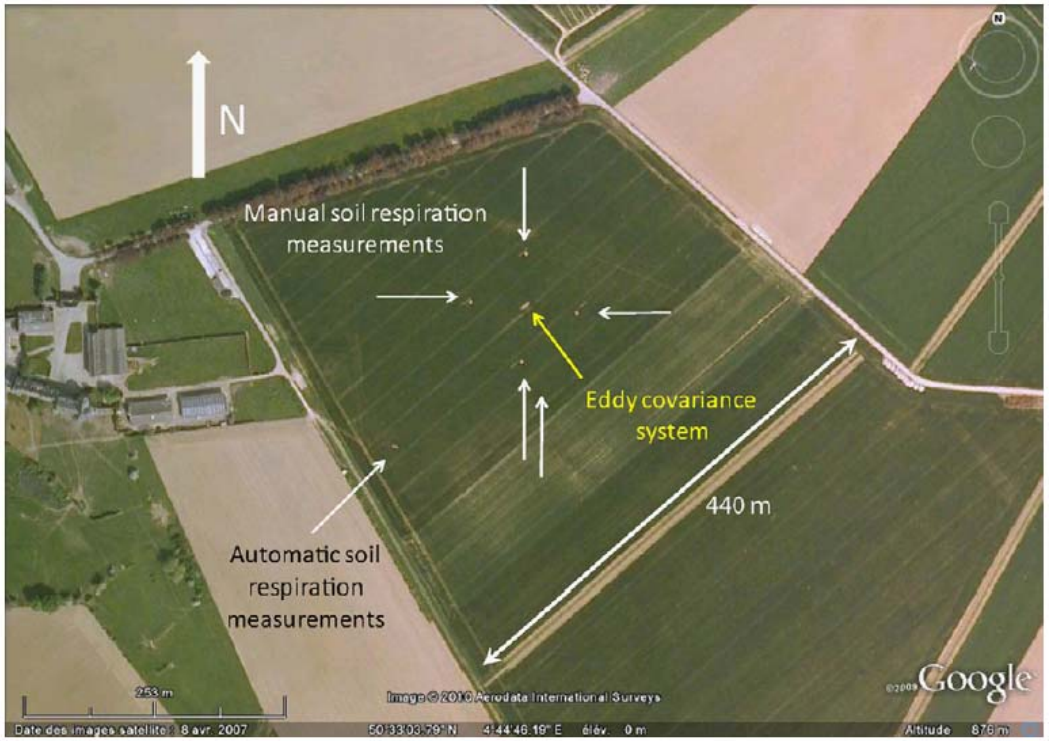
Carbon balance of crops: Overview of 7 years of investigation

Moureaux C., Dufranne D., Suleau M., Vancutsem F., Bodson B., **Aubinet M.**

Lonzée site (Belgium)

- 12 ha (~250 x 500 m)
- Fairly flat field
- $T_{average}$ = 10°C
- P_{annual} = 800 mm
- Cultivated for more than 75 years and for more than15 years with a 4-year rotation



Former papers on Lonzée site:

1st year of flux measurements on sugar beet crop:
Moureaux et al., AFM, 2006

Carbon balance of winter wheat:
Moureaux et al., GCB, 2008

Carbon budget of first 4-year rotation
Aubinet et al., AFM, 2009

Inter annual variability of winter wheat crop *(Dufranne et al., 2011)*

- 3 winter wheat crops (2005 – 2007 – 2009) on the Lonzée site
- Part of meteorological conditions and management in inter annual variability
  - Crop development
  - CO_2 fluxes
  - Yield

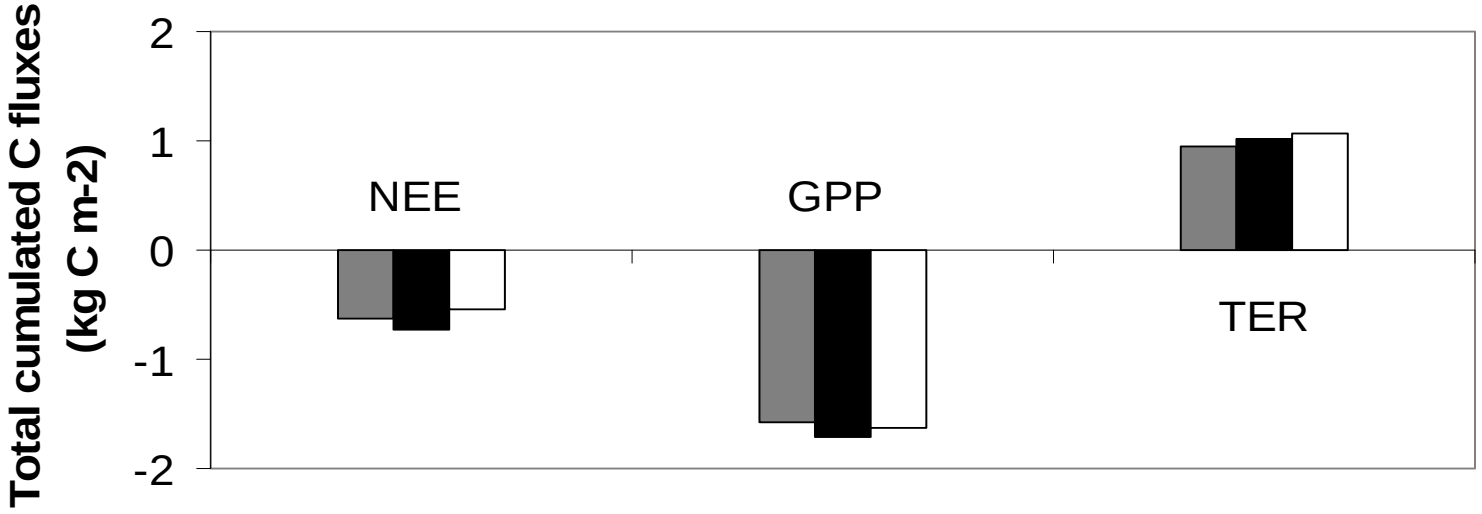
Main meteorological particularities

- Season B
  - Winter and early spring :
    - higher radiation
    - higher temperature
    - lower precipitation (0 mm in April)
  - Late spring and summer
    - lower radiation (15 and 30 % lower than in season A and B)
    - lower temperature
    - higher precipitation

NEE, GPP and yield

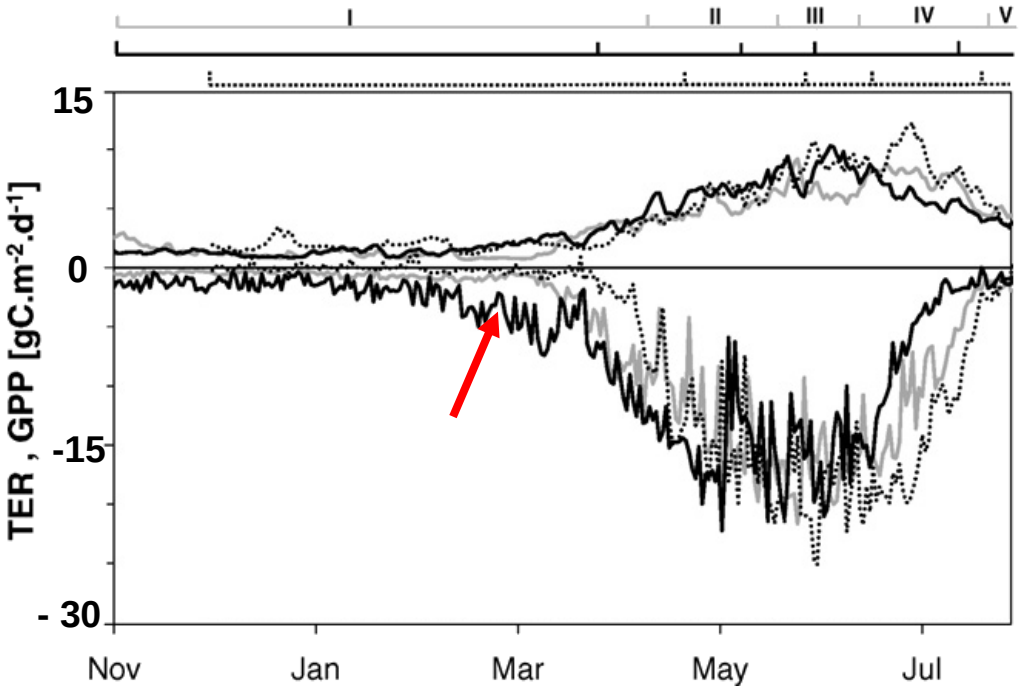
	Season A	Season B	Season C
Yield [t ha^{-1}]			
Grain	8.9 ± 0.3	7.5 ± 0.5	9.1 ± 0.4
Straw	4.2 ± 1.0	3.4 ± –	3.7 ± 1.1
Grain bulk density at 15% of humidity [kg ha l^{-1}]	75.7 ± 0.5	69.9 ± 0.5	77.7 ± 0.8
Ear density [ears m^{-2}]	464 ± 42	464 ± 62	426 ± 88

Dufranne et al. In press



GPP and yield

- Large GPP in season B results from high assimilation in early spring
- Yield was limited by late spring processes
  - Flag leaf size reduction
  - Fungal diseases



Dufranne et al. In press

TER partitioning into its autotrophic and heterotrophic components

Suleau et al., Agric.For.Metorol. (2011)

- Method :
  - TER obtained from discriminating eddy covariance NEE measurements
  - AR and HR obtained from soil respiration measurements carried in planted area and root exclusion zone
- 3 crops
  - Potato for seed (2006)
  - Winter wheat (2007)
  - Sugar beet (2008)

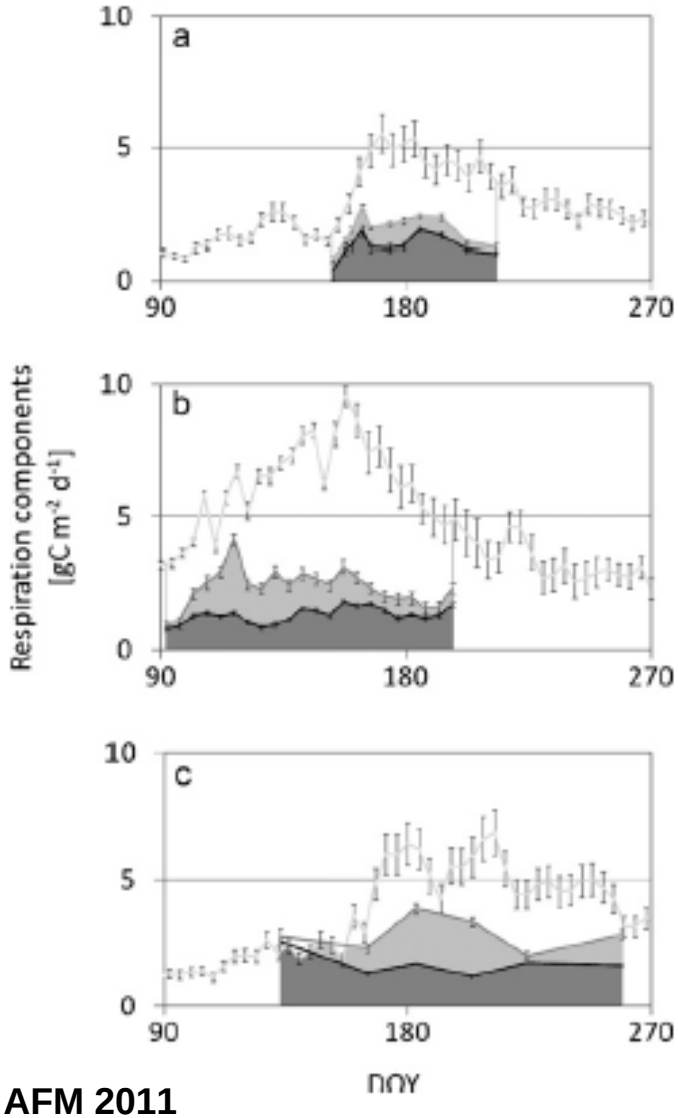
TER partitioning

TER : from 4 to 6.4 gC m^{-2} d^{-1}

HR : from 1.3 to 1.7 gC m^{-2} d^{-1}

AR : from 2.7 to 5.0 gC m^{-2} d^{-1}
(60 – 80 % of TER)

Ara : 60 – 80 % of AR



Suleau et al. AFM 2011

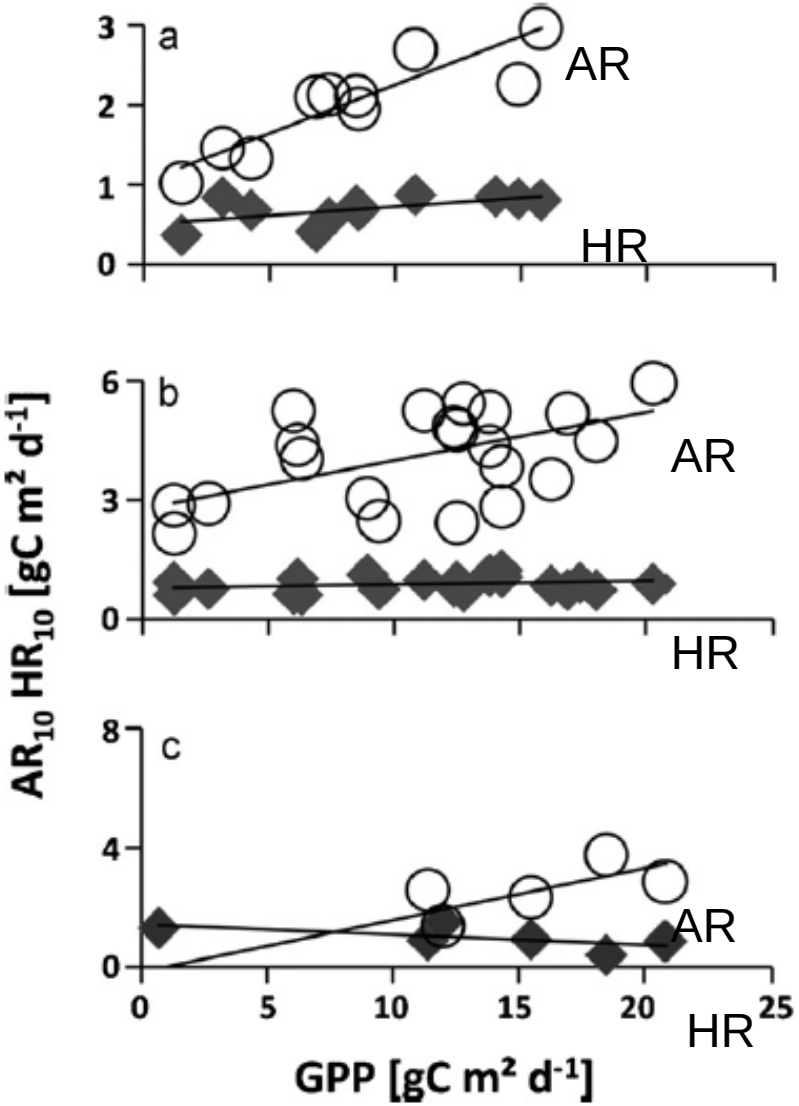
Main drivers of AR and HR

- HR dependency on temperature

	Q10	
	Estimate	95% CI
AR		
Potato	1.19	(0.62, 1.76)
Winter wheat	1.76	(-0.06, 2.44)
Sugar beet	1.19	(-0.14, 3.12)
HR		
Potato	**2.17**	**(1.70, 2.64)**
Winter wheat	**2.11**	**(1.78, 2.44)**
Sugar beet	**2.05**	**(1.32, 2.78)**

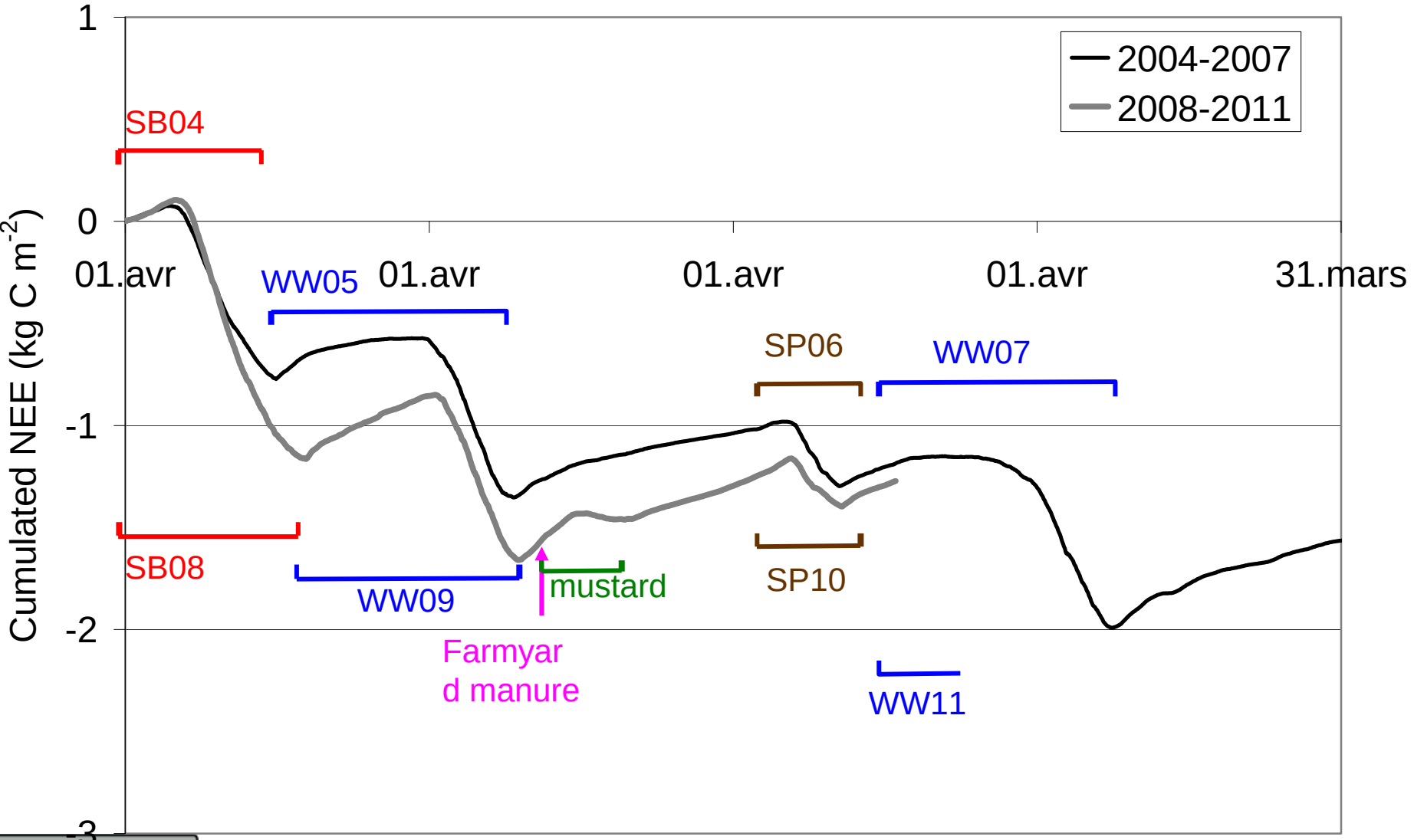
Main drivers of AR and HR

- AR_{10} dependency on GPP
- No significant relationship between HR_{10} and GPP

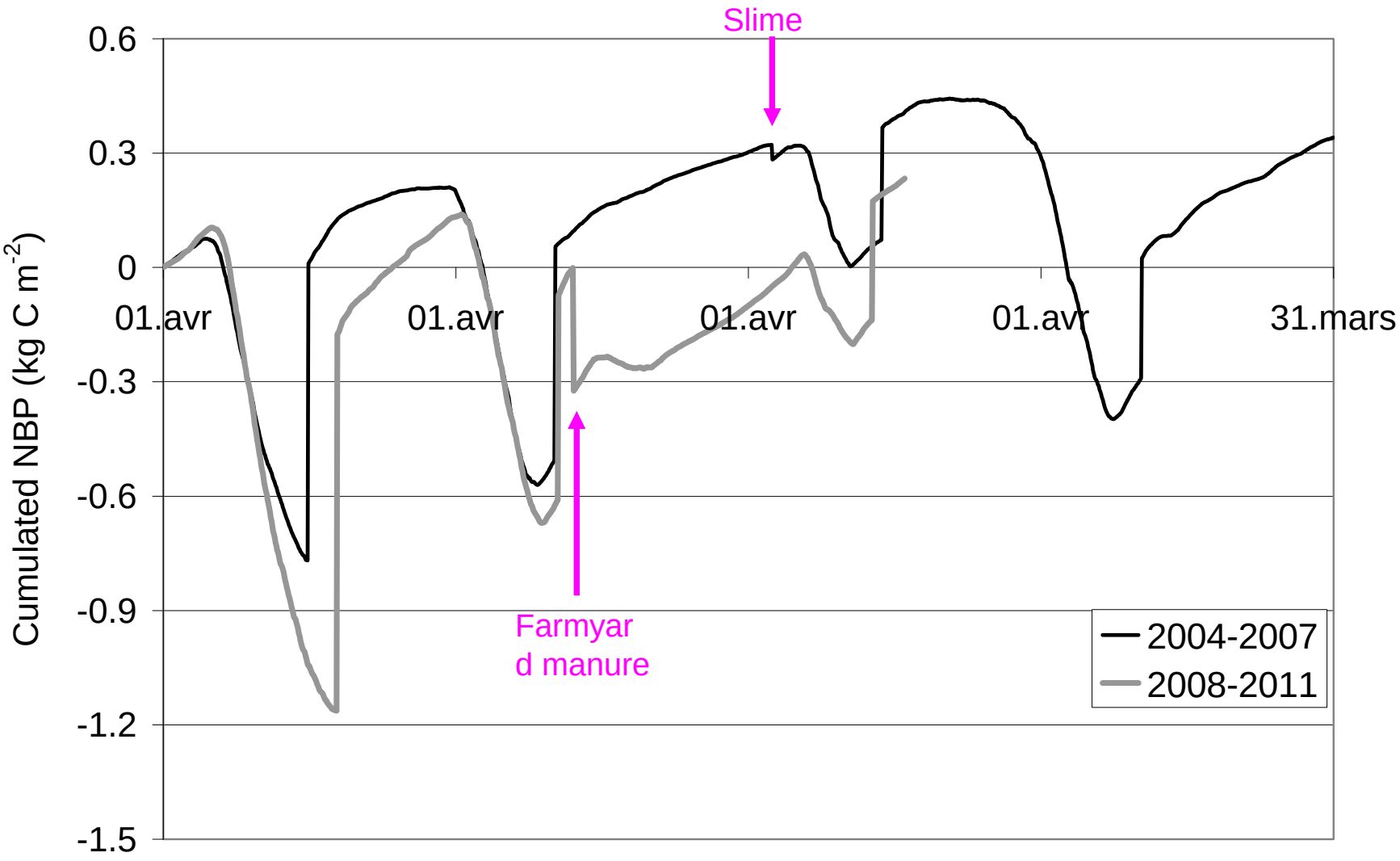


Suleau et al. AFM 2011

Cumulated NEE



Cumulated NBP



Summary

- GPP and NEE interannual variability not (always) linked with crop yield.
- In winter wheat, yield is linked to climate but through complex mechanisms (difficult to model).
- TER seasonal variability is mainly controlled by those of AR.
- AR and HR are driven by different variables.
- Results of second rotation seem to confirm that the crop behave globally as a source.

Thank you !