Global warming potential from French grassland / livestock systems

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Adaptation au Changement Climatique de l'Agriculture et des Ecosystèmes

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Grassland / livestock systems & Global warming / 1

- Global warming potential (GWP) is a measure of how much a given mass of greenhouse gas (GHG) contributes to global warming
  - Equal to 1 for CO_2, GWP is calculated by adding CH_4 and N_2O emissions to the net ecosystem exchange (NEE) values (IPCC, 2007a)

$$GWP = k_{N_2O}\ N_2O + k_{CH_4}\ CH_4 - NEE$$

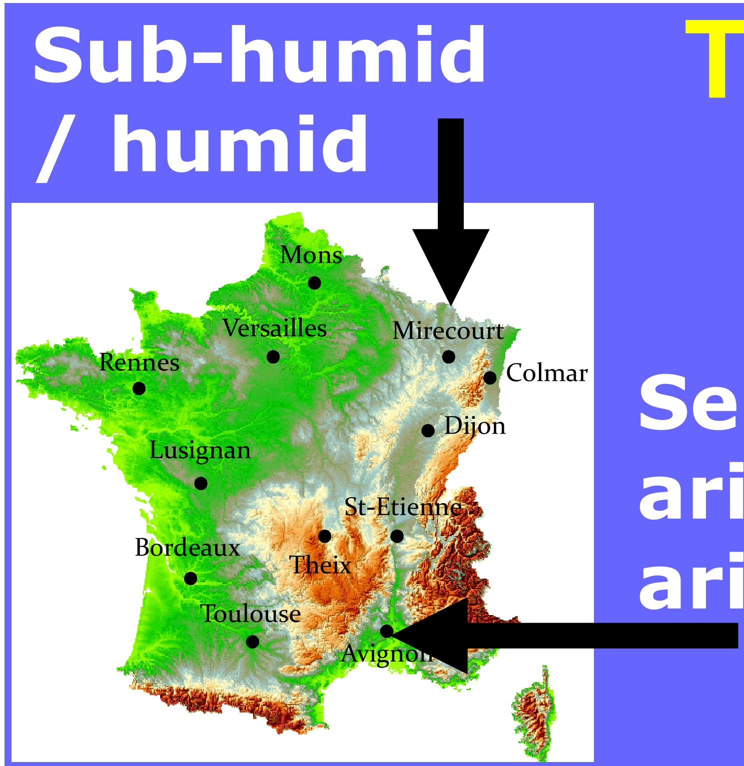
    - A positive GWP indicates a net source of GHG to the atmosphere and conversely
  - Of the three GHG exchanged by grasslands, CO_2 is exchanged with soil and vegetation, N_2O is emitted by soils, and CH_4 is emitted by livestock at grazing

Grassland / livestock systems & Global warming / 2

- Grassland / livestock systems differ for their impact on the magnitude of GHG fluxes and their GWP (FAO, 2006)
  - Livestock systems generate 18% of global GHG emissions, with considerable variability depending on both the animal (breed, age, kind of production, physiological stage, etc.) and the diet (level of intake, forage / concentrate proportion, feed processing, etc.)
  - Combined effects of elevated CO_2 and climate change may enhance net primary production and carbon (C) stocks, reducing GHG emissions by sequestering C in the soils
- A model-based study was employed to simulate prospective changes and feedbacks between grassland / animal performances and GWP in France

The simulation study / 1

- An array of scenarios was sketched to represent climate-soil-plant-management interactions under climate changes and CO_2 enrichment in France



Management	Sown		Permanent	
	Irrigated (SI)	Rainfed (S)	Intensive (PI)	Extensive (P)
Vegetation	monoculture *100% Lolium perenne* L.		multispecies 20% *Trifolium repens* L.	5% *Trifolium repens* L.
Fertilization (kg N ha^{-1})	320	200	200	0
Irrigation (% of needs)	80	0	0	0
Cutting dates	April 15 June 30 August 15 October 15		April 15 June 01 - -	April 15 June 01 - -
Grazing periods	- -		July 20 to August 05 October 15 to November 01	
Stocking density (Livestock unit ha^{-1})	-		1.5	0.8

The simulation study / 2

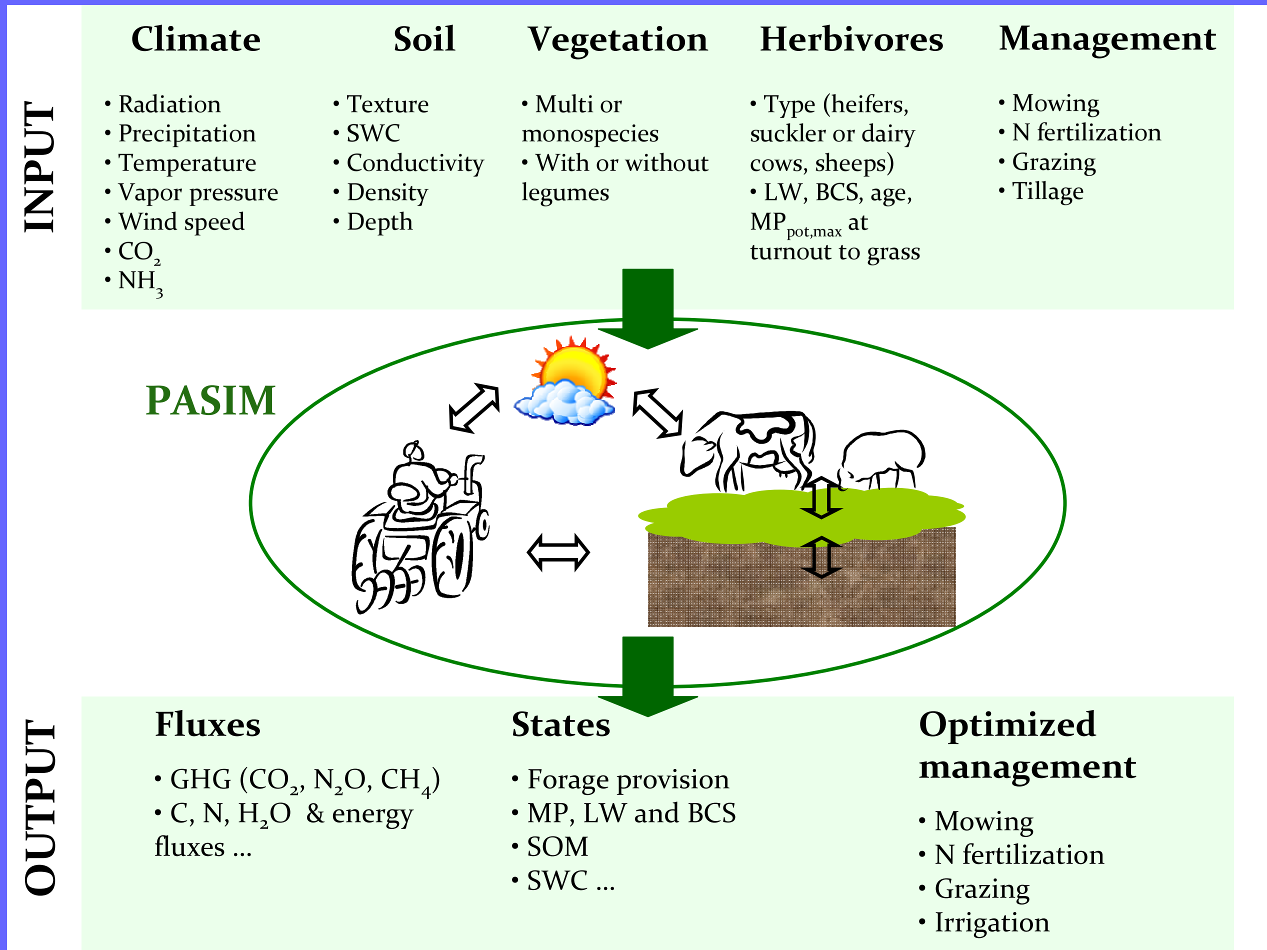
- Projections of climate conditions of near future (2020-2049) and far future (2070-2099) were generated from the Special Report on Emission Scenarios (SRES) by the Intergovernmental Panel on Climate Change (IPCC)…

SRES	GCM	Institute	Downscaling method	Initialization
B1	ARPEGE	CNRM	Variable corrections (VC)	
A1B	ARPEGE	CNRM	Anomalies	
A1B	ARPEGE	CNRM	VC	
A1B	ARPEGE	CNRM	Statistical disaggregation (SD)	1
A1B	ARPEGE	CNRM	SD	2
A1B	CGCM 3.1 T63	CCCMA	SD	
A1B	NASA/GISS AOM	GISS	SD	
A1B	CGCM 2.3.a	MRI	SD	
A1B	CCSM 3.0	NCAR	SD	
A2	ARPEGE	CNRM	VC	

- … crossing a range of global circulation models (GCM), downscaling methods / initializations in order to encompass the whole range of uncertainty associated with current climate modelling

The simulation study / 3

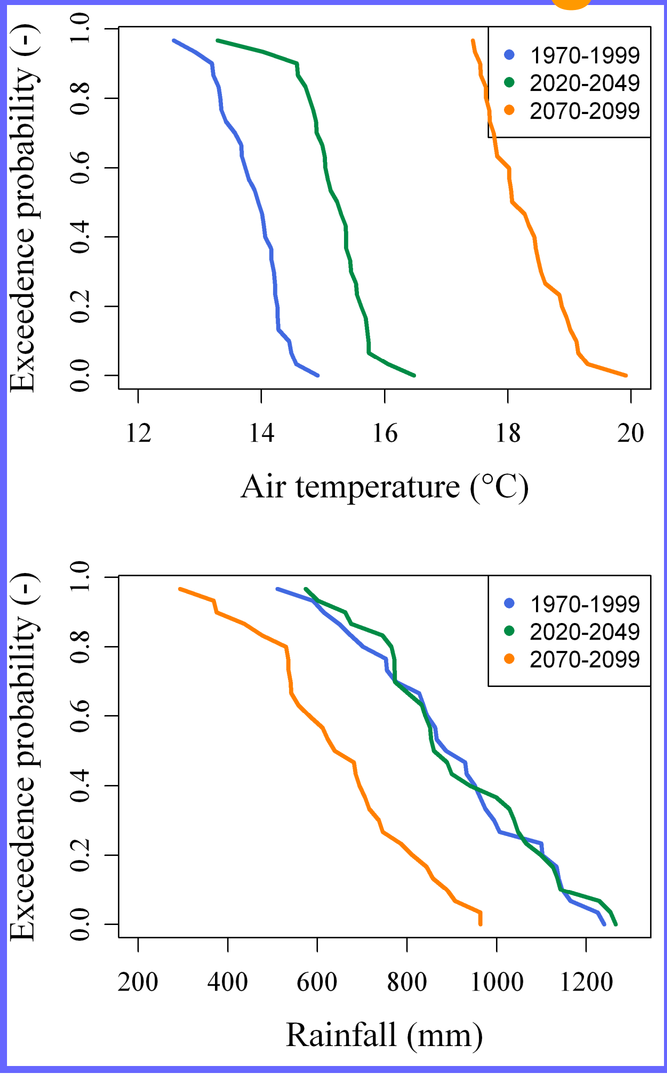
- The Pasture Simulation Model (PASIM) was employed to generate a variety of outputs related to GWP under future (2020-2049, 2070-2099) and near past (1970-1999) climate conditions



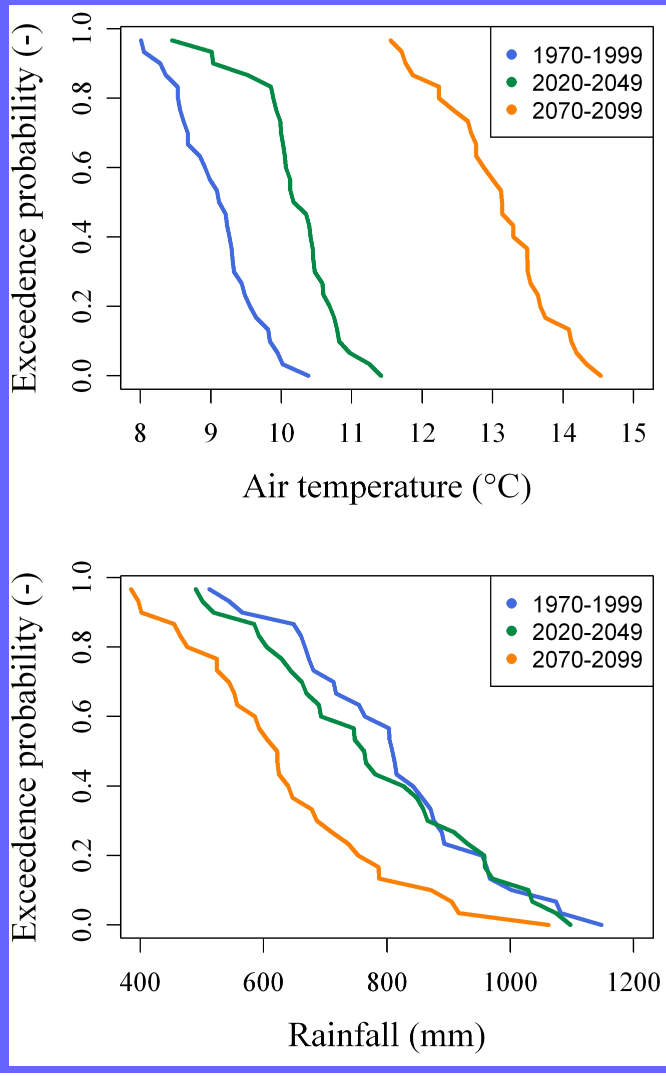
https://www1.clermont.inra.fr/urep/modeles/pasim.htm

Changes in rainfall and air temperatures: SRES A2, ARPEGE model, variable correction downscaling

Avignon

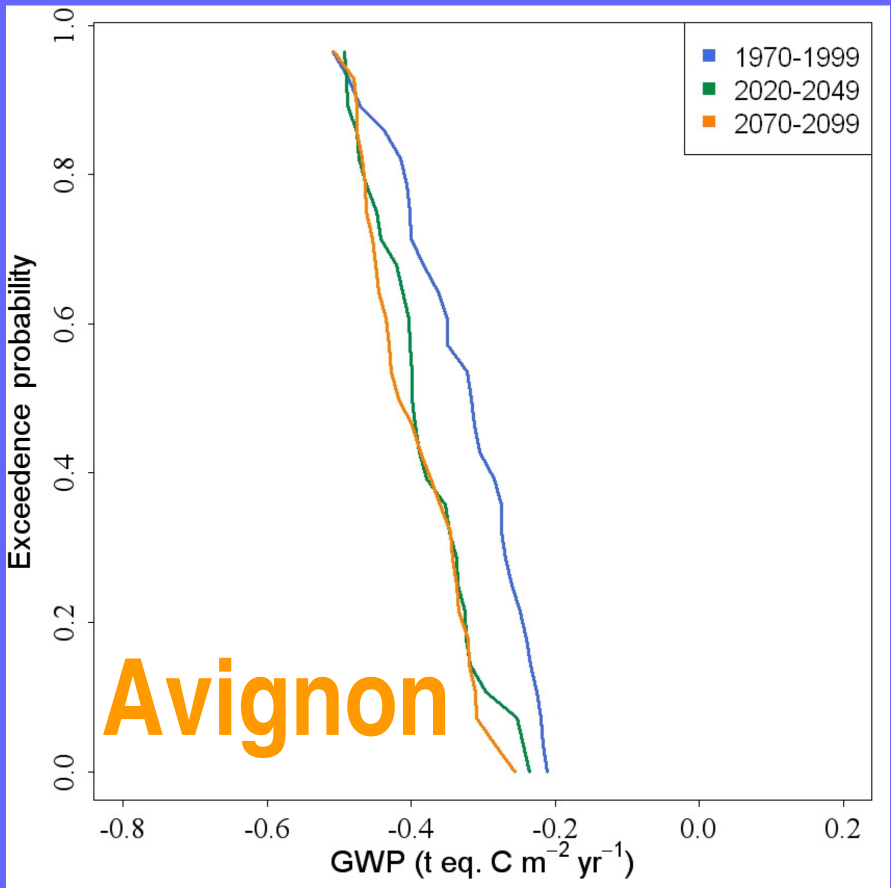


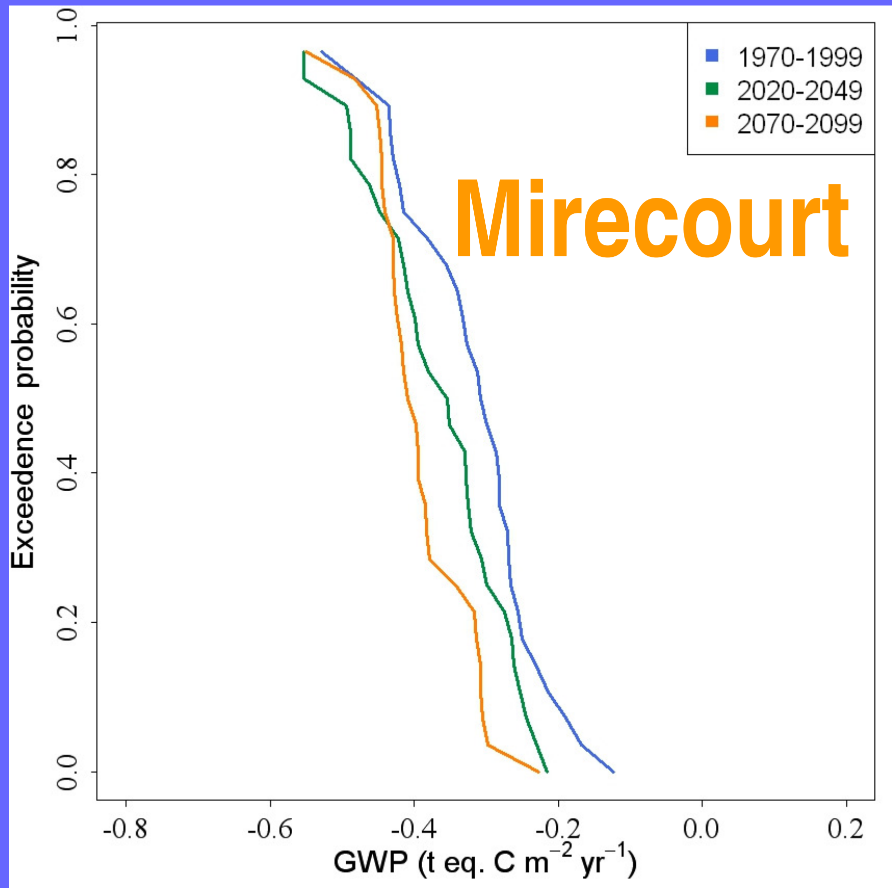
Mirecourt



Changes in the GWP:

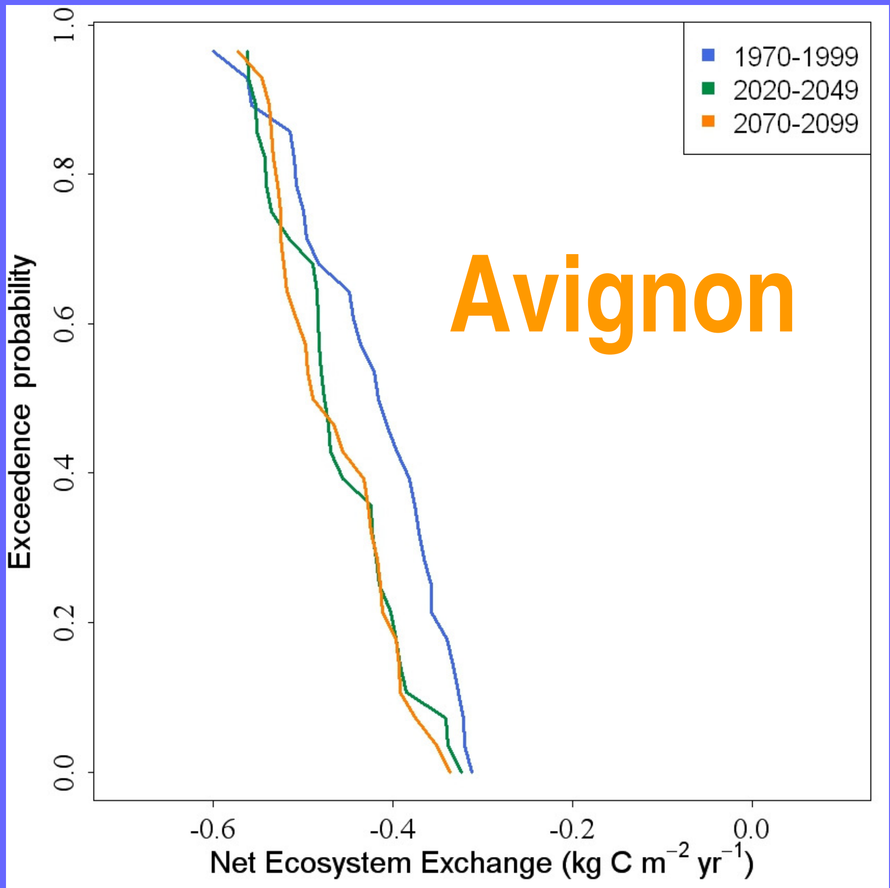
irrigated temporary grassland, shallow soil

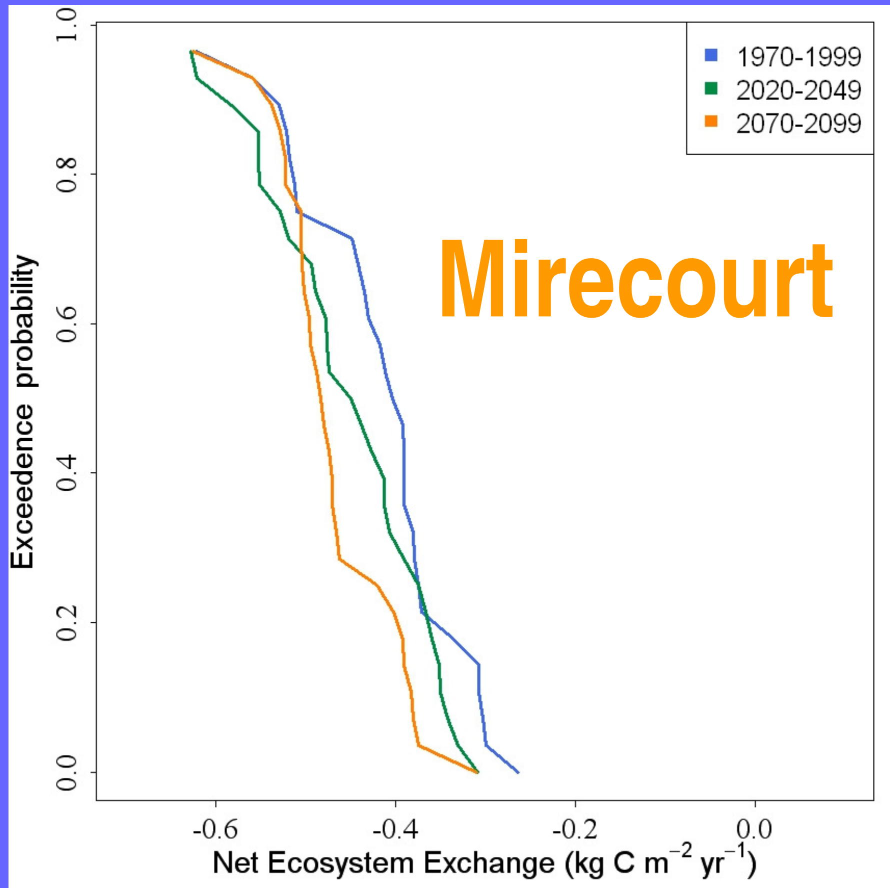




Changes in the NEE:

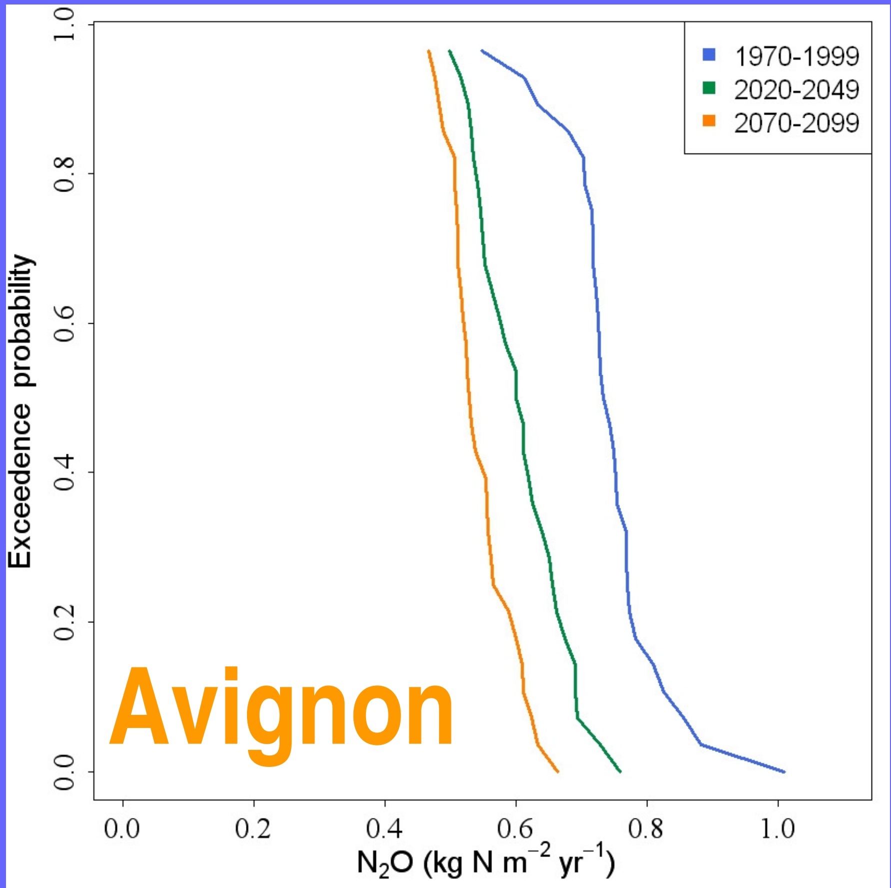
irrigated temporary grassland, shallow soil

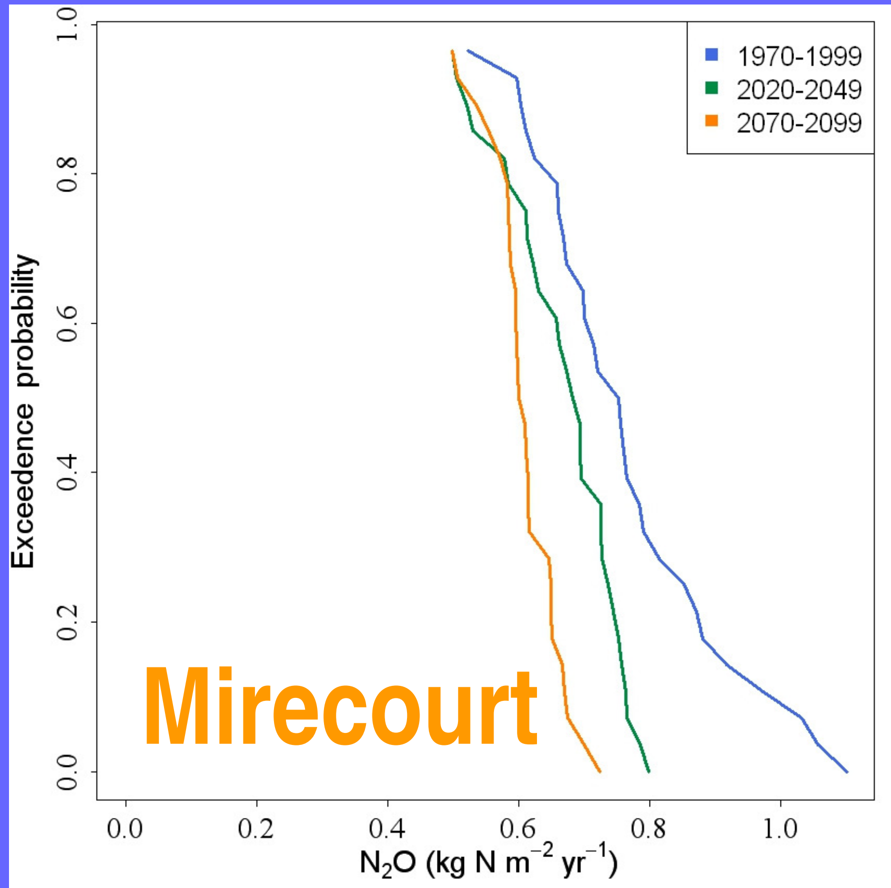




Changes in the N_2O:

irrigated temporary grassland, shallow soil





Overall findings

- While there are site-to-site and climate-to-climate variations, a conclusion is that the GWP may decrease in the future as result of increased soil dryness and C storage
- All systems were observed to be net sinks of C, with temporary irrigated grasslands offering the greatest potential to mitigate GHG in the future thanks to higher NEE
- Strategies to enhance fertilizer use efficiency, animal feed and return of animal waste could be explored as adaptation & mitigation measures

Thank you for your attention!!!

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