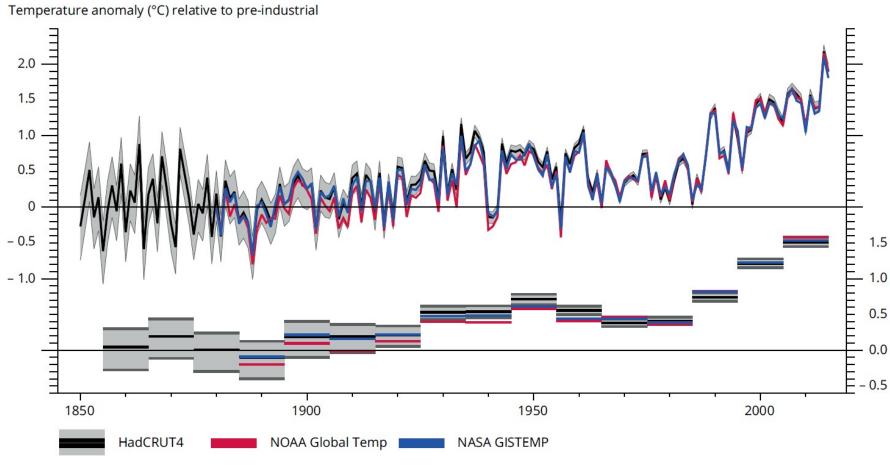
# Current climate change impacts and adaptation in European agriculture Professor Jørgen E. Olesen



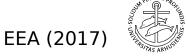




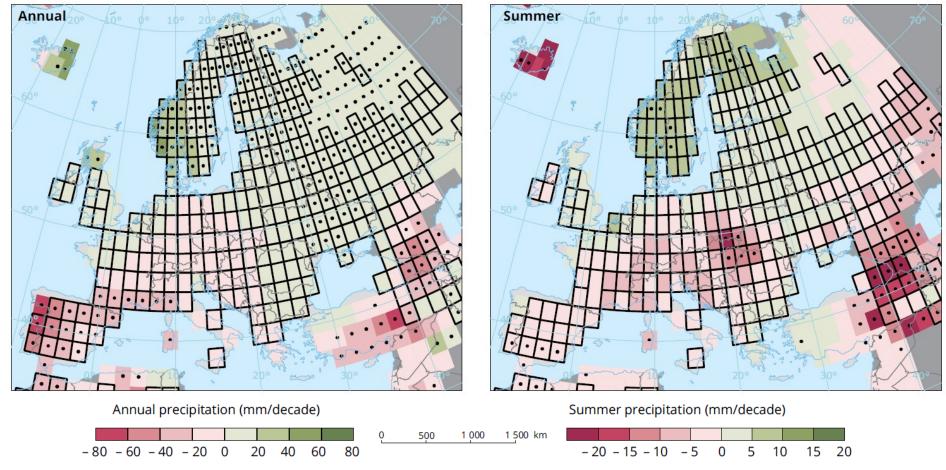
# Temperature over land i Europe increases rapidly







#### Spatial trends in precipitation

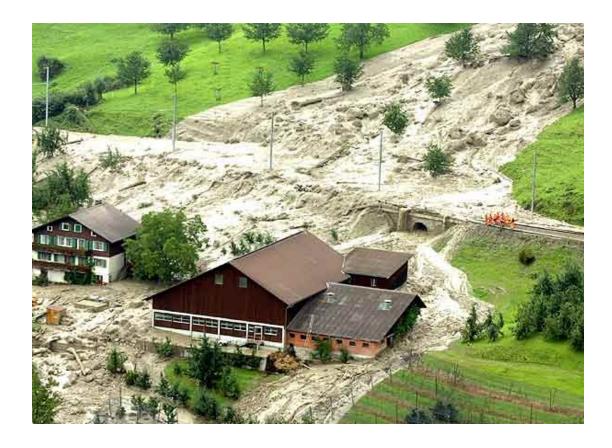






#### Climate change poses risks to current systems

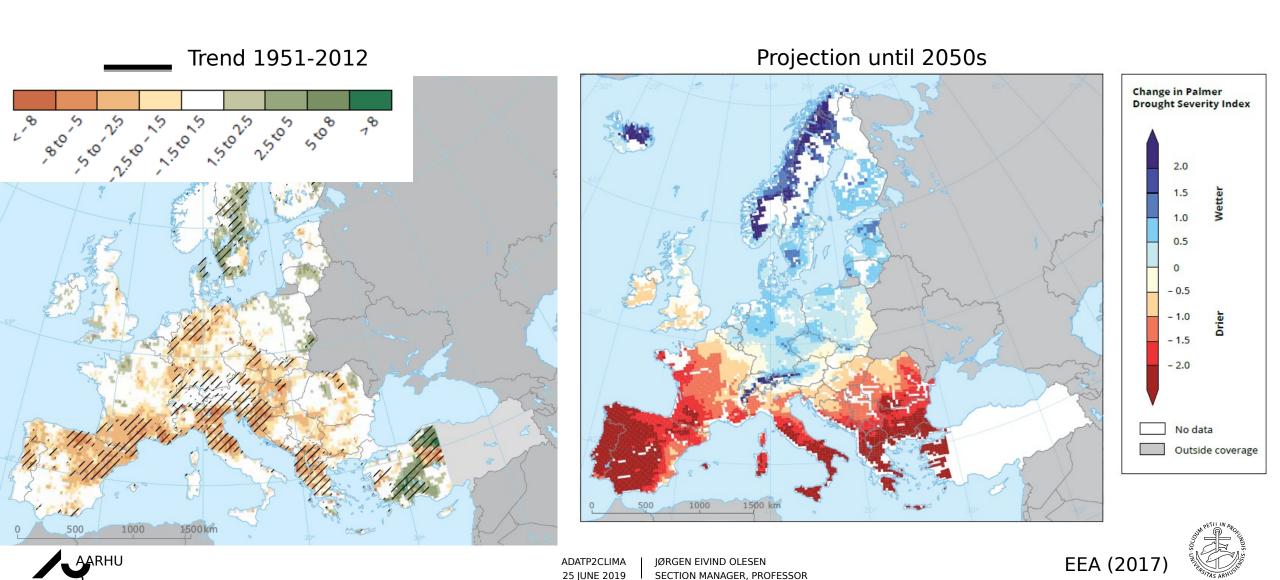
- Risks to production systems are mostly related to extreme events and new biotic interactions
  - Heat waves
  - Frost, snow, ice
  - Droughts
  - Intense or long lasting rainfall (floods)
  - Storms
  - Pest and diseases
- Climate change increases
  - Frequency of extreme events
  - Inter-annual variability



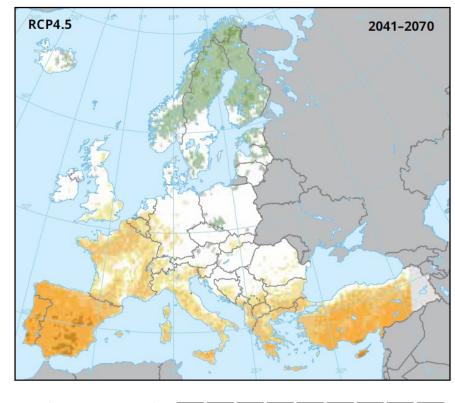


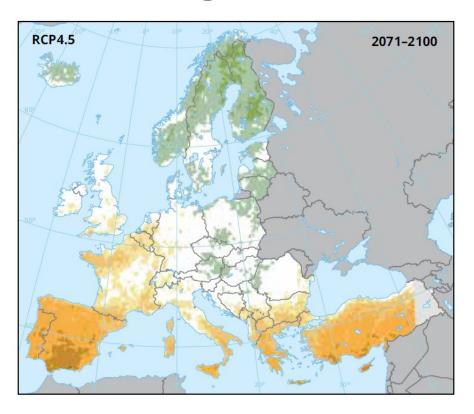


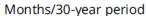
#### Trends in summer soil moisture

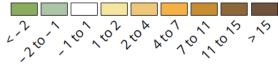


#### Change in frequency of extreme drought under moderate climate change

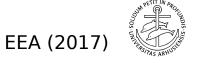




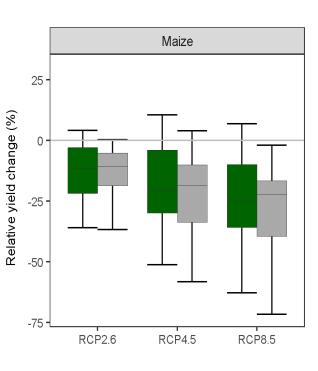


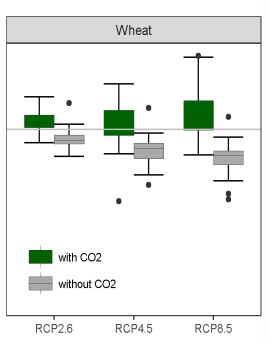


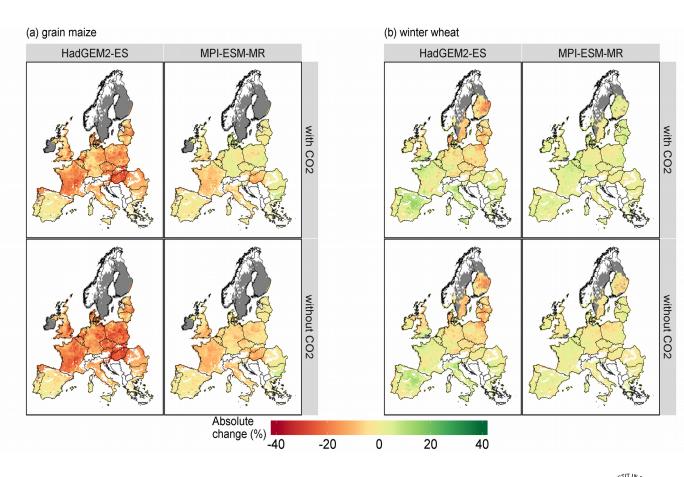




# Drought is the major threat for cereals under climate change in Europe (2050s)



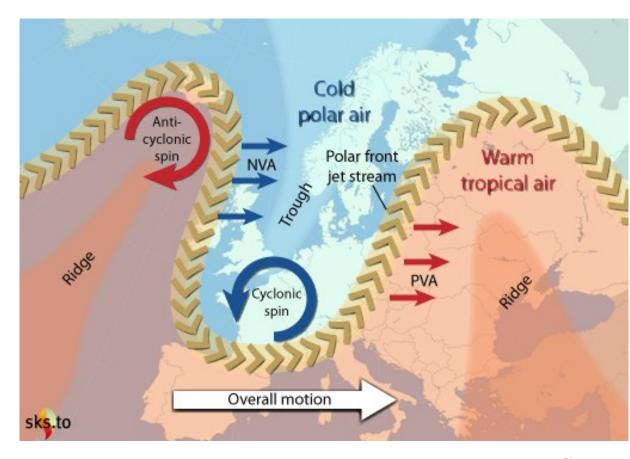






## Changes in the jet stream determines variability

- The jet stream determines the flow of cyclones at mid and high latitudes
- The suitable climate (varying dry and wet conditions in Nordic climate) is determined by this flow of cyclones
- Warming reduces temperature difference between arctic and midlatitude temperatures
- This weakens the jet stream, possibly resulting in more stable locking of the jet stream

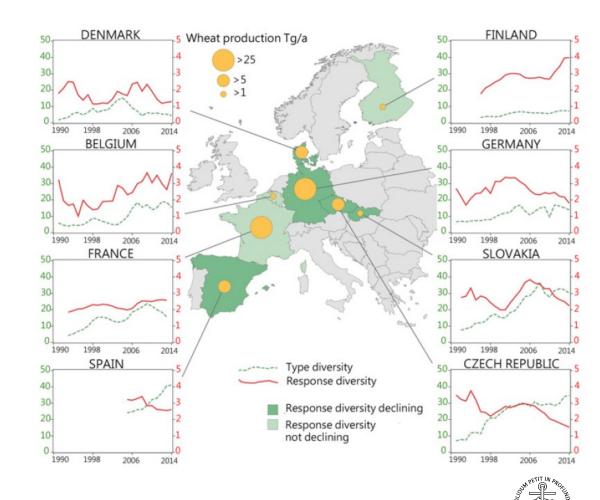






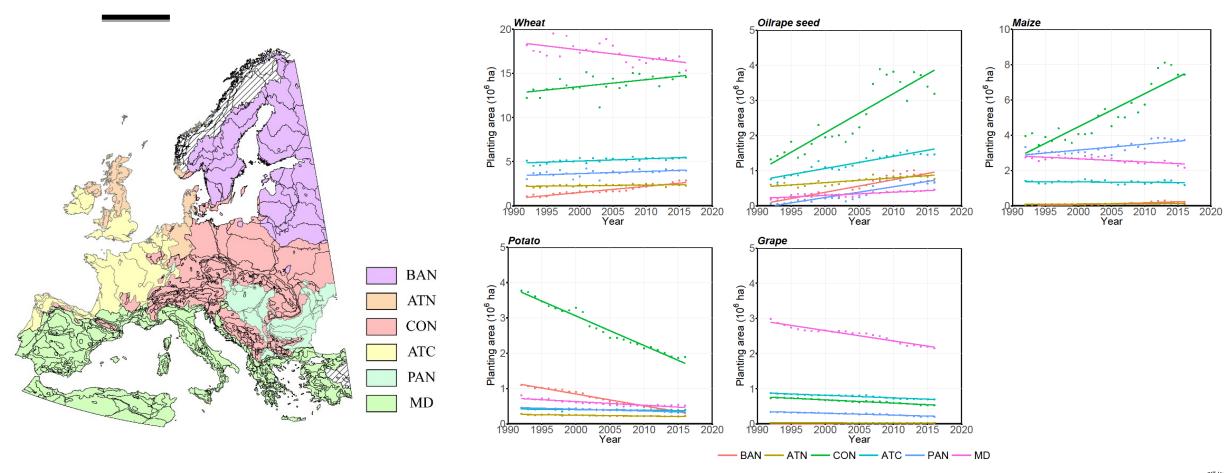
#### Declining resilence of European wheat

- Climate change increases variability in temperature and rainfall
- Adaptation to such changes requires increasing resilience
- Resilience may be achieved with greater varietal response diversity
- Analysis of >100.000 observations of yield from European variety trials
- Results show declining diversity and lower resilience
- Need for greater focus on diversity and resilience through breeding and variety choice





# Survey of impacts and adaptation in European crops







### Observed changes and attribution

					_	
tion  Timing of field operations New crops (silage maize) New crops (grain maize) New crops (soybean) New crops (sunflower)	3	1	2	2	2	2
New crops (silage maize)	2	2	2	3	1	2
New crops (grain maize)	2	1	1	2	2	2
New crops (soybean)	2	1	1	2	1	1
New crops (sunflower)	2	1	1	1	2	2
New crops (grapevine)	2	2	2	2	2	2
New crops (other, specify)	2	0	2	1	2	2
New cultivars (specify which crops)	4	2	2	2	3	1
Water saving cultivation	1	1	2	1	2	2
Erosion protection cultivation	3	1	2	1	3	1
Expansion of irrigated area	0	0	1	1	2	3
Reduction of irrigated area	0	0	1	0	3	2
Reduced cultivation of water demanding crops	0	0	0	0	1	2
Improvement of drainage systems	1	1	1	2	1	0
Breeding for changed crop phenology	0	0	2	2	2	1
Breeding for better drought tolerance	0	0	2	1	2	2
Breeding for changed disease and pest resistance	2	3	3	2	2	2
Changes in crop protection measures	3	1	2	1	2	3
Soil management for water harvesting-	0	0	1	1	2	2
Soil management to conserve water	2	1	2	1	2	2
New/changed scheme insurance against droughts •	2	1	2	1	1	3
New/changed scheme insurance against heat	4	0	1	0	2	2
New/changed scheme insurance against hail-	0	0	1	1	0	2
New/changed scheme insurance against flood	4	1	1	2	0	2
New/changed scheme insurance against bad weather during harvest	3	1	0	2	0	2
Change to other agricultural activities (e.g. livestock)	5	0	1	0	2	1
Leaving agriculture sector	2	1	1	2	2	2
Changing subsidy schemes	0	1	2	2	3	2
Early warning/forecast systems - national/regional	2	1	2	1	3	3
Early warning/forecast systems - farm based	2	1	1	2	2	2
	BÅN	AŤN	CON	AŤC	PAN	MD

Observed change

2	1	1	2	1	2	
1	1	1	0	0	2	
1	1	1	0	0	1	
1	0	1	1	0	1	
1	0	0	1	1	1	
1	1	1	2	1	1	
2	0	1	1	2	1	
2	1	1	2	1	1	
1	0	1	1	2	2	
0	0	1	1	1	2	
0	0	1	2	2	3	
	0	0	1	0	2	
	0	1	1	2	3	
0	1	1	1	1	1	
0	0	1	2	2	2	
0	0	2	1	2	2	
1	1	1	1	1	2	
1	0	1	1	1	2	
	0	1	1	1	2	
0	1	1	2	1	2	
1	0	2	1	1	2	
1	0	1	2	1	2	
	0	1	1	0	2	
1	1	1	2	0	2	
1	1	0	2	0	1	
0	0	0	0	1	1	
0	0	0	0	0	1	
	0	0	1	0	0	
1	0	2	1	2	2	
1	0	1	1	1	2 MD	
BAN	AŤN	CON	AŤC	PAN	MD	

Climate change attribution



ADATP2CLIMA 25 JUNE 2019 JØRGEN EIVIND OLESEN SECTION MANAGER, PROFESSOR



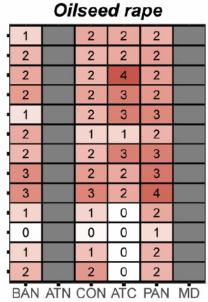
#### Planned adaptations

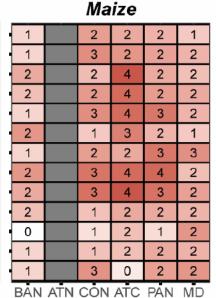
Changed timing of field operations-	2	1	2	2	2	1
Changed field operation practices	2	2	3	2	2	2
Changed fertilisation regime-	2	1	2	2	2	2
Changed crop protection -	3	2	3	2	2	2
Cultivars adapted to warmer and drier climate-	3	2	3	3	3	1
Other climate-proof cultivars-	2	2	3	2	2	1
Soil water saving technologies-	2	2	3	2	3	2
Soil erosion and fertility protection-	3	4	3	4	4	2
Monitoring drought, pests and diseases-	3	3	3	4	4	2
Use of seasonal weather forecasts-	4	0	2	1	2	2
Introduction of irrigation for the given crop-	4	1	2	1	1	3
Switched focus of the production (e.g. High quality products)-	2	2	2	3	2	3
Crop insurance or similar scheme-	4	2	2	3	2	3
New (warm season) crops-	2	2	1	3	0	4
Crop rotations for better water use-	1	4	2	2	2	4
Crop rotations for better nutrient use-	3	4	2	4	2	4
Expansion of irrigation systems-	2	1	2	2	2	4
Improvement of irrigation systems-	2	2	2	2	2	4
Regulation of water rights for irrigation-	1	2	2	2	4	2
Microclimate modification -	1	1	1	1	2	
Landscape changes (e.g. hedgerows, buffer strips)-	2	2	2	2	2	4
Revised environmental regulations	3	2	2	3	2	4
Revised subsidy schemes	3	2	3	2	2	4
Increased storage capacity-	1	2	2	3	2	3
Leaving the agriculture sector-	0	0	0	1	0	0
•	BAN	ATN	CON	ATC	PAN	MD

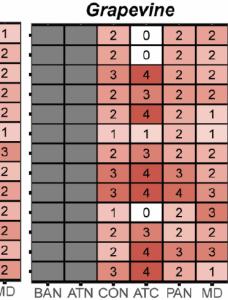


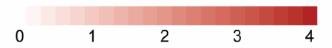
#### Planned adaptations

	Wheat					
Changed timing of field operations	2	2	2	2	2	2
Changed field operation practices	2	3	2	3	2	2
Changed fertilisation regime	2	2	2	3	2	1
Changed crop protection	2	3	2	3	2	1
Cultivars adapted to warmer and drier climate	1	4	2	3	3	1
Other climate-proof cultivars	2	2	1	2	2	1
Soil water saving technologies	2	4	2	3	3	2
Soil erosion and fertility protection	3	4	3	3	3	2
Monitoring drought, pests and diseases	3	4	3	4	4	2
Use of seasonal weather forecasts	1	1	2	1	2	1
Introduction of irrigation for the given crop	0	0	1	0	1	1
Switched focus of the production (e.g. High quality products)	2	4	2	2	2	2
Crop insurance or similar scheme	2	3	2	2	2	3
	BAN	ATN	CON	ATC	PAN	MD













# Challenges to current resource and environmental management

- Changes in climatic suitability will lead to changes in land use, greatly affecting production in agriculture and forestry, but also the quality of nature, the environment, groundwater and surface water systems.
- Future resource management needs to meet many conflicting goals.







#### Greater focus on adaptation to climate change is needed

- Planning of adaptation to climate change is essential where
  - There are long lead times before new technologies, materials or management schemes can be implemented
  - Involvement of several actors or institutions is required
- Examples of need for action on adaptation
  - Land use planning and management, e.g. related to drainage soils and water resources for irrigation
  - Enhanced focus on water/irrigation use efficiency
  - Use of genetic resources of plants and



