Plant genetic resources - snapshot – main challenges

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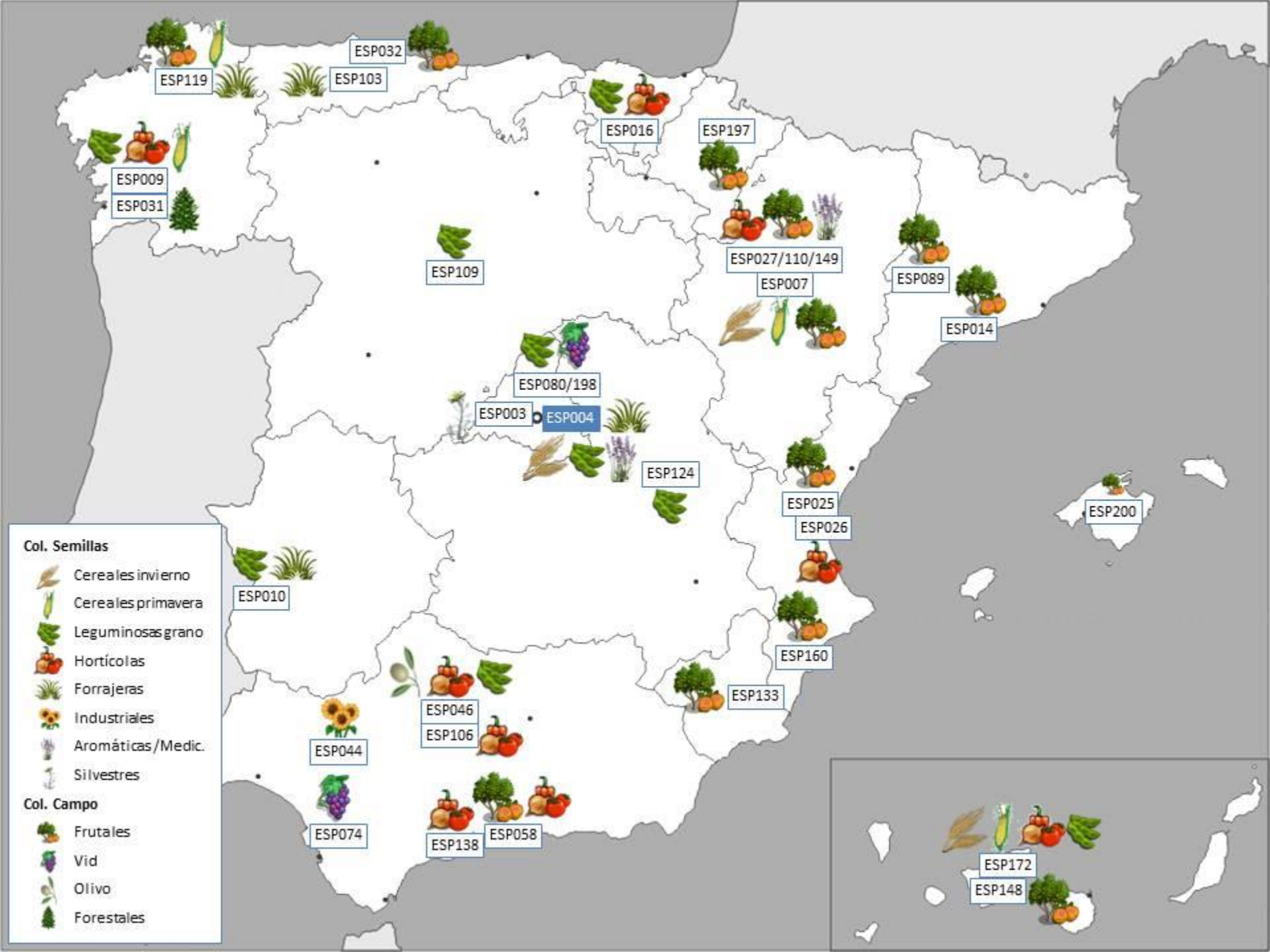
CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

- Spain holds the largest crop genetic diversity among western european countries, in crop wild relatives (more than 6500 taxa, Kell et al. 2008) and crops
- Well represented in major germplasm Banks worldwide, but best collections in the National Centre for Phytogenetic Resources in Madrid (CRF-INIA). Also many dedicated collections kept all over the country

Luis Guasch, Lucía de la Rosa

María Luisa Rubio, José M. Iriondo, Mauricio Parra, Elena Torres


ESP032
ESP119
ESP103
ESP016
ESP197
ESP009
ESP031
ESP109
ESP027/110/149
ESP007
ESP089
ESP014
ESP080/198
ESP003
ESP004
ESP124
ESP025
ESP026
ESP200
ESP010
ESP160
ESP133
ESP046
ESP106
ESP044
ESP074
ESP138
ESP058
ESP172
ESP148
Col. Semillas
Cereales invierno
Cereales primavera
Leguminosas grano
Hortícolas
Forrajeras
Industriales
Aromáticas/Medic.
Silvestres
Col. Campo
Frutales
Vid
Olivo
Forestales

- Utilization: **core collections** (barley, wheat, beans…)
- Best tool to access diversity in large collections
- Many advantages: allow systematic approach to exploration, permanent resources, scalable to purpose…

- Amenable to genomics studies, phenotypic exploration
- Genotyping, sequencing, not main problem anymore
- **PHENOTYPING is the bottleneck**

CAAS: Jiankang Wang, Jianmin Wan
Univ Barcelona: Jose Luis Araus

ISSUES and CHALLENGES

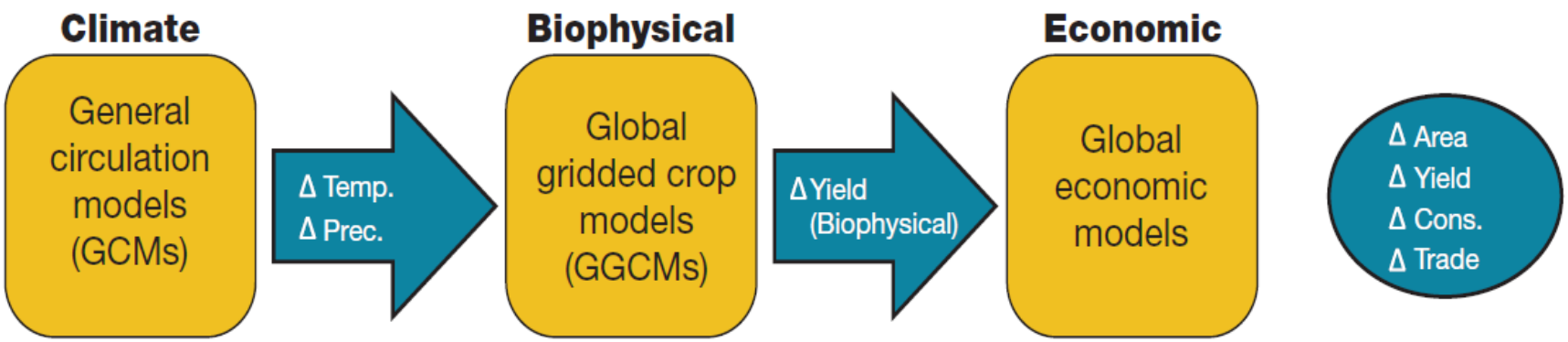
- Adapt crops to climate change, including shifts in cropping systems: knowledge of adaptation genes ESSENTIAL
- Biofortification of staple crops
- Germplasm, in situ and ex situ, CWR, key to find adaptation traits and genes
- Potential in neglected and underutilized species (NUS)
- Genomics: sequence more! One reference is not enough
- Phenomics: emergent field, still under development. Weak link. Raise awareness!
- Big data storage and sharing poses big problems
- Who cares for gene discovery? and who pays? Perfect ground for public-private partnerships
- Regulatory framework: Nagoya protocol, ITPGRFA

Main challenge for successful pre-breeding: effective PHENOTYPING systems, development of PHENOMICS approaches

- Phenotyping is the bottleneck of current experimental biology (Furbank and Tester, TIPS 2011)
- Fundamental technology: image analysis
- Measure MORE things, in a BETTER way, and NEW traits we were not aware of
- Diverse experimental settings possible: field, greenhouse, growth chamber
- Specific challenge: standardization of procedures, protocols, trait ontologies

Challenge for pre-breeding under climate change: MOVING TARGET

- Prediction of future conditions and of impact of traits and breeding strategies needed
- Integration of climate models with crop models to predict outcomes



Rötter and Höhn, 2015, FAO

- Climate change will shift seasonal and annual averages of climatic features but, also, will bring an increase and severity of extremen events
- Therefore, there will be a need to search for phenotypes-species that provide increased sustainability and resilience to agricultural systems

THANK YOU

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www.divseek.org/about/

DivSeek

HOME WHAT IS DIVSEEK? WORKING GROUPS PROGRESS RESOURCES CONTACT

The mission of DivSeek is to enable breeders and researchers to mobilize a vast range of plant genetic variation to accelerate the rate of crop improvement and furnish food and agricultural products to the growing human population.

As of October 2016 six Working Groups have been established.

Working Group 1 - Data Standards for Interoperable Tools

Working Group 2 - Genebank Information Management System

Working Group 3 - Genomics for Genebanks

Working Group 4 - Phenotyping for Seed Diversity

Working Group 5 - Semantics for Harmonizing Trait and Agronomic Data

Working Group 6 - Translational Approaches for Minor and Underutilized Crops

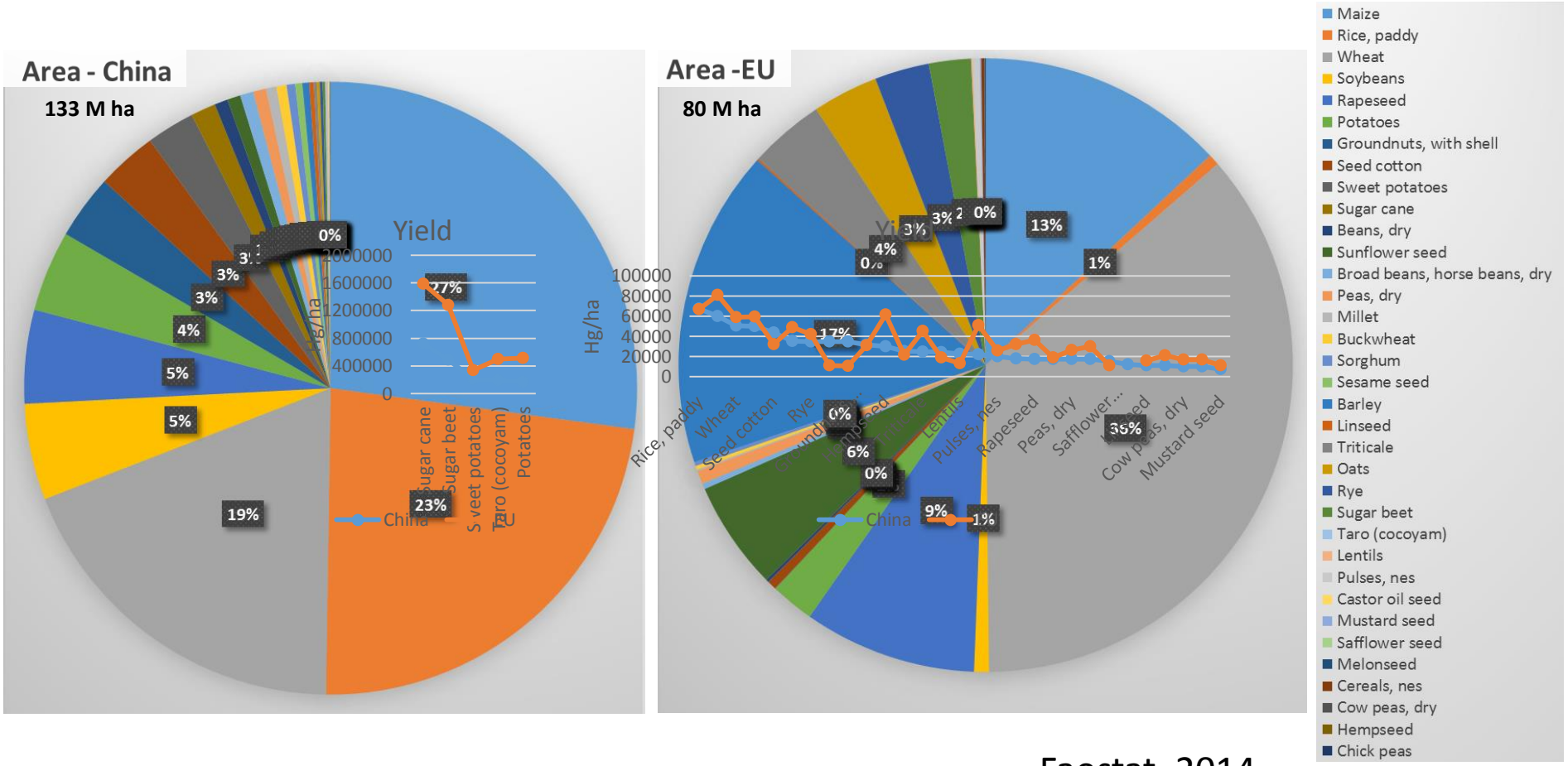
EU COST action ‘The quest for tolerant varieties: phenotyping at plant and cellular level (FA1306)'

Working groups

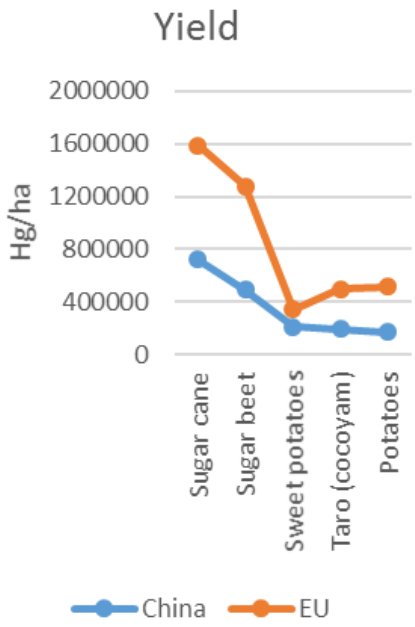
1. Working group 1 Phenotyping at plant/field level

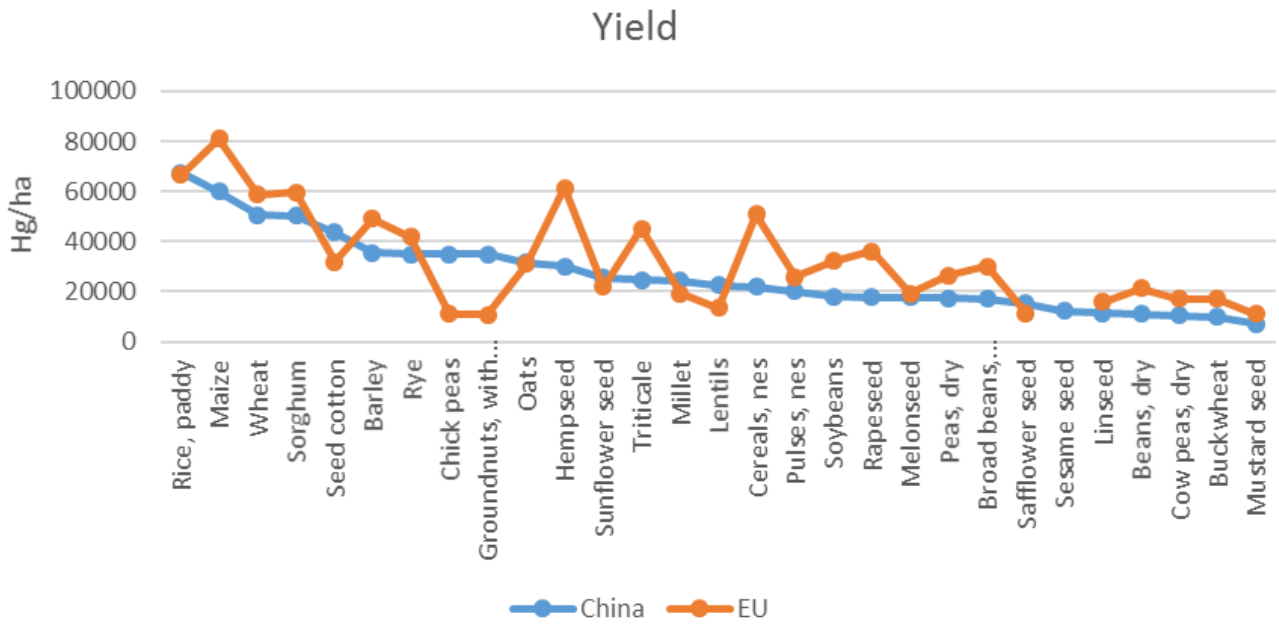
2. Working group 2 Phenotyping at cell level

3. Working group 3 Integration of phenotyping at both levels and translation into good practices

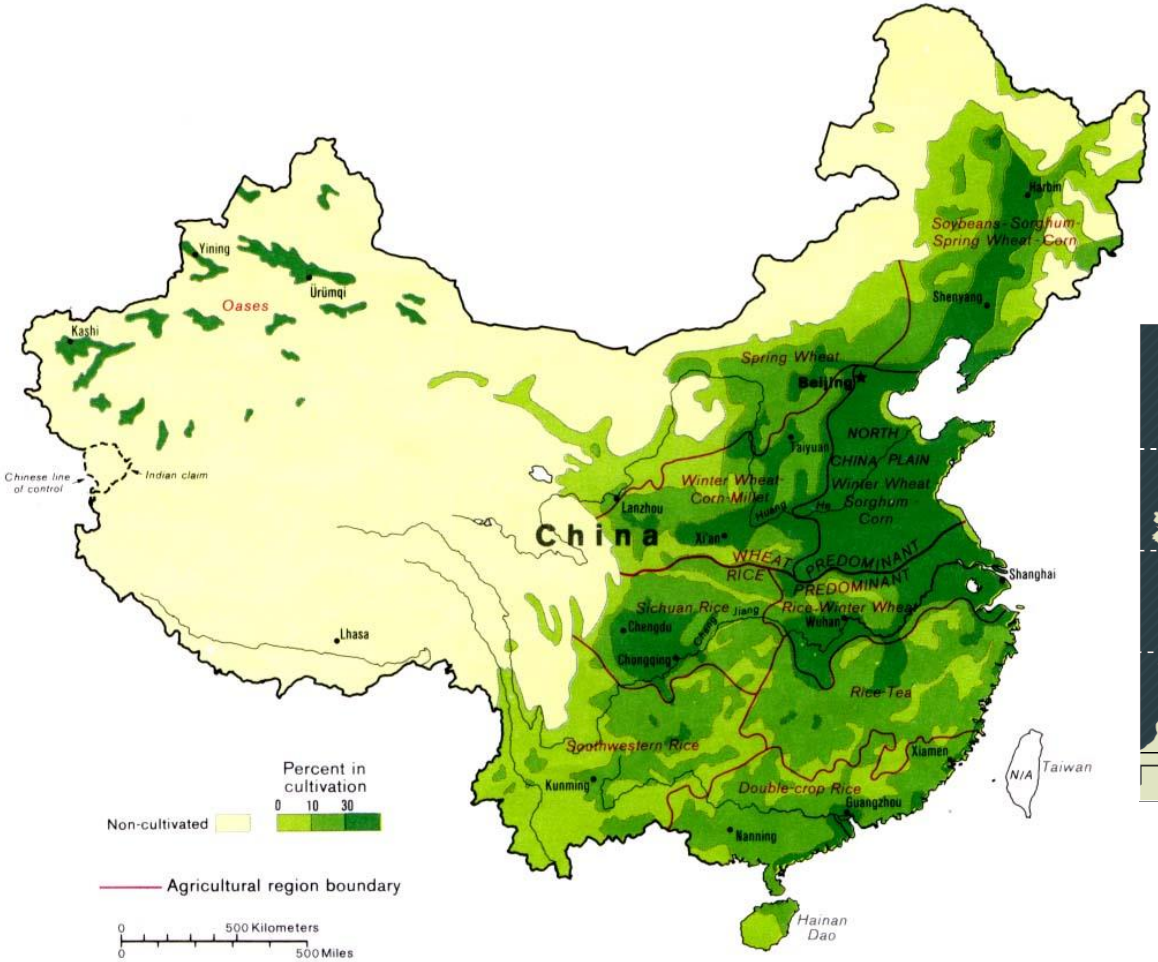


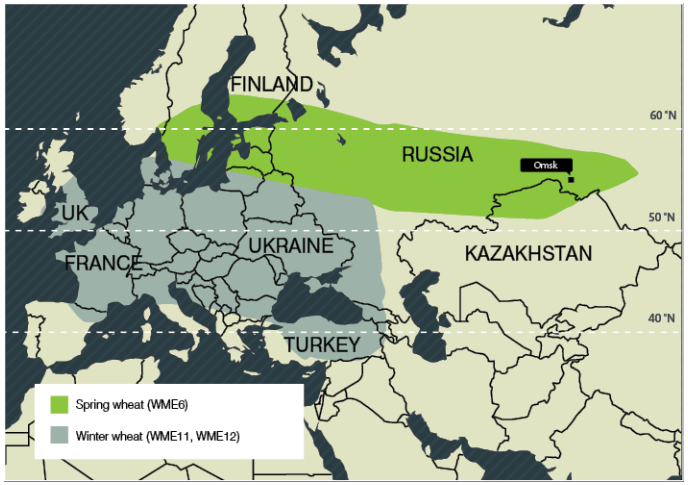
Faostat, 2014

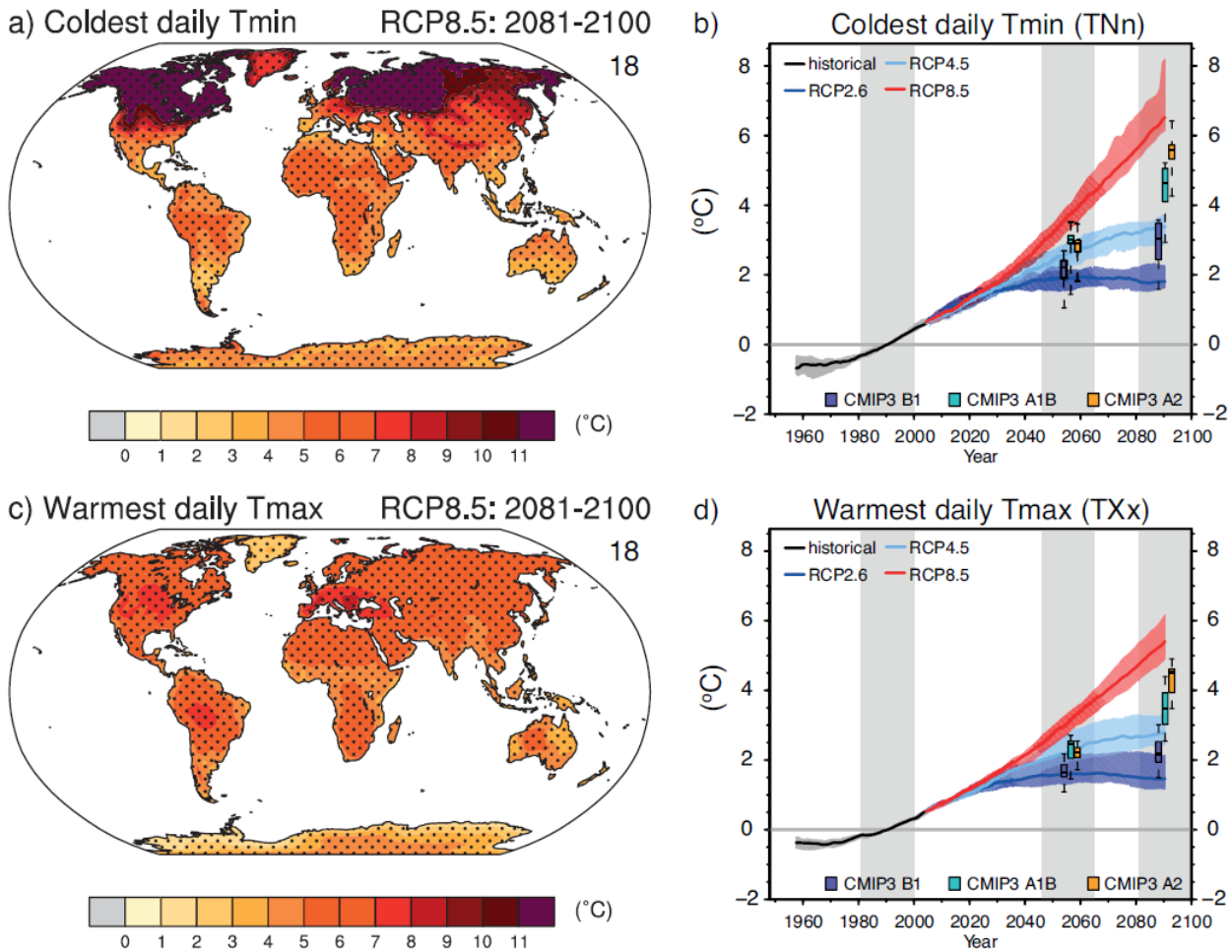




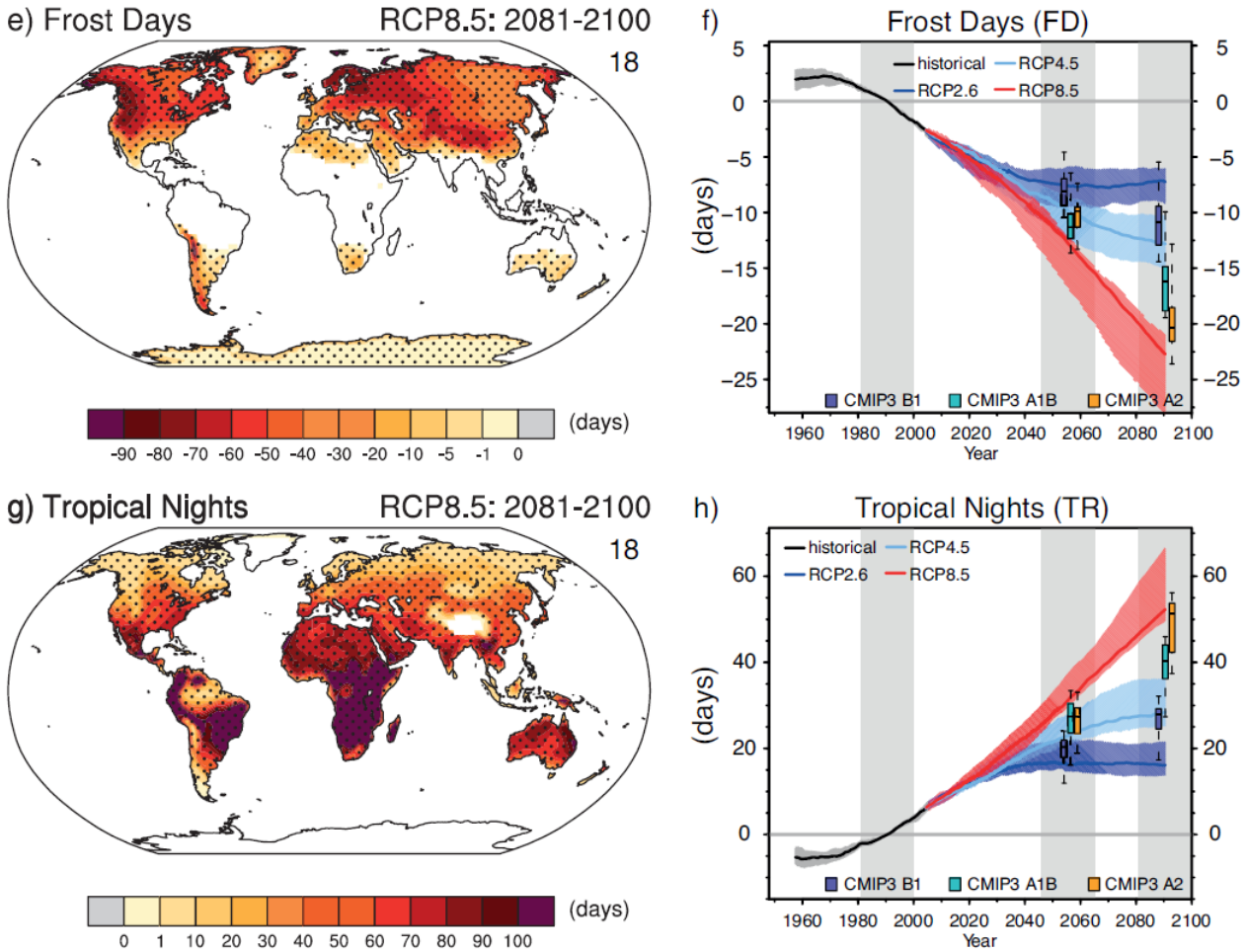
Faostat, 2014

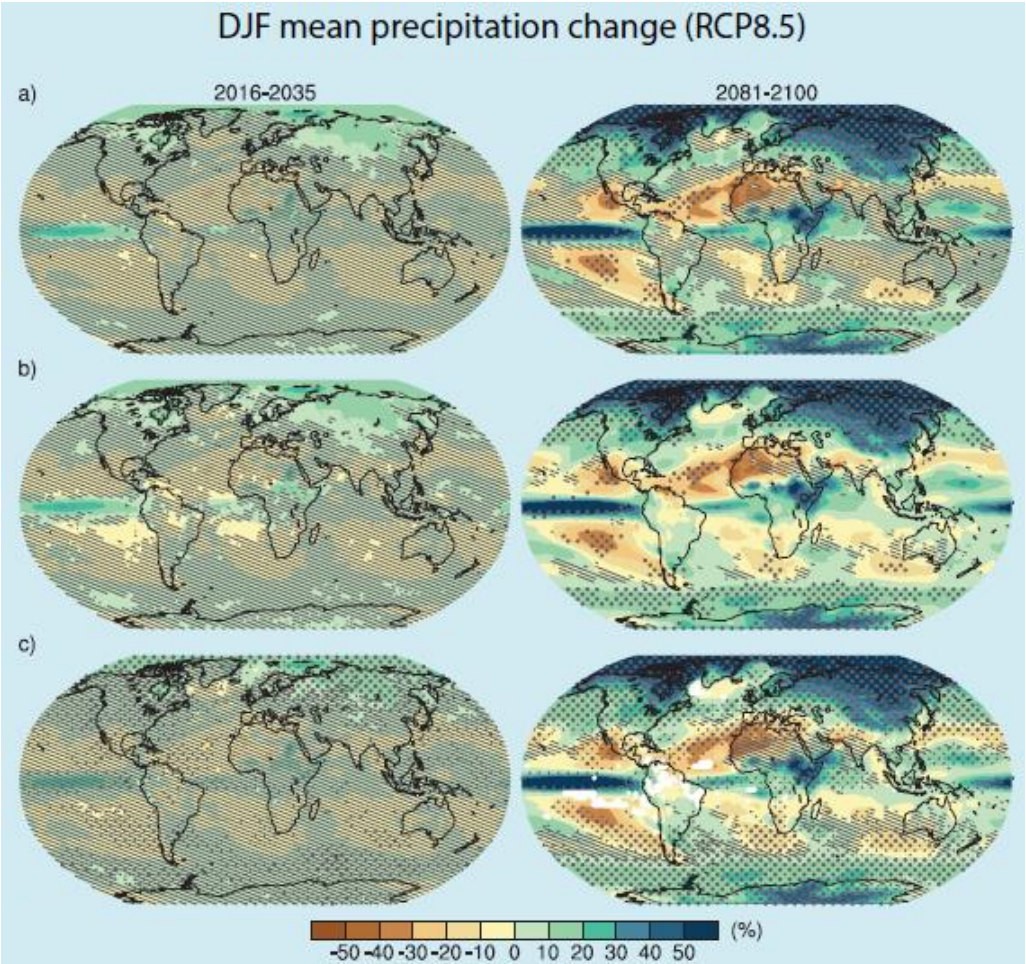

China
Harbin
Soybeans-Sorghum-Spring Wheat-Corn
Shenyang
Yining
Ürümqi
Oases
Kashi
Spring Wheat
Beijing
NORTH CHINA PLAIN
Taiyuan
Winter Wheat-Corn-Millet
Winter Wheat-Sorghum-Corn
Lanzhou
Xi'an
Chinese line of control
Indian claim
WHEAT PREDOMINANT
RICE PREDOMINANT
Shanghai
Sichuan Rice
Rice-Winter Wheat
Chengdu
Wuhan
Chongqing
Lhasa
Rice-Tea
Southwestern Rice
Xiamen
Kunming
Double-crop Rice
Guangzhou
Nanning
N/A
Taiwan
Hainan Dao
Percent in cultivation
0 10 30
Non-cultivated
Agricultural region boundary
0 500 Kilometers
0 500 Miles

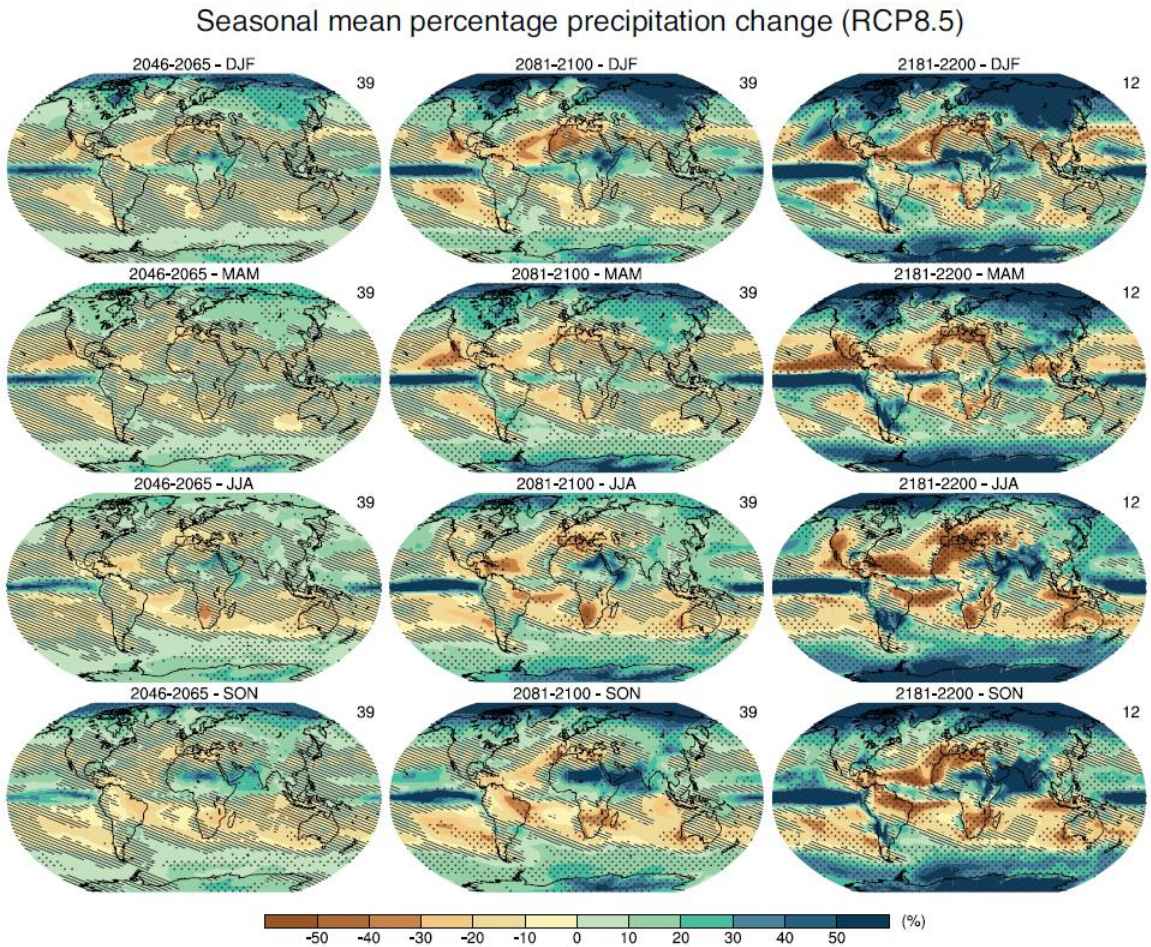

FINLAND
RUSSIA
Omsk
60 °N
50 °N
40 °N
UK
FRANCE
UKRAINE
KAZAKHSTAN
TURKEY
Spring wheat (WME6)
Winter wheat (WME11, WME12)

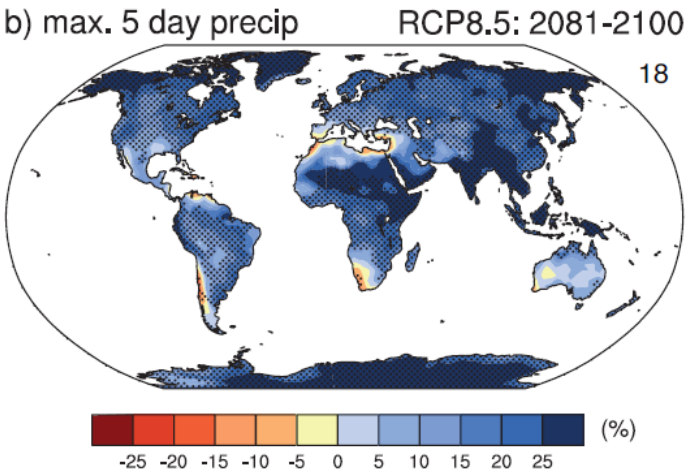

a) Coldest daily Tmin
RCP8.5: 2081-2100
18
(°C)
0 1 2 3 4 5 6 7 8 9 10 11
b)
Coldest daily Tmin (TNn)
historical
RCP4.5
RCP2.6
RCP8.5
(°C)
CMIP3 B1
CMIP3 A1B
CMIP3 A2
1960 1980 2000 2020 2040 2060 2080 2100
Year
c) Warmest daily Tmax
RCP8.5: 2081-2100
18
(°C)
0 1 2 3 4 5 6 7 8 9 10 11
d)
Warmest daily Tmax (TXx)
historical
RCP4.5
RCP2.6
RCP8.5
(°C)
CMIP3 B1
CMIP3 A1B
CMIP3 A2
1960 1980 2000 2020 2040 2060 2080 2100
Year

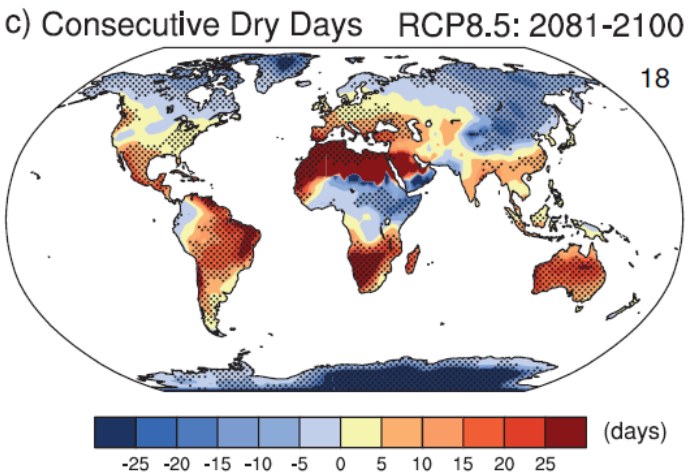
IPCC 2014


e) Frost Days
RCP8.5: 2081-2100
18
(days)
-90 -80 -70 -60 -50 -40 -30 -20 -10 -5 -1 0
f)
Frost Days (FD)
historical
RCP4.5
RCP2.6
RCP8.5
(days)
CMIP3 B1
CMIP3 A1B
CMIP3 A2
1960 1980 2000 2020 2040 2060 2080 2100
Year
g) Tropical Nights
RCP8.5: 2081-2100
18
(days)
0 1 10 20 30 40 50 60 70 80 90 100
h)
Tropical Nights (TR)
historical
RCP4.5
RCP2.6
RCP8.5
(days)
CMIP3 B1
CMIP3 A1B
CMIP3 A2
1960 1980 2000 2020 2040 2060 2080 2100
Year


DJF mean precipitation change (RCP8.5)
a)
2016-2035
2081-2100
b)
c)
-50 -40 -30 -20 -10 0 10 20 30 40 50
(%)


Seasonal mean percentage precipitation change (RCP8.5)
2046-2065 - DJF
39
2081-2100 - DJF
39
2181-2200 - DJF
12
2046-2065 - MAM
39
2081-2100 - MAM
39
2181-2200 - MAM
12
2046-2065 - JJA
39
2081-2100 - JJA
39
2181-2200 - JJA
12
2046-2065 - SON
39
2081-2100 - SON
39
2181-2200 - SON
12
-50 -40 -30 -20 -10 0 10 20 30 40 50
(%)

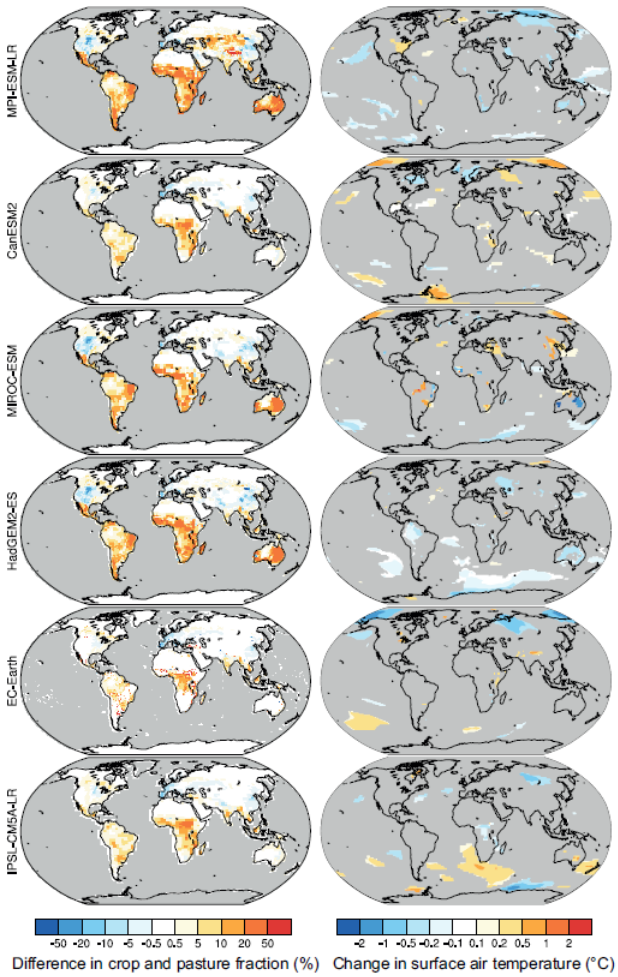




Increased temperature everywhere

Areas of increased rainfall (particularly in China),
and decreased rainfall (particularly Europe)

Increased occurrence of catastrophic events: see figure, also
Paper by Rötter; check occurrence of tropical stoms, monsoons


MPI-ESM-LR
CanESM2
MIROC-ESM
HadGEM2-ES
EC-Earth
IPSL-CM5A-LR
-50 -20 -10 -5 -0.5 0.5 5 10 20 50
Difference in crop and pasture fraction (%)
-2 -1 -0.5 -0.2 -0.1 0.1 0.2 0.5 1 2
Change in surface air temperature (°C)