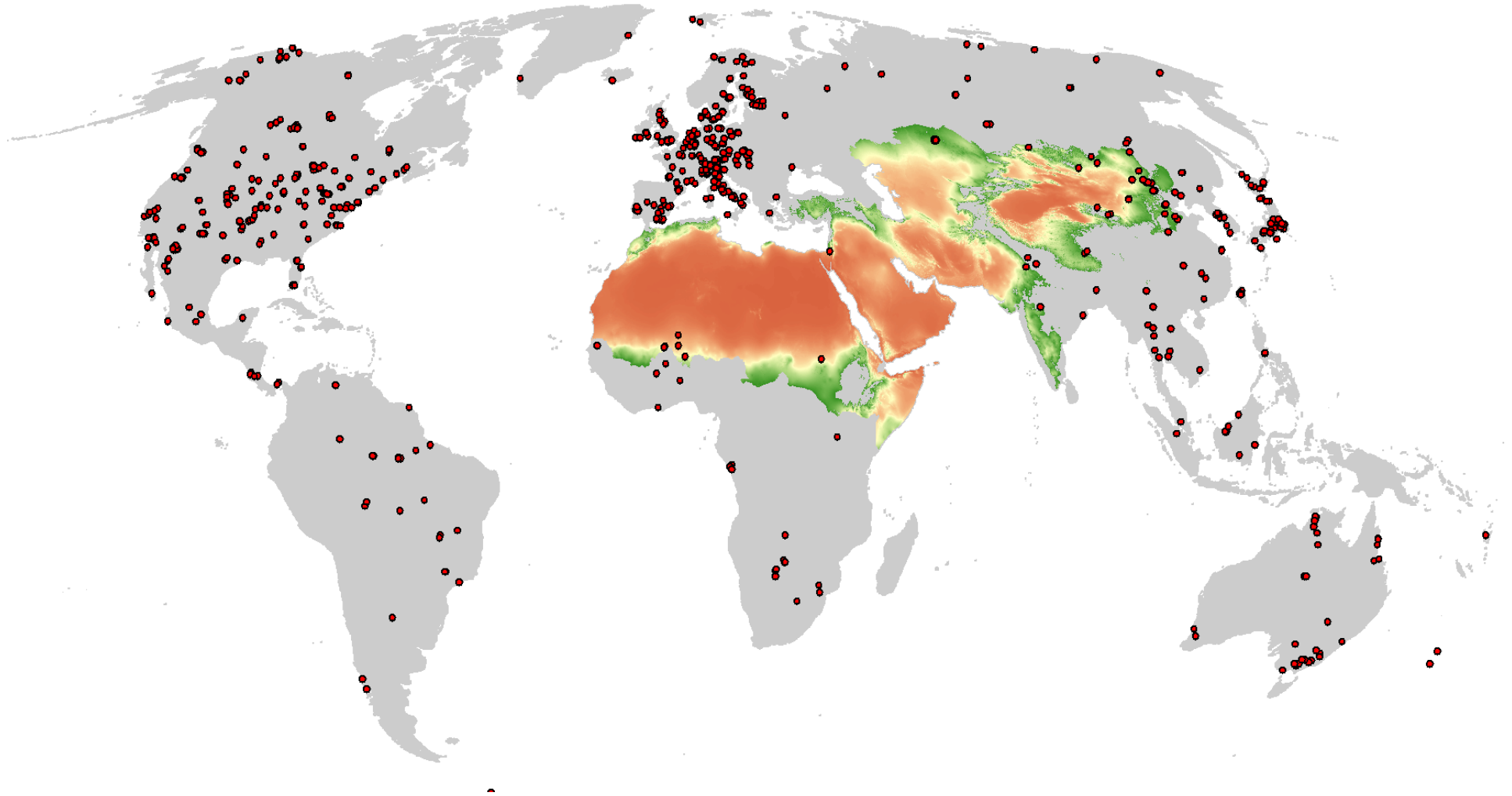# Climate Change in the DryArc Region
ICARDA's Vision to advance research and preparedness

Ajit Govind
Climatologist, ICARDA

First DryArc Workshop, Cairo.
25 Feb 2019

ICARDA
Science for resilient livelihoods in dry areas

# How (Agro)Ecosystems in the DryArc Behave under CC?

Some Thoughts on Dealing with CC issue in the DryArc

- How is the Climate Changing in the Dry Regions?

- Which meteorological parameters are changing and how? (Ta, RH, ET, Windspeed, Radiation....?)

- What are the hotspots of CC for each meteorological parameters?

- What are the spatio-temporal patterns in the Dry Region?

- How to use this information in our models (biophysical and socioeconomics) to understand the effect of CC on various processes in the DryArc countries.

- Identify efficient and robust methodologies to downscale coarse climate data to field (fine) scales.


RCP4.5

ΔT degrees
+3.5
-0.1

RCP8.5

ΔT degrees
+6.0
+2.0
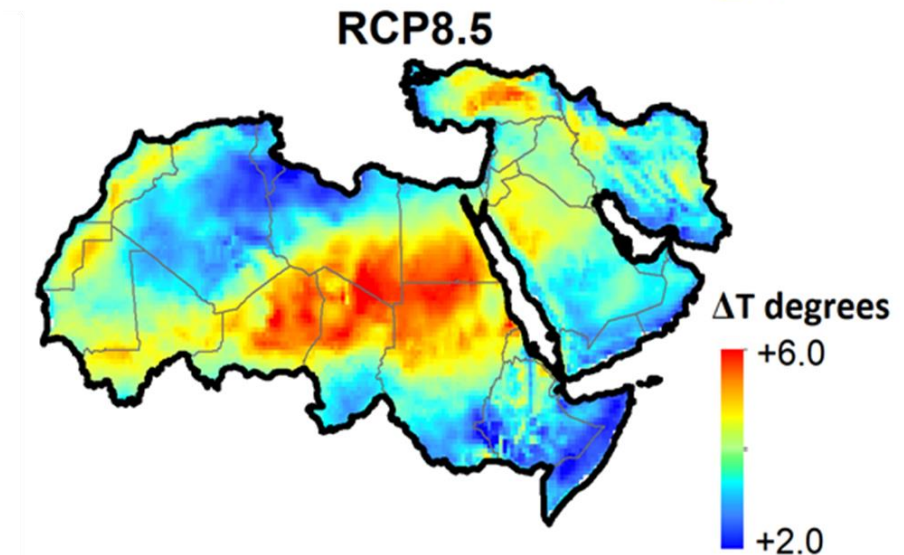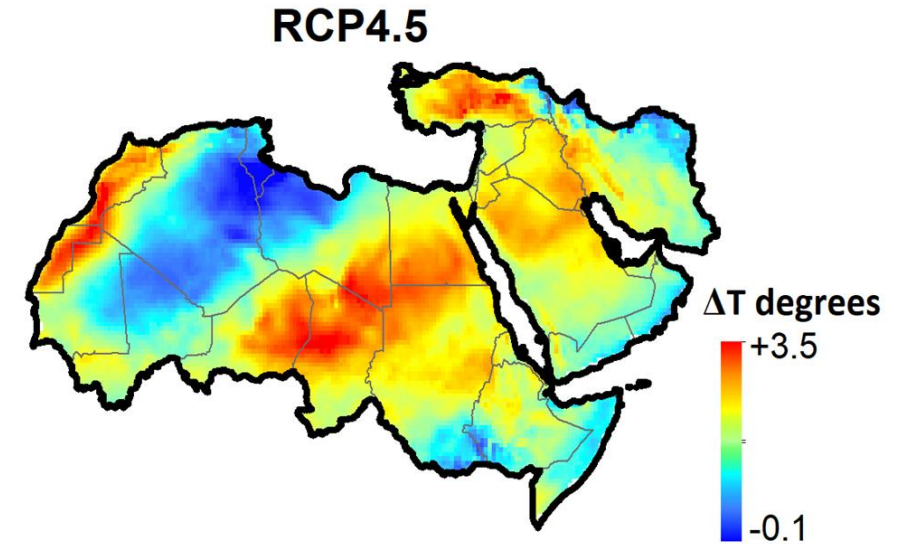
Hot spots of CC: Spatial Distribution of Statistically significant (*p<0.05*) Trends (*Slope of Linear Regression*) of Temperature and Precipitation over MENA (1980-2100)
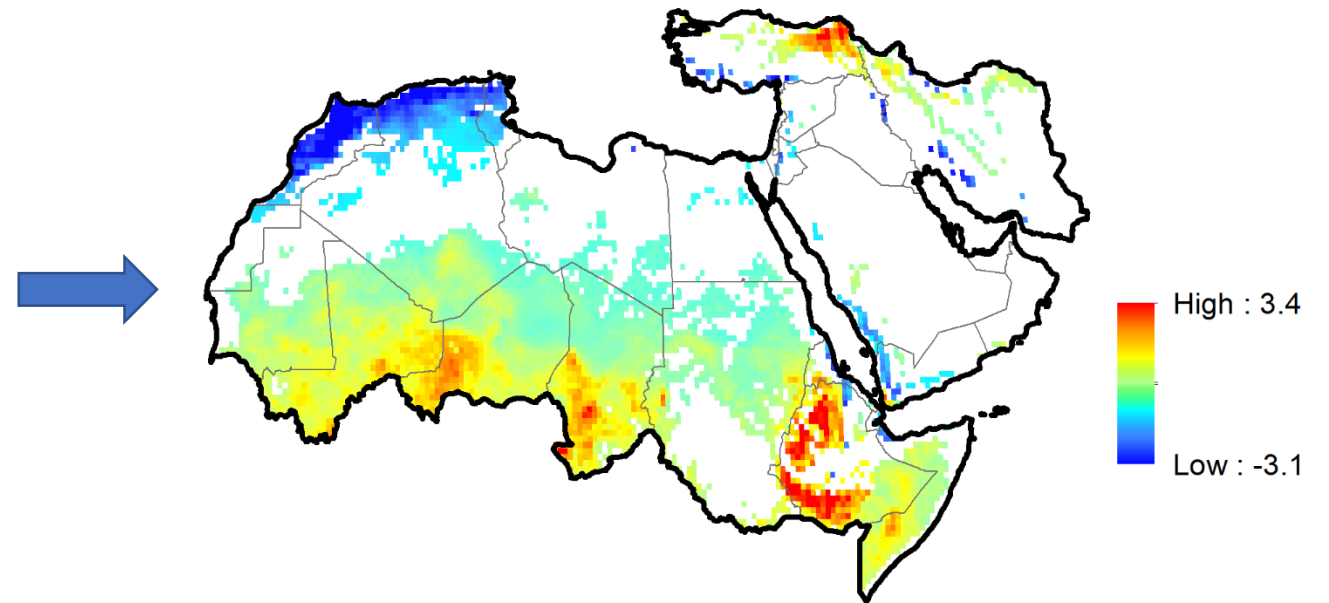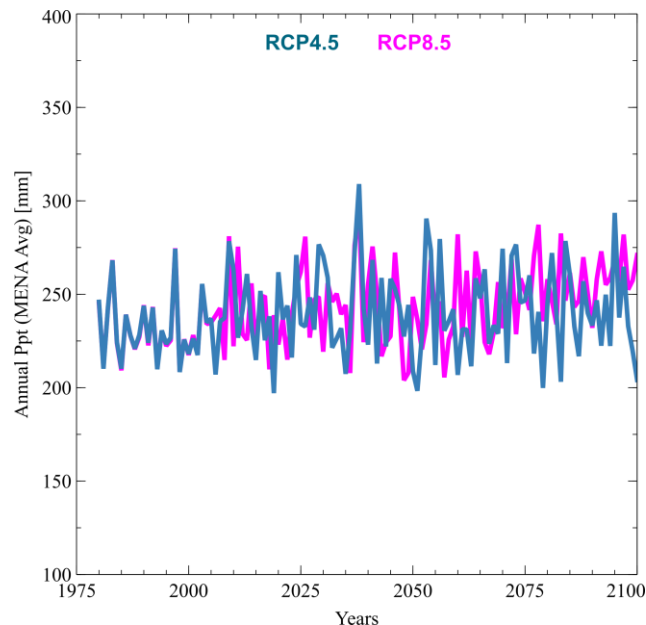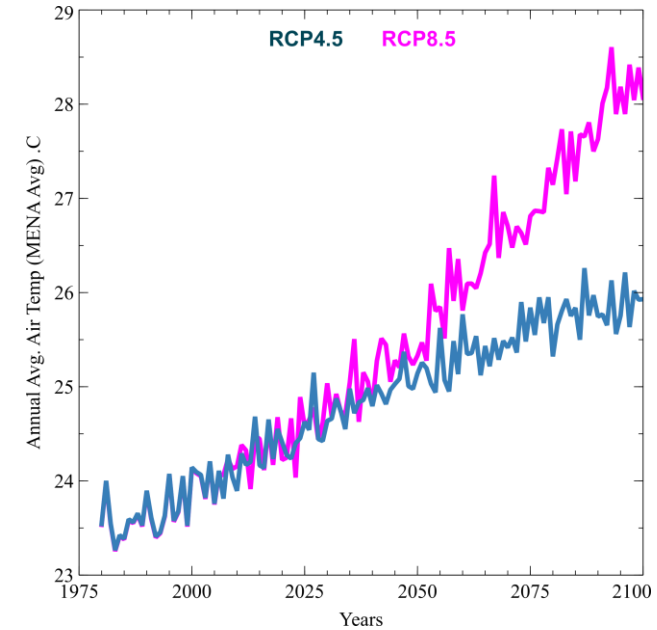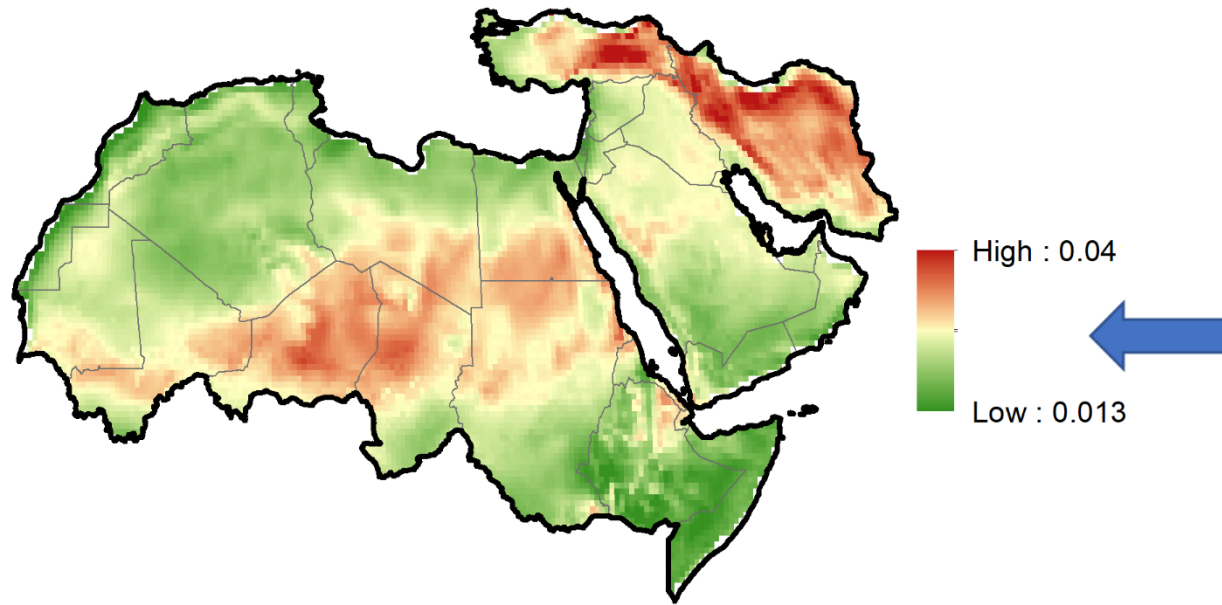
Take Home Messages

- Temperature is more dynamic than Precipitation under Climate Change.

- Hot Spots of Temperature Increase: Turkish and Iranian highlands, Niger, Chad, South Egypt

- Hot Spots of Ppt Increase: Ethiopian highlands, Niger, Chad, South Somalia and parts of Turkey

- Hot Spots of Ppt Decline: Highlands of Maghreb region (NW Africa)..Morocco, Algeria, Tunisia

- Why Mali, Niger, Chad show increased Ppt trends?

Plausible Explanation: Northwardly shift of the ITCZ under a changing Climate (LP systems develop on the Tibetian and Iranian highlands pulling ITCZ more northwards) . Our previous work show greening of Sahel and its links to increasing rainfall due to northwardly shifting of ITCZ
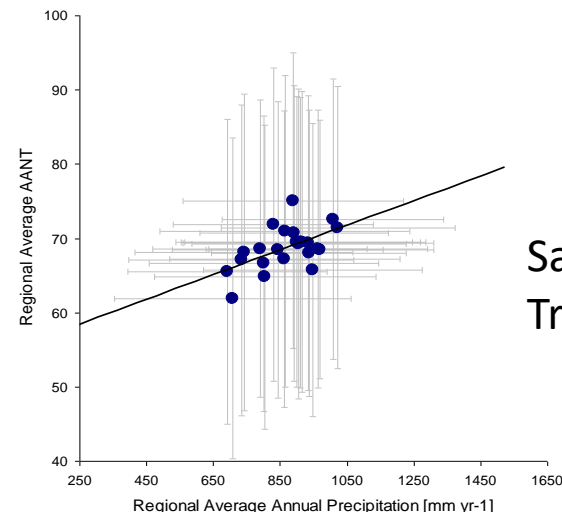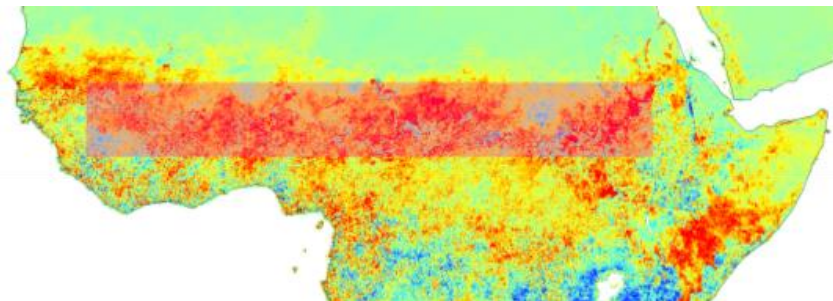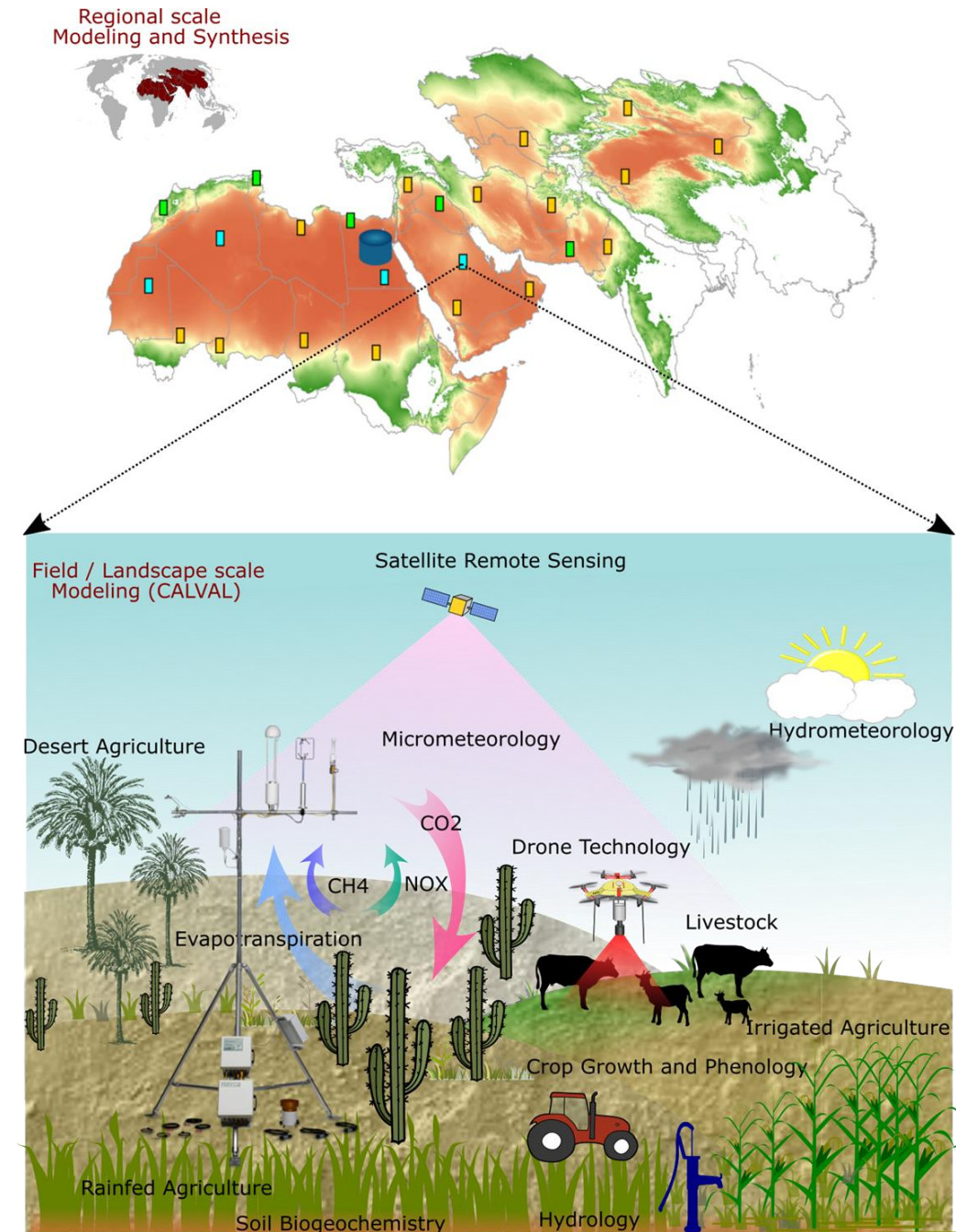

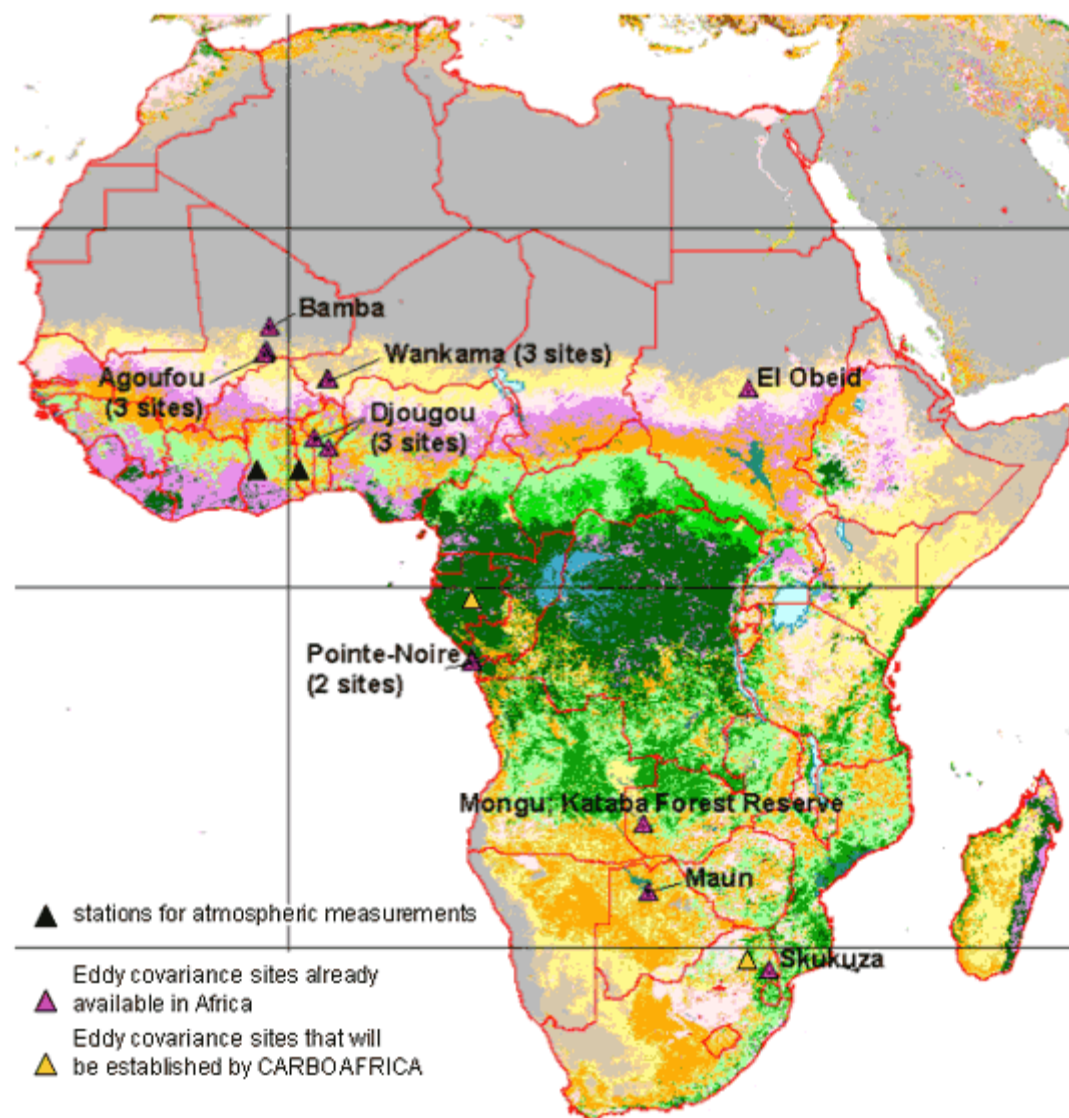Sahel is greening, along with the Northward Trend of the ITCZ

Inter Tropical Convergence Zone (ITCZ)-The Thermal Equator
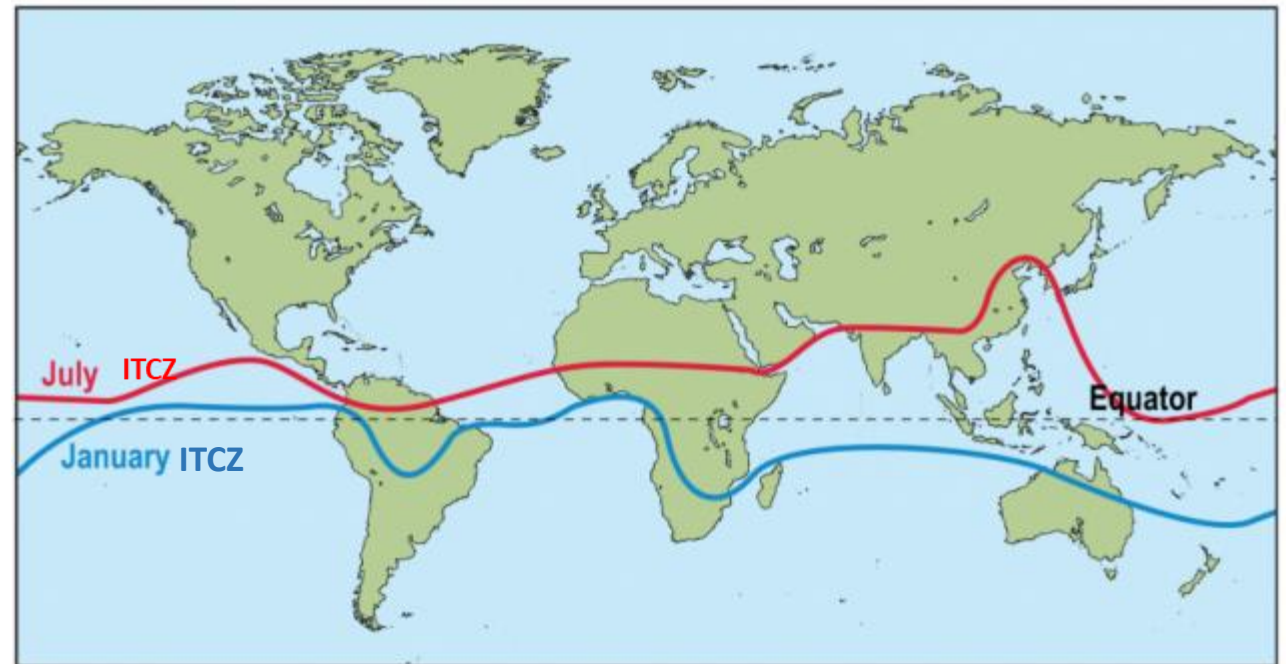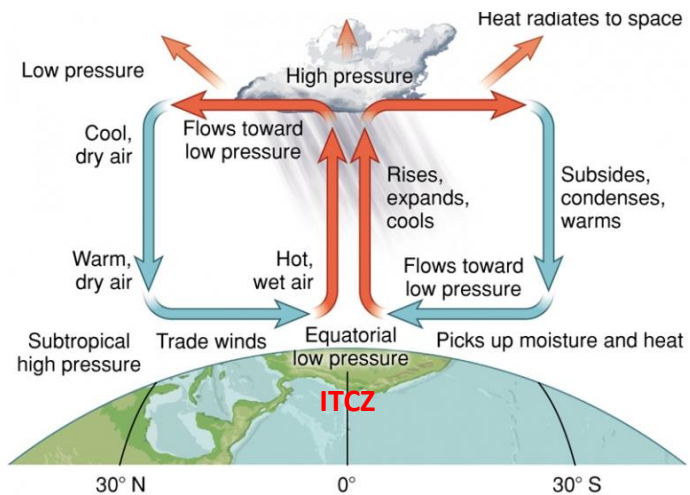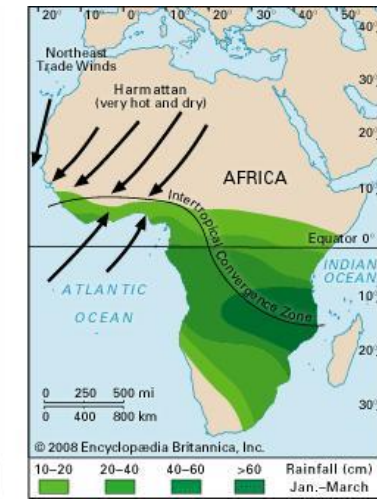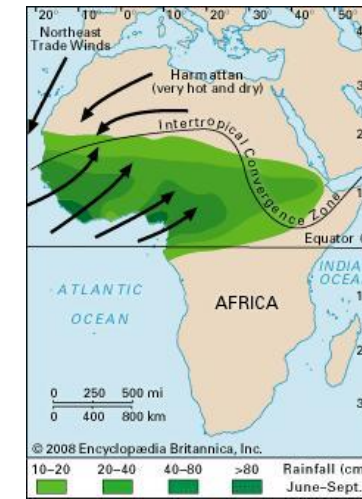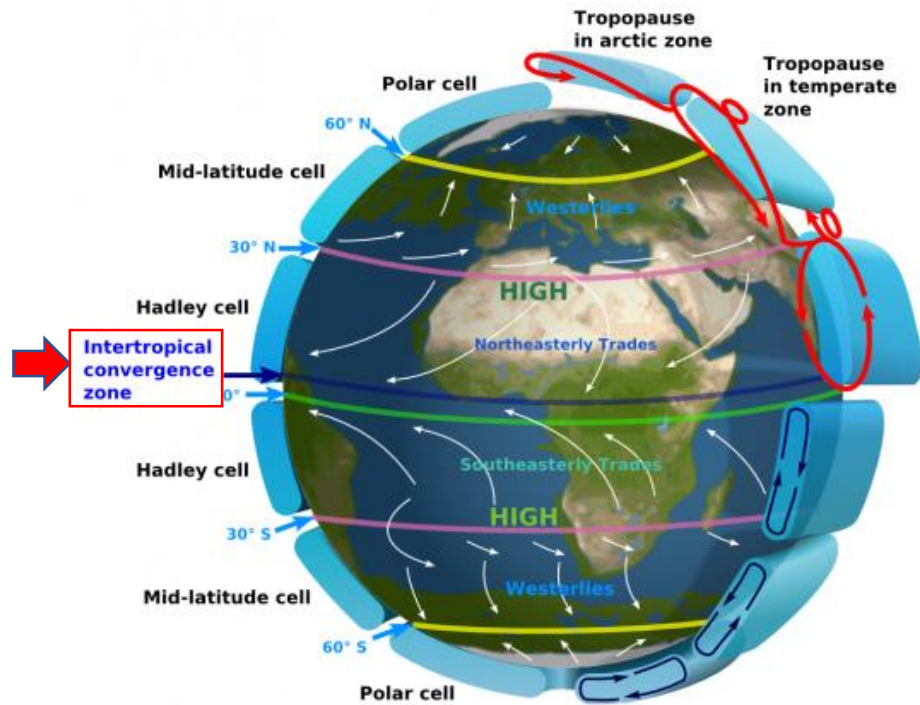
Need for a Collective Intelligence

- A schematic representation of a centrally-coordinated, multi-disciplinary, multi-locational , multi-scale, observational strategy having a standardized-protocol.

- Enrich a database on meteorological, hydrological, agronomic, livestock, edaphic, socioeconomic parameters in different ecosystems in the DryArc.

- Better understand CC and to aid in model CALVAL and analysis.

- It is also a strategy to enter into partnerships and engaging various actors in the region.

Bamba

Wankama (3 sites)

Agoufou
(3 sites)

El Obeid

Djougou
(3 sites)

Pointe-Noire
(2 sites)

Mongu; Kataba Forest Reserve

Maun

▲ stations for atmospheric measurements

Skukuza

Eddy covariance sites already
▲ available in Africa

Eddy covariance sites that will
▲ be established by CARBOAFRICA

CARBOAFRICA

Quantification, understanding and prediction of carbon
cycle and other GHG gases in Sub-Saharan Africa

# Possible Research Topics in DryArc (CC-focused)

1. CC-induced Water Scarcity in DryArc regions: Ag Productivity

2. GHG Fluxes across various (agro) ecosystems under CC and Management (crop, livestock, pristine, urban)

3. Alternative cropping system (Food system) design in DryArc

4. CC-inspired Plant breeding (in a true ecophysiological sense)-phytotrons, models

5. Achieving and degradation neutrality and optimal land use planning under CC

6. Capacity building in multiscale ecohydrological modeling

Example of a CC-focused research program in DryArc
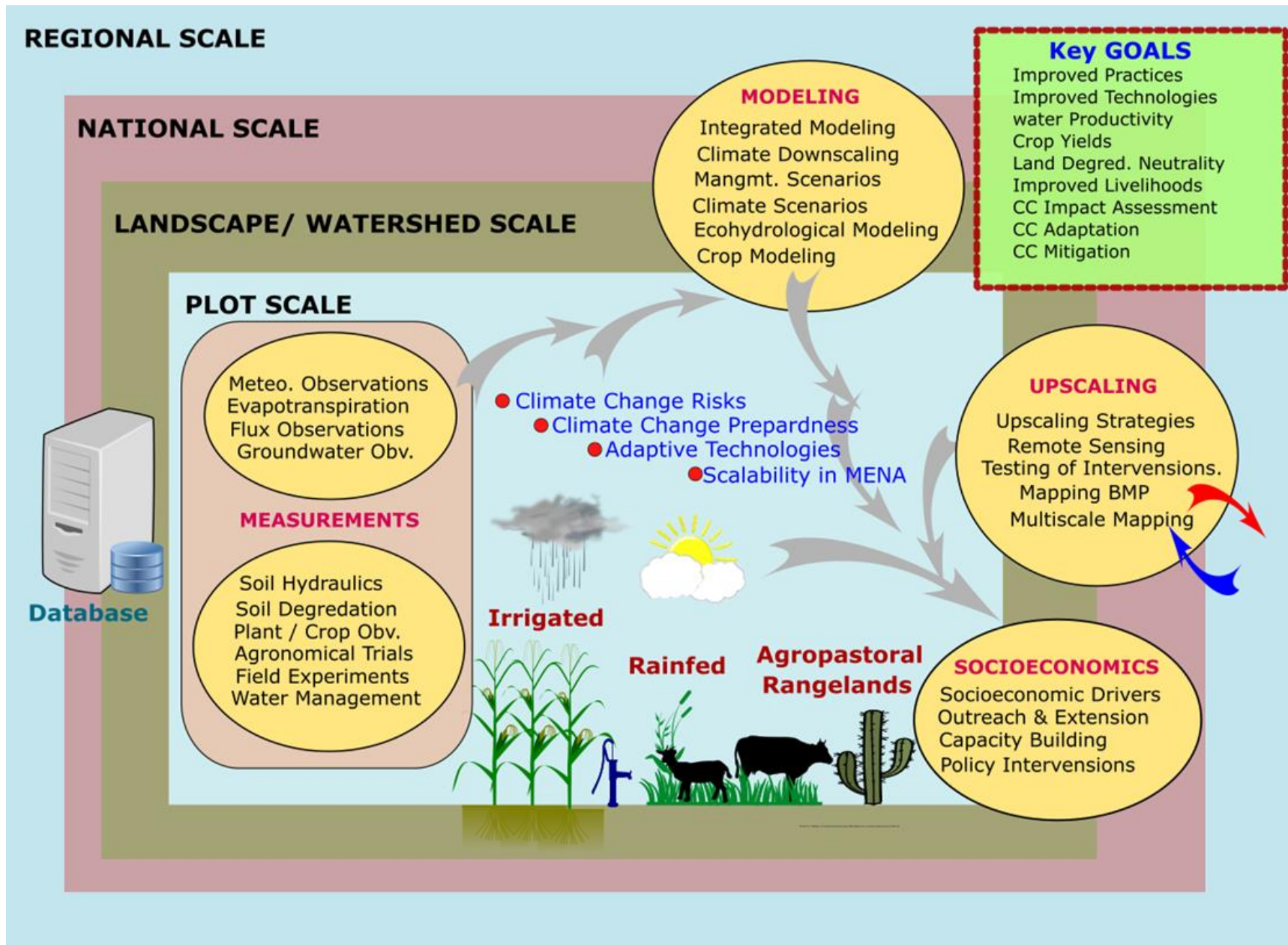
Key areas to support climate change research identified by ICARDA in its agenda along with its partners:

1. Development of Collective Intelligence to Support Climate Change Research in the MENA.

2. Spatio-temporal downscaling and analysis of regional climate datasets under different projections and assimilate it into various models to evaluate the effects of CC on agroecosystems.

3. Towards Resilient societies: transformative policy for stabilization and reconstruction under Climate Change.

4. Foresight advice on resilient food systems under Climate Change.

5. Sustainability of Agri-food Systems in the Food Baskets of MENA under Climate Change.

6. Livelihood approaches towards sustainable agriculture in marginal rangelands of MENA under Climate Change.
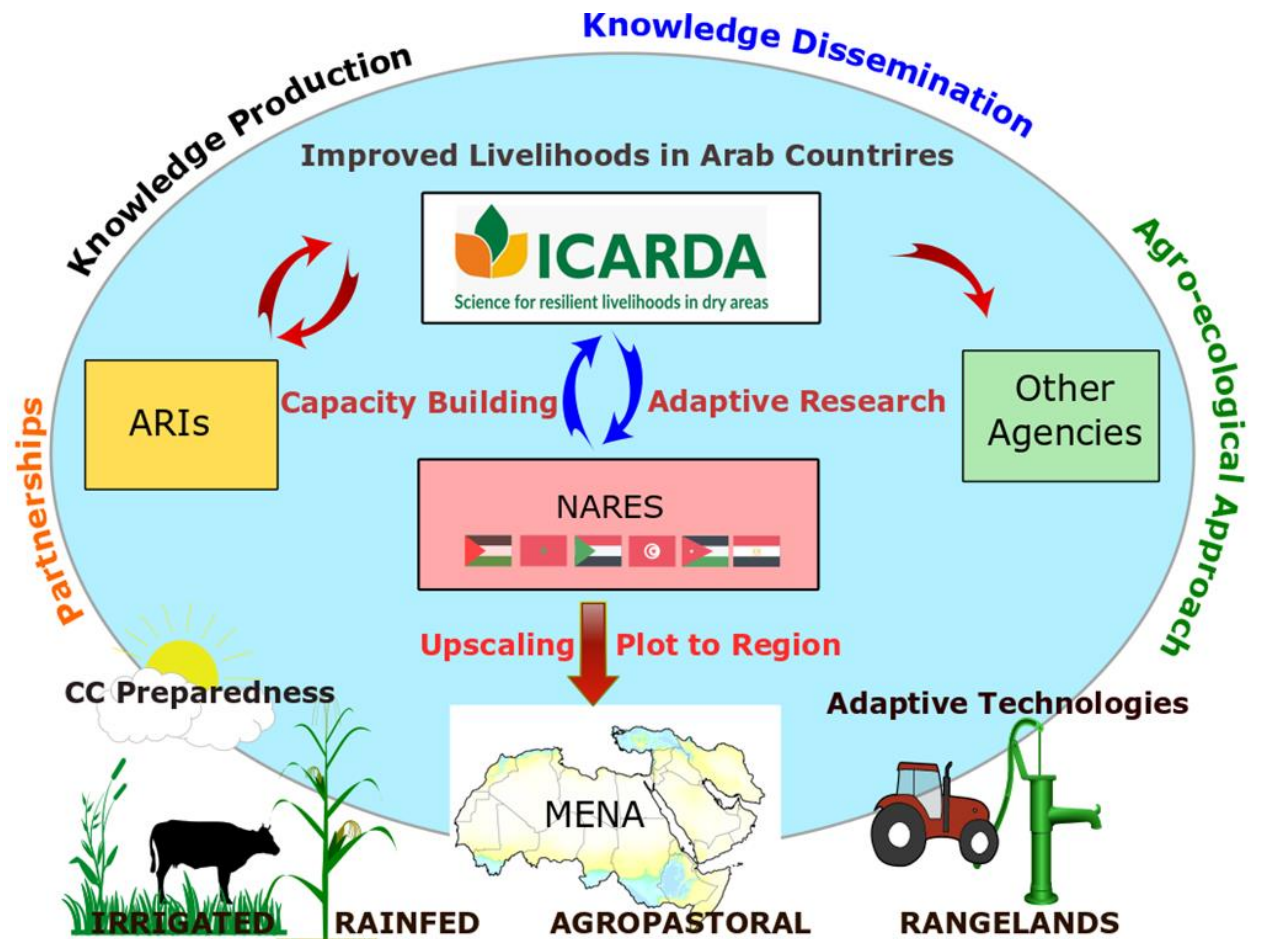
ICARDA's vision and spirit for climate change research activities is through close collaboration with its in-country partners and programs, the corner stones that collectively contribute to enhancing livelihoods in the MENA Region with a focus on all the three (agro) ecosystems viz. Irrigated, Rainfed and Agropastoral

Things we are (or Plan to) doing.

1. Development of Collective Intelligence to Support Climate Change Research in the MENA.

2. Iraq Climate Change Program (UNEP-UNFCC), Impact and Assesment

3. CCAFS-led Special Climate Change Initiative

4. CC-induced Water Scarcity and Ag Productivity (ArabFund)

5. Plans to collaborate with ICAR-India (CC and Land Degredation)

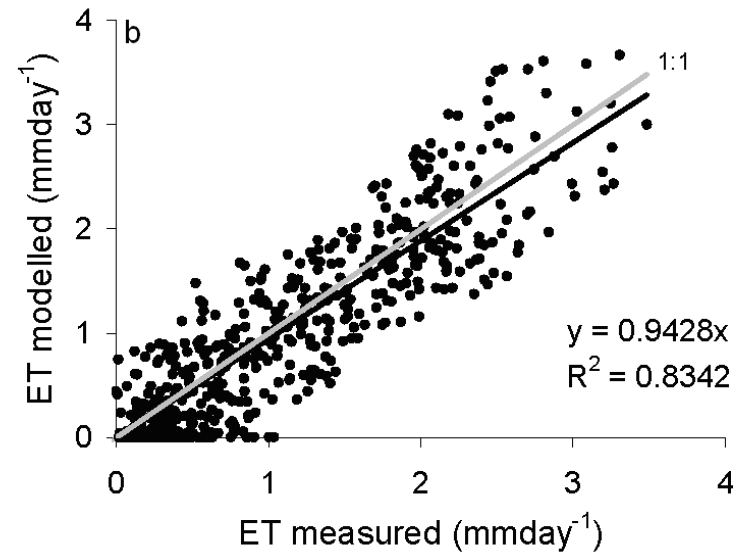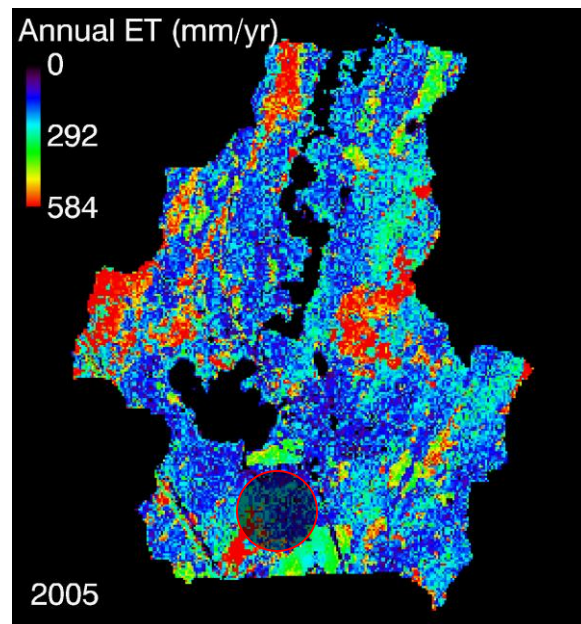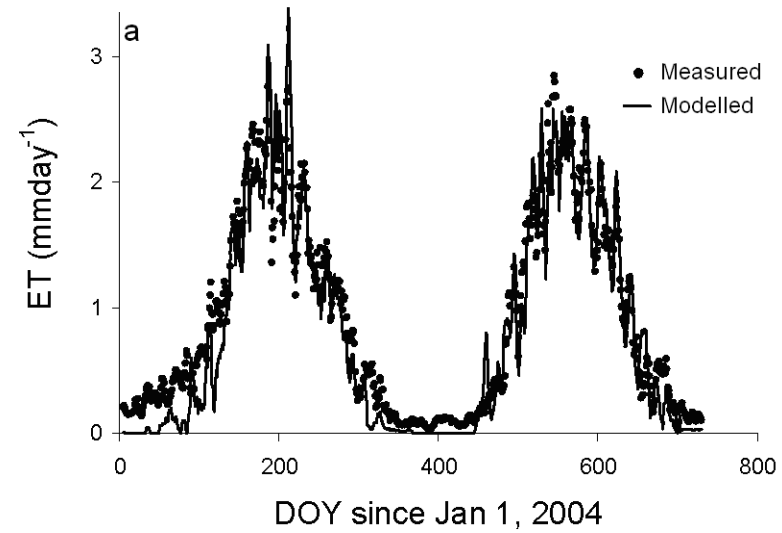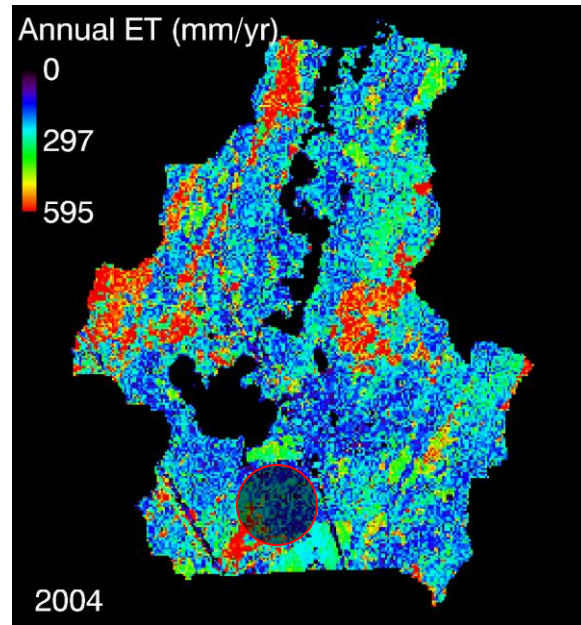6. MENA-scale GHG fluxes under CC (a PhD student project).

The STEPS model

STEPS- **S**imulator of **T**errestrial **E**cohydrological **P**rocesses and **S**ystems

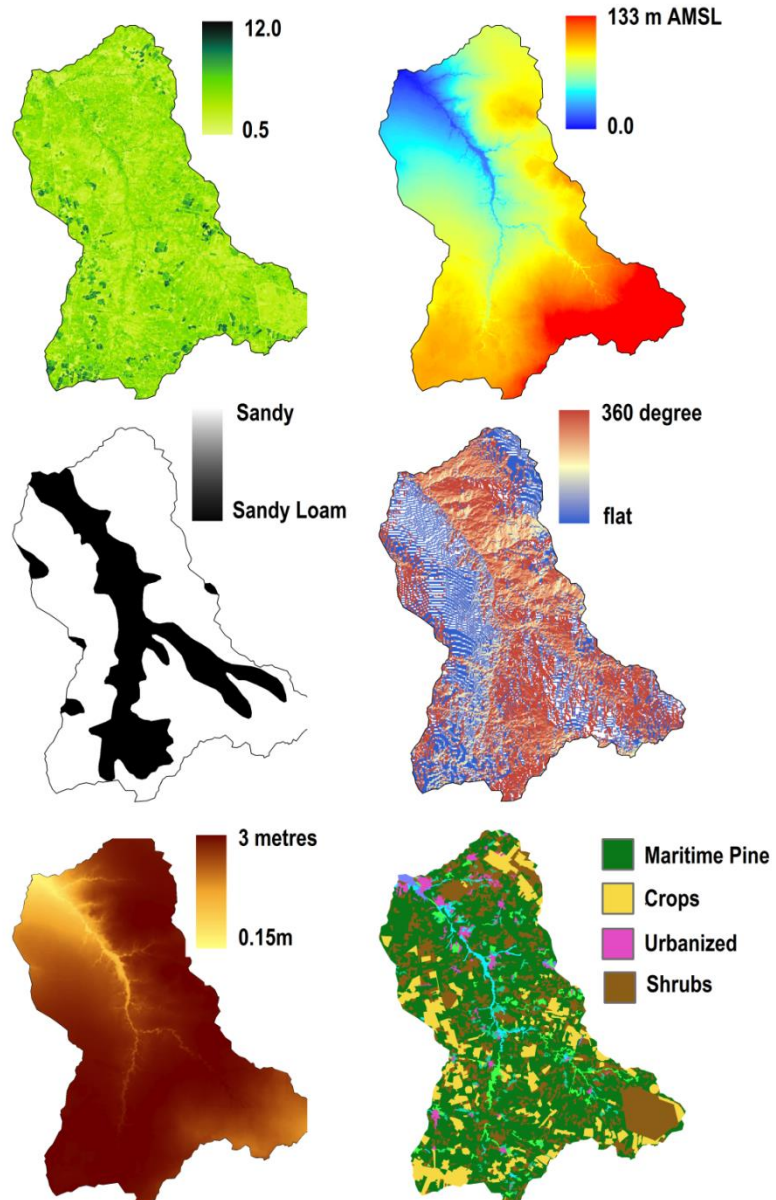Surface/Subsurface Flow Redistribution to/from Neighboring Pixels
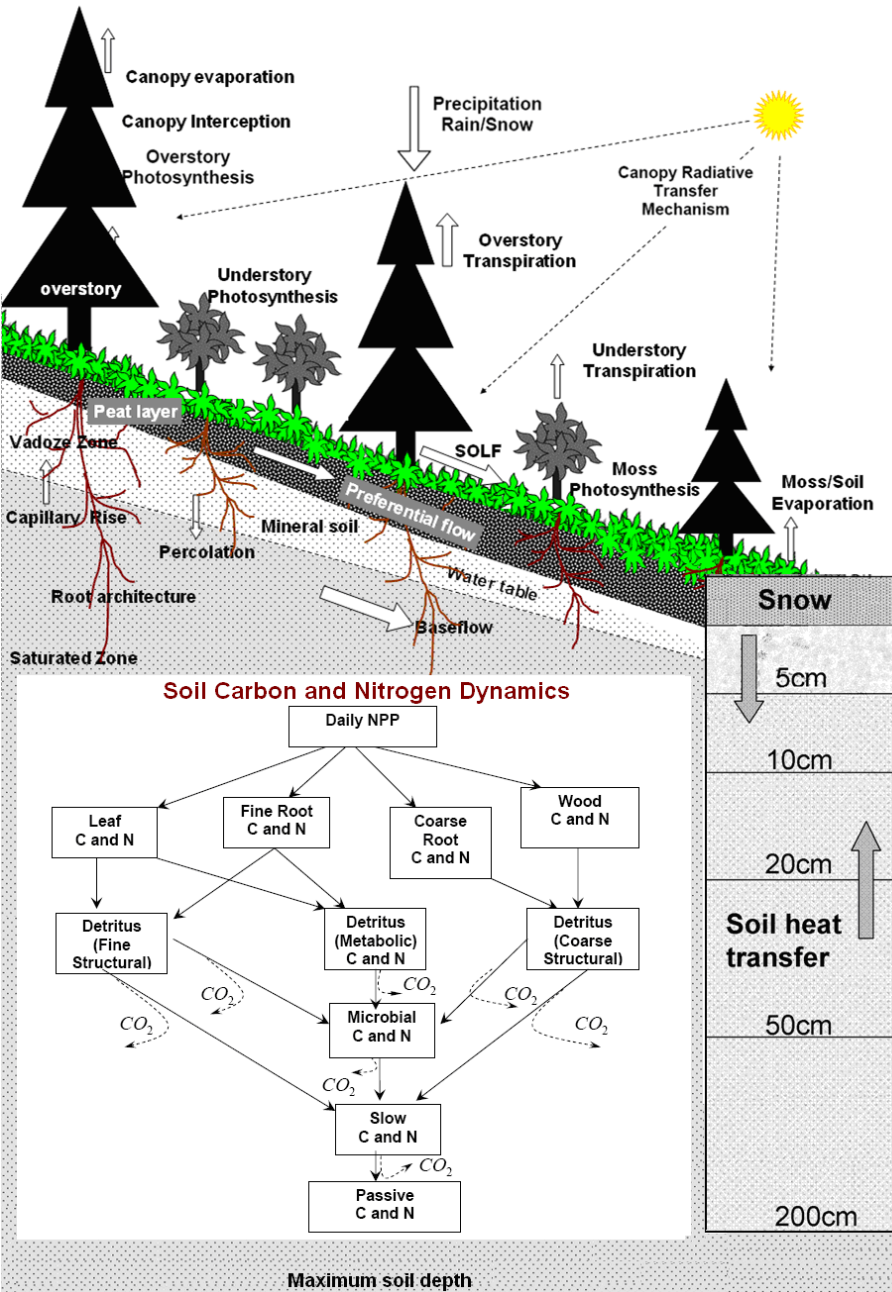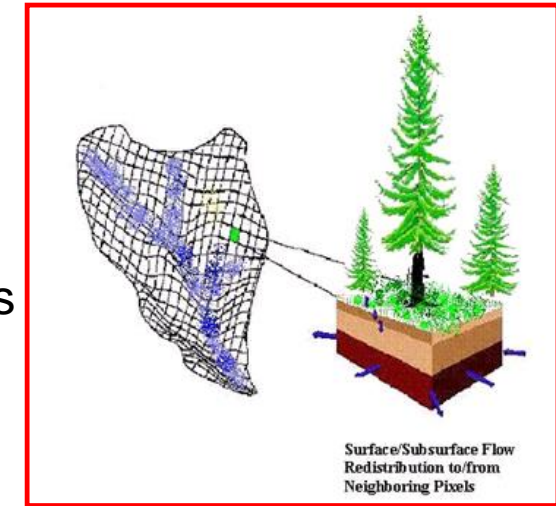
- Spatially- Explicit
- Spatial resolution is flexible
- Daily model
- Process-based
- Feed-back mechanisms addressed
- BGCs (C,W,N cycles) are tightly coupled
- Agroecosystems (C3 and C4 plants)
- DOC, DON etc
- Fate of N Fertilizer transformations
- Forest / Agroecosystem Management
- Biotic Stresses- Population Dynamics of an endemic pest

Govind et al. [2009a], J of Hydrology

Govind et al. [2009b], J of Geophysical Res.

Govind et al. [2015], Ecological Modeling

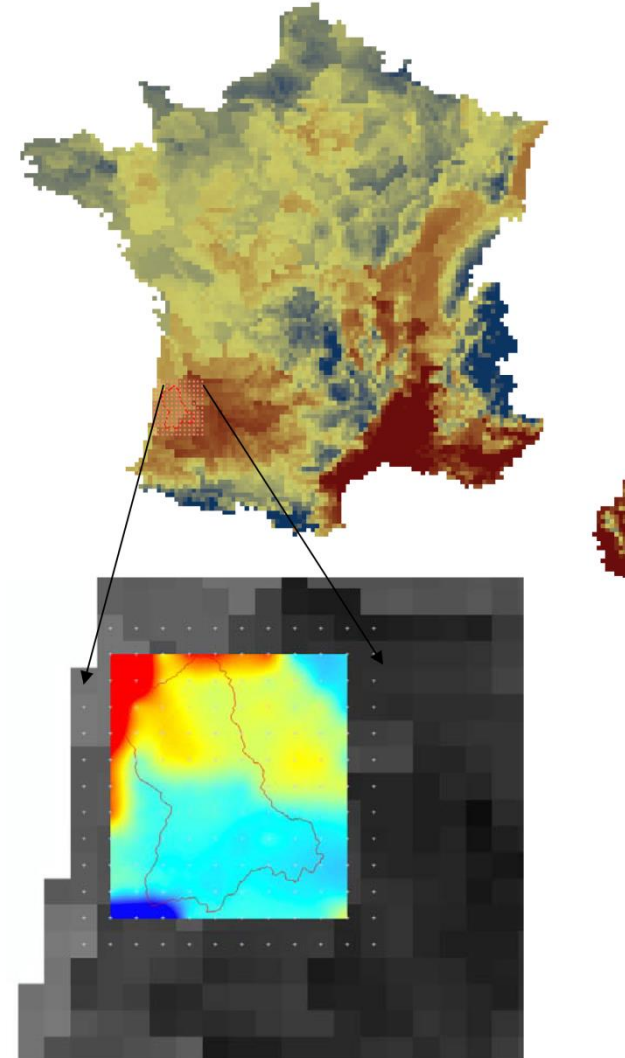# Validation of Simulated Evapotranspiration with EC-Measurements

Govind et al. [2009a] J of Hydrology

Some of the Key Spatial Inputs Used

Gridded Meteorological Forcing

SAFRAN data was downscaled using geostatistical techniques

Govind et al. [2015], Ecological Modeling

Spatial variation of annual ET and GPP over the Leyre Watershed

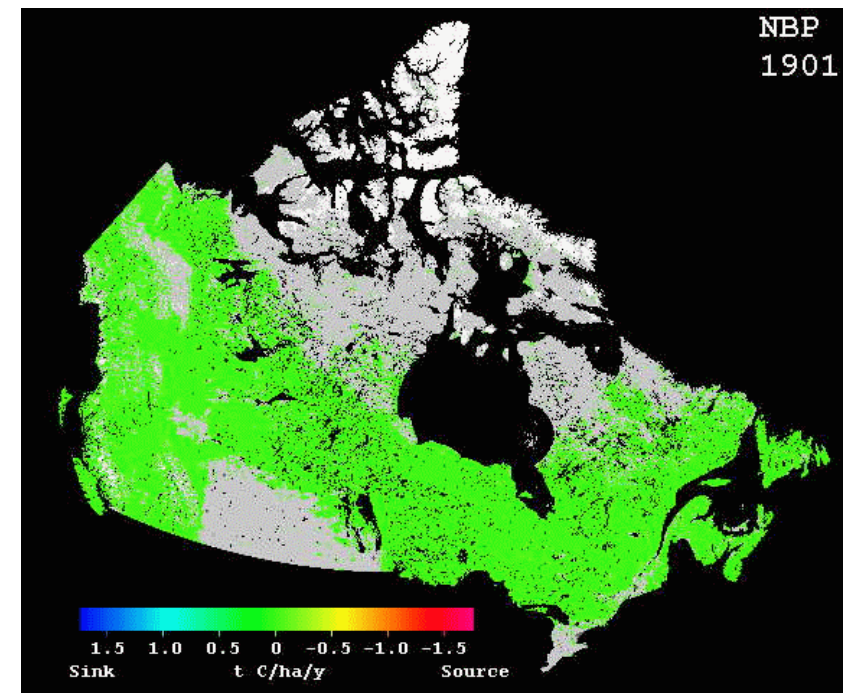*Govind et al. [2015], Ecological Modeling*
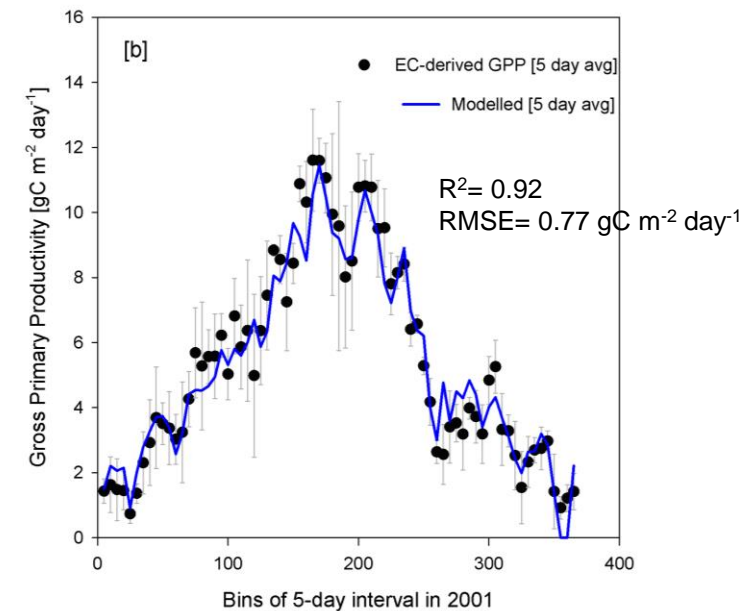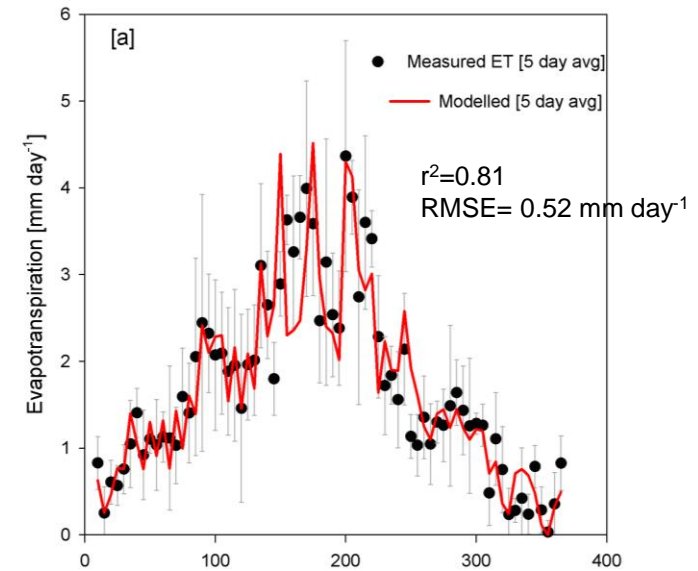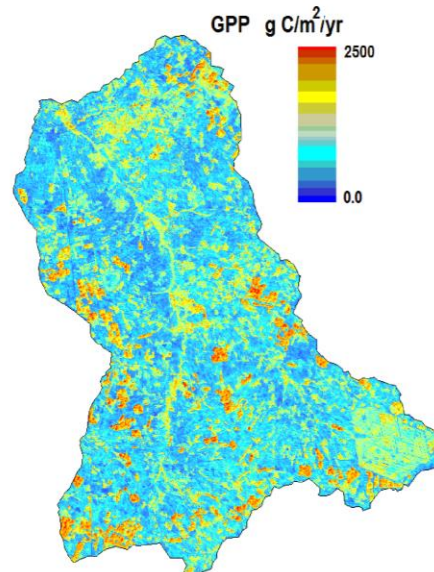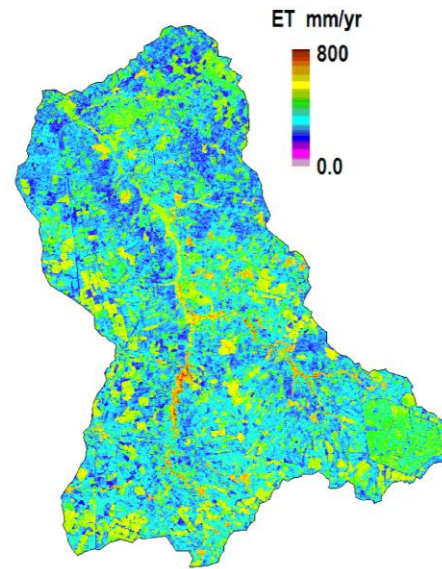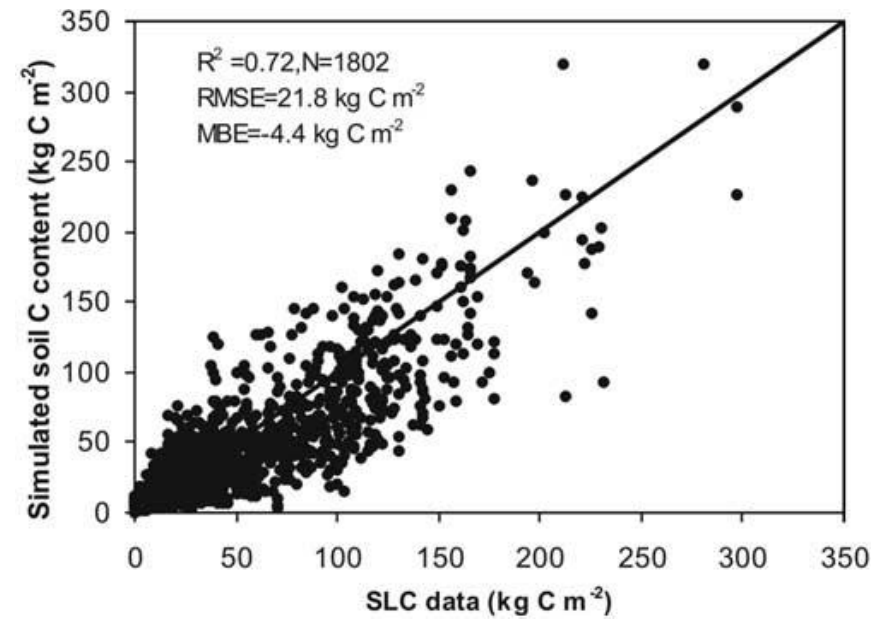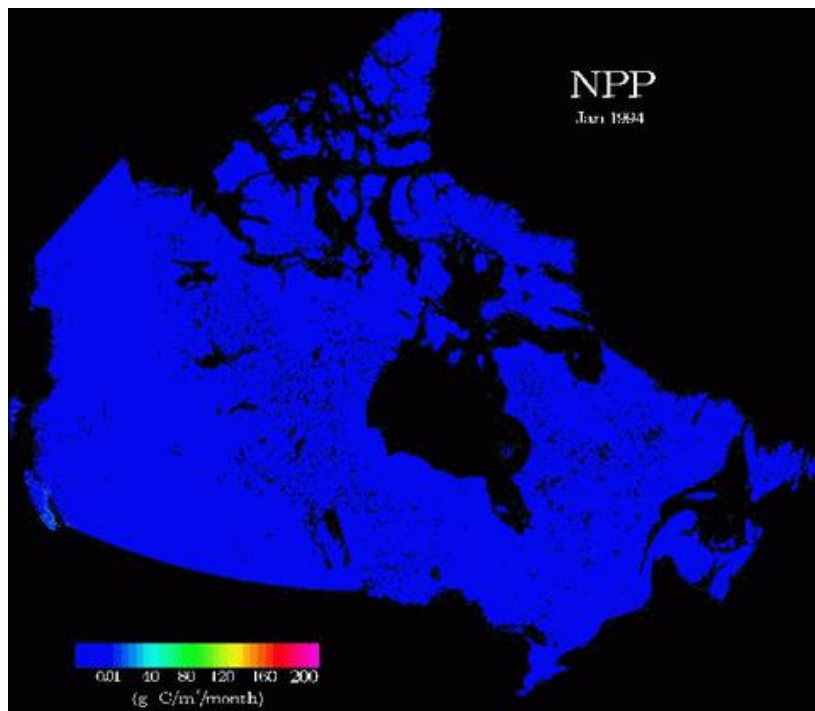
Ju et al. [2008], Global Biogeochemical cycles
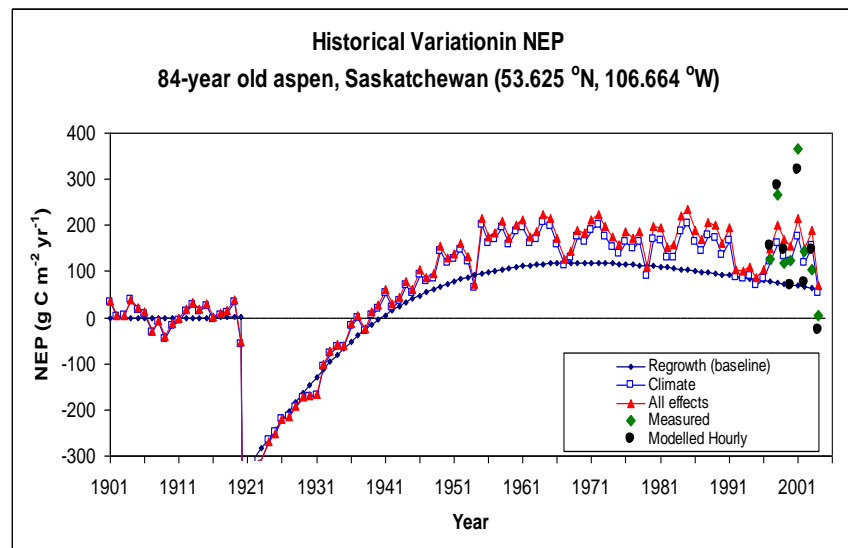
Chen et al. [2003] Tellus-B

Geophysical Impications of Irrigation-induced Greening of the Earth's Surface

My Hypothesis.
This is opposite of Charney's Hypothesis

Charney, J.G. (1975). Dynamics of deserts and drought in Sahel. Quart. J. Royal Meteor. Soc, 101, 193-202.
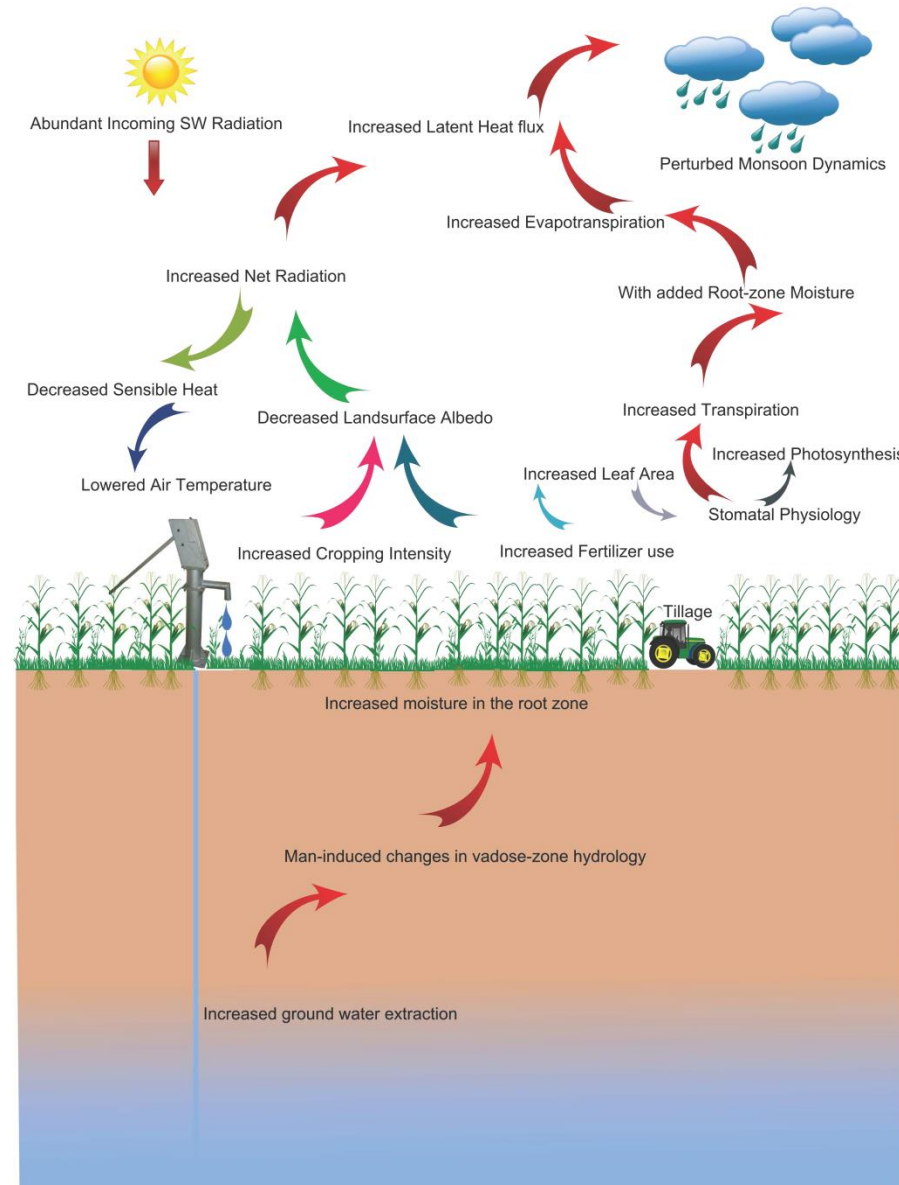

Jule Gregory Charney

Figure prepared by A. Govind

THANKS!!