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Challenges in agrometeorological research and applications

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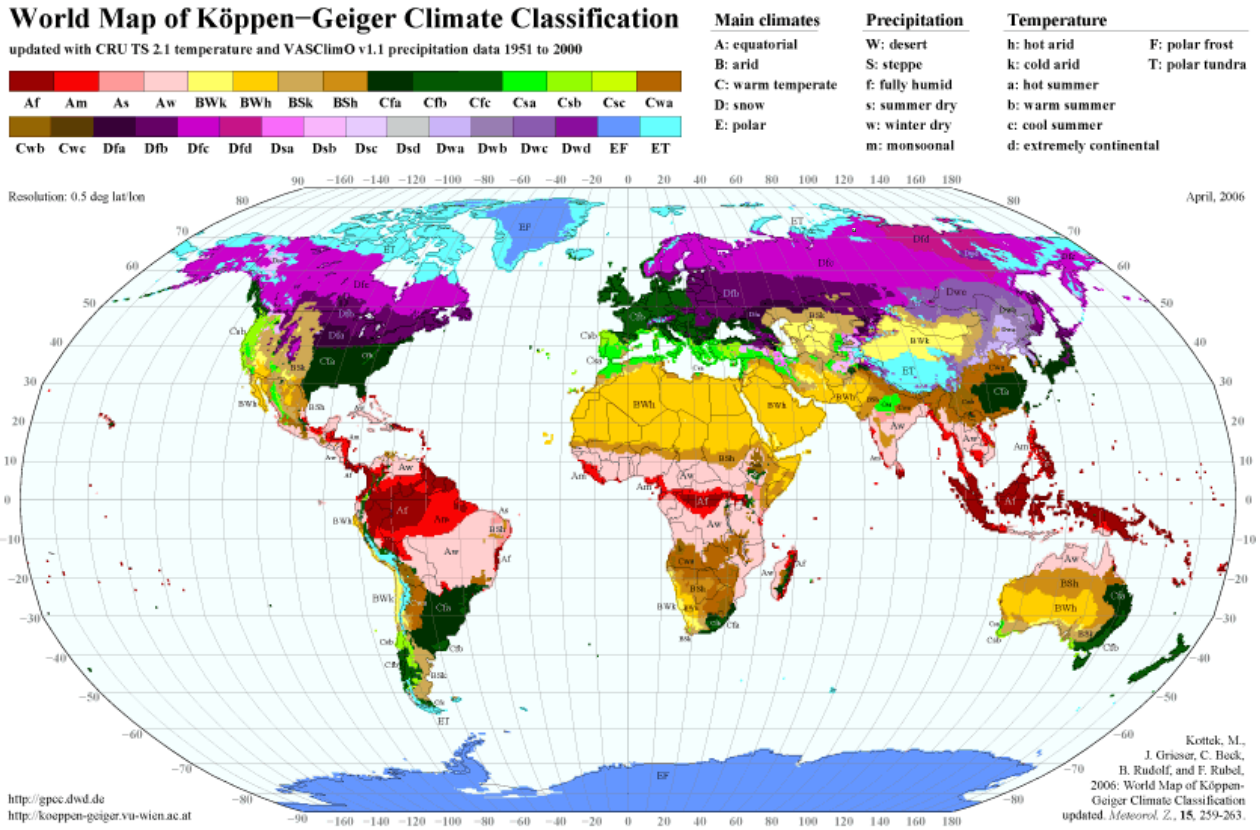
Overview

Agrometeorology is a very broad science with very “fuzzy borders.” Three subjects have been arbitrarily selected as “challenges” for applications (and research)

- A modern climate classification for agriculture
- Global distributions “maps” of crop types with their phenology
- “Simple” crop models

Climate classifications

The evergreen system of Wladimir Köppen (~1900)



Some history

- Most systems are threshold based (Köppen, Trewartha 1968, Ivanov 1948), index-based (Ivanov's moisture index, Thornthwaite's Precipitation Effectiveness Ratio 1931) and vegetation-oriented

- Water and energy balance is sometimes incorporated: ET by Thornthwaite (1948), radiation by Budyko (1955), vegetation period in Seljaninov's “agricultural classification” (1972)

- Sasko, Kloskov, Papadakis, botanists (Gaussen, de Martonne, Emberger), Lang, FAO (AEZ/LGP, 1985) etc.

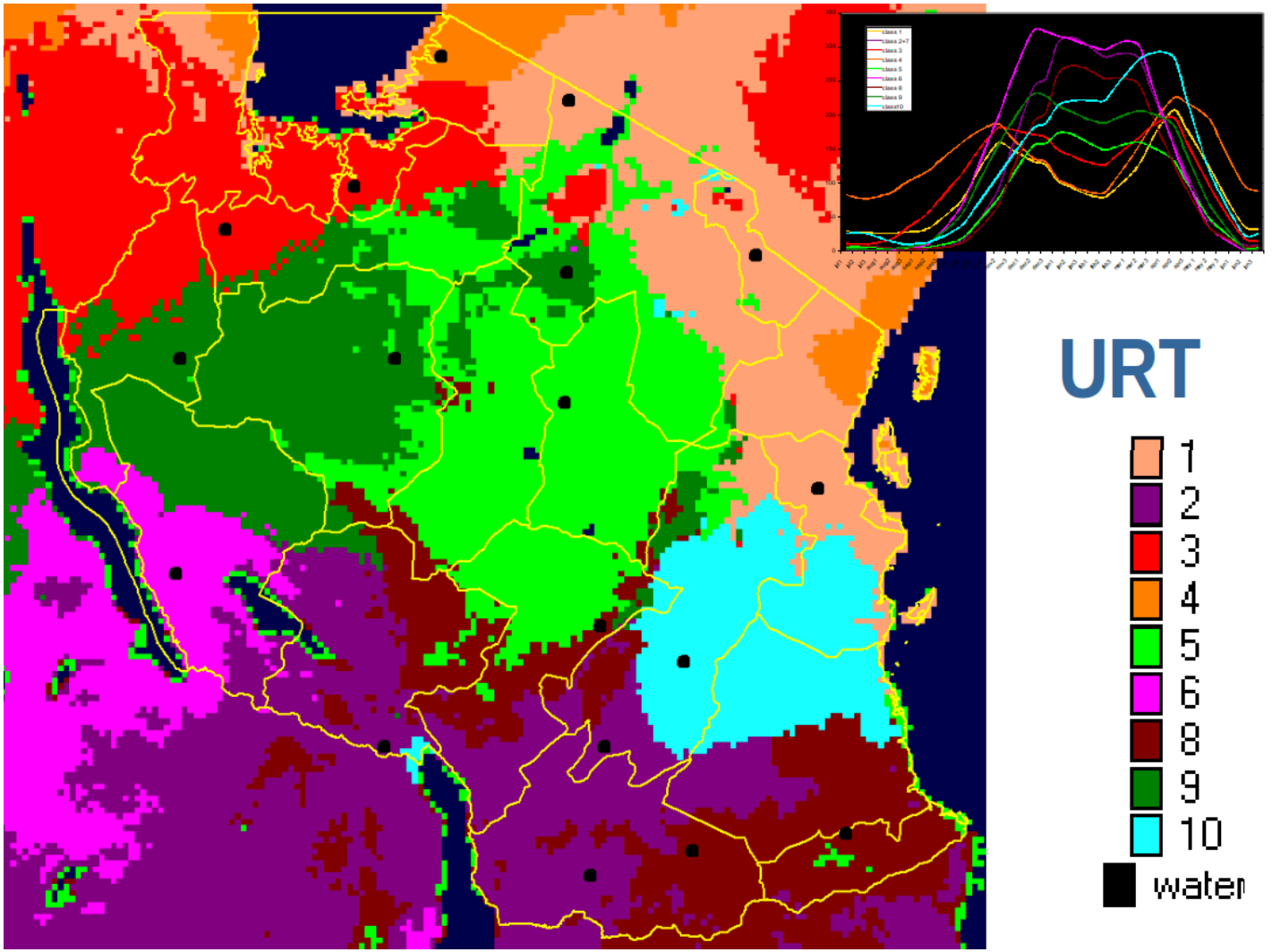
Why/how a “new” climate classification for agriculture

- Crops are are very “climate dependent” but they are “climate type independent”,because growing seasons are (usually) shorter that a calender year

- Availability of global climate + RS grids with **variability** (i.e. risk) and easily available spatial clustering techniques

Example of semi-automatic profile clustering & mapping

(Tanzania rainfall)



Why/how…

- Years to be subdivided into homogeneous “season-elements” accompanied by multifactorial risk patterns (“the climate complex”) and climate manipulation options (e.g. irrigation)

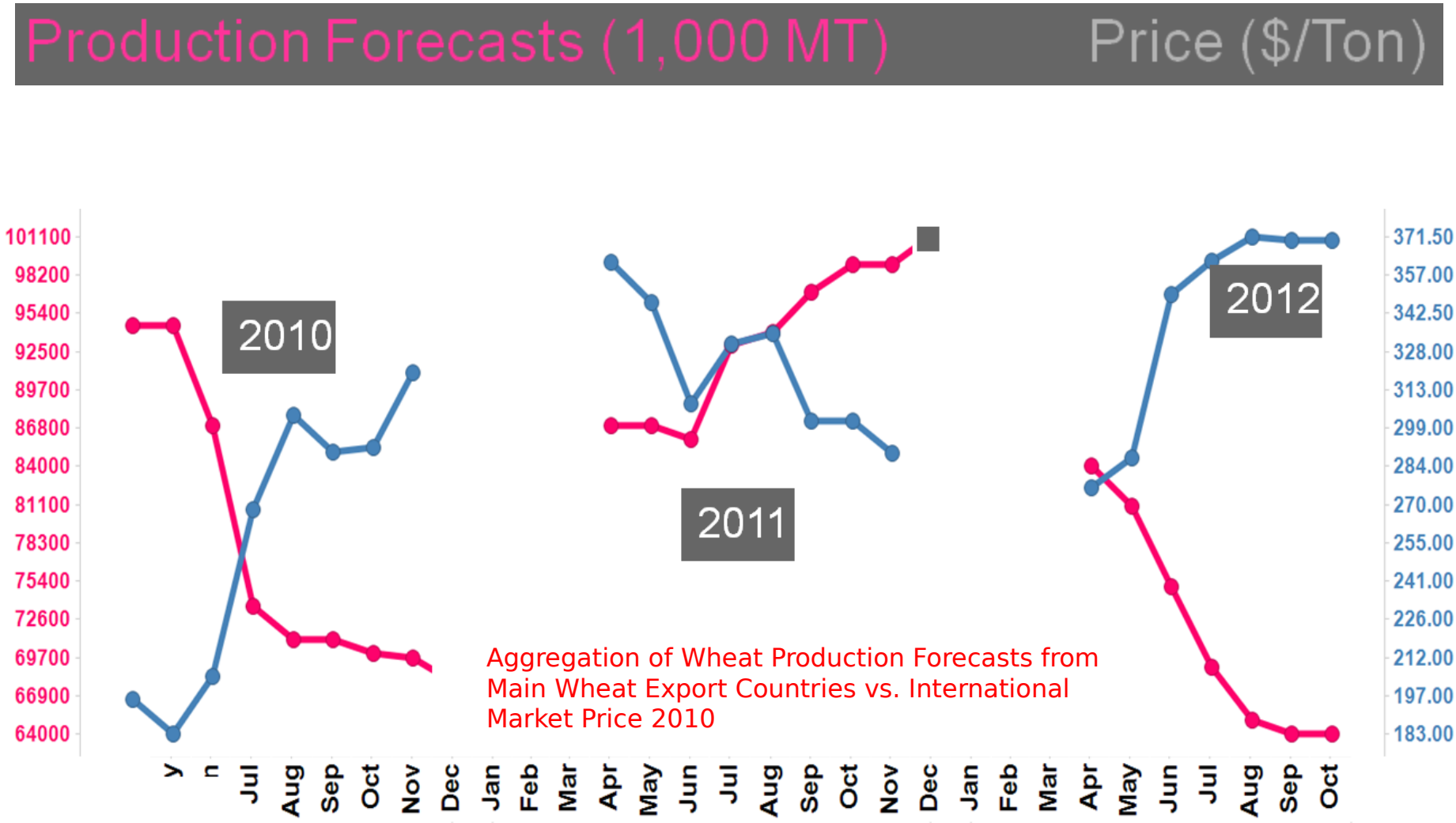
- Crops can be classified according to “ecophysio-types” based on ecophysiological requirements (but well beyond the current “summer/winter”, “equatorial/temperate” types) and “fitted” into season-elements. For instance, “teff ecophysio-type” can be fitted into the temperate summer.

Features...

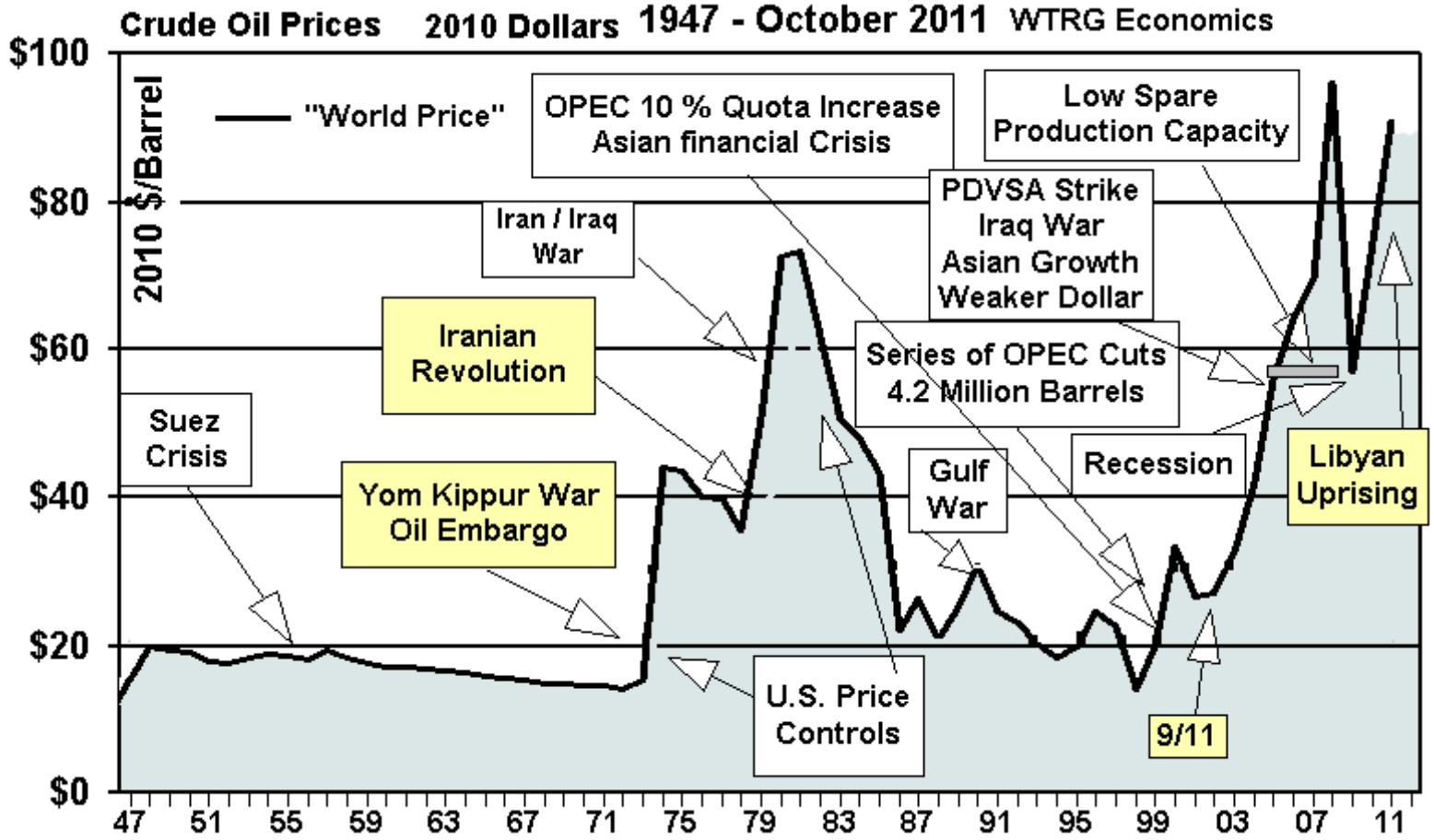
- Compatibility with existing classifications through the FAO-LCCS (Land Cover Classification System) approach, i.e. transparent links with existing classifications
- Modular-Hierarchical, i.e. mappable and scale independent
- Multifactorial (“climate complex”) with variability
- Organism-independent and organisms (pests, crops, diseases…) defined by parameters
- Useable assessments of potentials (qualitative: diversification, iso-climate) and quantitative (production, climate change)

Global crop distribution maps, with some background

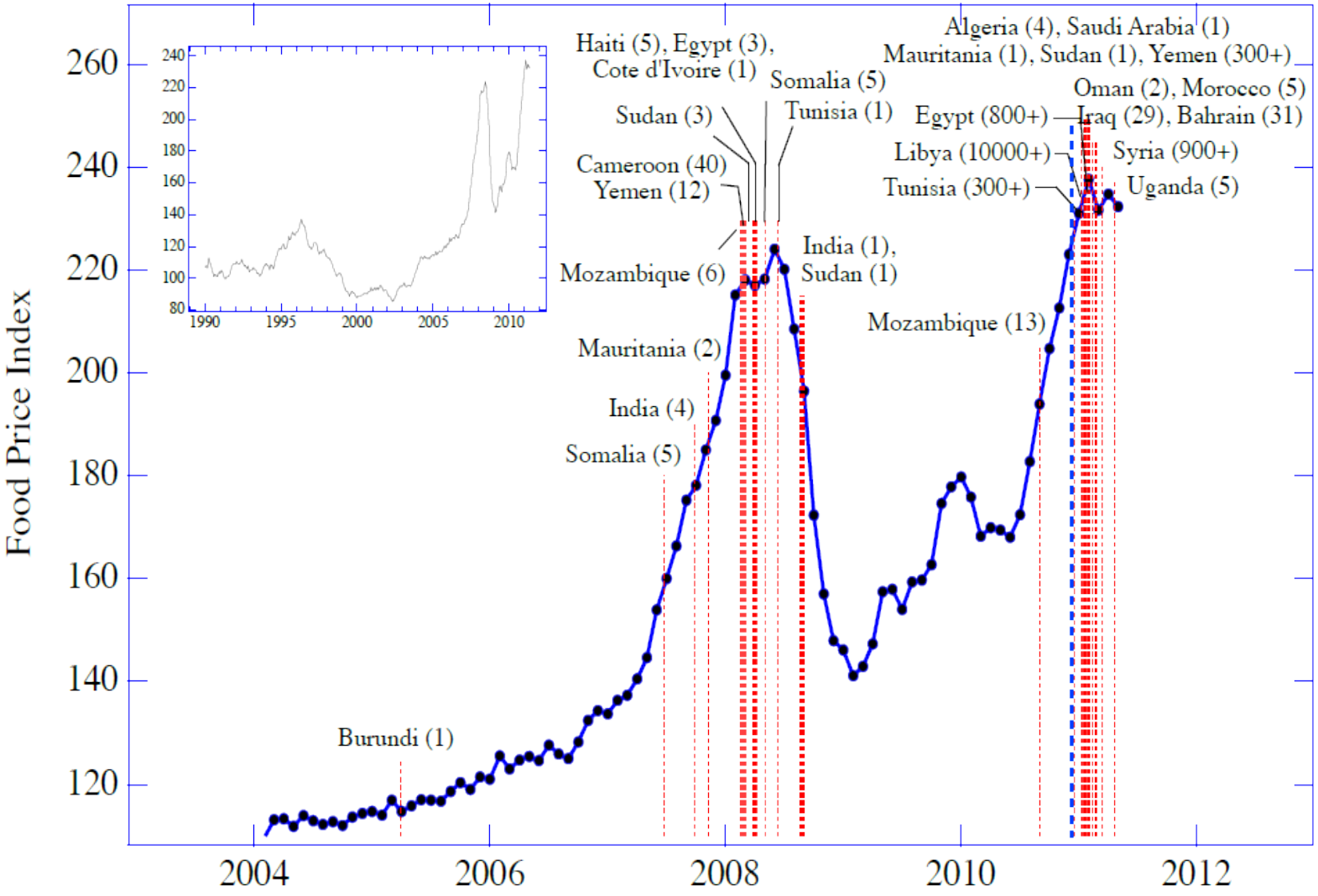
Why improved global forecasts?



Oil prices



Source: modif. From http://www.wtrg.com/oil_graphs/oilprice1947.gif



2008 food crop price crisis

Lagi, Bertrand & Bar-Yam, 2011.
http://necsi.edu/research/social/food_crises.pdf

Background

- World food security remains a major concern
- *I believe we need to create an international group of scientists from all over the world representing all the disciplines concerned, a bit like what was done for the climate, with the IPCC* (Sarkozy, June 2008, High level conference on food Security)
- Global Agricultural Geo-monitoring Initiative (GEOGLAM) launched by the Group of Twenty (G20) Agriculture Ministers in 2011 in Nice… with mixed suucess

Global crop monitoring products

- Crop-type distribution maps are badly needed for real-time impact modelling at the global and regional scales, at spatial resolutions of about 1 km.
- In addition to “distribution”, we need phenology and some farming practices data
- There are many LU maps where “agriculture” is usually the “residual” land use; it is not crop- or farming-system specific and affected by large uncertainties. One of the most reliable products is geo-wiki.org

More...

- Data – mostly “static” - sometimes exist at the national level but need to be collected and harmonised (e.g. is potato a “vegetable”?)
- A significant and concerted effort is required for a near-real time product, a combination of RS and ground data
- Several ancillary data sets are needed, e.g. on phenology (repeat!), which requires the development of more solid tools based on RS + ground (climate & history)

Simple crop models

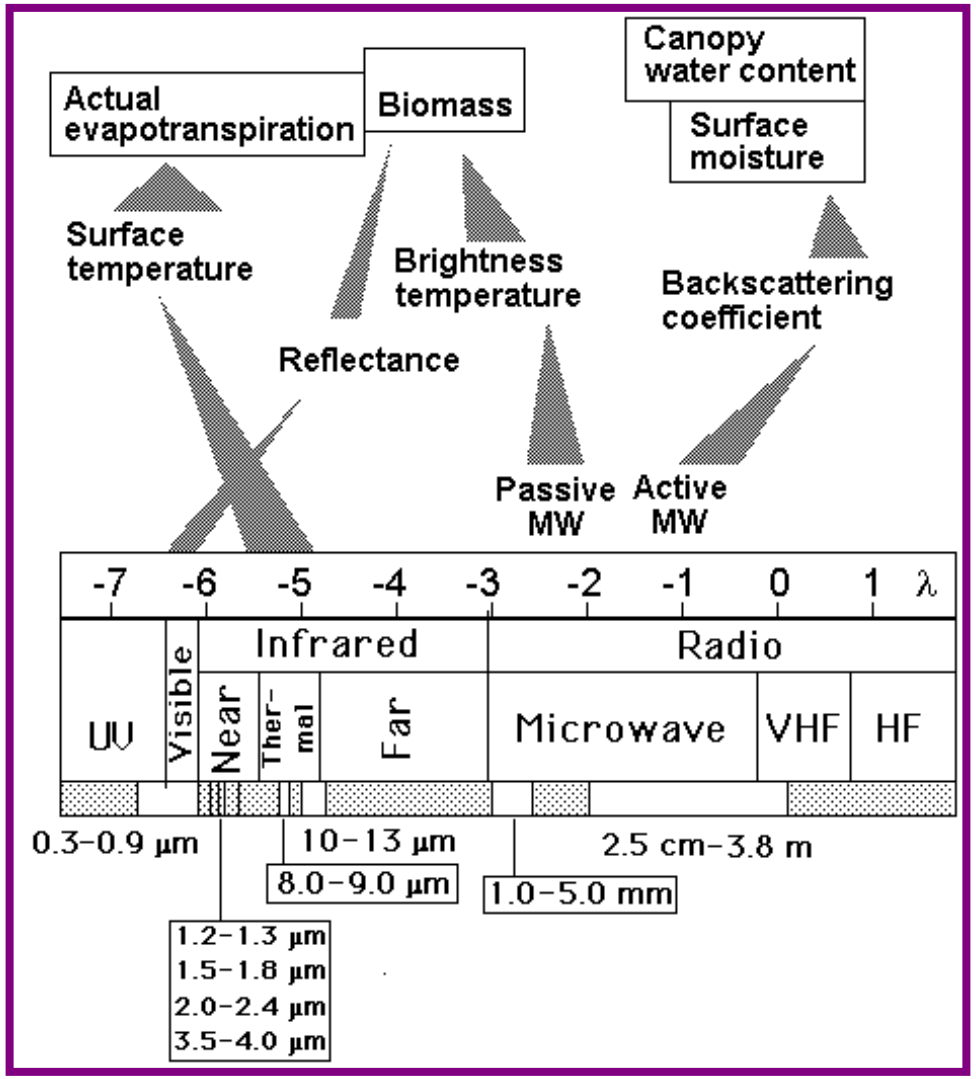
We must overcome the belief that

- Process-oriented models are better than other models – where “better” deserves defining -
- Complex models (DSSAT, EPIC, WOFOST families…) are “better” than simple models
- Model parameters (define!) can make models adaptable to any situation
- Research and operations can or must use the same models (or packaging: Whopper-cropper, a databse with graphic interface http://www.regional.org.au/au/asit)

In the real world...

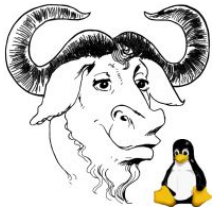
- We often don't have the variables and parameters that woud be required to operate a model, including some very simple ones. As aresult, they must be estimated beforehand
- Variables and parameters are often meaningless at the scale at wich the output is required (mostly: regional): soil water holding capacity, crop variety, calibration data
- Calibrating models against proxies is less than ideal
- Most models are proprietary or, at least "protected" using a variety of tricks

Remote sensing data used in crop yield forecasting



We need models that…

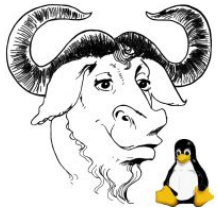
- Are as simple as possible and use only existing inputs compatible with the required outputs
- Operate at a spatial scale that is compatible with the required outputs (farm management, index-based insurance, national food production, market planning) and the available calibration data
- Do not hesitate to use RS inputs on the same footing as ground data



- Are modular, free and easily available, multi-platform, open-source and public domain, and **belong to the community of user**

Conclusions

- Challenges are many more than the three listed in this presentation (GDD, CWR in arid conditions, “violent” factor impacts, planting dates simulation...)
- Research and applications offer different “challenges.” The presenter’s belief is that in agrometeorology, research serves applications
- Some essential tools are now easily available (spatial interpolation) but some old problems keep getting sidelined!
- The future is community-developed models



Thank you

for listening so patiently for so long!

Source of farmer: 1634 etching by Rembrandt (Het Rembrandthuis Museum, Amsterdam)