Climate Change and Plant Biosecurity



Jo Luck, Kyla Finlay, Jean Philippe Aurambout, Darren Kriticos, Grant Hollaway, Angela Freeman, Kevin Powell, Sukumar Chakraborty and Samsul Huda

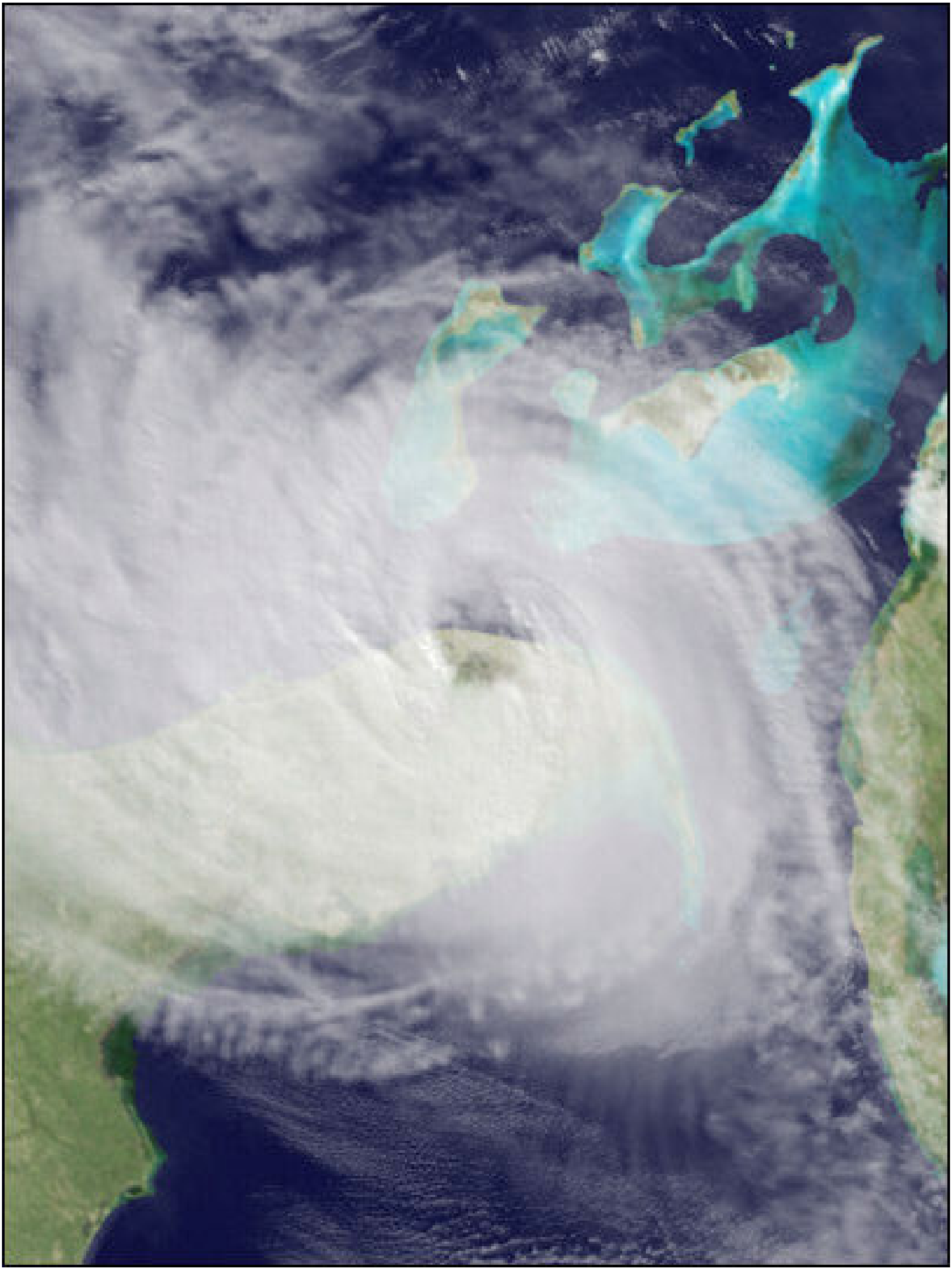
Dept. Primary Industries Victoria, CSIRO Plant Industry and University of Western Sydney

jo.luck@dpi.vic.gov.au

Climate Change and Food Security

- *Global food security is a growing concern - In 6 of the last 7 years, world grain production has not met global demand*
- *Climate change may negatively impact on production of food crops worldwide through increased floods, drought and increasing temperature*
- *An additional concern is how crop pests and disease behaviour and biology will be affected in future climates*





Hurricane Wilma

- *Citrus canker - bacterial disease spread by wind and rain.*
- *Spread through 220,000 acres commercial citrus in Florida ($US180m)*
- *Bacteria were able to move across 600 m quarantine zones*
- *In January 2006, USDA declared that citrus canker was impossible to eradicate*







Objectives

- To measure potential impact of climate change on key threats to Australian primary industries

- To anticipate and respond to any new or emerging threats as a results of climate change

Review of the potential impacts of climate change on plant biosecurity

- Identified the major climate changes events most likely to influence the behaviour and distribution of plant pests and diseases



- Developed three case studies to further explore the potential effects of climate change

- Reviewed the modeling tools used to study climate change and its influence on plant biosecurity

(Aurambout *et al*, 2006)

Climate change factors likely to influence pests and diseases

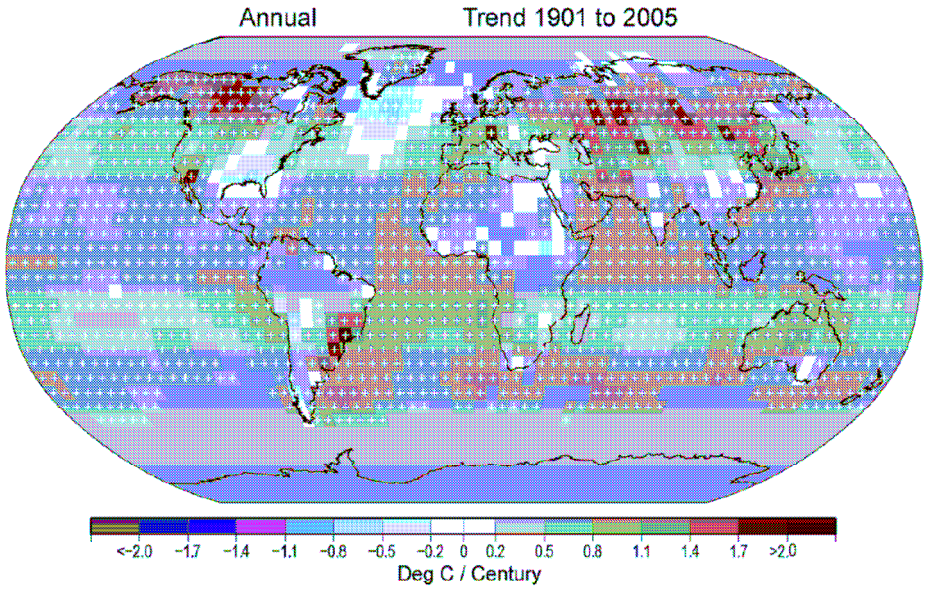
1. Increasing temperature
2. Altered precipitation and humidity
3. Increased severe weather events
4. Decreasing frosts
5. Increasing CO_2



Increasing temperatures

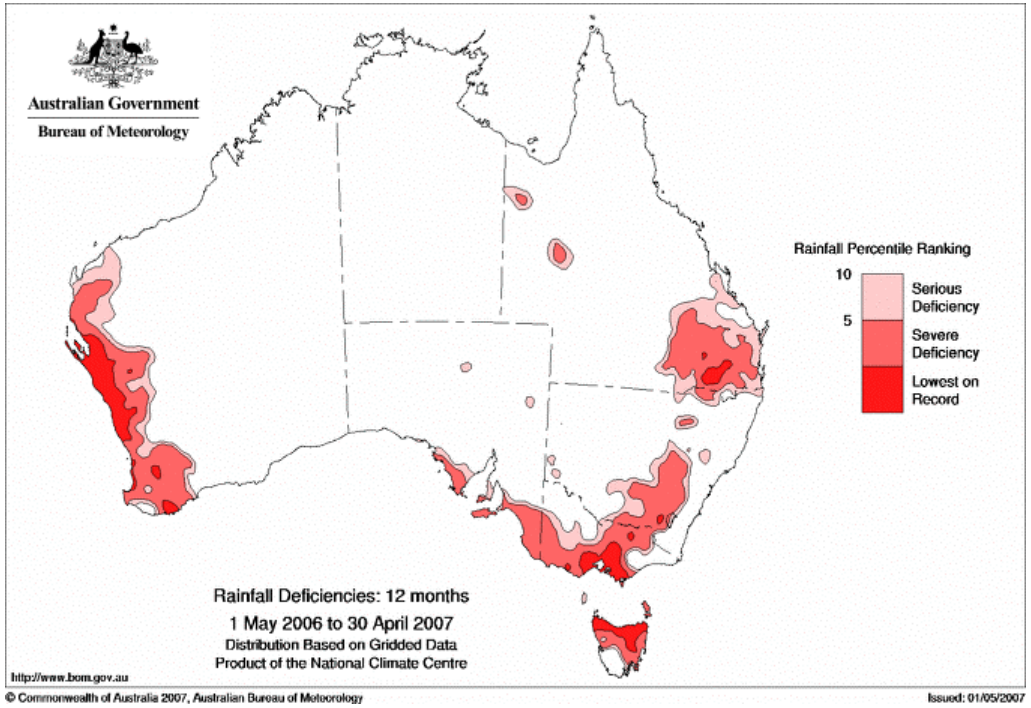
An increase in average annual temperature of 1.1- 6.4 °C by 2100 over most of Australia
(IPCC)

- Increase over- wintering populatior of pests and pathogens
- Changes to phenology of host may shift pest/predator/host dynamic
- Shorter life-cycles and more generations
- Pole-ward shift of historical geographic ranges



Reduced Rainfall

- *Predicted 20% reduction in southwest Australia by 2030*
- *Predicted increase across the tropical north (CSIRO, 2007)*
- *Likely reduction of some pests and diseases in lower rainfall areas in the south and potential increase across the tropical north*



Floods and Drought

Floods favour widespread dispersal of fungal and bacterial propagules eg. *Phytophthora*



- Drying trends will reduce plant vigour and increased susceptibility to pests and diseases
- Reduced bacterial and fungal infections
- Reduced soil-borne disease



Decreasing frosts

– Reduced bacterial and fungal infection points

– Increased survival of cold sensitive pests or pathogens





Increased frequency of category 4 & 5 cyclones

Increased winds, driving rains and damaged plants will enable widespread dispersal of spores, cells and insects and will facilitate infection and survival of many pathogens


Hurricane Katrina, New Orleans 2005


Cyclone Larry, Innisfail 2006

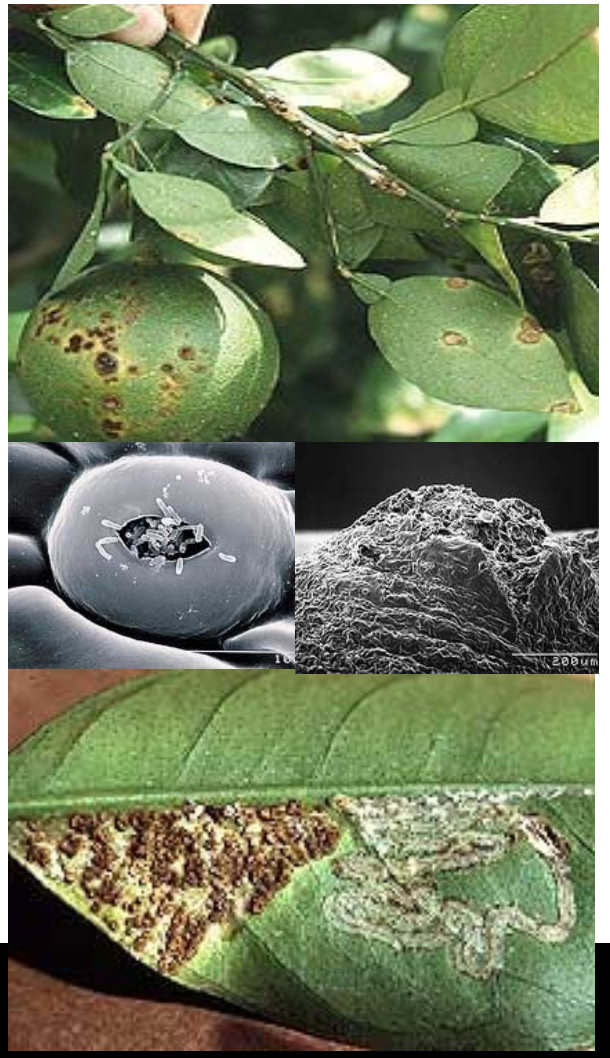

Citrus crop Katrina aftermath, New Orleans, 2005

Case Study-Citrus canker*Xanthomonas axonopodis pv. citri*

Citrus canker causes serious losses in tropical and subtropical countries worldwide.

Climatic factors influencing the survival and spread of the pathogen include;

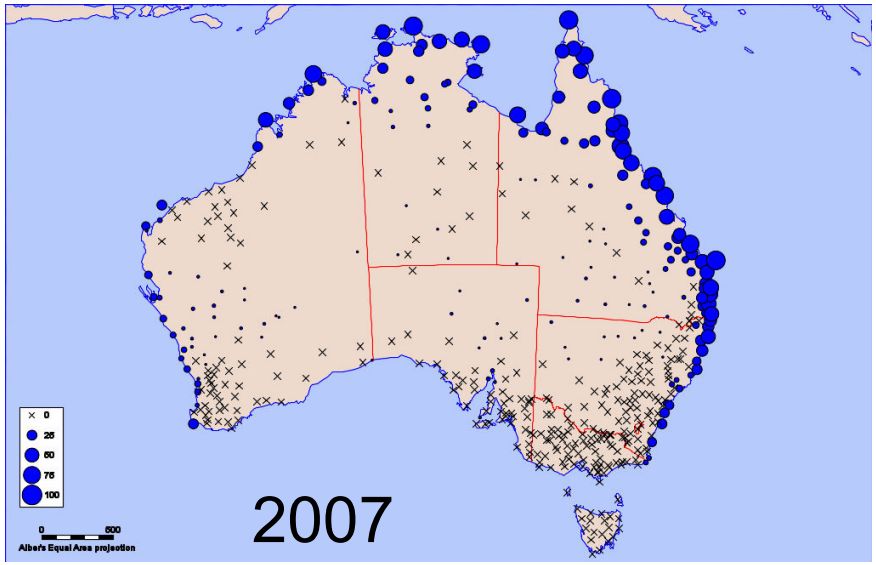
- •Rainfall, wind, severe weather events - dispersal
- •increasing temperatures-shift in geographic ranges

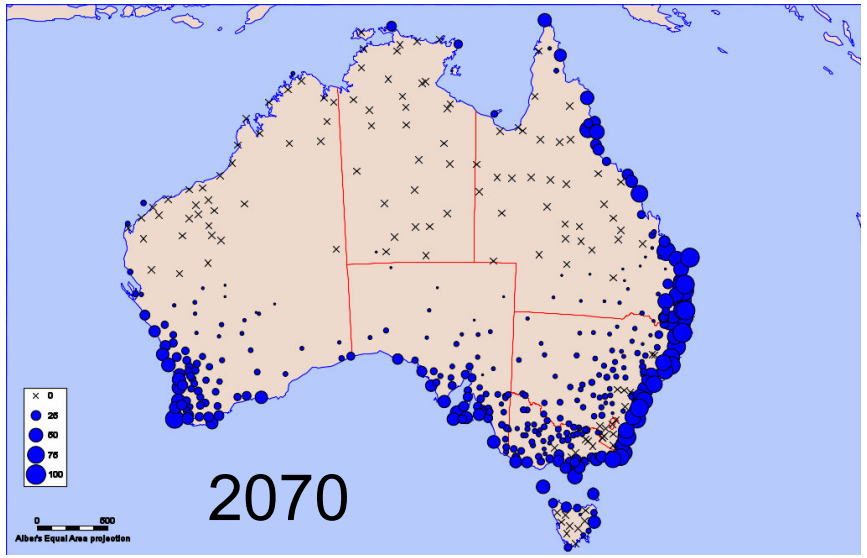


Source: TR Gotwald

Bioclimatic modeling Climex®

Bacterium's geographic range is predicted to shift to more southerly coastal and inland regions

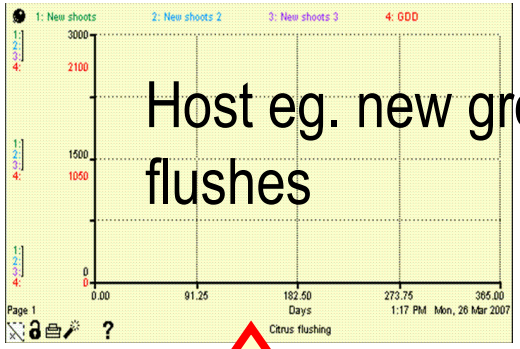




Rowles-Van Rijswijk (in preparation)

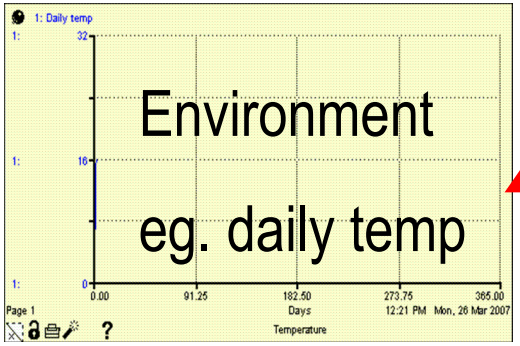
Diaphorina citri Kuwayama





Host eg. new growth flushes

The pest and disease triangle

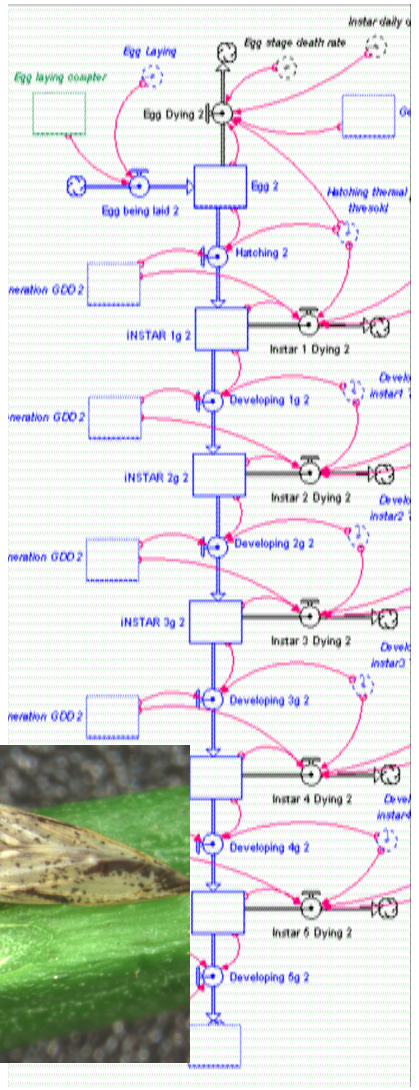


Environment

eg. daily temp

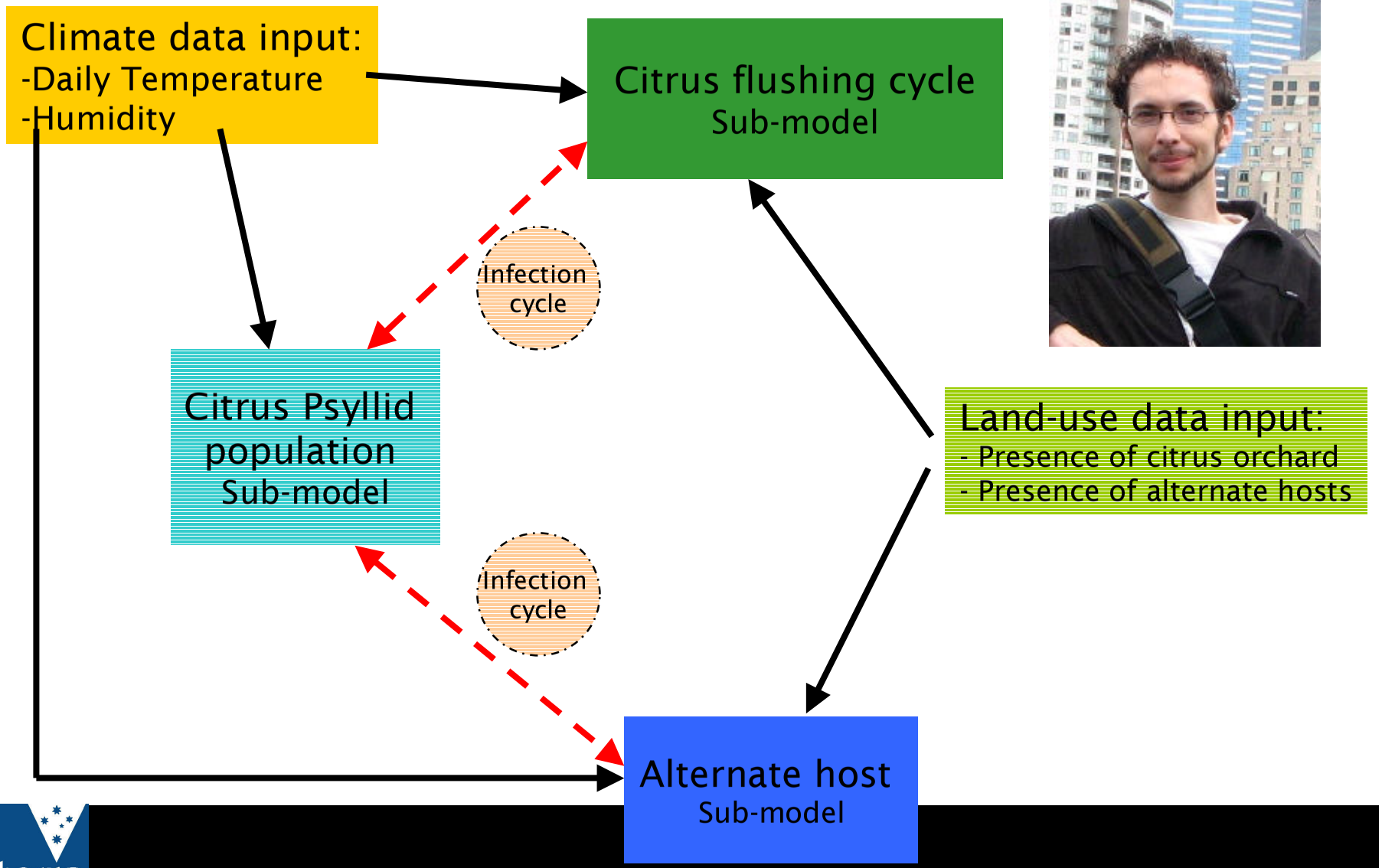
Pest





Aurambout *et al*, 2007

Structure of the Citrus Greening Model

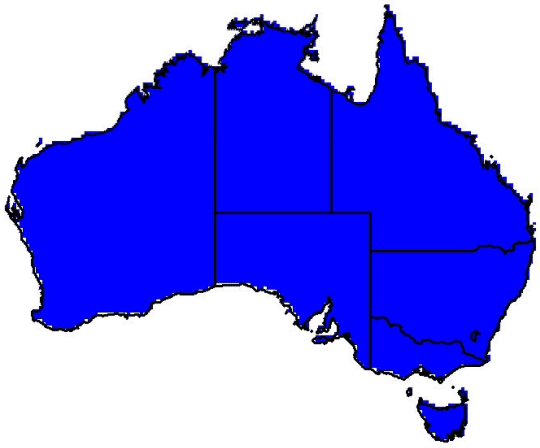


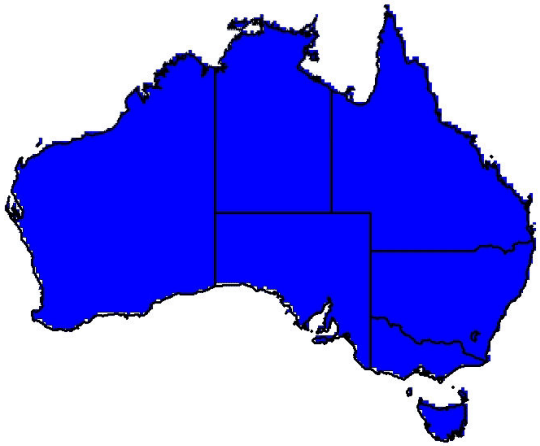
Adult psyllid population distribution and spread under increasing temperature scenarios

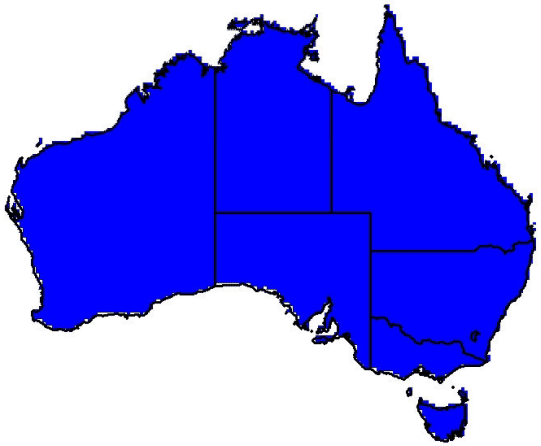




1990 2030 2070









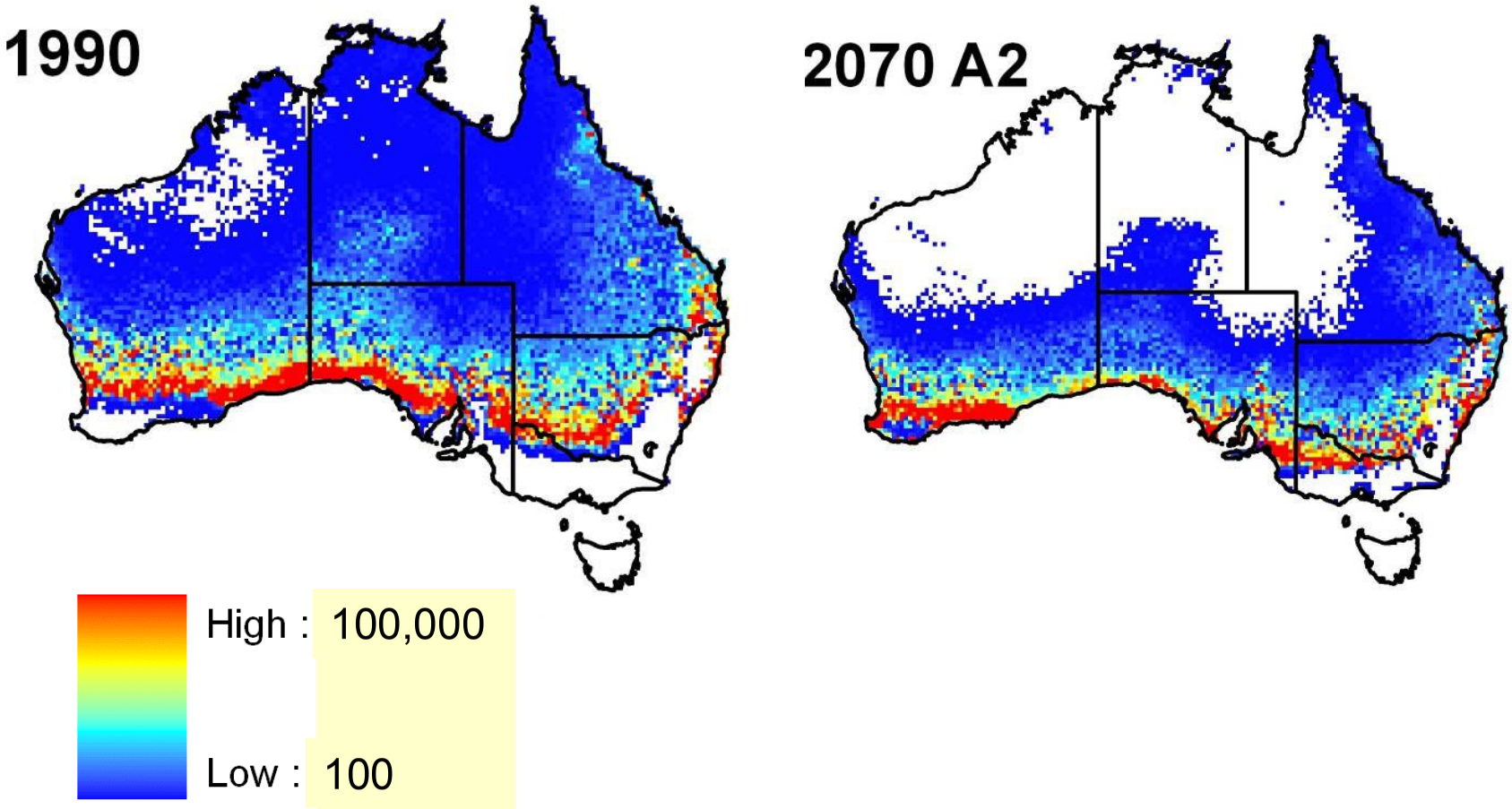
High : 100,000

Low : 100

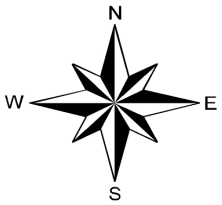
- Earlier growth flushes
- Population shift southward
- Population reduction north and inland
- Population diminishes over time

CRC PLANT biosecurity

Enhanced predictive models



Modeling Outputs



Legend

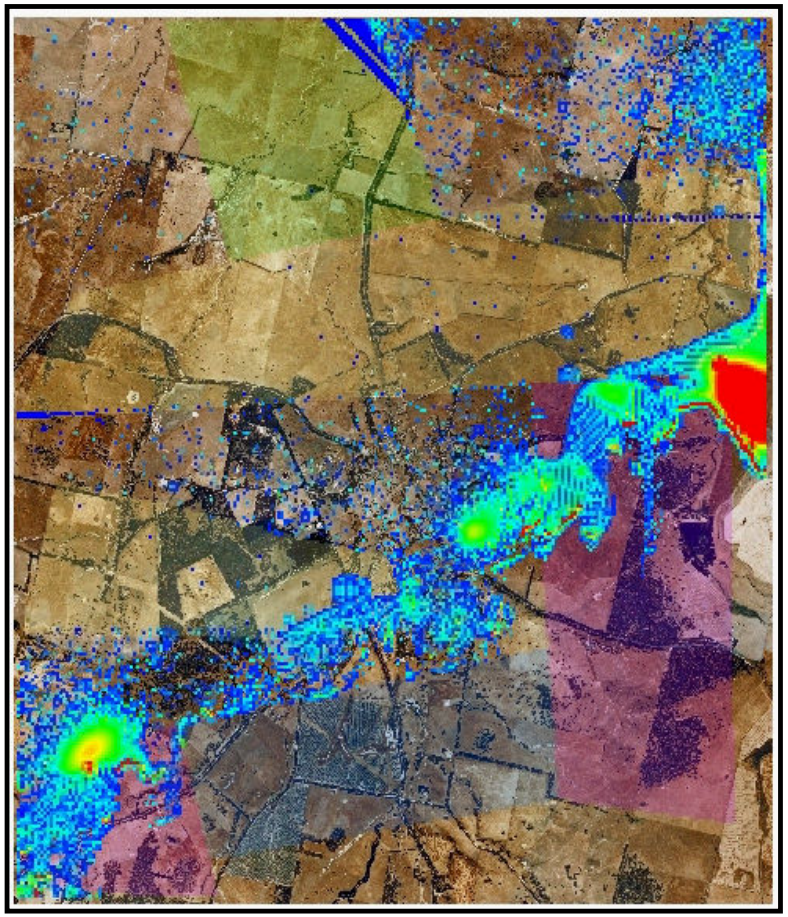
Wind Direction

- East
- South East
- South
- west

Population of adult locusts

- High
- Low

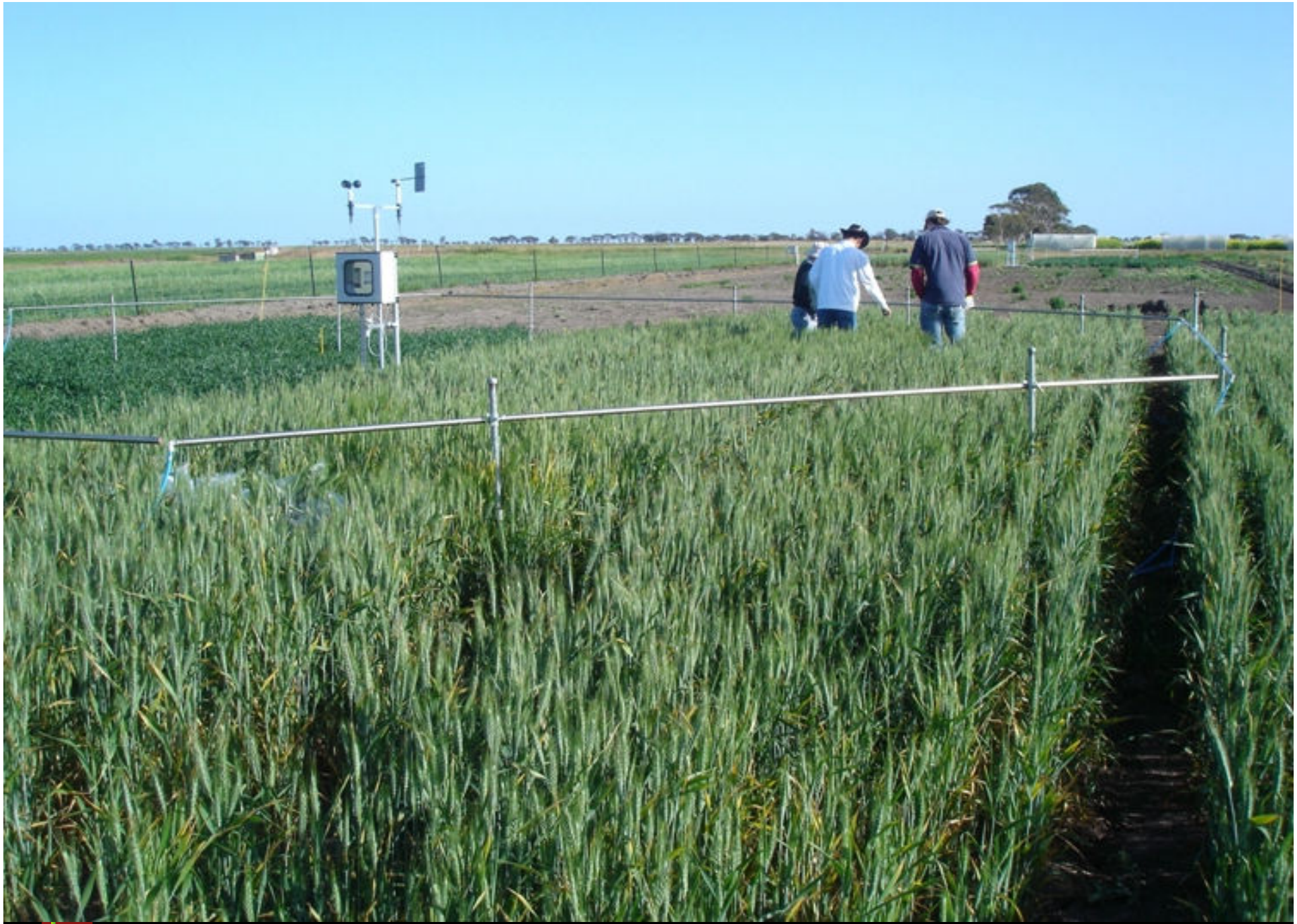
Spatial-temporal representation of locust plague based on locust physiology and behaviour, food availability and wind patterns





CRC PLANT biosecurity

http://www.jcci.unimelb.edu.au/FACE/FACEOutline1.htm



CRC PLANT biosecurity

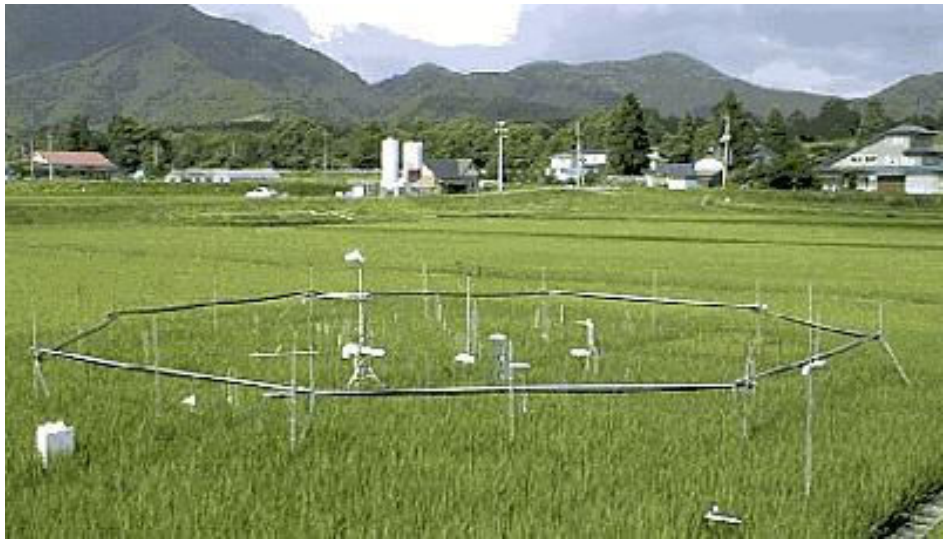
http://www.jcci.unimelb.edu.au/FACE/FACEOutline1.htm

Elevated CO_2 and plant pathogens

- Shown to modify pathogen aggressiveness and/or host susceptibility (Coakley *et al.* 1999)

- Increased fecundity and growth of some fungal pathogens (Chakraborty *et al.*,2000, Coakley *et al.* 1999, Hibberd *et al.* 1996).

- Predisposed rice to blast (*Magnaporthe oryzae*) and sheath blight (*Rhizoctonia solani*) (Kobayshi *et al*. 2006)



Enriched CO_2 and insects



- Increasing food consumption rates to compensate for lower food quality, “compensatory feeding” (Hunter, 2001)
- Diminished escape response in aphids in the presence of alarm pheromone under high CO_2 (Mondor *et al*, 2004)
- Altered population size, genotypic and phenotypic frequencies in aphids on broad bean (Mondor, *et al* 2005)
- Reproductive rate of the pea aphid, *Aulacorthum solani* and the peach potato aphid, *Myzus persicae* increased under elevated CO2 (Awmack *et al.,* 1997).



Response of key wheat pathogens to elevated CO_2

1. Wheat Stripe Rust (*Puccinia striiformis*)

- One of the most important diseases of wheat in Victoria
- Disease progression (inoculated and natural), aggressiveness, fecundity, latent period and host resistance

2. Crown Rot (*Fusarium pseudograminerarum*)

- Reduces Victorian wheat production by approximately $5 million per year and also produces a mycotoxin
- Incidence symptoms severity (stem browning and dead heads)
- Influence of CO_2 on life cycle of the pathogen

3.* Barley Yellow Dwarf Virus *and cereal aphid vector

- Most widely distributed virus in grains, causing up to 25% losses
- Movement of virus through plant
- Virus acquisition rate (chambers)
- Transmission rates (chambers)
- Natural infection of virus



Wheat Stripe Rust experimental design

		Row	20cm	20cm	20cm	20cm	20cm	20cm	20cm	20cm	20cm	20cm		
		1		Mira A	Mira A	Mira A	Mira A	Mira A	Mira A	Mira A	Mira A			
Area P/Q		2		Mira A	SUBPLOT 1						Mira A			
		3		Mira A							Mira A			
	SOUTH	4		Mira A	Mira A	Mira A	Mira A	Mira A	Mira A	Mira A	Mira A			NORTH
		5		Mira B	Mira B	Mira B	Mira B	Mira B	Mira B	Mira B	Mira B			
		6		Mira B	SUBPLOT 2						Mira B			
		7		Mira B							Mira B			
		8		Mira B	Mira B	Mira B	Mira B	Mira B	Mira B	Mira B	Mira B			
							EAST							

Randomised planting in Subplot 1 & 2 with cv. Janz (Medium Resistance) and H45 (Very Susceptible) surrounded by border planting of cv. Mira (Rust Resistant) 8 1 X 2m rows.

Treatments = +/- CO_2, +/- H_2O, E/L sowing (4 replicates)



Adaptation strategies to and minimise the impact of climate change

- Modifications to quarantine and surveillance zones eg. Shift in fruit fly trap deployment
- Threat categorisation tools used by biosecurity policy
- New diagnostic tools for emerging threats eg. Bluetongue virus
- Review and update contingency plans eg. Canker
- Incursion management strategies eg chemical or biocontrol (IPM)
- P & D resistant varieties

Linking to International Networks

Collaboration with European Union and Asia Pacific region through "PRATique" and APN projects

1. *Shifts in geographic distribution of disease with projected climates*

2. *Changes to behaviour and biology of P&D under future climates eg. Increasing CO_2*

Thank you !

INSAF

APN

DPI Victoria

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