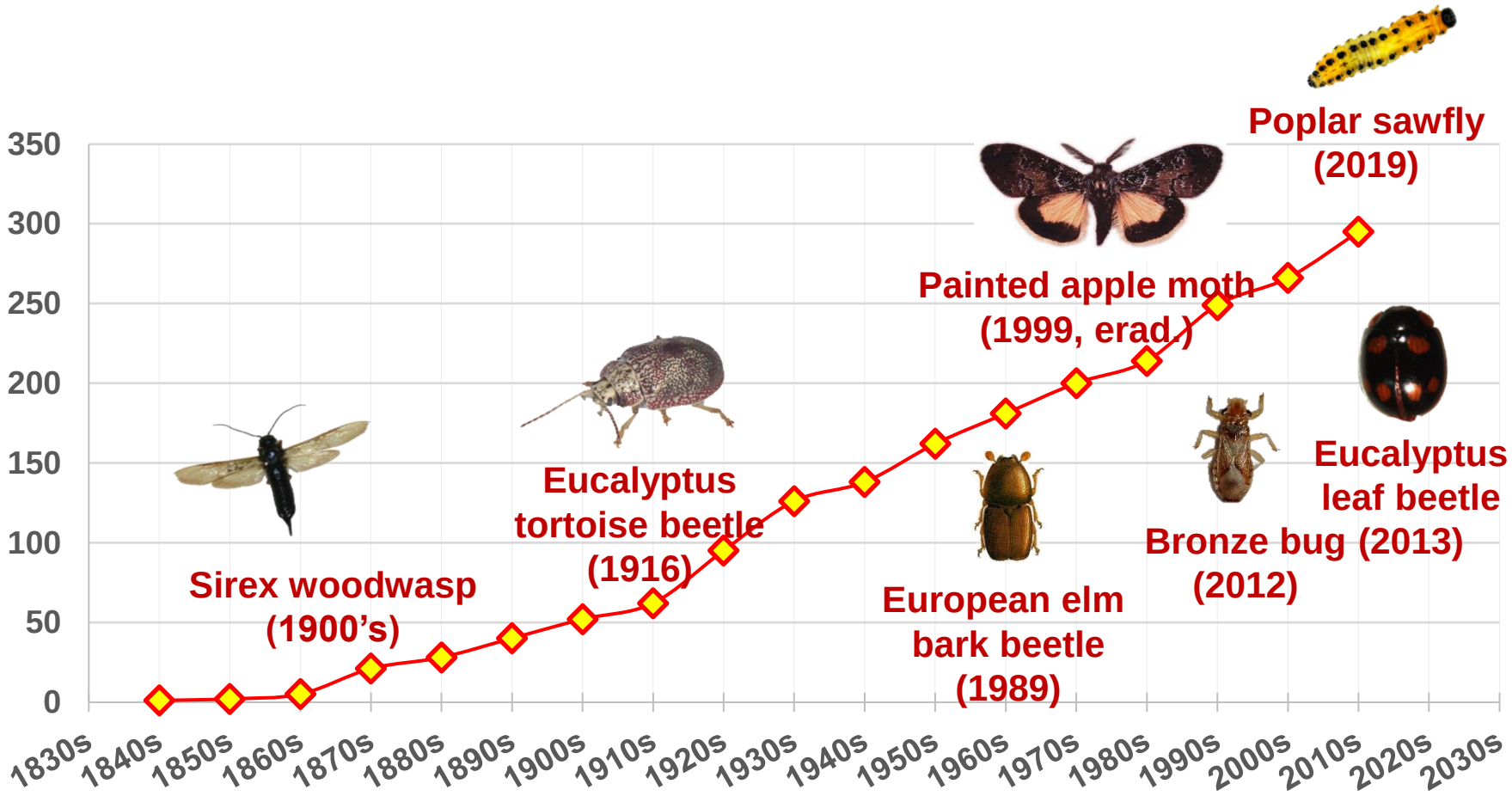
Forestry insect pest incursions into New Zealand and the role of trans-Tasman aerial dispersal

Toni Withers, Ilze Pretorius, Wayne Schou, Brian Richardson, Tara Strand
October 2023
Scion Rotorua and Christchurch, New Zealand

New Zealand's steady flow of forestry pest incursions



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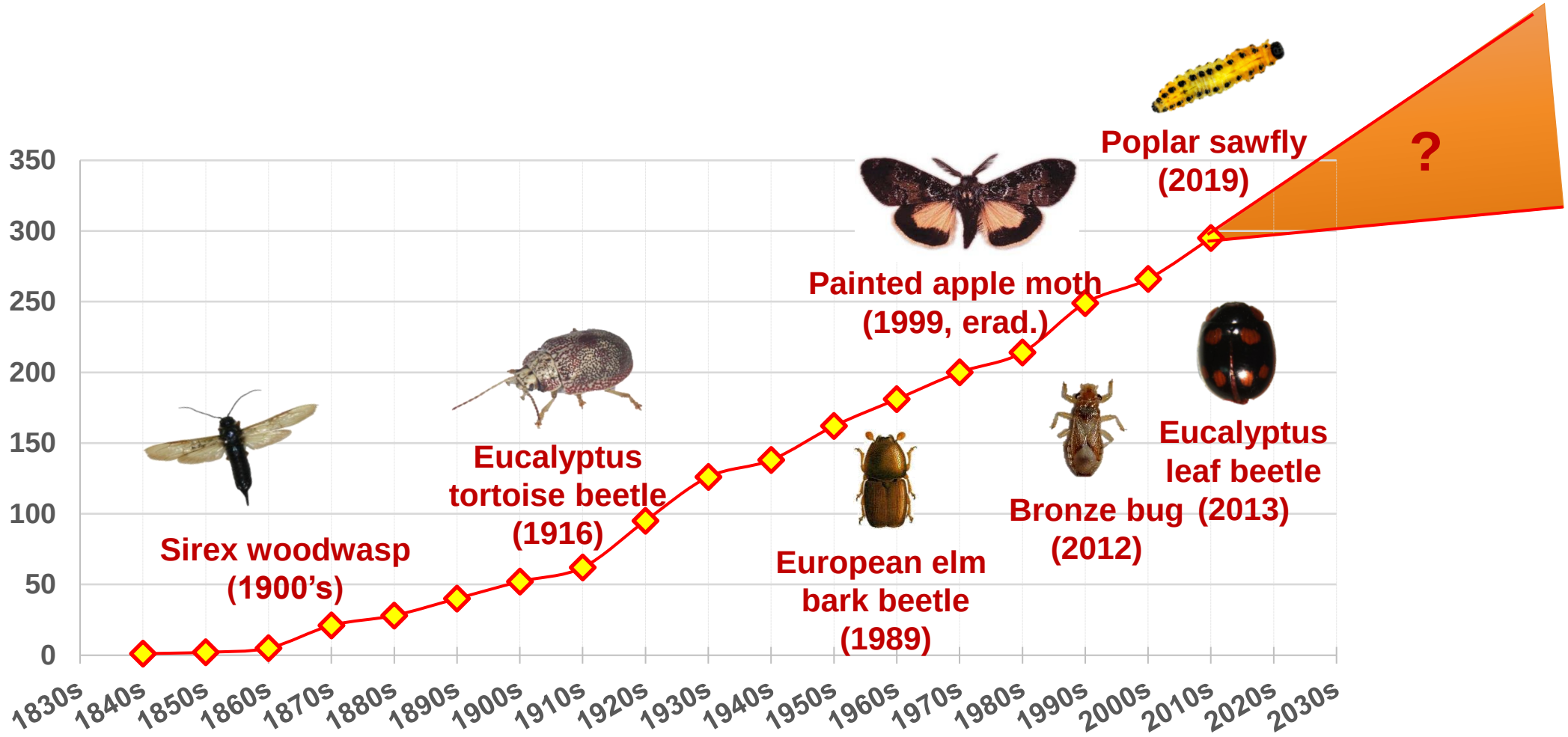
Keen to reduce this, but the pathways are often uncertain



Most challenging is the trans-Tasman aerial pathway..

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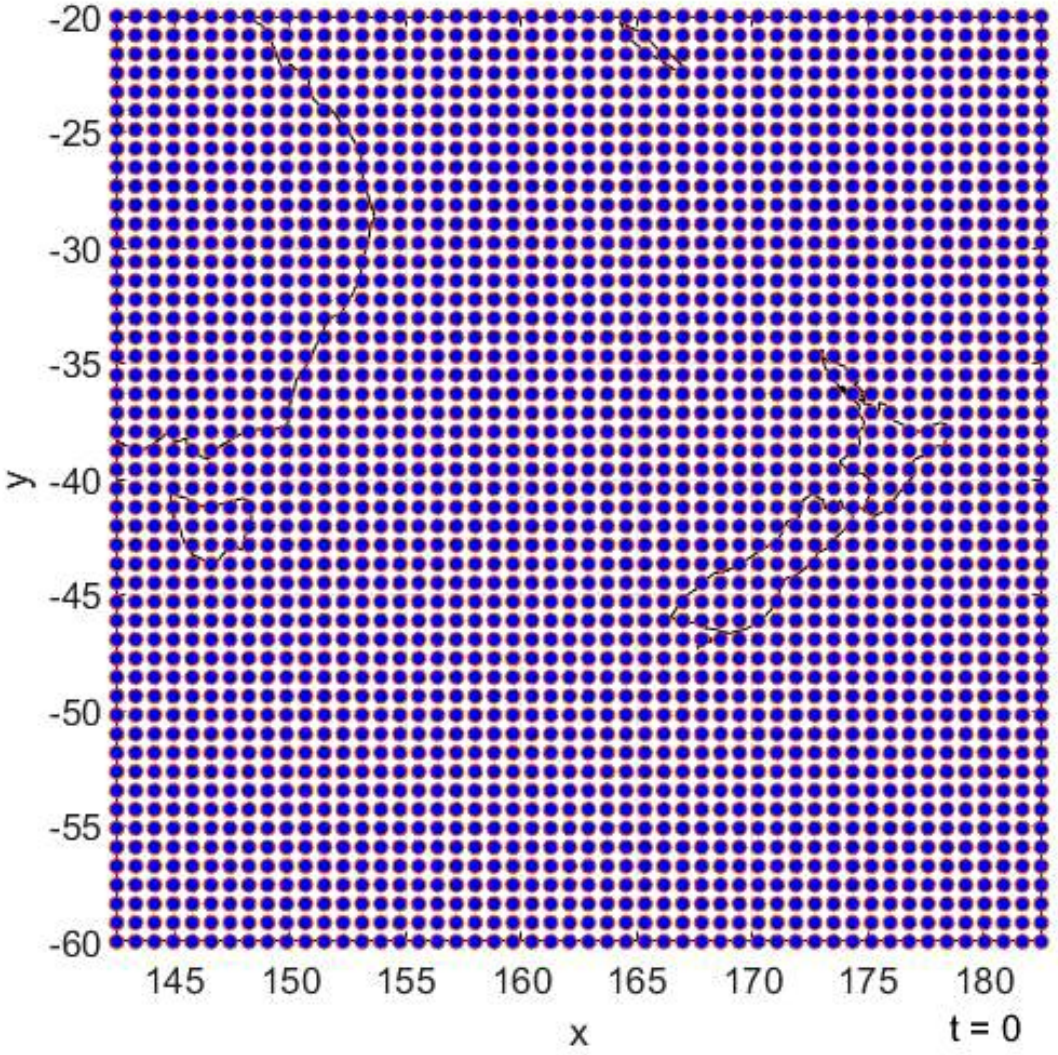
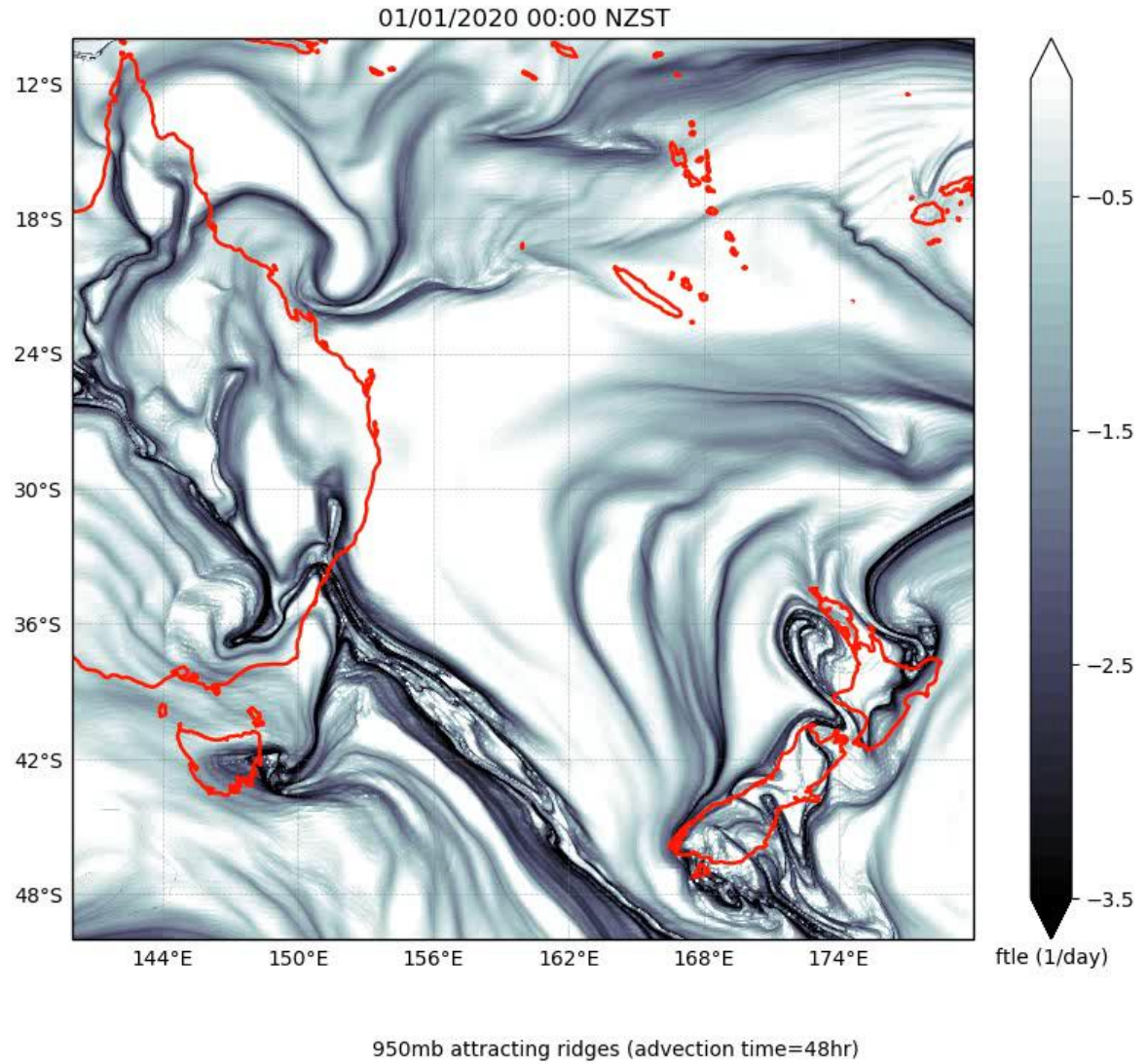
Lagrangian Coherent Structures – what are they?





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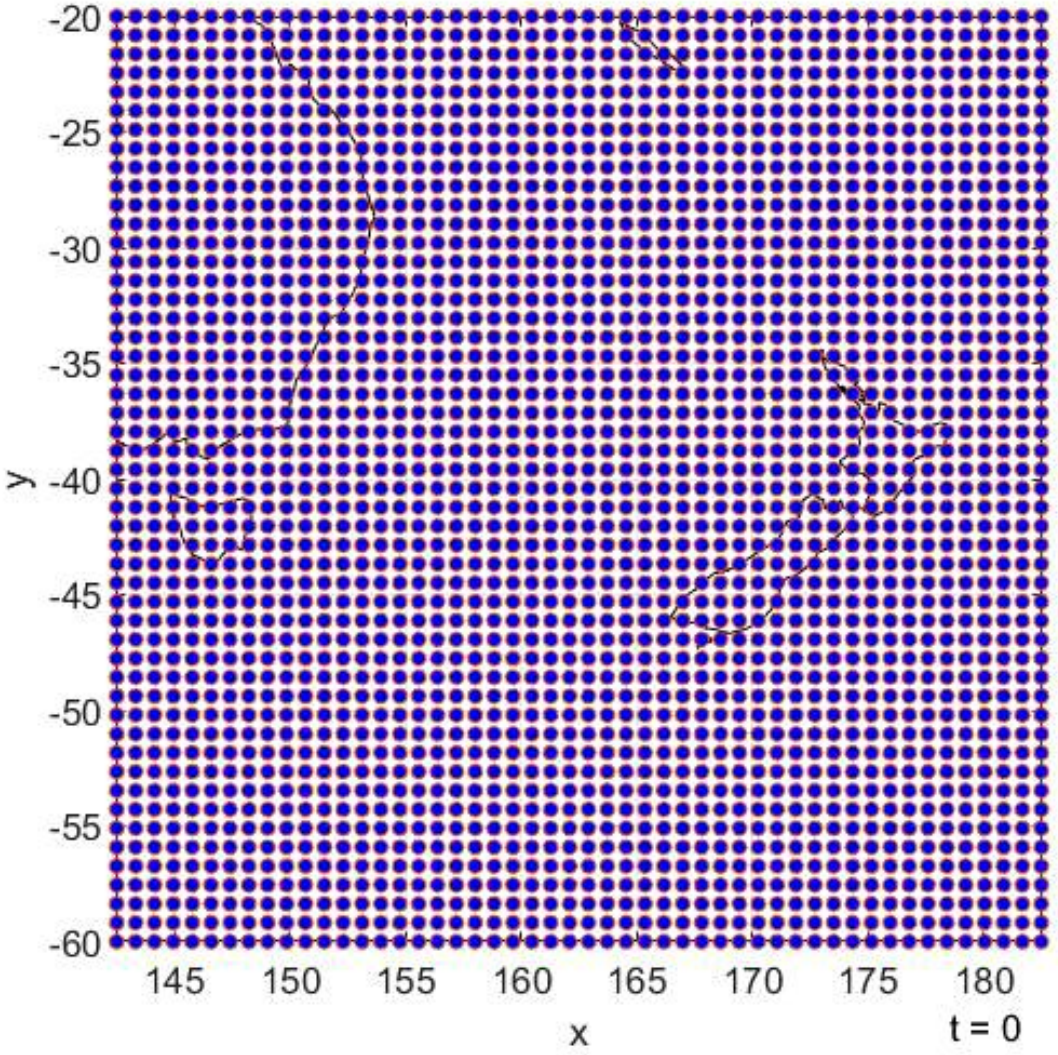

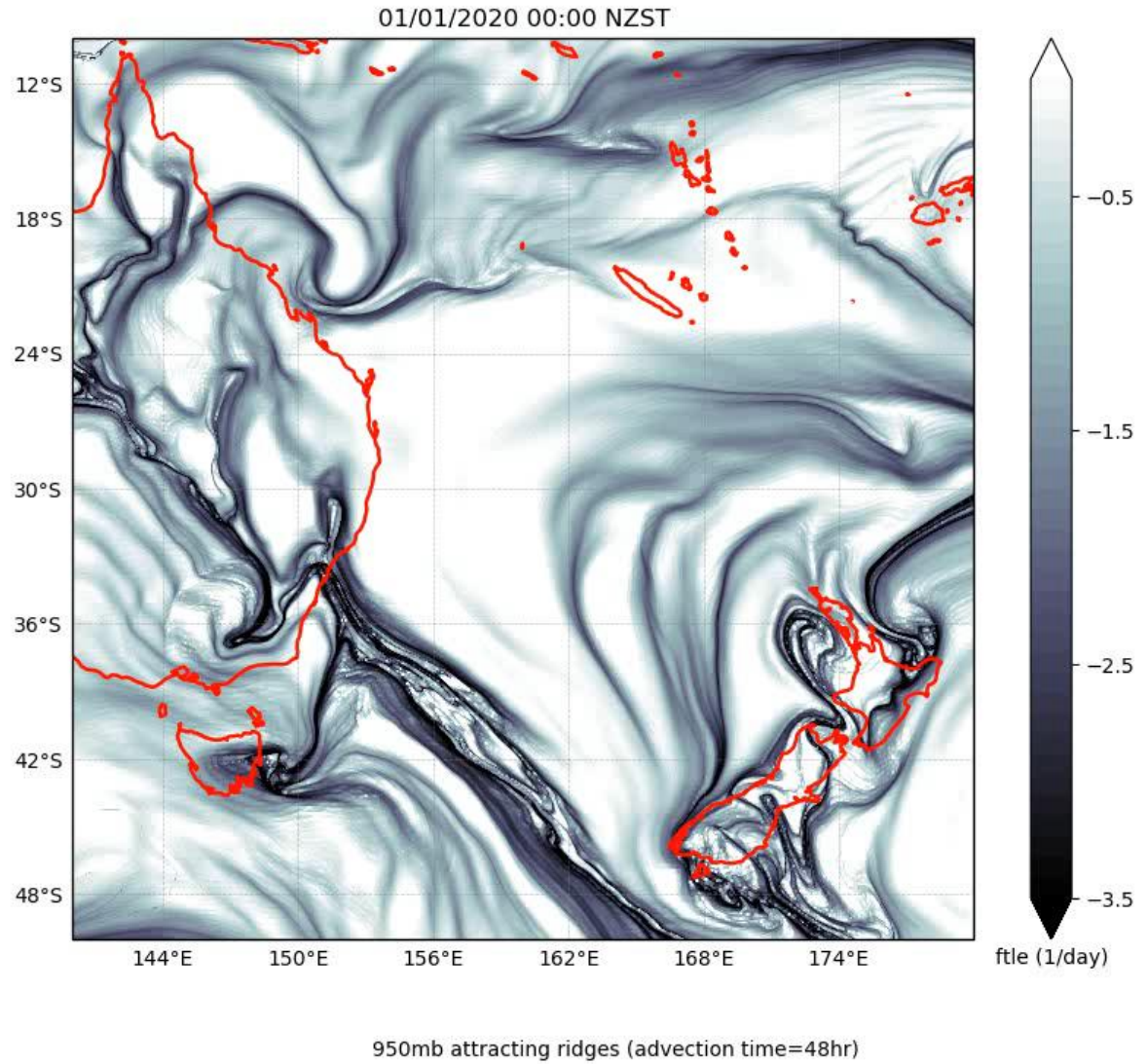

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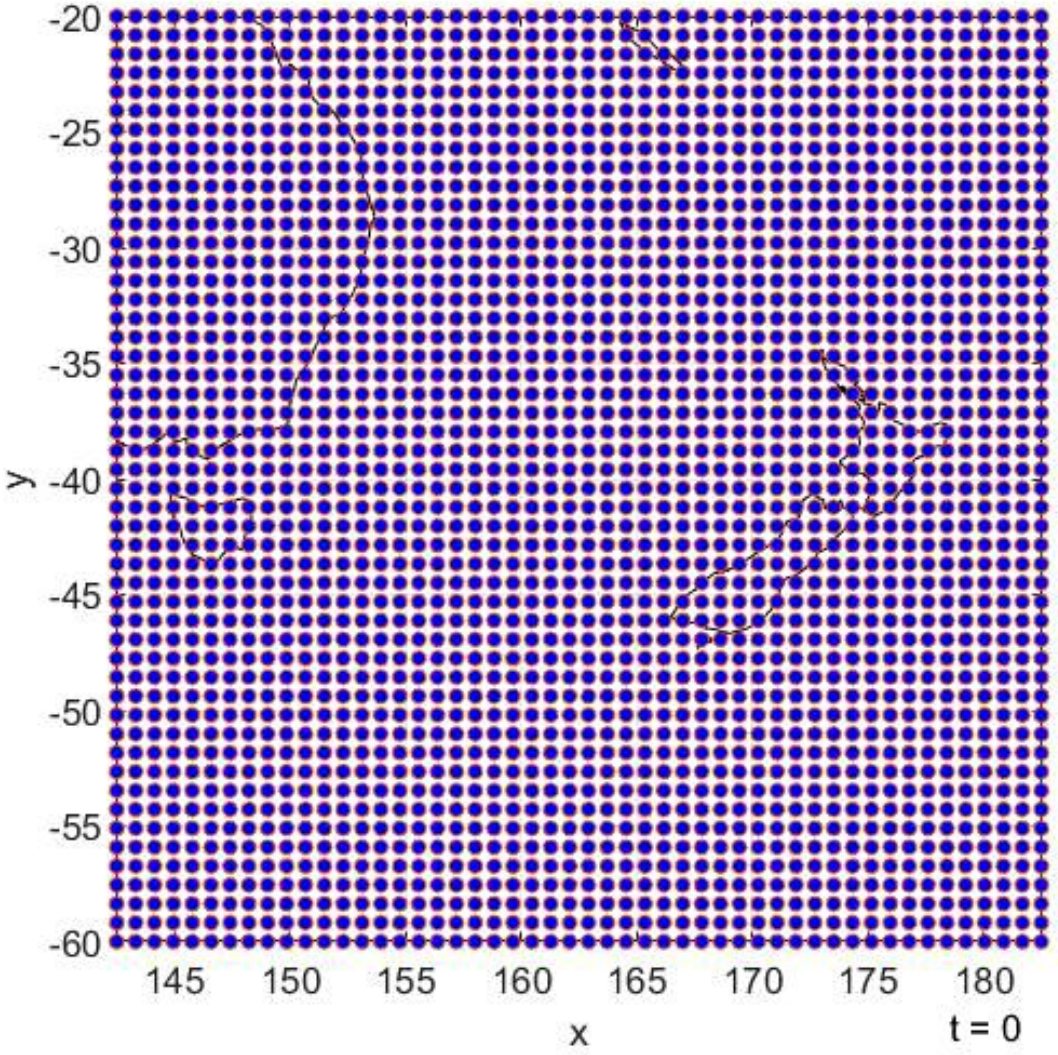

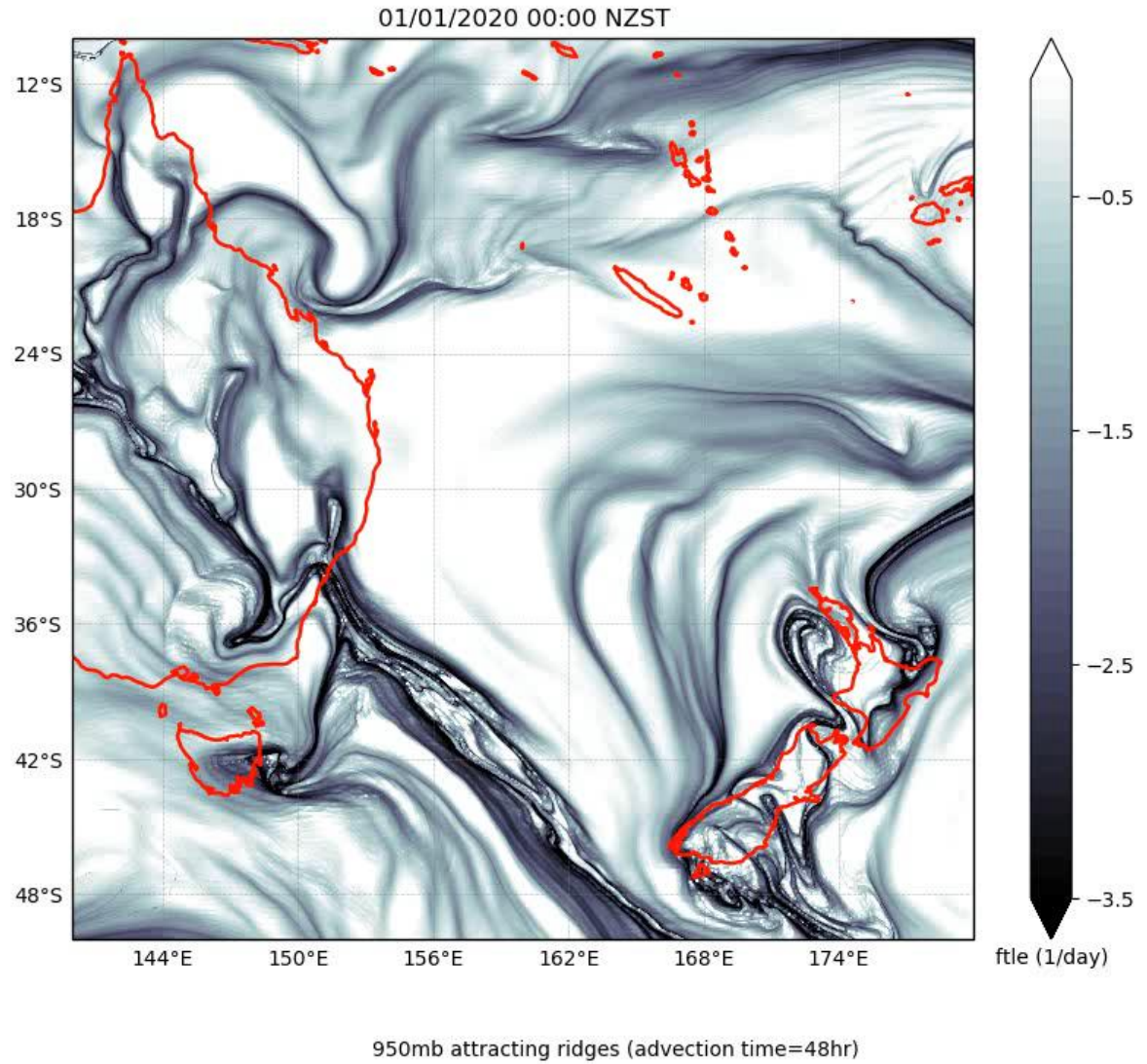

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Case studies used to evaluate the LCS

1. Published observations of Lepidoptera incursions –

368 *The New Zealand Entomologist, 1978, Vol. 6, No. 4*

The Transoceanic Migration of Lepidoptera to New Zealand — A History and a Hypothesis on Colonisation

K. J. Fox
Box 23, Manaia, Taranaki

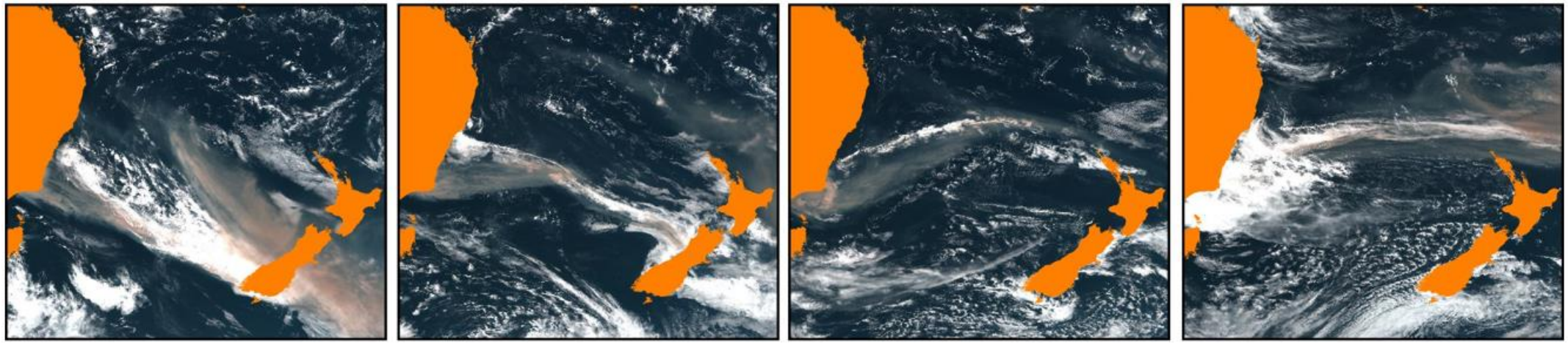
Journal of Biogeography, **26**, 1161–1167

1999

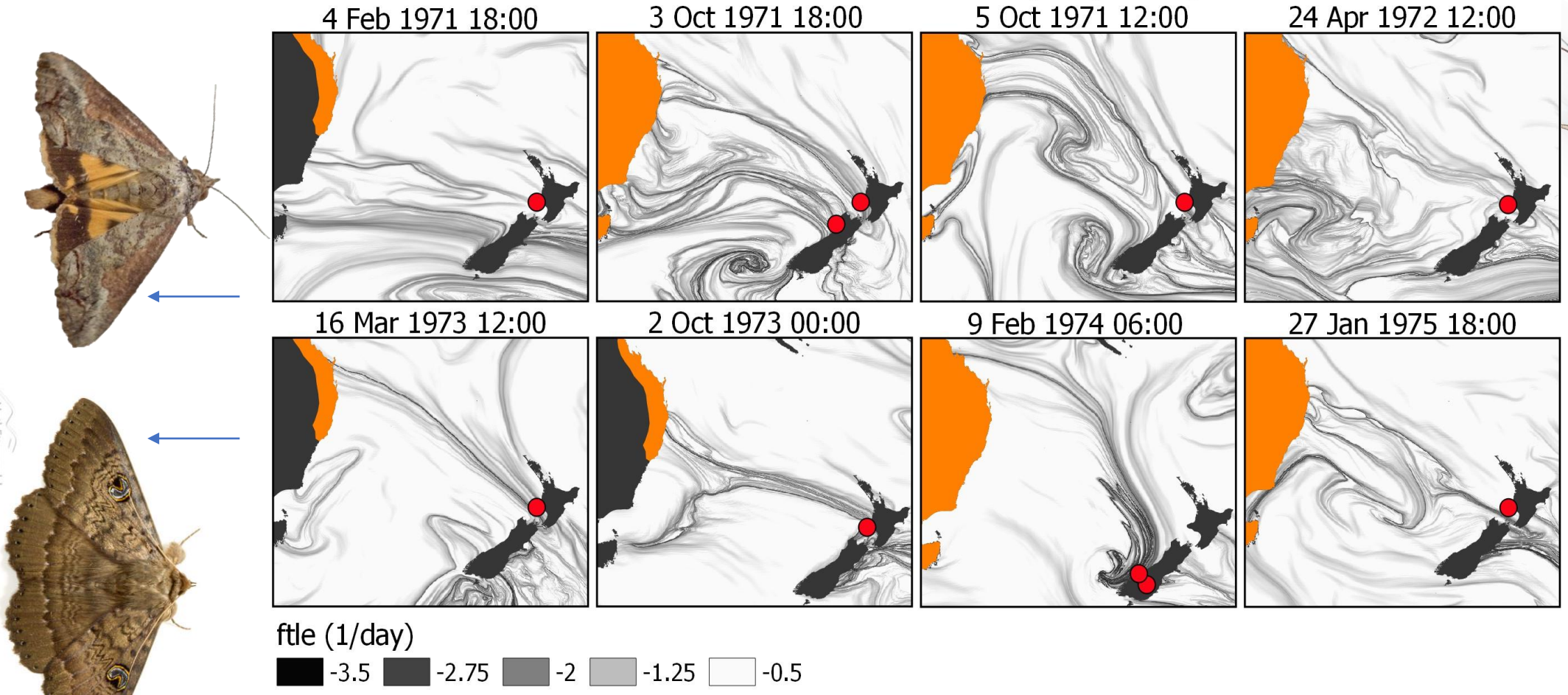
Long distance migration of insects to a subantarctic island

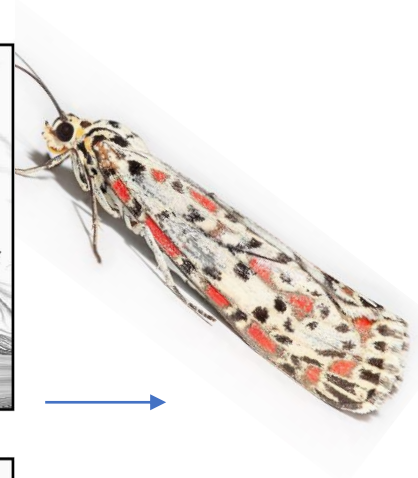
Penelope Greenslade[1], Roger A. Farrow[2] and Jeremy M. B. Smith[3] [1]*CSIRO Entomology, GPO Box 1700, Canberra, ACT 2601, Australia,* [2]*formerly of CSIRO, now of Tilembeya Consulting, Tilembeya, RMB 777, Urila Road, via Queanbeyan, NSW 2620, Australia,* [3]*formerly of Australian Antarctic Division, Channel Highway, Kingston, Tasmania 4050, now at Department of Geography and Planning, University of New England, Armidale, NSW 2351, Australia.*

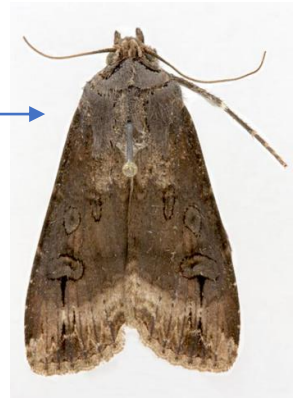
2. Smoke transport from 2020 Australian bushfires – Himawari-8 satellite imagery



Australia to New Zealand (Fox, 1978)







LCS Air bridges took 2-6 days at a speed of 3 m/s :

- Feb 1971 - Variable yellow underwing (*Hypocala deflorata*, Erebidae)
- Oct 1971/ April 1972 – Heliotrope moth (*Utetheisa pulchelloides vaga,* Erebidae)
- Mar 1973 – Northern Wattle Moth (*Dasypodia cymatode)s* & Tropical armyworm (*Spodoptera litura)*
- Jan 1975 – Black cutworm (*Agrotis ipsilon* Noctuidae)

Passage of a very large intense cyclone Pam: early Feb 1974

The following tropical insects arrived in Fiordland & Otago:

- Australian painted lady (*Vanessa kershawi,* Nymphalidae)
- Lesser wanderer (*Danaus petilia*, Nymphalidae)
- Blue moon butterfly (*Hypolimnas bolina,* Nymphalidae)
- Fruit piercing moth (*Eudocima materna*, Erebidae)

Photo: Butterfly conservation South Australia Inc.

Photo: Cambridge butterfly conservatory

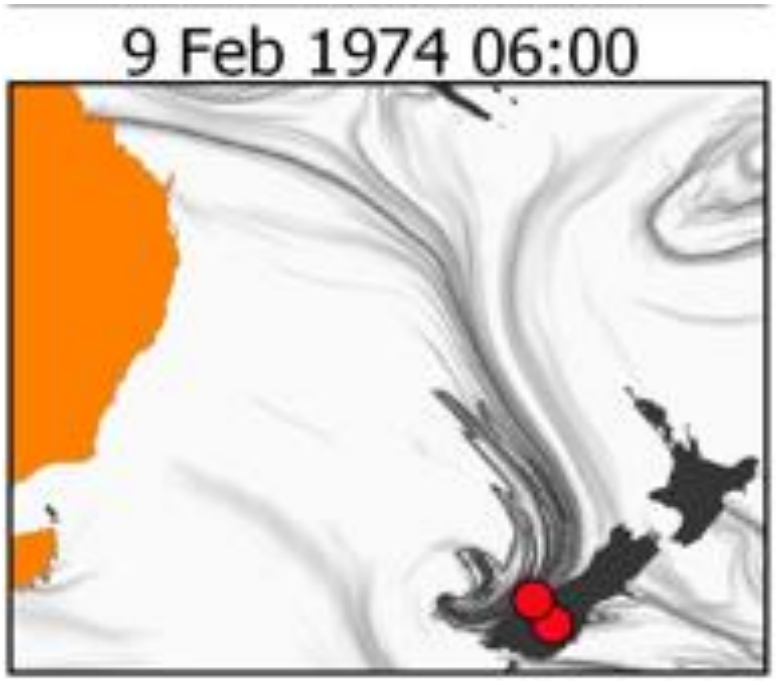


Photo: Afaq Ahmad Dar

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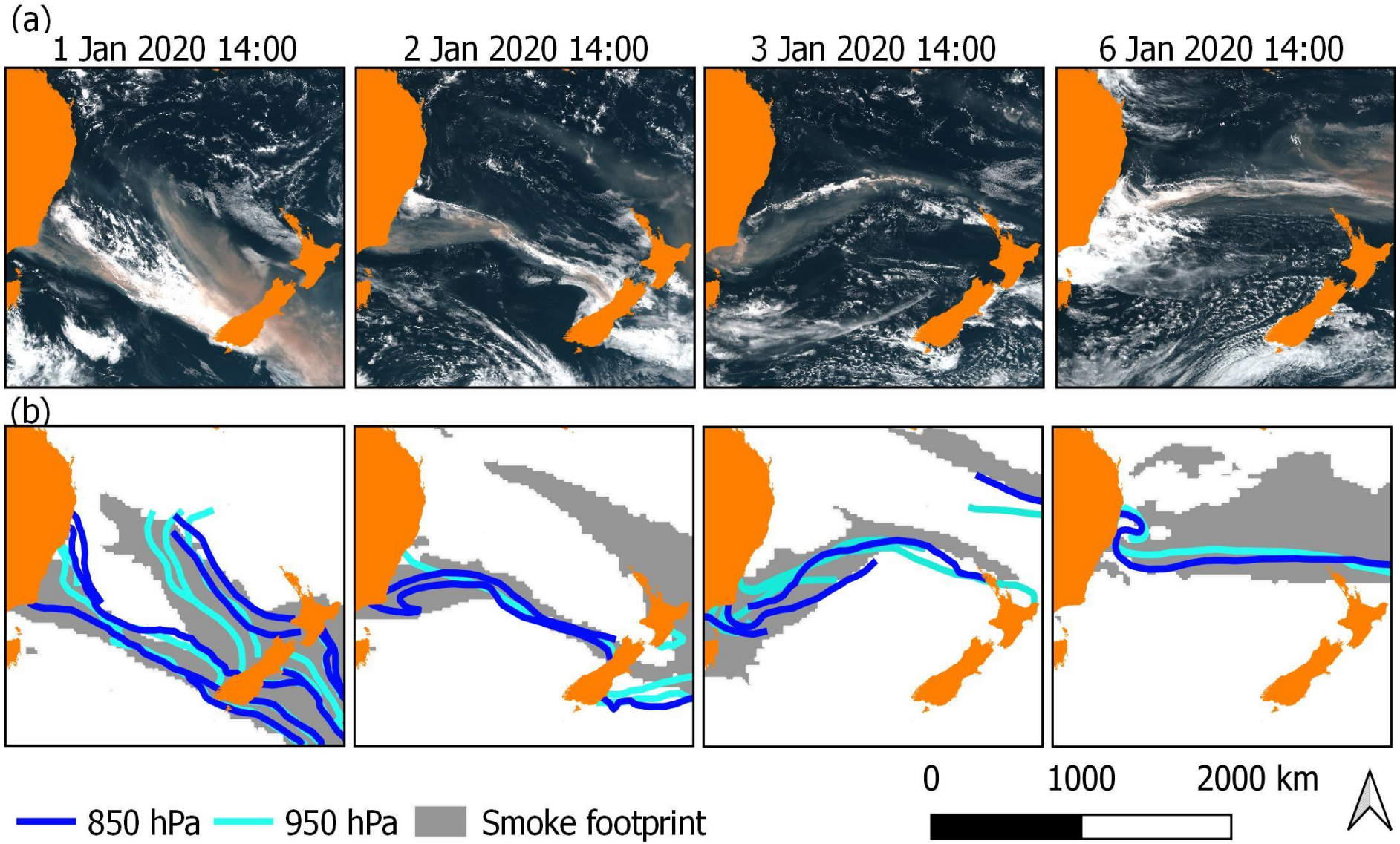
Moth incursions to subantarctic Macquarie Island

Black Cutworm *Agrotis ipsilon*, Old lady moth *Dasypoda selenophora,* Southern armyworm *Persectania ewingii*

- LCS Air bridges took 20-43 hours at a speed of 3 m/s :

LCS model evaluation– 2020 Bushfire smoke



What role has migration played in NZ forest insect incursions?

- Since 2001, 19 of 31 species of Lepidoptera that established in NZ were of Australian origin, another 2 from Norfolk Island.
- Pathways of entry are unknown
  - Some of our first records are near ports,
  - but port cities also contain our keenest insect spotters
- We now know many are capable of flying the 2-5 days on an LCS airbridge
- Migrations are a significant pathway
- Have any been forestry pests?

Some invasive Lepidoptera from Australia on tre - since 1988

Species	Family	First locality	Hosts
Heliozela cf. catoptrias	Heliozelidae	1994 Great Barrier Island	Tea Tree *Kunzea ericoides* (Myrtaceae)
Acrocercops laciniella	Gracillariidae	1999 Auckland	*Eucalyptus* spp. (Myrtaceae)
Stegommata sulfuratella	Lyonetiidae	1999 Auckland	*Banksia* (Proteaceae)
Holocola sp.	Tortricidae	1999 Nelson	*Acacia longifolia* (Fabaceae)
Zomaria doxasticana	Tortricidae	1990 Northland	*Acacia longifolia, Acacia melanoxylon* (Fabaceae)
Coscinoptycha improbana	Caroposinidae	1999 Northland	*Citrus*, (Myrtaceae, Celastraceae)

Image: Scion

Some invasive Lepidoptera tree defoliators – since 1970's

Species	Family	First locality	Hosts	Size
Stericta cabonalis	Pyralidae	2009 Banks Peninsular	Eucalyptus (Myrtaceae)	20mm
Cizara ardeniae	Sphingidae	1982 Otago	*Coprosma* (Rubiaceae Proteaceae)	56mm
Dasypodia selenophora	Erebidae	1886 Sth Island	*Acacia* (Fabaceae)	90mm
Dasypodia cymatodes	Erebidae	1973 Taranaki	*Acacia* (Fabaceae)	80mm
Uraba lugens	Nolidae	1992 Tauranga	*Eucalyptus* (Myrtaceae)	24mm

New Zealand Entomologist

ISSN: 0077-9962 (Print) 1179-3430 (Online) Journal homepage: https://www.tandfonline.com/loi/tnze20

Adventive species of Lepidoptera recorded for the first time in New Zealand since 1988

Robert J. B. Hoare

Adventive moths (Lepidoptera) established in mainland New Zealand: Additions and new identifications since 2001

Authors: R JB Hoare; N Hudson

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PUBLICATION DETAILS

Date of Publication: December 2018

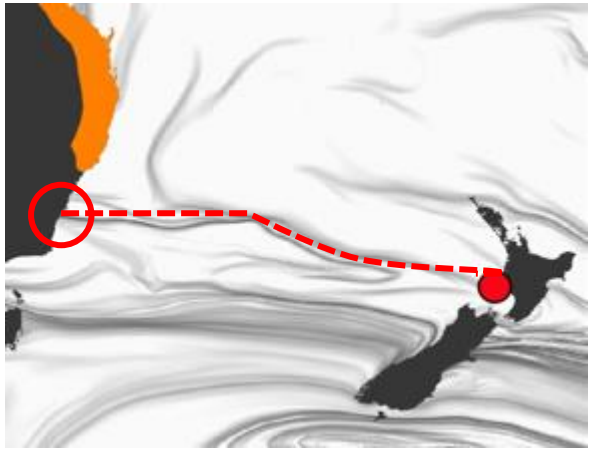
Closing the aeri ew Aerial Invaders research progra

- Scion has 5 years fundi
  Zealand from aerial inva
- We will be:
  - Improving the accur
    models
  - Using aerial LIDAR
    conditions pests and
    travel on the LCS, ta
  - Studying survival du
  - Capturing spores, particles and macro lepidoptera upon Mt Taranaki to trace the LCS pathways in real time
  - Developing aerobiological and climatic models with regional spread to enable predictions of incursions

i.e. Mt Doom from the Lord of the Rings, 2518m asl

Seeking Collaborations – toni.withers@scionresearch.com

- For any exotic lepidoptera we intercept on Mt Taranaki from 2024-2027
- Seek to ascertain dates of their mass flights, and locations of take-off points from Eastern Australia
- Will enable validation and improved accuracy of our LCS airbridge models
- Initiating collaborations with:
  - iMapPESTS
  - Zenith-pointing linear-polarized narrow-angle conical insect scan radar (NSW)
  - Bogong moth tracker citizen scientists
  - Butterflies Australia
  - Others..?



BUTTERFLIES AUSTRALIA

In Conclusion

- Luckily the highest risk defoliators considered threat to *Pinus radiata* are NOT at this time in Australia or the Pacific
- This gives NZ Forest Industry time to improve its knowledge of the aerial pathway through our Aerial Invaders programme
- Time to develop Lepidoptera readiness plans and surveillance methods
- One of our Government and Forest Industry priority research areas

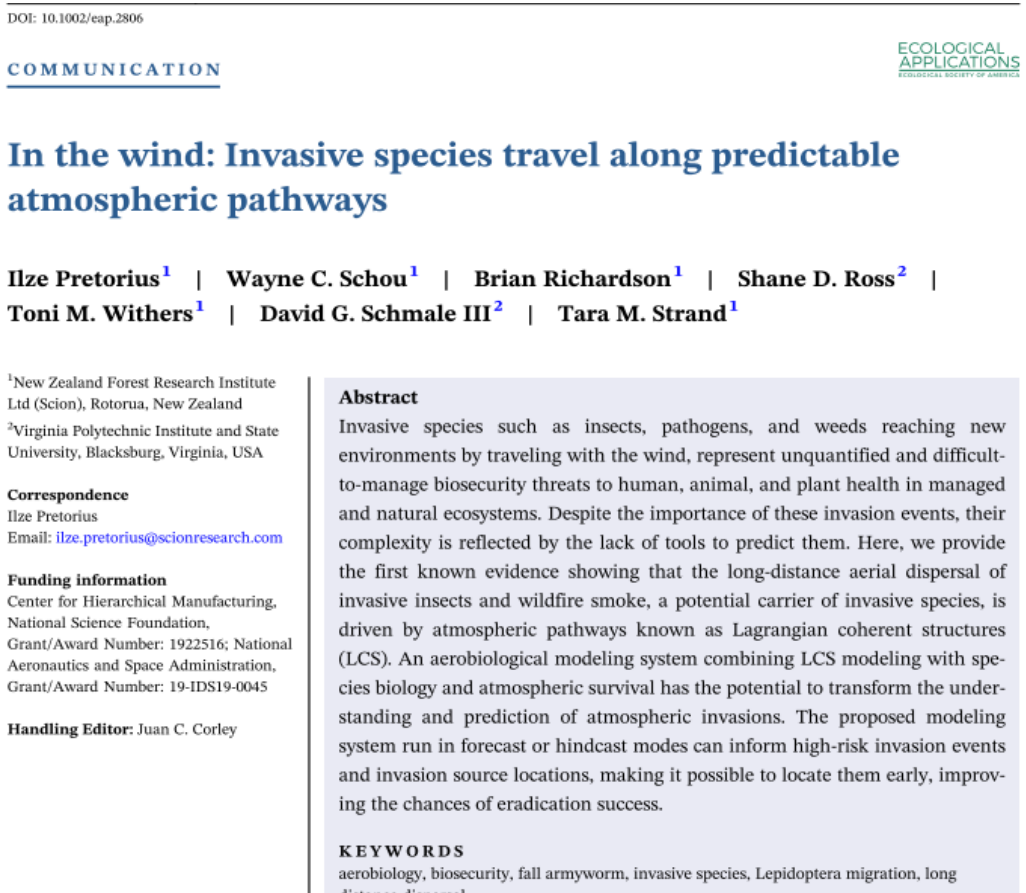
Photo: John Ghent

Photo: Thomas County Ag

Acknowledgements

Shane Ross and David Schmale, Virginia Polytechnic Institute and State University, Virginia, United States of America.

Belinda Gresham, Nicolas Meurisse and Honey Estarija, Scion



DOI: 10.1002/eap.2806

COMMUNICATION

ECOLOGICAL APPLICATIONS

In the wind: Invasive species travel along predictable atmospheric pathways

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Handling Editor: Juan C. Corley

Abstract

Invasive species such as insects, pathogens, and weeds reaching new environments by traveling with the wind, represent unquantified and difficult-to-manage biosecurity threats to human, animal, and plant health in managed and natural ecosystems. Despite the importance of these invasion events, their complexity is reflected by the lack of tools to predict them. Here, we provide the first known evidence showing that the long-distance aerial dispersal of invasive insects and wildfire smoke, a potential carrier of invasive species, is driven by atmospheric pathways known as Lagrangian coherent structures (LCS). An aerobiological modeling system combining LCS modeling with species biology and atmospheric survival has the potential to transform the understanding and prediction of atmospheric invasions. The proposed modeling system run in forecast or hindcast modes can inform high-risk invasion events and invasion source locations, making it possible to locate them early, improving the chances of eradication success.

KEYWORDS
aerobiology, biosecurity, fall armyworm, invasive species, Lepidoptera migration, long

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Prosperity from trees *Mai i te ngahere oranga*