



JBA
trust

Identification of coherent weather features in three dimensions

Environmental Modelling in Industry – Study Group

Rob Lamb & Kay Shelton

21st - 24th September 2015

JBA Trust - the basics...



‘developing knowledge and skills for environmental risks and resources management’

- Set up in 2011
- Funded by JBA Group but legally independent of JBA Group
- Majority external Board of Directors



Rob Lamb MA PhD
Managing Director

Rob has 20 years' experience in academic and commercial research and development. He specialises in hydrology and flood risk science, has published work in numerous journals and is co-author of two text books. Since 2008, Rob has been Chief Scientist to the JBA Group, leading JBA's scientific research and development. In 2013 Rob was made an Honorary Professor at Lancaster University.



Jim Hall FEng
Chair of the Board of Trustees

Jim is Professor of Climate and Environmental Risks and Director of the Environmental Change Institute at the University of Oxford. His research focuses upon management of climate-related risks in infrastructure systems, in particular relating to flooding, coastal erosion and water scarcity.



Keith Beven

Keith is Distinguished Professor of Hydrology at Lancaster University, with research interests in risk and uncertainty in environmental modelling, particularly in the areas of rainfall runoff modelling, flood inundation, flood forecasting, hydrological change, and water quality modelling.



Jeremy Benn FEng

Jeremy is a Director of the Trust and CEO of the JBA Group. He has 30 years' experience of water engineering and hydrology gained from consultancy work in the UK, Ireland, Sri Lanka, Eastern Europe and Australia.



Nick Russell ACIB

Nick is a Director of the Trust. Having gained almost 40 years' experience in corporate banking he is now an independent financial consultant.

What we do



Research

- Foster links with UK universities and R&D organisations
- Publish research and data
- Share knowledge and good practice



Events

- Training events and practical demonstrations (hydraulic flumes, wave tanks)
- Science fairs, public events
- Conference sponsorship



Support for students

- Financial support for MSc and PhD students
- MSc placements in JBA
- Access to data and guidance

Scholarships for Flood and Coastal Risk Management

JBA Trust is fully funding two places on Lancaster University's Flood and Coastal Risk Management Postgraduate Certificate course in 2014/15.



JBA Trust supports training and education in the fields of environmental risks and resources. The challenges of more frequent extreme weather and new flood risk responsibilities mean that there is a growing need for skilled water and environmental management professionals.



Find out more



JBA trust Home Who We Are How We Work Research Programme MSc Support and Bursaries Demonstration Flume River Restoration Contact Us

Assessing the multiple benefits of SuDS
Flood and scour related failure incidents at railway assets between 1846 and 2013
How well do flood defence models match reality?
Modelling to support resilient integrated catchment management
Multi-Objective Flood Risk Management Demonstration Project
Susceptibility of catchments to Intense Rainfall and flooding - SINATRA
Tools and guidance for covariate analysis of flood and wave threshold exceedances
UK multi-scale spatial/temporal rainfall and river flow extremes

Flood and scour related failure railway assets between 1846 and 2013

In 2013 JBA Trust funded a summer placement to investigate railway asset failure incidents due to flooding and scour between 1846 and 2013.

The project built on a report carried out by JBA for the Standards Board (RSSB) in 2004 to investigate and report on railway assets in flood conditions.

Flood and scour related failure incidents at railway assets

News

MSc student bursaries - APPLY NOW!
The British Hydrological Society and JBA Trust Studentship Award is now open for applications, 10 July 2014

JBA Trust Annual Trustees Report
The trustees are very pleased to be able to share the first annual report of the JBA Trust. 3 June 2014

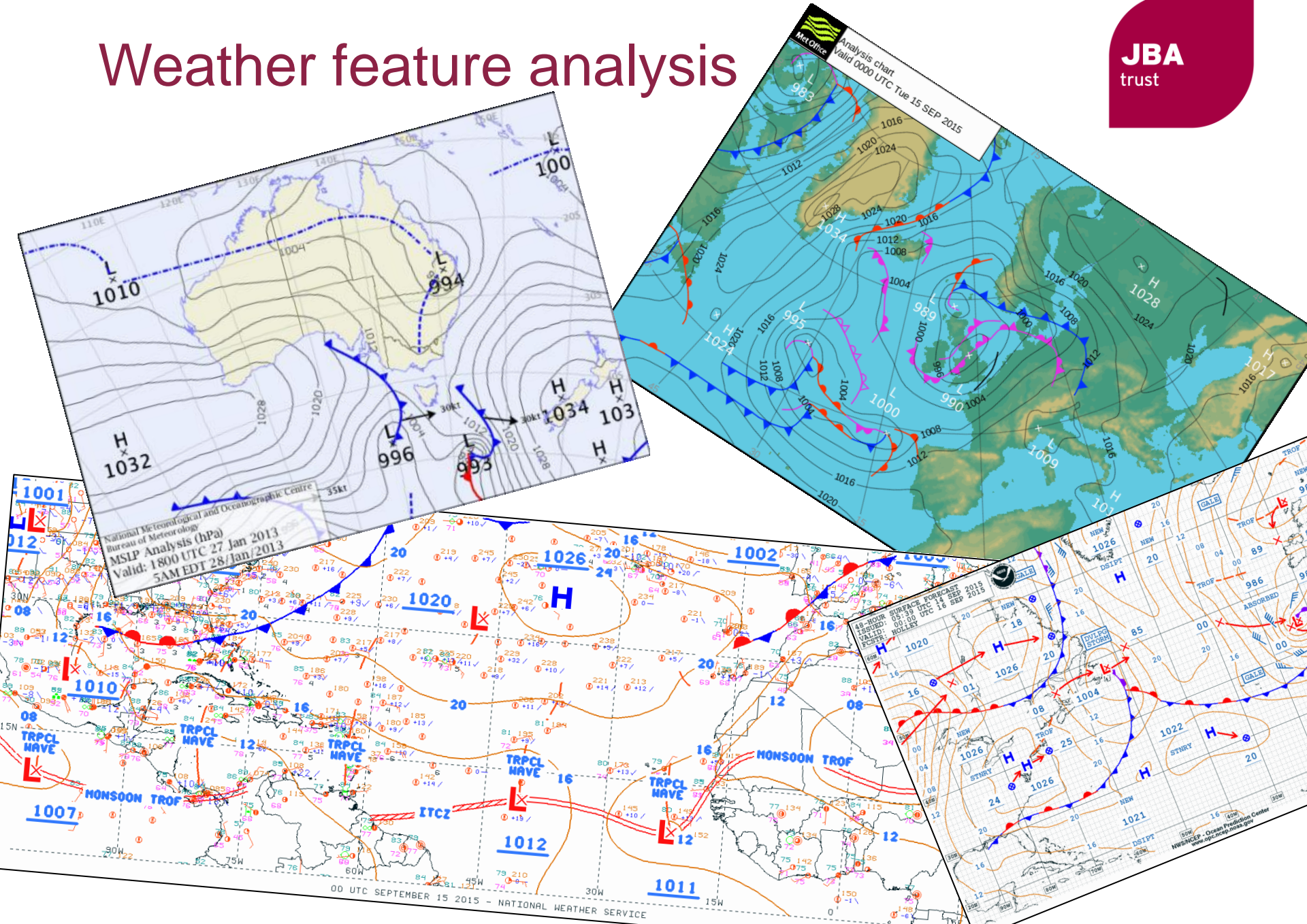
International Flood Risk Workshop in Xiamen, China
Professor Rob Lamb of the JBA Trust gives keynote talk on "Managing large scale inter-connected systems for sustainable flood risk reduction" 31 March 2014

BLOG: My experience of Science in Industry
To celebrate National Science and Engineering Week, Rob Lamb writes about his experiences of Science in Industry 21 March 2014

1 of 8 next >

www.jbatrust.org

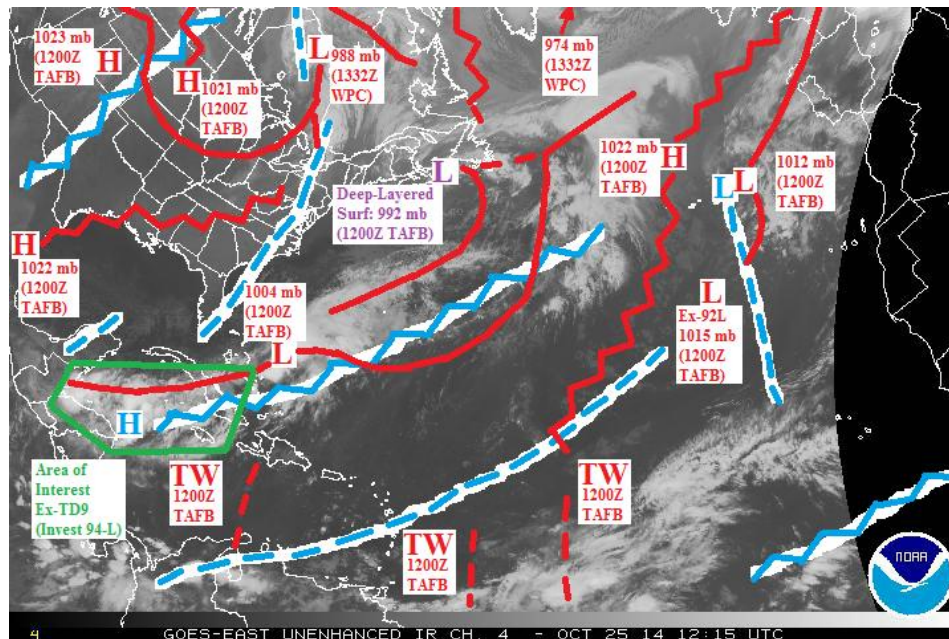
Weather feature analysis



Weather feature analysis

Quickly and easily provides a wealth of information to both forecasters and general public.

- Often manually analysed by forecasters
- Subjective and artful, experienced forecasters can add value
- Routine manual analysis still a primary tool used by forecasters in operational centres around the world.

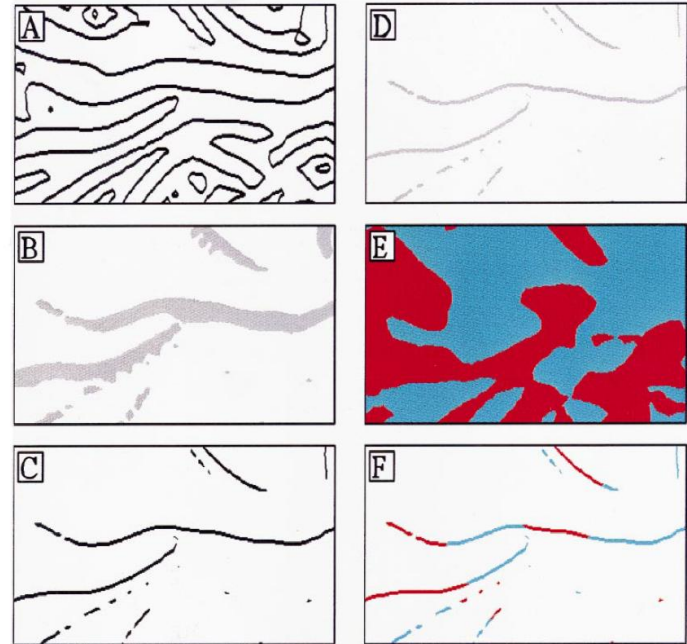


Objective front depiction

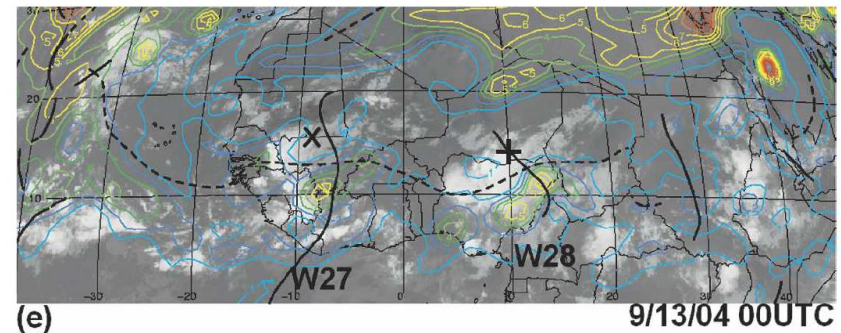
- Work to identify and draw objective fronts operationally progressing since 1960s (Renard and Clarke, 1965).
But still not routine.
- Often not used for research purposes
– errors and inconsistencies are important.
- Recent push by UK Met Office to produce objectively identified fronts and cyclones using calculations and graphical masking (Hewson, 1997, 1998).
- Similar, augmented, technique applied to easterly waves (Berry et al., 2007).

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Hewson (1998)

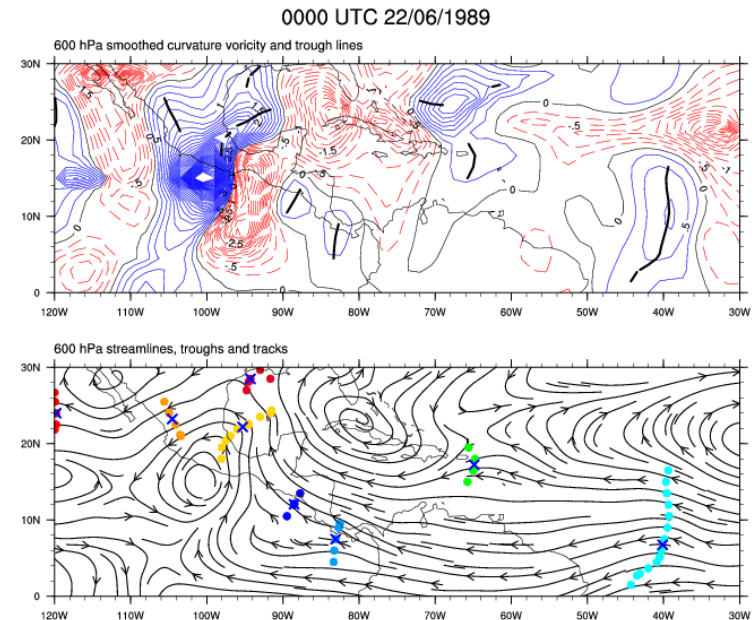


(e)

Berry et al. (2007)

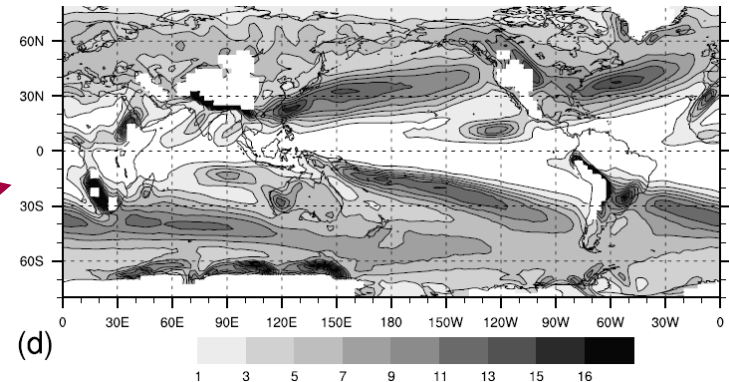
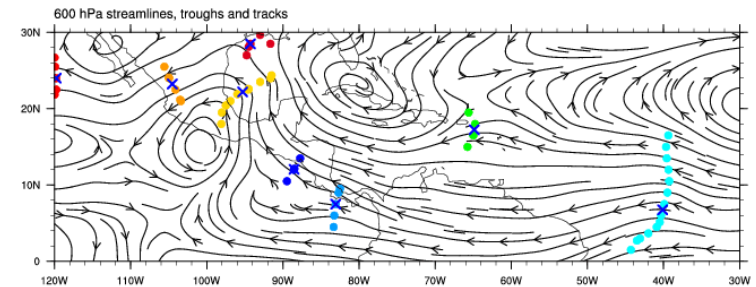
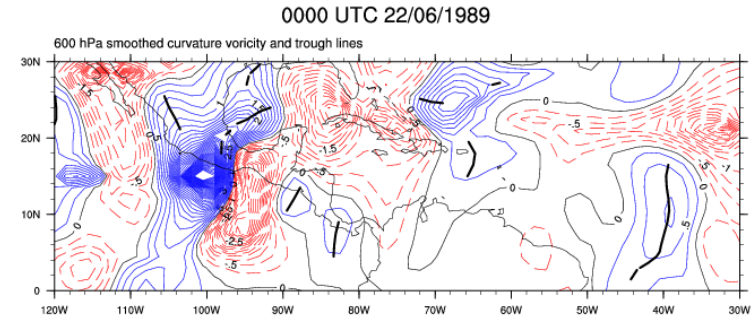
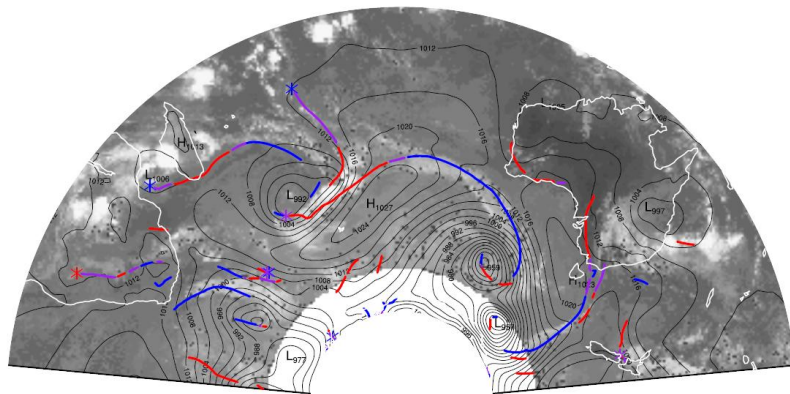
Feature identification in 2D (i)

- My PhD built on Hewson and Berry et al. technique, to devise method to numerically define easterly wave axes as a series of continuous points.
- Allowed for waves to be numerically tracked, composited and statistically analysed.
- Paved the way for the global climatology of fronts (Berry et al., 2011).



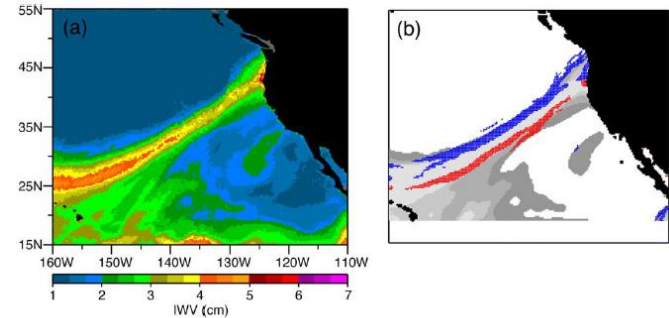
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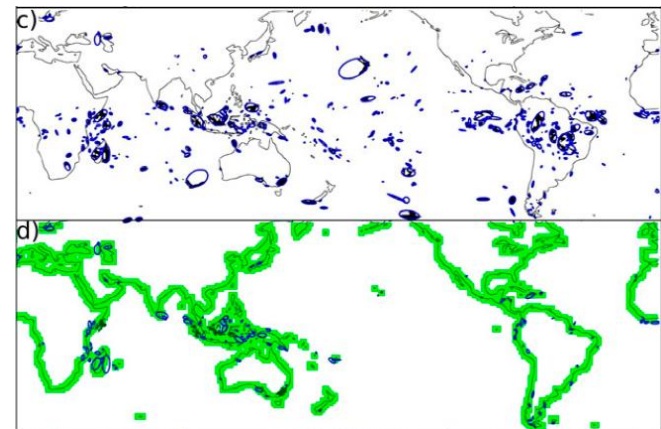


Feature identification in 2D (ii)

- Extratropical, tropical cyclone and other vorticity or pressure maxima/minima (Hodges 1995; reviewed by Tory et al. 2012)
- Markov random field statistical model for locating the ITCZ in the eastern Pacific (Bain et al., 2011).
- Image processing technique used in identification of atmospheric rivers (Wick et al. 2013).
- Pattern recognition for coastally orientated rainfall signatures (Bergemann et al., 2015).
-and others.....



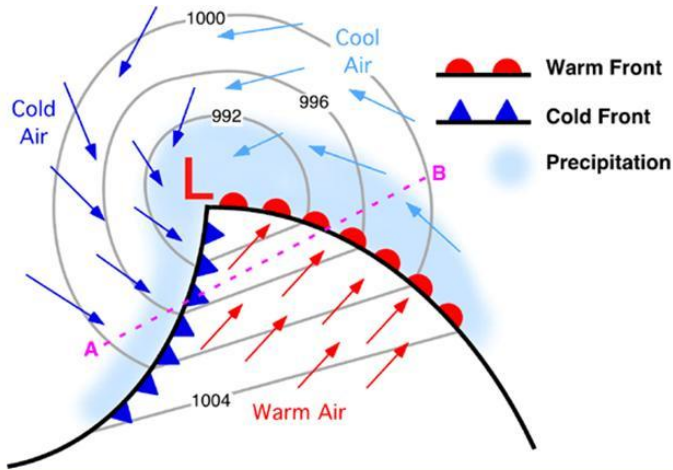
Wick et al. (2013)



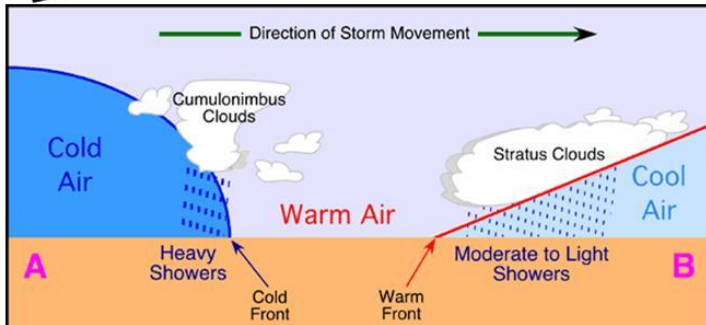
Bergemann et al. (2015)

Weather is three-dimensional! (i)

TOP
VIEW

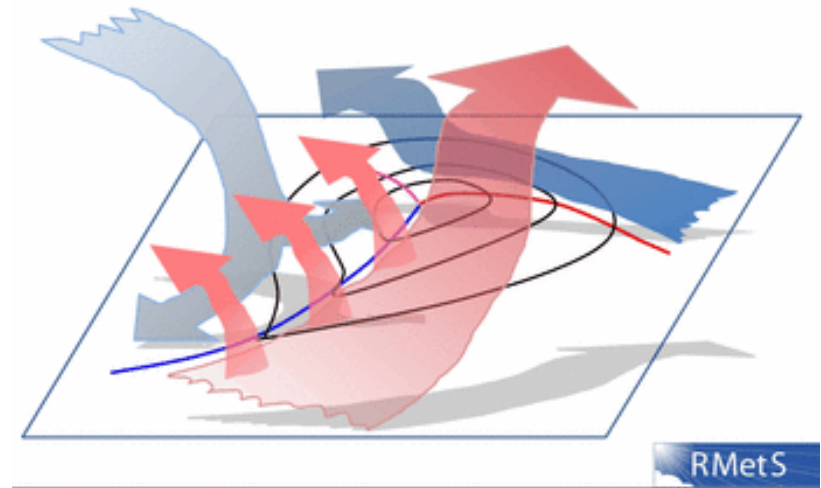


SIDE
VIEW

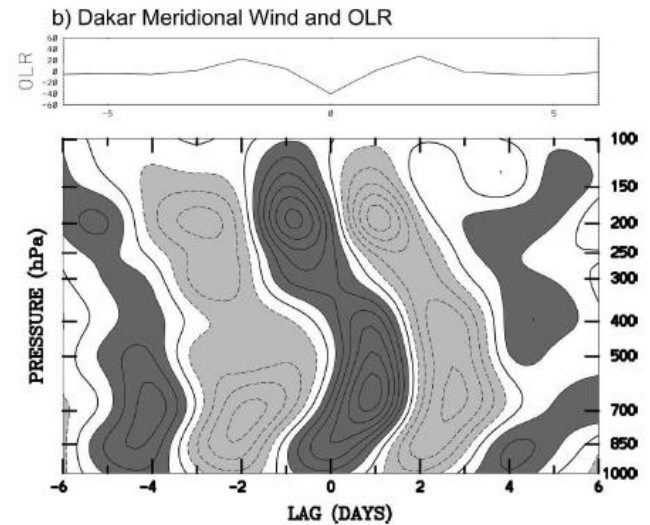
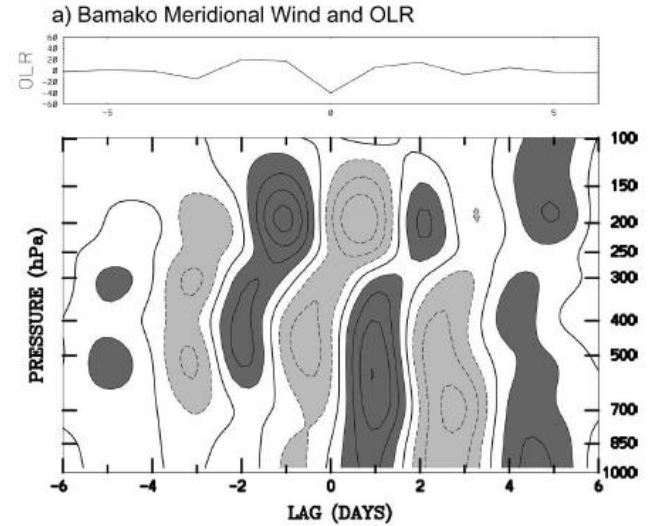
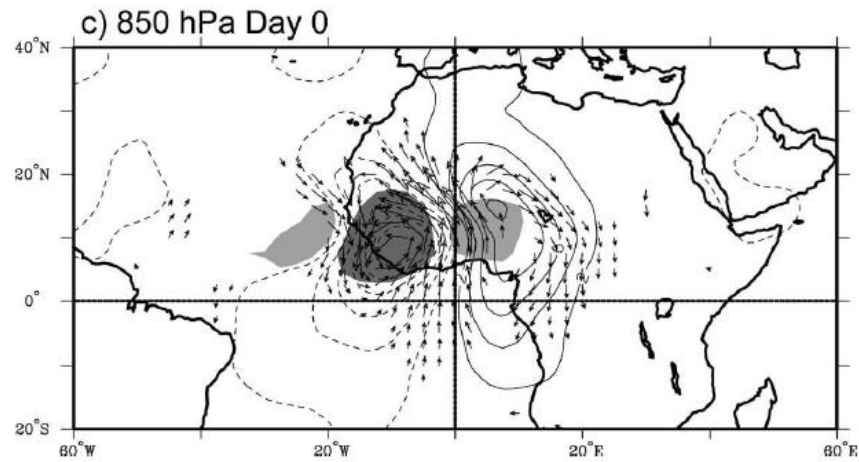
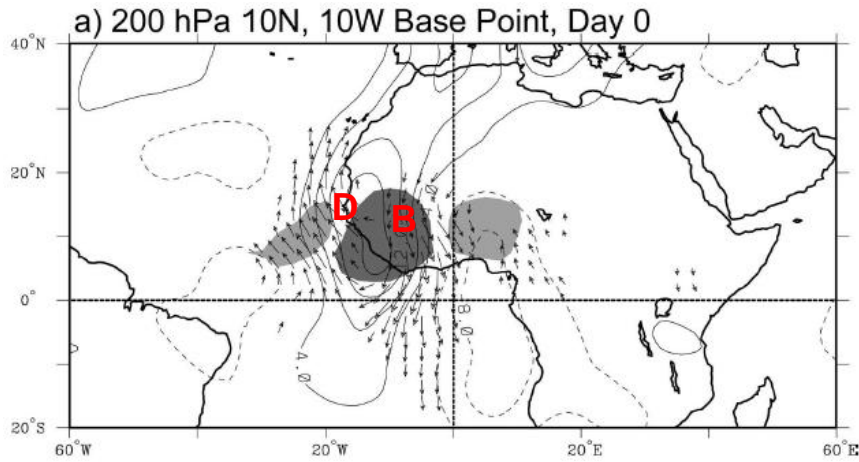


PhysicalGeography.net

Conveyor belts



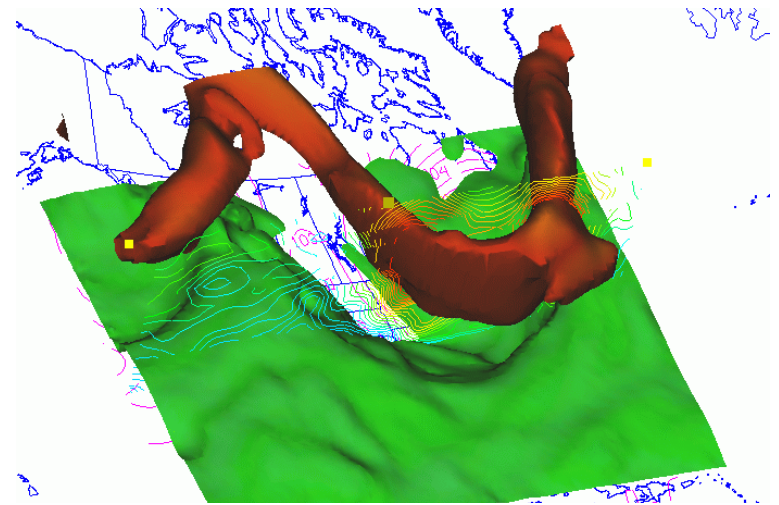
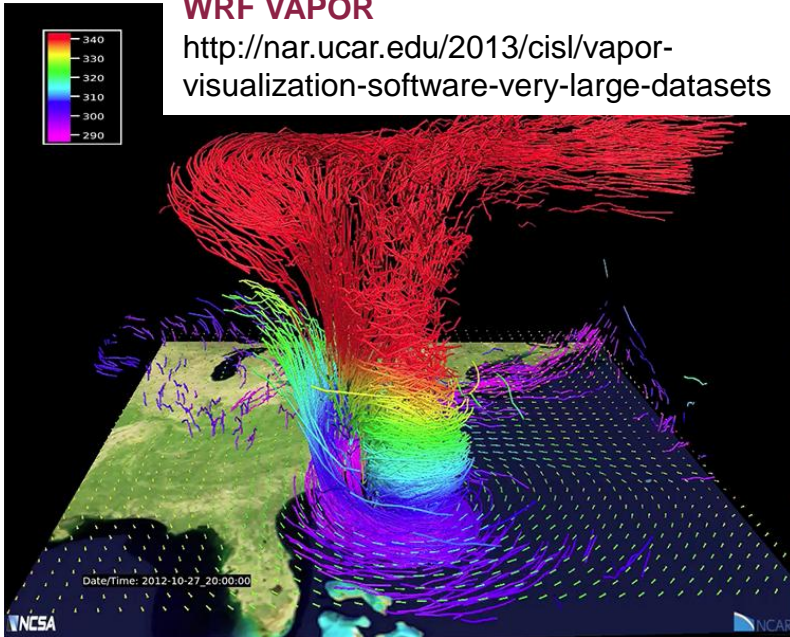
Weather is three-dimensional! (ii)



3D visualisation of weather (i)

WRF VAPOR

<http://nar.ucar.edu/2013/cisl/vapor-visualization-software-very-large-datasets>

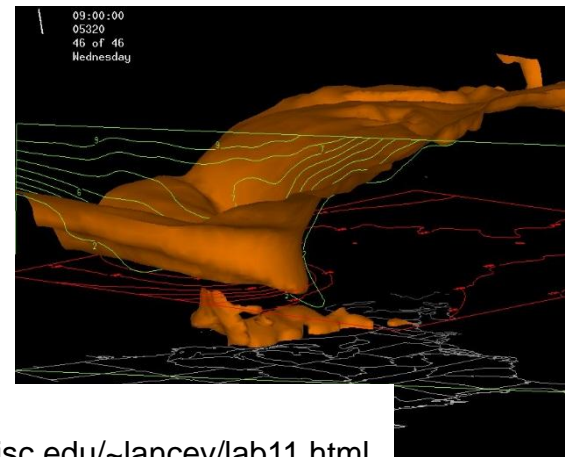
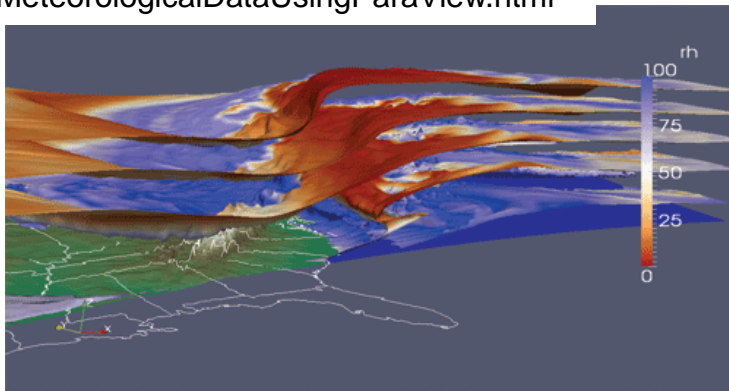


IDV

<http://www.unidata.ucar.edu/software/idv/gallery/jetStream.gif>

ParaView

<http://www.kitware.com/media/html/DesktopVisualizationOfMeteorologicalDataUsingParaView.html>



Vis5d

<http://aos.wisc.edu/~lancev/lab11.html>

3D visualisation of weather (ii)

- Those examples are not an exhaustive list; other visualisation labs include:
 - MetOffice Informatics Lab;
 - NOAA's Weather and Climate Toolkit;
 - Exelis 4D Weather Visualization Workbench (for NWS)
- Rendering the complexities of the atmosphere in 3D generally means some amount of simplification needs to be made. But....
- 3D visualisation of what is inherently a three dimensional fluid can provide insight into how weather features form, evolve and interact with their environment.
- It can also aid diagnosis and interpretation of the processes involved.

<https://www.youtube.com/watch?v=BBfR0HczH1s>

The problem

3D visualisation of weather aids interpretation; could analysis of weather features in 3D further our collective understanding?

- Objective identification of weather features in 2D is not trivial; extending this to 3D adds more complexity and computational requirements.
- Is the extension of 2D feature finders to 3D simply by performing 2D analysis at many vertical levels appropriate?
 - How should the features at adjacent vertical levels be associated with one-another to form vertically coherent features?
- Is there a more holistic approach that utilises information in the vertical in addition to the horizontal to identify horizontally and vertically coherent surfaces and/or volumes?

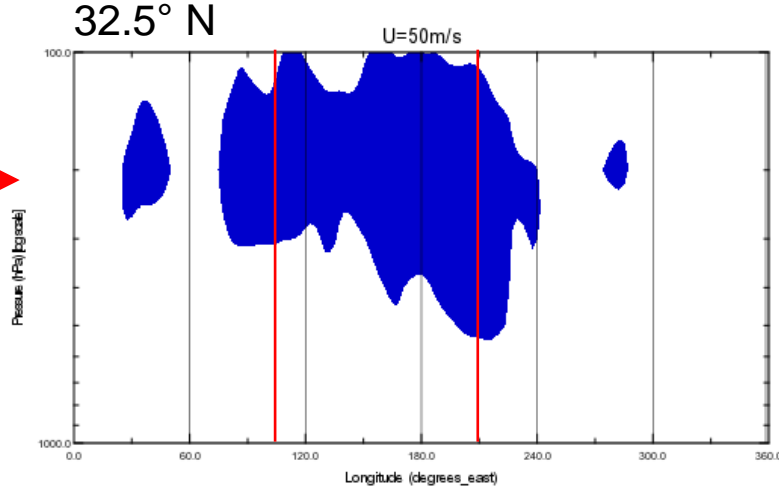
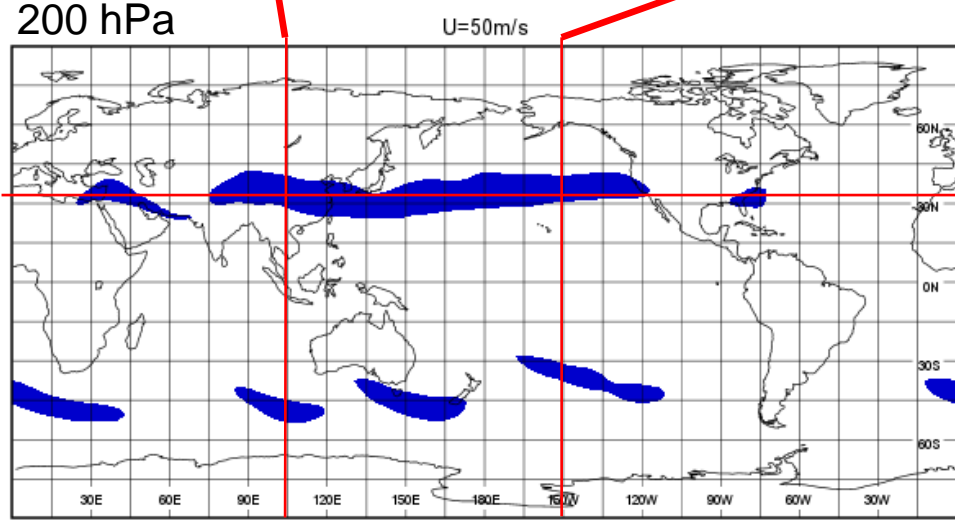
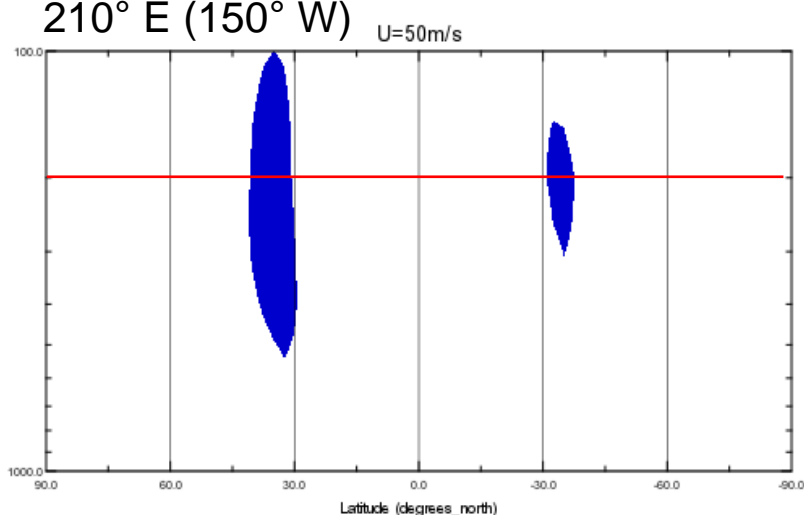
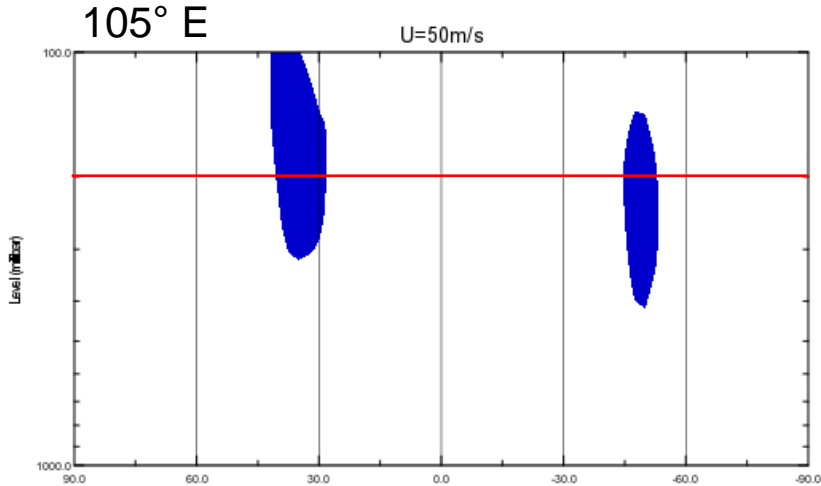
Approaches



Start with simple 3D volumes and surfaces and build up the complexity

- Use simplified datasets containing basic shapes to investigate possible methods for isolating the outer surface and retrieving the coordinates.
- Apply methods to simplified atmospheric datasets, e.g., jet stream.

Jet stream in 3D



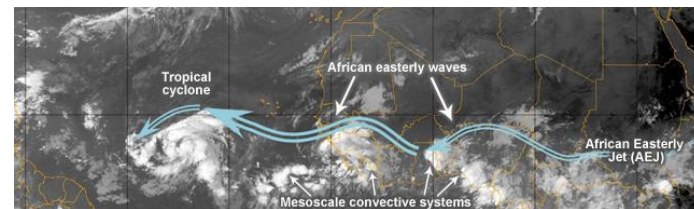
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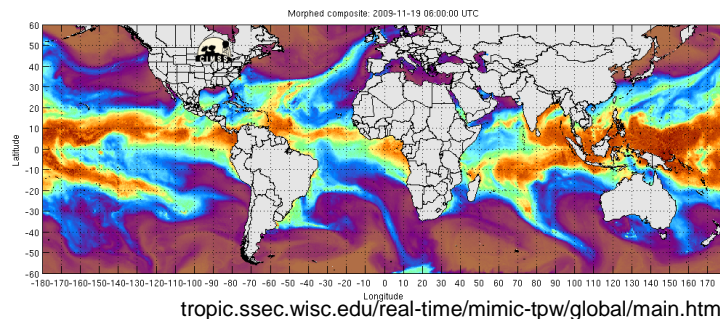
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Use existing feature datasets to investigate how to marry data together in vertical

- Easterly waves trough axis



- Atmospheric rivers



Datasets

NCEP/NCAR Reanalysis 1: 2.5°, global, 17 pressure levels, 2006 & 2009

- Zonal wind (u): identify Jetstream
- Zonal and meridional winds (u and v) and specific humidity (q): calculate horizontal water vapour transport to identify atmospheric rivers
 - Atmospheric river axis dataset

ECMWF Interim Reanalysis (ERA-Interim): 1.5°, tropical strip, 37 pressure levels, Jul-Oct 2000

- Zonal and meridional winds (u and v): identify wave trough axis
 - Easterly wave trough axis & tracks dataset

Thank you



Questions?