The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

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International Atomic Energy Agency

1968-11

Conference on Teleconnections in the Atmosphere and Oceans

17 - 20 November 2008

Basic ideas on teleconnections

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Basic Ideas on Teleconnections

Brian Hoskins

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Aspects to be discussed

1. Global constraints
2. Movement/adjustment of large-scale structures
3. Rossby wave propagation
4. Impact of climatological background
5. Storm-track involvement
6. Interaction with slower parts of the system

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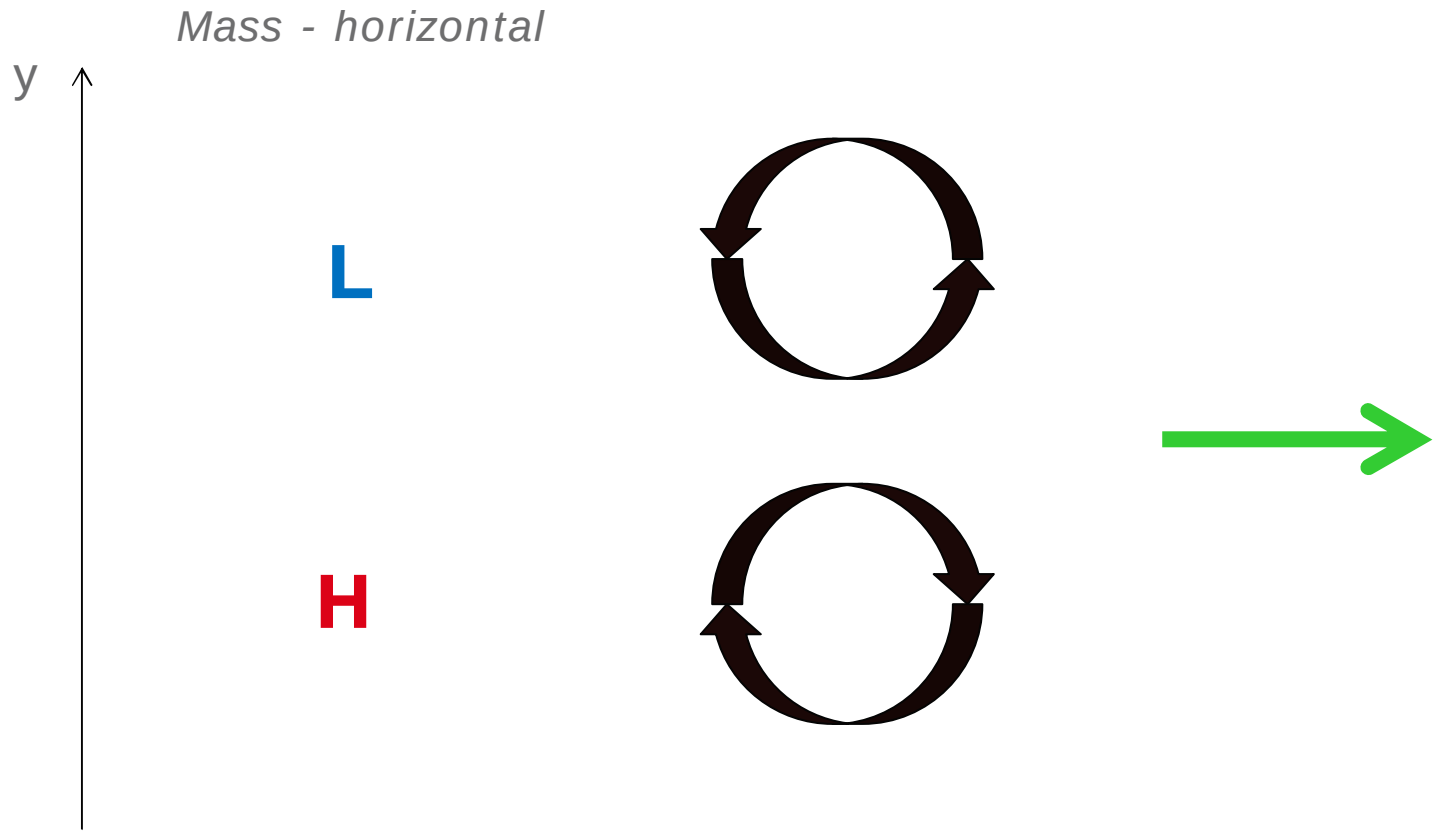
1. Global constraints



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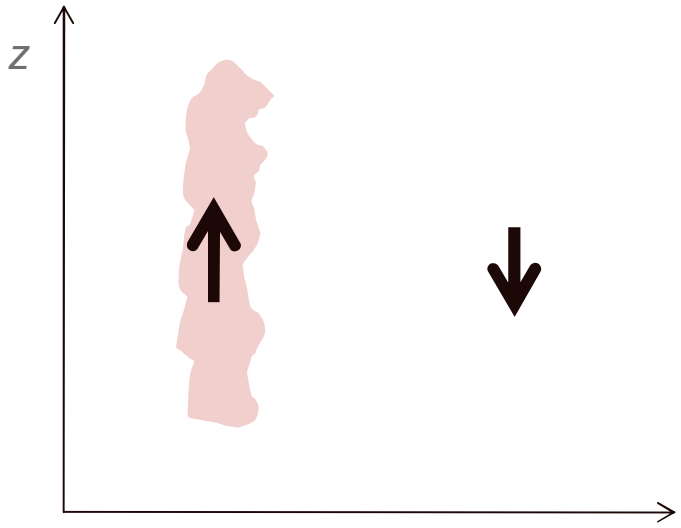
1. Global constraints

Mass - z



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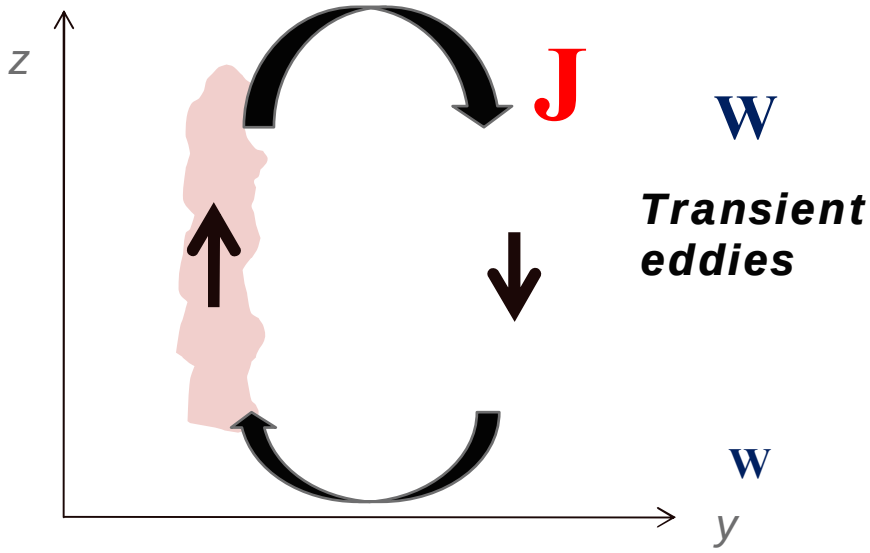
1. Global constraints

Mass - z



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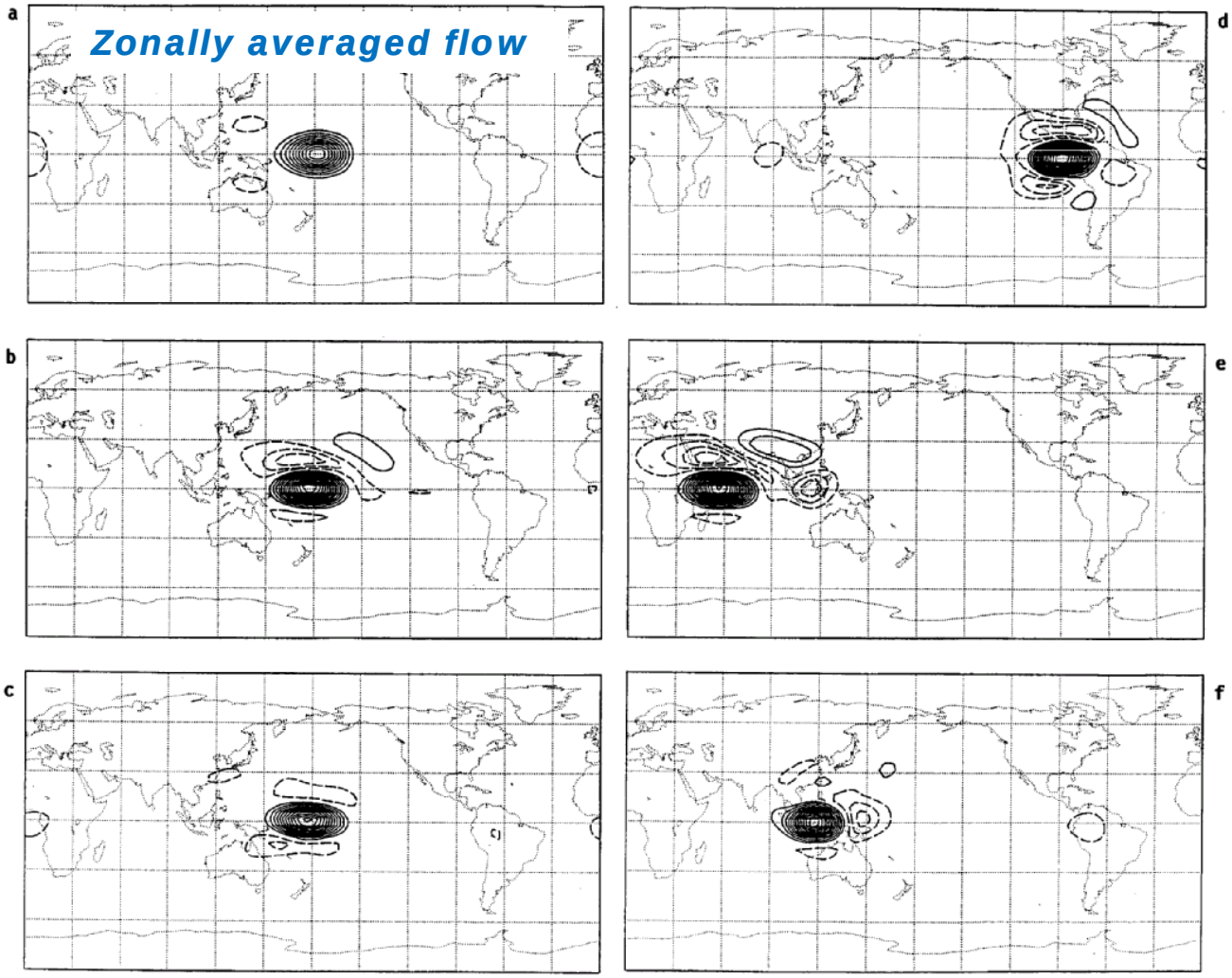
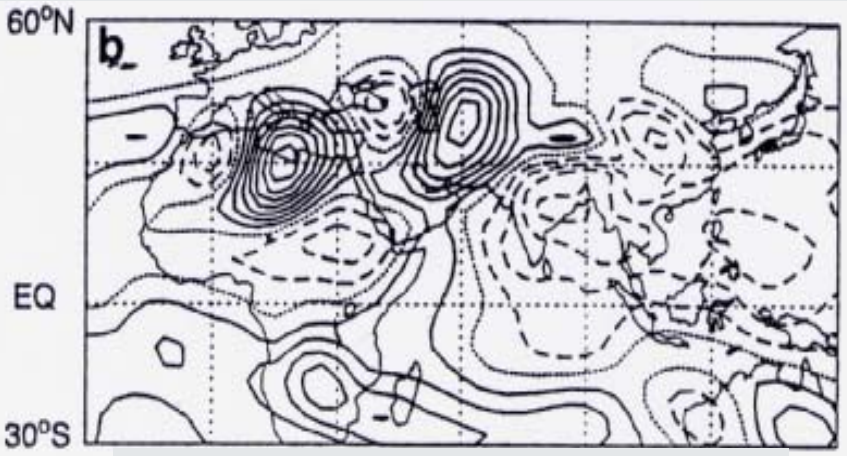
Upper tropospheric divergence 5 days after switching on equatorial heating in a DJF flow



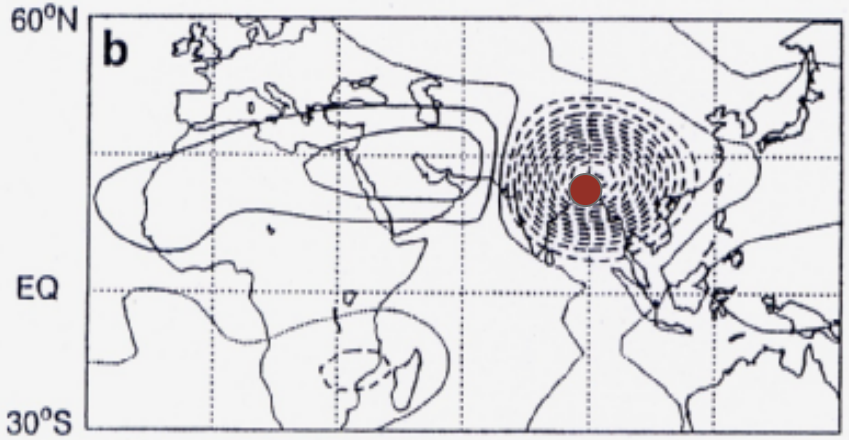
Fei-Fei & H, 1995

Compensating descent in a range of situations

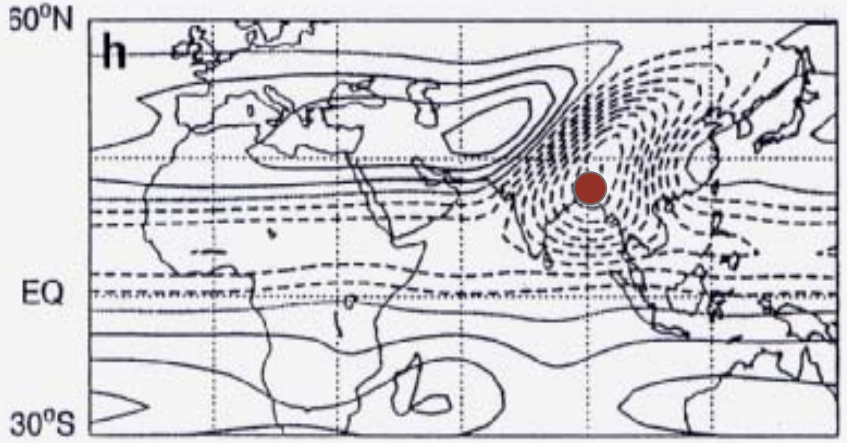
Rodwell & H



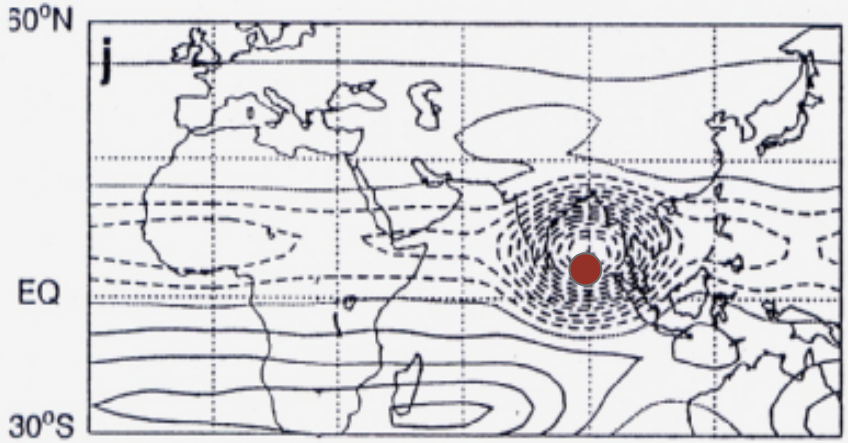
Realistic + topography



25°N resting atmosphere



25°N on zonal average



10°N on zonal average

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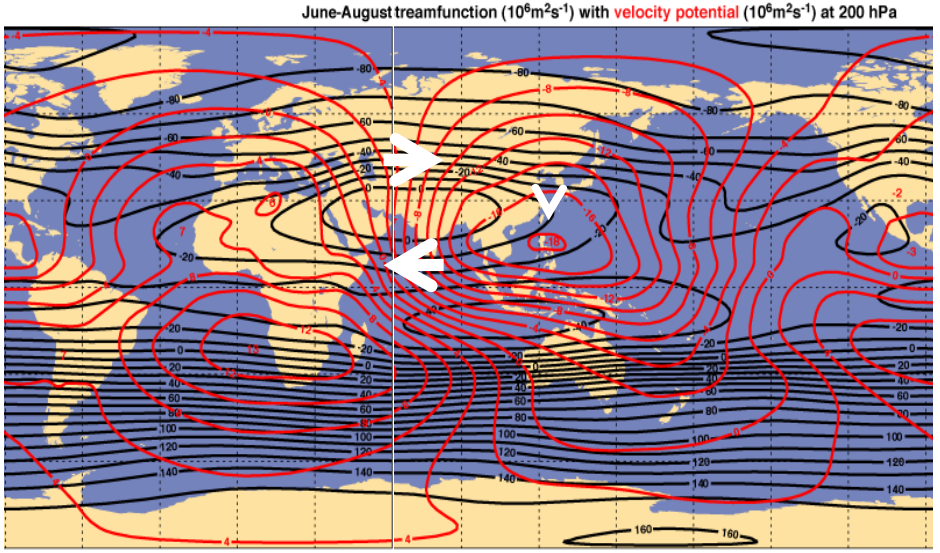
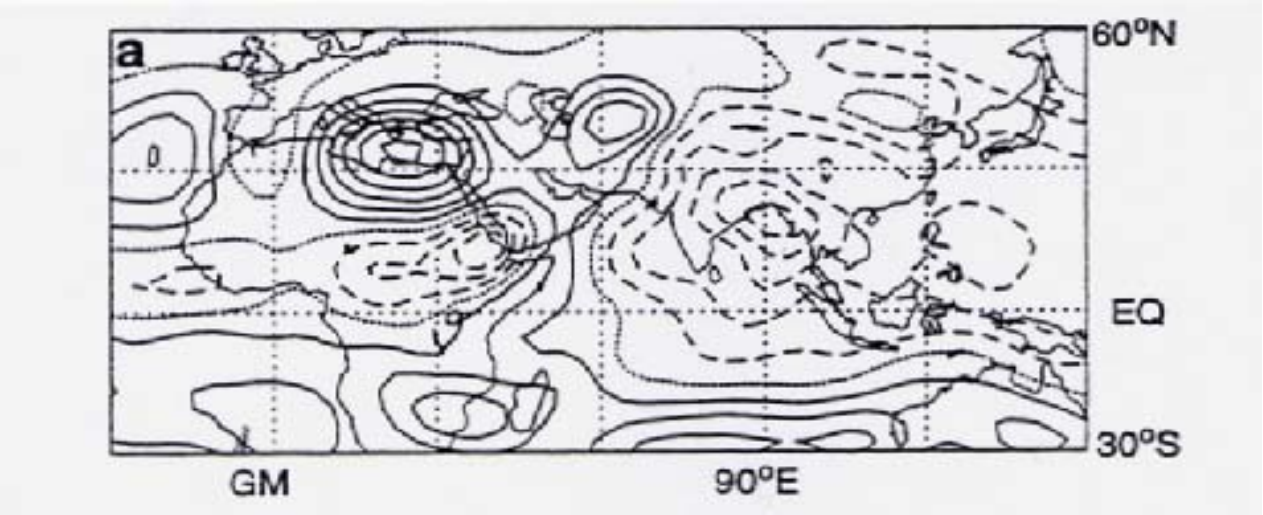
Observed JJA upper ψ, χ and mid w





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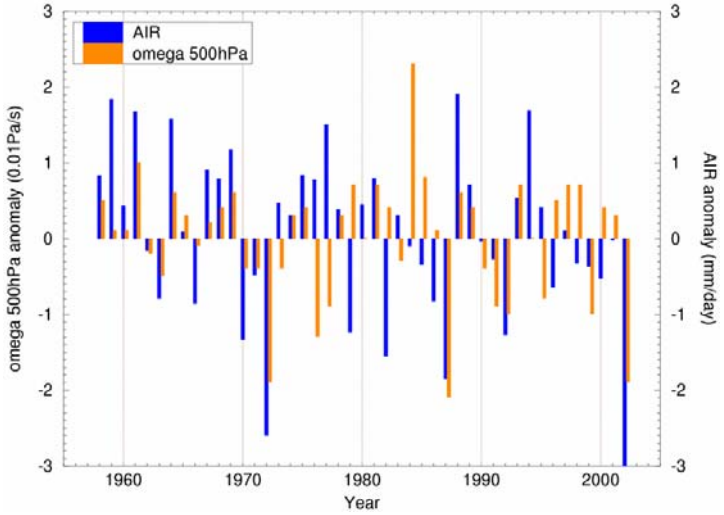
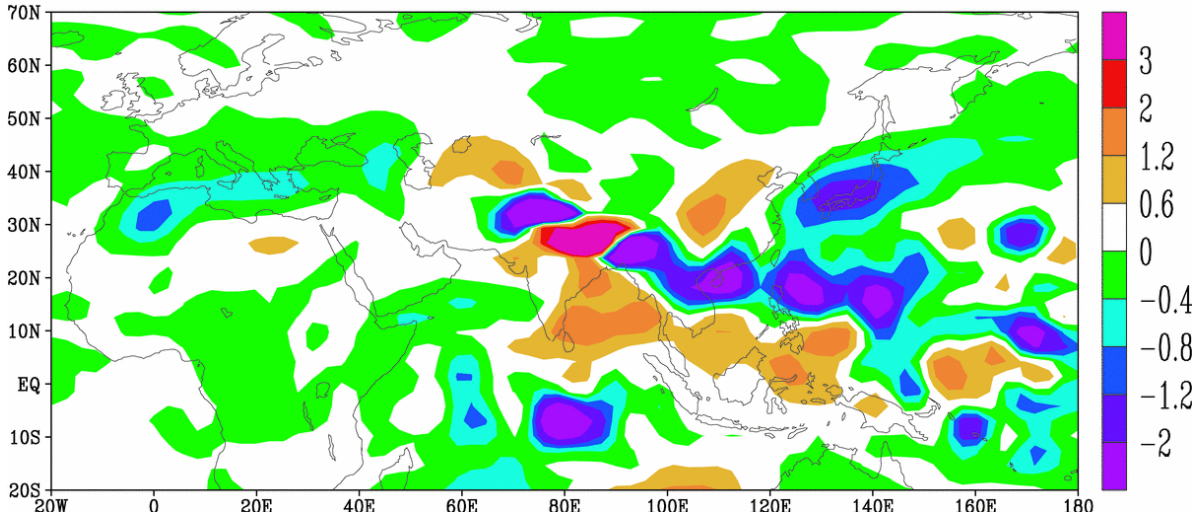
Summer 2002: floods in Europe & drought in India

All India rainfall

Mediterranean descent

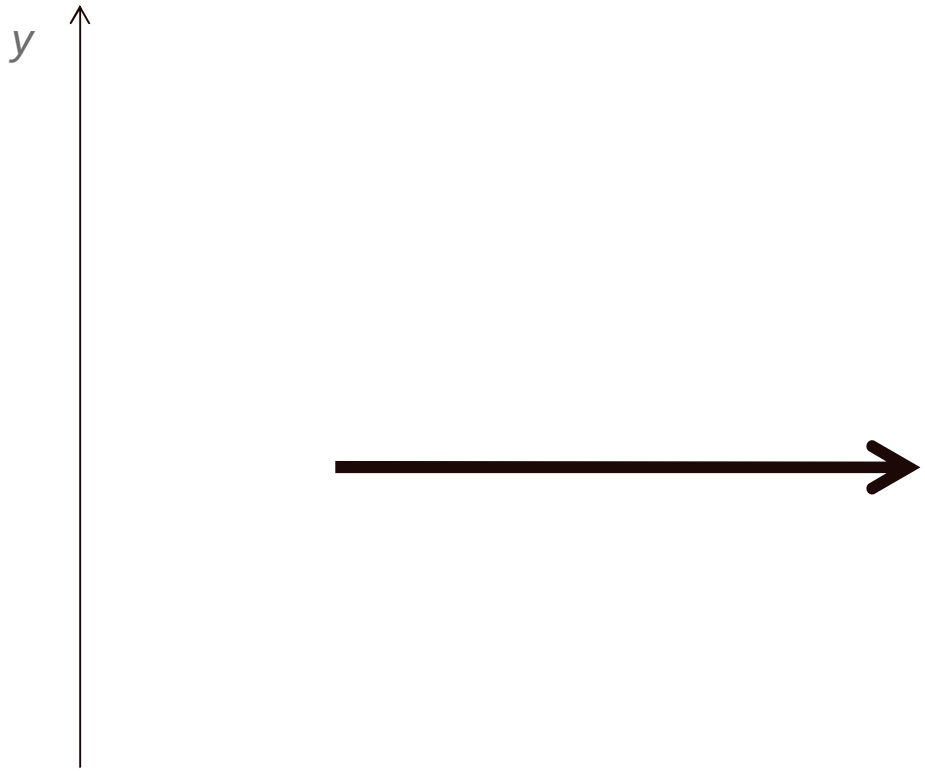


Idealised model: response in vertical motion to 2002 Asian Monsoon anomaly



Blackburn, Hoskins & Liu (2004)

2. Movement / adjustment of large-scale structures



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2. Movement / adjustment of large-scale structures

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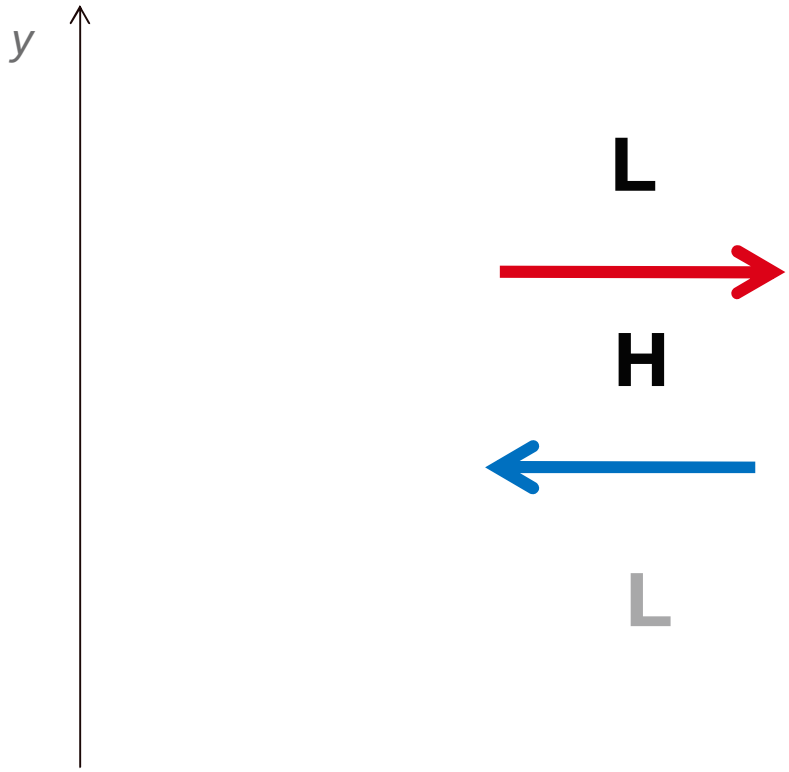
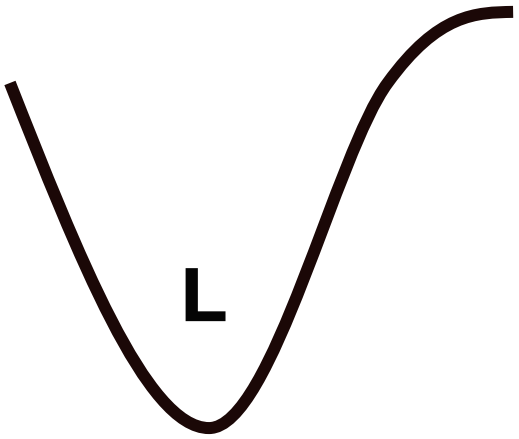
2. Movement / adjustment of large-scale structures

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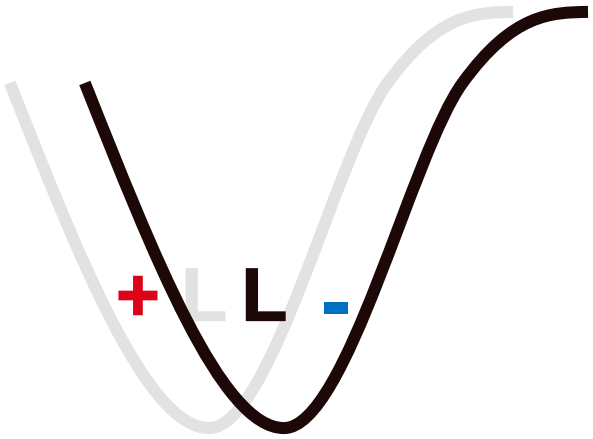
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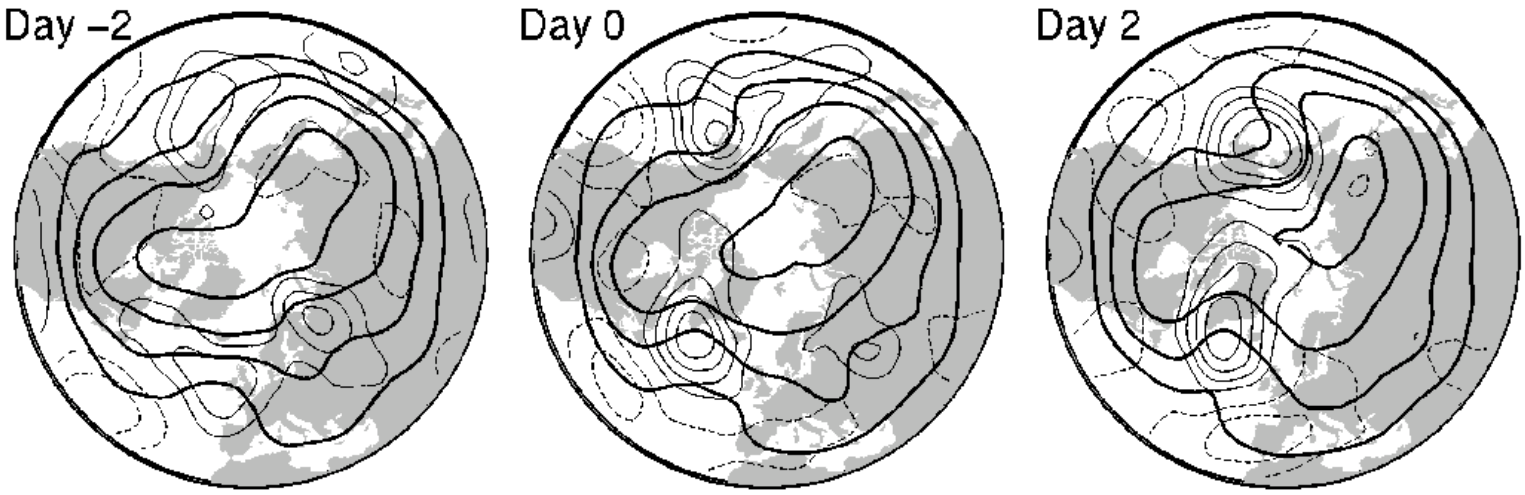
Composite of Simultaneous N Atlantic – Pacific High Lat Blocking



Woollings & H, 2008

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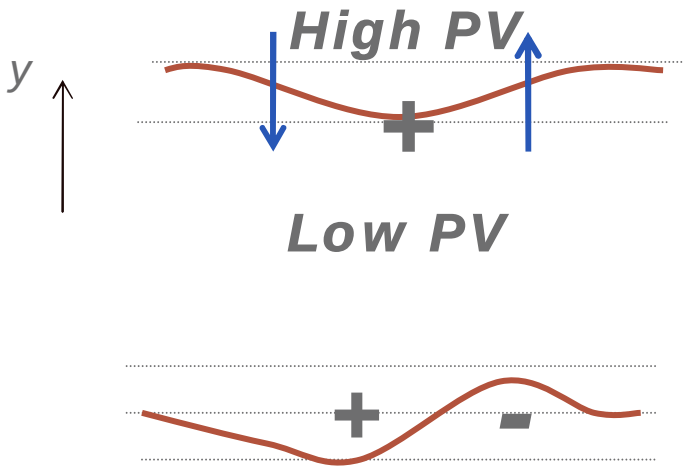
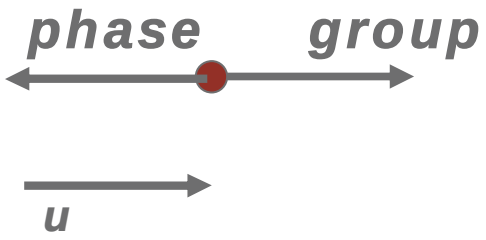
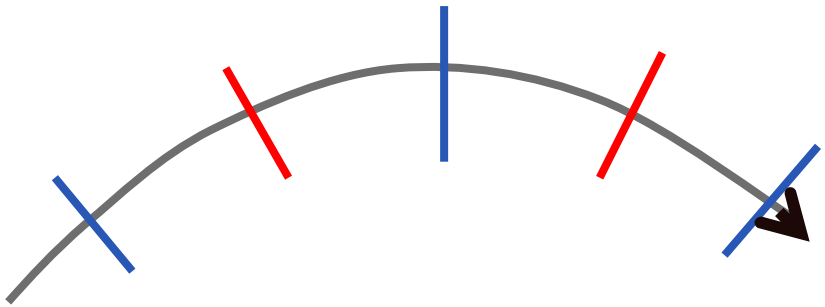
3. Rossby wave propagation - horizontal



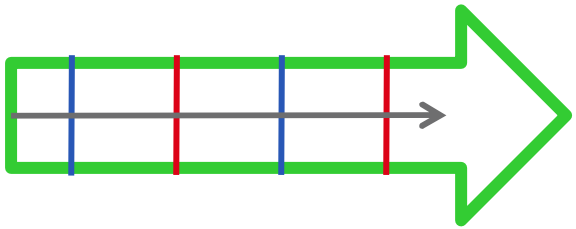


Stationary waves possible
Influence to the east

On the sphere and influenced by the ambient jets



Strong jets can act as waveguides



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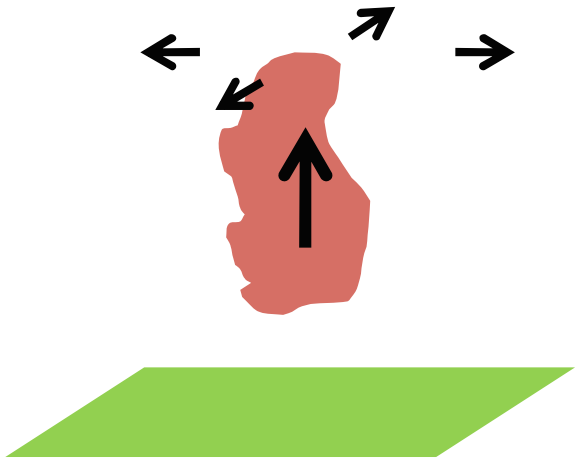
Rossby wave source associated with tropical heating

Vorticity equation for w=0

$$(\partial_t + \boldsymbol{v}_\psi .grad\ )\xi + \beta\, v_\psi = -\zeta D - \boldsymbol{v}_\chi .grad\ \zeta$$



Sardeshmukh & H

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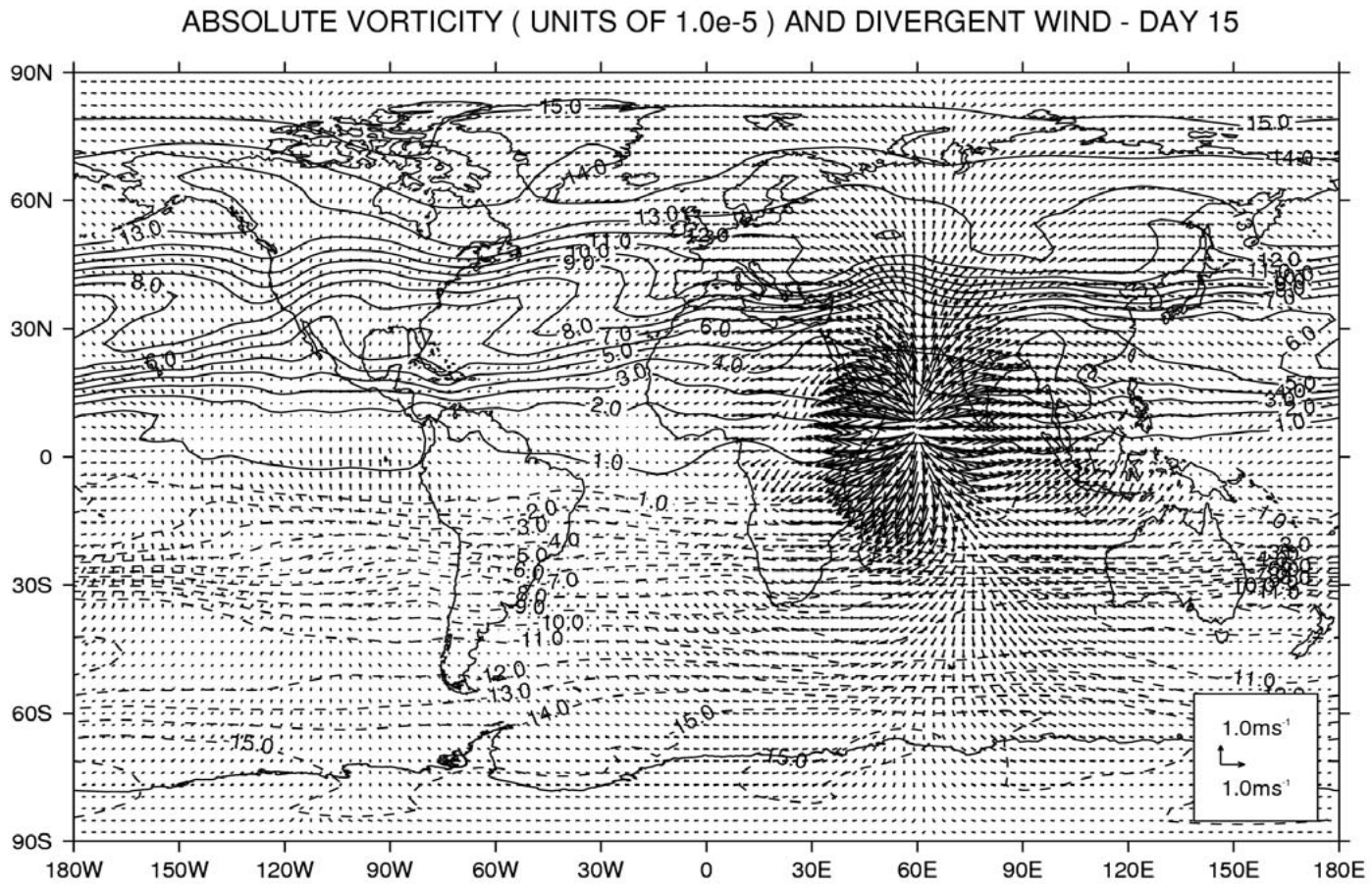

Ricardo Fonseca

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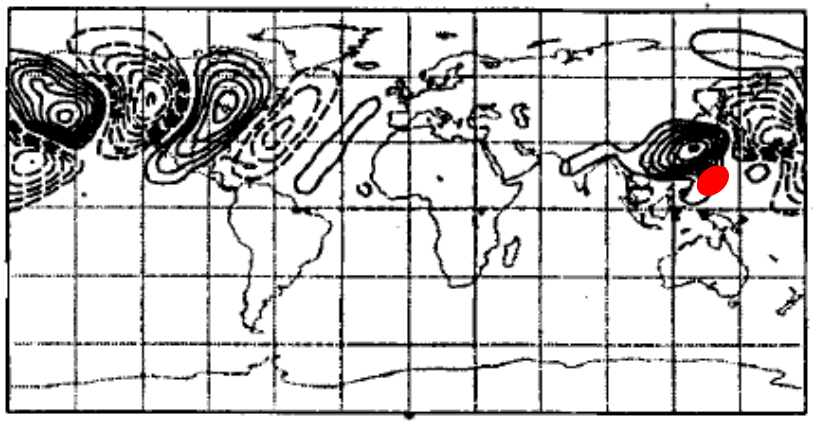
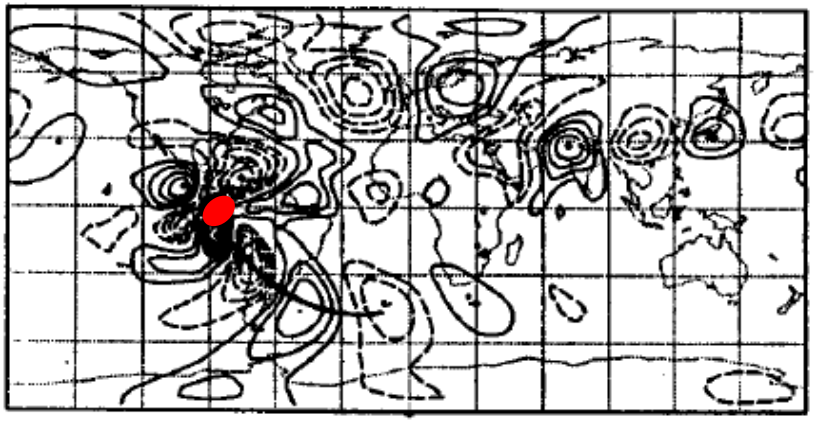
Propagation of Rossby waves from regions of tropical convection



After 9 days



After 9 days

Ambrizzi and Hoskins (1997)

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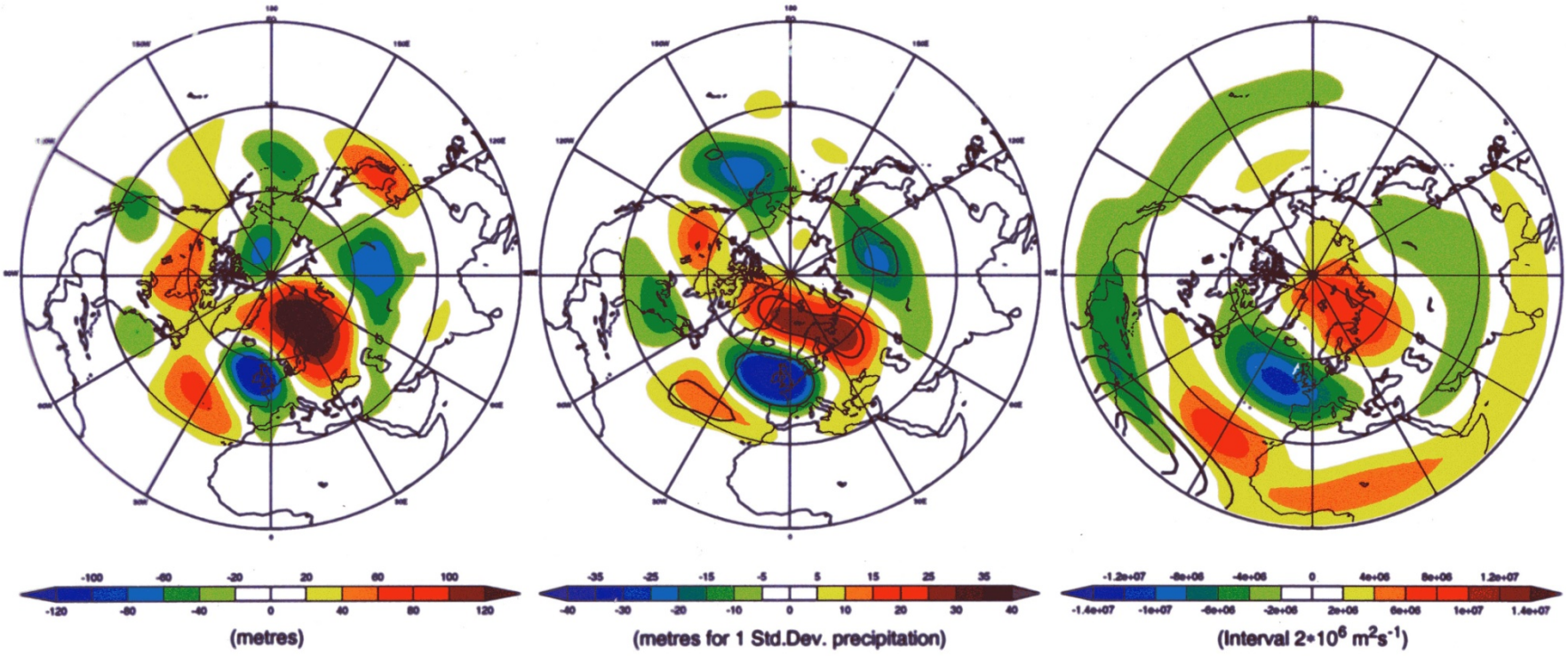
Autumn 2000: record rain in the UK

2007 Anomalies in 300Z

300Z anomalies regressed against E&W precip 1958-99

Idealised model forced from 45W 5N



Blackburn & Hoskins (2002)

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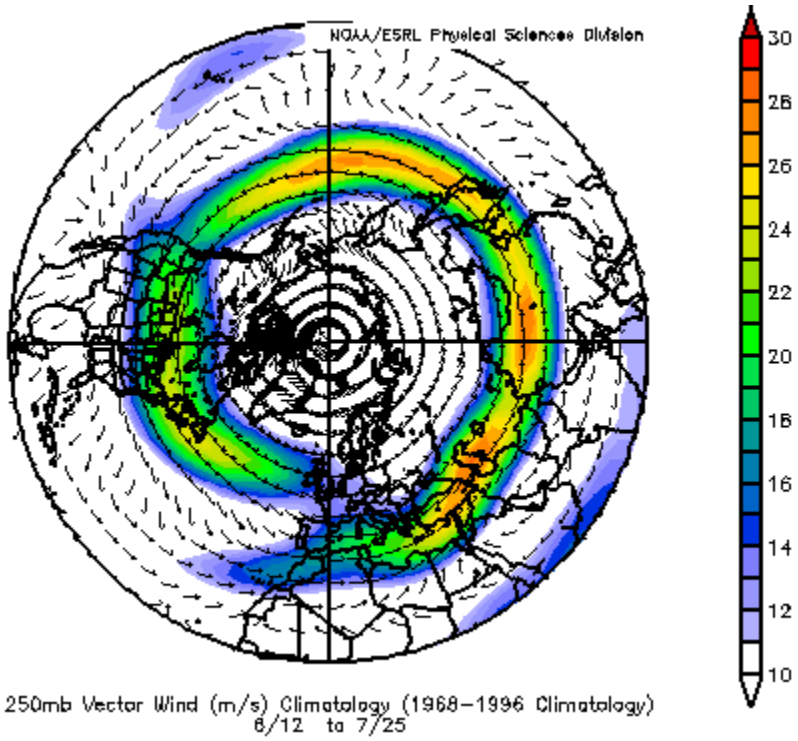
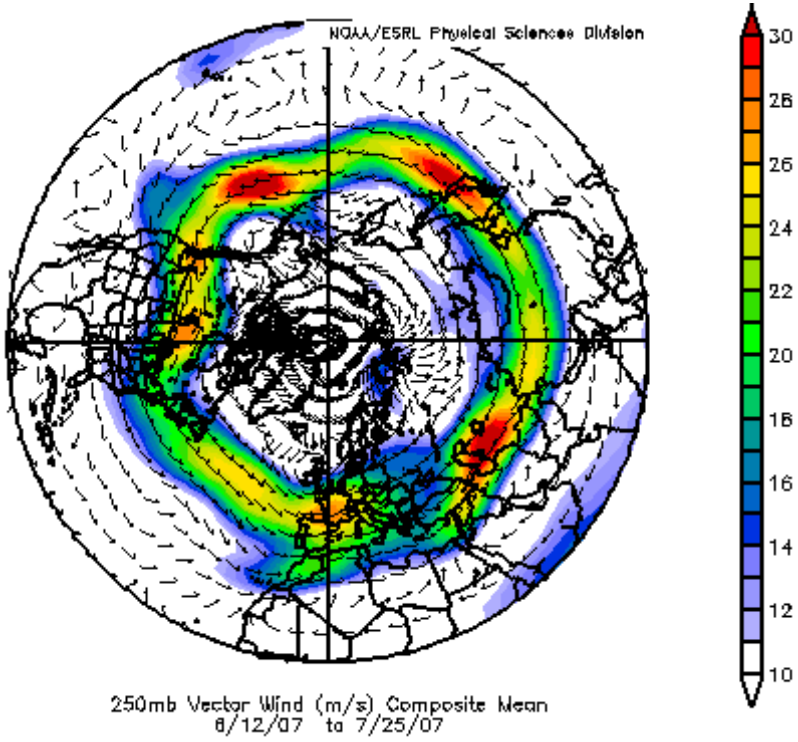
Summer 2007 UK floods - 250hPa v

Average from 12 June to 25 July

Climatology



2007



Blackburn et al, 2008

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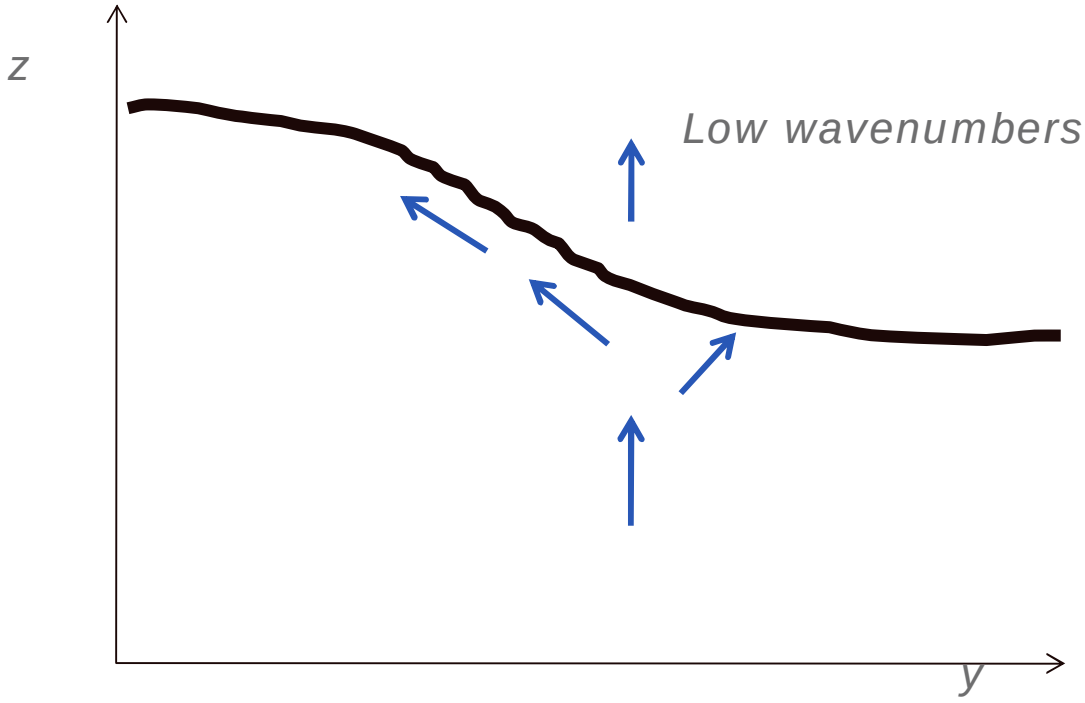
3. Rossby wave propagation - vertical



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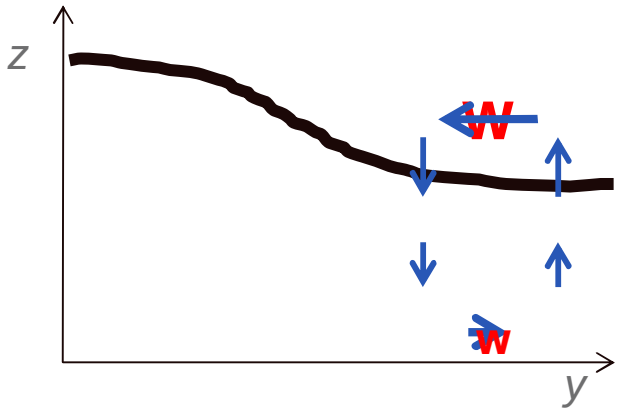
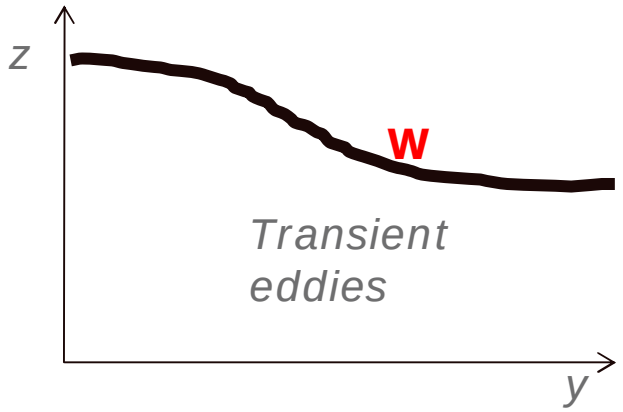
Stratosphere influence on troposphere





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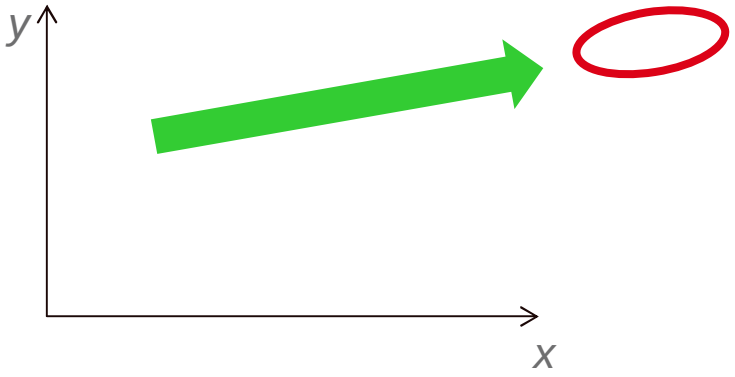
4. Impact of climatological background

- Preferred regions for compensating descent
- Movement/adjustment of features
- Rossby wave refraction & trapping
- Preferred regions for synoptic/blocking events
- Growth of elongated perturbations in the jet exit



Preferred patterns
Modes?

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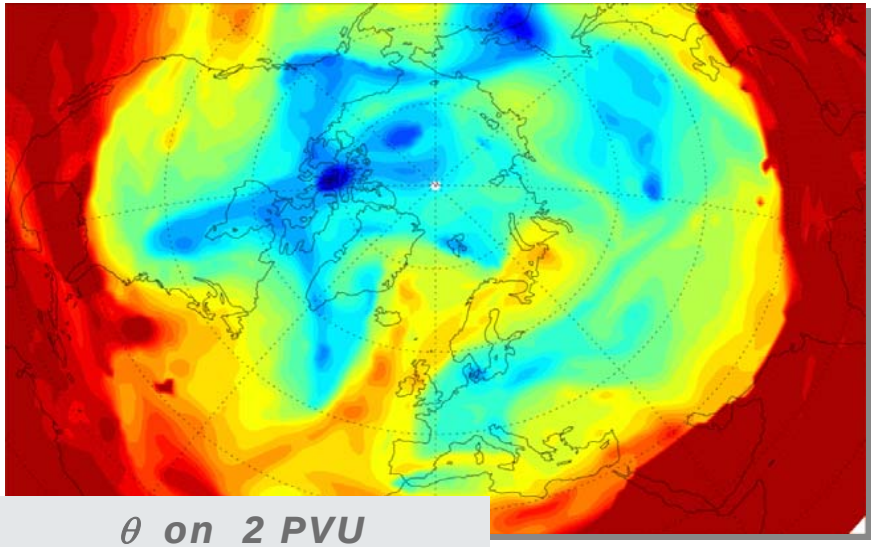
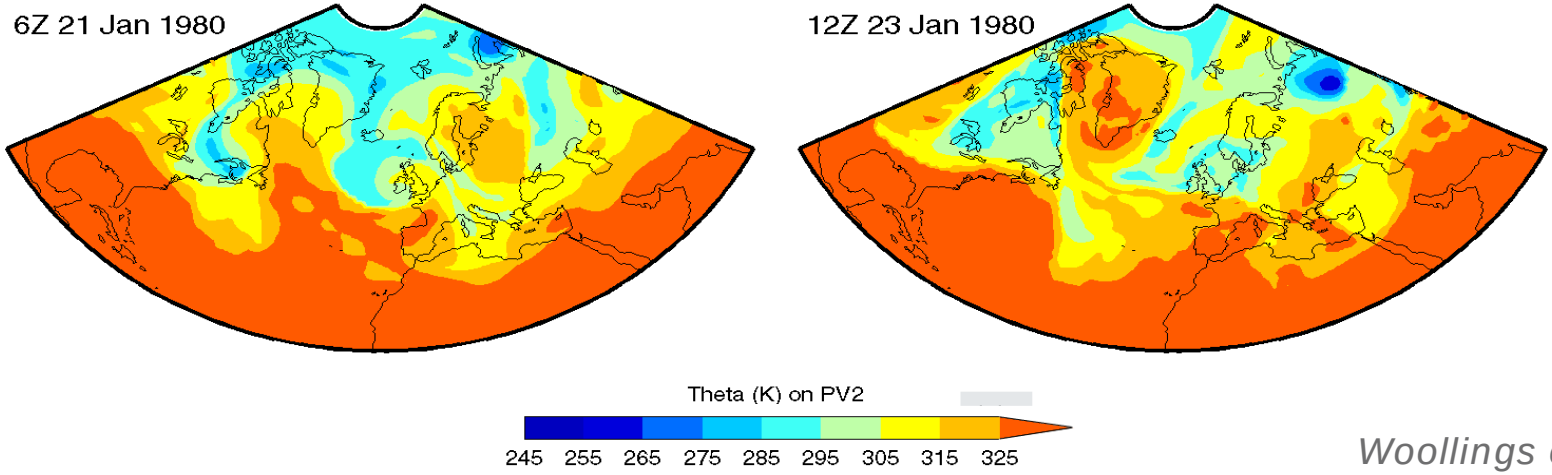
5. Storm-tracks & transient events

Blocking



θ on 2 PVU

Tyrlis & H, 2008



Woollings et al, 2008

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6. Interaction with slower parts of the system

Some examples

Winter/Spring circulation over Asia → *Spring snow cover*

→ *Asian summer monsoon*

N Atlantic winter storm-track → *SSTs*

→ *Circulation in the following autumn*

Oceanic circulation → *Patterns of SST*

→ *Atmospheric circulation*

→ *Oceanic circulation*

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Aspects discussed

1. Global constraints
2. Movement/adjustment of large-scale structures
3. Rossby wave propagation
4. Impact of climatological background
5. Storm-track involvement
6. Interaction with slower parts of the system

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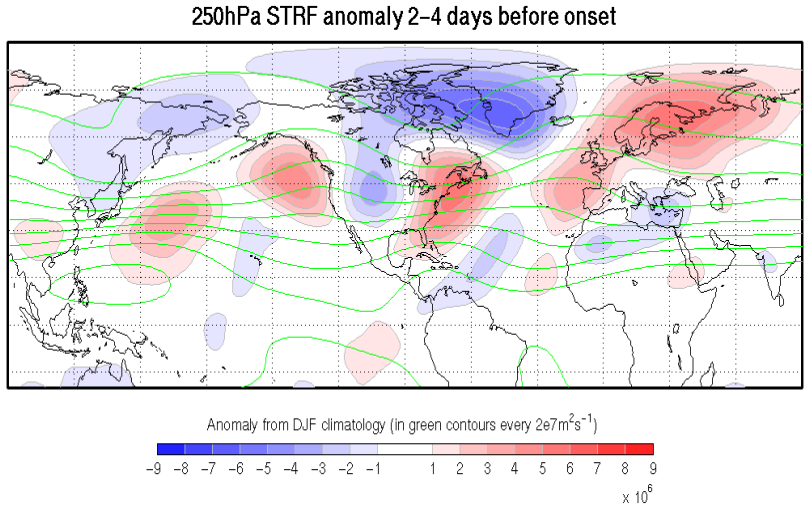
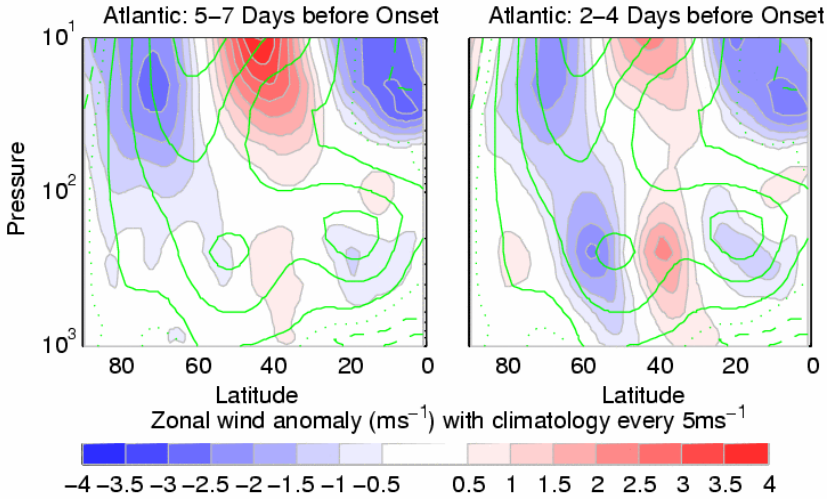
Dynamical precursors for N Atlantic High latitude Wave-breaking

1. European blocking

2. Rossby wave-train from the Pacific

3. A shift in the stratospheric jet





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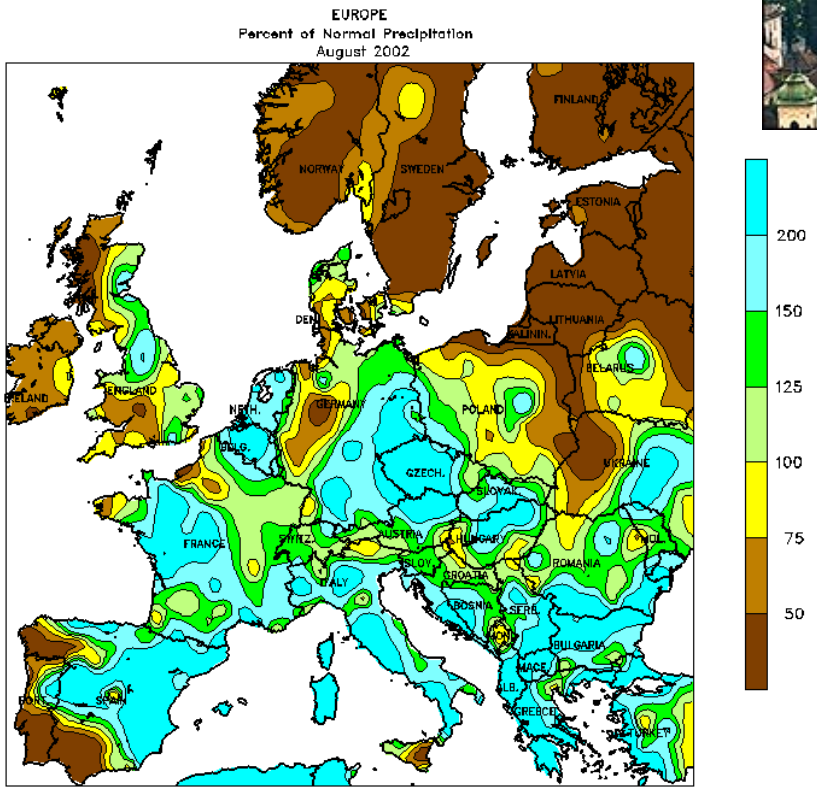
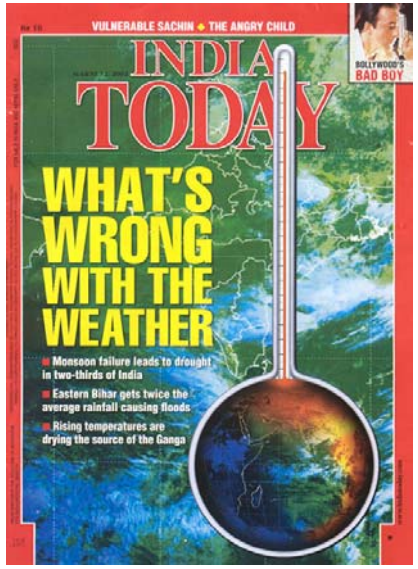
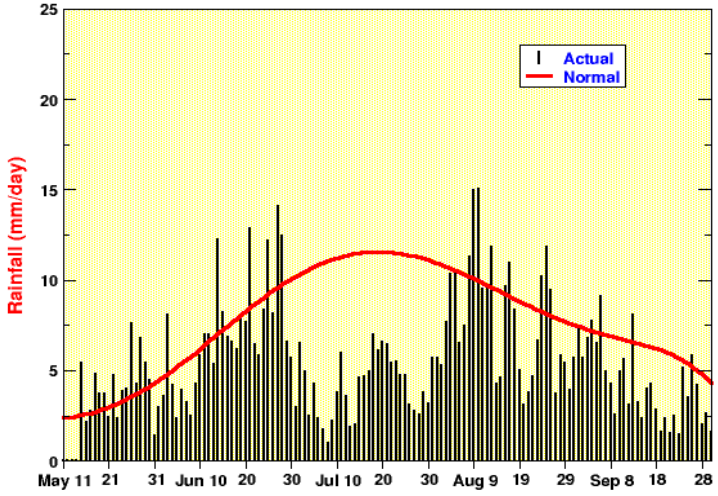
Summer 2002

Flooding in Central Europe





Drought in India



Blackburn & Hoskins (2006)

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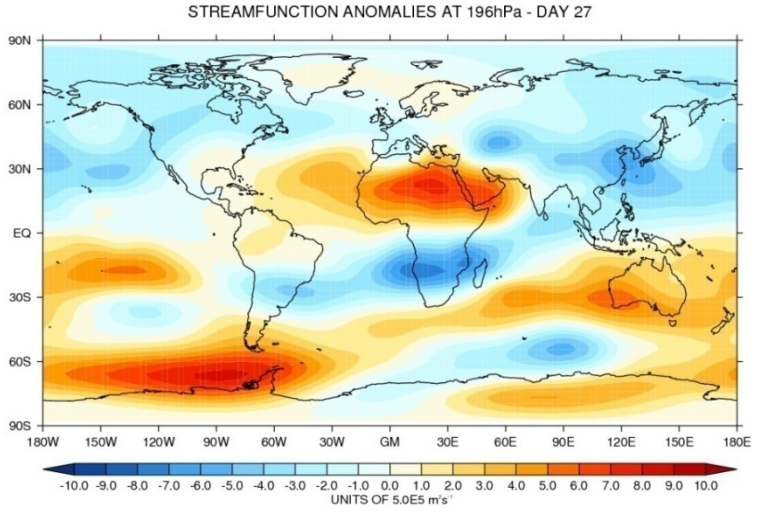
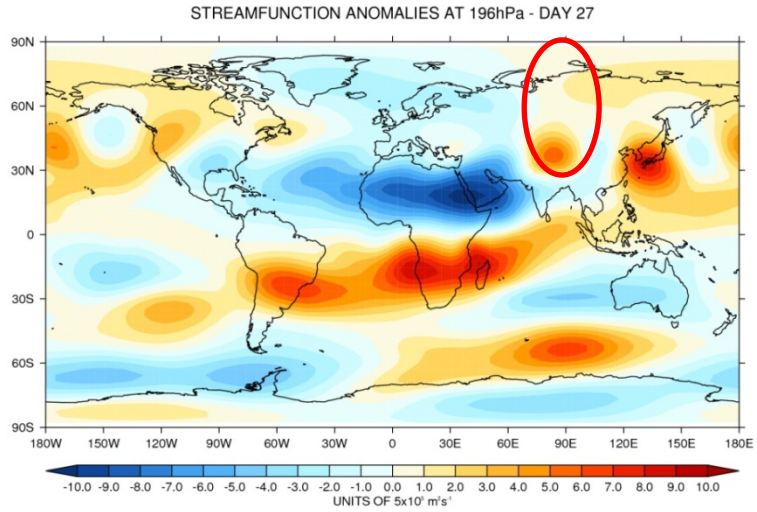
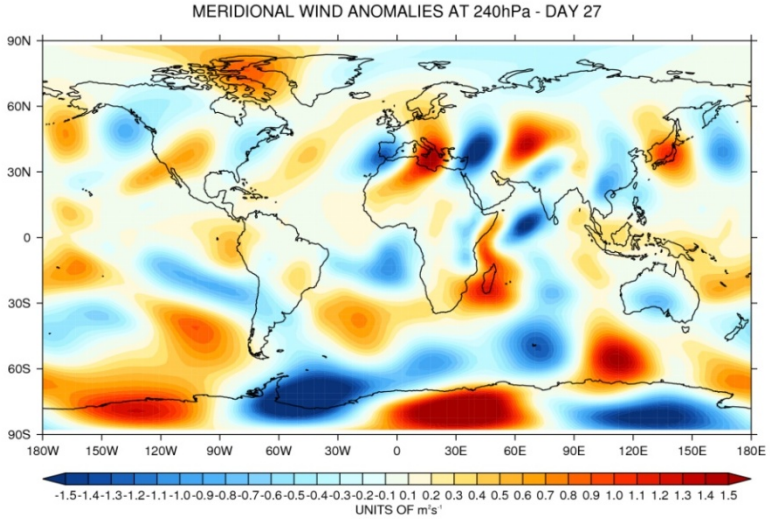
ANOMALY OVER THE INDIAN OCEAN (8°N, 64°E)

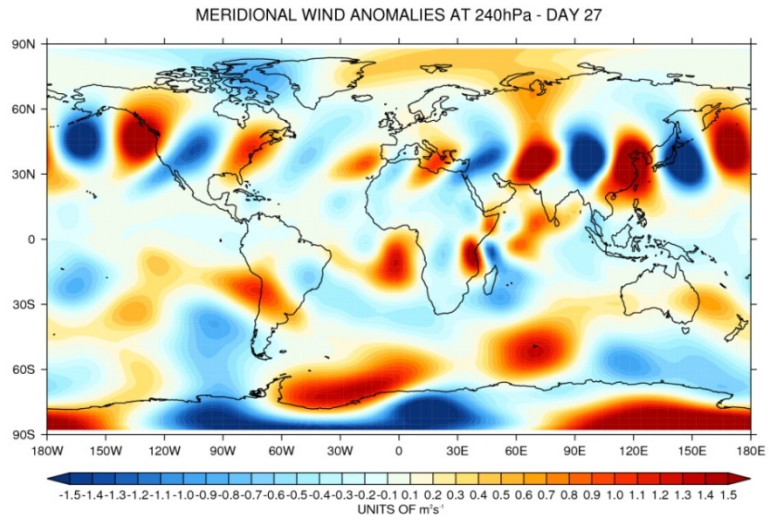
ANOMALY OF THE OBSERVED SIGN (HEATING)

ANOMALY OF THE OPPOSITE SIGN (COOLING)









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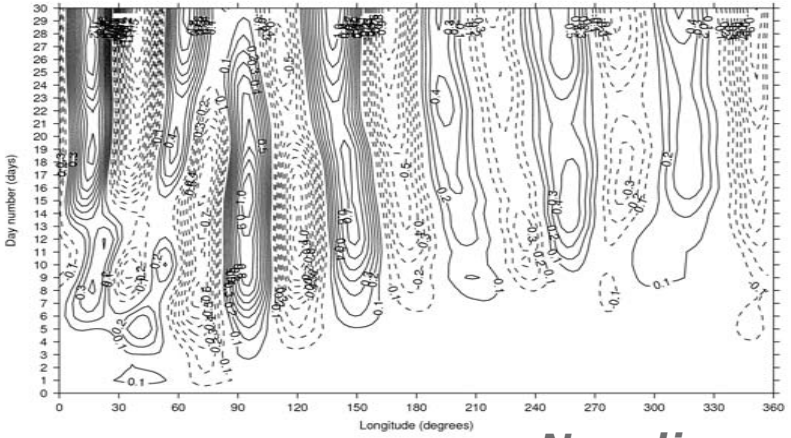
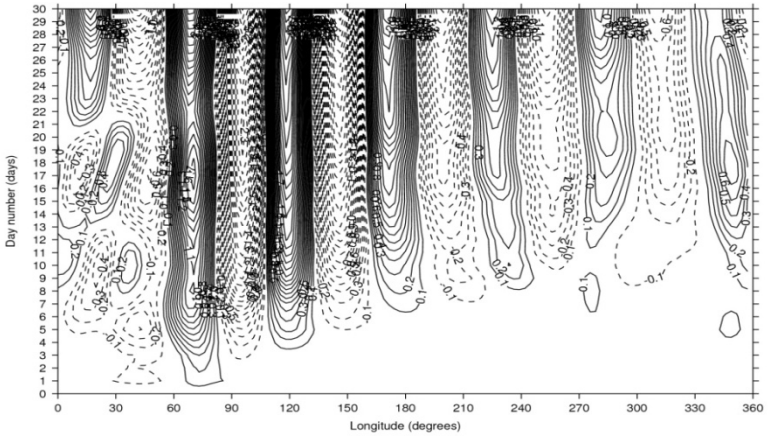
HOVMÖLLER AVERAGED OVER 30°N-45°N

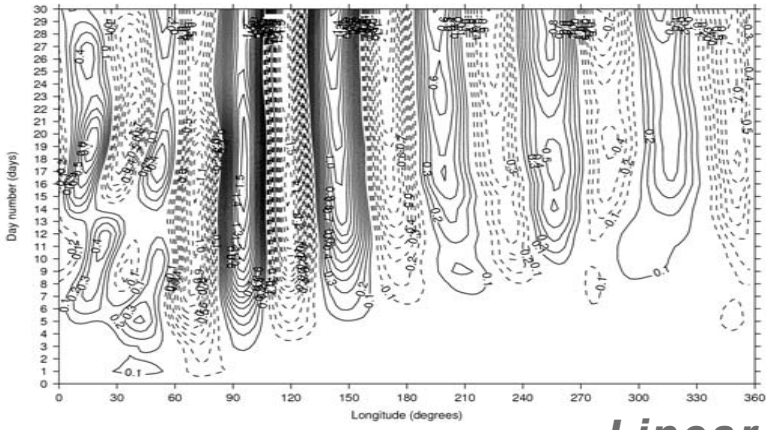
Heating



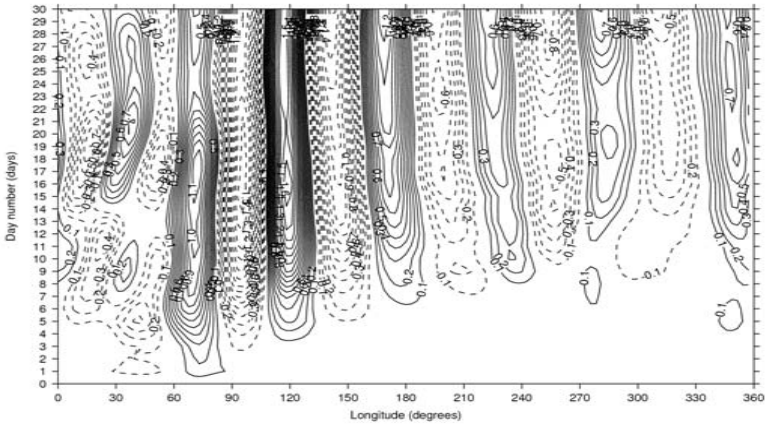
Cooling



Non-linear



Linear



AS ABOVE BUT WITH THE HEATING LINEARISED