

Predictability from a dynamical meteorology perspective

B Hoskins

Department of Meteorology, University of Reading

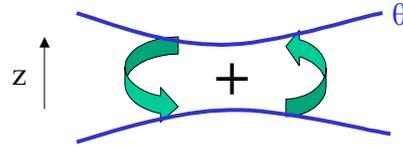
Origins of Predictability

- Annual cycle
- Phenomena,
 e.g. cyclone, MJO, ENSO
- Balanced motion:
 PV & Rossby waves
- Slower parts of the climate system,
 e.g. cyclones, long waves, SSTs,
 soil moisture

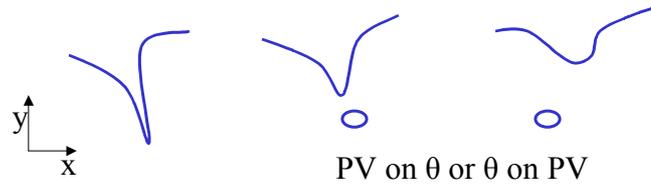
Topics

1. PV & balanced motion
2. Rossby waves
3. Baroclinic growth, optimal perturbations
4. Blocking & NAO
5. Summer 2002

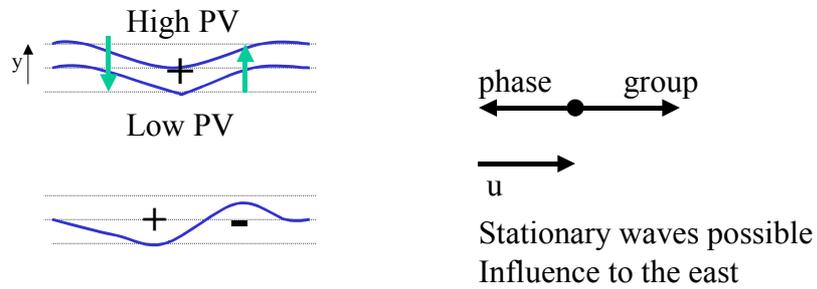
Balanced motion provides the background for most weather and is uniquely determined by the Potential Vorticity(PV)



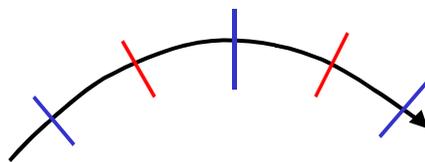
PV & θ conserved following adiabatic motion

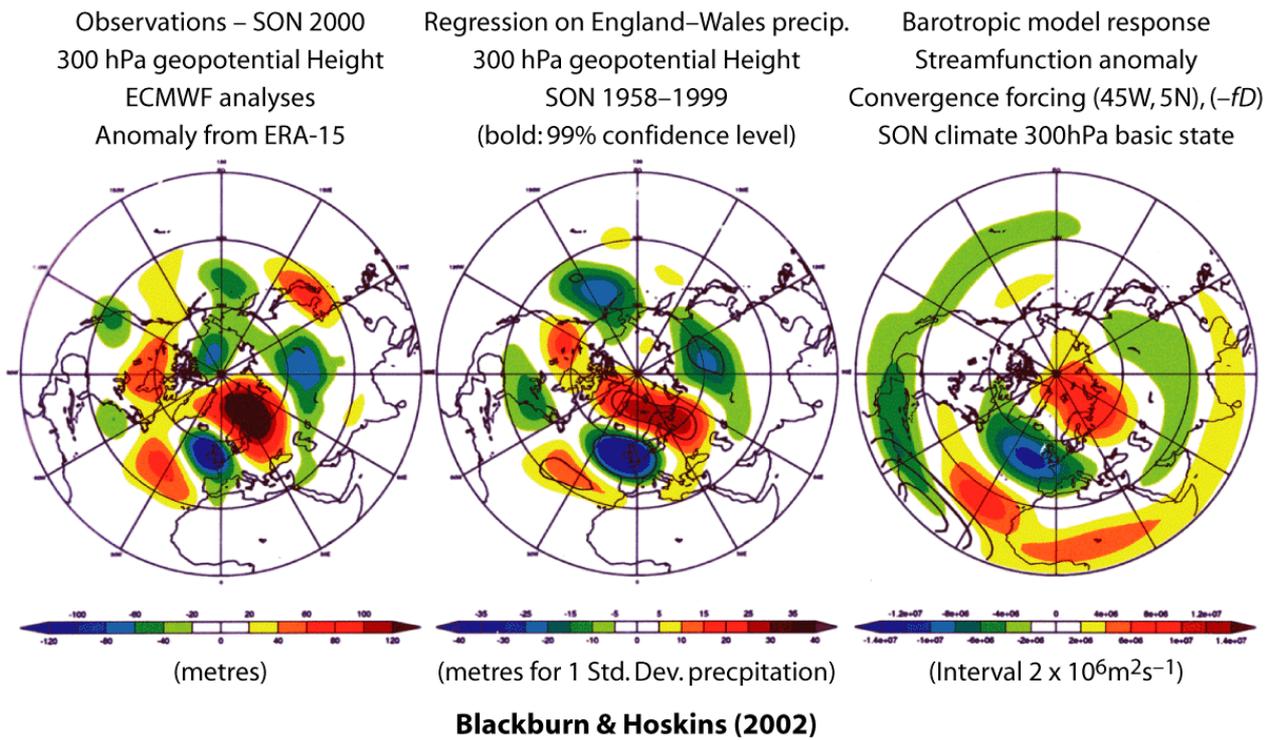


Rossby Waves

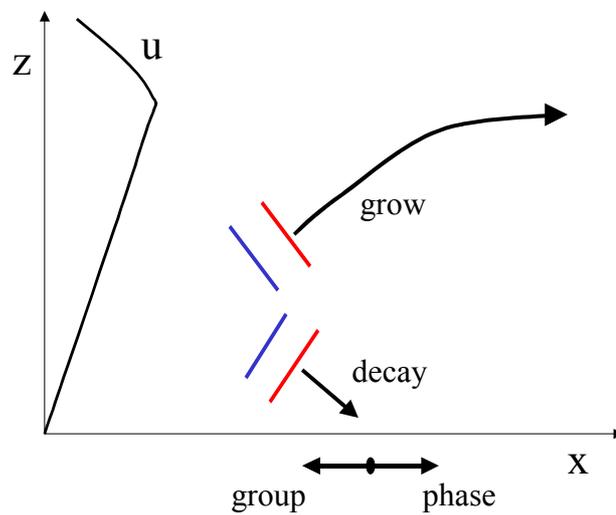


On the sphere and influenced by the ambient jets

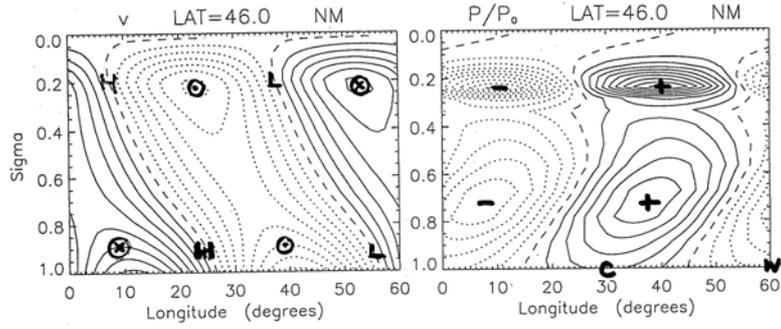




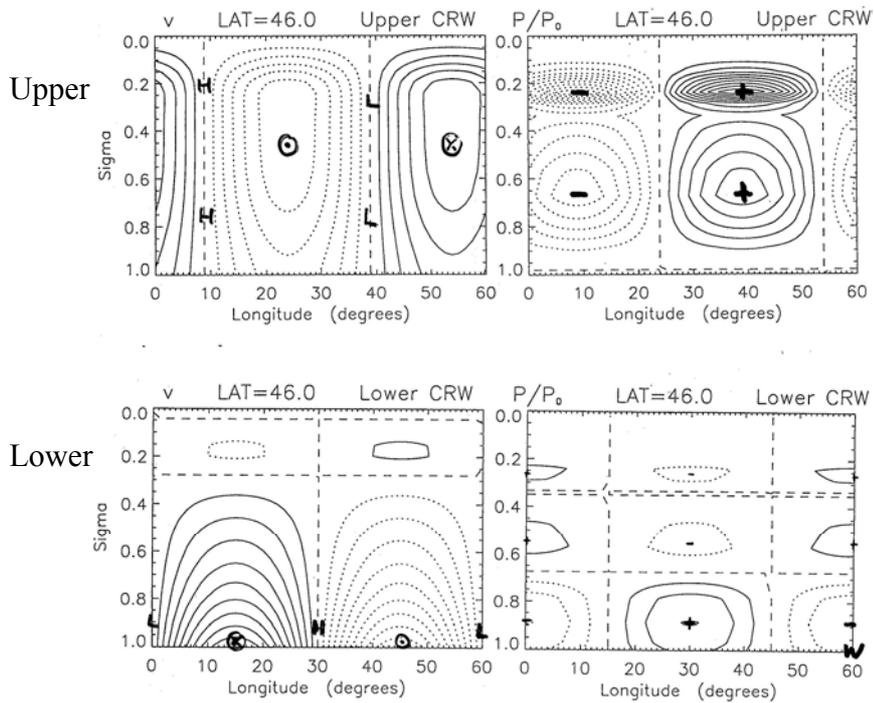
Vertical propagation of Rossby waves



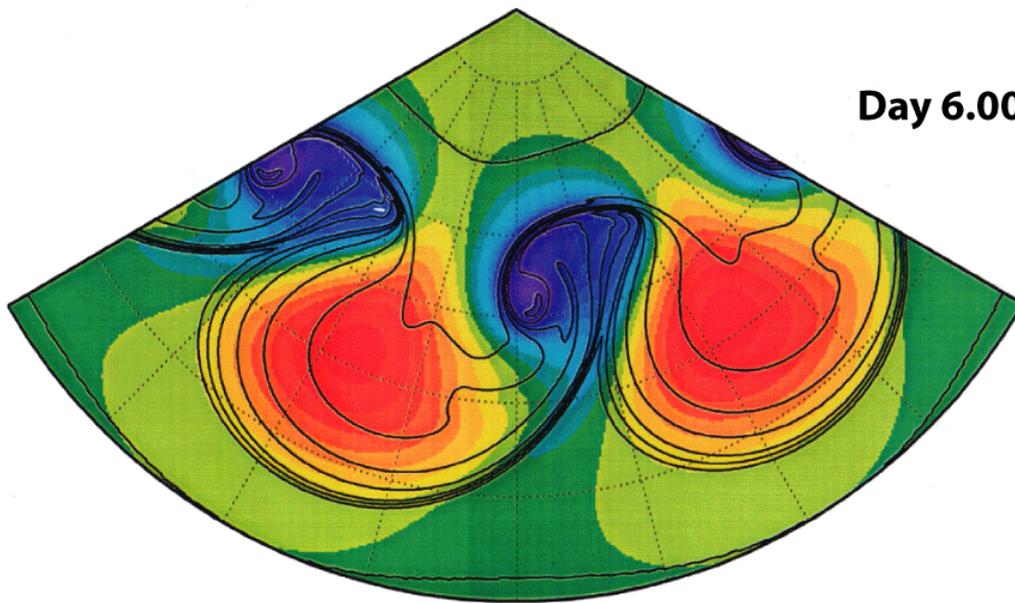
Longitude- σ section of most unstable wave number 6
on a jet on the sphere



Methven, Heifetz, Hoskins & Bishop (2002)



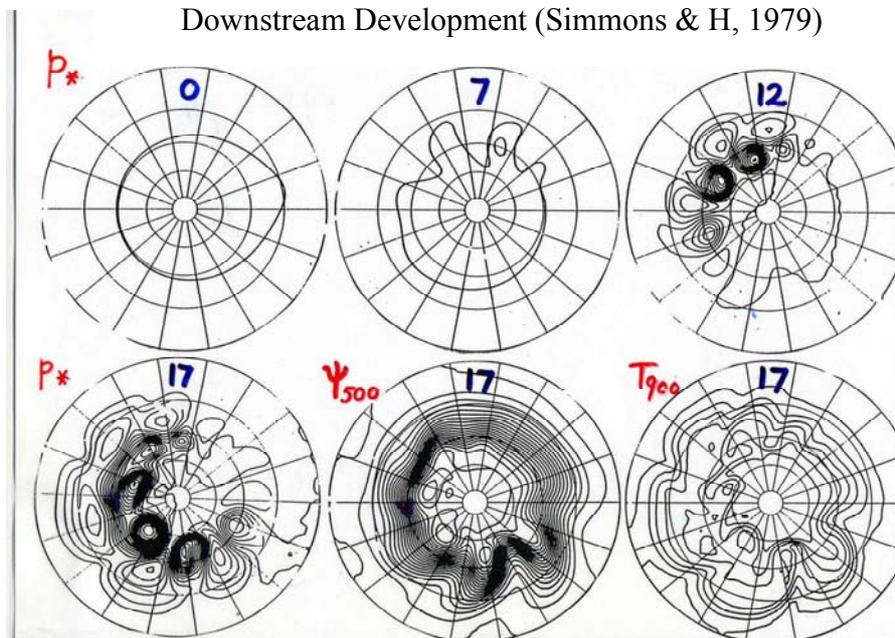
Surface pressure and temperature LC1



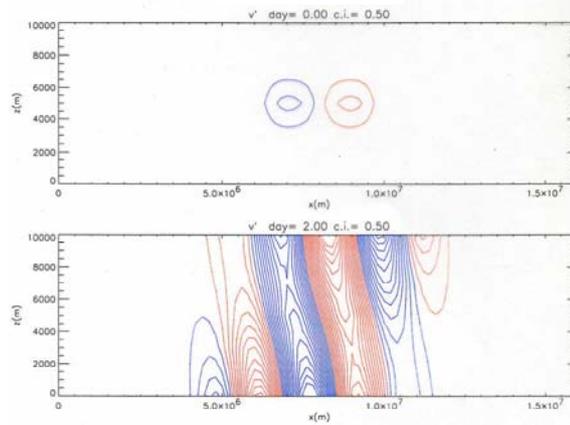
CI = 4 mb and 5K

John Methven

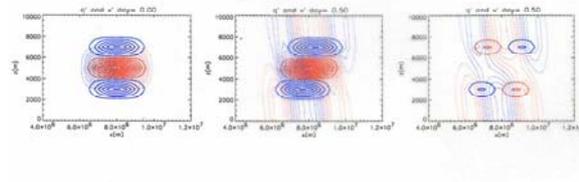
Downstream Development (Simmons & H, 1979)



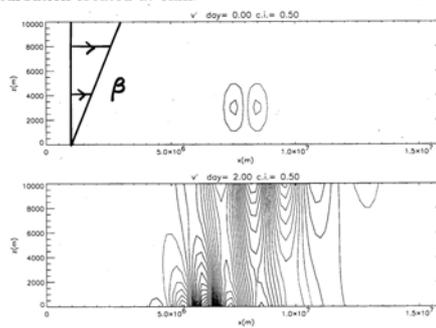
Eady model result: Badger & H, 2001



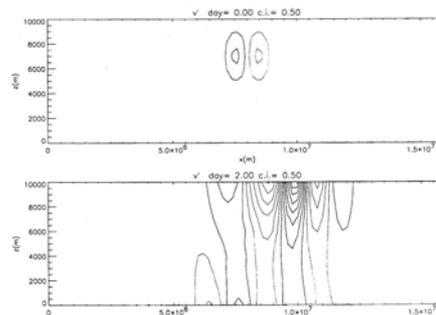
A q' and v' view of unshielding:



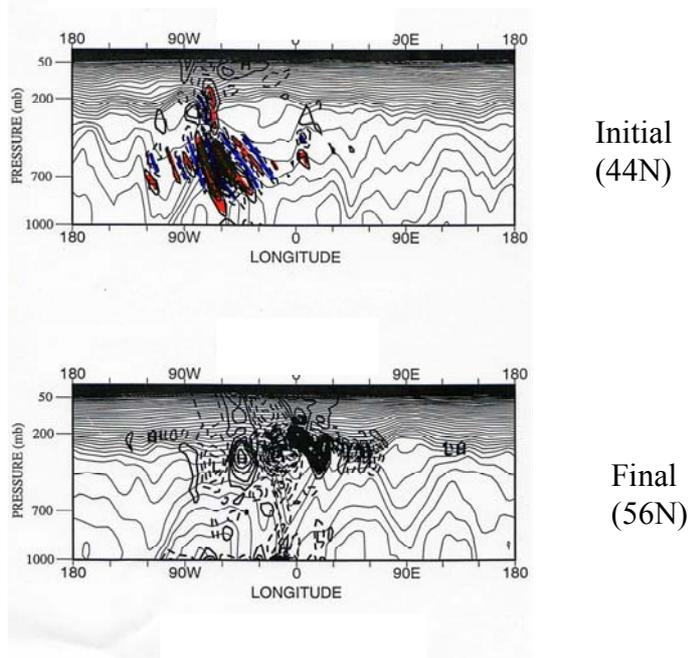
Perturbation located at 3km:



Perturbation located at 7km:



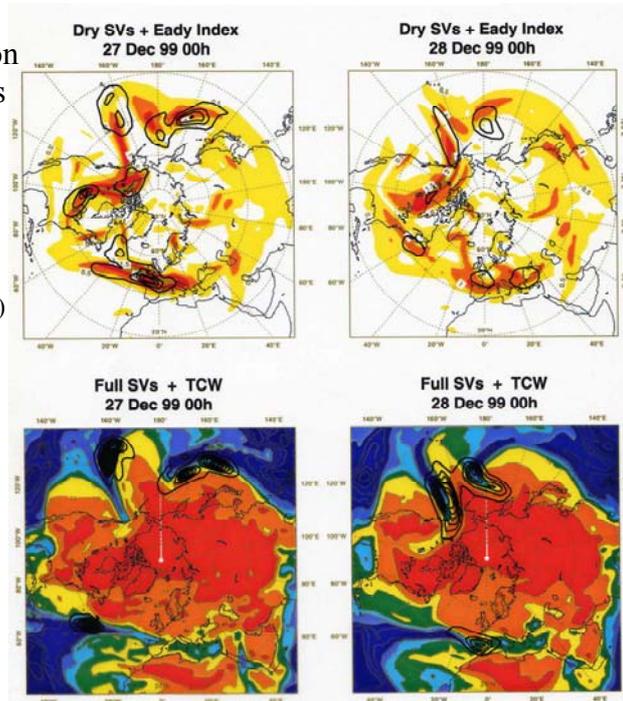
PV Section for ECMWF SV1 for 17-19 Feb 1997 (H, Buizza & Badger, 2001)



Energy distribution
for top10 24h SVs
27-28 Dec 99

(Mariane Coutinho)

Dry
(Eady index)

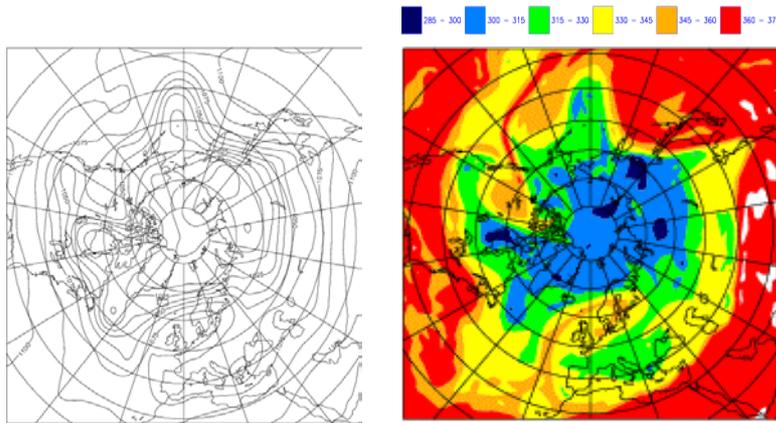


Moist
(column
water)

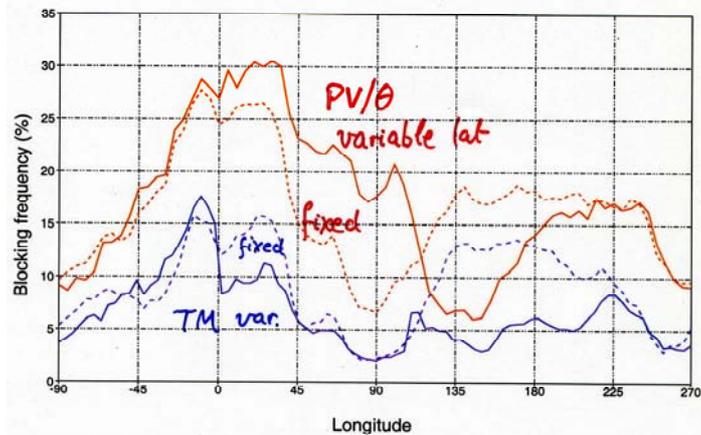
21 September 1998

250 Z

θ on PV2



Annual mean, local, instantaneous blocking frequency against longitude between June 1996 and May 2001



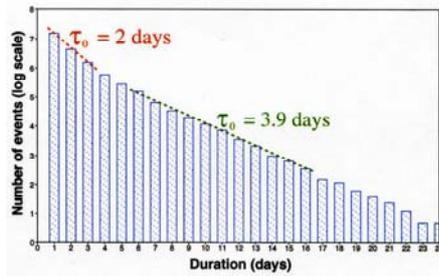
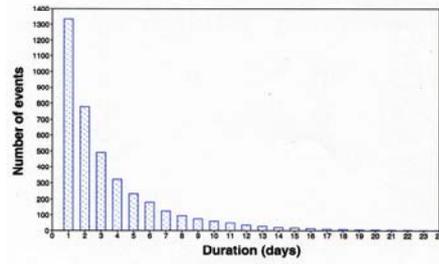
Red solid curve: Pelly and Hoskins PV/ θ index, variable blocking latitude

Red dashed curve: Pelly and Hoskins PV/ θ index, fixed blocking latitude (50°N)

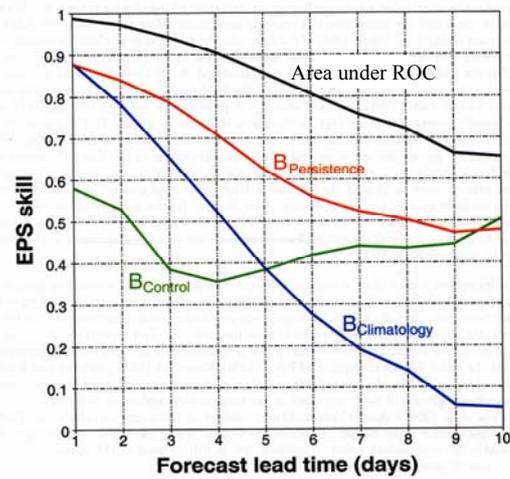
Blue dashed curve: Tibaldi and Molteni Z500 index, fixed blocking latitude (50°N)

Blue solid curve: Tibaldi and Molteni Z500 index, variable blocking latitude

BLOCKING EVENT DURATION (1 August 2000 to 31 July 2001)

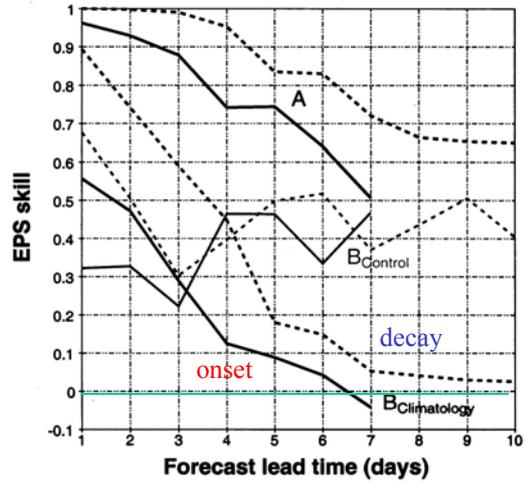


SECTOR BLOCKING IN THE EURO-ATLANTIC SECTOR (1 August 2000 to 31 July 2001)



BLOCK ONSET AND DECAY IN THE EURO-ATLANTIC SECTOR

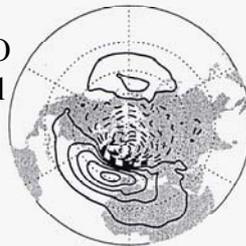
(1 August 2000 to 31 July 2001)



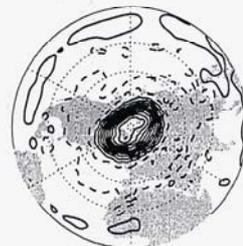
NAO & Stratospheric Vortex

(Ambaum & H, 2002)

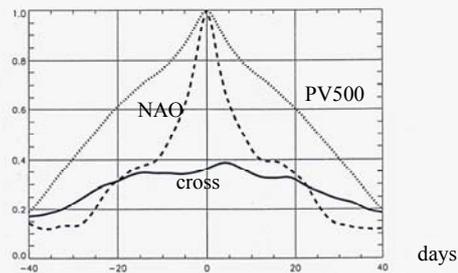
NAO
Pmsl



PV500K

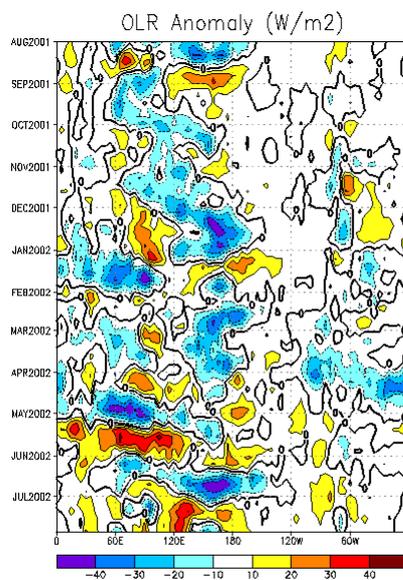


Lagged correlations
& autocorrelations



Some Events of 2002

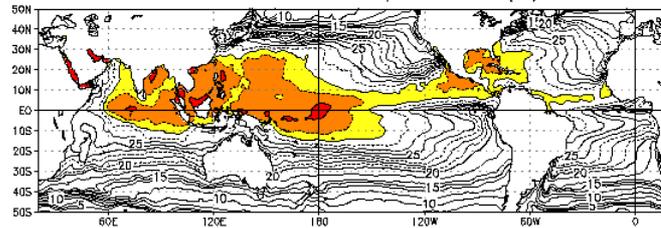
- Strong intraseasonal variation in tropics
- Development of El Nino
- Failure of Indian Monsoon
- Floods in Europe



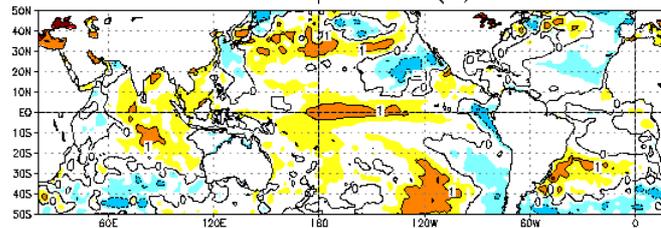
CLIMATE PREDICTION CENTER/NCEP

July 2002

Sea Surface Temperature (C)



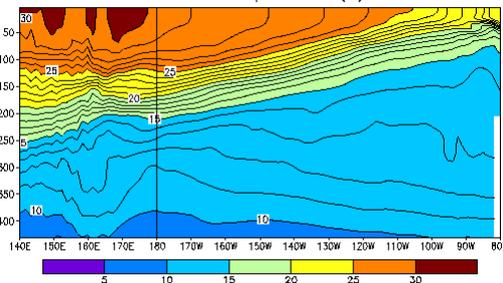
Sea Surface Temperature (C) Anomalies



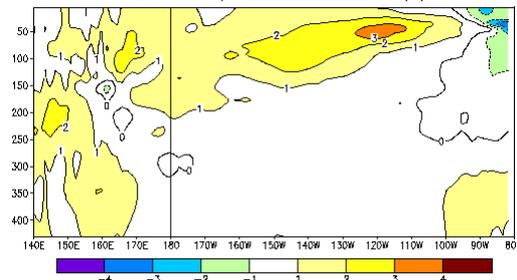
CLIMATE PREDICTION CENTER/NCEP

July 2002

Equatorial Depth-Longitude Section
Ocean Temperature (C)



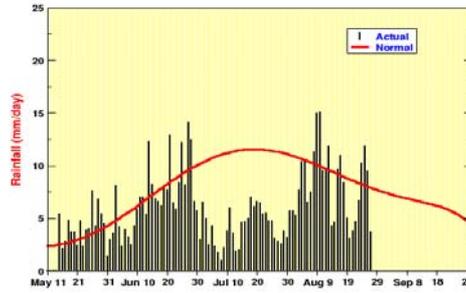
Equatorial Depth-Longitude Section
Ocean Temperature Anomalies (C)



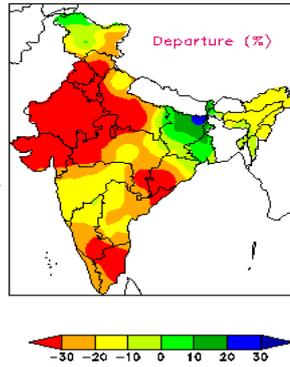
CLIMATE PREDICTION CENTER/NCEP

Indian Summer Monsoon 2002

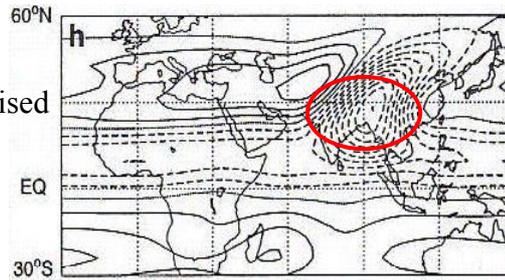
All India Daily Rainfall



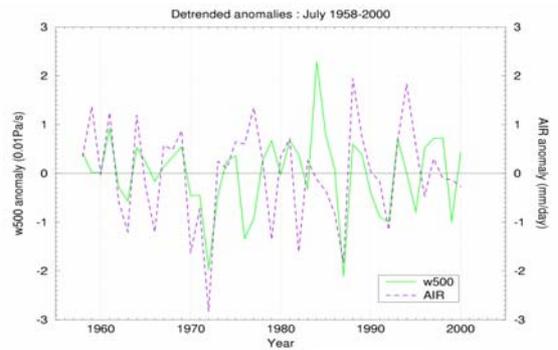
Cumulative Rainfall Anomalies: 11 May to 21 August



500 hPa ω for Idealised Monsoon Heating



July 1958-2000
All India Rainfall
500 ω 0-30E, 35-45N



Event	Forecast	Predictability	Reason
MJO	substructure	days	
	event	1 month	structure
	season	?	
ENSO	event	season-year	structure MJO
	climate	?	mean state
Ind S Mon	sub-season	1 month?	MJO
	season	some	SST etc MJO
	climate	?	mean state
Eur S Floods	event	1d-1week	synoptic org
	month	some?	MJO/ISM mid-lat
	season	some??	ISM
	climate	?	mean state

Origins of Predictability

- Annual cycle
- Phenomena,
e.g. cyclone, MJO, ENSO
- Balanced motion:
PV & Rossby waves
- Slower parts of the climate system,
e.g. cyclones, long waves, SSTs,
soil moisture