Dynamical-Process Studies using Reanalysis Data

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with input from

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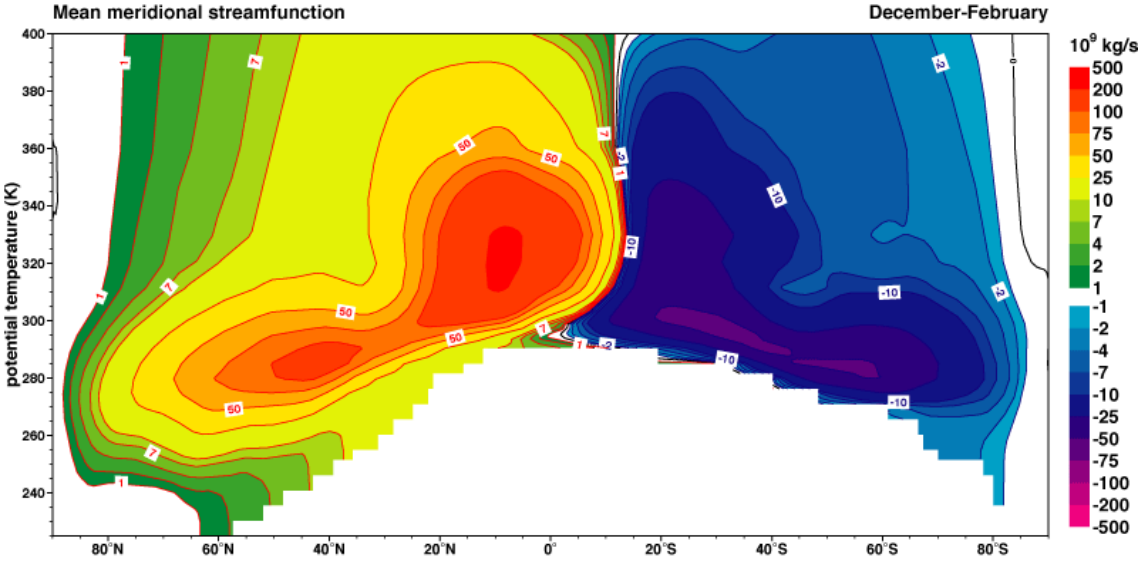
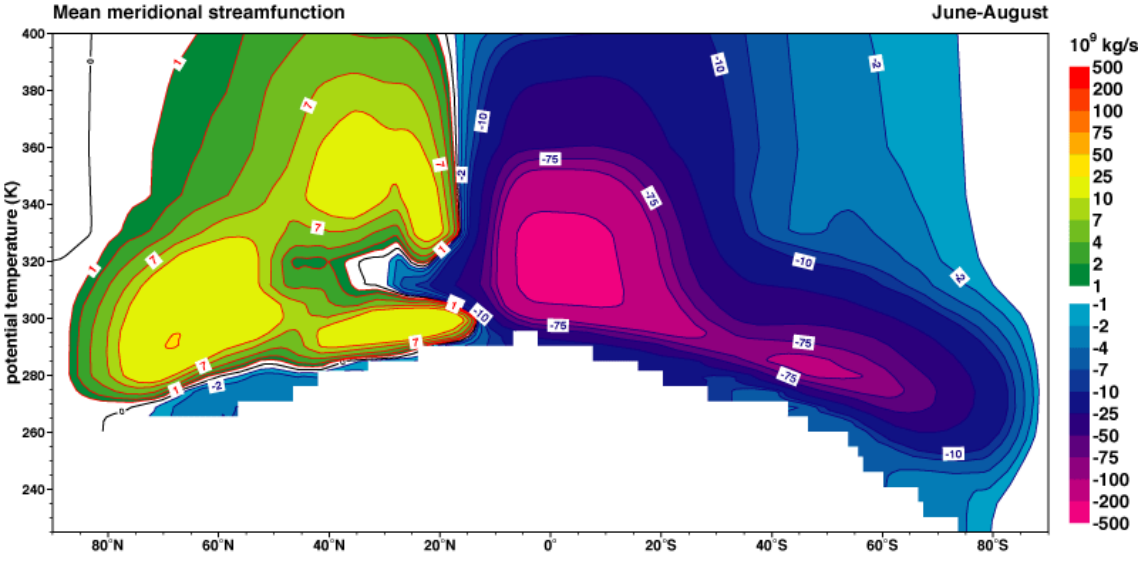
Mike Blackburn, Evangelos Tyrlis,
Piero Cau & John Methven

ERA-40 Atlas: Mean Meridional Circulation in θ coordinates



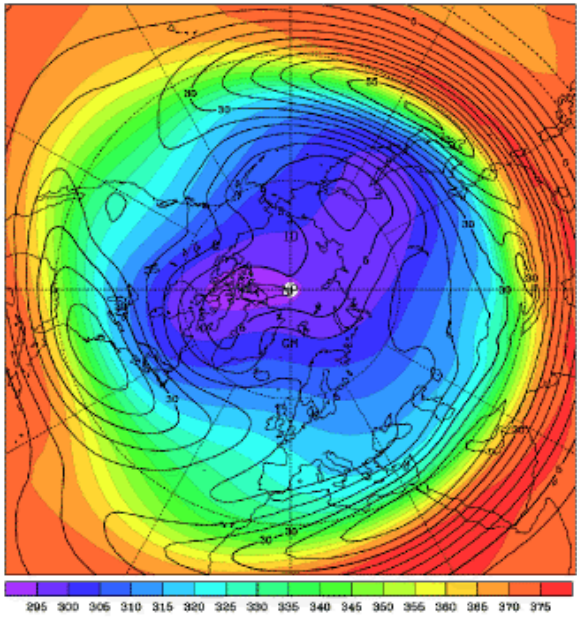
DJF



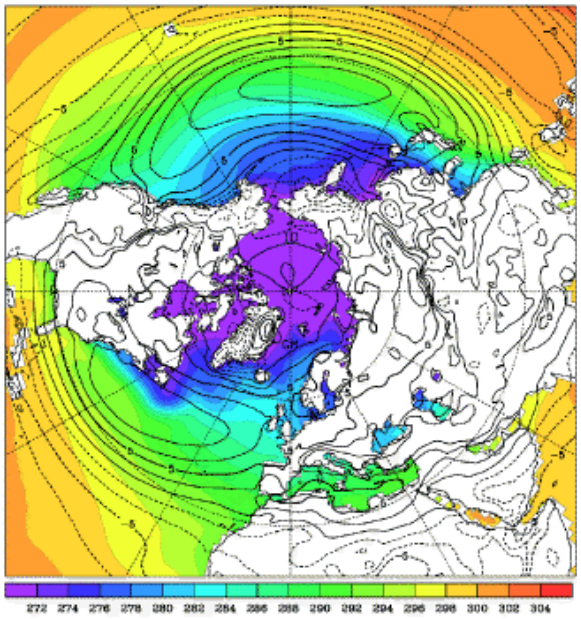
JJA

NH Winter (DJF) Mean State

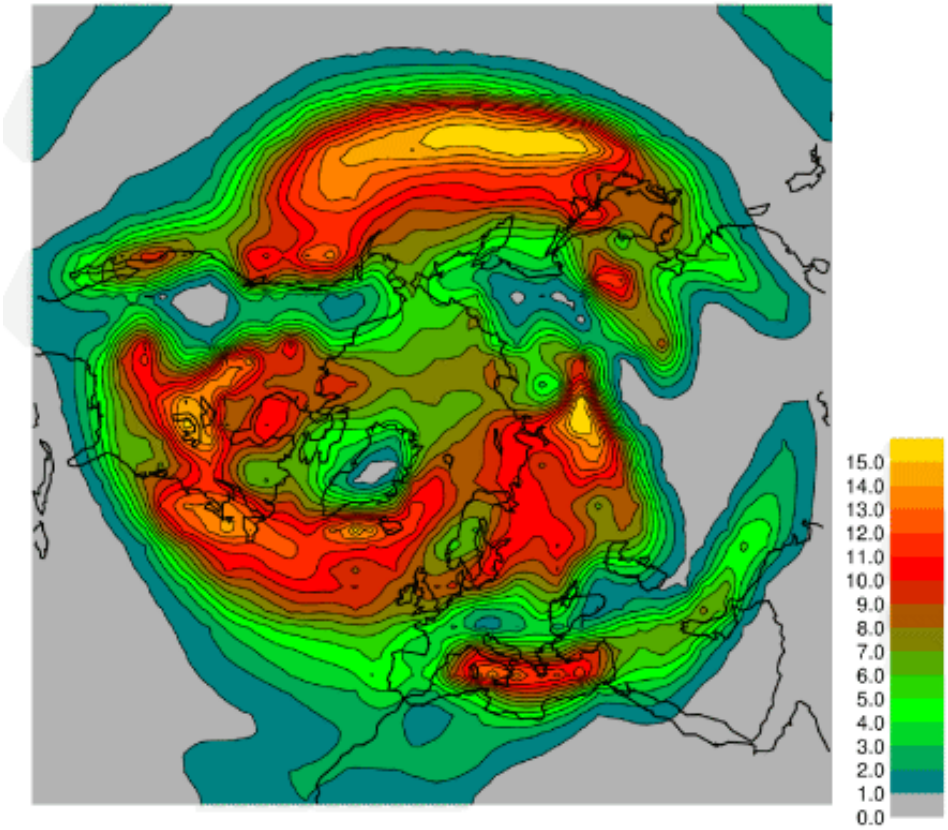
DJF, θ(PV=2)
& U(PV=2)



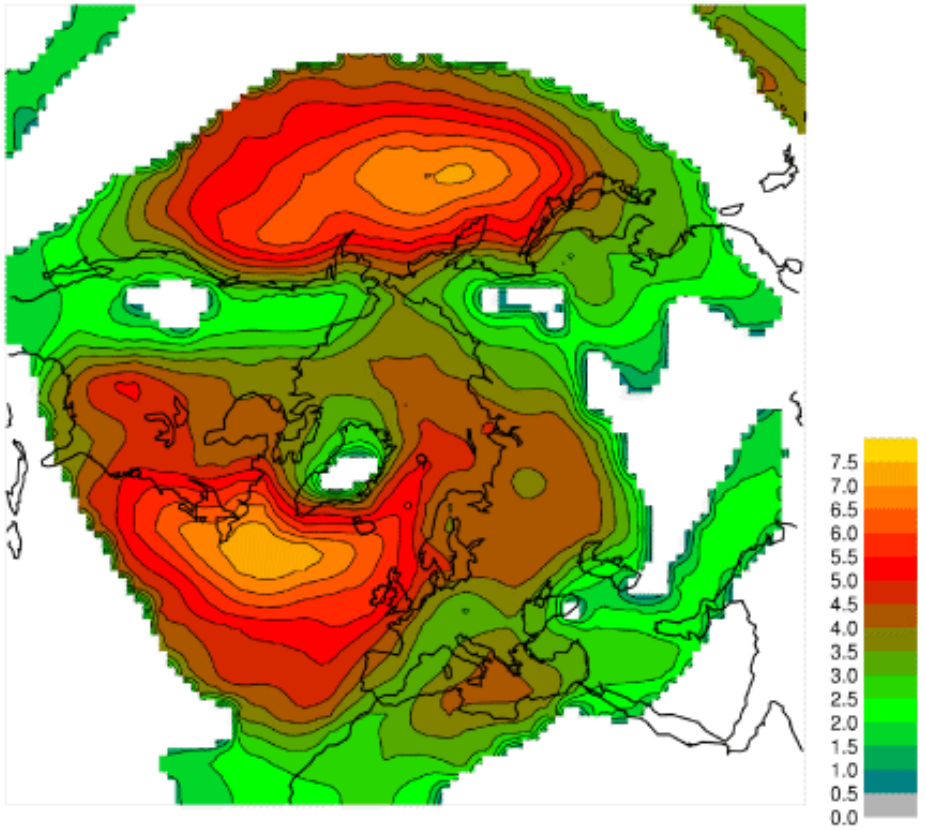
DJF, SST
& U850



DJF, ξ_{850} Tracking Statistics



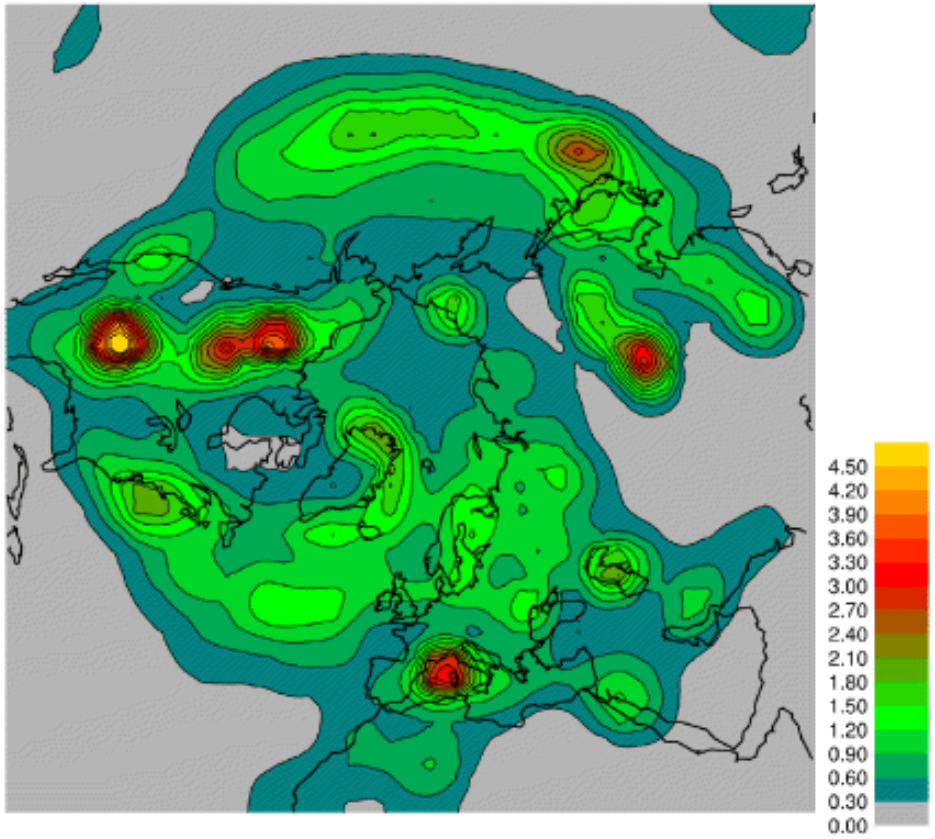
Track Density



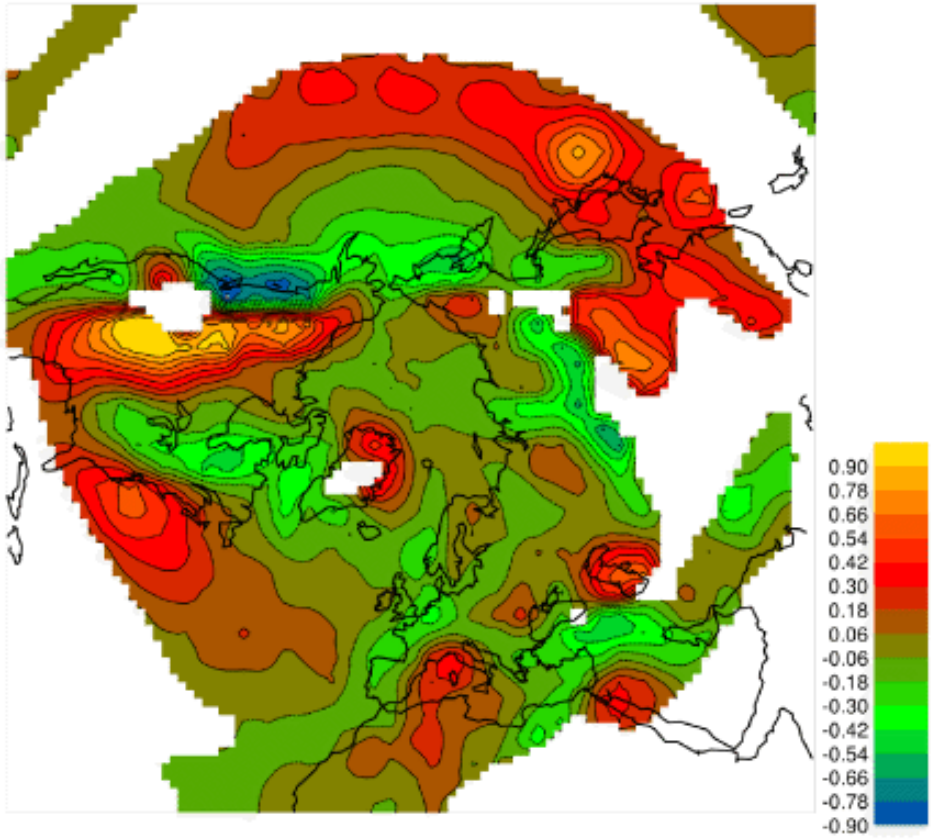
Mean Intensity

Hoskins & Hodges (2002) J Atmos Sci

DJF, ξ_{850} Tracking Statistics

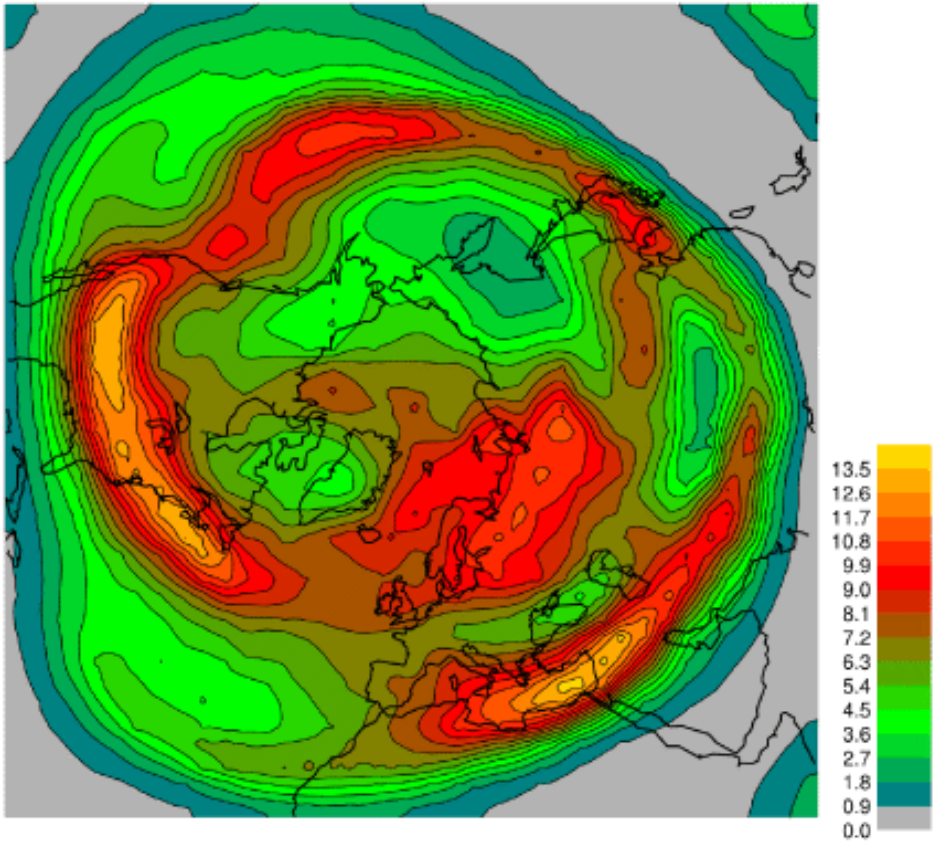


Genesis Density

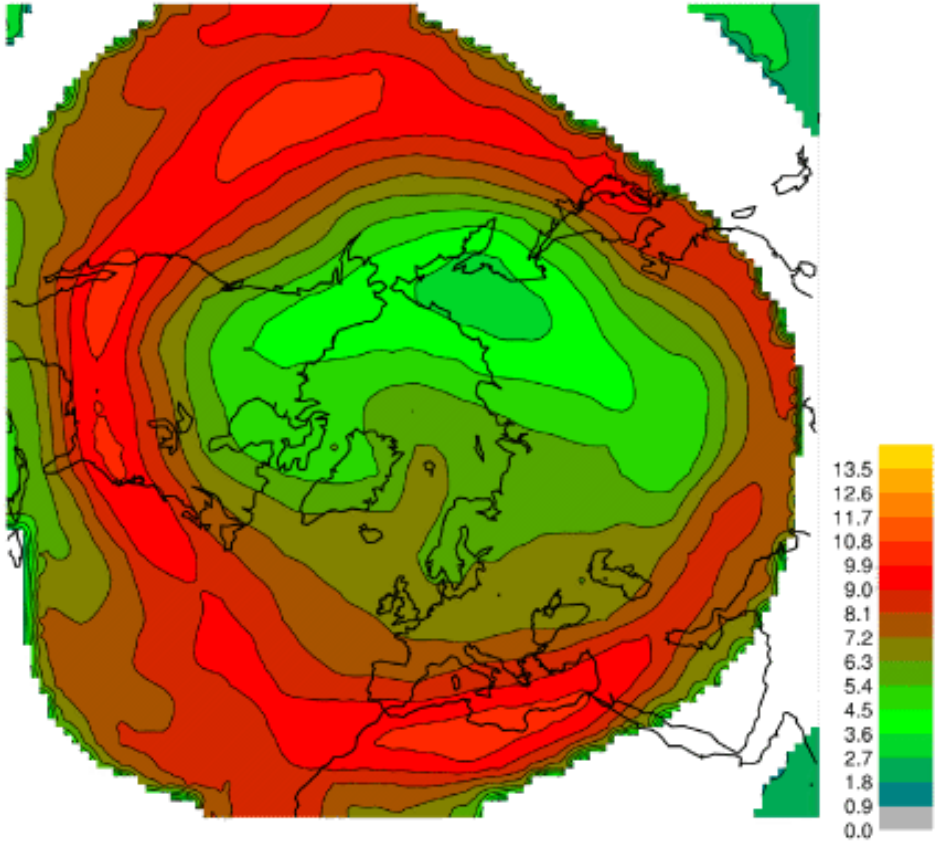


Growth/Decay Rates

DJF, ξ_{250} Tracking Statistics



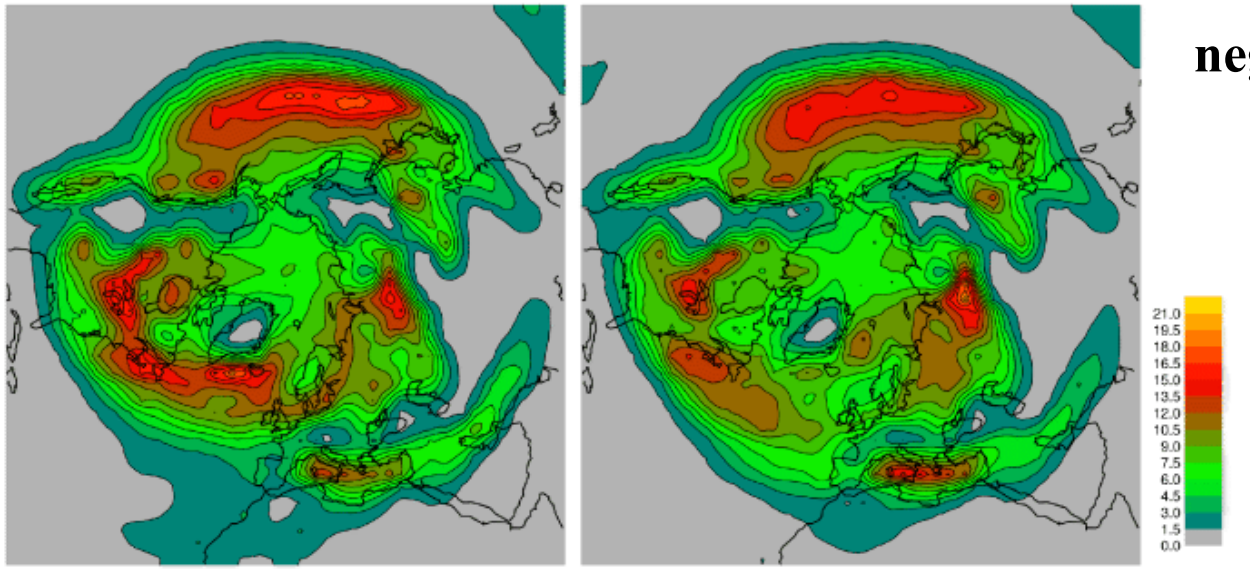
Track Density



Mean Intensity

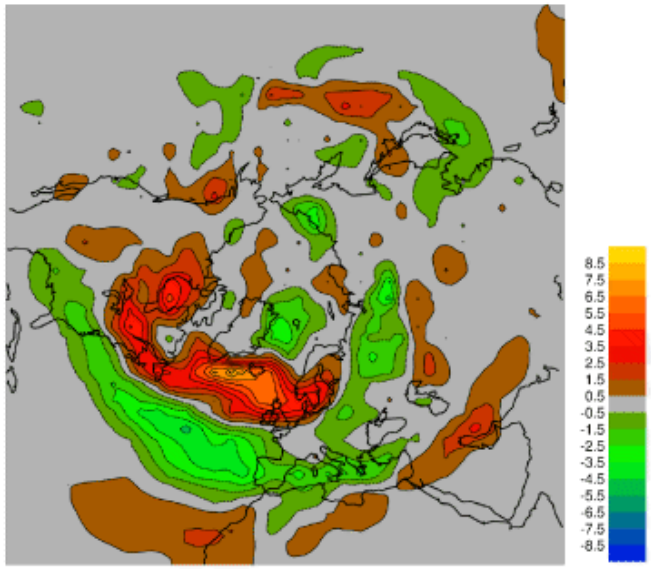
Storm-track density variation with NAO

positive



negative

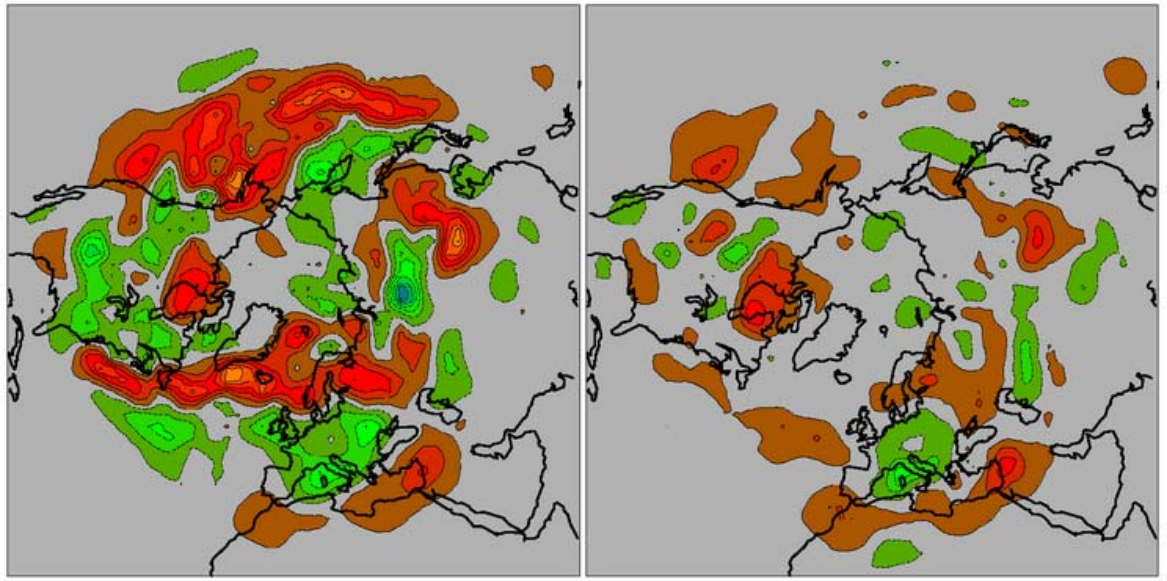
difference
pos - neg



MSLP, Track Density; 1979/03-1958/78

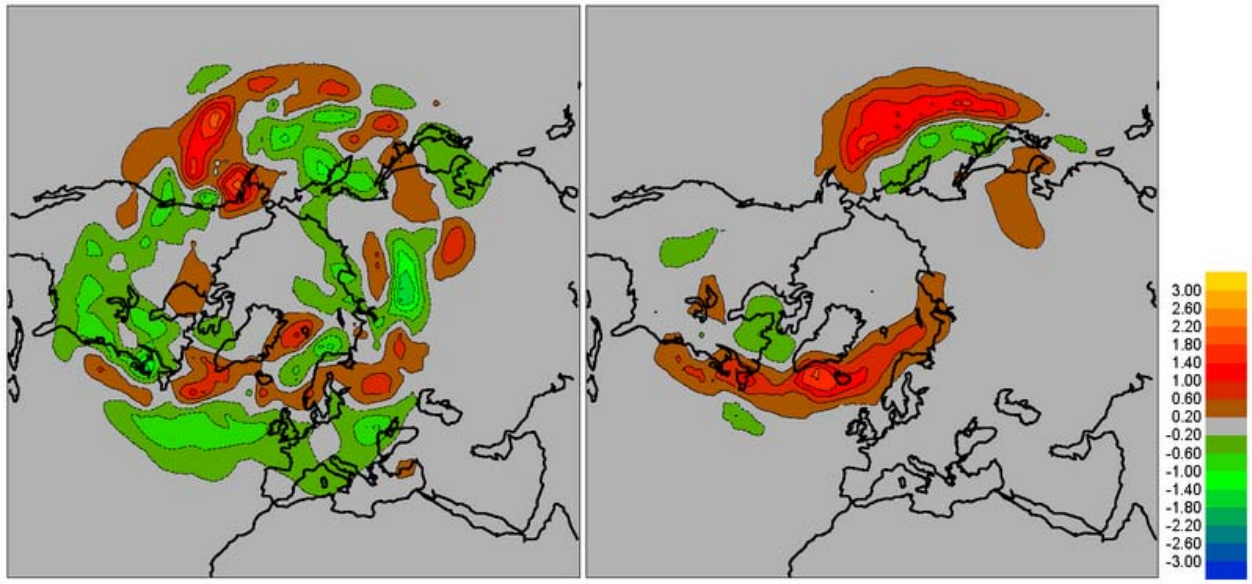
Total

<20hPa



20-40hPa

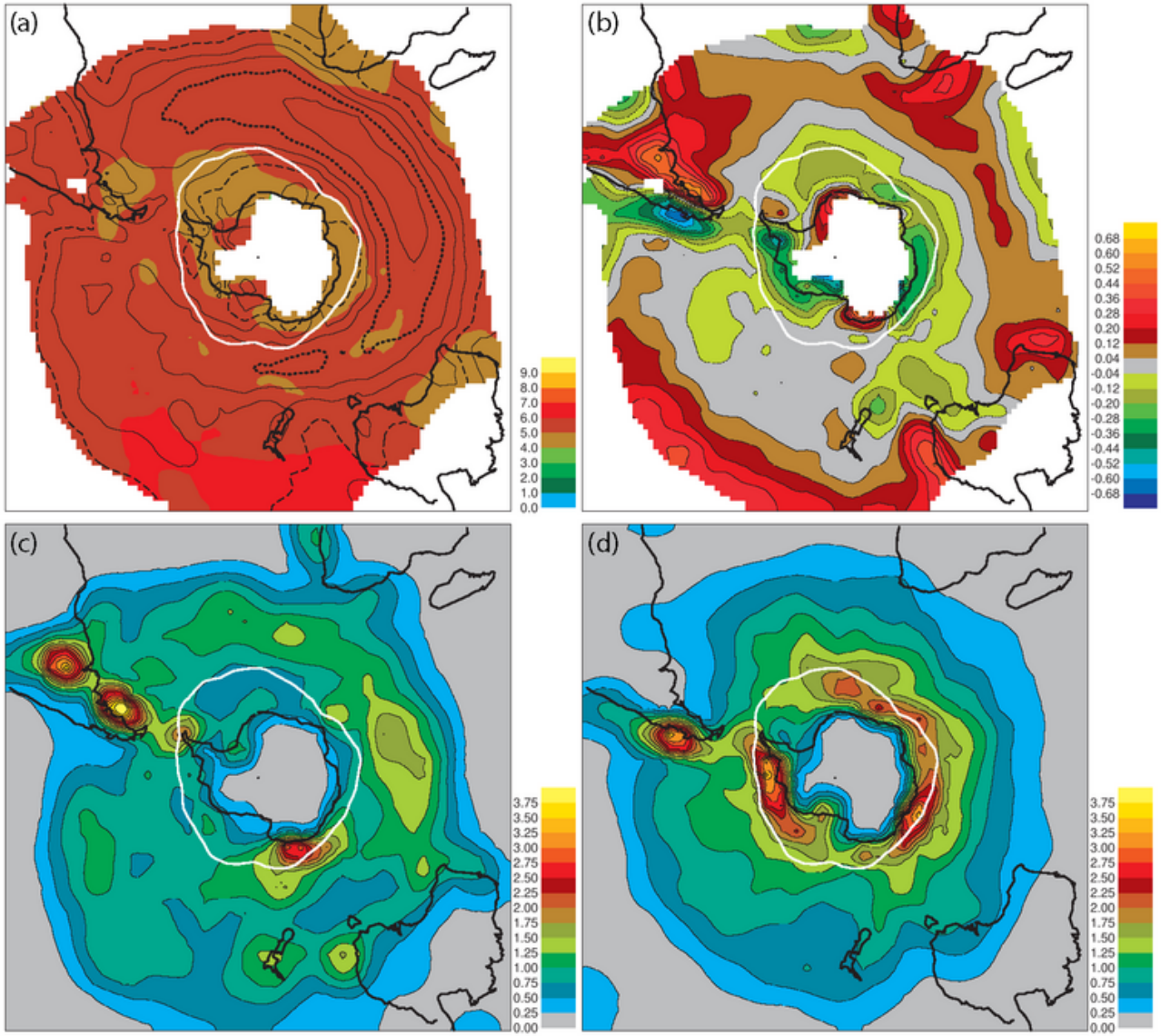
>40hPa



Some SH Winter Cyclone Statistics

lifetime

growth rate

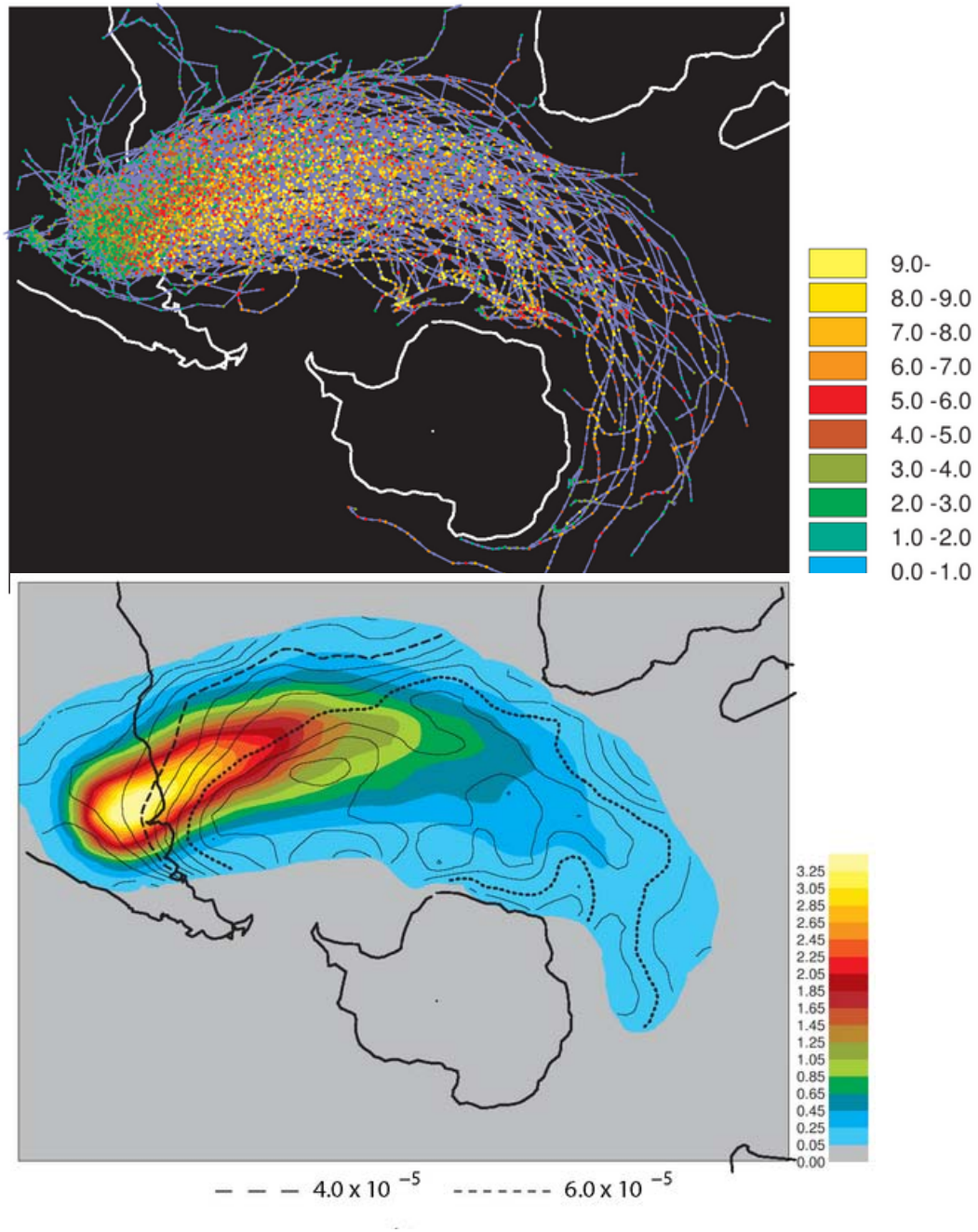


genesis

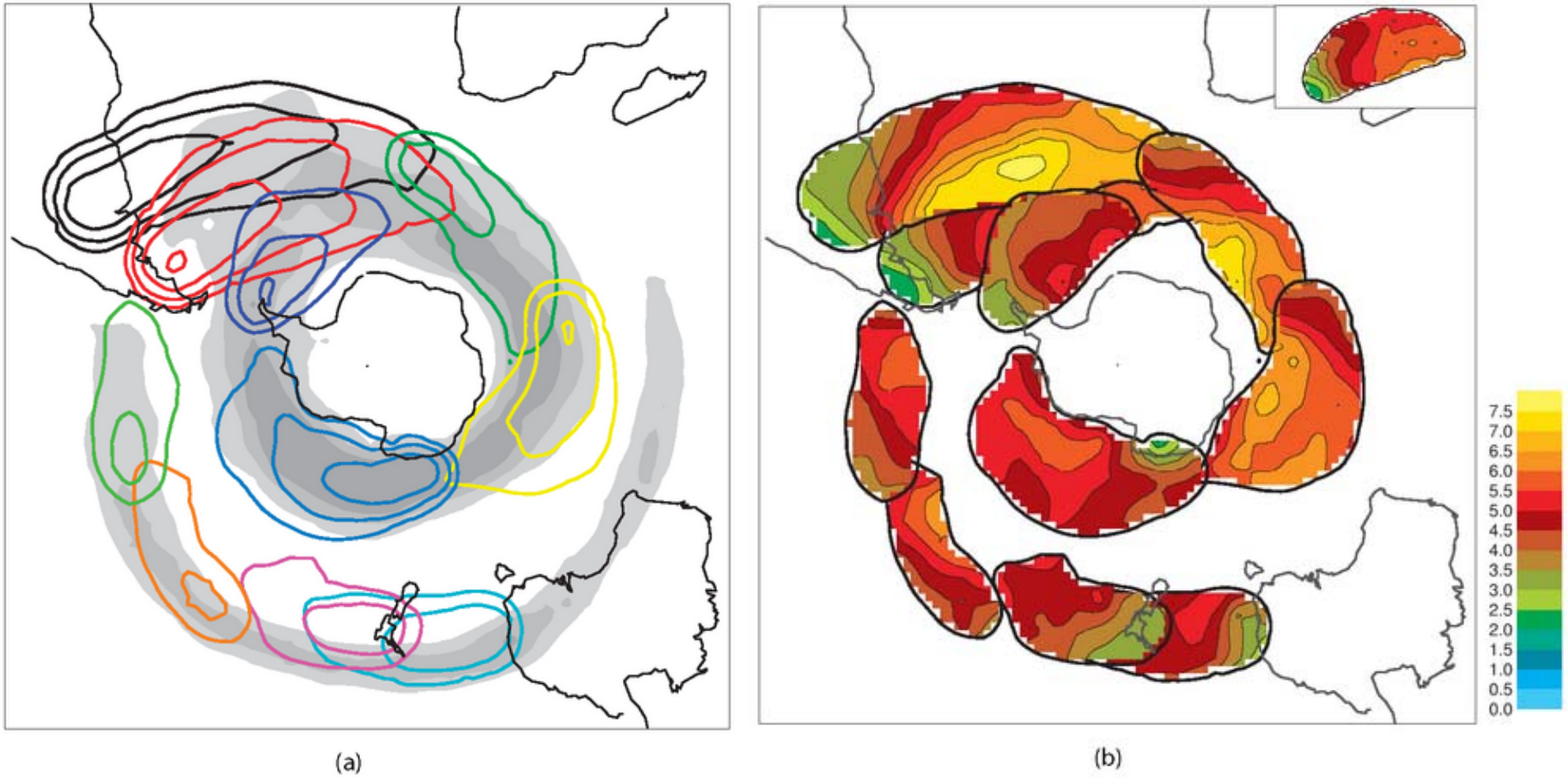
lysis

H & Hodges (2005)

Tracks of all cyclones from 1 genesis region



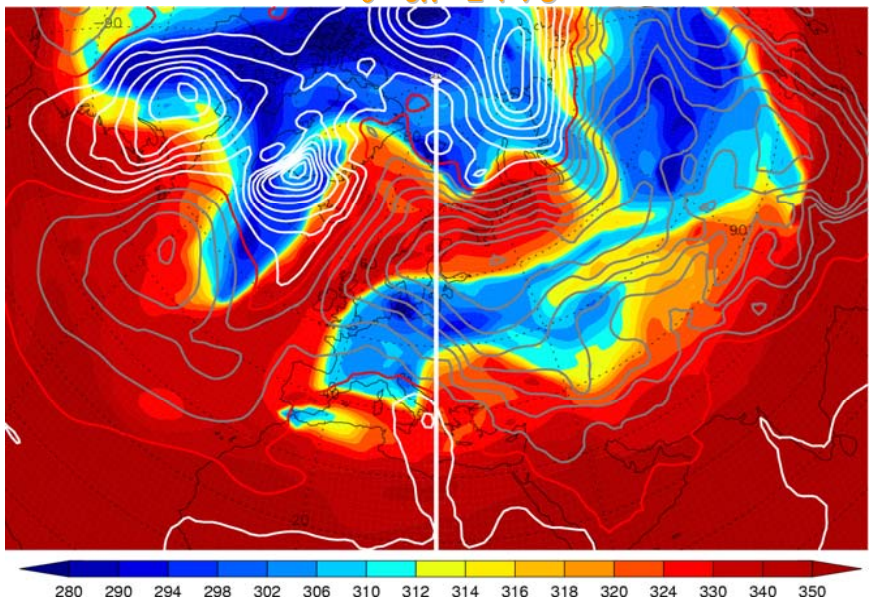
Track density & mean intensity for tracks from the main genesis regions



(a) (b)

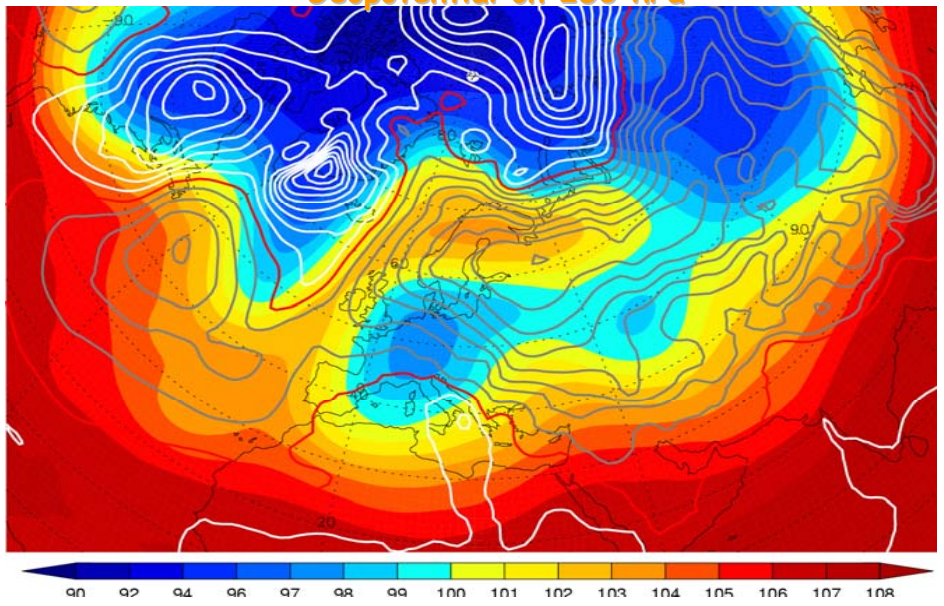
Anatomy of a typical blocking dipole: 20 November 1993 12 UTC

θ on 2 PVU



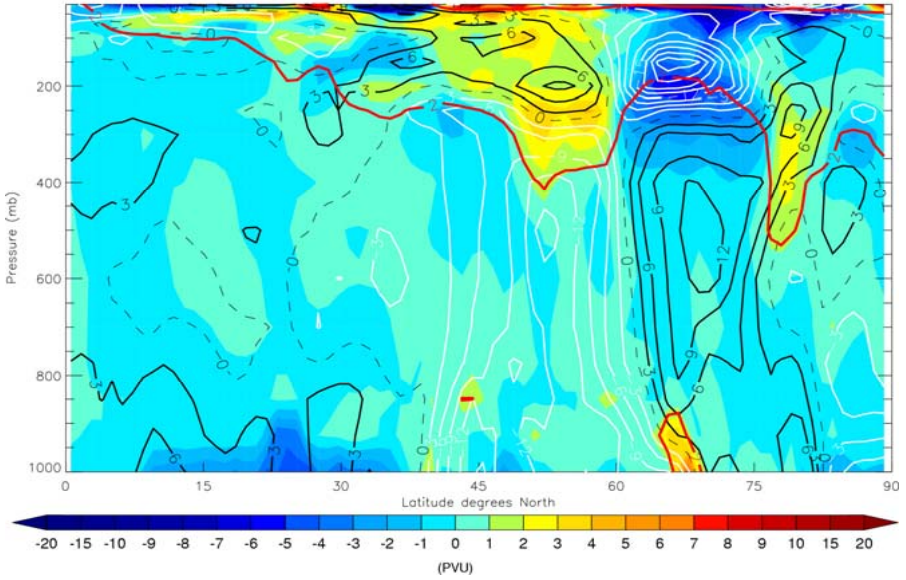
Kelvin

Geopotential on 250 hPa



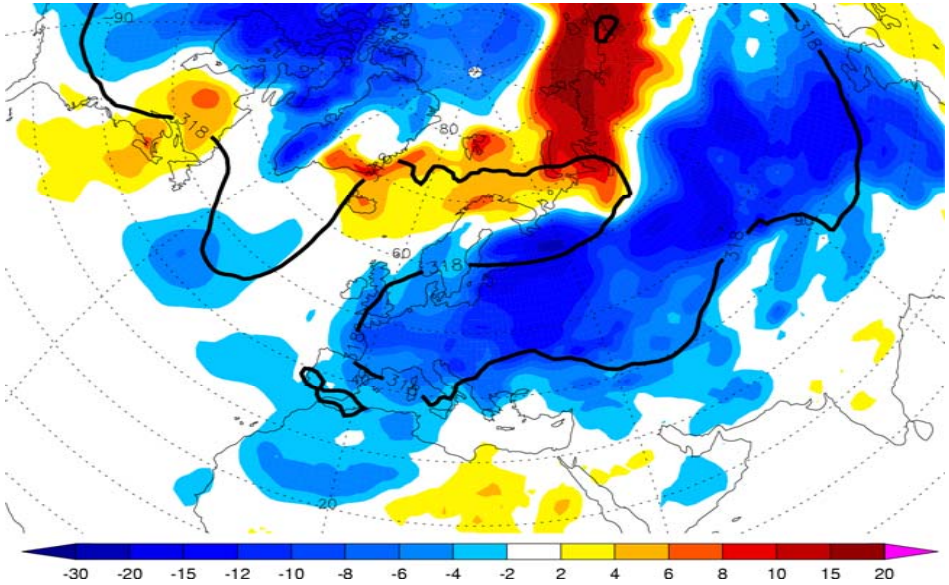
m^2/sec^2 ($x\ 10^3$)

Vertical cross section: anomalous θ and PV



PVU

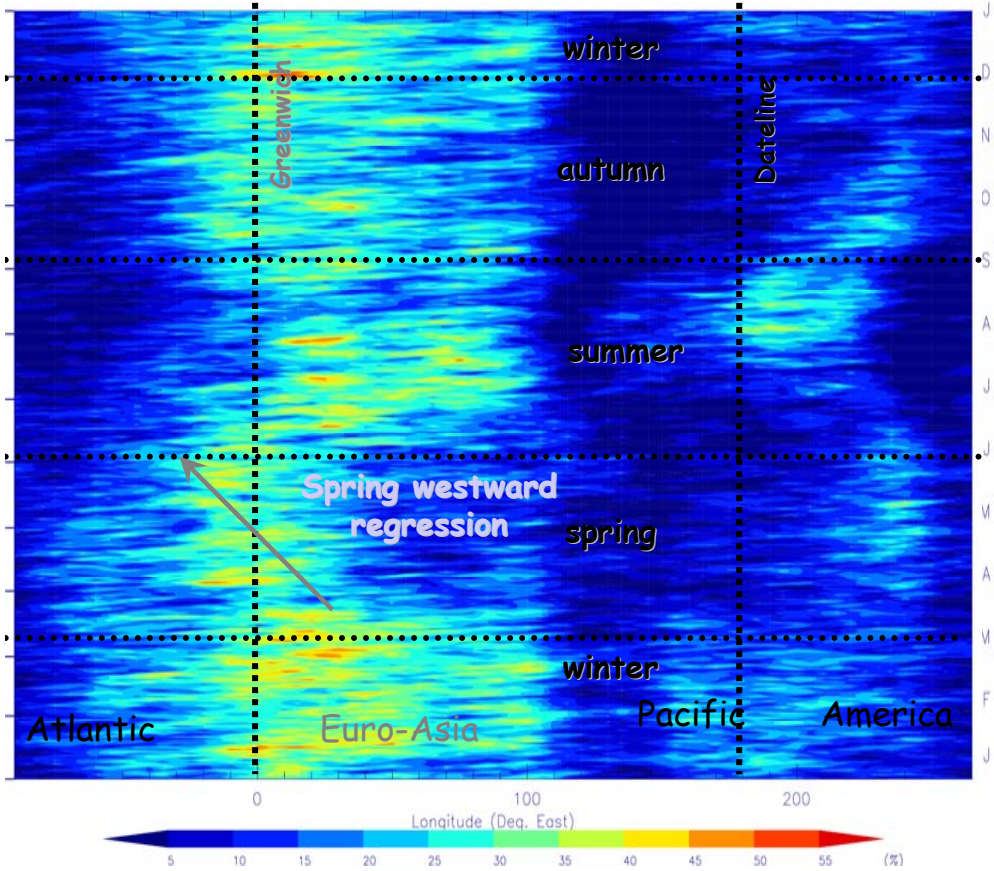
Daily anomaly of T 2m



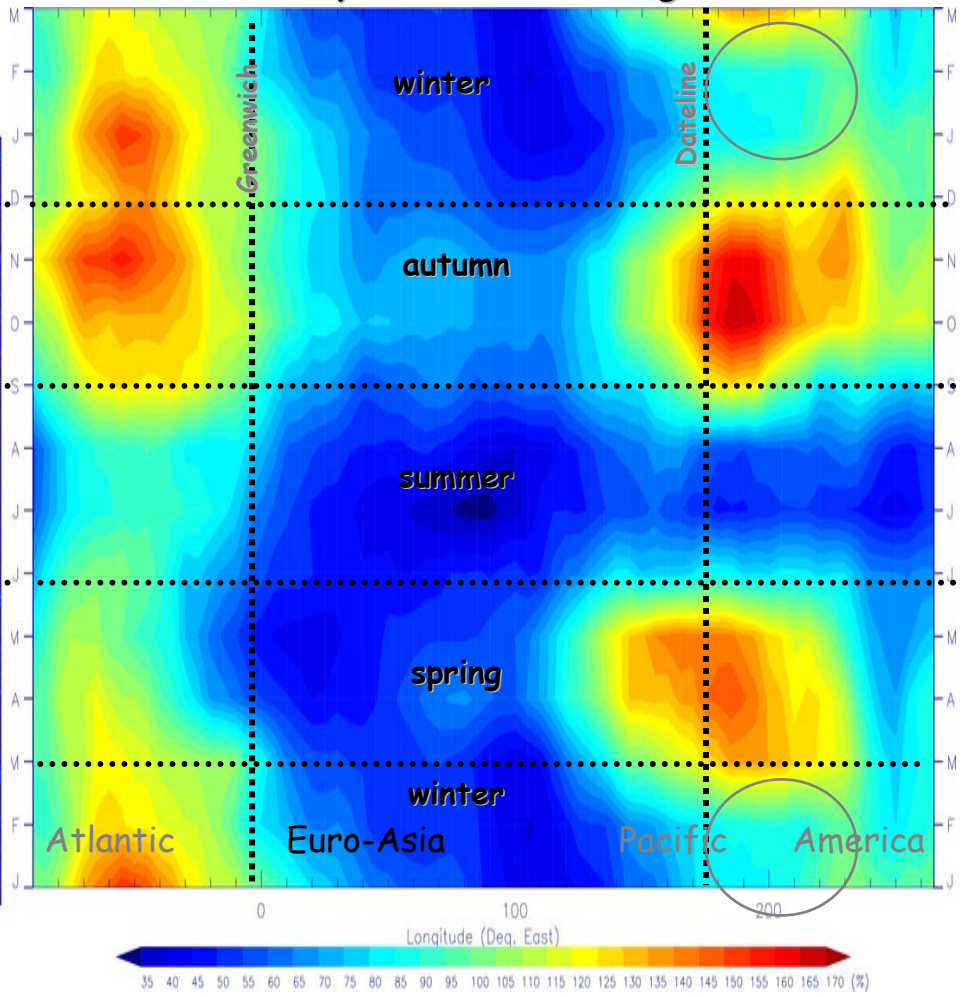
Kelvin

Climatology of Blocking Frequency and Synoptic Activity

Seasonal cycle of LIB frequency

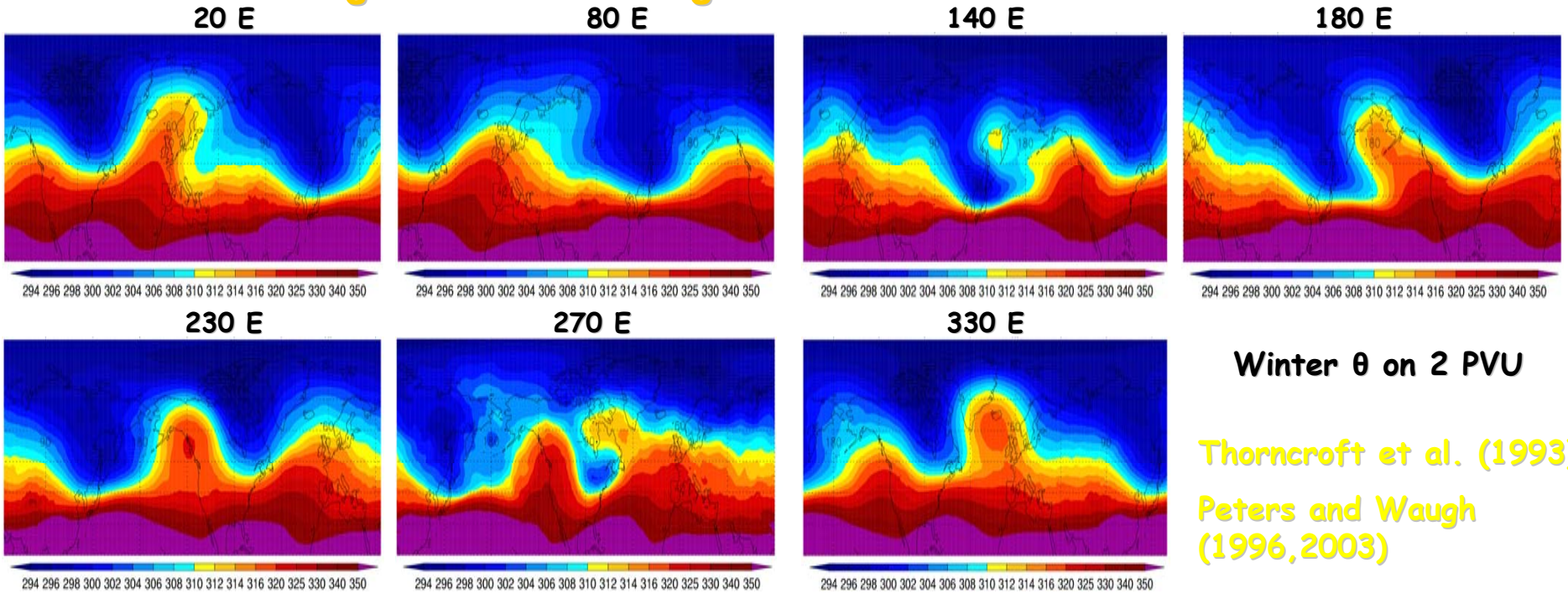


Seasonal cycle of TEKE along CBL



- Mid-winter synoptic depression is more pronounced in central Pacific.
- Atlantic storm track in summer is located further east compared to spring.
- In conclusion blocking areas are located downstream of the main Northern Hemisphere storm tracks.

Blocking as wave breaking and the influence of wind shear

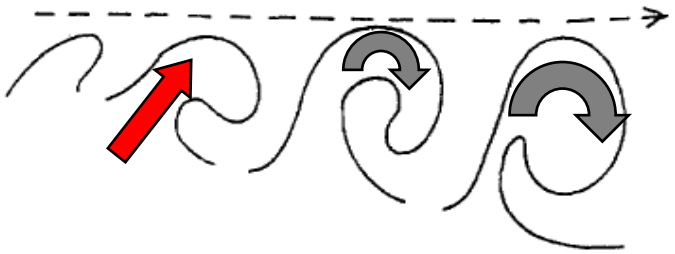


Winter θ on 2 PVU

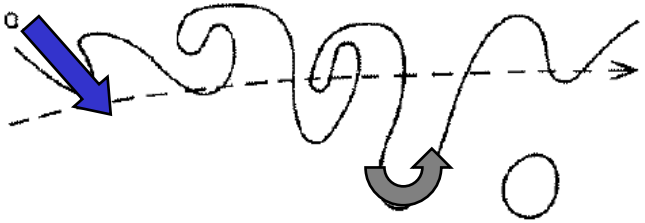
Thorncroft et al. (1993)

Peters and Waugh (1996,2003)

Strong downstream blocking ridge



No SBE but a cut-off low.



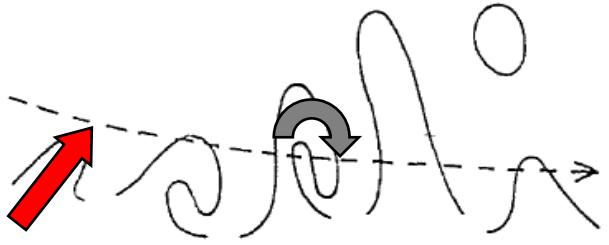
Anticyclonic wind shear.

Jet far to the north.

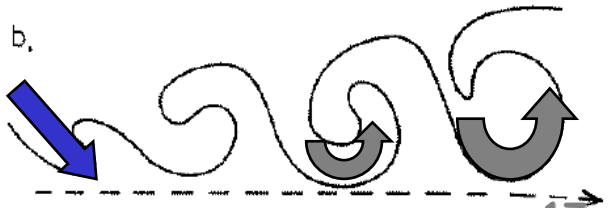
Cyclonic wind shear.

Jet far to the south.

No SBE. Weak anticyclonic circulation.

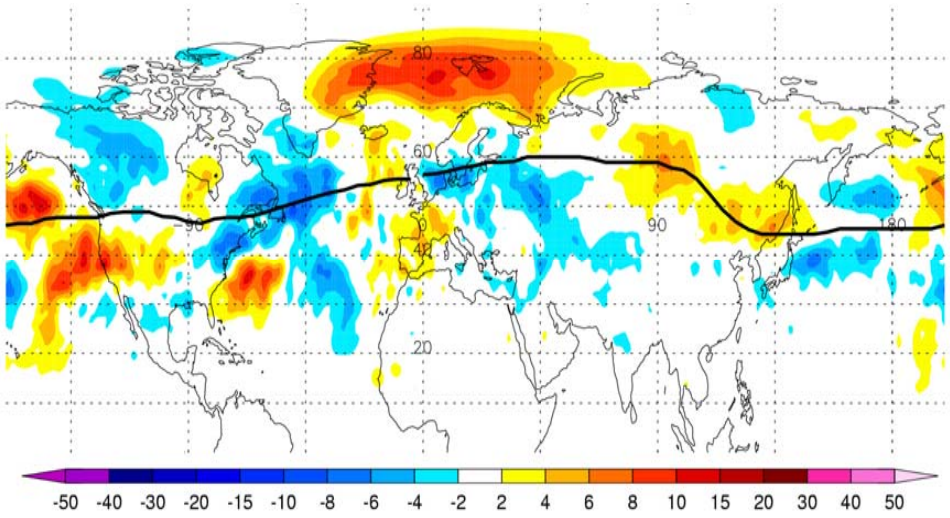


Blocking dissipates fast.

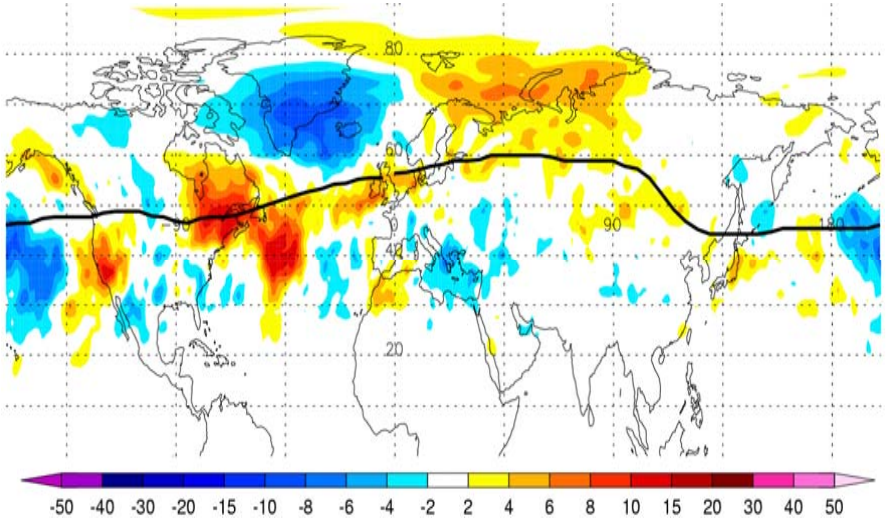


Precursor of Winter European Blocking

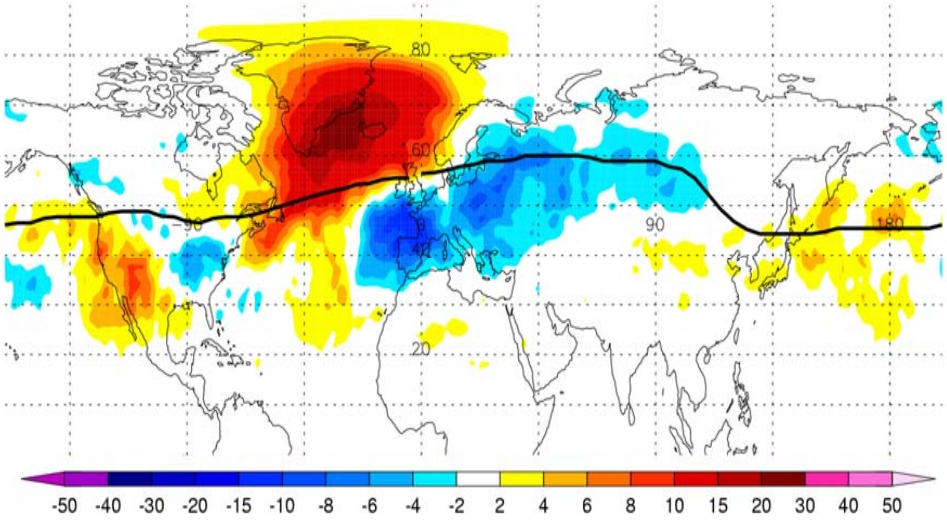
Winter Transient activity anomaly 6-7 prior onset



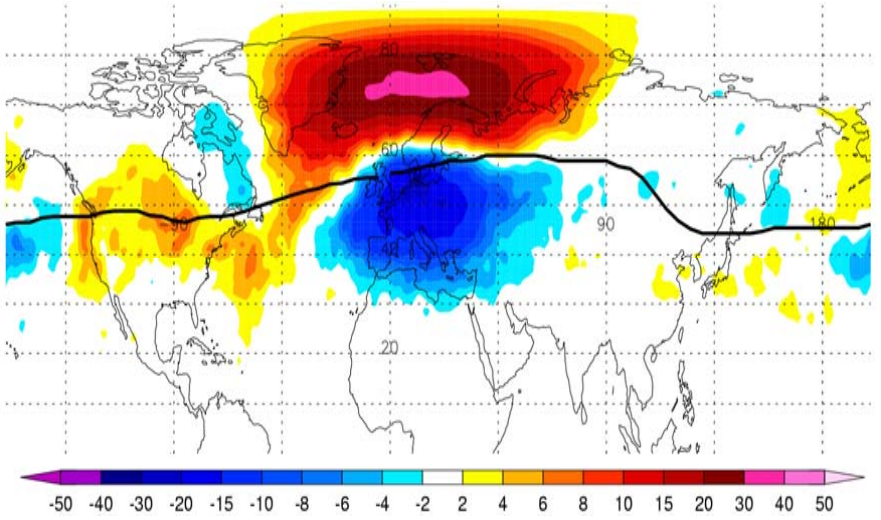
Winter Transient activity anomaly 4-5 prior onset



Winter Transient activity anomaly 0-3 prior onset

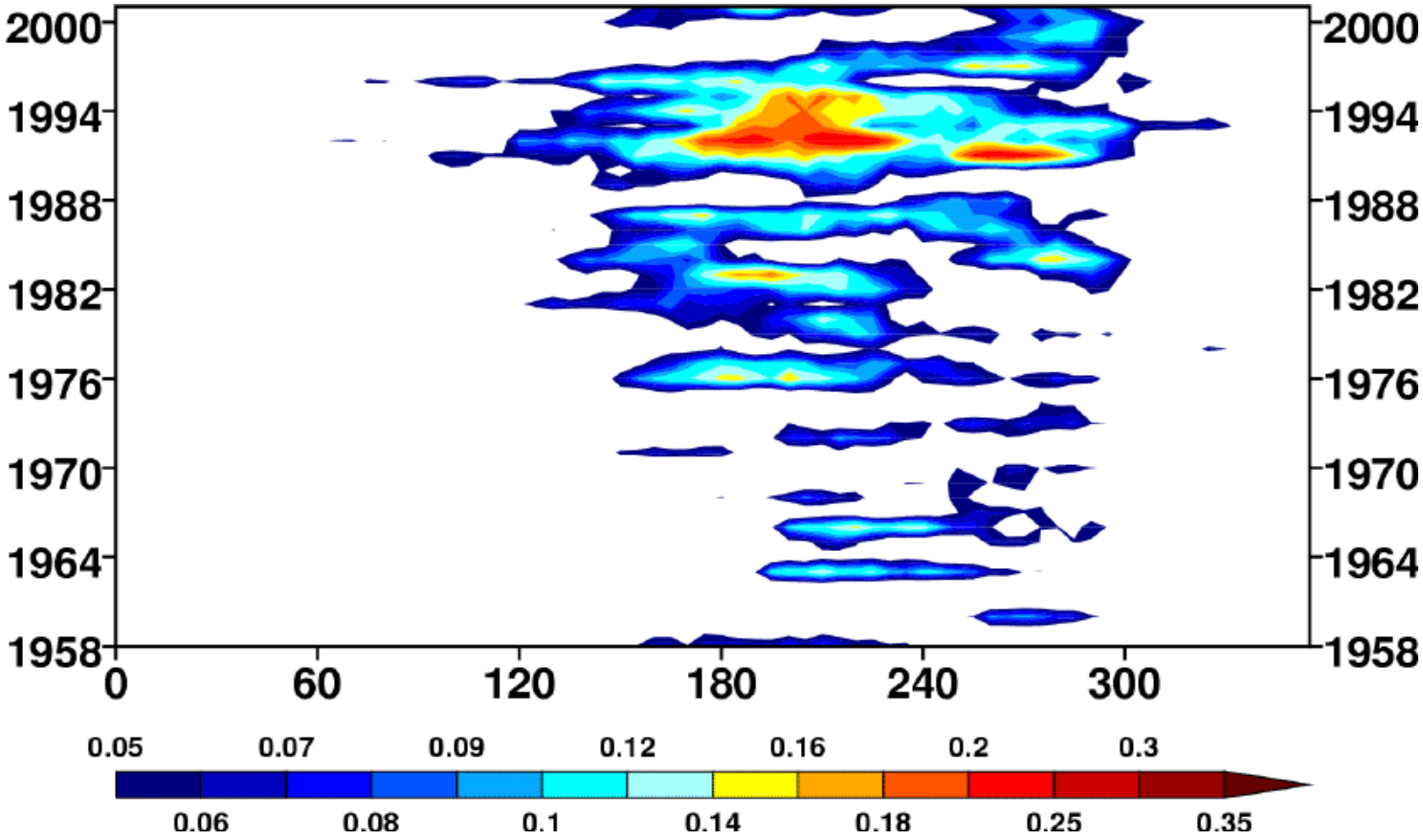


Winter Transient activity anomaly 1-5 after onset



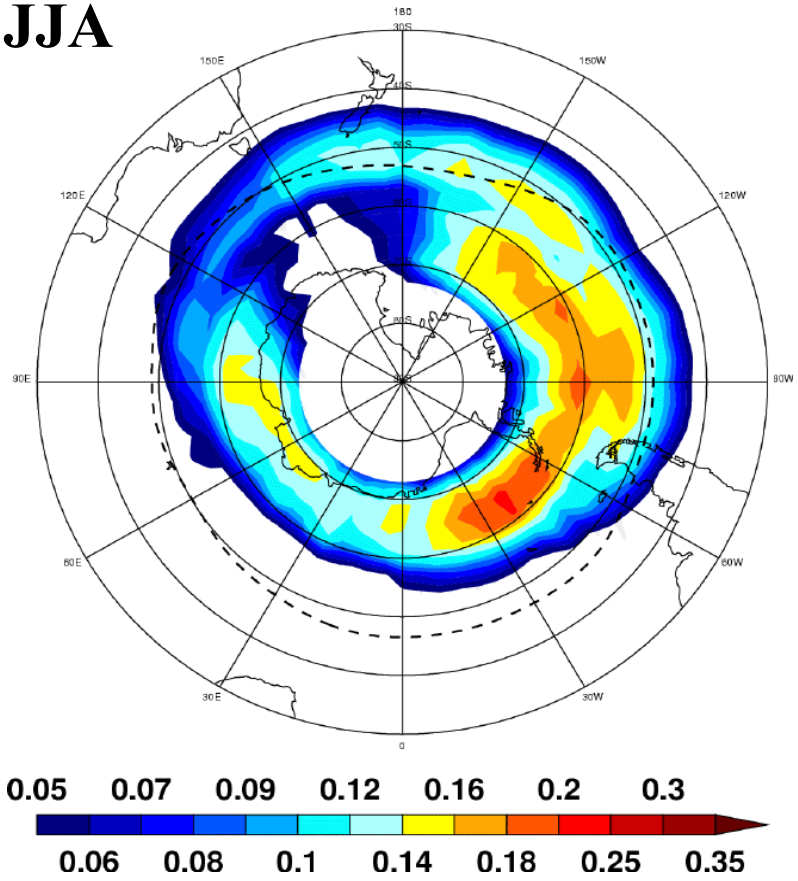
'Dirty TEKE' = $\langle (1/2)*[(Du)^2 + (Dv)^2] \rangle$ measure of daily transient activity

Interannual Variability of SH Blocking Episodes

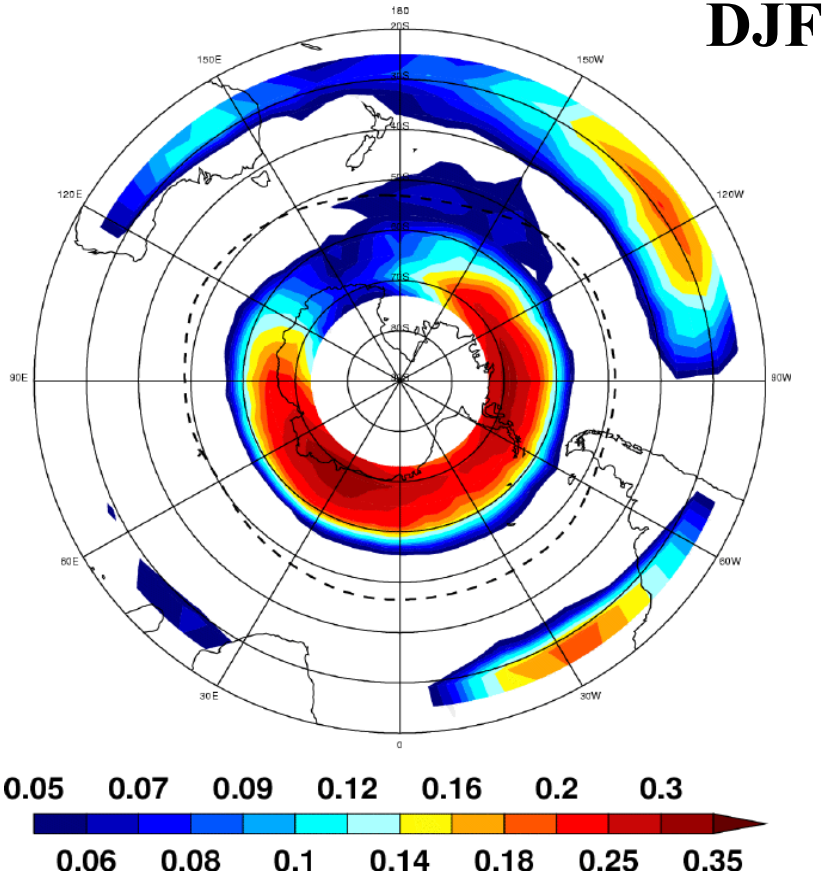


2-D Frequency of θ on PV2 Wavebreaking/Blocking Episodes

JJA

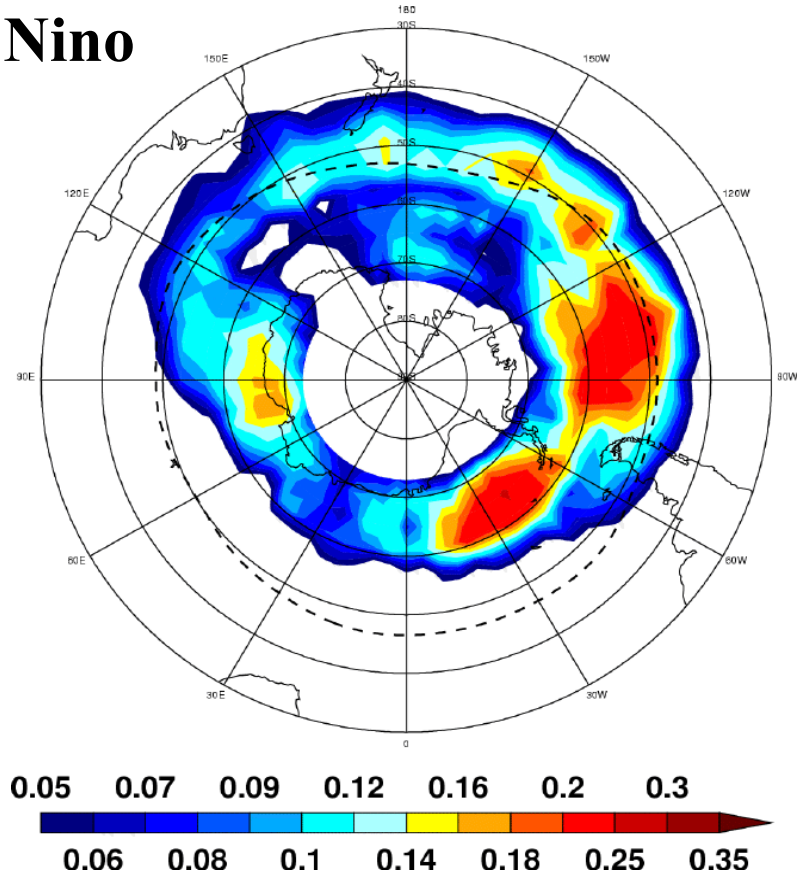


DJF

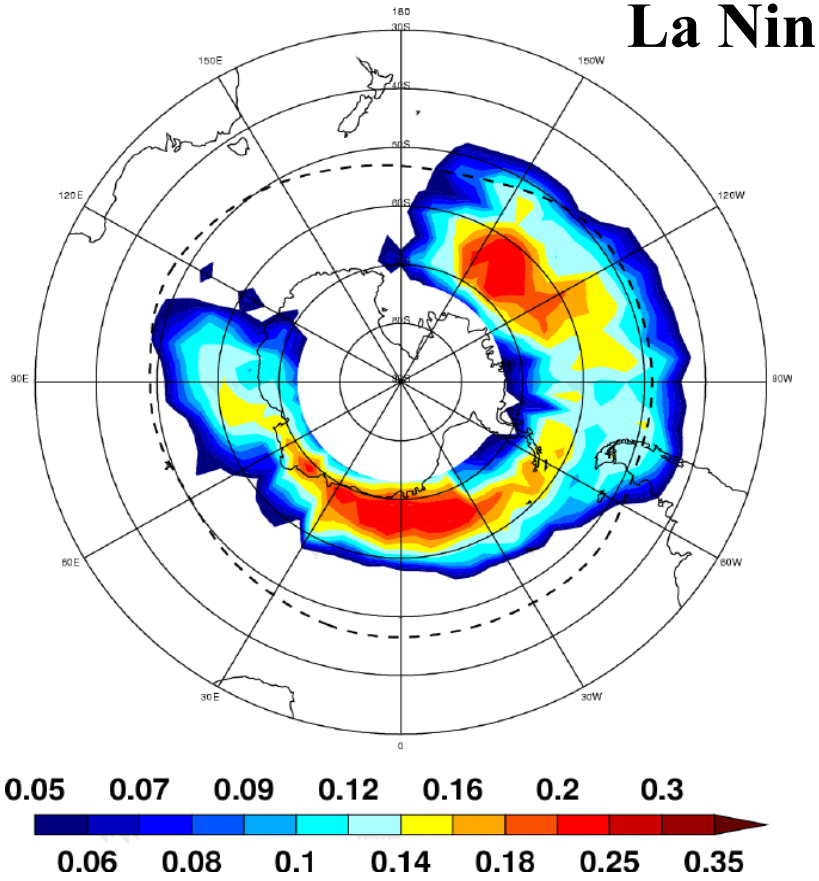


2-D Frequency of θ on PV2 Wavebreaking/Blocking Episodes: Variation with ENSO

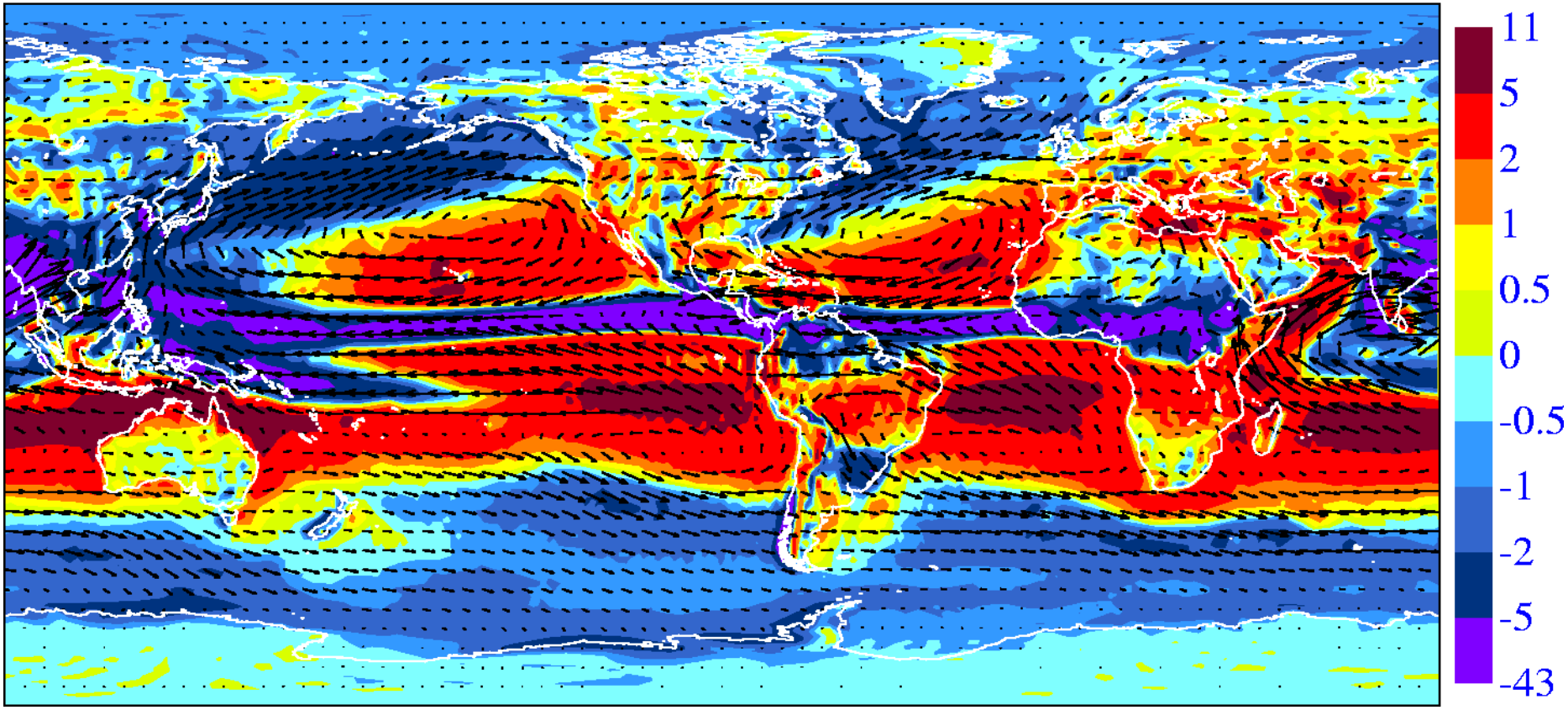
El Nino



La Nina



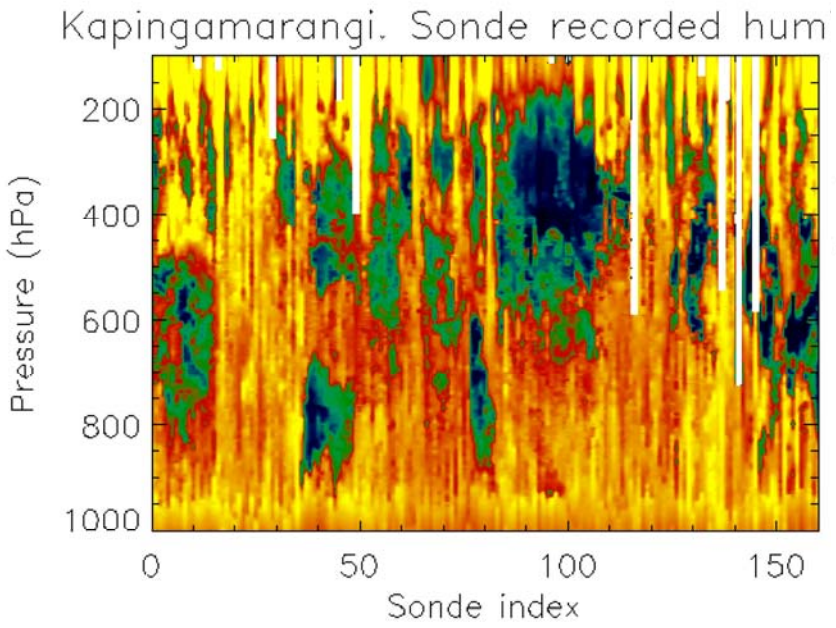
Water vapour transport by the atmosphere in June-August & implied evaporation - precipitation



600 kg $m^{-1}s^{-1}$

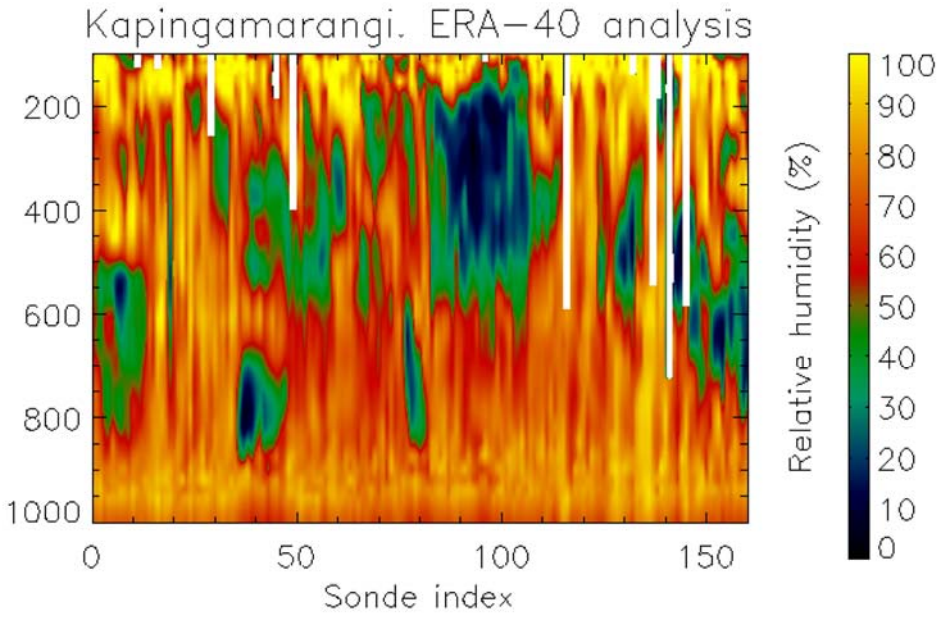
Relative humidity for 1 station during TOGA-COARE

Sonde



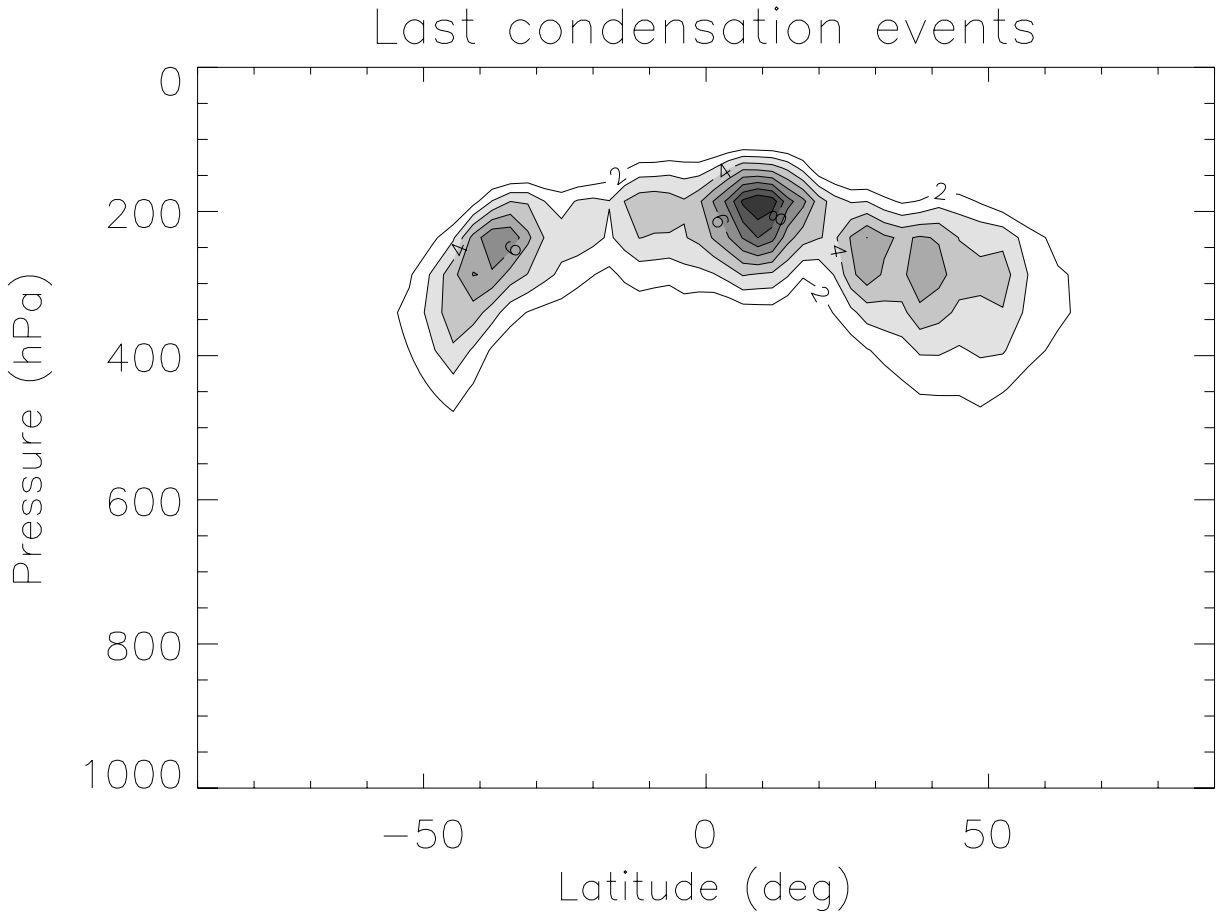
t

ERA-40



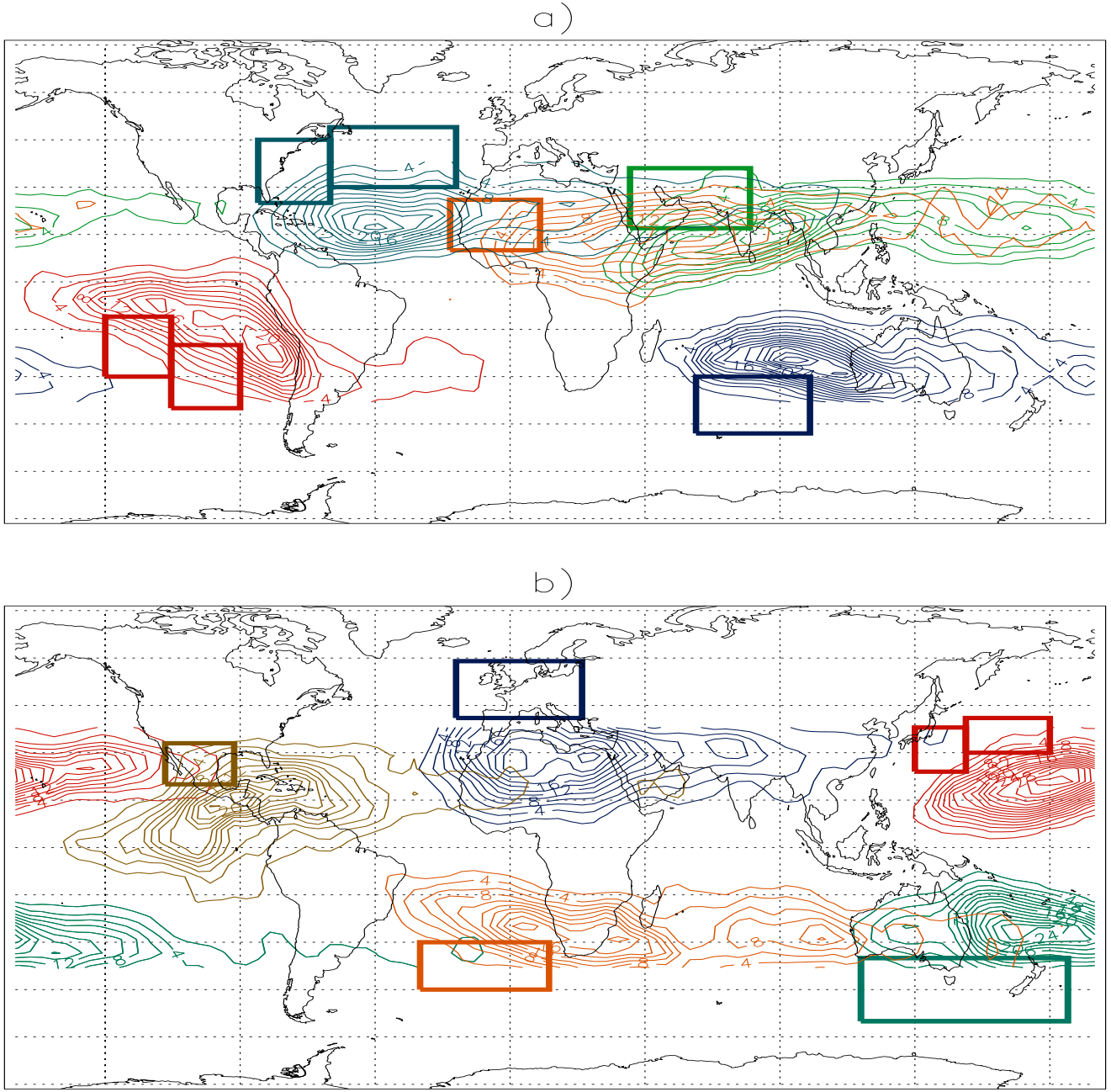
Cau, Methven & H (2005)

Origin of very dry air (< 20% rh) in tropics using back trajectories (Jan)



Cau, Methven & H (2006)

Final densities of dry air with origin in boxes

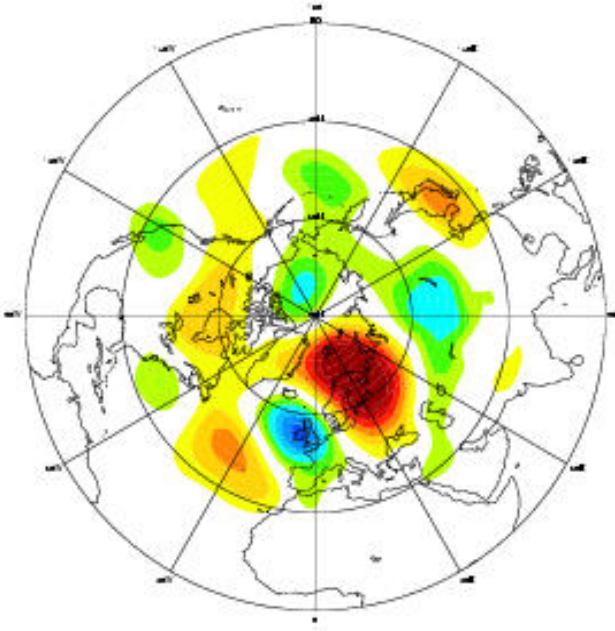


Observations - SON 2000

300hPa Geopotential Height

ECMWF analyses

Anomaly from ERA-15



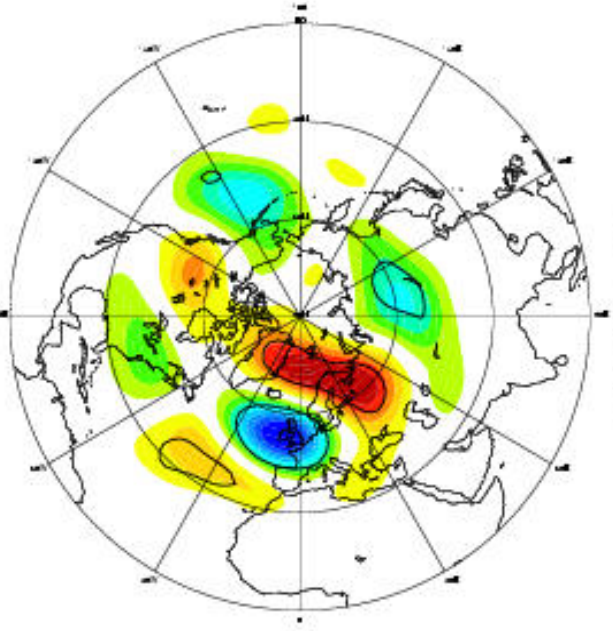
(metres)

Regression on England-Wales precip

300hPa Geopotential Height

SON 1958-1999

(bold: 99% confidence level)



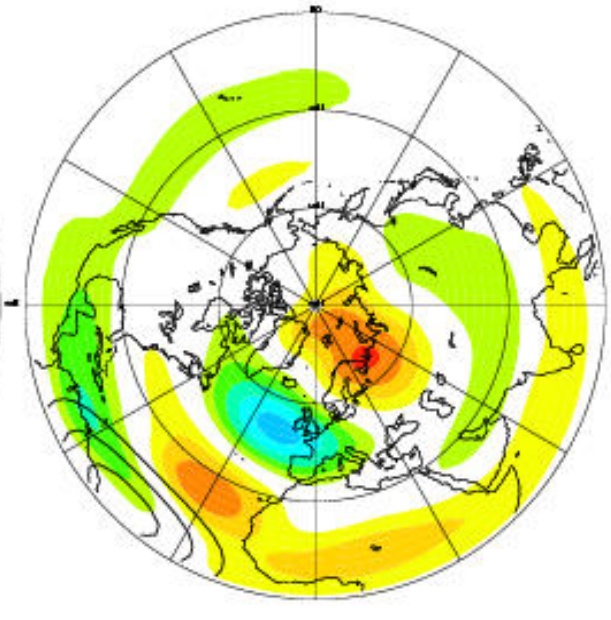
(metres for 1 Std.Dev. precipitation)

Barotropic model response

Streamfunction anomaly

Convergence forcing (45W,5N), ($-fD$)

SON climate 300hPa basic state



(Interval $2*10^6$ m^2s^{-1})

Concluding Comments

- Many other topics not mentioned,
  e.g. convectively coupled equatorial waves,
  Asian Monsoon studies
- Reanalyses have become one of the pillars of
  dynamical/process study research on
  planetary to synoptic scales