ECMWF/CLIVAR Workshop on Simulation and Predictability of Intra-Seasonal Variability with Emphasis on the Madden-Julian Oscillation

- Why an ECMWF workshop on Intraseasonal Variability?
  - ECMWF has begun routine 30-day ensemble forecasts with a TL159 coupled ocean-atmosphere model (hi-res version of seasonal forecast system).
- Why MJO?
  - MJO is the dominant “mode” of tropical intra-seasonal variability – important in its own right;
  - MJO contributes to intra-seasonal predictability in extratropics eg Europe;
  - GCMs have difficulty in simulating MJO;
  - MJOs can impact on development of ENSO – important for seasonal prediction.

Madden-Julian Oscillation – composite analysis based on EOFs of OLR

Ferranti et al, 1990

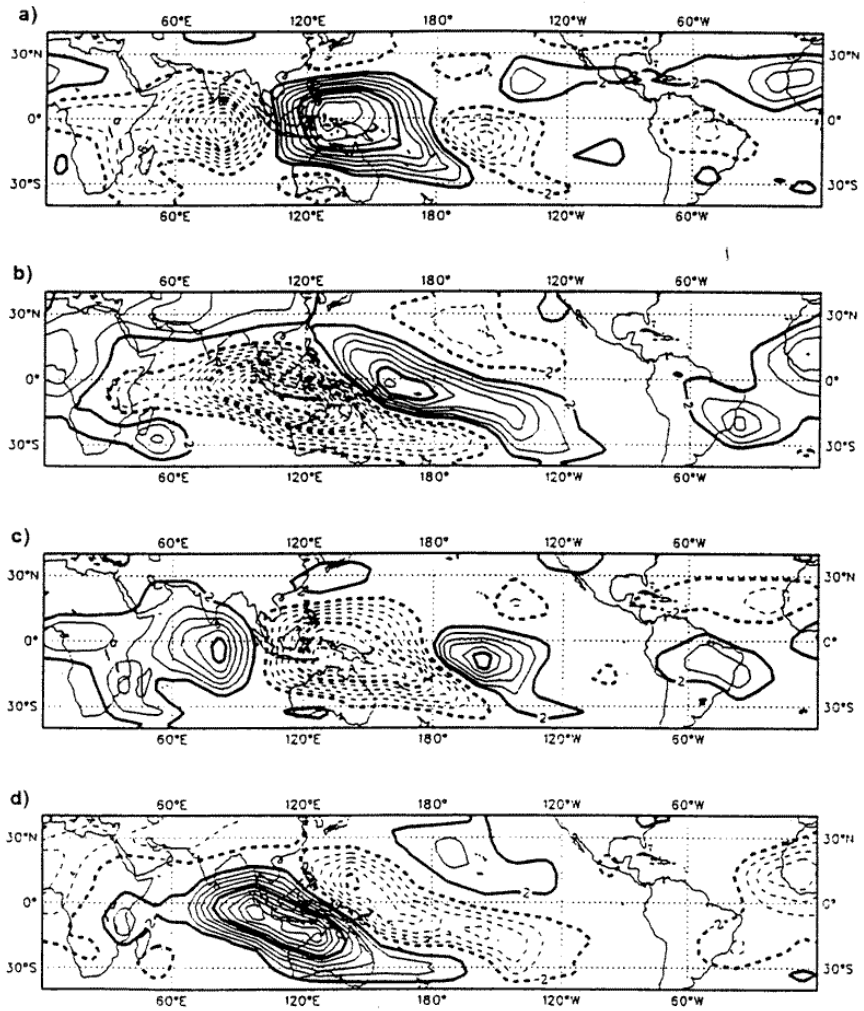


FIG. 3. Composite of OLR formed by selecting days when a) the coefficient of the second EOF was greater than one standard deviation, (b) the coefficient of the first EOF was greater than one standard deviation, c) the coefficient of the second EOF was less than minus one standard deviation, d) the coefficient of the first EOF was less than minus one standard deviation. Contour interval 2 W/m^2.

500hPa anomaly associated with MJO composites

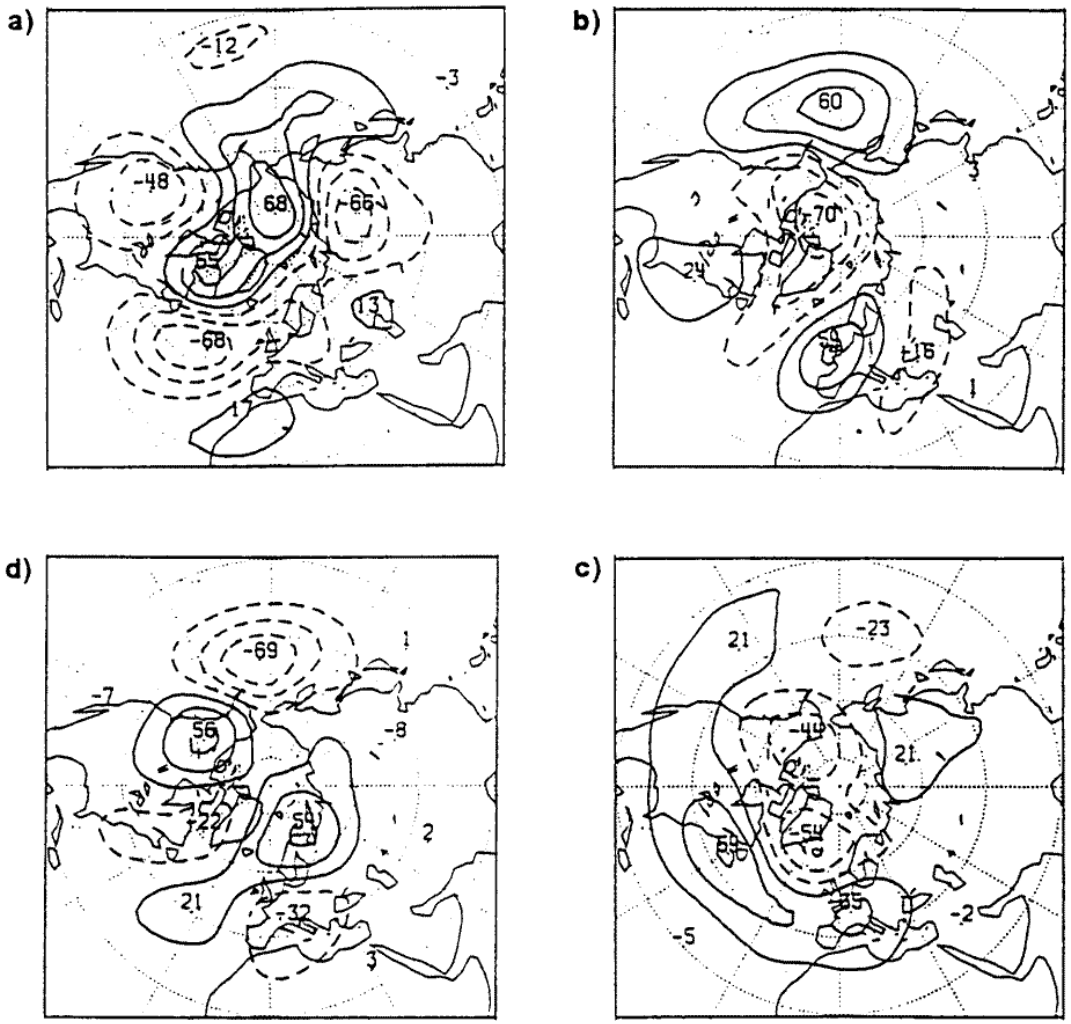
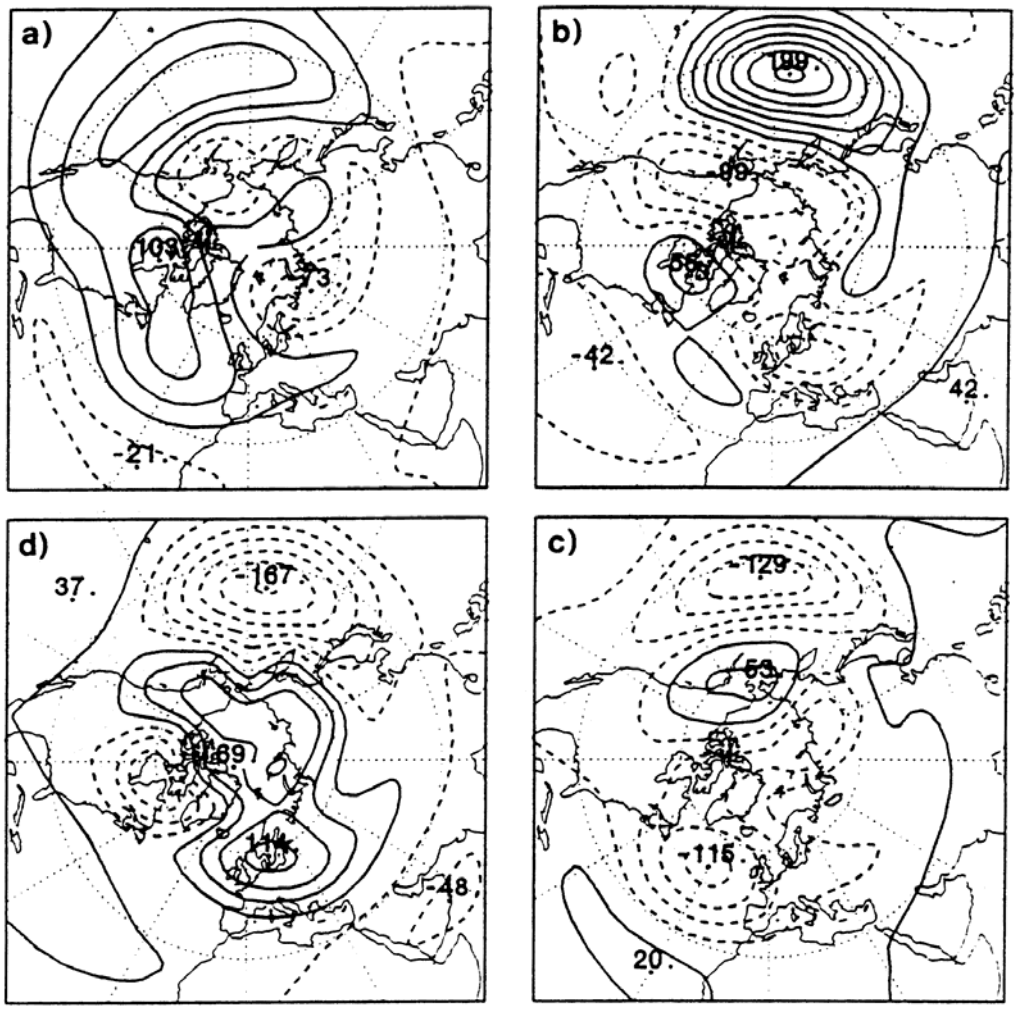


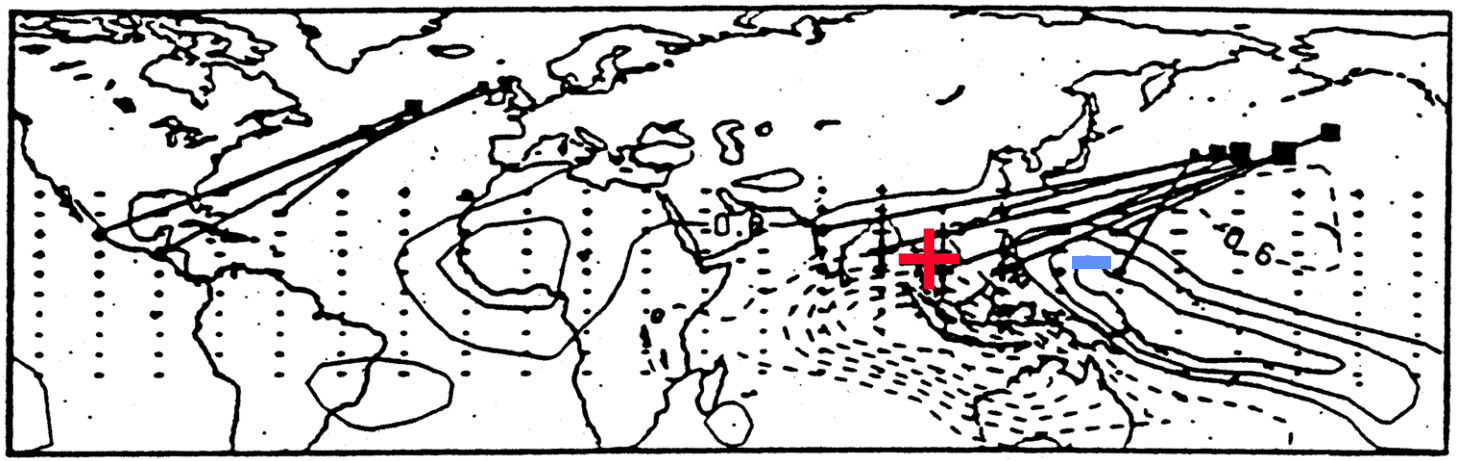
FIG. 5. Composite of extratropical 500 mb geopotential height formed by selecting days when a) the coefficient of the second EOF of OLR was greater than one standard deviation, b) the coefficient of the first EOF of OLR was greater than one standard deviation, c) the coefficient of the second EOF of OLR was less than minus one standard deviation, d) the coefficient of the first EOF of OLR was less than minus one standard deviation. Contour interval 20 m.

Ferranti et al, 1990

Barotropic Model Response to Composite MJO Forcing

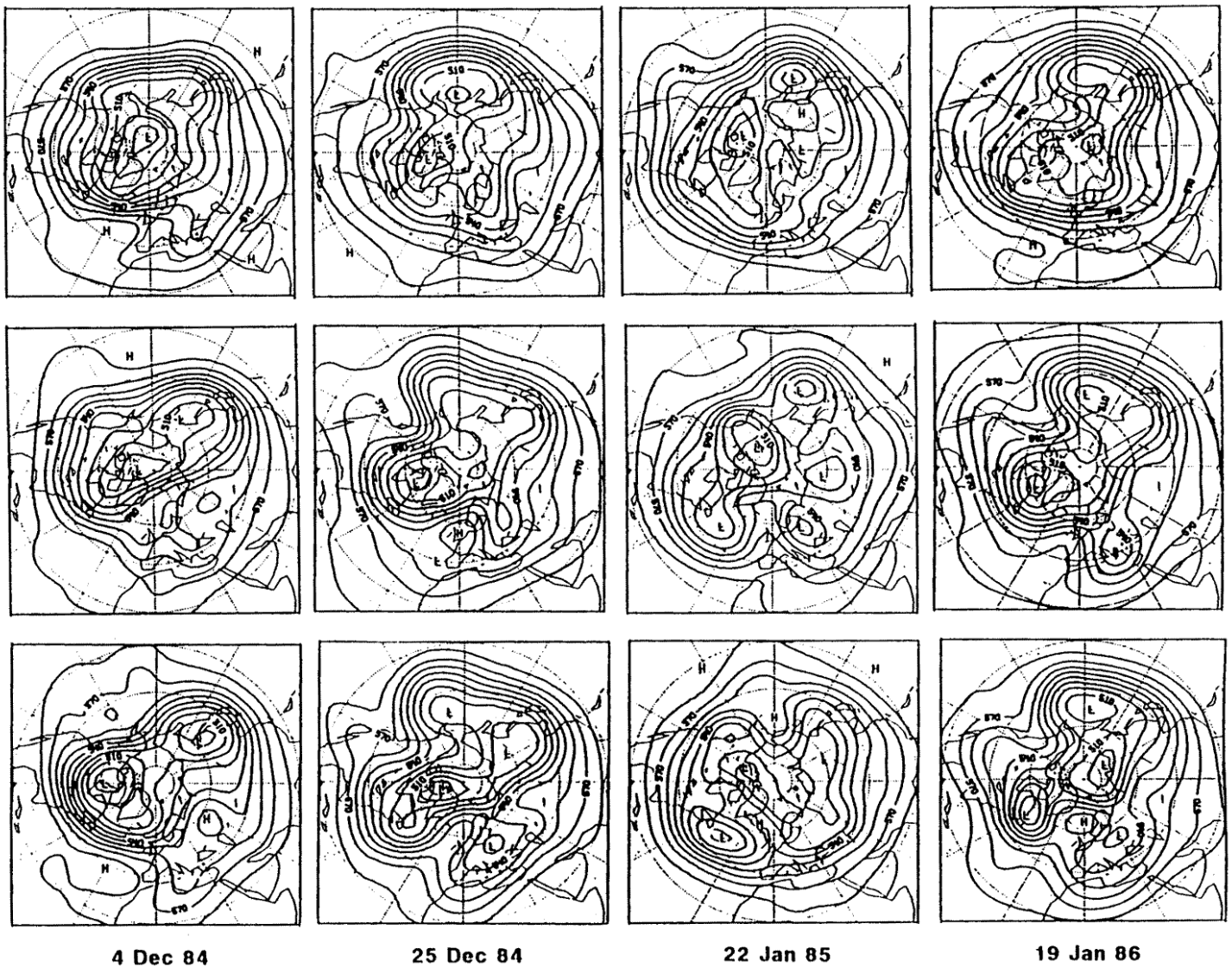


MJO is optimally configured to project onto NH extratropical barotropic eigenmodes.



Superposition of Simmons et al barotropic adjoint analysis onto Ferranti et al composite MJO analysis

D16-20 500mb height: Ferranti et al, 1990

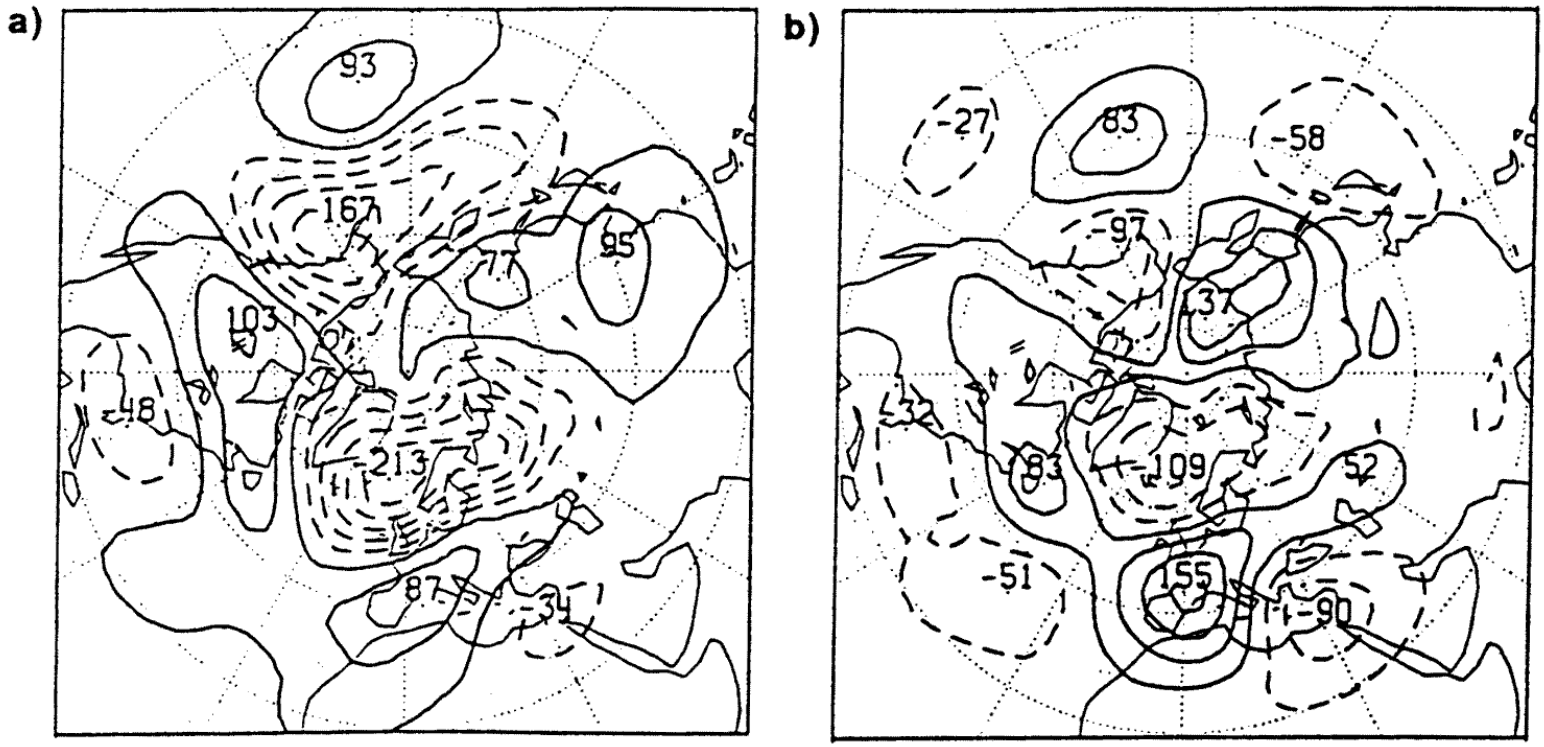


Control

Relax to analysis in tropics

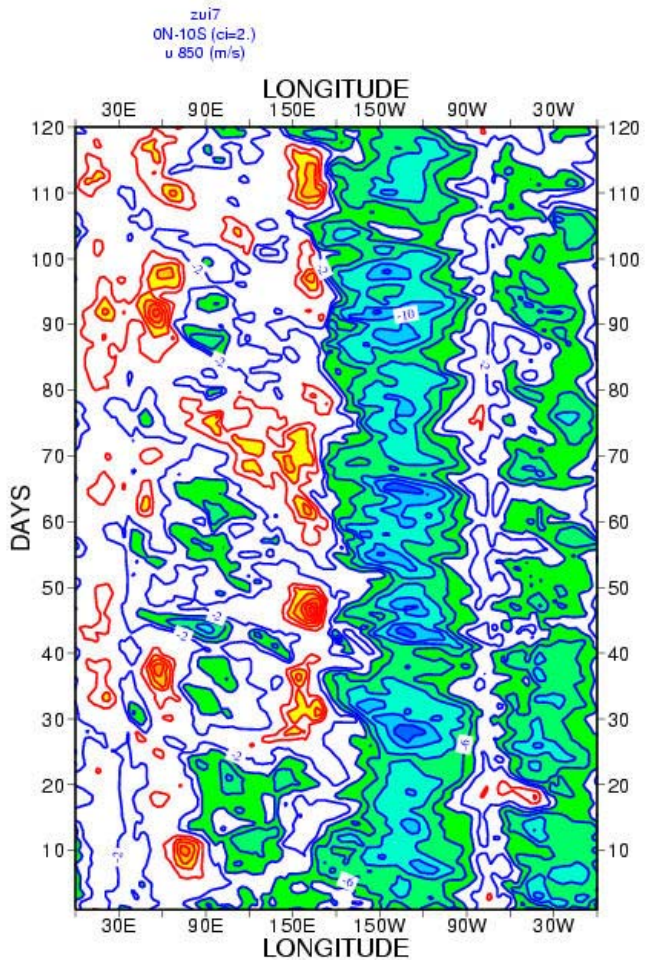
Verification

Mean Error (D11-20): a) unconstrained b) with relaxation to analysis in tropics

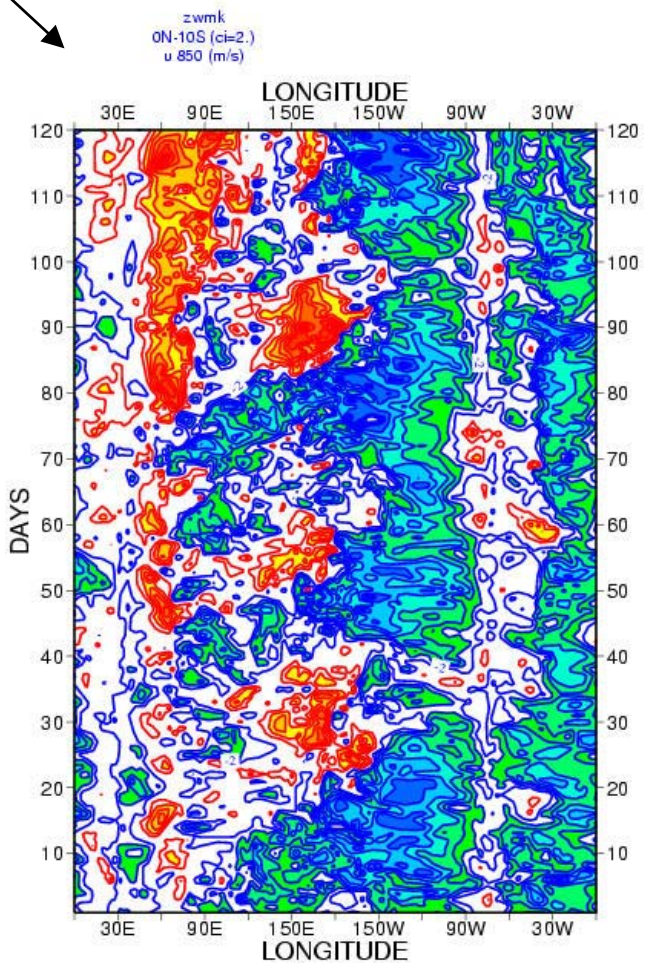


ECMWF model can simulate MJO - but with poor Hadley Cell

T63 Operational Parametrisation (16r4)



T63 No convection if CAPE<500 J/kg(16r4)



U 850hPa

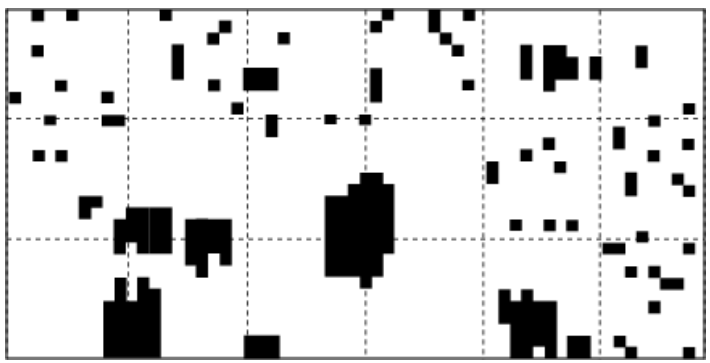
L. Ferranti, P.C.

Some important questions for ECMWF.

Not whether it is possible for NWP/GCMs to simulate MJO (it is possible), but whether it is possible to simulate both the time-mean flow (eg strength of Hadley Cell) and variability (eg strength and phase speed of MJO), with conventional resolution/ parametrisation combinations.

If it is not possible, is it necessary to go “all the way” to cloud-resolving models (cf superparametrisation), or can computationally cheaper stochastic-dynamic models do as well?

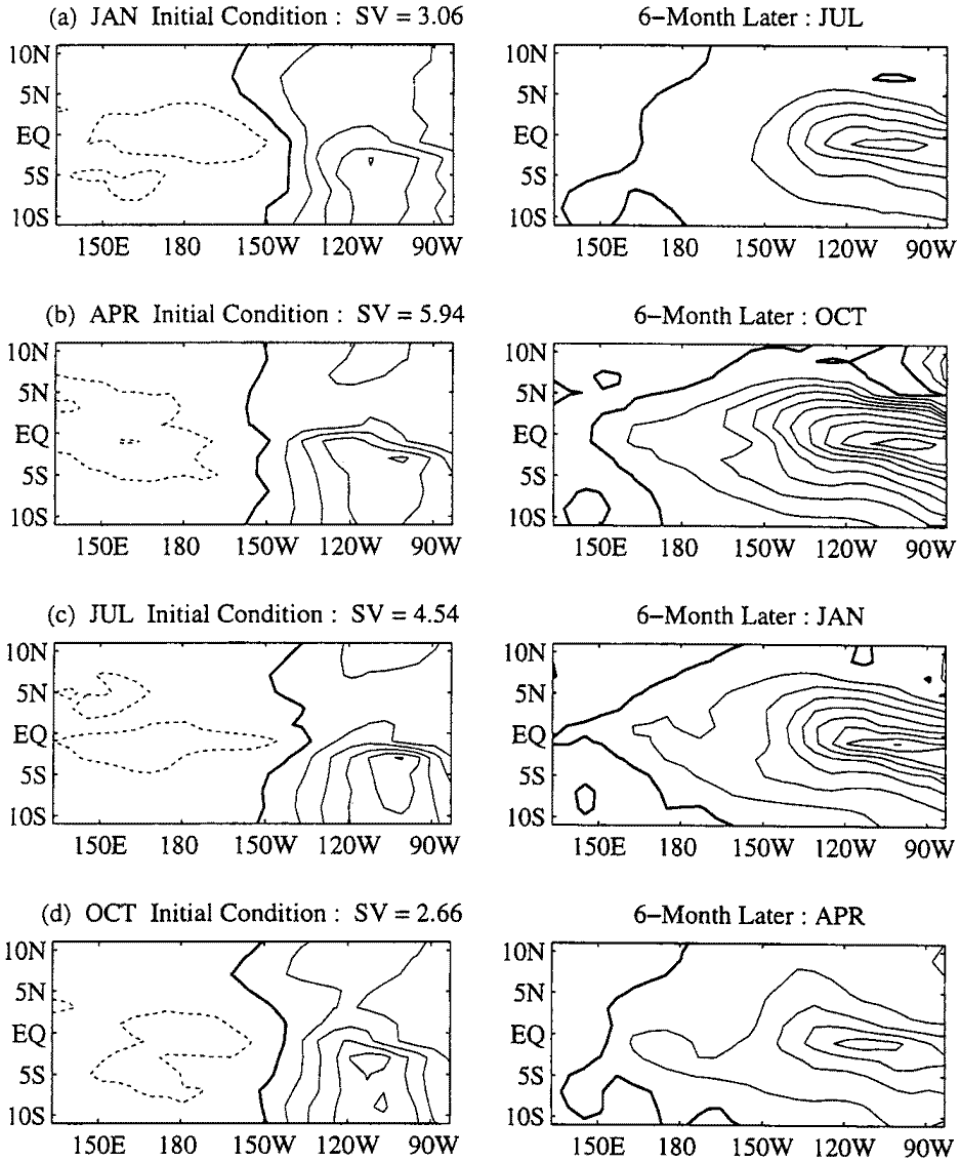
Stochastic-dynamic cellular automaton for organised convection



What fraction of available computational resource should be spent simulating the oceanic component of the MJO, in relation to the atmosphere?

How predictable is the MJO? Perfect predictability experiments from GCMs suggest ~ 15 days, but MJOs in GCMs are generally weak. Is there evidence (eg from empirical statistical models) that 30-day prediction of the MJO is feasible?

How important is it to simulate well the MJO in order to predict ENSO on seasonal timescales? Eg Cane-Zebiak claim to be able to forecast big ENSO events 1-2 years ahead without simulating MJO.


(a) JAN Initial Condition : SV = 3.06
6–Month Later : JUL
(b) APR Initial Condition : SV = 5.94
6–Month Later : OCT
(c) JUL Initial Condition : SV = 4.54
6–Month Later : JAN
(d) OCT Initial Condition : SV = 2.66
6–Month Later : APR
10N
5N
EQ
5S
10S
150E
180
150W
120W
90W