Climate variability research at BMRC in support of dynamical seasonal prediction

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Plan

- Brief overview of POAMA-2 system
- Overview of climate variability research
  - MJO
  - ENSO
  - Indian Ocean
- Summary:

POAMA: **P**redictive **O**cean **A**tmosphere **M**odel for **A**ustralia

- **Global coupled model seasonal forecasting system**
- **BMRC/CSIRO joint project**
- **POAMA-1 operational in October 2002**
- **Products submitted to APCC**
- **POAMA-2 operational mid-2006**

POAMA-1 vs POAMA-2

- POAMA-1 - forecast of El Nino SST anomalies
- POAMA-2- forecast of Indo/Pacific SST + Rainfall/temperature

	POAMA-1	POAMA-2
Atmospheric Model	BAM3 T47 17 Levels Bucket land surface	BAM 4 T63/95 60 Levels EC Land-surface New Phys: Radiation, land surface, GWD
Coupler	OASIS 3 Daily coupling	OASIS 4 Time step coupling Currents impact stress
Ocean Model	ACOM2 1.8x0.5 in equatorial strip Damped SSS	ACOM2 Re-tuned east Pacific Full SSS

POAMA-1 vs POAMA-2: Initialisation

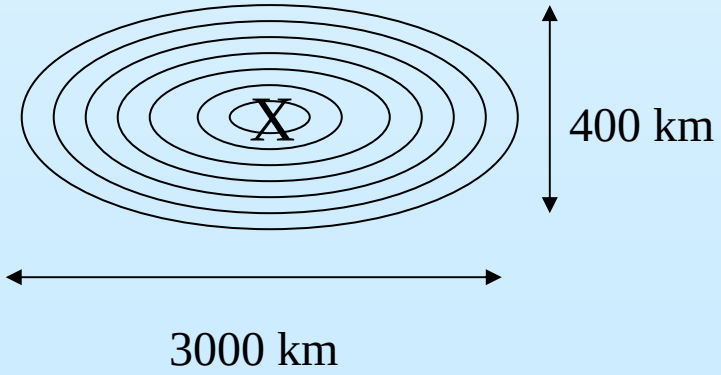
	POAMA-1	POAMA-2
Atmospheric initialisation	NWP - operationally AMIP run for hind-casts	NWP operationally ERA40 for hind-casts
Land surface initialisation	Climatology	Stand alone land-surface model forced by rainfall
Ocean assimilation	Optimum interpolation (OI) 2 dimensional Uni-variate Static covariances Geostrophic adjustment Temperature profiles	Ensemble OI 3D Multivariate (S, u, v from T) Time evolving covariances Temperature + Salinity+SST
Ensemble generation	1 per day	?? SV from assim ensemble

New ocean data assimilation system

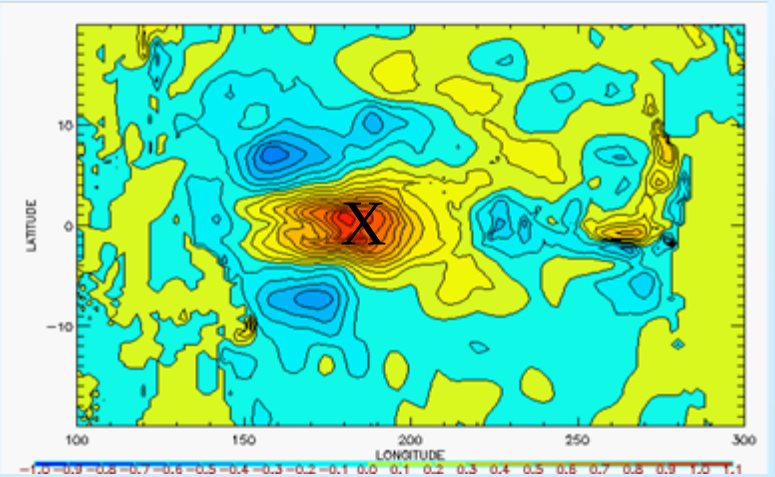
BMRC: Alves, **Yin**, Spillman, Brassington, Belyaev CSIRO: Oke, Pavel

- **Basic ensemble OI system developed in BMRC/CSIRO/Navy ocean forecasting project**
- **3-dimension multi-variate ensemble OI (T, S, u, v)**
- **POAMA implementation: covariances from perturbed forecast ensemble (Alves and Robert 2005: almost Ensemble Kalman Filter)**
- **re-analyse last ~ 25+ years + run in real-time**
- **Assimilate Temperature, salinity (e.g. Argo), SST (Buoys+ships)**

Old Gaussian horizontal covariances

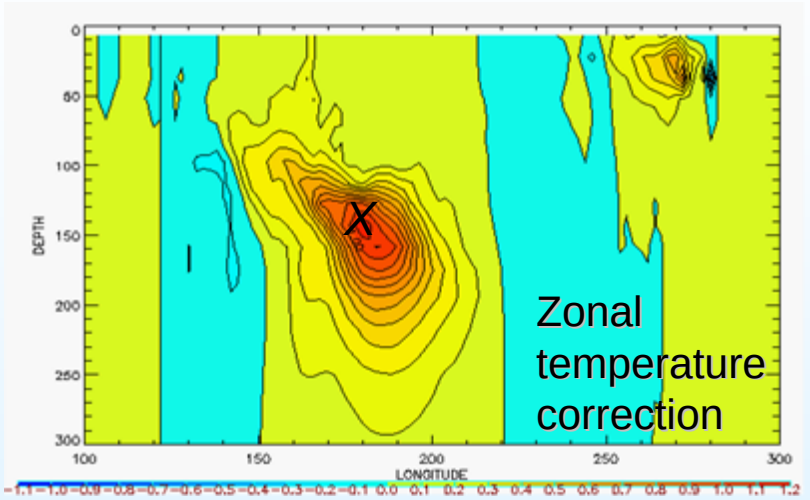


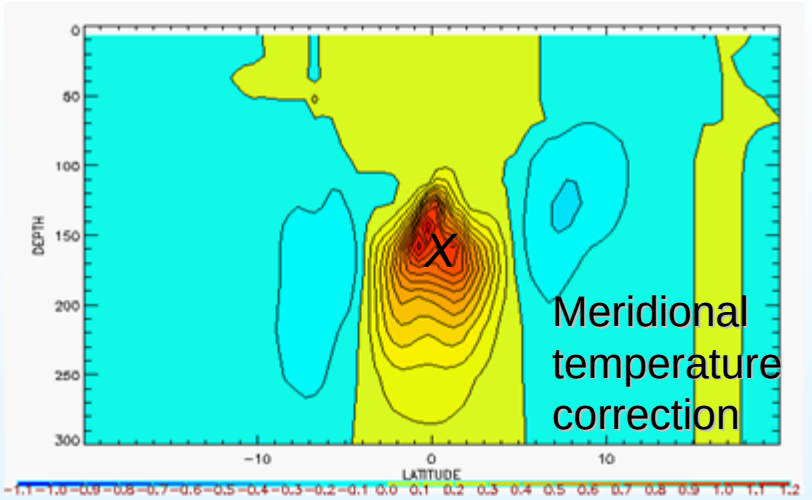
New thermocline covariances



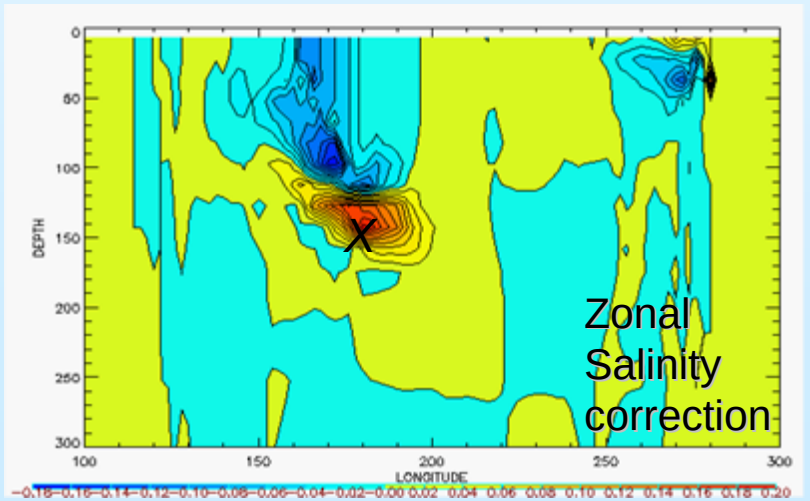
New scheme 3D and flow dependent (varies with background state)

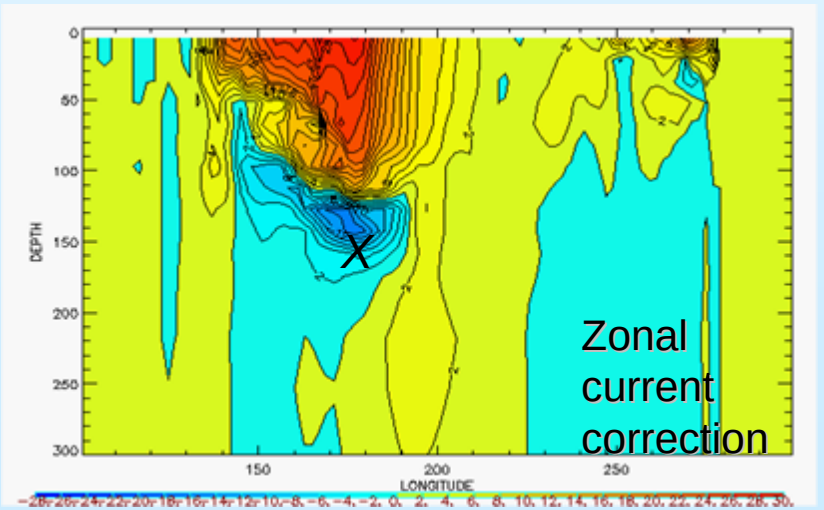
With the temperature at 180W 0N depth 160m





New scheme multi-variate





POAMA2

- **Operational version (POAMA-2.0) mid 2006 - hard deadline**
- **Some improvements may not make it in time so added later (POAMA-2.1, 2.2, etc)**
- **25 years hind-casts, 10 member per month (POAMA-2.0, 2.1, 2.2 ….)**
- **Real-time system 30-60 forecasts per month**
- **Products available on web site and raw data on openDAP/Dods server**
- **Contribute to APCC, COPES, etc**

- **Rainfall forecasts - some statistical downscaling/bridging**

Intra-seasonal variability

1. **Analysis of MJO in model simulations (Marshall, Alves)**

Intra-seasonal variability

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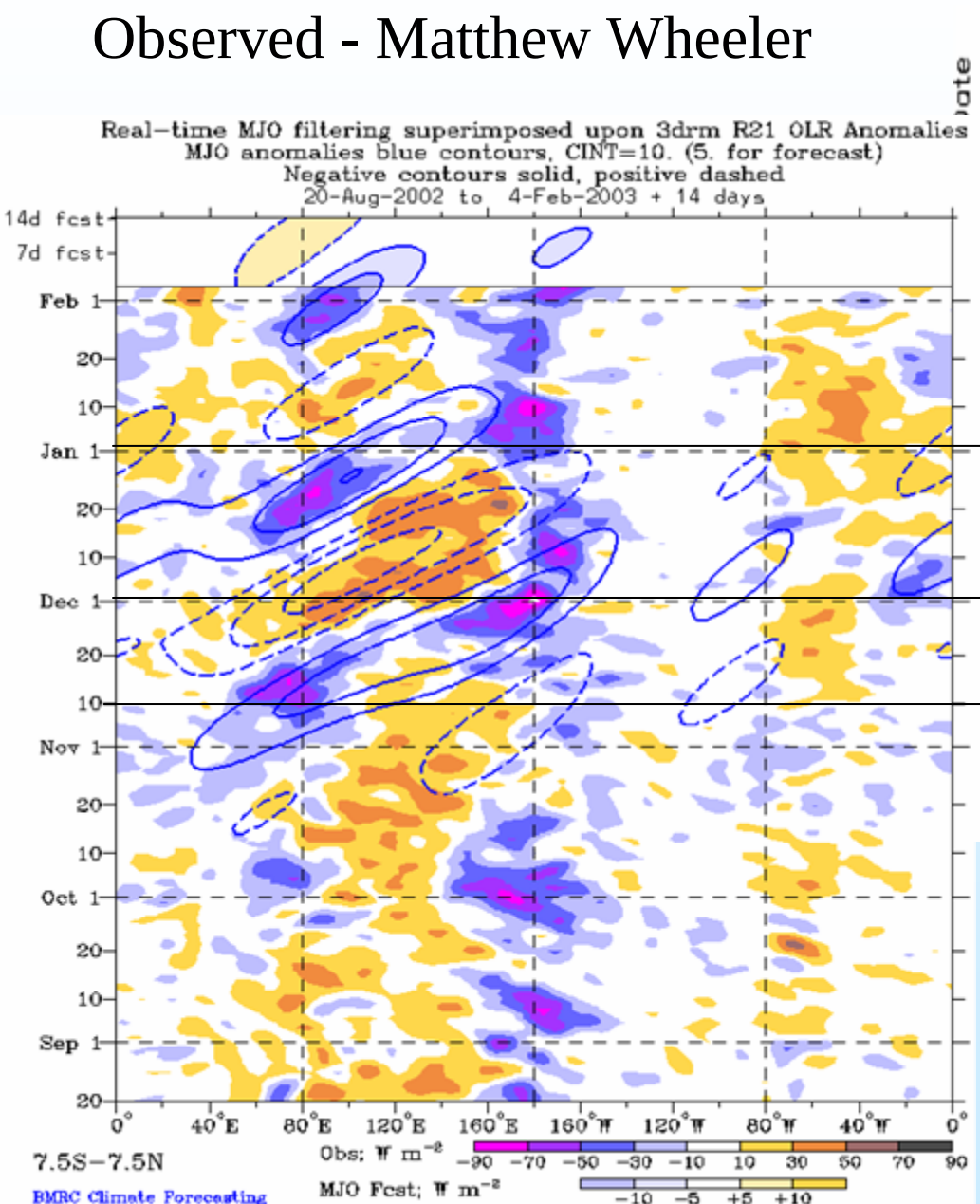
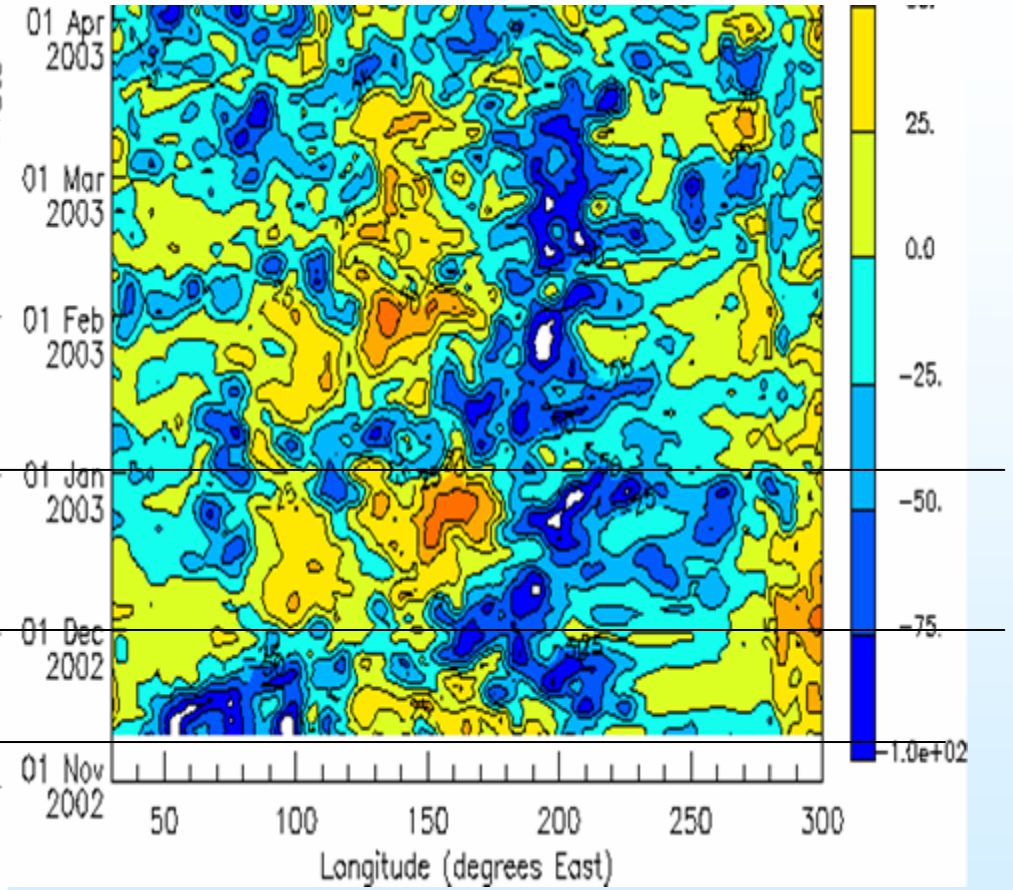
2. **Forecasts of MJO (Alves, Wang)**

Observed - Matthew Wheeler





Coupled forecast starting 10th November

Intra-seasonal variability

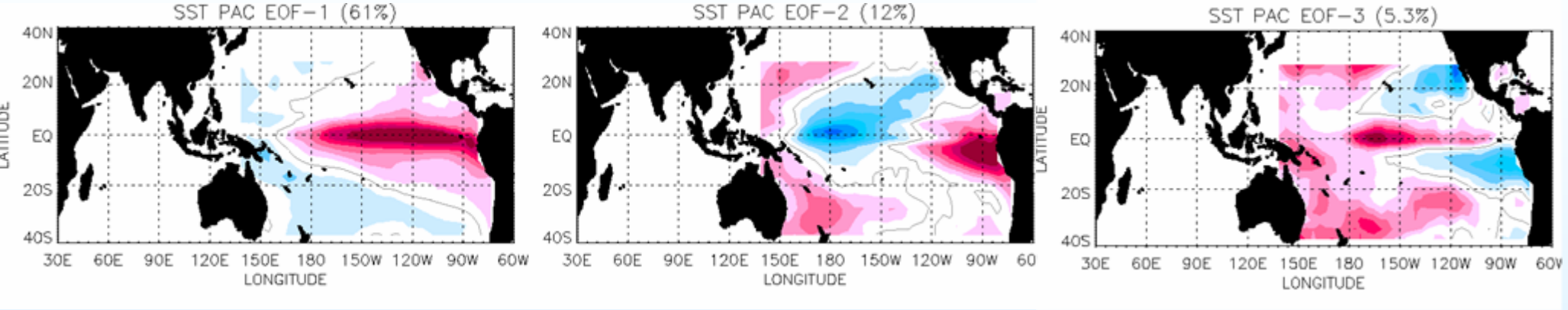
1. Analysis of MJO in model simulations (Marshall, Alves)
2. Forecasts of MJO (Alves, Wang)
3. **Impact of air/sea coupling on MJO (Marshall -PhD thesis, Alves)**

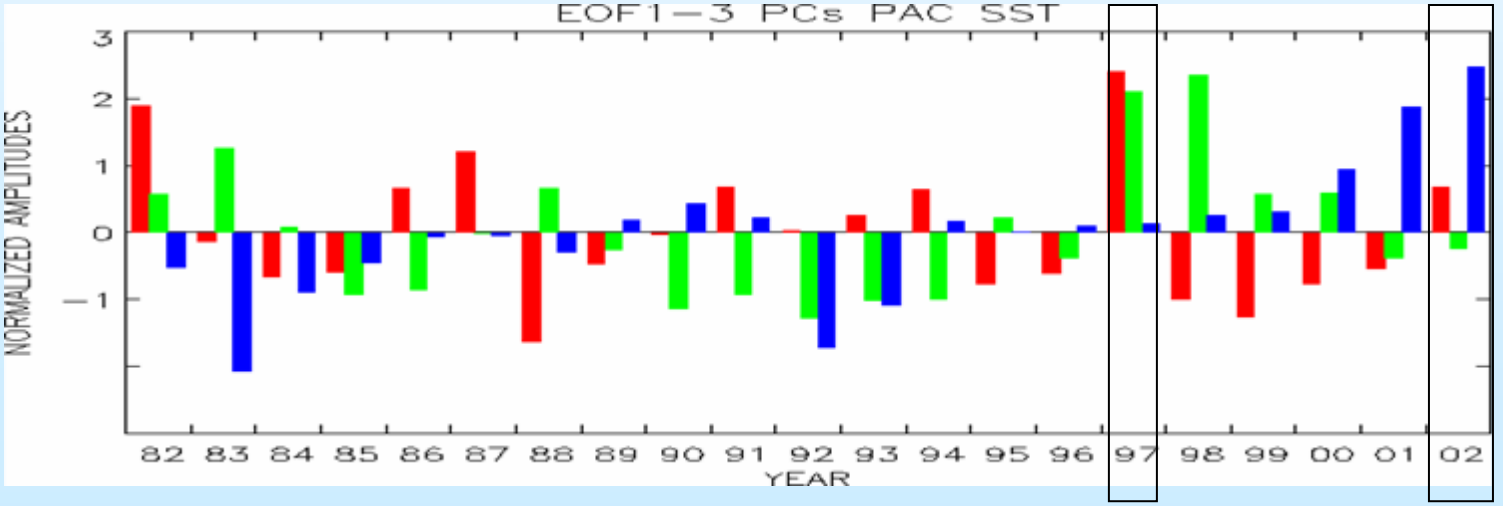
ENSO

1. **Impact of ENSO on Australian rainfall (Wang, Hendon)**

ENSO and Australian Rainfall

2002 vs 1997 El Nino (Wang and Hendon 2005)





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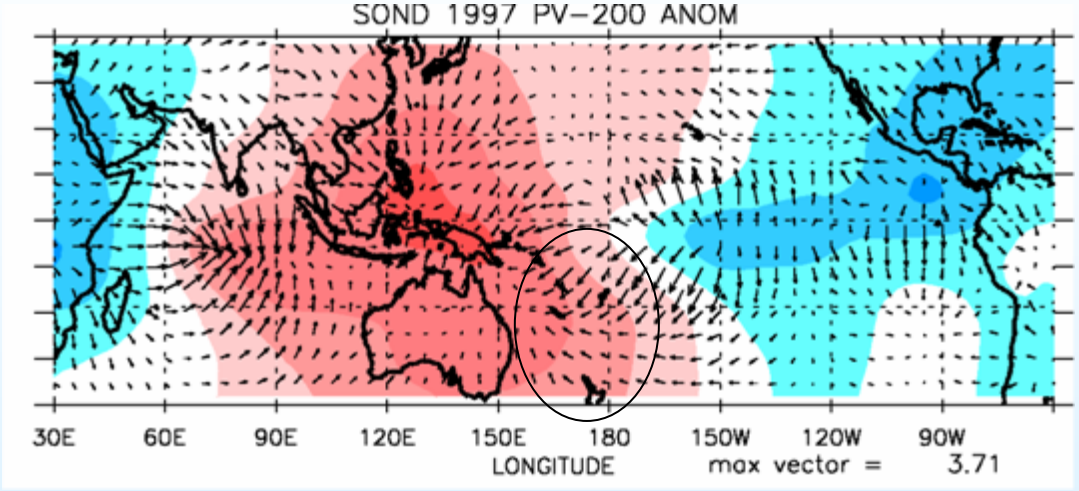
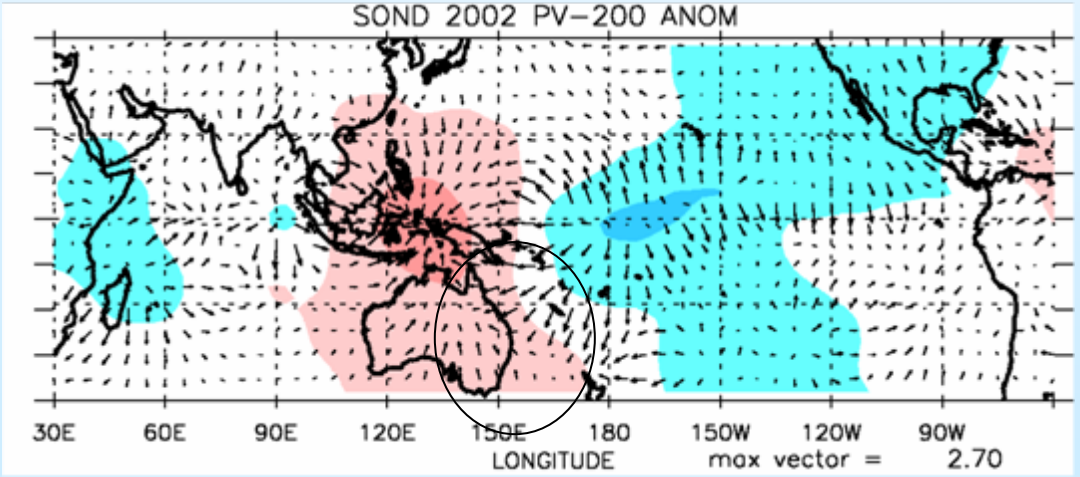
200hPa Velocity Potential and Divergent Wind Anomalies

NCEP re-analysis data





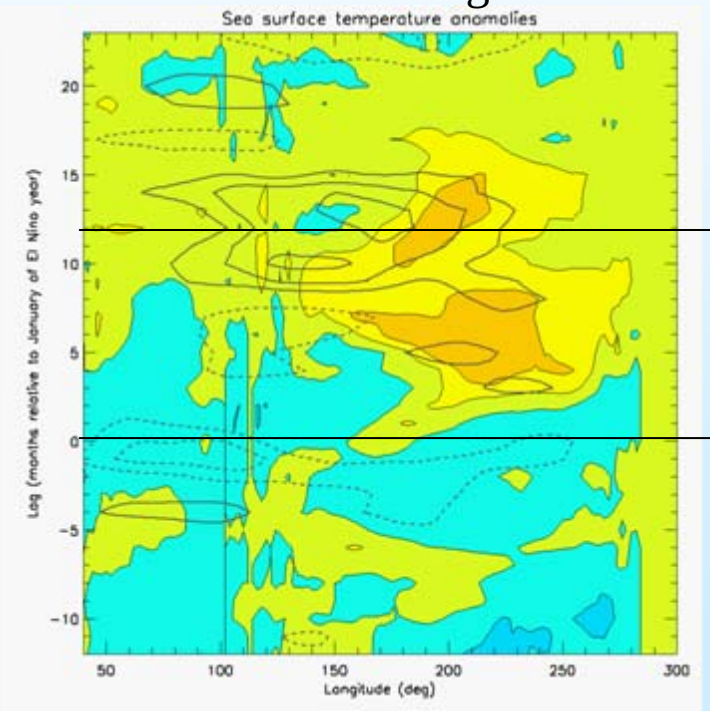
ENSO

1. Impact of ENSO on Australian rainfall (Wang, Hendon)
2. **Role of MJO in ENSO onset (Marshall, Alves, Hendon)**

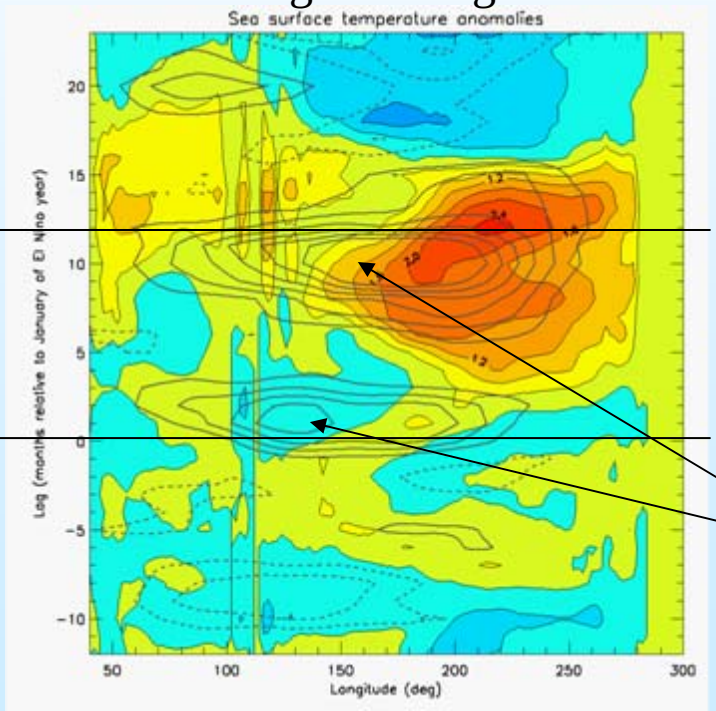
ENSO/MJO

- **150 year coupled run**
- **Pick warming periods from low heat content anomalies in January**
- **Create composites for weak warming and strong warming**
- **MJO activity - 3 month mean magnitude of eastward prop intraseasonal wind**

Weak warming



Strong warming



Jan

Jan

Enhanced MJO activity

Andrew Marshall's PhD (Paper in prep)

ENSO

1. Impact of ENSO on Australian rainfall (Wang, Hendon)
2. Role of MJO in ENSO onset (Marshall, Alves, Hendon)
3. **Impact of ENSO on MJO in coupled models (Rashid, Alves, Hendon)**

ENSO

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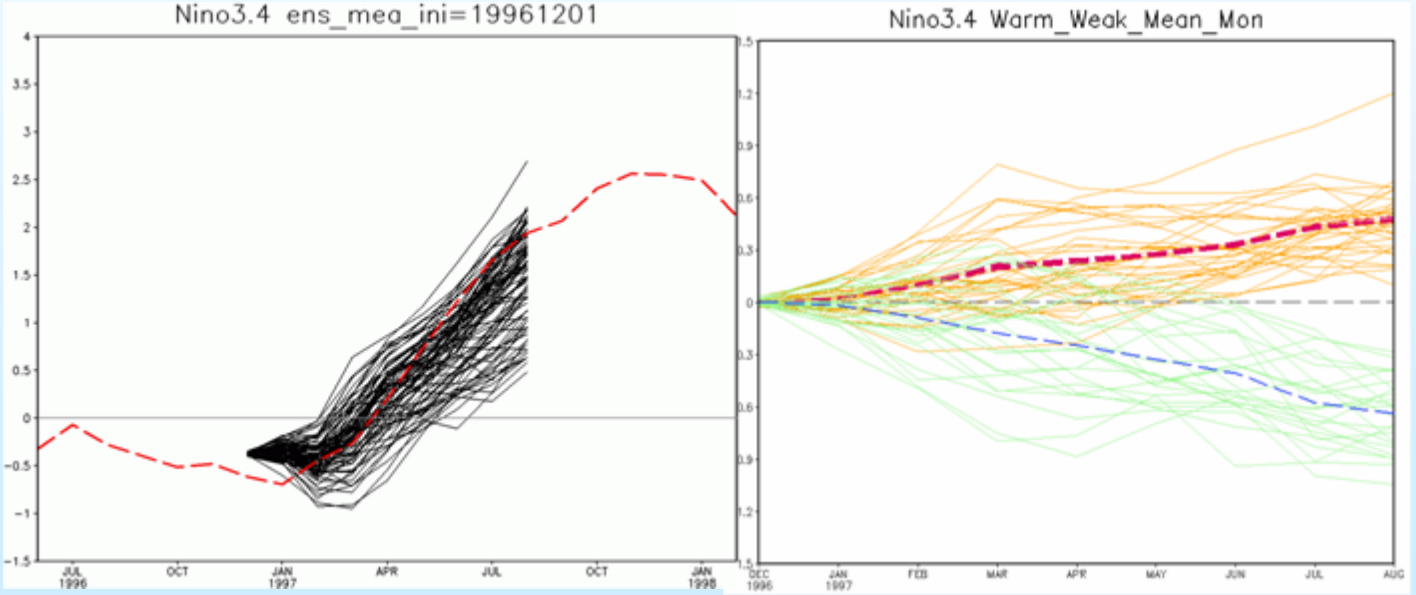
4. **Role of noise on amplitude of 1997/8 El Nino (Shi,Alves, Hendon, Wang)**

ENSO Predictability

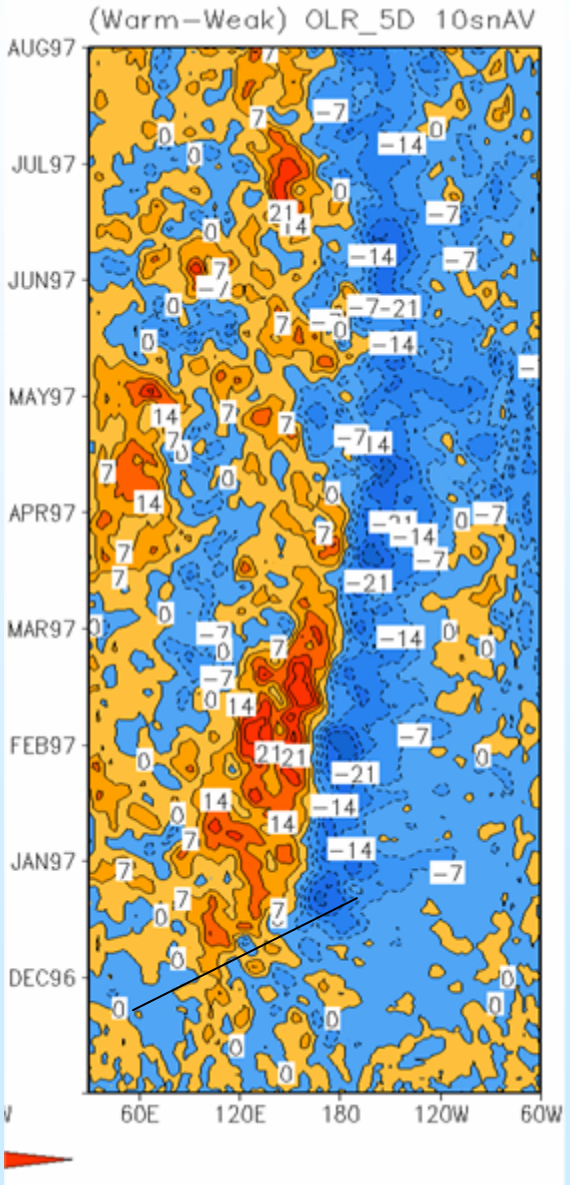
1997 El Nino case study

90 forecasts starting 1st Dec 1996

~0.001C perturbation to initial SST



OLR Strong-weak



Shi et al - details of the noise (MJO) matter

ENSO

1. Impact of ENSO on Australian rainfall (Wang, Hendon)
2. Role of MJO in ENSO onset (Marshall, Alves, Hendon)
3. Impact of ENSO on MJO in coupled models (Rashid, Alves, Hendon)
4. Role of noise on amplitude of 1997/8 El Nino (Shi,Alves, Hendon, Wang)
5. **Importance of atmospheric initial conditions for ENSO prediction (Shi, Alves)**

Indian Ocean Variability

1. **Indian ocean variability driven by ENSO (Zhong, Hendon, Alves)**

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2. **Indian ocean variability independent of ENSO (Hendon, Zhong, Alves)**

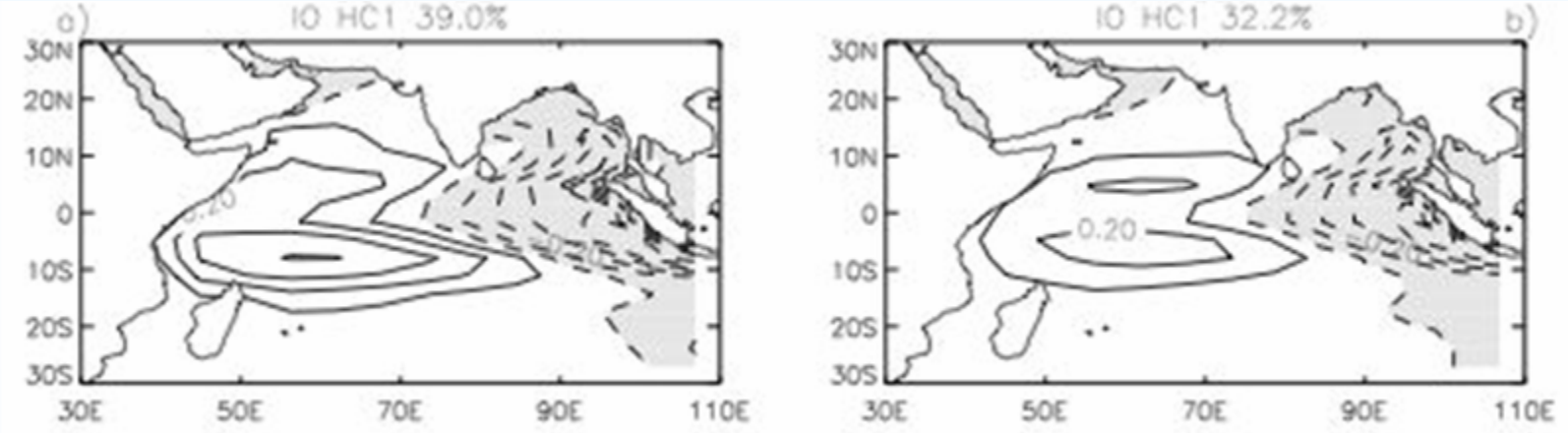
Indian Ocean Variability

- Long coupled run - IOD event mostly dependent on ENSO but not all (Zhong et al, J Clim)
- Run with ENSO suppressed (model climatological stresses in Pacific) (Hendon et al, sub J Clim)

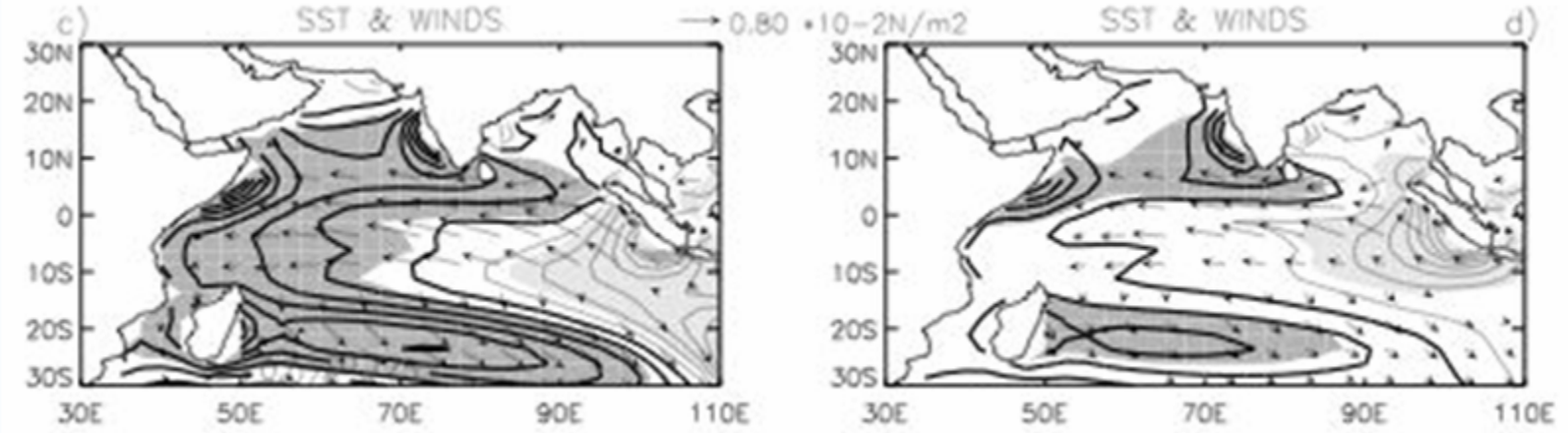
With ENSO | **Without ENSO**

EOF1 SON

Heat content



SST and wind



Indian Ocean Variability

1. Indian ocean variability driven by ENSO (Zhong, Hendon, Alves)
2. Indian ocean variability independent of ENSO (Hendon, Zhong, Alves)
3. **Skill in forecasting Indian Ocean SST (Wang, Alves)**

Summary

POAMA-2

- **Operational implementation mid 2006**
- **Aim tropical SST + regional rainfall prediction**
- **New Atmos, data assimilation, land surf init, etc**
- **25 + year ocean re-analysis + ensemble hind-casts**

Climate variability research

- **ENSO predictability (MJO/ENSO)**
- **Indian ocean variability**
- **Australian precip**

Longer term - POAMA-3

- **New national earth system model (MOM4 + new atmos model)**
- **Ensemble Kalman filter**