



# Impact of the MJO on tropical cyclones and Northern Extratropical Weather in the ECMWF forecast system

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# Hindcast Experiment

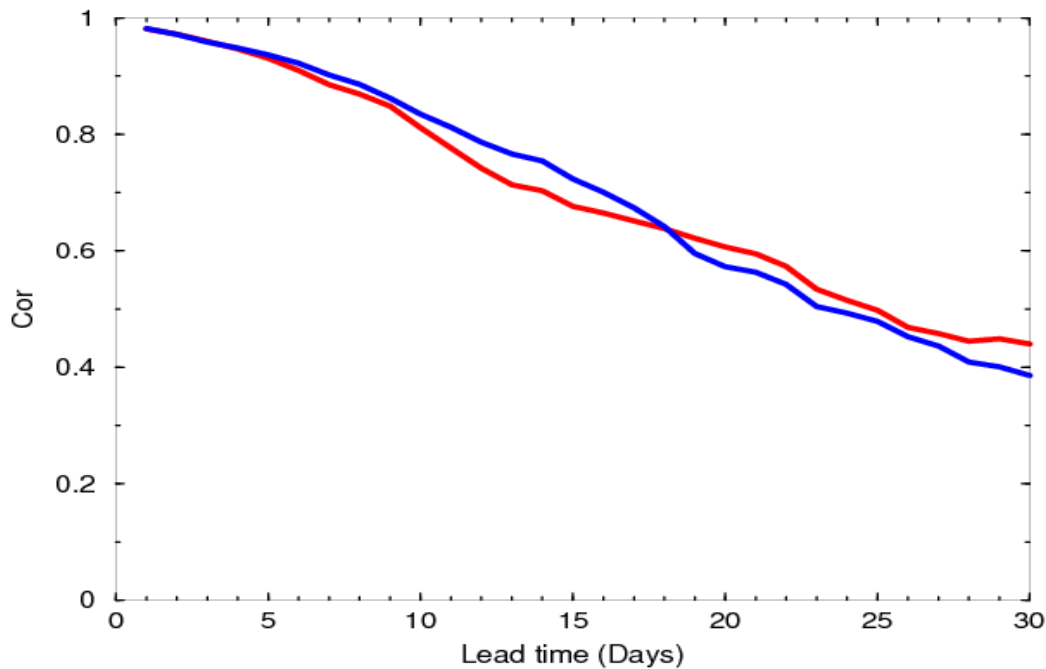
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- 15-member ensemble forecasts starting on the 15<sup>th</sup> of each month from 1989 to 2008.
- 46-day integrations
- Cycle 32R3
- T399 (50 km) uncoupled till day 10 and T255 (80km) coupled after day 10

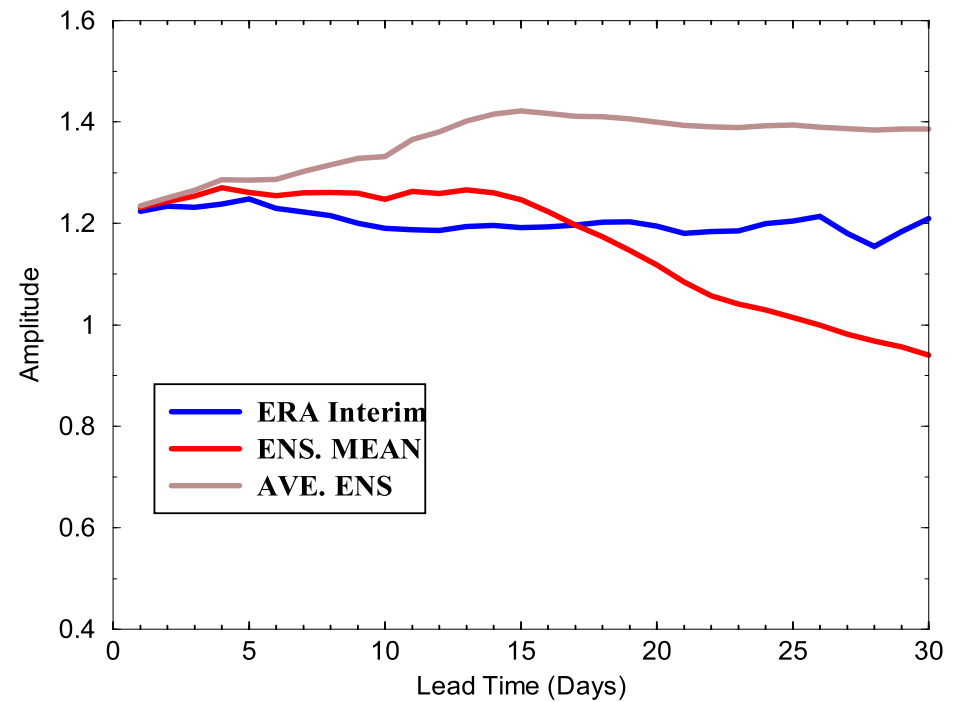


# MJO Skill and amplitude

Correlation with analysis (ERA Interim)



Amplitude

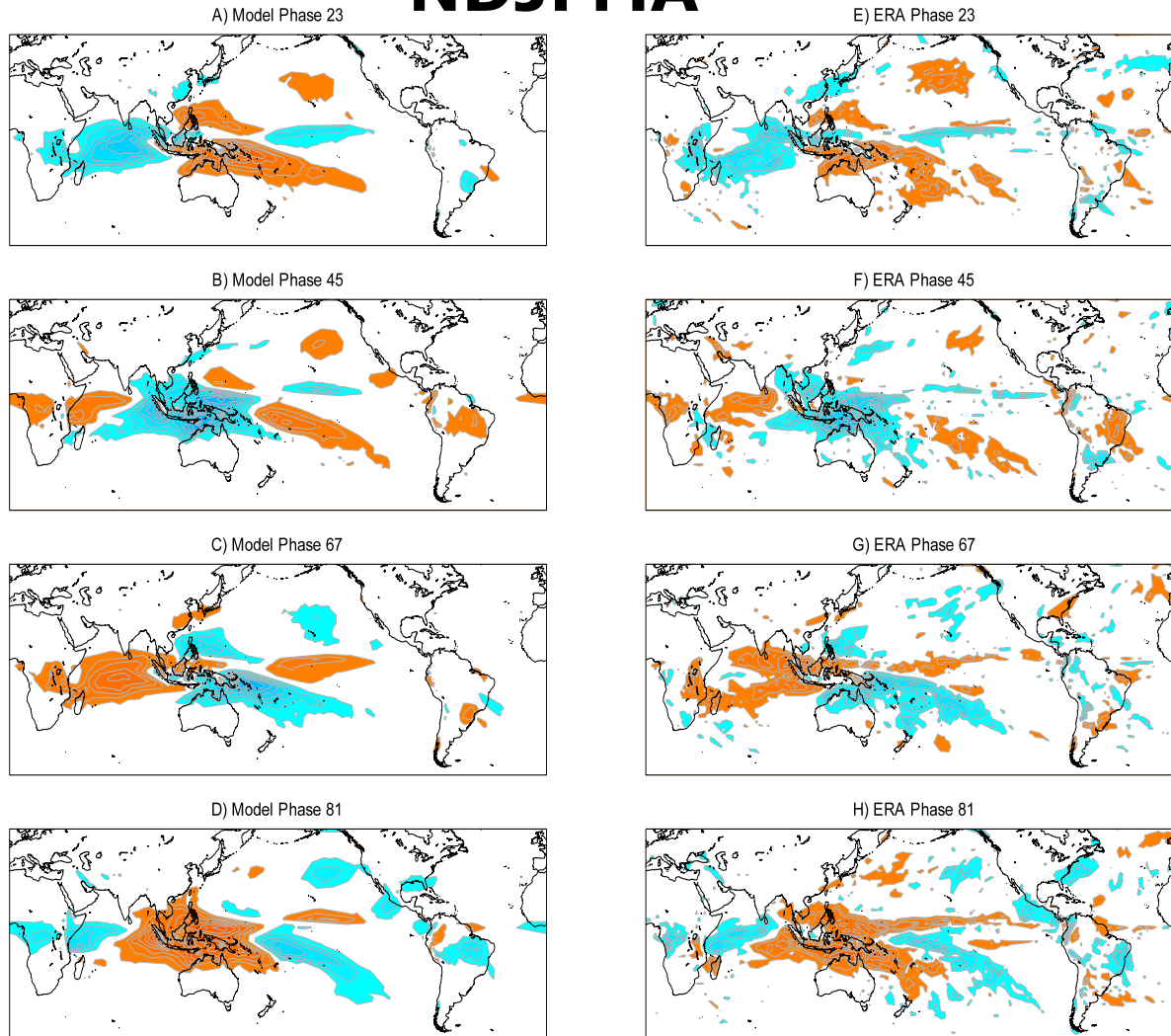


Winter All year



# Impact on precipitation

## NDJFMA

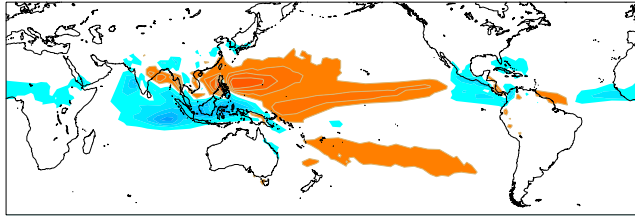




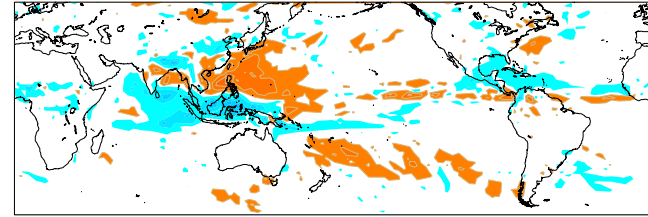
# Impact on precipitation

## JJA

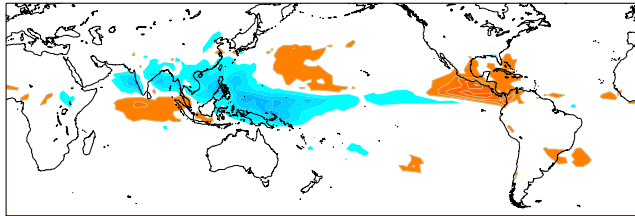
Model Phase 23



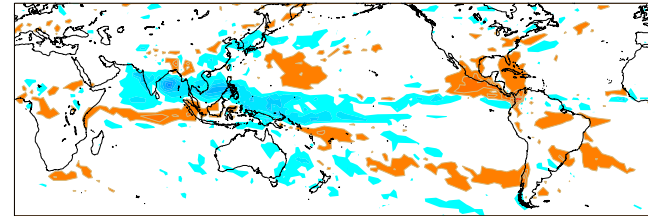
ERA Phase 23



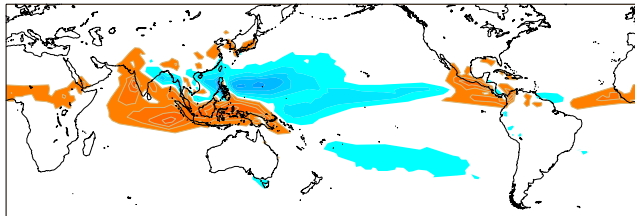
Model Phase 45



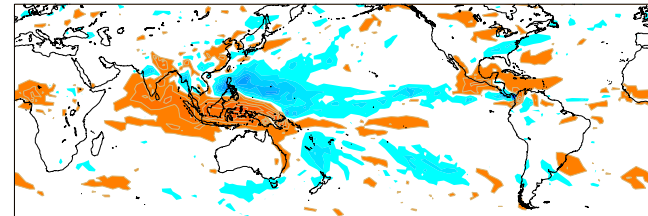
ERA Phase 45



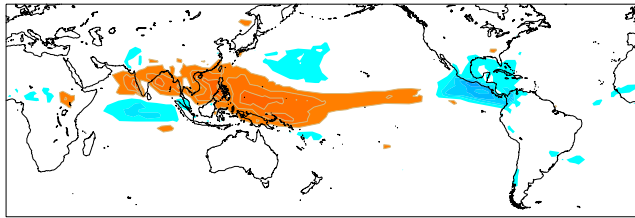
Model Phase 67



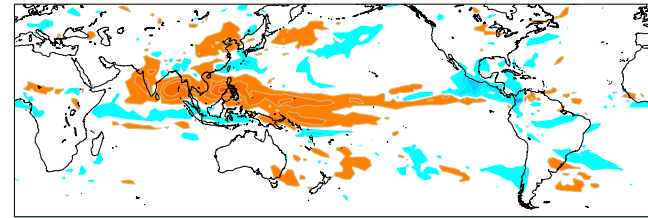
ERA Phase 67



Model Phase 81



ERA Phase 81





# Modulation of TCs by the MJO

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- **Western North Pacific:**

Nakazawa (1988); Liebmann et al (1994)

- **Eastern North Pacific:**

Molinari et al, (1997); Maloney and Hartmann (2000)

- **Gulf of Mexico:**

Maloney and Hartmann (2000); Mo (2002)

- **South Indian Ocean:**

Bessafi and Wheeler (2006); Ho et al (2006)

- **Australian region:**

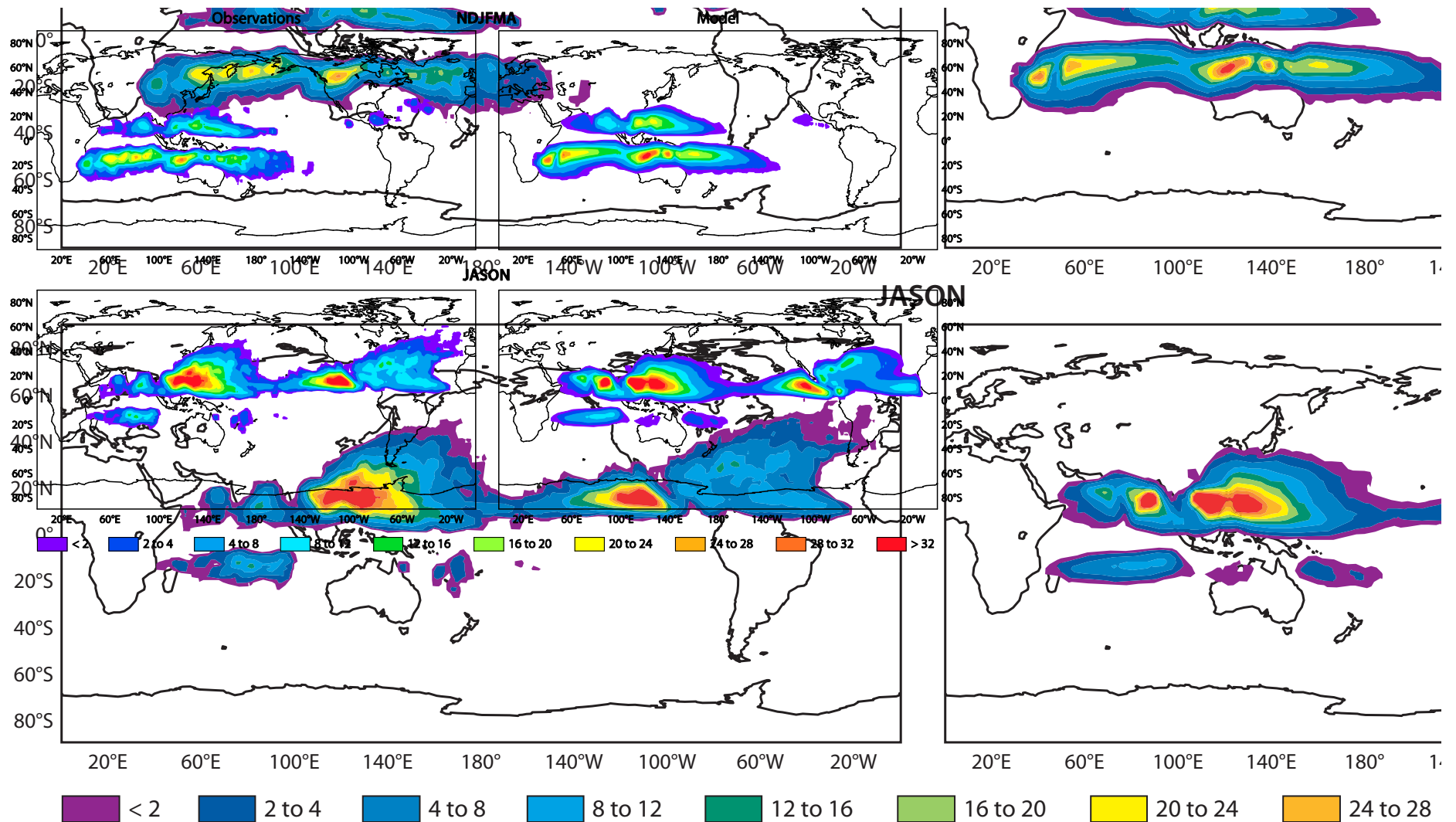
Hall et al (2001)

- Impact on tropical cyclone genesis index: Camargo et al (2009)



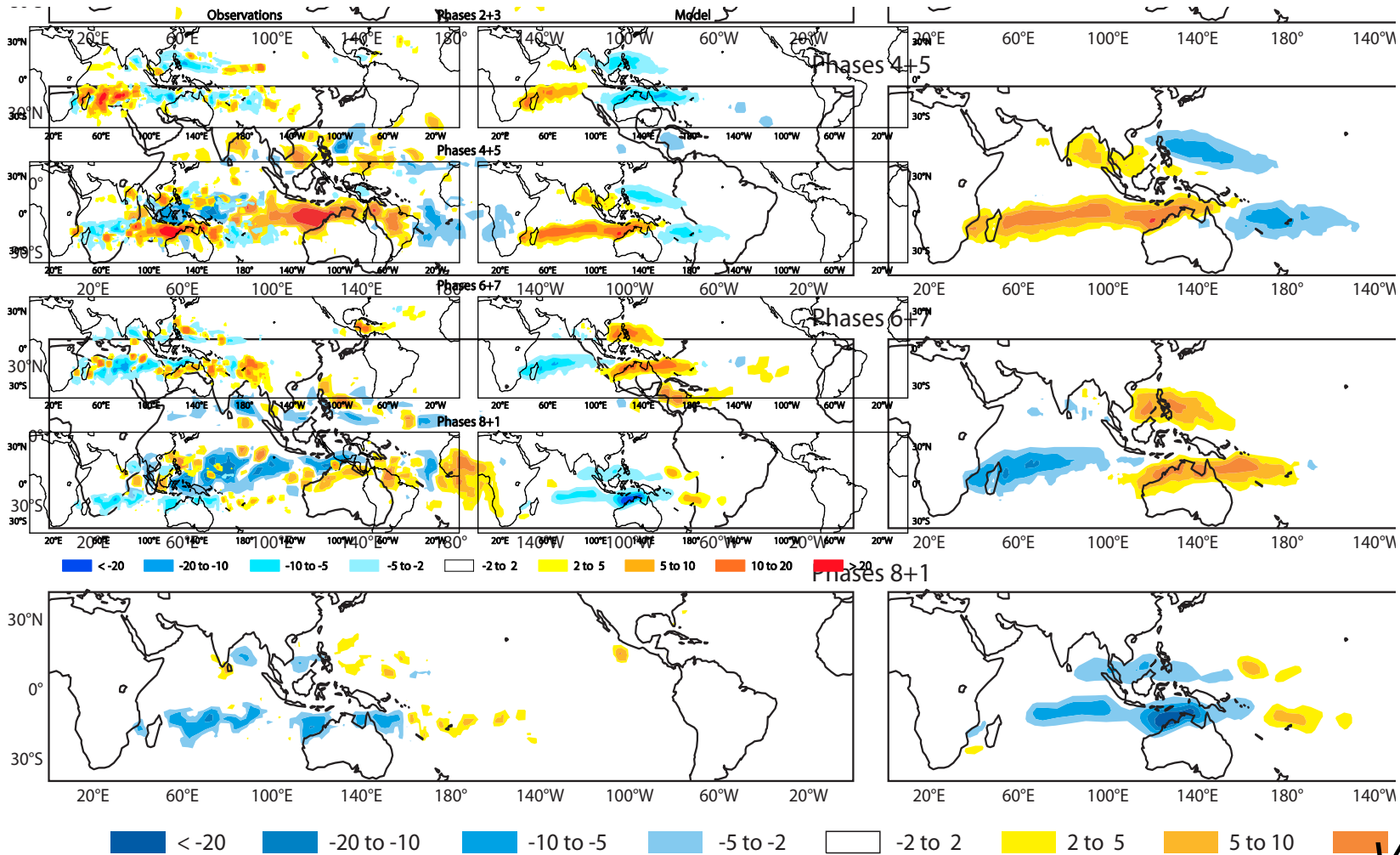
# Tropical Cyclone Density climatology

## 1989-2008



# Impact of the MJO on tropical Storm Activity

## NDJFMA



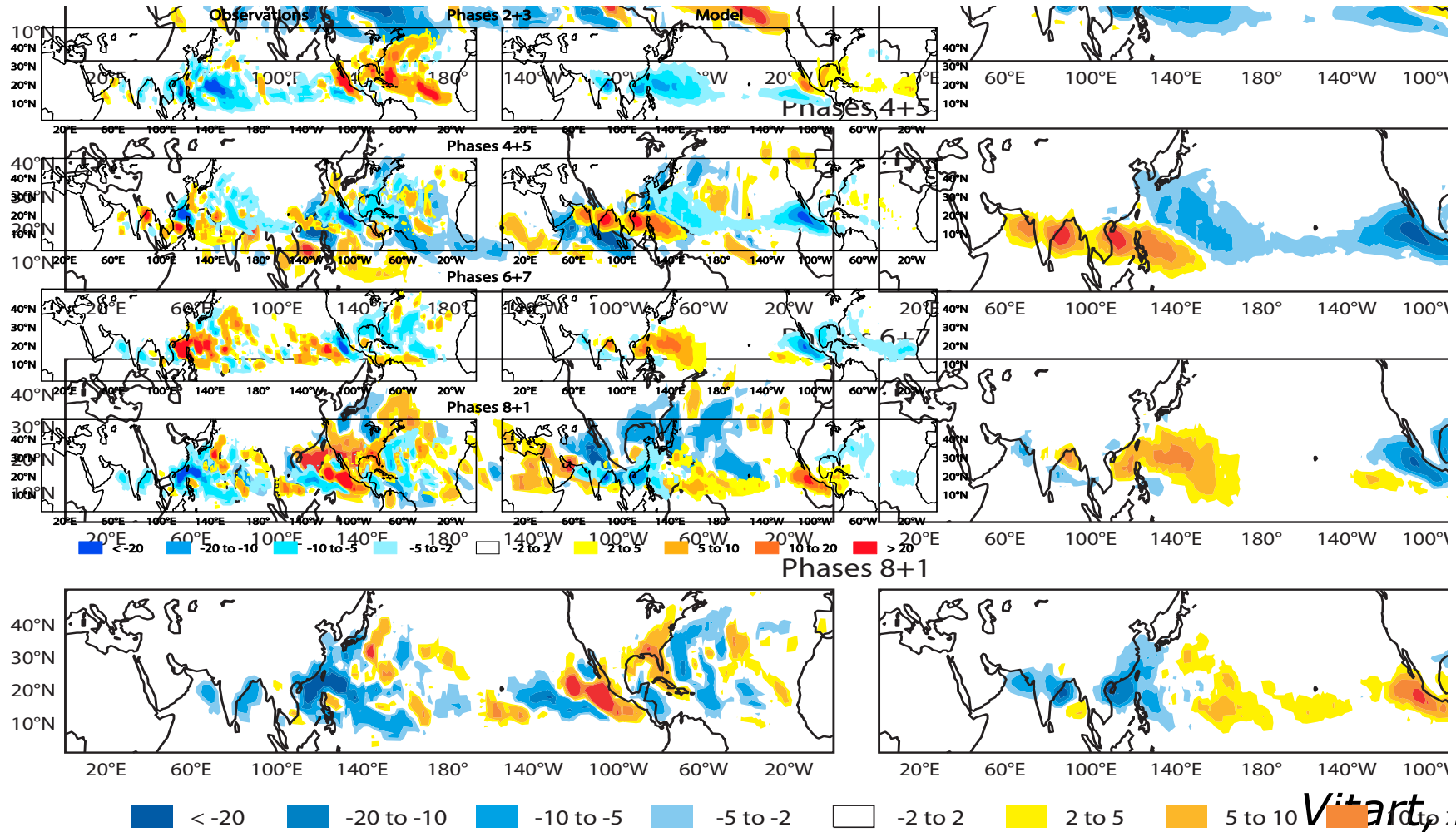
Vitart, 2009





# Impact of the MJO on tropical Storm Activity

## JJASO



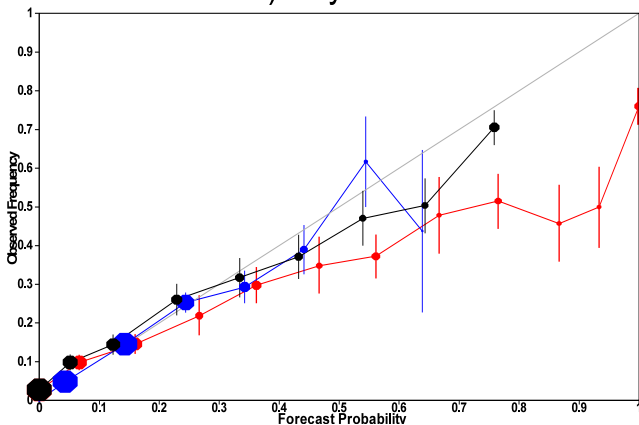
Vitart, 2009



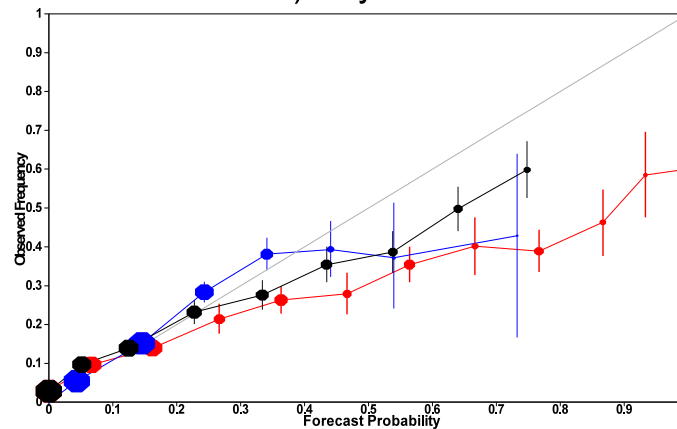
# Tropical Storm Sub-seasonal Prediction

## Verification over the Southern Hemisphere as in Leroy et al (2007)

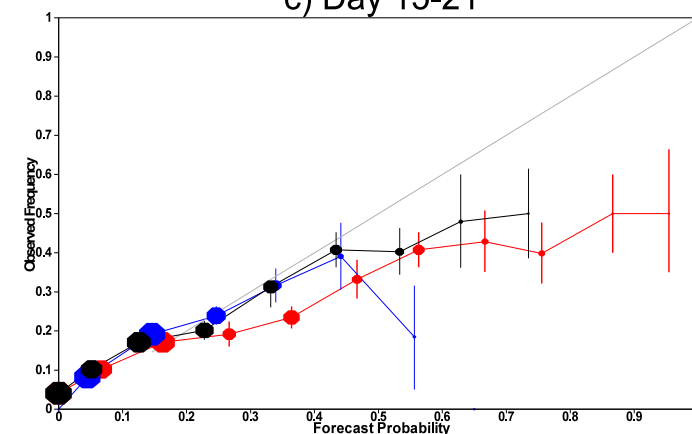
a) Day 1-7



b) Day 8-14



c) Day 15-21

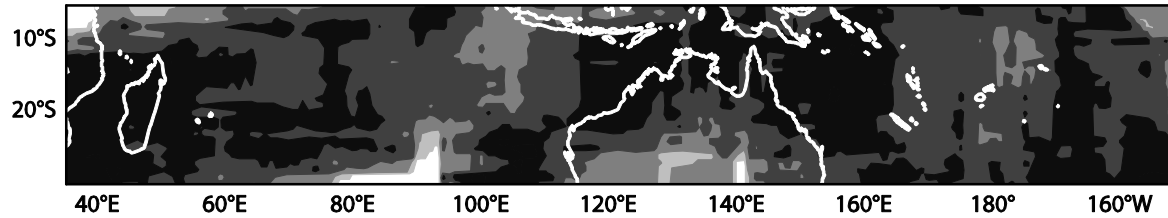


	Var Clim	Stat	ECMWF	CECMWF
Week 1	0.032	0.096	0.20	0.25
Week 2	0.057	0.096	0.025	0.13
Week 3	0.046	0.04	0.038	0.085

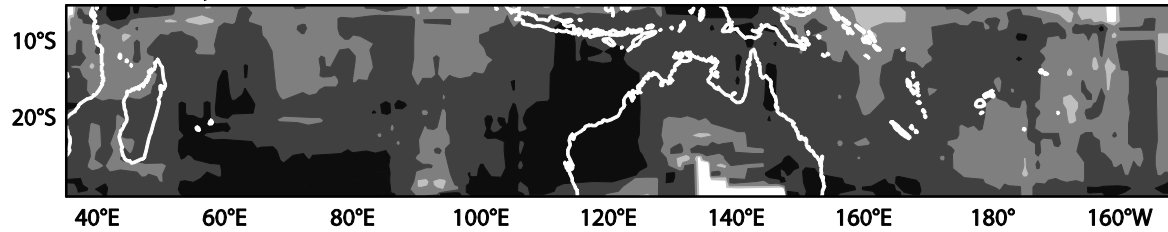


# Tropical Storm Sub-seasonal Prediction

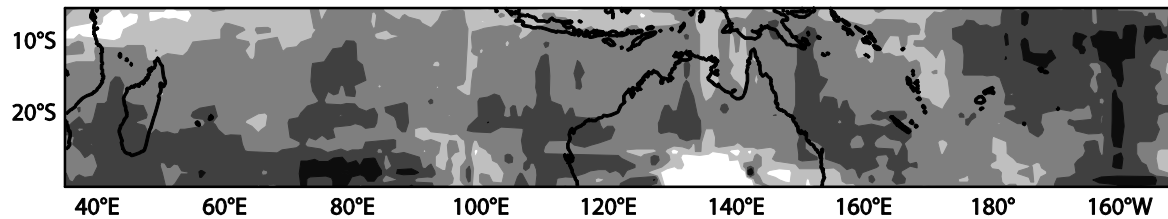
Week 1 (Day 1-7)



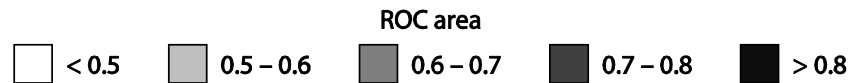
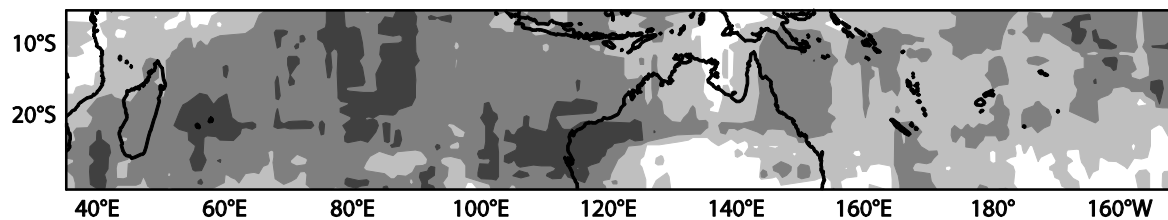
Week 2 (Day 8-14)



Week 3 (Day 15-21)



Week 4 (Day 22-28)





# Tropical Storm Sub-seasonal Prediction

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## ROC AREA over SH

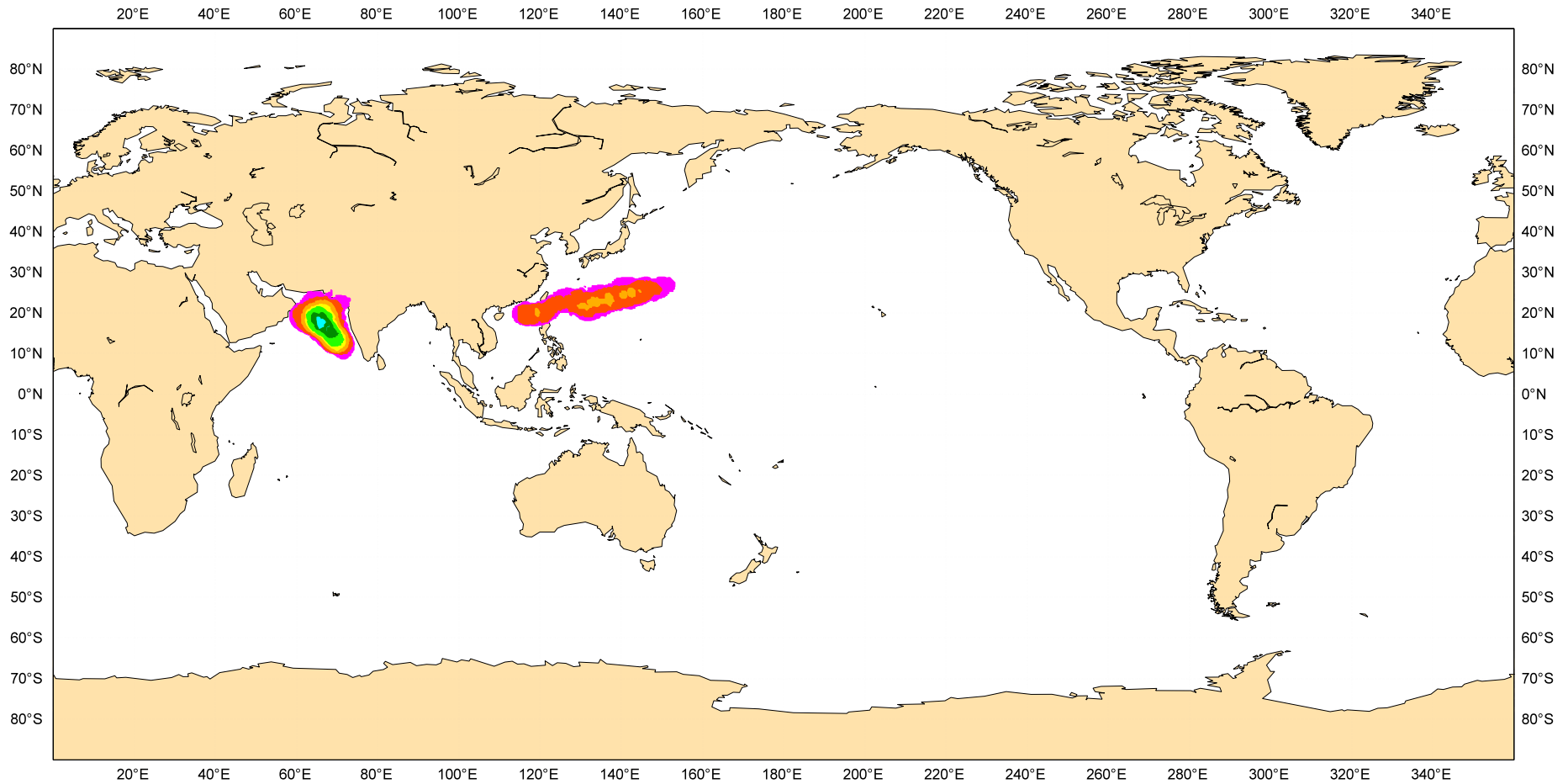
	<b>WEEK 1</b>	<b>Week 2</b>	<b>Week 3</b>
<b>Weak MJO</b>	<b>0.78</b>	<b>0.72</b>	<b>0.68</b>
<b>Strong MJO</b>	<b>0.87</b>	<b>0.79</b>	<b>0.74</b>



# Tropical storm Prediction

Weekly mean Tropical Storm Strike Probability. Date: 20100527 0 UTC t+( 96-264)  
Probability of a TS passing within 300km radius

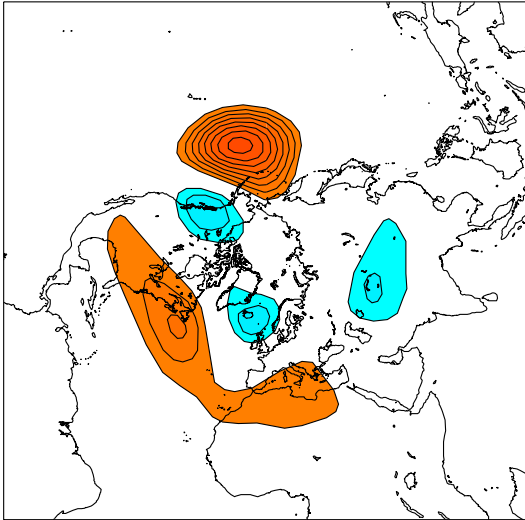
**< 10%**   **10..20**   **20..30**   **30..40**   **40..50**   **50..60**   **60..70**   **70..80**   **80..90**   **> 90%**



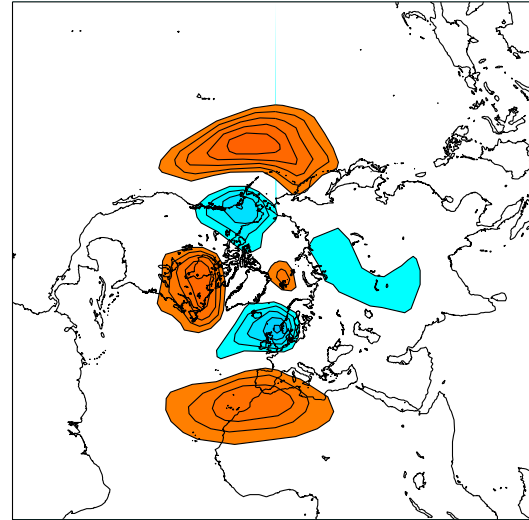


# Impact on Z500

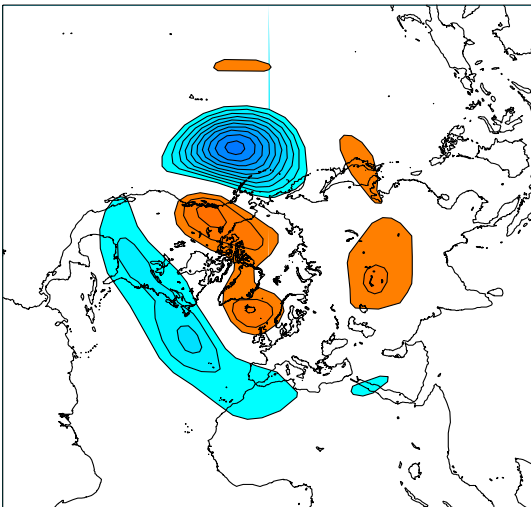
Model Phase 45



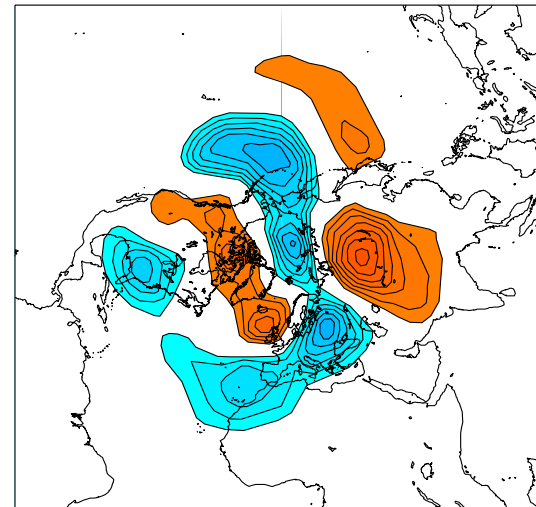
ERA Int. Phase 45



Model Phase 81



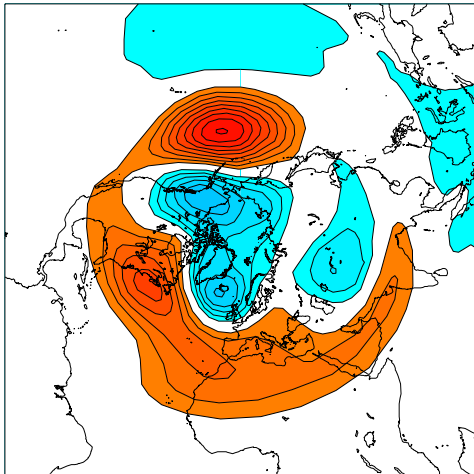
ERA Int. Phase 81



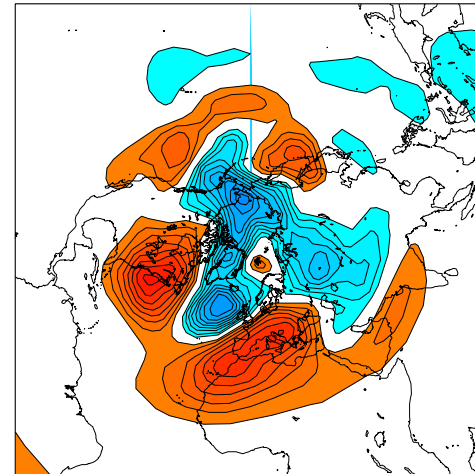


# Impact on Z500

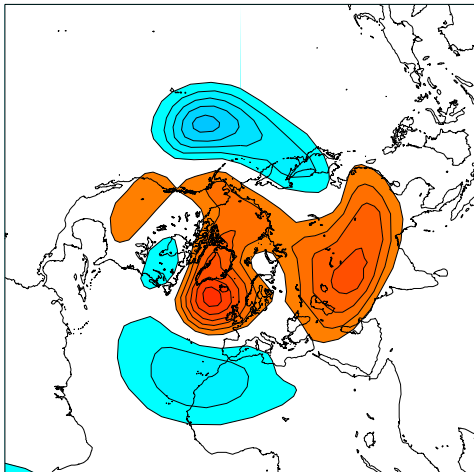
MODEL Phase 3 + 10 days



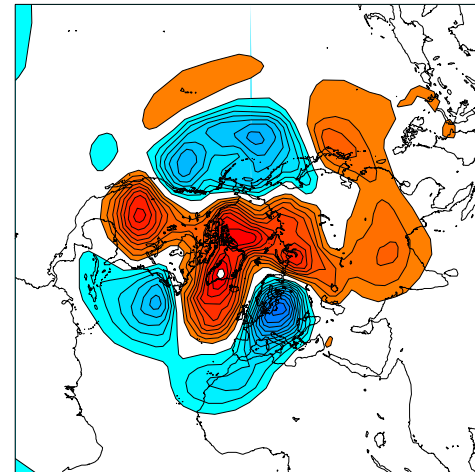
ERA Phase 3 + 10 days



MODEL Phase 6 + 10 days



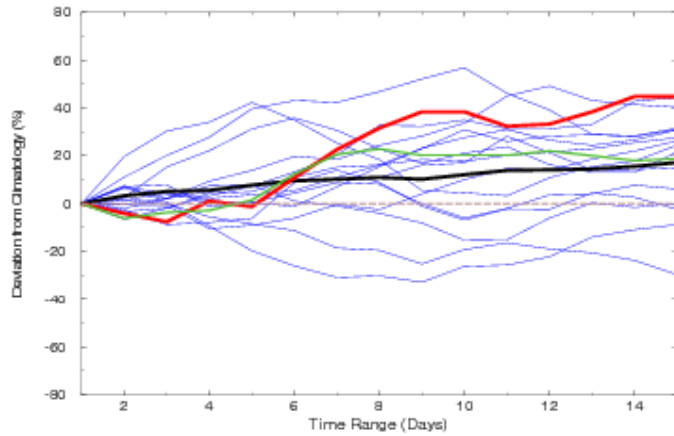
ERA Phase 6 + 10 days



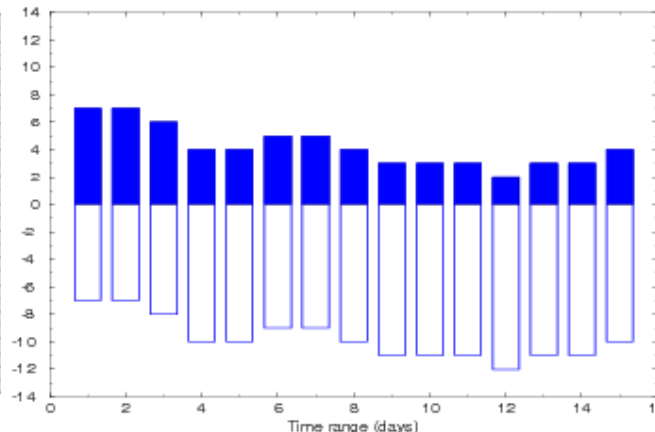
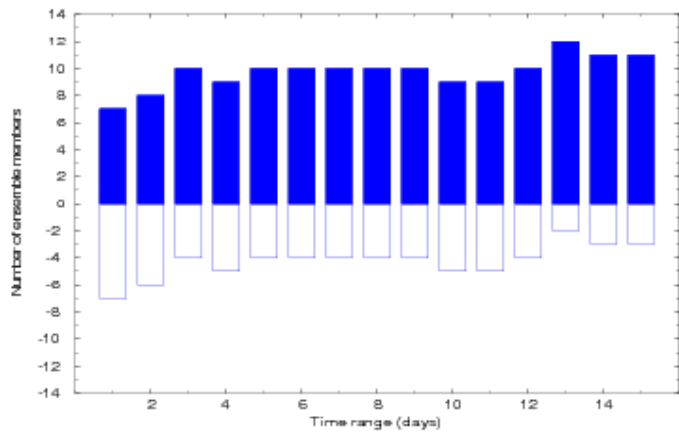
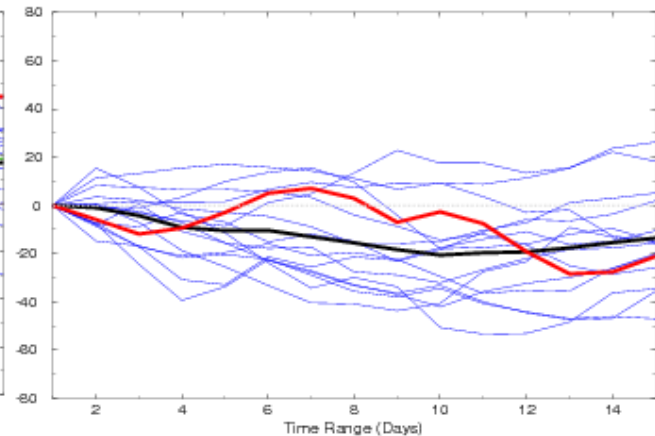


# Weather Regimes : Impact of MJO on NAO+

**PHASE 3**



**PHASE 6**

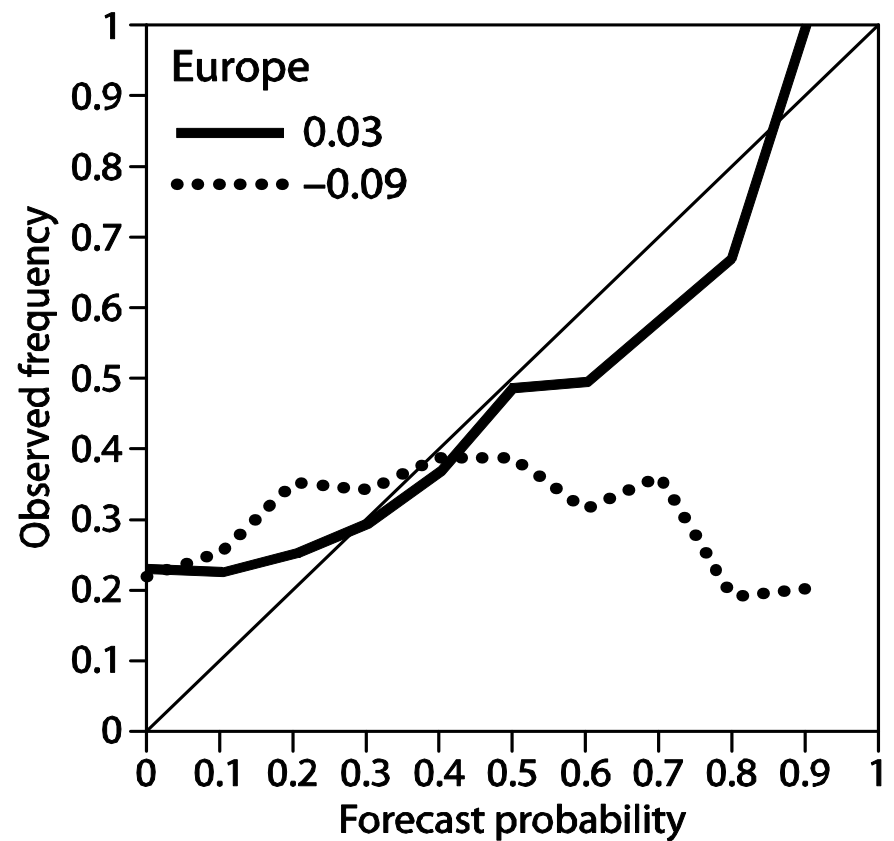
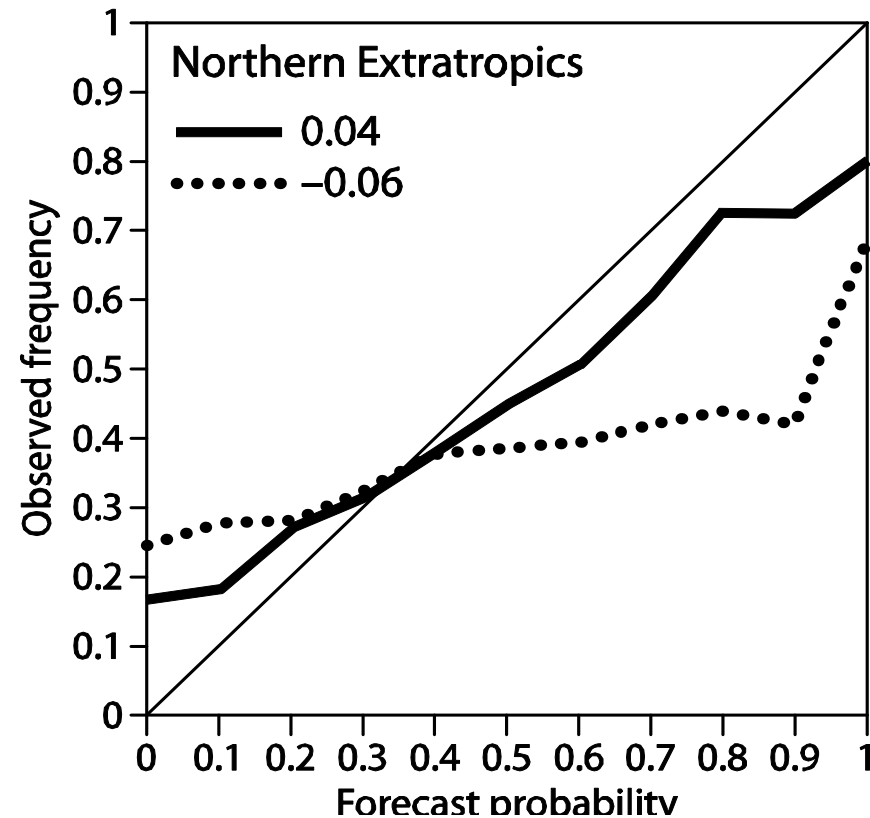






# Impact on the Extratropics- Forecast Scores

## Reliability Diagram Probability of 2-m temperature in the upper tercile Day 19-25



**MJO in IC**



**NO MJO in IC**

**Vitart and Molteni, 2010**



# Conclusion

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- 46-day EPS hindcast experiment indicates that the model has some skill to predict the evolution of the MJO up to about day 20.
- MJO Teleconnections:
  - Generally good in the Tropics
  - Realistic modulation of TCs by the MJO.
  - Impact on NAO consistent with observations

This leads to significant impact on the probabilistic skill scores in the first weeks of the ECMWF EPS forecasts.

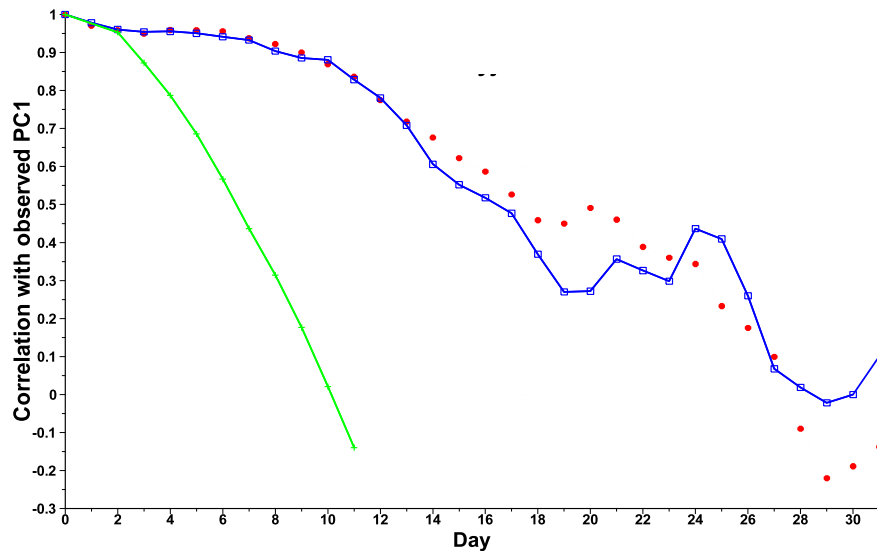
It is therefore expected that improvement in the prediction of the MJO should lead to improved monthly forecasts.



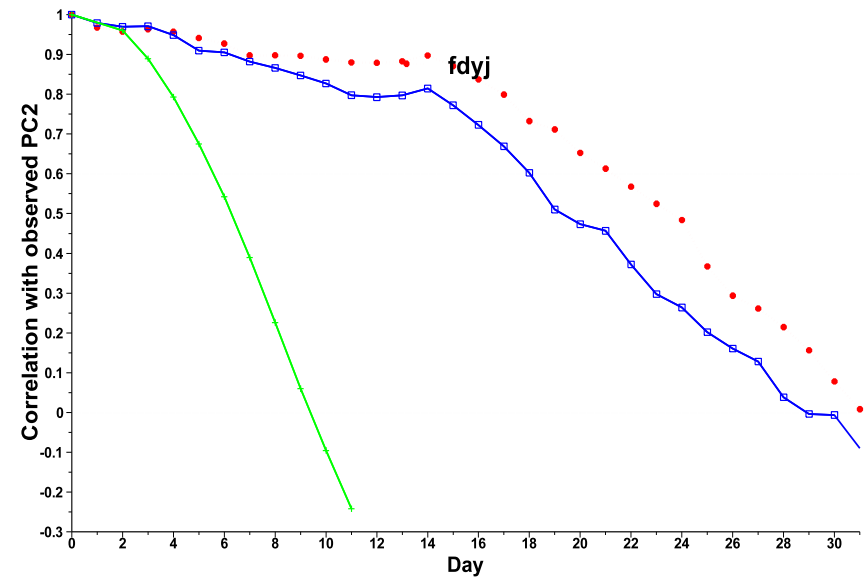
# New CYCLE 36R4

## Serial integrations 15/12/92-31/01/93

### PC1



### PC2



**Pers.**



**CY36r2**

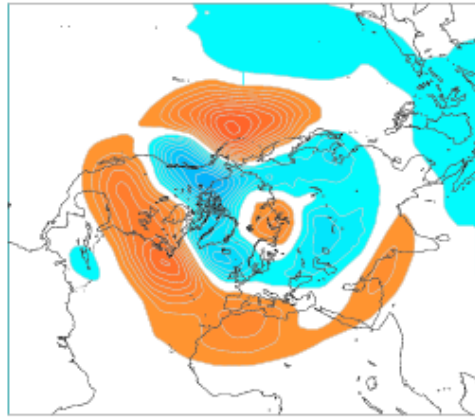


**CY36r4**

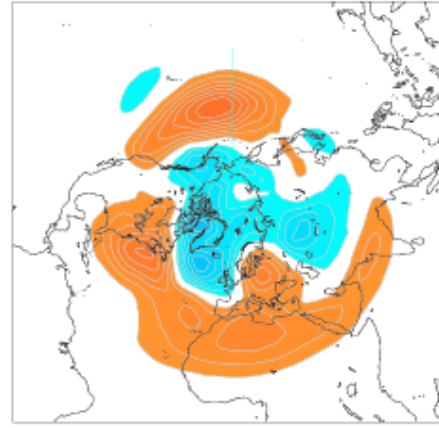


# Impact on Z500

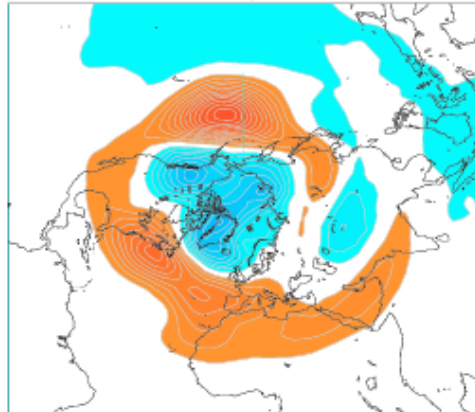
PERT 0+1



PERT 2+3



PERT 13 + 14



PERT 7+8

