# DIURNAL CYCLE OF PRECIPITATION IN WEST AFRICAN MONSOON (WAM) REGION

## PROBLEM STATEMENT

**What can we learn from the diurnal cycle for future climate model development?**

The West African climate has been recognized as one of the "hot spots" in earth climate system. Accurate representation of the WAM precipitation on diurnal time scales could notably increase our level of understanding of this system, not only in this region but also for global climate. Recently, owing to the **A**frican **M**onsoon **M**ultidisciplinary **A**nalysis (**AMMA**) **L**and surface **M**odel **I**ntercomparison **P**roject Phase **2** (**ALMIP2**), high resolution and intensive observation could be achieved as the best tool to evaluate the reliability of current climate models and to provide a key test bed for future model development.

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## RESEARCH SUMMARY

### Model and Experimental set up

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|---|---|
| **Model:** | **The NCEP Regional Spectral Model (RSM)** |
| **Period:** | **Analysis:** 2005.01.01 — 2008.12.31<br>**Spin up** : 2004.01.01 — 2004.12.31 |
| **Data:** | **RA2** for synoptic features & lateral boundary<br>**ALMIP2** (0.05˚, 30mins) precipitation products |
| **Domain:** | **Region:** West and North Africa<br>**Grid:** 271×209 (20 km), 12 layers<br>**Meso-scale:** Benin (lat: 8.95N~10.2N; lon: 1.45E~2.85E) |

### Method— Harmonic Analysis

**Diurnal** ($S_1$) and **semidiurnal** ($S_2$) harmonics of ***normalized*** precipitation are estimated as follows:

$$r(t_i) = a_0 + \sum_{k=1}^{2} c_k \cos\frac{2\pi k t_i}{24} + \sum_{k=1}^{2} s_k \sin\frac{2\pi k t_i}{24} + \varepsilon$$

$$\approx a_0 + S_1 + S_2$$

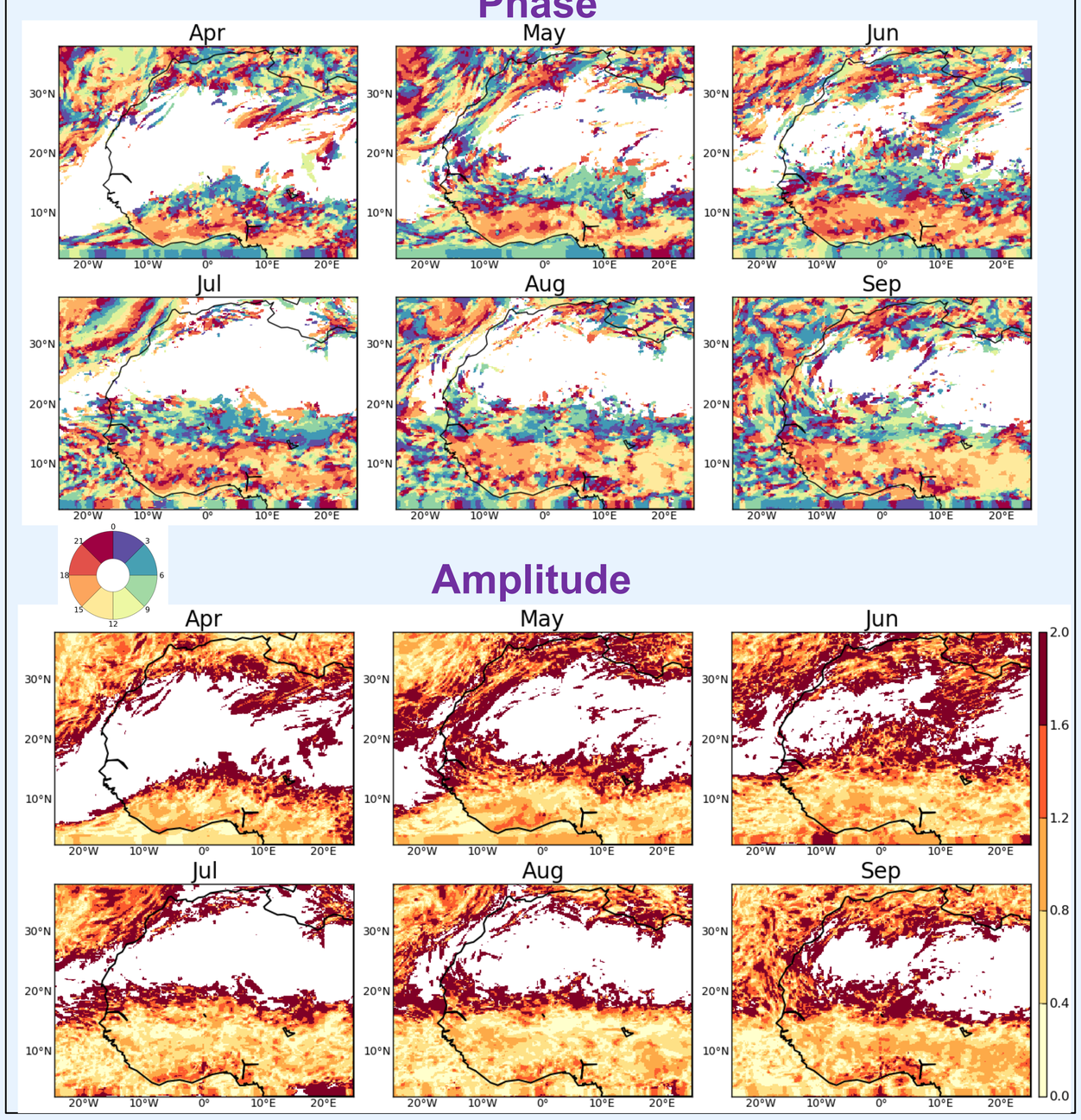
$$S_k(t_i) = A_k + \cos(kt - \phi_k)$$

$$A_k = \sqrt{c_k^2 + s_k^2} \rightarrow \textbf{Amplitude}$$

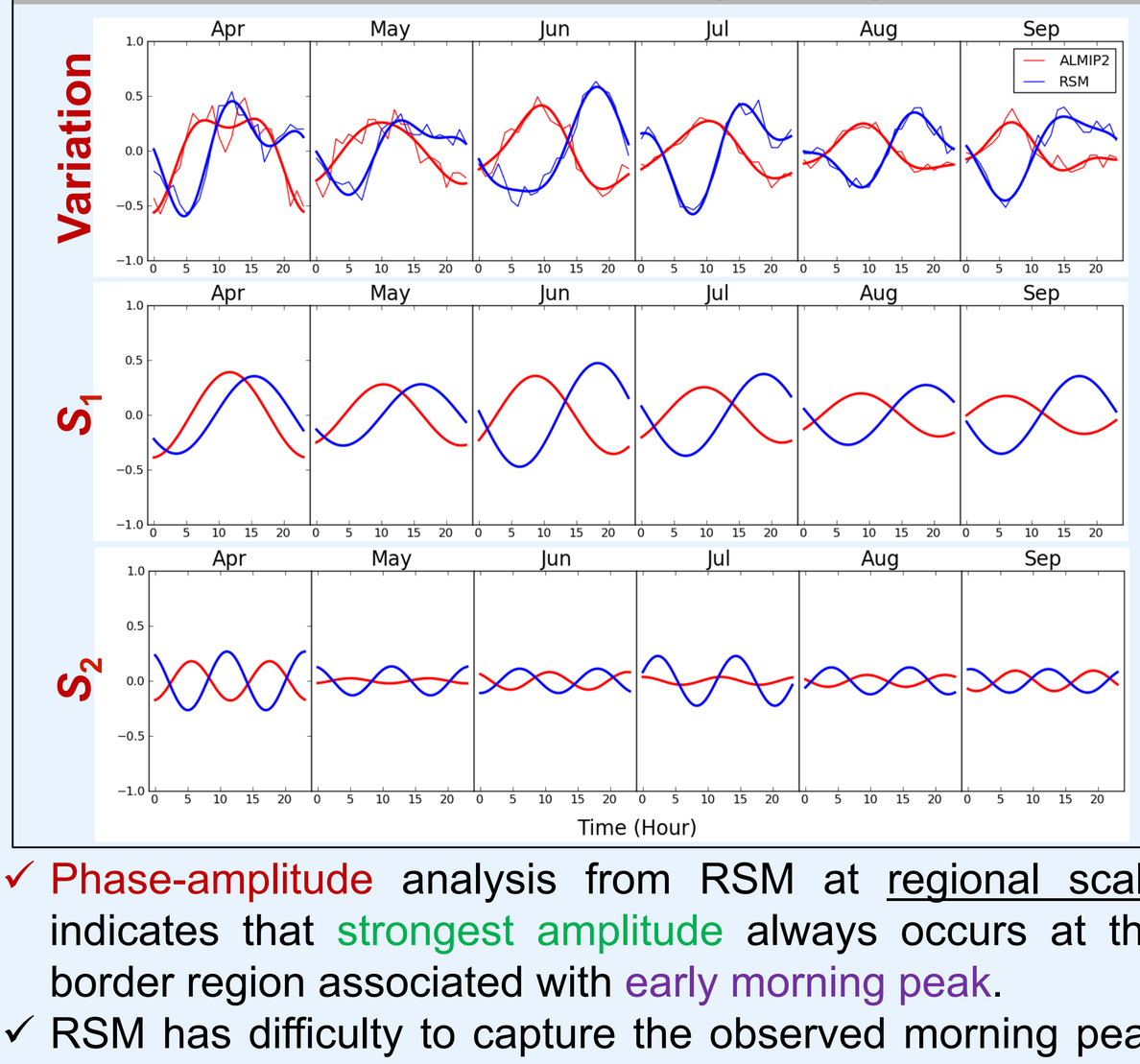
$$\phi_k = \tan^{-1}(s_k / c_k) \rightarrow \textbf{Phase}$$

### Diurnal cycle of precipitation

#### Regional characteristics




#### Meso-scale site (Benin)




- ✓ Phase-amplitude analysis from RSM at regional scale indicates that strongest amplitude always occurs at the border region associated with early morning peak.
- ✓ RSM has difficulty to capture the observed morning peak of rainfall with opposite phase at meso-scale.
- ✓ Harmonic analysis shows that model can adequately reproduce the amplitude of diurnal cycle, but semi-diurnal cycle of that appears distinct and stronger variability.

## SIGNIFICANCE OF THIS STUDY

The failure of RSM in the depiction of the diurnal cycle of precipitation in WAM points to the need of improving the model physics. Climate modeling groups should also realize that realistic simulation of the diurnal cycle is an important task in terms of weather forecasts as well as long term planning under future climate change conditions.