Subseasonal forecast of the MJO over Tropical America

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The Intraseasonal Oscillations

The dominant mode of the subseasonal scale is the **Madden-Julian Oscillation (MJO)**, which shows a seasonal dependence, with stronger signal during boreal winter, and tilted convection center during boreal summer. The latter is also called the **Boreal Summer Intraseasonal Oscillation (BSISO)**.

Several studies have shown that both modes can be divided into types, according to its propagation characteristics. The MJO split in four: **stationary, fast, slow and jumping**; while the BSISO into three types: **canonic, northward dipole and east expansion**.

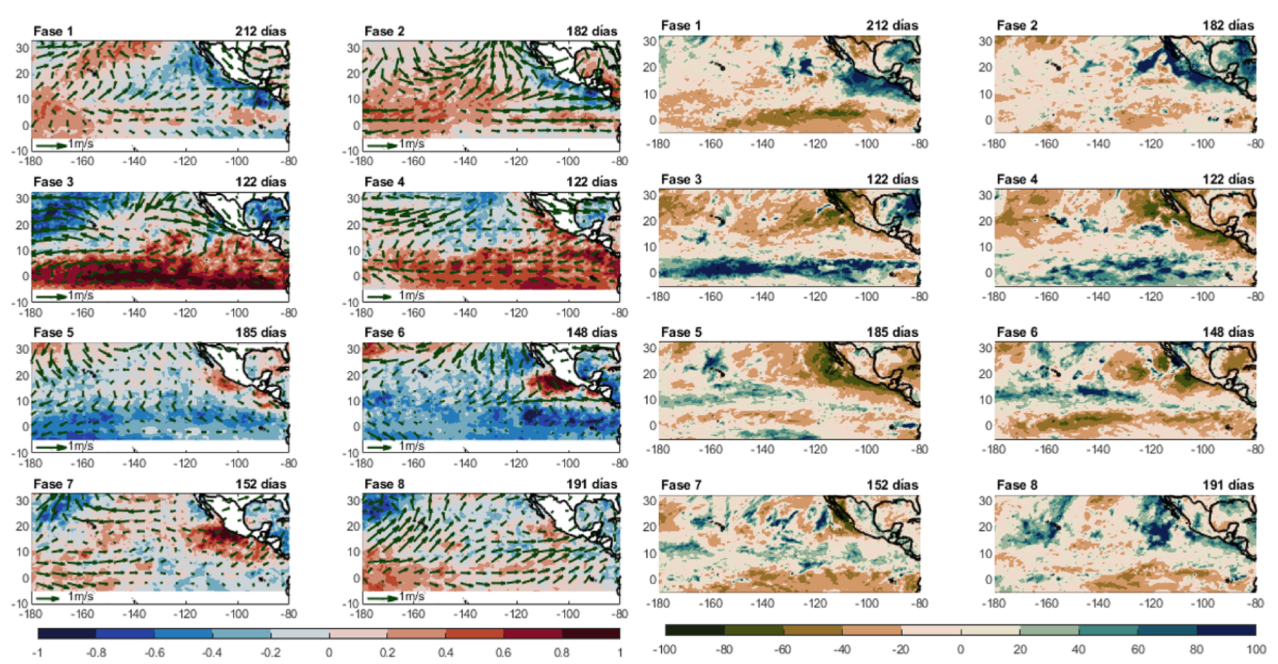

Figure 3. *Composites during MJO phases: a) Standardized anomalies of sea surface temperature and 10 m wind. b) Daily percentage precipitation anomalies (%).*

The MJO is capable of inducing modulation of precipitation and ocean dynamics over Mexico. During boreal summer, the **MJO phases 3 to 7** (according to the RMM Index) reduces precipitation over the Mexican Pacific, and western Mexican coast, while enhancing sea surface temperature (SST) positive anomalies. On the other hand, the **MJO phases 8, 1 and 2** enhance precipitation, develops negative SST anomalies and westerly surface winds.

Although the **subseasonal to seasonal (S2S) database** was developed, national research in this field is relatively recent, and the ability of models to simulate the influence of the MJO and BSISO types on Mexico's climate is unknown.

This study aims to **evaluate global couple S2S model's ability** to simulate the modulations induced by the MJO and BSISO types over diverse atmospheric and oceanic variables.

Data and Methods

The ERA5 database reanalysis was used in order to locate MJO and BSISO types in the **period 1980-2018**. The procedure to define MJO and BSISO events takes into account:

MJO

20 to 70 passband filter over OLR data

↓

Box-averaged daily OLR over 10°N-10°S and 74°E-96°E.

↓

OLR values below one standard deviation for a minimum of five successive days are considered MJO events.

↓

Cluster analysis of Hovmöller plots considering zonal average 14°N-14°S and coordinates 64°E-160°E.

BSISO

20 to 70 passband filter over OLR data

↓

Box-averaged daily OLR over 10°N-10°S and 74°E-96°E.

↓

OLR values below one standard deviation plus the total mean are considered a BSISO event.

↓

Cluster analysis from pentads (average of every 5 days), over coordinates 14°S-26°N and 60°E-170°E.

The OLR minimum defined day 0, the beginning of the event, the **initial conditions.**

The S2S models ECMWF, KMA, ECCC and IAP-CAS were used, downloading each initial condition by MJO and BSISO type over the **period 2002-2017**, using OLR, wind speed and total precipitation.

The **Anomaly Correlation Coefficient (ACC)** and **Mean Square Skill Score were used (MSSS)** to measure potential skill and skill, respectively. The verification was calculated over weekly means: **week 1 (day 5-11), week 2 (day 12-17), week 3 (day 19-25), week 4 (day 25-32), week 5 (day 32-39)**

RESULTS

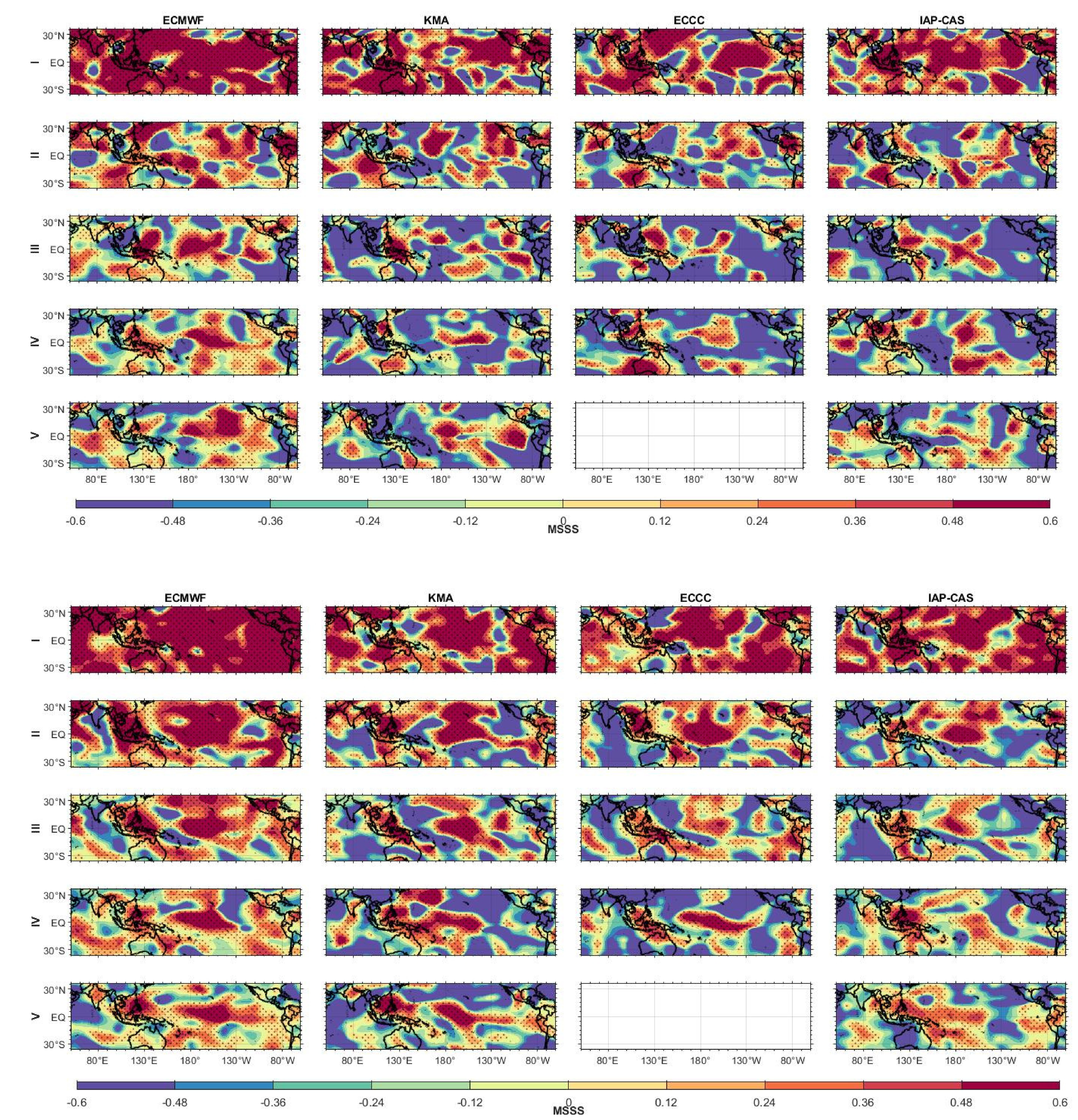

Figura 3.55. *Mean Square Skill Score of weekly OLR anomalies for S2S models, during northward dipole BSISO (above) and slow MJO (below). Dotted regions show score higher than zero, meaning the model behaviour is better than the reference forecast.*

All the models showed noticeably **skill loss after week 1**.

Northward dipole BSISO and slow MJO showed better skill over Mexico and the Mexican Pacific, compared to other MJO and BSISO types, reaching 3 and 4 weeks, respectively. Both types have **westerly 850 mb winds** over Mexico during week 1, which may help increase the continuous skill over Mexico.

ECMWF and KMA models have better skill, although ECMWF prevails as the best model due to a slower loss of predictability skill. Besides, KMA achieves higher skill over Mexico discontinuously in some types.

In some cases, the models enhanced their skill after week 4, suggesting that the seasonal signal could be present.

FUTURE WORK

These results should serve as a starting point for carrying out more studies in Mexico during the subseasonal scale. Although the north and slow dipole cases denote both potential ability and ability up to 4 and 5 weeks in different variables, this does not mean that the models are totally efficient; since the MJO/BSISO is a phenomenon that occurs directly over the oceans of the eastern hemisphere. A correct representation of the models leads to consistency of skill over the tropical belt region.

Due to the above, it is necessary to resort to analyzes that accurately determine the reasons that give rise to greater ability in the country and not necessarily in the region of development of the oscillation. Obtaining the complex mechanisms that induce the ability of the country will lead to the study of those mechanisms that are not easily reproduced by the models.

Studies related to the analysis of the dynamics of the MJO/BSISO –even before its appearance-, the subseasonal verification and subsequent bias correction, and the homogenization of the initial conditions in the models are essential to make significant advances at the subseasonal scale, and achieve a true bridge between weather and climate.

References

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Photography not allowed