A case study of coastal El Niño event in early 2017

- Persistent heavy rains from January to March over the northwestern part of South America -

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1. Introduction

● Heavy Rains in Colombia and Peru

- Japan Meteorological Agency (JMA) issued a climate monitoring report in April 2017, regarding the persistent heavy rains from January to March over the northwestern part of South America (Fig. 1).
- According to the official report, floods and landslides due to heavy rains in the region caused totally hundreds of fatalities in Colombia and Peru.

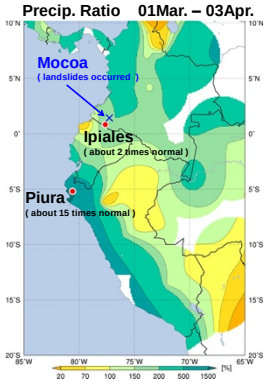


Fig. 1. Precipitation ratio in and around northwestern part of South America from 01Mar to 03Apr 2017

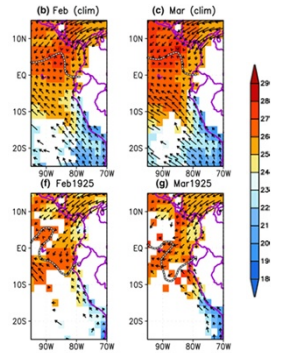


Fig. 2. Surface wind and SST in Feb.-Mar. climatology (1920-1939) and 1925
- The past example of strong coastal El Niño event -
(K.Takahashi et al 2017, The very strong coastal El Niño in 1925 in the far-eastern Pacific)

● Coastal El Niño (e.g. K.Takahashi et al 2017)

- This widespread and persistent rainfall is supposed to be led by the **strong coastal El Niño,** which seems to be a rare phenomenon (2nd time since 1925) that **SST** (sea surface temperature) **becomes far warmer** than normal **off the northwestern coast of South America** but unlike normal El Niño, SST is not so warm in the central to eastern part of the equatorial Pacific.

Question

● How was this situation maintained?

- We investigated **how such SST anomalies were maintained**, and evaluated the relationship between the atmospheric circulation and the heavy rains during this coastal El Niño event.

2. Data

The data we used for Jan.-Mar. 2017 (JFM2017) were as follows.

- Observation: SYNOP
- OLR: NOAA OLR
- SST: COBE-SST (Ishii et al. 2005)
- Atmospheric circulation: JRA-55 (Kobayashi et al. 2015)
- Oceanic circulation: MOVE/MRI.COM-G2 (Toyoda et al. 2013)

Climatological "normal" was defined as the 30-year average during the period from 1981 to 2010, and "anomalies" were defined as deviations from the normal.

3. Atmospheric circulations and SSTs in JFM2017

Wind-Evaporation-SST (WES) feedback (Xie and Philander 1994)

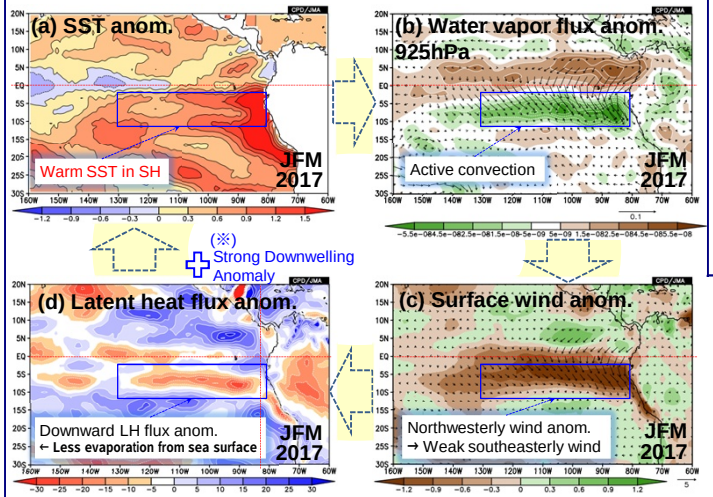


Fig. 3. (a) SST [℃], (b) Water vapor flux at 925hPa [kg/kg m/s] and its divergence [kg/kg/s], (c) Surface wind and wind speed [m/s], (d) Latent heat flux [W/m^2] , anomaly in JFM2017, (e) Ocean current divergence [s^{-1}] (contour) and its anomaly (shade) along 82.5W in JFM2017

High SST (> 27 ℃) triggered convection?

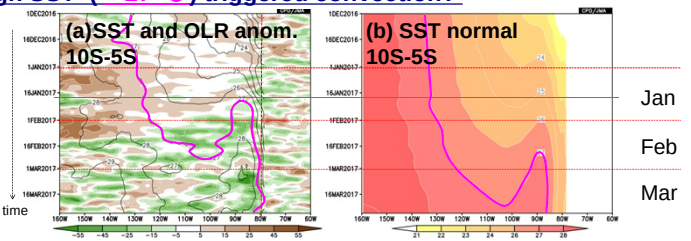
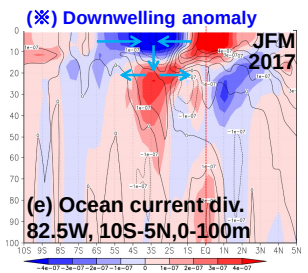


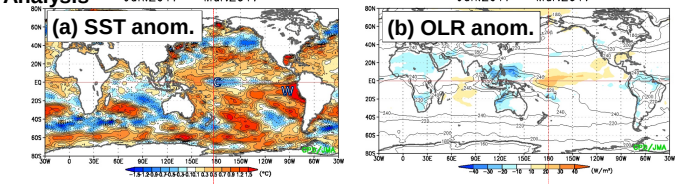
Fig. 4. Time-Longitude cross section of (a) SST [℃] (contour) and OLR anomaly [W/m^2] (shade) in JFM2017, (b) SST [℃] normal in JFM, averaged over 10S-5S



- SSTs near the coast of Peru were warmer than about 27℃ since mid-January, which were favorable for active convection.
- Active convection induced northwesterly wind anomalies, which weakened trade winds in part of the eastern equatorial Pacific in the Southern Hemisphere.
- Weak trade winds suppressed the evaporation from the sea surface -- i.e., latent heat flux from the sea surface were weakened, which in turn kept the SST warmer-than-normal.
- Downwelling (or weak upwelling) also contributed.

4. Statistical analysis

Analysis Jan.2017 – Mar.2017



Regression (onto precip. over Peru in JFM 1997 - 2017 (Fig. 5))

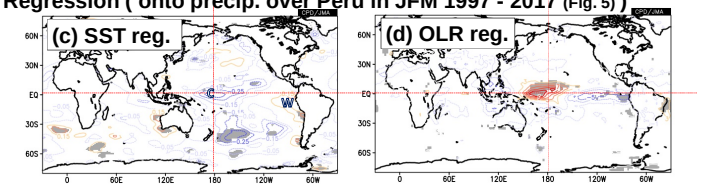
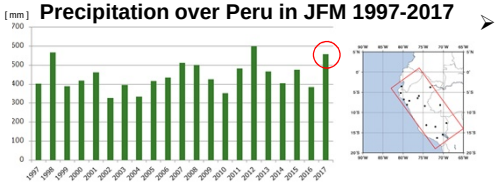


Fig. 6. (a), (b): Analysis of (a) SST [℃], (b) OLR anomaly [W/m^2] in JFM2017.
(c), (d): Regression between precipitation over Peru in JFM and (c) SST, (d) OLR from 1997 to 2017
Areas exceeding the significance level (95%, one side) are shaded in gray.

- Precipitation amount over Peru in JFM seems to have associations with the warmer-than-normal SST near the northwestern coast of South America and the enhanced convective activities over the eastern equatorial Pacific.

Precipitation over Peru in JFM 1997-2017



- Precipitation over Peru in JFM2017 was the 3rd largest since 1997 after 2012, 1998 (a strong ENSO year).

Fig. 5. Precipitation amount over Peru in JFM 1997-2017 using SYNOP messages

Summary and Future tasks

● Significantly Warm SST off the northwestern coast of South America

- persistent heavy rains in JFM2017 over the northwestern part of South America

● Coastal El Niño maintained by WES feedback

- It was maintained by **WES feedback (rather than Bjerknes feedback)** . Downwelling (or weak upwelling) near the coast of Peru also contributed.

● Future Work

- Investigation on the relation between the precipitation amount over Peru and **the negative SST anomaly near dateline (Fig. 6)**, and survey on the current and the temperature in the ocean near the western coast of South America etc. are subjects for the future.