review:

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A Study of CINDY/DYNAMO MJO Suppressed Phase

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KEY WORDS

- MJO suppressed phase
    - Wheeler and Hendon real-time multivariate MJO index phases 5–8.

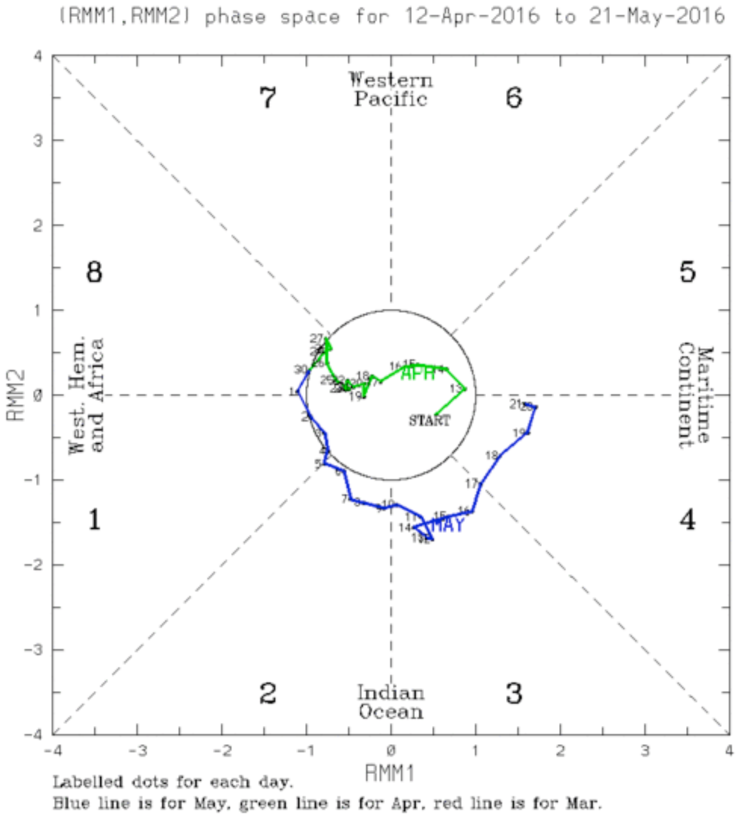

Table 1. Dates of Occurrence of Each WH MJO Phase During DYNAMO-AMIE

Phase	Dates
1	15–19 October, 17–20 November
2	20–29 October, 21–25 November
3	30 October to 1 November, 26–30 November
4	2–5 November, 1–5 December, 13–24 December
5	6–8 November, 6–12 December, 25–28 December
6	1–4 October, 9 November, 29 December to 7 January, 10–16 January
7	5–8 October, 10–12 November, 8–9 January
8	9–14 October, 13–16 November

Power and Houze (2013)

KEY WORDS

- moist resurgence process
  - onset of MJO2: 23 Nov.

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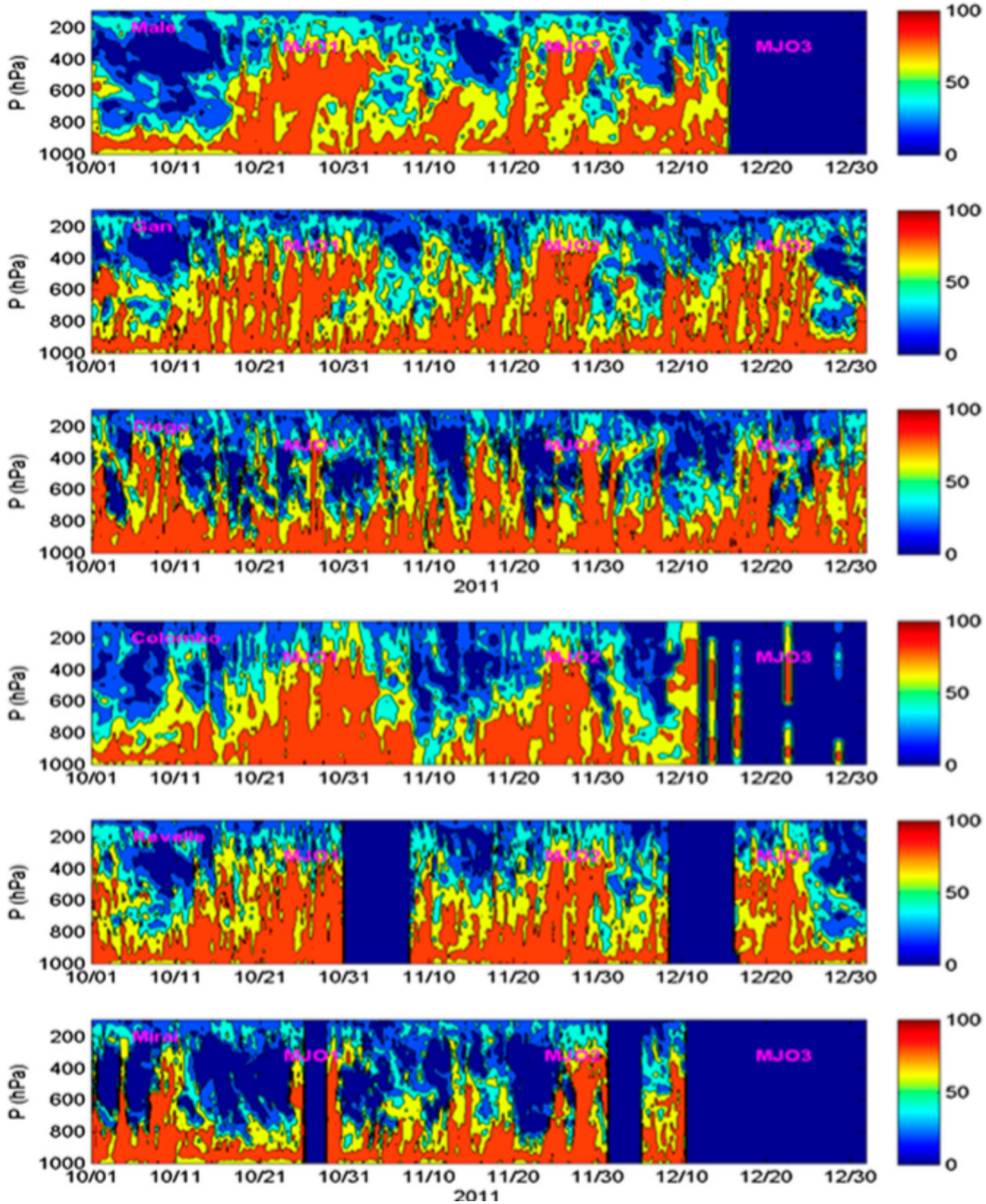
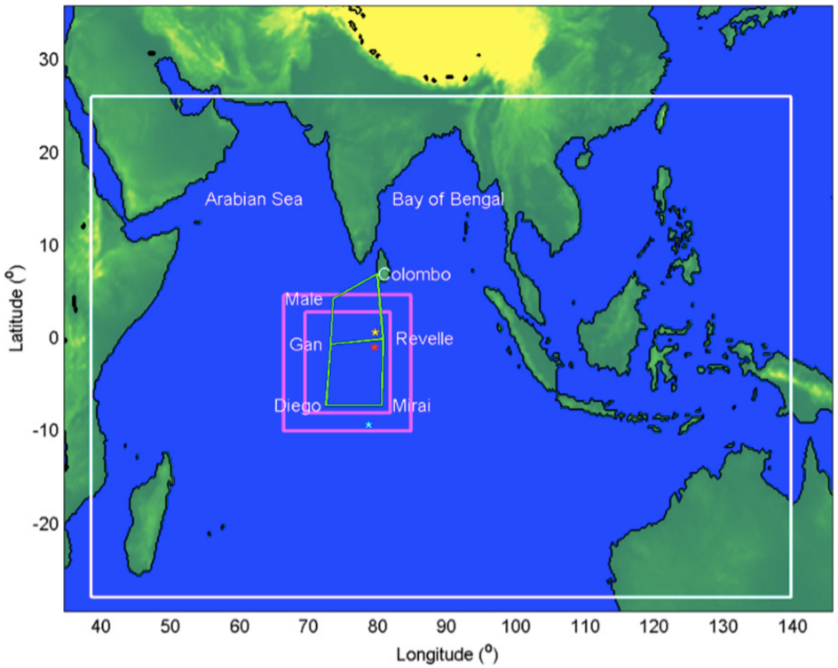


0. GOAL OF THIS PAPER…

- Utilize these unique datasets to investigate and improve our understanding of the processes impacting the deep moisture resurgence prior to the DYNAMO MJO initiation phase.
- What processes govern the time scale for the observed moisture resurgence in the post-MJO dry air mass prior to the subsequent MJO onset?
- What relative roles do diurnal ocean temperature anomalies and surface fluxes play in regulating or initiating the deep vapor resurgence?

1. METHODOLOGY

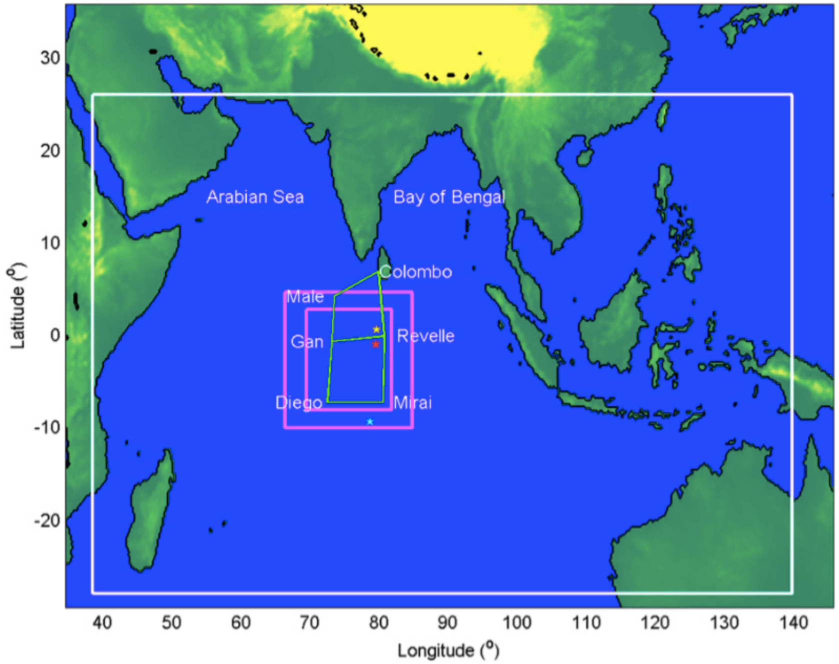
- Observations
  - DYNAMO sounding network
  - The Earth System Research Laboratory (ESRL) direct covariance flux system, moorings, and sea gliders
  - TRMM-3B42 and METEOSAT7



Locations of CINDY2011/DYNAMO IOP sounding and mooring sites overlaid on the COAMPS atmospheric, ocean, and wave domains. The green box indicates the coverage area of the IOP array connecting the sounding sites Malé, Colombo, Gan, R/V Revelle, Diego Garcia, and R/V Mirai. The stars are the mooring sites D1 (yellow), D2 (red), and D3 (cyan). The inner-two atmospheric grids are shown as magenta rectangles, and the ocean and wave model grid is shown in white. The 3-km atmospheric nest 3 covers an area of 8.1S–2.8N and 69.5–81.9E.

1. METHODOLOGY

- Power spectral density and wavelet analysis
- COAMPS (air–ocean–wave Coupled Ocean–Atmosphere Mesoscale Prediction System)
  - Use a 6-hourly data assimilation cycle in the atmosphere and ocean from 17 August 2011 to 15 January 2012 and issue a 4-day forecast once a day at 1200 UTC.
  - The atmospheric coarse domain covers the area of 25S–25N and 30–150E while the 3-km atmospheric nest was designed to encompass the entire DYNAMO southern sounding array
  - The ocean and wave domain are the same size and slightly smaller than the atmospheric coarse domain.



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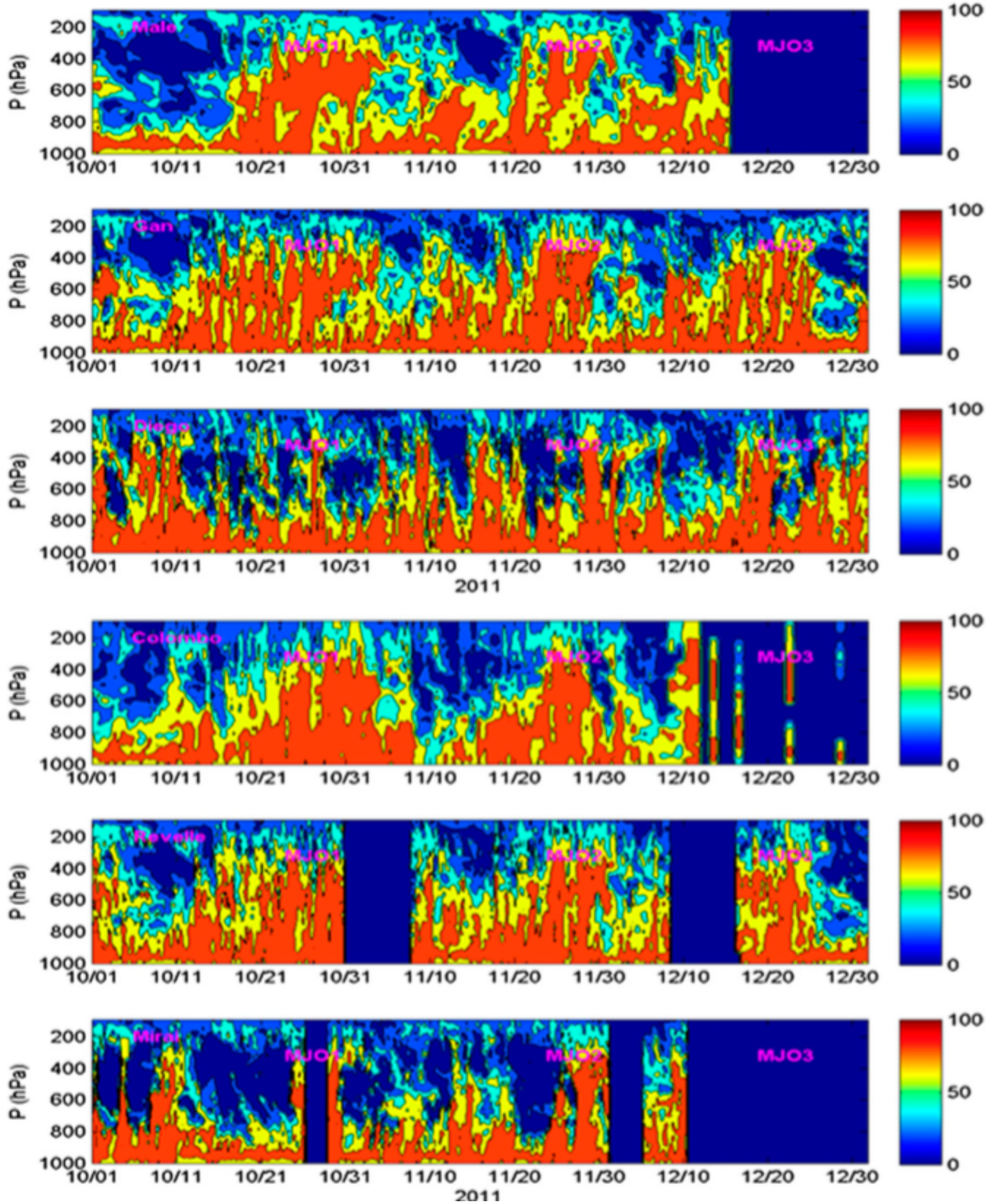
2. OBSERVATIONS: ATMOSPHERE AND OCEAN



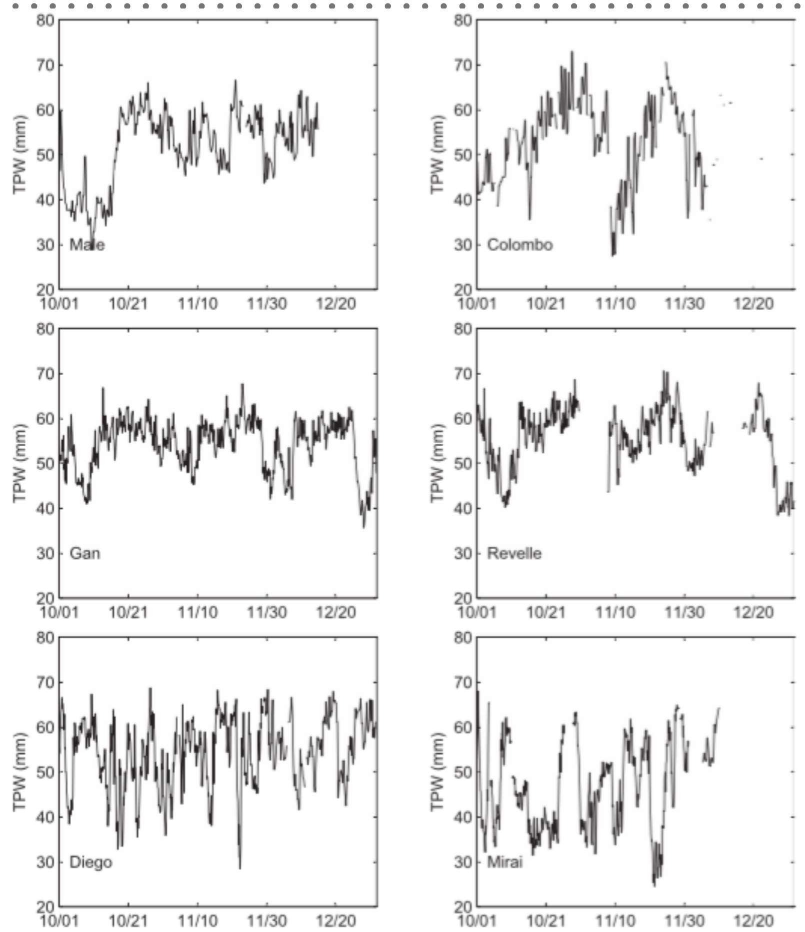


Fig 3. Time–height relative humidity [with respect to liquid water (%)] analysis derived from observed soundings. The contour interval is 20% and the three primary MJO's arising during this period are labeled in magenta.

FIG. 4. Total precipitable water (mm) vs time computed from the 3-hourly DYNAMO L4 soundings

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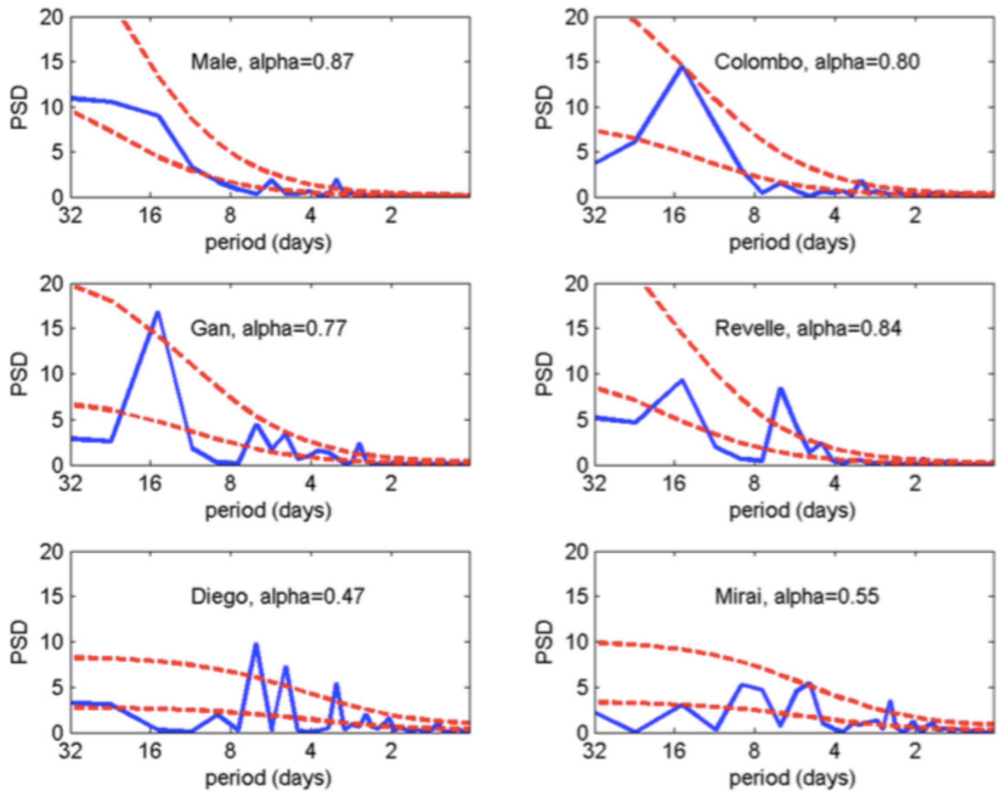


FIG. 5. Normalized power spectral density of total precipitable water derived from the sounding sites shown previously in Fig 4. The lower dashed line is the red-noise spectrum. The upper dashed line is the 95% confidence red-noise spectrum. Alpha is the value of the lag-1 autocorrelation.

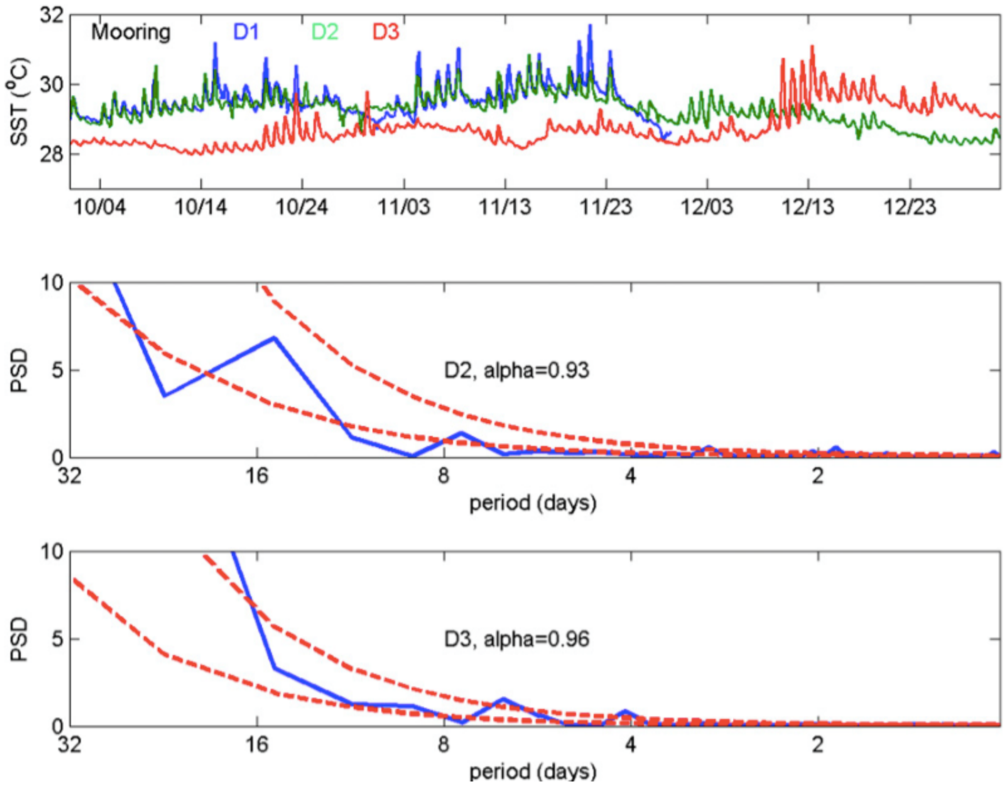
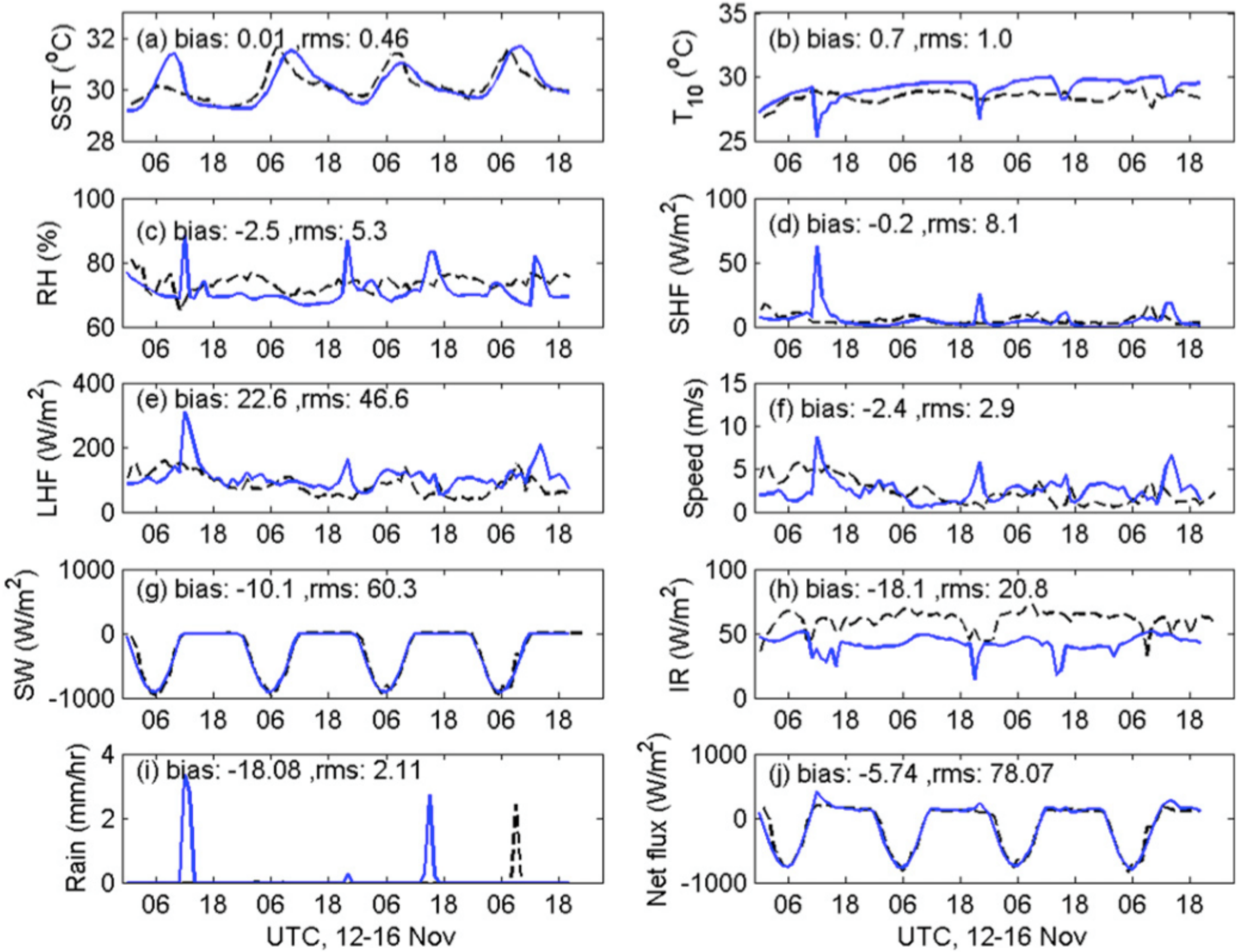


FIG. 8. (top) Three-hourly SST from the DYNAMO moorings D1, D2, and D3 and their normalized PSD analysis. The PSD from the (middle) D2 and (bottom) D3 moorings show 2-, 3–4-, 6–8-, and 16-day oscillations.

3. VERIFICATION OF COAMPS



black (dashed line):

- *Revelle observation*

blue (solid line):

- *COAMPS simulation*

bias = model - obs

some parameters:

T_{10}: 10-m air temperature

SHF: sensible heat flux

LHF: latent heat flux

speed: 10-m wind speed

SW: shortwave radiation

IR: longwave radiation

Rain: hourly precipitation

Net flux: net flux to the ocean

4. COAMPS SIMULATIONS (REAL CASE)

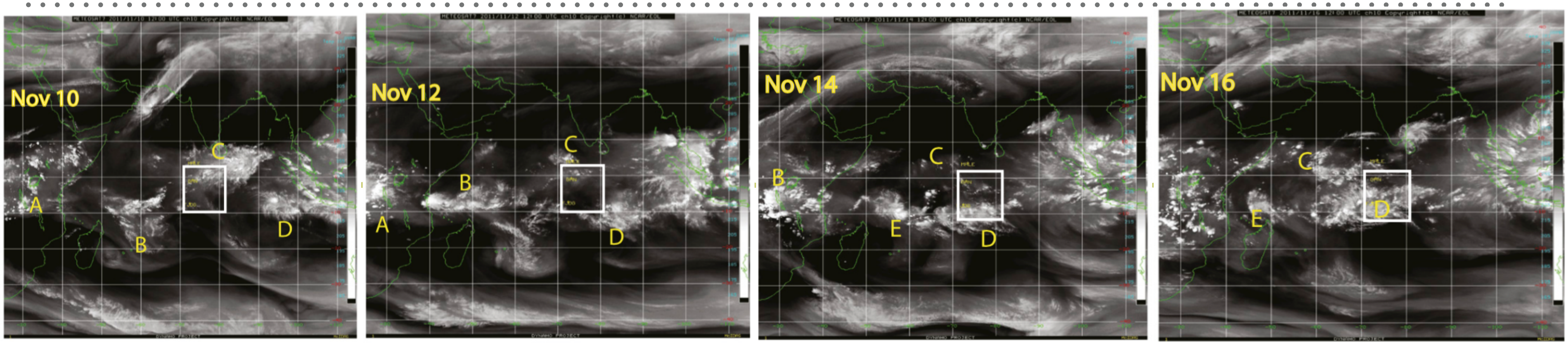
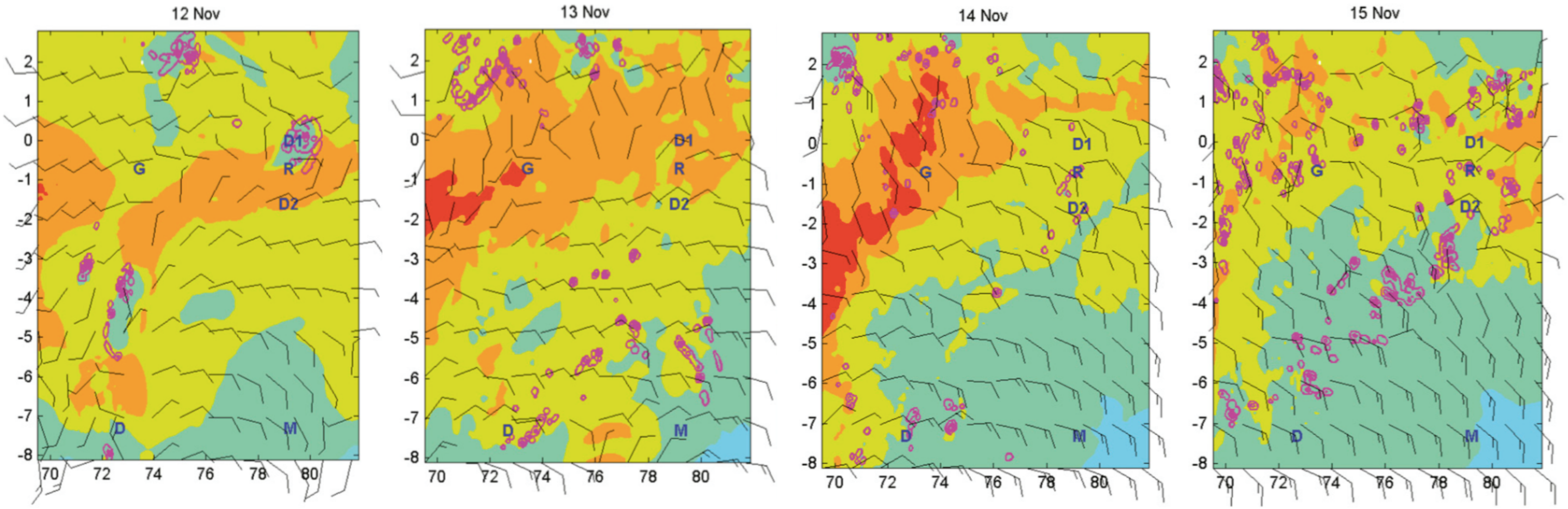


FIG. 12. Meteosat-7 channel-10 water vapor images. The bold white box represents the COAMPS grid-3 domain. The convective regions C and D are seen to impact the northern and southern grid 3 of the COAMPS model domain.

Fig 13. COAMPS forecast on 3-km grid:

color shaded: SST [interval 1°C]; black barbs:10-m wind; magenta contour:hourly rain rate [interval 10mm/hr]



4. COAMPS SIMULATIONS (REAL CASE)

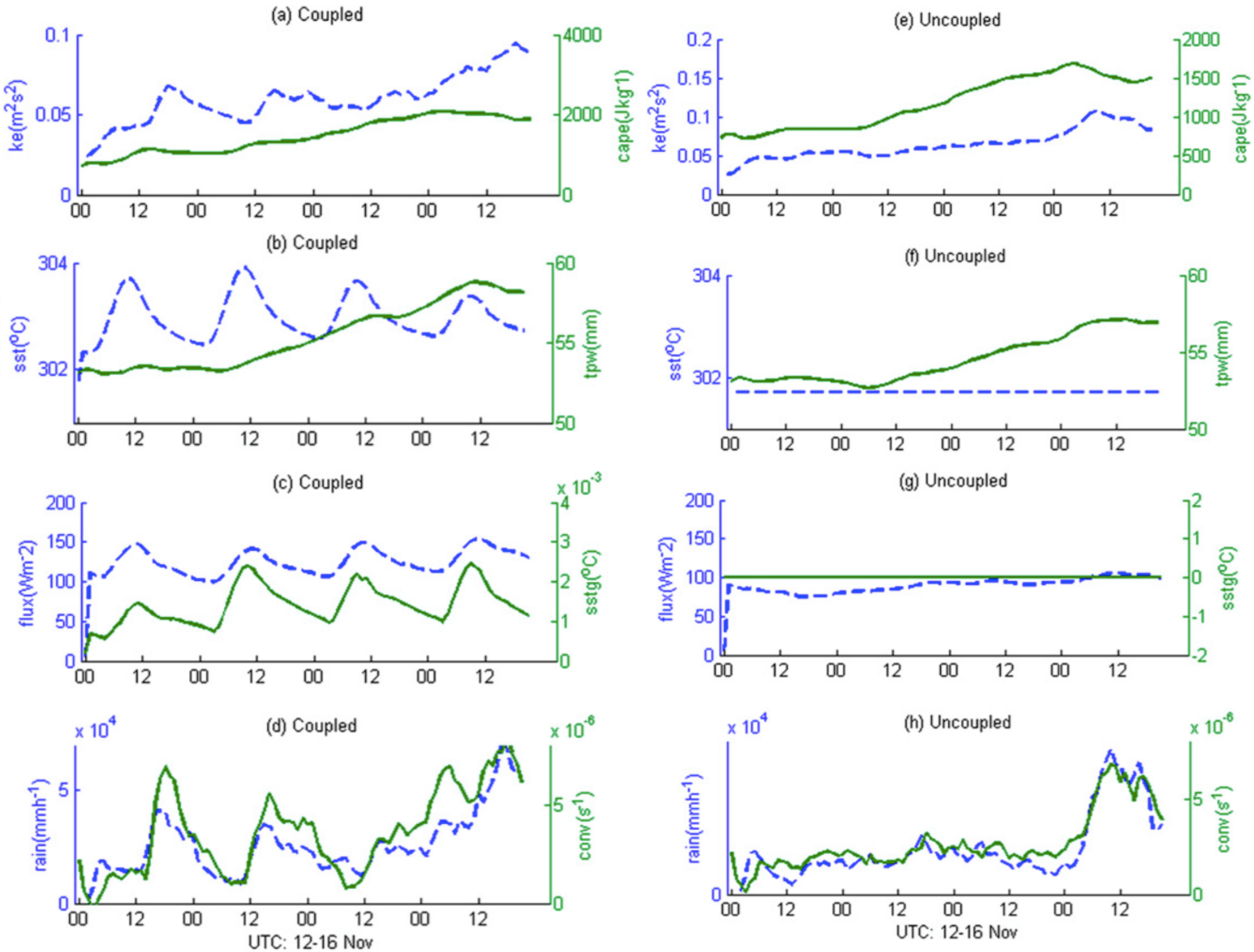


FIG. 14. Time series plots of coupled/uncoupled COAMPS grid-3 domain mean:

(a/e) kinetic energy and CAPE

(b/f) SST and total precipitable water

(c/g) enthalpy flux and absolute magnitude of SST gradient (°C 9 km^{-2})

(d/h) domain total precipitation and domain mean low-level convergence

4. COAMPS SIMULATIONS (REAL CASE)

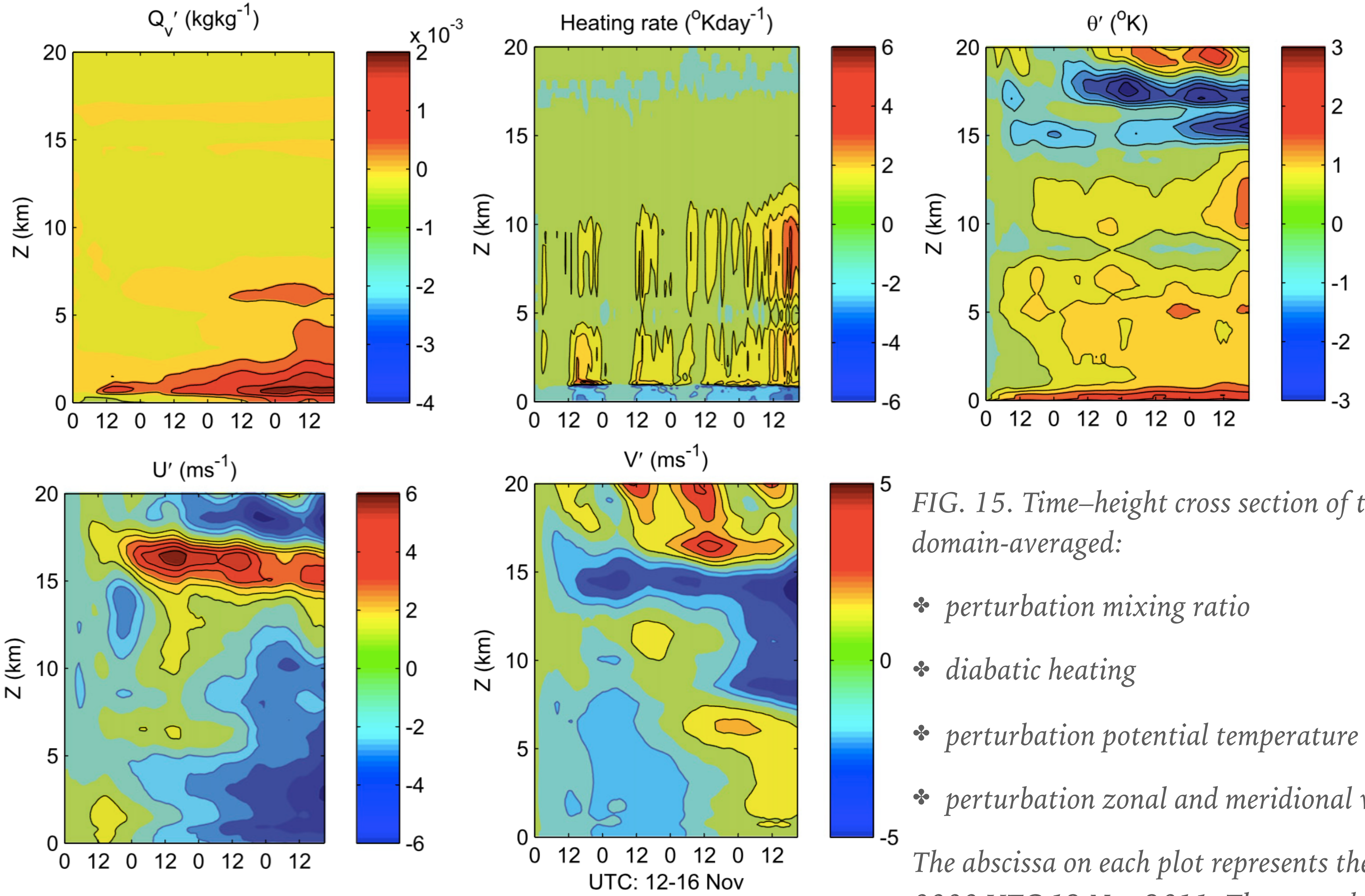


FIG. 15. Time–height cross section of the COAMPS grid-3 domain-averaged:

- *perturbation mixing ratio*
- *diabatic heating*
- *perturbation potential temperature*
- *perturbation zonal and meridional velocity components*

The abscissa on each plot represents the time starting at 0000 UTC 12 Nov 2011. The perturbations are computed from the domain mean values at each model level.

4. COAMPS SIMULATIONS (IDEALIZED)

TABLE 2. A list of idealized COAMPS mixed–Rossby gravity wave experiments.

Experiment name	Model setup
EXPA	Dry with fixed SST
EXPB	Dry with time-varying SST
EXPC	Full physics with time-varying SST

- The temporal change in the TPW from the initial value of 50 mm was on the order of 9%–13% for the three experiments (54.7[expA], 56.4[expB], and 56.3[expC] mm) with the maximum change found to arise in the experiments including the SST cycling.

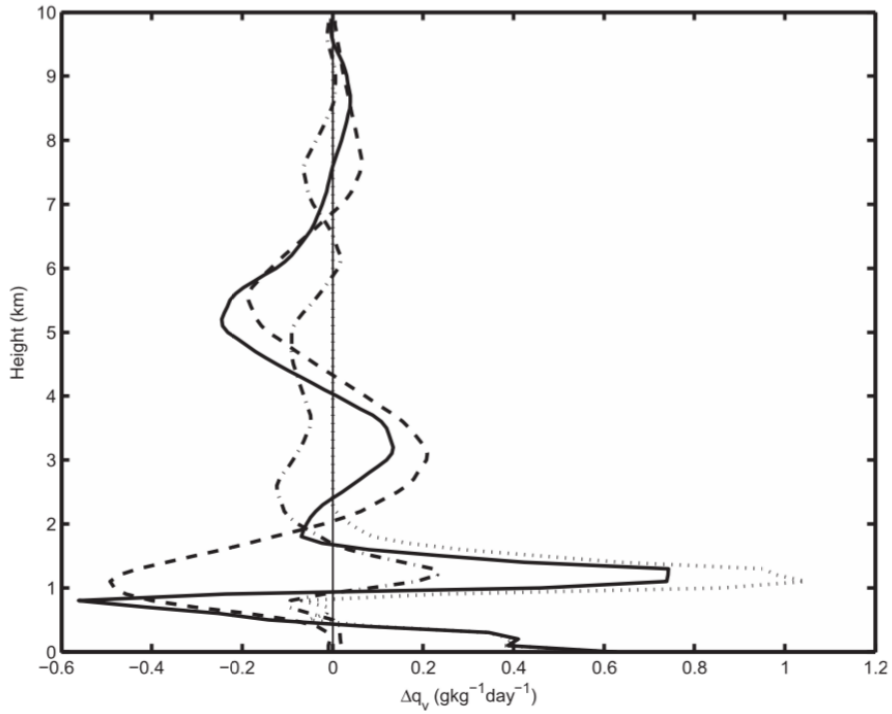


FIG. 19. A vertical profile of the EXPA 96-h mean water vapor budget (g kg^{-1} day^{-1}) for the budget point

- soild: total budget
- dashed: vertical advection
- dashed-dotted: horizontal advection
- dotted: vertical mixing

SUMMARY

- Resurgence of moisture is tightly coupled with the ocean, and occurs in a reoccurring fashion that includes diurnal, quasi-2-, quasi-3–4, quasi-6–8-, and quasi-16-day oscillations.

- Both the diurnal sea surface temperature (SST) pumping and horizontal and vertical moisture transport associated with the westward propagating mixed Rossby–Gravity (MRG) waves play an essential role in the moisture resurgence during the MJO suppressed phase.

- The MRG sensitivity experiments showed the TPW increase varies from 9% to 13% with the largest changes occurring in the simulations that included a diurnal SST variation of 2.5°C as observed.