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Supplement of

The Regional Coupled Suite (RCS-IND1): application of a flexible regional coupled modelling framework to the Indian region at kilometre scale

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S1 Introduction

This supplementary material to the main paper is designed to help users of the RCS-IND1 framework to configure their systems appropriately. Interested researchers are strongly encouraged to contact the corresponding author and to be provided with access to configurations as a rose suite via the https://code.metoffice.gov.uk/trac/roses-u/browser/b/f/9/4/5/trunk repository.

S2 Example rose namelists for RCS-IND1 configurations of UM, JULES, NEMO and WAVEWATCH III namelists

The provided text file gmd-2022-rcs-ind1-namelists.txt includes a set of UM, JULES, NEMO and WAVEWATCH III rose namelists for an atmosphere-ocean-wave simulation run of the RCS-IND1 configuration, using UM code base vn11.1, JULES vn5.2, NEMO vn4.1, WAVEWATCHIII vn4.18.

S3 Code modifications applied for RCS-IND1

A number of code adaptations were required in order to develop the RCS-IND1 configuration, and associated component model configurations. These are summarised below. All code modifications were implemented as distinct branches from the baseline code (e.g. trunk). These branches are merged to form a single code set as part of the fcm_make configuration build process within each rose suite prior to running. For convenience, a copy of the merged code for each component is made available to registered researchers to support collaboration, as described in the main paper (Code Availability section).

The following tables provide supplementary detail on the underpinning code branches used for RCS-IND1. All are also accessible to registered researchers, although the authors would recommend either working with the provided copy of the merged code or preferably making use of the rose suites described which include automated extraction, merging and compilation of the relevant codes from the various repositories using the fcm_make functionality.

Met Office Unified Model branch name	Code revision	Purpose
ukeputils/trunk/gmd-2022/rcs-ind1/um	**RCS-IND1**	**Merged copy of RCS-IND1 UM code**
Contains merge of:		
vn11.1 trunk	56263	Root UM vn11.1 code base, tagged um11.1
paulselwood/vn11.1_fix_gwd4a_race	57003	Technical branch to correct race condition in GWD
paulselwood/vn11.1_fix_ukv	57531	Technical branch to correct OMP behaviour
juanmcastillo/vn11.1_ukep_rivrouting	61978	Enable relevant river routing diagnostics in JULES

juanmcastillo/vn11.1_wave_coupling	60846	Add wave coupling capability to UM

Table S1: Summary of Unified Model code branches merged and used in the RCS-IND1 framework, containing relevant adaptations from the version 11.1 baseline code. All model codes are accessible via https://code.metoffice.gov.uk/trac/um/wiki. Registered users can directly access the copy of the merged code provided and each separate code branch listed at the revision used in RCS-IND1 by following the direct code revision links provided in the Table.

JULES land surface model branch name	Code revision	Purpose
ukeputils/trunk/gmd-2022/rcs-ind1/jules	**RCS-IND1**	**Merged copy of RCS-IND1 JULES code**
Contains merge of:		
vn5.2 trunk	12251	Root JULES vn5.2 code base, tagged um11.1
juanmcastillo/vn5.2_river_fixes	12815	Apply trunk code modification to routing not at vn4.7
juanmcastillo/vn5.2_wave_coupling-Charnock	12950	Implement wave coupling within surface exchange
johnmedwards/vn5.2_debug_surfex2	12834	Modify iterative initial condition for surface exchange

Table S2: Summary of JULES code branches merged and used in the RCS-IND1 framework, containing relevant adaptations from the version 5.2 baseline code. All model codes are accessible via https://code.metoffice.gov.uk/trac/jules/wiki. Registered users can directly access the copy of the merged code provided and each separate code branch listed at the revision used in RCS-IND1 by following the direct code revision links provided in the Table.

NEMO ocean model branch name	Code revision	Purpose
ukeputils/trunk/gmd-2022/rcs-ind1/nemo	**RCS-IND1**	**Merged copy of RCS-IND1 NEMO code**
Contains merge of:		
vn4.0.1 trunk	12083	Root NEMO vn4.0.1 code revision used
UKMO/r8395_India_uncoupled	11080	Amend boundary data vertical interpolation
UKMO/r8395_cpl-pressure	11080	Use coupled MSLP rather than file forcing
UKMO/r8395_coupling_sequence	10764	Set the required order of coupling fields
UKMO/r8395_restart_datestamp	10765	Add timestamp to NEMO restart file
UKMO/r8935_mix-lyr_diag	11347	Additional mixed-layer diagnostics

Table S3: Summary of NEMO code branches merged and used in the RCS-IND1 framework, containing relevant adaptations from the baseline trunk code at version 4.0.1 (revision 12083). Model codes are accessible via http://www.nemo-ocean.eu. Registered users can directly access the copy of the merged code provided and each separate code branch listed at the revision used in RCS-IND1 by following the direct code revision links provided.

NEMO compilation keys used in RCS-IND1	
key_zdfgls	GLS generic length scale vertical mixing
key_FES14_tides	Tidal potential forcing

key_iomput	Model output via XIOS with I/O server
key_netcdf4	Netcdf support
key_oasis3	Enable coupling with OASIS3-MCT
key_oa3mct_v3	Enable coupling with OASIS3-MCT

Table S4: Summary of NEMO v4.0.1 compilation keys used in the RCS-IND1 framework.

WAVEWATCH III branch name	**Code revision**	**Purpose**
ukeputils/trunk/gmd-2022/rcs-ind1/wav	**RCS-IND1**	**Copy of RCS-IND1 WAVEWATCH III code**
Contains:		
WW3v4/branches/dev/frhl/r966_ww3v4_ukep	2211	New implementation of wave coupling to ATM/OCN

Table S5: Summary of WAVEWATCH III code branch used in the RCS-IND1 framework, containing relevant adaptations from the baseline trunk code at version 4.18. This code can be shared with registered users of WAVEWATCHIII, with further details available at https://polar.ncep.noaa.gov/waves/wavewatch/wavewatch.shtml.

WAVEWATCH III compilation switches used in RCS-IND1			
ST4	Ardhuin et al. (2010) source term package	SMC	Spherical Multi-Cell coordinate system
NL1	Discrete interaction approximation	WNT1	Linear wind speed interpolation in time
BT1	JONSWAP bottom friction formulation	CRT1	Linear current interpolation in time
DB1	Battjes-Janssen depth-induced breaking	WNX1	Approx. linear wind speed interpolation in space
TR0	No triad interactions	CRX1	Approx. linear current interpolation in space
BS0	No bottom scattering	FLX0	Flux computation included in source terms
XX0	No supplemental source terms	RWND	Correct wind speeds for current velocity
LN1	Cavaleri and Malanotte-Rizzoli linear input	REF0	No source term for reflection

Table S6: Summary of WAVEWATCH III compile switches used in the RCS-IND1 framework.

KPP branch name	**Code revision**	**Purpose**
ukeputils/trunk/gmd-2022/rcs-ind1/kpp	**RCS-IND1_**	**Copy of RCS-IND1 KPP code**
Contains:		
KPP_ocean_svn/KPP_ocean/branches/dev/hadzc/r194_r183_couple_flags_OMP	194	Development branch

Table S7: Summary of KPP code branch used in the RCS-IND1 framework, containing relevant adaptations from the baseline trunk code at http://cms.ncas.ac.uk/wiki/PumaService

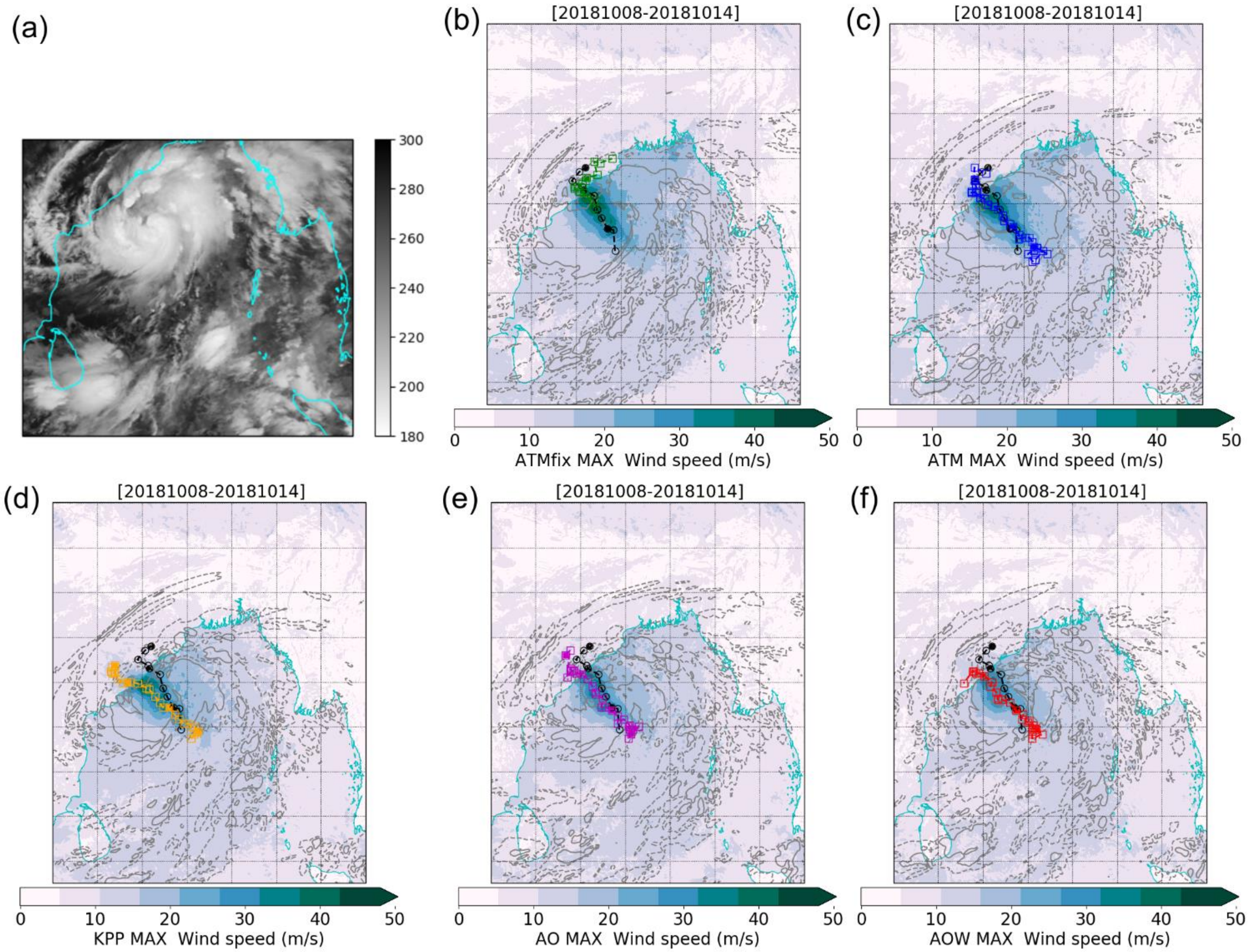

Figure S1: (a) Illustration of Cyclone Titli satellite observed brightness temperature from Meteosat at 00 UTC on 10 October 2018. In (b)-(f), results from RCS-IND1 experiments showing maximum wind speed during the 7-day simulation (coloured shading). Also plotted is the diagnosed simulated cyclone track at 3-hourly intervals (coloured line and squares) compared with observed track at 6-hourly intervals (black line and circles). Line contours show instantaneous simulated outgoing longwave radiation at top of atmosphere (dashed line indicating 150 Wm^{-2}, solid line 100 Wm^{-2} contour) at coincident hour to the satellite observation in (a). See Figure 3 for corresponding figure for simulations with frictional heating enabled.

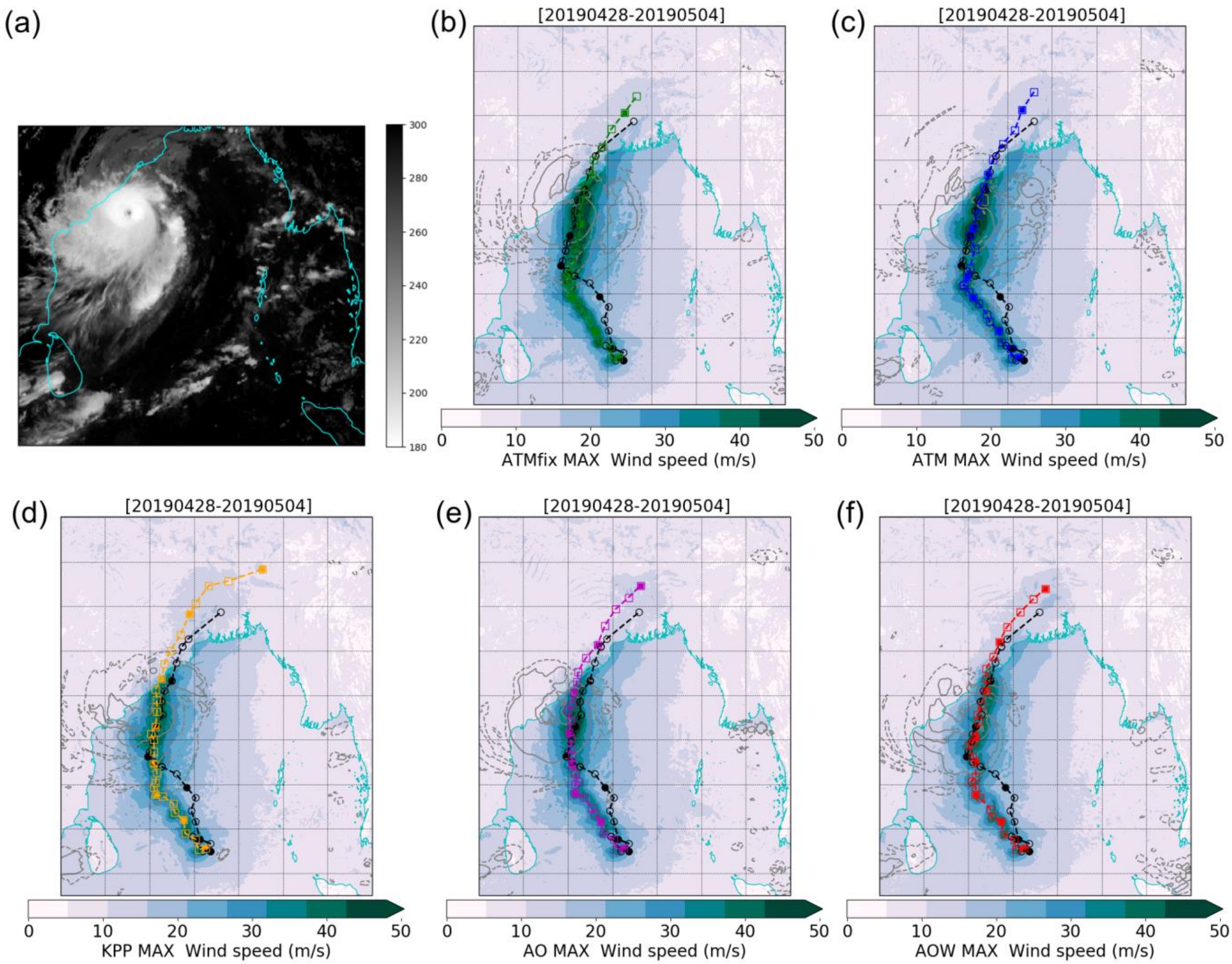

Figure S2: (a) Illustration of Cyclone Fani satellite observed brightness temperature from INSAT at 06 UTC on 2 May 2019. In (b)-(f), results from RCS-IND1 experiments showing maximum wind speed during the 7-day simulation (coloured shading). Also plotted is the diagnosed simulated cyclone track at 6-hourly intervals (coloured line and squares) compared with observed track at 6-hourly intervals (black line and circles). Line contours show instantaneous simulated outgoing longwave radiation at top of atmosphere (dashed line indicating 150 Wm^{-2}, solid line 100 Wm^{-2} contour) at coincident hour to the satellite observation in (a). See Figure 4 for corresponding figure for simulations with frictional heating enabled.

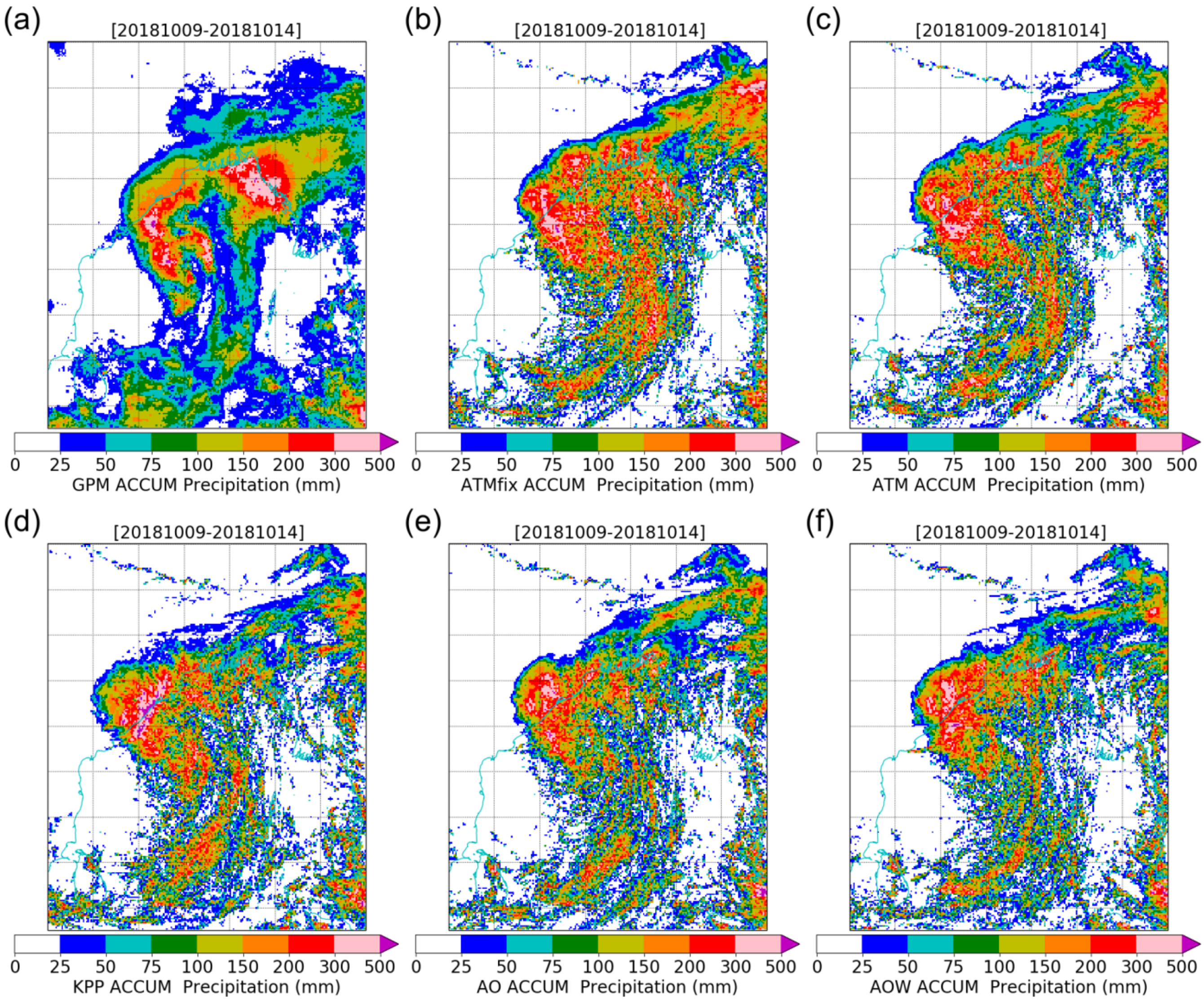

Figure S3: 7-day precipitation accumulation during Titli case study over Bay of Bengal sub-domain region (a) observed by GPM (NASA Global Precipitation Measurement), and simulated by (b) ATMfix_FH, (c) ATM_FH, (d) KPP_FH, (e) AO_FH and (f) AOW_FH. All simulated data are interpolated to the GPM resolution prior to computing accumulations. See Figure 10 for corresponding figure for simulations with frictional heating enabled.

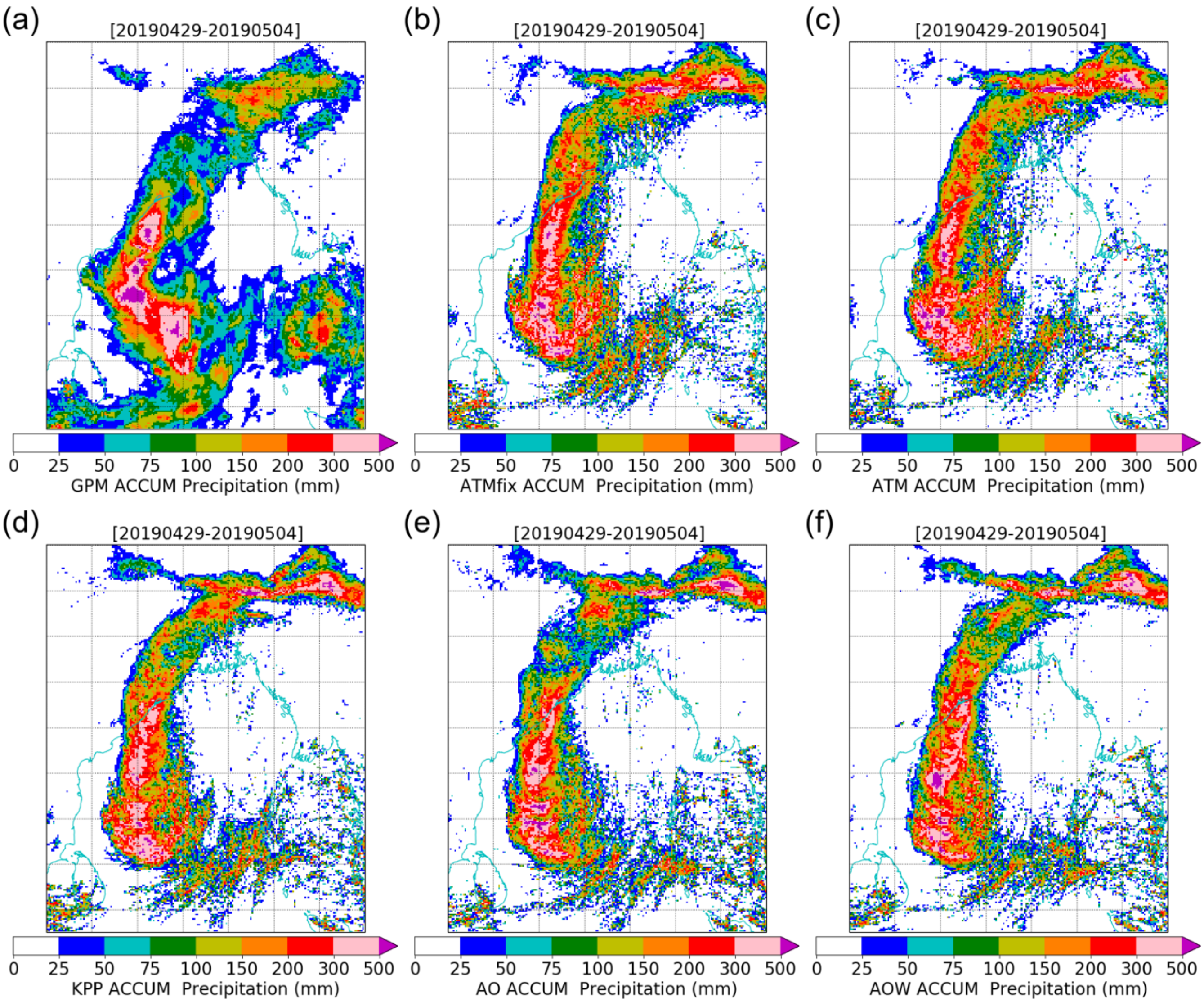

Figure S4: 7-day precipitation accumulation during Fani case study over Bay of Bengal sub-domain region (a) observed by GPM (NASA Global Precipitation Measurement), and simulated by (b) ATMfix_FH, (c) ATM_FH, (d) KPP_FH, (e) AO_FH and (f) AOW_FH. All simulated data are interpolated to the GPM resolution prior to computing accumulations. See Figure 11 for corresponding figure for simulations with frictional heating enabled.