GCSS Working Group 4: Case 5 - Transition of Tropical Convection
Work Package 2: Studies with NWP models

Martin Willett[1], Jon Petch[2] and Steve Woolnough[3]

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1 Introduction

GCSS WG4 Case 5 plans to look at the transition of tropical convection using TOGA–COARE data. This document described the details of work package 2, the intercomparison of NWP models. There are a number of differences from previous Working Group 4 case studies.

- This component involving the use of NWP models forecast models will provide much stronger links between the CRM/SCM community and the NWP community. A later stage of this case study will involve forcing CRMs and SCMs with an analysis or forecast dataset to allow for direct comparison with NWP Global and Limited Area Models.
- To extend beyond simple comparisons between models, a new set of diagnostics has been requested to permit a stronger process study component. This case study is focused on the transition from shallow to deep convection, and a set of budget diagnostics has been requested to identify the way in which convection modifies its environment during this transition period.

The documentation for the CRM and SCM components in this study is available from http://www.convection.info/.

2 Motivation

The transition from suppressed to deep convection presents a particular challenge for NWP and climate models, particularly for their convective parametrizations. A good representation of this is likely to be important if we hope to model the transition from the break phase to the active phase of the MJO. See http://www.convection.info for a fuller discussion of the motivation for this work.

The aims of this study are:

[1]Met Office, UK
[2]Met Office, UK
[3]NCAS Centre for Global Atmospheric Modelling, University of Reading, UK

- to determine the processes that are important for the transition from suppressed to deep convection
- to determine the role that shallow and mid-level convection play in this transition
- to see how various parametrization schemes currently cope with this transition
- to compare the response of parametrizations in the full NWP model with those isolated in a SCM.

3 Methodology

Unlike in previous GCSS WG4 case studies NWP models are to be included. This NWP component will allow comparisons among the NWP models, between the NWP models and the CRMs, SCMs and the obsevations. In addition, the NWP models will be used to generate forcing data for the SCMs and for Limited Area NWP Models (LAMs).

4 Numerical Experiment Protocol

This section describes the periods for which forecasts are to made and details of the data used to initialise the forecasts. The NWP integrations should use the operational configuration of their model as the standard integration. Results from additional integrations using non-standard configurations may be submitted separately.

4.1 Experiments

The start times and forecast periods are identical to 48-hour integrations defined for the SCMs. If you are not able to do all of the experiments then please do B and C rather than A as they define a continuous period.

A1,A2,...,A13 A series of 13, 48 hour integrations, the first beginning at 00UTC on 27th November 1992, with each subsequent integration beginning 24 hours later, the last beginning at 00UTC on 9th December 1992.

B1,B2,...,B13 A series of 13, 48 hour, integrations, the first beginning at 00UTC on 8th January 1993, with each subsequent integration beginning 24 hours later, the last beginning at 00UTC on 20th January 1993.

C1,C2,...,C9 A series of 9, 48 hour, integrations, the first beginning at 00UTC on 20th January 1993, with each subsequent integration beginning 24 hours later, the last beginning at 00UTC on 28th January 1993.

Integrations B13 and C1 are identical for reasons of consistency with the SCM test. Please submit the results twice, once for each experiment.

4.2 Obtaining and reading the data files

The forecasts are to be run from the ECMWF's ERA40 analyses. The data is available grib file format. For details of ERA40 see http://www.ecmwf.int/research/era/. A limited range of data is available direct from ECMWF's website. However, to discuss any addition requirements please contact Martin Willett (martin.willett@metoffice.gov.uk).

4.3 Initial Conditions

It is recognised that each participant may require different information to provide their initial conditions. For example, different variables or different grids may be required for the different models. It is therefore impratical to prescribe the exact variables, grid or resolution to use for the experiments. Each participant should select the ERA 40 variables, grid and resolution most appropriate to their NWP model.

For example, the UK Met Office have run from the following ERA40 variables. The pressure levels used in hPa were 1000, 925, 850, 775, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2 and 1.

Variable	Horizontal grid	Vertical coordinates
Temperature	1.5°lat / long	Pressure levels
Specific humidity	1.5°lat / long	Pressure levels
U-wind	1.5°lat / long	Pressure levels
V-wind	1.5°lat / long	Pressure levels
Natural log of surface pressure	1.5°lat / long	Single level
Land-sea mask	1.5°lat / long	Single level
Surface geopotential height	1.5°lat / long	Single level
Surface skin temperature	1.5°lat / long	Single level

5 Results to submit

The results for the NWP runs fall into four catagories: area-averaged detailed diagnostics from the IFA; detailed diagnostics from a single point at the centre of the IFA; detailed diagnostics from other grid points within the IFA; and a very limited range of diagnostics for the region surrounding the IFA. If you are not able to produce data for all the locations priority should be given in the following order: area-averaged diagnostics, centre of the IFA, limited regional diagnostics, and other points within the IFA.

As the analysis of these integrations progresses it may be that additional diagnostics are requested. Therefore, it is requested that you retain sufficient information to generate additional diagnostics. With your results please submit a file *modeller*.desc.*run*, which descibes the model. A template file can be found on the Case 5 webpage (`http://www.met.rdg.ac.uk/~swrwoono/WG4_CASE5/template.desc`).

5.1 Detailed area-averaged diagnostics

The diagnostics and formats have been chosen to be consistent with the SCMs. To examine how the convection modifies the profiles during the transition from the suppressed to deep convection a number of diagnostics have been requested in the budget section to decompose the temperature and moisture tendencies of the convection.

5.1.1 Location, vertical resolution and time resolution

The area chosen to define the IFA average is $1°S$ - $3°S$, $153°E-157°E$. The IFA itself is not actually rectangular. These coordinates were chosen as they are the simplest choice that covers the majority of the IFA. Participants should submit the area average of all the gridpoints that lie within this region, at each model level, and on each model timestep for the entire 48-hour forecast.

5.1.2 Profiles

Submit the results for each quantity listed below as a separate ASCII file in the file format described in appendix A. Include the height z (km, F7.3) of the model level or half level as appropriate, and the mid-point of the time interval $\overline{t}$ (hours, F6.1) from the start of the integration x,y coordinates respectively. Please include AREA_AVG in the comments line of the file, e.g.

```
# AREA_AVG
```

Name each file as *experiment*.np*item*.0.*modeller*(.*run*) where *experiment* is the experiment number given in section 4.1, *item* is the number of the diagnostic from the list below and *modeller* is the name of the modeller. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup.

Please provide timestep profiles of

1 Pressure, $\overline{p}$ (hPa), (F8.2)

2 Temperature, $\overline{T}$ (K), (F7.2)

3 Potential Temperature, $\overline{\theta}$ (K), (F7.2)

4 Density, $\overline{\rho}$ ($\mathrm{kg\,m^{-3}}$), (F7.4)

5 Water Vapour Mixing Ratio, $\overline{q}$ ($\mathrm{g\,kg^{-1}}$), (F7.3)

6 Relative Humidity, R (unitless), (F6.3): R $= \overline{q}/q^*(\overline{T},\overline{p})$, where $q^*(T,p)$ is the saturation mixing ratio over water.

7 Cloud water (suspended liquid water), $\overline{q_c}$ ($\mathrm{g\,kg^{-1}}$), (F7.4)

8 Cloud ice (suspended ice), $\overline{q_i}$ ($\mathrm{g\,kg^{-1}}$), (F7.4)

9 Rain (falling liquid water), $\overline{q_r}$ ($\mathrm{g\,kg^{-1}}$), (F7.4)

10 Snow (slow falling ice), $\overline{q_s}$ ($\mathrm{g\,kg^{-1}}$), (F7.4)

11 Graupel (fast falling ice, including hail if you have any), $\overline{q_g}$ ($\mathrm{g\,kg^{-1}}$), (F7.4)

12 Cloud fraction, $\overline{\sigma}$ (unitless), (F6.3):

13 Total hydrometeor fraction, if appropriate $\overline{\sigma_{HM}}$ (unitless), (F6.3):

14 Horizontal wind velocity in the x-direction, $\overline{u}$ ($\mathrm{m\,s^{-1}}$), (F7.2)

15 Horizontal wind velocity in the y-direction, $\overline{v}$ ($\mathrm{m\,s^{-1}}$), (F7.2)

16 Apparent heat source, $\overline{Q_1}$ ($\mathrm{K\,day^{-1}}$), (F7.2)

$$\overline{Q_1} = \left(\frac{\overline{p}}{p_0}\right)^{\frac{R}{c_p}} \left[\frac{\partial\overline{\theta}}{\partial t} - \left.\frac{\partial\overline{\theta}}{\partial t}\right|_{LS}\right] - \overline{Q_R}$$

17 Apparent moisture source, $\overline{Q_2}$ ($\mathrm{g\,kg^{-1}\,day^{-1}}$), (F7.2)

$$\overline{Q_2} = \left[\frac{\partial\overline{q}}{\partial t} - \left.\frac{\partial\overline{q}}{\partial t}\right|_{LS}\right]$$

18 Shortwave Radiative heating rate, $\overline{Q}_R^{SW}$ ($\mathrm{K\,day^{-1}}$), (F7.2)

19 Longwave Radiative heating rate, $\overline{Q}_R^{LW}$ ($\mathrm{K\,day^{-1}}$), (F7.2)

20 Large scale temperature increments, $\left.\frac{\partial\overline{\theta}}{\partial t}\right|_{LS}$ ($\mathrm{K\,day^{-1}}$), (F7.2)

21 Large scale humidity increments, $\left.\frac{\partial\overline{q}}{\partial t}\right|_{LS}$ ($\mathrm{g\,kg^{-1}\,day^{-1}}$), (F7.2)

22 Convective Cloud fraction σ^{conv}, (F6.3)

23 Convective Updraft Mass Flux (if appropriate), M_cu, ($\mathrm{kg\,m^{-2}\,s^{-1}}$), (F7.4)

24 Convective Downdraft Mass Flux (if appropriate), M_cd, ($\mathrm{kg\,m^{-2}\,s^{-1}}$), (F7.4)

25 Convective cloud water, q_l^{conv} ($\mathrm{g\,kg^{-1}}$), (F7.4)

26 Convective cloud ice q_i^{conv} ($\mathrm{g\,kg^{-1}}$), (F7.4)

27 Large-scale Cloud fraction σ^{LS}, (F6.3)

28 Large-scale cloud water q_l^{LS} ($\mathrm{g\,kg^{-1}}$), (F7.4)

29 Large-scale cloud ice q_i^{LS} ($\mathrm{g\,kg^{-1}}$), (F7.4)

30 Clear Sky Shortwave Radiative heating rate, $\overline{Q}_R^{SW}$ ($\mathrm{K\,day^{-1}}$), (F7.2)

31 Clear Sky Longwave Radiative heating rate, $\overline{Q}_R^{LW}$ ($\mathrm{K\,day^{-1}}$), (F7.2)

5.1.3 Budget terms

The diagnostics in this section contain terms which will allow the contributions to the models Q_1 and Q_2 to be diagnosed. These terms will be compared with the more detailed breakdown provided by CRM simulations. Comparisons between the NWP budgets and the CRM and SCM budgets will provide useful information on which components of the convection are currently poorly represented by parametrization schemes.

All modellers should provide items 1-6 listed below which provide a breakdown of the contribution from separate physics packages to Q_1 and Q_2. If you have additional physics packages not mentioned below which contribute to Q_1 and Q_2, please supply these terms.

Where possible any additional breakdown of the physics package including any diagnosis of boundary layer type, shallow or deep convection etc would be helpful. If you are easily able to provide a more detailed breakdown of contributions within a particular physics package, (particularly the convection scheme, e.g. contributions to Q_1, Q_2 from updraughts and downdrafts for a mass flux scheme, or even further to e.g. subsidence and detrainment terms) please do.

Submit the results for each quantity listed below as a separate ASCII file in the file format described in appendix A. Include the height z (km, F7.3) of the model level or half level as appropriate, and the mid-point of the time interval $\bar{t}$ (hours, F6.1) from the start of the integration x,y coordinates respectively. Please include AREA_AVG in the comments line of the file.

Name each file as *experiment*.nb*item*.0.*modeller*(.*run*) where *experiment* is the experiment number given in section 4.1, *item* is the number of the diagnostic from the list below and *modeller* is the name of the modeller. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup.

Please provide timestep profiles of

1 Rate of change of potential temperature due to convection, $\overline{D\theta}^{conv}$ (K day^{-1}) (F7.2):

2 Rate of change of water vapour due to convection, $\overline{Dq}^{conv}$ (g kg^{-1} day^{-1}) (F7.2):

3 Rate of change of potential temperature due to boundary layer and vertical diffusion, $\overline{D\theta}^{BL}$ (K day^{-1}) (F7.2):

4 Rate of change of water vapour due to boundary layer and vertical diffusion, $\overline{Dq}^{BL}$ (g kg^{-1} day^{-1}) (F7.2):

5 Rate of change of potential temperature due to large-scale clouds and precipitation, $\overline{D\theta}^{CLD}$ (K day^{-1}) (F7.2):

6 Rate of change of water vapour due to large-scale clouds and precipitation, $\overline{Dq}^{CLD}$ (g kg^{-1} day^{-1}) (F7.2):

5.1.4 Timeseries

Submit results for each of the groups in separate files. Name each file *experiment*.nt*group.0.modeller*(.*run*), following the convention for the profile diagnostics. Start each file with the two comment lines described in the special file format in appendix A, with the group number for *item* and omitting *variable_name*. Please include AREA_AVG in the comments line of the file.

Please write the data as: all the variables for each time level 1 on one line, all the variables at time level 2 on the next line, ..., all the variables at the last time level on the last line. Using the formats specified below, with no spaces between the variables, will ensure all the data fits on one line of 80 characters. Please output data for each model timestep

Group 1:

1 Time at midpoint of averaging interval, $\bar{t}$ (h), (F7.2)

2 Sea Surface Temperature, SST (K), (F7.2)

3 Near surface dry static energy, $\overline{s}_0$, ($\mathrm{kJ\,kg^{-1}}$), (F7.2): $s = c_pT + gz$. "Near-surface" is the first model-level.

4 Near surface water vapour mixing ratio, $\overline{q}_0$, ($\mathrm{g\,kg^{-1}}$), (F6.2)

5 Near surface moist static energy, $\overline{h}_0$: , ($\mathrm{kJ\,kg^{-1}}$), (F7.2): $h = s + L_vq$.

6 Near surface horizontal wind velocity in the x-direction, $\overline{u}_0$ ($\mathrm{m\,s^{-1}}$), (F7.2)

7 Near surface horizontal wind velocity in the y-direction, $\overline{v}_0$ ($\mathrm{m\,s^{-1}}$), (F7.2)

8 Surface turbulent flux of sensible heat $\overline{F_{s0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1): $F_s = \overline{\rho}c_p\left(\frac{\overline{p}}{p_0}\right)^{R/c_p} < w''\theta'' >$.

9 Surface turbulent flux of latent heat $L_v\overline{F_{q0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1): $F_q =< w''q'' >$.

10 Surface turbulent flux of horizontal momentum in the x-direction $\overline{F_{u0}}$ ($\mathrm{N\,m^{-2}}$), (F8.4): $F_u = \overline{\rho} < w''u'' >$.

11 Surface turbulent flux of horizontal momentum in the y-direction $\overline{F_{v0}}$ ($\mathrm{N\,m^{-2}}$), (F8.4): $F_v = \overline{\rho} < w''v'' >$.

Group 2:

1 Time at midpoint of averaging interval, $\overline{t}$ (h), (F7.2)

2 Surface downwelling solar radiative flux, $\overline{F^-_{SW0}}$ ($\mathrm{W\,m^{-2}}$), (F7.1)

3 Surface downwelling infrared radiative flux, $\overline{F^-_{LW0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1)

4 Surface upwelling solar radiative flux, $\overline{F^+_{SW0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1)

5 Surface upwelling infrared radiative flux, $\overline{F^+_{LW0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1)

6 TOA (top of atmosphere) downwelling solar radiative flux, $\overline{F^-_{SWT}}$ ($\mathrm{W\,m^{-2}}$), (F7.1)

7 TOA upwelling solar radiative flux, $\overline{F^+_{SWT}}$ ($\mathrm{W\,m^{-2}}$), (F7.1)

8 TOA upwelling infrared radiative flux, OLR ($\mathrm{W\,m^{-2}}$), (F7.1)

9 Cloud amount, $\overline{A_{cld}}$ (unitless), (F6.3): Cloud shadow as seen by radiation.

Group 2a:

1 Time at midpoint of averaging interval, $\overline{t}$ (h), (F7.2)

2 Clear Sky Surface downwelling solar radiative flux, $\overline{F^-_{SW0}}$ ($\mathrm{W\,m^{-2}}$), (F7.1)

3 Clear Sky Surface downwelling infrared radiative flux, $\overline{F^-_{LW0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1)

4 Clear Sky Surface upwelling solar radiative flux, $\overline{F^+_{SW0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1)

5 Clear Sky Surface upwelling infrared radiative flux, $\overline{F^+_{LW0}}$ ($\mathrm{W\,m^{-2}}$), (F6.1)

6 Clear Sky TOA upwelling solar radiative flux, $\overline{F^+_{SWT}}$ ($\mathrm{W\,m^{-2}}$), (F7.1)

7 Clear Sky TOA upwelling infrared radiative flux, OLR ($\mathrm{W\,m^{-2}}$), (F7.1)

Group 3:

1 Time at midpoint of averaging interval, $\bar{t}$ (h), (F7.2)

2 Surface rainfall rate, $\overline{\mathrm{PPT}}$ ($\mathrm{mm\,day^{-1}}$), (F7.2):

3 Precipitable water, $\overline{\mathrm{PW}}$ ($\mathrm{kg\,m^{-2}}$), (F6.2): $\mathrm{PW} = \int_0^{z_t} \bar{\rho} q\, dz$, where z_T is the model top height.

4 Cloud liquid water path, $\overline{\mathrm{LWP}}$ ($\mathrm{kg\,m^{-2}}$), (E10.3): $\mathrm{LWP} = \int_0^{z_t} \bar{\rho} q_c\, dz$,.

5 Cloud ice path, $\overline{\mathrm{IWP}}$ ($\mathrm{kg\,m^{-2}}$), (E10.3): $\mathrm{IWP} = \int_0^{z_t} \bar{\rho} q_i\, dz$,.

6 Convective precipitation $\overline{\mathrm{PPT}_{CV}}$ ($\mathrm{mm\,day^{-1}}$), (F7.2):

7 Large-scale precipitation $\overline{\mathrm{PPT}_{LS}}$ ($\mathrm{mm\,day^{-1}}$), (F7.2):

5.2 Detailed single-point diagnostics from the centre of the IFA

The diagnostics and formats are identical to those for the area averaged diagnostics. The only differences are the file names and the inclusion of the latitude and longitude in the comments line.

5.2.1 Location, vertical resolution and time resolution

The centre of TOGA-COARE IFA is defined to be $2°S$, $156°E$. This is chose for consistency with the SCMs. It should be noted that it is not the centre of the region used for the area averged diagnostics. Participants should submit results from the gridpoint nearest to this location, at each model level, and on each model timestep for the entire 48-hour forecast.

5.2.2 Profiles

Submit the results for each quantity as a separate ASCII file in the file format described in appendix A. Include the height z (km, F7.3) of the model level or half level as appropriate, and the mid-point of the time interval $\bar{t}$ (hours, F6.1) from the start of the integration x,y coordinates respectively. In the comments line of the file please include the exact latitude ($°N$,F8.2) and longitude ($°E$,F8.2) of the point actually used, e.g.

```
#   -2.22  155.83
```

Name each file as *experiment*.np*item*.1.*modeller*(.*run*) where *experiment* is the experiment number given in section 4.1, *item* is the number of the diagnostic from the list below and *modeller* is the name of the modeller. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup.

The list of diagnostics is the same as for the IFA area average case.

5.2.3 Budget terms

Submit the results for each quantity listed below as a separate ASCII file in the file format described in appendix A. Include the height z (km, F7.3) of the model level or half level as appropriate, and the mid-point of the time interval $\bar{t}$ (hours, F6.1) from the start of the integration x,y coordinates respectively.In the comments line of the file please include the exact latitude ($^{\circ}N$,F8.2) and longitude ($^{\circ}E$,F8.2) of the point actually used.

Name each file as *experiment*.nb*item*.1.*modeller*(.*run*) where *experiment* is the experiment number given in section 4.1, *item* is the number of the diagnostic from the list below and *modeller* is the name of the modeller. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup.

The list of diagnostics is the same as for the IFA area average case.

5.2.4 Timeseries

Submit results for each of the groups in separate files. Name each file *experiment*.nt*group*.1.*modeller*(.*run*), following the convention for the profile diagnostics. Start each file with the two comment lines described in the special file format in appendix A, with the group number for *item* and omitting *variable_name*. In the comments line of the file please include the exact latitude ($^{\circ}N$,F8.2) and longitude ($^{\circ}E$,F8.2) of the point actually used.

Please write the data as: all the variables for each time level 1 on one line, all the variables at time level 2 on the next line, ..., all the variables at the last time level on the last line. Using the formats specified below, with no spaces between the variables, will ensure all the data fits on one line of 80 characters. Please output data for each model timestep

The list of diagnostics is the same as for the IFA area average case.

5.3 Detailed single-point diagnostics from the other points in the IFA

In order to assess the spatial variability with the IFA, participants are requested to supply results from other gridpoints within the IFA. The diagnostics and formats are identical to those for the area averaged diagnostics and the centre point of the IFA. The only differences are the file names and the inclusion of the latitude and longitude in the comments line.

5.3.1 Location, vertical resolution and time resolution

Participants should submit results from the other gridpoints within the region $1^{\circ}S$ - $3^{\circ}S$, $153^{\circ}E - 157^{\circ}E$. If you are not able to supply all the points then priority should be given to those gridpoints nearest to the gridpoint used as the centre of the IFA in Section 5.2. The results from the centre of IFA (Section 5.2) should not be repeated in this section. Results should be supplied for each point, at each model level, and on each model timestep for the entire 48-hour forecast.

5.3.2 Profiles

Submit the results for each quantity and gridpoint as a separate ASCII file in the file format described in appendix A. Include the height z (km, F7.3) of the model level or half level as appropriate, and the mid-point of the time interval $\bar{t}$ (hours, F6.1) from the start of the integration x,y coordinates respectively. In the comments line of the file please include the exact latitude ($^\circ N$,F8.2) and longitude ($^\circ E$,F8.2) of the point actually used, e.g.

```
#   -2.22  155.83
```

Name each file as *experiment*.np*item.gridpoint.modeller*(*.run*) where *experiment* is the experiment number given in section 4.1, *item* is the number of the diagnostic from the list below and *modeller* is the name of the modeller. *gridpoint* is a integer greater or equal to 2 that is unique to the gridpoint (*gridpoint*=0 is used for the area average, *gridpoint*=1 is used for the centre of the IFA). The gridpoint in the north-west of the area supplied should be *gridpoint* =2. The value of gridpoint should increase from west to east and then from north to south. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup.

The list of diagnostics is the same as for the IFA area average case.

5.3.3 Budget terms

Submit the results for each quantity and gridpoint listed below as a separate ASCII file in the file format described in appendix A. Include the height z (km, F7.3) of the model level or half level as appropriate, and the mid-point of the time interval $\bar{t}$ (hours, F6.1) from the start of the integration x,y coordinates respectively.In the comments line of the file please include the exact latitude ($^\circ N$,F8.2) and longitude ($^\circ E$,F8.2) of the point actually used.

Name each file as *experiment*.nb*item.gridpoint.modeller*(*.run*) where *experiment* is the experiment number given in section 4.1, *item* is the number of the diagnostic from the list below and *modeller* is the name of the modeller. *gridpoint* is a integer greater or equal to 2 that is unique to the gridpoint (*gridpoint*=0 is used for the area average, *gridpoint*=1 is used for the centre of the IFA). The gridpoint in the north-west of the area supplied should be *gridpoint* =2. The value of gridpoint should increase from west to east and then from north to south. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup.

The list of diagnostics is the same as for the IFA area average case.

5.3.4 Timeseries

Submit results for each of the groups in separate files. Name each file *experiment*.nt*group.gridpoint.modeller*(*.run*), following the convention for the profile diagnostics. Start each file with the two comment lines described in the special file format in appendix A, with the group number for *item* and omitting *variable_name*. *gridpoint* is a integer greater or equal to 2 that is unique to the gridpoint (*gridpoint*=0 is used for the area average, *gridpoint*=1 is used for the centre of the IFA). The gridpoint in the north-west of the area supplied should be *gridpoint* =2. The value of gridpoint should increase from west to east and then from north to south. In the comments line of the file please include the exact latitude ($°N$,F8.2) and longitude ($°E$,F8.2) of the point actually used.

Please write the data as: all the variables for each time level 1 on one line, all the variables at time level 2 on the next line, ..., all the variables at the last time level on the last line. Using the formats specified below, with no spaces between the variables, will ensure all the data fits on one line of 80 characters. Please output data for each model timestep.

The list of diagnostics is the same as for the IFA area average case.

5.4 Regional diagnostics

In addition to the detailed diagnostics, it is requested that the participants submit a much smaller range of diagnostics covering a region surrounding the IFA. This is to allow the detailed diagnostics to be put into the context of the local large-scale circulation and possibly to identify the sources of any gross differences between the models. There will be no direct comparision between these large-scale diagnostics and the SCMs or CRMs, and therefore, there is no advantage in retaining common file formats with the SCMs and CRMs. The four-dimensional nature of the large-scale diagnostics means that the ASCII file format is no longer applicable. Therefore, the large-scale diagnostics may be submitted in either grib or netcdf formats.

5.4.1 Location, vertical resolution and time resolution

Diagnostics are requested from the region between $20°S$ and $20°N$, $130°E$ and $180°E$. This region is approximately centred on the centre of the IFA at $2°S$, $156°E$. Participants should submit results from all the gridpoints within this region. For multi-level fields, diagnosics should be produced on the following pressure levels: 1000hPa, 850hPa, 700hPa, 500hPa, 400hPa, 300hPa, 250hPa, 100hPa. The diagostics should be produced every 3-hours, i.e. fields valid at T+3, T+6, ..., T+45 and T+48. The data should be put in a single file for each experiment. Name each file *experiment*.nr.*modeller*(.*run*).*type* where *experiment* is the experiment number given in section 4.1, and *modeller* is the name of the modeller. *run* is an extra 6 (exactly) character file extension to identify data from additional integrations with the non-standard setup. *type* is the file extension - select either grib or netcdf as appropriate.

5.4.2 Multi-level fields

1 Temperature, $\overline{T}$ (K).

2 Relative Humidity, R (unitless), (F6.3): R = $\overline{q}/q^*(\overline{T},\overline{p})$, where $q^*(T,p)$ is the saturation mixing ratio over water.

3 Horizontal wind velocity in the x-direction, $\overline{u}$ ($\mathrm{m\,s^{-1}}$).

4 Horizontal wind velocity in the y-direction, $\overline{v}$ ($\mathrm{m\,s^{-1}}$).

5.4.3 Single-level fields

1 TOA upwelling infrared radiative flux, OLR ($\mathrm{W\,m^{-2}}$)

6 Forcing data for SCMs/CRMs

There are currently no guidelines for producing forcing data for SCMs or CRMs. Anyone wishing to do this should contact Martin Willett (martin.willett@metoffice.gov.uk), Jon Petch (jon.petch@metoffice.gov.uk) or Steve Woolnough (s.j.woolnough@reading.ac.uk).

7 Forcing data for LAMs

Participants wishing to produce forcing data for limited area models should consult directly with the operators of the LAMs. The results from the LAMs should be submitted in the same format as for the global NWP models described in this document.

A Special File Format

Please use this format for submitting 2D arrays $f(x, y)$ with x,y coordinates.

```
# experiment modeller p/b/t item run variable_name
# comments
nx ny
x(1) x(2) ...x(nx)
y(1) y(2) ...y(ny)
f(x_1,y_1) f(x_2,y_1) ...f(x_nx,y_1) f(x_1,y_2) ...
f(x_1,y_ny) f(x_2,y_ny) ...f(x_nx,y_ny)
```

Where `experiment, modeller, p/b/t, item, run` are the identifiers used in the filename and described in section 5. For the control integration please use `xxxxxx` as the run identifier in the file (but not in the file name). Please supply a short variable name as a double check. Include in the comments line, the sampling frequency used. If you have no data to submit for a particular variable please submit a file containing the first two lines with `NO_DATA` as the first comment.