SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2023
Project Title:	An evaluation of the advanced model physics in cycle 46/48 of HARMONIE-AROME with particular emphasis on the new microphysics, radiation and surface schemes.
Computer Project Account:	SPIEGLEE
Principal Investigator(s):	Emily Gleeson
Affiliation:	Met Éireann
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…………………………………………………………….…… …………………………………………………………….……
Start date of the project:	2022
Expected end date:	2024 (as I plan to request an extension)

Computer resources allocated/used for the current year and the previous one

(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	35 M	0 M	35 M	5.6 M
Data storage capacity	(Gbytes)			(National allocation used)	

Summary of project objectives (10 lines max)

An evaluation of the advanced model physics in cycle 46/48 of HARMONIE-AROME with particular emphasis on the new microphysics, radiation and surface schemes.

Summary of problems encountered (10 lines max)

As is often the case in modelling, delays were encountered with model versions so that the nature of the testing has also changed from what I had originally planned to do. The delays also mean that I'd very much appreciate an extension to the project to the end of 2024.

Firstly, we do not yet have a CY48 HARMONIE-AROME flavour of the modelling system and the versions of ecRad (radiation) and LIMA (microphysics) within CY43 are incomplete and cannot be used. Therefore, to test these schemes requires a later version of the model, probably CY49 in the case of HARMONIE.

Summary of plans for the continuation of the project (10 lines max)

So far I have started testing CAMS near real-time and CAMS climatological aerosols in HARMONIE CY46, as well as ICE-T, which is similar to ICE3 but contains elements of the Thompson scheme relevant for supercooled liquid water. The impact of the aerosols used, and the ICE-T scheme, is significant on cloud and radiation, so much so that it will be necessary to run many tests using HARMONIE in climate mode to get a good handle on the impact of several of the settings.

Therefore, for the continuation of the project, I plan to run the model in climate mode, continue testing various settings associated with CAMS nrt aerosols, such as the minimum cloud droplet number concentration, the inclusion of sea salt and desert dust emissions, the addition of extra aerosol types in the radiation calculations, and several other tuneable parameters. ICE-T requires further extensive testing and within the next year, a later cycle of HARMONIE will be available, which will include the full ecRad and LIMA schemes to enable testing of these for operational purposes.

List of publications/reports from the project with complete references

None so far but a paper is in progress led by Daniel Martín, AEMET. Results have been presented at a few meetings, but I have no formal reports to include at this stage.

Summary of results

Essentially the project started this year as I did not have a version of the code to work with last year. So far about 50 experiments have been run over a small domain covering Ireland and the UK. 4 two-week periods covering the 4 seasons were considered. Experiments were run using the Tegen and CAMS aerosol climatologies and CAMS nrt aerosols. Some tunings were considered such as the minimum CDNC, minimum supersaturation and the use of sea-salt emissions. In addition, the use of the ICE-T option in cloud microphysics was tested and a variable called RFRMIN(24) which allows for an extra variance term was also tested, as the default setting leads to an under-estimation of low cloud.

The aerosols, ICE-T and RFRMIN(24) all have a large impact on clouds and hence radiation. Similar experiments are being carried out by others over the Spanish, Dutch and Danish domains. The large impact of each option also means that a lot more testing and experimenting is required. So far the tests have purely been treated as sensitivity studies and it will be crucial to compare the outputs to useful observations, such as those available in Cloudnet and satellite products.

Sample results are shown below, with further information included in the captions.

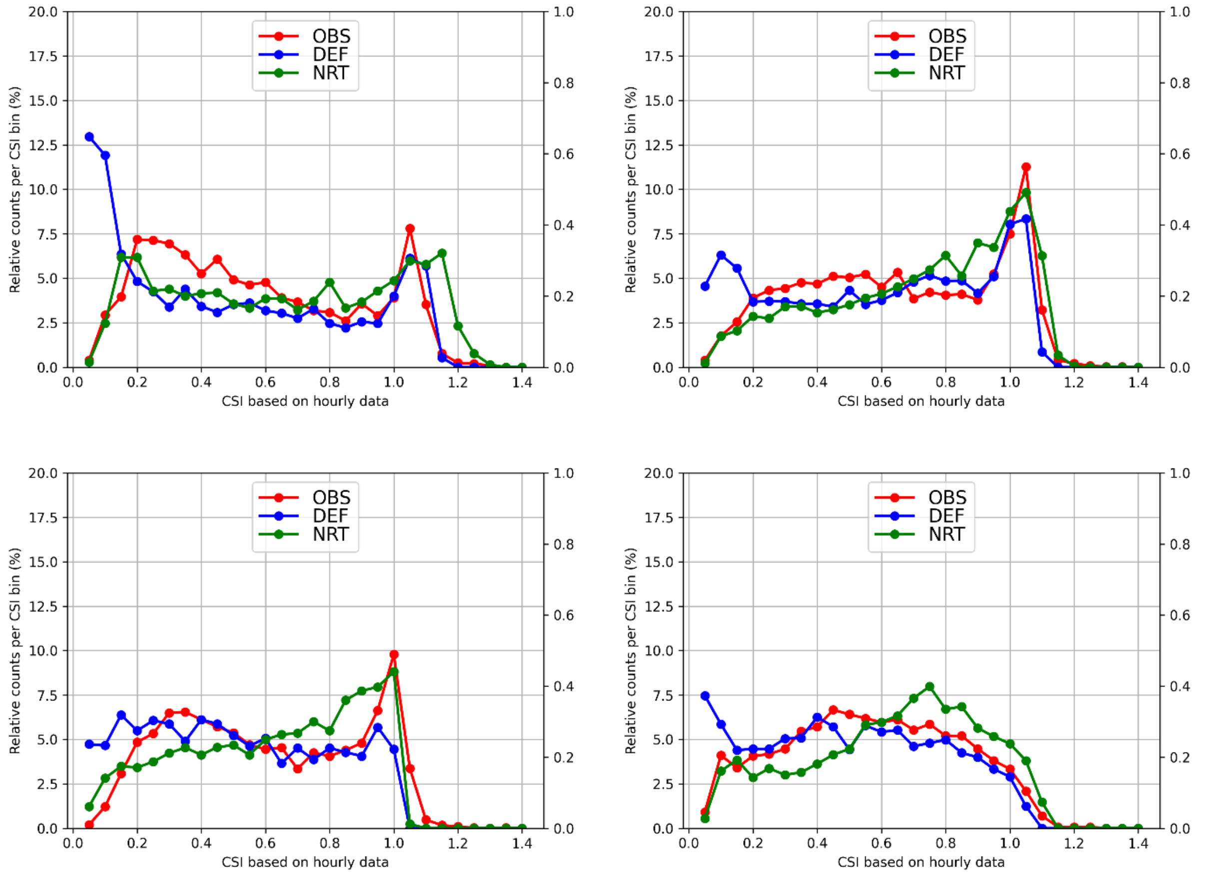

Figure 1: Histograms of clear sky index (i.e. shortwave radiation divided by clear-sky shortwave radiation) calculated for 20 stations in Ireland for Autumn, Spring, Summer and Winter periods. Low CSI generally means thick clouds whereas high CSI values correspond to clear skies or thin cirrus conditions. DEF means the experiment was run with the default Tegen aerosol climatology and it is clear that using Tegen results in a large over-estimation of low CSI cases. At the low CSI end of the scale, the use of nrt aerosols improves things significantly.

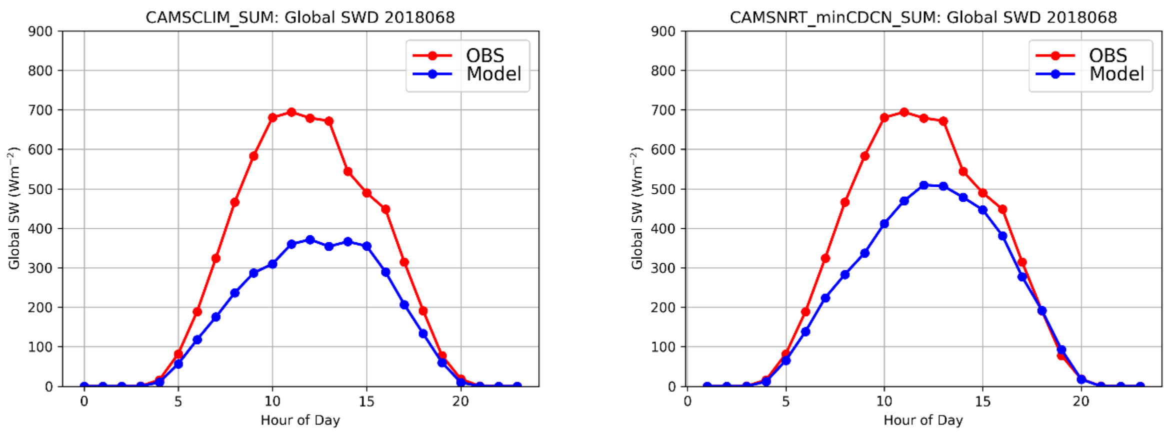

Figure 2: This shows the cycle of global SW radiation (model vs observations) over the course of a day 08/06/2018. Both experiments used nrt aerosols, with the experiments only differencing in the choice of minimum CDNC (left) 10E6 (right) 20E6. The impact is clear and large – over 100 W/m^2 in this case, highlight the importance of the setting and the fact that it should potentially be variable rather than fixed.

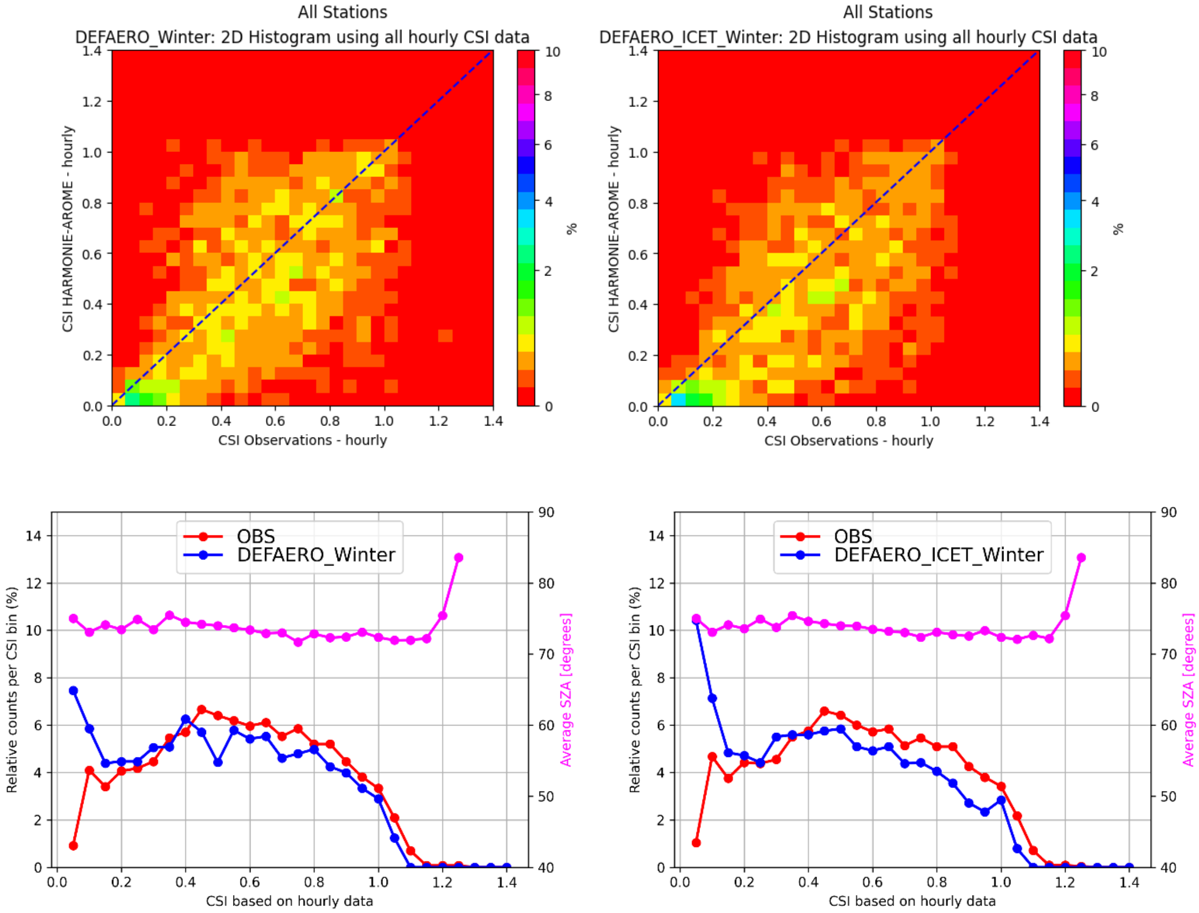

Figure 3: 2D and 1D CSI histograms (winter case) with ICE-T turned on in the plots on the right. Tegen aerosols were used in each case. It is clear than ICE-T leads to an increase in cloud, especially noticeable at the low CSI end of the scale.

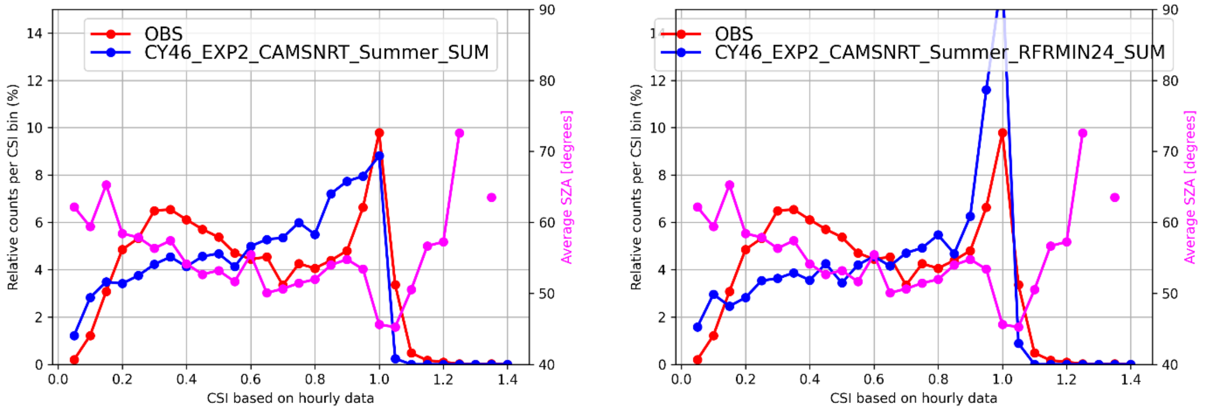

Figure 4: 1D CSI histograms (summer case) with RFRMIN(24)=2.5 on the left and 1 on the RHS. The large impact on cloud is obvious as there is an noticeable increase in high CSI when RFRMIN(24)=1 i.e. less cloud