# 1. Summary

- This poster contains a summary of current or recently completed work using different versions of the HARMONIE-AROME configuration of the shared ALADIN-HIRLAM system.

**Topics include:**
- Evaluation of solar irradiance using observations
- Shortwave (SW) indices as a cloud evaluation tool
- Aerosol climatologies
- Comparison of SW radiation schemes
- Improvements to snow and ice albedos
- Consistency in cloud condensate effect radii used by the cloud microphysics and radiation schemes

# 2. SW Irradiance vs Observations

**Datasets:**
- Irish & Danish global radiation networks (20/26 stations)
- MÉRA 2.5 km reanalysis for Ireland (1981-present) [1]
- DMI NEA domain operational runs (June-Dec. 2017)
- MÉRA versus NEA (model differences):
  - MÉRA: cycle 38H1, IFS SW radiation scheme based on cy25r, SW inhomogeneity factor of 0.7, 3DVar – conventional observations.
  - DMI NEA: cycle 40H1, NLE cloud liquid optical property scheme, SW inhomogeneity factor of 1, significantly more observations than used in MÉRA’s 3DVar.
- Main physics differences are: SURFEX version 7.2 vs 7.3, inhomogeneity factor (0.7 vs 1.0) and turbulence scheme (CBR vs RACM).

**Bias:**
- Biases of 10-20 Wm⁻² for June-Sept. in NEA.
- Change in sign of the bias between MÉRA and DMI runs may be related to the inhomogeneity factor as shown in Section 3.
- See [2] for more detail on the analysis presented in this section and Section 3.

# 3. Indices for Evaluating SW Irradiance/clouds

- GHI provides an objective and quantitative measure for evaluating cloud forecasts during daylight hours.
- We used a clear sky index (CSI) [3] and a variability index (VI) [4].
- CSI involves the ratio of GHI and the theoretical GHI during clear sky conditions; we used the clear sky model of [5].
- Model integrated water vapour was used in the DMI calculations; for MÉRA a typical mid-latitude value of 2.5 g/cm² was assumed.
- A frequency distribution of daily mean CSI weighted using GHI (computed using hourly CSI and GHI) using MÉRA and Irish observations is shown in Fig. 3.

**VI:**
- VI is high for subgrid scale variability that is unresolved by the models.
- VI provides a method of classifying cloud situations.

# 4. Aerosols: Tegen vs CAMS

- Aerosol concentrations and inherent optical properties (IOPs) are needed for atmospheric radiative transfer calculations in NWP.
- The Tegen [6] and CAMS [7] climatologies differ in concentration and IOPs. The difference in IOPs is illustrated in Fig. 6 and 7 which show the ratio of IFS AOD (aerosol optical depth) to AOD at 550 nm at a range of wavelengths for 4 aerosol categories, and the corresponding ratio of CAMS mass extinction (ME) to ME at 550 nm.

# 5. Radiation Scheme Comparison

- HARMONIE-AROME run for Spring 2017 using the IFS cy25r (EC), ACRANE92 (ac) and HIRLAM (hl) radiation schemes.
- Fig. 8 shows observed and modelled GHI at Uti in Finland, a station that represents open sea conditions.
- The forecasts using each scheme follow each other more closely than they follow the observed values. Observed daily averages tend to be lower than forecast, especially when the fluxes are small due to clouds or low solar elevation.
- Under clear skies the differences are small, with a slight underestimation of GHI by each scheme compared to observations.

# 6. Snow and Ice Albedo

- Since autumn 2016 DMI and IMO have initiated glaciers in their domains with 10000 kg/m² of snow on Sept. 7th.
- This is the recommended way for the ECOClimap glacier cover type: “Permanent snow”, and it removes the previously exposed glacier errors [8].
- An example of the current HARMONIE “IGB” Greenland albedos in mid July is shown in Fig. 9, and can be compared with the MODIS July albedos shown in Fig. 10.

- It can be seen that the large dark exposed glacier ice area in Western Greenland is too bright in HARMONIE-AROME.
- Also, the dark patches on the interior ice sheet are not seen in the satellite-derived albedos. Here the aging effect on the snow albedo assumed in the D9S scheme [9] is clearly too high.
- The snow albedo aging effects for glacier snow are better in the CROCUS/ES [10] scheme, but these albedos are also too low (not shown).

# 7. Radiation/ Microphysics Consistency in HARMONIE-AROME

- In IFS cy25r the scheme in [11] is used to parameterize the effective radius of cloud liquid particles. This scheme assumes CCN of 50 and 900 for marine and land aerosols.
- The microphysics parameterization assumes CCN of 100 and 300 for the same aerosol types. Such difference influence the effective radii of cloud liquid particles.
- Subgrid scale fractions of cloud water/ice are also inconsistent between the radiation and microphysics parameterizations.
- Testing is underway to harmonise what is used/available in each scheme.

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**References:**

[2] Nielsen & Gleeson, Atmosphere, 2018
[7] Bozzo et al., ECMWF, 2017
[8] Mottram et al., ASR, 2017
[9] Douville et al., Climate Dynamics, 1995
[10] Vinnet et al., GMD, 2012