Update on the Aerosol GCM Trajectory Experiment

David Neubauer on behalf of Daniel Partridge, Paul Kim and all the participants

17th AeroCom workshop – 16th Oct 2018 – NOAA, College Park, MD, USA

University of Exeter
College of Engineering, Mathematics and Physical Sciences

Eulerian evaluation of Arctic aerosols in GCMs

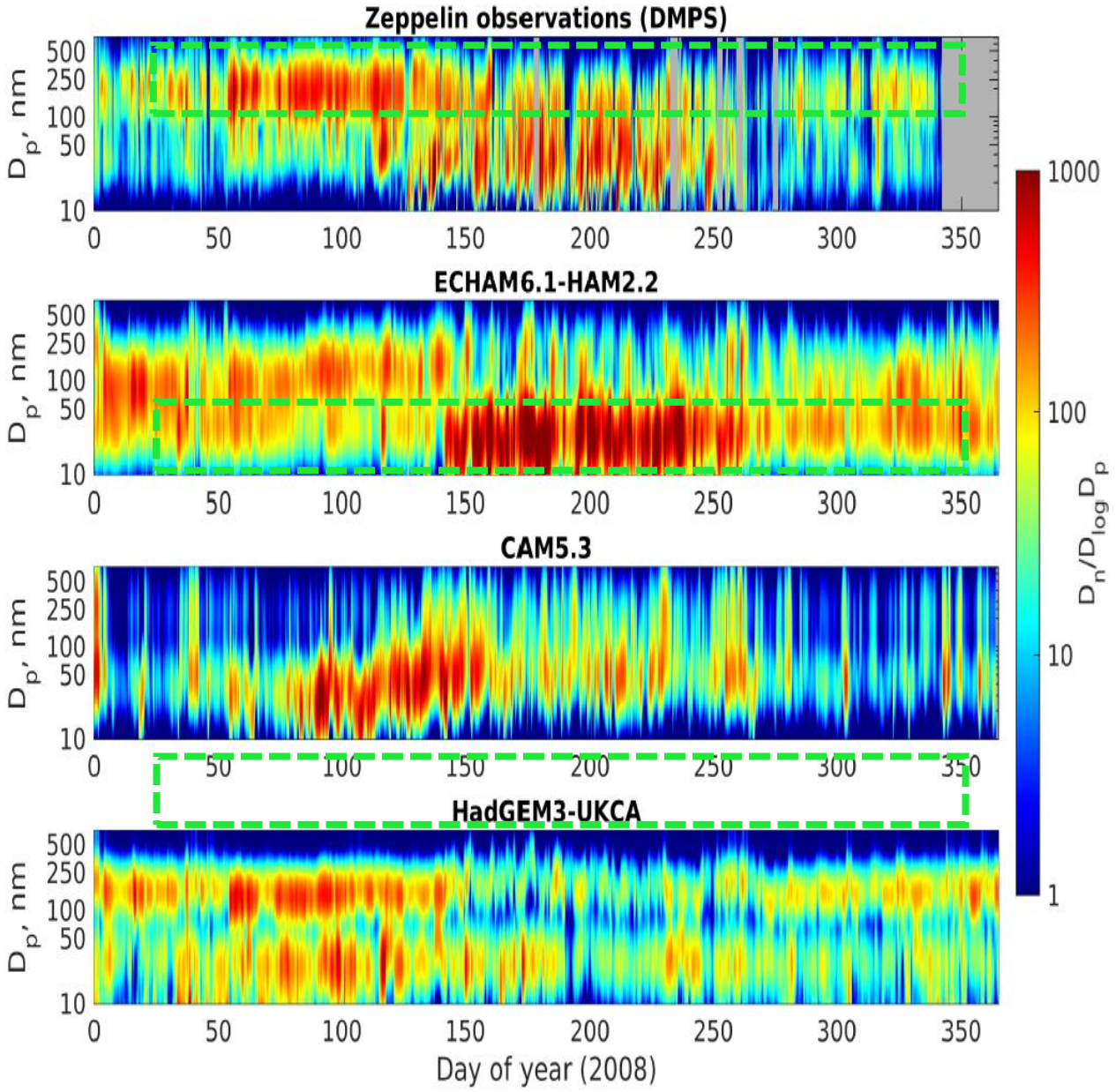
Co-locate model output to observations at target measurement station:

- Spatially
- Temporally (3hr resolution)
- Instrumentation size grid

Provides:

✓ Easy interpretation

✓ Time resolved information of discrepancies.



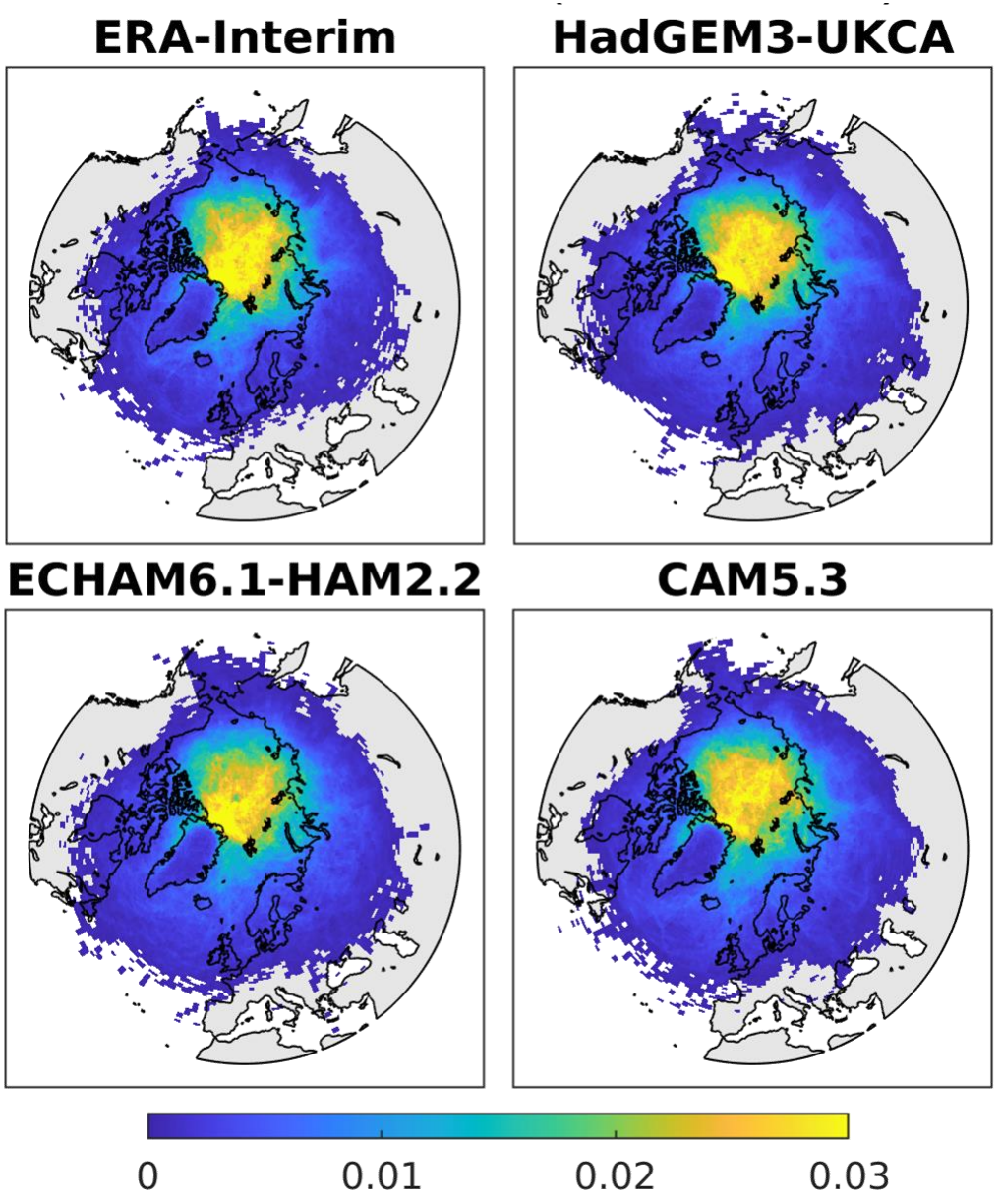
Partridge et al., (in-prep). GCM simulated aerosol size distribution versus Zeppelin DMPS measurements.

What we will do in this experiment:
Lagrangian evaluation of aerosols in GCMs

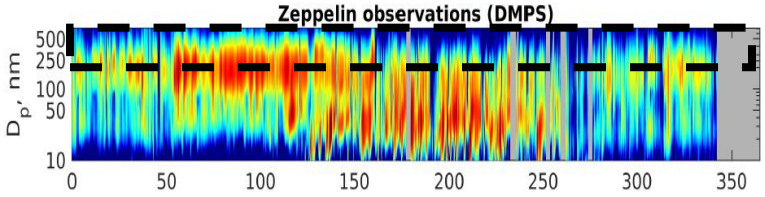
- Transparently attribute discrepancies to model representation of aerosol sources/sinks during transport.
- Perform Lagrangian evaluation for a range of environments: Arctic – Zeppelin, Coastal – Mace Head, Boreal – Hyytiala.
- Compare experimentally derived source-receptor relationships (e.g. BC measurements) with model derived.
- Identify optimum model improvement pathways to reduce current uncertainties in GCM aerosol forcing estimates.

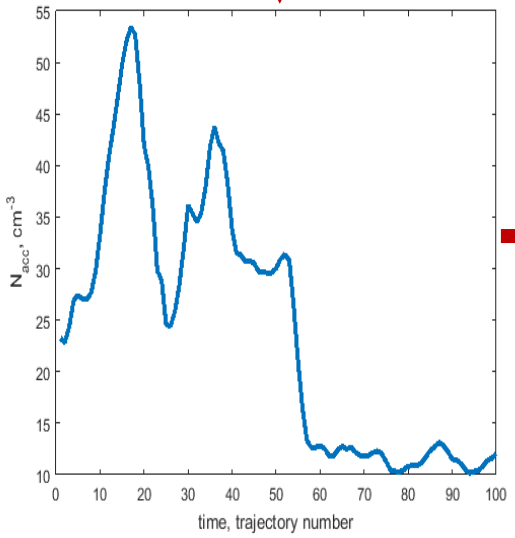
Mt Zeppelin transport climatology (2006-2009 average) on reanalysis and GCM data using HYSPLIT4 trajectory model

- All GCMs nudged to ERA-Interim reanalysis in simulations.
- Trajectories calculated for each model using HYSPLIT and GCM meteorological fields.
- Fraction of trajectory “hits” crossing each grid on average (2006-2009); one trajectory every three hours (ca 10000 trajectories per plot).
- ✓ Successfully calculated GCM trajectories. Dominant transport pathway to Zeppelin station is over ice pack



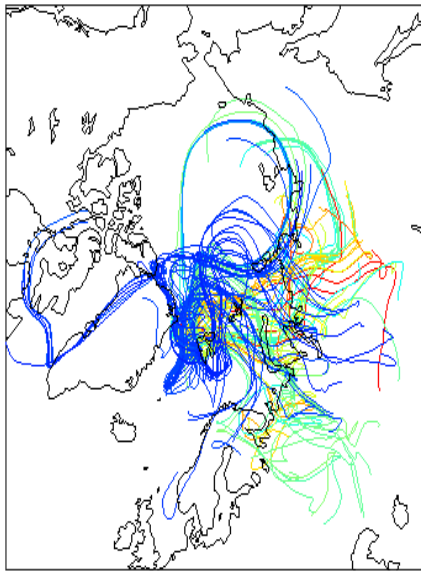
Linking aerosol source areas to observed concentrations at receptor station (Zeppelin, Arctic)



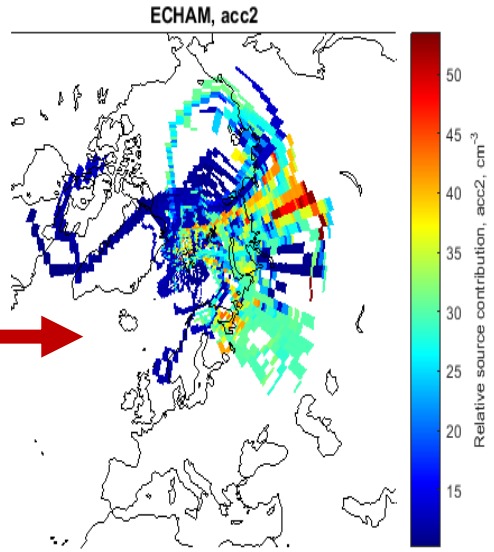


(1) Observed or modelled quantity e.g. N_a (D_p = 250:630nm) extracted with hourly resolution.

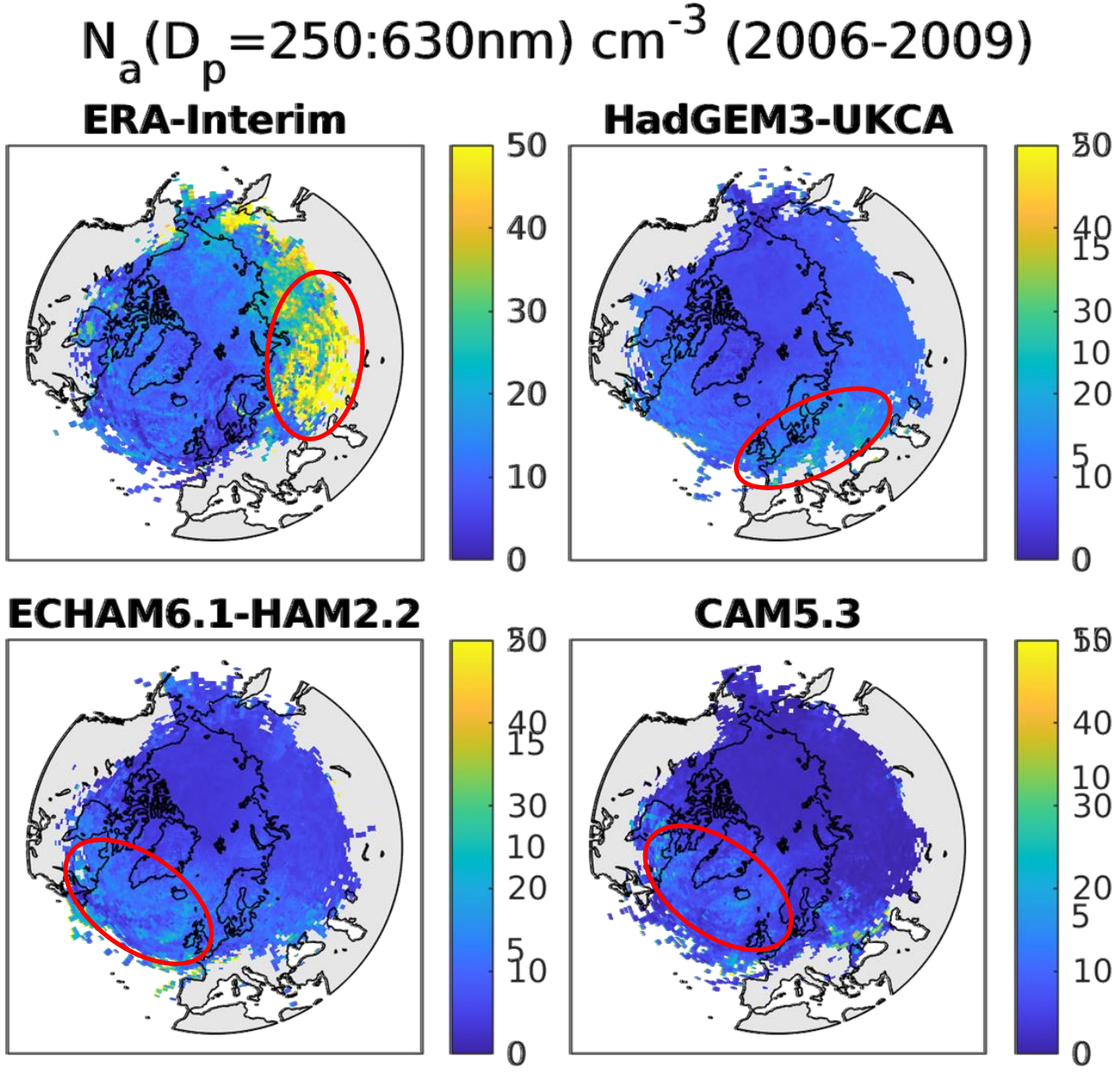
(2) Each trajectory endpoint is assigned a value corresponding to observed concentration



(3) The average value for each grid point is calculated, revealing potential source regions



Relative source contribution of aerosol particle conc. to Svalbard

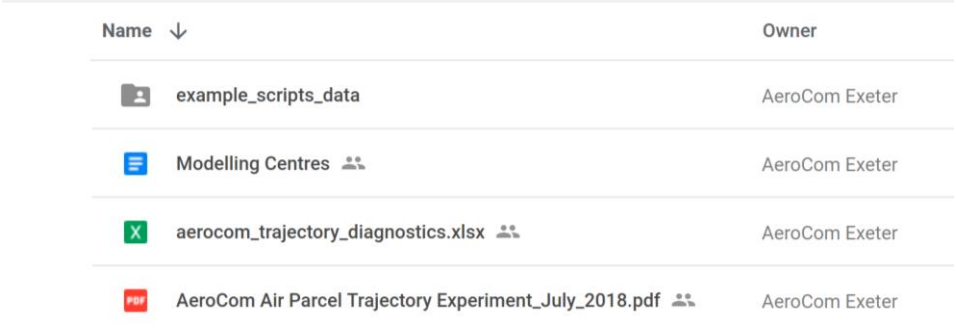


Progress - Experiment protocol & list of diagnostics finalised

Drive

https://drive.google.com/drive/folders/1In35b3Z5iEignZAk3Ad2INAx2JKU3dA3?usp=sharing

Trajectory_Experiment



Name	Owner
example_scripts_data	AeroCom Exeter
Modelling Centres	AeroCom Exeter
aerocom_trajectory_diagnostics.xlsx	AeroCom Exeter
AeroCom Air Parcel Trajectory Experiment_July_2018.pdf	AeroCom Exeter

All necessary resources required for participation can be found online

→ Example postprocessing scripts for conversion of model output to GRIB1.

→ List of participants/ GCM details: Please fill in

→ Details of required GCM diagnostics

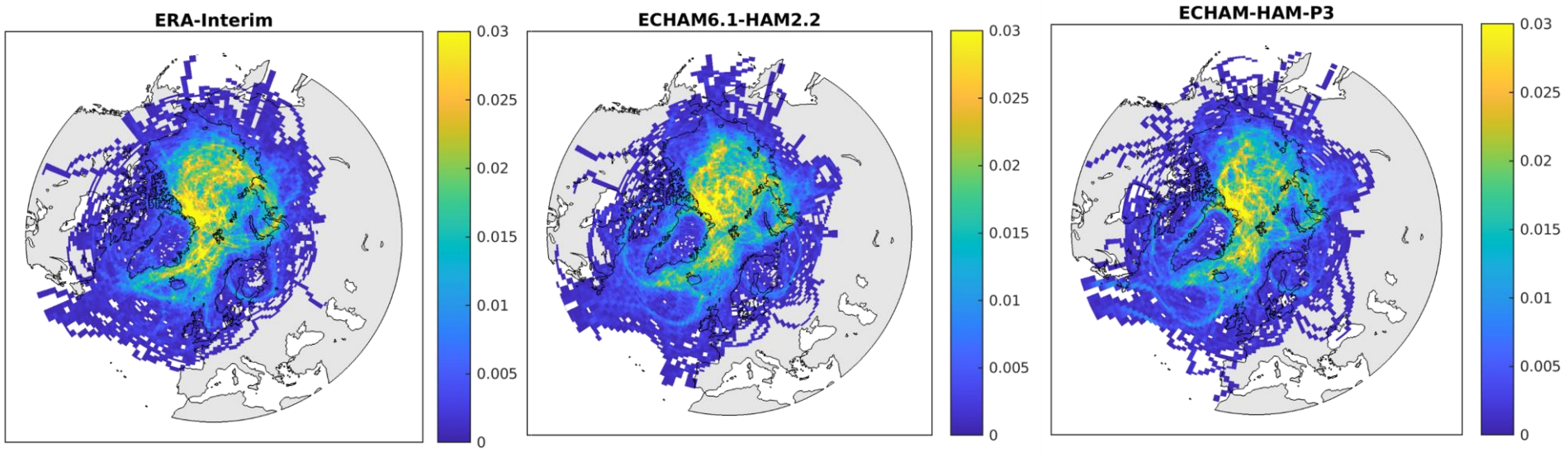
→ Details instructions for participation

- A data server has been setup on Dr Partridge's research groups modelling server at the University of Exeter.
- This will provide efficient interim data storage prior to post-processing model outputs by UoE into trajectory files which will be uploaded to the AeroCom server.

- Approximately 15 models expected to engage. Some model simulations for phase 1 completed or ongoing:
  - *ECHAM-HAM-P3*
  - *ECHAM-SALSA*
  - *HadGEM3-UKCA*
  - *UKESM1*
  - *CAM5*
  - *MIROC-SPRINTARS*

Progress: ECHAM-HAM-P3 successfully submitted Phase 1

Fraction of trajectory “hits” crossing each grid on average during short 6 month simulation (2006-03:2006-09)



- The purpose of Phase 1 is to ensure correct conversion of GCM meteorological fields into required format for trajectory calculations.
- This is achieved by comparing transport climatology of the nudged GCM to ERA-Interim reanalysis derived transport climatology’s.
- One Phase 1 is complete for each model Phase 2 of the experiment will involve repeating the same simulation for a longer duration.

Timetable

- ***Expected submission of model outputs for Phase 1 (short 6 month simulation) submission by November 2018:*** *There is obviously flexibility with dates and new participants are welcome to join.*

- ***Confirmation of successful conversion by UoE by Jan 2019:*** *We will compare transport pathways from model outputs with reanalysis derived climatology for Zeppelin station.*

- ***Expected submission of model outputs for Phase 2 submission by Spring 2019:*** *Simulation configuration identical to Phase 1 only longer (optional 60/120 month period) to span observational records.*

- ***First summary of results to be presented at AeroCom 2019.***

Daniel Partridge
Uni. Exeter Climate Systems (XCS)

Thanks!

Any questions can be addressed to:

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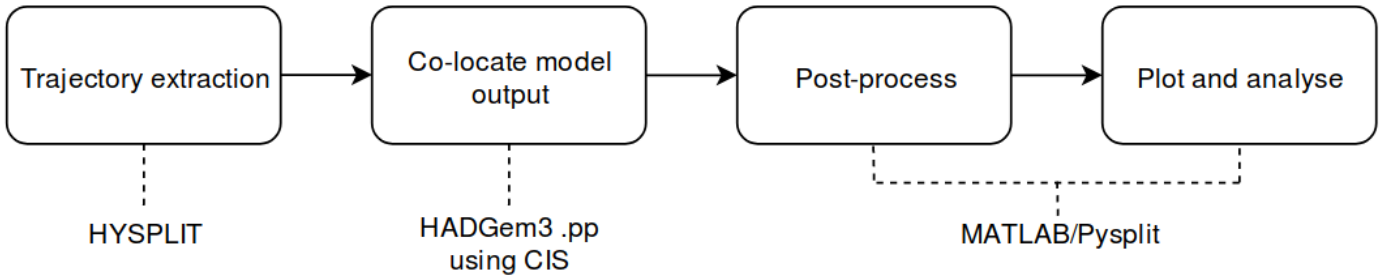
Paul Kim, PhD student
University of Exeter

Appendix

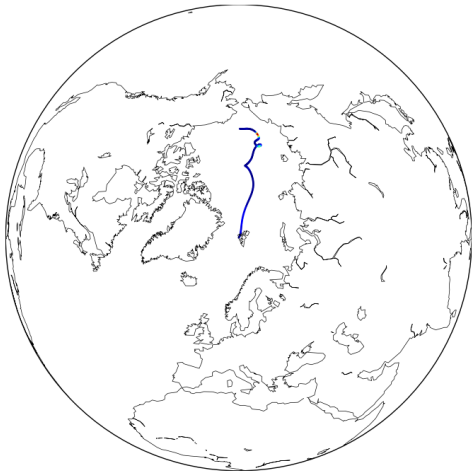
STEP 3: Collocation of GCM simulated aerosol/cloud properties during transport

Community Intercomparison Suite

Lagrangian analysis of simulated trajectories:

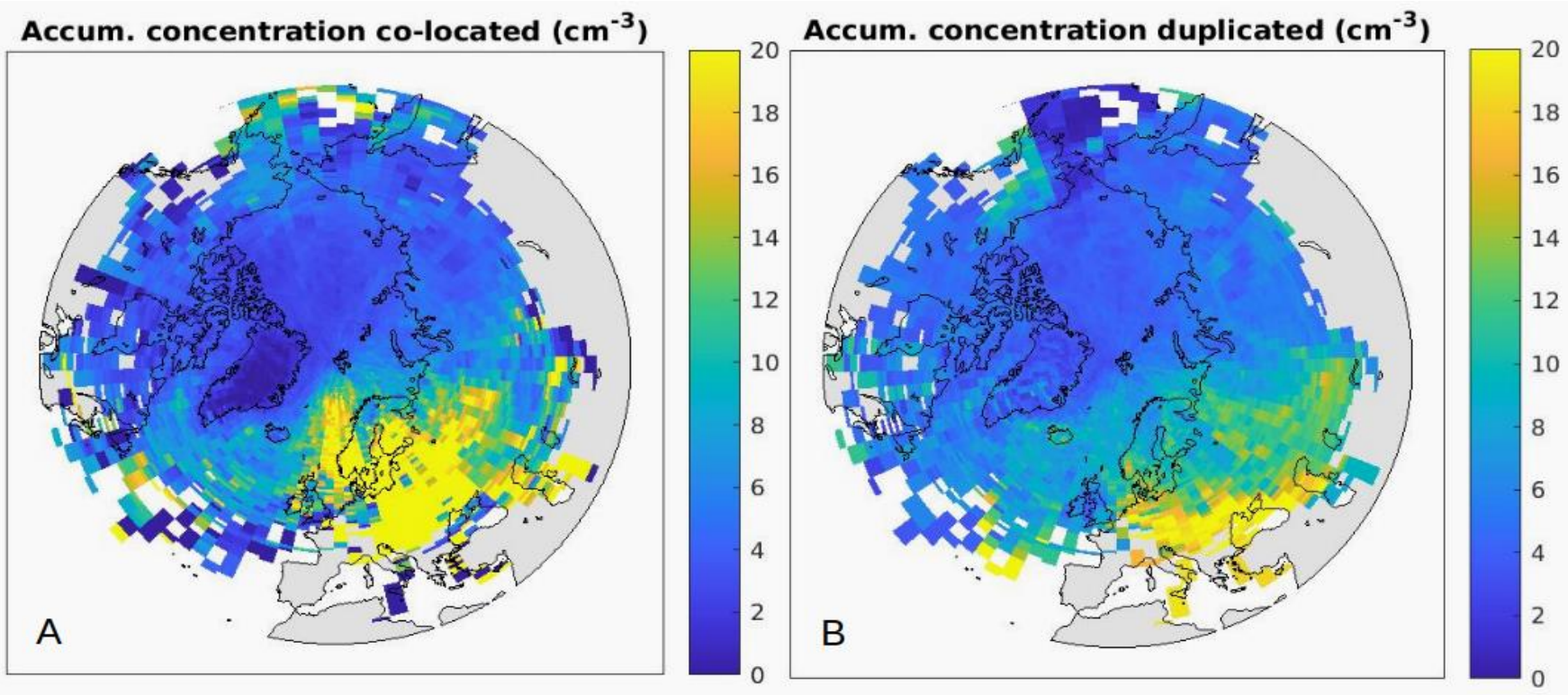


- Understand observed discrepancies between GCMs and observations
- Show how parameterisation affects output through analysis of model fields related to aerosol lifecycle
- Improve GCM representation



Precipitation amount co-located onto HYSPLIT trajectory

Collocation of GCM simulated aerosol/cloud properties during transport. *HadGEM-UKCA, Prelim.*



- Incorporates changes during transport.
- Shows more accurate estimate of source regions and transport pathways.
- Now we can repeat for any model output parameter to investigated sources/sinks *during* transport to the Arctic, e.g. Precipitation, Chlorophyll emissions.

AeroCom Trajectory Data submission