COMBLE Project: On the Road to an LES/SCM Intercomparison

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with contributions from Ann Fridlind, Israel Silber, and many others

General philosophy

To develop a **flexible**, yet comprehensive, **framework** that will **foster collaborations** between international groups of observationalists and modelers, leading to **meaningful scientific results**
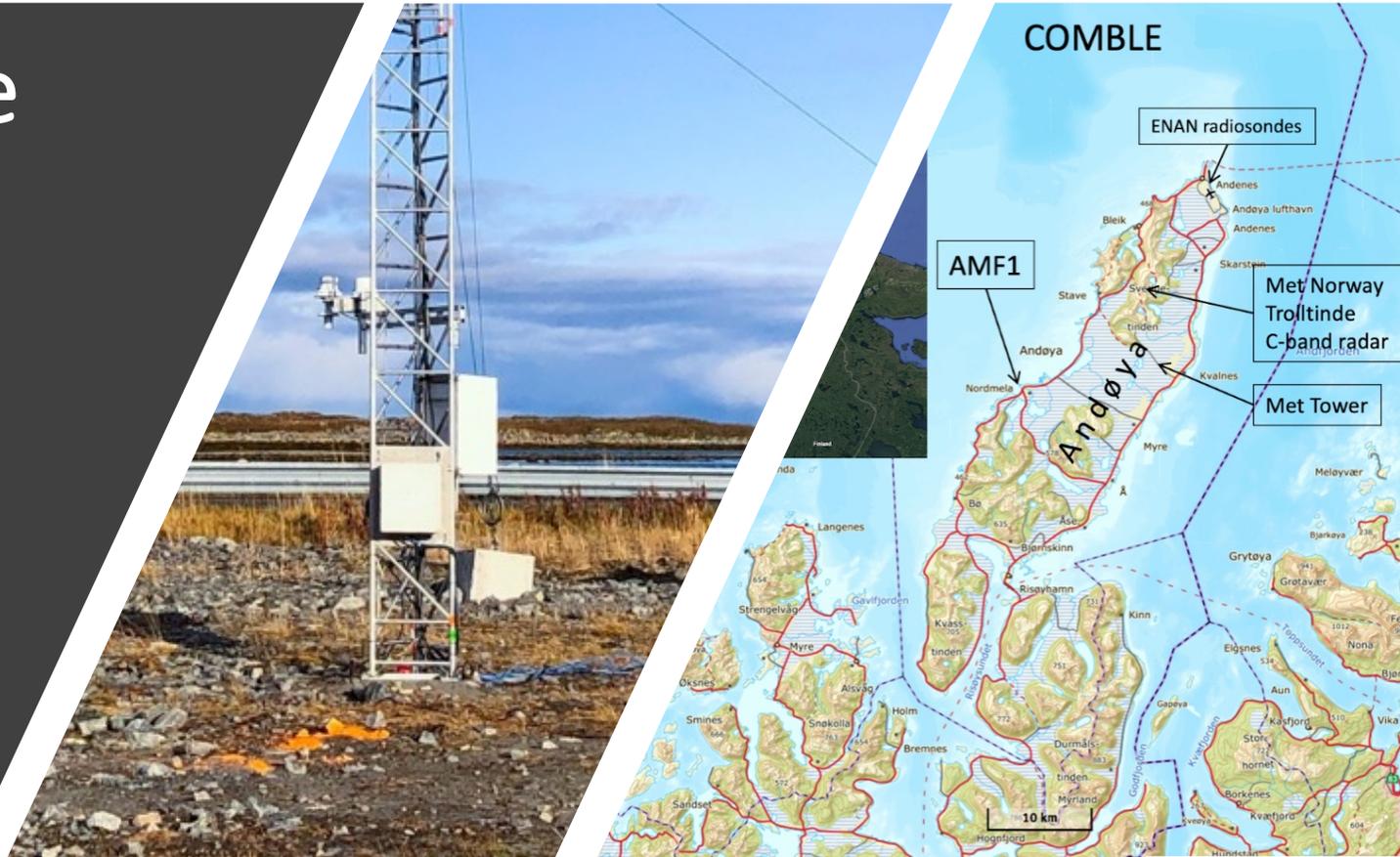
Cold-Air Outbreaks in the Marine Boundary Layer Experiment – COMBLE

- 1 Dec '19 – 31 May '20
- AMF1 with AOS at Andenes
- Instrument suite at Bear Island
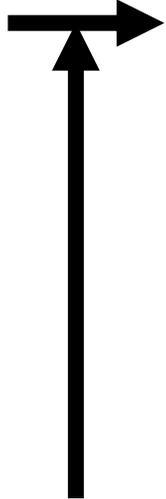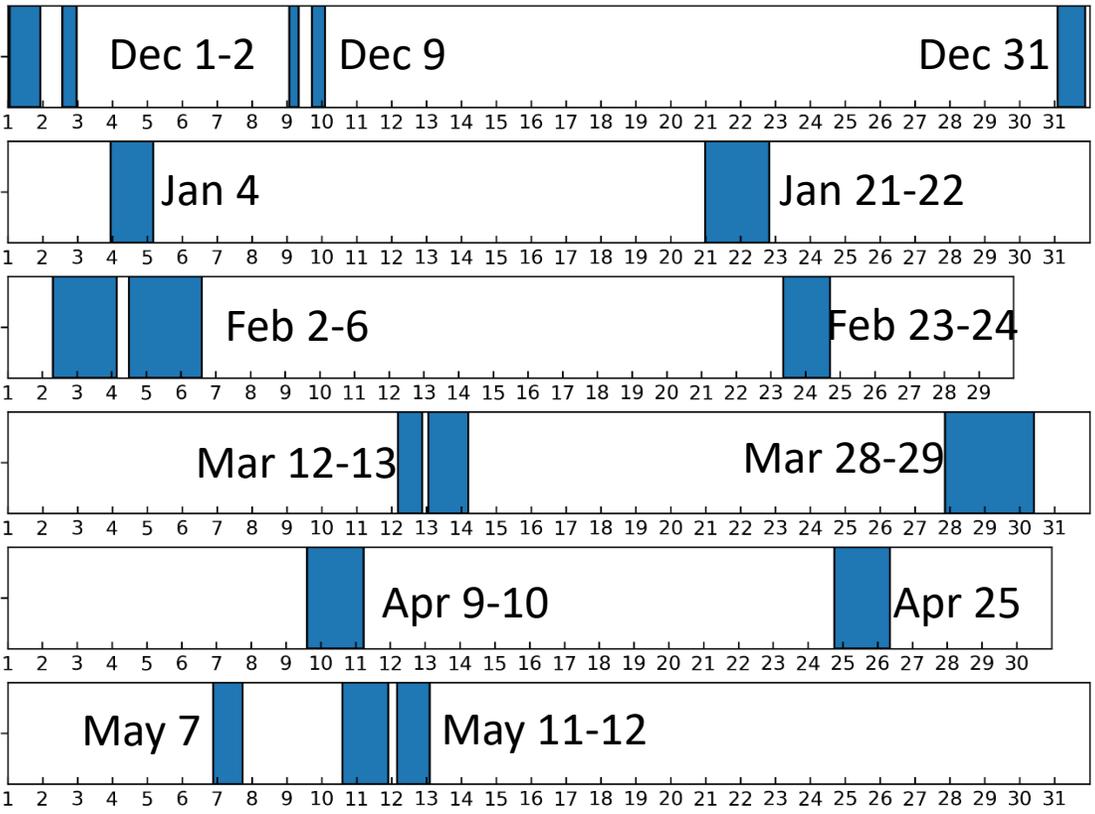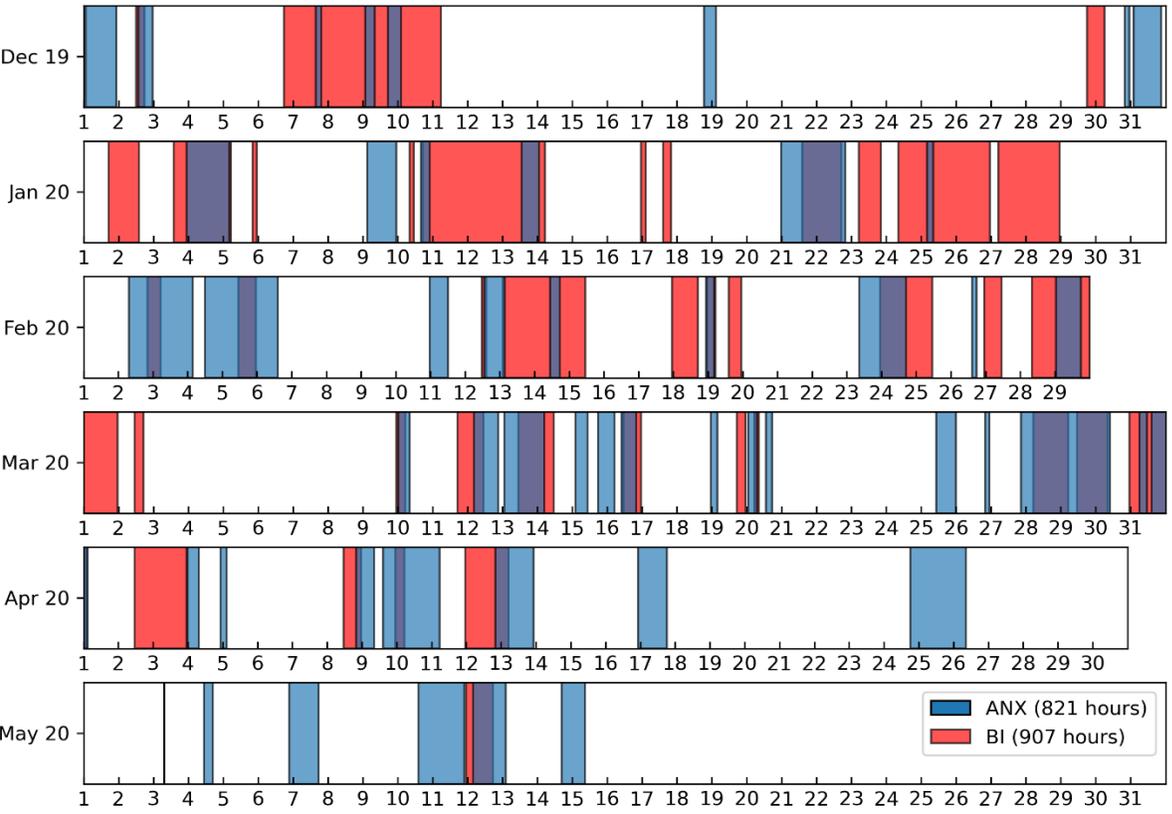
Courtesy: Bart Geerts

Selecting a CAO case study

CAO conditions based on *instability* (MCAO-index),
and *wind speed* and *direction*

CAO: $M \equiv \theta_{SST} - \theta_{850\,hPa} > 0$

Reduction to most "interesting" cases based on duration, intensity,
vertical transects, and satellite imagery

Courtesy: Christian Lackner
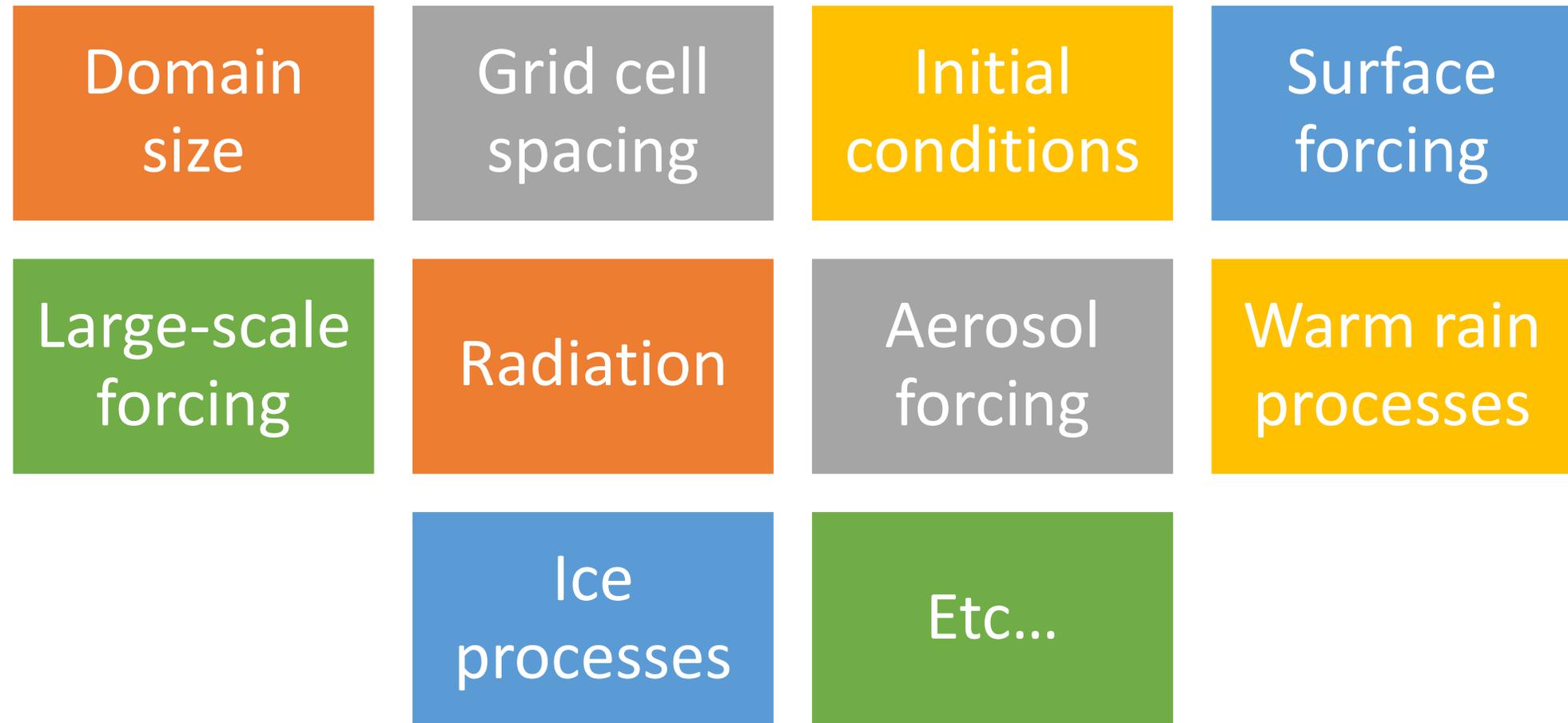
CAO Case Rankings

Ranking	Intensity	Data Availability	Trajectories	Total
1st	Mar 12-13	May 7	Apr 25	**Mar 12-13**
2nd	Mar 28-29	Apr 25	Jan 4	Apr 25
3rd	Feb 2-6	May 11-12	Mar 12-13	Feb 2-6
4th	Jan 4	Apr 9-10	May 11-12	Mar 28-29
5th	Dec 1-2	Mar 12-13	Jan 21-22	May 11-12
6th	Apr 9-10	Feb 2-6	Mar 28-29	Jan 4
7th	Feb 23-24	Dec 1-2	Feb 2-6	Dec 1-2
8th	Dec 31	Feb 23-24	Dec 9	Apr 9-10
9th	Jan 21-22	Dec 31	Dec 1-2	May 7
10th	Dec 9	Mar 28-29	Feb 23-24	Feb 23-24
11th	May 11-12	Dec 9	May 7	Jan 21-22
12th	May 7	Jan 4	Dec 31	Dec 31
13th	Apr 25	Jan 21-22	Apr 9-10	Dec 9

Then came fruitful discussion and extensive testing to understand sensitivity and determine "best choice"

Domain size	Grid cell spacing	Initial conditions	Surface forcing
Large-scale forcing	Radiation	Aerosol forcing	Warm rain processes
	Ice processes	Etc...	

White Paper presented to the Pan-GASS community

Evaluating simulated convective clouds during Arctic cold-air outbreaks: A model intercomparison study based on COMBLE

Timothy W. Juliano[1], Florian Tornow[2], Ann M. Fridlind[2], Andrew S. Ackerman[2], Bart Geerts[3], Branko Kosović[1], Mikhail Ovchinnikov[4], Peng Wu[4], Lulin Xue[1]

[1]National Center for Atmospheric Research (NCAR)
[2]NASA Goddard Institute for Space Studies (GISS)
[3]University of Wyoming
[4]Pacific Northwest National Laboratory (PNNL)

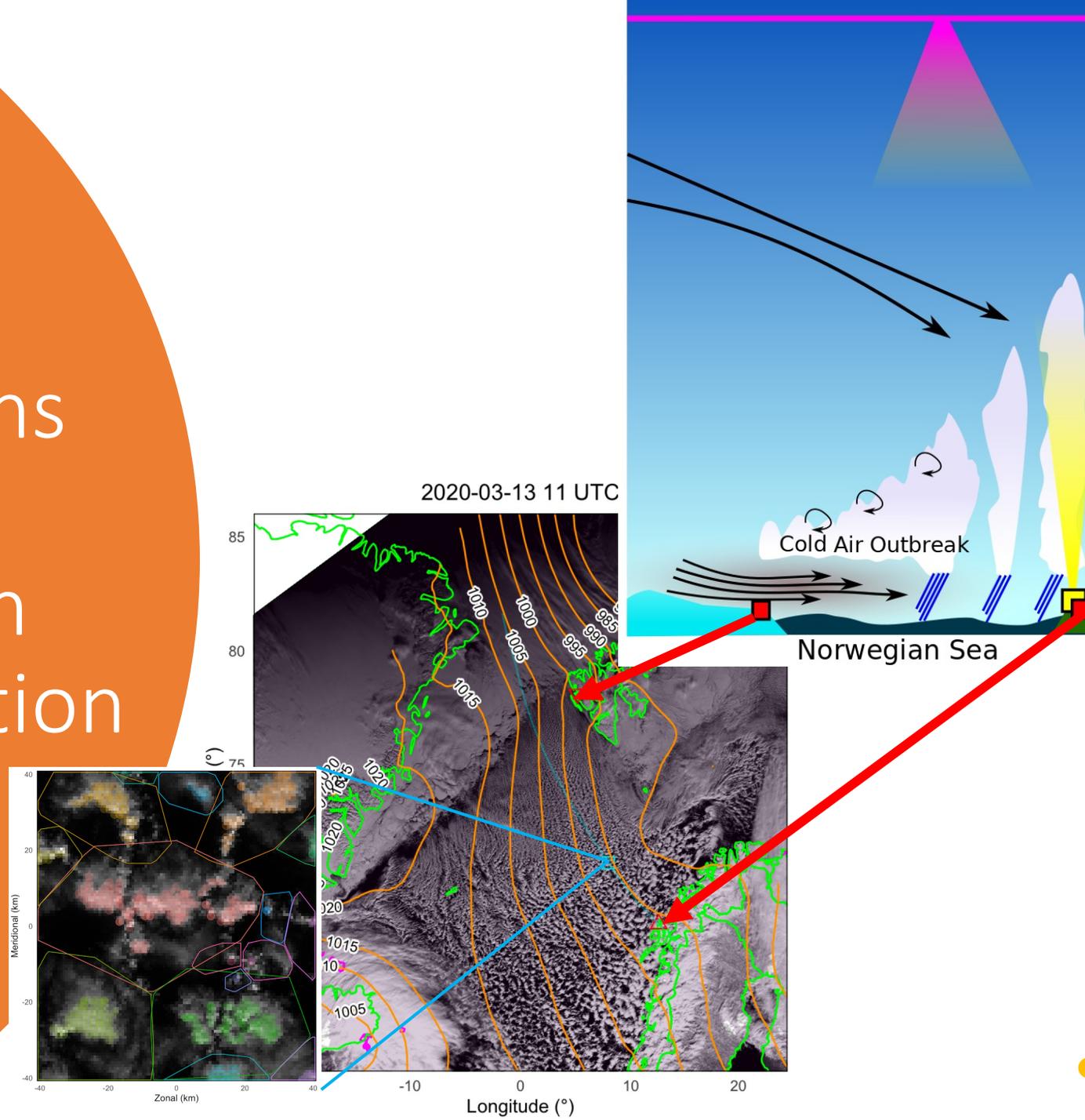# A two-pronged LES & SCM intercomparison

Lagrangian simulations using simplified aerosol treatment

- Diagnostic cloud droplet number and ice number concentrations
- Enabling a focus on thermodynamic forcing

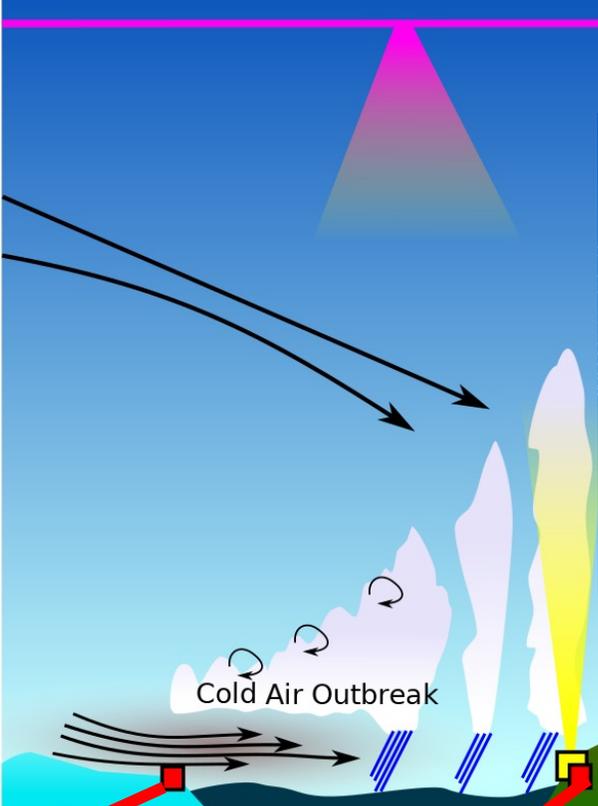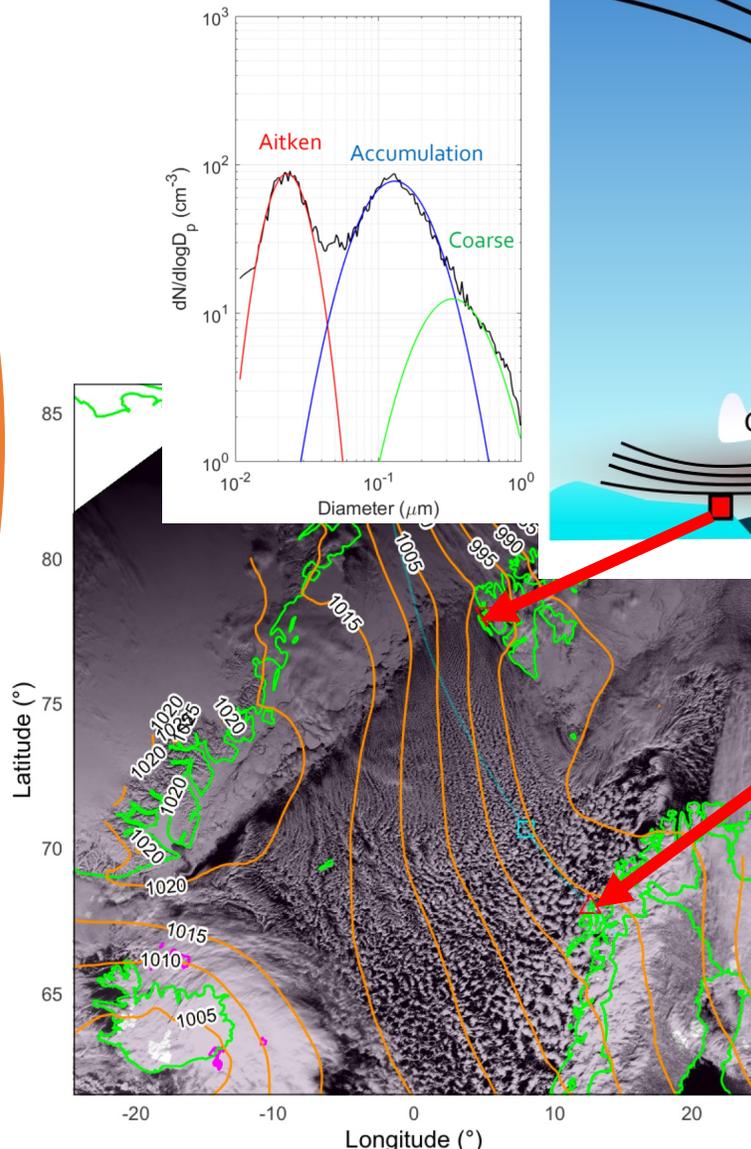**Lagrangian simulations using prognostic aerosol and hydrometeors**

- Multi-modal aerosol informed by upwind ground-based measurements
- Predict cloud droplet number concentration and primary ice formation

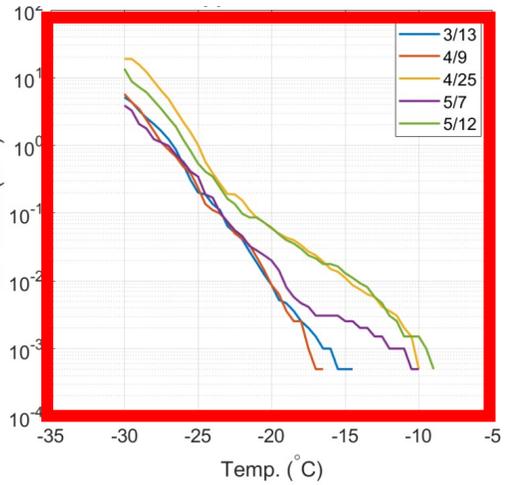Observations for model initialization and evaluation
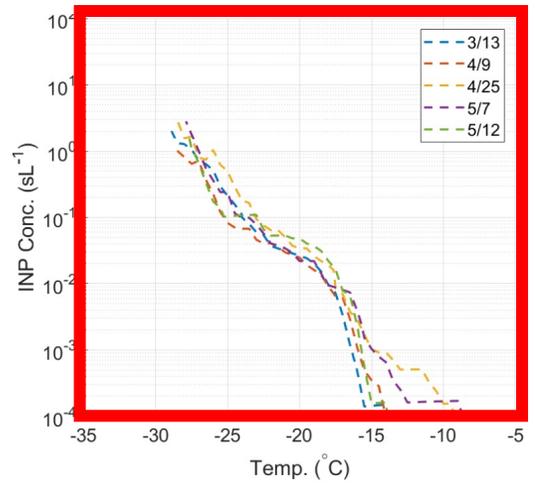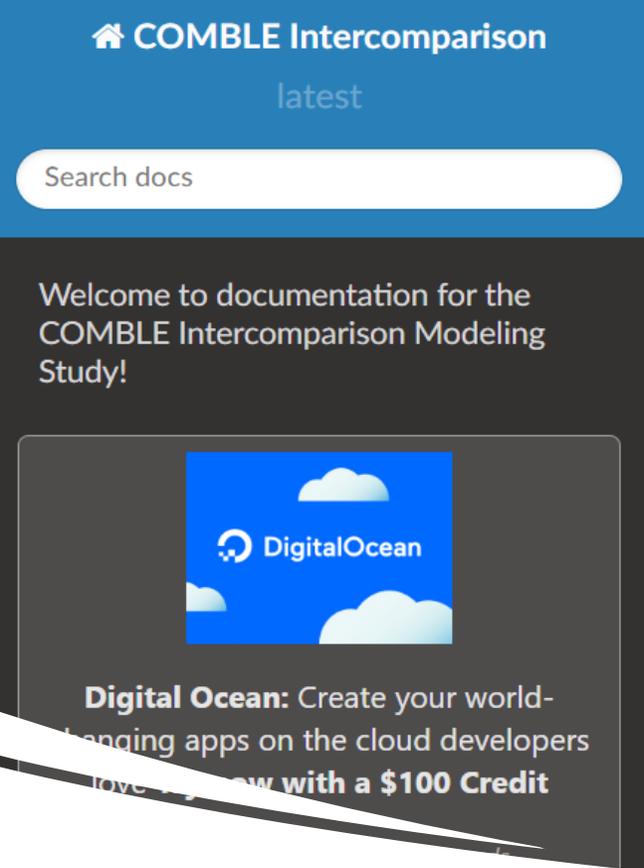
Observations for model initialization and evaluation

Courtesy: Abigail Williams

Initial aerosol PSD

Upwind INP

Cold Air Outbreak

Norwegian Sea

Downwind INP

Resources for participants

- We have created a website that will provide
  - details about the case study
  - Python Notebooks developed to simplify the process for everyone

ARM is supportive of the endeavor

We have acquired access to the DOE Cumulus HPC to

| host model outputs from participants | conduct model evaluations using ARM observations | archive results for future use |

Our hope is that this framework will be adopted for similar intercomparison studies in the future, as historically many diligent efforts have "fallen by the wayside"

Thank You! Questions or Comments?

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