Challenges of Applying EnKF on Arctic Mixed-Phase Clouds

Hui-Wen Lai

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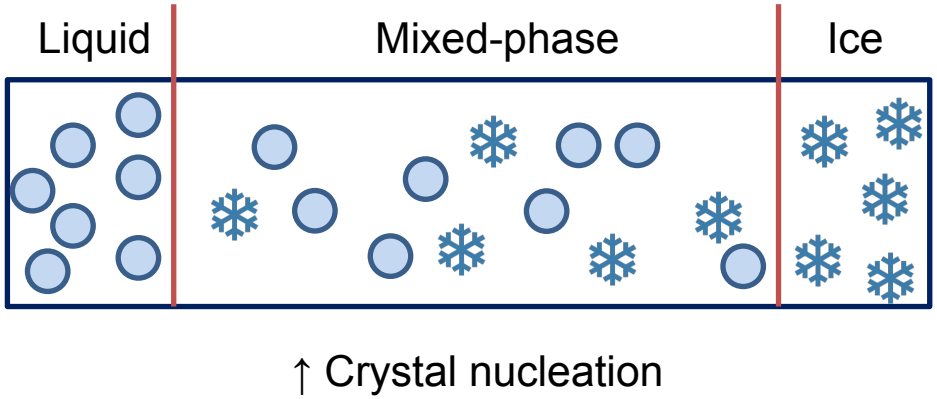
Objective

- Precipitation events around the North Slope of Alaska site are characterized by mixed-phase clouds.

- The processes involved in ice particle formation are more complicated and less well understood than for water droplet formation.



Model Setting

Domain :

D01 : 301 ×201 ×100 (9km)

CASE 1 :

2013/05/02 16UTC

CASE 2 :

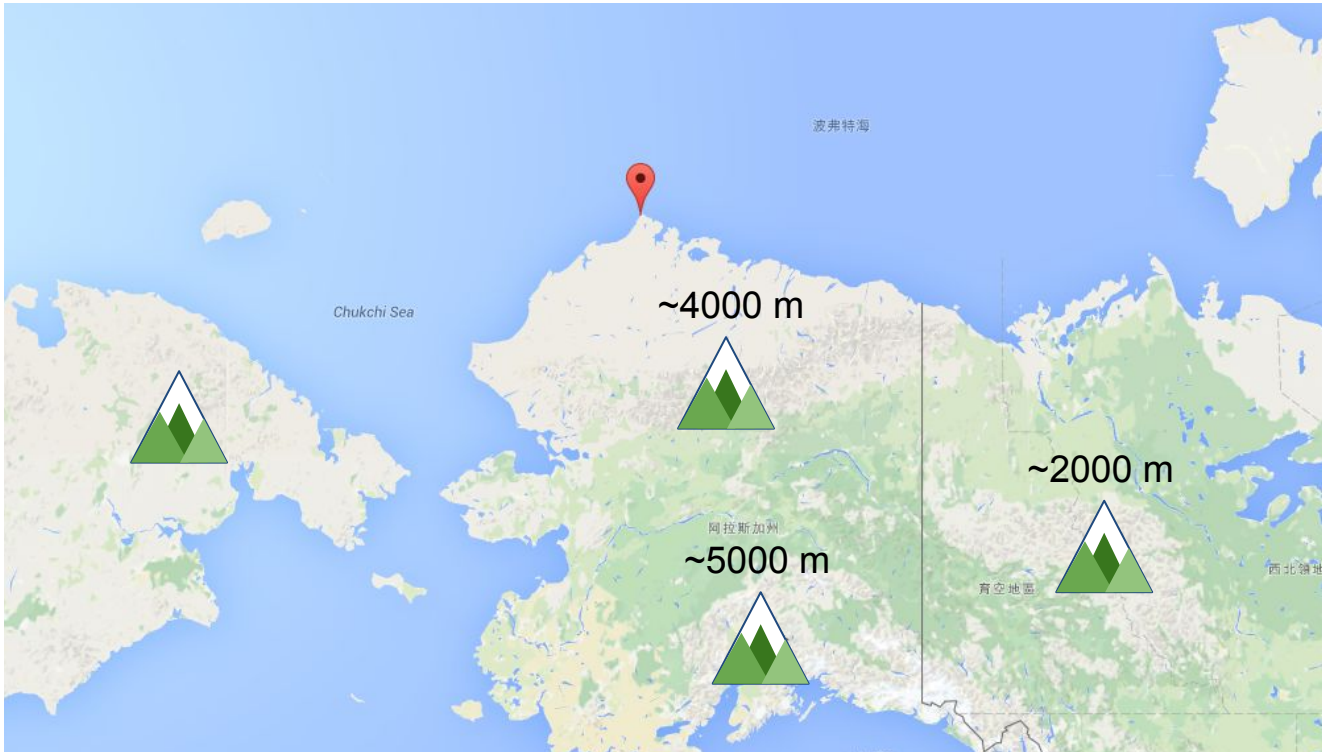
2013/05/02 19UTC

EnKF test option:

1.Different scalings for IC perturbation
2.Different domain sizes

Challenges

- Perturbation
- Topography
- Physical parameterization



Next steps

Atmospheric rivers (ARs) transport and the microphysical processes of precipitation in the Pacific Northwest

- CalWater2
  - The evolution and structure of ARs
  - Aerosol interactions with ARs and the impact on precipitation
- ARM Cloud Aerosol Precipitation Experiment (ACAPEX)
  - Quantify the moisture budget and precipitation processes associated with ARs and characterize aerosol-cloud-precipitation interactions
  - Focus on the clouds and orographic effects over the western coastal range

Next steps

Atmospheric rivers (ARs) transport and the microphysical processes of precipitation in the Pacific Northwest

- The joint CalWater 2/ACAPEX field campaign fills the gap of observations and improve modeling of large-scale dynamics and precipitation processes

- The observations from these field campaigns can be applied in EnKF to help us understanding of the microphysical processes of precipitation and moisture budget in ARs.

Thank you

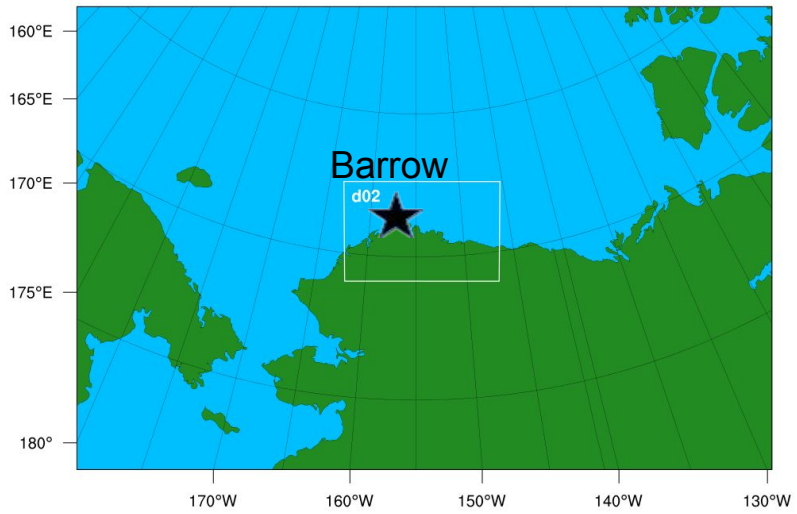
Objective

Mixed-phase clouds

- Mixed-phase clouds are composed of a mixture of supercooled liquid water and ice crystals.

- The processes involved in ice particle formation are more complicated and less well understood than for water droplet formation.

Model Setting



Domain :

D01 : 301 ×201 ×100 (9km)

CASE 1 :

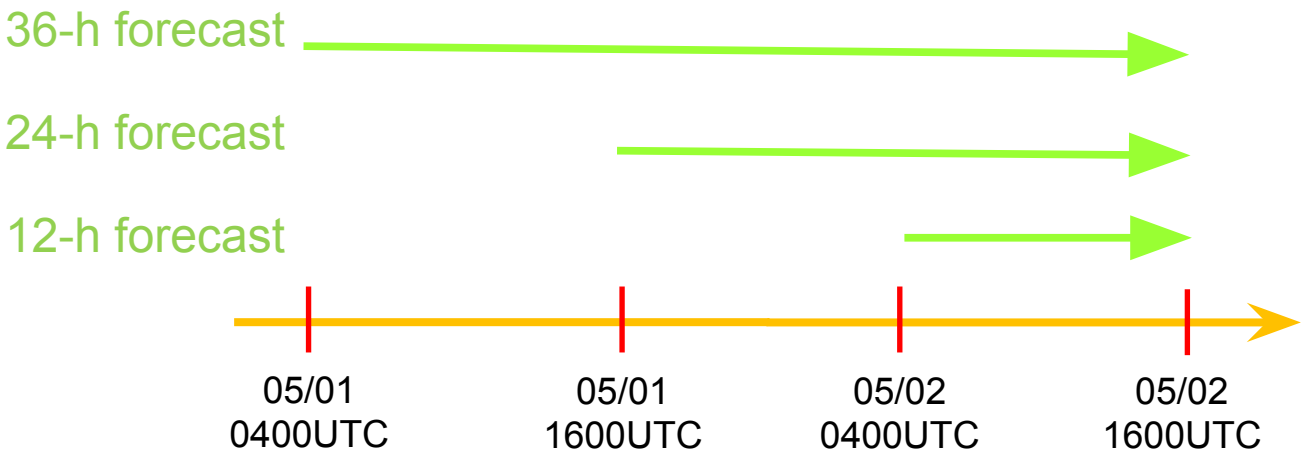
2013/05/02 16UTC

CASE 2 :

2013/05/02 19UTC

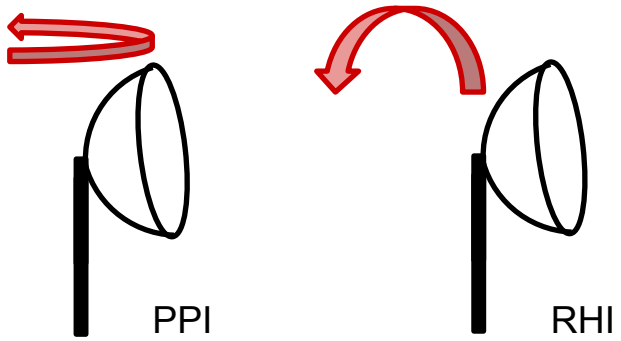
Physics Options in WRF :	
Cumulus Parameterization:	Grell-Freitas ensemble scheme
PBL Schemes:	Yonsei University scheme
Radiation Schemes:	CAM
Surface Schemes:	Noah Land Surface Model
Cloud microphysics:	Morrison 2-moment scheme

Simulation experiments



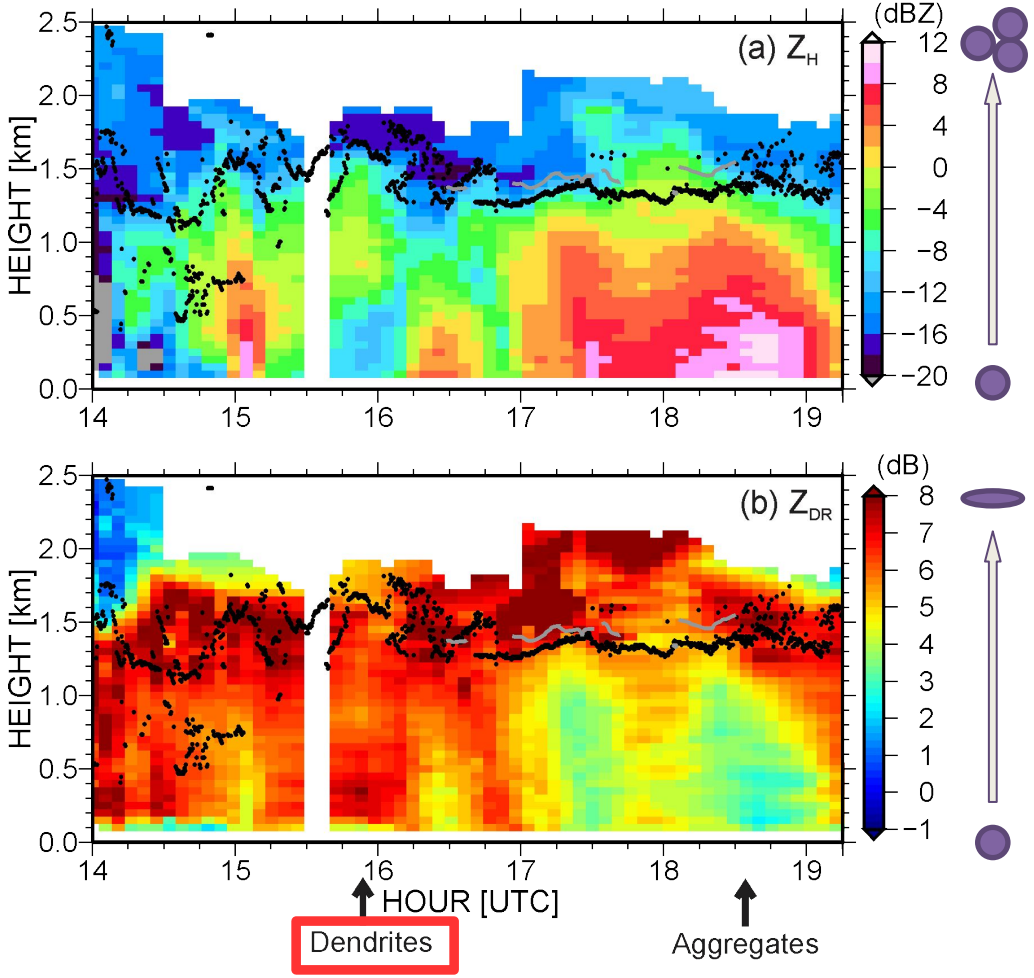
Observation

- The DOE-ARM X-band scanning precipitation radar (X-SAPR) at Barrow, Alaska
- Plan Position Indicator (PPI)
- Range Height Indicator (RHI)



Case (I) Dendrites

Shallow boundary layer cloud system
1600 UTC 2 May 2013

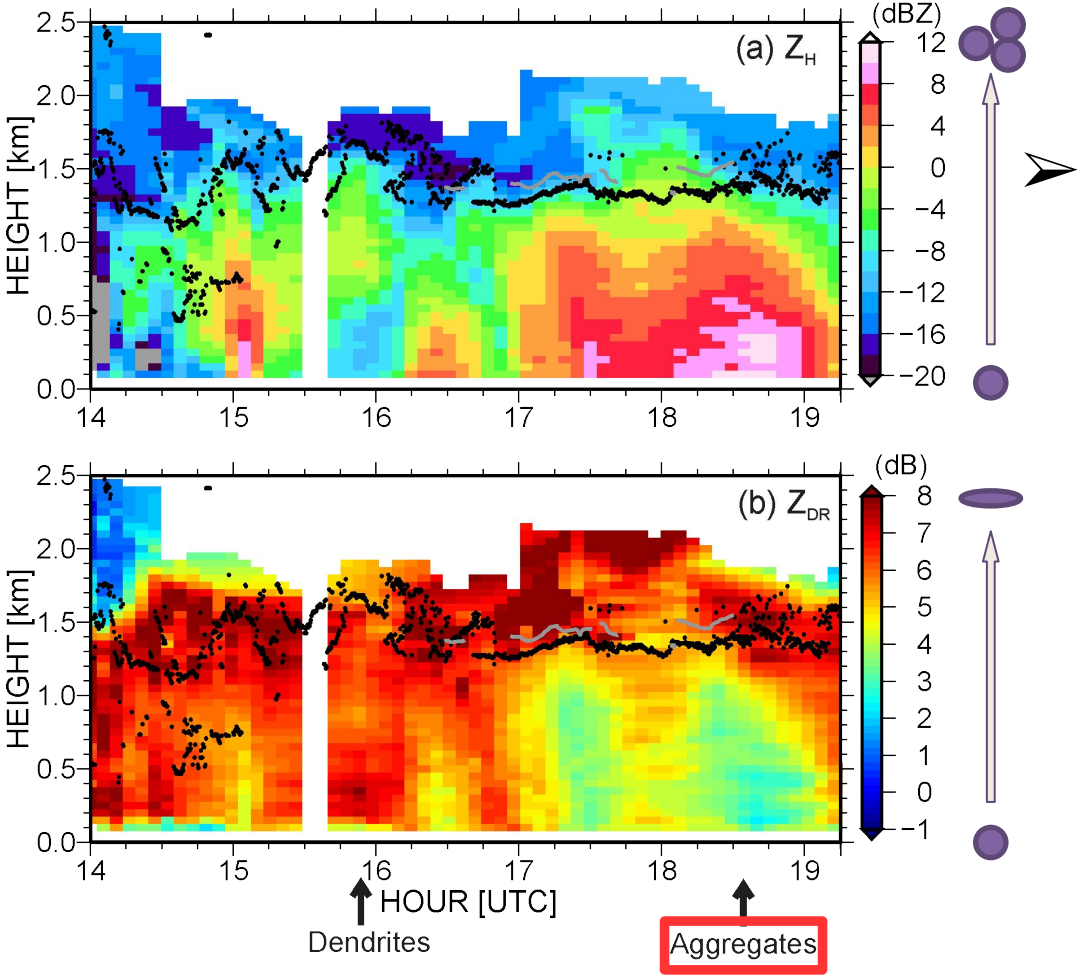


(Oue et al, 2015)

- A weak surface trough approached.
- Ice particles from that cloud layer fell into the liquid-cloud layers in a seeder-feeder scenario.

Case (II) Aggregates

Shallow boundary layer cloud system
1900 UTC 2 May 2013



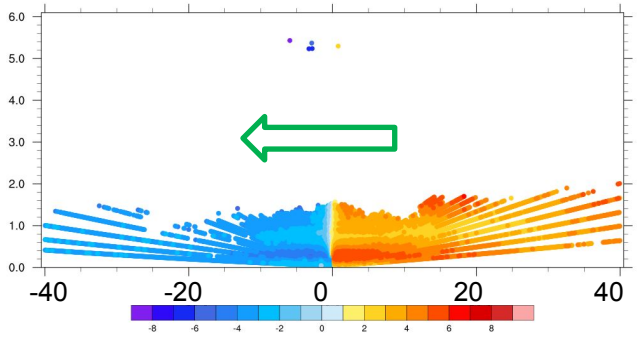
(Oue et al, 2015)

Precipitation particles from the top cloud layer fell into the liquid-cloud layers in a seeder-feeder scenario.

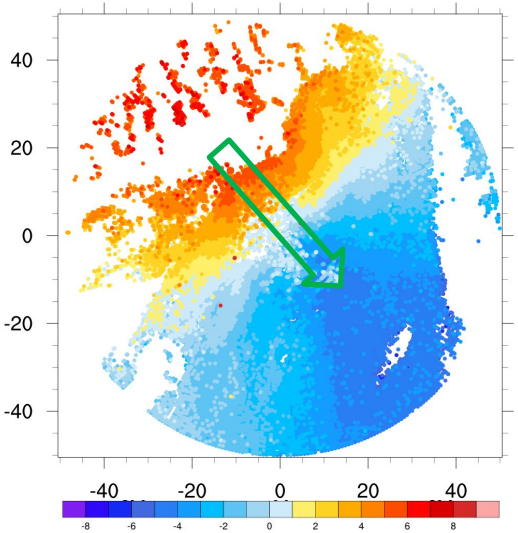
Case (I & II) Dendrites and Aggregates

Observation

Radial Velocity
Azimuth 7°

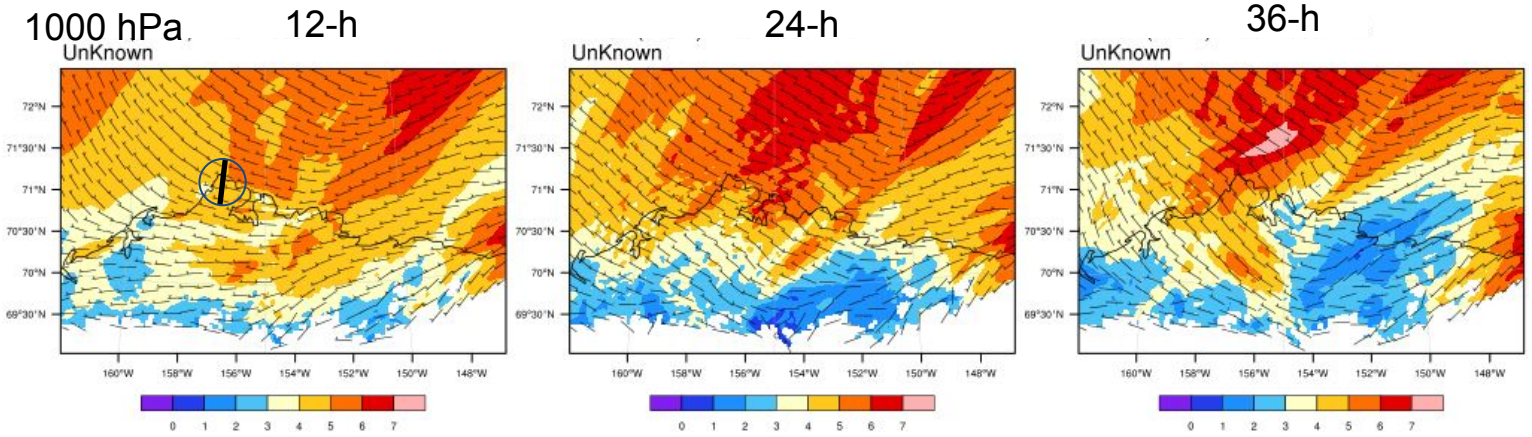


Radial Velocity
Elevation 0.5°



Simulation

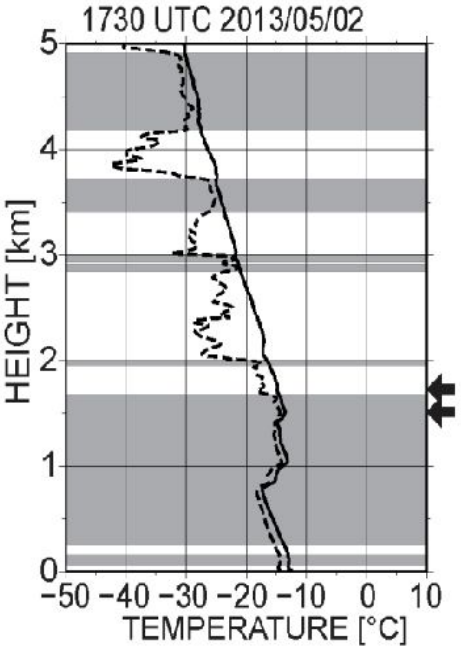
Horizontal wind speed and direction



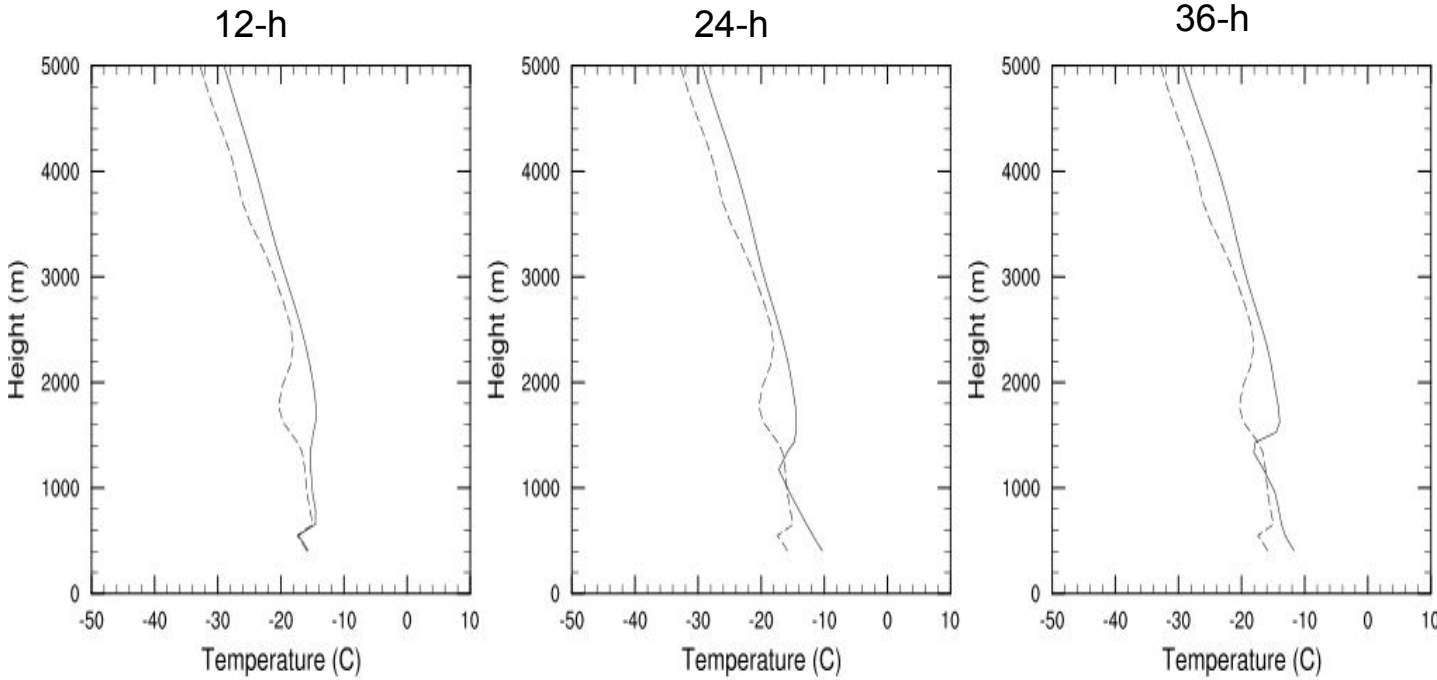
Case (I & II) Dendrites and Aggregates

Temperature and Dew point vertical profile

Observation



Simulation



(Oue et al, 2015)

Shaded region: Supersaturation condition with respect to ice
Arrows: Liquid cloud tops for the pristine dendrites case (1.75 km) and aggregates (1.5 km)

Summary and future work

- In these cases, ice particles from seeder-clouds at the top of the system fell into at least one liquid-cloud layer embedded in the ice precipitating cloud systems.

- From the preliminary results, the model provided a consistent wind field between simulations and observations. However, it did not portray the different properties of the flows in the different layers due to the unclear thermodynamic process.

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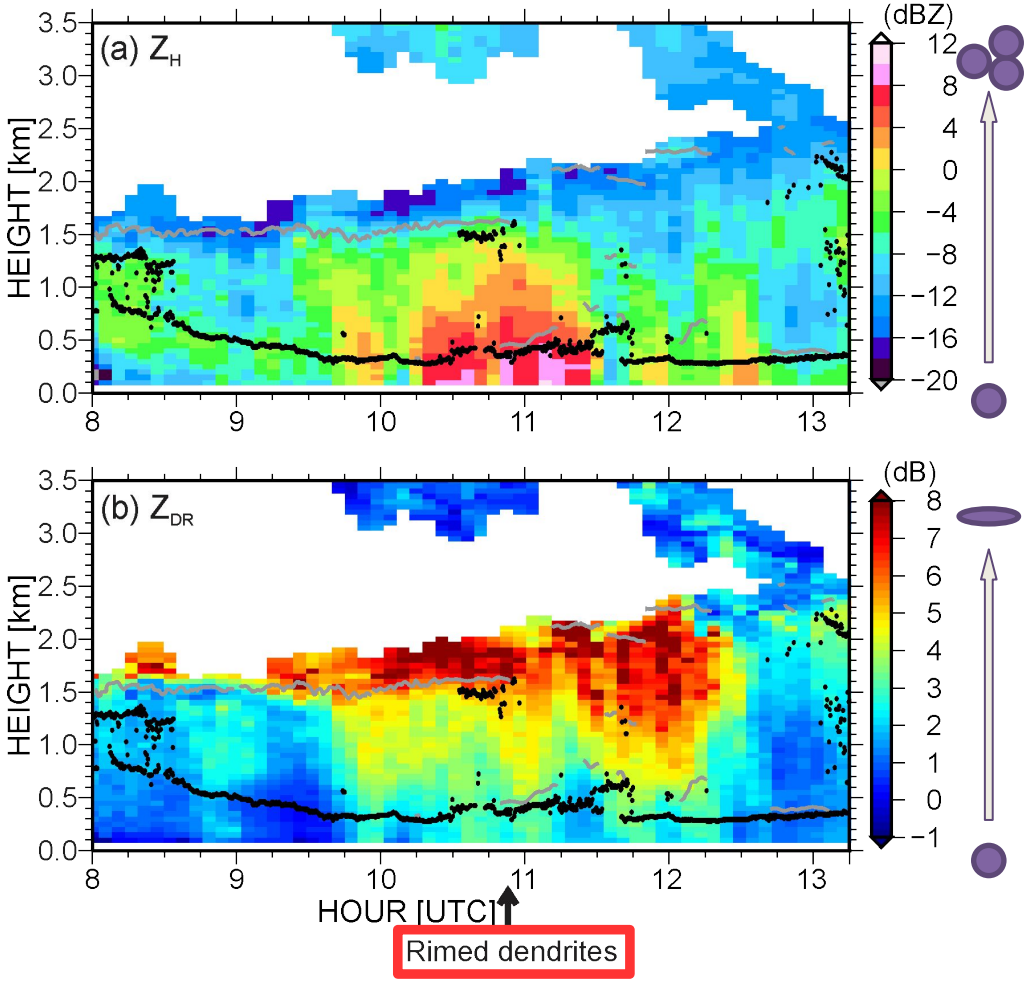
- Assimilating radar radial velocity/GTS into ENKF

Case (III) Rimed dendrites

Frontal system
1100 UTC 6 May 2013



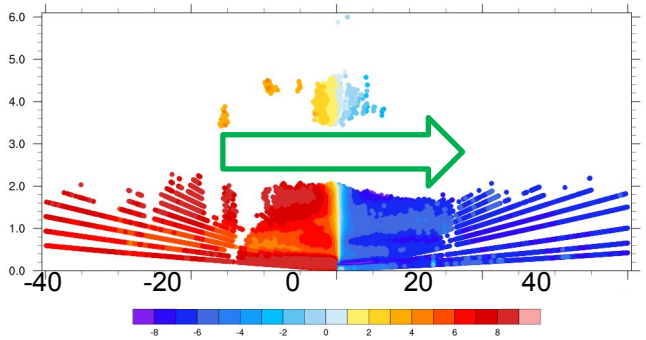
- A slow-moving surface trough passed through Barrow from the southwest to northeast.

(Oue et al, 2015)

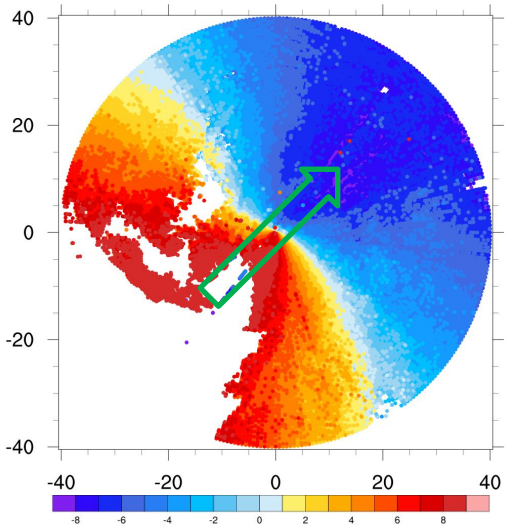
Case (III) Rimed dendrites

Observation

Radial Velocity
Azimuth 7°

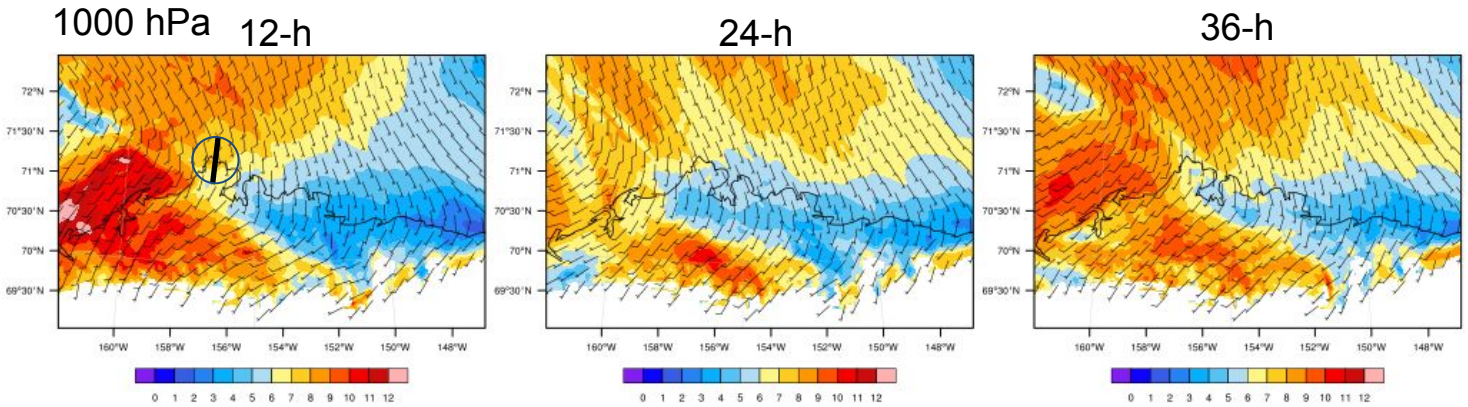


Radial Velocity
Elevation 0.5°



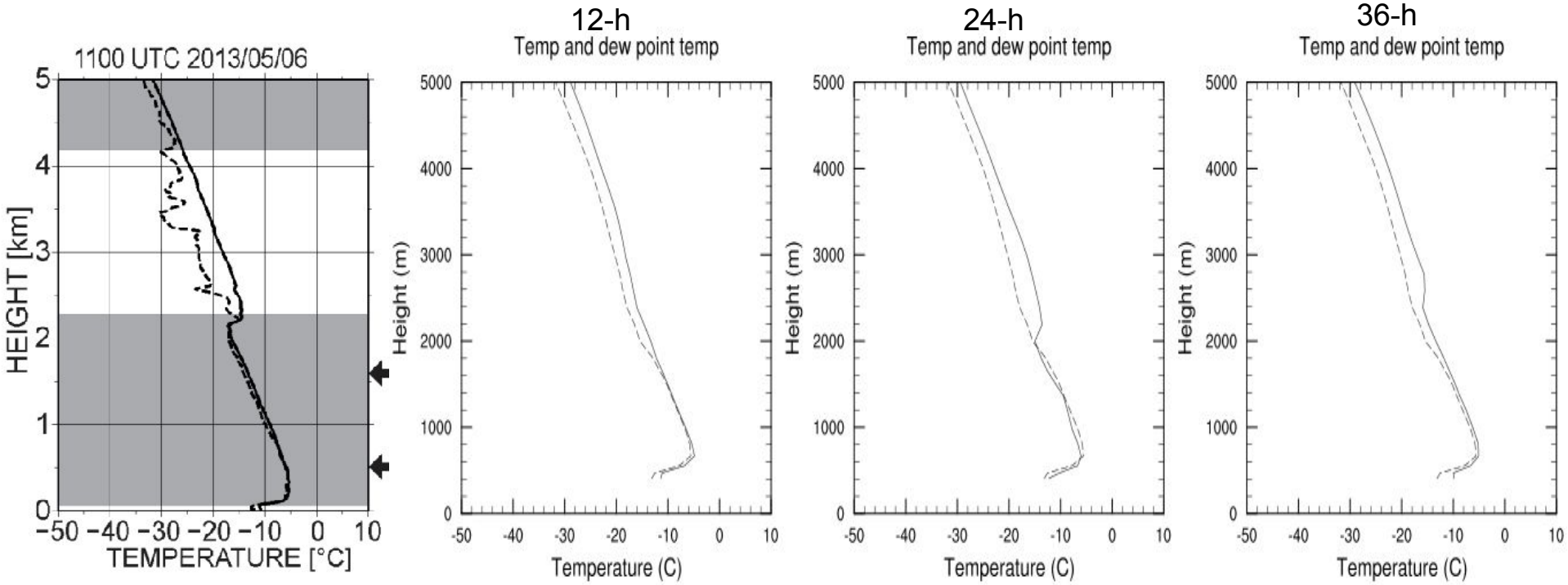
Simulation

Horizontal wind speed and direction



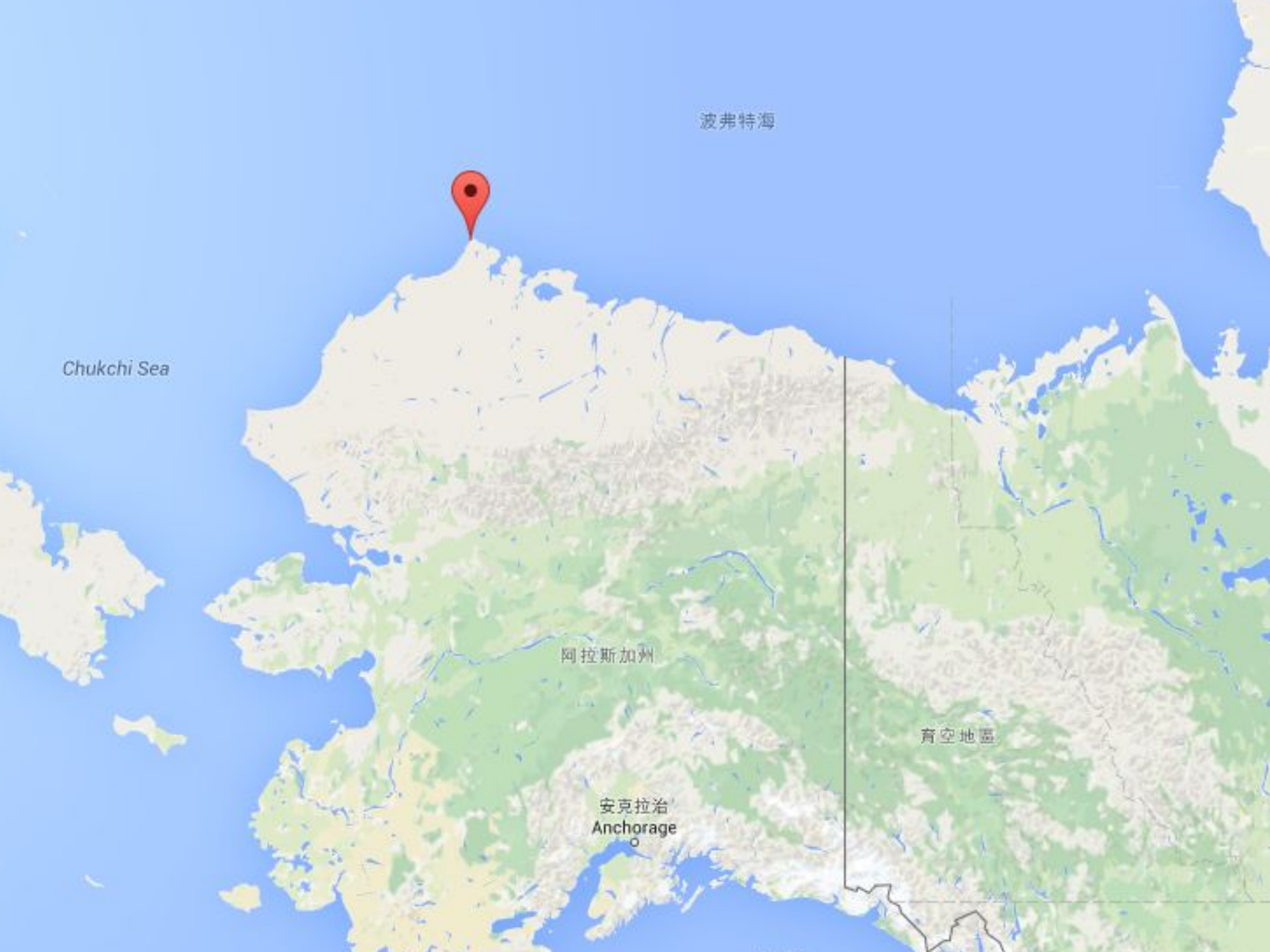
Case (III) Rimed dendrites

Temperature and Dew point vertical profile



Shaded region: Supersaturation condition with respect to ice

Arrows: Liquid cloud tops for the rimed dendrites case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Chukchi Sea
阿拉斯加州
育空地區
安克拉治
Anchorage