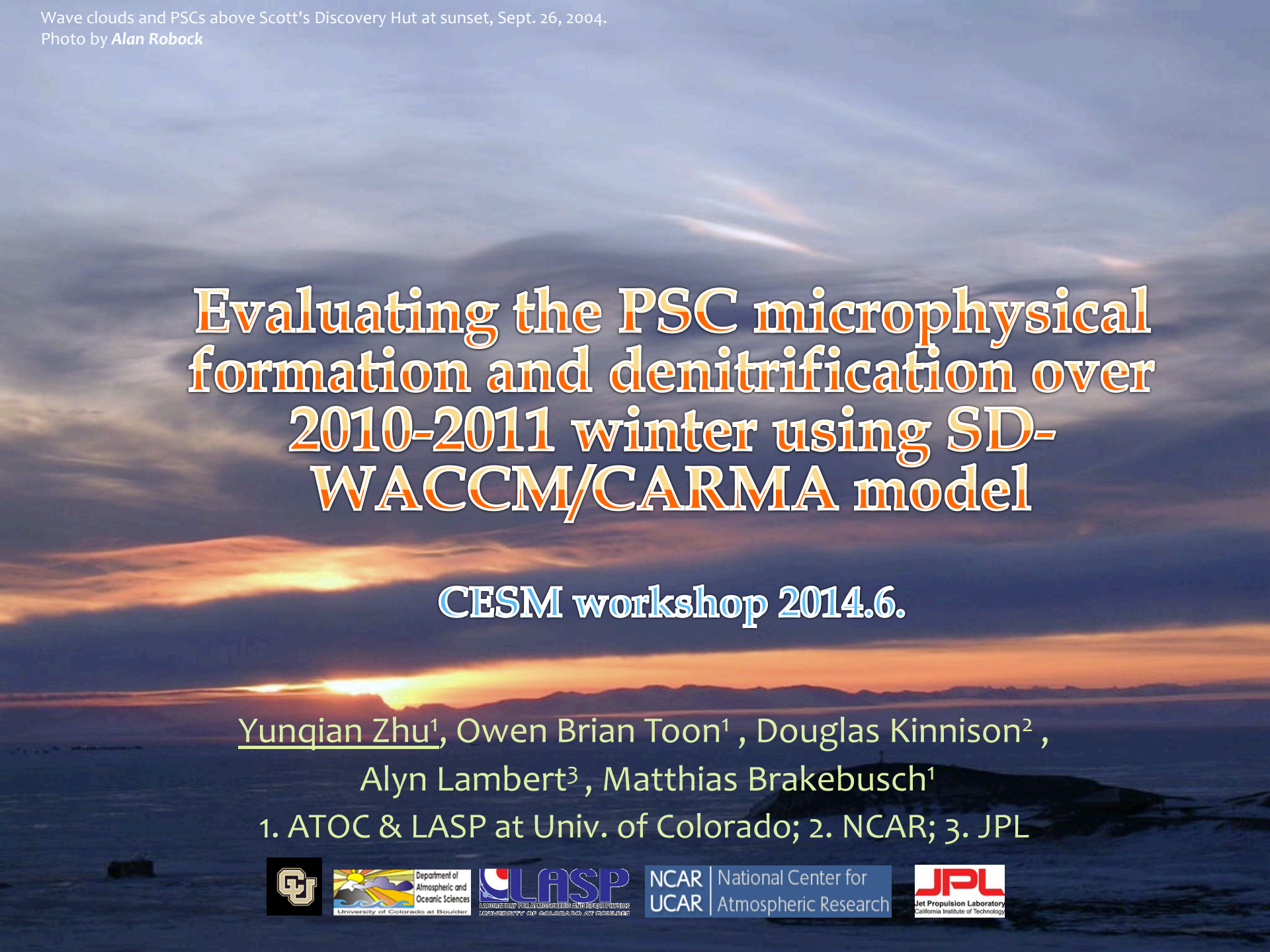


Evaluating the PSC microphysical formation and denitrification over 2010-2011 winter using SD-WACCM/CARMA model

CESM workshop 2014.6.

Yunqian Zhu[1], Owen Brian Toon[1] , Douglas Kinnison[2] ,
Alyn Lambert[3] , Matthias Brakebusch[1]
1. ATOC & LASP at Univ. of Colorado; 2. NCAR; 3. JPL

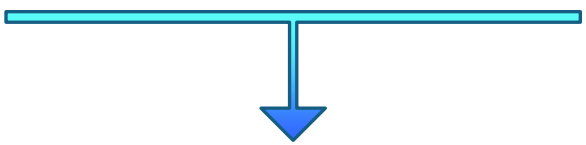
What are PSCs and what do they do?

H_2SO_4 aerosol

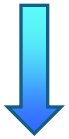
STS (Supercooled Ternary solution)

NAT (Nitric acid trihydrate)

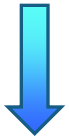
Ice particle



Chlorine activation

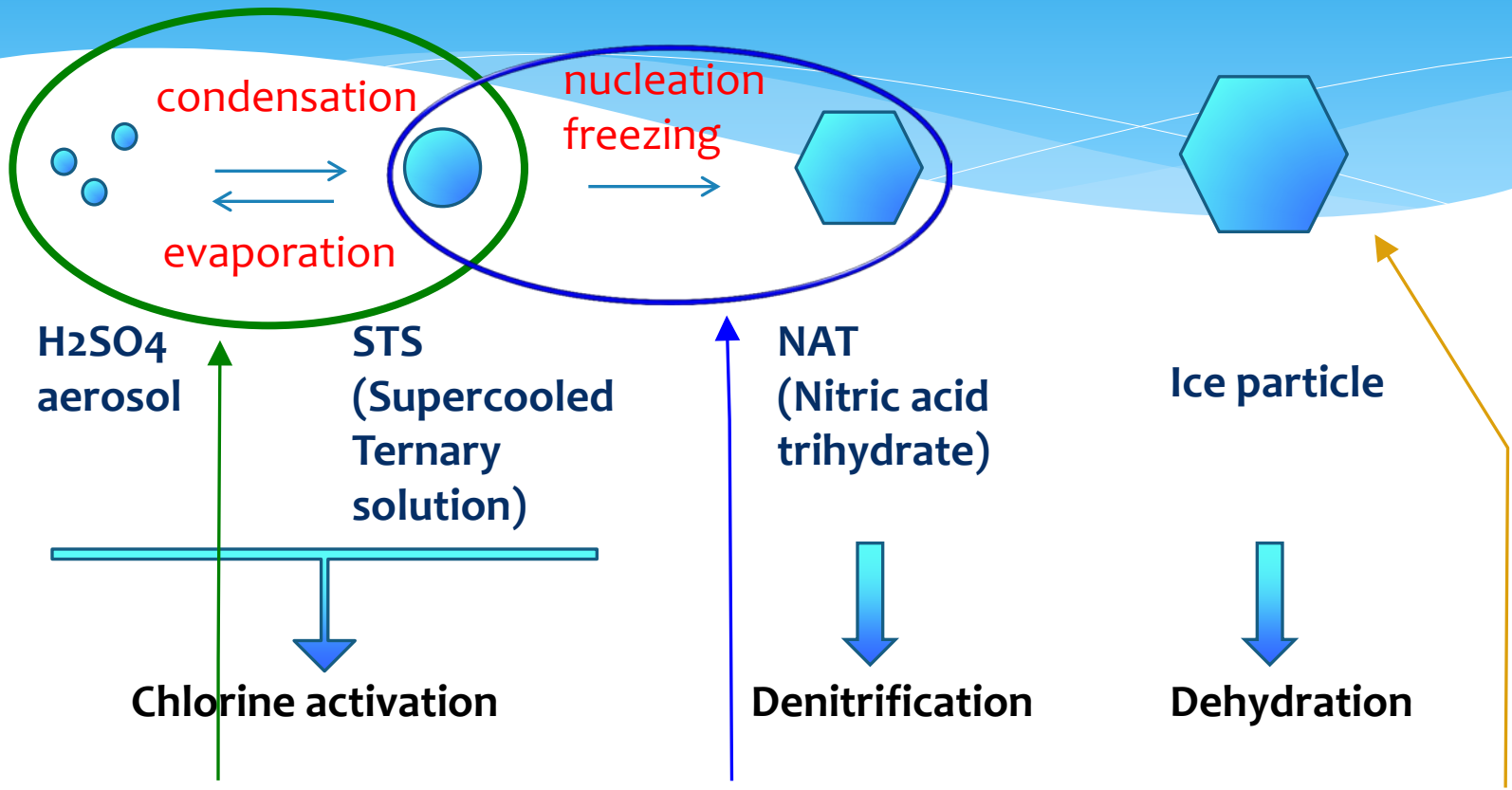


Denitrification



Dehydration

How do we present PSCs in the model

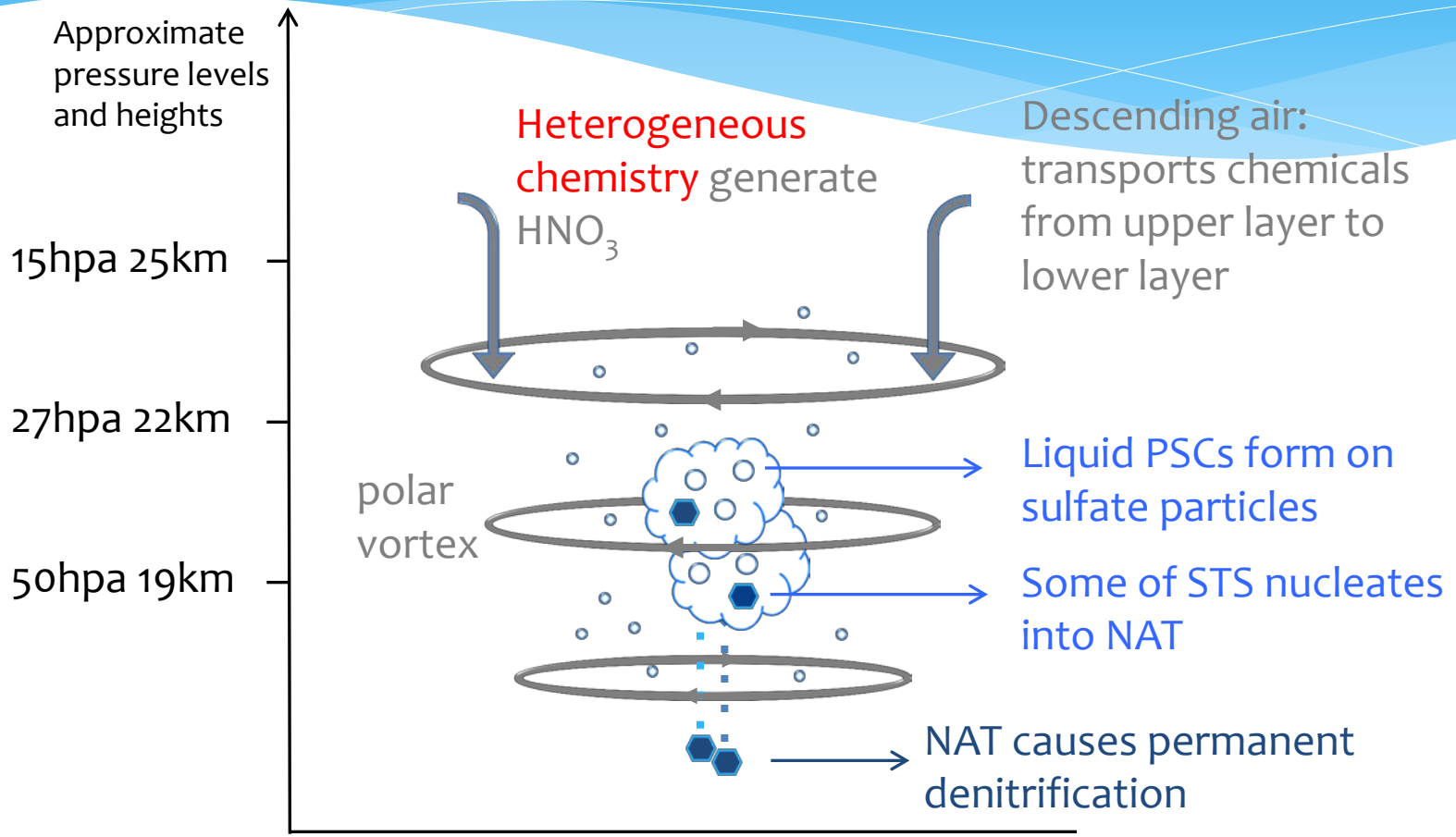


1st step: Growth and evaporation of STS based on sulfate aerosols

2nd step: Homogeneous nucleation of NAT from STS particles

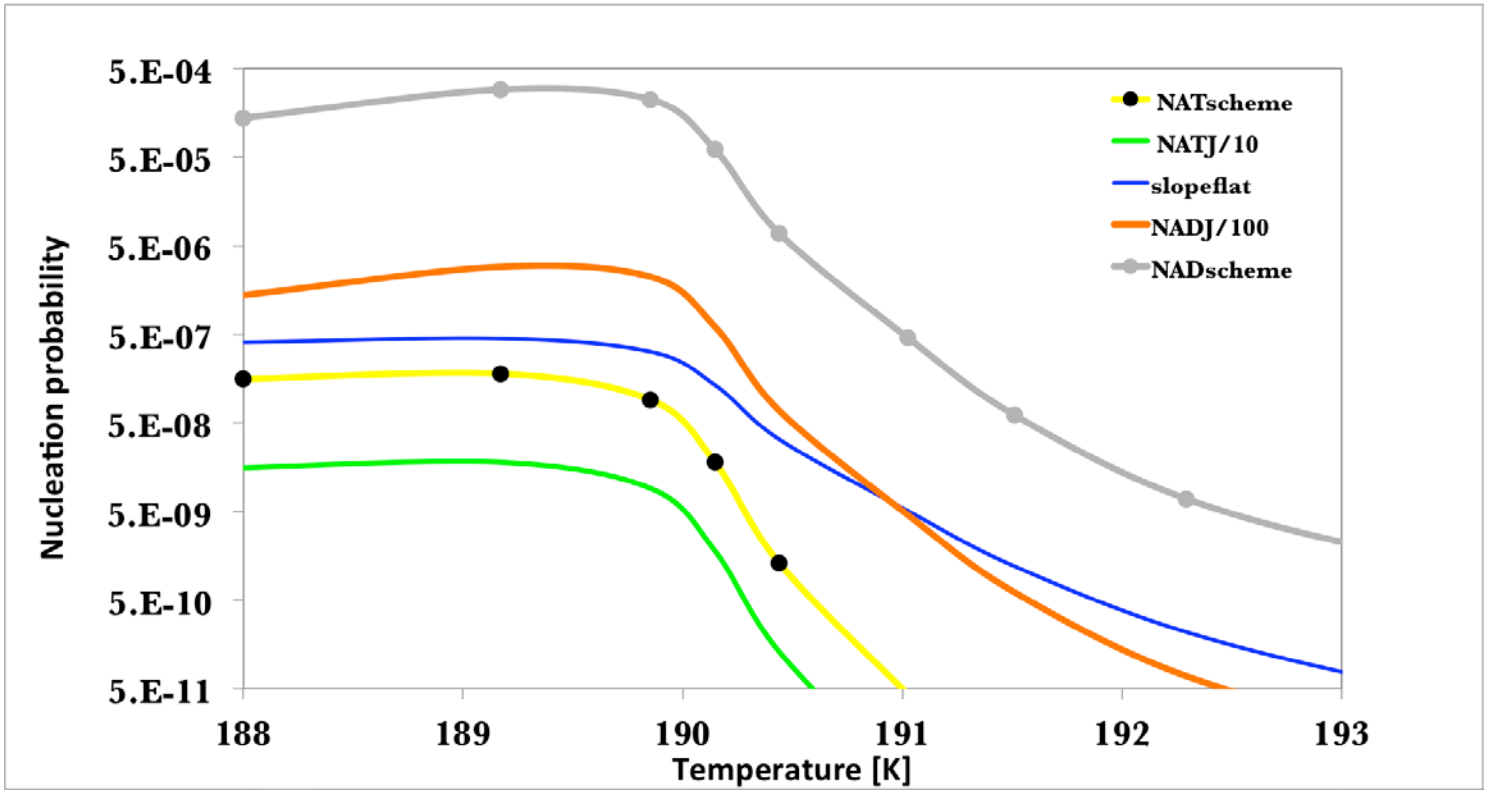
Using CAM parameter

The source and sink terms that influence the HNO_3 abundance



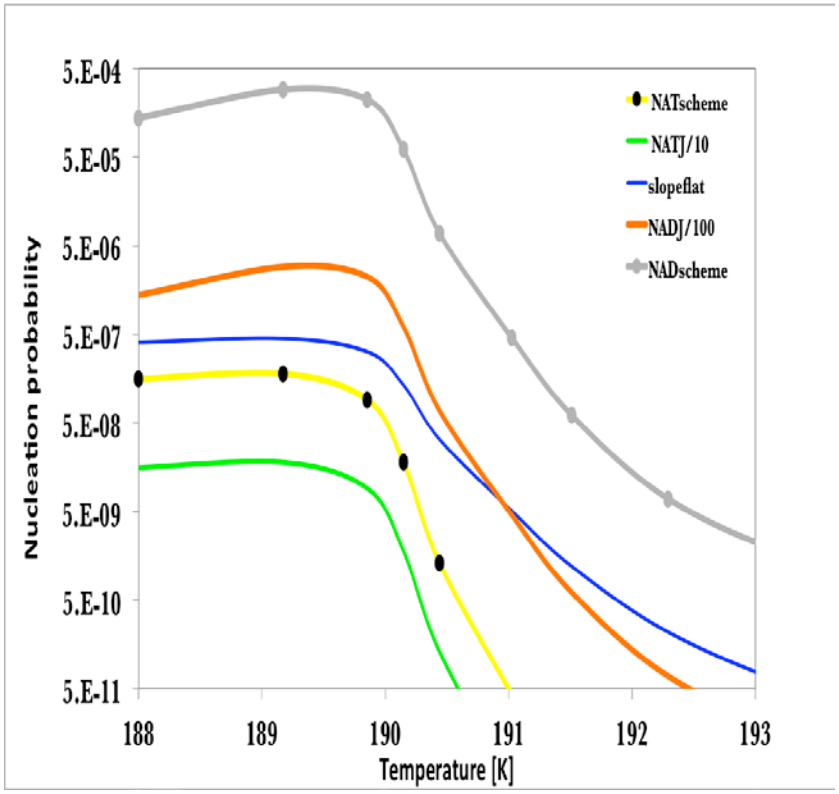
NAT homogeneous nucleation scheme

The NAT nucleation probability describes what fraction of STS nucleates into NAT in a model time step (30min).
It is as a function of temperature and HNO3 mole fraction of the STS particles [Tabazadeh, 2002].

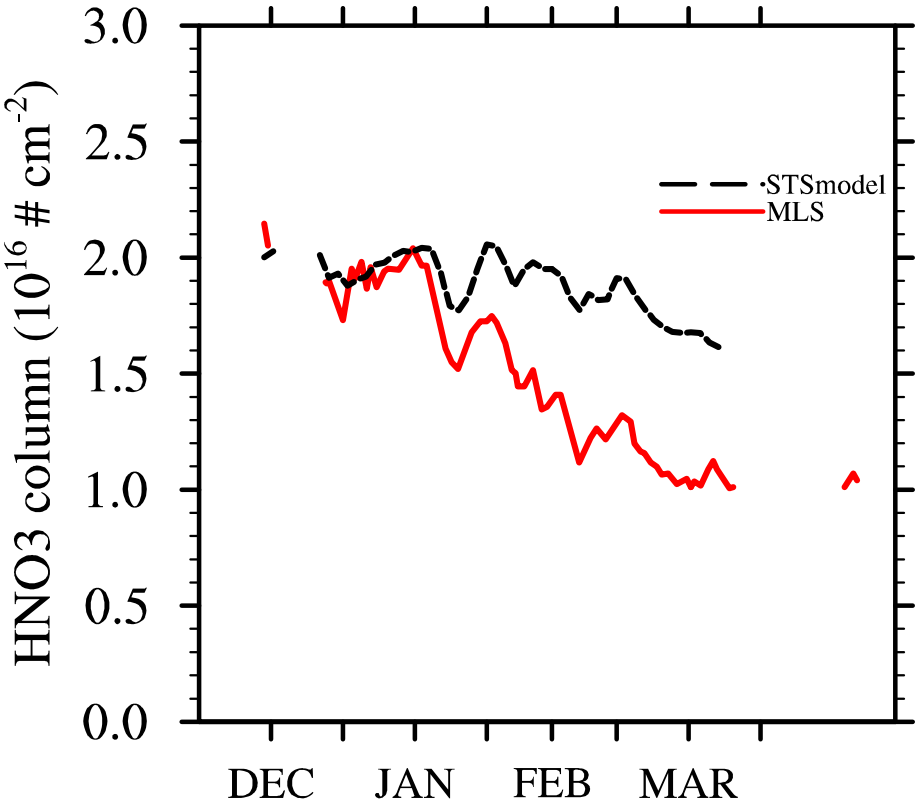


NAT homogeneous nucleation scheme

The NAT nucleation probability describes what fraction of STS nucleates into NAT in a model time step (30min).
It is as a function of temperature and particles [Tabazadeh, 2002].

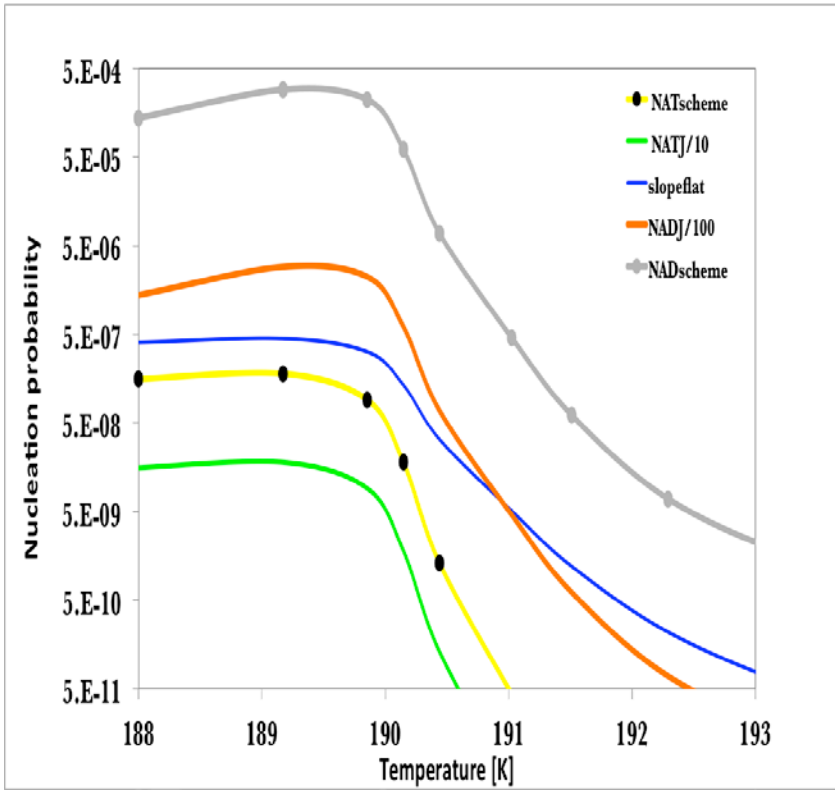


Slopeflat case: HNO3 partial column compares well with MLS observations

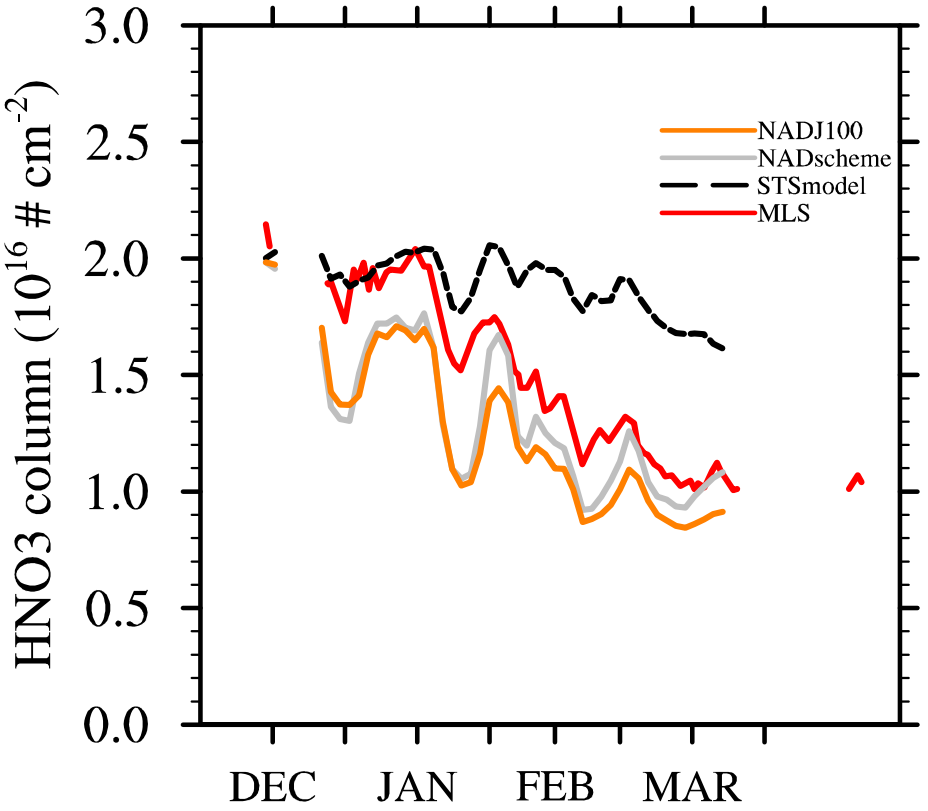


NAT homogeneous nucleation scheme

The NAT nucleation probability describes what fraction of STS nucleates into NAT in a model time step (30min).
It is as a function of temperature and particles [Tabazadeh, 2002].

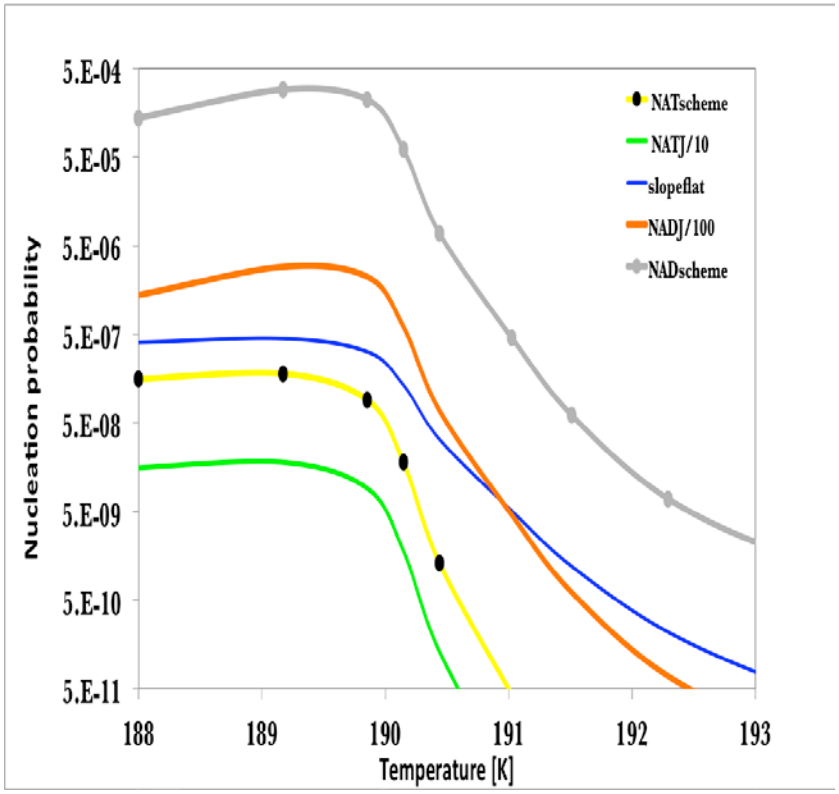


Slopeflat case: HNO3 partial column compares well with MLS observations

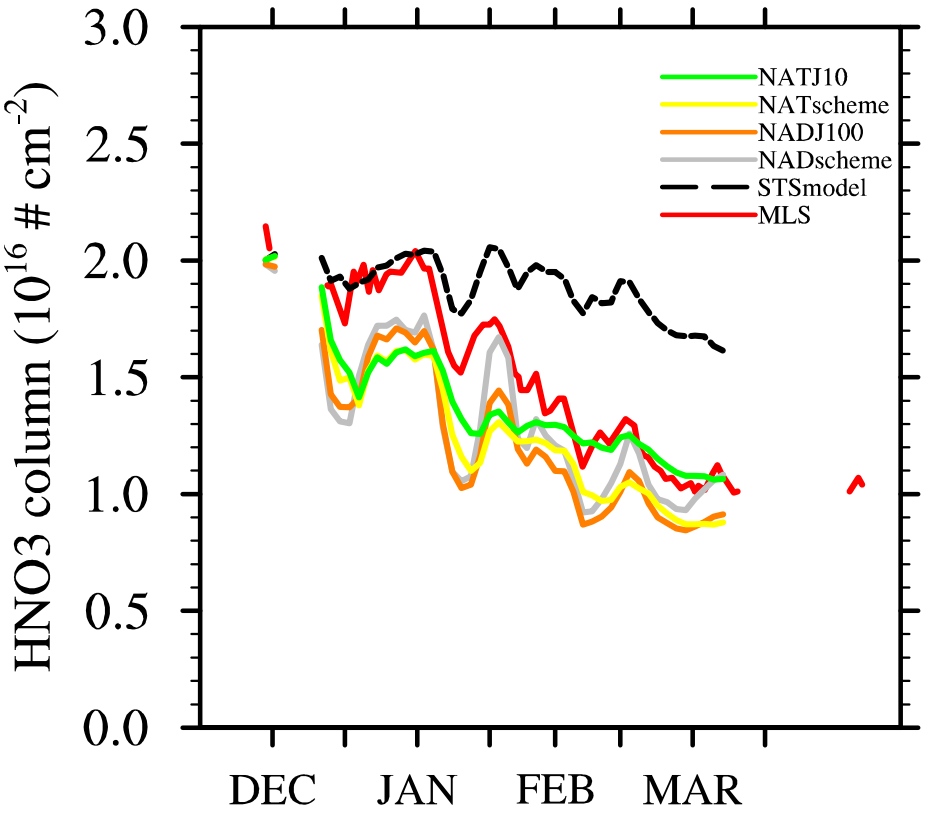


NAT homogeneous nucleation scheme

The NAT nucleation probability describes what fraction of STS nucleates into NAT in a model time step (30min).
It is as a function of temperature and particles [Tabazadeh, 2002].

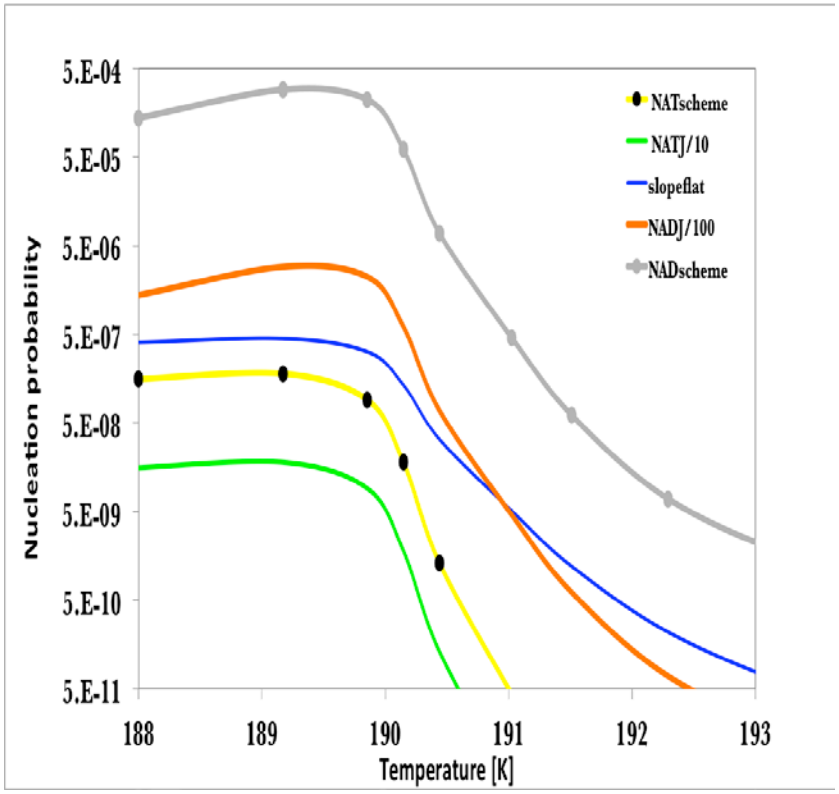


Slopeflat case: HNO3 partial column compares well with MLS observations

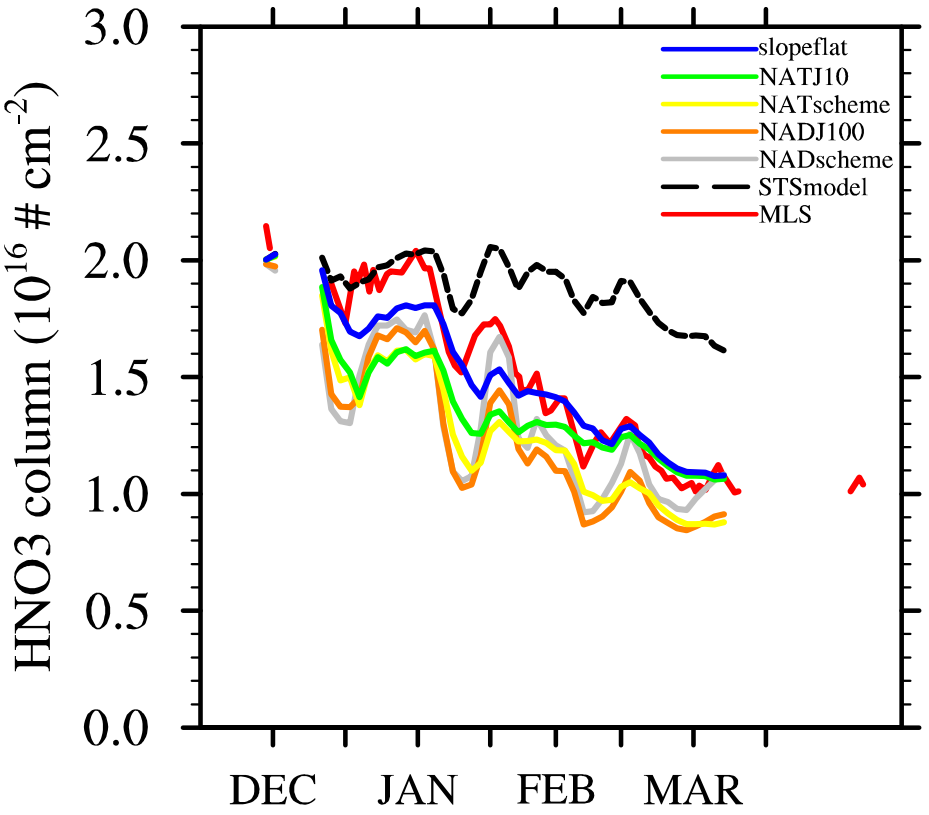


NAT homogeneous nucleation scheme

The NAT nucleation probability describes what fraction of STS nucleates into NAT in a model time step (30min).
It is as a function of temperature and particles [Tabazadeh, 2002].



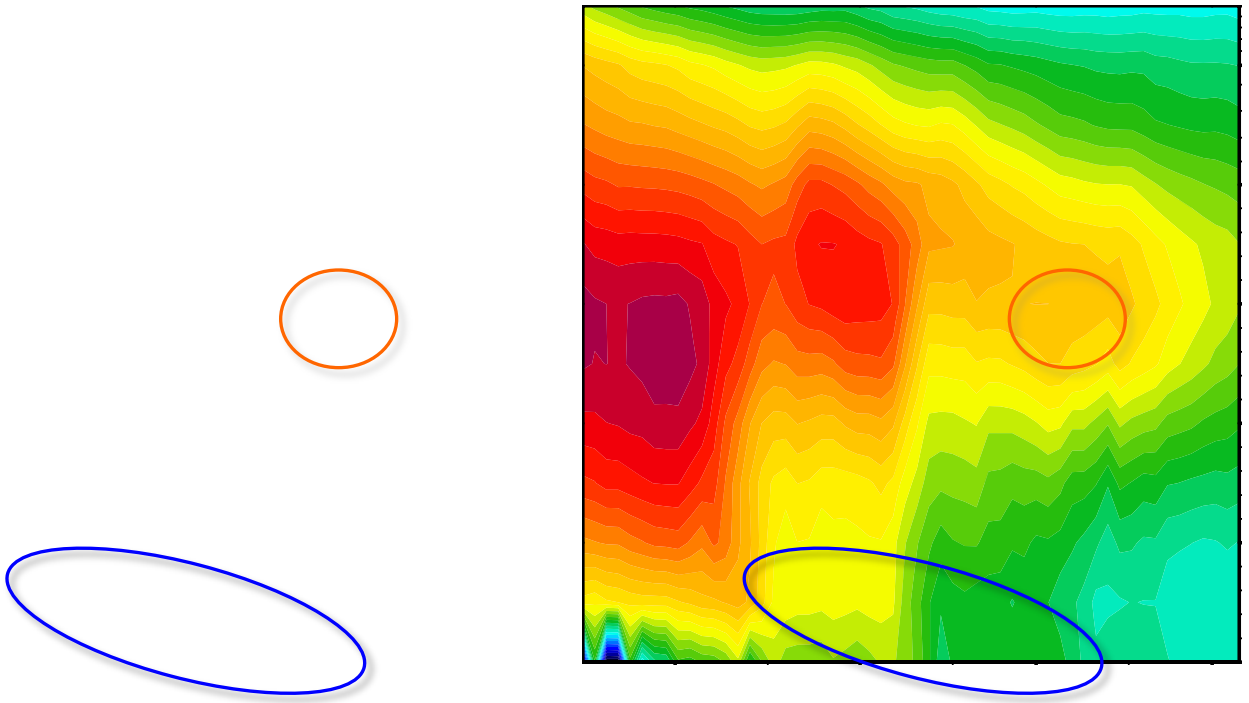
Slopeflat case: HNO3 partial column compares well with MLS observations



The Model shows a faster falling of HNO_3 than MLS observation. The model doesn't show a PSC formation on 550K on late February as MLS does.

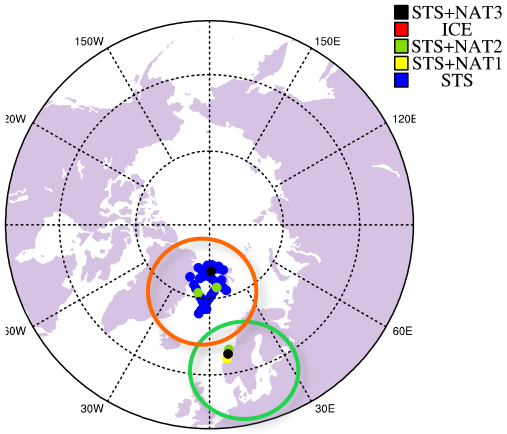
MLS gas

Model gas

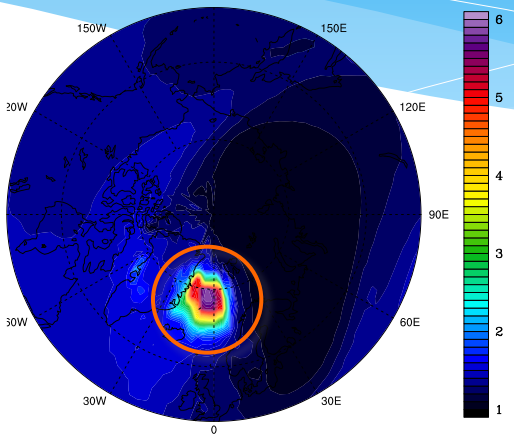


The model captures the locations of STS and NAT; and shows the same magnitude of backscattering ratio as CALIPSO does.

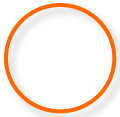
CALIPSO composition



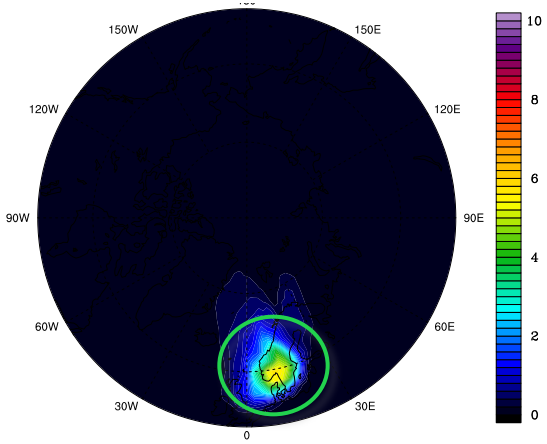
STS backscattering ratio



CALIPSO backscattering ratio

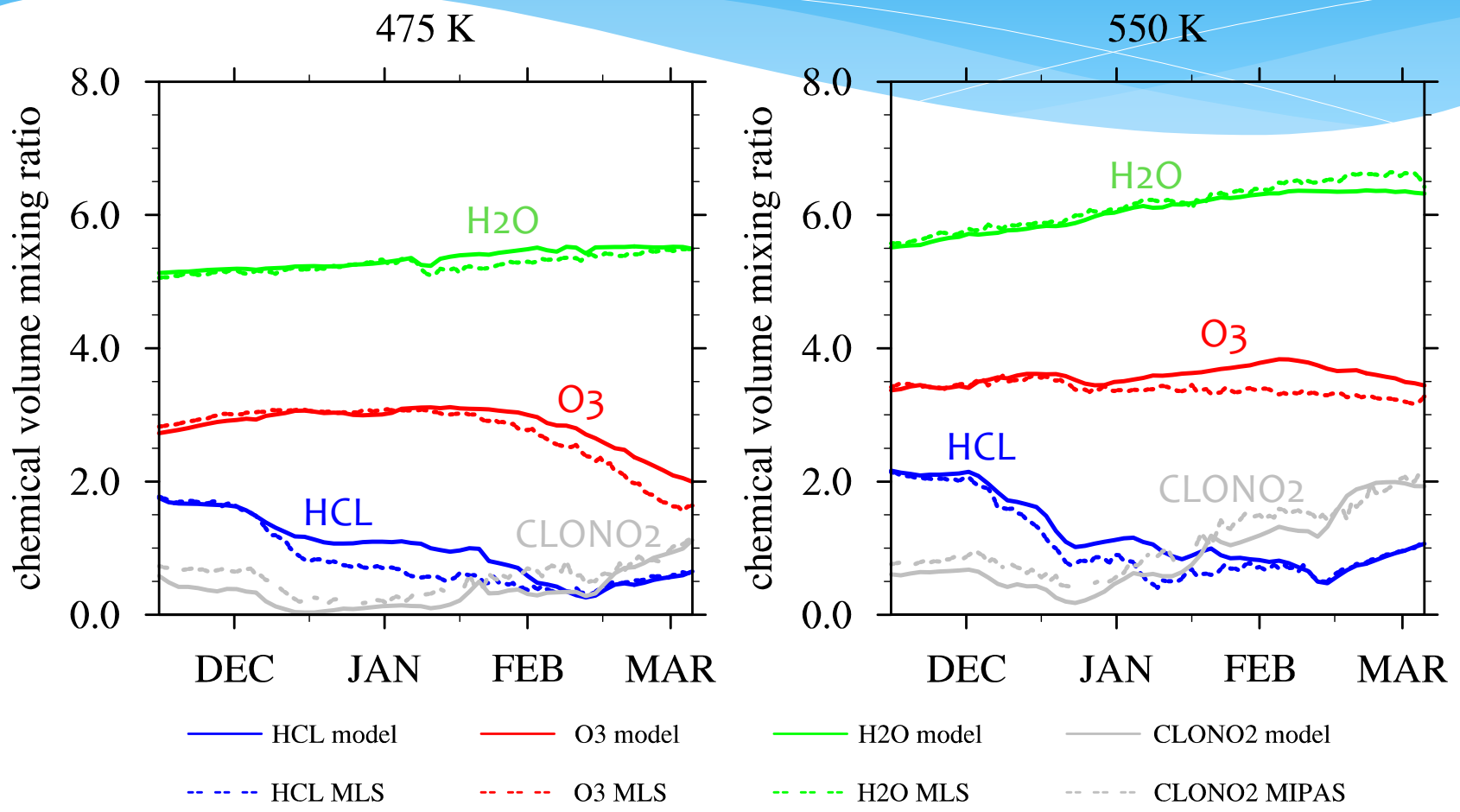


HNO3 inside NAT particle [ppbm]



CALISPO data from 22km and model output at 26 mbar (about 22 km) on Jan 03, 2011

The model predicts the chemicals very close to MLS observations. The model underestimates about 15% of the Ozone depletion.



Conclusion

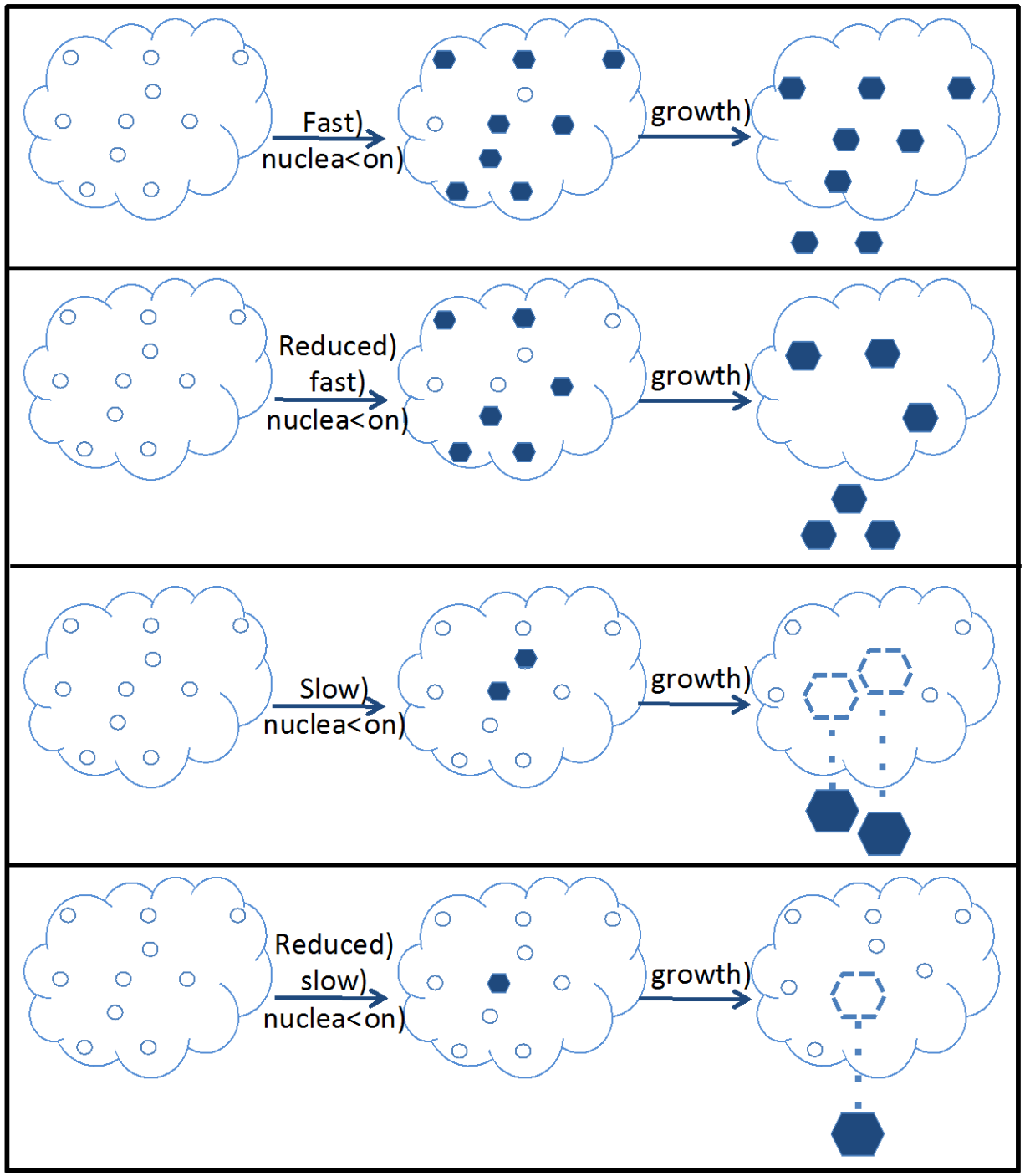
* By tuning the NAT nucleation rate, the model case Slopeflat predicts HNO_3 evolution as MLS observes.
* The contour plot shows NAT particles fall faster in the lower level (~450K) in the model than the MLS data.
* The backscattering ratio and PSC compositions from CALIPSO observations match the model results.
* The model predicts the ozone chemicals very close to MLS observations on those PSC formation levels.

Future work

* To finish the exploration on this winter, we still need to find out a better NAT scheme to have a slower falling of NAT.

* Next step, we will focus on the Antarctic PSC simulation and its ozone effect.

Yunqian 2013. 6.



The)NAT)par<cle)uptake)all)the)HNO3)mass,)but)reduced)J_s)results)in)fewer)pa<cles)with)bigger)radius.)

Reduce)the)nuclea<on)rate)will)increase)the)denitrifica<on)

The)NAT)par<cles)doesn't)have)enough)surface)area)to)uptake)all)the)HNO3)from)STS)paricles)before)it)fall)out.)

Reduce)the)nuclea<on)rate)will)decrease)the)denitrifica<on)