

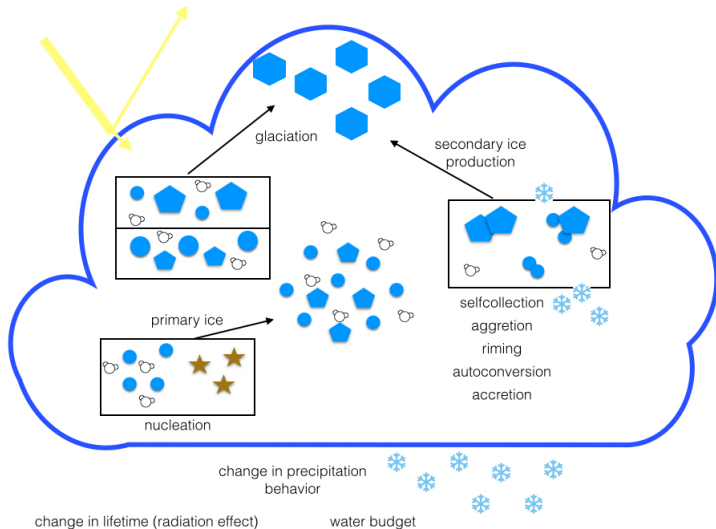
Regional modelling of orographic mixed-phase clouds

Olga Henneberg

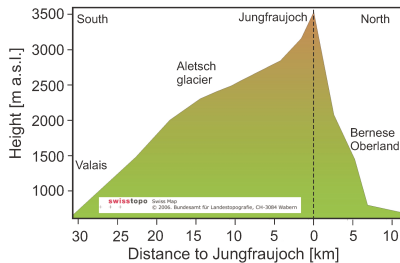
Institute for Atmospheric and Climate Science
ETH Zürich

March 4, 2015

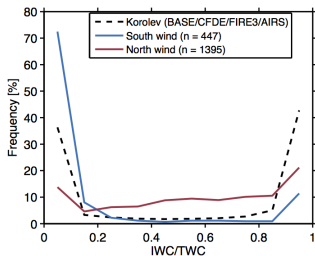
Mixed-phase clouds (MPC)



Mixed-phase clouds at Jungfrauoch

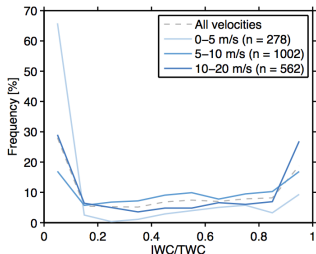
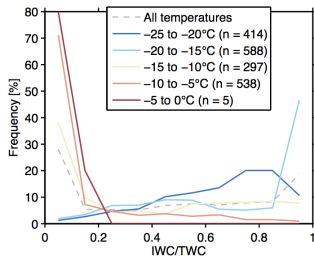
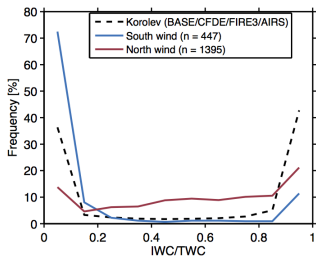


Observation of mixed-phase clouds



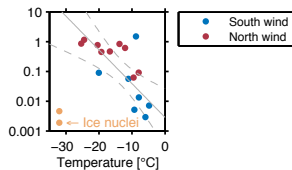
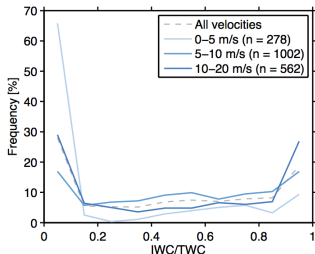
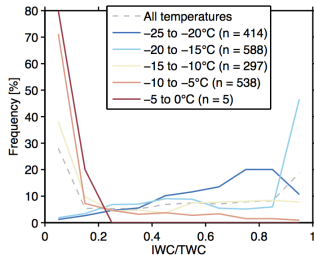
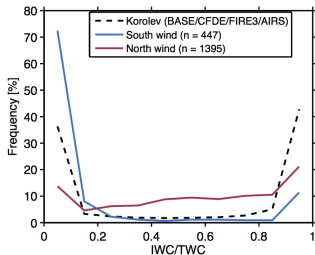
Jan Henneberger

Observation of mixed-phase clouds



Jan Henneberger

Observation of mixed-phase clouds



Jan Henneberger

Findings from observations

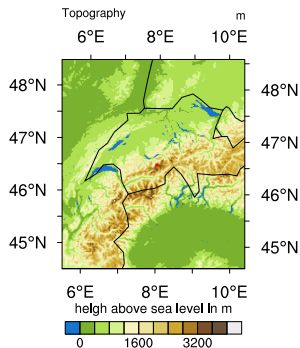
- MPC mostly occur during north wind conditions
- Ice crystal number concentration exceed IN concentration at JFJ /measurement location

Remaining questions

- Where does the cloud form?
Where are the relevant processes for so many ice crystals active?
- What is the role of IN in orographic MPCs?
- What updraft velocities are necessary to keep water content for so long?
- What are the differences between north and south wind cases beside the vertical velocities?

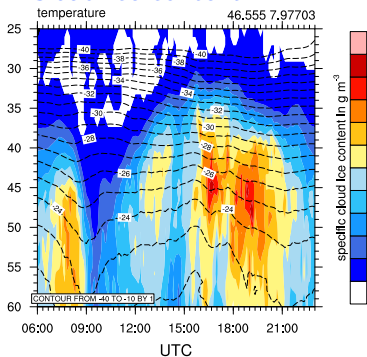
COSMO simulation

- 1 km resolution
- 350 × 400 gridpoints
- Hourly nudged into 2 km COSMO analysis
- Two moment microphysics scheme (Seifert and Beheng (2008))
- Phillips et al. (2008) ice parametrization
- Planned: interactive aerosol module (ART - M7)
- Two north wind days simulated until now with fix aerosol concentration
- Sensitivity study: variation of pre described CCN and IN

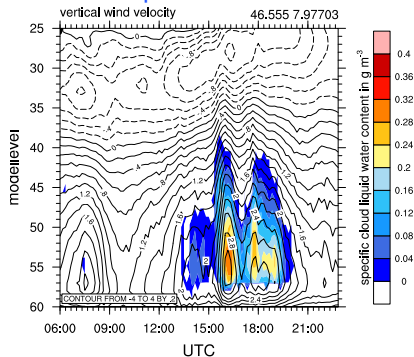


Time development of MPC on 07 Feb 2013

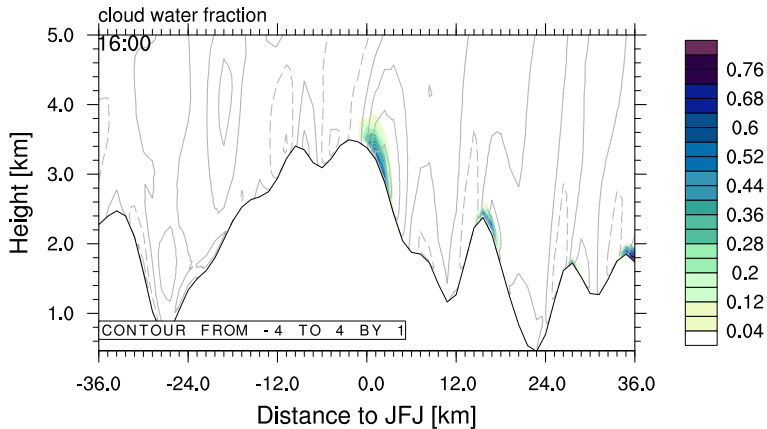
Cloud ice content



Cloud liquid content

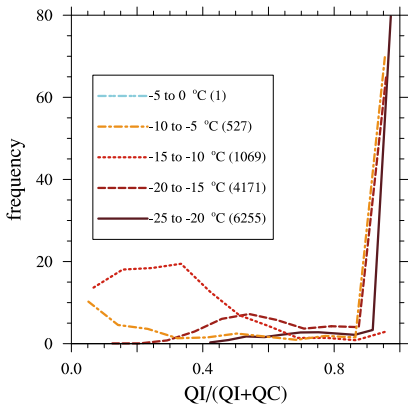


LWC/(IWC+LWC) 07.02.14 16:00

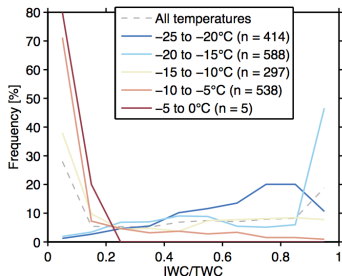


PDF over two north wind cases with MPC

Model

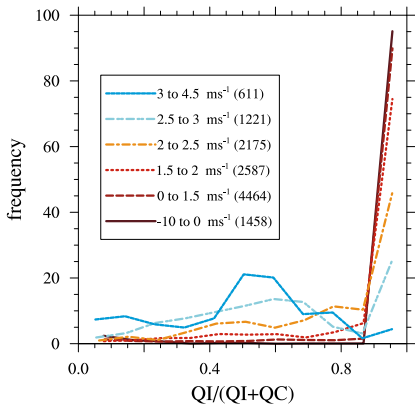


Observed at JFJ

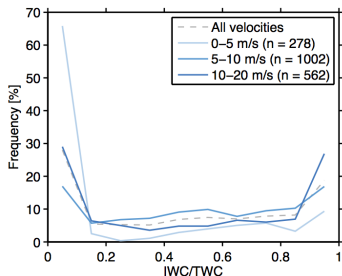


PDF over two north wind cases with MPC

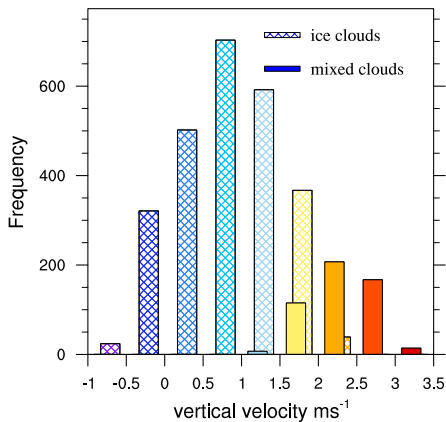
Model (vertical velocities)



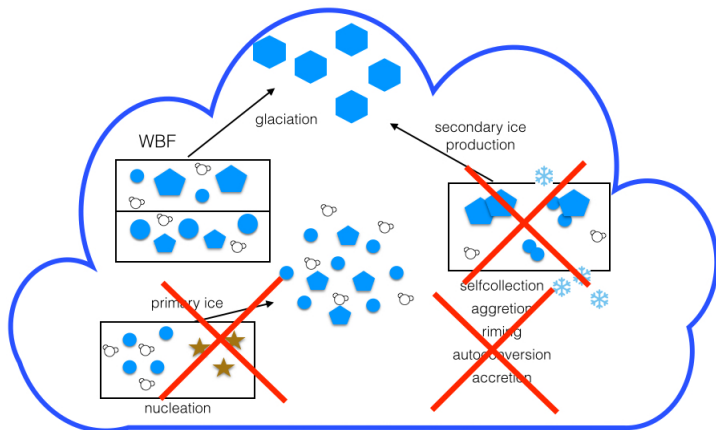
Observed (horizontal velocities)



At which updrafts does MPC occur?

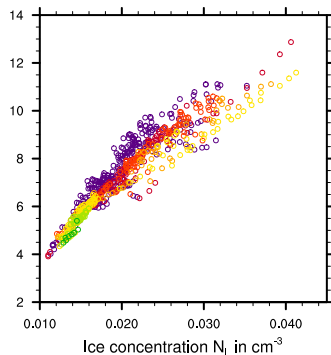
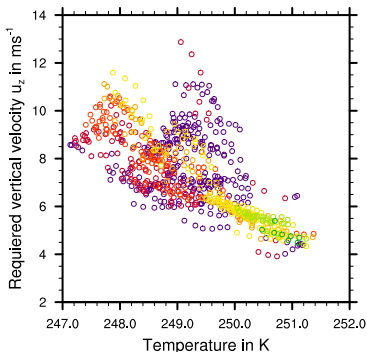


Can the required velocities be calculated?



Can the required velocities be calculated?

- Consider only WBF process (Korolev and Field 2007)
- Vertical velocity most depends on T and QNI

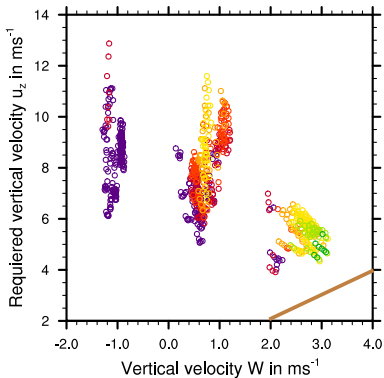


- Calculation based on values after microphysics
- Is this calculation sufficient for JFJ clouds?

Can required velocities be calculated?

$$\text{frac} = \text{IWC}/(\text{IWC}+\text{LWC})$$

- $0.4 \geq \text{frac} < 0.5$
- $0.5 \geq \text{frac} < 0.6$
- $0.6 \geq \text{frac} < 0.7$
- $0.7 \geq \text{frac} < 0.8$
- $0.8 \geq \text{frac} < 0.9$
- $0.9 \geq \text{frac} < 1$
- $\text{frac} = 1$



First findings:

- COSMO reproduces measurements concerning cloud water and ice content
- Updraft velocities play a major role for the longevity of MPC
- Considering only WBF process is not sufficient

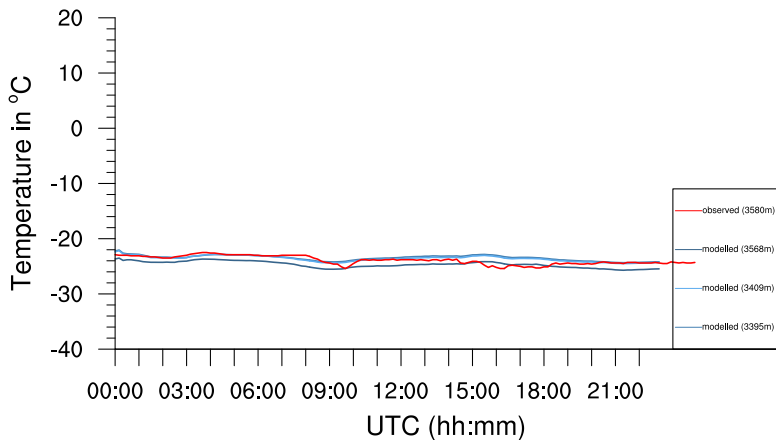
Open questions:

- How to carve out aerosols influence?
- Which microphysical processes mainly influence the dependence of MPC by vertical velocities?

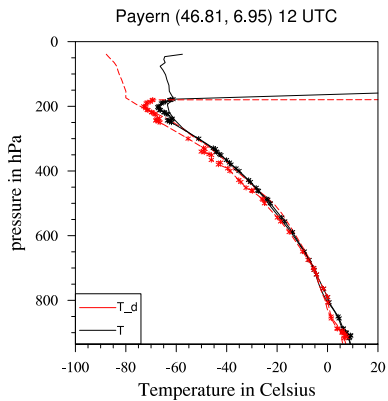
Upcoming steps:

- Analyse microphysical and dynamical processes
- Sensitivity study with different aerosol concentration
- More cases
- Include aerosol module

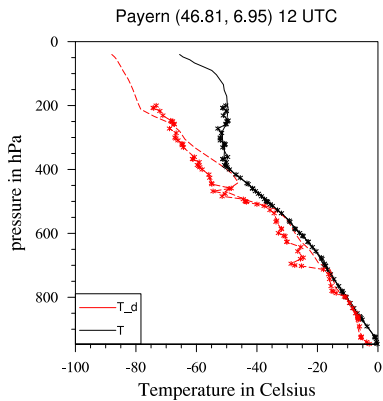
How does the model perform in this region?



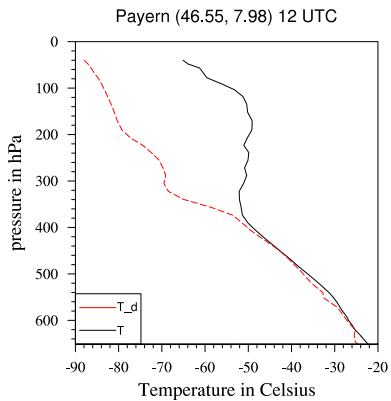
profiles



profiles

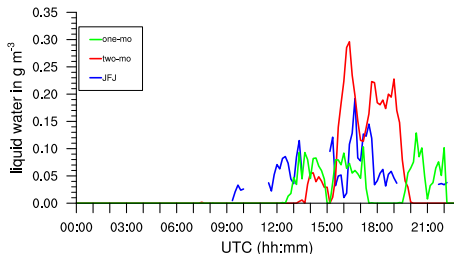
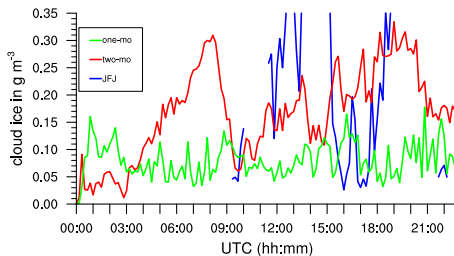


profiles

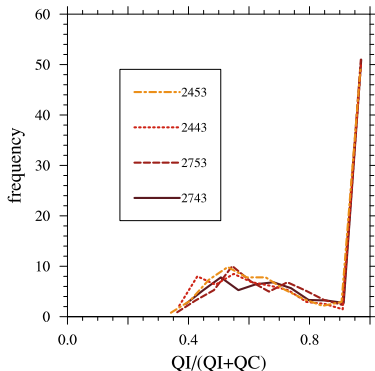


How does the model perform in this region?

level 55 (3287.73m)

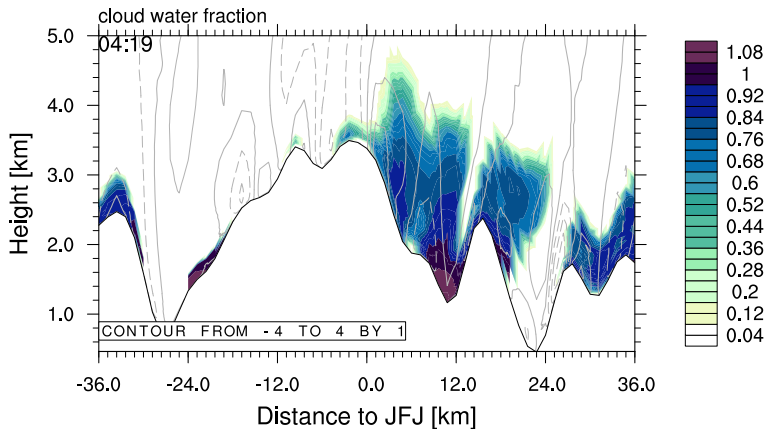


How does aerosol concentration influence?

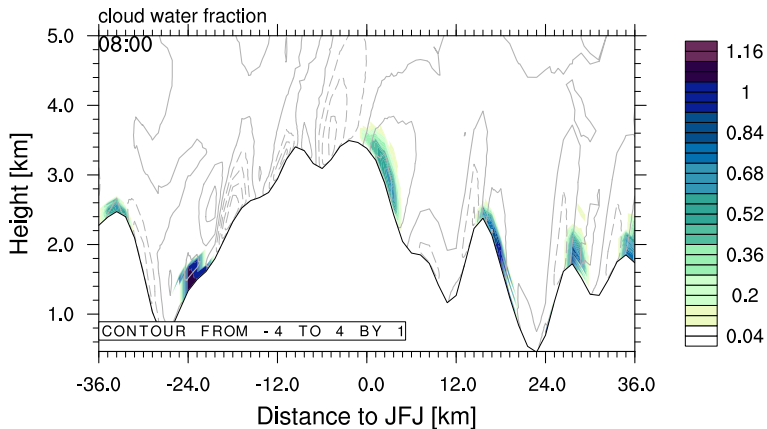


- First modification in IN do not change hydrometeor concentration much
- What is there influence in the interplay with dynamics?

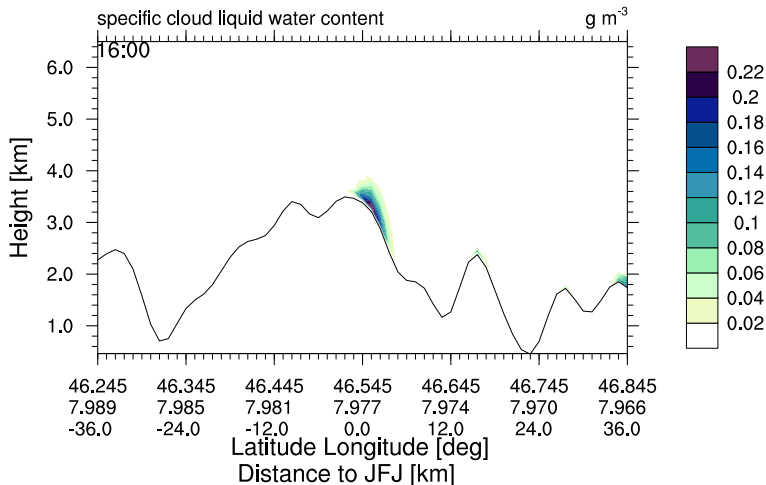
QC 02.02.13 4:20

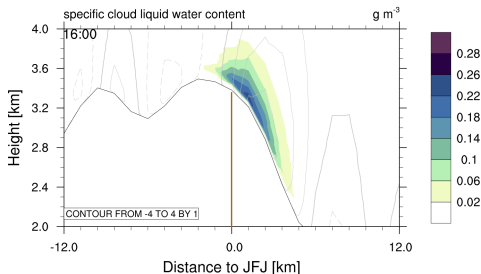


QC (02.02.13 8:00)

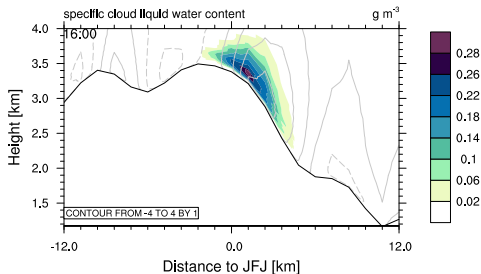


QC (07.02.13 16:00)





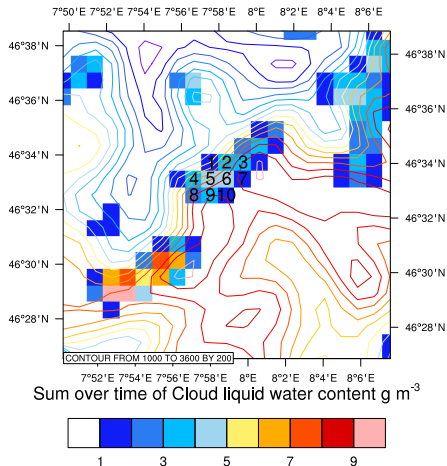
Simulation with $dt = 10\text{s}$



Simulation with $dt = 15\text{s}$

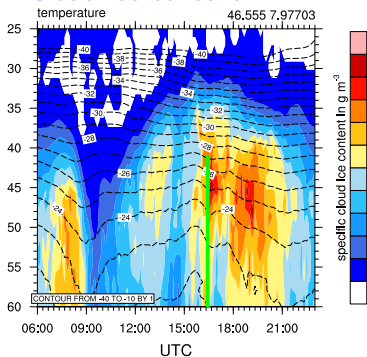
QC, 07.02.13, level 55, sum over time

no_art_extmetch_130207_350x400_twomo_smooth31_h00 130207at lev 55

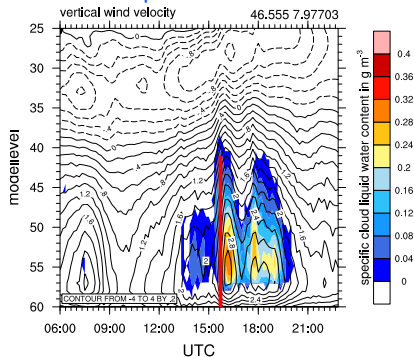


Time development of MPC on 07 Feb 2013

Cloud ice content

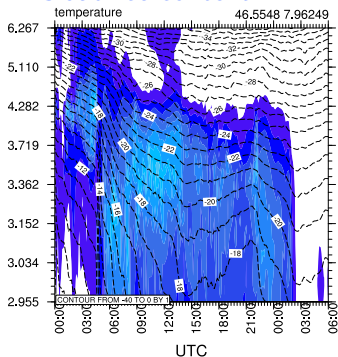


Cloud liquid content

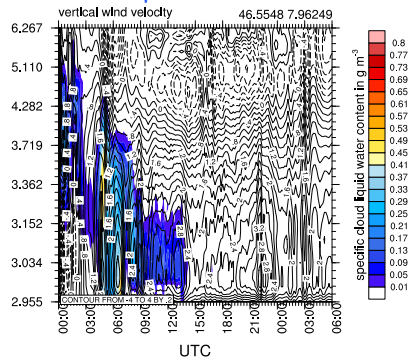


Time development of MPC on 02 Feb 2013

Cloud ice content

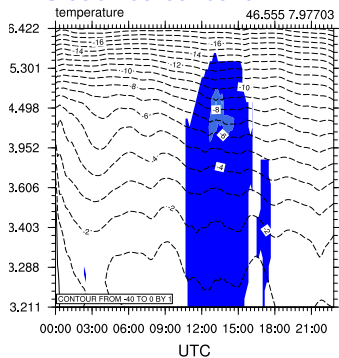


Cloud liquid content

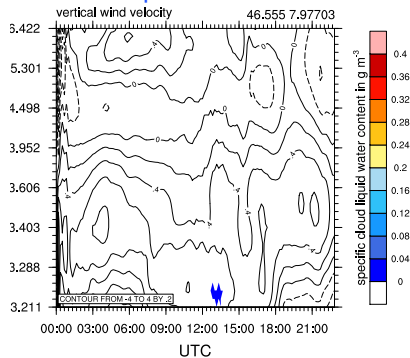


Time development of MPC on 18 Apr 2013

Cloud ice content



Cloud liquid content



orography at JFJ

