CONDITIONS FOR PMC FORMATION IN 2002-2008 ESTIMATED FROM TIMED/SABER MEASUREMENTS

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A simplified model of PMC formation

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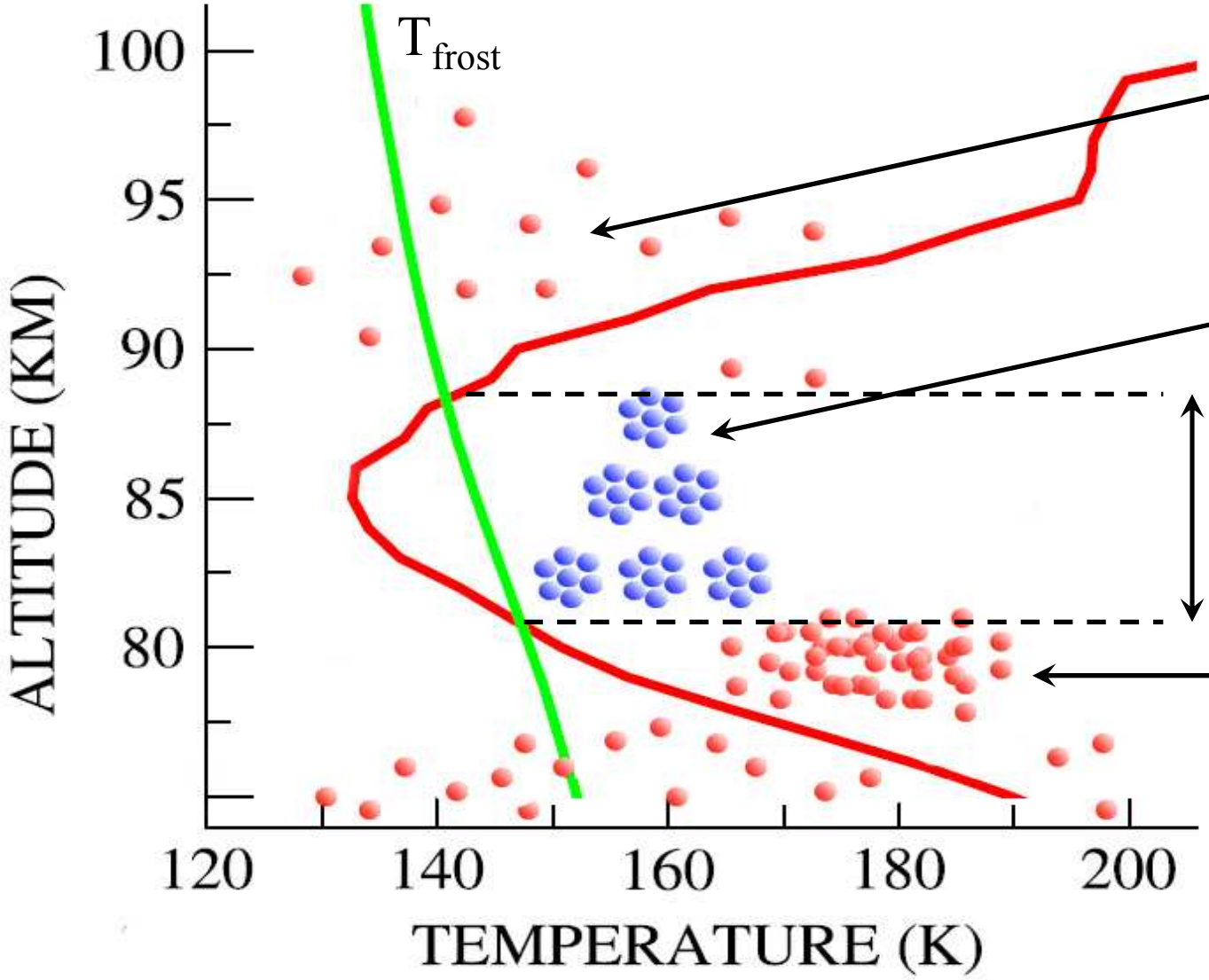


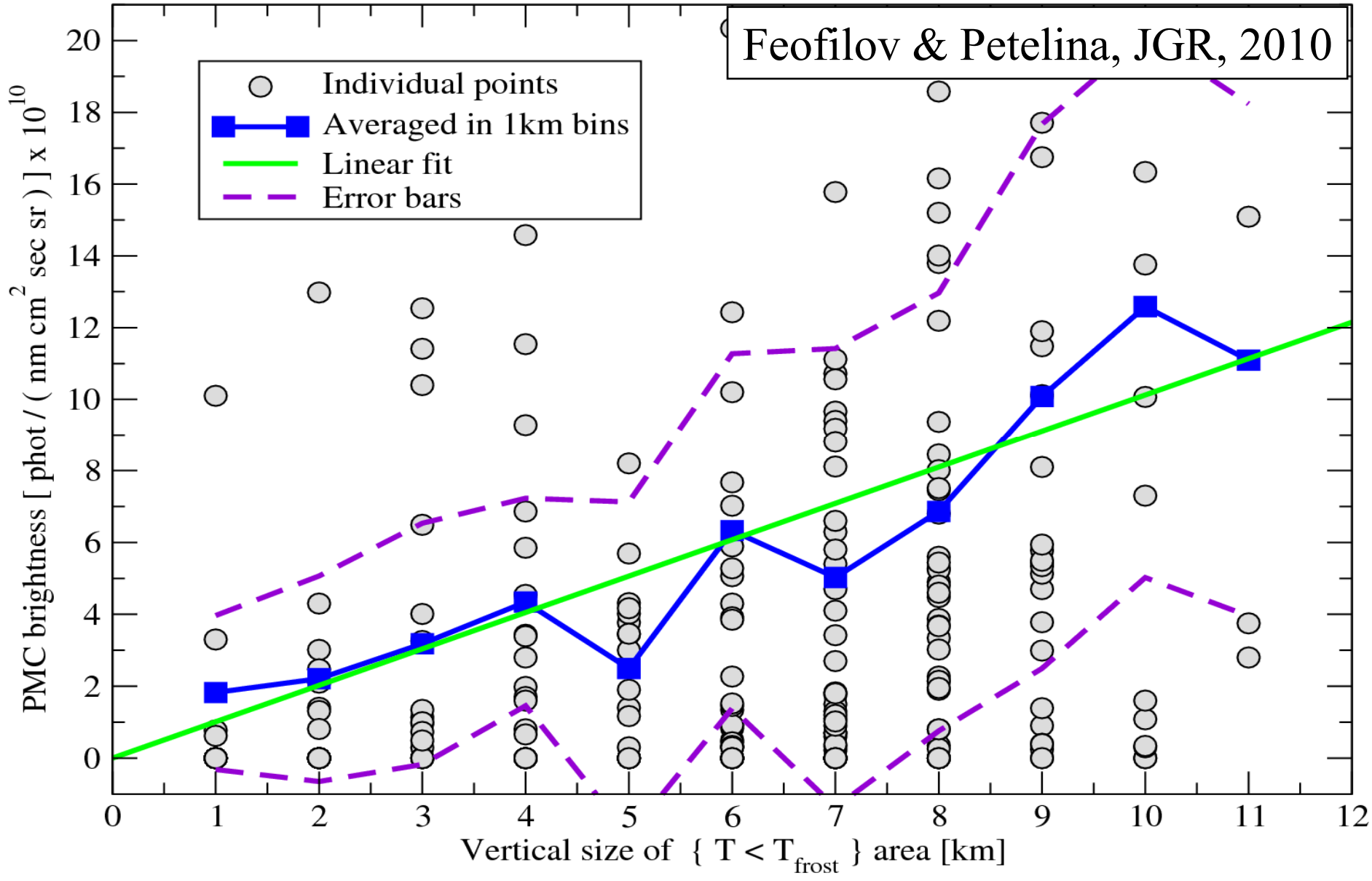
Water vapor

Precipitating ice particles

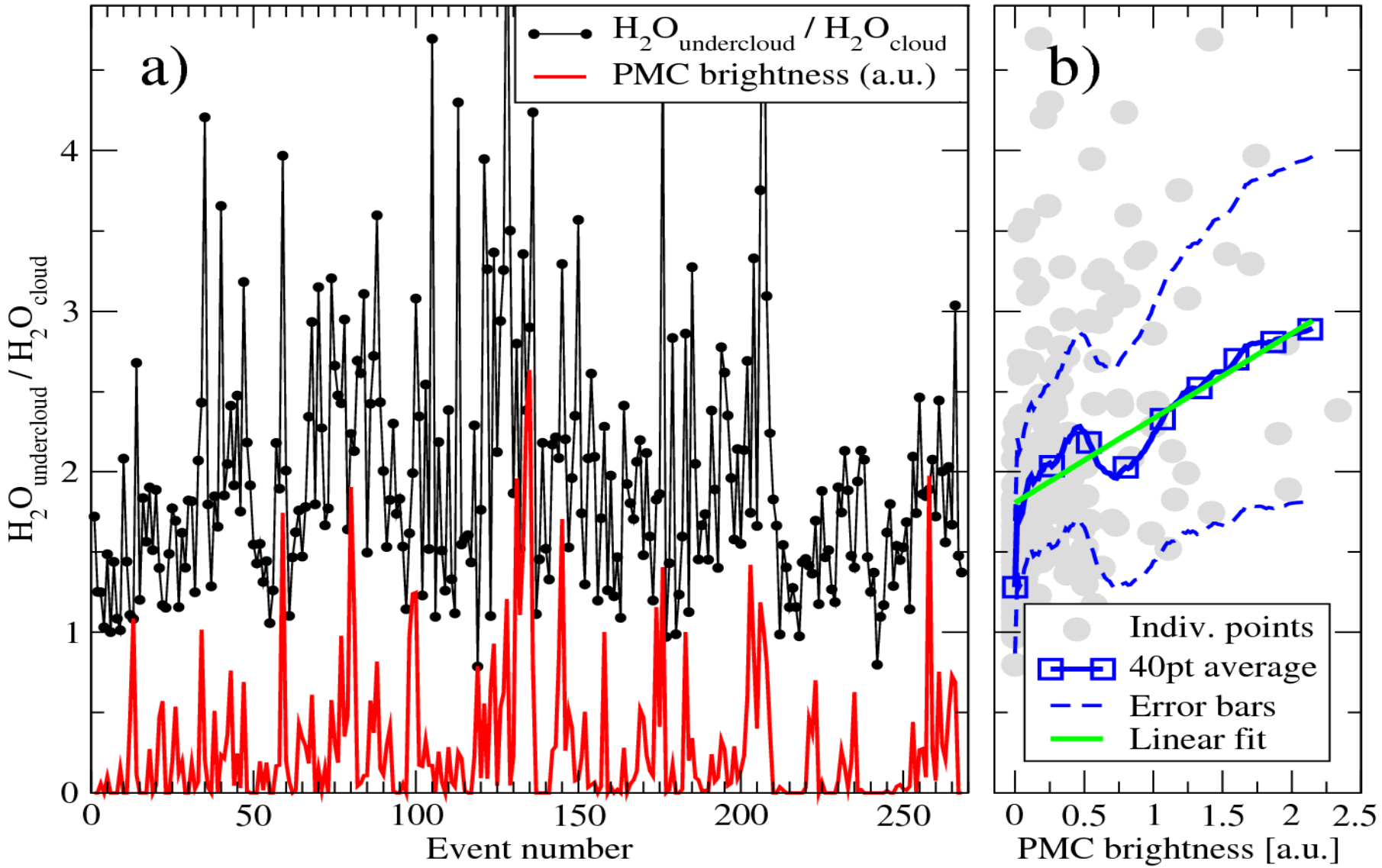
L_{frost}: the vertical size of the area where PMCs can form

Sublimated ice = enhanced H_2O

OSIRIS PMC brightness vs integrated L_{frost}

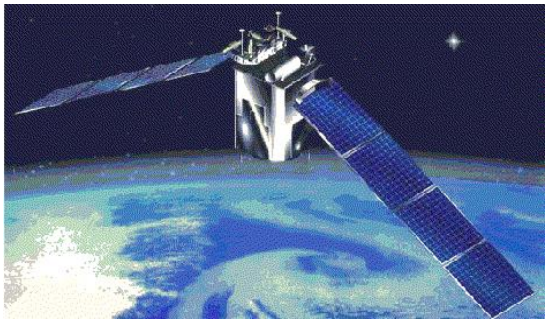


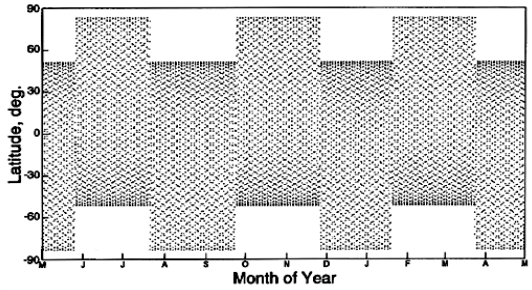
PMC brightness correlated with H_2O VMR in and below the cloud (Feofilov & Petelina, 2010)



The SABER Instrument Aboard the TIMED Satellite

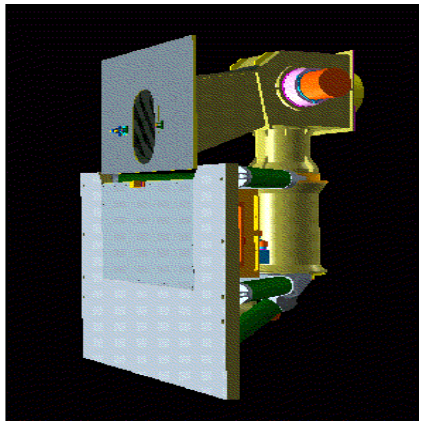
TIMED: Thermosphere, Ionosphere, Mesosphere Energetics & Dynamics
74.1° inclined 625 km orbit;
Latitudinal coverage: 83°S–52°N / 53°S–82°N
Data available since 25 January 2002





SABER: Sounding of the Atmosphere Using Broadband Emission Radiometry

- Limb scanning infrared radiometer (~10–100 km, ~2 km footprint)
- 10 broadband channels (1.27–17 μm)
- Products: kinetic temperature, pressure, CO_2, O_3, H_2O, NO, O_2, OH, O, H



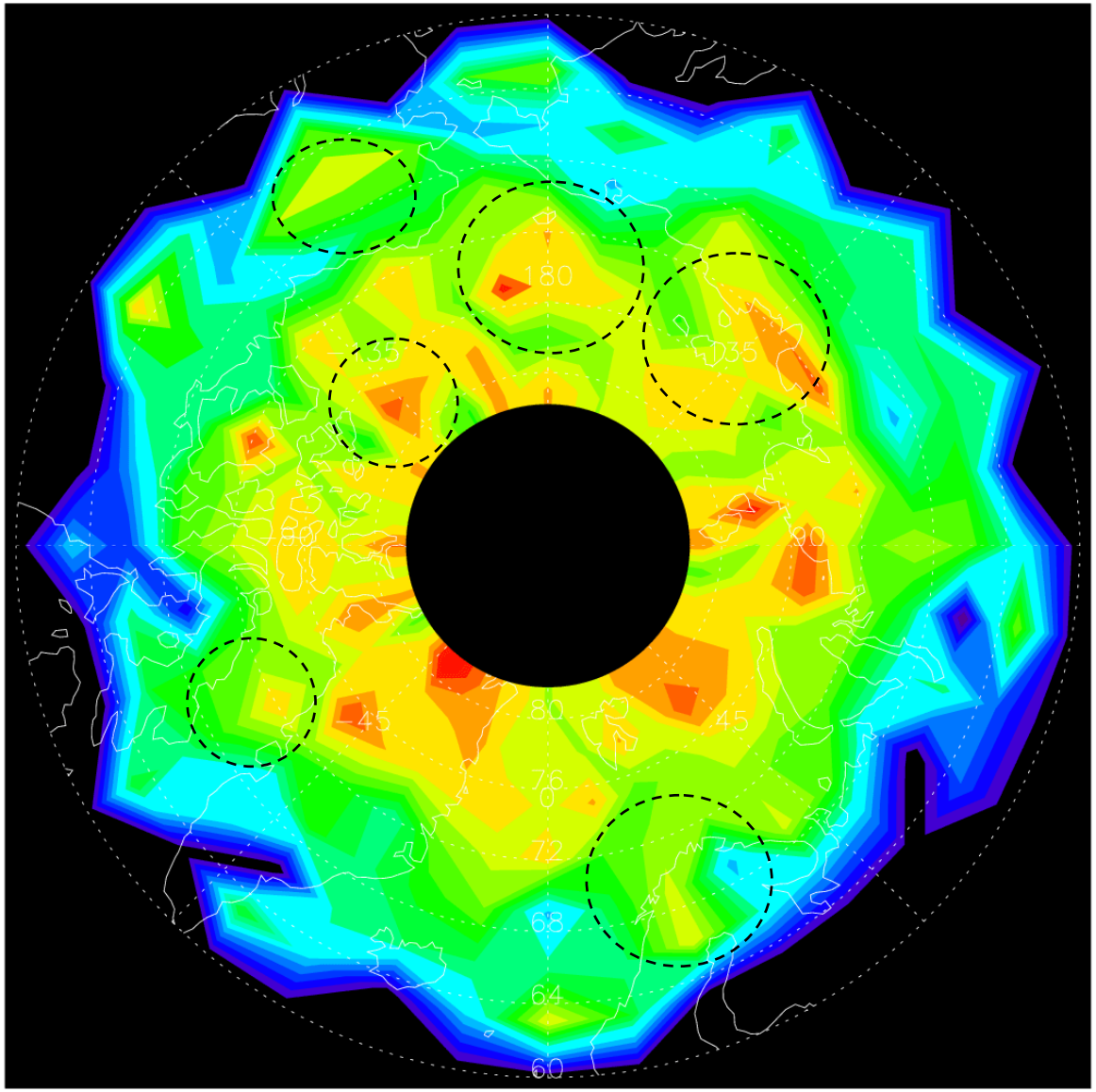
General idea and approach

- A simplified model of PMC particles lifecycle is shown on Fig. 1. It does not take into account meridional transport effects that are important in some cases. However, as Fig. 2 and 3 show (see also [Feofilov and Petelina, JGR, 2010]), there is an obvious correlation between the ***local*** atmospheric parameters and PMC brightness.
- The latter appears to be proportional to L_{frost}, the vertical size of the area where $T<T_{frost}$, and to the ratio of H_2O VMR below and in the cloud that are related to the ice sublimation and freeze drying effects, respectively.
- In this work we continued studying the polar summer mesosphere using SABER/TIMED instrument (Fig. 4) and plotted the maps of L_{frost} and ($H_2O_{undercloud}$ / H_2O_{cloud}) ratio for polar summer seasons of 2007-2008 (see the examples on Fig. 7-9).

Results and discussion

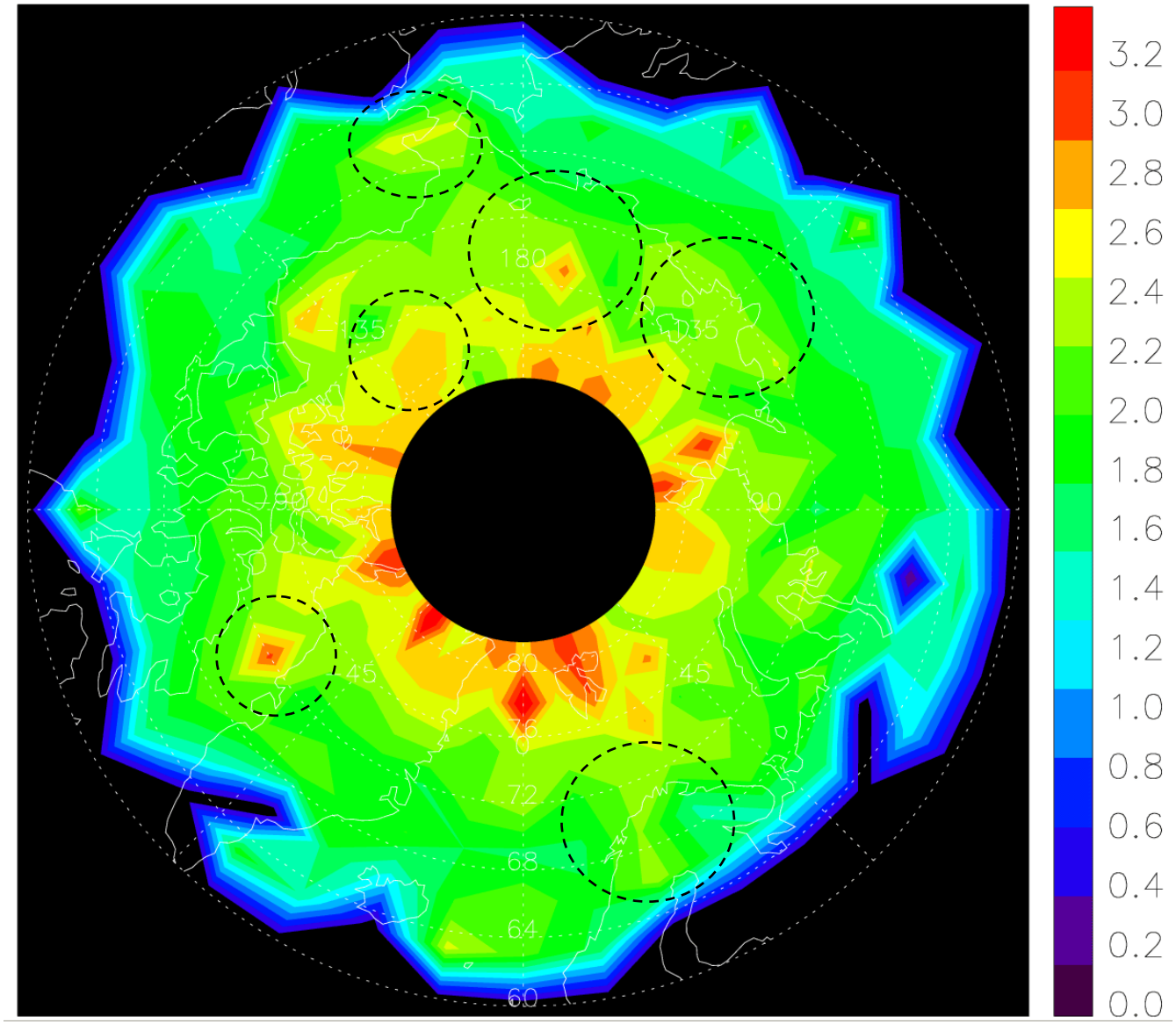
- Fig. 7 shows the L_{frost} distribution that gives the estimate for the PMC brightness as follows from Fig. 2.
- Fig. 8 demonstrates the ratio of $H_2O_{undercloud}/H_2O_{cloud}$ for the same conditions. Both figures demonstrate the similar latitudinal behavior: the values shown tend to increase to the pole. The fine structures seen on these plots are similar. This proves the concept used in [Feofilov and Petelina, 2010].
- Fig. 9 shows the PMC albedo measured by CIPS instrument onboard AIM satellite for the same days. The meridional behavior is consistent with that seen in Fig. 7 and 8 while the fine structure does not always repeat that of those figures. This is linked with high temporal variability of the mesospheric area within the day.

Vertical size of $T<T_{frost}$ area, L_{frost}, 2007, 183-196



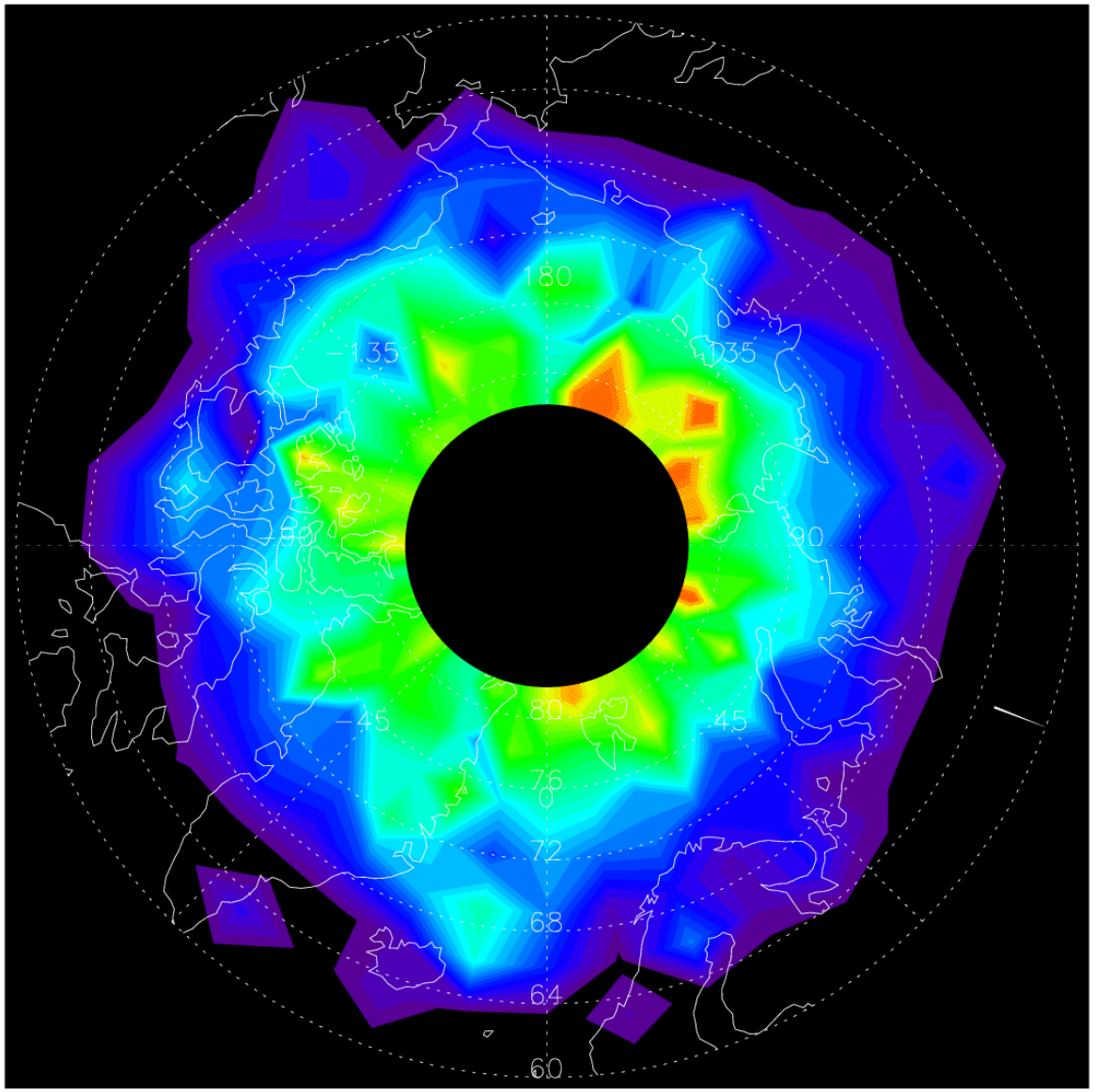
- T_{frost} estimated in accordance with Murphy and Koop, 2005.
- SABER V1.07 data (P,T)
- H_2O profiles retrieved in accordance with Feofilov et al, 2009.
- 3° lat × 10° lon bins
- Two-week averages of L_{frost} values is shown.
- Larger L_{frost} values "predict" brighter clouds.
- Latitudinal behavior agrees with that of CIPS PMC brightness (see Fig. 9).

$H_2O_{undercloud} / H_2O_{cloud}$ ratio, 2007, 183-196



- Parameters are the same as on Fig. 7.
- Ratio of H_2O VMR below and in the cloud is shown.
- Only the cases with $T<T_{frost}$ = "allowed" PMCs are considered.
- Typical ratio for the non-PMC cases is 2.
- Note the similarities in the structures seen on this figure and Fig. 7 marked by dashed circles.

PMC albedo measured by CIPS, 2007, 183-196



- CIPS 03.20 level 4 data.
- 3° lat × 10° lon bins.
- Daily overlaps with SABER selected.
- Two-week average of daily "snapshots" presented.
- Latitudinal behavior agrees with that seen on Fig. 7 and 8 though the structures do not always match.