FMI and EuroPlaNet N2 DWG-1

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Mars' lower atmosphere: introduction and background I

- FMI involved in Mars atmospheric studies as of mid-1980s
- *In situ* observational systems based on sensor technology originating from Vaisala Inc.
  - Pressure
  - Humidity
  - (temperature)
- Near-Mars space studies, e.g., oxygen loss

- Involvement in several Mars lander missions *or mission proposals*:
  - Mars 96
  - *MarsNet, InterMarsnet*
  - Mars Polar Lander
  - Beagle 2
  - *NetLander*
  - Phoenix
  - MetNet
  - ExoMars

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Mars' lower atmosphere: introduction and background II

- Lower atmosphere modelling work carried in a joint University of Helsinki – Finnish Meteorological Institute research group
- Collaboration initiated in early 1990s
- Currently 4+3 scientists
- Collaborations with, *e.g.*, Oxford AOPP, LMD, JPL, York, Spanish MSL groups

- Process models for parameterisation methods and schemes
- Spatially 1-D, 2-D and 3-D dynamical as well as aerosol micro-physical models in use and development

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MetNet

- FMI-Babakin lander concept for a network consisting a larger number of small *meteorology* landers, possibly launched over several opportunities
- Unconventional and innovative entry, descent and landing system – no parachutes and semi-hard landing
- NetLander-ATMIS-type payload

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1-D & 2-D models

- Based on terrestrial models, adapted to Mars at UH as of early 1990s
- 1-D
  - Column model
  - Process and algorithm testing, thermal cycles, PBL
- 2-D: Mars Mesoscale (Circulation) Model 2-D (MMM2D)
  - Primitive equations
  - Vertical and one horizontal axes – a "slice"
  - Inherent limitation due to the reduced dimensionality
  - Horizontal variations ⇒ slope and sea-breeze -like winds – forced by *e.g.*, topo-graphy and albedo, thermal inertia, ice coverage contrasts

3-D: the Mars Limited-Area Model (MLAM)

- Spatially fully 3-D (limited-area) MMCM based on the dynamical core of the operational weather prediction model HIRLAM
- The model “physics”, i.e. subgrid parameterisations partly inherited from accumulated development on the 1-D and 2-D models; partly new development
- Initial and boundary conditions (IBCs) from Oxford MGCM scenario and assimilated MGS/TES results
- collaboration with Spain/MSL?
- Three other MMCMs in the USA, one in Canada – MLAM the only European 3-D MMCM

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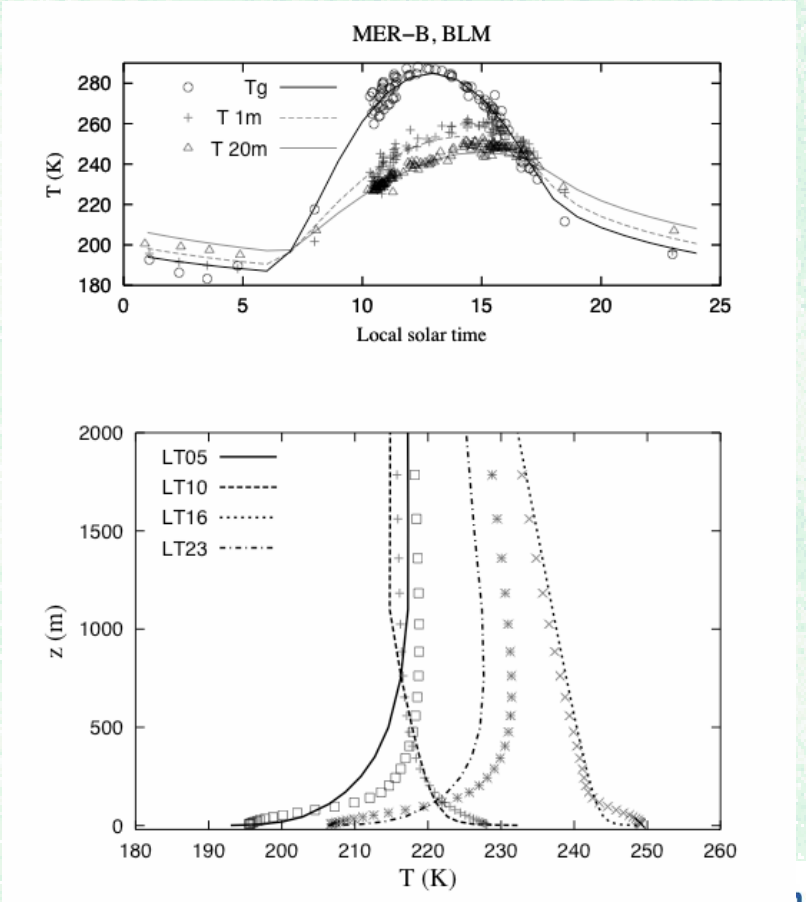
1-D column model

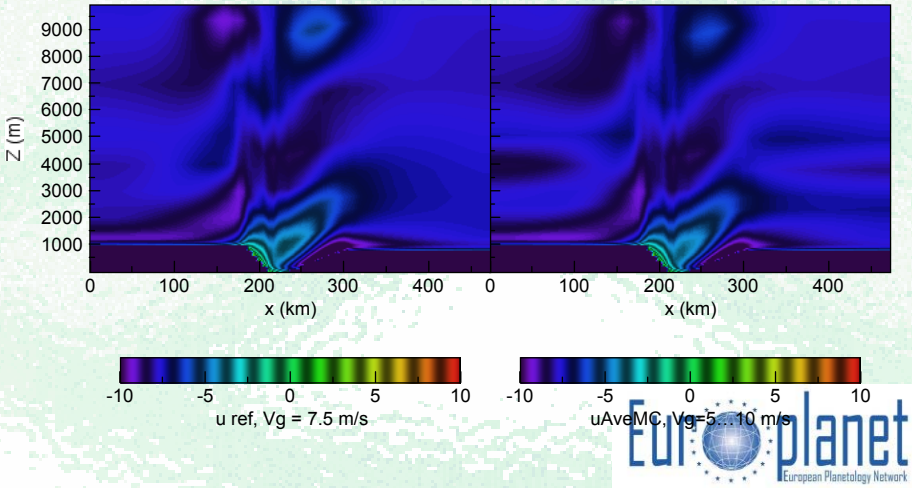
- Based on terrestrial model, adapted to Mars at UH as of early 1990s
- Process and algorithm testing, thermal cycles, heat diffusion in the soil, PBL
- In use also at York
- Comparisons with VL, MPF and MER p, T & H data
- Comparisons in radiative transfer with line-by-line code from JPL/Crisp



2-D model: pilot studies of *ensemble* type approaches

- Until recently single-run simulations – one fixed set of initial and boundary conditions
- Imperfect data + sensitivity to initial conditions
- Ensemble approach
  - Multiple runs with perturbed I- & b-conditions
  - Statistical forecasts – sensitivity & robustness
  - Computationally costly

- 2-D model limited in capabilities but computationally much cheaper than 3-D
- Ensemble pilot study started



3-D model: status & recent results

- Reference version almost complete
- Model testing and tuning – comparisons with VL, MPF and MER (possibly also with assimilated TES) data
- Participation in the first MMCM intercomparison – model comparisons

Summer solstice ($L_s \approx 90°$) at $z \approx 1.5$ m

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VL1

MPF

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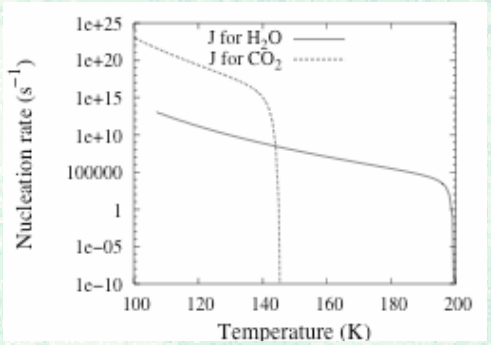
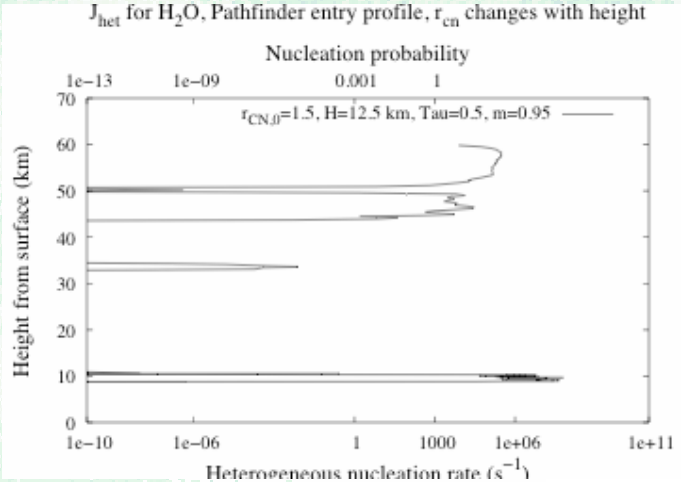
Aerosol microphysics

- Modelling of nucleation of H_2O and CO_2, search for saturation ratios S and threshold temperatures $T_{th,S}$
- Modelling also as a function of altitude based on Pathfinder and 1-D model profiles; agreement with Inada, Colaprete models good
- Two-component modelling started, results from homogeneous and heterogeneous nucleation forthcoming





Future work & prospects, conclusions

- 2-D model delegated to specialised niche(s)
  - Ensemble methodology and algorithm testbench, quick-look tool
  - H_2O, CO_2, dust process development
  - Beagle 2, possibly MPF ensemble simulations & data comparisons
- 3-D MLAM online & main focus
  - H_2O, CO_2, dust processes
  - Hellas impact basin, dust
  - Polar circulations, transport (re: NASA Phoenix)
  - Tool for landed mission support forecasts and studies – Aurora?

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European Aurora astronaut carrying out field work on 2035-04-06 noticing the morning fog reliably predicted by the regional MLAM weather prediction system (v. 14.1)?

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