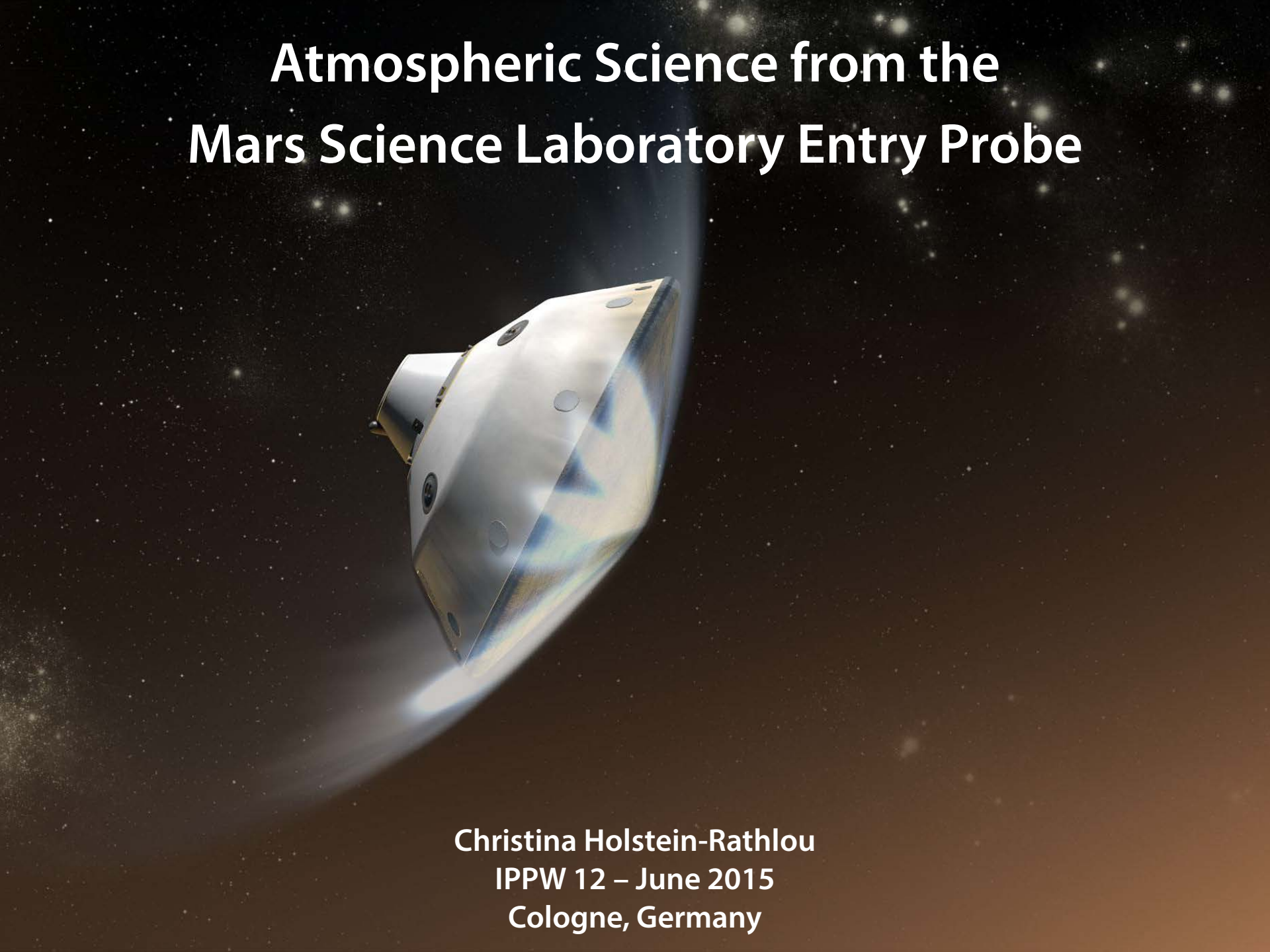
Atmospheric Science from the Mars Science Laboratory Entry Probe

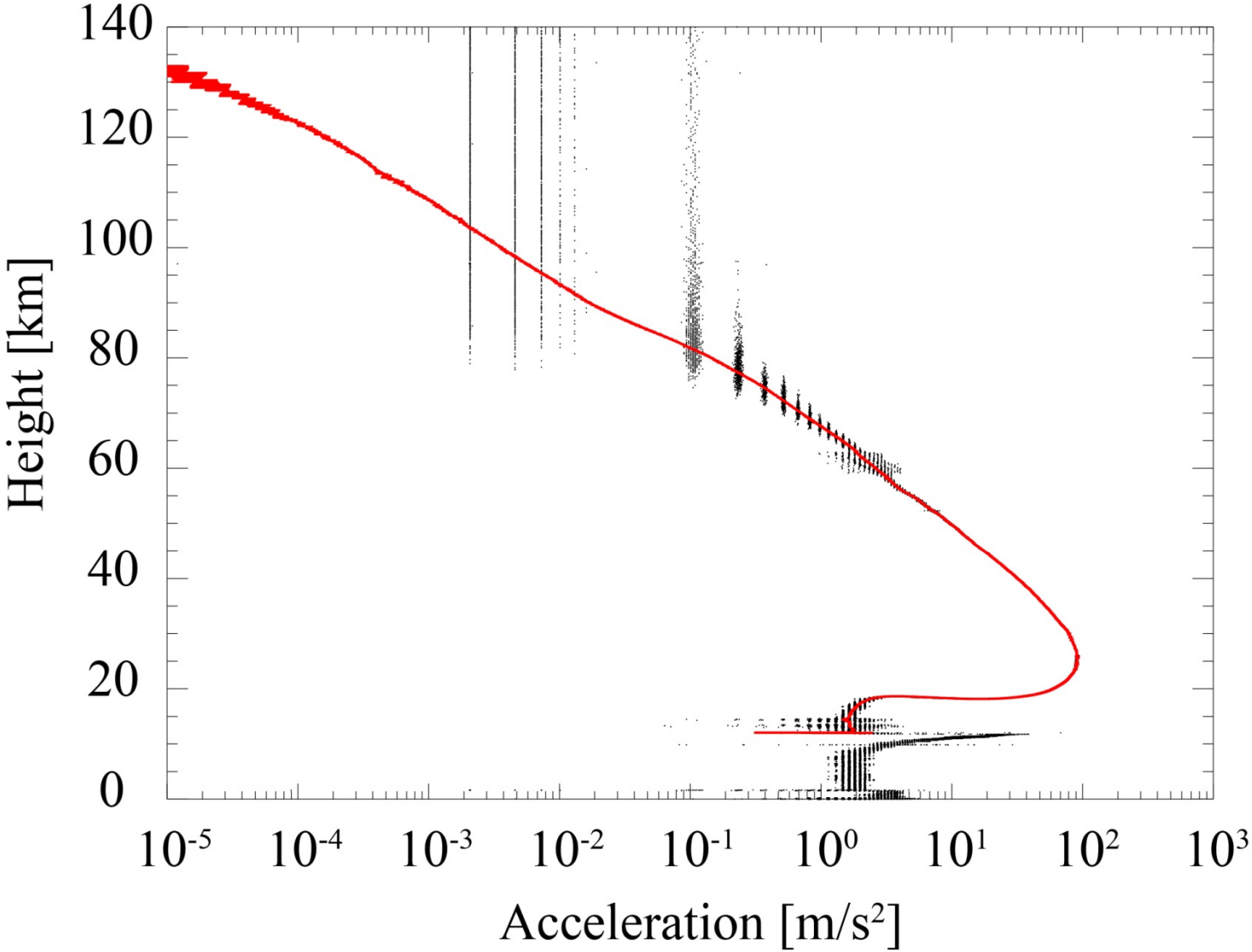


Christina Holstein-Rathlou

IPPW 12 – June 2015

Cologne, Germany

Accelerations



Atmospheric reconstruction

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Three main equations:

Drag equation

$$\rho = -\frac{2\, m_{SC}\, a}{C_A v_{rel}^2\, A_{SC}}$$

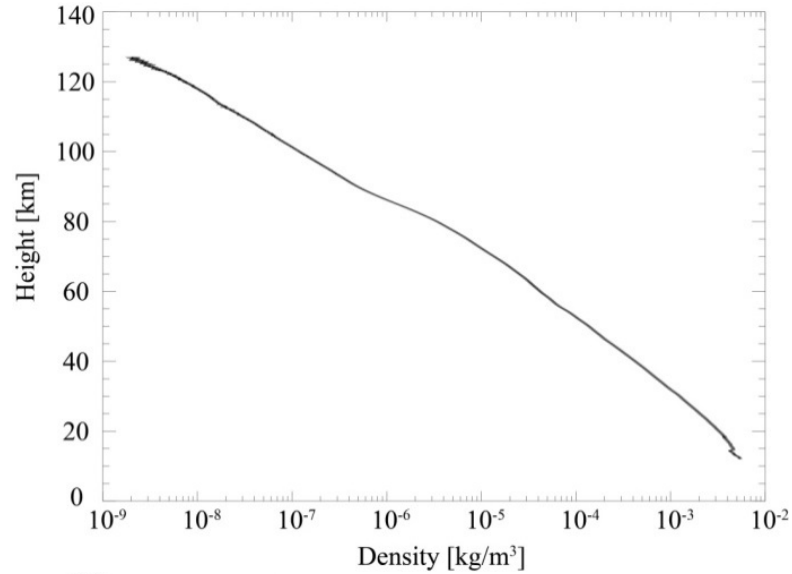
Hydrostatic equilibrium

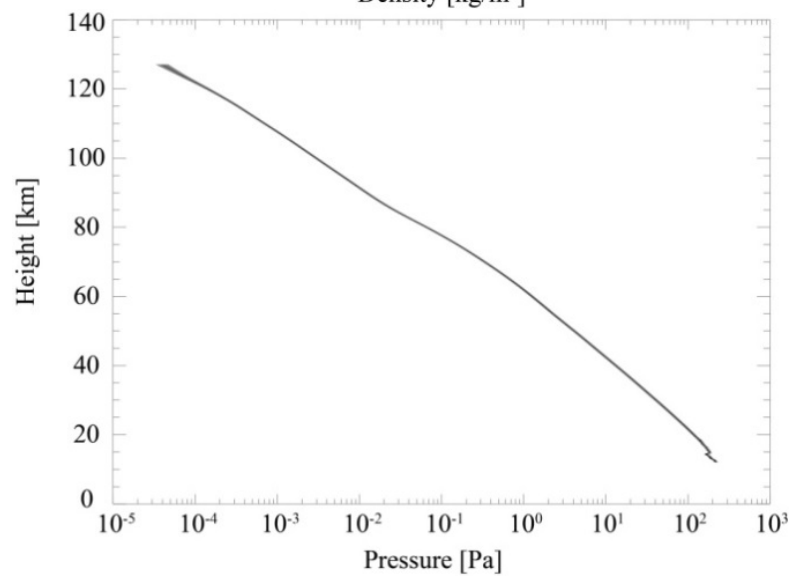
$$\frac{dP}{dz} = -\rho\, g_z$$

Ideal gas law

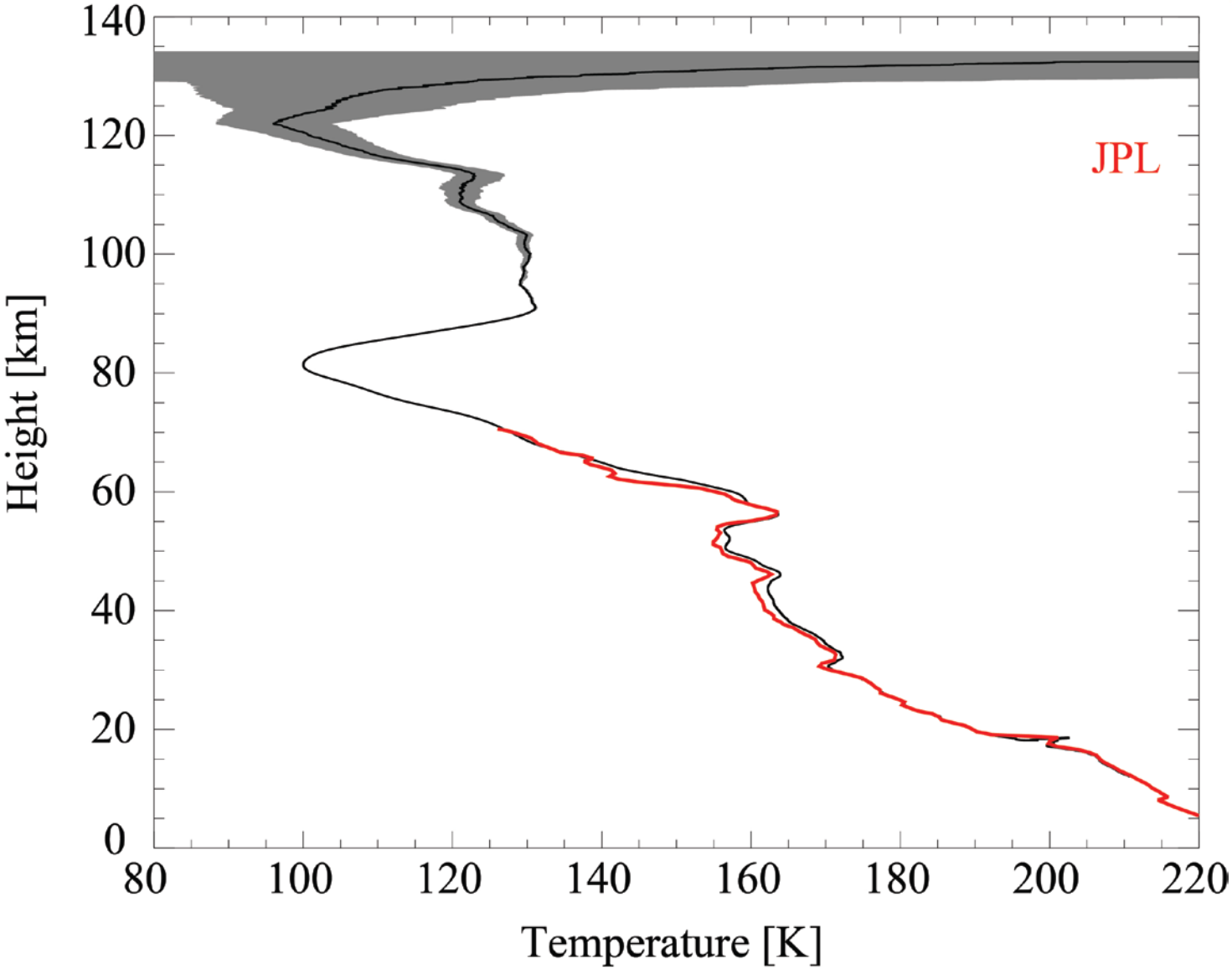
$$T = \frac{P\, M}{\rho\, k_B\, N_A}$$

Horizontal flight: got P from JPL T





Temperatures



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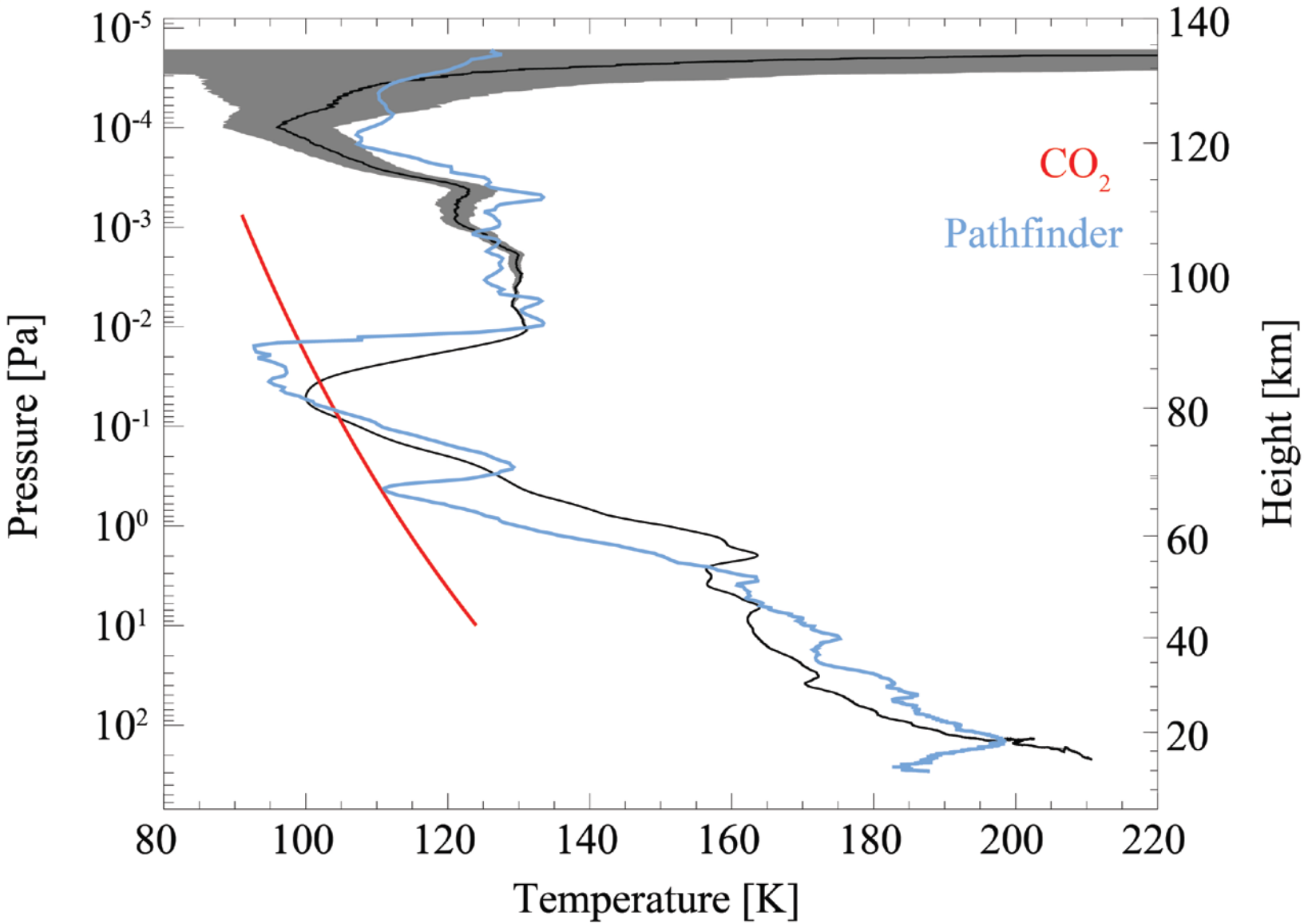
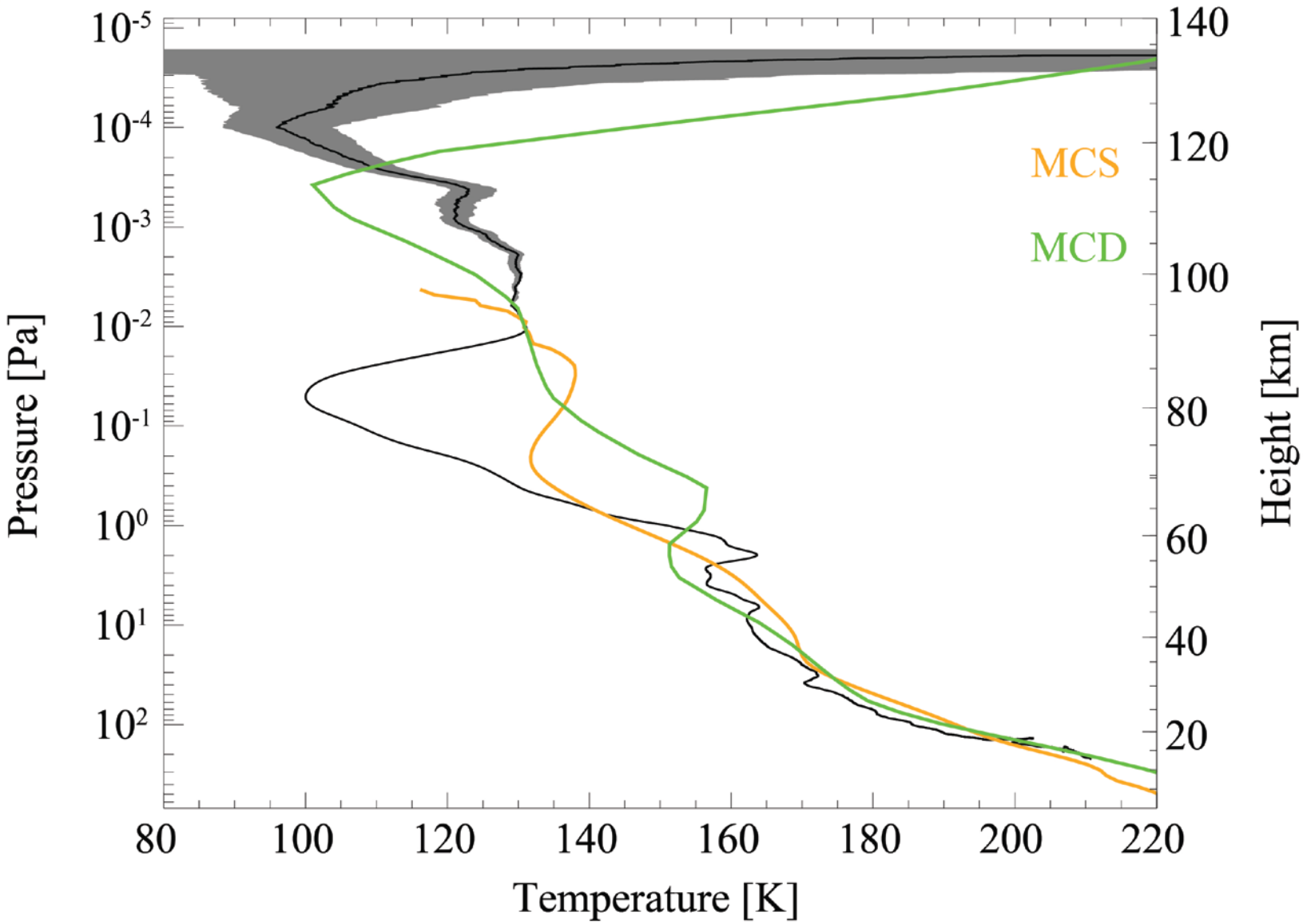
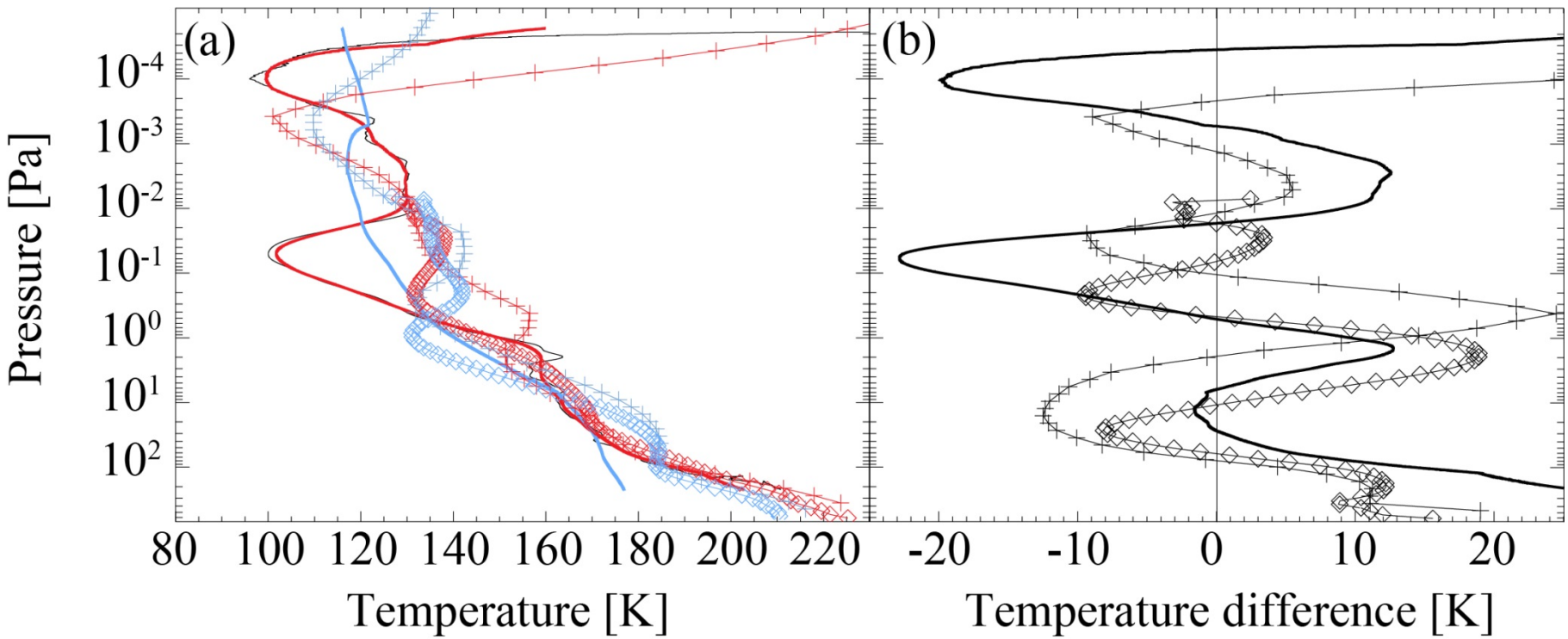


Temperatures



Atmospheric tides

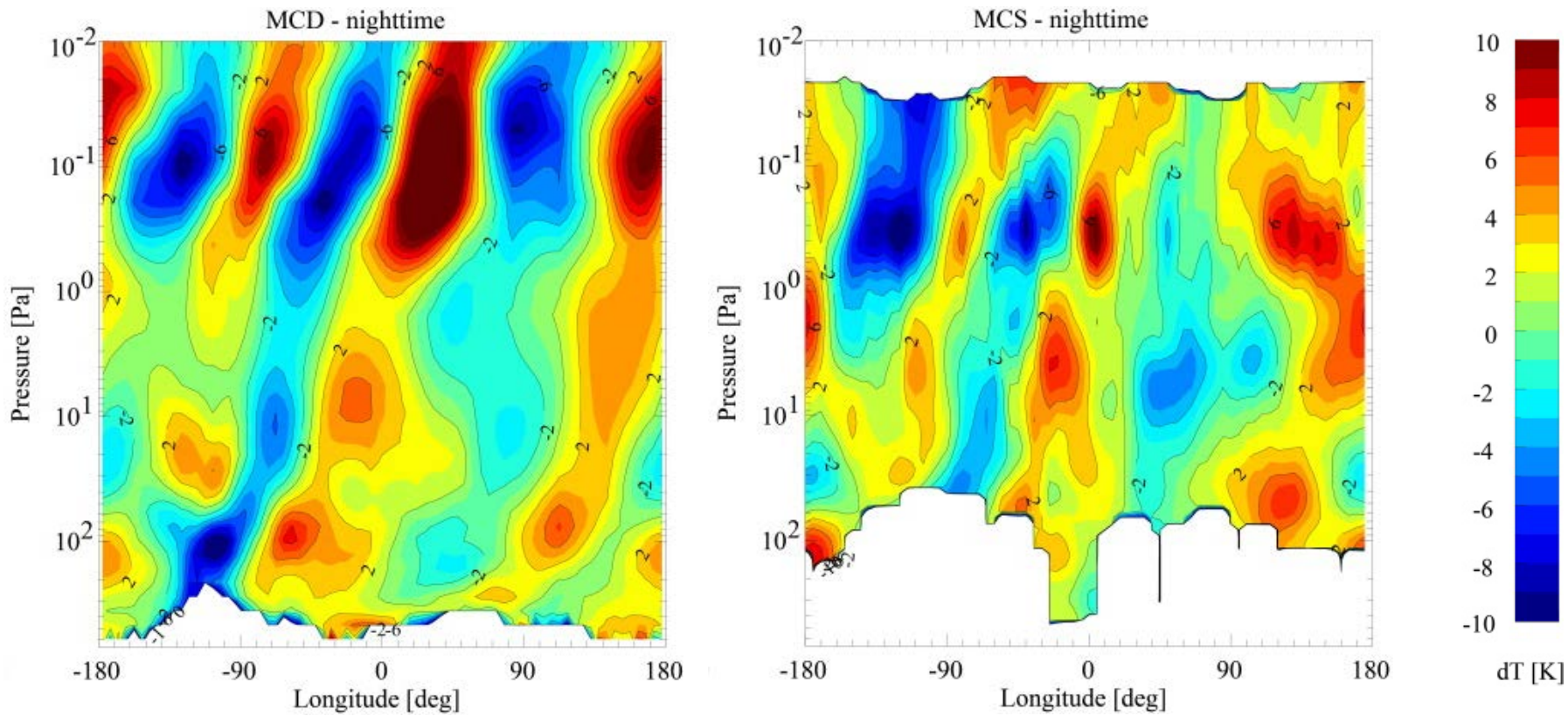


Legend

Day	— MSL
Night /	◊ MCS
3H average	+ MCD

Definite diurnal signature
however λ_z > predicted λ_z
→ Not pure diurnal migrating tide

Atmospheric tides



Non-migrating with wave 3 structure, diurnal, eastward propagating
→ Diurnal Kelvin 2 (DK2) wave

Take-away and thanks

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MSL atmospheric science extended to twice the altitude of the engineering reconstruction

MSL did most likely not descend through a CO_2 cloud

MSL entry profile contains signatures of diurnal tides

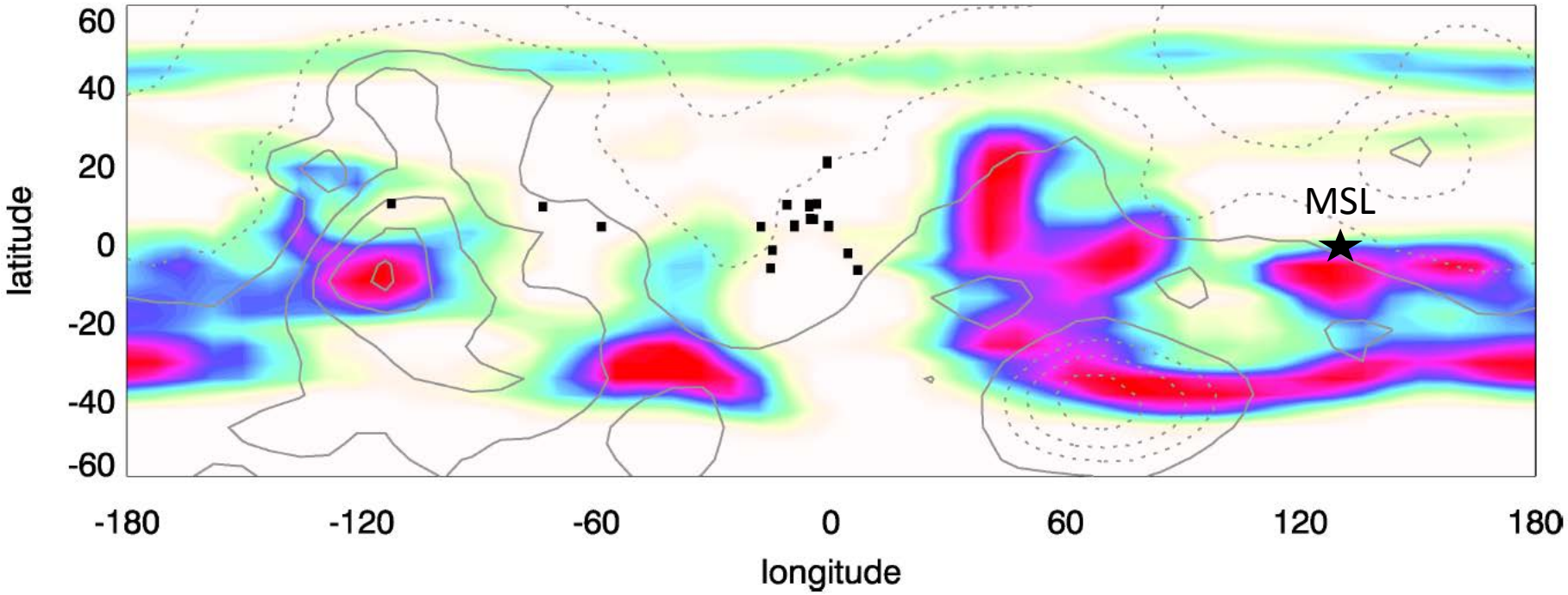
Thanks to…
Paul Withers
Anthony Maue

Allan Chen
Anni Määttänen
MSL Council of Atmospheres
JPL grant 1472312

Extras, unwanted etc.

You will be given **12 minutes** to present your material. Please plan the amount of material accordingly--no more than 6-8 charts.

Temperatures



Ls = 150° ± 15° ; Local time = 14:00 ± 00:30 (*Spiga et al, GRL, 2014*)

Atmospheric tides

Thermal tides: Global-scale oscillations in atmospheric properties (ρ, P, T) caused by solar heating

→ Thermal tides have periods that are integer fractions of the martian day

Focus: Diurnal tides, which are evident in temperature difference plots

Migrating tides
- Sun-synchronous
- westward travelling

Non-migrating tides
- not Sun-synchronous
- west- or eastward travelling
- excited by longitudinal variation in heating

Atmospheric reconstruction

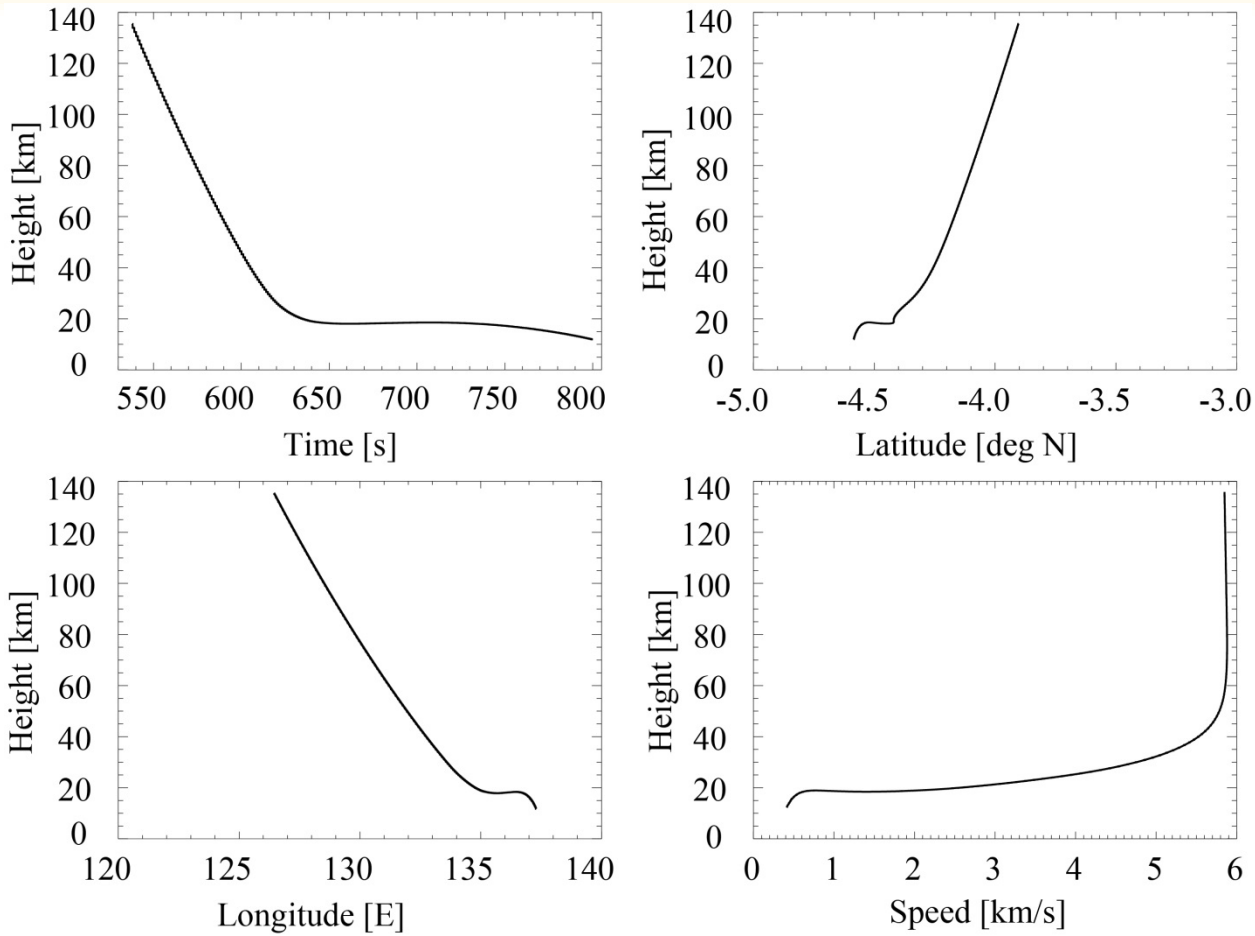
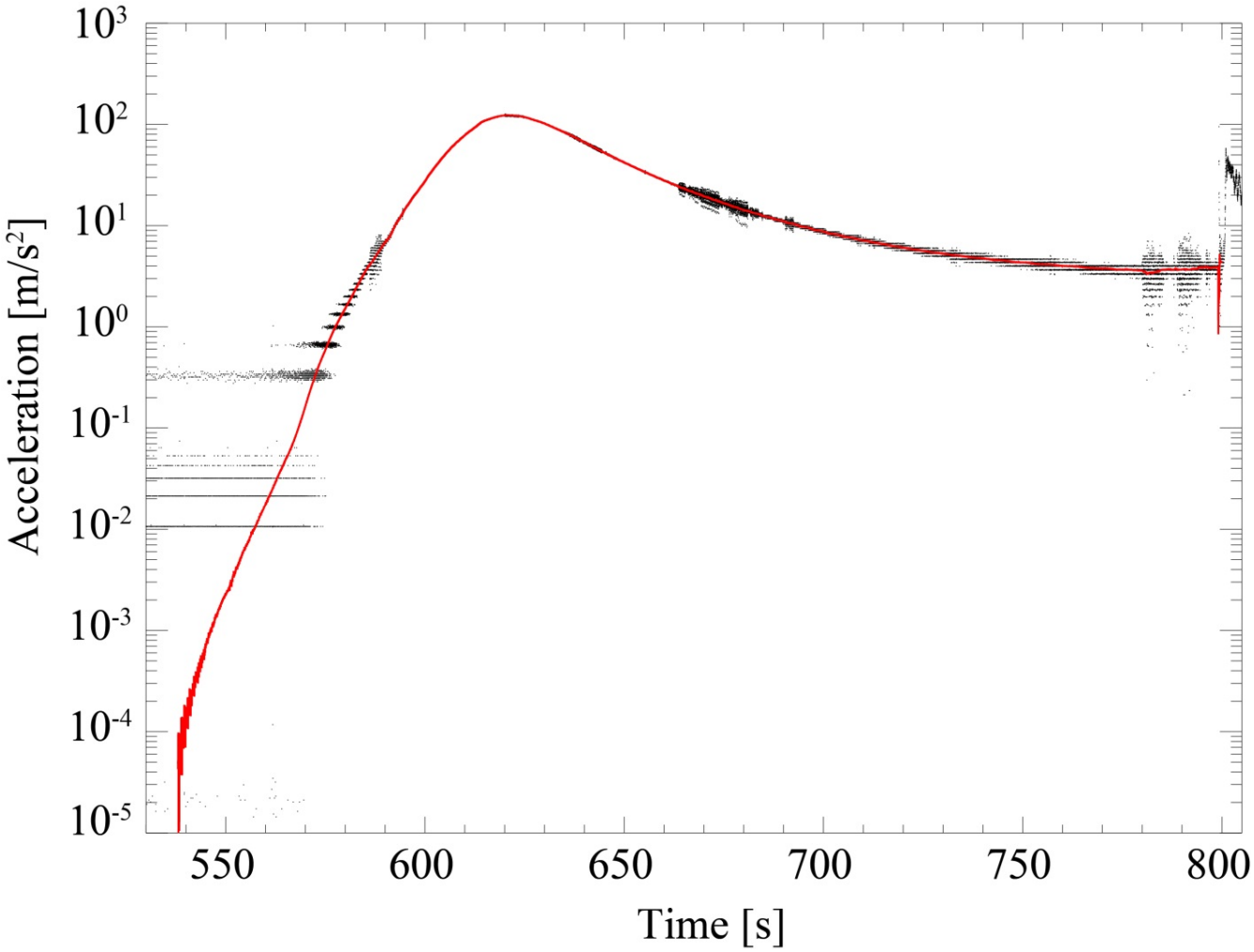
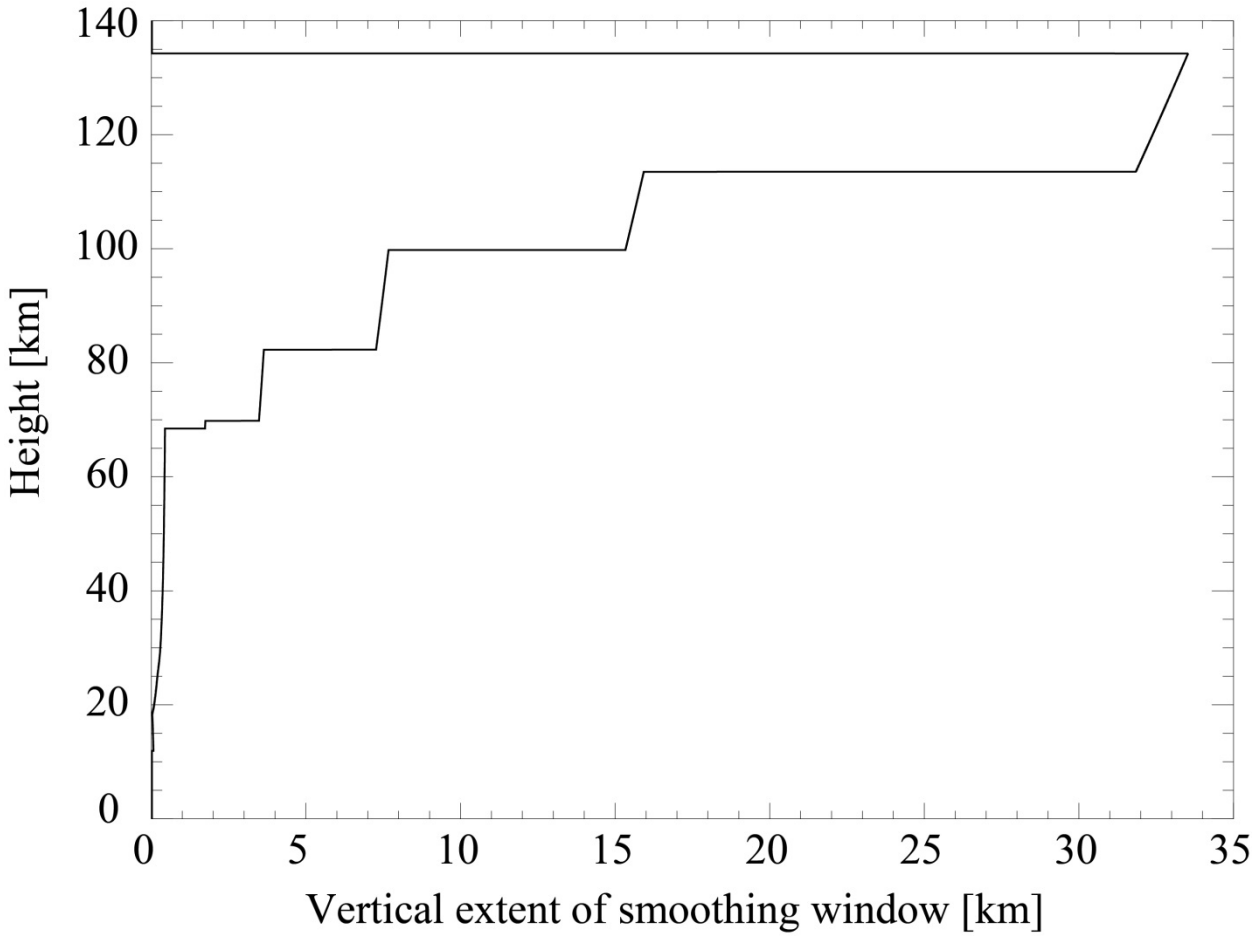
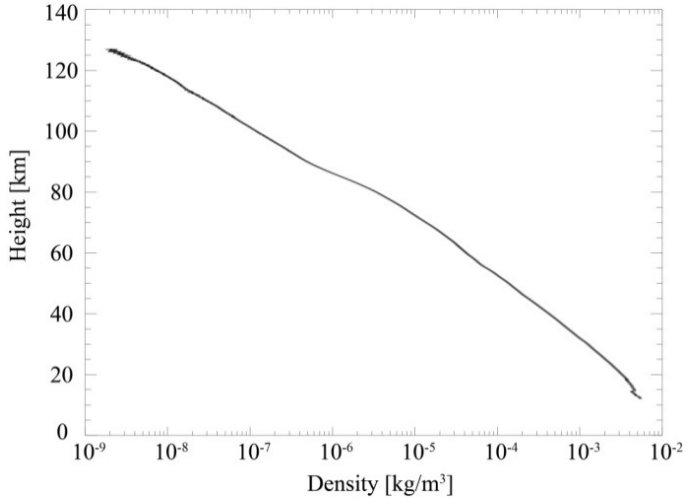


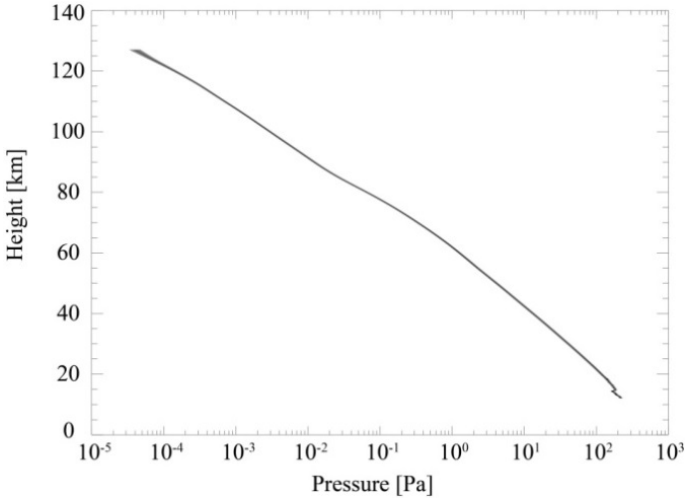
Figure 1: MSL entry trajectory (time, latitude and longitude) and spacecraft speed as a function of height above the landing site from atmospheric entry to parachute deployment. The horizontal flight period is clearly visible just below 20 km height.

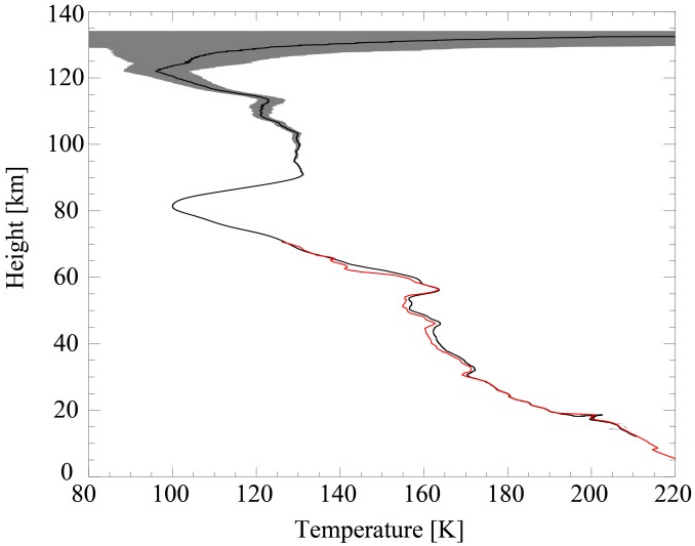
Accelerations



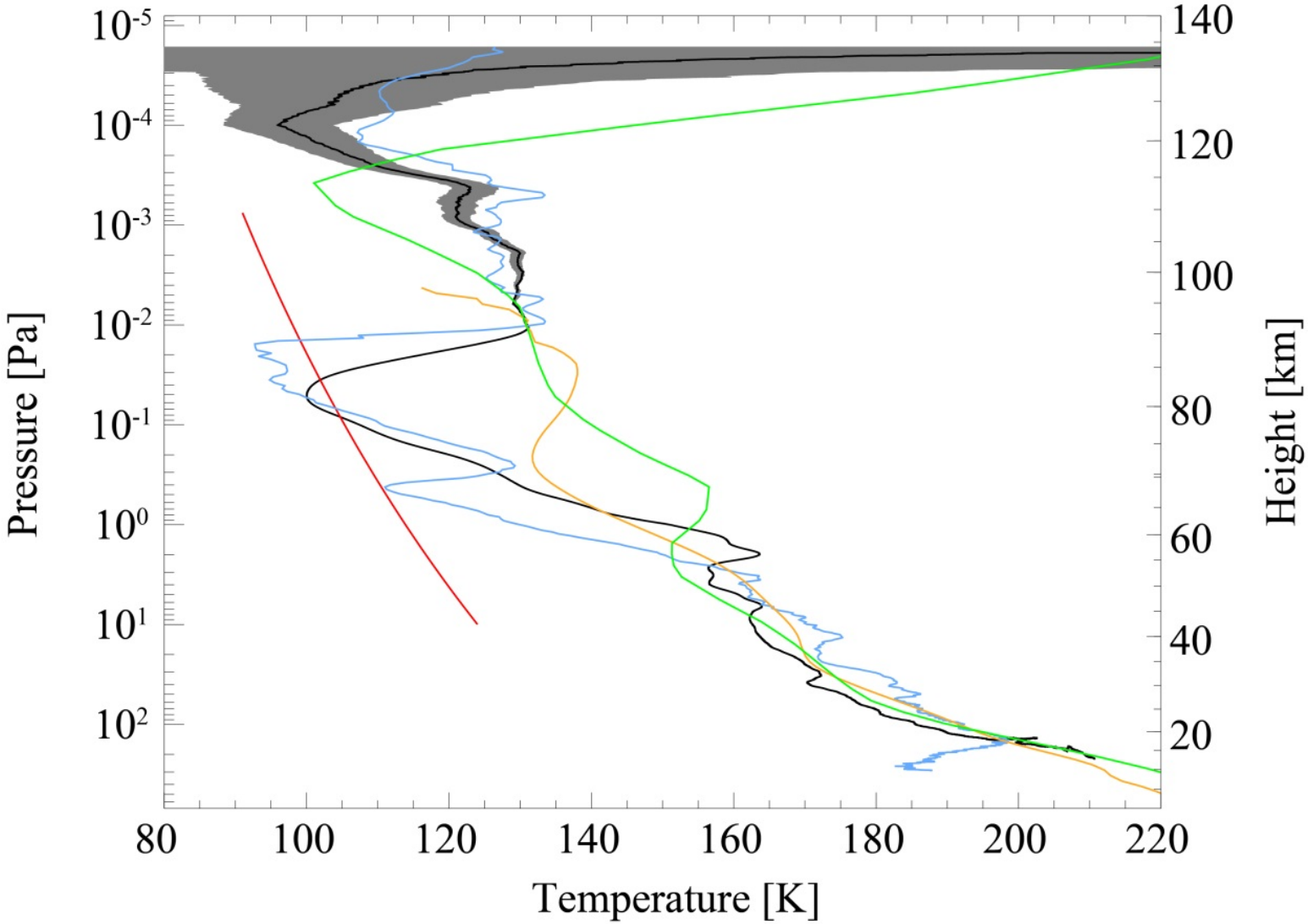

140
120
100
80
60
40
20
0
Height [km]
0
5
10
15
20
25
30
35
Vertical extent of smoothing window [km]


Height [km]
Density [kg/m³]

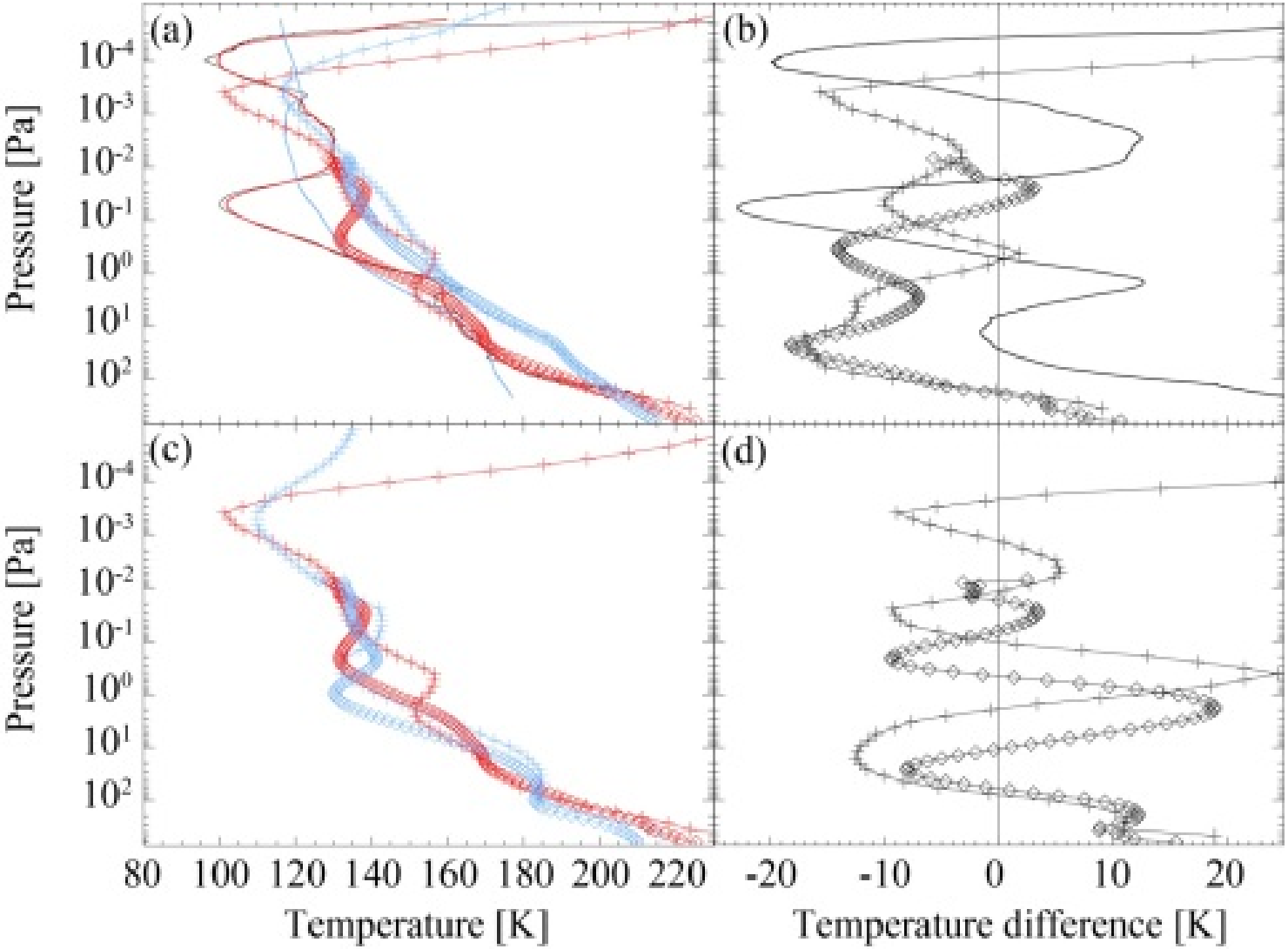

Height [km]
Pressure [Pa]


Height [km]
Temperature [K]

Temperatures



Atmospheric tides



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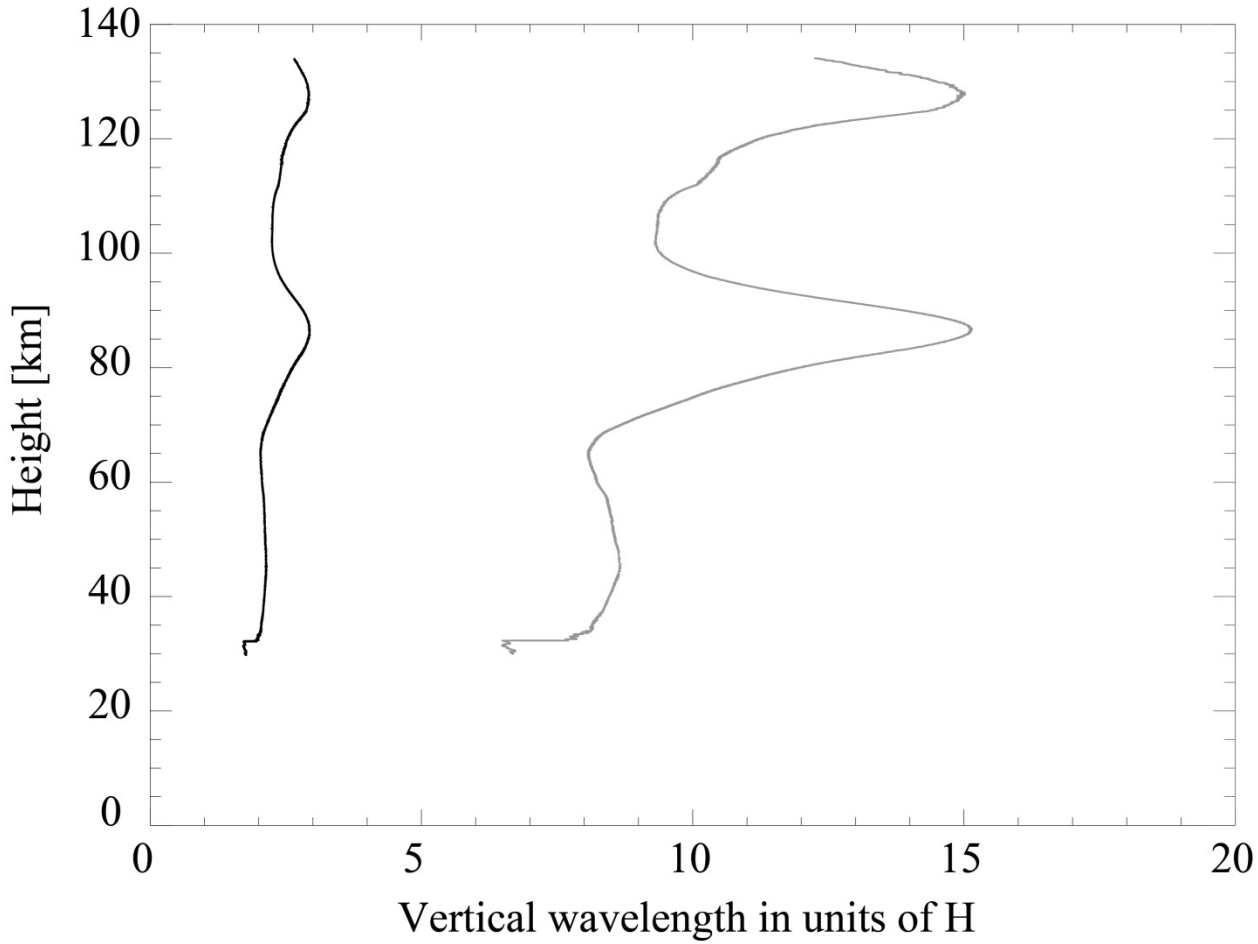
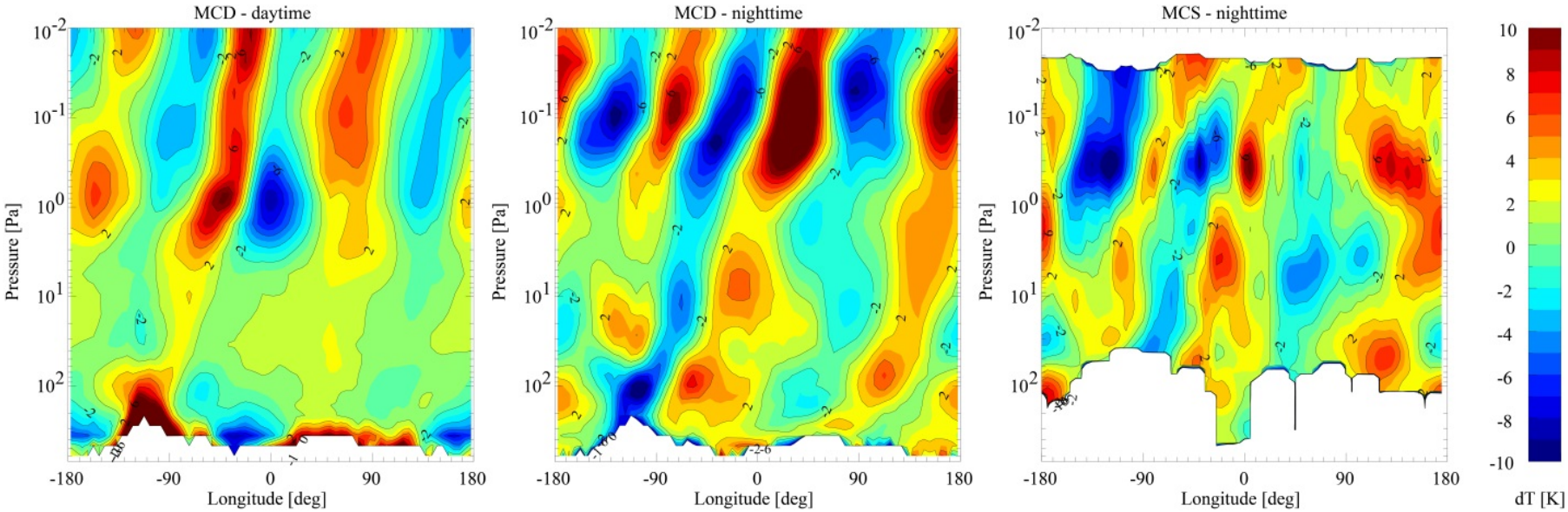
Atmospheric tides