PSIDA

Retrieving Single Scattering Albedos and Temperatures from CRISM Hyperspectral Data using Neural Networks

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- Simulations Test
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Introduction & Motivation

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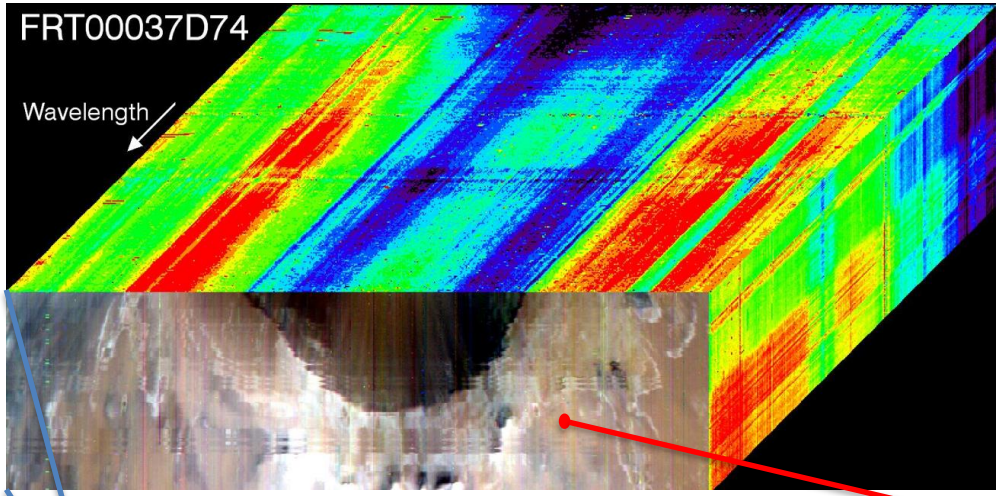
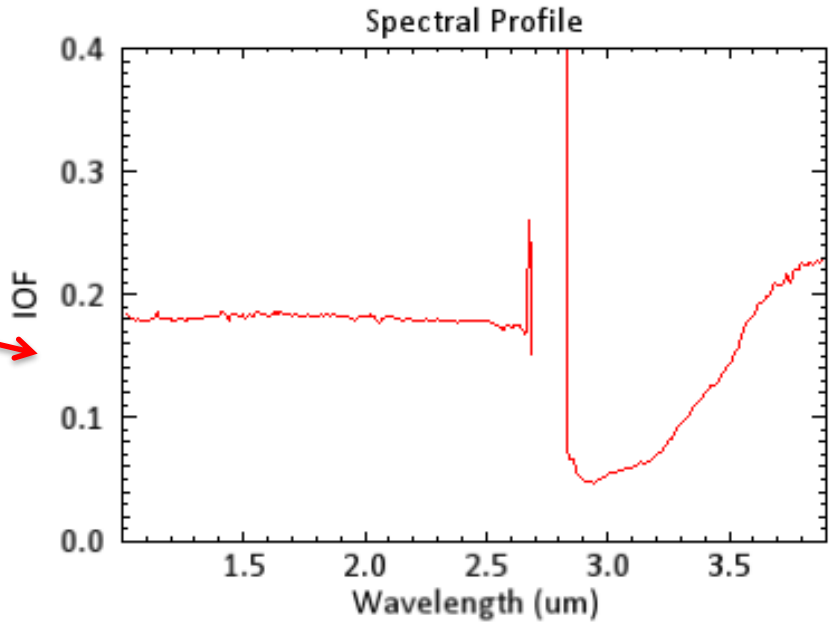


Compact Reconnaissance Imaging Spectrometer for Mars (CRISM)



Reflectance -> Mineral

- Reflectance IOF
- Thermal IOF

Introduction & Motivation

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Single Scattering Albedo

SSA + T + geo ~ IOF (Reflectance IOF + Thermal IOF)

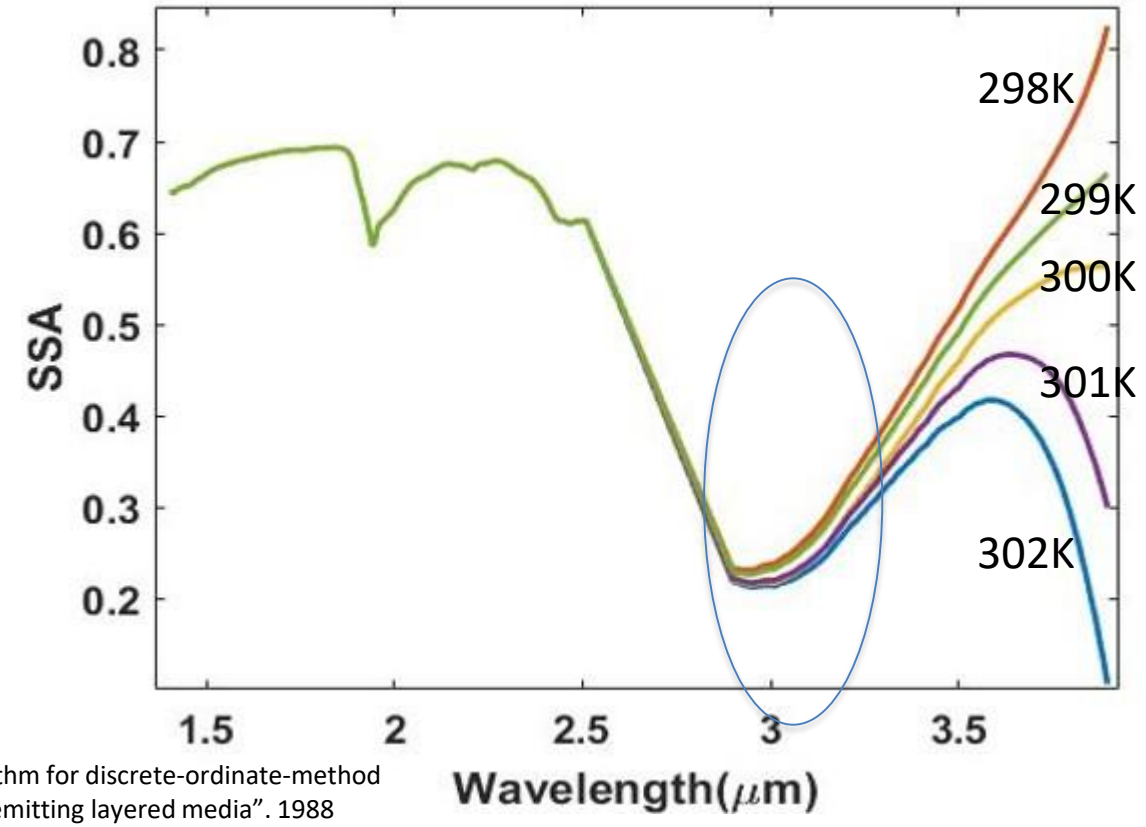
DISORT (Discrete Ordinates Radiative Transfer) model[1]:
Describe the relationship between IOF, SSA and temperature

- SSA_{pre}

  SSA + geo ~ IOF

- SSA_{post}

  SSA + T + geo~ IOF



[1]K. Stamnes, et al. "Numerically stable algorithm for discrete-ordinate-method radiative transfer in multiple scattering and emitting layered media". 1988

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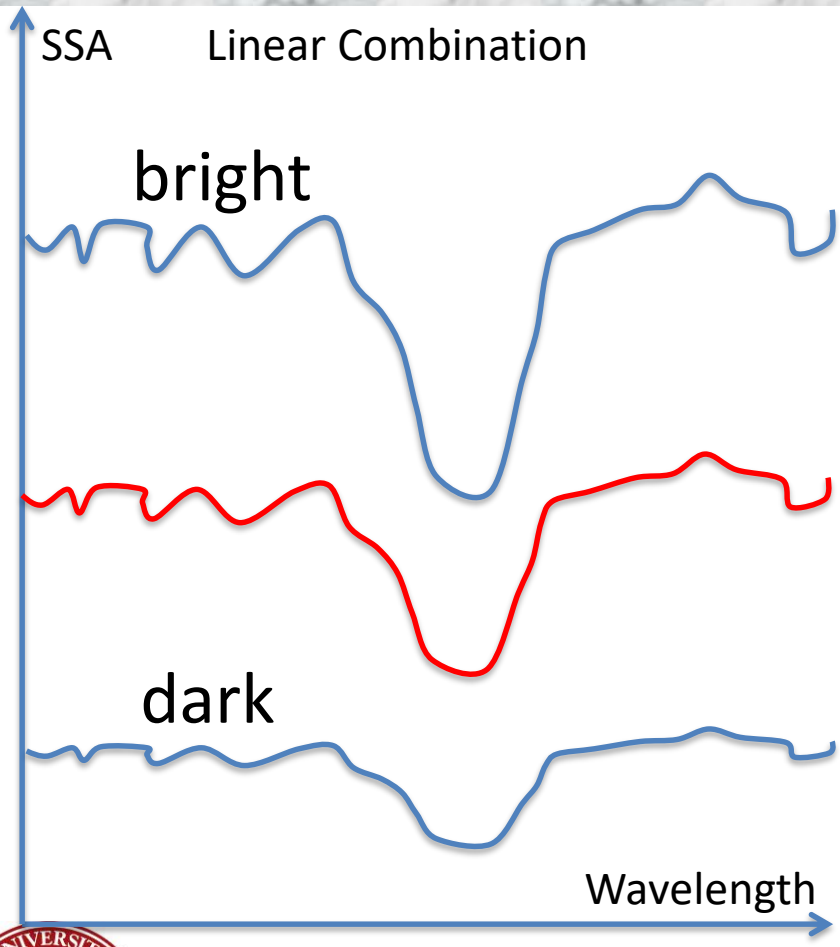
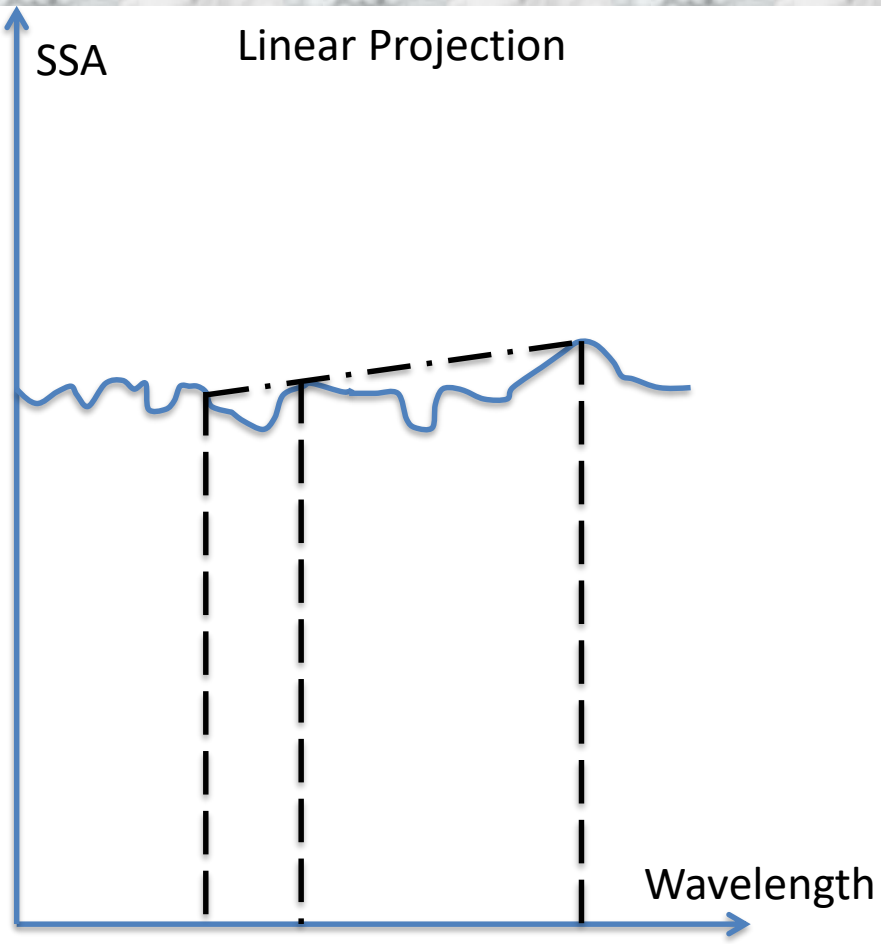
Introduction & Motivation



Method 1[1]



Method 2[2]

[1]Erard, Stéphane, and Wendy Calvin. "New composite spectra of Mars, 0.4–5.7 µm." 1997

[2]Clark, Roger N., et al. "Thermal removal from near-infrared imaging spectroscopy data of the Moon."2011

Neural Network

Known Relationship:

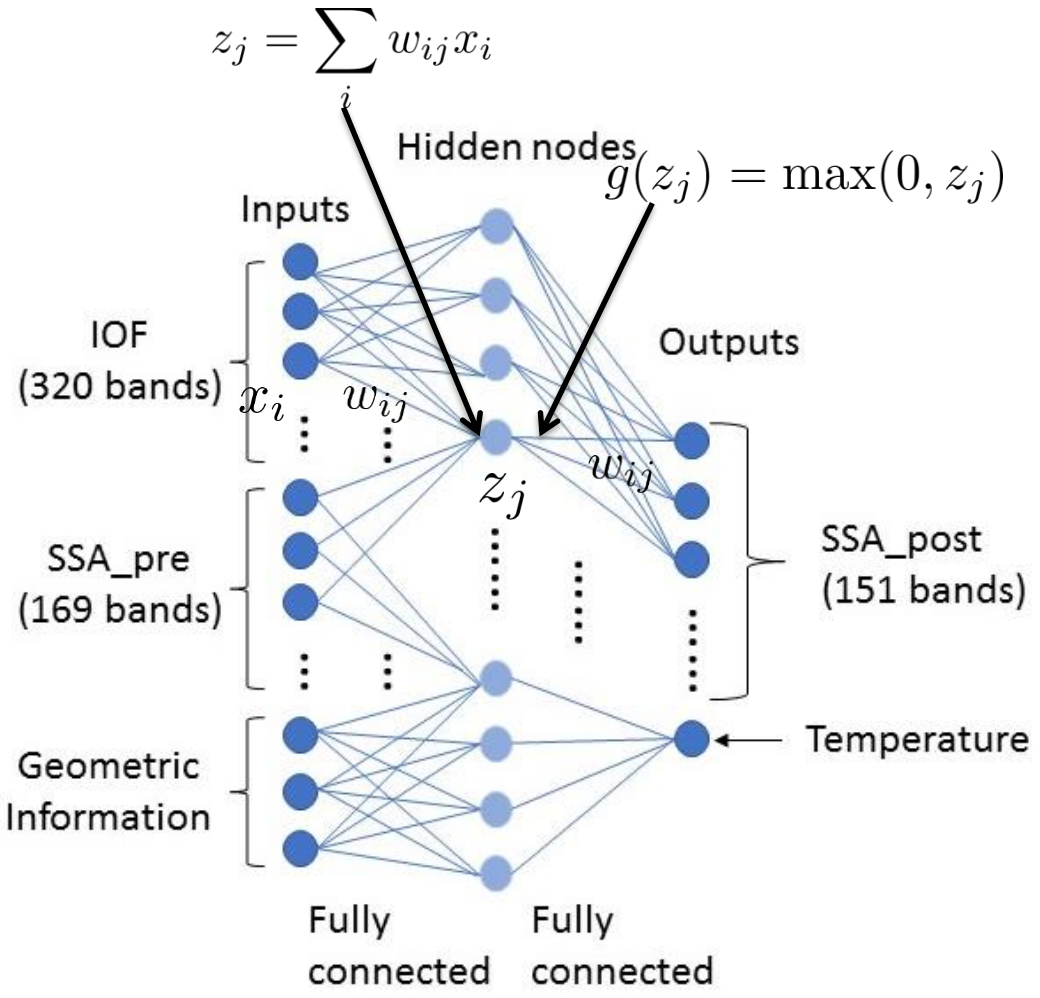
$$IOF = f(SSA_{pre}, SSA_{post}, T, geo)$$

DISORT model

Aimed Relationship:

$$[SSA_{post}, T] = f^{-1}(SSA_{pre}, IOF, geo)$$

NN model



Neural Network

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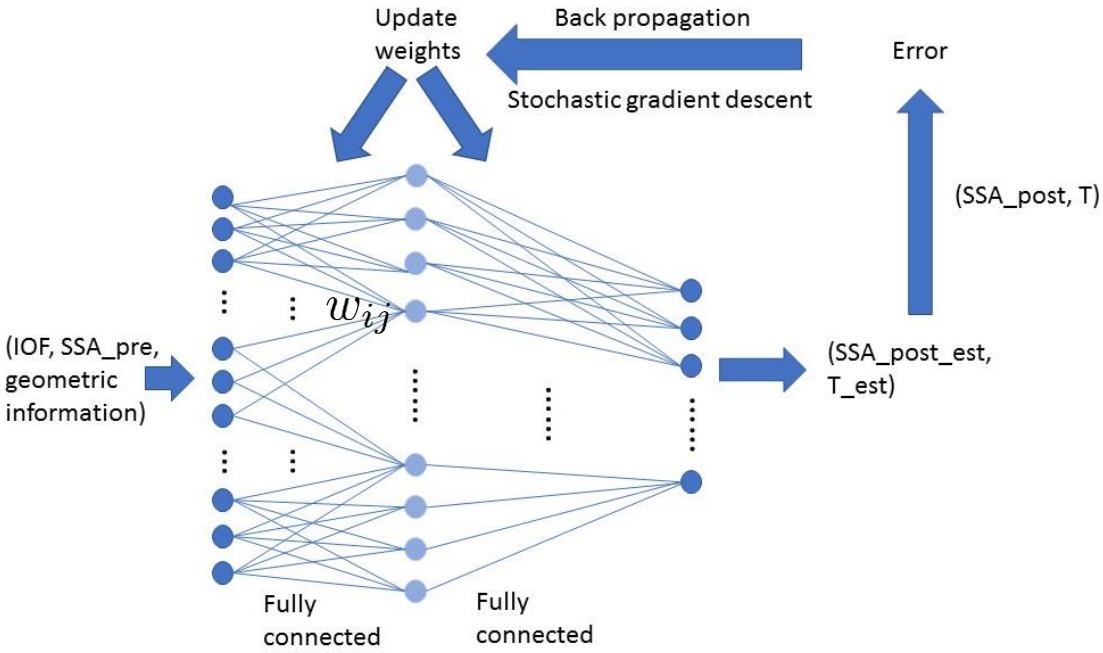
Training w_{ij}

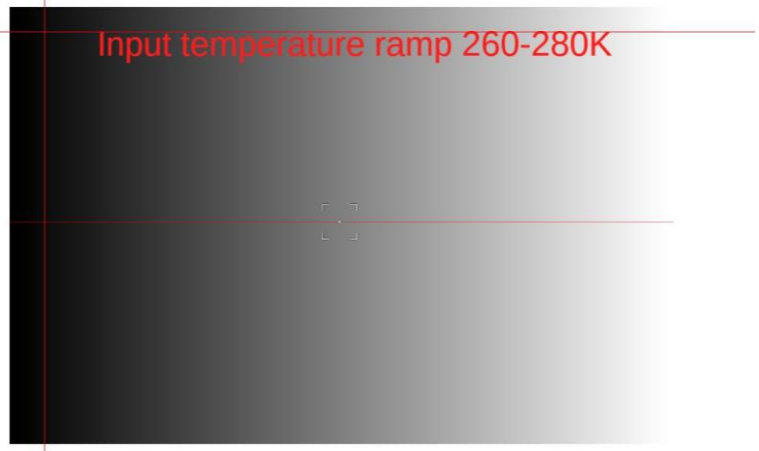
Training Set: lots of known $[SSA_{pre}, SSA_{post}, T, IOF]$

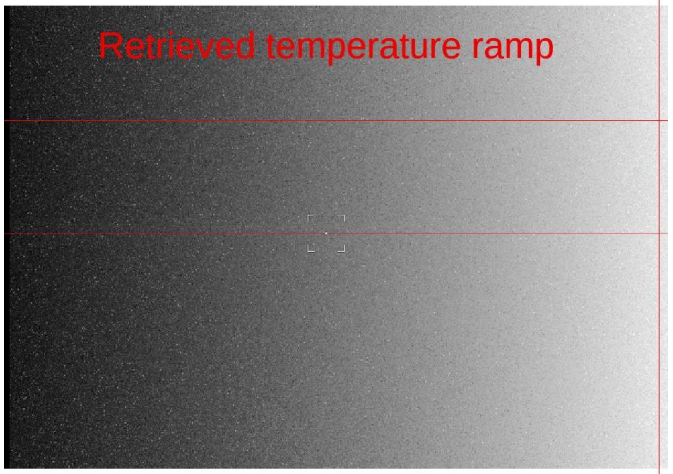
- SSA from library;
- T randomly chosen in a reasonable range
- IOF generated from DISORT model

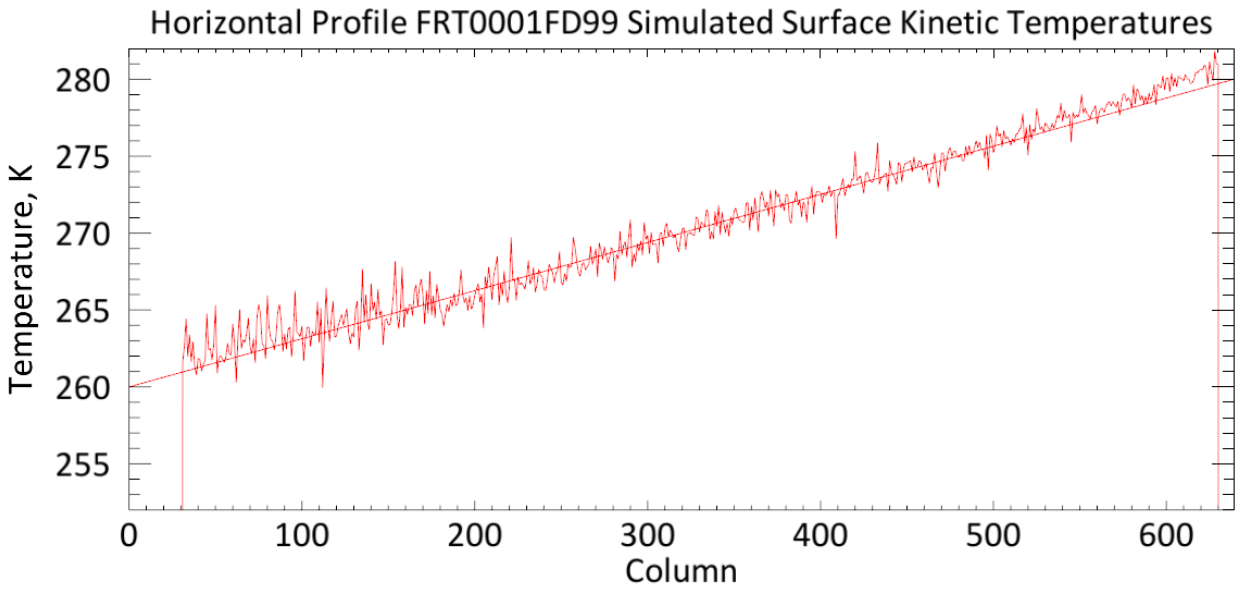
$$IOF = f(SSA_{pre}, SSA_{post}, T, geo)$$



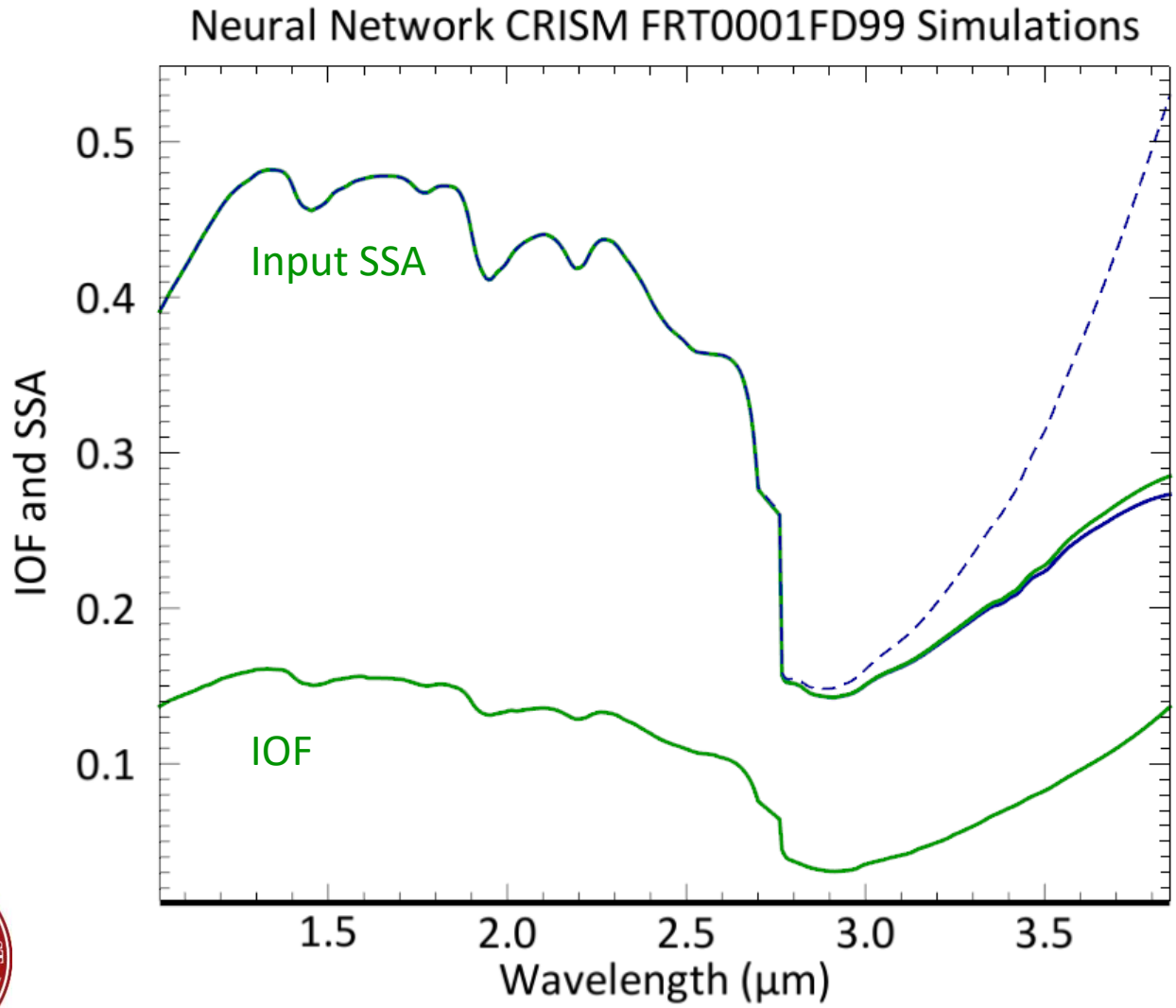
Simulations Test







Simulations Test

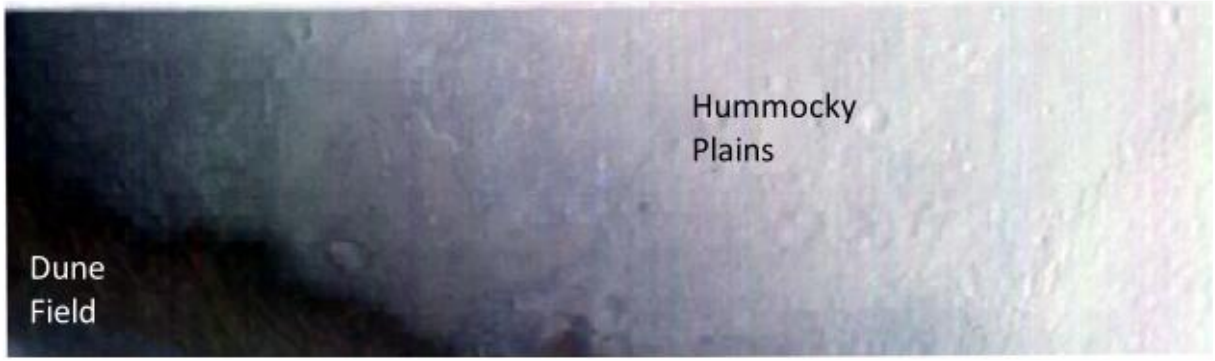


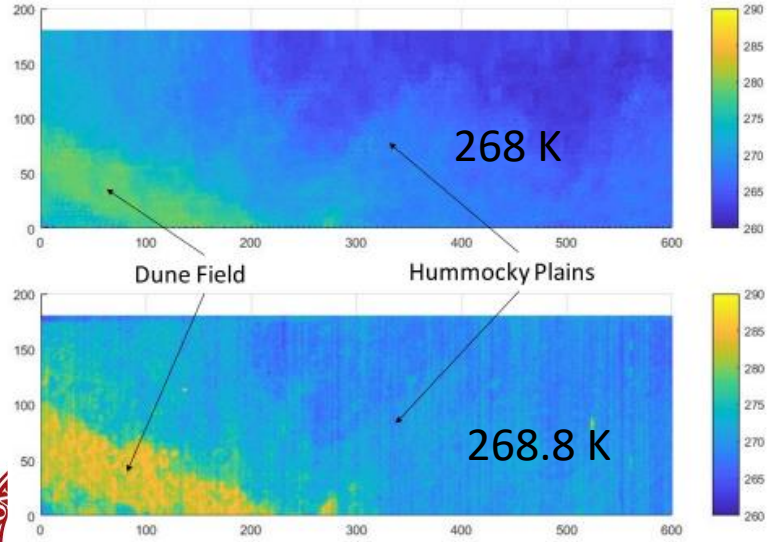
No Temperature Information

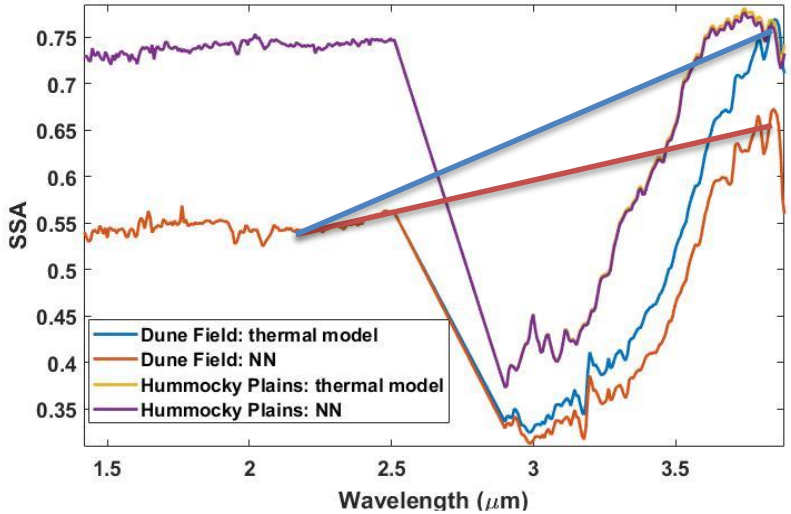
Our method

CRISM Data

FRS00028346







Conclusions & Future Plan

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- ✓ NN with one layer can retrieve reasonable temperature mapping and SSAs from IOFs
- ✓ Performance is tested on simulations and CRISM data
- ❑ Try deep NN
- ❑ Add spatial continuity
- ❑ Extend NN to OMEGA data

Back-up Slides

- Generator of Training SSA

Basic SSA: $A = \{a_1, \cdots, a_K\}, K = 98$

Our SSA: $B = \{b_1, \cdots, b_N\}, N = 300,000$

$$b_j = \sum_{i=1}^{M} w_i a_i, \text{ with } \sum_{i=1}^{M} w_i = 1$$

Randomly chosen from A

Randomly generated

Back-up Slides

- Generator of Training SSA

Basic SSA: $A = \{a_1, \cdots, a_K\}, K = 98$

Mars Analog Materials[1]

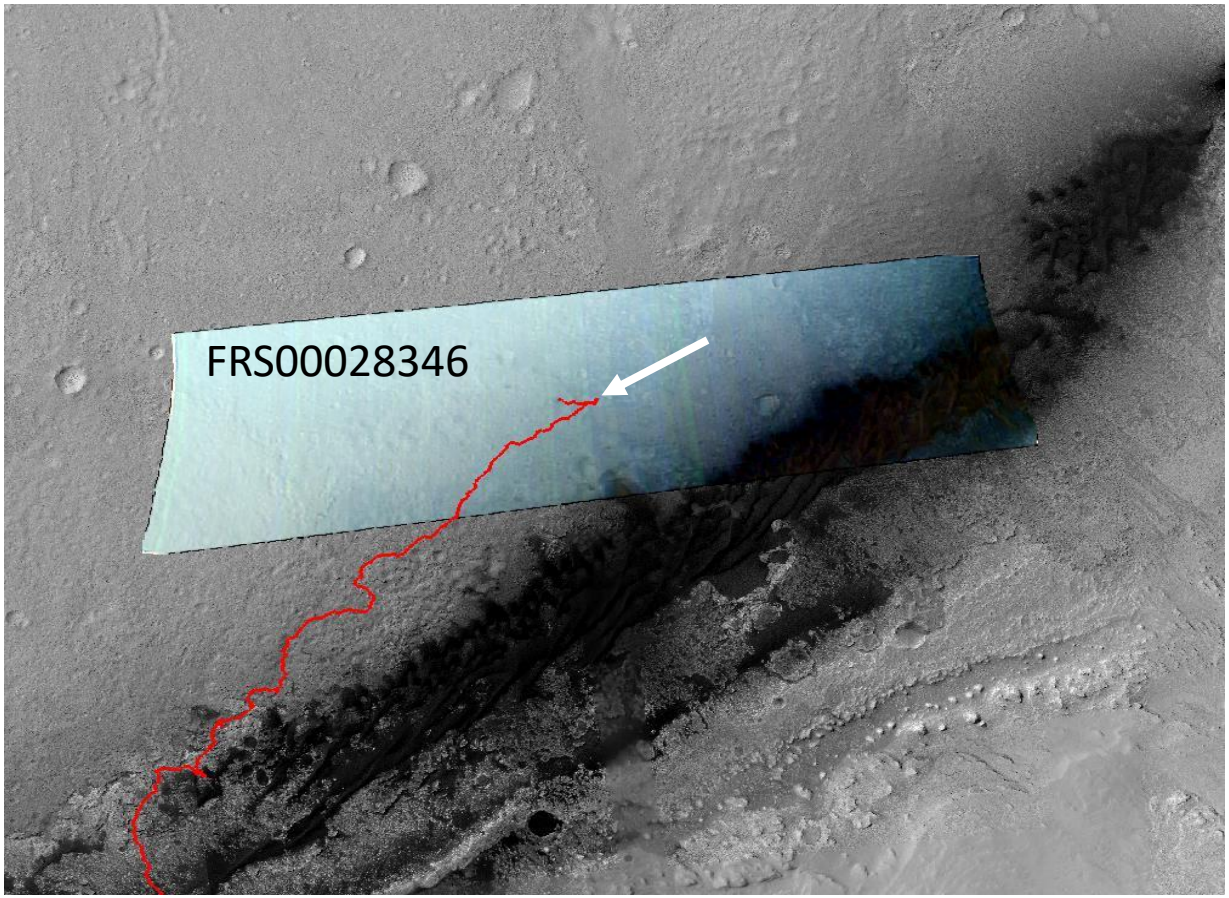
Source	Materials
JHU[2]	basalts, basaltic andesites, gabbros, and soils
USGS[2]	hydrated sulfates
RELAB[3]	basalts and gabbros as well as olivine, pyroxene, plagioclase, and iron oxides
JSC (Richard Morris)	tephra and ash samples from Mauna Kea, basaltic glass, Martian meteorites, olivine, pyroxene, clays, and carbonates

[1]Ehlmann & Edwards, "Mineralogy of the Martian surface." 2014
[2] Baldridge, A. M., et al. "The ASTER spectral library version 2.0." 2009
[3]www.planetary.brown.edu/relab

Back-up Slides

- Further Processing:

MLM[1]



[1]C. Kreisch, et al. “Regularization of Mars Reconnaissance Orbiter CRISM along-track oversampled hyperspectral imaging observations of Mars.” 2017