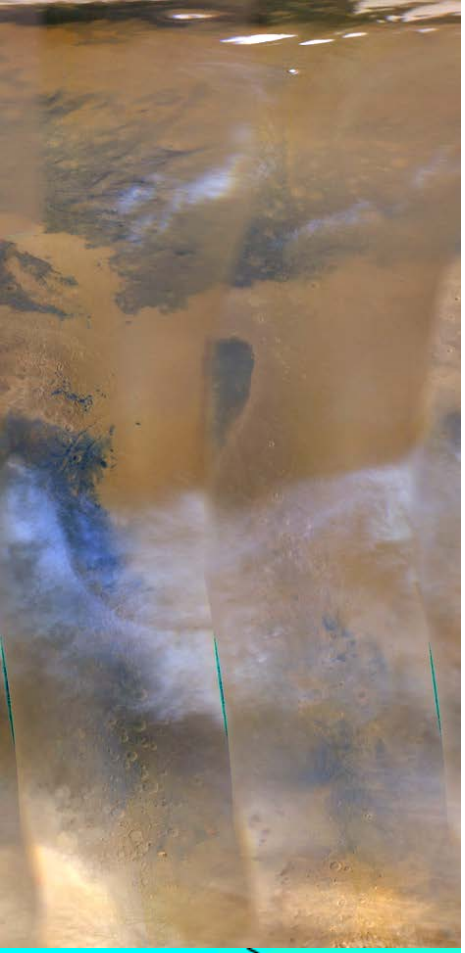

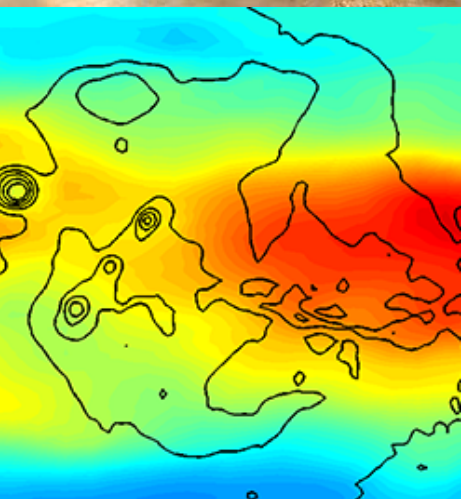

Jet Propulsion Laboratory
California Institute of Technology

Mars 2020
Entry, Descent, and Landing Atmosphere Characterization

Presented by Gregory Villar
on behalf of the Council of Atmospheres

13th International Planetary Probe Workshop
Laurel, Maryland
June 2016

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Overview

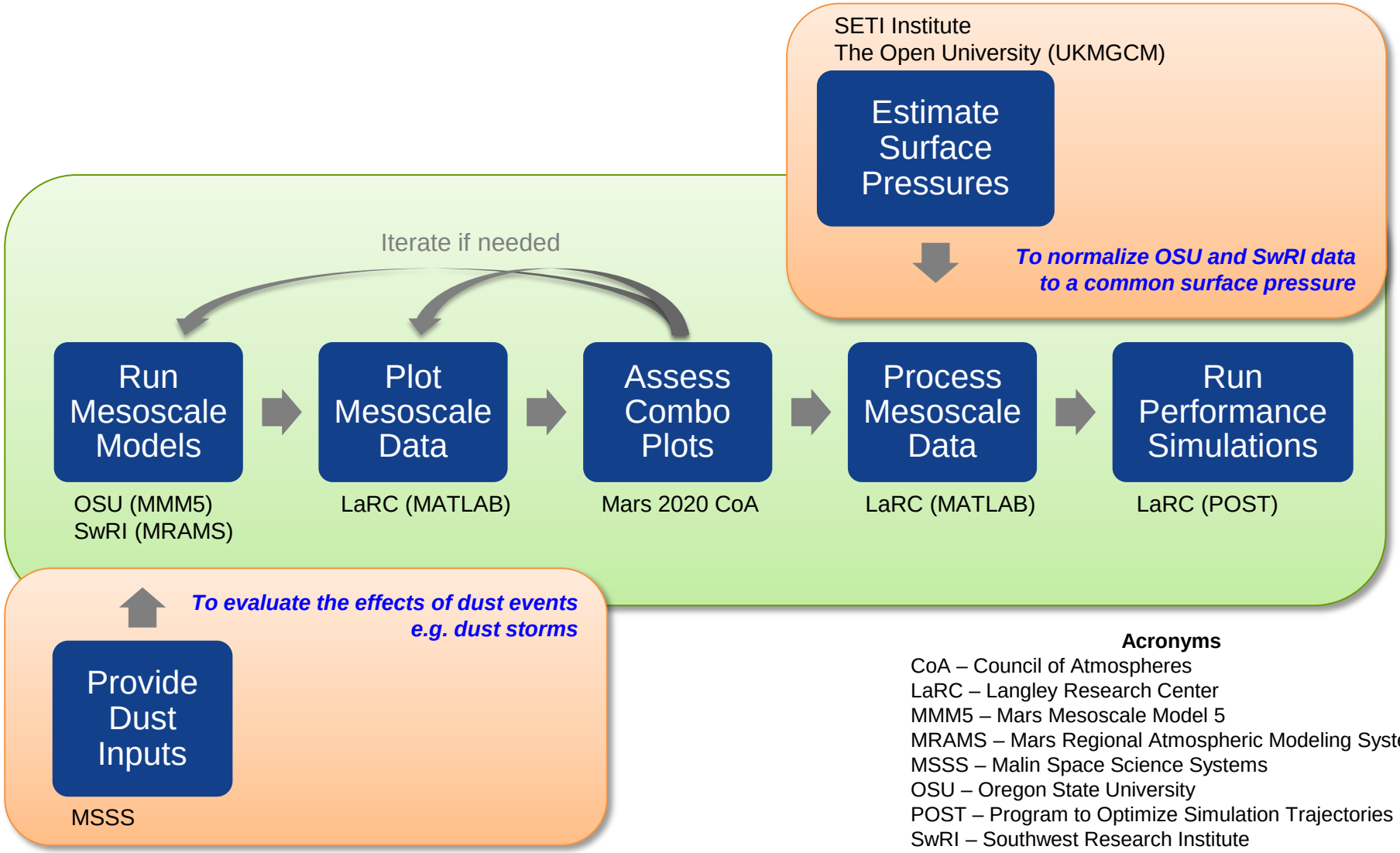
- **This presentation is about the teams, tools, and processes involved in generating the atmospheric data that are used in EDL performance simulations.**
- **The overall methodology used by the Mars 2020 Council of Atmospheres is largely the same as the Mars Science Laboratory.**
- **Preliminary analysis shows that atmospheric conditions at the candidate landing sites do not significantly affect EDL performance.**
- **Assessing atmospheric conditions is critical to providing representative environmental conditions into the EDL simulations, but proves to be challenging due to limited measurement data.**

Team

- **Council of Atmospheres**
  - Joint engineering and science team
  - Tasked with assessing atmospheric EDL risk
  - Provide mesoscale data to EDL performance simulation

- **Participating Institutions**
  - Jet Propulsion Laboratory
    - Gregory Villar
    - Al Chen
    - Michael Mischna
    - David Kass
  - Langley Research Center
    - Som Dutta
    - Dave Way
  - Oregon State University
    - Dan Tyler
    - Jeff Barnes
  - Southwest Research Institute
    - Scott Rafkin
    - Jorge Pla-Garcia
  - SETI Institute
    - David Hinson
  - The Open University
    - Stephen Lewis
  - Malin Space Science Systems
    - Bruce Cantor

Process and Tools

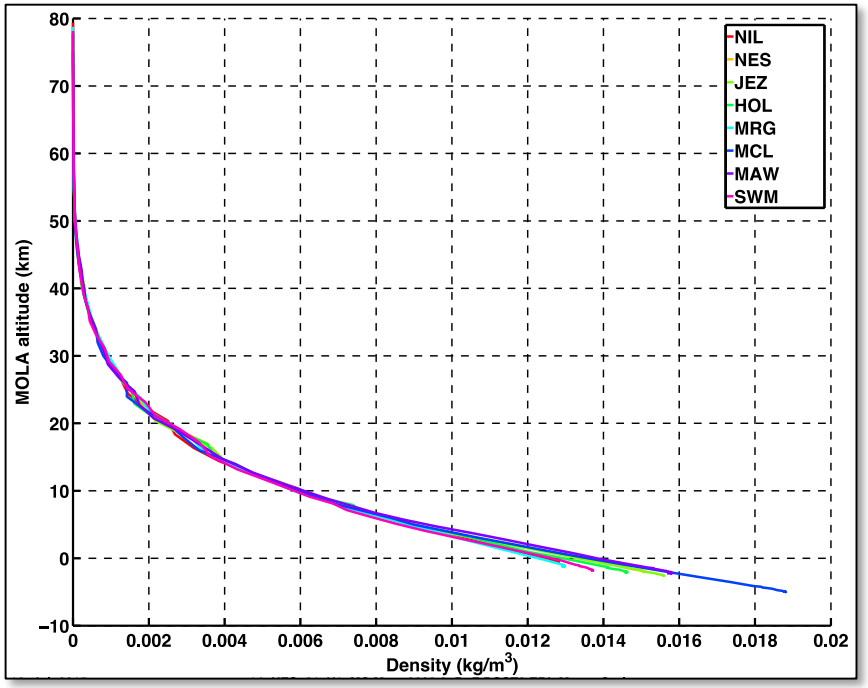


Acronyms

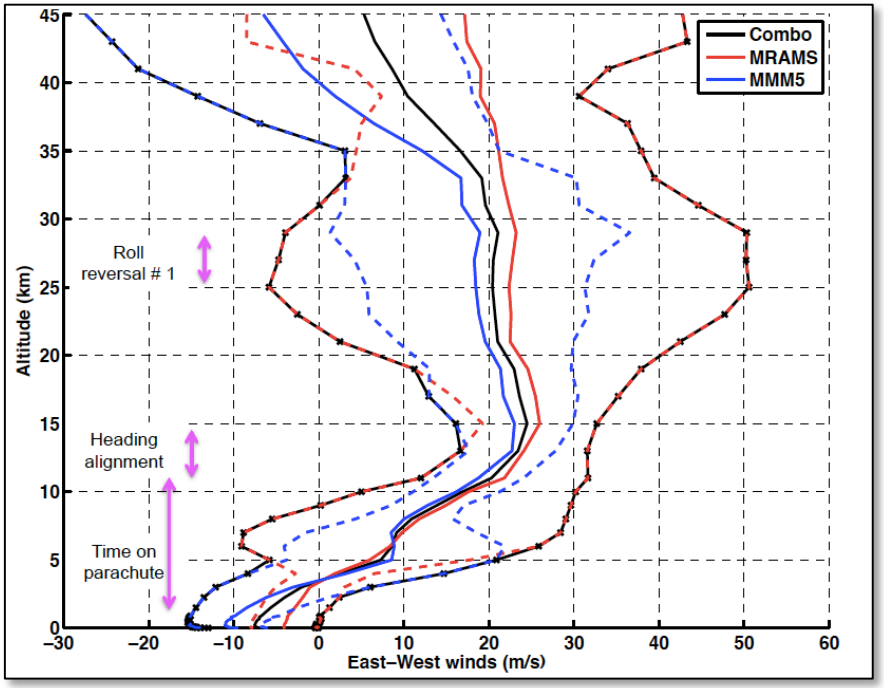
CoA – Council of Atmospheres
LaRC – Langley Research Center
MMM5 – Mars Mesoscale Model 5
MRAMS – Mars Regional Atmospheric Modeling System
MSSS – Malin Space Science Systems
OSU – Oregon State University
POST – Program to Optimize Simulation Trajectories
SwRI – Southwest Research Institute
UKMGCM – United Kingdom Mars Global Climate Model

Mesoscale Model Outputs

- **Primary outputs considered in EDL performance**
  - Winds – most influential from parachute deploy to touchdown
  - Densities – contributes to experienced loads
- **Temperatures and pressures were also modeled**
  - However, EDL performance is not as sensitive to these outputs



Density at Candidate Sites



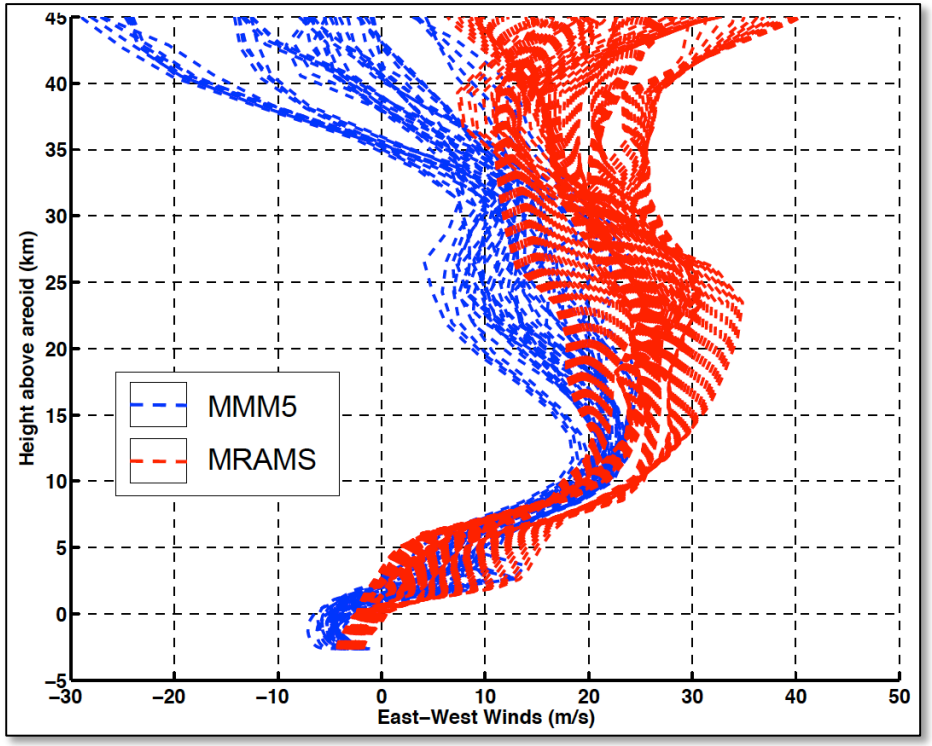
Example of Mesoscale Products

North East Syrtis – East-West Winds

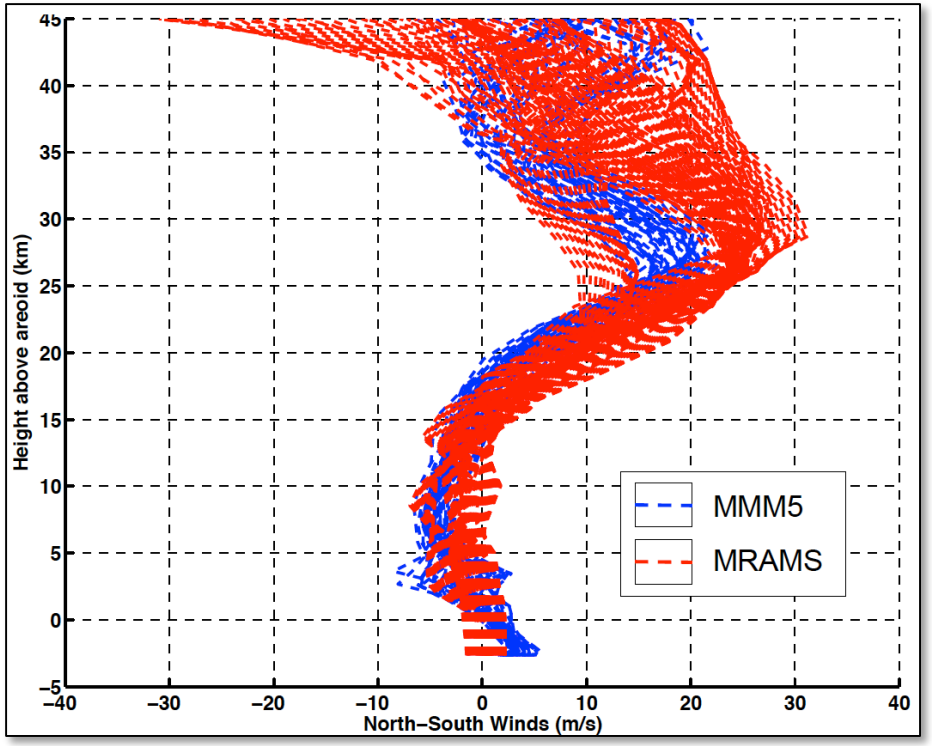
Plot Credit: Dutta

Example of Wind Profiles

Plot Credit: Dutta



Jezero East-West Winds

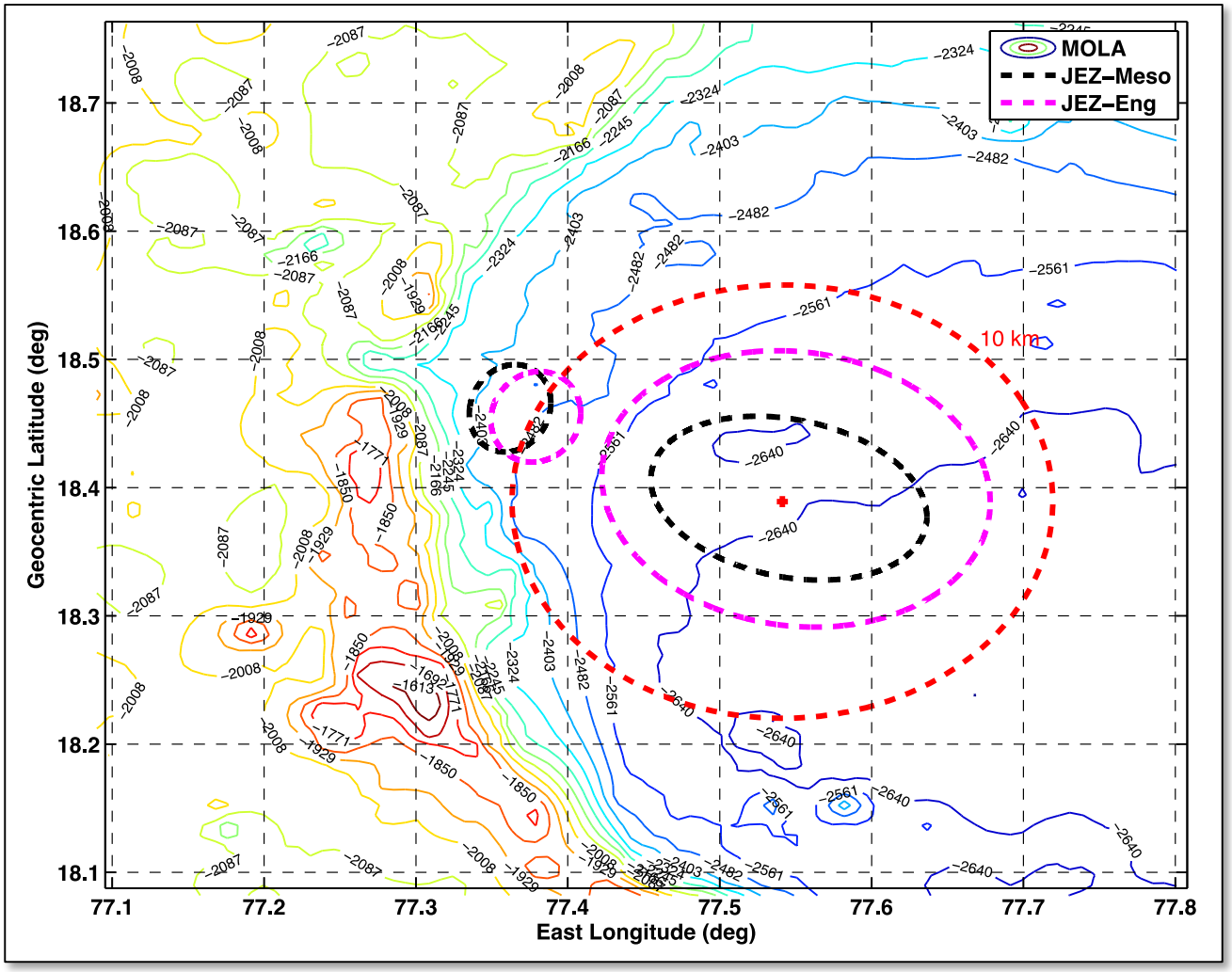


Jezero North-South Winds

General agreement (wind speed & direction) between two mesoscale models

Mesoscale Winds Effect
on Landing Ellipse

Plot Credit: Dutta



Jezero

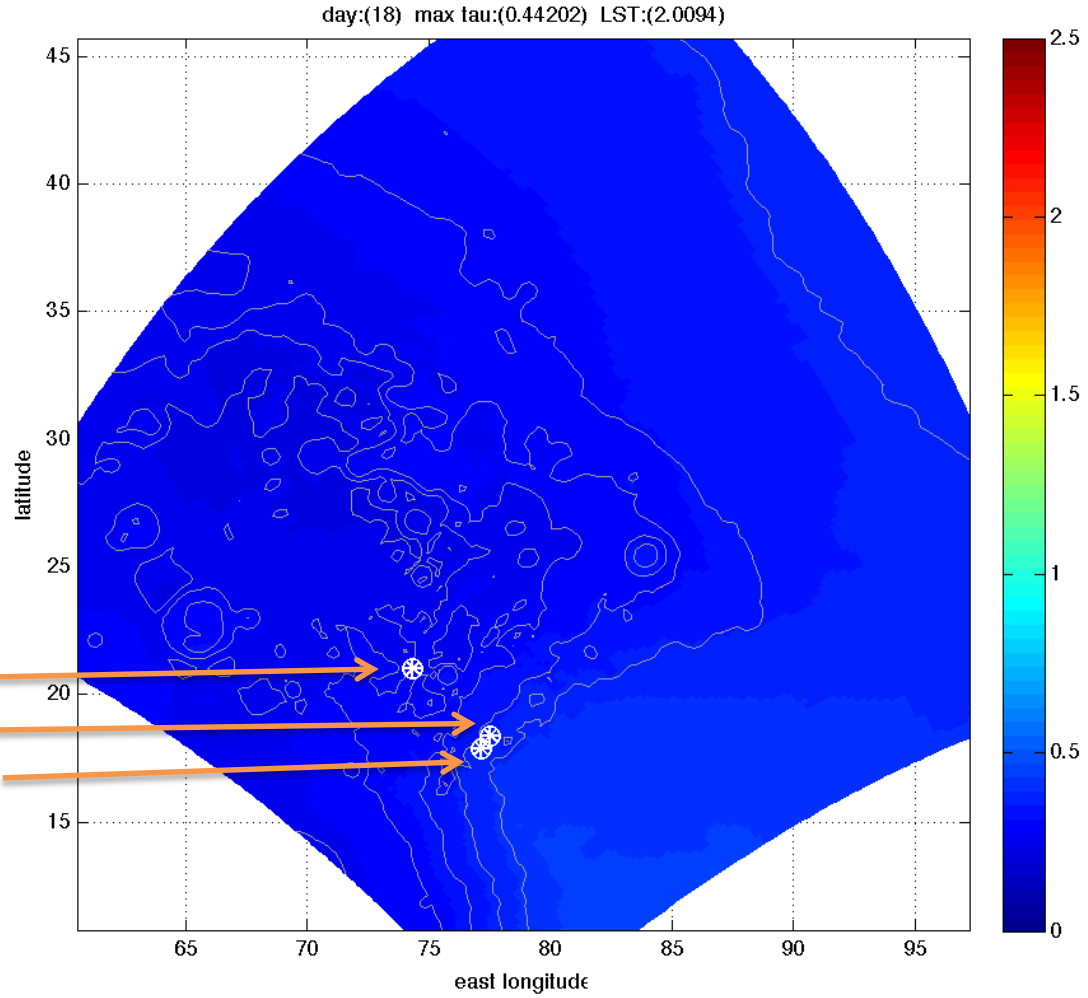
Landing ellipses are smaller using mesoscale winds

Future Work

Dust Injection

Animation Credit: Tyler

5-Day Storm Animation

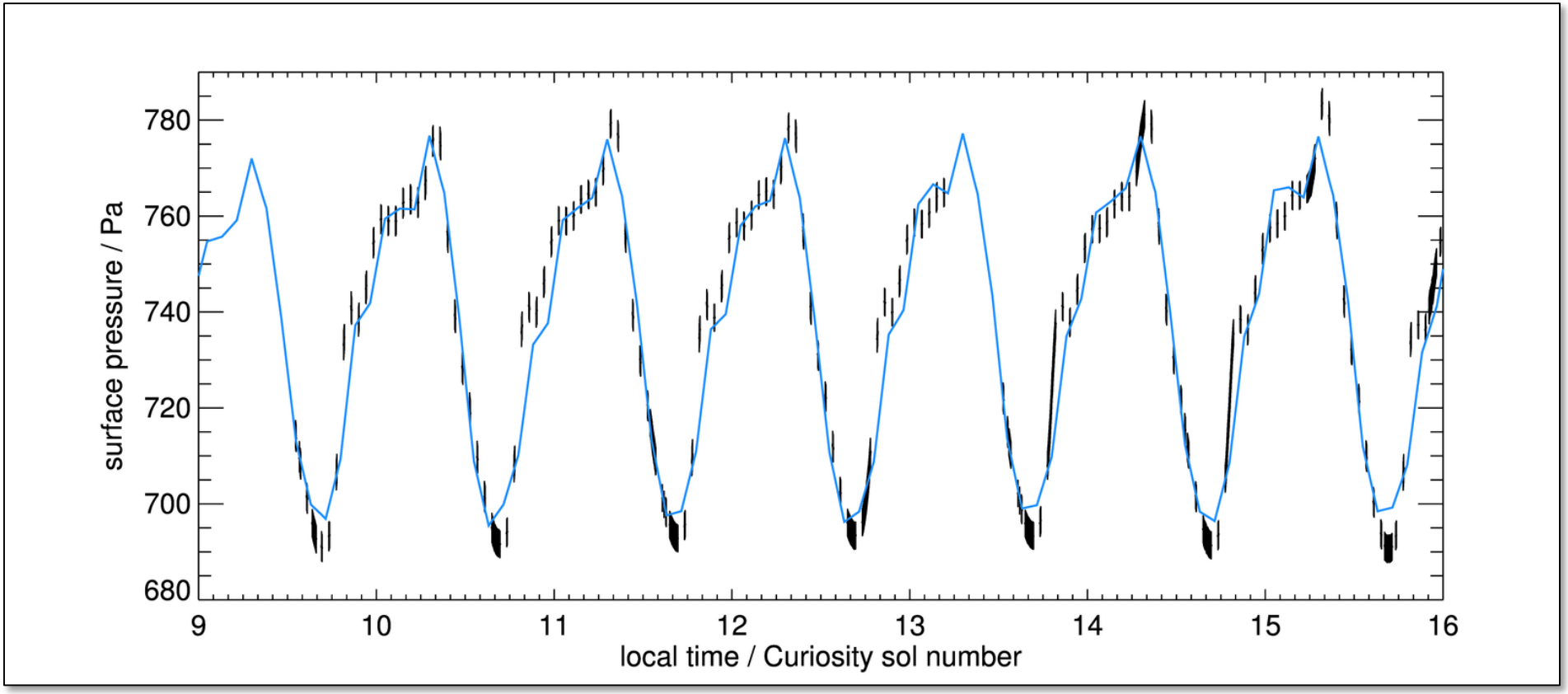


- Nili Fossae
- Jezero
- North East Syrtis

Injecting dust storms into mesoscale runs to assess impact on EDL performance

Surface Pressure Estimates

Plot Credit: Hinson, Lewis



Curiosity Surface Pressure
Prediction vs. Data

Pre-landing surface pressure estimates closely agrees with MSL data

Dust Statistics

Credit: Cantor

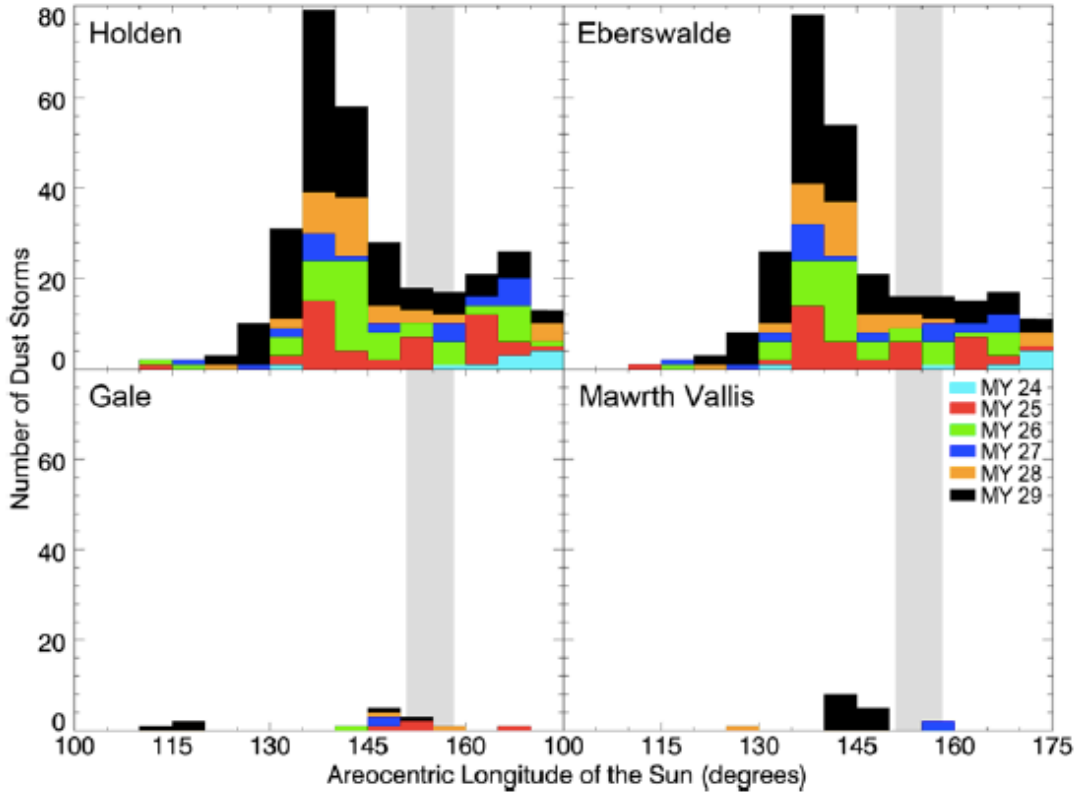


Fig. 9 Histogram of the number of local dust storms at the four finalist landing sites between $L_s = 100–175°$. *Colored bars* represent individual Mars years. The *gray region* in each plot marks the $L_s = 151–158°$ landing season considered for MSL at the time of the study

Space Sci Rev (2012) 170:793–835
DOI 10.1007/s11214-012-9911-3

Dust statistics at the local time and season of Mars 2020 is being generated

Summary

- **Timeline**
  - 2014 September — Mars 2020 initiated the Council of Atmospheres
  - 2015 August — Landing Site Workshop #2
  - 2016 September — Council of Atmospheres Assessment Delivery
  - 2017 January — Landing Site Workshop #3

- **Work Performed**
  - Employed MSL-like process for candidate landing sites
  - Preliminary mesoscale results from 2 models integrated in EDL simulations

- **Key Result**
  - As expected, landing ellipses are smaller using mesoscale winds

- **Work To Go**
  - Assess off-nominal cases (dust injection)
  - Estimate surface pressures

Results are preliminary and several validation steps are ahead of us