Indexing of exoplanets in search for potential habitability: application to Mars-like worlds

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Data Source: For 3500+ exoplanets
1. Habitable Exoplanet Catalog-University of Puerto Rico (www.phl.upr.edu)
3. Exoplanet.org/eu.
Calibration of Surface Temperature

\[ T_s = 3.83 + 1.12 \times T_e \]

\[ T_s = 12.35 + 1.12 \times T_{eq} \]

J. M. Kashyap et al. (2017), Astrophys Space Sci
Earth Similarity Index (ESI)

ESI is a scale to measure the similar parameters as that of Earth.

$$ESI_x = \left(1 - \left|\frac{x - x_0}{x + x_0}\right|^m\right)^{w_x}$$

Where, $x$ is the property of the planet—in this case, either radius, density, escape velocity or temperature.

$x_0$ is the value of this property for Earth,

$m$ is the input variable

$w_x$ is the weight exponent of a property.
## Calculated weight exponents

<table>
<thead>
<tr>
<th>Planetary Property</th>
<th>Ref. Value for ESI</th>
<th>Ref. Value for MSI</th>
<th>Weight Exponents for ESI</th>
<th>Weight Exponents for MSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Radius</td>
<td>1EU</td>
<td>1MU</td>
<td>0.57</td>
<td>0.77</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>1EU</td>
<td>1MU</td>
<td>1.07</td>
<td>2.09</td>
</tr>
<tr>
<td>Escape Velocity</td>
<td>1EU</td>
<td>1MU</td>
<td>0.70</td>
<td>1.04</td>
</tr>
<tr>
<td>Surface Temperature</td>
<td>288K</td>
<td>240K</td>
<td>5.58</td>
<td>3.08</td>
</tr>
</tbody>
</table>
Interior, Surface ESI & Global ESI

\[ ESI_I = (ESI_r \times ESI_p)^{1/2} \quad ESI_S = (ESI_e \times ESI_T)^{1/2} \]

\[ ESI = (ESI_I \times ESI_S)^{1/2} \]
Comparison of $ESI_s$ and $ESI_1$
Scattered ESI Plot results
Mars Similarity Index (MSI)

MSI is a scale to measure the similar parameters as that of Mars.

$$\text{MSI}_x = \left(1 - \left(\frac{x - x_0}{x + x_0}\right)^n\right)^{w_x}$$

Where, $x$ is the property of the planet - in this case, either radius, density, escape velocity or temperature.

$x_0$ is the value of this property for Earth,

$m$ is the input variable

$w_x$ is the weight exponent of a property
Interior, Surface MSI & Global MSI

\[ MSI_I = (MSI_R \times MSI_{\rho})^{1/2} \]

\[ MSI_S = (MSI_T \times MSI_{v_e})^{1/2} \]

\[ MSI = (MSI_I \times MSI_S)^{1/2} \]
Comparison of interior and surface MSI

![Graph showing comparison of interior and surface MSI](image)

Number of Rocky Exoplanets

$MSI_s$

$MSI_i$

$ISM$
Scattered MSI plot result
Mass v/s Radius Plot in (EU)
Using the known data for the Solar System objects, we established the calibration relation between surface and equilibrium temperatures to devise an effective way to estimate the value of the surface temperature of exoplanets.

From our study, we found that 20 Earth-like exoplanets with ESI value above 0.8 are potentially habitable planets.

12 Mars-like planets with MSI, to search methane specific extremophiles.

Thank you!
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[http://dx.doi.org/10.17632/c37bvvxp3z.6](http://dx.doi.org/10.17632/c37bvvxp3z.6).

Thank you!
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