A Site Atmospheric State Best Estimate of Temperature for Lauder, New Zealand

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Site Atmospheric State Best Estimates (SASBEs)

- Combine measurements from multiple instruments to create the best-possible vertically resolved time series of target parameter above one site.
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▶ Contain all available knowledge about the state of target variable at that site
Site Atmospheric State Best Estimates (SASBEs)

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- Contain all available knowledge about the state of target variable at that site

- Include an estimate of the uncertainty on every value
Temperature SASBE for the distributed GRUAN site at Lauder and Invercargill has been published.
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Temperature SASBE for Lauder

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  - Available for 1997-2012

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1 ground, 925 hPa, 850 hPa, 700 hPa, 500 hPa, 400 hPa, 300 hPa, 200 hPa, 150 hPa, 100 hPa, 70 hPa, 50 hPa, 30 hPa, 20 hPa, 10 hPa
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Hourly temporal resolution

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Hourly temporal resolution

Vertically resolved on standard pressure levels

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Schematic explanation of temperature SASBE for Lauder

\[ T_{\text{SASBE}}(t_{\text{SASBE}}) = \text{Diurnal cycle} + \text{Lauder component} + \text{Invercargill component} \]
Calculating the upper-air diurnal temperature cycle

- Diurnal cycle calculated by fitting Fourier series to ERA5 → climatological mean diurnal temperature cycle for every day
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- The fitting uncertainty is calculated as:

\[ \sigma_{fit} = \sqrt{\sum_{i=1}^{81} \sigma_{\zeta_i}^2 \left( \frac{\partial T_{Diur}}{\partial \zeta_i} \right)^2} \]  

→ Indicates how good the regression model fits the 8 years of reanalysis
Calculating the upper-air diurnal temperature cycle

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- Representativeness of diurnal cycle for measured temperatures is estimated as the standard deviation of the differences between \( T_{RS} \) and \( T_{Diur} \)
Uncertainty on the diurnal cycle is estimated as:

\[ \sigma_{T_{Diur}} = \sqrt{\sigma^2_{fit} + \sigma^2_{representativeness}} \]  

Figure 1: Diurnal cycle 925 hPa above Lauder at the 1st of January.
Lauder component

- Lauder RS80 and RS92 radiosonde

At the time of a measurement, SASBE temperature agrees with measured temperature and the uncertainty agrees with RS uncertainty:

- RS80: $1-\sigma = 0.5 \text{ K}$
- RS92: $1-\sigma = 0.25 \text{ K}$
Lauder component

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Lauder component

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- RS80: $1-\sigma=0.5\,\text{K}$, RS92: $1-\sigma=0.25\,\text{K}$
Temperature anomalies from Invercargill are transferred to Lauder with a regression model

\[ \hat{T}'_{Lau} = \gamma + \beta \cdot T'_{Inv} + \eta \cdot \Delta SP + \kappa \cdot \Delta ST' + \epsilon \]

(3)
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\[
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\]

Temperature anomaly term is expanded in a Fourier series of the wind direction.
Combining the SASBE components

The SASBE combines the diurnal cycle, the Lauder component and the Invercargill component.

\[
T_{SASBE}(t) = T_{Diur}(t) + \sum_{i=1}^{N} \phi_i \cdot w_i \cdot T_{iLau}^*(t) + \sum_{j=1}^{M} (1 - \phi) \cdot w_j \cdot \hat{T}_{jLau}^*(t)
\]  

(4)
Combining the SASBE components

The SASBE combines the diurnal cycle, the Lauder component and the Invercargill component.

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\]

Using the attenuated temperature anomaly \( T^* \):

\[
T_{i_{Lau}}^*(t) = T'_{Lau}(t_i) \cdot \text{acf}(\Delta t_i)
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Combining the SASBE components

The SASBE combines the diurnal cycle, the Lauder component and the Invercargill component.

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\]

Using the attenuated temperature anomaly \( T^* \):

\[
T_{iLau}^*(t) = T_{Lau}'(t_i) \cdot acf(\Delta t_i)
\]

The uncertainties are propagated through Eq. (4).

\[
\sigma_{TSASBE}(t) = \sqrt{\sigma_{T_{Diur}}^2 \left( \frac{\partial T_{SASBE}}{\partial T_{Diur}} \right)^2 + \sigma_{T_{RS}_{Lau}}^2 \left( \frac{\partial T_{SASBE}}{\partial T_{RS}_{Lau}} \right)^2 + \sigma_{\hat{T}_{RS}_{Lau}}^2 \left( \frac{\partial T_{SASBE}}{\partial \hat{T}_{RS}_{Lau}} \right)^2}
\]
Example of the temperature SASBE

2010-12-06

- $T_{SASBE}$
- $T_{Diur}$
- $T_{RS}$ Lauder
- $T_{RS}$ Invercargill

- $\sigma_{TSASBE}$
- $\sigma_{TDiur}$
- $\sigma_{Lauder}$
- $\sigma_{Invercargill}$

- $\alpha$,
- $1 - \alpha$

Site Atmospheric State Best Estimate for Lauder
Jordis Tradowsky

Introduction
Methodology
Components of the SASBE
Example of the SASBE
Summary
References
Figure 1: Example of the temperature SASBE

(a) Temperature data for 2010-12-07 with error bars indicating uncertainty. The black line represents the temperature SASBE, the red asterisks represent the TRS Lauder, and the green dashed line represents the TRS Invercargill.

(b) Standard deviation (σ) for each component: TSASBE, TDiur, and TRS Lauder for the Lauder component, and TSASBE, TDiur, and TRS Invercargill for the Invercargill component.

(c) Anomaly data for each component showing the deviation from the baseline.

(d) Weight distribution for each UTC hour of the day, with blue blocks representing α and red blocks representing 1 - α.
Summary

- The final version of the SASBE for Lauder has been published
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The methodology has been published as discussion paper (Tradowsky et al., 2018) → please provide feedback

Outlook:
I will keep working with Greg and colleagues from around the world (GRUAN, radio occultation, measurement campaigns).

→ if you are interested to cooperate on a project, please let me know

Outlook: Funding dependent: SASBEs for West Antarctic Ice Sheet → radiative transfer calculation using SASBE → study the sensitivity of the radiation balance to changes in the surface emissivity. For the motivation please see Feldman et al. (2014).
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References I


Thank you for your attention!