Motivation

Planetary boundary layer (PBL) information from reanalyses is used in important practical applications, such as:
- air quality forecasting and development of air pollution regulations
- modeling dispersion of atmospheric releases of hazardous materials
- inverse modeling of biogeochemical budgets, including the carbon cycle

Reanalysis representations of the PBL may be used in lieu of observations for:
- evaluation of free-running climate models
- detection of long-term climate trends

But representation of the PBL in ERA-Interim, or other reanalyses, has not been evaluated against long-term global observations to identify potential temporal and spatial patterns of bias. This study evaluates ERA-Interim representations of PBL climatology using radiosonde observations.

Methodology

We employ a PBL “mixing height” metric based on Bulk Richardson number

\[ Z(R_i) = \frac{\left( \frac{g}{\theta_v} \right) \left( \theta_v - \theta_h \right) (z - z_s)}{(v_z - u_z)^2} \]

Example: 0000 UTC 28 June 2006 radiosonde observation of T, RH, and wind profiles at Minneapolis, Minnesota (45 N, 94 W) is used to compute virtual potential temperature and bulk Richardson number, for location of Z(R_i).

For this study, we
- Computed Z(R_i) from radiosonde station data (2x/day) and ERA-Interim gridded (8x/day) data for continental United States and Europe
- Created climatological seasonal values for 25-yr period 1981-2005. Diurnal cycle analysis is based on data for 2000 only.

Challenges

1. Complex vertical structure, diurnal variability, and spatial heterogeneity of the PBL are unlikely to be fully represented in radiosonde or ERA-Interim data
2. Subtleties in PBL type are lost when applying automated algorithms to large datasets
3. Limitations of radiosonde data (vertical resolution, lack of u, v, lack of surface winds) require adjustments to Z(R_i) algorithm. We set \( b=0, \ a_i, v_i, z_i \) as 2-meter values.
4. Limitations of ERA-Interim (mainly gridding/spatial resolution) compromise direct comparison with radiosonde data

Related Studies

An analysis of PBL height algorithms suitable for application to large datasets:


A comparison of ERA-Interim, radiosonde, and climate model representations of the polar PBL, specifically surface-based inversions.