Moisture transport to East Antarctica
in radiosoundings and reanalyses

Ambroise Dufour
Olga Zolina

Institut des Géosciences de l'Environnement, Université Grenoble Alpes
P.P. Shirshov Institute of Oceanology, Russian Academy of Science

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Orense
Snowfall over East Antarctica

- Input term of the mass balance:
  - 111 mm per year (Arthern et al. 2006 via ground-based and satellite measurements)
  - Equivalent to 2.6 m of sea level rise

Future trends:
- Water holding capacity of the air increases
- Moisture transport to Antarctica also (e.g. Bengtsson et al. 2011)
Snowfall over East Antarctica

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### Reanalyses used

<table>
<thead>
<tr>
<th>Reanalysis</th>
<th>Model Vintage</th>
<th>Approximate Resolution</th>
<th>Data Assimilation</th>
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</thead>
<tbody>
<tr>
<td>NCEP NCAR R1</td>
<td>1995</td>
<td>210 km</td>
<td>3D-Var</td>
</tr>
<tr>
<td>NCEP DOE R2</td>
<td>2001</td>
<td>210 km</td>
<td>3D-Var</td>
</tr>
<tr>
<td>JRA 25</td>
<td>2004</td>
<td>120 km</td>
<td>3D-Var</td>
</tr>
<tr>
<td>ERA Interim</td>
<td>2006</td>
<td>80 km</td>
<td>4D-Var</td>
</tr>
<tr>
<td>NCEP CSFR</td>
<td>2009</td>
<td>38 km</td>
<td>3D-Var + FOTO</td>
</tr>
<tr>
<td>MERRA</td>
<td>2009</td>
<td>55 km</td>
<td>3D-Var + IAU</td>
</tr>
<tr>
<td>JRA 55</td>
<td>2009</td>
<td>55 km</td>
<td>4D-Var</td>
</tr>
</tbody>
</table>
Atmospheric moisture budget

\[
\text{moisture convergence} + \text{evaporation} = \text{precipitation}
\]
Atmospheric moisture budget

- NCEP NCAR R1
- NCEP DOE R2
- JRA 25
- ERA Interim
- NCEP CFSR
- MERRA
- JRA 55

1979-2013

- evaporation
- moisture convergence
- precipitation

mm/year
Problems with reanalyses

- Non-closure of the moisture budget
- Net precipitation is ambiguous due to model spin-up
- Trends are untrustworthy (Bromwich et al. 2012)
  - Artificial jumps with new satellites
  - Incoherent regional trends
- Even advection (analysed) is incoherent
Radiosoundings from IGRAv2

East Antarctic stations with radiosonde programs
(> 10 years between 1979 and 2013)
Number of valid soundings

SANAE
NEUMAYER
AMUNDSEN-SCOTT
HALLEY
NOVOLAZAREVSKAJA
SYOWA
MOLODEZNAJA
MAWSON
DAVIS
MIRNYJ
CASEY
DUMONT D'URVILLE
MARIO ZUCHELLI STATION
MCMURDO

number of valid soundings per month
Moisture fluxes into East Antarctica
Linear trends of transport anomalies

moisture flux anomaly (kg m$^{-1}$ s$^{-1}$)

NCAR R1
DOE R2
JRA 25
ERA I
CFSR
MERRA
JRA 55
IGRA
Global time series of transport anomalies

moisture flux anomaly $(kg \, m^{-1} \, s^{-1})$

NCAR R1  ERA I  JRA 55
DOE R2  CFSR  IGRA
JRA 25  MERRA

number of available stations

20 14 12 10 8 6 4 2 0
Conclusions

- Disagreement between reanalyses over climatological
  - net precipitation
  - moisture convergence

IGRAv2 radiosonde dataset:
- moisture advection as a proxy for snow accumulation
- high temporal resolution (as opposed to e.g. stake farms)
- the higher the reanalysis resolution, the closer the match

Moisture advection shows decadal variability but no trends
No long term change in humidity either
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