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YOPP
YEAR OF POLAR PREDICTION

The vertical structure of atmospheric rivers and their impact in the Atlantic sector of Antarctica from the Year of Polar Prediction observations

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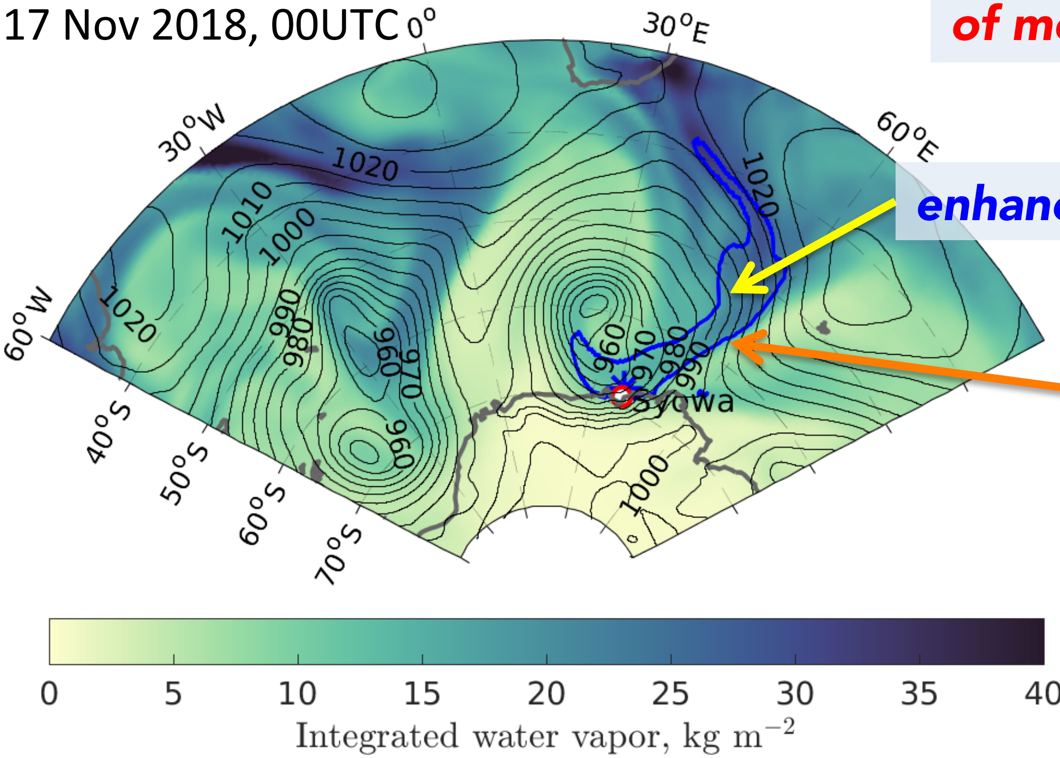
AR affecting Syowa
17 Nov 2018, 00UTC

Atmospheric Rivers bring large amounts of moisture and heat to Antarctica…

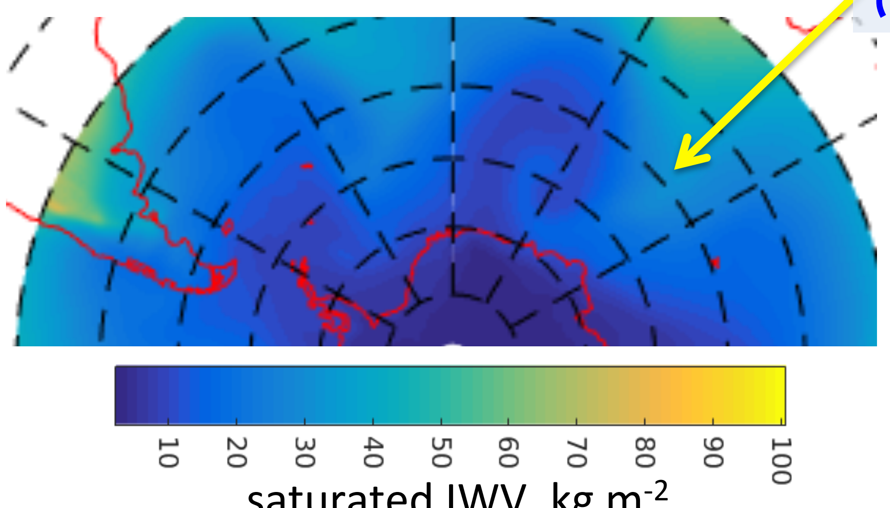


enhanced integrated water vapor (IWV)

AR identification (blue contour) based on IWV and IWVsat threshold and geometric criteria

(algorithm Gorodetskaya et al 2014, updated Gorodetskaya et al 2020)

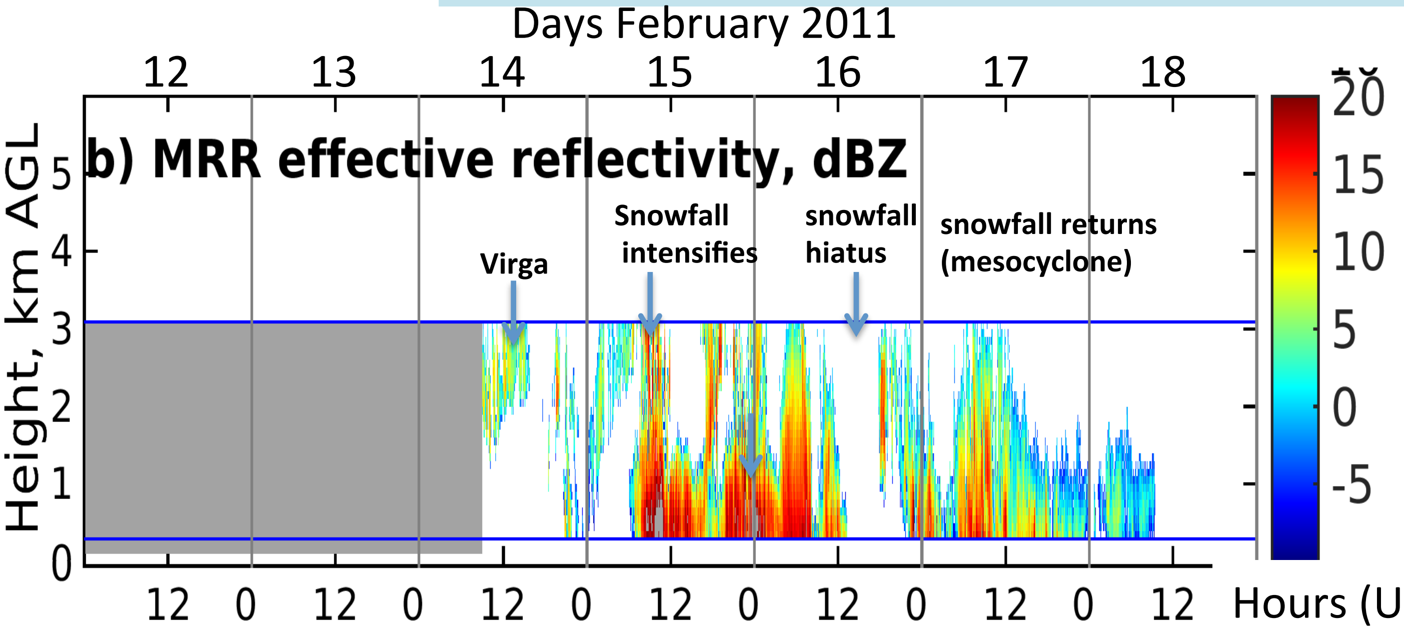
within warm sector (enhanced saturated IWV)



Gorodetskaya et al (2020, Adv Atm Sci)

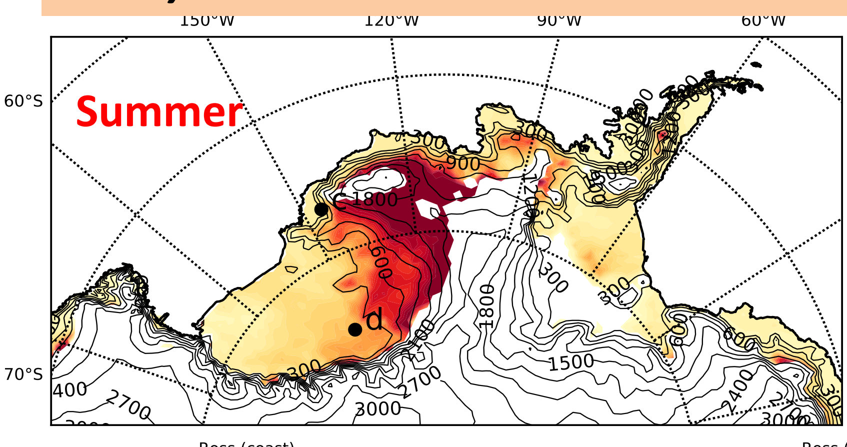
In Antarctica

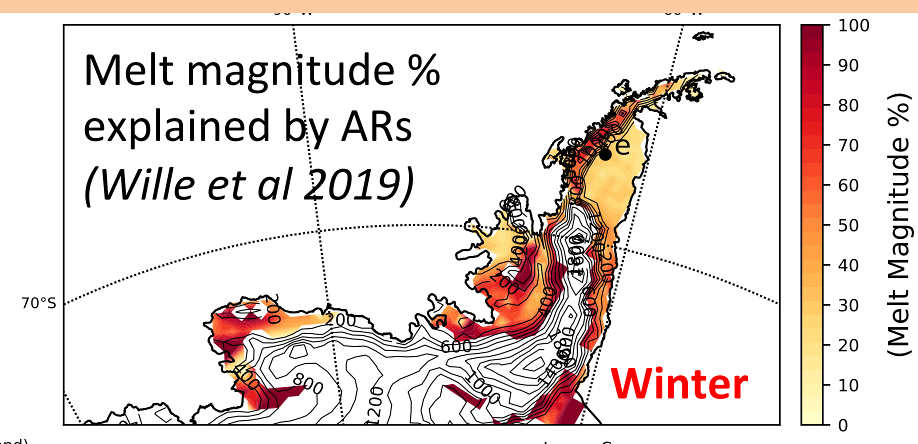
ARs have been responsible for several anomalous precipitation events in East Antarctica.. *(Gorodetskaya et al 2014)*:



One of anomalous precipitation events caused by an AR recorded by radar at Princess Elisabeth station 12-18 Feb 2011 (*Gorodetskaya et al 2015*)

...temperature record at the Antarctic Peninsula (*Bozkurt et al 2015*) and major melt events in West Antarctica resolved by MAR model *(Wille et al 2019)*:





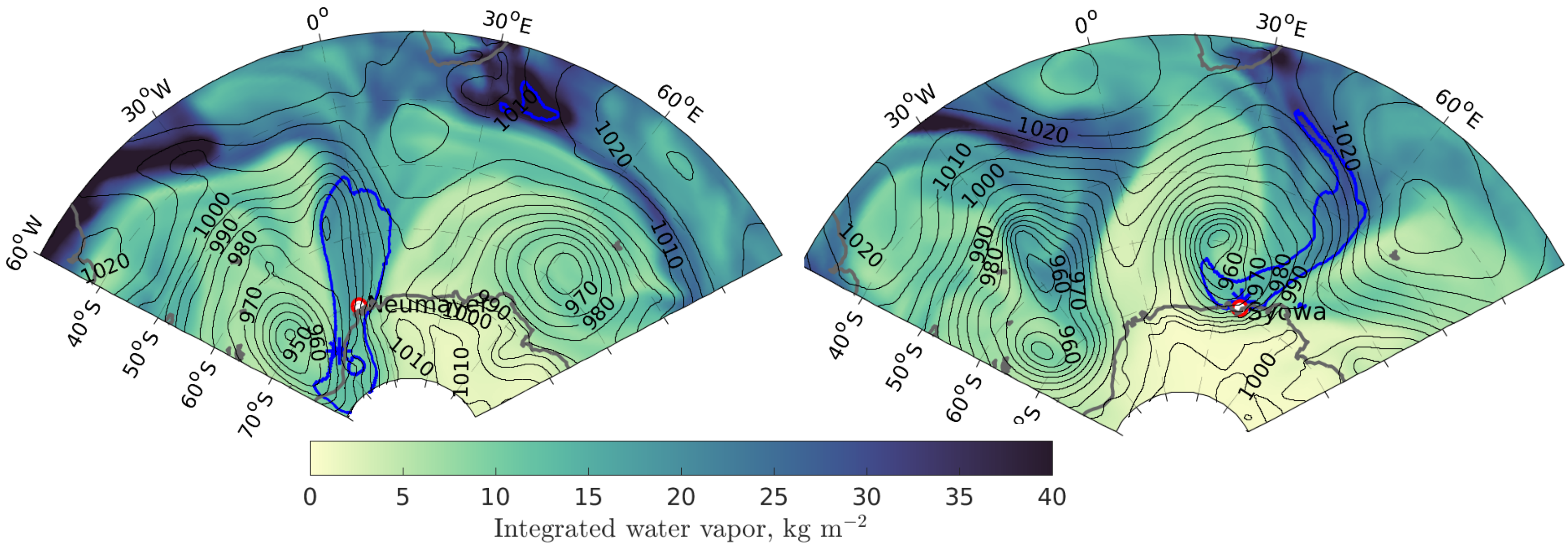
Gorodetskaya et al (2020, Adv Atm Sci)

During **YOPP-SOP-SH period (15 November 2018 – 15 February 2019)**
10 ARs had **landfall in extended Dronning Maud Land** (60ºW-90ºE), East Antarctica

Prominent AR events that affected **Neumayer** and **Syowa** stations:

AR affecting Neumayer
18 Dec 2018, 18UTC

AR affecting Syowa
17 Nov 2018, 00UTC



NEU 18dec	Sonde	ERAI	ERA5
IWV, kg m^{-2}	15	15	16
IVT, kg m^{-1} s^{-1}	340	330	343

SYO 17nov	Sonde	ERAI	ERA5
IWV, kg m^{-2}	9	9	9
IVT, kg m^{-1} s^{-1}	192	163	183

AR affecting Punta Arenas (southern Chile) *and* King George Island (KGI, north of Antarctic Peninsula)

6 Dec 2018, 18UTC

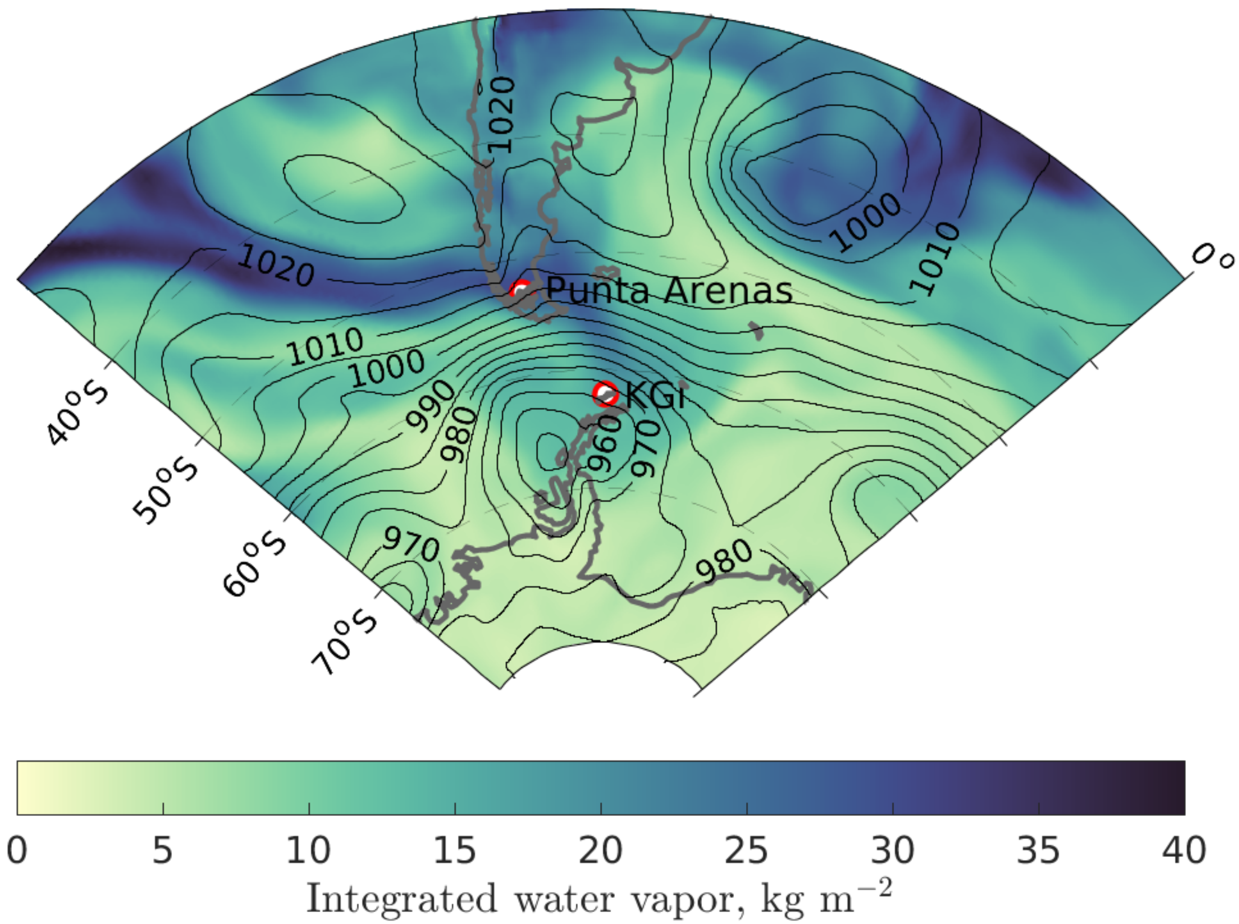


Fig. 11/section 5 by Gorodetskaya et al in Bromwich et al 2020 (BAMS, accepted)

...The Year of Polar Prediction Special Observing Period unprecedented measurements allowed us to study in detail the Atmospheric Rivers vertical structure and impacts

...at Escudero station

Photo credit: Penny Rowe, Edgardo Sepulveda

...at King Sejong station

Photo credit: Sang-Jong Park

...at Syowa station

Photo credit: Shogo Tanaka, Naohiko Hirasawa

...at Neumayer station

Photo credit: AWI, Polar Prediction

Photo credit: Heike Kalesse, Cristofer Jimenez

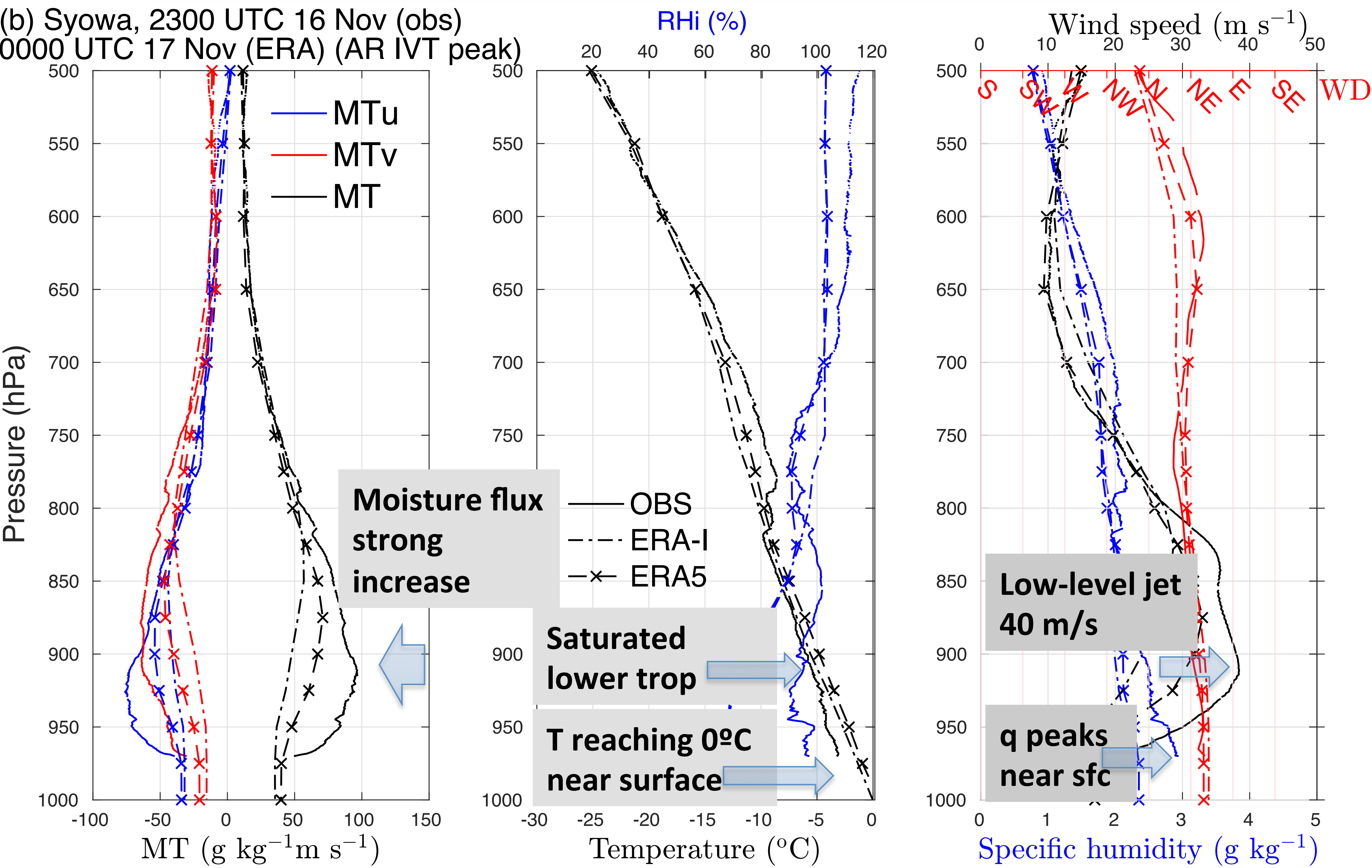
...at Punta Arenas (southern Chile)

They are accompanied by strong winds and intense snowfall... making measurements difficult or impossible

Video of radiosonde launch at Syowa. Credit: Shogo Tanaka, Japan Meteorological Agency

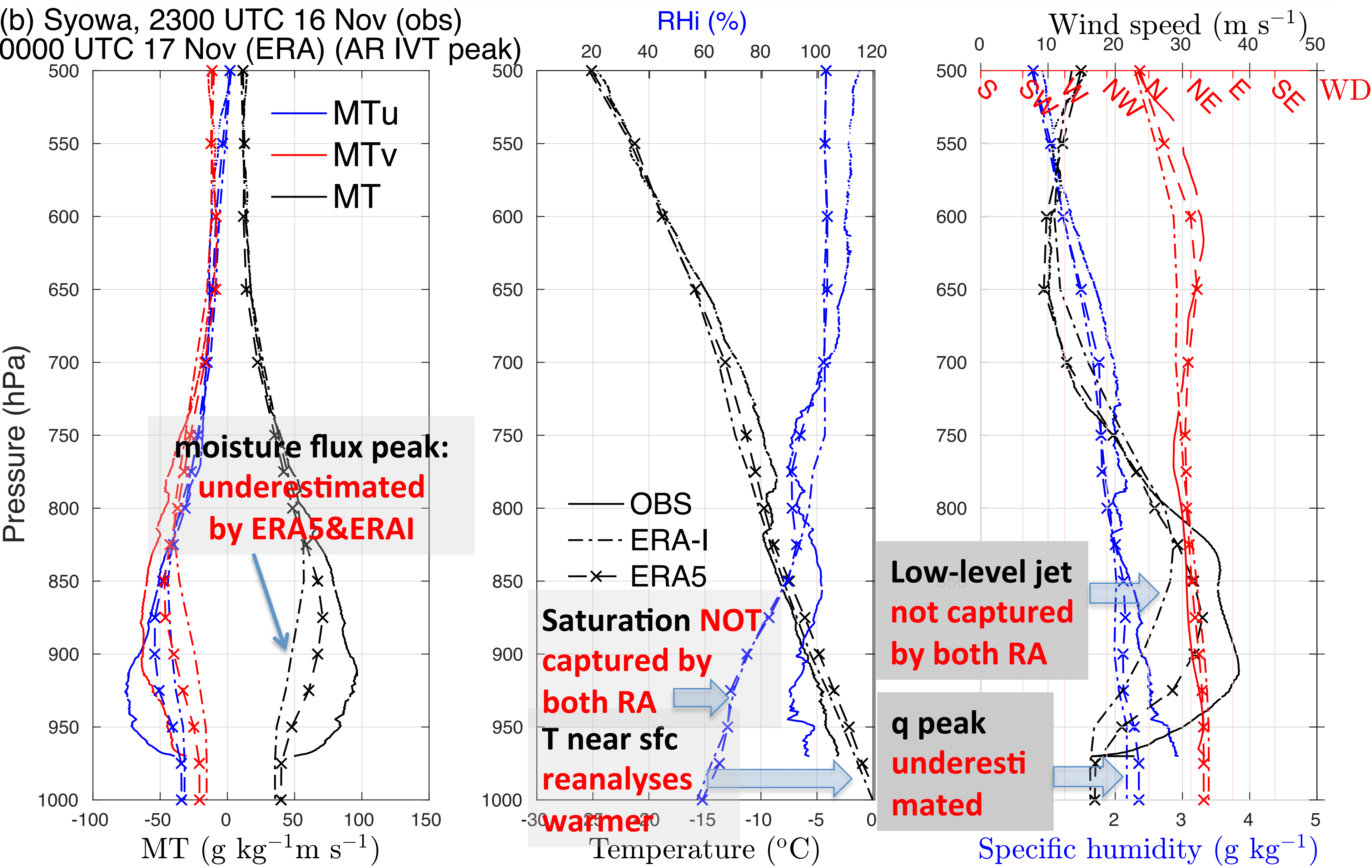
You can see the video at: https://twitter.com/IrinaGorodets/status/1257582996116340736
or https://twitter.com/polarprediction/status/1257549685415346176

AR signatures in vertical profiles at Syowa: radiosondes



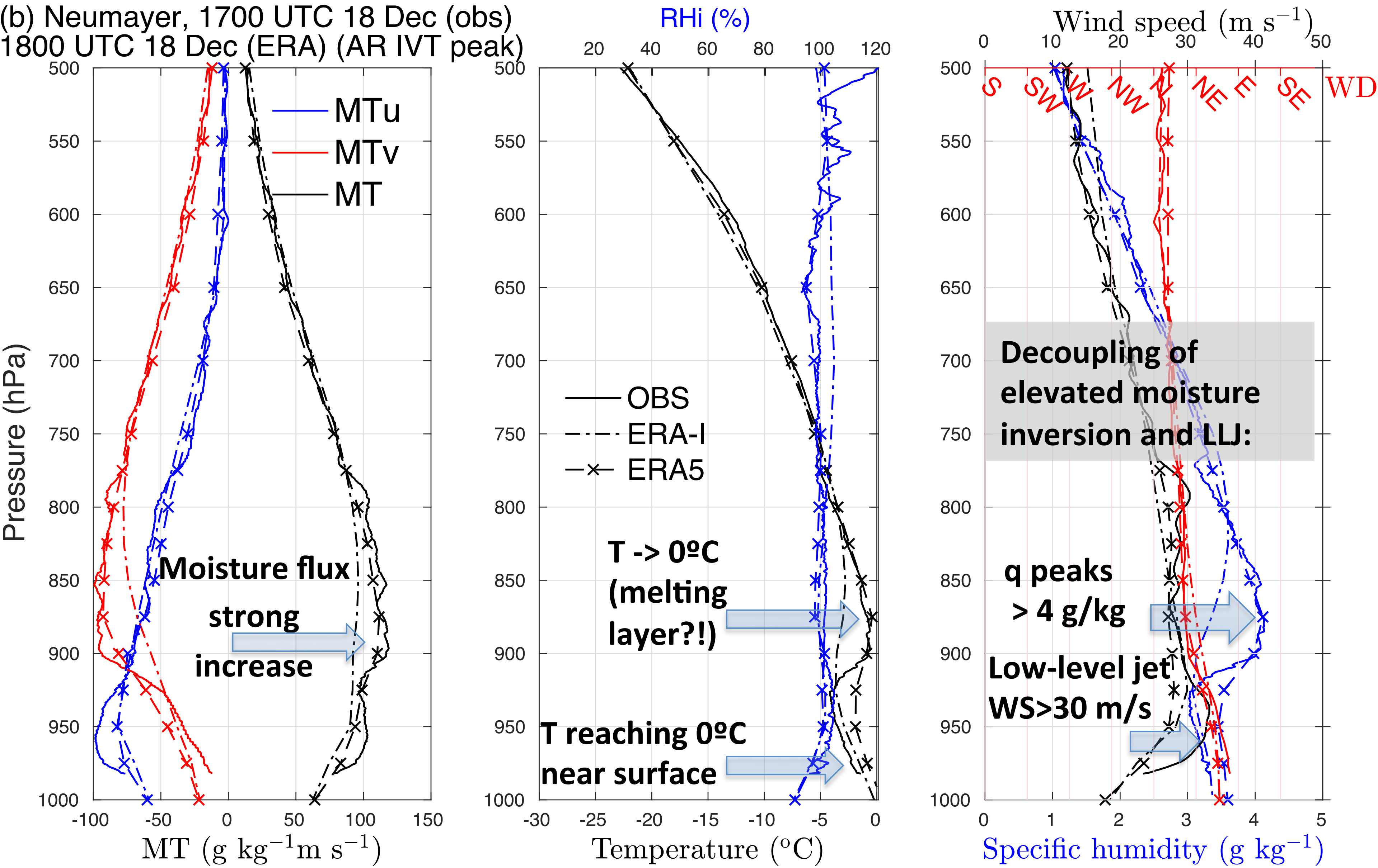
Gorodetskaya et al (2020)

AR signatures in vertical profiles at Syowa: ECMWF ReAnalyses?



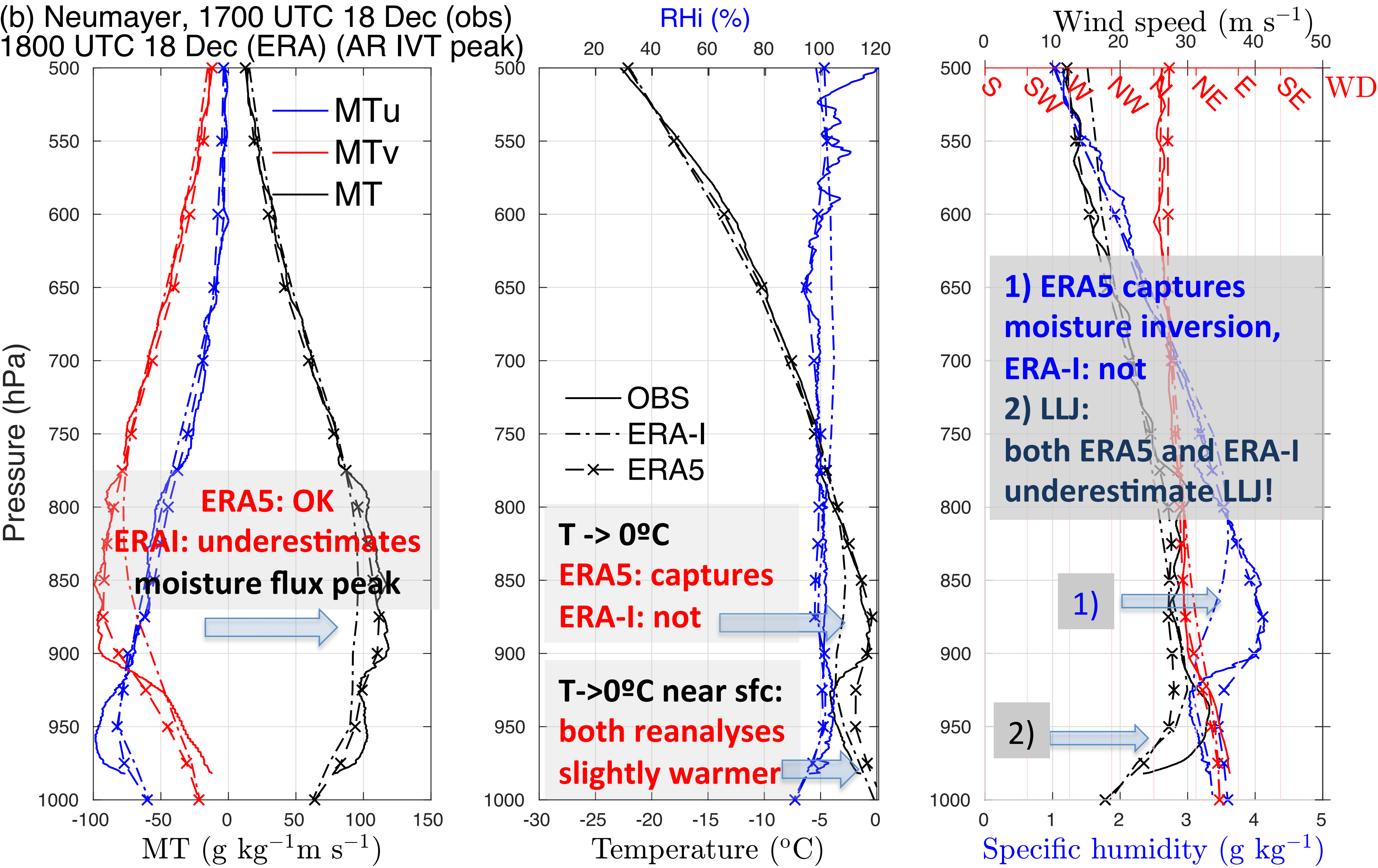
Gorodetskaya et al (2020)

AR signatures in vertical profiles at Neumayer: radiosondes



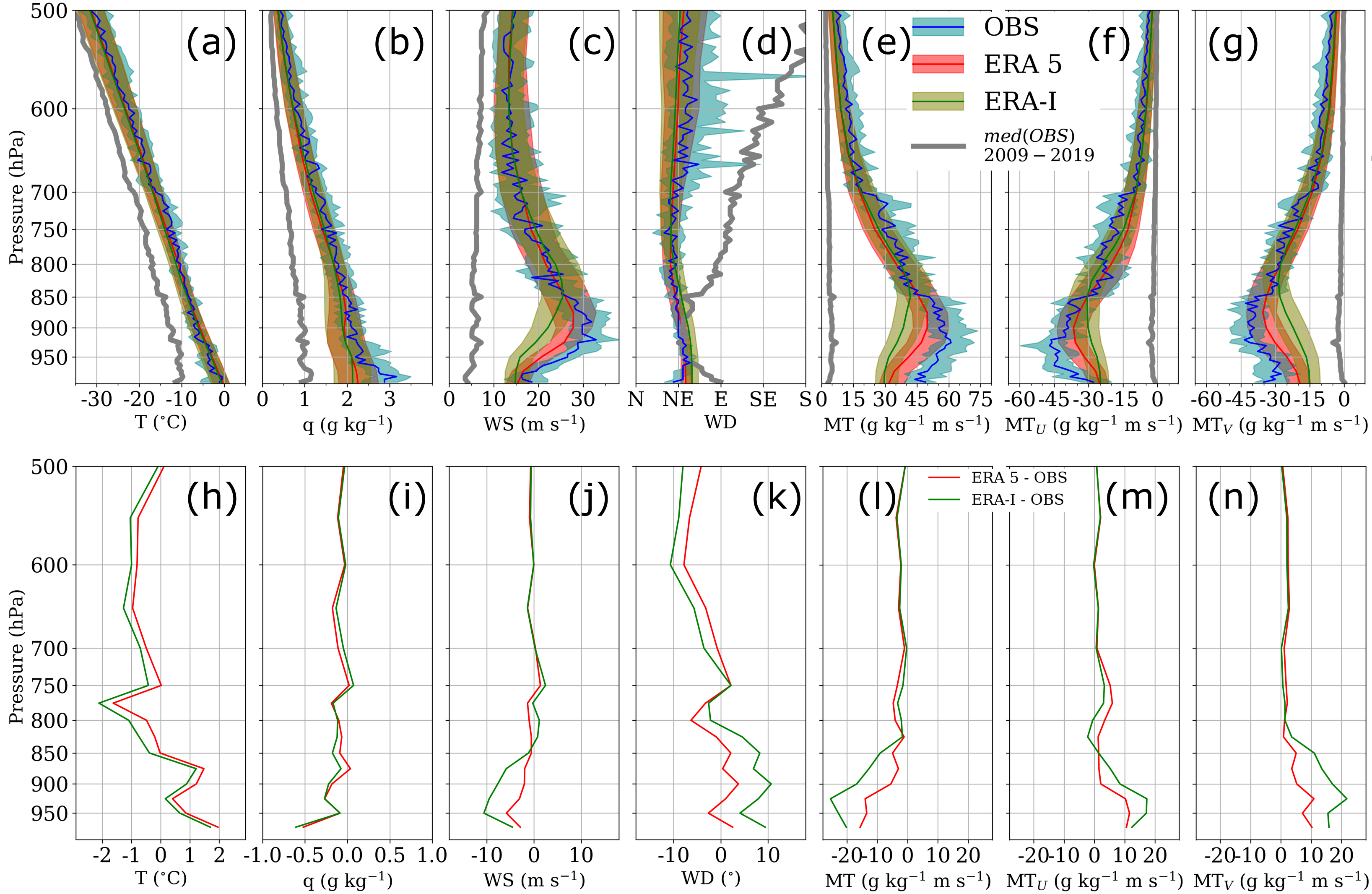
Gorodetskaya et al (2020)

AR signatures in vertical profiles @Neumayer: ECMWF ReAnalyses?



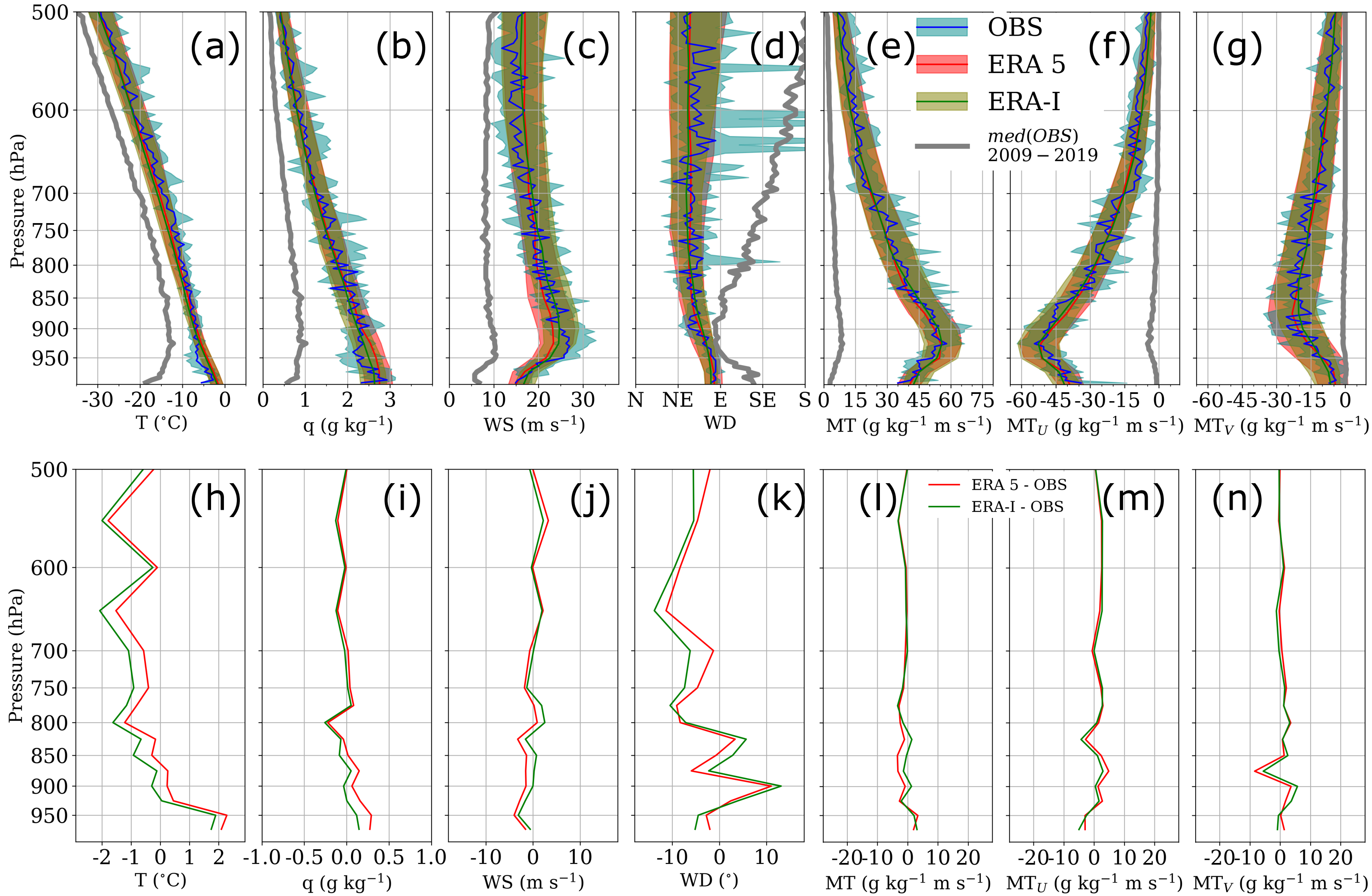
Gorodetskaya et al (2020)

Let's look at ALL enhanced moisture transport events in radiosondes and re-analyses compared to the median state during 2009-2019 at Syowa:

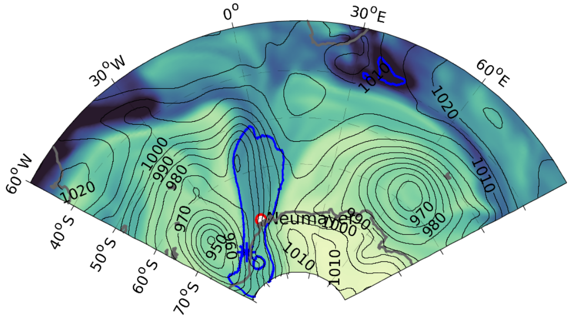


Gorodetskaya et al (2020)

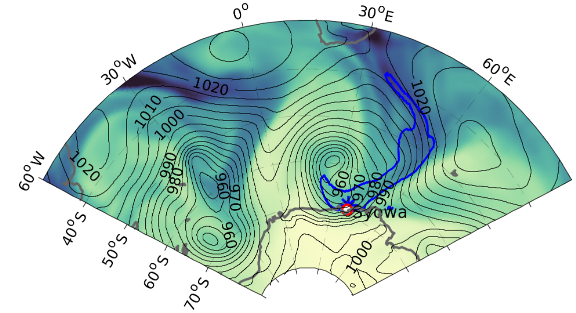
Let's look at ALL enhanced moisture transport events in radiosondes and re-analyses compared to the median state during 2009-2019 at Neumayer:



Gorodetskaya et al (2020)



Key conclusions from AR study at Neumayer and Syowa:



- **Atmospheric river signatures show an extreme state of the lower troposphere** at the East Antarctic coast as shown by radiosonde observations and reanalysis data

- **Enhanced moisture transport** is driven by the low-level jet and humidity maximum, which show decoupling at the Antarctic coast

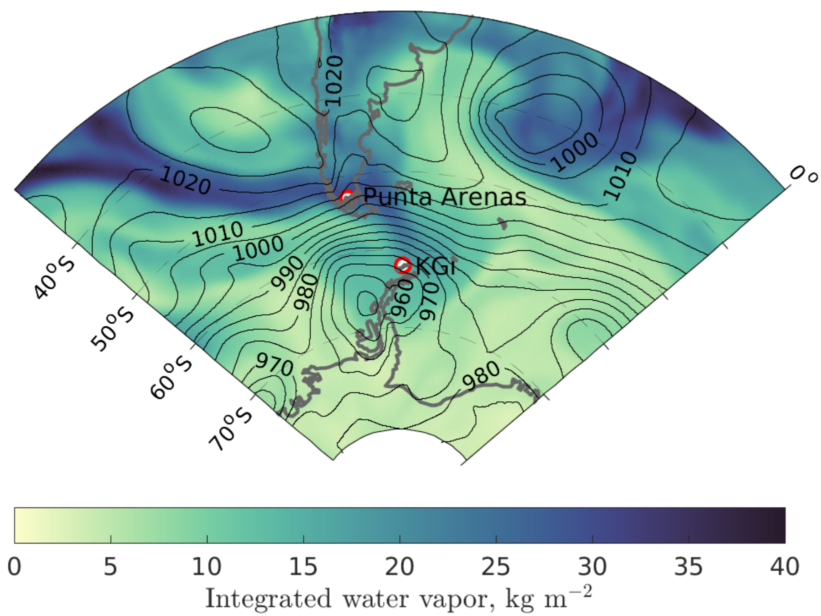
- **ERA5 shows improved representation of ARs vertical structure** compared to ERA-Interim at Neumayer, while **both reanalyses underestimate** atmospheric-river moisture transport at Syowa (strong underestimation of both LLJ and moisture increase)

More details in Gorodetskaya et al (2020)

AR affecting Punta Arenas (southern Chile) *and* King George Island (KGI, north of Antarctic Peninsula)

- Strong increase in integrated water vapor measured at Punta Arenas (MW radiometer) and KGI (radiosondes)
- Cloud liquid water path peaks at Punta Arenas
- Thick low-level liquid-containing clouds at KGI
- Strong cloud radiative forcing at both Punta Arenas and at Escudero station (KGI) (next slide)

6 Dec 2018, 18UTC



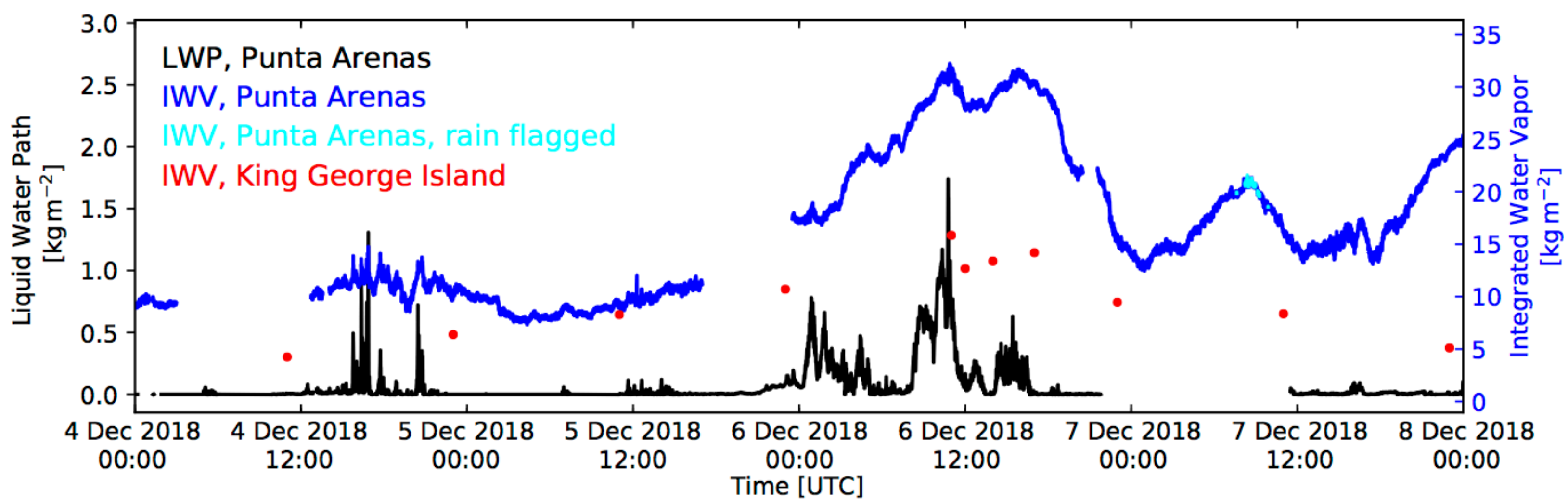
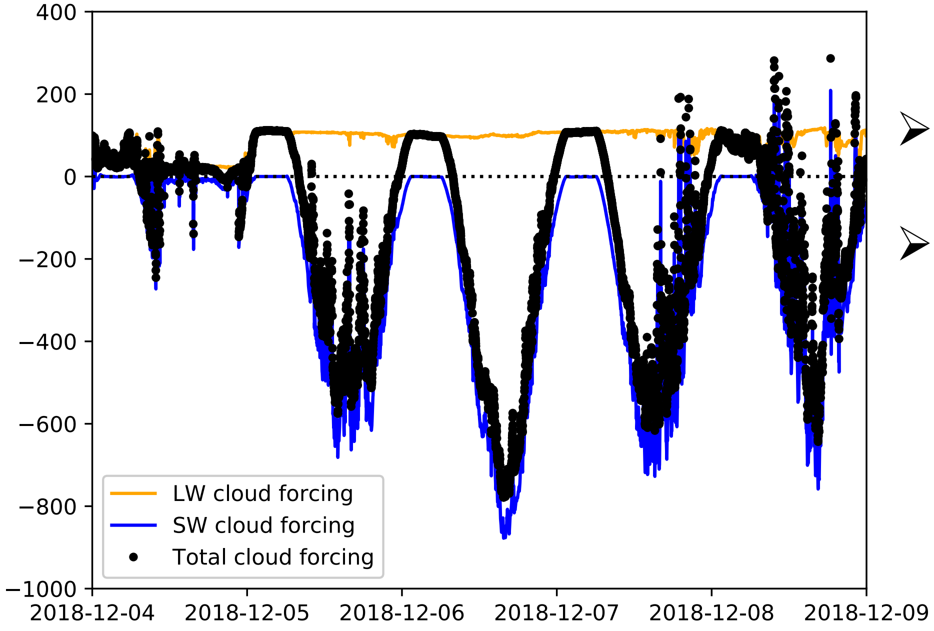


Fig. 11/section 5 by Gorodetskaya et al contribution to Bromwich et al 2020

AR affecting southern Chile and north of Antarctic Peninsula 5-7 Dec 2018

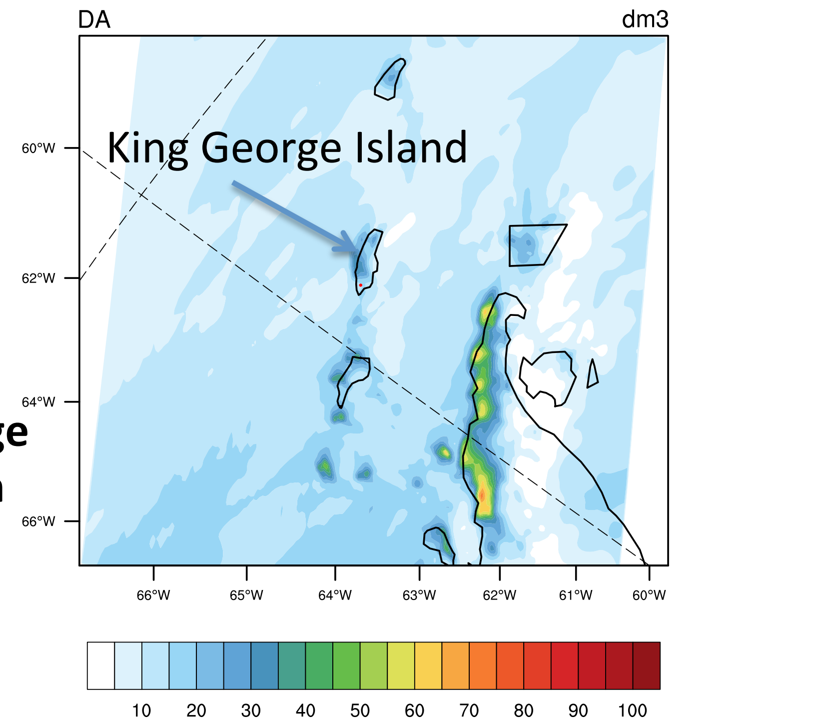


- Persistent thick low-level liquid-containing clouds observed at Escudero
- Cloud forcing:

  Night: warming the surface

  Day: cooling the surface >> warming

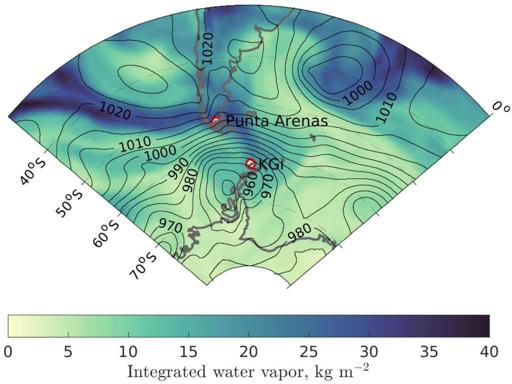
Accumulated Rain (mm) from 2018120512 to 2018120812



- Precipitation by Polar WRF with YOPP measurements data assimilation experiment
- Moderate increase of precipitation at King George Island and orographically enhanced precipitation in the western Antarctic Peninsula

Fig. 11/section 5 by Gorodetskaya et al contribution to Bromwich et al 2020

Key conclusions from AR case affecting southern Chile and Antarctic Peninsula:



- On the **Antarctic Peninsula**, the surface mass balance can be especially sensitive to AR events during summer, when **surface temperatures vary around zero** and frequent **transitions occur between snow and rainfall**

- High precipitable water, presence of liquid-containing clouds and only light rainfall observed at Punta Arenas during AR**: the lack of moisture loss via precipitation over southern Chile** allowed the enhanced IWV to reach and strongly affect Antarctic Peninsula weather and surface radiation

- **Transition from snowfall to rain and mixed-phase precipitation** during the AR event

- **AR conditions** (strong wind, low clouds, precipitation) have important consequences for air, ship and station operations around the Antarctic Peninsula but **forecast is challenging**: **improved rainfall and wind using YOPP data-assimilated experiments** with Polar WRF

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***in bold: authors working on AR section 5 (Fig. 11)**

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Thank you!
Questions? Comments?
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