

## Evidence & theories linking Arctic Amplification to prolonged and/or extreme weather in mid-latitudes such as UK (and USA)

**Could UK winters be more severe and drier (and maybe summers wetter?) - as implicated by recent theory? rather than the hotter drier summers and milder wetter winters as predicted by the Met Office Hadley Centre, with the aid of their computer modelling (their reports [refs/links appended here] were last updated circa Spring 2012):**

One interesting recent theory is that our UK weather is affected by arctic amplification via the arctic's effect on the jetstream:

**AA Arctic Amplification** (Arctic temp risen roughly twice as fast as global average as a result of positive feedback warming in arctic due to reducing albedo when reflective ice melts to reveal dark absorptive water) → arctic sea, then arctic air, both warmer than they used to be → reduces temperature gradient between arctic and mid-latitude air masses, and (because warm air is of lower density than cold air) thus also reduces the height-gradient of the top of the atmosphere, between arctic and mid-latitude air masses → [because the steepness of these gradients powers strength of jetstream (and its location)] → slows jetstream so it meanders more (increased Rossby Wave amplitude) and loops extend Southwards → these loops can get stuck (& with e.g. 'blocking highs' from high pressure zones to North of jetstream) leading to persistent weather conditions → extremes eg drought, cold dry winters or flooding (depending on location of loop etc). Because arctic sea is most exposed circa September these effects are considered likely to be greater over subsequent months.

This is one of the first papers I heard of re this explanation:

'Evidence linking Arctic amplification to extreme weather in mid-latitudes' - Jennifer Francis & Stephen Vavrus <http://www.agu.org/pubs/crossref/2012/2012GL051000.shtml> Article first published online: 17 MAR 2012  
And her videos (links below) help explain the mechanisms I've attempted to summarize above.

But NB this is just one mechanism at play, and other natural processes add variability eg Arctic Oscillations etc

**Links to relevant articles (in chronological order, more recent at the top):**

**Videos: Jennifer Francis** 'Explains How Loss Of Arctic Ice Weakens Jet Stream, Amplifies Extreme Weather' - ThinkProgress 16apr13 <http://thinkprogress.org/climate/2013/04/16/1867371/video-explains-how-loss-of-arctic-ice-weakens-jet-stream-amplifies-extreme-weather/>

Yes, Climate Change Is Worsening U.S. Drought -- NOAA Report Needlessly Confuses The Issue ThinkProgress 12apr13 - Joe Romm and Dr Kevin Trenberth criticizing report by Martin Hoerling: [http://feedproxy.google.com/~r/climateprogress/ICrX/~3/pW4O\\_ljmjZU/story01.htm?utm\\_source=feedburner&utm\\_medium=email](http://feedproxy.google.com/~r/climateprogress/ICrX/~3/pW4O_ljmjZU/story01.htm?utm_source=feedburner&utm_medium=email)

'Met Office investigating Arctic link to record low temperatures in UK' - ITV News 10apr13

<http://www.itv.com/news/2013-04-10/met-office-investigating-arctic-link-in-record-low-temperatures/>

Includes interviews with e.g. Dr Julia Slingo of UK Met. Office, Dr Jennifer Francis - contributor to recent papers on recent theory above. Dr Julia Slingo reckons prolonged dry cold periods in winters support a connection with the warming arctic but she's not as yet convinced re wet summers having this connection [< I've poorly expressed this]. I hate the way Lawrence McGinty introduces subject by saying "arctic a dreadful place" - otherwise article good. At 2:16 in his video he describes effect of AA on jetstream and our UK weather. Also see - twitter conversation with Met Office's Richard Betts - appended below>>>

Re weather March 2013 (cold in UK): Climate Change News - 'Warm Arctic, chilly mid-latitudes' 4apr13 <http://climate.nasa.gov/news/894> Shows **Arctic Oscillation AO** [c.16day wavelength] and map of world temp

anomalies in mid-March. Refs incl <http://www.climatecentral.org/news/from-heat-wave-to-snowstorms-March-weather-goes-to-extremes-15763> interesting discussion headed 'Arctic climate change fingerprints?' "Recent research suggests that rapid Arctic climate change, namely the loss of sea ice cover, may be contributing to blocking patterns like we're seeing right now. ..." but it's not simple: This in turn refers to: A Closer Look at Arctic Sea Ice Melt and Extreme Weather Climate Central 19sep12 <http://www.climatecentral.org/blogs/closer-look-at-arctic-sea-ice-melt-and-extreme-weather-15013> - Andrew Freedman discusses AA and AO etc and says that there are a number of mechanisms/factors of variable influence i.e. more complex than just one explanation - natural variability [- so beware of predicting that one factor/mechanism will in future be over-riding].

Scientists link frozen spring to dramatic Arctic sea ice loss Environment guardian.co.uk John Vidal 25mar13 <http://www.guardian.co.uk/environment/2013/mar/25/frozen-spring-arctic-sea-ice-loss>

Phil England @ClimateRadio4h Yesterday's @guardianeco @john\_vidal story on link between UK's harsh winter & Arctic melt touched on in our Jan show [bit.ly/11GWN89](http://bit.ly/11GWN89) <http://climateradio.org/an-arctic-wake-up-call/> 'Scientists link frozen spring to dramatic Arctic sea ice loss - Melting sea ice, exposing huge parts of the ocean to the atmosphere, explains extreme weather both hot and cold' John Vidal, Environment guardian.co.uk 25mar13 [http://www.guardian.co.uk/environment/2013/mar/25/frozen-spring-arctic-sea-ice-loss?CMP=tw\\_tfd](http://www.guardian.co.uk/environment/2013/mar/25/frozen-spring-arctic-sea-ice-loss?CMP=tw_tfd) Five reasons why the speed of Arctic sea ice loss matters Carbon Brief 22mar13 - vg summary of its impacts & implications <http://www.carbonbrief.org/blog/2013/03/climate-impacts-of-nearly-ice-free-arctic-summers>

**NEW:** 'Cold winter extremes in northern continents linked to Arctic sea ice loss' Qihong Tang<sup>1</sup>, Xuejun Zhang<sup>1,2</sup>, Xiaohua Yang<sup>2</sup> and Jennifer A Francis<sup>3</sup> - Abstract - Environmental Research Letters - IOPscience Published 12mar13 <http://iopscience.iop.org/1748-9326/8/1/014036>

NOAA Bombshell Warming-Driven Arctic Ice Loss Is Boosting Chance of Extreme U.S. Weather ThinkProgress by Joe Romm 11oct12 <http://thinkprogress.org/climate/2012/10/11/989231/noaa-bombshell-warming-driven-arctic-ice-loss-is-boosting-chance-of-extreme-us-weather/>

Global warming could make washout UK summers the norm, study warns Environment guardian.co.uk 10oct12 [http://www.guardian.co.uk/environment/2012/oct/10/global-warming-washout-summer?CMP=tw\\_tgu](http://www.guardian.co.uk/environment/2012/oct/10/global-warming-washout-summer?CMP=tw_tgu) Scientists from the Universities of Sheffield in the UK and Rutgers and Washington in the US & NOAA Edward Hanna, co-author of the study at Sheffield University

The recent shift in early summer Arctic atmospheric circulation - Overland - 2012 - Geophysical Research Letters - Wiley Online Library James E. Overland<sup>1\*</sup>, Jennifer A. Francis<sup>2</sup>, Edward Hanna<sup>3</sup>, Muyin Wang<sup>4</sup> Article first published online: 10 OCT 2012 <http://onlinelibrary.wiley.com/doi/10.1029/2012GL053268/abstract>

Arctic sea ice melt 'may bring harsh winter to Europe' guardian.co.uk 14sep12 re work by Jennifer Francis Rutgers Uni. <http://www.guardian.co.uk/environment/2012/sep/14/arctic-sea-ice-harsh-winter-europe?intcmp=239>

Arctic Warming is Altering Weather Patterns, Study Shows Climate Central 30aug12 [re Francis & Vavrus paper] <http://www.climatecentral.org/news/arctic-warming-is-altering-weather-patterns-study-shows>

The melting north 16jun12 The Economist The Arctic is warming twice as fast as the rest of the planet, says James Astill. The retreating ice offers access to precious minerals and new sea lanes—but also carries grave dangers <http://www.economist.com/node/21556798>

BBC News - Arctic sea ice reaches record low, Nasa says 27aug12 Roger Harrabin <http://www.bbc.co.uk/news/science-environment-19393075> incl re Reading Uni on 5-30% due to AMO Atlantic Multi-decadal Oscillation (65-80yrs): Melting Arctic sea ice how much is down to us 26jul12 <http://www.reading.ac.uk/news-and-events/releases/PR457684.aspx>

Why The Arctic Sea Ice Death Spiral Matters ThinkProgress <http://thinkprogress.org/climate/2012/08/26/745571/why-the-arctic-sea-ice-death-spiral-matters/>

Arctic Warming is Altering Weather Patterns, Study Shows Climate Central 30sep12 & apr12 <http://www.climatecentral.org/news/arctic-warming-is-altering-weather-patterns-study-shows/>

Declining sea ice - Met Office - updated 30aug12 (esp. see last paragraph) <http://www.metoffice.gov.uk/research/news/sea-ice> via Gwen Harrison

BBC News - Arctic sea ice set to hit record low - Mark Kinver 21aug12 <http://www.bbc.co.uk/news/science-environment-19330307> AND Arctic sea ice levels to reach record low within days Environment The Guardian John Vidal 23aug12 <http://www.guardian.co.uk/environment/2012/aug/23/arctic-sea-ice-record-low>

Funny weather we're having... how the melting Arctic is affecting global weather patterns in a sinister way Campaign against Climate Change 5aug12 <http://www.campaigncc.org/node/1259> jetstream Arctic Amplification Global Warming, Arctic Amplification and Extreme Weather MeteoKlima <http://meteoklima.wordpress.com/2012/04/19/global-warming-arctic-amplification-and-extreme-weather/>

Jennifer A. Francis and Stephen J. Vavrus, 2012. Evidence linking Arctic amplification to extreme weather in mid-latitudes. Geophysical Research Letters, Vol. 39, L06801, doi:10.1029/2012GL051000 <http://www.agu.org/pubs/crossref/2012/2012GL051000.shtml>

\*The melting north [v readable] The Economist 16jun12 <http://www.economist.com/node/21556798> "Since 1951 it [the Arctic] has warmed *roughly twice as much* as the global average. In that period the temperature in Greenland has gone up by 1.5°C, compared with around 0.7°C globally." Arctic Amplification albedo effect

\*\*\* 'Evidence linking Arctic amplification to extreme weather in mid-latitudes' - Jennifer Francis & Stephen Vavrus <http://www.agu.org/pubs/crossref/2012/2012GL051000.shtml> Article first published online: 17 MAR 2012

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### **Previous UK climate/weather predictions - which appear now to be inconsistent with the recent theories above.**

With thanks to Gwen Harrison for providing me these refs / links

**Hotter drier summers and milder wetter winters** are predicted for the mid 2020s in a Medium emissions scenario in the following web-page: <http://ukclimateprojections.defra.gov.uk/22198> - based on Met Office (Hadley Centre) studies using climate science and computer modelling etc.

UK CLIMATE PROJECTIONS: <http://ukclimateprojections.defra.gov.uk/22198> - via Gwen Harrison - thanks Gwen! NW CCRA pdf: [A Summary of Climate Change Risks for North West England](http://climatechangenorthwest.co.uk/sites/default/files/00112a%20CCRA%20NW%20Pack.pdf) - via Gwen Harrison - link: <http://climatechangenorthwest.co.uk/sites/default/files/00112a%20CCRA%20NW%20Pack.pdf>

Adapting to climate change - Policies - Inside Government - GOV.UK 9apr13

<https://www.gov.uk/government/policies/adapting-to-climate-change> links to:

UK CCRA: UK climate change risk assessment Government report - Publications - Inside Government - GOV.UK 26jan12 <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report>

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April 2013 on twitter Met Office's Richard Betts is questioned on his view of new theory:



The screenshot shows a Twitter thread with four tweets. The first tweet is from John Russell (@JohnRussell40) posted 36 minutes ago, mentioning a news report on Arctic ice and its link to weather, with a link to itv.com/news/2013-04-1... and the hashtag #Climate. The second tweet is from Andy Revkin (@Revkin) posted 28 minutes ago, questioning the link between Arctic ice and cold UK weather, mentioning @richardabetts. The third tweet is from John Russell (@JohnRussell40) posted 17 minutes ago, discussing the meandering jetstream and its effects on UK weather (cold, warmth, drought, flooding) and its link to AGW, also mentioning @richardabetts. The fourth tweet is from Richard Betts (@richardabetts) posted 12 minutes ago, responding to the conversation and mentioning an jury still out on the effects of Arctic sea ice.